Hydrothermal magnetite ore in seafloor ultramafic rocks? A case from Cogne (NW Italian Alps)

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The Cogne magnetite deposit (Val d'Aosta, Italy) is hosted by a serpentinite unit, which is part of the ophiolitic complexes of the Piemonte Zone, NW Alps. With a tonnage of $1.9 \cdot 10^6$ tons at 37% Fe average grade, it is among the largest known serpentinite-hosted magnetite deposits in the world. The origin of the Cogne magnetite has long been debated, also because its composition, which is characterized by only trace amounts of Cr, Ti and V, is unusual for ultramafic-hosted magnetite. In this preliminary study we explore the possibility that the Cogne deposit is a fossil, metamorphosed, seafloor hydrothermal system, a hypothesis that is corroborated by the comparison of the magnetite compositional data with those for worldwide magnetite of different origins. Our new petrographic and chemical data on the magnetite-rich mineral assemblages and their host rocks allow us to propose the following sequence of events: (i) an early seafloor serpentinization process, marked by replacement of peridotite minerals with lizardite and minor magnetite, forming typical mesh textures and bastites; (ii) a subsequent hydrothermal metasomatic event, which is responsible for the deposition under static conditions of abundant magnetite and formation of diopside (± chlorite)-rich lithologies; (iii) prograde subduction metamorphism, responsible for the replacement of lizardite and part of the magnetite by antigorite and the subsequent stabilization of olivine at the expense of antigorite. The above sequence would be consistent with a subseafloor hydrothermal origin of the Cogne deposit during the oceanic stage of the Piemonte Zone. Thermodynamic modeling of metamorphic and hydrothermal systems, as well as oxygen isotope and trace elements analyses are being carried out to further constrain the conditions of formation of magnetite. The suggested link between magnetite and seafloor hydrothermal activity might contribute to our understanding of some reported magnetic anomalies in modern oceanic environments.