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PRELIMINARY REPORT ON THE FERRUGINOUS BAUXITES OF THE PAKARAIMA MOUNTAINS

by

J.H. Bateson, Geologist

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Geological Survey Department
P.O.Box 789
Brickdam, Georgetown.

FOREWORD

Specimens of high-grade bauxite collected in the Pakaraima Mountains have been sent to the Geological Survey from time to time, and in 1959 Mr D. Bleackley, then Senior Geologist, followed up this clue during a special study of the laterites and bauxites of British Guiana. He found that dolerite sills, which outcropped extensively on the high plateaux, had been weathered over a period, which is estimated to be some 50 million years, to form a thick layer of aluminous laterites and ferruginous bauxites. This discovery led to an intensive campaign of exploration in 1959-60 in which six geologists took part at various times.

The aluminous laterites and ferruginous bauxites were found to extend over some 1000 square miles with a thickness generally exceeding 10 feet. Three areas were selected for more detailed work, and in one of these, the Kopinang River basin, a deposit of ferruginous bauxite, with low silica, has been outlined which would be promising at the present time if it were not so remote from the seaboard.

The area explored measures 1500 miles from NW to SE and is some 45 miles wide. It is only inhabited by scattered Amerindian settlements, and is still difficult of access. The mapping, pitting and drilling programmes have been much hampered by poor communications, changing personnel and lack of labour. Assessment of the results has been further delayed by difficulties encountered in setting up the new Geological Survey laboratory building. The present report must therefore be considered as purely preliminary. Search continues in the enormous area now outlined for better grade bauxites more suitable for the present-day methods of processing.

The deposits now described in the Pakaraima Mountains add to the already vast reserves of ferruginous bauxites which have been mapped in British Guiana. This material is a source of both aluminium and iron, two of the metals most in demand in modern industry, but it is only of marginal economic interest at the present time: it is generally too low-grade for the Bayer alumina process, although the alumina contained is high enough to exclude it from conventional iron and steel works.

Research is proceeding, however, on commercial methods for recovering both alumina and iron, and since these materials are in such great demand it is perhaps not too fanciful to imagine an industrial complex exploiting these low-grade ores with the help of British Guiana's great hydro-electric potential.

R. B. McConnell
Director Geological Survey
5 July, 1961

on separate aliquots, the former volumetrically with potassium dichromate and the latter colorimetrically with hydrogen peroxide.

Alumina was determined by subtracting iron and titania from the weight of mixed oxides, while "loss on ignition" was carried out on a separate portion of the sample.

The amount of alumina obtained by this method is the total combined in the sample, all of which cannot be recovered by the usual Bayer process. The alumina contained with silica to form minerals of the Kaolinite group is not recovered. A factor of 1.1 x SiO_2% has been adopted in the U.S.A. to determine the "available alumina" by subtraction from the total alumina. This figure was arrived at from empirical data obtained from alumina plants which showed that for every pound of silica 1.1 to 2 pounds of alumina were lost.

In this report the figures for the Al_2O_3 given in the analyses are total alumina.

Preliminary Results

The pits in the Pakaraima Mountains were sited on the outcrop of the dolerite (see Fig. 5) in two main areas, one enclosing the area of the Kopinang valley and the other covering the area to the west of Ayanganna as far as the Eborupu Mountains immediately to the south of the Kamarang River. In all the following tables the pits referred to by a code letter and number can be located in Figs. 3 and 4. Drill holes can be found in Fig. 5.

The average chemical composition for each of the areas is indicated in the accompanying table. The analyses from 35 pits have been incorporated in the average for the Kopinang area and from the pits in the Kamarang-Kukui area.

TABLE 1.- Average analyses of ferruginous bauxites from the Pakaraima Mountains

	1	2	3
SiO_2	6.1	20.3	13.2
Al_2O_3	40.4	33.3	36.9
Fe_2O_3	27.6	19.7	23.7
TiO_2	2.1	2.4	2.3
L.O.I.	23.7	18.2	21.0
Average depth	10 ft.	14 ft.	12 ft.

1. Kopinang valley area (35 pits) Analysed by Demerara Bauxite Co. Ltd., 1959.
2. Kamarang-Kukui area (16 pits) Analysed by Geological Survey, 1960.
3. Average of both areas.

From these average analyses it can be seen that the Al_2O_3 content in all cases is in excess of the iron oxides for which reason these Pakaraima deposits are referred to in this report as aluminous laterites or ferruginous bauxites.

The laterite is often represented at the surface by a hard iron rich cap which varies both in its thickness and in its lateral extent. In hand specimen this cap varies in colour from a rich chestnut-brown to an ochrous yellow. There are two main lithological types of the cap, one having a vesicular appearance whilst the other of lesser importance, has a compact nature. In the vesicular or "honey-comb" laterites the rock is composed of yellowish clay material completely surrounded by hard "shells" of iron rich material. Upon weathering the clay material is easily removed leaving behind a honey-comb structure rich in iron. The size of the clay pockets varies very considerably from a fraction of an inch up to two inches in diameter but on average they are about ½ inch across. In some examples the iron content is so high that there occur occasional layers and stringers of crystalline haematite. The compact varieties consist of homogeneous bands of iron rich material with the clay material occurring as thin lenses and layers. This last type of deposit occurs much less frequently in the Pakaraimas than the honey-comb laterites.

The pitting of the laterites has served to show that there is a fairly standard profile with depth through these deposits, but unfortunately in no case was the unaltered bedrock encountered in any of the pits.

The upper zone of the profile through the laterite varies from a few inches to six feet in thickness. It is characterized by a large proportion of hard ferruginous material in the form of irregular masses and 'pans' set in a matrix of yellow-brown clay. Beneath this variable zone there is often a zone in which the clay fraction becomes relatively more important and in approximately equal proportions with the hard rather nodular iron-rich material. Together these two zones constitute the "laterite" zone described by Eyles (1952) in the Antrim laterites.

Below about 10-12 feet the lithology of the profile again changes. The hard material becomes very much reduced in quantity (as little as 1% in some cases), the dominant lithology being a yellow, red and brown mottled clay. This is comparable with the "lithomarge" described in Antrim (Eyles op. cit.)

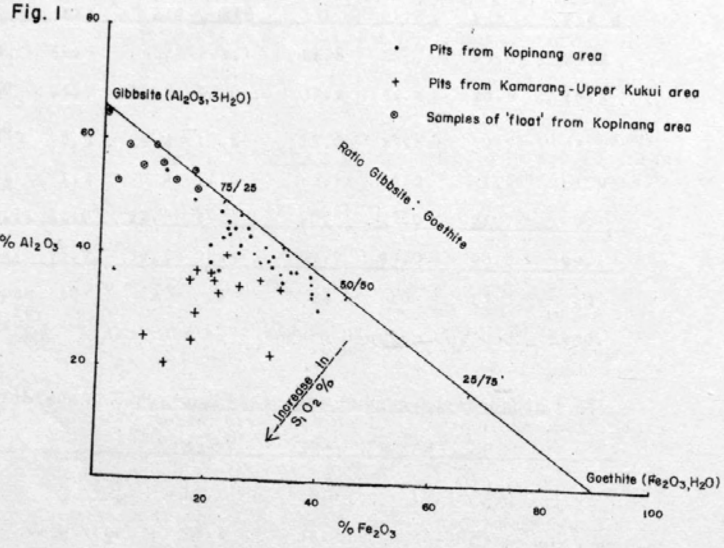
In a number of areas, and particularly in the Kopinang region, the hard material contained in the lowest of the two zones of the laterite and the lithomarge often occurs as small flat irregular discs up to three or four inches across or as short "pipes". These small bodies are often of a creamy white colour and have a rather porous texture. They represent the relatively aluminous rich material in these zones.

Occasionally at the bottom of a pit there occur a few boulders of very altered dolerite in which, although the minerals have all been deeply weathored, the original doleritic texture can be seen.

