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**Petrography.** — “*The mineralogic and chemical composition of some rocks from Central Borneo*”. By J. SCHMUTZER. (Communicated by Prof. A. WICHMANN).<sup>1)</sup>

(Communicated in the meeting, of October 31, 1908).

Prof. M. DITTRICH at Heidelberg analyzed the following four rocks, collected by Prof. G. A. F. MOLENGRAAFF in Central Borneo :

- II 710, a glassy amphiboledacite, found as a boulder on a boulder-bank in the Soengei Sebilit,  $\pm$  3 KM. above Kebijau.<sup>2)</sup>
- II 599, the glassy amphiboledacite of which consist the rocks, 1.50 m. high, in the Soengei Embahoe, below Nangah Pemali; the hand-specimen was struck close to the contact with the adjacent rock (silicified tuffbreccia).<sup>3)</sup>
- II 749, biotiteamphibolandesite with old habitus from the right bank of the Soengei Tebaoceng over against Nangah Oeroei.<sup>4)</sup>
- I 893, aplitic microgranite from the waterfall, N.W. cliff, Boekit Kelam.<sup>5)</sup>

I. *Hyalopilitic Amphiboledacite* (Amphibolephyritroyellowstonose).

The grey-black, glassy rock shows a rough, conchoidal fracture; only very indistinctly a few white feldspar-phenocrysts, whose diameter does not exceed 1 mm., and very rare, bright glittering, still smaller green amphibole-needles appear forth from the greasy-shining ground-mass. Under the microscope the *plagioclase* of the first generation (andesine-oligoclase) forms sharp idiomorphic crystals, lying mostly isolated, but sometimes combining into aggregates. Zonal structure is locally finely developed; among the twin-laws the albite-law reigns, the Carlsbad- and pericline-law occur only subordinately. Here and there the feldspar shows a pronounced inclination to forming skeleton

<sup>1)</sup> The Dutch communication was entitled “The mineralogic and chemical composition of some rocks from the Müller-Mountains in Central-Borneo”. I avail myself of this opportunity to repair a lapsus calami, only the three first rocks described originating from the Müller-Mountains, Mt. Kelam not forming part of this range.

<sup>2)</sup> cf. MOLENGRAAFF, Geological Explorations in Central Borneo, Leyden 1902, 209, where this rock is named pitchstone.

<sup>3)</sup> The label bears the indication “1 Km. below Nangah Pemali”, whilst according to MOLENGRAAFF's description, op. cit. 267, and the map VIIIb, published by him at the same time, this should rather be about 100 meters. There can be no doubt, however, about the identity of the rock meant by him in his work i.e., with that described here, as the rock builds up the *first* dyke of andesite in the tuffbreccia below Nangah Pemali.

<sup>4)</sup> Mt. Loeboek consists of the same rock, *ibid.* 293 - 295.

<sup>5)</sup> *ibid.* 127 (Chapt. VI), 138.

crystals, partly in consequence of differences in the velocity of crystallization in not equivalent directions, by which planes (by preference (010)) broaden lamellarly to far beyond the original boundary ribs, partly by a dense accumulation of glass-inclusions with negative crystal-forms, which at bottom is connected with the same phenomenon. These glass-inclusions press the feldspar-substance together into narrow little laths with two main directions and which combine into a very complicated meandrous pattern, while also the crystal-circumference assumes an irregular indented shape. The glass, however, also forms irregular notch-like or claviform inclusions and is neither in colour, nor in the nature of the microlites to be distinguished from the glass of the groundmass.

The *amphibole* occurs in fresh little columns and crystal-fragments; the corrosion of the crystals by the magma at the effusion has not given rise to the origin of a proper resorption-border, but has confined itself to rounding the crystals and largely accumulating the magnetite-globulites of the groundmass along their periphery. The dichroism moves between darkgrey-green // the *c*-axis and greenish grey-yellow perpendicularly here to; with regard to the axis of elongation an extinction of  $15^\circ$  was measured. Parallel to (100) and (001) we sometimes find a narrow twin-lamella linked between. Besides the good prismatic cleavage a system of rough cracks shows itself perpendicularly to the *c*-axis. Quartz is wanting.

The *groundmass* consists principally of colourless glass in which excellent idiomorphic lathshaped or tabular feldspars, the former often with fine skeleton-forms and exhibiting a fluidal texture, come to the front. Albite-lamellae and feeble zonal structure are general, glass-inclusions much less frequent than in the phenocrysts; on the other hand the crystals contain many microlites of magnetite and bronzite. Those two last minerals take an important place among the secretions of the base. The magnetite, which on the ground of the chemical analysis seems to contain  $TiO_2$ , may, according to the size, be brought to two distinctly separated generations. The intratelluric magnetite (average crystal diameter  $15 \mu$ ) forms excellent octahedrons, which occur both in the groundmass and in the phenocrysts. In the groundmass the magnetite crystals are found partly isolated, partly in aggregates and then often grown together to dendritic markings. That the on an average  $10 \times$  smaller magnetite-crystals and globulites, occurring by the side of those mentioned above, did not crystallize until the effusion-period, is proved by their accumulation at the circumference of the corroded amphibole-substance. The *bronzite* forms a pretty compact tissue of slender needles, which generally show an

irregular transverse cracking. From the feldspar-microlites they are distinguished by the strong refraction, from apatite (occurring as inclusion in the plagioclase-phenocrysts) by their behaviour when tested it by means of a  $\frac{1}{4}$   $\lambda$  mica plate in parallel polarized light, from the very few dichroitic, green, sometimes parallel to a (100) twinned hornblende-prisms of the second generation, mixed up with them, by the very light colour, the weak double refraction and the right extinction.

