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CORPORACION DE FOMENTO DE LA PRODUCCION

CHILE

PERFILES ELECTRICOS
EN EL VALLE DE COPIAPO.

Naciones Unidas

1963.

CORPORACION DE FOMENTO DE LA PRODUCCION

CHILE

UNITED NATIONS

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SPECIAL FUND MINERAL SURVEY

ELECTRICAL TESTS IN THE COPIAPO VALLEY

FEB. 12 - 16, 1963

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ELECTRICAL TESTS IN THE COPIAPO VALLEY

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INTRODUCTION.

Carrying on hydrological surveys in the Copiapó valley, CORFO (and Halconsult) needed geophysical profiles across the valley, on two particular areas. The purpose of such prospections was to determine the shape of the bed-rock and to give some informations about the quality of the alluvium which fills the valley. The problem, as it was presented to us, was not to look for the most favourable places where underground water could be found, but only to give a cross section of the valley, for subsequent hydrological tests by lines of wells.

Our principal task in Chile being to make geophysical prospections concerning only mineral resources we could not perform a complete survey of the areas proposed by CORFO. Anyway, it was decided to make a test profile, in order to establish:

- what geophysical method should be used,
- what informations could be provided,
- what further investigation should be done.

THE GEOPHYSICAL PROBLEM.

According to the Copiapó geological map (see fig. 1) the area where our tests were done (La Bodega, about 8 km. west of Copiapó) is surrounded by cretaceous rocks, as follows:

Kgdl: leucogranodiorite and leucodiorite with quartz,
Kgdm: granodiorite and diorite,
Kd : diorite and gabbro,
kmc : metamorphic rock.

The alluvial overburden hinders all observations in the valley where the main faults (NNW-SSE) cannot be traced.

This overburden, as it may be infered from a set of wells, is chiefly made of sand, clay, gravels... which form irregular layers. The known underground water is lying in small sandy lenses embedded into a clayey material. The water level is generally shallow (5 to 30 m from the surface) and salt contents can reach nearly 2 mg/litre.

It is obvious that either seismic or electrical measures would give only general indications concerning the alluvium: a sandy lens, 100 m deep and 5 m thick, for instance, could not be separated from the whole sand and clay overburden. In relation with this, the estimated depth to the top of the bed-rock has some chances to be somewhat approximate by places.

Anyway we could suppose that the predominantly clayey alluvium should have a low resistivity, which could permit to distinguish this terrain from the highly resistant bed-rock (intrusive rocks). We thence could succeed in drawing a cross section of the valley by means of electrical soundings. Besides, any large lens of sand or gravels, if not too deep seated, should be well marked on the diagrams, giving these indications as to the best place where to start drilling for underground water.

ELECTRICAL SOUNDINGS.

By means of two sets of electrodes (A,B) a direct current is sent into the ground. The resulting difference of potential measured in the surface between two other sets of electrodes (M,N) leads to the computation of a figure, representing the apparent resistivity for the corresponding lenghts AB and MN. By increasing the AB length the computed resistivity corresponds to deeper layers and a curve can be drawn, giving the variations of apparent resistivity with AB length (i.e. with depth). See ex. on fig. 2.

This curve is called an electrical sounding diagram (E.S.). By comparison with theoretical master curves, true resistivities and thicknesses of the successive layers (under the center of the E.S.) can be estimated. An accurate determination of these parameters generally requires comparison with data from geology or mechanical drillings.

FIELD WORKS.

Field works have been carried out from February 12 till February 16, with the assistance of Corfo. Seven E.S. were made;

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* All informations from Messrs. K. Segerstrom and C. Ruiz "Quadrangle Copiapó"

they are distributed along a profile starting from a small outcrop (P on fig. 1) and ending on Punta Pinchincha (P').

The maximum power line length reached 800 m. measures were made with a "Schlumberger potentiometer". The topographical works were performed by CORFO.

RESULTS.

All E.S. diagrams are shown on fig. 2 (2a to 2g) and an estimated cross section is drawn in fig. 3.

On the E.S. several layers may be distinguished, which are from the surface:

1 - a 300 - 500 Ω m layer, existing only on E.S. 1 and 5,

2 - a high resistivity layer ($\geq$ 1.500 Ω m),

3 - a lower resistivity layer, appearing principally on E.S. 5, 6,7 (ρ: about 500 Ω m),

4 - a low resistivity layer, very well marked on all the curves ($\rho \leq 100$ Ω m),

5 - a final, high resistivity (> 1000 Ω m) layer.

With reference to geology the following correspondence might be made:

a) layers 1,2 : upper part of overburden, essentially dry,

b) layer 3 : sandy (or gravel) bed, possibly with water.
or:
clayey upper part of the alluvium,

c) layer 4 : lower part of the alluvium, which appears rather clayey,

d) layer 5 : bed rock.

This list is established by taking into account both electrical (resistivity, thickness) and geological data. We cannot for instance suppose that layer 4 is made of wet alluvium (salt water) because nowhere in the Copiapó valley a 100 m-thick underground water seems to be existing. More probably, the lower part of the alluvium is made of a great quantity of clay with small sand contents.

We have said that layer 3 might correspond to wet sands (or gravels). In this hypothesis we must suppose that such a layer exists only towards N and that, if it is also occurring on the southern part of the profile, it should be very narrow there. Compare, for instance, E.S.6 and E.S.3. On E.S.6 an intermediate layer must be

supposed to exist between the 1.200 Ωm first terrain and the 80 Ωm clayey material (no good coincidence can be found with a two-layer master curve). On E.S.3, on the contrary, a good coincidence with a two-layer master curve can be found. We can, surely, also suppose that an intermediate 500 Ωm layer is existing in E.S.3 but an estimation of its possible extension shows that this formation should be only some meters thick, that is, with no great hydrological interest, if any.

