

PETROLOGY AND GEOCHEMISTRY OF THE NINGQIANG (CV3) CHONDRITE; Ch.Koeberl (1), Th.Ntaflos (2), G.Kurat (2), and C.F.Chai (3). (1) Institut für Geochemie, Universität Wien, A-1010 Vienna, Austria. (2) Naturhistorisches Museum, A-1014 Vienna, Austria. (3) Institute of High Energy Physics, Academia Sinica, Beijing, P.R.China.

The Ningqiang meteorite fell on June 25 1983 in the Shanxi province, is the first Chinese carbonaceous chondrite recovered and has previously been classified as a member of the CV3 group (1-3). We have started a geochemical and petrological study of this meteorite, a preliminary report of which is presented here.

Petrology: Ningqiang mainly consists of a variety of mm-sized olivine and olivine-pyroxene aggregates embedded in a fine-grained dark matrix. In our sample (2 g) we did not find a real (liquid droplet) chondrule nor a CAI. Common are amoeboid olivine objects and isolated olivine fragments. One coarse-grained orthite-pyroxene object was encountered. Opaques inside the aggregates and within the matrix comprise awaruite, pentlandite, pyrrhotite, magnetite and some unidentified complex oxides.

Compositions of the olivines are highly variable and range from Fo 99.7 to Fo 43.7 (Table 1). The most magnesian compositions are exclusively encountered in the cores of large olivines, either inside aggregates or isolated, similar to what has been observed in Allende (4). All olivines are rich in minor elements (Table 1, Fig.) with generally rather poor interelement correlations except for an anticorrelation between CaO and FeO and a rough positive correlation between CaO and Al₂O₃. However, the most magnesian olivines appear to consist of two populations with a similar CaO content (0.7 wt.-%) but different Al₂O₃ contents (0.26 vs. 0.40 wt.-%). This is similar to what has been observed in olivines from the Y82042 (C2) chondrite (5). Low Ca pyroxenes are abundantly present in some aggregates where they form coarse-grained rims. They show polysynthetical twinning and almost always poikilitically include olivines. These pyroxenes are generally poor in FeO and rich in minor elements (Table 2). Surprising, however, is the fact that all magnesian pyroxenes are richer in FeO than the most magnesian olivines. This in spite of comparable grain-sizes. They are, however, always much more magnesian than the coexisting (poikilitically enclosed) olivines which tend to be rich in FeO (Fo 92).

Geochemistry: INAA analysis of the bulk (Table 3) shows Ningqiang being compositionally very similar to Allende as was previously found by (1). The bulk composition of one isolated aggregate is similar for the lithophile elements but displays fractionated siderophile element contents with a pronounced Ni-Co-Fe fractionation and a positive Au anomaly.

Conclusions: Ningqiang is an oxidized CV3 chondrite consisting mainly of primitive mineral aggregates. Oxidation was severe, leaving no trace of metal from the previously reduced mineral association. However, reduced olivine compositions apparently survived a strong metasomatic event in the cores of large olivine crystals within and outside the primitive mineral aggregates. The different Al₂O₃ contents of these relics could

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indicate a succession of different olivine compositions condensing early from the vapor (5). Subsequent metasomatic exchange of Fe for Mg^{2+} affected all small olivine grains and major portions of the large ones. This exchange reaction with the vapor phase was accompanied by losses of CaO , TiO_2 , and Al_2O_3 and gain of Cr_2O_3 and MnO . There is also some indication for gain of oxidized Ni. The constituents of Ningqiang appear to not have encountered a severe heating event before agglomeration which is documented by the lack of molten aggregates (chondrules). In spite of the apparent underabundance of CAI's in Ningqiang, the bulk has its full share of refractory elements if compared to Allende. This could indicate a more even distribution of the refractory elements between the different object of Ningqiang as compared to Allende. The observation that all low-Ca pyroxenes are richer in FeO than the most magnesian olivines could indicate a primary feature: textural evidence clearly indicates that low Ca pyroxenes formed after olivine. And these pyroxenes forming fairly late could have a higher primary FeO content, similar to what has been observed for RP chondrules from Allende (7).

