

Learning from Earthquakes

Preliminary Observations on the November 3, 2002 Denali Fault, Alaska, Earthquake

This report is based on data collected after the earthquake by a number of teams and individuals, and compiled by John Aho of CH2M Hill in Anchorage, Alaska. EERI wishes to thank the following for their contributions: Mark Yashinsky and John Eiding of the American Society of Civil Engineers/Technical Council on Lifeline Earthquake Engineering investigation team; John Aho, James Grey, Scott Simmons, and Ted Smith of the building damage assessment team; Robert Kayen, Nicholas Sitar, Gary Carver, Brian Collins, and Robb Moss of the National Science Foundation's geotechnical reconnaissance team; Gary Tindell, John Rezek, and John Prusak of the Alaska Department of Transportation; Tom Brooks of the Alaska Railroad; Eldon Johnson and James Roddick of Alyeska Pipeline Service Company; Keith Meyer of Michael Baker Jr., Inc.; and Peter Haeussler and Cindi Preller of the U.S. Geological Survey. Douglas Nyman of D.J. Nyman & Associates also offered valuable assistance with data gathering for this report. The research, publication, and distribution of this report were funded by National Science Foundation grant #CMS-0131895 as part of EERI's Learning from Earthquakes Program.

Introduction

At M_w 7.9, the Denali fault earthquake in Alaska was the largest strike-slip earthquake in North America in almost 150 years. Because of its remote location, the large earthquake resulted in no loss of life and relatively minor damage to the built environment, about \$90 million in direct economic losses to lifelines, and temporary economic disruptions of about \$60 million. (\$60 million of oil was not deliv-

ered to Valdez for the two days when the pipeline was shut down.) Nonetheless, studies of this earthquake will yield important insights into the processes and effects of large strike-slip earthquakes, such as those that occur in California. For example, it was the first earthquake in which a structure built to withstand the fault offset was tested—the Trans-Alaska Pipeline.

The earthquake created a ripple effect thousands of miles away. The passing seismic waves triggered a series of micro-earthquakes ($M < 3$) at the Geysers geothermal area in northern California and at Yellowstone National Park in Wyoming. In the New Orleans area (over 3,000 miles away) residents saw water in Lake Ponchartraine slosh about as a result of the quake. Similar observations were recorded in Seattle, Minnesota, Texas, and Louisiana. As far east as Pennsylvania and Georgia, USGS instruments recorded significant changes in ground-water level immediately following the earthquake. Minnesota and Wisconsin residents reported that water wells became turbid.

In the region of strong ground shaking can be found towns of a few thousand people each (Tok, Glenallen, Delta Junction), Athabascan villages of several hundred people each (Mentasta, Slana, Tetlin), and widely disbursed, single-family homesteads. There are no doctors or hospitals in the area of moderate to high ground shaking. Just one person was injured by the main shock, and one by an after-shock.

Geology

The chief geologic feature in the earthquake-affected region—the Alaska Mountain Range—was formed by subduction of the Pacific Plate. The



Figure 1 - Surface trace of Denali fault, 3 km west

resulting stresses have produced the southeast-trending Denali and Totschunda right-lateral faults (figure 1). The Alaska Range is slowly being eroded by glaciers that deposit silts and gravel onto the mountains' flanks. This material is further eroded by rivers and streams. Wind-blown loess blankets the hills in these river basins. Much of the silt is carried to valley floors, incorporated with organic debris, and subsequently frozen and occasionally thawed. In cold regions, a top layer of frozen soil (called permafrost) may remain frozen throughout the year. Where permafrost exists, the top several meters of soil may experience considerable temperature variation with depth.

At the time of the earthquake, the top foot (or so) of soil was frozen, but the underlying several feet (up to a few meters) of alluvial material remained thawed due to the unseasonably late onset of cold winter weather. This left the sandy soil vulnerable to ground shaking-induced liquefaction.

Seismicity

Fault System: The Denali fault is part of a system of faults in southern Alaska that accommodate colli-

sion of the Yakutat terrain into the cusp of southern Alaska (figure 2). The Yakutat terrain is a crustal fragment that used to lie offshore between southeastern Alaska and southern Vancouver Island. Around 25 to 30 million years ago, it began to collide with the continental margin, resulting in uplift of the eastern Chugach-Saint Elias Mountains. The Yakutat terrain is moving at 4.4 cm per year toward an azimuth of 323°, and the Pacific plate is moving beneath southern Alaska at a rate of 4.9 cm per year toward an azimuth of 349°. These velocities are similar, but the azimuths are significantly different. As a result of the collision, parts of southern Alaska are being extruded to the west and southwest.

