Level 1 82E

52.

THE DISPERSION OF URANIUM IN THE VICINITY OF MIOCENE 'BASAL TYPE' URANIUM OCCURRENCES IN LASSIE LAKE AREA, SOUTH-CENTRAL BRITISH COLUMBIA

Project 750051

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Boyle, D.R., The dispersion of uranium in the vicinity of Miocene 'basal type' uranium occurrences in the Lassie Lake area, south-central British Columbia; in Current Research, Part A, Geol. Surv. Can., Paper 79-1A, p. 349-356, 1979.

Abstract

Lassie Lake area in the Okanagan Highlands of British Columbia contains at least three occurrences of Miocene 'basal type' uranium mineralization in sediments underlying Plateau Basalt outliers. The results of a detailed geochemical drainage survey in this area are described. Stream and spring waters were analyzed for U, F, Na, K, Ca, Mg, Cl, SO_4^-, HCO_3^- *pH and conductivity; associated sediments were analyzed for U, Cu, Pb, Zn, Fe, Mn, Ni, Ca, Mo, and loss on ignition (organic content).*

Uranium in sediments shows no significant correlation with any of the base metals and the latter elements are, therefore, of little interpretative or pathfinder value when prospecting for this type of deposit. Water chemistry and sediment composition (organic content) have some effect on the dispersion and concentration of uranium, but lithology, structure and hydrology (e.g. fissure controlled waters) have been found to be more important in interpreting anomalies.

The observed dispersion patterns of uranium in the vicinity of mineralized and unmineralized sediments underlying the basaltic outliers are described and guidelines on sampling techniques which can be employed in the search for this type of mineralization are proposed.

Introduction

Subsequent to the joint Federal-Provincial geochemical reconnaissance program covering NTS sheets 82E, L and M (Geological Survey of Canada, 1976), and as part of a more extensive follow-up program, a detailed geochemical survey was carried out in the Lassie Lake area of the Okanagan Highlands, British Columbia (Fig. 52.1). The area contains economically interesting 'basal type' uranium mineralization and was studied for the following reasons:

a. to determine whether more specific exploration targets within regionally anomalous areas can be delineated geochemically;

b. to develop geochemical methods of assessing the uranium potential of fluvial sediments capped by Plateau Basalts;

c. to study the dispersion characteristics of uranium in the vicinity of known 'basal type' mineralization in the context of other types of anomalies that might occur in the Okanagan Valley and Highlands region of British Columbia.

The Lassie Lake area forms part of NTS map area 82E 10 and is about 50 km southeast of Kelowna and 50 km east of Penticton, British Columbia. The small settlement of Beaverdell is located 18 km to the southwest.

The area is within the Okanagan Highlands, a region of moderate relief consisting of plateau areas (e.g. Lassie Lake area) separated by incised river and creek valleys. The average elevation of the Lassie Lake plateau is approximately 1200 m with local topographic highs reaching 1400 m.

Drainage is generally restricted due mainly to the flat tableland aspect of the area. Kettle River to the east and Trapping and Copperkettle creeks to the north act as major drainage cutoffs.

Bedrock, although exposed in places on local topographic highs and along some stream beds, is generally mantled by a thick cover of glacial overburden (up to 20 m).

Geology

The Lassie Lake area is enclosed within a large intrusive body of quartz monzonite mapped by Little (1957, 1961) as part of the Valhalla Intrusions. Beginning in 1968,