GRAPH TO ILLUSTRATE CHEMICAL COMPOSITION AND VARIATION IN PIT SAMPLES

By J.H. Bateson 1961

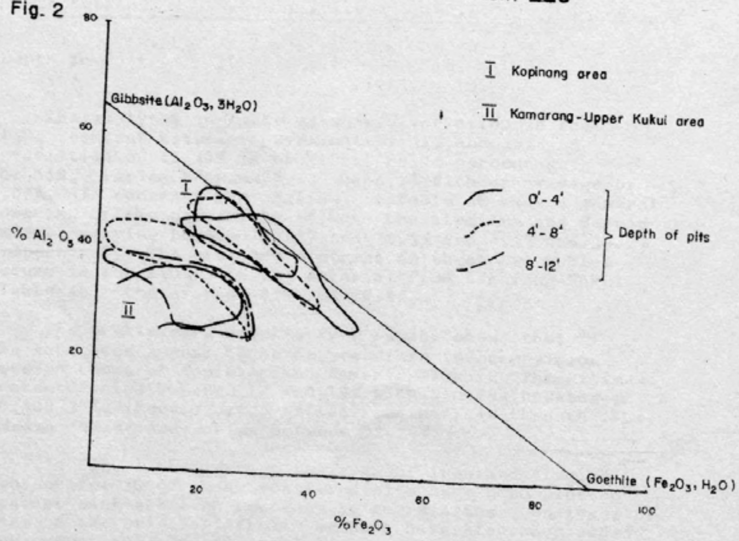
Fig. 1



(Based upon chemical analyses from 50 pits and 9 samples of 'float')

GRAPH TO SHOW CHEMICAL VARIATION WITH DEPTH OF PIT SAMPLES

Fig. 2



(Based upon 114 chemical analyses)

Examination of the resulting scatter shows that the analyses of the material from the Kopinang area (represented by dots) fall within an easily defined area, whilst the analyses from the Kamarang-Kukui region (identified by crosses) fall within a second area. The area occupied by the Kamarang-Kako analyses lies very much closer to the intersection of the ordinate and the abscissa compared with the Kopinang samples which occupy a zone parallel and close to the gibbsite-goethite line.

The analyses (in Tables 4a, 4b and 5b) indicate that the main difference in material from these two areas is the SiO_2 content which is indicated in Fig. 1 by movement away from the gibbsite-goethite line by the analyses of the Kamarang-Kukui area. This same trend is also found in Fig. 2 to which the average analyses of the pits have been plotted for every 4 feet of depth. The resulting scatter indicates the variation of chemical analyses with depth.

In the Kopinang area there is a trend (Fig. 2 and table 5a) with depth of increasing content Al_2O_3, which is accompanied by a decrease in the percentage of SiO_2 indicated by the analyses of the 8-12 foot zone falling closer to the gibbsite-goethite line. In the material from the Kamarang-Kukui area (Fig. 2 and Table 5b) it is the 4-8 foot zone in which the Al_2O_3 is increased and is reduced in the lowest zone (8-12 feet) and accompanied by an increase in the SiO_2 percentage.

Table 5a. - Analyses to demonstrate variation with depth in pits from Kopinang area.

No	Depth	L.O.I.	SiO_2	TiO_2	Fe_2O_3	Al_2O_3
K2	0-4	24.63	8.35	1.67	24.24	41.06
	4-8	25.87	13.19	1.13	24.68	45.12
	8-12	26.10	8.21	1.55	20.80	43.3
K27	0-4	19.77	5.43	2.17	46.72	25.90
	4-8	22.51	2.55	4.31	28.72	30.90
	8-12	24.19	1.67	3.53	33.60	37.01
K31	0-4	18.70	1.59	2.77	56.76	19.67
	4-8	22.09	2.08	2.30	38.08	34.84
	8-12	28.45	1.99	2.11	21.40	45.98

(Analyses by Demerara Bauxite Co.Ltd. 1960)

Table 5b. - Analyses to demonstrate variation with depth in pits from Kamarang-Kukui area

No.	Depth	L.O.I.	SiO_2	TiO_2	Fe_2O_3	Al_2O_3
X18	0-4	21.5	18.5	2.3	20.6	36.8
	4-8	21.9	21.3	1.8	17.4	37.0
	8-12	19.3	25.8	1.5	18.2	34.6
X31	0-4	21.8	21.9	4.2	16.6	35.1
	4-8	22.8	19.3	1.9	14.0	42.4
	8-12	20.8	17.9	1.7	23.8	35.5
X14	0-4	26.4	7.0	2.5	23.6	38.7
	4-8	25.1	9.0	2.3	23.2	39.9

(Analysed by Geological Survey British Guiana 1961)

In Table 5a there is a general decrease of SiO_2 and increase of Al_2O_3 with depth usually accompanied by a marked decrease in the amount of Fe_2O_3 present. In the typical examples the Al_2O_3 peak is found in the zone 4-8 feet, below which the iron content increases at the expense of the alumina.

From the analyses obtained from this widespread pitting programme, it appears that there are at least two chemically distinct laterites (Table 6) developed in the Pakaraimas. The bedrock underlying the Kopinang area consists of the Lower Kopinang sill, only two or three pits are sunk into the remnants of the overlying highly metamorphosed shales. In the Kamarang and Upper Kukui areas the bedrock is of a similar doleritic sill which is regarded as an extension of the Lower Kopinang sill (p. 10) but may be the upper or more siliceous horizon.

Table 6. - Comparison of average analyses

	L.O.I.	SiO_2	TiO_2	Fe_2O_3	Al_2O_3
I. - Kopinang					
	22.84	5.24	1.90	30.07	39.67
II. - Kamarang-Kukui					
	18.5	21.5	2.6	24.9	31.7

The outstanding difference is in the percentage of SiO_2 in these laterites, being very much higher in the Kamarang-Kukui area. Since the difference between the averages is so very marked - some 15% - this may reflect some difference in the parent rock from which the laterite has been developed. The uppermost zone of this sill has recently been re-examined (personal communication D.D.Hawkes) and the top 300 feet has been shown to include granophyric rocks with a higher SiO_2 content than the rest of the sill.

Erosion in the Kopinang valley has left only a small selvage of the silica rich zone at the foot of the mountains. Hence the pits in the valley have all been sited in the noritic and pyroxene zones of the dolerite which are relatively poor in SiO_2. Since the Kamarang sill has all the petrological characteristics of the Lower Kopinang sill and has been equated with it (p. 10) it would seem that the pits of the Kamarang and Kukui region are in fact sited in the upper granophyric zone. In this way the high content of SiO_2 can be explained.

The areal extent of these laterites based on the reconnaissance mapping that accompanied the pitting is estimated at 1000 sq. miles; 300 sq. miles in the Kopinang valley, 400 sq. miles in the Kamarang-Kukui area, and 250 sq. miles in the Sukabi basin. On average the pits dug were all carried down to depths of 10-12 feet but in no case was the unaltered bedrock reached. The maximum thickness of the laterite is not known but in places it is probably at least two or three times the thickness investigated in the pits.

MINERALOGY

The mineralogy of the bauxites and aluminous laterites has been studied by microscopic examination of thin sections, by differential thermal methods and by the use of X-ray diffusion techniques.

During the course of his studies on the origins and occurrence of bauxites and laterites Bleackley (1961c) examined a number of thin sections of Pakaraima aluminous laterites from the Pakaraima Mountains. In These slides he confirmed the presence of gibbsite, kaolinite, ilmenite and haematite.

Unfortunately insufficient data is available to show the progressive changes that take place in the weathering of the dolerite except in the broadest terms. Bleackley (p. 120) states that near to the weathering shell of the dolerite: ".....minute cracks develop in the feldspars and become filled with scales of gibbsite which increase at the expense of the feldspar, isolating small fragments of it elsewhere along a sharp but irregular line. The feldspars give the impression of undergoing corosion and solution. At the same time the cleavages of the pyroxene become filled with iron oxides which finally surround small fragments of unaltered augite which persist after the labradorite has become completely altered to gibbsite."

