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REPORT ON EXPLORATION FOR STRATABOUND COPPER-ZINC-LEAD DEPOSITS IN THE LAKE MISTASSINI AREA

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# REPORT ON EXPLORATION FOR STRATABOUND COPPER-ZINC-LEAD DEPOSITS IN THE LAKE MISTASSINI AREA

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## SUMMARY

The 1974 Lake Mistassini exploration program consisted of drilling fourteen holes totalling 11,235 feet, limited ground magnetic surveys, and mercury geochemical surveys, along with accompanying geologic studies.

None of the drill holes encountered ore grade mineralization. However, the ubiquitous traces of zinc and copper sulphides in the basal sedimentary unit, correlative with mineralization at the Icon Sullivan and Perch River deposits, are encouraging and indicate that the basal unit has probably the best potential as an ore bearing horizon within the Mistassini basin.

Drilling results appear to indicate the inapplicability of magnetic surveys as a means of locating drilling targets in the basin. Other geophysical methods are believed to be eliminated as prospecting tools by cost and/or technical factors. Paleofacies and depositional environment analyses appear to be the most promising tool in determining targets for the possible occurrences of stratabound sulphide deposits. The mercury geochemical survey analyses have not yet been completed.

Available geological evidence suggests that the basal sedimentary unit. the algal stromatolitic dolomite, at the north and south ends of the basin may have favorable lithologic development for sulphide accumulation. Selected areas within this unit in proximity to apparent irregularities in the basin margin are recommended for additional prospect drilling. In addition, a geochemical prospecting program is proposed in selected areas underlain by Upper Albanel dolomite which appear to exhibit karst features that may be host areas for sulphide mineralization in a manner analogous with central Tennessee or the Tri-State districts. A $250,000 budget is tentatively recommended for a 1975 exploration program to be carried on in the summer months.

## INTRODUCTION

The 1974 drilling program in the Lake Mistassini basin is the planned second phase of systematic exploration of this carbonate basin for Mississippi Valley type stratabound base metal deposits.

The basin had been chosen as an exploration target based on the belief that the three small copper sulphide orebodies at the Icon mine had characteristics in common with the Southeast Missouri subtype of Mississippi Valley type ore deposits. It was also postulated that minor lead-zinc occurrences in carbonate rocks in the basin might be indicative of a favorable host environment for such ore deposits.

The 1973 exploration program, conducted by General Crude Oil personnel, consisted of surface prospecting, geological examination and evaluation of outcrops, limited ground magnetic surveys and experimentation with mercury detection devices in the field. In addition, consultants for General Crude Oil carried out airphoto interpretation studies and analyses of magnetic data to guide and assist future exploratory work. The reinterpretation of the magnetic data resulted in the preparation of downward continuation maps at 1000 and 2000 feet below original flight lines and second derivative maps for the basin area. The study concluded with the preparation of a depth to basement map.

In the fall of 1973, G.C.O. arranged with Ernest K. Lehmann & Associates Inc. to undertake day-to-day operation of the project during phase II, to be carried out in 1974. The resultant work was supervised for G.C.O. by Dr. Ted Foss and was carried out by E. K. Lehmann & Associates Inc., personnel. Ernest Lehmann has acted as project supervisor with Dr. Vladimir Jindrich as senior geologist. Jean Guy Barrette assisted in the work as a junior geologist throughout the 1974 season and Roger Baer, another junior geologist, was also assigned to the winter drilling program.

The strategy of the exploration program was to obtain regional data on stratigraphy through widely spaced holes and to drill the most prominent magnetic anomalies shown on the aeromagnetic maps published by the Geological Survey of Canada. We had speculated that the anomalies might reflect basement topographic highs. Following the analogy with the Missouri Lead Belt, such highs could result in nearby deposition of favorable sedimentary facies and could, directly or indirectly, result in the formation of stratigraphic or structural traps for sulphide mineralization. Individual magnetic anomalies were tested by single or widely spaced holes to check for topographic highs and to obtain regional information on the spatial and temporal distribution of principal lithofacies and to give information on their environmental significance. Prior to this time, information of this nature has been virtually unknown for the sediments of Mistassini Group and knowledge of this type is vital in the effective exploration of favorable carbonate environments for Mississippi Valley type ore deposits. The widely spaced drilling carried out in 1974 also assisted in reinterpreting drill data from prior drilling by Cominco, Campbell Chibougamau and others.

In addition to exploration by drilling, a limited ground magnetic program was to be undertaken to locate and check certain magnetic anomalies on the ground. During the course of the year, core and outcrop geochemical studies were added to the program.

Organization of the program began in October 1973 with the preparation of bid documents for drilling. In the following months, drill contracts were let, planning of logistical aspects was undertaken, office and living space was rented, and field equipment and supplies were arranged for. The 1974 program began promptly with the arrival of E. K. Lehmann & Associates personnel in Chibougamau beginning January 2nd. Field operations continued until the break up on April 18th and were resumed on June 12th. A limited geochemical field program was still in progress September 1st, and not all analytical results have been received. However, the need to plan 1975 operations dictates that a report be prepared and submitted at this time summarizing results to date.

## WORK PERFORMED

### Core Drilling:

The diamond core drilling was performed by Bradley Bros. Drilling Company of Noranda, Quebec who were low bidders. A total of 12 holes were drilled during the winter (January - April) exploration program. Two additional holes were drilled during the summer (June - July) program. Technical data on the holes are summarized in Table 1, and the location of the holes is shown in Figure 2. The total footage drilled was 11,235 feet of which 360 feet was piping through water, 1512.5 feet was overburden drilling and the balance was in rock. The deepest hole drilled, hole LM74-D-2, was 2099 feet deep and the average depth of the 11 holes completed in rock was 992 feet. Three holes were abandoned in overburden.

All holes were drilled vertically. Survey by acid tests and the Tropari method show negligible deviation from the vertical with the maximum recorded being $7^{o}$. Collar elevations were surveyed by the Paulin altimeter, or estimated for those holes close to or at the level of Lake Mistassini. Location of holes drilled on the lakes was obtained by pace and compass surveys from blazed and marked witness trees on the shore. These witness trees were located on air photos. On completion, plugging and cementing of holes was done in holes that were deemed to be within any possible potential target area for further exploration and where such holes were located on the main lake.

In general, holes were drilled down to the Archean basement. Two holes, LM 74-J-3 and LM74-F-1, located within the central island chain in the deep parts of the basin, were purposely terminated well above the basement after obtaining geological information desired.

Windy weather and deep subzero temperatures, reaching down to -67° F, considerably affected the course of the drilling program and flying operations during the winter months. Mechanical problems and long delays in drilling progress were caused by the bouldery glacial drift that veneers much of the dry land and lake bottoms. Whereas drilling in dolomite progressed at a rate of up to 100 and even 130 feet per 8 hour shift, progress in the overburden was generally 20 feet or less per shift. Overburden on the lake bottom posed relatively less difficulties in drilling than overburden on dry land. This is probably due to sieving of lacustrine silt and sand through the coarse glacial drift to form tightly packed material on the lake bottom. This is contrasted to the coarse drift on land which lacks interstitial material and where water circulation was frequently lost. Because of the mechanical difficulties in penetrating the surficial bouldery overburden, holes LM74-K-1, LM74-K-2A, and LM74-K-2B were abandoned before bedrock was reached at 157 feet, 104 feet, and 65 feet respectively.

Logistics:

Operation of two separate field camps as self-sustained units for individual target areas was basic to the logistical plan during the winter exploration phase.

Each of the camps included one drilling rig and three tents to accomodate respectively the drill crew, the geologist and field assistant, and the cook and food preparation and serving facilities. Short-distance commuting to drill sites and transportation of core between the drill site and the camp was done mainly by snowmobiles. The snowmobiles were also utilized in carrying out the ground magnetic survey. A John Deere tractor, one for each camp, was furnished by the contractor to move rigs onto drill sites, prepare roads, etc. Because of thin ice, one tractor broke through near Camp III and several days were lost in retrieving it.

The initial mobilization included transport of all equipment by road to the Temiscamie air base, 120 miles north of Chibougamau. The nature and remoteness of the terrain required the use of an aircraft as a principal means of transportation in installing and supplying the field camps. Both the DeHavilland "Otter" and "Beaver" bush aircraft, equipped with skis, were used for transport during the winter exploration phase. This equipment was supplied by A. Fecteau Transport Aerien Ltee., from Chibougamau. Otters were used during the initial mobilization, primarily for the transport of heavy equipment and bulk supplies.

Transport by two Otter aircraft to the previously selected Camp I and Camp II sites commenced on January 11. Following the camp installations, the exploration program was initially started with the collaring of hole LM74-J-1 at Camp II on January 21. Camp I remained at the same location during drilling of the M and K target areas. Camp II, after termination of the hole LM 74-J-3, was abandoned and Camp III was erected in the F target area to the south. Following the initial mobilization of field camps, a Beaver aircraft was contracted for the rest of the winter phase for supplying camps with fuel, food, and other light-weight equipment, and for commuting by drill crews between the camp and more distant drill sites. While under contract, the Beaver and its pilot were stationed in the camp. Drill and camp moves, as well as demobilization, were done primarily with Otter aircraft. One aircraft crashed during the program but fortunately no personal injury resulted. Movement of the drill rig to and from M-3 and the K target areas, where landing conditions for a fixed wing aircraft were restricted, necessitated use of Huey and Jet Ranger helicopters contracted for short terms from TransQuebec Helicopters based at Matagami. One delay was encountered in use of helicopters due to dropping of the drill rig when a cable broke with consequent damage to the drill mounting. Communciation between the field camps, Fecteau air base in Chibougamau, and Bradley Bros. Drilling Company in Noranda, was maintained-atmospheric conditions permitting - with two battery-powered radios at each camp.

Due to the worsening of flying conditions with the onset of spring, the winter exploration program was terminated with the bottoming of hole LM74-F-3 on April 17.

During the summer exploration phase, an Otter aircraft equipped with floats, was contracted from Fecteau. This aircraft was used to transport equipment and supplies and to move the drill crews from field camp to drill sites. For auxilliary transport, boats and canoes were used. An aluminum boat powered with 25 HP outboard motor was rented in Chibougamau. Canoes purchased for the 1973 summer program were used for short reconnaissance trips and supervision of drilling. Due to the limited extent of the summer exploration phase, which included drilling of only two holes, only one rig and one camp were employed. Camp III, in the F target area had been maintained by a watchman during the spring break-up, and was reoccupied June 12th for use while drilling the hole LM74-D-2. This hole was collared on June 24. Following completion of this hole, Camp IV, accessible by trail from the road leading to Poste Mistassini was installed to service the hole LM74-D-1. The summer exploration phase was terminated by bottoming of the latter hole on July 16.

A clean-up of all camp and drill sites by the contractors constituted an integral part of the summer exploration phase.

Basement office space for logging of drill cores, preparation of samples and storage of equipment and supplies had been rented for the project in Chibougamau. All core equipment and supplies are currently stored in this space. Costs incurred from January through August 1974 are summarized in Appendix A.

<u>Geophysics</u>:

During the course of winter drilling detailed ground magnetic surveys were carried out on two selected portions of the F and J target areas. In the 'J' area, the purpose of the magnetic survey was to locate on the ground and relative to the drill holes, the large and distinctive magnetic feature indicated on the CGS magnetic surveys. This anomaly was believed to be due to a combination of change in basement magnetic susceptibility and basement topographic relief. The survey in the F area was designed to test and trace lakeward, a presumed small basement high identified in outcrop on shore. Magnetic susceptibility measurements and specific gravity determinations made on outcrop samples in the previous year and to assist in evaluation of published magnetic data and its reinterpretation and analysis by Edcon, the geophysical contractors. These susceptibility and specific gravity data are summarized in Table II.

A scintillometer was available during the winter portion of the project and checks for radioactivity indicated no anomalous readings on the cores checked.

Core Logging, Sample preparation and Assaying:

In order to direct drilling activities in the field, preliminary logging was performed by junior geologists at field camps. Subsequently the core was transported from field camps to Chibougamau and final logs were prepared by the senior geologist. In this way uniformity of lithologic description was maintained. These descriptions follow generally the terminology proposed by R. Folk. All cores have been retained pending completion of the project.

A masonry saw with a 14 inch diamond blade was modified for use in splitting cores and slabbing hand specimens. A 14 inch vibrating lap was purchased and used to prepare drill core samples and hand samples for etching. In addition, selected samples were thin sectioned for petrographic study. (Appendix B)

In order to check visual observations and to check for base metals possibly masked by or disseminated through black shales or masked by association with pyrite, core from selected intervals in LM74-J-1, LM74-J-2 and LM74-M-1 was assayed throughout the basal section for zinc and copper. The initial assay results suggested varying concentrations of copper and zinc in trace amounts in the black shale immediately overlying the algal dolomite breccia zone. These are being further investigated as to their significance by sampling the lower black shales in the other holes where these shales are present. The results of this sampling will be reported on separately. The core in intervals selected for assay have been cut in half with the diamond saw and one foot sample intervals have been used throughout. Analytical work has been done by Assayers Ltd., Rouyn, Quebec.

