The Ligurian ophiolite: An analogue to marine serpentinite-hosted hydrothermal systems

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Carbonate-veined mantle sequences in ophiolites exposed on continents show strong similarities to oceanic core complexes and to moderate temperature, peridotite-hosted hydrothermal systems found along slow-spreading ridges. Serpentinization processes associated with exposure of mantle rocks at the ocean floor thereby play a fundamental role in the global marine bio-geochemical cycles and in mass transfer between seawater and the oceanic lithosphere. Here we present a mineralogical and C and S geochemical study of serpentinites and ophicalcites from an ophiolitic sequence in the Northern Apennine (Italy) and compare this sequence to calcite-veined serpentinites from the Iberian Margin and serpentinites from the basement of the Lost City Hydrothermal Field. The comparison between ancient and modern peridotite-hosted hydrothermal systems provides constraints on fluid pathways, fluid fluxes, redox conditions and microbial activity and their time-integrated changes.

The Northern Apennine ophiolites include serpentinites and ophicalcites that are bounded by shear zones that form domal structures and are characterized by distinct talc-amphibole-chlorite alteration assemblages, which strongly resembles the damage zones associated with detachment faults along ocean ridges. The serpentinites and ophicalcites record multiple phases of seawater infiltration, with initiation of serpentinization above ~300°C and calcite precipitation at temperatures < ~150°C. The sulfide mineralogy is dominated by pentlandite, pyrrhotite, pyrite, millerite and siegenite, which reflects fairly oxidizing conditions and corresponds to redox-gradients typically found in oceanic serpentinites. The sulfur isotope signatures also indicate a multiphase history of fluid-rock interaction, but show a strong influence from microbial activity, similar to signatures in serpentinites from the Iberian Margin. Field and mineralogical observations show a strong relation of the Northern Apennine ophiolite to an oceanic setting near a mid-ocean ridge assoctiated with detachment faults. In addition, the results of our study suggest that major fault zones strongly influence fluid circulation in these hydrothermal systems and control the incorporation of both carbon and sulfur from seawater.

Base metal ore deposits and marine mineral resources: Rare metal sources for sustainable energies?

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The progress in modern electronic technologies and the need for the use of renewable energies both increase the worldwide demand for metals and metalloids that are critical in high-technology products. There is significant and increasing demand for trace elements like indium, gallium, tellurium, selenium, molybdenum, cadmium, but also for major commodities like nickel, cobalt, copper. The group of so-called ‘electronic metals’ is already an integral part in most technical houseware and office products i.e., computers, notebooks, televisions, cell phones. New technologies and the need for renewable energy concepts in times of global climate changes lead to growing markets in photovoltaic industries. All major worldwide economies face a 20% - target of energy production from renewable energies until 2020. High-efficiency thin-film devices base on metals like indium, gallium, cadmium, tellurium, selenium, molybdenum; their substitution by keeping the high efficiency remains undeveloped. The market situation for these trace elements is tight and demand increases by an increasing number of industrial consumers. Production comes from known ore deposits on land and requires suitable and qualified technical facilities for the recovery of these trace components as by-products from conventional base metal concentrates. Few land-based ore deposits are known to host and produce these trace metals. Production increase, however, is limited due to restrictions on the production of the main commodities, metallurgical constraints, and limited refining capacities. A number of additional ore deposits, however, are capable to meet the demand if more scientific and technical effort is laid on the by-products. As a potential future source, marine mineral resources like manganese nodules, manganese crusts, and polymetallic massive sulfides are locally highly enriched in these trace metals and may define additional reserves. Enrichment factors, elevated concentrations, the mineralogical control, and ore characteristics in base metal deposits represent favourable conditions for the recovery of these metals. The actual production and demand situation is presented for the most important ‘electronic metals’ and the enhanced potential of ore deposits and marine resources in the future supply is discussed.