

Formation conditions for triple-chain silicates

BRIDGET E. AMS* AND DAVID M. JENKINS

Department of Geological Sciences and Environmental Studies, Binghamton University, Binghamton, New York 13902, U.S.A.

ABSTRACT

Since the first report of triple-chain silicates in 1977, there has been considerable uncertainty about their formation in nature, primarily concerning whether they are stable minerals or an intermediate step in the formation of other chain or sheet silicate minerals. The lack of thermochemical data and relevant experimental studies for any triple-chain silicate has impeded establishment of their thermodynamic stability relative to other minerals. Here we combine recently reported thermochemical data for a sodium-analog of the triple-chain silicate clinojimthompsonite (Na-cjt) with existing data for various common minerals (i.e., enstatite, talc, anthophyllite, and chrysotile). We also present new experimental data to show that Na-cjt should form stably at typical metamorphic conditions of 0.2 GPa and 450 °C. Ion-activity vs. pH diagrams calculated at 100–300 °C and 0.1 GPa show that Na-cjt could form by reaction between primary igneous minerals (enstatite, forsterite) in oceanic harzburgite and seawater at temperatures up to 300 °C. However, formation of Na-cjt from harzburgite that has been altered to talc and chrysotile is not expected to occur, except at the unusually high pH conditions observed for forearc serpentine mounds. Estimates of the thermochemical properties of the Na-free end-member clinojimthompsonite $[\text{Mg}_{10}\text{Si}_{12}\text{O}_{32}(\text{OH})_4]$ suggest that it also should form from the primary mineralogy of harzburgite at temperatures and Si concentrations typically observed for various oceanic hydrothermal and geothermal systems, but probably not from ultramafic rock already hydrated to serpentine.

Keywords: Triple-chain silicates, clinojimthompsonite, jimthompsonite, pyriboles, serpentine mounds