Three spot-samples of pyritized black shale that overlies the units assayed for copper and zinc, were selected for the fluorescent x-ray spectographic qualitative and semiquantitative analysis to check for possible accumulations of finely disseminated economic metals and trace elements. The analysis was made by the Fluo-X-Spec Analytical Laboratory, Denver, Colorado. All analyses are posted on drill logs. (Figs. 24-37)

# DISCUSSION OF PROGRAM RESULTS

## General Geology of the Basin:

The Mistassini basin, whose south end is located about 50 miles north of the town of Chibougamau (Fig. 1), measures about 25 miles in width and extends over 100 miles along the NNE axis. Much of the basin strata is concealed under the Lake Mistassini and adjacent Lake Albanel. These lakes closely conform to the basin's outline.

The sediments occupying the synclinal Mistassini basin, the Mistassini group, are probably of Proterozoic age and immediately unconformably overly the Archean granitic and volcanic rocks of the Superior province (Fig. 3). Exposed strata of the Mistassini group have a regional dip of 3-5% toward the southeast. The southeast limit of the basin is the Mistassini fault zone, separating the rocks of Superior province from the Grenville metamorphic province to the east. Although there is insufficient subsurface evidence, in a simplified view the west side of the basin can be considered as a sedimentary wedge arcuate in plan, which thickens toward the southeast towards the axis of the basin and attains a maximum thickness of about 6000 to 9000 feet in the vicinity of the east side of Lake Albanel. East of the axis, sediments on the east margin of the basin may be upwarped along the east side of the asymetrical Mistassini syncline and dip steeply to the northwest. At the south, rocks of the Mistassini basin onlap the Archean rocks to form an arch or a horst block separating the Mistassini and Waconichi basins. To the north of Lake Mistassini, the dolomitic rocks of Mistassini group grade laterally into the clastic formations of the Otish Basin.

## Stratigraphy:

The Mistassini group was described by Neilson (1966) as consisting of the Papaskwasati, Cheno, Lower Albanel, Upper Albanel and Temiscamie formations. The first two formations were characterized as assemblages of quartz-pebble conglomerate, quartzite and sandstone with minor dolomite interbeds. The Lower Albanel was described by Neilson as a thick succession of grey dolomite and black shale; the Upper Albanel is characterized by pink sandy dolomite; and the youngest Temiscamie formation is characterized by banded iron formations. The Papaskwasati and Cheno formations were described from the northern end of the Mistassini basin and were considered by Neilson as the oldest deposits of the Mistassini group and as underlying the Lower Albanel formation. More recently, Chown and Caty (1973) concluded that all the three formations are time equivalent, the Cheno being merely transition facies between the dolomitic Lower Albanel and clastic Papaskwasati. The latter authors maintain that the Papaskwasati formation is restricted in its occurrence to the extreme northern end of the Mistassini basin and Papaskwasati embayment further to the north. Our results substantiate this view.

To date in our exploration program, only the Lower Albanel formation, and particularly its lower half, has been of immediate concern to us. The following description of the stratigraphy of this part of the formation and immediately overlying and underlying units is based upon the data from our drilling, supplemented by information available from the drilling by others and from published literature.

The Archean Basement:

The Archean basement rocks include granitic and quartz-feldspathic gneisses and metavolcanic rocks. The granite occurs in a wide variety of pink and greenish-grey, fine to coarse-grained types. The fine-grained varieties locally grade into aplitic granite. The drill cores from the basement interval commonly display interlayered gneissic rocks and granite with gradational contracts.

Basalt, andesite and trachyte form the basement in holes LM74-M-1 and LM74-M-2 at the north end of the Mistassini basin (Fig. 35,36). These rocks probably belong to the suite of metavolcanics that, as proposed by Chown and Caty (1973), form a broad ridge farther to the north and separate the Mistassini basin from the Papaskwasiti embayment.

The basement surface is commonly altered to a regolith forming a layer of in situ material of weathered Archean rocks (Fig. 5). The upper contact of the regolith with the sediments of Mistassini group, as well as the lower contact with the parent basement rocks, in some cases has the appearance of a gradational contact.

Generally, the regolith has mottled or nodular appearance consisting of the basement rock, overlying sedimentary material and secondary quartz (chalcedony), and calcite. The secondary materials occur as:

1. Products of calcification and silicification impregnating the weathered zone.

2. Filling of close-spaced joint systems in the basement rock.

3. Nodular structures of acicular calcite and chalcedony layers.

In holes LM74-D-1 and LM74-J-1 the regolith is represented by an unaltered granite interval, 2 feet thick, underlain by several feet of dolomite with nodular quartz-carbonate structures before fresh granitic basement was encountered again. The weathered basement layer observed in our holes ranges in thickness from zero (hole LM74-D-2) to about 20 feet. Granite regolith penetrated in hole LM74-F-3 is associated with sericitization and chloritization including intense shattering of and slickensides in the underlying granite. We tentatively interpret part of this altered zone, totalling 70 feet, as a mylonite.

Earlier workers (Deland and Sater, 1967) describe a succession of coarse clastics, referred to as a basal conglomerate, deposited upon the basement surface. Similar rock types, up to 90 feet in thickness, are noted in all logs of holes drilled by Cominco in 1967 that penetrated down to the basement. However, in a recent work of Caty and Chown (1973) and Chown and Caty (1973), the basal clastics are considered as the regolith described above. In the lack of supporting evidence for the presence of basal conglomerate, our interpretation is in agreement with that of Chown and Caty.

Papaskwasati Formation (Unit 1, Fig. 4).

A bed of coarse dolomitic sandstone to sandy dolomite, 2 feet thick, overlies the Archean granite regolith in the hole LM74-M-3, located at the mouth of the Papaskwasati River. The dolomitic sandstone may represent the edge of the Papaskwasati (or Cheno) formation, that is, the intertonguing of the clastic facies with the dolomitic Lower Albanel formation in the manner described earlier.

Lower Albanel Formation:

SH Algal Stromatolite (Units 2 and 3, Fig. 4). An algal dolomite is the basal depositional unit of the Mistassini group. It overlies directly either the unaltered Archean basement or its regolith. The unit is characterized by the presence of Cryptozoon type of algal stromatolites. Individual forms, ranging in height from less than one inch to about one foot and several inches in diameter, are classed as vertical stacked hemispheroids with variable basal radius SH-V type (Fig. 6). Detailed observation of core samples show local transitions to the compound forms of the latter type and the Collenia type of spaced, lateral linked hemispheroids LLH-S type (Fig. 6). The compound structures of discrete and confluent algal heads probably evolved during the growth by sediment infilling of interstructural spaces. In a vertical succession, the algal structures are commonly cut by erosion surfaces associated with thin irregular bands of sandy dolomite containing angular to rounded, variously sized clasts of algal dolomite and black shale to black argillaceous dolomite. Similar lithologies, in addition to quartz-carbonate stringers and blebs of hydrocarbon, occur as interstructure filling.

The algal structures observed in a growth position are noted in a vertical interval of 5 to 45 feet thick. Upward and downward, the structures become progressively more disrupted and displaced to form a breccia. The breccia is commonly mottled with irregular bands of sandy dolomite containing medium to coarse quartz grains that are rounded and sorted. Whereas the lower algal breccia attains thickness of about 1 to 5 feet, thickness of the upper brecciated zone ranges from about 5 to 50 feet. It is the upper brecciated zone where the mottling is most pronounced and the detrital quartz admixture most widespread. Here, beds of sandy dolomite to dolomitic sandstone, containing scattered algal blocky clasts, are commonly several feet thick and attain maximum thickness of 58 feet in hole LM74-D-1. The upper algal breccia, grading upward into the sandy dolomite, marks the top of the SH algal stromatolite horizon. At the Icon Sullivan mine the reported two algal stromatolite horizons are separated by the sandy dolomite and breccia 70 feet thick (Fig. 9).

Due to the presence of sandy intercalations, varying in thickness, mottling and gradual contacts of individual lithologies within the stromatolite horizon, it is difficult to make detailed correlations of these individual sub-units based on widely spaced holes (Fig. 9). Examples of lithologies of the SH stromatolite unit are shown in Figure 7.

Lower Black Shale Complex - (Unit 4, Fig. 4). This complex of rocks overlies the algal stromatolite horizon with a well defined contact marked by a bed of black shale. There are up to five black shale horizons that, together with grey dolomitic rocks, make up the lithologies of this complex. The top black shale, forming the top of this complex, ranges in thickness from 65 to 125 feet and represents one of the best stratigraphic markers of the Lower Albanel formation. Lower black shale horizons, 4 to 25 feet thick, are developed at varying intervals below the top shale. The black shale horizons were used for correlation of holes by Cominco geologists at the southern end of the Mistassini basin.

The black shale is generally thin-bedded to laminated with abundant nodules and bands of disseminated pyrite. Locally, irregular stringers and bands, up to 1 foot thick, of coarse crystalline quartz-carbonate are present. Dolomitic rocks that separate the shale horizons are light to dark grey, medium to fine grained varieties. The dark types occur closely associated with the black shale and grade into the argillaceous dolomite. The light grey dolomite commonly grades into beds of dolomitic limestone. A varying proportion of rounded, fine to medium quartz grains are locally concentrated as layers of sandy dolomite to dolomitic sandstone up to several feet thick. The dolomitic rocks overlying the lowermost black shale contain at varying positions laminated algal mats, probably of the LLH-S type. In hole LM74-D-1 a crenulated algal laminations form several 1 to 2-feet-thick beds as high as 265 feet above the basal algal stromatolite horizon.

The black shale complex thins from about 485 feet in the southern part of the Mistassini basin to about 150 feet at its northern periphery. The northward thinning is due primarily to wedging out of the dolomitic beds underlying the top black shale horizon.

Banded Dolomite - (Unit 5, Fig. 4). The black shale complex is overlain by a thick, monotonous sequence of grey and dark grey banded dolomite. Fine to medium crystalline dolomite, argillaceous dolomite and minor sandy dolomite are the principal lithologies forming alternating beds generally less than 1 foot thick. Dolomite and sandy dolomite locally grade into dolomitic limestone. The occurrence of dolomitic limestone is volumetrically less abundant than in the underlying black shale complex.

The dolomitic rocks exhibit planar and small-scale crossbedding and frequent erosion surfaces associated with cut and fill structures and convolute bedding. Individual lithologies are commonly arranged in an upward-fining cycles up to several feet thick, ideally with sandy dolomite at base and argillaceous dolomite at top.

There is very little direct evidence on the total thickness of the banded dolomite. Hole LM74-D-2 intersected this sequence over a total thickness of 1514 feet. The great thickness of this sequence is also indicated in the Rosario hole P-1, located four miles to the southeast from Post Mistassini. The hole was probably collared in the LLH stromatolite complex and bottomed at a depth of 1502 feet without encountering the top black shale of the underlying black shale complex. Present data suggest that the banded dolomite outcrops in the lake bottom of a major part of Lake Mistassini between its western shore and the central island chain.

Upper Black Shale Complex - (Unit 6, Fig. 4). The banded dolomite grades upward into an interbedded dark grey argillaceous dolomite and black shale with minor grey dolomite. The lithology of this succession is similar to that of the lower black shale complex differing only in quantitative representation of individual rock types. Here, the dominant lithology is laminated dark grey, finely crystalline dolomite to argillaceous dolomite, grading locally into black shale. Individual beds of black shale, several feet thick, contain irregular veins of coarsely crystalline quartz-carbonate, one to six inches thick.

None of our holes penetrated the entire thickness of the upper black shale complex. Hole LM74-D-2 encountered only the lower 125 feet, holes LM74-J-3 and LM74-F-1 cut 182 feet and 175 feet at the unit respectively. This was the upper part of the unit since both holes were bottomed at 701 feet before encountering the base of the upper black shale complex. We estimate some 300 feet of a total thickness for this unit.

LLH Algal Stromatolite - (Unit 7, Fig. 4). This sequence of dolomitic rocks containing algal-mat structures is the youngest sedimentary unit of the Mistassini group drilled in our exploration program.

