52. *Notes on Stray Earth Currents.*

By Fuyuhiko KISHINOUYE,

Earthquake Research Institute.

(Read Oct. 17, 1950 and May 15, 1951.—Received Sept. 20, 1951.)

During the years 1946–47, the writer carried out electrical prospecting by the method of spontaneous polarization at the Hidachi Mine, Ibaragi Prefecture. The measurements of electrical potential was so much disturbed by stray earth currents that the reading of potentiometer changed from time to time and would not give a definite value of potential differences. The distribution of potential differences is as shown in Fig. 1. The potential decreased to the NE direction in the surveyed area as much as 500 mV, and there seemed to be no limit to the deceasing of the potential.

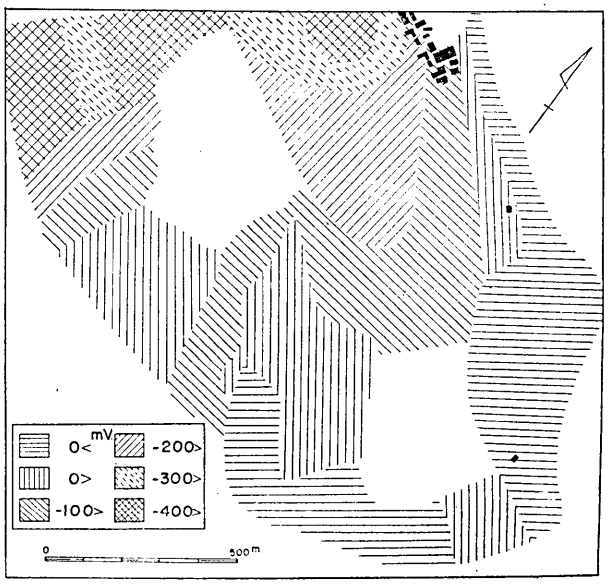

Fig. 1. Survey by spontaneous polarization method in day time.

The disturbance or the fluctuation of the potential was ascribed to electric currents which returned to the earth from electric cars at

the mine. And the apparent endless decrease of the potential was considered as a consequence of the return currents from electric cars or leakage currents of the electrical refinary about 4 km ESE from the observed area.

Then the writer recorded the currents on photographic papers with galvanometers for several days.[1] As a result of the observations, the daily variation of the current was made clear. The currents are strong in day time, and weak during midnight or between 23 h and 5 h in the next day. Since the daily variation was found out, the prospecting by the method of spontaneous polarization was carried out at night to avoid the disturbances by the stray currents at the Hidachi

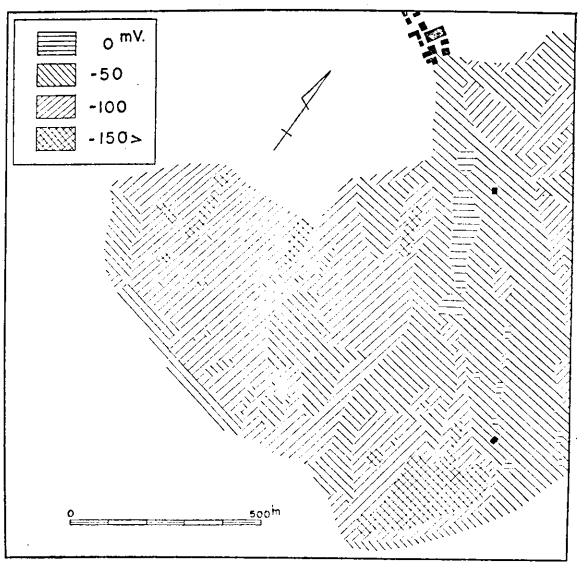

Fig. 2. Survey by spontaneous polarization method at night.

Mine. The result of the night measurement carried out in the same area as that of Fig. 1 is shown in Fig. 2. The great negative value of the potential in Fig. 1 vanished and the places of minimum potential coincided with places where an outcrop of pyrite was found or are nearly above the pit of the mine. Thus electrical prospecting at night may be made use of even at disturbed area.

For the above measurements, non-polarizing electrodes were used and the two electrodes were set at a distance of 10 m apart.

1) THE SPEC. COMM. EXPLORATION OF MINERAL DEPOSITS, GEOLOGY, *Ore Deposit and Geophysical Prospecting. II.* Tokyo, 1951, 119–131.

The Direction of Stray Currents

Comparing the distribution of the potential with the geological map, the writer considered that the distribution of the potential is connected to some measure with the electrical property of rocks. For example, the boundary of −100 mV and −200 mV in Fig. 1 nearly coincides with that of granodiorite and schist. As such boundary the variation of stray currents may be found out by observing the amount and bearings of the currents. But for the sake of simplicity, the writer measured only the direction of the stray currents at many places near the Hidachi mine to test the new method of prospecting. The result may prove not satisfactory, but it will be described here.

