

MAGNETIC PROSPECTING AT THE TJIKOTOK GOLD MINE, WEST JAVA

H. HIGASINAKA ¹⁾, M.T. ZEN ¹⁾, and SIDHARTA SOEMARNO ¹⁾

A B S T R A C T

From November to December 1967 at Tjiparaj in the area of the Tjikotok gold mine, the magnetic survey was carried out with a Ruska vertical field balance, the scale value of which was adjusted 3.54 γ /s.d.

The number of observation points amounts to 309 with a spacing of 10 m.

To eliminate the diurnal variation of the earth's magnetic field and the change of the instrumental condition, a loop measurement for repeating at the base point was completed within nearly one hour.

From the magnetic anomalies obtained, has been found a peculiar feature, which is considered to characterize the anomalies of vertical intensity in the equatorial region.

As to the gold bearing quartz vein, the southern part in the surveyed area may be considered more promising than the northern part.

C O N T E N T S

Introduction.	48
An outline of the Tjikotok gold mine.	48
The surveyed area.	50
Instrument.	51
Method of the survey.	52
Result of the survey.	53
Conclusions.	56
References.	56

1) Division of Geology, National Institute of Geology and Mining, Bandung

INTRODUCTION

The Tjikotok area has been developed as a chief gold and silver mine in Indonesia since first undertaken by Erzmann & Sielken in 1936. However, according to the rate of production and other recent information, the mine seems to retain its life only for 15 years, although it has progressed northward. That is to say, the mine is confronted to the situation that new ores have to be found. This is the first reason why we intended to carry out the geophysical prospecting at the mine.

To apply the magnetic method for finding out nonmagnetic substance may be as a rule considered to be not easy, although the examples which show successful results can be found in literatures of other countries. The second object of our survey is to know the applicability of the method to the prospecting of the quartz vein in the andesitic area in the equatorial region, where the vertical intensity of the earth's field is rather small.

The survey for the vertical component of the earth's magnetic field was carried out from 10 November to 2 December 1967 by the members of National Institute of Geology and Mining in Bandung, namely, Drs. M. T. Zen, Senior Lecturer, Ir. Sidharta Soemarno, Researcher, and Mr. Iwan Tachjudin, Student of ITB, with the collaboration of Prof. H. Higasinaka. The total number of observation points was 309, which were generally taken with a spacing of 10 m.

Because of the rainy season, the surveyed area was mostly covered with vegetation, partly with dense jungle. Therefore, trails for the course of observations had to be made by cutting the vegetation. Besides, to avoid the attack of large beetles, the surveyors had always to look to their own safety.

The surveyors were not only assisted by the members of the mine to minimize these difficulties but also given a comfortable room of the guest house and treated to good foods by courtesy of the staff of the mine. We express here our sincere thanks to the kind gentlemen, especially to Mr. Prijono, Director of the mine, Mr. Akil, Acting Director, and Mr. Siregar, Chief Engineer.

Special gratitudes are also due to Dr. A. Gritly, Resident Representative of the United Nations Development Programme in Djakarta who encouraged us in carrying out our project and gave financial help, without which the survey might have never been executed.

AN OUTLINE OF THE TTIKOTOK GOLD MINE

The Tjikotok gold mine is situated 63 km. directly to the west of Sukabumi in West Java. To reach there we have to take the road from Sukabumi via Palabuhanratu of the southern coast, from where a coarse metal road extends 50 km. to the mine, running crookedly on the flanks of rugged mountains. A jeep needs two and half hours for this 50 km. The road was constructed, for the transportation of ores, during the interval of 1937-1939 by the Dutch company then, overcoming difficulties. (Fig. 1).

