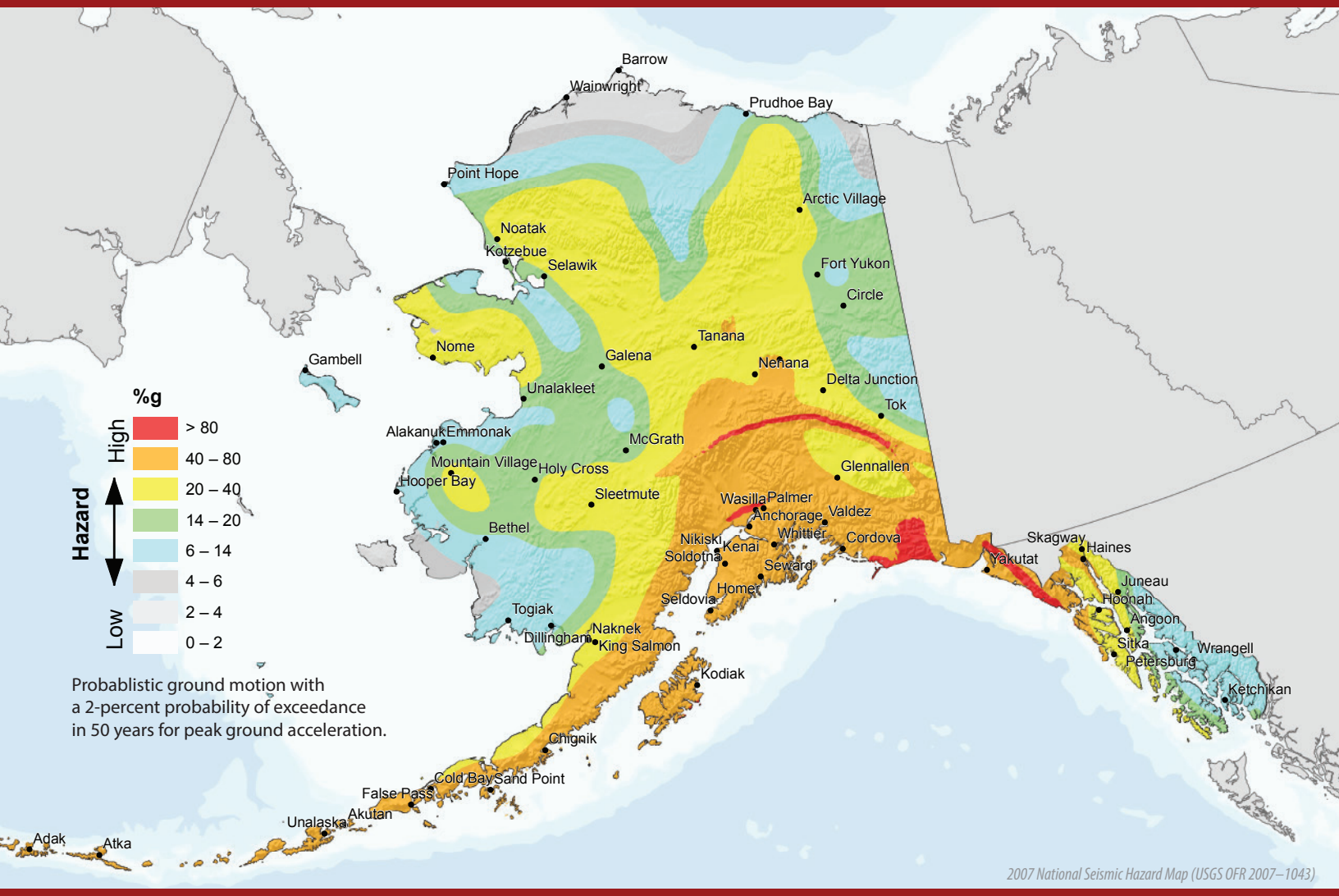
Are you prepared for the next big

EARTHQUAKE

in Alaska?



2007 National Seismic Hazard Map (USGS OFR 2007–1043)

Take action now to reduce future losses from earthquakes.

FLASH · ALASKA EARTHQUAKE CENTER · ASHSC Alaska Seismic Hazards Safety Commission · USGS science for a changing world · FEMA · WSSPC Western States Seismic Policy Council

WHY YOU NEED TO PREPARE FOR THE NEXT EARTHQUAKE

Scientists have long recognized that Alaska has more earthquakes than any other region of the United States and is, in fact, one of the most seismically active areas of the world. The second largest earthquake ever recorded shook the heart of southern Alaska on March 27, 1964. The largest strike-slip earthquake in North America in almost 150 years occurred on the Denali fault in central Alaska on November 3, 2002. “Great” earthquakes (larger than magnitude 8) have rocked the state on an average of once every 13 years since 1900. It is only a matter of time before another major earthquake will impact a large number of Alaskans.

Alaska has changed significantly since the damaging 1964 earthquake, and the population has more than doubled. Many new buildings are designed to withstand intense shaking, some older buildings have been reinforced, and development has been discouraged in some particularly hazardous areas. Despite these precautions, future earthquakes may still cause damage to buildings, displace items within buildings, and disrupt the basic utilities that we take for granted. We must take every reasonable action to prepare for damaging earthquakes in order to lower these risks.

Preparedness for earthquakes and other natural disasters is both a collective and an individual responsibility. As a society we have created agencies and organizations to assess, monitor, and respond to various threats from natural disasters. The Alaska Division of Homeland Security and Emergency Management (DHS&EM) is responsible for providing Alaskans with earthquake preparedness information and training. The Alaska Earthquake Center (AEC), the UAF Geophysical Institute (UAF-GI), the U.S. Geological Survey (USGS), the Alaska Division of Geological & Geophysical Surveys (ADGGS), the National Oceanic Atmospheric Administration National Tsunami Warning Center (NTWC), the Alaska Seismic Hazard Safety Commission (ASHSC), and the Federal Emergency Management Agency (FEMA) work together to provide data and information to the public and to local, state, and federal authorities for use in earthquake hazard mitigation and response. This alliance of agencies carries out our collective effort to understand and prepare for earthquake disasters.

As individuals, we must also take steps to prepare for earthquakes in order to protect ourselves, our loved ones and our property. By identifying the greatest hazards to our personal safety, we can set priorities for using our resources effectively to reduce possible damage. By becoming aware of the hazards posed by earthquakes, and by taking appropriate actions such as those described in this pamphlet, we can drastically reduce the loss of life and property and make Alaska a safer place to live. The choice is ours.

Earthquakes in the United States with magnitudes of 5 or greater, 1995-2015. Eighty-five percent of these 877 earthquakes occurred in Alaska.

WHAT TO DO DURING AND AFTER AN EARTHQUAKE

The first reaction many people have during an earthquake is to run out of a building. This increases the likelihood that you will be hit by falling objects. Most earthquake-related injuries in the United States occur in this way. The most serious injury sustained during the November 2002 Denali fault earthquake occurred when a woman slipped and broke her arm while exiting her home. In the past, it was recommended that you stand in a doorway during an earthquake. This is not the best place to go because only one person can fit in a doorway, and you won't be protected from falling and flying objects. A woman was trapped in a doorway during the Denali fault earthquake when the door slammed shut on her hand. This not only injured her but also stopped her from taking cover from falling objects.

- If you are indoors, DROP to the floor, COVER your head and neck with your arms while seeking shelter under a sturdy desk or table, and HOLD ON to it and be prepared to move with it. Hold the position until the ground stops shaking and it is safe to move. If you are in a crowded area, take cover where you are. Stay calm and encourage others to do likewise.
- If you are outside, get into the open, away from buildings and power lines.
- If you are driving, stop if it is safe to but stay inside your car. Stay away from bridges, overpasses and tunnels. Move your car as far out of the normal traffic pattern as possible. Avoid stopping under trees, light posts, power lines, or signs. Stay inside the vehicle until the shaking is over. If a power line falls on the car, stay inside until a trained professional removes the wire.
- If you are in a mountainous area, or near unstable slopes or cliffs, be alert for falling rocks, snow, and other debris that could be loosened by the earthquake.
- If you are near the ocean, drop, cover, and hold on until the shaking stops. If severe shaking lasts twenty seconds or more, immediately evacuate to high ground as a tsunami might have been generated by the earthquake. Move inland two miles or to land that is at least 100 feet above sea level immediately. Don't wait for officials to issue a warning. Walk quickly, rather than drive, to avoid traffic, debris, and other hazards.
- If you are unable to drop, cover, and hold on: If you have difficulty getting safely to the floor on your own, get as low as possible, protect your head and neck, and move away from windows or other items that can fall on you.
- In a wheelchair, lock your wheels and remain seated until the shaking stops. Always protect your head and neck with your arms, a pillow, a book, or whatever is available.

For more information on safety actions for people with disabilities and other access and functional needs, visit *http://www.earthquakecountry.org/downloads/ShakeOut_Earthquake_Guide_Disabilities_AFN.pdf.*

EARTHQUAKE SAFETY CHECK

Check for injuries: Do not move a seriously injured person unless they are in immediate danger of further injuries.

Gas leaks: Shut off the main gas valve only if you smell natural gas, hear gas escaping, or suspect a broken gas pipe, vent, or flue. Wait for the gas company to turn it back on after the damage is repaired.

Oil or propane tanks: Check that the supports are intact and that connecting pipes and hoses are not broken.

Downed or damaged chimneys: Approach chimneys with caution. They may be weakened and could topple during an aftershock.

Damaged electrical wiring: Shut off power at the distribution panel or breaker box.

Downed or damaged utility lines: Stay away from downed lines even if power appears to be off.

Fallen objects in closets and cupboards: Displaced objects may fall when you open the door.

Check your telephone: Make sure each phone is on its receiver. Update your out-of-area contacts, then keep telephone lines clear for others. Emergency responders need to use phone lines for lifesaving communications.

Clean up: Clean up potentially hazardous materials and/or medicines which may have spilled.

Tsunami hazard: If you live along the coast, be alert for tsunami warnings issued by the National Tsunami Warning Center or community officials. Most Alaska communities that are at risk for tsunamis use sirens to broadcast warnings. However, if you experience a strong or long-lasting earthquake, there may not be time for a warning to be issued. Move inland or to higher ground as soon as you can, and stay there until the authorities indicate it is safe to return.

Expect aftershocks: The only time that we know earthquakes will occur is after another large earthquake. Most aftershocks are smaller than the main earthquake, but some may be large enough to do additional damage to weakened structures.

CHILDREN AND EARTHQUAKES

Earthquakes are traumatic events for all of us, but they are especially frightening for children who may be forced to leave their homes and everything that is familiar to them. A child does not usually understand such events and feels anxious, confused, and frightened. Fear is a normal reaction to any danger which threatens life or well-being. After an earthquake, a child's fears are those of recurrence, injury, death, or of being alone and separated from the rest of the family. Aftershocks can increase these fears. Parents sometimes ignore the emotional needs of a child once assured of their physical safety. A child's persistent fears may generate disruptive behavior, surprising and frustrating a parent who is trying to continue with the daily family routine.

