MASTER

Original
FINAL REPORT

Application of Natural Electromagnetic Field Methods
(Magnetotellurics/Geomagnetic Variations)
to Exploring for Energy Resources:
Development of a Broad-Band Data Acquisition/Processing Facility

DE-ACO-2-79ER10401.A000

May 1, 1979 - April 30, 1980

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SUMMARY SHEET

Thermal Regimes of Major Volcanic Centers: Magnetotelluric Constraints on the Coupling of Deep-Seated Magma Genesis to High-Level Geothermal Reservoirs

DE-AC02-79ER10401

Accomplishments May 1979 through April 1980

- I. Reviewed present state of knowledge of the deep thermal regimes associated with major rift systems of the world.

Considerable interest is focussed by the scientific community on the thermal regimes associated with geodynamic processes in the continental crust. In particular, continental rifts represent dramatic evidence of coherent geologic processes over distances of 1,000 km and greater. Often crustal extension is associated with thermal anomalies at depths of 10-100 kms and result in significant first-order geophysical anomalies. In a report prepared for the International Commission for Geodynamics, we have compared five major rift areas of the world: the Baikal rift (USSR), the Rhine Graben (Federal Republic of Germany), the East African rift (Ethiopia and Kenya), Iceland and the Rio Grande rift (USA).

- II. Mobilized a long-term field investigation of several major tectono-magmatic systems in the western US and elsewhere. Activities centered on continued analysis of geophysical/geological data from major volcanic centers which are promising targets for scientific deep drilling. We have particularly been interested in developing models for the Jemez Mts. and the Rio Grande rift, the Basin and Range and Long Valley, the Imperial Valley of California, and Iceland. Although Iceland is clearly not a target for the continental drilling program, certain processes associated with crustal evolution are active there, which have direct analogs within the western US, for example the Basin and Range and the Imperial Valley. A field program is being developed for the Basin and Range province in Utah, Nevada and eastern California and for the Long Valley volcanic complex.

As a member of the Thermal Regimes Panel of the Continental Scientific Drilling-Committee of the Geophysics Research Board, National Academy of Science, the principal investigator is able to integrate these activities with national scientific/technological priorities.

- III. Completed initial design and initial concept testing of new magnetotelluric/geomagnetic variation field system for application to studying thermal regimes in the continental crust.

The central objective behind developing our field system has been to assemble highly portable, low-power instrumentation that can provide an analysis of electromagnetic parameters from natural source-field experiments in essentially real-time. We have designed a micro-processor based data acquisition system that should enable us to obtain reliable magnetotelluric parameters using suitcase-sized instruments. The interpretation of these data will be complemented by low-powered magnetic gradiometric units.

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Title: Application of Natural Electromagnetic Field
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to Exploring for Energy Resources: Development
of a Broad-Band Data Acquisition/Processing
Facility

Person in Charge: John F. Hermance

Scope of Work

The focus of activity at this laboratory is on applying geophysical/electromagnetic techniques to detecting and characterizing geological features within the earth related to energy resources.

Our present attention is being directed toward acquiring an understanding of dynamical processes and thermal regimes associated with centers of major volcanic activity. Clearly, this is of central importance not only to basic science, but to national priorities on research programs involving a number of resource-related areas: geothermal energy; the migration of minerals and the emplacement of economic ore deposits; as well as to deep drilling for scientific research. We feel that to understand the dynamical evolution of intra-place silicic centers in the western U.S., one must also understand the evolution of precursory high-level basaltic activity. This is because the segregation of basaltic magma from parent mantle material at depth (30-100 km), and its migration to higher levels in the crust (5-15 km), offers an effective mechanism for transferring heat from deep mantle sources to episodes of crustal melting at shallow depth, leading to the initiation of silicic volcanism at the surface.

To investigate these phenomena, we are mobilizing a long-term geophysical field program (using tellurics, magnetotellurics and geomagnetic variations; 1000 Hz-10⁴ sec), under joint support from the DOE/Division of Basic Energy Science, along with several other government agencies. A comparative study will be undertaken of selected major volcanic centers in terms of their association with regional tectono/magmatic phenomena in the deep crust and upper mantle.

Our focus this year has been on developing a magnetotelluric/magnetic variation field system capable of (a) high data quality, (b) increased frequency band coverage (10^4 sec to 10^3 Hz), (c) on-site data processing, (d) computer generated graphical displays of data parameters on maps of the survey area while the field system is on-site, (e) minimal turn-around time from making the measurement to final data analysis.

We have also been doing a background study on the past application of these techniques to various tectonic areas around the world in an effort to ascertain the effectiveness of electromagnetic methods in constraining models of the thermal regime of the crust associated with active volcanoes.

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