GEOLOGICAL INVESTIGATION OF THE KÖSENÇAYIRI DAM AREA

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ABSTRAGT. — The arca where Kösençayırı Dam is planned to be constructed and which lies 18 km NW of Tosya is generally covered by metamorphic schists, serpentines, limestones, Neogene and alluvium. There are folded schists, highly decomposed serpentines, fracturcd limestones, argillaceous and pebbled Neogene. An active fault cuts our investigation area on the SE corner of the dam site.

The thickness of alluvium, Situation of schists and serpentines, probable faults mentioned in previous studies. were all investigated with the Electrical Resistivity Method.

At the end of this investigation, boring work was carried out on favorable spots.

I. GENERAL INFORMATION

1. Preface

The construction of a dam is being planned at the Kösençayırı location, 18 km NW of Tosya, with the purpose of benefiting from it in irrigation work. For this purpose, the people of Tosya formed a society under the name of «Dam Construction Society».

While Süha Somer and Kemal Noyan worked on the survey and project of this dam, under the technical control of the General Directorate of State Waterworks, I was given the duty of investigating this area from the geological point of view.

2. Previous investigations

This area was investigated in general by M. Blumenthal (2) and in detail by M. Topkaya (5) and Celal Balkır (1).

M. Blumenthal's investigations were involved in the geological mapping work of the M.T.A. Institute, on a scale of 1 : 100,000 and the investigation area was shown as covered only by metamorphic schists. It is not, of course, possiblc to go into much more detail on a map of this scale.

The same area was investigated by M. Topkaya (5) in September 1961. According to M. Topkaya, this area is represented by metamorphic schists, serpentines, limestones and probably.-two faults parallel and perpendicular to the dam's axis. He is of the opinion that the Kösençayırı area is the most favorable spot for the construction of a dam.

Later, in November 1962, C. Balkır, Geologist of the State Waterways, investigated the same area and mentioned the existence of schists, serpentines, andesites and limestones. In order to come to a decision for the construction of a dam, he recommended that three bore-holes should be placed, two 25 m in depth on the right and left slopes of the dam's axis and one 15 m deep in thalweg.

3. Investigation method

We started our investigations by studying surface geology. Then, we carried out electrical sounding work in order to find out the thickness of the weathered parts on slopes. We used the same method to find out the thickness of alluvium and investigate the faults observed previously. We also benefited from the resistivity method in determining the kind and thickness of materials.

II. MORPHOLOGY AND GEOLOGY

1. Morphology (summarized)

The dam site is located at the source of Deringöz Çay, south of Ilgaz Mountains. The dam is planned to be constructed on Karovun River. The highest peak on the drainage basin is the Paşapınarı Hill of 2431 meters. There is a close relationship between the topography and geological structure. Hard rocks such as limestone and andezite constitute steep slopes, yet the formations such as schist and serpentine have a smooth topography.

A relationship might be set up between the vegetation and geological structure : On the way to the dam site from Tosya, oak trees predominate where the area is covered by Neogene, Cretaceous limestones and igneous rocks. Yet, we observed Coniferac such as Cedrus and Abies, instead of oak trees, in the areas covered by Paleozoic schists.

2. Geology

A) Stratigraphy

Beginning with the oldest one, the investigation area consists of the following formations :

— Metamorphic schists
— Serpentines
— Limestones
— Neogene sediments
— Accumulation cones
— Alluvium

Metamorphic schists. — These formations, predominating all over the investigation area and belonging to Paleozoic, constitute the basis of this area (see Fig. 3).

They are mostly developed in the vicinity of the source of Karovun River. It is nearly impossible to find an outcrop as they are very much decomposed. The outcrop followed on the NS 30.360 - ES 31.000 coordinate, dips 60° north.

