Australia’s high heat producing granites: Importance, distribution and genesis

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Valuable new insights into the distribution and geological settings of U, Th and K rich (HHP) granites in Australia have come from interrogation of national datasets, supplemented by recent regional studies [1]. Within Australia, such granites have been implicated in the formation of U mineralization and are actively being investigated for geothermal energy potential.

The oldest HHP granites in Australia are late Archean (2.85 and 2.65-2.63 Ga) K-rich I-types in the Pilbara and Yilgarn Cratons [2]. These were produced on a large scale, cutting across terranes, by melting of tonalite-trondhjemite-granodiorite (TTG)-rich crust.

I- and A-type granites with high K and, locally very high U and Th are widespread in the Proterozoic in Australia. These also formed by crustal reworking particularly in the 1.8-1.5 Ga period [3].

Both I- and S-type HHP granites occur within the Paleozoic. The majority of these appear to have been derived by crustal melting, largely in late syn-tectonic, to post-collisional and back-arc extensional settings [2].

The high Th and U reflect both crustal reworking and fractional crystallisation, though enriched lower crustal sources are important for the Archean and most Proterozoic granites. The necessary high crustal geothermal gradients were possibly linked to crustal thinning, mantle inputs and thermal blanketing by sediments. Fractional crystallisation was dominant in the Palaeozoic high HHP granites.

[1] http://www.ga.gov.au/minerals/research/oesp/index.jsp
[2] Champion& Smithies (2007). 6th Int. Hutton Symp., Univ. Stellenbosch, S Africa, 2-6 July (2007). [3] Budd *et al.* (2001) *Geoscience Australia Record* 2001/12. 152pp.

Visualizing cell surfaces and biominerals in 3D: Cryo-electron microscopy and tomography of iron-oxidizing bacteria

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Prokaryotic microorganisms are small and abundant, representing an enormous amount of surface area available to interact with minerals and solutes in the environment. Despite much research on cell walls, membranes, and extracellular polymers, we are still learning about the variety of microbial surface configurations. Recent years have seen the development of cryotechniques for electron microscopy, which can eliminate traditional fixation and dehydration methods that severely damage cell components. With cryoTEM and tomography, more realistic, detailed, hydrated, 3D views of ultrastructure have been obtained, beginning a revolution in our understanding of cell organization and processes. In particular, delicate surface and extracellular structures are preserved, finally giving accurate images of surfaces exposed to the environment.

We focus on aerobic iron-rich systems because of their abundance in terrestrial and marine environments (e.g. iron seeps and hydrothermal vents), and because the constant mineral precipitation poses particular challenges to cells. We have been studying two iron-oxidizing bacteria: the terrestrial FeOB *Gallionella ferruginea* and marine FeOB *Mariprofundus ferroxydans*. While not closely related, they are remarkably similar in morphology and metabolism, making them an ideal pair for comparison. Both excrete abundant extracellular polymers in the form of twisted stalks, which appears to be a mechanism to rid the cell of ferric iron and nucleate further iron mineralization. Our previous work on culture and environmental samples (by scanning transmission x-ray microscopy and TEM) has shown that the cells escape encrustation. Thus, we hypothesize that they have developed surfaces designed for this task. We will present our results of live-cell time lapse microscopy, showing mineral formation processes of both microbes. We will also present cryo-transmission electron microscopy and tomography images, movies, and analyses, showing novel surface structures exhibited by both *Gallionella* and *Mariprofundus* cells. To our knowledge, these structures have not been documented in other microbes, and may represent a particular adaptation to highly mineralizing environments.