

This is presumably the result of disorder, in the solid state. Thus, a previous observation [23] that the σ of albite increased several orders of magnitude on melting has to be qualified to take into account the temperature-time history of σ . This has implications for the discovery and delineation of partial melt zones in the earth.

2. Electrical conductivity and f_{O_2}

Figure 1 is the electrical conductivity of polycrystalline olivine of composition ranging from pure fayalite to pure forsterite as a function of temperature at various pressures. It is compared with the σ of a single crystal of Fo 90 composition from St. John's Island, Red Sea, Egypt [14]. Several features

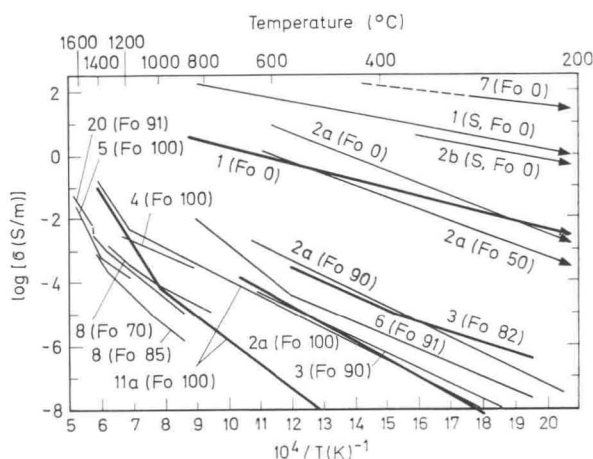


Fig. 1. The electrical conductivity of olivine. All measurements are powdered material except # 20. Composition and phase are identified in parentheses. S refers to the conductivity of spinel phase, composition ranges from pure fayalite (Fo 0) to pure forsterite (Fo 100). Numbers refer to studies identified below: 1) AKIMOTO and FUJISAWA [1]; 2a) BRADLEY et al. [6]; 2b) BRADLEY et al. [5]; 3) HAMILTON [19]; 4) JANDER and STAMM [21]; 5) PLUSCHKELL and ENGELL [34]; 6) SCHULT and SCHÖBER [39]; 7) MAO and BELL [26]; 8) DUBA [10]; 11a) HUGHES [20]; 20) DUBA et al. [14]

of the figure are noteworthy. Two investigators [1, 5] report an increase in σ with the inversion of olivine (Fo 0) to the spinel phase. At about 800 °C the reported σ of pure fayalite is 10^8 times higher than that for pure forsterite. The σ reported for olivine of interest to the upper mantle (Fo 90) and pure fayalite (Fo 0) span about four orders of magnitude at about 800° and 300 °C, respectively, while the largest span for reported σ of pure forsterite is less than two orders of magnitude at 800 °C. These large differences may be attributed to the enormous number of experimental variables among these

studies. Pressure, sample purity and preparation methods, single crystal vs. polycrystal, and experimental atmosphere are obvious reasons to explain the differences observed. The question becomes one of choosing the data which were collected under experimental conditions most relevant to the interior of the earth. Polycrystallinity is an obvious consideration, and most reported values of the σ of polycrystals are higher than that of a single crystal under

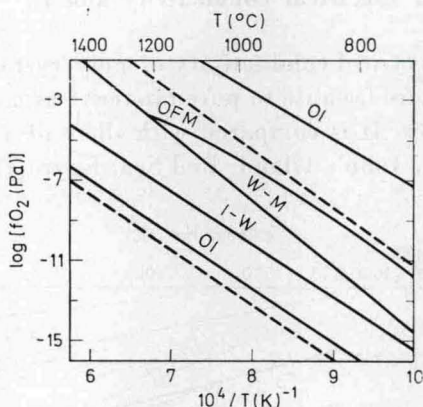


Fig. 2. Stability field of olivine as a function of temperature and f_{O_2} . Top line labelled O1 is for oxidation of olivine (Fo 90) NITSAN [28]; bottom line is for reduction of olivine (Fo 90) (DUBA and NICHOLLS [11]). QFM, W-M, and I-W are discussed in the text. Dashed lines represent the f_{O_2} as a function of temperature for the most oxidizing and reducing CO_2/CO mixes easily produced by our gas mixer

controlled f_{O_2} of similar forsterite content [compare polycrystal σ -lines 2a(Fo 90), 3(Fo 90, Fo 82), and 6 — with single crystal σ -line 20]. However, a polycrystal under controlled f_{O_2} is comparable in σ to a single crystal of similar forsterite content [compare polycrystal σ -line 8 (Fo 85) — with single crystal σ -line 20]. This observation is consistent with that of SCHOCK et al. [38] that the σ of polycrystals at high pressure is within one-half order of magnitude of that of the natural single crystals from which it was prepared and the difference is likely due to differing experimental f_{O_2} . Thus it is safe to assume that most σ results for polycrystals in Fig. 1 are not applicable because of oxidation problems during sample preparation and measurement in the laboratory [12]. There is a further issue that makes the measurements on polycrystals suspect when the heater is composed of graphite. It has been our experience that σ measured on alumina (DUBA, unpublished results) when graphite heaters were employed was several orders of magnitude higher than that measured when platinum foil heaters were used. This is because of the extreme mobility of carbon at high temperature which leads to contamination of the sample with highly conductive films of carbon. Because of oxidation