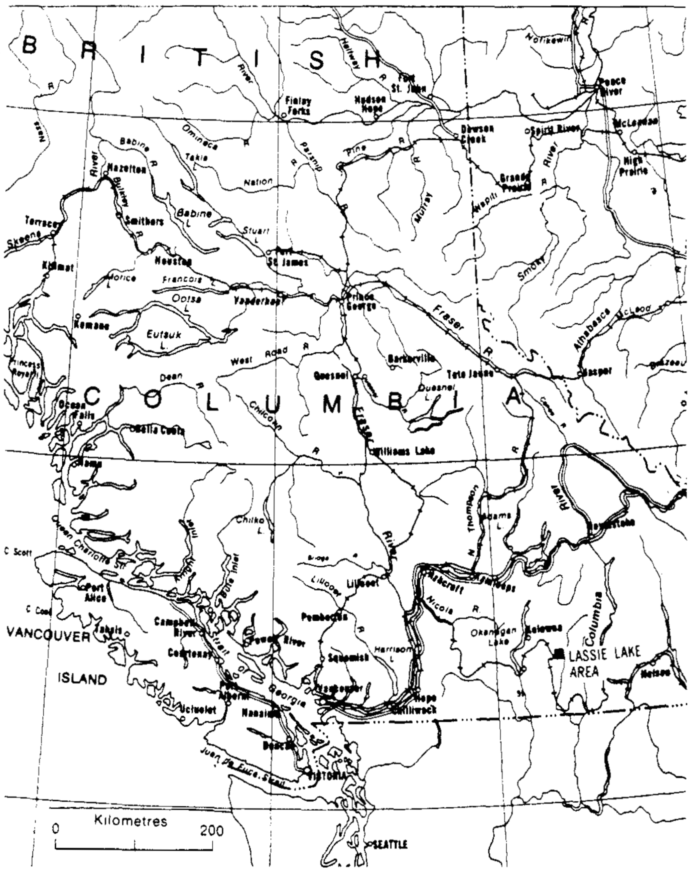

Figure 52.1. *Location of Lassie Lake area.*

GSC 79-1A.

