3. *Earth-current Potentials near Boundaries of Various Geological Formations.*

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1. Introduction.

Since the natural potential method came into use in the field of the geophysical exploration for ores, the nature of the earth-current potential was brought to light to some extent. The factors which affect the earth-current, such as topographies and kinds of rocks, have been also studied from the viewpoint of application to explorations. In fact, the method of the natural potential well-logs, which is based on the knowledge of natural potential among different kind of sedimentary rocks, is now adopted in the exploration for oil.

Some geophysicists had already expected[1] and pointed out the existence of anomalous earth-current near the boundaries of formations. Though their remarks were keen and suggesting, most of them were based only on observations at some scattered points near the boundary-lines aimed at and not on those at sufficient networks all over the area in question, as usually done nowadays in electrical prospectings.

The purpose of the present study is to make up for this imperfectness in those past observations, to find out the relations between geological structures and earth-current potentials if any and to throw some light upon the nature of earth-current.

2. Method and Results of the Observations.

Two Cu–$CuSO_4$ electrodes in the unglazed porcelain pots each 5 cm in diametre and 13 cm in length, were adopted to minimize the polarization effects. The electromotive force between the electrodes was measured by a potentiometer constructed for this purpose. The elect-

1) S. ONO, *Nippon Gakuzyutu-Kyōkai Hōkoku*, **14** (1939), 530. (In Japanese).
M. NAMBA, *Mem. Coll. Sci. Kyoto*, A. **21** (1938), 203.
G. PETRUCCI, *Rivista Geomineraria*, **9** (1943).

rodes were buried in the ground, and after the electromotive force was read, the electrodes were exchanged and the second reading was taken. The average of the two readings gives the natural earth-current potential in the section. All of the sections in the network was occupied in this way.

A) Natural potential near an active fault. (The Tanna Fault at the Ikenoyama-Pass).

The Tanna Fault, which is one of the most remarkable geological faults in the Idu Peninsula, runs nearly in the N–S direction over the Ikenoyama-Pass. At the time of the Idu Earthquake in 1930, the western side of the fault subsided and slided to the south about 1 m,

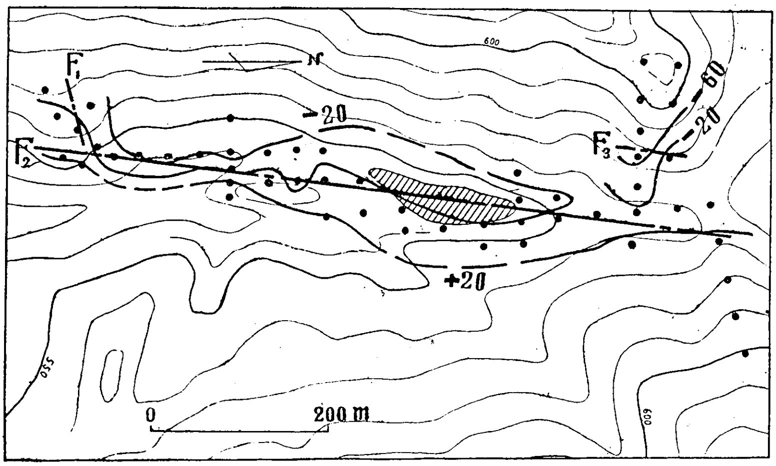

Fig. 1. Topographies and the earth-current at the Ikenoyama-Pass. (in mV) hatched area: pond, F_1, F_2, and F_3: faults in the 1930 earthquake, black circle: position of electrode.

in the same way as those which had occurred in geological ages.[2] Slight traces of the activities of the fault at that time was noticed on the Ikenoyama-Pass. A shallow pond exists along the fault-line. The route of the present survey traversed several times across the fault-line. As will be seen in Fig. 1, a remarkable zone of negative potential runs on and along the fault-line itself, superposed by general earth-current which flows from east to west. Rocks which compose the mountain in this area are all quarternary andesite lavas and no

2) Y. OTUKA, *Bull. Earthq. Res. Inst.*, **11** (1933), 530.
H. KUNO, *Bull. Earthq. Res. Inst.*, **14** (1936), 92; 619.

decisive difference was found between the rocks from the eastern and western side of the fault in the detailed petrological studies by H. Kuno.

Soon after the Idu Earthquake, Y. Kato[3] measured earth-current at several points in this area. Though his survey did not cover the whole of the present area, the direction of earth-current agrees with the present results. Persistency of this kind of anomaly can be inferred from the fact.

B) Difference in the natural potential among various formations. (Akane-saki).

