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GEOPHYSICAL REPORT
1982 SEISMIC & GRAVITY
SURVEY IN SAATCHI'S CREEK AREA
PROJECT 246-06-05-81-06
PETRO-CANADA

Canada Oil and Gas Lands
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GRAVITY STRUCTURE INTERPRETATION MAP, GRAVITY BASE MAP

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CAMP ROUTE MAP
FUEL ROUTE MAP
GRAVITY MODEL SECTION (4)

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<u>7X</u>	_____	_____	_____
<u>11X</u>	_____	_____	_____
<u>17X</u>	_____	_____	_____
<u>23X</u>	_____	_____	_____
<u>25X</u>	_____	_____	_____
<u>34X</u>	_____	_____	_____
<u>35X</u>	_____	_____	_____
<u>40X/50X/100X</u>	_____	_____	_____
<u>41X</u>	_____	_____	_____
<u>45A</u>	_____	_____	_____
<u>46X/70X</u>	_____	_____	_____
<u>52X/54</u>	_____	_____	_____
<u>103X</u>	_____	_____	_____
<u>105X</u>	_____	_____	_____

PROJECT ACTION SHEET

RESOURCE EVALUATION BRANCH

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REPORT TITLE: *Simmons Creek*

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Reports and maps date-stamped

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John O'Bester Feb 3rd/1984

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SAMMON'S CREEK GRAVITY DATA
INTERPRETATION
OF 1982 FIELD PROJECT.

(Report for N. Alta Region, Mainland Canada Division.)

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TECHNICAL SERVICES DEPARTMENT
PETRO-CANADA
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Scale 1:100,000

- PLATE 1. INDEX MAP of Sammon's Creek area. Index map shows the location of seismic lines along which the gravity metering was done. The line numbers on the map correspond to the actual seismic line names as line number 100+X = seismic line name. Example. line number 156 = 56X (line name) line number 207 = 107X (line name). Shot points locations are indicated by numbers and ticks.
- PLATE 2. BOUGUER GRAVITY MAP of Sammon's Creek area, scale 1:100,00. Map shows the contoured Bouguer anomalies. Contour interval 0.5 mgal. Survey lines are also shown and their numbers can be retrieved by comparison with the index map. Note: the survey lines on this map are shown as straight lines connecting the first and last shot points of actual seismic lines.
- PLATE 3. RESIDUAL GRAVITY MAP of Sammon's Creek area, scale 1:100,000. Map shows the residual Bouguer anomalies obtained as difference between observed Bouguer anomalies and Bouguer anomalies, continued up 2 km. Contour interval 0.5 mgals.
- PLATE 4. STRUCTURAL INTERPRETATION MAP of Sammon's Creek area, scale 1:100,000. Map shows the integrated results of interpretation of gravity data: folds, faults and approximate contours of the top of carbonate formation. Map can be compared with BOUGUER GRAVITY MAP and RESIDUAL GRAVITY MAP by matching the coordinates along the boundaries.
- SECTION 1. LINE 107X, MODEL 1, scale 1,50,000 - simplified geological cross-section, showing the geological formations, their density, the total gravity effect and observed gravity profile along seismic lines.
- SECTION 2. LINE 107X, MODEL 2, the same as for line 107X, model 1.
- SECTION 3. LINE 36X, MODEL 1, the same as above.
- SECTION 4. LINE 36X, MODEL 2, the same as above.

I. INTRODUCTION

Petro Canada contracted a detailed gravity survey in Sammon's Creek area which was run simultaneously with seismic shooting and along seismic lines. The main goals of survey were to confirm the interpretation of seismic data, to support correlation between seismic profiles and provide additional structural and lithological information.

The distribution of gravity data was determined by outlay of seismic program. The latter did not always satisfy the requirements of potential field measurements. On average, the density of observation along profiles relates to the distance between them was 1:24. Nevertheless, we were able to compile the contoured gravity map, thanks to the nearly consistent spacing between lines and their orientation across the general strike of gravity anomalies.

II. DATA ACQUISITION

II.1. Base Network.

The observed gravity at Government Station #8549-59 (Norman Wells airport terminal) was tied with the initial base station at SP 854 of line 46X by double helicopter ties with average accuracy of $\pm 0.01 - 0.02$ mgal.

The further development of base network was accomplished by "step-by-step" method, where each previously set base was used as the reference for the next one. Theoretically speaking, this method inevitably leads to accumulation of errors and must be used, only if it is technically impossible to use "radial" method, when each base is tied with a main base by independent ties. Actual RMS error of base network in our case doesn't exceed ± 0.06 mgal, which lies well within required limits. However, such good accuracy can be considered as a matter of luck, because the last base wasn't tied back to Norman Wells (the loop was actually closed on one of the first bases close to the initial base at SP 854, line 46X). There were twenty-eight bases altogether. Usually they were located and temporarily fixed at seismic lines intersections. After clean-up it will be rather difficult to find their exact position, and practically speaking, they can't be used again.

II.2 Gravity Meters.

One LaCoste & Romberg gravity meter No. G-232 was used for the entire survey. The sensitivity function of the meter within range of measured anomalies was practically flat, so one conversion constant C-1.05526 was used. Typical drift was no more than 0.005 mgal per hour. The meter worked very steadily even when the thermostating eventually went down.

II.3 Gravity Measurements

The gravity survey was carried out by Airborne Geophysical Survey Ltd. (Calgary) during the months of January - May, 1982 (operator - M. McCombe). The following are the principal facts about survey:

Reading interval - 264 m (each second shot point).

Number of independent readings at each station - 3.

Method of meter setting - on tripod, with measuring the elevation above ground.

Total number of stations metered - 3146.

Total number of lines - 50.

Total distance covered - 370.31 km.

RMS accuracy of single observation - 0.022 mgal. (100 check points)

Cost (\$)

a) total	\$38,431.
b) per km	\$ 44.15
c) per station	\$ 12.22

II.4 Vertical Control

Western Geophysical Survey Ltd. carried out both the elevation and horizontal survey. Elevations were provided to operator with significant delay in time, so no gravity reduction was done in the field. The survey specs required the closure to be no more than 0.9 meters. We estimated the final accuracy of survey by RMS error of misties at intersections, which provides an independent and exhaustive control. Such a statistic shows (Appendix 2) that RMS error of misties reaches ± 1.20 meters, which is above the specified limits. Fortunately enough, it doesn't affect the accuracy of gravity data, as it follows from statistics, but, given the same contractor in the future, we shall pay more attention to the quality of vertical control.

II.5 Horizontal Control

The accuracy of horizontal control lies well within the specified limits. However, the positioning for Sammon's Creek survey was presented in inconvenient form: X and Y coordinates were given only for the start and end points of lines and for inflection points in-between. It slowed down the in-house processing, because we had to write a special program for linear interpretation to obtain coordinates for each shot point.

II.6 Accuracy and Data Quality.

The accuracy of Bouguer gravity, as a final product of any survey, is affected by accuracy of each variable, involved in calculation of Bouguer anomaly:

- 1) observed gravity
- 2) elevation
- 3) positioning
- 4) terrain and tidal corrections.

$$E(\text{Bouguer}) = \pm \sqrt{E^2(\text{obs-gr}) + E^2(\text{elev}) + E^2(\text{pos}) + E^2(\text{ter}) + E^2(\text{tide})}$$

where E = RMS error.

Accuracy of observed gravity is affected by the quality of base network and systematic and random meter errors. Accuracy of single observations, calculated from double observations, gives a good estimate of E(obs) and in our case is close to 0.02 mgal.

Elevations, as stated above, are known with accuracy of ± 1.2 m. Using the vertical gravity gradient of 0.3086 mgal/m, such an error will provide uncertainty in gravity observation of ± 0.37 mgal in Free air anomaly and approximately + 0.27 mgal in Bouguer anomaly.

Errors in horizontal positioning about 1-2 m have negligible effect on gravity calculations.

Terrain corrections were applied only to observations made at very rough terrain and comprise less than 1% of stations. The accuracy of terrain corrections is difficult to estimate, but we believe that errors don't exceed 0.08 mgal in inner zone of Hammer's chart.

Tidal effect is calculated with high precision and need not be taken into consideration when evaluating errors. Finally we can expect the accuracy of survey to be no worse than:

$$\begin{aligned} E_{\text{obs}} &= \pm 0.02 \text{ mgal} \\ E_{\text{elev}} &= \pm 0.27 \text{ mgal} \\ E_{\text{terr}} &= \pm 0.08 \text{ mgal} \end{aligned}$$

$$\text{and } E_{\text{Bouq}} = \pm \sqrt{(0.02)^2 + (0.27)^2 + (0.08)^2} = 0.0797 = \pm 0.28 \text{ mgal}$$

Actual accuracy was estimated by our processing of RMS errors of Bouguer anomalies at intersections and is given in appendix 1. Statistics show that actual RMS error before systematic adjustments is ± 0.25 mgal, which is very close to what we previously estimated. Systematic adjustments improved the accuracy significantly up to ± 0.13 mgal. The last figure indicates very good quality of survey. With such an accuracy, the anomalies of order of 0.3 mgal can be considered as real. Contouring interval of 0.5 mgal can also be statistically justified.

III. DATA PROCESSING

The data processing included the next major steps:

1. Interpolation of X and Z coordinates and hand input of all pertinent information (lines and stations numbers, coordinates and elevations, observed gravity).
2. Calculation of Bouguer anomalies with density 2.35 g/cm^3 for each line (appendix 1)
3. Merging the line data into the Merged Survey File (MSF).
4. Low-pass filtering of Bouguer profiles.
5. Calculation of intersection statistics.
6. Systematic adjustment of all the data.
7. Plotting of the index map, contour maps and all the profiles.
8. Indexing the gravity data.

The package of final processed data includes:

- a) Gravity profiles along seismic lines at a scale of 1:50,000 (Previously sent to Regions).
- b) Index map (shows the location of seismic lines). Scale 1:100,000 (plate 1.)
- c) Bouguer gravity contour map with contour interval 0.5 mgal. Scale 1:100,000. (plate 2)

IV. INTERPRETATION.

IV.1. General features of gravity field.

Visual analysis of the Bouguer gravity map reveals rather distinct and strongly disturbed gravity field in the area. Absolute values of gravity field vary from -82 mgal to -52 mgal with relative change about 30 mgal over the distance of about 25 km.

The major elements of the gravity field in the surveyed area are:

- deep gravity low in northern - central part (NE end of line 119X) with the lowest values of Bouguer gravity about -82 mgal.
- strong gravity high in western - central part (SW end of line 23X, NW end of line 35X) with maximum g value of -52 mgal, separated from gravity low by latitudinal linear high gradient zone; this high consists of two weaker linear highs, separated by linear negative anomaly; these weaker highs are far apart at the east and come closer westward, merging together west from line 23X.
- several transverse high gradient zones of NNW and NNE strike, almost normal to the prevailing trend; the most significant ones are located east from line 119X and east from 107X.

East - west orientation of major elements prevails in the area. Only at very east and south-east one can see the gradual deviation to the S.E.

IV. 2. Geological background and density determination.

The stratigraphic sequence of geological formations and their lithology in the area can be determined from several wells drilled in the vicinity.

Surface geology of well-exposed Franklin mountains and other adjacent areas also provides abundant geological information.

The generalized stratigraphic column in Samson's Creek area, from the bottom to the top, looks as follows:

1. Procrmbrian. (Middle-Upper Proterozoic) - A thick sequence, apparently unbroken by unconformities, of quartzites, sandstones and shales, which form the major stratigraphic unit - Katherin Group of Helikian age. Dolomites and limestones of the Little Dal formation may be present at the very top of Proterozoic section.
2. Lower and Middle Cambrian. - Shales, sandstones, siltstones and limestones of thin (less than 100m) Mount Cap formation unconformably overlay the Proterozoic units.
3. Upper Cambrian - Saline River formation. This is a recessive unit characterized by gypsiferous shales, siltstones, mudstones and evaporites. The normal thickness is about 100m but this may change drastically in areas of salt accumulation. Contact with underlying Mount Cap formation is erosional.

4. Upper Cambrian - Lower Ordovician - Franklin Mountain formation - a thick sequence of carbonate strata, mostly dolomites. The formation lies conformably on Saline River red beds, where they are present, and with a regional unconformity on pre-Saline River formations where the latter is absent. The thickness of Franklin Mountain formation may reach 1000m.

5. Ordovician - Silurian The typical unit is known as Mount Kindle formation. It consists mainly of dolomites with overall thickness of 300-400m.

6. Silurian - Devonian. - is represented by thick concordant (about 1000m) sequence of dolomites (Delorme formations) or dolomites with anhydrite (Bear Rock formation). The latter formation alone has a typical thickness about 250-350m.

7. Devonian - includes limestones of Hume, Ramparts (or Kee Scarp) formations and shales of Imperial formation.

8. Cretaceous - marine and non-marine classic rocks.

As far as gravity interpretation is concerned, this stratigraphic sequence can be further generalized by combining stratigraphic units into lithological units of roughly uniform density. From this point of view the lithological column will look as follows: (from the bottom to the top)

1. Proterozoic clastics, (Katherine group)
2. Cambrian clastics and evaporites (Mount Cap and Saline River)
3. Ordovician - Devonian dolomites and dolomites with evaporites (Franklin Mountain, Mount Kindle, Delorme and Bear Rock formations).
4. Devonian limestones (Hume, Hare Indian, Ramparts)
5. Devonian clastics (Imperial formation)
6. Cretaceous and younger clastics.

Acoustic log from three wells drilled in the vicinity was used for density determination in the Sammon's Creek area. Those wells are:

1. AQUIT MOBIL AMHES DODO CANYON (65°02' 33.36"W, 126°46.13'96"W)
2. TRIAD BP ARCO CC CAROLJOU L-24 (65°33'34"W, 128°50'20"W)
3. McD CAN GCD MAIDA CK F-57 (65°36'17"W, 128°10'36"W)

The results of density study is shown in table 1.

