

## GEOLOGICAL AND GEOPHYSICAL INVESTIGATIONS OF THE KLIRIPAN MANGANESE FIELD, CENTRAL JAVA

H. HIGASINAKA <sup>1)</sup>, SUKENDAR ASIKIN <sup>1)</sup>, and R. SOEBEDO <sup>2)</sup>

### ABSTRACT

Mining activities in the Kliripan manganese field are historically compiled since the first excavation in 1912.

The geology of the Krengseng manganese mine in the Kliripan field is described, together with the manganese ores.

A magnetic survey for measuring the anomaly of the vertical intensity was carried out in the Krengseng mine. The anomalies observed are as a whole small, but towards the west the effect of the andesitic rocks are conspicuous. While, the whole distribution of the anomalies seems to be explained by the assumption that the geological bodies are magnetized by the earth's field in a low geomagnetic latitude of the Southern hemisphere.

The widely spread part of the zone of positive anomalies seems to coincide with the area ascertained by bore-holes to reserve a manganese layer. However, it is questionable whether the coincidence shows a logical relation between the anomalies and the manganese layer.

### CONTENTS

Introduction. . . . .	26
Mining activities of the Kliripan district. . . . .	28
Geology of the Krengseng area. . . . .	30
A. Stratigraphy. . . . .	30
B. The ore bodies. . . . .	32
Magnetic Survey. . . . .	32
A. Instrument and method of the survey. . . . .	32
B. Distribution of magnetic anomalies. . . . .	33
C. Conclusions. . . . .	35
References. . . . .	36

1) Division of Geology, NIGM, Bandung.

2) Division of Mining, NIGM, Bandung.

## INTRODUCTION

Manganese ores in Indonesia are found in Java, Kalimantan, Sumatra, Sulawesi, Timor, Bangka, Roti, Sumbawa, Flores, Buru and Halmahera. Among these the most important districts are Karangnunggal, South Tasikmalaja (West Java) and Kliripan, Jogjakarta (Central Java). The Kliripan manganese mine is the second producer after the Karangnunggal.

Existing facilities for ore handling are mostly carried out by man powers and the transportation is by road and rail between the mine and the ports of shipment, which are Tjilatjap of the southern coast of Central Java and Surabaya, East Java.

In the Kliripan district, there are three manganese fields. They are the Kliripan field, the Andjir field and the Kembang field.

Of the above fields, the most noteworthy field may be the Kliripan, in which the present investigations were carried out at one locality, Krengseng. Fig. 1 shows the locations of the Kliripan district and the three manganese fields in it.

Principally the present paper consists of three parts, which are descriptions on mining activities, studies on geology, and the magnetic survey. They are investigated mainly by R. Soebedo, Sukendar Asikin, and H. Higasinaka respectively.

The Krengseng mine under discussion, lying in the southeastern part of the West Progo mountains, is situated 30 km. west of Jogjakarta, and is in easy access by car.

The geology of the West Progo mountains, which includes all the three manganese ore fields mentioned above — Kliripan, Andjir and Kembang, has been studied widely by Koolhoven (1936). In December 1968, Sukendar Asikin investigated the geology of a small area occupying only the Krengseng mine and mapped on a scale of 1 : 1000. The result forms a part of this paper.

A magnetic prospecting was attempted as a trial for manganese ores. Manganese itself seems to have no effect on the earth's magnetic field. However, since it is often associated with iron, the survey by the magnetic method may sometimes be useful for locating manganese ores. Although the iron content of the manganese ore in the Kliripan mine is rather small, we attempted to make a magnetic survey in the field.

The test survey measuring the vertical intensity of the earth's magnetic field was carried out from 15 to 19 December 1968 by Ir. Harsono Raf and Ir. Darmoko Slamet, who are the members of NIGM, with a torsion magnetometer equipped recently at the NIGM.

The surveyors stayed comfortably at a local house which was prepared by Perusahaan Pertambangan Mangan Daerah Istimewa Jogjakarta (Manganese company, Jogjakarta, owned by local government). We express our sincere thanks to Mr. Hadijanto Martosubroto, Director of Perusahaan Negara Aneka Tambang Djakarta (General mining company, Djakarta, owned by government) and Mr. Dirdjonegoro, Director of Peru-

sahaan Pertambangan Mangan D.I.J., who permitted us to execute the survey in the mine and gave conveniences in every respect in completing the survey.

