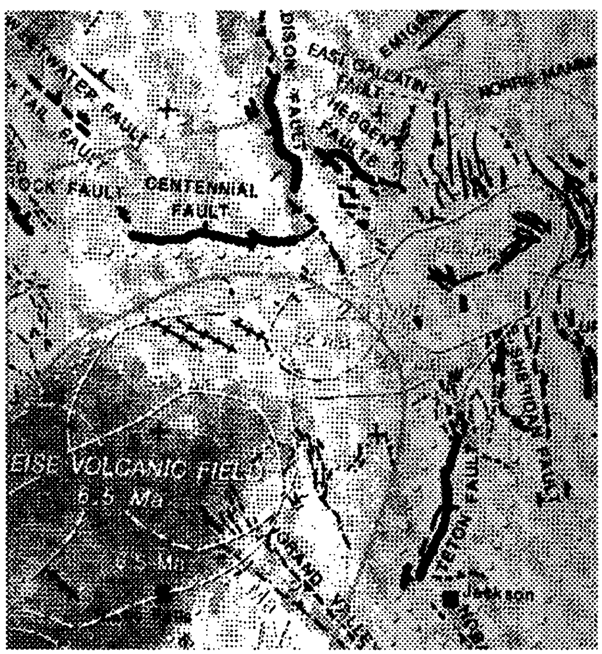
Earthquakes and Faulting, Northeast Margin of the Snake River Plain: a 35 mm Slide Set for Earth Science Educators

Roy M. Breckenridge
Kurt L. Othberg



Staff Reports present timely information for public distribution.
This publication may not conform to the agency's standards.

Staff Report 95-4
June, 1995

Idaho Geological Survey
University of Idaho
Moscow, Idaho 83844-3014

Earthquakes and Faulting, Northeast Margin of the Snake River Plain: a 35 mm Slide Set for Earth Science Educators

Roy M. Breckenridge and Kurt L. Othberg

INTRODUCTION

This is the second in a series of 35 mm slides intended as a classroom aid for earth science education with special emphasis on the geology of Idaho. The content is appropriate for any audience that has a minimal amount of background information about earthquakes. The instructor can determine the technical level of a presentation. Additional classroom materials covering the topics of geomorphology or landforms as well as tectonic and volcanic processes would be useful, particularly with advanced students. We originally produced these photographs for the Second Annual Idaho Earthquake Field Workshop in July of 1994. The workshop was conducted by the Idaho Geological Survey and sponsored by the Idaho Bureau of Disaster Services and the Federal Emergency Management Agency.

DESCRIPTIONS OF SLIDES

1. **Title slide**

2. **Digital physiography of the western United States.** Mountain ranges and valleys reflect tectonics (mountain building processes) at work. A pattern of basin and range faulting dominates the southwestern U.S. interior as far north as Oregon and Idaho. The track of the Yellowstone hot spot is shown by the eastern Snake River Plain. (Illustration from *Landforms of the Conterminous United States—A Digital Shaded Relief Portrayal*, by G.P. Thelin and R.J. Pike, U.S. Geological Survey Map I-2206, 1991.)

3. **The path of the Yellowstone hot spot across eastern Idaho.** The hypothesized hot-spot path has been compared to the shape of a comet with basalts of the eastern Snake River Plain in the wake and giant calderas (explosive volcanic fields) developed at the head. The calderas become younger eastward with the migration of the hot spot which is now under Yellowstone Park (actually, the North American Plate is moving westward

over the hot spot). Deformation of the earth's crust around the "halo" of the hot spot has produced a pattern of extensional faulting. This zone of active faults has undergone the two largest earthquakes in the conterminous United States in the last 40 years: the M 7.5 Hebgen Lake earthquake in 1959 and the M 7.3 Borah Peak earthquake in 1983. (Illustration from *The Track of the Yellowstone Hot Spot*, by K.L. Pierce and L.A Morgan, Geological Society of America Memoir 179, 1992.)

