THERMODYNAMIC MODELLING OF THE ORIGIN OF THE DIVNOE ACHONDRITE, M.I. Petaev and A.A. Ariskin, Vernadsky Inst. Geochem. Analyt. Chem., Russian Acad. Sci., Moscow, Russia.

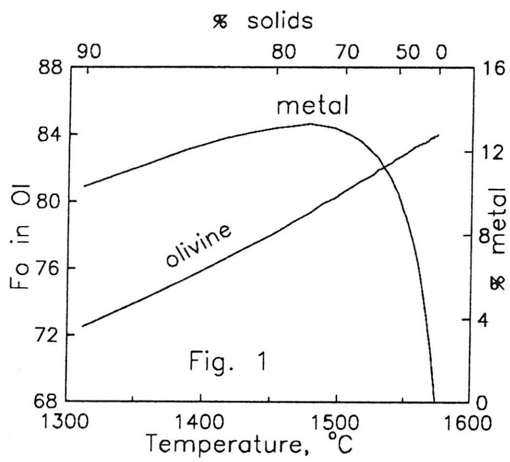
Chemical and petrologic properties of the Divnoe achondrite [1-3] suggest that the fractionated nature of the meteorite resulted from extraction of a partial melt from chondritic source material; Divnoe represents residual material together with a few solids crystallized from remaining partial melt [4]. The present abstract reports the results of thermodynamic modelling studies of equilibrium melting and subsequent crystallization of the Divnoe partial melt.

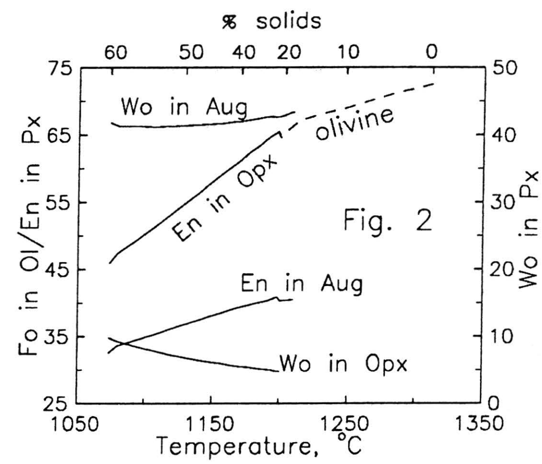
To model phase relations we used a new version of the LUNAMAG code [5,6], which calculates equilibrium phase assemblages in closed systems as a function of temperature, pressure, bulk composition, and oxygen fugacity. The phases can include a silicate melt and, in the appropriate range of f_{O2}, Fe metal. The system composition assumed was that of Divnoe [1] (excluding FeS, Cr_2O_3, H_2O, Ni, Co, Cu, and C). For computation of equilibrium phase relations in the system inputs were f_{O2} and the degree of melting, which defines the temperature at which the assemblage is assumed to equilibrate. Three parameters were chosen to constrain the conditions of partial melting: (1) the mean Fa content of Divnoe olivine (26.2 mol %); (2) the modal (pure Fe) metal content of the meteorite, 10.3 wt.% [1]; and (3) a temperature of 1293±22°C, derived from the Mg-Fe partitioning between olivine and chromite [4]. Working from these constraints we found (Fig.1) that at $\log(f_{O2})$ = IW - 1.8 and t = 1311°C the equilibrium assemblage consists of 79 wt.% Ol (Fa 26.2), 10.3% Fe metal, and 10.6% of melt containing (wt.%): SiO_2 - 58.96, TiO_2 - 0.27, Al_2O_3 - 3.93, FeO - 16.30, MnO - 0.27, MgO - 8.32, CaO - 9.59, Na_2O - 1.38, K_2O - 0.10, and P_2O_5 - 0.89.

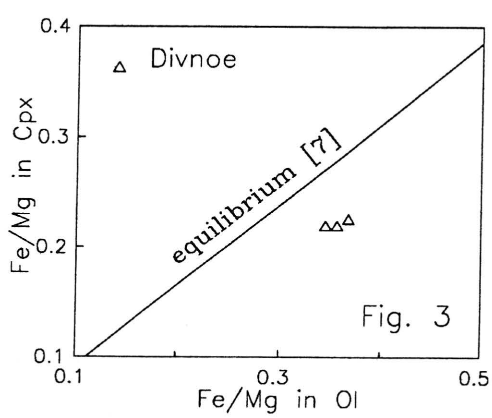
Further evolution of the melt was treated ignoring interaction with the residue. At $\log(f_{O2})$ = IW - 1.8 cooling of the melt results in the crystallization of olivine and free metal; the latter is stable over the entire temperature range shown in Fig. 2. After 17% of solids have crystallized augite appears (Fig.2), and soon thereafter melt begins to react with the olivine to form OPX. Plagioclase appears only after 60% of solids have crystallized. At $\log(f_{O2})$ = IW - 1.0 the sequence of crystallization is similar, but metal is absent and silicates are more ferrous.

The computed crystallization sequence agrees with petrographic observations in Divnoe, except pyroxenes in the former are enriched in Fs (4 - 5 mol.%; Fig.2) compared to the pyroxenes in Divnoe [3]. The Mg number of the silicates can be changed by assuming lower f_{O2} or reaction between the partial melt and residual olivine. CPX and olivine in Divnoe are not in equilibrium (Fig. 3), which implies either reequilibration of olivine with the melt or a cumulate origin for the CPX. Petrographic observations suggest also that the plagioclase and OPX crystallized simultaneously, while the model calculations predict earlier crystallization of OPX than plagioclase. This discrepancy may result from a higher Al_2O_3 activity in the melt which crystallized the Divnoe minerals than in the computed melt phase. If a subchondritic composition is assumed for the source region of Divnoe, partial melting would produce a liquid richer in Al and Na than the model melt and a residue similar in composition to the olivine + metal assemblage in Divnoe. Such an enrichment of the liquid in Na and Al might enlarge the plagioclase stability field and explain the ~andesine composition of the Divnoe plagioclase in spite of the fact that the meteorite is depleted in Na and Al.

REFERENCES: [1] Petaev *et al.* (1992), this volume. [2] Petaev *et al.* (1990) *LPSC XXI*, 948. [3] Zaslavskaya *et al.* (1990) *LPSC XXI*, 1371. [4] Petaev *et al.* (1990) *LPSC XXI*, 946. [5] Ariskin *et al.* (1990) *Geokhimiya*, No. 10, 1416 (in Rus.). [6] Ariskin *et al.* (1992), this volume. [7] Barmina *et al.* (1988) *Geokhimiya*, No. 8, 1108 (in Rus.).







Figures 1-3. Computed relationships between mineral compositions, metal abundance, and temperature.