PROPERTIES AND CONSTITUTION OF A VOLCANIC SOIL, BUILT IN 50 YEARS IN THE EAST-INDIAN ARCHIPELAGO

BY

PROF. J. VAN BAREN
WAGENINGEN

WITH 2 MAPS; 2 PHOTOGRAPHS; 6 MICROPHOTOGRAPHS
AND A COMPLETE BIBLIOGRAPHY
OF THE GEOLOGY OF THE KRAKATAU-GROUP

SAMENVATTING IN HET NEDERLANDSCH
ZUSAMMENFASSUNG IN DER DEUTSCHEN SPRACHE
RÉSUMÉ EN FRANÇAIS

Mededeelingen van de Landbouwhoogeschool
Deel 35 — Verhandeling 6

H. VEENMAN & ZONEN — WAGENINGEN — 1931

PROPERTIES AND CONSTITUTION OF A VOLCANIC SOIL, BUILT IN 50 YEARS IN THE EAST-INDIAN-ARCHIPELAGO

by Prof. J. van Baren, Wageningen

Everyone knows the history of the stupendous volcanic explosion of the Krakatau (Krakatoa; Rakatoa) in the Sunda Strait, between Sumatra and Java, on the 26th and 27th August 1883, so elaborately described in VERBEEK'S famous work. A large part of Krakatau disappeared, enormous quantities of dust were projected into the atmosphere spreading around the globe and the two neighbour-islands, Verlaten Eiland (Forsaken Isle) and Lang-Eiland (Long Isle) were covered with volcanic material.

Though many botanists and zoologists visited Krakatau to study the flora and the fauna, no scientist was interested to study the *soil*, its properties and constitution, built since 1883.

Thanks to the cooperation of Mr. A. C. DE JONGH, Chief of the Netherlands East Indian Geological Survey (Bandoeng); Mr. CH. E. STEHN, Chief of the Netherlands East Indian Volcanological Survey (Bandoeng); the Director of the station for water-research in Manggarai, Mr. P. C. MOM and the volcanological observator on Lang-Eiland Mr. F. ECOMA VERSTEGE, I was able to obtain material to study the microscopical, physical, chemical and bacteriological constitution. Dr. L. MÖSER in Giessen (Germany), verified on my request the presence (or absence) of 27 constituents.

My Colleague in microbiology at this University arranged the study of the microbes by his scholar Mr. SCHUITEMAKER (now in the East Indian Archipelago).

My hearty thanks to all these collaborators.

The methods used are described in *English* in: J. VAN BAREN, Microscopical, physical and chemical Studies of limestones and limestone-soils from the East Indian Archipelago (Communications from the Geological Institute of the Agricultural University, Wageningen, Holland, No. XIV, 1928);

and in *German* in: J. VAN BAREN, a.o., Vergleichende mikroskopische, physikalische- und chemische Untersuchungen von einem Kalkstein und einem Löss-Bodenprofil aus den Niederlanden; Vergleichendes Studium von einem Kalkstein-Bodenprofil aus Holland und einem Kalkstein-Bodenprofil aus Java. (Ibidem, No. XVI, 1930.)

I. TOPOGRAPHY

According to VERBEEK the square area of Lang-Eiland (Malayan: Poeloe Rakata Ketjil) was before 1883: 2,9 km^2, in 1885: 3,2 km^2.

The topographical map of the Krakatau-group shows, that the highest point is 147 m above sea-level.

II. GEOLOGY

Whoever is interested in the geology of the Krakatau-group may consult the complete bibliography at the end of this memoir.

CH. E. STEHN, in his paper entitled, *The geology and volcanism of the Krakatau-group* (printed as part I of the booklet Krakatau, offered to the members of the Fourth pacific science congress, Batavia 1929) gives the latest summary. In this paper 3 chemical analyses of seawater are given, in order to study the influence of the latest eruptions of Krakatau on the composition of the sea-water and 8 analyses of the older and newer volcanic material of Lang-Eiland.

The analyses give the percentages of 15 constituents, viz.: SiO_2 – Al_2O_3 – Fe_2O_3 – FeO – MnO – MgO – CaO – Na_2O – K_2O – TiO_2 – Cl – SO_3 – P_2O_5 – H_2O + – H_2O –.

III. CLIMATE AND VEGETATION

By kind permission of Mr. CH. E. STEHN, Chief of the Netherland East Indian Volcanological Survey, I here communicate the rainfall and the temperature observed on Lang-Eiland during 1929.

a. Rainfall

Jan.	Febr.	March	April	May	June	
356,5	619,5	266,5	178	72	138	
13,61 % of the total	23,65	10,17	6,79	2,75	5,27	
July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
9	79	–	68,3	244,7	588,5	2620 mm
0,34	3,01	–	2,61	9,34	22,46	100%

b. Temperature

Jan.	Febr.	March	April	May	June	
27,7° C	27,9	27,4	27,8	28,2	27,3	
July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
26,9	27,6	28,6	28,7	28,2	26,9	27,8° C

c. Rainfactor (LANG)

$$\frac{\text{Annual rainfall}}{\text{Annual temperature}} = \frac{2620}{27,8} = \mathbf{94.}$$

d. Chemical constitution of rainwater from Lang-Eiland and Batavia

	Lang-Eiland		Manggarai Mr. Cornelis near Batavia
	Febr. 1930	June 1930	Nov. 1931
pH	5,2	6,6	4,6
HCO_3	nihil	nihil	6,1 mg/l
$KMnO_2$	3,6 mg/l	1,1 mg/l	6,6 mg/l
NH_3	0,1 mg/l	trace	0,18 mg/l
proteid NH_3	nihil	nihil	nihil
NO_2	0,02 mg/l	0,01 mg/l	nihil
NO_3	trace	0,1 mg/l	nihil
Hardness (German grades)	0	0,8	0
Ca	nihil	trace	nihil
Mg	nihil	trace	nihil
Fe	nihil	nihil	nihil
Mn	nihil	nihil	nihil
CO_2	—	11,– mg/l	2,2 mg/l
SO_4	nihil	nihil	nihil
Cl	trace	trace	nihil
Dry-rest	20 mg/l	55,2 mg/l	5,2 mg/l
Rest after ignition	15 mg/l	30,4 mg/l	2,1 mg/l

These analyses are the first, as far as I know, from rain-water of the isle of Java.

e. Vegetation

Ferns; grasses (*Imperata* sp.); *Casuarina ; Ficus.*

IV. THE SOIL-PROFILE

On the 31st October 1928, Mr. F. ECOMA VERSTEGE collected on the westcoast of Lang-Eiland, 50 m from the southern radio-antenna, height about 50 meter above sea-level, on a spot, where the total thickness of the pumice was > 40 meter a profile, consisting of 3 samples:

A. the under-layer = the mother-rock. Thickness: 42 meters.
B. the middle-layer, between A and C. Thickness?
C. the upper-layer, surface-soil. Thickness: 35 centimeters.
D. weathered rock-fragments in C.

6

V. MINERALOGICAL RESEARCH

a. Thin sections

Glassy pumice; magnificent amorphous fluidal structure; a great number of gasbubbles in pearlchains; hypersthene, amphibole with inclusions, augite and andesine in well-built crystalline form; the last often with anormal double-refraction; the amorphous mass often partly dark-black.

b. The minerals, prepared from the material: a. dry; b. after treating with water and c. after boiling with diluted HCl.

C. The humic surface-layer.

Amphibole, lightgreen till darkgreen, often with cristallographical planes, with inclusions of unknown nature. The surface possesses often a burned crust.

Amphibole, brown, strong-pleochroitic.

Anhydrite, microchemical reaction on SO_4 positive.

Apatite, colorless; occurs only as an inclusion in plagioclase and hypersthene; one time in plagioclase as a crystal with prism, pyramid and basal plane; in needles with beautiful basal cleavage.

Augite, darkgreen, with good cleavage and burnt surface.

Hypersthene, green till yellow, pleochroism well-defined, many fragments with crystal-planes.
Inclusions of magnetite. On the surface gas-bubbles.
As an inclusion in plagioclase and in this hypersthene an inclusion of apatite.

Ilmenite, well-built crystals, often with impressions.

Kyanite, blue till colorless (fig. 1), one time as an inclusion in plagioclase.

Magnetite, in magnetic [1]) grains, rare as octahedron.

Olivine, green; irregular grains.

Plagioclase, (Andesine) the most frequent occurred mineral; idiomorphic crystals often in polysynthetic twinnings; zonal buildings; optical anomalous extinction (molecular strain ?).
Inclusions from hypersthene, magnetite and apatite.
Refractory index = 1,555.

[1]) See for non-magnetic grains my study on limestone and limestone-soils (Communication No. XIV of this laboratory, p. 15).

Plagioclase often luted with amphibole, augite, ilmenite, magnetite and – plagioclase itself.

Remarkable is the occurrence of a great number of gasbubbles *in* the andesine and the often gaseous surface. One time a little isomorphic crystal *in* a great isomorphic one.

Pyrite, with coloured lustre.

Quartz, some colorless grains; clear uni-axial positive.

Volcanic glass, colorless with gasbubbles, inclusions of apatite-needles; when colored brown and black (= obsidian); one time brown with white inclusions of unknown nature. Some round, black buttons of (what seems to be) *Billitonite* (?), but pits or furrows absent.