4. **False-color infrared LANDSAT image of the Henrys Lake region**. Henrys Lake is at center. Hebgen Lake is upper right and Earthquake Lake and the Madison Canyon landslide are at upper center. The Centennial Range is the prominent east-west trending range at the bottom left. The Yellowstone Plateau is on the right. The Yellowstone National Park boundary is marked by the edges of timber clear-cuts.

5. **Northward view of the Madison Range near Madison Canyon.** Note the steep and uneroded appearance of the range front. The Madison Range fault line is visible at the break in slope about one-fourth up the front of the range. The fault is "normal" with the mountain range moving up and the valley moving down. Small scarps formed along the Madison Range Fault during the 1959 earthquake.

6. **Index map of the Hebgen Lake Earthquake area of the Gallatin National Forest.** The map shows the location of faults and the local geography.

7. **View along the 1959 scarp of the Hebgen Lake fault at Cabin Creek.** The 8-mile-long rupture cut through this campground area and displaced the ground surface as much as 21 feet. The fault is "normal." The right side in the view moved up; the left side moved down.

8. **View of 1959 scarp of the Red Canyon Fault.** Rupture of this fault in the 1959 earthquake was 14 miles long and formed waterfalls, fissures, ground cracks, landslides, and rockfalls. Motion on the fault here is "normal" with the geologists on the upthrown block and the viewer on the downthrown block.

9. **View of the Madison Range and canyon from Missouri Flats.** The Madison Canyon Slide is visible in the canyon. The landslide came from the southern side of the canyon (note the scar) and traveled across the canyon and up the other side. The terraces along the Madison River represent episodes of glaciation and tectonic activity.

10. **Aerial view of the Madison Canyon Slide.** This massive debris slide was triggered by the August 17, 1959, M 7.5 Hebgen Lake Earthquake. The landslide debris is about a mile long and three-quarters of a mile wide and contains over 80 million tons of rock.

11. **"Tragedy."** This U.S. Forest Service display describes the loss of life and other effects of the landslide.

12. **View of the portion of the slide that traveled up the north side of the canyon**. The large dolomite boulders are part of the rock layer that failed during the earthquake. As the dolomite began to move, the mountainside of weaker schists and gneisses also gave way and slid. The largest boulder contains a bronze memorial to the 28 people who died from the earthquake.

13. **Mass Movement Classification after C.F.S. Sharpe.** This classification is based on the type of earth material, water content, and rate of movement of the landslide. Gravity is the driving force. The Madison Canyon landslide is classified as a debris slide.

14. **View of the landslide scarp from north.** Seconds after the earthquake, the dolomite buttress at the base of the slope gave way, and the schist and gneiss that form the rest of the 1,300-foot-high slope rapidly failed. The mass moved at speeds approaching 100 miles an hour. When it came to rest in the middle of the canyon, the landslide debris was 225 feet thick and dammed the Madison River. The lake, named Earthquake Lake, immediately began to fill the valley behind the dam. In anticipation of a possible failure of the landslide dam and a catastrophic emptying of Earthquake Lake, the U.S. Army Corps of Engineers excavated an emergency spillway through the landslide debris.

15. **View of Earthquake Lake formed behind the landslide dam on the Madison River.** Water from huge waves (called seiches) in Hebgen Reservoir sloshed over the top of Hebgen Dam, and the level of the new lake rose quickly. As it rose, Earthquake Lake drowned the old riverbed, Forest Service campgrounds, and U.S. Highway 287. The rising water reached a maximum level of 50 feet above the present lake level before the Corps of Engineer's spillway was completed.

16. **View of the Madison River downstream from the landslide**. This stretch of the Madison River is braiding in response to the increased stream load caused by the landslide debris. Presently it is eroding material from the upthrown Madison Range and filling the down-faulted Mission Flats valley. In response to the 1959 tectonic event, the river will eventually incise the braided channel and leave a terrace. Eventually the river will incise the braided channel and leave a terrace—a physical record of the 1959 tectonic event.