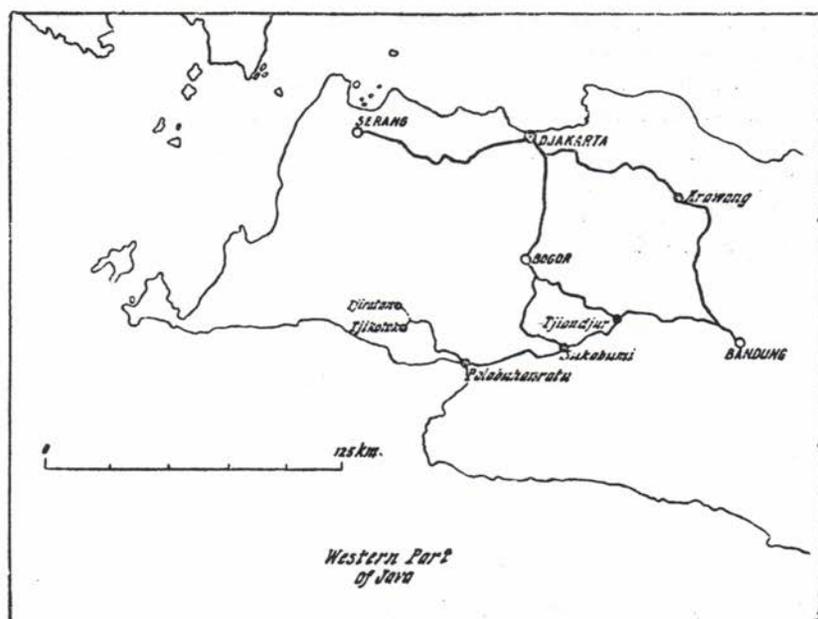


Fig. 1. Index map showing Tjikotok.

The Tjikotok gold mine here called includes two mines, the original Tjikotok and the Tjirotan located 16 km. to the north of the former. Besides these, in Pasir Gombong, 50 km. to the west of the original Tjikotok, there is a dressing plant, where the ores of two mines are transported by two rope ways. The length of the rope way from the Tjirotan to the plant is 9 km. and that from the Tjikotok 4 km.

The ores of the two mines are obtained from the gold and silver bearing quartz veins found in the so-called "Old Andesite Formation" of the Tertiary age, which, being mostly propylitized, are distributed broadly in this region (Katili and Koesoemadinata, 1962).

In the Tjikotok area, the quartz vein, 1 to 8 m. in width, extends nearly to the northwest and vertically downward. The ores contain 8 gr. gold per ton and 400–500 gr. silver per ton (Kaliti and Johannas, 1961, p. 11). To a main shaft and its additional shaft extending in total to a depth of 189 m. from the surface, are connected five levels, from which ores are mined. The production is 25–35 ton/day.

In the Tjirotan mine, the quartz vein, somewhat coloured and sulphurous, and having a variable width of 1 to 10 m., extends N–S and dips 70–80° E.

The ores contain 10 gr. gold per ton and 300 gr. silver per ton. Besides, galena is contained in the vein, relatively rich in the lower part and in the northern extension of the vein, say 3%. In this mine, there are seven levels tunnelled from a sloping surface, each being separated

successively about 30 m. in height and the depth of the seventh level from the nearly highest surface being about 190 m. The production is now in November 1967 100 – 150 ton/day, which is much higher than the original Tjikotok. Galena has not yet been operated.

The ores collected to Pasir Gombang from the Tjikotok and the Tjirotan are processed there, and the concentrated precipitates containing 1% gold and 46% silver (October 1967) are sent to Djakarta once every 10 days by a truck carrying 700 kg. of them.

THE SURVEYED AREA

The surveyed area is located at Tjiparaj in the Tjirotan area; that is, about 1.5 km. to the north of the clubhouse of the Tjirotan mine. The geographic position of the clubhouse is given as

Latitude = 6°46'.6 S

Longitude = 106°18'.5 E

Height = 725 m. above sea level.

The quartz vein extending to the north in the Tjirotan mine disappears somewhere to the north of the clubhouse. Still toward the north from that spot, some exposures of quartz vein can be found, but their mutual relations have not yet been clarified. In some parts there are the remains of old tunnelling for direct exploration, which might show the unsuccessful result at that time.

