The Earth and its building blocks

W. F. McDonough[1]

[1] Dept of Geology, University of Maryland, College Park, MD, 20742-4211, USA.

The composition of the Earth was shaped by the chondritic building blocks that most likely populated the inner solar system. The observed isotopic composition of the *available* chondrites, which are few and only recently (<10^5 years) delivered, reveal an enstatite chondrite (EC) match, or similarity, to that of the Earth. However, and in stark contrast, the Earth does not match EC for their volatile element abundances, nor their mineralogical attributes. Based on the planetary mass fraction of Fe in the Earth's core, the planet is strongly reduce, intermediate in redox potential between ordinary (OC) and EC. Increasingly, it is observed that the niningerite and oldhamite in EC, as well as other phases, is the the alteration product of sulfidation of ferromagnesian silicates and not a primary feature[1].

The 142Nd isotope data [2] has opened up a new vista in revealing aspects of solar system history and the nature and distribution of the early building blocks. A fundamental observation from this isotope system is that the three domainant classes of chondrites, CC, OC and EC, have clear differences in their average 142Nd/144Nd compositions and the Earth is most similar to the EC class [3]. Interpretation of the 142Nd signature of the Earth include a deep hidden reservoir [4] or loss of the equivalent reservior to space by an ablation process [5]. Alternatively, the data are consistent with early solar system heterogeneity [6].

Neutrino geoscience, the detection of electron anti-neutrinos from beta-decays of Th and U series, is now providing data on the amount and distribution of U and Th inside the Earth. The latest results from the KamLand and Borexino experiments were reported earlier this year [7,8] and demonstrate that the Earth contains a considerable amount of primordial heat and favors both cosmochemical [9] and geochemical models [10]. Combined with data for the composition of the continental crust, these models will be interpreted in terms of the residual amount of heat producing power left in the mantle needed for mantle convection and driving plate tectonics.

[1] Lehner *et al*. 2013, GCA 101; [2] Boyet & Carlson 2005, Science 309; [3] Gannoun et al. 2011, PNAS 108; [4] Boyet & Carlson 2006, EPSL; [5] O'Neill & Palme 2008, Phil. Trans. R. Soc. A 306; [6] Qin et al. 2011, GCA 75; [7] Bellini et al. 2013, arXiv:1303.257; [8] Gando et al. 2013, arXiv:1303.4667v2; [9] Javoy et al. 2010, EPSL 293; [10] McDonough and Sun 1995, CG 210.

Remarkably hot quartz in resurgent intrusions associated with the 18.8 Ma Peach Spring Tuff supereruption

S.M. McDowell[1]*, C.F. Miller[1] and J. Wooden[2]

[1]Vanderbilt University, Nashville, TN 37235, USA (*correspondence: susanne.m.mcdowell@gmail.com)
[2]Stanford University, Palo Alto, CA 94305 (jwooden@stanford.edu)

The Silver Creek caldera (southern Black Mountains, western Arizona) is the source of the 18.8 Ma, >700 km^3 Peach Spring Tuff (PST), the only supereruption deposit in the Colorado River Extensional Corridor (CREC) [1]. A 30 km^2 intrusive complex within the caldera records ~200 ka of post-PST resurgent magmatism and consists of two primary units: the intermediate to felsic Moss porphyry (62-68 wt% SiO_2; 18.81 ± 0.09 Ma [TIMS U-Pb zircon age]) and the felsic Times porphyry (>72 wt% SiO_2; 18.63 ± 0.08 Ma) [2]. Both units intrude trachytic, densely welded intracaldera PST.

To investigate epizonal magmatic processes during and immediately after the PST supereruption, and to constrain the thermal history of the PST magmatic center, we applied Ti-in-quartz thermometry [3] to two samples of Moss, one sample of Times, and one sample of a younger (18.21 ± 0.07 Ma) crosscutting quartz porphyry dike. Quartz in the Moss yields conspicuously high Ti concentrations (~60 to 340 ppm; avg. 160 ppm), corresponding with Ti-in-qtz temperatures of ~730-980ºC (avg. 840°C, $a_{TiO2} = 0.7$). Ti-in-qtz concentrations for the Times (~45-150 ppm; avg. 95 ppm) and quartz porphyry dike (~50-110 ppm; avg. 70 ppm) give mean Ti-in-qtz temperatures of 780°C and 745°C, respectively. Quartz temperatures are broadly consistent with trends in zircon saturation and Ti-in-zircon temperatures for the same units. Moss temperatures are higher than those for all other units in the CREC except intracaldera PST, which yields comparable Ti-in-zircon temperatures [4, 5].

Mineral thermometry suggests that the Moss records a brief period of exceptionally hot magmatism that coincides temporally and spatially with the PST eruption. Quartz data are consistent with the hypothesis that influx of anomalously warm and/or voluminous mafic magma led to rapid production and accumulation of massive, high-T PST magma [6]. Temperatures of successive post-PST intrusions fell at a rate of ~0.25ºC/k.y.

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