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EVIDENCE OF LAKE BONNEVILLE FLOOD ALONG SNAKE RIVER BELOW KING HILL, IDAHO

Abstract: A catastrophic flood, probably exceeding 10 million cfs, was released down the Portneuf River at Red Rock Pass, Idaho, when ancient Lake Bonneville broke its natural dam in Wisconsin time. The flood entered the Snake River and overflowed banks at bends and constrictions, scoured deep channels (many of which are now abandoned), and left extensive high bars of sand, gravel, and boulders. The flood was at least 410 feet deep at Brownlee damsite near Homestead, Oregon.

Pleistocene Lake Bonneville had its only outlet through Red Rock Pass near Preston, Idaho. Gilbert (1890, p. 177) described the effects of the resulting great flood near McCammon, Idaho. Malde (1960, p. B295) has described evidence of the flood between Pocatello and Twin Falls. The flood was of such great volume that, at bends and restrictions in the Snake River Canyon, it would overflow the bank and shortcut across the plain creating spectacular bars and plunge pool holes where the overflow waters returned to the canyon. Opposite King Hill is a large bar, and another remnant of a bar lies upstream at the bend in the river. The flood overtopped the canyon rim at the start of the bend and gouged Pasadena Valley in the weak Pliocene Hagerman Formation. An undrained depression containing a pond occupies an abandoned plunge pool in Pasadena Valley, and downstream from the valley is a voluminous deposit of sand and gravel, one of the many large bars left in the wake of the flood. This deposit, like many of the others, is a valuable source of sand and gravel.

The flood exceeded the capacity of the big bend in Snake River canyon south of Mountain Home even though the canyon is 210 feet deep and 500 feet wide at the lava-rock constriction 2 miles downstream of the Loveridge Bridge on Snake River. The excess water bypassed the bend, flowed across the desert underlain by the weak Hagerman Formation, and cascaded back into the Snake River canyon at the mouth of the Bruneau River. Here it overtopped the opposite bank of Snake River valley and dug a plunge-pool hole and built a voluminous bar of unusual gravel. The writer described this deposit (Stearns, 1952) and erroneously attributed its origin to the breaking of a hypothetical lava dam upstream. Subsequently, he searched for the lava dam and never found it; hence he concluded that the gravel must have been laid down by the Bonneville flood.

A spectacular deposit of huge boulders and thick loose sand and gravel lies near the Guffey bridge on the road to Murphy and is well exposed in borrow pits. The sand is foreset-bedded against the north canyon wall and much higher than the boulder bar. This is a puzzling relationship until it is realized that the bar was reworked in the channel as the flood receded while the sand remained as a high terrace in a re-entrant where the receding water could not reach it. Subsequent floods also probably reworked the boulder bar.

During excavation for the Brownlee Dam 16 miles above Homestead, Oregon, loose water-laid sand was found in a small re-entrant 290 feet above the river at an altitude of 2090 feet. The canyon is 1400 feet wide at this elevation, and bedrock lies at 1680 feet. Assuming the flood scoured to bedrock, the water was at least 410 feet deep and must have been of the order of 10 million cubic feet per second. Where the canyon widened at the mouth of Brownlee Creek, 2 miles upstream from the dam, a large bar of loose sand was deposited by the flood. The sand was used as a borrow pit for the dam, and a few bones of Pleistocene animals were found in the bar. Near Twin Falls, Minidoka, and American Falls bones of extinct elephants, bison, horses, etc., are common in the older alluvium (Stearns et al., 1938, p. 92). It is possible that many animals were drowned in the flood.

Near the Oxbow Dam, where Snake River has an altitude of 1700 feet, a terrace on the Idaho bank stands 150 feet above the river.

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The terrace was covered with large boulders but, upon excavation, was found to contain only fine sand and small gravel in foreset bedding dipping toward the Idaho bank, apparently all that remains of a former voluminous bar. No positive evidence of overflow was found in the road-pass notch at an altitude of 1969 feet in the Oxbow Ridge although a deep plunge-pool hole was found by drilling directly below the notch on the downstream side at the site of the former power house. If the flood was as high at this point as at Brownlee Dam, water may have spilled through the notch. However, the plunge-pool hole lies at the intersection of two major faults, hence the hole could have been cut into the weak fault breccia by the flood in the main canyon. During excavation for the Oxbow surge tanks, a fault crack was encountered which contained 2 feet of bedded loose sand and gravel in its bottom between elevation 1828 and 1830. The top of the crack was 195 feet above the river and indicates that the flood reached this height at this point. Drill holes indicated bedrock to be 90 feet below Snake River near the terrace described above. It is assumed that a flood of such magnitude scoured to bedrock. If so, the water was at least 285 feet deep at this place at the time of the flood.

The next extensive deposit downstream, of lag boulders and sand, lies at Big Bar about 15 miles below Homestead where the canyon widened and the flood lost velocity. The bar is a mile long, nearly a mile wide, and rises about 170 feet above the river. While mapping the geology of the proposed Hells Canyon dam site, the writer found the rocks swept clean of debris and polished, to a point 235 feet above the river. Bedrock in the river is 100 feet below water surface; hence the depth of the flood exceeded 335 feet.