HOW A PARENT CAN HELP:

- **Keep the family together. This provides immediate reassurance to a child; fears of being abandoned and unprotected are alleviated.**
- **Reassure children with words as well as actions. Emphasize the positive: "We are all together and nothing has happened to us," or "You don't have to worry, we will look after you."**
- **Encourage the child to talk. It can also be helpful to include other family members, neighbors, and their children in a conversation about our reactions to the earthquake.**
- **Include the child in family activities. There will be important concerns and things to do after an earthquake, such as checking on the damage and cleaning up broken glass and fallen furniture. Whenever possible, a child can and should be included in these activities.**

At bedtime, a child may have difficulty falling asleep. They may wake up during the night or have nightmares for weeks or months after the earthquake. These situations may be dealt with by allowing the child to move into a room with another child or to sleep on a mattress in the parents' room, or simply by a parent spending a little extra time in the child's room giving reassurance.

Use flashlights or battery-powered lanterns. Do not use lighters, matches, candles, or gas lanterns until you are sure that there are no gas, propane or oil leaks.

Use your telephone only in the event of life-threatening emergencies.

Turn on a battery or crank-powered radio for information, damage reports, and for information on volunteering your assistance.

Keep streets clear for emergency vehicles. Cooperate with public safety officials.

In 1964, two people were killed by falling concrete outside the J.C. Penney building in downtown Anchorage.

HOW TO PREPARE FOR AN EARTHQUAKE

Most people in Alaska should survive the next big earthquake with little loss. However, some people may be severely affected. Actions you take now can reduce injuries and property loss.

PRACTICE "DROP, COVER, AND HOLD ON" DRILLS AT HOME WITH YOUR FAMILY AND AT WORK.

- Most injuries and deaths in the U.S. during earthquakes are caused by falling objects. Knowing how to protect yourself when the shaking starts may save your life. Show children safe areas to Drop, Cover, and Hold On.

DEVELOP AN EARTHQUAKE PLAN AT HOME, IN YOUR NEIGHBORHOOD, AT SCHOOL, AND AT WORK.

- Determine the safest places in your home and at work. These should be away from heavy furniture or appliances, woodstoves, fireplaces, open shelves and bookcases, kitchen cabinets, large panes of glass, windows and doors, pictures, or mirrors.
- If an earthquake occurs during the day, family members may be separated for hours or days. Plan ahead and select a safe place where you can reunite after the earthquake. Consider your family's possible needs and select alternative locations to meet near places of work or school.
- Find out the policy of your local school concerning the release of children after an earthquake.
- When communicating with family and friends after an earthquake, remember to text first and talk second. Text messages can be received and sent using less bandwidth than telephone calls. Consider teaching family members short messages to text, e.g. "I am ok."
- Identify an out-of-area contact rather than a local one to coordinate family contact. All family members should call or text this person and tell them where they are. Everyone must know your contact's phone number.
- The most common cause of earthquake-related fires are broken gas lines. Everyone should know how to turn off the gas supply at the meter. Buy a special wrench that fits your gas turnoff valve and fasten it next to the valve. You should only turn off the gas if there is evidence of a leak, such as hearing it (the hissing), smelling the gas (rotten egg smell), or seeing visible damage, e.g. a broken supply line to a gas appliance. If a leak is suspected, evacuate the area.
- Arrange with neighbors to watch out for your family and property in case you are not at home.
- Every business should have an emergency response plan.

PICK TWO PLACES TO MEET

(1) Right outside your home.

(2) Outside your neighborhood in case you are not able to return home. Everyone must know the address and telephone number.

FILL OUT, COPY, AND DISTRIBUTE TO ALL FAMILY MEMBERS

EMERGENCY MEETING PLACE (OUTSIDE YOUR HOME) _____

MEETING PLACE (OUTSIDE YOUR NEIGHBORHOOD) _____ PHONE _____

ADDRESS _____

_____

_____

FAMILY CONTACT _____

PHONE (HOME/WORK) _____ PHONE (CELL) _____

EMERGENCY SUPPLY LIST

Keep enough supplies in your home to meet your needs for at least seven days. Store these items in sturdy, easy-to-carry containers such as backpacks, duffel bags, plastic bags, or covered trash containers. These are the basics to have on hand for any emergency:

Flashlights with spare batteries: Keep a flashlight beside your bed. Do not use matches, candles, or gas lanterns after an earthquake until you are certain no gas leaks exist.

Hand-crank or battery-operated radio with spare batteries: Most telephones will be out of order or in use for emergency purposes, so radios will be your best source of information. An automobile radio is a good substitute.

First aid kit and first aid knowledge: Have a first aid book such as *First Aid & Emergency Preparedness* by the American Red Cross. Have members of your household take basic Red Cross first aid and CPR courses.

Fire extinguisher: Keep a fire extinguisher handy for small fires. Some extinguishers are only good for certain types of fires–electrical, grease, or gas. Class ABC extinguishers are designed to be used safely on any type of fire.

Food: It's a practical idea to keep a supply of non-perishable food on hand that can be rotated into your diet and replenished on a regular basis. Have a supply of canned or dehydrated food, powdered milk, and canned juices that is sufficient for at least seven days.

Water: Water should be stored in airtight containers and replaced every six months. Store at least three gallons per person. For water not treated by a commercial facility, add 16 drops or ¼ teaspoon of household bleach per gallon of water. Stir and let stand for 30 minutes. Use bleach that has 5.25% hypochlorite as the only active ingredient, with no fragrance and soap additives. Do not store in used plastic milk containers because bacteria may be present.

Warm clothes and blankets: Have enough warm clothes, blankets, and sleeping bags to survive sub-zero winter temperatures. If possible store these items outside of the home so they will be accessible after a rapid evacuation. Also, consider indoor heating options such as wood stoves, generator-driven heaters, and handwarmers.

Special items: Keep at least one week's supply of medications and special foods on hand that are needed for infants or for those on limited diets.

Tools: Have a pipe wrench and an adjustable wrench for turning off gas and water mains.

Pet Care: Have at least a two-week supply of dry food in water-tight container or canned food (include a manual can opener) and at least a two-week supply of clean water – large dogs need one gallon per day. Medications such as flea and tick preventative or heartworm preventative and any prescription medicines should be included.

EMERGENCY BROADCASTS AFTER AN EARTHQUAKE

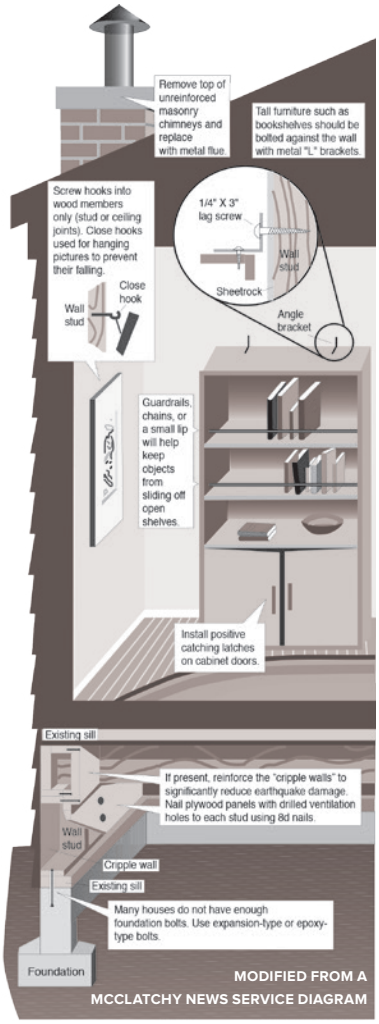
Monitor radio and television channels for emergency broadcasts after an earthquake. Have a hand-crank radio available in case you lose power. Remember that initial news reports may be inaccurate. Don't believe everything you hear. Pay particular attention to information from a governmental source.

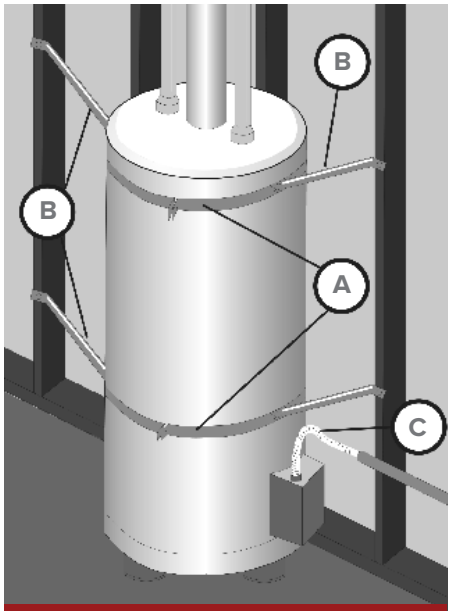
The first information about a large local earthquake may come from the Alaska Earthquake Center, the USGS, the State of Alaska Department of Geological & Geophysical Surveys or from the NOAA National Tsunami Warning Center www.wcatwc.arh.noaa.gov. Initial estimates of location and magnitude of an earthquake are likely to be revised as more information is analyzed.

PROTECT YOUR BELONGINGS

Falling objects and toppling furniture present the greatest physical danger and the biggest potential financial loss for most people. Even a relatively small earthquake can violently empty your kitchen cabinets. At home, at work, and in schools, building contents should be secured.

- Secure or remove heavy items, such as pictures or mirrors, that can fall on your bed, where you typically spend a third of each day.
- Secure tall furniture and bookcases to the wall. Add lips to shelves to prevent costly items from sliding off. Be sure that adjustable shelves cannot slide off their supports.
- Put strong latches on cabinet doors. Fasten heavy or precious items to shelves or tables. Secure file cabinets, computers, televisions, and machinery that may overturn during an earthquake.
- Store potentially hazardous materials such as cleaners, fertilizers, chemicals, and petroleum products in appropriate containers in sturdy cabinets that are fastened to the wall or floor.
- In your office, fasten heavy objects to the building structure and not just to a movable wall. Ask a carpenter or an electrician to check light fixtures and modular ceiling systems.
- Fasten your water heater to the wall studs and connect gas heaters and appliances to the gas pipe through flexible tubing. If you use propane or heating oil, be sure the storage tank is secured against overturning and sliding.
- Secure your woodstove to wall or floor studs. Make sure you have a fire extinguisher close at hand.
- Check with school officials to be sure they have taken similar precautions in your children's school buildings.





Wrap a 1½" wide, 16-gauge-thick metal strap (A) around the top of the water heater and bolt the ends together. Do the same about 1/3 of the way up the side of the water heater. Take four lengths of EMT electrical conduit, each no longer than 30". Flatten the ends. Bolt one end to the metal strap (B). Screw the other end to a 2" by 4" stud in the wall using a 5/16" by 3" lag screw. Be sure a flexible pipe (C) is used to connect the gas supply to the heater.