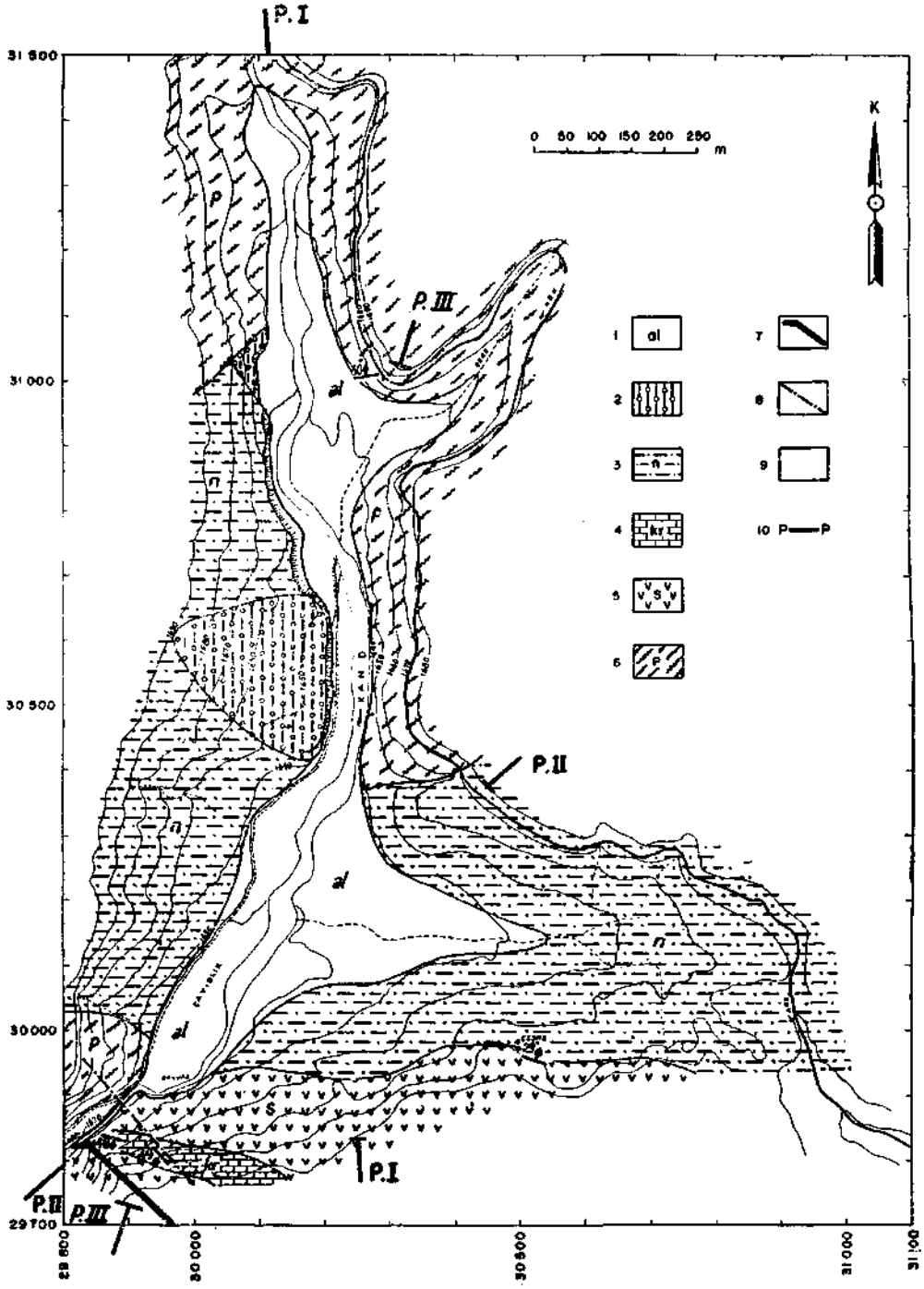

Fig. 1 - Geological map of the Tosya - Kösençayırı Dam site

1 - Alluvium; 2 - Accumulation cone; 3 - Clay, sand, gravel - Neogene (continental); 4 - Limestone - Cretaceous?; 5 - Serpentine (decomposed); 6 - Metamorphic schist - Paleozoic (decomposed); 7 - Fault; 8 - Dam's axis; 9 - Strike and dip; 10 - Cross-sections.