Considered from the exposures existing scattered, more than one vein must exist. Among these assumed veins, we selected the one which seems to be important inferred from geological and topographical aspects around there. In Fig. 2 showing the surveyed area, there have been found four such exposures, three of which are approximately in a line extending to the north and south direction. The line is nearly parallel to the ridge of the hill and is located almost to occupy the ridge, differing from the latter by small separation of only about 20 m. to the east.

The fact seems to show that the exposures must be of a quartz vein and some country propylitized andesite might have been eroded away leaving more resistant rocks, which forms the ridge and the nuclear part of which may be the quartz vein.

According to the analysis, the samples from the exposures mentioned above have gold of 2 – 3 gr/ton. Although the content is rather small, we could expect a larger content of gold in some lower part where the weathering can hardly reach or the secondary enrichment might have occurred owing to the infiltration of weathered materials.

Based upon the above inference, the area for surveying has been selected in order to detect the assumed vein.

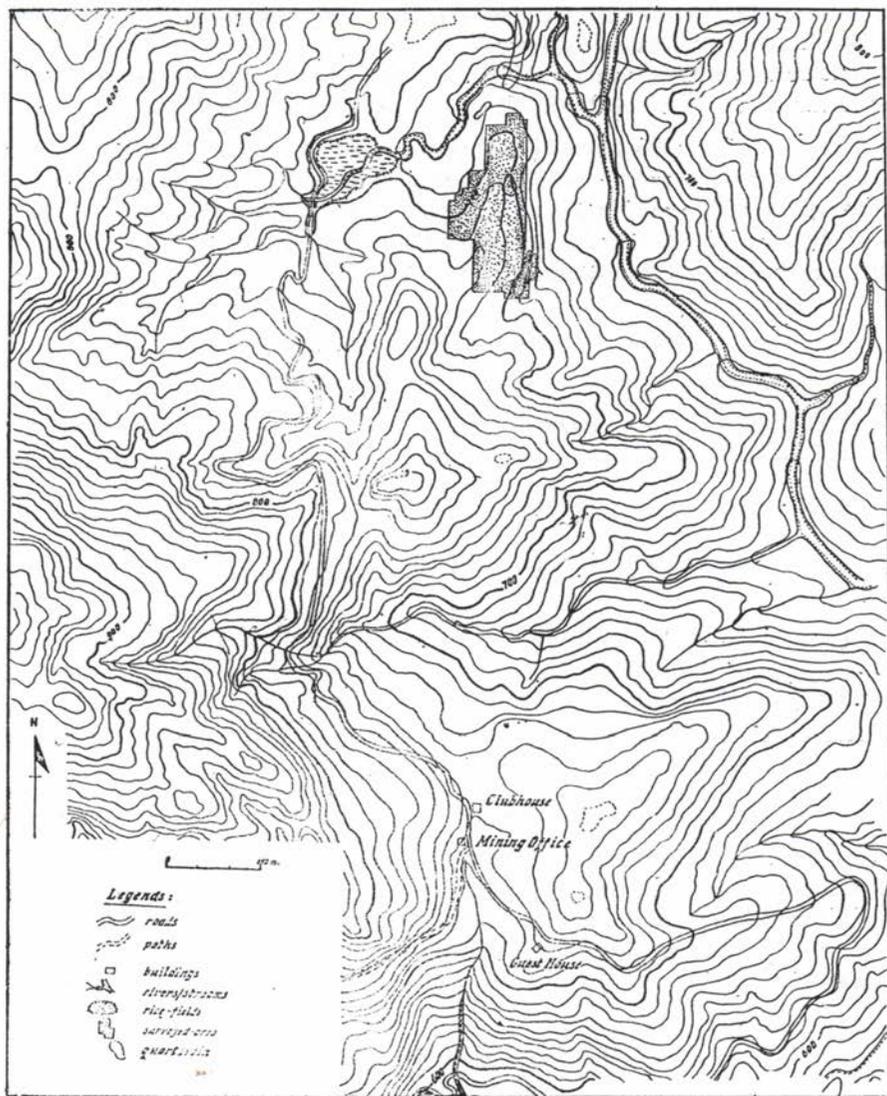


Fig. 2. Index map showing the surveyed area.

