REPORT ON AN EARTH RESISTIVITY SURVEY NEAR RIVER JÖKULSÁ Á FJÖLLUM IN THE SUMMER 1958

by

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Introduction.

This report gives the results of earth resistivity measurements carried out in the area between Lake Mývatn and River Jökulsá á Fjöllum in July 1958. The purpose of this survey was to obtain information on the thickness of the lava in this area. The measurements were carried out with a Gish-Rooney apparatus using the Wenner electrode configuration with equal spacings between the electrodes.

Location of stations.

The resistivity survey was carried out at altogether 12 stations, whose location is shown on the accompanying map of the area. Two of the stations, no. 5 and no. 7 were placed at points outside the post-Glacial lava flow for the purpose of gaining more accurate information on the resistivity of the rock below the uppermost layer of lava. In this report, post-Glacial lava will for convenience be called lava only.

Interpretation of the resistivity curves.

The resistivity curves are plots on a log-log paper of apparent resistivity versus electrode spacing. The interpretation of these curves consists in determining the sequence of layers both as regards thickness and resistivity corresponding to the form of the resistivity curve. For the case of two layers this is done by comparing the measured curves with theoretical curves (method given by Roman). For three layers the two layer theoretical curves are used in connection with empirical formulas, [1] that give the parameters of the second and third layer.

In selecting the stations it was endavoured to seek out such places that had a relatively smooth surface as the otherwise very rough and irregular surface of the lava would give rise to a high dispersion in apparent resistivity values and thus make comparison with theoretical curves difficult.

Station 1. (max. electrode spacing: 120 meters). The resistivity of the lava is about 13000 Ωm and this value extends down to about 30 meters. Below that the resistivity falls to a value in the range 1000-2000 Ωm. Although this curve indicates a thickness of 30 meters of the uppermost layer, it may well consist of two or more layers with the same or nearly the same resistivity. The dispersion of the points on this curve was rather great, especially at larger electrode spacings, which makes the interpretation difficult.

Station 2. (max. electr. spacing 144 meters). This station was located roughly 500 meters south-east of no. 1. The resistivity of the uppermost layer of lava is about 14000 Ωm and thickness about 10 meters. Below that is a layer with resistivity 5800 Ωm which extends down to a depth of some 50-70 meters. This depth is rather uncertain due to large dispersion of resistivity values. Below this the resistivity decreases still to a value probably in the range of 1000-2000 Ωm.

Station 3. (max. electrode spacing: 128 meters). This station was located roughly 100 meters east of a row of craters running parallel to the line of electrodes. The resistivity curve has a rather uncommon form and it may be suspected that this is due to inhomogenities in the horizontal layer structure. Therefore no attempt is made at interpreting this curve in terms of horizontal layers.

Station 4. (max. electrode spacing: 120 meters). This station was located on the relatively smooth surface of a lava flow, roughly 500 meters from its edge. The uppermost layer of lava has a thickness of about 10 meters and resistivity 14000 Ωm. Then comes a layer with ρ = 9800 Ωm which extends down to a depth of 50-60 meters where the resistivity goes down appreciably (possibly to 1000-2000 Ωm).

Station 5. (max. electrode spacing: 64 meters). This station was located on a moraine just outside the lava flow on which station 4 was situated. The top layer is about 0.7 meters thick and has a resistivity of 1600 Ωm. Then comes a 1.9 meters thick layer with ρ = 2000 Ωm. Below this is a thick layer with ρ = 5000 Ωm which extends down to a depth of at least 40-50 meters. By comparing the resistivity curves at stations 4 and 5 it is evident that the rock under the uppermost layer of lava at station 4 has a distinctly higher resistivity than the rock under the glacial till at station 5. The distance between stations 4 and 5 is estimated about 700 meters.

Station 6. (max. electrode spacing: 48 meters). This station was located on a lava flow roughly 200 meters south of station 5. The lava has a thickness of about 10 meters and ρ = 13500 Ωm. Below is a rock with resistivity of about 4700 Ωm which agrees fairly well with the value of 5000 Ωm obtained for the rock under the moraine at station 5.

