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Carbonic springs as distal manifestations of geothermal systems, highlighting the importance of fault pathways and hydrochemical mixing: Example from the Jemez Mountains, New Mexico

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11 ABSTRACT

12 We examine a series of carbonic warm and hot springs in northern New Mexico,
13 USA: 1) Tierra Amarilla springs 2) Penasco Springs and 3) Soda Dam, Jemez and Indian
14 hot springs. Spring geochemistry is compared to waters from the Valles Caldera
15 geothermal system and to groundwater in nearby sedimentary aquifers. Multiple
16 hydrochemical tracers are applied to quantitatively evaluate flow paths and mixing at
17 varying distances from the caldera. We test three hypotheses for source and transport of
18 waters to Tierra Amarilla and Penasco Springs: San Juan basin origin, meteoric flow
19 from the Nacimiento Mountains, and/or influence from the Valles Caldera geothermal
20 system. Geochemically, carbonic spring groups are distinct from meteoric and
21 sedimentary aquifer waters. Based on isotopes of He and Sr, and concentrations of Cl,
22 SO₄, Li and B we interpret these carbonic springs to be distal manifestations of fluid
23 circulation along faults with a mixture of Valles Caldera geothermal waters, local
24 meteoric and Paleozoic aquifer waters, with the potential for small contributions from the
25 San Juan Basin aquifers. Semi-confined fault conduits, the Jemez fault and Nacimiento
26 fault systems provide connectivity and help explain geochemical similarities and mixing
27 trends within carbonic spring systems, and between these systems and the distal Valles
28 Caldera. In addition, Penasco Springs are interpreted to reflect a component of outflow
29 from the geothermal system that crosses the Nacimiento Mountain basement block along
30 NE-trending faults. Input of deeply sourced waters can degrade water quality by

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