Sm-Nd SYSTEMATICS AND INITIAL $^{87}Sr/^{86}Sr$ IN THE PIPLIA KALAN EUCRITE.

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We have determined Sm-Nd isochrons for the Piplia Kalan eucrite. In a separate abstract we report also on the Al-Mg and Mn-Cr systems, using thermal ionization mass spectrometry (TIMS). In a recent report, Srinivasan et al. [1] identified the presence in this eucrite of excess ^{26}Mg, correlated with Al/Mg. This was the first report of excess ^{26}Mg in a eucrite. Because of the importance of this report we investigated the Sm-Nd system, especially for the purpose of identifying the initial ^{146}Sm/^{144}Sm in this meteorite. Piplia Kalan, a recent fall in India [2], is a monomict eucrite and consists of lithic clasts in a brecciated matrix. The lithic clasts show a large range in grain size and texture [2,3] but have similar bulk compositions, consistent with a single melt event. Major phases are pyroxene (55-65%) and plagioclase (25-45%), with chromite, ilmenite, and troilite as minor phases. While phosphates have not been identified petrographically, the Sm-Nd behavior during leaching (see below) clearly indicates that phosphates, or equally easily soluble phases, play a major role in the distribution of the rare earths (REE). This is similar to the earlier observations made from for the work on mesosiderites and the Ibitira eucrite [4-6]. Piplia Kalan shows evidence of shock and brecciation, with extensive microscopic intergrowths in plagioclase, making mineral separation harder. We chose a coarse grained lithology (~200 µm). For materials crushed and sieved in the range 60-125 µm, we obtained mineral separates using density separation, followed by magnetic separation. We measured a pyroxene (PX) separate without leaching. Based on the observation of only a small difference of Sm/Nd between the plagioclase and the unleached PX separates, we proceeded to apply a weak leach (2N HCl, cold, 10 minutes) to a second aliquot of the PX separate. We determined that large fractions of Sm and Nd (69% of Sm and 80% of Nd) were present in the PX leach. The Sm/Nd in the leach is relatively low, which is consistent with provenance from a residual phase with high REE concentrations, such as phosphate. The enhanced presence of Nd and the lower Sm/Nd in the leach result in a significantly higher Sm/Nd value in the PX residue. As a check that differential leaching did not disturb the Sm-Nd systematics in the PX residue, we analyzed also the Sm-Nd in the PX leach. The data are shown in Table 1 and in Fig. 1-2. We obtain a large range in measured ^{143}Nd/^{144}Nd from -20.5 εu for the PL to +84.5 εu for the PX. The data define an isochron which yields a ^{147}Sm-^{143}Nd age of 4.57 ± 0.10 Ga and an initial $(^{143}Nd/^{144}Nd)_{CHUR}$ of −0.71 ± 3.6 εu. The data show small deviations from a single isochron, which are reflected in the relatively larger uncertainty in the age. The ^{142}Nd/^{144}Nd data are shown in Fig. 2. The data show a significant excess in ^{142}Nd/^{144}Nd in the PX and a small but significant deficit in ^{142}Nd/^{144}Nd in the plagioclase. We included in Table 1 the measurement of ^{142}Nd/^{144}Nd in a 2nd PX sample, which was greatly underspiked. The resultant uncertainties in Sm and Nd concentrations do not permit plotting this point, but the ^{142}Nd/^{144}Nd clearly shows the excess ^{142}Nd in the PX. These data permit the determination of the initial ^{146}Sm/^{144}Sm at the time of crystallization as equal to $(4.4 \pm 1.2) \times 10^{-3}$. We note that, given the relatively old ^{147}Sm-^{143}Nd age for this meteorite, the initial ^{146}Sm/^{144}Sm is lower than expected by about a factor of 2, corresponding to an interval equal to the half-life of ^{146}Sm (10^2 Ma). This is shown in Fig. 3, where we have summarized data from this laboratory on eucrites, clasts from mesosiderites, and a silicate inclusion from the Caddo iron meteorite [4-6]. The relatively low initial ^{146}Sm/^{144}Sm in Piplia Kalan can not be considered consistent with the presence of live ^{26}Al. The possibility that the ^{146}Sm-^{142}Nd system is more susceptible to a partial resetting with only small effects being resolvable for the ^{147}Sm-^{143}Nd system has been discussed by [4,6]. We note that Kumar et al. (1998) [7] have determined the ^{147}Sm-^{143}Nd age of Piplia Kalan as 4.570 ± 0.023 Ga and the initial $(^{143}Nd/^{144}Nd)_{CHUR}$ of -1.3 ± 0.7 εu. The results from both studies are consistent. ^{142}Ce mass interference prevented the determination of ^{142}Nd/^{144}Nd in the work by Kumar et al. [7]. We have also determined the ^{87}Sr/^{86}Sr in plagioclase from Piplia Kalan. We measured $^{87}Sr/^{86}Sr = 0.69923 \pm 0.00004$ and we calculate an initial $(^{87}Sr/^{86}Sr)_I = 0.69900 \pm 0.00004$, which is insensitive to the age of Piplia Kalan and indistinguishable from BABI [8]. This result is identical to the value determined by [7].

