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CO_2-Vの結晶構造: 下部マントルでの有力な含炭素相

Crystal structure of solid carbon dioxide CO_2-V : a possible host for subducted carbon in the lower mantle.

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The amount of carbonate within marine sediment that is subducted at convergent margins is estimated to be as much as 1.8 x 10^{12}mol/year; this represents an important problem in the global recycling of carbon in terms of the depth to which the carbonates are transported into the Earth's interior. Although uncertainty remains as to whether carbonatitic melts are produced in basalt + carbonate composition along subduction geotherm in the upper mantle, it is not necessarily the case that all of hosts of subducted carbon are removed from the subducted slabs before reaching the lower mantle. Here, we demonstrate the fate of subducted carbonates under the lower mantle condition
High-pressure and high-temperature experiments were performed using laser heating diamond anvil cells involving three systems as follows: (i) calcite + MORB, (ii) magnesite + silicon dioxide, and (iii) carbon dioxide. Run products were characterized by synchrotron radiation X-ray diffraction, transmission electron microscopy, and Raman spectroscopy. In basaltic composition, $CaCO_3$(calcite and aragonite), the major carbon-bearing phase in marine sediments, is promptly altered into magnesite ($MgCO_3$) via reactions with Mg-bearing silicates under the upper mantle conditions. After reaching the lower mantle, the magnesite decomposes into an assemblage of CO_2+ $MgSiO_3$perovskite in the presence of SiO_2, which is a major phase of basaltic composition within the lower mantle. Magnesite is not the only host phase for subducted carbon: solid CO_2also carries carbon in the lower mantle. Under the lower mantle conditions, CO_2crystallizes as a non-molecular (or polymeric) phase (CO_2-V): The diffraction pattern of the CO_2-V is consistently interpreted in terms of a tetragonal unit cell (Z = 4, a = 3.584 A, c = 5.908 A at 50GPa). A beta-cristobalite structure (space group $I\bar{4}2d$) gives a good account of our data qualitatively. Isothermal molar volume (300K) of the CO_2-V in the present study is smaller than that indexed as a tridymite structure proposed by previous studies at any pressures.