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DIVERSION(S) OF THE LOWER BEAR RIVER IN GEM VALLEY, SOUTHEAST IDAHO, BY A TECTONO-VOLCANIC VALVE

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DIVERSION(S) OF THE LOWER BEAR RIVER IN GEM VALLEY, SOUTHEAST IDAHO, BY A TECTONO-VOLCANIC VALVE.

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The lower Bear River of Utah and Idaho was once a tributary of the Snake River that flowed along the NE edge of the Great Basin. Similar biological communities in the upper Bear and Snake Rivers attest to this phase of its history. Basalt flows in Gem Valley, Idaho, diverted the lower Bear River southward into the Bonneville Basin during the late Pleistocene [1] [2] [3]. However, there is no consensus about the timing, location, and mechanism of this major diversion [4][5]. Landscape and image analysis reveals previously unmapped active normal faults and characterizes Late Pleistocene to Holocene(?) volcanic fields. Our discovery of a meandering basalt flow SE of Bancroft, Idaho, suggests that fault-guided basaltic volcanism created a “switching valve” for the Bear River where it enters Gem Valley from the east. This tectono-volcanic valve causes northward flow of the Bear River to switch abruptly to southward flow or back again, as basalt flows in the east-central part of Gem Valley flows into the river bed. We envision a mechanism in which flow of the Bear River and lava competed to occupy the same lowest terrain within graben of the East Gem Valley fault zone. Whenever a new basalt flow blocked the river’s northern route, the Bear River was diverted south to fill Lake Thatcher in southern Gem Valley. Eventually lava dams grew high enough for Lake Thatcher to overflow south into the Great Basin. Incision of Oneida Narrows was the final step in the transfer of the Bear River.

Introduction: Gem Valley is an unusual Basin and Range graben in SE Idaho. The slip rate on the basin-bounding normal faults is low, consistent with its position in the inner, inactive zone of the tectonic parabola centered on the Yellowstone hot spot. Quaternary volcanism built basaltic shield volcanoes and cinder cones in and near the eastern margin of the basin, near the midpoint of its active basin-bounding fault. Features unusual for an active graben include: a drainage divide near the middle of the basin, a grossly radial, westward slope of the basin floor, away from the main normal fault, and the position of the lowest points of the valley floor in the distal north and south ends of Gem Valley. These features are the product of volcanic processes that outpaced tectonic subsidence.

The Bear River in Utah, Idaho, and Wyoming makes a hairpin turn in SE Idaho. The upper Bear River flows NNW ~300 km from the northwest Uinta Mountains through Bear Lake Valley to Soda Springs, Idaho. Entering central Gem Valley, the river turns

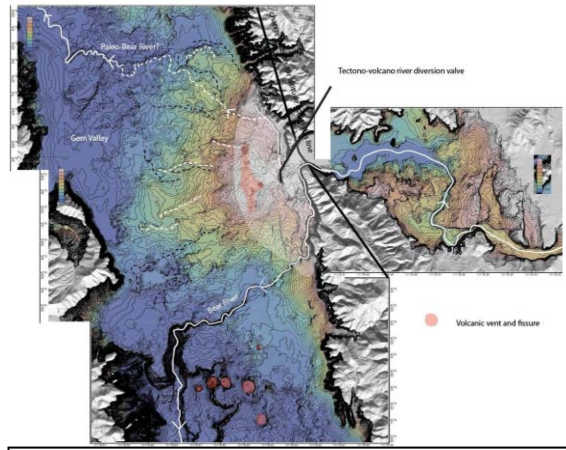

Figure 1. Tectono-volcanic valve model of the diversion of the Bear River in the central part of Gem Valley. Digital elevation model show highlands in white and deeper surfaces in blue. One basalt flow in the northwest corner solidified in the meandering shape of the paleo-Bear River that it occupied.

sharply south, and flows through Oneida Narrows into Cache Valley, through the Cutler Narrows into Lower Bear River Valley, and into the Great Salt Lake. This lower reach of the Bear River, downstream of Soda Springs was diverted from a paleo Bear River that once flowed into the Snake River and was part of the greater Columbia drainage basin [1-4]. Commonalities of fish species in the upper Bear River and the Snake River drainages are a result of this early history.

Diversion of the lower Bear River was initiated by basalt flows in Gem Valley that diverted the river southward and at times formed a freshwater lake [1-8]. However, older and incomplete geologic mapping in Gem Valley does not identify specific lava dams, vents, or other details. The location, age, geometry, and frequency of diversion are poorly constrained.

Our discovery of a meandering Late Pleistocene basalt flow southeast of Bancroft, Idaho, identifies the specific site of one diversion and provides the means to date diversion events. We examine how the volcanic landforms and active faulting in Gem Valley interacted [conspired] to divert the Bear River into Lake Thatcher and the Great Basin.