The use of a portable Eberbach Portable differential thermal apparatus indicated the presence of gibbsite and kaolinite minerals with endothermic peaks at 310°-340° and 560°-600°C respectively. The presence of goethite, although having a similar peak temperature to that of gibbsite, has been indicated in many of the samples by the broadening of the gibbsite peak to as low a temperature as 300°C.

This method was employed on 37 pits dug in the area from which an average recovery of 59% was obtained after washing.

The washed material is appreciably lower in SiO_2 content and whilst there is no very marked increase in the Al_2O_3 there is a relative increase in the percentage of iron oxides present.

Some analyses of the material washed through the 19 mesh sieve were also undertaken. In a large number of these samples the SiO_2 obtained is greater than 15% and in some as much as 40%. In others however, these samples gave analyses that are similar to those obtained from the residue. The main conclusion drawn from this is that whilst in some cases silica can be removed by simple washing and screening, the evidence seems to suggest that some of the Al_2O_3 is present as particles smaller than the 19 mesh. It is possible that experimentation with various sized screens would result in the reduction of the amount of Al_2O_3 washed out in this manner.

CONCLUSIONS

From the work already completed it is established that the Lower Kopinang dolerite sill has been weathered to laterite and lithomarge over the major portion of the 1000 square miles of its outcrop. The upper 10-15 feet of the "laterite" is enriched in alumina to form a ferruginous bauxite or aluminous laterite, the silica content is variable but increases sharply downwards at the base of the laterite to form a zone of "lithomarge".

Exploration has defined three areas of possible economic interest, in which the character of the laterites differs, as follows:-

1. The Kopinang River Basin. In this area the upper 10 feet of the deposit, over some 300 square miles, is a ferruginous bauxite low in silica with an average analysis, based on the sampling of 35 pits, of 40.4% Al_2O_3, 6.1% SiO_2, 27.6% Fe_2O_3, 2.1% TiO_2 and L.O.I. 23.7%.
2. The Sukabi River Basin. Laterites cover some 250 square miles but only 3 pits have so far been sampled. These preliminary results indicate a higher content of silica, the average analysis for a depth of 16 feet shows 34.4% Al_2O_3, 16.5% SiO_2, 25.8% Fe_2O_3, 1.9% TiO_2 and 21.8% L.O.I.
3. The Kamarang-Kukui Area in the basin of the Upper Mazaruni River. 16 pits have been sampled over an area of some 400 square miles and the average analysis of the top 14 feet shows a considerable increase in silica (SiO_2 20.3%) with a decrease in iron oxides (Fe_2O_3 19.7%) and alumina (Al_2O_3 33.3%).

The ferruginous bauxites of Kopinang appear to be of slightly higher grade than those of Oregon (Libbey et al 1946, Allen 1948), and compare well with the "ferruginous" bauxites" of Ghana (Cooper 1958) and the "red ferruginous" bauxites" of Antrim, N. Ireland, as described by Eyles (1952). The material from the Kamarang-Kukui and Sukabi areas appears too high in silica for treatment by present day commercial processes.

Attempts to beneficiate the material by washing and screening, although not conclusive, seem to indicate that it would be possible to reduce the silica content, but the yield would be low and much alumina lost in the tails.

The grade of material from the Kopinang area, as estimated from only 35 pits (approximately 1 per 10 square miles) appears to be too low grade for treating by the normal Bayer process. The Pederson process utilizes lower grade ores recovering both alumina and iron, but requires low-cost electric power besides large quantities of lime and coal. There is a great undeveloped hydro-electric potential in the Pakaraima Mountains, but the lime and coal would have to be imported.

The future of these deposits rests either (1) on the discovery of areas of higher grade bauxite, or (2) the development of a process for the economic extraction of both alumina and iron. Exploration continues, and possibilities of the second alternative are increased by the existence of additional vast deposits of low-silica aluminous laterites elsewhere in British Guiana, as well as by the great hydro-electric potential in the rivers descending from the Pakaraima Mountains.

The results of the investigation can be summarized as follows:-

1. Ferruginous bauxites have been formed in the Pakaraima Mountains from prolonged weathering of a dolerite sill exposed on extensive planation surfaces. These deposits are part of an immense extent of aluminous laterite in which Al_2O_3 dominates over Fe_2O_3 and silica content is variable.
2. Aluminous laterites with ferruginous bauxites are extensively developed over an area of approximately 1000 square miles.
3. The average depth of alumina-rich deposits over the greater part of this area is probably at least 10 feet.
4. The material is very variable in composition both laterally and in depth.
5. Exploration (which is continuing) may locate areas richer than average in Al_2O_3.
6. A very large tonnage of ferruginous bauxites in the Kopinang basin is sub-marginal for the present-day Bayer process, but might become economic with improved transport or suitably modified processing.

7. The Pakaraima deposits add to the enormous tonnages of ferruginous bauxite and aluminous laterites in British Guiana which could attain great economic importance if a process were developed for the production of both alumina and iron. A large hydro-electric potential is believed to exist in the Pakaraima Mountains.

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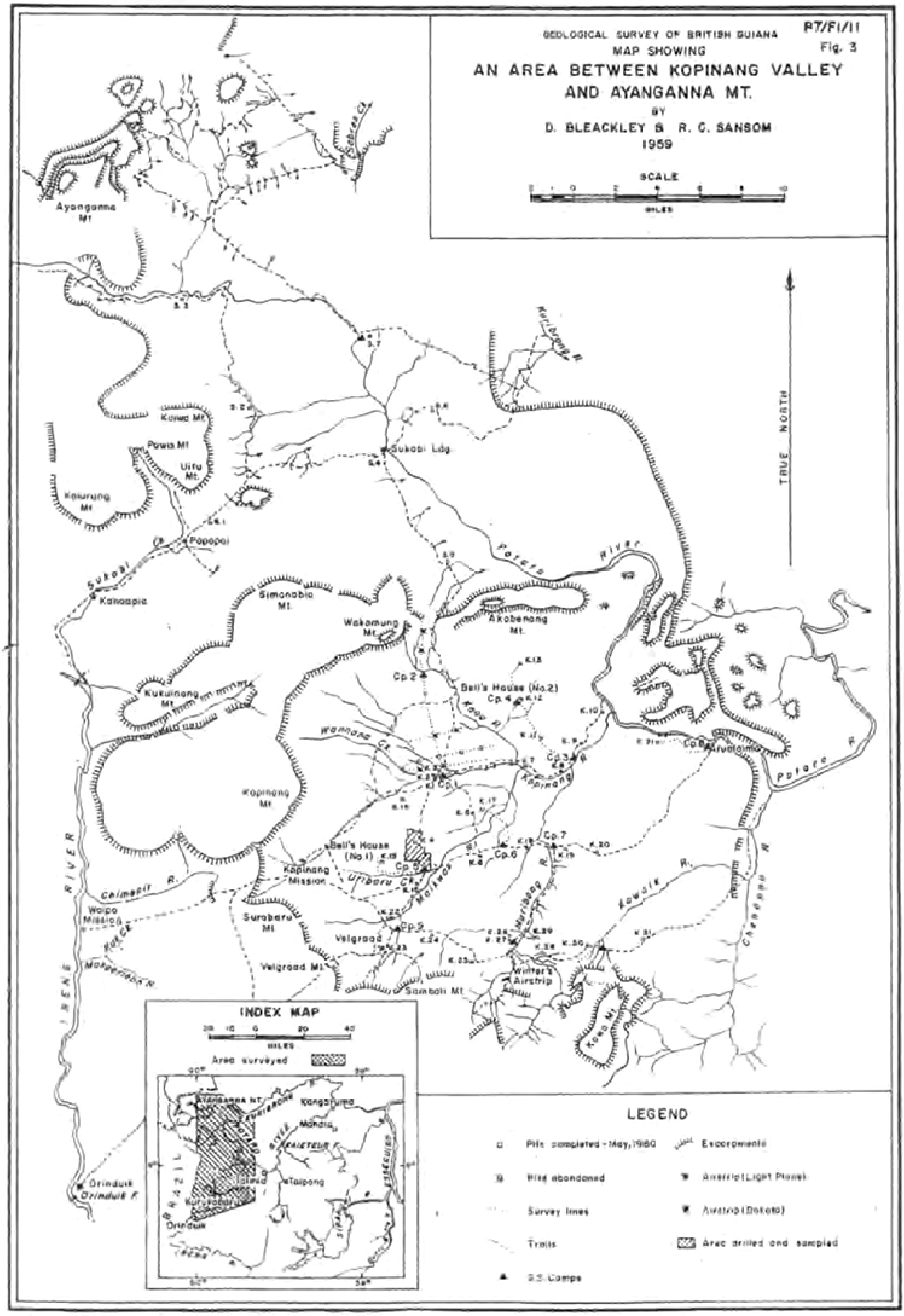
June, 1961.