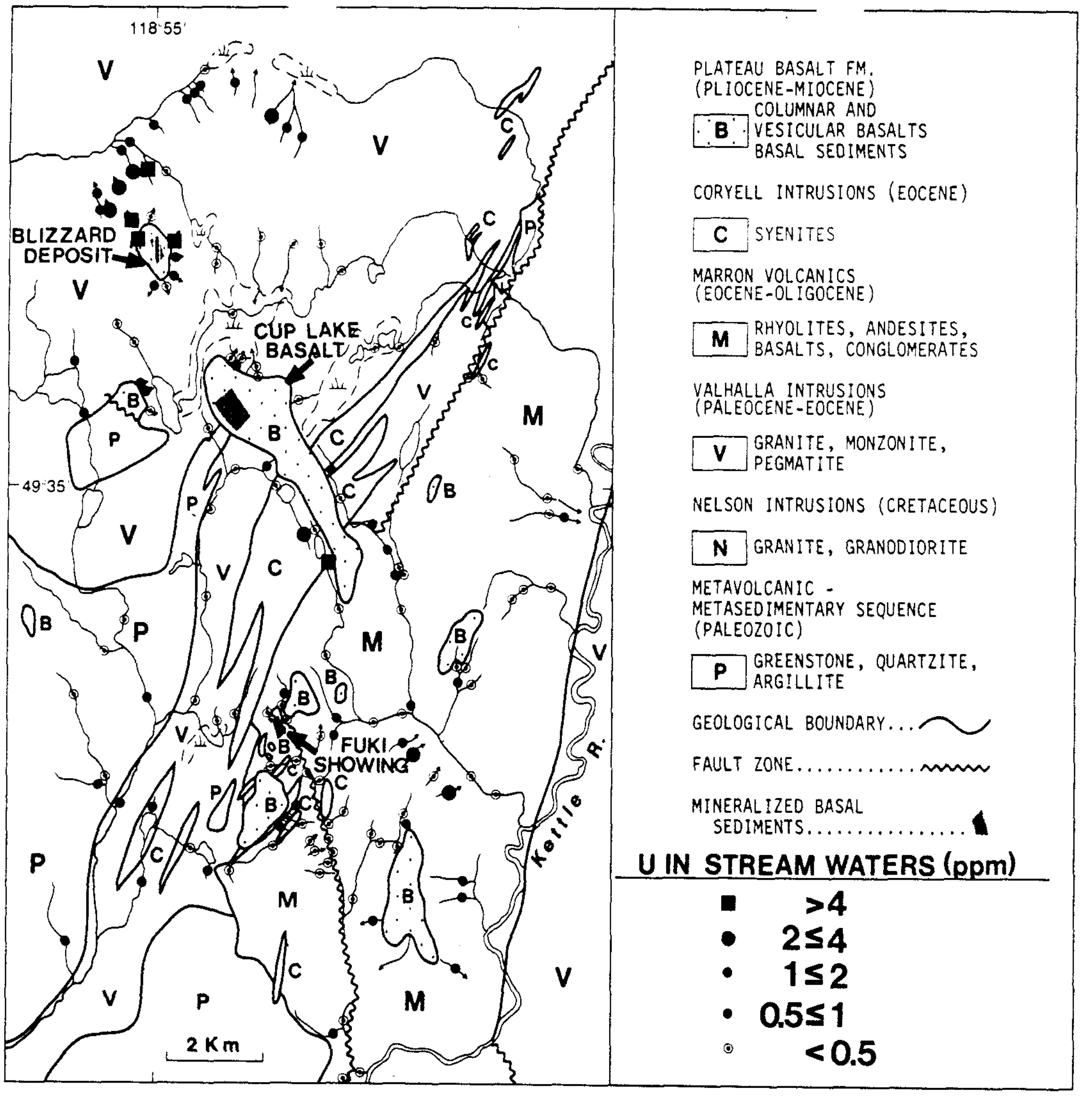

Figure 52.2. *Uranium in stream and spring waters.*

exploration and geological mapping by company geologists of the Power Reactor and Nuclear Fuel Development Corporation, Norcen Energy Resources Ltd. and Noranda Exploration Ltd. has resulted in a clearer understanding of the geology of the area. The generalized geology of the study area, summarized from company reports, is presented in Figures 52.2 and 52.3. Numerous ground checks by the author have confirmed the geology as presented to be reasonably accurate. A more comprehensive geological map of the area at a 1:50 000 scale is also available (Christopher, 1978).

The oldest rocks within the area are Paleozoic greenstones, quartzites and argillites forming three main roof pendants on the intrusive basement complex in the southwestern corner of the area. These pendant rocks have a very low radiometric total count (av ≈ 10 ur, using McPhar TVIA instrumentation)[1] and are volumetrically small compared to the basement and Tertiary volcanic-sedimentary rocks.

The basement complex comprises rocks of the Nelson, Valhalla and Coryell intrusions.

The Nelson rocks consist of large blocks of granodiorite and diorite that have been rafted into the Valhalla complex. They have the lowest average radiometric total count of the intrusive rocks (13 ur).

The Valhalla rocks are volumetrically the most significant and consist of medium grained quartz monzonite and granite containing variable amounts of plagioclase, orthoclase, smoky quartz, muscovite, biotite and hornblende. Some phases are porphyritic containing large feldspar phenocrysts. In many places the main mass of the Valhalla complex contains segregations and dykes of very coarse grained leucocratic pegmatites basically having the same mineralogical composition as the Valhalla intrusive mass. These grade imperceptibly into the finer grained monzonite and granite phases. Distinct chill zones are observed only where the pegmatites intrude the Nelson granodiorite. Based on field relationships and age dating of the Valhalla elsewhere these rocks are most probably upper Cretaceous to Paleocene in age (pers. comm., P.A. Christopher, British Columbia Department of Mines and Petroleum Resources). The average total radiometric count for the monzonitic rocks is approximately 27 ur (35 readings); the pegmatites may range up to 40 or 45 ur.

In the eastern portion of the area the Valhalla basement rocks are mantled by Eocene-Oligocene volcanic-sedimentary rocks. These consist of rhyolites, rhyodacites, andesites, andesite tuff breccias, minor basalts and tuffaceous sediments. Radiometric total counts for this volcanic-sedimentary succession may vary from 13 to 27 ur.

