GEOLOGICAL SURVEY OF CANADA

OPEN FILE 1586

OVERBURDEN GEOCHEMISTRY AND POSSIBLE RELATIONS TO GOLD-BEARING ALLUVIAL DEPOSITS, SOUTHWEST GASPÉSIE, QUEBEC

Contract Serial Number 23233-6-0407/01-SZ

M.E.R.I. Project P85-15

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1987

ABSTRACT

Possible sources of various elements and minerals, including gold and garnet, found in anomalous concentrations in stream sediments within the Matapedia River drainage basin in southwest Gaspésie were investigated in a study of the geomorphology and compositional nature of the upland overburden in an area of about 2400 km^2.

Investigations on the geomorphology of the area show that Pleistocene events have had little influence in shaping the observed topography and drainage patterns. The project area is a dissected plateau with summit altitudes from 1300 to 1500 feet (396 to 457 m) above sea level, and floors of the major valleys from 150 to 750 feet (46 to 229 m) above sea level.

Upland overburden is thin and commonly not thicker than the soil profile. It varies from a diamict with a large proportion of the underlying bedrock and a lesser component of far-travelled material, to a rubble composed almost entirely of weathered underlying bedrock.

Major element analyses of the -60 mesh (<250 µm) fraction of overburden and trace element analyses of heavy mineral concentrates show changing compositions across the area in approximate correspondence with changes in underlying rock types. The abundance of heavy minerals in overburden is related to the concentration of Shield-derived minerals within the heavy mineral fraction. The distribution of heavy mineral abundances in turn reflects the distribution of bedrock lithologies and suggests that lithological differences may have affected the pattern of

deposition and erosion of the Laurentide ice sheet as it flowed across the area.

Gold analyses within the -60 mesh (<250 µm) fraction of overburden show that gold is in very low concentrations. However, gold analyses within heavy mineral concentrates extracted from overburden provide a better estimate of gold variation across the area and outline a number of anomalous zones. High abundances of gold in heavy mineral concentrates from overburden samples collected north of the mouth of the Assemetquagan River and east of the Matapedia River (within a 36 km^2 area) support the hypothesis of a local source to the north-northwest for the alluvial gold at the mouth of the Assemetquagan River.

1.0 INTRODUCTION

In this project the geomorphology and compositional nature of upland overburden is examined in a 2400 km^2 area of southwestern Gaspesie (Fig. 1). The purpose of the investigation is to ascertain the role of the surficial cover as a source of specific elements and minerals, including gold and garnet, found in the stream sediments of tributaries of the Matapedia River. Stream sediments have been systematically collected across the entire report area by the Ministère des Ressources Naturelles du Québec (Tremblay and Choinière, 1978; Choinière, 1984) with more recent sampling in the Assemetquagan River basin by the Geological Survey of Canada (Maurice, 1986). This report is to provide data chiefly on the geochemical and heavy mineral composition of upland overburden which comprises thin glacial drift (till), alluvium of fluvioglacial and non-glacial origin, colluvium, rubble and other diamict materials of uncertain origin. Sampling for this project was carried out in 1985 and 1986. The 1986 sampling program work was conducted in a 36 km^2 area outlined by UTM coordinates 639000 and 645000 E and 5324000 and 5330000 N. This area encloses the Assemetquagan River alluvial gold occurrence (Maurice, 1986).

2.0 PREVIOUS WORK

The numerous bedrock geology maps of the Gaspésie Peninsula were compiled by McGerrigle and Skidmore (1967) and Skidmore (1977,1980), to provide a framework for the region under study.

Details of the lithostratigraphic characteristics of individual formations within the project area were obtained from Béland (1960), Stearn (1965), Lachance (1974,1977,1979) and Bourque and Lachambre (1980).

The surficial deposits of western Gaspésie have been studied for many years by J. Lebuis and P.P. David who summarized their findings in 1977 (Lebuis and David, 1977) and, following further work mainly by Lebuis, presented a revised theory of glaciation of the Gaspésie (David and Lebuis, 1985). Their studies are concentrated along the north coast of the peninsula where the glacial deposits are thicker and where there are stratigraphic successions, but the sparse drift of the southern part of the peninsula was also examined. Some of the findings of Prichonnet and Desmarais (1985) concerning the stratigraphy and composition of drift in the Lake Matapedia area may have some relevance to the compositional nature of drift in our area.

The Quebec Government conducted an extensive stream sediment trace element geochemical survey which covered the entire Gaspésie Peninsula (Choinière, 1982). Results of the 15-year survey were published as a series of 7 geochemical atlases. A set of 1:500 000 scale compilation maps summarizing the 75 000 samples analysed was presented by Choinière (1984). One of the main findings of the survey was that the concentration of trace elements in the stream sediments varies characteristically across the peninsula with changes in the underlying rock types. Choinière therefore suggested that Quaternary glaciations had very little influence in shaping the observed geochemical patterns, except in the the north-central part of the peninsula where north-northeastward geochemical dispersion from the McGerrigle Mountains could be associated with northeastward glacial transport of drift as documented by Chauvin (1984).

Tremblay and Wilhelm (1978) evaluated the use of heavy mineral sampling of stream sediments as prospecting tools in a section of the peninsula which included a part of the present study area.

Girard (1985) investigated gold and associated minerals in heavy mineral and fine fractions of stream sediments of the Assemetquagan River. He proposed, from their physical appearance, that garnet and magnetite have a long transport history and that pyrite, hematite and ilmenite are of a more local origin.

Maurice (1986) made regional and detailed stream sediment surveys for gold in southwest Gaspésie. From an orientation survey in the auriferous lower segment of the Assemetquagan River he found that gold is preferentially concentrated in crevices and cleavage openings of fissile bedrock and also in moss on surfaces of boulders and bedrock. He suggested that the gold may have been eroded from Fortin Group lithologies by the Laurentide ice sheet during its southeastern movement across western Gaspésie. Deposition of gold and Shield-derived heavy minerals in the Assemetquagan valley would have been promoted by the retardation or obstruction of the debris-rich basal part of the ice sheet by the higher northwest-facing valley wall.

3.0 GEOLOGICAL FRAMEWORK

The stratigraphic and lithologic character of the sedimentary formations which underlie the report area (Fig. 2) are summarized in Table 1.

The Gaspēsie peninsula forms the northwestern extremity of the Appalachian Physiographic Region on the continental mainland (Bostock, 1970). First order subdivisions include (1) the Notre Dame Mountains, an elevated upland surface which extends along the northern two-thirds of the peninsula and includes the Shickshock and McGerrigle mountains, and (2) the Chaleur Upland, a deeply dissected upland surface which borders Chaleur Bay to the south.

Within the western part of the Gaspēsie peninsula, the Notre Dame Mountains and Chaleur Upland subregions consist of 3 major SW-NE trending, fault-controlled belts of tightly to gently folded Paleozoic rocks. The northern (Taconic) belt extends 40 km inland to the south margin of the Shickshock range and it is separated from the adjacent central belt to the south by the Shickshock fault. It consists of Cambro-Ordovician flysch sediments of the Quebec Group and includes the metavolcanic and metasedimentary rocks of the Shickshock Group, and the intrusive rocks associated with the McGerrigle plutonic complex. The adjacent central belt is a zone 65 km wide of gently folded, weakly recrystallized Silurian to Devonian strata. The northern 40 km consists of a basal Lower Silurian siltstone unit (St.-Lēon Fm.) overlain by two units of Early to Middle Devonian limestone units (Cap Bon-Ami and Grande-Grēve Fms.) and topped by a sequence of Lower to Middle Devonian terrigenous clastic sediments (York Lake, York River, Lake Branch and Battery Point Fms.). The entire siltstone-limestone-sandstone succession is adjoined to the south by a trough of thick Lower Devonian siltstone and shale (Fortin Gp.) 25 km wide, with minor interbedded acid and intermediate volcanics and pyroclastics (Stearn, 1965). The southern belt borders Chaleur Bay to the south and is separated from the central belt by the Matapedia (Restigouche) fault. It contains a variety of rocks of different ages, ranging from Upper Ordovician to Lower Silurian flysch sediments (Honorat and Matapedia Gps.), through Upper Silurian to Lower Devonian shallow marine and terrestrial clastic sediments and associated mafic intrusions and andesitic volcanics (Chaleur Gp.), to Carboniferous terrestrial conglomerates and sandstones (Bonaventure Fm.).

The Taconic Orogeny (Upper Ordovician) caused most of the deformation recorded in the Cambro-Ordovician rocks (Williams and Hatcher, 1982). Later deformation during the Acadian Orogeny (Middle Devonian) affected the Siluro-Devonian strata and produced the major SW-NE trending structures observed across the southwestern part of the peninsula.

4.0 GEOMORPHOLOGY

The project area is a dissected plateau with summit altitudes from 1300 to 1500 feet (396 to 457 m) above sea level, and floors of major valleys from 150 to 750 feet (46 to 229 m) above sea level. Projected profiles show that the upland is a rolling surface having about 300 feet (91 m) relief, and that the present valleys are incised into broad valleys with floors now about 1000 feet (305 m) above sea level. The present streams occupy V-shaped valleys incised about 500 feet (152 m) below the ancient valley floors. The Assemetquagan and Milnikek Rivers have formed ingrown meanders in the younger inner valleys; however the present rivers are changing from a smoothly sinuous meander pattern to one of straight segments and sharp bends. This suggests that the river is actively cutting downward into bedrock, perhaps as a result of reduction in grain size of the load that it carried when the smoothly sinuous pattern formed.

Transverse profiles across the Matapedia valley suggest an ancient valley floor at about 1000 feet (305 m) above sea level, and one or two sets of lower terraces above an inner valley. North of Latitude 48° 15' the Matapedia valley is broad, with a floodplain in which the river meanders in an overfit fashion. South of this latitude the valley is a narrow, in places sinuous, canyon with little or no floodplain. The northern segment, which crosses relatively competent rocks (dominantly siltstones), is a typical glaciated valley, but the southern segment, deeply entrenched across weak shales of the Fortin Group, shows little evidence of glacial erosion.

A study of air photographs yielded no conclusive evidence of glacial erosion in the region: in two places small lakes occupy basins that may have been glacially formed in valleys that have broad U-shaped profiles, but such profiles may be produced by processes other than glacial activity.

The drainage pattern of the area, especially the first and second order streams, is strongly controlled by structure. In the northwestern third (north of the Fortin Gp., Fig. 2) the main streams trend northwest across anticlinal and synclinal structures, and lesser subsequent streams are in valleys between resistant beds. In this region the drainage pattern is in part deranged, mainly by the glacial erosion of northwest-trending valleys and later deposition. In the central part of the area, from the northern boundary of the Fortin Group to the divide on the south side of the Assemetquagan valley, the streams have a modified dendritic pattern and are deeply incised into the shales. This is part of a larger basin trending southwest-northeast across the Matapedia valley, including the valleys of du Moulin River and the lower part of the Milnikek River in the west and the Assemetquagan River in the east. These rivers discharge southeast through the Matapedia valley. First and second order streams form a sharply rectangular pattern, with a tendency for northwest trends to be closely spaced and southwest trends to be farther apart Some of the southwest-trending valleys form lineaments that can be traced for many kilometers. In some places the asymmetric, coarsely pinnate patterns of low order streams suggest a response to the dip directions of the rocks.

In the southeastern quarter of the area (south of the southern watershed of the Assemetquagan River) the streams have a parallel pattern flowing southeast, and the lower half to two-thirds of their courses lie in the relatively resistant rocks of the Matapedia and Chaleur Groups. These streams are eroding headward and capturing drainage areas within the Fortin Group.

The Matapedia is the main trunk of the drainage system. In the south half of the project area, below Ste. Florence, its valley is anomalously straight and narrow for the downstream segment of a valley that systematically broadens north of Ste. Florence. The southern part follows the regional southeast trend. North of the mouth of the Milnikek River, the valley appears offset to the east, and south of it, it is aligned with the lower reaches of the Milnikek River and a minor tributary. There are two occurrences of ice-contact stratified deposits plastered against the east side of the narrow Matapedia valley. The valley floor is gravel derived from fluvioglacial outwash and younger alluvial fans.

The present drainage has evolved through a long interval, possibly extending back into late Paleozoic time. The major forms are little modified by Pleistocene events. The narrow, steep valleys incised into an older rolling surface suggest rejuvenation by uplift or obliteration of lithologic base levels rather than by climatic change. There are relatively few barbed tributaries and wind gaps, which suggests that much denudation has occurred since adjustment to structure was first achieved. The narrow valley of the lower Matapedia appears to be very young by comparison; however it must antedate the last glaciation. An arcuate valley as wide and deep as the Matapedia joins the head of a tributary of the Assemetquagan River to the Kempt-Ouest River and may have been the outlet of the Moulin-Assemetquagan basin before headward growth of a south-flowing stream captured the system and became the Matapedia River. It is also possible that a diversion of the present Matapedia drainage through this valley was caused by a lobe of ice advancing down the Restigouche valley from the southwest, for which there is some other evidence, albeit sparse (Fig. 3).

If the Fortin Group formed a basin at some time in the past when the Matapedia and Restigouche Groups formed a range of hills on the north side of the Restigouche valley, the basin may have discharged around the west end of the hills via the Patapedia system or northward through the Matapedia valley (reversed) north of Ste. Florence. It can be speculated that the southern hills must have shed detritus that accumulated on the Fortin Group as a series of alluvial fans. The steep gradient of the southeast-flowing streams would have caused them to grow headward across the hills and eventually capture the drainage on the Fortin rocks.

5.0 SURFICIAL GEOLOGY

The surface deposits of the region were studied by Lebuis (1975), whose work is summarized in David and Lebuis (1985). In the northwest and northeast corners of the study area till is as thick as two meters, and eskers, other ice-contact stratified drift, and outwash are common. Colluvium on valley sides contains more than one lithology and includes a component derived from till. However in the southern part of the Matapedia valley, glacial deposits are represented by only two ice-contact deposits. The valley contains much sand and gravel on the floor and in terraces. Some of this is outwash, much of which is reworked by the present river. There are several alluvial fans deposited by tributary streams, which are still active. These fans have a generous proportion of cobbles and boulders. Accumulations of reworked outwash sands reaching thicknesses of up to 90 meters are found on the valley sides of the Matapedia River below the mouth of the du Moulin River (Fig. 3). These thick sand deposits originated from the alluvial reworking of large outwash fans that were deposited in the narrow Matapedia valley at the mouths of du Moulin River and tributaries to the south when the last ice sheet was actively retreating to the north, releasing large volumes of detritus into the Matapedia River and its tributaries. The great thickness of the alluvium on the valley walls of the Matapedia valley from the mouth of the du Moulin River south to Chaleur Bay may have been associated with the presence of an ice lake in Chaleur Bay at the time of deglaciation. Damming of the Matapedia River at or near its mouth would have resulted in a wave of deposition upstream causing a rise in the elevation of the valley floor and deposition of large outwash fans at the mouth of tributaries possibly all the way up to the Assemetquagan River.

On the uplands of most of the area the drift is thin, commonly not thicker than the soil profile. It is generally a diamicton with a large proportion of underlying bedrock, but locally contains sparse to rare erratics. In places the upper part is fine sand or silt that may have been windblown. Exposures are poor, and it is not clear how important the role of cryoturbation is in mixing bedrock fragments with overlying material. The upland overburden over much of the south-central section of the report area consists of a thin veneer of rubble derived from the physical weathering of the underlying rock, in which is mixed a very small component of far-travelled material. Sparse to rare erratics mantle the upland surface and provide evidence that the area was glaciated. Colluvium derived from the fissile shales and siltstones of the Fortin Group forms extensive and commonly thick sheets at the foot of valley slopes. It is clearly evident, from the often impressive recent accumulations of talus along road cuts within Fortin lithologies, that the colluvium-forming process provides a very effective pathway for moving materials from the upland areas to the valley floors and into the drainage systems.

David and Lebuis (1985) have strong evidence of a southward flow across our area in the distribution of erratics from the Precambrian Shield (gneisses, anorthosites), and the distinctive Val Brillant quartzite. We are able to add to their data points, and to add another rock type, the red Lake Branch sandstone, from which erratics are distributed a few kilometers both to the north and south of the source exposure (Fig. 4). Some pink granitic erratics on the north side of the Restigouche estuary may have come from the west. A limited number of striations in northern New Brunswick reported by Rampton et al. (1984) support the tenuous evidence in our area for glacial flow at some time from the west or southwest.

6.0 METHODS

6.1 Field Methods

The 1985 field sampling program was designed to provide a representative coverage of the study area. Overburden was sampled by collecting approximately 10 litres of diamicton from the C horizon of hand-excavated pits at approximately 1.5 to 3 km intervals along roads accessible by 2-wheel-drive vehicle. Samples with a high matrix (sand size and finer)-to-clast ratio were collected where possible, but where the matrix fraction was small, larger samples up to 20 litres were taken. In all, 295 samples were collected (Appendix 1).

During the summer of 1986, overburden samples were collected in a 36 km^2 area which encloses the mouth of the Assemetquagan River (Fig. 1). The sampling procedure was modified to take into account the very low abundance of far-travelled material in the upland drift in the general surrounding area. Overburden was sampled by collecting approximately 25 litres of material screened on site to -4 mesh (<4.75 mm). Care was taken to collect samples in the C horizon; however at most sites the overburden was thin and lacked distinct soil horizons. Sixty-nine samples were collected on the upland surface at a spacing of 500 to 700 m. A further 13 samples were collected on the valley slopes within the lower 1 km segment of the Assemetquagan River (Appendix 2).

Sample treatment is illustrated in Figure 5. Approximately 1 litre of material was separated from the 1985-series samples and then screened to -4 mesh (<4.75 mm) in preparation for geochemical analysis. The remaining fraction of the sample was then wet sieved to obtain the 63-250 µm (very fine to fine sand) fraction from which heavy minerals were extracted and analysed. Sample treatment was slightly modified for the 1986-series samples. These were wet sieved to a larger size fraction (63-450 µm) in an attempt to produce heavy mineral concentrates suitable in size for geochemical analysis.

Where observed, glacial erratics were identified and plotted on a map. Particular attention was given to the areal distribution of red sandstone erratics from the Lake Branch Formation which forms a narrow belt across the Matapedia River, 6.5 km south of the village of Causapscal (Fig. 2), and white orthoquartzite indicators of the Val Brillant Formation which outcrops west of Lake Matapedia. Specimens of each of the various sedimentary formations that outcrop in the study area were also collected for major and trace element analysis.

6.2 Geochemical Methods

The -4 mesh (<4.75 mm) 1985-series samples were dry sieved to obtain 140-180 g of the -60 mesh (<250 µm) fraction, for use in determining gold, major and trace element content. The samples were milled to -200 mesh (<75 µm) and then sent to a commercial laboratory where they were analysed for gold by combined fire assay and plasma emission spectrometry (detection limit of 2 ppb). One hundred of these samples were also analysed for major and trace elements using a Philips PW 1400 X-ray spectrometer in the Department of Geological Sciences, McGill University. Loss on ignition was also measured on these samples.

Two hundred and forty (0.2 - 2.0 g) heavy mineral concentrates were sent to a second commercial laboratory where they were analysed for gold and 25 other elements by regular irradiation neutron activation. Ninety-six of these samples are from the detailed 1986 study area.

6.3 Heavy Mineral Studies

Light and heavy preconcentrates were obtained from 165 1985-series samples and all of the 1986-series samples using a Mozely MK II mineral separator. Heavy minerals were then extracted from the preconcentrates by density-dependent settling in methylene iodide (3.3 s.g.). Magnetic minerals were removed from the heavy fraction using an automagnet. The resulting mineral fractions were weighed to provide weight percentages of heavy mineral in the total sample and magnetic minerals in the heavy mineral fraction. The loose non-magnetic heavy mineral fractions were examined under a binocular stereoscopic microscope in order to determine (1) the characteristic mineral assemblages, (2) the approximate proportion of local and far-travelled components and (3) the presence of visible gold in the samples.

7.0 RESULTS

7.1 Major and Trace Element Analyses

The results of the major and trace element analyses on the 100 -60 mesh (<250 µm) samples are given in Appendices 4 and 5. A legend for analytical Appendices 4 and 5, and Tables 2 and 3 is given in Appendix 3. Analyses are arranged by underlying rock formation or group and overburden type, and averages for the grouping are given in Tables 2 and 3.

As a generalization, overburden samples collected from the northern half of the project area have the highest concentrations of SiO_2 (74.33-81.33% avg.) (underlain by York Lake, York River, York Branch, Cap Bon-Ami and Grande-Grève Formations). Samples collected over Fortin Group lithologies in the central part of the area have intermediate SiO_2 contents (70.9-74.6% avg.) and those underlain by the Matapedia Group show the lowest SiO_2 concentrations (61.7-68.2% avg.) A cursory inspection of the lithological characteristics of the different formations (Table 1) and their respective approximate SiO_2 contents (Table 4) shows that the north to south decrease in the concentration of SiO_2 in overburden corresponds to a general trend of decreasing SiO_2 across the different lithological units, from sandstones, siltstones and silty limestones in the northern units, shales and siltstones in the Fortin Group, and limestones and calcareous mudstones in the Matapedia Group. The parallelism of SiO_2 variation in overburden with that of the underlying lithologies indicates that the composition of the former is greatly controlled by the composition of the latter, in other words, the overburden contains a significant proportion of locally-derived bedrock, a feature readily observed in the field.

The few bedrock specimens analysed do not permit estimation of compositional ranges within lithological units or comparison of SiO_2 concentrations in overburden in relation to a specific formation or group. The bedrock samples roughly match their corresponding overburden equivalents. The principal exception is the rock specimen from the Grande-Grève Formation which is high in CaO and low in SiO_2 in contrast to till and colluvium samples which are high in SiO_2 and low in CaO. A second exception is the single Fortin Group bedrock sample with a CaO concentration (1.74%) well outside the range of CaO (0.07-0.43%) in the corresponding overburden samples.

A comparative summary of trace element averages for the major overburden types and the stream sediment data of Choinière (1982) is shown in Table 5. Observed concentration differences among upland overburden, stream sediments, and lithological formations and groups cannot be readily explained without taking into account variations associated with differing analytical procedures and detection limits, and the number of samples analysed. Considerable concentration overlap exists, and patterns like the ones observed with the major element distribution are not apparent.

7.2 Heavy Mineral Concentrate Analyses

The results of the trace element analyses on the 221 heavy mineral concentrates are listed in Appendices 6 and 7. A further 19 analyses are from check samples inserted to verify the precision of the results (Appendix 7).

The geochemical data were subjected to factor analysis (Table 6). Selenium and Ag were excluded from all statistical treatment because of abundances below the detection limit in almost all cases. Because detection limits were highly variable for certain elements (a function of sample size and composition), analyses below the detection limit were considered as missing values. The missing values were treated by pair-wise deletion, that is, in the calculation of the correlation coefficient matrix, a sample would be deleted from the calculation of the coefficient for an element pair if one or both of the elements had missing values.

Geometric means and standard deviations of trace element concentrations in the heavy mineral fraction of overburden are listed by lithological units in Table 7. The distribution of trace elements can be summarized as follows: (1) Heavy mineral concentrates from overburden samples collected over the Cap Bon-Ami and Grande-Grève Formations show the lowest contents of rare earth elements (REE), Mo, Ni, and Th. (2) Overburden from the Fortin Group shows the highest abundances of REE, Hf, Th, Sc, W, U, and Ni, with intermediate concentrations of As, Co, and Sb. (3) Arsenic, Co, Sb, Fe, and Zn are highest in abundance in heavy mineral concentrates of overburden from the Matapedia Group. Gold is also high but was detected in only two samples. (4) Finally, overburden collected from the York Lake and York River Formations shows the highest contents of Cr and Ta.

One of the more striking features of the trace element distribution is the high concentration of REE, Hf, Th, U, W, and Ni in the heavy mineral fraction of Fortin Group overburden. These elements also show a particularly strong loading on Factor 1 in the table of factor analysis (Table 6), the REE, Hf, Th, and U displaying the highest correlation coefficients among each other (Appendix 8). The strong correlation among the latter elements suggests an association with a specific mineral phase, the most likely being zircon. Qualitative X-ray fluorescence analysis of one concentrate from Fortin Group overburden which displayed a high Hf content (4700 ppm) also showed a high Zr content and the presence of zircon was confirmed by X-ray diffraction analysis.

If the concentration of REE, Hf, Th, and U in the heavy mineral samples is a function of the proportion of zircon, then the proportion of zircon in the heavy mineral concentrates must be higher over the Fortin Group than over other formations. As expected, microscopic examination revealed higher proportions of zircon (>10%) in Fortin Group heavy mineral concentrates. Low abundances of zircon (<1-5%) are characteristic of heavy mineral concentrates from overburden both north of the Fortin Group (York Lake, York River, York Branch, Cap Bon-Ami and Grande-Grève Formations), where dilution by Shield-derived heavy minerals is widespread, and south of it (Matapedia Group), where pyrite, limonite and various other sulphides are the dominant heavy mineral constituents.

The other factors shown in Table 6 are less readily interpreted. Factor 2 (As, Co, Sb and Fe) could be an indicator of the presence of sulphides. The highest concentrations of Factor 2 elements are in heavy minerals of the Matapedia Group where a number of small sulphide mineralizations have been reported (Savard, 1985). The correlation of Au with Zn and Ta in Factor 4 and with -Fe, Ba and Mo in Factor 5 is accidental and reflects the effect of a very high outlier Au value (sample 272) on the calculation of the factors.

Choinière (1982,1984) has shown that the Fortin Group is overprinted by a large geochemical anomaly or "formational anomaly" of uranium in stream sediments. Choinière (1982, p. 129) concluded that

> "the stream sediment samples from the Gaspé area reflect variations in the geochemical composition of the underlying bedrock."

Our data lend support to Choinière's findings in that the heavy mineral fractions of Fortin Group overburden are enriched in uranium, and uranium is related to the presence of zircon, a significant mineral phase in the heavy fraction of the rubble and colluvium derived from the weathering of the underlying Fortin Group lithologies.

7.3 Gold Distribution

The regional distribution of gold in the -60 mesh and heavy mineral fractions of overburden are shown in Figures 6 and 7. Figure 8 shows the distribution of gold in overburden within the detailed study area.

The -60 mesh (<250 µm) results (Fig. 6) show that the overburden cover in general contains very low concentrations of gold. The highest concentrations observed, 30 ppb (sample 277) and 7 ppb (sample 67), occur in overburden samples collected over the Fortin and Matapedia groups respectively. An association of gold with sulphide minerals in sample 277 is suggested by the dominance of pyrite and limonite in the heavy mineral fraction. Sulphide minerals are present, but in lower abundances (<10%), in sample 67, collected on the upland surface which lies between the Matapedia and Milnikek Rivers.