From the 7 E.S. of the profiles, we thus arrived to the section shown on fig. 3.

Starting from SSW, the bed rock seems to plunge rapidly. This sharp deepening could be in relation with a fault which could have displaced the northern part of the intrusive, just at the limit of the P outcrop. According to Mr. Segerstrom this situation is not impossible, other faults being known further south and an accident stretching out very probably between Punta Pinchincha and Cerro Bramador.

The bottom of the valley would, after this, be rather regular (as long as can be inferred from a small number of E.S.) two sections are provided on fig. 3, depending upon the supposed resistivity of the alluvium, either unchanging or varying between 80 and 110 Ωm. No important change can be seen.

As to the overburden we suppose that no important sandy (or gravel) bed exists there, with perhaps an exception on E.S.5, 6,7 - the alluvium is mostly clayey and a few water could be found in narrow lenses of sand - The water level seems to be about 15m-20m deep in the valley.

CONCLUSIONS - PROPOSED STUDIES

The quick tests carried out in La Bodega show that electrical soundings could be used to study the bed rock of the Copiapó Valley - If a great accuracy is required, detailed works should be done and longer lines used, in order to follow the possible irregularities and changes of nature of the bed rock.

On our present profile it is possible that a fault cuts through the valley, between E.S.1 and outcrop P. This means that

South of P the alluvium overburden has all chances to be very thin. Underground water would then be found only North of P.

In this last area no indications of important favourable beds was found. It should be yet interesting to test the valley near the present Copiapó river where a 500 Ωm-resistivity layer could be an aquifer.

Example of suggested program in La Bodega.

a complete survey would require:

a) E.S. tests on existing wells in the Copiapó valley, near the city
b) One E.S. profile south of the P outcrop
c) E.S. profile from Punta Pinchincha to Cerro Bramador
d) Eventually, intermediate E.S. and a resistivity map if any large sandy (or gravel) beds may be supposed to exist, from the first E.S.

We insist upon the very approximate character of our present tests which were carried out mainly to establish in which conditions geophysical surveys should be made - Anyway it would be interesting to check by drillings the provisory indications provided here.

Santiago, February 20, 1963.

J-P ROCROI
UNSFMS - Geophysical Section

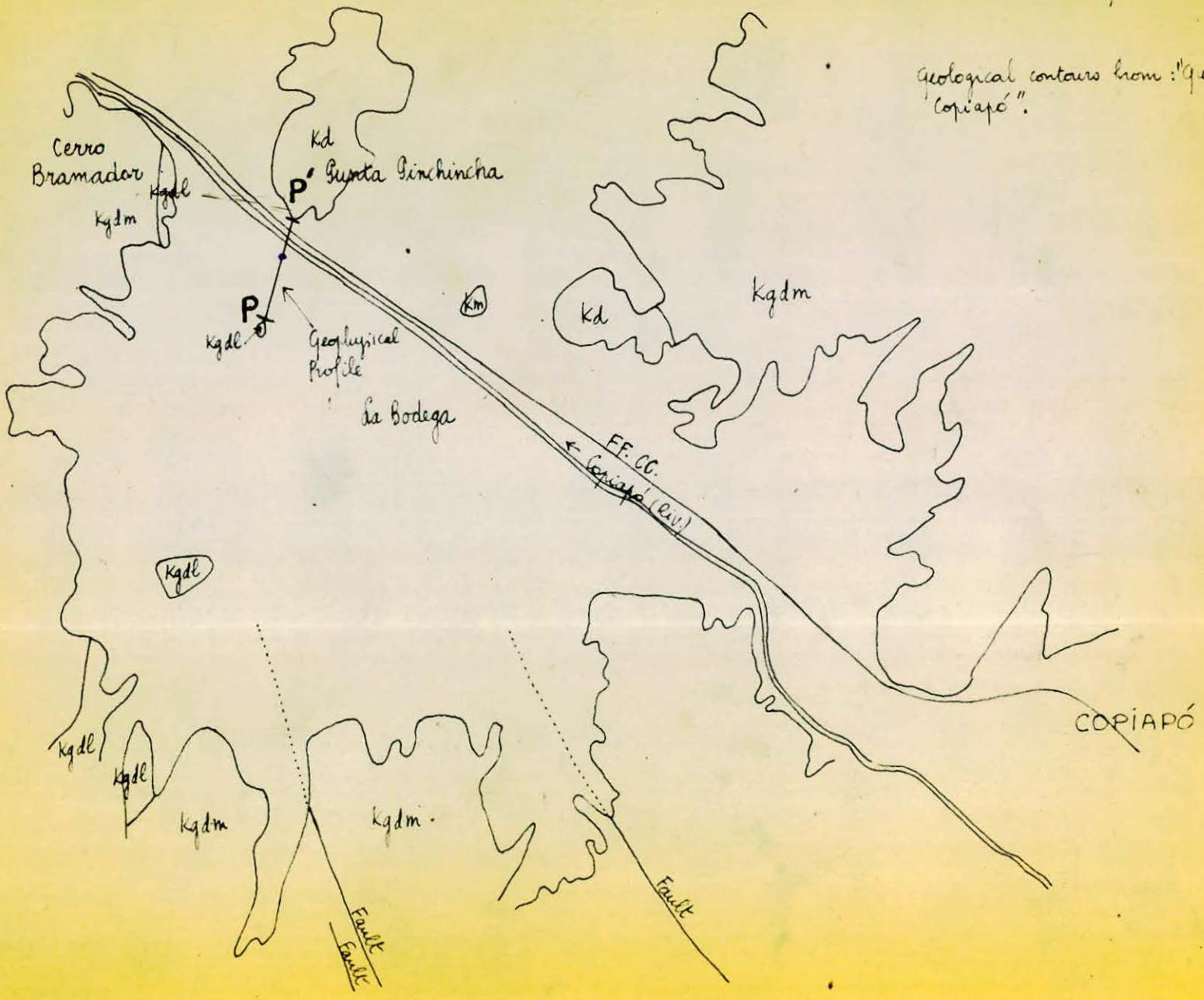
JPR/gmc.

fig. 1 Electrical tests in the Copiapó valley.

