Recent Developments in Uranium Exploration in British Columbia

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ABSTRACT

Improvements in uranium prices and an outlook for strong demands has stimulated new interest in the uranium potential of British Columbia. Exploration activity is again at a high level with areas known uranium prospects providing targets for prospecting efforts. The geological and geochemical settings of known uranium occurrences are reviewed with emphasis on (1) hydrothermal uranium minerals in pyritized tuffs at the Rexspar property near Birch Island and (2) secondary minerals in unconsolidated fluvial sediments that underlie plateau basalts in south central British Columbia (Pb, Fuki, Donen).

An outline of the distribution of uranium occurrences in British Columbia and a classification of deposits in terms of geological setting, age and origin are presented. Geochemical associations and pathfinder elements for uranium are reviewed.

PART 1 GEOLOGICAL SETTING

INTRODUCTION

The widespread distribution of radioactive occurrences in British Columbia is demonstrated by figure 1. The apparent concentration of occurrences in south-central British Columbia is overemphasized by greater intensity of exploration with recent activity stimulated by the discovery of basal type uranium mineralization below Tertiary plateau basalts in the Kelowna-Beaverdell Area. The setting of recent discoveries indicates the difficulty of directing prospecting efforts for highly mobile uranium. The following statement from lecture notes on prospecting for uranium (presented in Vancouver in 1955), "The most definite advice that can be given is where not to seek uranium ore. Uranium would not be found in the lava fields of the interior....", emphasizes the difficulty of directing exploration.

The best direction for further uranium exploration is provided by an understanding of the setting and distribution of previous discoveries. While examining similar settings, other possible traps should be explored. This paper attempts to familiarize the prospector with the geological setting of known radiometric occurrences by updating the status of uranium exploration in British Columbia.

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Distribution and Type of Deposits

Figure 1 summarizes the distribution and types of radiometric occurrences in British Columbia. Table 1 summarizes the type, setting and age of mineralization. A comprehensive list of references with short descriptions of each occurrence accompanies B.C.D.M. preliminary map No. 22 (Christopher, 1976).

Deposits are classified according to form or type of host. Most of the occurrences are either late Mesozoic or Cenezoic pegmatite deposits generally found in metamorphic complexes of unknown age. Deposits related to suspected carbonatites are believed to be either Paleozoic or Precambrian. Known reserves are small and occur mainly in stratabound deposits at Rexspar and in basal type in mid or late Tertiary sediments. A short description of each type of deposit follows.

Pegmatites

Pegmatites occur mainly in the southern part of the Omineca Belt. Similar occurrences have probably been found further north in the Omineca Belt but have received little attention because of their remote location. The largest concentration of reported pegmatite occurrences is in the Grand Forks-Nelson area near the SD prospect (#1 figure 1 receiving most of the recent interest.)Large open pit potential has been suggested for this type of deposit but small bonanza deposits or reconcentration into secondary deposits are more likely.

Tabular Deposits

Tabular deposits are divided into 1) veins, 2) fissures, 3) shears, 4) dikes and 5) seams. Many of these occurrences have received attention because of the presence of gold, silver, cobalt-nickel sulpharsenides, molybdenum and tungsten. Uraninite-bearing polymetallic veins occur in the Rocher Deboule Range near Hazelton and in the Bridge River - Lillooet area. Fissure and shear occurrences are associated with molybdenum and tungsten prospects in Nelson and Coryell intrusive rocks in south-central British Columbia. The possibility of by-product uranium with molybdenum and tungsten deposits should be tested.

The polymetallic veins contain significant gold as well as uranium, silver, tungsten, and molybdenum. With the increased price of these metals, the polymetallic veins warrant examination as small, high value per ton operations.

Disseminated Uranium Deposits

Disseminated uranium mineralization is known to occur with some molybdenum deposits. The Coryell intrusives, Bugaboo stock, and Horsethief stock represent high background granitic rocks in southern British Columbia. Sutherland Brown et al. (1971) suggested that many younger granitic intrusions in northern British Columbia are known from airborne geophysical surveys to have above-normal levels of radioactivity. The possibility of secondary enrichment of high background granitic rocks or of forming contact deposits (eg. Midnite Mine) is intriquing.

Carbonatites

The association of uranium with carbonatites is well known. Probably the best known carbonatite, Palabora, was initially explored for uranium. In British Columbia carbonatites appear to occur near the Rocky Mountain Trench. The Ice River complex and Lempriere (Verity, Paradise), Lonnie? and Virgil? prospects have been refered to as carbonatites or possible carbonatites. Carbonatites in the Frenchman's Cap Gneiss Dome have been described by McMillian and Moore (1974) and McMillian (1970). Additional exploration attention to carbonatite related deposits is warranted.

Skarn or Contact Deposits

Although only a few uranium occurrences in British Columbia are considered to occur in skarns, some of the occurrences classed as carbonatites may actually represent dolomitic limestone horizons, and the Midnite Mine in Washington has significant amount of uranium mineralization in a skarn or lime silicate horizon. Where high background granitic rocks are incontact with sediments, the contact zone may provide a favourable trap.