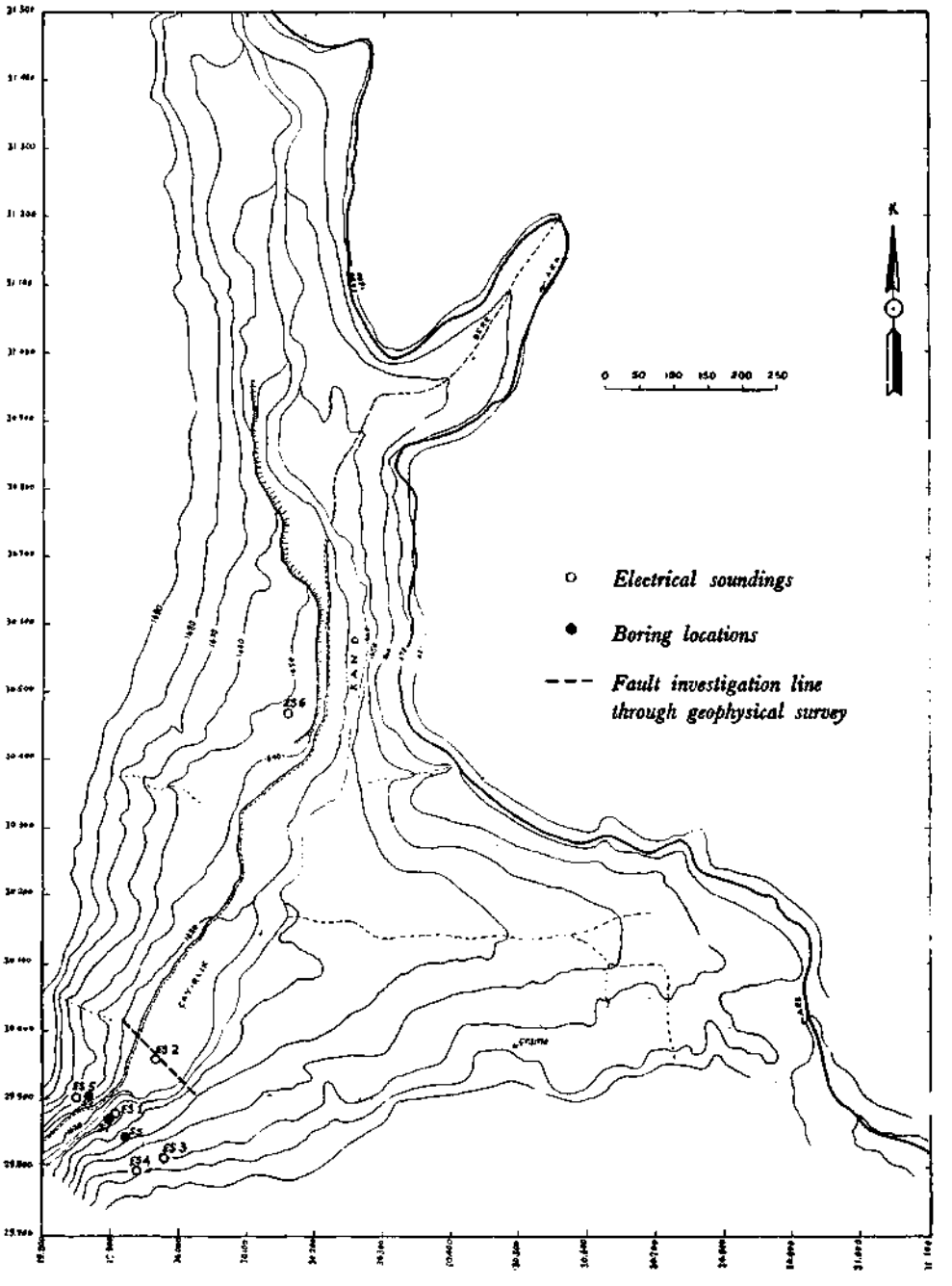

Fig. 2 – Map showing the electrical soundings and boring locations at the Tosya - Kösençayırı Dam site

