Isostatic Deformation of Bonneville Shorelines.

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In order to compare this pattern of observed uplift with the load of water to which it is presumably related, a second map has been prepared showing the depth of water averaged over circles of 40 miles radius (fig. 2). By comparison of figures 1 and 2, and from a consideration of the available data about the chronology of the lake, the following conclusions and working hypotheses have been derived:

(1) The new data fully confirm Gilbert's pattern of isostatic rebound. Elevations of 5,300 feet in several places west of present Great Salt Lake indicate that maximum uplift is about 210 feet. This is at least 70 percent of the theoretical maximum based on the average depths of water shown in figure 2, and an assumed subcrustal density of 3.25.

(2) Regional tilting of the Bonneville basin as a whole is small. The southernmost shorelines, at the end of a long shallow arm that ended about 3 miles south of Lund, stand at an altitude of 5,090 feet compared with the altitude of 5,085 at Red Rock Pass. This value was obtained by adding Gilbert's spirit level determination of the shoreline elevation above Swan Lake station (303 feet) to the elevation USC&GS BM at Swan Lake.

Regional tilting in an east-west direction is largely obscured by isostatic uplift, but there is a suggestion that shorelines along the western margin may average as much as 20 feet higher than those along the east side.

(3) Because the amount of isostatic uplift exceeds 200 feet in the center of the basin and approaches 100 feet along the steepest margins, consideration of geologic events involving the shoreline must take account of these differences of elevation as well as of the time required for isostatic adjustment to occur. For example, the differences in average elevation along the east edge of the lake between the first deposits at the Provo shoreline (4,800) and the second (4,770) may be due largely to the fact that during the Provo I stillstand, the basin was overcompensated owing to the rapid lowering of the water to that level from the immediately preceding Bonneville maximum, whereas during the Provo II stillstand, the basin was undercompensated owing to the preceding nearly empty condition.

(4) It is generally assumed that the Alpine cycle was longer than the Bonneville. If this is true, its shore features should be arched up farther in the center of the basin than those of the Bonneville. Data about the relative water level of the two cycles are still very fragmentary, but the few facts available suggest that they coincided closely near the center of the basin, whereas the Alpine deposits fell short of the Bonneville by some 40 feet along the eastern margin. Comparison with the better-known Bonneville warping suggests that Alpine deposits will be found at still lower elevations at the extremities of the basin. This leads to the hypothesis that the Alpine deposits may not extend above altitudes of 5,000 to 5,025 feet in the northern part of Cache Valley.

(5) A protracted high stand during the Alpine cycle, less than 100 feet below the alluvium-filled spill point in Red Rock Pass suggests the existence of a separate rock-defended threshold to control the Alpine water level. Bright (1960) has presented evidence that the Bear River once flowed northward into the Snake River via part of the present course of the Portneuf, and that that northward course was blocked by the extensive Pleistocene lava flows of Gem Valley. The isostatic data suggest that Lake Bonneville itself may at some time have drained northward across a threshold now concealed beneath those lavas.

(6) Comparison of the rates of loading and recovery of Lake Bonneville with those in Scandinavia suggests that the apparent viscosity of the subcrust in the Bonneville area is on the order of 10^{21} poises, compared with a value of 10^{22} poises for Scandinavia.

(7) Post-Bonneville displacements on the Wasatch fault and other normal faults of the Basin and Range province are opposite in direction from those that would be expected due to isostatic unloading of Lake Bonneville. This suggests that the two types of deformation operate independently, and by separate mechanisms; Basin and Range structures seemingly characterize the crust, whereas isostatic processes take place below the crust.

References

Bright, R. C., 1960, Geology of the Cleveland area, southeastern Idaho: Utah Univ. unpublished thesis.