INSTRUMENT

Using a Ruska vertical magnetometer, we measured the vertical intensity.

The magnetic negative effect of the quartz vein would be small and might be covered by the effect due to the surrounding andesitic rocks. On the other hand, since the vertical intensity of the earth's magnetic field is not large in this region, the vertical magnetization of materials must be somewhat small.

According to the above considerations, we changed the sensitivity of the balance to a much higher than for usual surveys. The calibration of the scale value was made by using a Helmholtz coil, for several different currents and for both sides of the coil turned upside down.

The similar calibrations have been carried out several times and the mean of these observed values was taken as the scale value for this survey. The results of the calibrations are shown in Table 1, where each scale value was obtained by taking the average of 20 observed values for different currents and both the settings of the coil.

Table 1. Determination of the scale value.

Date	Time	Place	Scale value
8 Nov. 1967	12 ^h 04 ^m	I. G. M.	3.55 γ / s. d.
13 „ „	8 21	Surveyed area	3.48
21 „ „	7 35	„	3.65
29 „ „	12 25	„	3.49
Mean			3.54

The magnetometer is old and there is a certain difference in scale readings between the two observed in the position set in E direction and in W direction. Therefore, we carried out the observation, paying special care to get nearly the same difference of the two readings at each observation point.

METHOD OF THE SURVEY

Before the magnetic survey was started, by favour of the land surveyors of the mine, the route for the measurements was begun to be made, bushes being cut, and the small pegs indicating observation points were driven at every 10 m. along the route. The total number of points observed amounts to 309, as already stated. It is not to mention that having taken such a small spacing of points was for the purpose of obtaining detailed information about the underground structure rather than to find the broad structure.

The base point for the survey was selected at a favourable place near the centre of the surveyed area and in a gentle topography where a relatively small magnetic anomaly may be assumed.

To eliminate the effect of diurnal variations of the earth's field as well as the drift of the instrument due to the change of temperature and others, we used such a method of looping as follows. First we measure at the base point, then at several field points consecutively and finally repeat the measurement at the base point. Such measurements of a loop must be made within more or less one hour, during which the diurnal variation of the vertical magnetic field and the change of the condition of the instrument may be regarded as linear. The difference of the two readings obtained by the repeated measurements at the base point is distributed to the field points of that loop according as the order of the measurement.