Situation map

scale: 1/50000

Geological contours from: "Cuadrangulo Copiapó".



UNSFMS. Geophysical section Feb. 63

Iquique, March 7, 1963

Copies:
Mr. Ruiz
Corfo

Mr. E. Dahlström
Project Manager
UN Special Fund Mineral Survey
SANTIAGO

Dear Sir,

I beg to send you herewith the Bodega report. I received yesterday only the topographical profile from Copiapó, which explains that we are somewhat late in d livering this report.

As it is explained in the text, the results should be considered as very provisory, no complete survey having been made in the region. Our purpose was only to determine what method could be used and what data could be provided. All depth indications should be taken as approximate informations.

It would be very interesting to know the conclusions of subsequent works in Bodega (mine of wells proposed by Italconsult).

I join two copies of the report, one for Mr. Ruiz and the other for Corfo.

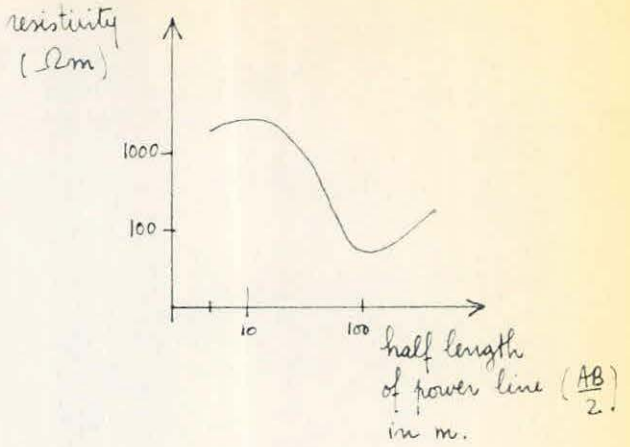
All complementary information will be sent at your request.

Very sincerely yours,

JP Rocroi
Naciones Unidas
Casilla 268
IQUIQUE

fig 2

Electrical soundings -
Diagrams



Mission Copiapó (Bodega)
Date 120263

S.E. 1

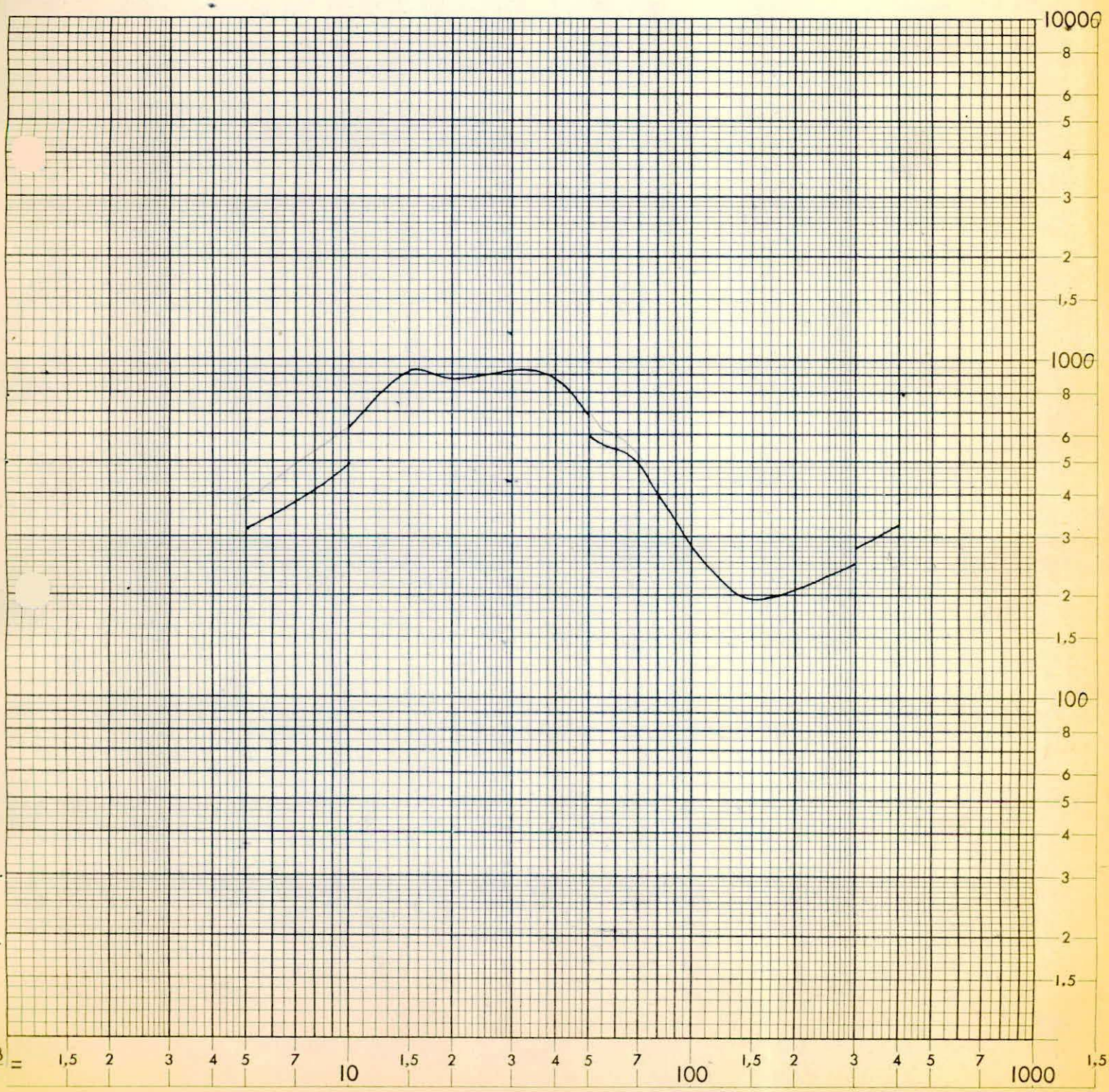
Forage

fig 2a

Interprétation :

