ELECTRICAL CONDUCTIVITY OF SEVERAL SAMPLES OF OLIVINITES, PERIDOTITES, AND DUNITES, AS A FUNCTION OF PRESSURE AND TEMPERATURE

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Reprinted for private circulation from
GEOPHYSICS
Vol. 38, No. 1, February, 1973

GEOPHYSICS, VOL. 38, NO. 1 (FEBRUARY 1973), P. 14–24, 5 FIGS., 3 TABLES

ELECTRICAL CONDUCTIVITY OF SEVERAL SAMPLES OF OLIVINITES, PERIDOTITES, AND DUNITES, AS A FUNCTION OF PRESSURE AND TEMPERATURE†

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The electrical conductivity σ of several samples of olivinites, peridotites, and dunites was measured in the temperature range between 250 and 700°C under quasi-hydrostatic pressures from 1 to 20 kb. Using a straight line extrapolation of $\log\sigma$ values taken at pressures greater than 6–8 kb, graphs of $\log\sigma$ versus $1/T$ were plotted for 0 and 20 kb. These graphs exhibit similar general features to those obtained under room pressure by other authors, but they appear to be shifted towards the low temperature side. This shift may be explained plausibly by assuming much higher values of the preexponential term but only minor variations of the exponential term in the expression $\sigma=\sigma_0 \exp(-A/kT)$. The electrical conductivity of the samples with high percentage of serpentinized olivine (more than 35 percent) is characterized by a decrease of σ in the temperature interval between 470 and 625°C and is related to the content of serpentine in the samples and its dehydration in this temperature range.

Some estimates of temperature within the earth based on conductivity data inferred from magnetotelluric and geomagnetic variation methods are discussed in terms of the present results which suggest substantially lower values of T to be attained at a particular depth. Also, an attempt is made to reexamine assumptions involving the theoretically deduced equation of the electrical conductivity within the earth.

INTRODUCTION

The upper mantle of the earth is believed to be composed mainly of olivine with smaller amounts of pyroxenes and garnets. It is assumed that under continents there is a zone of variable thickness, reaching to a maximum depth of about 150 to 200 km, which consists predominantly of peridotite and dunite with lesser amounts of eclogite in the form of local segregations. Under the deep oceanic basins, however, this zone is missing, or alternatively, it may be present down to a depth of a few tens of kilometers. Further down, this layer passes into a primitive mantle material, pyrolite, consisting of approximately three parts of peridotite and one part of basalt (Ringwood, 1966, 1969).

To learn something about the physical properties of the upper mantle of the earth, experiments should be performed under physical conditions similar to those in a particular depth in the earth and also on possible mantle constituents which can be expected within the region of interest.

The present paper summarizes results of electrical conductivity measurements made on olivinites, peridotites, and dunites obtained in the temperature range from 250 to 700°C and under quasi-hydrostatic pressures between 1 and 20 kb (these conditions correspond to a maximum depth of about 60 km).

EXPERIMENTAL INVESTIGATION

Method and procedure

All the measurements were made using samples 4 mm thick and 10 mm in diameter in a piston-cylinder type of high-pressure apparatus (Parkhomenko and Bondarenko, 1963). The equipment consisted of a piston, a die, and two supporting

† Manuscript received by the Editor June 15, 1972; revised manuscript received September 18, 1972.

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