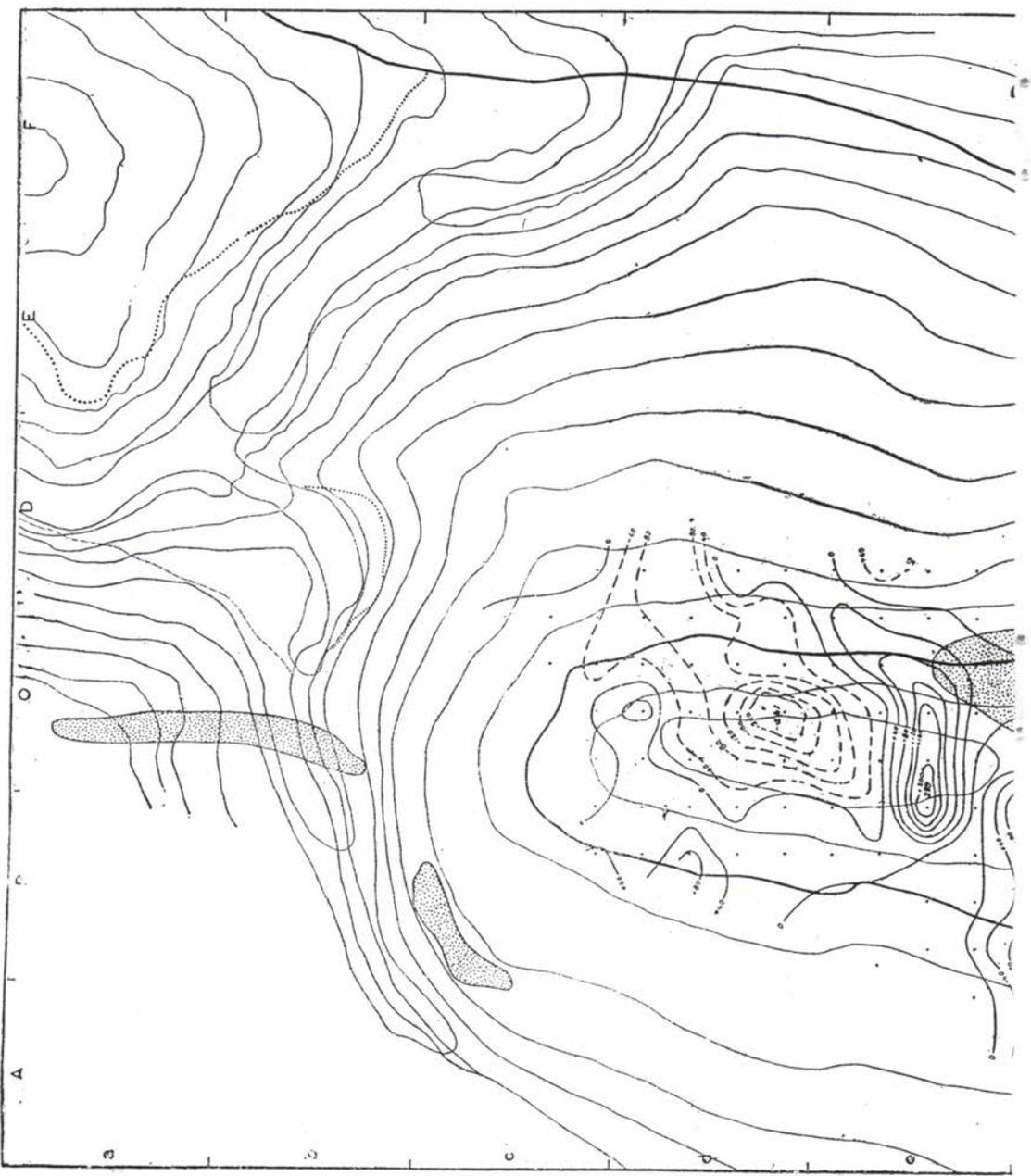
For the field points far from the base, we planned at first to take some points already measured as the auxiliary bases, which are connected directly to the original base. However, for the present survey we have not had such necessity, because not only the area was not large, but we tried to take always one base point for securing the accuracy of the measurements.

RESULT OF THE SURVEY

In the locality surveyed, the magnetic anomaly extends from -261γ (C, d) to $+229 \gamma$ (B, e) in the northern part, the maximum range being about 500γ . Viewed from these extreme values and the distribution of anomalies seen from Fig. 3, negative anomalies appear to predominate in the absolute value. This may be accounted for by the fact that the inclination of the earth's magnetic field is negative, although the apparent distribution may depend upon the anomaly at the base point (B, f).

The distribution of the anomalies may be explained as a whole by the induction of the earth's magnetic field, if the topographical effects are taken into account. Generally, the large anomalies are found along the ridge running nearly N-S. Also we can find somewhat a peculiar fact that nearly along the ridge there are some couples of the minimum anomaly to the north and the maximum to the south as follows: 1) -200γ contour (C, d) and $+200 \gamma$ contour (C, e); 2) -200γ contours at the two places (C, f) and $+80 \gamma$ contour (C, g); 3) -200γ contour (B, i) and $+40 \gamma$ contour (B, i).

