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$^{142}Nd/^{144}Nd$ IN SNCs AND EARLY DIFFERENTIATION OF A HETEROGENEOUS MARTIAN (?) MANTLE;

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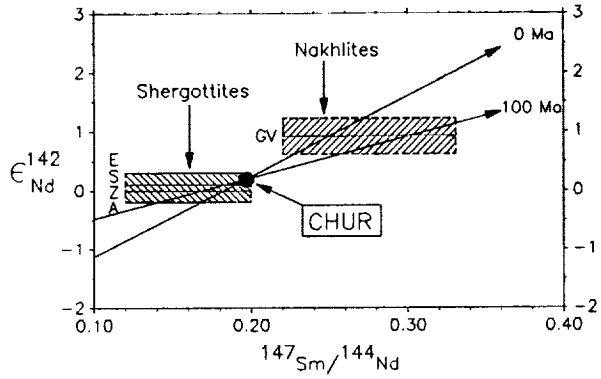

Figure 1. $^{142}Nd/^{144}Nd$ in SNC meteorites compared to the correlation with $^{147}Sm/^{144}Nd$ observed by (4) for the LEW86010 Angrite (0 Ma isochron) and that 100 Ma later.

Sm/Nd correlated variations in $^{142}Nd/^{144}Nd$ have been observed for mineral phases of achondrites from decay of live ^{146}Sm ($T_{1/2}$ = 103 Ma) in the early solar system (1,2,3,4). Crystallization ages of SNC meteorites are ≤1.3 Ga, so variations of $^{142}Nd/^{144}Nd$ among mineral phases of the SNCs are not expected. However, if SNCs were derived from source reservoirs of differing Sm/Nd ratios, established while ^{146}Sm was still alive, and which remained isolated except for magma extraction, then variations in $^{142}Nd/^{144}Nd$ would exist among individual SNC meteorites. Rb-Sr (5) and U-Pb (6) isotopic data for the shergottites imply differentiation of their parent planet ~4.6 Ga ago. Although the crystallization ages of the shergottites are uncertain, Shih et al. (5) considered it probable that all of them came from sources having undergone similar $^{143}Nd/^{144}Nd$ evolution. In this case, the Sm-Nd whole rock age, 1.3 Ga, approximates the crystallization age and the average $^{147}Sm/^{144}Nd$ required in the source between 4.56 Ga and 1.3 Ga is 0.165, corresponding to initial ϵ_{Nd} = -13. Nakamura (7) measured the Sm-Nd age, 1.26±0.07 Ga, and ϵ_{Nd} = +16 for Nakhla. Several authors (8,9,10) assumed shergottites and nakhlites came from a common parent body (SPB=Mars?) and considered the isotopic systematics of the SNCs together. Jones (9) concluded that SNCs were derived from an approximately homogeneous mantle having depleted LREE and $^{147}Sm/^{144}Nd$ ~0.234. These estimates of Sm/Nd in the source(s) of SNCs are sufficiently different from one another to suggest variations in $^{142}Nd/^{144}Nd$ among the SNC meteorites might be detectable.

Figure 1 shows $^{142}Nd/^{144}Nd$, expressed as ϵ^{142}_{Nd}, for shergottites, Shergotty, Zagami, ALHA77005, and EETA79001, and nakhlite Governador Valadares (T_{Rb-Sr} = 1.3 Ga (11)). No detectable $^{142}Nd/^{144}Nd$ anomalies were found for the shergottites. Nakhlite Governador Valadares, however, shows an apparent enrichment of +0.9±0.3ϵ in $^{142}Nd/^{144}Nd$. When these results are compared to values expected from the correlation of $^{142}Nd/^{144}Nd$ and $^{147}Sm/^{144}Nd$ observed for the LEW86010 angrite (4), the magnitude of the $^{142}Nd/^{144}Nd$ excess found for Governador Valadares is seen to correspond to $^{147}Sm/^{144}Nd$ ~0.25 in the nakhlite source if it formed contemporaneously with LEW86010. This Sm/Nd ratio agrees satisfactorily with that inferred by Jones (9) for the SPB mantle. A delay of ~100 Ma in establishing the source reservoir would require a higher value of $^{147}Sm/^{144}Nd$ ~0.3. The $^{142}Nd/^{144}Nd$ data do not support derivation of shergottites and nakhlites from a homogeneous depleted mantle source. In the Jones (9) and similar models, Nd in Shergotty and Zagami is assumed to be dominated by "crustal" Nd (ϵ_{Nd}<0), whereas Nd in the Antarctic shergottites is dominated by mantle Nd (ϵ_{Nd}>0). $^{142}Nd/^{144}Nd$ for the Antarctic shergottites is indistinguishable from that for Shergotty and Zagami, suggesting similar chondritic or slightly subchondritic Sm/Nd ratios in the primordial sources of the shergottites. The amount of mixing of Nd from different reservoirs inferred from $^{142}Nd/^{144}Nd$ is independent of the exact age of the shergottites. Thus, the conclusion that the nakhlites and shergottites were derived from different source regions and that, consequently, the SPB mantle was heterogeneous, seems firm.

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