

Citation:

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If from this the vapour pressure is calculated at 360°, we find 440 mm., so far below the atmospheric pressure.

BAKER's vapour density determinations are carried out in boiling mercury (360°) both according to VICTOR MEYER's method and according to DUMAS. That the substance would have had such a small pressure in the first determinations is, indeed, little probable. Professor BAKER informed me that the DUMAS-bulb entirely filled with water after the experiment; the absence of air proves that the vapour pressure was not smaller than one atmosphere. Accordingly I am of opinion that BAKER's experiments cannot be explained by the current theoretical considerations either.

So we have here two series of experiments, those of JOHNSON and those of BAKER, which are both still unexplained. It is desirable in my opinion that the vapour tension determinations of dry ammonium chloride are carefully repeated. It can then appear at the same time whether the vapour tension lines of dry and humid NH_4Cl coincide or intersect; the latter is in my opinion the more probable according to the theoretical views.

Petrography. — "*On the post-carboniferous age of granites of the highlands of Padang.*" By Dr. H. A. BROUWER. (Communicated by Prof. G. A. F. MOLENGRAAFF).

(Communicated in the meeting of March 27, 1915).

The occurrence of young granites in the East Indian Archipelago has first been stated by MOLENGRAAFF¹⁾ as a distinct contact-metamorphism was observed by him at the contact of granites with rocks of the mesozoic, probably jurassic Danau formation.

Of late, mesozoic granites have been stated by WICHMANN²⁾ to occur also in the Moluccas, (Taliabu, Sula-isles).

In Sumatra, till of late all the granites have been considered as precarbonic ones, but the researches of these later years by SCRIVENOR, TOBLER and VOLZ have proved or made probable the occurrence of mesozoic granites in Sumatra and in the neighbouring Malacca³⁾.

¹⁾ G. A. F. MOLENGRAAFF. Geologische verkenningstochten in Centraal-Borneo p. 458. Leiden 1900.

²⁾ C. E. A. WICHMANN. On some rocks of the island of Taliabu (Sula Islands). Proceedings Royal Acad. of Sciences. Amsterdam. Vol. XVII (1914), p. 226.

³⁾ J. B. SCRIVENOR. The Rocks of Pulau Ubin and Pulau Nanas (Singapore). Quart. Journ. Geolog. Soc. 66. 1900. p. 429. A. TOBLER. Voorloopige mededeeling over de Geologie van de Residentie Djambi. Jaarb. Mijnw. Ned. Indië over 1910, p. 18—19. W. VOLZ. Oberer Jura in West-Sumatra. Centralbl. f. Min. 1913, p. 757.

In connection with the presupposed precarbonic age of all granites, the occurrence, in the Highlands of Padang, of rocks with contact-minerals (crystalline limestones with garnet and vesuviane-garnet-rocks, silicified marly claystones, a. o.), which often occur in immediate contact with granites, has been explained as a consequence of the intrusion of younger basic rocks (diabases, gabbro), and solutions that at the same time caused the formation of different ores, were supposed to have circulated at the very contact of the granite with the adjacent rocks.

In the following pages examples will be cited, from which it is evident that the metamorphism at the contact of granites and carboniferous — partly perhaps younger — sediments, agrees with that which is always considered as a proof for the younger age of the granites. The very interesting mineralogical characteristics of this contact-metamorphism will form the subject of a paper dealing more particularly with the matter, only the chief characteristics being mentioned here. I shall treat subsequently a granite-limestone-contact to the West of Kota Tua on the northern foot of the volcano Singgalan, a granite contact near Pamusian on the Sinamar, already mentioned by VERBEEK, and the contacts of the Siboumboun mountains (to the East of the Lake of Singkarah¹⁾, equally mentioned by VERBEEK.

Contact to the West of Kota Tua.

On the left wall of the river Sianog, before the mouth of the S^{ca} Limau originating on the volcano Singgalan, and close N.N.E. of the bridge along the road to Matour over the latter river, I found in a landslip a contact of granite and limestone strongly metamorphosed at the contact (fig. 1). As a matter of course, in con-

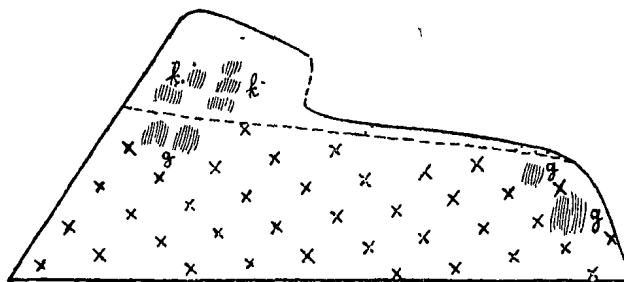


Fig. 1. Contact between granite and limestone, exposed in a landslip to the W. of Kota Tua (L = contactmetamorphic limestone, garnet-rock etc.).