The method of determining the bearings of the currents was simple; two pairs of non-polarizing electrodes were set 10 m apart in two directions, E-W and N-S or NE-SW and NW-SE, and the bearings were obtained from the ratio of potentials in the two directions

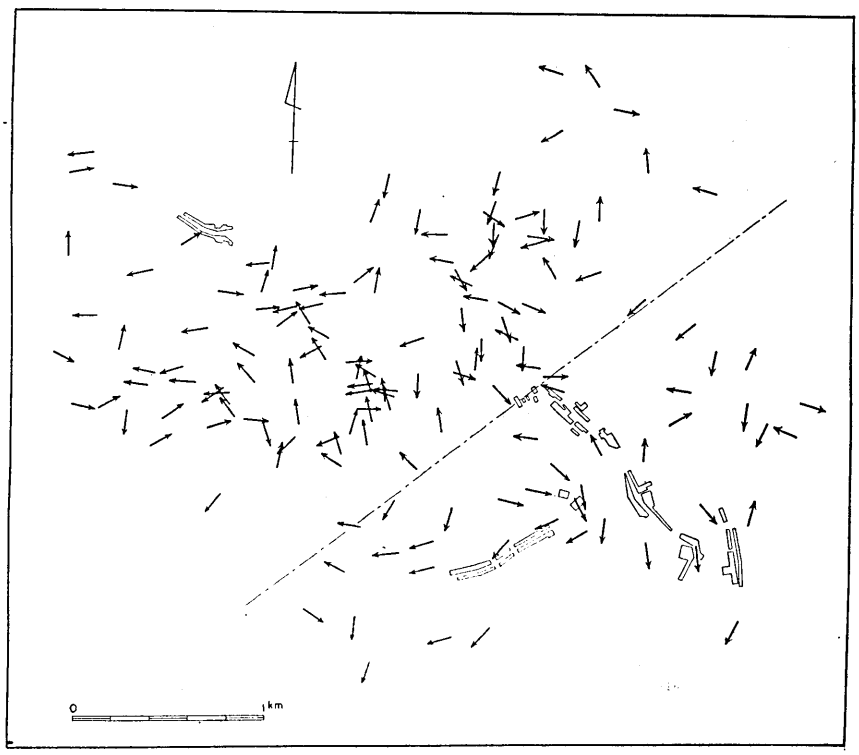

Fig. 3. Direction of stray currents.

measured by a bridge circuit. The sensitivity of the galvanometer used for the circuit was 2.2×10^{-7}A. The bearings at the neighbourhood of the Hidachi mine were partly shown in Fig. 3. Of course, the directions are nearly perpendicular to the equipotential lines in Fig. 1. During the measurement the writer thought most of the directions pointed to the west in the western area of the measurement. Dividing the area of the measurement into two by the narrow zone of sericite, frequency-distributions of the bearings were obtained: the bearings in the eastern part is shown in Fig. 4 and the wesern part in Fig. 5. Although the difference between the two areas are not clear, the sericite zone which associated with pyrite ores may be regarded as a factor causing the difference. The bearings in the area east far off from the area in Fig. 3, pointed mostly to the east. Then the stray currents were then ascribed to the current which flew from the electrical refinary which is nearly at the centre of the whole measured area.

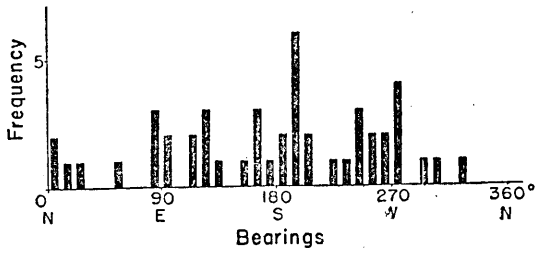

Fig. 4.

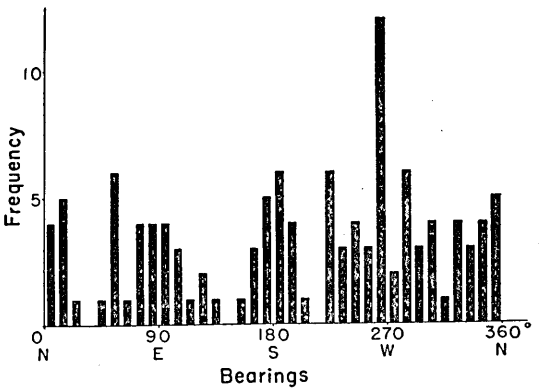

Fig. 5.

The writer wishes to carry on the present study further as a method of prospecting. It would be a great merit of this method for it may be made easy and possible in day time.

Stray Currents observed at Tokyo

To compare the stray earth currents in quiet condition and in disturbed condition, the writer observed changable earth currents near our Institute at Hongo, Tokyo. The currents were considered to be due to the return currents of electric street cars which are driven by D.C.

In this case carbon electrodes were used and the electrode distance was 2.3 m at the depth of 10 cm under the surface of the ground. The currents were strong that high resistance was put in series into the galvanometer circuit, and the so sensitivity of the galvanometer was sometimes decreased with a shunt.

The variation was different from that at Hidachi in that it was greater than those observed at Hidachi, and was irregular as shown in Figs. 6 (1) and 6 (2). Periods of the variation were in confusion, and amplitudes were from 1/3 to 1/10 of the mean currents.

