uncertainties, both demonstrations of the jump in σ associated with the fayalite to spinel transition [5, 1] are open to question. Assuming the observation of a σ jump to be valid (and it is plausible), the absolute σ is still in question of the unknown contribution of contaminants such as Fe^{3+} and/or carbon.

Figure 2 shows the olivine stability field for f_{O_2} vs. T^{-1} for olivine containing 10% fayalite (solid lines). The upper line is from NITSAN [28] and the bottom from DUBA and NICHOLLS [11]. Solid lines labelled QFM, W–M, and I–W are the solid buffers quartz–fayalite–magnetite, wüstite–magnetite, and iron–wüstite, respectively, and are taken from EUGSTER and WONES [18]. The dashed lines are the limits of f_{O_2} provided by our gas mixer and were calculated from thermodynamic data [7] for the reactions:

$$H_2 + \frac{1}{2} O_2 \rightleftarrows H_2O$$

$$CO_2 \rightleftarrows CO + \frac{1}{2} O_2$$

for various mixes [13]. The recent publication of DEINES et al. [8] provides a most convenient tabulation and display of f_{O_2} for various gas mixes which agrees with our calculations and is preferable and more reliable and convenient than calculations from thermodynamic data. The most useful feature of gas mixes for f_{O_2} control during experiments at high temperatures is that the f_{O_2} produced by constant gas mixes as temperature is increased, follows a path that is almost parallel to the olivine stability field and to the natural buffer systems—QFM, W–M, and I–W. This is significant for two reasons: as temperature is increased, f_{O_2} is maintained close to the f_{O_2} produced during heating of buffers which are likely to operate in the earth; and since the f_{O_2} of the experimental atmosphere is almost parallel to the olivine stability field, the number of oxygen defects produced during heating cycles is almost constant.

Figure 3 provides a demonstration of the large effect of Fe^{3+} on the σ of olivine. Line P1 is the σ of a peridotite measured in an unspecified atmosphere [31]; line 1 is the σ of olivine from San Carlos Indian Reservation, Arizona, measured in argon [9]; line 7a is σ for olivine from the same locality measured in air [11]. Slightly below 800 °C, the σ began to become irreversible. A gas mixer designed to control f_{O_2} was then attached to the sample assembly and a $\sigma - T$ path was followed as indicated by the dashed line. The H_2/CO_2 mix was changed to maintain a constant f_{O_2} of 10^{-7} Pa up to about 1300 °C, at which point the mix was maintained constant and provided a $f_{O_2} - T$ trajectory about one order of magnitude above and almost parallel to the bottom line marked "01" in Fig. 2. The $\sigma - T$ path followed by the sample on heating and cooling cycles with this atmosphere is line 7b and is in good agreement with σ measured for gem quality, and Fe^{3+}-poor [12], olivine from the Red Sea measured as follows: in argon (6a— [9]), in air (3— [20]), and in a mix of H_2 and CO_2 that is about one order below, and parallel to, the upper dashed line in Fig. 2 [14]. Admission of a small amount of air into the experimental atmosphere at 1000 °C causes an almost immediate increase in σ of several orders of magnitude. It then requires two to six hours for the

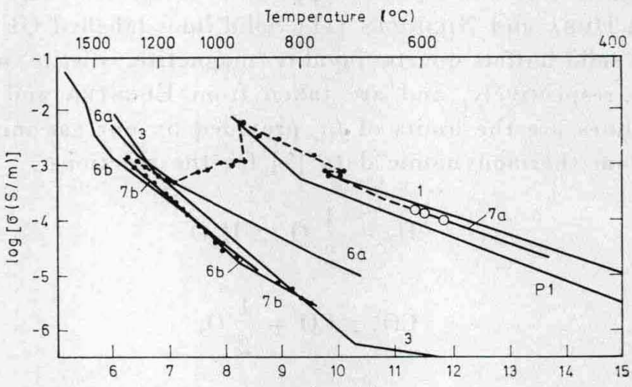

Fig. 3. The electrical conductivity of olivine single crystals of —10% fayalite composition. Lines are coded as follows, 1) Olivine from San Carlos Indian Reservation, Arizona, in argon, DUBA [9]; 3) olivine from St. John's Island, Red Sea, Egypt, in air, HUGHES, 1975; 6a) olivine from St. John's Island, Red Sea, Egypt, in argon, DUBA et al. [14]; 6b) same specimen as 6a, but under controlled f_{O_2}, DUBA et al. [14]; 7a) olivine from San Carlos Indian Reservation, Arizona, in air, DUBA and NICHOLLS [11]; 7b) same specimen as 7a, but under controlled f_{O_2}, DUBA and NICHOLLS [11]; Pl) peridotite, locality and atmosphere of measurement unknown, PARKHOMENKO [31]

σ to be re-equilibrated in a H_2/CO_2 mix which is inside the olivine stability field as delineated by the solid lines marked "01" in Fig. 2. The effect of pressure on σ in olivine over an 800 MPa (8 kbar) range is less than a temperature change of ± 5 °C at temperatures between 1270° and 1440 °C [14].

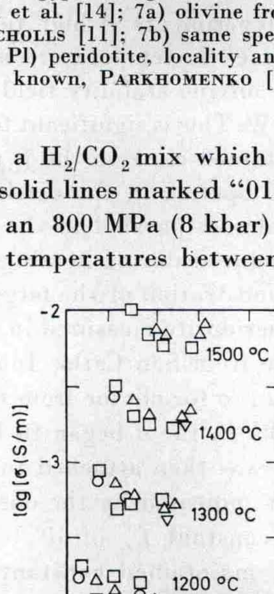

Fig. 4. Electrical conductivity of olivine from St. John's Island, Red Sea, Egypt, as a function of temperature and f_{O_2} (DUBA et al. [15]