The Denali fault is the largest of the active faults associated with the Yakutat collision. Its total length is 1,700 km, and about 1,140 km of the fault has evidence for Quaternary movement (figure 3). The Totschunda fault is a 210-km-long splay of the Denali fault at its eastern end that strikes more southeasterly and is parallel and aligned with the plate bounding the Queen Charlotte-Fairweather fault system. This relationship suggested to USGS workers in 1971 that the Totschunda is the more active fault and will eventually link up with the Fairweather fault. Subsequently, workers found that the magnitude of Quaternary river and glacier offsets was approximately the same on both the Totschunda and Denali faults, indicating the fault systems have been moving together for



Figure 3 - Canwell Glacier showing trace of Denali Fault in glacier ice



Figure 4 - View of Denali Fault trace at Gillett Pass

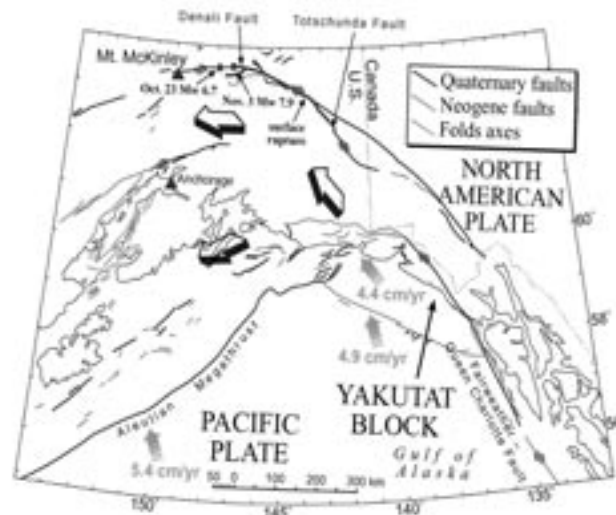


Figure 2 - Neotectonic Setting of Southeastern Alaska

some time.

Central-interior Alaska has many earthquakes despite its large distance from the plate margin. Numerous small earthquakes define a series of northeast-trending left-lateral strike-slip faults north of the Denali fault. These faults are probably responsible for three magnitude 7 earthquakes in the region in the last 100 years.

There have been no previous historic earthquakes unequivocally on the Denali fault. Nonetheless, the Denali fault (figure 4) has long been regarded as an active fault, and geotechnical studies in the early 1970s focused on the risk posed by the fault to construction of the Trans-Alaska Pipeline.

Ground Motions: The November 3 earthquake was preceded on Octo-

ber 23 by the Mw 6.7 Nenana Mountain earthquake. This event was also located on the Denali fault, 22 km west of the epicenter of the November 3 earthquake. It was also a right-lateral strike-slip earthquake, but there was no surface rupture. The November 3 earthquake began with a ~M7.2 thrust event at the epicenter. Rupture then progressed for about 100 seconds from west to east along the Denali fault, and then turned onto the Totschunda fault (figure 5).

Observations of surface faulting reveal that three faults ruptured: the Denali, the Totschunda, and the previously unknown Susitna Glacier fault. The total length of surface ruptures was about 335 km, which includes 224 km on the Denali fault, 69 km on the Totschunda fault, and 48 km on the Susitna Glacier fault (figure 6).

The Susitna Glacier fault splays off the western end of the Denali fault and had scarps up to 5 m high. Where it could be observed, the fault dips 10° to 25° to the north. This north-side upthrust fault is interpreted as the surface expression of the initial seismically inferred thrust faulting. Inferred average slip along the Susitna Glacier fault, based on the scarp height, was around 2 m. Slip along the Denali fault averaged about 5 m. The