Azimut de AB 160 gr (mag.)
Cote de surface

Coupe des terrains



Symbole C.G.G. 8 BA

MN =

Mission Copiapó - Bodega
Date 130263

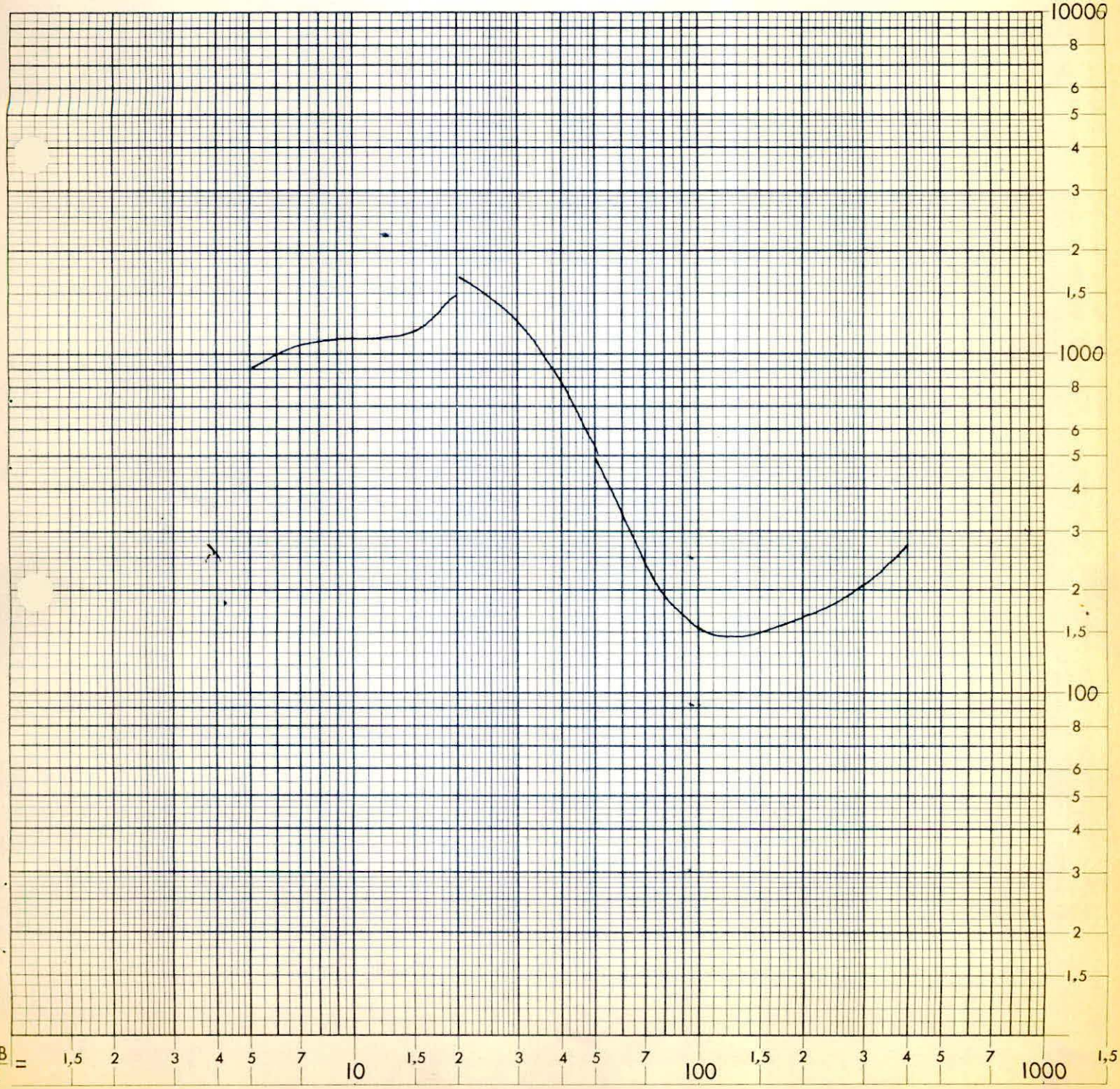
S.E. 2
Forage

fig 26

Interprétation :

