Tom Schroeter

INDUCED POLARIZATION AND RESISTIVITY IN THE GIBRALTAR AREA, BRITISH COLUMBIA

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CONTENTS

ILLUSTRATIONS

INTRODUCTION

The authors, by means of this paper, will attempt to show the role of Induced Polarization and Resistivity surveys in the discovery of the orebodies of Gibraltar Mines Limited (N.P.L.). In this paper, we will also attempt to show the importance of conducting large enough surveys in order to properly evaluate the results obtained from these surveys.

LOCATION

The orebodies of Gibraltar Mines Limited (N.P.L.) are located on the western slope of Granite Mountain, central British Columbia ($52^{o}30'$ north, $122^{o}16'$ west)(See Fig. 1). The property lies approximately 28 miles north of Williams Lake, B.C. and can be reached by way of 10 miles of newly improved road from McLeese Lake, on the Cariboo Highway. The area in and around Gibraltar Mines has a moderate topographic relief with elevations between 3,500 and 4,100 feet.

EARLY HISTORY AND GEOLOGY

The present Gibraltar Mines property before amalgamation consisted of the Pollyanna property (Duval-Canex) and the Gibraltar property (original Gibraltar Mines) as well as some Coast Silver and McLeese Lake Copper claims (See Fig. 2).

The Pollyanna property was first described in the 1917 B.C. Minister of Mines Report which referred to it as the "Rainbow Group". The development at that time consisted of several open-cuts on copper bearing quartz veins.

By 1925, the Rainbow Group came to be known as the Pollyanna property and was described in the B.C. Minister of Mines Report as "a wide zone of shearing in granodiorite at least 60 feet in width and possibly wider". Copper mineralization on the Pollyanna and the adjoining Copper Queen group to the south had been found by 1929 in scattered outcrops over a distance of 2,000 feet along a northwest-southeast trend. This mineralization was always found within the sheared granodiorite. Limited work was carried out on the property until Keevil Mining came on the scene in 1963-64.

The Gibraltar property was discovered around 1927 and was mentioned in the 1928 B.C. Minister of Mines Report as the Hill property. The only significant copper showing was exposed along the side of Granite Creek about 6,000 feet west of the Pollyanna showing. Very little work was carried out on the property until 1957 when Kimaclo Mines drove an adit for 110 feet along the mineralized shear zone. Subsequent drilling showed the mineralized zone at the adit was over 100 feet wide and extended along both a localized shear at the adit and the regional foliation for an undetermined distance. In 1962, Keevil Mining carried out the first geophysical program on the property in conjunction with a geochemical soil sampling survey.

HISTORY OF THE INDUCED POLARIZATION AND RESISTIVITY SURVEYS

No Induced Polarization and Resistivity surveys were conducted on the properties until the early 1960's when the first survey was conducted

on behalf of the Keevil Mining Group Ltd. This survey was carried out in 1962 by Geophysical Engineering and Surveys Limited on the "Major Property" (Gibraltar)(see Fig. 3) of Keevil Mining and Canadian Devonian Petroleums. The Keevil survey was made with equipment of a type unknown to the authors. A small survey over a restricted area was conducted by Hunting surveys in 1963 near the Sunset adit. This survey tested part of the area which had been covered by the eariler Keevil survey.

In 1964, Duval Corporation of Canada optioned the Pollyanna property from R. Glen and had McPhar Geophysics conduct a limited I.P. survey the following year over an area which extended from the zone of known mineralization to the eastern boundary of the property. The Duval geologist at this time recognized the occurrence of limonite after chalcopyrite as a typical porphyry environment which stood a good chance of having a zone of supergene enrichment. The McPhar survey was extended in 1966 by Heinrichs Geoexploration Company to further delineate the Pollyanna zone (See Fig. 4). Also in 1966, Cominco, using McPhar frequency effect equipment, re-surveyed the area covered by Keevil Mining (See Fig. 5). In 1967, Canex Aerial Exploration joined Duval on an equal participation basis. At this time the surveys on both Pollyanna and Gibraltar were extended by Canex and McPhar respectively to cover both properties in their entirety except along the property boundaries (See Fig. 6 and 7). The remaining Keevil property to the east of Pollyanna was also covered by a McPhar I.P. survey in 1967 (See Fig. 8). The property owned by Gunn Mines was optioned in 1968 by Canex-Duval and the portion bordering on Pollyanna-Gibraltar was covered by an I.P. survey.

In 1969, Canex-Duval optioned the Gibraltar Mines property and the I.P. surveys were tied in along the mutual borders with Pollyanna. This data enabled a complete picture of the I.P. surveys to be assembled. By this time, a total of 165 line miles of I.P. had been carried out in and around the area of the 4 orebodies over a span of 8 years. The I.P. survey coverage was subsequently extended to cover the region of the proposed tailings impoundment area to the north of the orebodies. This brought the total mileage of I.P. coverage in the area to 260 line miles.

EQUIPMENT USED

The majority of the equipment used was frequency type equipment with the exception of that used by Hunting. The McPhar, Cominco and Canex surveys all used McPhar equipment and employed frequencies of 0.31 and 5.0 Hertz. The dipole-dipole method was employed for all the frequency type surveys with 300 foot dipole lengths and separations of N = 1,2 and 3. The Heinrichs survey used frequencies of 0.05 and 3.0 Hertz and a 400 foot dipole length. Their results were modified to fit the other frequency effect data. The use of similar frequencies and dipole lengths proved to be very important in the combining of the survey data.

RESULTS OF THE I.P. SURVEYS

Gibraltar Area

An instrument of unknown characteristics was used on the early survey on the Gibraltar property for Keevil Mining. The results of this survey were very erratic and little meaningful interpretation could be made of the data obtained. However, the survey did outline a rather large resistivity low which corresponds roughly to the areas of the Gibraltar

East and West orebodies. The Hunting survey during the following year was conducted only over the Gibraltar West zone near the Sunset adit. This survey outlined the higher grade Gibraltar west zone quite well.

The survey by Cominco in 1966 was, as stated in a report by G. Tikkanen, designed to cover areas of known mineralization and to cover some of the interesting parts of the property away from the known mineralization. This survey revealed a distinct anomaly over the known mineralization at the adit (Gibraltar West) and a somewhat stronger anomaly to the north of the adit anomaly. This stronger zone (Gibraltar East) was only partially drilled at this time and discouraging results were obtained.

In 1967, McPhar Geophysics carried out an I.P. survey for Cominco over the remainder of the Gibraltar property (See Fig. 9). Several anomalous zones were detected in this survey. The largest of these zones corresponded to the present Granite Lake orebody and was stated to be a possible extension of the northern zone (Gibraltar East) detected in the earlier Cominco survey.

Pollyanna Area

The McPhar survey conducted over the Duval ground in 1965 discovered an anomalous zone to the east of the known mineralized area. This zone was not completely outlined as the I.P. lines were not of sufficient length to get off the anomalous zone (Pollyanna). This survey also detected an anomalous zone (Gibraltar East) to the west of the Pollyanna zone. Drilling of the main Pollyanna zone was started early in 1965 and a major

area of copper mineralization was discovered. At this time, the coverage of the Pollyanna zone was extended by Heinrichs Geoexploration Co. This work, combined with that of the previous year, outlined a "northwest-southeast trending anomalous zone approximately 2,000 feet wide and 10,000 feet or more in length". In 1967, Canex acquired a 50 percent interest in the Pollyanna property and the rest of the property was covered by I.P. (See Fig. 10). This survey extended the anomalous zone from the east boundary of the property to the west boundary but did not reveal any additional anomalous zones.

Gunn Area

The 1968 survey, on the west half of the Gunn ground, by Canex-Duval outlined two anomalous zones. One zone corresponded to an area of known mineralization on the Gunn property while the other zone was detected on the Gunn-Pollyanna-Gibraltar boundary near Granite Lake (Granite Lake Zone) (See Fig. 11).

Combined Area

In 1969, Canex-Duval optioned the Gibraltar ground and tied in the various I.P. surveys across the mutual boundaries. The survey results were combined and a contoured plan map was drawn up of first separation frequency effect.

DISCUSSION OF RESULTS

The earliest I.P. survey on the Gibraltar property gave readings which were of little use in delineating the ore zones (Gibraltar West and East). The later surveys all detected part of the major anomalous zone but the overall significance of the results was not clearly understood.

In 1967, an attempt was made by Canex to combine the early Cominco data from Gibraltar with the McPhar-Heinrichs' data from Pollyanna (See Fig. 12). Because of insufficient data (i.e. the Granite Lake area had not been covered) only an L-shaped anomaly could be surmised. The method of plotting these earlier I.P. results as definite, probable, and possible anomalous zones by means of dashes and solid bars did not tend to give a clear picture of the sulphide content of the rock while the contoured plan did give a clearer picture.

Late in 1968, Dr. A.D. Drummond and S.J. Tennant of Canex Aerial Exploration carried out a study of the total Gibraltar-Pollyanna information. They concluded that the Gibraltar West zone was restricted in further potential and that any further drilling should be carried out along the Gibraltar-Pollyanna boundary. Meanwhile, personnel connected with Gibraltar Mines conducted an independent analysis of the available information and arrived at a similar conclusion. Therefore, drilling to check out the anomalous I.P. zone between the Pollyanna and Gibraltar West orebodies was recommended. Drilling was started on the Gibraltar side by Gibraltar Mines in March 1969, and by Canex-Duval on the Pollyanna side in May 1969.

At the time of the above evaluations, the Cominco-McPhar I.P. data was received by Canex and it was combined with all of the previous data of the general area. A first separation, percent frequency effect map of the combined data was drawn up with the resultant map showing the Granite Lake anomaly as part of the major anomalous zone. A study of this map led to the suggestion that the overall picture could represent a large pyrite halo (See Fig. 13). Because of the favorable results obtained from the early

Gibraltar East drilling, the Gibraltar Mines property was optioned by Canex-Duval. The Gibraltar East orebody was subsequen'ly outlined and at the same time the Pollyanna orebody was drilled off.

In order to explain the pyrite halo sufficiently, a younger intrusive was postulated to occur in the central core of the anomalous I.P. zone. No geologic information was available to confirm or deny the existence of this intrusive as this area was entirely overburden covered. When the drilling was finished on the Pollyanna orebody, a decision was made to step off drill holes to the south of Pollyanna. This drilling resulted in the subsequent discovery of the Granite Lake orebody and also the confirmation of a barren intrusive occurring in the central core of the pyrite halo (See Fig. 14).

