Gold scavenging by liquid bismuth melts

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Bismuth is associated with gold in several different types of ore deposits. It has a melting temperature of only 271°C and therefore, when bismuth becomes saturated in a hydrothermal fluid at temperatures above this, it will precipitate from the fluid, not as a solid, but as a liquid. This liquid bismuth can subsequently continue to interact with and be transported by the hydrothermal fluid. Numeric modelling has shown that gold concentrations become several orders of magnitude higher in a bismuth melt versus the corresponding Bi-absent hydrothermal fluid, supporting the theory that a bismuth melt can scavenge and concentrate gold and other metallic ions from the hydrothermal fluid [1]. This theory is known as the Liquid Bismuth Collector Model (LBCM) [2].

We have investigated the bismuth-rich Stormont gold prospect in north-western Tasmania, to test the LBCM. Conditions at Stormont have been found to be favourable for bismuth to have precipitated as liquid with mineralisation temperatures between 400-500°C. In situ evidence for gold-scavenging by liquid bismuth is observed in the close textural relationship between native gold and bismuth. Zoned andradite crystals suggest hydrothermal fluid composition fluctuations, which may have contributed to zone refinement within the prospect. Liquid bismuth can sequester gold from undersaturated fluids [1]. Therefore, a zone refining process can potentially operate in a system where repeatedly infiltrating undersaturated fluids, controlled by favourable structures, can dissolve gold not attached to bismuth and then re-precipitate it where bismuth is concentrated. This leads to enhanced correlation between the two elements.

[1] Tooth *et al*. (2008), *Geology* **36**, 815-818. [2] Douglas *et al*. (2000), *15th Australian Geological Convention*, 135.

Revealing the hidden signature of biomacromolecules in ancient organic fossils

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The organic fossil record of eukaryotic organisms reaches back to the dawn of the Paleozoic. In the case of the arthropod fossil record, the preserved organic residue is derived from arthropod's exterior cuticle, the rigid exoskeleton characteristic of all members of the Arthropod phylum. In modern arthorpods, the exocuticle is composed of a nanocomposite of chitin and structural protein with very exterior region also containing fatty acids. The conventional geochemical view holds that the biopolymer chitin and structural protein is not preserved in ancient fossils as they are readily degradable through microbial chitinolysis and proteolysis and otherwise susceptible to destruction during diagenesis. Recently, however, we showed that a clear molecular signature of relict chitin-protein complex is preserved in a Middle Pennsylvanian (310 Ma) scorpion cuticle and a Silurian (417 Ma) eurypterid cuticle via analysis with carbon, nitrogen and oxygen X-ray Absorption Near Edge Structure (C-, N-, and O-XANES) spectro-microscopy [1]. The application of high-resolution X-ray microscopy employing functional group derived absorption contrast reveals the complex laminar variation in major biomolecule concentration across modern scorpion cuticle; XANES spectra highlight the presence of the characteristic functional groups of the chitin-protein complex. Modification of this complex is evident via changes in organic functional groups. Both fossil cuticles contain considerable aliphatic carbon relative to modern cuticle. In both cases, however, the concentration of vestige chitin-protein complex is high, 59 and 53 % in the fossil scorpion and eurypterid, respectively. We have recently used the Scanning Transmission X-ray Microscope (STXM) at beam line 5.3.2 at the Advanced Light Source to analyze the preserved organic cuticle of a Cambrian (507 Ma) trilobite from the Wheeler Shale. The thin section was prepared using a focused ion-beam mill. We detect very high N/C and O/C consistent with preservation of abundant, albeit altered, remnants of chitin/protein complex.

[1] Cody *et al*. (2011) *Geology* **39**, 255-258.