The grounds on which the presence of bronzite, and not of enstatite or hypersthene is assumed, will further be explained. We can conclude the microscopic description by mentioning the occurrence of extremely fine undefinable microlites with a strong double refraction, whose length is only a few  $\mu$ , the width by estimate no more than 0.1  $\mu$ .

The chemical analysis yielded the following values, from which is calculated the norm of the rock according to CROSS, IDDINGS, PIRSSON and WASHINGTON<sup>1)</sup>.

	%	Mol. Prop.	ilm.	orth.	alb.	anorth.	cor.	magn	bronz.	quartz
SiO <sub>2</sub>	66.16	1.103	—	126	384	124	—	—	33	456
Al <sub>2</sub> O <sub>3</sub>	15.30	0.151	—	21	64	62	4	—	—	—
Fe <sub>2</sub> O <sub>3</sub>	1.25	0.08	—	—	—	—	—	8	—	—
FeO	1.72	0.024	6	—	—	—	—	8	10	—
MgO	0.90	0.023	—	—	—	—	—	—	23	—
CaO	3.47	0.062	—	—	—	62	—	—	—	—
Na <sub>2</sub> O	3.94	0.064	—	—	64	—	—	—	—	—
K <sub>2</sub> O	2.00	0.021	—	21	—	—	—	—	—	—
H <sub>2</sub> O <sup>1)</sup>	4.94	—	—	—	—	—	—	—	—	—
TiO <sub>2</sub>	0.50	0.006	6	—	—	—	—	—	—	—
	100.27									

<sup>1)</sup> Loss of ignition 5.11%,

<sup>1)</sup> Quantitative classification of Igneous Rocks, Chicago, 1903.

From this the following norm may be calculated:

quartz	26.16	$Q = 26.16$	}	Sal = 89.03
orthoclase	11.68	$F = 62.46$		
albite	33.54			
anorthite	17.24			
corundum	0.41	$C = 0.41$	}	Fem = 6.39
bronzite	3.62	$P = 3.62$		
magnetite	1.86	$M = 2.77$		
ilmenite	0.91			

so that according to the American system the rock belongs to Class 1 (Persalane); Subclass 1, (Persalane); order 4 (Brittanare); Rank 3 (Coloradase); Subrank 4 (Yellowstonose). The only positive deviation, which the mode shows with respect to the norm, is the presence of amphibole, so that the described rock ought to have the name of Amphibolephyrivitroyellowstonose<sup>1)</sup>.

The chemical analysis throws some light on the nature of the rhombic pyroxene. The microscopic examination stopped at the observation that the pyroxene was distinguished from the hypersthene by its light colour. The above combination of the oxydes to mineral-molecules now proves that in the pyroxene-molecule MgO predominates strongly with respect to FeO. That the mode of the rock by the appearance of amphibole deviates somewhat from the norm calculated here, does not alter this fact considerably; even if we set aside the circumstance, that the amphibole is quantitatively far inferior to the crystallized rhombic pyroxene. For the fact that in the resorption of the amphibole-phenocrysts only magnetite, no pyroxene as a new

<sup>1)</sup> In spite of the lack of quartz in this rock, it is, on the ground of the high SiO<sub>2</sub> quantity, ranked not under the andesite but under the dacite; the same thing was done with the rock II 599 from the Soengei Embahoe. With the rock-analyses, gathered by OSANN, Beiträge zur chemischen Petrographie, II Teil, Stuttgart 1905, the above types are grouped as follows after the SiO<sub>2</sub> quantity (not free from H<sub>2</sub>O):

SiO <sub>2</sub> in %	75	74	73	72	71	70	69	68	67	66	65	64	63	62	61	60	59	58	57	56	55	54	53	52	51	50	
Nr. of analyses	1	—	1	—	3	5	4	7	3	4	3	3	2	1	1	—	—	—	—	—	—	—	—	—	—	—	
	Dacite	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
	Andesite	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

From this may be calculated that the SiO<sub>2</sub> quantity with the dacite is fluctuating round a mean of 67.5%, with the andesite round 59.5%. Of course these figures have only a very relative value; the rocks II 710 and II 599 however take up places also in the projection-triangle of OSANN which fall entirely within the sphere of the dacite- and quartzporphyriteprojections, but only near the border of the sphere of the andesites (glimmer-, hornblende-, hypersthene resp. augiteandesites and porphyrites, cf. OSANN, Versuch einer chem. Classification der Eruptivgesteine, Tsch. Min. Petr. Mitt. XX, Heft 5. 6 1900, Taf. IX, X).

secretion shows itself, justifies the supposition that the amphibole must be said to belong to the ferruginous varieties, and from this may be concluded that the ratio of the oxyde-quanta MgO and FeO, which after the crystallization of the amphibole remained available for the formation of rhombic pyroxene, could not be altered very much at the expense of MgO, compared with the ratio which the norm-calculation yields. These different grounds, therefore, tell against hypersthene, and for bronzite or ferruginous enstatite. In accordance with our conclusion, as will appear further on, unmistakable enstatite-(bronzite-)crystals of greater dimensions are found in the glassy dacite II 599 of the Soengei Embahoe, which has a close chemical and mineralogic similarity with this rock. There, too, the glass-base possesses the same characteristic rhombic pyroxene microlites, whose bronzite-nature is made probable by the chemical analysis.