We are also grateful to Dr. A. Gritly, Resident Representative of the United Nations Development Programme in Djakarta, who had an interest in the survey and gave willingly financial help for it. To the members engaged in the measurements as well, we express our thanks for their painstaking efforts.

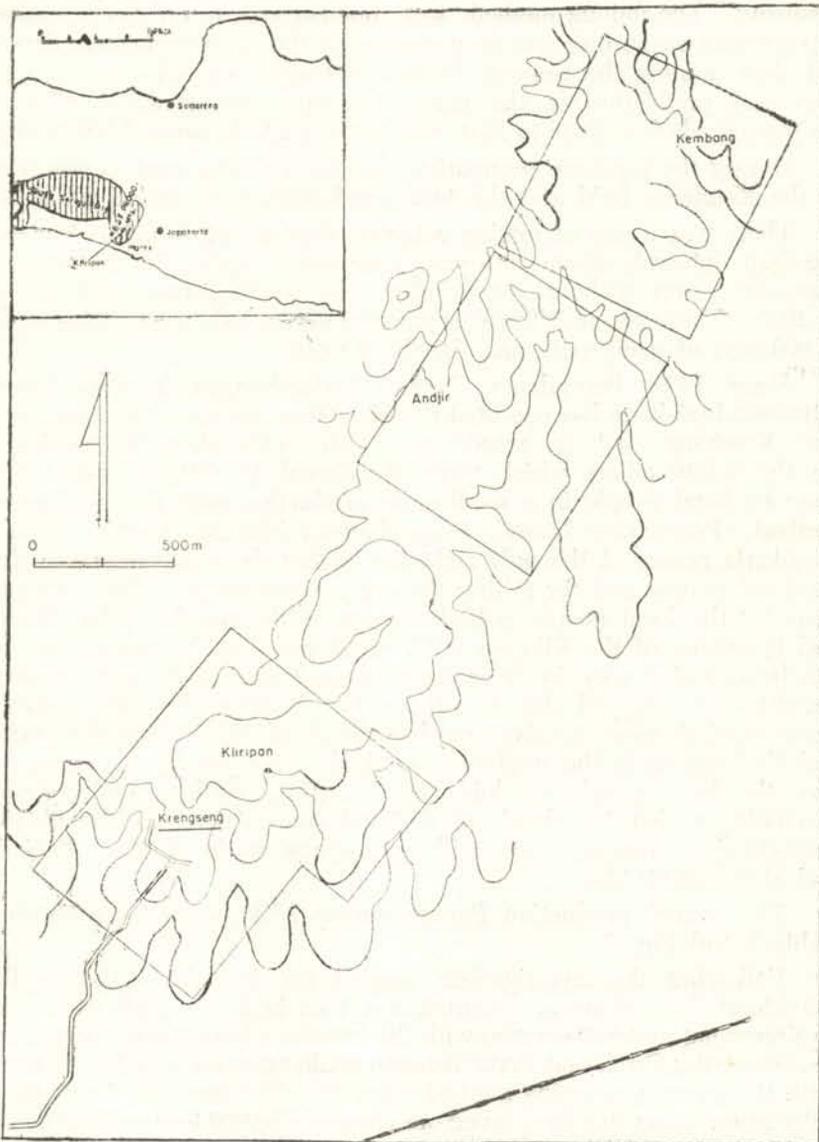


Fig. 1. Index map of the Kliripan manganese field.

## MINING ACTIVITIES OF THE KLIRIPAN DISTRICT

In 1912 Van Dalzen excavated first manganese ores in the Kliripan district. The quantity of the ore which had been produced by him from 1912 to 1918 was around 30,000 tons.

Then in 1918 AIME (Algemeene Industriële Mijnbouw en Exploitatie Maatschappij) possessed the mining rights. The excavation of the manganese ores was carried out in the three fields, Kliripan, Andjir and Kembang. The mining methods were openpit mining for the manganese deposit near the surface and deep mining for the deep manganese deposit. For deep mining the stoping method of room and pillar was applied. The total production of the manganese ores excavated by AIME in the three fields from 1918 to 1941, was estimated to be around 160,000 tons.

During the Japanese occupation, mining activities were concentrated in the Kembang field and the total production was around 6,000 tons.