A better estimate of the variation of gold in overburden on a regional basis is obtained from measurements within the heavy mineral concentrates (Fig. 7). The relative differences in gold abundance among the samples are more likely to be detected by this type of analysis because of the large concentration factor involved (100 to 1000) in separating the heavy mineral fraction from the original sample. The presence of gold is also more likely to be detected because of the large volume of original material (25 l) that the heavy mineral sample represents.

Anomalous gold values in the heavy mineral concentrates analysed (Figs. 7 and 8) appear to be associated with 4 different geological settings: (1) in a number of colluvium and rubble samples collected over Fortin Group lithologies (including the highest observed gold concentration in a heavy mineral sample; 2 100 000 ppb in sample 272 collected off a west tributary of the Escuminac Nord River); (2) in 3 samples (4, 35 and 78) collected along the section of the faulted contact between the Fortin Group and York River formations where intermediate volcanic lavas outcrop; (3) in 5 overburden samples collected over Cap Bon-ami and St.-Léon lithologies on the west side of the Matapedia River; and (4) in 1 anomalous sample (280) collected over Matapedia Group rocks.

The distribution of gold concentrations in heavy mineral fractions of overburden within the 36 km^2 area surrounding the Assemetquagan alluvial gold occurrence is shown in Figure 8. The overburden cover in this area consists of a thin mantle of rubble on the upland surfaces, extensive colluvium on valley slopes, reworked outwash sands on the lower slopes of the Matapedia River, south of the du Moulin River, and more recent floodplain alluvium (Fig. 3). Heavy mineral abundances in the overburden (Fig. 9) reflect the distribution of overburden types, with alluvium containing five to ten times more heavy minerals than rubble and colluvium.

Figure 8 shows that, although the highest gold concentration in a heavy mineral sample is from overburden collected on a small plateau south of du Moulin River, most high values occur within rubble and colluvium on slopes and upland areas north of the mouth of the Assemetquagan River and east of the Matapedia River.

Evidence put forward by Girard (1985), Maurice (1986) and Bergeron _et al._ (1986) indicates that the alluvial gold within the lower 2 km segment of the Assemetquagan River is derived from local Fortin Group lithologies. However, Maurice was the only one to outline a model explaining the presence of the gold. He tentatively proposed that:

> "...gold was eroded from a bedrock source within Fortin Group sediments by the Laurentide ice sheet as it flowed southeasterly across western Gaspésie. It was then preferentially deposited in the Assemetquagan River valley, along with a large quantity of Shield-derived heavy minerals (almandite garnet and ilmenite), because the valley gorge constituted a major obstacle which impeded advancement of the debris-rich basal part of the ice sheet, thus concentrating the detritus in the river channel."

Our data point to a closed anomaly within the upland overburden north of the mouth of the Assemetquagan River. This supports Maurice's hypothesis of a local source to the north-northwest. However we find little evidence to support a model of glacial erosion within valleys to the northwest followed by transport and massive deposition of debris in the lower few kilometers of the Assemetquagan River. The valleys and upland areas within Fortin lithologies south of Ste. Florence show little if any evidence of large-scale glacial erosion and transport. The upland drift is very thin and consists largely of underlying bedrock, with which is mixed a very small component of englacially transported material. Other evidence (see

Section 7.4) suggests that lithological differences across the area may have locally affected ice flow conditions, and hence the pattern of erosion, transport and deposition of debris.

Although conclusive evidence to support Maurice's model was not found, glacial erosion and transport is not precluded from the area in question. Small ice tongues may have occupied individual valleys and caused localized erosion and deposition of material. However, it appears unlikely that any of these would have been large enough to cross upland divides and deposit material in adjacent valleys.

7.4 Heavy Mineral Studies

The heavy mineral concentrates separated from the overburden samples were examined under a stereoscopic microscope and the relative proportions of individual mineral phases were noted. The heavy mineral assemblages in the sand fraction of till and colluvium samples collected in the northeastern third of the study area (within the Causapscal drainage basin including the area which forms the upper section of the Assemetquagan drainage area) consist predominantly of magnetite, garnet and ilmenite. When combined, these form an estimated 80 to 95% of the total heavy mineral fraction. The remaining 5-20% is epidote and clinopyroxene, with minor orthopyroxene, hematite, zircon, pyrite, leucoxene, rutile, chromite, amphibole and kyanite. Three common varieties of garnet are identified: a subangular, dull orange variety; a subangular, transparent, bright orange variety which locally contains oxide inclusions; and a subangular to subrounded, transparent, light pink variety. These garnet almandites with various proportions of pyrope and grossularite molecules. Ilmenite, hematite and magnetic minerals occur as subangular to subrounded grains which characteristically display surfaces reminiscent of euhedral habits. Electron microprobe analyses of ilmenites found in stream sediments of the region (Maurice, 1986) indicated that these are exsolved hemo-ilmenite varieties. At least 5 different types of magnetic minerals are noted: (1) highly magnetic true magnetite grains, (2) layered magnetite-hematite grains, (3) magnetic hematite grains, (4) weakly magnetic ilmenite grains, and (5) magnetic chromite grains. The garnet and ilmenite grains along with a large portion of the magnetite minerals are thought to be derived from the Canadian Shield. These form the bulk of the far-travelled component within the heavy minerals. Other far-travelled components include elongate pink and fluorescent zircons, rutile, amphibole, and kyanite.

Four varieties of zircon grains are noted within the samples: (1) a subhedral to euhedral, large (>100 µm), elongate, light pink and transparent variety , (2) a subhedral to euhedral, small (<100 µm), cloudy white variety, (3) a less common subhedral to anhedral, fluorescent to non-fluorescent, frosted tabular to rounded variety, and (4) a rare subhedral to anhedral, non-frosted, colourless to purple variety.

The heavy minerals in these samples are almost entirely angular and appear fresh, and few grains show evidence of pre- or post- erosional mechanical rounding or chemical alteration. Mineral grains which display "mature" appearances show either surface frosting, chemical replacements, or rounded habits. Features observed include limonite replacements of pyrite cubes, leucoxene alteration of ilmenites, frosted garnets, pyroxene and epidotes, and frosted round zircon grains. Locally-derived mineral phases include zircon, epidote, pyrite, hematite, barite and chromite. Zircon, hematite and chromite are accessory phases within the arenaceous units in the area.

In contrast to overburden samples examined above, the heavy fraction of till and colluvium samples collected in the northwest third of the report area show variations in both mineral assemblages and mineral proportions. Magnetic minerals continue to be ubiquitous components of the samples, but the relative proportion of far-travelled and locally-derived minerals varies. Oxidized sulphide (oxidized pyrite, limonite, botryoidal sulphides) and irregular oxide minerals in several samples become the dominant phase, with subordinate garnet, pyroxene and true ilmenites. Some of the samples with high sulphide content show anomalous concentrations of gold.

Samples examined from the south third of the study area (below Ste. Florence) show the lowest proportions of far-travelled minerals. Garnet and ilmenite on average form less than 10% of the total heavy mineral fraction. Pyrite, zircon and epidote along with barite and fluorescent minerals form the major components. Zircon in Fortin Group rubble samples reaches proportions of up to 80%. Pyrite and associated sulphides reach highest proportions in samples within Fortin Group overburden samples in the southeast corner of the area and in Matapedia

Group samples.

Figure 10 shows the distribution of heavy mineral abundances in the overburden within the regional area. The heavy mineral concentration in the samples examined varies from <0.1% to 1.5% (see also Appendix 9).

On the basis of the relative abundance of total heavy minerals, the study area can be divided into three broad zones. This division is approximately the same as the division into zones on the basis of mineral proportions that were defined earlier. The zone of highest proportion of Shield-derived heavy minerals (northeastern third) corresponds to the zone of highest abundances of heavy minerals (>0.5%), which in turn corresponds to the zone of thickest till in the area. As expected, similar heavy mineral concentrations were observed in the adjacent stream sediments by Maurice (1986), who defines the area as a zone of high abundance of heavy minerals (0.1 to 1.5%).

The northwest third of the report area corresponds to a zone of both intermediate heavy mineral concentrations (0.1-0.5%) and intermediate proportions of Shield-derived heavy minerals. The samples within this zone overlie lithologies of the Cap Bon-Ami, Grande-Grève and St.-Léon Formations. Higher concentrations to the immediate south appear to be associated with the underlying sandstone units (York River and Lake Branch Formations). The southern third of the project area (south of Ste. Florence) lies within Zone III of David and Lebuis (1985). This zone is characterized by a lack of glacial deposits, sparse erratics, deeply weathered bedrock and extensive colluvium containing a high content of locally-derived bedrock. Overburden samples collected within this area show the lowest heavy mineral abundances (<0.1%) along with the lowest proportions of Shield-derived components. Low abundances of heavy minerals were also recorded in stream sediments of the upper central Assemetquagan drainage basin by Maurice (1986). However, the lower central section, which includes a segment of the Assemetquagan River and the lower part of the Creux River, is shown as a zone of high abundance of heavy minerals. The lack of available data on the composition of overburden in this area does not allow the nature of the contribution of heavy minerals from overburden to the stream sediment to be evaluated.

The lower section of the Assemetquagan drainage area can be divided into two segments on the basis of the abundance of heavy minerals in the stream sediments (Maurice, 1986): a lower 900 m segment rich in heavy minerals and gold where the Assemetquagan River is narrow, rapid and turbulent; and an upper segment where heavy minerals show intermediate abundances. Overburden samples collected within the detailed study area surrounding the mouth of the Assemetquagan River (Fig. 9) show very low abundances of heavy minerals (<0.1% for rubble and colluvium). This suggests that the overburden in the lower section of the river basin is not a significant contributor of heavy minerals to the stream sediments. A possible explanation for the high abundance of Shield-derived heavy minerals within this section of the river is that they are derived from an overburden source within the central and/or upper sections of the drainage basin, and that they have been transported downstream and concentrated in the lower segment by stream processes. The Assemetquagan drainage basin contains important sources of Shield-derived heavy minerals in its upper reaches. High discharges associated with northward-retreating ice during deglaciation could have transported and deposited outwash rich in Shield-derived minerals in the Assemetquagan River and its tributaries. Post-glacial hydraulic action (most effective under seasonal high meltwater discharges) would erode, redistribute and concentrate this material within different reaches of the river as well as erode tills in the upper part of the drainage basin and colluvium in the central and lower parts. Shield-derived heavy minerals at the mouth of the Assemetquagan River owe their presence to a combination of all these processes. Which process(es) account(s) for the bulk of the heavy minerals present could not be resolved with the evidence at hand.

Perhaps equally as interesting is the apparent relation between heavy mineral abundances in overburden and underlying lithological units. The highest abundances of heavy minerals are in tills and colluvium underlain by the more resistant sandstone units, the intermediate abundances in tills and colluvium underlain by siltstones and limestones and the lowest abundances in colluvium and rubble of soft Fortin shales and Matapedia Group limestones. One may speculate that competency differences between the various lithological groups affected the local resistance to basal flow and hence the pattern of erosion and deposition of the Laurentide ice sheet as it moved south-eastward across the area. Debris derived from competent sandstone units may have provided the most resistance to flow and hence localized accumulations of materials within the basal debris layer of the ice. How this may have affected the pattern of deposition of Shield-derived materials or the pattern of ice flow across the less competent Fortin Group lithologies is unclear, and more detailed investigation will be required to explain all the observed features.

8.0 CONCLUSIONS

1. The project area is a dissected plateau with summit altitudes from 1300 to 1500 feet (396 to 457 m) above sea level, and floors of the major valleys from 150 to 750 feet (46 to 229 m) above sea level. Investigations on the geomorphology of the area show that Pleistocene events have had little influence in shaping the observed topography and drainage patterns. The upland is a rolling surface having about 300 feet (91 m) relief. The present rivers and streams occupy V-shaped valleys incised about 500 feet (152 m) below floors of ancient valleys now approximately 1000 feet (305 m) above sea level. The drainage pattern, especially the first and second order streams, is strongly controlled by structure. The Matapedia River is the main trunk of the drainage system. It is incised 1000 feet (305 m) below the floor of a large cross-axial valley. North of Ste. Florence the present Matapedia valley is broad and typical of glaciated valleys. South of Ste. Florence the Matapedia River is entrenched in a narrow straight canyon.

2. Upland overburden is thin and commonly not much thicker than the soil profile. It consists of glacial drift (till), alluvium of fluvioglacial and non-glacial origin, colluvium, rubble and other diamict materials of uncertain origins. The overburden is composed largely of material derived locally with a small component of far-travelled materials. Lake Branch sandstone erratics are transported south in the drift and alluvium near and in the Matapedia valley; erratics of this formation are also found in drift and alluvium up to 20 km north of their source. Evidence of southward flow across the area is also provided by the distribution of Val Brillant erratics. Some eastern transport, as suggested by meagre erosional features, is not precluded.

3. Major element analyses of the -60 mesh (<250 µm) fraction of overburden support a model of changing composition from north to south in approximate correspondence with changes in bedrock composition. This agrees with the observation that the overburden contains a significant component of locally-derived bedrock. Trace element analyses of the same material are less reflective of this trend. However, analyses of heavy mineral concentrates show significant trace element variations between overburden from different lithological units. The relative enrichment of REE, Hf, Th and U in heavy mineral samples extracted from Fortin Group rubble and colluvium reflects the higher proportion of locally-derived zircon within the heavy mineral fraction. Low abundances of zircon are characteristic of heavy mineral concentrates from overburden both north of the Fortin, where dilution by

Shield-derived heavy minerals is common, and south of it, where sulphide minerals form the dominant heavy mineral constituent.

4. The distribution of heavy mineral abundances and the proportions of individual mineral phases are related to the distribution of overburden types. High heavy mineral abundances are associated with high proportions of Shield-derived heavy minerals and correspond to till and colluvium from the northeast third of the area. Low heavy mineral abundances reflect low proportions of far-travelled mineral components and correspond to rubble and colluvium from the Fortin and Matapedia Groups.

   Heavy mineral abundances in overburden reflect heavy mineral abundances in adjacent stream sediments for the upper and central parts of the Assemetquagan drainage basin. Low concentrations of heavy minerals in overburden adjacent to the lower 1000 m of the Assemetquagan River do not explain the high abundance of Shield-derived minerals in the stream sediments. A possible explenantion is that these were transported from upstream sources and concentrated in the lower section of the river by hydraulic activity. Possible sources include outwash deposited within the valley and till and colluvium rich in Shield-derived heavy minerals in the upper reaches of the drainage area.

5. The distribution of overburden types can be related to the distribution of underlying rock types. Tills rich in Shield-derived minerals occur over sandstone lithologies, with some

overlap onto Fortin shales and siltstones to the south. Overburden with intermediate heavy mineral abundances and proportions of Shield-derived minerals overlie siltstone and limestone units in the northwest third of the area. Overburden with the lowest abundances of heavy minerals and proportions of Shield-derived heavy minerals occur on soft Fortin Group shales and siltstones and Matapedia Group limestones. This suggests that lithological differences may have affected the local resistance to basal flow and hence the pattern of erosion and deposition of the Laurentide ice sheet as it moved southeastward across the area.

6. Analyses of -60 mesh (<250 µm) show that gold is in apparently very low concentrations with the exception of two samples containing 30 ppb and 7 ppb gold. A better estimate of the variation of gold in overburden is obtained from measurements within heavy mineral concentrates. Although sample density is low, heavy mineral gold analyses outline a number of anomalous areas. High abundances of gold in heavy mineral concentrates from overburden samples collected north of the mouth of the Assemetquagan River and east of the Matapedia River (1986 study area) support Maurice's (1986) hypothesis of a local source to the north-northwest for the alluvial gold at the mouth of the Assemetquagan River.

9.0 ACKNOWLEDGMENTS

This project was funded by the Geological Survey of Canada, under the authority of Y.T. Maurice. We thank him for visiting

the area in 1985 and 1986 and for his continued interest and useful discussions.

Able field assistance was provided to M.A. Bernier in 1985 by J. Chan and M. Fay and in 1986 by G. Henricksen and P. D'Amours. M. Leroux of the Department of Mining and Metallurgical Engineering at McGill University made available mineral separation facilities. G. Henricksen and J. McCubbon provided laboratory assistance. Chemical analyses at McGill University were done by S.T. Ahmedali. We are grateful to all these individuals for their participation.

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Table 1. Lower Paleozoic formations and groups within the study area and their chief lithological characteristics. After Stearn (1965), Lachance (1977, 1979), Skidmore (1977) and Bourque and Lachambre (1980).

Period or Group (Gp.)	Formation (Fm.)	Lithology	Tectono-Stratigraphic Classification
Middle Devonian	Battery Point Fm.	Green and red arkosic sandstone, siltstone; shale and conglomerate; minor intermediate volcanics.	Central Belt* Gaspé-Connecticut Valley Synclinorium**
	Lake Branch Fm.	Red arkosic sandstone, siltstone; minor shale.	
Lower Devonian	York River Fm.	Grey-green argillaceous sandstone, siltstone.	
	York Lake Fm.	Grey-green arkosic sandstone, calcareous siltstone; minor silty limestone, shale, volcanics.	
	Fortin Gp.	Dark grey to brown, calcareous to non-calcareous shale and siltstone; arkosic sandstone, conglomerate; minor andesitic flows and pyroclastic volcanics.	
	Grande-Grève Fm.	Medium grey to light brown silty limestone, calcareous siltstone; minor mudstone.	
	Cap Bon-Ami Fm.	Medium grey argillaceous to silty limestone, shale, mudstone; minor sandstone, andesitic volcanics.	
Lower Silurian to Lower Devonian	St.-Léon Fm.	Greenish-grey calcareous siltstone, limestone, calcareous mudstone, shale; minor sandstone.	
	Chaleur Gp.	Grey siltstone interbedded with calcareous mudstone; minor volcanics.	Southern Belt* Aroostook - Percé Anticlinorium**
Upper Ordovician to Lower Silurian	Matapedia Gp.	Grey banded argillaceous and silty limestone and shale; locally hydrothermally altered and intruded by porphyritic dykes of intermediate compositions.	

* After McGerrigle (1950)

** Poole and Rodgers (1972)

Table 2. Summary of major element averages (%) by soil type and underlying rock (recalculated to exclude LOI in summation)

SOIL	ROCK	n	EAST	NORTH	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO	MgO	CaO	Na_2O	K_2O	LOI
C	B	1	2555.	4795.	81.33	.760	9.52	3.54	.040	1.00	.20	1.46	1.71	3.58
T	B	1	3755.	5300.	74.87	.749	13.55	6.70	.034	.97	.29	1.18	1.51	15.79
T	BY	1	3555.	5400.	67.72	.992	16.89	8.24	.044	2.08	.12	.97	2.79	8.25
T	C	2	3940.	6205.	76.92	.746	12.04	4.26	.040	1.39	.55	1.56	2.00	4.83
A	F	1	5100.	2820.	70.09	.905	15.46	7.97	.035	1.88	.20	1.50	2.10	9.06
C	F	27	5450.	4248.	70.53	.875	16.42	6.79	.041	1.66	.19	1.41	2.10	10.88
T	F	10	4995.	4835.	74.60	.825	13.91	5.50	.043	1.51	.19	1.34	2.02	7.08
U	F	8	5281.	4211.	71.35	.886	15.73	6.95	.042	1.58	.24	1.24	2.02	14.21
U	FM	1	5180.	2665.	67.38	.929	17.59	8.59	.036	1.64	.12	1.44	2.00	14.12
C	G	3	3255.	6092.	74.95	.635	12.94	5.60	.070	1.66	.27	.87	2.37	5.82
T	G	14	2566.	6497.	77.27	.662	11.76	5.11	.049	1.37	.34	1.11	1.90	7.85
U	G	1	2405.	6170.	81.06	.655	9.35	3.69	.180	.85	.71	1.10	1.56	13.90
C	M	4	6153.	3085.	61.70	.886	16.16	6.94	.069	1.74	8.19	1.45	2.80	11.63
T	M	5	6829.	3296.	66.59	.898	17.14	8.10	.084	2.75	.32	1.58	2.80	9.11
U	M	3	7028.	3510.	68.02	.891	17.03	7.24	.087	2.33	.21	1.43	2.97	7.28
C	Y	3	4385.	5755.	74.33	.906	12.93	6.72	.073	1.16	.32	1.44	1.96	8.21
T	Y	13	4242.	6282.	76.06	.852	12.62	5.16	.048	1.35	.28	1.55	1.93	5.40
C	YG	1	3975.	7090.	79.09	.724	10.51	4.26	.036	1.13	.33	1.52	1.63	5.07
T	YG	1	3745.	5700.	75.04	.811	13.62	5.86	.031	1.18	.25	1.23	1.67	8.31

Table 3. Summary of trace element averages (ppm) by soil type and underlying rock

SOIL	ROCK	n	EAST	NORTH	Ba	Co	Cu	Ni	Zn	Nb	Zr	Y	Sr	Rb	Pb	Th	U
C	B	1	2555.	4795.	288.	5.	28.	36.	40.	12.	411.	14.	80.	67.	15.	10.	11.
T	B	1	3755.	5300.	250.	9.	34.	24.	33.	15.	296.	13.	75.	64.	18.	12.	14.
T	BY	1	3555.	5400.	328.	23.	14.	75.	69.	18.	249.	18.	67.	117.	18.	13.	9.
T	C	2	3940.	6205.	394.	5.	28.	33.	55.	9.	389.	22.	104.	86.	20.	12.	10.
A	F	1	5100.	2820.	374.	31.	28.	59.	69.	19.	310.	22.	63.	98.	19.	12.	11.
C	F	27	5450.	4248.	323.	19.	33.	58.	69.	16.	264.	20.	63.	98.	21.	13.	10.
T	F	10	4995.	4835.	316.	11.	31.	65.	73.	13.	276.	17.	68.	89.	21.	12.	10.
U	F	8	5281.	4211.	299.	17.	32.	56.	68.	17.	272.	21.	58.	97.	22.	12.	10.
U	FM	1	5180.	2665.	270.	22.	24.	55.	115.	19.	239.	19.	71.	105.	20.	12.	9.
C	G	3	3255.	6092.	435.	11.	42.	54.	78.	15.	179.	26.	66.	114.	24.	11.	8.
T	G	14	2566.	6497.	404.	8.	10.	37.	70.	13.	232.	19.	79.	90.	22.	11.	11.
U	G	1	2405.	6170.	485.	5.	26.	16.	96.	6.	232.	11.	84.	79.	26.	7.	11.
C	M	4	6153.	3085.	302.	21.	23.	70.	70.	19.	222.	27.	186.	114.	22.	14.	10.
T	M	5	6829.	3296.	320.	29.	29.	80.	87.	20.	203.	23.	57.	123.	23.	14.	9.
U	M	3	7028.	3510.	361.	28.	26.	72.	78.	22.	231.	20.	58.	131.	26.	16.	7.
C	Y	3	4385.	5755.	337.	15.	27.	47.	53.	14.	370.	21.	91.	94.	18.	13.	10.
T	Y	13	4242.	6282.	329.	12.	33.	49.	56.	15.	314.	17.	90.	83.	21.	11.	11.
C	YG	1	3975.	7090.	331.	5.	38.	36.	44.	10.	303.	13.	95.	69.	21.	12.	13.
T	YG	1	3745.	5700.	288.	13.	48.	41.	103.	14.	270.	14.	80.	84.	19.	12.	10.

Table 4. Chemical analyses of rocks in the Matapedia area

	Val Brillant sandstone	St.-Leon Formation	Battery Point sandstone	York River sandstone	Fortin Group	Ste. Marguerite volcanics	Matapedia Group	Grande-Grève Formation
Sample	85-8	85-7	85-2	85-3	85-4	85-1	85-5	85-6
Major Elements (%) recalculated to exclude LOI in summation								
SiO_2	98.21	81.23	79.68	76.99	66.67	63.35	61.85	50.25
TiO_2	.05	.43	.55	.49	.87	1.25	.74	.19
Al_2O_3	.52	8.15	9.54	10.40	15.96	16.99	13.71	4.04
Fe_2O_3	.11	3.16	3.19	3.17	6.72	5.34	5.49	1.84
MgO	n.d.	1.77	1.23	2.05	2.68	2.14	3.03	4.08
CaO	.02	1.27	.42	1.14	1.74	1.74	9.74	36.97
Na_2O	.03	.90	2.31	1.83	1.91	6.83	2.21	.34
K_2O	.17	1.94	2.13	2.69	2.99	1.09	2.78	1.01
LOI	.24	2.82	1.89	3.19	4.60	2.93	10.36	25.43
Trace Elements (ppm)								
Ba	n.d.	124	192	228	248	537	192	226
S	n.d.	n.d.	n.d.	40	n.d.	n.d.	n.d.	n.d.
Cr	n.d.	196	111	102	94	n.d.	57	n.d.
Co	47	13	18	21	15	5	4	n.d.
Ni	n.d.	31	27	202	78	n.d.	37	n.d.
Cu	41	124	45	106	78	6	n.d.	n.d.
Zn	8	60	37	33	84	111	72	23
Nb	<10	12	15	14	18	29	17	10
Zr	184	386	230	184	221	417	185	63
Y	<10	23	21	22	27	45	29	14
Sr	13	58	74	71	135	589	199	387
Rb	16	70	66	72	115	34	101	41
Pb	12	18	12	16	22	24	21	10
Th	<10	<10	<10	<10	<10	13	11	<10
U	12	10	<10	<10	<10	16	10	16

n.d. = not detected

Table 5: Comparison of trace element analyses with alluvium (Choinière, 1982)

Sample Type	Formation or Group	No. of Samples	Cu (ppm)		Zn (ppm)		Pb (ppm)		Ni (ppm)		Co (ppm)		U (ppm)		MnO (%)	
			Arith. Mean	Std. Dev.	Arith. Mean	Std. Dev.	Arith. Mean	Std. Dev.	Arith. Mean	Std. Dev.	Arith. Mean	Std. Dev.	Arith. Mean	Std. Dev.	Arith. Mean	Std. Dev.
Colluv.	Fortin	27	33	12	69	17	21	3	58	18	19	10	10	1	.041	.022
Till	Fortin	10	31	9	73	19	21	1	65	23	11	5	10	2	.043	.013
Alluv.‡	Fortin	1968	12.6	5.2	80.5	32.9	19.1	10.2	34.6	11.3	11.2	4.1	4.1	4.6	.1006	.0995
Rock	Fortin	1	78	-	84	-	22	-	78	-	15	-	<10	-	n.d.	-
Till	Gr.-Grève Cap Bon-Ami	14	40	24	70	22	22	4	37	14	8	5	11	2	.049	.027
Alluv.‡	Gr.-Grève Cap Bon-Ami	2730	30.6	29.5	99.6	41.7	21.9	8.2	38.5	15.2	20.1	9.7	2.4	2.2	.1167	.1031
Rock	Gr.-Grève	1	n.d.	-	23	-	10	-	n.d.	-	n.d.	-	16	-	n.d.	-
Till	York River York Lake	13	33	12	56	17	21	3	49	17	12	9	11	2	.048	.028
Alluv.‡	York River York Lake Batt. Point	1102	8.7	4.6	75.6	32.0	19.0	7.2	40.2	11.5	14.3	5.2	3.1	3.6	.1003	.0909
Rock	York River	1	106	-	33	-	16	-	202	-	21	-	<10	-	n.d.	-

‡ Data from Choinière (1982)

Table 6: Factor analysis, Varimax-rotated loadings on log transformed data, H.M.C. analyses.