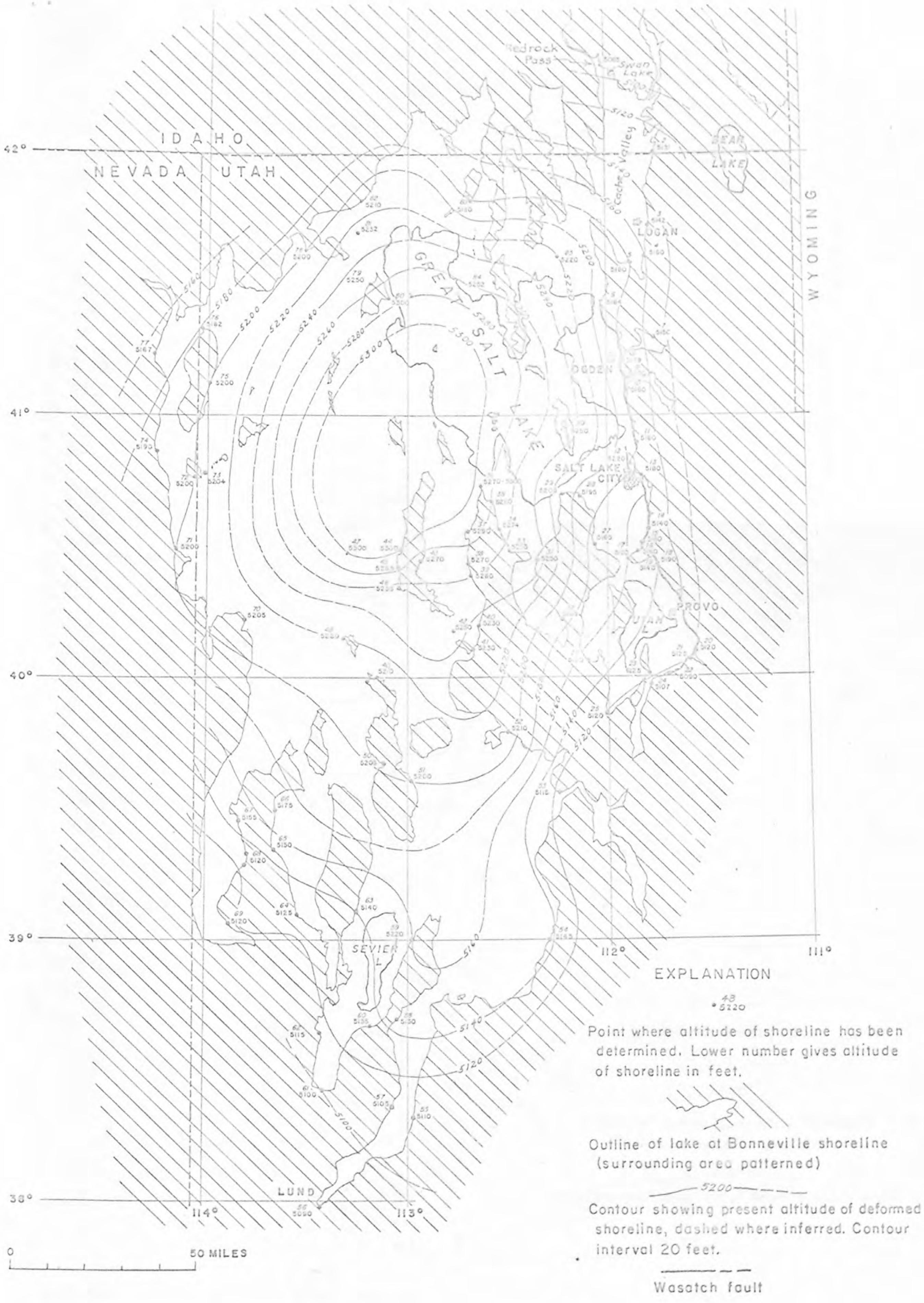

Figure I. Map showing deformation of the Bonneville shoreline.

