An experimental study of the role of subsurface plumbing on geothermal discharge

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In order to better understand the diverse discharge styles and eruption intervals observed at geothermal features, we performed three series of laboratory experiments with differing plumbing geometries. A single, straight conduit that connects a hot water bath (flask) to a vent (funnel) can originate geyser-like periodic eruptions, continuous discharge like a boiling spring, and fumarole-like steam discharge, depending on the conduit length and radius. The balance between the heat loss from the conduit walls and the heat supplied from the bottom determines whether and where water can condense which in turn controls discharge style. Next, we connected the conduit to a cold water reservoir through a branch, simulating the inflow from an external water source. Colder water located at a higher elevation than a branching point can flow into the conduit to stop the boiling in the flask, controlling the periodicity of the eruption. When an additional branch is connected to a second cold water reservoir, the two cold reservoirs can interact. Our experiments show that branching allows new processes to occur, such as recharge of colder water and escape of steam from side channels, leading to greater variation in discharge styles and eruption intervals. This model is consistent with the fact that eruption duration is not controlled by emptying reservoirs. We show how differences in plumbing geometries can explain various discharge styles and eruption intervals observed in El Tatio, Chile, and Yellowstone, USA.

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