Wollastonite, colorless; fibrous; rare.

B. Partly weathered middle-layer, between C and A.

The minerals, found in this layer, are the same as the minerals of the C-layer, but luted.

A. The under-layer = the mother-rock.

Great fragments of the rock = pumice with small holes in which glassy threads, glassy feldspar with gasbubbles along the sides and inclusions of apatite, amphibole, ilmenite in the middle.

REPARTITION OF THE MINERALS IN THE 3 LAYERS

	C Surface-layer (soil)	B Middle-layer (transition between rock and soil)	A Rock
Amphibole, green	×	×	×
Amphibole, brown	○	○	—
Anhydrite*	○	—	—
Apatite	○	○	○
Augite	×	×	×
Hypersthene	×	×	×
Ilmenite	×	×	×
Kyanite	○	○	×
Magnetite	×	×	×
Olivine	○	○	○
Plagioclase	+	+	+
Pyrite*	○	—	—
Quartz	○	—	—
Volcanic glass	×	×	×
Wollastonite*	○	—	—
	15	11	10

+ = very much; × = much; ○ = few; — = absent; * = new-built.

Tridymite and Cordierite meet by VERBEEK (tridymite) and HARLOFF (Cordierite) have not been found.

V. CHEMICAL ANALYSES

From the volcanic ashes and the pumice, fallen on the isles of the Krakatau-group a great number of chemical analyses were made. Whoever is interested in these must read the French edition of VERBEEK'S standardwork on Krakatau and the work of Mr. CH. E. STEHN already cited.

The analyses, communicated here, were made, on my request, by Dr. L. MÖSER (Giessen). They are the first complete analyses from Lang-Eiland and the most complete one, ever made from rocks and soils of the Dutch East Indies.

	A Rock in %	B Middle-layer in %	C Surface-layer in %	D weathered fragments from C. in %
1. SiO_2	67,55	65,87	61,13	63,77
2. TiO_2	0,70	0,83	0,93	0,96
3. ZrO_2	0,03	0,015	0,01	0,025
4. Al_2O_3	15,19	16,31	17,24	15,67
5. Fe_2O_3	1,52	1,74	2,56	2,89
6. Cr_2O_3	0,01	0,01	0,005	trace
7. V_2O_3	0,005	0,005	0,005	trace
8. FeO	2,15	2,05	2,59	2,15
9. MnO	0,17	0,18	0,18	0,14
10. NiO	0,001	trace	—	trace
11. CaO	2,89	3,07	3,61	2,86
12. SrO	trace	trace	trace	trace
13. BaO	0,027	0,030	0,025	0,016
14. MgO	0,72	0,74	0,76	1,09
15. Na_2O	4,47	4,01	3,90	4,28
16. K_2O	1,95	1,53	1,78	1,70
17. Li_2O	trace	trace	trace	trace
18. $H_2O + 110°$ C.	2,46	3,17	3,25	3,16
19. $H_2O - 110°$ C.	0,04	0,33	1,53	1,27
20. CO_2	—	—	0,04	0,06
21. SO_3	0,005	0,007	0,007	0,007
22. SO_2	—	—	—	—
23. Sulfid-S	0,040	0,032	0,025	0,025
24. P_2O_5	0,04	0,22	0,22	0,17
25. Cl	0,024	0,198	0,017	0,010
26. Organic matter	—	—	0,45	—
	99,992	100,347	100,264	100,253
27. Later on Dr. Möser determined also the N-percent.	0,018	0,012	0,035	0,027

Exchangeable Ca of the surface-layer: 0,~~027~~ 562 %.

a. Molecular-ratio.

	A. Rock in %	B. Middle-layer in %	C. Surface-layer in %	D. weathered fragments from C. in %
SiO_2	69,015	66,002	60,128	62.815
TiO_2	0,536	0,628	0,687	0,712
ZrO_2	0,018	0,009	0,005	0,014
Al_2O_3	9,155	9,643	10,005	9,106
Fe_2O_3	0,585	0,658	0,948	1,075
Cr_2O_3	0,006	0,006	0,002	trace
V_2O_3	0,001	0,001	0,001	trace
FeO	1,842	1,721	2,135	1,776
MnO	0,147	0,151	0,148	0,118
NiO	0,0006	trace	—	trace
CaO	3,172	3,304	3,819	3,029
SrO	trace	trace	trace	trace
BaO	0,010	0,012	0,008	0,005
MgO	1,102	1,105	1,115	1,603
Na_2O	4,442	3,909	3,730	4,098
K_2O	1,275	0,978	1,120	1,069
Li_2O	trace	trace	trace	trace
H_2O	8,551	11,739	15,734	14,606
CO_2	—	—	0,053	0,083
SO_3	0,003	0,004	0,004	0,004
SO_2	—	—	—	—
Sulfid-S	0,073	0,054	0,041	0,041
P_2O_5	0,018	0,090	0,088	0,071
Cl	0,030	0,332	0,027	0,017
	99,9816	100,346	99,798	100,242

	Soluble in HCl			Insoluble in HCl		
	A. Rock in %	B. Middle-layer in %	C. Surface-layer in %	A. Rock in %	B. Middle-layer in %	C. Surface-layer in %
SiO_2	1,72	3,83	7,87	65,83	62,04	53,26
TiO_2	0,09	0,16	0,25	0,61	0,67	0,68
ZrO_2.......	traces	traces	traces	0,03	0,015	0,010
Al_2O_3	0,17	0,58	2,98	15,02	15,73	14,26
Fe_2O_3	0,56	0,79	1,88	0,96	0,95	0,68
Cr_2O_3	0,008	0,008	0,005	0,002	0,002	0
V_2O_3	0,005	0,005	0,005	0	0	0
FeO.......	0,25	0,30	0,72	1,90	1,75	1,87
MnO	0,02	0,03	0,06	0,15	0,15	0,12
NiO	traces	0	0	0,001	traces	0
CaO.......	0,20	0,21	0,67	2,69	2,86	2,94
SrO	0	0	0	traces	traces	traces
BaO	0	0	0	0,027	0,030	0,025
MgO.......	0,10	0,11	0,47	0,62	0,63	0,29
Na_2O......	0,36	0,32	0,22	4,11	3,69	3,68
K_2O	0,13	0,12	0,12	1,82	1,41	1,66
Li_2O	traces	traces	traces	0	0	0
SO_3	0,005	0,007	0,007	0	0	0
P_2O_5......	0,04	0,10	0,18	0	0,12	0,04
	3,658	6,570	15,437	93,770	90,047	79,515
Rest	93,58	89,61	79,11			
H_2O	2,50	3,50	4,78			
Cl, S, N ...	0,082	0,242	0,527			
	99,820	99,922	99,854			

MOL. RATIO

	Soluble in HCl			Insoluble in HCl		
	A. Rock in %	B. Middle-layer in %	C. Surface-layer in %	A. Rock in %	B. Middle-layer in %	C. Surface-layer in %
SiO_2	2,00	4,42	9,38	71,62	67,98	58,72
TiO_2	0,08	0,14	0,22	0,50	0,55	0,33
ZrO_2.......	0	0	0	0,01	0,01	0,01
Al_2O_3	0,12	0,39	2,09	9,62	10,13	9,26
Fe_2O_3	0,24	0,34	0,83	0,39	0,39	0,28
Cr_2O_3	0	0	0	0	0	0
V_2O_3	0	0	0	0	0	0
FeO.......	0,24	0,29	0,72	1,73	1,60	1,72
MnO	0,02	0,03	0,06	0,14	0,14	0,11
NiO	0	0	0	0	0	0
CaO.......	0,25	0,26	0,86	3,14	3,36	3,48
SrO	0	0	0	0	0	0
BaO	0	0	0	0,01	0,01	0,01
MgO.......	0,17	0,19	0,84	1,01	1,03	0,48
Na_2O......	0,40	0,36	0,26	4,33	3,90	3,93
K_2O	0,10	0,09	0,09	1,27	0,99	1,17
Li_2O	0	0	0	0	0	0
SO_3	0	0,01	0,01	0	0	0
P_2O_5.......	0,02	0,05	0,09	0	0,06	0,02
	3,64	6,57	15,45	93,77	90,15	79,52

b. Weathering-quotient.

$$ki = \frac{SiO_2}{Al_2O_3} \times 1{,}7. \qquad K = \frac{\text{ki soil}}{\text{ki rock}}$$

ki A, rock $= \frac{67{,}55}{16{,}19} \times 1{,}7 =$ 7,56

ki B, middle-layer $= \frac{65{,}87}{16{,}31} \times 1{,}7 =$ 6,86

ki C, surface-layer $= \frac{61{,}13}{17{,}24} \times 1{,}7 =$ 6,03

$\frac{\text{ki surface-layer}}{\text{ki rock}} = \frac{6{,}03}{7{,}56} = K =$ 0,93

$\frac{\text{ki middle-layer}}{\text{ki rock}} = \frac{6{,}86}{7{,}56} = K =$ 0,91

$\frac{\text{ki surface-layer}}{\text{ki middle-layer}} = \frac{6{,}03}{6{,}86} = K =$ 0,87

$$ba = \frac{CaO \times 1{,}822 + Na_2O \times 1{,}646 + K_2O \times 1{,}082}{Al_2O_3}.$$

$$B = \frac{\text{ba soil}}{\text{ba rock}}.$$

ba A, rock $= \frac{2{,}89 \times 1{,}822 + 4{,}47 \times 1{,}646 + 1{,}95 \times 1{,}082}{15{,}19} =$ 0,96

ba B, middle-layer $= \frac{3{,}07 \times 1{,}822 + 4{,}01 \times 1{,}646 + 1{,}53 \times 1{,}082}{16{,}31} =$ 0,85

ba C, surface-layer $= \frac{3{,}61 \times 1{,}822 + 3{,}90 \times 1{,}646 + 1{,}78 \times 1{,}082}{17{,}24} =$ 0,86

$\frac{\text{ba surface-layer}}{\text{ba rock}} = \frac{0{,}86}{0{,}96} = B =$ 0,89

$\frac{\text{ba middle-layer}}{\text{ba rock}} = \frac{0{,}85}{0{,}96} = B =$ 0,89

$\frac{\text{ba surface-layer}}{\text{ba middle-layer}} = \frac{0{,}86}{0{,}85} = B =$ 1,01

c. $Al_2O_3 = 1$.

