Re-Os SYSTEMATICS IN PALLASITES AND MESOSIDERITES. J.J. Shen[1,2], D.A. Papanastassiou[1], & G.J. Wasserburg[1]
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We have pursued our work on pallasites and mesosiderites [1] in order to attempt to correlate the Re-Os and Sm-Nd systematics in mesosiderites and to provide critical data for pallasites which have not been dated reliably by long lived parent-daughter systems. Whole-rock Re-Os data on iron meteorites from groups IAB, IIAB, IIIAB, IVA, and IVB define a precise isochron [2]. The data from all groups are consistent with the well-defined isochron for Group IIAB, with a slope of 0.07848 ± 0.0018 [corresponding to an age of 4.61 ± 0.01 AE, for (^{187}Re = 1.64×10^{-11} a^{-1})] and initial ^{187}Os/^{188}Os = 0.09563 ± 0.00011 (all uncertainties are 2σ). The data on group IVA suggest the possibility of an older age (by 40-50 Ma), which is qualitatively consistent with the relative chronology based on ^{107}Pd-^{107}Ag[3]. The Re-Os data are also in agreement with Morgan et al. [4] and Smoliar et al. [5], except for the data on IVAs which appear to be younger in the latter work. In order to check further the reliability of the techniques we have developed, we obtained repeat analyses of the iron meteorite Needles (group IID). The results show a tight range in Os and in Re concentrations of 5‰ and 7‰, respectively. The deviations of the Needles data from the best fit line for the IIABs are from -3.9 to +4.9‰ (in ^{187}Re/^{188}Os), with three of the points within 1.3‰ of each other. Therefore, the data for Needles show good reproducibility and fall precisely on the IIAB isochron.

We report Re-Os on metal extracted from pallasites and mesosiderites and on the Bencubbin breccia. The pallasites analyzed include Eagle Station (from the ES Group) and five members of the Main Group (MG) pallasites[6]. The data are listed in the Table. The low Re contents of Otinapa and Newport are subject to significant contamination due to use of a new batch of CrO_3. These analyses will be repeated with improved Re blanks. While the data on Otinapa and Newport are consistent with the other pallasite data, within the larger uncertainties, they are not used in the discussion. The data are shown in a Re-Os evolution diagram in Fig. 1 and in Fig. 2, as deviations from the reference IIAB isochron, in permil. For this graph, we assigned the deviations of the data from the best fit isochron to the uncertainty in ^{187}Re/^{188}Os. The data on the pallasites yield a significant range in Re/Os which permits the determination of a whole-rock isochron for pallasite metal. Re-Os data on pallasites yield a slope and age which are identical to those for the IIAB isochron. The initial ^{187}Os/^{188}Os for the pallasites is within error of that for the IIAB irons and about 2‰ higher. We note that the Re-Os systematics for pallasite metal are identical to the systematics for iron meteorites from all measured groups. Therefore, the uniform Re-Os systematics in pallasites and iron meteorites neither support nor contradict the association, based on siderophile element abundances, of MG pallasite metal with the IIIAB irons [6]. Similarly, the Re-Os systematics do not permit the identification of distinct evolution between the MG and ES pallasite groups.

The four mesosiderites show a very limited range in Re-Os and do not permit an independent whole-rock isochron determination. The mesosiderite data cluster in a tight area very close to the IIAB isochron. The data are slightly displaced from the general whole-rock isochron for irons and pallasites and yield model ages of 4.63-4.64 AE. These are suggestive of open system behavior for Re-Os at a time different than the time defined by the whole rock isochron of irons and pallasite metal. This is, in principle, consistent with the more extensive history of about 100 my indicated by Sm-Nd internal isochrons on mesosiderite silicate clasts [cf 7]. The mechanism of Re-Os fractionation is not evident. It is possible that a small transport of Re to the silicates have occurred, or some minor fractionation associated with localized metal melting. For Bencubbin, a metal-silicate breccia, the Re-Os in the metal shows larger deviations from the iron meteorite isochron. This may reflect the chondritic composition of the silicates, carbon content, low metal content, and melting during formation of the breccia, in the presence of sulfide [8, 9].

The apparently identical behavior of Re-Os for iron meteorites and pallasite metal must reflect the post-condensation incorporation of Re and PGEs in the metal and then fractionation through metal melting and fractional crystallization, which fractionated Re and Os on parent planets and which took place in a very narrow time interval (~10 my). We note that, based on chemical zoning in olivine, a very fast cooling rate (in the range 1100-600 ^{o}C) and a very shallow burial depth is deduced for pallasites[10]. All subsequent events did not produce substantial Re-Os fractionation, as they have not left an overprint on the Re-Os whole-rock systems. This is compatible with the interpretation of the Pd-Ag data [3]. Similarly, it is apparent that diffusion of Re-Os at the lower temperatures at which schreibersites and then the Widmanstaetten patterns developed is limited to a very local scale [11,12].

