108. *Petrological Properties of the Komagataké Magma Just Before the Explosion in 1928.*

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From the petrological and volcanological view points, it would be extremely important if we could obtain some exact data regarding any quantitative relations between crystallized minerals and the residual solution in a vitreous rock consolidated rapidly from volcanic magma whose chemical composition can be accepted with sufficient approximation (Table I). For these studies, in addition to the determination of the precise physical and chemical properties of the rock components, special importance is attached to the correct measurements of the proportions of the crystallized minerals and the glass-base forming the rock. These investigations can be made in cases where the crystallized components in the rock mass are actually separable from the glass-base. The pumice newly ejected in enormous quantity from Komagataké in Hokkaido in 1928 possesses a nature suitable for such investigations and we were able to undertake the following experiments.

Proportion between coloured minerals and non-coloured components:—As the pumice can be taken as the quenched part of the magma kept at a temperature at which the explosion took place, the phenocrystic minerals in the pumice must be the primary phases crystallized out from the magma solution, and the glass-base may be taken as the residual solution which had been in equilibrium, or approximately so, with the phenocrystic minerals at that temperature. The phenocrysts in the pumice are hypersthene, augite, magnetite and plagioclase, scattered in the glass-base in which minute crystals crystallized out after the explosion are practically free.

We attempted first the separation of coloured minerals, viz. hypersthene, augite, and magnetite, from the non-coloured components, viz. plagioclase and glass-base, using the Thoulet solution. For this purpose, three different rock-specimens from the Akaigawa-flow were used, and 89.10, 73.90 and 55.00 grams were taken for this experiment from the respective specimens. The results obtained are 17.63% in weight for the coloured minerals and 82.37% for the non-coloured components.

The separation of plagioclase from the glass-base and their chemical compositions:—The complete separation of plagioclase from the mixture of the mineral and the glass was practically impossible by the heavy solution method only, because the latter adheres firmly to the former

even though they are crushed into fine grains. However, it was not difficult to obtain by means of a heavy solution the pure plagioclase or the pure glass respectively from their mixture if we reject the firmly adhering parts of these two components. So we could obtain the mixing ratio of plagioclase and glass in the rock by using the two methods of heavy solution and chemical analysis in combination.

After analysing chemically the composition of the pure plagioclase and the pure glass respectively (Table I), we determined the weight percentages of three groups of oxides, SiO_2 , $\text{Al}_2\text{O}_3 + \text{Fe}_2\text{O}_3 + \text{FeO}$ and CaO , in a mixture of plagioclase and glass mixed in the original ratio existing in the pumice, the results being given in Table II. From these three series of the chemical results, the mixing ratio of plagioclase and glass can be obtained by calculation using a simple equation. The result is given as *plagioclase : glass* = 45.51 : 54.49 in wt. % in the non-coloured components (Table II). As the non-coloured components form 82.37% of the whole mass of the rock, the plagioclase and the glass must be present in the rock in the proportion 37.49 : 44.88 in wt. %.

TABLE I.

	Pumice	Phenocrysts		Ground-mass
		Plagio.	Aug., Hyp., Mag.	Glass
SiO_2	61.41	54.09	41.72	74.07
Al_2O_3	15.42	27.27	0.59	12.61
Fe_2O_3	2.64	0.35	10.21	1.39
FeO	4.93	0.40	24.84	0.67
MgO	2.34	0.62	11.84	0.25
CaO	6.70	10.22	7.12	4.49
Na_2O	4.72	4.52	0.78	5.37
K_2O	1.10	1.51	0.30	0.91
$\text{H}_2\text{O} +$	0.52	0.26	1.20	0.40
$\text{H}_2\text{O} -$	0.02	0.06	0.08	0.06
TiO_2	0.46	tr.	1.48	0.32
P_2O_5	n.d.	tr.	n.d.	tr.
MnO	tr.	tr.	0.04	tr.
Total	100.26	99.30	100.20	100.54

TABLE II.

	Oxides forming the minerals, in wt. %			Minerals in wt. %	
	Plagioclase	Glass	Colourless minerals, separated from pumice, i.e., Plagio.+glass.	Plagioclase	Glass
SiO_2	54.09	74.07	65.07	45.05	54.95
Al_2O_3	27.27	12.61	} 21.03	45.92	54.08
Fe_2O_3	0.35	1.39			
FeO	0.40	0.67			
CaO	10.22	4.49	7.10	45.55	54.45

* FeO is taken as Fe_2O_3 .

The chemical composition of plagioclase :—As is seen in the result of the chemical analysis made for plagioclase crystals, 1.37% of Fe_2O_3 , FeO and MgO are present as impurities. If we reject these oxides,

the mean chemical composition of the plagioclase crystals can be obtained as $\text{Or}_{8.93}\text{Ab}_{40.44}\text{An}_{50.63}$ in mol. %.