Many specialty earthquake fasteners are commercially produced. Check with your hardware store for products, or ask your local emergency management office for the names of products and vendors. Searching the internet for "earthquake fasteners" will also yield many results. FEMA's website, www.fema.gov, contains much information about preparing for earthquakes.

FUEL TANK SUPPORTS AND EARTHQUAKES

The use of raised fuel tanks to provide gravity flow to oil heaters is common throughout Alaska. During the Denali fault earthquake on November 3, 2002, several 300 gallon fuel tanks tipped off or slid from their supports, demonstrating their vulnerability. By strengthening fuel tank supports and connectors to withstand ground shaking, the risk of damage, hazardous spills, and the loss of heating oil can be reduced. Once the structure is built, regular inspection is recommended to ensure structural integrity.

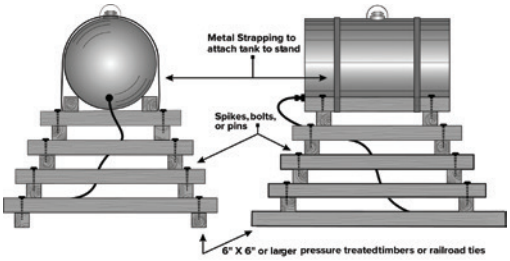
A wood support is vulnerable to damage due to deterioration or inadequate cross-bracing and fastening. It should be inspected for rot damage, and any deteriorating wood supports should be replaced. Existing wood supports with cross-bracing, or insufficient bracing, should have diagonal bracing and gussets added to strengthen the support. Utilizing wood-to-wood connecting plates, bolts, lag screws, and nails can help to reduce vulnerability, but their effectiveness is limited by the tendency of wood fibers to split and tear when subjected to large loads.

CRADLE SUPPORT

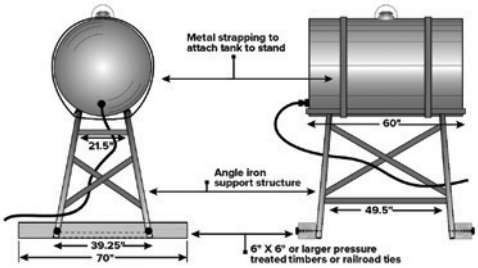
- A timber cradle support is a safe and affordable wood support option. Strength and stability are provided by the broad base and the criss-cross stacking fashion of the timbers. The timbers need to be pressure treated and should be 6-inches by 6-inches or larger. Each layer is spiked to the one below with large spikes, pins, or bolts that are driven into pre-drilled holes to prevent splitting. The tank is strapped to the cradle with two steel bands (a special banding tool is required).

STEEL SUPPORT

- A steel support system is available when purchasing a tank from a fuel company. The steel support's angle iron construction and welded joints provide rigidity and strength to resist gravity loads and mild shaking. Steel supports with a wide footprint will have increased stability. Some steel supports may not have adequate diagonal bracing. Retrofitting may be needed to withstand strong lateral motion during an earthquake. Stability can also be improved by securely bolting the steel support to 6-inch by 6-inch pressure treated wood timbers or railroad ties on the ground. Steel banding to tie the tank to the support is another important retrofit.



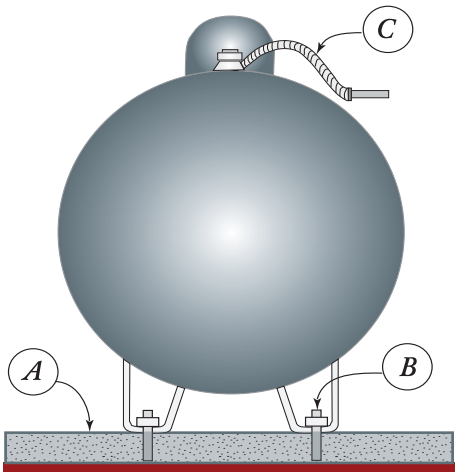
This diagram illustrates how to build a wood cradle that is likely to withstand large earthquakes. The design uses commonly available items and can be built by most people. This stand is designed to support the average size fuel tank (300 gallons) at a typical height of 4'.



This diagram illustrates how a steel tank support can be improved to withstand large earthquakes. These supports are commercially fabricated using welded angle iron, and they typically support 300 gallon tanks at heights of 3' to 5'. A wider base, and bolting the support to pressure treated timbers, provides more stability.

PROPANE TANKS

Many residents in rural areas of Alaska use above-ground propane tanks. These tanks may move, slide, or topple during strong ground shaking. Gas leaks are frequently the cause of earthquake-related fires. The following recommendations can be followed to reduce the post-earthquake fire hazard associated with propane tanks.



Mount the tank on a 6” thick concrete pad (A) using four ½” diameter bolts (B) imbedded a minimum of 3” into the concrete. Install a flexible hose connection (C) between the tank and the rigid supply line.

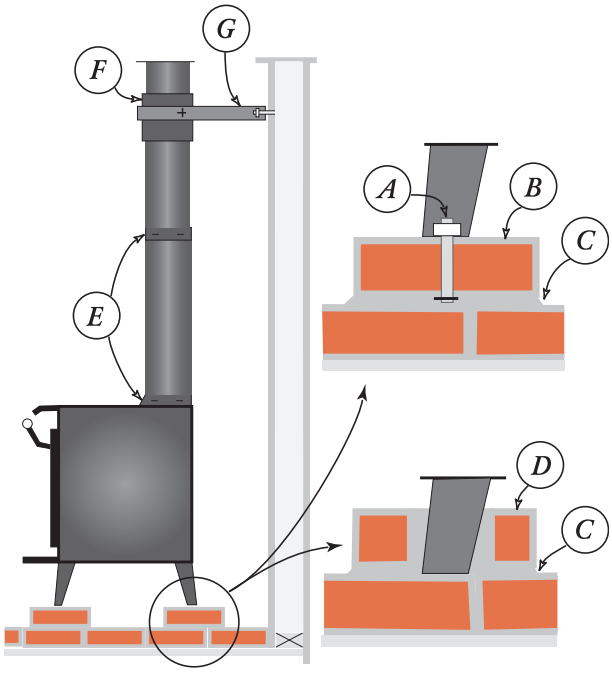
MOUNT THE TANK ON A CONTINUOUS CONCRETE PAD AND BOLT THE FOUR LEGS TO THE PAD

- Install flexible hose connections between the tank, supply line, and the entrance to your home or business.
- Clear the area of tall or heavy objects which can fall and rupture the tank or supply line.
- Keep a wrench tied on a cord near the shut-off valve and make sure that family members or employees know how to use it.
- Seismic shut-off valves are available for large tanks.

WOOD-BURNING STOVES

Free-standing wood-burning stoves pose an additional risk to many in Alaska. Even very heavy objects such as stoves are likely to move during strong ground shaking. Fire codes dictate that stoves must be unsupported on all four sides, and therefore they are more vulnerable to sliding or overturning during an earthquake. If a stove were to tip and/or separate from the stovepipe, cinders or sparks might easily cause a fire in the home. To reduce the potential fire hazard following an earthquake, the stove should be anchored to the floor and stovepipe sections should be secured. It is important that the seismic anchors or braces do not conduct heat from the stove into the floor. Although there are many types of stoves in use, the recommendations here can be used for most installations:

- Stoves resting on a brick hearth can be anchored using bricks and mortar
- Woodstoves resting on a concrete slab on grade can be anchored directly to the concrete.
- Stovepipes should be anchored to the flue exit, and each of the stovepipe segments should be securely together.
- Mobile home approved units come with predrilled holes in the pedestals or legs and can be safely anchored to the underlying floor framing.



For a stove on a brick hearth, anchor the legs with a 3/8” diameter bolt (A) through a ½” hole to a new brick (B). Ground the new brick (B) to the hearth with 1” of new grout (C). Alternatively, build an 8” square brick pad with a grout pocket (D) at each leg. Provide at least 1” of space around each leg and fill the pocket completely with grout. Install sheet metal screws (E) at the flue exit and between the stovepipe sections. Install a radiation shield with a pipe clamp (F) braced to a wall using two tension ties (G) attached to a wall stud with 3/8” by 3” lag screws.

ASSESSING YOUR RISK FROM EARTHQUAKES

Earthquakes are a hazard that creates risks to life and property that we must accept as part of living in Alaska. We face many other hazards in our lives, and we routinely take precautions to reduce our losses or lower our risk. For example, we wear seat belts to lower the risk of injury during an automobile accident. This is an action that most people have come to accept as a reasonable precaution.

Earthquake risk also can be reduced significantly by individuals, businesses, and governments when appropriate actions are taken. The basic actions described in these pages are reasonable precautions that should be taken by all Alaskans. Other actions—such as strengthening a dangerous building or choosing to live elsewhere—may involve significant expense and disruption. Still, damage to buildings and other structures is the primary cause of death, injury, and financial loss during large earthquakes.

To decide how much action is required for protection from earthquake hazards, you must estimate your risk. Earthquake risk varies from location to location, from structure to structure, and from person to person.

WHAT CAUSES DAMAGE DURING AN EARTHQUAKE?

Duration of shaking: Duration depends on how the fault breaks during the earthquake, on the distance from the rupture, and on the types and thicknesses of soils underlying the site. The strongest shaking during the 1964 earthquake lasted 3 to 4 minutes. During a magnitude 7 earthquake, the shaking may last 30 to 40 seconds. The longer buildings shake, the greater the damage.

Strength of shaking: Many damaging earthquakes occur within 15 miles of the Earth's surface. In this case, shaking decreases rapidly with increasing distance from the fault that produced the earthquake. In Alaska, these earthquakes are most common in central and southeastern Alaska. Deeper earthquakes are common beneath southern Alaska and the Aleutian Islands. Because of their greater depth, the shaking directly above such shocks is reduced, and the shaking decreases gradually with increasing distance from the epicenter of the earthquake.

Type of soil: Strength of shaking is greater on soft, thick, and wet soils. In certain soils the ground surface may settle or slide. Damage is typically less in buildings located on bedrock.

Frequency of shaking: Shallow earthquakes, such as those that typically occur in central and southeastern Alaska, produce more rapid shaking than deeper earthquakes, such as those in southern Alaska and the Aleutian Islands. Buildings with a natural shaking frequency that "resonates" with the ground motion will suffer the most damage. Houses and short buildings have high resonant frequencies of shaking (1 to several shakes per second), tall buildings have low resonant frequencies (up to several seconds per shake). Thus it is possible, as occurred in Mexico City during a 1985 earthquake, for mid-height buildings to suffer great damage during a medium-frequency earthquake, while short and tall buildings survive with little or no damage.

