*American Mineralogist, Volume 101, pages 205–210, 2016*

# Phase stabilities and spin transitions of $Fe_3(S_{1-x}P_x)$ at high pressure and its implications in meteorites

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## Abstract

Fe-S-P compounds have been observed in many meteorites and could be the important components in planetary cores. Here we investigated the phase stability of $Fe_3(S,P)$ solid solutions and synthesized high-quality $Fe_3(S_{1-x}P_x)$ high-pressure phases in the multi-anvil press. The physical properties of $Fe_3(S_{0.5}P_{0.5})$ were further studied in the diamond-anvil cell by synchrotron X-ray diffraction and emission spectroscopy. The solubility of S in the $Fe_3(S,P)$ solid solution increases with increasing pressure. The minimum pressure to synthesize the pure $Fe_3S$ and $Fe_3(S_{0.13}P_{0.87})$ is about 21 and 8 GPa, respectively. The observed discontinuity in unit-cell parameters at about 18 GPa is caused by the high-spin to low-spin transition of iron, supported by X-ray emission spectroscopy data. The sulfur solubility in $Fe_3(S,P)$ solid solutions could be an excellent pressure indicator if such solid solutions are found in nature.

**Keywords:** Iron sulfides, iron phosphides, high pressure, meteorites, spin transition