The four orebodies were found to occur along the inside of the I.P. halo. The halo grades outward from 1.0 percent frequency effect at the center to 10.0-15.00 percent frequency effect at the rim. The better grade ore lies in the 2.5 to 7.5 P.F.E. zone (See Fig. 15-18 incl.). A study of the overall drill results shows a zoning of the mineralization which adheres roughly to the following sequence:-

Barren porphyry at center - Foliated Q. diorite with bornite and molybdenite - Molybdenite-chalcopyrite - Chalcopyrite-pyrite - Pyrite-chalcopyrite - Pyrite at the outside edge of the halo (See Fig. 19). The I.P. halo follows this zoning of the mineralization as close as can be expected in any given field environment. The mineralization emplacement was controlled to a large part by the regional foliation of the Q. diorite. The foliation strikes about 110^{o} and dips $20\text{-}30^{o}$ southerly.

The foliation thus aided in the mineralization emplacement on the Polly-anna zone and acted as a dam on the Granite Lake zone. The dip of the regional foliation is quite steep at the west end of the Granite Lake zone. This steepness resulted in a narrow mineralized area just west of Granite Lake and thus the I.P. anomaly is quite sharp. The other portions of this ore zone and the other ore zones have broad I.P. anomalies due to the shallow dip of the foliation which allowed a greater dispersion of sulfides. We have found, therefore, from our own experience that the contouring of the frequency effect and the resistivity results on a plan map gives an excellent insight into the relative shape of the anomalous zone.

CONCLUSIONS

It is concluded that the induced polarization method did play an important role in the discovery of orebodies of Gibraltar Mines. It can also be concluded from the results that an early idea of the orebody locations would have been obtained through either of the following two things: 1. extension of lines over property boundaries with mutual consent of owners or 2. mutual exchange of adjoining data.

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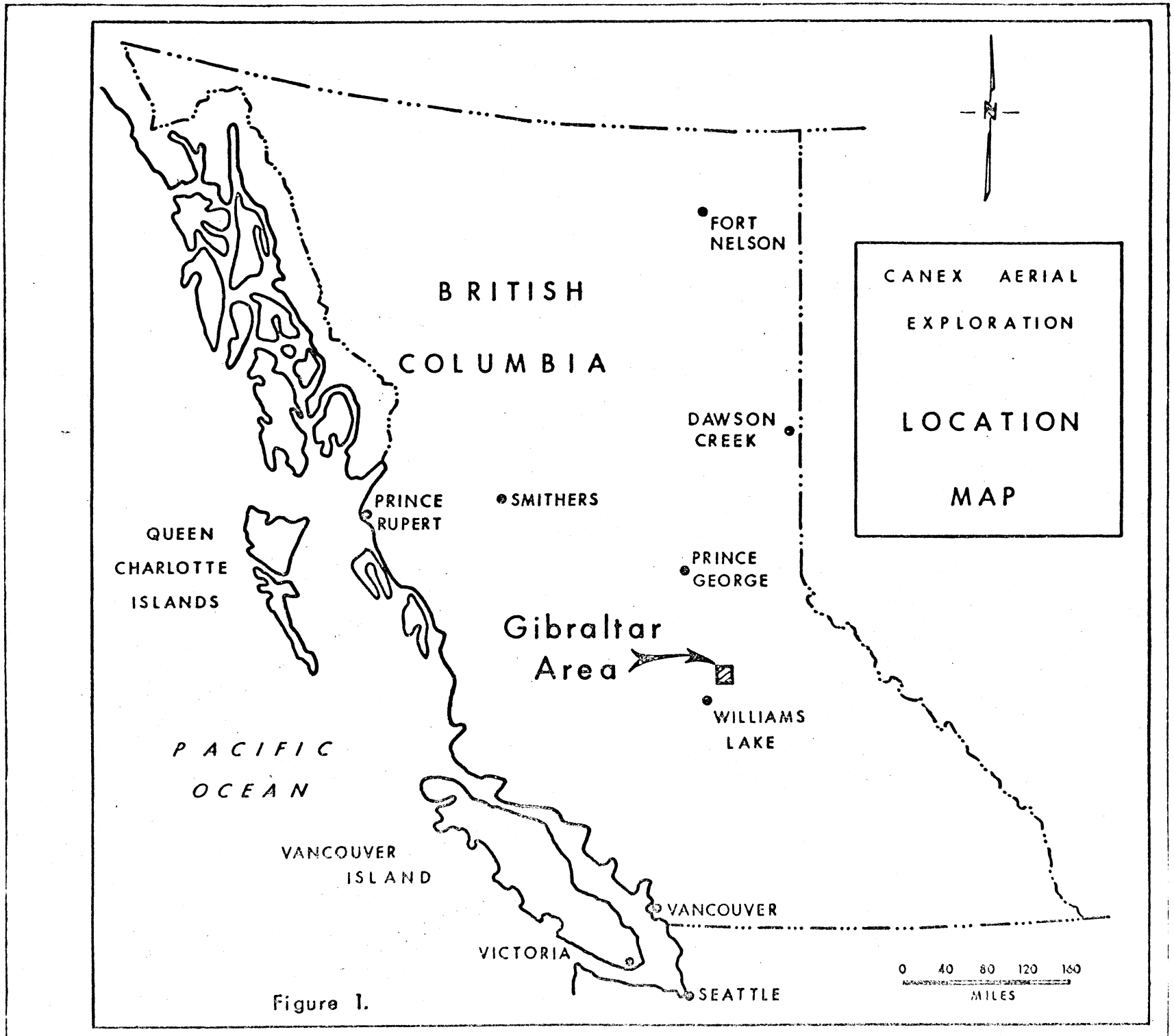

CANEX AERIAL EXPLORATION
LOCATION MAP
BRITISH COLUMBIA
FORT NELSON
DAWSON CREEK
PRINCE RUPERT
SMITHERS
PRINCE GEORGE
QUEEN CHARLOTTE ISLANDS
Gibraltar Area
WILLIAMS LAKE
PACIFIC OCEAN
VANCOUVER ISLAND
VANCOUVER
VICTORIA
SEATTLE
0 40 80 120 160
MILES

Figure 1.

