The Borah Peak Earthquake: a 35 mm Slide Set for Earth Science Educators

Kurt L. Othberg
Roy M. Breckenridge

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University of Idaho
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INTRODUCTION

This is the first in a series of 35 mm slide sets intended as classroom aids 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 assembled a similar slide set in conjunction with the First Annual Idaho Earthquake Field Workshop in July of 1993. The workshop was conducted by the Idaho Geological Survey and co-sponsored by the Idaho Bureau of Disaster Services, the Federal Emergency Management Agency, and the Idaho Earth Science Teachers Association.

DESCRIPTION OF SLIDES

1. **Title slide.**

2. **False-color infrared satellite view of the basins and ranges north of the Snake River Plain.** The tectonic processes (mountain building forces) are reflected in the great relief among the mountain ranges and valleys of central Idaho. This pattern of basin and range faulting is characteristic of the southwestern U.S. interior and extends northward into Oregon and Idaho. The Lost River Range is in the lower center of view. The Lemhi Range is upper center. The town of Challis is left of center. The epicenter of the 1983, magnitude 7.3, Borah Peak earthquake and the aftershocks are shown by yellow circles. The segment of the Lost River Range fault that moved during the 1983 earthquake is shown by a yellow line. The pattern of these earthquakes shows the activity on the fault segment along which the Lost River Range moved up and the adjoining valley moved down.

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 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 Lost River Range fault, seen in the left center of the view, is 160 miles from Yellowstone, but the active fault and the M 7.3 Borah Peak earthquake in 1983 prove the earth's crust there is still reacting to the great stretching caused by passage of the hot spot. (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. **View of the Lost River Range looking east from Thousand Springs.** Borah Peak, highest mountain in Idaho at an elevation of 12,662 feet, is left of the center skyline. The fault scarp, along which Borah Peak rose during the 1983 earthquake, is near the base of the sunlit slope. Rock Creek valley is on the left side of the view. The photograph was taken from the surface of a broad alluvial fan seen in the lower third of the view. This alluvial fan is part of the sediment accumulated in the valley that has dropped down along the fault.

5. **View from helicopter of fault scarp in bedrock at Rock Creek.** In this view, the foreground (the valley side of the fault) is alluvium, and the mountain side of the fault is bedrock. During the earthquake moved the bedrock and Borah Peak up and the alluvium down. Rock Creek, like the other creeks flowing westward out of the Lost River Range, has been cutting down through the bedrock as the mountains rise and has been filling in alluvium on the other side of the fault as the valley drops.

6. **View from a helicopter looking southeast along the fault scarp.** The subsided ground at the fault is a graben formed along the fault trace. Note the offset in the road and the vehicles and people for scale. This view shows the disruption of the surface of one of the alluvial fans as the valley side of the fault (right side of view) not only dropped but pulled away from the mountain side of the fault. Here, Willow Creek has been depositing sediment across the fault, but movement on the fault during the Holocene has been faster than erosion and deposition can smooth the ground rupture features.

7. **Northwest side of Rock Creek valley showing fault displacement of an irrigation aqueduct.** In this view the apex of Rock Creek's alluvial fan is cut by the fault. The concrete irrigation aqueduct originally curved down across an old scarp formed during an earlier earthquake-generating fault movement. The 1983 fault movement broke the aqueduct as seen in this view.

8. **View from a helicopter, looking northeast along Doublespring Road across the fault scarp.** Willow Creek is on right side of view. Use the size of the vehicles and people on the road for judging scale. Note that the road is offset both vertically and horizontally; it shows evidence

for strike-slip as well as dip-slip movement on the fault.

9. **View of the fault scarp, looking northeast from Doublespring Road, showing vertical offset of the road.** A downward curve of the up-thrown side of the fault is a relict from an earlier earthquake-generating fault movement. Vertical displacement of the ground along the fault during the 1983 earthquake is approximately the height of the freshly broken ground, or somewhat more than the height of the people standing nearby.

10. **View of Birch Springs landslide taken from near the trace of the fault.** The headwall scarp of the landslide forms the freshly broken ground across the upper center of the view. Around the world, landslides are associated with strong earthquakes. New movement on this landslide was initiated by the 1983 earthquake. As the ground shook, it weakened here and slid. There is evidence of water and debris that flowed down slope from the headwall of the landslide and across the fault.