Station 7. (max. electrode spacing: 128 meters). This station was located on a moraine north of the lava flow where stations 8 to 12 were situated. It was expected that this station would give an independent value for the resistivity of the rock below the uppermost layer of lava at stations 8-12. The top layer has a thickness of about 0.6 meters and ρ = 1170 Ωm. Then comes a 3.6 meters thick layer with ρ = 2600 Ωm. Below this the resistivity increases to 6100 Ωm and this value extends down to a depth of about 63 meters where the resistivity drops to about 1000 Ωm.

Station 8. (max. electrode spacing: 168 meters). Here the lava has a thickness of about 8 meters and ρ = 22000 Ωm. Below the lava the resistivity decreases to about 5600 Ωm which extends down to about 62 meters. Here the resistivity drops below 1000 Ωm.

Station 9. (max. electrode spacing: 168 meters). The lava has a thickness of about 9 meters and ρ = 16000 Ωm. Then comes a layer with ρ = 7000 Ωm, which extends down to a depth of about 68 meters, where the resistivity drops to roughly 600 Ωm.

Station 10. (max. electrode spacing: 168 meters). The thickness of the lava is about 11 meters and ρ = 19000 Ωm. Below the lava the resistivity drops to about 6600 Ωm, which extends down to a depth of about 60 meters, where it drops to about 1000 Ωm.

Station 11. (max. electrode spacing: 176 meters). At stations 8 to 10 conditions were rather similar with regard to thickness and resistivity of the lava. Here, however, the lava flow appears to be thinner and have a higher resistivity. The thickness seems to be about 5 meters and the resistivity roughly 75000 Ωm. Below the lava, conditions are the same as at the other stations with the resistivity ρ = 6000 Ωm extending down to about 58 meters where it drops to roughly 650 Ωm.

<u>Station 12.</u> (max. electrode spacing: 200 meters). Here the unexpected result was that the top layer of lava, which was found in stations 8 to 11, was absent, and conditions were found to be rather similar to those at station 7, which was located on a moraine. The uppermost layer has a thickness of about 2 meters and $\rho = 2500\,\Omega$m. Below the resistivity increases to about 6500 Ωm which continues down to a depth of about 58 meters, where it falls down to about 700 Ωm.

<u>Discussion.</u>

The results of this survey are summarized in Table I. In fig. I a profile is drawn based on the measurements at stations 4,5 and 6. From Table I it is apparent that the thickness of the post-Glacial lava at most of the stations is about 10 meters which is a normal value. At station no. 1 the thickness of the uppermost layer is given as 30 meters, but this does not exclude the possibility that the post-Glacial lava flow is thinner and underlain by a rock of similar resistivity. The measurements give only variations in electrical resistivity with depth.

It is also apparent from Table I, that the rock below the post-Glacial lava or moraine at most of the stations has a resistivity in the range 5000-7000 Ωm and this value extends down to a depth of about 60 meters, where the resistivity falls to a value in the range 500-2000 Ωm. The interpretation of these data may be based on the following two alternatives:

1) The rock below the post-Glacial lava and the moraine could be a late Pleistocene grey basalt. This hypothesis is supported by outcrops of grey basalt north of the area of post-Glacial lava on which stations no. 8 to 12 are located. Furthermore the resistivity of 5000-7000 Ωm agrees well with values found earlier for grey basalt on the Reykjanes Peninsula in SW-Iceland. This grey basalt

might extend at least as far down as the measurements reach which is about 80-100 meters. The change in resistivity at a depth of about 60 meters could then be due to the ground water table, which would have an elevation of about 20 meters above the water table at Lake Mývatn. The resistivity of 500-1000 Ωm is, however, somewhat lower than that found for ground water soaked grey basalt on the Reykjanes Peninsula.
2) Secondly, the late Pleistocene grey basalt, assumed in the first alternative, may extend down to about 60 meters only, and the underlying rock may then be an early Pleistocene formation, basalt or palagonite. Experience in Iceland has shown that the resistivity of the rock decreases with increasing age. The hypothesis of a palagonitic rock below the grey basalt is supported by a hill of this rock north of the area of stations 8 to 12, and also by resistivity values obtained earlier for palagonite in other parts of Iceland.

