REDOX FRACTIONATION AMONG CHONDRITES: MÖSSBAUER STUDY.

Malysheva T.V.

V.I.Vernadsky institute of Geochemistry and Analytical Chemistry, Russian Academy of Sciences, Moscow, Russia

Every model of the origin of chondrites must explain how the various oxidation states arose. To solve this problem it is necessary to determine the exactly correlation between ferruginous phases in the first place. The multivalent element Fe is an indicator of the oxidation states of matter. Mössbauer spectroscopy on the nucleus of $^{57}$Fe gives the possibility to identify the fine-grained matter (e.g. the matrix of unequilibrated chondrites).

On the bases of Mössbauer investigations a diagram of the iron distribution among mineral phases in unequilibrated chondrites was obtained (Fig.1). We see that the oxidation state of iron alone does not allow to distinguish C3 and ordinary chondrites. In one time the Prior's classification of ordinary chondrites was based on the iron quantity in pyroxenes. By means of Mössbauer spectroscopy it was determined that in ordinary chondrites some iron enters pyroxene but in CO3 and CV3 chondrites pyroxene are practical iron-free (+2 rel%).

The question is one of what processes favour to enter the iron into pyroxenes. To elucidate this circumstance termal treatment of carbonaceous chondrites was carried out. The heating of CM2 chondrites Murchison and Murray was conducted at 250-1000°C in various conditions and the results were investigated by means of Mössbauer spectroscopy. We undertake to compare these results, Chondrite Murray was heated in helium flow during 40 min. (Malysheva et al., I977), and chondrite Murchison - in $10^{-5}$ atm H$_2$ during 1 wk (Morris et al., I994). Nevertheless, the maximum on the curve of Fe$^{3+}$ formation (Fig.2) is the same (400-500°C). The discrepancy at 600-700°C is caused with incomplete decomposition and reduction of Fe$^{3+}$ in phyllosilicate during 40 min. heating. We doubt, that Fe$^{2+}$ doublet (2.26-2.40 mm/s) may be assignment to pyroxene (Morris et al., I994). It is because the main pyroxene doublet is 2.05-2.10 mm/s and does not alter by heating (Dovykin et al., I975; I977). Rather this doublet defines intermediate phases.

Above date suggest that dehydration occurs very rapiely and
REDOX FRACTIONATION AMONG CHONDrites. Malysheva T. V.

independently from external conditions of heating. Above 700°C dehydration ceases. Reaction from hydrous phase passes to solid one and slows down. The oxidizing conditions change to reducing ones. The main Fe-bearing phase becomes olivine, and above 1000°C - also FeO. But iron does not enter pyroxene because of the next kinetic limitations: 1) a slow Fe-Mg exchange in pyroxene as compared with olivine; 2) high rate of iron reduction. At the end-point of the reduction process there exists an assembly of minerals resembling those in enstatite chondrites. In the intermediate phases the iron distribution is close to its distribution in C3 chondrites: for CO3 in the open system, and for CV3 in the closed system. In order to receive an iron phases analogous to those in ordinary chondrites: Fe(01), Fe(Px), FeS and FeO, it is necessary to change reduction conditions into oxidation ones (Malysheva, 1994).


Fig.1. The distribution of iron among mineral phases in unequilibrated chondrites: X-Fe3+; O-Fe2+; □-FeS; △-FeO.
Fig.2. Fe3+ vs heating temperature: ■ chondrite Murchison; ○ - chondrite Murray.