Assumed a uniform magnetization of the rocks in the direction of the earth's field, which points up with a relatively small negative dip, the minimum anomaly will appear on the top or the northern side of a hill and the maximum on its southern side. The fact that the direction of the magnetization considered at 3) of the south deviates from N-S may be chiefly attributed to the effect of the topography, that is, the change of direction of the ridge to SW. Because as a rule the magnetic effects have the tendency to appear remarkably along the direction perpendicular to the line in which a magnetic body is elongated, when the direction perpendicular to the axis of the elongated body does not deviate too much from that of the normal earth's magnetic field.



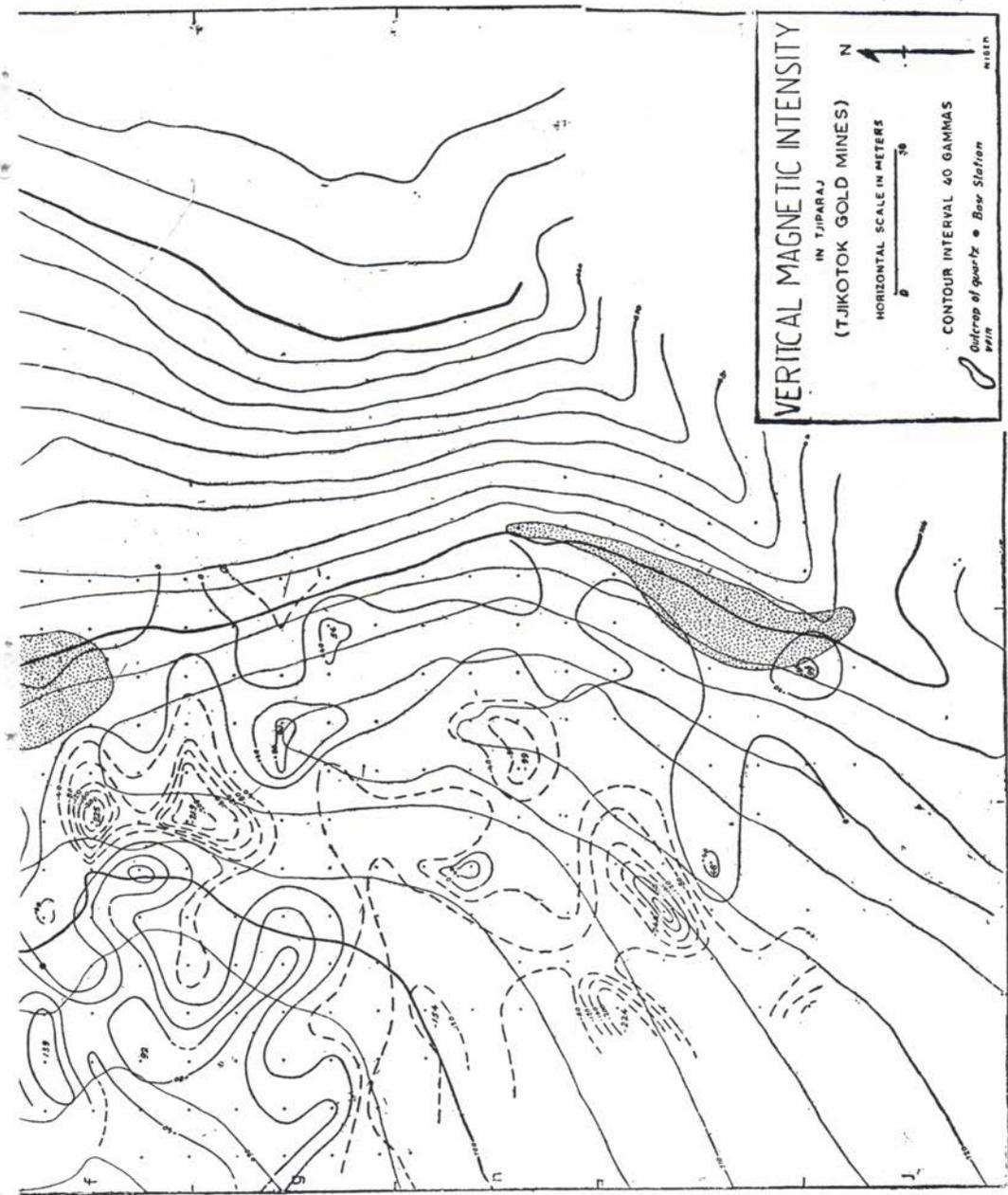


Fig. 3. Magnetic anomalies of vertical intensity at Tjiparaj, Tjikotok gold mine.

In the region of the middle or high latitude of the Northern hemisphere, the magnetic anomalies for the horizontal component may be expected to occur in such a feature that the centre of the negative anomaly appears generally to the northern side of a magnetic body and that of the positive to the southern side of the body except the locality is in the hollow or the irregular topography. It is noteworthy that this characteristic feature can be seen in the anomalies for the vertical component obtained from our survey carried out near the equator.

As to the relation between the quartz vein and the magnetic anomalies, there seems to exist no distinguished feature in the distribution of the anomalies. This matter is reasonably inferred from the view that the effect of quartz vein on the magnetic field may be mostly covered with that of the country rocks. However, it can be easily seen that the anomaly on the locality between the southern and the middle outcrops of the quartz vein is much smaller than that between the middle and the northern outcrops. From this fact we may conclude that the quartz vein extends from the southmost outcrop to the middle, then declines to the north. To the south from the southmost outcrop the survey may be hopefully needed.