There was a gap of mining activities during 1945 – 1953. But after the gap interval, seven different companies started to excavate the manganese ores without any license. The works continued from 1953 to 1959. These seven different companies succeeded in producing around 57,000 tons of manganese ores for the 6 years.

Since 1959, Perusahaan Daerah Pertambangan Mangan Daerah Istimewa Jogjakarta has operated the manganese mines in Kliripan, Andjir and Kembang, but in small scale. The excavation is emphasized on the safety pillars which were abandoned by AIME, and is being done by local people in a small scale production with the hand mining method. Perusahaan Daerah Pertambangan Mangan Daerah Istimewa Jogjakarta possessed the only right for buying the manganese ores from the local people and for selling the ore to consumers. Mine excavation done by the local people is limited only in the two localities, Kliripan and Penggung of the Kliripan field. It seems that the mining activities can be executed only in dry season, because during the wet season all activities are stopped due to rain water entering the mine openings. Some vertical mine openings reach a depth of 30 m. from the surface, and the stoping is the gophering method. To upgrade the manganese ore, the local people is doing hand sorting, washing and screening manually so that two kinds of finished concentrates can be obtained respectively: manganese ore with an average grade of 46 – 48 % Mn and above 48 % Mn.

The annual production figures during 1959 – 1968 are shown in Table 1 and Fig. 2.

Following the investigations carried out by Akira Abe in 1959, Direktorat Pertambangan executed ten bore-holes in 1960 in the area of Krengseng under discussion with the long-year boring rigs. From these ten bore-holes Direktorat Pertambangan made estimation of the ore reserve with the triangle grouping method regarding the bore-holes location. The calculation shows that the proved ore reserve is 88,000 tons and the possible ore reserve is 46,000 tons with an average grade of 30 % Mn. Koike had studied the data of the bore-holes and obtained 286,000 tons as the total

reserve, in which 182,000 tons has an average grade of 35% Mn. In order to obtain a reasonable figure of the reserve, we must know the extent of the ores as well as the forms of the ore bodies. Otherwise the deep mining may not be planned.

Consumption of these ores is now partly for domestic battery factories and the rest is exported to Japan.

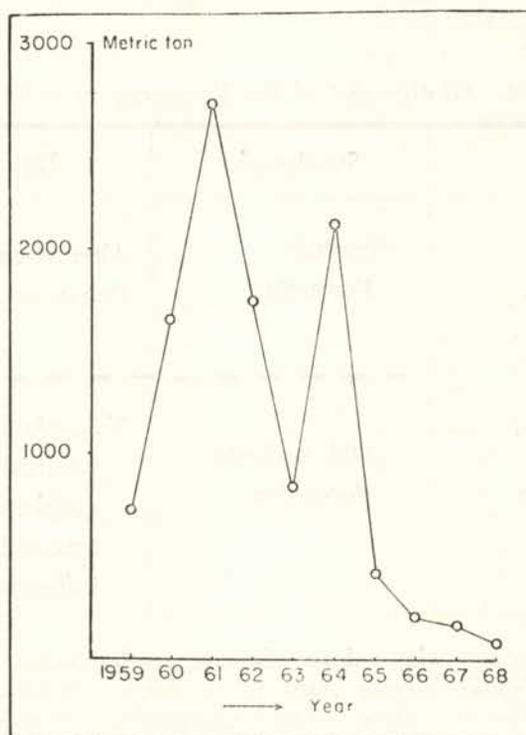


Fig. 2. Total production figure 1959-1968 of small manganese mines Kliripan and Kembang, Jogjakarta, Java (46% and more Mn).

Table 1. Annual production figures of 46% and over Mn in the Kliripan and the Kembang fields.

Year	Production in metric ton	Year	Production in metric ton
1912 - 1958	250,000	1964	2,124,015
1959	729.445	1965	415,201
1960	1,654.929	1966	203,570
1961	2,723.379	1967	170.469
1962	1,744.551	1968 (Nov.)	80.793
1963	834.800		

## GEOLOGY OF THE KRENGSENG AREA

## A. Stratigraphy

The oldest rocks exposed in the area are of Oligo-Miocene age and are unconformably overlain by rocks of the Middle Miocene to Pliocene. The stratigraphic succession of rocks exposed in the area mapped is summarized in Table 2.

Table 2. Stratigraphy of the Krengseng area, Kliripan.