Azimut de AB 174 gr (mag.)
Cote de surface

Coupe des terrains



Symbole C.G.G. 8 BA

MN =

Mission Copiapó - Bodega

Date 13 02 63

S.E. 3

Forage

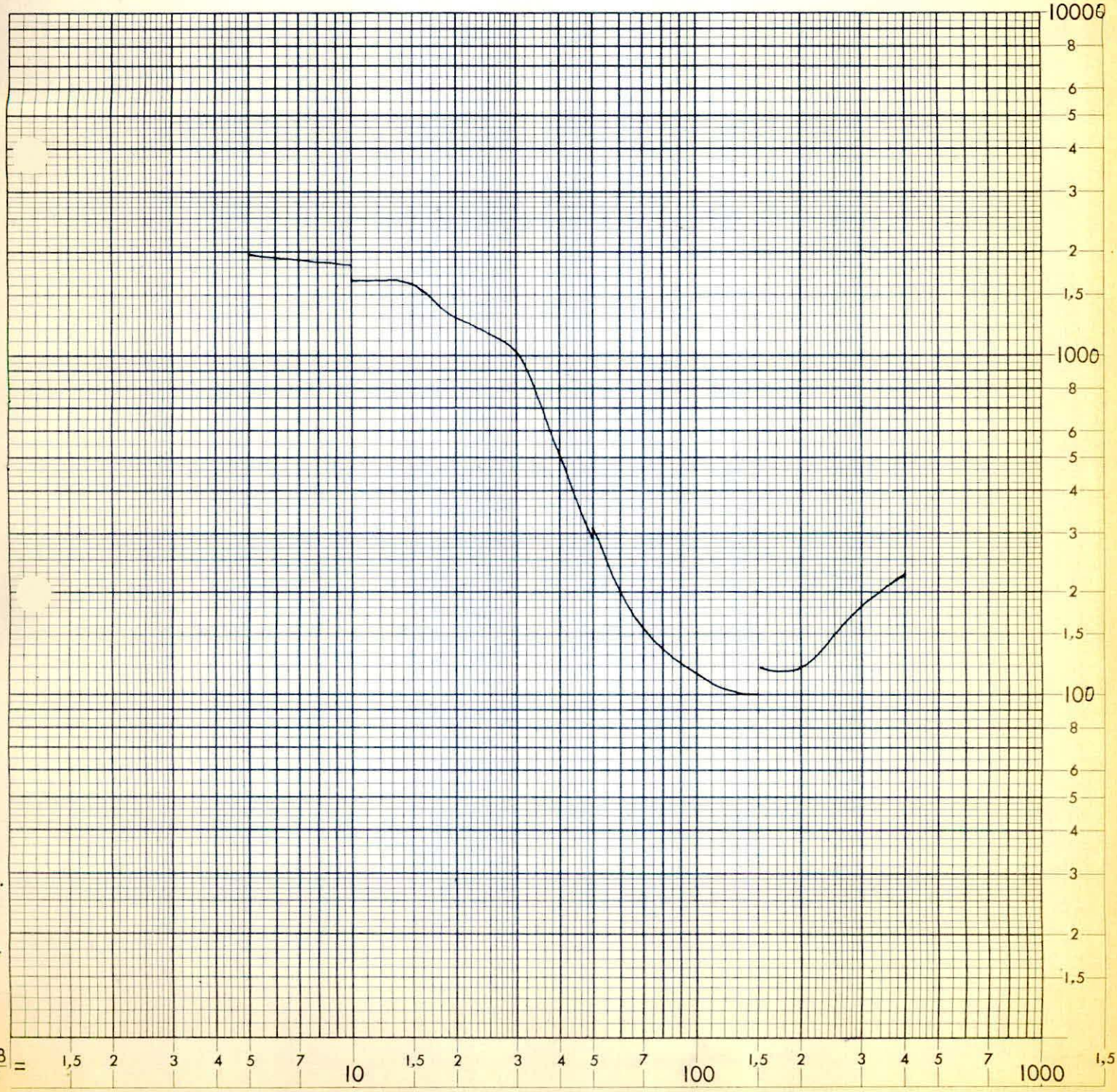
fig 2c

Interprétation :

Azimut de AB 180 gr (mag)