CONCLUSIONS

In conclusion, we summarize the result obtained from our survey as follows :

The relatively large magnetic anomalies varying up to about 500 γ have been found along the ridge.

The anomalies may be explained for the most part as the effect of the magnetization of the country rocks induced by the earth's magnetic field.

The distribution of anomalies shows a peculiar feature that large anomalies always occur as a pair of centres of negative and positive anomalies lying respectively to the north and to the south. The feature must be characterized to the anomalies found in the equatorial region when the magnetization of the effective body is due to the induction by the earth's magnetic field.

The quartz vein may be considered to be probably more promising to the south from its middle outcrop than to the north.

REFERENCES

- KATILI, JOHN A. and JOHANNAS, 1961, Review of the status of the mineral industry and the perspective of mineral exploration in Indonesia, Contr. Dept. Geol. Inst. Tech. Bandung, No. 36, p. 11.
- KATILI, JOHN A. and KOESOEMADINATA, P., 1962, Structural pattern of south Banten and its relation to the ore bearing veins, Contr. Dept. Geol. Inst. Tech. Bandung, No. 52.

RECORDS AND ACTIVITIES

SCIENCE MEETING ON GEOLOGY AND MINING ORGANIZED BY NIGM

In January 1968 the Science Meeting on geology and mining was organized by the National Institute of Geology and Mining with the collaboration of the Faculty of Mineral Technology, Institute of Technology Bandung (ITB). The Science Meeting, dealing chiefly with results of original research, is held regularly once a month at NIGM or ITB, and conducted in English.

Up to July 1968, the following papers have been presented. The convenor has been Drs. Sukendar Asikin, Assistant Director, NIGM, and the chairman Prof. H. Higasinaka.

First Science Meeting

Date : 29 January 1968.

1. Ir. Sidharta Soemarno (NIGM): Magnetic prospecting at the Tjikotok gold mine.
2. Dr. P. Koesoemadinata (ITB): Stratigraphic occurrences of oil in West Indonesia and its future potentials.

Second Science Meeting

Date : 6 March 1968.