Element	Factors 1	2	3	4	5
Hf	0.953	-0.078	-0.0129	-0.163	0.093
Lu	0.950	-0.132	-0.171	-0.080	0.119
Yb	0.949	-0.147	-0.152	-0.079	0.138
Th	0.920	-0.173	-0.217	-0.116	0.196
U	0.903	-0.157	-0.160	-0.227	0.180
Ce	0.885	-0.232	-0.219	-0.015	0.240
Sm	0.878	-0.269	-0.236	-0.045	0.251
La	0.859	-0.295	-0.242	-0.058	0.256
Eu	0.822	-0.314	-0.313	-0.054	0.235
Cr	0.756	0.025	0.176	-0.336	-0.089
Sc	0.743	-0.076	0.068	-0.298	-0.246
W	0.598	-0.227	-0.464	-0.260	0.031
As	0.200	-0.913	-0.050	0.045	0.123
Co	0.267	-0.850	-0.160	-0.162	-0.045
Sb	0.341	-0.779	-0.122	-0.124	0.066
Fe	-0.094	-0.594	0.049	0.075	-0.626
Ni	0.234	-0.397	-0.864	-0.331	-0.006
Na	0.239	0.025	-0.814	0.010	0.123
Ta	0.431	0.189	0.008	-0.762	-0.006
Zn	0.080	-0.444	-0.146	-0.756	0.080
Au	0.155	-0.095	-0.275	-0.633	0.695
Ba	0.142	-0.393	0.130	-0.226	0.695
Mo	0.326	0.057	-0.268	0.004	0.629
Variance explained by rotated components:					
	9.513	3.542	2.294	2.145	1.931
Percent of total variance explained:					
	41.363	15.401	9.974	9.326	8.394

Table 7: Characteristics of trace element concentrations in the heavy mineral fraction of overburden in relation to the underlying bedrock formations or groups.

Element	Fortin			Gr.Grēve-Cap Bon-Ami			York Lake-York River			Matapedia			St-Lēon			Lake Branc		
	n.	Geom. Mean	log Std. Dev.*	n.	Geom. Mean	log Std. Dev.*	n.	Geom. Mean	log Std. Dev.*	n.	Geom. Mean	log Std. Dev.*	n.	Geom. Mean	log Std. Dev.*	n.	Geom. Mean	log De
As	122	116.95	2.42	38	64.42	2.90	27	37.24	2.32	9	242.66	2.37	8	36.98	2.88	4	43.45	1.
Au	48	368.13	13.09	13	389.94	37.15	7	46.67	1.74	2	1534.62	60.81	3	29.38	1.29	0		
Ba	83	1177.61	2.12	20	1253.14	3.98	13	668.34	1.74	4	1737.80	2.01	3	1940.89	10.45	2	489.78	1.
Ca	4	7.82	1.96	6	2.75	1.31	0			2	11.22	1.37	2	3.87	1.44	1	3.00	
Co	124	100.69	1.88	38	76.03	2.10	27	57.54	1.63	9	179.89	1.78	8	60.95	1.95	4	34.12	1.
Cr	124	7244.36	1.56	38	5035.01	2.84	27	10351.42	1.92	9	3953.67	2.25	8	5069.91	2.04	4	7961.78	1.
Fe	124	20.89	1.53	38	22.23	1.70	27	20.99	1.55	9	35.24	1.32	8	21.33	1.67	4	22.44	1.
Hf	124	1073.99	1.86	38	401.79	2.39	27	674.53	1.75	9	344.35	2.49	8	528.45	1.77	4	494.31	1.
Mo	35	23.88	2.13	13	12.16	1.74	6	14.93	2.06	3	50.58	2.96	3	27.67	1.67	2	14.42	1.
Na	103	.10	1.60	33	.09	1.35	20	.11	1.69	5	.11	1.34	7	.11	1.31	3	.07	1.
Ni	16	1253.14	1.97	3	543.25	1.43	1	899.50	0	1	1300.17	0	0			0		
Sb	123	7.40	2.16	36	4.53	2.70	26	3.47	1.97	9	12.82	2.72	8	3.50	2.26	4	4.58	1.
Sc	124	53.83	1.30	38	44.06	1.77	27	49.20	1.56	9	29.04	1.61	8	46.77	1.62	4	37.58	1.
Ta	117	14.00	1.69	37	14.16	2.08	27	16.83	1.65	6	11.09	2.07	8	12.19	2.10	4	13.87	1.
Th	124	128.82	2.19	38	37.76	2.43	27	68.71	1.73	9	55.34	1.92	8	42.56	1.98	4	46.56	1.
U	124	56.10	2.02	37	19.91	2.49	27	36.39	1.90	9	26.67	2.14	8	22.86	1.99	4	29.24	1.
W	73	43.95	2.00	13	20.99	2.34	8	25.23	1.37	2	15.89	1.49	1	26.00	0	3	18.11	1.
Zn	93	205.12	1.75	33	250.03	1.94	24	240.99	1.71	7	486.41	2.92	7	208.93	1.79	3	157.04	1.
La	124	597.04	2.32	38	150.31	2.30	27	260.62	1.76	9	391.74	1.49	8	166.34	1.85	4	171.79	1.
Ce	124	924.70	2.20	38	295.12	2.16	27	496.59	1.75	9	550.81	1.33	8	286.42	1.66	3	423.64	1.
Sm	124	63.24	2.25	38	20.42	2.07	27	30.90	1.71	9	35.89	1.52	8	23.01	1.61	4	21.38	1.
Eu	123	13.55	2.31	38	4.31	2.19	27	5.58	1.84	9	7.21	1.64	8	4.32	1.68	4	4.92	1.
Yb	124	78.16	1.84	38	27.86	2.11	27	40.46	1.69	9	25.64	2.14	8	34.04	1.64	4	28.18	1
Lu	124	15.67	1.85	38	5.40	2.13	27	8.18	1.67	9	4.89	2.27	8	6.67	1.69	4	5.62	1.

Geom. = Geometric
n. = Number of cases
* log Std. Dev. = Antilog of the standard deviation of the log data
ppm = As,Ba, Co, Cr, Hf, Mo, Ni, Sb, Sc, Se, Ta, Th, U, W, Zn, La, Ce, Sm, Eu, Yb, Lu
% = Ca, Fe, Na ppb = Au

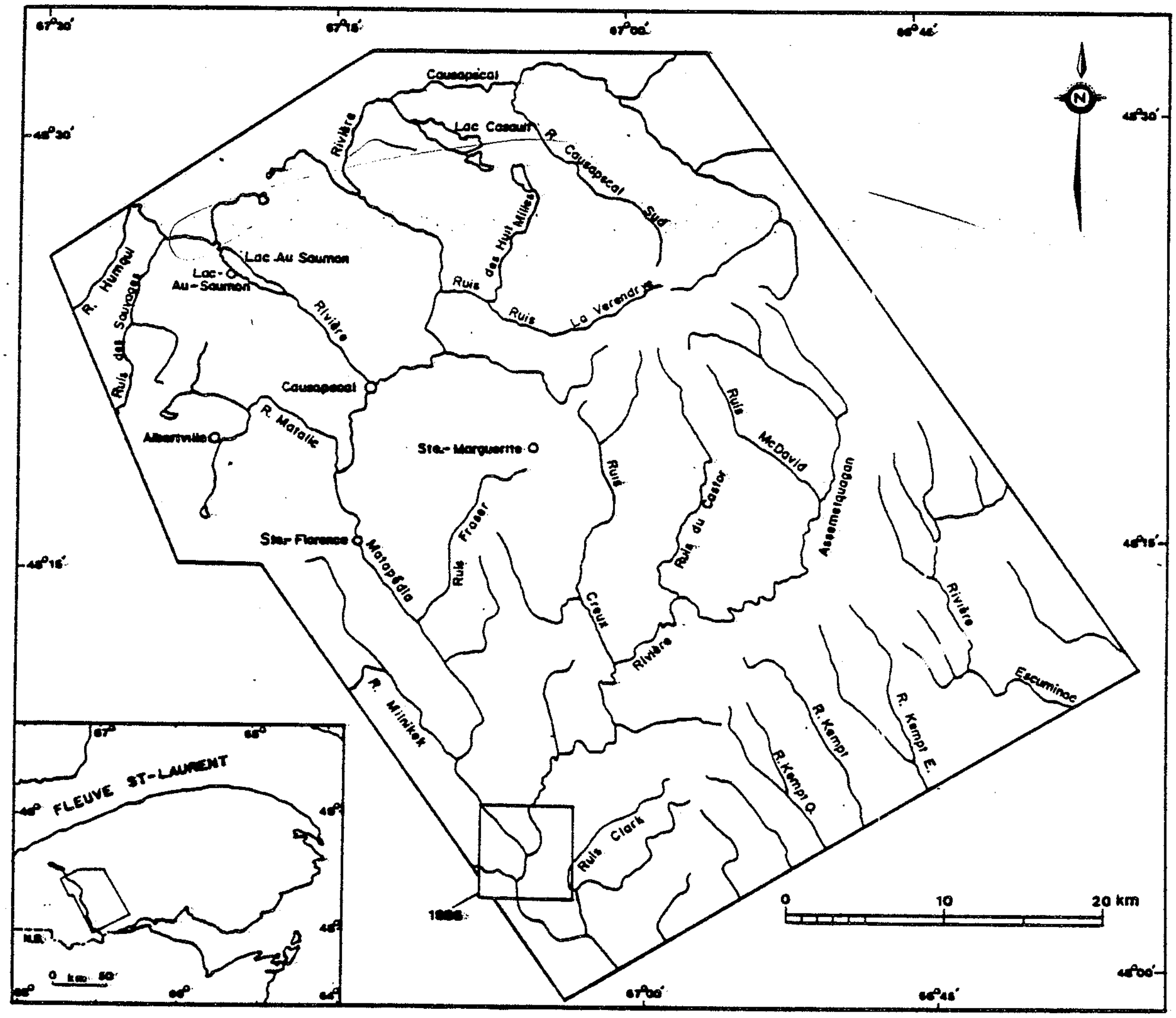


Fig. 1. Location map

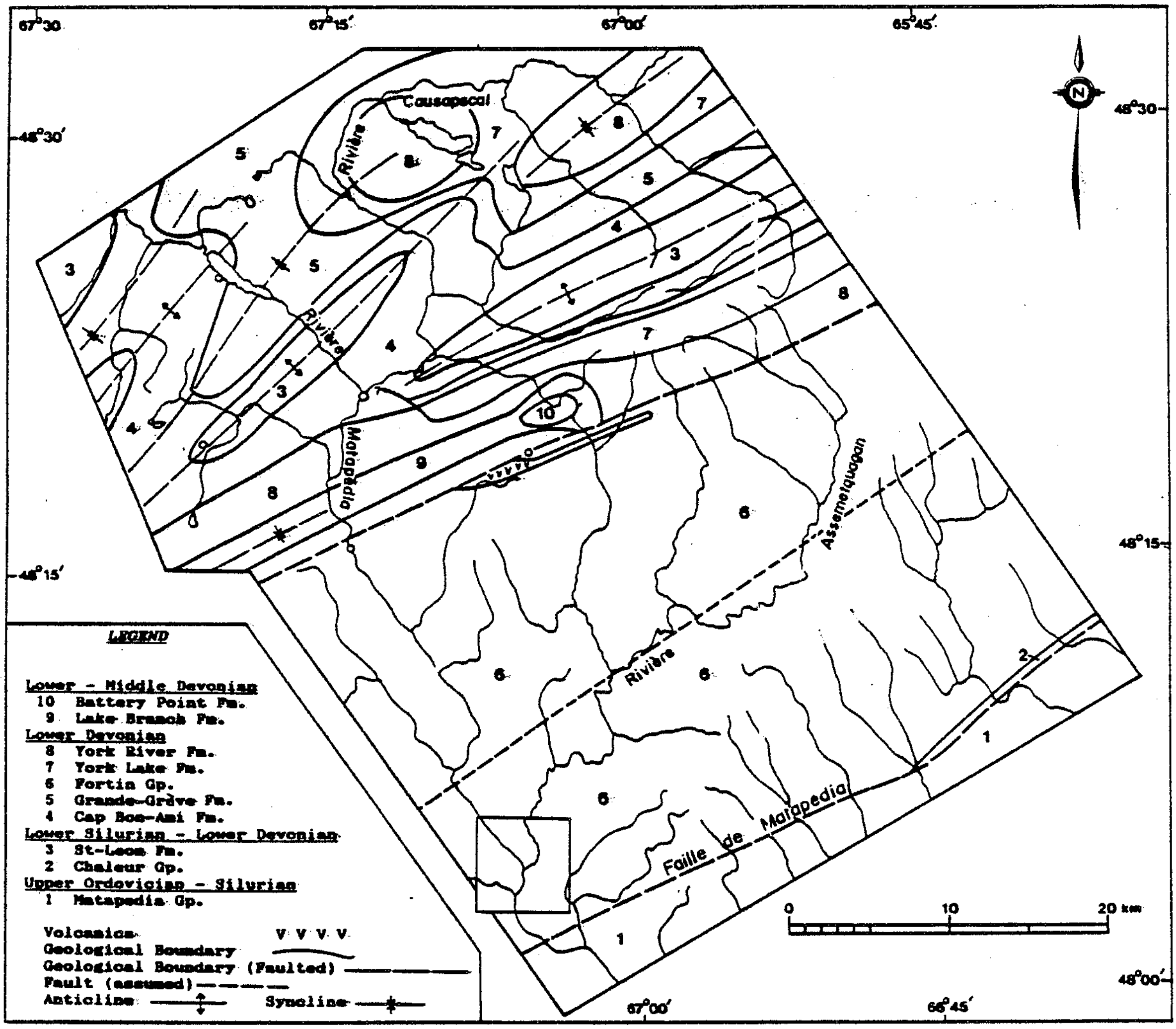


Fig. 2. Geological map of the project area

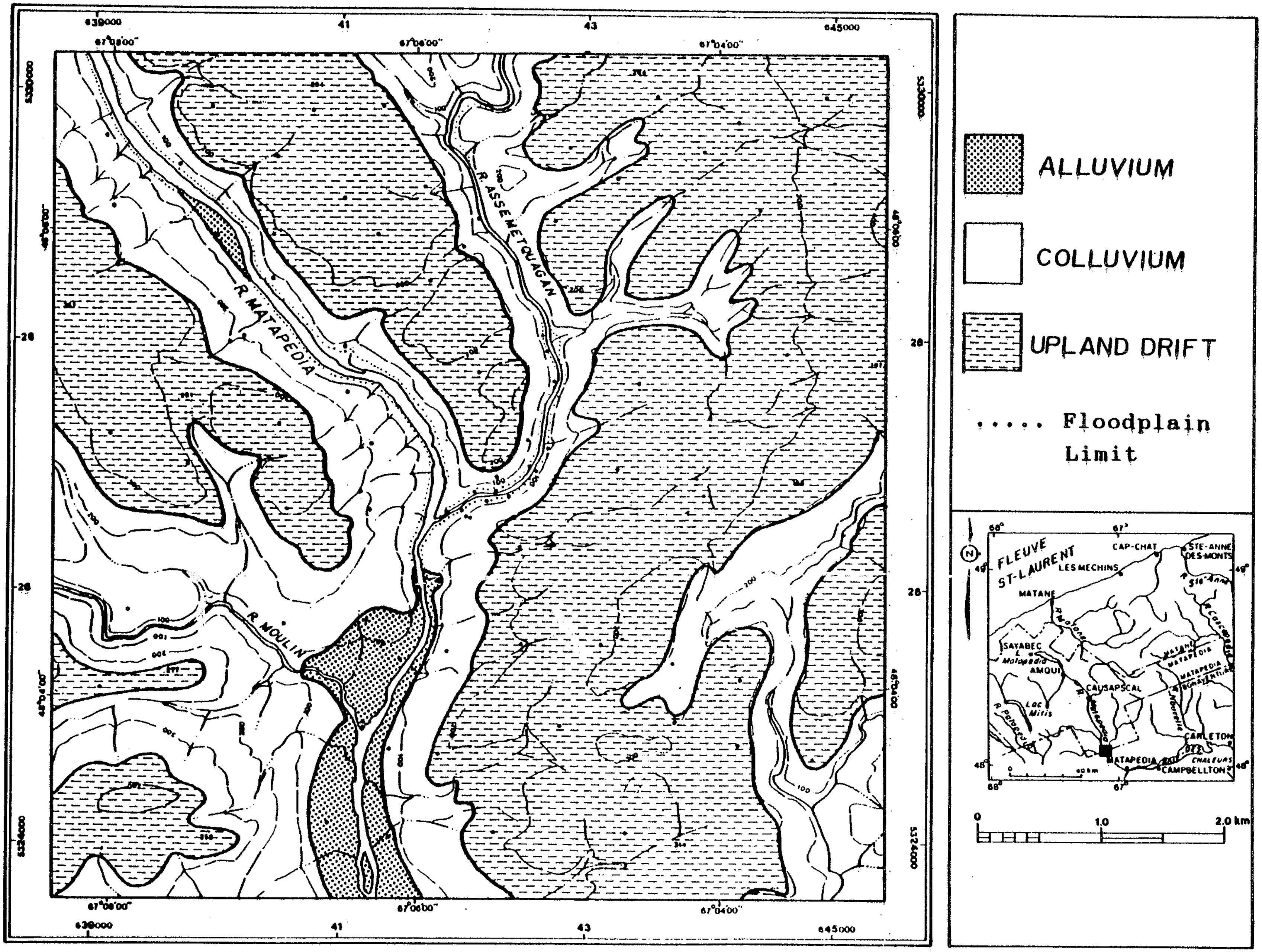


Fig. 3 Distribution of overburden types within the 1986 study area.

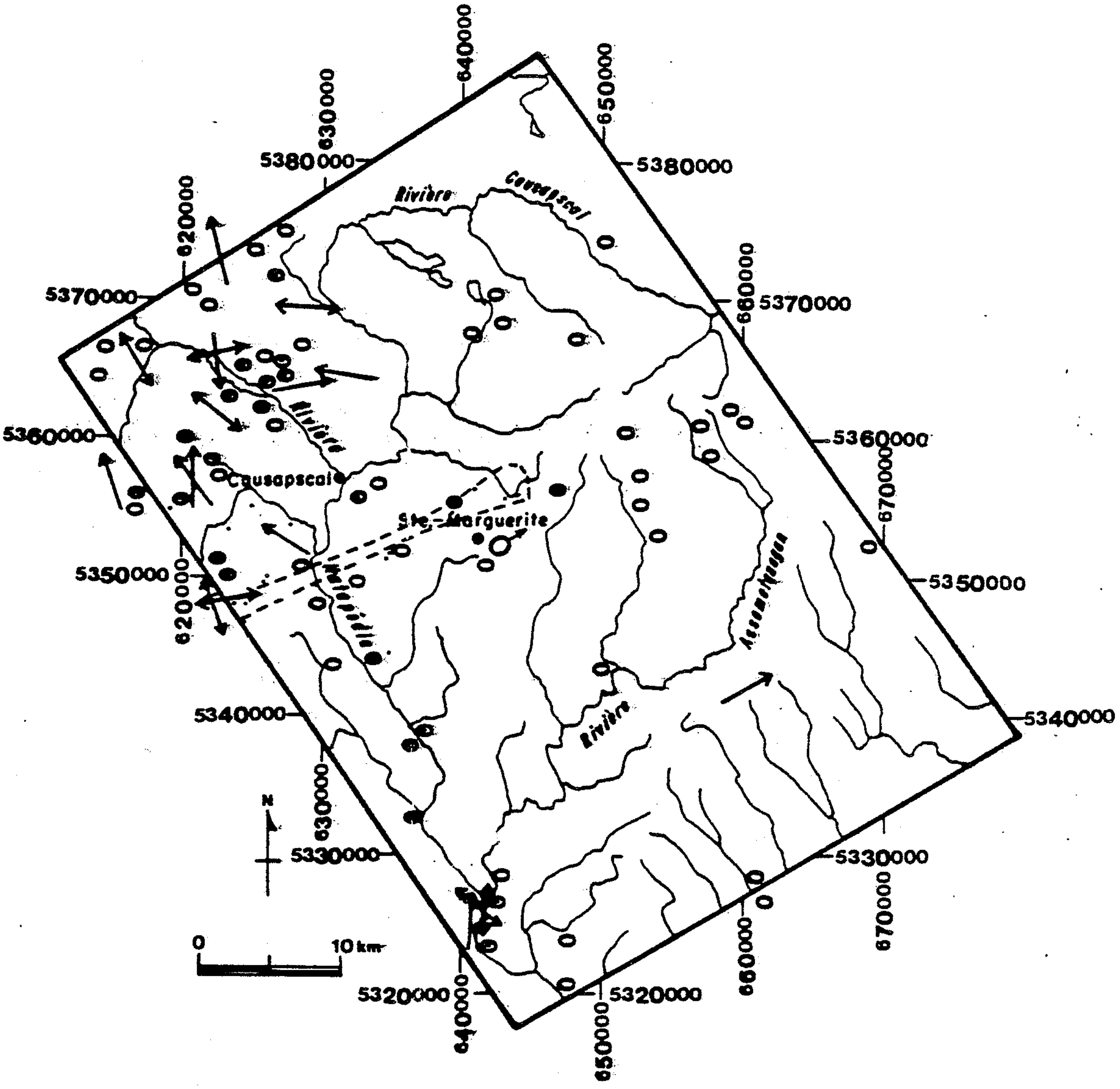


Fig. 4 Map of ice flow direction indicators. (Modified after Lebuis, 1975, David and Lebuis, 1985)

<u>Glacial striae</u> <u>Erratics</u>

↗ direction known O Val Brillant
↙↗ trend only . York Branch
==== York Branch Fm.
rock boss indicating ice flow direction

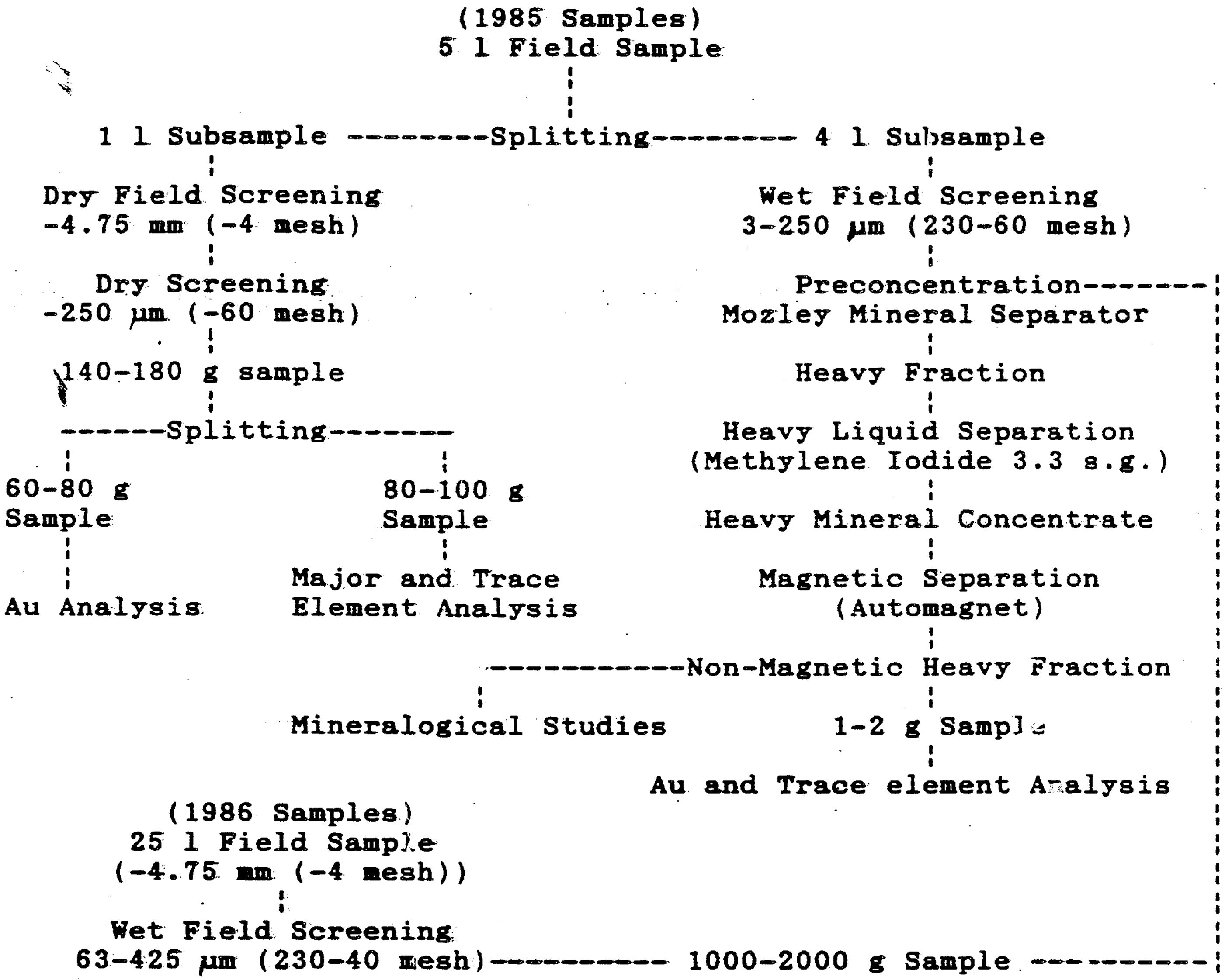


Fig. 5: Sample Treatment Chart

Appendix 7. Trace element concentrations in 19 heavy mineral concentrates and their respective duplicates.

