

1986TS775

FIRST YEAR EXPLORATION SUMMARY, CHARLEVOIX IMPACT STRUCTURE

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Numéro du dossier	:	1986TS775	Code gouvernemental:	0025 ()
Nom du dossier	:	RAPPORT DES TRAVAUX / 1986PG775		
Informations supp.	:			
Grande-catégorie	:	PERM	Permis	
Catégorie	:	TS	Rapport statutaire	
Sous-catégorie	:	G	Général	
Intervenant	:	La Corporation GHK	Actif (O/N)	: o
Archivé ou Indexé ¹	:		Numéro de GM ² :	
Date d'indexation ³	:	/ /	Classeur	: 6
Date pré-archivage ³	:	/ /	Tiroir	: 0
No pré-archivage	:	0	Boîte	: 0

Groupe Exploration

29/08/97

Légende:

- 1 A: Archivé; I: Indexé.
- 2 Le numéro de GM correspond au numéro tel que spécifié par le Secteur des mines.
- 3 Format de la date: AA/MM/JJ.

FIRST YEAR EXPLORATION SUMMARY

CHARLEVOIX IMPACT STRUCTURE

The Province of Quebec, Canada
A Hydrocarbon Prospect

Pre-Exploratory Summary

There is much evidence for the presence of methane and other hydrocarbons in the crystalline basement rocks of the Canadian Shield. Irrespective of theories of origin of the substances, it is of interest to discover whether commercially significant quantities can be found in areas hitherto not suspected as possible prospects.

While in most crystalline basement areas the porosity and permeability levels are too low for commercial production, this is not necessarily so in areas where a massive fracturing of the rock has taken place. This is presumed to have been the case in large impact structures, such as the Charlevoix Impact Structure.

The Charlevoix Impact Structure is approximately 30 miles in diameter and lies on the northern shore of the St. Lawrence River between La Malbaie and Baie Saint-Paul in the province of Quebec, Canada. The age of the impact is estimated to be 360 million years old, occurring during the Devonian Period (L. Silver, P. Schultz, 1982). The Charlevoix Structure is complex with a central uplift and only remnants of crater-fill are preserved on the surface.

The techniques for searching for hydrocarbon deposits in crystalline basement rock are necessarily quite different from those commonly employed in sedimentary deposits. The first year exploratory program entailed cursory field trips for soil gas measurements and acquisition and processing of publicly available gravity and magnetic data.

First Year Exploration Summary

Exploration licenses (numbers 775, 776, 777, and 778) were issued June 19, 1986 covering approximately 40,000 square miles over the Charlevoix Impact Structure (figure I.) The impact structure exhibits the typical topographic elements considered to reflect the results of a meteorite impact, namely: peripheral valley, plateau, ring of hills, inner valley and central peak. The exception with Charlevoix is that the St. Lawrence River cuts the southeastern portion of the impact structure disturbing its original symmetry, leaving only slightly more than half of the original structure expressed geomorphologically.

The Charlevoix Impact Structure was formed in Precambrian age crystalline rocks of the Canadian Shield known as the Grenville Province. These rocks and the impact structure itself are separated from Paleozoic age sedimentary rocks of the Appalachian orogeny to the southeast by the St. Lawrence River. The impact structure lies on what is today a layered intrusive complex made up of granitic gneisses, anorthosite and dioritic and gabbroic rocks. The dense anorthosite complex is known to outcrop on the western edge of the impact feature and is surrounded by even denser dioritic and gabbroic rocks. The spatial and age relationships of these suites of rocks are very complex and require further work.

Gravity data was obtained and processed by Barringer Geoservices in hope of providing leads to areas of intense fracturing. Interestingly, there does not appear to be any gravity anomaly directly confined to the impact structure (plate I.) This is highly unusual since it is characteristic for impact structures to have noticeable gravity lows as a result of brecciation from impact (Innes, 1961, 1964; Dence and Popelar, 1972; Waddington and Dence, 1979.) However, a northwest-southeast striking gravity low is observed along the western rim of the impact structure that is of interest. This feature is not entirely confined to the impact structure and appears to be related to the anorthosite complex intersecting the northeast trending St. Lawrence tectonic structure at approximately right angles. Unfortunately, the gravity data is too sparse to accurately delineate the gravity low and there are no mappable geological units that correlate perfectly with the anomaly. The correlation of the gravity anomaly with the anorthosite complex is unusual in that the anorthosite should yield a gravity high.

Although the gravity low is not confined to the impact structure, it does correlate closely with the anorthosite complex suggesting that indeed the anorthosite complex has been highly fractured and brecciated. It is in this area where the potential for reservoir quality rock could exist and deep seated hydrocarbons could have been trapped.