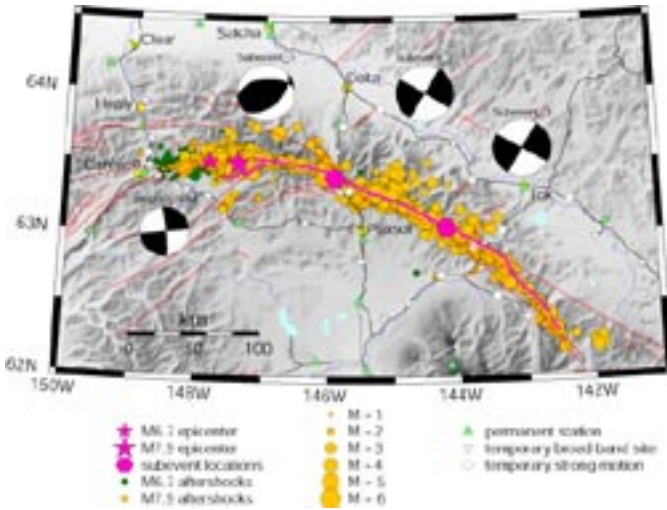


Figure 5 -
Seismicity map of Alaska

bar deposit appears to have failed.

Further east, for many kilometers around Northway and Slana, large continuous lowland areas of liquefaction and lateral spread failures were observed. Two measured transects along the Tanana River at Tetlin bridge showed 1.6% to 3.8% of lateral extension (spreading) of sand bars across distances of 200 meters (21 fissures) and 400 meters (48 fissures). Also, compression zones occurred in some places where separate lateral spreads collided.

In addition to the liquefaction observations, lake-ice cracking supported directivity effects on ground motion. Many lakes dot the region and were for the most part frozen at the time of the earthquake. Cracking of the surface ice due to ground shaking (figure 7) was prevalent over the entire region. Cracked lake ice was observed within 30-40 km of the fault along the western portion of the rupture, whereas the affected region was much larger toward the east where lake ice cracking extended out to approximately 100 km from the fault.

This was the second earthquake in which fault traces were observed to cut glacier ice. In some places, the equivalent of classic hard rock structures developed, such as restraining and releasing bends. In other locations, the fault trace paralleled medial moraines, indicating that the glacier ice fabric influenced



Figure 7 -
Lake ice cracking close to Denali and Totschunda faults

region with the highest offsets, locally up to 8.8 m, was just west of the junction with the Totschunda fault; this region also had the largest felt intensities and the most abundant liquefaction features. Slip along the Totschunda fault was 1 to 2 m. Inversions of teleseismic, strong motion, and GPS data all indicate a large amount of moment release on



Figure 6 -
Susitna Glacier thrust fault

the eastern end of the Denali fault, which is consistent with the surface observations.

Accelerations of about 0.35g and peak ground velocities of about 45 inches per second were recorded at Pump Station 10, which is located 3 km north of the fault trace. These accelerations and velocities are within the expected range of \pm one standard deviation from median expected motions for a location 3 km from a strike-slip event in an alluvial basin.

Geotechnical Effects

Liquefaction was widespread throughout eastern-central Alaska, and its pattern suggests that the directivity of rupture amplified motions towards the eastern region. Liquefaction and related ground deformations, both derivative features of the event, noticeably increased in severity and spatial extent towards the east end of the Denali-Totschunda fault rupture area. Sparse sand vents and lateral spreads on bars of the western Tanana River, from Fairbanks to Delta, became pervasive to the east.

For the four glacier-proximal rivers draining toward the north, little or no liquefaction was observed on the western Delta and Johnson Rivers, whereas the eastern Robertson and Tok Rivers and especially the Nabesna River had observable-to-abundant fissures and sand vents.

On the north side of the Alaska range in the Tanana River Valley, extensive liquefaction was observed where very young river deposits were capped by a thin (<0.3m) frozen surface layer at source distances of 50 to 120 km. Tanana River Valley liquefaction was widespread from Fairbanks in the west, to at least several hundred kilometers eastward. Liquefaction damage became increasingly severe to the east of Delta Junction, even as the distances to the fault increased. In the Tok region, nearly every river

the observed surface rupture. There was an unusually small amount of snow on the ground for early November and, as a result, cracks that developed along the fault trace were easily seen.

Rockfalls and landslides straddle the trace of the Denali and Totschunda faults. The most abundant large landslides were along the Black Rapids (figure 8), Canwell, and Gakona glaciers. The largest was on the northeastern side of Mount McGinnis, estimated at 20-40 million cubic meters of material. The landslides appeared to be unusually focused on the mountainsides adjacent to the surface trace of the faults, and were not spread over a wide area. The topography is not as steep along the eastern end of the rupture zone, so it is difficult to compare the landslides of the western and eastern parts of the surface rupture.