Principal lithologies of the complex include the LLH type of stromatolitic dolomite, breccia and massive micritic dolomite. Subordinate thin beds of black shale occur throughout the complex. The stromatolitic dolomite is characterized by irregular, discontinuous and crenulated laminations involving light and dark algal-mat laminae. The laminated layers are commonly disrupted and detached or gently domed. Detached layers occur as blocky clasts set in micrite matrix and form breccia with varying matrix-clast ratios. Locally, the breccias grade into mottled beds containing birdseye structures. Conspicuous is the presence of crystalline quartz-carbonate and solid hydrocarbon that fills irregular vugs, occurs as nodular stringers and, replaces micrite matrix in the breccia. Some of the quartz-carbonate may be a replacement material of evaporite molds. This is suggested by the outward increase in crystal size of the quartz-carbonate fillings, these being marked by straight sides and rectangular re-entrants. In other cases, observed in outcrops, the quartz-carbonate filling displays disc-shaped outlines, up to three by ten inches in size, causing gentle doming of the overlying algal-mat laminae.

The contact zone between this unit and the underlying black shale complex, is marked by the gradual disappearance of black shale beds with substitution of laminated dolomite and associated breccia.

The interbedded algal-laminated dolomite and breccia form the central island chain of the Lake Mistassini. In the vicinity of Post Mistassini these rocks form a wide outcrop belt that swings easterly and northeasterly, parallel to the basinal margin, until they are obliquely cut by the Mistassini fault. There is no direct evidence of the total thickness of this sedimentary unit. Holes LM74-J-3 and LM74-F-1, collared in the central island chain, penetrated 501 feet and 516 feet, respectively, of the algal-laminated dolomite and breccia. We estimate the thickness of this unit to be about 550 to 600 feet in the central island chain area. Examples of algal lamination and breccias are shown in Figure 8.

In describing the laminated rocks of this complex, previous workers have failed to recognize their algal origin. For this reason logs from the drilling by Rosario, Serem, Sudbury and McAdams on the Muscocho property in the southern portion of the basin, provide only a poor picture on the subsurface distribution of this algal complex in that area.

Some of the algal-laminated rocks, exposed along the western shore of the island chain, display mound-like structures up to several hundreds of feet across and up to several tens of feet in height. Geometry of these structures, locally coalescing in trains, resembles some modern carbonate mudbanks from the tidal flats of southern Florida and the Bahamas. Highly varying dips of the algal-laminated beds draping over the mound-like structures and the associated algal-mat breccias were probably used by Chown and Caty (1973) as evidence for folding and faulting. In our opinion, the tectonic concept of these authors, a concept purporting small polygonal blocks separated by hypothetical faults and small, subparallel folds does not seem substantiated.

Quaternary Deposits:

Quaternary deposits constitute an extensive, continuous cover over the Proterozoic strata of the Mistassini basin. The unconsolidated Quaternary materials include primarily glacial outwash and till locally overlain by peat beds, lake bottom sediments and other lacustrine and alluvial deposits.

The till is composed of unsorted clay, silt, sand and gravel, including boulder-sized dolomite and granitic material. Largely sand-sized material was encountered in holes LM74-D-1 and LM74-M-3, 83 feet and 214 feet respectively, which penetrated an esker and glacio-fluvial outwash. Inasmuch as the glacial sediments form the present topography of drumlins, eskers and ground moraines that rest upon the ice-eroded bedrock, their thickness varies greatly from place to place. The maximum thickness of 257 feet, including coarse till and silty lacustrine sediments, was encountered on the bottom of the Lake Mistassini in hole LM74-J-1.

Facies Relationships and Their Environmental Significance:

One of the conspicuous aspects noted in the drillholes is the general consistency of stratigraphic column in the basin's marginal belt over a distance of more than 100 miles.

Widespread extent of the SH stromatolite unit, directly overlying the granite or its regolith, indicates a slow marine transgression over a flat or broadly undulating, weathered relief. Weathering agents of a warm arid climate appear to be the ultimate set of conditions in molding the basement relief. We infer that the algal growths were initiated upon the regolith which was garnished by exfoliated granite blocks surrounded by locally abundant, thick gruss. Although there is only limited supporting evidence, the existence of local elevations, protruding above the basement surface as knobs, cannot be ruled out.

In analogy with modern examples, the SH stromatolite structures are thought to have developed in the intertidal environment. Inasmuch as the structural relation of the algal stromatolite unit with respect to the basin remains unknown it is tentatively designated as a reefal biostrome because of its sheet-like geometry.

Upward brecciation of the stromatolite structures associated with mottling and lenses of quartz sand suggests deposition in the supratidal environment induced by relative emergence. The breccia is thought to represent storm deposits irregularly interlayered with sand deflated from coastal dunes. If this interpretation is correct, then the repeated occurrence of the SH stromatolite structures above the breccia and sandy dolomite at Icon Sullivan mine could be viewed as a local restoring of intertidal conditions by renewed submergence.

Strong mottling and brecciation of the stromatolite structures are particularly noted in the M series of holes at the northern end of the Mistassini basin. In this area the breccia and mottled structures reach a maximum recorded thickness of 106 feet (hole LM74-M-3) and constitute almost the entire stromatolite unit. The anomalous thickness of the breccia, in a view of environmental interpretation stated earlier, suggests that the deposition of stromatolite unit at the north took place primarily within the supratidal environment.

Growth of the SH stromatolite structures was terminated by the deposition of black shale. The local presence of algal mats within the shale implies its shallow-water origin. The black shale was deposited in a low-energy euxinic environment, most likely either as an enclosed subtidal lagoon or intertidal flat or, combination of both. Occurrence of the lowermost, thin shale beds suggests that the onset of euxinic conditions took place during periods of short duration, probably of local extent. In later periods of deposition, the euxinic conditions occurred on a regional scale as evidenced by the widespread thick deposit of the 'big black shale'.

Speculating upon the spatial facies distribution it is assumed that, the SH stromatolite and black shale, encountered in a vertical succession, existed also adjacent to one another as synchronous facies. This thesis is strongly supported by the presence of black shale as a common constituent in the sedimentary fill between the stromatolite structures. However, lack of the subsurface data from deeper basinal parts prevents a more thorough paleogeographic reconstruction.

As revealed by drilling, the northward facies change in the earliest deposits of the Lower Albanel formation is summarized as follows:

1) Replacement of the lowermost part of the SH stromatolite unit by thin sandy dolomite at the north (probably the transition Cheno facies discussed in the section on stratigraphy).

2) Thickenning and replacement of the intertidal SH stromatolite unit by supratidal breccia.

3) Progressive thickness reduction of the lower black shale complex by disappearance of interlayered dolomitic rocks.

These facies changes, illustrated in Figure 9, are connected with the existence of broadly doming granite-volcanic basement separating the Mistassini basin from Papaskwasati embayment at the north. Probably due to the presence of volcanic rocks, the granite basement acted as a relatively rigid, stable block with respect to the more subsiding basin at the south.

Except for the anomalous development of the stromatolite unit at the Icon mine, described earlier, rocks of the Lower Albanel formation do not reveal significant facies change on approaching the basin's termination at the south. Record of a reduction in thickness or deposition of clastics replacing the carbonate facies, if these ever existed at the south, could have been removed by erosion.

Lithology and sedimentary structures of the thick banded dolomite succession indicate deposition in a turbulent shallow water within the coastal shelf environment. Repeated occurrence of black shale, grading upward into the LLH stromatolite complex implies renewal of the euxinic conditions evolving later into the supratidal algal-mat environment. The repeated shift from the high-energy to the low-energy conditions, as documented by the stratigraphic column, appears to have been accomplished mainly by a differential carbonate buildup of partially emergent system of island bars. Lateral progradation of these low standing islands, probably by algal growths, led in a developing of land-locked euxinic lagoons or tidal flats on one side and open, free circulating waters on the other side.

Lithology of the LLH stromatolite complex records and intertonguing of supratidal and intertidal environments. Stromatolite forms, fabrics and sedimentary structures of this rock succession may be compared to those now forming on the supratidal flats (sabhkas) and associated environments in the Persian Gulf. On the basis of the few data available, we were unable to detect any regional lateral facies change within the LLH stromatolite, underlying black shale and banded dolomite.

Characteristic sedimentary structures of individual Lower Albanel lithologic units and their environmental significance is summarized in Figure 4.

Mineralization:

Pyrite of diagenetic origin occurs in abundance as nodules or disseminations parallel to bedding in the black shale.

Occurrence of the copper, zinc and lead sulphides in the rocks of Lower Albanel formation is confined almost entirely to the basal stromatolite unit, partially extending into the overlying black shale, and the LLH stromatolite complex.

Sulphides in the basal, SH stromatolite and overlying black shale - Stratabound accumulations of chalcopyrite form several small, high-grade ore bodies exploited by Icon Sullivan and Perch River copper mines at the southern end of the Mistassini basin. Three separate ore bodies at Icon Sullivan are developed at the undulating interface of the basal stromatolite and the lower black shale complex and extend upward into the lowermost black shale bed. The Perch River ore body occurs within the black shale that corresponds probably with the thick top shale horizon higher in the column. Chalcopyrite with minor pyrite and sphalerite, associated with crystalline quartz-carbonate (calcite, dolomite, ankerite) are the characteristic mineral assemblages of the ore bodies mined. Open space filling and replacement appear to be the chief mechanisms of mineralization. Detailed description of the Icon Sullivan deposit is given by Troop and Darcy (1973). The association of the sulphide bodies with porous, organic carbonate rocks capped by black shale at both localities is one of the classic geologic settings in ore deposits of the Mississippi Valley type.

Traces of sphalerite and/or chalcopyrite are observed practically in all core segments retrieved from the basal stromatolite unit and similar occurrences are documented in logs from previous drilling. The sulphide grains occur most characteristically in the algal breccia immediately below the lowermost black shale, concentrating thus in a stratigraphic position that corresponds to the Icon Sullivan. In core specimens the sphalerite and chalcopyrite grains, locally accompanied with pyrite, are associated with the crystalline quartz-carbonate and hydrocarbon that fill the irregular cavities in the mottled structures and between algal structures or their clasts. Detailed examination shows that pyrite, forming rims of infilled cabities, was emplaced first followed by the quartz-carbonate and sphalerite. The best sulphide occurrence, several sphalerite grains in clusters up to 5 cm across, is noted in hole LM74-J-2 at the depth of 1221 feet. This assayed 1.76% zinc and 0.008% copper in a one foot core interval. In other samples assayed, the content of zinc and copper does not exceed 0.2%. Fluorescent x-ray checks for a possible fine dissemination of base metals in overlying black shale (hole LM74-J-1) gives a maximum of 0.82% zinc and 0.11% copper.

Sulphides in the LLH stromatolite complex - All occurrences of sulphide mineralization in rocks of this complex are known only from the surface showings. Among the best known is the 'Muscocho showing', located in the southern part of the basin in the close vicinity of Mistassini fault, and the 'Opemisca showing', located within the central island chain. Several other showings exist in the area of the Post Mistassini settlement, and along the central island chain.

The sulphide mineralogy of these showings is characterized by the assemblage of galena and sphalerite in about equal proportions, and a lack of chalcopyrite. In addition, the quartz-carbonate filling, although abundant in the rocks of this complex, does not show as direct an association to the chalcopyrite and sphalerite mineralization as noted in the basal SH stromatolite unit.

The galena-sphalerite mineralization occurs in irregular stringers and blebs a fine grained dolomite or dolomitic algal-mat breccia. In local patches, the ammount of sulphides at Muscocho and Opemisca showings approaches an ore grade. However, several close-spaced holes drilled at Muscocho by McAdams and Flanagan, and our hole LM74-F-1 collared in the immediate vicinity of the Opemisca showing, failed to confirm lateral extent or downward continuation of the surface mineralization.

Geophysics:

Magnetic surveys have been a useful prospecting tool in southeast Missouri and other Mississippi Valley districts. In these areas, magnetic surveys have been used to indicate basement topographic highs. Such highs may influence sedimentary depositional patterns and form structural and stratigraphic traps for ore-forming fluids. On the basis of theoretical considerations, the downward continuation models and second derivative models prepared by Edcon for the airborne magnetic data suggested at best a limited applicability of this method to the Mistassini basin. However, an empirical analysis of the Woolett Lake Quadrangle to the northwest of the lake basin suggested that magnetics might be a useful tool.

Table III compares the estimated depth to basement as determined from Edcon interpretative maps of the airborne magnetics and estimates made by Edcon for specific anomalies with drilling results. As can be seen from this table, in about 50 percent of the cases, Edcon's estimates were quite good (holes LM74-M-1, M-2, J-2, F-2, and D-1). In other cases the estimates were well wide of the mark, at the maximum, in the case of LM74-D-2, by 1000 feet.

Results of the ground magnetic survey in the F and J areas is shown in Figures 18, 19 and 20. Of special interest is the case of drill hole LM74-J-1 where a strong magnetic anomaly, existing on the airborne map, was confirmed on the ground (Figs. 19, 20). Drilling failed to confirm an identifiable topographic high though some topographic relief may be indicated by the presence of a granite boulder or block a few feet above the basement. Even if a major high exists, a magnetic susceptibility change in the basement had to be postulated to account for the anomaly. However, the magnetic susceptibility of the basement appears to be less than 20 x 10-6 cgs for the 245 feet of granite gneiss encountered. This is much too low a susceptibility to explain an anomaly of this magnitude. One must conclude that the anomaly may be due to a deep seated ultrabasic mass which was not cut by the present drilling.

