Ottawa

673-08-04-065

GRAVITY SURVEY

CLOVERLEAF, NORTHWEST TERRITORIES

Permit Numbers: 5382 & 5383

Project Number: 673-8-4-73-2

Report by

R. J-M. Weber January 1974

AQUITAINE COMPANY OF CANADA LTD.

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for

AQUITAINE COMPANY OF CANADA LTD.

Calgary, Alberta

Contractor

AIRBORNE GEOPHYSICAL SURVEYS LTD.

Calgary, Alberta

May 1973

R. B. Galeski
Airborne Geophysical Surveys Ltd.

R. J-M. Weber
Aquitaine Company of Canada Ltd.

SUMMARY

A gravity test has been performed over two seismic lines shot across the Silvan Plateau anticline.

Rugged mountainous topography outruled further detail study of this anticline by seismic methods. Therefore, in an attempt to improve the outline of the subsurface of this anticline, path of the axis and trace of postulated faults, an airborne gravity survey was planned.

However, before committing to a systematic gridded airborne survey, Aquitaine tested the feasibility and chances of success of this method in checking on two seismic lines, if there were a good relationship between the gravitational changes and the seismic structure.

Interesting results were obtained, however it also appeared that, due to the lack of accurate topographic controls outside the surveyed profiles, adverse "terrain effects" which might mislead the interpretation could not be sufficiently removed. A decision has then been taken not to further carry on with the planned airborne gridded survey.

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INTRODUCTION

The Cloverleaf area is 70 miles due south of Ft. Norman, N.W.T., centred at about latitude 63°53'N and longitude 125°30'W (Fig. 1, Location Sketch). A seismic programme had been completed in here previously. In an effort to expand the seismic interpretation, it was decided to meter the shotpoint locations on two of the lines and look for a relationship between gravitational changes and seismic structure. Should an interpretational relationship exist, it was then planned to complete a large, gridded airborne gravity survey throughout the area.

FIELD OPERATION

On May 21, 1973, operator M. McCombe was sent to Norman Wells with a G-model LaCoste and Romberg meter and auxiliary equipment to conduct the survey of the two seismic lines. He was stationed at Norman Wells and flown daily to the area of the work by United Helicopters. Procedure was to move along the lines on foot, taking meter readings at shot hole tags. Elevations determined in the course of the seismic survey were used later in making Bouguer corrections.

The work was completed in the field on May 22, 24, 25, and 26. May 23 was a weather day and May 27 and 28 were travel days for the return to Calgary. 85 stations were metered, covering approximately 13 miles of seismic line.

REDUCTION OF THE GRAVITY DATA

Latitude corrections were applied to each drift corrected station value on the basis of the formula: $K = 1.307 \sin 2 \emptyset$, where K is the rate of change in milligals/mile and $\emptyset$ is 63°53' (central latitude of the area).

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Bouguer and free air corrections were made with an elevation correction factor of 0.061 (surface density of 2.6). No density profile had been run, and this factor was chosen because of reports of high density surface materials. However, the factor appeared to be too low. When results were plotted, it was apparent that there was an inversion to topography. Therefore computations were repeated with a factor of 0.065 (surface density of 2.3) and much of the topographic effect was removed. Both sets of Bouguer values have been plotted in profile form, and these profiles accompany this report (Pl. 1a, 1b, 2a, and 2b). In addition, the 0.065-corrected and smoothed Bouguer values have been plotted on a map of the area (scale: 2" = 1 mi.) and tentatively contoured (Pl. 3).

Terrain corrections: In this area, the terrain in the vicinity of the gravity station is often far from being flat. Sharp rises, hills, and often cliffs are encountered. Unfortunately, adequate elevation data are not available for proper correction.

However, two attempts were made in order to appreciate the "terrain effect":

- Model a: infinite cylinder approximation: It was assumed that elevation in circle segments perpendicular to the seismic lines at each shotpoint was equal to that of the shotpoint itself. For segments on the line the measured shotpoint elevations were used. Differences between on-line segments and lateral segments were pro-rated among the intermediate segments. Terrain effects, computed in this manner were minimal in the "G" and "H" circles on test.