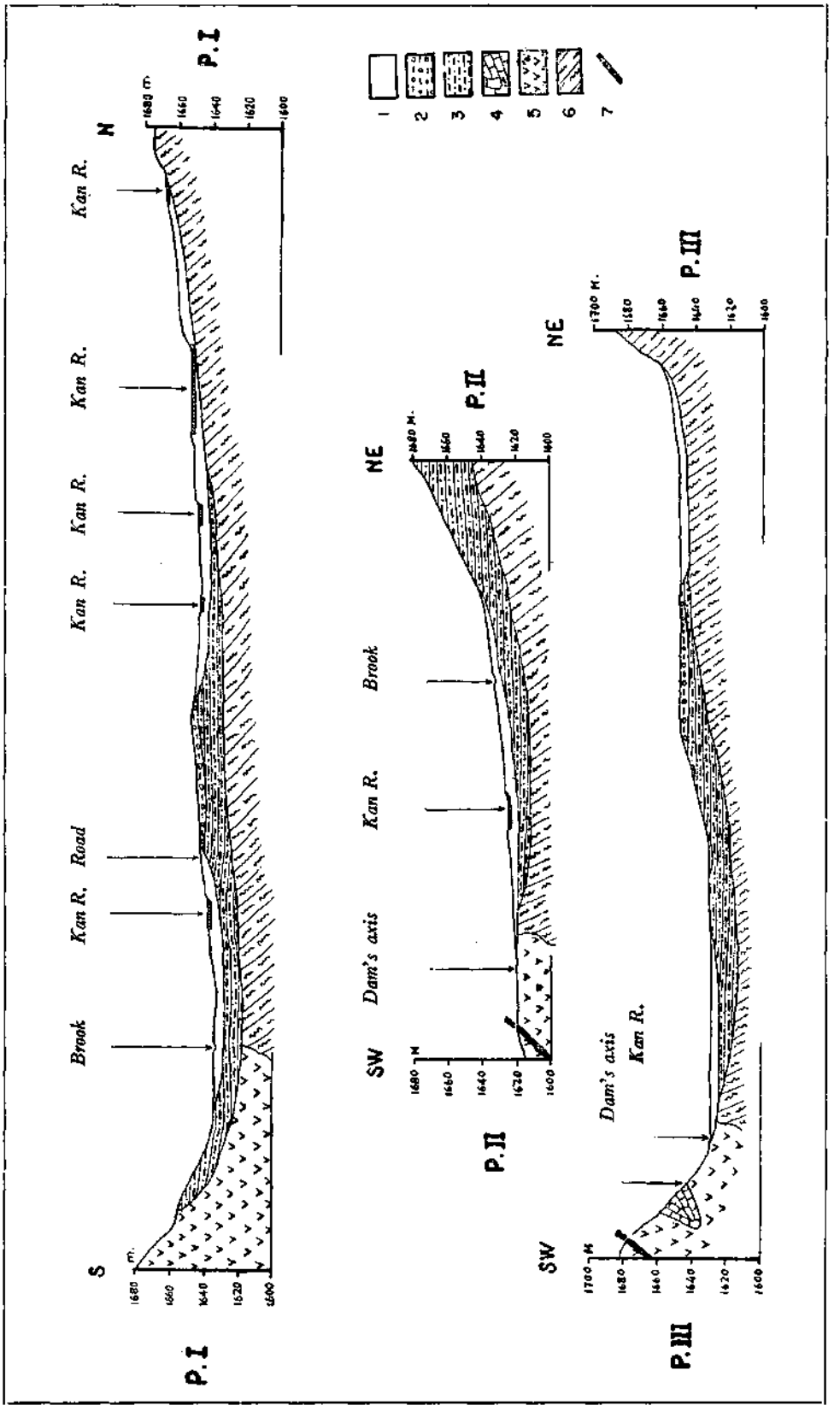

Fig. 3 - Geological cross-sections at the Tosya - Kösençayırı Dam site

1 - Alluvium; 2 - Accumulation cone; 3 - Clay, sand, gravel - Neogene (continental); 4 - Limestone - Cretaceous?; 5 - Serpentine (decomposed); 6 - Metamorphic schist - Paleozoic (decomposed); 7 - Fault.

The Paleozoic schists found on the right slope of the dam's axis are completely in boulders and partly decomposed.

According to İ. Ketin (4), schists are composed of mesozone series. The most common kinds are : green schists, serpentine-schists, epidote-chlorite bearing schists, graphite schists, quartzite schists, sericite schists and partly colored phyllites. Various opinions were put forward about the age of these formations, but it is not right to come to a decision depending upon the observations made on a small area and it will not have a practical value. As far as we know, the oldest formation in this area is metamorphic schist.