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References: (1) Chai Zh. et al. (1986) *Kexue Tongbao* 31, 111. (2) Chai Zh. et al. (1986) *ibid.* p 115. (3) Wang D. (1986) *Meteoritics* 21, in press. (4) Grossman L. and I.M. Steele (1976) *GCA* 40, 149. (5) Kurat G. et al., unpublished data. (6) Mason B. (1979) USGS Prof. Pap. 440-B-1. (7) Kurat G. et al. (1985) *LPS* XVI, 471.

Table 1: Selected analyses of olivines and pyroxenes from Ningqiang (CV3) (in weight-%).

	OLIVINES				PYROXENES				
	blue 1	2	red 3	4	dark 5	6	7	8	9
SiO ₂	43.6	42.4	43.0	43.2	35.2	43.0	59.7	58.3	59.9
TiO ₂	0.08	0.14	0.04	0.06	<0.02	<0.02	0.12	0.21	0.05
Al ₂ O ₃	0.40	0.25	0.07	0.13	0.03	0.05	0.86	1.21	0.41
Cr ₂ O ₃	0.09	0.11	0.06	0.20	0.20	0.11	0.51	0.41	0.82
FeO	0.35	0.32	1.15	1.21	45.6	2.30	0.87	1.02	1.58
MnO	<0.02	<0.02	0.03	0.11	0.42	0.11	0.06	0.05	0.21
NiO	<0.02	<0.02	0.03	<0.02	0.03	<0.02	0.04	0.02	0.05
MgO	53.7	56.0	56.2	56.7	19.9	54.8	37.8	38.3	36.8
CaO	0.66	0.57	0.33	0.20	0.24	0.14	0.41	0.47	0.38
Tot.	98.88	99.79	100.91	101.81	101.62	100.51	100.37	99.99	99.82
Fo	99.6	99.7	98.9	98.8	43.7	97.7			
En							98.0	97.7	96.9

1: object NQ2-A; isolated olivine (core)
2,3,4: object NQ1-O; coarse-grained aggregate
5,9: object NQ1-D; fine-grained aggregate
6: object NQ1-H; small isolated olivine surrounded by opx No 7
8: object NQ1-K; coexisting with dark olivine

Table 2: Preliminary results of INAA of Ningqiang bulk and aggregate NING-E; Allende data from (6) (in ppm, except for Fe).

Sample	Bulk	NING-E	Allende
M	mg	mg	
Na	4310	3300	3400
Cl	250	<300	220
Sc	9.60	15.0	12.7
Cr	2940	5310	3600
Mn	1610	1040	1500
Fe(%)	23.3	15.6	23.6
Co	650	882	610
Ni	16900	29800	14200
As	1.2	2.6	3
La	0.39	0.60	0.44
Sm	0.232	0.35	0.29
Yb	0.39	0.49	0.32
Au	0.216	0.46	0.16

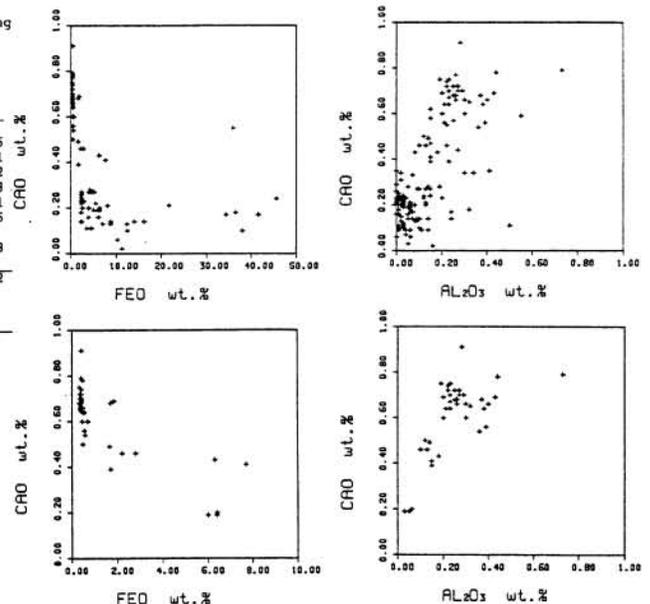


Fig.: Olivine compositions in Ningqiang. upper part: all olivines. Lower part: one single isolated olivine.