Black Shale and Phosphate Deposits

In the United States uraniferous phosphatic deposits are known to occur in the Phosphoria (Permian) formation of Idaho and the widespread Chattanooga shale (basal Mississippian and upper Devonian) provides a good example of a radioactive black shale. In British Columbia the Eastern

Marginal Belt contains similar formations worthy of examination either for their uranium content or as source beds for secondary or regenerated deposits. The Montney formation (Triassic) in northeastern British Columbia contains radioactive black shales as well as phosphate horizons and several phosphatic horizons in the Fernie fromation (Jurassic) in south eastern British Columbia have previously been examined as uranium prospects. The Exshaw shale (basal Mississippian) has widespread distribution and is identified by high gamma ray background in well logs. The Klua Creek (mid Devonian), Muskwa (early upper Devonian) and Norddeg (lower Jurassic) are black shale horizons in northeastern British Columbia that give similar high gamma readings.

The Klua Creek is a black shale horizon in a reefal environment. In northeast British Columbia and adjacent areas, porous sections of reef environments have been extensively explored for epigenetic mineral deposits. Metal rich shale horizons have often been suggested as source beds for metals deposited in the reef environment. The possibility the uranium migrated with other metals to the same or similar traps should be tested.

Placers

The distribution of uranium mineralization in placer deposits has lead to the location of high background intrusive bodies. Most of the known uranium bearing placers occur in or near the Rocky Mountain Trench and reflect concentrations from alkaline stocks and carbonatites.

Stratabound Uranium Deposits

The Rexspar deposit and Fuki, Donen Pb etc, basal type uranium deposits in the Kelowna-Beaverdell area are stratabound occurrences. The Rexspar deposit is well known and has been explored intermittently since 1918 with uranium first detected in 1949. The Fuki outcrop was discovered in 1968 using a car-borne scintillometer survey with geological, geochemical, geophysical surveys and diamond drilling leading to the discovery of the Donen and Pb deposits.

Basal type uranium deposits are wide-spread in Tertiary formations of Japan (Katayama and Kamiyama, 1976) with the Tono (about 10.9 million tons @ 0.054% U_3O_8) and Ningyo-toge (about 5 million tons @ 0.050% U_3O_8) mines the largest deposits (Kamiyama, 1974). In Washington the Northwest Uranium (about 8 million tons @ 0.09% U_3O_8) reported in Nash and Lehrman, 1975) and Big Smoke mines are basal type deposits in carbonaceous sediments of the mid-Tertiary Gerome andesite. Knowledge of the existence and geological settings of these deposits provide a stimulus for the exploration program that led to the discovery of the Fuki outcrop.

Figure 2 shows the general geology of the Fuki-Donen uranium prospects and Figure 3 shows the general geology of the Hydraulic Lake area (Pb and other prospects). Secondary uranium minerals are situated in unconsolidated or loosely consolidated carbonanaceous sediments that are preserved below a cap of Pliocene (4.7 ± 0.2 m.y. whole rock K-Ar age) and Miocene? plateau basalt. Mineralized deposits occur in fluvial sediments that unconformably overlie metamorphic rocks (Anarchist or Monashee Groups), early Tertiary volcanic and sedimentary rocks (Marron Formation or Kettle River Formation)

and Nelson, Valhalla, and Coryell intrusive rocks. Strong faults occur in the area of the mineral depostis but their relationship to the mineralization has not been determined.

Secondary uranium minerals occur as films on pebbles and in the matrix of unconsolidated or loosely consolidated conglomerate and carbonaceous sediments that were deposited in paleo-stream channels. Metaautunite is the only uranium mineral that has been identified. Authigenic pyrite is common in the unconsolidated sediments and in the Hydraulic Lake area massive sulphide sections have been encountered.

Figure 4 shows a typical section of a basal type uranium deposit in south-central British Columbia. Uranium mineralization occurs in groundwater traps at several horizons within the basal sediments but commonly at or near the unconformities. The base of the Eocene (Marron and Kettle River Formations) has been tested for similar deposits but significant uranium mineralization has not been detected.

Similar geological settings have been reported in the Quesnel-Prince George, Endako and Atlin area. A poorly explored favourable environment for basal type uranium deposits appears to exist in vast area of British Columbia.

The general geology of the Rexspar property is shown in figure 5. A highly faulted, northeasterly trending belt of trachyte tuffs and flows (alkali feldspar porphyry) overlies a series of Paleozoic or earlier quartz-sericite schists with interbedded carbonaceous and phyllitic units. Uranium mineral deposits occur as tabular, fault controlled, replacement zones within areas of the trachyte that are rich

in mica, pyrite (5-20%) and fluorite. A separate zone, reported to contain over a million tons of 15-20% fluorite and 10-15% celestite but only minor uranium, is refered to as the "Fluorite Zone".

The association of purple fluorite with uranium mineralization is commonly known but the 'massive sulfide' environment which contains uranium at Rexspar and in basal type deposits at Hydraulic Lake deserves more attention.

Summary and Conclusions

Improvements in uranium prices and an outlook for strong demands has stimulated exploration activity for uranium in British Columbia. Several favourable environments still warrant further consideration or have been virtually overlooked.

