Seismic Hazards

Primary earthquake hazards include strong ground shaking that may affect large areas and a rupturing of the ground surface along the fault or fault zone. Secondary earthquake hazards such as landslides, rockfall, liquefaction, and tsunamis can have severe impacts on life, infrastructure, and property. Earthquakes do occur in Colorado. They can cause significant damage to building stock and infrastructure. Steep terrain in the state, already prone to landslide, is susceptible to additional earthquake-triggered failures. Fortunately the state is not at tsunami risk. However, large and potentially damaging waves called seiches may form in lakes during an earthquake. These hazards underscore the need for emergency preparedness and hazard mitigation.

Building damaged by a magnitude 5.3 earthquake west of Trinidad, Colorado on August 22, 2011.

What is the Colorado Earthquake Hazard Mitigation Council?

The Colorado Earthquake Hazard Mitigation Council (CEHMC) is a multi-disciplinary organization that is developing a better understanding of earthquake hazards in Colorado. Council members include emergency and risk managers, geologists, geophysicists, seismologists, along with civil, mechanical, geotechnical and structural engineers from the private sector, academia, and government. The CEHMC has been in existence in various forms for more than thirty years.

Colorado Earthquake Hazard Mitigation Council

A consortium of academia, government and private industry

FEMA

OF-20-08

How to Protect Yourself in an Earthquake

Federal, state, and local emergency management experts and other official preparedness organizations all agree that "Drop, Cover, and Hold On" is the appropriate action to reduce injury and death during earthquakes. The ShakeOut is our opportunity to practice how to protect ourselves during earthquakes. In MOST situations, you will reduce your chance of injury if you:

DROP where you are, onto your hands and knees. This position protects you from being knocked down and also allows you to stay low and crawl to shelter if nearby.

COVER your head and neck with one arm and hand

—If a sturdy table or desk is nearby, crawl under neath it for shelter

—If no shelter is nearby, crawl next to an interior wall (away from windows)

—Stay on your knees; bend over to protect vital organs

HOLD ON until shaking stops

Under shelter: hold on to it with one hand; be ready to move with your shelter if it shifts

No shelter: hold on to your head and neck with both arms and hands.

What to do after an Earthquake?

- ***Expect aftershocks to follow the main earthquake***
- ***Get out or move away from damaged buildings***
- ***If you are trapped, cover your mouth. Send a text, or bang on a pipe or wall if shouting does not work***
- ***Seek higher ground in tsunamis prone areas***

*Participating in preparedness drills like the annual **Great Colorado Shakeout (shakeout.org /Colorado)** are a great way to make sure you know what to do during an earthquake.*

How to Prepare for Earthquake

Secure your water heater. Unsecured water heaters often fall over, rupturing rigid water and gas connections. If your water heater does not have two straps that wrap completely around it and are screwed into the studs or masonry of the wall, then it is not properly braced. Bracing kits are available that make this process simple. Also, have a plumber install flexible (corrugated) copper water connectors, if not already done.

Plan to be safe. Create a disaster plan and decide how you will communicate in an emergency. Will everyone in your household do the right thing during the violent shaking of a major earthquake? Before the next earthquake (or snowstorm, flood, or tornado), get together with your family or housemates to plan now what each person will do before, during and after.

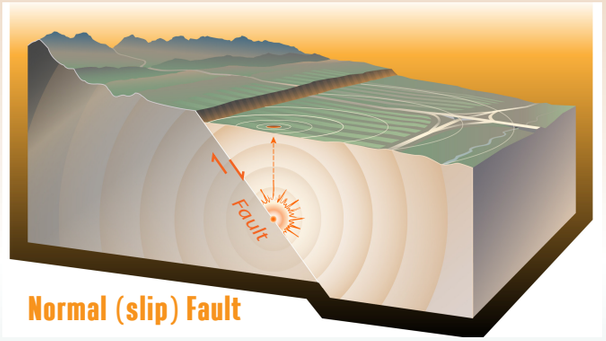
Organize disaster supplies. Everyone should have personal disaster supplies kits. Keep them where they can be reached even if your building is badly damaged. The kits will be useful for many emergencies. Include medications, first aid kit, water for 3 days, snack food high in calories, personal hygiene supplies, toiletries, flashlight, and batteries.

www.earthquakecountry.org/prepare/

EARTHQUAKES in COLORADO

Faulting

A sudden earth movement along a fault results in an earthquake: the greater the movement, the larger the earthquake. Geoscientists carefully study the particular characteristics of faults and the associated effects caused by ground movement. They can often estimate when the fault last moved and how large the associated earthquake might have been in the geologic past as well as estimating the size of prior earthquakes. In some cases, it is possible to determine how frequently large earthquakes occurred historically on a specific fault.