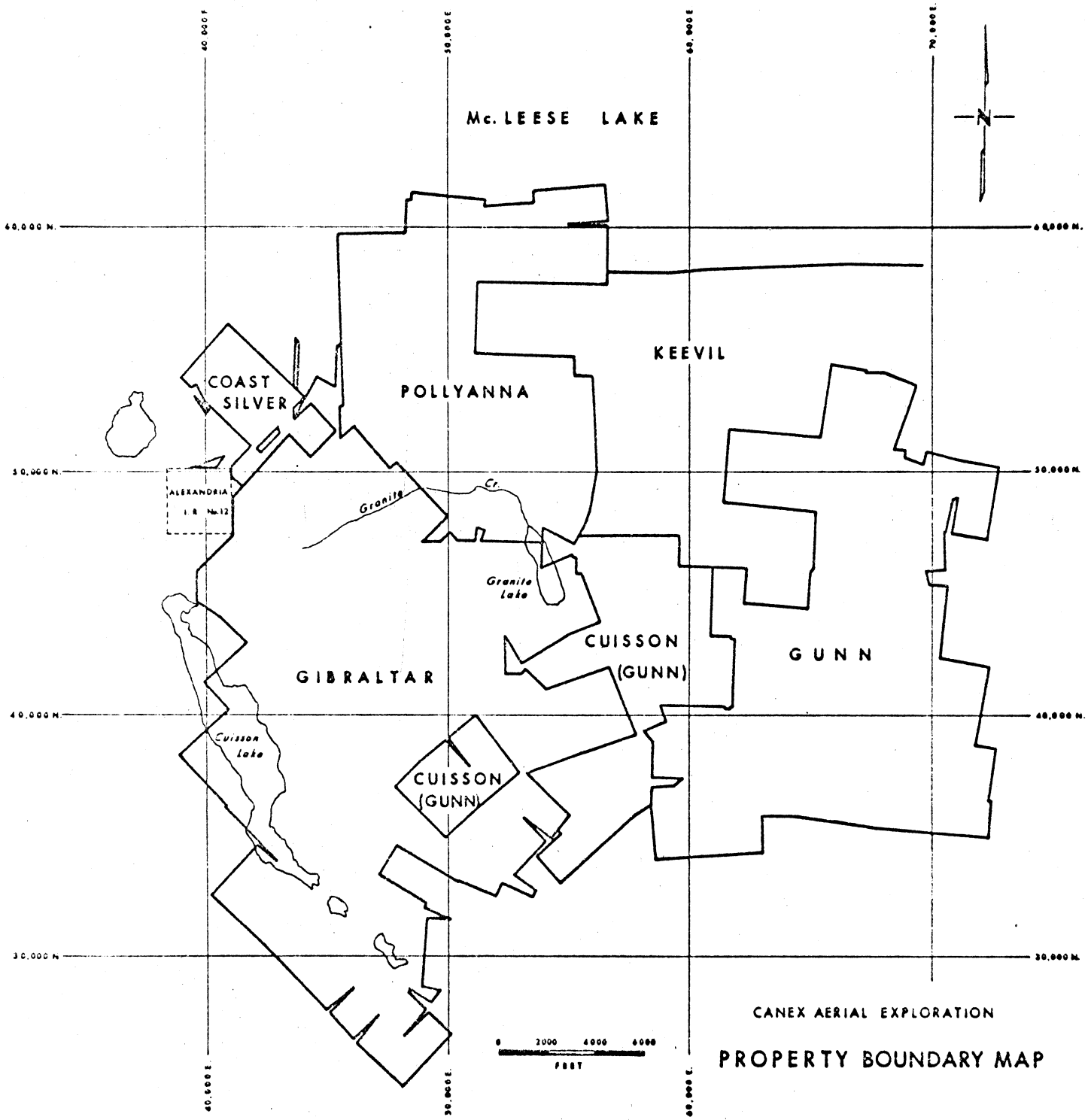
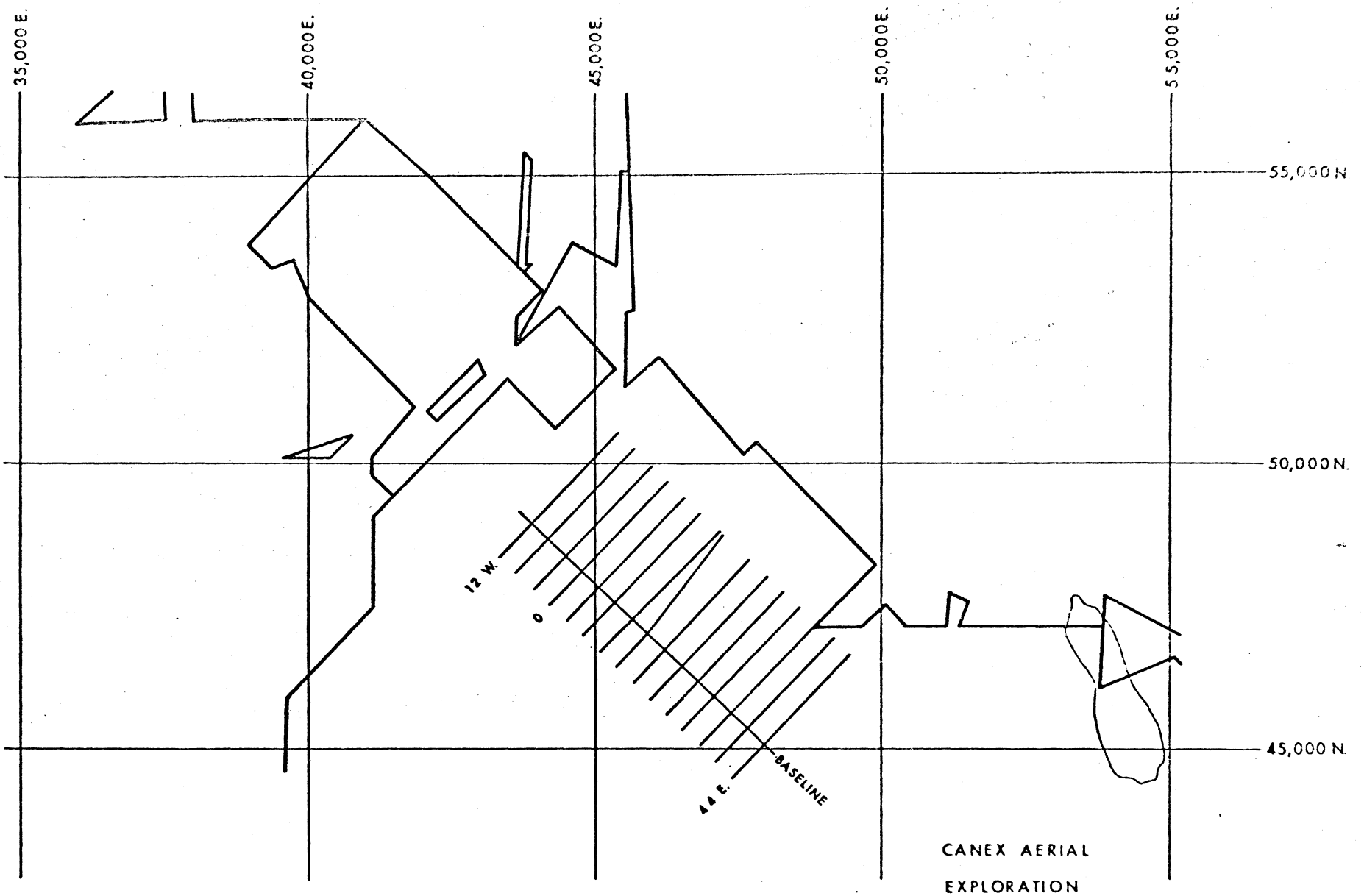
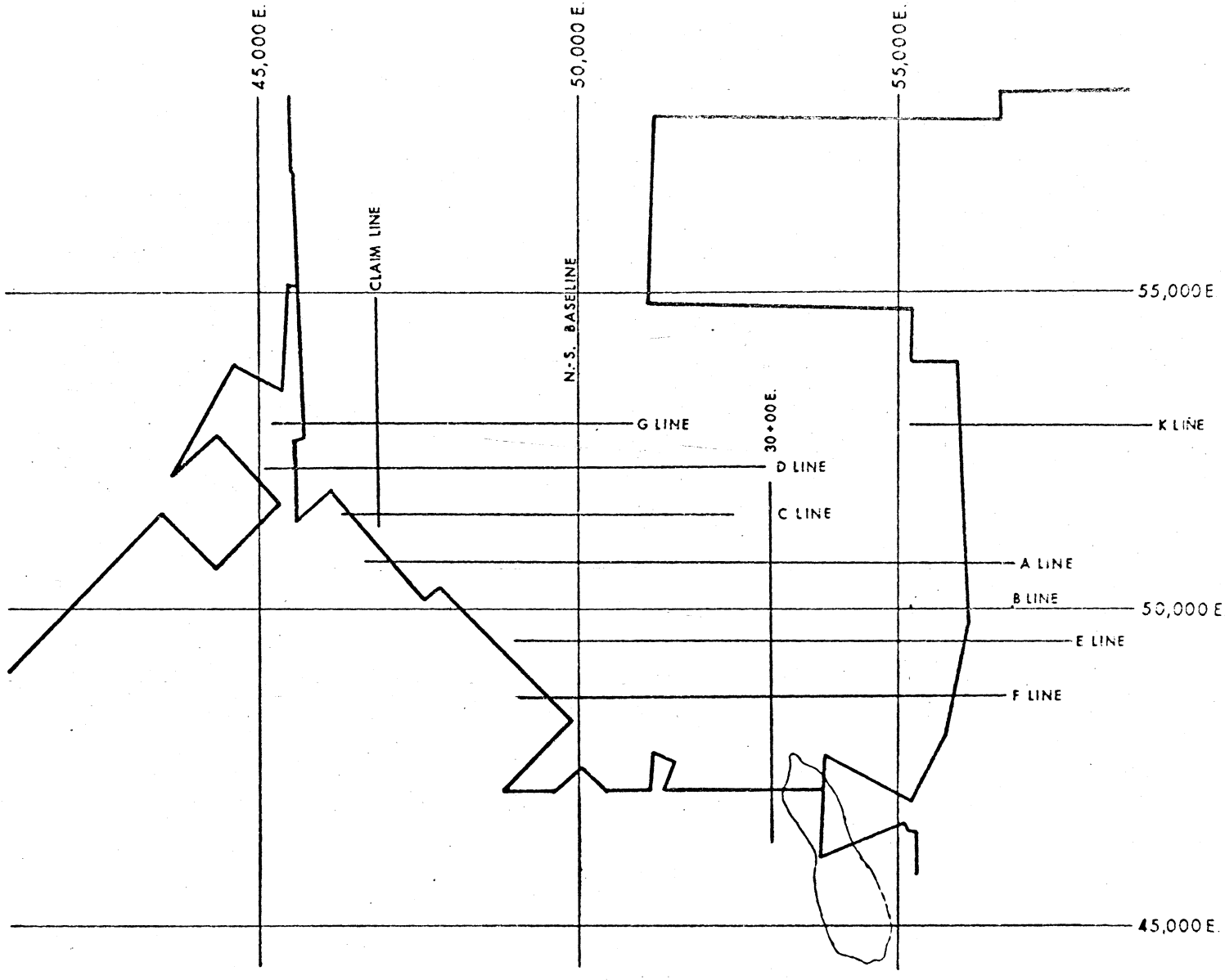

Mc. LEESE LAKE
N
KEEVIL
COAST SILVER
POLLYANNA
ALEXANDRIA I.R. No.12
Granite Cr.
Granite Lake
CUISSON (GUNN)
GUNN
GIBRALTAR
Cuisson Lake
CUISSON (GUNN)
60,000 N.
50,000 N.
40,000 N.
30,000 N.
40,000 E.
50,000 E.
60,000 E.
70,000 E.
0 2000 4000 6000
FEET
CANEX AERIAL EXPLORATION
PROPERTY BOUNDARY MAP

Figure 2.



KEEVIL GRID ON THE MAJOR PROPERTY (GIBRALTAR)

Figure 3.



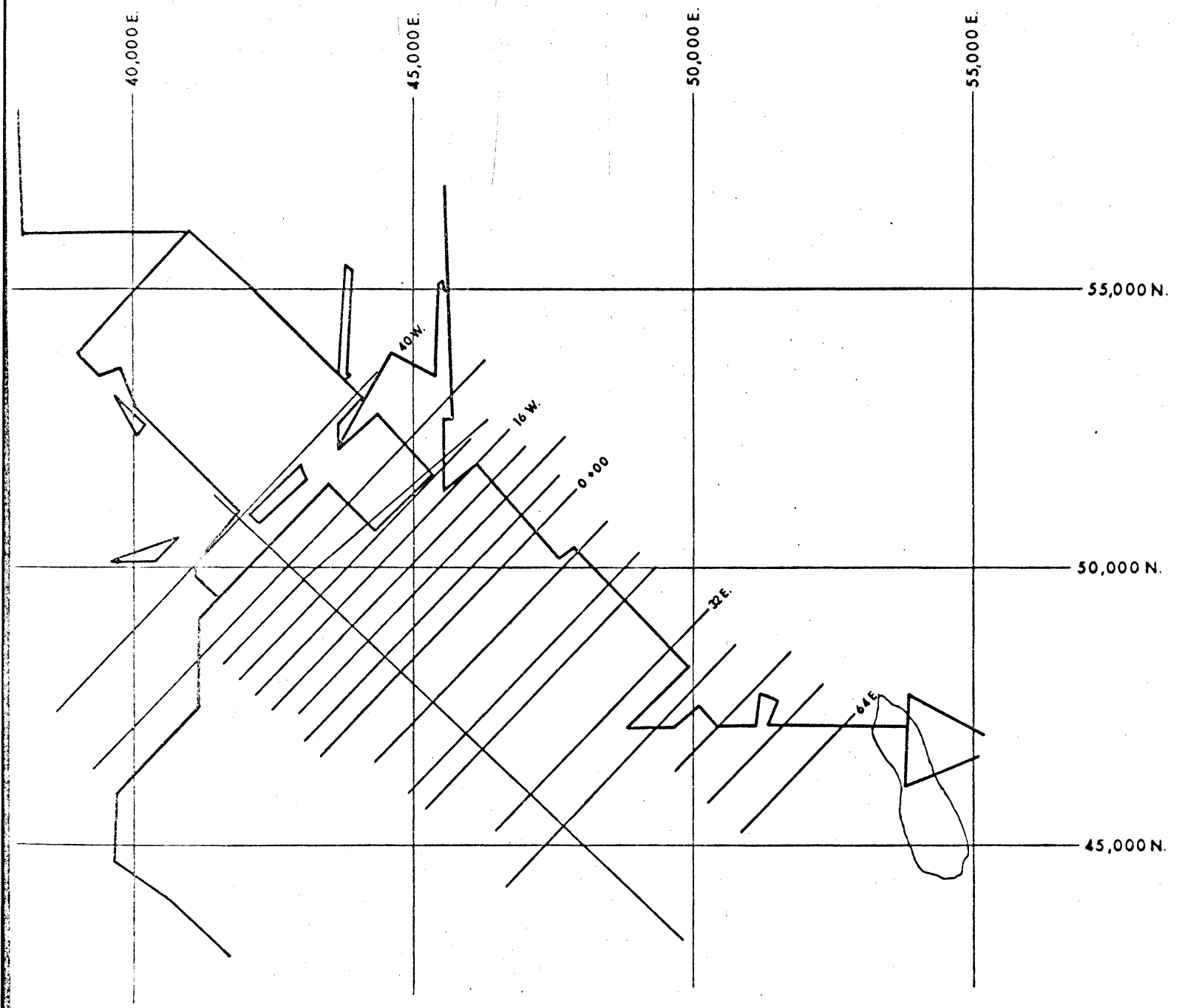
CANEX AERIAL

EXPLORATION

0 1000 2000 3000

FEET

McPHAR & HEINRICHS GRIDS ON THE POLLYANNA PROPERTY



CANEX AERIAL
EXPLORATION

0 1000 2000 3000
FEET

COMINCO GRID ON THE GIBRALTAR PROPERTY

Figure 5.

