minimum in India and Australia and weakened by the maximum, as must undoubtedly be the case, the successive stages may be imagined as follows. During the barometric minimum an increased mixing takes place with the cool air from higher latitude together with an increased supply of cold water. By these causes after the barometric minimum a temperature minimum is developed in the lower strata of the atmosphere. In the upper strata, however, by the greater heat of condensation, resulting from the increased ascending motion of the air, a temperature maximum will develop simultaneously with the barometric minimum and this maximum will in its turn determine and strengthen the barometric minimum. This latter process will continue until the progressive sinking of the temperature of the water and the air below, cause the condensation to diminish and the atmospheric pressure to rise by a smaller supply of water-vapour and greater density of the air and in this way the following phase is prepared.

The energy required for keeping up this process is partly supplied by the increased heat of condensation during the barometric minimum and may for another part be derived from the interaction with the active centres of higher latitude where the deviations, once started, reinforce themselves, contrary to the tropical system of circulation where they are self-regulating [1]).

Weltevreden, May 10, 1912.

Geology. — "*On Orbitoids of Sumba*". By Dr. L. RUTTEN. (Communicated by Prof. A. WICHMANN).

(Communicated of the meeting of September 28, 1912).

From Professor WICHMANN I received a short time ago a small collection of specimens of rocks and fossils belonging to a collection gathered by Mr. H. WITKAMP, geologist of the Bataafsche Petroleum-Maatschappy in the southern part of the Island of Sumba.

I beg to communicate here some particulars about the Orbitoids found in this collection. In 5 of the samples sent to me I discovered Orbitoids i.e. in 4 numbers (81, 114, 166 and 167) the subgenus Orthophragmina, and in 1 number (105) the subgenus Lepidocyclina.

[1]) Cf. Metereol. Zeitschr. loc. cit.

Orthophragmina.

Previous findings in the Dutch East Indies.

The first Orthophragmina were described by R. D. M. VERBEEK [1]) from South-East Borneo. A few years afterwards his material was investigated by VON FRITSCH [2]), who determined 5 species. A short time after K. MARTIN [3]) reported the existence of Orbitoids with Nummulites of the river Teweh in South Borneo, whilst TH. POSEWITZ had collected in the neighbourhood of Muara Teweh analogous Orthophragmina as VERBEEK had gathered in South-East Borneo [4]).

In recent times H. DOUVILLÉ [5]) and IRENE PROVALE [6]) have again described Orthophragmina of South Borneo whilst the latter determined moreover a series of Orthophragmina of Udju Halang on the Upper-Makaham (Central Borneo) [7]).

Of West Borneo we know through JENNINGS [8]), and R. B. NEWTON and R. HOLLAND [9]) some findingplaces of Orthophragmina.

In Java Orbitoides with rectangular median chambers have been found at the surface in the residences of Bagelen, of Djokjokarta and of the Preanger [10]) Regencies, whilst also in a boring near Ngembak (Recidency of Samarang) a few Orthophragmina were found [11]).

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[1]) R. D. M. VERBEEK. Die Nummuliten des Borneo-Kalksteines. Neues Jahrbuch für Mineralogie etc. 1871, p p. 1—11.

[2]) K. v. FRITSCH. Einige eocäne Foraminiferen von Borneo. Jaarboek van het Mijnwezen in Ned.-Indië. 1879. 1. p.p. 236—251.

[3]) K. MARTIN. Neue Fundpunkte von Tertiärgesteinen im Indischen Archipel. Samml. Geol. Reichsmuseums. Leiden. (1). 1. 1881—83, p.p. 131—193.

[4]) TH. POSEWITZ. Das tertiäre Hügelland bei Teweh. Nat. Tijdschr. van Ned.-Indië XLIII. 1884, p p. 169—175. — TH. POSEWITZ. Borneo. 1889. p.p. 383—384.

[5]) H. DOUVILLÉ. Les Foraminifères dans le tertiaire de Bornéo. Bull. Soc. géol. de France. (4). 5. 1905, p p. 435—464.

[6]) I. PROVALE. Rivista italiana di Paleontologia. 15. 1909. p.p. 65—96.

[7]) I. PROVALE. Rivista italiana di Paleontologia. 14. Perugia 1908, p.p. 55—80.