Age	Stratigraphy	Description
Pliocene	Sentolo Formation	Alternation of limestone and marl
Miocene		<i>unconformity</i>
Oligocene	Old Andesite Formation	Volcanic breccia interbedded with conglomerate, tuff and tuffaceous sandstone

Oligo-Miocene. The volcanic breccia is the oldest rocks mapped. They are andesitic breccia with interbedded conglomerate, tuff and tuffaceous sandstone. These rocks undoubtedly belong to the volcanic group known as the "Old Andesite Formation" of the West Progo and is therefore assigned to the Oligo-Miocene (v. Bemmelen 1940).

Mio-Pliocene. The limestone and marl sequence rests unconformably on the volcanic breccia below. This sequence can be assigned as belonging to the Sentolo Formation, a name introduced by van Bemmelen (1940) for a sequence of rocks made of marls and bedded limestone outcropping in the area east and southeast of the West Progo mountains. The top part of the limestone are thinly bedded. The age of the formation was recently determined by Harsono P. (1968) based on planktonic Foraminifera and proved to be Burdigalian (Middle Miocene) to Pliocene.

Structure. Measurements made on the limestone show that the Sentolo Formation is slightly dipping to the southeast not more than  $10^\circ$ , with exception reaching  $15^\circ$  to  $18^\circ$  in some places. The presence of a normal transverse fault striking NNW-SSE was assumed based on the peculiar sharp bend of the limestone boundary in the north and its topographic expression.