Serpentines. — They cover the left slope of the dam site and the southern part of the investigation area. It is not perhaps right to name these formations as serpentines, because they are weathered to such an extent that in many parts they are very much like dark-gray clay. The only outcrop which was not subjected to decomposition might be found on the NS 30.500 - ES 29.950 coordinate. The pebbles appearing in the same area, as the result of decomposition, indicate the typical serpentine or other similar rocks. However, it would be more convenient to call these formations in general, the «ophiolitic series».

According to İ. Ketin (4), the stratigraphical development of this series outcropping in the massif of Ilgaz Mountains, cover a long period between Malm and Upper Maestrichtian, but they are mostly formed during Cretaceous, especially Upper Cretaceous.

Limestones. — They are situated in the upper part of the left slope of the dam. Limestones cover a smaller area when compared with other formations. They are sometimes found in boulders, over the ophiolitic series. Limestones are strongly fractured and partly crystallized. They are found in unconformity on the ophiolitic series. As there are no fossils, it is not possible to determine their age exactly. But, by comparing with other areas, we might assume it as Upper Cretaceous.

Neogene. — Neogene formations cover a large area. They can be easily distinguished both with their topographic forms and clay, sand and gravel content. Their general appearance gives the impression that they are continental Neogene, but might be a thick slope debris. Stratigraphically, they constitute the youngest formations. They are important only as a source of semi-permeable material for the dam.

Accumulation cones. — There are two accumulation cones on the right-slope of the Karovun River. The upper parts consist of coarse-grained sand and gravels, the lower parts contain clay. Resistivity tests show that gravelly zones are not more than 4 meters thick.

Accumulation cones are important as they supply permeable materials for the construction of dam.

Alluvium. — These are recent formations covering the bottom of Karovun River. There are boulders, gravels and, sands in the upper part, and clay in the lower part. Gravels and sands deposited in the upper part can be used as permeable material.

B) Tectonics

Kösençayırı dam site is located in Pontids, one of the tectonic units of Turkey. The border line of Anatolids located in the southern part of Pontids passes through Tosya; thus the dam site is very near the borders of these two units. The folding axes in this area dip towards NE-SW.

Schists are strongly folded. Limestones dip 48-50° towards the south.

The most important tectonic event in this area is the existence of a fault in the southern part of the dam's axis, dipping towards NW-SE. This fault is clearly seen in the topography. The formation of a lake of some kilometers length, in conformity with the axis of fault, is an evidence showing the existence of this fault. The landslides in the valley and fractures in the uppermost overburden are evidences showing the activity of the fault.

M. Topkaya (5) mentions the existence of a fault, cutting the dam's axis vertically and dipping towards NE-SW. But the investigation carried out through resistivity methods, shows that there is no such fault.

III. ENGINEERING GEOLOGY

1. Materials condition

The impermeable or semi-permeable materials needed for the dam might be found abundantly in the lower parts of Neogene and accumulation cones. The upper parts of accumulation cones and alluvium supply permeable materials. After determining the amount of materials needed for the dam, an investigation should be carried out to calculate the reserves of permeable material. As the gravels and sands of alluvium and accumulation cones are usually composed of schists, they might not be used satisfactorily as concrete aggregates. Los Angelos tests especially might give negative results. It is necessary, we think, to carry out another prospection for concrete aggregate. It is the same with rocks. Both schists and limestones are not suitable to be used as fill and construction material.

2. Ground water

Because of the permeable materials existing in alluvium, it is natural that they should contain ground water. The alternation of permeable and impermeable levels in alluvium secured the formation of «confined aquifers». As a matter of fact, in the bore-hole no. 1, located at thalweg, was observed an artesian water having a piezometric level of + 3.90.

There are some springs in the eastern part of the investigation area. They occur at the contact of the upper gravel levels of Neogene and lower clays.

