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Origin of Fe-Ca-metasomatism and associated mineralization hosted in detachment-related exhumed mantle rocks at the MARK area, 23°N, ODP Leg 153

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Mid-Oceans Ridges are common places of intense fluid-rock interactions. At slow-spreading ridges where mantle exhumation accommodates part of the extension thanks to detachment faults (i.e. oceanic core complex), the coupling between active extensional tectonics and magmatism triggers hydrothermal fluid circulations leading to typical alterations such as serpentinization and carbonation of mantle rocks, and the formation of high-temperature seafloor mineralized systems. Although mineralized systems have been investigated in the last two decades through multi-approaches studies, our knowledge about processes occurring in the deeper part of these systems remains approximative. Indeed, studies have been limited by the depth and scarcity of drill holes in such environments, and in many cases documented via dredged samples, or during dives, providing access to the ocean floor only.

Here, we focused on samples from ODP Leg 153, where serpentinized mantle rocks exhumed along a detachment fault have been drilled south to the Kane Transform Zone. Besides their intense serpentinization degree, mantle rocks underwent a Fe-Ca-metasomatism responsible for the formation of ilvaite, Fe-diopside, hydro-garnet, magnetite and chlorite assemblages, talc-actinolite-chlorite veins, and was accompanied with few sulfide mineralization (pyrite, chalcopyrite and pyrrhotite). This kind of metasomatism is poorly studied at present-day spreading centers but does occur in the fossil Platta nappe (Tethyan ophiolite), where it was contemporaneous to the formation of a Cu-Fe-Co-Zn-Ni mineralization. Through petrographic analyses, we show that Fe-Ca metasomatism at Kane occurred prior to the main serpentinization event of mantle rocks. Trace element and metal concentrations highlight local Cu and Zn enrichments in metasomatized rocks, while serpentinites in the vicinity are slightly depleted. Cu and Zn isotope compositions of metasomatized mantle rocks encompass those of the country serpentinized peridotites. Hence, Fe-Ca metasomatism was not disconnected to the serpentinization, but may have occurred at high temperature, with the inhibition of serpentinization, and possibly during the late magmatic evolution of the massif. Geochemical compositions of metasomatized mantle rocks at Kane suggest that high temperature alteration efficiently mobilizes metals from mantle rocks.