DISCOVERY OF TWO URANIUM OCCURENCES IN PALEOZOIC SEDIMENTARY ROCKS AT SOUTH MARCH, ONTARIO AND SOUTH MAITLAND, NOVA SCOTIA BY AIRBORNE GAMMA-RAY SPECTROMETRY AND COMPARISON WITH SURVEY OVER PRECAMBRIAN TERRAIN

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ASTRACT

During the last ten years approximately two million km² of Canada have been covered with Federal and Federal-Provincial airborne gamma-rayspectrometer surveys, mostly over Precambrian crystalline terrain. The resultant contour maps and profiles have been useful in defining regional radioelement patterns, geological relationships, and in outlining areas of potential uranium mineralization. Anomalies are often strong and the map patterns well developed in this environment.

A relatively small percentage of the area sureyed to date lies over Paleozoic sedimentary rocks. Although surveys over these areas do not usually exhibit anomalies with the same amplitude as over the crystalline Shield, several features of possible exploration significance have been indicated. Two of the most interesting are:

1. U-Cu horizons in Ordovician sandy dolomites near South March, Ontario.
2. U mineralization in brecciated Mississippian carbonate rocks near South Maitland, Nova Scotia.

At both localities the limited surface expression of the uranium mineralization produces relatively small and somewhat discontinuous uranium and uranium/thorium ratio anomalies.

Techniques which may help accentuate economically significant anomalies include:

1. examination of profiles and profile maps;
2. preparation of standard deviation maps;
3. preparation of maps which simultaneously illustrate K, eU, eTh concentrations.

INTRODUCTION

The purpose of this paper is to illustrate the style of radio-metric anomalies which occur over some uraniferous areas in the Canadian Precambrian Shield and to then describe anomalous patterns which had led to discovery of two type of uranium occurence in Paleozoic sediments.

The Geological Survey of Canada has been systematically collecting high sensitivity airborne gamma-ray spectrometry surveys have been described in several places (e.g. Richardson, Darnley and Charbonneau, 1975). These surveys have been useful in mapping regional radio-element distribution patterns, showing geological relationships, and in outlining areas of potential uranium mineralization (Charbonneau et al, 1976; Darnley, Charbonneau and Richardson, 1977).

Approximately 2,000,000 km² of Canada has been surveyed. Although the basic reconnaissance program calls for 5 km flight line spacing to define regional patterns (Darneley, Cameron and Richardson, 1975) some detailed surveys

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have been flown with closer line spacing in order to give better definition of patterns.

Localities discussed in this paper are: Havre St. Pierre, Quebec; Elliot Lake, Ontario; Cree Lake, Saskatchewan; and Key Lake, Saskatchewan in the Precambrian Shield; and South March, Ontario and South Maitland, Nova Scotia in the Paleozoic sedimentary environment (Fig. 1).

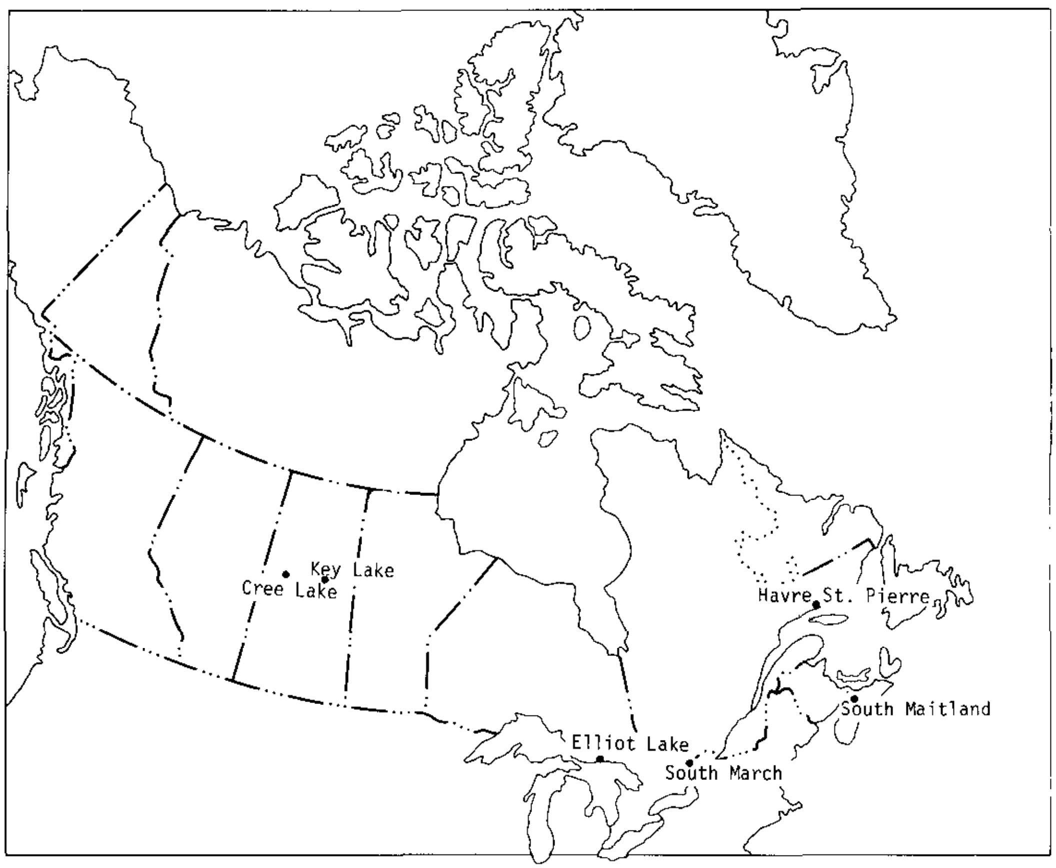

Fig. 1. Location of areas discussed in Scotia; Havre St. Pierre, Quebec; Elliot Lake, Ontario; paper - South March, Ontario; South Maitland, Nova Cree Lake, Saskatchewan; Key Lake, Saskatchewan.

Precambrian Shield

Havre St. Pierre Area

Figure 2 shows the eU distribution over an area of approximately 10,000 km² on the north shore of the St. Lawrence River in Quebec. The survey covers the Havre St. Pierre, 1:250,000 map sheet. Uraniferous pegmatitic granite occurs near Johan Beetz, in the south central part of the area. Ground to the immediate west and a linear zone to the east are also under investigation by the mineral exploitation industry. Reference to the geological map of the area (Fig. 3) shows that the most southerly of several areas of syenite and granite is most enriched in uranium. A NNE trending body to the east is also anomalous. Minor anomalous zones occur over Wakeham Bay sediments and over granite gneiss. The block outlined in the south central part of the map sheet is the area of a detailed survey flown with 1 km line spacing (Darnley, Cameron and Richardson, 1975).

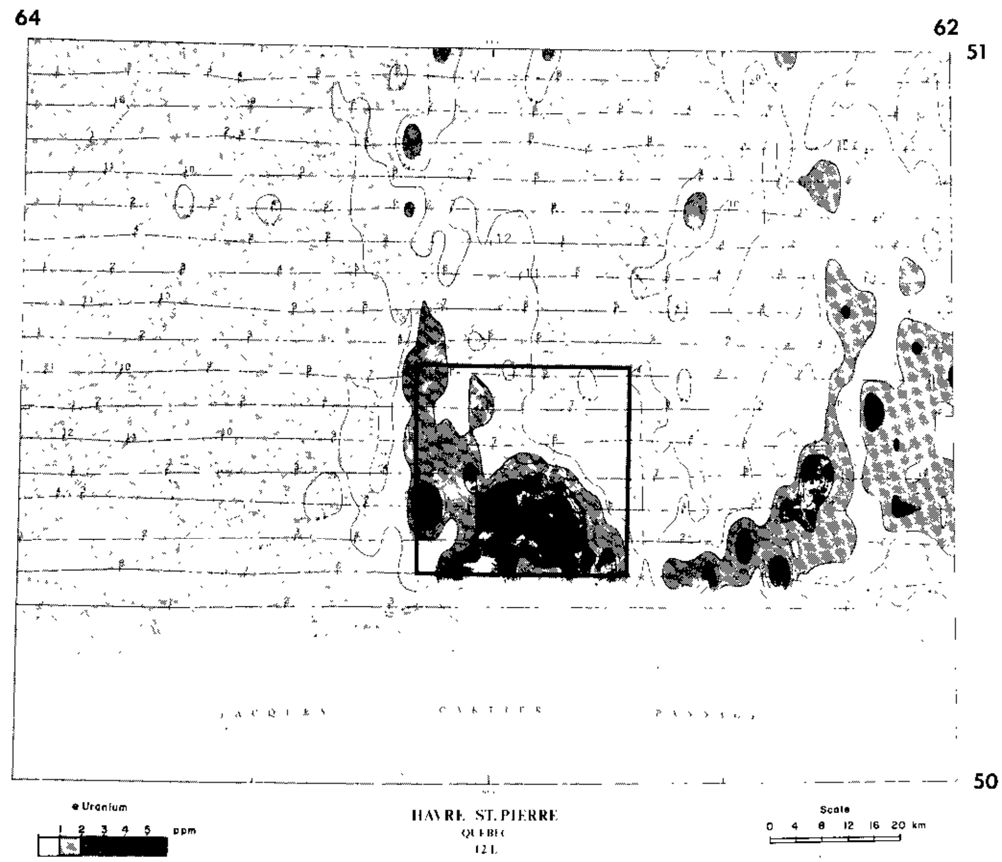

Fig. 2. Equivalent uranium map of the Havre St. Pierre area Quebec.

The Havre St. Pierre survey is an example of the effectiveness of regional radiometric surveys in outlining areas of anomalous uranium concentration. The anomalous Johan Beetz district is a comparatively isolated feature some 20 km x 15 km within the map area. Scattered ground measurements by portable gamma-ray spectrometer have yielded values in excess of 200 ppm eU. Uranium occurrences of the general "pegmatitic class"are often very well defined by regional airborne gamma-ray spectrometer surveys.

