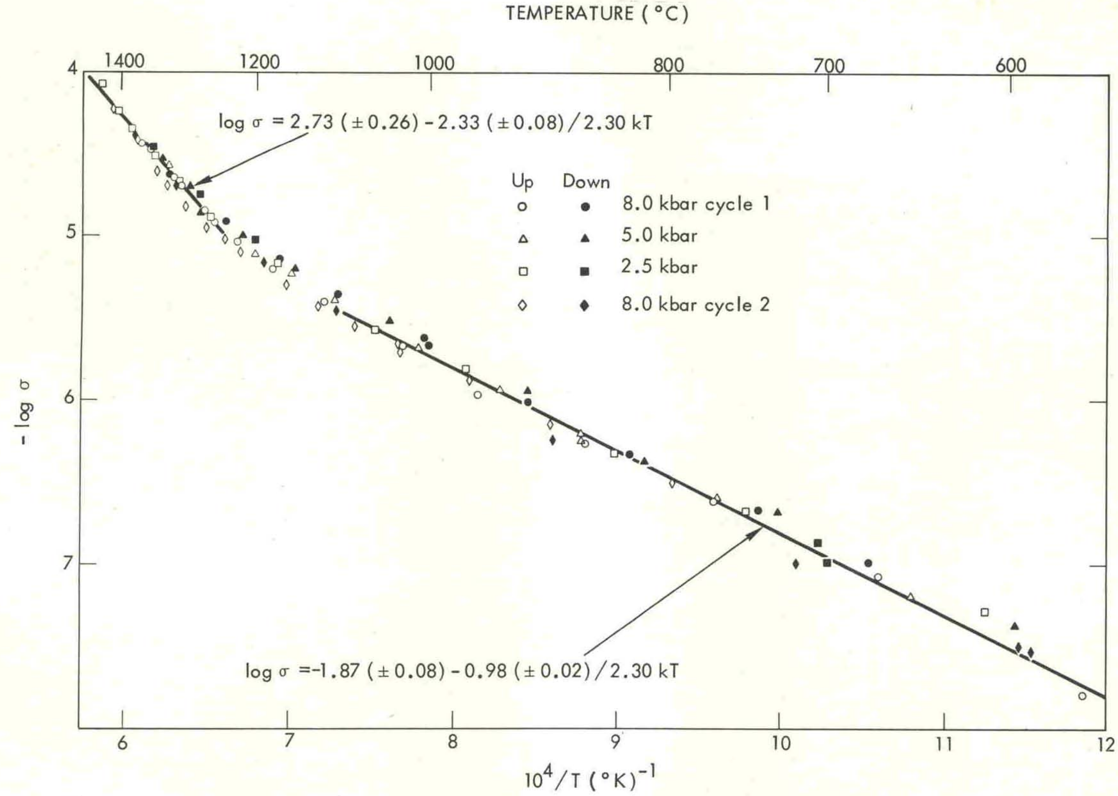

Fig. 2. Compilation of the data in Figure 1 with linear regression fit to (1).

TABLE 1. Results of Linear Regression Analyses of σ Data for Red Sea Olivine [100]

