Radiation damage in biotite: Defined by Micro XAS and XRD

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Radiation damage in mineral structures is of interest because of their consideration as radioactive waste forms. Examples of damage occuring on geological timescales are available in nature. Alpha particle damage around actinide-bearing inclusions in silicates is best observed in the mineral biotite where a *ca* 35 micron damage halo is seen. By using combined synchrotron XAS and XRD at the Diamond Light Source, UK, the changes across the damaged zone around a U/Th-bearing monazite inclusion was investigated. Fe K-edge XANES from a traverse shows that within the damaged zone the biotite Fe^{3+} is reduced, perhaps as a consequence of radiolysis of the OH groups in the octahedral layers. The Fe K-edge EXAFS show an increase in disorder in the damaged zone. The micro XRD showed major changes in the biotite lattice as the U/Th containing inclusion was approached. The use of a single crystal positioned perpendicular to (001) enhanced the a, b plane reflections. The diffraction spots representing 110 and other sub-parallel planes show evidence of amorphisation of the biotite lattice. Also new reflections appear at d-spacings close to the main reflections, indicating local changes to the structure as a result of atomic displacements during the development of Frenkel pairs.

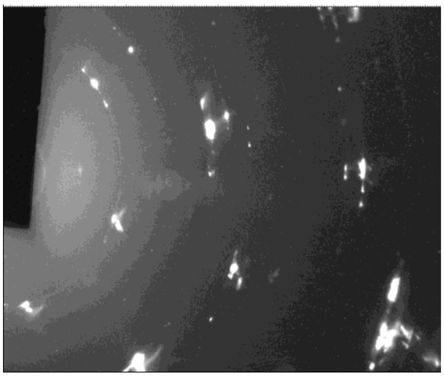

Figure. 1. Synchrotron diffraction image of biotite adjacent to an alpha particle emitting inclusion.

Melt inclusion Pb-isotope analysis by LA-MC-ICPMS: Assessment of analytical performance and application to OIB genesis

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We present laser ablation MC-ICPMS lead isotope measurements of olivine-hosted melt inclusions, analyses that include the low abundance Pb-isotope, ^{204}Pb, measured on an ion counter. These data were collected using a unique parallel ion counter-faraday cup method, developed for melt inclusion isotope analysis [1]. We tested this technique on an isotopically homogeneous sample from Tonga to provide constraints on both precision and accuracy. Using the variability of these data we then re-investigate two OIB inclusion suites. These new data demonstrate that greater variability than would be expected from analytical errors alone can be discerned in the two OIB suites.

Our data suggest that melt inclusions are not biased towards grain-scale phenomena and thus may indeed be representative of geologically significant processes in magma chambers. In the case of the Pitcairn Seamounts, we find that each sample contains melt inclusion compositions with the same variablity as the entire whole-rock sample population for these seamounts. Similarly, melt inclusion data from the island Mangaia show the same degree of compositional variability as defined by all lavas on the island.

In addition, our Pb isotope measurements of individual samples suggest that discrete batches of isotopically distinct melt exist to high levels in magmatic plumbing systems.

We also present two preliminary combined trace element/Pb isotope measurements for two inclusions, which we believe demonstrate the potential of such an approach for future studies. Results from the Pitcairn Seamounts suggest that isotopic variability is inherited from the mantle source and not necessarily from late stage crustal contamination.

[1] Paul *et al*. (2005) *J.A.A.S*. **20**, 1350–1357.