Comparison of highly siderophile element data in Earth's upper mantle derived by different analytical methods

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The relative "high" abundances of highly siderophile elements (HSE) and their approximately chondritic proportions in the Earth's undepleted primitive upper mantle (PUM) have been used to argue for the addition of a late chondritic veneer after core formation (e.g. Kimura et al. [1]). Many recent studies of primitive mantle samples have documented significant regional variations in absolute PGE abundances and inter-element ratios (Pattou et al. [2], Rehkämper et al. [3], Snow and Schmidt [4], Schmidt et al. [5], Lorand et al. [6], Snow et al. [7], Schmidt et al. [8], Becker et al. [9]). Such variations may have been caused by complex geochemical processes in the subcontinental lithosphere and probably in some cases by the analytical method [9] used for the determination of the HSE. Selected instrumental neutron activation data from our own studies ([6,7,10-12], Tab. 1) are compared with data obtained by other methods, e.g. isotope dilution, with Os and other HSE separated by solvent extraction and anion exchange chromatography [9].

In Fig. 1 the HSE data are plotted normalized to CI-abundances [13,14]. In a large number of fertile lherzolites from the studies by Pattou et al. [2], Lorand et al. [6], Snow et al. [7], and mantle-derived samples from Morgan et al. [15] and Meisel et al. [16] the abundance distribution of the HSE is remarkably uniform with slightly increasing abundances with decreasing refractory character of the elements, except the data by [9]. Abundances of HSE in PUM sampled by lherzolites from our studies are listed in Tab. 1. From a large number of mantle derived peridotites Morgan et al. [17] have found that Ir is normally distributed with a mean of 3.2±0.2 ng/g or (6.7±0.5) x 10^{-3} CI. The worldwide distribution of Ir agrees reasonably well with the mean Ir value of 2.80±0.34 ng/g Ir estimated by this work (Tab. 1). As can be seen in Fig. 1 the Re, Os, Ru, Pt and Pd data by [9] are slightly higher than previous estimates from different authors. The Ru/Ir as well as the Pd/Ir ratio of PUM obtained by Becker et al. [9] with a different method on different samples as used in our studies are remarkably consistent with our previous data [6,7,10-12]. In contrast, as can be seen in Tab. 1 the Os/Ir ratio from Becker et al [9] is about 14% higher and the Pt/Ir ratio is about 25% lower than our derived values for PUM. For Rh and Au no data are available by isotope dilution from Becker et al [9]. From our data I suggest that the material that enriched the Earth's upper mantle in HSE closely resemble enstatite or LL-chondrites [6,7,10-12]. Morgan et al. [17] assumed that the excact identity of the late veneer object(s) can be found only in the ancient lunar breccias created at that time. Becker et al. [9] assume from there new data that the HSE pattern of PUM best matches the HSE pattern of 3.9 Ga lunar impact melt breccias from the Serenitatis impact basin [18]. Future studies should convince us if higher contents found by isotope dilution [9] in comparison to radiochemical [15] as well as instrumental neutron activation methods are not an analytical artifact of the method used by these authors, e.g. incomplete sample-spike equilibration or incomplete digestion of refractory alloys.

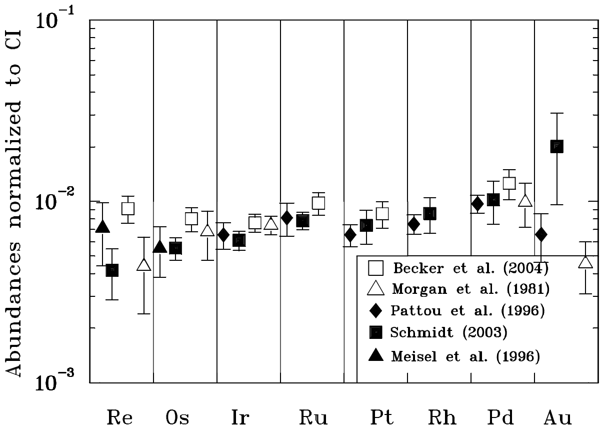

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TABLE 1. Comparison of highly siderophile element contents in the Earth's mantle.

	Re ng/g	Os ng/g	Ir ng/g	Ru ng/g	Rh ng/g	Pt ng/g	Pd ng/g	Au ng/g	Re/Ir	Os/Ir	Ru/Ir	Rh/Ir	Pt/Ir	Pd/Ir	Au/Ir
Becker et al. (2004)[1]															
Average (N=23)	0.35	3.9	3.5	7.0		8.5	7.0		0.100	1.12	2.02		2.19	2.01	
1σ	0.06	0.6	0.4	1.0		1.4	1.3		0.002	0.09	0.13		0.23	0.28	
Schmidt (2003)[2]															
Average (N=13)[3]	0.16	2.69	2.80	5.60	1.20	7.33	5.68	3.06	0.06	0.96	2.01	0.43	2.74	2.03	1.12
1σ	0.05	0.38	0.34	0.61	0.27	1.55	1.52	1.60	0.02	0.07	0.12	0.09	0.54	0.47	0.64
in % from Becker et al. [9]	45.1	68.9	80.0	80.1		86.3	81.1		57.3	85.7	99.4		125.0	101.1	
CI-chondrite*	38.3	486	459	714	140	994	556	152	0.08	1.06	1.56	0.31	2.17	1.21	0.33

[1]Isotope dilution, with Os and other HSE separated by solvent extraction and anion exchange chromatography.

[2]Abundances determined by instrumental neutron activation analysis (INAA) with NiS fire-assay preconcentration.

[3]Except Pt with an average content derived on 9 samples from the Liguride Units.

*CI-chondrite data from Palme and Beer [13], Rh from Jochum [14].