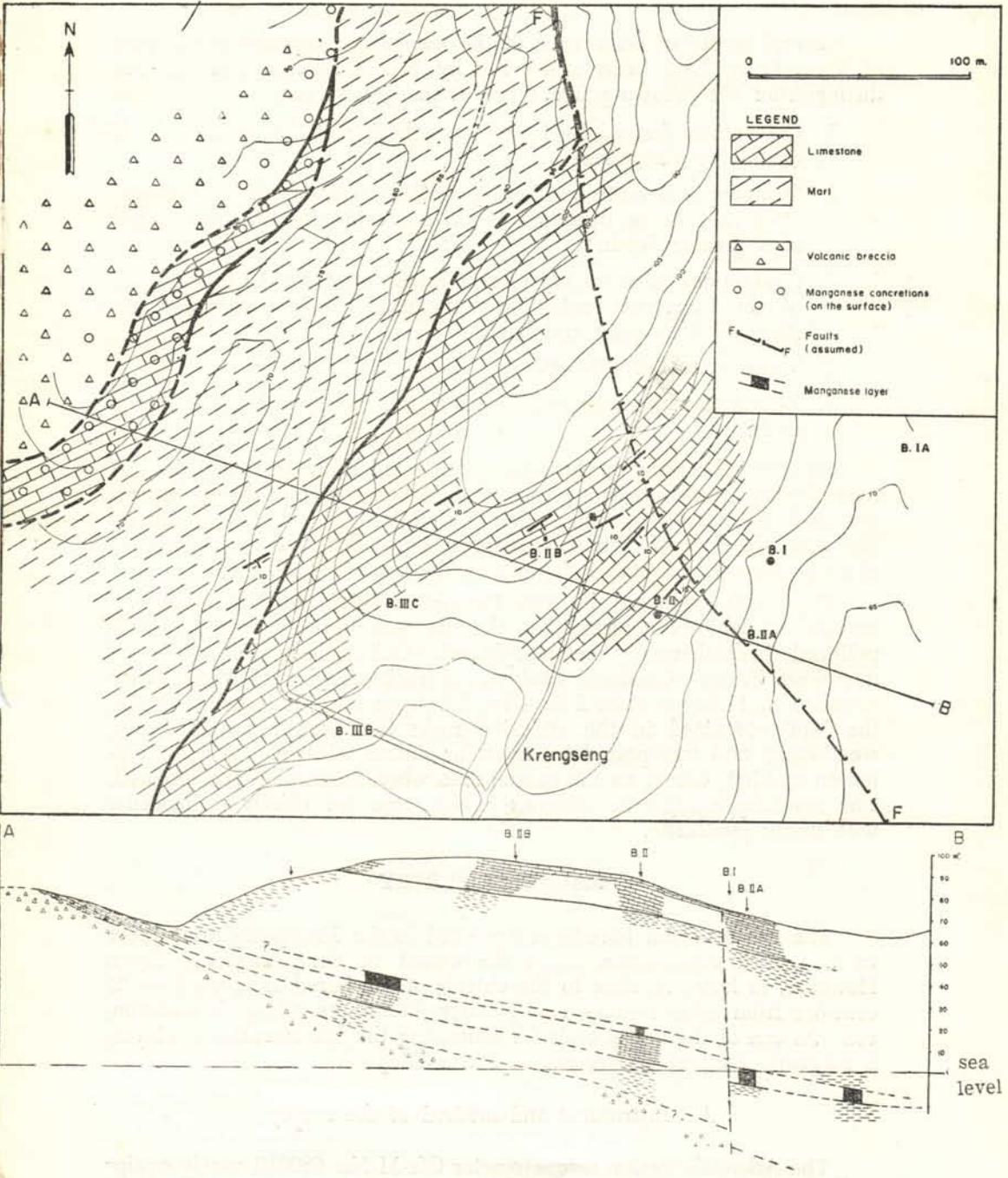


Fig. 3. Geological map of the Krengseng mine, Kliripan.

## B. The ore bodies

Several modes of occurrence of the manganese deposits in this part of West Progo have been considered by van Bemmelen (1949 b). He distinguishes the following five types of manganese ore.

1. Concretions formed by lateritic weathering at the surface of soil containing manganese.
2. Stringers in lateritic weathering profiles, in which the manganese, after first being dissolved by humic acids etc., is precipitated at a greater depth.
3. Concretions in or on top of reef limestone, formed by dissolving of the limestone containing manganese. Such concretions are generally very pure and hard.
4. Veins in reef limestones.
5. Lenses of manganese ore, found in the marly basis of limestone reefs.

Surface indications in the area investigated show that only the 3rd type of manganese deposits is present and the concretions of the manganese ore are found, associated with chalcedony, in crystalline limestone (Fig. 3). However, the data of drill holes suggest a possibility of the occurrence of lense shaped or layerlike deposits in the marl (Fig. 3).

Hypothesis proposed by van Bemmelen (1940) on the genesis of manganese deposits suggests that the ore was derived from the propylitized (hydrothermally metamorphosed) "Old Andesite Formation" of the West Progo. Chemical analyses of rock samples of West Progo revealed that they contain 2 to 4 kg. MnO per ton. It is believed that the MnO contained in the andesitic rocks has been removed during weathering, and transported by rivers as sulfate solution. Thus, precipitation of MnO<sub>2</sub> occurs on the coastal area where limestones accumulated. The resulting manganese minerals in this area are chiefly psilomelane with minor pyrolusite.

## MAGNETIC SURVEY

The result of ten bore-holes executed in the Krengseng mine gives us a certain information about the extent of the manganese layer. However, to know its state to the outside of the bored area, we have to consider from other sources, say, geology, literatures, villager's tradition, etc. As one of the useful tools for estimating the full extent of the layer, a magnetic method undermentioned was adopted.

### A. Instrument and method of the survey

The Askania's torsion magnetometer Gfz-M No. 680010, newly equipped at NIGM in 1968, was used for the survey. The scale value E determined by the manufacturer is

$$E = 246.3 \gamma / ^\circ\text{C}.$$

Having checked at our laboratory with an apparatus having a Helmholtz coil, the value has been ascertained unchanged and to be employed for our survey.

The temperature compensation of the magnet system is adjusted by the manufacturer under the vertical intensity  $Z$  of the normal earth's field  $- 24900 \gamma$ , which approximates to that in Java, and according to the certificate given by the manufacturer the temperature coefficient under the above condition is less than  $0.1 \gamma / ^\circ\text{C}$  for the range of  $Z = + 5000 \gamma$  and  $- 55000 \gamma$ , which covers of course the whole of the Indonesian territory.

Throughout our survey, the change of temperature during the necessary interval has been less than  $10 ^\circ\text{C}$ . So the temperature correction to be added to the observed value with an accuracy of  $1 \gamma$  has been found unnecessary.

The procedure of carrying out the survey was as follows: Over the assumed manganese layer, six traverse lines were selected, almost in parallel each other and separated successively by about  $40 - 50 \text{ m}$ . Along each line, the observation points were taken at every  $20 \text{ m}$ . They are totally 109 in number.