Chemical components		Molecular ratio	$Al_2O_3 = 1$	
A. Rock				
Al_2O_3	15,19 %	0,1486		= 1,—
SiO_2	67,55 %	1,1202	$\frac{1,1202}{0,1486}$	= 7,54
CaO	2,89 %	0,0515	$\frac{0,0515}{0,1486}$	= 0,35
MgO	0,72 %	0,0179	$\frac{0,0179}{0,1486}$	= 0,12
K_2O	1,95 %	0,0207	$\frac{0,0207}{0,1486}$	= 0,14
Na_2O	4,47 %	0,0721	$\frac{0,0721}{0,1486}$	= 0,49
H_2O + 110° C.	2,46 %	0,1365	$\frac{0,1365}{0,1486}$	= 0,92
H_2O — 110° C.	0,04 %	0,0022	$\frac{0,0022}{0,1486}$	= 0,15
B. Middle-layer				
Al_2O_3	16,31 %	0,1596		= 1,—
SiO_2	65,87 %	1,0924	$\frac{1,0924}{0,1596}$	= 6,84
CaO	3,07 %	0,0547	$\frac{0,0547}{0,1596}$	= 0,34
MgO	0,74 %	0,0183	$\frac{0,0183}{0,1596}$	= 0,11
K_2O	1,53 %	0,0162	$\frac{0,0162}{0,1596}$	= 0,10
Na_2O	4,01 %	0,0647	$\frac{0,0647}{0,1596}$	= 0,41
H_2O + 110° C.	3,17 %	0,1759	$\frac{0,1759}{0,1596}$	= 1,10
H_2O — 110° C.	0,33 %	0,0183	$\frac{0,0183}{0,1596}$	= 0,11

Chemical components		Molecular ratio	$Al_2O_3 = 1$
C. Surface-layer			
Al_2O_3	17,24 %	0,1687	= 1,—
SiO_2	61,13 %	1,0138	$\frac{1{,}0138}{0{,}1687} = 6{,}01$
CaO	3,61 %	0,0644	$\frac{0{,}0644}{0{,}1687} = 0{,}38$
MgO	0,76 %	0,0188	$\frac{0{,}0188}{0{,}1687} = 0{,}11$
K_2O	1,78 %	0,0189	$\frac{0{,}0189}{0{,}1687} = 0{,}11$
Na_2O	3,90 %	0,0629	$\frac{0{,}0629}{0{,}1687} = 0{,}37$
H_2O + 110° C.	3,25 %	0,1804	$\frac{0{,}1804}{0{,}1687} = 1{,}07$
H_2O — 110° C.	1,53 %	0,0849	$\frac{0{,}0849}{0{,}1687} = 0{,}50$
D. Weathered fragments from C.			
Al_2O_3	15,67 %	0,1533	= 1,—
SiO_2	63,77 %	1,0575	$\frac{1{,}0575}{0{,}1533} = 6{,}90$
CaO	2,86 %	0,0510	$\frac{0{,}0510}{0{,}1533} = 0{,}33$
MgO	1,09 %	0,0270	$\frac{0{,}0270}{0{,}1533} = 0{,}18$
K_2O	1,70 %	0,0180	$\frac{0{,}0180}{0{,}1533} = 0{,}12$
Na_2O	4,28 %	0,0690	$\frac{0{,}0690}{0{,}1533} = 0{,}45$
H_2O + 110° C.	3,16 %	0,1754	$\frac{0{,}1754}{0{,}1533} = 1{,}14$
H_2O — 110° C.	1,27 %	0,0705	$\frac{0{,}0705}{0{,}1533} = 0{,}46$

VIII. PHYSICAL RESEARCH

a. Color.

	A Rock white	B Middle-layer white	C Surface-layer grey
(Klinksieck and Valetta) No. ..	153*a*	153*a*	148

b. Mechanical analyses (With KRAUSS elutriator).

	B Middle-layer	C Surface-layer
2 –0,2 mm	25,2 %	29,1 %
0,2 –0,1 mm	11,4 %	14,9 %
0,1 –0,05 mm	15,9 %	14,0 %
0,05–0,02 mm	18,7 %	15,9 %
0,02 mm	22,4 %	26,1 %
floating on the water	6,4 %	–
	100,0 %	100,0 %
c. Watercapacity	50,25%	51,94%
d. Hygroscopicity	4,5%	5,9%

e. Ph value, colorimetrical determined by means of the „Hellige Komparator".

A Rock	B Middle-layer	C Surface-layer
5,3	5,8	6,0

f. Radio-activity.

On my request, Prof. Dr. FERD. SCHMIDT, Heidelberg, examined the radio-activity of the surface-layer (C), the middle-layer (B) and the rock (A) and wrote me, dd. 28th Nov. 1930: „Die mir übersandten drei Proben Vulkanasche habe ich mehrmals mit der empfindlichsten gamma-Strahlmassmethode unseres Institutes auf Radio-aktivität untersucht. Alle drei Proben zeigen *keine* Radio-aktivität".

VIII. MICROBIOLOGICAL RESEARCH

My colleague in microbiology at this University, Prof. Dr. N. L. SÖHNGEN, wrote me (date 8-10-1929): „Mr. SCHUITEMAKER, agricultural engineer, studied, on your request, in my laboratory the microbes in the surface-layer (C) of your material from Lang-Eiland and compared the results with those of the surface-soil of the garden of my laboratory.

The approximative numbers (in 1 gram soil) are the following:

	Lang-Eiland	Wageningen
Bact. coli	10.000–100.000	100–1.000
Anaerobic organisms fermenting starch (amylum)	10.000–100.000	1.000–10.000
Organisms fermenting ureum	100.000–1.000.000	10.000–100.000
Denitrifying bacteria (nitrate)	10–100	100–1.000
Denitrifying bacteria (nitrite)	100–1.000	10–100
Azotobacter	100–1.000	100–1.000
Nitrifying bacteria ($CaCO_3$)	100–1.000	10–100
Nitrifying bacteria ($MgCO_3$)	100–1.000	100–1.000
Aerobic organisms fermenting starch (amylum)	1.500.000	2.500.000

These results are to be considered as preliminary.

IX. CONCLUSIONS

In Lang-Eiland we have for the first time an excellent occasion to get an idea about the rapidity and intensity of „tropical weathering"[1] far from human influences. We learn from the given dates, that in a period of 50 years humus has been formed for 0,45%; SiO_2, Na_2O and K_2O are decreased; Al_2O_3, Fe_2O_3 and H_2O(−110° C) increased. For the rest, one can study the following table:

	Lang-Eiland (pumice)	Java (limestone)	Holland (limestone)	Holland (loess)
K. (see p. 12)	0,93	0,74	0,28	1,20
B. (see p. 12)	0,89	0,0003	0,0008	0,28

(Al_2O_3 = 1; mol. ratio).

	Lang-Eiland		Java		Holland		Holland	
	Pumice	Pumice soil	Lime-stone	Lime-stone-soil	Lime-stone	Lime-stone-soil	Loess	Loess soil
SiO_2	7,54	6,01	3,61	2,66	58,56	16,39	14,82	17,70
CaO	0,35	0,38	626,75	0,12	630,13	0,24	1,89	0,21
MgO	0,12	0,11	6,76	0,06	9,78	0,13	0,43	0,16
K_2O	0,14	0,11	0,04	0,002	1,43	0,20	0,29	0,23
Na_2O	0,49	0,37	0,03	0,003	0,65	0,12	0,24	0,23
H_2O (+110°C.)	0,92	1,07	9,19	2,28	17,73	2,21	1,37	1,19
H_2O(½110°C.)	0,15	0,50	1,77	2,45	15,95	2,31	1,18	1,15

[1]) Compare the rain-analyses.

HET BODEMPROFIEL VAN HET VULKANISCHE LANG-EILAND

(KRAKATAU-GROEP)

Ofschoon wij van de flora en fauna van het eiland Krakatau, na de uitbarsting van 1883 meer of min goed onderricht zijn, weten wij van den verweeringsgrond, waarin de planten wortelen, niets af, nòch van dit eiland, nòch van de twee naburige eilanden: het Verlaten-Eiland en het Lang-Eiland. Dit was aanleiding te trachten materiaal te verwerven voor een uitvoerig onderzoek en wel van het Lang-Eiland, omdat hier een waarnemer van den Vulkanologischen Dienst tijdelijk is gestationeerd.