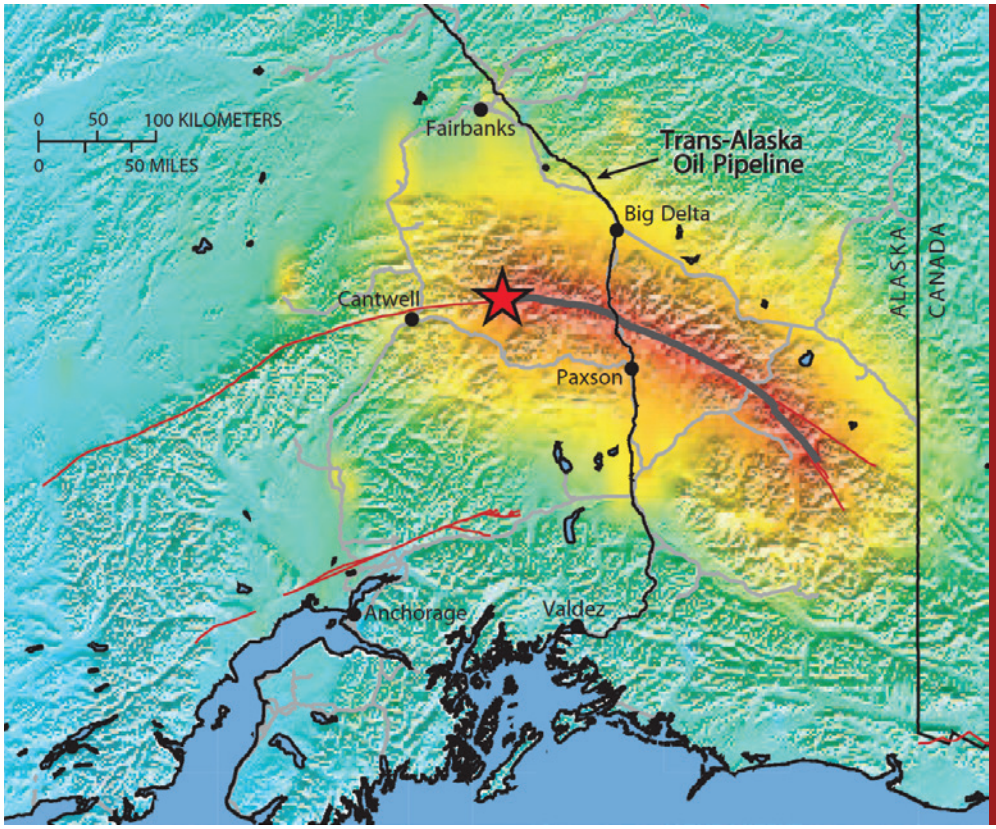
Type of construction: Some existing buildings are not resistant enough to the side-to-side and up-and-down shaking common during earthquakes. Unreinforced masonry buildings are usually the most deadly.

ESTIMATE YOUR RISK

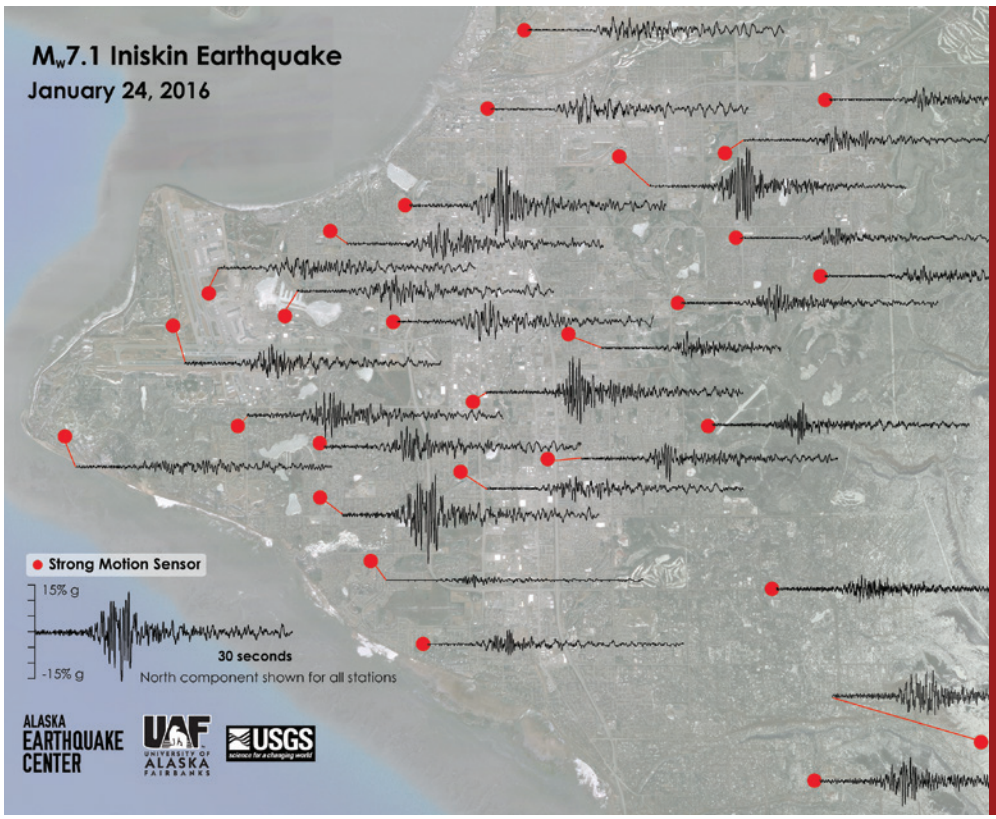
- Is there a risk of serious injury or even death for occupants of a specific building?
- What would be the cost of repairing or replacing a building after a large earthquake?
- What would be the cost of not being able to use a building after a large earthquake?
- What are the odds that time and money spent on preventive action today will prove cost-effective within your lifetime, and within the lifetimes of existing structures?
- If a structure will be replaced by normal development within 10 years, is strengthening it to resist earthquake damage cost-effective?
- Is such strengthening required by a governmental agency, is it economically reasonable, or is it morally necessary?

THE UNIFORM OR INTERNATIONAL BUILDING CODE

Modern criteria for seismic design and construction have been included in the Uniform Building Code since 1973. The 2000 and later editions are termed the International Building Code and have the most up-to-date requirements. Most large communities in Alaska have adopted either the International Building Code or the Uniform Building Code. The codes require greater strength for essential facilities and for sites on soft soil where shaking intensity is increased. The codes set minimum requirements that assure life safety but allow earthquake damage and loss of function. Owners who desire less potential damage and continued use of the building after severe earthquakes should insist on higher standards for design, construction, and inspection. Discuss with an architect or a civil or structural engineer what level of damage will be acceptable (references on page 27).



The strength of shaking is controlled in part by the location and size of the earthquake. Ruptures at the surface tend to produce strong shaking close to the fault. The shaking from deep earthquakes is spread over a large area. This figure shows the intensity of the shaking along the rupture of the 2002 M7.9 Denali fault earthquake. Strongest shaking is shown in red.



Shaking is also influenced by the immediate surroundings. Soil and subsurface conditions can amplify shaking by a factor of ten or more over very short distances. This example shows large variations in shaking across Anchorage during the January 2016 Iniskin earthquake.

DETERMINE THE SAFETY OF YOUR HOME AND SCHOOL

Most people in Alaska are safe at home if they live in a one- or two-story wood-frame building. These buildings are not likely to collapse during earthquakes. The most common damage is light cracking of interior walls, cracking of masonry chimneys, and cracking and possible collapse of brick or masonry veneer on exterior walls. A cracked chimney should be inspected by a qualified professional before the woodstove or fireplace is used.

Unfortunately, some one- or two-story wood-frame buildings can be hazardous. Buildings that are not adequately bolted to their foundation may fail at or near ground level. Adding foundation bolts and bracing cripple walls found in some older homes can vastly reduce the earthquake risk. Correcting these problems will vastly reduce the earthquake risk for most residents. For many homes, additional bracing of water heaters, propane tanks, or oil tanks is an important retrofit that should be completed (see pages 9 - 11). Modern elementary and high school buildings have generally performed well during earthquakes, with the exceptions of the Government Hill School and West High School in Anchorage in the 1964 earthquake. The old Government Hill School was built on unstable soils and probably could not have been engineered to survive the massive landslide that occurred in 1964. The new Government Hill School is built on more stable soils farther from the bluff.

Knowledge about proper seismic design and where to locate buildings has increased dramatically since 1964. However, older school buildings may need to be reassessed in light of modern building codes. Mobile homes, portable classrooms, and modular buildings can slide or bounce off their foundations during earthquakes. Their supports should be braced to resist vertical and horizontal forces. If portable classrooms are used at your local school, you should ask school officials whether they are properly braced.

DETERMINE THE SAFETY OF OTHER BUILDINGS YOU USE

Buildings designed and constructed according to modern codes have generally performed very well during earthquakes. However, certain types of buildings, especially older ones, are potentially hazardous. Unreinforced brick buildings pose a particular hazard even in moderate earthquakes. Unbraced railings and walls inadequately anchored to the floors and roof can topple onto sidewalks or adjacent buildings.

Major damage often occurs in buildings with a “soft” first story. Usually, soft stories consist of an open space with stand-alone columns rather than interior walls supporting the building above. Such spaces are usually used as garages, stores, or large offices. The first floor does not have enough strength to resist the horizontal shaking force of the upper parts of the building. Similarly, rooms added over garages of private homes or older split-level homes may not be adequately supported.

Damage to all of these types of buildings poses a threat to both life and property during earthquakes. These losses can be significantly reduced by strengthening structures before an earthquake. Investment in strengthening offices and commercial buildings will reduce structural and nonstructural damage and may allow continuation of business after severe earthquakes.

For single-family homes, ask a licensed engineer or architect to look at your home while you are present and to discuss the seismic issues with you. A written report, or plans and specifications for corrective action, may involve more time. You may want to ask for a seismic inspection before buying a new home.

HOW DO YOU LOCATE A PROFESSIONAL TO ADVISE YOU ON THE RESISTANCE OF YOUR BUILDING TO EARTHQUAKE SHAKING?

Civil and structural engineers and architects are trained and licensed to provide such information about structures. Geologists, foundation engineers, and geotechnical engineers are trained and licensed to evaluate the soil conditions and recommend appropriate action.

When hiring such a consultant, you are asking an experienced professional to review a potential problem and possibly to provide plans and specifications for correcting the problem. The amount of work required is not known when you hire the consultant, and thus it is important to select someone you trust, and to develop a scope of work as you

proceed. A good place to start is to call a professional organization (refer to the *Other Sources of Information* section at the back of this pamphlet) for information about different types of work that might be required and how to find and select an engineer, geologist, or architect. Contact several firms or individuals to determine if they do the different types of work you need. Ask for information that explains the type of firms they are and that identifies others whom they have served. Check to see how satisfied other clients were with their services. Recognize that the quality of the advice given and of the work performed, as well as the price you pay, may depend critically on the care you take in making a selection.

Become informed. Even if you do not understand the technical details, ask enough questions to understand the concepts and relative importance of the issues involved. Do not be afraid to ask questions that you fear might appear foolish. Your money is going to be expended and your life and belongings are at risk, so you have a right to understand what needs to be done and why.