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[1] In accordance with the recommendations of IAEA Technical Report No. 174, measurements of total radioactivity are reported in terms of "units of radioelement concentration", abbreviated 'ur'.

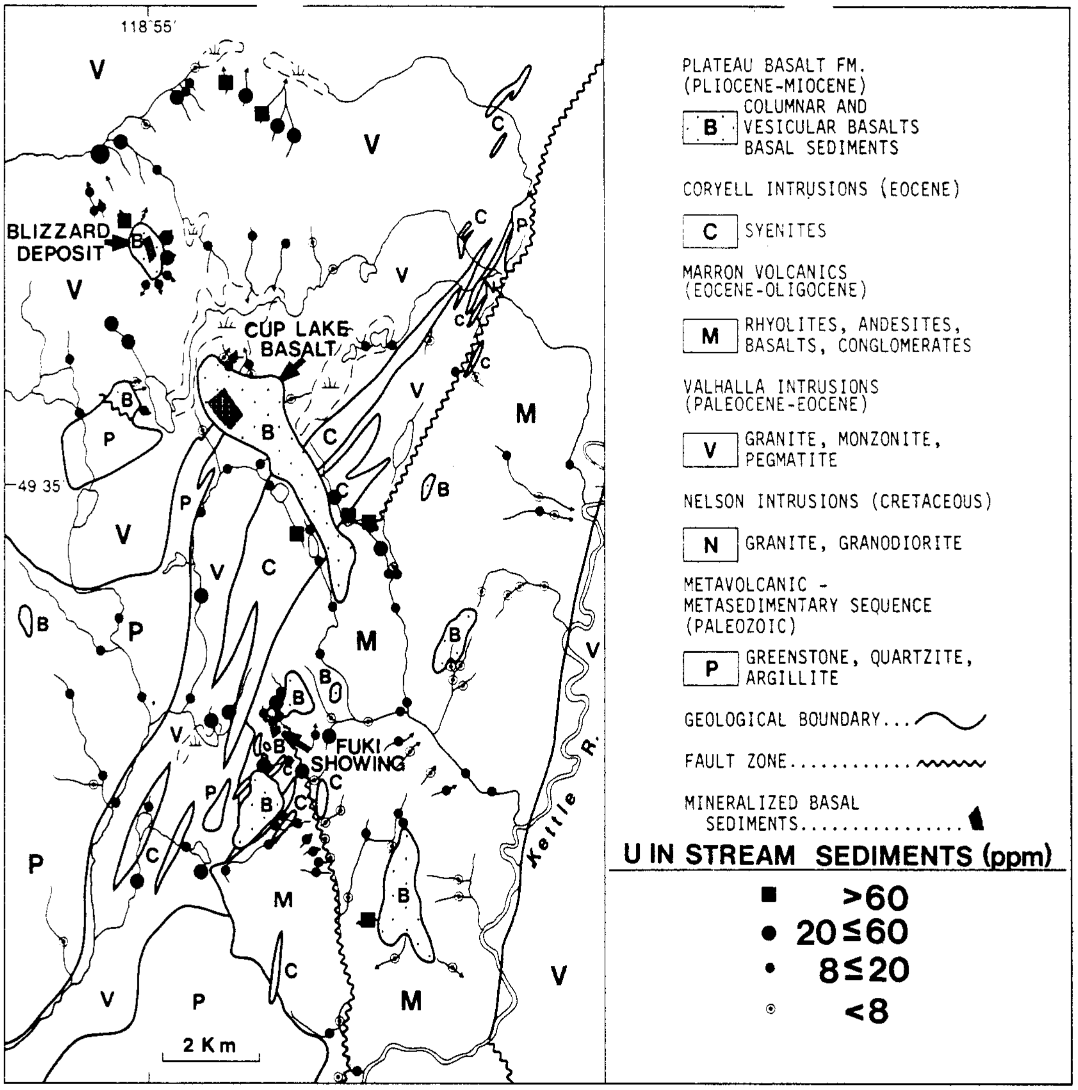

Figure 52.3. *Uranium in stream and spring sediments.*

The Eocene Coryell syenites, comprising both masses and dykes, are intrusive into all rock units except the Plateau Basalts and the Miocene sediments. The main mass centred around Cup Lake, consists of a slightly weathered pink to grey medium grained syenite. Elsewhere, numerous dyke equivalents of the Coryell are present in the intrusive and Tertiary volcanic rocks. These rocks, which may often have a trachytic composition and texture, consist mainly of aphanitic pink syenite porphyry and grey quartz feldspar porphyry. Their predominant trend is northeast, as is that of the main syenitic mass; dykes trending northwest and north are also present. With the exception of the mineralized Miocene sediments, the Coryell has the highest total radiometric count of all the rock units of the Lassie Lake area occasionally reaching 60 ur (av = 33 ur, 18 readings).

In this area the Miocene was a period of erosion during which Tertiary valleys were filled with clastic sediments. This was followed in the late Miocene or early Pliocene by eruption of alkali olivine-bearing basalts which filled the valleys and probably covered many of the upland areas. The 'capped' fluvial sediments afford excellent traps for uranium entering via groundwaters; because the Lassie Lake area contains a number of preserved 'basaltic caps', these have formed the foci of exploration activity throughout the Okanagan region.