Cote de surface

Coupe des terrains



Symbole C.G.G. 8 BA

MN =

Mission Copiapó - Bodega

Date 14 02 63

S.E. 4

Forage

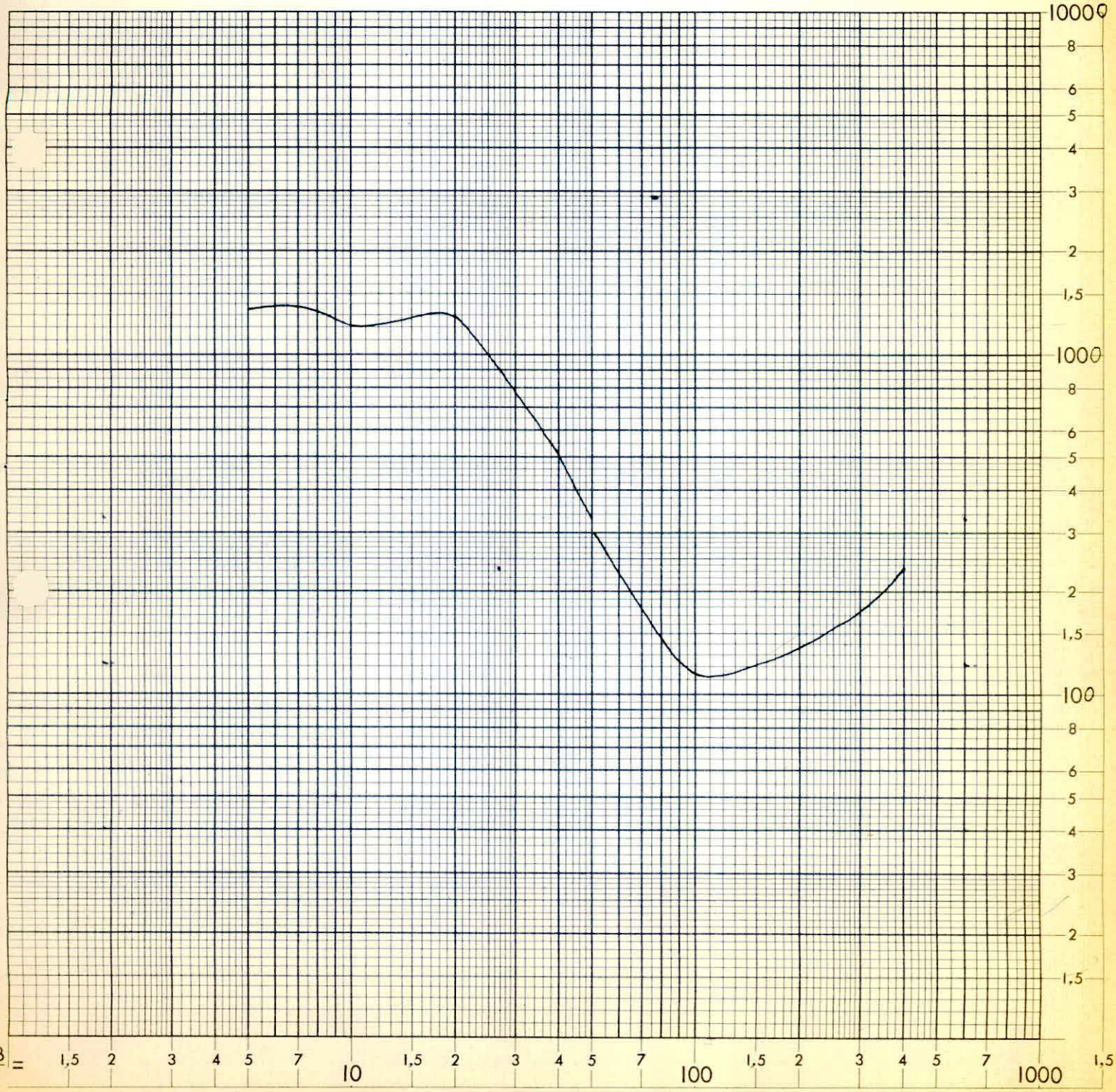
fig 2d

Interprétation :

Azimut de AB 142 gr (magn)

Cote de surface

Coupe des terrains



Symbole C.G.G. 8 BA

=MN =

Mission Copiapó - Bodega

Date 140263

S.E. 5

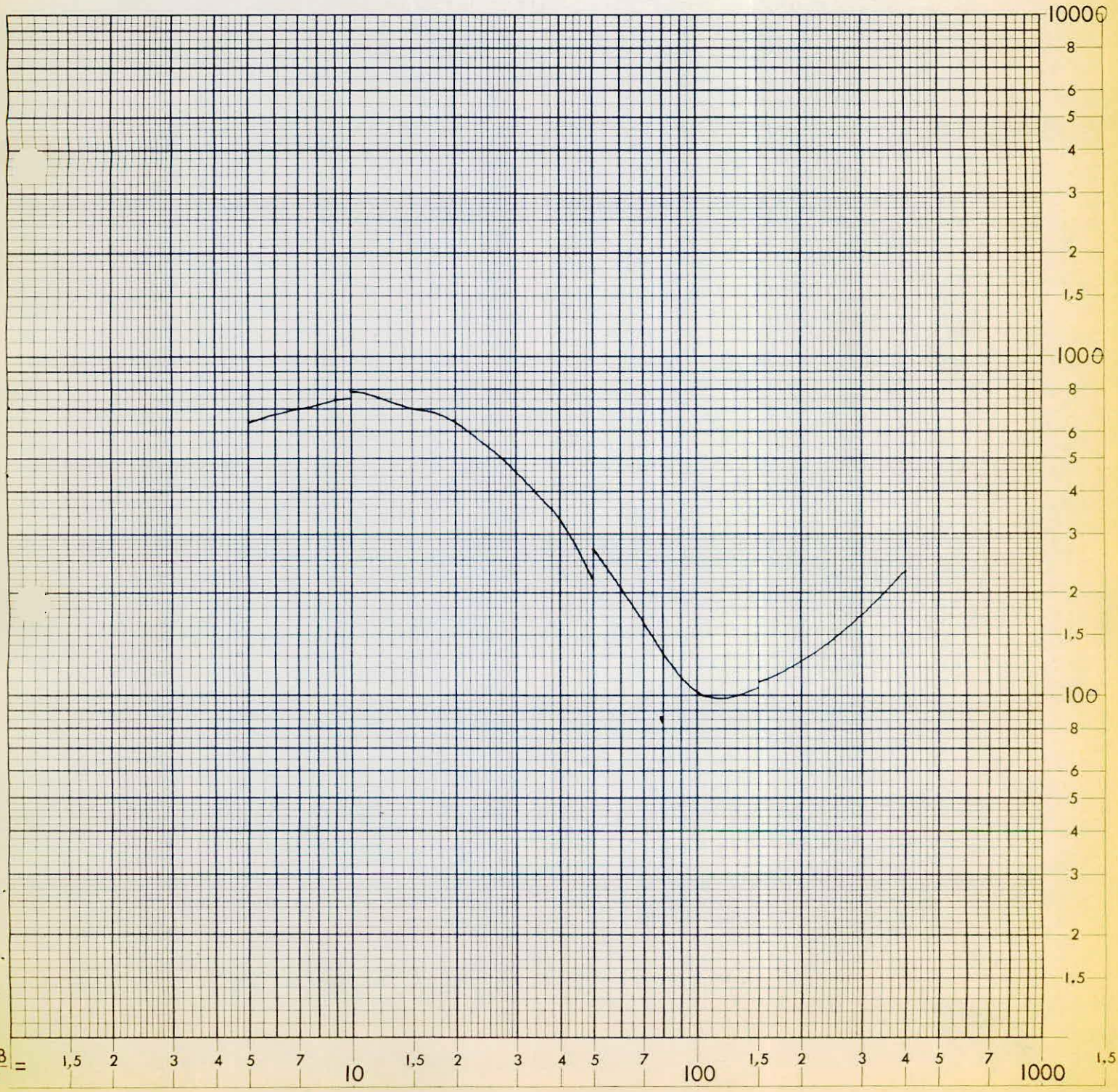
Forage

Interprétation :