For projects more complex than inspecting a single family home, you should meet with the selected firm and discuss the options. In almost every case, there will be a number of approaches for solving any given problem. Get the consultant to explain the pros and cons of each, as well as the dollars and risks involved. Once this is done, you will have defined the work the consultant will do for you. Then a fee can be set and you can discuss how changing the work would change the fee.

State and federal agencies do not inspect individual buildings. Your local building department may be willing to inspect your building, but they are not authorized to recommend actions to be taken.

EARTHQUAKE INSURANCE

Standard homeowners insurance does not cover earthquake damage. Many people are unaware that their existing fire insurance does not cover fires caused by earthquakes. The 1989 Loma Prieta earthquake in California caused over 6 billion dollars in damage, but insured property damage accounted for only 16 percent of this loss. In Alaska, only about 12% of homeowners have purchased earthquake insurance. The most common type of earthquake insurance is normally added as an endorsement on a standard homeowner's insurance policy. Typically, there is a deductible of 10 percent of the value of the home. This means that for a home currently insured at $300,000 you would have to pay $30,000 in damages before the insurance company would pay anything. Separate deductibles may apply to the contents of the house and the structure. Another important coverage is temporary living expense, which pays for motel and meals if you have to move out of your home. There is usually no deductible on this coverage. The yearly cost of residential earthquake insurance is normally about $3.00 per $1,000 of coverage on a conventional frame home. However the rate may rise to $13 per $1,000 of coverage on structures with brick or masonry veneer on the outside. To find out more about earthquake insurance, ask your insurance agent.

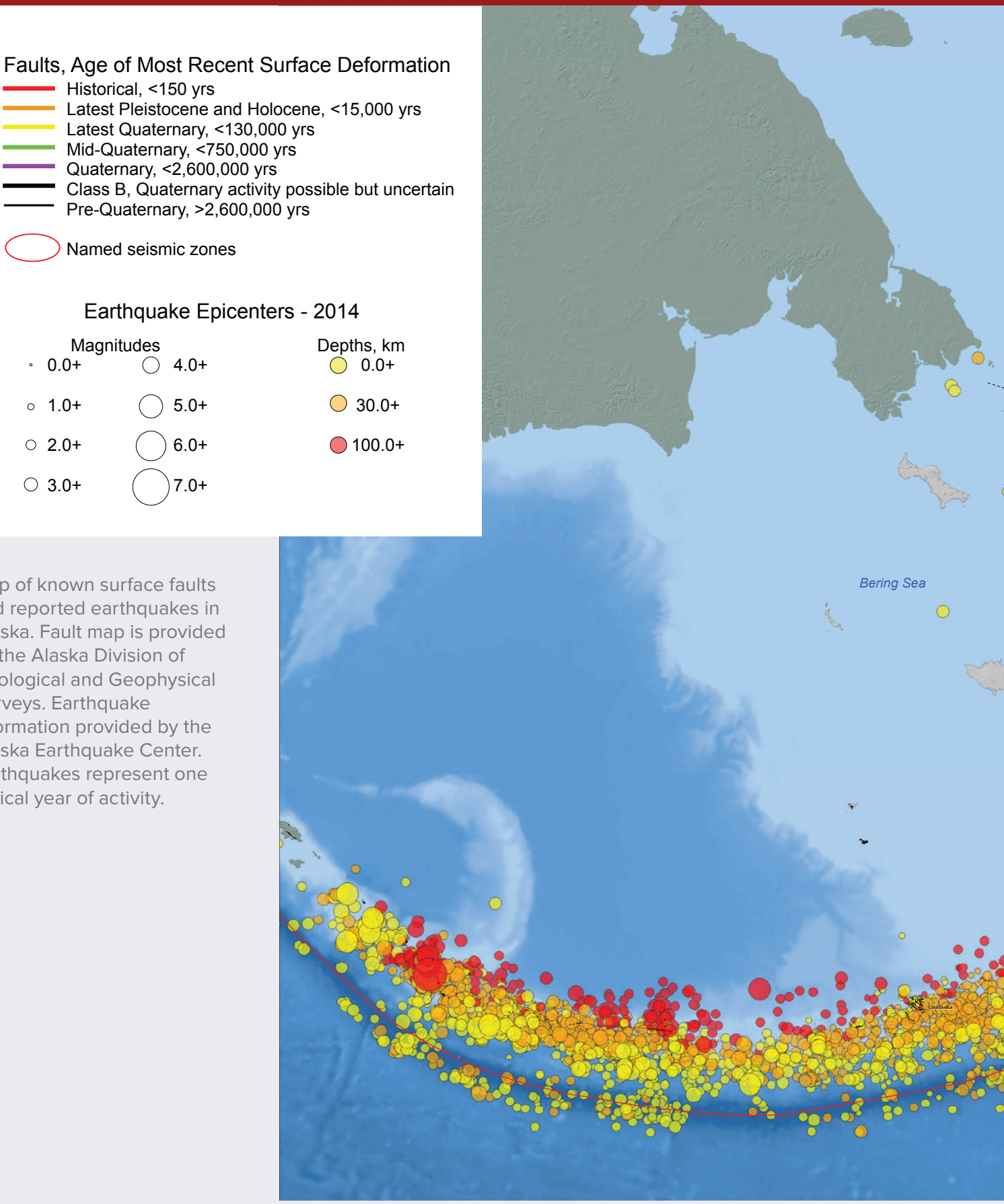
The 2016 M7.1 Iniskin Earthquake damaged ductwork and ceiling tiles at Romig Middle School in Anchorage.

If you believe a structure that you or your family uses is hazardous and you would like to find out more or determine who you can consult, refer to the *Other Sources of Information* section at the back of this pamphlet. Ask the building owner what consideration has been given to seismic design and strengthening. Many civil and structural engineers and architects are trained and licensed to investigate the strength of a structure and to recommend appropriate action to reduce earthquake risk.

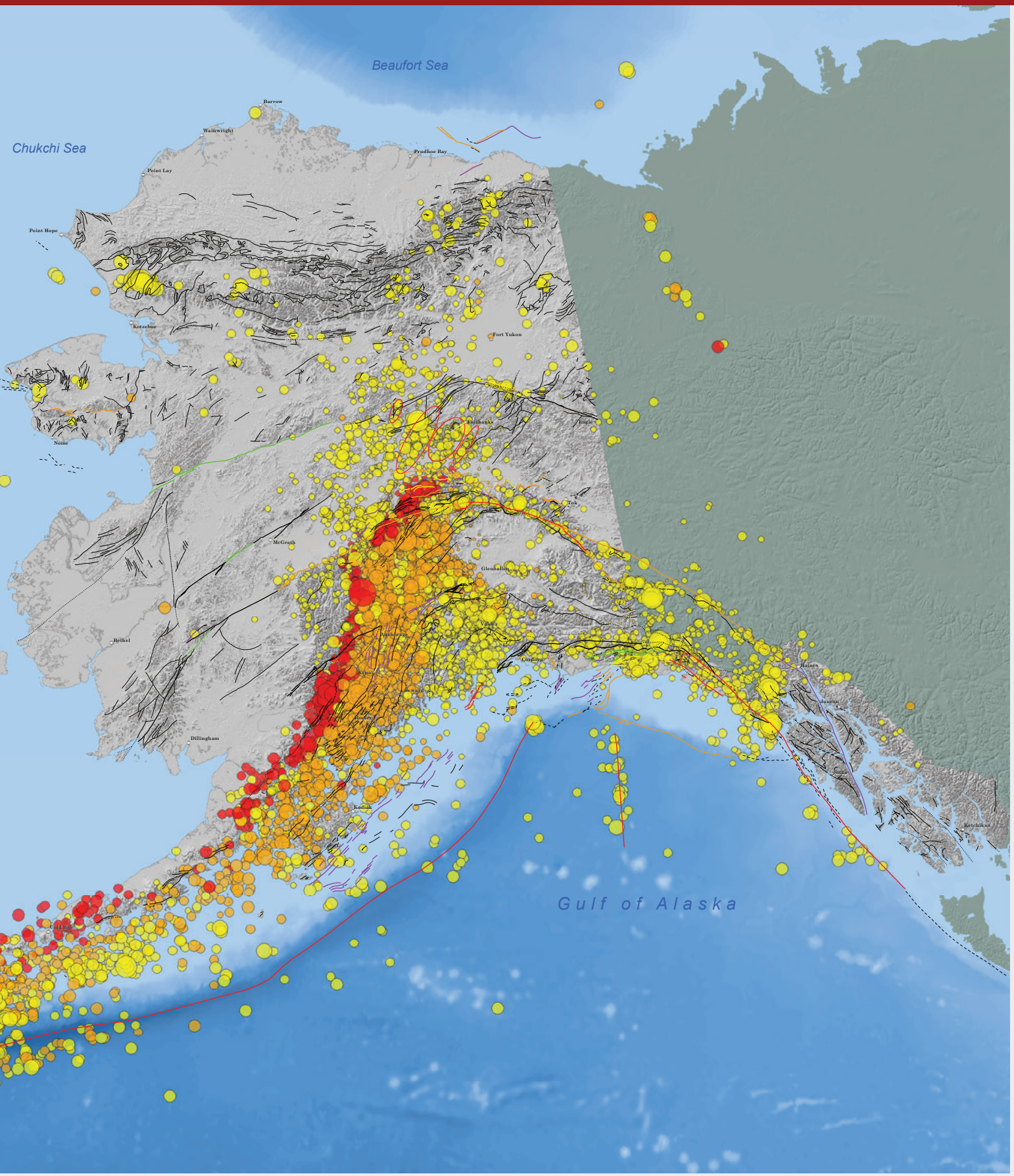
How do you locate a professional to advise you on the resistance of your building to earthquake shaking?

For single-family homes, ask a licensed engineer or architect to look at your home while you are present and to discuss the seismic issues with you. A written report, or plans and specific actions for corrective action, may involve more time. You may want to ask for a seismic inspection before buying a new home.

EARTHQUAKES IN ALASKA



Map of known surface faults and reported earthquakes in Alaska. Fault map is provided by the Alaska Division of Geological and Geophysical Surveys. Earthquake information provided by the Alaska Earthquake Center. Earthquakes represent one typical year of activity.