The Miocene tuffs and the pyroxene-dacite lavas are sharply bordered by a nearly vertical distinct fault which runs E–W near the Akane-saki at the eastern coast of the Idu Peninsula. The slope towards the sea is so steep that the potential survey was confined to only one route along the coast highway. Results are shown in Fig. 2. Besides the

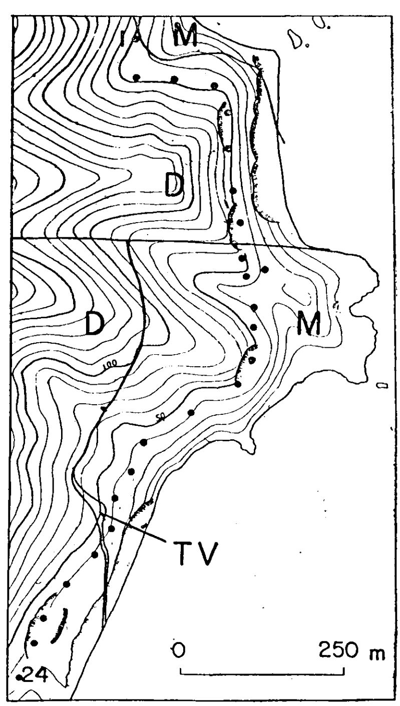

Fig. 2 (a). Geology and the route of the survey near Akane-saki.

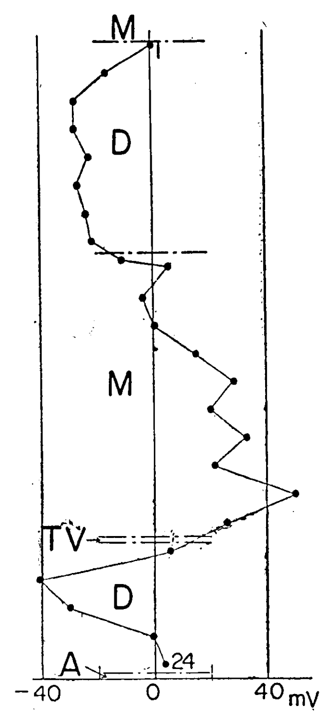

Fig. 2 (b). Earth-current potential along the route.

M: Miocene tuff, D: Dacite, TV: andesite, A: alluvium.

3) Y. KATO, personal communication.

effect of the distinct fault as seen in the former example of the Tanna Fault, the dacites have negative potential in comparison with the adjacent tuffs. These systematic potential differences among various formations which amounted to 20–60 mV are quite similar to the phenomena which are utilized in the electrical-logs in oil wells, though they differ greatly both in the scale of dimension of structures and in the kind of rocks.

C) An example of natural potential across a geological fault, (Usami).

As will be seen in Fig. 3, the steep slope, which consists of layers of lavas and pyroclastic materials, has suffered erosion much along the fault. Rocks on both sides of the fault are the so-called Aziro-basalts, olivine-twopyroxene-basalts and andesites at the northern side and olivine-augite-basalts at the southern side[4]. Earth-current potential is greatly disturbed near the fault, but any simple tendency in the type of anomaly such as at the Ikenoyama-Pass and Akane-saki could hardly

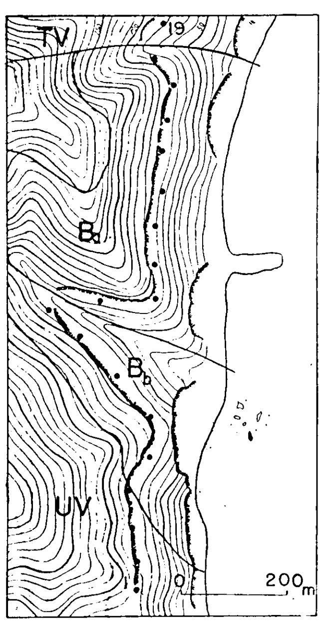

Fig. 3 (a). Geology, topography and the route of survey near Usami.

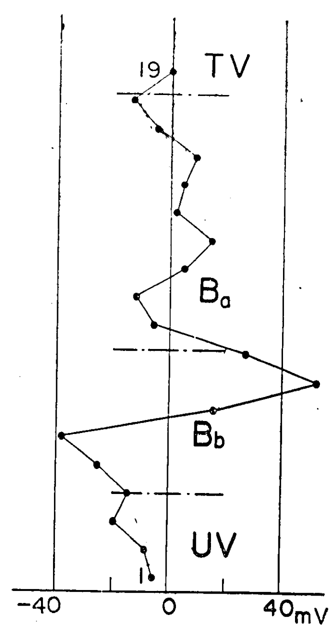

Fig. 3 (b). Earth-current potential along the route.

