RESOLVING Lu-Hf IN CHONDRITES AND THE BULK EARTH COMPOSITION

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Introduction: Interpretation of Hf isotope data for planetary material evolution is highly dependant of the ^{176}Lu-^{176}Hf system parameters employed. Beyond the ^{176}Lu decay constant discrepancy (e.g., [1]), Lu-Hf Chondritic Uniform Reservoir (CHUR) and Bulk Silicate Earth (BSE) compositions need to be clarified. The Lu-Hf CHUR determination is hampered by a variation in Lu/Hf of ~20% (2σ SD) among the ordinary (OC) and carbonaceous chondrites (CC) analyzed previously [2-4]. This contrasts with Sm/Nd which varies by only ~3% [5, 6] and has prevented an unambiguous choice for the Lu-Hf BSE composition from the chondrite data. The BSE value should correspond to CHUR as both Lu-Hf and Sm-Nd isotopic systems involve refractory and lithophile elements.

Results: We analyzed twenty new chondrites for Lu-Hf and Sm-Nd isotope systematics. While most OC used in previous studies were petrologic types 4 to 6 [2-4], we investigated thirteen of the least metamorphosed H, LL and L chondrites available (types 3.0 to 3.8) which limits the growth of phosphate (main carrier of REE). We also analyzed seven CC of types 1 to 3 from the CI, CV, CO and CK groups. Including four CC data previously analyzed [4], we obtained mean values of ^{176}Lu/^{177}Hf = 0.0337 ± 3 and ^{176}Hf/^{177}Hf = 0.282802 ± 23 (2σ SE, n=22), which we consider to be our best estimate of CHUR. These two values are respectively higher by 0.0005 and 0.000030 (~1 epsilon unit), than the values currently in use [2] which were determined from twenty one OC and two CC data. For the Sm-Nd system, the values for these same chondrites yield, ^{147}Sm/^{144}Nd = 0.1961 ± 6 and ^{143}Nd/^{144}Nd = 0.512629 ± 16, within the lower limits of [5, 6].

Discussion: The ^{176}Lu/^{177}Hf range obtained from all the types 1 to 3 CC and OC is now constrained to ~4%, which is similar to Sm/Nd. Our new Lu-Hf CHUR estimate places the chondrite composition within the Hf-Nd isotope correlation of the Earth's mantle and continental crust [7]. It consequently involves a chondritic evolution of the BSE and removes the need for a hidden reservoir to explain the Lu-Hf systematics. The ~20% range of Lu/Hf, mostly due to the equilibrated OC, must reflect partly the sample heterogenities and also the open behavior of the Lu-Hf system during thermal metamorphism of the chondrite parent bodies. Both are related to the heterogeneous phosphate growth effects as these minerals are characterized by extremely fractionated ^{176}Lu/^{177}Hf of 0.3 to 100 [8] and only slightly lower ^{147}Sm/^{144}Nd of 0.18 to 0.19 [6] compared to the respective whole-rock isotopic ratio.

References: [1] Albarède, F. et al. 2006. *GCA*, 70: 1261-1270. [2] Blichert-Toft, J. and Albarède, F. 1997. *EPSL*, 148: 243-258. [3] Bizzarro, M. et al. 2003. *Nature*. 421: 931-933. [4] Patchett, P.J. et al. 2004. *EPSL*, 222: 29-41. [5] Jacobsen, S.B. and Wasserburg, G.J. 1980. *EPSL*, 50: 139-155. [6] Amelin, Y. and Rotenberg, E. 2004. *EPSL*, 223: 267-282. [7] Vervoort, J.D. et al. 1999. *EPSL*, 168: 79-99. [8] Amelin, Y. 2005. *Science*, 310: 839-841.