Elliot Lake Area

Figure 4 illustrates the eU distribution over a 10,000 km^2 area around Elliot Lake, Ontario. Figure 5 summarizes the geology of this survey area. This survey was flown with 5 km flight line spacing. The anomalies over the main mining areas on the north and south limb of the Quirke Lake syncline (marked "1" and "2" on Fig. 4) are influenced by mine waste. Portions of the basal Huronian away from the mining areas have anomalies in excess of 2 ppm eU and this can be considered significant. The area inside the rectangular box on Figure 4 has been surveyed in detail with 1/2 km flight line spacing, and the results in Figure 6 show the detailed correlations of airborne survey results with the geology of Twp. 155 (Robertson, 1971). The eTh map as well as the eTh/K map effectively define the Cobalt Group, Hough Lake Group, Elliot Lake Group and the Archean basement (Charbonneau, Richardson and Grasty, 1973).

However, the most prominent feature in the Elliot Lake survey (Fig. 4) is the broad band runing WNW to ESE across the top of the map

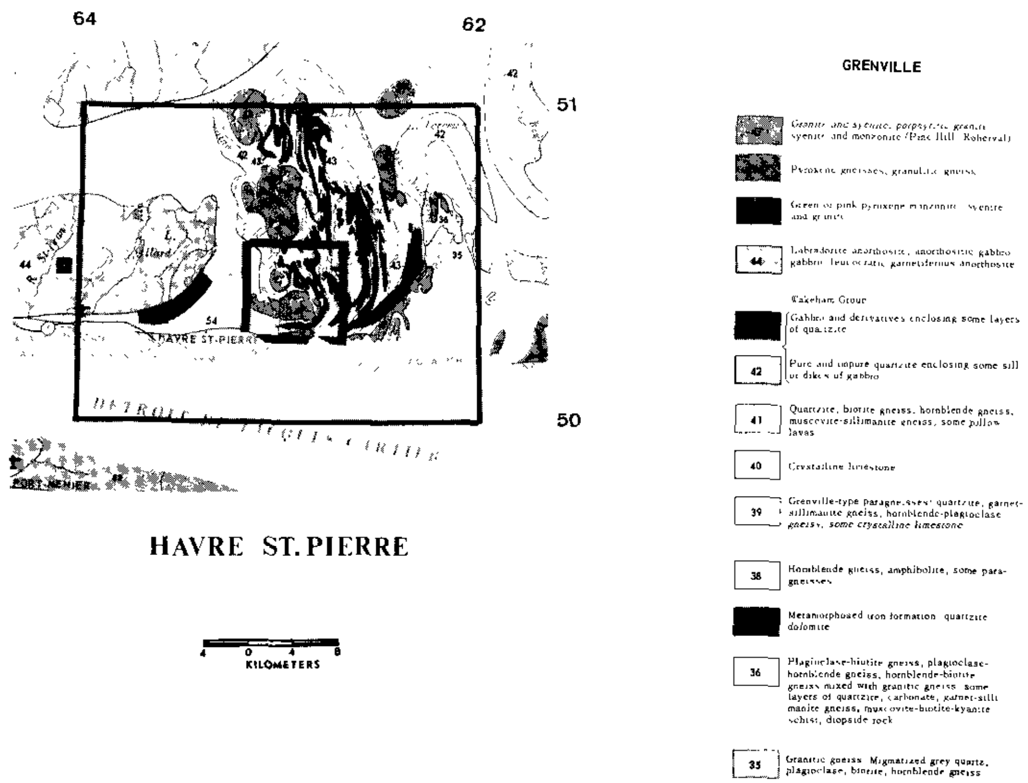

Fig. 3. *Geology of the Havre St. Pierre area Quebec.*

sheet where eU values are in excess of 3 ppm. This feature stands out prominently even on cross country profiles (Darnely, Charbonneau and Richardson, 1977). *Airborne survey results* indicate more than 1,000 km^2 with mean surface concentration greater than 3 ppm eU. A ground profile (C-D on Fig. 4) of in situ gamma-ray spectrometry measurements on bedrock shows bedrock contents of more than 10 ppm eU. This is not surprising. The measurement from the air provides an average surface concentration of radioelements for the area along the aircraft flight path. The moving aircraft covers a swath on the ground, comprising overburden, vegetation, variable amounts of water and some outcrop. For this reason the average surface concentration determined by airborne spectrometry is usually a *minimum value relating to the* concentration in overburden. The relationship between average surface concentration and the concentration in bedrock is more variable because outcrop usually constitutes only a small percentage of the area analyzed. Charbonneau *et al, 1976 investigated the* relationship between average surface concentration and bedrock concentration and found that in areas of heavy drift cover airborne values of 1-2 ppm eU generally corresond to outcrop concentrations of 4-5 ppm; airborne values of 2-3 ppm correspond to outcrop concentration of 7-8 ppm and airborn values of 3-4 ppm correspond to 10-11 ppm eU in outcrop.

Figure 7 is flight line 26 from the Elliot Lake survey. The location of this profile can be seen on Figure 4. The broad zone of uranium enrichment to the north over the granitic rocks is easily detected on the profile. Narrow zones of *high uranium concentration can be seen over* the basal Huronian (arrow). These anomalies are the features of direct economic interest.

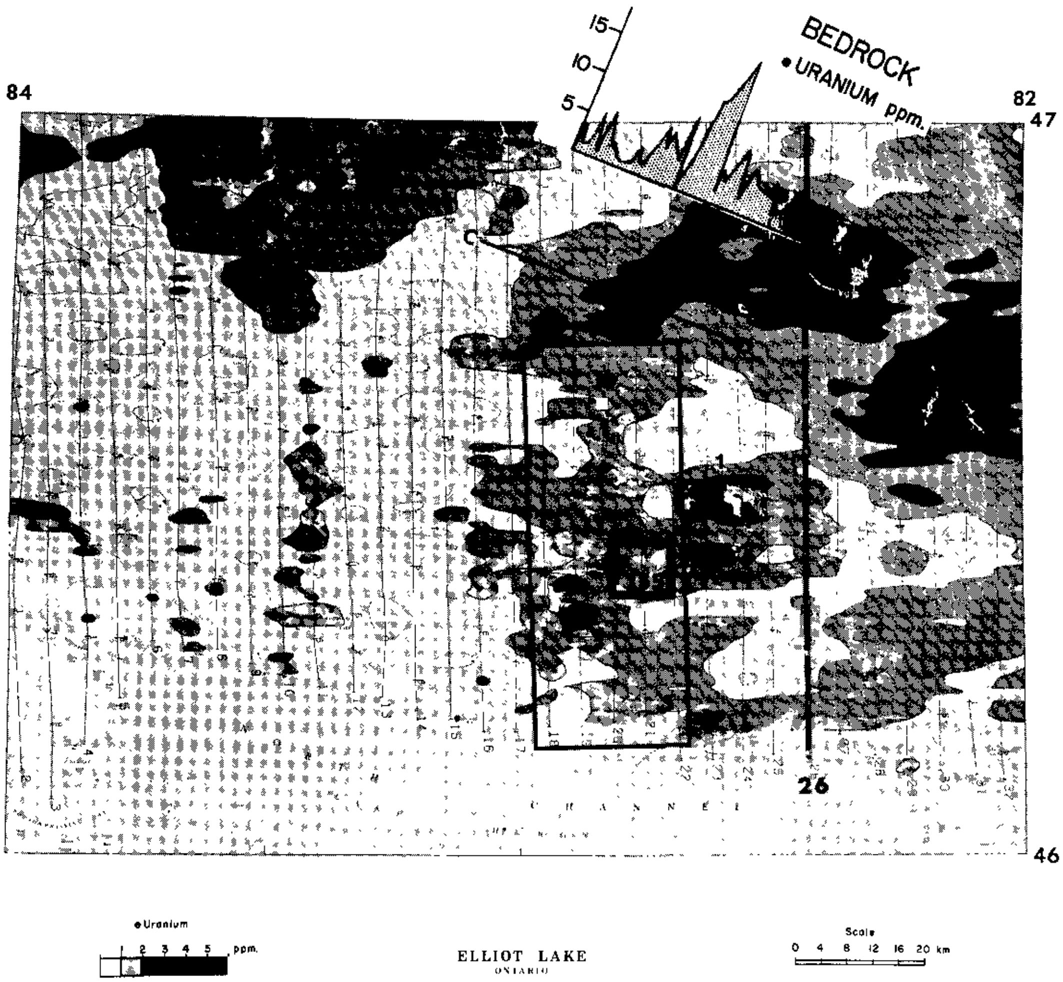

Fig. 4. Equivalent uranium map of the Elliot Lake area showing location of detailed airborne survey, Township 155 and some ground study.

Whereas the Havre St. Pierre example illustrates the localization of a uraniferous area directly by radiometric surveys the Elliot Lake example illustrates the localization of uranium deposits near an area of possible source rocks (Roscoe and Steacy, 1958).

Northern Saskatchewan

The Cree Lake area south of the Athabasca formation in Saskatchewan displays a rather uniform level of radioactivity disturbed only by small anomalies of moderate amplitude. This type of area is similar in radiometric expression to many areas of Paleozoic sediment. Such areas can be subjected to simple statistical treatment to produce computer plotted anomaly maps similar to those produced by Department of Energy in the United States (Geodata International Inc., 1975). Figure 8 illustrates such an anomaly map. Mean values of uranium were calculated for each flight line and points which exceeded the mean by 1, 2, 3 standard deviations were indicated by dots plotted along the flight line. This map (Richardson and Carson, 1976) shows prominent anomalies on several flight lines near the contact between the quartz monzonite gneiss (1) and the Virgin River Schist Group (3) as

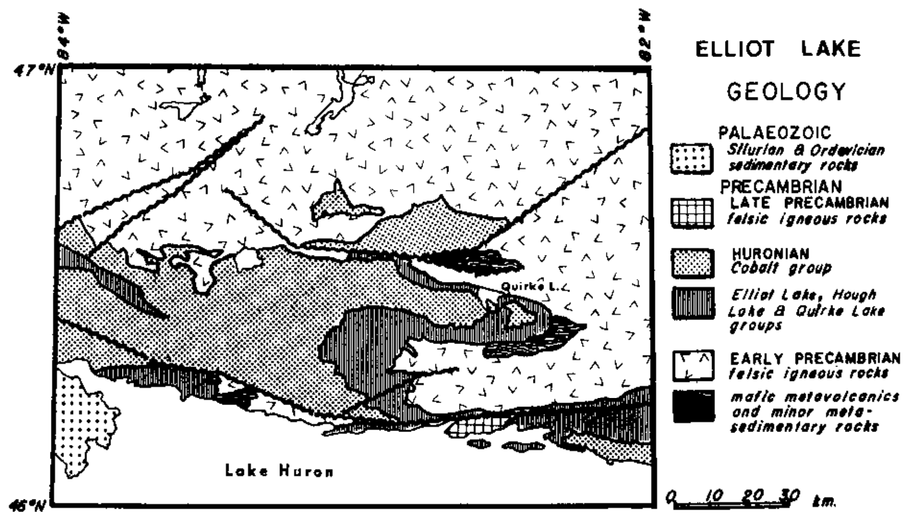

Fig. 5. Geology of the Elliot Lake area.