Normal (slip) Fault

Natural Earthquakes

There are two general types of earthquakes—natural and induced—both occur in Colorado. The primary difference between the two is the force that causes the earthquake. Natural earthquakes are generated through the sudden release of stresses within the earth's crust. Human activities directly contribute to induced earthquakes.

Induced Earthquakes

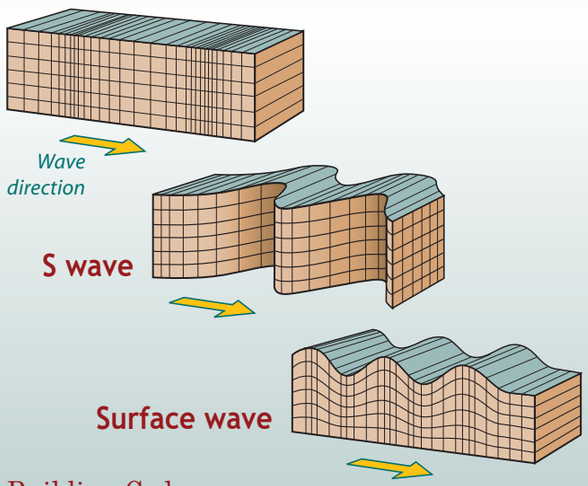
Typically, a large volume of wastewater is produced when oil, natural gas, or coalbed methane is extracted from the earth. The water often contains elevated concentrations of salts and metals and is not suitable to drink or to discharge onto the ground surface. Due to the expense of treating this wastewater, oil and gas companies usually dispose of the water back underground in deep injection wells. The results of injection can change the state of natural stresses in the earth's crust and may trigger earthquakes. Induced earthquakes may also occur from geothermal energy production, mining activities, and filling of large reservoirs.

Historic (Pre-Instrument) Earthquakes

Estimating the locations and magnitudes of historic earthquakes—those prior to the advent of modern scientific instruments—is important for understanding future earthquake hazards. For earthquakes that occurred in human occupied places, geoscientists can estimate the locations and magnitudes from written reports of shaking and damage. They may also use evidence in the geologic record to estimate the timing and size of prehistoric earthquakes.

Seismic Waves

When an earthquake occurs, the ground shakes in waves. A seismometer is an instrument that records the arrival of those waves which travel at different speeds through the earth. Pressure (or "P") and shear (or "S") waves travel through the interior of the earth and are called body waves. The most damaging type of waves, though, are called surface waves. These waves travel relatively slowly at the earth's surface, and typically cause the largest displacements and hence the greatest damage.



Building Codes

The adoption of current and locally applicable building codes is an important first step to strengthen a community's resilience to earthquakes and other hazards. Building codes rely on U.S. Geological Survey (USGS) hazard maps. These are based on prior known earthquake events and fault locations along with their seismic history. Given that the maps are periodically updated, building codes also need regular review. It is important for state and local governments to adopt and enforce the most recent building codes for their area.

COLORADO'S EARTHQUAKE and FAULT MAP

1882 Earthquake (6.6)

The largest historical earthquake in Colorado occurred on November 7th, 1882. There were no seismographs yet to record the event so the exact location is uncertain. However, geoscientists generally conclude that the quake was centered in the northern Front Range, northwest of Denver. With an estimated magnitude of 6.6, the earthquake was felt over the northern half of Colorado, as well as southern Wyoming, eastern Kansas, and Utah. The causative fault has not been conclusively identified.