P7/F1/11
Fig. 3
GEOLOGICAL SURVEY OF BRITISH GUIANA
MAP SHOWING
AN AREA BETWEEN KOPINANG VALLEY AND AYANGANNA MT.
BY
D. BLEACKLEY & R. C. SANSOM
1959
SCALE
MILES
TRUE NORTH
Ayanganna Mt
Kowa Mt
Powis Mt
Ulfu Mt
Kaiurung Mt
Papapai
Sukabi Ck
Kanaapia
Simonabia Mt
Wakamung Mt
Akobenang Mt
Potaro River
Sukabi Ldg
Kukuinang Mt
Kopinang Mt
Wannaba Ck
Kaaa R
Bell's House (No.2)
Cp. 4
Cp. 2
Cp. 1
Cp. 3
Kopinang
Tuwaima
Bell's House (No.1)
Kopinang Mission
Cp. 6
Cp. 7
Ulfbaru Ck
Chinapir R
Waipa Mission
Suraberu Mt
Velgraad
Velgraad Mt
Cp. 5
Samboli Mt
Winter's Airstrip
Kowaik R
Chenapau R
Koma Mt
Ireng River
Orinduik
Orinduik F.
INDEX MAP
MILES
Area surveyed
AYANGANNA MT.
Kangaruma
Mahdia
KAIETEUR F.
Tumatumari
Taipong
Kurukabaru
Orinduik
BRAZIL
LEGEND
Pits completed - May, 1960
Pits abandoned
Survey lines
Trails
G.S. Camps
Escarpments
Airstrip (Light Plane)
Airstrip (Dakota)
Area drilled and sampled

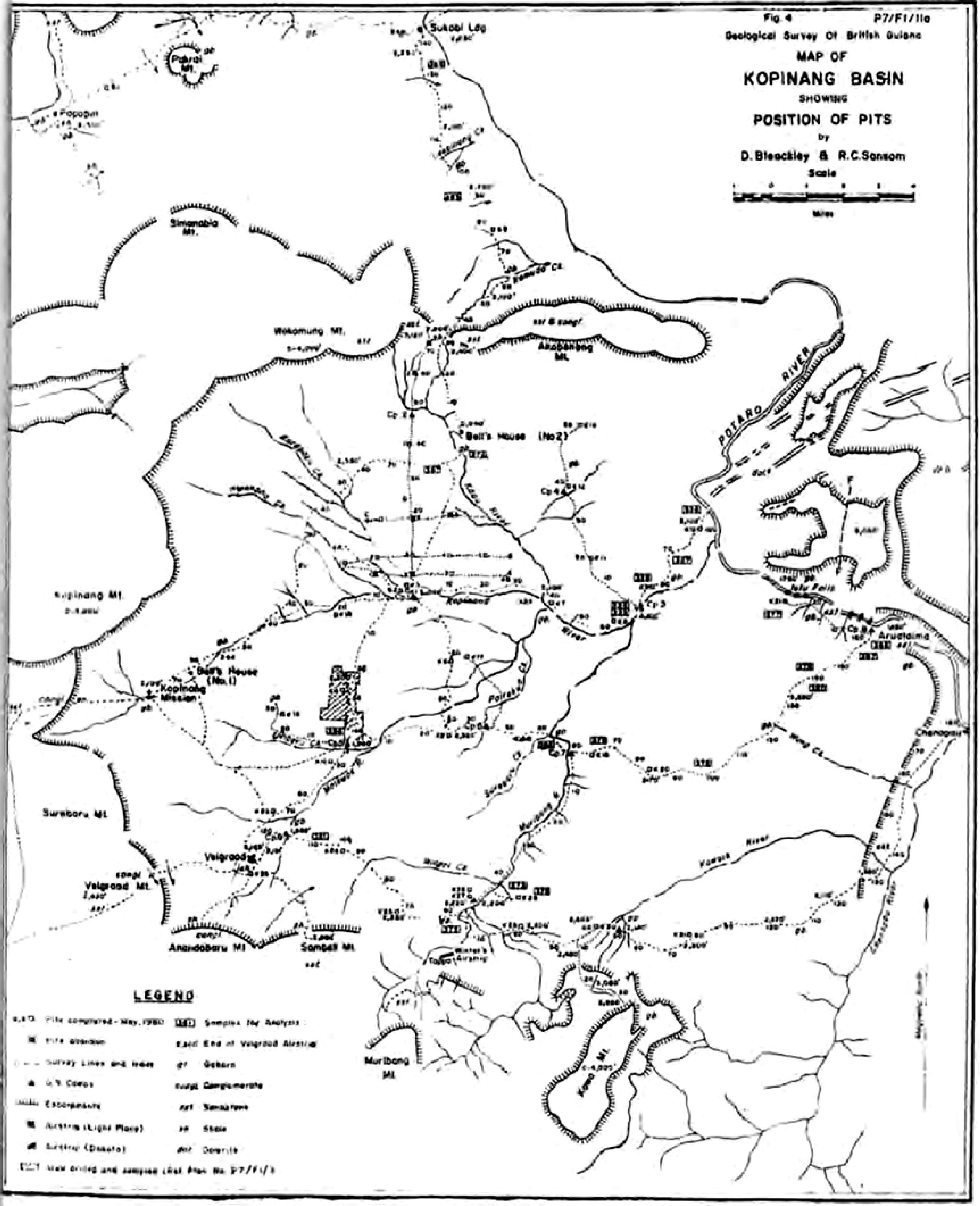
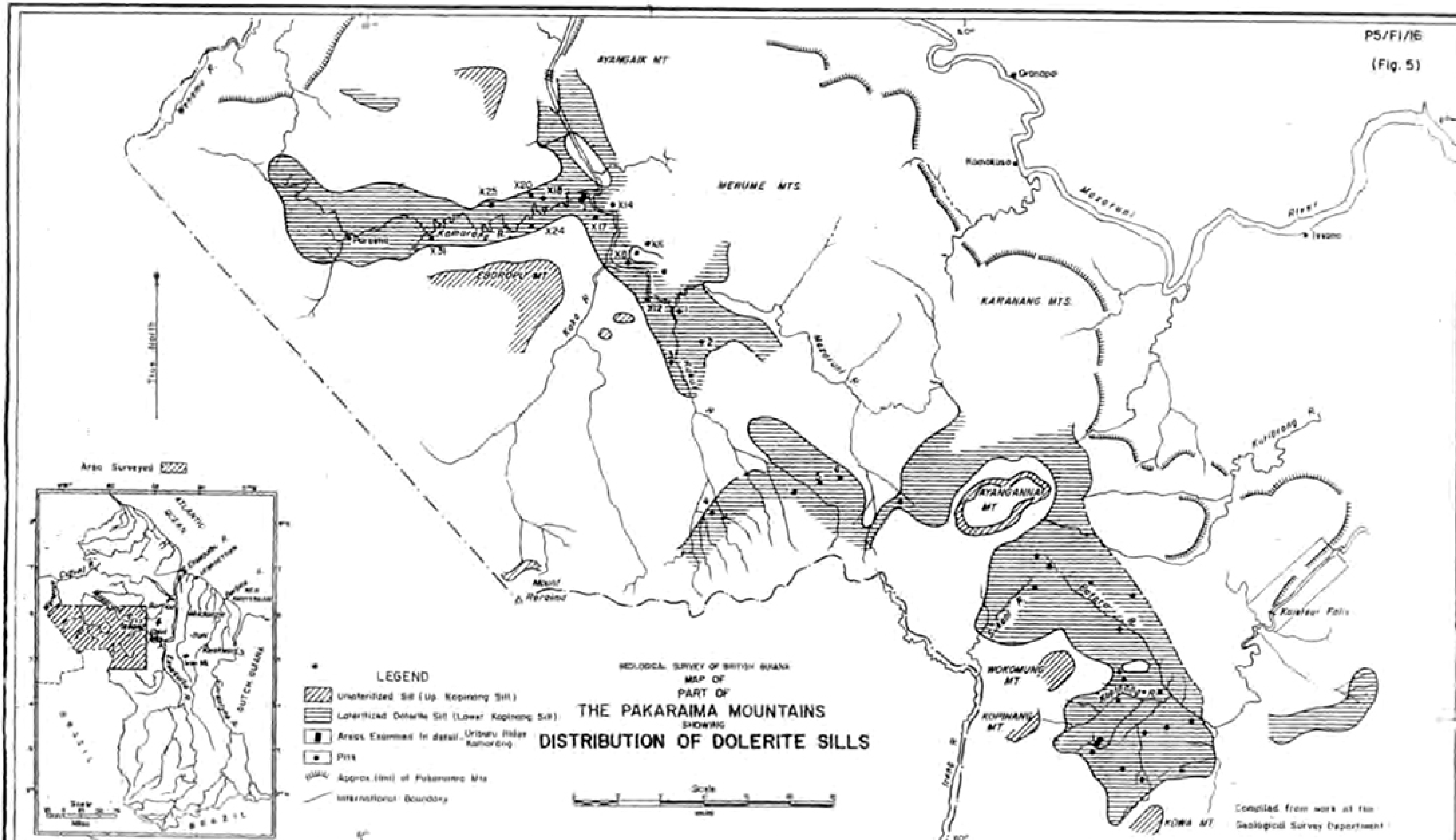


