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Mud Volcano Breccia — Similar to Breccia being followed at base of Old Geiger Grade and up slope to New G.Gr.

Deposits here called mud-volcano breccia have been recognized and mapped only in a relatively small area, 1100 feet long and from 100 to 800 feet wide, northwest of Sinter Hill.

The characteristics and probable origin of these deposits were discussed briefly by White as a possible prehistoric example of a violent mud-volcano eruption similar to the one that occurred at Lake City Hot Springs in California , in 1951. At Steamboat Springs, debris containung bleached and iron-stained boulders and fragments of Tertiary volcanic rocks, opaline and chalcedonic sinter and disintegrated granitic debris occurs on both sides of a north-trending fault.

This debris was first considered to be a local phase of pre-Lake Lahontan alluvium that was bleached and hydrothermally altered in place by sulphuric acid. Evidence that definitely disproved this hypothesis was found when the Steamboat ditch from the Truckee River was extended into the area in 1947, and a trench was cut through the low mound west of the fault. The exposed section in the bsal part consists of pre-Lahontan alluvium, with numerous pebbles and boulders as much as 1 foot in diameter and a single large boulder 10 feet in diameter. Sinter and hydrothermally altered rocks are completely absent. The upper 2 to 5 feet of section, however, is very different, consisting of iron-stained debris that is unbedded except in the basal 6 inches. The debris contains chalcedonic and partly chalcedonized sinter and isolated rock fragments that must have been bleached by acid attack, prior to transport to present position. Outcrops of such rocks do not occur west and upslope from the cut. The only local source for many of the breccia fragments is in and near the fault zone east of the cut; the breccia fragments must have been ejected into their present position by a violent hydro-thermal eruption.

Similar eruptions have also occurred at Waiotapu, New Zealand about 900 years ago, and perhaps in Jigokudani, Hokkaido, Japan in 1951 and 1952. As in the Lake City Hot Springs, the energy for eruption seems to have been stored in the hydrothermal system from an ultimate volcanic source, but there is no evidence for direct involvment of new magma in these eruptions. A hydrothermal system wit temperatures at depth close to the boiling points for prevailing hydrostatic pressures is unstable and contains stored energy whooly adequate for a geyser eruption. As stated by White:

> "If material is suddenly removed at the top of the system, the pressure is lowered throughout. Each point at depth, formerly just at its boiling point, is now above its boiling point. Boiling then starts throughout the column, or if mild boiling had previously existed, the rate (and total depth range) of boiling rapidly increases.

"In competent fractured rock, water is displaced upward and out of th system by expanding gas bubbles decreasing the hydrostatic pressure on the system and setting off a chain reaction that results in geyser action."

White also pointed out that all recorded mud-volcano eruptions in areas containing nearly neutral chloride waters involved fine-grained clastic sediments with no near-surface competent rocks. Such incompetent material has little strength to resist long applied stresses. The load pressure of the plastic sediments is effective in restricting or closing channels of water movement. The pressure on the water can then be significantly higher than the hydrostatic pressures of water in fractured comeptent rocks near the surface, and is likely toapproach load pressure. Under these conditions of higher pressure, temperatures may be much higher than in a water system under hydrostatic pressure alone. The higher permissable temperatures in incompetent materials are accompanied by higher stored energy and even greater instability than in geyser systems.

The actual triggering mechanism is not clearly understood but several possibilities have been discussed by White and Lloyd. A local earthquake that forces a large volume of water to rise rapidly into lower pressure environements where boiling points are exceeded is a plausible explanation, but no evidence of an earthquake was found for the 1951 eruption of Lake City Hot Springs. Another possibility involves a rapid lowering of barometric pressure, which would increase the rate of boiling in the upper part of the system.

The hydrothermal eruption hypothesized for the mud-volcano breccia of Steamboat Springs occurred after the pre-Lake Lahomtan alluviuk was deposited and perhaps before deposition of the alluvium contemporaneous with Lake Lahontan. Definite evidence for the latter is missing but the Steamboat ditch exposure previously described includes a small north-striking normal fault dipping steeply toward the probable source area of mud-flow breccia. The base of the breccia is faulted downward about 3 feet to the east, but the time since eruption and faulting has been sufficiently long for erosion to remove all evidence of the fault scarp. Numerous preserved fault scarps in the Truckee Meadows area are younger than the pre-Lae Lahontan alluvium but none clearly displaces Lake Lahontan sediments. The mud-volcano breccia is therefore considered to be slightly older than Lake Lahontan and Taho Glaciation.

A small mud pot or mud volcano was active in recent time where Auger hole 8 was bored about 100 feet northwest of Traverse 8. A low mud cone still exists, and a temperature of 95.2 degrees centigrade, which is nearly boiling for this altitude, was measured in the hole at a depth of 14 feet.

Reaction: From the great length of explaining, DLE feels that the authors are trying to talk themselves into something they are not too sure about.