Merging Historical and Recent Records of Seismicity to Better Define Earthquake Source Zones within the Anchorage Region

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Diane I. Doser
The University of Texas at El Paso
Department of Geological Sciences, 500 W. University Ave., El Paso, TX 79968
(915)-747-5851 (office), (915)-747-5073 (FAX), doser@geo.utep.edu,
http://www.geo.utep.edu/Faculty_Staff/doser.html

Element II

Geophysics, seismology, source characteristics, seismotectonics

Investigations Undertaken:

This research concentrates on merging results of studies of historic and recent earthquakes to better define earthquake source zones in the Anchorage region (within ~100 km of Anchorage). The study involves 5 main tasks: 1) relocation and merging of recent seismicity (1971-present) recorded by the U.S. Geological Survey (1971-1988) and the Alaska Earthquake Information Center (1988-present), 2) relocation of older events (1928-1971) using recent events as master events, 3) waveform modeling studies of moderate (5.4<M<6.5) events occurring up to 15 years prior to the 1964 mainshock, 4) collection of intensity information for historic and recent earthquakes, and 5) Coulomb failure stress modeling studies of crustal events.

During the summer of 2001 Dr. Doser visited colleagues at the University of Alaska Fairbanks and the U.S. Geological Survey in Anchorage to discuss access to seismological data and to insure that our research would not duplicate research efforts by other workers. She began collection of network phase data and intensity data, which continues to the present.

In September 2001 Ms. Claudia Flores, an MS student in geophysics, was hired as a research assistant to help in the relocation project. Ms. Flores had spent the summer of 2001 at Los Alamos National Laboratory learning to use new earthquake location codes, including HYPODD (Waldhauser and Ellsworth, 2000). She is currently collecting phase information for older (pre-1964) events.

Initial studies of Coulomb failure stress modeling were undertaken in April and June 2001. Results of the stress modeling will be presented at the Fall 2001 meeting of the American Geophysical Union (Doser and Flores, 2001).

Results:

Because we are still in the early stages of the data collection process, we have few results to report on earthquake relocations. The Alaska Earthquake Information Center is assisting us in obtaining phase data for M_L>2.0 earthquakes occurring between 1988 and the present within 100 km of Anchorage. We have also made arrangements to obtain phase data from the U.S. Geological Survey's south-central Alaskan network for events occurring between 1971 and 1988. We have ordered a CD-ROM of phase data from the International Seismological Centre for events occurring between 1964 and 1971. We already have collected phase data for most south-central Alaskan events of M>5.5 occurring between 1928 and 1964 (relocated by Doser and Brown, 2001) and plan to collect data for the remaining events in November 2001. We hope to assemble the complete data collection before the end of 2001.

We have searched the NOAA/NGDC on-line intensity database for all earthquakes occurring in the region between 1900 and 1985. In addition, we have collected intensity information from the USCGS volumes on United States Earthquakes and have some newspaper accounts for the 1933 and 1943 events near Anchorage. We are attempting to locate other intensity accounts from Alaska Railroad publications.

Preliminary results of Coulomb failure stress modeling are shown in Figures 1 to 3. Figure 1 shows the Coulomb failure stress (δCFS) induced by the 1933 Upper Cook Inlet earthquake (orange square) for faults with similar orientation to the 1933 mainshock. Aftershocks of the sequence are plotted as yellow dots. Three of the five aftershocks fall within regions where δCFS > 0.1 bars (red regions), the δCFS threshold level for triggering of aftershocks that has been suggested by King et al. (1992) and Reasenberg and Simpson (1992). The two aftershocks that do not correspond to regions of higher δCFS could either have occurred on faults with different orientations than the mainshock or could be mislocated (mislocations of no more than 10 km would place the events within the higher δCFS regions). This highlights the importance of master event relocations for older foreshock/aftershock sequences in order to better correlate locations with induced stress modeling results.

Figure 2 shows δCFS from the 1933 mainshock (orange square) for faults oriented similar to that of the 1943 mainshock (yellow dot). The yellow ellipse indicates the error associated with the 1943 mainshock location. Most of the error ellipse falls within a zone of negative δCFS, suggesting that the 1933 event did not induce the 1943 event.

Figure 3 shows the contributions of the 1933, 1943 and 1962 mainshocks (orange squares) to δCFS along faults similar in orientation to the portion of the Castle Mountain fault that ruptured in the 1984 Sutton earthquake. Note that the Sutton epicenter does not fall within a zone of high δCFS, although δCFS appears to have increased along the portion of the Castle Mountain fault that is closest to Anchorage.

We plan to re-examine the δCFS patterns once we have obtained better relocations for these older earthquakes. We plan to examine the effect of recent (post-1964) M>4.5 earthquakes on stress along the Castle Mountain fault as well as examine how δCFS relates to aftershock patterns of other moderate to large earthquakes, including the 1984 Sutton event.

<u>Non-technical Summary:</u>

This study focuses on earthquake hazards of the Anchorage, Alaska region. Major tasks in the study are to relocate and merge hypocentral data for the 1928-2001 time period in order to examine the nature of shallow crustal and deeper Pacific plate earthquake source zones near Anchorage. We will also compile intensity information for earthquakes in the region, which will provide insight into variations in ground shaking and their relationship to local geologic conditions.