Beaufort Sea
Chukchi Sea
Gulf of Alaska
Barrow
Wainwright
Prudhoe Bay
Point Lay
Point Hope
Kotzebue
Fort Yukon
Fairbanks
Eagle
Nome
Tok
McGrath
Glennallen
Bethel
Valdez
Anchorage
Cordova
Haines
Kenai
Seward
Homer
Juneau
Dillingham
Sitka
Kodiak
Ketchikan
Cold Bay

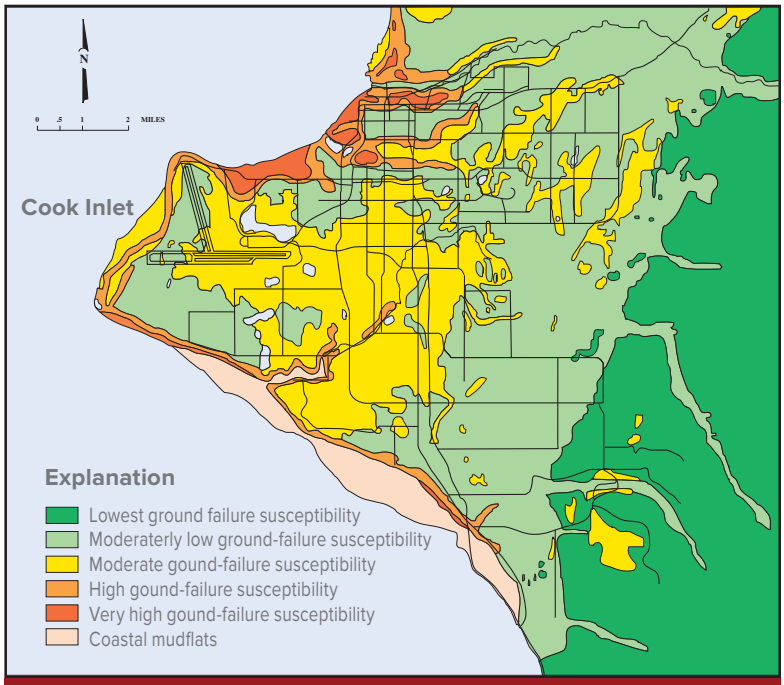
DETERMINE IF YOU LIVE OR WORK IN HAZARDOUS AREAS

Earthquake damage is typically concentrated in areas that can be identified in advance. The amount of shaking experienced in an earthquake can be very different in locations less than a hundred yards apart. Determine for yourself if the places where you live and work are particularly dangerous. Seeking answers to the questions on the following pages is an excellent start.

DO YOU LIVE WHERE THE GROUND CAN SETTLE, SLIDE, OR SHAKE VIOLENTLY?

Landslides are likely to be triggered by significant earthquakes, especially on steep slopes and in areas underlain by soft ground. During the 1964 Alaskan earthquake, much of the Turnagain Heights area of Anchorage slid toward Knik Arm because the area is underlain by a kind of soft, wet clay that is prone to sliding if shaken violently. The clay in the Anchorage area and other types of soft ground can also intensify the shaking of an earthquake.

Fortunately, most areas that can settle, slide, or shake violently can be identified before the next major earthquake. Even reasonably detailed maps give only an overview of the potential for shaking, liquefaction, landslides, faulting, and damage. To investigate a particular building site, you should consult an engineering geologist, geotechnical engineer, or a foundation engineer.



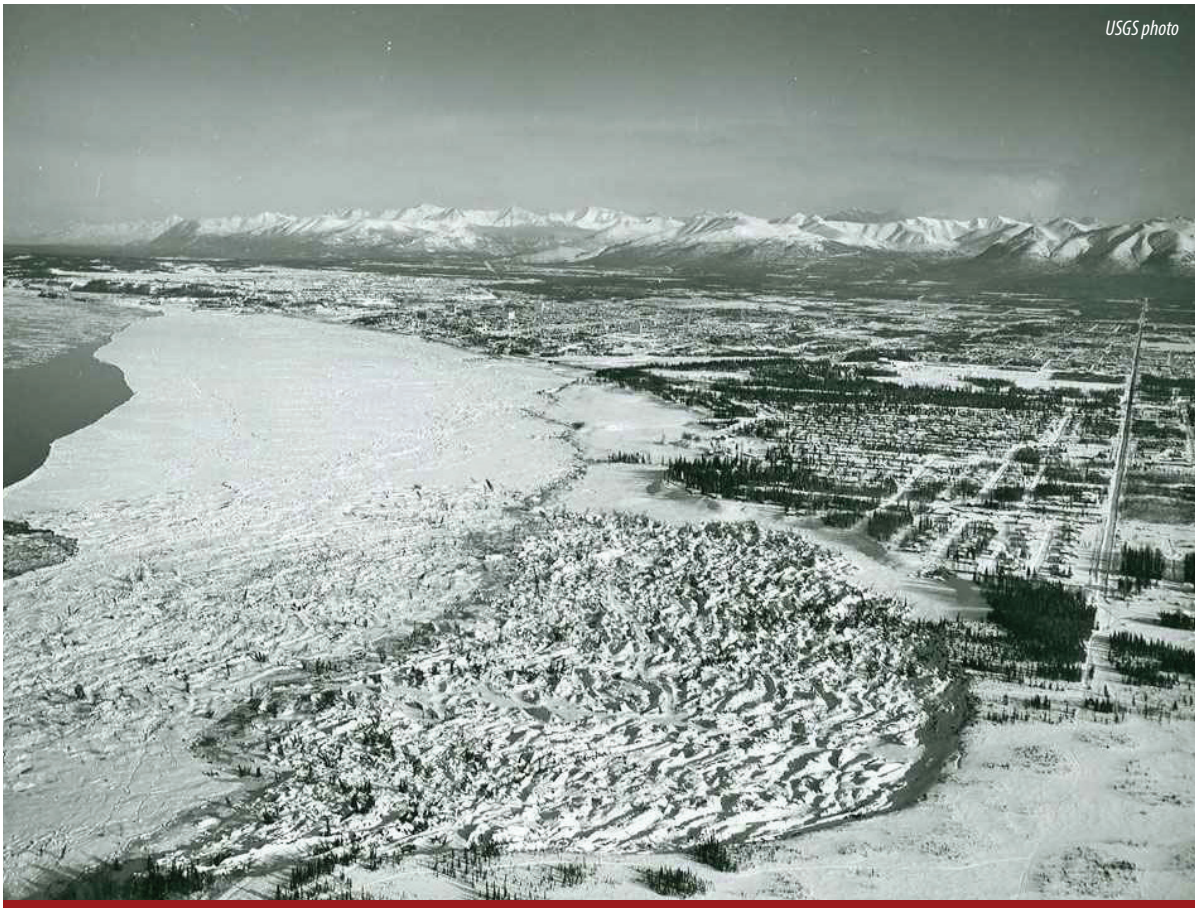
This is a map of the Anchorage area showing the relative chances of earthquake-induced ground failure in different locations. If the ground "fails" during an earthquake, it will probably shake excessively, cracks may open up on the surface, and the area may be involved in a landslide. Buildings on areas with high ground-failure susceptibility may be severely damaged in future earthquakes. This map is not intended as a substitute for on-site investigations by a professional geologist or geotechnical engineer. Source: Anchorage Coastal Resources Atlas, v. 1, Anchorage Bowl available at local libraries , or online at www.dggs.dnr.state.ak.us (Publication MP32).

SOIL LIQUEFACTION

When loosely packed, wet sand is shaken during an earthquake, it may flow like liquid. This is called liquefaction. Anyone who has walked on a beach may have seen a small-scale version of this process. Stamp your foot in the sand near the water's edge and suddenly the area of your footprint vibrates like gelatin.

Earthquake-induced liquefaction is often accompanied by cracks in the ground surface and small eruptions of sand and water called sandblows. During the 2002 Denali fault earthquake, people in Northway watched sand erupting four feet out of the ground. When soil liquefies, it is unable to support the weight of the ground or any structures above it. Bridges and buildings may settle and tilt even though they withstood strong ground shaking. If the liquefied area is on a slope, massive landslides may result.

The Bootlegger Cove formation is the name of a soil that underlies much of Anchorage. Liquefaction of a part of the Bootlegger Cove formation caused much of the destruction in the Anchorage area during the 1964 earthquake, and it causes people to feel earthquakes more strongly in western Anchorage. Soils that liquefy are not limited to the Anchorage area but are present in many low-lying parts of Alaska where soil near the surface is saturated with water.



USGS photo

About 75 homes in the Turnagain Heights area of Anchorage were destroyed in 1964 by a massive landslide. This area is underlain by soil that flows like water when it is shaken.

TSUNAMI RISK

Perhaps the greatest danger of death in a major Alaska earthquake comes shortly after the ground stops shaking. Tsunamis can kill thousands who are unfortunate enough to be near the ocean shore after a large earthquake. More than 90 percent of the deaths from the 1964 earthquake were the result of tsunamis triggered by the quake. Understanding what tsunamis are and how to respond can save your life.

WHAT IS A TSUNAMI?

A tsunami is a series of waves with a long time and distance between crests.

- Wind-generated waves have only a few seconds between crests. At the other end of the spectrum, the daily tide typically has about 12 hours between crests.
- Tsunamis fall somewhere in between these more common waves, having anywhere from a few minutes to an hour between crests.
- While wind waves break and lose energy offshore, tsunamis flood onshore with strong currents.

Tsunamis are generated by large, sudden movements of the ocean.

- Earthquakes trigger most tsunamis by lifting or dropping the sea floor over a large region. This perturbs the sea level which gravity then acts on, generating the tsunami.
- Landslides into or under the water can also trigger tsunamis. These tsunamis are very dangerous in that they can be large and will strike near-by shores within a few minutes of the slide – in most cases too soon for warnings to be disseminated.
- Volcanic eruptions can also trigger tsunamis. These are uncommon, but have occurred in Alaska. Most notably, the 1883 eruption of Mt. Augustine in the Cook Inlet generated a large tsunami.

Tsunamis can range in height from inches to more than 100 feet in extreme cases.

- Due to the flooding nature of tsunamis, even moderate-sized tsunamis with heights of three feet can induce dangerous currents.
- Tsunami danger increases closer to shore where the waves slow down and build in height.
- Some coastal areas have a configuration which enhances tsunami impact.
- Tsunami speed depends on the depth of water through which it travels; the deeper the water the faster it goes. Tsunamis travel about 475 mph in 15,000 feet of water and slow to about 40 mph in 100 feet.

ALASKA'S LARGEST TSUNAMIS

The tectonic plate boundaries along the southern and southeast coasts of Alaska have produced the majority of dangerous tsunamis triggered in the United States. Some of these are described here:

- The first well-documented tsunami in Alaska occurred in 1788 along the Alaska Peninsula coast. Russian missionaries documented this event, which appears to have had a tremendous impact caused by wave heights up to 100 feet.
- Lituya Bay in Southeast Alaska:
  - This bay has seen tremendous tsunamis, including the highest elevation reached by a tsunami ever recorded anywhere in the world.
  - Studies of the forest around Lituya Bay indicate that around 1853 a major tsunami occurred in the bay. Native Alaskan stories also suggest a tsunami destroyed a settlement near the entrance of the bay around this time, killing everyone except one woman who was picking berries on a hill.
  - Other large tsunamis were either observed or inferred by photos in the years 1874, 1899, and 1936.
  - 1958: A magnitude 8.3 earthquake triggered a massive rockslide into the head of Lituya Bay. This rockslide, in turn, generated a wave which eradicated the forest to a height of 1720 feet in one location. Three boats were in the bay at the time. One lost all on board while the other two miraculously survived.
- 1899: A magnitude 8.2 earthquake near Yakutat generated multiple tsunamis from Valdez Inlet down to Lituya Bay.

