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141. GRAVITY, VOLCANISM, AND CRUSTAL DEFORMATION IN THE EASTERN SNAKE RIVER PLAIN, IDAHO

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A regional gravity survey in the eastern part of the Snake River Plain, Idaho, was made in 1961 as a continuation of the gravity network established by Hill and others (1961) in the western part of the Snake River Plain. Seven hundred and seven gravity stations were established, and the measurements were reduced to the simple-Bouguer anomaly assuming a density of 2.67 g per cm^3 for the rocks above sea level. The resulting data were plotted on a map and contoured at an interval of 10 milligals (fig. 141.1).

The Snake River traverses more than 400 miles from the Teton Mountains, Wyo., across southern Idaho to the Oregon-Idaho border. Over most of this course it follows the crescent-shaped, broad structural depression known as the Snake River Plain, most of whose 19,000 square miles is north of the river. The plain

can be divided into two parts, western and eastern, approximately along long $114^{\circ}30' \text{ W}$. The western plain trends west and northwest; the eastern plain trends east and northeast.

The low gravity relief of the eastern plain strongly contrasts with the high-amplitude anomalies of the western plain (Hill and others, 1961). There are four major gravity features in the eastern plain: (1) a broad high, which is an extension of the series of large gravity highs of the western plain; (2) a set of elongated, alternating lows and highs which trend normal to the axis of the eastern plain; (3) a series of small local highs on the southern and southeastern boundaries of the plain; and (4) a prominent low, centered over Mud Lake, in the northern part of the surveyed area (fig. 141.1).

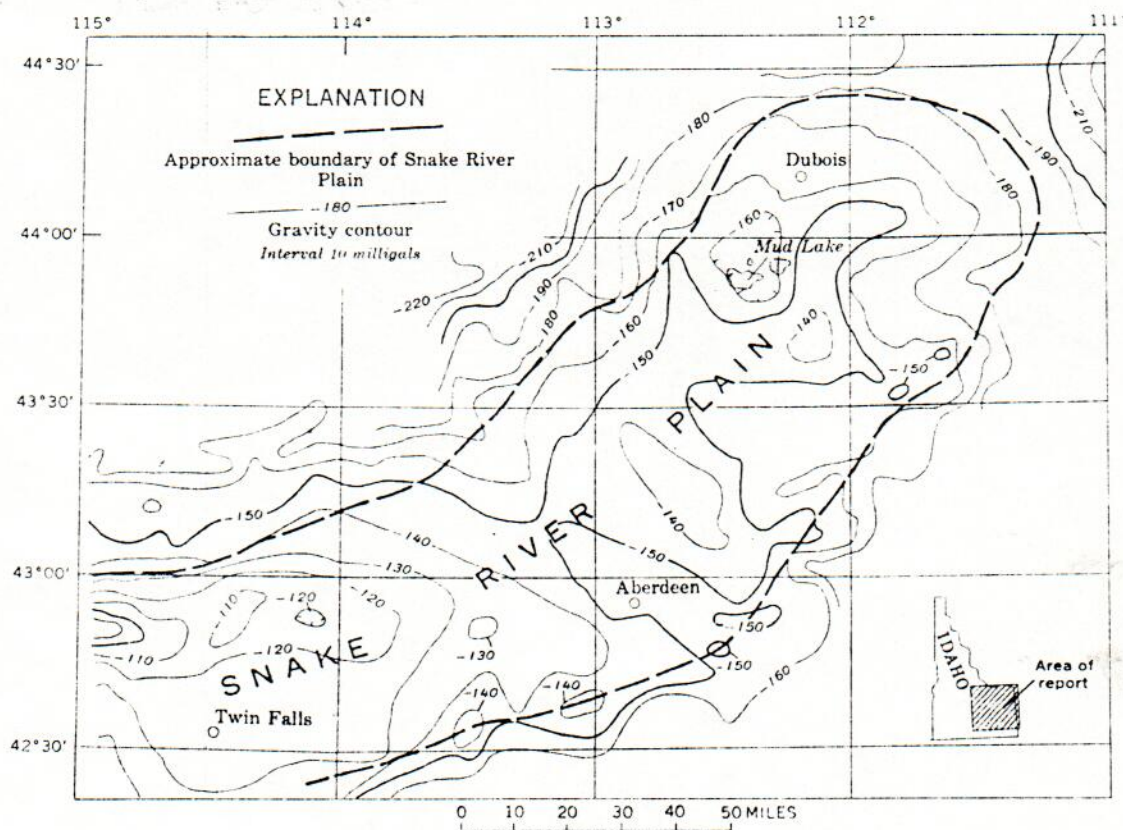


FIGURE 141.1—Simple Bouguer-anomaly map of the eastern Snake River Plain, Idaho.

