Mapping Alteration Footprints of IOCG Systems: A Case Study of the Ernest Henry Camp, Cloncurry District, Queensland

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Vectoring towards ore deposits using a combination of geochemical and mineralogical indicators has been successfully applied in exploration for diamonds and porphyry copper deposits. However, practical applications of such studies are often limited by availability of suitable samples and/or analytical techniques. Furthermore, alteration footprints of porphyry deposits are typically <2 km. Conversely, IOCG systems are typified by large alteration halos (>5 km), comprising regional and multiple local stages of alteration, including Na-Ca, Ca-Fe, K-Fe, and/or hydrolytic. The Cloncurry district, Queensland, contains numerous economically important IOCG deposits, of which the Ernest Henry deposit is the largest and most well-studied. Here we apply our analytical workflow to track changes in geochemical and mineralogical footprints of large IOCG systems, using the Ernest Henry camp (including the E1 deposit) as a case study.

The Ernest Henry and E1 IOCG deposits are hosted within Proterozoic metavolcanic and metasedimentary rocks of the eastern Mount Isa Province. A challenge of navigating alteration footprints in the Ernest Henry camp is the presence of multiple generations of alteration phases occurring in mineral assemblages formed at the regional metasomatic (Na-Ca, albite-actinolite-titanite-carbonate), pre-ore (K-feldspar-biotite-magnetite-titanite), syn- (magnetite-chalcopyrite) and post-ore (carbonate-fluorite-barite). We selected over 200 samples from drill cores within and spanning 3-4 km outside the Ernest Henry and E1 deposits to determine how geochemical and mineralogical footprints change with distance to ore. Using multiple analytical techniques (multielement geochemistry, HyLogger, μXRF, SEM-TIMA, EPMA and LA-ICP-MS) to characterise the samples and target suitable phases, we build on existing works by taking a holistic mineral chemistry approach by analysing multiple generations of actinolite, biotite, chlorite, apatite, titanite, feldspars and sulphides to map integrated mineral system footprints using trace element and stable isotope geochemistry (S, Cu, Fe, O) that could be used for vectoring towards ore in other camps of the Cloncurry district and in similar terranes.