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## SOUTHWARD EXTENSION OF THE BOZEMAN TER- TIARIES INTO UTAH

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(*ABSTRACT*)

Bozeman Beds is a term which is applied to certain gravel deposits that saddle the continental divide in Montana and Idaho. These beds are true epirotic accumulations. They appear to be mainly fluvial in origin; although they manifestly are partly eolic in nature. Consisting of gravels, sands and silts they chiefly lie in old intermontane valleys. Their age is pre-Glacial.

Originally described and mapped in southwestern Montana and around the headwaters of the Missouri river they are traceable far beyond the confines of this basin. Inasmuch as the formations cover the flanks and crest of the Rocky Mountains it is inferred that they were laid down before that range was upraised. The peneplain surface so conspicuous in the Yellowstone Park may be the destructive contemporary of the constructive Bozeman deposits.

Since the time when the Bozeman Beds accumulated some curious physiographic changes appear to have taken place in the Missouri headwaters region. The Atlantic-Pacific drainage divide has shifted more than 150 miles to the westward. By headwater erosion the tributaries of the Missouri river have extended their valleys from Great Falls to the crest of the Bitterroot range. Thus the Missouri river has captured a large portion of the former catchment basin of the present Snake river. The latter was presumably the headwaters area of the old but now vanquished Virgen river, which formerly appeared as the twin branch of the Green river. As such it flowed through the Bonneville basin of eastern Utah, and united with Green river at the great bend in Arizona to form the Colorado river.

The extension of the Bozeman Beds of Montana over the Rocky Mountains into the valleys of the Salmon fork of the Columbia and the Snake river explains the presence of similar or identical deposits in the last named valley at Pocatello, Idaho. In the broad north and south valley south of that place the gravels and sands continue far into the Great Salt Lake basin. With this clue it is possible that

the Bozeman Beds may be eventually traced southward so far as the Arizona line.

The gravels of the Pocatello valley are sometimes regarded as having been deposited by the outlet of ancient Lake Bonneville. These coarse, fluvial beds are well displayed near the Red Rock Pass, which, by the way, chances to be the present low-rim-point of the Bonneville basin. Singularly enough the Red Rock Pass presents none of the earmarks of a lacustral outlet. The manifest movement of the gravels and sands is directly opposite to that of the old lake's hypothetical discharge. To all appearances it is a point of stream entrance rather than of exit. As lately summed up the history of the ancient lake is as follows: The great body of water of which Great Salt Lake is a last vestige is not an anomaly among desert features, as is often regarded, but it merely represents a special phase of a through-flowing stream that was not quite large enough to master the orographic barriers which happened to arise athwart its path, while its nearest neighbor and parallel stream, the Grand river, reinforced by the Grand, and other eastern tributaries, proved sufficiently powerful to hold its own against all vicissitudes and to carve through the rapidly bulging Colorado dome a Titan among chasms. Blocked by such a formidable rampart as this great uplift the old Virgen river spread out behind the dam far and wide over the adjoining intermontane plains, until finally, after the stream's headwaters were diverted, it could no longer furnish the lake with its former supplies.

The main cause for the decline of ancient Lake Bonneville appears to have been the cutting off of the headwaters of the old Virgen river of which the lake was an inflated part. This depletion of water supplies seems to have taken place in two ways. The capture of its large gathering area by the Missouri river, by the Yellowstone river, by Clarke's fork of the Columbia river, and by the Salmon fork of the Columbia, a tract larger than the state of Massachusetts, displaced the larger part of the water supply. Choking of the old river channel at Pocatello by basalt flows completely eliminated the supply from this direction and turned the volume of the headwaters out over the Idaho lava plains where it finally gathered along the lowest line as the Snake river of today.

Now, the complex of headstreams which at the present time gather together to make up the Snake river of Idaho presents strong evidences of being a newly adjusted system. Traces of relatively recent diversions are indicated in many places. One of the principal tributaries, the Port Neuf river, after flowing due south for

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many miles, sharply swings around to the northwest and empties into the Snake river near Pocatello town. Another stream, the Bear river, likewise turns squarely upon itself, its upper half running parallel to the lower half but in a diametrically opposite direction. Other streams of the region have equally erratic courses.

Near Pocatello the Port Neuf river crosses an old stream channel of large size which is now filled high with lava, for the ancient drainage-ways and valleys of southern Idaho seem to have often flowed with liquid rock as well as water. This old channel apparently extends far to the northward. Southward it reaches the Red Rock Pass, and there coincides with the old river bed which Gilbert interpreted to represent the position of the outlet of Lake Bonneville. That this old channel belonged to a south-flowing, and not a north-running, river of considerable size seems to be clearly indicated by the disposition of the old stream gravels. The pebbles composing these gravels are not chiefly derived from local rock ledges, but from pre-Cambrian crystallines, such as characterize the Yellowstone Park region. They are numerous, of nearly uniform measurement, and of a size that suggests their removal a distance of about one hundred miles from their parent ledges.

While, then, there is not much doubt but that the Bozeman Beds extend well into Utah the further problem is their tracing southward to their ultimate limit.