B_a and B_b: Aziro-basalts, TV: andesite of the Taga volcano, UV: andesite of the Usami volcano.

4) H. TSUYA, *Bull. Earthq. Res. Inst.*, **8** (1930), 409; **15** (1937), 215.

be pointed out. No remarkable anomaly was found at the less distinct boundary-line between the Aziro-basalt and the andesite lavas of the Usami volcano.

Summarizing these three cases, we can infer the following nature of the earth-current.

(1) Earth-current potentials always differ obviously among those formations the rocks of which differ greatly from one another in physical and chemical properties. In contrast to that, no remarkable anomaly in earth-current is observed on or along comparatively level ground, when there is no distinct difference among the rocks.

(2) Even on similar kind of formations, however, remarkable anomalies in natural potential are observed across distinct faults. Though the types and the causes of the anomaly could not yet be clarified, the negative potential zone along the Tanna Fault seems to be one of the representative cases.

D) Earth-current in the old atrio of Volcano Asama.

On the basis of the above mentioned results, the writer examined the results of the earth-current survey at Yunotaira, the atrio of

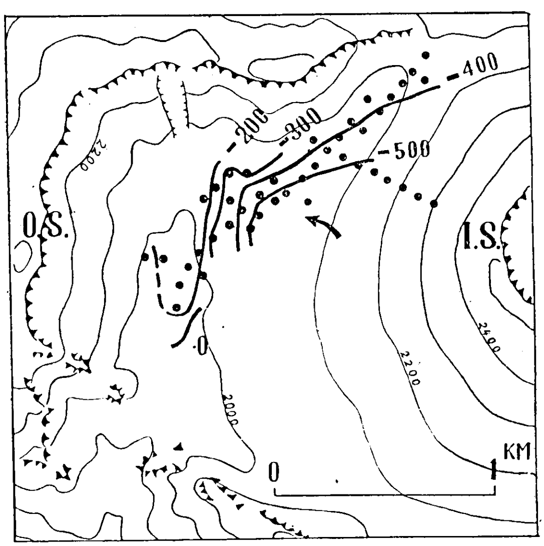

Fig. 4. Earth-current potential at Yunotaira. (in mV).
I.S.: inner somma, O.S.: outer somma, arrow: sink-line.

Volcano Asama, which was carried out by him in 1947. The inner somma lava-flows and other volcanic materials occupy the surveyed area. On Fig. 4, however, a line of sink of earth-current seems to exist along the nearly E–W line across the crater, if we eliminate the topographical effects, such as the upward earth-current. When we consider the geological history of the Asama volcano, it must not be out of description that the centre of volcanic activities shifted from west to east as if a weak zone existed beneath the atrio in the E–W direction. It is not too unreasonable to infer that the distribution of the earth-current potential may be in connection, to some extent, with the above presumed weak zone.

On the mechanism of causation of earth-current, especially on the anomalies near the boundaries of formations, various interpretations may be given from both chemical and physical standpoints. However, the present writer restricts himself here to point out the existence of some relations of earth-current with structures of the earth's surface.

In concluding, the writer expresses his sincere thanks to Dr. H. Kuno, Dr. T. Nagata and Dr. T. Minakami for their valuable advices and criticisms given in the course of this work. The expense for the research was defrayed from the Funds for the Scientific Research from the Ministry of Education.

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3. 各種の地質境界線の近くの地電位差

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かつて小野澄之助博士等によつて，地質の不連續線附近で地電位差異常があることが指摘されているが，その後電氣探鑛法としても，岩質の相異に伴ふ地電位差の現象が用いられる様になつた．筆者は，なるべく簡單な條件と考えられる地質境界線の二三の例について詳しく地電位差を測つた．

(A) 明瞭な斷層を境として，岩質の略同一な岩石が接している例として丹那斷層をしらべた．斷層線に沿ひ，明かに帶狀の負電位の地域がある．

(B) 岩質の明にちがう例として，凝灰岩と石英安山岩が斷層で接する赤根崎附近の地電位差分布をみると，地質境界線で 20～60 mV の電位の相異があらわれ，凝灰岩が高電位となる．

(C) 宇佐美北方の網代玄武岩中の斷層線の附近にも著しい地電位の變化があるが，前二者ほど簡單でない．

(D) 淺間火山の火口原の地電位差分布を檢討すると，山地の上向電流と重なつて略東西に走る負電位帶があるかに思われる．上述の知見から，これを既に地學的見地から想像されている東西方向の弱線とむすびつけて考えることも出來よう．