Element	Sample No.													
	001*	005	002*	053	003*	074	310*	089	307*	222	008*	231	306*	226
Ag (ppm)	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
As (ppm)	49	63	29	31	28	30	5	8	<2	28	16	23	7	11
Au (ppb)	200	420	<9	13	<20	<22	<15	<13	<22	85	<21	30	<19	<19
Ba (ppm)	600	<500	400	300	<500	<600	<300	<800	900	<1300	<500	<400	700	<400
Ca (%)	<3	<3	2	<1	<3	<3	2	<1	<3	<6	<2	<3	4	<2
Co (ppm)	65	74	41	43	52	59	37	35	39	110	45	42	42	38
Cr (ppm)	9500	8900	1500	1500	15000	15000	700	790	6200	15000	6900	7400	4000	41000
Fe (%)	21.4	23.8	32.4	31.5	21.5	18.1	18.9	18.6	16.8	43.8	20.4	25.3	18.4	18.4
Hf (ppm)	720	620	200	180	740	730	140	150	620	1300	590	620	440	460
Mo (ppm)	21	<5	<5	<5	<5	<5	<5	7	<5	<14	<5	<5	<5	<5
Na (%)	.09	.07	.13	.13	<.05	<.05	.08	.06	<.05	.13	.17	.06	.06	.07
Ni (ppm)	400	<400	<200	<200	<400	<400	<300	<300	<400	<400	<400	<300	<400	<400
Sb (ppm)	5.7	8	1.1	1.2	2.1	3.1	<0.2	<.04	.9	3.3	.80	1	<.6	<.6
Sc (ppm)	46.4	49.10	44.7	45.4	45.8	52.4	54.9	52.5	60.7	145	52.5	46.2	59.4	59.5
Se (ppm)	<16	<17	<5	<6	<16	<20	<10	<9	<18	<43	<18	<13	<15	<15
Ta (ppm)	13	13	8	9	15	25	19	13	17	16	23	13	18	19
Th (ppm)	54	49	16	19	65	66	13	17	65	130	59	59	44	42
U (ppm)	32.7	31.4	9.1	8.1	35.1	42	5.3	7.4	36.2	77	29.6	29.9	16.6	12.4
W (ppm)	19	<16	<7	<8	18	<12	<9	<8	14	<32	24	<15	<11	<11
Zn (ppm)	260	270	110	140	220	170	140	140	110	500	120	250	190	130
La (ppm)	189	194	75	78	255	254	55	58	241	476	194	219	157	155
Ce (ppm)	384	367	164	270	474	461	147	170	728	1520	367	365	514	551
Sm (ppm)	25	23.1	14.3	14.5	31.1	27	9	8.9	26.2	56.4	20.5	25.1	18.6	18.6
Eu (ppm)	3.4	3.4	2.5	2.5	5.9	64	1.4	1.9	6.5	11.3	2.70	3.4	4.1	22
Yb (ppm)	39.8	35.9	19.9	19.4	40.5	39.9	20	19	40.8	90.2	33.3	34.9	33.4	33.2
Lu (ppm)	7.79	6.95	3.36	3.23	8.32	8.16	3.62	3.50	7.96	17.5	6.96	6.89	6.48	6.13

* Duplicate

Appendix 7. (cont.)

Element		Sample No. 398*	361	397*	368	396*	367	395*	338	394*	364	393*	343	391*	316
Ag	(ppm)	<5	<5	<15	<5	<5	<5	<5	<9	<5	<5	<8	<5	<5	<5
As	(ppm)	17	19	150	190	81	98	160	190	47	40	83	74	70	100
Au	(ppb)	<31	26	86	67	<27	<24	<28	14	<20	2100	<14	<16	940	460
Ba	(ppm)	700	400	500	<500	600	<1200	400	500	<300	400	<200	600	600	<600
Ca	(%)	<4	<2	<3	<3	<4	<3	<3	<1	<2	<3	<1	<2	<4	<5
Co	(ppm)	43	48	95	110	70	74	100	110	49	55	56	55	74	82
Cr	(ppm)	5600	6700	2600	2400	3800	3700	4200	4600	4000	5000	1900	2300	5900	6000
Fe	(%)	22.4	26.3	29.7	32.2	24.6	27.5	26.9	31.4	25.7	25.6	25.1	25.8	21	23.4
Hf	(ppm)	780	760	230	210	520	440	450	390	430	600	140	190	770	720
Mo	(ppm)	<5	<5	15	12	13	9	<8	<5	13	23	7	<5	<5	31
Na	(%)	.14	.06	.08	.06	<.05	.06	.08	.07	.05	.05	.05	.06	.12	.12
Ni	(ppm)	<500	<300	<500	<500	<400	<400	<400	<200	500	<400	<200	<300	600	1000
Sb	(ppm)	1.6	1.7	5.4	7.1	2.6	5	6.2	7.4	2	2.6	2.8	3	2.7	3.8
Sc	(ppm)	45.2	47.4	41	44.8	38.5	40.8	39	40.5	38.8	40.6	43.3	44.1	44.3	48.8
Se	(ppm)	<34	<8	<21	<24	<27	<25	<12	<12	<28	<29	<12	<14	<13	<42
Ta	(ppm)	12	11	8	7	9	11	7	7	9	11	5	5	9	10
Th	(ppm)	67	67	20	16	49	41	37	34	31	44	10	15	70	67
W	(ppm)	31	32.7	7.5	7.8	26.8	19.8	22	16.1	16.1	22.8	5.1	9	34.9	29.1
U	(ppm)	28	44	20	<15	20	<12	<15	<6	<12	<11	<9	11	<17	<12
Zn	(ppm)	100	60	160	<60	80	120	170	190	<210	130	130	140	140	190
La	(ppm)	291	254	86	74	232	199	173	126	152	215	45	57	322	302
Ce	(ppm)	347	444	135	176	329	322	296	216	260	321	95	116	538	487
Sm	(ppm)	27.5	30.4	9.9	8.8	19.9	18.3	16.9	15.8	13	18.6	6.1	5.7	31.4	30
Eu	(ppm)	5.9	4.8	2.2	2.4	4.6	5.9	5.8	3.6	3.3	4.1	1.4	1.8	8	7.7
Yb	(ppm)	45.2	50.4	21	24.8	33.2	29.5	31.4	31.9	27.5	35.4	20.2	21.4	45.2	45.8
Lu	(ppm)	9.68	10	4.61	4.69	7.3	6.24	6.02	6.07	5.51	7.72	3.99	4.30	9.74	9.42

* Duplicate

Appendix 7. (cont.)

Sample No.

Element	390*	372	389*	341	388*	317	309*	157	392*	383
Ag (ppm)	<5	<5	<7	<7	<6	<5	<5	<5	<5	<5
As (ppm)	65	73	150	170	62	79	44	37	70	67
Au (ppb)	<19	<19	<11	27	<11	<24	<16	<21	19	<15
Ba (ppm)	<300	<1000	200	200	400	<1300	1000	<400	<700	400
Ca (%)	<2	<2	<1	<1	3	<3	<3	<3	1	<1
Co (ppm)	66	69	85	93	62	73	39	39	56	51
Cr (ppm)	4900	5000	1900	2100	3400	3300	10000	11000	2300	2400
Fe (%)	24.9	26.2	31.6	32.7	22	22.8	25.5	26.3	25.6	25.6
Hf (ppm)	410	450	150	140	320	300	470	530	190	190
Mo (ppm)	12	<5	<5	<5	<5	<5	<5	<5	<5	7
Na (%)	.07	.06	<.05	.05	.12	.13	.08	.13	<.05	.06
Ni (ppm)	400	<300	<200	<200	300	<500	<300	<400	<300	<300
Sb (ppm)	2.9	2.9	4.9	5.7	2.4	3.3	6.4	7	2.4	2.6
Sc (ppm)	41.7	44	40	41.4	44.2	49.3	35.3	36.8	44.3	42.8
Se (ppm)	<9	<21	<5	<5	<5	<23	<12	<15	<12	<12
Ta (ppm)	8	10	7	5	7	6	11	10	5	7
Th (ppm)	32	37	13	10	26	23	58	66	13	14
U (ppm)	15.6	16	4.6	6.7	13.3	12.5	28.7	35.3	7.8	8.1
W (ppm)	<12	<10	8	7	47	<10	<12	21	<10	21
Zn (ppm)	340	110	140	140	110	200	310	370	170	150
La (ppm)	144	161	39	41	109	125	205	204	54	58
Ce (ppm)	253	279	79	80	197	195	356	397	99	94
Sm (ppm)	14.9	16.6	6	6.2	15.3	14.8	23.5	25.9	6.3	6.5
Eu (ppm)	5	5.6	1.6	1.7	3.7	5.9	4.5	5.8	1.5	1.3
Yb (ppm)	28.2	29.1	21.8	19.8	27.4	26.9	28.7	31.2	23.3	22
Lu (ppm)	5.71	6.32	3.79	3.64	5.1	5.44	6.03	6.09	4.78	4.65

* Duplicate

Appendix B: Correlation coefficients for log transformed data, H.H.C. analyses

	As	Au	Ba	Co	Cr	Fe	Zn	Hf	Mo	Na	Ni	Sb	Sc	Ta	Th	U	W	La	Ce	Sm	Eu	Yb	Lu
As	1.00																						
Au	.201	1.00																					
Ba	.361	.425	1.00																				
Co	.820	.271	.344	1.00																			
Cr	.113	.213	.145	.245	1.00																		
Fe	.348	-.252	-.129	.447	-.043	1.00																	
Zn	.374	.437	.397	.513	.294	.113	1.00																
Hf	.279	.354	.270	.355	.761	-.130	.264	1.00															
Mo	.091	0303	.333	.056	.175	-.291	.121	.352	1.00														
Na	.088	.148	.150	.223	.145	-.192	.202	.338	.380	1.00													
Ni	.408	.647	.141	.522	.078	.247	.526	.437	.225	.720	1.00												
Sb	.812	.133	.318	.724	.251	.249	.506	.414	.180	.148	.632	1.00											
Sc	.130	.221	.180	.338	.588	.206	.269	.709	.128	.222	.169	.265	1.00										
Ta	-.086	.435	.076	.075	.615	-.224	.485	.485	.242	.068	.279	.197	.502	1.00									
Th	.380	.383	.317	.426	.675	-.140	.295	.960	.432	.392	.524	.497	.623	.446	1.00								
U	.348	.435	.316	.433	.745	-.136	.374	.963	.416	.383	.460	.498	.624	.513	.969	1.00							
W	.347	.355	.247	.437	.481	-.125	.405	.702	.340	.369	.789	.519	.477	.345	.725	.711	1.00						
La	.477	.405	.356	.517	.573	-.066	.312	.898	.477	.389	.554	.553	.553	.369	.968	.925	.683	1.00					
Ce	.413	.360	.357	.456	.582	-.074	.223	.899	.474	.390	.507	.505	.597	.365	.957	.912	.672	.968	1.00				
Sm	.452	.368	.354	.493	.571	-.074	.301	.905	.452	.412	.512	.546	.591	.371	.970	.924	.706	.985	.970	1.00			
Eu	.419	.373	.375	.524	.519	-.073	.285	.866	.406	.391	.687	.579	.570	.360	.925	.887	.689	.953	.932	.954	1.00		
Yb	.344	.332	.295	.403	.644	-.110	.240	.968	.401	.354	.435	.466	.726	.427	.964	.938	.705	.930	.931	.946	.913	1.00	
Lu	.334	.326	.281	.387	.655	-.115	.223	.974	.384	.358	.468	.458	.724	.429	.963	.940	.706	.923	.922	.938	.906	.996	1.00

Appendix 9: Heavy mineral separation data sorted by decreasing heavy mineral content, 1986 samples.

Sample No.	Comp.	Weight (g)	Wt. H.M. (g)	Wt. M.M. (g)	%H.M. x 100	%M.M.
343	A	618.40	9.012	.8010	145.73	8.89
383	A	1000	12.238	1.4421	122.38	11.78
341	A	569.80	3.683	.6489	64.64	17.62
364	C	1151.97	5.712	.7296	49.58	12.77
372	A	1177.80	5.393	.6311	45.79	11.70
317	A	1000	3.703	.4653	37.03	12.57
338	A	1092.40	3.694	.5408	33.82	14.64
368	A	824.90	2.686	.4232	32.56	15.76
316	A	1175.40	3.468	.4325	29.50	12.47
318	D	816	2.121	.2586	25.99	12.20
361	A	1001.70	2.523	.1457	25.19	5.78
362	C	1000	2.510	.4490	25.10	17.89
353	A	1000	2.123	.3760	21.23	17.71
367	A	1861.62	3.890	.6264	20.90	16.10
321	R	1000	1.611	.0839	16.11	5.21
354	C	1000	1.381	.1229	13.81	8.90
355	A	1000	1.110	.1205	11.10	10.86
312	C	1071	1.161	.1196	10.84	10.30
363	C	1000	1.072	.1068	10.72	9.96
350	C	2079.79	2.167	1552	10.46	7.16
315	C	1151.90	1.204	.0050	10.45	.42
386	R	1000	1.038	.0671	10.38	6.46
374	A	1000	1.035	.1591	10.35	15.37
369	A	1145.57	1.131	.0954	9.87	8.44
365	C	1040.50	1.020	.1346	9.80	13.29
313	C	977.20	.854	.0895	8.74	10.48
352	C	1000	.865	.0685	8.65	7.92
387	R	1161.72	1.002	.0296	8.63	2.95
329	C	1057.60	.906	.0617	8.57	6.81
331	R	1017.50	.850	.0735	8.35	8.65
308	C	1000	.830	.0950	8.30	11.45
351	C	1047.10	.799	.0678	7.63	8.49
319	R	1000	.752	.0605	7.52	8.05
314	A	1249.22	.903	.0954	7.23	10.56
332	R	1000	.706	.0531	7.06	7.52
322	R	1000	.700	.0335	7.00	4.79
307	R	1031.20	.707	.0853	6.86	12.07
328	D	1000	.679	.0545	6.79	8.03
347	C	1000	.670	.0551	6.70	8.22
346	R	1931.77	1.293	.0980	6.69	7.58
306	R	1269.33	.816	.1041	6.43	12.76
330	R	1000	.643	.0655	6.43	10.19
326	R	1007.20	.636	.0287	6.31	4.51
370	C	1000	.628	.0915	6.28	14.57

Appendix 9. (cont.)

384	R	1091.50	.610	.0109	5.59	1.79
349	D	1660.84	.909	.0687	5.47	7.56
357	D	1000.50	.506	.0346	5.06	6.84
325	R	1000	504	.0372	5.04	7.38
324	C	861.80	.421	.0381	4.89	9.05
340	C	1010.20	.487	.0401	4.82	8.23
339	C	982.60	.445	.0424	4.53	9.53
382	C	1000	.434	.0038	4.34	.88
385	R	1081.30	.467	.0320	4.32	6.85
327	C	1006.60	.427	.0463	4.24	10.84
358	C	1101.50	.459	.0432	4.17	9.41
366	C	1000	.415	.0541	4.15	13.04
336	R	1005.60	.408	.0146	4.06	3.59
337	R	1319.29	.518	.0417	3.93	8.05
344	R	1079.30	.424	.0202	3.93	4.76
311	C	1000	.368	.0300	3.68	8.15
323	R	1000	.368	.0301	3.68	8.18
333	D	1000	.366	.0171	3.66	4.67
345	R	1000	.362	.0202	3.62	5.58
342	A	639.30	.222	.0161	3.47	7.25
356	R	1000	.325	.0317	3.25	9.75
375	C	1000	.325	.0250	3.25	7.69
334	D	1024.40	.328	.0320	3.20	9.76
376	C	1000	.303	.0202	3.03	6.67
379	R	728.80	.220	.0007	3.02	.32
309	R	1000	.296	.0438	2.96	14.80
359	R	1000	.292	.0284	2.92	9.73
320	R	1261.83	.329	.0269	2.61	8.18
381	C	1082.90	.280	.0243	2.59	8.68
373	C	1000	.241	.0216	2.41	8.96
360	R	1000	.239	.0135	2.39	5.65
380	R	1000	.229	.0251	2.29	10.96
335	R	1002.10	.207	.0132	2.03	6.38
378	R	927	.184	.0350	1.98	19.02
310	C	1000	.190	.0148	1.90	7.79
348	C	1094.10	.195	.0058	1.78	2.97
371	C	1011.40	.130	.0025	1.29	1.92
377	R	1000	.057	.0025	.57	4.39

A: **Alluvium** C: **Colluvium**
D: **Diamicton** R: **Rubble**

Wt. : **Weight**
H.M.: **Heavy Mineral Fraction**
M.M.: **Magnetic Mineral Fraction**
%H.M.: **Heavy Mineral abundance: (H.M. / Wt. of Sample)100**
%M.M.: **Magnetic Mineral abundance: (M.M./H.M.)100**

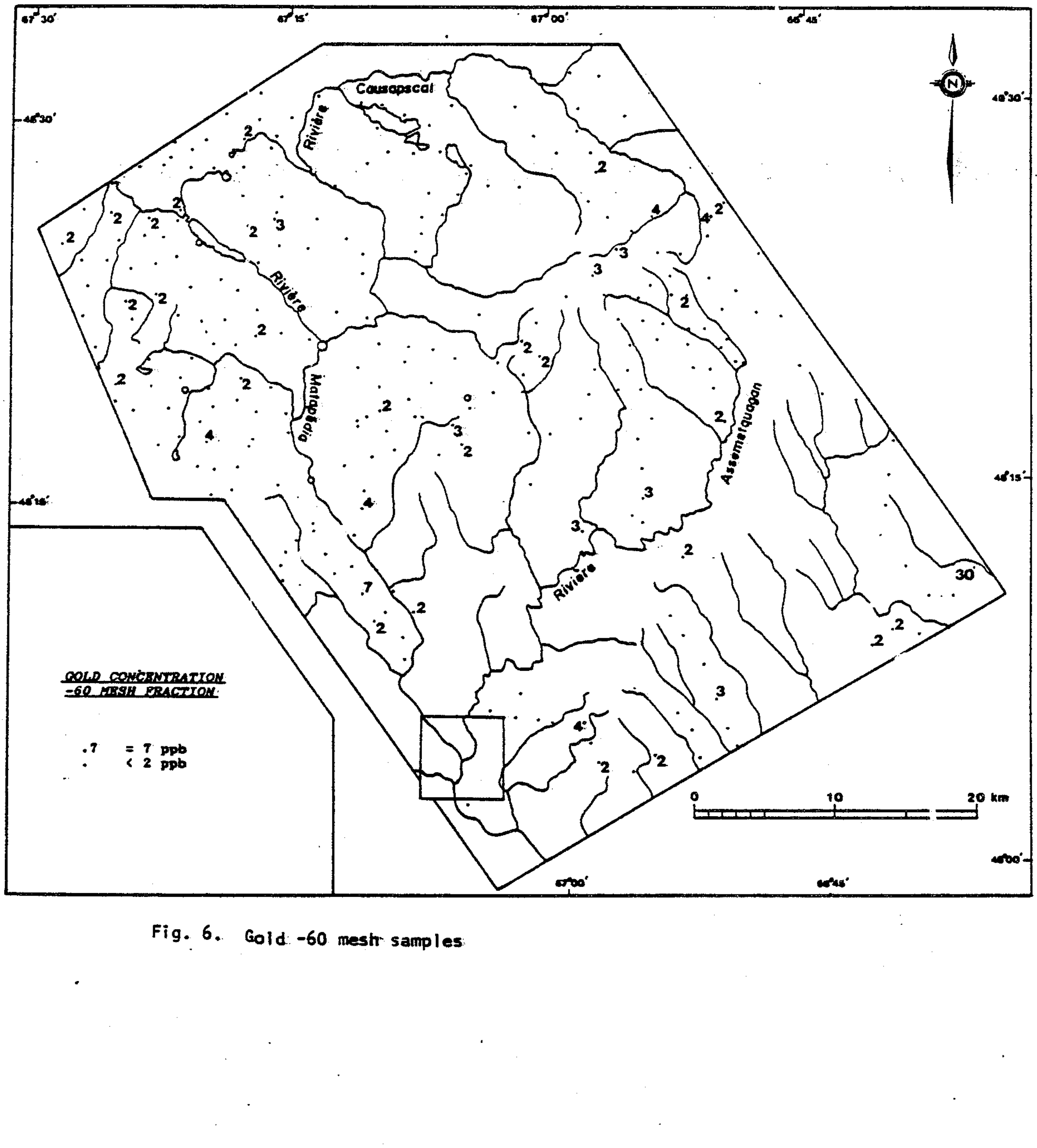


Fig. 6. Gold -60 mesh samples

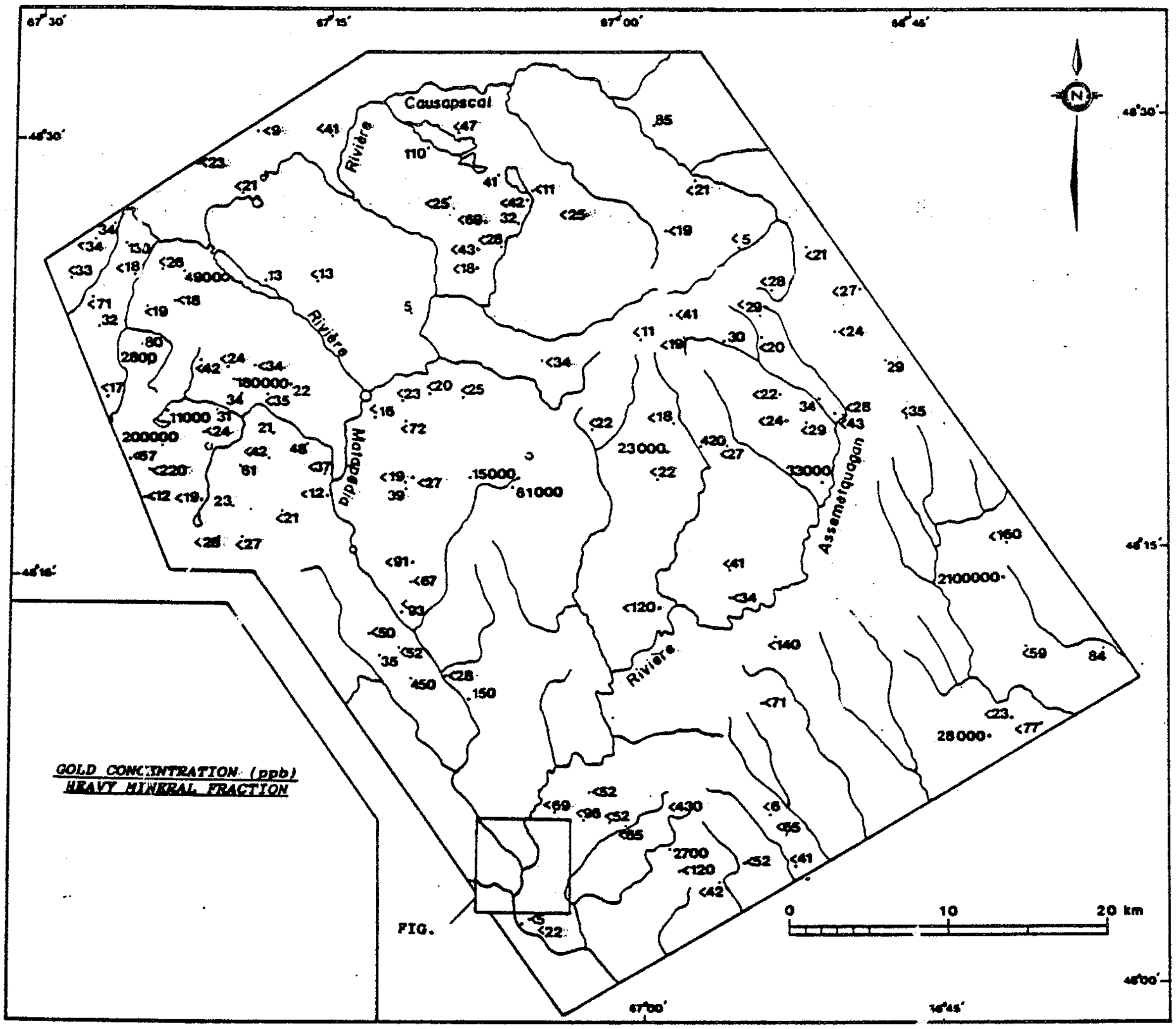


Fig. 7. Gold in heavy mineral concentrates

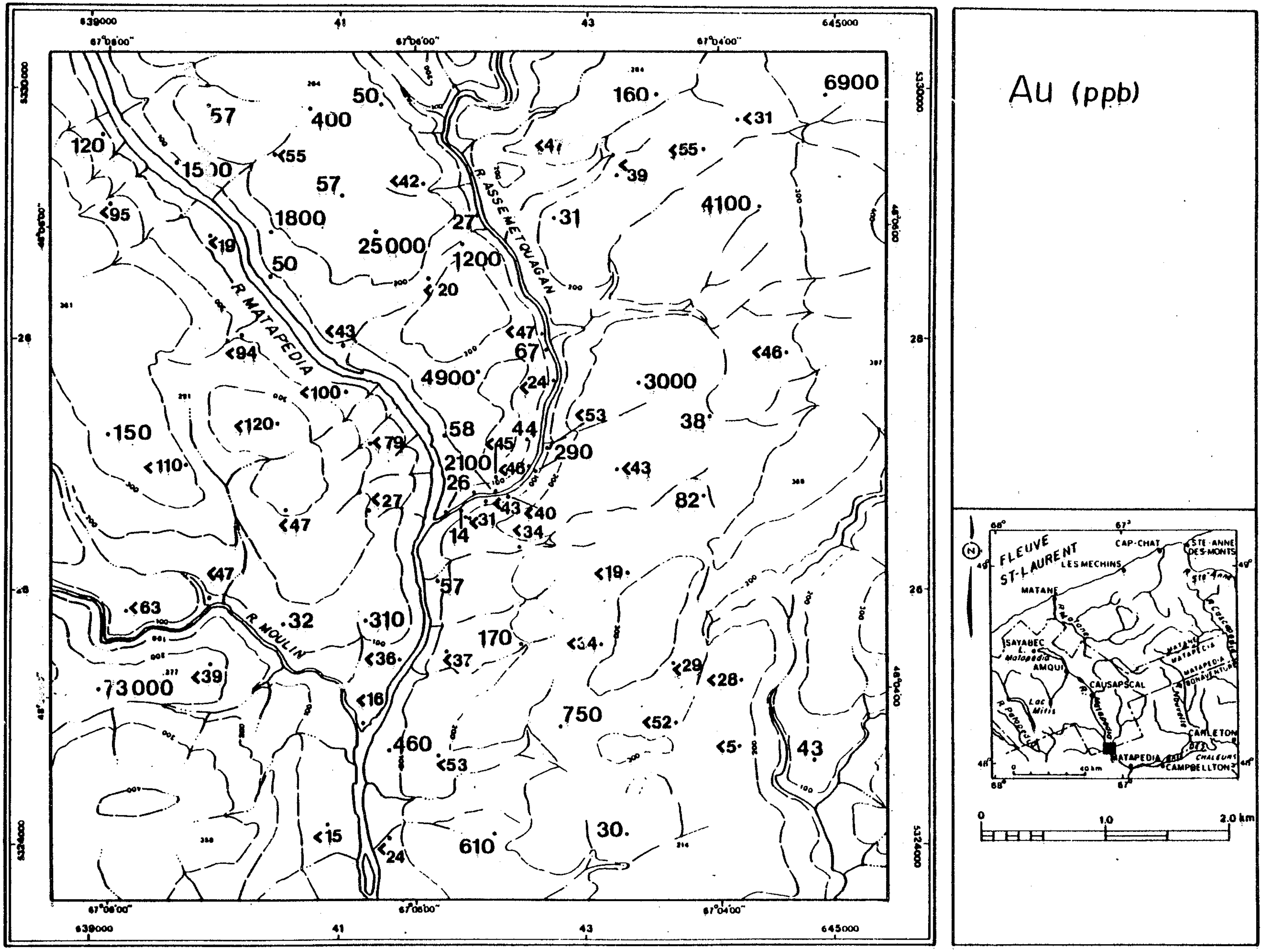


Fig. 8 Gold concentration in the heavy mineral fraction of overburden; 1986 study area.