1. Only the south-central part of British Columbia has been intensely explored for basal type uranium deposits but the favourable environment appears to extend from Washington to at least the Yukon.
2. Uranium should not be ignored when examining for other types of deposits and other metals, eg. massive sulphide deposits, stratabound Pb-Zn deposits, porphyry and skarn deposits (especially Mo, W, Sn etc.)
3. Potential for carbonatite deposits in areas such as the Frenchman's Cap Gneiss Dome (McMillan, 1974) is favourable.
4. Gamma ray logs that are used for correlation in petroleum and coal exploration might provide leads.
5. High background intrusive rocks have potential for secondary enrichment and/or contact deposits.
6. Mineral deposits aren't found at C.I.M. meetings, so see you in the field with your silt bags, water bottles, scintillometers, divining rod, E.S.P. or whatever works.

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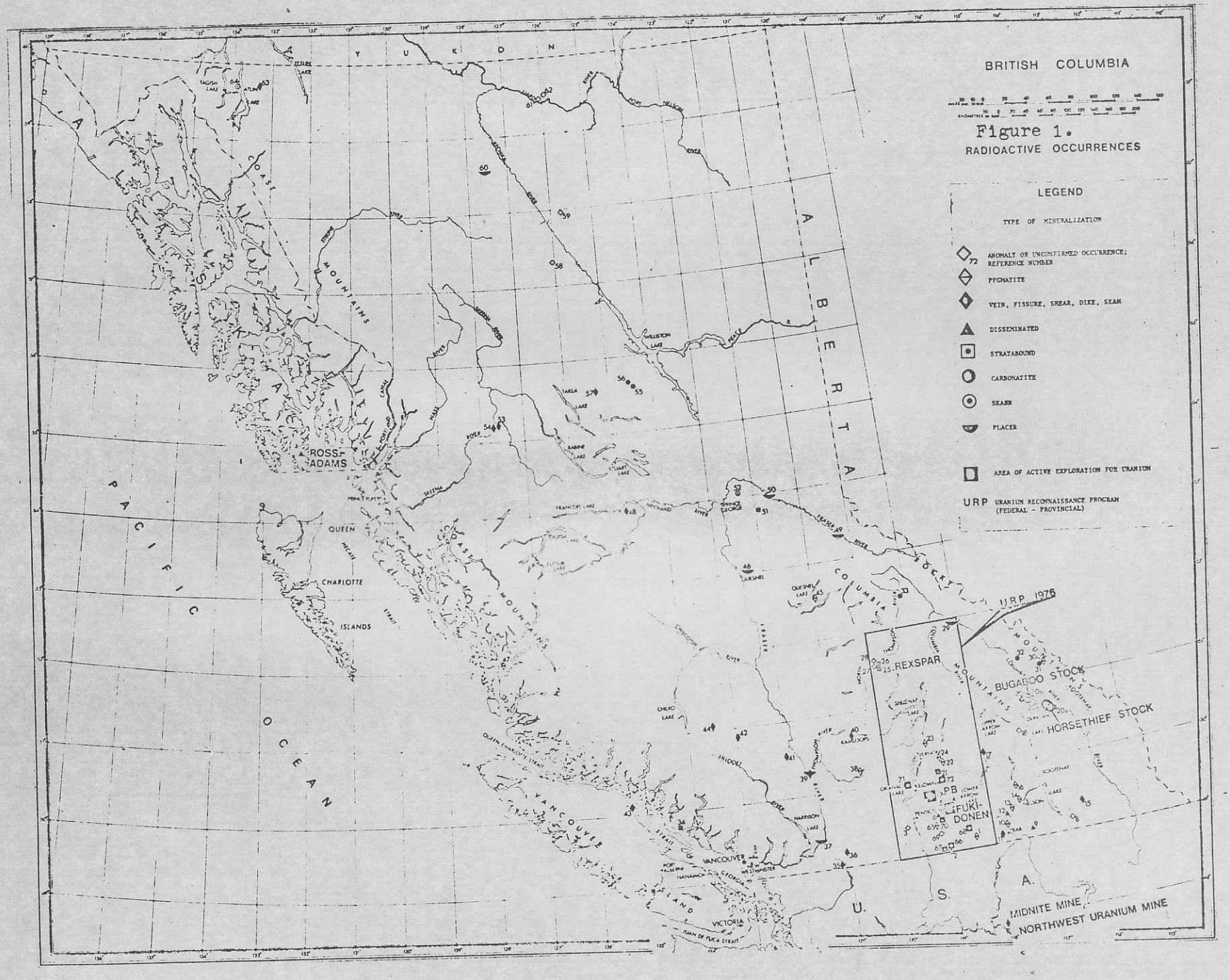

BRITISH COLUMBIA
Figure 1.
RADIOACTIVE OCCURRENCES
LEGEND
TYPE OF MINERALIZATION
ANOMALY OR UNCONFIRMED OCCURRENCE; REFERENCE NUMBER
PEGMATITE
VEIN, FISSURE, SHEAR, DIKE, SEAM
DISSEMINATED
STRATABOUND
CARBONATITE
SKARN
PLACER
AREA OF ACTIVE EXPLORATION FOR URANIUM
URP URANIUM RECONNAISSANCE PROGRAM (FEDERAL - PROVINCIAL)
YUKON
ALBERTA
PACIFIC OCEAN
ROSS-ADAMS
QUEEN CHARLOTTE ISLANDS
REXSPAR
BUGABOO STOCK
HORSETHIEF STOCK
PB
FUKI-DONEN
URP 1976
MIDNITE MINE
NORTHWEST URANIUM MINE
U. S. A.
VANCOUVER
VICTORIA

TABLE I.