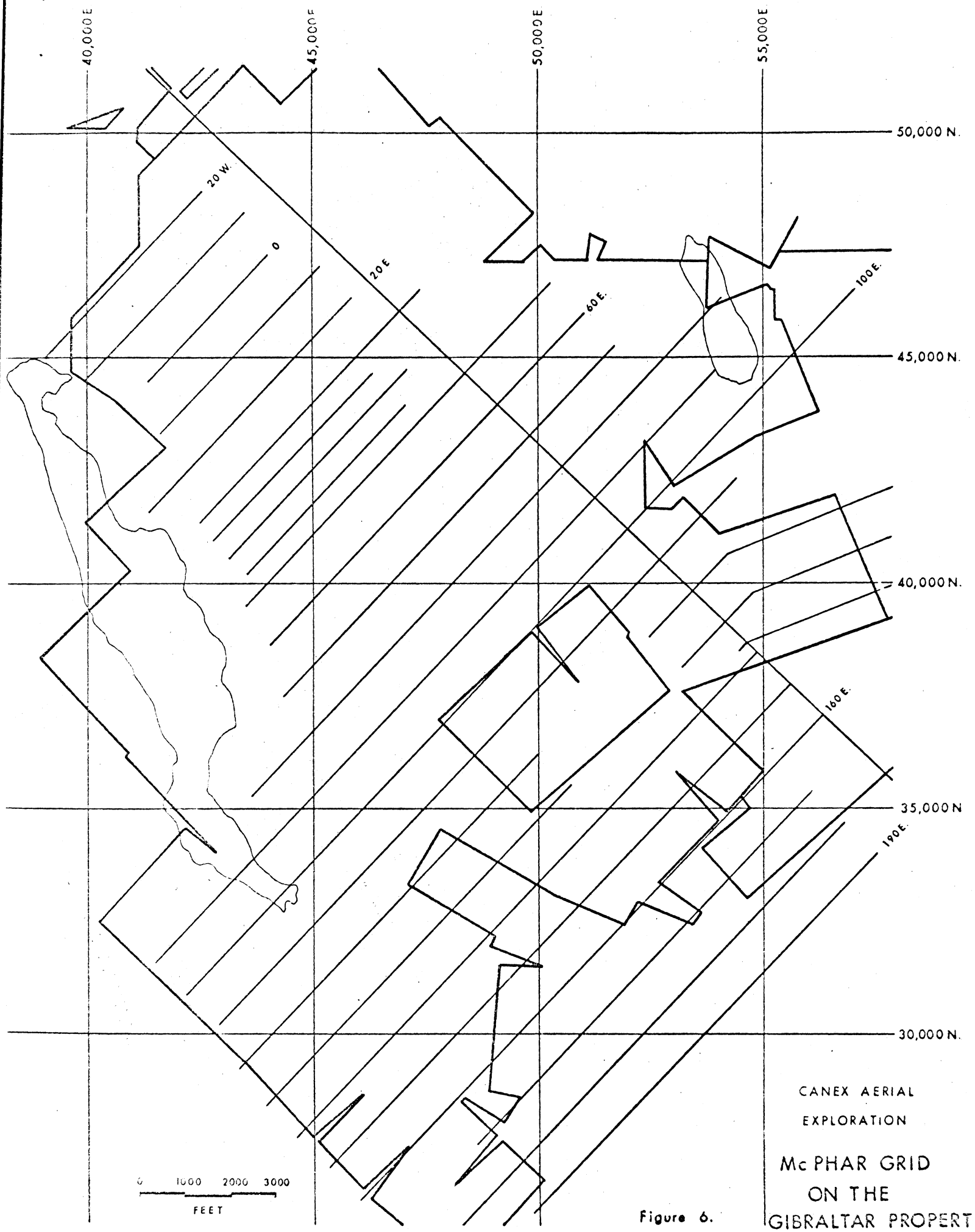
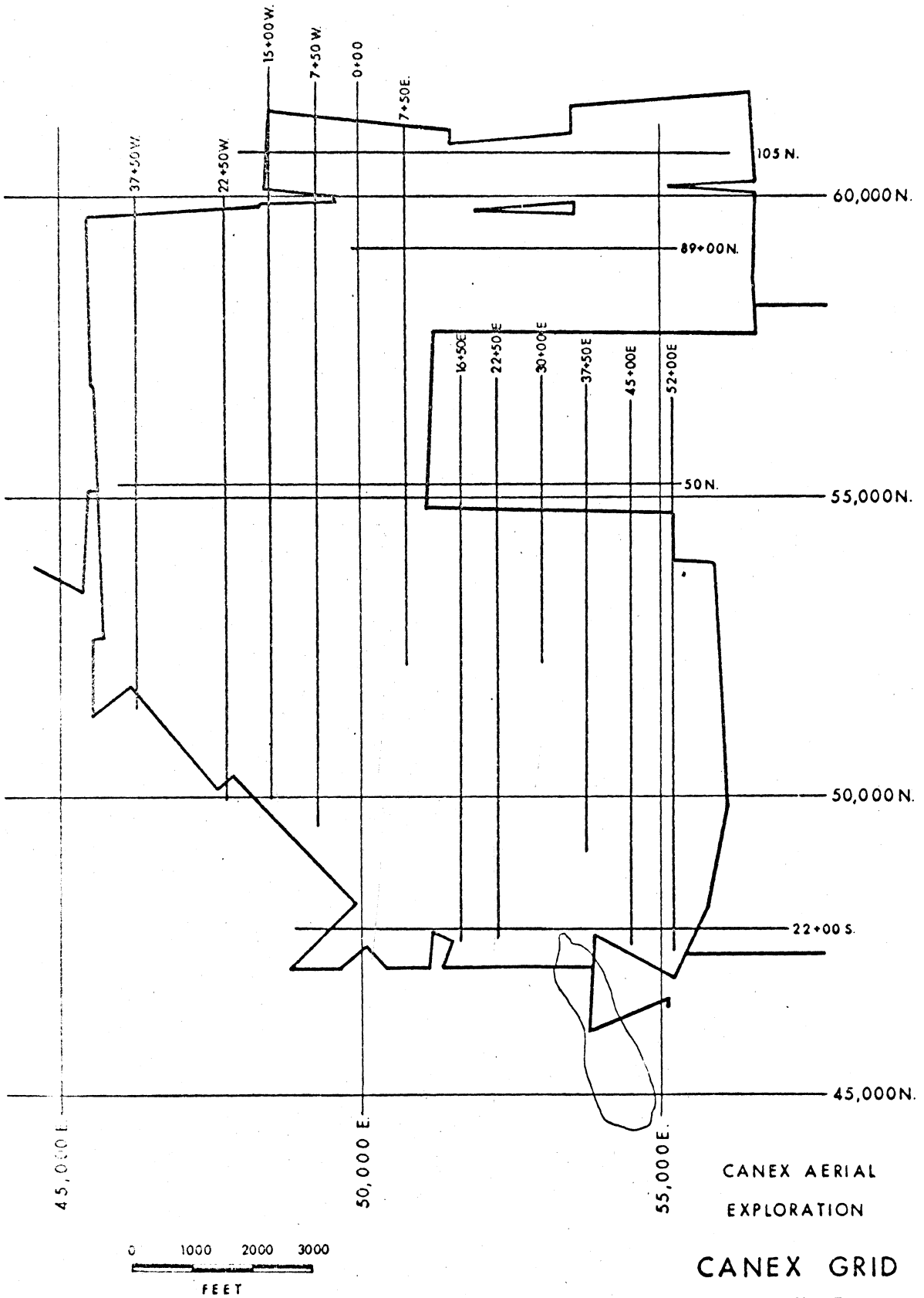

40,000 E
45,000 E
50,000 E
55,000 E
50,000 N.
45,000 N.
40,000 N.
35,000 N
30,000 N.
20 W.
0
20 E
60 E.
100 E.
160 E.
190 E.
0 1000 2000 3000
FEET
CANEX AERIAL
EXPLORATION
Mc PHAR GRID
ON THE
GIBRALTAR PROPERT

