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The solubility of CO_2 was measured as a function of pressure at liquidus temperatures in complex kimberlitic, olivine melilititic and carbonatitic compositions. The chosen compositions were characterized by (in wt.-%) 35.9% SiO₂, 35% MgO, 8.7% CaO in the kimberlitic composition and ranged between 39 to 5% SiO₂, 13 to 28% CaO at app. 16% MgO in olivine melilitic and carbonatitic compositions. CO₂ solubility in kimberlite increases from 5.7 wt.-% at 20 kb to 9.8 wt.-% at 30 kb and 11.9 wt.-% at 40 kb. There seems to be no increase from 40 to 50 kb. The solubility of CO₂ at 20 kb is lower in kimberlite than in the Ca-rich olivine melilitite of similar SiO₂ content, at 30 kb it is however very similar. This is probably due to preferred complexing of a carbonate molecule with Ca at lower pressures while at higher pressures Mg is equally well suited. CO₂ solubility increases at 30 kb from 9 wt.-% for the olivine melilitite composition to 37 wt.-% for the carbonatitic composition and is linearily dependent on the CaO content of the melt. An increase from 10 to 30 kb raises the CO₂ solubility by 6 wt.-%, independent of composition.

The CO_2 -saturated liquidus temperatures for the kimberlite composition chosen range from 1460°C at 20 kb to 1690°C at 50 kb with olivine as the liquidus phase from 20 - 40 kb and olivine and orthopyroxene at 50 kb. It has been shown (Brey, 1976; Eggler and Wendlandt, 1977) that in systems with both CO_2 and H_2O garnet, magnesite and possibly clinopyroxene come close to the liquidus of kimberlitic compositions in addition to olivine and orthopyroxene. This may also be true for pure CO_2 systems at higher pressures. Thus kimberlites may indeed be partial melting products of a peridotitic mantle (see also Wyllie, 1980).

In the series of compositions from olivine melilitite to carbonatite the liquidus phases change at 30 kb from garnet + clinopyroxene to clinopyroxene only, then to olivine + clinopyroxene and finally to periclase for the carbonatitic composition. The field of periclase expands dramatically at lower pressures to SiO_2 -richer compositions. Periclase is the liquidus phase at 5 kb for a composition with 23 wt.-% SiO_2. Carbonatitic melts generated at depth in a peridotitic mantle with CO_2 as the only volatile species will, on ascent, immediately crystallize periclase, become SiO_2 -rich by fractional crystallization and cannot reach the earth's surface. This is only possible in the additional presence of H₂O since water expands the stability of silicates towards carbonatitic compositions.

REFERENCES

BREY, G.P. 1976. Ph.D. Thesis, Australian National University, Canberra, unpub. EGGLER, D.H. and WENDLANDT, R.F. 1977. Extended Abstracts, Second International Kimberlite Conference.

WYLLIE, P.J. 1980. J. Geophys. Res. 85, B12, 6902-6910.