11. **View of the headwall and rotated blocks in the upper part of the Birch Creek landslide.** Note the sag ponds impounded by the rotated blocks. The landslide probably started at the same time as the intense earthquake vibrations, but because landslide debris covers the fault scarp, the landslide was active longer than the time it took for the fault scarp to form.

12. **Aerial view at Chilly Buttes shortly after the earthquake.** This view shows the northeast corner of Chilly Buttes where the bedrock of the buttes joins the alluvium of Thousand Springs valley. Large volumes of water are discharging from crevasses in the bedrock. These crevasses probably connect to faults and fractures at depth under the buttes. The intense shaking tended to reduce the pore space in the saturated valley sediments, and the excess water was squeezed out onto the land surface. Also, during the earthquake, the valley dropped, suddenly lowering the land surface relative to the water table.

13. **View of one of the sand boils near Chilly Buttes.** During the earthquake, shaking caused the eruption of ground water and sand through the alluvium. These "sand boil" features occur when some of the alluvium liquefies as the excess water is squeezed out of the ground. This phenomenon, called liquefaction, and the resulting sand boils are common features associated with earthquakes.

14. **Geologists study a trench excavated across the fault scarp near Doublespring Road.** Trench studies help geologists interpret not only the fault movement during the most recent earthquake but also the evidence for ancient fault movements and keys to determining the ages of those movements. This trench provided evidence confirming the presence of an old fault scarp that may have formed during an earthquake about 10,000 years ago.

15. **Foundation separation near Chilly Buttes caused by liquefaction.** The rapidly rising water table and earthquake shaking in the Thousand Springs valley not only caused flooding but also liquefaction of soft sediment below the surface. During liquefaction, the sediment loses most of its strength and can move laterally, even on gentle slopes. The building foundation, seen here

separated from the walkway, is a result of liquefaction movement.

16. **Ground cracks and separation in ranch building also caused by liquefaction during the earthquake.** Ground cracks do not actually represent motion on the fault but movement in the overlying unconsolidated alluvium and soil. These secondary fractures often cause more damage than the rupture along the fault.

17. **Earthquake damage to the Custer Hotel in Mackay.** One of the most severe hazards to people during earthquakes is falling masonry and parapets. This view shows the low strength of untied brickwork when shaken by horizontal earthquake forces.

18. **Car crushed by debris from earthquake-damaged building in Mackay.** Falling bricks can be killers!

19. **Earthquake damage to the IGA store in Mackay.** Many attachments to buildings have strength in the vertical direction only, i.e., strong enough to prevent falling due to gravity. Strong horizontal forces during the earthquake knocked down this store-front cover, and presented an extreme hazard to people trying to exit the building.

20. **Aerial view of Challis and rockfall hazard area.** We are all aware of large boulders found at the bases of steep slopes, especially in central Idaho. Numerous boulders toppled and fell from high perches throughout a large area affected by strong earthquake shaking during the 1983 Borah Peak earthquake and aftershocks. In Challis, some of the boulders fell and rolled right into the town. This aerial view shows how precariously close the bouldery cliffs are to part of Challis's residential area.

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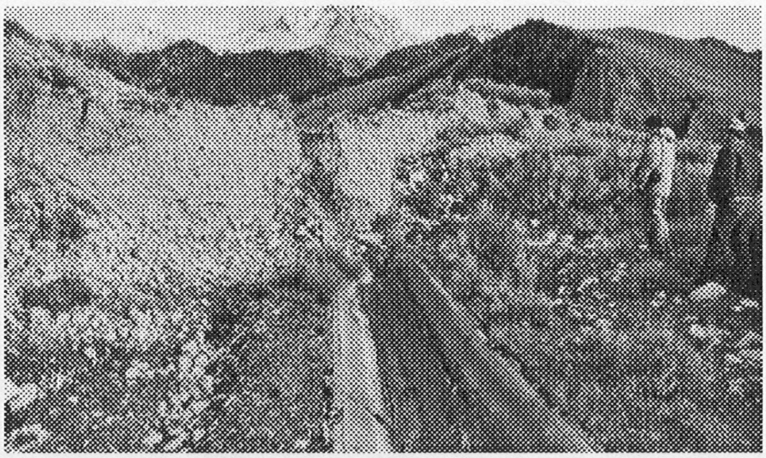

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