



## **The affect of bulk rock chemistry and fugacity on phase equilibria in low-temperature moderate-high-pressure metamorphic environments**

**G. Phillips** (1), R. Offler (1) and M. Hand (2)

(1) Discipline of Earth Sciences, School of Environmental and Life Sciences, University of Newcastle, Callaghan, NSW 2308, Australia, (2) Continental Evolution Research Group, School of Earth and Environmental Sciences, The University of Adelaide, SA 5005, Australia  
([Glen.Phillips@newcastle.edu.au](mailto:Glen.Phillips@newcastle.edu.au) / Fax: +61 02-49216925 / Phone: +61 02-49215410)

Mafic rocks from the Silurian to lower Carboniferous southern New England Fold Belt accretionary prism of eastern Australia are characterised by different metamorphic mineral assemblages. Assemblages range between magnesioriebeckite-epidote-chlorite-albite-quartz-actinolite (retrograde) and actinolite-pumpellyite-chlorite-albite-quartz associations. Rocks containing these assemblages can be observed in the same outcrop and do not appear to be separated by major crustal structures. This indicates that variable mineral assemblages do not represent the juxtaposition of different crustal levels or metamorphic grade. As it is well known that variations in bulk rock chemistry and/or oxygen fugacity can strongly affect mineral equilibria, modeling of these mineral assemblages in the system NCFMASHTO was carried out at constant  $P - T$  and transient bulk rock chemistry-fugacity conditions. For the modeling, bulk rock chemistry and  $\text{Fe}^{2+}/\text{Fe}^{3+}$  was determined by XRF and titration to best represent the natural metamorphic conditions. From these analyses, magnesioriebeckite-epidote associations were characteristic of a  $\text{Fe}^{3+}$ -rich/Ca-poor protolith, while pumpellyite-bearing assemblages were characteristic of a  $\text{Fe}^{3+}$ -poor/Ca-rich protolith. Through applying this transition in bulk rock composition and fugacity, magnesioriebeckite to pumpellyite bearing equilibria could be calculated at comparable  $P - T$  conditions. This is demonstrated on a  $P - X$  diagram where it is also shown that a variation in bulk rock  $\text{Fe}^{3+}$  content can result in a difference of up to 5 kbar in estimates of  $P$ .

Based on this, it is concluded that an accurate determination of  $\text{Fe}^{2+}/\text{Fe}^{3+}$  is critical when modeling  $P - T$  conditions from low-temperature, moderate-high pressure metabasic rocks. Also of interest is the variable preservation of relict igneous phases that are also characteristic of low-temperature, moderate-high-pressure metabasic rocks. In  $\text{Fe}^{3+}$ -rich/Ca-poor samples, igneous clinopyroxene is partially to thoroughly recrystallised and pseudomorphed by magnesioriebeckite-chlorite-actinolite. In samples that are  $\text{Fe}^{3+}$ -poor/Ca-rich, igneous clinopyroxene is relatively pristine and pumpellyite growth is restricted to extension fractures in this mineral. The breakdown of relict igneous phases and its affect on the bulk rock chemistry that contributes to metamorphic mineral equilibria is explored using  $P - X$  diagrams.