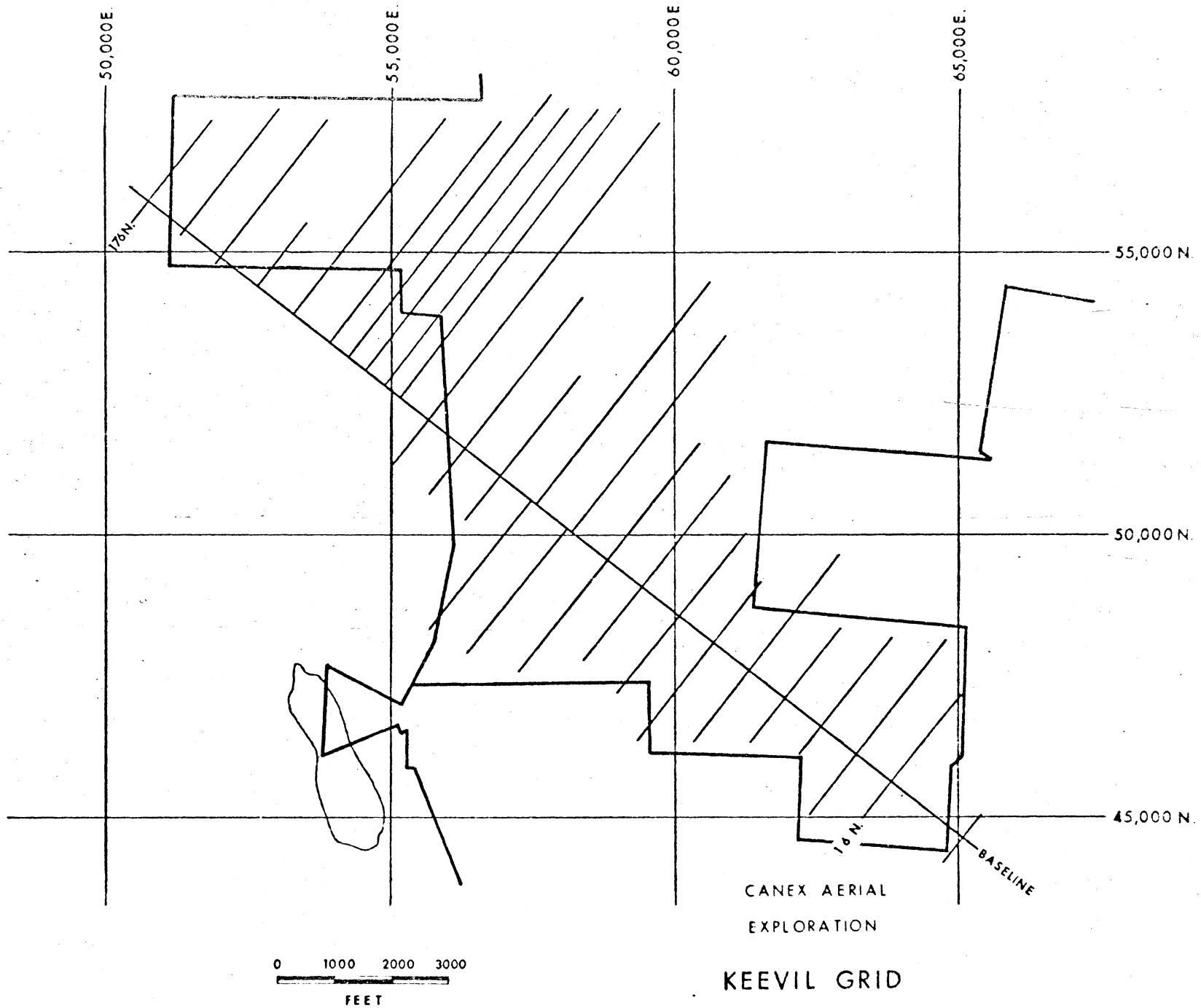
Figure 6.



CANEX AERIAL EXPLORATION

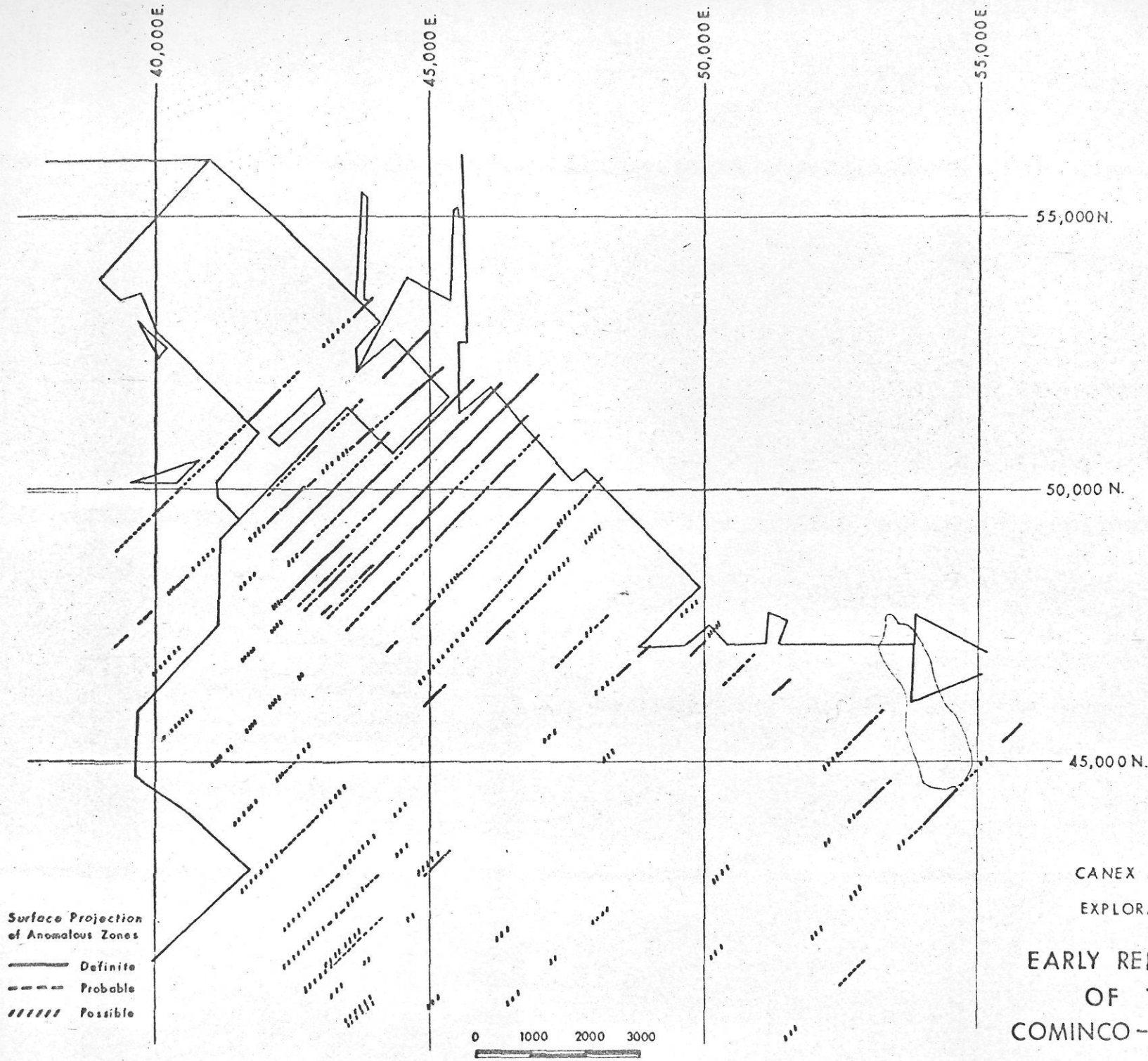
CANEX GRID ON THE POLLYANNA PROPERTY

Figure 7.



KEEVIL GRID
ON THE
KEEVIL PROPERTY

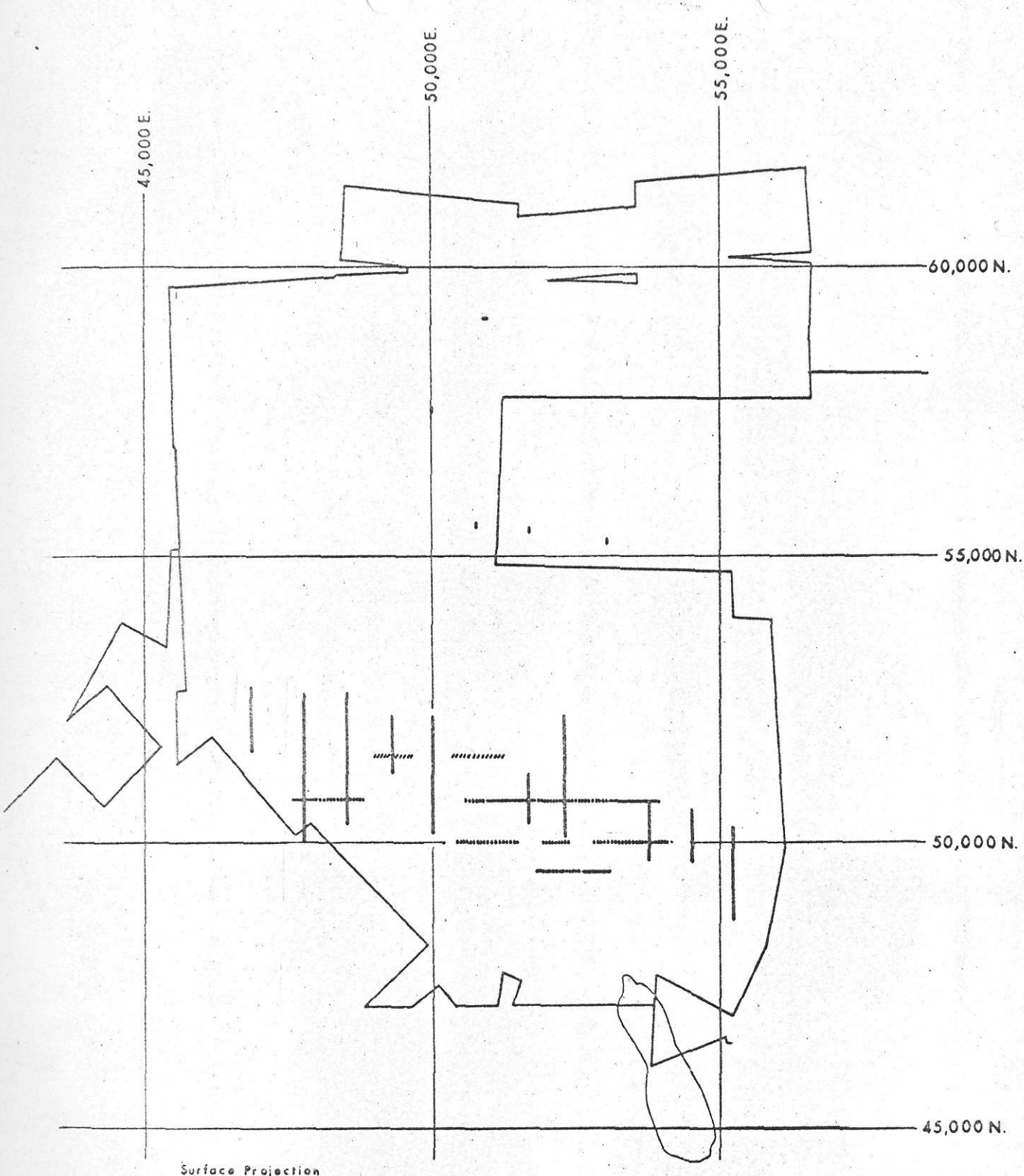
Figure 8.