The degree by which the depth estimates at D-2 and M-3 erred is disturbing, but from the experience in this phase of the drilling program one can generally conclude that the depth estimated by Edcon in the deeper parts of the basin are probably accurate within plus or minus 20 percent. It is also apparent that magnetic surveys in the Lake Mistassini area are, at best, of a limited value for prospecting. These surveys are probably most useful in indicating the general shape of the basin and order of magnitude of the depth to basement. Magnetics do not seem to be well suited to distinguishing individual topographic highs in this area.

Other geophysical techniques have been considered. Any EM or IP effects which might be caused by sulphide mineralization would be masked by the black shales that are present through most of the basin. These shales would produce countless spurious anomalies. Gravity and seismic methods have also been considered but both are hampered by the difficult terrain on land and the high cost of over-water surveys. Because of the close similarity in density between the dolomitic rocks and the acidic basement rocks, resolution of either technique would probably be poor and the costs do not seem to warrant the probable benefits.

## CONCLUSIONS

The end of the present drilling program is an appropriate time to review the premises on which the project is based and to review prior conclusions or draw new ones.

The principle premise of the exploration program is that the Icon copper deposit is a stratabound, Mississippi Valley type deposit, probably of southeast Missouri type. If this is so, then other mineral shows in the carbonate rocks of the Mistassini basin, chiefly of lead and zinc, are probably of similar or related origin and this carbonate sequence is a favorable target area for discovery of other ore deposits of this type. This latter postulate stems from the empirical observation that mineral deposits in Mississippi Valley type districts rarely occur as single deposits but generally include a number of deposits of varying size and grade spread over a large area. Another postulate previously advanced was that the present shape of the basin closely approximates the original shore line. It was also believed that magnetics might assist in locating basement highs that would create favorable stratigraphic or structural settings for ore deposits.

The premise that the mineralization at the Icon mine and of other sulphide occurrences within the basin is of the Mississippi Valley type should be reexamined. The main lines of evidence to be considered are the nature of the ore occurrence at the Icon Mine and the nature of other mineralization found in the basin.

1. Evidence at the Icon mine includes the following: The mineralized quartz-carbonate masses appear to be aligned over the axis and along one flank of a linear mound or bar of sandy dolomite at the No. 1 orebody and concentrically around and above a basement high at No. 3 orebody. The quartz-carbonate fills tension fractures as open space fillings above and northward of the No. 3 orebody in such a position as to indicate that this quartz-carbonate filling must predate the Mistassini fault. The overlying shale and shaley dolomite beds are draped over the No. 1 and 3 orebodies in a manner that suggests initial dips of sediments deposited over a more resistant mass now replaced by quartz-carbonate. Gilles Allard reports the observation of abundant sulphide in the interdigital breccia and clastic carbonate material in the zone immediately below the quartz-carbonate of No. 3 ore body. It follows that the mineralized quartz-carbonate must clearly pre-date the Mistassini fault and almost all tectonic disturbance of the sediments.

2. Evidence from other mineralized occurrences in the basin include the following: Lead, zinc and copper mineralization intersected in drilling, though minor in quantity, is generally widespread, occurring in most of the holes we drilled. The mineralization occurs generally in association with quartz-carbonate. The quartz-carbonate fills interstromatolite spaces, or occurs as open space fillings or veinlets. Sulphide mineralization occupies the same types of spaces as the fossil hydrocarbon, anthraxolite, which is widely dispersed through the same beds. Most of the mineralization intersected in drilling occurs in association with the basal SH algal stromatolite though minor amounts occur in other units. The mineralization found in surface prospecting during 1973 occurred mainly in association with the algal mound facies (LLH algal stromatolite complex) exposed in the central island chain. The association of most of the mineralization with specific biogenic units, and with early, diagenetic quartz-carbonate which filled original and extensive porosity, combined with its lack of restriction to the vicinity of tectonically disturbed zones, reinforce the belief that the mineralization is of the Mississippi Valley type.

It was a prime objective of the 1974 program to gain an understanding of the stratigraphy of the basin. As a result of the drilling, certain conclusions have now been reached regarding the stratigraphy of the lower part of the Lower Albanel formation.

1. The basal SH stromatolite unit and the associated brecciated zone is wide spread throughout the basin, as are the overlying units. There are no major facies changes in the area drilled, an expanse over 100 miles long and 1000 square miles in area. There are however some subtle changes, the most important of which may be the thickening of the SH stromatolite unit to the north and especially in the vicinity of hole LM74-M-3. This thickening is accompanied by an increase in brecciation indicating a higher energy environment of deposition and

a possible shelf margin as the Papaskwasati basin is approached. Corallary evidence of higher energy environments in this area is suggested by the reported occurrence of oolitic * beds in this unit in Campbell Chibougamau's hole TK-3. Accompanying the thickening is a decrease in thickness of the overlying lagoonal black shale unit, mainly due to a decrease in the amount of subtidal dolomites.

2. The basal contact of the SH stromatolite unit is with a granite regolith. There is no evidence of deposition of a basal conglomerate and only at the north end a thin sandy dolomite interfingers with the SH stromatolite unit. The presence of an aquifer, either a permeable unconformity or a permeable lithologic unit, a short distance above or more generally below an ore horizon is an empirical observation on most Mississippi Valley type districts. Based on our present knowledge, the north end of the basin, where intertongued sandstone is present in the basal SH stromatolite, conditions most closely approximate those found in many districts of this type.

From the evaluation of results regarding the mode of occurrence and extent of the sulphide mineralization, the following conclusions are drawn:

1. Due to the presence of two thick successions of black shale, separating the stratabound mineralization of the Icon Sullivan type and Muscocho-Opemisca type, and because of the differing mineralogy between the two types, we are inclined to abandon the original thesis that the sulphide showings in the central island chain may represent leakage from deep-seated ore bodies. Consequently, we do not consider the LLH stromatolite complex as a potential target for further exploration.

2. The ubiquitous, spotty occurrence of sulphides in the basal SH stromatolite unit, correlative with the Icon Sullivan and Perch River ore bodies, implies that the basal stromatolite unit offers best potential for exploration of stratabound ore deposits within the Lower Albanel formation.

Another objective of the 1974 program was to try to develop techniques of locating and to locate topographic high on the basement surface. A number of conclusions have been reached in this regard.

1. We conclude that magnetics do not appear to be good tools in the search for basement 'highs', in this district. In most cases, it would appear that susceptibility changes mask any magnetic effects due to topographic relief of the surface.

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* Note: The large diameter (¼" and larger) reported for these "ooliths" suggests that they are algal oncoliths rather than ooliths.

2. Other geophysical tools (seismic or gravity surveys) do not appear to be well suited to the terrain and the geology and their costs are prohibitive in terms of the information to be gained.

3. The probability of some and perhaps locally substantial basement relief exists. A granite outcrop area is reported on the Neilson River, north of hole LM74-M-3. From drilling, it would appear that in this area, the relief of the granite surface is on the order of 400 feet per mile. A nose of basement rock forms a "high" northwest of Campbell Chibougamau's hole TK 2B and this hole may be well up on the flank of this high. Basement relief is also suggested by the presence of possible granitic blocks perhaps derived from exfoliating granitic domes in the basal parts of holes LM74-D-1 and LM74-J-1.

4. Attempts to reconstruct basement topography through isopach maps of selected units result in conflicting interpretations, depending on the units chosen. So far these studies have not proved enlightening. As more reliable and closer spaced drilling data is obtained such techniques may prove to be more valuable.

The process of exploration should involve the continued evaluation of other possible exploration techniques and targets. From our work this year, we draw the following conclusions in this regard:

1. A test of new mercury sensing technology appeared worthwhile and is now in progress. Final evaluation of its utility will have to be covered by a separate report at a later time.

2. Assays of the black shales which immediately overly the SH algal stromatolite unit show a modest increase in copper and zinc in the black shale overlying mineralization in the SH algal stromatolite in LM74-J-1 and J-2 as compared to the copper and zinc content in the black shale over the unmineralized SH algal stromatolite unit in LM74-M-1. Further tests of the significance of this observation appeared warranted and samples of the lower black shale from other holes are being prepared. The copper-zinc content in the black shale might be an indicator of nearby mineralization, perhaps because the black shales could act as a collector of metal values.

3. EM and IP would not be usable in this terrain for reasons previously described.

4. Use of the "Air Trace" system on a selected portion of the basin (in the vicinity of LM74-D-1, M-3 or TK 2B) should be considered, provided the contractual terms are attractive.

5. A study of air photos and fragmentary field evidence from 1973 field work suggests the presence of solution collapse structures in parts of the outcrop belt of the Upper Albanel formation between Lake Mistassini and Lake Albanel. Since karst zones are the prime ore hosts for the other large subtype of Mississippi Valley deposits

(those analogous to the Missouri-Kansas-Oklahoma Tri-State and to East Tennessee) these areas represent possible targets for prospecting. The most promising tools for initial prospecting are a combination of air photo interpretation, heavy metals geochemistry and outcrop reconnaissance. Future consideration to other exploration systems for these target areas should be considered in the future.

6. Logistical and drilling problems in the area were more severe than anticipated. As a result, higher costs per foot were incurred than had been planned and productivity of drill crews was substantially less than anticipated. No ready solution for these problems is available. One must conclude that most future exploration efforts on the area will be difficult and relatively costly.

## RECOMMENDATIONS

Because of previous premises as to the nature of mineralization in the Mistassini basin, the occurrence of favorable lithologies, the occurrence of widespread trace mineralization, and the identification of probable basement 'highs' at the north end of the basin, near the interface with the clastic basin to the north, the following actions are recommended:

1. Completion of collection and testing of samples for trace mercury and analysis of the data obtained from this prospecting method in the south end of the Mistassini basin.

2. Completion of the work being carried out on determination of concentrations of copper and zinc in the lower black shale units above the SH algal stromatolite.

3. Continued maintenance of office and storage facilities in Chibougamau during the coming calendar year.

4. Initiation of discussions with Aquitane and Gunnex on a joint exploration program in the south end of the basin. In case of negative response to a proposal for a joint exploration program, consideration should be given to carrying out a limited drill program in the south end of the basin in the vicinity of LM74-D-1 in the period January - April 1976.

5. Initiation of detailed planning of a limited drilling program in the Neilson and Takwa river areas (with the Neilson River area having first priority) for the summer season of 1975. The program would be supplemented by a limited geochemical prospecting program of areas underlain by Upper Albanel rocks exhibiting possible karst terrain features in the area between Lake Mistassini and Lake Albanel. The combination of the two programs will permit more efficient use of personnel, camps and support aircraft. Because of the location of potential drill sites, helicopters will be required to move drill equipment and crews from a base camp to actual drill sites.

The program envisaged would include drilling a total of 8 to 15 holes for a total of about 5000 feet of drilling. These holes would be expected to be 500 feet or less in depth and would be drilled to basement. The holes would be positioned in irregular fences crossing an area extending about one to one and a half miles out from the presumed granite outcrop as mapped by Neilson (1966). It is proposed that about 120 claims be staked during the winter by a staking contractor in this area to accomodate this drilling (Fig. 14).

Logistics would be handled by establishing a base camp on one of the larger lakes in the vicinity of 51° 27' north, 73° 57' west. The base camp could then be supplied by fixed wing aircraft from Temiscamie and drill moves and service carried on with a Jet Ranger helicopter. Depending on the results of this drilling and on the availability of funds some drilling may also be carried out in the Takwa River area, to prospect the basement "high" indicated in this area. In anticipation of this, a block of 84 claims should be staked in this area. In the event of drilling in this area, the same drill crews would be utilized, but it may be desirable to move the camp location closer to the Takwa River.

The drilling would be supervised by a senior geologist. In addition to supervising the drilling, the senior geologist would also supervise a two man prospecting crew working out the same camp and out of spike camps along the west shore of Lake Albanel and east shore of Lake Mistassini. The combination of the two activities, drilling and prospecting, would economize on helicopter time and would justify having a Jet Ranger under contract for the duration of the project.

Assuming that the foregoing recommendations are followed, a $250,000 budget is tentatively recommended for 1975. This budget is detailed in Table IV. It is subject to revision if major program changes are made and may also be subject to change because of the rapid escalation in exploration costs which has been experienced during the past year. Based on present costs and with the ample experience of the 1974 program, we believe that the budget and goals are realistic.

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# APPENDIX A.