(See Preliminary Map No. 22, Christopher, 1976, for References)

LOCATION - NUMBER - NAME	1 PEGMATITE 2 VEIN 3 DISSEMINATED 4 VEIN & DISSEMINATED	MINERALIZATION	TYPE OF MINERALIZATION: PEGMATITE	VEIN	DISSEMINATED	STRATIFORM	CARBONATITE	SKARN	PLACER	VOLCANIC	HOST ROCKS: GRANITIC	SEDIMENTARY	METAMORPHIC	AGE	COMMENTS
			θ	♦	▲	□	●	⊙							
82E 1W - 1 - SU		Sulphides, uraninite, uraphane	X										X		Monashee Intrus
82E 2W - 2 - Dolo	1	Magnesite, Tungsten, Thorium										X			In dolomite
82E 5W - 3 - Reno	1	Gold, silver, niobium, (columbite ?)													With chert & ultramafics
82E 10W- 4 - Sund, Cup, Lassie		Sulphides, weak uranium						X			X		X	Eocene	
82E 10W- 5 - Fuki, Donen		Uranium				X						X		Tertiary	In conglomerate
82E 11E- 6 - Carmi Molybdenum		Fluorite, molybdenite, uraninite		3	X(?)						X			Eocene	Brecciated
82E 14E- 7 - PB	2					X						X		Tertiary	In conglomerate
82F 1W - 8 - Lucky	1	Thorite													
82F 3W - 9 - Molly		Molybdenite, tungsten, uraninite			X						X			Cretaceous	
82F 4E -10 - Mota		Uraninite	X										X		In schist and gneiss
82F 4W -11 - Grant, Corey	2	Molybdenite, radioactive		3							X		X	Eocene	Mixed breccia zone
82F 5E -12 - Gibson Creek Gold Mine		Uraninite			X						X				
82F 7E -13 - Lucky Boy		Samarskite, ilmenorutile	X								X				
82F 6W -14 - Lucky, Bill, Tag		Uraninite	X												
82F 8E -15 - Caribou		Sulphides, schmelite, uranium		2									X		In metasediments
82F 11W-16 - Try Again (Lemon Creek)		Allanite, ferrosonite (?)	X								X				
82F 9E -17 - Sta, Tita (Arrow Lake)	2	Uranium, thorium		5							X				
82F 6W -18 - Lucky, Jack, Bullock	1	Uranium													
82F 9W -19 - Ice 9, Annette, Slide	3	Molybdenum, uranium, Niobium			X			X			X		X		
82K 9W -20a- Forster Creek		Uraninite, pyrochlore				X						X			In conglomerate
82K 15W-20b- Vowell Creek		Uraninite, pyrochlore				X						X			In conglomerate
82K 15W-20c- Malloy Creek		Uraninite, pyrochlore				X						X			In conglomerate
82K 15E-20d- Bugaboo Creek		Uraninite, pyrochlore				X						X			In conglomerate
82L 2W -21 - Val		Uranium				X						X		Tertiary	In conglomerate
82L 2W -22 - Spar		Monazite thorium, secondary uranium	X										X		In schist, gneiss
82L 6E -23 - Brett, Bird		Uraninite	X										X		In schist, gneiss
82L 7W -24 - SH, As		Uraninite	X												Host rock not reported
82M 12W-25 - Rexspar		Fluorite, celestite, uranium				X				X				Tertiary (?)	In trachyte (?) & metasediments
82M 12W-26 - Bullion		Fluorite, pyrite, celestite, uraninite				X				X				Tertiary (?)	In trachyte (?)
82M 12W-27 - Ray	1	Fluorite, uranium												Tertiary (?)	
82M 12E-28 - My, Ray	2	Uranium, thorium													
82M 12E-29 - Iridium Creek	2								X						Also seams in quartzite
82N 1W -30 - Dew (Demon, Colt)		Kaipetite, ilmenite, rutile, thorium, niobium	X								X				
82N 1W -31 - Waterino		Sodalite, uranium		1	X		X(?)				X	X			Nepheline syenite and calcareous rocks
82N 7W -32 - King David		Germanium, zirconium, uranium		1		X(?)						X			Limey, shales
82O 4E -33 - Verify, Paradise		Pyrochlore, uranium, columbite					X						X		In gneiss
93 16W-34 - Long Bay (?)		Germanium				X						X		Tertiary (?)	Lignite & calcareous shale
92M 3E -35 - International		Sulphides, carnotite (?)		2						X					
92M 3E -36 - AN		Sulphides, monazite, uraninite		2								X		Tertiary (?)	Chert & argillite breccia