[8]) A. V. JENNINGS. Geological Magazine (3). 5. 1888. p p. 530—532.

[9]) R. B. NEWTON and P. HOLLAND. Annals and Magazine of Natural History. (7). 3. 1899, p.p. 245—264.

[10]) R. D. M. VERBEEK. Tijdschr. Ned. Aardr. Genootschap. 1, Amsterdam 1876, p.p. 291 et seq.

K. MARTIN. Samml. Geol. Reichsmuseums. Leiden. (1). 1. 1881—83. p.p. 105—130.

R. D. M. VERBEEK. Natuurkundig Tijdschrift van Nederl.-Indië. 51. 1892. p.p. 101—138,

R. D. M. VERBEEK et R. FENNEMA. Description géologique de Java et Madoura. 1896. Tome 2.

C. SCHLUMBERGER. Bull. Soc. géol. de France. (4). 3. 1903. p.p. 293 et seq.

H. DOUVILLÉ. Samml. des Geol. Reichsmus. Leiden. (1). 8. 1904—12. p.p. 279—294.

[11]) K. MARTIN. Samml. des Geol. Reichsmus. Leiden. (1). 3. 1887. p.p. 327 et seq.

For a short time past Orthophragmina of Nias [1]) are known, whilst in the eastern part of our archipelago they were found in West Celebes [2]), West Timor, the new island near Ut, Great Kei, Kilwair, Tofuré, in New-Guinea eastward of the Etna Bay, Rendjuwa [3]) and in West Buru [4]).

With the great number of very often incompletely described species of Orthophragmina that are known from the Dutch East-Indies, it will often be difficult to decide with which species a special form must be classed; fortunately this difficulty did not present itself with regard to the Sumba material, as the Orthophragmina in question belong to 2 wellknown species, O. javana Verb. and O. dispansa Sow., as will appear from the description.

Orthophragmina javana VERBEEK.

Syn. O. papyracea Boubée, in von Fritsch 1879?
O. papyracea Boubée, var. javana in Verbeek. T. A. G. 1.
O. papyracea Boubée, var. javana in Verbeek 1892 and 1896.
O. dispansa Sow. in Martin 1881 (partim).
O. javana Verbeek in Douvillé 1905.
O. javana Verbeek in Douvillé 1912.
Discocyclina discus Rütimeyer in Verbeek 1908. p. 304.

From the finding-place n°. 105 I received 5 isolated Orthophragmina, which, though they are very different in size (diam. 6, 12, 14, 24 and 27 mm.), cannot be separated from one another and must be classed with one species.

The pretty well conserved fossils have the form of regular lenses, showing either no central chamber at all or one which is but little pronounced in its youth; most of them are symmetrically thickened towards the centrum; the specimen of 27 mm. diameter had a thickness of 6 mm. The surface of the fossils is somewhat disintegrated, so that the fine-granular, dense, and very symmetrical granulation cannot very well be seen. Three horizontal sections were made, from which it appeared that the larger specimens of 24 and 27 mm. diameter were microspheric and the one of 12 mm.

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[1]) H. DOUVILLÉ. Samml. des Geol. Reichsmuseums Leiden. (1). 8. 1904—12. p.p. 253—278.

[2]) H. DOUVILLÉ. l.c. 1905.

R. D. M. VERBEEK. Molukkenverslag. Jaarb. van het Mijnw. Wetensch. Ged. XXXVII. 1908, p.p. 54, 80, 81.

[3]) R. D. M. VERBEEK. l.c. 1908. p.p. 398, 625, 613, 616, 255, 474, 754 en 304.

[4]) J. WANNER. Centralbl. für Mineralogie, Geologie und Paläontologie. 1910, p. 140.

diameter was megalospheric. With regard to the two first-mentioned specimens I did not succeed in including the little embryonal chamber into the preparation.

1. Megalospheric form.

The median plane is but little curved: the median chambers form frequently incomplete circles round the very large embryonal chambers, whose maximal and minimal diameters are 2500 μ and 1800 μ. The parietis of the embryonal chamber is thin. The peripherical, median chambers of the first round are larger than those situated more outward:

1st round diameter of the chamber radiary 190 μ, tangentially 55—75 μ
more peripherically maxim. diameter radiary 150 μ, tangentially 60 μ.