Utilities and Pipelines

With a few exceptions, only slight damage occurred to buried lifelines, largely because they were located some distance away from the earthquake. Alyeska (the operator of the Trans-Alaska Pipeline) decided to close the pipeline at about 2:00 p.m., while 11 crews completed their inspections and initiated repairs. All repairs were made quickly and the pipeline was reopened 66 hours later.

The Alaska Power and Telephone



Figure 8 - View of East Algon slide of Black Rapids Glacier

Company, the Copper Valley Electric Association, and the Golden Valley Electric Association all sent out linemen to inspect equipment. Minor repairs are expected to continue into the spring.

Trans-Alaska Pipeline System

(TAPS) Performance: Design-level earthquakes rarely occur during the lifetime of a project, but this earthquake approached design criteria for a section of the pipeline system. TAPS was designed to accommodate the severe natural hazard environment of Alaska, including the presence of permafrost and the effects of great earthquakes. The 1287-km-long (800-mile) pipeline is placed above-ground for 676 km (53%) of its route to avoid locations of unstable permafrost. This unique pipeline design accommodates 6.1 m (20 feet) of horizontal and 1.5 m (5 feet) of vertical fault displacement at the fault crossing, using extra-long cross beams placed on the ground and extra-long sliding shoes (figure 9).

Outside the actual 1,900-foot-long fault crossing zone, the pipeline is constructed in both an above-ground mode and a conventional buried mode. Pump Station Number 10, located approximately 3 km to the north of the fault crossing, is currently non-operational. Several valves, pipeline appurtenances, roads, bridges, communication sites, and other related facilities are located near the fault. This earthquake thus afforded a test



Figure 9 - Pipeline location pre-earthquake (left) and post-earthquake (right)

of many aspects of the pipeline's capacity to withstand large earthquake effects.

The Denali fault intersects the pipeline as it passes through the Alaska Mountain Range at milepost (MP) 588 (from Prudhoe Bay) in the vicinity of its Pump Station Number 10 (figure 10). There were maximum ground accelerations of about 0.35g and ground velocities of about 45 inches per second recorded along the pipeline right-of-way about 3 km north of where the pipe crosses the fault. The horizontal fault rupture offset was nearly 3 m at the fault trace, with a total displacement of about 4 m distributed across the fault zone. A 0.5 m downward displacement of the south fault block was also noted at the pipeline fault crossing. Maximum horizontal surface fault displacements were nearly 9 m at a location approximately 120 km southeast of the pipeline crossing.

Preliminary review of the ground motion and fault rupture data for the earthquake indicates that this event was remarkably consistent with the design earthquake postulated for this segment of the pipeline route. It has been estimated that the M7.9 event has a recurrence interval of 600 years, which compares closely with the approximate 500-year recurrence inherent in the TAPS seismic design criteria.

The pipeline withstood the fault rupture and associated ground shaking with

dam-age to the pipe
 e oil,
 s inci-dental damage to
 d sup-port hardware.
 was shut down for 66
 ections and repairs.
 umber
 ing sup-
 ports was required to
 restore the fault movement capacity
 to an additional 2 m strike slip,

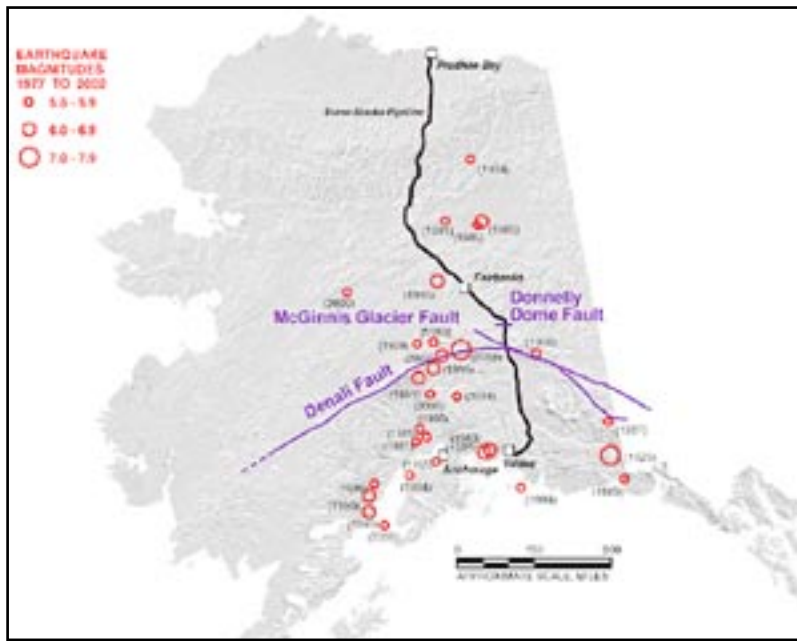


Figure 10 - TAPS pipeline alignment

which accommodates estimates of fault displacements that can reasonably be expected in the short term if further activity occurs on the fault.