92N 7W -37 - Hook	2	Black sand							X						
92I 2E -38 - Copperado		Allanite	X								X				
92I 6W -39 - Wigwam (antenna occurrence)		Uranium, thorium		3								X			In limestone
92I 6W -39 - Lytton Bar		Uranium							X						
92I 5E -39 - Orleans (Paquet occurrence)	2	Copper carbonates		3								X			Black slate
92I 10E-40 - Copper King		Cu sulphides, pitchblende		3							X			Triassic	Old workings
92J 9E -41 - Index	2	Molybdenite, radioactive		2							X				
92J 15W-42 - Ore (Little Gem)		Cobalt, gold, molybdenite,	X	2							X				
92J 1W-43 - Cobalt (Pacific Gold, Uranium)		uraninite, albapite, collingite, danaite	X	2							X				
92K 3E -43 - Radium (Baxter, Quadra Is. Occur.)		Carnotite		5						X					
92O 3W -44 - Taweko, Mohawk (Mathewson)	2	Sulphides		1	X						X				In fracture zone
93A 17W-45 - Eaglet		Fluorite, allanite	X										X		In gneiss
93B 16W-46 - Columbia River		Monazite							X						
93J 4 -47 - Procise Well	2	Radioactive	X								X				
93J 1W-48 - Ace (Molly)		Subugalite [illegible]nite		2,4							X				Rhyolite porphyry dike
93H 8E -49 - McBride	2	Thorium (?)							X						
93H 13E-50 - Gold-Thorium Claim	2	Thorium (?)							X						
93H 1W-51 - Joe, Kay		Thorium, gold, [illegible]rium				X						X		Eocene	In shale below coal seams
93J 1W-52 - Gisborne (Jim, Samson)		Sulphides, pyrochlore (?)		4				X				X			
93M 6E -53 - Wartenia		Sulphides, uraninite, allanite		1							X			Cretaceous	
93M 4E -53 - Rattlesnake		Molybdenite, uraninite		1							X			Cretaceous	
93M 4E -53 - Highland Boy		Uraninite		1							X			Cretaceous	
93M 4E -53 - Anchor Intrusion		Uraninite		1							X			Cretaceous	
93M 4E -54 - Black Prince	2	Schmelite, radioactive		3							X			Cretaceous (?)	
93M 4E -54 - Blue Lake	2	Schmelite, radioactive		3							X			Cretaceous (?)	
93M 4E -54 - Golden Wonder		Sulphides, uranium		2						X				Cretaceous (?)	In tuff
93M 9W -55 - Connie		Uraniferous pyrochlore					X(?)						X	Precambrian (?)	In carbonate complex
93M 5W -56 - Virgil		Niobium, uranium					X(?)				X		X	Precambrian (?)	Syenite-carbonate complex
93M 11W-57 - Socke		Uraninite		2							X				Alaskite plug
93L 8E -58 - Ice	2	Hafnium in zircon										X			In silicified limestone
94F 13 -59 - Springiron Lake (Gataga River)		Uranium, vanadium										X			Gossan in shale
94L 12E-60 - Dall Lake	2								X						Float
94M 8E -61 - Lizard River Hotsprings	3	Radioactive													Spring water & tufa
94M 17W-62 - Wasmuth Well (Near M. Springs)	3	Radioactive													Spring water & tufa
104M 14W-63 - Purple Rose-Fisher (Cracker Cr.)		Zeunerite, autunite		1							X			Cretaceous	Quartz in alaskite
104M 1W -64 - Hazeltons (Beaver)		Sulphides, fluorite, uraninite						X							Anthrolite
82L 6W -65 - Lynx, Kate		Cyrtolite, betafite, brannerite (?), euxenite (?)	X								X			Eocene	With disseminated copper sulphides in Coryell
82L 7W -66 - Lux	2	Radioactive								X	X			Eocene	
82L 8E -67 - May	2	Radioactive			X						X			Eocene (?)	High background, Coryell
82L 7E -68 - JP	2	Radioactive									X			Eocene	High background, Coryell
82L 8E -69 - Lour	3	Uranium									X				Valhalla (?) intrusive
82L 6E -70 - Uncle	2	Thorite				X(?)						X		Tertiary	Conglomerate (?)
82L 13E-71 - CM	3														
82L 15W-72 - Pearson Creek	3														