Three large remnants of high sand and gravel bars lie on the Idaho bank of the Snake River about 16 miles above the mouth of the Imnaha River. Other large thick deposits of loose sand and small gravel lie both above and below Lewiston. These have been ascribed by Bretz to the Spokane flood (Bretz, 1929, p. 22), but he was unaware of the Bonneville flood.

The re-entrant deposits of gravel and sand resemble each other. They are dark, because of the predominance of basaltic sand, and in most places are coarsely foreset-bedded toward the canyon walls. Their color becomes lighter toward Lewiston because of the addition of quartz sand which dominated the river-bed deposits below Weiser.

The bar remnants indicate that vast quantities of sand and gravel have been carried to the Columbia Basin. Large boulders were concentrated, while fines were washed away. However, the narrow canyon above Twin Falls is 9 miles long, and some of the longer coves probably were not cut entirely by the great flood. Doubtless each spring meltwaters from the wasting glaciers in the Centennial and Teton ranges, plus the overflow from Lake Bonneville, increased Snake River to many times its present peak flood runoff which was 100,000 c.f.s. on March 3, 1910, at Weiser, Idaho. It was higher in 1894, but the flow was not measured.

Thus, each summer, floods of great magnitude carried away more and more of the loose debris from the original flood bars and channel fills and rapidly cut the narrow gorge which now runs through miles of hard but highly fractured basalt from Shoshone Falls to Milner Dam (Malde, p. B296).

Bonneville Lake had at least two high stages, and probably three. The first, or Alpine Stage, is pre-Wisconsin in age. It rose to elevation 5050 but did not reach the Red Rock Pass level. The second lake, in the Wisconsin Epoch, reached elevation 5135 and spilled through the pass and cut it down about 315 feet. The reduction of the spillway caused the lake to fall to elevation 4820, known as the Provo I Stage (Eardley *et al.*, 1957, p. 1166). Williams (1952, p. 1375) states that the spillway is 400 feet wide at the top and 500 feet deep. The materials in the pass acted as a fuse plug. The lake had an area of about 19,750 square miles at elevation 5135 and 15,000 square miles at the Provo Stage (Eardley *et al.*, 1957, p. 1145). Using Eardley's data, the first 100 feet in depth would have yielded about 7 billion acre-feet. The upper part of the fuse plug, consisting of soil, alluvium, and weathered rock, must have gone out quickly, thus releasing the main flood in a matter of hours, or at most in a few days. Later the overflow was eroding harder Paleozoic rocks (Williams, 1952) and probably lasted for months. Evidently Lake Bonneville reached the pass and overflowed it during the Provo II Stage after a period of regression (Eardley *et al.*, 1957, p. 1198), but this stage would not have produced a wall of water such as passed down Snake River during the earlier blow-out of the fuse plug in the pass.

One of the important economic effects of the flood was the carrying to the ocean of nuggets and large flakes of gold, which must have been accumulating in the gravels in the bed of Snake River. Almost all the placer gold in the area has been found either in the tributary valleys, such as Connor Creek, or in early Pleistocene cemented terrace gravels not carried away by the flood. Small nuggets were common in the big pothole at the bottom of the Brownlee Dam but mainly flour gold is found in the younger alluvium, which is chiefly reworked Bonneville bars and bedload.

The age of the flood is uncertain as shown by the following quotation from a letter from Eardley (1961):

"This happens to be a controversial problem because C^{14} ages, according to Broecker and Orr (1958), give it as very young, while geologists consider it the oldest of the beaches. But how old, we do not agree on. My present belief is that it is in the early part of the last glacial which lasted from about 25,000 to 11,000 years ago. It should be about 20,000 years since the lake overflowed and cut down its outlet into the Snake."

References Cited

Bretz, J H., 1929, Valley deposits immediately east of the channeled scabland of Washington: Jour. Geology, v. 37, p. 393–541

Broecker, W. S., and Orr, P. C., 1958, Radiocarbon chronology of Lake Lahontan and Lake Bonneville: Geol. Soc. America Bull., v. 69, p. 1009–1032

Eardley, A. J., Gvosdetsky, V., and Marsell, R. E., 1957, Hydrology of Lake Bonneville and sediments and soils of its basin: Geol. Soc. America Bull., v. 68, p. 1141–1201

Gilbert, G. K., 1890, Lake Bonneville: U. S. Geol. Survey Mon. 1, 438 p.

Malde, H. E., 1960, Evidence in the Snake River Plain, Idaho, of a catastrophic flood from Pleistocene Lake Bonneville: U. S. Geol. Survey Prof. Paper 400-B, p. B295–297

Stearns, H. T., 1952, Unusual gravel at Strike Dam, Elmore County, Idaho (Abstract): Geol. Soc. America Bull., v. 63, p. 1372

Stearns, H. T., Crandall, L., and Steward, W. G., 1938, Geology and ground-water resources of the Snake River Plain in southeastern Idaho: U. S. Geol. Survey Water-Supply Paper 774, 268 p.

Williams, J. S., 1952, Red Rock Pass, outlet of Lake Bonneville (Abstract): Geol. Soc. America Bull., v. 63, p. 1375

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