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THE LEUCITE NEPHELINE DOLERITE OF MEICHES, VOGELSBERG, HESSEN

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The nepheline dolerite of Löbau, Saxony and its leucitic relative, the leucite nepheline dolerite of Meiches in the Vogelsberg, Hessen, are recognized as the type examples of such assemblages in petrographic literature.

The latter rock with its component minerals was early subject to detailed chemical investigation by Knop (1865) and his data have been incorporated in successive editions of Rosenbusch's *Elemente der Gesteinslehre.*

Sommerlad (1883) later provided additional microscopic data on the rock but there appears to be no recent reassessment of its mineralogy and composition.

In view of the phase equilibrium studies in the system $NaAlSiO_4$—$KAlSiO_4$—SiO_2, this Vogelsberg assemblage is of particular interest as it carries the three phases—leucite, nepheline and alkali feldspar which are known to co-exist at the ternary point in this system.

In the preliminary account of the experimental system, Schairer and Bowen (1935) delineated the primary phase fields in the quadrilateral $NaAlSi_3O_8$–$KAlSi_3O_8$–$KAlSiO_4$–$NaAlSiO_4$, but tie lines for the principal phases were not then reported.

For some natural assemblages equivalent tie lines joining co-existing nepheline and alkali feldspar solid solutions can be drawn and these data for a number of phonolitic lavas have now been determined (Tilley, 1954, 1956).

Sobolev (1956) has recently used Knop's early analyses of the minerals of the Vogelsberg rock to present graphically the triangle of solid phases (leucite, nepheline, alkali feldspar) for the reaction point of the system, but these analytical data are much too inferior to be of service in this connection; moreover some of Sobolev's deductions on the crystallization phenomena in this system are fallacious.

It is imperative that modern analyses of the Vogelsberg rock and its constituent salic minerals should be available before its crystallization phenomena can be reliably discussed. This chemical analytical work has now been carried out by Mr. J. H. Scoon and is reported below.

The leucite nepheline dolerite of Meiches is built of titaniferous augite in crystals reaching dimensions of one centimeter or more in length, rounded leucites, euhedral nepheline, anhedral sanidine, and as accessories, iron ores and apatite. Biotite and occasional grains of sphene are

also recorded in sections. It is clear that the accessories, the titanaugite and the nepheline crystallized at an early stage and were followed by leucite with sanidine as the last mineral to crystallize. This is evident from the textural relations, for the sanidine envelopes both nepheline and leucite, forming an interstitial cement to the assemblage as a whole.

Table I presents the analyses of the rock and its constituent sanidine

TABLE 1

	1	2	3	Norm of 1		Metal atoms to 32 oxygens in 2		
SiO_2	43.18	42.28	63.62					
Al_2O_3	20.72	33.71	19.12	Lc	22.67	Si	8.18	
Fe_2O_3	2.39	0.80	0.47	Ks	0.47	Al	7.66	15.98
FeO	5.21			Ne	35.07	Fe'''	0.14	
MnO	0.13			An	6.95			
MgO	3.22	0.03	0.05	Cs	0.37	Ca	0.11	
CaO	8.00	0.56	0.05	Di	22.99	Na	6.22	ΣR
Na_2O	7.65	16.61	2.66	Wo	0.46	K	1.43	7.87
K_2O	5.07	5.75	12.09	Il	5.47			
H_2O-	0.42	0.03	nil	Mt	3.48	$Ne_{76.2}Ks_{19.5}An_{2.8}Qz_{1.5}$		
H_2O+	0.67	0.34*	0.11*	Ap	1.01	$(Ne_{78.4}Ks_{20.0}Qz_{1.6})$		
TiO_2	2.90	0.07	0.08	Ct	0.18			
P_2O_5	0.42			Rest	1.09			
BaO	0.12		1.56		100.21			
CO_2	0.08			$(Ne_{60.2}Ks_{29.1}Qz_{10.7})$				
	100.18	100.18	99.81					

* Loss on ignition.

1. Leucite nepheline dolerite, Meiches, Vogelsberg, Hessen.
2. Nepheline } from 1.
3. Sanidine $(Or_{73.0}Ab_{22.9}An_{0.3}Cs_{3.8})$ }

and nepheline. An analysis of the leucite fraction which contained minor amounts of impurity not separable, gave figures for alkalis K_2O 19.42, Na_2O 1.12, these results confirming earlier analytical data on this mineral that replacement of potassium by sodium in rock forming leucites is quite limited. The analyses have been plotted in Figure 1 in the customary manner, the rock analysis by transformation of the salic constituents of the norm, less anorthite, to the co-ordinates of the system $NaAlSiO_4$–$KAlSiO_4$–SiO_2.