Fe<sub>2</sub>O<sub>3</sub> being reduced to FeO, the molecular proportions, calculated on a sum of 100, yield the following values (TiO<sub>2</sub> added to SiO<sub>2</sub>):

SiO <sub>2</sub>	Al <sub>2</sub> O <sub>3</sub>	FeO	MgO	CaO	Na <sub>2</sub> O	K <sub>2</sub> O
75.45	10.27	2.72	1.56	4.22	4.35	1.43

from which follows the formula according to OSANN:

	s	A	C	F	a	c	f	n	m	k	Series
I	75.45	5.78	4.49	4.02	8.09	6.28	5.62	7.53	10.00	1.46	α r
II	75.45	5.78	4.22	4.29	8.09	5.90	6.00	—	—	—	
III	—	—	—	—	(12.14	9.42	8.43)	—	—	—	
IV	—	—	—	—	(12.14	8.85	9.00)	—	—	—	

These figures require some explanation. As appeared already at the calculation of the norm, there remained after saturation of the alkalis and CaO with Al<sub>2</sub>O<sub>3</sub> a not unimportant quantity of sesquioxide. The analyzed material being absolutely fresh and even microscopically free from every trace of decomposition, there is no possibility of a relative increase of Al<sub>2</sub>O<sub>3</sub> by a removal of alkalis and CaO: a consequent distribution of the Al<sub>2</sub>O<sub>3</sub>-remainder over alkalis and CaO<sup>1)</sup> could not be reasonably defended here. Also the dissolution by the andesite-magma of fragments from an adjacent rock rich in aluminium cannot but be highly improbable; both macroscopically and microscopically there is not the least indication for it. For the rest the Al<sub>2</sub>O<sub>3</sub>-remainder cannot be found in amphiboles or pyroxenes<sup>2)</sup>

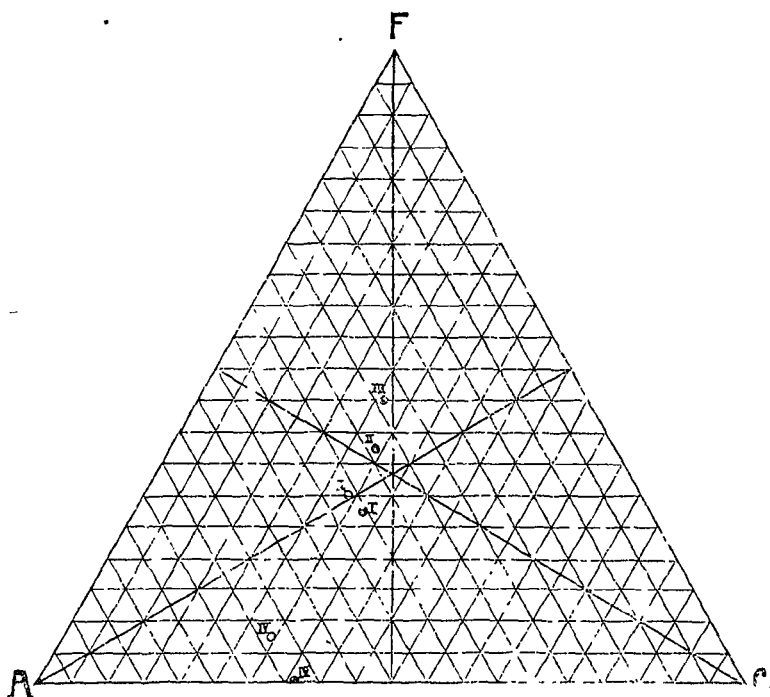
1) L. MILCH, Ueber Spaltungsvorgänge in granitischen Magmen nach Beobachtungen im Granit des Riesengebirges, Festschrift H. ROSENBUSCH, 1906, 127.

2) A. OSANN, Versuch einer chemischen Classification der Eruptivgesteine, Min Petr. Mitt. XXII, 1903, 337.

exceedingly rich in  $\text{Al}_2\text{O}_3$ , as appears sufficiently from the microscopic examination; it has on the contrary to be looked for in the glass of the groundmass.

In the rare cases, in which after saturation of the alkalis and lime an  $\text{Al}_2\text{O}_3$ -remainder shows itself, OSANN substitutes  $\text{MgO}$  in the atom-group  $\text{CaAl}_2\text{O}_4$  <sup>1)</sup>, whilst BECKE <sup>2)</sup> neglects the  $\text{Al}_2\text{O}_3$ -rest in the formula and mentions it separately; it amounts here in molecular proportions to 0.27. Accordingly in I the rock-formula is given according to OSANN, in II after BECKE. In III and IV these double values for a, c and f after BECKE have been calculated on a sum of 30 instead of 20 (I and II).

In the following graphic notation I denotes the projection of the rock; the filled circle with the values of a, c, f according to OSANN as base, the one not filled with those according to BECKE.



II. *Hyalopilitic Amphiboledacite* (Amphibolephyritroyellowstonose). From the glassy base of this greasy-shining, blackish grey rock, which shows an inclination to a conchoidal fracture and in one of the hand-specimens a distinct and pretty regular separation into thin, level plates from 1—7 mm. in thickness, already macroscopically small plagioclases with lively microtine-habitus and glittering amphibole-prisms are coming forth. The very fresh, also here mostly idio-

<sup>1)</sup> Min. Petr. Mitt. XXII, 1903. 337.