CANEX AERIAL EXPLORATION

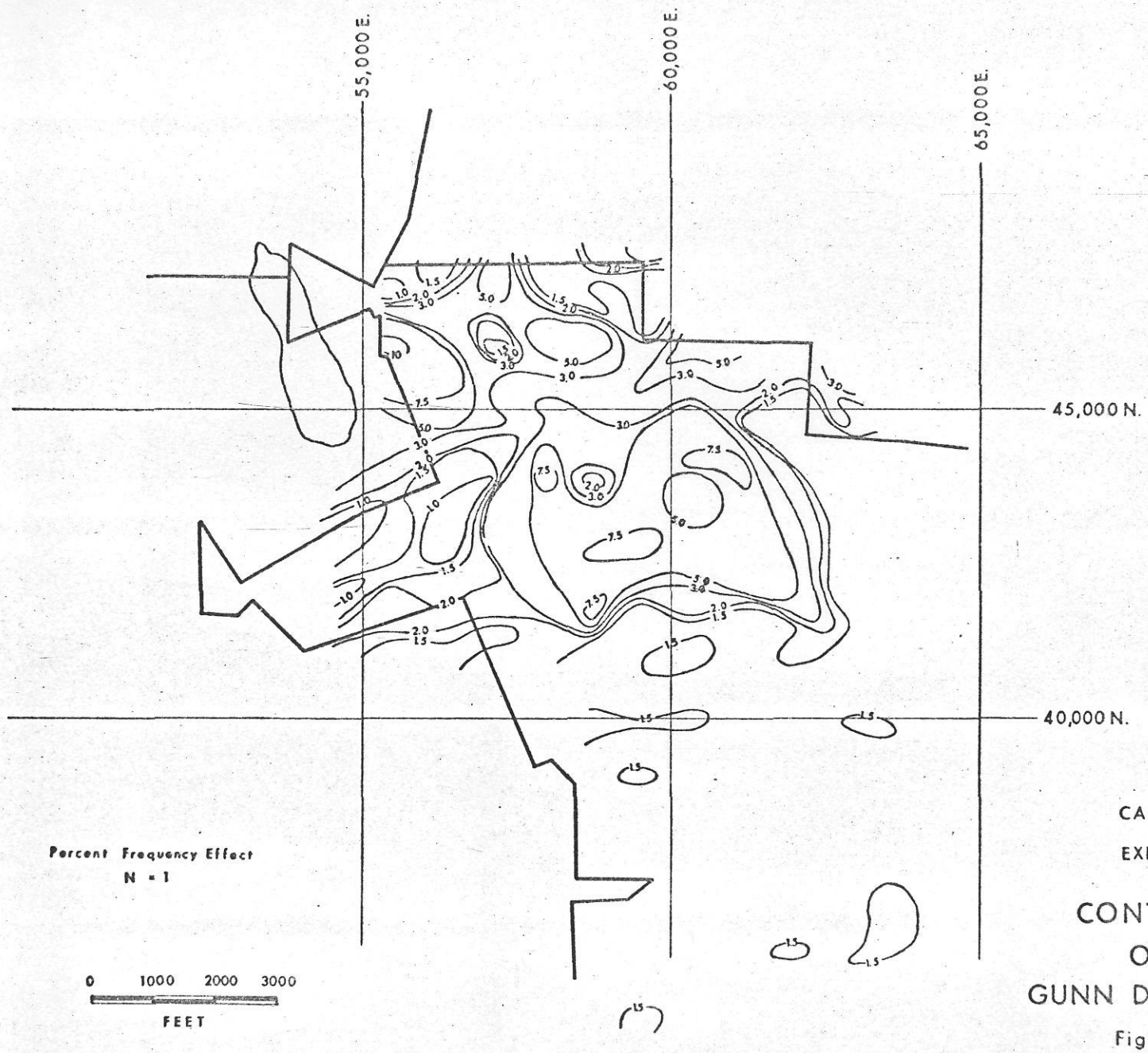
EARLY REPRESENTATION OF THE COMINCO-McPHAR DATA ON THE GIBRALTAR PROPERTY

Figure 9.



EARLY REPRESTATION OF THE CANEX-McPHAR DATA ON THE POLLYANNA PROPERTY

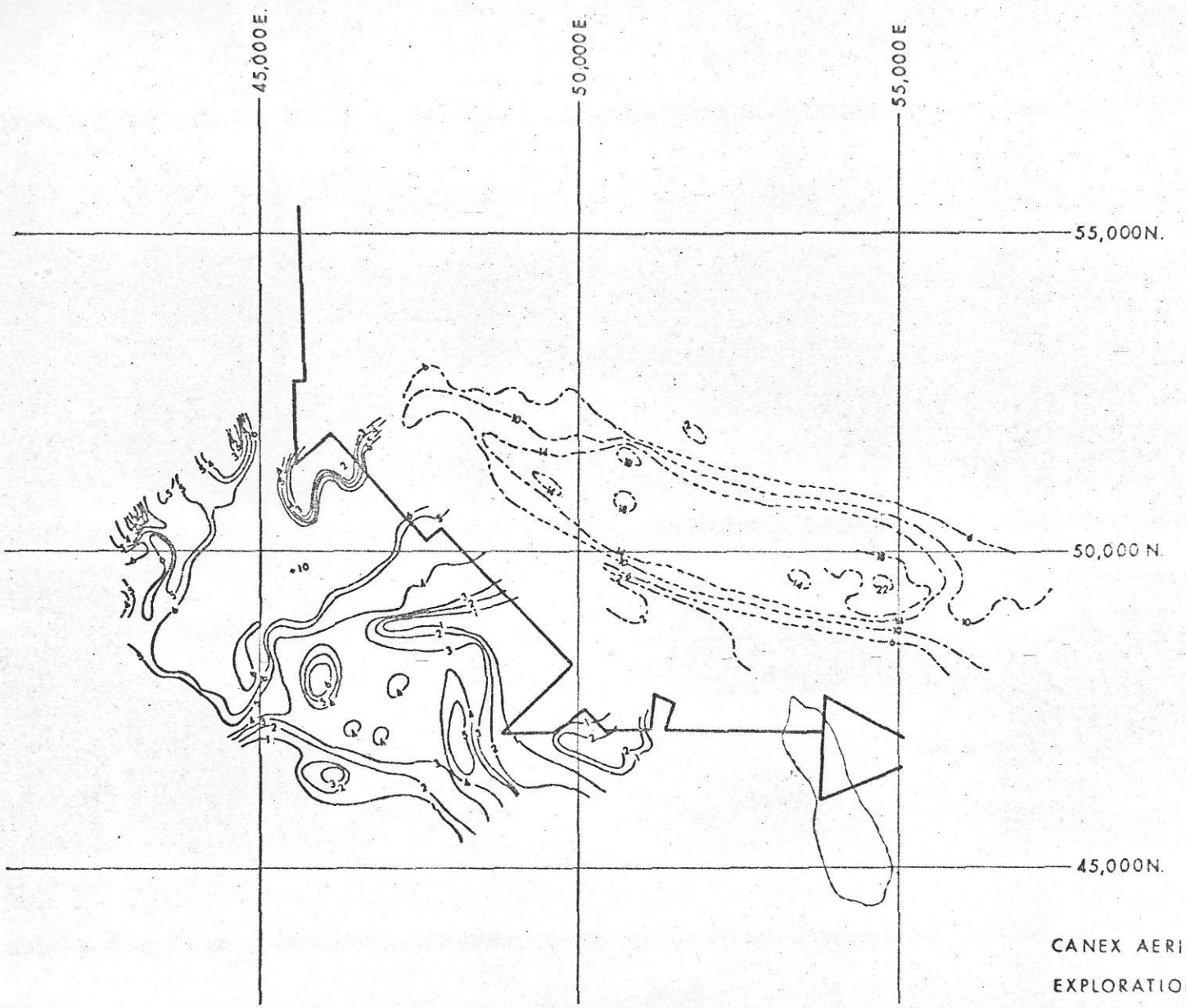
Figure 10.



CANEX AERIAL
EXPLORATION

CONTOUR PLOT OF THE GUNN DATA BY CANEX

Figure 11.



CANEX AERIAL
EXPLORATION

INITIAL ATTEMPT AT COMBING EARLY COMINCO - Mc PHAR-HEINRICHS DATA

Figure 12.