Ground motions measured at a distance of about 3 km from the fault slightly exceeded the TAPS seismic criteria at periods longer than about 1.0 second and generally approached design criteria at shorter periods. Thus, the ground motion at this location provided a test of the pipeline design for ground motions essentially equivalent to those considered in the original design analyses. The duration of strong shaking was approximately 100 seconds, undoubtedly contributing to liquefaction of subsurface deposits along the pipeline route evidenced by numerous sand blows. In some areas in proximity to the Denali fault crossing, there were moderate lateral spread movements. Landsliding did not occur along or across the pipeline right-of-way, although there were a number of landslides and rockfalls along the highways in the area and along the east-west trending fault trace.

The long-period nature of the ground motion, which produced

a maximum ground velocity of approximately 114 cm/sec (45 inches per second), coupled with possible liquefaction along the pipeline right-of-way, could have caused bending and axial strain in the buried pipeline. The pipeline was excavated at a location where surface ground movement was apparent, but there was no evidence of damage in the form of wrinkling or buckling of the pipe. Approximately one month after the earthquake, the pipeline was inspected in-line using a curvature-monitoring and deformation-monitoring “smart pig.” The pig data showed no evidence of deformation, increasing pipe strain, or exceeding of curvature limits, even in the areas with observed liquefaction.

The earthquake provided a “live” test of the Trans-Alaska Pipeline System earthquake emergency response plan. The plan consists of an Oil Spill Contingency Plan coupled with an Incident Command System (ICS). ICS provides an emergency management structure for pipeline system emergencies, road and highway closures, commercial power outage, loss of communications, and general disruption, including oil spills. In the event of an earthquake, particular emphasis

has been given to reconnaissance of potential faulting, liquefaction, and landslide areas, including the evaluation of the pipeline for excessive strain conditions or wrinkling. The plan anticipates the type and distribution of damage and provides for an adequate inventory of replacement pipe, repair sleeves, and spare parts to minimize interruption of operations. Personnel are periodically trained for postearthquake response and recovery.

As an integral part of the post-earthquake emergency response capability, an earthquake monitoring system (EMS), has been included as part of the pipeline control system since the start-up of the crude oil pipeline operation in 1977. The EMS was developed pursuant to federal and state government requirements and consists of 11 remote digital strong-motion accelerometer (DSMA) stations distributed over the 800-mile pipeline route. The earthquake triggered six of the 11 stations into an alarm status. The EMS automatically processed ground-motion data immediately after the event to evaluate the severity of ground shaking along the pipeline route, and to assess the potential for damage to the pipeline and supporting facilities. The most important objectives of this assessment are to determine the need for a pipeline shut-down and to delineate inspection requirements for the affected portion of the route. The use of a comprehensive and focused field inspection effort based on estimates of ground-motion shaking severity allowed the pipeline operation to resume after a 66-hour shutdown.

Transportation Systems

Roads, bridges, airports, and other transportation infrastructure were damaged during the earthquake due to poor soil, strong shaking, and proximity to the fault rupture. Figure 11 shows the location of the most serious damage. About \$30

million in emergency repairs were carried out immediately after the earthquake, but more work (perhaps at an equal cost or higher) will have to be done in the spring after the soil thaws.

Highways: The highway system was not specifically designed to accommodate or mitigate the effects of fault offset, ground shaking, or liquefaction, and sections of it suffered greatly. Several of the longer bridges had transverse shear keys, and newer bridges were designed using the AASHTO seismic criteria current at the time. It is unusual to see single-span bridges so severely damaged that they need to be replaced. Engineers are familiar with the settlement, loss of bearing capacity, and lateral spreading of poorly compacted, fine-grain soil. However, these effects are more pronounced, more difficult to repair, and more difficult to mitigate when they occur above permafrost or in seasonally frozen soils.

