CONFIGURATION AND EVOLUTION OF THE SULPHUR SPRINGS HYDROTHERMAL SYSTEM, VALLES CALDERA, NEW MEXICO -- INITIAL EVIDENCE FROM CSDP COREHOLE VC-2B

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Results of preliminary alteration and fluid-inclusion studies of CSDP corehole VC-2B, in the Sulphur Springs area of the Valles caldera, clarify the hydrothermal history of the Sulphur Springs geothermal system. VC-2B penetrated 1762 m through Plio-Pleistocene intracaldera volcanic and volcaniclastic rocks (above 742 m depth) and subjacent Miocene to Pennsylvanian sedimentary rocks (742-1558 m) into Precambrian quartz monzonite (1558-1762 m/TD). Bottom-hole temperature measured shortly after drilling was nearly 300°C. Hydrothermal alteration and vein/breccia mineralization are extensive above 800 m depth and below a depth of 1500 m, but intervening Paleozoic strata appear to be essentially unaltered. Sericitization, with kaolin above 56 m, is the principal alteration type to a depth of 300 m, below which moderate-intensity chlorite-sericite alteration prevails to 800 m depth. Locally strong silicification between 235 and 300 m is accompanied by prominent dissolution porosity in tectonic and hydrothermal breccias. Propylitic alteration affects the deep quartz monzonite and immediately overlying Paleozoic rocks.

Most of the Paleozoic sequence intersected by VC-2B is characterized by anomalous clay mineralogy, out of equilibrium with the present hydrothermal regime. Although these Paleozoic rocks are presently very hot (200-280°C), they contain abundant mixed-layer illite/smectite (I/S) with up to 45% smectite interlayers. At current temperatures in the sequence, the I/S ideally should contain less than 10% smectite. We suspect that although hot these rocks have not been invaded by hydrothermal fluid, and have retained their original diagenetic signatures.

Veins and breccia cements in both the shallow and deep alteration zones penetrated by VC-2B host abundant fluid inclusions, all of which are two-phase (liquid plus vapor) at room temperature. Liquid-rich and vapor-rich varieties commonly coexist, indicating formation form boiling fluid. Homogenization temperatures (T_h) for inclusions in deeper veins and breccias reach 295°C, and closely match the present temperature profile (especially where there is evidence for boiling), suggesting recent entrapment of the contained fluids. Shallow T_h's, however, are up to 150°C hotter than present temperatures, a relationship most likely due to a drop in the water table since the inclusions were formed. Shallow inclusion fluids are dilute (0.0-0.7 wt.% equiv. NaCl; similar to contemporary Valles geothermal reservoir fluid), but deeper ones are apparently much more saline (up to 2.9%). If, as suspected, the deep veins and breccias currently channel hot, chloride-rich waters similar to these inclusion fluids, then VC-2B may have penetrated, above and below the impermeable Paleozoic sequence, "stacked" hydrothermal cells with much different compositions and temperatures.