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Table 1. Os and Re Analytical Results: Mesosiderites and Pallasites

Sample[a]	Weight mg	Os ppm	Re ppb	$^{187}Re/^{188}Os$[b]	$^{187}Os/^{188}Os$[b]	$\delta(^{187}Re/^{188}Os)$[c] permil
Bencubbin	176	2.908	241.1	0.3992±4	0.12630±5	21.5
Bencubbin	209	2.960	240.3	0.3909±2	0.12615±7	5.2[f]
Mesosiderites						
Estherville	229	4.141	354.5	0.4123±2	0.12814±3	-4.5
Mt. Padbury	174	6.064	476.3	0.3795±3	0.12562±5	-7.3
Emery[e]	229	2.802	236.9	0.4071±1	0.12779±3	-6.4
Crab Orchard[e]	277	2.493	209.7	0.4052±3	0.12758±2	-4.9
Pallasites						
Eagle Station	109	15.21	1172.0	0.3708±1	0.12469±4	1.2
Thiel Mountains	537	0.167	18.33[d]	0.5289±11	0.13703±20	2.8
Marjalahti	184	2.743	195.6	0.3432±2	0.12254±4	1.0
Finmarken	248	3.437	228.7	0.3190±5	0.12053±2	5.5
Otinapa	658	0.2525	17.13[g]	0.327±8	0.12210±7	-31
Newport	447	0.1375	14.65[g]	0.541±13	0.13689±11	-23
Iron Meteorite						
Needles (IID)	239	4.838	435.6	0.4338±2	0.12981±2	-3.9
	240	4.861	438.6	0.4348±4	0.12963±5	3.6
	209	4.857	438.3	0.4345±2	0.12956±10	4.9
	176	4.837	438.8	0.4371±2	0.12978±4	4.5

[a] Sources of samples (USNMNH; Field Museum). [b]Uncertainties are 2σ. [c] Deviations from the best fit line for IIAB iron meteorites, assuming the deviations are dominated by uncertainties in $^{187}Re/^{188}Os$. [d] Blank correction for Re was applied (0.18%). [e] Metal mixed with massive silicate. [f] Sample overspiked by a factor of four. [g] Sample subject to large Re blank from "new" CrO_3 (4.5% for Otinapa and 5% for Newport).

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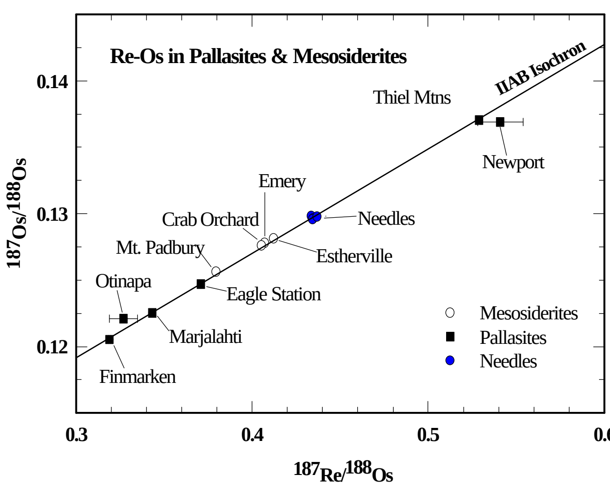

Figure 1. Re-Os evolution diagram.

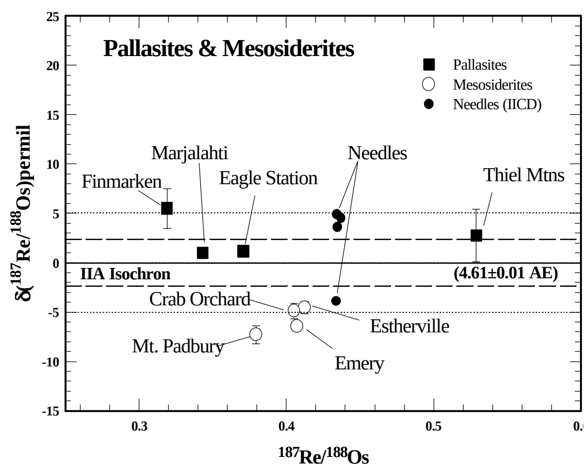

Figure 2. $\delta(^{187}Re/^{188}Os)$ vs $^{187}Re/^{188}Os$ diagram.