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Vestaite, $(Ti^{4+}Fe^{2+})Ti_3^{4+}O_9$, a new mineral in the shocked eucrite Northwest Africa 8003

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Abstract

Our investigations on the shocked eucrite Northwest Africa (NWA) 8003 revealed the occurrence of a new mineral, vestaite [IMA 2017-068; $(Ti^{4+}Fe^{2+})Ti_3^{4+}O_9$]. This mineral coexists with corundum, ilmenite, and Al-Ti-rich pyroxene in shock melt pockets. It has an empirical chemical formula of $(Ti_{0.73}^{4+}Fe_{0.63}^{2+}Al_{0.60}Mn_{0.03}Mg_{0.02}Cr_{0.01})Ti_3^{4+}O_9$ and the monoclinic $C2/c$ structure of schreyerite. The ideal vestaite structure can be considered as a modular structure with an alternate intergrowth of M_3O_5-type (M = Ti^{4+},Fe^{2+},Al) and Ti_2O_4-type slabs. Alternatively, it can also be envisaged as a crystallographic shear structure with periodically shearing of rutile or α-PbO_2 units. Streaking and splitting of diffraction spots observed in selected-area electron diffraction patterns indicate planar defects in the modular structure of vestaite. Our observations reveal that vestaite crystallized at high pressure (≤10 GPa) from a melt that represents a mixture of ilmenite and silicate components. A robust constraint on its formation conditions and stability field cannot yet be provided due to the lack of experimental data for these systems. Vestaite is a new, shock-generated mineral first found in a meteorite of the howardite-eucrite-diogenite (HED) clan, the largest achondrite group. Its discovery is not only of significance to the meteoritic mineralogy, but it could also be of interest to materials science.

Keywords: Vestaite, new mineral, Northwest Africa 8003, HED meteorites, shock metamorphism