The stability of slopes

Except the decomposed ophiolitic series on the left-hand side slope of the dam's axis, other slopes are stable. But this particular slope slides continuously as the result of desintegration. It is very easy to recognize previous landslides with

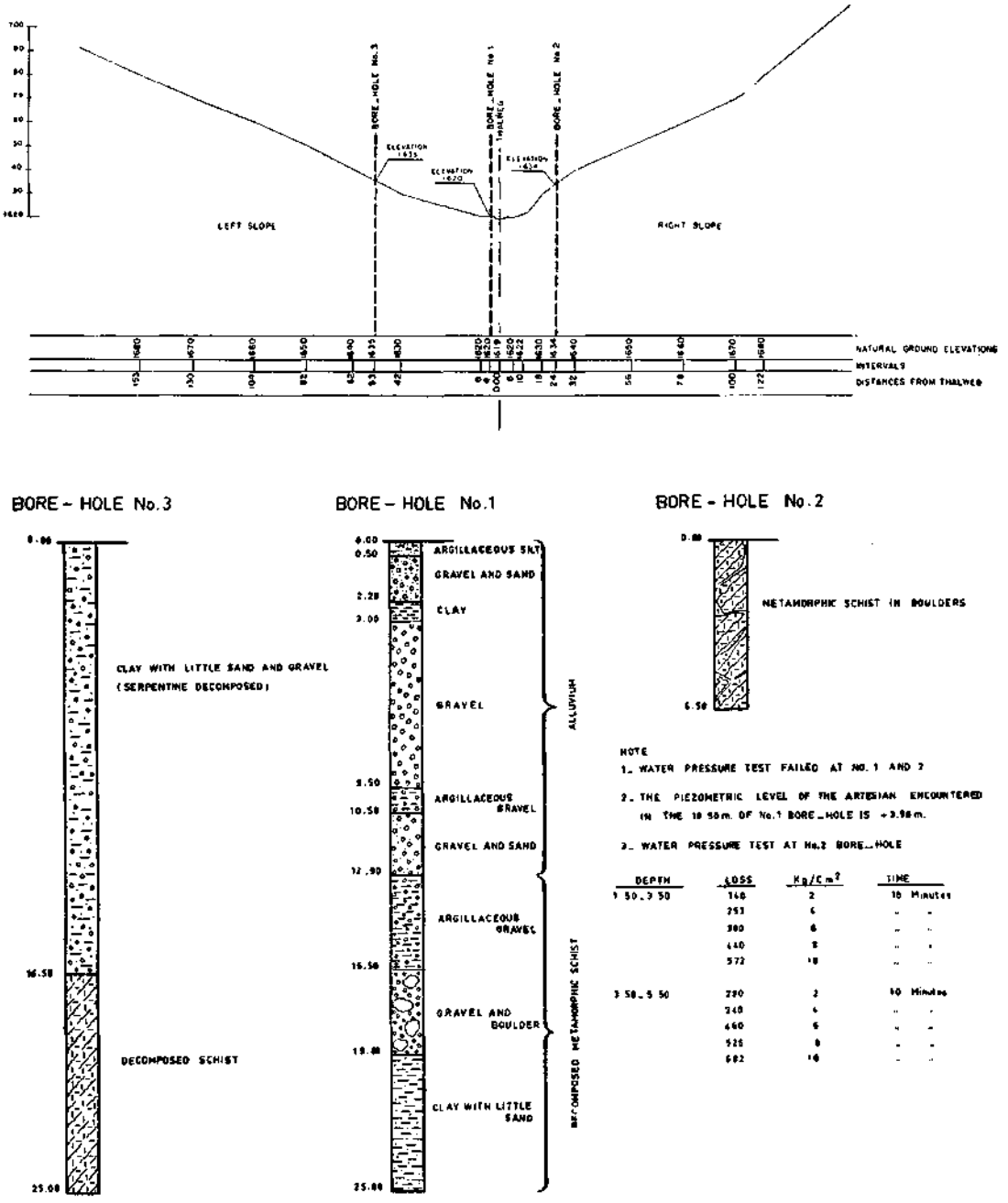

Fig. 4 - Bore-holes executed at the Kösençayırı Dam site

the help of land forms. There are organic clays in the bore-hole no. 3; this probably results from the decay of plant remnants covered by previous landslides.

CONCLUSION

The investigation of the dam site through geological and geophysical methods and borings gave the following results :

a) There is an active fault, 75 meters far from the dam's axis.
b) The left slope of the dam is not stable.
c) The bottom of the dam is permeable in an economical depth.

According to Grosby (3), it is possible to construct a dam on the area where active faults exist, after necessary precautions are taken. It might be possible to construct it by overcoming unfavorable conditions. The person who is going to prepare the project of the dam, should investigate whether this would be economical or not.

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