In situ redox chemistry of hydrothermal fluids at the Loihi Seamount Microbial Observatory

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Loihi Seamount is a submarine, active volcano located on the southeast flanks of the Big Island of Hawaii. It is considered to be the youngest volcano in the Hawaiian chain, sharing the hot spot magma chamber with Mauna Loa and Kilauea. Sites of both vigorous and diffuse hydrothermal venting can be found surrounding the pit crater summit (~1000m) and on the flanks of the seamount, down to its base (~5000m). Vent fluids at Loihi are chemically distinct from other well-studied marine hydrothermal systems and have been shown to be enriched in carbon dioxide, iron(II), and manganese(II), and deplete in sulfur species. The Loihi summit is located within a zone of low oxygen, further enabling elevated iron(II) concentrations and support for a dominant community of iron-oxidizing bacteria.

We deployed a combination of a sensor wand consisting of up to four voltammetric working electrodes and the ROV Jason temperature probe, and/or a submersible micromanipulator with voltammetric electrodes to provide real time in situ redox characterizations of hydrothermal fluids and geochemical gradients associated with iron-oxidizing microbial mats and flocs. Our in situ electrochemical analyses provided an efficient and valuable means for directed discrete sampling of hydrothermal fluids and microbial flocs, as well as previously unattainable high spatial resolution geochemical profiles through the mats.

Automated fission track dating of apatite and monazite by image analysis and ICP-MS

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The microscopic identification and counting of fission-tracks in accessory minerals by a manual observer has been a significant limitation to the widespread adoption of fission track dating (FTD). Manual counting methods require a high level of observer skill and calibration, and provides a practical limit to the number of tracks counted and hence on the precision achieved. It has long been hoped that automated methods for track recognition and counting could enhance the objectivity of fission-track analysis, and improve both precision and overall productivity. We have recently developed a new image analysis method, called *'Coincidence Mapping™'* that for the first time shows great promise in achieving these aims.

Another limitation in traditional FTD arises from the use of thermal neutron irradiation to induce more fission-tracks as a proxy for uranium abundance in the same area counted for fossil fission-tracks. While providing an elegant analytical solution at the ppm level with high spatial resolution (typically <100μm), this approach involves sample turnaround times of mostly several months. Laser-ablation ICP-MS techniques are now able to provide rapid uranium analyses with similar spatial resolution to the older method (Hasebe *et al*., 2004). This approach greatly improves sample throughput, but has the disadvantage that the target grain and its fossil fission-tracks are destroyed. A combination of automated fission-track counting and laser ablation ICP-MS analysis, however, should prove particulalry advantageous.

Implementation of our automated fission-track counting system requires a microscope with both transmited and reflected light optics, a motorised stage and digital microscope camera, all under computer control. The software system consists of an image acquisition module that automatically acquires a series of reflected and transmitted light images at each area selected for counting. These are archived and a separate automated counting and review module is then used offline to analyse the data. The archived images constitute a digital replica of the mineral grains which are then analysed by laser ablation ICP-MS using the stage coordinates to control positioning. The system has so far been applied successfully to fission track dating of accessory apatite and monazite.

Reference

Hasebe N, Barberand J, Jarvis K, Carter A and Hurford AJ, 2004. *Chemical Geology* **207**, 135-145.