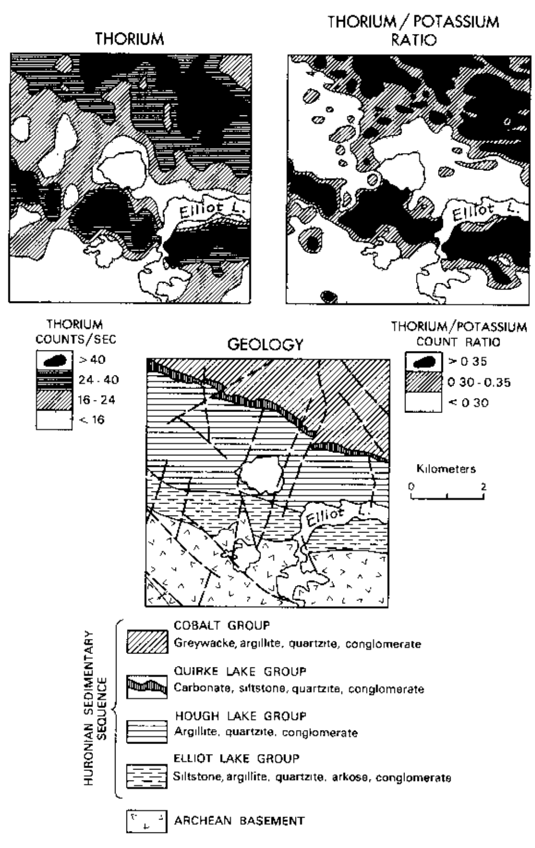

Fig. 6. Equivalent thorium map, equivalent thorium/potassium ratio map and geology of Township 155.

mapped by Jonson, 1968. A few anomalies also occur in the S.E. edge of the quartz monzonite gneiss near its contact with the biotite garnet and diorite gneiss (2) as mapped by Sproule and Downie, 1941. On Figure 8 unit 4, is mainly volcanic and unit 5 is the Athabasca Sandstone. It should be pointed out that no known uranium occurrences relate to the above anomalies.

Figure 9 illustrates an anomaly (black arrow) that is even more subtle than those described above. A small anomaly exceeds the 0.6 ppm eU contour level at Zimmer Lake, 8 km south-west of Key Lake. This anomaly relates to a boulder field containing pitchblende boulders which have been moved by glaciation from the subcrop of the rich Key Lake uranium deposit. Thus it can be seen in the Shield that uranium concentrations may relate directly to highs, may be near regional highs or in certain cases may only produce very subtle anomalies which can be only considered significant with correlative information.

PALEOZOIC SEDIMENTARY ROCKS

South March, Ontario

Initial indications of uranium-copper enrichment in the Paleozoic sediments of the Ottawa-St. Lawrence lowlands were obtained by the Geological Survey of Canada in the fall of 1972, from ground investigations of an airborne gamma-ray spectrometer anomaly (Grasty, Charbonneau and Steacy, 1973; Charbonneau, Jonasson and Ford, 1975). An

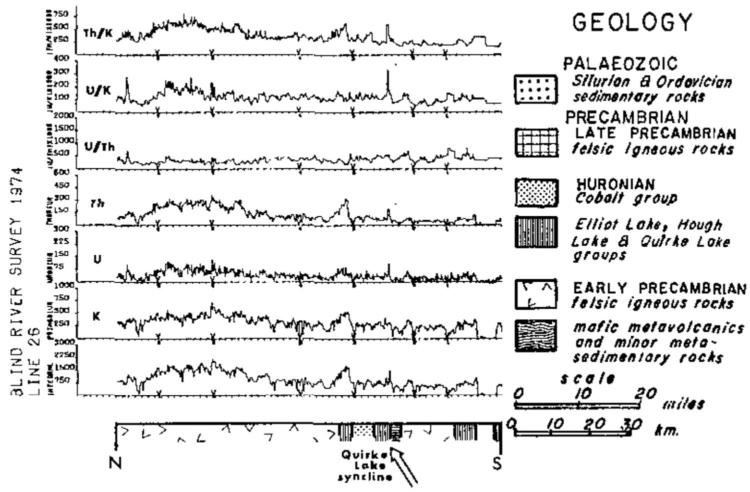

Fig. 7. Airborne radiometric profile across radioactive granites and Huronian syncline showing the broad "high" over the granites and the sharp narrow "high" over the basal Huronian sediments.

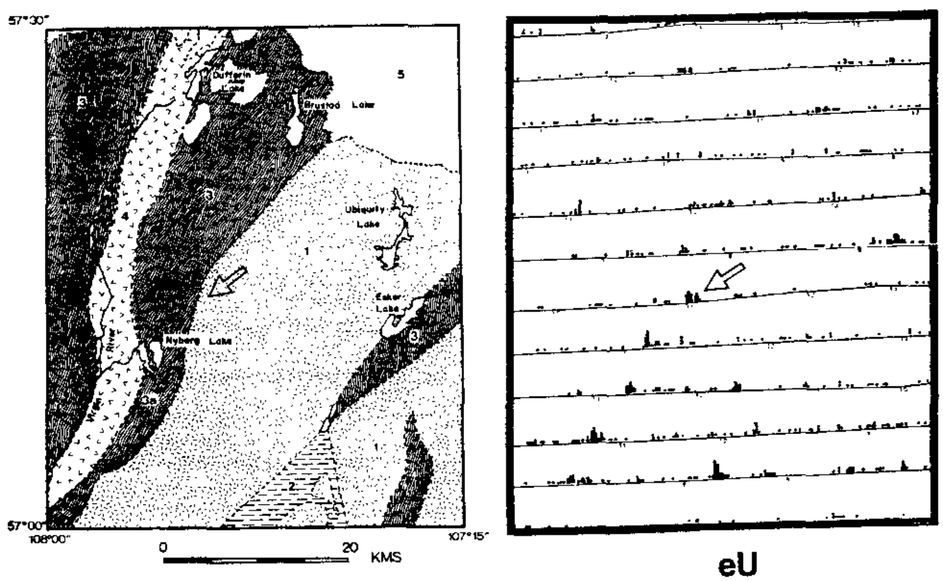

Fig. 8. Equivalent uranium profile map showing one, two, three standard deviations from line average and geology of the Nyberg Lakes area Saskatchewan.

airborne spectrometer profile showing the anomaly is reproduced in Figure 10.

The anomaly is almost entirely caused by increase in uranium concentration without increase in thorium or potassium. Anomalies in the eU/eTh and eU/K ratios are well defined.

Figure 11 shows eU and eU/eTh contour maps of the South March area, compiled from an airborne spectrometer survey with 1/2 km line spacing (Charbonneau et al, 1975). The eU map shows several small areas exceedng 1 ppm and two areas exceeding 2 ppm. The overall pattern is not well defined. The eU/eTh ratio

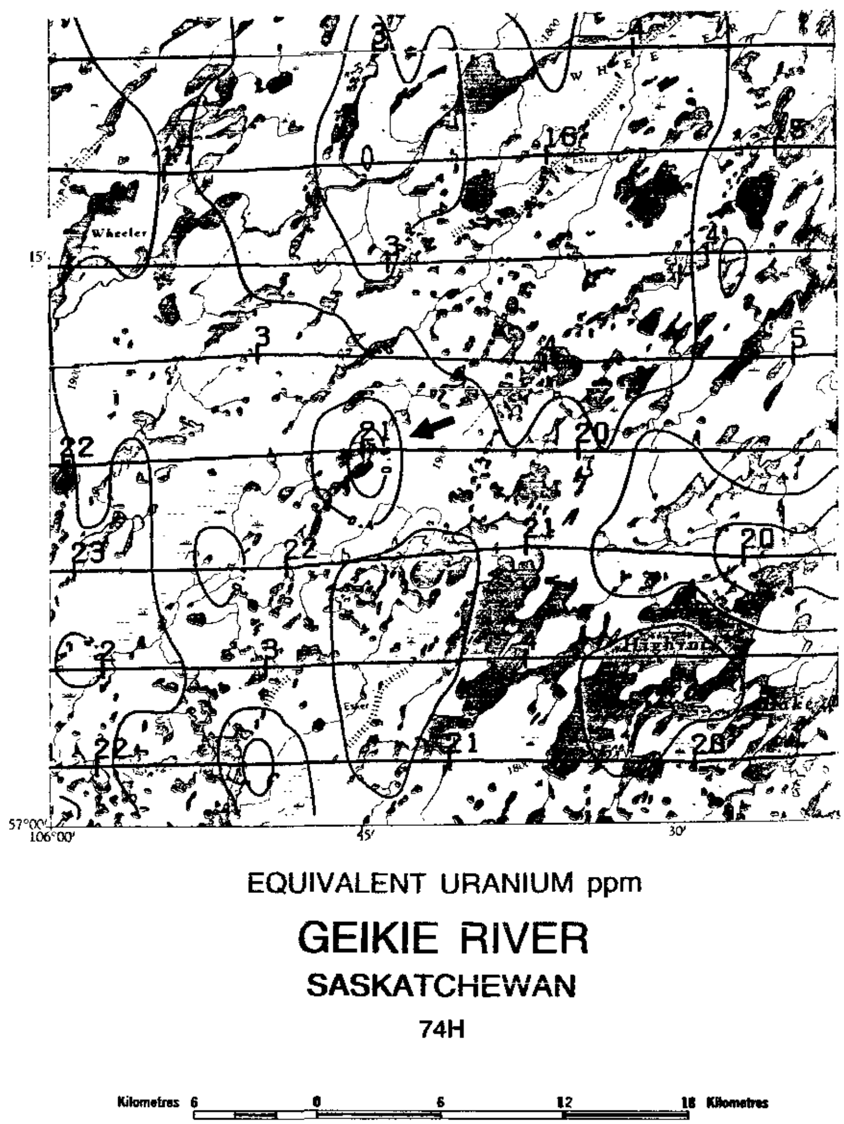

Fig. 9. Equivalent uranium map of the "Key Lake" area Saskatchewan.

map shows four areas where contour levels exceed 0.50 or twice the average crustal level (Clarke et al, 1966). The area of principal interest within the survey is outlined with a solid black line. The geology of this area compiled from Wilson (1946); Livingstone et al (1974); and Kirwan (1962) can be seen on Figure 12. This map also shows the location of known uranium occurrences and the area of a detailed ground study by Ford (1975). Anomalies at M4 and M5 have been studied by Harder (1976).

