3D geologic controls on hydrothermal processes in the northern Granite Springs Valley geothermal area

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Abstract: The 3D map presented herein was built as part of the DOE GTO-funded INnovative Geothermal Exploration through Novel Investigations Of Undiscovered Systems (INGENIOUS) project to help constrain the structural controls on the hydrothermal processes indicated by thermal gradient drilling in northern Granite Springs Valley. The northern Granite Springs Valley geothermal area is located in northwestern Nevada, USA, in the geothermally prolific Great Basin region. In recent research, northern Granite Springs Valley area emerged from the Nevada Play-Fairway project (2016-2019) as a particularly prospective blind geothermal resource. As part of this effort silica sinter, silicified sediments, and carbonate tufa were discovered cropping out discontinuously along a ~6 km (north-south) profile adjacent to a known thermal anomaly. Associated geophysical and geological studies informed a six well thermal gradient drilling campaign. Maximum temperatures of 95.5°C at 150-250 m depth and 77.5°Cat 150 m depth were encountered at the northern and southern extents of the surface geothermal deposits, respectively. The 3D geologic map was built using Leapfrog Geothermal software and is supported by detailed modeling and analysis of geologic data, gravity data, magnetic data, and re-interpretation of legacy seismic reflection profiles. A key structural feature described in the map is a ~6 km (north-south) by 4 km (east-west) horst block in the central part of the Granite Springs basin. Here, the Tertiary volcanic section crops out locally, and the underlying Mesozoic basement rocks lie at shallow depths (~100-230 m). This bedrock section is down-faulted ~1 km on the east side of the horst block by east-dipping faults and ~2.5 km by west-dipping faults on the west side. The five faults that define the structural relief along the western side of the horst block spatially correspond with the surface geothermal deposits and the long axis of the thermal anomaly. These faults define an echelon, right step-over. This complex structural zone is inferred to host upwelling geothermal fluids. 3D fault intersection density, dilatation, and coulomb shear stress change were calculated based on the 3D fault map. These quantities may be proxies for the distribution of permeability and porosity in the subsurface.