CARBONATE COMPOSITION AND STABILITY IN THE MARTIAN MANTLE: PRELIMINARY RESULTS; M. I. Odezynskyj, J. R. Holloway, Depts. of Chemistry and Geology, Arizona State Univ., Tempe, AZ, 85287

Initial results from experimental studies of carbonate equilibria in a model Martian mantle peridotite are presented. While it is probable that the Martian mantle is enriched in both volatiles and iron relative to the Earth (Dreibus and Wänke, 1987), little work has been done on the nature of the carbonate phase and on the affect of carbonate and high iron content on melting reactions and on the composition of primary melts. The experiments done to date allow an estimate of the iron-magnesium partitioning between carbonate and olivine.

Five experiments have been run. The starting materials have been summarized in Table 1; in all cases, basalt was included as a flux. For runs one to three, all materials were ground together to 200 mesh size; for runs four and five, 40 mesh dolomite was added to the mixture after grinding. Sample, graphite inner capsule and platinum capsule were dried before welding. In all runs, the components were mixed in equal weight percentages, except the second where a double amount of dolomite was used. Run conditions for all experiments were 25 kbar, 1175°C and 24 hrs, using a piston-cylinder apparatus.

Table 1

run #	starting assembly
1	dolomite (dolo)[1], olivine (ol)[2], diopside (di)[2]
2	dolo[1], ol[2], di[2]
3	dolo[1], ol[2], di[2], enstatite (en)[3]
4	dolo[1], ol[4], clinopyroxene (cpx)[4], orthopyroxene (opx)[4]
5	dolo[1], ol[4], cpx[4], opx[4]

[1] - end-member dolomite
[2] - from San Carlos, Arizona peridotite nodules
[3] - from Bamble, Norway
[4] - synthesized from oxides to have Mg/Mg + Fe=75.

The mineral assemblage includes all members of the GEDOD oxygen fugacity buffer (Eggler and Baker, 1982):

$$2\ En + 0.5\ Dolo = Ol + 0.5\ Di + Graphite + O_2.$$

The fugacity during an experiment was calculated according to:

$$f_{O_2(experimental)} = \frac{a_{Fo}^{Ol}\left[a_{Di}^{Cpx}\right]^{1/2} a_C}{\left[a_{En}^{Opx}\right]^2\left[a_{Dolo}^{Carbonate}\right]^{1/2}} \bullet f_{O_2(E,B)}$$

where $fo_2^{(E,B)}$ was determined as in Eggler and Baker (1982), activities of silicates were calculated following Nicholls (1977), and of carbonate by:

$$a_{Dolomite}^{Carbonate} = \chi_{Ca}^{Ca\text{-}site} \bullet \chi_{Mg}^{Mg\text{-}site}.$$

Log fo_2 calculated according to Eggler and Baker for the pure magnesium end-member reaction was -7.7; calculated experimental log fo_2 (for the fifth run)

was -7.4 (0.9 log units below NiNO at run conditions). Log fo_2 determined from iron content of a platinum wire included in the sample and coexisting with olivine and orthopyroxene, was found to be -8.3.

Polished sections of each run were analyzed by electron microprobe; CO_2 in the carbonate phase was determined by difference. The run products include carbonate, olivine, clino- and orthopyroxene, garnet and graphite in most experiments although carbonate and orthopyroxene were absent in the first run and orthopyroxene was absent in the second. Samples three and five also contain quench crystals. Averaged analyses of fifth run carbonate are given in Table 2. Figure 1 shows the change in chemistry of the carbonate phase from the starting material to the final product.

Figure 1
Compositional Change in Carbonate

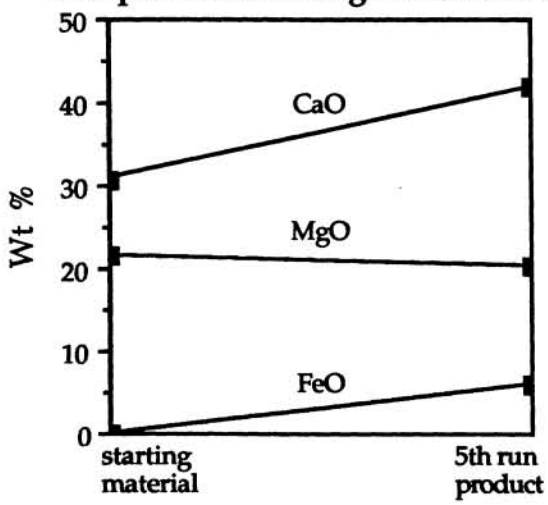

Table 2

Wt % Oxide		Atom. Prop. (per 6 Oxygen)	
CaO	41.95	Ca	1.5020
MgO	10.33	Mg	0.5144
FeO	5.81	Fe	0.6124
SiO_2	0.02	Si	0.0006
Al_2O_3	0.02	Al	0.0007
Na_2O	0.02	Na	0.0013
MnO	0.01	Mn	0.0003
CO_2(diff)	41.84	C	1.9088

Probe analyses demonstrate that the samples did not reach equilibrium between the pyroxenes and garnet, but it appears that the carbonate and olivine have reached Fe/Mg exchange equilibrium. Thus, olivine and the carbonate were used to establish Fe-Mg partitioning. $K_D = (Fe/Mg)_{ol} / (Fe/Mg)_{carb}$, was 1.1 (on average) for the second and fifth runs. In run four, there was iron loss to the platinum capsule resulting in an average $K_D = 2.1$. However, when the addition of enstatite to the third run assembly lowered the melting temperature, the iron partitioned into the carbonate phase and average $K_D = 0.68$.

The results to date demonstrate that carbonate stability is not appreciably affected by addition of iron to the simple system studied by Eggler (1974), and that the partitioning of iron and magnesium between carbonate and olivine is close to unity. These experiments have also provided a lower temperature limit for carbonate stability. Future work will be at higher temperatures in order to constrain the carbonate stability field and in order to speed up reactions among the silicate phases.

References:
Dreibus, G., Wänke, H., (1987) Icarus, 71, 225-240.
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