EARTHQUAKE ALASKA—ARE WE PREPARED?

Proceedings of a conference on the status of knowledge and
preparedness for earthquake hazards in Alaska
November 19-20, 1992
Anchorage, Alaska

U.S. Geological Survey
Open-File Report 94-218

Published in cooperation with
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EARTHQUAKE ALASKA—ARE WE PREPARED?

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Prepared in cooperation with
ALASKA DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS

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Front Cover: *View of Anchorage looking east soon after the great Alaska earthquake of March 27, 1964. Many homes in the Turnagain heights subdivision were destroyed by a massive earthquake-induced landslide (foreground). U.S. Army Corps of Engineers photograph, courtesy of Alaska Earthquake Photograph Archive, University of Alaska (archive no. TRN-35).*

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INTRODUCTION

by
Roger Head
Conference Chair
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A conference entitled "Earthquake Alaska-Are We Prepared?" was held in Anchorage, Alaska on November 19 and 20, 1992. Earthquake Alaska was a new concept in public education of the short- and long-term hazards associated with seismic activity in urban centers. The conference focused on the similarities of two "sister communities," one of which had experienced recent devastating impacts from a recent earthquake. The experiences over a wide range of community infrastructure were presented by numerous local professionals. Bringing the experiences of one community to another and comparing the attitudes and plans of the professionals provide a much more realistic and often surprising perspective of the multitude of problems the second community might face if a similar event strikes.

The conference was held in Anchorage, a community well aware of earthquake hazards. In 1964 one of the largest recorded earthquakes struck southcentral Alaska, causing several hundred millions of dollars of damage. Since then, Anchorage has been shaken by literally hundreds of smaller earthquakes, none of which have caused significant damage.

Anchorage is a modern and relatively young community. It was not settled until 1917 and experienced little growth until World War II. Most new structures comply with the seismic requirements of the Uniform Building Code. The need for sturdy construction dictated by a colder climate, together with the prohibitive cost of importing materials associated with seismically unsafe unreinforced masonry structures, have resulted in the construction of buildings that are relatively earthquake resistant. However, parts of Anchorage are highly susceptible to earthquake-induced ground failure. Since 1964, there has been no earthquake damage to alert the public to potential hazards.

Although the 1964 earthquake was a major blow to Anchorage, it serves as a poor illustration of the magnitude of problems the community can expect today in responding to a similar event. In 1964, Anchorage was a small community with a resident population of about 35,000. The biggest industry was the military, supporting both Elmendorf Air Force Base and Fort Richardson Army Base. Anchorage considered itself a pioneer community. Most residents were relatively self sufficient, using on-site fuel oil or wood for heating and were always prepared for power outages that occurred on a regular basis. Only a small part of the community had public sewer and water. Most residents had on-site wells and septic tanks. Today Anchorage is a quite different community. The population has grown to 250,000 and the city has an urban horizon of high-rise buildings. The modernization of Anchorage has eliminated the self-sufficient systems so prevalent in 1964. The community depends on public lifelines: natural gas, electricity, public sewer and water, and freeways complete with grade-separated interchanges. For these and other reasons, Anchorage was perhaps better prepared in 1964 than now for the impacts of a destructive earthquake.

The Earthquake Alaska conference compared Anchorage to Santa Cruz County, California and, in particular, the cities of Santa Cruz and Watsonville during and after the 1989 Loma Prieta earthquake. Although these communities are distinctly different geographically, they have many disaster-related commonalities. The population in Santa Cruz County is about 250,000, and is composed of a mix of urban and rural community life styles. The City of Santa Cruz is largely composed of a middle- to upper middle-class population with an above-average education level. It is the location of the University of California, Santa Cruz. Anchorage has very similar sociologic makeup and is the center for the University of Alaska, Anchorage.

Santa Cruz is considered remote by California standards. In fact, its single-road access across the Santa Cruz Mountains was a key factor in the delay in deployment of state and national assistance after the Loma Prieta earthquake. Anchorage is isolated from rapid major outside assistance. While the type of isolation is different, the response delay in an emergency is similar.

Earthquake Alaska was conducted in four half-day sessions. Session 1 established the earthquake-hazard setting in both geographic regions. This session provided a basis for comparison of the similarities and differences in the seismic environment and hazards of the two regions. Session 2 reviewed the disaster response following the Loma Prieta earthquake. Anchorage-area speakers presented the plans that have been developed to address first-response issues in Anchorage. Session 3 addressed the issues Santa Cruz dealt with in the long-term recovery phase of the Loma Prieta earthquake. In this session local speakers discussed the economic factors that are likely to occur in an Anchorage disaster. The final session reviewed the community-planning issues that have taken place in Santa Cruz County and economic consequences that have permanently changed the community infrastructure. Local speakers addressed public issues that are being considered because of the increasing knowledge of the nature of seismic activity in the Anchorage region.

This proceedings volume consists of transcripts of the presentations recorded at the Earthquake Alaska conference. The authors had the opportunity to revise their transcripts and to include figures if they so desired. All reports were lightly edited to provide consistency in terminology, capitalization, and punctuation, but to retain the style and flavor of the spoken presentations. We hope this proves to be an effective format for conveying the results of this informative and stimulating conference.

ACKNOWLEDGMENTS

Funding for this conference was provided by the U.S. Geological Survey (USGS) through USGS grant 14-08-0001-G1949 to the Alaska Division of Geological & Geophysical Surveys (ADGGS) and by the Federal Emergency Management Agency (FEMA) through the Alaska Division of Emergency Services (ADES). We thank the Municipality of Anchorage for providing an excellent meeting room in Loussac Library and the Earthquake Engineering Research Institute, Alaska Chapter, for assisting with meeting registration and providing refreshments. Roberta Carney, ADES, assisted with meeting logistics and organized an earthquake-awareness poster session in the Anchorage schools in conjunction with the conference. The high response to this poster session substantially increased public visibility of the conference. We are also grateful to Jaci LeDoux, Alaska Department of Transportation and Public Facilities, for providing many hours of administrative support and organizing postconference revision of speakers' transcripts for this proceedings volume. Thanks also to Julie Hart for copy editing and to Joni Robinson for final revisions, layout, and cover design.

SETTING THE SCENE

HISTORIC SEISMICITY IN ALASKA

by
Charlotte Rowe
Deputy State Seismologist
Geophysical Institute
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John Davies and I are going to give you a brief overview of Alaska's earthquakes, the earthquake potential, and the sources. We're not going to get too detailed or too technical; we just want to give you a general introduction to what we're dealing with in terms of seismic hazards in Alaska.

I would like to begin by stating that earthquakes occur worldwide and they are produced as a result of the moving crustal plates on the earth's surface. There are many active seismic zones around the world. Alaska is part of one of the most seismically active areas—the boundary between the Pacific and North American plates.

Figure 1 is a map of large earthquakes in Alaska. The dots in this picture represent the epicenters for earthquakes of magnitude 7 and larger that have occurred in Alaska since the turn of the century. There are about 85 earthquakes that you can see in this figure. Most of them, as

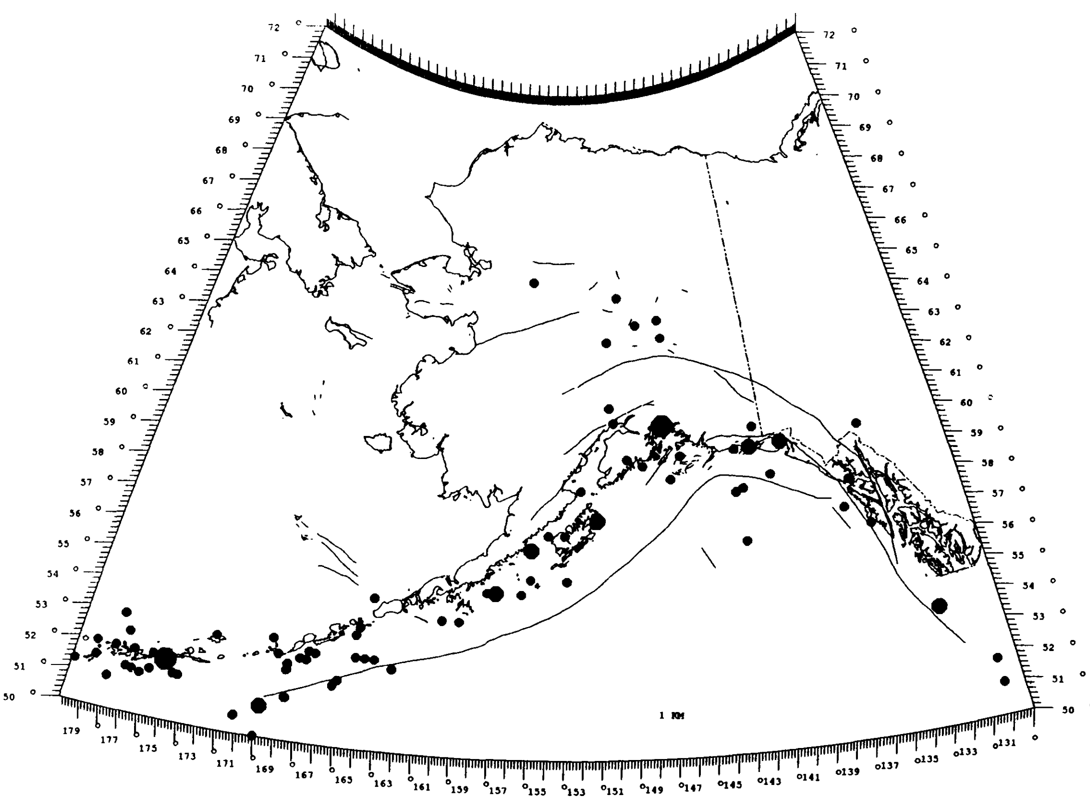


Figure 1. *Earthquakes of magnitude 7.0 and larger in Alaska, 1899 to 1988. The three sizes of dots represent earthquakes of magnitudes 7-8, 8-9, and above 9, respectively. Lines indicate faults.*

you'll notice, are in the Anchorage, Cook Inlet, Alaska Peninsula, and Aleutian areas. In fact, 75 percent of the seismicity in Alaska occurs in this region. About 15 percent of the seismicity occurs in southeast Alaska, and in the Interior we get about 10 percent of the state's earthquakes. At the Alaska Earthquake Information Center we typically will record 80 to 120 earthquakes per week in Alaska with magnitudes of 1.0 and greater. Because our network does not cover the Alaska Peninsula and Aleutian Islands as densely as it does the central part of the state, we are unable to locate earthquakes smaller than about 4.0 all along this active plate margin. Thus it is safe to say that the number of earthquakes occurring there is easily twice what we report.

Figure 2 is another map showing a number of things. The sausage-shaped areas represent the rupture zones, or the areas which failed, in different earthquakes. Also shown are the years in which the earthquakes occurred.

The size of the rupture zone is roughly proportional to the magnitude of the earthquake. So, the bigger the earthquake, the more area that's going to rupture.

The blank segment in figure 2 represents what we call a seismic gap. A seismic gap is a region which does not appear to have ruptured recently. Therefore, there is the potential for a great deal of stress to have been built up in the area as a result of the shifting plates of the earth's crust. The stress has been relieved on either side of the gap, where there <u>have</u> been large earthquakes, but nothing appears to have happened within the gap itself.

There are a number of different interpretations for what may be going on at seismic gaps. It could be that the region within the gap is relieving stress quietly. Or it could be that stress is building up, and that we should be concerned about the likelihood of a significant earthquake occurring in the gap sometime soon.

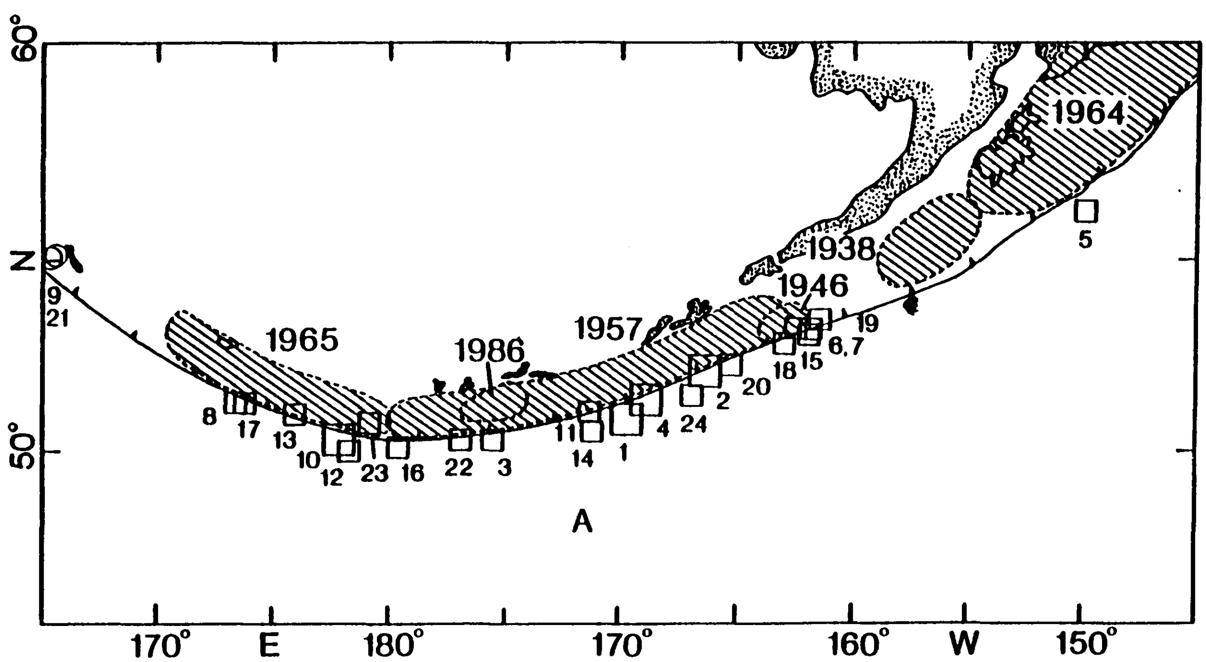


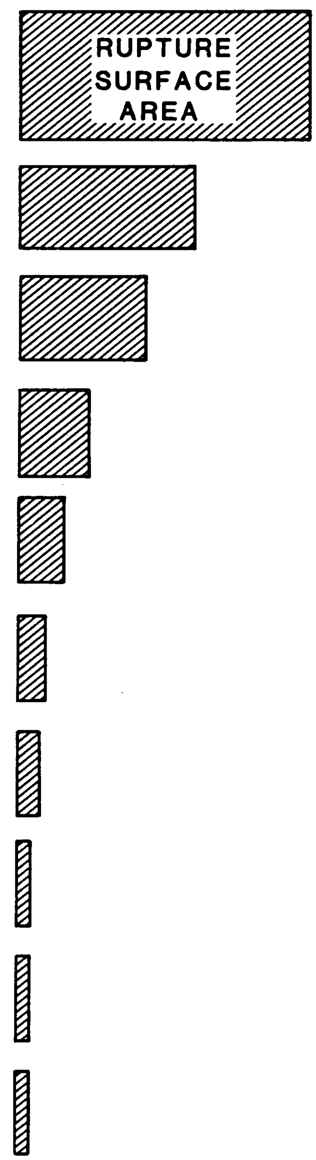
Figure 2. *Rupture zones of large underthrusting earthquakes (hachured areas) with year of occurrence indicated. Small boxes represent subsequent small earthquakes. Note that the rupture zone of the 1986 earthquake (Mw=7.9) is superimposed on the rupture zone for the 1957 event (Mw=9.1). The epicenters of these two events, separated by only 29 years, were in nearly the same location. Modified from McCann and others (1979, fig. 5).*

Some of the different rupture zones shown in figure 2 represent significant earthquakes, which I will discuss. But first a few statistics. We came up with a list of the top 10 earthquakes in the world, in terms of magnitude, which have occurred since the turn of the century. Alaska has had three of these, as illustrated in figure 3.

The second largest earthquake in this century, with a moment magnitude (Mw) of 9.2, was the 1964 Good Friday earthquake. You're going to be hearing a lot about that one today. In 1957,

TOP TEN QUAKES IN THE WORLD 1904-1984

No.	Location	Year	Mw	Energy*
1.	CHILE	1960	9.5	2000
2.	ALASKA	1964	9.2	820
3.	ALASKA	1957	9.1	585
4.	KAMCHATKA	1952	9.0	350
5.	ECUADOR	1906	8.8	204
6.	ALASKA	1965	8.7	125
7.	ASSAM	1950	8.6	100
8.	BANDA SEA	1938	8.5	70
9.	CHILE	1922	8.5	69
10.	KURILES	1963	8.5	67



*Energy in dyne-cm $\times 10^{27}$

Figure 3. *Largest earthquakes in the world since 1904. Note that Alaska is included three times among the top 10. Rupture surface area is indicated proportionately for each event.*

there was an earthquake of magnitude 9.1 in the Andreanof Islands. Then, in 1965, very far out in the Aleutians (Rat Islands) an earthquake of magnitude 8.7 occurred which, if we hadn't had instruments, could have gone nearly unnoticed. You may notice in looking at this chart that California, the part of the United States that is typically considered to be "earthquake country," does not appear. Alaska is demonstrably more seismically active than is California.

Figure 4 highlights the comparison between Alaska and California seismicity. The bar chart has a breakdown, by year, of the number of significant (magnitude 5 or greater) earthquakes in Alaska compared to California. Alaska has a significantly higher number every year. Some of this discrepancy can be accounted for by the greater extent of the plate margin contained in Alaska, but even allowing for that, Alaska would have a higher rate of activity than California. This is a result of the difference in tectonic settings, which John Davies will discuss in his talk.

I'm going to be moving on now to talk about a few particular earthquakes and their effects. The star on the map in figure 5 shows where the epicenter for the main shock of the 1964 earthquake was. The squares shown to the south and southwest represent aftershocks of magnitude 6 and larger which occurred over the course of subsequent days from the 1964 earthquake. The aftershocks define the region we consider to be the rupture zone, or the part of the plate margin (or fault) which has failed during this earthquake. This rupture zone extends about 700 kilometers southwest of the main shock. The 1964 earthquake resulted in permanent ground deformation, large tsunamis, a great deal of property damage, and loss of life, about which subsequent speakers today will elaborate.

The 1946 earthquake at Unimak Island (fig. 2) produced a tsunami which destroyed the lighthouse at Scotch Cap. If you were to go there today, all you would see would be the bare hint

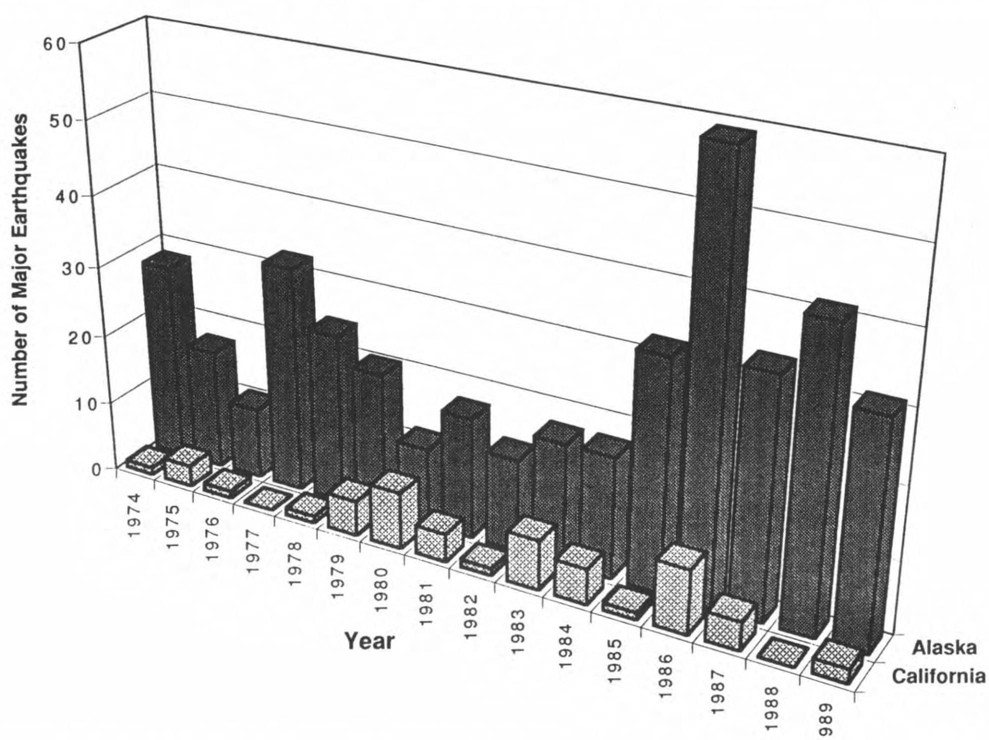


Figure 4. *A comparison of seismicity in Alaska and California. Vertical bars represent the number of events of magnitude 5.5 and larger between 1974 and 1989. Data compiled by Steve Estes.*

of the foundation of what was a 1-foot-thick, 90-foot-tall, reinforced concrete wall. The tsunami was on the order of 90 to 100 feet high. An interesting thing about this particular earthquake is that although the surface-wave magnitude was only 7.6, when the magnitude was recalculated based on estimations from the size of the tsunami, a number closer to 9.3 was arrived at for the magnitude of this earthquake. There is some speculation that part of the contribution to the water displacement that produced this wave was a submarine landslide. This may explain the difference between the instrumentally measured magnitude and the estimated "tsunami magnitude."

There was an earthquake at Lituya Bay in 1958 that produced one of the most phenomenal examples of a sea wave that has ever occurred. If you were to visit Lituya Bay today, you would see a bare rock face at the head of the bay, which is a scar from a landslide caused by the shaking of the earthquake. The landslide fell into the water and produced a wave whose amplitude—height, not run-up—was on the order of 1,500 feet. All of the trees on the hillsides were completely wiped off the slope up to a level of about 1,500 feet along the sides of the bay.

The wave actually washed over an island in the middle of the bay, taking some fishing boats over the top of the island. There are some phenomenal first-person accounts from survivors on the boats regarding their observations as this wave of water came rushing over them.

The significant thing about this earthquake, and the thing that can tie it in to some other occurrences, is that its tsunami was largely the result of a secondary effect, a landslide; it did not arise as a result of the earthquake itself. This is a very spectacular example of exactly the same thing that happened in Valdez in 1964.

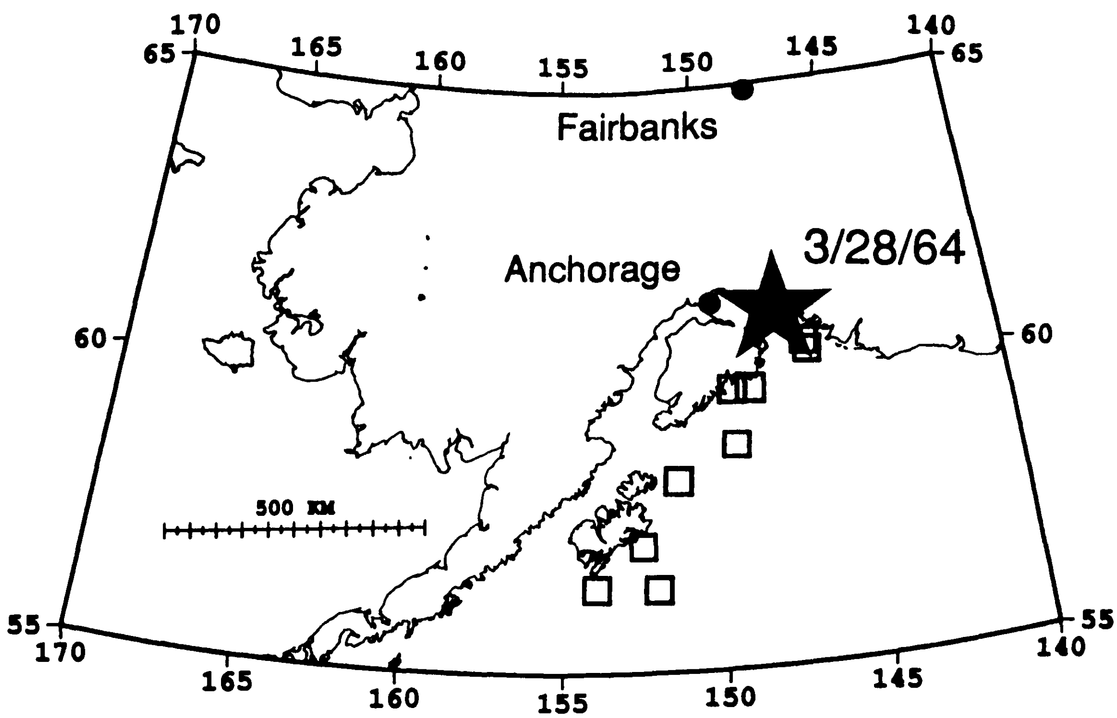


Figure 5. *Main shock and largest aftershocks of the 1964 Alaska earthquake. The main shock, represented by the large star, had a moment magnitude (Mw) of 9.2. Aftershocks of magnitude 6.0 and larger are shown by boxes. The aftershock region defines the rupture zone, which was more than 700 kilometers long.*

Please note in figure 2 the aftershock zone for the 1957 earthquake, magnitude 9.1. The 1986 Andreanoff Islands earthquake, magnitude 7.9, had its epicenter in exactly the same place. Although the aftershock zone is much smaller for the 1986 event (because it was a smaller earthquake), at magnitude 7.9 it was still a pretty hefty shock. The lesson is that we can't simply assume that because there has been a large earthquake in a particular area we don't have the potential for another large earthquake in the same place in the near future. It was only 29 years between the 1957 and the 1986 earthquakes. Anchorage should not be too complacent about its seismic risk just because the 1964 earthquake, with a magnitude very similar to that of the 1957 Andreanof Islands event, was only 29 years ago.

REFERENCE CITED

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EARTHQUAKE SOURCES IN ALASKA

by
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Geophysical Institute
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I'm going to carry this story on, in a broad-brush introductory format, to say a little bit about what the earthquake sources are and what causes the earthquakes in the Anchorage area.

We're going to start with the map in figure 1. The heavy lines on this map represent the major earthquake zones, which divide the surface of the earth into large plates. As you know, the theory of plate tectonics tells us that the surface of the earth is divided into perhaps a dozen large plates that are somewhat rigid and move relative to one another.

In this case we want to focus on the relative motion between the Pacific plate and the North American plate. And as we talk about things here, we'll assume that the North American plate is fixed and that the Pacific plate is moving to the northwest relative to North America and Alaska. It's this motion that is the culprit. That's what's causing the earthquakes in the Alaska-Aleutian zone and in the Queen Charlotte-Fairweather zone along the southeastern part of Alaska. Indeed, it's the same motion of the Pacific plate relative to North America that's causing the earthquakes in California. So there's a very direct tie between the theme of this seminar and the underlying cause of the earthquakes in both California and Alaska.

We have calculated that this motion occurs at the rate of approximately 6 centimeters per year. I want to take a little digression to show just one measurement that I think rather spectacularly demonstrates that that's in fact the case, and that we can measure it on an annual basis.

This measurement, called very long baseline interferometry (VLBI), is carried out with radiotelescopes and uses radio waves that come from the most distant stellar objects, the quasars. The advantage of using these very distant objects is that you have essentially a plane wave front as the wave passes by two radiotelescopes, which span the distance you want to measure.

It turns out that by making 100 or so of these measurements you can calculate the distance between the radiotelescopes to a precision on the order of 1 centimeter. So it's the most precise geodetic measurement available to us at this time. We can measure large distances. We can, for example, have one of these antennas down in California and one, say, in Fairbanks; in fact, that's the case. We can measure this distance, some 6,000 kilometers, to an accuracy on the order of 1 centimeter. So it's a very, very precise and accurate measurement.

I want to focus on only one such measurement in this talk and that's to look at the motion of Cape Yakataga relative to North America. In figure 2 the motion of this point is plotted relative to North America. One thing that you have to realize is that Yakataga is actually still moving with the Pacific plate. So, as the Pacific plate moves to the northwest, Yakataga is also riding along on top of it. The block on which Yakataga rides is an example of a terrane, a piece of territory, that's still arriving and being plastered onto Alaska. It's a very exciting geological, geophysical situation that we're working with.

[1]Presently Alaska State Representative from Fairbanks.

The Fairweather fault is essentially the plate boundary between the Pacific plate and the North American plate. It runs between the place where this measurement is made and North America. So you can actually measure the motion of Cape Yakataga relative to North America. That's what the data in figure 3 show. They're from an experiment that NASA has run since 1984 and up through 1990 in Alaska. Each one of the ellipses in figure 3 represents the summary of a

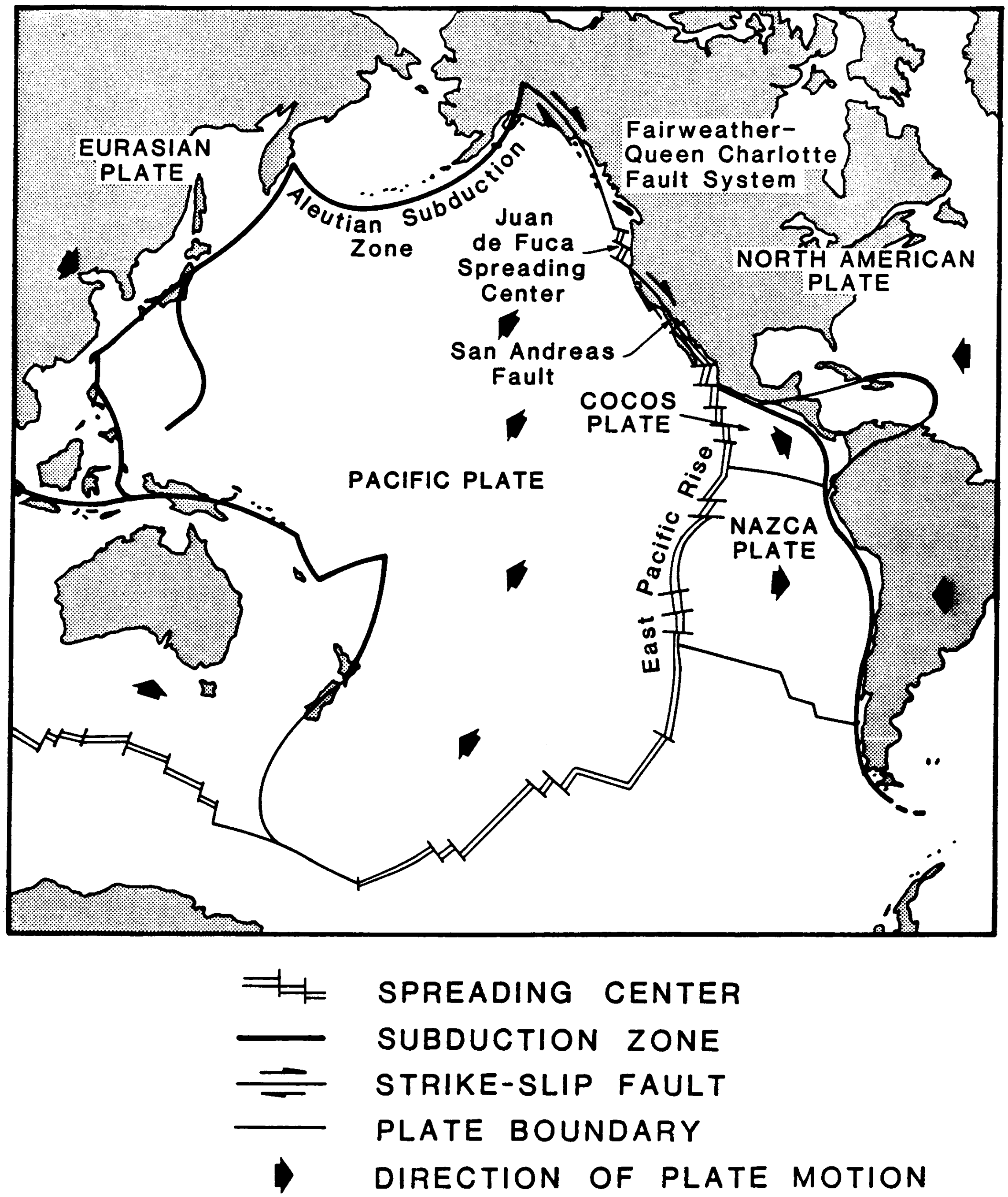

Figure 1. *Major earthquake zones are defined by the boundaries between the earth's crustal plates. Of particular interest for earthquake hazards in Alaska is the boundary between the Pacific and North American plates. Heavy black arrows indicate direction of motion of each plate relative to North America.*

whole summer's campaign of measurements. So hundreds of measurements made by pointing radiotelescope antennas at different quasars allowed us to make these plots. What's plotted here is an estimate of the position of this point relative to North America.

Generally what we see from these measurements is that Yakataga is moving to the northwest. There was a large offset in 1987, and then it continued to move to the northwest again. This large offset is interesting because it relates to the occurrence of a large earthquake that occurred out in the Gulf of Alaska in November of 1987. So we can actually measure some strain offsets at that point several hundred kilometers distant. That gives you another indication of how sensitive these measurements are.

So what we see is a direct measurement of some 5 centimeters per year of motion to the northwest. You can see that it's very regular and that it continues as an inexorable kind of conveyor

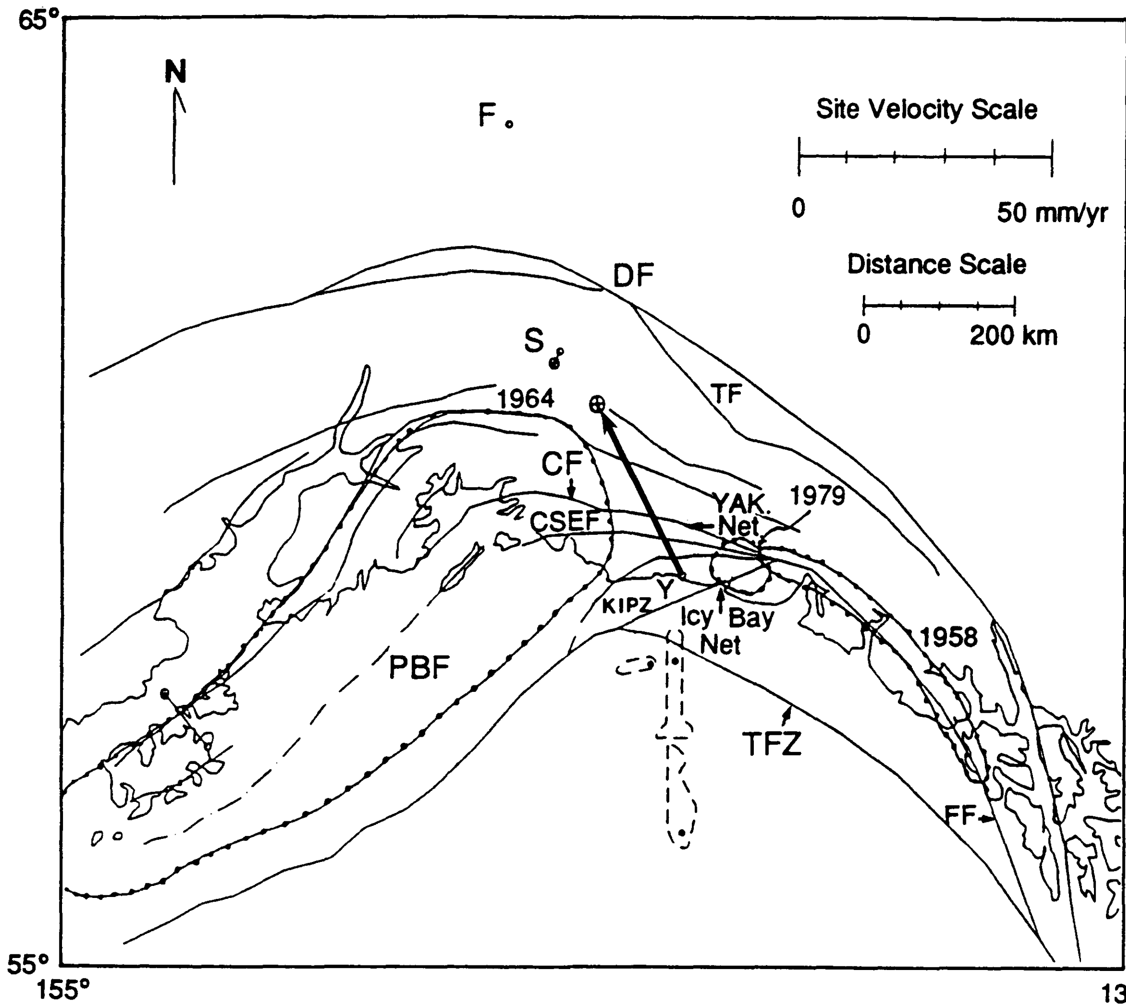

Figure 2. *Map showing relative motion of the Yakutat block (small circle labeled Y near center of figure) to Fairbanks (circle labeled F at top). Northwest-trending arrow illustrates motion, about 50 millimeters per year north-northwest. Dashed lines outline rupture zones of the 1987 Gulf of Alaska earthquakes (Mw greater than 7); dotted lines outline rupture zones of the 1958 Lituya Bay, 1964 Good Friday, and 1979 Mt. St. Elias earthquakes. Modified from Lahr and others (1988).*

belt, moving on an annual basis on the order of 5, 6, 7 centimeters per year. That motion, that conveyor belt motion, is what drives the loading up of strain energy in this area that then gets released in the form of earthquakes.

If you can imagine what this looks like in a cross section through Anchorage (fig. 4), you can see that the plate continues from the Gulf of Alaska on under the Kenai Peninsula, indeed under Anchorage. And in fact it continues at some depth clear up under the Alaska Range. So we have a major plate boundary that's about 25 to 30 kilometers beneath our feet right now that's the result of this plate motion. And, again, that's what causes the earthquakes.

I'm going to talk a little bit now about how this motion, this conveyor belt motion, affected this area during the 1964 earthquake. Figure 5 is a location figure from a paper that George Plafker of the U.S. Geological Survey wrote just following that earthquake. The epicenter was near College Fiord in northwestern Prince William Sound. The dashed lines represent the limits of damage and the felt limits of the earthquake in Alaska. There were actually observations of this

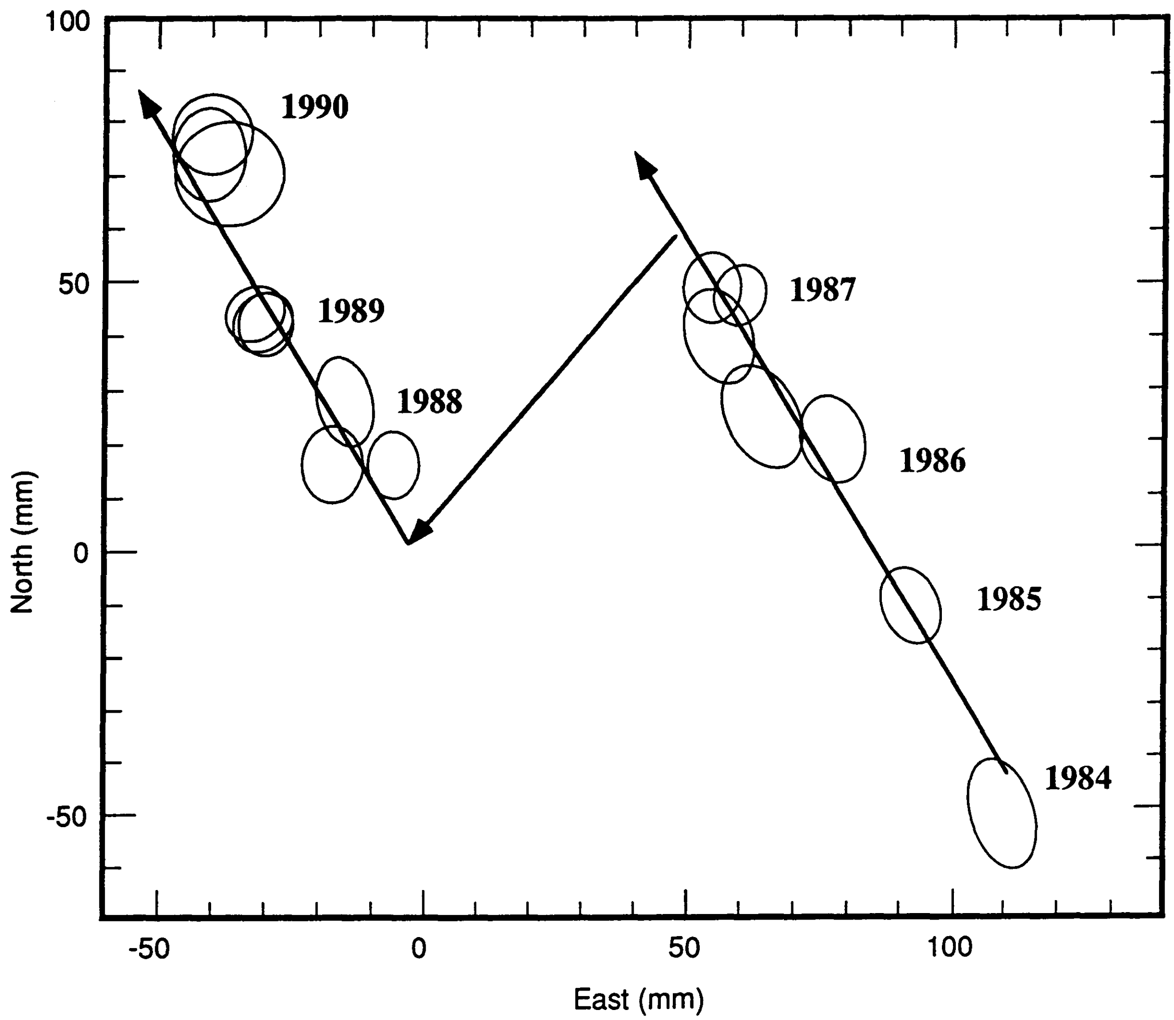

Figure 3. *Very Long Baseline Interferometry (VLBI) measurements plotted for motion of the Yakutat block relative to Fairbanks during the period 1984-1990. Southwestward jump in the trend between 1987 and 1988 reflects relaxation following the 1987 Gulf of Alaska earthquakes. From Sauber and others (1992).*

earthquake in places as distant as Louisiana where long-period seismic waves excited the water in shallow bayous and caused small boats to be swamped.

Figure 6 shows the region that was substantially uplifted or downwarped during the earthquake. There's sort of a zero line that runs through it separating an area that was subsided during the earthquake from an area that was uplifted. In the cross section you can see the amount of uplift and downwarp. The maximum downdrop is on the order of 9 feet; the maximum uplift is on the order of 30-40 feet. These are relatively large effects over a very large area, extending about 800 kilometers in length.

There was also major horizontal deformation from the 1964 earthquake. The Seward area, for example, moved to the southeast relatively immediately after the earthquake on the order of about 30 feet compared to a point near Palmer. That's a rather abrupt and large motion. It shouldn't be any surprise then that a large tsunami was generated on the continental shelf from that earthquake with that kind of horizontal and vertical motion.

I think these figures very graphically show how the strain energy is stored and then released in a large earthquake; this is one of the main points I want to leave you with from this discussion of the 1964 earthquake and the associated plate motion. What's happening right now is that this

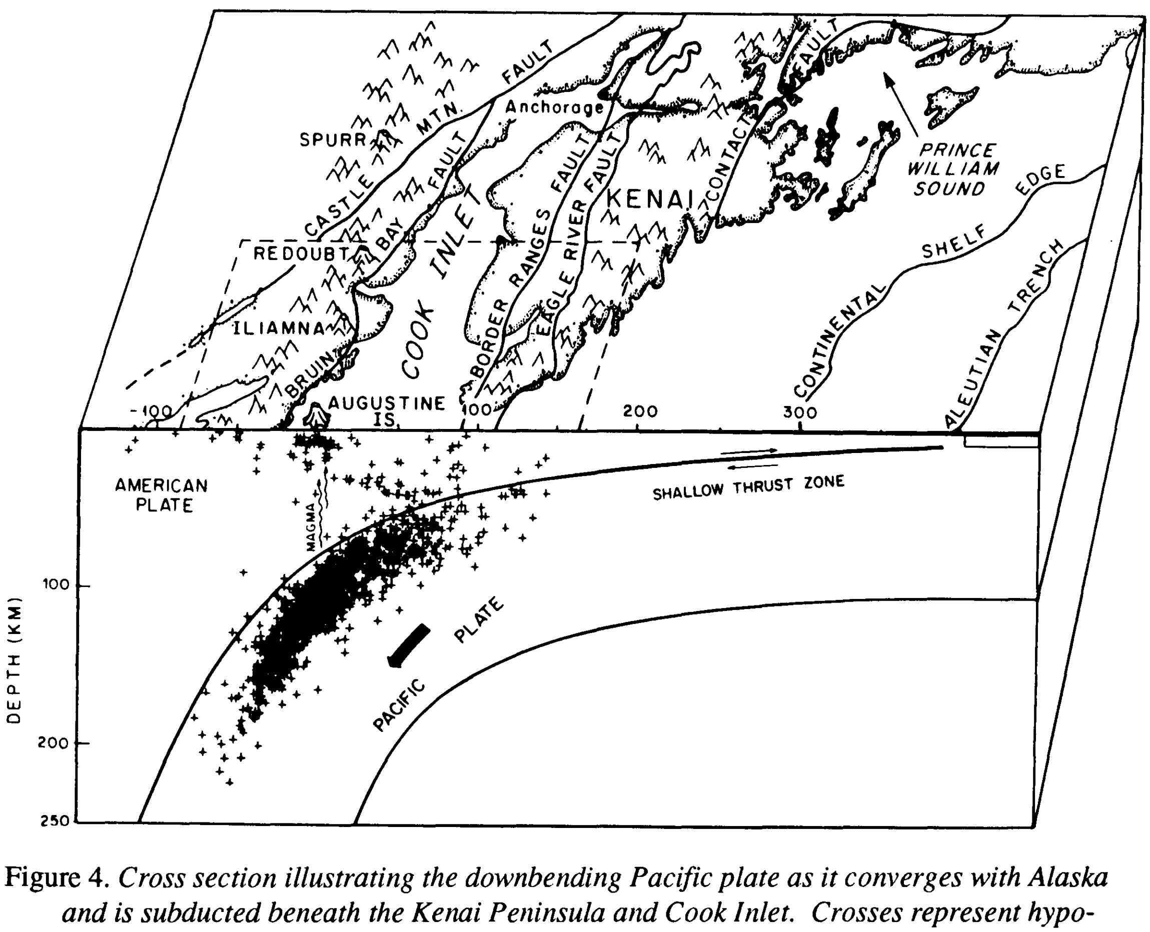

Figure 4. *Cross section illustrating the downbending Pacific plate as it converges with Alaska and is subducted beneath the Kenai Peninsula and Cook Inlet. Crosses represent hypocenter locations of earthquakes, which provide seismologists with a measure of the depth to the subducting plate. Hypocenters shown on cross-section are projected from earthquakes located beneath the dashed box.*

process is being reversed. This area is being squeezed back to the northwest as a result of the plate motion that continues inexorably beneath our feet. The plate boundary now is locked. That is, there is little or no relative motion occurring between the Pacific and North American plates. And so, as the Pacific plate moves to the northwest, the Anchorage area is being squeezed like a large spring. And it's storing energy. When that process continues to a failure point, this area will again pop back to the southeast, releasing the energy that's been stored in the interim. That process repeats itself many times over centuries and millennia.

Figure 4 shows a cross section and map view of some of the other sources of earthquake energy—other potential places where this kind of strain energy can be released. One of the main sources is along the shallow thrust zone that we've been talking about. The plate boundary in cross section dips at a very shallow angle. It starts way out in the Gulf of Alaska and continues clear under Anchorage and then under the Alaska Range.

There are other major sources that run through or near the Anchorage area. There's the Castle Mountain fault that's just to the north. The Castle Mountain fault is clearly active; it has both geologic and seismic evidence of motion. Estimates are that it could generate a magnitude 7.5 earthquake. There's also the Border Ranges fault that runs right through our back yard here in Anchorage. This one is a little more problematical in that the evidence is mixed. To be safe, most engineering analyses in the Anchorage area assume that this fault is capable of generating a magnitude 7.5 earthquake, although there is some argument about that in the geological community.

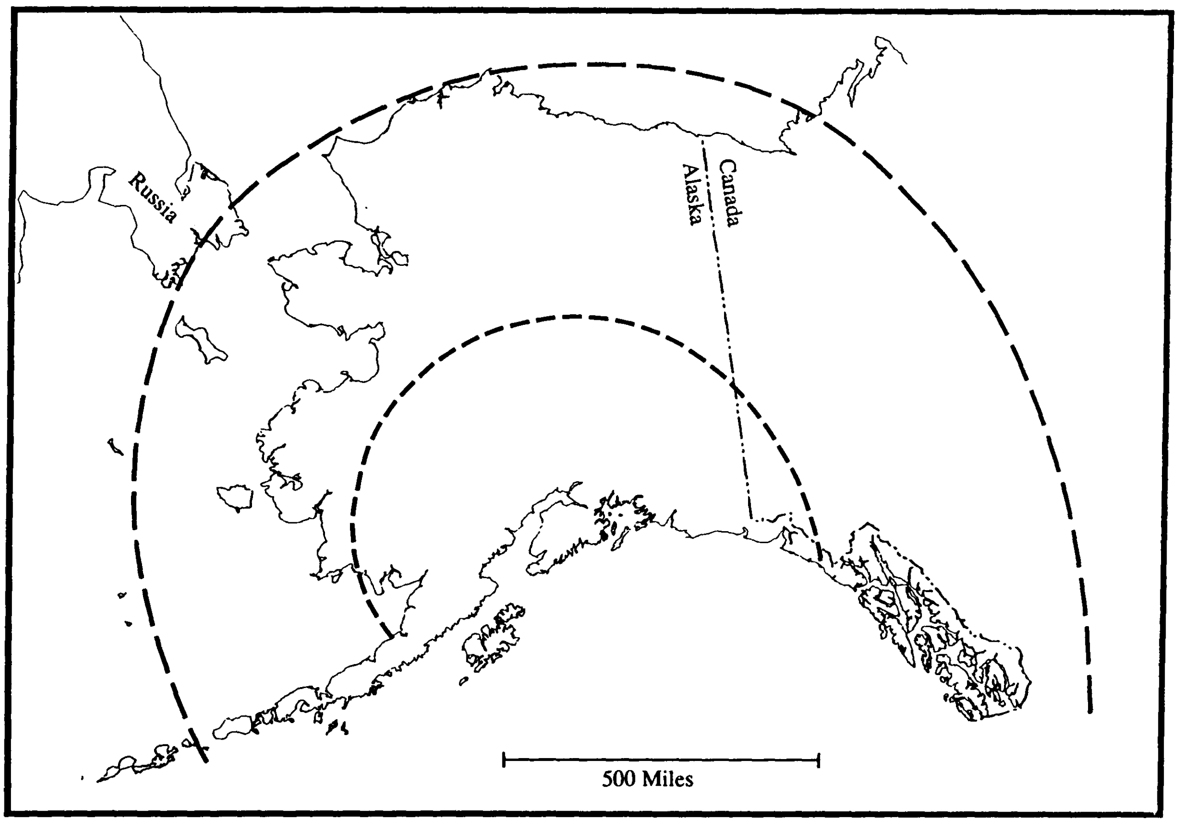

Figure 5. *Area affected by the 1964 great Alaska earthquake. Outer dashed line represent the extent of felt effects; inner dashed line shows approximate limit of landslides, avalanches, and ground cracks. Modified from Plafker (1969).*

It's important to answer that question. That's an important outstanding research area. We need to know how big an earthquake could, in fact, if any, occur on this fault.

The crustal region under Anchorage, above the main thrust zone but not necessarily associated with any one of these faults, could also contain other buried faults that we don't know

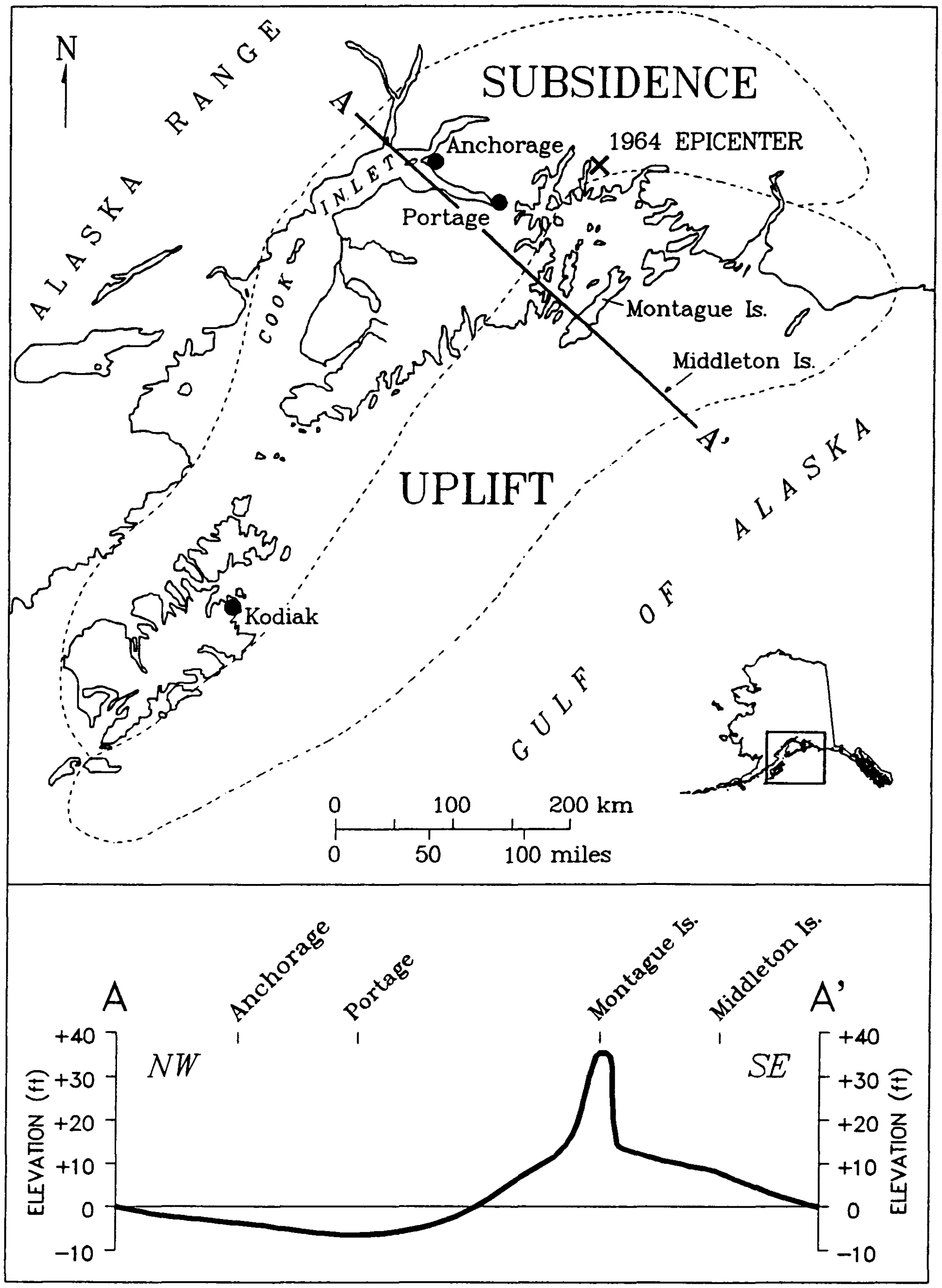

Figure 6. *Area of measurable vertical ground deformation associated with the 1964 earthquake (top) and profile of deformation along line A-A' (bottom). Note the maximum uplift of approximately 35 feet at Montague Island. Modified from Plafker (1969).*

anything about. Most geoscientists assume that such buried faults could generate a magnitude 6 or 6½ earthquake in the Anchorage area.

Again, all these faults are being loaded. That is, strain energy is being accumulated around them by the motion of the Pacific plate. So any one of these faults, the Castle Mountain, the Border Ranges, portions of the shallow thrust zone, or just regions in the crust could fail, essentially, any time. It could be tomorrow. It could be a hundred years from now.

I'm not making a forecast here. I'm not saying tomorrow there's going to be an earthquake. But the strain energy has accumulated in the same sense as Charlotte indicated in making the comparison from the 1986 to the 1957 earthquakes in the Aleutians. There's enough strain energy now accumulated here in the region of the 1964 earthquake to generate a magnitude 7 or greater earthquake in the Anchorage area.