Table 1.

Formations	Thickness (m)			Density g/cc		
	1	2	3	1	2	3
Cretaceous	800	-	>200	2.45	-	2.35
Imperial	840	930	360	2.50	2.65	2.50
Kee Scarp	-	260	140	-	2.7	2.7
Hare Indian	-	200	170	2.50	2.65	2.55
Hume	165	100	90	2.79	2.70	2.70
Bear Rock	345	270	230	2.95	2.9	2.95
Silurian + Ordovician	750	>300	>450	2.8	2.75	2.8
Saline River	-	-	-	-	-	-
Mount Cap	-	-	-	-	-	-
Proterozoic	-	-	-	-	-	-

(The densities of the Saline River Mount Cap formations, as well as Proterozoic are given in the report on the interpretation of Tweed Lake field project)

Finally the next densities, were assigned to the next lithological units:

- a. Cretaceous (classics) - 2.40 g/cc
- b. Imperial (classics) - 2.50 g/cc
- c. Kee Scarp - Ordovician, including Hume, Bear Rock and other (carbonates) - 2.80 g/cc
- d. Saline River + Mount Cap - 2.30 g/cc
- e. Proterozoic - 2.65 g/cc

Analyzing these figures, one can anticipate, that the Ordovician - Devonian carbonate sequence, with a strong density contrast of 0.3 g/cc between it and the overlying clastics, and with thickness greater than 1000m, will be the major source of gravity anomalies in the area. The gravity effect of Proterozoic clastics will be less because of smaller density contrast between them and Ordovician - Devonian carbonates (0.15 g/cc). Cambrian Saline River and Mount Cap formations are rather thin and, despite their low density and strong density contrast (up to -0.5 g/cc), their contribution to the overall gravity field will be insignificant.

IV.3. Interpretation Technique

The expressive and distinctive character of gravity field in Sammon's Creek area, the well defined trend of gravity anomalies and relatively regular seismic coverage enable us to apply the simplified approach to the technical side of interpretation. This approach consisted of the next steps:

1. Separation of gravity fields on 'regional' and 'local' components.
2. Selection of some typical seismic lines which cross the well expressed gravity anomalies, structural interpretation of these lines and comparison with gravity profiles.
3. Designing of simplified geological cross-sections and interactive two-dimensional modelling.
4. Checking the geological model which provides a reasonable fit with observed gravity by other methods.
5. Synthesis of obtained information into resulting interpretive map.

The following are some comments on some of those steps.

1. Despite the obvious absence of apparent regional trend, the attempt was made to stress the effect from sources in Ordovician - Devonian part of geological section and suppress the influence of one Proterozoic section. For that purpose we applied upward continuation of observed gravity field g_{obs} to a level 2 km above the observation plane. That procedure filters out high frequency anomalies from shallower sources and produces the gravity field, g_{reg} , which would be created only by deeper sources. Consequently, the residual gravity field, g_{res} is

$$g_{res} = g_{obs} - g_{reg}, \text{ and it will represent the gravity anomalies due to shallower sources.}$$

The graphical output of that procedure is illustrated by plate 3 - the contoured residual gravity anomalies with contour interval 0.50 mgal. This map in comparison with observed Bouguer gravity map (Plate 2) shows much better resolution and visual expressiveness, because gravity highs here have positive values and lows - negative. That map was used as a basic map for preparation of structural interpretive map (Plate 4).

2. Two groups of seismic lines were selected for gravity interpretation. The first group includes lines 107X, 119X, 23X, and 35X as almost perpendicular to the major strike and crossing the strongest and the best expressed gravity anomalies. The second (lines 46X and 36X) represents lines which are oriented along the major strike, but perpendicular to the transverse (north-south) elements of gravity field.

After study of first group of lines, it became clear that all of them illustrate the same tectonic pattern: two faulted anticlines on the northern and southern ends and a broad flat syncline in-between. The gravity profiles along those lines are similar as well: each of them have two gravity highs which coincide with anticlines and a gravity low over the syncline. Finally, line 107X was selected for modelling as being typical of the NE-SW lines. We chose line 36X from the second group. Here the sharp drop in gravity in the middle part of the line coincides with a graben - like structure on the seismic section.

3. Two dimensional modelling of lines 107X and 36X, with densities defined in IV.2, was accomplished by program POLYGRAV in a batch mode. The criteria of quality of fit was assumed to be equal to contour interval, e.g. 0.5 mgal so we modified our models until such fit was obtained.

IV.4. Results of modelling.

Line 107X (Sections 1 and 2)

The gravity profile along this line contains two asymmetric (with steeper NE slope) positive anomalies in the NE and SW, separated by a broad gravity low in the middle of the line. The SW anomaly has a relative amplitude of about 7 mgal, narrow crest and high-gradient NE slope, which indicate a rather shallow source. The NE anomaly is weaker (about 3 mgal) and wider (approx. 6 km). It has a relatively flat top with additional local disturbances, which indicates the presence of multiple sources.

We used the following geological formations and their densities:

- Cretaceous - 2.4 g/cc
- Imperial - 2.6 g/cc
- Bear Rock - 2.90 g/cc
- Silurian - Ordovician - 2.7 g/cc
- Saline River - 2.45 g/cc
- Proterozoic - 2.75 g/cc

The geometry of model was determined from depth-converted seismic sections. Section 1 illustrates the final product of modelling with a good quality fit between observed and calculated data. The following observations can be made:

- The geological structure is the combination of folds and faults of different types;
- Thickness of Cretaceous clastics increases rapidly in synclines and may exceed 1000m.
- The thickness of Imperial formation decreases toward NE, which implies an erosional contact between Cretaceous and upper Devonian.
- Asymmetric anticline in Devonian - Ordovician carbonates (including Bear Rock formation) at the SW end of profile has a width of about 3 km and an amplitude of 400-500m and may be caused by thrust faulting.
- The syncline in the central part of line is 8 km wide with carbonates reaching 2 km below sea level in the deepest part.
- The NE wing of syncline is disturbed by several imbricate thrusts, gently deeping to the SW. The combination of thrusts leads to the stacking of Bear Rock dolomites and anhydrites in the upper part of Devonian - Ordovician carbonate section. It seems that the thrusts have their origin in plastic Cambrian Saline River formation and are Laramide in age, because they obviously disturb the Cretaceous;
- The model shows the dramatic salt accumulation in the Saline River formation SW and NE from the trough of the central syncline, where the Saline River is presumably absent. The assumed maximum thickness of salt may reach 1000m between SP's 386- 400. An isolated salt dome may exist at the very NE end of line (SP's 490-498).

- Top of Proterozoic lies at depth 2.5-3.0 km below sea level without any regional tilt, which reflects the apparent absence of any regional trend in the gravity field. The asymmetric graben-syncline with gentle NE slope and normal fault at SW side (1000m of downthrow) is formed between SP's 386-458.

Despite the good fit, we found this model unsatisfactory in three major points:

- The thickness of Cretaceous is too great.
- SW anticline may not necessarily be related to thrust faulting; it may be caused by block movements along a deep-seated normal fault.
- The scale of salt accumulation in Saline River formation is unrealistic and the presence of an isolated salt dome at NE end of line is questionable (profiles end there).

Section 2 illustrates the corrected geological model, which also produces a reasonable fit (the difference between calculated and observed gravity is almost constant value of approximately 1 mgal). After moving the calculated profile down by that amount the fit will be well within limits. In this model we included the Bear Rock formation into the Devonian - Ordovician carbonate section and used the next densities:

Cretaceous - 2.4 g/cc
Imperial - 2.50 g/cc
Devonian - Ordovician - 2.80 g/cc
Cambrian - 2.30 g/cc
Proterozoic - 2.65 g/cc

The final geometry of this model geologically looks more realistic than the first model. Calculations show that 60% of total gravity effect comes from interface of the Cretaceous clastics and the Devonian - Ordovician carbonates. The independent depth estimates made by using the second vertical derivative of Δg (shown by small circles on section 2) confirm that this contact is the main source of gravity anomalies in the area.

The following conclusions can be drawn:

1. The major structures at the upper part of Phanerozoic section can be caused either by Laramide thrust faults (NE part of profile) or by deep-seated normal faults of late Proterozoic - early Cambrian age (SW anticline). In the latter case the ancient faults might be reactivated in Cretaceous time with tectonic forces not reaching the threshold of brittle deformation (at least in upper horizons).
2. Salt tectonics is unlikely in the area. Given the most probable density of salt leaving formations, their real thickness and depth, any tangible gravity effect can be obtained with unrealistic exaggeration of salt thickness. The fact that the salt bearing formation is overlain by competent Paleozoic carbonates also speaks against salt tectonics here. The variation of thickness of Saline River formation, reflected in second model, have rather erosional, than tectonic, nature.

3. The top of Precambrian is not flat and depicts rather prominent structures with amplitude 0.8-1.0 km and 8-10 wide. However, the average depth to Precambrian seems to be consistent, and only in the southwest we can see the apparent deep of the top of Proterozoic toward the Franklin Mountains.

Line 36X

We undertook the modeling of this line, because it crosses the elongated NNW negative anomaly, transverse to the major strike. Gravity values along line 36X drop gradually toward the SW (section 3 and 4) from 76 mgal to 70 mgal. The negative anomaly (SP's 564-604) has a relative amplitude of -1.5 mgal and is slightly asymmetric with a steeper SE slope.

We tested two slightly different models: Model No. 1 (section 3) was based on very small uplift of Proterozoic in the NW end of line, which was compensated by thickening of Devonian - Ordovician carbonates. Model No. 2 (section 4) has constant thickness of all Paleozoic formations. In order to maintain a good fit between observed and calculated gravity we had to include a greater uplift of Proterozoic basement (up to 500m between SP's 508-556). Both concepts work equally well and produce an excellent fit. Additional geological or seismic control is necessary to decide which one is preferable.

Both models reveal that:

1. The local transverse negative anomaly may be caused by an asymmetric graben with roots in Proterozoic basement.
2. The SE flank of the graben is formed by a nearly vertical normal fault, which penetrates into Cretaceous sediments; the NW fault dips to SE and probably does not reach the Cretaceous.
3. The width of the graben at the top of the Paleozoic is about 7 km and top of Precambrian - 2 km, average downthrow - 300-400 m.
4. All horizons plunge to SE on 1000 m (top of Devonian - from -1 km to -2 km, for instance).

IV.5. Structural Interpretation

As we mentioned before, the lines selected for modelling are typical for each group. For instance, the features of line 107 can be found in virtually all lines on NE-SW orientation. This, plus the well expressed linearity of major gravity anomalies, enabled us to extrapolate the results, described in previous paragraph, through the entire surveyed area and produce the final structural interpretation map (Plate 4). This map shows the spatial distribution of structural elements, derived from interpretation of gravity data. We also made an attempt to interpret the depth to the top of Devonian carbonates. This boundary, as was said above, produces the major part of total gravity effect. We used the simplest solution of the contact surface determination problem.

based on relationship:

$$\Delta H = \frac{\Delta g}{2H G \Delta \rho} \text{ cm}$$

where ΔH - change in elevation of constant surface;
 Δg - change in gravity, caused by change in elevation;
 $\Delta \rho$ - density contrast at that contact;
 G - universal gravity constant

Using an average density contrast of 0.15 g/cc at the contact between Devonian - Ordovician carbonates and overlying clastics (Imperial + Cretaceous) we obtain the approximate gradient of 0.63 mgal for each 100m of elevation. The same gradient from models, where g and H can be directly measured, gives 0.7 mgal/100 m, which is very close to theoretical value. Using the average gradient of 0.65 mgal/100m and initial depth of the Devonian carbonates -400m at SP 364 of line 107X, we estimated the depths to the same surface at several locations and contoured them with interval 200m. The procedure was carried out only for depths below sea level because the operation is not valid when contact surface reaches the surface of observation. Of course, accuracy of this procedure is very low and one can consider this as qualitative illustration of behaviour of the top of the Devonian carbonates, rather than an exact quantitative interpretation.

V. Summary

The following summarizes the results of gravity interpretation in Sammon's Creek area.

1. Two asymmetric anticlines of east-west strike form the major structural elements in the area. The asymmetry of the anticlines reflects the tectonic tension from the south - southwest. Anticlines are separated by a syncline, broad in the eastern part (line 107X), and narrow in the west (line 25X), so both anticlines tends to merge together west from line 25X. The axes of the structures plunge eastward from the surface to at least 1.5 km below sea level and deviate slightly to the south-east.
2. The northern anticline is genetically linked to Laramide thrusts faults while the southern one have originated by reactivation of old normal faults (Late Proterozoic - Cambrian).
3. A deep trough filled by Mesozoic rock, is present just north from thrust fault, where the top of Devonian carbonate may deepen to 2000m below sea level. The shape and actual size of this negative structure is unknown because of absence of data, but to the west its extension can be seen on gravity map at lines 51X, 45X and 37X.
4. Among the youngest deformations in the area are the transverse normal faults of NE and NNE strike. These faults cut the axial lines of folds as well as faults and displace them. Some of them may have a strike-slip component and cause the elbow-like bend of southern anticline in the central part of the area (NE end of line 6X). The combination of two normal faults with matching throws

produces the graben - syncline of NNE strike, which cuts the northern anticline at the intersection of lines 9IX with lines 44X, 46X and 36X and seems to merge with southern anticline at the southern end of lines 10IX and 89X. The axis of northern anticline east from graben can be traced along line 44X. The dome-like structure adjacent to the eastern flank of graben-syncline is obviously caused by interaction of younger normal faults with growing anticline and active east-west thrusts. The top of Devonian carbonates in the crest of the dome lies at a depth of 1300m below sea level.

5. Salt movements and salt tectonics does not play any significant role here. We can suspect the minor activity of that kind only in the trough of the central syncline.

VI. Discussion and Recommendations on Future Gravity Surveys.

The gravity method in this area proved to be a very good tool for tracing the major geological structures. However, there are several important points which needs discussion and thorough consideration.