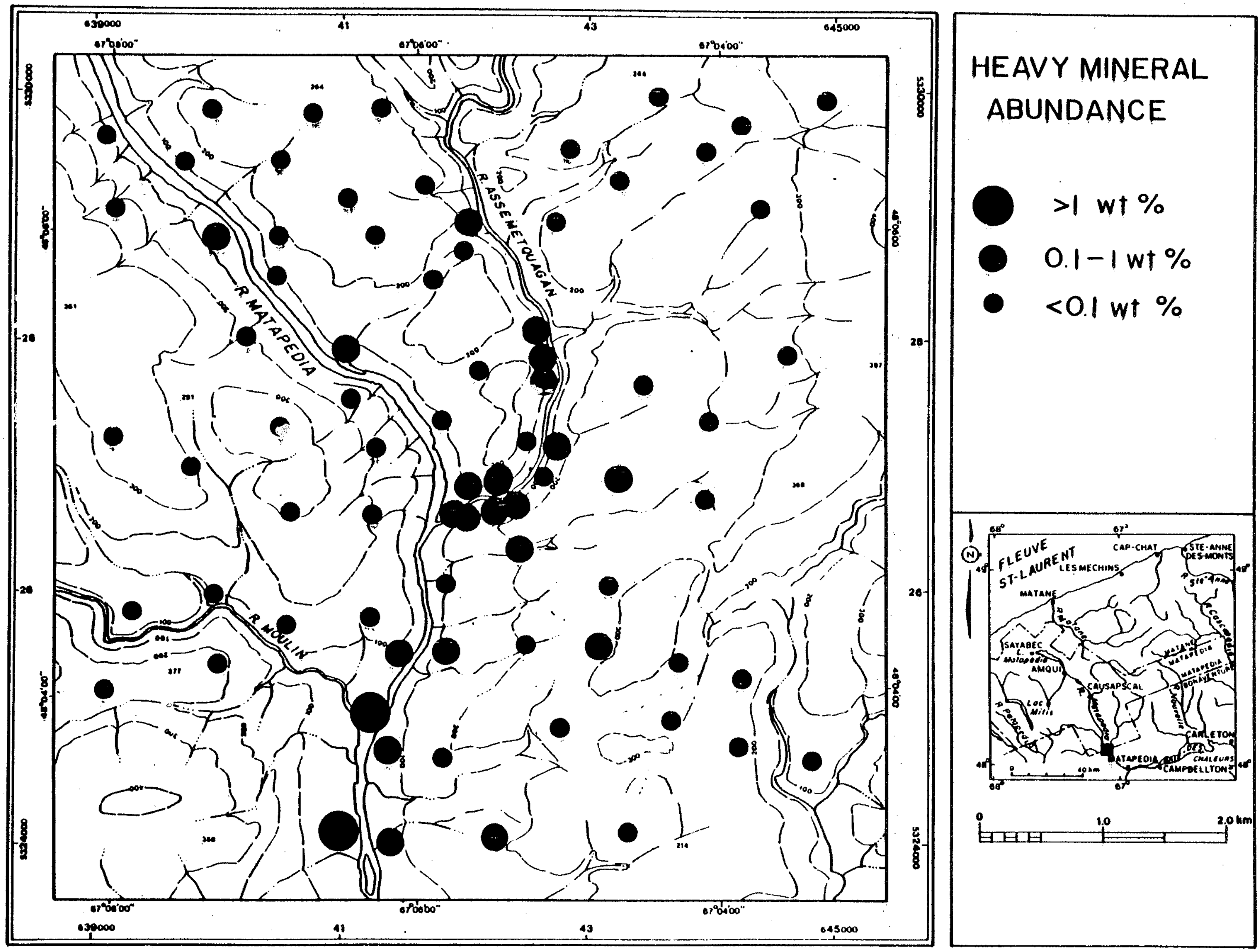


Fig. 9 Heavy mineral abundance in overburden; 1986 study area.

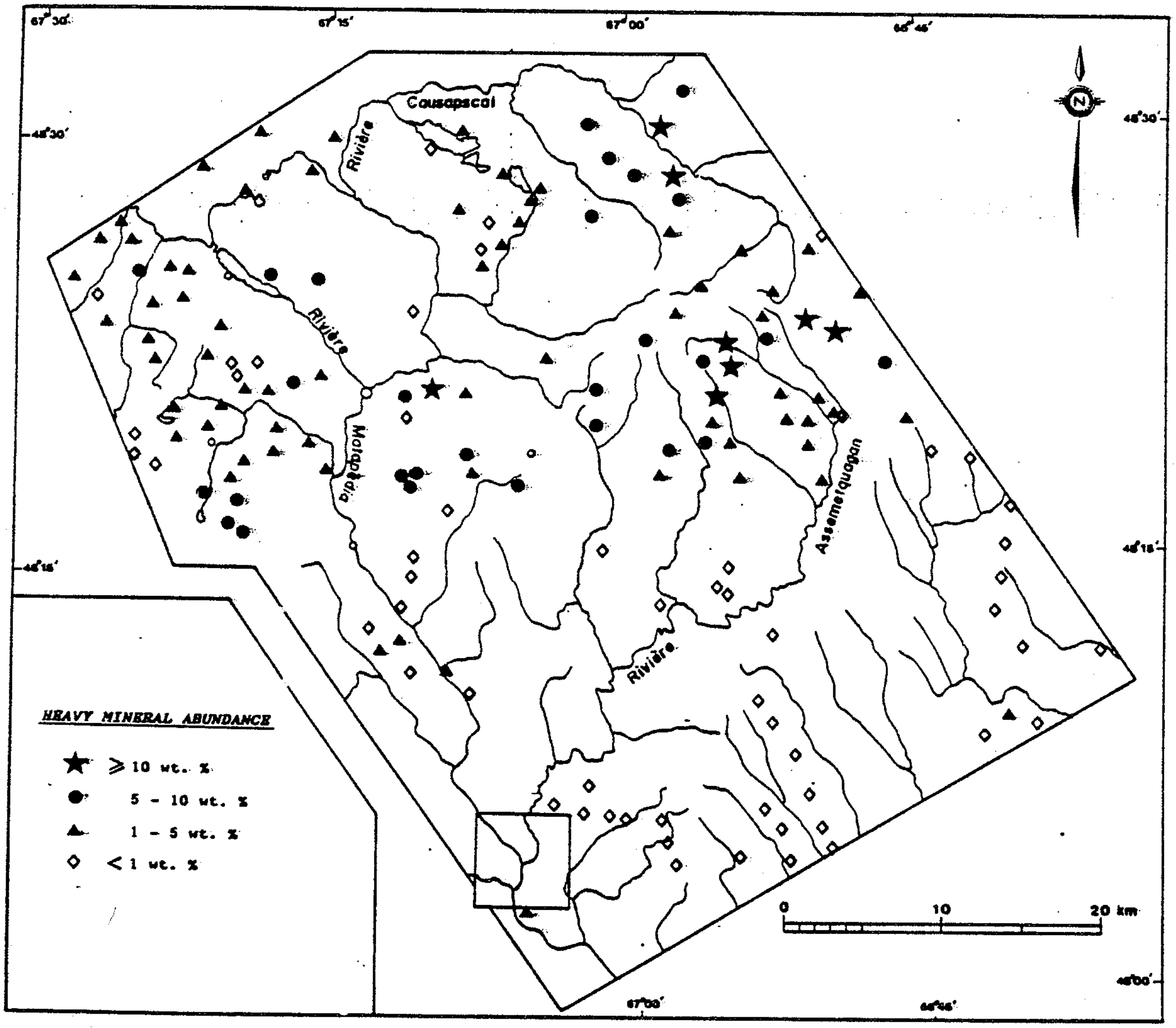
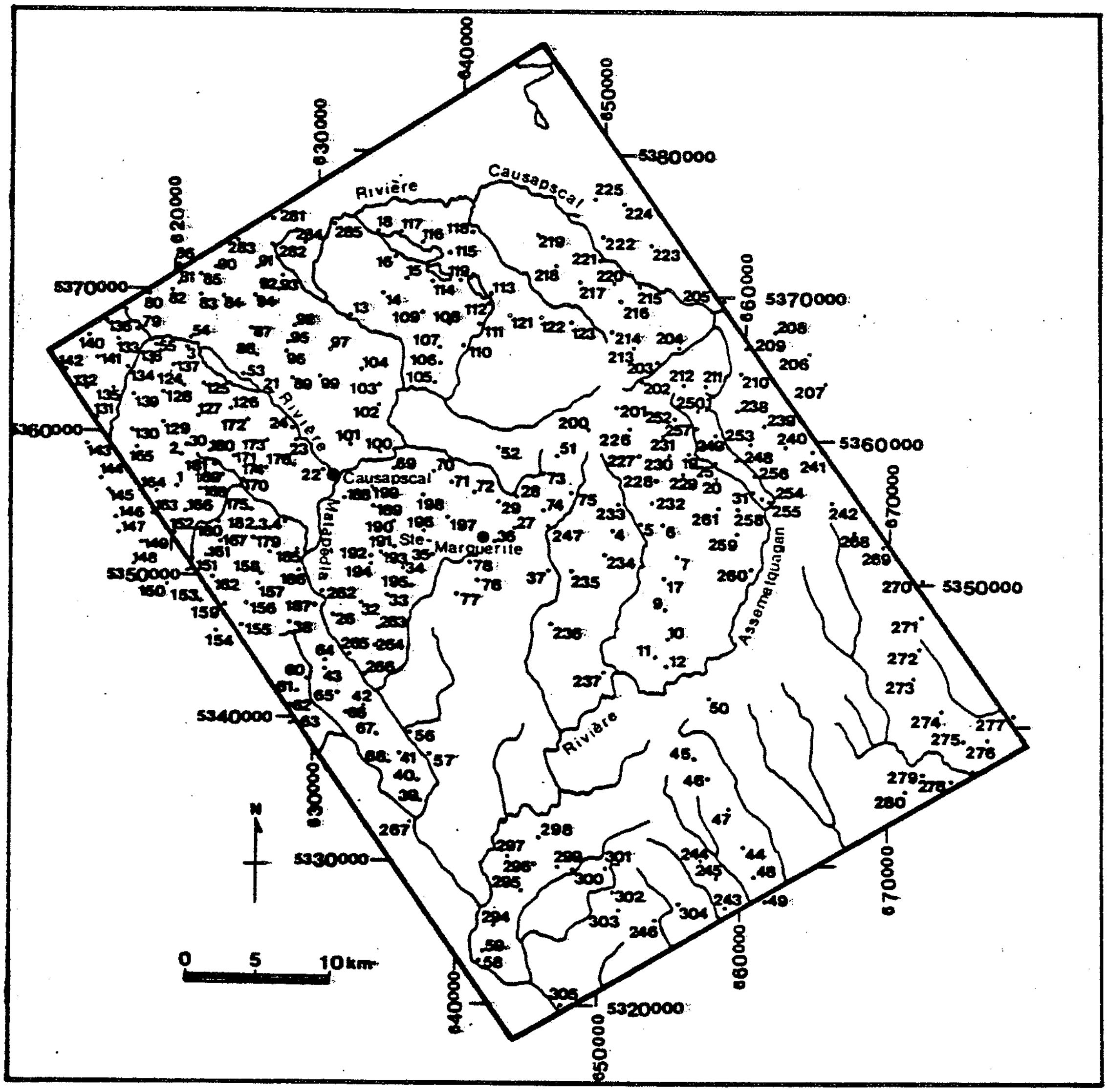
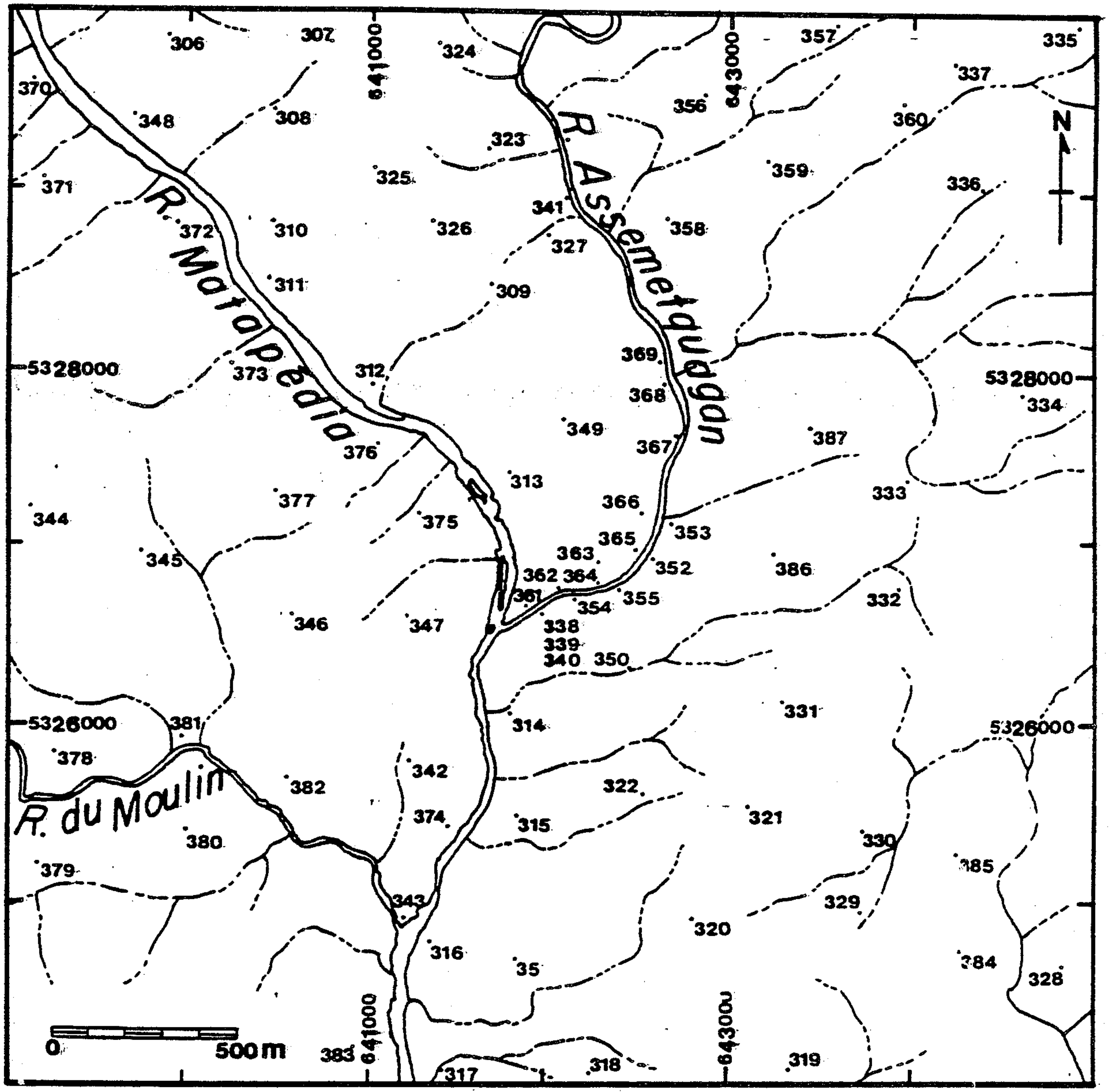


Fig. 10 Heavy mineral abundance in overburden



Appendix I. Sample location map, 1985-series samples



Appendix 2. Sample location map, 1986-series samples

Appendix 3. Legend for Appendices 4 and 5 and tables 2 and 3

Symbols for "SOIL" (overburden)

C - Colluvium

T - Till

A - Alluvium

U - Undifferentiated diamicton

Symbols for "Rock" (lithological units)

B - York Branch Fm.

C - St.-Léon Fm.

F - Fortin Gp.

G - Cap Bon-Ami and Grande-Grève Fms.

M - Matapedia Gp.

Double letters indicate samples at or close to lithological boundaries

n - Number of samples in a given category

LOI - Loss on ignition

North - Abbreviated northing

East - Abbreviated easting

e.g. East 2555 and North 4795 represent UTM designation 19UFD25554795

Appendix 4: Overburden Samples (1985-series)- Major element (%) recalculated to exclude LOI in summation.

SAMPLE	SiO2	TiO2	Al2O3	Fe2O3	MnO	MgO	CaO	Na2O	K2O	LOI	EAST	NORTH	SOIL	ROCK
156	81.33	.760	9.52	3.54	.040	1.00	.20	1.46	1.71	3.58	2555	4795	C	B
196	74.87	.749	13.55	6.70	.034	.97	.29	1.18	1.51	15.79	3755	5300	T	B
190	67.72	.992	16.89	8.24	.044	2.08	.12	.97	2.79	8.25	3555	5400	T	BY
174	78.15	.660	11.53	4.19	.028	1.46	.23	1.31	1.94	4.66	2675	5765	T	C
213	75.70	.833	12.55	4.33	.052	1.33	.87	1.81	2.06	4.99	5205	6645	T	C
302	70.09	.905	15.46	7.97	.035	1.88	.20	1.50	2.10	9.06	5100	2820	A	F
266	73.84	.807	13.65	6.90	.016	1.43	.17	1.27	1.81	12.01	3425	4325	C	F
56	76.82	.809	12.21	4.48	.060	1.58	.24	1.81	2.25	4.84	3650	3930	C	F
57	68.95	.878	16.68	7.29	.025	2.19	.13	1.67	2.69	7.85	3810	3755	C	F
12	68.56	.954	17.26	6.90	.073	2.22	.16	1.21	2.62	6.63	5430	4450	C	F
272	70.81	1.023	16.54	6.84	.024	1.18	.16	1.42	2.37	13.60	7190	4545	C	F
11	69.84	.872	16.63	7.25	.032	1.88	.14	1.46	2.00	9.38	5310	4505	C	F
301	56.27	.880	24.81	13.72	.123	1.28	.11	.89	1.62	29.46	5055	2955	C	F
9	71.25	.915	15.51	6.25	.057	2.03	.26	1.38	2.43	5.29	5460	4795	C	F
300	73.42	.856	14.15	5.43	.031	1.85	.14	1.82	2.03	4.37	4865	2960	C	F
296	68.67	.858	18.01	6.55	.032	1.92	.13	1.54	2.23	12.10	4550	2990	C	F
297	69.18	1.008	16.76	7.57	.021	1.56	.11	1.34	2.25	11.51	4360	3030	C	F
270	59.38	.785	24.16	11.08	.050	1.65	.08	1.18	1.97	23.46	7240	5020	C	F
271	72.65	1.066	15.55	6.42	.024	.98	.07	1.07	1.99	13.69	7200	4750	C	F
261	73.82	.834	14.69	5.95	.033	1.22	.27	1.29	1.68	12.45	5790	5545	C	F
242	76.15	.561	14.35	5.86	.031	.93	.16	.94	1.25	18.24	6595	5575	C	F
269	72.18	.898	15.32	5.92	.060	1.88	.28	1.10	2.45	5.13	6975	5310	C	F
294	74.94	.834	13.26	5.04	.025	1.67	.22	1.88	1.84	5.40	4285	2575	C	F
10	67.60	.928	18.51	6.88	.040	1.83	.43	1.37	2.36	10.77	5455	4605	C	F
237	66.47	.986	18.47	7.21	.042	2.38	.11	1.53	2.85	7.37	5030	4350	C	F
274	72.16	.882	15.30	6.39	.043	1.51	.13	1.50	1.96	8.47	7325	4095	C	F
236	72.70	.803	14.89	5.87	.025	1.89	.17	1.74	2.07	5.64	4665	4645	C	F
273	68.62	.946	18.12	6.81	.050	1.71	.28	1.48	2.22	11.77	7145	4315	C	F
234	70.97	.765	17.02	5.91	.030	1.50	.19	1.29	1.78	15.28	5010	5170	C	F
260	72.38	.844	15.63	6.19	.021	1.64	.18	1.42	2.13	8.94	6050	5120	C	F
295	70.31	.869	15.87	6.66	.039	1.96	.21	1.64	2.32	8.02	4450	2810	C	F
233	74.00	.809	14.91	5.49	.069	1.32	.36	1.14	1.76	12.16	5120	5535	C	F
244	72.44	.959	15.14	6.42	.031	1.56	.18	1.63	1.79	9.97	5720	3030	C	F
240	79.32	.872	11.14	3.78	.041	.96	.32	1.36	1.84	3.83	6275	5905	T	F
44	74.08	.910	13.80	5.82	.039	1.37	.19	1.63	1.79	7.32	6000	3150	T	F
6	76.20	.821	13.19	4.84	.041	1.41	.26	1.30	1.94	5.36	5450	5370	T	F
47	71.51	1.038	15.58	6.38	.038	1.46	.15	1.49	2.06	9.37	5925	3380	T	F
37	74.33	.740	13.45	5.52	.023	1.70	.13	1.43	1.78	7.75	4610	5080	T	F
258	71.12	.925	16.36	6.57	.067	1.49	.20	1.11	2.01	11.32	5980	5470	T	F
77	77.25	.593	12.60	5.35	.060	1.31	.10	1.13	1.56	10.72	3975	4895	T	F
38	72.12	.838	14.94	5.88	.054	2.14	.24	1.67	2.62	3.48	2850	4690	T	F
33	75.97	.726	13.26	5.10	.033	1.78	.16	1.55	2.05	4.40	3530	4885	T	F

Appendix 4 (cont.)

SAMPLE	SiO2	TiO2	Al2O3	Fe2O3	MnO	MgO	CaO	Na2O	K2O	LOI	EAST	NORTH	SOIL	ROCK
232	74.06	.787	14.83	5.76	.036	1.50	.10	.69	2.50	7.26	5350	5525	T	F
45	67.25	.930	17.48	7.93	.059	1.98	.12	1.19	2.53	8.92	5650	3750	U	F
4	76.14	.807	13.40	5.67	.030	1.28	.17	1.11	1.73	10.66	5060	5355	U	F
46	68.83	.945	17.69	7.39	.060	1.67	.13	1.21	2.19	14.31	5755	3615	U	F
17	70.41	.930	16.52	6.27	.031	1.79	.83	1.25	2.18	32.25	5430	5010	U	F
59	74.97	.829	13.73	5.25	.028	1.56	.18	1.61	1.80	6.31	4230	2365	U	F
7	71.86	.872	16.18	6.12	.048	1.71	.24	1.14	2.23	8.27	5520	5165	U	F
298	69.85	.934	16.82	6.69	.047	1.82	.16	1.50	2.10	8.39	4615	3155	U	F
259	71.51	.839	14.05	10.27	.033	.83	.09	.93	1.38	24.54	5985	5275	U	F
303	67.38	.929	17.59	8.59	.036	1.64	.12	1.44	2.00	14.12	5180	2665	U	FM
100	78.82	.509	11.53	4.52	.027	.96	.28	.65	1.80	7.02	3450	5915	C	G
175	76.13	.645	11.57	5.07	.134	1.82	.37	1.21	2.70	3.62	2575	5485	C	G
109	69.91	.750	15.73	7.22	.048	2.21	.16	.74	2.62	6.82	3740	6875	C	G
107	77.71	.652	11.37	5.66	.043	1.06	.19	.85	1.35	10.65	3855	6645	T	G
98	78.53	.601	11.85	4.38	.042	1.09	.50	1.20	1.40	12.20	2825	6805	T	G
166	74.64	.782	12.57	5.57	.035	1.65	.65	1.46	2.26	7.39	2115	5430	T	G
92	78.67	.677	10.87	4.16	.048	1.57	.29	1.50	1.88	3.69	2775	7120	T	G
139	80.84	.632	10.08	3.65	.043	1.13	.25	1.13	1.80	4.68	1765	6245	T	G
90	79.16	.569	10.72	6.00	.031	.94	.20	.97	1.31	11.57	2295	7180	T	G
124	80.54	.515	9.83	3.90	.077	1.28	.32	.91	2.01	3.06	2060	6350	T	G
89	75.62	.794	13.07	5.55	.047	1.38	.54	1.22	1.51	11.39	2840	6410	T	G
103	72.94	.733	14.12	5.21	.027	2.19	.09	1.02	2.95	5.10	3445	6370	T	G
88	73.44	.608	14.30	6.10	.051	1.39	.78	1.23	2.01	10.10	2585	6565	T	G
133	70.72	.725	14.28	6.94	.130	2.60	.19	.87	3.24	4.63	1600	6650	T	G
165	81.46	.623	9.92	3.21	.029	.96	.23	1.14	1.89	4.64	1765	5845	T	G
105	76.89	.734	11.40	5.99	.028	1.05	.28	1.25	1.69	9.85	3815	6380	T	G
83	80.55	.618	10.22	5.17	.057	.83	.25	.89	1.34	10.95	2180	6965	T	G
126	81.06	.655	9.35	3.69	.180	.85	.71	1.10	1.56	13.90	2405	6170	U	G
277	60.66	.877	16.68	6.64	.075	2.76	7.85	1.25	3.30	10.86	7825	4130	C	M
246	68.87	.785	16.76	7.10	.099	1.50	.19	2.12	2.87	5.09	5380	2600	C	M
245	71.41	.973	15.31	7.31	.031	1.19	.16	1.58	1.81	10.69	5835	2895	C	M
304	45.88	.910	15.87	6.70	.069	1.52	24.57	.66	3.23	19.86	5570	2715	C	M
280	63.45	.890	19.44	8.71	.095	2.90	.14	1.47	3.47	9.25	7110	3535	T	M
48	72.34	1.002	14.69	6.79	.055	1.21	.31	1.53	1.93	12.55	6075	2930	T	M
49	64.60	.923	17.40	7.49	.069	4.54	.17	1.60	3.13	6.38	6190	2730	T	M
279	64.64	.773	17.74	9.77	.155	1.92	.48	1.67	3.17	8.32	7295	3650	T	M
278	67.93	.903	16.45	7.76	.048	3.19	.47	1.63	2.28	9.07	7475	3635	T	M
276	65.27	.923	18.43	7.76	.073	3.27	.12	1.19	3.39	7.87	7700	3900	U	M

Appendix 4 (cont.)

