Origins of Proterozoic Cu-Au-Fe deposits and regional Na-Ca alteration in the Broken Hill - Olary region, Australia

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Recently discovered Cu-Au-Mo deposits of the Curnamona Province are members of the diverse family of iron-oxide associated Cu-Au deposits found in Australian Proterozoic terranes and elsewhere. The Broken Hill and adjacent Olary Domains experienced similar lithostratigraphic and tectonic evolution, yet the Olary Domain appears better endowed in Cu-Au-Mo mineralization, syntectonic regional Na-Ca-Fe alteration and fractionated ~1580-1590 Ma granitoids. Syntectonic alteration includes calcsilicate-matrix breccias, vein networks, and associated 'albitized' zones, containing Na-plagioclase, clinopyroxene, clinoamphibole, quartz, magnetite, hematite, garnet and titanite.

Oxygen isotope geothermometry of mineral pairs in syntectonic breccias and veins indicate isotopic equilibration at ~450-550 degrees C. Quartz-amphibole-magnetite assemblages at the Kalkaroo and Waukaloo Cu-Au-Mo prospects yield isotopic temperatures of ~420-450 degrees C, whereas later chlorite formed at ~300-420 degrees C. Calculated delta-18-O compositions of regional alteration fluids are mainly in the range 8-11 per mil (n=25). Compositions of fluids involved in Cu-Au-Mo mineralization are significantly lower with delta-18-O = 4.2-8.5 per mil (n=12). There is no distinction between calculated delta-D for fluids in regional alteration and Cu-Au-Mo mineralization (-44 to -67 per mil; n=14).

Syntectonic regional alteration is interpreted as the product of intermediate-redox to oxidized Na-Ca-Fe-rich fluids isotopically resembling metamorphic waters, that equilibrated with Paleoproterozoic felsic igneous and siliciclastic rocks. Input of magmatic fluid, or of evaporitic brine, was probably minimal. We infer, however, that Cu-Au (-Mo) ore fluids contained significant D-depleted magmatic water, together with possibly metamorphic fluids. Thus, although regional syntectonic alteration indicates extensive hydrothermal fluid flow, it may be only indirectly related to Cu-Au-Mo mineralization.