In dezen mag een woord van hartelijken dank aan Dr. CH. E. STEHN, Ir. A. C. DE JONGH en den Heer F. ECOMA VERSTEGE niet ontbreken.

Onderzocht werden van het uit 3 lagen bestaande profiel, nl. gesteente, tusschenlaag en bovenlaag met verweerde brokjes (de dikte dezer laag bedroeg 35 cm), de navolgende eigenschappen en samenstelling:

I. DE NATUURKUNDIGE EIGENSCHAPPEN

Kleur – korrelgroote – watercapaciteit – hygroscopiciteit – zuurgraad en radioactiviteit.

II. DE SCHEIKUNDIGE SAMENSTELLING

Bepaald werd het procentisch gehalte van 27 verbindingen, nl. SiO_2 – TiO_2 – ZrO_2 – Al_2O_3 – FeO_3 – Cr_2O_3 – V_2O_3 FeO – Mno – NiO – CaO – SrO – BaO – MgO – Na_2O – K_2O – Li_2O – H_2O(+ 110° C) – H_2O (— 110° C) – CO_2 – SO_3 – S – P_2O_5 – Cl – N – humus, en ten slotte het % uitwisselbare kalk.

III. DE MINERALOGISCHE SAMENSTELLING

Hierbij kon de aanwezigheid van 15 mineralen aangetoond worden, waarvan 3 nieuw gevormd (ná 1883) nl. anhydriet, pyriet en wollastoniet.

IV. DE MICROBIOLOGISCHE EIGENSCHAPPEN

Een cultuurgrond van Wageningen werd vergeleken met den cultuurgrond van Lang-Eiland.

Gegevens t.a. van de *flora*, de *temperatuur*, den *regenval* en de *scheikundige samenstelling van het regenwater* worden medegedeeld.

Uit de groote hoeveelheid gegevens is wellicht het belangwekkendste feit, dat in ongeveer *vijftig* jaar 0,45% humus is gevormd, op uitsluitend natuurlijke wijze, zonder invloed van den Mensch.

Dit eerste onderzoek verkrijgt eerst dan waarde, indien het na verloop van een aantal jaren herhaald wordt met nieuw materiaal, op dezelfde plaats verzameld, met dezelfde methoden onderzocht en waarbij aan dezelfde oogmerken gedacht wordt. Dit onderzoek zou zeer goed in Ned.-Indië kunnen verricht worden, indien er dàn althans belangstelling, hulpmiddelen en onderzoekers voor aanwezig zijn.

EIN BODENPROFIL DES VULKAN-INSELS LANG-EILAND
(KRAKATAU-GRUPPE)
GEBILDET INNERHALB 50 JAHRE

Wie bekanntlich, erlebte der Vulkan Krakatau (Rakata) im Jahre 1883 eine grossartige Explosion, wobei die zwei Nachbarinsel: Verlaten Eiland und Lang-Eiland mit einer grossen Menge Auswurfsmassen überdeckt wurden. Die Frage, wie aus dieser Masse im Verlaufe von nahezu 50 Jahren ein Boden war entstanden, war bisher noch nie in Angriff genommen. Die zufällige Anwesenheit eines Beobachters des vulkanologischen Dienstes (Bandoeng), behufs Studium des wiedererwachten Vulkans Krakatau, veranlasste mich die Hilfe einzurufen der betreffenden Herren und so sammelte im Jahre 1928 Herr F. ECOMA VERSTEGE ein 3-schichtiges Profil und zwar:

A. Gestein (Bimstein); B. Zwischen-Schicht; C. Oberste Schicht (vgl. Abb. II). Diese 3 Schichten zusammen mit verwitterten Fragmenten des Bimsteins aus C (hier angedeutet mit D) wurden nun einer ausführlichen Untersuchung unterworfen, wobei der Analytiker Dr. L. MÖSER (Giessen) für die nötigen Analysen sorgte und Prof. Dr. FERD. SCHMIDT (Heidelberg) für eine Untersuchung nach der Radioaktivität.

I. PHYSIKALISCHE EIGENSCHAFTEN (vgl. S. 15)

Farbe; Körnergrösse; Wasserkapazität; Hygrosopizität; Ph (kolorimetrisch); Radioaktivität.

II. CHEMISCHE ZUSAMMENSETZUNG (vgl. S. 8)

Eine so ausgebreitete Untersuchung, wie Herr MÖSER auf meiner Bitte fur mich ausführte ist bisher weder Stein wie Boden in Indien teil geworden. Aus den Bauschanalysen sind die Molekular-Verhaltnisse berechnet und nebenbei die Quotiente im Sinne HARRASSOWITZ und STREMME. (S. 12, 13.)

III. PETROGRAPHISCHE ZUSAMMENSETZUNG (vgl. S. 6)

Die folgenden Mineralien werden gefunden:

Amphibol; Anhydrit; Apatit; Augit; Cyanit; Hypersthen; Ilmenit; Magnetit; Olivin; Plagioklas; Pyrit; Quarz; Vulkanisches Glas; Wollastonit.

Anhydrit, Pyrit und Wollastonit sind Neubildungen.

IV. BAKTERIOLOGISCHE ZUSAMMENSETZUNG

	Kulturboden Lang-Eiland	Kulturgarten des Instituts für Bakteriologie in Wageningen
Bact. coli	10.000–100.000	100–1.000
Anaerobe Stärke-spaltende Organismen	10.000–100.000	1.000–10.000
Ureum-spaltende Organismen	100.000–1.000.000	10.000–100.000
Denitrifizierende Bakterien (Nitrat)	10–100	100–1.000
Denitrifizierende Bakterien (Nitrit)	100–1.000	10–100
Azotobacter	100–1.000	100–1.000
Nitrifizierende Bakterien ($CaCO_3$)	100–1.000	10–100
Nitrifizierende Bakterien ($MgCO_3$)	100–1.000	100–1.000
Aerobe Stärke-spaltende Organismen	1.500.000	2.500.000

Dieses Resultat muss als vorläufig angesehen werden.

V. KLIMA UND VEGETATION

Jahrestemperatuur: 27,8° C.
Jährliche Regenmenge: 2620 mm.
Regenfaktor (LANG): 94.
Chemische Zusammensetzung des Regenwassers: vgl. S. 5.
Vegetation: Farnen, Gras, *Casuarina*, *Ficus*.

VI. ERGEBNISSE

Wie massgebend bei der Verwitterung der Einfluss des Gesteins und des Alters sind zeigen die nachstehenden Daten, welche aber für weitergehende Schlussfolgerungen noch nicht zu verwenden sind. Die Daten sind vollkommen richtig aber ihre Zahl ist zu wenig.

	Lang-Eiland (Bimstein) rezent	Java (Kalkstein) Tertiär	Holland (Kalkstein) Senon	Holland (Löss) Quartär
K. (vgl. S. 12)	0,93	0,74	0,28	1,20
B. (vgl. S. 12)	0,89	0,0003	0,0003	0,28

($Al_2O_3 = 1$; mol. Verhältnisse)

	Lang-Eiland		Java		Holland			
	Bimstein	Bimstein-Boden	Kalkstein	Kalk-stein-Boden	Kalkstein	Kalk-stein-Boden	Löss-Gestein	Löss-Boden
SiO_2	7,54	6,01	3,61	2,66	58,56	16,39	14,82	17,70
CaO.........	0,35	0,38	626,75	0,12	630,13	0,24	1,89	0,21
MgO	0,12	0,11	6,76	0,06	9,78	0,13	0,43	0,16
K_2O	0,14	0,11	0,04	0,002	1,43	0,20	0,29	0,23
Na_2O........	0,49	0,37	0,03	0,003	0,65	0,12	0,24	0,23
H_2O (+110°C.)	0,92	1,07	9,19	2,28	17,73	2,21	1,37	1,19
H_2O (-110°C.)	0,15	0,50	1,77	2,45	15,95	2,31	1,18	1,15

Was die Analysen betrifft, hat es sich gezeigt, dass sich innerhalb 50 Jahre 0,45% Humus hat gebildet; Kieselsäure, Natron und Kali (molekular) abgenommen sind; Aluminiumoxyd, Eisenoxyd und Wasser (—110° C) (molekular) dagegen zugenommen sind.

LA FORMATION D'UNE TERRE ARABLE D'ORIGINE VOLCANIQUE PENDANT 50 ANNÉES

Dans le détroit de Soenda ou de la Sonde (entre Java et Sumatra) se trouve un groupe des îles volcaniques nommé: Krakatau, Verlaten Eiland (île abandonnée) et Lang-Eiland (île longue).

Lang-Eiland se compose à la surface des pierres ponces (fig. II), dont l'auteur a étudié un profil vertical:

C. la terre végétale, puissance 30 centimètres;
B. la couche au-dessous: ponce pulvérulente;
A. la roche-mère (= des pierres ponceuses dures).

Les recherches executées sont les suivantes:

I. PHYSIQUE

Couleur; analyse mécanique; capacité d'imbibition; hygroscopicité; réaction du sol; radioactivité.