SAMPLE	SiO2	TiO2	Al2O3	Fe2O3	MnO	MgO	CaO	Na2O	K2O	LOI	EAST	NORTH	SOIL	ROCK
243	68.81	.953	16.14	7.19	.103	2.22	.32	1.55	2.95	7.11	5895	2715	U	M
275	69.99	.797	16.53	6.77	.084	1.50	.19	1.54	2.59	6.86	7490	3915	U	M
158	75.24	.890	12.55	5.30	.028	1.42	.18	1.70	2.14	4.32	2665	5020	C	Y
201	70.24	.995	14.68	9.87	.057	.80	.32	1.00	1.89	15.78	5090	6195	C	Y
231	77.49	.833	11.55	5.01	.133	1.28	.46	1.61	1.84	4.53	5400	6050	C	Y
185	74.78	.797	13.51	5.25	.032	1.53	.19	1.60	2.07	5.42	2885	5210	T	Y
120	77.76	.838	11.44	4.44	.043	1.25	.18	1.46	1.98	4.06	4025	6865	T	Y
249	75.57	.962	13.46	4.96	.042	1.12	.18	1.49	2.19	4.08	5760	6035	T	Y
223	78.00	.721	12.25	4.44	.026	1.34	.21	1.31	1.62	5.32	5320	7360	T	Y
220	78.67	.770	11.30	4.07	.039	1.05	.41	1.76	1.69	4.11	5045	7110	T	Y
218	81.69	.764	9.64	2.87	.041	.91	.41	1.78	1.74	2.31	4650	7205	T	Y
74	77.14	.876	12.04	4.50	.038	1.33	.30	1.51	2.03	5.26	4595	5490	T	Y
194	79.34	.794	11.17	4.27	.032	1.28	.19	1.39	1.87	4.27	3395	5105	T	Y
13	77.98	.814	11.71	4.39	.028	1.29	.34	1.57	1.57	6.66	3200	6835	T	Y
15	68.63	.825	16.14	9.93	.037	1.45	.35	1.29	1.48	11.51	3600	7075	T	Y
161	72.69	.928	13.49	5.93	.116	1.75	.28	1.73	2.82	4.36	2235	5145	T	Y
211	72.91	.976	14.69	6.30	.056	1.42	.28	1.67	1.57	9.19	5740	6355	T	Y
51	73.66	1.005	13.19	5.79	.101	1.82	.27	1.54	2.47	3.63	4690	5875	T	Y
119	79.09	.724	10.51	4.26	.036	1.13	.33	1.52	1.63	5.07	3975	7090	C	YG
70	75.04	.811	13.62	5.86	.031	1.18	.25	1.23	1.67	8.31	3745	5700	T	YG

Appendix 5. Overburden samples - Trace elements (ppm) except Au (ppb)

SAMPLE	Ba	Co	Cu	Ni	Zn	Nb	Zr	Y	Sr	Rb	Pb	Th	U	Au	EAST	NORTH	SOIL	ROCK
156	288	<5	28	36	40	12	411	14	80	67	15	10	11		2555	4795	C	B
196	250	9	34	24	33	15	296	13	75	64	18	12	14		3755	5300	T	B
190	328	23	14	75	69	18	249	18	67	117	18	13	9		3655	5400	T	BY
174	388	<5	29	34	48	8	239	21	79	93	17	10	9	2	2675	5765	T	C
213	400	5	26	32	62	9	538	22	129	79	22	13	10		5205	6645	T	C
302	374	31	28	59	69	19	310	22	63	98	19	12	11		5100	2820	A	F
266	233	20	19	38	47	17	208	17	58	99	20	12	12		3425	4325	C	F
56	279	9	31	54	46	21	270	22	75	107	24	12	10		3650	3930	C	F
57	397	31	29	70	71	20	214	21	58	119	23	15	9	2	3810	3755	C	F
12	391	32	33	70	80	21	265	25	61	118	22	11	8		5430	4450	C	F
272	354	8	12	25	29	13	264	20	59	109	19	13	7		7190	4545	C	F
11	309	19	33	60	73	16	234	21	56	101	16	12	10		5310	4505	C	F
301	198	44	30	40	95	17	191	18	46	83	22	14	12	4	5055	2955	C	F
9	442	21	42	67	72	24	289	24	71	107	25	15	10		5460	4795	C	F
300	314	9	24	67	71	14	302	23	67	94	19	13	10		4865	2960	C	F
296	318	13	58	62	63	17	283	21	59	101	21	14	9		4550	2990	C	F
297	355	21	19	48	83	19	230	21	53	117	18	13	9		4360	3030	C	F
270	251	30	21	41	81	17	189	16	40	94	19	12	9		7240	5020	C	F
271	325	11	30	27	38	12	273	22	47	97	20	14	9		7200	4750	C	F
261	259	20	29	43	65	10	283	17	73	80	20	12	11		5790	5545	C	F
242	153	8	38	30	48	9	175	10	50	69	21	13	11		6595	5575	C	F
269	425	21	28	69	66	21	308	22	72	102	20	11	10		6975	5310	C	F
294	316	<5	33	48	60	11	318	20	76	84	16	13	9		4285	2575	C	F
10	440	31	50	78	90	22	294	24	83	103	28	13	8	3	5455	4605	C	F
237	468	34	45	95	101	19	246	24	57	127	26	13	7	3	5030	4350	C	F
274	264	13	27	54	73	11	291	19	70	96	20	13	11		7325	4095	C	F
236	292	18	65	60	81	20	285	21	63	95	24	15	10		4665	4645	C	F
273	317	13	36	87	69	15	307	22	70	96	21	12	8		7145	4315	C	F
234	238	10	26	57	61	8	235	16	58	86	20	12	10		5010	5170	C	F
260	329	22	28	70	59	17	296	18	61	101	21	11	9	2	6050	5120	C	F
295	380	20	42	61	76	18	277	22	68	102	22	13	13		4450	2810	C	F
233	348	10	28	51	72	10	281	15	86	76	18	9	11		5120	5535	C	F
244	316	15	29	87	89	15	307	22	71	88	15	11	11		5720	3030	C	F
240	395	<5	28	31	39	12	373	16	94	75	20	12	10		6275	5905	T	F
44	266	8	21	52	60	14	292	19	74	87	19	13	11	3	6000	3150	T	F
6	339	10	26	75	89	11	307	17	75	86	21	12	10		5450	5370	T	F
47	309	20	25	120	93	17	314	22	70	100	23	11	7		5925	3380	T	F
37	202	11	35	62	65	12	224	16	59	87	22	13	11		4610	5080	T	F
258	333	14	23	58	97	12	268	19	64	95	22	11	9		5980	5470	T	F
77	213	<5	49	50	55	8	198	13	46	77	22	13	14		3975	4895	T	F
38	383	17	42	71	64	14	311	18	86	82	19	11	11		2850	4690	T	F
33	325	11	25	66	77	9	246	19	68	93	21	14	10		3530	4885	T	F
232	391	8	34	68	90	19	224	15	48	108	23	12	9		5350	5525	T	F

Appendix 5. (cont.)

SAMPLE	Ba	Co	Cu	Ni	Zn	Nb	Zr	Y	Sr	Rb	Pb	Th	U	Au	EAST	NORTH	SOIL	ROC
45	384	31	31	66	91	21	249	23	49	118	21	11	5		5650	3750	U	F
4	253	10	21	44	51	15	266	15	58	83	18	11	[illegible]		5060	5355	U	F
46	304	17	76	61	76	11	288	23	49	98	26	12	10	2	5755	3615	U	F
17	288	9	22	50	64	19	297	22	65	100	23	13	9		5430	5010	U	F
59	326	10	27	55	54	12	296	27	73	94	20	12	11		4230	2365	U	F
7	337	18	22	70	81	19	283	21	65	100	24	14	11		5520	5165	U	F
298	313	18	28	87	87	20	293	24	63	100	23	14	11		4615	3155	U	F
259	187	24	28	14	43	19	203	12	40	79	21	11	12		5985	5275	U	F
303	270	22	24	55	115	19	239	19	71	105	20	12	9	2	5180	2665	U	F
100	348	<5	32	38	68	10	135	11	55	100	22	11	9		3450	5915	C	G
175	518	15	57	57	88	18	241	50	78	109	27	11	9	2	2575	5485	C	G
109	441	12	38	66	78	17	160	18	66	134	23	11	7		3740	6875	C	G
107	203	<5	46	36	100	16	196	9	76	80	20	10	11		3855	6645	T	G
98	246	<5	15	32	57	8	258	11	90	64	19	10	12		2825	6805	T	G
166	348	12	39	43	79	19	352	16	81	97	21	10	11		2115	5430	T	G
92	279	9	49	49	42	6	322	18	93	79	23	13	12		2775	7120	T	G
139	595	<5	57	24	44	8	226	22	71	90	19	11	10		1765	6245	T	G
90	190	5	105	21	112	17	179	9	70	73	27	10	14		2295	7180	T	G
124	729	<5	28	33	67	10	193	28	73	92	22	13	11		2060	6350	T	G
89	310	<5	23	32	55	10	275	14	91	73	22	11	13		2840	6410	T	G
103	399	8	58	31	105	17	175	14	63	131	24	16	9		3445	6370	T	G
88	509	12	18	55	50	16	206	46	105	90	19	9	8	2	2585	6565	T	G
133	806	17	52	61	78	19	157	49	52	145	32	14	7	2	1600	6650	T	G
165	534	<5	32	12	57	7	201	9	77	94	20	10	13		1765	5845	T	G
105	286	19	9	34	63	17	293	13	81	77	19	8	11		3815	6380	T	G
83	226	<5	31	54	73	8	214	10	79	75	19	8	10		[illegible]180	6965	T	G
126	485	<5	26	16	96	6	232	11	84	79	26	7	11		2405	6170	U	G
277	266	25	24	70	72	18	193	26	236	132	20	13	8	30	7825	4130	C	M
246	359	19	29	94	66	25	201	43	57	119	25	15	8		5380	2600	C	M
245	271	18	15	39	66	15	317	21	78	91	21	14	12		5835	2895	C	M
304	312	20	25	76	74	18	177	17	374	113	23	12	12	2	5570	2715	C	M
280	424	36	41	76	125	21	177	16	53	146	27	15	6	2	7110	3535	T	M
48	236	19	34	38	64	17	265	19	71	99	20	11	8		6075	2930	T	M
49	411	28	17	137	58	22	207	14	40	122	23	16	9		6190	2730	T	M
279	284	39	29	60	86	21	158	53	59	136	25	18	9	2	7295	3650	T	M
278	246	25	24	90	91	20	207	11	62	111	20	12	12		7475	3635	T	M
276	353	32	30	80	107	20	218	21	46	139	27	17	7		[illegible]700	3900	U	M
243	385	27	26	78	69	27	240	17	51	139	24	14	6		5895	2715	U	M
275	345	24	22	59	59	19	234	21	76	115	26	18	8		7490	3915	U	M
158	323	10	14	47	35	12	311	16	87	95	15	13	10		2665	5020	C	Y

Appendix 5. (cont.)

SAMPLE	Ba	Co	Cu	Ni	Zn	Nb	Zr	Y	Sr	Rb	Pb	Th	U	Au	EAST	NORTH	SOIL	ROC
201	321	25	25	41	74	18	328	19	84	109	20	14	9	3	5090	6195	C	Y
231	368	9	41	53	50	12	471	28	101	78	20	11	11		5400	6050	C	Y
185	300	10	66	44	68	16	279	17	85	100	17	12	10		2885	5210	T	Y
120	289	<5	31	45	50	9	297	16	91	85	20	12	12		4025	6865	T	Y
249	365	11	21	54	58	16	396	21	88	90	19	12	10	2	5760	6035	T	Y
223	202	6	34	58	58	15	264	13	82	84	21	13	10		5320	7360	T	Y
220	349	<5	27	32	39	12	318	15	104	80	17	9	11		5045	7110	T	Y
218	335	<5	26	19	25	7	351	16	107	71	18	10	13		4650	7205	T	Y
74	378	13	36	49	57	14	336	17	85	78	19	11	12		4595	5490	T	Y
194	343	<5	26	44	42	16	336	15	81	79	20	11	13		3395	5105	T	Y
13	258	<5	38	35	37	15	340	15	89	76	23	12	12		3200	6835	T	Y
15	305	33	28	43	69	16	239	14	83	73	21	11	12		3600	7075	T	Y
161	455	14	35	75	62	19	288	24	91	95	26	12	8		2235	5145	T	Y
211	270	22	36	65	86	17	295	18	96	74	22	11	15		5740	6355	T	Y
51	429	20	25	78	74	20	340	26	94	96	28	13	10		4690	5875	T	Y
119	331	<5	38	36	44	10	303	13	95	69	21	12	13		3975	7090	C	Y
70	288	13	48	41	103	14	270	14	80	84	19	12	10		3745	5700	T	Y

Appendix 6. **Trace element results, heavy mineral concentrate analyses.**

NUCLEAR ACTIVATION SERVICES LIMITED

1280 MAIN STREET WEST, HAMILTON, ONTARIO, L8S 4K1

PHONE (416) 522-5666 TELEX 06-986947

CERTIFICATE OF ANALYSIS

TO: MC GILL UNIVERSITY
ATTN: M.A. BERNIER
DEPT. OF GEOLOGICAL SCIENCES
3450 UNIVERSITY STREET
MONTREAL, QUEBEC

CUSTOMER NO. 133/01/02

DATE SUBMITTED
04-FEB-87

REPORT: 7661 FILE NUMBER: 9356

100 UNPREPARED SAMPLES PO# C 50043IR

WERE ANALYZED AS FOLLOWS:

ELEMENTS	DETECTION LIMIT	UNITS	METHOD	ELEMENTS	DETECTION LIMIT	UNITS	METHOD
AG	5.0000	PPM	INAA	SC	0.1000	PPM	INAA
AS	2.0000	PPM	INAA	SE	5.0000	PPM	INAA
AU	5.0000	PPB	INAA	TA	1.0000	PPM	INAA
BA	100.0000	PPM	INAA	TH	0.5000	PPM	INAA
CA	1.0000	%	INAA	U	0.5000	PPM	INAA
CO	5.0000	PPM	INAA	W	4.0000	PPM	INAA
CR	10.0000	PPM	INAA	ZN	50.0000	PPM	INAA
FE	0.0200	%	INAA	LA	1.0000	PPM	INAA
HF	1.0000	PPM	INAA	CE	3.0000	PPM	INAA
MO	5.0000	PPM	INAA	SM	0.1000	PPM	INAA
NA	0.0500	%	INAA	EU	0.2000	PPM	INAA
NI	200.0000	PPM	INAA	YB	0.2000	PPM	INAA
SB	0.2000	PPM	INAA	LU	0.0500	PPM	INAA

COMMENTS:

NOTE: DETECTION LIMIT RAISED DUE TO SAMPLE SIZE & COMPOSITION.

DATE 23-FEB-87

NUCLEAR ACTIVATION SERVICES LIMITED
CERTIFIED BY Blackwood.....

*** UNLESS INSTRUCTED OTHERWISE WE WILL DISCARD ALL SAMPLES ***
IRRADIATED SAMPLES AFTER 30 DAYS, ANY OTHER MATERIAL AFTER 120 DAYS

NUCLEAR ACTIVATION SERVICES LIMITED

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S A M P L E N U M B E R S

295-H**	85-0296-H**	85-0297-H**	85-0298-H**	85-0299-H**	85-0300-H**
<35	~~<61~~	~~<5~~	~~<29~~	~~<31~~	<5
[illegible]	310	290	140	320	100
<61	<96	<69	<52	<52	<65
100	<1800	<1400	2000	1200	2600
<11	<21	<14	<10	<11	<1
150	170	100	91	200	90
9400	9300	5600	8000	7000	12000
28.2	26.9	31.1	18.7	26.0	15.8
1400	1300	1400	2400	1700	3200
<5	<5	<5	23	<5	59
0.07	0.16	0.12	0.07	0.07	0.13
1000	<1600	<1300	<800	<900	<1000
13	21	12	9.9	15	7.9
64.4	62.7	49.7	70.1	58.7	80.5
<69	<87	~~<59~~	~~<21~~	~~<61~~	<120
18	<13	13	17	15	27
200	180	200	310	230	380
72.9	67.8	75.0	106	89.2	142
28	61	<24	90	44	46
290	390	<190	270	150	280
367	1130	984	1350	1100	1660
1480	1840	1630	2270	1840	2580
102	118	106	153	120	176
17.3	18.9	31.0	29.4	29.0	43.4
108	103	102	178	135	207
21.9	19.2	20.9	35.0	26.0	43.3

NUCLEAR ACTIVATION SERVICES LIMITED

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S A M P L E N U M B E R S

ELEMENT ! & UNITS !		85-0301-H**	86-0306-H**	86-0337-H**	86-0346-H**	86-0349-H**	86-0350-H**
AG	PPM	<5	<34	<20	<24	<5	<21
AS	PPM	240	280	310	120	190	150
AU	PPB	<430	57	<31	<47	4900	<34
BA	PPM	<9100	1500	1800	1700	2200	700
CA	%	<70	<11	<6	<9	<1	<7
CO	PPM	250	140	180	120	100	100
CR	PPM	11000	6200	7100	8500	6700	6900
FE	%	32.0	29.9	30.0	28.2	19.9	21.5
HF	PPM	1400	790	1000	2100	1500	1200
MO	PPM	<290	5	<5	<5	<5	20
NA	%	0.42	0.07	0.09	0.12	<0.05	0.09
NI	PPM	9100	<900	<600	<800	<200	<600
SB	PPM	49	9.7	11	8.5	9.1	8.2
SC	PPM	43.0	47.9	52.5	79.7	56.3	50.0
SE	PPM	<520	<27	<34	<60	<5	<51
TA	PPM	<45	19	10	12	13	17
TH	PPM	260	99	170	230	190	140
U	PPM	89.4	34.0	53.8	87.5	70.3	56.6
W	PPM	530	<21	36	<16	33	34
ZN	PPM	<1000	<150	<90	190	90	150
LA	PPM	845	774	849	1140	996	714
CE	PPM	1370	1160	1390	1650	1390	1020
SM	PPM	80.6	66.0	96.3	115	93.9	63.3
EU	PPM	<35.1	24.4	22.7	25.2	22.5	14.3
YB	PPM	98.2	69.6	90.8	137	108	78.7
LU	PPM	22.7	13.2	16.9	29.4	23.0	16.3

NUCLEAR ACTIVATION SERVICES LIMITED

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S A M P L E   N U M B E R S

** -0369-H**	** 307-H**	** 308-H**	** 309-H**	** 310-H**	** 311-H**
<5	<45	<34	<5	<5	<5
32	230	260	270	140	340
<47	400	<55	<70	1800	50
1400	2300	<1100	2500	1600	1900
<8	<16	<10	<1	<12	<11
59	130	170	130	100	150
11000	6300	5900	9500	7900	6900
25.7	25.2	34.2	22.9	25.2	28.3
1500	1700	920	1800	1500	1900
21	<5	<31	<5	78	<5
0.08	0.14	0.08	<0.12	0.19	0.14
<900	<1200	<1000	<1000	<1000	1400
3.6	9.2	10	10	10	14
64.9	64.4	55.3	64.9	57.3	67.2
<62	<89	<58	<60	<60	<17
15	24	10	15	22	15
130	230	100	230	220	300
66.0	87.0	39.5	80.8	89.0	117
48	36	<22	<38	<39	43
220	<200	<140	260	<140	240
571	1260	554	1140	1020	1690
917	1720	650	1610	1640	2650
55.7	117	52.5	108	113	166
13.4	27.5	11.0	25.8	26.0	35.1
37.7	124	69.0	124	117	161
19.5	25.9	14.7	26.4	24.1	31.6

NUCLEAR ACTIVATION SERVICES LIMITED

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S A M P L E   N U M B E R S

ELEMENT !	& UNITS !	** 312-H**	** 313-H**	** 314-H**	** 315-H**	** 316-H**	** 317-H**
AG	PPM	<5	<5	<5	<5	<5	<5
AS	PPM	170	240	260	11	100	79
AU	PPB	<43	58	57	<37	460	<24
BA	PPM	<2300	<2300	1000	<800	<600	<1300
CA	%	<8	<7	<9	<7	<5	<3
CO	PPM	110	110	130	38	82	73
CR	PPM	5300	4800	6500	9400	6000	3300
FE	%	24.0	27.9	26.2	19.0	23.4	22.8
HF	PPM	1100	530	1000	1200	720	300
MO	PPM	11	6	<5	89	31	<5
NA	%	0.13	0.07	0.14	0.10	0.12	0.13
NI	PPM	<700	<800	1200	<700	1000	<500
SB	PPM	6.6	9.9	9.2	3.5	3.8	3.3
SC	PPM	50.2	45.8	48.4	61.7	48.8	49.3
SE	PPM	<51	<42	<51	<19	<42	<23
TA	PPM	11	<5	9	13	10	6
TH	PPM	120	54	110	110	67	23
U	PPM	50.1	20.4	45.7	54.4	29.1	12.5
W	PPM	22	<16	<18	<15	<12	<10
ZN	PPM	<50	220	220	250	190	200
LA	PPM	657	316	567	521	302	125
CE	PPM	911	407	953	878	487	195
SM	PPM	59.9	31.2	54.2	49.3	30.0	14.3
EU	PPM	15.6	5.9	13.7	12.7	7.7	5.9
YB	PPM	71.5	43.1	69.6	75.4	45.8	26.9
LU	PPM	15.2	8.51	14.0	15.6	9.42	5.44

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S A M P L E N U M B E R S

ELEMENT !	& UNITS !	** 318-H**	** 319-H**	** 320-H**	** 321-H**	** 322-H**	** 323-H**	** 324-H**	** 325-H**	** 326-H**	** 327-H**	** 328-H**	* 329-H*
AG	PPM	<5	<13	<5	<5	<14	<5	<5	<16	<5	<17	<13	<5
AS	PPM	66	150	45	73	76	190	160	190	58	160	220	120
AU	PPB	610	30	750	<34	170	<42	50	57	25000	1200	43	<52
BA	PPM	900	800	1200	800	600	2200	1200	1200	2200	700	400	1300
CA	%	<5	<4	<8	<7	<5	<8	<8	<6	<14	<6	<4	<9
CO	PPM	63	98	54	74	74	110	99	98	49	100	130	96
CR	PPM	6000	6900	11000	5800	14000	7900	7900	6500	6400	7500	7100	8700
FE	%	20.5	25.1	20.2	16.9	18.1	25.0	20.9	26.7	16.1	25.9	29.8	17.7
HF	PPM	980	840	2200	960	1400	1400	1600	880	1600	1400	800	1300
MO	PPM	<5	<5	26	<5	<5	<5	18	<5	49	16	<5	33
NA	%	0.12	0.14	0.09	0.19	0.08	0.11	0.13	0.12	0.19	0.08	0.12	0.11
NI	PPM	<500	500	<700	<600	<400	<700	<700	<500	<1100	<600	<400	900
SB	PPM	3.8	20	4.6	4.5	5.1	7.3	8.1	6.9	5.0	6.6	52	11
SC	PPM	52.7	50.5	64.6	52.6	54.3	49.5	57.6	51.2	61.5	53.4	43.6	59.6
SE	PPM	<38	<11	<25	<41	<13	<50	<16	<31	<24	<42	<10	<26
TA	PPM	11	9	16	14	15	12	13	11	16	8	8	13
TH	PPM	98	110	220	170	160	210	240	130	240	150	93	160
U	PPM	43.4	44.4	93.2	50.6	64.1	62.8	77.6	50.6	102	69.6	40.5	68.2
W	PPM	24	74	61	16	24	50	59	30	<29	84	97	22
ZN	PPM	130	120	250	170	140	170	220	100	370	200	90	<120
LA	PPM	474	453	867	635	644	1200	1220	675	1140	712	377	745
CE	PPM	754	772	1560	894	1060	1940	1990	1070	1640	1230	629	1160
SM	PPM	45.2	52.9	106	60.5	71.9	123	129	70.3	112	80.2	45.5	74.0
EU	PPM	11.6	11.0	20.6	15.7	17.6	24.9	25.9	12.7	24.4	18.3	10.3	17.3
YB	PPM	62.3	66.8	147	71.0	96.0	113	128	73.4	116	102	59.1	91.7
LU	PPM	13.3	13.5	30.3	14.1	18.8	22.5	25.3	14.1	24.9	20.6	11.8	19.2

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SAMPLE NUMBERS

**	**	**	**	**	**
330-H**	331-H**	332-H**	333-H**	334-H**	335-H**
<15	<5	<5	<20	<5	<5
150	85	150	110	180	120
<29	<19	32	38	<46	6900
300	500	2300	1100	1400	1800
<5	<3	<11	<7	<8	<12
94	62	110	83	140	79
9000	4700	6800	11000	8500	8300
20.6	23.2	21.3	18.6	14.6	14.7
1500	750	1200	1400	1600	2200
<5	<5	37	<5	<5	<5
0.12	0.12	0.11	0.23	0.12	<0.07
<400	<300	<1000	<600	<700	<1000
9.4	4.4	8.3	6.1	15	7.3
56.5	49.2	54.3	59.3	68.4	68.7
<12	<20	<56	<38	<23	<24
12	10	16	17	25	15
180	79	160	200	270	320
63.5	34.9	63.6	69.8	95.0	107
51	38	56	48	100	52
170	140	270	150	210	<140
711	366	795	775	1010	1430
1200	611	1060	1380	1810	2370
92.1	40.4	76.9	94.6	133	171
16.8	9.7	18.7	16.2	29.2	32.9
111	57.8	83.6	103	136	165
21.9	11.1	17.5	20.2	27.7	33.5

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ELEMENT !		**	**	**	**	**	**
& UNITS !		336-H**	338-H**	339-H**	340-H**	341-H**	342-H**
AG	PPM	<5	<9	<17	<17	<7	<26
AS	PPM	130	190	260	180	170	560
AU	PPB	4100	14	<30	<31	27	310
BA	PPM	2100	500	1100	1100	200	1100
CA	%	<8	<1	<5	<6	<1	<8
CO	PPM	90	110	120	96	93	190
CR	PPM	8200	4600	6300	6600	2100	5000
FE	%	17.0	31.4	26.6	24.7	32.7	30.3
HF	PPM	1900	390	770	1000	140	860
MO	PPM	36	<5	<5	<5	<5	<5
NA	%	0.12	0.07	0.12	0.08	0.05	0.09
NI	PPM	<600	<200	<400	<500	<200	<300
SB	PPM	5.5	7.4	16	7.9	5.7	21
SC	PPM	63.6	40.5	48.8	50.6	41.4	40.2
SE	PPM	<12	<12	<14	<30	<5	<17
TA	PPM	10	7	11	14	5	6
TH	PPM	250	34	100	150	10	130
U	PPM	87.3	16.1	37.9	54.3	6.7	48.8
W	PPM	42	<6	17	19	7	75
ZN	PPM	170	190	140	<80	140	190
LA	PPM	1150	126	473	723	41	588
CE	PPM	1960	216	799	1160	80	959
SM	PPM	129	15.8	54.4	79.2	6.2	68.1
EU	PPM	25.6	3.6	15.2	16.5	1.7	12.5
YB	PPM	141	31.9	63.0	82.9	19.8	73.2
LU	PPM	28.4	6.07	11.8	15.5	3.64	14.5

