Ore-forming process of the Menez Gwen hydrothermal field: *in situ* S isotopes and trace metals constraints

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The Menez Gwen hydrothermal field (37º50'N), is located near the top of a young volcano at the Mid Atlantic Ridge. It is characterized by small chimneys, diffuse venting associated with breccia cemented by hydrothermal amorphous silica-barite. This work presents *in situ* trace elemental and S isotopic compositions of pyrite and chalcopyrite in three types of hydrothermal samples from this field: high-temperature chalcopyrite-pyrite chimney (HT-ch); mid-temperature sphalerite-pyrite-barite chimney (MT-ch) and low-temperature amorphous silica-barite breccia (LT-br). The results show a systematic distribution of trace metals from LT-br to HT-ch. Trace metals of pyrite analysed on HT-ch samples contain higher concentrations of elements derived from high-T fluids (e.g. Se, Co, Ni and Cu), indicating preferential incorporation of these elements in the lattice of pyrite at higher-Ts. However, some pyrite-chalcopyrite aggregate identified within the base of LT-br also show high-T derived elements, suggesting higher temperature conditions below the sub-surface, probably as a result of a decrease in permeability during slab formation. Framboidal and colloform pyrite observed in most of the LT-br clearly display an enrichment of elements derived from lower-T and oxidative conditions (e.g. Mn, Tl, Mo, Cr and V). Sulphide phases have $\delta^{34}S$ values ranging from -2.5 to 7.8‰ with an average of 1.5‰, indicating a mantle S source. Analyses of framboidal pyrite from LT-br show the lowest $\delta^{34}S$ values, ranging from -5.6‰ to -12.2‰, inferring the contribution of biogenic S. The chalcopyrite-pyrite pairs in HT-ch show an equilibrium fractionation of S isotope ($\Delta^{34}S_{Py-Cpy}$: 0.2‰ to 1.4‰, average of 1.0‰), indicating a temperature ca. 390°C. Our study highlights that S and metals of sulphides in Mendez Gwen were derived from the basement mafic crust leached by high-T hydrothermal fluids, where the impermeable breccia seems to work as a barrier for oxidative and biogenic involvement beneath the sub-surface.