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Oxybarometers as key tools for petrogenetic and geochronological interpretation of vaugnerites

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The assessment of magma redox states is critical for understanding mineral crystallization sequences. In basic-to-intermediate plutonic rocks lacking primary Fe-Ti oxide pairs, the annite–sanidine–magnetite (ASM) and titanite–magnetite–quartz (TMQ) assemblages, together with whole-rock oxidation models, are widely used as oxybarometers. However, these equilibria may record either magmatic or subsolidus conditions, with important implications for redox interpretation and geochronology. We investigated vaugnerites from Spain using four oxybarometers to evaluate the primary nature of the mineral assemblage: (i) Rhyolite-MELTS modeling (Gualda et al., 2012); (ii) the ASM equilibrium (Wones & Eugster, 1965); (iii) a combined biotite–whole-rock approach (Burkhard, 1991); and (iv) the intersection of biotite and titanite stability curves (Wones, 1989). Results from the ASM assemblage yield conditions of ~870 °C and log fO_2 of –12.3 (slightly above Ni-NiO). Rhyolite-MELTS modeling provides consistent magmatic liquidus temperatures for the ASM assemblage. Conversely, the titanite-based equilibrium (Wones, 1989) yields significantly lower conditions (700 °C; log fO_2 –14.8). As the water-saturated solidus of these rocks is ~730 °C (Piwinskii & Wyllie, 1968), and titanite fails to saturate in MELTS simulations, the TMQ assemblage is interpreted as subsolidus. The intermediate results from whole-rock dependent methods (Burkhard, 1991) further suggest a mixed signal. We conclude that titanite in the studied vaugnerites formed via subsolidus fluid interaction, also re-equilibrating pyroxenes (López-Moro & López-Plaza, 2004). Consequently, U-Pb dating of this titanite would likely yield the age of the hydrothermal event rather than magmatic emplacement, as observed in previous allanite dating in these rocks (López-Moro et al., 2017).

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