<sup>2)</sup> Ibid. 215.

morphic, prismatic and tabular *plagioclase*-phenocrysts are often lying together in groups and possess an excellent zonal structure showing itself already in obliquely transmitted ordinary light by parallel strongly luminous stripes and in which acid and basic zones frequently interchange. The same twin-laws are found as in the preceding rock; the albite-lamellae sometimes fit into each other with irregular indentations, in consequence of which through the growing together of several crystals a confused polarization-image arises. The plagioclase of the phenocrysts belongs to somewhat more basic mixtures than in the preceding dacite; the basicity falls to that of basic labrador, but on the other side approaches that of andesine. The crystallization of the basic plagioclase had already ended before that of the amphibole-phenocrysts, but for a time coincided with it; the more acid plagioclase on the other hand often contains amphibole-prisms inclosed. According to the dimensions the plagioclases in this rock may be divided into three groups: *a*) crystals with an average diameter of 1.5 mm., generally strongly laden with colourless and brown glass-inclusions and often entirely filled with these, with the exception of a peripheric zone; *b*) crystals, on an average twice as small and in which the brown glass-inclusions are very rare, the colourless ones on the whole being much less numerous; *c*. still smaller prismatic crystals, which always show a zonal structure and a twinning after the albite- and Carlsbad-law, and which gradually pass into the youngest and smallest skeleton-shaped, mostly fluidally arranged feldspars of the glass-base. Whilst *b* has still to be reckoned among the real phenocrysts, *c* had better be placed in the second generation. As appears, the boundary-line between the crystals of the 1<sup>st</sup> and 2<sup>nd</sup> generation can with the feldspars not be drawn exactly, though there is no doubt about the extremes. Higher up we mentioned the appearance of two kinds of glass-inclusions, which also here often assume the form of negative crystals: 1. of almost colourless ones, which seem to have a very light pink tinge and sometimes contain numerous microlites and 2. of brownish grey ones, which are strongly spherulitically devitrified. The nature of this brown glass, also occurring in patches in the colourless glass-base, is not quite obvious. Only it seems to be certain that the brown glass has no genetic relation with the colourless. But then these two sorts of glass must have existed side by side as far back as the intratelluric period, as they occur by the side of each other in the plagioclase and amphibole phenocrysts. Therefore the brown glass probably contains dissolved foreign matter, or, what is perhaps more acceptable, it is a product of intratelluric liquation.



The *amphibole*, which abundantly occurs, forms blunt needles, not exceeding a length of 1 mm. :  $c =$  green,  $b =$  greyish green and  $a =$  greyish yellow, in which  $c > b > a$ , but  $c$  and  $b$  differ only insignificantly. Now and then a zonal structure comes to the front, which is perceptible especially in some sections perpendicular to the axis of elongation. In this case there is seen parallel to the crystal-circumference a zone, showing the colours  $a =$  blue greyish green or dark greyish green,  $b =$  brown greyish green,  $c =$  light greyish green. The idiomorphic crystals have often been so strongly affected by resorption, that the groundmass penetrates into them with deep windings. The resorption-border is formed by an exceedingly dense felt-like tissue of fine microlites, becoming larger here and there, in some places even exceeding the feldspar-laths of the groundmass in size and which can then with certainty be recognised as a rhombic pyroxene. Mixed with them we find magnetite and strongly double-refracting grains, which have probably to be taken for augite. The resorption-border is not everywhere distinctly developed, in some crystals it seems even to be wanting partially. An explanation of this might be given by the supposition that the rock, even after the resorption-period, has been raised with violence, by which movement the components of the resorption-border were in some places swept away from the phenocryst. This conception is positively backed by the observation that the border often passes cloudlike into the groundmass, while the bigger needles pretty generally by transversal cracks are broken into pieces, which have lost their mutual orientation. But besides the components of the first generation show mechanical deformations, which have come about before the solidification of the glass-base and in all probability after the resorption-period. The feldspar shows irregular fissures and rents, along which pieces of broken twin-lamellae have sometimes moved with respect to each other and which are filled with glass of the groundmass as soon as the fragments through a mutual transposition are no longer closely united.

By irregular cracks perpendicular to the axis of elongation, the amphibole too is nearly always broken into fragments, which are often tolerably far carried away from each other; not rarely also opened wide along the cleavage directions. Also here the gaping rents are filled with glass and stress is to be laid upon the fact that this glass is nearly always entirely free from the resorption-products, which show themselves along the original crystal-boundaries. This proves that those rents were opened at an epoch when the resorption-period was all but over, a conclusion which is wholly in accordance with the above fact that the needles themselves, forming the

resorption-borders, are frequently broken. This makes the existence of a third phase in the cooling-process of the rock plausible, which affords a striking parallelism with the existing different feldspar-generations described.

To the second generation belong strictly idiomorphic crystals of rhombic pyroxene, somewhat bigger than the described needles out of the resorption-border, but genetically identical with them. They are often parallelly grown together; the planes (100) and (010) are strongly developed and sometimes push away the prismplanes (110) ( $\bar{1}\bar{1}0$ ) entirely. To the latter a distinct cleavage runs parallel; in some places also a pinacoidal splitting shows itself. They have a light-grey colour and display a slight dichroism. Some excellent sections  $\perp c$  yielded in convergent light centrally the locus of an acute positive bisectrix, so that, added to this the right extinction, the *enstatitic* (bronzitic) nature of the mineral is certain.

The *groundmass*, finally, is formed by a glass-base, in which, besides the above feldspars, occur: amphibole-prisms of much smaller dimensions than the proper phenocrysts, which, however, pass into them without a distinct limit of size, and as appears from the dense peripheric microlite-border belong to the first generation; magnetite, just as in the described dacite II 710, present in two generations, and numberless bronzite-needles with the characteristic rough cracking // (001). Apatite occurs as inclusion in the amphibole.

