

Tracing the magmatic-hydrothermal transition in mafic intrusions through primary fluid inclusions in magmatic ilmenite

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Magmatic volatile phases play a major role in igneous systems, but indirect sampling of magmatic fluids, especially in mafic magmas, remains challenging. Here, we characterize two early Carboniferous mafic magmatic systems related to Variscan Sb deposits—the Saint-Jean-du-Doigt intrusion (Armorican Massif, France) and the La Codosera syncline mafic sills (Central Iberian Zone, Spain)—to assess their role as metal suppliers during this magmatic event. We present compelling evidence of primary fluid inclusions trapped within magmatic ilmenite from these two distinct mafic intrusive settings.

Although qualitative, our results show that the chemistry of fluid inclusions (i.e., Na-Ca-Cl-S-Fe solute composition) is consistent with what is known and expected for magmatic fluids associated with mafic magmas. These inclusions likely record the onset of late-stage magmatic volatile saturation in these mafic systems and are enriched in Cu, Sn, Mo, Sb, W and Pb. Hence, we argue that the presence of fluid inclusions in ilmenite may serve as a reliable indicator of magma degassing in such settings and, importantly, records the magmatic-hydrothermal transition.

This study reveals that magmatic fluids from early Carboniferous mafic magmatism contain metals and metalloids and thus may have contributed to the preconcentration of these elements in the Variscan Belt. We suggest that the trapping of magmatic volatile phases during ilmenite crystallization may be more common than currently recognized and be an indicator of late-stage magmatic fluids in mafic igneous systems.