Fig. 4
P7/F1/11a
Geological Survey Of British Guiana
MAP OF
KOPINANG BASIN
SHOWING
POSITION OF PITS
by
D. Bleackley & R.C.Sansom
Scale
Miles
Sukabi Ldg
Pakrai Mt.
Simanabia Mt.
Wokomung Mt.
Kopinang Mt.
Bell's House (No.2)
Bell's House (No.1)
Kopinang Mission
Kopinang
POTARO RIVER
Cp 3
Cp 4
Cp 5
Cp 7
Arudaima
Chenapau
Sureboru Mt.
Veigroad Mt.
Anandaboru Mt
Sambali Mt.
Muribang Mt.
Kowa Mt.
Kowrak River
LEGEND
Samples for Analysis
Gabbro
Conglomerate
Sandstone
Shale


P5/FI/16
(Fig. 5)
AYANGAIK MT
MERUME MTS.
KARANANG MTS.
EBOROPU MT
AYANGANNA MT
WOKOMUNG MT
KOPINANG MT
KOWA MT
Mazaruni River
Kamarang R
Kako R
Kaieteur Falls
Kuribrong R.
Mount Roraima
Paruima
Imbaimadai
Kamakusa
Issano
X25
X20
X18
X14
X17
X24
X31
X6
X5
X12
Area Surveyed
ATLANTIC OCEAN
BRAZIL
DUTCH GUIANA
LEGEND
Unlaterized Sill (Up. Kopinang Sill)
Laterized Dolerite Sill (Lower Kopinang Sill)
Areas Examined in detail. Uriwaru Ridge Kamarang
Pits
Approx. limit of Pakaraima Mts
International Boundary
GEOLOGICAL SURVEY OF BRITISH GUIANA
MAP OF
PART OF
THE PAKARAIMA MOUNTAINS
SHOWING
DISTRIBUTION OF DOLERITE SILLS
Scale
Compiled from work of the Geological Survey Department

THE IRON ORE DEPOSITS OF TIGER HILL, DEMERARA RIVER.

1. Discovery of the Occurrence.

Tiger Hill is the most accessible of a number of laterite-capped hills which lie scattered over the wide savannah and bush covered plains between the Berbice and the Essequibo Rivers.

The Demerara River flows through the middle of this plain. Indeed, it has cut a gorge right through Tiger Hill itself, forming the first rapids up river from Georgetown, about 85 miles distant.

Unfortunately for the discovery of Tiger Hill, the many explorers and prospectors who might have appreciated its importance all passed up the Essequibo, the main highway to the Colony's mineral wealth.

Thus the first mention of these hills consists of some rather inaccurate comments on Arisaru and Yagi Mountains by Schomburgk on his way up the Essequibo in 1841.

Barrington Brown also landed at Arisaru on his way up to the Rupununi in 1871. Both he and Sawkins make only passing references to Tiger Hill, though Sawkins frequently refers to banks of laterite gravel which he saw on his wwy up the Demerara River.

Harrison, however, makes numerous references to Tiger Hill, as well as to Arisaru, in "The Goldfields of British Guiana" 1908.

The first of the hills to be surveyed in detail was Wamara, and its south-eastern extension, Iron Mountain. Wamara lies within a mile of the Demerara River, but it was first approached (Brown, 1873) and later surveyed (1953) by means of lines cut from the Berbice, some 20 miles distant.

In late 1953 a short reconnaissance of the Tiger Hill ferrite deposits was carried out by Mr. T.P. Larkin, who has applied for an exclusive permission to prospect the area for iron ore.

Tiger Hill was not, however, examined in detail until 1954, when a small G.S. party spent May of that year in a detailed examination of the economic possibilities of the area. Previous study of Air Photos recently made available, enabled line cutting and drilling for samples to be planned in detail before entering the field. In this way the most effective use could be made of the short time available.

Each of these was analysed separately, with the following results:-

	SiO_2	Fe_2O_3	TiO_2	Al_2O_3
Coarse gravel	1.08	77.84	3.6	10.06
Medium gravel	1.15	79.43	5.90	6.62
Sand	13.12	40.34	13.65	20.81
Clay washings	20.40	32.22	21.0	22.53

It will be seen that the coarser fractions are markedly enriched in iron, while the fine samples carry relatigely high values of titanium.

These results suggest that further gravel samples should be similarly treated. If such partition of the iron and titanium is a normal feature, and if sufficient gravel could be proved, the deposits might merit consideration as an economic and easily worked source of iron ore.

(c) Other laterite deposits in the vicinity. Numerous other laterite capped hills and gravel deposits have been reported in the area between Tiger Hills and Iron Mountain. A map showing the approximate position of these with a list of the original references, forms Appendix 3 to this report.

Conclusions.

It has been shown that the Tiger Hills are largely covered by deposits of lateritic iron ore. A rough estimate indicates that these deposits may contain some 50 to 60 million tons of ore averaging around 45 - 50% Fe_2O_3.