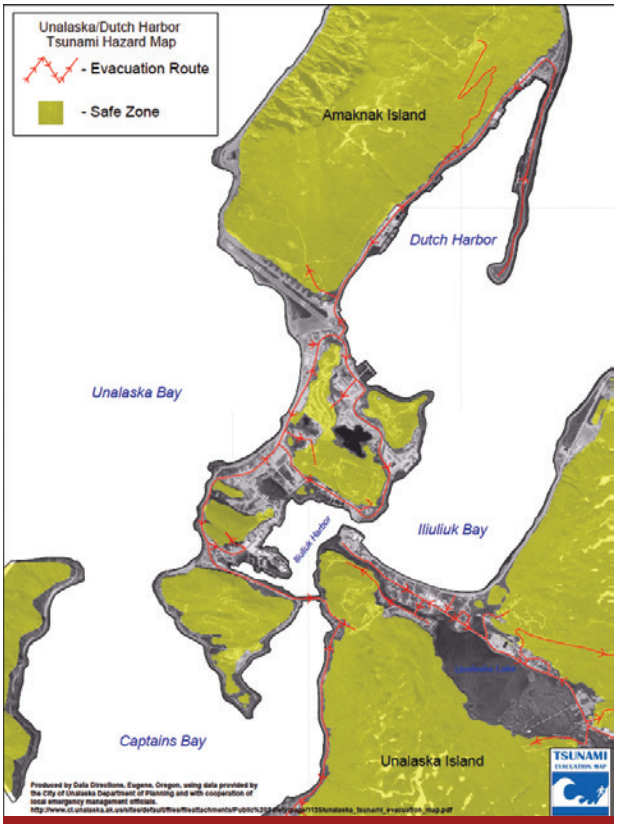
- 1946: A massive tsunami was generated south of the eastern Aleutian Islands, reaching over 100 feet in height locally and killing the five Navy lighthouse keepers at Scotch Cap. The tsunami reached Hawaii five hours later and killed 158 more people there. This disaster led to the development of what is now the Pacific Tsunami Warning Center.
- 1957: A magnitude 8.6 earthquake struck in the central Aleutian Islands, triggering a large tsunami but causing little damage in Alaska due to the remoteness of the source.
- 1964: The Great Alaska Earthquake generated a major Pacific-wide tsunami as well as several landslide-induced local tsunamis, killing 106 people in Alaska and 19 along the US west coast. This disaster led to the development of what is now the National Tsunami Warning Center.

USCG photos

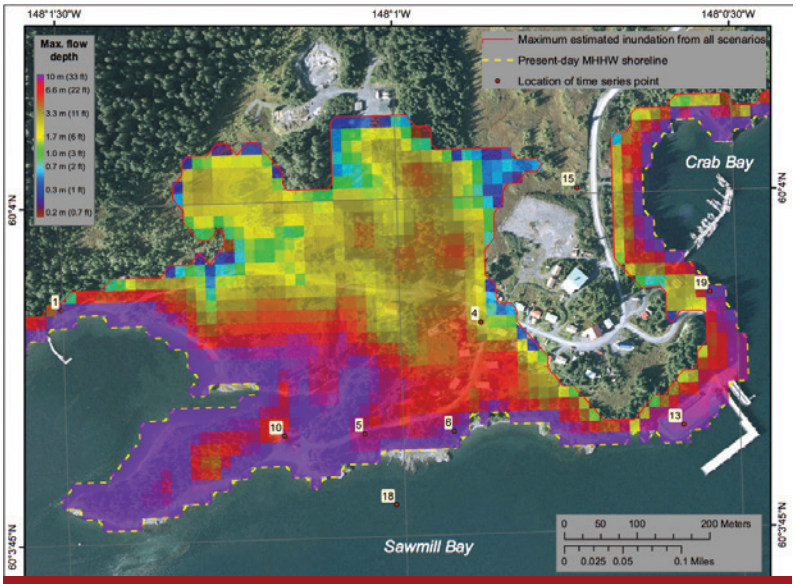
BEFORE

AFTER

Above: The first victims of the 1946 tsunami were here in Alaska, at the Coast Guard's Scotch Cap light station, which was washed away by a wave over 100 feet high. The tsunami went on to devastate Hilo, Hawaii and even destroyed a hut in Antarctica.



Local officials worked with the Alaska Earthquake Center to produce this tsunami hazard map of Dutch Harbor and Unalaska showing the evacuation routes and safe areas.



The Alaska Earthquake Center tsunami group researches possible impacts from a range of scenarios that could occur in at-risk communities. This map shows the potential extent and depth of tsunami innundations for Sawmill Bay.

TSUNAMI INUNDATION MAPPING FOR ALASKAN COMMUNITIES

The Alaska Earthquake Center helps Alaskan coastal communities to mitigate the risk from tsunamis by mapping the potential inundation zones for each community. This project is a part of the National Tsunami Hazard Mitigation Program, a cooperative effort of NOAA, the USGS, and the western coastal states of Alaska (AEC, DHS&EM, ADGGS), Washington, Oregon, California, and Hawaii. This process involves identifying likely tsunami sources for each coastal community, modeling potential areas of inundation, and creating a hazard map and report. These products are used by local emergency managers to create evacuation plans and for public education about tsunami risk and other hazard mitigation efforts. Many of Alaska's coastal communities have the highest tsunami hazard found anywhere in the United States. Mapping is planned for all coastal communities with significant risk. DHS&EM prioritizes communities for inundation mapping based on historical tsunami hazard, population, infrastructure at risk, availability of bathymetric and topographic data, and the level of community commitment to hazard mitigation. High-risk communities such as Kodiak, Homer, Seward, and Sitka have taken top priority. Work will continue until all communities meeting DHS&EM criteria are accurately mapped.

REDUCING TSUNAMI DANGER

FORTUNATELY, DEATH AND DAMAGE CAN BE REDUCED BY UNDERSTANDING THE THREAT AND TAKING PRE-EMPTIVE MEASURES

- Individuals have a responsibility to understand nature's warning signs and respond appropriately, as described in the next section on safety measures.
- Coastal communities develop tsunami response plans and help educate their residents and visitors.
- Coastal states coordinate tsunami response actions and can take advantage of support through the National Tsunami Hazard Mitigation Program (NTHMP), a cooperative effort of NOAA, USGS, FEMA, and coastal states and territories.
- The federal government leads the effort by providing tsunami warning services and the framework for a national response through the NTHMP.

NOAA operates two Tsunami Warning Centers in the US: the National Tsunami Warning Center (NTWC) in Palmer, Alaska, and the Pacific Tsunami Warning Center (PTWC) in Pearl Harbor, Hawaii.

- The NTWC is responsible for issuing alerts to Alaska.
- Alerts are normally issued within 5 minutes of the earthquake for surrounding coasts.

A Tsunami Warning indicates that a tsunami capable of inundating the coast may occur.

A Tsunami Advisory indicates that a tsunami capable of producing damage due to currents, but not likely to inundate the land, is expected.

A Tsunami Watch means to stay alert for more information as a tsunami has been generated far away which may later be dangerous to your coast.

A Tsunami Information Statement provides information on earthquakes and tsunamis which are not expected to be dangerous to your coast.

- Alerts are transmitted by several means including the Emergency Alert System, NOAA Weather Radio, several internet-based services, and state/community based systems such as sirens.
- For the latest tsunami information, see *ntwc.arh.noaa.gov.*

The National Weather Service has developed a program called TsunamiReady®.

- TsunamiReady provides a set of criteria which can be followed by communities to help prepare for a tsunami.
- If the criteria are met, the community is recognized as TsunamiReady by the NWS.

The Alaska Earthquake Center (AEC) at the University of Alaska Fairbanks helps communities identify threatened areas through numerical modeling and mapping of potential tsunamis in that community.

- Identifying the threatened zone is a requirement of the TsunamiReady program.
- The modeling indicate what areas need to be evacuated during an alert and are critical in developing tsunami response plans.
- Tsunami modeling has been completed for many Alaska communities and work is ongoing for others.

TSUNAMI SAFETY RULES

A TSUNAMI MAY OCCUR AT ANY TIME

- Prepare a family emergency plan.
- Prepare a safety backpack.
- Identify tsunami danger zones, safe areas, and the assembly locations.
- Identify evacuation routes.

PAY ATTENTION TO ANY OF THESE WARNING SIGNALS

- Strong earthquake or one of long duration (20 seconds or more)
- Official tsunami alert by sirens, commercial radio, television, or NOAA weather radio.
- Sudden sea level change.
- Loud noise coming from the sea.

IN CASE OF AN EARTHQUAKE, PROTECT YOURSELF

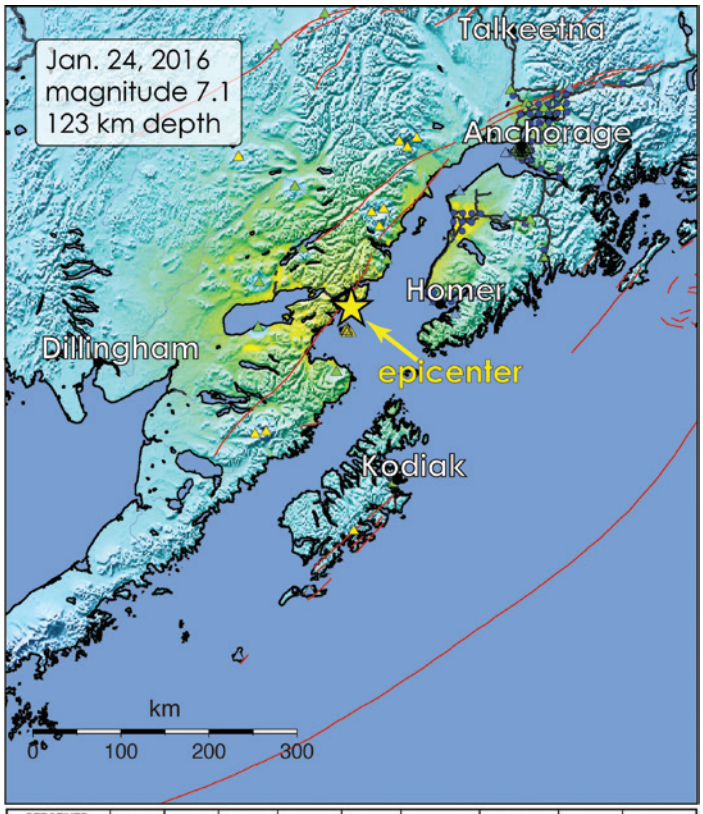
- Drop, Cover, and Hold On.