The salic composition of the rock as calculated from the norm falls inside the solid phase triangle Lc-Ne-Sa at N, but with this method of

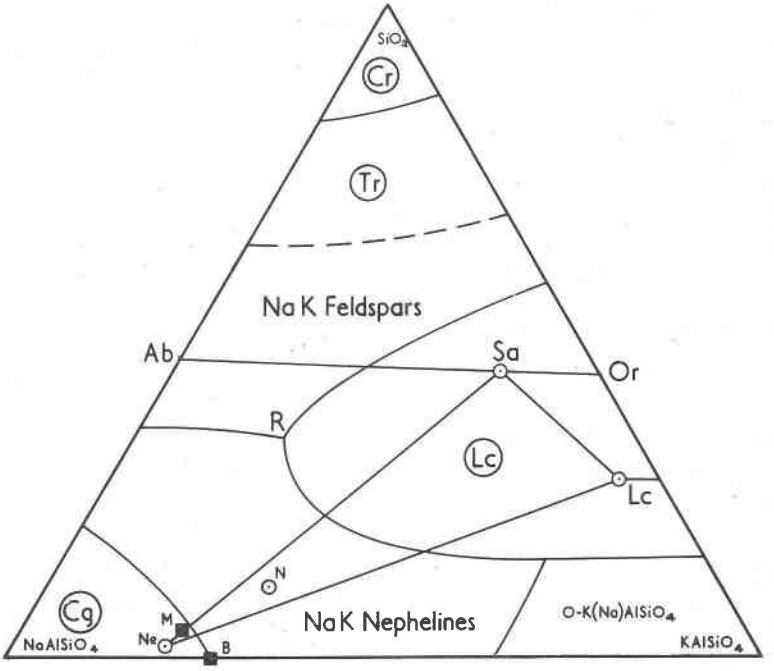

FIG. 1. Plot of the compositions of the Vogelsberg leucite nepheline dolerite and its salic minerals in the system $NaAlSiO_4$—$KAlSiO_4$—SiO_2.

N = rock, Ne = nepheline, Lc = leucite, Sa = sanidine, M and B nepheline formulae of Morozewicz and Buerger respectively (Tilley, 1954, pp. 65–66).

calculation we cannot derive therefrom the relative proportions of the constituent phases.

It is clear however from the position of N that nepheline should be the primary phase among the salic minerals, and that in the course of crystallization it would be joined by leucite, the two crystallizing together to the reaction point R*, when crystallization would be completed by a reaction involving partial resorption of leucite and precipitation of sanidine along with nepheline.

$$R_{liq} + \text{leucite} \rightarrow \text{nepheline} + \text{sanidine}$$

The observed textural relations of the minerals are as already noted in conformity with this sequence of crystallization and indeed with the

* In Dr. Schairer's revision of the $NaAlSiO_4$—$KAlSiO_4$—SiO_2 system (1950, fig. 1, p. 514) the temperature of this ternary point is redetermined at $1020° \pm 5°$ C. On my enquiry, Dr. Schairer informed me that he believed the minimum on the boundary curve feldspar-nepheline lies so close to the ternary point in temperature and composition as to be within experimental error in these viscous melts where equilibrium is attained so slowly.

crystallization history now inferred from the bulk chemical composition of the rock and the known phase relations within the ternary system.

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NOTE ON LITHIOPHOSPHATE

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This name has been given by V. V. Matias and A. M. Bondareva to Li_3PO_4 occurring as a hydrothermal replacement of montebrasite in a Kola pegmatite according to an abstract by M. Fleischer. Over eight years ago the writer took an x-ray diffraction pattern of the synthetic powder of this material (see the table), suspecting that it would be present in his pegmatite collections; but it never turned up. This pattern agrees well with that by A. P. Denisov quoted in the Fleischer abstract.

Zambonini and Laves found synthetic Li_3PO_4 to be orthorhombic with the olivine-triphylite structure with unit cell $a=10.26$, $b=4.86$, $c=6.07$kX. (orientation of chondrodite with $c<a$), space group *Pnam*. The indices shown in the table are accordingly taken from those given for the corresponding olivine reflections by Swanson and Tatge.

C. Guillemin's suggestion that this should be called lithiophosphatite is one that should meet with general agreement. Dana's System has in class 38 no place for the $A_3(XO_4)$ type that would seem to include lithiophosphatite. However it is proper to place it near the triphylite group of $AB(XO_4)$ type, just as the heterosites are put here rather than with