19. *Chemistry of the Aqueous Inclusion in Nepheline-basalt from Nagahama, Hamada-si, Simane Prefecture. (II).*

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(Comm. by Y. SHIBATA, M. J. A., March 12, 1949.)

Introduction.

In the foregoing paper (Proc. Imp. Acad. Tokyo, Vol. 20, No. 10, pp. 721—724) the present writers reported of the chemical and spectrochemical analysis of the nepheline-basalt from Nagahama and of its aqueous inclusion and gave a series of facts which agree with the view that the inclusion is the residual water from the crystallization of the mother magma of the rock in question.

Last summer, the writers resumed and advanced the study, as a part of the work of the Special Committee for Igneous Actions, National Research Council.

The study was extended along three different lines, (1) determination of the variation of the chemical composition of water samples from different cavities, (2) determination of the nature and the amount of the dissolved gases in the inclusion, and (3) the computation of the chemical composition of the residual water at the stage just before the minerals, lining the wall of cavity (zeolite and calcite), separated.

The variation of the chemical composition of the inclusion water from several cavities.

(a) The variation in chlorine concentration.

21 kinds of waters were examined, of which two were mixed samples, each respectively from three different cavities, seven, denoted by p, came each from more than three cavities, and the others from single ones.

The result, shown by Table I, tells that the chlorine concentration varies between 25—1220 mg Cl/l.

TABLE I.
Variation of the inclusion in
chlorine-ion concentration.

Sample	Amount collected cc	Cl ⁻ mg/l	Remarks
No. 1	0.24	1	100
2	0.50	1	25
3	0.37	1	29
4	0.12	1	140
5	0.15	3	210
6	0.81	1	270 ○
7			*
8	0.71	3	130 ○
9	0.59	1	150 ○
10	1.1	1	150 ○
11	0.15	1	130
12	0.15	1	58
13	1.82	1	60 ○
14	1.6	p	430 △
15	1.0	p	97 ○
16	1.2	p	290 ○
17	2.2	p	610 △
18	1.5	p	1220 △
19	1.9	1	730 △
20	0.67	1	250 ○
21	3.0	p	560 △
22	1.0	p	720 △

* An example of hole cavities. Cavity No. 7 was washed out with a certain amount of distilled water, and its chlorine content was determined with the result Cl<0.002 mg.

TABLE II.
Chemical composition of the
inclusion

	Sample I.	Sample II.
Na	139 mg/l	491 mg/l
K	—	120 "
Ca	76 "	112 "
Mg	22 "	11 "
Fe	4.1 "	2.3 "
Al	11 "	16 "
NH ₄	0.08 "	14 "
Cl	170 "	732 "
NO ₃	4.4 "	97 "
NO ₂	21 "	0.54 "
SO ₄	173 "	326 "
SiO ₃	35 "	28 "

(b) The variation of the chemical constituents other than chlorine.

For the complete analysis, two kinds of samples were prepared differing in chlorine concentration, the one (I) low in chlorine, by uniting the samples denoted by ○ in Table I and the other (II), rich in chlorine, from the samples denoted by △.

The result of analysis (Table II) tells that variation is so marked of the constituents other than chlorine too and that the

close resemblance between the inclusion and sea water in their relative compositions of the principal components, which was pointed in the previous report, was a casual one. It is also notable that the present samples were very rich in nitrogenous components and they were acidic, i.e., the sample (I) contained as much as 21 mg NO₂ per litre with pH=5.6, while the sample (II) 97mg NO₃ per litre with pH=3.6.

Summarizing the results, it is concluded that the inclusion varies much in the relative composition of the constituents as well as in their absolute concentration from sample to sample and pH-value varies between 3.6—8.1, so far as the data tell.

Dissolved gases in the inclusion.

For the determination of the gases kept in solution in the inclusion, samples No. 13 and No. 19 were chosen.

The result, shown by Table III, tells that the gas consists solely of nitrogen and carbon dioxide, of which the latter, carbon dioxide, came no doubt mainly from the carbonate ion in solution, or calcite particles in suspension. Thus nitrogen is taken as the principal component of the actually dissolved gases.

TABLE III.

Dissolved gases in the inclusion		
	No. 13 cc/1	No. 19 cc/1
O ₂	0.00	0.00
N ₂	6.32	13.54
CO ₂	2.25	1.23
H ₂	0.00	0.00
CH ₄	0.00	0.00
Tension of nitrogen gas	0.366 atm.	0.795 atm.

From the amount of the dissolved nitrogen, its tension in the gaseous phase, in equilibrium with the water, can be computed. The values, given in Table III, show that the tension is more or less below the atmospheric pressure. The fact tells that there has been no communication between the inside of the cavity and outside, and denies any suspicion that the inclusion might have come in from outside, secondarily, along the fissures of

the rock. Also the fact agrees with the radon determination by K. Kuroda, Tokyo University, who showed that the content of the inclusion of this element lies below 0.8×10^{-10} curie/l, in contrary to much higher values of common outside waters such as sea-, rain- or spring waters. Such can not be the case, if the water were of outside origin.

The computation of the composition of the inclusion water before the minerals, lining the cavity-wall, separated.

The computation of the nature and the chemical composition of the inclusion water at an earlier stage, where the minerals, lining the cavity-wall, has not yet been crystallized out, but their constituents remained in solution, is important at the point that it gives an example of the residual water of magmatic crystallization at its earliest stage. Our computation was carried out as follows: Cavity No. 13, with a volume of 5.0 cc, was chosen and the amounts and the chemical compositions of calcite and zeolite, lining the cavity-wall, were determined. From the result, the amounts of several constituents which came from the inclusion water, were calculated. The values are given in the 2nd to 4th columns, Table IV, from which those of

the 5th column, the assumed composition of the inclusion before crystallization, was calculated. It is notable that the concentration is very high, that is, 3.65 times higher than the Japanese record of hot springs salinity, 77.1 g/l of Arima-shin-onsen.

TABLE IV.

Amounts of lining minerals				The computed composition of the inclusion water be- fore the lining minerals crystallized out
	Calcite 0.95g	Zeolite 1.3g	Total 2.25g	
Ca	380 mg	67 mg	447 mg	89.4 g/l
Mg	0.62 "	0.94 "	1.6 "	0.32
Fe	0.18 "	2.6 "	2.8 "	0.56
Al	0.43 "	198 "	198 "	39.6
SiO ₂	5.4 "	750 "	755 "	151
				<hr/> 280.88 g/l