Andradite U-Pb Dating at the Ernest Henry IOCG deposit, NW Queensland: Constraints on the Timing of Cu-Au Mineralization

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The Ernest Henry deposit, 40 km NE of Cloncurry, Queensland, is the largest iron oxide copper-gold (IOCG) system in the Eastern Succession of the Mount Isa Inlier and the fourth largest in Australia. Despite numerous geochronological investigations of multiple hydrothermal alteration and ore minerals at the deposit (e.g., apatite, titanite, rutile, molybdenite, etc.), a robust age of Cu-Au mineralization remains elusive. A major hindrance is the complex U-Pb behavior in many of the studied minerals, which translates into high uncertainties that cannot resolve independent hydrothermal events. Recently, rare andradite-bearing samples of the host volcanic succession – taken at depth in the deposit – were dated via laser ablation-inductively coupled plasma mass spectrometry (LA-ICPMS). Andradite (and grossular) are robust chronometers in the U-Pb system, with closure temperatures exceeding 800°C, unlike other, more commonly dated minerals at Ernest Henry (e.g., apatite). At Ernest Henry, andradite is intergrown with pyrite, magnetite, quartz, calcite, and chalcopyrite, the latter two of which display textures that suggest either contemporaneous formation with andradite or shortly following. Importantly, unlike the more common Fe-Mn-rich garnet species at Ernest Henry, andradite exhibits minimal retrogression to lower-temperature assemblages (e.g., chlorite). Uranium-Pb dating of andradite yielded a weighted mean age of 1552 ± 6 Ma (2σ, MSWD = 1.57, n = 25), which is older than previous age estimates for Cu-Au mineralization at Ernest Henry (~1530 Ma), younger than peak metamorphism in the region (~1580 Ma), and overlaps recent age estimates for Ernest Henry K-Fe-Mn-rich ‘protore’ (1555 Ma). Moreover, the low uncertainty of this age indicates that andradite’s U-Pb systematics are relatively undisturbed, a feature which can potentially help resolve the ages of geologic events in the Eastern Succession, leading to more robust exploration models in this region.