Origin of high μ isotope signature in late Archean granitoids

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The 2.8Ga Long Lake igneous suite of the Beartooth Mountains, Wyoming Craton, is characterized by elevated (high μ) ^{207}Pb/^{206}Pb but relatively mantle-like Sr and Nd isotope compositions. Mueller and Wooden [1] proposed that this phenomenon and the homogeneity in initial Pb isotopes is most easily explained by addition of sedimentary crustal Pb to a mantle source, hence implying the operation of sediment recycling as far back as 2.8Ga. The alternative explanation is that the high μ Pb was inherited from crustal contamination.

Here we present new Pb isotope data that confirm the high μ character of this suite but also demonstrate a previously unrecognized isotopic heterogeneity, particularly in the leached feldspar data. We also present >2,000 in situ LA-ICP-MS zircon U/Pb dates that show a clear element of zircon inheritance from crustal sources ranging in age between 2.9 and 3.5Ga. This we take as prima facie evidence for crustal assimilation. New whole rock trace element data, including many fluid-sensitive elements (B, Tl, W, As, Pb, Sb) show that most of the Long Lake gneisses are true adakites, interpreted as direct melts of eclogite facies subducted oceanic crust. These melts are inherently depleted in fluid mobile elements, including Pb but relatively enriched in Sr and Nd. Therefore, relatively mild crustal contamination is most readily seen in Pb isotopes while Nd and Sr are progressively more resilient to the crustal input.

[1] Mueller & Wooden (1988) *Geology* **16,** 871-874.

Geophysical imaging of the fluid distribution in active orogens

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Geological studies of ancient orogens have shown that fluids play an important role in the evolution of these regions. Geophysical data can complement geological studies by providing constraints on the present day fluid distribution. Seismic exploration can be used to delineate these fluids. However, the presence of fluids has a much greater effect on electrical resistivity than the seismic velocity. Remote sensing of subsurface resistivity can be achieved with the magnetotelluric (MT) method which uses natural radio signals to image to depths in excess of 200 km. In this presentation I will describe how recent MT studies of active orogens can be used to determine the amount, and type of fluids in the crust and upper mantle.

An extensive set of magnetotelluric data was collected as part of the INDEPTH investigation of the India-Asia collision zone in Tibet. Models derived from these data reveal a pervasive zone of mid-crustal low resistivity that extends across the north-south extent of the Tibetan Plateau. The resistivity values can be explained with an elevated fluid content; either partial melt and/or aqueous fluids. Unsworth *et al.* [1] showed that the fluid fraction in Southern Tibet is high enough to weaken the crust and is consistent with zones of crustal flow. Similar features have been observed in the crust beneath the Arabia-Eurasia collision in Eastern Anatolia.

Subduction zones have also been studied with magnetotelluric data. Soyer and Unsworth [2] showed that in the Cascadia subduction zone, fluid pathways could be mapped above the subducting slab. In the back arc region the magnetotelluric data reveal a shallow asthenosphere. The elevated conductivities in this region can be explained by either dry partial melting, or a lower fraction of water saturated melt.

Most previous geophysical studies of orogenic belts have collected data on a series of linear profiles. However, new studies such as USArray are proceeding with fully 3D magnetotelluric imaging and are systematically imaging entire orogens, not just selected transects. This approach will result in more reliable images of subsurface fluid distribution.

[1] Unsworth *et al.* (2005) *Nature* **438**, 78-81. [2] Soyer & Unsworth (2006) *Geology* **34**, 53-56.