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Therefore, computations were made out to the "F" circle only. These terrain-corrected Bouguer values are plotted on the 0.065 profiles.

- Model b: In a very localized area (line 13, SP 120), a better knowledge of the shape of the terrain is available (reconnaissance on a proposed drilling location). The following model was constructed: a downward slope of the 20° to 40° to the north, west, and south of shotpoint 120 and a downward slope of 10° to the east of shotpoint 120, as well a cliff, 120 feet in height, was located 60 feet northwest of shotpoint 120.

Based on this model and the 1/250,000 topographic map of the area, the terrain effect corrections were calculated using Hammer charts. It was found that in this area the terrain corrections could range from 3.60 to 5.25 milligals.

INTERPRETATION

A strong Bouguer positive (apex between shotpoints F126 and F128, line 13) of 2.8 mgals amplitude has been tentatively correlated with a broader feature of the similar amplitude at F29 on line 11. Gravitational plunge to the northwest is indicated. A smaller positive (0.5 mgal.) is present at the southwest end of line 11. At the northeast end of line 12 a large (3+ mgals) positive is probably present, as in the case of the 0.5 mgal feature, line 12 is too short for proper evaluation.

The 2.8 mgal positive has been given a <u>two-dimensional residual extraction</u> of lines 11 and 13. It has the appearance of a broad anticline or a horst. Assuming a 0.2 density contrast, one can compute 1100' relief

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and a depth to top of causative mass of about 2000' subsea on line 11. The potentially larger feature on the northeast end of line 12 may have 1300' relief under the same assumptions. Seismic line 11 is a broken confused picture which is neither comparative nor contrasting to the gravity profile.

Seismic line 13 had a strong reversal at shotpoint 120. Principal reflecting band indicates about 3100' northeast dip from 200' subsea at the apex to 3300' subsea at SP 90. A gravity positive peaks at SP 126 - about one mile southwest of the seismic high. Using the same density contrast as before, 0.2, we can compute 1100' causative mass relief here, as on line 11. However, top is at 1200' above sea level. If there is a common causative mass on lines 11 and 13, we have 3200' plunge from line 13 northwestward to line 11. This is consistent in direction with the Bouguer drop between the two lines.

Were we to use a 0.07 density contrast in the previous calculations, the depth to top of causative mass would change from 2000' subsea on line 11 to 900' subsea and from 1200' above sea level to 1200' above sea level on line 13. In either case, it is apparent that the principal source of the gravity anomaly is shallower than the main reflecting band on seismic line 13. Furthermore, a density contrast of 0.07 would yield relief comparable to the seismic relief noted on line 13.

It is noted that the seismic apex (SP 120, line 13) is a topographic high. Furthermore, the sides of this high are steep (600' ±/mile). It yields a local coincident gravity low of 1.5 mgals which has been ignored in the above discussion. The presence of the low strongly

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suggests that either a thick section of light surface material is present between shotpoints 116 and 123 or that this anomaly is caused by terrain effect (see "Model b" discussion in "terrain corrections").

In an attempt to discover what density material would be required to remove this gravity low, Bouguer corrections were calculated for densities of 2.0 gm/cc and 1.85 gm/cc. It was found that a density of 1.85 gm/cc did remove this gravity low. However, this density appears probably too low for the rocks in this area. (Imperial formation outcropping. Candex et al. DAHADINNI M43A, density log shows in same formation, densities ranging from 2.6 to 2.65). Most of this abnormal gravity low is thought mainly due to terrain effect.

CONCLUSION

The results of this test showed that although a relationship between gravitational changes and seismic structure was apparent, the effect of the rugged topography which is uncontrollable without an extensive surveying can be detrimental and misleading to the interpretor. Therefore, it was decided not to carry on with the planned large gridded airborne gravity survey.

RESPECTFULLY SUBMITTED,

AQUITAINE COMPANY OF CANADA LTD.