The chemical analysis of the rock yielded:

	%	Mol. Prop.	ilm.	magn.	orth.	alb.	anorth.	diops.	bronz.	quartz
SiO <sub>2</sub>	65.72	1.095	—	—	72	408	136	14	42	423
Al <sub>2</sub> O <sub>3</sub>	15.06	0.148	—	—	12	68	68	—	—	—
Fe <sub>2</sub> O <sub>3</sub>	1.25	0.009	—	9	—	—	—	—	—	—
FeO	1.80	0.025	6	9	—	—	—	} 7	42	—
MgO	1.57	0.039	—	—	—	—	—			—
CaO	4.18	0.075	—	—	—	—	68	7	—	—
Na <sub>2</sub> O	4.24	0.068	—	—	—	68	—	—	—	—
K <sub>2</sub> O	1.07	0.012	—	—	12	—	—	—	—	—
TiO <sub>2</sub>	0.48	0.006	6	—	—	—	—	—	—	—
H <sub>2</sub> O - 105°	0.69	—	—	—	—	—	—	—	—	—
H <sub>2</sub> O + 105°	3.77	—	—	—	—	—	—	—	—	—
	99.93									

From which follows the following norm:

quartz	25.38	Q = 25.38	} Sal = 86.58
orthoclase	6.67	F = 61.20	
albite	35.63		
anorthite	18.90		
diopside	1.54	P = 6.03	} Fem = 9.03
bronzite	4.49	M = 3.00	
ilmenite	0.91		
magnetite	2.09		

and the rock is placed in Class I (Persalane); Subclass 1 (Persalane); Order 4 (Brittanare); Rank 3 (Coloradase); Subrank 4 (Yellowstonose).

If we take into consideration that the diopside-molecule is crystallized as amphibole, there is a satisfactory agreement to be observed between norm and mode.

If  $\text{Fe}_2\text{O}_3$  is reduced to  $\text{FeO}$ , the molecular proportions, calculated on a sum of 100 ( $\text{TiO}_2$  added to  $\text{SiO}_2$ ) give the following values:

$\text{SiO}_2$	$\text{Al}_2\text{O}_3$	$\text{FeO}$	$\text{MgO}$	$\text{CaO}$	$\text{Na}_2\text{O}$	$\text{K}_2\text{O}$
74.14	9.97	2.83	2.63	5.05	4.58	0.81

so that the formula according to OSANN is:

	s	A	C	F	a	c	f	n	m	k	Series
I	74.14	5.39	4.58	5.93	6.78	5.76	7.46	8.5	9.2	1.56	av

II (10.17 8.64 11.19)

In I  $a + c + f = 20$ ; in II  $a + c + f = 30$ .

Both dacites, therefore, show a great chemical similarity, which is also expressed by the graphic notation, fig. 1. The somewhat greater basicity of the second rock, which contains more  $\text{CaO}$  and  $\text{MgO}$ , a little less  $\text{SiO}_2$ , and half the quantity of  $\text{K}_2\text{O}$ , manifests under the microscope by the character of the feldspars and the greater quantity of amphibole.

In order to compare them some analyses have been brought together, which show a great similarity with the two discussed above:

	I	II	III	IV	V	VI	VII
SiO <sub>2</sub>	67.34	66.16	65.83	65.72	65.66	65.39	64.81
Al <sub>2</sub> O <sub>3</sub>	15.96	15.39	15.61	15.06	15.61	15.49	15.73
Fe <sub>2</sub> O <sub>3</sub>	3.38	4.25	2.42	1.35	2.10	2.80	1.68
FeO	0.80	1.72	2.71	1.80	2.07	1.99	2.91
MgO	0.88	0.90	1.76	1.57	2.46	2.06	2.82
CaO	2.98	3.47	3.70	4.18	3.64	4.48	4.22
Na <sub>2</sub> O	4.12	3.94	3.92	4.24	3.65	4.56	3.98
K <sub>2</sub> O	1.66	2.00	2.20	1.07	2.03	1.50	1.43
H <sub>2</sub> O+	2.20	4.94	1.05	3.77	1.07	0.55	0.62
H <sub>2</sub> O-	—	—	—	0.69	—	—	—
CO <sub>2</sub>	—	—	sp	—	—	—	—
TiO <sub>2</sub>	0.56	0.70	0.43	0.48	1.37	—	0.08
P <sub>2</sub> O <sub>5</sub>	—	—	0.13	—	sp.	0.11	0.23
MnO	—	—	0.08	—	—	—	0.08
Sum	99.78	100.27	100.00	99.93	100.27	99.02	100.61

- I. Biotitedacite, Kolantziki, Megara, Greece, anal. A. ROHRIG, cf. WASHINGTON, Journ. Geol. III, 150, 1895 (Yellowstonose).
- II. Amphiboledacite, boulder from boulder-bank, Sebilit-river, ±3 KM. above Kébijau, anal. M. DITTRICH.
- III. Granite, Mazaruni District, Brit. Guyana, anal. J. B. HARRISON, cf. WASHINGTON, Chem. Anal. of Igneous Rocks, 1903, 191 (Yellowstonose).
- IV. Amphiboledacite, first dyke below N<sup>a</sup> Pémali, Embahoc-river, anal. M. DITTRICH.
- V. Dacite, Sepulchre Mountain, Yellowstone nat. Park, anal. J. E. WINTERFIELD, cf. J. P. IDDINGS, XII Ann. Rep. U. S. Geol. Surv. I, 648, 1891 (Yellowstonose).
- VI. Pyroxenedacite (Quartzpyroxeneandesite), Cumbal, Columb. Andes, cf. KUHN, N. Jahrb. f. Min. 1886, I.
- VII. Biotiteporphyrite, North Mosquito, Col., anal. HILLEBRAND, cf. CROSS, XII<sup>a</sup> Monogr. U. S. Geol. Surv., CLARKE, U. S. Bull. No. 168, 155. (Yellowstonose).

