OTTAWA



# GRAVITY SURVEY

of the

## LA BICHE RIVER - NAHANNI AREA

60° to 62° North Latitude
123° to 125° West Longitude

by

OVERLAND EXPLORATION
SERVICES (1969) LTD.

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# INTRODUCTION

During 1972 and 1973 Overland Exploration Services (1969) Ltd. conducted a gravity survey in the La Biche River - Nahanni area of the Yukon - Northwest Territories. Actual location of the survey was between 60° and 62° North latitude, and 123° and 125° West longitude. Approximately 10,000 square miles were covered in this survey.

A Hughes 500 series helicopter was obtained from McCord Helicopters Ltd., Calgary and was used to move the gravity meter operator from station to station within the project area. The base camp was established at the west end of the Beaver River airstrip and all operations were conducted from this locality. Gravity stations were established at suitable helicopter landing spots throughout the area and in all approximately 2,000 stations were recorded. All the usual corrections were applied to the gravity data and in addition, terrain corrections to the "M" ring were made on every station.

The results of the survey are shown on a Bouguer Gravity Map and two Second Vertical Derivative Gravity Maps, one focused at 5,000 feet below surface and the other focused at 10,000 feet below surface. All three maps were machine contoured on a scale of 1:100,000 and the data was digitized by Digitech Ltd. of Calgary. They also prepared the maps.

Gravity readings were recorded with a LaCoste & Romberg Model G gravity meter and station elevations were established by altimeters. Three altimeters were carried by the meter operator and read at each gravity station. In addition, a second altimeter operator was stationed on one side of the work area each day and a recording barograph was stationed on the other side. By recording the barometric changes at two base stations on each side of the work accurate elevations can be obtained by the use of altimeters.

## GENERAL GRAVITY STATEMENT

Exploration by gravitational methods is the technique of measuring the differences or deviations of the gravitational field at the earth's surface and using the data thus obtained to predict subsurface features. Gravitational methods are analogous to magnetic methods in that quantitative investigations are made of a natural field of force. The physical property of the subsurface materials which produce the significant or diagnostic gravitational anomalies is density of subsurface materials; it is necessary that they be of large enough magnitude to overcome the effects of near-surface, topographic and regional effects. The magnitude of any gravity anomaly is dependant upon the density, geometric configuration, depth and location of the structure with reference to the point at which the effect of the structure was measured.

If the earth were a homogeneous, stationery, isolated sphere, the sphere would exert a radical force on objects at its surface and the force per unit mass would be the same at all points on its surface. However, the earth is neither homogeneous, stationery, isolated nor spherical. The result is that the force of gravity per unit mass varies, both in direction and in magnitude, from place to place and from time to time. Furthermore, data on gravitational anomalies furnish information about the deviation of the earth from a homogeneous, stationery, isolated sphere. Interpretation of the field measurements made in gravity surveying is based on these variations.

The earth's deviation from a sphere is caused by two factors: (a) topographic features, hills, valleys, mountains, etc; and (b) the oblate spheroid shape resulting from its rotation. This latter factor introduces a variation in the force of gravity which is a function of latitude. This variation plus the effect of the centrifugal force of rotation are usually combined and called the "latitude, or north-south correction". From a knowledge of the mean shape of the earth and its speed of rotation, the latitude correction may be calculated mathematically; the correction amounts to about $1/194 \sin.^2 (\text{latitude})$.

In the survey conducted in the LaBiche River - Nahanni area, Yukon - Northwest Territories, the "Relative Gravity" was the value recorded and calculated. It is the value of gravity at any station in reference to the known or assumed absolute value of gravity at some base station. Direct determination of the relative gravity with a gravity meter consists of "weighing" the same object with very great precision, at various localities. The weight of an object at any location of the earth's surface is equal to the force of attraction exerted by the earth on that object. That is, the weight is equal to the product of the mass "m" of the object (which remains the same at all locations) and the acceleration "g" due to gravity. Hence, the weight of a constant mass "m" at any station is affected by the nature of the subsurface materials. For example, it is larger at stations where the subsurface material is relatively dense. The observed changes in weight are very small, being of the order of one part in ten thousand, or one part in ten million of the total value of gravity.

## TECHNICAL DATA

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| Bouguer Free-Air Correction Constant | - 0.0609 |
| Latitude Corrections | - 4,737.00 ft/mg |
| Density | - 2.6 |
| Diurnal Drift | - Taken from base plots |
| Terrain Corrections | - Taken to "M" ring every station |
| Meter Number | - LaCoste & Romberg 239 |
| Meter Constant | - 1.06473 |
| Base Value | - Arbitrary value of 500 milligals |
| Datum | - Sea level |

## BOUGUER GRAVITY MAP

The Bouguer Gravity Map shows the total gravity intensity and contrast in gravity emanating from all depths from the surface to the earth's core. In most cases, especially where the sedimentary rocks are flat-lying, the Bouguer Gravity values must be refined in order to enhance the appearance of gravity anomalies which emanate from shallow depths. However, in the area covered by the present gravity survey the density contrasts in the upper 10,000 to 15,000 feet of sedimentary rock are so great that they completely dominate the Bouguer Gravity Map and this map becomes useful as a Residual Gravity Map.

Reference to the Bouguer Gravity Map and surface geological maps of the area shows that in many cases there is a strong coincidence between positive gravity features on the Bouguer Gravity Map and structural highs on the geology map. Similarly, areas of mass deficiency (i.e. gravity lows) are often coincident with synclinal areas on the geology map. Because of the length and breadth of the geological features present within the area and the mass of rock involved in them we have prepared two Second Vertical Derivative Gravity Maps, one focused at 5,000 feet below surface and the other at 10,000 feet below surface. The map focused at 10,000 feet below surface is the most useful of the two and it will be discussed in the next section of this report.

## SECOND VERTICAL DERIVATIVE GRAVITY MAP

The Second Vertical Derivative Gravity Map which is focused at 10,000 feet below surface is the main map we have used for analysis of subsurface features in this area. It is at approximately this depth below surface that production is encountered in the Middle Devonian reefs in the Pointed Mountain and Beaver River Gas Fields.

Reference to the map will show that the areas of gas production which are surface anticlines show up as large gravity positive features. The coincidence between the geology and the Second Vertical Derivative Map is so strong that where there is any contrast between the two we would recommend that further work should be done to clarify the discrepancy. It could well be that subsurface features do not always appear as surface anticlines and that the gravity map will prove to be a very useful device in detecting such subsurface features.

The Pointed Mountain and Beaver River Gas Fields both show up on these maps and the well-known Mattison Anticline is also detected. Further, particular attention should be paid to the gravity expression of the Nahanni Ridge as it appears that this structure carries to depth and is not just a surface feature.

Respectfully submitted by:

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