II. CHIMIQUE

Les éléments suivants sont déterminés:
SiO_2 – TiO_2 – ZrO_2 – Al_2O_3 – Fe_2O_3 – Cr_2O_3 – V_2O_3 – FeO – MnO – NiO – CaO – SrO – BaO – MgO – Na_2O – K_2O – Li_2O – H_2O (+110° C) – H_2O(—110° C) – CO_2 – SO_3 – SO_2 – S – P_2O_5 – Cl – N – Humus – Ca (échangé).

III. MINÉRALOGIQUE

Les mineraux suivants sont trouvés:
amphibole; anhydrite; apatite; augite; cyanite; hypersthène; ilménite; magnétite; olivine; plagioclase; pyrite; quartz; verre volcanique; wollastonite. Anhydrite, pyrite et wollastonite sont formés *après 1883*.

IV. MICROBIOLOGIQUE

Comparaison des microbes de la terre végétale d'un jardin du laboratoire microbiologique à Wageningen et de Lang-Eiland.

	Lang-Eiland	Wageningen
Bact. coli	10.000–100.000	100–1.000
Microbes anaérobies détruisant l'amidon.	10.000–100.000	1.000–10.000
Microbes détruisant l'urée	100.000–1.000.000	10.000–100.000
Microbes dénitrificateurs (nitrate)	10–100	100–1.000
Microbes dénitrificateurs (nitrite)	100–1.000	10–100
Azotobacter	100–1.000	100–1.000
Microbes nitrificateurs ($CaCO_3$)	100–1.000	10–100
Microbes nitrificateurs ($MgCO_3$)	100–1.000	100–1.000
Microbes aérobies détruisant l'amidon	1.500.000	2.500.000

Les résultats des recherches microbiologiques doivent considéré comme d'être provisoirs.

V. CLIMAT ET VÉGÉTATION

Température annuelle: 27,8° Celsius.
Quantité annuelle de pluie: 2620 mm.
Quotient LANG $\left(\frac{\text{quantité annuelle de pluie}}{\text{température annuelle}}\right) = 94$.

VI. CONCLUSION

Pendant 50 années se formait 0,45% humus; SiO_2, Na_2O et K_2O diminuaient; Al_2O_3, Fe_2O_3 et H_2O(—110° C) augmentaient. Du reste, je me réfère aux données suivantes:

	Lang-Eiland (pierres ponces)	Java (calcaire)	Hollande (calcaire)	Hollande (loess)
Quotient K. (p. 12) ..	0,93	0,74	0,28	1,20
Quotient B. (p. 12) ..	0,89	0,0003	0,0008	0,28

(Al_2O_3 = 1)	Lang-Eiland (pierres ponces)		Java (calcaire)		Hollande			
					calcaire		loess	
	roche-mère	terre arable	roche-mère	terre arable	roche-mère	terre arable	roche-mère	terre arable
SiO_2	7,54	6,01	3,61	2,66	58,56	16,39	14,82	17,70
CaO	0,35	0,38	626,75	0,12	630,13	0,24	1,89	0,21
MgO	0,12	0,11	6,76	0,06	9,78	0,13	0,43	0,16
K_2O	0,14	0,11	0,04	0,002	1,43	0,20	0,29	0,23
Na_2O	0,49	0,37	0,03	0,003	0,65	0,12	0,24	0,23
H_2O (+110°C.)	0,92	1,07	9,19	2,28	17,73	2,21	1,37	1,19
H_2O (-110°C.)	0,15	0,50	1,77	2,45	15,95	2,31	1,18	1,15

GEOLOGICAL BIBLIOGRAPHY OF THE KRAKATAU-GROUP

1681

1. KRAKATAU, Duur der eruptie van 1680, in het Dagh-Register gehouden in 't Casteel Batavia, *1681*, p. 292.

1690

2. VOGEL, J. W., Journal einer Reise aus Holland nach Ost-Indien, Theil II, Leipzig, *1690*.

1883

3. BERG, N. P. VAN DEN, Poeloe Rakata of Krakatau. Algem. Dagblad van N.-I., Batavia, 23 Mei *1883*.
4. BOUQUET DE LA GRYE, Sur la propagation des lames produites par l'éruption des volcans de Java (Août 1883). Comptes Rendus Acad. Sci. Paris, T. 97, *1883*, pp. 1228–1230.
5. BURG, E. A. VAN DER, Examen des cendres tombées à Batavia pendant la catastrophe de Krakatau. Recueil des travaux chimiques des Pays-Bas, Tome II, pp. 296–303, Leiden *1883*.
6. FLAMMARION, C., L'éruption du Krakatoa (1883) et les tremblements de terre, p. 94, Paris.
7. LESSEPS, F. M. DE, Propagation maritime de la commotion du tremblement de terre de Java. — Comptes Rendus Acad. Sci. Paris; T. 97, *1883*, pp. 1172–1174.

1884

8. BERG, N. P. VAN DEN, Vroegere berichten omtrent Krakatau.De uitbarsting van 1680. Tijdschr. Ind. Taal-, Land- en Volk, XXIX, *1884*, pp. 208–228.
9. BEYERINCK, M. W., The Remarkable Sunsets. Nature, vol. XXIX, London, *1884*, pp. 308–309.
10. BLANFORD, H. F., On some effects of the Krakatoa eruption. Proceedings Asiatic Society of Bengal, Calcutta, *1884*, pp. 54–56.
11. CROIX, J. ERRINGTON DE LA, Eruption du Krakatoa. Vitesse de propagation des ondes marines. — Comptes Rendus Acad. Sci. Paris, T. 98, *1884*, p. 1324.
12. MAC LEOD, N., De uitbarsting van Krakatau. Met 1 kaart. Tijdschr. Kon. Ned. Aardr. Gen., 2e S., I (1) Leiden, *1884*, pp. 184–191.
13. MARCOU, J., The geological relatives of Krakatao and its late eruption. Science (New York), III, *1884*, pp. 762–765.
14. OEBBEKE, K., Ueber die Krakatau Asche. Neues Jahrb. f. Min., usw. Stuttgart, *1884*, II, pp. 32–33.
15. SANDICK, R. A. VAN, Een zeebeving (Eruptie Krakatau). Nieuwe Rotterdamsche Courant van 23 Oct. 1883. Overgenomen in Tijdschr. Kon. Ned. Aardr. Gen., Januari *1884*, Mededeeling, pp. 149–153.
16. ———, Le désastre de Krakatau. Bulletin mensuel de la Société scientifique Flammarion, 2. Argentan, *1884*, pp. 4–28, Avec carte. La même communication: La Nature française, No. 552, 29 décembre 1883.
17. ———, La catastrophe de Krakatau. Bulletin mensuel de la Société scientifique Flammarion, 2 Argentan, *1884*, pp. 168–175.

18. SAUER, A., Die Krakatoa-Aschen des Jahres 1883. Sitzungsber. der naturf. Gesellsch. zu Leipzig, 1883, p. 187. (Sitzung vom 13 Nov. 1883). Vgl. auch: Chemisches Centralblatt, Hamburg und Leipzig, 3te Folge, XV, 1884, pp. 129–135.
19. SVEDMARK, E., De vulkaniska utbrottenpa ön Krakatau i Sundasundet ar 1883 och den dermed sammenhängende jordbäfningen (met afbeelding en kaart), Ymer, Stockholm, *1884*, 131 pp.
20. VERBEEK, R. D. M., Kort verslag over de uitbarsting van Krakatau op 26, 27 en 28 Augustus 1883. Javasche Courant van 7 Mrt. *1884*. Ook als afzonderlijke brochure bij de Landsdrukkerij te Batavia in 1884 gedrukt.
21. ———, Over de tijdsbepaling der grootste explosie van Krakatau op 27 Augustus 1883. Versl. en Med. der Kon. Akad. v. Wetensch. Afd. Nat., 3e reeks, deel I, pp. 45–57, Amsterdam *1884*, met 1 plaat.
22. VETH, P. J., De uitbarsting van den vulkaan Krakatau in 1680. Tijdschr. Kon. Ned. Aardr. Gen., 2e s., I (1) Leiden, *1884*, Versl. en Aardr. Med., pp. 24–27.
23. WIIK, F. J., Undersökning of Pimsten, fran vulkanen Krakatoa's utbrott den 26–27 Augusti. Ofversigt af Finska Vetensk. Soc. Förhandl. 26, 1883/4. Helsingfors, *1884*, pp. 155–157.

1885

24. NEALE, PH., The Krakatoa Eruption. The Leisure Hour (London) *1885*, p. 348, 379, 486, 554 and 635.
25. RATH, G. VOM, Ueber Krakatau. Correspondenzblatt der niederrheinischen Gesellsch. in Bonn, *1885*, p. 134.
26. RETGERS, J. W., Onderzoek van de vulkanische asch van Krakatau, gevallen te Buitenzorg, den 27 Augustus 1883. In Verbeek's Krakatau, *1885*, pp. 217–285. Fransche editie, Krakatau, 1886, pp. 227–298.
27. VERBEEK, R. D. M., Krakatau deel I, Batavia, 1884, deel II met 43 kaarten en 25 platen, Batavia *1885*.
28. ———, Krakatau, Batavia *1885*, met atlas en album.