<u>Reports Published:</u>

Doser, D.I. and C. Flores, Crustal earthquake source zones within the Anchorage, Alaska region, abstract submitted to Fall 2001 meeting, American Geophysical Union.

<u>Availability of Data Sets:</u>

Copies of phase data and intensity data that will be used in the analysis will be available in paper or digital form. First motion data and waveform data will also be available in digital form. Contact the principal investigator, Dr. Diane Doser, for more details at (915)-747-5851 or doser@geo.utep.edu.

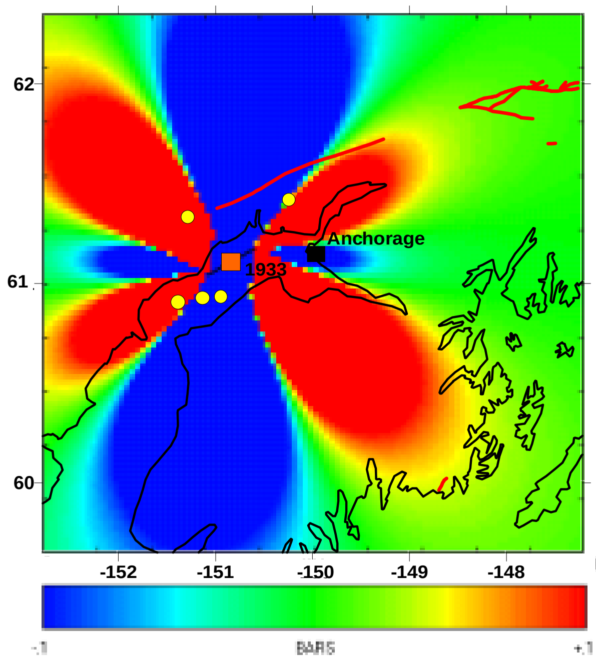

Figure 1. Induced Coulomb failure stress (δCFS) from the 1933 Upper Cook Inlet mainshock (orange square) for faults with orientations similar to that of the mainshock. Red indicates δCFS >0.1, a threshold value suggested for triggering of earthquakes. Yellow dots are aftershocks. Black square shows location of Anchorage. Red lines denote faults showing Quaternary movement.

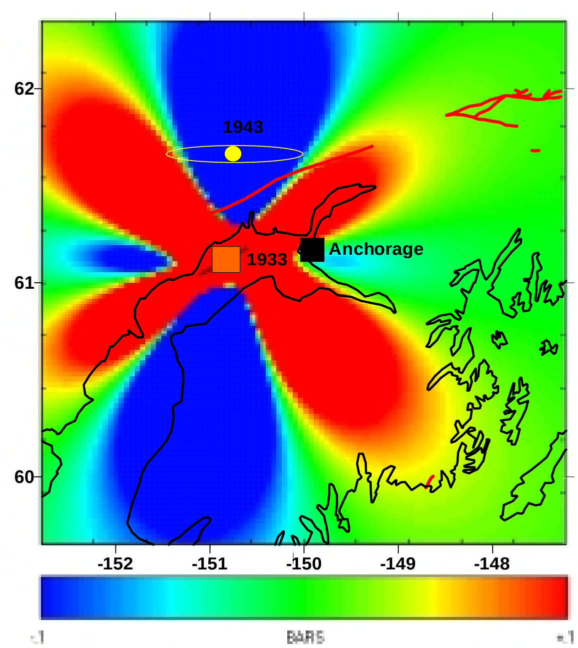

Figure 2. Induced Coulomb failure stress from the 1933 Upper Cook Inlet mainshock (orange square) for faults with orientations similar to the 1943 earthquake (yellow dot and associated yellow error ellipse).

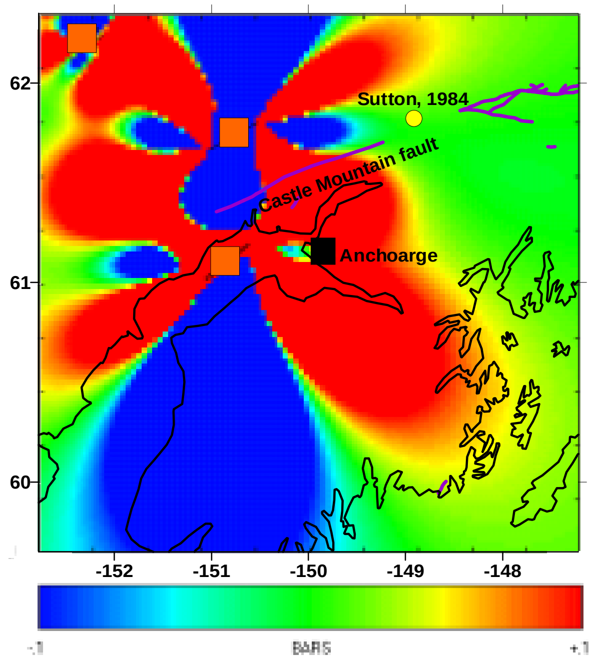

Figure 3. δCFS from 1933, 1943 and 1962 mainshocks (orange squares) for faults oriented similar to that of the 1984 Sutton earthquake (dot) on the Castle Mountain fault (in purple).