doi:10.1130/G33378Y.1

The fluorine link between a supergiant ore deposit and a silicic large igneous province

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Manning (2012) has challenged our suggestion that dissolution by hydrofluoric acid (HF) contributed to the formation of the Olympic Dam breccia complex (McPhie et al., 2011b). Manning has summarized the outcome of considerable experimental and other research on HF-granite interactions under magmatic and near-magmatic temperature and pressure conditions. Under these conditions, a reaction takes place, rather than dissolution, and produces a crystalline quartz-topaz assemblage. However, these conditions are not relevant to our proposal that HF played a role in the formation of the Olympic Dam breccia complex.

The supergiant Olympic Dam Cu-U-Au-Ag ore body occurs within hematite-rich breccia surrounded by Mesoproterozoic granite (the Roxby Downs Granite). The mineralized hematite-rich breccia is part of a breccia complex that mainly consists of granite clasts, but minor volcanic and bedded sedimentary clasts are also present (Reeve et al., 1990; McPhie et al., 2011a). The granite and volcanic rocks are part of the regionally extensive and voluminous (~90,000 km^3) Gawler silicic large igneous province (SLIP). The Gawler SLIP rocks contain magmatic fluorite and other F-bearing magmatic minerals (topaz, bastnasite, biotite, amphibole, sphene; Agangi et al., 2010). However, as previously stated (McPhie et al., 2011b), all igneous wall rocks were already solid when the breccia complex formed, and incapable of directly outgassing F or F-complexes.

The evidence for the Olympic Dam hydrothermal fluid being F-rich is largely empirical and based on the high abundance of F-bearing hydrothermal minerals (fluorite, chlorite, sericite, apatite, bastnasite, and synchysite) in the mineralized breccia, and the intimate association of fluorite with copper sulfides and U-bearing minerals (Reeve et al., 1990; Oreskes and Einaudi, 1990). We suggested that the F in the Olympic Dam ore ultimately came from the F-rich Gawler SLIP but *not* under magmatic conditions. The immediate wall rocks for circulating meteoric and hydrothermal fluids at Olympic Dam were the F-rich Gawler SLIP rocks. The exact pathway linking F-bearing minerals in the wall rocks to the F-rich hydrothermal fluid is not known, but could have involved acidic groundwater focused in and around pyritic faults.

The evidence for dissolution being an important mechanism of breccia formation is textural—granitic and volcanic clasts within the breccia complex commonly have amoeboid and ragged shapes (Fig. 1) that are consistent with fracture-controlled dissolution. Our contention that HF may have been involved is a reasonable one, given the inference that the hydrothermal fluids were F-rich. Furthermore, dissolution of silicate rocks in HF is routinely performed under normal laboratory conditions (room temperature, atmospheric pressure) in analytical chemistry (e.g., Kline and Fogler, 1981). Dissolution under these conditions produces a solution (not a solid crystalline product).

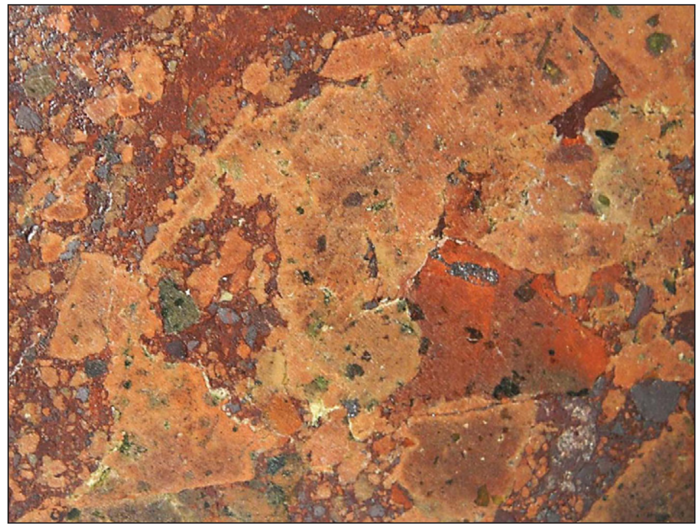

Figure 1. Amoeboid volcanic clast in hematite-rich breccia at Olympic Dam. Drill core RD2899, 409.4 m, width of photo is 5.5 cm.

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