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Lingering Effects of Alaska's Largest Earthquake

Alaska's Good Friday earthquake, a magnitude 9.2, is the second-largest seismic event ever recorded. Though it occurred more than 35 years ago, the earthquake may still be rearranging the Kenai Peninsula, according to Associate Research Professor Jeff Freymueller.

Freymueller and his colleagues say that Homer and other places on the western Kenai Peninsula are moving south/southeast, contrary to the motion of the Pacific plate. Seward and other areas of the eastern peninsula are moving as researchers expect them to move, in a north/northwest direction.

Freymueller visited the Kenai Peninsula last summer to enhance a network of global positioning system (GPS) stations. The GPS system, composed of 24 U.S. Air Force satellites that broadcast radio signals, allows researchers to determine ground movement with an accuracy of two millimeters.

Using GPS, Freymueller and other researchers have determined that Homer and Kenai are moving about 2 centimeters each year to the south/southeast, while Seward and other sites on the eastern Kenai Peninsula are moving about 3.5 centimeters each year to the north/northwest.

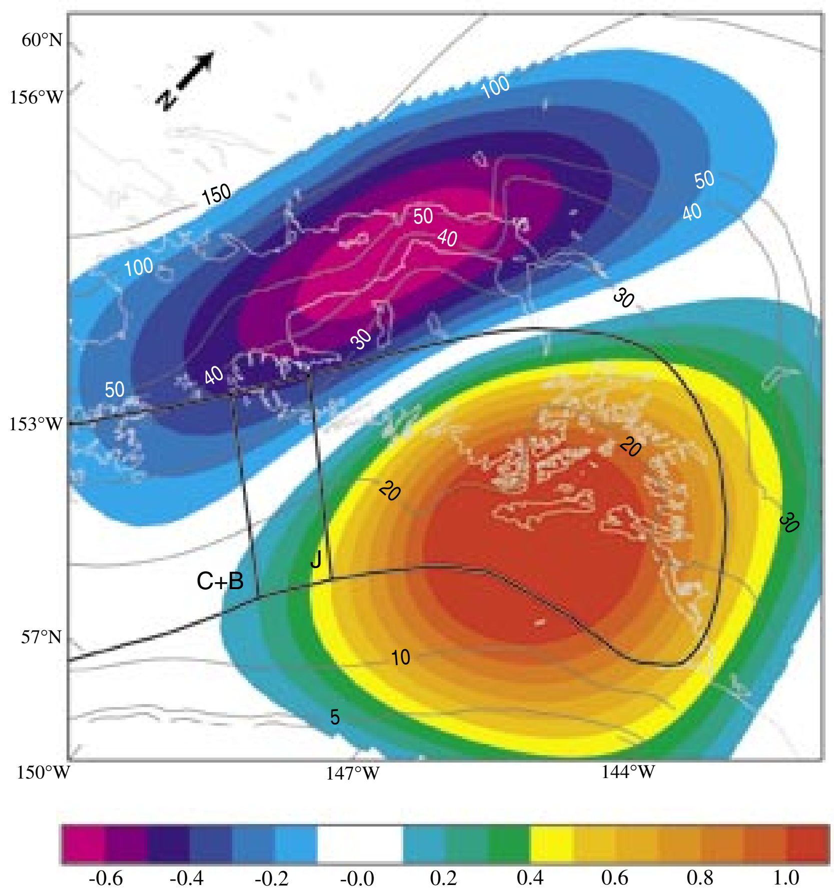
Freymueller thinks the wayward motion of the western peninsula is due to the lingering effects of the 1964 Good Friday Earthquake. That earthquake occurred on the boundary of the Pacific and North American plates. Located on a fault line that runs northeast to southwest from Prince William Sound to Kodiak island, the Pacific plate dives beneath the North American plate. Slippage along the plate boundary makes Alaska the most seismically active state in the nation. Freymueller thinks the stressed boundary of the Pacific and North American plates may be trying to "catch up" with the cataclysmic movement of 1964.

About 15 miles under the surface, where rocks are so hot they flow like molasses, the big shake might still be keeping things unstable enough to cause movements on the ground consistent with the surprising GPS measurements. Freymueller said the ground movement on the Kenai Peninsula mimics the ground motion that was measured in the vicinity of Landers, California, one year after a magnitude 7.3 earthquake.

Freymueller has extended the range of GPS measuring points across Kachemak Bay from Homer, at other sites of the western Kenai Peninsula, and on the west shore of Cook Inlet. The expansion will help researchers further measure the possible effects of the 1964 earthquake.