Experimental Conditions	Temperature Range, °C	log σ_x	A_x, eV	Number of Observations
8.0 kbar in argon (Fig. 1*a*)				
Cycle 1	560 to 1120	-1.77 ± 0.11	1.00 ± 0.02	14
	Transition region	...	...	4
	1270 to 1370	2.46 ± 0.35	2.24 ± 0.11	6
Cycle 2	600 to 1120	-1.85 ± 0.12	0.99 ± 0.03	17
	Transition region	...	...	6
	1270 to 1410	3.66 ± 0.34	2.64 ± 0.11	9
5.0 kbar in argon (Fig. 1*b*)	600 to 1100	-1.76 ± 0.17	0.99 ± 0.04	12
	Transition region	...	...	4
	1270 to 1370	2.18 ± 0.82	2.15 ± 0.26	6
2.5 kbar in argon (Fig. 1*c*)	610 to 1060	-2.12 ± 0.16	0.92 ± 0.04	7
	Transition region	...	...	4
	1310 to 1440	2.36 ± 0.23	2.20 ± 0.08	13
8.0, 5.0, and 2.5 kbar in argon (Fig. 2; Fig. 4, curve 7)	560 to 1120	-1.87 ± 0.08	0.98 ± 0.02	50
	Transition region	...	...	18
	1270 to 1440	2.73 ± 0.26	2.33 ± 0.08	34
$f_{O_2} \sim 10^{-8}$ bar at 1200°C* (Fig. 3; Fig. 4, curve 4)				
Cycle 1 (up)	890 to 1390	-0.18 ± 0.05	1.51 ± 0.01	31
	1400 to 1500	3.42 ± 0.28	2.74 ± 0.10	15
	1510 to 1540	18.01 ± 0.85	7.89 ± 0.30	5
	1550 to 1660	5.07 ± 0.17	3.23 ± 0.06	19
$f_{O_2} = 10^{-8}$ bar at 1200°C (Fig. 3; Fig. 4, curve 6)				
Cycles 1 (down), 2, 3	870 to 1320	-0.76 ± 0.05	1.34 ± 0.01	43
	1380 to 1450	2.41 ± 0.22	2.36 ± 0.08	19
	1450 to 1490	11.48 ± 0.87	5.46 ± 0.30	11
	1490 to 1640	5.21 ± 0.16	3.26 ± 0.03	48
$f_{O_2} = 10^{-8}$ bar at 1200°C (Fig. 4, curves 4 and 6)	1490 to 1660	4.82 ± 0.15	3.13 ± 0.06	67

*Includes $f_{O_2} = 10^{-8.4}$ bar at 1200°C.