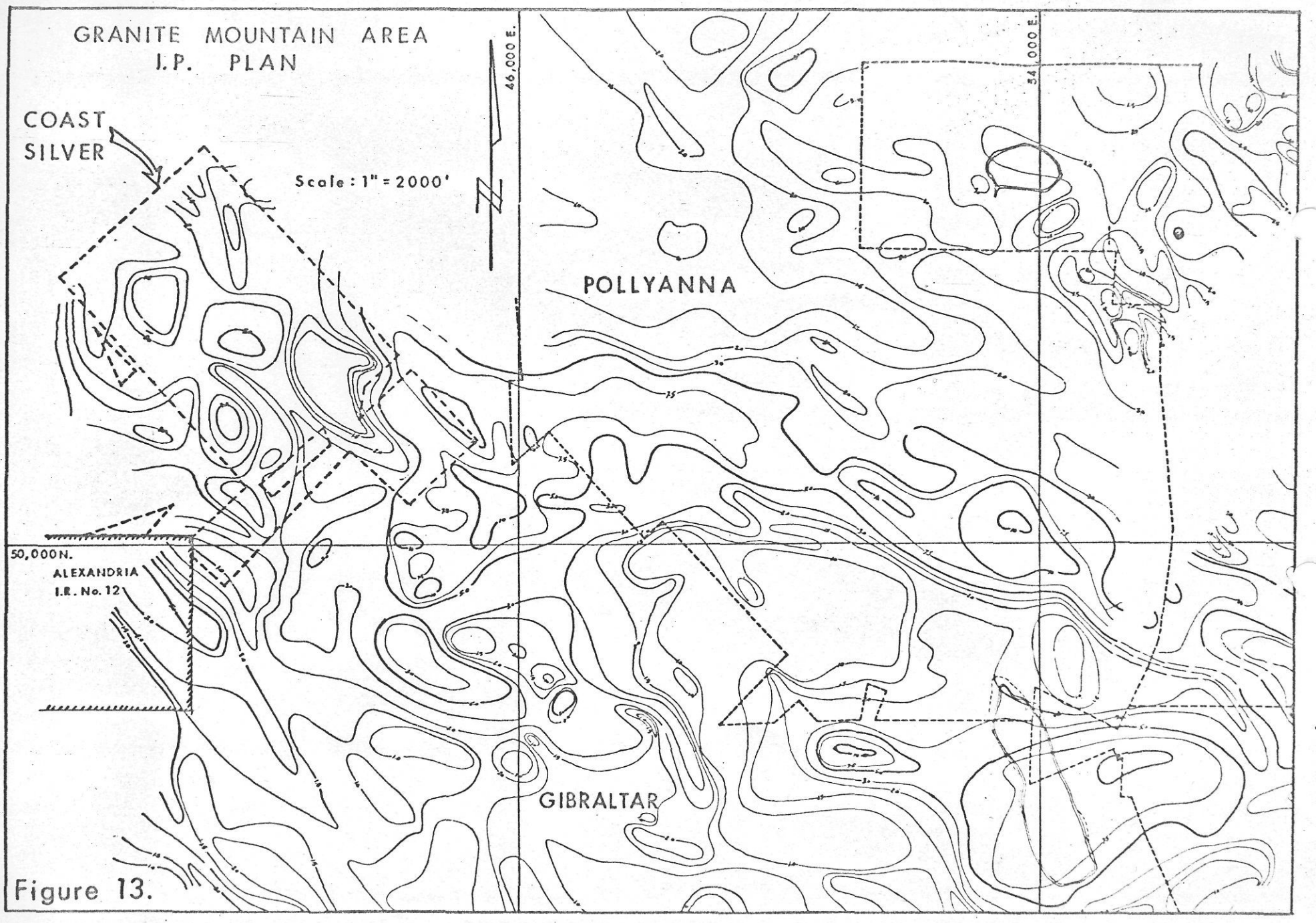
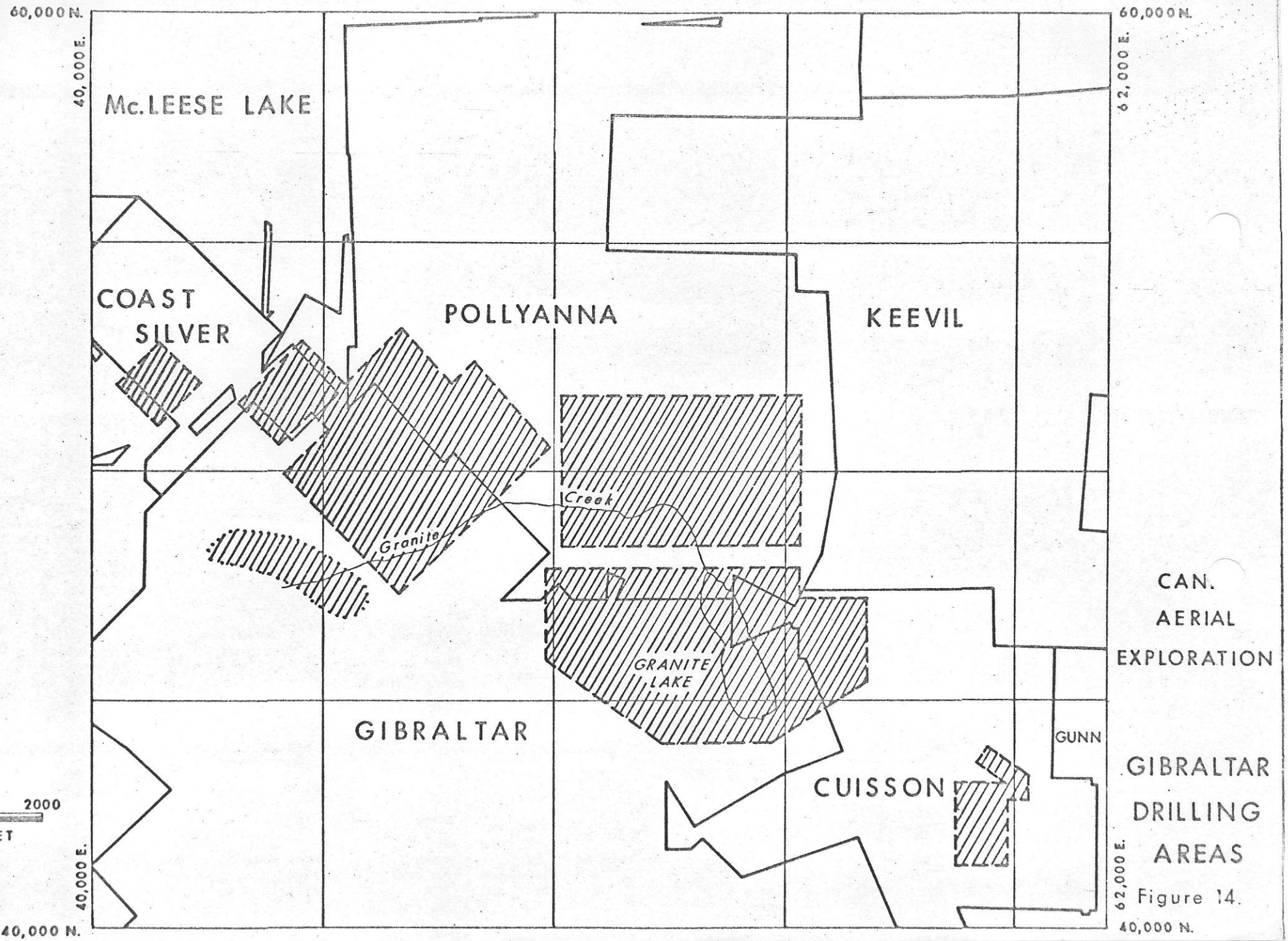

GRANITE MOUNTAIN AREA
I.P. PLAN
COAST
SILVER
Scale : 1" = 2000'
46,000 E.
34,000 E.
POLLYANNA
50,000N.
ALEXANDRIA
I.R. No. 12
GIBRALTAR

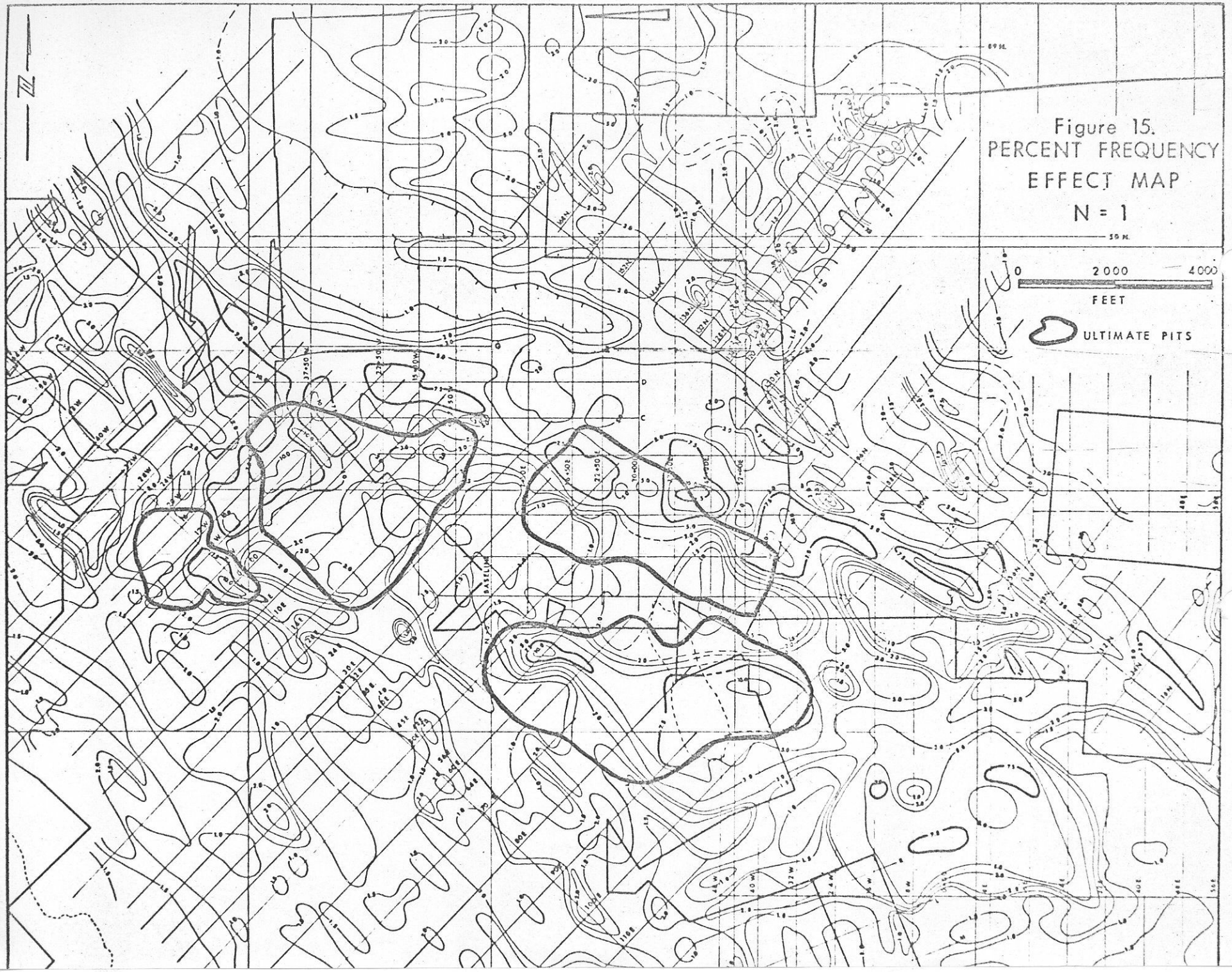
Figure 13.



CAN.
AERIAL
EXPLORATION

GIBRALTAR
DRILLING
AREAS

Figure 14.