In an effort to summarize all costs related to the 1974 program, we have tabulated costs on the following pages. The tabulation is reasonably complete and is based on the best information available to us. Part I. includes costs incurred between January 1 and September 1. Part II. includes those costs which were prepaid in 1973 for the program or were 1973 costs directly attributable to the 1974 program (field supplies and equipment, time spent on logistics, etc.) Part III includes those costs which are estimated for the balance of the current year. Certain items over which we had no control or no information are not included. These include charges such as those for the magnetometer, operator's overhead and custom brokerage charges.

The costs are stated in Canadian dollars and costs incurred in US dollars have been converted to Canadian currency by multiplying by .97. The miscellaneous costs include exchange charges for conversion of US funds to Canadian funds.

For the foregoing reasons, the costs as tabulated here will not match those billed to the participants in the joint venture. The cost analysis, however, is instructive in planning future programs. To assist in such planning, per foot costs have been calculated as have percentages of total project costs.

The entire project, including the pre-program planning and logistics that occurred in 1973, have resulted in a total effort of about 530 professional man days by geologists of Ernest K. Lehmann & Associates, Inc. Of this professional effort, about 5% was expended in pre-field program planning and organization, 58% is directly attributable to drilling activities in the winter program, about 8% to ground magnetic surveys, 15% to the summer drilling program, 6% to the experimental geochemical program on mercury halos and 8% to report preparation and demobilization. Approximately $15,800 of the total tabulated expenditures of $418,362 is assigned to the cost of ground magnetics and $6,600 to the geochemical program. The balance is directly assignable to the drilling project.

## SUMMARY OF COSTS

### 1974 EXPLORATION PROGRAM

| | Winter Program | | | Summer Program & Report | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|
| | Can. $ | $/Ft. | % | Can. $ | $/Ft. | % | Can. $ | $/Ft. | % |
| I. 1974 Cost 1/1 - 8/31 | | | | | | | | | |
| A. Direct Drilling Expenses | $156,394.56 | $18.29 | 37.38 | $46,949.76 | $17.48 | 11.22 | $203,344.32 | $18.10 | 48.60 |
| B. Air Support | | | | | | | | | |
| Fixed Wing | 47,796.07 | 5.59 | 11.42 | 23,046.57 | 8.58 | 5.50 | 70,842.64 | 6.31 | 16.93 |
| Helicopter | 17,826.02 | 2.09 | 4.26 | 0 | 0 | 0 | 17,826.02 | 1.59 | 4.26 |
| Total: | $65,622.09 | $7.68 | 15.68 | $23,046.57 | $8.58 | 5.50 | $88,668.66 | $7.90 | 21.19 |
| C. Assay & Lab Costs | $1,669.09 | $0.20 | 0.39 | $ 15.54 | $0.01 | 0.01 | $ 1,684.63 | $0.15 | 0.04 |
| D. Other Costs (2) | | | | | | | | | |
| Postage | 39.53 | <0.01 | <0.01 | 0 | 0 | 0 | 39.53 | <0.01 | <0.01 |
| Tel & Tel | 1,439.83 | 0.17 | 0.34 | 622.41 | 0.23 | 0.14 | 2,062.24 | 0.18 | 0.49 |
| Office Space | 1,115.50 | 0.13 | 0.26 | 218.25 | 0.08 | 0.05 | 1,333.75 | 0.12 | 0.31 |
| Miners Licenses | 291.00 | 0.03 | 0.06 | 0 | 0 | 0 | 291.00 | 0.03 | 0.06 |
| Labor | 4,385.21 | 0.51 | 1.04 | 581.88 | 0.22 | 0.31 | 4,967.09 | 0.44 | 1.18 |
| Transportation | 5,298.29 | 0.62 | 1.26 | 2,739.98 | 1.02 | 0.65 | 8,038.27 | 0.72 | 1.92 |
| Room & Camps | 1,963.54 | 0.23 | 0.46 | 594.73 | 0.22 | 0.14 | 2,558.27 | 0.23 | 0.61 |
| Meals - Town | 2,906.37 | 0.34 | 0.69 | 486.04 | 0.1809 | 0.11 | 3,392.41 | 0.30 | 0.81 |
| Meals - Bush | 2,873.53 | 0.34 | 0.68 | 1,067.50 | 0.40 | 0.25 | 3,941.03 | 0.35 | 0.94 |
| Misc. Travel Exp. | 257.89 | 0.03 | 0.06 | 72.72 | 0.03 | 0.01 | 330.61 | 0.03 | 0.07 |
| Maps & Publications | 139.32 | 0.02 | 0.03 | 0 | 0 | 0 | 139.32 | 0.01 | 0.03 |
| Drafting & Reproduction | 1,713.81 | 0.20 | 0.40 | 619.56 | 0.23 | 0.14 | 2,333.37 | 0.21 | 0.55 |
| Boat Rental | 0 | 0 | 0 | 436.50 | 0.16 | 0.10 | 436.50 | 0.04 | 0.10 |
| Field Supplies | 2,677.89 | 0.31 | 0.64 | 570.57 | 0.21 | 0.13 | 3,248.44 | 0.29 | 0.77 |
| Freight & Haulage | 288.06 | 0.03 | 0.06 | 30.22 | 0.01 | <0.01 | 318.28 | 0.03 | 0.07 |
| Misc. | 603.83 | 0.07 | 0.14 | 308.95 | 0.12 | 0.07 | 912.78 | 0.08 | 0.21 |
| Professional Services | 38,095.08 | 4.46 | 9.10 | 13,764.79 | 5.12 | 3.29 | 51,859.87 | 4.62 | 12.39 |
| Total Other Costs: | $64,088.66 | $7.50 | 15.23 | $22,114.10 | $8.23 | 5.40 | $86,202.76 | $7.69 | 20.52 |
| TOTAL OF I. | $287.774.40 | $33.67 | 68.68 | $92,125.97 | $34.30 | 22.13 | $379,900.37 | $33.84 | 90.35 |

| II. 1974 Program | Winter Program | | | Summer Program & Report | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|
| Costs incurred 1973 | Can. $ | $/Ft. | % | Can. $ | $/Ft. | % | Can. $ | $/Ft. | % |
| A. Direct Drilling Expense | $7,900.00 | $0.92 | 1.88 | | | | $7,900.00 | $0.70 | 1.88 |
| B. Air Support | | | | | | | | | |
| C. Assay & Lab Costs | | | | | | | | | |
| D. Other Costs | | | | | | | | | |
| Tel & Tel | 231.02 | 0.03 | 0.05 | | | | 231.02 | 0.02 | 0.05 |
| Office Space | 582.00 | 0.07 | 0.13 | | | | 582.00 | 0.05 | 0.13 |
| Transportation | 1,669.32 | 0.20 | 0.39 | | | | 1,669.32 | 0.15 | 0.39 |
| Room & Camps | 2,889.60 | 0.34 | 0.69 | | | | 2,889.60 | 0.26 | 0.69 |
| Meals - Town | 376.91 | 0.04 | 0.09 | | | | 376.91 | 0.03 | 0.09 |
| Misc. Travel Exp. | 37.93 | <0.01 | <0.01 | | | | 37.93 | <0.01 | <0.01 |
| Maps & Pub. | 114.95 | 0.01 | 0.02 | | | | 114.95 | 0.01 | 0.02 |
| Drafting & Repro. | 1,288.58 | 0.15 | 0.30 | | | | 1,288.58 | 0.11 | 0.30 |
| Field Supplies | 6,106.25 | 0.71 | 1.45 | | | | 6,106.25 | 0.54 | 1.45 |
| Freight | 69.35 | 0.01 | 0.01 | | | | 69.35 | 0.01 | 0.01 |
| Professional Services | 6,208.00 | 0.73 | 1.48 | | | | 6,208.00 | 0.55 | 1.48 |
| | $19,573.91 | 2.30 | 4.62 | | | | $19,573.91 | $1.74 | 4.62 |
| II. TOTAL | $27,473.91 | $3.22 | 6.50 | | | | $27,473.91 | $2.44 | 6.50 |

| III. 1974 Program Cost 9/1 - 12/31 (estimated) | Winter Program | | | Summer Program & Report | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|
| | Can. $ | $/Ft. | % | Can. $ | $/Ft. | % | Can. $ | $/Ft. | % |
| A. Direct Drilling | | | | | | | | | |
| B. Air Support | | | | | | | | | |
| Fixed Wing | | | | $721.46 | $0.27 | 0.17 | $721.46 | 0.06 | 0.17 |
| C. Assay & Lab | | | | 850.00 | 0.32 | 0.20 | 850.00 | 0.08 | 0.20 |
| D. Other Costs | | | | | | | | | |
| Tel & Tel. | | | | 200.00 | 0.07 | 0.04 | 200.00 | 0.02 | 0.04 |
| Office Space | | | | 1,100.00 | 0.41 | 0.26 | 1,100.00 | 0.10 | 0.26 |
| Transportation | | | | 1,000.00 | 0.37 | 0.23 | 1,000.00 | 0.09 | 0.23 |
| Rooms | | | | 200.00 | 0.07 | 0.04 | 200.00 | 0.02 | 0.04 |
| Meals | | | | 225.00 | 0.08 | 0.05 | 225.00 | 0.02 | 0.05 |
| Misc. Travel Exp. | | | | 30.00 | <0.01 | <0.01 | 30.00 | <0.01 | <0.01 |
| Drafting & Repro. | | | | 615.00 | 0.23 | 0.14 | 615.00 | 0.05 | 0.14 |
| Boat Rental | | | | 346.00 | 0.13 | 0.08 | 346.00 | 0.03 | 0.08 |
| Field Supplies | | | | 450.00 | 0.17 | 0.10 | 450.00 | 0.04 | 0.10 |
| Freight & Handling | | | | 50.00 | 0.02 | 0.01 | 50.00 | <0.01 | 0.01 |
| Professional Services | | | | 5,100.00 | 1.90 | 1.21 | 5,100.00 | 0.45 | 1.21 |
| Misc. | | | | 100.00 | 0.04 | 0.02 | 100.00 | 0.01 | 0.02 |
| | | | | 9,416.00 | 3.50 | 2.19 | 9,416.00 | 0.85 | 2.19 |
| III. TOTAL | | | | $10,987.46 | $4.09 | 2.56 | $10,987.46 | $0.99 | 2.56 |
| PROJECT TOTAL | $315,248.31 | $36.89 | 75.18 | $103,113.43 | $38.39 | 24.69 | $418,361.74 | $37.27 | 99.41 |

# APPENDIX B

## Thin Section Petrographic Descriptions

| Sample No. | hole / depth in feet | Description |
|---|---|---|
| LMTS - 1 | LM74J-1<br>1641 | Granite - Quartz monzonite depending upon microcline/plag. ratio<br>Texture - Allotriomorphic granular ave. 1mm grain- max 2 mm<br>Essential Minerals<br>Quartz 30 - 40%<br>Microcline 25 - 30%<br>Plagioclase 20%<br>Accessories - hornblende, biotite, magnetite, zircon<br>Alteration - sericite and calcite in plagioclase |
| LMTS - 2 | LM74M-1<br>1424 | Basalt, - olivine (?) basalt<br>Texture - Intergranular to subophitic<br>Essential Minerals<br>Pyroxene - augite - alt rims - brown - amphibole? 20%<br>Olivine (?) 10%<br>Plagioclase - laths altered 30% to clays, calcite 5-10% & sericite 40-50%<br>Amphibole - blades<br>Accessories - magnetite - small euhedra in and around pyrox; also mag-ilmenite |
| LMTS - 3 | LM74M-1<br>1386 | Andesite (?)<br>Texture - Intersertal - average $\frac{1}{2}$ x 1 mm irregular laths<br>Essential Minerals<br>Plagioclase - 70%<br>Accessories - magnetite $<$ 5%, zeolites ? 5%, quartz 5%, alkali feldspar may be in groundmass<br>Little evidence of ferromagnesian minerals. |
| LMTS - 4 | LM74M-1<br>1357 | Dolomite<br>Texture allotriomorphic granular (igneous term)<br>Average crystal less than $\frac{1}{2}$ mm<br>Dolomite - 80-85% - crystals zoned<br>Orthoclase ? 10-15% euhedra |
| LMTS-5 | LM74M-1<br>821 | Siltstone<br>Coarse - average grain size $\leq \frac{1}{2}$ mm quartz rounded-sub-rounded. 75%<br>These $\frac{1}{2}$ mm grains are fairly well sorted and float in matrix of pure crystalline calcite with some fine-grained quartz.<br>Calcite 20%. About one-fourth of calcite is in form of ovoids similar in size to large quartz grains.<br>Fine-grained sandstone<br>Fine-banded - fine-grained ($<$ .05 mm) angular to subangular quartz in calcareous and carbonaceous matrix. Carbonaceous material in bands.<br>Approximately 50% quartz, 3 - 5% plagioclase (unaltered) and 30-40% calcite. |