The main feature of the geology is a Pre-Cambrian spur of Grenville paragneiss and granitic gneiss within Ordovician rocks

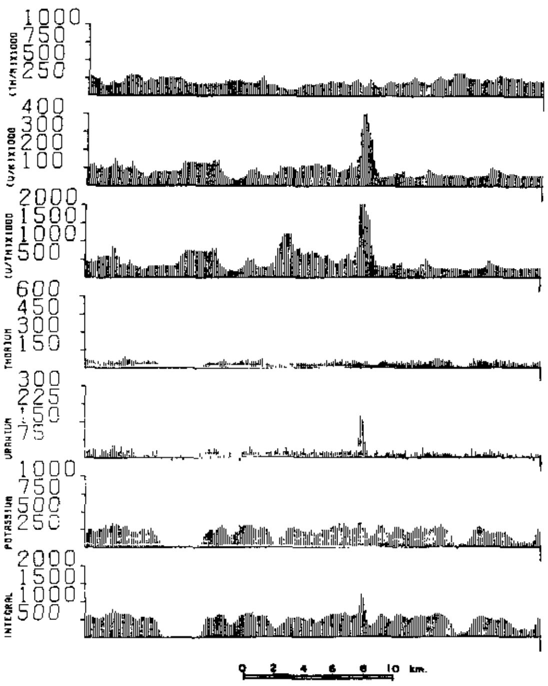

Fig. 10. Airborne radiometric anomaly across the main South March U-Cu occurrence.

comprised of the Nepean sandstone, the March sandy dolomite, Oxford dolomite, Rockcliffe shale and Ottawa limestone. The largest eU anomaly, exceeding 2 ppm, is located in the *northeast corner of the survey and corresponds* to Precambrian gneisses and syenite of the Gatineau Park. Bedrock levels of eU are substantially above average crustal values here based on measurements by the Geological Survey of Canada and these rocks could represent uranium source rocks. The sporadic eU concentration increases to the south over the Paleozoic rocks would not likely attract interest were it not for the coincidence of some of these features with eU/eTh anomalies. As a word of caution, contour maps should always be examined in conjunction with profiles because the computer processing which averages and grids radiometric data prior to contouring may effectively remove or reduce small sharp anomalies on the profiles to a level where they would be overlooked on the contour maps (Cameron et al, 1976).

Of the four areas of eU/eTh ratios greater *than 0.50 the most significant one (arrow, Fig.* 11) relates to the major exposure of U-Cu mineralization in the March formation (M3, Fig. 11). *The anomaly six kilometres to the east* (M6, Fig. 12) relates to another exposure of this type of mineralization. The elongate eU/eTh ratio anomaly to the north overlies an old Ottawa River *channel which formerly* extended from Constance Bay to Lac Deschenes (Richard et al, 1977). It is suggested that drainage of uranium and uranium decay *products may have taken place into the* material in this channel and been fixed there. It is also possible the anomaly might relate to uranium mineralization in directly underlying rocks.

On Figure 12 it can be seen that a uranium occurrence M4 and a much weaker one M5 have no evident airborne expression. Even at a line spacing of 1/2 km features of this type occuring between flight lines can be missed. At locality M1 uranium occurs as uraninite grains in black biotite in pegmatite (Lang et al, 1962). M2 is another type of uranium mineralization, with coffinite occurring in fractures extending down into the basement rocks (Ruzicka and Steacy, 1975).

Results of a detailed ground study carried out at the main showing of March Formation uranium-copper mineralization can be seen on Figures 13, 14. A grid was marked out over the area with 100 m station spacing, decreasing to 50 m spacing in the vicinity of the anomaly core. Results of ground gamma-ray spectrometry measurements made at 341 stations can be seen in Figure 13. The survey was carried out with a spectrometer placed directly on the surface. The spectrometer had a 76 x 76 mm NaI (Tl) crystal and was calibrated at the Geological Survey calibration facilities (Killeen and Cameron, 1977). All stations were taken on thin overburden. Bedrock is not exposed over the main part of the grid (March formation); there is some outcrop over the southern part of the grid (Nepean formation). Values defining the core of the anomaly were 20 ppm eU (10 times the geometric mean of all 341 stations) with maximum values at the center greater than 110 ppm eU on overburden. An area of cleared bedrock yielded a value of 250 ppm eU. The eU/eTh ratio value defining *the anomaly core is 1.5. Ratio values in the* centre of the anomaly were greater than 10 on overburden. Equivalent thorium showed no increase. A slight increase in potassium can be seen.

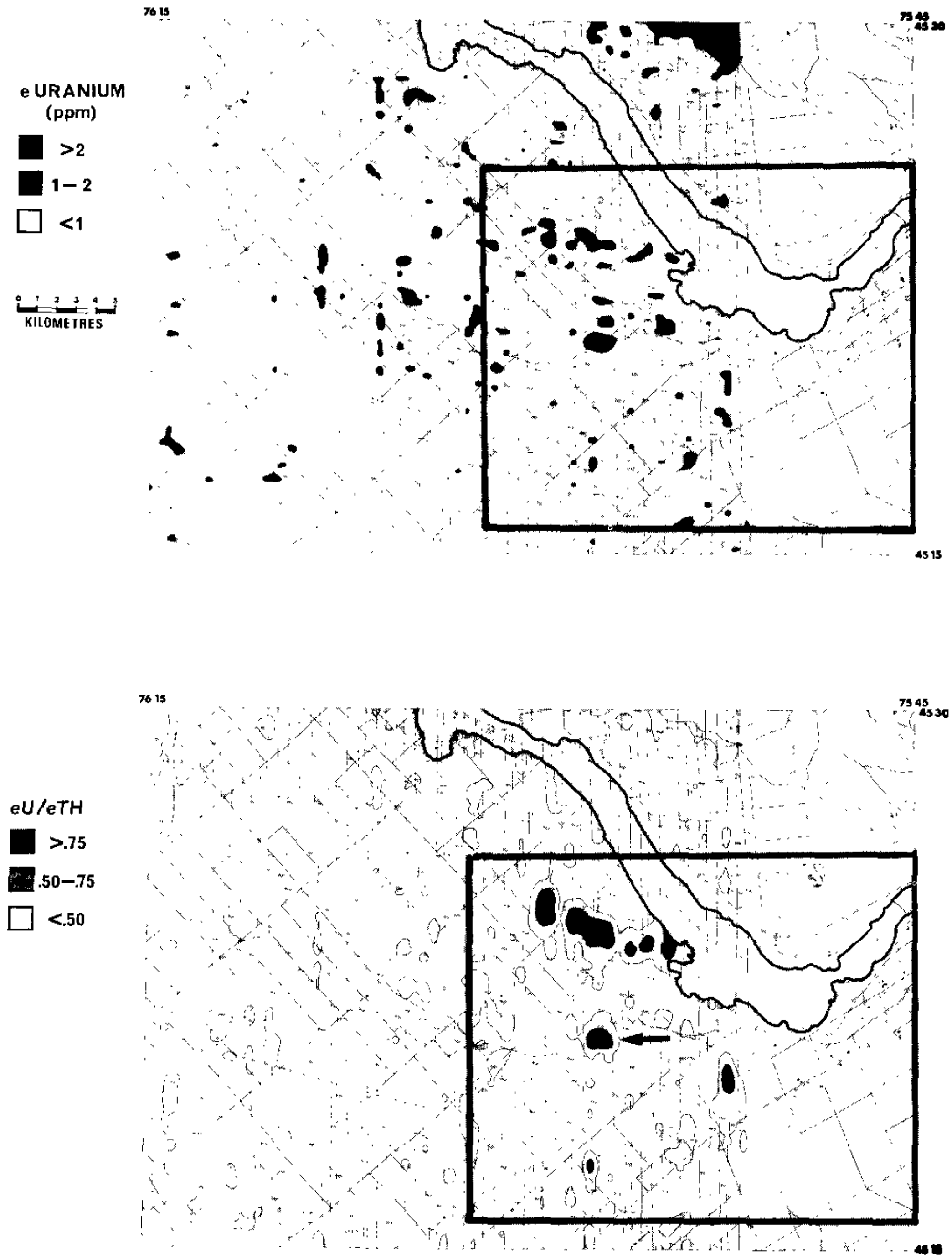

Fig. 11. Equivalent uranium and equivalent uranium/equivalent maps for the Ottawa-Arnprior area.