The base point for the measurement was selected near the centre of the surveyed area, and on each traverse line a local base point was provided. The measurements were carried out with a loop method, having started from the base (or local base) point and ended there. Each of the loop measurements was completed within one hour to minimize the effect of the diurnal variations of the earth's field and the effect of the change of instrumental condition during a loop measurement. The difference of the two values observed repeatedly at a base point of a loop was mostly less than  $10 \gamma$ , which is small enough and reasonably considered to be distributed pro rata to the local stations with the order of the measurement as the base correction. The relative values at local base points were obtained from a loop measurement comprising only the base and local base points.

In addition to the base correction mentioned above, we have to take the latitude correction into account. However, it is almost negligibly small for our survey, because it attains approximately  $1 \gamma$  for a difference of  $70 \text{ m}$  in a nearly NS direction.

#### B. Distribution of magnetic anomalies

In general the magnetic anomalies of the vertical intensity in the surveyed area are small as expected from the geology. However, from the distribution of the anomalies (Fig. 4), we notice the following two remarkable facts.

1. Along the western valley somewhat large anomalies of Z, reaching  $-571 \gamma$ , are found.
- 2 The southerly central part of the surveyed area shows as a whole positive anomalies, which extend from west to east and spread widely in the eastern part.

The large anomalies along the valley may be attributed to the effect of the andesitic rocks which expose or approach to the surface around there.

The above second fact may be considered to be due to the following two reasons. First, the positive anomalies occupy mostly the southern slope of the hill. If the geological bodies are magnetized inductively by the normal earth's field, negative anomalies of Z and the corresponding positive anomalies are apt to prevail respectively on the hill and its southern slope or foot.



Fig. 5. Magnetic measurement in Kliripan.

Secondly, compared with the promising area of manganese ores shown by bore-holes, the area of the positive anomalies occupies the ground under which the existence of a manganese layer is assumed.

Although the magnetic property of the ores is so weak that it may be almost overlooked, iron minerals spreading possibly around the layer and the closely underlying rocks of igneous origin must give effect to the magnetic anomaly.

According to the result of bore-holes, the thickness of the ore varies with location, attaining some meters as a maximum. Therefore, the ores may be considered to exist as scattered bodies having lenticular forms. However, since they appear to be nearly in a definite geological horizon, they may be regarded as constituting a layer with a variable thickness.

Viewed from these statement, the anomalies seem as if to have a definite relation with the manganese layer and to suggest the extent of the layer.

On the other hand, however, if an underground layer is magnetized by the induction of the earth's field, the magnetic effect on the surface will normally give negative anomalies of Z, provided the surface be flat. But, on the contrary, the positive anomalies have been found. So, we should not conclude whether the coincidence of the area shows a definite relation between the magnetic anomalies and the manganese layer.

### C. Conclusions

For the most part, the anomalies of the vertical intensity were found small as expected from the prevailing calcareous rocks.

Relatively large anomalies attaining nearly  $-600 \gamma$  found along the western valley may be ascribed to the andesitic rocks coming up from the east and exposing just to the west of the valley.