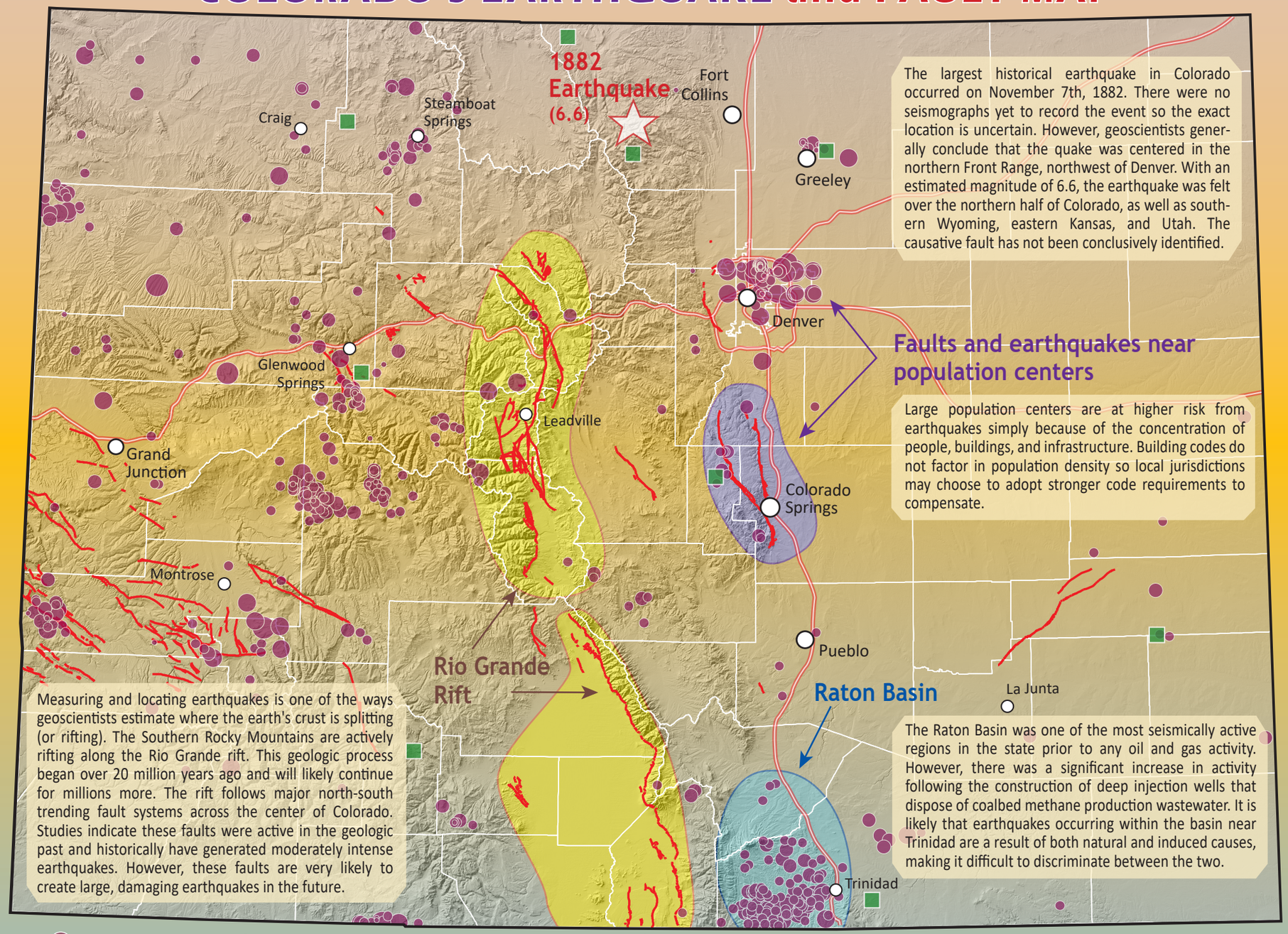
Faults and earthquakes near population centers

Large population centers are at higher risk from earthquakes simply because of the concentration of people, buildings, and infrastructure. Building codes do not factor in population density so local jurisdictions may choose to adopt stronger code requirements to compensate.

Measuring and locating earthquakes is one of the ways geoscientists estimate where the earth's crust is splitting (or rifting). The Southern Rocky Mountains are actively rifting along the Rio Grande rift. This geologic process began over 20 million years ago and will likely continue for millions more. The rift follows major north-south trending fault systems across the center of Colorado. Studies indicate these faults were active in the geologic past and historically have generated moderately intense earthquakes. However, these faults are very likely to create large, damaging earthquakes in the future.

Raton Basin

The Raton Basin was one of the most seismically active regions in the state prior to any oil and gas activity. However, there was a significant increase in activity following the construction of deep injection wells that dispose of coalbed methane production wastewater. It is likely that earthquakes occurring within the basin near Trinidad are a result of both natural and induced causes, making it difficult to discriminate between the two.



Earthquake epicenters (size denotes relative strength)

Known or suspected fault displacement of Quaternary deposits (approx. past 2.6 million years)

Seismic monitoring station (CGS network)