1886

29. COTTEAU, E., Krakatau et le détroit de la Sunda (Sonde). Le Tour du Monde, 25e année, No. 1311, Paris, *1886*, pp. 113–128. Avec 13 figures dans le texte.
30. RETGERS, J. W., Die Mineralien der Krakatau-Asche, gefallen zu Buitenzorg. Groth's Zeitschr. für Krystallographie und Mineralogie, XI, *1886*, pp. 415–419.
31. VERBEEK, R. D. M., Note accompagnant une photographie de la partie moyenne de la paroi du Krakatau. 2 pages avec photogr. Batavia. Landsdrukkerij *1886*.
32. LECKY, BSSE VON DEDEM, MRS. E., Mr. VERBEEK on the Krakatao dustglows. Nature, Vol. XXXIV, London, *1886*, p. 33.

1888

33. COTTEAU, E., En Océanie, *1888*, Krakatau, pp. 35–77.
34. JUDD, J. W., The natural history of lavas as illustrated by the materials ejected from Krakatoa. The Geological Magazine, London, *1888*, pp. 1–11.

35. SYMONS, G. K., The Eruption of Krakatau and subsequent phenomena. Report of the Krakatau committee of the Royal Society. London *1888*.
36. USHER, J. E., Personal reminiscenses of the great eruption of Krakatoa (Java). Transact. and Proceed. of the Royal Geogr. Soc. of Australasia, Victoria Branch, VI, part I, Sydney, *1888*).

1889

37. JUDD, J. W., The earlier eruptions of Krakatao. Nature, Vol. XL, *1889*, pp. 365–366.

1890

38. SANDICK, R. A. VAN, In het rijk van Vulcaan. De uitbarsting van Krakatau en hare gevolgen. Zutphen *1890*. Met 1 titelplaat en 1 kaart.
39. SCHMITZ, G., Ponces de l'éruption de Krakatau, Annales de la soc. géol. de Belgique, XVII, Liege, *1890*, pp. LXI–LXIII.

1897

40. MÜLLER, J. J. A., De eilanden Krakatau en Lang-Eiland. Tijdschr. Kon. Ned. Aardr. Gen., 2e Serie, deel XIV, Leiden, *1897*, pp. 118–122.

1902

41. BOSSE, P. M. VAN, Over een vermeende werkzaamheid van Krakatau in Augustus 1902. Javasche Courant van 26 Augustus *1902*, No. 68, pp. 898–899.

1908

42. COOL, H., Krakatau (waarnemingen in Mei en Augustus 1908). Verslag van het Mijnwezen over het 3de kwartaal *1908*.
43. FRANSSEN HERDERSCHEE, A., COOL, H., BEMMELEN, W. VAN, BAKKER, C. A., JACOBSON, ED. R., De opneming van de Krakatau-groep in Mei 1908. Jaarverslag van den Topografischen Dienst in Ned. Indië over *1908*, Batavia, p. 150.
44. VERBEEK, R. D. M., Photographieën van den steilen wand van Krakatau. Tijdschr. Kon. Ned. Aardr. Gen., 2e Serie, deel 25, Leiden, *1908*, pp. 1194–1195.

1909

45. BEMMELEN, W. VAN, Over Krakatau in 1908. Nat. Tijdschr. v. N.I., LXVIII Batavia, *1909*, pp. 242–244.
46. COOL, H., Over Krakatau in 1908. Nat. Tijdschr. v. N.-I., LXVIII, Batavia, *1909*, pp. 244–247.

1910

47. BECK, R., Ueber die in Tektiten eingeschlossenen Gase. Monatsber. d. deutsch geol. Gesellsch., Berlin, *1910*, pp. 240–245.
48. COOL, H., Krakatau in 1908. Jaarboek van het Mijnwezen in Ned. Oost-Indië, 37ste jrg. 1908, pp. 183–193, Batavia *1910*.

1911

49. BRUN, ALBERT, Recherches sur l'exhalaison volcanique, Paris *1911*. Krakatau, pp. 228–232.

1913

50. BROUWER, H. A., Over een bezoek aan Krakatau in Mei 1913. Tijdschr. Kon. Ned. Aardr. Gen., XXX, Leiden, *1913*, pp. 657–658.

1914

51. ANDERSON, T., The volcanoes Bromo and Krakatau. A brief account of a visit to them. Alpine Journal, Vol. 28, No. 204, London, *1914*, pp. 178–182. With 2 illustrations.

1916

52. JONGH, C. A., DE, Puimsteen op de Krakatau-eilanden. Jaarb. Mijnwezen N.O.I., Batavia, *1916*, Verhandelingen 2de gedeelte, pp. 39–46, met 1 kaartje.
53. OVERBECK, T., Ein Nachtrag zu der Katastrophe von Krakatau in der Sundastrasse, Naturw. Wochenschrift, *1916*, pp. 433–434.

1919

54. ESCHER, B. G., Excursie-gids voor Krakatau, Batavia *1919*.
55. ———, Veranderingen in de Krakatau-groep na 1908. Handelingen van het Eerste Nederlandsch-Indisch Natuurwetenschappelijk Congres. Weltevreden 3–6 October *1919*, pp. 198–219.
56. ———, De Krakatau-groep als vulkaan. Handelingen 1e Ned. Ind. Natuurw. Congres, gehouden te Weltevreden, 3–6 October *1919*, Weltevreden 1920, pp. 28–35.

1922

57. TAVERNE, N. J. M., Krakatau. In Report of the month of February *1922* of the Volcanological Survey. Unpublished in the archives of the Geological Survey of N.-I.

1925

58. SCHARFF, R. F., Sur le problème de l'île de Krakatau. — Comptes Rendus Congr. Assoc. franc. à Grenoble, *1925*, p. 4.

1927

59. STEHN, CH. E., Krakatau (Land-Eiland, Verlaten-Eiland). Bulletin of the Netherlands East Indian Volcanological Survey, No. 1, Bandoeng, *1927*.

1928

60. ESCHER, B. G., Krakatau in 1883 en in 1928. Tijdschr. Kon. Ned. Aardr. Gen. 2e Serie, dl. XLV, Leiden, *1928*, pp. 715–743.

61. STEHN, CH. E., De Krakatau en zijn jongste eruptie. De Ingenieur, Den Haag, 43e jrg., No. 43, 27 October *1928*, p. 75–77.
62. ———, Krakatau (Lang-Eiland, Verlaten-Eiland). Bulletin of the Netherlands East Indian Volcanological Survey, No. 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14. Bandoeng, *1928*.
63. UMBGROVE, J. H. F., The first days of the new submarine volcano near Krakatoa. Leidsche Geologische Mededeelingen, II, Leiden, *1926-1928*, p. 325.

1929

64. DOCTERS VAN LEEUWEN, W. M., DAMMERMAN, K. W., STEHN, CH. E., Excursions on Krakatau. Proceedings of the fourth Pacific Science Congress, Java 1929, Vol. I, General part and reports on oceanography, pp. 166–168.
65. RECK, H., Uebersicht über die Tätigkeit des Krakatau im Jahre 1928. Zeitschr. f. Vulkanologie, XII, *1929*, pp. 52–55.
66. STEHN, CH. E., DOCTERS VAN LEEUWEN, W. M. and DAMMERMAN, K. W.
Part I: The geology and volcanism of the Krakatau Group.
Part II: Krakataus' New Flora.
Part III: Krakatau's New Fauna.
(Fourth Pacific Science Congress, *1929*).
67. STEHN, CH. E., Krakatau (Lang-Eiland, Verlaten-Eiland). Bulletin of the Netherlands East Indian Volcanological Survey, No. 15, 16, 17, 18–19, 20-21, 22-23, 24, 25, 26. Bandoeng, *1929*.
68. TAYLOR, G. I., The air wave from the great explosion of Krakatau. Proceedings of the fourth Pacific Science Congress, Java *1929*, Vol. II B, Physical Papers, pp. 645–655.

1930

69. NASH, J. M. W., Twee vliegtochten naar den Krakatau. Tijdschr. Kon. Ned. Aardr. Gen., *1930*, pp. 498–505. Met 3 kaarten, 1 grafiek en 9 foto's.
70. STEHN, CH. E., KRAKATAU (Lang-Eiland, Verlaten-Eiland). Bulletin of the Netherlands East Indian Volcanological Survey, No. 27, 28, Bandoeng, *1930*.

This bibliography is compiled from the well-known bibliographies of Dr. R. D. M. VERBEEK and Dr. N. WING EASTON entitled: Geologisch-Mijnbouwkundige Bibliografie van Nederlandsch-Indië, Vol. I, 2665 titles, Den Haag 1912; Vol. II, 1079 titles, Den Haag 1914; Vol. III (not completed) 1457 titles, Den Haag 1931, which give all informations to everyone, whishing to know something about the mineralogy, geology and paleontology of the Indian Archipelago as a whole and on every island for its own.

The book which gives us the best review of our contemporary knowledge about the geology of the Indian Archipelago is the well-illustrated book of Prof. Dr. L. M. R. RUTTEN: Voordrachten over de geologie in Nederlandsch-Indië, Groningen 1927, 810 pp, with 243 fig.

A concise work is: H. A. BROUWER: The geology of the Netherlands East Indies, London 1925, 160 pp, 17 fig, 18 pl.

The history of geological science gives: Science in the Netherlands East Indies by L. M. R. RUTTEN, Amsterdam 1929, 432 pp.