(Thin Section Petrographic Descriptions - Continued)

| Sample No. | hole / depth in feet | |
|---|---|---|
| LMTS - 6 | LM74M-1 / 755 | Siltstone<br>Fine-grained angular to subangular quartz and plagioclase (K spar also?) in calcite matrix. Approximately 50% calcite.<br>Quartz 25 - 30%<br>Feldspar 10%<br>Pyrite 5 - 10%<br>Quartz-feldspar $< 0.05$ mm. Pyrite disseminated and in stringers. Pyrite grains from 0.05 mm to 1 mm euhedral and subhedral. |
| LMTS - 7 | LM74M-2 / 1129 | Altered Trachyte (?)<br>Felty trachytic texture composed of chlorite, calcite and feldspar ?<br>Maximum crystal size approximately 0.1 x 1 mm.<br>About 50% calcite - as replacement of feldspar laths ?<br>Calcite optically continuous across several laths in various orientations.<br>Chlorite replacing elongate crystals of amphibole (?) and in ground mass. Probably potassium feldspar in fine crystalline ground mass. Dark yellow-brown crystals - felty, long axes are subparallel - trachytic texture, possibly epidote - 5% |

| Hole No | Date Collared | Date Ended | Elevation | Total Depth | Water Depth | Over-Burden | Depth to Basement | Acid Test | Tropari Test | Depth of plug |
|---|---|---|---|---|---|---|---|---|---|---|
| LM 74 D-1 | 7/16/74 | 7/20/74 | 1232.0' | 587.0' | - | 83.0' | 528.0' | - | - | - |
| LM 74 D-2 | 6/24/74 | 7/10/74 | 1231.0' | 2099.0' | - | 48.5' | 2074.5' | 100'- 88°<br>700'- 87°<br>1400'- 86°<br>2000'- 83° | - | - |
| LM 74 F-1 | 3/28/74 | 4/ 4/74 | 1229.0' | 701.0' | 10' | 0' | - | 701'- 90° | - | 50.0' |
| LM 74 F-2 | 4/ 9/74 | 4/13/74 | 1229.0' | 462.0' | 97' | 157.0' | 435.0' | - | - | 285.0' |
| LM 74 F-3 | 4/14/74 | 4/17/74 | 1229.0' | 225.0' | 32' | 120.0' | 155.0' | - | - | 200.0' |
| LM 74 J-1 | 1/21/74 | 2/11/74 | 1299.0' | 1868.0' | 110' | 257.0' | 1643.0' | 400'- 84°<br>1000'- 90°<br>1560'- 84 | -<br>-<br>- | 675.0' |
| LM 74 J-2 | 2/17/74 | 3/ 6/74 | 1299.0' | 1309.5' | 110' | 162.0' | 1273.0' | 1309'- 83° | (Incl:84°)<br>( 675' )<br>(Dir:317°) | 420.0' |
| LM 74 J-3 | 3/13/74 | 3/17/74 | 1235.0' | 701.0' | - | 18.0' | - | 701'- 90° | - | - |
| LM 74 K-1 | 3/26/74 | 4/ 3/74 | 1233.0' | 157.0' | - | 157.0'+ | - | - | - | - |
| LM 74 K-2A | 4/ 9/74 | 4/12/74 | 1233.0' | 104.0' | - | 104.0'+ | - | - | - | - |
| LM 74 K-2B | 4/12/74 | 4/15/74 | 1233.0' | 65.0' | - | 65.0'+ | - | - | - | - |
| LM 74 M-1 | 1/26/74 | 2/ 5/74 | 1259.5' | 1424.5' | 1' | 87.0' | 1387.0' | - | - | - |
| LM 74 M-2 | 2/ 9/74 | 2/22/74 | 1291.0' | 1129.0' | - | 40.0' | 1047.0' | 500'-86°<br>1000'-88° | -<br>- | -<br>- |
| LM 74 M-3 | 3/10/74 | 3/21/74 | 1236.0' | 403.0' | - | 214.0' | 376.5' | - | - | - |
| TOTALS | | | | 11235 | 360 | 1512.5 | | | | |

TABLE I.
SUMMARY OF DRILL HOLE DATA

TABLE II

MAGNETIC SUSCEPTIBILITY AND SPECIFIC GRAVITY DATA

| Sample Designation | Location | Depth | Rock Type | Bulk density grams/cc | Magnetic Susceptibility 10-6 cgs units | Natural Remanent Magnetization: Magnitude in gammas | Natural Remanent Magnetization: Koenigsberger ratio for F=50,000 gammas |
|---|---|---|---|---|---|---|---|
| LM-MS-1 | Drill hole LM74J-1 | 1839.0 | granite | 2.67 | 20 | | |
| LM-MS-2 | " LM74J-1 | 1654.5 | granite | 2.64 | 20 | | |
| LM-MS-3 | " LM74M-2 | 1070.0 | basalt | 2.98 | 100 | | |
| LM-MS-4 | " LM74M-3 | 397.5 | granite | 2.63 | 20 | | |
| LM-MS-5 | " LM74J-2 | 1308.6 | granite | 2.70 | 20 | | |
| LM-MS-6 | " LM74M-1 | 1423.0 | trachyte-andesite | 2.94 | 20 | | |
| LM-MS-7 | " LM74D-1 | 578.0 | granite | 2.81 | 510 | | |
| LM-MS-8 | " LM74D-2 | 2082.0 | granodiorite | 2.63 | 20 | | |
| M-27-73 | See fig. 3 | surface | | 2.58 | 170 | 7 | 0.82 |
| 5-7-4S | " | " | | 2.74 | 20 | | |
| 8-8-1-F | " | " | | 2.68 | 20 | | |
| 8-8-2-F | " | " | | 2.60 | 20 | | |
| 8-8-3-F | " | " | | 2.70 | 20 | | |
| 10-7-6S(A) | " | " | | 2.61 | 20 | | |
| 10-7-6S(B) | " | " | | 2.57 | 20 | | |
| 10-7-7S | " | " | | 2.62 | 750 | 7 | 0.19 |
| 10-7-8S | " | " | | 2.65 | 20 | | |
| 10-7-9S | " | " | | 2.97 | 20 | | |
| 15-7-3 | " | " | | 2.59 | 20 | | |
| 18-6-1 | " | " | | 2.97 | 580 | 34 | 1.17 |
| 18-6-2 | " | " | | 2.61 | 380 | 7 | 0.37 |
| 20-7-1(A) | " | " | | 2.66 | 1200 | 20 | 2.00 |
| 20-7-1(B) | " | " | | 2.67 | 1100 | 14 | 0.25 |
| 20-7-2(A) | " | " | | 2.70 | 20 | | |
| 20-7-2(B) | " | " | | 2.68 | 20 | | |
| 29-7-2-0 | " | " | | 2.68 | 20 | | |
| 30-7-1-0(A) | " | " | | 2.68 | 20 | | |
| 30-7-1-0(B) | " | " | | 2.97 | 7900 | 800 | 2.02 |
| 30-7-2-0 | " | " | | 2.58 | 20 | | |
| 30-7-3-0(A) | " | " | | 2.86 | 1300 | 6600 | 102.00 |
| 30-7-3-0(B) | " | " | | 2.68 | 20 | | |
| 30-7-4-0 | " | " | | 3.20 | 20 | | |

# T A B L E III

## COMPARISON BETWEEN ESTIMATED DEPTH TO BASEMENT AND ACTUAL DEPTH FROM HOLES DRILLED TO BASEMENT

| DRILL HOLE | ESTIMATE (From Edcon Maps) | ESTIMATE (Edcon Tables) | ACTUAL DEPTH |
|---|---|---|---|
| LM74-M-1 | 1350 | 1200 | 1387 |
| LM74-M-2 | 1050 | | 1047 |
| LM74-M-3 | 1310 | | 376.5 |
| LM74-J-1 | 1360 | 1300 | 1643 |
| LM74-J-2 | 1200 | | 1273 |
| LM74-F-2 | 520 | | 435 |
| LM74-F-3 | 400 | | 155 |
| LM74-D-1 | 600 | | 528 |
| LM74-D-2 | 1050 | 1000 | 2074.5 |

# TABLE IV

## PROPOSED 1975 LAKE MISTASSINI BUDGET

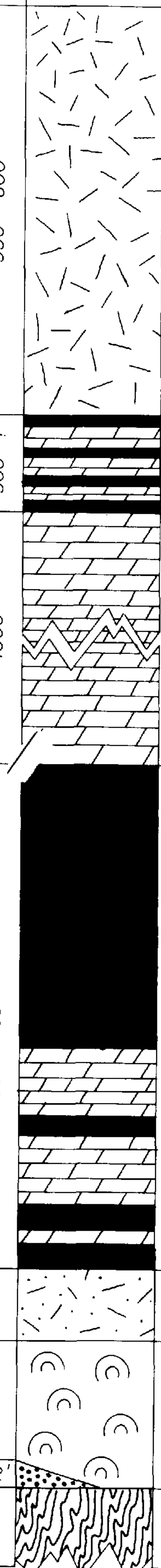
| | | | |
|---|---|---|---|
| Project Maintenance | | | |
| Office rent and utilities, general supervisory time and expenses: | | | $ 9,600.00 |
| Drilling and Geochemical Program | | | |
| Direct drilling costs for 5000 feet @ $18 /foot: (footage charges, mobilization, moves, stand-by time, delays, lost equipment, etc.) | | | 90,000.00 |
| Air Support | | | |
| Fixed Wing Aircraft | | | |
| Otters @ $150/ hour for mobilization and demobilization and ferrying supplies to and from Temiscamie | | $22,500 | |
| Helicopter - Jet Ranger | | | |
| 75 days @ $700/day | | 52,500 | |
| Total air support | | | $75,000.00 |
| Claim Staking | | | |
| 204 claims @ $55/claim | | | 11,220.00 |
| Geology, Drilling Supervision and Geochemical Prospecting | | | |
| Professional Services | | | |
| Project Supervisor | $ 7,500 | | |
| Senior Geologist | 12,000 | | |
| Geologist | 9,625 | | |
| | | $29,125 | |
| Labor | | | |
| Field Assistant (student) | $2,550 | | |
| Technician (labourer) | 1,020 | | |
| | | 3,570 | |
| Analyses & Lab Expenses | | | |
| Assays | $1,250 | | |
| Geochemical Samples | 2,500 | | |
| Other | 250 | | |
| | | 4,000 | |

| | | | | |
|---|---|---|---|---|
| Camp Expense | | | | |
| Camps | $2,025 | | | |
| Meals (including pilots) | 4,500 | | | |
| Radios | 300 | | | |
| Field Supplies | 2,100 | | | |
| Boat Rental | 1,500 | | | |
| | | $10,425 | | |
| Other | | | | |
| Travel | $2,000 | | | |
| Vehicle | 2,400 | | | |
| Room & Meals (town & travel) | 2,600 | | | |
| Tel & Tel | 1,200 | | | |
| Maps & Publications | 200 | | | |
| Drafting & Reproduction | 1,500 | | | |
| Report & Preparation | 5,000 | | | |
| Freight | 300 | | | |
| Miscellaneous | 400 | | | |
| | | $15,600 | | |
| | | | TOTAL | $ 62,720.00 |
| | | | GRAND TOTAL | $248,540.00 |