2. Microspheric form.

In these large Orbitoids of exterior regular lensshape the median plane shows a strong saddle-shaped curve, as in the median horizontal section only narrow ligaments of median chambers running hyperbolically have been struck (comp. VERBEEK and FENNEMA 1896. Pl. 10, Fig. 150). The radiary diameter of the median chambers increases from the centre of the periphery, though constantly smaller chambers are scattered among the larger ones. The normal dimensions of the chambers are about:

At 2 mm. from the centre: radiary 45-75 μ, tangentially 35-55 μ.
Nearer to the periphery: „ 135-190 μ, „ 35-55 μ.

The grouping of the intermediate skeleton-columns to which of late, for a systematical purpose, DOUVILLÉ (l. c, 1912) attaches such a great value can distinctly be observed. Their thickness in tangential diameter is 55—95 μ, it may be however that very near the periphery they are a little thicker. As a rule columns are only separated from each other by a single row of spacious lateral chambers.

Consequently the exterior habitus and structure of these Formanifera correspond very well with the forms described by VERBEEK (1896) as O. papyracea var. javana and with those described by DOUVILLÉ (1912) as O. javana, only the megalospheric form of this species was not yet known hitherto.

From the finding-place near Mount Madu (n°. 81) I received two Orbitoids (diam. 14 and 30 mm.) which correspond very well with the former, and the larger of which was again microspheric. I succeeded in including into the preparation the very small embryonal chambers round which the first peripherical cham-

bers are grouped in circles. The tangential diameter of these first rounds of peripheric chambers is larger than the radiary one (comp. VERBEEK 1896, pl. 10 f. 157). The columns are here a little thicker (100—180 μ) than with the forms described above; they show both in a transversal and in a longitudinal section a very distinct, fibrous structure. The lumen of the lateral chambers is in a vertical direction very wide and their horizontal parietes are very thin.

From the finding-place N°. 167 *a* I received likewise a specimen of O. javana.

Orthophragmina dispansa Sowerby.

Syn. O. dispansa Sow. in VON FRITSCH 1879?
O. dispansa Sow. in VERBEEK 1892 and 1896.
O. dispansa Sow. in MARTIN 1881 (partim) and 1887.
O. dispansa Sow. in DOUVILLÉ 1912.

The rock N°. 16 is entirely filled up with Orbitoids which, by disintregation, are partly laid bare, so that their exterior habitus can be studied. The maximal diameter amounts to 9 mm, the height to 3 mm. The fossils are considerably thickened in the centre, whilst at the periphery they have an excessively thin edge. The surface is strongly granulated; the granulae however are not symmetrically divided over the whole surface. They are largest on the central tubercle (100—190μ), towards the periphery they become very small, but on the very thin edge again larger granulae are perceptible.

Though in general the granulae are separated by a single row of spacious lateral chambers, it often occurs that there are two rows of chambers between them.

In sections only macrospheric individuals were found. The diminutive size and the spacious lateral chambers make this form correspond entirely to O. dispansa Sow, as DOUVILLÉ described them a short time ago (1912).

Rare specimens of Calcarina and little Nummulites are found in the limestone N°. 238, together with these Orthophragmina, whilst it is by no means impossible that still another very thin Orthophragmina is met with; the material was however insufficient to decide in this respect.

Lepidocyclina.

The brecciated rock N°. 105 contains many but fragmentary fossils, among which Lithothamnium, Cycloclypeus, Heterostegina, and Lepidocyclina can be recognized.

The individuals of the latter genus seem to reach a size of about 10 mm.; the median chambers are spatulated to rhombic. It is impossible specifically to determine them for want of orientated sections, and isolated specimens.

Since VERBEEK's publication of 1892, nearly all authors on Indian Orbitoids agree that Lepidocyclina and Orthophragmina never occur together in one stratum, and that the latter are characteristic of the Eocene, the former of the Upper-Oligocene and Miocene.

