Resource from animation found at: <http://www.iris.edu/hq/inclass/search>

**Narration from the animation:**

**Alaska: Tectonics & Earthquakes**

The circum-Pacific region is dominated by subduction zone plate boundaries that not only produce 80% of earthquakes worldwide, but has over 400 active volcanoes, earning the title “Pacific Ring of Fire”. The earthquake belt sweeps through Alaska where more earthquakes occur than in the other 49 States combined, *and* it is home to the second-largest earthquake ever recorded.

Pacific–North American plate interactions dominate Alaskan tectonics. The Queen Charlotte transform fault, a right-lateral strike-slip fault, accommodates the northwest motion of the oceanic plate. The megathrust boundary between the Pacific and North American Plates results in both the 4,000-km-long Aleutian Trench and in the arc of active volcanoes that lie subparallel to the trench. Note that the North American Plate is oceanic beneath the western Bering Sea, and continental adjacent to mainland Alaska.

Lithospheric plates are spherical shells similar to pieces of an eggshell resulting in changing rates and directions during movement on a spherical surface. Along the immense length of the Aleutian Trench, the subduction rate increases from 5.5 cm/yr in the Gulf of Alaska, to 7.8 cm/yr in the Near Islands region where relative motion is highly oblique and the plate boundary is mostly right-lateral strike-slip.

In addition to the changing rate and direction of subduction, the *angle* of subduction changes from steep in the west to shallow in the east. A seismic cross section through the Andreanov Islands shows how earthquakes outline the subduction geometry. To 70 km depth, earthquakes are concentrated along the plate boundary but also occur within both plates near the boundary. Below 70 km depth, earthquakes occur only within the relatively cold, and therefore brittle, subducting plate. Volcanoes are located above the point where the top of the Pacific Plate has subducted to about 70 km depth about 170 km from the trench. Melting of mantle rocks just *above* the subducting plate, *not* melting of the subducting plate itself, generates the magma that supplies these volcanoes. The Pacific Plate subducts at a shallower angle beneath Shumagin Bank and the distance from the trench to volcanic arc has increased to 360 km. Beneath Cook Inlet, the subduction angle becomes very shallow and the distance from the trench to the volcanic arc increases to 420 km, one of the largest in the world**.**

Since 1900, six Great megathrust earthquakes, *above magnitude 8* , have occurred on the Aleutian subduction zone producing destructive tsunamis. Red circles mark the epicenter above the site where fault rupture began, whereas yellow shows the area on the megathrust fault that ruptured. A great earthquake also occurred in 1949 on the Queen Charlotte transform fault.

Alaska has over 24,000 measured earthquakes every year with, on average, a *major M7* event every 2 years. By examining the pattern of seismic activity of *all* earthquakes greater than magnitude 4 during the same 15-year period, we see the expected patterns of shallow to deep earthquakes along the Aleutian subduction zone and shallow earthquakes along the Queen Charlotte Transform Fault. In addition, there are hundreds of earthquakes far north of these plate-boundary faults, especially in the mountainous south central part of Alaska. **Accretion of the Yakutat terrane** is largely responsible for the tectonic and earthquake activity to Fairbanks and even farther north. But what is geologic terrane and how does accretion deform continental crust into mountains and break it into crustal blocks that grind past each other on crustal faults?

A terrane is an assemblage of rocks that were transported far from where they formed and are distinct from surrounding rocks. To show how accreted terranes form, we begin with a generic ocean-continent subduction zone. As sediment is scraped off the top of the subducting oceanic plate, an accretionary wedge builds on the continental plate margin. An oceanic plateau with thick and therefore buoyant crust is traveling on the oceanic plate. When the plateau reaches the trench, it cannot easily subduct and instead collides with and wedges beneath the continental margin. Terrane collision deforms the continental margin into a new mountain range and slows the subduction process with resulting decrease in magma supply to the volcanic arc. The plateau may continue wedging beneath the continent for millions of years causing deformation and uplift of an immense new mountain range. Although the following process is not occurring in Alaska, eventually the oceanic plate, still driven by tectonic forces, *could* buckle and break to form a new subduction zone outboard of the accreted terrane. In that case, magma generation would resume to form a new volcanic arc.

The Yakutat terrane is an oceanic plateau that traveled northwest on the Pacific Plate. It is bounded by the Queen Charlotte-Fairweather transform fault, the Chugach-St. Elias thrust fault, the Aleutian megathrust, and the Transition fault on the south. About 25 million years ago, the Yakutat terrane began colliding with and wedging beneath the continental margin. The top of the subducting plate directly below Anchorage is only 50 km deep 400 km from the trench. Because Yakutat crust is thicker and more buoyant than the Pacific oceanic crust to the southwest, the Yakutat megathrust boundary is an interface of very high friction. Indeed the M 9.2 1964 Great Alaska Earthquake rupture started on that thrust-fault boundary then progressed along the Aleutian megathrust to the southwest.

GPS observations indicate that the Yakutat terrane is still moving northwest at about 5 cm per year. The ongoing collision is thickening the crust and uplifting the Chugach and St. Elias ranges into some of the tallest and steepest mountains on Earth.4

In addition to local mountain building, Yakutat terrane acts like a geologic snowplow as it shoves immense blocks of crust into counterclockwise rotation.Because the effects of Yakutat collision decrease to the north, crustal block rotation is faster between the Chugach-St. Elias thrust fault and the Castle Mountain Fault, and slower between the Castle Mountain and the Denali faults Right-lateral strike-slip faulting along the Castle Mountain and Denali faults is caused by decreasing rate of block rotation . Both faults experience major earthquakes.

The 2002 magnitude 7.9, Denali Fault Earthquake rupture initiated on a previously unknown thrust fault, produced up to 8 meters of right-lateral displacement on Denali fault, then branched onto the Totschunda fault for a total rupture length of 340 km. Strong ground shaking caused large rock avalanches from steep-sided valleys. This major earthquake triggered sequences of small earthquakes up to 3600 km away in southern California and even affected geothermal activity at Yellowstone caldera in Wyoming.

In the earthquake hazard map for Alaska, regions near the subduction zone and the Queen Charlotte Transform Fault are clearly high-risk zones. In addition, the earthquake hazards are high in the region affected by Yakutat terrane collision and resulting crustal faults to the north.