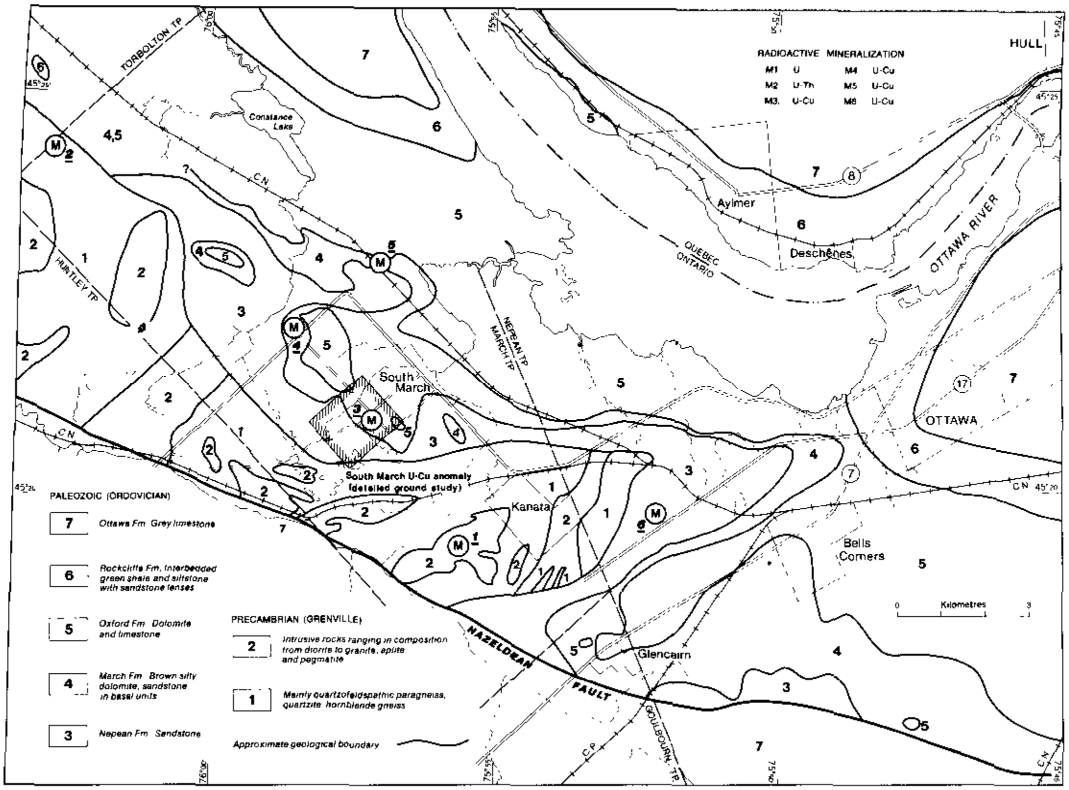

Fig. 12. South March area showing geology and radioactive mineral occurrences.

Figure 14 shows geochemial survey results. For consistency all samples were collected from the B horizon which was typically reddish brown and showed a mottling in certain parts of the study area. Average abundances of uranium, copper, molybdenum, and zinc in soils are given as 1, 20, 2, and 50 ppm, respectively (Hawkes and Webbs, 1962). The survey results clearly show anomalous levels in all but zinc with a substantial area in the core of the anomaly containing more than 20 ppm U, 300 ppm Cu and 16 ppm Mo. Maximum values measured were 250 ppm U, 3600 ppm Cu and 50 ppm Mo.

Autoradiographs of rock specimens can be seen on Plate 1. Much of the radioactivity is evidently controlled by features parallel to bedding. In other samples the radioactive mineralization is apparently more erraticaly distributed.

The March formation uranium-copper mineralization is associated with amorphous hydrocarbon (Steacy et al, 1973). The host rock of the mineralization is a marine dolomitic sandstone of the lower Ordovician March formation. In places hand specimens contain up to .05% of U and 4% Cu. Other metals as shown in table 1 are dominantly Mo but include Pb, Mn, Ag (Jonasson, Charbonneau and Ford, 1977). Measurements of elemental uranium values by delayed neutron activation are close to equivalent uranium concentrations determined by laboratory gamma-ray spectrometry indicating that overall disequilibrium in the uranium decay series is not prominent in South March occurrences.

Chalcopyrite usually occurs interstitially to quartz associated with coarse sparry calcite Plate 2 (1). The hydrocarbon material itself contains up to 4.7% uranium; thorium was not

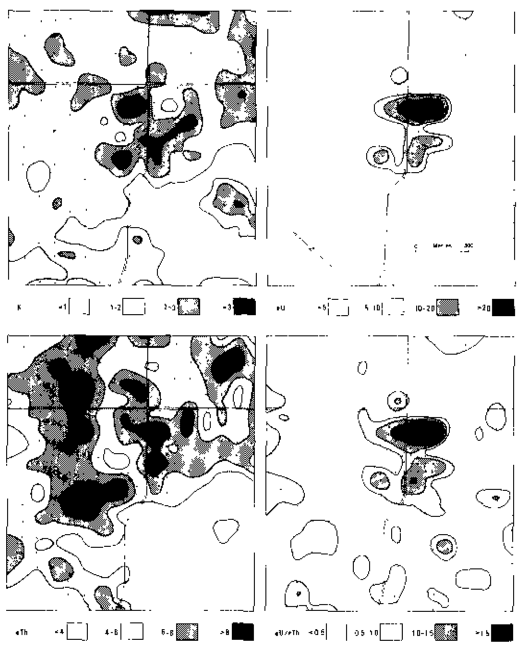

Fig. 13. Ground gamma-ray sepctrometry at the main South March U-Cu mineralization.

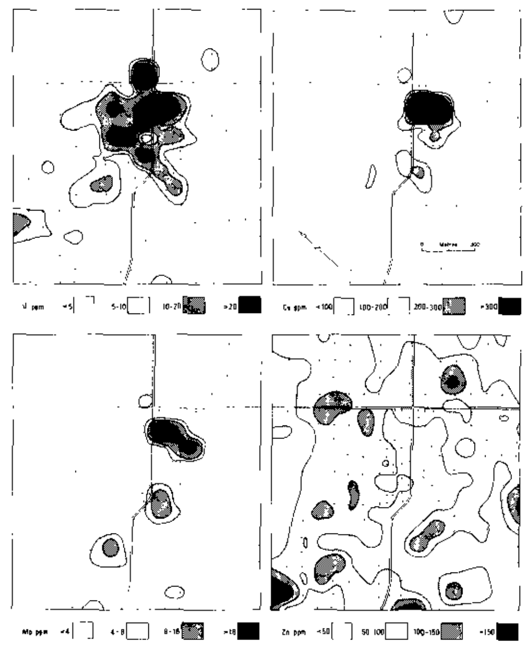

Fig. 14. Geochemistry at the main South March U-Cu mineralizatio n.

detected; Cu, Ca, Fe, Si, Ti are comon constituents (Ford, 1975). Hydrocarbon occurs as irregular grains and as seams on parting planes within the carbonate sediments and within interstices between quartz grains. Rarely uraniferous hydrocarbon can be seen intergrown with pyrite Plate 2 (2).

Specimens of radioactive hydrocarbon have also been found in vertical fractures in the overlying Oxford formation in close proximity to U-Cu showings in March formation. Electron microprobe analysis revealed the main mass of the hydrocarbon material was homogeneous hydrocarbon containing 5% Ca, minor Cu, Fe, Ti, Si, Mg and Sn (Jonasson, Charbonneau and Ford, 1977).

The U-Cu occurrences found in the March formation are considered to be of epigenetic origin (Steacy et al, 1973; Jonasson et al, 1977). The original source for the humic material may have been from within the March formation. The time of emplacement is in some doubt but the material introduced into overlying Oxford formation dolomites may be somewhat later than the blanket-like deposits in the March formation. The regional distribution of these occurrences as revealed by drilling results kindly provided by the Kerr Addison Company suggests that certain thin rubbly intraformational strata may be host to the mineralization over a wide area. These strata may represent ancient aquifers. It is postulated that the deposits were formed by transportation of U-Cu material in a humic-fulvic complex into the sediments (Jonasson, Charbonneau and Ford, 1977). The ability of humic-fulvic complexes to dissolve silicates as indicated by the texture in Plate 2 (3) has been demonstrated (Huang and Keller, 1972). The March formation is the focus of interest for an unusual style of U-Cu mineralization.

South Maitland, Nova Scotia

During 1976 gamma-ray spectrometry surveys were flown over southern Nova Scotia (Geol. Surv. Can. Geophysical Series map 35121G; and Open Files 466, 467, 468). The location of the survey covering the

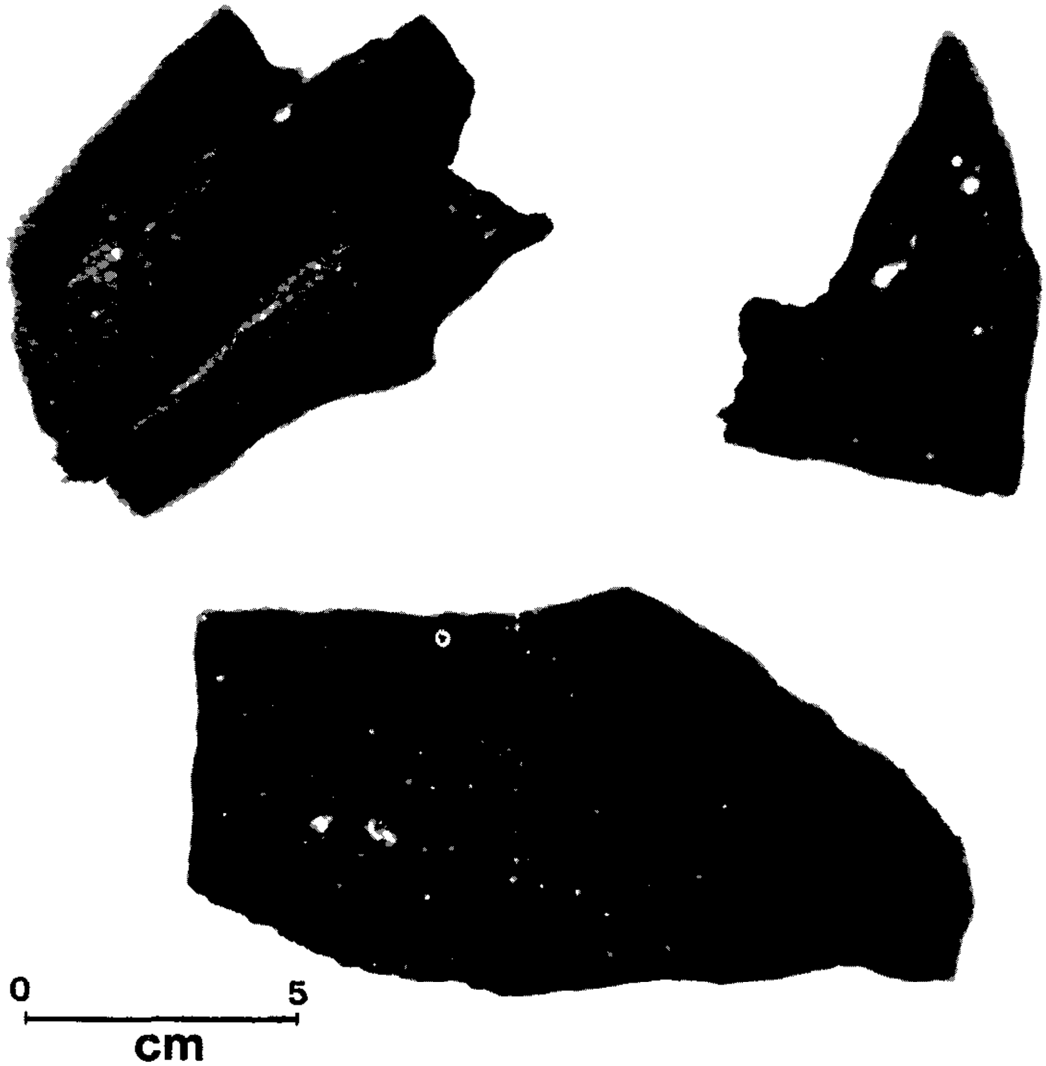

Plate 1 — Autoradiograph of three samples of South March mineralization.

