

LETTER

**Transformation of pentlandite to violarite under mild hydrothermal conditions**

**CHRISTOPHE TENAILLEAU,<sup>1,†</sup> ALLAN PRING,<sup>1,2,3,\*</sup> BARBARA ETSCHMANN,<sup>1</sup> JOËL BRUGGER,<sup>1,2</sup>  
BEN GRGURIC,<sup>4</sup> AND ANDREW PUTNIS<sup>5</sup>**

<sup>1</sup>Department of Mineralogy, South Australian Museum, North Terrace, Adelaide, S.A. 5000, Australia

<sup>2</sup>School of Earth and Environmental Science, University of Adelaide, Adelaide, S.A. 5005, Australia

<sup>3</sup>Ian Wark Research Institute, University of South Australia, Mawson Lakes, S.A. 5095, Australia

<sup>4</sup>Exploration Group, BHP Billiton Ltd, P.O. Box 91, Belmont, W.A. 6984, Australia

<sup>5</sup>Institut für Mineralogie, Universität Münster, Corrensstrasse 24, D-48149 Münster, Germany

ABSTRACT

The transformation of pentlandite,  $(\text{Ni,Fe})_9\text{S}_8$ , to violarite,  $(\text{Ni,Fe})_3\text{S}_4$ , has been investigated under mild hydrothermal conditions, at constant values of pH (range 3 to 5) controlled by the acetic acid/sodium acetate buffer. At 80 °C, 20(4) wt% of the pentlandite transforms to violarite in 33 days; with the addition of small amounts of  $\text{Fe}^{3+}(\text{CH}_3\text{COO})_2(\text{OH})$  and  $\text{H}_2\text{S}$  the reaction reaches 40(4) wt% completion in this time. At 120 °C and a pressure of 3.5 bars the reaction is complete in 3 days at pH 3.9. Electron backscatter diffraction and backscattered electron imaging reveal that the reaction textures are typical of a coupled dissolution-reprecipitation reaction, rather than a solid state electrolytic process as has been previously reported. The gap between the dissolution front and the precipitation front of violarite is less than 400 nm. The violarite produced by these hydrothermal transformations is texturally similar to supergene violarite, being fine grained, porous and finely cracked.

**Keywords:** Transformation, replacement reactions, pentlandite, sulfides, violarite