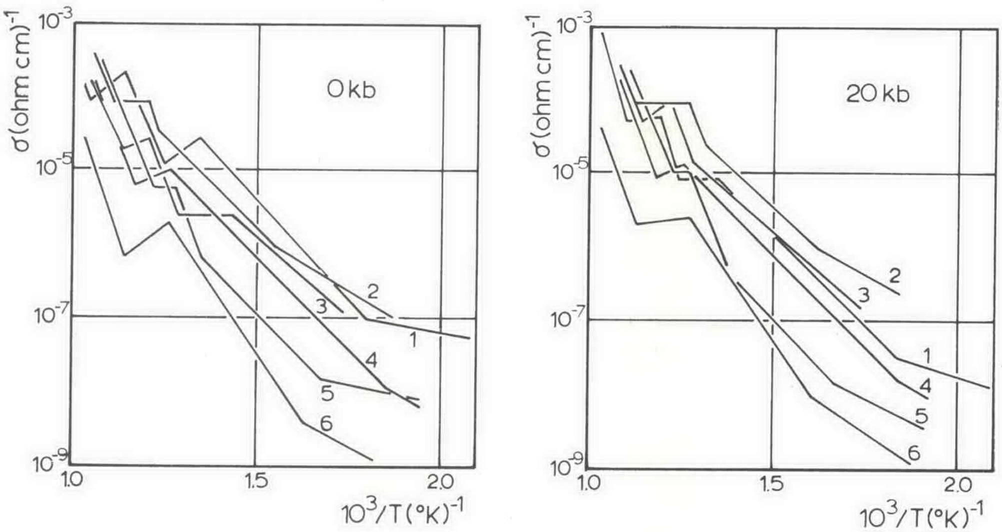

FIG. 3. Conductivity versus $1/T$ for dunites: 1—4825; 2—7199; 3—6672; 4—5556; 5—7198; 6—5577.

structed for 0 and 20 kb and are summarized in Figure 3. (Samples no. 5556 and no. 5577 represent averages of two experiments made on different cuts of the same rock.) Similar to peridotites and olivinites, the electrical conductivity data tend to form straight line portions in the $\log\sigma$ versus $1/T$ plots. These plots, however, are not as regular as those of olivinites and peridotites. In the low-temperature region up to 270–360°C, conductivity values are much higher, given by $0.2 < A < 0.7$ eV, and $-6.1 < \log\sigma_0 < -1.4$, and at higher temperatures by $0.85 < A < 1.45$ eV, and $0.7 < \log\sigma_0 < 3.4$. Starting from 470–560°C, an interval, about 70–100°C broad, is found, which is characterized by a decrease of conductivity. In the following interval σ, expressed by A between 2.45 and 2.85 eV and $\log\sigma_0$ between 9.6 and 11.2 is reached, both constants being essentially in agreement with the high-temperature values for olivinites and peridotites.

Trying to express the obtained results in more general terms, limits of the variations of $\log\sigma$ with $1/T$ were determined for 0 and 20 kb. By using a simple graphical method, the mean curve was found for a given P which was used to calculate values of A, $\log\sigma_0$, pressure coefficients, and second derivatives $\Delta(\Delta\log\sigma/\Delta P)/\Delta T$ (Table 2).

Values of A in the temperature region below 310 to 350°C were found to increase with increasing pressure. Above this region, to 500–520°C, only a small change in A was found. At 20 kb this resulted in about a 2.5 percent decrease from the zero pressure value. The table does not give any numerical values for the next rather narrow temperature interval, which is characterized by an irregular course of conductivity. (Unfortunately,

Table 2. The average characteristics of dunites.

T(°C)	A_{0kb}(eV) $(\log\sigma_0)_{0kb}$	T(°C)	A_{20kb}(eV) $(\log\sigma_0)_{20kb}$	$\Delta\log\sigma/\Delta P$ (kb^{-1})	T(°C)	$\Delta\log\sigma_0/\Delta P$ (kb^{-1})	$\Delta(\Delta\log\sigma/\Delta P)/\Delta T$ (°K^{-1} kb^{-1})
250–310	0.34	250–350	0.59	6.50×10^{-3}	255	124.5×10^{-3}	20.2×10^{-5}
	-4.78		-2.29	17.00×10^{-3}	308		
310–515	1.23	350–505	1.20	1.00×10^{-3}	352	-11.0×10^{-3}	-1.7×10^{-5}
	2.86		2.64	-1.45×10^{-3}	496		
585–700	2.64	605–700	2.54	6.25×10^{-3}	612	-22.0×10^{-3}	-3.9×10^{-5}
	10.06		9.62	4.50×10^{-3}	670		

the coarse temperature step of 50°C used throughout the experiments does not permit examination of this feature in more detail.) Starting from between 585 and 605°C, a decrease of A was found, which at 20 kb amounts to approximately 3.8 percent of the zero pressure value.

