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Comment on Origin of Groundwater Discharge at Fall River Springs

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Disclaimer

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To Whom It May Concern,

I'm writing at the request of the Pit River Tribe to offer my professional opinion as a geochemist regarding the origin of groundwater discharge at the Fall River Springs, Shasta Co., California. In 1997, I conducted a study of the large volume cold springs associated with the Cascade Volcanoes in northern California, in collaboration with one of my colleagues. This work was published as a Lawrence Livermore National Laboratory report (Davisson and Rose, 1997).

The Fall River Springs emerge from the distal end of the Giant Crater Lava Field, a laterally extensive basalt flow that stretches from the southern flank of Medicine Lake Volcano southward for a distance of 40 km. Both Medicine Lake Volcano and the Giant Crater Lava Field have virtually no surface water drainages. Precipitation that falls in these areas is inferred to seep into fractures in the rock, where it is carried down gradient under the force of gravity. Mean annual precipitation rates on Medicine Lake Volcano and the Giant Crater Lava field are adequate to account for the ~1200 ft^3/sec discharge of the Fall River Springs.

To evaluate the origin of the springs using geochemical methods, water samples were collected from the Fall River Springs and the Medicine Lake highlands and analyzed for oxygen and hydrogen isotope ratios. The isotope ratios measured for a groundwater sample are diagnostic of the average composition of the precipitation from which the water was derived. The isotope ratios of rain and snow also vary systematically with elevation, such that groundwater derived from recharge at higher elevations can be distinguished from that which originated at lower elevations. The stable isotope data for the Fall River Springs are consistent with groundwater recharge on the Medicine Lake Volcano and adjacent lava field. Mass balance calculations suggest that approximately half of the Fall River Springs flow is derived from the volcanic edifice.

Rose and Davisson (1996) showed that the large volume cold springs associated with the Cascade Volcanoes commonly contain dissolved CO_2 that originated from the volcanoes. This volcanic CO_2 component is readily identified from carbon-14 measurements of the water. Carbon-14 analyses of the Fall River samples indicate that at least 27% of the dissolved inorganic carbon in the springs was derived from a volcanic CO_2 source. Such a large volcanic CO_2 flux requires that the groundwater supplying flow to the Fall River Springs must originate from a volcano where magma degassing is actively occurring. Given the hydrogeologic configuration of the Fall River aquifer system, it appears that

the Medicine Lake Volcano is the only likely source of the volcanic CO_2. These data independently confirm the Medicine Lake highlands as a significant recharge source for the Fall River Springs. Moreover, these data indicate that groundwater recharge occurring on Medicine Lake Volcano must interact with a CO_2 volatile phase derived from the geothermal system beneath the volcano.

The lack of hot springs on Medicine Lake Volcano suggests that the geothermal system underlying the volcano is relatively tightly sealed. Nevertheless, it is probable that the geothermal fluid originates from precipitation falling on the volcanic edifice. This is the same water that supplies an important fraction of the Fall River Spring discharge. The source of the geothermal fluid can be evaluated using stable isotopes. The oxygen isotope signature of the geothermal fluid may have been modified by high temperature oxygen isotope exchange with the surrounding rock, but the hydrogen isotope signature should still be diagnostic of the origin of the fluid.

Although the geothermal system appears to be largely decoupled from the shallow groundwater system that supplies the Fall River Springs, it is uncertain what impact the development of the geothermal system as an energy resource would have on groundwater circulation patterns on the volcano. Given the importance of the Fall River Springs as a water resource for the State of California, it would be prudent to carefully evaluate this question before proceeding with geothermal energy development on Medicine Lake Volcano. Should you have any questions regarding my comments, please feel free to contact me by phone (925-422-6611) or e-mail (rose23@llnl.gov).

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References Cited

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