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New Evidence for Multiple Periods of Gold Emplacement in the Porcupine Mining District, Timmins Area, Ontario, Canada

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Abstract

The Porcupine mining district is the largest lode gold-producing district in North America, with production in excess of 62,000,000 troy oz. Nearly all of the Au has come from quartz-carbonate lode systems hosted by metamorphic rocks of greenschist facies. Field relationships and radioisotope ages of intrusions indicate that gold emplacement occurred over a span of at least 7 m.y. Depositional events that predated formation of the Timiskaming unconformity surface are manifested by auriferous clasts of detrital pyrite, banded quartz sulfide, and quartz sulfide in basal Timiskaming conglomerate. Pyritic clasts contain on average 2.54 ppm Au and are conclusive evidence for the existence of pre-Timiskaming-aged auriferous pyritic deposits. These clasts may have been derived from pyritic bodies in carbonaceous argillites of the Tisdale Group, from sulfide facies iron-formation of the Deloro Group, or from pyritic deposits of unknown genesis. Auriferous banded sulfidic quartz clasts were probably derived from iron-formation of the Deloro Group and auriferous sulfidic quartz clasts possibly from epigenetic quartz sulfide veins.

Intrusion-related and post-Timiskaming gold deposition is evidenced by Cu-Au-(Mo) mineralized porphyry and younger quartz-carbonate gold veins. The magmatism that emplaced feldspar and quartz-feldspar porphyries was accompanied by Cu-Au-(Mo) mineralization at the Dome mine, where a conformable quartz-feldspar porphyry intrusion and its host greenstones are pervasively and atypically copper and gold mineralized, and the porphyry is anomalously molybdenum enriched. A new U-Pb zircon date on this mineralized porphyry fixes its emplacement and the maximum age of Cu-Au-(Mo) deposition at 2688 ± 2 Ma. This mineralization was overprinted by later gold mineralization in the form of planar, sheeted, and en echelon auriferous quartz veins and by mineralized shear and/or fault zones. Field relationships indicate that these veins significantly postdate emplacement of the porphyries and Timiskaming sedimentation. The latest vein systems form the bulk of the ore at the Dome mine and are similar to the most economically significant veins of the district.

The largest gold deposits of the district are spatially associated with, but not in, porphyries similar to those exposed at the Dome mine. This association has led to considerable speculation regarding the genetic relationship of felsic porphyry emplacement to ore formation. The results of this study show that although some Au was deposited during a Cu-Au-Mo event temporally linked to porphyry emplacement, most of the Au at the Dome mine was emplaced significantly later than the porphyries. The documentation of at least three broad periods of Au emplacement, at least two of which are premetamorphic, is permissive and supportive of genetic hypotheses that invoke metamorphogenic remobilization of Au from earlier formed deposits. Alternatively, the coincidence of early gold enrichments and later economic concentrations may reflect a single, unidentified gold source from which successive but unrelated hydrothermal activity mobilized, transported, and deposited Au, with no direct genetic link between early and late episodes of gold deposition.