Application of the PbSL technique to garnets from high-grade metamorphic terranes

MAURIZIO TONELLI[1], JANET HERGT[1] AND JON WOODHEAD[2]

[1]Predictive Minerals Discovery Cooperative Research Centre (pmd*CRC), School of Earth Sciences, The University of Melbourne, VIC., 3010, Australia (tonelli@unimelb.edu.au)

[2]School of Earth Sciences, The University of Melbourne, VIC., 3010, Australia

The Pb-Pb step leaching technique (PbSL) underwent a brief period of rapid growth in the mid-late 1990's with the studies of Frei and co-workers at the University of Bern, Switzerland. Despite the promising results, the technique has not been widely employed.

In this study we report PbSL investigations performed on Proterozoic garnets in order to test the reliability of PbSL as a dating tool in highly deformed terranes. These tests therefore examine the viability of this method to undertake direct dating of structurally well constrained metamorphic porphyroblasts.

The success of the PbSL technique relies on its ability to differentially extract radiogenic and common Pb components from the crystal lattice. The mechanisms by which this may occur have been investigated using microbeam analytical techniques (SEM, PIXE and EMPA) applied to leached grains. SEM and PIXE data document the retention of high field strength elements and Th^{4+} in the leached layer. It is proposed that radiogenic Pb, possibly as Pb^{4+}, also behaves as a tetravalent cation during leaching and is retained in the leached structure relative to common Pb. Combining these observations with theoretical considerations, it is proposed that the ability to generate a range in Pb isotope ratios during PbSL is controlled by two processes; the surface/crystallographic dependent hydrolysis of metal cations, and the progressive remobilisation of radiogenic Pb from the leached gel-like structure.

One pitfall in analysing porphyroblasts is their propensity to contain inclusions such as monazite and zircon as these may degrade the PbSL isochrons. Even careful handpicking cannot avoid micro-inclusions, however, the 3D visualisation of PbSL data makes it possible to identify and remove the effects of such inclusions prior to regression of the isochron.

The PbSL technique has been applied to a small number of structurally well-constrained samples from the Southern Cross area of the Broken Hill Block, Australia. This area has undergone multiple episodes of amphibolite facies metamorphism and ages of 1599±1 Ma, 1594±7 Ma, 1592±16 Ma, 1556±10 Ma and 1498±28 Ma have been obtained from garnets extracted from five samples encompassing different lithologies and recording garnet growth during different events.

The potential of molecular biology and biotechnology in the search for extraterrestrial life

J. TOPORSKI AND A. STEELE

Geophysical Laboratory, Carnegie Institution of Washington, 5251 Broad Branch Road, Washington D.C., 20015-1305, USA (j.toporski@gl.ciw.edu)

We seek to demonstrate the relevance and potential of molecular biology and biotechnology instrumentation that are relevant in solar system exploration. Miniaturization and nano-technology have been integrated with biotechnology in new fields of research towards the development of "lab-on-a-chip" instruments. Such techniques have been developed to answer on Earth the questions we wish to address in solar system exploration: is/was there microbial life present, what are its characteristics, how can we detect it in small abundances and what effects does it have on its environment and vice versa. There are several relevant categories of molecules that must be detected and distinguished: 1. Prebiotic molecules: e.g. amino acids, nucleotides, PAH. 2. Terrestrial contaminating organisms: whole cells, cell components 3. Chemical contamination: e.g. lubricants, plastics, biomolecules. 4. Earth-like organisms: transferred from Earth or evolved independently in a similar manner to life on Earth (e.g. specific genes, membrane components, enzymes). 6. Non-Earth-like organisms: similar biochemistry but selected different molecules for information storage and transfer, compartmentalization and enzymatic activity (e.g. novel amino acids or nucleotides). 7. Fossil biomarkers: e.g. hopanes, steranes, isoprenoids.

Miniaturization of common laboratory techniques has produced systems relevant for solar system exploration:

Microfluidics Microfluidic systems can perform a number of tasks such as capillary electrophoresis, flow cytometry, PCR, mass spectrometry, microarray inoculation, ELISA, cell culturing, sample separation, processing and concentration of analytes.

Microarrays These can fit up to several million separate tests per glass slide. These are mostly DNA and protein based, but their use can be diversified to any test using any reagents that produce a color change during the detection of a primary molecule.

Probe design Many techniques used to find life are centered around probe technology. The essence of this technique is the use of a detector molecule that is linked to a substrate or reporter molecule and interaction of the target molecule and the probe is then detected. Examples of probes are: 1. Nucleic acids: short strands of DNA and RNA that can recognize bind to complimentary strands of DNA and cell surface proteins. Aptamers can also be used in the detection of a variety of molecules.. 2. Antibodies: monoclonal and polyclonal antibodies exist for a range of target molecules (e.g. prebiotic chemicals, indicators of viable life and fossil biomarkers). 3. Enzymes: e.g. the Limulus Amebocyte Lysate assays.

An overview on current concepts and technology will be presented.