Snake River Basalt of Quaternary age is exposed at the surface over almost all of the eastern plain. Because the steepest gravity gradients occur over the mountains to the north and south of the eastern plain (in some places a considerable distance away from the edge of the basalt) it is presumed that these gradients, for the most part, result from large-scale geologic features. The generalized regional gravity anomaly could be caused by a local upward displacement of the base of the earth's crust of about 6 km, from a normal crustal thickness of about 40 km. This estimate is based on depth estimation formulas (Bott and Smith, 1958; LaFehr, 1962) and two-dimensional graticule analysis.

RELATIONS OF GRAVITY AND GEOLOGY

The alternating lows and highs imply relatively near-surface geologic relief, although that relief may not be directly related to the mountains whose axes are cut nearly at right angles by the Snake River Plain. Of particular structural importance is a widespread series of silicic volcanic rocks (largely rhyolite) of Miocene or Pliocene age that underlie the basalts of the Snake River Group. These silicic volcanic rocks occur in the mountains on both sides of the plain. Because they tend to dip toward the plain, Kirkham (1931, p. 471-481) concluded that the plain had been downwarped. Geologic and drilling information indicate that the rhyolite floor under the later basalt flows has considerable relief, which implies a variation in near-surface densities that could cause the gravity anomalies. With an assumed density contrast of about 0.3 g per cm³ between the basement complex and the denser basalt, residual anomalies reveal thickness variations of the basalts of Quaternary age ranging from a few hundred to as much as 5 thousand feet.

The gravity low at Mud Lake (fig. 141.1) is attributed to an accumulation of less than 2,000 feet of lacustrine deposits that crop out over a wide area in this part of the plain. This estimate is based on an assumed density contrast of -0.5 g per cm³.

COMPARISON OF THE EASTERN AND WESTERN PLAINS

The remarkable difference between the gravity fields of the eastern and western parts of the Snake River Plain demands a searching inquiry for other differences—geologic, topographic, or tectonic—which are, as yet, not established in the literature. The change in the gravity pattern occurs approximately where the axis of the plain is most strongly bent. The down-

warp hypothesis (Kirkham, 1931), which has been ruled out for the western plain (Malde, 1959; Hill and others, 1961), remains a possible explanation for the eastern plain. The eastern plain is transverse to the major topographic trends of the region. Fingerlike extensions of the mountain ranges face each other on opposite sides of the plain. The western plain also is bordered by mountains, but their trends do not seem to be so distinctly broken by the plain.

A study of earthquake epicenters in the United States (Woollard, 1958) outlines areas of recent tectonic activity. On the basis of these patterns, Malde (1959, p. 272) states: "The crustal break implied by the gravity measurements is possibly expressed by a line of earthquake epicenters that extends diagonally from Puget Sound, across the Columbia River Plateau, along the northern boundary of the western Snake River Plain, and thence across the plain to northern Utah." This suggests a basic difference between the western and eastern plains: The western plain may be structurally controlled by a major break in the earth's crust; the eastern plain cannot be structurally controlled by this proposed break.

The lava in the western plain probably escaped along or near this crustal break and along adjoining long fissures, giving the gravity field its en echelon character. The main channels of escape for the basalts of the eastern plain, in contrast, may be vents or short fissures, causing the circular and oblong gravity highs along the boundary. It may be significant that they are aligned on the south and southeast boundary. It is perhaps along or near a fault, delineating this edge of the plain, that the magma found its escape.

The extensive fissure flows that predominated in the early formation of the western plain probably filled a large graben. The formation of the eastern depression has almost certainly been accompanied by faulting, but the regional structural control of the western plain is seemingly not a factor in the depression of the eastern plain, as manifested in their different gravity fields, recent tectonic history, and topographic settings. The accumulations of basalt has been less in the east and has filled troughs or valleys in an undulating subsurface floor rather than a large regional graben.

REFERENCES

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Hill, D. P., Baldwin, H. L., and Pakiser, L. C., 1961, Gravity, volcanism, and crustal deformation in the Snake River