MOVE AWAY FROM THE HAZARD AREAS (IN PREFERENCE ORDER, DEPENDING ON YOUR LOCATION)

- Run to higher ground and/or away from the coast to a tsunami shelter or assembly area.
- Go to a third floor or higher in a concrete building.
- Climb a tree.
- If you are on a boat, move to deeper water (at least 150 feet).

Damage in Seward following the 1964 earthquake. The waterfront area, railroad yard, and petroleum storage tank facilities were devastated by the tsunami.

MEASURING AN EARTHQUAKE



PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Mod./Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	<0.05	0.3	2.8	6.2	12	22	40	75	>139
INTENSITY	I	II–III	IV	V	VI	VII	VIII	IX	X+

MAGNITUDE

After an earthquake, most people want two pieces of information first: where did it happen, and what was its magnitude?

Magnitude describes the strength of an earthquake at its source. Seismologists use several different methods to calculate magnitude, but all of these methods are calibrated to the same numerical scale. Thus, the crucial thing to know about magnitudes is how the numbers on the scale relate to each other.

Each step represents a tenfold increase in the amplitude of shaking and a 32-fold increase in the amount of energy released. For example, a magnitude 7 earthquake is 100 times larger than a magnitude 5 and releases about 1,000 times more energy. Small numerical increases in magnitude represent large increases in the severity of an earthquake.

ACCELERATION

Magnitude gives an objective measure of the size of an earthquake, but it cannot describe how strongly an earthquake affects a given area. Knowing the actual force of shaking at a specific location is critical for safe engineering. If the forces exceed the design standard of a building or structure, then a structure may longer be safe.

These forces are often stated in terms of the acceleration of gravity, or "% g." Humans can feel shaking that is less than 1% g, but we begin to worry about damage in poorly built structures at 5-10% g. Above 25% g, the shaking is very strong and damage can become severe.

The severity of local shaking depends on many factors, including distance from the epicenter, the type of underlying soil, and building materials and design. Because of these variables, a single earthquake can produce drastic differences in shaking in places only hundreds of feet apart. Tools such as ShakeMap use ground accelerations to convey these variable levels of shaking to policy makers, emergency managers, and citizens.

INTENSITY

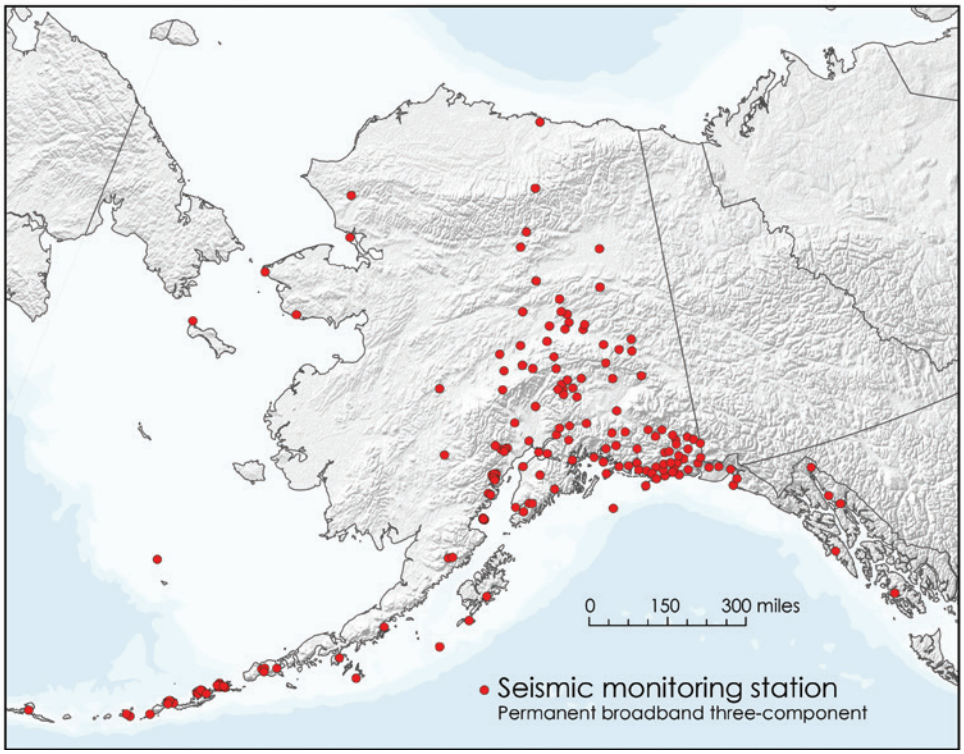
The Mercalli Intensity scale uses human observation to describe the effects of an earthquake. Perception of shaking increases as accelerations increase (see chart above). Though intensity is not as precise as measured accelerations, these two types of data complement each other by providing both quantitative and qualitative measures of the shaking. Together, acceleration and intensity are often more important than magnitude.

SEISMIC MONITORING IN ALASKA

Across Alaska, several hundred seismic stations constantly monitor for earthquakes. The information collected from those stations helps scientists and engineers to better identify hazards, to improve construction methods, and to advance understanding of earthquakes in general. However, the primary function of the statewide seismic network is to provide timely information about significant earthquakes that may threaten life and property.

The Alaska Earthquake Center at UAF uses the statewide seismic network to identify earthquakes within minutes of occurrence. For significant earthquakes (magnitude 3.5+ in the mainland and magnitude 5+ in the Aleutians), the on-duty seismologist provides detailed information to emergency managers and the public within 30 minutes. Smaller earthquakes are located automatically and reviewed later. Altogether, the Earthquake Center reports roughly 35,000 earthquakes per year. Information about these earthquakes is made available to the public at *earthquake.alaska.edu.*

Operating the statewide network is a multi-agency effort. For example, most of the Alaska Peninsula and Aleutians stations were installed by the Alaska Volcano Observatory to monitor volcanoes, but those stations are also critical for locating earthquakes. Likewise, the National Tsunami Warning Center in Palmer operates is own stations while using data from selected Earthquake Center stations to provide rapid tsunami forecasting after large earthquakes (see pages 22-23). Sharing data and operating costs greatly increases the reach and effectiveness of the statewide network for each participating agency.



Permanent broadband seismic stations operated by all partners in Alaska.

OTHER SOURCES OF INFORMATION

Your local library is a good place to start. Ask for the material referenced below. Many valuable information resources are available on the internet. Internet addresses are provided in the sections below. Ask your local chapter of the American Red Cross for pamphlets on preparedness and survival.

Agencies & Organizations:

Alaska Division of Geological & Geophysical Surveys, *www.dggs.alaska.gov*, 3354 College Road, Fairbanks, AK 99709, (907) 451-5010. Technical publications and maps about energy and mineral resources, geologic hazards, and water resources.

Alaska Division of Homeland Security and Emergency Management, *www.ak-prepared.com*, P.O. Box 5750, Fort Richardson, AK 99505-5750, (907) 428-7000 or (800) 478-2337. Conducts preparedness and mitigation programs and workshops. Materials available upon request.

Alaska Earthquake Center, University of Alaska Fairbanks, *http://earthquake.alaska.edu/,* 903 Koyukuk Dr., P.O. Box 757320, Fairbanks, AK 99775-7320, (907) 474-7320. Provides seismic monitoring for the State of Alaska and has compilations of location, magnitude, and depth of Alaskan earthquakes.

Applied Technology Council, *www.atcouncil.org*, 201 Redwood Shores Parkway, Suite 240, Redwood City, CA 94065, (650) 595-1542. Provides technical publications for engineers, architects, and other people interested in the details of design for reducing earthquake damage to buildings and their contents.

Earthquake Engineering Research Institute, *www.eeri.org*, 499 14th St. #320, Oakland, CA 94612-1934, (510) 451-0905. Technical information of most interest to engineers, researchers, and practicing professionals. videos, annotated slide sets, and reconnaissance reports about earthquake hazard mitigation and the response of buildings, lifelines, and bridges during major earthquakes around the world. Free publications and reports available.

Federal Alliance for Safe Homes (FLASH)®, *www.flash.org*, 1708 Metropolitan Boulevard, Tallahassee, FL 32308, (877) 321-SAFE (7233). Disaster safety information for individuals and families.

Federal Emergency Management Agency, *www.fema.gov*, Region 10 (includes Alaska), 130 228th Street, SW, Bothell, WA 98021-9796, (425) 487-4604.

Municipality of Anchorage, Building Safety Division, *www.muni.org/bsd/mainpage.cfm*, P.O. Box 196650, Anchorage, AK 99519-6650, (907) 343-8211. Conducts and provides training for post-earthquake building safety evaluations.

National Tsunami Warning Center, *ntwc.arh.noaa.gov*, Palmer, AK, (907) 745-4212. Provides tsunami alerts and information to coastal residents of Canada, Puerto Rico, Virgin Islands, and all U.S. states except Hawaii. Online training about tsunamis and the "Tsunami Warning System are available through the COMET MetEd program at *https://www.meted.ucar.edu/training_course.php?id=38."*

U.S. Geological Survey, *www.usgs.gov,* 4200 University Dr., Anchorage, AK 99508, (907) 786 7000. Publications and maps concerning earthquake hazards, faults, volcanoes, and permafrost."

ADDITIONAL WEB LINKS

http://earthquake.alaska.edu/earthquakes Alaska Earthquake Information Center website with list of most recent earthquakes in Alaska.

earthquake.usgs.gov - Main webpage of USGS earthquake hazards program, with information about recent large earthquakes around the world.

http://pubs.dggsalaskagov.us/webpubs/dggs/mp/oversized/mp141_sh001.pdf Alaska Division of Geological & Geophysical Surveys map of Alaska's Quaternary Faults in the centerfold of this pamphlet.

https://www.ready.gov/kids -FEMA Ready website for kids, parents and educators, current disaster information, preparedness, facts and figures, disaster experiences related by children, games & quizzes.

http://www.fema.gov/earthquake – FEMA earthquake safety and preparedness information.

http://wcatwc.arh.noaa.gov/ - NOAA National Tsunami Warning Center

http://www.tsunamiready.noaa.gov/ - "TsunamiReady" program of the National Weather Service

AMERICAN RED CROSS

Anchorage	(907) 646-5400
Fairbanks	(907) 456-5937
Juneau	(907) 463-5713
Soldotna	(907) 262-4541
Wasilla	(907) 357-6060

LOCAL EMERGENCY MANAGEMENT OFFICES

Anchorage	(907)343-1400
Emergency Info.	(907) 343-4701
(24 hour) Anchorage Fire Dispatch	(907) 267-4950
Fairbanks	(907) 459-1481

Road damage from the November 3, 2002 Denali Fault earthquake.

GI-UAF graduate student Kelly Kore installing a temporary seismic station to monitor aftershocks from Denali fault earthquake.

Additional copies can be obtained from the Alaska Division of Homeland Security and Emergency Management, the Alaska Earthquake Center, the U.S. Geological Survey, and the Alaska Division of Geological & Geophysical Surveys.
This publication is also available online at *http://earthquake.alaska.edu/*

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