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SAMPLE NUMBERS

** 343-H**	** 344-H**	** 345-H**	** 347-H**	** 348-H**	** 351-H**	ELEMENT ! & UNITS !		** 352-H**	** 353-H**	** 354-H**	** 355-H**	** 356-H**	** 357-H**
<5	<5	<5	<14	<5	<5	AG	PPM	<5	<5	<5	<5	<30	<18
74	160	110	170	120	71	AS	PPM	140	150	25	170	210	290
<16	150	<110	<27	1500	<53	AU	PPB	290	<30	<43	<40	<47	160
600	900	2100	890	3300	1100	BA	PPM	2200	500	800	<800	<700	600
<2	<7	<22	<5	<16	<9	CA	%	<12	<5	<8	<7	<8	3
55	97	95	110	40	61	CO	PPM	130	100	57	110	110	110
2300	4900	11000	7100	8000	10000	CR	PPM	11000	5500	9600	6200	6900	6700
25.6	18.1	8.66	25.1	9.74	19.8	FE	%	29.6	23.0	18.7	23.6	23.8	22.2
190	1300	2500	1000	3300	1400	HF	PPM	1900	950	1700	790	1100	1200
<5	<5	<5	<5	90	3	MO	PPM	61	<5	<5	<5	<5	<5
0.06	0.12	0.16	0.06	0.13	0.07	NA	%	0.12	0.08	0.11	0.10	0.13	0.17
<300	<500	<1600	<400	1700	1000	NI	PPM	<1100	<500	<600	<700	<200	<500
3.0	10	18	7.9	8.6	2.5	SB	PPM	5.7	4.6	2.7	7.6	10	13
44.1	55.1	73.3	46.1	67.9	57.2	SC	PPM	76.4	45.6	53.2	49.2	53.0	48.7
<14	<16	<120	<10	<87	<63	SE	PPM	<77	<42	<53	<49	<14	<12
5	18	37	11	15	13	TA	PPM	28	9	22	10	16	9
15	220	400	130	570	140	TH	PPM	210	83	140	77	180	170
9.0	72.8	130	49.1	157	71.1	U	PPM	85.3	39.4	75.7	39.2	66.6	67.2
11	33	66	40	79	35	W	PPM	42	30	20	<19	35	56
140	190	<250	170	270	<110	ZN	PPM	380	100	130	170	170	130
57	966	1630	646	2450	607	LA	PPM	936	395	635	377	1000	894
116	1580	2510	1050	4110	911	CE	PPM	1500	571	896	598	1600	1400
6.7	113	176	68.0	288	59.0	SM	PPM	97.3	36.4	59.2	36.9	110	93.9
1.8	24.4	38.3	15.6	67.7	10.0	EU	PPM	21.6	10.2	16.8	8.4	22.7	18.4
21.4	112	190	75.8	300	89.8	YB	PPM	124	57.3	99.5	55.3	98.6	95.8
4.30	21.8	39.8	14.5	56.2	19.0	LU	PPM	25.9	11.5	20.3	11.7	18.4	17.9

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** 358-H**	** 359-H**	** 350-H**	** 361-H**	** 362-H**	** 363-H**	ELEMENT !	& UNITS !	** 364-H**	** 365-H**	** 356-H**	** 367-H**	** 368-H**	** 370-H**
<5	<23	<5	<5	<20	<5	AG	PPM	<5	<25	<16	<5	<5	<5
210	310	120	19	96	58	AS	PPM	40	130	280	98	190	110
31	<39	<55	26	<26	<45	AU	PPB	2100	<46	44	<24	67	120
1500	800	<2400	400	<1300	1100	BA	PPM	400	<900	1100	<1200	<500	1100
<6	<7	<11	<2	<4	<8	CA	%	<3	<7	<4	<3	<3	<10
110	140	88	48	85	65	CO	PPM	55	99	130	74	110	80
6700	6100	9500	6700	5700	7300	CR	PPM	5000	8000	7500	3700	2400	6100
25.4	30.3	19.0	26.3	23.1	21.2	FE	%	25.6	21.8	29.1	27.5	32.2	24.5
1200	930	1500	760	770	1000	HF	PPM	600	1100	910	440	210	920
<5	<5	<5	<5	<5	18	MO	PPM	23	55	<5	9	12	<5
0.07	0.11	0.11	0.06	0.06	<0.05	NA	%	0.05	0.08	0.11	0.06	0.06	0.14
<500	<600	<800	<300	<400	<700	NI	PPM	<400	<700	<500	<400	<500	1500
9.2	11	7.4	1.7	4.1	4.1	SB	PPM	2.6	4.8	13	5.0	7.1	5.9
52.5	53.0	60.6	47.4	42.5	48.8	SC	PPM	40.6	49.3	47.0	40.8	44.8	46.0
<17	<39	<26	<8	<31	<48	SE	PPM	<29	<23	<26	<25	<24	<25
8	11	25	11	11	12	TA	PPM	11	7	9	11	7	11
170	140	260	67	66	110	TH	PPM	44	100	100	41	16	100
63.6	54.1	87.0	32.7	28.2	43.3	U	PPM	22.8	45.3	43.8	19.8	7.8	42.9
57	20	98	44	<13	<21	W	PPM	<11	32	40	<12	<15	<26
130	160	<120	60	140	200	ZN	PPM	130	220	150	120	<60	210
796	672	1250	254	342	496	LA	PPM	215	439	428	199	74	800
1310	1110	2130	444	534	846	CE	PPM	321	710	727	322	176	944
89.6	76.6	143	30.4	31.1	48.3	SM	PPM	18.6	45.8	51.9	18.3	8.8	67.0
20.3	12.7	27.5	4.8	6.8	13.3	EU	PPM	4.1	9.1	11.0	5.9	2.4	18.9
93.2	79.3	122	50.4	46.6	66.4	YB	PPM	35.4	67.5	66.2	29.5	24.8	64.7
13.4	14.1	23.2	10.0	9.85	13.9	LU	PPM	7.72	14.5	13.6	6.24	4.69	12.3

S A M P L E N U M B E R S

** 371-H**	** 372-H**	** 373-H**	** 374-H**	** 375-H**	** 376-H**
<5	<5	<5	<5	<5	<5
21	73	350	210	230	55
<25	<19	<24	<36	<79	<100
500	<1000	<1600	<600	1800	2600
<17	<2	<19	<5	<14	<18
93	69	170	130	120	49
0000	5000	4800	4300	7100	13000
3.77	26.2	25.8	25.4	20.8	13.0
4700	450	1000	500	1200	2800
<5	<5	31	16	<5	<5
0.12	0.06	0.15	0.08	<0.10	0.14
1200	<300	<1500	<600	1800	<1400
5.3	2.9	15	7.3	9.9	8.0
78.4	44.0	48.2	48.0	52.9	68.9
<140	<21	<93	<33	<80	<130
21	10	<11	11	13	<11
640	37	150	51	150	310
224	16.0	69.2	20.9	73.2	168
440	<10	<42	<17	<37	<43
<190	110	<220	200	260	<220
2470	161	797	285	822	1120
4050	279	1190	427	1140	1300
290	16.6	73.7	28.9	79.8	127
59.9	4.6	15.6	11.1	26.1	27.1
367	29.1	77.8	39.2	85.9	193
71.6	6.32	17.4	8.05	18.5	41.7

S A M P L E N U M B E R S

ELEMENT !	& UNITS !	** 377-H**	** 378-H**	** 379-H**	** 380-H**	** 381-H**	** 392-H**
AG	PPM	<5	<29	<5	<20	<5	<5
AS	PPM	120	300	99	100	120	11
AU	PPB	<120	<63	73000	<39	<47	32
BA	PPM	2300	1700	2100	<600	2800	700
CA	%	<24	<10	13	<7	<9	<5
CO	PPM	120	150	50	66	99	36
CR	PPM	9900	8000	11000	5400	8500	11000
FE	%	10.0	23.6	6.33	22.0	13.7	13.3
HF	PPM	2300	1100	2600	1000	2000	1600
MO	PPM	<5	23	55	<5	<5	<5
NA	%	<0.17	0.13	0.08	0.10	0.09	0.19
NI	PPM	<1700	<200	<800	<600	<700	<500
SB	PPM	14	17	17	6.3	8.3	3.3
SC	PPM	73.3	55.9	77.1	52.6	64.9	57.2
SE	PPM	<120	<47	<29	<39	<47	<14
TA	PPM	28	17	27	10	21	14
TH	PPM	450	200	390	140	320	200
U	PPM	185	65.5	144	60.8	114	73.2
W	PPM	110	33	100	27	67	64
ZN	PPM	<270	260	290	<90	170	130
LA	PPM	1960	1030	1420	732	1350	736
CE	PPM	3420	1740	2510	1130	2220	1280
SM	PPM	265	114	192	74.6	159	84.1
EU	PPM	50.1	18.6	36.0	16.0	29.0	15.4
YB	PPM	197	105	206	80.1	167	115
LU	PPM	39.2	19.5	42.6	16.3	34.7	24.7

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** 383-H**	** 384-H**	** 385-H**	** 386-H**	** 387-H**	** 388-H**
<5	<21	<5	<5	<5	<6
67	<2	110	69	72	62
<15	<5	<28	<43	3000	<11
400	3400	1000	<2100	2400	400
<1	<1	<5	<7	12	3
51	69	96	62	64	62
2400	35000	9700	6300	7200	3400
25.6	3.93	21.3	16.1	13.9	22.0
190	2900	1100	1200	1500	320
7	50	<5	<5	<5	<5
0.06	<0.05	0.08	0.13	0.12	0.12
<300	600	<400	<600	<600	300
2.6	6.7	10	4.1	3.8	2.4
42.8	94.7	53.9	52.6	57.6	44.2
<12	<5	<13	<45	<75	<5
7	27	13	13	14	7
14	380	150	150	190	26
8.1	153	58.8	68.2	75.3	13.3
21	63	[illegible]	<22	<24	47
150	230	520	200	130	110
58	1180	613	725	828	109
39	1900	1020	1040	1270	197
6.5	124	71.2	69.5	85.7	15.3
1.3	26.7	14.3	13.8	17.2	3.7
22.0	199	83.6	81.8	100	27.4
4.65	41.6	16.6	17.8	21.6	5.10

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S A M P L E N U M B E R S

ELEMENT !	& UNITS !	** 389-H**	** 390-H**	** 391-H**	** 392-H**	** 393-H**	394-
AG	PPM	<7	<5	<5	<5	<8	<5
AS	PPM	150	65	70	70	83	47
AU	PPB	<11	<19	940	19	<14	<20
BA	PPM	200	<300	600	<700	<200	<300
CA	%	<1	<2	<4	1	<1	<2
CO	PPM	85	66	74	56	56	49
CR	PPM	1900	4900	5970	2300	1900	4000
FE	%	31.6	24.9	21.0	25.6	25.1	25.7
HF	PPM	150	410	770	190	140	430
MO	PPM	<5	12	<5	<5	7	13
NA	%	<0.05	0.07	0.12	<0.05	0.05	0.05
NI	PPM	<200	400	600	<300	<200	500
SB	PPM	4.9	2.9	2.7	2.4	2.8	2.0
SC	PPM	40.0	41.7	44.3	44.3	43.3	38.8
SE	PPM	<5	<9	<13	<12	<12	<28
TA	PPM	7	8	9	5	5	9
TH	PPM	13	32	70	13	10	31
U	PPM	4.6	15.6	34.9	7.8	5.1	16.1
W	PPM	8	<12	<17	<10	<9	<12
ZN	PPM	140	340	140	170	130	<210
LA	PPM	39	144	322	54	45	152
CE	PPM	79	253	528	99	95	260
SM	PPM	6.0	14.9	31.4	6.3	6.1	13.0
EU	PPM	1.6	5.0	8.0	1.5	1.4	3.3
YB	PPM	21.8	23.2	45.2	23.3	20.2	27.5
LU	PPM	3.79	5.71	9.74	4.78	3.99	5.51

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ELEMENT !		**	**	**	**
& UNITS !		395-H**	396-H**	397-H**	398-H**
AG	PPM	<5	<5	<15	<5
AS	PPM	160	81	150	17
AU	PPB	<28	<27	96	<31
BA	PPM	490	600	500	700
CA	%	<3	<4	<3	<4
CO	PPM	100	70	95	43
CR	PPM	4200	3800	2600	5600
FE	%	26.9	24.6	29.7	22.2
HF	PPM	450	520	230	780
MO	PPM	<8	13	15	<5
NA	%	0.08	<0.05	0.08	0.14
NI	PPM	<400	<400	<500	<500
SB	PPM	6.2	2.6	5.4	1.6
SC	PPM	39.0	38.5	41.0	45.2
SE	PPM	<12	<27	<21	<34
TA	PPM	7	9	8	12
TH	PPM	37	49	20	67
U	PPM	22.0	26.8	7.6	31.0
W	PPM	<15	20	20	28
ZN	PPM	170	80	160	100
LA	PPM	173	232	86	291
CE	PPM	296	329	135	347
SM	PPM	16.9	19.9	9.9	27.5
EU	PPM	5.8	4.6	2.2	5.9
YB	PPM	31.4	33.2	21.0	45.2
LU	PPM	6.02	7.30	4.61	9.68

EXPLANATION OF CODES

VARIABLE DETECTION LIMITS DUE TO SAMPLE COMPOSITION

Appendix 6. (cont.)

NUCLEAR ACTIVATION SERVICES LIMITED
1280 MAIN STREET WEST, HAMILTON, ONTARIO, L8S 4K1
PHONE (416) 522-5666 TELEX 06-986947

CERTIFICATE OF ANALYSIS

TO: MC GILL UNIVERSITY
ATTN: M.A. BERNIER
DEPT. OF GEOLOGICAL SCIENCES
3450 UNIVERSITY STREET
MONTREAL, QUEBEC

CUSTOMER NO. 133/01/02

DATE SUBMITTED
26-MAR-87

REPORT: 7945 FILE NUMBER: 9638

140 UNPREPARED SAMPLES PO# C-50063-IR

WERE ANALYZED AS FOLLOWS:

LEMENTS	DETECTION LIMIT	UNITS	METHOD	ELEMENTS	DETECTION LIMIT	UNITS	METHOD
AG	5.0000	PPM	INAA	SC	0.1000	PPM	INAA
AS	2.0000	PPM	INAA	SE	5.0000	PPM	INAA
AU	5.0000	PPB	INAA	TA	1.0000	PPM	INAA
BA	100.0000	PPM	INAA	TH	0.5000	PPM	INAA
CA	1.0000	%	INAA	U	0.5000	PPM	INAA
CO	5.0000	PPM	INAA	W	4.0000	PPM	INAA
CR	10.0000	PPM	INAA	ZN	50.0000	PPM	INAA
FE	0.0200	%	INAA	LA	1.0000	PPM	INAA
HF	1.0000	PPM	INAA	CE	3.0000	PPM	INAA
MO	5.0000	PPM	INAA	SM	0.1000	PPM	INAA
NA	0.0500	%	INAA	EU	0.2000	PPM	INAA
NI	200.0000	PPM	INAA	YB	0.2000	PPM	INAA
SB	0.2000	PPM	INAA	LU	0.0500	PPM	INAA

COMMENTS:

NOTE: DETECTION LIMIT RAISED DUE TO SMALL SAMPLE SIZE & HIGH ACTIVITY.

DATE 16-APR-87

NUCLEAR ACTIVATION SERVICES LIMITED
CERTIFIED BY ..K.Blackwood....

*** UNLESS INSTRUCTED OTHERWISE WE WILL DISCARD ALL SAMPLES ***
IRRADIATED SAMPLES AFTER 30 DAYS. ANY OTHER MATERIAL AFTER 120 DAYS.

NUCLEAR ACTIVATION SERVICES LIMITED

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SAMPLE NUMBERS

**	**	**	**	**	**
0001-H**	0002-H**	0003-H**	0008-H**	0057-H**	0283-H**
<5	<5	<5	<5	<5	<5
49	29	28	16	240	18
200	<9	<20	<21	150	<9
600	400	<500	<500	<4400	300
<3	2	<3	<2	<37	<1
65	41	52	45	210	27
9500	1500	15000	6900	6000	2000
21.4	32.4	21.5	20.4	20.8	36.8
720	200	740	590	3100	240
21	<5	<5	<5	<5	<5
0.09	0.13	<0.05	0.17	<0.22	0.10
400	<200	<400	<400	<3100	<200
5.7	1.1	2.1	0.8	56	1.3
46.4	44.7	45.8	52.5	76.2	29.0
<16	<5	<16	<18	<77	<6
13	8	15	23	88	7
54	16	65	59	360	19
32.7	9.1	35.1	29.6	270	9.5
19	<7	18	24	<80	<7
260	110	220	120	1200	230
189	75	255	194	1740	69
384	164	474	367	2020	151
25.0	14.3	31.1	20.5	163	13.3
3.4	2.5	5.9	2.7	23.1	2.7
39.8	19.9	40.5	33.3	223	16.1
7.79	3.36	8.32	6.96	46.5	2.97

NUCLEAR ACTIVATION SERVICES LIMITED

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SAMPLE NUMBERS

ELEMENT !		**	**	**	**	85-5**	85-6
& UNITS !		0306-H**	0307-H**	0309-H**	0310-H**-H	86-3-24**-H	86-2-28
AG	PPM	<5	<5	<5	<5	<5	<5
AS	PPM	7	<2	44	5	63	85
AU	PPB	<19	<22	<16	<15	420	<27
BA	PPM	700	900	1000	<300	<500	500
CA	%	4	<3	<3	2	<3	<4
CO	PPM	42	39	39	37	74	110
CR	PPM	4000	6200	10000	700	8900	7900
FE	%	18.4	16.8	25.5	18.9	23.8	25.2
HF	PPM	440	620	470	140	620	600
MO	PPM	<5	<5	<5	<5	<5	20
NA	%	0.06	<0.05	0.08	0.08	0.07	0.07
NI	PPM	<400	<400	<300	<300	<400	<500
SB	PPM	<0.6	0.9	6.4	<0.2	8.0	3.8
SC	PPM	59.4	60.7	35.3	54.9	49.1	48.8
SE	PPM	<15	<18	<12	<10	<17	<36
TA	PPM	18	17	11	19	13	19
TH	PPM	44	65	58	13	49	65
U	PPM	18.6	36.2	28.7	5.3	31.4	30.1
W	PPM	<11	14	<12	<9	<16	<20
ZN	PPM	190	110	310	140	270	<110
LA	PPM	157	241	205	55	194	236
CE	PPM	514	728	356	147	367	452
SM	PPM	18.6	26.2	23.5	9.0	23.1	31.0
EU	PPM	4.1	6.5	4.5	1.4	3.4	5.1
YB	PPM	33.4	40.8	28.7	20.0	35.9	33.7
LU	PPM	6.48	7.96	6.03	3.62	6.95	6.89

NUCLEAR ACTIVATION SERVICES LIMITED

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SAMPLE NUMBERS

85-10**	85-12**	85-31**	85-45**	85-50**	85-53**
86-3-11**	-H 86-5-7**	-H 86-6-10**	-H 86-5-9**	-H 86-5-7**	-H 86-6-10**
<5	<18	<5	<37	<5	<5
130	140	110	300	220	31
<41	<34	34	<71	<140	13
<900	900	600	2600	<3500	300
<8	<7	<3	<16	<27	<1
110	120	110	330	250	43
4400	6300	14000	9100	9600	1500
23.7	24.4	27.1	23.7	23.5	31.5
830	750	1000	1500	1400	180
<5	<5	<5	<5	<93	<5
0.07	<0.05	0.14	<0.09	<0.17	0.13
<700	<600	<400	1500	<2600	<200
14	8.6	6.7	24	25	1.2
58.2	55.5	54.4	53.6	49.7	45.4
<32	<27	<15	<68	<140	<6
20	18	12	8	86	9
120	130	110	210	170	19
58.9	51.8	49.2	115	62.9	8.1
<20	<17	66	<33	<64	<8
260	180	180	<350	1100	140
555	524	371	1080	791	78
691	663	737	1320	952	270
63.9	60.2	52.1	120	74.5	14.5
11.3	13.8	5.7	23.5	19.0	2.5
61.5	56.1	61.1	137	89.0	19.4
12.5	11.2	11.2	24.9	16.2	3.23

NUCLEAR ACTIVATION SERVICES LIMITED

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SAMPLE NUMBERS

ELEMENT !		85-56**	85-58**	85-59**	85-65**	85-66**	85-67
& UNITS		!-H 86-3-17**	-H 86-6-10**	-H 86-2-28**	-H 86-5-7**	-H 66-5-4**	-H 86-5-9
AG	PPM	<5	<5	<5	<5	<15	<5
AS	PPM	38	47	22	120	91	160
AU	PPB	<28	<22	<5	<50	35	450
BA	PPM	1500	1300	700	<3100	900	<2600
CA	%	<3	<4	<5	<8	<6	<10
CO	PPM	50	65	48	190	110	160
CR	PPM	5800	7300	7800	12000	14000	9700
FE	%	21.8	22.5	23.9	23.3	24.2	27.1
HF	PPM	490	700	700	650	860	910
MO	PPM	<5	<5	<5	18	<5	<30
NA	%	0.16	0.08	0.08	0.05	0.07	<0.07
NI	PPM	<500	<400	<500	<1000	<500	<800
SB	PPM	2.5	3.2	1.7	15	6.5	7.3
SC	PPM	54.6	50.8	50.6	52.8	55.8	56.0
SE	PPM	17	<19	20	<41	31	<50
TA	PPM	10	12	12	43	11	19
TH	PPM	48	72	67	87	86	130
U	PPM	21.0	40.6	37.1	45.2	43.5	52.2
W	PPM	<19	<15	25	34	<15	<23
ZN	PPM	260	140	310	390	<140	310
LA	PPM	200	277	364	594	489	985
CE	PPM	361	529	581	1000	555	1000
SM	PPM	28.4	36.2	38.8	58.0	46.4	84.7
EU	PPM	5.5	7.0	8.7	13.4	9.5	12.9
YB	PPM	36.2	45.3	47.0	53.9	53.7	72.7
LU	PPM	7.08	9.15	8.65	9.62	10.0	13.1

NUCLEAR ACTIVATION SERVICES LIMITED

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S A M P L E N U M B E R S

85-70** -H 86-5-5**	85-74** -H 86-5-7**	85-84** -H 86-4-24**	85-86** -H 86-4-24**	85-106** -H 86-4-24**	85-107** -H 86-3-17**
<5	<5	<14	16	<5	<5
30	30	52	86	85	43
<25	<22	<21	<23	<18	<43
700	<600	500	<600	500	<1000
<4	<3	2	3	2	<6
62	59	69	75	81	78
9800	15000	5700	2300	3000	6300
28.1	18.1	24.0	27.5	24.3	29.6
630	730	430	340	290	480
<5	<5	<5	8	<5	<24
0.05	<0.05	0.06	0.05	0.05	0.09
<500	<400	<500	800	<400	<900
2.0	3.1	1.5	23	1.6	3.5
55.7	52.4	47.7	32.9	46.3	57.6
<22	<20	<18	<19	<13	<35
16	25	9	12	19	35
52	66	33	22	30	49
33.8	42.0	17.6	11.9	12.9	13.7
<14	<12	<11	<11	<9	<25
130	170	270	370	180	350
222	254	113	90	108	166
306	461	220	178	202	241
25.3	27.0	14.3	11.9	14.0	19.1
7.0	6.4	3.3	3.6	4.1	7.5
43.7	39.9	28.1	18.3	20.4	28.5
8.36	8.16	5.51	3.89	4.52	5.83

NUCLEAR ACTIVATION SERVICES LIMITED

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S A M P L E N U M B E R S

ELEMENT & UNITS		85-108** -H 86-5-5**	85-119** -H 86-5-5**	85-122A** -H 86-6-10**	85-131** -H 86-6-10**	85-138** -H 86-6-10**	85-14 -H-86-6-1
AG	PPM	<5	<5	<5	<5	<16	<5
AS	PPM	22	52	15	84	190	53
AU	PPB	<69	41	<25	32	<26	<33
BA	PPM	<1600	1500	800	<200	1900	<1700
CA	%	<11	<6	<3	3	<4	5
CO	PPM	76	78	44	96	150	100
CR	PPM	6500	37000	5200	4600	6400	2600
FE	%	29.9	12.9	26.2	32.2	30.4	30.8
HF	PPM	770	1400	450	380	460	410
MO	PPM	22	<5	7	<5	7	24
NA	%	0.10	0.07	0.09	0.11	0.11	0.08
NI	PPM	<1400	<600	<500	<200	<600	<700
SB	PPM	7.1	2.7	2.0	4.1	5.8	5.4
SC	PPM	64.8	58.0	49.3	47.2	50.6	60.1
SE	PPM	<57	<31	30	<7	<21	<24
TA	PPM	18	24	17	9	5	20
TH	PPM	54	170	40	27	38	18
U	PPM	24.2	68.3	17.2	13.7	17.5	12.4
W	PPM	<37	<24	26	73	17	26
ZN	PPM	350	330	350	280	180	240
LA	PPM	235	554	152	95	139	83
CE	PPM	480	847	334	397	272	143
SM	PPM	27.2	63.9	19.6	16.8	18.0	14.3
EU	PPM	7.7	11.0	2.4	2.0	4.0	4.0
YB	PPM	41.2	82.2	27.3	26.7	27.6	28.7
LU	PPM	8.84	15.8	5.66	4.94	5.78	5.70

NUCLEAR ACTIVATION SERVICES LIMITED

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S A M P L E N U M B E R S

85-144** 86-5-27**-H	85-157** 86-6-10**-H	85-159** 86-3-11**-H	85-167** 86-6-10**-H	85-174** 86-6-10**-H	85-180** 86-3-11**
<5	<5	<5	<7	<5	<14
48	37	70	160	49	200
<17	<21	<27	61	22	<24
500	<400	<600	<200	300	<1400
4	<3	3	<2	<2	<4
63	39	46	72	56	160
3800	11000	10000	9700	5800	12000
25.1	26.3	21.7	36.2	29.6	30.1
470	530	540	460	470	600
5	<5	<5	<5	<5	<5
0.11	0.13	0.05	0.07	0.10	0.08
<400	<400	<500	400	<300	<500
2.3	7.0	6.5	7.3	2.7	9.4
45.2	36.8	41.8	26.3	49.1	47.5
<13	<15	<22	<9	70	<19
11	10	22	8	11	7
34	66	52	51	44	55
19.0	35.3	37.2	25.4	17.4	27.3
<14	21	18	74	<10	<13
290	370	<120	140	130	370
150	204	210	181	146	242
267	397	425	361	294	324
19.7	25.9	19.9	24.8	23.9	28.4
3.0	5.8	5.7	3.9	2.9	5.8
28.4	31.2	29.9	27.5	34.0	35.0
5.56	6.09	5.64	5.07	6.20	7.01

