The Difference between Sheared and Granular Peridotites

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Sheared peridotites are often considered to be derived by metasomatism of granular peridotites (Ehrenburg, 1979; Gurney and Harte, 1980; Smith et al., 1993). However the differences between these two suites are too profound for this hypothesis to be tenable.

Sheared peridotites have rare earth and high field strength element concentrations which are close to chondritic (Shimizu, 1975; BVSP, 1981; Shimizu and Allègre, 1978). Depletion of sheared peridotites is demonstrated by Re-Os ratios (Walker et al., 1989), and this depletion may also be responsible for the non-chondritic CaO/Al_2O_3 ratio of sheared peridotites. Addition of a majorite garnet component, as included in Monastery diamonds, to sheared peridotite produces chondritic CaO/Al_2O_3 ratios, but silica contents are below the 48-50% range of chondritic mantle (Taylor and McLennan, 1985; Anderson, 1983) (Table 1). This suggests that sheared peridotites formed from mantle which first lost silica to the core, then underwent majorite extraction. Majorite, rather than basalt, is extracted becauses partial melting extracts low-temperature melt from the basalt during subduction, and only the refractory majorite or eclogite residuum reaches the lower mantle.

	Average mantle	**Majorite extract**	**Primitive Mantle** Calculated	**Primitive Mantle** McD&S
SiO_2	44.30	42.08	44.01	45.00
TiO_2	0.09	0.99	0.21	0.20
Al_2O_3	2.36	17.74	4.36	4.45
Cr_2O_3	0.43	0.04	0.38	0.38
FeO	8.31	15.09	9.19	8.05
MnO	0.13	0.29	0.15	0.14
MgO	41.64	11.12	37.67	37.80
CaO	2.20	12.03	3.48	3.55
Na_2O	0.23	0.71	0.29	0.36
K2O	0.04		0.03	0.03
NiO	0.27		0.23	0.25
Total	100.00	100.10	100.01	100.21
CaO/Al_2O_3	0.93	0.68	0.80	0.80
SiO_2/MgO	1.06	3.78	1.17	1.19

Table 1. Composition of Primitive Mantle calculated by addition of 0.87 Average Mantle (Herzberg, 1993) and 0.13 Monastery Majorite sub-population (Moore et al., 1991; Hatton, 1993). Primitive Mantle of McDonough and Sun (1995) is presented for comparison.

Granular peridotites have heavy rare earth and titanium contents which are much lower than chondritic (Shimizu, 1975; BVSP, 1981; Shimizu and Allègre, 1978).

Only very severe depletion, in multiple depletion events which culminated in komatiite extraction, can account for this. A two-stage melting event, involving extraction of iron-rich basalt, followed by komatiite extraction is shown in Table 2. The source rock has high silica, and could have originated from chondritic mantle, possibly added to the earth by impact after earlier extraction of Si to the core (Herzberg, 1993).

	Kaapvaal Peridotite PHN4265	**Barberton komatiite** 49J	**49J Source** Calculated	**Iron-rich basalt** ACH7	**ACH7 Source** Calculated	**Primitive Mantle** ACH7 Source-Si	**Primitive Mantle** McD&S
SiO_2	48.13	46.01	47.80	52.66	48.80	45.00	45
TiO_2	0.01	0.2	0.04	0.64	0.16	0.17	0.2
Al_2O_3	1.56	3.54	1.87	12.66	4.08	4.38	4.45
Cr_2O_3	0.41	0.42	0.41	0	0.33	0.35	0.38
FeO	5.6	11.03	6.44	11.16	7.41	7.96	8.05
MnO	0.11	0.21	0.13	0.19	0.14	0.15	0.14
MgO	43.13	32.63	41.50	9.8	35.00	37.60	37.8
CaO	0.69	5.05	1.37	10.53	3.24	3.49	3.55
Na_2O	0.08	0.47	0.14	2.37	0.60	0.64	0.36
K2O	0.03	0.19	0.05	0	0.04	0.05	0.03
NiO	0.25	0.25	0.25	0	0.20	0.21	0.25
Total	100	100	100.00	100	100.00	100.00	100.21

Table 2. Source of Barberton komatiite calculated by adding 0.155 komatiite 49J (Sun and Nesbitt, 1978) and 0.845 Kaapvaal Peridotite PHN4265 (Boyd and Mertzman, 1987; Herzberg, 1993); source of iron-rich basalt calculated by adding 0.205 Iron-rich basalt ACH7 (BVSP, 1981) and 0.795 Barberton source; Primitive Mantle calculated by subtracting 14% of total Si from ACH7 source. Primitive Mantle of McDonough and Sun (1995) is presented for comparison.

Metasomatism of granular peridotite is required to increase light rare earth contents. This, together with the very high degrees of melting during their genesis, is attributed to a volatile-rich system. Granular peridotites formed relatively late, after addition of volatiles to the earth by CM meteorites (Hatton, 1997). The source of sheared peridotites developed earlier, soon after the moon-forming impact which devolatilised the earth.

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