¹⁾ R. D. M. VERBEEK. Topographische en Geologische Beschrijving van een Gedeelte van Sumatra's Westkust. Batavia 1883. p. 160, 242, 250, 254 etc.

nection with the metamorphic character no fossils were found in the limestone, but I can point to the fact that they appear just under the covering of younger volcanic material in the north-western continuation of the granites, diabases, gabbro, carbonic limestones, marls etc. in the regions of the Siboumboun mountains and of the Bukit Pandjang, where VERBEEK has been able to state the carboniferous age of the limestones by the discovery of fusulines, schwagerines, trilobites and other Permo-carboniferous fossils. Again, in other places as where these older rocks are exposed between younger volcanic products of the Singgalan and the Manindju area, limestones occur together with granites and basic eruptive rocks.

At a short distance up the river from the landslip, porphyritic granitic rocks with very large porphyritic crystals of feldspar are exposed on the left wall, the rocks near the contact in the landslip showing a much less distinct porphyritic structure, the groundmass being much finer granular, and the porphyritic crystals smaller; larger, macroscopically visible quartz-crystals only occasionally occur in these rocks. Even microscopically the latter rocks appear to contain but comparatively little quartz and to approach to quartz-diorites; the quartz-crystals are often enclosed by a large seam of a granophyric mixture. The feldspars consist for the greater part of plagioclase; zonal structure with alternative more basic and more acid zones, often occurs; some central feldspars were determined to be labradore-bytownite. In the groundmass, along with quartz and feldspars, calcite, muscovite, chlorite, ore, titanite, apatite and epidote are found. In connection with the comparatively small percentage of quartz, and the high percentage of plagioclase there is the possibility of the granites being endomorphically metamorphosed near the contact.

As to the limestones which microscopically have not yet been examined more closely I may state here that rocks which are rich in contact-minerals (a. o. garnet) and garnet-rocks, occur near the contact. Somewhat higher up, above the landslip, we again observe granite in contact with grey crystalline limestone, in which macroscopically no contact-minerals were observed.

The contact-relations mentioned above, may be plainly explained as a normal contactmetamorphism of the limestones by the adjoining eruptive rocks, the granites possibly being endomorphically metamorphosed near the contact.

Along the road from Kota Tua to Matour, not far beyond the watershed, I found similar rocks rather poor in quartz, near the contact with grey crystalline limestone; perhaps various rocks which VERBEEK brings to the diabases of the Manindju area, and in

some of which orthoclase occurs with plagioclase and quartz, may be in genetical connection with granites.

Although the limestones will provisorily be regarded as of carboniferous age, we must point to the fact that VOLZ¹⁾ has found in limestones of this area a Milloporide, *Myriopora Verbeeki*, which corresponds to the *Stromatopora Japonica* which has already been described by YABE²⁾, and has been found in intermediate strata between the jurassic and cretaceous formations in Japan; thus various limestones of Sumatra, the age of which had hitherto not been determined, may be much younger (late mesozoic).

The constitution of the rock between Ahour and Tampouroungo, described by VERBEEK as a quartz-diorite, also contains far more plagioclase than orthoclase; although elsewhere occur some veins of quartz-diorite in granite, still often the two rocks graduate insensibly into one another, which points to about equal age. In connection with a small seam of a malacolite rock occurring near Ahour at the contact of the quartz-diorite with carboniferous limestone, VERBEEK considers it possible that this quartz-diorite is post-carboniferous.

Contact near Pamusian.

The kampong of Pamusian on the Sinamar can be reached by various footpaths from the road Pajakombo—Bua, e. g. from Halaban. One passes the Sinamar over a very primitive swinging bridge of rottan. Near this bridge, down the river, contacts of granite with various metamorphic sediments are exposed on both sides of the river.

A. *Left side of the Sinamar.* Between the kampong and the bridge of rottan, when the water-level is not too high, the contact of granites is plainly uncovered on this side of the river. Up the river from the kampong, we find at the contact a complex of often banded, compact to fine-crystalline siliceous rocks, among which occurs dark-coloured fine-crystalline hornfels containing much biotite. The macroscopically compact rocks also show clear signs of contact metamorphism; from a preliminary examination of some samples on 7 or 8 metres from the contact. light-coloured parts turned out to consist of a mixture of quartz with grains and short crystals of augite, or of a mixture of quartz and feebly-coloured amphibole with or without flakes of brown biotite. Occasionally also calcite occurs in these rocks. In the darker coloured parts the biotite can sometimes be seen with the naked eye.

