ties. Table 4 compiles the results of wet chemical analyses of the three olivines, as well as spectrographic determination of impurities in all four natural olivines studied here. Electron-microprobe and spectrographic analyses indicated no significant difference in impurity levels of all four samples, although there was a slight calcium enrichment in the Fa 26.4. The amount of Fa 26.4 was insufficient for wet chemical analysis; thus its composition as determined by the electron microprobe is given in Table 4.

Table 4 indicates that Fa 9.4 has little or no Fe^{3+} when compared with Fa 8.2 and Fa 7.7. During chemical analysis J. Ito (personal communication, 1971) noted that the Fa 9.4 olivine was much more stable with respect to oxidation than the Fa 8.2 olivine, because the Fa 8.2 turned reddish brown rapidly and was 80% oxidized when heated to 1150°C in air for 3 hours, whereas the Fa 9.4 changed color slowly and was less than 20% oxidized after heating at 1150°C in air for 3 hours.

This analysis, coupled with the observation that oxidation of the olivine during the experiment caused increased σ owing to an increase in the intercept with no change in slope, indicates that the σ mechanism associated with the 0.7-ev slope is due to Fe^{3+} ions in the olivine structure. The σ can be the result of either the 'hopping mechanism' proposed by *Bradley et al.* [1964] or ionic motion enhanced by local charge imbalance introduced by the presence of the Fe^{3+} ion in the olivine structure.

For all samples studied here only one mechanism of σ was observed between 800°C and the temperature at which leakage conductance affected the measurements. In this respect the data agree with the observations of *Mizutani and Kanamori* [1967] for olivine from Miyakejima (Fa 18) and *Shankland* [1969] for synthetic forsterite and disagree with the observations of *Noritomi* [1961] for olivine from Bonin Island and Sado (Fa 20) and *Hughes* [1953] for the Red Sea peridot. This disagreement can be explained as a result of differences in impurity levels of olivines from different localities and, in the case of Hughes, whose measurements were made in air, as a result of oxidation.

The variation of σ with crystal direction in the Fa 8.2 is included in Figure 2. These data are the result of linear-regression analyses of at least two runs for each crystal direction at 7.5 kb. Although the data for individual and combined runs tend to plot in the order shown in Figure 2, the difference in σ as a function of crystallographic orientation is within the experimental accuracy, as is indicated by Table 3.

The data for the temperature region between

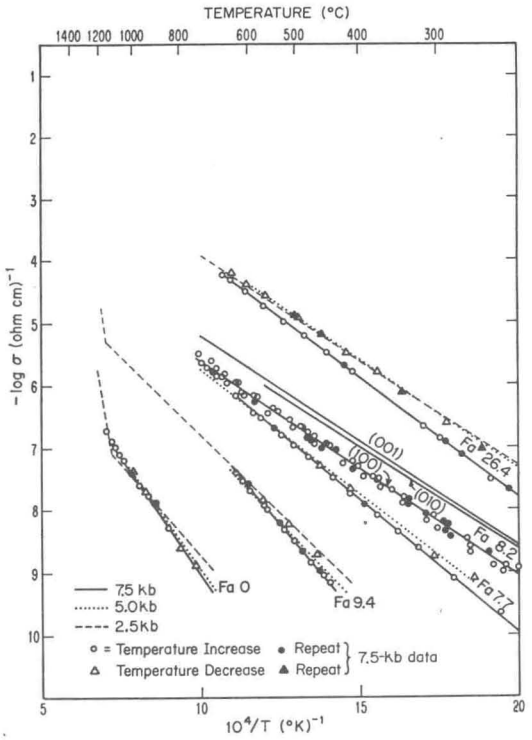

Fig. 2. Electrical conductivity of olivine as a function of temperature, pressure, composition, and crystal direction. Solid lines are for 7.5-kb data. Data points are as follows: open circles, temperature-increase measurements; shaded circles, a cycling down of 100°–200°C to check reproducibility; open triangles, measurements taken after the maximum temperature has been attained; shaded triangles, a cycling up of 100°–200°C to check reproducibility. As can be seen, most of the pressure effect can be attributed to some change in the system after the highest temperature was achieved. The small pressure effect for Fa 8.2 could not be plotted on this scale. The variation of conductivity with direction is plotted for this composition as the result of least-squares fits to at least two runs on two different sections of the same crystal in each direction. The data points for the three runs in the (100) direction are plotted. The scatter is large because of thickness and size-measurement errors among the three samples.

TABLE 3. Results of Linear-Regression Analysis of Experimental Data

osition	Crystal Direction	Pressure, kb	Temperature Range, $10^4/T$ (°K)$^{-1}$	log σ_x	A/k	Sta
7.7						
		7.50	18 to 11	-1.428	0.4272	
		5.00	19 to 10	-1.675	0.4056	
8.2						
	(100)	7.50	20 to 11	-1.764	0.3701	
	(100)	7.50	20 to 11	-2.080	0.3565	
	(100)	5.00	22 to 11	-2.036	0.3566	
	(100)	2.50	22 to 11	-2.022	0.3575	
	(100)	7.50	20 to 10	-2.135	0.3441	
	(100)	7.50	20 to 11	-2.126	0.3478	
	(010)	7.50	20 to 11	-1.571	0.3644	
	(010)	7.50	22 to 9	-1.945	0.3389	
	(010)	7.50	22 to 11	-1.931	0.3377	
	(010)	5.0	24 to 11	-1.982	0.3323	
	(010)	2.5	24 to 12	-1.711	0.3523	
	(010)	0	19 to 11	-1.910	0.3450	
	(010)	7.50	20 to 12	-1.917	0.3399	
	(001)	7.50	22 to 10	-1.735	0.3500	
	(001)	5.00	23 to 11	-1.700	0.3477	
	(001)	2.50	24 to 12.5	-1.536	0.3558	
	(001)	7.50	21 to 10	-1.646	0.3505	
	(001)	7.50	21 to 10	-1.697	0.3507	