Finally, table 1 is a compilation of earthquakes of magnitude greater than 7 that have occurred near Anchorage. These events occurred in 1912, 1934, 1943, and 1964. The average interval is something like 17 years. So it's quite conceivable that another magnitude 7 earthquake in the vicinity of Anchorage could occur essentially anytime.

Table 1. *Earthquakes of magnitude greater than 7 within 150 kilometers (90 miles) of Anchorage since 1900. Average recurrence interval is 17.4 years*

Date	Location	Depth (km)	Magnitude	Interval (years)
Jan. 31, 1912	61.1°N, 147.5°W	80	7.3	--
May 4, 1934	61.3°N, 147.5°W	80	7.2	22.3
Nov. 3, 1943	61.8°N, 151.0°W	25	7.3	9.4
Mar. 28, 1964	61.1°N, 147.5°W	23	9.2	17.4
			Average	17.4

The main message I want to leave you with is that Anchorage is in earthquake country. And that we shouldn't—because there are long intervals between magnitude 9 earthquakes—relax in the belief that we can't experience a damaging earthquake in our lifetime. A magnitude 7 or 8 earthquake could occur essentially at anytime. So we should be prepared for that.

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Questions from the Audience

MR. COMBELLICK: John, what do you think the sources are for these magnitude 3 and 4 events that we feel so frequently around Anchorage?

MR. DAVIES: Well, most of them occur either in the crustal area that I pointed out or actually within the Pacific plate. The majority of the intermediate-sized earthquakes or moderate-sized earthquakes actually are occurring within the Pacific plate under Anchorage. Those are small faults that are within the brittle part of that subducting plate. So they're often 30 or more kilometers deep, either under Cook Inlet or north like under Talkeetna. That's the major source of seismic activity.

One of the things I should point out is that something on the order of 50 percent of the destructive earthquakes that occur in California occur on fault structures that were not identified as capable faults. And so if it's true that in California, where there's probably a geologist for every square kilometer, half of the earthquakes occur on structures that we haven't forecast, it shouldn't be a surprise that we have earthquakes that occur in the Anchorage area on structures that we haven't identified.

QUESTIONER: I'm a basic novice on earthquakes. But when you were talking about being able to measure displacement of these plates, are these plates assumed to be fixed masses that don't compress or expand on their own? I mean, do they move as one solid block compared to like the North American plate?

MR. DAVIES: We assume for purposes of the short-term interferometry interpretation that they're rigid but they, in fact, aren't exactly rigid. But relative to the motions between the plates, if this is North America and this is the Pacific plate, they do move essentially as rigid bodies. There is a significant amount of internal deformation. But it's orders of magnitude less than the relative motion between the plates. So the deformation between the plates is on the order of say, 10 centimeters. The deformation within the plate is on the order of a millimeter or less.

QUESTIONER: But that then means that over this entire Pacific plate, if you measure a movement in Anchorage or Yakutat or wherever it is, that it means that you would end up with the same kind of relative movement compared to Japan or Hawaii?

MR. DAVIES: That's correct. In fact, those kinds of measurements have been made. If you compare Vandenburg Air Force Base relative to Fairbanks, and Yakutat relative to Fairbanks, you get about the same kind of numbers. Yakutat relative to Fairbanks is about 5 centimeters per year. And Vandenburg Air Force Base relative to Fairbanks is about 6 centimeters per year. And they're both on the westward side of the main plate-boundary faults that separate the Pacific and North American plates.

QUESTIONER: One last question then. What is the depth of these plates?

MR. DAVIES: Their thickness is in the order of 100 kilometers.

QUESTIONER: All right. Thank you.

MR. HUDSON: I'm Ken Hudson with the Matanuska-Susitna Borough. And my question is relative to the rise or the fall of land, subsidence, or the raising effects. In the Matanuska-

Susitna Borough, we would be on the North American plate, I guess. And the question from a long-term planning perspective is in a larger earthquake can we expect to be uplifted? We have rivers and water bodies issues that if we're going to have significant rises of 6 or 10 or 20 feet, we're going to have some severe problems we have to deal with.

MR. DAVIES: One of the things is that these motions are reversed in the interim between earthquakes. So what's happening between earthquakes is that the area is being squeezed and the area in the immediate area around Cook Inlet here is being uplifted. During the earthquake when that area pops back to the south, the uplift is reversed and the area subsides. So the net effect is much smaller in the long term.

QUESTIONER: On your last slide you had a picture of an Eagle River fault. I'm not familiar with that. Could you tell us more about it?

MR. DAVIES: The Eagle River fault, if I remember right, is part of the extension of the Border Ranges system. It's a fault that's been studied quite a bit. And it's not clear what the current capability of that fault is. There are people who think that it's capable of generating a major earthquake and people who think that it's not. It's still the subject of a lot of research.

GEOLOGIC EVIDENCE OF EARTHQUAKE FREQUENCY IN SOUTHCENTRAL ALASKA

by
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How likely is another major subduction earthquake in the Anchorage region during our lifetime or during the useful life of an engineered structure? The answer to this question can only be expressed in terms of probabilities. For example, if we know that major earthquakes occur an average of once every 100 years, then that gives us about a 30 percent probability of occurrence within a 30-year period. If, on the other hand, they occur every 600 years, then the probability within a 30-year period goes down to about 5 percent.[1]

This kind of information would be useful in deciding whether to use more costly design and construction practices to reduce earthquake risks to proposed structures. The problem in the Anchorage area is that the region has had only one great earthquake in historic time—a great earthquake is one of magnitude 7.8 or larger—and that was the 1964 great Alaska earthquake. So we can't determine from the historic record how often these big earthquakes occur.

Fortunately, the geologic record gives us some clues as to how often these major earthquakes have occurred, at least during the past 5,000 years or so. We can use Carbon-14 dating to get a rough idea of the timing of some earthquake effects and, from this we can estimate the average frequency of occurrence.

To understand how geology can be used to determine the frequency of these big earthquakes, let's first examine the permanent geologic record left by the 1964 event. This photo (fig. 1) shows two effects of the 1964 earthquake. First, up to about 15 feet of vertical displacement occurred along this fault near the southwest end of Montague Island. Second, and more significant for our purpose here, the southwest end of Montague Island was uplifted about 35 feet relative to sea level so that this surface, which was formerly submerged at low tide, is now fully exposed even at high tide. At Portage, which is about 50 miles southeast of Anchorage at the head of Turnagain Arm, the earthquake resulted in about 8 feet of subsidence, allowing tide water to flood the town and the large forest area around it. The resulting daily influx of saltwater killed all the trees in a very large area surrounding Portage.

The U.S. Geological Survey identified an area about 500 miles long in which uplift and subsidence occurred as a result of the 1964 earthquake (fig. 2). The pre-1964 shoreline features, then, have become a permanent record of this deformation, much the way a bathtub ring in a tub filled with dirty water could allow you to measure the tilt of your house if one end settled relative to the other. In the case of the 1964 earthquake the deformation was not uniform and along line A-A' looked like the profile shown in the lower portion of figure 2. Montague Island was uplifted about 35 feet along a fault on its southeast side. Middleton Island went up about 11 feet, Anchorage subsided about 3 feet, and Portage subsided about 8 feet.

Soon after the 1964 earthquake, geologists recognized that a record of prehistoric uplifts, perhaps related to major earthquakes, was preserved in a series of five terraces on Middleton

[1]This example somewhat oversimplifies earthquake probabilities for purposes of illustration. Occurrence probabilities, in fact, change over time because the stresses in the crust change as slippage takes place.

Figure 1. *Aerial view looking southwest along the Hanning Bay fault scarp and an uplifted wave-cut surface on southwest Montague Island. The ground northwest of the fault (right side of photo) was displaced upward as much as 16 feet relative to the ground southeast of the fault during the 1964 earthquake, and both sides were elevated relative to sea level due to regional tectonic uplift. (U.S. Geological Survey photograph)*

Island (fig. 3). Here we see the exposed surface of a wave-cut bench that was exposed as a result of uplift during the 1964 earthquake. More than 100 feet above it is another large wave-cut terrace that was probably uplifted during an earlier major earthquake. Driftwood on this surface was Carbon-14 dated at about 1,300 years before present, giving an approximate time for that uplift. There are four higher terraces on Middleton Island that aren't shown in this photograph. They were all similarly dated, each representing successively older events. The highest, or oldest one, which is off the left of the photograph, was found to be about 5,000 years old.

Figure 4 is an aerial view of the Portage area and upper Turnagain Arm looking northwest. Girdwood, which I'll discuss later, is about 12 miles northwest of Portage. The coastal marsh at Girdwood is similar to this but smaller. The entire brown area in the center of the photograph was flooded following subsidence during the 1964 earthquake. Also in this area are the trees that died from saltwater influx. As a result of this new mud deposition and about 2 feet of tectonic rebound since the earthquake, most of this area now remains above high tide except during the very highest tides.

At Portage, new silt deposited rapidly by the tides after the 1964 earthquake filled in and partially buried structures in the abandoned village and buried the vegetation that was growing in the Portage area at the time of the earthquake. New vegetation has become well established on this restored surface, which is now mostly above high tide.

This riverbank exposure (fig. 5) shows the remains of some of the trees killed at Portage during the 1964 earthquake. The root systems of these trees are now buried under about 6 feet of new tidal mud. Because of this rapid mud deposition, evidence of the 1964 earthquake is now preserved as a layer of rooted stumps and peat about 6 feet below the present ground surface. The

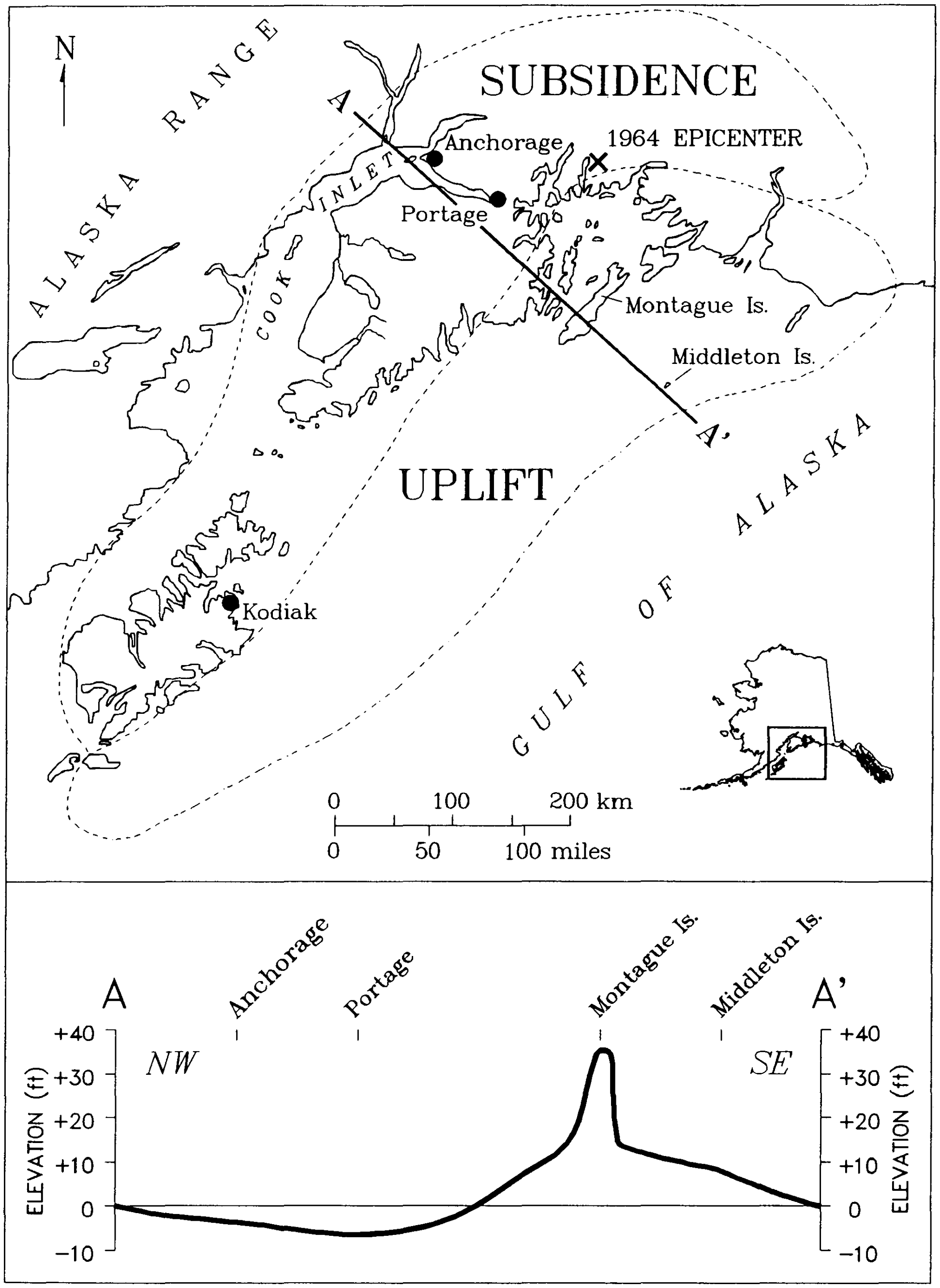

Figure 2. *Region of southcentral Alaska affected by vertical tectonic deformation during the great 1964 earthquake (top) and profile of deformation along line A-A' (bottom). Maximum uplift of about 35 feet occurred along a fault on the southeast side of Montague Island. Maximum subsidence of about 8 feet occurred near Portage. Modified from Plafker (1969).*

above-ground portions of these dead trees will eventually decay and disappear. But the buried stumps that are not exposed or removed by stream erosion will be preserved as evidence of the 1964 earthquake.

By drilling boreholes in an area near Portage that hasn't been affected by stream erosion, we discovered several additional peat layers below the one buried as a result of the 1964 earthquake. Because these peat layers are well below sea level, they're below the level at which freshwater vegetation can grow. We conclude that these were submerged and buried during earlier major earthquakes as a result of subsidence similar to that in 1964.

For each peat layer, shown by dark bands in the next photo (fig. 6), the core samples show a gradual upward increase in plant or organic matter, indicating a gradual change from a muddy subtidal flat to a vegetated supratidal flat, then a layer of concentrated peat representing freshwater vegetation growth on a stable surface. A very abrupt contact between the peat and overlying inorganic mud must represent sudden submergence and burial of vegetation by intertidal mud during an earthquake. Moving upward in the core, we see another gradual increase in plant matter, a concentrated peat layer, a sharp upper contact, then back to organic-poor mud. This cycle repeats during successive events.

By dating the plant matter at the top of each peat layer with Carbon-14 dating, we can get an approximate age of each of these subsidence events. Six to eight peat layers are visible below the

Figure 3. *Aerial view of two uplifted wave-cut surfaces on Middleton Island. The rock platform between the base of the cliff and the new high-tide level was exposed by uplift of about 11 feet during the 1964 earthquake. The upper terrace, 110 to 125 feet above sea level, is the next older of five higher wave-cut surfaces representing uplift during previous uplifts. From Plafker (1969).*

1964 layer at Portage, representing six episodes of earthquake-related subsidence during about the last 5,000 years. The Seward Highway protected the site of these boreholes from significant mud deposition after the 1964 earthquake, so evidence of that event is not recorded at this location. That peat layer is still at the ground surface.

If these peat layers represent all of the previous earthquakes that were large enough to cause subsidence during those last 5,000 years, then they indicate an average recurrence interval of about 800 years. However, there's also evidence in these boreholes that major earthquakes can occur very close together in time. Two peat layers separated by about 5 ft of mud have age ranges that are almost identical—somewhere between 2,600 and 3,000 years ago. That could mean that two earthquakes occurred very close together in time, or no more than 400 years apart if they occurred at the extreme ends of these ranges.

Similar evidence for major earthquakes is visible at Girdwood, about 12 miles northwest of Portage on Turnagain Arm. Here we also see standing dead trees resulting from the 1964 earthquake (fig. 7A). The root systems of these trees are buried beneath a layer of new mud about 1 foot thick that was deposited over them after the earthquake. There is an older layer of buried stumps, about 3 or 4 feet below the layer buried in 1964.

In this photograph (fig. 7B), also at Girdwood, we can see the layer of new silt deposited after the 1964 earthquake. The sharp contact between the surface silt and the underlying peat is a result

Figure 4. *Aerial view of the Portage area and upper Turnagain Arm, looking northwest toward Girdwood. Tidal flooding following subsidence during the 1964 earthquake killed most trees in the central part of the photograph. Deposition of nearly 6 feet of tidal silt since 1964 has buried the vegetation that grew in the flooded area prior to 1964 and has restored the surface to approximately its pre-1964 elevation.*

of sudden submergence and burial during the earthquake. Below the peat is a 3-foot-thick layer of tidal mud. Below the mud is the layer of stumps that are rooted in an older peat layer. Carbon-14 ages of the wood from these stumps and from the peat within which they are rooted place the subsidence somewhere between 700 and 900 years ago.

We have found up to four older peat layers lower on the bank at Girdwood, exposed during extreme low tide, and in nearby boreholes. These peat layers are indicated by arrows in figure 8. The oldest peat layer at Girdwood was buried between about 3,400 and 4,100 years ago. A peat that's about 2,600 years old (fig. 8) is about 30 feet below high tide. Higher in the section is another layer about 2,000 years old. Still higher is a layer with rooted stumps that's about 1,300 years old. The 800-year layer is near the top of the section. At the top are some of the trees killed in 1964.

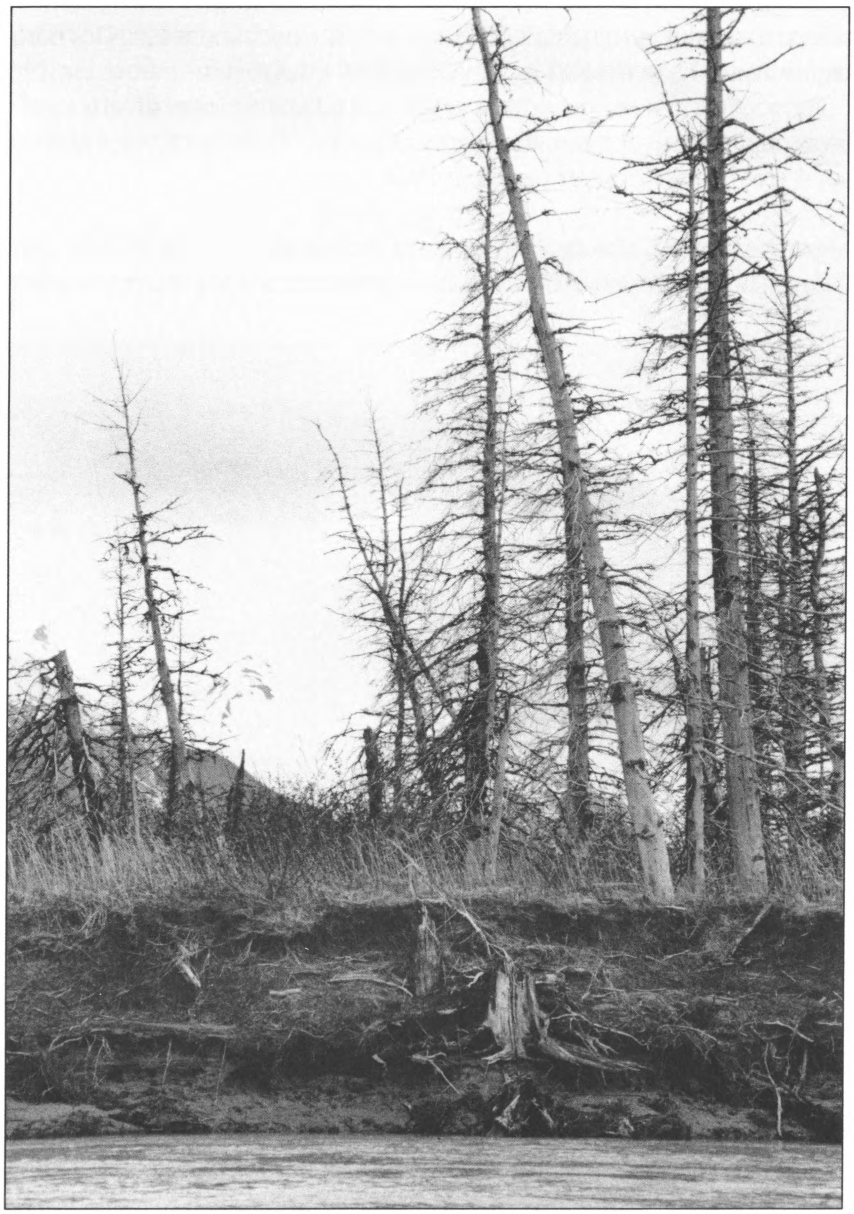

Figure 5. *Riverbank exposure near Portage, showing buried remains of trees killed by salt-water inundation following subsidence in 1964.*

We've examined five coastal marshes in the upper Cook Inlet area and have found similar evidence of prehistoric earthquakes at all of them. The ages of the layers at these locations don't all agree. This is probably due to the problems in precision with radiocarbon dating. As a result, the exact timing of these events is still unclear. Some locations show fewer buried peat layers, indicating that the earthquakes didn't affect all areas in the same way or that vegetation may not have been present at some sites when the earthquake occurred.

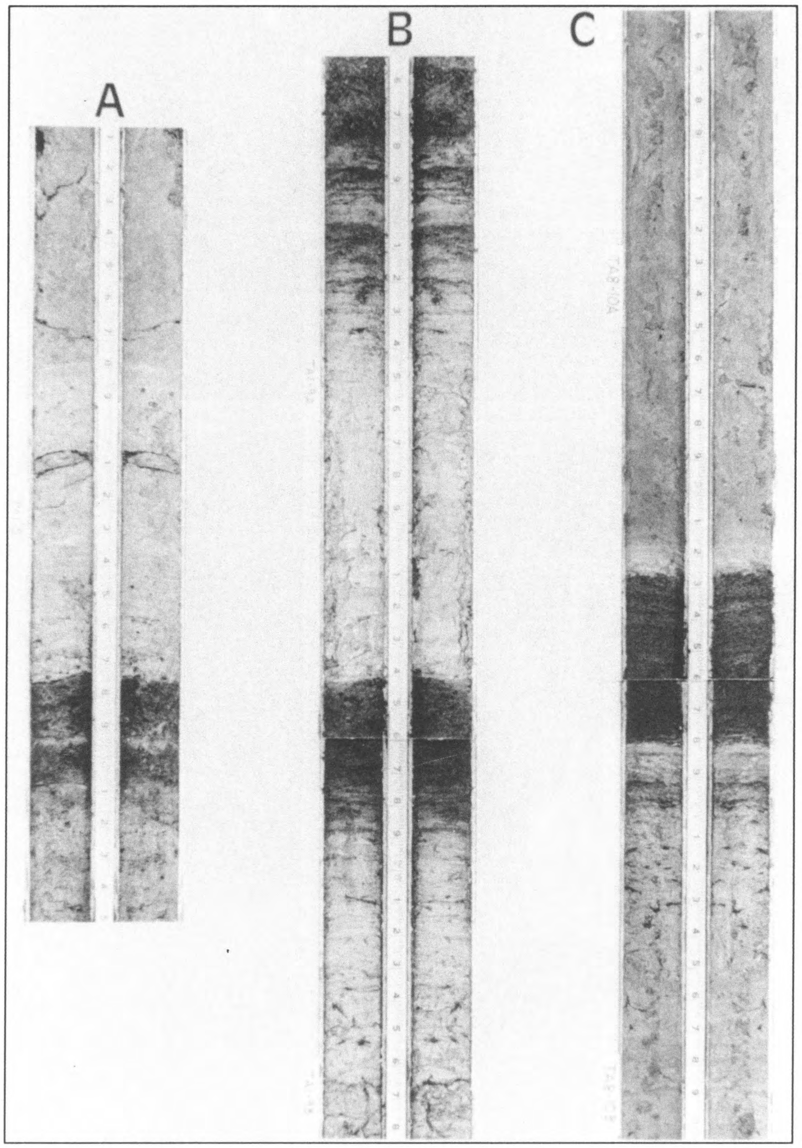

Figure 6. *Photograph of core samples collected from coastal marshes at Portage and Girdwood. The dark layers are peats composed of the remains of freshwater grasses, mosses, and shrubs. Overlying the peat layers is intertidal mud that is nearly devoid of plant material near the basal contact with the peat, but shows a gradual upward increase in plant material toward the next overlying peat. The sharp contact between the peat and the overlying mud indicates rapid subsidence and burial of a vegetated surface.*

Figure 7. *Erosion has exposed root systems of two generations of dead spruce trees in coastal banks along upper Turnagain Arm near Girdwood.* ***(Top)*** *View of standing trees that probably died from saltwater inundation following submergence during the 1964 earthquake. The roots of these trees and other contemporaneous vegetation have been buried by postearthquake deposition of tidal silt. Stumps along the base of the bank are rooted in an older peat layer, which is buried beneath about 3 feet of intertidal silt.* ***(Bottom)*** *Close view of older stumps rooted in a peat layer about 3 feet below the base of the peat layer that was sub-merged in 1964. Base of scale card marks the sharp contact between the upper peat layer and the overlying intertidal silt that was deposited after the 1964 event. Death of the older trees and burial of the lower peat layer within which they are rooted probably resulted from subsidence during the previous great earthquake 700 to 900 years ago.*

Our subsidence data from the Cook Inlet area and the U.S. Geological Survey uplift data from the Gulf of Alaska coastal area allow us to come to some general conclusions about the long-term earthquake frequency in the region affected by the 1964 event. The regional evidence suggests that there have been six to eight earthquakes prior to 1964 during the past 5,000 years. Therefore, the average recurrence interval for great earthquakes during this period was about 600 to 800 years.

Second, the intervals between these events range from less than 400 years, as we saw in the Portage boreholes, to as much as 1,300 years. Although great earthquakes are thought to occur after sufficient time has elapsed for strain to reaccumulate, there are historic cases, notably from south Japan and Alaska's Andreanof Islands, in which great earthquakes have occurred within just a few years after the previous one in the same area. So we can't just assume that the next great earthquake is going to wait for another 700 years or even 400 years.

Third, we have strong regional evidence from several submerged marshes in upper Cook Inlet and from several uplifted locations in the Gulf of Alaska that the last great earthquake before 1964 was sometime between 700 and 900 years ago.

I've been using this term "great earthquake" rather loosely, because we really have no way of determining the magnitude of these prehistoric earthquakes from the geologic data. We do know from worldwide data on subduction earthquakes that it takes a minimum magnitude of about 7.5 to cause widespread permanent vertical deformation. Also, there have been eight earthquakes of magnitude 7 to 7.4 recorded in the northern part of the region affected by the 1964 earthquake

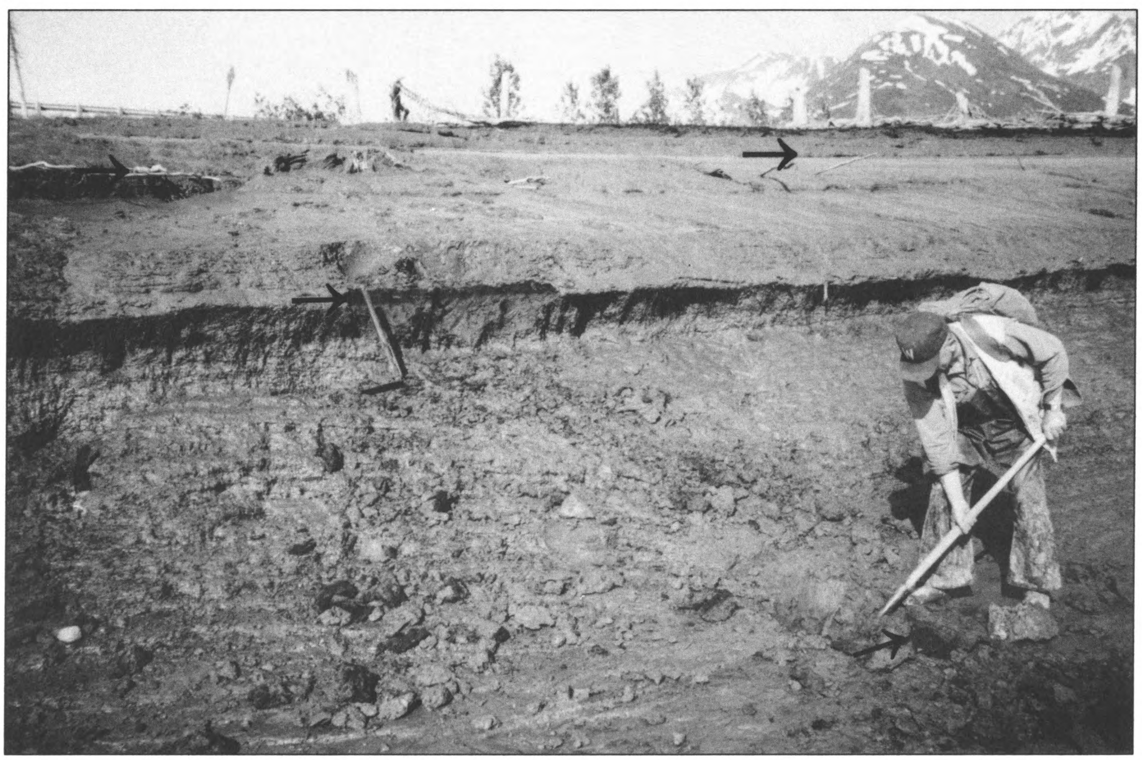

Figure 8. *View of lower tidal bank at Girdwood during extreme low tide. Four peat layers that pre-date the layer submerged in 1964 are exposed in this bank and indicated by arrows. Radiocarbon dating places the ages of prehistoric subsidence at roughly 800, 1,300, 2,000, and 2,600 years ago. The geologist here is collecting a sample of the 2,600-year-old peat.*

since the beginning of this century. None of these earthquakes, that we know of, resulted in measurable permanent vertical deformation. So I think we can consider 7.5 to be a reasonable minimum magnitude of prehistoric earthquakes for which evidence of uplift or subsidence is likely to be preserved in the geologic record.

From the size of the region over which we have evidence of this event 700 to 900 years ago, I estimate that its magnitude must have been at least 7.8. My feeling is that it was probably much larger than that; probably similar to the magnitude 9.2 earthquake in 1964. Because the geologic record says little or nothing about magnitude, we need to consider that the preserved evidence for these earthquakes probably represents only the largest earthquakes, perhaps those similar to the 1964 event. The recurrence interval for smaller great earthquakes in the magnitude 7.8 to 8.5 range could be much shorter than the 600- to 800-year average suggested by the geologic data.

In my presentation, I've only been discussing evidence for major subduction-zone earthquakes. As John Davies mentioned, there are other earthquake sources in the Anchorage region (fig. 9). Probably the most important of these is the Castle Mountain fault, which we know is

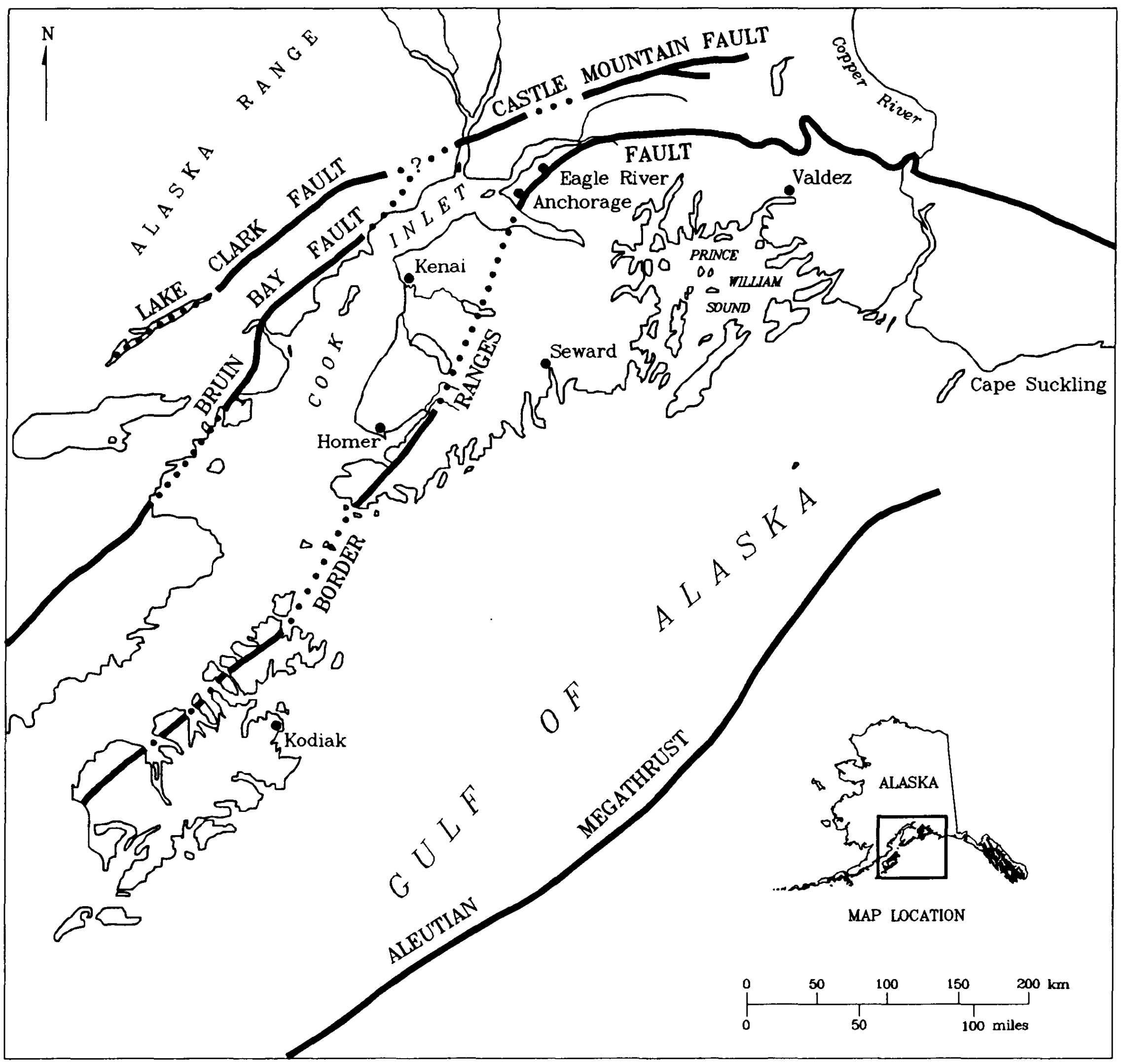

Figure 9. *Map of major potentially active faults in southcentral Alaska.*

active. We're also concerned about the Border Ranges fault, which is even closer to Anchorage than the Castle Mountain fault.

The Castle Mountain fault is only 40 miles northwest of Anchorage, but we know very little about it (fig. 10). It has produced one recent moderate earthquake that we know of, a magnitude 5.7 event near Sutton in 1984. We know that it has had displacement during recent geologic time because of features like this scarp that cut across geologically recent deposits in the Susitna Valley. But we really don't know the long-term frequency of major earthquakes generated by this fault. We're not very confident in the estimated maximum credible magnitude that John Davies mentioned. We don't know enough about the Castle Mountain fault and its relationship to other regional faults to be confident in that magnitude estimate.

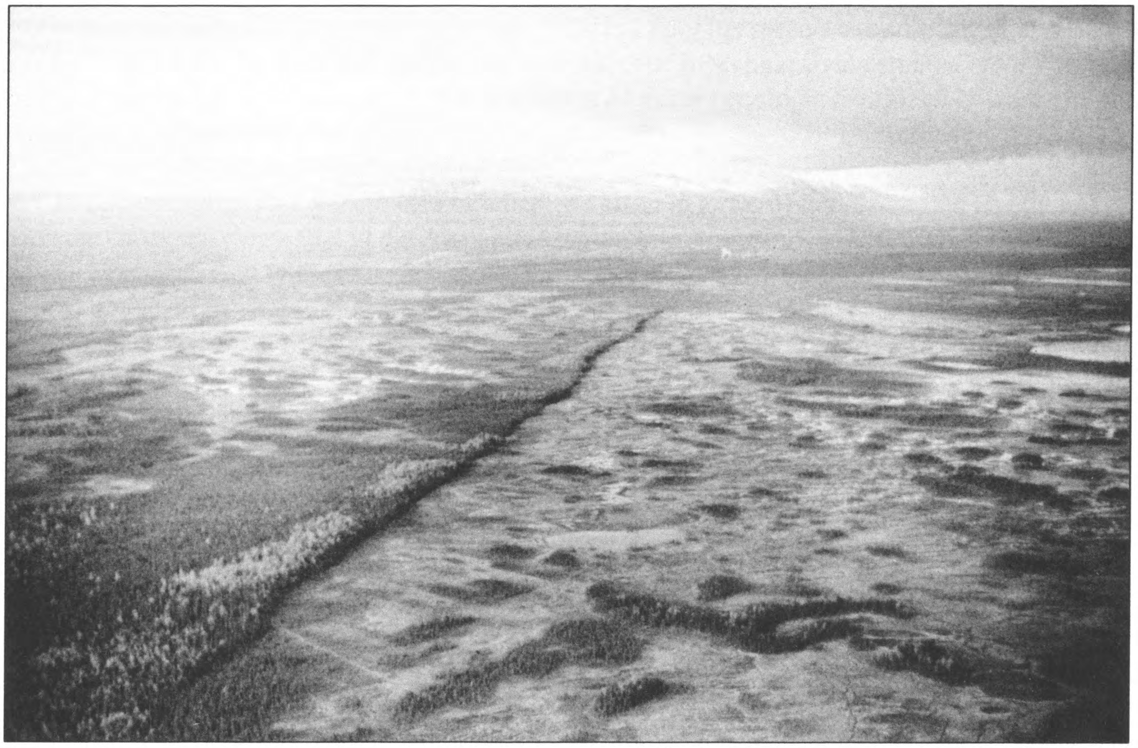

Figure 10. *Aerial view looking northeast along a scarp of the Castle Mountain fault in the Susitna River valley, about 40 miles north of Anchorage. The minimum age of this scarp is approximately 225 years, based on tree-ring counts of the oldest trees growing on the scarp. The maximum age of the scarp is 1,860±250 years before present based on radiocarbon dating of organic material from a buried soil horizon that was displaced by the fault (Detterman and others, 1974). Therefore, the last surface displacement on the Castle Mountain fault occurred about 225 - 2,100 years ago.*

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COMPARISON OF KNOWLEDGE OF EARTHQUAKE POTENTIAL IN THE SAN FRANCISCO BAY AND ANCHORAGE REGIONS

by
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INTRODUCTION

I have been asked to compare our knowledge of the earthquake potential in the San Francisco Bay region with that in the Anchorage region. This is a very instructive exercise because it contrasts the level of understanding that has been achieved in an intensively studied area—namely, the San Francisco Bay region—with that in a region of greater geologic complexity, where the pace of study is much slower.

In this talk I will give you an idea of where we stand in terms of understanding and quantifying the earthquake potential in the Anchorage region in comparison to what we have achieved in the San Francisco Bay region.

I want to leave you with two primary ideas: first, through geologic and seismic investigations scientists can gain sufficient understanding of earthquake processes to make useful quantitative statements about future earthquake potential. This emerging capability is perhaps best illustrated by the recent progress in quantifying earthquake potential in the San Francisco Bay region.

Second, the level of understanding regarding future earthquake potential in the Anchorage region lags far behind that in the San Francisco Bay region. However, those of us who are engaged in earthquake investigations in Alaska are optimistic that progress is being made, although the pace is slow in relation to the importance of the problem.

I will begin my talk by comparing the geologic setting and historical seismicity of the two regions. Then I will discuss recent estimates of earthquake probabilities in the San Francisco Bay region. To conclude, I will review our level of knowledge regarding the earthquake potential in the Anchorage region.

COMPARING THE TWO REGIONS

Anchorage and San Francisco both sit on the boundary between the Pacific and North American plates. The Pacific plate is moving northwestward with respect to the North American plate. Along the southcentral coast of Alaska, the two plates are converging at about 2 inches per year.

A belt of earthquakes encircles the Pacific Ocean. The belt is very wide in southern Alaska relative to central California. This reflects the different tectonic situation in the two regions.

In Alaska the Pacific plate is being thrust beneath the southern edge of the continent at a gentle angle. This type of underthrusting produced the great 1964 earthquake (magnitude 9.2) in the Prince William Sound-Kodiak Island region. In central California, the Pacific plate is slipping horizontally past the North American plate. There, the major earthquakes occur on vertical rather than shallow-dipping faults as in coastal Alaska. This difference in the dip of the plate-boundary faults is reflected in the size of the largest earthquakes in the two regions. Plate-boundary faults are capable of generating earthquakes to depths of about 15 miles; at greater depths, the plates slide past one another smoothly without causing earthquakes along their boundary. Accordingly, where faults are vertical, as in central California, the width of an earthquake rupture, as measured down into the earth, does not exceed 15 miles. In contrast, where the plate boundary dips gently, the width can be large, about 125 miles for the 1964 earthquake rupture. Thus, the boundary-fault width in Alaska is several times that in California. This accounts for much of the size difference of the largest earthquakes. In terms of energy, the 1964 Alaska earthquake was roughly a hundred times larger than the 1906 San Francisco shock.

The difference in geologic setting also results in California faults being more accessible to study. They intersect the ground surface so you can see with your eyes what is happening. You can measure long-term rates of slip across these faults to obtain an idea of the relative activity of faults. This is not possible when faults are buried below the surface, as is the main fault that broke in the 1964 Alaska earthquake. This factor contributes to the difference in the status of our level of knowledge in the two regions.

Now, let us compare the number of earthquakes larger than magnitude 7 in the two states. In southern Alaska, the recorded earthquake history dates back to about 1899, when a series of big earthquakes, as large as magnitude 8, occurred in the vicinity of Yakutat Bay. In California, where the missions were established in the late 1700s, the history goes back an additional century. The historical records indicate the magnitude 7 shocks are about three times more frequent in southern Alaska than in California. The relatively short history for Alaska means that we know less about the recurrence rates of earthquakes in Alaska than for California shocks. Rod Combellick discussed how we can obtain information from the geologic record that helps us decipher the long-term rate of earthquake occurrence.

EARTHQUAKE PROBABILITIES IN THE SAN FRANCISCO BAY REGION

I'm going to focus now on the San Francisco Bay region, where we have a very serious earthquake problem. You might ask why the problem is so severe, when the earthquakes are not as large or frequent as they are in southern Alaska. The answer is the San Andreas fault and its branches pass through, or adjacent to, heavily urbanized areas. San Francisco abuts the San Andreas fault, Oakland is cut by the Hayward fault, and San Jose lies between the two faults. Thus, two major faults traverse the heavily urbanized Bay region.

The 1989 Loma Prieta earthquake (magnitude 7.0) ruptured a 25-mile section of the San Andreas fault in the southern Santa Cruz Mountains, a sparsely populated region between San Jose and Santa Cruz. Santa Cruz and Watsonville, the two most heavily damaged cities, lie about 10 miles from the fault. A great deal of the destruction, however, and most of that seen on national television, occurred in Oakland and San Francisco at about 50 miles. A total of 62 people were killed. Property damage was estimated at about $6 billion.

The problem in the Bay area is that the faults in the east bay and on the San Francisco Peninsula lie much closer to the major urbanized region than did the fault segment that caused the Loma Prieta disaster. We can compare the population exposed to intense shaking for a similarsized future earthquake on the southern part of the Hayward Fault to that for the Loma Prieta shock. About 3 million people live within the region of intense shaking for the Hayward fault earthquake, 15 times the number within the same-sized region around the Loma Prieta rupture. Hence, the losses are expected to be much greater in future earthquakes of comparable magnitude.

Obviously we have a very serious problem. How can we address this problem? Until recently it has been difficult to confront the earthquake problem because we have known little about how frequently damaging shocks are likely to occur. The situation has changed in California. The results of recent geologic and seismic studies have enabled us to make useful statements about the likelihood of a damaging earthquake over some future time interval, say, a 30-year period, which is the time span for which many economic decisions are made.

After the Loma Prieta earthquake, we reexamined the probability of various-sized earthquakes occurring in the Bay region. I would like to take you through that exercise because it illustrates how we derive such estimates and it also provides a framework for keeping score of our level of knowledge about earthquake potential in the Anchorage region.

The bottom line for the San Francisco Bay region is that there are four fault segments for which the probability of a magnitude 7 earthquake in the next 30 years is 22 to 28 percent (fig. 1). If these probabilities are aggregated, the probability of one or more magnitude 7s in the Bay region during the next 30 years is 67 percent. That is a chance of two out of three. These odds are high enough that earthquake risk is now beginning to be factored into long-term planning and decisions, both in the public and private arenas.

We undertook a major effort to disseminate this information to the public. We prepared a color magazine insert that was distributed in the Sunday newspapers in San Francisco Bay region. We distributed 2½ million copies, including Spanish and Chinese editions. The magazine had a significant impact. It alerted a lot of homeowners to the seriousness of the earthquake threat and caused them to discuss things that they should be doing to prepare for earthquakes. But I think the most encouraging fact is that now businesses are really beginning to take into account the probability of an earthquake in their planning decisions.

Now, let us consider how we generate such a probability estimate. There are five questions that we need to address in regard to earthquake potential. The first one is, where are the active faults? In the Bay region, the San Andreas is the principal actor, and the Hayward is the second-ranked fault. There are other faults, but about three-quarters of the plate boundary motion in the Bay region is accommodated on the San Andreas and Hayward faults together. So these are the principal culprits.

The next question is, how are the faults segmented? Not necessarily the entire fault ruptures in an earthquake, maybe only a part of it. This is an important issue because the size of an earthquake increases in proportion to the length of the fault segment that slips in an earthquake.

In the Bay region, the San Andreas fault is divided into three segments, each capable of generating an earthquake of magnitude 7 or larger (fig. 2). Similarly, the Hayward fault including its northern extension, the Rodgers Creek fault has three segments, each capable of a magnitude 7 shock (fig. 2).

Answers to the third question, how large can the earthquakes be, come from the length of the fault segment and also from the historical record. It is important to understand that more than one fault segment may rupture in a single earthquake. For example, the 1906 San Francisco earthquake ruptured both the North Coast segment of the San Andreas, north of the city, and also the Peninsula segment, south of the city (fig. 2).

The last two questions are: How frequently do the large earthquakes occur and when was the last one? From geodetic surveys in the Bay region, we know the long-term average slip rate for this part of the San Andreas fault is about 3/4 inch per year. And for the Hayward fault it is about 1/3 inch per year. Knowledge of the average slip rate for a fault enables us to estimate how long it will take for the stresses in the rock on the two sides of the fault to accumulate to the breaking point. Then, if we know when a fault segment last broke, we can estimate when it will next rupture. The long historical record tells us that the last large earthquakes on the Hayward fault segments were in 1836 and 1868 (fig. 2). Of course, in Alaska we do not have comparable

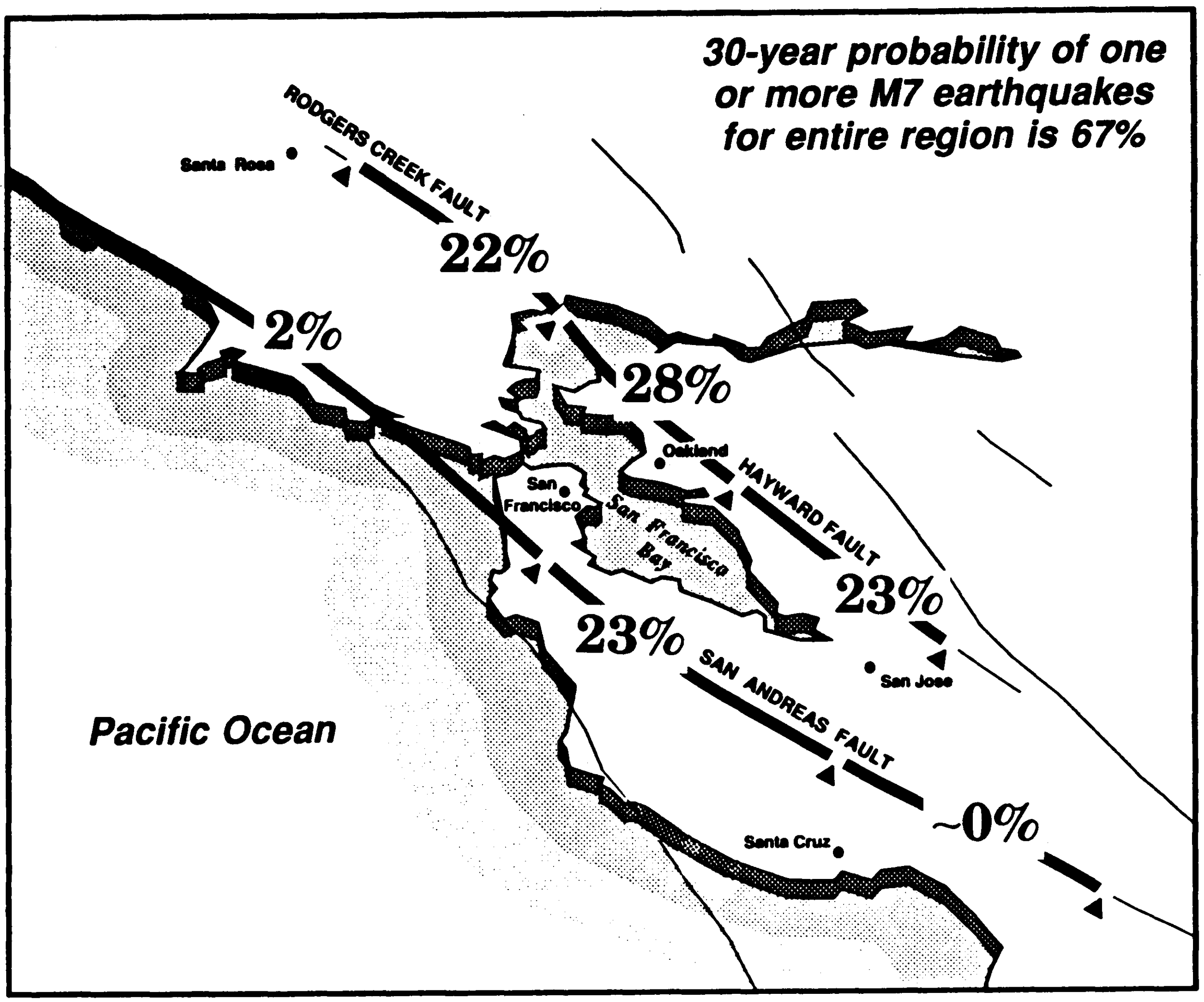

Figure 1. *Probabilities of large earthquakes in the San Franscisco Bay region, California, for the inter-val 1990-2020. The probabilities of magnitude 7 or larger earthquakes are shown for individual segments of the two primary active faults (heavy lines). The aggregate probability of one or more magnitude 7 or larger shocks from the entire region during this interval is 67 percent. Fault segments are marked by arrowheads. Adapted from Probabilities of Large Earthquakes in the San Francisco Bay Region, California, U.S. Geological Survey Circular 1053.*

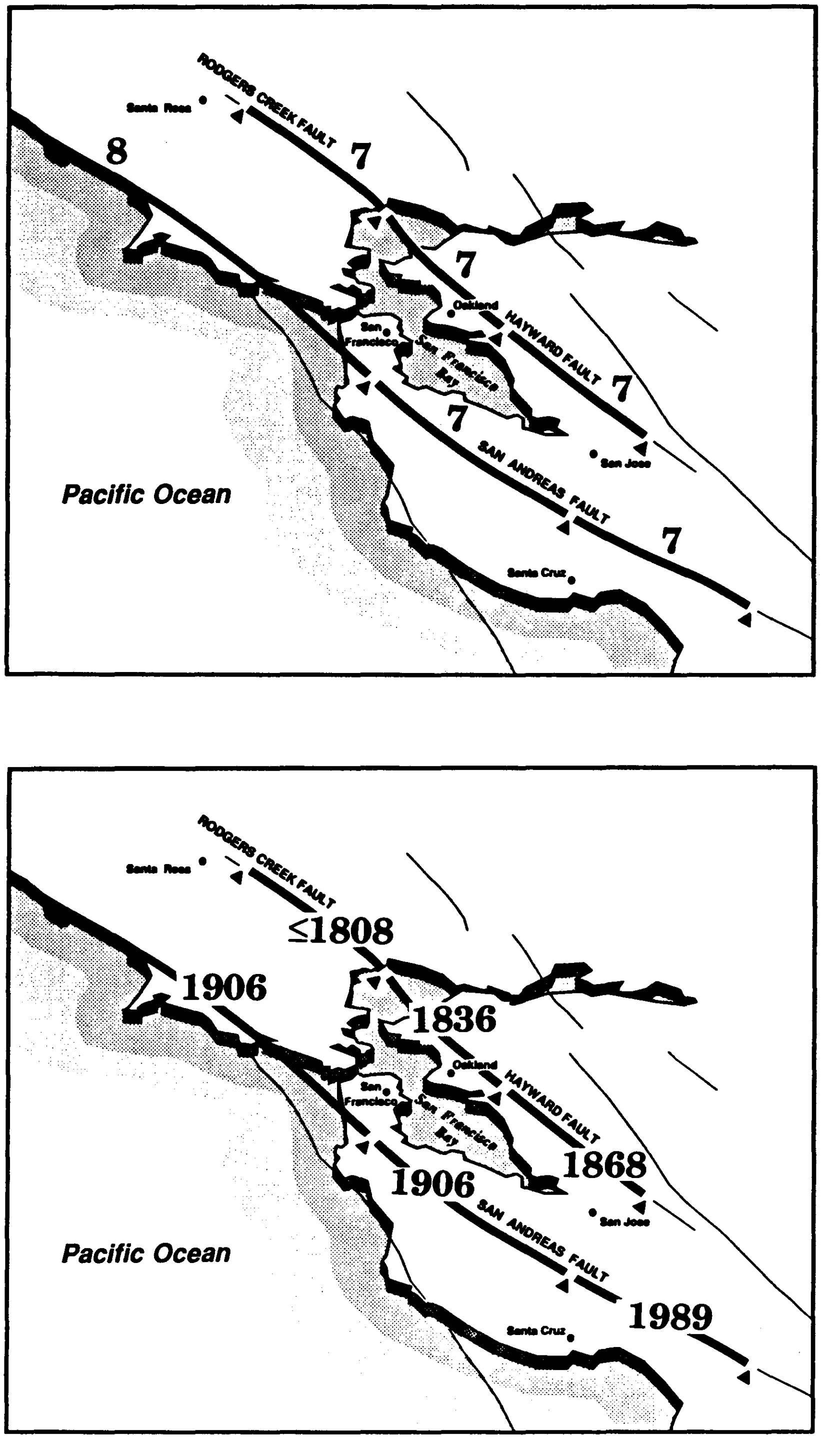

Figure 2. *Fault segments capable of generating large earthquakes in the San Francisco Bay region and related earthquake magnitudes (top) and dates of most recent large earthquake for individual segments (bottom). Fault segments are marked by arrowheads. Adapted from* Probabilities of Large Earthquakes in the San Francisco Bay Region, California, *U.S. Geological Survey Circular 1053.*

knowledge dating back to those times, except for some places in the Aleutian Islands. On the Rogers Creek fault, we do not know when the last large shock occurred, but geologic evidence suggests it was earlier than 1808.

Thus, with answers to these five questions, we are able to provide a useful statement regarding the probabilities of future damaging earthquakes for a specific time window (fig. 1).

How do we use this type of information regarding earthquake potential? It is not sufficient just to say that there is a certain probability that a particular size earthquake is going to occur. What is also needed is some statement of what the intensity and duration of ground shaking will be in different localities.

We have compared the expected levels of shaking for each of the future Bay area earthquakes with the shaking experienced in the Loma Prieta earthquake. In Santa Cruz, the intensity of shaking in future earthquakes will probably not exceed that in the Loma Prieta earthquake. The shaking should be about the same, for example, in a magnitude 7 on the Peninsula segment of the San Andreas fault.

In Oakland, however, if the segment of the Hayward fault that traverses the city should rupture, the level of shaking is expected to be about 12 times as great as that experienced in Oakland during the Loma Prieta earthquake. Many buildings suffered damage in Oakland during the recent earthquake.

LEVEL OF KNOWLEDGE IN THE ANCHORAGE REGION

Let us jump back to Alaska. The largest earthquakes that threaten the Anchorage region occur along the plate boundary. The entire boundary along the coast in southern Alaska has ruptured in a series of magnitude 7 or greater earthquakes in the last 60 years, except the section between Kayak Island and Icy Bay (fig. 3). This area is referred to as the Yakataga seismic gap. It has not generated a major earthquake since 1899. Earth scientists regard this seismic gap as a likely site for the next magnitude 8 earthquake in southern Alaska. The gap could rupture within the next few decades in a single magnitude 8 or alternatively in a series of large magnitude 7 earthquakes. An additional uncertainty regarding the Yakataga seismic gap is whether an earthquake rupture that begins in this area will stop at the eastern edge of the 1964 rupture or whether it would re-rupture part of the 1964 fault segment. We do not know the answer.

