OXIDES IN R CHONDRITES: IMPLICATIONS FOR THERMAL METAMORPHISM

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R chondrites are among the most oxidized chondrite groups, reflected by the rarity or absence of metallic Fe-Ni [1-5], high Ni contents in metal (mainly awaruite) [2-5], abundance of NiO-bearing olivine (Fa37-40) [5], presence of Fe^{3+}-bearing oxides, and in R6 LAP04840, major hornblende and accessory biotite [6]. We determined olivine compositional distributions (to ascertain petrologic type) and studied oxide phases in 12 R chondrites, including a newly discovered R4 clast in Bencubbin (adding to the diversity of chondritic clasts in this polymict breccia). Petrologic types were assigned to PRE95404, LAP02238, LAP03645, MET01149 and PRE95411; PRE95404 (R3.6) is among the least-equilibrated R chondrites.

We observed magnetite (mt), hercynite-rich chromite (hr-cm), magnetite-chromite solid solution (mt-cm), chromite (cm), and ilmenite (il). Literature data [1-5] indicate the presence of these same phases in other R chondrites. All oxides contain NiO (0.06-0.45 wt%). Compositional data (wt%) for mt-cm and hr-cm are given in the table; all Fe is expressed as FeO. PRE95404 also contains mt; PRE95411 and Y-980702 contain il. There is no correlation between petrologic type and oxide composition. Fe is the dominant +2 ion; except in hr-cm, the dominant +3 ion is Cr. In individual meteorites, the oxide compositions are equilibrated (relative standard deviation of Cr_2O_3 < 10%) except for mt-cm in MET 01149 (31-56 wt% Cr_2O_3) and mt-cm in PRE 95411 (32-51 wt% Cr_2O_3). Several oxide grains are zoned in Al and Ti, possibly due to partial equilibration with ilmenite.

		oxide	#	TiO_2	Al_2O_3	Cr_2O_3	FeO	MgO
R3.6	PRE 95404	mt-cm	15	6.5	4.8	42.7	41.7	1.1
R3.7	LAP 02238	mt-cm	8	5.3	5.3	37.4	47.1	1.2
		mt-cm	5	5.7	4.5	31.9	51.7	1.2
R3.7	LAP 02238	cm	3	4.6	6.8	46.5	39.4	1.1
R3.8	LAP 03645	mt-cm	21	5.6	4.6	36.0	49.1	1.1
		mt-cm	4	7.3	4.8	28.4	54.0	1.3
R3.8	MET 01149	mt-cm	12	4.9	5.1	44.5	39.3	1.2
R3.8	NWA 978	mt-cm	1	5.8	8.2	43.3	38.4	1.9
R3.8	PRE 95411	hr-cm	2	1.1	28.6	34.2	29.4	4.2
		cm	11	5.8	4.3	45.7	38.9	1.5
R4	Asuka 881988	mt-cm	29	2.0	2.0	11.5	75.2	1.6
R4	NWA 2198	cm	17	6.8	5.7	44.5	40.2	1.0
R4	Bencubbin clast	mt-cm	18	5.0	2.9	30.3	54.8	2.1
R6	LAP 04840	mt-cm	17	1.4	2.4	20.0	68.1	1.7
R5	NWA 830	cm	4	5.7	5.1	47.0	38.8	1.0
R6	Y-980702	mt-cm	10	7.2	4.4	47.5	37.0	3.5

Olivine-chromite geothermometry [7] indicates 550-690°C for R4-5 and 880ºC for R6. The isochemical bulk composition of R chondrites [5] suggests that the variations in oxide minerals reflect local (cm-scale) reactions at different temperatures between an oxidant (presumably water) and metal in the parent body.

References: [1] Rubin A. E. and Kallemeyn G. W. (1989) *GCA* **53**, 3035-3044. [2] Schulze H. et al. (1994) *Meteoritics* **29**, 275-286. [3] Rubin A. E. and Kallemeyn G. W. (1994) *Meteoritics* **29**, 255-264. [4] Bischoff A. et al. (1994) *Meteoritics* **29**, 264-274. [5] Kallemeyn G. W. et al. (1996) *GCA* **60**, 2243-2256. [6] McCanta M. C. et al. (2008) *GCA* **72**, 5757-5780. [7] Wlotzka (2005) *MPS* **40**, 1673-1702.