The Zn-Pb-Ag San Cristobal district, Central Peru: Isotope and Fluid inclusion constraints

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The Zn-Pb±Ag±Cu San Cristobal district is located 100 km east of Lima in the Western Cordillera of Peru. It is centred around the Chumpe intrusion (U/Pb age of 6.6 $^{+1;-3.6}$ Ma) and is composed of a vein type and a carbonate replacement ore type. Veins present a paragenesis that can be subdivided into 3 phases: (a) an early wolframite-quartz-pyrite stage, (b) a quartz-base metal stage and, (c) a late quartz-carbonate-barite stage. The sericite alteration around the veins has been dated by $^{40}Ar/^{39}Ar$ at 4.78 $^{\pm 0.16}$ Ma and 4.90 $^{\pm 0.15}$ Ma. The carbonate replacement ore bodies have a mineralogical assemblage that is similar to that of the veins, with the only difference that the early wolframite-quartz-pyrite stage is absent and an important iron oxide stage is observed early in the paragenetic sequence.

Fluid inclusions in sphalerite and quartz homogenise to the liquid phase between 140 and 330°C and are two-phase (0.4 and 6.7wt% NaCl) at room temperature; rare inclusions contain an additional crystal of halite in the early stage (28 to 50wt% NaCl). The vein data show a decrease in homogenisation temperatures concomitant with a salinity decline. Contrary to the veins, the data from the carbonate replacement ores show a wide variation in salinity (3.3 to 14wt% NaCl) at constant homogenisation temperature. This can be explained either by mixing of the fluid related to the vein system and a hot brine, or by boiling of the fluid migrating out of the veins into the carbonate. Wolframite and galena from each ore type yield similar lead isotopic compositions and overlap with those of the Miocene intrusions. On the contrary, strontium isotopic compositions of carbonate and barite are highly variable and too radiogenic to be explained by magmatic input only. It may correspond to a predominantly magmatic fluid followed by incoming of ^{87}Sr enriched fluids. This evolution is consistent with hydrogen and oxygen isotope data, which reveal a magmatic component for the early stage, extending to lower $\delta^{18}O$ and δD values for the second stage. This trend may be explained by admixture of meteoric water to a dominantly magmatic fluid. Their different origins are confirmed by laser ablation ICP-MS analyses of the two-phase primary inclusions. The early stage inclusions have high concentrations of base metals and W, and the late ones contain less base metals but four times more Ba and Sr. While decreasing concentrations of W and base metals can be explained by mineral deposition, abrupt increase of Ba and Sr concentrations can only be explained by the input of a fluid from a different origin.

Archean mantle hidden in Proterozoic crust in SW Norway

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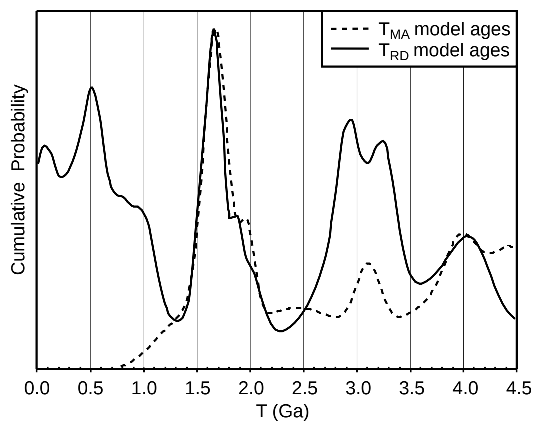
Garnet-bearing peridotites occur at several localities in the Western Gneiss Region (WGR) of SW Norway. The recent development of high-precision *in situ* laser-ablation techniques enables rapid acquisition of Re-Os isotopic data from single sulfide grains in such peridotites (Pearson *et al*., 2002). Re-Os model ages were measured for twenty-three sulfides from peridotites at Almklovdalen in the southern WGR.

Re-Os T_{MA} and T_{RD} model ages for Almklovdalen sulfides define a series of peaks (Fig. 1), some of which can be matched with known crustal events. The Proterozoic peak has a maximum at ~1.7 Ga which falls within the age range for the Gothian orogeny (1.60-1.75 Ga) and is close to the calculated Sm-Nd mineral age (1703±23 Ma) for Almklovdalen garnet peridotites (Jamtveit *et al*., 1991).

Figure 1. Re-Os isoplot for sulfides in WGR garnet peridotites.



Peaks in the Archean do not correspond with any known event in the WGR crust and suggest that the peridotites experienced an Archean partial melting event. The preservation of Archean ages in the WGR garnet peridotites supports compositional evidence that some Proterozoic mantle sections represent strongly modified Archean mantle (Griffin *et al*., 2001).

References

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