American Mineralogist, Volume 90, pages 779–789, 2005

Factors in the preservation of coesite: The importance of fluid infiltration

Jed L. Mosenfelder,[1,*] Hans-Peter Schertl,[2] Joseph R. Smyth,[3] and Juhn G. Liou[4]

[1]Division of Geological and Planetary Sciences, California Institute of Technology, M/C 170-25, Pasadena, California 91125, U.S.A.
[2]Institut für Geologie, Mineralogie und Geophysik, Ruhr-Universität Bochum, D-44780 Bochum, Germany
[3]Department of Geological Sciences, University of Colorado, Boulder, Colorado 80309-0399, U.S.A.
[4]Department of Geological and Environmental Sciences, Stanford University, Stanford, California 94305-2115, U.S.A.

Abstract

The survival of coesite in ultrahigh-pressure (UHP) rocks is most commonly attributed to rapid exhumation, continuous cooling during uplift, and inclusion in strong phases that can sustain a high internal over-pressure during decompression. Exceptions to all of these criteria exist. Perhaps less attention has been paid to the role of fluid infiltration in the preservation of coesite. We used infrared spectroscopy to measure water contents of coesite and coesite pseudomorphs in a variety of UHP rocks. In all cases, OH concentrations in coesite are below the detection limit of ~100 ppm H_2O. The silica phases surrounding coesite, however, show varying amounts of H_2O. This is most spectacularly observed in pyrope quartzites from the Dora-Maira massif that contain at least three phases of silica replacing coesite, also distinguished by varying color of cathodoluminescence (CL): palisade-textured quartz (<100 ppm H_2O, red-violet CL); "mosaic" quartz, which is actually chalcedony (up to 0.4 wt% H_2O, yellow/brown CL); and a rare, highly hydrated silica phase interpreted to be opal (~7 wt% H_2O, dark blue CL). Very similar signatures are observed in a grospydite xenolith from the Roberts Victor kimberlite. The quartz replacing coesite in other UHP samples studied contains on the order of 500 ppm H_2O or less, and most measurements are under the detection limit of our technique. We infer that palisade quartz forms under dry or nearly dry conditions and at high temperatures during dilation of the host phase. The formation of hydrous silica phases such as chalcedony and opal, however, must take place at much lower temperatures, after cracking of the host phase, which allows external fluids to infiltrate. Delay of fluid infiltration to low temperatures, where kinetics are slow even in the presence of water, is the most critical factor in the preservation of coesite.