

## LETTER

# Crystal structure of a new spinelloid with the wadsleyite structure in the system $\text{Fe}_2\text{SiO}_4\text{-Fe}_3\text{O}_4$ and implications for the Earth's mantle

A.B. WOODLAND<sup>1</sup> AND R.J. ANGEL<sup>2</sup>

<sup>1</sup>Mineralogisches Institut, Universität Heidelberg, Im Neuenheimer Feld 236, D-69120 Heidelberg, Germany

<sup>2</sup>Bayerisches Geoinstitut, Universität Bayreuth, D-95440 Bayreuth, Germany

### ABSTRACT

A new spinelloid polytype with a composition  $\text{Fe}_{2.45}\text{Si}_{0.55}\text{O}_4$  has been synthesized at 1100 °C and 5.6 GPa that is isostructural with wadsleyite [ $\beta\text{-(Mg,Fe)}_2\text{SiO}_4$ ]. The refined parameters (space group *Imma*) are:  $a = 5.8559(2)$  Å,  $b = 11.8936(4)$  Å,  $c = 8.3684(2)$  Å,  $V = 582.84(2)$  Å<sup>3</sup>. Tetrahedrally coordinated  $\text{Fe}^{3+}$  and Si are completely disordered and the substitution of  $\text{Fe}^{3+}$  for nearly one-half of the Si results in a significant expansion of the tetrahedra. This is the first direct evidence that significant amounts of  $\text{Fe}^{3+}$  can be incorporated into the wadsleyite-type structure. Because the  $\beta$  form of  $\text{Fe}_2\text{SiO}_4$  is unstable, the implication is that  $\text{Fe}^{3+}$ , by the substitution mechanism:  $2\text{Fe}^{3+} = \text{Si}^{4+} + \text{Fe}^{2+}$ , acts to stabilize the wadsleyite structure. It is possible that the addition of  $\text{Fe}^{3+}$  could stabilize  $(\text{Mg,Fe})_2\text{SiO}_4$  wadsleyites to lower pressures, which would influence the exact position of the “410 km” discontinuity. The apparent compatibility of  $\text{Fe}^{3+}$  in the wadsleyite structure, suggests that available  $\text{Fe}^{3+}$  will be readily incorporated in the modally dominant phase in the upper parts of the transition zone, thereby leading to a low  $f_{\text{O}_2}$  in this region of the mantle.