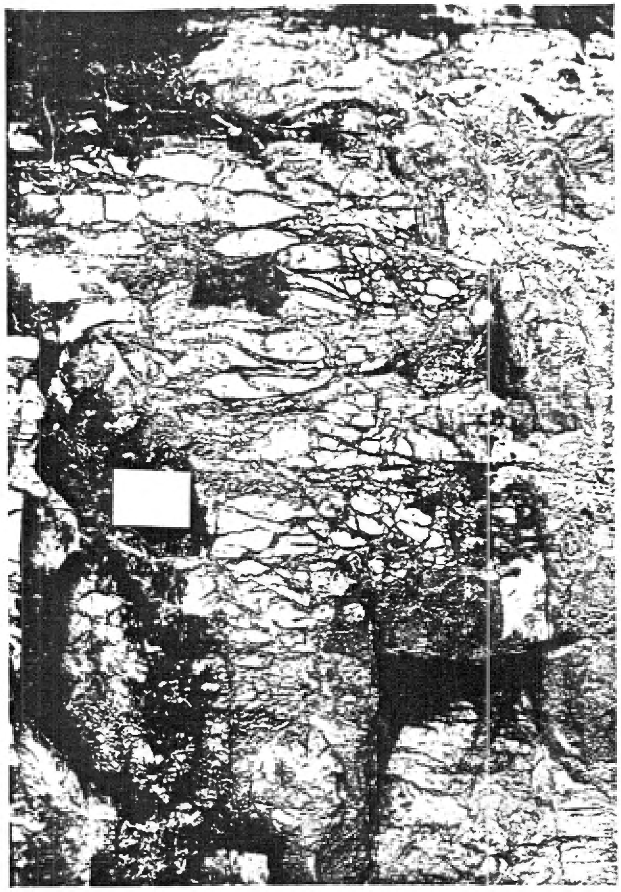

Area of report

Figure 1. Location Map

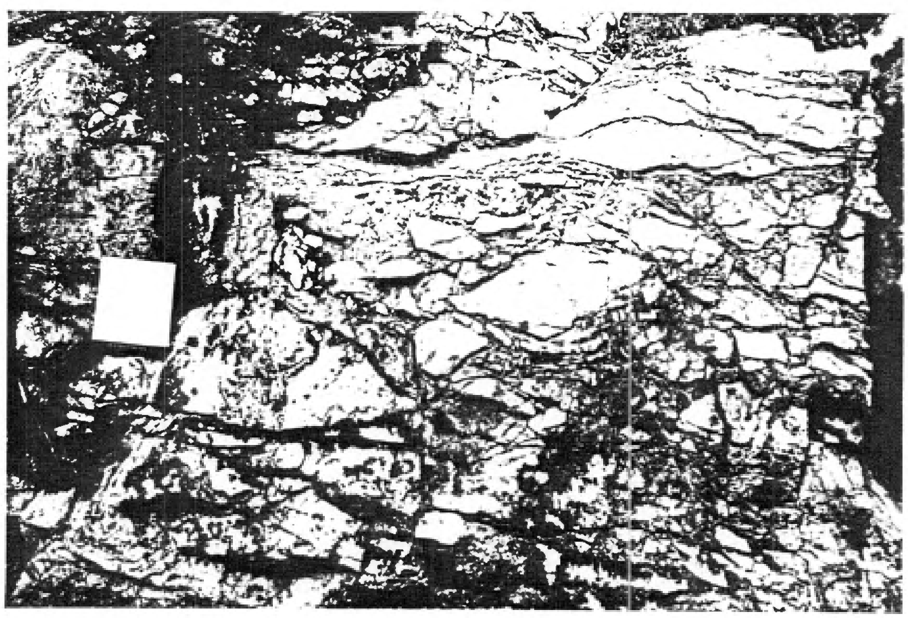
Figure 4 Generalized stratigraphic subdivision of the Lower Albanel formation (Late Proterozoic), Mistassini Basin.



| Unit No. | Thickness | Stratigraphy | Lithology | Characteristics | Depositional Environment | Mineralization |
|---|---|---|---|---|---|---|
| 7 | 550' - 600' | | Interbedded algal stromatolitic dolomite, algal dolomite breccia, and gray dolomite (dolomicrite) | Irregular crenulated lamination (LLH algal stromatolites), detached and disrupted bedding, lithoclasts, flat-pebble conglomerates, dessication features. Abundant voids and vuggy veins filled with quartz-carbonate and hydrocarbon | Alternating supratidal with intertidal (wave-protected, lagoonal shore, tidal flat) | Traces and blebs of sphalerite and galena (replacement? and open-space filling) |
| 6 | 300' ? | | Interbedded black shale and gray dolomite | Planar bedding and lamination | Intertidal-subtidal (euxinic tidal flat, enclosed lagoon?) | |
| 5 | 1500' + | | Gray and dark gray banded dolomite. Dolomitic limestone locally at base. Scattered beds of sandy dolomite and black shaly dolomite | Bedding planar, some convolute; small-scale cross-bedding, upward-fining cycles, cut-and-fill | Shallow marine | |
| 4 | 150' - 485' | | Black graphitic shale (2-5 horizons; top shale 60-120 feet thick), argillaceous dolomite, gray dolomite, dolomitic limestone; locally algal mats | Planar bedding and lamination. Local disrupted bedding, brecciation, crenulated and discontinuous lamination | Intertidal-subtidal (euxinic tidal flat, enclosed lagoon?) | Disseminated and nodular pyrite<br>(chalcopyrite, Perch River) |
| 3 | 15'-70' | | Algal dolomite breccia, gray dolomite, bands of sandy dolomite (medium dolomitic sandstone) | Mottling, lithoclasts, irregular laminations. Abundant vugs filled with quartz-carbonate, hydrocarbons | Supratidal | Chalcopyrite, sphalerite, pyrite (Icon Sullivan) |
| 2 | 0 - 91' | | Algal dolomite. Locally thin sandy dolomite at base | SH-V and compound SH & LLH algal forms. Brecciation, mottling at base. Voids and vuggy veins filled with quartz-carbonate. | Intertidal (unprotected shore); reefy biostrome? | Blebs and grains of pyrite, sphalerite; traces of chalcopyrite |
| 1 | 0-2' | | | | | |
| | ? | | Archean granite-granodiorite, granitic gneiss, metavolcanics. Regolith at top. | | | |



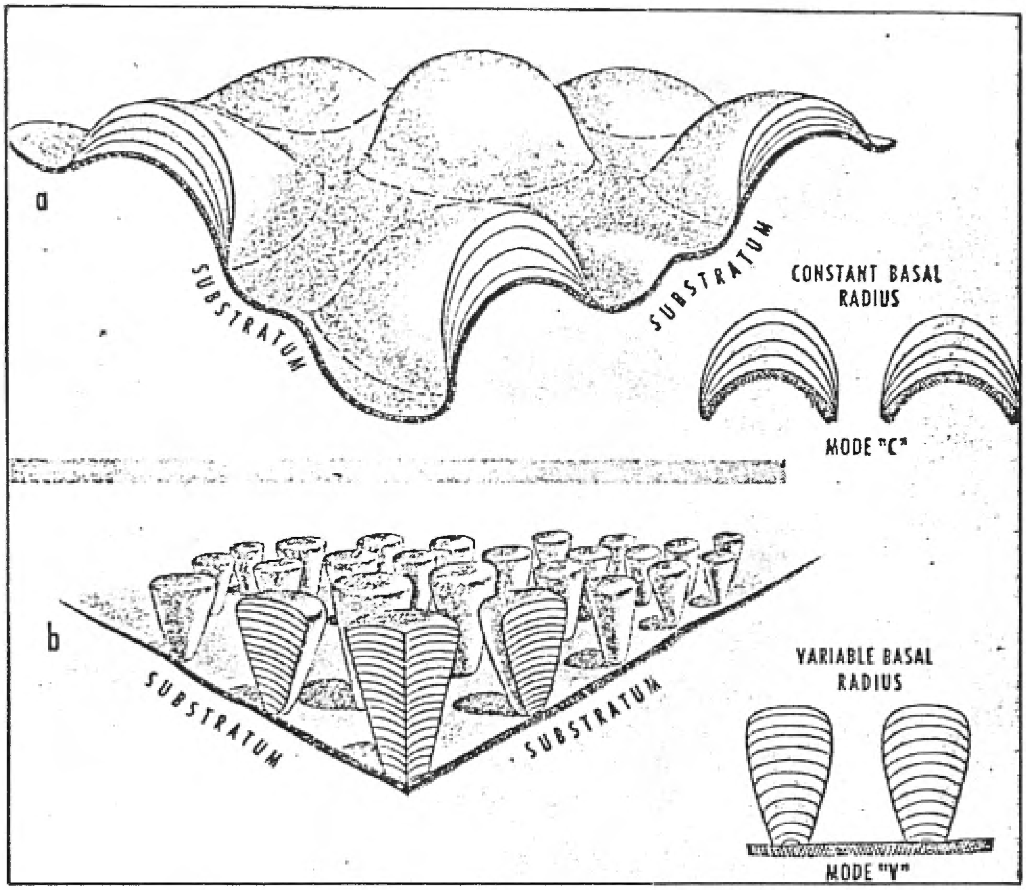
5A



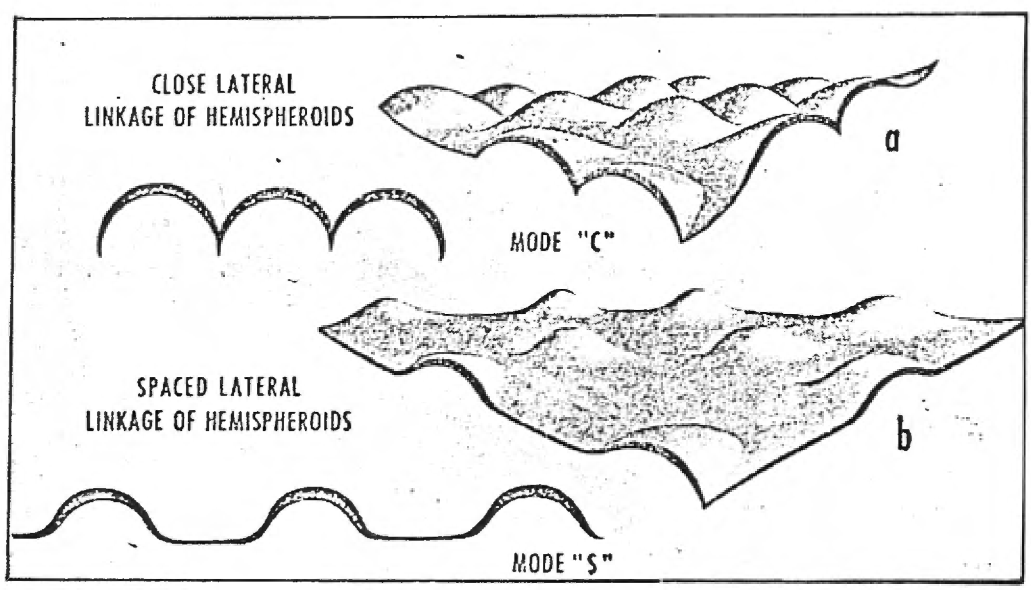
5B

Figure 5 A, B. Outcrop showing a portion of the fossil regolith developed in the Archean granite. (Located in cliff at the mouth of unnamed creek 1.2 miles southwest of drill hole LM 74 D-1, southern end of Mistassini Basin. Cigarette pack at left center of photos indicates scale.)

The in situ fresh granite slabs and blocks (white and light gray) are separated by dolomite, siliceous sandy dolomite, and chalcedony, introduced along joints. Intersected by drilling, such a sequence could be logged as a conglomerate or breccia.




SH: Vertically Stacked Hemispheroids, modes SH-C and SH-V.




LLH: Laterally Linked Hemispheroids, modes LLH-C and LLH-S.

Figure 6. Geometric classification of algal stromatolites (after Logan, Rezak, and Ginsburg, 1963.)

Figure 7. Core samples from the basal SH stromatolite unit. (Core diameter is 35 mm.)

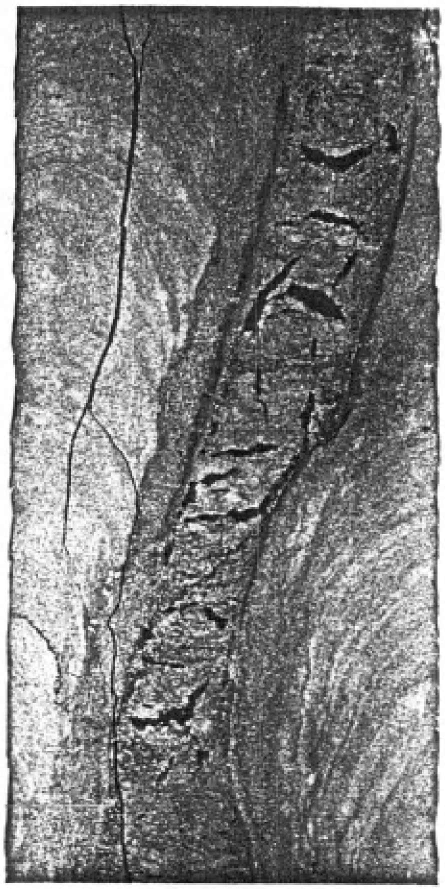
7A

Example of the SH-V stromatolite structures. Sedimentary interstructural filling is replaced by quartz-carbonate (light gray) and solid hydrocarbon, anthraxolite (black). Untreated core sample, hole LM 74 F-2, depth 430 feet.