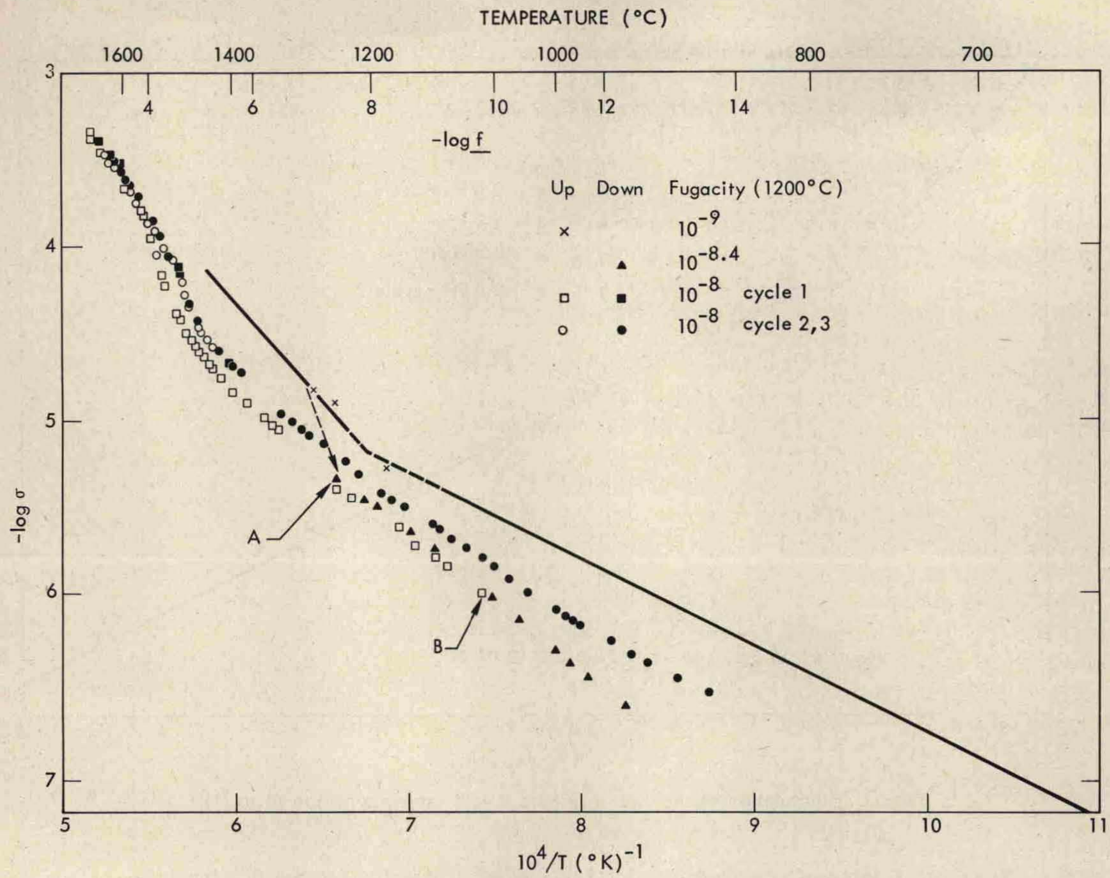

Fig. 3. Conductivity (Ω^{-1} cm^{-1}) of Red Sea olivine [010] to 1660°C. The linear regression fit for high- and low-temperature regions was replotted from Figure 2. Point A was measured after 15 hours at ~1200°C. Point B was measured after 30 hours at ~1000°C. For a H_2/CO_2 mix yielding $f_{O_2} = 10^{-8}$ bar at 1200°C, $-\log f_{O_2}$ is plotted along the upper abscissa.

tivity data identical with those for the second cycle. Analyses of the data from the various cycles are summarized in Table 1. After removal from the assembly several additional fractures were noted, and the sample was somewhat paler than when originally inserted.

The irreversible increase in σ below 1500°C, which was observed after the temperature increase portion of the first cycle, could be the result of fracturing or contamination of the sample with impurities released from the furnace parts at high temperature [*Osburn and Vest*, 1971]. Besides the increase in σ, which occurred after the first temperature increase cycle to 1660°C, the most remarkable feature of the higher-temperature data is the discontinuous change in σ between temperatures of 1460°–1500°C. This completely reversible discontinuity was observed in all three cycles to high temperature.

DISCUSSION

The data of Figures 1, 2, and 3 indicate that the temperature variation of the σ of olivine may be described by the equation

$$\sigma = \sum_x \sigma_x \exp(-A_x/kT) \quad (1)$$

where σ_x is a constant dependent on mechanism x, A_x is an activation energy for the conduction mechanism, k is the Boltzmann constant, and T is temperature. Table 1 lists σ_x and A_x at several values of pressure and f_{O_2} for various temperature ranges. Figures 1 and 2 and Table 1 demonstrate that pressure to 8 kbar has no measurable effect on the σ of the present sample. For olivine from the same locality, *Hughes* [1955] reported a pressure effect equivalent to about a 14° change in temperature over an 8.2-kbar range between 1060° and 1240°C. This observation lies within the scatter of our data and is less than the temperature gradient across his sample. Hughes determined his pressure effect with measurements at only three temperatures: 1060°, 1160°, and 1240°C, each at six different pressures. Between 1060° and 1240°C we typically have 10 data points at each of three pressures.

The lack of a measurable pressure effect, distinct from experimental uncertainty, in the present study may be due to a number of factors. The error associated with the σ measurement is 1–2%. The error in temperature measurement is more difficult to assess. Although the temperature differences across the 0.37-mm-thick sample were 10°C or less, the thermocouples would undergo 5°–15°C fluctuations with time, evidently in response to convection in the argon. Thus a good proportion of the uncertainty is due to our inability to determine adequately the temperature of the sample in the pressure vessel. Another potential contributor to a change in σ is a partial equilibration of the olivine with the high-pressure atmosphere during the measurement, since no annealing at high temperature and high pressure was performed prior to the σ measurement. On the other hand, the effect of pressure on σ is expected to be instantaneous in comparison with any chemical reaction. Thus any appreciable pressure effect should dominate initially. We conclude that the maximum