A Practical Predictive Targeting Model for Convergent Margin Gold and Copper Deposits

Jon Hronsky[3], Graham Begg[5]
1. Western Mining Services, West Perth, WA, Australia, 2. Minerals Targeting International, West Perth, WA, Australia, 3. 2. Centre for Exploration Targeting, School of Earth Sciences, University of Western Australia,, Crawley, WA, Australia, 4. 2. Centre for Exploration Targeting, School of Earth Sciences, University of Western Australia, Crawley, WA, Australia, 5. 4. Australian Research Council Centre of Excellence for Core to Crust Fluid Systems (CCFS) and GEMOC, Macquarie University,, Sydney, NSW, Australia

The majority of the world's resources of gold and copper are hosted by convergent margin settings, mostly because these are the primary tectonic environments where fluids are cycled from the mantle into the near-surface. The basic hypothesis of this paper is that, to a first order, we can explain all convergent margin-related Cu and Au deposits by the interplay of only two fundamental processes, operating in a range of geodynamic contexts. In this framework, ore formation is seen as the predictable consequence of certain particular, although relatively rare, segments of the 4D evolution of host terranes, not simply the result of the random coincidence of multiple positive factors.

The two underlying fundamental processes are 1) the Loucks process and 2) the FUME (Fertile Upper Mantle Extraction) process. The Loucks process is most relevant to copper metallogeny, whereas the FUME process is most relevant to gold metallogeny. Critically, both processes require specific anomalous geodynamic processes within the context of the evolution of their host convergent margin settings, thereby providing a potentially robust regional-scale predictive capability.

These two processes commonly coincide because the same geodynamic conditions may favour both at the same location and time. In practice, there is a spectrum between Cu-only (Loucks process-dominant) and Au-only (FUME process-dominant) end members.

This model implies that regional-scale metallogenic fertility has both static and dynamic aspects.

Static fertility is the requirement for a metasomatised upper-mantle source region, which is an inherited property, not dependent on syn-mineralisation geodynamics. It is only relevant to the FUME process and Au metallogeny.

Dynamic fertility is the requirement for a favourable, anomalous geodynamic context that allows the FUME and/or Loucks process to operate. This is transient in both time and space, driven by heterogeneities in regional-scale geodynamics, and is relevant to both Cu and Au metallogeny.