Constraints on hydrogen generation during serpentinization of ultramafic rocks

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In recent years, serpentinized ultramafic rocks and minerals have received considerable attention as a source of H_2 for hydrogen-based microbial communities and as a potential environment for the abiotic synthesis of methane and other hydrocarbons within the Earth's crust. Both of these processes rely on the development of strongly reducing conditions and the generation of H_2 during serpentinization, which principally results from reaction of water with ferrous iron-rich minerals. We will present numerical geochemical models combined with a review of laboratory experimental studies to evaluate constraints on H_2 production during serpentinization. The results suggest that thermodynamic constraints on mineral stability and the distribution of Fe among mineral alteration products as a function of temperature are predominant factors controlling the extent of H_2 production. At high temperatures (>~315ºC), rates of serpentinization reactions are fast, but H_2 concentrations may be limited by the attainment of stable thermodynamic equilibrium between olivine and the aqueous fluid. Conversely, at temperatures below ~150ºC, H_2 generation is severely limited both by slow reaction kinetics and partitioning of Fe(II) into brucite. Peak temperatures for H_2 production occur at 200-315ºC, indicating that the most strongly reducing conditions will be attained during alteration within this temperature range. Fluids interacting with peridotite in this temperature range are likely to be the most productive sources of H_2 for biology, and should also produce the most favorable environments for abiotic organic synthesis. The results also suggest that thermodynamic constraints on Fe distribution among mineral alteration products have significant implications for the timing of magnetization of the ocean crust, and for the occurrence of native metal alloys and other trace minerals during serpentinization.

New high-resolution records of dustiness over recent centuries from Greenland and Antarctic ice cores

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Archived in glaciers and ice sheets are long term records of dustiness. Dust impacts Earth's radiative forcing directly by modifying the radiation budget and affecting cloud nucleation and optical properties, and indirectly through ocean fertilization which alters carbon sequestration. Because of their short atmospheric lifetimes, dust aerosol concentrations are highly variable in both time and space. The mineralogy and elemental characteristics of dust aerosols may indicate provenance and so past climate and atmospheric circulation and transport.

We present continuous ice core records of continental dust deposition during recent centuries at a number of ice core sites in Greenland and Antarctica. These new records were developed using a novel ice core analytical system which allows for simultaneous measurements of more than 30 elements and chemical species. We explore the similarities and differences between the records and use model simulations to evaluate relationships between dustiness and recent climate change and land use in possible source areas.