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MAGNETOTELLURIC MAPPING OF UPPER CRUSTAL ISOTHERMS BENEATH THE VALLES CALDERA HYDROTHERMAL SYSTEM

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FALL AGU
SAN FRANCISCO
1993

ABSTRACT

Magnetotelluric (MT) soundings across the western margin of the Valles Caldera hydrothermal system in New Mexico have revealed a striking correlation between depth of the electrically conductive portion of the upper crust and isotherms projected from deep geothermal test wells. The crust is highly resistive (≥ 1000 ohm-m) in the range of 2 to 4 km depth where temperatures of over 300°C have been logged in test wells. However, at greater depths the upper crust becomes increasingly conductive; in this range, the conductivity contours closely match the projected isotherms. The inferred geoelectric section was obtained by two-dimensional inversion after shallow three-dimensional distortion corrections were applied to the data. Inversions were constrained to depths as great as 4 km by borehole electric logs which were highly compatible with the nearby MT soundings.

Possible reasons for the positive correlation between the conductive depth patterns and the isotherms are: 1) fluid accumulation within the thermally controlled brittle-ductile transition and 2) a halo of conductive mineralization (e.g., connected sulfide films) surrounding a still cooling, shallow intrusive.

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JAN 27 1994

VALLES CALDERA REGION
(AFTER GOFF ET AL., 1992)

VALLES CALDERA
MT SITES AND TIPPER MAGNITUDE

VALLES CALDERA
GEOTHERMAL WELLS AND HOT SPRINGS
(GOFF ET AL., 1992)

VALLES CALDERA
TEMPERATURE GRADIENT MAP
(SASS AND MORGAN, 1988)

GT-2 BOREHOLE E LOG

LOG RESISTIVITY (OHM-M)
SYNTHETIC CURVE

1-D INVERSE MODEL

LOG RESISTIVITY (OHM-M)
TM CURVE

1-D INVERSE MODEL

SOUTHWESTERN VALLES CALDERA
GEOLOGY AND ISOTHERMS CROSS SECTION
 (SASS AND MORGAN, 1988)

2-D GEOELECTRIC SECTION

2-D GEOELECTRIC SECTION

CONCLUSIONS

GROOM-BAILEY ANALYSIS REQUIRED
STANDARD (SWIFT) ANALYSIS INADEQUATE

1-D AND 2-D GEOELECTRIC MODELS

UPPER 5 KM

STRONGLY CORRELATES WITH BOREHOLE DATA
DISTINCT CONTRAST BETWEEN
HOT-WATER-SATURATED VOLCANICS/SEDIMENTARY
ROCKS (<100 OHM-M)
AND
PRECAMBRIAN BASEMENT (>100 OHM-M)

DEEP CRUST (5-25 KM)

DEPTH TO CRUSTAL CONDUCTIVE ZONE MATCHES
PROJECTED ISOTHERMS
POSSIBLY CONTROLLED BY <100 KA MAGMATIC EVENT

ROLES OF BRITTLE-DUCTILE TRANSITION, PARTIAL MELT,
WATER, AND CONDUCTIVE MINERALS (E.G., GRAPHITE,
ILMENITE, SULPHIDES) UNCERTAIN
POSSIBLE ASSOCIATION WITH DIHEDRAL ANGLE H₂O WETTING

DIHEDRAL ANGLE IMPLICATIONS IN METAMORPHIC ROCKS

SCHEMATIC SINGLE GRAIN WATER DISTRIBUTION	DEEP CRUSTAL PROPERTIES		
	WATER	ELECTRICAL	RHEOLOGICAL
$\Theta \geq 60^\circ$	ISOLATED	RESISTIVE	LOW STRAIN RATE
$\Theta \leq 60^\circ$	CONNECTED	CONDUCTIVE	HIGH STRAIN RATE

**DATE
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