DISCUSSION AND SOME GEOPHYSICAL IMPLICATIONS

Graphs of $\log\sigma$ versus $1/T$ for 0 kb, when compared with those obtained by other authors at room pressure, show a rather significant shift toward the low-temperature side, which resulted in large changes of the preexponential term [σ_0 in (1)]. However, the general features of both graphs are essentially preserved, as is indicated by a comparison with Lubimova and Feldman's data (1970, Figure 11) for room pressure, and with those of Bradley et al (1964) for pressures of about 20–24 kb. These data seem to be most representative of results obtained by many authors for olivine-bearing rocks. (In this context it may be pointed out that according to Figure 5 of the paper by Bradley (1964), for temperatures greater than 580°C, an additional value of activation energy close to 2.5 eV can be deduced from the graph of olivine of the 90 percent Fo+10 percent Fa composition.)

Effect of repeated heating

With repeated heating appreciable differences of σ values were found between subsequent temperature runs (Figure 1b and Figure 4). These differences, which also have been observed under similar experimental conditions by other investigators (Schober, 1971; Duba, 1972), can probably be explained by effects of the temperature treatment which produce changes in the sample. It is known that at low temperature, both ionic and electronic conductivities vary greatly from sample to sample and depend significantly on each sample's thermal history. The preexponential term [σ_0 in (1)] decreases as the purity of the sample increases, while A stays at about the same value (Lidiard, 1957, Ioffe, 1960). As this is borne out by our results, it seems reasonable to conclude that the low-temperature interval (up to 530–580°C) is the region of an impurity conduction. The change of σ with repeated heating might thus be explained by assuming an increase in the number of impurity carriers, i.e., an increase in a number of charge carriers due to the heat treatment.

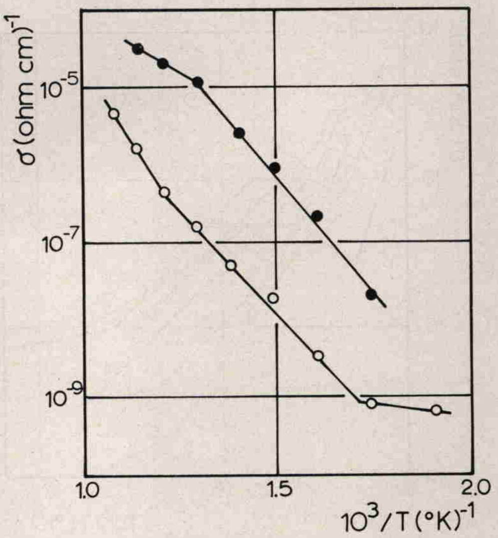

FIG. 4. Variations of conductivity at 0 kb as a function of $1/T$ for peridotite no. 5375 (open circles) as compared with values taken during repeated heating (full circles).

However, a change of surface and grain boundary conditions in the sample due to repeated heating may be considered as another possibility. Suppose the specimen is composed of a large number of crystal grains, with the boundary regions between them exhibiting a strong disorder rather than an ordinary crystalline arrangement. We might then expect the atoms in this boundary region to move with an activation energy lower than that for the interstitial and vacancy movement in the interior of the crystal grains (Lidiard, 1957). Thus, if the grain boundary conditions are changed by repeated heating, a change of σ will also result.

In this stage we are not able to explain the observed differences in full detail. However, the latter hypothesis may be favored against the first one on the basis of comparison with the experiment performed by Parkhomenko and Bondarenko (1963). They examined samples of different rocks, including highly serpentinized dunite (55 percent serpentine), which were exposed to quasi-hydrostatic pressure of about 40 kb and temperatures up to 400°C. A macroscopic study revealed considerable changes in the structure of serpentine, which formed deformation margins around the olivine grains, but no essential change in composition.

Schober (1971) observed the irreversible changes