Sample	Fe%	U%	Zn	Cu	Pb	Ag	Mo	Mn
1.	3.61	0.02	66	3200	91	4	27	1850
2.	1.54	0.01	11	320	17	1	3	600
3.	1.25	0.01	13	420	50	5	40	650
4.	1.63	0.02	25	2300	330	5	120	1070
5.	2.77	0.01	47	1500	120	5	87	1230
6.	2.23	0.02	20	790	340	36	77	1460
7.	4.41	0.04	40	4900	720	44	110	2720

Table 1 — Metal content of typical South March material.

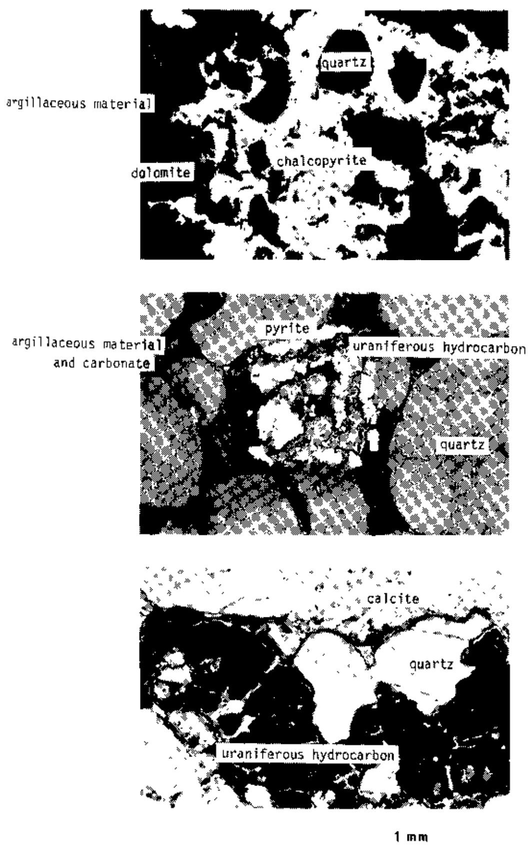

Plate 2 — Three photomicrographs of South March mineralization.

Kennetcook 1:50,000 scale map sheet with 1 km line spacing is outlined (A) on Figure 15. The survey covers part of the Windsor basin just west of Truro, Nova Scotia and extends as far north as the Minas Basin. The geology of the area as published in 1965 by the Nova Scotia Department of Mines is shown in Figure 15. The airborne gamma-ray spectrometry survey, released in September 1977 as GSC Open File 467, contains initial results of a ground study made during the summer of 1977 (Charbonneau and Ford, 1977).

The Kennetock airborne gamma-ray spectrometer survey results in Figure 16 reveal
1 the presence of several areas exceeding 2 ppm
eU. Ratios of eU/eTh greater than 0.5 or more
than twice average crustal eU/eTh ratio are
evident. Such an increase in eU and in eU/eTh
ratio may indicate a zone of uranium
mineralization. Three of these ratio anomalies
(Area B Fig. 15, 16) correlate with the base of
the Marine Mississippian Windsor Group
which overlies continental Horton Group
sandstone and shale as mapped by Weeks
(1948) and Stevenson (1959). This correlation
2 was particularly evident between Five Mile
River and Noel Lake. The relationship of the
eU/eTh ratio anomalies to the Windsor-Horton contact can be seen more clearly as Area
B on Figure 17 (Charbonneau and Ford,
(1977).

In order to gain an understanding of the
significance of these features an anomaly was
investigated in detail in the Five Mile River
3 area west of South Maitland, Nova Scotia. At
this locality access was reasonably good, the
surface relatively undisturbed and some

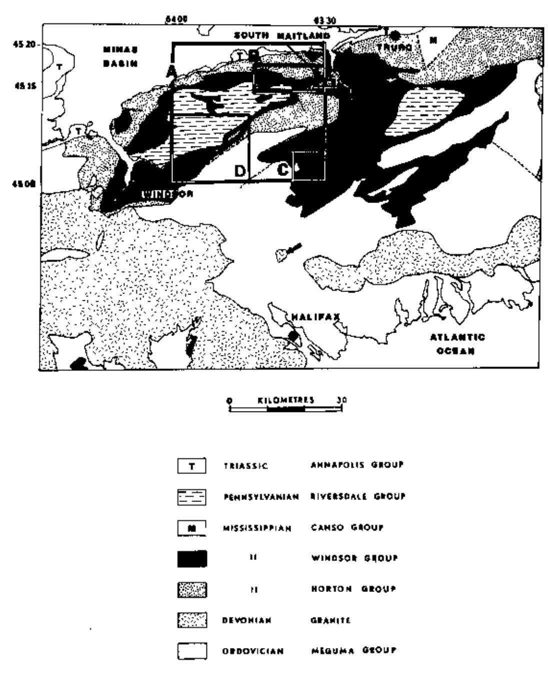

Fig. 15. Geology South Maitland area Nova Scotia showing the location of detailed study areas.

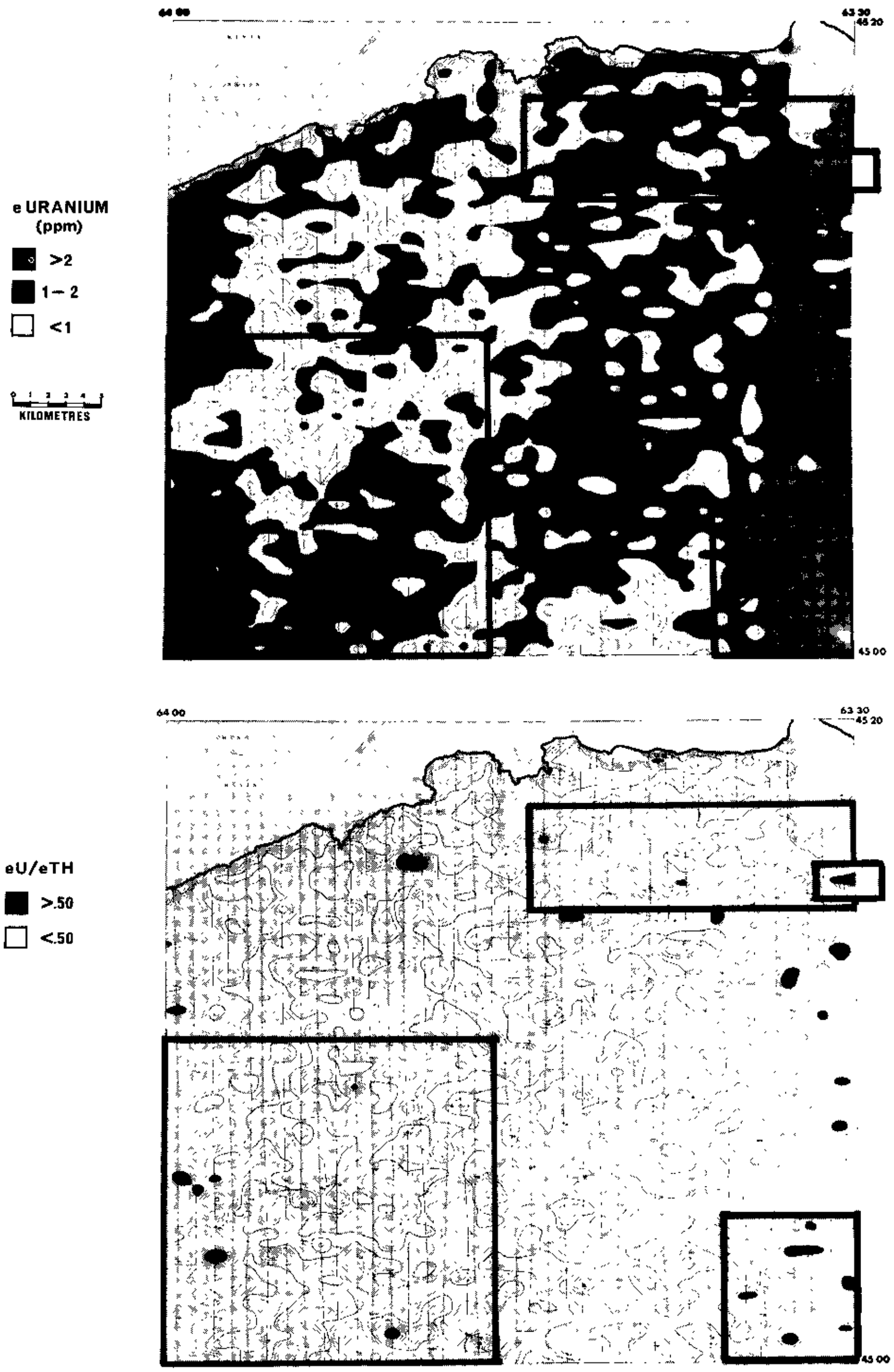

Fig. 16. Equivalent uranium and equivalent uranium/equivalent thorium ratio for Kennetcook map sheet showing locations of detailed study areas.