Azimut de AB 145 gr (magl

Cote de surface

Coupe des terrains



Symbole C.G.G. 8 BA

MN =

Mission Copiapó - Bodega

Date 15 02 63

S.E. 6

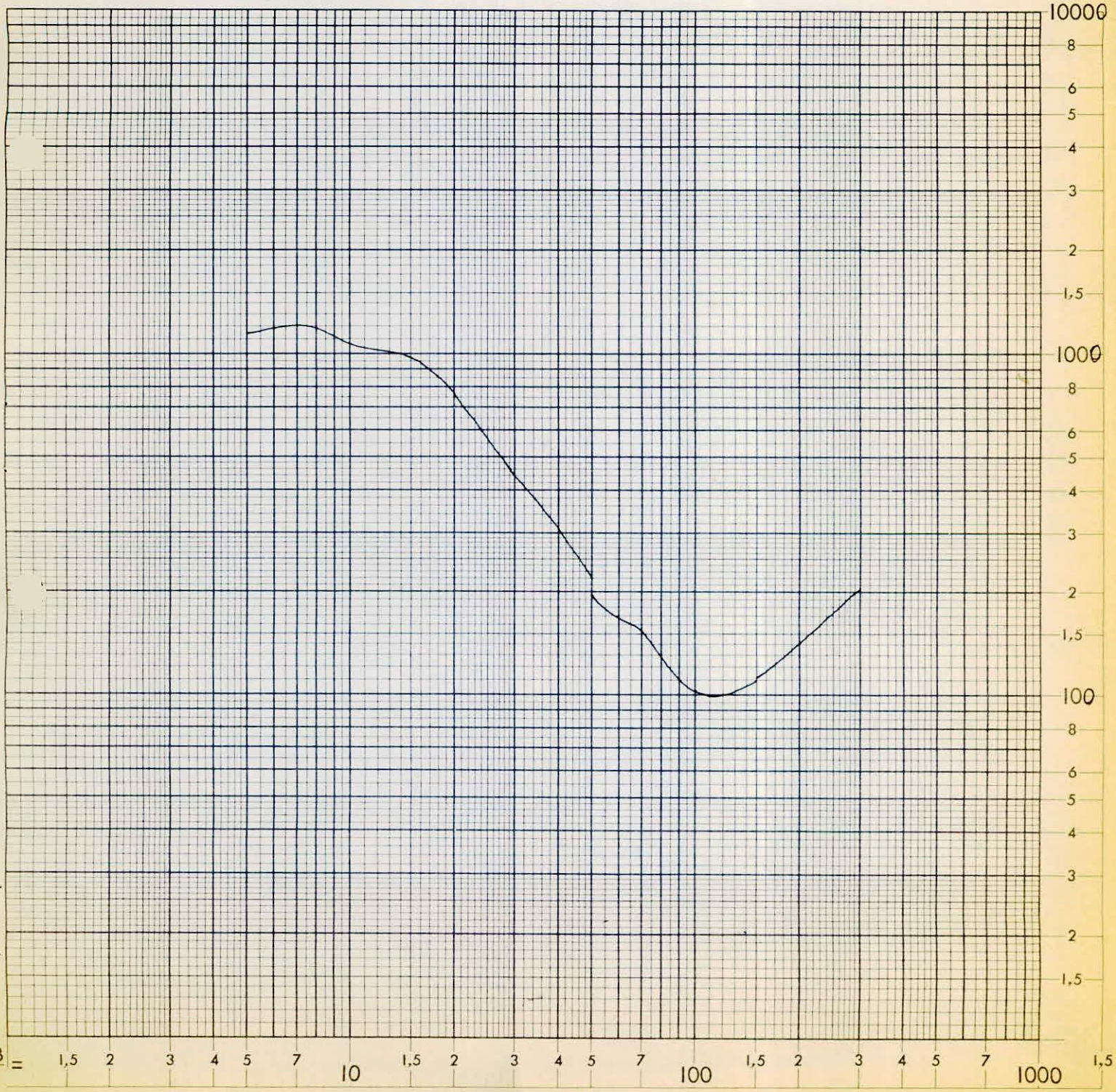
Forage

Interprétation :

Azimut de AB 140 gr (mag)