The Alaska Department of Transportation (ADOT) sent out two teams to inspect bridges on the Richardson Highway and the Tok Cutoff Highway on November 4 (a third team went out on November 5). Emergency repairs were initiated by maintenance crews, and traffic was allowed back on the Richardson and Alaska Highways on Monday, November 4. The Tok Cutoff was reopened to one-way traffic using pilot vehicles

on Tuesday, November 5, and the emergency repairs were completed on December 20. Emergency repairs to the Northway Road were expected to continue until January 15, 2003.

The Richardson Highway suffered cracking and slumping damage at several locations between MP 197 and 216.7. Approximately 2200 feet of the roadway at MP 216.3—where the Denali fault crosses the road—were completely destroyed as the ground slumped and cracked on the grade south of the bridge. There was a lateral shift of about 8 feet, with the south side finishing 2 feet lower than the north side. The cracking and slumping was confined to about 600 feet, but realignment of the roadway tangent between curves will be required to correct the lateral offset (figure 12).

On the Tok Cutoff between MP 44 and MP 98, the most significant damage occurred near the Slana Slough bridge (at MP 75.5 to MP 77.2) and where the Denali Fault crosses the highway (at MP 80.2 and 82.6). The roadway was essentially destroyed in those areas (figure 13), requiring extensive work by state maintenance forces to open a lane through the damage.

Highway Bridges: About 300 of Alaska's 1,000 highway bridges are located in the area of strong (>0.10g) ground shaking. The longer spans are through-trusses, while shorter

spans are steel or precast concrete girders. These bridges were built from the 1940s to the 1990s and follow the American Association of State Highway Official (AASHTO) bridge design specifications that were current at the time. This means that the seismic design for most bridges was a small (6%) lateral load until the Applied Technology Council's ATC-6 report was adopted by AASHTO in the 1980s. Although many bridges were damaged and several will have to be replaced, all bridges continued to carry traffic after the earthquake (a few with load restrictions).

Both the Mabel Creek Bridge (at MP 76.3 of the Tok Cutoff) and the Slana Slough Bridge (at MP 75.8) are 41-ft-long precast, prestressed concrete "T" girder bridges with steel sheet pile abutments, built in 1979. The embankments settled several feet, and the top of the sheet pile abutments rotated backward (figure 14). Both bridges will be replaced.

There was remarkable damage to a steel culvert on the road to Mentas-



Figure 11 - Damage to transportation infrastructure from the Denali fault earthquake



Figure 12 - Fault offset on Richardson Highway



Figure 13 - Liquefaction-induced lateral spreading on Tok Cutoff

ta. The culvert showed excessive ovalization, changing the original circular cross section into a near-figure 8. Still, the road was kept in service over the damaged culvert.

Airports: There are dozens of airports in the area of strong shaking. The lack of roads and the large distances make air travel a necessity in Alaska. An airport near Northway suffered severe damage. Originally built during World War II, the airport complex included a 5,100-ft-long paved runway, an apron, runway lights, VAS lights, an FAA weather



Figure 14 - Embankment movement

station, a fueling facility, a separate ski strip, a fire station and a small hotel and restaurant. During the earthquake, the soil liquefied (figure 15), causing large cracks to split the runway (figure 16). A \$10 million temporary fix was made. Due to the cold weather, the pavement could not be reinstalled, and the runway will require more work in the spring when the soil thaws.

Railroads: The Alaska Railroad (ARR) has almost 500 miles of track from Seward to Fairbanks. Because the ARR was some distance from the rupture, and because the direction of faulting propagation was away from the ARR, the railroad suffered relatively modest damage from this earthquake. The track was inspected immediately after the earthquake by track supervisors and foremen. Most bridges received an initial inspection from track personnel; major bridge structures were examined by a bridge foreman

or supervisors, as needed. Operations were resumed later the same day (with speed restrictions placed at two locations). Immediate repairs included rolling a few rocks out of the way in slide zones (although no large slides were triggered, and no heavy equipment was needed to clear the tracks) and touching up one area of subsidence at MP 377.5 (15 miles north of Healy).