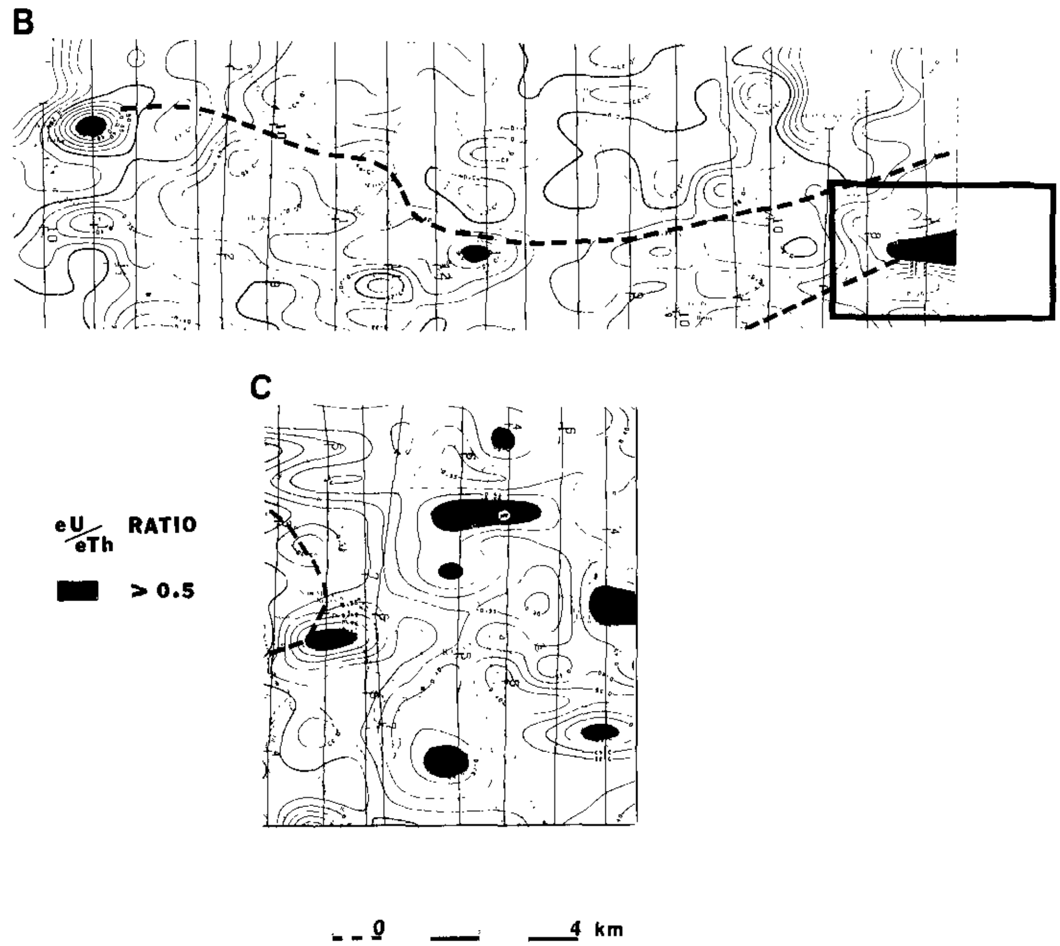

Fig. 17. Equivalent uranium/equivalent thorium ratio map in areas of interest.

outcrop was exposed along the river and adjacent slopes. The location of this anomaly, which is on the south limb of a syncline can be seen on Figures 15 and 16 as the small rectangle inside area B. An airborne profile over the mineralization (Fig. 18) does not show a particularly strong anomaly (arrow near fiducial 1). This is because of relatively thick overburden over much of the anomaly. In contrast the South March mineralization which is overlain by very thin overburden is marked by a prominent profile anomaly (Fig. 10). The South Maitland anomalies were considered significant because the contour maps indicated the correlation of anomalies with a particular geological horizon.

Figure 19 shows the location of ground gamma-ray spectrometry and scintillometry traverses with 50 metre station spacing. Readings were taken with the detector on the ground. The location of the 2 ppm eU contour from the airborne survey is also shown.

Uraniferous rocks were restricted to a relatively thin horizon composed of the Pembroke formation limestone conglomerate and brecciated Macumber formation laminated carbonate (Weeks, 1948; Stevenson, 1959). Since no consensus exists as to the absolute criteria for separating brecciated Macumber formation from Pembroke conglomerate the two units have been grouped as basal Windsor

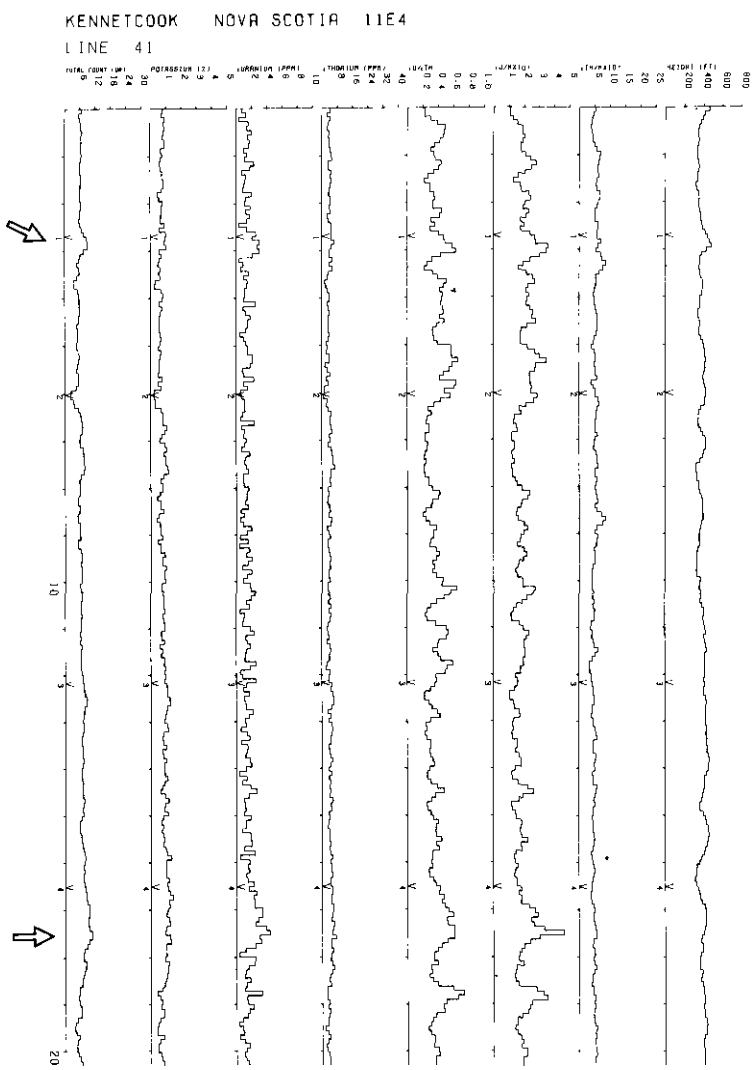

Fig. 18. Airborne radiometric profile across South Maitland mineralization.

on Figure 19. In this area it would appear that the mineralized rocks lie between the Horton sandstone and shales which have uniformly low uranium content in this area and the evaporitic sequences above the Pembroke-Macumber which are again uniformly low in uranium. The mineralized horizon appeared in all exposures to be grey to grey-brown. Characteristically a fetid gas smell was noticed when the rocks were struck with a hammer.

Radioactive spots with scintillometer readings exceeding 200 ur (units of radioelement concentration, as defined by IAEA, 1976) or approximately ten time the average surface values were noted at eight localities in a zone about 100 m wide and 2 km long. The nature of the mineralization is spotty but the distribution of U symbols on Figure 19 shows the stratigraphic restriction to the basal Windsor. All of the U symbols are on bedrock.

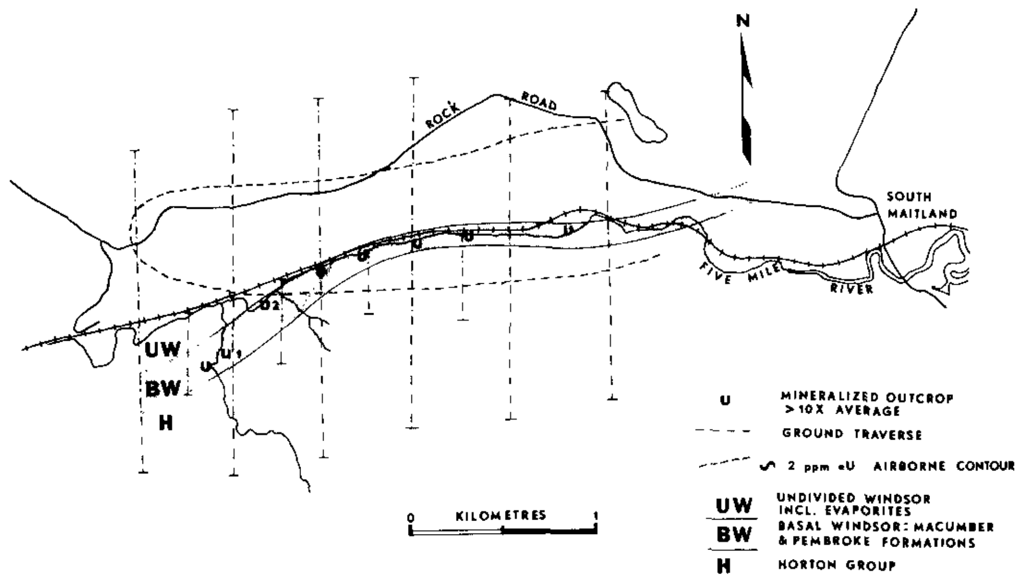

Fig. 19. Ground study at South Maitland, Nova Scotia.

Equivalent uranium values >100 ppm were noted at two localities, U1 and U2, near the western extremity of the anomaly. The uranium mineralization is best exposed at locality U1 in a cut formed by a creek flowing into Five Mile River. More highly radioactive material than the above can be found in float slabs near U1.

Sample material from U1 gave a laboratory gamma-ray spectrometry determination of 150 ppm eU and sample material from U2 gave 425 ppm eU. The average of four delayed neutron activation uranium determinations was 32 ppm for locality U1 and 135 ppm uranium for U2. The difference between the radiometric and elemental uranium values indicates significant disequilibrium in the uranium decay series in this uranium occurrence. Disequilibrium of this type with relatively large amounts of decay products relative to parent uranium probably results from uranium leaching (Rosholt, 1959).

Table 2 illustrates the typical metal content of South Maitland material after Charbonneau and Ford (1977) with additional analyses for P, Mo, V, Se included. U, Pb, V and Se are present in anomalous concentrations. The metal association suggests an oxidation-reduction mechanism for the formation of these deposits (Harshman, 1974); possibly gas was part of the reduction mechanism (Adler, 1974).

