RESULTS OF DEEP DRILLING IN THE VALLES CALDERA, NEW MEXICO

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Over 42,000 meters of deep drilling have been completed by Union Oil Co. during geothermal exploration of a portion of the Valles caldera in New Mexico. Data from the drilling now forms the basis of a scientific study of eruptive history, structural development of the resurgent dome of the caldera, hydrothermal alteration, ore deposit formation, and the dynamics of an active hydrothermal convection system.

Caldera formation was initiated upon a deeply incised erosional surface composed largely of Pliocene volcanic rocks of intermediate composition. The initial products of the felsic activity are a series of ash-flow tuffs and associated rocks which are poorly exposed outside the caldera. At 1.4 my the formation of the Toledo caldera resulted in the deposition of the Otowi Member of the Bandelier Tuff. After a period of erosion, the Tshirege Member of the Bandelier Tuff was emplaced during the formation of the Valles caldera (1.1. my ago). Both of these members are predominantly densely welded with distinctive interior zones of granophyric crystallization. Closely following the emplacement of the Tshirege Member, resurgent doming was initiated. At this time pre-existing fault structures were reactivated as evidenced by erosion and fluvial deposition oriented along the Jemez fault, a pre-caldera structural trend. During the resurgent doming phase, localized ash-flow tuff eruptions produced at least three additional cooling units.

We have used our subsurface observations to apply a numerical model of dome formation to the development of the resurgent Redondo Dome. This model helps explain the structural relationships observed in the dome. The model also supports present concepts of resurgent dome formation by predicting that the magma responsible for the resurgent doming should occur beneath present drilling depths.

Hydrothermal alteration is both stratigraphically and structurally

controlled. It is most intense not only in and adjacent to well developed faults and fractures, but also within permeable (or initially permeable) volcaniclastic and non-welded tuff units. Beneath a high-level clay-rich zone, alteration assemblages are dominated by micaeous illite with commonly abundant pyrite. Within the clay-rich zone, calcium-rich smectite and allevardite-ordered, mixed-layer illite-smectite are the principal phases. The illite-smectite, normally stable at temperatures greater than 100°C, is found in the clay-rich zone at current temperatures as low as 30°C. This implies that the hydrothermal system in this areas was at one time hotter than it is at present.

Most of the lithologic samples from the Valles wells are drill cuttings. Although cuttings can yield valuable information if carefully investigated, they have obvious disadvantages in scientific studies, and the geologic community is well aware of the need for core from holes which are drilled for scientific purposes. In addition, we would also point out the advantages of placement of a deep scientific hole in areas which already contain a large subsurface data base.