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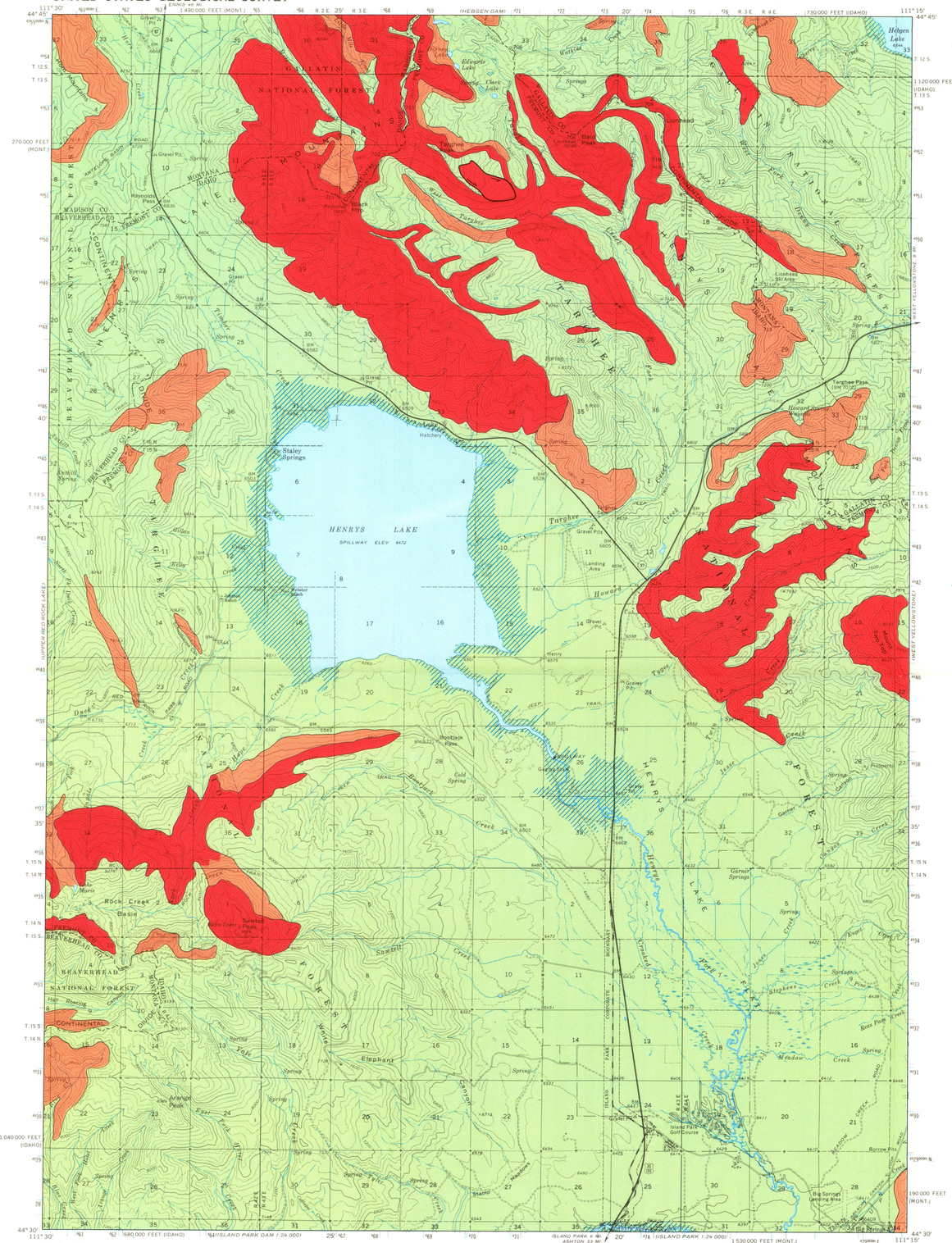


Base from U.S. Geological Survey, 1964
10,000-foot grids based on Idaho coordinate system, east zone and Montana coordinate system, south zone
1000-meter Universal Transverse Mercator grid ticks, shown in blue

SCALE 1:62500
CONTOUR INTERVAL 80 FEET
DATUM IS MEAN SEA LEVEL

# MAP SHOWING SEICHE, ROCKSLIDE, ROCKFALL, AND EARTHFLOW HAZARDS IN THE HENRYS LAKE QUADRANGLE, IDAHO AND MONTANA

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FOLIO OF THE
HENRYS LAKE QUADRANGLE, IDAHO—MONTANA
MAP I-781-C

## EXPLANATION

This map is one in a series that depicts the geologic events, such as ground breakage, landsliding, and seiches (periodic oscillations of standing bodies of water such as lakes), which will occur if the area is shaken by a major local earthquake. Such a possibility is very real, for on the Seismic Map of the United States (Algermissen, 1969) the Henrys Lake quadrangle is wholly within seismic risk zone 3, defined as an area in which "major destructive earthquakes may occur."

Area that will probably be flooded by seiche

A *seiche* is a periodic oscillation of a body of water in a containing basin. If this area were shaken by a major local earthquake the waters of both Henrys Lake and Hebgen Lake would almost certainly be thrown into periodic oscillations during which the lake shores would be successively inundated for brief periods of time. (It is much as if a person carrying a basin of water were inadvertently jostled. The water would slosh back and forth, and might even top the basin's sides.) During the seiche it is likely that some waters would top Henrys Lake outlet dam and flow southeastward, following the Henrys Lake outlet, and spread across the basin floor. Henrys Fork might also swamp parts of its flood plain for brief periods.

