Palaeoproterozoic Fe-rich tholeiites in Eastern Australia: A geochemical link between inliers?

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Palaeoproterozoic sedimentary basins of north-eastern and central-eastern Australia are host to large amounts of variably deformed and metamorphosed Fe-rich tholeiitic rocks. Emplacement and/or extrusion of the mafic rocks occurred during one or more episodes of crustal thinning relating to a period of regional extension and sedimentation across Palaeoproterozoic northeastern Australia (ca. 1730-1650 Ma; [1, 2, 3]). The widespread occurrence of Fe-rich tholeiites of similar age, coupled with other geochronological and tectonic evidence, has led some authors to suggest a shared evolution for these terranes [3, 4].

With the addition of new geochemical and isotopic data from the Curnamona Province of western NSW [5, 6] and the Georgetown Inlier of north Queensland, the geochemical characterisitcs of the mafic rocks can be compared. The most primitive tholeiites from the Curnamona Province and Georgetown Inlier were both derived from a depleted mantle parent (avg. $\varepsilon Nd_{(t)}$ ~ +3 to +4), and have strong Fe-enrichment trends (up to ~ 25 wt % $Fe_2O_{3(total)}$) consistent with simple closed-system crystal fractionation. Both suites also experienced low degrees of crustal contamination (La_N/Sm_N ~ 0.5-1.3).

Despite pervasive metamorphism and recrystallization, the suites also appear geochemically similar to Fe-rich tholeiites of the Mt Isa Eastern Succession (western Queensland). However, at present there are no significant isotopic datasets available for this suite. The geochemical similarities between the Fe-rich tholeiites is of regional significance, as it may point to a tectonic relationship between the Palaeoproterozoic terranes of eastern Australia between ca. 1700 Ma and 1650 Ma.

[1] Etheridge *et al.* (1987) *Amer. Geophy. Union Geodynamics Series* **17**, 131-147. [2] Betts *et al.* (2002) *AJES* **49**, 661-695. [3] Giles *et al.* (2002) *Geology* **30**, 823-826. [4] Black *et al.* (1998) *AJES* **45**, 925-935. [5] Rutherford *et al.* (2006) *AJES* **53**, 501-519. [6] Raveggi *et al.* (2007) *Precam. Res.* **156**, 55-84.

Core formation and the Pb and Tl isotope evolution of the silicate Earth

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Recently published Hf-W data for lunar rocks [1] indicate that the Moon formed late, at least 50 Myr after the formation of the solar system. A protracted period of terrestrial accretion was previously also inferred from the Pb isotope composition of the Earth [2]. Further constraints on accretion processes are provided by the recently discovered extinct ^{205}Pb-^{205}Tl decay system ($t_{1/2} \approx 15$ Myr) [3]. Previous combined modeling of the U-Pb and Pb-Tl chronometers indicated that the Pb and Tl concentrations and isotope composition of the bulk silicate Earth (BSE) could be explained by assuming that a fast initial period of accretion was followed late sulphide segregation, which sequestered chalcophile Pb and Tl into the core [4].

Here we reexamine this conclusion in the light of the late Hf-W age of the Moon using new constraints that are provided by (i) high-pressure metal-silicate partitioning data for Pb and Tl that were obtained at temperatures and pressures of up to 2673 K and 24 GPa, and which indicate that Tl behaves increasingly siderophile at high pressure; and (ii) new Tl isotope analyses of chondrites, which provide revised estimates of the initial ^{205}Pb abundance and Tl isotope composition of the solar system.

The modeling shows that the Pb and Tl systematics of the BSE can be readiliy explained with the available partitioning data, even if the giant impact was associated with only incomplete equilibration of the impactor core with the BSE. Such disequilibrium during accretion is required to reconcile the young Hf-W age of the Moon with the 2□ difference in the W isotope compositions of the BSE and chondrites [2]. Successful U-Pb-Tl models feature an Earth with $\mu \approx 0.7$-0.8 and may feature but do not require late-stage Pb-Tl segregation into the core with small amounts of sulphide. Late volatile loss of Pb and Tl is not indicated by the available constraints.

[1] Touboul *et al.* (2007) *Nature* **450**, 1206. [2] Halliday (2004) *Nature* **427**, 505. [3] Nielsen *et al.* (2006) *GCA* **70**, 2643. [4] Wood *et al.* (2008, in press) *EPSL.*