Microbially mediated formation of gold in calcrete anomalies in Australia

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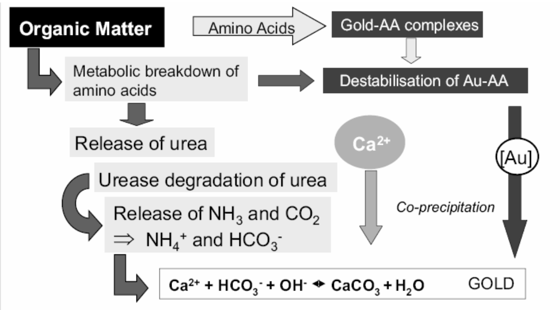
Regolith carbonates (calcrete) are widely used in Au exploration in Australia, because Au, which is often finely dispersed in calcrete, and Ca are highly correlated suggesting co-precipitation. The genesis of carbonates in pedogenic environments is dominantly ascribed to microbial processes, in particular to microbially mediated carbonate precipitation via ureolysis. Contrary to a genesis model recently published by Lintern *et al.* (2006), Schmidt Mumm and Reith (2007) proposed a comprehensive coupled model that includes a microbial component, which may control Au and Ca co-precipitation (Fig. 1).

Figure 1: Model for the microbially mediated formation of gold in calcrete anomalies (Schmidt Mumm and Reith, 2007).



Using microcosms and microbial enrichment culture experiments to assess the ureolytic capacity of the bacterial community combined with molecular profiling (shotgun cloning and DGGE of 16S rDNA), showed that *Bacilli* spp. resident in calcareous materials at the Barns anomaly are capable of producing Au anomalous Ca-carbonates. Within 96 to 240 h from the start of the incubation the urea was turned over to NH_4^+, the pH in solution rose by approximately 1 unit to pH 9 and Ca^{2+}_{aq} was precipitated as Ca-carbonate crystals; in sterile the controls no carbonates were precipitated. Gold (been added as Au-aspartic acid complexes to the growth medium) was co-precipitated with Ca and uniformly dispersed in the dominantly vaterite crystals, as shown by laser ablation ICP-MS and SEM. These results suggest that microorganisms play an important role in the formation of Au anomalies in calcrete in Australia.

References

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Origin of brines in the northern Gulf of Mexico

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Brines from the the northern Gulf of Mexico show distinct differences with respect to element concentrations and oxygen, hydrogen, and strontium isotope signatures. Three sites at different water depth were investigated; Bush Hill, GC415 East, and GC415 West at water depths of 540, 950 and 1050 m, respectively. All three locations accommodate near-surface gas hydrates and chemosynthetic communities at the sediment surface. They are characterized by a distinct increase in salinity with depth, however, the origin of this increasing salinity is different for the GC415 sites and Bush Hill and the depth source of the brines is considerably different for all sites. The more saline brines of the GC415 sites result from the dissolution of halite (Fig. 1) by formation water. The brine of GC415 East has most likely a deeper origin and experienced elevated temperatures leading to intensive mineral/water reactions. This process is expressed by the heavier oxygen isotope values and distinct Li, Sr, and Ca enrichments. The brine of GC415 West has a shallower origin which is expressed by a smaller enrichment in Li, Sr, and Ca and lighter oxygen isotopes (Fig.1). The brine from Bush Hill is less saline and its fluid signature indicates intensive water/mineral interaction. Oxygen (Fig. 1) and hydrogen isotope values as well as Na/Cl and Br/Cl molar ratios indicates that the salt enrichment could have been caused by phase separation under sub-critical conditions. A simple heat flow model simulation suggests sub-critical phase separation at a depth of ~1650 m at ~350°C.

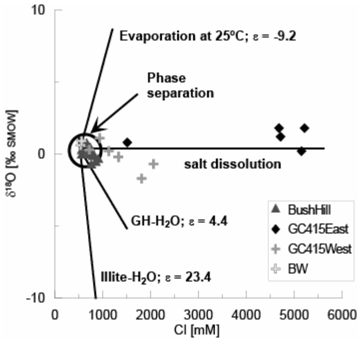

Fig. 1: Cl vs. $\delta^{18}O$ plot. Solid lines show the evaluation path of Cl vs. $\delta^{18}O$ values for (i) evaporation at ~25°C, (ii) gas hydrate (GH) formation, (iii) illite formation, and (v) dissolution of halite; the field expected for phase separation (no fractionation) is indicated by the solid circle.