DESCRIPTION OF THE PLATES AND FIGURES

Photo 1. Outlet of the erosion-gully, westcoast of Lang-Eiland. Photo: W. PETROESCHEVSKY, Volcanological Survey, Bandoeng.

Photo 2. Erosion-gully, south of the observationstation of the Volcanological Survey on Lang-Eiland. The soilprofile was sampled in the pumice-mass on the left.
Photo: Dr. CH. E. STEHN, Volcanological Survey, Bandoeng.

Fig. 1. *Kyanite*, cleavage-pieces, 200 ×. Under-layer.

Fig. 2. *Hypersthene*, with figures of combustion. 80 ×. Middle-layer.

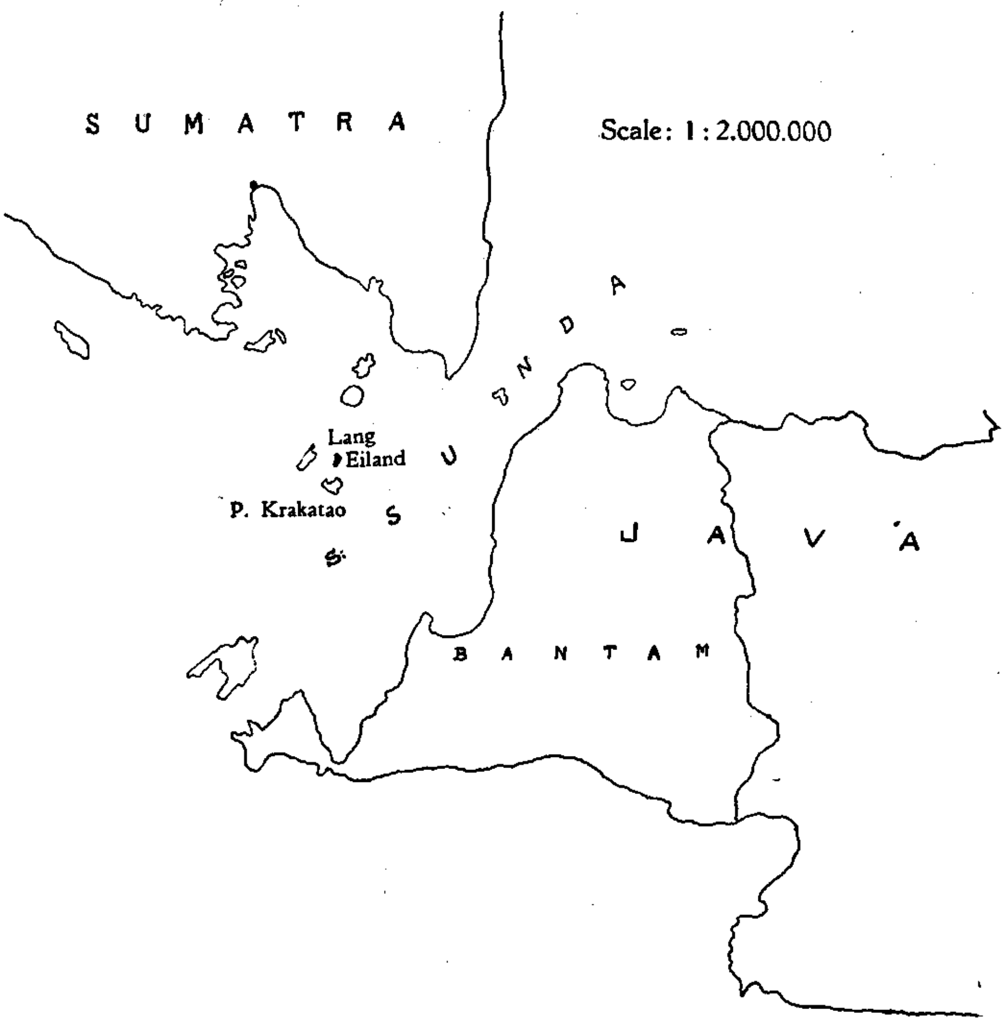
Fig. 3. *Plagioclase*, with inclusions of hypersthene, ilmenite and magnetite. 50 ×. Surface-layer.

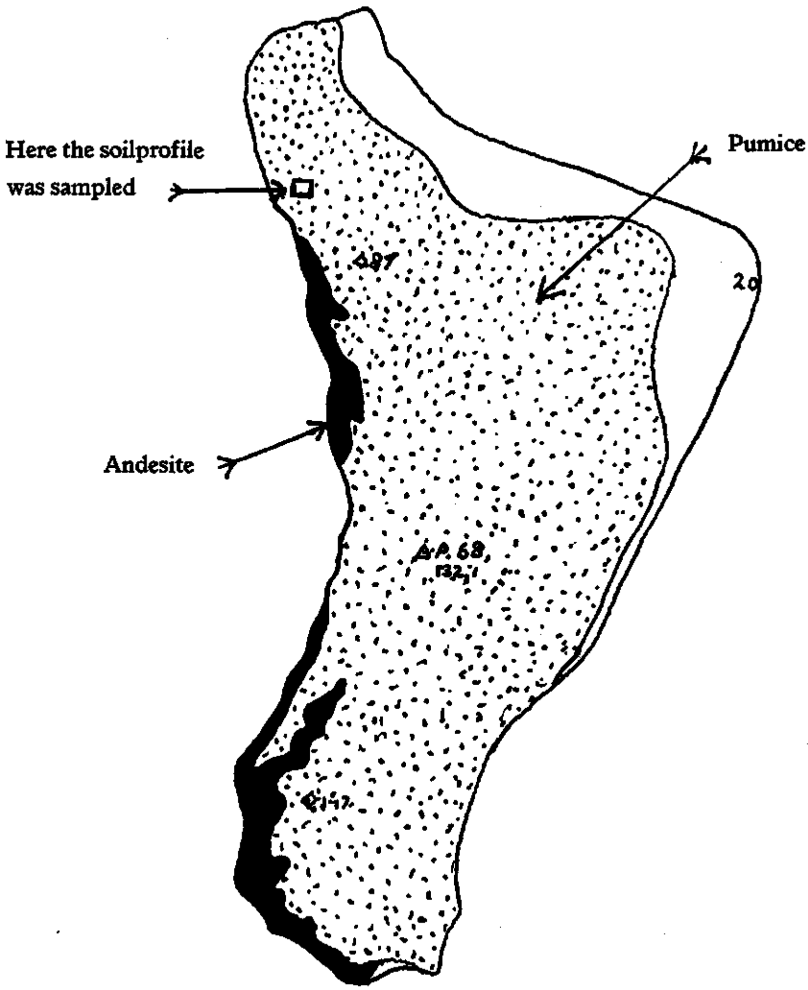
Fig. 4. *Plagioclase*, with gasbubbles and inclusions of apatite. 50 ×. Surface-layer.

Fig. 5. *Plagioclase*, with figures of combustion. $12^1/_2$ ×. Surface-layer.

Fig. 6. *Volcanic glass*, with gasbubbles. 200 ×. Surface-layer.

The figures are drawn by Mr. A. G. EYMERS, Wageningen.