7B

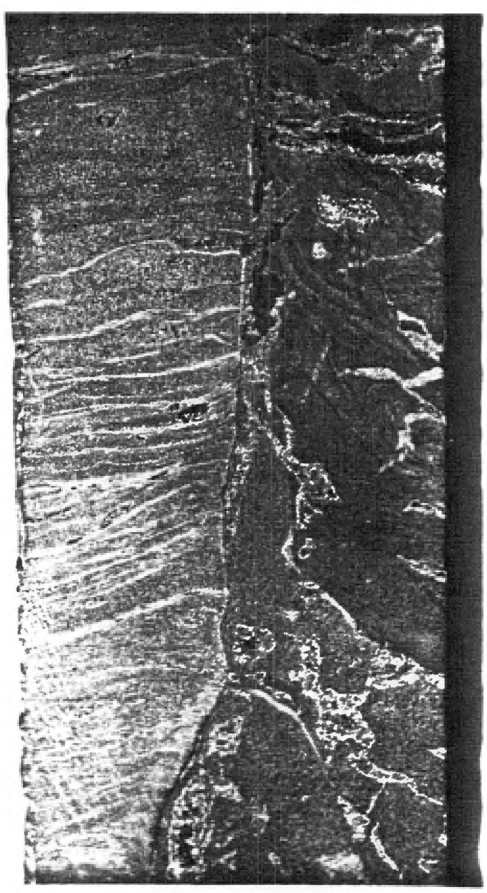
Nodular structures formed by concentric layers of acicular calcite, chalcedony and algal laminae. Cluster of rounded clasts of fine-grained dolomite forms nucleus of the large nodular structure at the center. At the bottom, a bleb of chalcopyrite, overlain by pyrite veinlet. Untreated core sample, hole LM 74 D-1, depth 526 feet.

Figure 7, continued. Core samples from the basal SH stromatolite unit.



7C

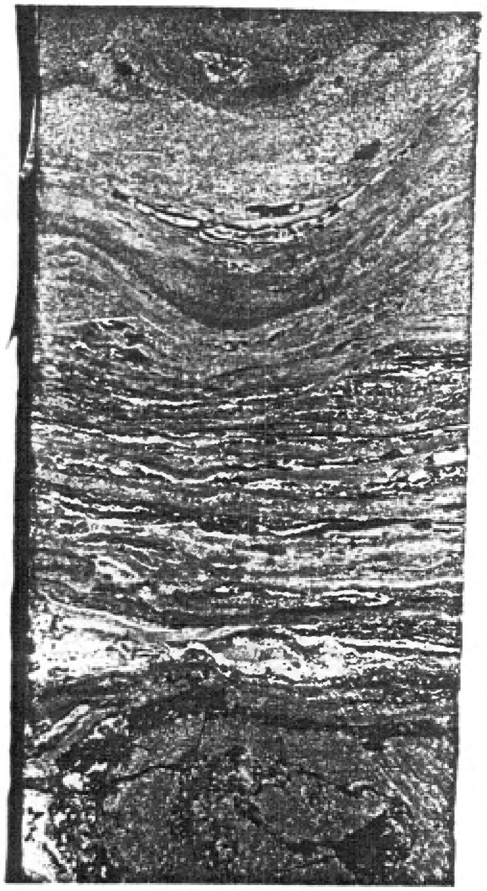
Detail of sedimentary filling between two SH stromatolite structures, intersected at the left and right hand side of the core. Note irregular vugs filled with finely crystalline quartz-carbonate (black). Etched core slab, hole LM 74 J-1, depth 1625 feet.



7D

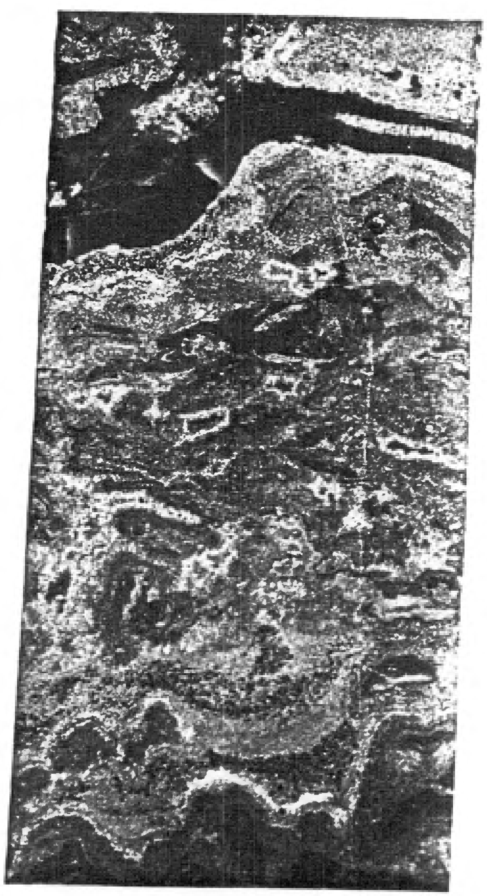
SH stromatolite structure (to the left) and interstructural space filled with detrital quartz (black dots) and mottled dolomite. Note the irregular vugs filled with calcite mosaic (light gray) and chalcedony (dark gray). Etched core slab, hole LM 74 M-1, depth 1323 feet.

Figure 7, continued. Core samples from the basal SH stromatolite unit.



7E

Example of gently domed Collenia, LLH-S structure (center), developing by upward growth into two separate Cryptozoon, SH structures. Etched core slab, hole LM 74 M-1, depth 1327 feet.



7F

Example of mottled structure involving detrital quartz, algal clasts, black shale and fine-grained dolomite. Abundant irregular vugs filled with chalcedony (top, dark gray) and crystalline carbonate (light gray). Etched core slab, hole LM 74 M-2, depth 986 feet.

Figure 8. Core samples from the LLH stromatolite complex (core diameter is 35 mm.)

8A

Chips and blocky clasts of algal-mat dolomite displaying discontinuous crenulated lamination. Space between the detached and displaced clasts, interpreted as a result of dessication, is filled with finely crystalline quartz-carbonate containing detrital quartz. Etched core slab, hole LM 74 F-1, depth 397 feet.

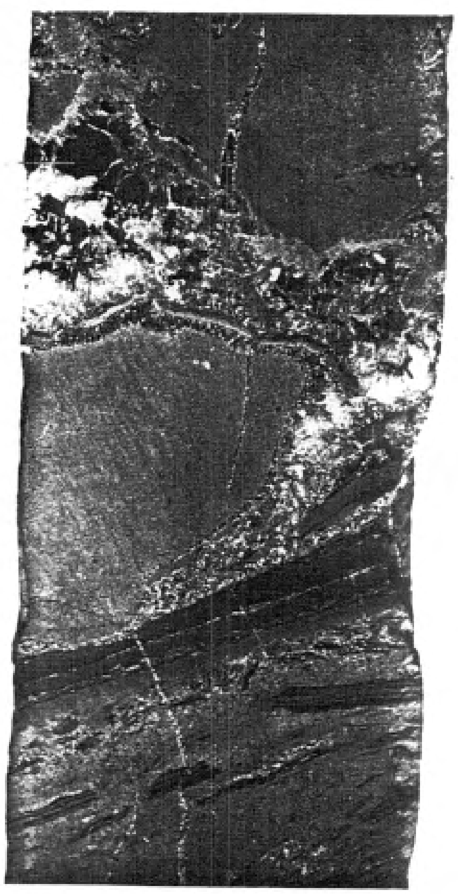
8B

Brecciated algal-mat dolomite showing crenulated lamination. Blocky algal clasts are embedded in a dolomitic micrite matrix (bottom right). Note quartz-carbonate filling (right center) containing blebs of hydrocarbon (shown in black, upper right). Etched core slab, hole LM 74 J-3, depth 340.5 feet.

Figure 8, continued. Core samples from the LLH stromatolite complex.

8C

Algal breccia. Blocky algál-mat dolomite embedded in a dolomitic micrite matrix. Crystalline quartz-carbonate fills open space and partially replaces micrite in rims surrounding algal clasts. Etched core slab, hole LM 74 J-3, depth 188 feet.



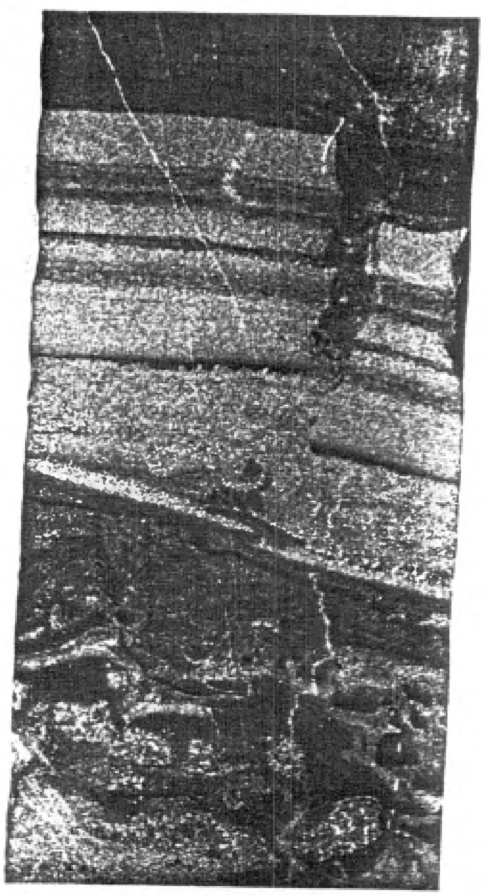
8D

Example of open space filling and micrite replacement by crystalline quartz-carbonate and hydrocarbon (shown in black) in algal-mat dolomite breccia. Etched core slab, hole LM 74 J-3, depth 187.5 feet.

Figure 8, continued. Core samples from the LLH stromatolite complex.

8E

Mottled structure involving algal mats (dark) and dolomitic micrite (light). Etched core slab, hole LM 74 J-3, depth 343 feet.



8F

Algal-mat dolomite breccia displaying mottling and dessication features. Core slab, hole LM 74 J-3, depth 477 feet.

ERNEST K. LEHMANN & ASSOCIATES, INC.

GEOLOGISTS

GENERAL CRUDE OIL COMPANY

HOUSTON, TEXAS

# REPORT ON EXPLORATION FOR STRATABOUND COPPER-ZINC-LEAD DEPOSITS IN THE LAKE MISTASSINI AREA

January - August, 1974



By

Ernest K. Lehmann, AIPG

and

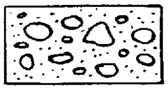
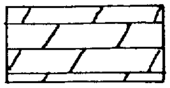
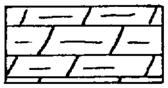
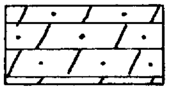
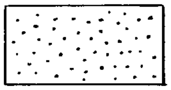
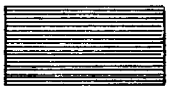
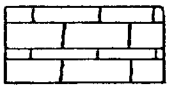
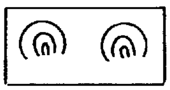
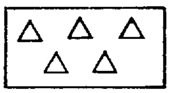
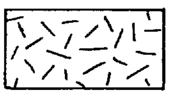
Vladimir Jindrich, AIPG

Ernest K. Lehmann & Associates, Inc.

Minneapolis, Minnesota

September, 1974

# LEGEND FOR GRAPHIC LOGS

| | |
|---|---|
|  | Glacial till, outwash |
|  | Dolomite |
|  | Argillaceous dolomite |
|  | Sandy dolomite |
|  | Sandstone |
|  | Conglomerate |
|  | Black graphitic shale |
|  | Limestone |
|  | Algal dolomite containing distinct algal biscuits or columns (probably in growth position) |
|  | Brecciation, disrupted bedding, and irregular mottling of uncertain origin |
|  | Algal dolomite containing distinct algal biscuits or columns that are largely disrupted and brecciated (algal breccia) |
|  | Igneous, volcanic and metamorphic rocks of the Superior Province (Archean) |

| | |
|---|---|
| X | Pyrite observed (noted only where substantial) |
| Z | Sphalerite observed |
| □ | Galena observed |
| ▽ | Chalcopyrite observed |
| Ø | Water seam encountered in drilling |
| ◆ | Denotes sample other than for fire assay |

## ABBREVIATIONS EMPLOYED IN GRAPHIC LOGS

| | |
|---|---|
| ab'dt | abundant |
| argill | argillaceous |
| bd'd | bedded |
| bdg | bedding |
| blk | black |
| congl | conglomerate |
| cont | contains, containing |
| decr | decreasing |
| dissem | disseminated |
| dk | dark |
| dol | dolomite |
| dol'tc | dolomitic |
| g'd | grained (as, fine-grained) |
| gn | green |
| gy | gray |
| impreg | impregnated |
| incr | increasing |
| irreg | irregular |
| loc | local, locally |
| lt | light |
| med | medium |
| qz | quartz |
| sh | shale |
| sl | slightly |
| ss | sandstone |
| twd | toward |
| v | very |
| w/ | with |
| wht | white |
| xbdg | cross-bedding |
| xbd'd | cross-bedded |
| xl | crystal |
| xln | crystalline |
| | |
| < | less than |
| > | more than |

# Microfilm

**PAGE DE DIMENSION HORS STANDARD**

**MICROFILMÉE SUR 35 MM ET**

**POSITIONNÉE À LA SUITE DES**

**PRÉSENTES PAGES STANDARDS**

# Numérique

**PAGE DE DIMENSION HORS STANDARD**

**NUMÉRISÉE ET POSITIONNÉE À LA**

**SUITE DES PRÉSENTES PAGES STANDARDS**