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Geology. — *"On Tin-ore in the Island of Flores"*. By Prof. A. WICHMANN.

(Communicated in the meeting of June 29, 1918).

Some years ago I maintained on the ground of geological studies that tin-ore does not occur in the island of Flores, at all events not to an amount worth mentioning [1]). As appeared from a memoir brought forward last year by Prof. S. J. VERMAES, the author is otherwise-minded [2]). I think it worth while to study the author's arguments, which he pretends to be based on the doctrine of the deposition of ore, on ethnography and on metallurgy.

Geological researches have not been made in Flores of late years, so that in this respect there was no need for revising my paper. Nevertheless Prof. VERMAES supposes he has been fortunate enough to make a discovery, which throws a new light upon the matter [3]). This finding appears to be nothing else but a piece of tin-ore, exposed in the Colonial Museum at Harlem, "weighing 131 grms and composed of chlorite and tin-ore with fissures, in which occurs some kaoline. Besides the two mentioned minerals a single grain of chalcopyrite is also noticeable".

Prof. VERMAES altogether fails to see that the finding place "Gunung Rokka", indicated on the label must be fictitious, since the mountain — the Inije Rije of the natives — is a volcano and even now is in the condition of solfataric activity [4]). Indeed, not one of the researchers has ever found the least indication of the occurrence of ores on that mountain and even C. J. VAN SCHELLE, who never shrank from a bold hypothesis, has wisely refrained from making inquiries after tin-ore in the volcanoes of Flores. He looked

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[1]) "On the tin of the Island of Flores". These Proceedings Amsterdam. Vol. 17, 1914, p. 474—490.

[2]) Tinerts op Flores. De Ingenieur. **32**. 's Gravenhage 1917, p. 584—590.

[3]) l. c. p. 584.

[4]) J. J. PANNEKOEK VAN RHEDEN. Overzicht van de geographische en geologische gegevens, verkregen .... van het eiland Flores in 1910 en 1911. Jaarboek van het Mijnwezen in Ned.-O.-Ind. **40**. 1911. Batavia 1913, blz. 219—220. — Eenige geologische gegevens omtrent het eiland Flores. Jaarboek van het Mijnwezen. **39**. 1910. Batavia 1912. Verhandelingen, p. 135—136.

for it, at haphazard in a district supposed by him to contain tin-ore, which was partly overlaid by volcanic formations [1]).

As to his arguments based on metallurgy, it strikes us that Prof. VERMAES has deemed it unnecessary to inquire further into the matter as regards tin, or he could not have written as follows: "He (WICHMANN) also cites what he wrote before, namely that tin-ore could not be reduced by burning grass. I have often seen alang-alang burning, still I *would not make bold to say on metallurgical grounds what* WICHMANN *presumes* [2])". A geologist will not confine himself to merely "see" an alang-alang field "burning", but will also try to watch the effect such a fire has on the components of the soil under it. I myself experienced that the volcanic sand and the lapilli of augite-andesite at the foot of the Batu angus baru in the Minahassa did not change a bit. Nor could anything else be expected, for the grass (*Imperata cylindrica* Beauv.) furnishes such an insignificant quantity of fuel that it is burnt away in a trice. This short burning process does not even extend as far as the roots, so that when the West Monsoon sets in, the grass begins to sprout again.

Prof. VERMAES continues: "We read, however, in VAN SCHELLE's report: ""When the forests are on fire, part of the ore seems to be reduced . . . ."", after which Prof. VERMAES concludes: "If, therefore, a mass of tin-ore is imbedded near the surface in the root-leaves of a large tree and, after felling the tree, a pile of combustible materials is kindled at the stump, *there is no doubt but that the tin-ore is reduced to metal* [3])".

First and foremost I wish to quote a passage from P. VAN DIEST's well-known work on Banca: "The remainders of a charcoal-furnace [4]) are identified by the natives as the spot near which it is supposed that tin was first discovered in Banca, that is after the burning of part of the forest near the spot [5]). The belief in those stories is negatived even more, when we reflect that the heat produced by a burning pile of tree-trunks is not adequate to reduce tin-ore without a certain amount of coal being mixed with them, especially

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[1]) Verslag van het onderzoek naar het voorkomen van tinertshoudende gronden op Flores. Extra-Bijvoegsel der Javasche Courant. Batavia 1890. N°. 10. (Uittreksel: Tijdschr. voor Nederl.-Indië. Zaltbommel 1890. 2, p. 79).

[2]) The italics are mine.

[3]) The italics are mine.

[4]) On the Sambong giri hill near the Lindjoe mine.