The Yakataga seismic gap is a large distance from Anchorage, about 200 miles. For this reason, a magnitude 8 in this location would not have a large direct impact on Anchorage, although very large or tall structures are likely to be set into motion.

The plate-boundary segment closest to Anchorage broke in 1964 in the second largest earthquake of this century worldwide. We are uncertain whether this segment only breaks in magnitude 9.2-type shocks. A fault segment that produces a magnitude 9.2 event on one occasion might also be capable of generating a series of magnitude 8 shocks on different subsections of the segment over another time interval. Such magnitude 8 shocks might occur more frequently than the 600-to-800-year interval suggested for the recurrence of 1964-size earthquakes.

Anchorage sits above the underthrust Pacific plate. Beneath the city the gently dipping boundary separating the North American and Pacific plates is at a depth of about 20 miles (fig. 5, top). Is this section of the plate boundary capable of generating a big earthquake? We do not have any evidence that it is. Significant shaking was not generated by sudden slip on this section of the plate boundary in 1964. The significant shaking in 1964 originated from slip on the seaward, shallower section of the plate boundary. At this time, we feel it is unlikely that a large earthquake could occur on the section of the plate boundary below Anchorage.

So far we have been addressing only the plate boundary earthquakes. There are other types of shocks that threaten Anchorage (fig. 4, bottom). One is the type that occurs on faults within the part of the Pacific plate that has been thrust beneath the continent. Most of the earthquakes felt by Anchorage residents originate in the underthrust Pacific plate (fig. 5, top). Such shocks are frequent. An example of these shocks are the pair of magnitude 6.2 - 6.4 earthquakes that occurred in 1983 in the Columbia Bay area, about 100 miles east of Anchorage, but only 25 miles from

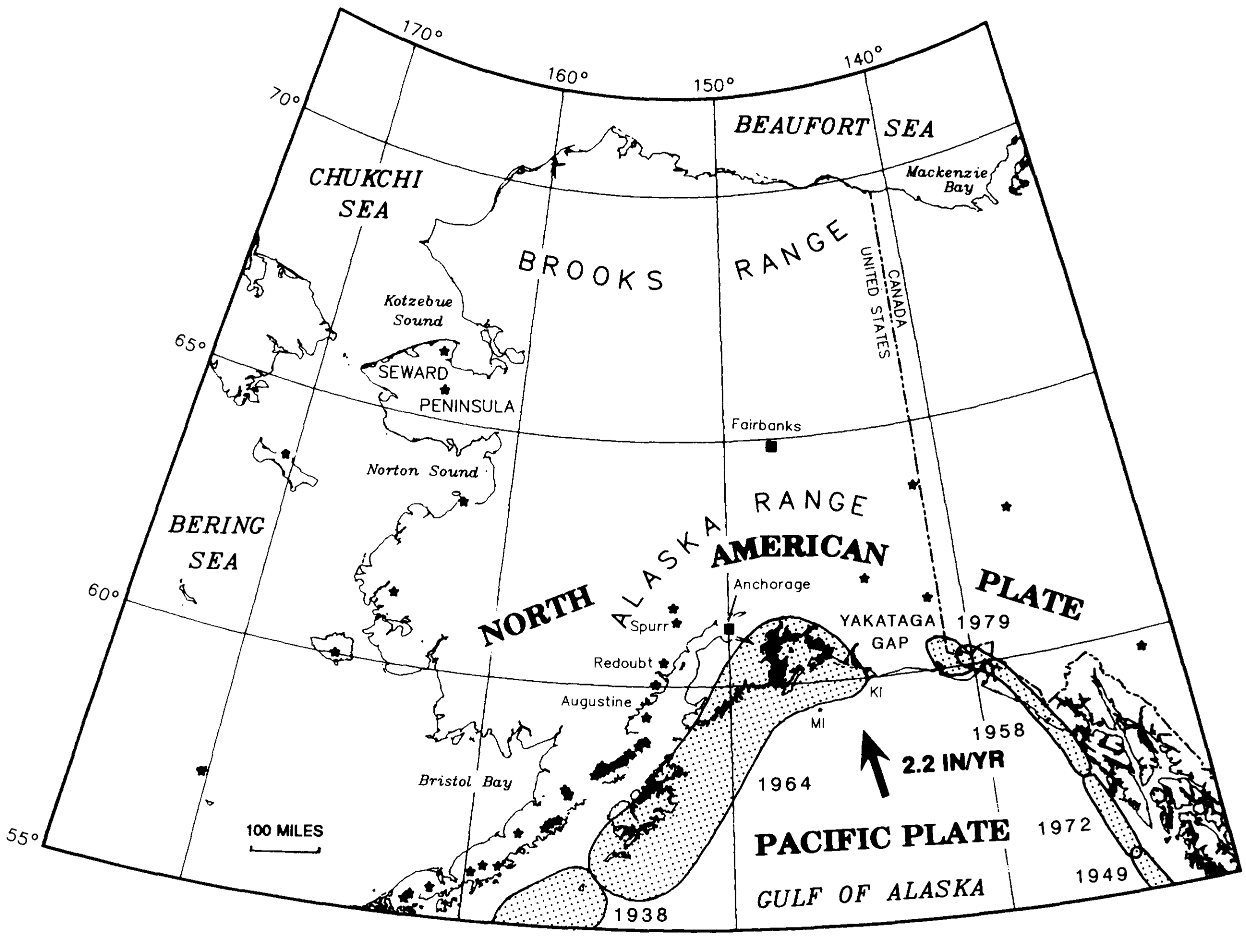

Figure 3. *Rupture zones and dates of large plate-boundary earthquakes since 1935 and location of the Yakataga seismic gap, a likely site for the next magnitude 8 shock along the Gulf of Alaska. Arrow indicates motion of the Pacific plate relative to the North American plate, which is assumed to be stationary in this figure. Along the coast of southern Alaska, the plate motion is convergent and the Pacific plate is thrust downward beneath the continent. This process gives rise to the volcanoes (stars) on the Alaska Peninsula and on the west side of Cook Inlet. In contrast, along the coast of southeast Alaska, the two plates slide horizontally past each other, as they do along the San Andreas fault in California.* ***KI****, Kayak Island;* ***MI****, Middleton Island.*

Valdez. These earthquakes shook goods off of shelves in Valdez and caused minor cracking in structures, but no severe damage. Again, the shocks were 25 miles from Valdez.

Earthquakes of this size certainly can occur right below Anchorage. In fact, the historical record suggests that earthquakes as large as magnitude 7¼ occur in the underthrust plate. We do not have any reason to believe that one of those could not occur beneath the city slightly deeper than 20 miles.

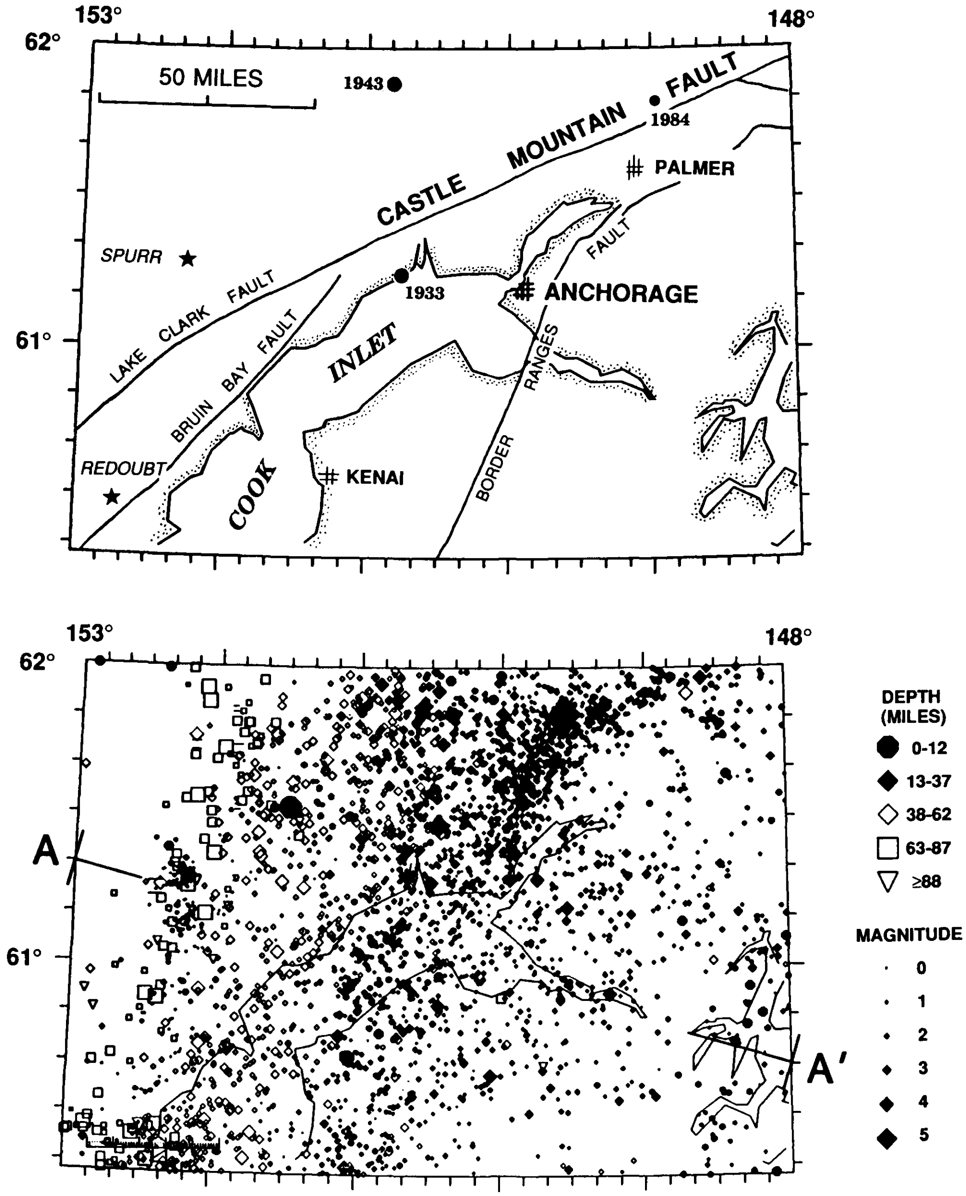

Figure 4. *Geologic setting and earthquakes of the Anchorage region. (**Top**) Faults and volcanoes (stars). Large dots indicate locations of two large historical earthquakes discussed in text; small dot indicates the 1984 Sutton earthquake. (**Bottom**) Earthquakes located by the southern Alaska regional seismograph network for the interval 1971-1982. Symbol type indicates depth at which earthquake occurs; shocks shallower than 38 miles are shown as solid symbols. Symbol size increases with magnitude. Line AA' is location of vertical cross section in top of figure 5.*

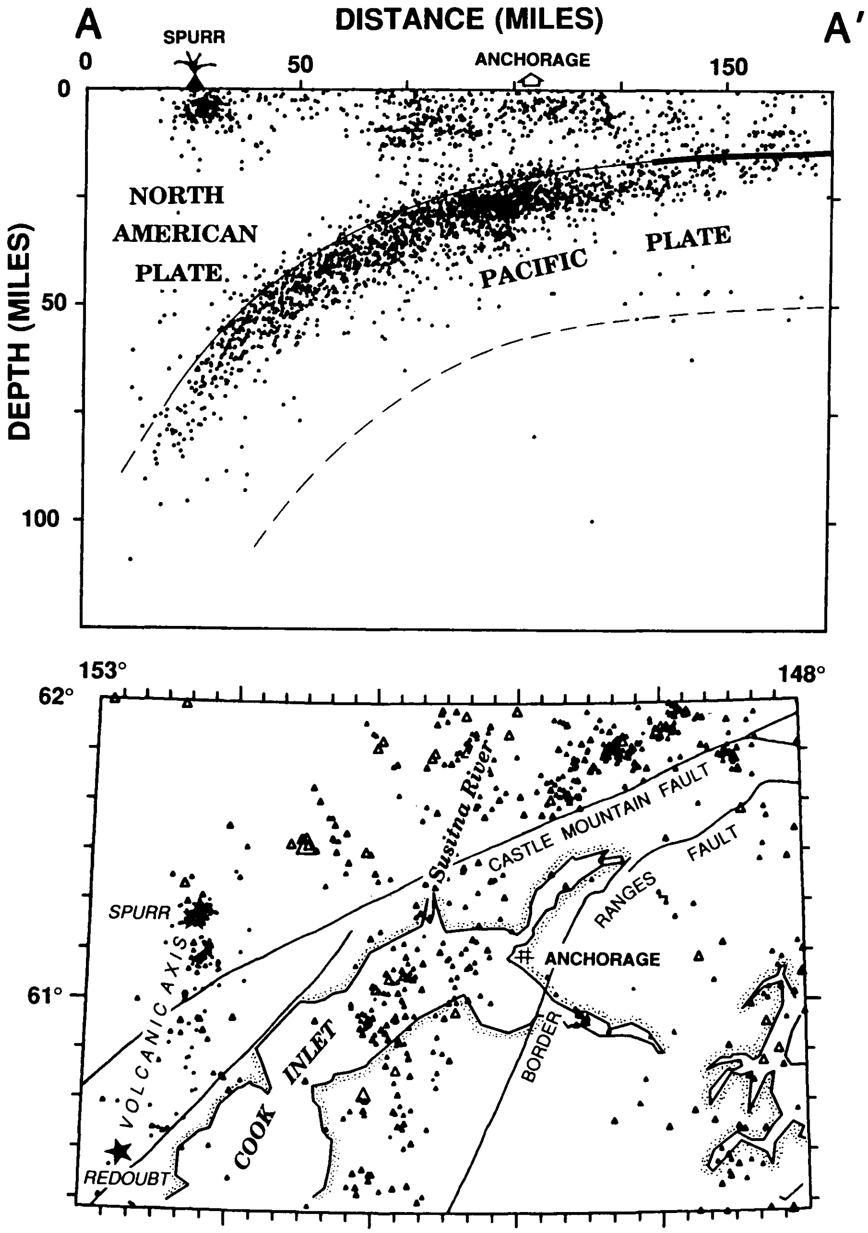

Figure 5. *Earthquakes in the Anchorage region for the interval 1971-1982. (**Top**) Vertical cross section through earthquakes shown in map view in figure 4 bottom. Most of the earthquakes originate in the underthrust Pacific plate. The boundary between the Pacific plate and the overlying North Ameri-can plate lies along the top edge of the dipping seismic zone and is at a depth of about 20 miles beneath Anchorage. The heavy line indi-cates the shallow segment of the plate boundary that slipped in the great 1964 earthquake. Earthquakes also occur at shallow depth in the over-riding plate. (**Bottom**) Map of earthquakes shallower than 13 miles. Practically none of the activity is concentrated along the known major faults. There is a cluster of shocks at Mt. Spurr volcano, but most of the activity lies in three diffuse bands located north of the Castle Mountain fault, along the volcanic axis west of Cook Inlet, and beneath the western Kenai Peninsula and upper Cook Inlet. Stars indicate volcanoes (the star at Mt. Spurr is obscured by epicenter symbols).*

Another category of earthquakes are those that occur in the overriding North American plate (fig. 5, bottom). Unlike the San Francisco Bay region, there are few active faults that have been mapped in south-central Alaska. In fact, the Castle Mountain fault is the only known active fault mapped within a 60-mile radius of Anchorage.

The Castle Mountain fault approaches to within about 25 miles of the city (fig. 4, top). Where the fault crosses the Susitna lowlands, it exhibits a very clear scarp, a sign of recent geological movement on the fault. Geologic studies show that there has been at least 21 feet of horizontal slip in the last few thousand years; however, we do not possess information for this fault on long-term slip rates. Thus, we cannot evaluate the likelihood that the Castle Mountain fault will produce a damaging earthquake during the next 30 years, as we can for active faults in the San Francisco Bay region.

A magnitude 5.6 earthquake in 1984 near Sutton (fig. 4, top) confirmed that the eastern section of the Castle Mountain fault was active. Previous geologic investigations failed to find evidence of recent activity, in part because young geologic deposits are scarce along most of this segment. If the entire Castle Mountain fault were to break in a single event, the magnitude of the earthquake would be about 7.5.

Two large historical earthquakes have been located in the Susitna lowlands (fig. 4, top), but their origins remain uncertain. One is an earthquake in 1933 of about magnitude 7, and the other is a magnitude 7.3 event in 1943. The precision of earthquake locations from that time are not sufficient to preclude the possibility that they occurred on the Castle Mountain fault. Research is underway to examine some of these old earthquakes to see if we can attribute them to particular faults. The 1933 shock may have been in the overriding plate, possibly on the Castle Mountain fault, because it was followed by lots of aftershocks. On the other hand, we do not have records of many aftershocks being felt in the Anchorage and surrounding regions after the 1943 shock. Perhaps it originated in the underthrust Pacific plate. The origins of both shocks need to be confirmed.

Regional earthquake monitoring in the Anchorage region since 1971 shows that earthquake activity in the overriding plate is not restricted to the Castle Mountain fault (fig. 5, bottom). In fact, few of the located events are associated with the fault. Rather, there are diffuse concentrations of activity in the Talkeetna Mountains north of the Castle Mountain fault, along the axis of active volcanoes west of Cook Inlet, and in a broad swath that crosses upper Cook Inlet. We need to understand the origins of such activity and know whether potentially damaging shocks could originate from these areas.

Finally, we should state that we find no seismic evidence indicating that the Border Ranges fault is active (fig. 5, bottom). Whether or not this fault is active is a critical question because it is so close to Anchorage. Accordingly, we have to be very cautious in concluding from the absence of small earthquakes during this relatively short interval of geologic time that the fault is incapable of generating a damaging earthquake in the future.

SUMMARY

In summary, we know that Anchorage has a serious earthquake problem. Unfortunately, our current level of knowledge for this region is not sufficient for making reliable estimates of earthquake probabilities for specific faults as we have done in the San Francisco Bay region.

However, if geologic and seismological studies could be accelerated over the next decade or two, we could look forward to having reliable quantitative estimates of future earthquake potential in the Anchorage region early in the next century.

As a concluding remark, I would like to caution the Anchorage community not to be as complacent as some of the communities in California have been for most of this century. A quote describing damage in the City of Santa Cruz from the 1906 earthquake says, "The City of Santa Cruz furnishes excellent evidence of the effect of soil formation on the intensity of the earthquake shock. On the high ground only about one fourth of the chimneys fell and a little plastering was cracked, while in the lower ground near the business section, several brick and stone buildings were partly taken down." In 1989, we saw the same pattern of damage. Most damage occurred on low ground near the river where the shaking was amplified on the soft alluvium underlying the central business district. By ignoring the 1906 experience, Santa Cruz was condemned to relive the agony of an earthquake disaster.

Questions and Comments from the Audience

MR. UPDIKE: My name is Randy Updike. I have one question for the two of you concerning these large plate boundary earthquakes. Is it possible to have a couple of these very large earthquakes in a very short time interval, say, within 25 years? If that is possible, would the type of investigation that you conduct, Rod, reveal geological evidence of an event, say, like the one that occurred 800 years ago?

MR. PAGE: Let me answer the first part: Is it possible? To have exact repeat earthquakes within a few decades, we do not think is possible. But, where you have two sections of a plate boundary, one that has recently ruptured in a great earthquake and an adjacent one that has not ruptured recently, an earthquake will start in the portion that has been locked longer and the fault break may propagate into the recently ruptured section. This possibility has been suggested for the northeastern end of the 1964 fault rupture. There is evidence from uplifted wave-cut terraces on Middleton Island that the uplift in 1964 was not nearly as great as the elevation differences between older terraces. This suggests that in a short time, compared to the time required for waves to cut a new terrace, Middleton Island may be uplifted by another earthquake. An underlying assumption is that the uplift will occur as it has during the last few thousand years.

MR. COMBELLICK: I will answer the part of your question regarding the geologic evidence for very large events. As I mentioned, it appears we may have evidence at Portage of two earthquakes occurring close together in time. The evidence is not really strong, however, because it is seen at only a couple of sites. Fortunately, though, the disturbances occur in the same geologic section. So we know there were two events at Portage, separated by an apparently brief period of time.

The resolution of the Carbon-14 dating technique is limited and would not allow us to resolve a short time difference between these events. In fact, if the evidence was age-range estimates from two separate locations, it would be difficult to show that the disturbances represented two separate events. The fact that the evidence comes from one geologic section shows that we have two events at Portage. The error range for those events was about 400 years, so resolving them in time would be very difficult.

QUESTIONER: To those of you who know a lot about this sort of thing, maybe these questions are dumb. But I was told that these plates are basically solid masses and that they migrate at some reasonably fixed rate. I am confused about slip along a fault line. At some place along the fault line we have a weak spot that keeps getting deformed until it finally ruptures. At this instant the two sides of the fault move relative to one another, but 200 miles away the fault does not move?

MR. PAGE: That is basically the picture. What happens is that where the plates are in contact, there is some straining at the edges of the plates. You can actually measure it geodetically. You can determine that the ground is, say, compressing or extending. Strain energy is being stored in the edges of these plates just the way energy is stored in a rubber-band.

An earthquake occurs when the forces resulting from the straining of the plates overcome the friction on the fault that normally keeps the plates from slipping. Then you have a sudden slip on a segment of the fault. This releases the strain energy stored in the rock along this segment of the fault. In the rubber-band analogy, you let go of one end of the rubber band and it snaps back to its original shape. Thus, the borders of these plates undergo repetitive elastic straining and relaxation. It is on the edge of these plates where the energy is stored for these big earthquakes. In contrast, the interior of the plates generally behave in a relatively rigid fashion, like a block.

QUESTIONER: I am still a little bit confused by the idea of the plates sliding horizontally past each other along the San Andreas fault while they are converging and one is being thrust beneath the other in southern Alaska. If 300 miles of this area along San Andreas deforms when you have an earthquake, why doesn't it break the entire length of the fault?

MR. PAGE: The character of the deformation along the plate boundary changes along the course of its length.

When the San Andreas fault reaches northern California, the plate boundary bifurcates at Cape Mendocino. From there northward to British Columbia, small oceanic plates lie between the Pacific and North American plates. Still farther north along the panhandle of southeast Alaska, the Pacific and North American plates are in contact again along the Fairweather fault. The Fairweather fault has horizontal slip just like the San Andreas fault.

Then once you start going around the bend along the Gulf of Alaska, purely horizontal motion between the plates is no longer possible. The motion between the two plates becomes convergent and the edges of the plates undergo compressional deformation until an earthquake occurs and the Pacific plate is thrust beneath the North American plate, thus, the sense of motion changes from horizontal in California and southeast Alaska to convergence seaward of Anchorage and along the eastern Aleutian Island.

MR. COMBELLICK: Let me add another answer. The fact that a rupture occurs in an isolated area of this 300-mile, or so, length of fault in California, and not anywhere else along that boundary, is a reflection of the fact that the plates are not entirely rigid.

Various parts of the interface between the plates lock up at different times. You will see strain accumulating there. During an earthquake, part of the deformed plate relaxes and the strain is shifted to some other portion of the boundary.

REGIONAL TSUNAMI POTENTIAL

by
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When we talk about tsunamis, we are talking about water motion. This water motion, or waves, can travel across the Pacific Ocean in about 24 hours and create disasters and deaths of hundreds. The Aleutian-Alaska megathrust subduction zone is one of the most dangerous in the Pacific for generating Pacific-wide tsunamis. In this presentation I will cover tsunami mechanisms, historical earthquakes along the coast of Alaska that have generated tsunamis, some tsunami modeling, and past tsunami damage. The focus will be on the coastal areas of Alaska.

The historical data cover about a 200-year period, which is a short seismic period. The data were obtained from the National Earthquake Information Center (NEIC), NOAA's National Geophysical Data Center (Lander and Lockridge, 1989), and the Russian tsunamigenic data bases (Soloviev and Go, 1974, 1975). Only those earthquakes were considered for which a magnitude was assigned. Except for the magnitude, all the other earthquake parameters came from the NEIC data base. For the magnitude of tsunamigenic earthquakes, which in most cases compares with one of those given in the NEIC data base, we used the National Geophysical Data Center (NGDC) assigned magnitude.

It is not good enough anymore just to say we had an earthquake occur and we have a tsunami generated. When an earthquake occurs, the questions become: Did it generate a tsunami? And if so, how large is that tsunami going to be at various places in the Pacific? Where is the maximum going to be? The answers to these questions would considerably help the emergency services and many others. To seek answers to these questions, we are developing models to forecast tsunami wave heights for coastal earthquakes in Alaska and along the U.S. west coasts.

I will finish my presentation with a few slides showing tsunami damage. As you know, the 1964 earthquake resulted in 115 deaths in Alaska. Of these, 106 deaths were due to tsunamis and the remaining nine were due to the earthquake. The past tsunamigenic earthquakes in Alaska have resulted in wave heights ranging up to 30 meters and more, destroying villages and other structures. In one case, a landslide-caused tsunami of about 525 meters occurred in Lituya Bay in 1958.

With regard to tsunami potential in Alaska, I wish to leave you with two thoughts concerning precautions. First, if you have a large coastal earthquake, you could experience a very large and deadly tsunami due to sea floor uplift. Secondly, in certain areas, you should be aware of what is around you because you could be inundated by another type of tsunami generating source, for example, a landslide. This can occur with or without earthquake shaking taking place. I will discuss several historical landslide tsunami sources.

Of the world's 10 largest earthquakes since 1900, the largest occurred in Chile. Of the remaining nine, three have occurred in Alaska (1964 Mw=9.2; 1957 Mw=9.1; 1965 Mw=8.7) [NOTE: Mw means moment magnitude]. Even though the 1964 and 1957 earthquakes both generated tsunamis, they were vastly different in the wave heights. For the 1964 earthquake, it was common to have 5, 10, and 20-meter wave heights, and far from the source. The 1957 earthquake, which occurred in the far western Aleutians, had wave heights of about 10 meters. Outside of this immediate area, the tsunamis were very small along the remaining Alaskan coastal areas. Similarly, in 1965, we had a magnitude 8.7 earthquake, again in the far western Aleutians which only affected the immediate area with minimal tsunamis elsewhere. In these examples, the source had a considerable effect upon the tsunami that was generated.

In general, a tsunami is a series of waves that can be generated by mechanisms such as earthquakes, landslides, volcanoes, nuclear bombs, and something falling into the ocean and displacing water, such as a meteorite. Although I will concentrate on the first two mechanisms, we did have a tsunami generated by Augustine volcano in 1883, and by a nuclear bomb in 1965 (Lander and Lockridge, 1989; Soloviev and Go, 1984).

An earthquake generating a tsunami moves the crust in the vertical direction, thus setting into motion the overlying water. This is referred to as a tectonic mechanism. This water moves out from the center as a series of waves that can travel across the Pacific and be deadly thousands of miles from the generating source. A landslide-generated tsunami can occur from subaerial and submarine land mass movements. Landslides, with induced massive local tsunamis, can and have occurred without an earthquake. The earthquake-induced ones occur within several minutes after the shaking has started. The subsequent tsunamis generated are normally very localized, unlike the tectonic ones that traverse the Pacific. However, they can generate massive local area waves.

The following three slides (figs. 1-3) show Alaska's seismic history covering about 200 years with emphasis on tsunami potential. They show tsunamigenic and non-tsunamigenic earthquakes in the magnitude ranges from 6.0-7.0, 7.1-7.5, and those greater than 7.5, respectively. Additionally, each tsunamigenic earthquake is identified by date and magnitude (Ms, Mw, if both are available). The figures show the relative frequency of earthquakes in the various ranges, geographical distributions, and symbols differentiating those earthquakes that generated a wave less than 1 meter (shaded triangle) from those that are about 1 meter or more (shaded circle). Only coastal tsunamigenic earthquakes are addressed, although some inland earthquakes may be plotted. The letter X designates those coastal earthquakes that were not tsunamigenic.

In the magnitude range of 6.0-7.0, figure 1 shows a plot of about 471 coastal earthquakes ranging from the far western Aleutian Islands through southeast Alaska from 1788 to the present time. Of these, most did not produce tsunamis or they were very small. Six earthquakes are reported to have generated a tsunami of less than 1 meter, and one generated a tsunami greater than 1 meter. The tsunami that was about 1 meter was probably due to a landslide in Valdez which caused part of a dock to collapse.

In the magnitude range of 7.1-7.5, figure 2 shows about 49 coastal earthquakes. Of these earthquakes, 45 did not generate tsunamis, three generated a tsunami of less than 1 meter, and one generated a devastating tsunami in 1946 (Ms7.4). This unique earthquake in 1946 was the impetus for starting the Tsunami Warning System in the Pacific. This tsunami destroyed the Scotch Cap lighthouse, which was about 100 feet high. This tsunami also generated Pacific-wide tsunamis causing death and destruction at many other places. An earthquake such as this one, which has a small magnitude and generates a very large tsunami, is called a tsunami earthquake (Kanamori, 1972).

In the magnitude range greater than 7.5, figure 3 shows that 28 earthquakes have been recorded (for which a magnitude can be assigned). Sixteen of these earthquakes have not generated

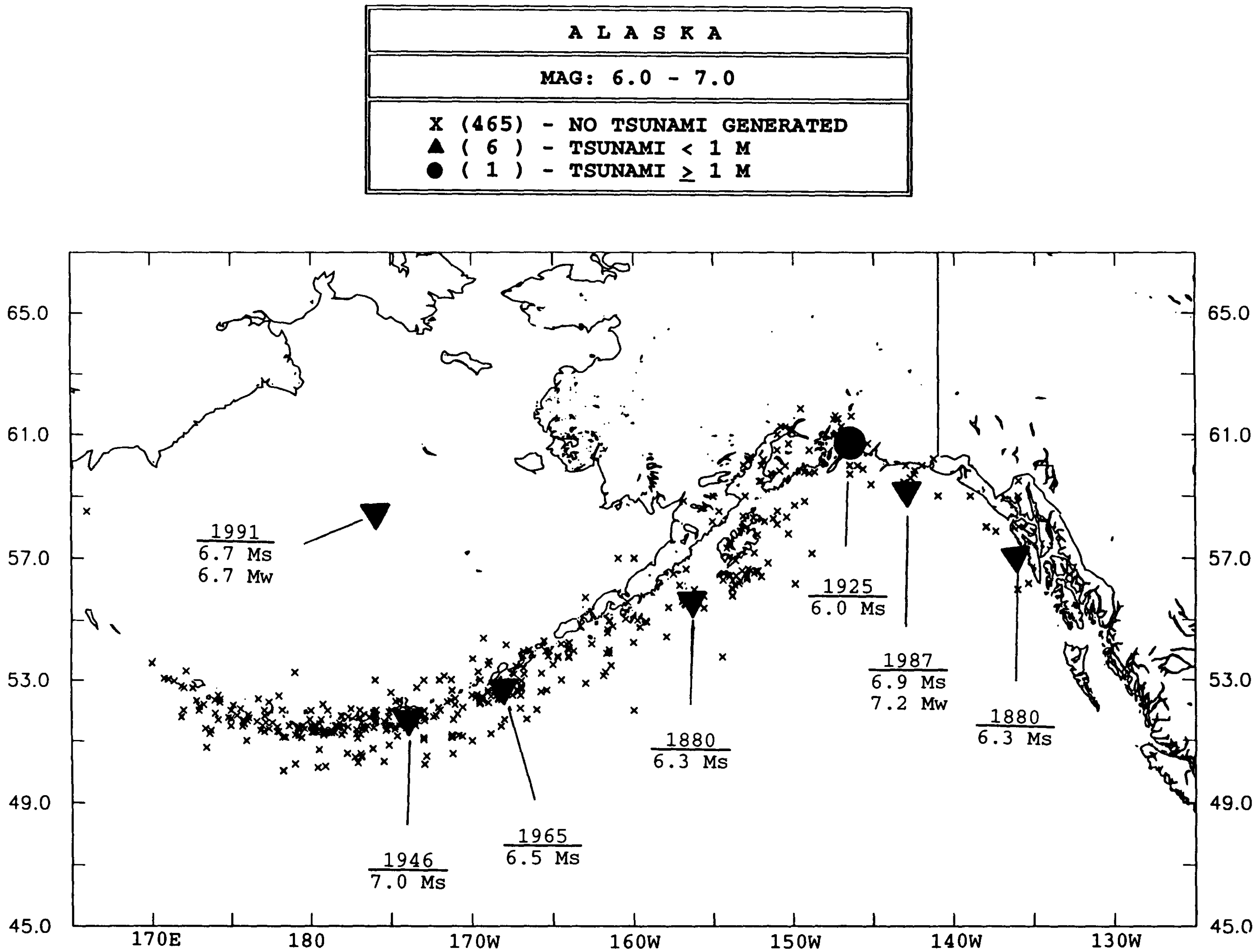

Figure 1. *Tsunamigenic and non-tsunamigenic earthquake in the magnitude range M=6.0-7.0 in Alaska.*

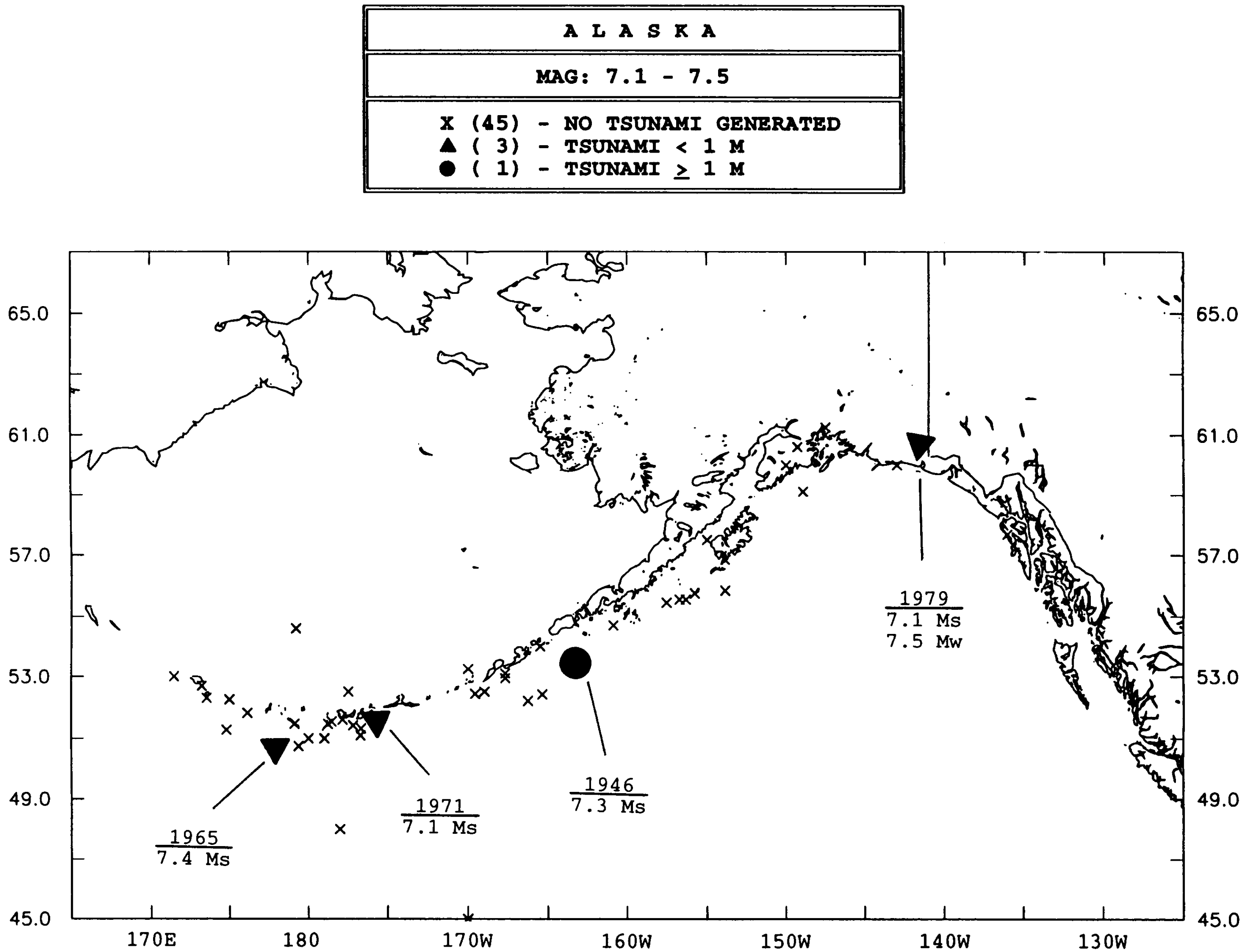

Figure 2. *Tsunamigenic and non-tsunamigenic earthquakes in the magnitude range M=7.1-7.5 in Alaska.*

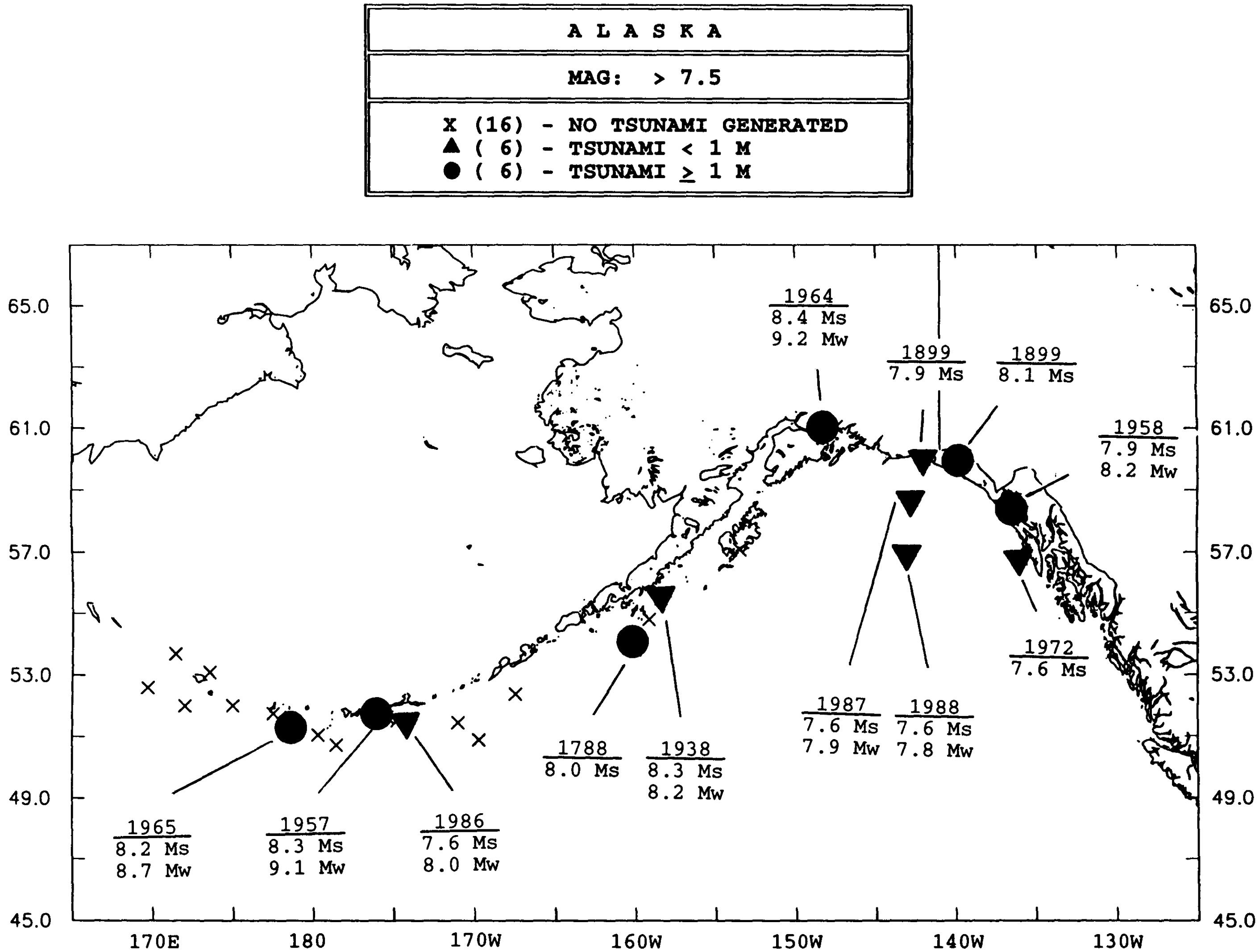

Figure 3. *Tsunamigenic and non-tsunamigenic earthquakes in the magnitude range M > 7.5 in Alaska.*

tsunamis, six have generated tsunamis of less than 1 meter, and six have generated tsunamis greater than 1 meter. In general, the sources of the tsunamigenic and non-tsunamigenic earthquakes are distributed throughout the coastal areas of Alaska, with some concentration in the southcentral-southeast areas. Of the six that generated a tsunami of less than 1 meter, one had a magnitude of 8.3 (1938) and the remaining ones had magnitude 7.6-7.9. The 1938 earthquake occurred near the Alaska Peninsula and generated waves of less than 10 centimeters. All of the six that generated a tsunami greater than 1 meter were magnitude 7.9 or greater. Figure 3 shows that for those coastal earthquakes greater than magnitude 7.5, I could expect about 45 percent to generate a tsunami, and about 50 percent of the tsunamis generated could be very destructive. It should also be noted that most of the past damage that we experienced along the west coast of the U.S. occurred from tsunamigenic earthquakes whose sources were in Alaska.

In southeast Alaska, the main threat from a great earthquake is from slide/slumping-induced tsunamis, even though the inland Fairweather fault has experienced 12 meters or more of uplift. Furthermore, those areas that experienced slide-induced tsunamis are located near steep slopes, glaciers, sediment deposits, or are situated at the edge of deep fjords.

Landslide-induced tsunamis can and have occurred with and without earthquake-induced shaking and with volcanic eruptions. Let us review the history of some of these landslide-type tsunamis that have occurred. With regard to earthquakes, three of these earthquakes (1899, 1958, 1964) occurred in the Gulf of Alaska/southeast Alaska and induced local slumping; landslides of rock, soil, and glaciers; and/or submarine landslides. The 1899 earthquake occurred at the tip of Yakutat Bay, and caused at least five local tsunamis, including two at Yakutat, and one each at Katalla, Lituya Bay, and Valdez. The largest tsunami was 18 meters. The 1958 earthquake occurred on the northern coast of Cross Sound and caused at least six local slide-induced tsunamis at Lituya Bay, Yakutat Bay, Disenchantment Bay, Dry Bay, Glacier Bay, and Dixon Harbor. The largest landslide-induced tsunami wave was 525 meters high at Lituya Bay in 1958. The well known 1964 earthquake generated a tectonic-uplift tsunami plus at least five local slide-generated tsunamis within minutes after the earthquake started. These occurred at Valdez (two), Seward, Whittier, and Kachemak Bay.

Although there are several reports of volcano-induced sea agitation in Alaska, the 1883 volcanic event is documented as inducing a tsunami by mass movement from the slopes of Augustine volcano. English Bay experienced a 9.1-meter wave that carried boats onshore and then out into the bay, and then onshore again. The first wave was followed by two others estimated at 5.5 and 4.6 meters. Due to the shallow water depths, the wave energy was rapidly dissipated. Damage was minimal due to low tide. It should be noted that the travel time for the tsunami wave from Augustine took about an hour to go to Port Graham and English Bay, and a little over an hour to go to Homer.

Even without earthquakes, southeast Alaska seems to have a propensity for slide/slump-induced local tsunamis. In addition to the aforementioned effects associated with the 1899 and 1958 earthquakes, southeast Alaska has experienced slide/slump tsunamis in 1905, 1853/54, 1874, and 1936. In late 1853 or early 1854, a probable landslide source on the south side of Lituya Bay produced a tsunami that cleared trees to a height of 120 meters. Some people in canoes perished at Lituya Bay. In about 1874 there was another probable landslide source in Lituya Bay. Evidence of flooding and washing to 24 meters was found. In 1905, a glacier tumbled down about 300 meters into Disenchantment Bay and caused a 4-6 meter wave in Russel Fjord. In 1936, there was an enormous wave of 150 meters in Lituya Bay.

It is important to be aware of what is around you so that preventative measures can be taken in case there is a landslide-induced tsunami, either with or without the occurrence of an earthquake.

As I mentioned earlier, we are currently attempting to determine tsunami wave heights (single amplitude) for an earthquake by developing and integrating developed models to forecast wave heights and currents from source mechanisms (Dunbar and others, 1989; Kanamori and Given, 1983; Kowalik and Murty, 1987; Okada, 1985; and others). Before this, we could only speculate on the magnitude of tsunami wave heights using past historical wave heights as a guide. This direction by the Alaska Tsunami Warning Center (ATWC) was initiated a few years ago and we are now starting to realize some preliminary results. Some of the initial modeling results that I will be presenting today include sources in the Bering Sea, Yakataga region, Shumagin Islands region, and the Cascadia zone near the U.S. west coast (Kowalik and Whitmore, 1991; Whitmore, 1993). The modeling discussion is intended to focus only on tsunamis affecting Alaska. The results of these models are preliminary and depend upon the input source parameters which were obtained from numerous research sources. For example, the source parameters for the Yakataga regions were obtained from USGS scientists at Menlo Park. In addition to forecasting future wave heights from possible source areas, we have modeled many past tsunamigenic earthquakes to determine the accuracy of the modeled results (Kowalik and Whitmore, 1991). These have correlated well with past historical tsunami wave heights. In places where we wanted more detailed results, the bathymetric data with 12-second intervals were used. The method of computation is described in some detail by Whitmore (1993). For each model, tsunami wave heights and currents were computed for approximately 150 different locations. Not all were plotted on the figures. Only a representative maximum was plotted for the various areas from the far western Aleutians to southeast Alaska.

On February 21, 1991, an earthquake occurred in the Bering Sea that generated a small tsunami of less than 10 centimeters at Adak. This earthquake was modeled and the tsunami wave heights reproduced. The source parameters used were: latitude=59.4N; longitude=175.4W; strike=315 degrees; dip=30 degrees; slip=90 degrees; length=22 kilometers; width=12 kilometers; depth=13 kilometers; and Mw=6.8. The computed wave heights were less than 10 cm at Shemya, Amchitka and Adak. Modeling of larger magnitudes (Mw>6.8) for this location showed that the affected areas would be the islands of St. Matthew, St. Paul and St. George, and places in the Aleutians from Atka to Shemya. The maximum wave height for a Mw=7.5 was less than 0.3 meters.

The next modeled tsunamigenic source is in the Shumagin Islands. The parameters used were: latitude=54.6N; longitude=159.7W; strike=254 degrees; dip=11 degrees; slip=90 degrees; length=250 kilometers; width=100 kilometers; depth=26.7 kilometers; and Mw=8.5. Most of these parameters were taken from scientists from Lamont-Doherty Geological Observatory. The maximum uplift in the Shumagin Islands is about 2.8 meters and the maximum subsidence is about 1.4 meters. Figure 4 shows that for Alaska, the larger wave heights are distributed about the epicenter with a maximum of about 5 meters. In the far western Aleutians, the amplitudes show a significant decrease in amplitude to less than 20 centimeters. In southeast Alaska and on the Pacific side (outermost islands facing the Pacific Ocean), wave heights are shown to reach a maximum of about 1 meter. They decrease considerably inland toward, say, Ketchikan or Metlakatla.

The parameters used for the Yakataga model were: latitude=60.0N; longitude=144.2W; strike=270 degrees; dip=12 degrees; slip=90 degrees; length=250 kilometers; width=100 kilometers; depth=35 kilometers; and Mw=8.6. Most of these parameters were obtained from scientists at the USGS in Menlo Park. The maximum uplift and subsidence in the Yakataga region were 3.3 and 0.3 meters respectively. Figure 5 shows the results of modeled tsunami wave heights

TSUNAMI WAVE HEIGHTS

SHUMAGIN IS. REGION: Mw 8.5

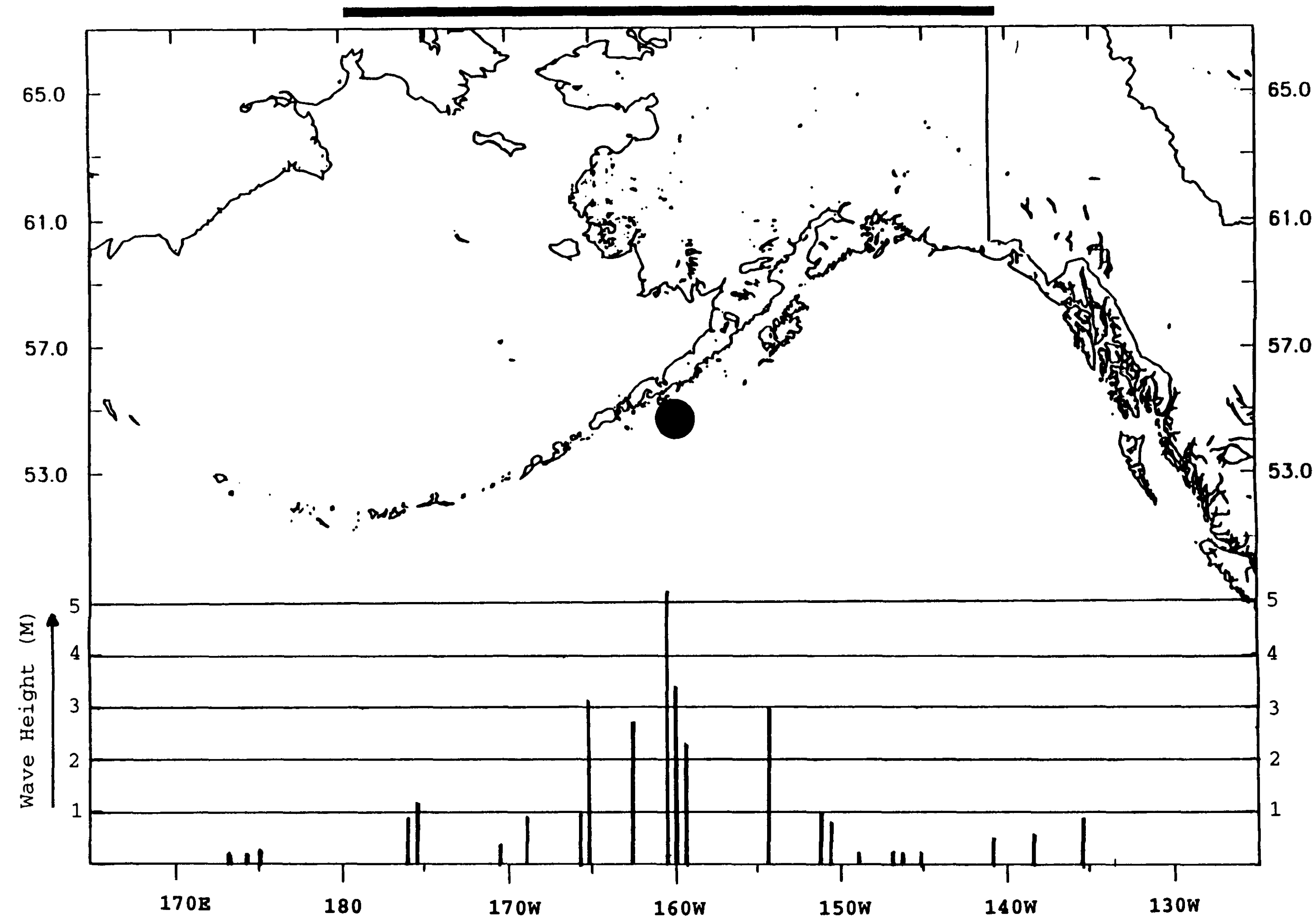

Figure 4. *Modeled tsunami wave heights determined for various locations on the Pacific side of the Alaska coast from an earthquake occurring in the Shumagin Islands. The determined wave heights are shown at the bottom of the figure. These heights represent coastal localities that are projected onto the longitude scale. Maximum wave height of about 5 meters is shown near the epicenter. Large shaded circle shows the earthquake source.*

TSUNAMI WAVE HEIGHTS

YAKATAGA REGION: Mw 8.6

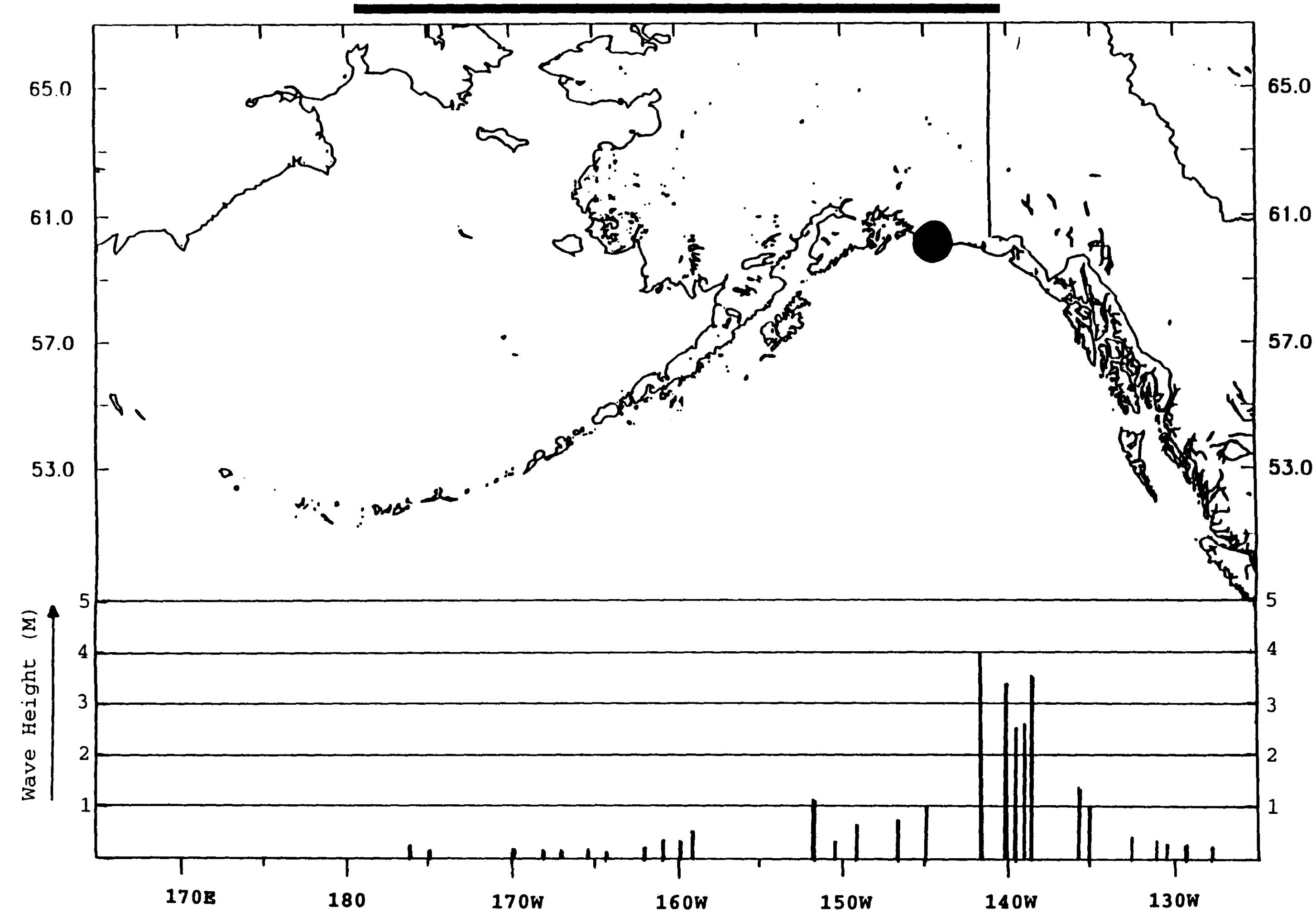

Figure 5. *Modeled tsunami wave heights determined for various locations on the Pacific side of the Alaska coast from an earthquake occurring in the Yakataga region. The determined wave heights are shown at the bottom of the figure. These heights represent coastal localities that are projected onto the longitude scale. Maximum wave height of about 4 meters is shown near the epicenter. Large shaded circle shows the earthquake source.*

determined at various coastal areas of Alaska. This figure shows a lack of symmetry in the distribution of wave heights about the epicenter which seems to reflect the extensive shelf area in the vicinity of the epicenter. The larger wave heights are located to the east and southeast of the epicenter with a maximum of about 4 meters near the epicenter. Further from the epicenter in the southeast direction, the amplitudes decrease to less than about 0.5 meter. Immediately to the west of the epicenter, there is an abrupt decrease in the amplitude to about 1 meter or less. Further west of the epicenter there is a significant decrease in the amplitude to less than 0.2 meter.

