American Mineralogist, Volume 88, pages 246, 2003

ELECTRONIC ARTICLE

Isotope geochemistry of Proterozoic talc occurrences in Archean marbles of the Ruby Mountains, southwest Montana, U.S.A.*

JOHN B. BRADY,[1] JOHN T. CHENEY,[2] AMY LARSON RHODES,[1] ANGELA VASQUEZ,[2] CHRIS GREEN,[2] MATHIEU DUVALL,[3] ARI KOGUT,[4] LEWIS KAUFMAN,[5] AND DANA KOVARIC[1]

[1]Smith College, Department of Geology, Northampton, Massachusetts 01063, U.S.A.
[2]Amherst College, Department of Geology, Amherst, Massachusetts 01002, U.S.A.
[3]Colorado College, Department of Geology Colorado Springs, Colorado 80903, U.S.A.
[4]Beloit College, Department of Geology, Beloit, Wisconsin 53511, U.S.A.
[5]College of Wooster, Department of Geology, Wooster, Ohio 44691, U.S.A.

ABSTRACT

Talc occurs as massive, economic deposits in upper amphibolite facies marbles of Archean age in southwestern Montana. Previous workers have demonstrated that the talc is a replacement of the marble that resulted from interaction with a large volume of fluid. $\delta^{18}O$ (SMOW) values for dolomite and calcite range from 20–25‰ for the unaltered Archean marbles to as little as 8–10‰ in the talc deposits, suggesting that the metasomatic fluids had low $\delta^{18}O$ values. In contrast, $\delta^{13}C$ values for calcite and dolomite are similar for all samples (–2 to +2‰ PDB). Therefore, it is likely that the metasomatic fluids were oxygen-rich and carbon-poor, namely water-rich and CO_2-poor. A CO_2-poor fluid is also indicated by $\Delta^{13}C$ (calcite-graphite) values (3.6–5.3‰), which appear little altered from values expected for upper amphibolite facies marbles, and by the occurrence of the mineral assemblage talc+calcite. $^{40}Ar/^{39}Ar$ age spectra for hornblende, phlogopite, and biotite record cooling at 1.72 Ga from a regional thermal event. $^{40}Ar/^{39}Ar$ age spectra of fine-grained muscovite associated with the talc date talc formation at 1.36 Ga. The Ar data limit the temperature of talc crystallization to below ~350 °C, the biotite closure temperature for Ar diffusion. If the metasomatic fluid was seawater (0‰), then the carbonate oxygen data require a minimum temperature of 270 °C for talc formation. Oxygen ($\delta^{18}O$ = 4.7 to 8.8‰) and hydrogen (D/H = –49.9 to –57.6 SMOW) isotope data for the talc are consistent with a 200–300 °C metasomatic fluid derived from seawater, based on theoretical models of the fractionation of oxygen and hydrogen between talc and water. Regional, northwest-trending faults associated with the extension that formed the Belt Basin in the Middle Proterozoic may have provided channels for seawater to circulate in continental crust and to react with marble, forming talc at depths of 5–10 km.

*This article is designed to be read on a computer with internet access. The full text of the article can be obtained in pdf format at http://gmr.minsocam.org/Papers/v1/v1n2/v1n2abs.html.

ORIGINALLY PUBLISHED IN GEOLOGICAL MATERIALS RESEARCH ON DECEMBER 31, 1998

0003-004X/03/0001–246$05.00