Mantle convection and K/U

W.F. McDONOUGH*AND R.J. AREVALO

University of Maryland
(*correspondence: mcdonough@geology.umd.edu)

Models for the deep Earth must be challenged. Where are we with respect to understanding the composition of the Deep Earth? Researchers continue to challenge the dominant paradigm of a compositionally homogenous pyrolitic model at the gross scale. A major focus now is on the nature of the core-mantle boundary and what might potentially exist in this remote location.

The distribution of heat producing elements in the Earth drives convection and plate tectonics. Recent results from geoneutrino studies are coincident with pyrolitic-type models for the Th and U content of the Earth. Geoneutrino detectors continue to come on line and count events, thus their data are increasing in quality and uncertainties continue to reduced with time (at present 2 detectors are accumulating data). Geochemical models posit that ~40% of the heat producing elements are in the continental crust, with the remainder distribute throughout the mantle. Our recent data on K/U for oceanic basalts revises considerably the mantle value from 13,000 to 18,000. Although models of core formation allow for the incorporation of heat producing elements, the core contribution of radiogenic heating is considered to be negligible. The Mantle Urey (Ur) ratio (radiogenic heat contribution to the total mantle heat flux) is estimated to be ~0.3 from chemical and isotopic data. Such a low mantle Urey ratio is at odds with the paradigm of parameterized convection models (i.e., Ur = 0.7) for the Earth. Thus, recent results challenge the dominant geophysical models of mantle convection and call for a significant contribution heat from secular cooling of the mantle.

In situ geochemical and Sm-Nd isotopic fingerprinting of high-T hydrothermal alteration

C.R.M. McFARLANE*

Research School of Earth Sciences, Australian National University, Canberra ACT 0200, Austraia
(*correspondence: Geology Dept., Univ. of New Brunswick, Fredericton NB E3B5A3, crmm@unb.ca)

A combination of EPMA imaging and analysis, LA-ICPMS trace-element quantification, and LA-MC-ICPMS Sm-Nd systematics has been applied to two alteration styles (calic-sodic vs. potassic) characteristic of Fe-oxide-Cu-Au (IOCG) mineralization from the Southern Curnamona Province (SCP), Australia. The LREE-enriched nature of these systems gives rise to accessory minerals (e.g. monazite, allanite, apatite, titanite) that can be exploited using these *in situ* analysis techniques to define the temperature, timing, and crustal affinity for episodes of superimposed alteration over the course of collisional orogenesis.

Calic-sodic alteration is characterized by epidote-albite-magnetite-quartz hosting abundant chalcopyrite. This assemblage is superimposed on an older allanite-quartz assemblage. Whereas allanite contains elevated Be, P, Zn, As, Ba, LREE and traces of Au (10 ppb), altered allanite domains and neighbouring epidote are enriched in Cu, Sn, and Sr. *In situ* Sm-Nd systematics reveal that allanite has a Nd-isotope affinity to ~1620 Ma A- and I-type granites documented elsewhere in the SCP, whereas fluids responsible for ~1575 Ma epidote-bearing alteration were sourced from the underlying metasedimentary sequence.

Potassic alteration is characterized by K-feldspar, biotite, muscovite, and quartz with minor chalcopyrite and pyrrhotite. Accessory minerals include monazite, xenotime, apatite and rare titanite. Monazite typically forms as aggregates intergrown with either apatite or xenotime. The latter yield monazite-xenotime solubility temperatures between 550 to 600°C indicating alteration under amphibolite-facies conditions. *In situ* Sm-Nd systematics for monazite clusters within biotite yield precise initial-Nd that are indistinguishable from ~1575 Ma calcic-sodic alteration.

Construction of these *in situ* datasets reveals a long-lived interplay between magmatic, magmatic-hydrothermal, and hydrothermal fluids over the course of collisional orogenesis. This approach also provides a means to understand variations in metal associations and redox conditions in IOCG deposits as a function of temperatures, ages, and Nd-isotope signatures extracted directly from hydrothermal accessory minerals.