[5]) Tradition says this happened in 1710. (F. EPP, Schilderungen aus Archipel. Indiens Heidelberg 1841, p. 134; J. H. CROOCKEWIT. Banka, Malakka and Billiton. The Hague 1852, p. 134).

not in the case of the coarse-granular ore at the foot of this hill [1])".

This assertion is apparently founded on the fact that tin-ore is one of the minerals that are difficult of fusion, but that it is easily reduced to tin by the addition of charcoal. This assertion does not satisfy us any more than VERMAES's pronouncement that *"there is no doubt but that the tin-ore is reduced to metal"*, by means of a burning pile of wood. An experiment does not seem to have ever been made.

The melting point of tin-ore as established by R. S. CUSACK at 1127° C. [2]), seems to me to be too low, as higher points are found [3]) for much more fusible minerals, e. g. for augite 1100°—1200° (according to C. DOELTER [4])) and for plagioclases (labradorite to oligoclase) 1130°—1300° [5]). Anyhow CUSACK's melting point (1127°) being even higher than the heat produced by the burning of living wood — the only wood we have to deal with — it is obvious that a burning wood cannot reduce tin-ore to tin. Moreover, whereas alang-alang fires may occur repeatedly every year towards the close of the West-monsoon, forest-fires are decidedly the exception, so that even on this account the required amount of tin could not have been produced in this way.

Furthermore, it still remains to be seen whether the expected result can be obtained even at high temperatures. In modern mineralogical textbooks and manuals — with a few exceptions — the hypothesis is advanced that tin-ore does not undergo any change, when the blowpipe is applied. This squares entirely with the results most inquirers are capable of achieving in connection with the difficulty of mastering some facility in handling the blowpipe. Years ago BERZELIUS wrote: "Das Oxyd verändert sich und schmilzt nicht, aber von einem starken und anhaltenden Reduktionsfeuer kann reines Zinnoxyd ganz und gar ohne Zusatz zu Zinn reducirt werden. Dies erfordert indessen eine Gewohnheit das Löthrohr zu gebrauchen." [6]) This is in character with C. F. PLATTNER's opinion, who,

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[1]) Bangka, beschreven in reistochten. Amsterdam 1865, p. 68.

[2]) On the melting points of minerals. Proceed. R. Irish Acad. of Sc. (3) **4**. Dublin 1896—98, p. 413.

[3]) Beziehungen zwischen Schmelzpunkt und chemischer Zusammensetzung der Mineralien. Tschermaks Miner. petrogr. Mittlg. **22**. Wien 1903, p. 399—311.

[4])C. DOELTER, Handbuch der Mineralchemie **1**. 1912, p. 663.

[5]) The above mentioned melting-points are somewhat too low, as the author himself has acknowledged afterwards (Handbuch der Mineralchemie 2. 1. Dresden — Leipzig 1914, p. 579).

[6]) Von der Anwendung der Löthrohrs in der Chemie und Mineralogie. Uebersetzt von H. ROSE. Nürnberg 1821, p. 113—114. At present it is extremely difficult to ascertain whether any writer before BERZELIUS has obtained the same result.

however, adds that in this process a white layer of tin-oxide is formed.[1]) W. A. Ross, on the contrary, maintains that the ore does not melt "aber eine weisse *Ausblühung* kommt hervor"[2]). GIORGIO SPEZIA again believes that the ore changes, but "non par fusione ma par consumo" and he tries to account for the behaviour of the tin-ore by stating that in consequence of the intense heat a reduction takes place indeed, but that it is incontinently followed by an oxidation evolving the white layer.[3]) Should this interpretation be correct, there cannot possibly be any question about reducing tin-oxide by heat alone. Now which of us is, to quote from Prof. VERMAES, the "metallurgist of Flores" who has indulged in fancies[4])? And when the same writer continues: "WICHMANN ought to have considered that such utterances cannot but be fatal to the upgrowth of a mining concern, of which many experts anticipate great success", I feel urged to say that it is rather disappointing to find that still in the year 1918 one is obliged to appeal to the timeworn maxim that the man of science does not ask whether or no anything is fatal in its effect on a mining concern but that he considers his sole task to be to find the Truth. Apart from this, the effect of science can never be fatal, at all events not for those who know how to study it; on the other hand it is always inspiriting, even when an inquiry yields a negative result. If the mining industry had paid more regard to science, they would have been spared many disappointments in the island of Celebes and they could have saved many people's capital. Presumably they will not have become wiser by this time, in spite of all this.

Furthermore, if we reflect that tin foundries in Flores cannot be imagined without charcoal furnaces and agglomerations of tin-slags of which no trace was ever found, we are safe to say that Prof. VERMAES's endeavours to prove the occurrence of tin-ore on metallurgical grounds have utterly failed.