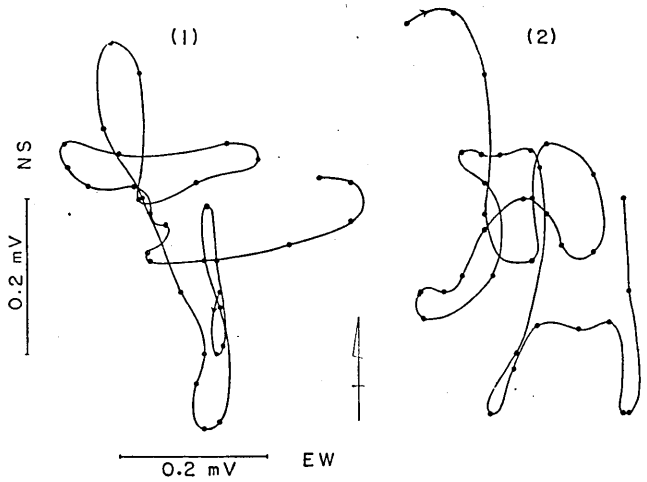

Fig. 6. Change of direction of stray currents.
Spots are time marks at every second.

The daily variation was clear as shown for example in Fig. 7. The stray currents were quiet during the hours between 23 *h* and 5 *h* of the next day. In the quiet time, a single shock or one-sided displacement was recorded from time to time. The number of the shocks became suddenly large early in the morning when the city electric cars began moving. As the numbers of moving cars increased the stray currents came to be recorded as continuous irregular oscillations.

Microseisms are sometimes considered as earth vibrations caused by many irregular shocks. The cause may be similar to that of the stray currents. But microseisms are rather regular, and the stray currents are always irregular. The difference may be due to the property of the ground: That is to say, microseism are proper vibra-

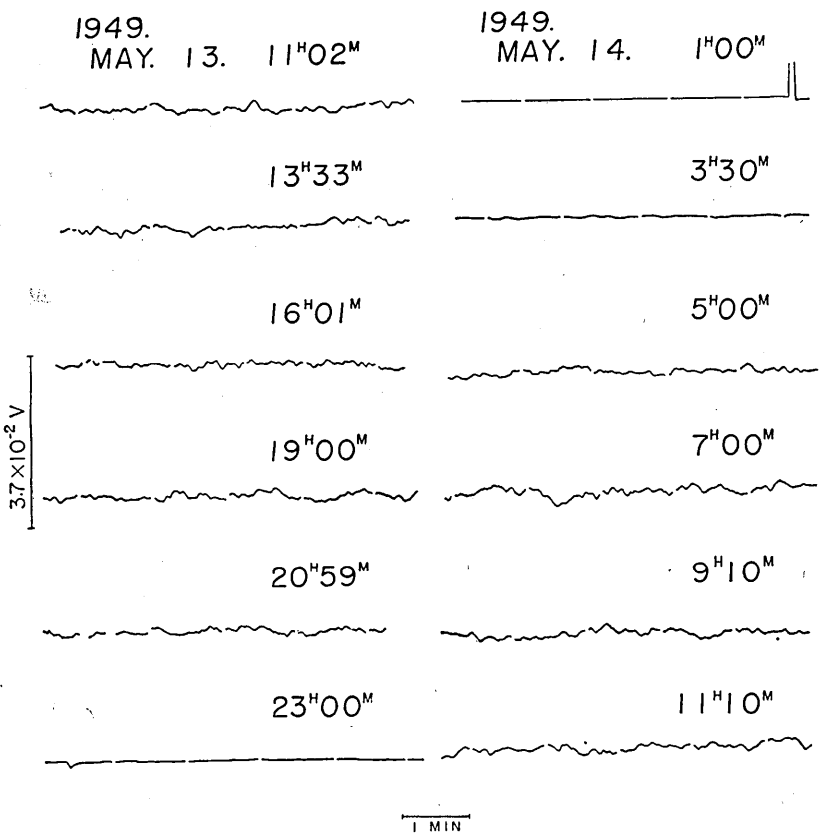

Fig. 7. Daily variation of stray current at Tokyo.

tions of the earth excited by irregular shocks, while the ground has no proper vibration of electric currents.

Acknowledgements

The writer expresses his best thanks to the members of the Hidachi Mine, especially to Mr. K. Ogino and Mr. T. Shimada for their kind help offered to his investigations there. Also he thanks Miss M. Kotaka for her assistance in the study of stry currents at Tokyo.

The cost of this investigation was defrayed from the Scientific Research Expenditure of the Department of Education.

52. 迷走地電流について

岸上冬彦

茨城縣日立鑛山附近で自然電位法による電氣探鑛を行つた時，迷走電流の爲測定が妨害された。又，測定地域の北に 500 mV 以上の負電位が現われ正電位に向う所が見つからなかつた。これは鑛山の電車などの接地線のため，迷走電流が一方に向けて流れるものと考へた。これについての研究は既に「地質鑛床と物理探鑛下卷」に記した。その後この電流の方向の分布を測定したので，その結果を圖示した。次に日立と比べるために東京において記錄した結果をのべた。日立では凡そ方向が求められたが東京では不規則である。