

## Ferromagnesian jeffbenite synthesized at 15 GPa and 1200 °C

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### ABSTRACT

Single crystals of Al-free, ferromagnesian jeffbenite up to 200  $\mu\text{m}$  in size have been synthesized at 15 GPa and 1200 °C in a 1200 tonne multi-anvil press from a starting composition in the forsterite-fayalite-magnetite-water system. This phase has the approximate formula  $\text{Mg}_{2.62}\text{Fe}_{0.87}^{2+}\text{Fe}_{1.63}^{3+}\text{Si}_{12.88}\text{O}_{12}$  and is observed to coexist with a Ca-free clinopyroxene plus what appears to be quenched melt. The crystal structure has been refined from single-crystal X-ray diffraction data and is similar to that determined for natural Al-bearing jeffbenite,  $\text{Mg}_3\text{Al}_2\text{Si}_3\text{O}_{12}$ , reported from inclusions in superdeep diamonds. The structure is a tetragonal orthosilicate in space group  $I\bar{4}2d$  with  $a = 6.6449(4)$  Å,  $c = 18.4823(14)$  Å, and is structurally more closely related to zircon than to garnet. The T2 site is larger than T1, shares an edge with the M2 octahedron, and incorporates significant  $\text{Fe}^{3+}$ . Because of the tetrahedral incorporation of trivalent cations, jeffbenite appears to be compositionally distinct from garnet. Previous speculations that the phase may only occur as a retrograde decompression product from bridgmanite are not supported by its direct synthesis under transition zone conditions. The phase has a calculated density of 3.93  $\text{g}/\text{cm}^3$ , which is indistinguishable from a garnet of comparable composition, and is a possible component in the mantle transition zone under oxidizing conditions or with Al-rich compositions.

**Keywords:** Jeffbenite, tetragonal almandine pyrope phase (TAPP), super deep diamonds, diamond inclusions