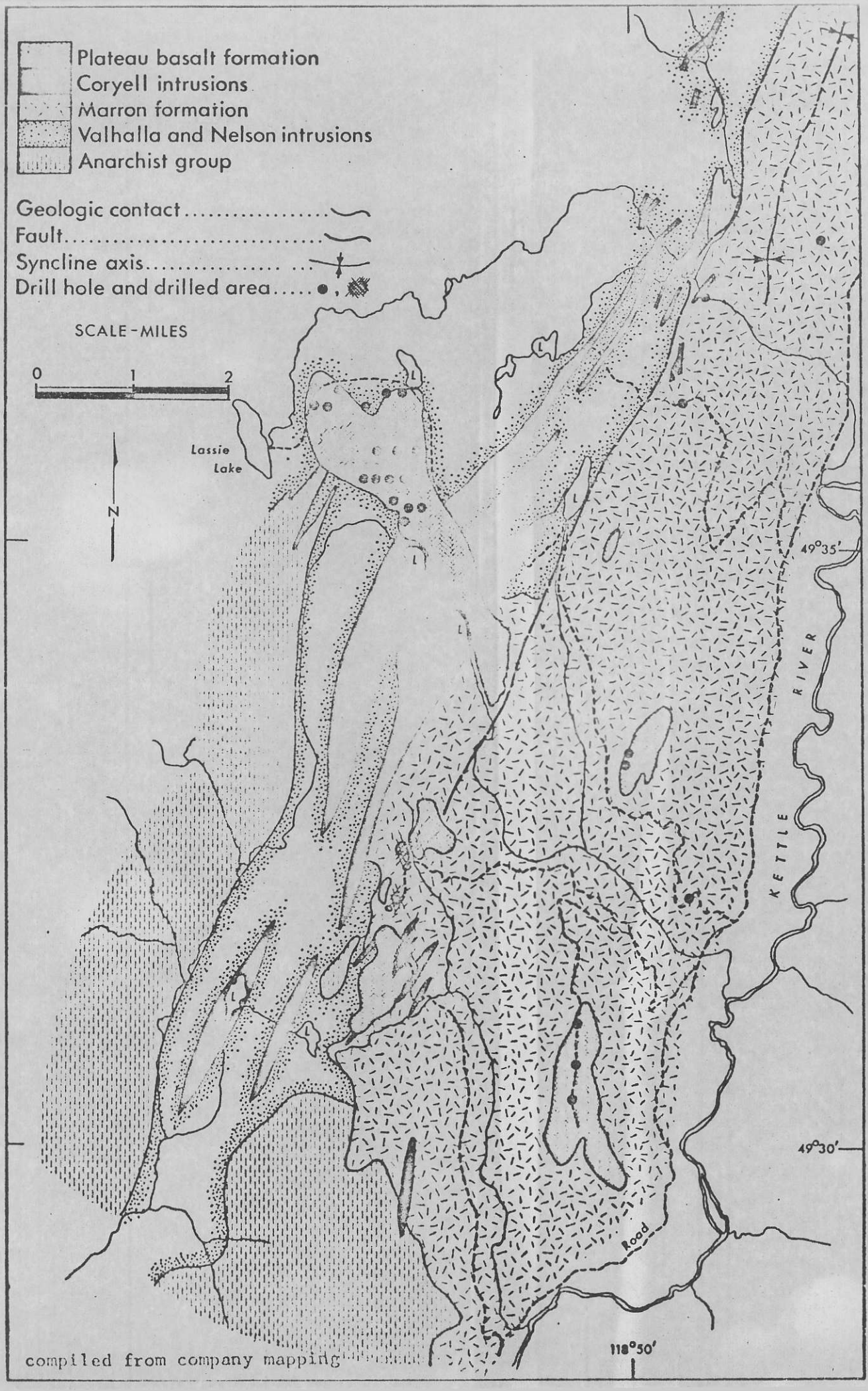


Fig. 2. General geology of Fuki-Donen uranium prospect (Christopher, G.E.M. 1975 in press)

Figure 3. General geology of the Hydraulic Lake Area (modified from company reports).