1. Ir. Arifin Thajab (NIGM): Some aspects about the application of ammonium nitrate as blasting agent in Indonesia.

Third Science Meeting

Date : 6 April 1968.

1. Dr. P. Koesoemadinata (ITB): Ancient deltas and petroleum accumulation with as example The Red Wash Field, Utah Colo. USA.
2. Ir. Sismarjanto Sadarjoen (NIGM) : A technical and economical study on the transportation of gas.

Fourth Science Meeting

Date : 4 May 1968.

1. Ir. Harsono Raf (NIGM): Primary cassiterite deposit in Pemali area.

Fifth Science Meeting

Date : 6 June 1968.

1. Drs. M. T. Zen: The occurrence of hill swarms and wave-like undulations around some Indonesian volcanoes.

Sixth Science Meeting

Date : 6 July 1968.

Special lecture. Prof. H. Higasinaka : A brief history of gravity measurements in Japan.

VISIT OF MALAYSIAN GEOLOGISTS TO ITB CAMPUS AND NIGM FIELD CAMP

Two staff members of the University of Malaya in Kuala Lumpur, Prof. N. S. Haile and Dr. B. Koopmans, and 14 students of its Geological Department, with a guest geologist of Esso in Singapore, Dr. E. Purdy, came to Indonesia for a geological field trip and a joint seminar on geology during their vacation.

After the joint seminar at ITB, Bandung, they went to Central and East Java, and from 10 to 12 March stayed at the field camp of NIGM in Kebumen, 140 km. west of Jogjakarta, where the students visited Pre-Tertiary outcrops.

Drs. Sukendar and Dr. Tjia served as guides to the geological excursions in Central and East Java.

JOINT SEMINAR ON GEOLOGY

On 4 and 5 March 1968, a joint seminar of the University of Malaya and ITB was held at ITB under the chairmanship of Dr. R. Soeria Atmadja.

Date : 4 March 1968.

1. Abu Daud Harahap (Grad. Student, ITB) : The letter classification of the Tertiary in Indonesia.
2. Inche Mohamad Ayob (Grad. Student, University of Malaya) : General outline of the geology of West Malaysia.
3. Dr. E. Purdy : Recent researches in carbonate rocks.

Date : 5 March 1968.

1. Dr. B. Koopmans : The stratigraphic correlation of West Malaysia and Bangka.
 2. Prof. Sartono : New finds of *Pithecanthropus erectus*.
 3. Drs. M. T. Zen : The grand volcanoes of Indonesia.
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COMMEMORATION LECTURE

On the occasion of the graduation ceremony at ITB, which is held on the anniversary of its founding, a commemoration lecture is customarily given by one of the professors.

For the ceremony of the year 1968, on 23 March, Prof. J. A. Katili gave the lecture entitled 'Living mountains in Indonesia and their significance for the development of Geology.'

This was published in Indonesian in Bandung.

RESEARCH PROJECT FOR 1968.

Geology division

1. Structure and magnetic studies of iron ore deposits in South Sumatra, by Prof. J. A. Katili and Drs. Sukendar for structure, and by Prof. H. Higasinaka and Ir. Sidharta Soemarno for geophysics.
2. Re-evaluation of the stratigraphy of some formations in the North Java oil basin, by Ir. Harsono Raf.

Mining division

1. Investigation of the mining system of manganese mines in West Java and Central Java, by Ir. Soebedo, Ir. Rachmadi Ambyah, and Ir. Rukman Adiradja.
2. Production analysis of coal mines in Bukit Asam and in Ombilin, respectively open pit and underground mining in Sumatra, by Ir. Soebedo, Ir. Rachmadi Ambyah, Ir. Alwi Ibrahim, and Ir. Partanto.

Petroleum Engineering division

1. Survey of natural gas in Java.
2. Adjustment of calculations for vertical lift performance to the characteristics of the hydrocarbons under field conditions in Indonesia.
3. Laboratory investigations to test secondary recovery method in relation with the reservoir parameters.