Methods: We mapped the Quaternary faults, volcanic centers, and their outflow products in the Gem Valley area. High resolution imagery in Google Earth and digital-elevation models produced many new insights into the geology of Gem Valley. Drillers’ logs of water wells provided subsurface control.

Volcanism in the Gem-Blackfoot Volcanic field: The major basaltic and minor rhyolitic volcanism of the Gem-Blackfoot volcanic field erupted from ~100 cinder cones and fissure eruptions within a 70 km long NNE-trending belt. A NNE-trending magnetic high coincides with the volcanic belt. Lava flows that erupted from these vents cover a large area adjacent to the alignment of vents. Groups of volcanic vents at Niter, Alexander, and on the east flank of the Soda Springs Hills, give way northward to more evenly distributed cinder cones, fissure vents, and domes.

Three groups of volcanics vents in and near Gem Valley interacted with a wide zone of active faults and fissures along the east margin of Gem Valley. Volcanic flows erupted from fault-controlled fissures and built three shield volcanoes in Gem Valley near active normal faults. Together they produced a SW-sloping bajada of loess-covered basalt flows in central Gem Valley. As these grew, they diverted the paleo and modern Bear River around the distal edges of the three shield volcanoes. When the shield volcanoes blocked the center of Gem Valley they pushed Late Pleistocene Lake Thatcher to the north and south, and eventually triggered the spillover of the lake into the Bonneville Basin, in the south [2, 3, 6].

Two of the vent clusters in Gem Valley were active long enough to produce sizable shield volcanoes. The northern Tenmile shield volcano is highly asymmetric because its flows all erupted from ~200 m higher elevations to the east within the Blackfoot volcanic field. The lava flows emanating from the Blackfoot field, flowed southwest through Tenmile Pass between the Chesterfield Range and Soda Springs Hills and then spread, fanlike, across the floor of northernmost Gem Valley. We propose that the paleo-Bear River flowed in the low area between this northern shield volcano and the Alexander shield volcano to the south based on the presence of a ~4 km long meandering former reach of the Bear River choked by lava SE of Bancroft. Lava dams appear to have formed small ponds at times behind low lava dams.

The ~15 x ~15 km Alexander shield volcano erupted from the NNW-striking Alexander fissure to form the largest volcano in Gem Valley. It filled Gem Valley progressively from east to west, and most of the shield volcano is downslope and west of its vent clusters near the eastern margin of Gem Valley. The modern Bear River flows south along the NE edge of this shield volcano in a narrow graben of the East Gem fault zone, then turns southwest and flows along the SE edge of the Alexander shield volcano.

The third group of volcanic centers lie ~4 km N30°W of Niter, Idaho. Twelve closely spaced maars and tephra cones lie on a plateau very close to the highest altitude of Lake Thatcher and an the inset terrace to the west. Most of the volcanoes form a pronounced E-W trending alignment at 42.535° N. The effusive volcanic activity around this group of vents was too limited to build a shield volcano. The distinctive explosive morphology of the tuff cones and maars is unique in the area, and strongly suggests eruption during a high-water phase of Lake Thatcher. Drillers' logs of water wells show thicknesses between 25 to 40 m of the basalt flows nearby.

Implications: The zone of active faulting and volcanism along the course of the Bear River near Alexander, Idaho, is probably the most important area in Gem Valley for the biogeography of the Bear River. The Alexander shield blocked the Bear River's access to Gem Valley. The present river flows along the edges of the extending Alexander shield. Graben in the East Gem Valley fault zone captured the Bear River as it entered from the east near Soda Springs. Depending on the most recent normal faulting and volcanic activity, the Bear River could flow either north or south along the range-front fault zone in one of its graben toward lower terrain at the north and south edges of the Alexander volcano. When the river flowed south, it ponded to form Lake Thatcher. When the Bear River was diverted back to a northern course, along the NE and then NW edge of the Alexander shield volcano, it flowed more directly to the Snake River. Our observations suggest that the interplay of volcanism and normal faulting had produced such a balanced topography that only subtle changes in the landscape were required to divert the Bear River. This mechanism accounts for the numerous diversions of the Bear River reported in prior studies [4, 5] and could produce a northward diversion of the Bear River in the future. The drainage divide of the northern Great Basin shifted northward about 40 km in the Late Pleistocene as the Bear River flowed through one actively, extending volcanic field, and skirted the edges of two others. More field work and dating are planned to test these hypotheses.

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Biographical Sketch of presenter:

Susanne U. Janecke is a Professor specializing in regional tectonics at Utah State University. Her research interested focus on extensional and strike-slip related processes and basins.