If the outlet dam were to fail – a remote possibility – it is estimated that about 80,000 acre-feet of water would fan out across the southern end of the Henrys Lake basin. Although some water would seep into the porous sands and gravels which floor the basin, much of the water would escape downstream following Henrys Fork. Ultimately these waters would discharge into the Island Park reservoir.

Estimates of the shape and extent of those areas likely to be flooded by seiches are based on three assumptions. First, the earthquake will be a major local one; second, the lakes will be at near capacity when the earthquake occurs; and third, during the first surges of the seiches the lakes will flood their shores to a level about 30 feet higher (as measured vertically, not horizontally) than their pre-earthquake levels. So, for Henrys Lake, the surface of which is at an altitude of about 6,472 feet when the lake is full, the waters may extend as far inland as the 6,500-foot contour (6,472 feet + 30 feet = 6,502 feet). For Hebgen Lake, whose surface is at an altitude of 6,544 feet when the lake is near capacity, the waters may flood all ground below the 6,575-foot contour (6,544 feet + 30 feet = 6,574 feet).

Judging by the action of Hebgen Lake during the 1959 earthquake, once the seiche has subsided, Henrys Lake will reflect the tilting of the block of the earth's crust on which it rests. Parts of its shoreline will be flooded even as the lake floor on the opposite side of the lake is exposed. The basin (in the example above) will have been tilted, and the surface of the water as it comes to rest after sloshing back and forth will act as a level to indicate the amount of tilt.

The periodic flooding that occurs during a seiche is short-lived and gradually subsides; by contrast, the lake shores that are submerged when the seiche ends will be permanently flooded. A block of the earth's crust containing the lake within its confines and possibly measuring hundreds of square miles in area will have shifted and it cannot rebound to its original position.

ZONE 1 – Area in which rockslides, rockfalls, or earthflows are very likely to occur if area is shaken by a major local earthquake

ZONE 2 – Area in which rockslides, rockfalls, or earthflows may occur if area is shaken by a major local earthquake

ZONE 3 – Area in which rockslides, rockfalls, or earthflows are unlikely to occur if area is shaken by a major local earthquake

Rockslides, rockfalls, or earthflows would occur in virtually all of the mountainous parts of the area if one of the active faults in the Henrys Lake quadrangle were to move and so cause an earthquake. Most of these landslide[1] phenomena would be small, but a few might be large enough to cause considerable damage.

The division of this quadrangle into three zones of hazard is based mainly on similar phenomena that occurred in the nearby Hebgen Lake area during the earthquake of August 17, 1959. In that area falling debris characterized practically every steep slope (45 percent gradient and greater). In most places the falling debris consisted of isolated boulders dislodged by the shaking of the earth, but in a few areas extensive rockslides and rockfall and debris avalanches occurred. In general, the number and intensity of the rockfalls mirrored the steepness of the slopes, and in one locality an earthflow lubricated by water slowly began to move a week after the earthquake. These various phenomena caused little damage to manmade structures, chiefly because few existed to be harmed.

The potential danger from such large numbers of falling boulders is great, however, and so on this map every steep slope has been placed in Zone 1 – "rockslides, rockfalls, or earthflows are *very likely to occur* if the area is shaken by a major local earthquake."

As individual falling boulders were much less common on the less steep slopes in the Hebgen Lake area, slopes of moderate gradient (25-45 percent) in the Henrys Lake quadrangle have been grouped in Zone 2 – "rockslides, . . . *may occur* . . ."

Large parts of Zone 3 – "rockslides . . . *unlikely* to occur . . ." – are virtually flat or have slopes that do not exceed 15 percent. Some insignificant movement of earth materials is likely on the broad flats of the Henrys Lake basin but will probably be confined to small sand and silt flows along stream embankments. A few boulders perched on some of the more gentle slopes may move short distances, but these too are likely to be of little consequence.

ROCKFALL AVALANCHE – A large potential rockfall avalanche is near the junction of West Targhee Creek with Targhee Creek. Here an enormous partly fragmented slump, shown on this map by a heavy outline, is precariously perched about a thousand feet above the streams, seemingly waiting to be jostled so that it can avalanche into the valleys and effectively block them.

ROCKFALLS – Although in some areas sizable piles of loose rock (rockslides and debris avalanches) would slide to lower altitudes, most of the rockfalls would involve single boulders, some as much as 15 feet on a side, which would literally bounce down the mountainsides until they came to rest in the valleys below. Thousands of boulders of all sizes did this during the Hebgen Lake earthquake.

EARTHFLOW – The term earthflow denotes the downslope movement of a large mass of moist to saturated unconsolidated debris. During an earthquake the springs so common at the head and along the flanks of an earthflow may increase their flow. The added water overcomes the friction between the earthflow and the ground on which it rests, and renewed movement of the earthflow becomes inevitable. Of the earthflows in the Henrys Lake quadrangle, one of the largest is at the head of the West Fork of Denny Creek in the northeast corner of the quadrangle. A much smaller earthflow is along the valley wall between the mouths of Tygee and Targhee Creeks. The access road for a development of summer homes crosses the earthflow, and the road is certain to be broken if the earthflow moves.

In addition to this renewed movement of the "old" established earthflows, new earthflows may be formed in various localities where partly saturated unstable units, mainly till, siltstone, and shale, crop out.

[1] The term "landslide" is used here in its broader sense of downward and outward movement of all earth materials.

Slump block – Arrows indicate direction of movement

## REFERENCE

Algermissen, S. T., 1969, Seismic risk studies in the United States: World Conference on Earthquake Engineering, 4th, Santiago, Chile.

For sale by U.S. Geological Survey, price 75 cents