

Endeavour Copper-Gold Porphyry Deposits, Northparkes, New South Wales: Intrusive History and Fluid Evolution

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Abstract

Four economic porphyry copper-gold deposits, Endeavour 22, 26, 27, and 48, occur within the Late Ordovician Goonumbra Volcanic Complex of central-west New South Wales, Australia. Together these deposits have a combined ore reserve of 63.6 million metric tons (Mt) at 1.1 percent copper and 0.5 g/t gold. Mineralization is centered in narrow, pipelike quartz monzonite porphyry (QMP) intrusive complexes.

We have recognized at least nine intrusive phases within the Endeavour deposits. These are, in order of emplacement, as follows: a premineral equigranular monzodiorite; early-mineral, equigranular to weakly porphyritic biotite quartz monzonite (BQM) stocks and dikes; synmineral K-feldspar QMP (K-QMP) pipes and dikes; late-mineral augite-biotite-K-feldspar QMP (KA-QMP) intrusions and biotite QMP (B-QMP) dikes; and postmineral basaltic trachyandesite dikes, augite monzonite porphyry dikes, and basaltic dikes.

Early-stage biotite-magnetite and propylitic alteration of the host volcanic rocks and K-feldspar alteration of the BQM occurred at each deposit during the intrusion of the BQM stocks and early-mineral B-QMP dikes. Transitional-stage unidirectional solidification textures and other related anisotropic textures formed mostly during the emplacement of K-QMP and KA-QMP intrusions. Main-stage sulfide mineralization at all four deposits is spatially and temporally associated with the K-QMP and, to a lesser extent, KA-QMP intrusions and their associated K-feldspar and sericite-hematite alteration assemblages, and is characterized by multiple generations of stockwork and sheeted quartz, K-feldspar, bornite, chalcopyrite, and gold-bearing veins. Late-stage sericite-quartz-copper-sulfide-carbonate-hematite alteration and vein assemblages formed prior to the emplacement of the postmineral intrusions. Weak to moderate postmineral propylitic alteration assemblages were the last alteration event related to the QMP intrusive complexes. Intrusive activity and associated biotite alteration occurred between 446 and 437 Ma, based on $^{40}\text{Ar}/^{39}\text{Ar}$ analyses of biotite and hornblende.

Based on microthermometric analyses of fluid inclusions from early-, transitional-, main-, and late-stage veins, the Endeavour deposits formed at depths between 1,000 and 1,700 m below the paleosurface, with a lithostatic pressure regime prevailing throughout the early, transitional, and main stages and near-hydrostatic pressures during the late-stage sericitic events. The first three stages were dominated by high-temperature (460°–550°C) magmatic-hydrothermal brines with salinities of ~55 to 60 wt percent NaCl ± KCl equiv. Although the late-stage fluids were cooler (350°–400°C) and less saline (~40 wt % NaCl equiv), their compositions are consistent with the magmatic-hydrothermal origin indicated by previous oxygen and hydrogen isotope studies, confirming that the Endeavour porphyry deposits are representatives of the orthomagmatic end member of the porphyry continuum.

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