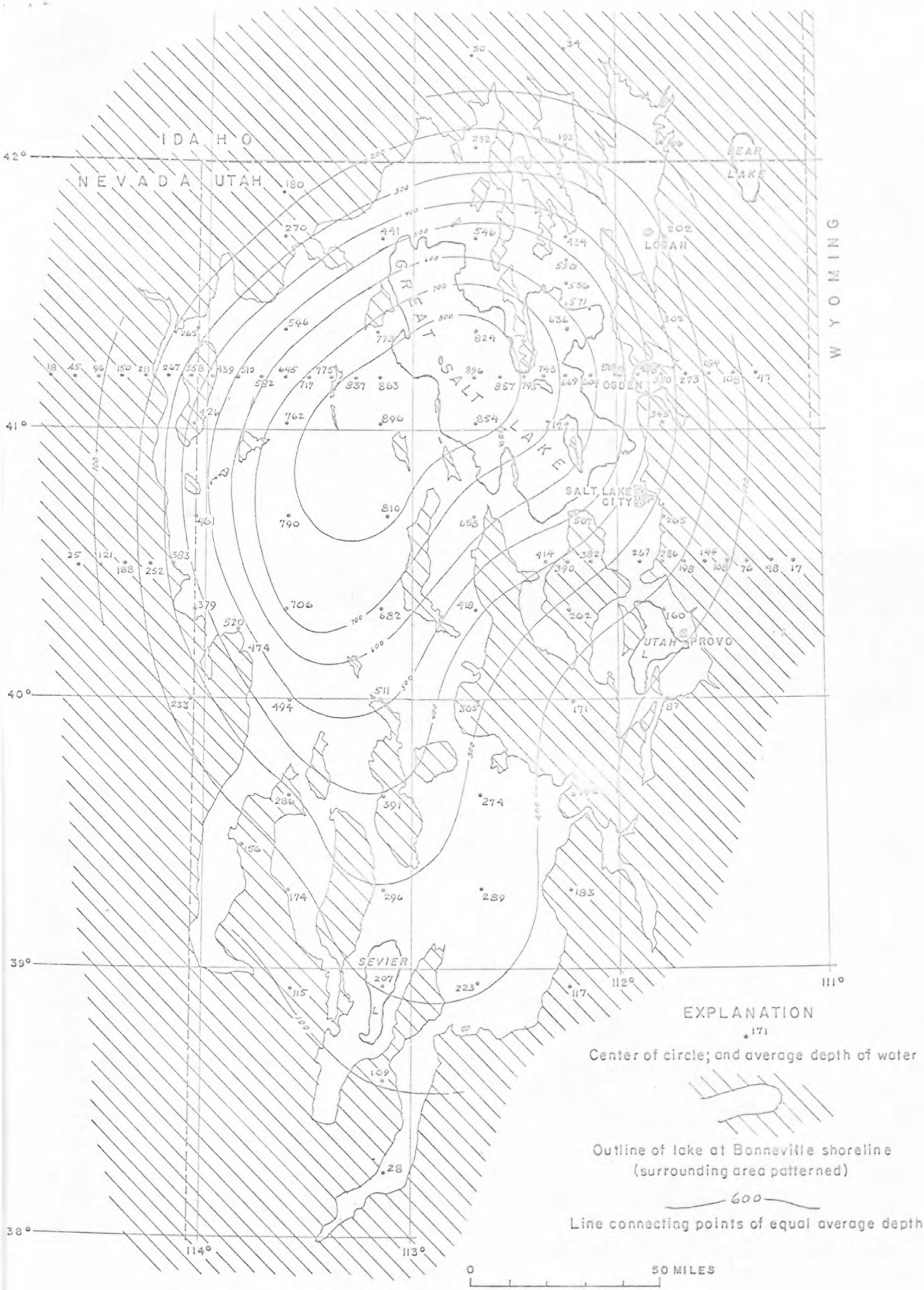

Figure 2. Map showing depth of water averaged over circles of 40 mile radius.