"This has the potential of being the best data set in the world representing a large earthquake," Freymueller said.

FIGURE BY CHRIS ZWECK AND JEFF FREYMUELLER



The above computer model image shows the coupling of the Pacific and North American plates in the region of Alaska's Kenai Peninsula. Colors describe the interaction between the plates. Red areas are zones where the two plates are locked; white areas are slipping freely at the plate convergence rate, and blue and purple areas are slipping faster than that rate. This faster slip, a continuing response to the 1964 earthquake, is the cause of the southward motion of the western Kenai Peninsula.

A Seismic Network Spanning the Alaska Range

Professor Doug Christensen and Research Assistant Liz Meyers plan to install seismometers in a transect that spans the Alaska Range this summer. The instruments will provide researchers detailed information about the structure of the earth beneath central Alaska.

Christensen and State Seismologist Roger Hansen are collaborating with Boston University's Geoff Abers on the Broadband Experiment Across the Alaska Range (BEAAR). Meyers' contributions to the experiment will help her earn a Ph.D.

The experiment, funded by the National Science Foundation, consists of 36 broadband seismometers on loan from the Incorporated Research Institutions for Seismology through their Program for the Array Seismic Studies of the Continental Lithosphere (PAS-SCAL). PASSCAL, located at the New Mexico Institute of Technology, has more than 400 portable seismic instruments available to those with successful proposal ideas.

Some of the PASSCAL seismometers used in the Alaska Range network were previously located in Antarctica and the former Soviet Union. Borrowing the seismometers negates the need to purchase new ones for about $24,000 each.

Christensen and Meyers will install seismometers every 10 kilometers from Nenana, which is north of the Alaska Range, to Talkeetna, which is south of the mountain range. They also will install seismic stations on the Denali Highway and along the road through Denali National Park, both of which run east-west.

The seismometer locations range from a high school teacher's backyard to a patch of woods near a town's shooting range. To create the proper spacing for the network, the seismologists got permission from a variety of landowners, including the State of Alaska, Alaska Native corporations, the National Park Service, the Bureau of Land Management, the Alaska Railroad, and others.

Seven stations in the network will be active for two full years, and 17 accessible stations will operate throughout the winter. The remaining 19 will operate seasonally due to power requirements.

Each station is powered by solar panels that charge two 12-volt batteries. The batteries power a computer hard drive that records seismic activity. A technician will swap hard drive disks every two weeks.