III. *Biotiteamphiboleandesite* (Biotiteamphibolephyrovitritonalose).

The rock of which Boekit Loeboek is composed, and of which the handspecimen II 749, struck over against Nangah Oeroei on the Soengei Tebaoeng, represents a sample, belongs to the freshest old andesites of the Western Müller-mountains. After the macroscopic habitus it takes a place quite by itself; a darkgreen groundmass, strongly fading in the more weathered rock, forms the cement between irregularly scattered plagioclases with microcline-habitus, sometimes densely crowded together and reaching a diameter of 6 mm., slender amphibole-crystals (to  $8 \times 2$  mm.) and hexagonal little tables of bronze-coloured biotite (3--4 mm. diam.). The twinned, often very distinctly zonal *plagioclase* is not really different from the one described above. The very first beginning of decomposition shows itself in a slight development of albite, secondary amphibole and troubling substances along cracks. The plagioclase, for the rest limpid, contains as inclusions primary amphibole, often twinned parallel to (100), magnetite, apatite, and occasional sharp prisms of zircon, whilst peripherically sometimes augite-grains are inclosed, which are characteristic of the resorption-borders of the amphibole-phenocrysts, and from this appears that the crystallization of the plagioclase did not come to an end until during or after the eruption.

The *amphibole* forms prismatic individuals, which are strongly corroded by the magma and surrounded by a broad, loose border of chloritizing amphibole-scales, pyroxene-, magnetite- and titanite-grains, mixed with the usual groundmass-components. Slender prisms are sometimes, to within a narrow, notched lath, entirely changed into these products. The extinction with respect to the *c*-axis reaches a value of  $20^\circ$ ; the pleochroism varies between dead brownish green and light brownish green; the usual twins parallel to (100) occur. As for inclusions the amphibole contains basic plagioclase, magnetite and cloudlike accumulations of extremely fine, parallel microlites, which probably, quite like a part of the magnetite-globulites, owe their individualisation to a chemical dissociation of the amphibole substance. The examination of the *biotite* yields no particular points of view. The acid *groundmass* consists of probably primary grains of quartz with wavy extinction containing colourless limpid glass-inclusions, sanidine and acid, short prismatic and zonal, but also slender lath-shaped plagioclase with polysynthetic twinning after the albite-law; these minerals are cemented by a small amount of colourless glass, strongly troubled by globulites. Here and there some grains of almost colourless augite, sometimes twinned and strongly laden with glass, are found, which as appears from their occurrence near the

resorption-zones of the amphibole-phenocrysts, even there, where they assume more considerable dimensions (to 0.1 mm.), must be considered as resorption-products. The glass of the groundmass contains magnetite in octahedrons, grains and prisms of apatite and of zircon, and is everywhere pushed away by fibres and little scales of a green chloritic product, strongly accumulating round the amphibole-phenocrysts and having formed principally at the cost of the secondary amphibole secreted in the resorption.

The analysis of the freshest material gave the following results:

	%	Mol. Prop.	ilm.	magn.	ham.	orth.	alb.	anorth.	diops.	enstat.	quartz
SiO <sub>2</sub>	62.70	1.045	—	—	—	114	396	152	22	52	309
Al <sub>2</sub> O <sub>3</sub>	16.37	0.161	—	—	—	19	66	76	—	—	—
F <sub>2</sub> O <sub>3</sub>	2.81	0.018	—	14	4	—	—	—	—	—	—
FeO	1.62	0.022	8	14	—	—	—	—	—	—	—
MgO	2.50	0.063	—	—	—	—	—	—	11	52	—
CaO	4.84	0.087	—	—	—	—	—	76	11	—	—
Na <sub>2</sub> O	4.05	0.066	—	—	—	—	66	—	—	—	—
K <sub>2</sub> O	1.83	0.019	—	—	—	19	—	—	—	—	—
H <sub>2</sub> O-105°	0.87	—	—	—	—	—	—	—	—	—	—
HO + 105°	1.79	—	—	—	—	—	—	—	—	—	—
TiO <sub>2</sub>	0.64	0.008	8	—	—	—	—	—	—	—	—
	100.02										

from which follows the composition:

Quartz	18.54	Q = 18.54	} Sal = 84.81
orthoclase	10.56	} F = 66.27	
albite	34.58		
anorthite	21.13		
diopside	2.38		} P = 7.58
enstatite	5.20		
ilmenite	1.22	} M = 5.11	
magnetite	3.25		
haematite	0.64		

The rock therefore belongs to Class II (Dosalane); Subclass I (Dosalone); Order 4 (Austrare); Rank 3 (Tonalase), Subrank 4 (Tonalose). The greater basicity with respect to the above mentioned rocks shows itself chemically in the decrease of the SiO<sub>2</sub>, the increase

of the MgO and the CaO quantity. The mode deviates rather considerably from the norm by the presence of biotite and amphibole, which minerals have to be considered as the bearers of the MgO, which is put here under the enstatite-molecule. A portion of the MgO, however, also occurs in the augite and the amphibole of the resorption-border and in the chlorite.

The molecular proportions calculated on a sum of 100 — Fe<sub>2</sub>O<sub>3</sub> reduced to FeO — yield:

SiO <sub>2</sub>	Al <sub>2</sub> O <sub>3</sub>	FeO	MgO	CaO	Na <sub>2</sub> O	K <sub>2</sub> O	TiO <sub>2</sub>
69.34	10.68	3.85	4.18	5.77	4.38	1.26	0.53

Formula according to OSANN:

s	A	C	F	a	c	f	n	m	k	Series
69.87	5.64	5.05	8.75	5.8	5.2	9	7.7	9.2	1.33	av
			(8.7)	(7.8)	(13.5)					

In the graphic notation it is the basic character which, by the side of the close similarity between the two preceding dacites, is distinctly expressed. To make a comparison we give here the analyses of some chemically closely allied rocks:

	I	II	III	IV	V	VI
SiO <sub>2</sub>	62.78	62.70	62.27	62.09	62.00	61.22
Al <sub>2</sub> O <sub>3</sub>	17.16	16.37	16.92	17.03	16.69	16.14
Fe <sub>2</sub> O <sub>3</sub>	1.96	2.81	2.40	2.38	1.45	3.01
FeO	2.31	1.62	2.59	2.69	3.76	2.58
MgO	2.32	2.50	2.87	3.08	1.93	4.21
CaO	4.84	4.84	4.78	5.05	6.08	5.46
Na <sub>2</sub> O	4.11	4.05	4.72	4.10	3.36	4.48
K <sub>2</sub> O	2.15	1.83	1.47	1.67	1.84	1.87
H <sub>2</sub> O+	0.88	1.79	1.22	0.13	1.47	0.40
H <sub>2</sub> O—	0.24	0.87	—	0.04	0.19	0.04
TiO <sub>2</sub>	0.56	0.64	0.16	0.65	0.32	0.61
P <sub>2</sub> O <sub>5</sub>	0.15	—	sp.	0.19	0.39	0.25
MnO	0.06	—	—	sp.	sp.	sp.
BaO	0.04	—	—	0.07	0.10	—
Som	99.58	100.02	99.47	99.84	99.77	100.36

- I Yentnite, Yentna River, Alaska; anal. H. N. STOKES, cf. J. È. SPURR, Am. Journ. Sci. X, 310, 1900 (Tonalose; included in the sum: S = 0.02, and traces of Cl, SrO, Li<sub>2</sub>O).
- II Biotiteamphiboleandesite, right bank of Tëbaoeng-river, opposite N<sup>a</sup>. Oeroci, Central-Borneo, anal. M. DITTRICH. (Tonalose).
- III Andesite, Punta della Civitate, Capraja-isl., Italy, anal. A. RÖHRIG, cf. H. EMMONS, Quart. Journ. Geol. Soc. XLIX. 142, 1893 (Cl = 0.07; Tonalose).
- IV Hypersteneangiteandesite, Palisades, Crater Lake, Oregon, anal. H. N. STOKES, cf. H. B. PATTON, Bull. U. S. Geol. Surv. 168, 223, 1900 (SrO = 0.07; Tonalose).
- V Hornblendeporphyrite, Nevada City, Calif., anal. H. N. STOKES, cf. W. LINDGREN XVII Ann. Rep. U. S. Geol. Surv. II, 59; 1896 (SO<sub>3</sub> = 0.10, Tonalose).
- VI Pyroxenemicadiorite, Electric Peak, Yellowstone Nat. Park.; anal. W. H. MELVILLE, cf. J. P. IDDINGS, XII Ann. Rep. U. S. Geol. Surv. I, 627, 1891 (NiO = 0.09, Tonalose).

IV. *Aplitic Microgranite* (normat. Graniphyrilassenose).

The rough, pure white, powdery, very fine-grained rock often contains holes, in which appear mica-rosettes and serpentinous products, which also in microscopic aggregates lie scattered through the whole rock and by this betray a certain porosity.

The proper rock-components are mostly rather fresh and in keeping with this the appearance of the secondary products — among which the muscovite takes a foremost place — seems with great probability to have to be attributed to pneumatolytic processes, not to atmospheric weathering. The structure is holocrystalline porphyric, but as such it is only to be recognized microscopically. The very few phenocrysts (average diam. 0.3 mm.) consist of *albite*; they show a little developed idiomorphy, are seldom twinned after the albite-law, but often occur irregularly grown together into groups of 2—3 individuals. A beginning of decomposition shows itself in the appearance of opaque globulites, principally arranged parallel to the cleavage-directions. Quartz and orthoclase-phenocrysts are entirely wanting. The holocrystalline *groundmass* consists of lathshaped, seldom tabular, strongly undulous, and always after the albite-law twinned, irregularly diverging, now and then parallelly arranged acid *plagioclases*, cemented by grains of *quartz* with sometimes tolerably pronounced idiomorphy, then, however, always peripherically cut asunder fringelike by feldspar, mostly, however, without indication of crystallographic boun-



daries, and further by somewhat orthoclase. The feldspar shows only a very slight beginning of decomposition; on the other hand, especially scales of secondary colourless mica, beside them serpentinous products and a few irregular crystals of secondary amphibole, together with a here and there condensing globulitic troubling, probably caused by limonite, are often met with in the groundmass. Primary bisilicates, therefore, seem to be entirely wanting in the rock; the plagioclastic character of the feldspar marks the rock as a basic aplitic facies of microgranite, rich in  $\text{Na}_2\text{O}$ .

The chemical analysis yielded :

	%	Mol. Prop.	magn.	orth	alb.	anorth	cor.	hyp.	quartz
$\text{SiO}_2$	72.44	1.207	—	132	438	88	—	7	542
$\text{Al}_2\text{O}_3$	16.51	0.162	—	22	73	44	23	—	—
$\text{Fe}_2\text{O}_3$	0.24	0.001	1	—	—	—	—	—	—
$\text{FeO}$	0.52	0.007	i	—	—	—	—	6	—
$\text{MgO}$	0.05	0.001	—	—	—	—	—	1	—
$\text{CaO}$	2.47	0.044	—	—	—	44	—	—	—
$\text{Na}_2\text{O}$	4.54	0.073	—	—	73	—	—	—	—
$\text{K}_2\text{O}$	2.13	0.022	—	22	—	—	—	—	—
$\text{TiO}_2$	sp.	—	—	—	—	—	—	—	—
$\text{H}_2\text{O}-105^\circ$	0.13	—	—	—	—	—	—	—	—
$\text{H}_2\text{O}+105^\circ$	1.43	—	—	—	—	—	—	—	—
	100.16								