Cote de surface

Coupe des terrains



Symbole C.G.G. 8 BA

Mission Copiapó - Bodega

Date 160263

S.E. 7

Forage

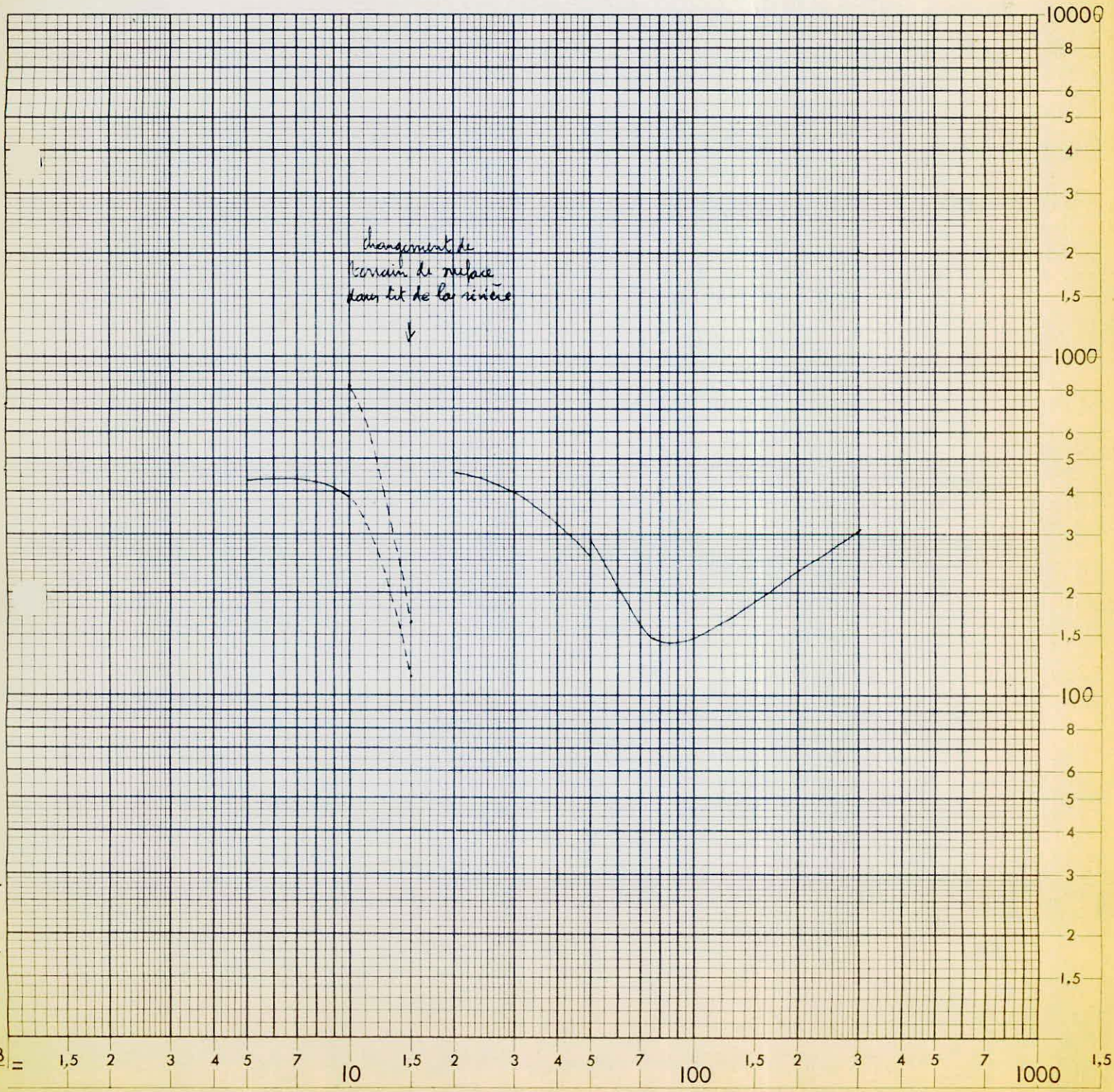
hq 2g

Interprétation :

Azimut de AB 140gr (mag)

Cote de surface

Coupe des terrains



Symbole C.G.G. 8 BA

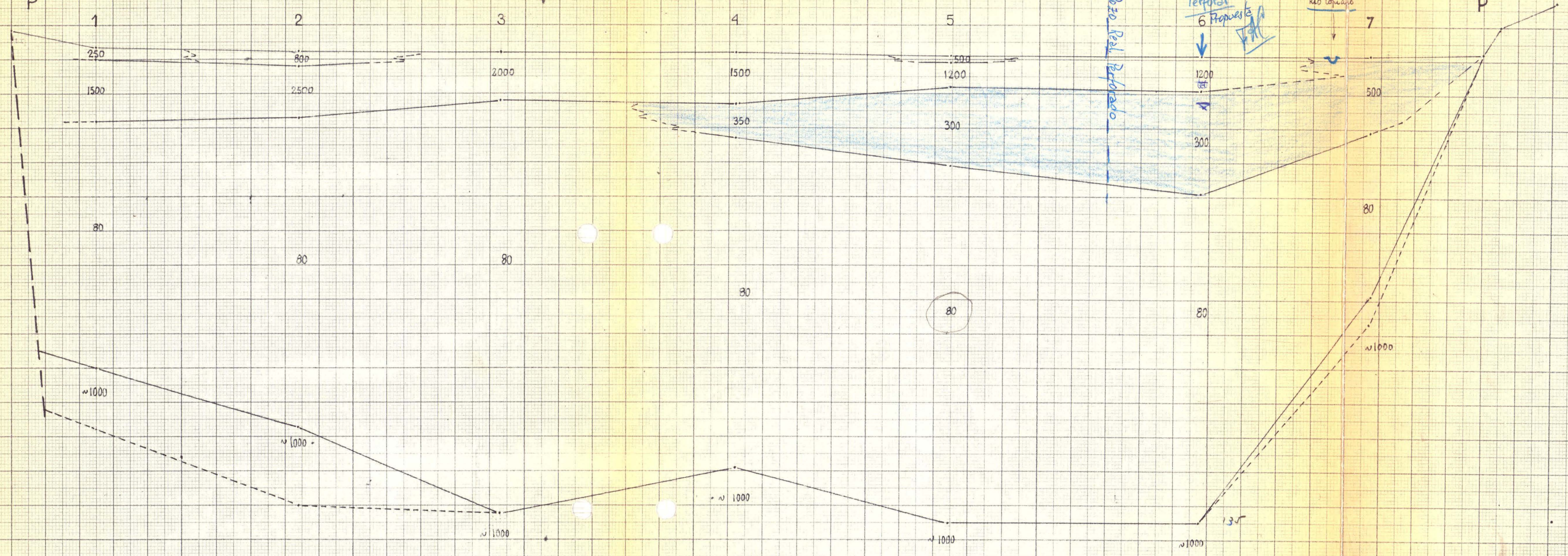
-MN =

SSW

Kydl outcrop

NNE

Punta Pinchincha



Electrical tests in the Capiapó valley

PP' Cross section

Hor. 1/2000

Sc:

Ver. 1/1000

6 electrical sounding

1200 estimated resistivity (Ωm)

N.B. the dotted line represents the bottom of the valley in the hypothesis of changing resistivity for the last alluvium layer (100 Ωm instead of 80 Ωm, in E.S. 1, 2 and 7)

UNSF MS. Geophysical section March 63