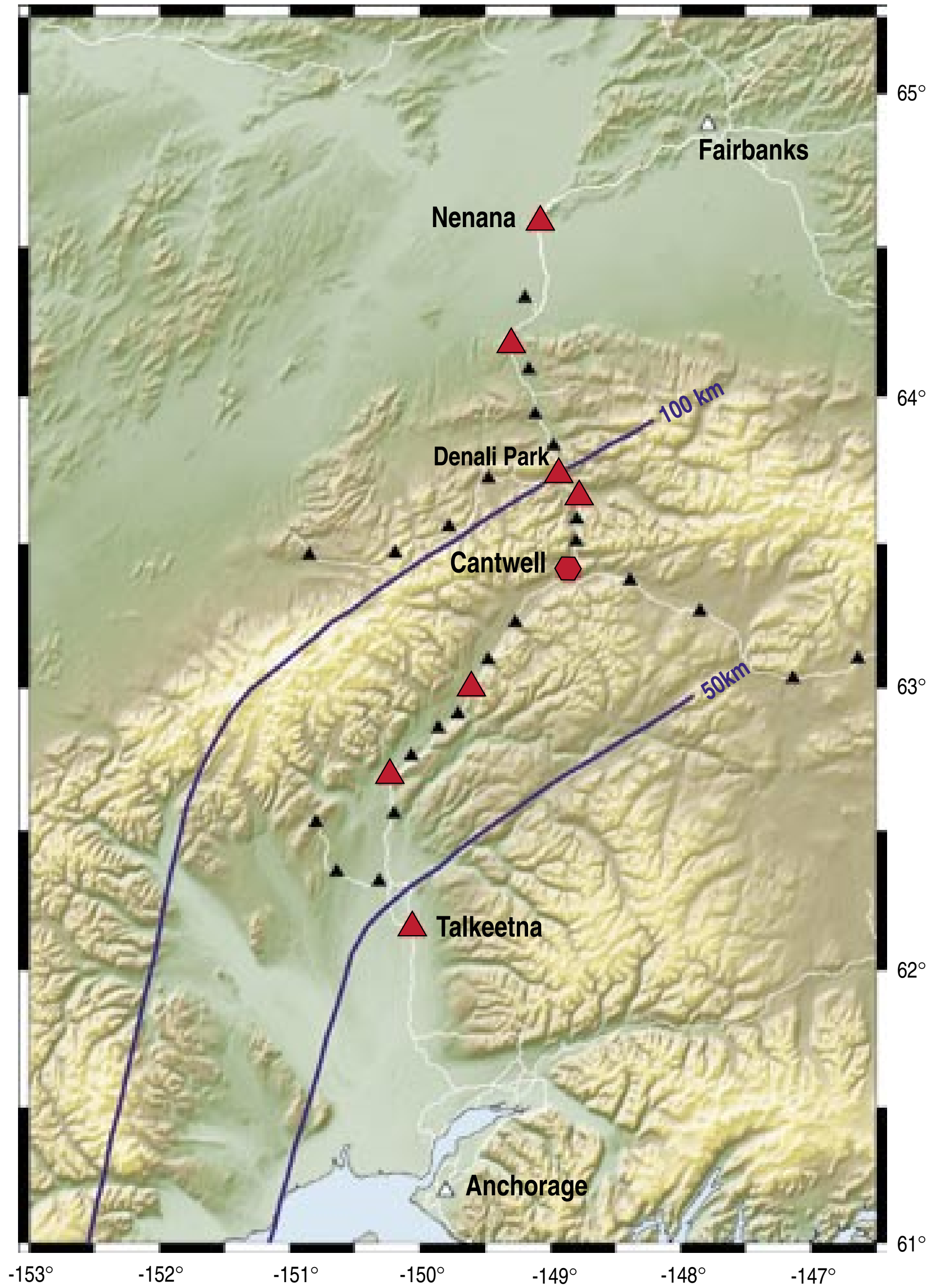


FIGURE BY GEOFF ABERS (MODIFIED BY DEB COCCIA)

BEAAR-*The Broadband Experiment Across the Alaska Range, graphically depicted above, will help seismologists learn more about Earth's crust and mantle. Triangles represent 36 seismometers that will be installed during the summer. Red triangles represent seismic stations that will be in place for more than two years; black triangles indicate seismometers installed for one season. The red hexagon represents an array of six seismometers. Blue lines show the depth to the subducting Pacific Plate.*

Information gained from the BEAAR experiment will help seismologists learn more about the boundary of Earth's crust, which extends from the surface to about 30K deep. It will also help them better understand the denser rocks beneath the crust, known as Earth's mantle.

One of the by-products of BEAAR research will be increased knowledge about the depth of the Alaska Range and about the precise depth of the Pacific Plate, which subducts beneath the North American plate in southern Alaska.

Seismic Zonation Maps Help Anchorage Planners

When an earthquake shakes Anchorage, not all parts of the city move in the same way, according to the results of ongoing research performed by Geophysical Institute seismologists.

For example, research results show that people living in downtown Anchorage may feel twice the effects of strong earthquakes as people living in the foothills of the Chugach Mountains.

The variety of response revealed by the study has prompted the municipality of Anchorage to consider improving building codes for Alaska's largest city.

Professor Niren Biswas and colleagues at the Geophysical Institute installed 22 seismic stations in the Anchorage area in 1995. All of the stations are connected by telephone line to the Municipality of Anchorage data center, and from there by Internet to the Geophysical Institute in Fairbanks.

Every day, scientists at the institute monitor the stations, which detect earthquakes with a magnitude greater than 3.5.

During the past four years, 70 earthquakes triggered the entire Anchorage network. Seismologists at the Geophysical Institute, including Biswas, Artak Martirosyan, and Utpal Dutta, compared the strength of the earthquakes at each of the 22 seismic stations. During the earthquakes, the downtown area shook up to three times as much as the foothills of the Chugach Mountains, which buttress the city to the east.

"This section of Anchorage will be very dangerous in a large earthquake," Biswas said pointing to the snout of Anchorage that juts into Cook Inlet. Sitting on that section of the city is the downtown area.