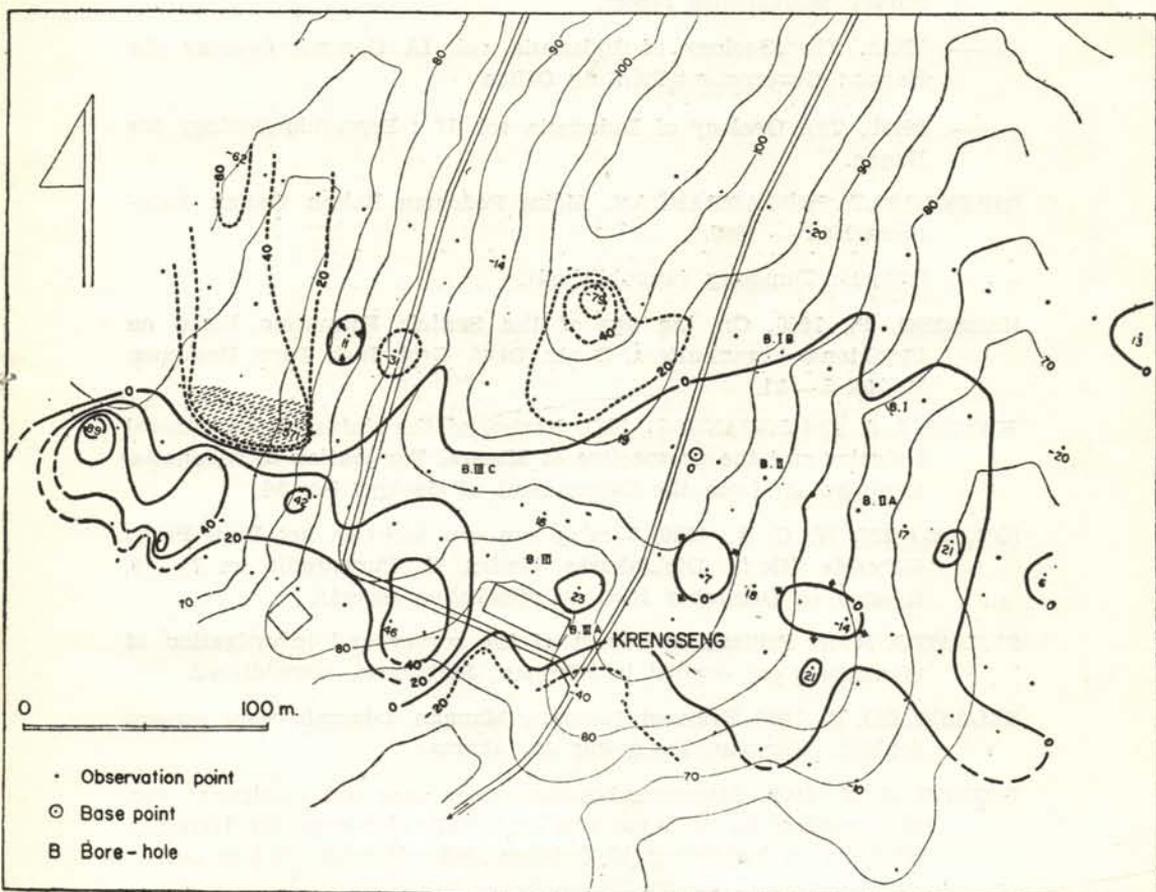


Fig. 4. Vertical magnetic anomalies in the Krengseng manganese mine, Kliripan.

The positive anomalies of Z extending from west to east on the southern slope of the hill may be considered to be due to the effect of the topography, if the geological bodies are assumed to be magnetized by the induction of the earth's field in low geomagnetic latitudes of the Southern hemisphere.

The eastern widely spread part of the positive area coincides nearly with the area of a manganese layer assumed from the results of bore-holes. This coincidence may not be concluded whether the anomalies have a relation to the manganese layer.

#### REFERENCES

- BEMMELEN, R. W. VAN, 1940, Verslag van een opname tocht in het gebied der kaartbladen 71, 72, 75, 76. (West — Progo gebergte) Geol. Survey, unpublished report.
- , 1949a, The Geology of Indonesia vol. IA General Geology the Hague: Government Printing Office.
- , 1949b, The Geology of Indonesia vol. II: Economic Geology the Hague.
- DIREKTORAT PERTAMBANGAN, Buku Pedoman Bahan Galian Indonesia 1950 — 1965.
- , Laporan Tambang (unpublished).
- HARSONO, P., 1968, On the age of the Sentolo Formation based on Planktonic Foraminifera, Contr. Dept. Geol. Inst. Tech. Bandung, No. 64, 5 — 21.
- KATILI, J. A. and JOHANNAS., 1961, Review of the status of the Mineral Industry and the prospective of Mineral Exploration in Indonesia. Contribution from the Department of Geology No. 36.
- KOOLHOVEN, W. C. B., 1936, Verslag van een tocht in het West Progo Gebergte (Gouv. Djokjakarta, bladen 72, Purworedjo en 7 — 76, Djokja) in December 1936. (Unpublished report).
- SUKAMTO, RAB., Priliminary report of the survey and investigation of manganese ore deposit in Kliripan, Jogjakarta, unpublished.
- SULASMORO, B., 1960, Evaluasi Tambang Mangan didaerah bekas konsesi A.I.M.E., Kliripan, Penggung, Jogjakarta.
- VOETEN, J. H., 1908, Algemene beschouwingen over het voorkomen van Mangaanerts en de Wyze van Exploitatie der consessie terreinen Kliripan en Penggung; 10 October 1908. (Unpublished report).

(Manuscript received 15 January 1969)