¹⁾ W. VOLZ, l.c. p. 755.

²⁾ H. YABE, On a mesozoic *Stromatopora*, Journ. Geol. Soc. Tokyo 1903.

At a short distance farther up the river, the left wall consists of granites. Here groups of sediments occur altered into hornfels, some of which appeared microscopically to consist of a quartz-biotite mixture with tourmaline, farther up the river light-coloured rocks containing garnet and hornfels containing mica being found on the contact with the granites, at some meters from the river-side. Downstream from the rottan-bridge, very near to it, a complex of strata is exposed, the harder rocks of which are stronger weathered out, the softer layers being washed away. The hard rocks probably are partly silicified marly rocks, crystalline to a small degree or not at all, sometimes showing light-coloured circular or elliptic sections that look much like those of the crinoid-rocks and -marls of Timor. I am strongly inclined to suppose the metamorphosed rocks of the contact above the kampong of Pamusian not to be older than carboniferous. Similar contact metamorphic rocks are of large extent in the Siboumboun mountains and there too they may easily be explained by contact-action of the granites.

Down the river from the kampong, at the first turn of the river to the right, rocks of granite emerge from the water when the level is not too high, on the left bank coarse-crystalline white limestones being exposed near the granites; macroscopically no contact-minerals could be observed in these limestones. At a short distance farther up the river on the left side, weathered granitic rocks with hard unweathered nodules are exposed, this being a characteristic often shown by these rocks also elsewhere in the Highlands of Padang.

B. Right side of the Sinamar. Near the rottan-bridge on the right bank granite is exposed in a steep wall. Farther down the river, the right bank lies thickly strewn with huge blocks of dark fine-crystalline hornfels, in some blocks the very contact with the granite being visible, whereas in others irregular granite-apophyses occur. Here too granite and its contact rocks are accidentally exposed as solid rocks.

This fine-crystalline dark hornfels macroscopically much resembles the felspar-hornfels described by the author at the contact of the granitic area of the Rokan-regions¹⁾. VERBEEK²⁾ already mentions felspar hornfels of Pamusian; he describes them as dark-grey, fine-crystalline very hard rocks, which macroscopically appear to consist

¹⁾ H. A. BROUWER. On the granitic area of Rokan (Middle-Sumatra) and on contact-phenomena in the surrounding schists. These Proc. XVII (1915), p. 1190.

²⁾ R. D. M. VERBEEK. l c. p. 179.

of quartz, brown and green mica in very numerous flakes and long cross-sections, plagioclase, opaque feldspars and iron ores. The laminated granite-apophyses alternating with the felsparhornfels near the contact of Rokan, were not found here.

Contacts of the Siboumboun mountains.

In the geologically and petrographically very interesting Siboumboun mountains, to the east of the lake of Singkarah, the contact of granitic rocks and of sediments described by VERBEEK ¹⁾ as carboniferous, appears clearly, especially so in the river Timbuloun, where it forms a small waterfall, partly over contact-metamorphic limestone, partly over the adjoining granites, opposite the Bukit-Tambang.

The granite contains dark-coloured inclusions; they are often sharp-edged, and their number increases near the contact. In close contact with the granites various rocks occur, being partly massive rocks of garnet, partly rocks containing much epidote, or apparently not very crystalline grey rocks without macroscopically visible contact-minerals and with veins of rocks rich in garnet or epidote. The plane of contact is sometimes very irregular. In the rocks containing much epidote and in the rocks which apparently are not very crystalline calcite-crystals of large size enclosing other minerals, sometimes are recognizable from lustrous cleavage-planes.

A few meters from the contact the character of the metamorphic rocks is less varying. First, we see a zone of some meters thickness of a white crystalline limestone with many brownish-red crystals of garnet bands which are very rich in garnet, alternate with bands which are very poor in them; farther from the contact massive garnet rocks are found, still farther white crystalline limestones appear, containing again garnet crystals, which occur in different layers with more or less frequency and which emerge as warts on the weathered surface.

In the neighbourhood, garnet-rocks are found in several places in close contact with granites; and crystalline limestones with or without contact-minerals very often occur, the contact with garnet-rocks being e. g. clearly exposed further down the river on the right wall of the river Timbuloun, close up the river from the left tributary Nibong. The garnet-rocks are often impregnated with copper- and iron ores.