The last modeling example involves the occurrence of a large tsunamigenic earthquake off the U.S. west coast and the wave heights determined for various places in Alaska. The parameters used were: strike=358 degrees; dip=13 degrees; slip=90 degrees; length=650 kilometers; width=80 kilometers; depth=20 kilometers; and Mw=8.8. Most of these parameters were obtained from various scientists' research papers. The maximum uplift and subsidence for Cascadia were 3.7 and 1.8 meters respectively. Figure 6 shows the maximum wave height to be less than 2 meters, with the maximum occurring about the Shumagin Islands area. It also shows that coastal areas from southeast Alaska to the western Aleutians can experience wave heights of about 1 meter or less.

The slides of tsunami effects show the devastation resulting from the 1964 tsunamis at Seward, Valdez, and Kodiak; the destruction of the Scotch Cap lighthouse on Unimak Island, Alaska in 1946; the destruction of the vegetation on the slopes of Lituya Bay where a landslide-generated tsunami in 1958 reached heights of 525 meters; and a wave crushing a pier in Hilo, Hawaii, from a tsunami generated by the 1964 earthquake in Alaska.

In conclusion, the Alaska Tsunami Warning Center (ATWC) continues to improve its operations Center by implementing research developments and integrating computers to improve both the reactive and predictive parts of the ATWC (Sokolowski and others, 1990; Sokolowski, 1991). The basic areas include automatic detection and analysis of seismic data in real-time; immediate near-automatic dissemination of critical earthquake and tsunami information; automatic detection and analysis of tidal data in real-time or near real-time; rapid discrimination of tsunamigenic and non-tsunamigenic earthquakes; and reasonable estimates of probable tsunami wave heights, current, and areas of inundation in the path of a tsunami. It should be noted that the wave heights given in this paper should be considered preliminary pending a national tsunami-inundation modeling effort.

TSUNAMI WAVE HEIGHTS

CASCADIA SUBDUCTION ZONE: Mw 8.8

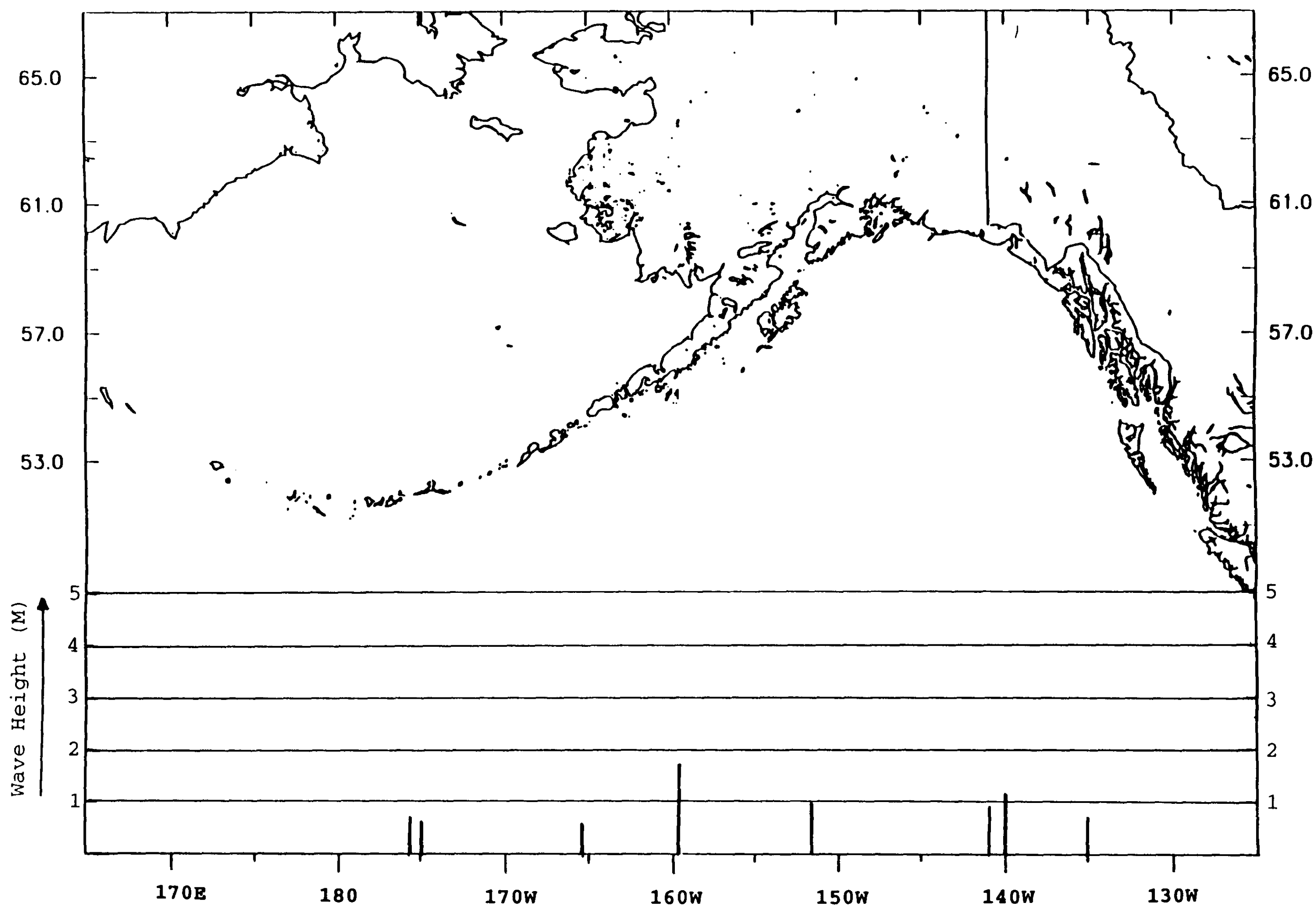

Figure 6. *Modeled tsunami wave heights determined for various locations on the Pacific side of the Alaska coast from an earthquake occurring in the Cascadia subduction zone near the U.S. west coast. The determined wave heights are shown at the bottom of the figure. These heights represent coastal localities that are projected onto the longitude scale. Maximum wave height of less than 2 meters are shown near Sand Point, Alaska.*

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POTENTIAL EFFECTS OF A MAJOR EARTHQUAKE ON STRUCTURES IN THE ANCHORAGE AREA

by
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What I'd like to do is take a brief excursion into the world of structural engineering and define some of the engineering terms that you often hear. I'll illustrate these with examples of building damage that results from processes like torsion and pounding. Then I'll relate some of the building damage that we've seen in other areas to what may happen in Anchorage.

As structural engineers or architects, we have to make one basic assumption when we design. And that's that the ground will stay under the building during a strong-motion earthquake. If we can't make that basic assumption, we have major problems. I'll show you at least one case where that basic assumption wasn't made. They, in fact, designed a building that is predicted to have a potential of several feet of vertical and horizontal movement under it. I'll just show you why, in their opinion, they were able to do this.

So what we'll do is we'll start going through a few terms. I'm going to be talking simply about buildings. I won't discuss lifelines. Randy Updike, in his talk at noon, will discuss lifelines—bridges, ports, and things of this nature. I'll really relate all of my information to the building environment.

Some of the important design issues have to do with occupancy. Occupancy and configuration are architectural consideration. But the structural engineers should really be involved in the selection of building configurations. Unfortunately, normally they aren't.

Typically the architect will set the building configuration and it may be irregular in plan and elevation, and then will expect the engineering professions to make the thing work. And that could be problematical sometimes. We're worried about the types of structural systems that are used, whether they're shear-wall type systems or building frames. We worry about structural detailing because improper detailing under seismic loading can be extremely dangerous. Typically the seismic load is always going to be much greater than the load that the building has actually been designed for. We depend on a property called ductility to absorb some of the excess energy. I'll talk about that in a moment.

Then we have to worry about nonstructural elements. Many times nonstructural elements, if they're indiscriminately placed in structures, can completely change the reaction of those structures. We have to worry about nonstructural elements stiffening the building to the point where we have perhaps an unsafe building.

In many earthquakes in other countries we find that the quality of construction and materials has a lot to do with failures in buildings. Structural system is where we talk about the weight of the structures. We talk about the different types of structural framing, whether it's frames or braced frames, or shear walls. These are the types of things that we worry about when we're designing a structure.

Under seismic issues I wanted to take a brief look at some major earthquakes that have occurred and the deaths that have resulted from those major earthquakes. I'm not so concerned about the deaths; but I'm more concerned about the types of structures that we tend to see fail, earthquake after earthquake. You'll notice the China earthquake, Tangshan, China, in 1976, where 242,000 people were killed. That's a big one. But what I really want to look at first is earthquake fatalities between 1900 and 1949. This gives you an idea of the type of buildings that failed.

We see the collapse of timber and reinforced concrete buildings. There were a lot of fatalities due to fire. And then, of course, the collapse of unreinforced masonry construction has always been a problem in other areas of the country, and led to a lot of deaths. California has a lot of legislation that deals with the strengthening of existing unreinforced masonry and, of course, we don't build that type of structure anymore. Alaska has very little unreinforced masonry unless a contractor has gotten away with something. Building codes, since 1964, have really strengthened the area of masonry construction, even though I firmly believe that high-rise masonry is really not a thing to build in earthquake country.

During 1950 to 1990, what's interesting is that the collapse of timber buildings was about the same. But we see a real increase in the collapse of reinforced concrete buildings. That's because there was a lot of concrete construction going on during that period. We really didn't have a full understanding of how to detail beam and column connections so they would properly perform under earthquake loadings. There was a big push for concrete construction. There were a lot of high-rise concrete buildings being built. So there were a lot of fatalities in building failures of this type. We still see the collapse of masonry in buildings being a big contributor to fatalities.

If a building is just sitting there, or you're just standing in some place, you simply have a gravity load pulling on you. But when we talk about earthquake forces, we're not only worried about looking at the vertical components of earthquake loads, but we're also looking at the horizontal components. When we design buildings we look at these horizontal earthquake forces in the transverse and longitudinal directions of the building. The codes don't really relate to vertical earthquake forces because there are other things that we do in designing the building for live and dead loads that really take into consideration this type of loading. But we're really worried about these horizontal loadings on the building. And this is somewhat complicated.

A building might respond like a pendulum when the ground is shaking. I'll talk a little bit about that response in a second. Configuration is extremely important. Architects and engineers should work very closely together to make sure that the building configuration doesn't detrimentally affect the response of that building during an earthquake.

When we talk about building configuration we really worry about whether it is irregular or simple in plan, or does it have a lot of reentrant corners and is it very complicated in plan. When you have things like reentrant corners, you can induce stresses under earthquake loadings that pose a major problem. If you don't consider that in your design, you can have problems under seismic loading. You can have similar problems with buildings that have irregular elevation shapes.

We look for vertical and plan discontinuities so we can take into account these irregularities. As long as we recognize the problem, then we can really design for it. In the past there have been a lot of failures of buildings because people didn't really recognize the problem with discontinuities. I'll show you a building later where that was the case.

This is an example of a building that's irregular in plan view. I'm not saying that it's an unsafe building. It was designed to modern codes. The engineer and the architect did take into consideration what might happen at this reentrant corner area. But that's an irregular building. This is the type of building that's very difficult to design using simply the Uniform Building Code, because the Uniform Building Code really deals with regular structures. And it's really a minimum standard for the design of those structures.

There can be serious damage if you have an irregular building supported, say, on a sloped area with different length pilings. Flexibility varies as the cube of the ratio of piling lengths. So a pile that is twice as long is eight times more flexible. This means that the shorter piling is much stiffer. If a 450-pound load is applied laterally, the short piling will take 400 pounds of that load and the long one takes 50 pounds. If you don't recognize that during design and account for it you can, in fact, overload the short pile. If both piles were the same size in cross section, you could overload the short pile unknowingly and cause failure.

Let's talk a little bit about torsion. Earthquake forces act through the center of mass of a building, but the center of resistance may be walls that are displaced from the center of mass. So the center of resistance has a resisting force that causes an eccentric loading on the building. If you designed simply for horizontal loads and forgot the torsional loads, you could be designing a very unconservative structure. This is the Penneys Department Store in Anchorage. Torsion was probably one of the main contributors to the failure of that particular building during the 1964 earthquake because it had stiff walls in two sides of the building and fairly flexible walls on the other side. So the center of mass and the center of resistance were displaced. There was a hellatious torsional load on this building that caused its failure. Hopefully when it was redesigned and reconstructed that was taken into consideration.

Let's take a real quick look at pounding and drift. When we talk about drift we're really talking about how far the building moves under shaking and the relative displacement between stories. In pounding, two buildings are knocking together, essentially. So when we design tall buildings next to short buildings, we have to really worry about how close those buildings are together, because they move at different frequencies. One building, in fact, can damage the other building during a strong-motion event.

We really worry about aspect ratios of buildings. Ideally, you'd like to keep the aspect—the ratio of the height to the width of the building—below around 3 or 4. That gives you a real stable structure. These very high aspect ratio buildings cause some real problems in designing the exterior columns, because when they shake, they get hellatious compression loads on the exterior. The load comes from either direction. So of course you get hellatious compression loads all the way around the building. You have to really worry about that problem.

This is an example from Mexico City where this particular building was moving at a different period than this very tall building next to it. It severely damaged the tall building. This building happened to be at about a mid-column height, so that made it even more dangerous.

I hope none of the building owners are in here. I show this because it illustrates a couple of things that normally you shouldn't do. You have a real soft story area here. The center of resistance is along this side. So it's well displaced from the center of mass, making this building subject to extreme torsion. And you have this very short building that's probably within inches of this wall. So there's some potential, when this building is shaking, that you'll have some pounding damage. And that pounding damage will occur at the mid-column height of the soft story.

The reason we worry about drift is what can happen if it drifts too far. We have a soft-story situation here where these upper walls are much more rigid. They tend to draw the earthquake loading. This lower floor is a very flexible area. We see a lot of building failures of this type. Here's one from Loma Prieta that just shifted. Again this is a soft story compared to the upper floors. We have to worry about drift because if an object is just sitting straight up and down and you put a force on it, you have simply a compressive force on that object. If that object starts to move that compressive force is displaced. You not only have the compressive force on the object, but because of the eccentricity that's developed, you get a torsion in that object also.

When we talk about ductility, we're simply talking abut the ability of a structure to absorb energy. We're talking about it being able to take excursions into what we call the inelastic-deflection range. Ductility is extremely important in earthquake design, because we're designing for loads much lower than the actual anticipated loads.

The period of shaking is essentially how long it takes something to go through one cycle. If we talk about frequency, we're talking about the number of cycles within a certain period of time. Here's an example of fundamental periods that you might expect from certain types of structures. Here's a piece of fastened equipment, with about a 0.05 second period; a bridge has a period of about 6 seconds. Tall buildings have periods on the order of 2 to 4 seconds. Shorter buildings, single story, have a period of 0.1 second. The characteristic period of a building is about one tenth the number of stories. So a 20-story building has about a 2-second period. That gives you a rough idea of what the frequency of a tall building might be.

This shows a simple way of how we can vary the frequency of a structure. If we have a flag pole with something on the top, we can lower that something and change the frequency. We can lower the flag pole itself. We can change the shape of the flag pole. We can change the material of the flag pole. Finally we can change the base of the flag pole. All of these methods can be used to change the frequency.

What we're worried about in earthquake design is we don't want the building frequency to be the same as the frequency of the soil. If we have those two frequencies very close together, we get resonance, which can cause very large deflections. The site period tends to reinforce the building period. In theory, at resonance, in a undamped item, you can predict infinite displacement. And of course buildings have trouble with infinite displacements.

We're concerned about modes of vibration, in this particular case in a very short building. We have a single mode of vibration. As we get into taller buildings, other modes of vibration enter into the picture. In the shorter structures in Anchorage, we're more interested in probably this first or second mode of vibration.

The goal of the Uniform Building Code is to resist minor earthquakes without damage, moderate earthquakes with possibly some architectural damage, and major earthquakes without collapse. Remember, I didn't say that it wouldn't be totally undamaged. I said without collapse. We want to get the people out. There's a new one that we want to worry about in important structures; we want them to remain functional.

Base shear is essentially the horizontal load that's coming into the building at ground level. We're going to distribute that load over the height of the building and then calculate the moments of shear because of that. The base shear equation is essentially force equals mass times acceleration. These are the types of equations that we use to calculate the force on a building. And then we mathematically distribute that force over the building.

Now I'll talk about base isolation. In a normal building that's connected to the foundation and to the ground in a normal manner, you get upward amplification of the forces because you get whiplash effect as you move up the building. You can get rid of a lot of that in many buildings by isolating the base. You essentially free the structure from the ground using some seismic-isolation system of some sort. And this is being done in many places. Contrary to popular belief there are no buildings in Anchorage on ball bearings.

This is an example of a building in Salt Lake City, Utah, a public-services building that was built in the 1900s, a very expensive building, but it was really seismically vulnerable. And they wanted to do something about it. So they freed this building from the ground by placing it on 458 isolators. First they lifted the foundation off the ground then they put these steel and rubber isolators underneath it. It was about a $40 million retrofit. They cut the expected ground acceleration that this building would experience from .4 g to about .05 g. And the building will, in fact, take that type of loading.

There was a risk study done in Anchorage. These are some of the results for a future earthquake: damage in the area of $407 to $600 million; deaths, three to four; injuries, 103 to 186. I don't have time to go into this. But this just gives you an idea that we're talking serious stuff as far as damage is concerned. I believe that the number of deaths will be higher.

This is the type of a thing that a structural engineer can't solve: Massive ground sliding or ground failure and then the splitting of the building. If you look at the parts that aren't in that area, they seem to be doing pretty well. But we can't handle that. So we shouldn't site structures in places like that.

Roofs tearing away from concrete or walls are prevented by our newest codes. But there are some old buildings in town that have the situation where the roofs are not well connected. We could anticipate failures of that type.

During search and rescue after the Chinese earthquake, they found that if they could get people out quickly they had about a 90 percent chance of survival. As the days progressed their chance of survival was extremely poor. Victim extraction and debris removal are areas of study that are really just getting started. It's something that Anchorage really hasn't paid much attention to and I think they really should.

Is Anchorage prepared? Well, we'll see. Thank you.

Questions and Comments from the Audience

MS. SCHULZ: On an average, do you feel like Anchorage has increased or decreased its vulnerability to earthquakes since the 1964 event?

MR. AHO: Well, there's definitely been an increase in vulnerability, for several different reasons. In 1964 we had 90,000 people. We had two or three what we'd call high-rise structures, 10 to 12 stories. By the way, the Westward Hotel had severe pounding damage during the 1964 quake. But we didn't have a lot of high-rise construction. Since then, we've built more high-rise construction. We've built more concrete construction. We've built in areas that in my opinion have a potential for massive ground failure. And we have increased our vulnerability.

On the positive side, we also are designing to very modern building code. And we have very competent designers working on these buildings. I'm not sure if we're ahead of the game yet or not, though.

A HYPOTHETICAL EARTHQUAKE ON THE CASTLE MOUNTAIN FAULT

by
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This morning you had a series of excellent talks on the seismic potential in this part of the country. There was quite a bit of emphasis on repeats of the 1964-style earthquake. And what I would like to do today is shift from that into something that I feel is equally as likely to strike southcentral Alaska, and that's a magnitude 7-type earthquake.

So here we are, next Monday morning, 10 a.m., a magnitude 7.1 earthquake about 8 miles from Wasilla and about 25 miles from Anchorage, middle of the morning. The idea as we go through here is to try and put it in your own life-style framework and see what you would be doing—how this would impact your life next Monday morning.

Now, again, as I just said, a lot of the discussion so far has been on the potential of an earthquake caused by the subduction of the Pacific plate under Alaska. And this subduction is the cause of a lot of the volcanic eruptions that Anchorage has currently been experiencing as well as the occasional big earthquake.

Here's our epicenter, next Monday, on the Castle Mountain fault, several miles northwest of Anchorage. That event is going to be strongly felt in the Anchorage area, and catastrophically in the Wasilla area. But also it will be felt throughout the entire southcentral region. The area from the Matanuska Valley on the north to Kodiak is going to see people experiencing ground motion. Kodiak is quite a distance away, so this earthquake will probably be not that dramatic compared to Anchorage. Again, you saw this slide before. We've got a fault that primarily is a strike-slip fault, similar to California, similar to the San Andreas fault. It also has a component of vertical motion on it, and that's what gives us the prominent relief.

We know that the Castle Mountain fault has potential. Bob Page pointed this out to us very distinctly with his diagrams this morning. We can see geologic features like the Little Susitna River here, that comes across the fault and gets entrenched in this zone right along the edge of the fault, clearly evidence of recent displacement.

The Division of Emergency Services, the focal point of the whole response activity is in the new facility at Fort Richardson. Sometime talk to the folks that work there about some of their worries about their work place and what's going to happen to computers, telecommunications and so forth if they get ½ g of acceleration. I'm not going to be pointing fingers at individual buildings as being a specific problem. But the idea is to try to capture the vulnerability that exists, the broad picture of a magnitude 7 vulnerability.

And of course, the first thing we look at is electrical power, which at this time of year is one of the most significant aspects of survival. We learned from Loma Prieta that these power stations such as this one out at Point Woronzoff do suffer particular problems due to the acceleration affecting things like insulators and some of these elevated towers. These things start banging against each other, shorting out, and breaking loose from their supports, moving horizontally, and all of a sudden, a "weakest-link" shutdown of these power stations occurs. So the home generator of Alaska becomes more important all the time.

John Aho pointed out some of these long, tall, thin structures and their vulnerability, especially if they may have resonance with the ground shaking. Towers like this that are not particularly designed for any type of horizontal loads can be a problem and telecommunications can be short-circuited.

Underground water and sewer lines: Every time there's a major earthquake anywhere in the world, water is one of the most serious impacts in these earthquakes, whether it's the Loma Prieta earthquake in California or one in Mexico City or South America. Water is always a serious problem because one of the most common side effects of an earthquake is fire. If you lose water supply you quickly are in problems with quelling fires.

Now, the reason I point out this particular pipeline is that this is the Eklutna water pipeline. In my hypothetical case, we're going to keep the Eklutna pipeline functioning because it is ductile reinforced concrete. The problem for water supply only shows up a week later. And the reason it shows up a week later is that up in Eklutna Valley major landslides came down and dammed off the river; that shuts off the water supply. So even though the pipeline keeps functioning, another side effect reduces our capability.

Anchorage International Airport: There's real worry about this tower. As John also had pointed out, a building can act like an inverted pendulum.

Roadways in Anchorage, of course, are critical. Movement around here, as you've probably already observed is very dependent upon a rather limited number of routes to get to certain parts of the city. And so we have to rely that those routes stay open. This happens to be built on an old landslide; in fact, the landslide extends under all of these lanes. If we only get 1 foot of horizontal displacement and 1 foot of vertical displacement in this area, you probably shut down that roadway, at least for the first 24 hours.

Here's Minnesota Drive in the Chester Creek area, where we have a transition from a rock-fill bed coming up through here down onto an area that was built on top of silty clays. In a period of consolidation due to shaking, there's a tendency for differential subsidence causing separations to occur about there. Now you can imagine, if you only put 1 foot of vertical separation on a road like this, you'll probably shut it off from being used by your BMWs or Porsches.

People today say, "You know, I did really fine in 1964. I came through that just fine." But the mentality and the lifestyle in Anchorage in 1964 was frontier town. And now when you look at the city, it's changed. I'm staying at a hotel in downtown Anchorage. And when I look down at the road watching vehicles going by, it's a bimodal distribution. There are people with $40,000 cars and there's $30,000 pickups. A lot of people fall in one of those two vehicular categories reflecting the different lifestyles of the region. In other words, our lifestyle has changed up here since 1964. We are a cosmopolitan city whereas in 1964 we were a frontier town.

Another aspect, another vulnerability, particularly of Anchorage, is seen by just driving up and down the streets and seeing how many overhead power lines and telephone poles are waiting to fall into each other in an earthquake. Although it doesn't pose a direct risk to life and limb, if you knock out all traffic signals throughout the city, or two-thirds of them, it does pose a risk to automobiles getting from one place to another. Also, if you knock out a few of these telephone poles, communications is vulnerable. If you look around, a lot of the telephone poles in Anchorage are still wood timber poles that have been sitting there for 25 years; those have a tendency to snap in an earthquake.

Let's look at bridges for a minute. I lived in Wasilla, and worked in Anchorage. One of the things that always concerned me was the fact that there was only one set of bridges that went to Wasilla and Palmer and that if those bridges got knocked out, I couldn't get home and neither could about 4,000 other people. The problem, of course, is that there's no alternative way to get out there so that you have pretty much cloistered people in Anchorage while their families are out in Wasilla.

Bridges are vulnerable and so are a major concern. You may recall that one of the big hang-ups for weeks after the Loma Prieta earthquake was the effect of that earthquake on bridges. Here on the Bay Bridge where one span separated in one section, and that was enough to shut down the bridge.

This is the bridge that goes across Knik River. I happened to do a project on this bridge and found out that this bridge was under construction in 1964. They had the piers up and they had the beams ready to go on up for the bridge deck. When the earthquake occurred, the sediment under the bridge liquefied and it caused the piers to slightly shift out of plumb; just enough that the girders that they had weren't long enough to fit onto the piers. And so they put in longer girders. It would seem to me that what we had was a message there that there is a tendency and that as soon as you have a slight excursion in an earthquake of only a few inches, you drop a span and you shut down the bridge.

Another aspect, this one being rather grim, is the failure of the supports that hold up bridges. That one's from Oakland. And we need to start looking at the bridges around here where supports may be a vulnerable point. If we're accelerating things strongly horizontally, and especially if we get a little torsion on this bridge, it can fail catastrophically. Torsion on a curved structure like this on single-point supports is hazardous.

Let's look at one other bridge before we go on; that is the C Street viaduct. It's built on sands and gravels which have a tendency to liquefy. It's also a hybrid if you look at it; it's two separate big bridges that are linked together. One of the questions that I've heard engineers ask is will these two bridges have a tendency to behave independently, so that we could actually get pounding between the two roadways.

Railroads: You may recall that in 1964 one of the more tragic things that happened was that some of the buildings in the railroad district partially caved in and there were overhead materials falling inside; there was loss of life there. There have been significant advances in making these safer work places. But I can remember going into one of these big repair facilities, and it's pretty hazardous considering the big, heavy stuff that's suspended and propped up.

Railroads are typically built in places where other things are not appropriate or other types of construction are not allowed. For example, in this area, you can see the railroad goes through a landslide area. This is up in the Peters Creek area; the landslide comes down every once in awhile, even without earthquakes. I'm suggesting that in a local 7.1 earthquake, this whole piece of railroad track would go out. In fact, this is all landslide material and they just keep plowing it out periodically and clear the track.

Again, vulnerable railways. In 1964 these bridges went out because the bridge supports were in materials that liquefy. These are old trestles and as far as I know, very little consideration has been given to whether they can sustain short-period horizontal acceleration.

Let's go to the Anchorage Port area. The Anchorage Port area is critical to the economic vitality of not just Anchorage, but all of southcentral Alaska, because it is the entry point for materials going to the interior of Alaska, energy, food and raw materials of all types. So if we have problems here at the port area, it's going to radiate out through the whole economy. To an earthquake-engineering type, the port looks very vulnerable. Let's start with the docks themselves. Again, they are located on this highly liquefiable material; material that also has high seismic amplification. It's some of these soft moist sediments that will take incoming energy waves and amplify it significantly from what the shaking would be on bedrock. So if you were on the hillside versus at the port, you would experience much less shaking than you would at the port area.

That has an impact then on things like these cranes which, I can still remember a picture of the container docks in Chile, where all the cranes during the earthquake toppled over. Every one of them went over and these aren't easy to get back up once they've tipped over. It also shuts down your port totally, a disaster especially if you're trying to get supplies in for reconstruction and all the unloading cranes are down.

Tank farms: There was damage in the port area in 1964 as a result of rupturing of tanks. What happens is that the fluid inside of the tank starts sloshing and, as you get a momentum set up inside, it causes the tank to literally slosh itself apart. It bulges at the base. And you get a rupture developing. Some of these tanks have had problems without earthquakes and it's clearly appropriate to think that if you have significant acceleration, more of these tanks would rupture, and more than likely fire would break out.

The other thing, before we leave the port area, is that if you drive around in the port area, you look at some of these sort of plain looking square buildings and wonder what kind of activities they're involved in. There's all kinds of hazardous chemicals, explosive materials being stored down in the port area. For the firefighting community, I think it would be a nightmare if you had three tanks ruptured from petroleum products, plus fires extending over into some of these warehouses. Am I ruining your lunch yet?

One other thing before we leave the port area. Just a kind of a sideline here. One of the most historic areas, which I think is the oldest residential neighborhood in Anchorage, is the Government Hill area. I would like to suggest that Government Hill came through pretty good in 1964 except for some landslides. But if we had a shallow nearby earthquake, we could get what's called a topographic effect where this ridge became a focus for incoming seismic waves. It could actually sustain much higher damage levels on this little ridge than say, another place in Anchorage.

In our hypothetical case next Monday we're going to let the Fourth Avenue landslide stay intact, nothing happens. In fact, we're not going to have much happen to any of the big landslides in a local 7.1 earthquake. There just isn't enough duration. This is only a 13-second or 15-second earthquake. It's not enough duration to get these big landslides going. But you can still imagine that things like the Holiday Inn and Sunshine Plaza are going to have some pretty intense nonstructural damage on the inside exteriors.

An area like this where we're going from a low basin up onto a ridge, where we're basically along a topographic edge, there is a tendency for strong motion to be more intense there than even a few blocks back behind. Also, most of the downtown area is on materials that tend to amplify incoming seismic waves.

Here's the Turnagain slide. We're going to leave that intact. Nothing happens. No new damage to the Turnagain area, but before we leave Turnagain, here's the Turnagain Elementary School on the other side of Northern Lights from the Turnagain slide area. This is built on soft soils, also in an area that has thick peat deposits. I would expect that a building like this would experience substantial amplification; substantial interior damage and at 10 o'clock on a Monday morning, should be a point of concern for anybody in the school districts.

As John Aho had pointed out, when you look at an area like downtown Anchorage, you get all kinds of variations in the type of construction both in the shape of buildings, some being fairly simple rectangular shapes, others being complexes. There's all kinds of variations in the damage that these buildings would experience.

Let's first look at a few hospitals, because you can bet by Monday afternoon the hospitals are going to be overloaded. Humana Hospital and Providence Hospital, I feel would both come through very well in a magnitude 7 earthquake. They're both constructed quite well. They're on good soils and they have been built to good earthquake codes.

This is the Native Hospital. It was here in 1964. Dave showed a picture of landslides encroaching on the Native Hospital. One landslide is here, another one is here. And if we were to have one more landslide associated with this area, it could very well take out the north wing of that particular hospital. Regardless of whether the landslide hit it, this building certainly could experience more than just superficial damage because the construction is not up to modern codes.

This is the hospital over on Elmendorf Air Force Base. This typifies another point that John made in a building where we have transitions in heights and configuration both vertically and horizontally. If earthquake design isn't carefully instituted, where elements come together, there can be substantial problems. I would be very worried about transition here. These look like masonry infill walls between structural elements. You may have seen pictures of X fracturing and pieces of infill falling out.

We're up in Wasilla at a convenience store. The store does pretty well. There were some beer bottles off the shelves, and a couple guys out in the parking lot started sobering up. But one of the problems that was not accounted for and isn't in this picture is that the gas pumps are under a protective roof that's on a single pillar. The pillars sheared off and so the roof went down on the pumps. This results in a significant fire problem right at the main intersection in the center of Wasilla.

To compound that, the firehouse is a combination of wood on the front and back sides, concrete block on the sides. So what you have is two relatively rigid walls. Two really flexible walls. The roof came down and no fire trucks could get out of there.

Back downtown again. Most of the big buildings that we see in downtown right now have been designed either by local engineers or engineers in the Lower 48 to very rigorous building codes. I don't know of any buildings in the downtown Anchorage that would particularly bother me.

The L Street landslide area is very controversial because of the big buildings that are put right on the front, top part of the scarp. The only reason I put this in is that, independent of the ability of these buildings to withstand strong motion, I think this is a good example of where, because of the difference in periods between the buildings, we could have a real problem, especially since these are mostly glass on the exteriors. They can be out of phase with each other, to review what John Aho was saying. If these buildings are moving out of phase at any particular time, they may be accelerating towards each other, which could cause a real problem if you're on the fourth floor looking out the window.

Parking garages: This is the newest parking garage downtown. John Aho told us he could design the garage to withstand an earthquake, but it still depends upon the soils underneath it.

This is a derelict building. You've probably seen it. This one went through the 1964 earthquake and there are pictures of the X-fractures between all the windows in this building. And the problem with a building like this is that even though it withstood the 1964 earthquake, we don't know what its current strength is; whether it was at the point of failing when the earthquake ceased and since then it's just been doctored up cosmetically to look all right. Is it almost ready to fail in a magnitude 7?

There's also a problem in an old building like this, and I don't know about this one particularly. But a lot of times these buildings that have been around for 25 or 30 years, it's hard to find out where the plans are and what the actual construction quality was that went into the building. Reality does not necessarily reflect the plans as they laid on the table.

This is an example of reinforced concrete construction that is fairly typical throughout Anchorage now, and is actually probably quite safe for the most part. The weakness of some of these buildings is in the ties between the foundation, concrete walls, and the roof diaphragm. And I don't know how rigorously those things are being pursued.

Here, for example, I watched this building under construction. This is a reinforced masonry building. It is a shopping mall. You can see the rebar projecting out of the top. Without reinforcement there was nothing holding the blocks together.

A famous landmark in Anchorage is this restaurant: I would be really worried in a magnitude 7 earthquake 30 miles from Anchorage, that I wouldn't want to be eating pie here. Might end up with pie in your face. Again, it's an old masonry building like this that we do not know whether there is sufficient reinforcement in the construction.

In some of the newer shopping malls here, you have very flexible diaphragm roofs and rigid walls that can flex out of phase with each other resulting in collapse of part of the roofs. This one is in Wasilla. This is a mall in south Anchorage that is built in an area of thick peat deposits overlying soft silts and clays. This may show maximum soil amplification and questionable performance of the roof relative to the walls during an earthquake.

This is new construction right down on the Ship Creek flood plain on an area that would experience both liquefaction problems and strong amplification. Amplification would occur for two reasons: One is that it is underlain by soft soils. The other is that it's sitting on top of a topographic basin, so that energy coming in has a tendency to focus.

The Anchorage jail facility: This is the jail annex at Post Road and Second Avenue. A very well designed facility, excellent engineering to the facility. The problem is the jail is built on a landslide and that landslide moved in 1964. It was there prior to 1964. If you drive up Second Avenue right now, you'll find that the Municipality has to occasionally repair the street out here because the slide keeps moving without an earthquake.

Now, this raises, I think, a really serious issue of a facility like this that has some people incarcerated. If we had 2 feet of horizontal displacement and a back wall pops loose, that could pose serious social hazards to the outside community. Also, we as the public have the responsibility for those people that we have behind locked doors. If they sustain injury because they couldn't escape, it would have a serious reflection on our public obligation.

Monday morning the earthquake occurs, magnitude 7.1. Everybody is at work and the seismologists start watching the seismographs carefully, watching the pattern of aftershocks. For those of you from California, remember one of the biggest things that you worried about after the main shock: Is this the end of the earthquake or is it building up to something bigger? What's going to happen?

It becomes very important that the public sector and the government be closely in communication about the possibility of a continuing event. We often don't just have the main earthquake and then it's over. You'll hear about this some more today. It becomes very important to consider the aftershocks of this earthquake. In this hypothetical case we're going to have the earthquake aftershocks start marching to the south as the hours pass during Monday and Tuesday. One of the things that was quite helpful in California after the Loma Prieta earthquake was giving forecasts of aftershocks and the probability for large aftershocks in the hours and days after the main event.

So probably by mid-afternoon on Monday, the seismologists would be giving advisories on what the probabilities were for additional large aftershocks. Then, on Tuesday evening, you have a magnitude 5.9, 35 kilometers west of Anchorage. You've had about 30 hours to recover from the first shock. You still don't have electric power up. Most of your bridges are out. The port has been devastated and is in flames. This sounds like some movie, doesn't it, but I think these are realistic vulnerabilities that you can face. A day after the 7.1 main event a 5.9 aftershock impacts Anchorage where a lot of structures have been severely damaged by the first event. This becomes an important issue for those of you who are in a response mode after the main shock to deal with these subsequent events. For the next several days you will continue to experience aftershocks, but you can begin the recovery.

DISASTER RESPONSE

DISASTER RESPONSE IN SANTA CRUZ COUNTY FOLLOWING THE 1989 LOMA PRIETA EARTHQUAKE

by
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I was in Fort Bragg, which is in Mendocino County just north of San Francisco, after the 1964 Alaska earthquake. We got the tidal wave from this earthquake. I can attest to the damage that it did, even in our area. So I am, indeed, impressed with the abilities of Alaska to produce big earthquakes.

For my part today, I'm going to give you just a little bit of a background of some of the effects of the Loma Prieta earthquake in Watsonville.

You saw from the engineering and geological perspective this morning a very detailed reason why these buildings fail, especially the unreinforced masonry buildings. I'm going to give a little bit more simplistic viewpoint about my reaction to earthquakes. In fact, it's very simple. When I hear that rumble now, I know Mother Nature just turned a man loose to kick some tail. And my first thought is take cover and survive. Because after living through a lot of the little shakers, I have a healthy respect now for what a larger earthquake can do.

And while I'm underneath that table in the duck-and-cover position, I'm just hoping and praying that the guy who designed this building attended this morning's class and learned a great deal about how to design these buildings to survive.

As you can see on this particular slide, the top of the building where the parapet was is the first to go, as well as the overhangs. And so, a lesson was learned about running from inside a building to the outside and thinking you're going to survive.

In fact, we had a victim right on this street corner where she was either pushed out into the sidewalk or actually ran out of that bakery into the street. The debris from the top of the building, the parapet that let loose, came down and landed upon her and her child. She fell on her child and unfortunately became a victim. So from the standpoint of hazards, watch really closely for falling overhangs.

Talk about contents and what they can do, this slide shows contents damage. Building contents just crashed right through that wall and is on the street below. Again, do you want to run outside the building? Think about these things. Take cover and survive.

The first phase of response that I go into with all of our emergency personnel and all the people that I know, is to really reinforce the fact that you've got to survive the quake. You can't do a darn thing about it until after it's over.

After it was over, there were many challenges ahead of us. We had many natural gas leaks and five different fires. In a small community like ours, I had every fire engine that the city owns out that night dealing with the fires, the natural gas leaks, and hazardous-materials problems.

Here's a slide that shows a good lesson with regard to hazardous materials contained in cylinders. It's not just the top that you want to chain. The bottoms also need to be secured. When these things fall over and the heads of these cylinders break off and release their contents, especially if they're lying on the ground, it comes out in an aerosol fashion, much faster and much more deadly. We had a number of cylinders that did that because they were chained high. They weren't chained low. So from seismic safety, it's a very important concern to secure your hazardous materials.

A cold storage facility lost an evaporator which allowed about 10,000 pounds of ammonia to be released inside a building. Fortunately, we were able to contain the ammonia in that building and then in a slower fashion be able to ventilate and control the release. But again, a mitigation would have been to strap that evaporator down and it would never have come loose and we wouldn't have been up against the problem.

The earthquake in our case lasted 22 seconds. For our response we had no power, no electricity, and communications systems had been knocked out.

From the standpoint of the challenges we were up against, they went from fire, emergency medical, rescue and hazardous materials. If it wasn't for those four things, it really wouldn't have been too much of a problem. But isn't that the way that it always goes?

I would like to summarize now, the first phase of the earthquake response. On the way up here I got inspired a little bit, because I remembered you were talking about wanting us to deal with the first 48 hours following an earthquake. Some real lessons were learned in Phase I. The first lesson, as I've already told you, is survive, and before you really do anything, capture your composure. Get your head. Get back into the ball game. It's like you've been knocked a good one. You fall over on your fanny. But you're going to get right back up and get organized and get moving with your efforts.

Check the status and the position of your equipment and the personnel. Develop some line of communication that you know everybody is back and rolling again and that in our system for responding to emergencies, that you're ready. And so that has a lot to do with being able to go into the next phase, knowing what your resources are, what your capabilities are, and how you're going to deal with the next potential problems.

And then this is a real key subject—establishing priority for your emergencies. We had, in our disaster plan, addressed this. But I found that I never had it near clear enough for all the emergency responders, the people in the field. Our priorities are for the fire department to control the most life-threatening fire first. Because there is no other service that's going to be able to deal with that potential problem. And if left out of control, it could take a good portion of the community.

Our second priority is to make sure our emergency medical system is in place. Now, there are people who are dealing with emergency medical problems. And we're hoping that through our planning and our effort with the local medical clinics, the paramedic groups, and the hospital, that they're organized enough.

Because real close in there comes hazardous materials releases, especially if you have a gas cloud developing. You have capability at the site to do a certain amount of management but from the standpoint of what it's going to do to the community, the city and particularly the emergency services, has to address the most life-threatening problem involving hazardous materials.

And then lastly, even though it's important, comes rescue. Our logic for putting rescue as a fourth priority is that generally speaking, you do have time to organize and address that, whereas, with fire or hazardous materials if you don't jump quickly, you may be in a defensive mode that loses a good portion of your city. So with those things in mind, the first thing people in the engine company do upon gaining their composure, getting organized, and getting rolling, is establish some disaster-response protocols.

In our case, our communication system was not strapped down nearly well enough, and we lost communications. The batteries came off their connection to the generator. And then in the communications center, we had equipment that had fallen and dispatchers abandoned ship. In fact, when I got over to where we were going to establish our emergency operations center, I saw a very panicked communications coordinator with a fire department portable radio in one hand and a police portable in the other. Everybody was still in kind of a state of shock.

So we had to gain our composure, get organized. And we actually set up a dispatch center in our parking lot that worked for the first half hour until we could get back in, get things organized and open the next part of our operations with regards to the phase that we were into.

You might have seen the tape of the Oakland Bay Bridge where a car was traveling along the bridge after the earthquake. The driver did not notice the bridge had completely failed. The car drove off an open part of the bridge. We have to be especially careful in traveling after an earthquake. And in fact, a California Highway Patrol officer was responding to a call and went over that ramp and went airborne. And when he lit he had to skid around and steer around these piers that had plunged through the pavement after the earthquake. When we get closer you can see the skid marks in and around the piers. And there were skidmarks in other places from that gentleman's experience! Driver training never was that exciting at the academy.

The other concern we have is in our case we have a great deal of natural gas in our community. In this case we had a lot of natural gas leaks. Some of them were major in the street. Others were in the low pressure system of a home.

We learned that the fire department and people with minimal training can do a great deal about stopping low pressure gas leaks. The redwood plug is one of the more valuable pieces of equipment that you can have at a time like this. A redwood plug works. I think that part of our training is to acknowledge that we can help out with the small leaks and turn the professional utility worker loose to deal with the big leaks in the streets and such because, obviously, fire and natural gas or any kind of a fuel like that don't get along. The sooner we coordinate and control those kinds of problems, the better.

A lot of communications systems bit the dust. I talked about ours. This is why our amateur radio operators came in to back us up. But again, that has to be planned. In our case cellular phones worked very well, too.

And believe me, if you haven't thought about contents damages in your facilities, things fly. If you're not underneath the desk or in a place that's protected, you're going to become victimized by it. Then when you try to organize to go back to work, again it becomes difficult. So think about this—early in your planning.

Now, let's highlight real quick, Phase II, the second half hour. You know, give yourself 15 minutes to get yourself organized. But then be ready to go to work. One of the things that I never had any problem at all with is having any of the emergency response people want to go home and check their families. But I went on the air real early and had people at the station who were arriving within the second half hour assure the people in the field that their families were being looked after. It's a terrible feeling to be out there doing work for the public and not know the status of your family or your home, especially as devastating as the community looks as you're working in it.

I'm going to leave a copy of our county earthquake emergency-response plan with the fire chief from Anchorage Fire Department, and he'll hopefully share it with anybody that wants. Or you can write to me and get a copy. We've put a lot of information in this from our lessons learned countywide about responding to emergencies after an earthquake. And there's a family check-matrix there that really works well for us.

Establishing an emergency control and command structure is very important. The incident command system works. Believe me, it does work. But it does take phasing into that operation. Right off the bat you have an incident commander, and then you have, in the case of our community, five different fires burning and two stations. We had to split up and go to each of the five fires and try to keep them from taking the entire block rather than the houses that were burning. And in doing that, actually the engine officers became incident commanders in their own way. They divided off and handled many major incidents.

As the second half hour developed, the need to delegate command really was important with regards to having people in charge of specific physical areas. It was important to have a clear communications network. So we had communications between our field commanders and the area commanders located at the emergency operations level. The next level, in our case, is the County Office of Emergency Services. It is really important to keep in communication with that next level, and for that level to communicate at a statewide level.

You know, I was convinced, as well as a number of other people, that this was a San Francisco earthquake for probably the first day we were into it And it was us that were just on the outskirts. Little did I know that we were in the middle of it. In fact, we were right next to the epicenter. And we never knew it. And so with that in mind, we were thinking, oh, the poor people in the Bay area. We're just going to have to stand on our own. And my demand for support was very minimal.

So the statewide system first thought that Watsonville and Santa Cruz must be OK, because they're not asking for much. Well, it was a perception problem. We had been trained up to that point to think, "Stand on your own for 24 to 48 hours." And we were trying to do everything to do that. Little did I know that 5 miles outside the City of Watsonville everything was OK. I saw something similar with the recent northern California earthquake up around the Eureka area. Fortuna and Ferndale and Rio Del got hit pretty hard. But Eureka came through it in fine shape. And Eureka was available to support those other communities.

But we needed to communicate our needs and at a level that could see the bigger picture for us. And then that bigger picture could be returned to us with a vision so we knew what we were up against. We really missed the boat in our area by not acknowledging that very early.

We would also like to do a coordinated windshield survey. I have a videotape which I'm leaving here that shows scenes immediately following the earthquake. A guy in his vehicle just started panning the area with his camera.

It's not hard to do a survey about where the fires are because you can see the smoke columns coming up from the different parts of the community. And then you know the areas. If you study your geology real well you know where to expect your damage. You know it's in areas with landslide potential, liquefaction potential, old structures—especially those that are unreinforced masonry. You look at those areas first. Because you can just guarantee that's where your major problems are going to be.

And then you can finish looking at the rest of your community. The sooner you can get that done the sooner you can assess what you're going to need for support. And in this second phase, it's nice to be able to develop that and then communicate it through so people can help you.

The state, the federal government, and the county services are ready to help. But they need to hear from you, the local people, where the problems really are. The benefit of planning and being prepared to deal with any disaster is being able to do these steps. And then get your emergency operations center opened and schedule the first meeting. In our case, we do it a little differently than some people in the emergency operations center. We don't have all of our people gather in one room and command and control the disaster. We have policy meetings where the lead people come to that one room and talk about what we're going to do about the disaster in the next phase. And then they go back to their own offices and actually carry out that plan.

We don't think it's right to take the public works director, who has all of his water maps, sewer maps, and all of his data and information at a office, in a facility that's designed to stand up to a heavy earthquake, and put him into a room with a telephone and a little cubicle and do his work. We want that public works director in the same room with the fire chief, the building official, the police chief, and everybody else that's in that policy group to relay their concerns so that we can get back and get organized and set a disaster response procedure in motion that actually addresses the problems.

So now, I'll go into the last phase of slides. This is a picture of our emergency operations policy room. We were just finishing a meeting here. We put all the information about the disaster that we can on the walls. And in this meeting when we come together, we spend about 10 to 15 minutes talking about what happened and about an hour on what we're going to do.

No more than an hour or an hour and 15 minutes, and then we opened our Emergency Operation Center. You need to schedule policy meetings on a basis that the group feels is necessary. Right after the earthquake, our meetings were about every four hours. But soon, it came twice a day, and then eventually once a day. The Emergency Operation Center stayed available for information from people for almost two and a half months.

If the finance director was here, he'd say it is very important to log all the information and capture all the details and write down all the numbers, all the hours worked, any kind of information you can get at all, about your response to the disaster is valuable. It may not seem as valuable then, but it's very valuable when we're trying to put the pieces together to get the funding back from the Federal Emergency Management Agency (FEMA) with regard to what they'll reimburse. At first, we were writing on a white board, and then I was erasing it every time. And so all that information I wrote down I lost. But if we were using a newsprint pad on the easel, we could have captured a lot of real key information that we would have needed for support.

The need for good, clean water obviously is important following an earthquake. Because of the damage to the water system and the sewer system, we couldn't guarantee the water quality. So bringing in water was critical. And it wasn't hard to do. We got a lot of support from outside the community on providing water.

Inspection of the buildings: A lot of people wanted to start to return to their buildings. Color coded inspection notices are best. Green for OK, yellow for better check it out with the inspectors, and red for do not enter.

The disaster response team needs a means for controlling traffic and isolating and dealing with people's needs, and for keeping them posted as to what's going on.

The logistical needs: Recovery is the real challenge in disaster response. The emergencies, to tell you the truth, were easy. Emergencies were over in the first four or five, six hours. We had a lot of things under control. Recovery went on for months. It's still going on in our community. And so when it comes to being prepared, the fire department and the police department have to really participate in the recovery process.

In fact, this is the engine room to one of our fire stations. It became a cafeteria, because all these people came to help, but they didn't bring their food with them. And of course you wouldn't expect that. You have to take care of them. You have to feed them. And take care of shelter and other personnel needs so they are prepared to serve in their disaster role.

One of my bigger requests that I must have put in about a half a dozen times was for somebody to come in with a kitchen facility. And it was funny, because four of them arrived at the same time, and then I was in hot water as to which ones to tell that they could go back home. But having that setup is critical. A lot of people can be just very, very valuable at times like this. Some people that are day-to-day staff members became real heroes in our disaster response. They weren't the fire chief. They weren't the police chief. They were people like this secretary that just really buckled down and did it for us in a fashion that really brought people back to their feet very quickly.

Tent shelters are another whole subject. Resources—like find a pair of size 6 shoes for this person in that pile of stuff. But, you know, it came in truckloads. And it was everything. Organizing this became a challenge. Now we have it in our plan to address those kinds of needs. We have a support system there and warehouses and a way of inventorying and giving out the resources.

And then, of course, was the demolition and recovery. Charles Eadie is going to talk about that from the City of Watsonville. He was also the incident commander at the City of Santa Cruz. You're in for some really good stories on recovery tomorrow from Charles. We've put together our community disaster plan that Charles is going to profile tomorrow. The plan really brings the people in Watsonville together around disaster-response needs based on the incident command system that gets us back on our feet in the recovery phase.

So the last thing I want to quickly do is to highlight some of these last-phase concerns. The first thing on the list, initiate the first EOC (Emergency Operations Center) policy meeting. Dwell on the lifeline issues. You have your emergencies themselves, the medical emergencies as well as hazard and fire. You have to get those under control. You have to start thinking about a shelter and food plan and inclement weather. You need a close working relationship with Red Cross and Salvation Army, some of the big players in getting the care to the people.

The city has a responsibility. If it's going wrong, I'll tell you, you'll be on the news, the headlines worldwide on how you're mistreating your people in your community, and that is the Municipality of Anchorage or any other public entity. You better take that part very serious, because it's a real challenging effort.

Assigning command functions: The big players right off the bat are the logistics people. They're the ones that are going to get all your supplies, your food, and everything else for responding to and dealing with the big needs during an earthquake. They're going to feed the people. They're going to care for the people. They're going to get you the fork lifts and everything else. The operations person is in charge of overall operations, and should make sure that we're coordinating back and between each other. Operations also may take on a liaison officer type of function.

Other essential functions are feeding and care of the emergency workers, organizing the support functions, and, of course, the incident command positions. Finance, public information and safety are very critical. Also, the plans section should be documenting the situation status to keep an ongoing assessment of the damages and the problems in the community and to keep your operational people focused on where the real priorities should be for delivering services.

DISASTER PREPAREDNESS IN THE MUNICIPALITY OF ANCHORAGE

by
Larry Langston
Anchorage Fire Department
Anchorage, Alaska

It's been about 30 years now since Anchorage had a major earthquake. And we've had a lot of time to think about what would happen if another one occurred of that dimension. In looking at what Santa Cruz did with their problem, it's very similar to what we would have here in Anchorage or any other community across the United States.

What I'd like to discuss with you is what the Anchorage Fire Department would try to think about as far as concerns in the first three to 12 hours of a major earthquake. It's a bit of a laundry list. But I think it is something that you might be able to take home with you to help you understand what we would be dealing with and maybe take back to your communities if you haven't thought about some of these aspects. And I'll try not to be redundant on what the chief has already covered.

In Anchorage, certainly, the time of year that the quake would occur would be very important from incident command point of view, from how we handle the operation. If one occurred today, in November, it would be significantly different than if it occurred in June. The time of day, of course is important. How many people are in a room like this versus at home in the residential areas? These are all important considerations.

The size of the quake will determine everything for us. We're all used to minor shakers here. There is a significant difference between the minor ones and one that can really damage the city to a high degree. We could possibly lose some high rises. And we could possibly even lose one or more of our four hospitals in the area.

When the quake initially hits, we know that it's going to take a while to activate our emergency operations center. So supervisors both in the police department, fire department are going to have to work autonomously. They're going to have to work through their own crews. Responsibilities will be handled on a very localized level until we get the communications system up and running. They're going to have to utilize their resources to a maximum degree during those initial moments until we can get people together to start getting this thing under control. We're going to ask certain key people to report to our emergency operations center. Much like what Chief Smith did.

The utilities are going to be important. Law enforcement, the fire department and the utilities will be important. And we're going to want to get assistance in getting the large equipment in Anchorage.

The way we've set up our system, the fire chief or his designee will assume operations command. The chief of police will take over for law enforcement duties.

One of the first things we're going to want to do is, after the emergency operation center is established, we're going to want to meet with the mayor and the city manager. It may be by telephone or whatever, but we have to make an early policy decision: Are we going to allow property to be destroyed in order to save lives? Now, that may not sound like a difficult decision. But it is. We have very limited resources. And we may have to make decisions that we're going to let significant property in Anchorage go in order to minimize the loss of life. And that will be a policy decision coming from the mayor's office or his designee.

Normally the fire chief, who will be the operational commander, will take appropriate action to mitigate any harm to the citizens in the municipality, and that goes for property as well. But to be successful the fire department will need four things. We're going to need water supply. We're going to need a significant number of on-duty personnel. We're going to need the necessary equipment and good communications. It's possible that we can handle a situation for a limited amount of time without communications. But we need the first three, absolutely.

We will utilize our incident command system. In Anchorage we respond to about 20,000 alarms a year. In approximately 4,000 of those, we utilize what's called the incident command system. It's an organized approach in how you have lines of authority for taking command of a situation because we know that with a city this size, we're going to have to activate mutual aid with other local police and fire departments. And we're going to have to divide the city into sectors.

Now, in activating mutual aid, we've done a lot of preparation over the last several years in putting together these mutual aid manuals. And they're updated every year. They cover all the resources available in the Anchorage area: What's available as far as manpower and equipment at Kulis Air Base, Chugiak Fire Department, the Girdwood Fire Department, and Matanuska-Susitna Borough. These books are going to be resources for us as we try to pull together.

Another priority is going to be to establish what radio frequencies we're going to use. Now that's going to be a real problem for us. We're moving towards trunk radio, which is a common band of communications. At this time we have VHF and UHF. But those don't interlink as much as they should.

The fire department is going to be putting in a trunk radio system this year for about $1.4 million. The Anchorage Police Department will be following shortly thereafter. And the two military bases already are on trunk radio. So, eventually, the plan is to bring the whole city area into the same type of frequency bands so that we can talk to each other.

In talking with other fire chiefs around the country about what they did in an earthquake, it became apparent that another thing we're going to want to do right away is give local telephone needs priority over calls coming from outside Alaska. So we're going to be asking Anchorage Telephone Utility to maximize their resources for the Anchorage area or other communities that are affected within Alaska. Because what will happen is, when an earthquake takes place, relatives and friends from all over the country are going to be trying to call in. And that will paralyze our telephone communications system.

Another thing that we'll be doing right away is we'll be asking, after a safety check of personnel and all our fire stations to pull engine companies, medic units, heavy rescue units, and ladder companies out of the fire stations and putting them in a safe area. Firehouses have a tendency to collapse in earthquakes because of the large span of the apparatus rooms.