From which follows the following norm :

quartz	32.52	Q = 32.52	} F = 62.71	} Sal = 97.58
orthoclase	12.23			
albite	38.25			
anorthite	12.23			
corundum	2.35	C = 2.35	} Fem = 1.12	
hypersthene	0.89	P		
magnetite	0.23	M		

If we suppose the rock to be fresh, it takes a place in class I (Persalane); Subclass I (Persalone); Order 4 (Brittanare), Rank 2 (Toscanase); Subrank 4 (Lassenose). The question, whether it can be placed in the chemical system must be considered however in con-

nection with the discussed decomposition of the rock. As follows from the microscopic description, the considerable remainder of  $Al_2O_3$  after saturation of  $K_2O$ ,  $Na_2O$  and  $CaO$  in the feldspar molecules must at least for the greater part be attributed to the appearance of muscovite. If we take for muscovite the formula  $KH_3Al_3(SiO_4)_3$ <sup>1)</sup>, the  $Al_2O_3$ -remainder disappears with the presence of 5.84% orthoclase by the side of 9.15% muscovite. This last value, however, is exaggeratedly high. If however, in accordance with a microscopic estimate, a quantity of about 3% muscovite is assumed, and the remainder of the  $Al_2O_3$  is equally divided over  $K_2O$ ,  $Na_2O$  and  $CaO$ , in the supposition that these oxydes in the same measure have been removed by solutions, the following composition of the rock is obtained:

quartz	28.32	$Q = 28.32$	}	Sal = 95.60
orthoclase	12.79	$F = 67.28$		
albite	40.87			
anorthite	13.62			
muscovite	3.00		}	Fem = 1.12
hypersthene	0.89			
magnetite	0.23			
water	1.11			
Sum	100.83			

Now, if we leave muscovite, as of apparently secondary origin, out of consideration, still then the rock takes the same place in the chemical system:

$$\frac{\text{Sal}}{\text{Fem}} = \frac{95.60}{1.12} > \frac{7}{1}, \text{ Persalane}$$

$$\frac{Q}{F} = \frac{28.32}{67.28} < \frac{3}{5} \text{ and } > \frac{1}{7}, \text{ Brittanare}$$

$$\frac{K_2O + Na_2O}{CaO} = \frac{23 + 78}{49} = \frac{101}{49} > \frac{5}{3} \text{ and } < \frac{7}{1}, \text{ Toscanase}$$

$$\frac{K_2O}{Na_2O} = \frac{23}{78} < \frac{3}{5} \text{ and } > \frac{1}{7}, \text{ Lassenose.}$$

Against the name of lassenose can no doubt no serious objections be raised.

Instead of hypersthene the rock contains amphibole and serpentine, the first of which minerals being very rare, whilst the last mentioned is

<sup>1)</sup> ROSENBUCH, Mikrosk. Physiogr. 1, 2, p. 262. 1905.

<sup>2)</sup> To each of the  $K_2O$ ,  $Na_2O$  and  $CaO$ -molekules 5 has been added, of which 4  $K_2O$  molekules however, go to the muscovite, which is left out of consideration here.

principally confined to the holes, taking as appears from the low MgO-quantity, no important place in the analyzed rocksample.

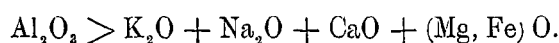
The molecular proportions yield,  $\text{Fe}_2\text{O}_3$  being reduced to FeO and the whole being calculated on a sum of 100:

$\text{SiO}_2$	$\text{Al}_2\text{O}_3$	FeO	MgO	CaO	$\text{Na}_2\text{O}$	$\text{K}_2\text{O}$
79.46	10.66	0.66	0.07	2.90	4.81	1.45

the formula according to OSANN.

	s	A	C	F	a	c	f	n	m	k	series
(OSANN)	79.46	6.26	3.63	—	12.66	7.34	—	7.7	—	1.73	av
(BECKE)	79.46	6.26	2.90	0.73	12.66	5.86	1.48			(10.0)	

Here we have the rare case that



If, like OSANN, we add MgO and FeO in the molecule  $(\text{MgFe})\text{Al}_2\text{O}_4$  to C, there remains a rest of  $0.77\text{Al}_2\text{O}_3$ ; if however like BECKE we neglect the  $\text{Al}_2\text{O}_3$  remainder above  $(\text{K}, \text{Na})_2\text{O} + \text{CaO}$ , equal to 1.50, then  $C = 2.90$  and  $F = 0.73$ . The calculation of  $a + c + f = 30$  yields:

	a	c	f
(OSANN)	18.99	11.01	—
(BECKE)	18.99	8.79	2.22

In the graphic notation IV denotes the place of the rock; the filled circle the values after OSANN, the not-filled circle the one after BECKE.

**Botany.** — “Some systematic and phytogeographical notes on the Javanese Casuarinaceae, especially of the State Herbaria at Leiden and at Utrecht.” (Contribution to the knowledge of the Flora of Java. N<sup>o</sup>. III).<sup>1)</sup> By Dr. S. H. KOORDERS.

#### § 1. Casuarina equisetifolia, Forst.

§§ 1. Geographical distribution outside Java: according to Hook, Flora Br. Ind. V. 598: in British India on the East side of the Gulf of Bengal, South of Chittagong, in the Malay Archipelago, in Polynesia and in Australia. In the State Herbarium at Leiden I saw, however, also specimens from Madagascar, Mauritius, Bourbon and Senegambia, although it did not appear with certainty from the herbarium labels, that they referred to uncultivated plants. In Herb. Leiden the species is also represented by specimens from

<sup>1)</sup> Continued from Transactions (Verhandelingen) Roy. Acad. Sciences Amsterdam Second Section Vol. XIV. (1908). N<sup>o</sup>. 4.