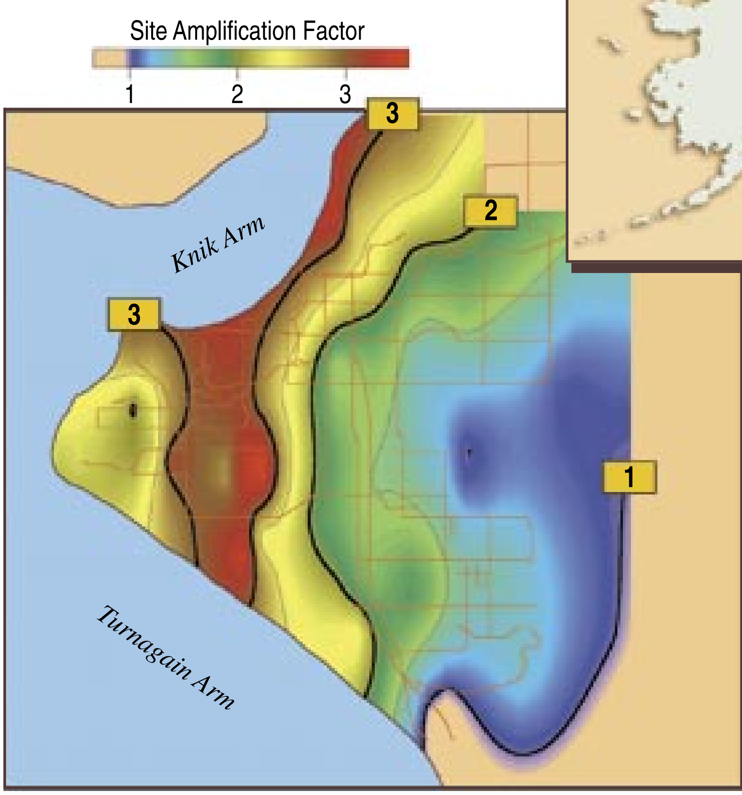
With their findings, Biswas and his colleagues hope to convince city leaders that engineers designing structures for downtown should be held to more rigorous specifications because offices and homes downtown will shake more than buildings in the hills during an earthquake.

Biswas has recommended to the Anchorage Planning and Zoning Commission that the city adopt three different building standards to correspond with the three different earth-movement zones.

Soils composed of sand and clay, known in Anchorage as the Bootlegger Cove formation, shake most during an earthquake. Those soils also are prone to liquefaction, a process during which soils act like a liquid after being shaken. Liquefaction was a major problem in Anchorage during the magnitude 9.2 1964 earthquake, which destroyed part of the city and killed about 100 people.

The institute's research in Anchorage has attracted the attention of Japanese officials, who have invited Biswas and others to Tokyo to discuss similar seismic work in progress there. The basin topography of Tokyo is similar to that of Anchorage, though on a larger scale.

The Anchorage strong-motion network has been funded by the Alaska Science and Technology Foundation, the Geophysical Institute, Emergency Management Services of the State of Alaska, and the National Earthquake Hazard Reduction Program of the U.S. Geological Survey.



Left—*Using 70 earthquakes with a magnitude greater than 3.5, researchers produced this map showing Anchorage's response to seismic waves at mid-frequencies. Red areas highlight those most susceptible to shaking, followed by less vulnerable areas in yellow, green, and blue.*

Right—*Triangles represent 20 of the seismic stations in the Anchorage strong-motion network. Red lines show major roadways.*

Infrasonics Help Detect Nuclear Blasts

Three Geophysical Institute scientists recently traveled to Antarctica to install equipment designed to help the Comprehensive Nuclear Test Ban Treaty Organization enforce the treaty, which prohibits the explosion of nuclear devices. Buck Wilson, Dan Osborne and Kay Lawson assembled and tested an infrasonics network at Palmer Station, located on the Antarctic Peninsula south of Chile. Wilson, a professor emeritus who came out of retirement in 1996 to work on the project, is principal investigator. Osborne is project engineer and Lawson is a field technician.

PHOTO BY BOB FARRELL

Dan Osborne, Buck Wil-son, Tom Cohenour, and Kay Lawson install a GPS antenna on Torgersen Is-land. The infrasonics mic-rophone rests in the fore-ground; digitizers are in the yellow box. Meteorological instruments are on top

PHOTO BY BUCK WILSON

Ken Dogget and Kay Lawson walk past Adelie penguins at the Torgersen Island rookery in Antarctica.

An infrasonics system is a microphone array used to catch subaudible signals from volcanoes, the aurora, winds over distant mountains, and man-made disturbances in the air, such as nuclear blasts. An infrasonics array in Fairbanks operated by Wilson, Osborne, and Professor John Olson has recorded nuclear blasts from China and countless other signals, including the eruption of Mount St. Helens in Washington.

Because infrasonics systems—networks of plastic tubes connected at the hub by a sensitive microphone—are simple and inexpensive, most nations involved in the test ban treaty install them. Following the success of the test at Palmer Station, the researchers will install a permanent infrasonic station there and at Windless Bight in Antarctica. The two stations will become part of a worldwide network of 60 such stations outlined by the Comprehensive Nuclear Test Ban Treaty.

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