THERE'S GOLD IN THEM THAR *SAND* HILLS!

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PREVIOUS STUDIES

Geochemical anomalies found above mineralization on a sand dune have been investigated. Anomalous metal concentrations were found for Au, Bi, Zn, and Ag in plant organs, soil and calcrete at the Barns Gold Prospect (Wudinna, Eyre Peninsula; Drown 2003; McEntegart and Schmidt Mumm, 2004; Lintern and Rhodes, 2005). An 8 m high sand dune located over mineralization was trenched for geochemical sampling, dune age determinations and the properties of the carbonate:

- Highest Au concentrations (9 ppb) occur in calcareous accumulations around roots including the upper part of the sand dune.
- Optically Stimulated Luminescence dating indicates the dune is about 27000 years old.
- Gold in the sand may have accumulated in <10000 years as a result of plant activity

It has been postulated that Au accumulations on the dune are biologically mediated (Lintern, 2005). Plant roots absorb Au from below the dune, shed leaves, bark and branches on the surface (containing adsorbed Au), and finally decomposition and rainfall move Au into the dune. Some Au and carbonate precipitates and accumulates around the roots due to transpiration. As the dune comprises coarse quartz sand and located above the surrounding landscape, possible contamination (contribution) by Au from (1) upslope colluvial processes, (2) groundwater and (3) capillarity are minimized, suggesting plants are the primary agents in this Au accumulation process.

CURRENT STUDIES

Strontium isotopes

Naturally occurring radiogenic Sr isotopes are useful in monitoring the biodynamics of ecosystems as they are not altered by biological or mineralogical processes. They are particularly helpful in determining Sr sources in calcrete developed on Archaean or Late Proterozoic landscapes since oceanic (atmospheric) Sr isotope ratios usually differ markedly from their craton-derived counterparts, and interpretations can be made with a high level of confidence. The Gawler Craton is abundant in naturally radiogenic ^{87}Sr produced by decay of ^{87}Rb (half life = 48.8 billion years).

The two main sources of Sr and Ca for calcrete and vegetation are from the atmosphere and bedrock. Strontium isotope ratios ($^{87}Sr/^{86}Sr$) in pedogenic carbonates indicate a principally atmospheric source of Sr (*e.g.*, Capo *et al.,* 1995; Goede *et al.,* 1998; Naiman *et al.,* 2000; Hamidi *et al.,* 2001; Dart et al., 2005), although bedrock may sometimes be the dominant source (Quade *et al.,* 1995). For vegetation, Sr is derived from atmospheric sources (Poszwa *et al.,* 2002), weathered bedrock (Bern *et al.*, 2005) or from mixed sources (Drouet *et al.,* 2005).

Ten Sr isotope analyses ($^{87}Sr/^{86}Sr$) of calcretes, saprolite-calcrete mixtures, sand-calcrete mixtures and vegetation were conducted on samples collected from and beneath the dunes overlying mineralization at Barns, to determine the source of Sr (and, by inference, Ca) in dune carbonate and vegetation. An overwhelming contribution from atmospheric sources to both the calcretes and the vegetation was determined. Some of the carbonate-saprolite samples results suggest, not surprisingly, mixed bedrock and atmospheric sources of Sr. Results compare favourably with other data (Quade *et al.,* 1995) for calcretes and bedrocks from the western Eyre Peninsula. These results indicate that at Barns, vegetation sources its Sr almost totally from the atmosphere either directly, via rainfall, dust, and by absorption as it percolates through the dune, or indirectly via deep roots into the older calcrete below the dune, with little Sr contributed from the weathered bedrock.

Laser ablation ICP MS

Laser ablation ICP MS was conducted on calcareous rhizoliths from the Barns dune in order to identify Au rich sites. Gold is unevenly distributed within the rhizolith suggesting that small Au particles are formed within the carbonate at nucleation sites as a result of soluble Au percolating down through the dune and precipitating. These nucleation sites do not appear to have any unusual major element concentrations such as Fe or Ca. SEM analyses have so far not identified any discrete Au particles in the Barns samples, but Au crystals (<1 μm) in pedogenic carbonate have been observed in other regions (Lintern, unpublished data).

FUTURE STUDIES

The Barns Gold Prospect is a principal site for investigation of geochemical processes in the formation of geochemical anomalies through transported overburden (AMIRA P778). Further work planned for the site may include:

- Detailed footprint study to show extent of anomaly in vegetation and soil.
- Partial and sequential extraction studies to determine any association of metals with particular mineral phases or size fractions.
- Shallow geophysical methods to determine thickness of sand.
- Field experiments to investigate uptake and expulsion of metals by plants.
- Litter traps, trunk analyses, rainfall and dust collection to improve the NPP and mass balance calculations. Analysis of other plants (including shrubs, grasses and wheat) to create a "4D ecosystem-scale, gold cycling-recycling model" for the system.
- Laboratory column experiments (using sand from Barns) to investigate the pathways of Au and other metals from the tree to litter, sand and calcrete.
- Isotope work to investigate origin of metals/water in plants and carbonates (C, Pb, Sr, O and H).
- Dendrochronology and ^{14}C to determine age of eucalypts.
- Core samples from other parts of dune to investigate Au and other metals in dune from background sites. Assess possible contribution from agriculture to any metal signatures in the dune. Sand analysis to identify provenance of sand.
- Hydroponic growing of key native species found at Barns to investigate differences in plant adsorption of metals.

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