R. J-M. Weber
Senior Project Geophysicist

REVIEWED AND APPROVED:

D. G. Aubin, Chief Geophysicist

126° 00'

125° 00'

64° 00'

63° 30'

RIVER

Redstone River

Wrigley Lake

Canol Declin Stewart
B-30

Decalta et al Keele R.

Amoco et al Red Dog
K-29

Decalta Dome Keele S
A-28

Imp Red Stone #1
J-42

Decalta cs Mesa Redstone
P-78

P-5383

P-5382

P-5380

P-5381

P-5379

P-5378

P-5377

P-5376

P-5443

W-6

W-7

W-3

W-2

Shell
I-46
Cloverleaf

O-G-51

12
11
10
9
8
7
6
5
14
13
2
1
25

GRAVITY PROGRAM

SEISMIC LINES

FIG. 1

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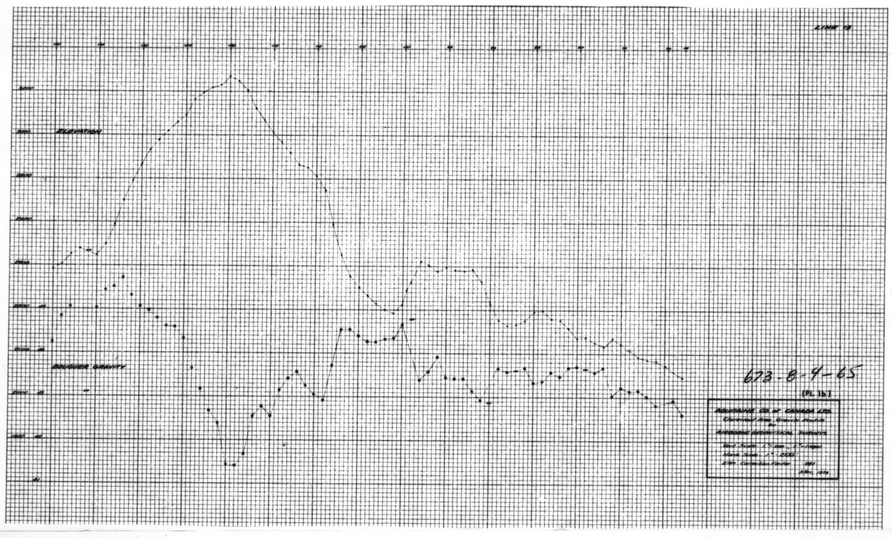
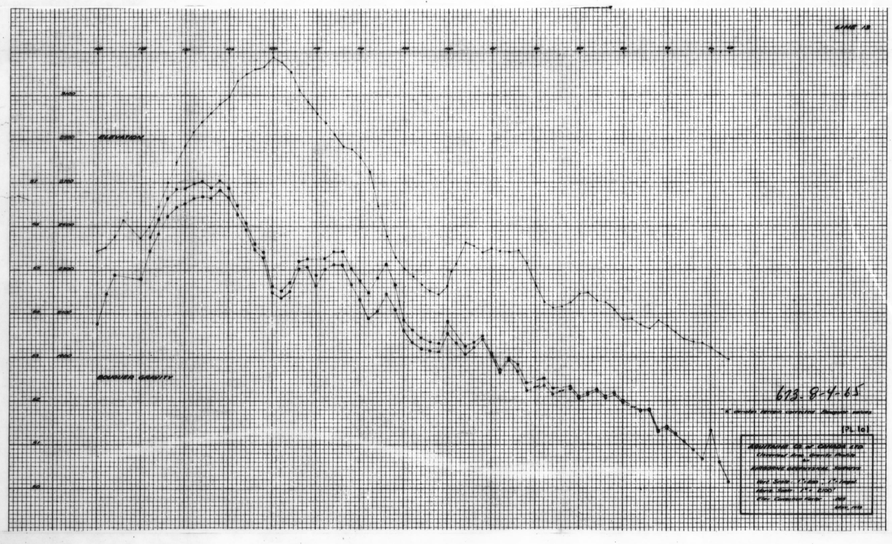
CLOVERLEAF AREA
NWT
LOCATION SKETCH





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