In San Francisco, an engineering study was done on their fire stations. And they expect if they have a significant quake to lose up to 40 percent of their firehouses. So in order to minimize that because of aftershocks, one of the first things we'll do is we'll pull our apparatus out of the stations so that they can respond as needed.

Like Chief Smith showed, one of the things we're going to be doing is to assure that our first responder personnel are comfortable that their families are safe. We know that's a priority from other communities that have gone through this. And so we'll be setting up a system for that.

After we divide the city into sectors, we're going to be looking at trying to get in the air as soon as possible to do a helicopter survey of what's going on out there. We'll be sending the fire crews to what's called their first-response areas initially. That's where they'll go out and assess in their immediate response areas the amount of damage and be reporting it. But we also are going to need to get in the air and see where we need to concentrate our efforts.

In a mass casualty situation, and I hope this never happens to Anchorage, but if it does and we have to activate mass casualty crews, our paramedics will be the primary triage teams in Anchorage. We have 36 paramedics. They will be responding to areas of high concentration of loss of life, of injuries. The plan in Anchorage as it stands right now is for the physicians to report to the hospitals, not to go to the building collapse or to the area that's sustained the damage.

After that, we will be setting up a hospital radio network. We test that every week. And I don't know that it's ever worked properly. We keep trying. The goal is to get all the hospitals up on the same frequency at the same time so that we can all talk to each other from the emergency operation center. The purpose is to be able to tell the field units what the capabilities are of each of the hospitals we'll be transporting victims to.

If you take Providence Hospital as an example, and you put three to four major burn patients into that emergency room, it can completely max out that facility. We need to know the types of patients and we need to be able to communicate with the hospital so that we can tell them what we want to bring in and they see their bed availability and they determine whether or not they can take the patient load. This has worked in drills to a certain degree. But it's fairly untested in Anchorage other than through drills.

We also expect that 911 will have delays initially of up to 30 minutes based on other communities that have been through this. If that occurs we will try to do the best we can to get to those areas with the crews we have, but you must remember, too, that Anchorage only has five paramedic units. Again, mutual aid will be very important.

Chief Smith mentioned that you had, what, five fires going on at once? We feel that if we have a significant earthquake here like we did in 1964, that we can expect about 20 to 60 fires in Anchorage after the quake. And from that, we'll have to again determine what resources we're going to use. That's why that initial decision of where we're going to put our resources is so important.

One major building collapse can normally take up all the resources of a fire department. So what we'll probably do after the helicopter review is set our priorities and try to put teams out there when we can get them there.

The other thing we now know is that when it comes to trying to get people out of a large building collapse, the heavy equipment is not very useful. And that really surprised me. Almost everything is done by hand. Hand tools and a lot of manpower are needed. So we'll be working through our Public Information Office trying to go out to the public, trying to get volunteers to help us.

The kind of PSAs, or public service announcements that we'll be trying to do will include asking volunteers to report to certain locations. Also we're going to want to put out announcements for people not to use their fireplaces until their chimneys have been checked out, to not use elevators in the high rises, and to not go back into structures until they've been OKd by engineers who will be sent out to check the structures for damage.

Fortunately, in Anchorage we have excellent fire codes. And we have had excellent building codes for a number of years. So the chance of massive damage here is fairly low. The problem that we've got isn't with the actual buildings themselves so much, I think, but with the soils that some of them have been built on. And that's where our concerns come in. For instance, we know that if a quake occurs, we can expect three times as many fires in buildings constructed on soft soil versus firm soil. So that's a real problem that we're looking at in some of the areas we've built in here in Anchorage.

Finally, we're going to be real concerned about rotating crews, getting food to the people, and incident debriefing. In San Francisco it was very important to get their crews that were on those first responses in for incident debriefings within the first six to 12 hours because of the amount of psychological trauma they went through in trying to get people out of cave-ins and building collapses.

After about three, six, 12 hours, depending on the size of the quake, we at the Anchorage Fire Department will probably turn over the command to the Public Works Department and the Emergency Operations Center. We will then take a back seat, in a support role.

Comments from the Audience

MR. STEWART: I would like to go over one question that was posed to me and I thought it might be of interest to a number of other people. The question was on the incident command organization, where was OEM. Well, OEM is Office of Emergency Management, and I'd like to say we're right up with the 1964 quake. Due to budget cuts we have one administrative position. And when the crisis action team is actually called in, I function as the incident commander. And if it goes beyond that then we call in whoever may be the most appropriate person to act as incident commander. And we expand; we stay flexible. From the incident command organization perspective, OEM, since we are one position deep, functions as a coordinator, both to help the incident commander out and to keep everybody else tuned in to what their job is and keep everything flowing. I might also mention that from a community involvement standpoint, we have probably a unique organization here in the Anchorage area that I have yet to see in the Lower 48. And that is what we call the Joint Medical Emergency Preparedness Group (JMEPG).

This is in fact a planning group, disaster planning group, keying on mass casualty for our medical community. We have a large number of participants. All of our major hospitals and many of our download hospitals are also involved along with key government agencies.

And the JMEPG runs a large exercise once a year where we move up to 100 volunteer victims. And then the other half of the year we also do a table talk. We also have initiatives with the Anchorage Chamber of Commerce, with the petroleum industry and with the Red Cross. The Red Cross is a key player in our emergency operations center.

RESPONSE OF THE PAJARO VALLEY UNIFIED SCHOOL DISTRICT FOLLOWING THE 1989 LOMA PRIETA EARTHQUAKE

by
Hank Hendrickson
Pajaro Valley Unified School District
Watsonville, California

I want to give a little history about our school district, just to put it in perspective. We have 25 schools in our district. And it covers an area about 20 miles long. It goes from the ocean up to the top of Santa Cruz Mountains. It covers about 450 acres and contains about 1.3 million square feet of school facilities. I'd like to also talk a little bit about what we did for planning, because I think that's important to let you know what we did right, what we did wrong. And believe me, we did some things wrong and we did some things right. You never find this out until after you go through a disaster.

I was involved in emergency planning ever since I came to the school district. And I'm real proud of the fact that they were very active in this area. Some of the things that we were involved in was purchasing water drums, storing water at each site in 20- to 55-gallon drums. We were involved with the normal drills in drop and cover and actually taking buses in and going through evacuation drills.

We were involved with communications drills. That meant that every school in the district had to report in to the superintendent's office along with all the supporting groups, such as transportation, maintenance and operations, special services, and all the other groups that were off-site away from the schools.

The other thing that we were involved in was outfitting and taking care of first aid kits. Probably the most important thing we did was getting involved in making sure that everyone on the staff, custodians, principals, vice principals, even secretaries were able to shut down the school sites. We were able to shut off the water, gas and electricity to ensure there were no fires.

This earthquake happened at 5:04 in the afternoon. So school was out. But all the custodial staff was at the sites. And I can say right here without a question that every site was turned off. They did what they were trained to do. And that was very, very important because we had many, many, many gas leaks. And if it hadn't been for that, I'm sure we would have had some fires.

We did another thing that I thought was very important. I think all schools, especially middle schools and high schools that have chemistry labs, have really got to take a close look at lab safety. We got to looking at this and really went out and studied and saw what went on there. And there was no segregation of chemicals separating caustics from flammables and this type of nature. I'm not a chemist. But I do know this much. If you start mixing chemicals you have a real problem.

In fact, I've heard some horror stories where chemicals in labs on second floors have mixed and actually eaten a hole right down through to the next room and on down as far as it would go. So you not only have a problem with damage to the building, but you also have a real problem with cleanup. And if any of you have been involved with cleanup of chemicals in this day and age, it's a pretty expensive proposition. So as a result of us looking at that very carefully, we were able to circumvent any serious problems with chemicals. And here again, we worked very closely with the Watsonville Fire Department on this. Tomorrow I'm going to get a little bit more into the nitty-gritty of some of this stuff. And that's as far as I'm going to go on that subject right now. But I just want to say that that part of it was very effective.

On the second day, people from the Office of the State Architect showed up. They were architects that came in to see just how well the school district buildings fared in that earthquake. And they were just there for a quick one day down, and one day back to their office, just to get an example of what happened to our buildings.

I can say I'm proud of our State of California architects. We went through this earthquake, and for all the damage that happened in the City of Watsonville, I can honestly say that not one school building collapsed. Not one school building was burned up. We did have one facility, a special education facility that was red-tagged, or condemned by the architects, and we had to move out of it. We had one large facility, a 34,000-square foot two-story high school that even though we had moved back into it, they kept going back into it and checking it, and finally come to the conclusion that it just wasn't safe to be used. And we had to evacuate it. But that didn't happen until April of 1990.

That was quite a job in itself just getting moved out of the building. There were 12 classrooms on the second floor. And there was the entire administration of that high school, serving 2,400 students, all operated out of that one building. So it was a disaster just trying to get people moved out and getting them to temporary facilities. But believe it or not, that all took place in a matter of seven days.

Also our district architect was called upon to come in and help us survey our buildings. And one of the problems we had with these buildings was even though we had very capable people going around and checking them all, you still had teachers and staff that refused to go into them unless they saw a structural engineer come in and actually say yes, it's safe to be in it. So we went through the route of hiring a structural engineer to go through all of our facilities and check them all out.

I'm sure not too many of you people know what a DSR is, but if you ever get involved in an earthquake you'll know right quickly what it is. It stands for a damage survey report. And up until that time that it happened, I never knew one existed. But 500 of them later, and I can always remember the very first day I told my secretary, "You better get a real big binder. I'm sure we'll fill up a binder before we get done." Well, I lined these binders up before I left, and took a picture of them. There are 15 binders filled with DSRs along with supporting documentation.

And you say to yourself, what do you need this for? Well, without that, you don't get paid. You've got to document everything. You've got to show proof of what happened. And you've got to have permission to do the repairs you did. And out of about—right now we estimate about $7.5 million worth of damage—I believe we'll probably miss out on about $200,000 worth. Now, that's a pretty good record when you figure who you're dealing with and who you're trying to get this money out of.

Some of our major problems and some of the major obstacles we had to overcome: first of all, no electricity. It was off from two to six days. And that's not really bad. We had no gas. We opened up several schools. And mind you, it took us seven days and nights to get schools opened up again. And after we got them open, it didn't mean that we had heat in all of them. In October, even in California, it gets cold at night. And it gets cold in the mornings. We also had no telephones.

I want to go back a little bit as I brushed over it. Talking about the other thing that was important was we made up some emergency kits as part of our emergency preparation. And part of the kits were emergency generators. And of all the things we did, that's the thing that was the most important. Because the first thing that happened was that, number one, the gas tanks that supplied our vehicles in our yard were underground and required a pump to pump the gas out. Well, with no power, you're not going to get gas. So the first thing we did was we had a generator there that we could hook up and get the gas out of the tanks. And naturally, all of the principals, the school board and everybody else, just happened to be out of gas. So we were actually rationing gasoline out to district staff.

The other problem is that we own our telephone systems. And they all have power supplies to them. And they're backed up by batteries. Well, batteries just last so long, especially in an emergency situation when everybody and their uncle is using them. Within 8 to 10 hours our batteries were dead and without the generators we would have been out of luck.

The other thing we did was we had spent a lot of money and a lot of time buying FM radio equipment, one for every school site. In fact, we started in 1985, because this equipment is expensive. And we, like every other school district, we didn't have the money to buy it all at one time. So we were taking four to five schools per year, buying radios, setting them up. And we went through a geographical area of those that were the most important. Those were the ones supplied first.

We also had to have a repeater up on Mount Toro. And that was our next big mistake. We had all these beautiful radios. And we had it all set up and all of our drills worked beautiful. We ignored one thing. And that was emergency power supply for the repeater on Mount Toro.

The thing that helped us out the most was a gift of 14 cellular phones that were portable that were given to us by an electronics firm. And that's what kept us in business. I don't think we'll have that problem next time because we've got an emergency generator for powering up our repeater on the mountain.

You have to kind of picture this area for those of you who haven't been there. The mountains come almost down to the ocean. And we have a lot of ravines and there are a lot of hills. It's not like here in this area. It's more close. So the hills cause problems with communications. And it requires a repeater on the top of the hill to make this FM system work.

The other thing that became a problem was broken glass. We found out quickly that you just don't have glass available to put back in.

And you also find out another thing, the supply of plywood evaporates very, very quick. Probably the kindest and the best thing that happened to me in this whole episode was a phone call I received from a company at Mount Shasta, California, about 250 miles north. It was a firm that made plywood. And they called me up one day and said, "We'd like to help. Could you use some plywood?" And I said, "Boy, I could kiss you." They said they would send some. And the next day, a semi load of plywood showed up. And that was a godsend. It was much better than the semi load of clothes that was dumped in our parking lot.

The other thing we had a problem with was trying to get around to all the schools, because the bridge going south out of town was closed. The main highway going south out of town, the one you saw the picture of, had collapsed. So we had some trouble getting out to get to some of these places to check them out to get them going.

At the same time the local police department was after us all the time wanting us to get the schools open again because they wanted to get the kids off the street so they would get them out of trouble. And number two, they wanted a place to feed them. So they were very, very anxious to see this happen as soon as possible.

And I think that in seven days, that was very, very fast and in certainly many cases, we weren't ready for them. We actually didn't receive the people we had before the earthquake. We were dealing with about 16,000 kids. And in that first week, we were down to about a third of them, along with staff. And it took a long time to get built back up again. We finished out the year with our average daily attendance down by 400 students. Many people actually left town.

Another thing that was done that I thought worked very well was that we actually established a command post just like the fire department, police department and everybody else. Our superintendent set up a command post. The entire school board, all the principals, myself, and all the support staff met every day at five o'clock. We discussed every school, where we're at, what it took to get it back in operation. We made a policy that all news releases—everything that went to the press, TV, radios, everything was written out. Because we found out anytime you call them and talk to them, it gets turned around. So we made it a point to make sure that everything was put in writing so that everybody got the same story and it was correct and accurate.

One of the problems we had that I never dreamt about was the fact that about 55 percent of our community is Hispanic. And even though we had kitchen facilities that were opened up by the Red Cross and by other groups, we couldn't get them to go inside. They just wouldn't go in. They wouldn't use our restroom facilities. They took over all of the athletic fields, the high schools, middle schools, and set up tent cities. But yet they did not have toilet facilities. So we had to bring in portable toilets. They wouldn't even go in to a cement-block toilet facility out in the athletic field. It was away from any building. It was safe as you can get. They still wouldn't go inside of it. So that created quite a problem.

Another problem we had was not all of our schools are on the city water system. One of our large high schools has its own water system, has its own well. It has two storage tanks; one is 240,000 gallons, one 400,000 gallons. The smaller of the two tanks tipped over by 12 inches, dumped the water out. And also the 12-inch main going out to the school ruptured. So we lost our water supply.

The well became contaminated. So that created some problems trying to get that one opened. Here again, another firm, a water distribution company, was very, very good to us and brought in about 20,000 gallons of potable water in 2½-gallon plastic containers. We got the pump going again in the well. And we used that for toilet facilities. But we were able to get by for awhile until we got the well straightened up again and got it back in operation.

One of the things that hasn't been talked too much about today and that's the fear and the things you go through in dealing with people. And I'll touch more on that tomorrow. But it's a very, very big thing. It's very difficult to get your crew back in and teachers and people that need to do the work for you, when their homes have burned down, or their homes are destroyed, their families injured. In many, many cases you have no choice but to just send them home. It doesn't do you any good to send somebody out to fix something and he gets out there and he's scared to go in the building.

One of the things that wasn't mentioned so far, I believe, was the fact that there were over 200 earthquakes between 3 and 5 magnitude in the first 30 days, something like that. So you can imagine being in these buildings. They're empty but you're inside of them and you're into the crawl space inspecting. You're in them, underneath them or up in the attics checking them out. It's pretty hairy when that thing starts shaking. So that became a real problem.

We had a policy that any employee that felt they couldn't get by, couldn't live with it, was to go home. All they'd do is come and tell us. We made sure that everyone was paid. They were told that in the first two weeks everybody received their paycheck whether they were there or not. That eased a lot of tension and a lot of problems.

Some of the principle types of damages: Tower roofs came off, ceilings in classrooms, particularly drop ceilings, acoustical ceilings came down. In the older schools built between 1917 and 1938, we had about five of those, where you had the old lath and plaster yet. That plaster naturally all came down. Windows come out. Concrete exploded. Sidewalks just erupted and naturally required a lot of cleanup and a lot of barriers around those. There's still evidence of that around town yet.

Boilers and heaters: One of the things that I never counted on was fire bricks in boilers. They all crumbled, just sort of fell in. And naturally, if you've got an old boiler that's built 20-30 years ago, they require a special fire brick. And it takes awhile to get them back in line again. So that was a problem I never anticipated, never gave it a thought.

Light fixtures, stage lights, fluorescent lights: You notice when I came in here, I didn't sit where you people are sitting? I sat over there, because I looked up there and I don't like those things. Guarantee you, I don't like them. No, one of our high schools, we had 12 of those come down. And you know, I'm just grateful that the kids weren't in there, because there could have been some very, very serious injuries.

The other thing, if you have any suspended heaters—those have to really be checked. There's a real problem there. And naturally, all the stacks, smokestacks for all these things, they all came off.

We had some problem with asbestos. We had some fiber release. We had some asbestos cleanup that had to be done.

Chimneys, we had some brick chimneys that cracked and had to be removed.

Naturally, all the office equipment, computers, typewriters, VCRs, all the audio-visual equipment, went flying. We did have a program set up where we were trying to attempt to fasten all these things down. But we hadn't succeeded. So an awful lot of that stuff was damaged.

We were involved very shortly with a lot of regulatory agencies—the Federal Emergency Management Agency (FEMA), California Office of Emergency Services (OES), United States

Department of Education. They've got rules like you wouldn't believe. For example, FEMA only deals with the facilities that have nothing to do with the kids: administration buildings, transportation, maintenance, special education, any administrative facilities.

But where you get into problems is where it's joint use. For example, our Watsonville High School swimming pool is also the City of Watsonville's swimming pool. So FEMA says, "No, that's students. And we won't touch it." And OES comes along and says, "No, we aren't going to touch that. The public uses that in the summertime." And you can't get the two agencies together to determine who's going to pay to get it fixed.

What happened was that the piping that went around that pool to fill it and to drain it ruptured. So it involved cutting up the concrete and getting the pipe repaired. There were big arguments about underground work. A gas line would feed into the administration building or a school. Who's going to pay for it? Well, they'd sit and argue about it. And they'd leave without saying who was responsible.

In fact, this lets you know a little bit about what you're up against. The first seven inspectors that showed up for FEMA, one was a female that was just out of school. And the other gentleman was a retired CalTrans engineer. And they started out on the job. And immediately, they didn't see eye to eye.

And if she said yes, he said no. So all of the sudden I end up getting all these damage survey reports that said he'd sign it where it says agree or disagree or approve or not approve. If he said yes, she'd say no. And if she said yes, he'd say no. So what do you end up with? How do you resolve this thing? Naturally, after a couple of weeks, they got mad at each other and they left. So the next inspectors come. And we start all over again. I went through nine sets of inspectors with FEMA. Believe it or not, we have persevered and we got about $300,000 out of them. It wasn't a lot. But we did get enough to take care of some of our problems. Naturally, these people all divide stuff up. For example, FEMA pays 75 percent and OES pays the other 25 percent. Then you get to the United States Department of Education, they pay 75 percent and OES pays 25 percent. So you get these percentages you're playing games with.

Some of the other problems you run into is we brought in these structural engineers to check the buildings out. And the structural engineers found problems with, say, five buildings. The Office of Emergency Services and FEMA said, "OK, we will pay for the structural engineer but only in the places he found the damage. And the rest of them, we won't pay for." So there you sit. You're stuck.

The other thing, the same way with asbestos. You know, if you've got asbestos in your schools, and you need to inspect the whole thing and you need a qualified person to do that, it was the same story. Yes, if you find a problem, we'll pay for it. But we won't pay for the rest of the inspection.

So there were all kinds of hidden costs. The same way with administrative's costs. Some of them will pay for it and some of them won't. For example, FEMA would pay—I think we got about $12,000—no, $9,000 out of FEMA and we got about $12,000 out of OES. And the United States Department of Education didn't pay anything.

DISASTER PREPAREDNESS IN THE ANCHORAGE SCHOOL DISTRICT

by
Tom Bibeau
Anchorage School District
Anchorage, Alaska

I think all of us know now that if this event that we're talking about occurs at 10 o'clock on Monday morning, it's December and it's 10 to 20 below outside, the community is going to be severely impacted. And we're going to need all the help we can get and all the cooperation we can get to get through the event.

When we started talking about disaster preparedness for the district, we first of all came up with a statement about what is it we can do and what do we want to do. We said, first of all, we want to make sure that we can maintain the operation of all the schools so that kids can be reunited with parents as quickly as possible. We'll try to maintain the school day.

If the students cannot stay in the school, elementary schools have alternate sites that the principals have picked and central administration knows about. If the alternate site doesn't work, we're going to have to take them to a central site. The central site will probably be a secondary school.

Let's look at the event now from central administration's standpoint. The event occurs, the superintendent sets up the emergency communication center in the administration building, if he can, if it's still operational, or at one of the secondary schools. We have WRD965, on 465 megahertz for an emergency broadcasting system. There are two-way radios in all of the secondary schools and a couple of the elementary schools to blanket the bowl area. Unfortunately, all of the elementary schools, the rest of them, only have one way. They'd have to send a runner to a secondary school or the nearest two-way communications location.

What the superintendent would be doing with the cabinet, or the emergency communication team, would be establishing who needs what. Where are the major damages and where do the resources need to go? We're also going to have a chair in the office of emergency management, or the emergency operations center with Bob Stewart, next to the Red Cross, to coordinate resources.

The resources obviously include facilities planning. Facilities planning of the district has four architects and four engineers. These people will start from the south end of town and work towards the north end of town surveying initially the buildings to determine whether or not they're habitable. This is a real quick check in writing. Let the emergency communications center know if they're habitable or not. Do they have water? Do they have light and what do they need? The resources again are people from transportation, student nutrition, maintenance and operations.

Let's look at the event now from the perspective of the schools. The event occurs, the elementary kids have been practicing duck and cover drills, duck and cover and hold. They may have to evacuate. They may not evacuate. That would be a building decision to make depending upon what the condition of the building is right after the event. They can initiate their school emergency disaster plan with disaster teams to sweep the building, check on the condition of kids, things like that.

There could be two scenarios, and one of them is there is significant damage where they may have to go to their alternate site or minor damage where they could stay in the building. There could be nonstructural damage and they could stay in the building. They could dismiss older kids; not elementary kids, but secondary kids, depending upon what the neighborhood is like, could be dismissed. The elementary principals know that we're going to be in charge of the elementary kids until they're turned over to parents or authorized adults.

The central site, again, if they need to go to the central site—let's say that there are kids who have not reunited with their parents by the end of the day, those kids would have to be taken to the central site, which could be a high school.

These are the things that we've asked our schools to think about in disaster planning. We have emergency operation plans or model plans for the schools that outline what things they should consider and what things they need to talk about. We've asked them to do a hazard hunt. And that's nonstructural hazards. Think about moving heavy things to lower shelves, things like that. Making sure that shelving is attached to walls.

We've asked them to do duck and cover and hold drills with the elementary kids. That's required monthly. Secondary kids, that's a part of their curriculum, but they don't—most of them do not practice that. It's done on occasion, but it's not practiced regularly like elementary schools. In elementary school, it's mandatory.

We've asked principals and parent-teacher associations to promote home planning to make sure parents are ready, and to make sure that they have alternate numbers, emergency numbers, and friends who are authorized to pick up their kids. And we're trying to get everybody trained in first aid.

I want to show you some of the things that are happening and some of the resources that are available if this occurs during the day. This is an example of some of the things that are happening in one of the schools. This is Chugach Optional. They didn't go into a very sophisticated kit. But they have two basically cardboard boxes in each end of the building. And those include things like cotton gloves, dust masks, student records, the safety plan, first aid equipment, things like that.

Northwood Elementary is sort of a test site. Mike Webb is working with Susan Usher, the principal, to try some things out. These are kids doing a duck and cover drill in Northwood Elementary. Again, duck and cover drills are mandatory in our elementary schools. They do it monthly. These are some of the kids in a classroom. A good shot of duck and cover and hold. These kids could get under there in just a matter of seconds. I was really surprised.

These are some of the hold-down devices that we're trying out in Northwood, made out of heavy-duty Velcro. They are sort of pricey, but I think they're going to work. That's on a key-board. That's on the monitor. It's tough to get that monitor to move once those things are in place. And you can just barely move it. It's difficult to tip it over.

This is a piano in the music room. The principal didn't want it to move around if the earth was moving. So they chained it to the floor. I thought that was good idea.

We have schools getting emergency kits, some more sophisticated than others. These are commercially available. And again, these are kind of pricey. These are $500-$600. For a four-member emergency team they include tools, hard hats, gloves, safety glasses, flashlights, rope, tools, plastic sheeting, tape, and first aid. And you can just grab it and run with it. Again, they're kind of pricey, $650. They're on wheels.

In terms of facilities, this is the transportation department out on Tudor Road. There are a hundred buses out there. Buses would be good not only for transportation, but they could be emergency shelters because they could be heated. They make great ambulances because you can get gurneys in and out of them. Obviously, that depends upon the condition of the roads. But they would be a great resource.

Ed Conner is the director of maintenances here. Maintenance would be a great resource. Lots of talented people out there with lots of mobile equipment to get the schools back on line. Shops—wood shops, auto shops.

Food service could stand alone. Dennis Barrett, the director, could put out about 15,000 meals a day for probably two weeks.

This is a warehouse located out in DeBarr. It has a generator that will run just about everything. The down side is it has gas-fired equipment. If we lose gas we're going to be eating cold cuts and sandwiches for awhile. There's a lot of stuff out there that would be available in an emergency. That's the assembly line for trayed meals, one of the walk-in coolers, some of the big cauldrons.

If the event occurs at 10 p.m. and it's 15 degrees below zero, the community is going to be impacted. Planning is going on. There are a lot of things available. More can always be done.

VOLUNTEERS AS A RESOURCE FOR DISASTER RESPONSE IN SAN LORENZO VALLEY, CALIFORNIA

by
Mary Hammer
Valley Resource Center
Ben Lomond, California

It's so much fun to be back here in Alaska. The last time I was here was before your earthquake. And it doesn't seem possible that was 32 years ago. Obviously, I was doing a lot different things than I am right now.

We live in the community that Hank was describing, up in the mountains. It has been said that it is a large city with trees. There are actually 49,000 residents between two valleys that are between the city of Santa Cruz and the metropolitan area of San Jose.

Believe it or not, 70 percent of our residents commute. So think about that in relation to living in an area that has had six federally declared disasters in the last 10 years. We've had two years of landslides where people were killed, heavy, heavy rains; 24 inches in 24 hours. All the arterials were closed. People were caught over in the Santa Clara/San Jose area. They couldn't get home. They had no idea what their children were doing.

The other problem that we have and I'm sure you have the same problem here, is that people move in from a more urbanized area thinking, gosh, it's going to be great to get out of the traffic. And we're going to live in a beautiful community where there are trees and we can smell clean air.

They forget that the power is out quite often. They can't get home because of roads being closed. And they are subject to all these different disasters that can hit. We had the landslides and the storms. We had the Lexington fire in 1985. We had another landslide storm era in 1986 on Valentine's Day. Then we had the 1989 earthquake, of course. And we ended up two years ago with a major freeze that has caused millions of dollars in the Watsonville/Santa Cruz area.

The only thing we haven't had is the locust or the pestilence. So hopefully we're not going to get into that.

So most of our population consists of commuters. We realized, and it was a small group of people who realized very early on that our residents—and this was through disaster relief organizations—that our residents were not the least bit prepared to be self-sufficient.

And so we formed an organization called the Valley Emergency Preparedness Project. The major goal was to enable our community and the surrounding communities to be as independent as they possibly could be and to become aware that the Red Cross is not going to be on their doorstep as soon as something happens, like you see on television, with the canteens out there. The fire departments are not going to be able to get to you right away. And so it is imperative that you, being the first people on scene, know what to do, because your own family and your neighbors are of course the most important to you.

What we did is we developed a very simple process whereby we mapped our area topographically, so that we formed sectors whereby people could walk to each other without crossing a stream or a known landslide area.

Within those sectors we have developed neighborhood areas, neighborhood coordinated areas. We have a neighborhood coordinator that takes care of 10 to 12 homes. Any more than that is too much. That neighborhood coordinator uses the card that I'm showing on the overhead to discover where the vulnerable populations exist and also where the resources, skills, and equipment exist within their neighborhood.

We do not share the vulnerable population with anyone. We thought at first it would be good to get the list of handicapped and the elderly and latchkey kids off to the fire departments. Well, because we live in small communities, fire departments pretty much know where those vulnerable populations are. And we did not want to have these lists floating around where someone could pick them up and just have a wonderful list to go to do illegal-type activities.

Once the neighborhood coordinator has gathered the information on resources and skills, they send it to a sector leader. And the sector leader is just one person who receives all the information from this topographically accessible sector. So now one person knows where the sheriff, deputies live, where anybody that has had any type of first aid training or nurses live. All those people that can be used as resources for their own small communities.

Within this area, and this came through grants from both the Bay Area Regional Earthquake Preparedness Project and Federal Emergency Management Agency (FEMA), we were able to organize the amateur and CB radio operators. And that is kind of an uncommon situation to have both disciplines working together. In this case it's worked very well.

We now have radio operators identified in each one of the sectors. For our area that's 6 square miles, we have 53 sectors and out of that we have 49 of them covered with a radio operator. The radio operator and the sector leader know where each other lives. And they know how to get in touch with each other. So this gives a simple way to get infomation in and out of an impacted area.

In Santa Cruz our communications system is in the basement of a nonreinforced concrete structure that sits in the flood plain of the San Lorenzo River. So we quickly decided that we needed to have an alternate communication, which we have in a local fire station, where we have two amateur and two CB radios set up. So there we'll be in close contact with county communications. But at least we have a way to get information into the responder's hands immediately. Because once a message gets into the local fire department, it's treated as a 911 call and then is sent by the fire departments to wherever the message needs to go to get help for that particular area. The Office of Emergency Services is our local county emergency services office. We either get messages into our area by phone, if the phones are working, or by radio, that tell us of a situation that's occurring.

One of the major problems for our area is if we're getting more than ½ inch of rain an hour. It means that we need to alert people who are in known landslide areas because that's the key that things may start coming down the hillside.

We also have a phone tree so if the phones are working we can very quickly get messages out to our neighborhood coordinators. It goes through the sector leader to the neighborhood coordinators and then out into the neighborhoods.

A good example of one of the things that happened was, during the freeze, the radios were telling people that—and this was the media—they needed to drip their faucets because that would allow the pipes to not freeze. Well, people felt that if dripping was good, letting it run full was going to really be good and really protect them. Well, what was happening in our areas was that were running out of water. So we immediately had to get the information out to people to stop dripping. And that worked. It did save some of the water.

The reason I started with this is that we had this in place prior to the 1989 earthquake. If you can imagine, it was hot. It was really hot. And everybody was sitting outside just before the World Series was to begin. Walked into the house, the earthquake hit. I took one look at the kitchen floor and everything that was going on and thought I don't want to be here. I knew my family was OK. I'd much rather go down to help. So I got down to the local fire department. And we were going to set up a shelter. We were standing there. There were approximately 14 fire department vehicles waiting for a major fire. Don't forget, we were in a drought. We had been in a drought for three years. We're now up to seven. But this was three years. So we were really concerned that we were going to get the major conflagration that we're hoping doesn't happen.

We also knew there was a major storm coming in that was going to carry our famous ½-inch rains with it. And we were also not sure we weren't going to have another major shock. So here we were standing in front of a fire department, knowing that at any moment we could have another major disaster.

However, as I started to tell you, this system was in place. And it did not take more than 20 minutes for the amateur radio, CB radio operators to get operating. And we were able to get communication among ourselves active. The phones, as someone said, were down, not because of damage to the system but because of being inundated by people calling into the area. So we did use our radio operators extensively.

What we found was that our short-term response was absolutely excellent. We were able to get volunteers immediately, we were able to get food cooking and begin to identify needs. We were able to determine collection and distribution sites for the food, the water, the clothing, the medical supplies for minor medical needs.

The local community-based organizations like the churches were able to give pretty good short-term response. The Red Cross came in and they had shelters set up that first evening.

So we began to assist in coordinating the community-based organizations and helping the federal and state agencies determine where they were going to locate. And we had to really push to get FEMA's disaster assistance centers, the DACs, into our area.

So that's something to remember, that you don't want the Disaster Assistance Center centrally located, which seems to make sense when you're looking from the outside at a problem. But what you really want is to get as many small Disaster Assistance Centers located in the impacted community as you can, with as many representatives of the agencies that have to evaluate the situation, like Small Business Administration, the Red Cross, FEMA, legal assistance in filling out forms, senior citizens networks; all those different people need to be at the Disaster Assistance Center so that people don't have to go to a number of different places. And it can be located in their own communities.

There should also be child care available, because people are stressed and they have to have their kids with them. And it can be really a very disturbing situation, especially when they're told they might not be able to get help for whatever reason.

Developing communication networks ahead of time between agencies is extremely important. And developing a system of updating information and referral information for victims and volunteers.

It's absolutely incredible how telephone numbers change, once the telephones get going. And people will move offices. So you must get that information to where people can get help out to them just as soon as you possibly can. And that's really best done at a very small community level.

What went right? Again, our short-term immediate response was wonderful. We had immediate activation of the amateur and CB radio net; immediate response by the American Red Cross and the churches. We realized very quickly that we needed to have debriefing. Someone else mentioned, I think, Mike Smith, that you do need to have psychological debriefings. We tend to think that it's just the victims that need it. That's not true. Anybody that's working within a disaster has conflicts within their workers and also within just trying to do the job they're doing under stress.

What went wrong? These are some of the things that, even looking back, are hard to figure out why. It was almost impossible for us to identify the needs, either short-term or long-term, of what was going on in our community. We knew that we needed the water. We knew that chimneys were down. So debris removal was a big one. But to try and get information out of our residents as far as what they needed, everybody was in shock. And they couldn't really come to grips with what it was that they wanted somebody to do.

Consequently, we had volunteers from everywhere I can think of. Biola College in Los Angeles. We had volunteers from Colorado, from everywhere you can think of. And we really didn't know where to send them and what to tell them that they should do. We had a group of four-wheel drive people that came down from the Central Valley. And they all had their beautifully fixed up four-wheel drives with little trailers. They wanted to know where to go. And I had gotten maps and sent them off with maps into some of the more isolated areas to go talk to the people, and really just interview people to get an indication of where the needs were.

They came back within four hours and said, "Hey, look. We really appreciate what you've done to try and organize us. But it's Halloween. It's coming up on Halloween. We're going to go home with our kids. And we're going to go home and watch our own soccer games. Because what we're seeing out there in this community that you've asked us to go and identify and to talk to is people really aren't interested. They want to play soccer and carve pumpkins. And so we're going to do it too."

What people, I think, were really trying to do psychologically was to get some kind of normalcy in their lives. And it wasn't until probably a month later that we really began to get an indication of what was going on.

So we had all these wonderful volunteers and we didn't know where to send them. And when all the needs began to be identified a month to two months later, in fact, we're still getting people coming in that have discovered damage. All the volunteers were gone. They went home.

So somehow, you've got to get a handle on a good way to identify what the needs are. And I think the best way, from our experience, is to determine in your own mind what the needs are going to be. And then just say, hey, we feel that this is what it is. Go out and do debris removal, start channeling water where it needs to go, all those different things.

Another problem that we had was duplication of efforts by community-based organizations and responding agencies. We really didn't have predetermined assigned responsibilities that all of us had said, like the PTA is going to do something and the churches are going to take on feeding, and Salvation Army will handle the clothes.

It's best to get organizations that normally work with a particular issue. Like food pantries deal with food. Salvation Army deals with clothes. That's the best way to handle it. But you really do need to predetermine the responsibilities for each one of the local community-based organizations or you begin to get people stepping on each other's toes. And that creates a problem that takes a long time to ease through.

We had no predetermined clear listing of our immediate needs: the kind and amount of clothing, food, camping supplies. Sanitary supplies was a big one with diapers, tampons, sanitary napkins. Those were things that we really needed.

Once again, I think Hank mentioned that they were just inundated with clothes. In fact, there were vans of clothes that would make a circle from the Santa Cruz Mountains, the northern end. Well, we'd tell them, well, go to Watsonville, they need clothes. And so, they'd go, and they'd just keep going round and round, with all these polyester clothes.

In earthquakes, and at least now at home, we didn't need clothes. I mean, you could get into your house and get those things out. In Alaska, that may be a different story. But you would be able to specifically say, we don't need polyesters, we need and whatever it is. And have those lists predetermined of what you think you are going to need.

We needed more adequate community education on what disaster victims can reasonably expect from any responding public or private agency. People have incredibly inflated ideas of what community-based organizations and responding agencies are going to be able to supply them.

It's hard to be able to say we're not going to be able to do what you expect us to do. People still are wondering why the Red Cross can't handle long-term needs. That's not their job. Their job is to take care of the short-term immediate needs and then other charitable organizations are to come in for long-term needs, and government help. So to get that message out prior to a disaster is extremely important.

Again, we weren't able to assign volunteers where they were needed. I'm kind of going through as things happened. But in our recovery process what we found was that federal and state agencies came in. And they had what we call boilerplate scenarios. They would tell us what our needs were. And they would tell us what the guidelines and the criteria were to get those needs met.

They may or may not have anything to do with our real community needs. A good example was, when FEMA was allocating amounts of money that would go for rebuilding, their top or maximum for square footage on reconstruction was $30 a square foot. In the bay area you cannot get any construction done for less than $70 to $80, and it may even be higher than that now. They absolutely could not believe that those costs were not being inflated to be able to get more money into the community.

The other thing is that there is and continues to be an inconsistency in the criteria and the guidelines for relief. The rules kept changing. When you're dealing with people that are under stress anyway, and they are told that if they get this paperwork with these guidelines met, they will then be able to get whatever relief it is that's promised. Not so. Because from week to week the rules changed. And that makes it very, very difficult.

There's an organization sponsored by the Red Cross and United Way that did an evaluation of response to the earthquake in the greater east bay. One of the major concerns that came out was when both government and helping agencies like the Red Cross would come in. They would bring their people from wherever their people came from. There were national people. And they would push out the local people, the local Red Cross, the local community-based organizations, and say, hey, we know best. We just went through Hurricane Hugo. We've gone to Galveston. We've done all these things. We know what you need. And that's just not so.

So as a community you need to protect yourself by having a good organization developed that you can say when those well-meaning people come in, please, we want you to listen to us because we know what our needs are. And this is how you can help us. And this is how you can be most effective.

I think that FEMA is beginning to get the message that they haven't been effective. And, because of the way they have handled situations, they've caused a lot of frustration and brought a lot of hurt to themselves.

What we are hoping, or at least I'm hoping, is that we can do what has been done in Australia following the bush fires. And I don't know if any of you are aware of an organization that started in Australia called Churches Uniting.

They were able to build on this idea that we're talking about: that the community knows what is going on in their own community. They have set up area coordinating councils that are made up of all the local community-based organizations, local government, and local large-scale charities. Those people are responsible for identifying what the needs are by actual contact with their neighbors and the people that go to their churches and schools. The parents come in, and the schools are a wonderful way to collect information. So they identify what the needs are. Then that organizing council sets the priorities. And then it's up to the federal and state agencies to supply the funds that will meet those needs that have been determined by the local community. And it works.

So on that note I am going to turn this over to the woman from the Red Cross. And all I can say is take control of your own community. Know what the hazards are. Be prepared for them. And then get right in and begin to work to get your own needs met.

DISASTER RESPONSE BY THE SOUTHCENTRAL ALASKA CHAPTER OF THE AMERICAN RED CROSS

by
Sue LaMunyon
American Red Cross
Anchorage, Alaska

I agree with a lot of what Mary was saying about volunteers and organizations coming to help out. The Red Cross is undergoing a lot of growth. They're undergoing a lot of changes.

If people have been watching the TV and the newspapers, you know we are. Since Elizabeth Dole came on board, she is busy with our board of governors. And they are revamping the Red Cross. They're looking at putting more of the responsibility for preparedness and planning right onto local chapters.

And this has affected our chapter greatly here in Anchorage. We used to have what they call operational headquarters. One in Burlingame, California, and then we had midwest and then we had Eastern Operations Headquarters. They're not there anymore.

There are going to be some regional offices set up, kind of what they did about 10-15 years ago. We had regional centers set up. But the bulk of the work is coming out of the chapters. We will take responsibility for what happens to us.

I do agree with what Mary was saying when she was talking about National Red Cross. And years ago, they would do that. They'd take over. And they'd push the chapters out. And that's dangerous.

We have not trained our volunteers here to do that when there is a disaster, earthquake or whatever it may be. If you remember the October 1986 floods, National Red Cross came in here. It was a side-by-side effort because we would not allow them to push us back into our little corners and do our job day to day.

We train our folks here to see a familiar face. And that is the most important thing. At least when I go out and I do training for our Red Cross Office here, I want to see a neighbor in that shelter that's working in that shelter. I don't want to see a strange face. They're not going to understand what I'm going through.

Our concern is emergency food, clothing and shelter. And we're going to meet those needs. But it's trained volunteers that are the key.

We're in the process of doing some extensive training with Alyeska Pipeline right now. We've done two sessions with them in the last month. We've trained 75 people. We're going to be training more, and then again some more after the first of the year in Valdez.

Their folks have agreed to come on board, work with Red Cross side by side to respond. They're going to take care of their families so that they can let their folks know up on the slope what's happening. Because, I imagine, that's going to be pretty frightening for those people up on the slope not to know what's happened to their families when disaster strikes.

So we're doing some damage assessment training to get these Alyeska folks out in the field. And in turn, they're going to do damage assessments for us. So it's a joint effort.

When we had the October 1986 floods, it was phenomenal. Volunteers were coming out of the woodwork. We didn't know what to do with them. We had folks wanting to give us their planes. They wanted to charter flights to get people in and out of the Matanuska-Susitna Valley, get people out of Seward and Kenai, send them wherever they want to go. And we had hundreds of them.

And I know in earthquakes you get thousands of them. It just depends upon what your needs are. Again, what delayed us is you've got to train those folks. So we put everything to a screeching halt for five days to get these folks to get out there and be functional.

You can coordinate your volunteers with the church groups, and with the Salvation Army. Because I'll tell you right now, we couldn't do what we do if the Salvation Army didn't do what they do. They're out there in the field. They're doing mobile feeding sites. We don't do that here. We don't have the capability of doing that here at this time.

We work in the shelters with the families. They work out in the field. We have a very good relationship. There's not a competition here that a lot of places have. We try and work closely with the churches and the schools, and the city. It's a joint effort. It's a team concept. And I'm really glad that we have that here.

If you've been looking back at some of the things that went on at Homestead Air Force Base during Hurricane Andrew, that's kind of scary. We watched the news up here in Alaska about those families at Homestead. They're not equipped to deal with the things that we're equipped to deal with here.

People here are more camper style. They've got their RVs, they've got their campers, they've got their tents, their sleeping bags. A lot of those folks in Homestead don't have that. And so when something big happens, they don't know how to deal with it.

I knew the Red Cross wasn't going to be in Homestead, right away. There was no way. It's not possible. Those people down there in Homestead were given the opportunity to evacuate. They chose not to.

And I'm not saying if I was in their shoes I wouldn't have stayed behind. They had been evacuated before. They had trouble with looting. That's a City problem that the City needed to take a look at. But in the course of staying behind, they didn't prepare themselves for what they were going to be facing. And they faced total devastation. Then they came on TV and nobody was there to help them. And I mean, nobody. And so they kind of banded together and broke into a school and got started.

But it's frightening. We're better off now here in Anchorage than we were when I first got here in 1983. There was a real apathetic attitude when I got here in 1983. It's not going to happen to me. It is going to happen to you. And it is going to happen to me. It's a matter of when it's going to happen.

In the last couple of years it has changed. The attitude is changing. As disasters go on around us, people are taking notice of what's happening. They're taking that extra eight hours of training. They're taking that time to meet with their supervisors and their coordinators and their businesses to say, yes, it is going to happen. And we need to do something about it.

Participation in classes, participation in community events, such as what you're seeing here, has increased. And I'm glad to see it. Because the Red Cross can't do it all. We are mandated by Congress to do this. But we are one organization. And for the State of Alaska, we have exactly two paid disaster staff. That's it. The rest is volunteers. We have some Red Cross volunteers sitting in this audience, that if we didn't take the time to train them, we couldn't be out there. They're acting on our behalf. But they're also acting on your behalf.

We spent some time with Salvation Army over the years. They've got a good group of people out there. They've been active in training and coordinating. They've recently reinstated the VOAD group, the Voluntary Organizations Active in Disaster. And I'm glad to see that up and running again. They're pulling the Boy Scouts and the Girl Scouts and the ham radio operators and Red Cross and the Salvation Army, all the volunteer and the church organizations together, so everybody knows what they're going to be doing.

When we did the Shaker III earthquake-response exercise recently we found that lots of people had things to do, but nobody knew how to do them and how to get them done. So we train and we practice and we train and we practice some more. And hopefully, when disaster strikes we will be able to provide the services that are needed to be provided to the community. But it's a joint effort.

Questions and Comments from the Audience

MR. COMBELLICK: I'm Rod Combellick with the Alaska Geological Survey. In comparing these two communities, one of the most striking differences that I see in this response effort is the weather. We saw pictures of tent communities in Watsonville. I understand now, after listening to Hank, that in a lot of those cases that was by choice from people who didn't want to go into the buildings. The possibility of a disaster here in Anchorage in December or January when the temperature is 15 or 20 below has been raised.

To me it seems like this would create a very serious problem for shelter, not only for the people whose homes are actually damaged in an earthquake, but at 20 below, if people are without electricity and gas, even without damage, they are in a survival situation in a very short period of time.

In Fairbanks, it could be 40 or 50 below in January. And that becomes very serious, very fast. Somebody said that they're telling people not to use their fireplaces until they're checked out for the chimneys to be safe. So you don't have that alternate source of heat. What do we do in Alaska in a situation like that?

MS. LaMUNYON: We had January, February 1989 freeze, And it was so cold it was 20 to 30 below and it was like that. And what we ended up doing was opening up a shelter that we could get some heat generated into. People in Alaska are not shelter oriented. They don't like to go to shelters. So we didn't have a good turnout for that. But they chose to stay home and stay put. And people did use their fireplaces. But that again, is a cold situation. It's not an earthquake situation.

I would imagine from things that Bob and I have done and the fire department, we've worked real close together; that when something like this happens, we will make sure that wherever we go, that it's heated. You have to. And people are going to have to bundle up and come out and stay together. It's a self-survival issue.

I don't know if Bob has something else he wants to add to that or the city maybe. But we've been working real close together trying to come up with a plan to take care of these folks when it is 20, 30, 40 below.

MR. SMITH: I can also add from our perspective that nobody likes to live in shelters. Shelter life is not an enjoyable way of life. You're placed in a situation where your family is all thrown together in one big group. And even though they're managed properly, the health and the food and everything is done appropriately, it's not good living.

So the only reason people are going to come to shelters is because they have no other choice. And in our situation, there were a lot of homes that were badly damaged in and around the liquefaction area. There was low-income housing. And about 90 percent of the people who lived in that area were Hispanic. And their choices were limited.

Most people want to stay close to their homes anyway, and make sure that they've secured and that they can get back on their feet. It's only in those times when they don't have any other choice.

Now, tent encampments don't have to be set up the way you saw. And in fact, in our effort after the earthquake, we've now got a new policy. Red Cross has never in the past even accepted a tent encampment as an acceptable standard for sheltering. We'll they've changed that policy and now are progressing on establishing a tent shelter.

Tents can be made with heat. In fact, I was sitting next to a gentleman from the Corps of Engineers in the Army, and some of the tents that we got were from the National Guard. And heaters are put in them. They're used in inclement weather and can be used as a quick way of establishing shelter if you have no other choice.

Obviously in this country in the wintertime, it would be my last choice. But it wouldn't be one that I would leave out of the disaster plan, because potentially you may need it if you have nothing else.

MR. WATTS: I'm Ron Watts with the Municipality of Anchorage Building Department. Let me make a comment that the majority of people in this room and in the local organizations that would be concerned should really be prepared personally and that means at home.

If we took an estimate, and I would say probably 75 percent of the residences in Anchorage would come through a fairly major earthquake in reasonably good shape. You probably may not have electricity, most likely wouldn't. You may or may not have gas. I think the probability of us having gas is better than electricity.

But worse-case scenario, if we had a situation where this type of event occurred in the wintertime as we're speaking of 20 below, probably one of the best things that a person could have would be the capacity to generate electricity. Because if we're not prepared personally, then we're going to really be in a bad shape when it comes to attempting to provide a service to the public.

So I think that every individual, particularly homeowners, really should look at being self sufficient. And of course one of the things would naturally be the capacity to generate. Because if you can generate some power, then you can run a heating system, assuming that you've got natural gas. And even if not, electricity can be used to maintain other life support systems and maintain a structure.

Another problem we would have in residences, if you don't have heat and it's that cold, is that it is not going to take very long for the pipes to freeze. So if you don't have that capacity to either blow out or remove the water from pipes within the structure, then you're going to have a real damage problem once it's over.

MR. HUDSON: Yes, I'm Ken Hudson with the Matanuska-Susitna Borough. And this brings up a point in trying to be prepared myself and explain to my wife our preparedness plan. She pointed out to me that her preparedness plan was to leave the state immediately and to wait for my call to tell her everything was fine to come back.

And so, is there a component for evacuation, because it's the case that in those cold weather scenarios it may be something to look at as an option is getting as many people who you can get to warmer climates. Has that been looked at as any kind of a component or anything like that?

MR. STEWART: I'm Bob Stewart from the Municipality of Anchorage. We have not looked at evacuating people out of here into a warmer climate just because we have an earthquake. One of the things that we have looked at is that in many of our potential shelters, if we can get electricity back into them, it may or may not provide the heat. We have learned some lessons as a result of some fairly substantial power outages here in the Anchorage area. We've learned to get out right away and check out. You need to have the electricity. You need to have the heat. They may not be synonymous. You need to have the people to man those shelters.

The other thing that we have learned is that people in the Anchorage area are very resourceful—probably more resourceful than we have thought. In the past we have opened shelters and very few people, if any, came. I know Mat-Su and Anchorage got together and opened shelters when we had a large number of homes with power outages over Christmas.

During that time we had one family show up at a shelter. I could not figure out why the rest did not. I started doing some digging and found out that many of the people that were in the outlying areas where the power outages were located were in fact taking the portable generators, and they were going from one house to another. They were sharing with their neighbors. They had developed their own informal network. Everybody that had an electric generator was in fact running it for so many hours at one house then switching to another. And they were able to keep the electricity serviced, and the water running, and the heat up to a livable level in homes with just one generator as they shared. Now, that's just one of the things that we have learned.

We recognize that here in the Anchorage area we could be subjected to some very severe weather conditions. There are some things that we keep in our hip pocket, if we have aircraft crashes, or if we have other things that may be related to power outages when we have low temperatures. In a real pinch, we have Transit People Movers that can be pulled out and distributed into certain areas. We have the buses from the school districts. Those are the types of things that we are going to draw on.

We recognize that in a disaster, and if weather is a significant factor, that also will tell us that we have to channel and provide resources into certain areas where we normally would not have to provide those resources.

So weather becomes, I agree with you, a very significant factor. But weather is one of the things that we plan for. Weather is one of the things that will determine where our priority efforts will be, where scarce resources will be allocated.

MR. WEBB: The one factor that we have is that we have become highly dependent upon natural gas within the Anchorage bowl since the 1964 earthquake. It is a very reliable source. But it is not totally reliable. And we have put entirely too much emphasis into the reliability of that resource.

We do not have the alternative fuel sources that we had for the 1964 earthquake, like Fairbanks has right now with the independent oil resources that they have, using heating fuel. So, yes, we have natural gas. Yes, it most likely will survive. But there are chances for interruption. And we're going to have some very, very severe problems which we're going to have to deal with at that time.

LONG-TERM RECOVERY

THE LOMA PRIETA EARTHQUAKE RECOVERY SAGA

by
Charles Eadie
Emergency Coordinator
City of Watsonville
Watsonville, California

Randy Updike's talk yesterday made me think about downgrading my status of happy to be here, to happy to be here, maybe. There are lots of things to worry about. And every time we do these earthquake discussions, I know for me it always all comes rushing back about all the tension and all the stress and all the different things you have to deal with.

When you have a disaster, you just go with it. You get as planned as you can be, but once it happens, it's bigger than anything you can imagine. And that goes for the emergency response and all the way into recovery.

Today I'm also going to be speaking in the afternoon, so I'm going to modify what I was going to do a little bit. Instead of focusing so much on the long-term recovery this morning, I'll do more of that this afternoon. This morning I want to talk about the transition between emergency response, short-term recovery and long-term recovery.

I think that as we look back on it, it all seemed very orderly. First there was the emergency response, and then there was the short-term recovery, and then there was the long-term recovery. But in fact, it all tumbles together. And at the time, you're never quite sure whether you're in the emergency response or long term recovery or what.

And there are some important lessons to be learned there. I'd like to go through some of those. They have to do with trying to meet the needs of the community, trying to adjust the organization to gear up to meet those needs and then ultimately leading into a long-term recovery. I will conclude today with a little discussion about the Community Based Disaster Response plan that Watsonville has done, which I think is a real good model.

The first thing dealing with the emergency response is that there are really two phases going on. One is what I call the rescue phase. That's what the emergency people are drilled and trained for. They know where the hazards are going to be and that sort of thing. And you can really understand what's going on with that in advance. It's a little easier because you're dealing with one guiding value. That guiding value is life safety.

But then the further away you get from the emergency, you get into something more complex. You begin to have to compromise or balance your life safety value with other things. And that is what I call the post-rescue phase.

Both Santa Cruz and Watsonville had to make a lot of mid-course adjustments in this post-rescue phase, because things happen that you just can't anticipate. And the real challenge is: Do you have an organization that can adapt and respond to what's going on?

The second point is that success in the post-rescue phase is highly dependent on recognizing the limits of what you can and can't do. I think there's a tendency as a local government to own the disaster and the emergency response and want to do it all. But as a matter of fact, you really have to be managing what's going on and spend a lot of time trying to link up with other resources, both within the community and outside of the community. So you can't do it by yourself.

Then, regarding recovery planning, probably the fundamental fact is that your community is changed forever. We have a little saying down in California: "Shift Happens." And once that shift happens, you can't put Humpty Dumpty back together again. This makes long-term recovery a tremendous challenge because political equilibrium is upset, economic equations change, people take on new roles. So it gets kind of complicated. I'll go into more of that later this afternoon.

This is not a computer generated model. What I wanted to illustrate with this slide is on the left is just some measure of, say, energy level or level of activity. And down below is time. The first little bubble is what we call the rescue phase. The second bubble is the post-rescue phase. The long dotted line that keeps going on and on is long term recovery. I think the key point here is that all three start at the same time. And over time your emphasis shifts.

Maybe it's the first 48 hours, maybe it's the first 24 hours, maybe it's the first week, that your emergency personnel are going to run the show. That's the rescue phase. And that's what they're trained to do, and that's what they do well.

Then they gradually phase down and pass the baton to this other big hump in the middle, the post-rescue phase. And that's when it gets a little bit creative, because suddenly there's just a whole host of decisions that have to be made that you didn't think you were going to have to make, and you don't have enough information to make them, but you have to go forward with what little you have.

The long-term recovery takes place from the start. Even some of the decisions that happen in the emergency phase are going to affect your long-term recovery. So there's an overlap that goes on. I think the success in the rescue and post-rescue phases, sets the stage for how well you recover over the long term.

Now, yesterday we talked a little bit about what went right and what went wrong, and you learn from that. I'm kind of a living guinea pig, I think; an example of how unexpected things happen. I didn't have any role in the emergency response plan in Santa Cruz prior to the earthquake. I was the city planner doing a general plan and some other things. And a week later I was appointed incident commander. And you know, I never did quite figure out what happened, but I keep trying. And that's why I get all these charts and things. Something must have happened.

And basically, what happened as far as I can tell is that the organization was doing the right things for awhile, but the things that needed to be done shifted dramatically.

I'll tell a little story to illustrate that. What happened in Santa Cruz is that the downtown area sustained most of the damage, nine square blocks of downtown. From the life safety point of view, the first thing to do was cordon that area off because it was incredibly dangerous. So within a half hour or an hour, they had police and fire personnel blocking all the streets. And everybody had gotten out of there. That was all well and good for awhile. But after day 1, day 2, day 3, day 4, the business community started to say, well, it was all fine to evacuate the area on Tuesday when the earthquake hit, but now, we've got to get back in there. We've got businesses to put back together.

