

3D characterization of the Astor Pass geothermal system, Nevada

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The Astor Pass geothermal system resides in the northwestern part of the Pyramid Lake Paiute Reservation, on the margins of the Basin and Range and Walker Lane tectonic provinces in northwestern Nevada. Seismic reflection interpretation, detailed analysis of well cuttings, stress field analysis, and construction of a 3D geologic model have been used in the characterization of the stratigraphic and structural framework of the geothermal area. The area is primarily comprised of middle Miocene Pyramid sequence volcanic and sedimentary rocks, nonconformably overlying Mesozoic metamorphic and granitic rocks. Wells drilled at Astor Pass show a ~1 km thick section of highly transmissive Miocene volcanic reservoir with temperatures of ~95°C. Seismic reflection interpretation confirms a high fault density in the geothermal area, with many possible fluid pathways penetrating into the relatively impermeable Mesozoic basement. Stress field analysis using borehole breakout data reveals a complex transtensional faulting regime with a regionally consistent west-northwest-trending least principal stress direction. Considering possible strike-slip and normal stress regimes, the stress data were utilized in a slip and dilation tendency analysis of the fault model, which suggests two promising fault areas controlling upwelling geothermal fluids. Both of these fault intersection areas show positive attributes for controlling geothermal fluids, but hydrologic tests show the ~1 km thick volcanic section is highly transmissive. Thus, focused upwellings along discrete fault conduits may be confined to the Mesozoic basement before fluids diffuse into the Miocene volcanic reservoir above. This large diffuse reservoir in the faulted Miocene volcanic rocks is capable of sustaining high pump rates. Understanding this type of system may be helpful in examining large, permeable reservoirs in deep sedimentary basins of the eastern Basin and Range and the highly fractured volcanic geothermal reservoirs in the Snake River Plain.