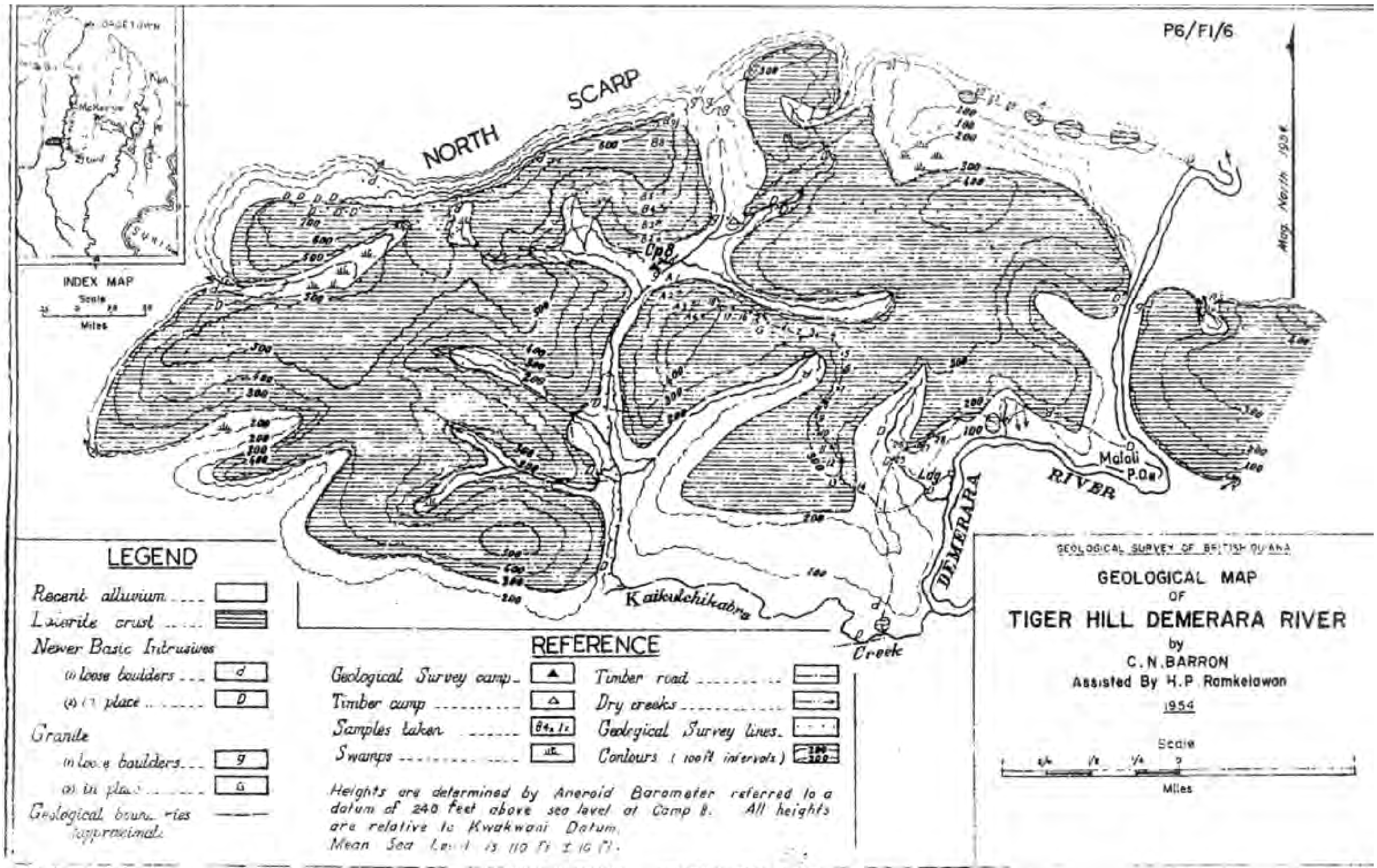
The bauxite shippingport at Mackenzie lies about 27 miles down the Demerara River, but shallow draught barges would be necessary for this distance. Alternatively, a road or railway would have to be constructed overland. The ore is considered too low in grade to permit economic exploitation at the present time.

Widespread laterite gravel deposits exist around the base of the hill. There is some evidence that the coarser grades of this gravel may be considerably richer in iron than the solid crust, while the finest grades appear to be relatively enriched in titanium.

Acknowledgements.

The writer would like to take this opportunity of thanking Mr. D.O. Pollard, Scientific Assistant, for all the grouble he has taken in connection with the sorting and analysis of the samples.

Geol. Survey Dept.,
Brickdam, Georgetown,
BRITISH GUIANA.


P6/F1/6
Mag. North 1954
NORTH SCARP
INDEX MAP
Scale
Miles
DEMERARA RIVER
Kaikutchikabra Creek
Malali P.O.
LEGEND
Recent alluvium
Laterite crust
Newer Basic Intrusives
(i) loose boulders
(ii) in place
Granite
(i) loose boulders
(ii) in place
Geological boundaries (approximate)
REFERENCE
Geological Survey camp
Timber camp
Samples taken
Swamps
Timber road
Dry creeks
Geological Survey lines
Contours (100ft intervals)
Heights are determined by Aneroid Barometer referred to a datum of 240 feet above sea level at Camp 8. All heights are relative to Kwakwani Datum.
Mean Sea Level is 110 ft ± 10 ft.
GEOLOGICAL SURVEY OF BRITISH GUIANA
GEOLOGICAL MAP
OF
TIGER HILL DEMERARA RIVER
by
C. N. BARRON
Assisted By H. P. Ramkelawan
1954
Scale
Miles

BRITISH GUIANA

GEOLOGICAL SURVEY DEPARTMENT

Mineral Resources Pamphlet

No. 3.

REPORT ON THE LATERITIC IRON ORE DEPOSITS AT IRON AND WAMARA MOUNTAINS, BERBICE, BRITISH GUIANA.

1954

Geological Survey Department,
Brickdam, Georgetown,
British Guiana
South America.

Price 50 cents

FOREWORD

Iron and Wamara Mountains are two flat-topped remnants of the 1000 ft. peneplain situated in heavily forested country between the Berbice and Demerara Rivers, about 35 miles from Ituni, the terminus of the Demerara Bauxite Company's railway.

This report describes the results of two reconnaissance Geological Survey expeditions to the area, respectively in 1952 and 1953, to examine the economic possibilities of the iron lateritic crust covering the summits and flanks of the two hills. Survey lines were cut at a density of 3.4 miles/square mile on Iron Mountain and 1.45 miles/square mile on Wamara Mountain. Twenty pits were put down into Iron Mountain, and 139 samples collected from them. No pits were dug on Wamara Mountain.

The crust of lateritic iron ore averages 12 feet thick. On this basis, it is estimated that Iron Mountain carries 410,000,000 tons and Wamara 510,000,000 tons of ore. Chemical analyses of samples collected from Iron Mountain indicates an iron content of about 38% Fe for the first 6 feet and about 34% Fe overall for the first 12 feet, the main impurity being a soft interstitial clay.

Experiments to improve the grade by washing out the clay have been undertaken in the laboratory and the results show that some beneficiation is effected.

It is for the larger mining companies to decide whether this grade of ore could justify large scale economic exploitation at the present time without beneficiation.

The Geological Survey Department in British Guiana believes that enough work (at least for the time being) has now been accomplished to indicate both the tenor and nature of the ore and the general size of these lateritic iron deposits situated between the Berbice and Demerara Rivers.

(SGD) G.M. STOCKLEY
Director, Geological Survey

Geological Survey Department
Brickdam
GEORGETOWN, BRITISH GUIANA
SOUTH AMERICA.

Recyclostyled Feb. 1960.

MINERAL RESOURCES PAMPHLET NO. 3

REPORT ON THE LATERITIC IRON ORE DEPOSITS OF IRON AND WAMARA MOUNTAINS, BERBICE, BRITISH GUIANA.

Maps illustrating report:-

1. Geological map of Iron Mountain. Scale 1:25,000
2. Geological map of Wamara Mountain. Scale 1:50,000
3. "Solid" Geological Map of the Iron and Wamara Mountains. Scale 1:125,000.

Price: 50 cents

REPORT ON THE LATERITIC IRON ORE DEPOSITS OF IRON AND WAMARA MOUNTAINS

by

D.M. McBeath, B.Sc., lately District Geologist, Berbice, & C.N. Barron, B.A., Geologist, Berbice

A. INTRODUCTION

This report contains the results of a survey carried out by D.M. McBeath assisted by H.P. Ramkelewan during the second field season of 1952, and by D.M. McBeath and C.N. Barron assisted by H.P. Ramkelewan during the second field season of 1953.

A report on the 1952 survey was published separately early in 1953. It dealt with Iron Mountain. The present report includes information contained in the 1953 report as well as material gathered on the 1953 survey which was concerned with both Wamara and Iron Mountains.