N
Figure 15.
PERCENT FREQUENCY
EFFECT MAP
N = 1
0
2000
4000
FEET
ULTIMATE PITS

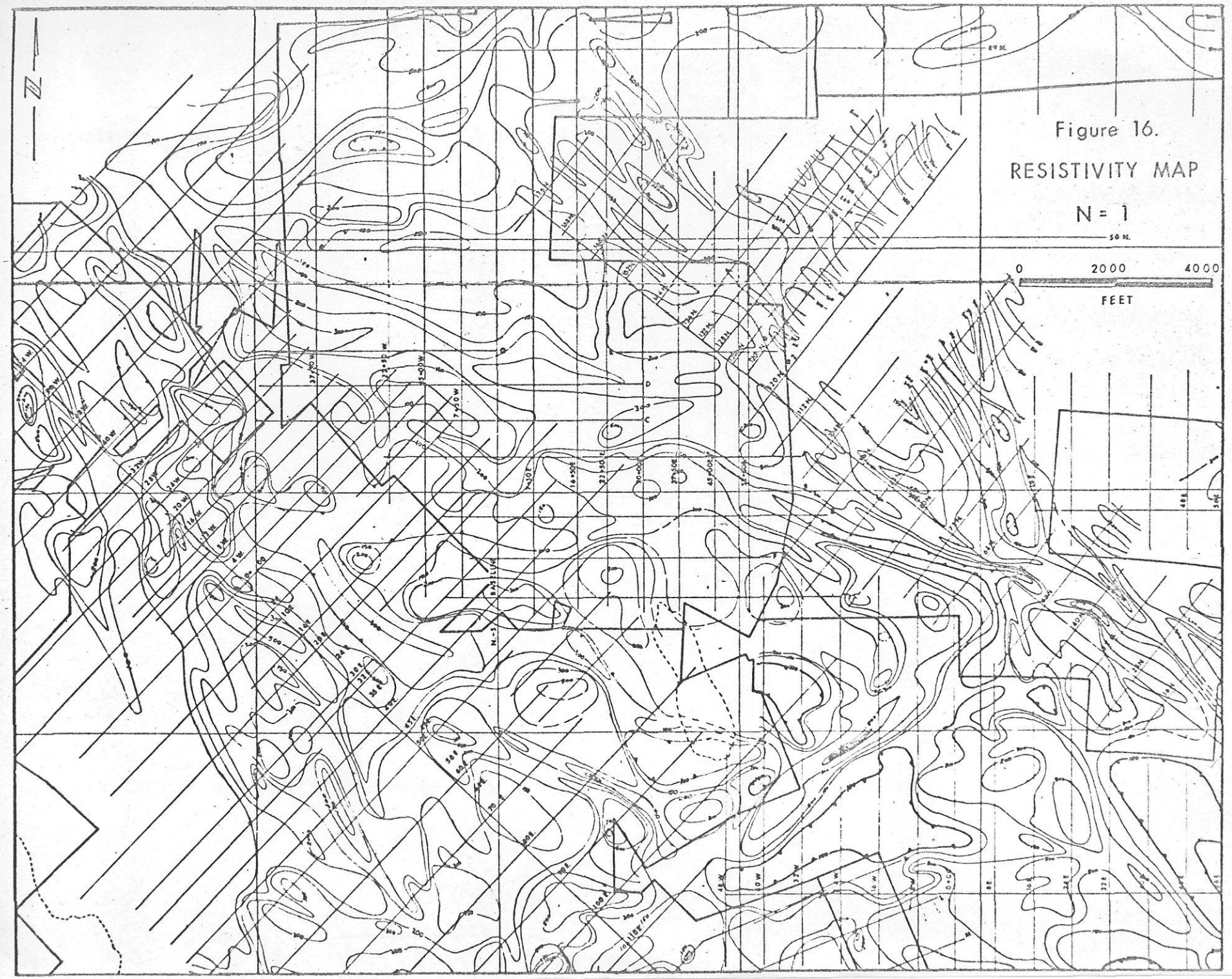


Figure 16.

RESISTIVITY MAP

N = 1

50 M.

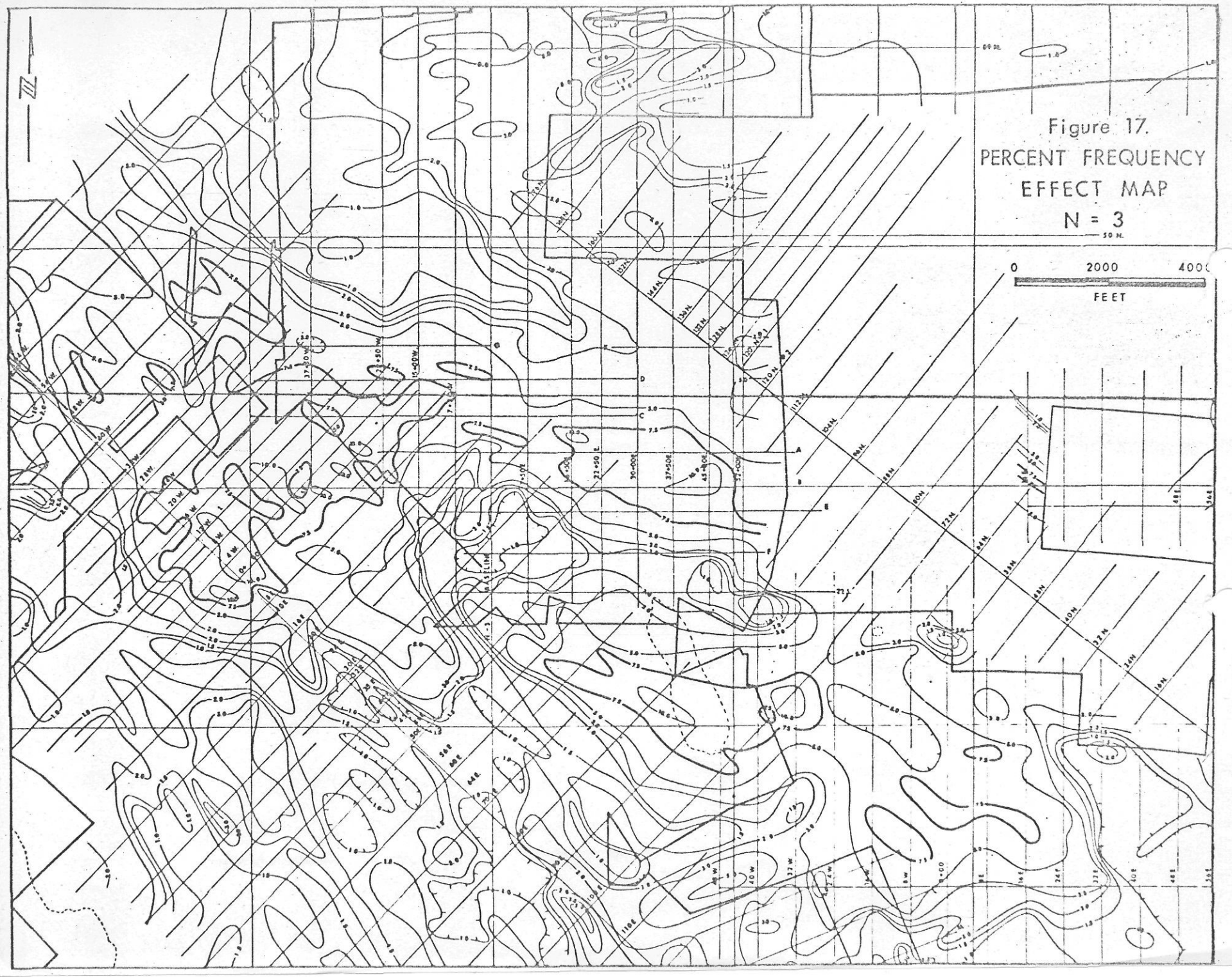
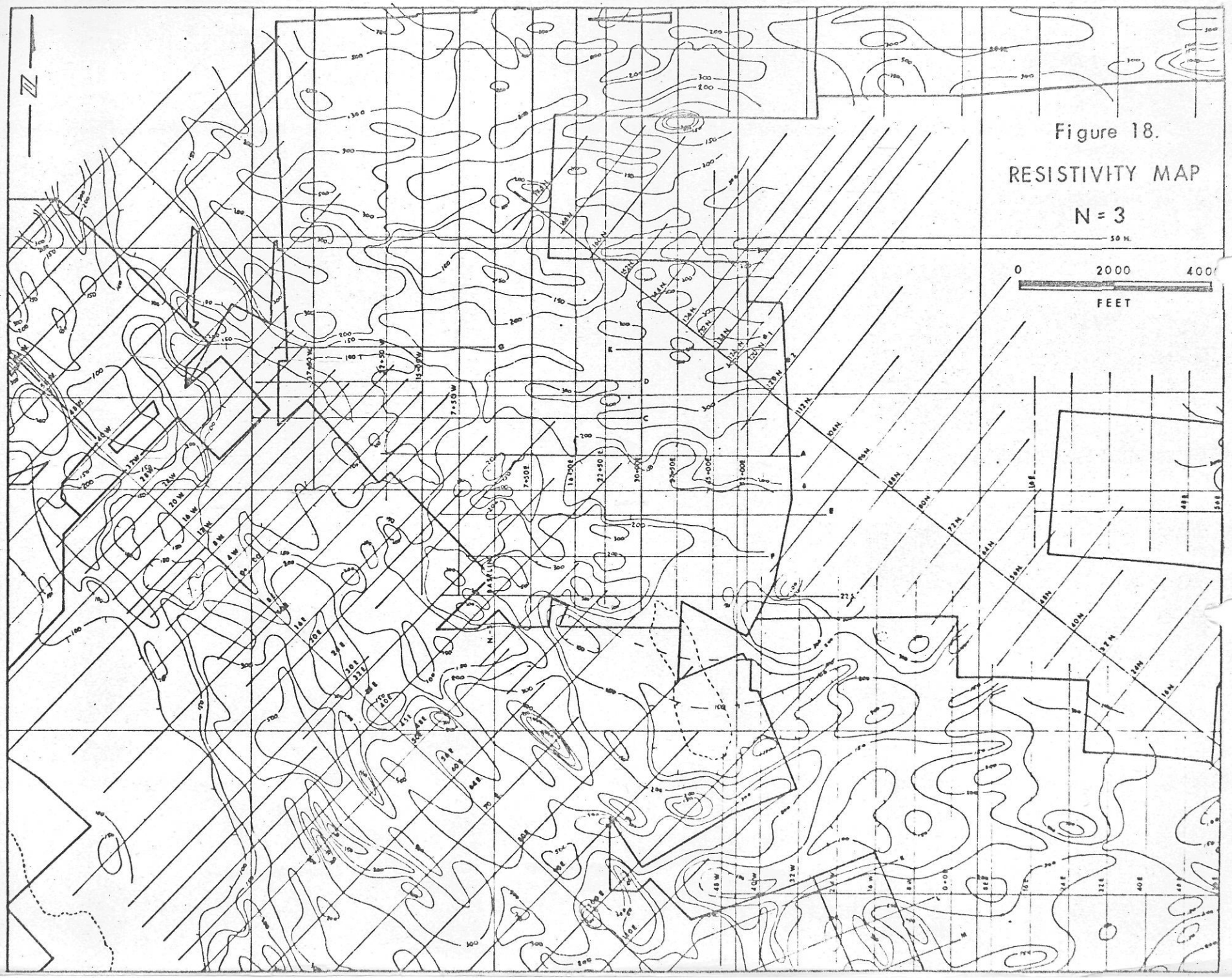


Figure 17.
PERCENT FREQUENCY
EFFECT MAP
N = 3
50 ft.
0
2000
FEET


N
Figure 18.
RESISTIVITY MAP
N = 3
0
2000
FEET