Gold- and Molybdenum-Tungsten–Bearing Mineral Systems of the Southern Thomson Orogen, Australia

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Geoscience Australia, in collaboration with the Geological Survey of New South Wales and the Geological Survey of Queensland, is investigating the regional geology and mineral systems of the southern Thomson orogen in the Tasman Element of eastern Australia. Much of this region is undercover and poorly understood. In particular, the geological relationship between the Thomson orogen and the neighboring Lachlan orogen to the south is uncertain, but the presence of world-class mineral resources in the Lachlan orogen makes the Thomson orogen an attractive target for exploration.

In this study we focus on the Cuttaburra and F1 prospects, two undercover prospects that are the target of exploration for Au, Mo, and W. These prospects are located slightly north of the Olepoloko fault, the boundary between the Thomson and Lachlan orogens. The geology of these prospects is poorly constrained, but is interpreted to be dominated by early Paleozoic sedimentary rocks intruded by Silurian-Devonian granites. Several sets of veins crosscut the granites and host sulfide mineralization. We integrate data from drill core, thin sections, sulfur isotopes, lead isotopes, and geochronology to investigate the mineral systems evolution of the area. We propose a new model for the area involving three stages of mineralization.

The first magmatic-hydrothermal stage (H1) is characterized by disseminated molybdenite, pyrite, pyrrhotite, and chalcopyrite hosted within granites. There is a strong correlation between W and Mo in company drill core assay data. New SHRIMP U-Pb zircon ages (Fraser, unpublished data) indicate that the host granites crystallized between ~430 and 425 Ma. Molybdenite from the H1 assemblage yielded Re-Os ages (Norman and Huston, unpublished data) that are within uncertainty of the magmatic crystallization ages, and new $\delta^{34}S$ data from H1 sulfides are consistent with a magmatic-hydrothermal source of sulfur.

The second hydrothermal event (H2) is characterized by chlorite-muscovite-calcite veins that crosscut the granites and host pyrite, molybdenite, chalcopyrite, and pyrrhotite. A third generation of hydrothermal mineralization (H3) is characterized by quartz-calcite veins that host chalcopyrite, arsenopyrite, galena, pyrite, pyrrhotite, sphalerite, molybdenite, and electrum. Lead isotope values of the galena (Huston, unpub. data; Rothery, 2013, AIG Bulletin 55, p 143–152) from this assemblage are similar to those from Cobar Cu-Au deposits approximately 250 km to the southeast, and yield locally constrained model ages of ~400–360 Ma. New $\delta^{34}S$ data for samples from the H2 and H3 assemblages are higher than those from the H1 assemblage, and suggest a hydrothermal rather than magmatic source of sulfur.

The evolution of this mineral system is consistent with an early intrusion-related Mo-W–forming hydrothermal event at ~430–425 Ma, overprinted by Au and base metal mineralization at ~400–360 Ma, possibly of Cobar-type.

Interpretation that the Au mineralization at the Cuttaburra and F1 prospects is of similar style and age to that of the structurally controlled Cobar-type deposits is broadly consistent with the location of the prospects adjacent to the Olepoloko fault. This suggested structural control requires further testing, but if valid would imply further exploration potential proximal to the Olepoloko fault.