I think the turning point came on Friday. President Bush visited Santa Cruz. This area that had been off limits to everyone for the most part was suddenly safe enough for the President. You had the President walking down the street, and Secret Servicemen on the buildings. On Saturday morning the business people were a little bit upset. They asked a fundamental question: "If this is so unsafe, how come the President can go in there and we can't." They had a point.

I went down to City Hall on Saturday and there was a meeting going on. It was just jam-packed. You couldn't get in. People were out in the courtyard listening over the loudspeaker, hanging in the windows. I looked in through the window. There was merchant after merchant pounding on the podium saying, "Look, we've got to get our business going. We've got to get into this area. We've got to get this stuff going."

And there's the TV cameras, the city manager with the sweat dripping down his face; and the public-works director. And they're nodding their heads. These people are really upset. They said, "Well, we'll have a plan for you on Monday about how we're going to deal with it." There were 600 businesses that were down there and 200 of them were displaced, 1,400 employees, and just a lot of people.

Well, to make a long story short, for whatever reason by Monday, they really didn't have a plan worked out to everyone's satisfaction. And there was a meeting Monday afternoon of the Downtown Association. And after that meeting I got a call from the public-works director, and he said, "Charlie, I'd kind of like you to be a liaison between the fire department and the Downtown Association, see what you can do with this thing." And just on Saturday I was looking in there and thinking, I wonder who's going to do that plan? Glad it's not going to be me.

You have to understand a little something about Santa Cruz. The downtown is in one of these areas like you've got here, where it's absolutely the worst place. It's a tsunami inundation area, it's a liquefaction area. It's a flood plain, it's got it all.

So the Emergency Center is established a mile away on the east side of town. And that's where the EOC was, the Emergency Operation Center. Then there was City Hall downtown. Then in the central business district near the City Hall was this thing called Pacific Operations, which is basically the gatekeeping operation for the cordoned-off area.

Well, after a week had gone by, the city manager was back in City Hall trying to deal with the property owners. Because FEMA said, "Look, you guys have got 30 days to get these demolitions going or else we're not going to fund it." And he wanted to get permission of the property owners. And the city engineer is trying to evaluate which buildings should come down and which shouldn't.

So that's taking place at City Hall. Meanwhile, over in the east side the Emergency Center is being operated, the Command Post. Then there's Pacific Operations downtown controlling access.

The first thing I did was hook up with the president and vice president of the Downtown Association. We went down to the Pacific Operation downtown. And the fire guys were there. We said, "Look, we've got to hold off the demolitions. We have to do a plan here to figure out how to get the merchants to get their merchandise out and to figure out which demolitions come first."

They had all these bulldozers and demolition trucks ready to go on Thursday morning. And here it was Tuesday. And we said, "We got to move these things back. You got to put the demolition back." And they said, "Well, who says?" And so we go down and talk to the city manager and explain all the deal. And he says, "OK, put off the demolitions until Saturday." So we went back to the Pacific Operations, and said demolition is off until Saturday. And who said? Well, city manager. OK. They wrote it down.

Then we met with all the business leaders. And they basically told us two things: one, they were afraid that the city was going to do like Coalinga did, which was cordon off the area and bulldoze the whole nine blocks and that's the end of it. They said if that happened they were out of business. And we couldn't do that.

And we said, "Well, that's not going to happen." The second thing they said is, "You got to do something quickly because we're trying to keep a handle on the rank and file. The natives are getting restless here." We said, "We just put the demolition off. We'll take care of it." And so we started setting up a planning process.

Then we went back down to Pacific Operations and the fire department had moved the demolitions back from Saturday to Thursday again. I knew this was not working well.

The president of the Downtown Association was a little less subtle. Smoke was coming out of his ears. And he said, "Well, who the hell said to do that?" And they said, "Well, the incident commander." "Well, who the hell is the incident commander?" Well, the incident commander was based over on the other side of town and was making that decision. And that's where those guys took their orders. So there was a communication problem going on between City Hall and Operations Center and downtown.

The long and short of it is we spent a lot of time trying to figure out what to do with that. And by the time I explained it to the city manager that evening, he said, "OK. Well, why don't you be incident commander." That was my introduction to emergency management. I knew about Commander Cody. But I didn't know anything about incident commander when I took the job. My kids called it "Infinite Commander," which I kind of liked.

But basically what was happening is that the organization went through a fundamental shift and moved out of this rescue phase and into this post-rescue phase. We hadn't really anticipated how to do that. And we're adapting to new circumstances, shifting the priorities and basically changing the organization. And we ended up setting up an entire organization down at Pacific Operations.

So really the lesson there I think is that doing the right thing is recognizing that maybe you're doing the wrong thing. And you don't know in advance quite what's right or what's wrong. But you have to read and react and change and adapt and act on that knowledge and on limited info. And that's a real important thing.

I think Yogi Berra said it best. He said, "When you come to a fork in the road, take it."

Before a flood it rains for a while. With a hurricane you get a warning. You get a little chance to gear up for these things. But an earthquake is going to get you whatever you're doing, right now. You sit down to a nice meal in a real cozy little restaurant and the next thing you know, you've got plaster falling in your gazpacho. It changes your outlook.

It can be a mess. And the damage is variable. In some places it's less, in some places it's more. Buildings are deceiving. They might look good from that point of view. Then you take a little step back and you see half the wall fell out. And it can be a wild ride.

There were just so many near misses that it's almost frightening to think about. But in the rescue phase, the fire people are the ones that really put it on the line for the community. That wall fell and killed three people. And these guys had to work overnight in lights with aftershocks taking place trying to dig through this rubble. And all the while, it's a media event.

During the rescue phase, you find that a lot of times people are already dead. And it can be a real psychological trauma to have risked your life knowing that there was pressure to do so, and knowing that the people were probably already dead anyway.

Fires have to be responded to. Sometimes you don't get to them right away. Housing looks like this. You've seen all the pictures. People evacuate and just set up wherever they can. We had another category of adapting. We set up the emergency shelter at the Civic Auditorium and then found out that the roof was leaking and had to move out of there.

Long lines of people started showing up for food at the parks in Watsonville. Eventually they got around to getting FEMA trailers in at Watsonville. And that took a while.

But the rescue phase, it's pretty basic. The post-rescue phase, again, gets complicated. You've got security issues. Merchants are exposed. And you have to figure out how you're going to deal with that and protect the merchandise. You cordon off the area. You need short-term patrols. And then you move into a more permanent deal with fences. Then you find out that you'd better do portable fences because you're going to be moving these fences around all the time.

People respond incredibly in terms of respect for the situation. There's an exposed building. And people just paraded around the downtown the day after the earthquake. And nothing was stolen or looted. Of course, German shepherds are a help to have present. So you know, you're balancing the good things with a few helpful reminders.

The media is something that you're going to have to deal with in a major way. They have a tendency to say things in extreme—downtown in ruins. The Public Information Offices, they're going to have so much effort expended on just dealing with the media. But the communication problems and issues are enormous. You're going to have to deal with getting information out to your client groups, to your people that are in business there, to the residents there. And that's something that you really need to pay attention to. And you need a lot of resources devoted to that. Because probably the biggest problem that you have to work with is communication.

Then, of course, you have to handle all the VIPs, the president and the congressmen, vice-president's wife, people like George Mader, all the researchers show up. And it's important to be nice to these people, because you never know when they can recommend a grant.

We brought in the Army Corps of Engineers to look at the levees and figured out right away that they might have money. So we got three former mayors to escort them. Then we had the guys down in the sign shop make a plaque. And we gave awards to a couple of the generals. And the next thing you know, we got our levees repaired. So that's the kind of thing to keep in mind: it's worth investing in a little bit of public relations. But it takes a lot of administration to pull it off.

And the merchants, of course, wanted to get back in. And how do you say what's safe and what isn't? These buildings are evaluated. And you have a red tag But there's a lot of question marks. This building has one of those erratic shear patterns. And the elevator shaft held this top part of this eight-story building on. And it actually snapped. A thick elevator shaft this thick snapped from the torsion. We ended up having to create a flight path around this building for about four months until it was rehabilitated and keep people away from that, because it was ready to fall down. You got one building threatening another. Somebody wants to get into their building, it's fine. But the building next door is ready to topple so you can't allow access to either building.

And the big problem with an earthquake is that it just it won't go away. You're never quite sure whether you've finished, whether it's getting better or it's getting worse. We had 7,500 aftershocks from the Loma Prieta earthquake. And by about the third one, you're pretty jumpy. And you've 7,497 to go.

I remember going into meetings and a truck would drive by and people would jump under the table. These aftershocks create some administrative challenges for you, because you have got to go back and keep reevaluating the situation and the building conditions. It's not like a flood, which recedes, and just leaves the mud. With an earthquake you wonder if it is just a prelude. Did we have the big one or didn't we? Is this the prelude, is this the aftershock?

And the geologists, they help some. They can predict within 200 years that you're due for an earthquake. So you have to make some decisions, educated guesses. You can't plan your calendar around geologic time. You have to make some decisions based on limited information. So there we're trying to convey all the red-tagged, the yellow-tagged, the green-tagged buildings on maps. And you know, again, it takes lots of people to do all this stuff.

Hank mentioned plywood yesterday. Boarding up all those windows, checking the buildings every day, setting up this whole apparatus to administer the access into this area. We had to get hard hats.

The city attorney said, "Look, you shouldn't be letting anybody in there. Somebody's going to get hurt." But the mayor and everybody said, "Yeah, that's well and good. But you know, if we don't let these people in there, we're not going to get reelected." So you take some risks and try to make things safe. And give everybody a hard hat, and give them identification, and have a fire escort. The logistics are enormous. We kept ordering 200 hard hats from Hewlett Packard. And they say, you want more? And we say, yeah.

We ended up, again, working with the Incident Command System, trying to adjust it. I think the key to this is the Downtown Association. All those positions that we invented at one time or another were filled by volunteers, because we didn't have the city personnel to do that right away.

An adversarial relationship that was potentially developing was diffused by virtue of the participation that we worked out with the merchants themselves. We spent an incredible amount of time planning out what we were going to do. And then using and asking—working with the client group directly in organizing these access; what we called the cattle drive going in to the buildings.

And there, Margaret Wilson, one of the merchants, is explaining the program to them. And I can't tell you how important it is to sort of blur the lines a little bit between government and the client group. Because you're all in it together. And you share all the information you can. And don't try to hold things back. Because if you do, people will be suspicious. And if they're suspicious, you're going to have an adversarial relationship. On the other hand, if you involve them completely in what you're trying to do, they're ready to help. And so there we were, running people in and out of these buildings. I don't even like to think about it.

That one building you just saw was demolished. Yet some historic preservation people were invited to come in. And they said, "Hey, this building is OK, why are you demolishing this building? This building is fine. It's just a simple tie and anchor job." And we said, "Well, we don't think so."

We had all these people going in and out getting their merchandise and records out. Then they went to demolish the building. The claw went up there and just touched the building and the whole thing collapsed. Maybe we were good. But I think we were pretty lucky.

Branch Rickey once said, "Luck is the residue of design." And you know, I like to think that we had a little bit of design. I know we had a lot of luck. But you have to take those risks.

Then you have special circumstances like building a tunnel into this building. And then 500 volunteers come down on the weekend helping the bookstore owner get his books out. Setting up for the residents, and putting numbers on people's backs so that you can keep track of who's escorting whom.

A guy wants to bring in a crane and get his coffee roaster out before the building is demolished. Well, it's not like the first priority you do, but you get around to it.

Then, of course, the demolition. You see, the thing about an earthquake, it only does half the job for you. To prepare for a demolition you got to check for asbestos and then you let her rip.

Then you got other problems, like what to do with all the rubble. We got about five years worth of landfill from the quake. And you've got to have information, like knowing which buildings have basements and which don't. That was important. And the reason it's important is these bulldozer guys are driving around. We identified most of the basements, but one time we missed a couple, and he's tearing down a building and the next thing you know, he's dropped a floor. He was OK. But he was a little shook up.

We tried to respond to special requests. Historic-preservation people wanted to save some of the artifacts of these nice old buildings that were lost. People wanted to get some of the merchandise out while it was being demolished. The lawyers really liked to get at their records. And then they said, "Well, never mind. A good time to clean house."

Then the task shifted to getting into the pavilions. Having a place for the merchants to go. And that was the passing of the baton. The earthquake happened on October the 17th, and we had until Thanksgiving to get the business district functioning. And we had to have a place for people to go.

And again, that was another hookup with the community, where the city in partnership with the Chamber of Commerce, the Cultural Council, and Downtown Association, put together these pavilions, completed demolitions and got places for people to go.

In Watsonville, they went with the trailers. But just to conclude. I had been giving all these talks, and I said, "Look, you know, the one thing you've got to do is figure out how to work with the community in the disaster, because it's bigger than the government can handle by itself."

When I got to Watsonville they were doing a community-based disaster plan. They went through all the categories of things that are going to happen. And they worked with every organization in the community from the Food Bank to the Red Cross to the churches. All these people were involved in the emergency response following the earthquake.

The coordination was an enormous effort. Now, through this plan the City of Watsonville has memoranda of understanding with all these various community organizations about who's going to do what, who reports to whom and all the relationships. And it's a fantastic document. And I'd highly recommend it as a model.

So with that, I would just say that I think both Santa Cruz and Watsonville had to be fairly inventive. We got through a lot of things but it could have been done a little easier with some advanced planning to help anticipate some of these unexpected events that arose in the post-rescue phase.

PUBLIC-WORKS ASPECTS OF LONG-TERM RECOVERY IN ALASKA

by
Ken Canfield
Public Works Department
Municipality of Anchorage

This has really been a grand experience for us folks from Anchorage to be able to sit down and hear all these talks and start thinking about what do we want to do to change the way we intend to operate if we get another great earthquake. And I take my hat off to the folks that have organized it. It has certainly been worthwhile.

I've heard throughout the conversations and the talks discussions about the next one will be tougher than the 1964 quake. We were a frontier town of 50,000 people, close knit. The next one with 250,000 people and a lot more structures, could be more of a challenge. And I think it will be. But I really am very optimistic that we're going to handle it. I don't think we're so big that communication with our counterparts throughout the Municipality will be hindered in any way.

During the 1964 earthquake I was the maintenance and repair officer for facilities at Elmendorf Air Force Base. And let me tell you, the only way we survived and got back on our feet was total and open cooperation between the agencies. In my particular case, doing facility repair, there were things we just had to have and didn't have, like transformers of a certain up and down voltage; water clamps for water mains. We had over 100 water main breaks. Line fuses for primary distribution system—we would kill for those if we could get our hands on them. We needed heavy equipment, particularly the D-9s and HD 21 tractors with hydraulic rippers, which were very rare in those days, to cut through that frozen ground to repair our water breaks. But it was tough. However, working with the city, we just opened our warehouse to them. And they opened their warehouse to us. And if they had something they didn't have an immediate need for, we got it; and the reverse. And Mayor Sharrock, I've never had the opportunity, sir, to meet you. And I'm 30 years late. But we really appreciated your help back there.

Our plan—well, here it is, a nice red folder. If we do have a good shaker, we'll be able to grab it in a hurry. It's a nice visible red folder so you won't lose it in the dust collection on your shelf. It was published in 1990, and before the ink dried, we were already making revisions to it. And we continue to do so. Because I don't think an operations plan can be published and just sit there. You have to constantly bring it up to the state of the art.

To give you a feel for how the plan is organized, it does have several annexes for different types of disasters. Annex C is the earthquake. We have a series of appendices to cover the different functional areas. And I'm talking about more than just public works here obviously.

Warning and communications is obviously a very important thing to keep the folks aware of what's going on. We have a requirement for a media center. That will be in, or right next to, our EOC, or Emergency Operations Center. We've got it in the open bay—the fire department's open bay, a very drafty area with no place to sit down. We're going to make it a decent place so that we can keep those folks under control.

On the 18th of August this year, we had not an earthquake, but a volcano across the Cook Inlet that started kicking out some of that nasty stuff. And we got an opportunity to test our communications. And being on the mayor's staff, I'm one of these guys that gets to carry one of these things (cellular phone) around. And it was absolutely useless, because the phone systems were tied up. We need to get quickly to the trunk system that the chief mentioned. And that was the only way we could really communicate. And so we know we got a problem, and we're working it.

Of course the law enforcement and fire service folks know their jobs and do it well. Health and Human Services has to be prepared to take care of the community's health needs. Inoculation programs, food service, shelters and those kinds of things.

Public works is not a classical public works department in Anchorage, Alaska. We have the roads, the drainage, the construction, maintenance and repair of those, and really only half of them, because the state has the rest. And that's really the sum total, along with the building department.

However, under the earthquake scenario, coming under the public works' umbrella will be a lot of the other departments, property and facility management. We'll have the cultural and recreation services, transit, the port, Merrill Field. Many other things come under the public works umbrella during this earthquake for functional control and better use of people.

And then last but not least are the utilities. They have to be a major part of any activity on recovery. And we've talked about a dead of the winter earthquake here, 10 below zero, which would be 40 below zero in Fairbanks. It could be a tough situation if we lose gas, electric, or both. And I can guarantee you that all of our resources will probably be devoted to getting the utilities back up on line. We'd clear the roads so that we would have a travel surface. But we would certainly have to work with the utilities to get them back on line. That's obviously our lifeline support.

Now, all the individual departments also have a plan that talks about things like family care and where you will report and those kind of things.

We've got the classic incident-command structure for our disaster-response activities. This is kind of the standard or the book solution that is familiar to many of you who have been to the famous Emergency Management Institute. They have a school in Maryland. A lot of you have been there. We've sent many people, thanks to Mike Webb and some of the others that have helped us get not only public sector, but private sector to that school. This is their solution, pretty much, to the disaster response organization.

The mayor would be up there in that top block. The incident manager or commander, however you want to call him, would initially be the fire chief and probably the city manager. And then when it ceases to be fun, it will probably be the public works director.

And then operations is really the EOC. We don't have the best one in the world. But it's satisfactory. It's not sitting on the crest of one of these hills that is underlain by what I call the silly putty, the Bootlegger Cove clay. It's in the middle of town, right on one of our three expressways in Anchorage, so it will be accessible. We struggled over who should be in that Emergency Operation Center, here just recently. And I think we've wrapped it up to about 15 functional areas, maybe 20 at the outside.

I've been in emergency operating centers that just become untenable when you get too many folks, radios, telephones. I've seen commanders stand up on the top of their desk and scream at the top of their voice, "shut up." And all of a sudden it gets quiet. And then he has to do it again, about a day later. But you really have to be careful about the number of people that you have in your Emergency Operations Center.

Obviously, we've got police, fire, public works, utilities, Office of Emergency Management, with a state representative, medical folks, Health and Human Service, military liaison, school district, Red Cross and Amateur Radio. And I'd like to get some comments from anyone, when we get through with this, to see who we missed or who could we kick out.

And then, in the plan, you've got to have a think tank. I think that's very important for some people to stay at arm's length from the event to kind of sit back and determine some strategy—where should we go from here? Do some advance planning.

Logistics-wise, of course once again, you've got purchasing, material handling, supply, those types of things, and obtaining employees, and finance, of course, is going to try to finance all this and pay for it and do some cost accounting.

We've got three emergency action levels. In a normal operation we get into minor emergencies every day with the fire department and the police department. And, in the major emergencies, we actually activate the EOC. And we've had some of those recently with the Mount Spurr eruptions giving us some problems. And of course, Level 4 is the major disaster where we really commit all the resources.

A good response force has to practice, practice, practice. So during the last four years, and the previous years have been the same, we've had a series of exercises. In June 1989 we just had a municipal exercise to get our act together with some new players. And then the next year we had a joint one. We had the folks from FEMA came out and gave us the old "Central City" scenario where they throw everything at you but the kitchen sink, to test us to see how well we could do. And we had the State of Alaska into that one.

And then in 1991 we had a Municipality of Anchorage/Alaska Railroad exercise. And most recently, the March 1992, Shaker 3 earthquake exercise, which was a full blown exercise that showed us some real problems. It was a good exercise, good participation, not only within the municipality, but the utilities as well, so that we could become familiar with the way they operate.

Understanding the sensitivity and the problems that you can get into with damage assessment becomes a real emotional operation when you get your house or your place of business shut down so that you don't have access. We've been really working hard at the damage assessment to improve our recovery response.

We're using the Applied Technology Conference procedures. That's more commonly known as ATC-20. And in October we had a very well received and attended training session on how to go out and perform damage assessments. We had around 80 people attend, both private and public sector, engineers and technicians. That kind of gives you a feel for the interest. And I've heard some discussion about volunteers that show up that aren't needed. Let me tell you, we're going to need every one of them in getting our arms around any kind of earthquake damage.

The exercise was jointly sponsored by the Municipality of Anchorage and the Alyeska Pipeline. Very well done. They went into the rapid visual screening techniques, what to do when you first go out. Prior to that, as the fire chief mentioned, we will use helicopter for a quick aerial overview, to kind of get our arms around the problem. We will take the Red Cross folks with us, the fire chief and our damage assessment people to give us a quick feel for where we're at. And then we'll follow up with the rapid visual screening of buildings and then the more detailed methodical evaluations. And we'll use the typical green, yellow, red cards with green OK to enter, yellow is caution, and red is of course, no entry. And those are the ones we want to make as good a shot at calling it right on the first go-around.

And then of course we'll try to come up with an expedited building permit procedure to get through that process as quickly as possible and get ourselves and our folks back up on their feet.

I'll just mention one thing about building codes. They've been kicked around quite a bit. And I think the consensus is we're in pretty good shape with building codes. We've been with the Uniform Building Code Series for many years, which is a good code. It does cover earthquake mitigation.

We, in Anchorage, are in zone 4, which is the most stringent in the Uniform Building Code. And then we have also gone a step further. You've seen the maps outside that show a color coding breakdown of Anchorage into five other codes or five other zones, I should say. We have increasingly stringent requirements depending on the type of facility and the area that facility is in, so that it may be necessary to look at liquefaction, slope stability, mass wasting, and even look at the possibility of stabilization before someone builds in the worst area with a critical facility.

The financial assistance program is probably one we're going to be learning some lessons on. And I certainly have been taking notes on some of the things that you folks have said about that operation.

Depending upon the magnitude of the earthquake, obviously, we're going to have increasing levels of support. State of Alaska will be first, if we get the governor to declare an emergency. Then comes FEMA. And I'm sure if you've probably been watching some of these disasters in the last couple of years, when FEMA does get tagged to go to an area, they're usually graded by the media or maybe—in a lot of cases, degraded on how quickly they can respond. And we would hope that with all the practice they've had that they can get up here quickly if we have an event. And we'll be prepared to support them.

We'll have disaster assistance centers, the DACs, and they will be under the Small Business Administration. And of course, we would hope that the Red Cross and our Department of Defense would provide the usual assistance that they have in the many events before.

Then lastly, I've put this slide up not for you to read but just to give you a feel that we do have an educational program here trying to increase the awareness of earthquakes. This is page 38 in the local telephone book. This is very typical of other types of handouts and information that are provided to develop that awareness. But really, Mother Nature takes care of that around here because hardly three or four months goes by that we don't get a little tremor, a little wiggle somewhere that keeps you aware that you're on the rim of fire. You'd better be prepared.

And that's about it. But I'd like to relate one war story about that 1964 quake. Some things stick out in your mind when an event of that sort is in your experience.

Let's see, it was a Friday afternoon. I left the base and went out to a bank on Government Hill, which is right next to Elmendorf Air Force Base, to get some weekend mad money. And I filled out my check to cash and slipped it across to the teller. And about that time it started. And of course, she smiled and I smiled. That's what we always did because we had hundreds of tremors at ever increasing frequency up to the big shaker. But this one didn't quit. It just kept right on going.

About that time I got hit on the head by a light fixture from the ceiling, and I said, "I'd better get outside." And I did. So I ran out—just outside to my car. And literally hung on to my car because it was oscillating and there was no way I could stand up as these waves would come through.

And it was, literally, waves. I'd say an amplitude of about 2 feet. Others would swear that it was 4 feet from trough to peak. But you could see the pavement rippling. You could hear the concrete grating and grinding. Incredible force.

And about that time I started hearing what I thought was small arms fire. And I couldn't figure out what was—I knew what small arms fire was from an automatic weapon. And I couldn't figure what it was. It was going, rat-tat-tat-tat-tat, rat-tat-tat-tat.

And then I started seeing these bolts falling down all around me. And for those of you that live here, you know there is an Alascom tower that's about 200 feet tall right above that area. That tower was spitting bolts all over the creation there. But it stayed up.

But, anyway, I forgot about my $25. And I took off back to the base, leaped over a couple of crevices in my old 1957 Ford, made sure that the family was OK, and headed down to the office to our Emergency Operating Center. Didn't need any money anyway, because we were pretty busy there for about two weeks working about 16-18 hours a day. Didn't have to buy any food because they provided them in these colored cans; if I ever see another can of C-rations again in 20 years, it'll be too much.

Two weeks later, I decided it was time for some more mad money. I went back down to the bank and walked into the entrance. The same teller lady was there and I was about ready to fill out my check. And she said, "You don't need to do that. I've been holding this $25 for you."

But are we ready? Are we a 100 percent ready? Well, I'm not going to tell you that. Charles has already mentioned that our seismologists and geologists, bless their hearts, keep trying to improve the predictability. But they can't tell us that a week from next Wednesday it's going to happen, you know. So we're not 100 percent ready. We could be if we could predict it that close. But I think we're close enough to where we'll come through it without any great, great problems. And thank you very much.

Questions and Comments from the Audience

MR. HUDSON: I'm Ken Hudson with the Matanuska-Susitna Borough. A question has come up about the utilities and the life lines. What's the situation on alternative power sources, for instance the intertie from Fairbanks? Do we have power that if we suffer a major damage to our local generating facilities that we can switch to? Or would that just be something we're going to have to deal with individually?

MR. CANFIELD: I'm not an expert in that area. But I do know that all of the utilities have got options and backup systems. The switching is not ideal at this point. They're continuing to improve. We may have some utility people here that might be able to better answer that. Is there? Anybody want to take that one on? But I'm not really qualified to answer that question for you.

MR. MALL: I'm Bob Mall from Matanuska Electric. Chugach Electric should probably be answering this question. But I'd like to just talk about it a little bit here. It may sound like a little bit of a pitch, but I don't think it really is. I think we've got to be realistic.

We were talking yesterday about the reliability of gas and electricity. And as we know, nothing is 100 percent reliable. On the other hand, in a climate of our sort, we have extremes of temperature like we're talking about. I think we can realize that in an earthquake situation if Fairbanks, for example, has an earthquake, we're probably not going to have the same earthquake at the same time or vice versa.

In order to protect ourselves, of course, we need to have backup power; what they call loop feeds in the Lower 48. And it does sound like a pitch, but I think I got to put it in at this point.

If we're going to talk about a situation where no matter how earthquake-proof we are, there is the possibility that the generating facilities could break down because of a tremendous earthquake. And the way the situation is now, the power lines from Fairbanks down here are not capable of delivering the power that we would need to keep the minor things going.

I think you should seriously think about supporting your legislatures in this area. Because in our climate, we need that line. Not that any generating facilities in Fairbanks then could support us totally, but it certainly could keep us going. And at least we wouldn't freeze to death.

We talked about the traffic lights and everything else, what a chaos that would be if these things weren't operating. And you know, you talk about the little standby generators. But there's a limit to this. Where do you go?

And so if you really want to think about things like this, and you should in this area, in our climate, we ought to be thinking about our facilities, that they be upgraded so they can carry the power that is available in both ends of the systems.

So that sounds like a pitch, but I think at a time of an earthquake, there isn't such a thing as a pitch for one way or another. I think we're talking survival here.

MR. AHO: Thank you. Roger, do you have a comment?

MR. HEAD: I've got a question for Charles Eadie. Charles, you said after about a week you were given the hat of the incident commander. And I wonder if you could just spend a couple of minutes talking about how long that lasted and when the EOC kind of folded back and you got back to normalcy in government?

MR. EADIE: Well, we're still not back to normalcy in government. That's an easy question. But actually, the way it worked is we moved the command center downtown and modified it. And we kept peeling off pieces that we didn't need anymore. So for example, we kept the logistics and we kept the public information. And then we added a whole slew of new positions dealing with the particular tasks that we had to do.

Then as we completed those tasks, we just started peeling away. So there wasn't a real fine thing that this is the end of it. But we just gradually took away the pieces.

So by about December, we were really down to a minimal operation. And it was kind of like what happened in Watsonville with Gary. He said they kept it going until around the first of the year. So it was about two and a half months. And then, like I said, nothing has been normal since.

MR. AHO: I've got one quick question for Ken. Considering the Shaker 3 exercise, what one or two items is the city working on or what did the city really learn from that exercise? Could you comment on that?

MR. CANFIELD: Bob, you want to try that? That's a deeper one.

MR. STEWART: I'm Bob Stewart from the Municipality of Anchorage. One of the things that we learned from the Shaker 3 exercise in March of 1992 is that we could not effectively operate with our logistics function being physically separated from the main EOC operation. We had put our logistics function at a separate location. We tried to tie it in with hot lines. We tried to tie it in with computer, optical scanners, with a computer at the other location, with an optical scanner. And it still did not work.

So one thing that we learned there is that we now have a policy that everyone will report to the EOC location, at 1301 East 80th, which is the main fire department area. And we're planning on taking over the entire fire department area, because the other people there will have duties that will supplement what we need from the municipality's standpoint.

And that's where Ken had talked about we're going to have a media center set up in the truck bay area where it's nice and cold for the press. And then the rest of our logistics function will be operating from the fire prevention area in the EOC. We're still working on going to the legislature with a request for funds so that we in fact can modify that entire area to make it a functional place for everyone that will have to report there.

One of the other things that we learned, and it may not be necessarily related to the earthquake exercise itself. But during the volcano episodes—and this could also apply to a moderate earthquake—is that sometimes you don't need an entire EOC operation with all of your people.

During the volcano episodes we have developed what we call a Crisis Action Team. Now, I may call that something else later on to make it synonymous with what the general community is doing. But that is a team that in fact has been able to handle the situation from a standpoint of monitoring city status, taking care of the press inquiries, and maintaining contact with the municipal agencies that are involved in response.

It's a core group that is able to handle the situation rather than activating the entire EOC. But by the same token, we keep direct contact with the mayor and the municipal manager as everything is going on. It's kind of a downsized EOC operation. It allows us to be more efficient. Those are the two things, I think that we have changed the most in the last year or so.

GLOBAL PERSPECTIVES ON POSTEARTHQUAKE REBUILDING

by
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William Spangle and Associates, Inc.
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I'd like to start by saying it's a pleasure to be back in Anchorage. I was here last, and the only time previous to this trip, in 1979 when we were starting a research project to look at the problems of postearthquake rebuilding. We selected three cities to study: San Fernando, Santa Rosa, and Anchorage.

I sense a real difference in attitude here since 1979. In 1979 we were told rather pointedly that politically people didn't want to discuss earthquakes in Anchorage. That it was better to put this out of one's mind. It's certainly healthy to see this being discussed here in this format, where there's real interest in the topic. So I think there's progress being made.

My comments this morning are going to be based largely on information from an International Symposium held at Stanford University in 1990, organized by our firm and funded by the National Science Foundation. People came from various countries and talked about rebuilding problems. Some of the people here today were involved in the symposium. Charles Eadie was there talking about his experiences in Santa Cruz. Mike Dever was there. Paula Schultz and Don Alspach, the deputy planning director here in Anchorage, were also involved.

First of all, I don't need to tell you, earthquakes are unique in that they attract everyone's attention at the same instant. No other natural event does that in the same way. Everyone who has been through an earthquake recalls exactly what he or she was doing at that particular moment. We've had testimony to that here from several speakers. From that time forward through the next hours, days, months, and even years, most of those people will be involved in some way in recovering from the earthquake. In the first hours following the earthquake, separate actions are taken by individuals in a rather chaotic environment to save lives and to establish communication. In the days that follow people and organizations come together in a more united and coordinated effort to care for the injured, clean up debris, and begin to repair their communities. The final healing and rebuilding of communities, however, takes years.

Recently, increased attention has been paid to the problem of recovering from earthquakes and rebuilding communities after major damaging earthquakes. We're learning through experience what to expect and how to go about solving rebuilding problems. Your conference is making a major contribution to this topic, and particularly for the Anchorage area.

I'd like to provide an overview of the recovery and reconstruction process and offer some suggestions for actions to take in anticipation of a future earthquake. In doing this, I'll use examples from several cities in different parts of the world. It's instructive to review the history of recovering in those countries because they provide insight into the potential magnitude and types of problems we might face in the U.S. Also, their experiences confirm lessons that we are learning in this country.

Now, fortunately for us, we've not experienced the extreme devastation that earthquakes have caused in other parts of the world. We have not had to face the overwhelming damage and loss of life. This is in part due to better construction in this country. On the other hand, we have not really tested a modern large U.S. city or metropolitan region in a great earthquake. The Alaska earthquake of 1964 occurred about 30 years ago and didn't test a large metropolitan area. The Loma Prieta and Whittier earthquakes have been our best tests. But neither displayed the full potential of a recent great earthquake.

In my presentation I'm going to show a lot of slides. Let me tell you a little bit about the countries that are involved. These are in chronological order. The 1963 earthquake in Skopje, Yugoslavia, magnitude 6.25, killed 1,100 people. 1964, Alaska, magnitude 8.7, 106 people died from tsunamis. 1969, Santa Rosa, magnitude 5.7, no deaths. 1971 San Fernando, the great awakening in California, magnitude 6.4, 64 people killed. 1976, magnitude 6.5, Friali, in the northern part of Italy, 1,000 people killed. The 1976, magnitude 7.1, Tangshan, China, 240,000 people killed. Absolutely incredible. And even at that, there's a question about the accuracy of that number. It could be higher. 1980, southern Italy, magnitude 6.5 the Compana-Basilica, area, 2,700 people killed. El Asnam, Algeria, 1980, magnitude 7.2, 3,000 plus people killed. Coalinga, California 1983, magnitude 6.7, no deaths. Mexico City, 1985, magnitude 7.9, at least 4,500 killed. Whittier, California, 1987, magnitude 5.9, no deaths. Armenia, 1988, magnitude 6.3, 14,000 killed. Loma Prieta, 1989, magnitude 7.1, 63 killed.

You can see the large difference between foreign events and earthquakes in this country. Although, as I've pointed out, the really great earthquake has not yet hit one of our major metropolitan areas.

Now I'd like to have the slides. This is a time line, as we call it. It is a generalized session of the rebuilding actions taken after earthquakes and extends out to 10 years or longer. It addresses the rehabilitation and rebuilding in a general sense and then, specifically, business recovery, housing, public facilities, public services, and financing.

Now, here's the earthquake. Prior to that we should have had pre-earthquake mitigation and preparedness. And that "should" is a very large topic. After the earthquake, we've broken the time line into three phases. The first two months, phase I, emergency relief. It could be one month or it might be slightly longer. Then maybe in a period up to about two years, Phase II, short-term recovery. Then maybe up to 10 years, long-term recovery. Now, those are general classifications. And they do overlap a bit. But for discussion purposes we can address them as defined.

We need to anticipate a sequencing of events after an earthquake. I don't need to remind you that the best defense is an offense. That holds true for the mitigation period you're going through now that is doing things right in advance to reduce the damage after an earthquake. However, no matter how perfectly we do advance work, there are always going to be surprises in the earthquake that we're going to have to deal with.

I'm going to now address with slides examples of these actions under phase I. Then, we'll go into phases II and III. One of the first things, of course, is just clearance of destroyed buildings. This is in Watsonville. Simply getting rid of things that fall down, bricks, and so forth; clearing up areas. In Whittier, piles of bricks simply have to be trucked out. That's one of the early things. You clear up the mess that's lying around.

Then you have to go in and inventory what's left. Part of that is posting buildings as to their safety. This is in Santa Cruz. The buildings are posted in green, yellow or red. Here's a red tag saying that the building is not safe to enter. We don't do this marking only in this country. Here is a shot in Italy with a building that's been tagged.

In El Asnam, here they've coded this building with a colored indication on the building saying it's not safe to enter. So we're not alone. This is done around the world, the initial classification.

We also go out and classify ground failures. You all know this area. It is the Turnagain landslide. This is a quite obvious landslide. These failures need to be mapped after an earthquake. There also may be areas of ground failure that are less obvious. These areas are marked on maps. This is one of the early maps after the Alaska earthquake showing areas of high risk from ground failure: Fourth Avenue, L Street, and the Turnagain area.

You have to then restrict people from going in and doing things until you've done an adequate job of defining the hazard and setting up standards for building. In the Santa Cruz Mountains, there were major areas with landslide problems. Here is a large area outlined in which care had to be taken in any action to reconstruct. The mapping is refined over a period of time but it's progressive. In this short time after the event, this initial kind of work has to be done.

Now, while that's going on, we then look at the business areas. This is Coalinga, after the earthquake, where they immediately set up boundaries to prevent people from going into the damaged area. We've talked about Santa Cruz, and as Charles mentioned, cordoning off that area to keep people out of the downtown and then setting up this perimeter fencing where anyone being admitted was done so with great care. And of course, as Charles pointed out, the business owners want to get back in very quickly.

Here is Potenza, in southern Italy. This area is the central part of the old city. It's blocked off as they're beginning to reconstruct the central area. While dealing with business area needs, emergency shelter becomes an issue. Here is Coalinga, where people are in tents and trailers trying to stay close to their homes. In Watsonville, tents were set up in a park as emergency shelter.

This is in Skopje, Yugoslavia, after their earthquake we see temporary makeshift shelters of any type they could come up with.

And then a rather interesting shot. This is in El Asnam, Algeria, where these very large tents have been set up outside the city because of the massive destruction that took place in the city.

Well, let's now look at public facilities and services. This is on Highway 17 in the Santa Cruz Mountains after the Loma Prieta earthquake—the highway that goes from San Jose to Santa Cruz. As you can see, half of the road is covered by a landslide, and traffic is being rerouted on the other side. As a result there were extreme traffic control problems in helping people get across the mountain on this critical link.

Minor problems occur, such as this water tank which shifted off its foundation, and the resultant need to go in and make emergency connections. And then one of the more chaotic scenes. This was in a telephone building in the San Fernando earthquake where, because banks of relays were not properly braced, they tumbled over. It looks like complete chaos in trying to reestablish communication. The damage could have been avoided with what would probably been a minor adjustment in bracing.

Then there is emergency work, such as patching streets, as shown here in Watsonville. They're simply bringing in asphalt to begin to patch the street. You can see the sides of the buildings of the structure are still cordoned off.

Now, let's talk about what happens a little later. This is phase II, generally the two-month to two-year period. Demolition takes place, rebuilding plans are started, and temporary sites are established for business and temporary housing maybe built.

This is the heavy stuff—demolition. This is in downtown Santa Cruz where a crane is shown taking down a building.

Now, the wrecking ball hasn't hit this. This is earthquake damage in 1980 to a hill town in southern Italy. There's been a bit of clearing of streets so rubble could be removed. Basically, the town just shook apart as earthquake forces probably focused on the hill. The debris disposal problem is shown here at the base of the hill. They're beginning to pile up the rubble of the city here bit by bit.

Here in Mexico City they're demolishing a hospital. They had a major problem moving debris out after the earthquake as illustrated by these trucks lined up at a demolition site just to remove the remnants of a building.

And then we have the Embarcadero Freeway in San Francisco, which still is being torn down after the Loma Prieta earthquake. Many people are pleased it's being torn down because they considered it to be a blight on the waterfront. This example points out an additional problem, that after an earthquake public opinion may cause a change in plans, such as in this case, causing the freeway to be torn down. Also, in Oakland the Cypress Freeway structure, which was damaged, was torn down because the community did not like the way it divided the community. In both cases it was a design question that came into play.

Now we turn to planning for rebuilding. Here we have the city manager in Coalinga beginning to work with the public at meetings. Note the banner which says "The spirit of Coalinga Lives On" as they're beginning to establish plans for reconstruction of that city.

Looking at the city of El Asnam in Algeria, here's a map done of the core of the city showing areas of high hazard. The analysis was done after the earthquake to identify problems of liquefaction and shaking. Through that analysis, it was determined that the old city should have minimal additional construction and that the new growth should go to the south and east of the city. So here is an example of a plan for rebuilding based on an analysis made after the earthquake.

Now, let's look at temporary business locations. Here's a business in Coalinga that was completely demolished. What happened? Well, trailers were brought in as temporary commercial sites, virtually across the street. Here is a hardware building in Coalinga which could still be used, but customers were not allowed to go into the building. Clerks met customers at the door and then went inside to get the requested items.

And you've already seen in Santa Cruz the setting up of these temporary pavilions for displaced businesses. The pavilions are still there, even this long after the earthquake.

This is a business street in Tangshan, China, after the 1976 earthquake. A lot of the construction is with rubble. Simply rebuilding temporary structure with whatever materials were available.

So everyone tries to establish temporary business sites.

Now, what about temporary housing? In Coalinga, FEMA brought in trailers. You saw some of those in Watsonville. It's my understanding that FEMA is going out of the business of doing this and, therefore, that solution may not be available in the future.

This aerial photo shows the outskirts of El Asnam. I want to point out the regular pattern made by housing in this area. If you look closely, you'll see that this is all temporary housing built after the earthquake. These prefab houses were brought in from around the world. They present a solution to an immediate problem, but a problem in the long run, in that with the population pressures it's unlikely they will be torn down. They're not standard buildings. They're not adequate for hot climate. You can see that it's a very rough site. By building temporary housing, they have probably made an addition to the city that they would have wished they could have considered more carefully or over a longer period of time.

Here we are in Tangshan, China, again. After that city was shaken apart, they rebuilt this area with light-weight roofs on a one-story. In the old part of the city you see acres and acres of this kind of building.

Here is a city in southern Italy. And if you look closely, you can see quite a bit of damage. Houses were knocked down. There was damage throughout. What did they do for temporary housing? Here it is—these little trailers lining the road all the way up to the city. The trailers must have come from all over the country.

This also is in southern Italy, and these are prefab units of different designs. These were brought in from various parts of western Europe. Some of these units, in more remote locations such as this, were completely prefab steel structures with plumbing and everything installed. They were brought in by helicopter and set down. It's remarkable to see the way in which the countries in Europe organize to provide this kind of emergency or temporary housing.

Also we have problems with major repairs to public facilities. Here we are in El Asnam with their above-ground aqueduct for their water. The aqueduct failed so their water supply was no longer available, and they had to make temporary repairs.

This, you may not realize, is a civic center. We're in another city in southern Italy. The public buildings were all damaged in the earthquake. These are prefab steel structures brought in to house the municipal functions.

Communication and transportation lines are also a concern. Here are some rail lines bent due to ground movement in the earthquake in Algeria. Obviously you can't use those until they're fixed.

And then the dramatic damage that we've all seen to the San Francisco-Oakland Bay Bridge.

Finally, phase III lasts somewhere on the order of two to 10 years. It includes rebuilding business districts, and building permanent housing and new public facilities.

Here in Santa Rosa is a retrofit of an unreinforced masonry building. You can see interior braces have been put in to strengthen the building, but the building maintains most of the original exterior features. In many cases those old buildings were torn down. Note the building next to it which is an unreinforced masonry building that has been completely redone inside and outside.

Nearby, however, where there were many blocks of old unreinforced masonry buildings, the community decision was to clear the site completely and erect a new shopping center as an anchor for the downtown area.

Now, closer to home, here we are back at the Fourth Street landslide where redevelopment took place with the intense use of federal funds to build a new commercial area.

Just after the earthquake a bold architectural concept was developed for the rebuilding of downtown Anchorage. This points out the exuberance that follows some disasters to improve upon whatever development existed prior to the earthquake. But by and large plans become much more modest with time as reality of the difficulty of carrying them out sinks in. There are many examples of this. Certainly, what has happened here in Anchorage after the earthquake is not what is shown here although there are some new buildings that perhaps in a way relate to the plan. But a dramatic clearance of the whole downtown, then rebuilding it, didn't happen. There was also discussion of moving the downtown or core area outside of the city, which certainly didn't stay around as an idea for very long.

Here we are in Coalinga, with cleared sites in the downtown area. But hardly anybody is rebuilding. And why is that? Because the economy was not sufficient to support it.

And then in Mexico City, here is a building being demolished and next to it is a site where a building had been. And we were told the vacant site was going to remain as a park. Now, that was a positive step forward in a crowded downtown area, to carve out a new area as open space. I hope it remains that way.

Here we are in northern Italy, after the Friali earthquake. There was heavy damage to this town and rather than going in and doing a massive clearance and rebuilding in one style, they had an architectural team work with individual families to discuss the type of housing they had, and how they wanted it rebuilt. Then the units were developed. While it looks like a project, it was nonetheless developed with the participation of the occupants of the houses that had been there. Apparently it has been quite successful in term of being adapted to the culture and the people of the area.

Here we are back in Tangshan, China, with new housing going up outside the city. The floor area per family is small, but incredibly improved over the rubble-built housing that I showed you a few minutes earlier.

Mexico City has a certain flair to its postearthquake design. These are shots of some new residential housing that went up after the earthquake showing bright colors and contemporary building designs.

Now we look at Leninakan in Armenia. Rather than doing a lot of rebuilding in the old part of the city, they designed an entire new extension to the city. The Russians did the work with participation from the Armenians. The city extension is an example of detailed architectural site planning on a grand scale. This entire area is new. The buildings are precisely laid out and the open spaces carefully designed. As shown, they went about doing the building with the sea of cranes putting up the housing very rapidly. It wasn't a matter of more than about a year before they had large amounts of new housing rebuilt. The housing is not terribly attractive, architecturally, but they got the job done.

Well, here's another place we all know. This is Valdez, which sits at an unenviable location. Valdez, is I believe, the only city that was completely relocated after an earthquake, built as a model, and then actually constructed. And that was, of course, completely federally financed. That's not going to be the norm.

Probably one of the most dramatic rebuildings of major cities was that of Skopje, in Yugoslavia. This is the core area, where there was a very massive planning project that went on for years involving international teams. The final product here along the river front reflects very much the careful design work of this team.

In closing, I want to leave a few recommendations with you. I've tried in my presentation to describe some of the problems that are likely to be faced during the three phases of earthquake recovery and reconstruction.

Each earthquake is unique, however. While we may be able to anticipate damage in a general sense, we cannot anticipate it in detail. We need to take as many measures before an earthquake as possible to minimize damage, and also be prepared to deal with postearthquake problems.

Based on the foregoing, I would like to draw some conclusions regarding important actions to take prior to an earthquake to facilitate reconstruction. I'll group my recommendations into three topics: have a sense of realism, have an orderly house and test your orderly house.

First, realism. Earthquakes are not fun and there are no easy fixes. By and large the economic conditions which exist in a community before an earthquake will shape recovery. Those communities with thriving economies before an earthquake generally recover and rebuild rapidly. Stagnating communities recover slowly, if at all. You should not expect miracles.

For instance, in our current economy the vast influx of federal money that helped rebuild many of the damaged communities of Alaska after the 1964 earthquake may not be repeated. Alaskans may have to rely on their own resources for most of the rebuilding. This requires advance consideration of how rebuilding might be carried out. Consider the difference to Alaska if federal money had not been used for projects such as the buttress of Fourth Avenue, the relocation and rebuilding of Valdez, or the port reconstruction in Seward.

Certainly, aid will come from the Federal Emergency Management Agency, but this aid will be limited and slow in coming. Nonetheless, FEMA assistance will be very important.

Second, have your house in order. By this I mean you need to have an up-to-date set of information, plans and regulations which will greatly facilitate the rebuilding process. Let me mention a few of the components. A. Have up-to-date general plans for your city so that the future desired change of the city has already been identified. This plan will provide critical guidance in rebuilding. B. Have a good data base. Maps should show buildings by type and underlying geology. This base will facilitate pinpointing damage after an earthquake and provide a basis for moving rapidly with planning for rebuilding.

C. Have up-to-date codes, especially up-to-date building codes, which will guide strengthening of damaged buildings and postearthquake reconstruction. D. Give special attention to retrofitting any historic buildings, since those can be difficult to deal with in face of the interest of preserving old buildings.

E. Be prepared to expand your staffs to handle the increased workload, particularly with respect to building permit requests, which will go up several-fold. F. Have emergency powers and ordinances established prior to the event so they can be put into operation immediately after the earthquake.

G. Identify in advance the types of hazards and damage you might expect in an earthquake: ground failure, tsunami, building damage, and infrastructure damage. Consider approaches to responding to damage. Identify potential sites for temporary housing and business locations. In other words, think ahead as to what might happen so that you'll be better prepared to respond.

H. Assign someone to keep up to date on FEMA regulations. The complexities involved in obtaining FEMA aid are much greater than most of you would imagine. Having an expert representing the city could make a major difference in being prepared to work with FEMA after an earthquake and then to actually work with FEMA. FEMA regulations are not static. Someone needs to stay current.

Third and finally, test your orderly house. It's been common for years to conduct emergency response exercises in cities. In these tests, the emergency responders, largely police and fire, test their ability to respond in the immediate aftermath of an earthquake. This is essential training.

It has not been common, however, to test the city's ability to recover and rebuild after an earthquake. You should test whether you have in place all of the information, plans and guidelines mentioned above for an orderly house. In order to test your readiness to deal with the recovery and rebuilding phase, a good procedure is to develop an earthquake scenario for the city, and then involve those agencies and interests who would have major responsibilities in rebuilding and recovery. Individuals who would probably be involved would include the city manager, planning director, director of public works, director of parks and community services, building inspector, police chief and fire chief.

This kind of exercise has recently been conducted in two cities in California. One was in the City of Pleasanton in September and one in the City of Los Angeles earlier this month. Each of these exercises lasted one day and simulated the recovery and reconstruction process that occurs over about a two-year period.

Such an exercise can be used to pinpoint inadequacies in your orderly house, and thereby identify what actions to take to improve it. It can be of major assistance to any city in a earthquake-prone area in testing its readiness to recover and rebuild after a future earthquake.

RECONSTRUCTION IN ANCHORAGE FOLLOWING THE 1964 EARTHQUAKE

by
George Sharrock
Former Mayor
Anchorage, Alaska

I'm afraid that my talk will be a little mundane after all the exciting talks you've heard about the earthquake mechanisms, the early response and the emergency periods. Mine's going to be about long-range reconstruction. I feel a little bit unprepared. And even that word is a no-no word in this seminar, because I have no slides or no charts. All I can give you is just audio.

A day or two before the earthquake I read in a periodical that experience is a great teacher, but it's a little perverse in the way it acts. First, you're given the test. And then you learn something about the lesson later on. On March 27th we weren't really prepared, weren't ready for that test. And I'm going to give you a few reasons why.

Most of us didn't appreciate the extent and the power of an earthquake. We didn't know anything about earthquake mechanisms. And we did not know what might happen. We had occasional earthquakes during the period of years that I've been here. But they were of low magnitude and were far away. I think most of us thought that a really large earthquake would not happen here, even though there had been in this century about four or five earthquakes of 8 magnitude in other parts of Alaska.

The other reason that we were not ready was that our civil defense organization was not prepared for earthquake disasters. When I became mayor two and a half years before the earthquake, one of my first jobs was try to reorganize the civil defense organization because it had sort of disintegrated. And one of the first jobs that I did was to convince the council that we get a director of civil defense for the city. And we did that.

But we found out before long that the national emphasis at that time was on fallout shelters. I didn't agree with that. I felt that fallout shelters, since we were only three miles from the runway on Elmendorf Air Force Base, if an atomic bomb were dropped on Elmendorf we'd be wiped out downtown and the fallout shelters would be of no use.

Our budgets at that time were also kind of low. The previous year, 1963, had been a slow year for military construction. Our economy at that time was not the greatest. We had timber, we had fishing, we had some tourism and military construction, and military establishments here were a large part of the economy, particularly in Anchorage.

So our budgets weren't very good. And in March, early March of 1964, our city council decided to cut the budget for the civil defense organization over my objections. But it was done. Three weeks before the earthquake our civil defense director resigned in protest, so that we had no civil defense director at the time of the earthquake.

Fortunately, the evening of the earthquake, I was making inspection rounds of Anchorage. And I stopped at the civil defense headquarters on East Fifth Avenue. There I found our civil defense director, who had just resigned. So, on the spot, I rehired him to come back to the city. And he came in that very night and worked all night and I think for the next three days and nights like most of us. That indicates that we had no specific plans on the books for earthquake disasters.

And now, with respect to the sources of my information, I can recollect many things myself. I was, of course, busy during the emergency and the early days after the earthquake. But I'm not going to talk about that although many fascinating stories could be told about things that happened in Alaska following the earthquake, the first few days or first week.

You know, the earthquake affected a large area of Alaska. There was damage in 50,000 square miles of Alaska. And about 40 percent of the population in one way or another was affected by the earthquake. So, I'm sure you realize that an earthquake that lasted four minutes created a lot of damage.

One of the sources that I had for my information tonight was one of six books that were published by the National Academy of Sciences entitled "The Great Alaska Earthquake of 1964—Human Ecology."

The day after the quake I appointed members to an Anchorage Reconstruction Commission, with one of the city councilmen as the chairman. This commission was represented by banking, business, city planning, state legislature, chamber of commerce, the Alaska Railroad, the Alaska General Contractors; many others were added at later times. But this was just the day after the earthquake.

Our city council had many special meetings in the next two or three days after the earthquake. And on Monday, the 30th, we passed 10 resolutions which were required legally in order to get assistance from the state and the federal government.

We learned during this period of time much of the legal information that we had to have in order to pass those resolutions. Through the next week, the council was involved with many other meetings; a meeting with the Federal Housing Administration, Urban Renewal, Alaska State Housing Authority, Small Business Administration, and branches of the Department of Defense.

We also made plans with the city manager and his staff for the emergency restoration of utilities and services and many other matters.

After April 3rd, the council passed a resolution for urban renewal in the downtown slide area. I'm sure most of you are familiar with where that was. On April the 7th we passed another resolution for urban renewal of the Turnagain Heights housing area. The action work would be conducted by the Corps of Engineers.

The council also approved application for $25 million for accelerated public works, which was needed for earthquake reconstruction in the early stages. We also approved a request to the governor of Alaska for revenue losses that we anticipated during the 1964 fiscal year. The funds would come from the federal government under special legislation and the state would distribute them.

I'd like to say at this time that all of the state and federal agencies involved with us during this period of time really made outstanding efforts, every one of them, to speed up the reconstruction projects within the constraints of the law. They, of course, had laws that they had to abide by.

There were almost continuous contact and exchange of information between all the other agencies, the council, the city law department, the city engineering department, civil defense, the police and fire departments and the city utility departments in order to speed up as fast as we could what had to be done.

From the very first night we were alert to the possibility of shortages in necessary supplies, including fuel. By the next day, however, after inventories were taken, we were certain we would have no problems. We knew that, although our port had received some damage, it was possible to dock ships there and discharge cargo. So we knew that we could get supplies in short order.

We learned through the first few days that our city departments and employees were well trained and equipped to do a very good job under disaster conditions. There were very few mistakes made, even though there had been no specific plans for an earthquake emergency and even though, because of the damaged infrastructure, actions were difficult and slower than under normal conditions.

Geologic studies had been made about five years earlier by Robert Miller and Ernest Dobrovolny of the U.S. Geological Survey. These studies had indicated certain areas of soil instability in downtown Anchorage. I am not certain what distribution these reports had, but they had not been called to my attention until after the earthquake.

I will now describe the damage, what work was done and what agency or agencies were involved in some of the reconstruction. Most destruction in Anchorage was because of earth slides. In the Fourth Avenue slide, virtually all structures in about 13 square blocks were almost completely destroyed. This damage was because of a downslope movement of land, triggered by seismic wave action. Studies and borings indicated that the underlying Bootlegger Cove clay had high water content and therefore low viscosity.

It was determined by the Corps of Engineers that by excavating all material down through the clay deposits and installing a drainage system and refilling with gravel, the resulting buttress would stabilize the land upgrade to the south so as to withstand future earthquakes of similar intensity. An urban renewal request was made, as I mentioned, through the Alaska State Housing Authority for funds for the design and construction of the proposed project. It was approved and construction by the Corps of Engineers was begun in 1965, which was a year later than the earthquake, and finished by 1967.

The urban renewal project specified that land use of the buttress area would be restricted. Low buildings would be permitted between Third and Fourth avenues with specified foundations. But the area north of Third Avenue would need to be used only for parks or parking areas.

The other major destruction in Anchorage was the earth slide in Turnagain by the Sea housing area. This was similar to the slide downtown, and caused by the same factors. For almost 2 miles the 70-foot bluff—from 600 to 1,200 feet deep back from the front of the bluff, the earth had collapsed and moved into the sea and 79 homes were destroyed.