At this time we consider that the various dating schemes applied to Piplia Kalan indicate both preserved vestiges of early formation as well as evidence of disturbed systematics which do not permit the conclusive comparison of time scales for different parent-daughter systems, with a range in half-lives as well as potentially different responses to shock and metamorphism. Given the brecciated nature of Piplia Kalan, it is possible that further detailed study will help elucidate some of the apparent inconsistencies.

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References: [1] Srinivasan G., Goswami J.N. & Bhandari N. (1998) *Meteoritics Planet. Sci.* **33** A148. [2] Vaya V.K. et al. (1996) *Current Science* **71** 254. [3] Shukla A. et al. (1997) *Meteoritics Planetary Sci.* **32** 611. [4] Stewart B. W., Papanastassiou D.A. & Wasserburg G.J. (1994) *Geochim. Cosmochim. Acta* **58** 3487. [5] Stewart B.W., Papanastassiou D.A. & Wasserburg G.J. (1996) *Earth Planet. Sci. Lett.* **143** 1. [6] Prinzhofer A., Papanastassiou D.A. & Wasserburg G.J. (1992) *Geochim. Cosmochim. Acta* **56** 797. [7] Kumar N., Gopalan K. and Bhandari N. (1998) submitted to *Geochim. Cosmochim. Acta*. [8] Papanastassiou D. A. & Wasserburg G.J. (1969) *Earth Planet Sci. Lett.* **5** 361.

Table 1. Piplia Kalan Sm-Nd Analytical Results.

Sample	Density	Nd (ppm)	Sm (ppm)	$^{147}Sm/^{144}Nd$	$\varepsilon^{142}Nd$	$\varepsilon^{143}Nd$
PL	2.7	2.3503	0.6322	0.1627±0.0009	-0.47±0.32	-20.5±0.41
PX	3.3	5.0856	1.7781	0.2121±0.0003	-0.35±0.31	7.2±0.33
PX-(R)	3.3	1.2858	0.7230	0.3404±0.0007	1.00±0.30	85.0±0.42
PX-(L)	3.3	5.1684	1.5810	0.1776±0.0016	0.00±0.39	-10.8±0.43
PX-(R) #2 *					1.34±0.40	84.5±0.30

Measured isotopic ratios relative to CHUR $\varepsilon_R = (R/R_{CHUR} - 1)x10^4$ where $^{142}Nd/^{144}Nd_{CHUR}$ =1.138305 and $^{143}Nd/^{144}Nd_{CHUR}$ = 0.511847. The uncertainties in the measurement are $2\sigma_m$. *Concentrations of Sm and Nd were not accurately determined due to underspiking; these data were not used for the isochron determinations.