We shall have to dwell more at large on his arguments derived from ethnography. In estimating his material Prof. VERMAES has entirely neglected to ascertain whether the premiss from which he started was correct, which is a common mistake among ethnologists.

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[1]) Probirkunst vor dem Löthrohre. 5. Aufl. bearbeitet von TH. RICHTER. Leipzig 1878, p. 136.

[2]) Das Löthrohr in der Chemie und Mineralogie, übertragen von B. COSMANN. Leipzig 1889, p. 161.

[3]) Sulla fusibiltà dei minerali. Atti R. Accad. delle sc. 22. Torino 1886—87, p. 422.

[4]) l.c. p. 588.

An early illustration of this error was afforded by J. H. CROOCKEWIT, who considered the absence of tin-objects in Billiton — those that were found there had been imported from Banca — to lend support to his hypothesis that *no* tin-ore was to be found in that island. [1]) Conversely C. J. v. SCHELLE's whole argumentation rested *only* on the fact that natives of Flores were found in possession of tin objects etc., on which fact also Prof. VERMAES set so high a value. This is the logic of a Papuan, who, judging from the knives and axes he gets from the merchants in exchange for his birds of paradise, believes that Holland is rich in iron-ore.

The truck to which the natives attach great value does not only serve as an ornament, but also as a form of investment, as sometimes occurs in Europe also. There is even among uncivilised nations a liking for capitalization, especially among the more intelligent part. This tendency increases with the degree of personal safety. That is why the government of a Western Power has always encouraged "capitalization". The natives' choice of articles of investment is very limited compared with that of Europeans, who prize stocks and other paper value so highly. Such articles must be proof against the influences of the climate and moreover be gaudy and showy. In districts where Europeans have settled or in not too insignificant commercial centra coined money, "rijksdaalders", [2]) and especially gold coins are greatly in favour.

If the soil does not produce the desired objects, as is the case in nearly all the islands of the Timor Archipelago [3]), the native is obliged to look about for foreign objects. Next to weapons and other iron tools all the native tribes set great value upon the "muti tanah", dirty-coloured orange-red glass beads. They are skilfully wrought, but not beautiful and owe their value rather to being "antique" and to the fact, that they were not imported after the pre-historic period, i. e. after the arrival of the Europeans.

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[1]) Extract from the report of a journey across the island of Billiton (Natuurk. Tijdschr. Ned. Ind. 3 Batavia 1852, p. 401.

[2]) Dutch coin worth 4/2.

[3]) It is true, gold and copper occur in Timor, but by far not sufficiently to meet the demand for those metals. Moreover the occurrence of ores does not prove at all that the natives are skilled in metallurgy. The inhabitants of Billiton e g. were entirely unacquainted with the art of reducing tin from tin ore, whereas from time immemorial they are quite familiar with the more complicated process of working iron, and it was only recently that F. SARASIN declared: "Die Kunst Metalle zu bearbeiten, haben die Caledonier trotz des enormen Reichtums des Landes an solchen, speziell von Eisen, nie gekannt und auch heute noch nicht gelernt" (Neu-Caledonien. Basel 1917, p. 83).

It is remarkable that in Flores the same legend about their origin prevails as regarding tin, viz. that they have been formed in the soil itself in consequence of the burning of alang-alang; they are accordingly called "muti tanah", that is: earth-beads. About their origin we are still as much in the dark as about that of the glass objects found in the South-Sea islands. Beside a marked concordance in their taste for beads the islanders of the East-Indian Archipelago evince none the less a vast difference respecting the other favourite objects for capitalization. While "moko-moko", peculiar kettledrums made of brass, are in vogue in the Alor-islands, elephants' tusks are generally in favour in the Solor-islands coming next to them in a western direction. In West-Flores there prevails a fancy for tin-ornaments, while the inhabitants of Rotti prefer chains made of gold-wire.

The reasonings of C. J. VAN SCHELLE and of Prof. VERMAES would lead us to conclude that there are coppermines in the Alor-islands, herds of elephants in the Solor-islands and gold-diggings in Rotti. It would be throwing words away to say more about it, but we wish to say a few words more about the tin objects of Flores.

Prof. VERMAES might adduce the argument that there is not a single record extant to support the assertion that tin or tin objects were imported into Flores. But the same argument could apply to the elephants' tusks of the Solor-islands. In the second half of the previous century cast moko-mokos were introduced into Java from Grissee, but the natives soon found out that they were imitations. In Rotti, where not a single grain of gold has ever been found, an old branch of industry has revived in consequence of the sale of horses to Australia, which brought a large number of sovereigns to the island, which were wrought into gold chains [1]).

