FAYALITIC RIMS AND HALOS IN FORSTERITES IN ALLENDE: NEW EVIDENCE AGAINST A METAMORPHIC ORIGIN

S. Weinbruch[1+2], H. Palme[2], W.F. Müller[3] and A. El Goresy[1]

[1] Max-Planck-Institut f. Kernphysik, P.O. Box 103980, D-6900 Heidelberg, Frg
[2] Max-Planck-Institut f. Chemie, Saarstr.23, D-6500 Mainz, Frg
[3] Inst. f. Mineralogie, TH Darmstadt, Schnittspahn-Str. 9, D-6100 Darmstadt, Frg

Fayalitic rims and veins in forsterites in type 2 and 3 carbonaceous chondrites were studied in detail by (1) and (2). Both groups reported enrichments of Cr, Al, Ti and V at the boundary between forsterite and fayalite. Fayalitic halos around FeNi-metal in forsterite were observed by (2). The origin of these iron-rich olivines is discussed controversly. A metamorphic reaction in the parent body (ies) is proposed by (3) and (4). Petrologic evidence against a metamorphic origin is presented by (1) and (2). Peck & Wood (1) propose a two stage model: diffusive exchange with nebular vapors followed by condensation. Hua et al. (2) conclude that the rims and veins are condensation products and that the fayalitic halos around FeNi-metal were formed at the same stage by oxidation of Fe. In this abstract we present new evidence against a metamorphic origin. The investigations were carried out using SEM and quantitative wavelength-dispersive analysis.

a) MnO/FeO-correlation:

We find positive MnO/FeO-correlations for most concentrations profiles across the fayalitic rims to the forsteritic cores. The MnO/FeO-ratios vary slightly in different profiles (Fig. 1). The measured MnO-contents for forsterites fall into the same range as reported by (5) for Allende. The MnO-content increases from 0.01-0.08 wt. % in forsterite (1.8-4.0 wt. % FeO) to 0.2-0.3 wt. % in the most iron-rich zones (30-36 wt. % FeO) of the rims.

In contrast MnO-contents in fayalitic halos are always low. Here, the MnO-contents are not correlated with the FeO-concentrations of the olivines (Fig. 1).

The correlation between MnO and FeO in the rims indicates that these two elements originated either from the same source, or were introduced by the same process. Consequently, matrix metal is excluded as a possible source for the fayalitic rims since this metal does not contain any Mn. If oxidation of matrix metal was responsible for the FeO in the fayalitic rims, then the MnO-contents in the rims should be as low as in the halos.

b) Chromites:

In the porous fayalitic rims we found idiomorphic chromites (Table 1):

- in the pores between fayalites (up to 25 microns diameter)
- as inclusions in fayalite (up to 4 microns diameter).

Table 1: Representative composition of chromite in fayalitic rims.

TiO_2	V_2O_3	CaO	MnO	FeO	NiO	Cr_2O_3	SiO_2	Al_2O_3	MgO	total
0.63	0.59	0.08	0.29	30.95	0.05	51.94	0.24	8.85	3.16	96.78 +

+ The low totals result from the bad conductivity of the porous rims. No other element with Z > 12 was detected.

At the boundary between forsterite and fayalite we found enrichments of Cr, Al, Ti and V as described by (1) and (2). Cr- and Al-concentrations exceed in some cases the amounts that can be dissolved in olivine. BSE imaging with SEM shows single grains indicating the existence of distinct phases (possibly chromites). TEM studies will be carried out to solve this problem.
The existence of idiomorphic chromites as inclusions in fayalite and in pores between fayalites cannot be explained by a metamorphic reaction. Thermodynamic calculations indicate that with increasing oxygen fugacity the condensation temperature of chromite increases drasticly. The halos around FeNi-metal indicate increasing oxygen fugacities for the forsterites. The same event may have led to the condensation of chromite and fayalite (6).

Ref.:
(1) Peck J. & Wood J.A. (1987), GCA, 1503. (2) Hua X. et al. (1988, in press),GCA. (3) Housley R.M. & Cirlin E.H. (1983), Chondrules and their origins, 145. (4) Housley R.M. (1986), Lunar Planet. Sci. XVII , 364. (5) Steele I.M. (1986), GCA, 1379. (6) Palme H. & Fegley B. (1987), Lunar Planet. Sci. XVIII, 754.

Fig. 1