After hearings and condemnation proceedings, the homes were bulldozed into rubble piles and burned by the Corps of Engineers. This area was then graded and sloped down to the ocean. Urban renewal had been proposed, but when it came time for the final approval by the city council in 1967, it was turned down. Later, after proper tests, a finding was made that the area had self-stabilized due to the great amount of earth that had moved, improved natural drainage of the system, and by the grading work that had been done.

Title to the land after resurveying was retained by the former private owners. And since then there has been progress made in putting in new roads and even housing developments planned.

The so-called L Street slide was along the bluff at the western end of downtown Anchorage. A very large block of land, five or six blocks long and about three blocks wide at the widest, moved diagonally toward the northwest, about 11 feet. This created a graben running southwest to northeast, perhaps 8 or 10 feet deep. The lateral movement of this block, of course, severed all the underground water, sewer and electrical connections. It created an uplift at the toe of the block at the bottom of the slope, which destroyed some properties.

Although this area was designated in both previous reports, by the engineering and geology evaluation group and the scientific and engineering task group of the Presidential Commission, as being high risk, no stabilization plan was made for this area that was ever acceptable or feasible.

Gradually building permits were approved for several large buildings on this block of land, one to a luxury hotel complex whose private consultant had produced a thoroughly investigated report which indicated that construction would be safe. Now the State Court Building is just across the street on Fourth Avenue in this area. Several other buildings have been built in this area since.

However, there was one building which was there in this block before the earthquake. I believe it was a six-story apartment building. The building moved intact the whole 11 feet with very little damage to the building itself, except, of course, it disconnected all the utilities. And it has since been renovated and is still standing and fully utilized.

There were a couple of other slides that I'll just mention that weren't as large. One was on Government Hill where a primary school had been built. And you saw slides yesterday here of the destruction on that school. Well, that school was razed, and as far as I know, there's been no construction on that site. It was graded down and left as it was.

The other one was on Fifth Avenue out by the Native Hospital. You saw slides on that yesterday and what happened there. But that was on federal land. And if there was any stabilization done there, I'm not sure what it was.

At the foot of that same slide was a 300,000-gallon oil tank that the city had used for storing oil to run its gas turbine generators in case of emergency. And after the earthquake the tank developed a leak. They did start up the production of electricity only a short time after the quake. But it ran only two hours because the oil had all leaked out. We had to get military oil hauled in from the military bases by truck. And that ran until Sunday morning at 4:00 a.m., when the gas company had the gas line repaired.

There were many other buildings, both single and multi-story structures, that were damaged by seismic ground waves. Most, if not all, had minor damage and were repaired. And most of them were not in these areas that we speak of as hazard areas. Other public properties, city, state, and federal and not in high hazard zones, were reconstructed, mostly in 1964. The costs were covered by federal disaster funds and funds from several other federal agencies through special programs.

Private property owners were aided by several programs for losses from destruction. The principal one you've heard of is the low interest disaster loans made by the Small Business Administration. And that was a great help to the private owners, not only residential people for their private homes, but also businesses. And some of the businesses were even able to get the low interest rate loans on debts that they had prior to the earthquake.

Private property owners who had a mortgage and whose property was that destroyed, or even very badly damaged, were aided in another way. The U.S. Congress passed legislation that would pay off the balance of mortgages when the mortgagee's loss was more than 60 percent of the property's value before the earthquake.

The Alaska Legislature also passed a similar legislation with the federal government and the state contributing equally to the aid funds. Each appropriation was $5.5 million for this program. It was called the Mortgage Adjustment Program.

Incidentally, I had something to do with that program. I became commissioner of commerce in 1966. And the applications had just come in for aid, about 200 of them. About a 100—something a little over a 100—were approved. The approval had to be made both by the state Department of Commerce and Fannie Mae, the federal organization that was set up to handle it with the state. The aid money, incidentally, was paid directly to the mortgagee, and did not go to the mortgagor.

This sort of completes my review of some of the badly damaged areas. I could go on for a long time for particularly outside of Anchorage where they had tsunami damage and waves that were caused by subsiding underwater land. But I won't have time for that. So we're going to have to miss those, although they were very important in the recovery process.

I shall now attempt to name some of the problems and conflicts that were encountered during the reconstruction period. The Federal Reconstruction and Development Planning Commission for Alaska, which was appointed by the president the next day after the earthquake, or in a few days, had two aims. One was to avoid placing reconstruction work on a crash basis so as to avoid inflationary pressures. And number two, to use as much Alaska labor as possible. And these were very desirable from our standpoint as well as theirs.

However, the first one clashed with the need to be ready for a usual Alaska summer season of work. Alaska's businessmen and workers were very much interested in the summer work season, during which most of the annual income was to be earned.

Federal agencies were charged with planning for ensuring that federal laws and regulations were followed in the reconstruction projects. Local officials were, of course, almost always interested in following the desires of their constituents and protecting their constituents' interests. Often these goals were in conflict and resulted in costly delays in the important job of reconstruction, not only in Anchorage, but in almost every town that was involved and had major destruction.

Many of the federal regulations were designed to protect us from ourselves, so to speak. For example, one rule was to prevent reconstruction in highly hazardous zones. And this happened in Anchorage. We had a few highly hazardous zones designated to prevent losses of life and property in the event of another violent earthquake.

Many local citizens did not believe that the city was justified in changing zoning laws which would prohibit restoration or reconstruction on private property. The government agencies responded that if the government was in any way financing the reconstruction then it should be able to deny aid if laws and regulations were not followed. Otherwise, they contended, such aid could lead to people being apathetic or careless in guarding against future disasters. This kind of conflict occurred in almost every community.

The geologists had very valid and persuasive arguments why their advice should be taken. However, business people and residents had answers that they also believed were valid. They maintained that strong earthquakes did not occur frequently. And it might be 50 or 100 years before another disastrous earthquake occurred.

It was proposed that the city center be moved to a less hazardous area, as someone pointed out earlier. But businessmen maintained that moving the city center would take much time and many businesses could fail or go into bankruptcy and employees would be out of work for long periods of time or be displaced.

The political pressures to rebuild or repair on present sites was great. It's evident that in most of the areas affected, the tendency of local officials and residents was to evade what they termed "radical proposals" unless the arguments for them were overwhelmingly strong. If they were, locals in most every case applied for urban renewal, which then would require that the land all be acquired by Urban Renewal. There would be no private property left, no title to any private property left in the project.

The Science and Engineering Task Force made the following recommendations for future guidance: Number one was to try to improve earthquake prediction technology. Number two, improve tsunami warning systems. Three, designate earthquake-hazard zones in populated areas. Four, require earthquake building codes. Improve and expand seismographic stations. Exchange earthquake technology information with Japan. Improve worldwide participation and set up federal and national disaster planning.

Many of these recommendations, I know, have been implemented and probably many more have been proposed since. Your theme of this seminar is "Are We Prepared?" From what I know, the agencies charged here in Anchorage and in the Anchorage area with the immediate response for a disaster have plans that appear to be adequate.

Randy Updike, yesterday, apparently believes we are not prepared. But he is looking at the possible causes of loss of life and property, mainly by building destruction either from faulty design or from construction on hazardous land. It would seem that this criticism might be directed to almost any city in the earthquake-prone areas. However, he is no doubt correct. It does call for better inspection of both design and construction of buildings built in hazardous areas or perhaps anywhere.

Since instability of the soil is indeed a culprit here in the Anchorage area, we need to find ingenious ways to stabilize the soil in areas already developed. I understand that there have been improvements in stabilization, especially by the Japanese.

In connection with improving enforcement of regulations or requiring zoning laws that would prohibit certain land uses in hazardous areas, I would suggest that the zoning requirements be phased in over a long period, maybe 30-50 years. This would give property owners time to amortize their investments.

I cite a law passed in Florida a few years ago for zoning near the beach areas. Florida has frequent hurricanes, as you know. And usually the storms pass from sea to land or vice versa. Many homes were being destroyed by hurricane-created waves on the beaches. The new law required that any new construction on the beach, lower than a specified height above high tide, be built so that the living quarters are raised one story above the ground and the building be designed so that water can flow through the lower portion. With this provision, they expect that many buildings will be saved. However, the State did not require that the homes already in place be condemned. But as they grow old and are removed, the new structures must conform to the new zoning law. Some such zoning laws might be designated for the hazardous zones in earthquake-prone areas, with full enforcement attained over many years.

THE HAZARDS OF LONG-TERM RECOVERY

by
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California Office of Emergency Services
Oakland, California

It's a pleasure to be back here in Alaska. I had the opportunity in February 1990 to participate in the EERI Learning From Earthquakes series. At that time, I was asked to talk about emergency response and social issues related to the Loma Prieta earthquake. That was about four months after the earthquake, and it was already pretty clear that the social issues, the recovery issues, the rebuilding issues, would be the ones most difficult to resolve. Our experience has emphasized the need for more and better recovery planning at the local and state government level.

We need to look at the recovery process as both a challenge and an opportunity. The challenge is how to put Humpty Dumpty back together again. And I think the opportunity is that you can put Humpty back better than he was when he took the fall. Now, he's probably never going to look the same. He'll have a little cheek bashed in here, and maybe one leg is going to be shorter than the other. But you can in fact, if you take some time, put him back together with super glue instead of Scotch tape, bolt him or brace him to that wall, and retrofit the wall so it doesn't crumble.

The state has a key role to play in the short- and long-term recovery effort. The first thing I want to mention is that the state gets involved with all the communities that are impacted. Today we've been hearing primarily about Santa Cruz and Watsonville, which were very close to the epicentral region of the earthquake. One of the things that we need to recognize is that the entire Bay area was impacted. We had a large area near the epicenter where the strongest shaking and the most widespread damage occurred. Areas of liquefaction, however, occurred south and also far north. In fact, most of the media attention in the immediate hours after the earthquake focused on the dramatic damage in Oakland and San Francisco.

So we really ended up with three disasters that we were trying to manage: southern, east bay and San Francisco. And they all deserved equal attention.

In assessing how the state is impacted, you have to look at the dual responsibility that the state has. It's important to remember that we are responsible for the welfare of all the citizens of the state of California, and that our primary role is to support local government in servicing their populations. On the other hand, there's also a responsibility of the state to take care of its own employees and facilities. There are three areas where the state is impacted strongly after any kind of a disaster, but particularly after an earthquake. They are personnel, financial and facilities.

<u>Personnel</u>. Many state agencies are involved in the recovery process. For example, the Office of Emergency Services, CalTrans, Social Services, Mental Health, Department of Aging, Department of Commerce, the State Comptroller's Office, the Franchise Tax Board, Office of Historic Preservation, Department of Education, Housing and Community Development, and last, but perhaps not least, the Attorney General's Office. Staff from a variety of agencies will be assigned new duties above and beyond their regular tasks. Frequently they will be asked to find solutions to problems that have never been encountered before. Often the only training they will get is on-the-job training.

Financial. We still haven't tallied the final costs of the Loma Prieta earthquake. We have estimates now that losses might reach $10 billion. In looking at how that gets paid for, right now we're estimating that less than 40 percent of the cost will be covered by disaster assistance funds. We need to explore more creative financing mechanisms for recovery programs. The state bears 25 percent of the disaster assistance program costs. In Loma Prieta, the state also covered the local costs, which I understand is the normal procedure for Alaska.

One of the ways that we tried to get some additional funds to help with the repair and reconstruction process was through a statewide sales tax. A 1/4 percent sales tax was in effect for 13 months. However it was inadequate to cover the needs and the costs.

Facilities. The state owns property in earthquake areas as well as anyone else. And it does seem that, particularly in California, the government buildings seemed to take the lion's share of the damage sometimes.

This slide shows a state office building in downtown Oakland. It doesn't look bad, but it has severe structural damage. Part of the building was evacuated immediately after the earthquake. The rest of it was evacuated and closed about two months later when a further analysis of the damage was done. There was also a major problem in that building with asbestos, which significantly contributed to the closing. The building still sits exactly as it was at 5:05 on October 17. At this time the decision has not been made on whether it will be repaired or demolished.

All of the employees in that building had to be relocated. People were working out of their homes. They were telecommuting. Meetings were being held in restaurants. And all of this was occurring at a time when we're supposed to be providing support and coming up with some solutions on how to handle the disaster.

In addition to dealing with your employees, there is a need to communicate with the public. You've got to be able to let people know where to go for services once you're out of your normal facility. This slide shows a marine research lab in the Moss Landing area. This was a virtually new $4 million facility in an area of high liquefaction potential. It had to be demolished. Reconstruction of an alternative facility has not yet occurred.

Probably the longest-term recovery problem for the state is the highway system. This slide shows the infamous Cypress structure that ran through Oakland. About 1¼ miles of this double-deck freeway collapsed. Prior to the earthquake, this freeway carried somewhere on the order of 25,000 trucks per day, primarily coming out of the port of Oakland, a large container shipping port.

The closure of this freeway is still affecting all of us. We sit in more traffic. We create more air pollution. Costs just continue to go up. The structure itself was demolished fairly quickly. There was a lot of rubble, something around the order of 600 tons for each section, from that freeway. Creative solutions to debris removal and storage had to be found.

This slide shows the final little section that was left standing to test our theories of how this structure failed. Some oscillators were put on it and it was run through a number of tests. This slide shows the failure point, where the second level fits on to the first. And you can see it really clearly. It's just one of a sequence of the demolition shots.

One of the things that we tend not to think about as state agencies are the people that we're affecting and we're impacting. We tend to get blinders on. We have a job to do. We want to do it in the quickest and most efficient way possible. I think we need to learn how to get more in touch with our communities. And frequently, if we don't, they're going to come back and show us how.

This slide shows the west Oakland area and actually you can see sections of the Cypress Freeway right here. That's the lower deck there. Some of it's collapsed in there. But it runs right through a neighborhood. People were living there during the earthquake. They were living there after the earthquake. They were living there through the 24-hour search and rescue operations, through the 24-hour demolition, with floodlights, generators, incredible noise and incredible vibrations and shaking. You know, people were losing their minds. They finally arranged it so that demolition would stop at 10 o'clock in the evening and not start until 7 in the morning, to give people at least some opportunity to try and get some sleep.

Another aspect of the community there was that they really didn't want the freeway put back where it had been before. Obviously that was the simplest solution. That was what CalTrans had in mind was to just put it back right where it had been before. Well, through years and years of hearings and different plans and different models, there is now a new route. Construction is expected to start maybe in 1993, and be completed in 1996.

This shows another double-deck freeway, the Embarcadero Freeway over in San Francisco. For the Embarcadero, there were a lot of questions about whether it could be repaired, should be repaired, or could the city take the opportunity to get rid of it. Many felt it was an eyesore. And there were a lot of people on both sides of that issue. Some of the business districts, the tourism industry down at Fisherman's Wharf, and Chinatown, wanted this structure repaired and repaired quickly, because it was access to their businesses. And nobody wanted to sit in the traffic to come around from the other side to get there.

Initially what has to be done while you're trying to figure out what you're going to do with the structure is to shore it up. It's still a potential hazard. It's got structural damage. Aftershocks could bring it down. So a fairly intricate system of reinforcing had to be placed under these levels to try to keep it up, while traffic and foot traffic continued underneath. It cost $34 million simply to shore this structure up and to protect life safety. Eventually it was demolished. There are still sections of it and access ramps to it that are currently in the process of demolition. Again, all of this is done with the goal of keeping traffic running and keeping businesses open.

I think one of the unique things about the Embarcadero is even though it's a state facility, legislation was passed turning over control of the future of that freeway to the city and county of San Francisco. It turned out to be their decision whether it would be demolished, rebuilt, and how it will be rebuilt. It will be done in corporation with the state. But the decisions and control belong with local government.

Another double-deck freeway we had is the Central Freeway. Again you can see in this slide some bracing to try to strengthen and shore these facilities up. The earthquake really teaches you about what you don't know about structures and engineering. We have a lot of great design concepts. We think our codes are pretty good. But when it gets right down to figuring out what to do with these things and how to make them structurally sound afterwards, it's extremely difficult.

A lot of money was spent in some very quick fixes, before adequate research and analysis had been done. What happened out of that was that the governor appointed a board of inquiry to look at a number of issues relating to the highway system. But one of the things it did was create an independent review panel to look at the repairs that were being done and to take a look at the long-term retrofit program that the state was involved in for the freeway structures. The independent panel discovered that the retrofit work that was going on for the repair was inadequate and was going to cause other problems. So the whole process was halted. And we're still working on this very, very slowly.

Another topic area I want to focus on is legislation. There's an incredible opportunity within the first year after your disaster. All of the landmark seismic legislation in the state of California was passed following a damaging earthquake: The Field Act after the 1933 Long Beach earthquake; the Hospital Safety Act after the 1971 San Fernando earthquake, and on and on.

The year after the Loma Prieta earthquake was also a big year for legislation. During the 1989-90 legislative session 443 bills were introduced that included the word seismic safety or earthquake. Of those, 137 were signed into law. And there was really a broad range. Many of them were related to disaster assistance and relief. One as I mentioned before was the state sales tax. This was statewide. And it actually had a lot more support than we expected it would get. Because when you're in California, there are few areas that aren't susceptible to this kind of earthquake. So, I guess they felt, well, we'll put in money now and maybe we'll get back some when it's our turn.

Tax relief was provided for business losses and homeowners to take some of the burden off the recovery costs. Small business grants were provided to try to get businesses up and running as quickly as possible.

Some funds were allocated through legislation for historical and state parks repair and reconstruction. Also there were a couple that deal with residential losses. One is our CALDAP program that tried to address the needs of people who couldn't qualify for SBA loans, who didn't have the resources, the equity, to qualify for a low-interest loan. This was an alternate program that they could go to.

A rather unique program that was instated following Loma Prieta is what we call the California Residential Earthquake Relief Fund (CRERF). The concept was that there are a lot of homes with minor damage; damage of $15,000 to $20,000, that is fairly simple to repair. What we found is that for homeowners who had earthquake insurance, for the majority of them, they didn't come up to their deductibles, their $15,000 or $20,000 deductible. So we initiated a program whereby for, I think a fee of $65 per year that was added to your homeowner's insurance when it came due, you bought into a program whereby following an event you could be eligible for up to $15,000 to do your repairs. The idea was that it should take some of the burden off the disaster assistance programs. The CRERF program was activated following the Cape Mendocino earthquake in April of this year as well as the Landers and Big Bear earthquakes the end of June.

We haven't been able to do an analysis of the program and how well it worked. But what has occurred since then is that that law was repealed. It was overturned. It was probably a poorly written law. It did not have language in it that really made it mandatory for people to buy into it. And it was fairly clear that the fund could be broken with one very, very serious earthquake, and that it really was inadequate. Folks who have not much more than chimney damage are going to have to figure out a different way to pay for it from now on.

<u>Disaster assistance</u>. I'll start this section off by saying everything you've heard about the disaster assistance process is true. There are no easy answers. The system is complex. And I

agree wholeheartedly with what George Mader said earlier. It is really the responsibility of both local jurisdictions and the state to know the regulations, to know the laws.

It's kind of like dealing with taxes, you know, with your state and federal taxes. You get your booklets from the IRS. It kind of lays out what you can do, what you can't do. But it doesn't tell you how to take advantage of the system in the best way you can.

And that really relates to the disaster assistance process as well. There really isn't going to be anyone coming in from the federal government and saying, well, gee, here are all the things that you can get. You really need to be aggressive in your own right in knowing the regs, understandings the regs, and looking at interpretations of the regs. And you'll find that each administrator may interpret it slightly differently. Get your city attorneys involved. It is a long-term process. This slide shows the last building to be repaired after the San Fernando-Sylmar earthquake in 1971. It took 20 years to close out this claim.

The two programs that our agency, the Governor's Office of Emergency Services, gets involved with are the individual assistance and public assistance programs. We have an individual assistance program that is parallel to the federal individual assistance program. It doubles the amount of grant funds that can go to an individual who doesn't have other resources and can't qualify for loans. It brings the total up to about $20,000 per individual.

Public assistance is the real long-term program. There are at least four areas to really be careful of in looking at the public assistance process. Probably the most important aspect is what's called codes and standards. The funds that you're eligible for or the repairs that can be paid for under public assistance are going to be very highly connected to what you have as a current building code or standard for repair. Now, I can't emphasize this strongly enough.

We run into a lot of problems after earthquakes. We don't know how to fix buildings that aren't covered by code. They're older buildings. They were designed and built before current codes that we know are seismically better. It's a dilemma. And it takes time, usually, to get codes in place. You need to have something ready before the earthquake that can be adopted quickly, such as local ordinances and legislation. If you don't, you're going to get caught short. If you have a Damage Survey Report (DSR) written and approved before you have your new code in place, you've just lost a great opportunity for mitigation and upgrading and repair.

Historic buildings are a real dilemma. Many of them are damaged enough that you really want to tear them down. The preservationists are going to oppose you. You are not going to be able to tear them down. These buildings will be some of your longest-term problems.

It's really important at the outset to try to establish relationships with the state and local historic boards, and to try to come to some kind of conclusions on how you're going to deal with those buildings.

Flood zones also come into play. Floods seem to govern everything in disaster assistance. But before you can get any approval on a DSR for earthquake damage, you have to reassess your flood zone, where the building is in your flood zone and whether you have flood insurance. It's kind of a back door approach to getting flood mitigation done.

The last issue, and probably the most controversial, is the cost benefit. And that really comes into play on the amount of funds that may or may not be available and whether you can repair or replace a public facility.

A couple of examples of these: this slide shows the city hall in Oakland, which was closed down immediately after the earthquake because of structural damage. Thousands of Oakland employees had to be relocated. Oakland was a hard hit community. It lost a lot of housing, as well as having to deal with the implications of the Cypress structure. So it was very difficult. It was a difficult decision for them to make. But they really had life safety at issue. I believe the DSR has now been approved for something like $65 million to repair this building. It's historically important. It's culturally important. And it's going to take a lot of money to put it back together.

Another example is the San Francisco City Hall. Now, San Francisco chose to keep its city hall open. And they made a very large point of telling their employees that the damage was really cosmetic, you know, don't worry about those cracks. We'll just put a little shoring up here and there, and it's not a problem.

Then they applied in their DSR for total seismic retrofit of the building. You can't have it both ways. Is it structurally unsafe or isn't it? It is difficult to make that case when the building has remained occupied for three years. So it's still under debate and probably will be for some time. That's one of the areas, where we talk about decisions that you make early in the game affecting the long-term recovery. If San Francisco had actually looked at that building carefully and closed it down after the earthquake they probably would be more successful in getting the funds that they're requesting.

"History At Risk" is a document that was put together by the Historic Preservation Foundation to try to bring some of the issues of historic buildings to light and to try to make recommendations for how, through the state process, we can be more sensitive to historic buildings and come up with some better solutions.

The last topic I would like to address is hazard mitigation. This is one of the greatest areas of opportunity after an earthquake. It's one of the areas where I think FEMA doesn't get enough credit. There are both requirements and opportunities within hazard mitigation process.

Section 409 of Public Law 93.288, which is one of the first things I learned after Loma Prieta, requires hazards mitigation plans. Basically it requires that the state produce a plan showing what you're going to do in the recovery that is going to make the community better and reduce the cost of disaster assistance in the future.

The other element of the hazard mitigation process is the Section 404 grant program. It provides matching funds through FEMA to make improvements to structures or properties that were not damaged in the earthquake. And so it provides a unique opportunity to upgrade those facilities that might have skated by this time, but might not the next time.

The beginning of the process is developing what's called a hazard mitigation survey-team report. This is the one that we did following Loma Prieta, primarily put together by state and federal agencies.

Since Loma Prieta we have tried to incorporate local government more into this planning process. It was extremely difficult in Loma Prieta because we were required to do this within two weeks of the earthquake. Local government didn't have time to deal with this. And a lot of state agencies didn't either. But to the extent that you can get local involvement or postpone the process until local involvement is available, you'll have a much stronger report and recommendations.

It's also required that the state submit a hazard mitigation plan to FEMA within 180 days of the disaster. We're fortunate in California that the Seismic Safety Commission is legislated to maintain a hazard reduction plan. And it's called "California At Risk." It's a five-year plan updated annually.

FEMA recognizes that document as the state's hazard mitigation plan for earthquakes. So it really took quite a load off to have that plan in place. That's one thing we didn't have to deal with in those first six months after the earthquake. The plan also helps lay out the priorities for how you might determine the best use of the hazard mitigation grant funds that you are eligible to apply for.

Following Loma Prieta we initiated the grant program process. We received 237 proposals from 187 different applicants, totalling $103 million. We had a lot of difficulty trying to pick the best ones. One of the things we did was set up a proposal review team.

At the time we were looking at a potential of about $40 million from the federal side that would have to be matched locally. At this point, we do have $38 million in approvals, although at last check, which was about two months ago, only about $18 million of that had actually been allocated and passed through.

The funds are coming slowly because the FEMA disaster reserve is broke. There has been nothing but disasters for the last three years. Certainly Hurricanes Andrew and Iniki are going to add to that problem.

So what we're finding is even when projects are approved, whether they are mitigation projects or disaster assistance projects, the funds trail way behind the approval. Getting the approval is struggle enough, but then you could wait a couple more years for the funds to come in.

Some of the kinds of things we were able to fund out of the hazard-mitigation grant program range from nonstructural retrofit of communications facilities or generators all the way up to the seismic retrofit of essential services buildings. I think in San Jose we provided funds for the retrofit of seven fire stations. The City of Santa Cruz had a fairly unique program where they acted as sponsor on behalf of individual homeowners to provide a program whereby, if they retrofit their residence, 50 percent of it could be paid with the hazard mitigation grant funds. There is a lot of opportunity and it can really be crafted to meet the needs of your community.

In closing, I'd like to emphasize a point that has been mentioned a number of times during the last two days. That is the need for interagency coordination. It's something that cannot be overemphasized.

The state is really a key link between the local and the federal government. We saw that in Hurricane Andrew, where two days after the hurricane Dade County was on TV saying, "Where's the cavalry?" What you didn't hear about is that FEMA was on the other side offering resources. The blockage was apparently at the state level.

There are probably a lot of versions of that story. It is really critical that the state be there and be an advocate for local jurisdictions and to run interference with the federal government. Know the regulations. Provide information to local jurisdictions. It's going to make the process run a whole lot smoother. You've got to be able to establish these relationships or the recovery process will be more of a struggle than it really has to be.

I think my closing comment is that the state is not going to get away scot free. The state may be a disaster victim itself. But it's absolutely crucial that the state also be able to be a resource to the recovery.

Questions and Comments from the Audience

MR. STEWART: I'm curious as to what effect the California governor's emergency declaration had on local government. Did that free up enough funds or did you have to go or did the state have to go to the legislature in order to make funds available beyond what the governor could make available?

MS. SCHULZ: Actually we still don't have enough funds to do everything that needs to be done. The greatest benefit to the governor declaring an emergency is that it does free up state resources to flow in assistance, and is the next step in requesting a federal declaration.

The governor maintains a disaster-contingency fund, a small reserve fund. It's clearly inadequate to deal with things beyond the relief process. It's inadequate to deal with recovery. It's inadequate to deal with a full relief system. And that was one of the reasons for the ¼ percent sales tax.

A large amount of that money went for the repair and retrofit of freeway systems. A part of it went to the CALDAP program for the low-cost loans to folks who couldn't qualify for regular disaster assistance programs. Some of it went for compensation for the deaths on the Cypress structure. I think we're somewhere around $67 million that was paid as compensation to victims and victims' families. There are a lot of unmet needs. And we're still looking for funds to support these efforts.

One of the things the state also did immediately was to try to front some of the federal reimbursement money to local jurisdictions, particularly, the funds that would reimburse for the response and debris clearing funds. And we were able to do that.

UNIDENTIFIED VOICE: In terms of the mitigation of hazards I was just wondering if you had any thoughts on the issues of liability, such as you just touched on about the deaths caused by the collapse of the Cypress structure, associated with some other things that we've been hearing here this morning where construction has occurred on land where there are studies that say it's unsafe. Then you have the later studies that say, oh, no, you can go ahead and do that.

I know in our area we get people who demand the right to develop. And then something happens. And then they want to sue you for allowing them to do it in the first place. Have you run into that or have you looked at it in terms of mitigation after a disaster?

MS. SCHULZ: I don't think we've had to deal with it much in terms of development being allowed to occur and then hazards occurring. There have been, certainly, some suits against building owners, particularly of unreinforced masonry buildings where it is clear the buildings are a hazard. It's well known they are a hazard. And then the question comes up whether the owner took any reasonable steps to mitigate that hazard.

Almost all of the lawsuits have been settled out of court. And generally when they're settled out of court there's no disclosure of the amount of the settlement. So it's unfortunate because then you can't really use those figures, when you start trying to justify the cost benefits of mitigation. Because you never end up knowing what the actual costs were for those losses.

I think there have been suits in southern California related more to landslides, where in fact there has been some liability that's been proven against the county. They did have to pay a settlement.

We're also running into a number of suits from the East Bay Hills fire up in Oakland, where it's clear there is a wildfire danger up there, and urban interface danger. There are suits against East Bay Municipal Utilities District, the water utility, and against the Oakland Fire Department, and you name it—anybody who may have been responsible for allowing the development without the appropriate water systems that need to be there for fire flow.

We're currently in some real debates about development farther south in the East Bay Hills, along the Hayward fault. I think there were somewhere around 2,000 people that showed up at a public hearing the other night to protest approval of the new development because of the fire danger, and the seismic danger. And that's one that I think, if the City of Oakland goes ahead with approval and there is a disaster, they're going to have some law suits.

COMMUNITY PLANNING

ECONOMIC IMPACTS AND PERMANENT CHANGES IN THE AFTERMATH OF THE 1989 LOMA PRIETA EARTHQUAKE

by
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As I mentioned this morning, the second part of this talk is really going to take it from what happened the first couple of months and the transition from emergency response to short-term recovery, and then carry it out over the subsequent three years.

But before I do that, I just wanted to have a postscript on a couple things. That is, for those of you in emergency response and recovery, the important point to keep in mind is the incident command system. You know, it's a command and control system. But what it really means is manage and delegate. And the way the thing is really going to be effective is if you let your people in the field make decisions. Give them the authority and they'll rise to the occasion. At the same time, you provide the big picture and make sure that everybody is moving in the same direction. And that's the only way to do it. Because if you try to control it, it's not going to work. There are just too many things happening, too much to do.

Well, in Santa Cruz, where I left off, we had gotten through to the Christmas season. And it had been a tremendous community-wide effort to survive, to get back on our feet and to get the downtown open. We got the demolitions completed. We got safe areas open. Part of the downtown was reopened. A minimal amount was fenced off. And we had the business pavilions going.

And that six weeks of effort was probably the most intense experience for just about everyone in the community. The downtown in a small town like Santa Cruz, and most towns, is really a special place. It's a public place. People consider the downtown as a public extension of their living room. And the people are ready to contribute and respond in any way possible.

An amazing thing happened that there was almost a euphoria that swept the community after we got through that initial six weeks. Santa Cruz has always been, at least in the last 20 years or so, kind of a Hatfields and McCoys kind of place politically. It's not a matter of interests. It's sort of right and wrong. If you don't agree with somebody, then they're bad. And if they don't agree with you, then you're bad. And in this context people have been yapping at each other for about 20 years.

A funny thing happened after the disaster. All this political habit almost got set aside and suspended. And there were people that, from a political standpoint, business people and the city council that didn't get along before who were actually working side by side. They got busy working and every once in awhile looked up said, "My gosh, I'm really working with this person."

There was just a real sense of common purpose and community purpose. The net result of that was a feeling within the community that, boy, we got through that. Rebuilding is now going to be a cinch. We can do anything. We can work miracles. And it was, in a real sense, a miraculous effort.

The community response was 24 hours a day. It was thousands of people working to get the downtown up and running again. Even people that couldn't do anything, particularly. At one point somebody organized an energy-in or something. You know, this is Santa Cruz, right? An academic town. They got about 200 people downtown and they all held hands around the cordoned off area in downtown, to sort of send out some good vibes or something. Why not? So, there's this feeling that boy, we can really charge forward now and we can be a different place than we were before if we can just sustain this sense of community, this sense of common purpose and not revert back to the old Hatfield and McCoy politics.

Let me give you a brief outline of the time span here. Then I'll go into some slides and tell you what happened. Picking up from where we left off, you see the rescue phase, the postrescue phase and the immediate recovery, the first 60 days. And then the long-range planning process.

And phase I it says, gearing up, sorting out, months 1 to 6. There's a real question as to what to do. It sounds pretty simple, you just go and rebuild, right? But it isn't quite that simple. I mean, George Mader always gives me a good lead-in when he talks about using your existing plans and general plans and that sort of thing.

Well, in Santa Cruz, I was working on the general plan before the earthquake. It was in a state of flux. We had a downtown plan. But the philosophy of the downtown plan was to preserve everything just the way it is.

There were people who literally thought all we need to do is amend the downtown plan. So I read the thing. And I said, "Well, you can do that. You can keep the cover. You can keep the back cover and take all the sheets out and start over and you have an amended plan."

The difference, the big difference in recovery planning from normal planning is the status quo is not an option. And when you think about it, there's a lot of resistance to change among people and among communities and for a lot of legitimate reasons.

Downtown Santa Cruz was a historic district. And it had a certain quality to it that people really liked and wanted to preserve for all time. Unfortunately, if you do historic preservation and you don't do retrofitting, preservation lasts only until the next big earthquake. A lot of the resources in the downtown area were lost.

So there was just a big fundamental question: What's the nature of the beast now? What are we doing? Are we doing a plan? Are we revising the existing plan?

We just picked up and started gearing up and sorting out. Then we got into some sort of agreement that, well, what would a plan look like, what would a recovery plan look like if we had one. That took another three months. And so it was really a year later that we actually got to the point where there was an agreement on doing a downtown recovery plan.

Now, this raises some interesting challenges because people want to move quickly at the same time. Go fast, go slow. And recovery planning is about a lot of opposites, paired couplets. Rebuild quickly, act quickly; don't move too fast. Preserve the past; change.

These are the kinds of questions for which there are no ready answers. It took us about a year just to get to the point of beginning the actual preparation of the downtown recovery plan. Part of the reason it took so long was because of the political situation as it had evolved over the years.

We were awarded a grant, myself and another person in the planning department, in January of 1990, for a downtown recovery plan. And we thought well, we're going to need to do a downtown recovery plan. That was eight months before everyone finally agreed that we were doing a downtown recovery plan. But if we hadn't applied for the grant we wouldn't have gotten the money to help support the plan.

So you have to take a few calculated risks. When the city manager found out that we were going to have to give the money back if we didn't do this recovery plan, then he finally agreed, "Yeah, I guess we do need a recovery plan."

So statistically, just a couple of things to kind of keep in mind. In the first 16 months, some of the things we had to do to gear up: Create a new redevelopment department. We couldn't do planning in the planning department. Had to do it in redevelopment, because there was some momentum of don't-change-anything in the planning department that the business community was concerned about. A few redevelopment districts were created.

A nonprofit public/private partnership was created with a 36-member board of directors representing every possible group in Santa Cruz. In the first 16 months, four people served as chair of this group, called Vision Santa Cruz. They had more than 50 board members in the first 16 months.

Then there were seven other task forces dealing with streetscape, economics, urban design, parking, social problems, you name it. Eleven consultants; economic consultants, design consultants, infrastructure consultants, engineers. The Urban Land Institute sent a team in to do a panel.

We also instituted a half-cent six-year sales tax within the county to create some financial resources. We received nearly $200,000 in contributions. Vision Santa Cruz had established itself as a nonprofit corporation, and received another $150,000 in in-kind contributions.

Then there were 10 public lectures, six public hearings, one town meeting, five conferences. Altogether, there were 251 Vision Santa Cruz events, public meetings, board meetings, committee meetings, conferences, study sessions, between January of 1990 and May of 1991. Another 73 recovery-related meetings were held by other groups.

Meanwhile, there was a 25 percent turnover in personnel in city hall. And it took 18 months to get a downtown recovery plan.

So I came to the conclusion after all this that surviving the earthquake is easy. It's surviving the recovery process that you really need to worry about.

The first thing that happens in a community after a disaster is like Mary Hammer said yesterday. People wanted to carve pumpkins and play soccer. There's a real sense that you want to be normal again. Because you know you never can and you know it's all different.

But that was the first thing. That's what we heard first from the public is we want it back the way it was. And they remembered the good things. They remembered the charm and the outdoor cafes and the historic character and all the vegetation. But they didn't necessarily remember the bad things about it. The vegetation got kind of overgrown. You've got to understand in Santa

Cruz there is an environmental/student kind of interest. And once a tree is planted, it sometimes takes on a sacredness. In India they have cows, in Santa Cruz we have trees.

The merchants, meanwhile, over the years were saying, hey, we've got to prune these dang trees. Nobody can see the display windows. It's too dark. Before the earthquake they went through a process which took them nine months to agree to take out six trees and prune the rest. And that's the politics of trees.

Then there were other problems, the street people, for example. I think a principle here is that an earthquake is not necessarily going to change all of what's there. It will just make problems that you already have more acute.

The business community was arguing that the downtown was declining. And they felt that the 17 seconds of the earthquake did about 10 year's worth of decline. Other people thought, hey, this is a wonderful park. And so, there was a failure to agree on what the world looked like prior to the earthquake. Well, it didn't matter after that. It was clear that the downtown had to change.

In Watsonville the problems of the housing got exposed because there were so many people that were living in overcrowded conditions in garages and this sort of thing. They all showed up and came out of the woodwork. And there were too many people for the number of houses in these neighborhoods.

So the earthquake made very apparent problems that over time you might ignore or have just a hard time dealing with.

Being an academic town, one of the best things that happened was right away a professor at the university organized a lecture series. It was really an idea of taking a positive look at things and saying, OK, this is now an opportunity. It's not just a disaster. It's an opportunity to correct some problems, to address some things we haven't.

They brought in some really great people from all over the country; lessons from the past, public spaces reconsidered, value of the ordinary, downtown life, great streets, making places from spaces. These are all on video. And it's probably as good a course on planning as I've ever attended. And the community loved those lectures.

So the first lecturer was the mayor. And her question to the community was that it's about time we cooperated with each other and carry forward this new momentum. So the era of co-operation began. Vision Santa Cruz was created.

But the era of cooperation began and people couldn't agree on what to name the group. So it wasn't exactly an auspicious start. Then some other people said, "Well, hell with them." You know, you can't figure it out, we'll figure it out.

Then of course, then the hurry up. Whatever you do, hurry up. So we did create some redevelopment districts, did some things right away. And keep in mind, doing things right away you have a real window of opportunity. Get up to your state legislature, get those bills passed. There are all sorts of one-time opportunities. Usually it takes years to set up a redevelopment district and you have a number of hearings and fiscal analyses and so forth. And we got legislation that allowed Santa Cruz and Watsonville and Oakland to establish districts without going through all the rigmarole.

So you have some opportunities. Do some things you can get done quickly. But "quickly" also has its problems. Somebody comes in and wants to rebuild. And everybody wants to do the thing right. And the first building proposal comes in and a city council member says, "Unfortunately, it looks like a barn."

Well, the city council swallows its pride and OKs the new building. Quickly the mayor decided to head out to Gottschalk's, which is a department store. They had a store in downtown Santa Cruz. They were based in Fresno. We wanted to get them to reopen again. And the answer was no. And back to economics. Their store was just fine in Santa Cruz, but once it's torn down, the cost of building that building and sustaining the new rent structure for that building doesn't work the way it worked with an old building with a low basis.

So then the council said, "Hurry up Vision Santa Cruz. Come up with first principles, involve the community." So we had these town meetings; got everybody to come out. And we had amazing citizen participation. In the first six months we came up with what was supposed to be the first principles. We completed the first principles dealing with things like building heights (two to three stories), retaining existing qualities, existing townscape. But what we found out for the first principles was that people couldn't agree on whether we were just starting or were completed.

Some people, again, back to politics, didn't want Vision Santa Cruz to exist. And they felt that it usurped the normal power structure. And other people said if you don't have Vision Santa Cruz you'll never recover. So some folks said the first principles were fine. The new mall will be a monument to consensus. A banker said that first principles are fine. But now what are we going to do?

So, meanwhile, the economic situation continues apace, and we're losing money. We brought in a consultant right away. We had about 1 million square feet right in the central core and 2- 2½ million in the whole downtown. About a third of it was destroyed, a third was damaged, and a third was OK. The economist came in and said, "Well, you guys can rebuild. You can get all that million square feet back up again and do fine. But there's one trick. You have to do 35 percent more business than you ever did before—35 percent more business." Everybody said, "OK, fine, let's go." But then suddenly, well, wait a minute. How do you do 35 percent more business in a downtown that had been flat or declining in the past? Suddenly, you're not into putting it back the way it was, but figuring out what it's going to take to have a different economic structure.

So the bankers, they're always right with you all the way. Sensible projects will get loans. And bankers are sensible. We were kind of wishing they were not sensible like they were in the 1980s. A banker was supposed to come up here and give this talk today, but he found out that you don't golf in November here in Anchorage. But now since he's not here I can say that.

So it became real clear that after the first six months we were still trying to figure it all out: Do we need a plan? Do we not need a plan? What's going on? And then we brought in some more experts. The guy comes in from Columbus, Ohio, the downtown Columbus organization where they do cradle-to-grave downtown, everything from zoning, architectural review, to retail recruitment and management. And he said, "Yeah, you guys will do all right. It'll take about 10 years to recover." And that guy just about got run out of town on a rail because people were still thinking, "Well, we're going to be recovered in about year, maybe two years."

I guess I would say that there is probably some value in thinking that it's going to be easier than it is. Because if you didn't you might get discouraged and not do all the work.

Meanwhile, you can't just rebuild. In a college town, you have to plan for the planning. Professor Pepper wanted Santa Cruz to think globally before rebuilding downtown. Well, we're trying to figure out, well, what are we going to plan for, the globe or downtown Santa Cruz? So we had a big fight over just the planning area that we were going to consider.

Then there were issues of design. Again, there was historic character before and some of these features that we wanted to retain. People pretty much knew what they didn't want. Historic preservation was an issue. This building—they tore down the building behind the walls and shored up the walls. And this made for an interesting short-term situation.

And as Paula mentioned, historic preservation is a real big issue. This hotel called the St. George Hotel was yellow tagged at first. And then it was red tagged. And then it was a fight. And so the newspaper says, "It's time to take down the St. George" and "Historic panel wants the St. George saved." Somebody else said, "Well, it was worn out in 1946. I don't know why we're just keeping that around."

But then people got a little excited about it: Save the St. George from the mall dragons. There were articles in the paper. Everybody is fighting. Call in a higher authority. Ask the State of California. Well, that didn't do much: "State officials mum. Keep mum on hotel."

So we asked the state, what do they think? They don't know. While everybody is arguing about the thing, the St. George kind of took care of itself. I think it was spontaneous combustion.

Then there's another issue. Listen to everybody in rebuilding, expert says. That's an admirable thing. And actually it's probably one of the most important things that you learn is that the community feels a lot about the downtown. And they're going to want to express all that.

So we did every sort of public information and public outreach known to humankind. Vision Santa Cruz finally set up a downtown information center. That was about a year's worth of a struggle.

Some people think "Why do we need this?" And others thought it was a great idea. In the downtown information center the community members built scale-model buildings of the existing downtown. Volunteers. People that have no architectural background.

We had a guy named Michael Angelo. That's true. This guy named Michael Angelo organized this. He was a furniture maker. And he said, "Well, we need a model of downtown." So he just lined up volunteers and told them, you do this building. And they gave them some pictures. And they all came out pretty well. We did use the scale model. It was a useful kind of thing. And we started making the architects build models of what the streetscape was going to look like and what the new buildings were going to be like.

The need for information in the community is critical. Because, while planning is going on, there's a lot of talk and negotiation. And people, meanwhile, they walk around downtown, and say, this is a heck of a mess. How come nothing is happening? And it's hard to tell people. They can't see it. They think nothing's happening. It's like: How do you watch a seed germinate? It's just the nature of planning.

So other people participated as best they could. Remember the holding hands around the fences. And the artists in town said, "Well, why don't we dress up the holes. And we'll put some neat little art projects in these vacant spaces." And I guess some people liked it. And some people didn't.

You know, this was a controversial item. Put a lighthouse in the middle of downtown. It was temporary, but it was one of those floating-base structures. It was OK in the earthquake.

Actually, we were a little concerned because the downtown is in the flood plain. And all this riparian vegetation started to grow back. And we thought, oh my gosh, now the environmentalists are going to come down and say you can't build here because it's a riparian area, or a wetland. You know, get the Corps of Engineers in. So we were a little worried about that.

Then there were all these meetings and organizing time lines and it was a real effort to keep things on track, keep things moving.

The problem with citizen participation is that participation is one thing, but getting people to agree on it is a little more difficult. And, of course, we had to disagree on everything. And, in fact, a lot of people felt that Santa Cruz was the kind of place where talk was always the product, not the action. We have a lot of university types and they enjoy talking. And so you have to make a provision for it.

But in the meantime here's an example of a conflict. The merchants said, "Well, what we need downtown is parking." And some of the other folks were saying, "Hey, we don't even want cars on the mall. In fact, we're planning for the planet. And cars are on the way out, fossil fuels are a losing proposition over the long haul. We ought to have a pedestrian mall."

So resolving these divergent viewpoints takes awhile. It's up to the planning people and the consultant and the whole process to show that, well, maybe there's a way to accommodate everybody here. We came up with this scheme of having the streets have cars on them, but then you can turn them into public plazas for special events. You can do a farmers market, close the street down on a temporary basis. And you have to reach these compromises.

So we did all that. And, finally, after seeing what the world looked like out there, we came upon it. And I think the solution we hit upon is what I like to call "think globally, park locally." And it really worked.

We had a lot of meetings. And it takes awhile to reach an agreement on these things. We finally got the merchants to OK trees. (It's hard to understand if you weren't there). But merchants didn't want trees. See, they figured if once you plant a tree it wasn't going to get pruned for 30 years. They didn't want any trees at all. And then other people wanted a forest there. So we finally got something that worked for everybody. And they approved the plan about 18 months down the road. Good for the city.

Vision Santa Cruz hung in there. We even gave them an award for hanging in there. So that was the planning process. And a few buildings got built right away. Parts of the downtown were opened.

The requirement for 35 percent more business made recovery longer and more difficult. So it was important to doll up the pavilions because they were going to be in there for the duration. They're finally taking the last one down this month, three years later. And initially those were supposed to be a two-month kind of deal.

Then some of the longstanding problems had to be corrected. The infrastructure under the street was 100 years old. Once you get started on rebuilding the downtown, suddenly the engineers show up and say, we can get some new sewer lines in there. And we can get new water lines. That's all well and good. Except the problem is they can't do any of their planning or any of their work until the community figures out where the trees are going to be. Because all the infrastructure is incredibly intricate.

So they had to wait about 18 months to start the utilities work. Then they got started digging up through the downtown. And then some of the private projects got going, for example, rehabilitation of the older buildings. And some of the new buildings got under construction.

But, just to illustrate the economics, this foundation costs about $700,000 to build. The guy that owned the building paid $700,000 for his entire building about 10 years before. The economics were just enormously challenging.

Meanwhile, down in Watsonville, Fords got a $24-million SBA loan, the largest SBA loan in the history of the Small Business Administration. And they opened on October 17, 1991, two years after the quake. That was an amazing accomplishment.

Then in Santa Cruz there was a ground-breaking ceremony for the new St. George Hotel. And there they were getting started. And a couple of new buildings. That gray building got retrofitted. The new one got built in between. And the walls were still hanging.

So where are we now, three years later? I think one thing we found out is that there's more money to be had in housing than there is for commercial. Actually after about two or three years most of the housing was rebuilt, repaired. These are some places in Watsonville. Some new housing, new low-income housing projects were built. The reason the housing got built is that there's all sorts of money for housing in California that there isn't for anyone else.

But look at how you got the State Department of Housing Community Development, a rental housing construction program with the city and Bank of America. We got Red Cross money. We got special disaster relief, city of Watsonville, agriculture grants, somebody's foundation, the Diocese of Monterey. This is just to put together a project. So you can see how time consuming these things can be.

We also got grants for both Santa Cruz and Watsonville from the federal government to build parking structures. And they had never given grants on parking structures before.

And you had some hard luck. Haber's store closed after 77 years in business. They had torn down part of their building and rebuilt. It was a beautiful design. A year after the quake it was up and running. But two years later they're out of business.

So, if you're going to have an earthquake, try not to have it at the onset of a recession. It's really bad timing. And those damned economists. You know, the problem with the market is that, you know, it doesn't have any flex to it. It's either there or it isn't. We lost a couple of the major projects in Santa Cruz that were intended to go in: an 80,000-square foot building up there on the left, and the big theater project was supposed to be the centerpiece of downtown.

There were personal circumstance problems, too. The guy that owned that building got washed off of a yacht in Santa Barbara about two months after the earthquake and then his whole estate had to be dealt with. So that building sat for a long time. And finally, about two years later, just when they got a project set up to rehabilitate that and tear down a part of the building next to it and put it together, it burned down, too. It was a real tragic loss. And they attributed the fire to homeless people that were living in the building.

Now in year three in Watsonville, Ford files for bankruptcy. The big success of year two is now a loss. The local economy was a major factor. Also, part of it was a marketing situation. They didn't understand the market. They tried to put a Nordstrom's in Watsonville, a kind of dirt-in-your-fingernails, working class town. And it just wasn't a good fit.

Also in Watsonville, some of the downtown businesses moved to the outlying shopping centers. The church in Watsonville sat and sat and sat. They thought they were going to rehab it for the first two and a half years. And then they figured out it was too costly. They're tearing it down now and they're going to build a replica.

Then there were some other buildings, this is in Watsonville, that are still kind of shaking through. But you can't tell somebody to go in and lose money. That's the fundamental problem facing reconstruction projects.

In Watsonville and Santa Cruz it's a mixed bag. You've got to do everything you can. We've got a main street program going. We're doing enterprise zones in Watsonville. They've now got a new holding company that's trying to rearrange Fords. And they think that might be able to survive.

Recovery happens gradually. And you keep after it. In Watsonville, we built some new buildings. They're open for business. Some other new ones that are under construction. And some that have been rehabbed. Again, a lot of that housing money, a lot of that state assistance.

But the costs are enormous. This project is now up to about a $100 a square foot to retrofit. And how are you going to sustain that without some sort of subsidy? Again, it's housing money that has been really supporting some commercial projects.

To give you an example—the St. George Hotel in Santa Cruz is an $11 million project. Sumatomo Bank is only putting up $3 million. The rest of that is coming from all these other sources, including developer equity.

A new health clinic in Watsonville. Other things planned coming up, some buildings completed. Streetscape, coming along in Santa Cruz. The building on the right is the one that the city council said looked like a barn. You can determine for yourself.

In Santa Cruz, the bicyclists and the motorists are coexisting, finding they can get along. And the building rehabilitation is getting completed. The St. George is now completed. The architect did a good thing. He said, "OK, look. The building is gone." But fortunately he had done measurements on the features. That tower is an exact replica of the tower that was there before. And it's helped the community feel better about the place. And now the new streetscape is coming in.

The walls have not come tumbling down. They're building a building behind those walls. Many never really thought that was going to happen. But it did. And the parking structure for Santa Cruz. And a new art and history museum that was a project in Santa Cruz that was initiated before the quake. That's going to be a boost.

The context is important for the town. The streetscape is just now going in. You'll see some buildings up, some down, some rebuilt. It's going to take years for all those holes to get filled in.

The last pavilion is going down. In Watsonville is the earthquake monument, kind of a symbol to what happened there. In the immediate background the building is still in limbo. In the far background you've got the parking structure and new buildings under construction.

So the saga of rebuilding is a long one. It requires lots of changes on the part of everybody. The government might have a certain institutional culture. It might not be geared up to be an active economic partner. Political shifts are going to have to take place. Economics is going to dictate success over the long haul.

It just takes some time. I think both Watsonville and Santa Cruz are making real good progress, but there's still a long way to go. So that's where we are today.

Questions from the Audience

MR. WATTS: Ron Watts, Municipality of Anchorage, Building and Safety. How did you handle the process of building permit applications? Normally, that can be anywhere from a day, a week, month, a time consuming operation, and particularly for residential buildings that just need rehab and rebuilding.

MR. EADIE: Well, several different things. First of all, we gave a high priority to downtown rebuilding projects, and went out and hired structural engineers. The city enacted new building codes after the earthquakes, closing the door after the horse got out. It really required structural engineering to review these things. There was an expediting procedure.

We brought in a lot of extra inspectors from the state and from mutual assistance for the initial period, because everybody in the town wanted their chimney inspected. So we came up with this form and passed it out to everybody about how to rebuild the chimneys. But you can't take any shortcuts. And you know, it does take time.

PREPARING FOR DISASTER AND ECONOMIC RECOVERY IN ALASKA

by
Robert Gray, President
National Bank of Alaska
Anchorage, Alaska

When you talk about preparing for a disaster and economic recovery, you have to remember that there's more kinds of disasters than earthquakes. You have to split it into how businesses cope with it and how individuals cope with it. I missed the Anchorage earthquake, but I didn't miss the Fairbanks flood. That was a big disaster for our state.

In our industry there was a huge fire in Minneapolis that destroyed the headquarters of the largest bank in the northern tier of the United States, all their credit files. I am originally from Iowa and I saw what tornadoes can do, personally.

In the United States we just had an example of a hurricane down in Florida and also one in Hawaii. In Alaska and in Anchorage we're starting to see what volcanoes can do. Mt. Spurr has irritated us. But if you want to know how bad it can get, just pull a 1912 National Geographic and see what the Mt. Katmai eruption did to Kodiak. It is so unbelievable it makes what happened in the Anchorage earthquake look very minor in comparison. That could happen any day. All that has to happen is one of those volcanoes to the west of us go off big with the wind in the right direction. Remember that the damage from the Anchorage earthquake, the big damage, was from tsunamis. The ground shaking did a lot of damage here in Anchorage. But it was really frightening when you see what happened to Kodiak and Seward and Valdez.

So there are many types of disasters. And both businesses and consumers need to do contingency planning. We're experts about it in the banking industry because our federal regulators force us to do contingency planning by law. We've been doing it at National Bank of Alaska for quite awhile.

One area that we are very sensitive to this is in the computer area. Banks don't run very well without computers anymore. And we are forced by law to have a third-party backup for all of our computer files. I don't know whether this has been discussed in your conference before, but any of your businesses that absolutely have to have computers to operate, an airline would be an excellent example, need backup. After you've made up your mind you're going to do it, and by the way, this is pretty expensive, you set up a third-party backup, and we do have one. There's no sense in having it located in Anchorage because the same kind of disaster that hits your computer center would hit the backup system.

You have to test the backup system. If you have reciprocal arrangements for backup with somebody else and that makes you feel good, and you've signed all the documents but you don't test it, believe me, they're not worth the paper they're written on. It has to be tested. And it has to be tested at least annually. The reason for that is you're changing your computer systems all the time. And you need to keep up with that.

Switching gears a little bit, I'd like to talk about the economic consequences of a disaster. We in the banking industry, of course, get directly involved in economic consequences. The prior speaker made several references to banks. And he's right. We're a private industry and we have a role to play in it. We have both immediate economic consequences and longer term ones. I think I'll talk about the immediate one first. The first one is you immediately go to a cash economy. Nobody is interested in credit cards. And they're not much interested in checks.

When I researched what happened during the Anchorage earthquake, of course the big problem was that the airport was damaged. So if the airport's damaged, the way I understand it, you had problems getting things in, like cash. People don't realize it but in the banking industry in Alaska, our particular state is a net user of cash. We bring cash into the state and then it goes somewhere else. One of the big reasons for this is the fishing industry. They're a huge user of cash.

Not every state is that way. There's users and suppliers. It tends to balance out. But Alaska is a big user of it. And we get frequent shipments of cash under a lot of security from the Federal Reserve. And if that stops, the economic consequences are relatively severe. The mere fact of cashing checks becomes a very severe problem. Why is it a problem? Because if the computers aren't working right you don't know if the people have the money in their account.

You've been talking about California. You can go back a little further in history, the San Francisco earthquake in 1906, and realize the problem that the banks had then. They had the cash. They couldn't get at it. The reason they couldn't get at it is the shifting ground changed the buildings so all the vault doors seized and they wouldn't open. That's something you wouldn't think about. But those are very, very heavy doors. And they've very delicately balanced. You drop one side an inch and leave the other side the same, and they won't open. So that gives you an example.