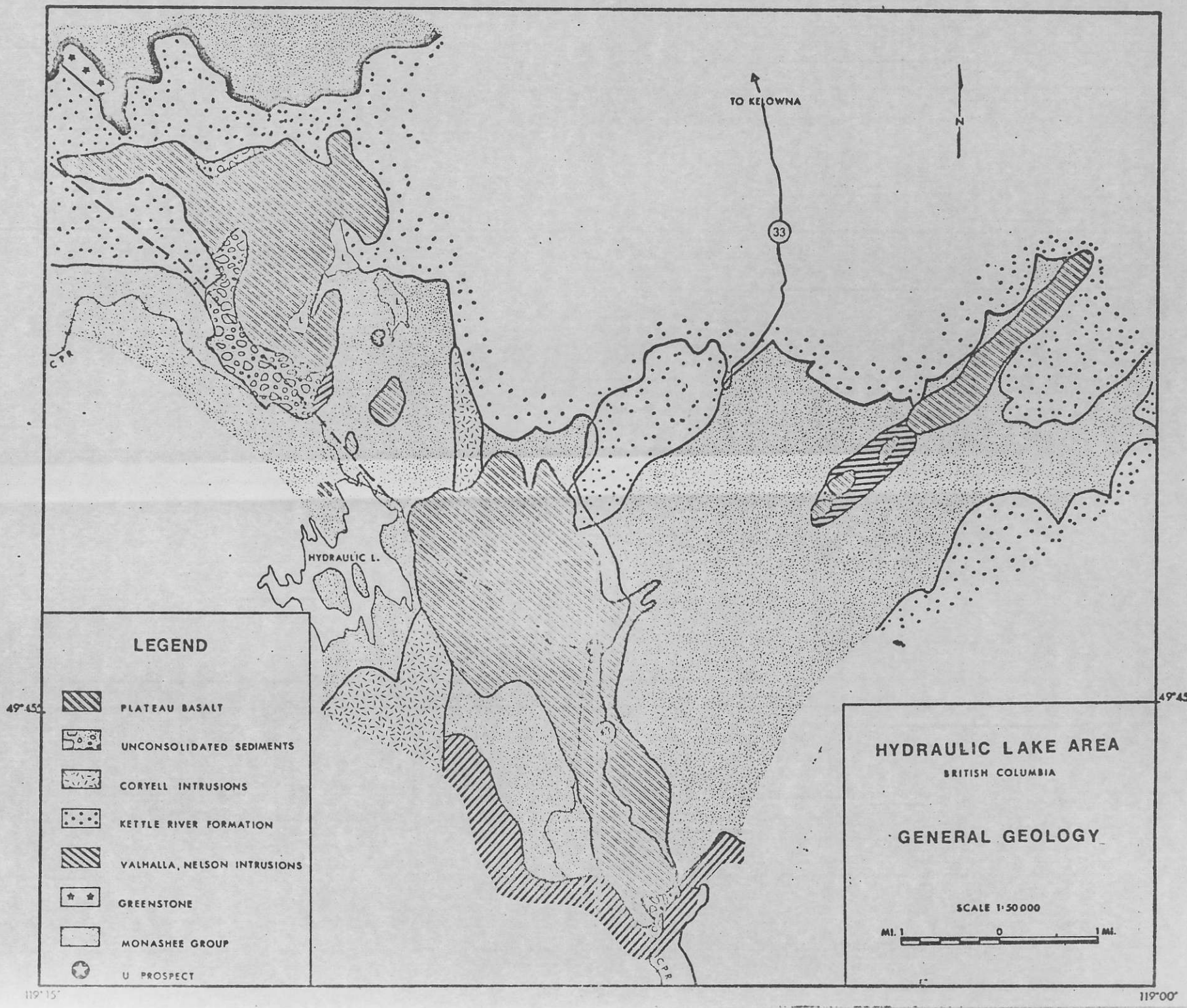
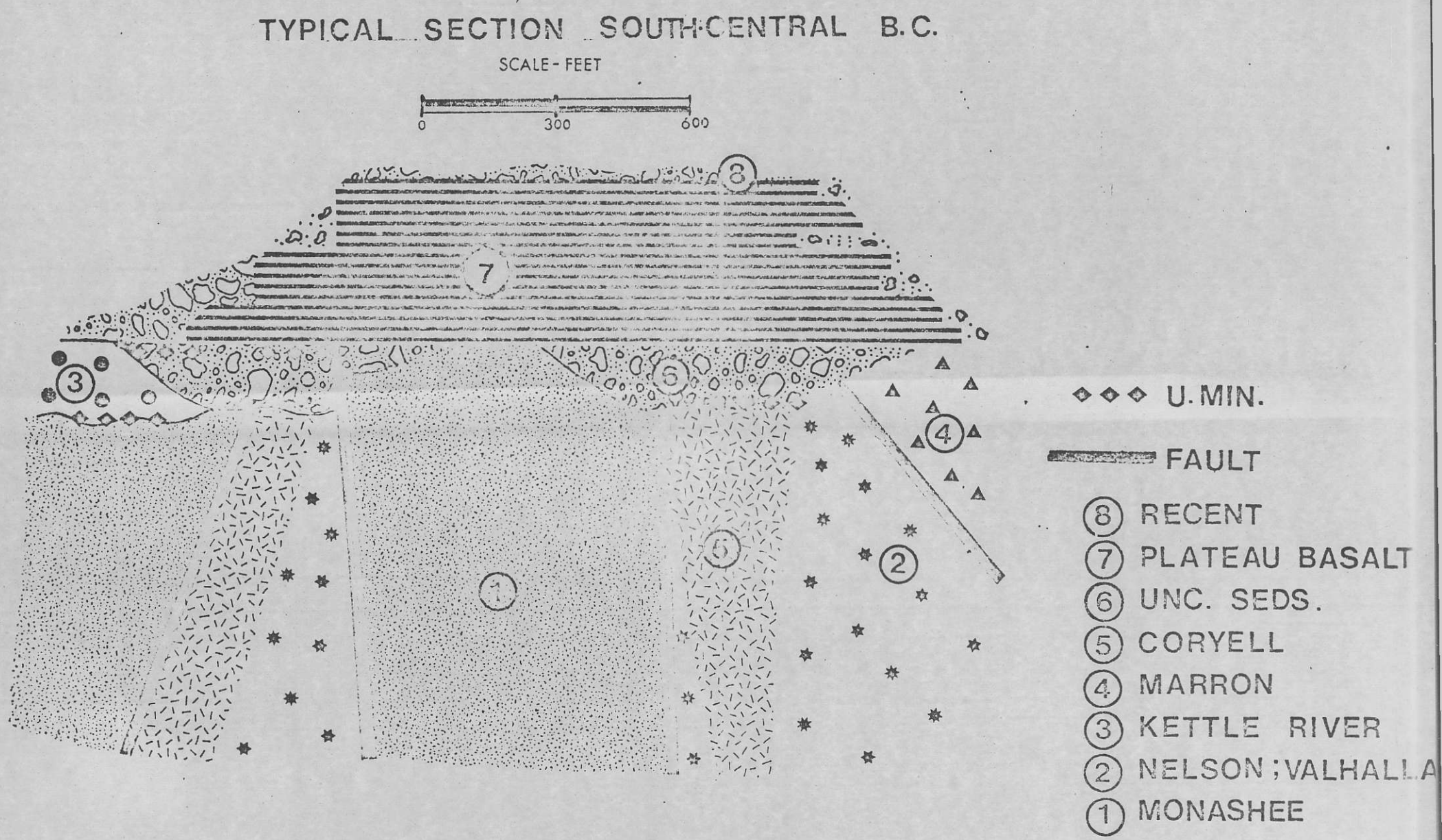