SUMATRA
Scale: 1 : 2.000.000
SUNDA
Lang Eiland
P. Krakatao
S.
JAVA
BANTAM



LANG-EILAND

Scale: 1 : 25000

Photo 1

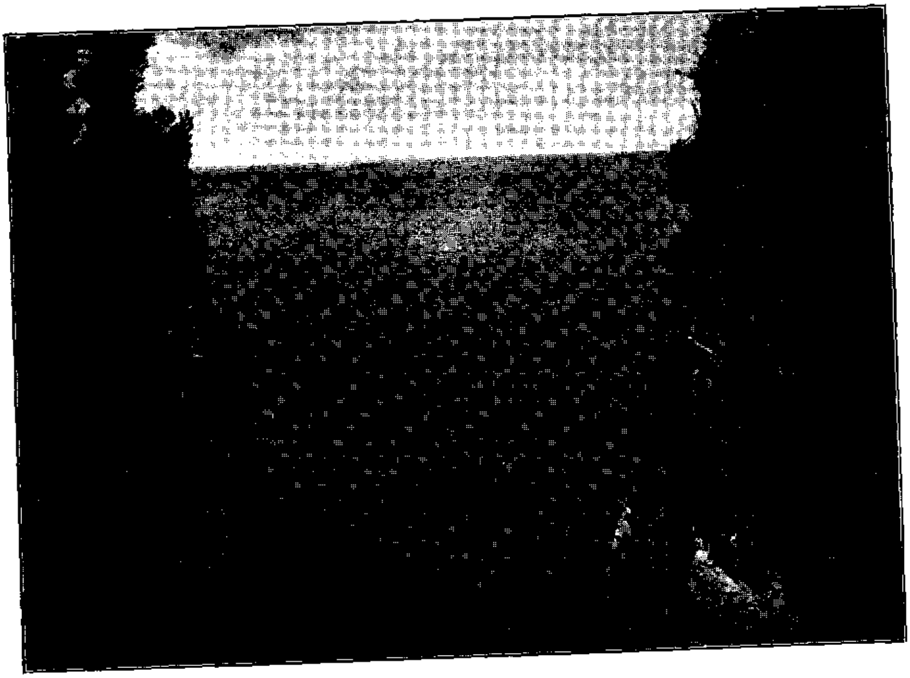


Photo 2

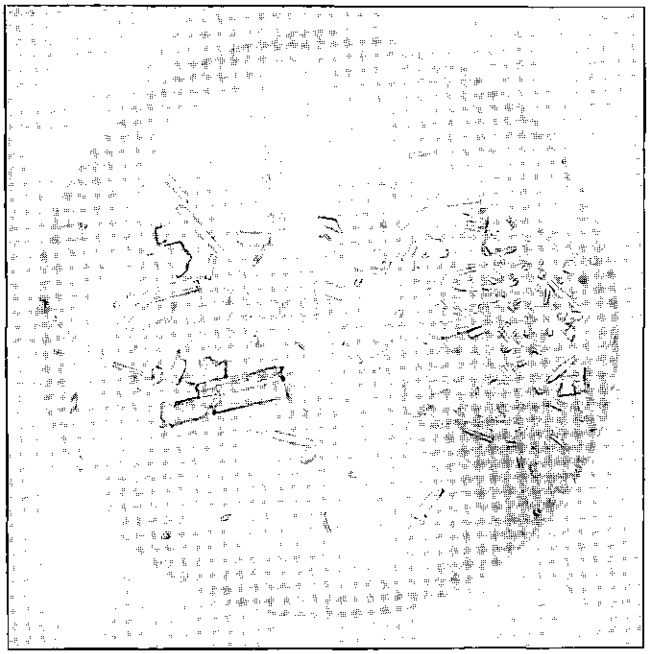


Fig. 1

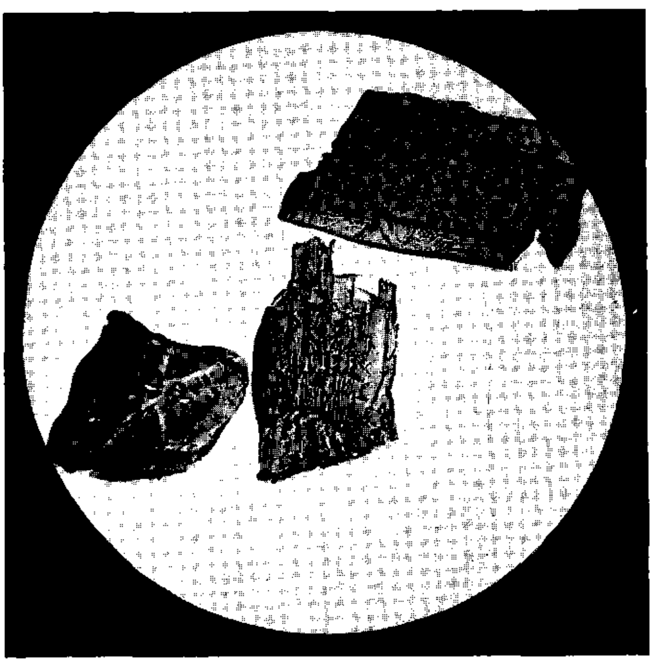


Fig. 2

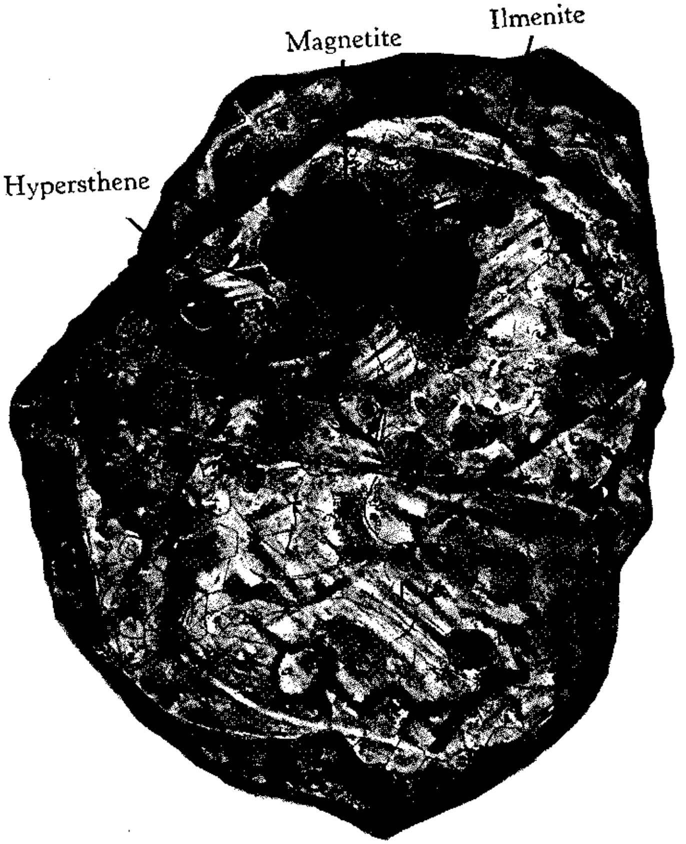


Fig. 3

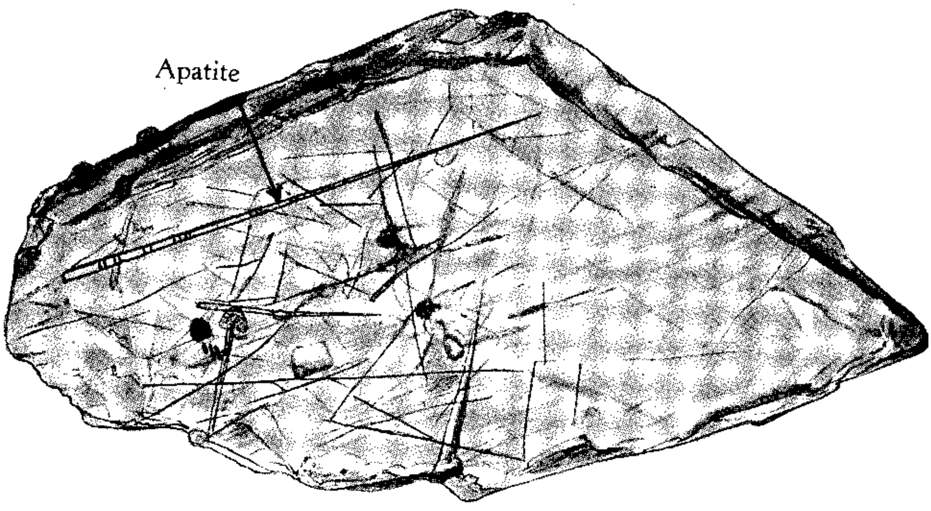


Fig. 4

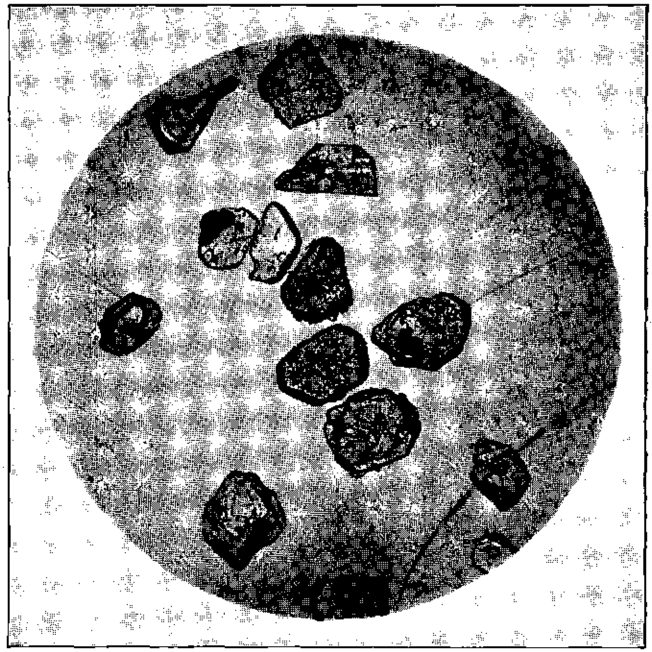


Fig. 5

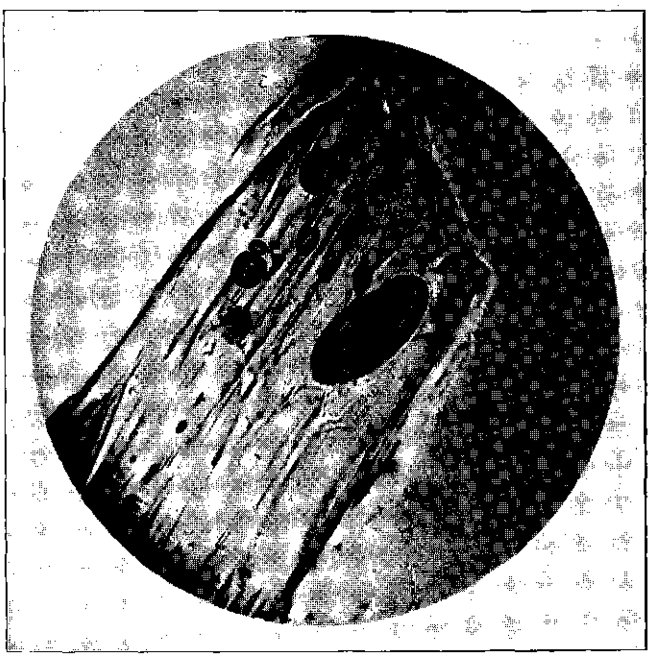


Fig. 6