The chemical composition of the glass-base.—The chemical composition of the glass-base, which forms 44.88% of the rock, is seen in Table I. If we compare this residual composition with that of the original pumice, we see that SiO_2 of 61.41% in the pumice increases into 74.07% in the glass, Al_2O_3 of 15.42% decreases into 12.61%, $\text{Fe}_2\text{O}_3 + \text{FeO} + \text{MgO}$ of 9.91% into 2.31% and CaO of 6.70% into 4.49%, while alkalis of 5.82% practically remain the same as 6.28%. Any detailed discussion of the volatile components contained in the glass can not be made at present, however it seems to be especially interesting to note that HCl can be expelled from the glass by heating and that the temperature at which the HCl is expelled is different in different types of glass, forming the “pumice-flow” or forming the “pumice-fall.” In the former, the HCl commences to be expelled at about 450°C and increases its amount rapidly at about 850°C , while in the latter the first temperature is about 700°C and the second is the same as before. It is also interesting to know that 800°C is the temperature at which the compact glass ejected with the pumice expands explosively and changes into pumice. It will be also important to add here our field observation that the sublimation product of ammonium chloride found in the ejected materials can be seen in the “pumice-flow” only, not in the “pumice-fall.”

Optical and chemical properties of the coloured components.—The chemical composition of the mixture of the mafic minerals, which occupy 17.63 wt. % of the pumice, is given in Table III. The result of the chemical analysis made for the hypersthene crystals, which were carefully selected under a binocular microscope, is as seen in Table III and the mean chemical composition obtained by computation is given as 71.1MgSiO_3 (En). 28.9FeSiO_3 (Hy). The mean refractive indices of the crystal are $\alpha=1.698$, $\beta=1.706$ and $\gamma=1.713$. The crystal material appears to be homogeneous under a usual microscope, but using a Universal Stage a faint zonal structure can be observed and the variation

TABLE III.

	Mix. of Aug., Hyp., Mag.	Hyp.	Aug.
SiO_2	41.72	51.33	50.40
Al_2O_3	0.59	0.45	1.63
Fe_2O_3	10.21	0.83	2.06
FeO	24.84	19.40	9.74
MgO	11.84	25.04	13.37
CaO	7.12	1.03	20.65
Na_2O	0.78	0.43	0.66
K_2O	0.30	0.18	0.23
$\text{H}_2\text{O} +$	1.20	0.51	0.48
$\text{H}_2\text{O} -$	0.08	0.04	0.03
TiO_2	1.48	0.87	1.13
P_2O_5	n.d.	n.d.	n.d.
MnO	0.04	0.09	0.09
Total	100.20	100.20	100.47

in its optic axial angle is measurable (60° – 66°).

The result of the chemical analysis of the augite crystals is as shown in Table III, the chemical composition obtained by the calculation from the result being 45.2 Wo, 41.3 En, 13.5 Hy. The mean refractive indices are $\alpha=1.691$, $\beta=1.697$ and $\gamma=1.718$. The extinction angle on (010) c//Z is about 43° and 2V varies between 51° and 66° . The crystal shows more distinct zonal structure than hypersthene.

The precise determination for the mixing proportion of the two kinds of these mafic minerals has not yet been successfully made, owing essentially to the firm attachment of the fine grains of magnetite with these pyroxenes. However

the hypersthene is abundant compared with augite observed under the microscope and the relative proportion may be 60 : 40 in great approximation, estimated from the chemical results under an assumption that the Wo-molecules entirely enter into the augite-component.

In short, in the Komagataké magma just before the present explosion, the plagioclase and the mafic minerals were already

TABLE IV.

	Phenocrysts		Ground-mass	Sum	Pumice, directly analyzed
	Plagio.	Aug., Hyp., Mag.	Glass		
	37.49%	17.63%	44.88%		
SiO ₂	20.28	7.36	33.24	60.88	61.41
Al ₂ O ₃	10.22	0.10	5.66	15.98	15.42
Fe ₂ O ₃	0.13	1.80	0.62	2.55	2.64
FeO	0.15	4.38	0.30	4.83	4.93
MgO	0.23	2.09	0.11	2.43	2.34
CaO	3.83	1.26	2.02	7.11	6.70
Na ₂ O	1.69	0.13	2.41	4.23	4.72
K ₂ O	0.57	0.05	0.41	1.03	1.10
H ₂ O +	0.10	0.21	0.18	0.49	0.52
H ₂ O –	0.02	0.01	0.03	0.06	0.02
TiO ₂	tr.	0.26	0.14	0.40	0.46
P ₂ O ₅	n.d.	n.d.	n.d.	n.d.	n.d.
MnO	tr.	0.01	tr.	0.01	tr.
Total	37.22	17.66	45.12	100.00	100.26

crystallized out in the proportions of 37.49% and 17.63%, compared with the whole mass of the pumice, and the residual solution was 44.88%, each of the chemical compositions of these components in the proportion in the original rock being given in Table IV.