PETROGENETIC CARBONATITE – MELILITITE RELATIONSHIPS IN THE KAISERSTUHL COMPLEX, UPPER RHINEGRABEN.

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In the alkaline rock/carbonatite complex of the Kaiserstuhl, Rhinegraben, the petrogenetic link between calciocarbonatites and silicate melts is represented by highly evolved ultrabasic melilitite-nephelinites. These compositions are traditionally termed *bergalites* (Soellner, 1913). Bergalites are calcite-bearing hauyne-nepheline-melilite-perovskite-apatite-magnetite rocks with SiO_2 contents of 31-37% (Table 1). In several petrological and geochemical aspects bergalites are similar to *turjaites* and *okaites* both being closely associated with carbonatites.

Bergalites occur as dyke rocks in the final stage of magmatic evolution, together with late alvikitic carbonatite dykes (lehnert, 1988). Often both rock types occur together in form of double dyke intrusions.

Sr-, Nd-, and Pb-isotopic evidence groups bergalites of the Kaiserstuhl closely together with carbonatites, and with the olivine nephelinitic and olivine melilititic primary magmas of the Rhinegraben area (Schleicher et al.1990). These three rock types form a petrogenetically coherent association.

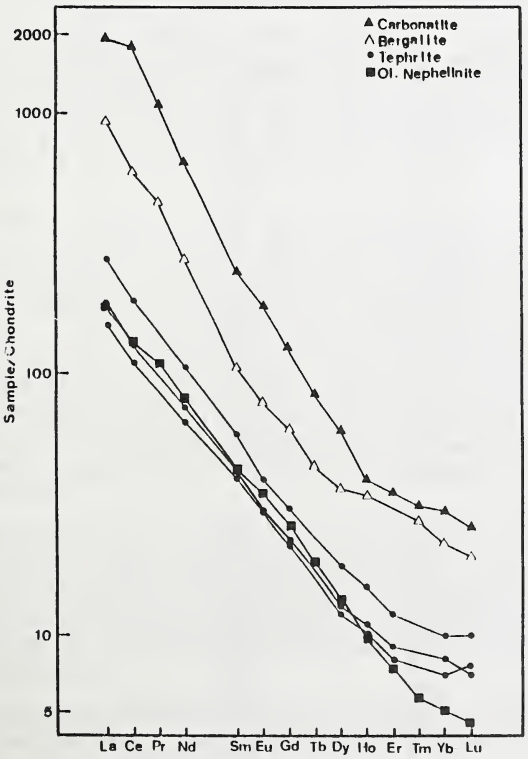

Figure 1: REE contents and patterns of bergalites from the Kaiserstuhl, compared to primary olivine nephelinite, carbonatite and tephrites.

The carbonate content which characterizes bergalites occurs in the form of late stage vugs or interstitial matrix. C/O isotopes have generally aquired a low temperature re-equilibration, however some examples with carbonate isotopic compositions falling in the field of primary igneous carbonatites have been analyzed (Hubberten et al. 1988).

Bergalites are considered transitional between carbonatites and the silicate magmas. Their chemical composition is quite variable (Table 1), but all varieties are highly fractionated with Mg-values of 54 to 38, and low Sc,Ni,Cr,Co contents. Bergalites are distinctly enriched in incompatible elements, especially Sr, Ba, LREE, Nb etc. giving in general a carbonatititic trace element signature.Bergalites are modelled having fractionated from primary olivine-melilite nephelinite at intermediate to high pressure.This extended fractionation is responsable for trace element and CO_2 enrichment.Carbonatite separation occurs at shallow level, but there is no unambiguous petrographic evidence available to decide whether final separation involves liquid immiscibility or residual melt separation.Bergalitic magma compositions (including okaites and turjaites) seem to occur in several carbonatite complexes and their petrogenetic role in the evolution of carbonatites merits focused petrologic attention.

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TABLE 1: Chemical compositions of bergalites from Kaiserstuhl Rhinegraben.

SiO_2	31.96	33.63	35.00	36.15
TiO_2	1.44	1.73	1.87	1.61
Al_2O_3	12.66	13.30	12.58	14.22
Fe_2O_3	6.06	5.69	6.82	6.51
FeO	3.79	4.43	3.75	3.98
MnO	.46	.43	.35	.48
MgO	3.00	3.78	4.54	5.71
CaO	16.65	13.79	16.94	11.33
Na_2O	3.94	6.93	4.40	6.59
K_2O	2.80	2.04	1.14	2.59
P_2O_5	.68	.86	1.13	.81
CO_2	8.32	6.71	4.75	3.34
SO_2	.62	.90	.70	2.02
H_2O	5.84	4.90	4.76	2.11
Total	98.22	99.12	98.38	97.45
V	466	430	510	526
Ni	16	2	15	0
Ba	3337	2320	1882	2909
Sr	3255	3003	3125	2982
Nb	565	548	447	553
La	368	306	263	280
Ce	431	546	479	421
Y	61	73	69	65
Zr	297	420	334	383