Melts, fluids, crystals, sulphides, metals: Trace element partitioning and geochemical applications

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First there was Goldschmidt [1], then there was lattice-strain [2], so what else is there to learn about partitioning behaviour? The answer is that we are now getting to the point where the geochemical problems are really interesting. Here are the things I will talk about:

Olivine-liquid partitioning and basalt genesis: Ni partitioning was completely understood long ago [3]. Ni contents of Hawaiian olivines hence seemed to require a pyroxenitic mantle source. New experimental olivine-melt partitioning data indicate however that they can be explained by relatively high temperature of melting of "standard" mantle.

Chalcophile elements in terrestrial and martian basalts: Chalcophile partitioning between sulphide melt and silicate melt is a simple function of the FeO content of the silicate melt. This means we can quantify the influence of residual sulphide on chalcophiles in terrestrial and martian melts. Residual sulphide appears to be critical to basalt generation on Mars.

Crystal-fluid partitioning of trace elements: Although crystal-fluid partitioning is difficult to systematize, applications of the lattice strain approach show that hydrothermal minerals record the compositions of the fluids from which they were generated when corrections for fluid speciation are applied.

The "melt-effect" and trace element partitioning: It is now possible to measure trace element activities in silicate melts using partitioning into metal as a monitor. The data are applicable to determination of melt composition effects on crystal-melt partitioning and other important properties such as volatility.

Metal-silicate partitioning and planetary core formation: We are just getting to grips with the high pressures of core formation on Earth and the effects of the light element in the core on partitioning between core and mantle. For Si, O and S these effects are large for many trace elements.

[1] Goldschmidt, V. M. *Geochemistry*. 730 pp (Clarendon Press, 1954). [2] Blundy, J. D. & Wood, B. J. *Nature* **372**, 452-454 (1994). [3] Hart, S.R. & Davis, K.E. *Earth Planet. Sci. Lett.* **40,** 203-219 (1978)

Temporal evolution of the Raahe-Ladoga Shear Complex, Finland: Constraints from a sheared granitoid in the Pielavesi Shear Zone

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The Fennoscandian Shield experienced several stages of brittle - ductile deformation during the Palaeoproterozoic. The Raahe Ladoga Shear Complex (RLSC) is a ~100 km wide, NW - SE striking set of strongly sheared rocks and intervening crustal blocks in which antecedent structures are preserved. These were formed by long-term and multi-phase Svecofennian convergent tectonic evolution and consist of supracrustal paragneisses and intrusive rocks. The latter are mostly pre- or syn-kinematic granitoids, but distinctly postkinematic granite veins occur in all areas. The Pielavesi Shear Zone (PSZ) in Central Finland is an important shear dominated, N-S striking unit within the RLSC.

At Heinäsuo, in the Pielavesi parish, Central Finland, pre- to syn-kinematic quartz diorite intrudes the PSZ. The quartz diorite has strong N-S foliation, likely developed during or immediately after crystallisation. This intrusion is cut by a late-kinematic, broadly N-S striking blastomylonite. U-(Th)-Pb geochronology of zircon, monazite and titanite are used to place constraints on the timing of deformation and shearing within the PSZ. Samples were collected from both the quartz diorite intrusion and the blastomylonite. Zircons were separated from the quartz diorite using standard gravitational separation methods, while polished chips of the blastomylonite were selected for *in situ* analysis of monazite. These were mounted in epoxy resin and analysed at the NORDSIM laboratory, Swedish Museum of Natural History, Stockholm, Sweden. Titanite was analysed *in situ* from polished thin sections of quartz diorite using LA-ICP-MS at the Geological Survey of Finland, Espoo, Finland.

Zircons have oscillatory zoning patterns in BSE images, characteristic of igneous zircon. Analysis of the zircons resulted in a concordia age of 1884 +/- 6 Ma, providing a magmatic age and constraining an age maximum for deformation in the PSZ. The monazite from the blastomylonite has a concordia age of 1793 +/- 3, placing the brittle - ductile shearing event at ~100 m.y. later. The titanite age, 1780 +/- 23 Ma, also indicates some recrystallisation in the quartz diorite during the late stage shearing event.

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