Data Processing.

The surface geology and seismic data show that different rock formation lie between sea level and surface: Cretaceous (and probably younger) low density clastics in the synclines (northern parts of the surveyed area) and Devonian dense carbonate in the exposed crest of anticlines (southern-central part). Meanwhile, we calculated the Bouguer anomalies with constant density of 2.35 g/cc. This density is good for clastics, but not for carbonates with average density of 2.75-2.8 g/cc. Thus, for place with shallow or exposed carbonates, the certain amount of observed gravity will be undercompensated. This means that we should process our data with variable Bouguer density. This sort of data processing at the present stage is beyond the capability of our automatic processing system. But, if necessity arises, it can be done by hand for specified gravity profiles.

Data Interpretation.

The validity of any gravity interpretation depends on the quality of density information. The chosen densities look reasonable enough, but the interpretation will have to be revised, if any new reliable density data become available. The interpretation presented is by no means exhaustive and leaves some questions open:

- true extent of salt accumulation and movements;
- reef development in carbonate formations;
- the degree of basement activation, mobilization and involvement.

The strong points of gravity method in this area are its ability

- to locate buried folds (even at significant depth) and trace them over large distances,
- to distinguish between normal faults and thrust faults
- to illustrate the spatial and time relationship between structural elements
- to reduce the number of seismic lines which need to be shot, given that gravity survey is run prior to seismic shooting. The last point can be

illustrated by the following approximate calculations. Let us presume, that the Sammon's Creek area of approximately 4000 sq. km is covered by a gravity survey with grid 2x5 km, for which 400 sections and \$400,000 would be necessary. By using the gravity map for designing the seismic survey, 40 lines with total distance of 700 km, instead of approximately 900 km of actual shooting, might be shot. With average price of \$10,000 per km, and \$400,000 for gravity survey the total expenditure will amount to approximately \$7,500,000 - \$1,500,000 saving, or 15%. The saving comes from dropping several seismic lines shot mainly for mapping purposes - the task which gravity can successfully assume.

Keeping in mind the high potential of gravity survey in the given geological environment, we can recommend the comprehensive gravity survey west from Sammon's Creek and along the foothills of Franklin Mountains - in direction of plunging of structures beneath Mesozoic sediments. This, together with stronger influence of Franklin Mountains overthrust, may provide us with good structural entrapment situation. In addition, the surface geology is not as informative there, as it is in the Sammon's Creek area. The gravity survey should have to cover a significant area - about 6,000 sq. km - in order to provide a wider perspective. The optimal grid as our experience shows, would be 2x5 or 2.5x5 km with helicopter support. Survey might be carried out with visual navigation and barometric vertical control. Estimated cost - \$500,000. Experience in Sammon's Creek area makes us confident that such a survey will serve as a good data base for future exploration activity in the region.

LL/mjo

REFERENCES

- Cook, D.G. and D. D. Aitken, 1974. Geology Carcajou Canyon Map area,
District of Mackenzie, N.W.T..
Geology Survey Can., paper 74-13.
- Nisonov, V. S. Kurs gravisarvedki (Gravity Survey)
Leningrad, U.S.S.R, "Nedra", 1980

U.S. AIR FORCE
 AIRCRAFT ACCIDENT REPORT

TIME REPORT	TYPE FAA	FAA FILE NO.	TYPE	TIME	NO. TIME	LOC.	NO. POINTS	TIME SHOT	TYPE SHOT	SHOT INC.	NO. SHOT
105	20X V	31100	C	31100	03	335	335	335	335	1	107
106	20X V	31100	C	31100	03	285	310	310	310	1	113
107	20X V	31100	C	31100	03	335	311	311	311	1	176
108	20X V	31100	C	31100	03	335	335	335	335	1	207
109	20X V	31100	C	31100	03	335	335	335	335	1	253
110	20X V	31100	C	31100	03	335	335	335	335	1	253
111	20X V	31100	C	31100	03	335	335	335	335	1	161
112	20X V	31100	C	31100	03	335	335	335	335	1	118
113	20X V	31100	C	31100	03	335	335	335	335	1	282
114	20X V	31100	C	31100	03	335	335	335	335	1	173
115	20X V	31100	C	31100	03	335	335	335	335	1	01
116	20X V	31100	C	31100	03	335	335	335	335	1	99
117	20X V	31100	C	31100	03	335	335	335	335	1	159
118	20X V	31100	C	31100	03	335	335	335	335	1	164
119	20X V	31100	C	31100	03	335	335	335	335	1	180
120	20X V	31100	C	31100	03	335	335	335	335	1	228
121	20X V	31100	C	31100	03	335	335	335	335	1	50
122	20X V	31100	C	31100	03	335	335	335	335	1	59
123	20X V	31100	C	31100	03	335	335	335	335	1	130
124	20X V	31100	C	31100	03	335	335	335	335	1	115
125	20X V	31100	C	31100	03	335	335	335	335	1	197
126	20X V	31100	C	31100	03	335	335	335	335	1	214
127	20X V	31100	C	31100	03	335	335	335	335	1	182
128	20X V	31100	C	31100	03	335	335	335	335	1	145
129	20X V	31100	C	31100	03	335	335	335	335	1	145
130	20X V	31100	C	31100	03	335	335	335	335	1	204
131	20X V	31100	C	31100	03	335	335	335	335	1	127
132	20X V	31100	C	31100	03	335	335	335	335	1	111

Appendix
-91-

150	55X V	23000	0	14722	03	238	170	170	1	194
152	55X V	23000	0	14722	03	123	110	100	1	95
157	55X V	12000	0	20200	00	153	220	250	1	70
162	55X V	11000	0	15000	03	155	200	100	1	71
164	55X V	20000	0	01700	00	110	184	100	1	145
165	55X V	31000	0	15000	03	210	200	200	1	98
171	75X V	20000	0	15100	03	71	10	40	1	33
174	75X V	11000	0	15000	03	65	350	300	1	39
175	75X V	11000	0	15000	03	120	100	100	1	67
176	75X V	10000	0	15700	03	133	320	200	1	63
178	55X V	10000	0	15000	03	210	500	100	1	96
180	55X V	10000	0	15000	03	215	300	450	1	78
181	55X V	30000	0	20600	03	187	300	400	1	67
201	110X V	10000	0	11000	03	207	100	400	1	117
202	110X V	10000	0	11000	03	210	100	400	1	100
204	105X V	40000	0	01000	03	171	240	400	1	160
207	105X V	50000	0	01000	03	180	100	400	1	170
211	110X V	21000	0	20500	03	406	100	100	1	194
217	110X V	30000	0	20000	03	123	100	100	1	90
220	110X V	20000	0	16000	00	210	100	500	1	105
227	110X V	20000	0	15000	03	217	100	100	1	108
228	110X V	20000	0	15000	03	154	100	100	1	75
229	75X V	31000	0	14000	00	205	200	100	1	102
1151	55X V	30000	0	15000	00	241	10	110	1	110

SUMMARY

TOTAL POINTS: 45 11760
 TOTAL NUMBER OF POINTS: 14006

4 RPL 2

SURVEY RELEASE REPORT

CHANNEL NAME: DATE: VPTS: 1957-11-14
 CTDN: 017 21 110 145
 SM. GIMP LE: 55hr

LINE	MILES	VALUE	PTS	LINE	MILES	VALUE	PTS	LINE	MILES	VALUE	PTS
105	8.7	351.0	335	105	8.7	-66.6	235	105	8.7		
107	13.1	357.4	336	107	13.1	-62.0	205	107	13.1		
109	17.5	363.8	335	109	17.5	-57.4	165	109	17.5		
111	21.9	370.2	336	111	21.9	-52.8	125	111	21.9		
113	26.3	376.6	335	113	26.3	-48.2	85	113	26.3		
115	30.7	383.0	336	115	30.7	-43.6	45	115	30.7		
117	35.1	389.4	335	117	35.1	-39.0	5	117	35.1		
119	39.5	395.8	336	119	39.5	-34.4		119	39.5		
121	43.9	402.2	335	121	43.9	-29.8		121	43.9		
123	48.3	408.6	336	123	48.3	-25.2		123	48.3		
125	52.7	415.0	335	125	52.7	-20.6		125	52.7		
127	57.1	421.4	336	127	57.1	-16.0		127	57.1		
129	61.5	427.8	335	129	61.5	-11.4		129	61.5		
131	65.9	434.2	336	131	65.9	-6.8		131	65.9		
133	70.3	440.6	335	133	70.3	-2.2		133	70.3		
135	74.7	447.0	336	135	74.7	2.4		135	74.7		
137	79.1	453.4	335	137	79.1	8.0		137	79.1		
139	83.5	459.8	336	139	83.5	13.6		139	83.5		
141	87.9	466.2	335	141	87.9	19.2		141	87.9		
143	92.3	472.6	336	143	92.3	24.8		143	92.3		
145	96.7	479.0	335	145	96.7	30.4		145	96.7		
147	101.1	485.4	336	147	101.1	36.0		147	101.1		
149	105.5	491.8	335	149	105.5	41.6		149	105.5		
151	109.9	498.2	336	151	109.9	47.2		151	109.9		
153	114.3	504.6	335	153	114.3	52.8		153	114.3		
155	118.7	511.0	336	155	118.7	58.4		155	118.7		
157	123.1	517.4	335	157	123.1	64.0		157	123.1		
159	127.5	523.8	336	159	127.5	69.6		159	127.5		
161	131.9	530.2	335	161	131.9	75.2		161	131.9		
163	136.3	536.6	336	163	136.3	80.8		163	136.3		
165	140.7	543.0	335	165	140.7	86.4		165	140.7		
167	145.1	549.4	336	167	145.1	92.0		167	145.1		
169	149.5	555.8	335	169	149.5	97.6		169	149.5		
171	153.9	562.2	336	171	153.9	103.2		171	153.9		
173	158.3	568.6	335	173	158.3	108.8		173	158.3		
175	162.7	575.0	336	175	162.7	114.4		175	162.7		
177	167.1	581.4	335	177	167.1	120.0		177	167.1		
179	171.5	587.8	336	179	171.5	125.6		179	171.5		
181	175.9	594.2	335	181	175.9	131.2		181	175.9		
183	180.3	600.6	336	183	180.3	136.8		183	180.3		
185	184.7	607.0	335	185	184.7	142.4		185	184.7		
187	189.1	613.4	336	187	189.1	148.0		187	189.1		
189	193.5	619.8	335	189	193.5	153.6		189	193.5		
191	197.9	626.2	336	191	197.9	159.2		191	197.9		
193	202.3	632.6	335	193	202.3	164.8		193	202.3		
195	206.7	639.0	336	195	206.7	170.4		195	206.7		
197	211.1	645.4	335	197	211.1	176.0		197	211.1		
199	215.5	651.8	336	199	215.5	181.6		199	215.5		
201	219.9	658.2	335	201	219.9	187.2		201	219.9		
203	224.3	664.6	336	203	224.3	192.8		203	224.3		
205	228.7	671.0	335	205	228.7	198.4		205	228.7		
207	233.1	677.4	336	207	233.1	204.0		207	233.1		
209	237.5	683.8	335	209	237.5	209.6		209	237.5		
211	241.9	690.2	336	211	241.9	215.2		211	241.9		
213	246.3	696.6	335	213	246.3	220.8		213	246.3		
215	250.7	703.0	336	215	250.7	226.4		215	250.7		
217	255.1	709.4	335	217	255.1	232.0		217	255.1		
219	259.5	715.8	336	219	259.5	237.6		219	259.5		
221	263.9	722.2	335	221	263.9	243.2		221	263.9		
223	268.3	728.6	336	223	268.3	248.8		223	268.3		
225	272.7	735.0	335	225	272.7	254.4		225	272.7		

LINE	PCP	XX-LINE	CDR	M.T.	VAL. BSA	VAL. ASA	M.T. ASA	PR.F. ADJ.	TOT. A
134				0.03	-65.88	-67.44	0.00	0.01	0.
135				-0.31	-66.83	-66.83	0.00	-0.01	0.
146				0.00	-65.06	-69.06	0.07	0.03	0.
LINE	PCP	XX-LINE	CDR	M.T.	VAL. BSA	VAL. ASA	M.T. ASA	PR.F. ADJ.	TOT. A
131				0.02	-65.42	-69.42	-0.07	-0.05	-0.
134				0.04	-66.37	-64.37	0.01	0.01	0.
136				-0.13	-67.36	-67.36	-0.16	-0.11	-0.
143				-0.06	-70.02	-70.01	-0.07	-0.05	-0.
142				0.38	-66.33	-64.33	0.00	0.16	0.
144				-0.34	-66.04	-64.04	-0.02	-0.13	-0.
146				0.00	-67.61	-71.61	0.01	0.01	0.
LINE	PCP	XX-LINE	CDR	M.T.	VAL. BSA	VAL. ASA	M.T. ASA	PR.F. ADJ.	TOT. A
134				-0.03	-65.67	-69.67	0.14	0.14	-0.
136				0.01	-66.67	-66.66	0.19	0.14	-0.
140				-0.37	-66.12	-64.12	0.13	0.11	-0.
142				-0.08	-65.62	-64.62	-0.62	-0.25	-0.
146				-0.03	-66.22	-66.41	0.17	0.13	-0.
LINE	PCP	XX-LINE	CDR	M.T.	VAL. BSA	VAL. ASA	M.T. ASA	PR.F. ADJ.	TOT. A
134				0.01	-69.62	-69.73	-0.14	-0.07	0.
140				0.20	-66.18	-66.35	0.08	0.05	0.
142				0.10	-65.16	-65.01	0.19	0.03	0.
146				0.04	-66.46	-66.31	-0.38	-0.05	0.
LINE	PCP	XX-LINE	CDR	M.T.	VAL. BSA	VAL. ASA	M.T. ASA	PR.F. ADJ.	TOT. A
140				-0.12	-63.13	-63.21	-0.04	-0.01	0.
LINE	PCP	XX-LINE	CDR	M.T.	VAL. BSA	VAL. ASA	M.T. ASA	PR.F. ADJ.	TOT. A
216				3.01	-67.88	-67.82	-0.04	-0.01	0.
LINE	PCP	XX-LINE	CDR	M.T.	VAL. BSA	VAL. ASA	M.T. ASA	PR.F. ADJ.	TOT. A
217				-0.36	-72.62	-71.62	0.00	-0.03	0.
LINE	PCP	XX-LINE	CDR	M.T.	VAL. BSA	VAL. ASA	M.T. ASA	PR.F. ADJ.	TOT. A
219				0.15	-75.42	-75.21	-0.05	-0.02	0.
LINE	PCP	XX-LINE	CDR	M.T.	VAL. BSA	VAL. ASA	M.T. ASA	PR.F. ADJ.	TOT. A
273				0.05	-75.62	-75.54	-0.05	-0.04	0.
122				0.30	-75.31	-74.23	0.04	0.02	0.
130				0.24	-76.43	-76.29	0.16	0.10	0.