NUCLEAR ACTIVATION SERVICES LIMITED

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S A M P L E N U M B E R S

ELEMENT ! & UNITS !-H		85-182** 86-3-24** -H	85-194** 86-5-7**-H	85-199** 86-4-24**-H	85-200** 86-6-10**-H	85-207** 86-3-17**-H	85-222 86-5-27
AG	PPM	<5	<5	<5	<5	<5	<5
AS	PPM	150	34	51	11	18	28
AU	PPB	48	39	<23	<11	<27	85
BA	PPM	700	700	61000	300	1100	<1300
CA	%	<4	<3	<2	<1	<4	<6
CO	PPM	100	45	61	24	61	110
CR	PPM	12000	13000	4200	3500	20000	15000
FE	%	26.8	20.5	19.7	6.88	19.3	43.8
HF	PPM	800	760	280	250	1000	1300
MO	PPM	<5	<5	11	<5	<5	<14
NA	%	0.06	<0.05	0.08	<0.05	<0.05	0.13
NI	PPM	<500	<500	<500	<200	<400	<1100
SB	PPM	7.1	5.8	2.2	1.0	3.1	3.3
SC	PPM	41.0	47.8	49.3	24.9	51.0	145
SE	PPM	<17	<22	<18	<9	<19	<43
TA	PPM	12	17	10	21	17	16
TH	PPM	76	80	24	21	85	130
U	PPM	41.1	51.1	13.7	13.3	50.7	77.0
W	PPM	<18	21	13	<6	40	<32
ZN	PPM	130	170	140	<50	230	500
LA	PPM	311	289	126	88	360	476
CE	PPM	556	518	335	247	578	1520
SM	PPM	40.0	32.3	15.6	9.2	43.5	56.4
EU	PPM	8.1	7.4	4.2	1.9	8.3	11.3
YB	PPM	44.2	41.8	21.6	15.9	57.4	90.2
LU	PPM	9.36	8.39	4.06	3.12	11.8	17.5

NUCLEAR ACTIVATION SERVICES LIMITED

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85-234** 86-4-24**	85-237** -H 86-5-7**-H	85-239** 86-3-24**-H	85-241** 86-3-24**	85-242** -H 86-5-1**-H	85-243** 86-4-24**
<5	<5	<5	<5	<5	<23
63	220	<6	9	92	210
<22	<120	<24	29	<35	<41
600	3500	600	500	<900	4600
<3	<28	<3	<2	<6	<8
100	180	37	34	99	220
5800	3600	4600	3900	11000	3000
22.2	23.6	19.4	21.7	35.4	39.7
530	1100	650	540	780	290
<5	17	<5	<5	<5	72
<0.05	<0.19	<0.05	0.09	0.05	<0.05
<500	<1700	<500	500	1100	1300
3.4	22	<0.7	0.7	7.3	15
50.2	55.5	52.4	46.9	41.4	25.0
<19	160	<19	<22	<31	150
22	16	24	12	11	8
68	250	51	45	93	54
31.4	71.3	28.2	25.8	50.5	17.3
<11	77	<13	<13	<19	<22
230	<570	160	140	220	310
194	2250	182	156	322	304
358	2430	286	303	417	469
21.8	205	15.7	21.3	32.7	24.8
1.8	43.6	4.7	3.2	7.0	6.7
31.5	141	30.8	34.5	48.2	20.6
6.01	23.7	6.16	6.87	9.85	3.47

NUCLEAR ACTIVATION SERVICES LIMITED

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S A M P L E N U M B E R S

ELEMENT ! & UNITS !		85-245** -H 86-5-1**	85-246** -H 86-5-1**-H	85-250** 86-3-17**	85-261** -H 86-5-5**-H	85-263** 86-5-27**	85-266 -H 86-5-
AG	PPM	<33	<24	<18	<5	<5	<5
AS	PPM	370	400	120	130	250	160
AU	PPB	<65	<42	<29	<24	<91	<93
BA	PPM	<1600	<1000	<600	<600	2200	<2200
CA	%	<13	14	<4	<4	<21	<23
CO	PPM	120	240	50	94	690	230
CR	PPM	14000	7300	3800	11000	11000	12000
FE	%	22.8	32.6	32.9	25.7	20.1	22.2
HF	PPM	1600	740	390	740	2200	1900
MO	PPM	<5	<5	21	<5	<5	<5
NA	%	0.11	<0.06	<0.05	0.05	0.20	<0.15
NI	PPM	<1000	<800	<600	<500	<1500	2000
SB	PPM	50	27	5.6	7.3	9.8	10
SC	PPM	57.0	41.8	113	53.2	58.4	60.6
SE	PPM	<54	<32	<20	<20	<80	<80
TA	PPM	34	<1	23	11	12	33
TH	PPM	180	110	51	66	290	250
U	PPM	112	49.2	16.5	40.2	136	141
W	PPM	<32	<22	30	<13	61	<48
ZN	PPM	2400	610	420	130	<440	<390
LA	PPM	641	821	211	261	1810	1570
CE	PPM	771	931	294	567	2030	1820
SM	PPM	69.3	71.3	29.9	27.5	163	128
EU	PPM	13.0	16.8	2.6	4.6	40.1	23.9
YB	PPM	101	50.2	29.2	40.7	155	133
LU	PPM	19.6	10.6	6.26	8.82	31.0	25.7

S A M P L E N U M B E R S

85-271** 86-5-27** -H	85-274** 86-5-1**-H	85-277** 86-2-28** -H	85-279** 86-5-1**-H	85-280** 86-3-11**-H	85-284** 86-4-24**
<5	36	<17	<13	<10	<5
240	260	290	150	150	47
<160	<59	84	<23	28000	<41
<8800	<1400	<600	<500	900	<1200
<41	<11	9	<3	<4	<6
840	230	340	160	97	66
11000	10000	3800	1400	1200	19000
15.6	26.0	42.7	34.5	47.3	17.1
2500	1400	330	130	94	1500
<5	<5	<5	<5	120	<5
<0.28	0.11	0.08	<0.05	<0.05	<0.05
<2600	1200	<600	<500	<400	<700
9.9	23	14	5.5	3.4	4.5
71.2	50.5	28.4	23.7	11.8	55.5
210	<46	<21	<14	37	<39
<1	17	5	6	<1	44
460	170	52	28	21	160
169	97.7	25.4	11.2	10.7	99.1
<76	65	21	<11	12	<18
<660	<260	270	220	<100	<200
4030	810	342	251	314	663
4540	884	521	350	558	1160
351	78.1	35.6	23.9	26.2	62.3
80.9	14.6	6.8	7.1	3.2	12.9
212	94.3	22.9	10.6	9.5	90.9
37.1	18.6	4.61	2.11	1.61	18.3

S A M P L E N U M B E R S

ELEMENT !	& UNITS !-H	85-293** 86-4-24** -H	85-258** 86-5-1**-H	85-302** 86-3-11**-H	85-303** 86-3-24**-H	85-304** 86-3-24**H	20 86-11-19
AG	PPM	<5	<5	<5	<5	<36	<5
AS	PPM	<14	120	170	240	1100	74
AU	PPB	<52	<29	2700	<120	<52	<22
BA	PPM	1800	<700	<3100	<3100	1700	<500
CA	%	<9	<6	<12	<21	<10	3
CO	PPM	56	92	120	140	290	86
CR	PPM	31000	11000	9900	25000	2700	8800
FE	%	12.8	25.9	21.3	23.2	42.9	21.3
HF	PPM	2500	1100	1600	2500	170	540
MO	PPM	<5	<5	<5	<5	15	<5
NA	%	0.10	<0.05	0.12	<0.15	0.12	0.06
NI	PPM	<700	<600	<900	<1700	<1100	<400
SB	PPM	3.7	8.3	12	31	37	4.6
SC	PPM	70.3	60.3	60.9	66.7	26.1	54.0
SE	PPM	<41	29	<44	<100	<31	<17
TA	PPM	16	27	10	38	<1	22
TH	PPM	290	120	200	240	44	39
U	PPM	138	52.0	104	217	17.5	27.3
W	PPM	<32	<16	39	<56	<26	<11
ZN	PPM	220	<140	<220	1400	1700	170
LA	PPM	1090	438	1020	885	451	161
CE	PPM	1710	593	1180	1100	505	303
SM	PPM	118	50.2	104	97.0	26.0	20.4
EU	PPM	16.8	7.9	18.0	12.8	4.4	3.7
YB	PPM	151	64.2	106	147	17.0	34.1
LU	PPM	30.5	12.6	20.5	29.7	2.65	7.22

S A M P L E N U M B E R S

30**	69**	93**	116**	137**	139**
6-11-19**H	86-11-14**H	86-10-30**H	86-11-19**H	86-11-19**H	86-10-30**
<5	<5	<5	<5	<13	<11
170	16	17	15	140	130
<42	<20	<27	<47	4900	<19
<1000	<400	800	<1200	4200	<500
<7	<2	<5	<8	<2	<2
130	39	55	62	110	100
13000	1300	14000	27000	3900	8600
33.2	25.6	17.9	15.3	24.1	22.0
630	230	910	1200	410	550
21	18	<5	<38	<5	16
0.08	0.14	0.12	0.07	0.07	0.08
<900	<400	<500	900	<400	<400
9.6	1.1	0.8	3.1	3.5	9.0
52.6	54.2	58.7	73.2	48.2	49.2
<38	<12	<25	<40	<17	<16
13	12	22	42	9	13
71	22	99	120	33	42
48.9	9.8	54.2	70.6	17.8	25.4
<25	<18	<15	33	<10	11
440	210	180	520	230	150
233	100	398	411	103	173
569	178	471	479	232	661
31.3	16.7	43.5	42.1	16.3	20.9
5.2	2.5	6.5	8.2	2.5	5.6
40.3	25.4	53.7	73.1	25.9	29.8
7.59	4.43	11.5	14.0	5.18	5.79

S A M P L E N U M B E R S

ELEMENT	!	151**	153**	162**	166**	168**	171*
& UNITS	!H	86-11-19**H	86-11-12**H	86-11-11**H	86-11-14**H	86-11-14**H	86-11-19*
AG	PPM	<5	<5	<12	<5	<14	<19
AS	PPM	51	38	85	67	150	200
AU	PPB	<19	<28	23	<24	31	<34
BA	PPM	500	<700	800	<1400	800	1300
CA	%	<3	<3	<3	<3	<3	<4
CO	PPM	37	47	67	66	120	170
CR	PPM	13000	12000	17000	14000	13000	18000
FE	%	29.3	18.9	20.6	21.3	24.5	33.1
HF	PPM	630	730	730	790	650	890
MO	PPM	8	<5	<5	<5	<5	<5
NA	%	0.07	0.07	0.05	0.06	0.05	0.07
NI	PPM	<400	<500	<400	<400	<500	<700
SB	PPM	6.3	4.6	7.5	6.1	7.6	10
SC	PPM	35.7	43.1	47.3	42.2	47.8	65.3
SE	PPM	<17	<25	<20	<21	<21	<28
TA	PPM	12	34	15	20	17	19
TH	PPM	53	72	80	73	51	65
U	PPM	36.4	43.9	47.4	45.2	33.8	47.3
W	PPM	<14	17	18	23	<13	<17
ZN	PPM	220	220	190	180	250	340
LA	PPM	220	252	300	287	216	297
CE	PPM	425	411	932	562	429	616
SM	PPM	27.1	24.9	32.6	31.6	25.5	34.7
EU	PPM	4.0	5.3	7.9	6.1	5.7	10.2
YB	PPM	30.9	36.0	39.8	39.8	34.3	48.2
LU	PPM	6.22	7.81	8.18	8.72	6.87	9.66

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S A M P L E N U M B E R S

175**	184**	185**	189**	192**	209**
6-11-19**H	86-10-30**H	86-11-14**H	86-11-10**H	86-11-19**H	86-11-19**
<5	<5	<5	<5	<5	<11
100	160	43	74	38	97
21	40	<37	<72	<19	<21
<900	900	1200	<1700	400	19000
<2	<5	<6	<14	<3	<3
87	120	68	110	27	87
3700	12000	25000	29000	10000	13000
14.9	28.7	22.4	27.0	29.2	16.3
240	700	1300	1600	520	740
<5	11	37	20	13	<5
0.08	0.14	0.15	<0.09	0.07	0.09
500	<600	<600	<200	<400	500
5.0	6.5	4.3	10	5.8	6.6
27.7	41.5	47.2	63.4	34.9	41.4
<13	<20	<28	<61	<13	20
12	9	20	33	12	9
26	70	110	150	51	71
19.5	31.4	65.2	67.3	32.0	43.3
<8	<23	<24	<37	<14	<10
180	400	340	530	230	260
89	280	495	599	183	269
172	491	893	1240	369	503
10.9	38.1	59.8	62.2	25.6	30.5
2.7	8.0	10.1	16.1	4.7	5.7
15.7	39.8	68.9	94.7	27.9	40.6
2.96	8.18	14.0	18.1	5.94	8.71

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S A M P L E N U M B E R S

ELEMENT	!	211**	214**	215**	231**	251**	255
& UNITS	!H	86-11-14**H	86-11-12**H	86-11-19**-H	86-3-17**H	86-11-10**H	86-11-19
AG	PPM	<5	<5	<5	<5	<5	<5
AS	PPM	55	10	7	23	45	12
AU	PPB	<28	<19	<21	30	<20	<43
BA	PPM	<600	<500	<500	<400	400	<2600
CA	%	<1	3	<2	<3	<3	<8
CO	PPM	88	49	39	42	77	74
CR	PPM	6100	5900	2600	7400	2500	15000
FE	%	30.0	15.0	18.1	25.3	37.7	21.9
HF	PPM	450	500	330	620	270	1200
MO	PPM	6	<5	<5	<5	<5	<5
NA	%	0.15	0.10	0.09	0.06	0.19	0.09
NI	PPM	<500	<400	<400	<300	<500	<800
SB	PPM	2.4	1.4	<0.7	1.0	1.8	3.3
SC	PPM	43.5	65.5	59.3	46.2	34.5	67.7
SE	PPM	17	<17	<15	<13	<15	<36
TA	PPM	11	21	24	13	12	39
TH	PPM	47	48	30	59	26	130
U	PPM	26.0	27.5	21.0	29.9	14.3	80.6
W	PPM	<20	<11	15	<15	31	<23
ZN	PPM	340	280	120	250	150	260
LA	PPM	171	190	123	219	87	384
CE	PPM	319	347	432	365	158	525
SM	PPM	22.9	25.0	26.9	25.1	10.6	44.6
EU	PPM	4.6	4.9	9.4	3.4	2.1	9.9
YB	PPM	28.1	37.4	38.9	34.9	16.9	71.0
LU	PPM	5.45	7.18	6.79	6.89	3.54	15.7

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               S A M P L E   N U M B E R S

    257**          278**      86-134**            4**            16**            35**
6-11-11** -H 86-5-1**-H 86-2-28**-H 87-2-25**-H 87-2-13**-H 87-2-25**
-------------------------------------------------------------------------------

    <5           <5           <5            <5            <5            <5
    26          290           52            50           240            65
   <20          <77          <18         23000           110         15000
  <500        <1600          500           700          <700          <600
    <3          <12           <2            <3            <6            <4

    47          310           56            75           140            77
  7800         6100         4000          5500          5000          9200
  24.6         42.2         27.6          26.5          25.5          24.7
   630          410          280           470           320           590
    <5          <41           23            17            27             5

  0.12         0.16         0.12          0.05          0.20          0.10
  <400        <1500         <400          <400          <800          <400
   1.5           15          3.0           2.1           6.4           3.0
  48.0         23.5         46.8          47.1          38.5          44.5
   <14          <51          <18           <17           <26           <19

    12           19            9            13            15            15
    70           47           24            47            46            73
  35.7         33.0         12.8          21.0          17.1          33.6
   <15          <39          <15            24           <22           <19
   230         <390          320           180           690           280

   242          400          130           169           177           259
   493          505          233           294           402           490
  29.1         38.8         18.5          19.4          30.0          33.9
   3.6          7.6          2.5           1.7           4.1           4.6
  41.0         26.0         23.9          30.8          23.9          34.9

  7.60         5.86         4.48          5.84          4.93          7.63
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                        S A M P L E   N U M B E R S

ELEMENT   !         42**         52**         78**         89**        102**        109
& UNITS   !-H 87-2-22**-H 87-2-23**-H 87-2-19**-H 87-2-23**-H 87-2-23**-H 87-2-19
----------+---------------------------------------------------------------------------

AG    PPM       <26           <5           <5           <5           <5           <5
AS    PPM       230           27           10            8           10          160
AU    PPB       <52          <34         6100          <13            5          <25
BA    PPM     <1200         1200          600         <800         1700          500
CA    %         <12           <5           <2           <1           <1           <3

CO    PPM       220           53           38           35            6          170
CR    PPM      6890        17000         4000          790          430         3200
FE    %        20.8         21.1         19.5         18.6         2.53         33.8
HF    PPM       770         1200          460          150           27          300
MO    PPM        <5           <5           <5            7           <5           11

NA    %        0.23         0.07         0.06         0.06        <0.05         0.08
NI    PPM      <900         <500         <300         <300         <200         <600
SB    PPM        15          3.4          0.9         <0.4          0.7          7.2
SC    PPM      49.8         58.2         53.7         52.5          2.9         40.6
SE    PPM       <38          <24          <13           <9           <5          <21

TA    PPM         2           16           19           13           <1            6
TH    PPM       120          130           40           17          3.2           25
U     PPM      57.7         61.1         24.8          7.4          1.7         13.5
W     PPM       <28          <22          <10           <8            4           17
ZN    PPM       620          250          140          140           80          360

LA    PPM       910          477          153           58           13           91
CE    PPM       854          838          288          170           26          170
SM    PPM      70.9         56.8         16.9          8.9          2.0         12.5
EU    PPM      17.3          9.7          4.2          1.9          0.4          2.8
YB    PPM      57.1         71.6         31.7         19.0          1.9         19.3

LU    PPM      11.3         14.0         5.98         3.50         0.39         3.53
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SAMPLE NUMBERS

110** 87-2-13**-H	111** 87-2-25**-H	112** 87-2-19**-H	113** 87-2-19**-H	128** 87-2-19**-H	130** 87-2-19**
<5	<5	<5	<5	<5	<11
17	15	22	11	32	170
<28	32	<42	<11	<18	80
<1600	<500	<900	200	600	5200
<4	<4	<7	<2	<2	<2
60	53	68	14	50	180
10000	16000	14000	3900	3500	7800
20.2	16.4	19.2	5.40	16.7	25.8
1000	860	890	170	370	510
<5	<5	<12	<5	<5	<5
0.11	0.18	0.19	<0.05	0.09	0.06
<500	<400	<700	<200	<400	<400
2.2	2.0	2.8	1.8	17	9.2
82.8	59.2	74.1	13.4	52.5	39.4
<25	25	<33	<7	<14	<17
28	17	18	4	17	20
100	110	97	18	37	46
54.6	45.7	53.2	7.7	20.5	27.4
25	<21	<24	<8	<10	<10
<130	190	220	60	<50	190
383	386	354	67	133	177
665	650	759	125	269	329
41.4	45.3	41.9	8.8	16.8	22.4
7.8	8.0	8.2	1.5	3.4	4.9
59.5	54.9	54.8	11.0	25.6	27.8
12.2	10.4	10.9	2.41	5.22	5.56

SAMPLE NUMBERS

ELEMENT !	& UNITS !-H	132** 87-2-19**-H	133** 87-2-13**	136H** 87-2-19**	140H** 87-2-19**	147H** 87-2-13**	148H 87-2-13
AG	PPM	<5	<15	<5	<5	<34	<5
AS	PPM	33	210	89	31	330	40
AU	PPB	<71	130	34	<34	<67	<12
BA	PPM	1700	600	27000	900	<3500	20000
CA	%	<10	<3	<3	<5	<8	<1
CO	PPM	78	260	90	53	170	19
CR	PPM	6100	1400	2900	5400	2800	1700
FE	%	25.1	39.2	27.1	26.9	36.1	10.2
HF	PPM	670	120	310	900	170	100
MO	PPM	18	25	49	18	<38	<5
NA	%	0.12	0.09	0.08	0.15	0.12	<0.05
NI	PPM	1700	<600	<500	<600	<1400	<200
SB	PPM	7.2	29	6.3	2.5	13	1.1
SC	PPM	64.2	39.6	48.2	55.3	29.0	16.5
SE	PPM	<60	73	<15	<23	<44	<9
TA	PPM	53	8	6	14	22	3
TH	PPM	62	12	22	78	29	8.4
U	PPM	34.7	7.4	10.1	35.5	<9.7	4.3
W	PPM	<41	<16	<23	<27	<36	11
ZN	PPM	<310	390	240	<50	790	<50
LA	PPM	223	98	100	287	119	38
CE	PPM	423	101	221	527	122	71
SM	PPM	30.1	22.6	16.5	39.3	15.1	6.0
EU	PPM	9.0	5.7	2.9	6.3	7.7	0.8
YB	PPM	44.0	16.1	26.4	46.4	14.3	8.5
LU	PPM	8.54	3.06	4.87	9.29	2.83	1.49

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149H** 87-2-23**	163H** 87-2-19**	164H** 87-2-19**	165H** 87-2-19**	169H** 87-2-19**-H	170** 87-2-25**
<5	<5	20	<19	<15	<5
95	140	120	370	170	41
<220	200000	11000	2800	34	<35
<5700	<2100	1100	1000	<700	<2200
<41	<9	<5	<3	<5	<7
100	100	110	250	140	69
32000	22000	19000	11000	11000	15000
9.24	23.2	30.4	29.4	29.8	20.9
2500	1100	1200	760	760	1300
<5	22	<5	<5	<5	<5
<0.29	<0.11	0.10	0.09	0.13	0.15
<3900	<800	<700	<500	<600	<600
30	5.9	10	13	9.1	7.7
113	50.6	75.1	54.0	47.7	62.6
<170	<54	<31	<23	<23	<29
180	25	34	15	14	30
350	100	110	72	55	130
164	65.8	64.1	35.8	36.0	75.4
<110	<4	<19	<13	<17	<19
2600	<190	330	<130	310	380
1070	466	463	259	216	471
1400	538	833	461	298	571
118	54.8	52.0	32.2	26.0	46.2
29.0	9.5	10.7	7.2	5.7	10.1
177	62.6	67.4	42.5	39.7	75.6
34.3	11.5	13.4	8.67	8.51	15.4

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ELEMENT & UNITS	! !-H	179** 87-2-23**-H	181** 87-2-25**-H	186** 87-2-11**-H	188** 87-2-23**-H	193** 87-2-25**-H	20 87-2-1
AG	PPM	<5	59	<5	<5	<5	<5
AS	PPM	93	130	29	35	46	22
AU	PPB	<42	180000	<12	<16	<27	<41
BA	PPM	<1100	<5200	<300	900	600	1000
CA	%	<5	<16	<1	3	<4	<8
CO	PPM	85	170	33	57	33	62
CR	PPM	17000	51000	4000	1700	10000	15000
FE	%	19.6	6.58	13.6	20.7	29.4	20.9
HF	PPM	1000	3000	260	210	820	1300
MO	PPM	<5	<78	<5	<5	16	<5
NA	%	0.39	<0.12	<0.05	0.13	0.09	0.09
NI	PPM	<700	<1200	<200	<400	<400	<700
SB	PPM	9.5	4.4	2.2	1.9	5.3	4.8
SC	PPM	56.4	81.1	33.2	50.0	41.3	72.1
SE	PPM	<35	<93	20	<12	<19	<33
TA	PPM	29	62	10	11	14	22
TH	PPM	91	330	25	18	71	140
U	PPM	60.5	145	14.4	8.5	42.7	68.5
W	PPM	<20	70	11	<10	30	<23
ZN	PPM	220	440	80	80	210	<170
LA	PPM	356	1060	87	93	260	536
CE	PPM	891	1260	<3	279	484	692
SM	PPM	39.6	109	12.6	13.7	32.6	59.5
EU	PPM	11.2	18.5	3.7	4.2	5.9	10.5
YB	PPM	53.7	153	18.2	20.8	41.6	80.2
LU	PPM	11.7	31.1	3.39	3.84	8.80	15.9

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                  NUCLEAR ACTIVATION SERVICES LIMITED

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                     S A M P L E   N U M B E R S

   204**        226**        228**        244**        254**        260**
87-2-13**-H 87-2-25**-H 87-2-19**8-H 87-1-6**-H 87-2-19**-H 87-2-25**
----------------------------------------------------------------------

     <5           <5           <5           <5           <5           <5
      7           11           25            6           20          110
     <5          <19          <18           <6          <28        33000
   <200         <400          400          200         <700        <4000
     <2           <2           <2           <1           <4           <9

     15           38           57            6           52          220
   1900         4100         5500         1200        15000        15000
   5.93         18.4         19.3         1.06         16.6         13.7
    230          460          370          200         1200         2000
     <5           <5           <5           <5           <5           <5

  <0.05         0.07         0.08        <0.05         0.23         0.58
   <200         <400          500         <200         <500        <1100
    1.0         <0.6          2.4          0.8          3.0          6.3
   14.8         59.5         55.3          5.9         60.1         68.4
     <7          <15          <14           <5           79          <72

      3           19           16           16           25           34
     23           42           33           22          120          220
   13.0         12.4         18.3         11.2         73.2          126
     <9          <11          <11           <4          <14           38
     70          130           90          <50          170          340

     87          155          118           77          376          712
    156          551          417           90          673         1230
   11.5         18.6         14.7          8.4         41.0         76.3
    2.0          2.2          3.8          1.6          9.3         21.8
   13.5         33.2         26.3         11.7         69.4          107

   2.58         6.13         4.52         2.26         14.2         22.1
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                                  NUCLEAR ACTIVATION SERVICES LIMITED

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                                       S A M P L E   N U M B E R S

ELEMENT  !        264**        272**
& UNITS  !-H 87-2-23**-H 87-2-25**
---------+-------------------------
AG    PPM          <5          870
AS    PPM         120         1900
AU    PPB         <67      2100000
BA    PPM       <1600        35000
CA    %           <11          <63

CO    PPM         310         1200
CR    PPM        9300         5800
FE    %          15.2         12.0
HF    PPM        2200         1500
MO    PPM          <5         <460

NA    %          0.56        <0.44
NI    PPM       <1100        <6000
SB    PPM         6.8           61
SC    PPM        63.3         44.1
SE    PPM         <58         <400

TA    PPM           7           <1
TH    PPM         260          230
U     PPM         137          234
W     PPM          32          270
ZN    PPM         390         3700

LA    PPM        1230         1850
CE    PPM        2010         2070
SM    PPM         122          140
EU    PPM        20.6         71.7
YB    PPM         135          102

LU    PPM        27.4         16.5

                    EXPLANATION OF CODES

      VARIABLE DETECTION LIMITS DUE TO SAMPLE COMPOSITION
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