J. PROVALE (l. c. 1908) holds a different view, she describes Orthophragmina and Lepidocyclina of Udju Halang in Central Borneo, which are said to proceed from one stratum, whilst G. OSIMO [1]) has mentioned rare Lepidocyclina of West Celebes (Donggala) that are reported to occur with eocene Nummulites. These assertions should, however, be accepted with some reserve.

In the first place at Udju Halang Lepidocyclina and Orthophragmina are not found in one and the same rock (PROVALE l. c. 1909 p. 75) [2]), so that it is likely that they occur in the proximity of each other, but not in the same stratum.

The same possibility, however, exists for the findingplaces near Donggala, the more so as VERBEEK (l. c. 1908, p.p. 58, 59) ascertained for the surroundings of Pangkadjéné and Maros, northward from Makassar the existence of eocene limestone with Orthophragmina, and of oligo-miocene limestone with Lepidocyclina the one in the proximity of the other.

For the present we may consequently certainly stick to the old view that in India Orthophragmina characterizes Eocene, Lepidocyclina on the other hand the Upper-Oligocene, so that from the above we may make the conclusion that in Sumba both Eocene and Miocene must be found. The limestone and marls of Sumba that are known up to the present (VERBEEK l. c. 1908) originated from the northern part of the island and were usually very young; the older ones were most likely classed with Miocene.

Buitenzorg, August 1912.

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[1]) G. OSIMO. Rivista italiana di Paleontologia. 14 Perugia 1908, p.p. 21—54.

[2]) I. PROVALE indicates in this place the age of the Orthophragmina as eocene, that of the Lepidocyclina as oligocene. (?)

Chemistry. — "*On the Quaternary system: $KCl—CuCl_2—BaCl_2—H_2O$.*" By Prof. F. A. H. SCHREINEMAKERS and Miss W. C. DE BAAT.

(Communicated in the meeting of September 28, 1912).

In the previous articles [1]) we already discussed the equilibria occurring at 30° in the quaternary systems:

$$NaCl — CuCl_2 — BaCl_2 — H_2O$$

and

$$NH_4Cl — CuCl_2 — BaCl_2 — H_2O$$

In the first system no double salt is formed, in the second occurs the double salt $CuCl_2 . 2\,NH_4Cl . 2\,H_2O$. As in the system:

$$KCl — CuCl_2 — BaCl_2 — H_2O$$

two double salts may appear, we have now investigated this system also.

The two double salts are:

$$D_{1.2.2} = CuCl_2 . 2\,KCl . 2\,H_2O$$

and

$$D_{1.1} = CuCl_2 . KCl .$$

The equilibria occurring have been investigated at 40° and 60°; these temperatures have been chosen purposely because at the first temperature (40°) only one of the double salts ($D_{1.2.2}$) still occurs; at the other temperature (60°) both double salts appear.

In the ternary system $KCl — BaCl_2 — H_2O$ occur as solid substances, at 40° and 60° KCl and $BaCl_2 . 2\,H_2O$ so that the isotherms also consist of two saturation lines.

The monovariant *(P)* equilibria occurring in the ternary system $KCl — CuCl_2 — H_2O$ have been described previously by W. MEYERHOFFER [2]); the isotherm of 30° has been determined by H. FILIPPO [3]).

From these investigations it follows that below 57°, in addition to KCl and $CuCl_2.2H_2O$ also occurs the double salt $D_{1.2.2}$, between 57° and 92° the double salts $D_{1.2.2}$ and $D_{1.1}$ and above 92° only the double salt $D_{1.1}$.

The isotherm of 40° therefore consists of the saturation lines of: KCl , $CuCl_2.2H_2O$ and $D_{1.2.2}$, that of 60° of the saturation lines of KCl , $CuCl_2.2H_2O$, $D_{1.2.2}$ and $D_{1.1}$.

The equilibria appearing in the quaternary system may be represented in space, in the well known manner with the aid of a tetrahedron, whose four apexes indicate the four components: KCl, $CuCl_2$, $BaCl_2$ and water. In Figs. 1 and 2 is found a projection of the

[1]) F. A. H. SCHREINEMAKERS and Miss W. C. DE BAAT. Chem. Weekbl. 1908.

[2]) W. MEYERHOFFER. Z. f. Phys. Chem. 3 336 (1889).

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[3]) H. FILIPPO. Not yet published.