***CONVERGENCE COMPLETE**

** 12 ITERATIONS PERFORMED**

***MAX. ERROR=0.014863E-01**

MAXIMAL CONNECTED SUBNETS :

LINE STATISTICS

LINE	NO. OF INT.	STD. DEV.	SYS. I.	MFG. BSA	MFG. ASA	...
136		0.032	-1.00	0.235	0.032	0.15
167		0.020	-0.26	0.047	0.015	-0.15
102		0.131	-0.086	0.003	0.133	-0.13
111		0.059	-0.196	0.127	0.050	-0.371
117		0.137	-0.122	0.198	0.135	-0.453
133		0.095	-0.133	0.042	0.042	-0.36
125		0.113	-0.315	0.143	0.110	-0.52
135		0.204	0.122	0.421	0.154	-0.32
137		0.073	0.060	0.133	0.073	-0.12

141	2	0.137	0.138	0.133	0.015	-0.075	
145	3	0.137	0.204	0.099	0.006	0.140	
150	4	0.136	0.212	0.221	0.114	-0.143	
151	1	0.136	0.211	0.230	0.045	0.4125	
152	4	0.031	0.033	0.036	0.077	0.1504	
154	2	0.173	-0.074	0.036	0.067	0.6253	
174	1	0.140	0.437	0.710	0.125	0.731	
170	1	0.244	-0.173	0.075	0.044	0.414	
1156	5	0.057	-0.172	0.230	0.073	0.169	
-----		-----		-----		-----	
18	48	0.047	0.002	0.013	0.041	0.0580	
TOT.	SUM	AVG.	AVG.	AVG.	AVG.	AVG.	

BEFORE REMOVAL OF SYSTEMATIC ERROR 0.09
 AFTER REMOVAL OF SYSTEMATIC ERROR 0.21
 RATIO 0.43

BEFORE REMOVAL OF SYSTEMATIC ERROR 0.10
 AFTER REMOVAL OF SYSTEMATIC ERROR 0.11
 RATIO 0.95

BEFORE REMOVAL OF SYSTEMATIC ERROR 0.20
 AFTER REMOVAL OF SYSTEMATIC ERROR 0.09
 RATIO 2.22

AVERAGE ASSUMED SYSTEMATIC ADJUSTMENT 0.18

SHIPMENT GRAVITY AND MAGNETICS PROCESSING SYSTEM
 PROGRAM NAME: A102STRM1

DATE JUL27/92 TIME 09:24:09
 SSRC 0.100
 FILE OPENED AS OLD CHANNELIT 10

 FILE NAME: SAGONS' CRV GRAV SURVY D2
 CYCLE NUMBER: 21
 TIME OF CREATION: 15:10:13
 DATE OF CREATION: JUL26/92
 NUMBER OF SURVY LINES: 90
 NUMBER OF CHANNELS: 47
 NO DATA VALUE: 0.1300000E+11
 RESERVED AREA: 0.0
 NUMBER OF BITS GROUPS: 01 167496
 NUMBER OF RECORDS: 462

ADJUSTMENT OF SN. SINE LT. 0.004 (SSR0)

CONVERGENCE COMPLETE

*** 3 ITERATIONS PERFORMED ***

MAX. FREQ=0.7240550E-01V

MAXIMAL CHANNEL'S SUBTABLE : 1

*** LINE STATISTICS ***

LINE	NO. OF INT.	STD. DEV.	SYS. ERR.	NO. OF A.	NO. OF B.
108	1	0.005	0.007	0.001	0.000
122	2	0.037	-0.011	0.027	0.035
124	4	0.056	0.016	0.035	0.062
130	5	0.090	0.030	0.157	0.075
131	4	0.063	-0.003	0.047	0.062
134	4	0.100	-0.017	0.025	0.074
136	0	0.000	-0.017	0.058	0.076
140	3	0.007	0.003	0.035	0.053
142	3	0.067	0.113	0.079	0.023
144	13	0.136	0.044	0.061	0.010
146	12	0.144	0.000	0.065	0.065
157	1	0.023	-0.007	0.010	0.010
163	2	0.040	-0.016	0.032	0.033
165	2	0.016	0.037	0.024	0.012
171	2	0.003	-0.002	0.004	0.002
173	2	0.031	0.005	0.030	0.010
176	1	0.140	0.015	0.043	0.060
186	1	0.109	0.004	0.025	0.005
187	1	0.101	-0.066	0.143	0.094
191	1	0.090	-0.113	0.117	0.113
201	1	0.100	-0.070	0.074	0.100
203	1	0.051	-0.000	0.110	0.041
209	1	0.119	0.016	0.157	0.144
207	1	0.111	-0.100	0.020	0.044
211	4	0.112	0.128	0.000	0.108
213	1	0.034	-0.080	0.121	0.034
215	1	0.041	0.005	0.005	0.041
217	1	0.060	-0.143	0.056	0.060
219	1	0.053	0.003	0.142	0.053

TOT.

110

0.002

0.001

0.112

0.015

BEFORE REMOVAL OF SYSTEMATIC ERROR
 AFTER REMOVAL OF SYSTEMATIC ERROR
 RATIO

4444 AVERAGE OF SQUARES OF RESIDUALS 4444
 0.24
 0.23
 0.10

BEFORE REMOVAL OF SYSTEMATIC ERROR
 AFTER REMOVAL OF SYSTEMATIC ERROR
 RATIO

4444 COEFFICIENT OF CORRELATION (R) 4444
 0.71
 0.73
 0.85

BEFORE REMOVAL OF SYSTEMATIC ERROR
 AFTER REMOVAL OF SYSTEMATIC ERROR
 RATIO

4444 AVERAGE OF SQUARES OF RESIDUALS (LEAST SQUARES SCATTER) 4444
 0.13
 0.13
 0.13

AVERAGE ABSOLUTE SYSTEMATIC ASSIGNMENT

0.14

31	119	0.626	-1.796	0.631	0.479	0.1
ICI:	304	1.163	0.000	1.12	0.375	-4.0
		AVC.	AVC.		AVC.	
**** AVERAGES OF SQUARES OF MISTIES ****						
BEFORE REMOVAL OF SYSTEMATIC ERROR		0.77				
AFTER REMOVAL OF SYSTEMATIC ERROR		1.03				
RATIO		1.463				
**** FULL MEAN SQUARE (RMS) MISTIE ****						
BEFORE REMOVAL OF SYSTEMATIC ERROR		0.90				
AFTER REMOVAL OF SYSTEMATIC ERROR		1.00				
RATIO		1.111				
**** AVERAGES OF ABSOLUTE MISTIES (MEAN RANDOM SCATTER) ****						
BEFORE REMOVAL OF SYSTEMATIC ERROR		1.04				
AFTER REMOVAL OF SYSTEMATIC ERROR		1.02				
RATIO		1.027				
AVERAGE ABSOLUTE SYSTEMATIC ADJUSTMENT		1.000				

NO. OF INT.	STP. COV.	SVN. AC FS	MRE. USA	MRE. J
107	0.341	-1.022	0.751	0.021
108	0.367	-0.085	0.240	0.327
109	0.473	-1.155	1.536	0.472
111	0.752	-0.717	1.595	1.444
117	0.217	-0.675	2.507	2.817
123	1.750	-1.022	2.370	1.755
125	1.006	-1.664	1.110	0.656
126	0.740	2.032	2.500	2.678
127	0.012	-1.444	0.155	0.012
131	1.014	-2.134	1.553	1.618
135	1.258	-3.244	0.424	1.165
136	1.638	-0.476	1.658	1.385
131	3.350	0.711	0.657	0.050
152	1.353	0.777	3.206	2.306
158	0.081	-0.055	0.455	0.076
164	1.472	2.076	0.885	1.258
170	0.054	-1.261	0.470	0.054
1156	1.621	-0.277	1.300	1.328

10	AVG	1.256	3.302	1.317
101	SUS	AVG	AVG	AVG
				1.102 0.1

BEFORE REMOVAL OF SYSTEMATIC ERROR
 AFTER REMOVAL OF SYSTEMATIC ERROR
 RATIO

**** AVERAGES OF SQUARES OF MISTILS ****
 4.48
 3.77
 1.50

BEFORE REMOVAL OF SYSTEMATIC ERROR
 AFTER REMOVAL OF SYSTEMATIC ERROR
 RATIO

**** MEAN SQUARE (MS) MISTIE ****
 2.62
 1.66
 1.29

BEFORE REMOVAL OF SYSTEMATIC ERROR
 AFTER REMOVAL OF SYSTEMATIC ERROR
 RATIO

**** AVERAGES OF ABSOLUTE MISTILS (BEAR FINDER SCATTER) ****

AVERAGE ABSOLUTE SYSTEMATIC DEVIATION

1.00

10

The terms and abbreviations used in the adjustment statistics report are defined as follows:

NO. OF INT. is the number of intersections on the line.

STD.DEV. is the standard deviation of the intersection misties.

SYS.ADJ. is the systematic adjustment applied to the line.

MRS is the mean random scatter or average absolute mistie for each line.

BSA and ASA are before and after systematic adjustment, respectively.

OR.M.T. is the original mistie value.

R.T.ADJ. is the random error adjustment.

FIN.CH represents the final-choice value at the intersection.

Note that there are two sets of values printed for mean random scatter at the end of the Line Statistics Tables: the averages at the bottom of the "MRS" column, and the values under a separate heading immediately below. The averages at the bottom of the column represent the average of all line averages, while the second set of values represent the average over the entire survey.

LINE HEALTH REPORT

LINE NUMB	LINE NAM	QUALITY RAT	LAST TIM	NO TIME	INC.	NO. POINTS	FIRST SHOT	LAST SHOT	SHOT TAC.	NO. SHOT	
105	58X	0	05300	0	05300	00	335	330	406	1	107
106	64X V	0	05400	0	05400	00	285	310	435	1	130
107	72X V	0	05500	0	05500	00	188	311	484	1	174
108	82X V	0	06000	0	06000	00	455	324	580	1	202
111	112X V	0	06500	0	06500	00	556	329	691	1	253
117	172X	0	07400	0	07400	00	355	370	530	1	161
122	222X V	0	08300	0	08300	00	255	605	722	1	118
123	222X V	0	08300	0	08300	00	380	441	682	1	242
125	252X V	0	08300	0	08300	00	350	374	546	1	173
128	282X V	0	08300	0	08300	00	190	590	680	1	61
130	300X V	0	08300	0	08300	00	193	521	608	1	88
131	300X V	0	08300	0	08300	00	229	955	1134	1	150
134	362X V	0	09000	0	09000	00	360	1029	1192	1	164
135	352X V	0	09000	0	09000	00	395	401	580	1	140
136	362X V	0	09000	0	09000	00	456	506	733	1	228
137	372X V	0	09000	0	09000	00	126	555	612	1	58
138	382X V	0	09000	0	09000	00	230	1038	1152	1	95
140	402X V	0	09000	0	09000	00	294	1023	1166	1	134
141	412X V	0	09000	0	09000	00	252	420	574	1	115
142	422X V	0	09000	0	09000	00	235	1030	1136	1	107
144	442X V	0	09000	0	09000	00	470	481	694	1	214
145	452X V	0	09000	0	09000	00	430	422	603	1	182
146	472X V	0	09000	0	09000	00	265	790	1134	1	245
150	502X V	0	09000	0	09000	00	445	10	213	1	204
151	512X V	0	09000	0	09000	00	370	600	626	1	127
											111

Appendix 1

154	4xV	33000	0	33000	03	228	170	471	1	128
156	5xV	23000	0	23000	03	120	310	364	1	55
157	5xV	10000	0	10000	00	153	229	298	1	70
162	6xV	14000	0	14000	03	155	250	320	1	71
164	6xV	20000	0	20000	03	114	344	488	1	145
165	6xV	31000	0	31000	00	219	209	207	1	28
170	7xV	23000	0	23000	03	73	13	42	1	33
171	7xV	11000	0	11000	03	65	320	358	1	39
173	7xV	11000	0	11000	03	126	315	371	1	67
176	7xV	12000	0	12000	03	138	329	382	1	63
185	8xV	12000	0	12000	00	210	301	376	1	96
189	8xV	10000	0	10000	00	215	363	457	1	98
191	8xV	32000	0	32000	03	147	360	426	1	67
201	11xV	41000	0	41000	00	297	380	456	1	117
203	11xV	41000	0	41000	00	249	380	481	1	109
205	10xV	43000	0	43000	00	371	240	498	1	160
207	10xV	40000	0	40000	03	386	321	496	1	176
211	11xV	21000	0	21000	00	426	315	523	1	104
211	11xV	33000	0	33000	03	120	380	438	1	94
215	11xV	21000	0	21000	00	230	444	543	1	105
217	11xV	21400	5300	44000	03	237	570	627	1	108
217	11xV	21000	20000	50000	00	164	600	674	1	75
271	7xV	41000	0	41000	00	224	220	321	1	102
1156	50xV	32000	0	40000	00	241	10	119	1	110