In 1953, D.M. McBeath was responsible for the reconnaissance survey of Wamara Mountain. Both Geologists were concerned with the completion of the mapping of Iron Mountain. C.N. Barron was responsible for pitting on Iron Mountain in 1953.

The object of the surveys was to make an estimate of the areal extent, depth and grade of the lateritic iron deposits in the area.

1. Location, Accessibility and Size of Area

The area investigated in 1952 lies immediately west of the Rupununi Cattle Trail between Miles 65 and 70 (see index map accompanying Map 1). The area surveyed in 1953 is near the Demerara River to the NW of Iron Mountain.

Since the Demerara River is not accessible to this point, approach to both areas must be made from the South or East. The route travelled by the two survey expeditions was up the Berbice to a point some 30 miles above Kwakwani, and then by a droghing* line for 8 miles to meet the Rupununi Cattle Trail which skirts the eastern end of Iron Mountain.

The droghing trail from the Berbice River is the quickest and most practicable way into the area. Unfortunately the river shallows rapidly above Kwakwani (where it is still tidal) and navigation to the Kuruduni Creek - a right bank tributary which joins the Berbice River opposite the droghing trail - is only possible with a 30 ft. river boat when the water is fairly high. Over the droghing trail all stores have to be carried manually.

Alternative routes would follow the Cattle Trail in part. This Trail is not suitable for motor transport, although it could be traversed by Land Rover for considerable distances in places. It provides easy going for pack mules and bullocks. Access to it may be obtained either from its starting point at Takama, some 95 miles up the Berbice, or from Ituni, a mining centre about 35 miles north of

---

* to drogh = to carry loads manually.

Chemical Analysis

Sample depths.	SiO_2 %	Fe_2O_3 %	= Fe %	TiO_2	Al_2O_3 %
0' - 2'	1.93	59.28	41.5	4.56	23.56
2' - 4'	2.19	60.07	42.0	4.25	24.33
4' - 6'	0.87	57.88	40.5	4.01	27.06
6' - 8'	1.00	42.51	29.8	4.50	41.49
8' - 10'	0.70	38.32	26.8	3.80	40.28
10' - 12'	2.20	32.57	22.8	3.40	39.83

Scarp XVIII Side of sinkhole. Altitude 630'.

General: Predominant type, when unweathered, seems to be a 'limonite'-lined, 'stony hematite' gravel.

0' - 1'6" Much whorl 'limonite' with interstitial orange or yellow clay.

2' ½" 'stony hematite' gravel with 'limonite' and 'metallic oxide' coating. This is the predominant laterite of the scarp, locally replaced by that described under 2' - 4'6".

2' - 4'6" 'Limonite' honeycomb. 1/3" cells more drawn out near top, filled by yellow clay. Much massive 'stony hematite', also some as 'limonite' coated nodules.
Locally replaced by 2' type (see above) or by a soft mottled clay mixture (red, yellow or white).

6' - 7' Hard 'stony hematite'. About 25% soft and hard or white clay in small vesicles. Some thin 'limonite' whorls.

Chemical Analysis

Sample depths.	SiO_2%	Fe_2O_3% =	Fe %	TiO_2%	Al_2O_3%
0' - 2'	2.84	64.51	45.2	3.4	19.13
2' - 4'	1.73	51.58	36.1	3.65	28.21
4' - 6'	1.80	45.19	31.6	3.80	31.21
6' - 7'	1.98	41.84	29.3	3.80	35.36
15" lake pits	17.77	12.77	8.9	9.91	49.32

Scarp XIX Altitude 210'.

General: Components very markedly flattened. The weathered face is a very good example of vesicular laterite.

0' 1'6" Flattened, very finely vesicular 'stony hematite', with vesicles empty or carrying earth, yellow or white clay. Cracks and joints coated blue-black. No 'limonite': apparently it has been replaced by 'stony hematite'.

3' - 5'9" Large vesicles, empty or with dry yellow or white clay, occasionally lined with 'ilmenite'. Many pale pink 'stony hematite. cobbles.

5'9" Yellow clay rich band.

Also ¼ x 2"-Mica schist fragments at 4' down.

Chemical Analysis

Sample depths.	SiO_2%	Fe_2O_3 % =	Fe %	TiO_2%	Al_2O_3%
0' - 2'	13.05	62.38	43.67	1.8	15.02
2' - 4'	14.10	60.04	42.03	1.7	18.46
4' - 6'	17.00	53.65	37.56	1.8	17.59

Scarp XX - Altitude 340'.

0' 8'6" Coarsely vesicular. 'Limonite' greatly exceeds 'stony hematite.'

8'6" -12' (Esp. 8'6" - 10'6"). Some ves., but mainly small gravelly fragments of 'stony hematite.' Also some small rounded boulders of a dark red homogeneous rock, finely threaded with 'metallic iron oxide' and with numerous white layered pea-sized vesicles (IMCB 77 & 78/53).

Chemical Analysis

	Sample depths.	SiO_2%	Fe_2O_3% =	Fe %	TiO_2%	Al_2O_3 %
	0' - 2'	19.33	43.27	30.3	1.50	23.79
	2' - 4'	21.81	41.64		1.90	24.94
	4' - 6'	20.13	45.99		1.60	26.09
	6' - 8'	19.35	43.11		1.60	26.09
	8' - 10'	20.82	39.84		2.15	18.81
	10' - 12'	19.63	45.31		2.30	24.67
Weathered surfaces	7'6"- 8'6"	12.41	45.35		2.00	28.45
	8'6"- 9'6"	10.60	50.46		1.80	26.70
Blasted face	7'6"- 8'6"	11.94	40.56		1.80	35.68
	8'6"- 9'6"	11.91	40.56		2.10	32.78

Pit XXI Altitude 255'.

No samples.

0' - 5'6" Sticky yellow clay.
5'6"- 7' Hard laterite ('ilmonite' and 'stony hematite'), with eroded upper surface.
Below 7' Sandy clay. 4" space at base of laterite.