To support his argumentation Prof VERMAES has added to his memoir not only a number of fine illustrations, but also numerous analyses of the metallic objects found in the island. I hope they will prove most interesting for the ethnography of Flores, but they are not relevant to the origin of the metals.

I can imagine the possibility of establishing through analysis that a table spoon has been procured by such and such a firm, but hundreds of analyses cannot enable us to establish the source of the silver used to make the spoon.

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[1]) The Rottinese are very superior in civilization to the people in Alor and Flores, who possess but little skill in working metals. J P. FREYSS says about them: "the art of forging is very little advanced among the inhabitants of West-Flores." (Reizen naar Mangarai.... Tijdschr. Ind. T. L. en Vk. 9. Batavia 1860, p. 511).

It strikes us that in former times neither export nor import of tin objects was ever thought of [1]). In the long run such a trading possibility could not have escaped European enterprise, no more than the trade in "Billiton-axes" and "Tambuku swords". It attracts our attention, however, that the tin objects in this poor island are found in the southwestern part in the possession of the natives. This might be due to the presence of tin-ore in that part; however the conclusion might also be drawn that the population disposes of more truck and consequently obtains possession of such objects as their countrymen in other parts must do without.

According to GODINHO DE EREDIA "cinnamon" [2]) was exported from these parts already in the time of the Portuguese settlement [3]) and the fort in Nusa Endeh was certainly not built only for the purpose of protecting the Dominicans. That also this product attracted the notice of the East-Indian Company is borne out by the report of P. A. LEUPE on the discussions at Batavia in 1757, which says: "They had still to contrive a means to get possession of the cinnamon-wood Rokko in Endeh [4])", and according to J. C. M. RADEMACHER it was in the year 1756 that "the Company permitted the natives of Makassar to trade on Endeh and the Mangary *provided no wild cinnamon was* exported, on the penalty of confiscation of ships and cargo" [5]).

Nearly sixty years ago J. P. FREYSS still wrote: The gathering of wax and cinnamon constitutes the chief commercial resource [6]). The natural result of this trade was a comparatively higher degree of prosperity than was enjoyed by their countrymen, whose income, derived from woodproducts, was smaller and who therefore had

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[1]) As I mentioned before only in 1871 J. A. VAN DER CHIJS made mention of the export of tin arm- and leg-rings from the Rokka district. (Tijdschr. v. Nijverheid en Landbouw in Nederl.-Indië **16**. Batavia 1871, pp. 158—159).

[2]) No doubt *Cassia* was meant. (J. G. F. RIEDEL The island of Flores or Pulau Bunga. Revue colon. internat. 1. Amsterdam 1886, p 66).

[3]) ANTONIO LOURENÇO CAMINHA, Ordonaçôes da India do Senhor Rei D. Manoel de eterna memoria Informaçâo verdadeira da Aurea Chersoneso feita pelo.... MANOEL GODINHO DE EREDIA. Lisboa 1807, p. 143 (written in 1599).

[4]) Besognes der Hooge Regeering te Batavia gehouden over de commissie van Paravacini naar Timor in 1756. Bijdr. t. de T., L. en Vk. (4) **1**. 's Gravenhage 1877, p. 479.

[5]) Korte beschrijving van het eiland Celebes en de eilanden Floris, Sumbawa, Lombok en Baly. Verhandel. van het Batav. Genootsch. van K. en W. **4**. Batavia 1786, p. 252.

[6]) Reizen naar Mangarai en Lombok in 1854—1856. Tijdschr. Ind T., L. en Vk. **9**. Batavia 1860, p. 512.

to be content with bartering their articles for necessaries of life, whereas the Rokkanese could also acquire articles of luxury. What, however, were the events that stopped the import of *muti tanah* and the objects made of tin, will long remain a puzzle, perhaps for ever.

Prof. VERMAES has prefixed to his mémoir the following quotation from CROOCKEWIT, as a motto: "I feel justified in concluding from these inquiries, made in three different ways, that the ore found in Billiton does not contain tin oxide" [1]). The tendency of this motto was to stigmatize my being mistaken with regard to Flores as CROOCKEWIT had been with regard to Billiton. As appears from the foregoing Prof. VERMAES has not succeeded in demonstrating that tin-ore occurs in Flores; the comparison therefore halts, and was at the very least premature. He has mistaken the persons also in another respect. It was not I, but VAN SCHELLE who, just as CROOCKEWIT, started from faulty premisses; it was not I but VAN SCHELLE whose inquiries, just as CROOCKEWIT's, led to wrong conclusions. No wonder that both failed.

[1]) Extract from the report of a journey through the island of Billiton. (Natk. Tijdschr. Ned. Ind. 3. Batavia 1852, p. 401.