SUMMARY

TOTAL NUMBER OF LINES= 93
 TOTAL NUMBER OF POINTS= 14224

LINE	REP.	M.T.	VAL.	ASA.	ASA.	ASA.	ADJ.	TOT.
233*	X-LINE	136	0.03	-0.04	-0.44	0.00	0.00	0.00
		146	-0.31	-0.03	-0.03	-0.05	-0.01	0.00
		146	0.06	-0.06	-0.06	0.07	0.07	0.00
205*	X-LINE	131	0.02	-0.42	-0.40	-0.07	-0.05	-0.00
		134	0.04	-0.27	-0.15	0.01	0.01	-0.00
		137	-0.11	-0.78	-0.72	-0.16	-0.11	-0.00
		140	0.00	-0.02	-0.01	-0.07	-0.05	-0.00
		142	0.35	-0.73	-0.32	-0.00	-0.16	-0.00
		144	-0.41	-0.09	-0.29	-0.22	-0.13	-0.00
		146	0.02	-0.51	-0.40	0.01	0.01	-0.00
207*	X-LINE	134	-0.01	-0.47	-0.06	0.14	0.11	-0.00
		136	0.01	-0.47	-0.06	0.14	0.14	-0.00
		140	-0.37	-0.11	-0.12	0.13	0.11	-0.00
		142	-0.38	-0.05	-0.11	-0.02	-0.05	-0.00
		146	-0.03	-0.42	-0.41	0.17	0.13	-0.00
211*	X-LINE	134	0.01	-0.02	-0.73	-0.14	-0.07	0.00
		140	0.20	-0.19	-0.05	0.04	0.05	0.00
		142	0.10	-0.11	-0.21	0.14	0.03	0.00
		146	0.04	-0.42	-0.11	-0.03	-0.05	0.00
213*	X-LINE	140	0.12	-0.13	-0.21	-0.04	-0.01	0.00
215*	X-LINE	146	0.01	-0.08	-0.02	-0.04	-0.01	0.00
217*	X-LINE	146	0.00	-0.42	-0.63	-0.07	-0.03	0.00
219*	X-LINE	146	0.14	-0.42	-0.21	-0.05	-0.02	0.00
273*	X-LINE	122	0.05	-0.42	-0.54	-0.05	-0.04	0.00
		128	-0.35	-0.31	-0.22	-0.16	-0.10	-0.00
		130	0.24	-0.13	-0.25	0.16	0.10	0.00

CONVERGENCE COMPLETE

** 12 ITERATIONS PERFORMED**

MAX. ERROR=0.014663E-01

MAXIMAL CONNECT'S SUBNETWORK : 2

*** LINE STATISTICS ***

LINE	NO. OF INT.	STD. DEV.	SYS.	MRS. ASA.	MRS. ASA.
106	3	0.032	-1.02	0.295	0.032
107	3	0.320	-0.26	0.047	0.019
109	3	3.181	-0.084	0.210	0.133
110	3	3.085	-0.196	0.127	0.080
117	2	3.137	-0.222	0.198	0.135
123	3	3.388	-0.133	0.082	0.089
128	3	0.111	-0.15	0.144	0.110
129	3	3.366	0.122	0.423	0.111

141	2	0.000	0.100	0.133	0.033	0.070
145	1	0.137	0.000	0.094	0.000	0.140
150	1	0.156	0.000	0.021	0.114	-0.100
151	1	0.180	0.000	0.700	0.000	0.450
152	4	0.091	-0.074	0.006	0.000	0.100
154	2	0.170	0.000	0.474	0.000	0.200
164	3	0.180	0.000	0.000	0.100	0.000
170	1	0.080	-0.100	0.074	0.000	0.400
1156	0	0.000	0.000	0.000	0.000	0.000
18	48	0.007	0.002	0.213	0.001	0.000
TOT.	SUM	AVG.	AVG.	AVG.	AVG.	AVG.

BEFORE REMOVAL OF SYSTEMATIC ERROR
AFTER REMOVAL OF SYSTEMATIC ERROR
RATIO

**** AVERAGE OF SQUARES OF RESIDUES ****
0.38
0.31
0.00

BEFORE REMOVAL OF SYSTEMATIC ERROR
AFTER REMOVAL OF SYSTEMATIC ERROR
RATIO

**** DELTA MEAN SQUARE (RMS) RESIDUE ****
0.00
0.11
0.00

BEFORE REMOVAL OF SYSTEMATIC ERROR
AFTER REMOVAL OF SYSTEMATIC ERROR
RATIO

**** AVERAGE OF ABSOLUTE RESIDUES (MEAN RANDOM SCATTER) ****
0.00
0.00
0.00

AVERAGE ABSOLUTE SYSTEMATIC ADJUSTMENT

0.00

***** START JHR 8834 08002A 11000VGH

FILED 000 0.20.03 AM 27 JUL 82 EDINTG1
 FILED 000 0.20.03 AM 27 JUL 82 EDINTG1

SHIPBORNE GRAVITY AND MAGNETIC PROCESSING SYSTEM

PROGRAM NAME ADJUSTREP

DATE JUL27/82 TIME 09:24:00

SSUG 0.191

FILE OPENED AS OLD ON UNIT 10

*****ADP*****

FILE ON UNIT 10

FILE NAME SAMSONS CRK GRAV SURVEY 82

CYCLE NUMBER: 21

TIME OF CREATION: 15:10:10

DATE OF CREATION: JUL 26/82

NUMBER OF SURVEY LINES: 50

NUMBER OF CHANNELS: 47

NO DATA VALUES: 0.1000000E+11

RESERVED WORDS: 0.0

NUMBER OF WORDS REJECTED: 16340

NUMBER OF RECORDS 660

ADJUSTMENT OF SM. SIMP LE B.GRA (SSNG)

CONVERGENCE COMPLETE

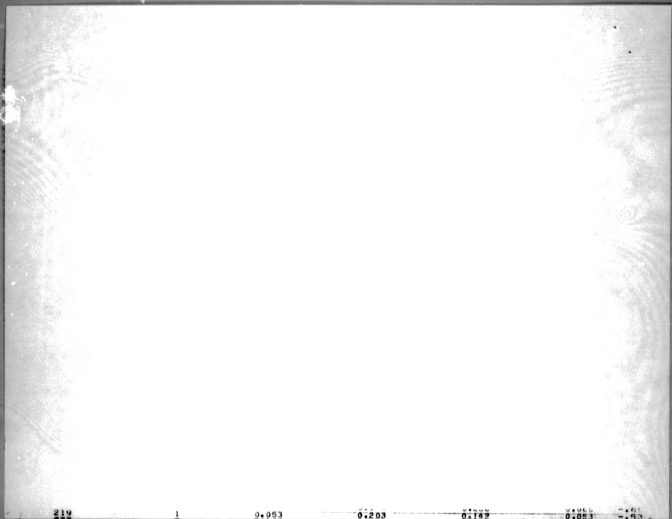
** 3 ITERATIONS PERFORMED **

MAX. ERROR=0.724055RF-01

MAXIMAL LENGTH OF SUBNETWORK : 1

*** LINE STATISTICS ***

LINE	NO. OF INT.	STD. DEV.	SYS. A.F.J.	MDS. BSA.	MDS. ASA.
122	2	0.335	0.000	0.000	0.000
128	5	0.086	-0.011	0.026	0.035
130	5	0.086	0.015	0.085	0.062
131	2	0.301	0.030	0.196	0.076
134	4	0.103	-0.003	0.037	0.062
136	0	0.000	-0.010	0.025	0.074
140	7	0.074	-0.017	0.035	0.075
142	3	0.467	0.021	0.090	0.053
144	10	0.113	0.113	0.477	0.420
146	13	0.126	0.255	0.261	0.110
157	1	0.384	0.000	0.060	0.068
163	2	0.033	-0.237	0.219	0.033
165	2	0.030	-0.176	0.112	0.058
171	2	0.016	-0.032	0.024	0.012
173	2	0.013	-0.062	0.184	0.062
178	2	0.021	0.025	0.136	0.010
185	3	0.780	0.015	0.043	0.000
189	3	0.104	0.064	0.025	0.005
191	3	0.191	-0.066	0.140	0.388
201	1	0.020	-0.113	0.117	0.313
203	1	0.139	0.000	0.243	0.188
205	1	0.021	-0.000	0.130	0.042
207	1	0.019	0.016	0.156	0.140
211	1	0.111	-0.102	0.222	0.208
213	1	0.112	0.128	0.098	0.108
215	1	0.034	-0.080	0.121	0.038
215	1	0.041	0.000	0.000	0.041



211

1

0.051

0.203

0.182

0.083

0.051

30

110

0.00

0.001

0.132

0.005

TOT.

SUM

AVG.

AVG.

AVG.

AVG.

BEFORE REMOVAL OF SYSTEMATIC ERROR
 AFTER REMOVAL OF SYSTEMATIC ERROR
 RATIO

**** AVERAGE OF SQUARES OF MISTIES ****
 0.94
 0.03
 0.10

BEFORE REMOVAL OF SYSTEMATIC ERROR
 AFTER REMOVAL OF SYSTEMATIC ERROR
 RATIO

**** COEFF. OF MEAN SQUARE (RMS) MISTIE ****
 0.71
 0.11
 0.05

BEFORE REMOVAL OF SYSTEMATIC ERROR
 AFTER REMOVAL OF SYSTEMATIC ERROR
 RATIO

**** AVERAGE OF ABSOLUTE MISTIES (MEAN RANDOM SCATTER) ****
 0.13
 0.13
 0.05

AVERAGE ABSOLUTE SYSTEMATIC ADJUSTMENT

0.01

SHIP ONE GRAVITY AND MAGNETIC PROCESSING SYS1

PROGRAM NAME ADJUSTMENT

DATE AUG13/82 TIME 101112Z
 WDM 0.100
 FILE OPENED AS OLD ON UNIT 10 1.000 100 0 1

*****OPEN*****
 FILE ON UNIT 10
 FILE NAME: SAMMONS CAK GRAV.SURVEY #2
 CYCLE NUMBER: 23
 TIME OF CREATION: 12122114
 DATE OF CREATION: AUG12/82
 NUMBER OF SURVEY LINES: 10
 NUMBER OF CHANNELS: 87
 NO DATA VALUE: 0.100000000000
 RESERVED WORDS: 0.0
 NUMBER OF WORDS REQUIRED: 172005
 NUMBER OF RECORDS 674

ADJUSTMENT OF WATER DEPTH-M (INTEN)

CONVERGENCE COMPLETE

** 21 ITERATIONS PERFORMED**

MAX. ERROR=0.241922-01

MAXIMAL CORRECTED SUBTASK : 1

*** LINE STATISTICS ***

LINE	NO. OF INT.	STD. DEV.	SYS. ADJ.	MRS. BSA.	MNS. ASA.	
102	1	0.034	1.263	0.703	0.034	0.32
102	1	0.162	-1.568	0.161	0.362	-0.22
128	5	0.107	-0.947	0.503	0.315	-0.74
130	5	1.227	-1.316	0.521	1.080	-0.50
131	2	0.745	0.074	0.341	0.745	0.24
134	4	1.213	0.071	0.943	0.503	10.22
136	4	1.702	1.123	1.495	1.211	0.13
138	4	1.036	0.001	1.531	1.414	0.40
140	4	1.527	0.523	1.068	1.122	0.42
142	4	4.419	-0.120	3.926	3.532	0.41
144	10	1.672	1.540	2.228	1.234	0.25
146	12	1.890	1.111	1.544	1.105	0.65
157	1	3.013	-1.425	0.465	0.013	0.10
163	2	0.100	-1.005	0.373	0.100	-0.21
128	2	0.372	-1.041	0.207	0.372	-0.17
171	2	1.309	-4.085	4.188	1.089	-0.24
173	2	0.827	0.792	0.857	0.024	-0.25
179	3	1.317	1.348	1.607	1.664	-0.24
185	3	0.479	1.514	0.410	0.476	-0.25
189	3	1.533	-1.207	2.476	1.444	-0.23
191	3	0.158	-0.727	2.065	0.172	-0.22
201	3	0.472	1.054	0.594	0.430	-0.21
203	3	1.051	-1.462	3.486	3.195	-0.15
205	7	2.975	1.402	2.042	2.165	-0.14
207	7	3.245	-0.922	2.317	2.419	-0.09
211	5	1.439	0.262	1.775	1.574	-0.16
213	2	0.766	-0.917	1.705	0.706	0.711
215	1	0.012	2.636	0.937	0.012	0.12
217	1	0.018	1.320	0.297	0.018	0.16
218	1	0.025	1.553	0.468	0.025	0.20

SI	119	1.862	0.000	1.12	0.978
TCT*	SUR	AVC.	AVC.	AVC.	AVC.

BEFORE REMOVAL OF SYSTEMATIC ERROR
 AFTER REMOVAL OF SYSTEMATIC ERROR
 RATIO

**** AVERAGES OF SQUARES OF MISTIES ****

BEFORE	1.77
AFTER	1.4
RATIO	1.27

BEFORE REMOVAL OF SYSTEMATIC ERROR
 AFTER REMOVAL OF SYSTEMATIC ERROR
 RATIO

**** ROOT MEAN SQUARE (RMS) MISTIE ****

BEFORE	1.34
AFTER	1.08
RATIO	1.22

BEFORE REMOVAL OF SYSTEMATIC ERROR
 AFTER REMOVAL OF SYSTEMATIC ERROR
 RATIO

**** AVERAGES OF ABSOLUTE MISTIES (MEAN RANDOM SCATTER) ****

BEFORE	1.54
AFTER	1.22
RATIO	1.27

AVERAGE ABSOLUTE SYSTEMATIC ADJUSTMENT 1.22

	NO. OF INT.	AVG. ADJ.	MRS. USA.	MRS. A.
107	2	1.191	0.751	0.441
109	2	0.167	0.290	0.367
111	1	0.471	1.536	0.472
117	2	0.755	1.502	1.424
123	2	0.217	2.007	2.017
125	2	1.755	2.379	1.755
135	2	3.606	3.836	0.666
137	1	2.140	2.500	0.678
141	1	0.010	0.190	0.012
145	1	1.404	2.593	1.614
150	2	1.033	0.424	1.165
151	2	1.038	1.658	1.385
152	1	3.150	0.657	0.050
156	2	0.300	3.406	0.306
158	4	0.300	0.455	0.076
164	2	0.094	0.852	0.255
170	1	1.472	2.076	0.054
176	1	3.024	1.261	1.328
1156	7	1.654	-0.257	1.390
18	48	1.255	0.002	1.217
TOT.	SUM	AVG.	AVG.	AVG.