The resistivity data can not discriminate between these two alternatives. A decision must be based on additional geological evidence, which could be obtained by drilling one or two holes and studying the cores. It is recommended that the drilling is done in the area where stations 8 to 12 are located.

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Reference.

1. Sorokin, L.W.: Lehrbuch der geophysikalischen Metoden zur Erkundung von Erdölvorkommen. Berlin 1953.

Table I. Summary of results.

Station no.

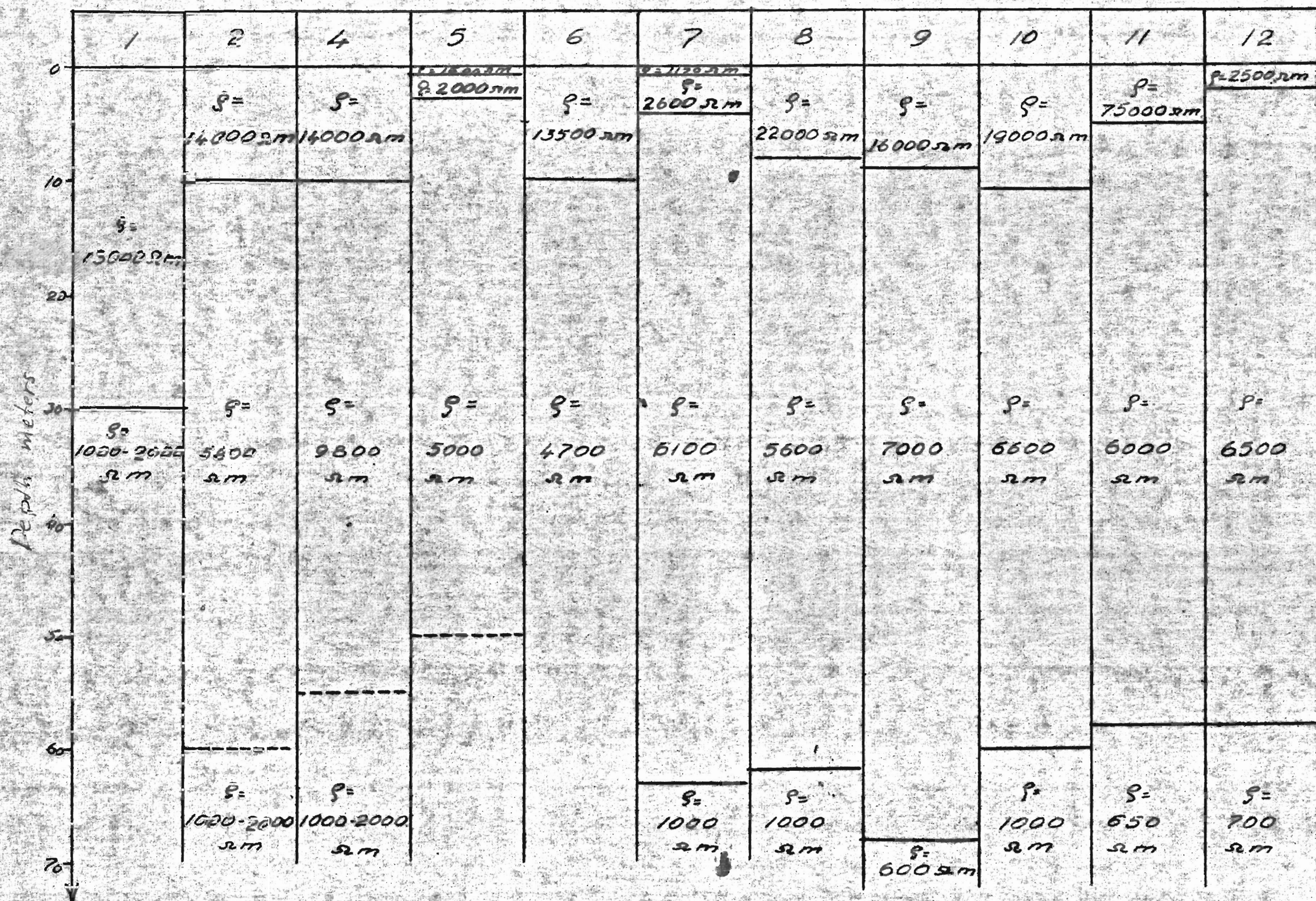

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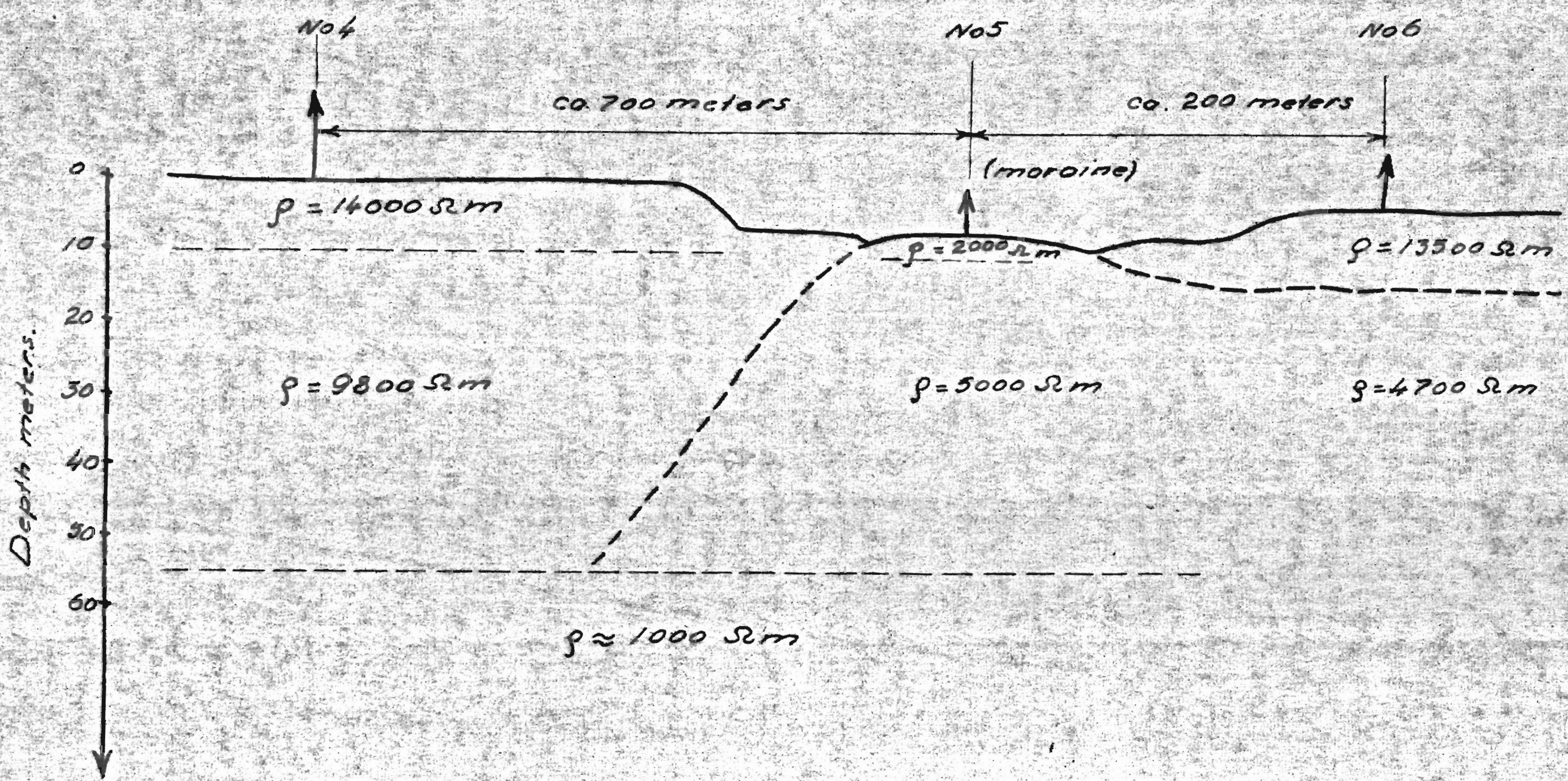
Fig. I. Profile through stations no. 4, 5 and 6.



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