Element	PPM
Mn	690
P	400
Fe	6629
Co	18
Ni	23
Cu	115
Zn	18
Ag	—
Pb	171
Mo	37
V	110
Se	50
U	135 (Neutron Activation)
U	425 (Radiometric)

Table 2 — Typical metal contents of South Maitland mineralization.

An autoradiograph of a mineralized specimen can be seen on Plate 3 and a photomicrograph showing breccia fragments of Macumber formation is shown in Plate 4. The conglomerate clasts (Plate 3) are rimmed by increased radioactivity. Some clouded areas on the autoradiograph suggest dispersed

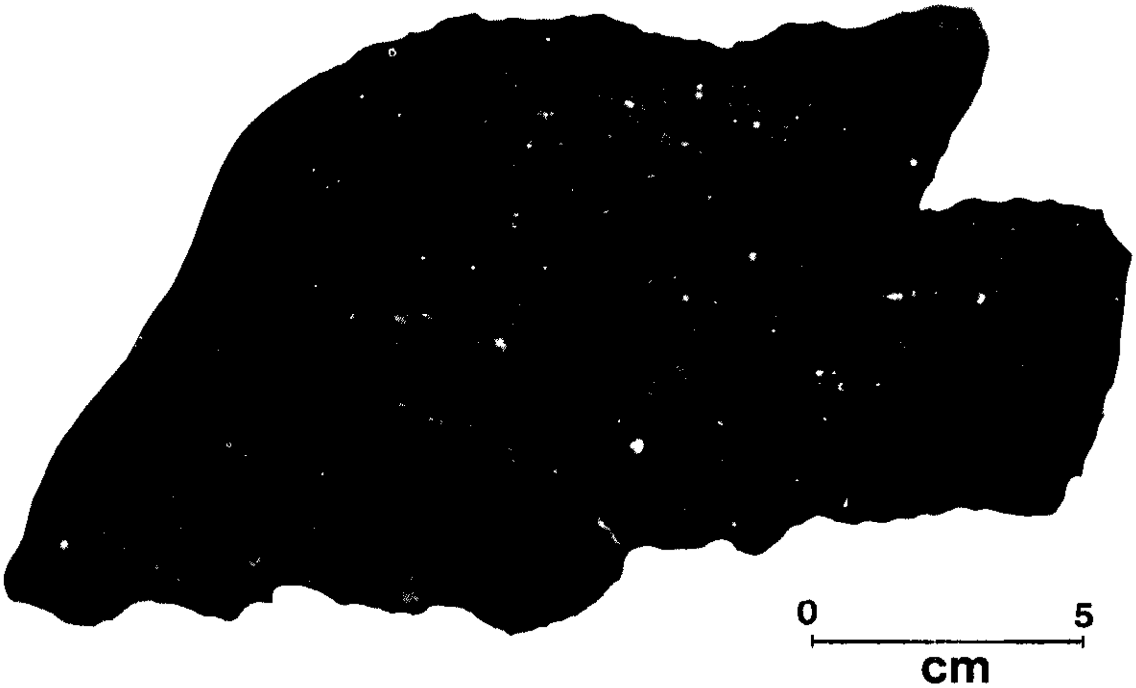

Plate 3 — Autoradiograph of South Maitland, Nova Scotia mineralization.

uranium. Uranium mineral species were not identifiable by electron microprobe and scanning electron microscope analysis, nor did microprobe investigation of highly radioactive spots indicated by the autoradiograph show any appreciable uranium concentration. Apparently these spots represent concentrations of uranium daughter nuclides and the uranium is dispersed in the rock.

Minor increases in radioactivity to about 60 ur were noted in overburden near Hardwood Lands in the southeast corner of the Kennetcook survey (area C on Fig. 15). Anomalous eU/eTh ratios (>0.5) can be seen on Figure 16 and on profiles, for example, Figure 18 near fiducial 4. This area is underlain by rocks of middle-upper Windsor Group suggesting that uranium ocurrences may exist higher in the section than the basal Windsor. Airborne radiometric anomalies similar in appearance to those over the basal Windsor are also found over the Ordovician Meguma Group and some weakly radioactive samples were found during field investigations. This material is associated with gold mineralization in quartz veins in Meguma rocks.

Large airborne radiometric anomalies (Geol. Surv. Can. Open File 468) which exist in the Uniacke sheet to the south of the Kennetcook

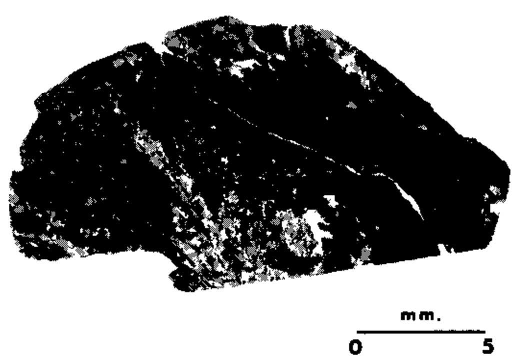

Plate 4 — Photomicrograph of sample of mineralized rock showing extreme brecciation.

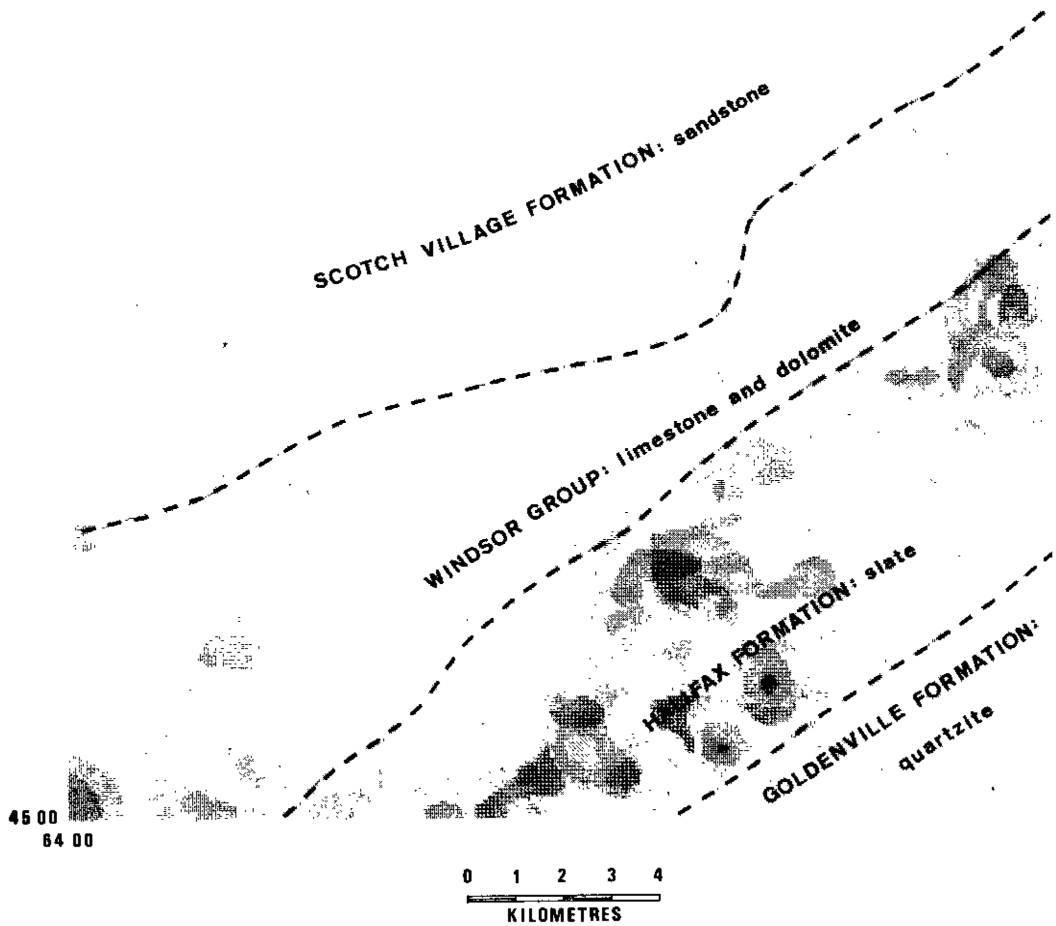

Fig. 20. Three component K, U, Th map of southwest part of Kennetcook map sheet.

sheet relate to the presence of muscovite-biotite "two mica" granite. These rocks could be source material for the uranium occurrences at the basal Windsor. A traverse across the small granitoid body (arrow Fig. 15) indicated an eU concentration of 6 ppm eU with eU/eTh ratio of aproximately 2. There is the possibility that the two mica granites themselves could host uranium mineralization in fracture zones as is the case in France.

Dunsmore (1977) has suggested that the evaporitic rocks in the area could be source rocks. The Halifax formation slates which are anomalously radioactive are another possible source rock.

Thus the Windsor-Horton contract presents an interesting environment for uranium exploration, but only extensive examination will permit an uranium assessment of this horizon.

Figure 20 illustrates a technique which has recently become available. By means of a computer controlled colour plotter concentration levels of potassium, uranium and thorium can be displayed simultaneously with increasing tone-density of three primary colours yellow, red, blue corresponding with increasing element concentration. Multi-colour maps can then be produced with the colours and intensities depending upon the proportions and concentrations of the radioelements. The area shown in Figure 20 is part of the Kennetcook survey (area D Fig. 15). In grey tones it is not possible to capture the full range of hues which can be seen on the coloured map which shows a clear subdivision of geologic formations as well as higher equivalent uranium and eU/eTh ratio spots in the Windsor Group which may have some exploration interest. This type of map display because of the three primary colours and three radioelements potassium, uranium, thorium seems inherently suited for application to gamma-ray spectrometry and should find wider application in the future (Newton and Slaney, 1978).

Conclusions

The discovery of the two paleozoic uranium occurrences reported in this paper serves to illustrate the unexpected locales for uranium mineralization which may prove significant in the future. If regional radiometric and/or geochemical coverage is applied to relatively unpromising terrains many other potential exploration environments may be uncovered.

Acknowledgements

The authors gratefully acknowledge the assistance of many individuals in the Geological Survey of Canada. In particular P. B. Holman and W. G. Hyatt for airborne gamma-ray spectrometry survey operations and map compilation; J. W. Kempt for autoradiographs and A. E. Whitehead for polished thin sections; A. G. Plant and H. R. Steacy for mineral identification and Miss M. Scott for manuscript preparation. The paper was critically read by A. G. Darnley and K. A. Richardson.

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