**** AVERAGES OF SQUARES OF MISTIES ****

BEFORE REMOVAL OF SYSTEMATIC ERROR	1.48
AFTER REMOVAL OF SYSTEMATIC ERROR	2.77
RATIO	1.90

**** ROOT MEAN SQUARES (RMS) MISTIE ****

BEFORE REMOVAL OF SYSTEMATIC ERROR	1.22
AFTER REMOVAL OF SYSTEMATIC ERROR	1.66
RATIO	1.39

**** AVERAGES OF ABSOLUTE MISTIES (MEAN RANDOM SCATTER) ****

BEFORE REMOVAL OF SYSTEMATIC ERROR	1.68
AFTER REMOVAL OF SYSTEMATIC ERROR	1.29
RATIO	1.29
AVERAGE ABSOLUTE SYSTEMATIC ADJUSTMENT	1.00

The terms and abbreviations used in the adjustment statistics report are defined as follows:

NO. OF INT. is the number of intersections on the line.

STD.DEV. is the standard deviation of the intersection misties.

SYS.ADJ. is the systematic adjustment applied to the line.

MRS is the mean random scatter or average absolute mistie for each line.

BSA and ASA are before and after systematic adjustment, respectively.

OR.M.T. is the original mistie value.

R.E.ADJ. is the random error adjustment.

FIN.CH represents the final-choice value at the intersection.

Note that there are two sets of values printed for mean random scatter at the end of the Line Statistics Table: the averages at the bottom of the 'MRS' columns, and the values under a separate heading immediately below. The averages at the bottom of the column represent the average of the line averages, while the second set of values represent the average over the entire survey.

Supplement to the report on
SAMMON'S CREEK GRAVITY DATA
INTERPRETATION

The necessity of writing this supplement arose from closer examination of seismic and gravity data over the area of future drilling location (line 23X) and of the most confusing structural situation (line 107X). As far as gravity is concerned, we found that gravity effects of near surface geology are much stronger, than we had anticipated. This occurs when carbonates of the Hume formation (density 2.75-2.8 g/cc) reach the surface (for instance SP 356-372 of line 107X), making our choice of Bouguer density of 2.35 g/cc incorrect. In such places the Bouguer gravity will be stronger than it should be, because the attraction of carbonates with density contrast of 0.4 g/cc (2.75-2.45 g/cc) was not taken into account. The problem was mentioned in chapter VI of our report (page 14), but only later have we realized that the difference may amount up to 5 mgals or more, depending on the size of outcrops.

The problem of variable density in Bouguer correction is a rather complicated one and is not solved yet in general. In our particular case we solved the problem by computing the gravity effect of carbonates between the surface and sea level by POLYGRAV (assuming a certain geometry) and by subtracting it from previously calculated Bouguer gravity.

The attached (figures 1 and 2) illustrate the process for lines 107X and 23X accordingly. Here the dot-dashed lines represent the original gravity and solid line represents gravity, corrected for near surface effects. Note that such correction reduces the anomaly by 3.5-4.5 mgals and shifts the location of gravity maximum to the south-west (to the left on profile display). After this correction was made, we created the geological models, based strictly on seismic interpretation and calculated the gravity effects of these models. We purposely did not make any alterations of geological models in order to find out which one is closer to the reality. Finally we came to the following conclusions.

Line 107X

1. The anticline model (fig. 1,a) evidently is very far from reality and must be abandoned.
2. The second model (fig. 1,b) is qualitatively better and supports the thrust hypothesis. That forced us to change our original interpretation of southern anomalous trend as caused by deep seated normal fault. Now we think of it as the regional thrust, roughly parallel to the northern one. That fits better into the regional tectonic framework and can be confirmed by gravity and seismic data from other lines. The appropriate change has been made in structural interpretation map (plate 4).

3. We still cannot adequately explain the observed gravity over the "wedge" between SP 368-388. Observed gravity strongly suggest that low density material should be placed there in order to eliminate the strange "bump" in calculated gravity between SP 368-400. We have no choice but to conclude that the "wedge" is primarily Cambrian section, which is the only low density material available. The question of its origin - whether it has been introduced into section by intricate thrust tectonics or it is a primary sedimentary feature (as we originally suggested) - remains open.

Line 23X

1. As we can see from figure 2 (part "A" represents our original interpretation, part "B" - interpretation after correction for near surface effects), the interpretation here is considerably simpler and is dominated by the same two major thrust planes which we see on line 107X. The problem which we can't explain on this line is that to the northeast of the thrust faults the modelled gravity is much higher than the observed gravity. We could explain this by increasing the depth of the Hume (thus increasing the vertical offset caused by the thrust fault), but this is badly at odds with the seismic picture. We can only suggest that there is some fundamental change (decrease) in the density of the Proterozoic section as one goes northeast. We realize that this is an ad hoc argument, but we have no better explanation.

2. In terms of the drilling decision for the proposed well on line 23X, the major question as we see it is where the thrust fault is just NE of the proposed location. We place it where we do (reaching the surface at SP 507) based on the inflection point of the observed gravity, the break slope, and the occurrence of carbonate outcrop as defined by shot-hole logs. It could be up to 5 shot points farther to the northeast, but we doubt it. The depth at which the drill will intersect the fault plane cannot be constrained by gravity modelling, although we believe our model is the most reasonable picture. However, given the uncertainty of the interpretation and the need to know where the second fault plane is in order to establish a regional interpretation in which one can have confidence, we suggest that the well be planned to intersect the second fault plane if that is within reach of the rig chosen. There is always a small chance of thin Cambrian slices being repeated, but we believe the prime justification for a deep well is (1) the risk of error in the present interpretation and (2) the need for stratigraphic control.

LL/mjo

246-06-05-115

GEOPHYSICAL REPORT
ON THE
SEISMIC REFLECTION AND GRAVITY SURVEY
IN
SAMMON'S CREEK AREA
NORTHERN INTERIOR PLAINS N.W.T.
(EXPLORATION AGREEMENT NO. 10)
BY
PETRO-CANADA EXPLORATION INC.

WORK PERIOD: DECEMBER 1981 THROUGH APRIL 1982
PROJECT: 246-06-05-01-06
LAND USE PERMIT: NB1B586
AUTHOR: K. LAU
DATE: APRIL, 1983
DATA ACQUISITION BY: WESTERN & AIRBORNE GEOPHYSICAL

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1. Seismic Lines
2. Staging Area
3. Fuel Truck Routes

I. INTRODUCTION

The Samson's Creek project is located 55km west of Norman Wells, District of Mackenzie, Northwest Territories (see accompanying map). The project is geographically bound by the Mackenzie River to the north, Three Day Lake to the east, the Carcajou Mountain Range to the south and Mountain River to the west. The project is located within the northeast corner of the physiographic sub-province of Mackenzie Plain.

The project involves a seismic and a gravity program. The gravity program was run essentially along the seismic lines. The programs were approximately split into halves by the Carcajou River. The north half is on relatively flat lying area (from 40 meters to about 200 meters above sea level) with easy access. The southern half has diverse terrain. The Imperial Hills with maximum elevation of just less than 600 meters is almost inaccessible. Walker Creek and Rankin Creek run into the Carcajou River. All three cut steep escarpments into the topography. These factors dictate, in part, the program layout and field operations. The majority of the timber here is light spruce, pine and willow.

The project objective is to evaluate PEX acreage and to obtain general subsurface information of the area. Target zone is the basal Cambrian sand. A total of 837 kilometers of seismic was shot and 870 kilometers of gravity was run. Seismic was shot by Western Geophysical Company

of Canada Limited under the supervision of Mr. Reid Gray of Petro-Canada Exploration Inc. and Mr. Bill Quirk of Western Geophysical Limited. The gravity was run by Mr. Mike McComb of Airborne Geophysical Surveys Limited. The field operation was co-ordinated by party manager Mr. Ross Brown. Dozing operations were co-ordinated by Mr. Dean Borek of Borek Construction.

Start up date of the crew was December 28, 1981. Normally 63 men were involved in all phases of the field operation including the expediting service in Norman Wells. All aspects of operation were finished by April 23, 1982.

II. LOGISTICAL SUMMARY

The geophysical equipment, dozers, camps and spare parts were assembled at various locations, in Alberta and at Dawson Creek, British Columbia, after August 1, 1981. The physical trucking of the various units, plus parts, took place during the latter part of August and the first half of September. Northern Transportation Company Ltd. had given a tentative barge departure date of September 15, 1981 and the complete seismic package was "on site" at the Hay River depot by that deadline.

The departure date was postponed due to the extremely low water levels in the Mackenzie River. This problem resulted in an extreme backlog in river traffic downstream from Norman Wells. A major concern of N.T.C.L.'s people in Hay River was the possibility of running aground near Raider Island. This island is approximately five miles downstream from Norman Wells with the navigable channel being very shallow even in normal years. The original staging permit was applied for under Land Use Permit N81B586, and related to the Maida Creek area, which is forty-eight miles downstream from Norman Wells. The Raider Island problem dictated that another staging area be located upstream from the island. A site was located, directly across river from Norman Wells and upstream from Bear Island. The water passage to the area was depth sounded in a small recreational craft and sufficient bottom clearances were found for the barges to land.

The W.T.C.L. barges were loaded September 28 and 29 with the seismic package plus 97,000 litres of diesel fuel. The departure occurred September 30 with the arrival at Norman Wells on October 6, 1981. The "tow" was somewhat delayed due to strong winds on Great Slave Lake.

Western Geophysical representatives arrived at Norman Wells at the end of September in order to prepare the equipment for barging and scout for an alternate staging site, as mentioned previously. The town clerk was contacted verbally by Bill Quirk in regard to the alternate staging site, after it was definitely known that the Raider Island problem would not allow river traffic downstream. The formal staging request was made October 20, 1981 by Mr. G. McCormick of Petro-Canada Exploration Inc.

Borek Construction Ltd.'s dozing personnel arrived on October 6 and all personnel were flown to the staging site by helicopter. The complete package was offloaded by October 7 including fuel and the Norman Wells based equipment. Fuel storage tanks were moved inland in order to be less visible from the river. The sleigh mounted trailers, sloops and storage units were "blocked up" and abandoned in position for startup during the post-Christmas week. The security of the area was maintained by the onslaught of winter until December at which time a Western representative was on hand at Norman Wells.

The Norman Wells expediting operation was mobilized in early December. The expediting service consisted of two expeditors, one truck, one Ardoo Buggy Model "K" (with a snowplough), telex, telephone, communication radios, and a mobile trailer used for office and sleeping quarters. Whenever possible crew members in transit stayed in this trailer. Fuels, foods, explosives, and other essential supplies were co-ordinated by the expeditor for the field operation.

The "start up" crew arrived in Norman Wells on December 28, 1982 with the majority of the crew following on January 3, 1982. The next few days were spent starting all the equipment, and preparing for work. At this time work had begun on an ice road. This ice road took off from an existing ice road that ran between Goose and Bear Islands; it joined the mainland again on the Canal Road. Until this ice road was completed the operation was dependant on a helicopter.

After some initial difficulties, snowploughing and line cutting operations began on line 57X on December 30, 1981. Drilling commenced on January 6, 1982 and the recording crew got underway on January 9. With the completion of the ice road, all fuel, explosives and food were transported via truck or Ardoo buggy.

In mid-February the creeks in the Canal Lake area began to flow and cut off the access to town. As a stop-gap alternative, an ice road was built on the Mackenzie River up to Maida Creek. Due to the steep banks

on the river the fuel truck was unable to get off the river unless assisted by a dozer. Another approach was also built on the end of line 119X, but with the same result. At this point a fuel train was utilized to haul fuel from the river. All other supplies were flown in. Field strips were constructed on lake ice. Aircraft control was assisted by the use of an air-to-ground radio.

In late February a detour was cut around Canol Lake. This detour utilized existing cut lines for the most part, and joined up with the original access route. It was used primarily by the fuel truck, as it cut down the distance for the fuel train. However, due to the distance from town, all other supplies were flown in. Once the crew recrossed the Carcajou River, the land access route was used for the remainder of the prospect.

Explosives, drill bits and a portion of the gear oils and lubes were obtainable in Norman Wells. Vehicle repair parts, etc. were purchased in Calgary. Food supplies were purchased from a local supplier in Norman Wells.

Key personnel were obtained from Calgary, Edmonton, Inuvik, and Peace River. Native residents of the northern territories were from Fort Norman, Norman Wells, Fort Good Hope, Inuvik, and Fort McPherson. Native residents comprised 30 - 35% of field personnel. Time off periods were on a self-determination basis subject to the availability of replacement personnel.

The crew fuel consumption per day was 6364 litres of diesel fuel and 182 litres of gasoline. Fuels and lubricants were purchased from a bulk station in Norman Wells.

A commercial air carrier, P.W.A., was utilized from southern Canada to ship men and parts to Norman Wells. The reverse was the rule upon completion of the winter's season. A Porter, and a Cessna 185 were utilized on a charter basis. These aircraft transported explosives, personnel, food, and parts. Personnel movement on time-off periods used both commercial carriers and chartered aircraft.