Figure 4. Typical section of basal type uranium deposits in south-central B.C.



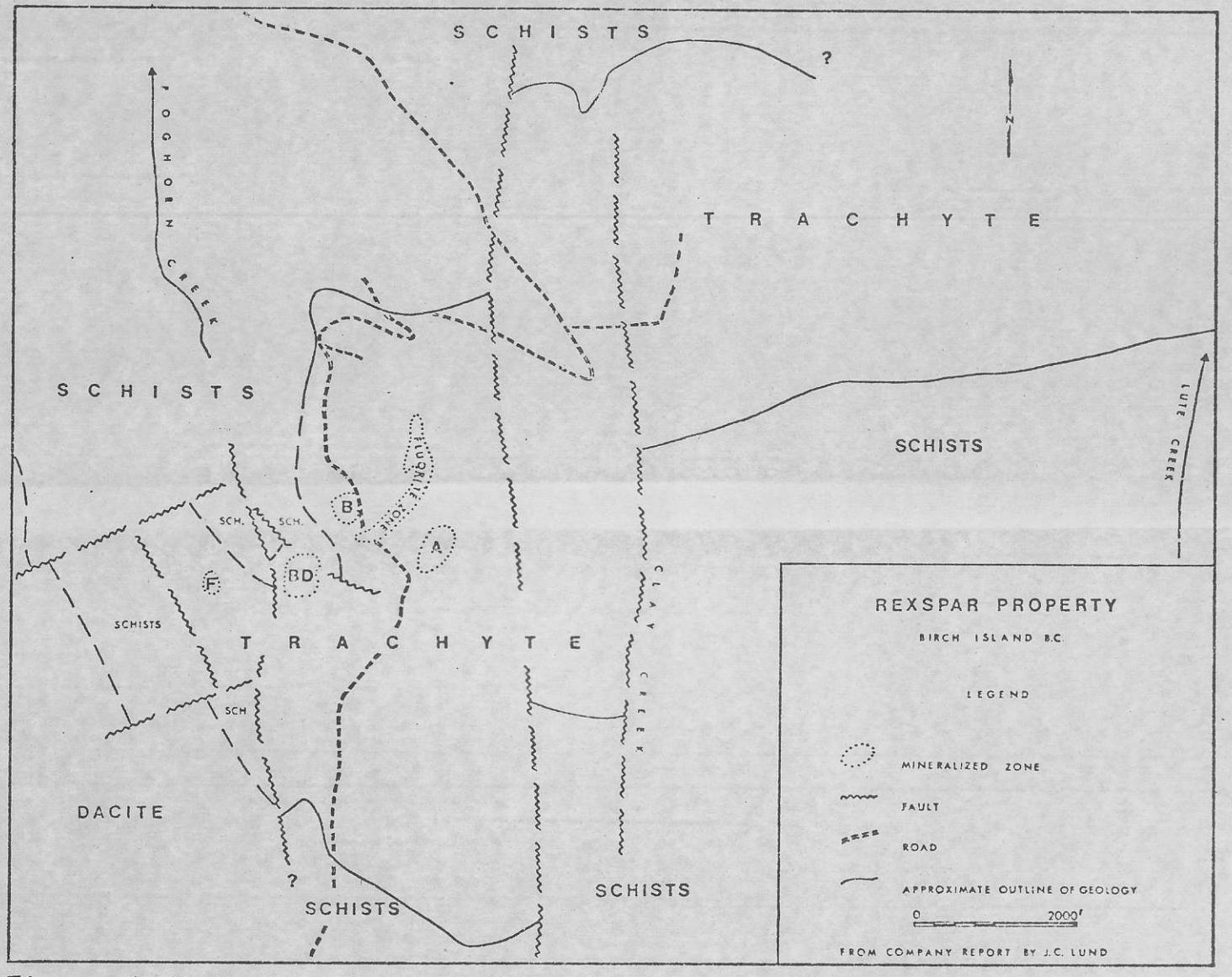


Figure 5. General geology of the Rexspar Property.