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Ferric iron in Al-bearing akimotoite coexisting with iron-nickel metal in a shock-melt vein in an L-6 chondrite

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Abstract

We report evidence for high ferric iron to total iron ($Fe^{3+}/\Sigma Fe$) ratios in Al-bearing akimotoite coexisting with other high-pressure silicates and Fe-Ni metal from shock melt-veins in the Sixiangkou (L-6) chondrite. The measurements were made using electron energy-loss near-edge structure (ELNES) spectroscopy. The results demonstrate that akimotoite in shock-melt veins of this meteorite has high proportions of Fe^{3+}, with a $Fe^{3+}/\Sigma Fe$ ratio of 0.67(3). In contrast, the coexisting majoritic garnet and ringwoodite, which are the typical Fe-bearing phases in shock veins in this meteorite, are enriched in Fe^{2+} rather than Fe^{3+}, with $Fe^{3+}/\Sigma Fe$ ratios of 0.10(5) and 0.15(5), respectively. We conclude that the higher affinity of Fe^{3+} for akimotoite, rather than for the other dense silicate phases, is related strongly to the substitution mechanism of trivalent cations. This mechanism is described as $^{VI(A)}Fe^{3+} + {}^{VI(B)}Al^{3+} = {}^{VI(A)}Mg^{2+} + {}^{VI(B)}Si^{4+}$ in the ABO_3 structural formula of $MgSiO_3$-ilmenite under high pressures and temperatures, and operates even at a low oxygen fugacity where Fe-Ni metal is stable.

Keywords: Meteorite, L-6 chondrite, electron microscopy, Fe-bearing silicates, akimotoite, high pressure, shock-melt vein