And now, I notice there's some people here from the municipality, I will hit a little closer to home. In the payroll area, many state and federal employees receive their pay electronically. That doesn't work if the computers don't work. That doesn't work if we don't have a computer link-up to the Lower 48. Even if our computers are working fine, if the communications systems, the dishes, the satellites, whatever, don't hook up to the Lower 48, you just don't get it, because we can't get the transmission. None of the Social Security people would get their money that are on direct deposit.

What I'm trying to emphasize is you do go to a cash economy. Now, I've researched again what happened in Anchorage in 1964. There was a terrific sense of cooperation in our community when that happened. And I think there probably was in Santa Cruz, people trying to pull together. But everything was much more manual. When you have everything as computerized as it is now, it's going to make it a little tougher. But basically, merchants have to give credit, in large extent, because there isn't that much cash out there.

Another thing that will happen is you'll immediately have large-loan demand. That's no surprise. And again that was mentioned previously. That puts a strain on the banking system. We don't staff our offices for this kind of demand. And so we obviously work long hours. But still everything kind of slows down.

There's another economic consequence that happens, I wouldn't say immediately, but close to immediately that some people don't think of. There's an extreme boost in economic activity. We saw this in Alaska with the Exxon Valdez oil spill. And it's not something anybody up here wanted, but it created a lot of economic activity very quickly in Alaska. We saw it in our bank. The whole state's economy shifted because of it. It wasn't just in Prince William Sound. We saw it very much in Anchorage and even all over the state.

So these are the kinds of things that happen immediately and for which there needs to be planning. We plan in the bank for the shortage of cash. We plan for the computer availability. We have contingency plans for staffing. We know who we're going to fly to the Lower 48 to run the computer systems that we have backed up. We have lists. We have phone numbers. They know they're on call periodically. And if something happens they're on an immediate flight, providing they can get on an airplane, to the Lower 48 to work our systems, to help our economy.

This would be a very unpleasant scenario, but I have a lot of confidence that Alaska could pull through that, wherever it happened in Alaska. This isn't just an Anchorage problem. As I say, Fairbanks had a very significant problem in 1967.

The harder part is the long-term problems. But there are solutions. The important part, which I'm sure you've been discussing in your conference, is you need to talk and think about solutions now rather than after disaster strikes. Because you don't have any time to do anything then. You don't have any time for planning.

On a business and personal level, the immediate and long term problem is you've had a massive destruction of property. I mean, it's so obvious and you showed the pictures of what happened in Santa Cruz. We've all seen pictures of the earthquake. Maybe we've all experienced it.

One thing that the federal government is very good about is that the Small Business Administration comes in immediately and makes a large amount of funds available at very low interest rate through the banking community. It did that in 1964. The interest rate then, if I remember right, was 3 percent. And there were many loans. We made countless loans in Kodiak and in Anchorage and Seward, and all over the state. And interestingly enough we had almost no defaults. The people paid them back. And it worked really well.

And people think that's the solution. Well, it really isn't. Like the previous speaker said, the cost structure changes. Here's how it changes. Let's say a person has a business and they've got a $300,000 loan on the building. And the building is destroyed in an earthquake. The government says, "Well, we'll give you a low-interest rate loan to pay it back." And it takes $1 million to rebuild this, hypothetically, but probably isn't far off.

Well, they've still got the $300,000 loan to pay off also. So now they've got a $300,000 old loan to pay off and $1 million new loan at a real low interest rate, but they still have to pay the principal. So, instead of $300,000 in debt, they're $1.3 million in debt. And they don't have any better ability than they had before, functionally. And they've had an interruption in business.

The point I'm trying to make for a business is that you need to insure as much as you can. There are several types of insurance. And of course you have to do it in relation to what you think your risk is and how affordable it is. And in our area earthquake insurance is good to have if you can afford it. A real important type of insurance that people don't think about is business-interruption insurance. Because you have a period of time when there's nothing coming in. You can insure against that.

Of course, individuals have the same issues with their homes. I haven't been at the previous conferences. But I'm sure it's been brought out that the earthquake risk in Anchorage is certainly not homogenous. And it's not priced that way either. So there are some areas of town where it is pretty hard to afford earthquake insurance. But in most of the town you can afford it.

Another thing that I'd like to talk about is updating insurance. Insurance is what solves the problem that the SBA doesn't solve, because it takes you out of that old debt. But you still have the very expensive new building. Use my $300,000 and the $1 million example, what you really want is a $300,000 loan paid off and another extra $700,000 or $800,000 to put toward the new one. That's what you really need.

So you need to update your insurance, not just on what the building is worth but as much as you can insure on what you need for replacement costs. People don't seem to think about replacement costs. They just think about well, this is an old building, it's not worth as much. Well, it's producing a cash flow. And the new building, nice as it may be, may not produce any more cash flow. So that's the basis from which you have to look.

The previous gentleman, I really enjoyed his talk, said that they needed 35 percent more business in the downtown Santa Cruz. Well, where is the business going to come from. You've got the same population. You've got the same payrolls. People aren't all of a sudden going to start driving down from San Francisco to shop at Santa Cruz because they need more business in Santa Cruz.

The classic result of that is a shrinkage in the number of businesses. And I think that's probably what the banker was talking about when he was talking about viable businesses. And that really isn't what you want.

I'm not an insurance salesman. I don't want people to think that. But insurance has a vital part in the plans that individual businesses should make. And I think that this conference could publicize that. Because a lot of the plans are for what the city is going to do, what the federal government is going to do. You need to recommend solutions for what the individual businesses and individual consumers are going to do. Because the town won't prosper unless the individuals prosper.

That pretty well covers most of my prepared remarks. I wanted to leave enough time for some questions.

Questions and Comments from the Audience

MR. COMBELLICK: I'm Rod Combellick with the Alaska Geological Survey. I have a question about economic impacts, not impacts of a disaster but economic impacts of mitigation.

MR. GRAY: Of what, litigation?

MR. COMBELLICK: Mitigation. Reducing the hazards. In my own case, I'm involved in mapping of geologic hazards. And a reaction that I'm often faced with is, "We don't want a map of our geologic hazards because where you map the hazard as high, it's going to reduce our property values." I just heard a story just a few minutes ago about a proposal for one of the local governments in Alaska that was approved for receiving federal funds to do a revision of the flood hazard mapping. The local assembly voted not to receive the funds because they didn't want the hazard maps to go out and reduce the property values in those areas mapped as high hazard. Well, how can we solve that kind of a problem?

MR. GRAY: Well, I guess you need to talk to the assembly. That's almost incomprehensible to me that they wouldn't want to know the truth or the true situation. Banks are required to assess flood risk for real estate loans. And there is flood insurance available. I'm sure the price would go up if it was shown to be in a flood risk area. And I think that's what you're talking about, changing the maps.

MR. COMBELLICK: That's right. And part of the problem here is the fear from the standpoint of getting loans for new construction; that if their spot on the map is now within an area mapped as high hazard, they risk the bank not approving the loan.

MR. GRAY: Well, the bank would approve the loan subject to insurance, flood insurance. And flood insurance can be purchased. If they're in that kind of an area, they ought to have flood insurance.

MR. COMBELLICK: Flooding—that's one area where there's good success in using insurance to deal with that hazard. There are a lot of other hazards. You can get earthquake insurance. But there are other things like landslide problems, which people may have a more difficult time getting insurance for if we, for example, make a map that shows an area subject to landsliding during earthquakes

MR. GRAY: Well, I guess I always have a problem with anybody saying that knowledge is bad.

MR. COMBELLICK: I do, too. But this is the reaction that we often get.

MR. GRAY: You know, where we run into it more than the areas that you're talking about is in environmental risk. We're running into it over and over again in having to test properties and finding that three lots down is a service station. And there's a problem with the ground water and it's moving. And you know, we're running into that a lot. That's squashing a lot of deals right now.

MR. COMBELLICK: I think it points up a real need in Alaska where everybody involved in this, the scientific community, the government and planning communities, and the business communities needs to start working together to dissolve some of these myths.

MR. GRAY: Well, I think you're absolutely right. I guess we don't have any argument.

MR. HEAD: Roger Head, Alaska Department of Transportation and Public Facilities. We rely on the banking industry for regulating a number of requirements that we might not otherwise get, such as you require code reviews and so on in order to lend. Do you see the banking industry moving in a direction toward requiring the kinds of insurance that you're advocating?

MR. GRAY: Yes, I do. In fact, this interruption-of-business insurance I'm talking about, we quite often require. The reason is, we're in the credit risk business and in the check clearing and payment system business. And these directly relate to credit risk because it's a form of risk that can impair the collectability of the loan. If we think it's a big enough risk to be meaningful, then we would make the loan subject to that risk being mitigated by insurance. It's no different than in the agricultural areas requiring hail insurance for farm loans, which is common.

MS. HAMMER: Mary Hammer from Boulder Creek, California. I have a question on the rebuilding of the subdivision in the Turnagain Arms landslide area. How does the bank enter into an agreement for development in an area that's a known landslide area where probably insurance would not cover a developer or more importantly, the individual homeowners, once the developer has sold the property?

MR. GRAY: I know the area you're talking about, of course. I don't know how we would do that. You know, I could give flippant remarks. But basically, we would be much, much tougher on the credit quality of the developer. That would be my immediate response. In other words, if your primary source of repayment is riskier than normal, then you would look to other sources of repayment, perhaps mitigating against that. Because we're not in the zoning business. You know, we follow the law. But we're not engineers and we're not in the zoning business. We are in the credit risk business.

And if we saw a lot of risk there, I would—and I haven't done anything specific personally in this area, so I'm saying this all hypothetically—I would look and ask for a lot more security in other areas from the developer. Maybe other real estate, cash, something like that.

MS. HAMMER: I see. Of course the problem we get into, and we have these situations in California, is when the developer is out of the process. And then the homeowner, unknowingly or knowing is left with that.

MR. GRAY: Yeah, we want to be good citizens and follow the law. But we basically cover our credit risk during the interval of the loan. And although you bring up a good point, if we thought that the developer couldn't sell the lots because of financing for a 30-year loan, that would impact our decision also.

MS. HAMMER: Sure. Of course then we have to look at the savings and loan bailout and all the other bailouts we're getting into because of risky loans, too. So, as a community and I think as a whole nation we have to look at what we're doing. Thank you.

MR. GRAY: That's right. We have to do a good job of analyzing risk.

MR. COLE: That was my question, having dealt in this community for some time. As a geotechnical engineer, foundation engineer, often I've been asked to do foundation analysis in areas that have been identified as susceptible to ground failure during earthquakes. And as designers, as engineers, we warn our clients that there is a problem, there is a substantial risk. The most prevalent response is, well, the bank won't loan me money if they don't think it's safe. The city won't give me a permit if they don't think it's safe. There are a lot of people saying it's somebody else's decision.

MR. GRAY: Right.

MR. COLE: And I'd like to get your view first hand on does the bank really get involved with it?

MR. GRAY: To the extent it impairs credit we do. I keep saying that term. And we would check with the FHA and Fannie Mae and people like that, make sure long-term financing was available in that area. That would be a critical question. If it weren't I can't imagine us getting involved in a subdivision loan. But from your statement, I just can't pass up the opportunity to say the buyer's got to take some responsibility, too. You know, they're the ones buying. It's for their benefit. And they should be as intelligent a buyer as they can. Now, they need facts to do that.

And like this gentleman said, it's pretty tough when somebody says they don't want the truth. But this conference here is an excellent example. I hope it gets a lot of publicity, to provide that information so that buyers can be more intelligent. Because I think that's the best way this could happen.

MR. SHECHTER: I say this to follow up with what Rod said, but I don't know if he's talking about our community. Bill Shechter from Fairbanks. I wasn't going to come up and say anything but you tripped me. The plan of identifying areas that are in the flood plain. And you said that's no problem because you can get flood insurance. The Federal Flood Insurance Program does not cover ground water flooding. And we have proven that in Fairbanks too many times.

What you're saying is the banking institutions may not loan money on a house unless they can get flood insurance. And if it's an area where it's established as a non-flood-insurance area because it's a ground water problem, it may potentially interfere with banking interactions for a loan, is that correct?

MR. GRAY: That's correct.

MR. SHECHTER: OK. I just wanted to hear it.

MR. GRAY: And we're required to check and see if it's in a flood area. If it's in a flood area, we need to get flood insurance. If we can't get flood insurance, I don't imagine we'd make the loan.

MR. SHECHTER: It could be in a flood area, but the type of flooding won't allow you to get the coverage for ground water problems.

MR. GRAY: Yeah. You seem to be knowledgeable in this area. If it's that kind of an area, why would somebody want to build there?

UNIDENTIFIED VOICE: Because it has a great view there.

MR. GRAY: Oh, I see. OK. All right. I hope it's a real good view.

LESSONS LEARNED FROM THE 1989 LOMA PRIETA EARTHQUAKE

by
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I'm just going to run the highlight reel for you here. One of the things that we want to make sure you get the point on is the degree to which all these topics intermingle with each other. These topics are not clear and distinct entities that you can break apart from all the other things that you've heard. You need to have an understanding of how all this works together.

In Santa Cruz our planning department is a little different than what you may have been used to. We do a lot of things other planning departments don't. We do building, geology, erosion control, and grading, plus planning. So we get a lot of involvement in natural disasters when they occur. And we've had our share of them in Santa Cruz County. About every two years we have a federally declared disaster of some sort. So we've had a lot of practice, unfortunately, with going through this.

It's become clear to us over the years and particularly with the Loma Prieta earthquake, that there are really two distinct functions in the disaster business—the response period and then the recovery period. And I'll talk about these separately.

When it comes to response, I think we do a great job of planning and practicing for response. We've got a great emergency response culture and an entire field of response work that goes on. We've got our first response organizations, like fire and police. They do a wonderful job of getting in and dealing with the response issues.

It's a little different for those of us who don't live in that field, though. We don't practice as much as fire and police do. And I think that's one thing you need to take into consideration when you do your disaster planning.

A lot of the people that are going to be involved in this process do it only very rarely although we spend a lot of time doing our disaster plans. Everybody runs out and gets a red binder. And people like me get out the red binder once a year. And we go through a tabletop exercise and we say, "OK, we're ready," and the binder goes on the shelf.

Now, I'll tell you what happens, particularly when an earthquake hits. Everything falls out of the bookshelves, and you have somebody like me saying, "Charlie, where's that big red binder that's been on my bookshelf for the past year."

So you pick up this big red binder. And in Santa Cruz our big red binder is two volumes thick. It's based on the state model, the multi-hazard functional index. The first thing you do is flip to your section of the plan and it's supposed to tell you everything you're supposed to do.

While you look through it the phone is ringing and people are going crazy. You try to find out how this disaster matches The Plan. You find out every time—it doesn't. You take the big red binder and you throw it away. And that's also happened every time.

So one of the things I want to get across, and here I may be the fly in the ointment, but I want 'to encourage you to not use those red binders as security blankets. Because you've done a plan doesn't necessarily mean that you're going to be able to work that plan when the disaster strikes. So we've tended to sort of lapse into planning the disaster, planning too specifically. Where I've seen these things work well, there's a great deal of flexibility built into the plan.

One example of planning too specifically is in Santa Cruz County where we have a geologic-hazards ordinance and we've got a seismic-safety element to the general plan. We've done disasters—by 1989 we had done this four times. We had landslides. We "knew" about the geology of the area. The only problem was, Loma Prieta didn't follow the plan. What we had been telling people in our seismic-safety element and our geologic reviews in the land-use process, was that ridge tops were the safer place to be. They're certainly better than lowlands and fill areas.

Then we discovered this unique and unsettling phenomenon that the geologists called "ridge top shattering." That was the worst place to be. I mean, we saw houses not only thrown off their foundations, I saw one house that came out of the ground with its foundation. I saw entire buildings moved 12 feet north. I think, at the time, it was the highest level of measured ground acceleration that the geologists had recorded—the worst place to be. So that threw us into a complete tizzy. Because we had this Plan. Things were supposed to happen a certain way. By George, they didn't happen that way.

So what did we do? We have spent a little over three years trying to convince the public that it's OK for them to wait while we figure out what happened. They don't play that game. The public won't wait for you to figure out the science of what happened.

It's unfortunate that we did that because in the process we really started depending upon geologists to tell what happened. What will happen next time? What's safe? Well, geologists can't really do that. And we had every geologist on the planet visiting us. We'd go out to public meetings and we'd be telling people who are ready to get back in their house, "Well, we don't really know what happened. We don't really know what's safe. But we want you to study things and prove to us that it's safe before you go back, before you can rebuild."

What happened is we managed to cut the base of support out from under the whole field of geology. The worst thing you could do in Santa Cruz County was show up at a public meeting with a geologist. Because everybody else will have had their own geologist. And somebody would ask the geologist, "Well, is this safe? What happened? What should we do?" The geologist would say "Well, we really don't know. It could take a couple of years of study. We have to wait for it to rain. And it may or may not do a range of things." The planners would be standing there saying, "Well, we don't know what to do now." So you have to really think about how much you want to depend upon what you think is going to happen. In my experience, it just doesn't work that way.

Along those lines, when all your preceding assumptions get turned upside down, we've found it's very important to have good thinkers in key spots. You know, a lot of times when we do disaster planning, we say the public-works director is going to do roads. And the planning director is going to do geology. And the finance director is going to do finance. Everybody is going to keep in their own discipline.

Well, the problem is, some people don't do well under stress. They don't do well when the world is going to hell in a handbasket. Some people that work for government don't do well when there are no rules. Some people don't do well when it's time to do things like "ready, fire, aim." You know, you have to make a decision without knowing all the facts. A good example is Charlie Eadie. This is not his field. This is not what he did for a living before the earthquake. It turned out he could use his head and he could get things done.

We had a big problem with finding temporary shelter and dealing with the federal and state housing bureaucracy. Now, those of you who have dealt with housing bureaucracies should know that it's like a government unto itself. It's just this whole world of rules and regulations that you don't normally deal with.

Well, it turned out that we assigned our data-processing director to set up the emergency housing effort. And why the data-processing director? He has a doctorate in public administration from the University of Southern California, and he eats bureaucracy for breakfast. And within two days he sounded like he grew up with housing. It was great. And he got things done. It was wonderful. If we had stuck with the regular model, it never would have happened.

We've heard a number of speakers talk about the psychological impacts of what happens. I want to let you know that that's something you really have to think about for your response efforts for your own people. Our building, the county building in Santa Cruz, is a five-story concrete building. It's designed to shift during earthquakes. And expansion joints are supposed to pop and a certain amount of concrete is supposed to spall and fall out. Well, engineers know that. Building designers know that. Building maintenance people know that. Secretaries and planners and just general people don't know that. When they see these things happening they do not want to be in that building. But that's our center of response. That's where everybody is when we're trying to respond to this stuff.

Remember what Charlie said, this is a period when the ground is acting like John Aho's Jello experiment. The ground is like Jello. It moves all the time—7,400 aftershocks. It wears on people real quickly. Every time we'd have an aftershock, I'd have to go and round up my staff. Because I don't know where the hell they'd go, but they were gone. And it's not just an aftershock. Loud noises, particularly loud deep noises.

I had an assistant director who just couldn't deal with afterschocks; he'd leave. People would come to work and they'd look up at the ceiling and there'd be a crack in the concrete. "Was that crack there yesterday? Oh, I don't know. We'd better call the engineers." There was no crack monitor. So what happened is we had this drill every day where we'd go through incredible psychological turmoil over whether the building still was safe. The best thing that happened was one of the structural engineers (that we had to import into the county, because we only have, I think three or four of them), started spray painting the cracks that he had checked. And that calmed people down a lot.

It didn't help when two graduate students from the University of Colorado came in one day and started taking pictures. You have all these people coming through, so you really don't know who's who. And these guys are taking pictures of these cracks. And they said, "Oh boy, I wouldn't be in this building!"

Somebody came and got me, and said, "Mike, you'd better come down here because they're evacuating the building division." And I said, "What do you mean? Who's evacuating the building division?" So I went down the hallway and (this is within our office) they're stringing up barricade tape, "Hazard, Do Not Enter." We've had people running around with hard hats on, leaving. I said, "What are you doing? There are people in the lobby trying to get emergency permits." "These guys said we shouldn't be in the building." "Well, who are these guys? Where are they? Get them in here." It turned out to be the two grad students from the University of Colorado. They weren't anybody official. They didn't have any background about what was going on with the building. They just made a comment. And everybody said, "That's all I need" and they were gone.

Along the lines of psychological stress you may have to go through, in addition to the physical strain, a lot of people have to make hard decisions in these kind of events. You have to get used to the concept that you might not be able to make it better. Everybody wants to come in and "fix it." And sometimes you don't get that luxury. Sometimes you have to make it worse.

You have to come in and you have to demolish people's homes. You have to demolish their businesses. And that is something you need to understand before you get into this. That's why it's important to have the right kind of people in those kinds of slots who can make those kinds of decisions. It ain't easy. It really is tough. You need to understand when you get into this stuff that your life is going to be hell for quite a while. And this is a little piece of the hell.

Often what happens in these events (and we've had fires and floods and earthquakes and like Mary said, toads and locusts are next) is people look for absolutes. In the earthquake one of the things that happened very quickly was people were looking for an absolute in terms of why their house fell down. "I built it to code. Why did my house have damage?" I think it was John Aho who said the other day, something that I had not heard before, and I can guarantee you the public doesn't know it, and that's what the codes are there to do. The maximum they're there to do is keep the structure from falling down, not to prevent damage.

Nobody knows that. I can guarantee you, nobody out there in the public knows that. They figure, "If I've got a permit, it was built to the code, and you inspected it, county, city, whoever. I want to know why there was damage. I'm going to have my lawyer see you."

We quickly went through the process of saying, "Well, OK, are they right? Is this the way it's supposed to be?" And keep in mind, I'm not a building official. I'm not an engineer. I'm just the guy that they hand this kind of stuff to and say "make it work."

So what we found out is that what falls down and what gets damaged depends on the quality of design, the quality and extent of the engineering, the quality of the materials, the quality of the construction techniques, the quality of the inspection, the quality of the maintenance, site specific soils, the site specific and surrounding geology, and the unique characteristics of that earthquake and how it combines with all those other things. Easy, right?

Let me show you some slides here of what I'm talking about. This is obviously a newer piece of construction. It's got the classic soft first story. These people were in my office saying, "I will sue you blind and the county because of what happened to our house. I built to your codes. I paid all your fees. I went through your process. And I still have damage." This was a new house.

This one is a newer house, a different kind of construction. This thing split right in half. The piece you see on the right pretty much stayed intact, the piece on the left went north.

Newer house, total failure. Same house. These are up in the Ben Lomond, Boulder Creek area. Pretty new house here, split right in half.

This is out by the beach on the coastal bluffs. This is a house that was built probably 15 or 20 years ago. It's nicely designed. The problem is that it sits on what the geologists have since called essentially accumulated beach sand that's been built up into these cliffs. About 100 yards down from this house we had to do a single family dwelling demolition because it was on one of these kinds of slopes. That cost $623,000, one house. I think it is the most expensive single-family demolition that FEMA has ever paid for. They weren't happy about it.

Here's another shot of that. So in some cases you get the structure which is fine, but the ground leaves. It's just not there anymore.

Again back up in the Soquel Hill area and Soquel Hill Foothills, the same sort of thing, a garage collapsed. This is in somebody's garage. And you see that basically the floor separated from the connectors and came right down on the garage. Brand new construction.

I had a hard time with this one trying to figure out which way was up. But this happened a lot up in the mountain areas on these ridge tops we were talking about. It just shook so violently. From a layperson's standpoint I don't think it would have made any difference how this building had been designed, how it had been built, engineered, anything. If it shakes hard enough long enough, it's going to fall down.

Another one where it just split right in half. The ground failed on the left side of the picture and the building went with it. And this is some of the older construction now, getting into things that were built probably in the 1940s. And you can see, this is a post and pier foundation that left the scene. At the time this was built, if there was a building code, this would have been fine. And in the meantime, there's no reason for us to go out and tell them to replace it. Although it's going to fail.

Now, we'll get into things that are a little bit older. And they may have survived some things in the past. This one didn't. There were a lot of old buildings up in the Santa Cruz Mountains. And we saw this a lot. The difficulty we had in finding some of these things is kind of interesting. A lot of people that live in the Santa Cruz Mountains don't want to be found. So when we were doing our damage assessments and trying to figure out where to post buildings as unsafe to occupy, a lot of times the vegetation is so dense you can drive within 20 feet of one of these houses and never see it.

So we kept finding out about these things for months after the earthquake. We kept discovering that there was a house in some state of disrepair that had never been posted. People would come in and say, "Oh, yeah, I need a permit to fix this and here's what happened." We couldn't prove what had happened. They got a free permit.

I included this one because this house sits up on one of the ridges that was shattered. There is a picture of this same house from the 1906 earthquake in the same condition. I wish I had brought it with me, but I didn't. It's instant replay. It looks exactly the same as this picture in 1906. It won't look this way again because it had to be demolished.

I just want to show you that you're going to get a lot of damage to a lot of different kinds of construction. And in some cases you can't really predict that kind of stuff.

So once you have the adventure of going through this response period, and we can move off of that, you move into recovery. Now, recovery is where you get the opportunity to turn a crisis into a disaster. As you've heard, the response period is short. It's brief. And in 10 years a lot of people won't even remember what you did.

If you screw up recovery, everybody will know it, and they'll know it for a long time. That's one way you can define a disaster, right? The difference between a crisis and a disaster? A disaster lasts for a long time, it affects people and property. That's what people remember. That's what you have to deal with.

Now, you can do some things, I think, to make some provisional operating guidelines for the postdisaster period. The message I want to get to you is, the last thing you want is to figure out what to do after everything has fallen down.

The land-use process in general is difficult. You're dealing with people's property. You're dealing with their homes. You're dealing with their investments, their futures. That's a very highly charged environment most of the time.

Do yourself a favor. Try to do the planning when you've got the opportunity to do it in as calm a situation as you can. We made that mistake. We were trying to make policy after the earthquake when everybody's been damaged to some extent. Everybody is charged up, the emotions are off the scale. When you start telling somebody, "Well, we don't know what we're going to do or how long it's going to take us to figure it out," it makes for some real interesting public meetings, which are about this far from a mob most of the time.

So let's talk about predisaster land-use planning. This is what we're trying to do, right? We're trying to develop policies and regulations designed to provide safe and commonly acceptable land uses which reflect circumstances created by an unpredictable event of unpredictable force, duration, location, disruption and potential for future risk. Easy, right?

Think about it. How much of this stuff can you really plan ahead of time? How much do you want to expect any disaster to follow what you put together in any plan? You have to give yourself some general operating guidelines about how you want to respond. But my advice to you is don't make it too detailed, because you'll box yourself in. If somebody can do this, let me know. I'd like to talk to you.

One of the things that doesn't seem to be unique to earthquakes, because I've seen it in earthquakes and floods and fires and now hurricanes, is that it is very gut-wrenching to deal with these kinds of questions at anytime, and particularly after it's happened. You've got people displaced from their homes. Your community is in shambles. There are huge issues being debated. There's a huge amount of financial risk. You're talking about the survival of your community. It's tough to make the right kinds of decisions in that context.

I'm going to show you something that appeared in the Honolulu newspaper. This is after the hurricane in Kauai this year. We were called over there to help them set up a recovery unit about two weeks after the storm. Since it's so small, let me read a couple of paragraphs:

"A report by a national engineering and research team says shoddy construction practices and a weak building code were responsible for much of the damage that Hurricane Iniki caused on Kauai. The team wondered why it appears nothing was learned from the devastation caused by Hurricane Eva, a much weaker storm that hit Kauai 10 years ago. The report said of particular concern is that with few exceptions the recommendations set forth in various engineering reports following Hurricane Eva were not adopted. The report says that if those recommendations had been implemented much of the wind-induced damage could have been prevented.

After Hurricane Eva, instead of requiring stronger building methods, the Kauai County Council waived building permits for emergency repairs."

That's not unique to hurricanes. Nobody, no legislator, wants to go out in front of their constituents and say, "You can't rebuild your life. You can't go back to the way things were. It's too dangerous." They won't do that, and I understand why they won't do that. It's tough. It's damned tough.

So that's why I'm encouraging you to try to make those decisions, try to get some of those concepts outlined in a less charged environment. It won't happen afterwards. And the further away you get from the event itself, the tougher it becomes. A year later, you can forget it. It won't happen.

One of the things that Charlie Eadie pointed out was the Vision Santa Cruz process. And that's turned out to be a pretty successful process. I think Charlie would admit that it was pretty trying at times. I mean, arguing about what they were going to be called and the shape of the table and all those traditional kinds of things.

One of the things that I'd like to recommend to you in your planning is to think about who needs to get together to talk. What are these groups? What's their role going to be? What's their mission? Because afterward, if you try to do that, everybody wants to help. Everybody has to have a say in what happens. I mean, this is their community, right? This is their life. Try to make those decisions if you can ahead of time.

Another thing that caused us a lot of heartache and headache is determining acceptable risk. Now, you know, a geologist won't tell you what that is. I wouldn't expect them to. It's difficult for us to be looking at building permits and development permits and such without a concept of what it is we're going to accept. How safe is safe?

Our people took on almost a religious belief in geology. We had the cult of the geologists. Not the geologist, per se, but people who were depending upon geologists to tell them "the answer." "What do I need to tell these people to do? If I tell people to engineer for a magnitude 6, is that OK?" It's tough to come up with that in black and white terms.

In our case we struggled with that for months. What's safe, what's going on? And we lost the credibility of the entire geologic review process. If you go to Mary's neighborhood and you say, "We're going to talk about geology of the San Lorenzo Valley and what it means for development," you will get a big turnout. You're going to have a lot of people there. And they're all going to have a geologist with them.

We've got one community in the mountains that had little things happen to them. There a 1,500-acre slide with 40 houses on it moved 15 or 20 feet. I've been to public meetings with 300 people where the whole point of the discussion was "What's a landslide?" Lost in this entire discussion, if you want to call it that, was whether there had been ground movement or not. "Has there been some event we need to pay attention to or not?" People were really concerned about their property values and landslides. These were key issues for them. If they could convince the USGS geologist, our geologist, and us, that a landslide didn't happen, if they didn't wind up in the bottom of Burns Creek, then everything should be OK, right? My advice to you is please, don't put yourself in that situation. You can't win it.

In terms of acceptable risk, one of the things I think it's important to do is ask yourself who's advice are you going to take. From a government decisionmaker's perspective, we're not going to have the technical expertise, we're not going to have the scientific background, but we do get the task of deciding what's going to happen and what's not going to happen.

Some things I think you can do is determine ahead of time whether you are going to accept sign-offs on construction from licensed architects, engineers, or engineering geologists. If they say it's OK, and they put a wet stamp on it, is that going to be good enough for you? There are two violently opposed camps on that subject.

You have the building officials in California that are saying, "Absolutely not. We've got to check it. We've got to make sure it's been done correctly, because it's our decision and our responsibility to provide for health and safety." You've got a whole other camp that is saying, "Wait a minute. These people are licensed professionals. They're putting their professional license on the line. Why do you need to question that a great deal?" That hasn't been resolved yet. It would have been great to have some of those things resolved ahead of time.

For people that work with the building codes or zoning regulations, what are you willing to exempt ahead of time? What kinds of things can you make a determination on that really aren't that important in terms of rebuilding your community? A question we keep asking ourselves is if it matters five years from now, maybe it's important. If it doesn't matter five years from now, we need to take a good look at why we're requiring it.

One thing we found out particularly in Loma Prieta is you need to determine which of your normal operations you're going to alter, suspend, terminate, postpone. What happened to us—the earthquake happened October 17th; we shut down the regular planning and zoning process for three months while we figured things out. And what we found out in that three months is we couldn't deal with the influx of applications and work from the earthquake and deal with all the regular business that normally goes on. So what happened from that?

What we did is inadvertently expand the impact of the earthquake to people that had no damage. There were a lot of areas in the county that were fine. So what we did is stop everything for three months. Now, people who didn't have any impact, they were dead in the water. The construction industry just loved it. The people who had bank loans they were paying interest on, they had construction ready to go. Contractors had business lined up. It stopped.

Another thing you can think about is thresholds for rebuilding requirements. Are you going to let people put back what they had there before? Will you let them put back what they had before as long as it's the same use and you can expand the footprint by 10 percent, 15 percent? When do you want plans? When do you not need plans? When do you need engineering? Those are things we tried to do on the fly. And we could have done it better. My advice to you again is try to do those things ahead of time.

With an earthquake, particularly the Loma Prieta earthquake—and remember it upset our prevailing wisdom about what was going to happen in an earthquake—we went overboard in terms of determining what we wanted to look at. In areas where there was minimal or nonevident damage, if you went out to a particular site you really couldn't see anything that indicated to you that there was a potential problem on the site. But because it happened to be within the confines of a line drawn on a map, we made them do geologic hazards assessments, geologic studies, geotechnical reports. And we were challenged quite a bit, "What's the basis for that? There's nothing going on here. I didn't have any damage! The ground isn't cracked in front of my house."

There's a number of areas you need to think about, particularly in land use. Nonconforming uses. What are you going to do with those? Are you going to let people build it back? Are you going to say "They can build it back if they make it conforming? What about things like infrastructure, parks facilities, public works facilities, hazardous materials facilities? What are you going to do with those things? What are you going to require of them to rebuild?

Take a look at your general plan uses. Maybe you've got some things in your general plan that if you had your druthers, you'd rather have that kind of use some place else. There may be some preexisting uses you'd just as soon have somewhere else in your community. Have some thought about "Where are some of the alternate sites we can put those things?" One thing that we had to spend a lot of time with was determining where we could put temporary housing units. It took weeks to get that figured out. In the meantime, Watsonville had quite a few people living in tents in their parks. It was raining. They weren't real happy that we couldn't figure out where to put them.

One of the biggest lessons that we learned is that the normal organizational structure of your government will probably be inadequate to deal with the event. Particularly if you think about dealing with normal work and dealing with the recovery work. In that case we came up with a concept we called the Earthquake Recovery Division to handle only earthquake repair and reconstruction. We set up an entirely new piece of the planning department that had all the building and zoning and plan check and engineering functions in it. It was a separate entity. It had separate staffing, separate funding. And when we got that open then we opened for regular business again.

At the time we didn't know if that was going to work or not. It turned out to work pretty well. In fact, it's been used as a model in a couple of other jurisdictions. The City of Oakland used that after their fire, and Kauai is using that now.

The other lesson from that is, as Charlie said before, you can't depend on government to do everything. We just don't have the resources to do that. Certainly, in California we're losing resources. From what I've heard talking to you in Alaska, you're in the same boat.

It's nice to have a plan. But you can't do everything. So you need to find your local resources, maybe some resources from outside the area that you can call on to do certain kinds of things. That's how we got the Earthquake Recovery Division set up and staffed for 18 months.

I went out and hired a contractor to bring in 41 people. From the time we got the go-ahead to the time the doors opened took two weeks. That's a building, computers, people, furniture, forms, phones, the whole thing. In a civil service system like we are, there's no way that's going to happen. It's going to take you months to get them, and it's going to take you months to get rid of them when things are finished.

So one recommendation is—since you get this opportunity of what we call Divine Redevelopment—think about having an element of your general plan that would be essentially a disaster-recovery plan. What kinds of things do you want to have changed in certain ways?

A thing that was of particular concern to us is, and I think it's been mentioned before, is beginning some work in identifying alternate funding sources for private property owners who can't afford the technical studies, engineering or construction, which you might require as a condition to rebuild—something we started calling institutionalized homelessness. We'd go in, post a home as unsafe, and the owner's insurance would pay for the demolition of their property. So now they've got a hole in the ground. And before they could rebuild, we'd suck up all their insurance money on tests and studies. Even if they did come back positively, we'd say, "OK, here's what you need to do. You have to have an engineered foundation. You've got to do all these things." And they'd say, "I'm out of money. I'm also out of a house. Thanks a lot." Particularly people on fixed incomes.

If you really want to have a gut-wrenching experience, have somebody that looks like your grandmother crying at your desk saying, "You've ruined me. I have nowhere to go. I have no money. I can't do these things. What am I supposed to do?" Not fun.

One of the things I want to make sure I get across, too, is in terms of setting yourself up to act and react and do your business differently, you need to think about developing financial regulations for your budget, your accounting process, and your purchasing functions that you'll use from the response period on through. A person who worked with us said it best. He was the gentleman who ran the contract for the Earthquake Recovery Division. "Governments should be focused on the process they want to have in place when the disaster strikes rather than try to reinvent, tweak, get around or ignore normal procedures when they're trying to move as quickly as possible to help the community." He's exactly right. You can't use your regular process. It just won't work.

One thing I want to leave you with is the idea that even if you can't get the political will together to develop a complete package, if you're in the land-use field, I strongly urge you to have some emergency ordinances, some emergency operating plan, some emergency procedures that you're going to use in your process. Have them in your hip pocket so you can show up on time when your city council or your board of supervisors is saying, "What are we going to do? What are we going to do about this?" Have something. Don't take three months to figure it out. Don't take a year to figure it out.

The last thing I want to leave you with is the concept of not trying to make land use policy after the disaster. Do as much as you can ahead of time. Keep it flexible. Keep it simple. Try to find the right people to put in those roles. I think your life will be a lot easier when it happens.

<u>Questions and Comments from the Audience</u>

MR. PAGE: My name is Bob Page with the U.S. Geological Survey. One of the comments you made was that a plan for responding to a disaster ought to be flexible because it will be unforeseen dimensions that will be part of that disaster. However, I think you might have left a misimpression. You suggested that by and large most of the things that happen geologically were unanticipated. I think that's the way the audience might remember some of your remarks. But I don't think that's true. I think that 90 percent of what we saw was expected. In fact, the quote that I showed the very first day from the 1906 report talking about the damaged brick structures down by the San Lorenzo River. Well, that's exactly what we saw. And if you went up to San Francisco and looked at the damage there, the damage occurred in areas that had been mapped out as being prone to liquefaction and ground failure.

I think in regard to the shattered ridge top, this is a phenomenon that was really highlighted by this earthquake. We hadn't had an earthquake where we had an awful lot of houses built high on the mountains with a source right near those houses high in the mountains. So that was a sort of a frontier bit of knowledge. That element of it is new. But I think that's only a very small fraction of what happened. I think the bottom line is that geologists could tell you ahead of time and did tell you ahead of time, 90 percent of what happened.

MR. DEVER: Right. And I don't mean to give you the impression that by and large the events that took place were completely unknown and unpredictable. From a land use perspective, from a land use policy perspective, it wasn't what we expected. And we've had development in areas where there has been no study. We've found a lot of unstable sites that we didn't know about. My point was not to say that you can't depend on what geologists tell you. My point is that you shouldn't think that you know everything.

LESSONS LEARNED FROM THE 1964 GREAT ALASKA EARTHQUAKE

by
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My purpose is to review with you the 28 years of recovery in Anchorage from the 1964 earthquake. I'll be weaving through some of the comments you've heard for two days, what some of the situation is today, and whether or not any lessons have been learned from 1964 to the present. I'll be marching through some things geographically, chronologically, and educationally.

The 1964 earthquake in Anchorage hit some areas very significantly. On Government Hill there was a school that was damaged extensively. The bluff behind the Alaska Native Hospital collapsed. The Fourth Avenue area had a substantial slide. There was a slide in the L Street area. And a slide in the Turnagain by the Sea area.

This figure just gives you an indication of where those occurred. Government Hill, Alaska Native Hospital, Fourth Avenue, L Street and Turnagain by the Sea. Today the school that was destroyed on Government Hill has been removed and a park has been established in that particular area. In the Alaska Native Hospital area, there hasn't been a lot of significant stabilization done. And within the next couple of years, a new native hospital is going to be built out on Tudor Road. I don't think that there's been a firm decision to this day what will be the potential reuse of either the facility that is vacated or what's done with the site after the Alaska Native Hospital relocates.

I'll go over in some detail what's occurred in Anchorage over the years in the Fourth Avenue area, in the L Street slide area, and in the Turnagain area. I think that significant things have happened in each of those areas. Possibly we can learn from those.

One of the things that has occurred during the years from 1964 up through quite recent history, was that there's been a lot of further clarification or studies as to what's going on and what caused the earthquake damage and what might that tell us in the future.

Immediately following the earthquake there was a task force, I think its title was Task Force Nine. They assessed the actual conditions that existed immediately after the earthquake and made some determination as to what caused the earthquake. That was followed by the Shannon & Wilson report which mapped some of the areas, particularly in the Fourth Avenue area and other ones that were affected by this earthquake.

Then in 1979 there was a study done which was known locally as the Harding-Lawson Study. And then as recently as 1986 there was a microzonation study done by Woodward-Clyde.

The Harding-Lawson study precipitated modifications to local codes and ordinances. As an example, the information that is in the Harding-Lawson Study affected the building code. The recent revisions of the Uniform Building Code took the zone 4 category and made some local adaptations to it. If you're in these areas, zone 4 or above, you have to go through some additional steps and studies before a building permit can be issued.

This was principally done to define more specifically areas of hazard concern. The same thing existed when we classified areas as susceptible to seismically induced ground failure. This particular study was done in relationship to the central business district plan that was developed back in 1979.

Then a further attempt was made, I believe in 1985 and 1986, to identify areas of seismic concern. All of these basically point out that we have attempted, on a continuing basis, to more clearly define what happens and what caused certain things to happen. Now, what we do with that information remains a concern to a lot of people.

Downtown & Buttress

Immediately after the earthquake, there was a downtown urban renewal project established in the Fourth Avenue buttress area. That was known as the R-20 Urban Renewal Project.

Within that particular urban renewal plan, there were plans that were made relative to land use. Where would there be commercial development, where would public uses be allowed, and where was no change anticipated? Generally speaking, over the years, the areas shown as commercial development have been redeveloped for commercial purposes. The blue areas are today basically parking lots within this particular area. And there hasn't been substantial development, at least to date, down in this area or the area between this and the Ship Creek area.

Right now and during the next few years there's going to be a lot of consideration for re-development activities down in the Ship Creek area. We've just had a meeting during the last couple of days with the developer of that area and his architect. They have been made extremely aware of the zone 4 hazard designation and the steps that they're going to have to work with the building official before they can get building permits down in this area of Ship Creek.

Again, back immediately following the earthquake, the urban renewal plan that was developed laid out some very specific objectives. It wanted to clear land and stabilize and buttress construction. Much of the area that I identified that is now parking lot and the sloping area down to the lower lands in the Ship Creek area were part of that stabilization.

There was the removal of substandard and damaged buildings. Making land available for commercial use. Redevelop the area to insure safety. Develop coordination with the portion of the central business district and provide right-of-way for highway projects. Those were some of the immediate concerns that came out of the urban renewal plan. And I think that was done probably in 1965.

The Fourth Avenue area was the only slide area in Anchorage which was deliberately stabilized and the only area for which an urban renewal plan was accepted and carried out. So, while I think there were seven slide areas, that was the only one that received specific redevelopment planning and actually carried it out.

Why was stabilization undertaken at all in the Fourth Avenue slide area when nothing was done to stabilize the other slides? A report was done I believe in 1980 that summarized land use planning after earthquakes, using the Anchorage situation as examples. But that report states a major reason is probably "the relatively high value of the property" to be stabilized.

Funds were insufficient to stabilize all the slide areas, all of the seven that I was talking about. And Anchorage corrected the problems with the funds that they could obtain from the federal source. But other communities absorbed a lot of the other federal funds that were available.

Another factor was undoubtedly that much of the land needed to achieve stabilization in the Fourth Avenue area belonged to the federal government. It was part of the federally owned and operated Alaska Railroad. A third reason was the desire to maintain the pre-earthquake location of the central business district.

Why was the redevelopment project limited to the area needed for stabilization? Under the redevelopment proposals, property owners in the project area were to be paid for the postearthquake value of their properties. This was much lower, as you can well imagine, than the value immediately before the earthquake. And it was considered inadequate compensation by those that were affected. So they didn't want urban renewal in their areas if it negatively affected the value of their properties.

In the postdisaster situation the desire to return quickly to normal appears to have exceeded any desire to take advantage of the opportunity to achieve objectives not directly related to re-construction. I think some of the prior speakers indicate that same type of thinking goes on today.

With so many buildings destroyed near the downtown or within the downtown area, there was little support for tearing down more buildings that were still standing and were still stable in the name of urban renewal. And then at the federal scene, the Federal Reconstruction Commission, which was charged with urban renewal, was reluctant to recommend funding urban renewal projects extending beyond areas of destruction or achieving objectives other than recovery. So generally speaking that gives you a picture of what happened and why it happened in the Fourth Avenue area immediately north of downtown.

L Street

Next are some examples of what's happened in the L Street slide area.

First of all, the L Street slide was a block slide caused by failure in saturated sand, silts and clays of Bootlegger Cove formation. Substantial portions of Anchorage are underlain with Bootlegger Cove clay. What tends to happen, as I understand it, in those situations is that buildings may remain intact, but where you are going to find them depends on how far they're sliding. We still have a lot of circumstances potentially related to exactly that situation.

The reconstruction task force recommendations weren't followed in the L Street slide area. There were substantial recommendations related to maintaining a very low-density, single-family residential development along L Street. It retains its high risk classification today. But the zoning was changed, I believe, a year after the earthquake. The zoning was changed to increase the density, to increase single-family dwelling uses and to permit multifamily dwelling uses, and to change portions of the area that will allow both multifamily and office building construction in the L Street area.

For those of you that are from the Anchorage area, you're very familiar with the type of situation that's redeveloped in the L Street slide area. Today I find it interesting that when a zoning issue will come up in L Street, there are two basic controversies. Neither one is related to the hazards in the area we're talking about. But generally speaking someone who already has a building in that location is concerned about, number one, preserving their view across the inlet. And they get very upset if a multistory structure is going up that blocks their view. So they argue about that.

Secondly, traffic congestion is a real concern in the area. And it's interesting to me that if people are concerned about access and traffic congestion today—granted we have limited roadway access through that area—but if and when another earthquake occurs that affects that area and blocks off roadways, access is going to be compounded even further. Getting emergency vehicles down into that area will be a substantial problem.

What are some of the reasons that L Street developed the way it is? Property owners in the L Street area did not wish to abandon structures that were undamaged or easily repaired. Again, compensation at the postdisaster values was not sufficient to induce them to relocate.

Owners began repairs with private funds almost immediately after the 1964 earthquake. And the city apparently felt it could afford neither stabilization of the slide nor purchase of the properties on the slide. Funds were not even allocated to undertake an economic study of stabilization. So generally speaking there was not much action from the government relative to that area. And apparently private interests were able to achieve financing that allowed them to start reconstruction almost within a year.

I'd like to show you again a few slides here that just typify what's gone on in the L Street area. This slide shows you what actually existed prior to 1964. This one indicates construction that went on 1964 to 1968. In the solid black dots, you can see that there's quite a flurry of activity that occurred between 1970 and 1979. Then from 1980 to 1989 some of the more significant things is that this new construction that went on in these periods of times was substantially higher in density and higher in value than anything that had existed down in that area prior to the earthquake.

Turnagain by the Sea

The last example I'm going to show is one which has been mentioned and questioned by a person from the audience after one of the previous presentations. The question: What's been Anchorage's reaction in the Turnagain by the Sea area? For those of you that are familiar with it at all, this is the Earthquake Park area. And this is the subdivision area that has been pretty controversial for quite a few years.

I arrived in 1976. And it was interesting to me that I had to do a catch-up on the history of the earthquake and what it meant in terms of some of these concerns about redevelopment. But there was a tremendous flurry of activity in the 1977 era.

A number of emergency ordinances went into effect because there were substantial pressures to redevelop a portion of the Turnagain Arm slide area. The first emergency ordinance identified the fact that there were potential hazards to the public safety, required studies for rational planning, for future development, and issuing building permits without a development plan may threaten public safety. I believe that was the 208th ordinance addressing issues in 1977, rapidly followed by ordinance 214. They required the formation of an improvement district for all elements of standard subdivision, required the formation of a park district, required the formation of a regional park, and placed a 120-day moratorium on development. Again, there were tremendous pressures for development from the private sector during that period of time.

That was followed a number of months later by ordinance 77-400, and assembly committee reports. There was a whole series of committee activities that went on, many of them being coordinated by Dr. Lidia Selkregg who was on the assembly at the time, and Arliss Sturgulewski—they got very involved in this process.

One of the things that happened during 1977 was the formation of a geotechnical advisory committee to the mayor and the assembly to address development in geotechnically hazardous areas. There was an extension of the moratorium until March of 1978. And it required specific geotechnical studies be done in the slide area.

That moved on into 1978. There was an ordinance, 78-84, to allow development that has paved streets, curbs and gutters, public water, public sewer, utilities, street name signs and street lights. But it required certification by the public-works director before that could occur.

The next thing that happened was the concerted push to redevelop this area, Turnagain by the Sea, as a subdivision. In 1982 in Turnagain Northeast Subdivision, the property owners formed a road improvement district and a water improvement district. One of the reasons that was done was that the neither the federal government nor the state government was willing to support financially infrastructure improvements in that area. So, the local ordinances said, "If you're going to assume the private risk of developing down there, you're going to do it by forming improvement districts."

A subdivision plat was required to identify right-of-way location after the slide. Again, this was an area that had substantial movements of the ground. The whole area had to be replatted. And the platting authority approved a plat in May 1982. That particular plat was not filed.

That was followed in 1984 and 1985 by a legal opinion that finds the municipality would not likely be held liable if any future hazards would occur if the area were developed. A new plat was presented to the platting authority. The platting authority, based on advice and recommendations from the geotechnical commission, rejected the plat. That was appealed to the municipal assembly. And the assembly, sitting as the board of adjustment, approved the plat. The plat was recorded in May of 1986. That was appealed to the court and the court overturned the assembly's action.

You can see that there's quite a flurry of action down in this area. And it wasn't always clear that development should occur. In 1987 through 1989 the mayor directed the platting authority to hold a new hearing. The plat was approved in June of '87, although again it wasn't filed. Geotechnical studies were done by Shannon & Wilson in March of 1989. And finally a new plat was approved and filed in 1990.

That merely gives you a brief history of the flurry of activity that occurred in the Turnagain area. The controversy continues today. I think our people from public works could give you a much more up-to-date picture. Part of the hassle and concern that exists today is that when you form the road improvement district, a lateral improvement district, and a water improvement district, the assessment and the allocation of those costs to the property owners becomes a question. How will it be done?

There are some people that are in closer proximity to the slide. There are some who are away from the slide that feel they should be treated differently. And I believe even this year the subject went to the Assembly for resolution.

Summary

That gives you a quick overview of what's happened in three geographic areas during 28 years. And there are a few lessons that I think have been learned locally from what's been going on.

In the downtown area we have had a series of public-facility concerns that have come up. One was location and design of a state courthouse and the possible location of a state office building. There was a potential new state office building location study done a number of years ago. A pretrial detention facility was sited and built within the immediate areas of the Fourth Avenue slide area.

Generally speaking the technical information that has been assembled, geotechnical information, has been closely adhered to when making public-facility site-study decisions or designing public facilities within those geotechnically hazardous areas. People tend to view public projects differently than private development. This is particularly true of the elected officials. There are differing views concerning public risk versus private risk.

I have spoken to a number of elected officials and people within the administration who feel that the private sector ought to be allowed to gamble and take the risk and build in those geotechnically hazardous areas if they can get the financing and if they can make it go. I think, in the long run, that can be extremely hazardous and expensive in the future. It may be that we will force the private sector to build road improvements, utility improvements, and construct the original infrastructure.

But, from all of the advice we get, it isn't IF another earthquake is going to occur, but WHEN it occurs. The point that raises: Are there going to be redevelopment expenses associated with those particular geographic areas, both L Street and Turnagain area. How are the local officials going to face the redevelopment subject when it comes up? Are they going to go in and rebuild at public expense the infrastructure that's damaged? That's almost a second stage of it. The first stage is going to occur in what expenses are going to be incurred with emergency recovery and mobilization to assist the people that are affected in those areas.

So there is going to be in the long haul a public expenditure in areas where people tend to say, "Let the private sector take its risk." On the other hand, where public risk is involved, there seems to be a great deal more caution exercised. We want to make sure that in siting public facilities we adhere to the advice and technical information as best we can and it's exemplified by siting and design of the courthouse, siting of a potential new state office building, and both siting and construction design of the pretrial detention facility.

We also went through a similar exercise during the past year and a half about the potential site for a new municipal office building. At least the dialogue that occurred indicated that the local elected officials are cognizant of the fact that when you are siting a public facility we'll pay a lot more attention to the risk factors than we do when we're dealing with private construction and private finance of facilities.

I have tried to provide you an overview of three or four different geographic areas, what's occurred over time. And maybe from some of the comments, you can gain particular insight as to what might be learned from that. I am not jumping to complete conclusions and saying as a result of that, this, this, this, and this can be learned from Anchorage. But one of the things that impressed me—impressed or depressed me—during the last two days, was observing the audience here. At least for the two days, the sessions that I've attended, I have yet to see one local elected official participating in or listening to the information that's been presented. I don't know when or how we get the people to attend who ultimately make the decisions that allow development to occur in hazardous areas.

I think that our technical people have done an excellent job over the years at doing the best they can with maintaining the building codes, fire codes, and things of this nature to anticipate as best they can the conditions that exist in Anchorage.

We have had an experience within the planning department that is somewhat distressing. You've heard the information during the last couple of days about geotechnical hazards and liquefaction and subsidence, and all that sort of thing. But we had a much simpler one. In the early 1980s we mapped the potentially hazardous avalanche areas within Anchorage. And those maps were basically intended to inform the general public of these hazardous areas and they were for information purposes to be considered by our planning and zoning commission and our platting board whenever development was proposed in those areas.

During the last two years we were severely criticized by people who are living in those areas or who own land in those areas. Someone had mentioned it earlier this afternoon in questions. We get criticized for mapping flood hazardous areas. Well, we've been criticized for mapping avalanche hazard areas.

I personally have attended a number of avalanche seminars. One of the things that you learn as you go to those seminars is that you can avoid the real hazard of avalanches if you stay out of the areas. Yet we have a continuing cry in this community by a number of people to allow the private sector to develop in avalanche chutes.

We held a seminar strictly on avalanche hazards late last winter. That seminar was held in response to people who wanted to force us to remove from the public counter the avalanche hazard maps, so that no one could see the information and so that the lending institutions wouldn't have direct access to that. So when they were considering making loans in those areas, that information wouldn't jeopardize the individual's chance to get financing. Well, fortunately, after a Friday, Saturday, and Sunday work session on avalanches where we consulted a number of experts in avalanches, we sent many invitations to people who were affected by those areas and who were complaining to us about the concerns. After the three days, we strongly got an indication that an awareness was created, that there is a genuine potential risk.

We aren't strictly trying to regulate and take away private enterprise or private opportunity to make money. But we're trying to protect lives by warning people about these particular areas. I have not heard within the past six or nine months any additional cries to remove from our public counter information on avalanche hazard areas.

It'll last for awhile. But I'm sure that sooner or later the same type of controversy is going to rise again. And we will be subjected to almost cruel and inhumane punishment. We get accused of being the "Bad News Bears" by making this information available. The same is true about information on the geotechnical hazards, the avalanche areas and the flood plain areas.

I guess maybe that's one of the things that planners are subjected to. If you really want to know what defining a hazardous area is, it's a planner's position. The mayor the other day was complaining to me that he felt that I was overweight. And I said, "Your Honor, I've been a planner for 30 years. I've been in this community for 16 years. I'm not overweight. I've gotten too short from getting hammered around the head and shoulders."

APPENDIX A

Acronyms used in this report

ADEC	Alaska Division of Emergency Services
ADGGS	Alaska Division of Geological & Geophysical Surveys
APD	Anchorage Police Department
ATC	Applied Technology Council
ATWC	Alaska Tsunami Warning Center
CALDAP	California Disaster Assistance Program
CalTech	California Institute of Technology
CalTrans	California Department of Transportation
CRERF	California Residential Earthquake Relief Fund
DAC	Disaster Assistance Center
DSR	Damage Survey Report
EERI	Earthquake Engineering Research Institute
EOC	Emergency Operations Center
FEMA	Federal Emergency Management Agency
IRS	Internal Revenue Service
JMEPG	Joint Medical Emergency Preparedness Group (Anchorage)
Mat-Su	Matanuska-Susitna Borough (Alaska)
ML&P	Municipal Light & Power (Anchorage)
MOA	Municipality of Anchorage
NEIC	National Earthquake Information Center
NGDC	National Geophysical Data Center
NOAA	National Oceanic and Atmospheric Administration
OEM	Office of Emergency Management (Municipality of Anchorage)
OES	Office of Emergency Services (State of California)
PSA	Public Service Announcement
PTA	Parent Teacher Association
SBA	Small Business Administration
UBC	Uniform Building Code (International Congress of Building Officials)
USGS	U.S. Geological Survey
VOAD	Voluntary Organizations Active in Disaster

APPENDIX B

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