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Ductile deformation during carbonation of serpentinitized peridotite

Manuel D. Menzel , Janos L. Urai, Estibalitz Ukar, Greg Hirth, Alexander Schwedt, András Kovács, Lidia Kibkalo & Peter B. Kelemen

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Abstract

Carbonated serpentinites (listvenites) in the Samail Ophiolite, Oman, record mineralization of 1–2 Gt of CO₂, but the mechanisms providing permeability for continued reactive fluid flow are unclear. Based on samples of the Oman Drilling Project, here we show that listvenites with a penetrative foliation have abundant microstructures indicating that the carbonation reaction occurred during deformation. Folded magnesite veins mark the onset of carbonation, followed by deformation during carbonate growth. Undeformed magnesite and quartz overgrowths indicate that deformation stopped before the reaction was completed. We propose deformation by dilatant granular flow and dissolution-precipitation assisted the reaction, while deformation in turn was localized in the weak reacting mass. Lithostatic pore pressures promoted this process, creating dilatant porosity for CO₂ transport and solid volume increase. This feedback mechanism may be common in serpentinite-bearing fault zones and the mantle wedge overlying subduction

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Author information

Authors and Affiliations

Tectonics and Geodynamics, RWTH Aachen University, Lochnerstrasse 4-20, D-52056, Aachen, Germany

Manuel D. Menzel & Janos L. Urai

now at: Instituto Andaluz de Ciencias de la Tierra (IACT) (CSIC-Universidad de Granada), Avenida de las Palmeras 4, 18100, Armilla, Granada, Spain

Manuel D. Menzel

The University of Texas at Austin, Bureau of Economic Geology, Austin, TX, USA

Estibalitz Ukar

Brown University, Department of Earth, Environmental and Planetary Sciences, Providence, RI, USA

Greg Hirth

RWTH Aachen University, Central Facility for Electron Microscopy, Aachen, Germany

Alexander Schwedt

Ernst Ruska-Centre for Microscopy and Spectroscopy with Electrons, Forschungszentrum Jülich, Jülich, Germany

András Kovács & Lidia Kibkalo

Lamont–Doherty Earth Observatory, Columbia University, New York, NY, USA

Peter B. Kelemen

Contributions

M.D.M. and J.L.U. designed the study; J.L.U. and P.K. were involved in sampling; M.D.M., J.L.U., and P.K. conducted microstructural analysis by optical microscopy; M.D.M. performed SEM imaging, EDS mapping, optical CL analysis, and image, and micro-CT processing; E.U. conducted SEM and SEM-CL analysis; A.S. and M.D.M. conducted EBSD analysis and data treatment; A.K. and L.K. performed FIB preparation, and TEM and STEM analysis. M.D.M., J.L.U., P.K., G.H. and E.U. were involved in extensive discussion and manuscript writing. All authors contributed to the interpretation of data and the manuscript text.

Corresponding author