III. STATISTICAL SUMMARY

DATES

Mobilization Date	January 3, 1982
Start of Recording	January 9, 1982
Completion of Recording	April 18, 1982
Demobilization Date	April 19, 1982

PRODUCTION

RECORDING

Total operating days	101 Camp (Jan.9-Apr.19)
Total recording days	94
Total moving days	0
Total weather days	1
Total testing days	0
Total down days	5
Production profiles shot	6356
Kilometres shot	837.86
Profile per day	67.62
Kilometres per production day	8.91
Total days moving mob/demob	1

PRODUCTION

DRILLING

Total moving days	0
Total testing days	0
Total weather days	0
Total drilling days	94
*Number of locations drilled	6470
**Average hole depth	18.05 metres
*Average holes per day	68.83
**Total metres drilled	116,763 metres
**Powder consumed	13,060 kgm.
**Average charge per hole	2.02 kgm.
Total days moving mob/demob	1

*Usable production locations only

**Includes all footage drilled and explosives lost due to cave-ins.

IV. EQUIPMENT AND FIELD PROCEDURE

RECORDING

Sample Rate	2 millisecond
Record Length	6 seconds
Recording Filter	8 - 128
Sub-surface Coverage	12004
No. of Groups	96
Group Interval	33 metres
Geophone Array	9 @ 56 metres
Seismometers per Group	9
Shot Point Location	132 metres
Holes per Location	1
Hole Depth	18 metres
Dynamite Charge	2 kilograms (single cap)

The cable layout was 1584-33-0-33-1584 balanced spread with shot points located on the group flags. A 33 metre gap was used on either side of the shot point. The shot point seismometer was placed 3 metres from the shot hole. Group 1 was always to the north or east of each line shot. All shot holes were filled by radio signals with the recording instruments the master unit.

Record quality ranged from poor (Hoosier Ridge) to good throughout the course of the survey.

Flagging for survey control, shot hole, and geophone locations was removed by the recording personnel after each line was shot. Aluminum tape tags were nailed to a tree near the shot hole location by the shooter. All tags indicated the land use number, line number, and shot point number of the location.

Due to program additions towards the end of the prospect, it was necessary to run a second shift on the recording operation. The double shift ran for 26 days, from March 23 to April 18. Without the second shift it is doubtful if the crew would have finished before break up.

TESTS

Western Geophysical instrument tests were run in Calgary prior to the recording package being shipped. Western instrument tests were run every 15 days and sent to Houston for processing.

No specific Petro-Canada instrument tests were requested.

Data processing and interpretation was handled under the direction of Mr. King-Hoi Lau of Petro-Canada.

DRILLING

Initially six drills were positioned on the crew. Three of these were air conventional drills; one was an air/water combination conventional; and two were air/water combination top drives. Late in January one of the top drives was replaced by an air conventional and late in February another air conventional was added. Shot points were all single holes at a depth of 18 metres. All production holes were preloaded with two kilograms of Geogel 60 and tamped with the cuttings. No holes were drilled on lakes or near watercourses and when applicable the shot point was skidded to maintain continuity.

Drilling formations varied from hard limestone or gravel with water seams to soft shale or wet clay. While the majority of the prospect was drilled with air, the air/water conventional was needed on lines 23X (at the base of the escarpment) and line 37X; here this rig was double-shifted in an attempt to keep up with the other drills. The air/water combination top drives proved their versatility and were particularly useful in the sticky clay formations.

Bit consumption was .41 bit per hole at an average cost of \$92.52 per bit. Drill bits used were heavy duty starters, inserts, and rock bits. One carbide-tipped button bit was tried on the hard limestone of the escarpment, but was not deemed useful. The sizes ranged from 3-1/2" to 5-1/8".

SURVEYING

Three Wild T-16 theodolite survey instruments were used for horizontal and vertical control. A Distomat D14L was also used for control throughout the prospect, especially in the more difficult terrain. An inordinate amount of survey and helicopter time was spent searching for benchmarks along the Mackenzie River. These were virtually impossible to find and satisfactory survey control for this prospect was a problem.

Mr. Doug Conacher, head surveyor, and Mr. Greg Sinclair, second surveyor, along with two experienced rodmen comprised two complete survey crews. In late January a fifth survey helper was brought in.

Shot point and geophone group location distances were derived by chaining. Pin flags marked the geophone and shot point locations.

Chainage notes were kept for each line and forwarded to Petro-Canada with the record shipments.

New cut line locations were derived from topographic features and sun shots. When a helicopter was available the machine was used for a "Line of Sight" to set off the dozers. Station elevations were computed by stadia and horizontal locations by latitudes and

departures. The lines were plotted on base maps obtained from Petro-Canada and all original survey notes, location sheets, closure sheets, base maps and final report maps were forwarded to Petro-Canada.

The final horizontal presentation was in the U.T.M. grid and all survey work was performed in the metric system.

DOZING

Only one-quarter of the prospect was existing line; the remaining line was new cut and the majority of lakes encountered had to have detours cut. The line was cut to a 9 metre width with the slash windrowed to one side of the trail and compacted by the dozers. Where timber density warranted, the slash piles were broken about every 305 metres. Creek crossings were snow fills which were removed after completion of the shooting.

Six dozers were assigned to the operation. Three D-7's cut and cleared the line; Two D-7's moved camp and did line clean up, windrowed the slash and removed creek crossings; One D-7 worked the fuel haul. Four of the six dozers were double shifted; the second shift ended April 8, 1982.

LAND USE

Land Use supervision was handled by the land use officer of the Department of Indian and Northern Affairs. The permit was issued by the Yellowknife office. Prior to the land use permit being issued, meetings occurred in Fort Good Hope, Fort Norman and Norman Wells, with the representatives of Petro-Canada, Land Use, and the native interest groups of the area. This meeting resulted in the conditions being drafted into the Land Use Permit.

A separate staging and access permit was obtained for the area around Canol Lake which was covered by the Norman Wells Block Land Transfer.

Field representatives from the N.W.T. Land Use Department and representatives of the Hunters and Trappers Associations of Fort Good Hope, Fort Norman, and Norman Wells visited the field party and saw the actual field work performed. The Norman Wells Land Use Office, under the direction of Mr. T. Rudolph and Mr. A. Williamson, was responsible for the area.

Dozers used "shoes" on the dozer blades to elevate the "cutting edge". This procedure resulted in a minimum of six inches of snow cover on the tundra. All flagging, lathe, and survey markers were removed from the surface behind the recording crew. Garbage, waste lubricants and other disposals were incinerated in a forced air, fuel fired, incinerator. The ashes and residue were then buried in garbage holes drilled near the various camp locations. A native monitor stayed with the crew to observe the operation while in the Fort Good Hope area.

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Final plans of the new cut line, campsite locations and access routes were submitted to the N.W.T. Land Use Office upon the termination of the Sammon's Creek survey.

CONTRACTORS

PRINCIPAL CONTRACTORS

Western Geophysical Company of Canada, Ltd.
2612 - 37 Avenue N.E.
Calgary, Alberta

Airborne Geophysical Surveys Ltd.
4215C - 11 Street N.E.
Calgary, Alberta

SUB-CONTRACTORS

Borek Construction
10401 - 10 Street
Dawson Creek, B.C.

Arctic Circle Enterprises Ltd.
Fort Good Hope, N.W.T.

Double R Drilling Co. Ltd.
R.R. 1
Spruce Grove, Alberta

EQUIPMENT

TECHNICAL

Amplifiers	Texas Instruments	DFS V
Tape Systems	Texas Instruments	DFS V
Oscillograph	Tektronic	
Camera	S.I.E.	ERC-10C
Remote Firing System	Input-Output	Encoder/Decoder
Cables	Geo Space Canada Ltd.	660 feet with 55 foot group interval 12 outlets per cable
Geophone Strings	Geo Space Canada Ltd.	Model 20D-10 Hz 670 OHM coil 9 @ 56 metres Array

VEHICLES

<u>No.</u>	<u>Use</u>	<u>Type</u>
1	Party Manager	F-250 4x4
1	Recorder	FN-110
1	Shooting	CF-60
4	Cable Trucks	FN-110 Crew Cab
1	Survey Truck	Bronco 4x4
2	Survey Trucks	CF-60 Crew Cab
2	Drilling Rigs	CF-110 Hillbrand C-1000 Air/Water
5	Drilling Rigs	CF-110 Mayhew Model 1000-Air
1	Drilling Rig	CF-110 Mayhew Model 1000 Air/Water
2	Camp Water Trucks	FN-110 Gin Poles
1	Drill Water Truck	FN-110
1	Mobile Shop	FN-110
1	Expediter Truck	F-250 4x4
1	Expediter Truck	Ardco Buggy Model "K" Snow Plough
1	Supply Truck	Ardco Buggy Model "K" Crew Cab

VEHICLES

<u>No.</u>	<u>Use</u>	<u>Type</u>
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CAMP - DRILLING

1	Kitchen-Diner	Sleigh mounted
1	Utility	Sleigh mounted
1	Office-Sleeper	Sleigh mounted
2	Sleepers	Sleigh mounted
1	Power-Shop-Storage	Sleigh mounted
2	Fuel Sloops (27,275 litre)	Sleigh mounted
1	Powder Magazine	Sleigh mounted

CAMP - RECORDING

1	Kitchen-Diner	Sleigh mounted
1	Power-Shop-Storage	Sleigh mounted
1	Utility-Sleeper	Sleigh mounted
2	Sleepers	Sleigh mounted
1	Incinerator	Sleigh mounted
1	Fuel Sloop (13,638 litre)	Sleigh mounted

DOZERSCREWS

VEHICLES

6	D7F Caterpillar Tractors	c/w hydraulic blades, winch and mushroom shoes
1	FN-60 Nodwell	Foreman's Vehicle

DOZER CREWS

CAMP

<u>No.</u>	<u>Use</u>	<u>Type</u>
1	Kitchen-Diner-Sleeper	Sleigh mounted
1	Sleeper-Utility	Sleigh mounted
1	Shop-Power Unit	Sleigh mounted
1	Fuel Sloop (9092 litres)	Sleigh mounted

FUEL HAUL CAMP

1	Kitchen-Diner-Sleeper-Power Unit	Sleigh mounted
3	Fuel Sloops (38,640 litres)	Sleigh mounted

CREW COMPOSITION

RECORDING

1 - Observer	
2 - Assistant Observer	
1 - Shooter	
1 - Assistant Shooter	
4 - Cable Truck Drivers	
8 - Recording Helpers	16 Men

DRILLING

7 - Drillers (includes relief personnel)	
7 - Drill Helpers (includes relief personnel)	
1 - Driller Mechanic	15 Men

SURVEYING

2 - Surveyors	
3 - Rodmen	5 Men

CATERING

2 - Cooks	
2 - Assistant Cooks	
1 - Camp Attendant	5 Men

ADDITIONAL

1 - Party Manager	
1 - Assistant Party Manager	
1 - Clerk-Supplyman	
2 - Mechanics	
1 - Mechanic's Helper	
1 - Expediter	
1 - Expediter's Assistant	8 Men

LINE CUTTING AND CLEARING

10 - Machine Operators	
1 - Foreman	
1 - Cook	
1 - Native Monitor	13 Men

GRAVITY

1 - Operator		<u>1</u> Man
Total Personnel		63 Men

GRAVITY DATA ACQUISITION

1. Base Network

The observed gravity at Government Station #8549-59 (Norman Wells airport terminal) was tied with the initial base station at SP 854 of line 46X by double helicopter ties with average accuracy of $\pm 0.01 - 0.02$ mgal.

The further development of base network was accomplished by "step-by-step" method, when each previously set base was used as the reference for the next one. Theoretically speaking, this method inevitably leads to accumulation of errors and must be used, only if it is technically impossible to use "radial" method, when each base is tied with a main base by independent ties. Actual RMS error of base network in our case doesn't exceed ± 0.06 mgal, which lies well within required limits. However, such good accuracy can be considered as a matter of luck, because the last base was not tied back to Norman Wells (the loop was actually closed on one of the first bases close to the initial base at SP 854, line 46X). There were twenty-eight bases altogether. Usually they were located and temporarily fixed at seismic lines intersections. After clean-up it will be rather difficult to find their exact position, and practically speaking, they can't be used again.

2. Gravity Meters

One LaCoste & Romberg gravity meter No. G-232 was used for the entire survey. The sensitivity function of the meter within range of measured anomalies was practically flat, so one conversion constant $C=1.05526$ was used. Typical drift was no more than 0.005 mgal per hour. The meter worked very steadily even when the thermostating eventually went down.

3. Gravity Measurements

The gravity survey was carried out by Airborne Geophysical Survey Ltd. (Calgary) during the months of January - May, 1982 (operator - M. McCombe). The following is the principal statistical summary of the survey.

Reading interval - 264 m (each second shot point).

Number of independent readings at each station - 3.

Method of meter setting - on tripod, with measurement of the elevation above ground.

Total number of stations metered - 3146.

Total number of lines - 50.

Total distance covered - 870.31 km.

RMS accuracy of single observation - 0.022 mgal. (100 check points).

4. Vertical Control

Western Geophysical Survey Ltd. carried out both the elevation and horizontal surveys. Elevations were provided to operator with significant delay in time, so no gravity reduction was done in the field. The survey specs required the closure to be no more than 0.9 meters. We estimated the final accuracy of survey by RMS error of misties at intersections, which provides an independent and exhaustive control. Such a statistic shows that RMS error of misties reaches \pm 1.20 meters, which is above the specified limits. Fortunately enough, it doesn't affect the accuracy of gravity data, as it follows from statistics, but, given the same contractor in the future, we shall pay more attention to the quality of vertical control.

5. Horizontal Control

The accuracy of horizontal control lies well within the specified limits. However, the positioning for Sammon's Creek survey was presented in inconvenient form: X and Y coordinates were given only for the start and end points of lines and for inflection points in-between. It slowed down the in-house processing, because we had to write a special program for linear interpretation to obtain coordinates for each shot point.

