

High $\delta^{18}\text{O}$ and low δD ratios of stringer systems of the northernmost IPB VHMS deposits: Evidence for a magmatic input to the hydrothermal ore-forming fluids?

Relaciones altas de $\delta^{18}\text{O}$ y bajas de δD en los bandeados de los depósitos norteños de IPB VHMS. ¿Se trata de pruebas de aportes magmáticos a los fluídos que forman la mineralización hidrotermal?

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A stable isotopic study has been undertaken on some VHMS deposits (Aguas Teñidas East, Concepción, San Miguel, San Telmo and Cueva de la Mora) situated at the northernmost region of the Iberian Pyrite Belt (IPB). The analyses were mainly performed on quartz, chlorite, carbonate and whole rock samples collected from the stockwork and associated hydrothermally altered footwall zones of the deposits, also comprising some direct measurements of fluid inclusion waters. Preliminary studies on fluid inclusions yielded homogenization temperature ranges from 120 to 280°C with salinities of 2 to 14 wt.% NaCl eq., with a few fluid inclusions having $T_h=80-110^\circ\text{C}$ and salinity of 16 to 24 wt.% NaCl eq. In addition, fluid inclusions from the Soloviejo Mn-Fe-jaspers (160–190°C and 6 wt.% NaCl eq.) and some Late to Post-Hercynian quartz veins (130–270°C and 4 wt.% NaCl eq.) were also studied.

Isotopic results indicate that fluids in equilibrium with measured quartz ($\delta^{18}\text{O}_{\text{fluid}}-2$ to 4‰), chlorites ($\delta^{18}\text{O}_{\text{fluid}}$ 8 to 14‰ , $\delta\text{D}_{\text{fluid}}-45$ to -27‰), whole rocks ($\delta^{18}\text{O}_{\text{fluid}}$ 4 to 7‰ , $\delta\text{D}_{\text{fluid}}-15$ to -10‰) and carbonate ($\delta^{18}\text{O}_{\text{Ankerite}}$ 14.5 to 16‰ ,

$\delta^{13}\text{C}_{\text{fluid}}=-4$ to -8‰) followed at least two main stages (waxing and waning stage) at continuously increasing temperature and decreasing water/rock ratio, also suggesting that the processes involved in the isotopic evolution of ore fluids were similar to those reported for most modern and ancient hydrothermal systems.

In short, the results (fluid inclusions, $^{18}\text{O}/^{16}\text{O}$ and D/H ratios) point to a highly evolved seawater, along with a variable (but significant) contribution of magmatic water as the most probable sources for the hydrothermal ore-forming fluids, also suggesting an intense interaction of the fluid with the underlying volcanic and sedimentary rocks after convective circulation through the upper crust during the lifetime of the system. Additionally, the suggested relative contribution of a magmatic volatile phase to the hydrothermal ore-forming fluid is considerably higher with respect to other IPB deposits (Barriga and Kerrich, 1984; Munhá *et al.*, 1986) and similar volcanogenic massive sulphide provinces (such as the Kuroko district; Ohmoto and Rye, 1974; Ohmoto, 1976).

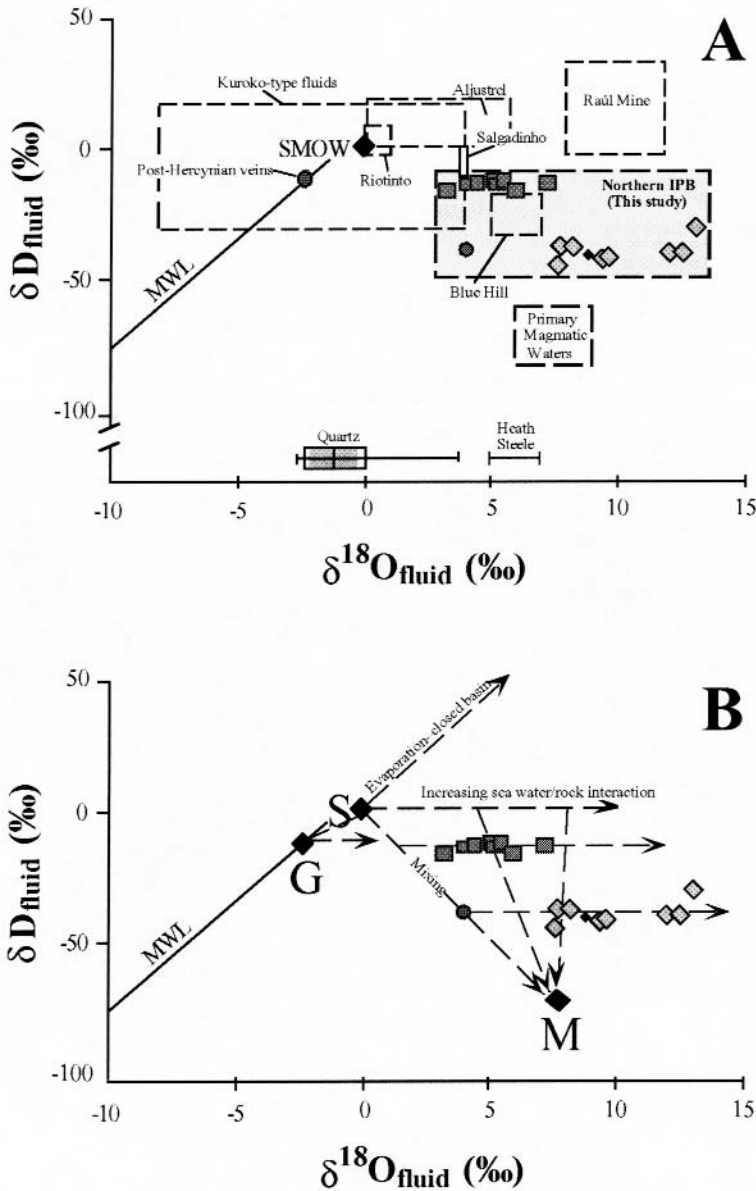


Fig. 1. (A) Synthesis of isotopic δD and $\delta^{18}\text{O}$ ratios of ore-forming fluids in this study, along with the fields of estimated fluid isotopic compositions for Kuroko (Ohmoto and Rye, 1974; Ohmoto, 1996), Raúl mine (Ripley and Ohmoto, 1977), and Blue Hill, Crandon, Salgadinho, Aljustrel and Rio Tinto (Munhá *et al.*, 1986). (B) Fluid reservoirs (S, Sea water; M, Primary magmatic water; G, Meteoric water) and mechanisms (fluid/rock interaction and mixing) invoked to account for the observed isotopic distribution of the obtained values. Symbols: *squares*, whole rocks; *diamonds*, chlorites; *circles*, quartz.

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