Community Impacts

Alaska has a population density of one person per square mile (the U.S. average is 74 persons per square mile). Alaskans consider themselves to be self-reliant and tend to look with disfavor on big government. Some local people look with disdain on having telephone service in one's home. About the only public entity viewed with favor is the Alaska Department of Transportation (ADOT), which is responsible for most of the state's roads, bridges, and airports. There is only one road from Canada to Alaska. Within Alaska, many roads are simply closed during the long, hostile winters.

The economy in the area of impact is based primarily on subsistence and seasonal activities such as hunting, fishing, and trapping. Many residents operate on the cash or barter system. Tok and Glennallen host small University of Alaska community colleges. Glennallen's non-denominational missionary college, SEND International, has substantial influence throughout the region. It owns and operates the region's only health clinic, emergency medical services, and local radio



Figure 15 - Sandboils in apron

station. Radio signals from Valdez, Anchorage, and Fairbanks can also be heard. Emergency medical services are available in Tok. Almost every community has at least one airstrip. The Ahtna Native Corporation, located in Glennallen, has a presence in the communities south of the fault, while the Upper Tanana Inter-Tribal Coalition influences several of the northern communities, including Tetlin, Tok, and Northway.

The earthquake had a positive effect on the economy, bringing unexpected income to local residents, primarily from ADOT. The earthquake also lured some people out of their solitude and into their communities, if only temporarily.

Building Performance: The communities of Slana and Mentasta felt the shaking strongly. Many people moved out of their houses, fearing the worst was not over. One local resident stated that "after a week of aftershocks, I am still sleeping on the office floor by the door. I don't plan on moving back to my bed in the loft 'til the earth quits rocking." Damage assessments were conducted in the villages of Mentasta, Tetlin, Tanacross, Mineral Lakes, Chistochina, Slana, Gakona, and the town of Tok. The structures in the communities examined were predominantly single story and of wood frame or log construction. The houses that were damaged were supported directly on the ground on timber foundations, or above ground on timber piling. Typical damage involved failure at the connection between floor beam and foundation



Figure 16 - Cracks in runway



Figure 17 - Tetlin community building foundation damage

(figure 17). In general, damage to buildings was minimal when compared to what might be expected from an earthquake of this magnitude because of the ductile behavior of log residences.

Most houses had interior nonstructural damage such as cracked gypsum wallboard, separation at non-load-bearing wall intersections, and some floor deformation. In addition, there was evidence of built-in cabinetry and equipment separation from wall surfaces. Overturned appliances and spilled cupboard contents were also a problem, and while they did not prevent re-occupancy of the homes, they required cleaning up (figure 18). Even though the damage to homes was not extensive, most of the residents have neither extra money nor the ability to obtain a line of credit or a loan, so making any kind of repairs will be difficult.



Figure 18 - Spilled contents in residence

There were a few pre-engineered steel-frame structures in the communities affected by the earthquake, but they were essentially undamaged by the shaking. In Mentasta, recommended repairs included tightening steel frame lateral bracing rods and checking base plate column bolts for tightness.

The school at Mentasta performed well during the earthquake, but did suffer damage to ceiling tiles, the



Figure 19 - Historic log structure at Gakona Lodge



Figure 20 - Mentasta interior damage

gymnasium ceiling grid, and gypsum wallboard. There was minor floor deformation, and some movement at a beam-to-column connection in the library area. The school was re-occupied immediately after the earthquake.

There was major damage at the Mentasta Lodge, estimated at \$500,000, and also a partial collapse of a historic log structure at Gakona Lodge (figures 19 and 20).

Emergency Response: The only injury from the main shock was to an elderly woman in Mentasta Village, who broke her arm while climbing down the stairs. She was driven to a local clinic and treated. A linesman for Alaska Power and Telephone (AP&T) was knocked off a ladder by an aftershock while cleaning snow off power distribution lines. He was seriously injured and had to be driven to Delta Junction.

There were no reported fire ignitions caused by the earthquake. Tok Fire Chief Tony Conrad reported a fire on December 5 caused by an aftershock. An illegally buried propane tank had a line break that poured propane into a home, and a pilot light was apparently the source of ignition. The house burned to the ground and toxic fumes from urethane insulation sent six firefighters to the hospital. (Tok provides fire fighting for most of the region with six vehicles with water or foam tanks.)

Damage assessment teams were in place by November 7 and initially concentrated on assessing damage to schools, public facilities, and State of Alaska infrastructure. There were also numerous requests from residents in the affected communities for inspection of their homes. Many residents would not return to their homes until these inspections took place.