6. Accuracy and Data Quality

The accuracy of Bouguer gravity, as a final product of any survey, is affected by accuracy of each variable involved in the calculation of Bouguer anomaly. They are:

- 1) observed gravity
- 2) elevation
- 3) positioning
- 4) terrain and tidal corrections.

$$\sqrt{E^2(\text{obs.gr}) + E^2(\text{elev}) + E^2(\text{pos}) + E^2(\text{tide})}$$

where E = RMS error.

Accuracy of observed gravity is affected by the quality of base network and systematic and random meter errors. Accuracy of single observations, calculated from double observations, gives a good estimate of E(obs) and in our case is close to 0.02 mgal.

Elevations, as stated above, are known with accuracy of ± 1.2 m. Using the vertical gravity gradient of 0.3086 mgal/m, such an error will provide uncertainty in gravity observation of ± 0.37 mgal in Free air anomaly and approximately ± 0.27 mgal in Bouguer anomaly.

Errors in horizontal positioning about 1-2 m have negligible effect on gravity calculations.

Terrain corrections were applied only to observations made at very rough terrain and comprise less than 1% of the stations. The accuracy of terrain corrections is difficult to estimate, but we believe that errors do not exceed 0.08 mgal in inner zone of Hammer's chart.

Tidal effect is calculated with high precision and need not be taken into consideration when evaluating errors. Finally, we can expect the accuracy of survey to be no worse than:

$$E_{\text{obs}} = \pm 0.02 \text{ mgal}$$

$$E_{\text{elev}} = \pm 0.27 \text{ mgal}$$

$$E_{\text{terr}} = \pm 0.08 \text{ mgal}$$

$$\text{and } E_{\text{Boug}} = \pm \sqrt{(0.02)^2 + (0.27)^2 + (0.08)^2} = 0.0797 = \pm 0.28 \text{ mgal}$$

Actual accuracy was estimated by our processing of RMS errors of Bouguer anomalies at intersections. Statistics show that actual RMS error before systematic adjustments is ± 0.25 mgal, which is very close to what we previously estimated. Systematic adjustments improved the accuracy significantly up to ± 0.13 mgal. The last figure indicates very good quality of survey. With such an accuracy, the anomalies of the order of 0.3 mgal can be considered as real. Contouring interval of 0.5 mgal can also be statistically justified.

V. DATA PROCESSING

The seismic data recorded was processed at GBOX Systems Limited (Calgary). The processing procedures are as follows:-

1. Demultiplex
2. Amplitude recovery
3. Spiking deconvolution
4. Structural static corrections
5. Preliminary normal moveout corrections
6. Surface stack residual statics
7. Trace kills
8. Statistical surface consistant statics
9. Final normal moveout corrections
10. Cross correlation
11. Mute
12. Gather
13. Stack
14. Filter
15. Scaling
16. Equalization
17. Migration

The lines are processed at 2 millisecond sample rate. Amplitude recovery includes both spherical divergence and attenuation corrections. Deconvolution tests were run whereby a 60 millisecond operator length and 1% prewhitening were chosen. Structural static corrections including elevation, weathering and drift corrections done by GEOX Systems Limited were applied with sea level as datum and 3506 meters/second as replacement velocity.

Normal moveout analysis was done using common offset stacks. Surface stack residual statics were hand picked and applied to the data. Bad traces were killed. Further autostatic adjustment and normal moveout analysis were done to refine the necessary static and dynamic corrections. Data were then muted, gathered and stacked. A time variant final filter and time variant scaling were applied. Migration in the K-K domain was done where required.

Gravity data processing included the following major steps:

1. Interpolation of X and Z coordinates and hand input of all pertinent information (lines and station numbers, coordinates and elevations, observed gravity).

2. Calculation of Bouguer anomalies with density 2.35 g/cm^3 for each line.
3. Merging the line data into the Merged Survey File (MSF).
4. Low-pass filtering of Bouguer profiles.
5. Calculation of intersection statistics.
6. Systematic adjustment of all the data.
7. Plotting of the index map, contour maps and all the profiles.
8. Indexing the gravity data.

VI. INTERPRETATION AND RESULTS

The stratigraphic column of the Sammon's Creek area consists of Proterozoic, Cambrian, Ordovician, Silurian, Devonian and Cretaceous units (Fig. 1). Tedji Lake gas discovery have encouraged exploration activities in Northern Interior Plains for Cambrian sand play. There is no Cambrian section exposed in the project area. It is found outcropping along the Mackenzie Mountain front to the south.

Major structural features in the project area is the Imperial Anticline. It is believed to be a Laramide structure. It runs along the Imperial Hills east-west wise before turning southeast as it approaches the Carcajou River. The arcuate form is typical of the structural style found in the area. The oldest unit found exposed along the anticline is the Ordovician-Silurian Mount Kindle carbonate.

Most of the seismic line were shot as dip lines across the anticline. Data quality is generally good when the drill hole bottomed in clastic rocks. Where carbonate outcrops or is close to surface, the data quality deteriorates to such an extent that only incoherent noise is observed in general. This created problem in correlation of events across the anticline. Carbonates crop out almost continuously along the anticlinal axis where seismic lines were shot. The deeply incised Carcajou River also prevent good continuous coverage. A few lines gave

reasonably good data and subsurface coverage across these two obstacles (e.g. lines 105X, 107X, 7X/117).

Two horizons were mapped. They are base of Franklin Mountain (Cambrian-Ordovician carbonate) and top of Proterozoic. Base of Franklin Mountain is a good mappable reflector due to strong velocity (and density) contrasts between the carbonate and the underlying clastics or salt. The event is tied into the Dodo Canyon K-03 well. No well has penetrated the total cambrian section in the general area. Top of Proterozoic is determined on the basis of truncation of events. It is best shown on the west end of line 46X.

Correlation shows that a "wedge" exists between the base of Franklin Mountain and top of Proterozoic (see line 105X). The zero edge of this "wedge" is located on the north side of the Imperial Anticline (mainly north of Carcajou River). The "wedge" thickens rapidly to over 900 millisecond (2-way time) underneath the surface anticlinal position. Using an estimated 4500 meters/second, 900 millisecond converts to a thickness of 2025 meters.

A number of geological possibilities may lead to the formation of this "wedge", such as: a) an erosional wedge, b) salt tectonics, c) thrusting, or d) any combination of above. From interpretation of the seismic data, the observed overall configuration of seismic events can be simply explained by the occurrence of a blind thrust. However, the ramp between the main lower and upper detachment surface is not

observed in the seismic coverage obtained. The postulated lower detachment surface being within the Proterozoic while the upper one is between the base of Franklin Mountain and top of Proterozoic. With the blind thrust model, the various folds and faults as observed on surface exposures can also be easily correlated with the subsurface configuration.

The blind thrust model led to the interpretation of the formation of duplexes as shown on lines 7X and 34X. The triangular shaped geometry as seen on migrated portion of line 7X can also be explained as the remnant of the original leading edge of the blind thrust rather than the existence of a depositional pocket.

If the blind thrust model is correct, the stratigraphic contact at the roof thrust and the floor thrust would control the structural position of the Cambrian sand play. Aitken and Cook (GSC paper 74-13) reported the existence of a low angle thrust slice of Proterozoic Katherine group separating Saline River Formation from underlying Mount Cap Formation at the head of the south fork of Katherine Creek. In this case, the Proterozoic section will be penetrated before reaching the Mount Cap sand. If the roof thrust is underneath the Cambrian Sand section, there will be no Proterozoic section above the Cambrian sand. If, in the former case, the Cambrian sand was brought up with the Proterozoic slice, a multiple Cambrian sand play may be present.

However, the other possibilities listed earlier cannot be ruled out nor the existence of a blind thrust proven until it is tested by drilling. Within the area, possibilities of a Kee Scarp Reef or basal Cretaceous sand play may also exist.

The gravity survey runs essentially along the seismic lines. Bouguer gravity map (plate 2) and residual gravity map (plate 3) show similar trends to the surface structural trends. The Cambrian to Devonian carbonate sequence is the dominant cause for the gravity anomalies. A structural map on the top of Devonian carbonates was made since it is a boundary of significant density contrast and accounts for a major part of total gravity effect.

Originally two lines were being modelled. They are lines 36X and 107X. Line 36X showed the calculated gravity of both section 1 and 2 fitting the observed gravity well. However, problems exist in modelling line 107X. Section 2 of line 107X has a more reasonable geological picture and fits the seismic better, but the calculated gravity does not fit as well as section 1.

As mentioned above, the carbonates have a dominant effect on gravity. The Bouguer correction was made using a constant density of 2.65 gm/c.c. It was found that the carbonate effect is more than anticipated, line 107X was remodelled and line 23X was added onto the modelling list.

Two uncertainties exist. One is the geometric construction of the subsurface geology. The other is the density of the Precambrian section. The observed gravity is the measurement of a three dimensional effect of depth to various density units and their horizontal extents.

Figures 1A and 1B show two remodelled interpretations of line 107X. Effort was made to fit the models to possible seismic interpretations. Both models encountered problems at the location where the wedge is present. The calculated gravity is too high for both models at the "wedge". Figure 1A assumes a simple anticline with the "wedge" underneath, while figure 1B assumes a thrust with a remnant wedge.

For line 23X, figure 2A has a better fit between the observed and calculated gravity while figure 2B shows quite a discrepancy. The former model was made to fit the observed gravity while the latter model was derived from the seismic section. North of shot point 580 in figure 2A, the sand-shale and carbonate density boundary has to be lowered by 1,000 meters in order to get the calculated gravity to fit the observed gravity as shown in figure 2B. This means a 300 millisecond difference on the seismic section or a drastic increase in velocity. The density and velocity of the carbonates and the above sand shale sequence are quite uniform from the few wells observed in the area. The cambrian section is expected to be relatively "thin" here i.e. the gravity contribution is small. A lowering of the density from 2.4 to 2.3 gm/c.c. still cannot explain the 10 milligal difference between the calculated and the observed value. By the process of elimination, we must have

a rather thick and low density Precambrian unit.

The problem of the carbonate outcropping, the three dimensional effect and unknown density units limit interpretation based mainly on gravity. It does, however, augment the seismic interpretation. On the whole, the gravity seems to support the overthrust model of the seismic interpretation.

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Date: 83-12-13

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VI. REFERENCES AND ENCLOSURES

References

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Aitken, J.D.; Cook, D.G.; Yorath, C.J.

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1973: Reconnaissance studies of Proterozoic and Cambrian stratigraphy, Lower Mackenzie River area (Operation Norman), District of Mackenzie; GSC paper 73-9

Enclosures

1. 3 Time Structure maps:

- a) Top of Proterozoic
- b) Base of Franklin Mountain
- c) Top of Kee Scarp

2. 46 seismic structure sections (with both normal and reverse polarity) as per attached list
14 migrated seismic sections (normal polarity only)

3. 50 gravity profiles/

4. 8 gravity model sections

5. Gravity maps - 1 Gravity base map /
1 Bouguer gravity map /
1 Residual gravity map /
1 gravity structural interpretation map /

LIST OF SEISMIC LINES

<u>Normal & Reverse Polarity</u>	<u>Migrated</u>
5AX ✓	
7X ✓	
9X ✓	7X ✓
11 ✓	
17X ✓	11X ✓
22X ✓	17X ✓
23X ✓	
25X ✓	23X ✓
28X ✓	25X ✓
30D ✓	
30X ✓	
34X ✓	34X ✓
35X ✓	35X ✓
36X ✓	
37 ✓	
38X ✓	
40X/50X/56A ✓	
41X ✓	40X/50X/56A ✓
42X ✓	41X ✓
44X ✓	
45A ✓	45A ✓
46X/70X ✓	46X/70X ✓
51 ✓	
52X/54 ✓	52X/54 ✓
56X ✓	
57X ✓	
63X ✓	
64X ✓	
65X ✓	
71X ✓	
73A ✓	
73X ✓	
79X ✓	
85X ✓	
89X ✓	
91X ✓	
101X ✓	
107X ✓	
105X ✓	103X ✓
107X ✓	105X ✓
111X ✓	
113X ✓	
115X ✓	
115X/5X ✓	
117X/7X ✓	
119X/9X ✓	

Sammon's Creek Area STRATIGRAPHIC COLUMN

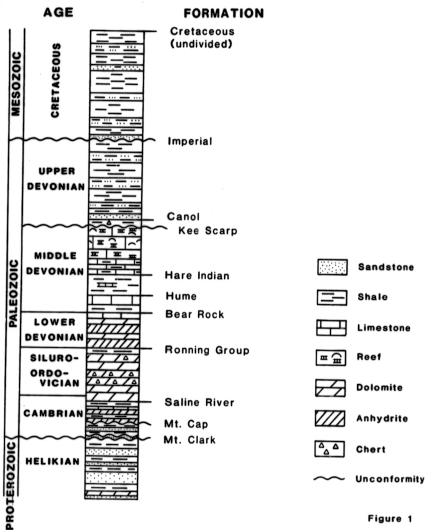
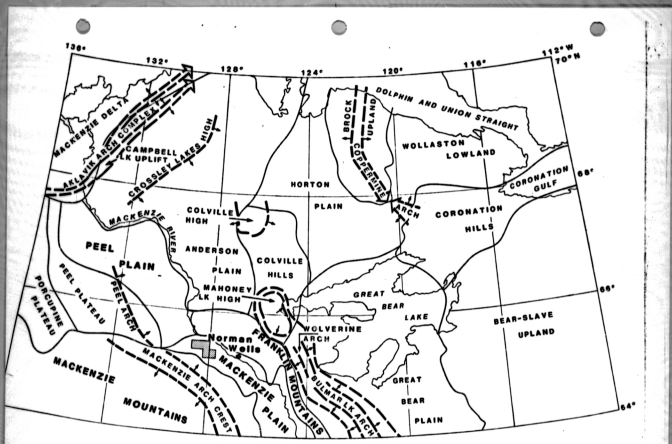


Figure 1



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**NORTHERN INTERIOR PLAINS
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