Elsewhere in Sumatra the copper ores appear to be bound to

¹⁾ R. D. M. VERBEEK. l. c. p. 242, 249. Id. Geologische Beschrijving van het Siboumboengebergte. Jaarb. Mijnw. 1876. II. p. 51.

the eruption of diabases, and to be deposited from circulating solutions during or after the eruption. However, there is no reason for attributing the formation of the contact-rocks found everywhere in the Siboumboun mountains, to contactmetamorphism by diabases which are not exposed; in the northern part we find gabbro, and everywhere else granitic rocks exposed at the very contact. The latter rocks are of great extent in the Siboumboun mountains.

The summit of a small hill on the eastern slope of the Bukit Tambang consists of crystalline limestone, in which bands rich in garnet and vesuvianite alternate with others containing little or none of these minerals. These bands are vertical and rest immediately upon a weathered granite, which is crossed by the footpath from Timbuloun to Dammer. These contact-limestones are beautiful rocks, with excellent contact-minerals on their weathered surfaces. Also siliceous rocks, showing clear signs of contact-metamorphism in the neighbourhood of granites (and gabbro) occur in numerous places in the Siboumboun mountains (surroundings of Batu Mendjular, of Limau Purut, of Timbuloun etc.); they will not be described more closely in this previous paper. Sometimes these rocks much resemble those mentioned above, occurring at the contact of granites near Pamusian on the left side of the Sinamar.

The age of the quartz-porphyry of the Siboumboun mountains.

Quartz-porphyries occur along with the granites, the rocks graduating into each other. Probably they are different facies of the granites, and of about the same age as these rocks.

Near the confluence of the river Silaki and its tributary Kapu these quartz-porphyries, in immediate contact with the limestone, are exposed. Occasionally this limestone, by the development of garnet and other contact-minerals, also shows clear signs of contact-metamorphism, this fact inducing us to suppose the quartz-porphyry also to be of post-carboniferous age.

It appears from the foregoing that at the contact of various granite rocks of the Highlands of Padang a distinct contactmetamorphism could be stated, and that a carboniferous (or later) age may be taken as certain at least for a part of these metamorphosed rocks. Thus part of the granites is post-carboniferous of age.

From the examination of the many rocks which I have collected, interesting results may be expected concerning the nature of the exomorphic and endomorphic contactphenomena, and the mutual connection of the different types of eruptive rocks.

Part of the granites and of similar rocks of the Highlands of Padang may very possibly be pre-carboniferous. But the missing of contact phenomena in adjoining limestones cannot count as a proof of a pre-carboniferous age, if part of these limestones is mesozoic; moreover the walls of limestone continuing sometimes uninterruptedly without transgression, conglomerates and without veins of granite or contact phenomena over the limit of granites and the surrounding sediments, may possibly be brought into contact with the granites by overthrusts, after the intrusion of these latter rocks; so that still these granites could very possibly be younger than carboniferous limestones resting upon them.

As to the rocks of upper-triassic limestone, which on the isle of Timor give to the landscape a similar peculiar character as many limestones of Sumatra and the "Klippen" of the Alps and the Carpathian mountains, MOLENGRAAFF¹⁾ and WANNER²⁾ suppose them to be the erosion-rests of an overthrust sheet. For Djambi TOBLER³⁾ has already suggested that the carboniferous rocks of Sangir-Pulau-Bajor, together with the mass of the Pulasian-Plepat-granites, is to be considered as an overthrust sheet. In the Highlands of Padang too there are signs which make possible a geological structure characterised by large overthrusts; however, to bear out this supposition we want further information concerning the age of the different rocks (for a good deal mesozoic and originally taken together as "old slates"), and concerning different facies of the carboniferous and these mesozoic sediments.

Physics. — "*The clustering-tendency of the molecules in the critical state and the extinction of light caused thereby*". By Dr. F. ZERNIKE. (Communicated by Prof. LORENTZ).

(Communicated in the meeting of February 26, 1916).

1. In a former paper by ORNSTEIN and the author¹⁾ an improved formula was derived for the scattering of light by a single substance in the neighbourhood of the critical point. In that paper the inaccuracy of former approximate formulae, which gave an infinitely strong

¹⁾ G. A. F. MOLENGRAAFF. Overschuivingen in overschuivingsbladen op de eilanden Timor en Leti Voordracht gehouden in de Bestuursvergadering van 18 Januari 1913. Tijdschr. Kon. Ned. Aardr. Gen. 2. XXX. p. 273. 1913.

²⁾ J. WANNER. Geologie von West-Timor, Geologische Rundschau Bd. IV. Heft 2.

³⁾ A. TOBLER. l.c. p. 29.

⁴⁾ These Proceedings XVII, p. 793. This paper will here be indicated by l. c.