Studies of Historical Earthquakes in South-Central Alaska

00-HQ-GR0014
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)
mailto: doser@geo.utep.edu
http://www.geo.utep.edu/Faculty_Staff/doser.html
Element II
Geophysics, seismology, source characteristics, seismotectonics

Investigations Undertaken:

This study emphasizes historical (pre-1964) seismicity of south-central Alaska in the region of 1964 Prince William Sound asperity. The analysis of seismicity includes relocation of M>5.5 events, determination of focal mechanisms from first motion data for M 5.5 to 6.4 events, and body waveform modeling of M>6.4 events. The study builds on previously funded research on post-1964 mainshock seismicity of the Prince William Sound/Cook Inlet and Kodiak Island regions. Comparisons between pre- and post-mainshock activity will help to understand the characteristics of the earthquake cycle in south-central Alaska.

Data collection for historic Kodiak events began in March 2000. Most seismograms were collected by mid-summer. Two graduate students collected additional seismograms in July 2000 at the California Institute of Technology's archives.

Graduate student Wesley Brown digitized and processed the historic data during the summer of 2000. He also integrated results from his thesis research on post-1964 mainshock seismicity in southern Kodiak Island with the results of the thesis research of Ms. Monique Velasquez on post-1964 mainshock seismicity of northern Kodiak Island and the Kennedy Entrance region. Mr. Brown defended his M.S. thesis in May 2000. Data for post-1964 events in the middle Kodiak Island region is still undergoing analysis. Mr. Jaime Hincapie began work as a research assistant in fall 2000. He is concentrating on relocations and first motion studies of historic Kodiak Island earthquakes.

Waveform modeling of historic earthquakes in the Prince William Sound (PWS) region began in spring 2000 and continued through the summer. A paper on the results of this research was submitted to the Bulletin of the Seismological Society of America in September 2000.

Dr. Doser attended the April 2000 meeting of the Seismological Society of America to present preliminary results of comparative studies of Kodiak and PWS seismicity. She also attended a workshop sponsored by the USGS and the Geological Survey of Canada on the hazards of intraplate slab earthquakes and presented an overview of intraplate slab events of the Cook Inlet/PWS region.

Results:

Studies of historic seismicity of the PWS region indicate that there is a persistence of normal faulting within the subducted slab in the Tazlina Glacier and Columbia Bay regions north of PWS and within northern Cook Inlet for the past 70 years. A higher level of shallow (depth<40 km) earthquakes occurred in upper Cook Inlet and north of Cook Inlet prior to 1964 and the range of earthquake focal depths (9 to 46 km) suggests that much of the crust may be seismogenic. There were also higher levels of seismicity within the subducting plate in the

south-central and eastern Kenai Peninsula prior to 1964. A lower level of seismicity was present in the offshore PWS region prior to 1964. Much of the lower plate seismicity over the past 70 years appears to cluster immediately downdip of the 1964 asperity.

Waveform modeling studies suggest the April 1993 Mw=6.9 earthquake occurred within Upper Cook Inlet. The local and focal mechanism of the event suggest it occurred along one of several offshore structures such as the North Cook Inlet or Beluga River fold/fault system. Slip appears to have been predominantly strike-slip, making the rupture difficult to detect if it occurred offshore. The earthquake produced a maximum intensity of VII and considerable damage in Anchorage. At least 10 other shallow structures have been identified by Haeussler et al. (2000) in Upper Cook Inlet that may be capable of producing events of Mw>6.5. Thus it appears that seismic hazard in the Anchorage area related to shallow events within Upper Cook Inlet is significant.

A second large (Mw~7.0) crustal event in 1943 occurred north of Cook Inlet in 1943. At a focal depth of ~27 km, fault rupture may not have propagated to the surface during the event. Although the focal mechanism of the event is consistent with rupture on a strike-slip fault with similar orientation to the Castle Mountain fault, the relocation error ellipse and lower intensities (maximum of V) suggest it occurred north of the Castle Mountain fault. This suggests there are other active strike-slip structures north of the Castle Mountain fault.

A third large crustal event (Mw=6.8) occurred in 1932. Although it was located near the Denali fault, its focal depth of ~40 km and focal mechanism are not consistent with rupture along the Denali fault. Its greater depth may explain why it was felt strongly within PWS, although located ~350 km away.

Although much of the lower plate beneath the PWS asperity appears to be aseismic since 1964, a Mw~6.7 event in 1949 in the central Kenai Peninsula indicates that occasional large events may occur beneath the asperity. The October 1954 Mw~6.7 earthquake was located at ~60 km depth near the western edge of the 1964 asperity. The earthquake caused considerable damage in Anchorage (maximum intensity VII) and should be considered representative of larger intraplate earthquakes expected in the Anchorage region.

Non-technical Summary:

This study continues research related to the seismic hazards of south-central Alaska (Prince William Sound to southern Kodiak Island), focusing on earthquakes occurring before the 1964 great Alaskan earthquake, whose causative faults and focal depths were virtually unknown. Results to date suggest that three large earthquakes near Anchorage have occurred within the crust at depths < 40 km and that events within the subducting Pacific plate at depths ~ 60 km have also caused significant damage in the Anchorage region. These observations will aid in developing better seismic hazard models for the Anchorage metropolitan area.

Reports Published:

Brown, W. A., D. I. Doser and M. Velasquez, Spatial and temporal variations in seismicity within the 1964 great Alaskan earthquake rupture zone, Seismol. Res. Lett. 71, 234, 2000.

Doser, D., M. Velasquez, W. Brown and A. Veilleux, Large (Mw≥5.5) intraplate slab earthquakes (1928-2000) of the Prince William Sound region, Alaska, invited abstract, International Workshop on Intraslab Earthquakes in the Cascadia Subduction System (sponsored by the U. S. Geological Survey and the Geological Survey of Canada), Victoria, Canada,

September, 2000.

Doser, D.I., and W. A. Brown, A study of historic earthquakes of the Prince William Sound, Alaska, region, submitted to Bull. Seismol. Soc. Am., August 31, 2000.

Availability of Data Sets:

Copies of seismograms used in the analysis are available in paper or digital form. Phase data and first motion data are also available. Contact the principal investigator, Dr. Diane Doser, for more details at (915)-747-5851 or doser@geo.utep.edu.