A regional soil gas methane survey was undertaken which resulted in the recording of anomalously high methane readings (plate B). The anomalously high readings, 50 ppm or greater (non-petroliferous typical soil methane ranges between 1-10 ppm), appear to be concentrated on either side of the gravity high which is located on the northern rim of the structure (plate A). The high readings to the west roughly correlate with the gravity low whereas the eastern high values appear to be unrelated to any gravity low. The correlation between the high methane values and the gravity low corroborate the interpretation that the anorthosite complex is highly fractured and brecciated as reflected in the regional gravity measurements and that methane is effluxing in the area. However, the resultant high methane readings found on the eastern half of the structure appear to be a mystery in relation to the gravity high found in this area.

One possible explanation is that the methane readings correlate with an inflection area between the gravity high located on the northern rim of the structure and a possible gravity low located in the St. Lawrence River. Unfortunately the gravity survey did not include the acquisition of data over the St. Lawrence. In further processing of the Bouguer gravity, a second vertical derivative map was constructed (plate III), which exhibits the possible gravity low in the La Malbaie area (the residual gravity map, plate II is essentially similar to the second vertical derivative map.) If this interpretation holds, this could be an area of deep seated faulting and brecciation that is providing a pathway for methane efflux.

The above interpretation appears to be supported by field observations of an unusual array of earth mounds protruding from the Malbaie alluvial plain. These mounds reach heights of about 40 feet and up to 100 feet in diameter at their base. They seem to be internally composed of the same alluvial material as the neighboring land. Thomas Gold, consultant to the Charlevoix project, suggests that these features are the result of high pressure gases forging their way through the alluvium, lifting it up in some erratic pattern; much like the formation of mud volcanoes except that the subsurface alluvium had too low a water content to

result in mud flows. The correlation between these earth mounds and the high methane readings suggest that gases are escaping in this area, and have in the past, through a pathway of faults at depth. In addition, earthquakes have been reported in the literature as far back as the 17th century which further substantiate these relationships. The earth mounds that were observed on the eastern rim near La Malbaie were also found in the St. Urbain area on the western rim. This occurrence again correlated very well with the high methane values and the gravity low.

As noted above, the gravity low intersects the St. Lawrence River at the approximate locality of the Ile Aux Coudres. During one of the field trips, an excursion to Ile Aux Coudres was taken and outcrops of Paleozoic sedimentary rocks on the south shore exhibited large calcite veins and odors of petroleum. The calcite vein samples were analyzed for carbon and oxygen isotopes. The calcite vein yielded a carbon 13 weight of -11.2 and the host rock yielded a value of -7.6. These values are extremely anomalous because normal values are never lighter than -3 or -4. The oxygen 18 values were -15 and -13.3 respectively and anomalously light. These anomalous values are correlatable with the efflux of methane and its resultant oxidation at the near surface. The petroliferous smell found in the other samples were analyzed and found to be mainly straight chain alkanes in the carbon number range 11-34 with a small proportion of branched chains suggesting a high paraffin crude.

The main feature found on the aeromagnetic map (plate IV, V and VI) is the peripheral dioritic and gabbroic rocks surrounding the magnetically quiet anorthosite complex. As mentioned, this gravity low correlates well with the anorthosite complex. The anomaly on the northeastern side of the anorthosite complex is related to the charnockitic granodiorites in this area. Also of note is the significant change in wavelength as the St. Lawrence is reached suggesting a substantial thickness of non-magnetic rocks in this area.

The composite interpretation (plate VII) is very difficult at this stage of the exploratory investigation. It is clear from the interpretation map that the gravity and magnetic expressions appear to be discordant to the Charlevoix Impact Structure itself. What we appear to have is two circular features overlapping each other. The Charlevoix Impact Structure lies on the southern lobe of what appears to be an even larger circular feature correlated with the anorthosite complex. It is puzzling that the impact structure should be preserved in rocks that apparently form the

roof of an intrusive and that the intrusive appears to be free of impact effects. It is also amazing that a meteorite, by sheer coincidence, should land squarely over the southern lobe of an apparently concealed anorthosite complex. These oddities pose further questions as to whether there is a genetic or simply a spatial relationship between the impact structure and the anorthosite complex. However, there are indications of brecciation and faulting at depth in both the Baie St. Paul - St. Urbain and the Malbaie areas where indications of effluxing methane have been recorded from soil gas samples and inferred from the formation of earth mounds. Perhaps the regional geochemical survey to be conducted this fall will help in the further delineation of the Charlevoix Hydrocarbon Prospect.

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