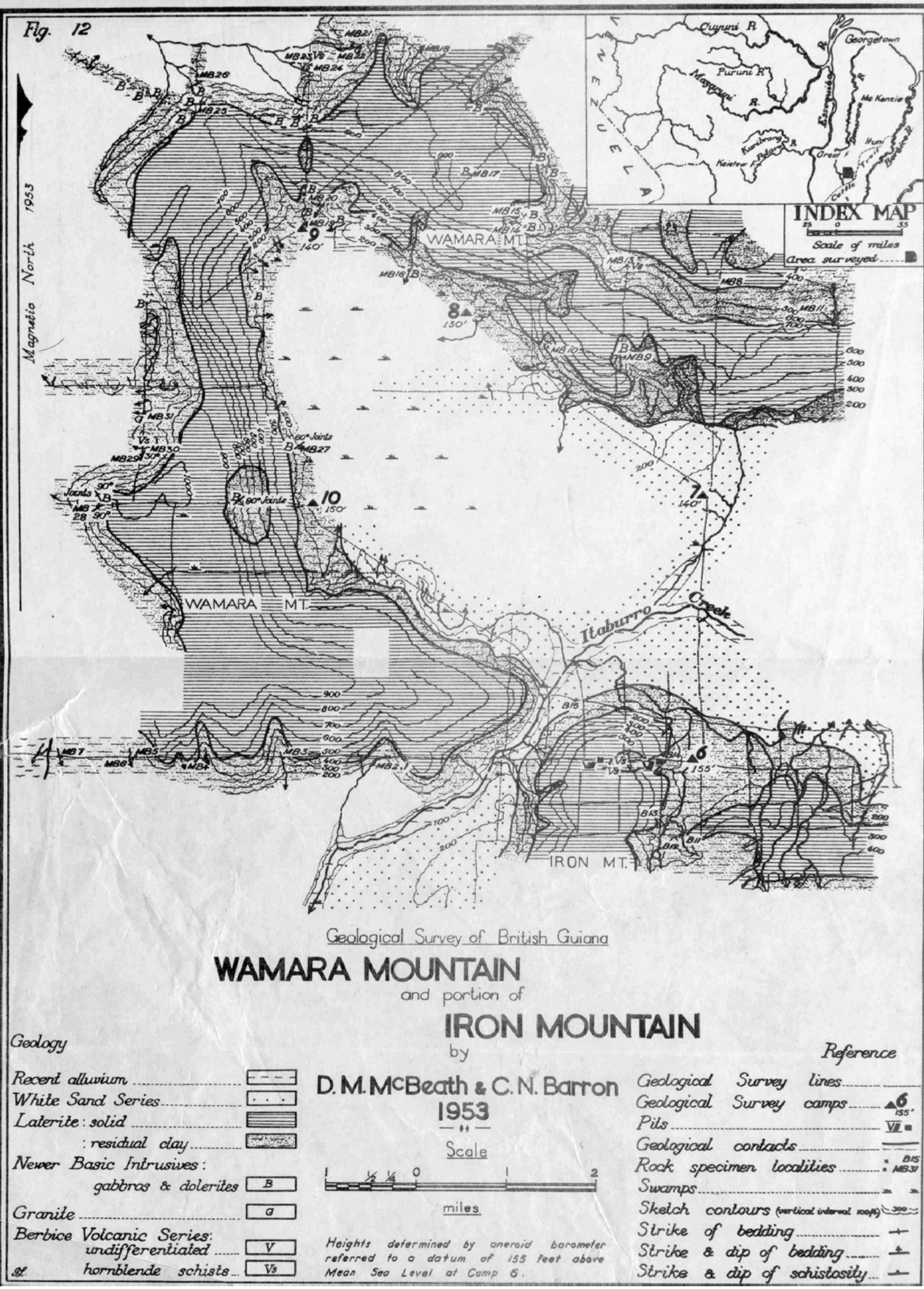


Fig. 12
Magnetic North 1953
INDEX MAP
Scale of miles
Area surveyed
Cuyuni R.
Puruni R.
Mazaruni R.
Georgetown
Essequibo R.
McKenzie
Berbice R.
VENEZUELA
Kurribrong R.
Potaro R.
Kaieteur F.
Great F.
Cattle Trail
WAMARA MT.
WAMARA MT.
IRON MT.
Itaburro Creek
Geological Survey of British Guiana
WAMARA MOUNTAIN
and portion of
IRON MOUNTAIN
by
D. M. McBeath & C. N. Barron
1953
Scale
miles
Geology
Recent alluvium
White Sand Series
Laterite: solid
: residual clay
Newer Basic Intrusives:
gabbros & dolerites
Granite
Berbice Volcanic Series:
undifferentiated
hornblende schists
Reference
Geological Survey lines
Geological Survey camps
Pits
Geological contacts
Rock specimen localities
Swamps
Sketch contours (vertical interval 100ft)
Strike of bedding
Strike & dip of bedding
Strike & dip of schistosity
Heights determined by aneroid barometer referred to a datum of 155 feet above Mean Sea Level at Camp 6.

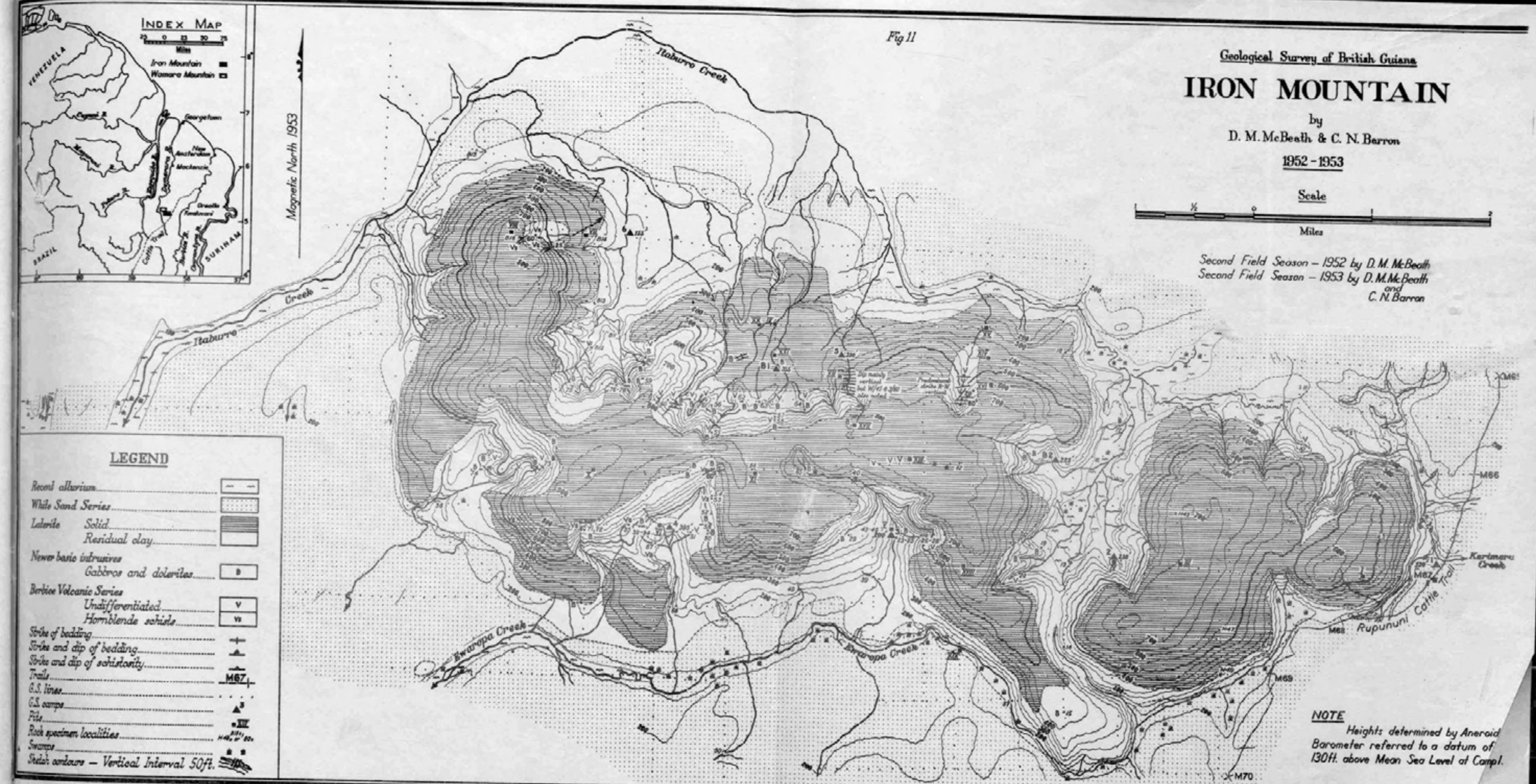


Fig 11
Geological Survey of British Guiana
IRON MOUNTAIN
by
D. M. McBeath & C. N. Barron
1952 - 1953
Scale
Miles
Second Field Season – 1952 by D. M. McBeath
Second Field Season – 1953 by D. M. McBeath and C. N. Barron
Magnetic North 1953
INDEX MAP
Miles
Iron Mountain
Wamara Mountain
VENEZUELA
Georgetown
New Amsterdam
Mackenzie
BRAZIL
SURINAM
Cattle Trail
Itaburro Creek
Itaburro Creek
Ewaropa Creek
Ewaropa Creek
Karimaru Creek
Rupununi Cattle Trail
M66
M67
M68
M69
M70
LEGEND
Recent alluvium
White Sand Series
Laterite Solid
Residual clay
Newer basic intrusives
Gabbros and dolerites
Berbice Volcanic Series
Undifferentiated
Hornblende schists
Strike of bedding
Strike and dip of bedding
Strike and dip of schistosity
Trails
G.S. lines
G.S. camps
Pits
Rock specimen localities
Swamps
Sketch contours – Vertical Interval 50ft.
NOTE
Heights determined by Aneroid Barometer referred to a datum of 130ft. above Mean Sea Level at Campl.