

Partitioning of sulfur between silicate melts and volatile phases as function of fO_2 : Clues from old models for a new reference framework

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The partitioning of sulfur between silicate melts and coexisting volatile phases is a key parameter to understand igneous processes such as massive S degassing in explosive eruptions (e.g. Mount Pinatubo, June 1991) and the formation of porphyry deposits (which in addition to Cu, Mo, and Au, are S anomalies). It is well-established that the S content at sulfide saturation (SCSS) in a silicate melt increases exponentially with increasing fO_2 regardless of whether the system is anhydrous or the melt is in equilibrium with a hydrous phase [1, 2, 3, 4]. It is also well-established that only S^{2-} and S^{6+} species are significant in silicate melts [5], whereas S^{4+} species (in addition to S^{2-} and S^{6+}) are significant in volatile phases [6]. Thus, the stability of S^{4+} species in the volatile phase is an essential parameter controlling S partitioning. Early studies of S behaviour between volatile phases and silicate melts [7, 8] have been used extensively to describe a “sulfur solubility minimum” that has no relevance to SCSS because the experiments in those studies lacked sulfides as run products. However, those experimental studies provide useful reference models when the data are recast in a more appropriate framework (i.e. to express S partitioning between the input gas and the silicate melt). The results show that, at atmospheric pressure, a S partitioning maximum exists at fO_2 conditions that may be attributed to S^{4+} dominance in volatile phases at low pressure (and that overlap the fO_2 range corresponding to the S^{2-} to S^{6+} transition in silicate melts at high pressure). Linking the two types of data (SCSS at high P and $D_{S^{gas/melt}}$ at atmospheric P) provides a useful model to understand S mass transfer from silicate melts into volatile phases during volatile exsolution and degassing resulting from magma ascent and decompression.

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Natural type-C olivine fabrics in garnet peridotites in North Qaidam UHP collision belt, NW China

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Water is known to change the lattice-preferred orientation (LPO) of olivine, which significantly affects seismic anisotropy in the Earth's upper mantle. Research into the LPO of olivine in the deep interior of the Earth has been limited due to inadequate specimens. We report both the water-induced LPOs of olivine and the presence of large quantities of water inside olivine, enstatite, and garnet in garnet peridotites from the North Qaidam ultrahigh-pressure (UHP) collision belt in NW China. We show that the [001] axis of olivine is aligned subparallel to the lineation and that the [100] axis is strongly aligned subnormal to the foliation. This alignment is a known feature of type-C LPO of olivine formed experimentally under water-rich conditions (≥ 700 ppm H/Si) at high pressure and temperature. Enstatite possessed an LPO with the [001] axis aligned parallel to the lineation and the [100] axis aligned normal to the foliation. FTIR analysis of this specimen revealed that olivine contained concentrations of water up to 1130 ± 50 ppm H/Si in clean areas, whereas olivine, enstatite, and garnet contained considerably more water, i.e., 2600 ± 100 ppm H/Si, 5000 ± 100 ppm H/Si, and 21000 ± 200 ppm H/Si, respectively, when exsolved inclusions were visible. Confocal micro-Raman spectroscopy of these exsolved inclusions revealed that they were composed of hornblende and amphiboles. Straight dislocations were also commonly observed in olivine and are characteristic of olivine that had been experimentally deformed under hydrous conditions. These observations suggest that the type-C LPO of olivine in the North Qaidam UHP belt formed under water-rich conditions.