The Plateau Basalt formation is flat lying and consists of vesicular and columnar olivine basalt flows with occasional interformational sediments. It has an average thickness of the order of 70 m and has been dated as Pliocene (4.7 ± 0.2 and 5.0 ± 0.5 Ma whole rock K-Ar ages; Christopher, 1978). The isolated basalt cappings in the Lassie Lake area generally form distinct topographic expressions as do most of the cappings in the Okanagan region. The basaltic outliers have either northwest or northeast orientations.

The Miocene sediments underlying the Plateau Basalts are composed of unconsolidated fluvial sandstones and conglomerates with intercalated mudstones. Cobbles within the conglomerates are predominantly granitic in composition and carbonaceous trash is abundant in all of the sedimentary beds. Channel structures (paleostream beds) occur at various horizons in the basal sediments.

Mineralization

Three occurrences of uranium mineralization in basal Miocene sediments have been found in the Lassie Lake area (see Fig. 52.2 and 52.3). A small showing (Fuki showing), which initially attracted mining companies to the area, is located in the south central portion of the area near the source of Dear Creek (Doi, 1969; Kikuchi and Kikuchi, 1970;

Table 52.1

General statistics ($\log_{10}$ transform) for elements in stream and spring waters, Lassie Lake area (all values in ppm except where noted)

	U (ppb)	F (ppb)	Cl	Na	K	Ca	Mg	HCO_3	SO_4	COND (μmhos)	pH
Minimum	0.07	96	0.5	0.3	0.2	1.9	0.5	7.5	2.0	20.8	6.0
Maximum	74.0	1000	57.0	50.0	60.1	38.0	29.4	539.0	71.9	781.0	8.5
Mean	0.49	236	0.6	2.8	0.9	7.7	2.5	44.8	3.3	83.2	7.4
Mean + One St. Dev.	1.24	359	1.0	5.9	1.7	15.8	5.7	99.1	7.7	167.5	7.9
No. Cases	149	149	149	149	149	149	149	149	149	149	149

Table 52.2

General statistics ($\log_{10}$ transform) for elements in stream and spring sediments, Lassie Lake area (all values in ppm except where noted)

	U	Zn	Cu	Pb	Ni	Co	Ag	Mn	Fe(%)	Mo	LOI(%)
Minimum	0.8	6	1	2	1	1	0.1	33	0.2	0.3	1.2
Maximum	178	296	77	36	212	105	1.4	17,313	44.1	21.0	78.4
Mean	12	39	15	10	11	6	0.2	582	2.0	1.6	11.4
Mean + One St. Dev.	27	71	35	18	31	12	0.4	1,580	3.6	4.1	24.9
No Cases	142	137	137	137	137	137	137	137	137	137	141

and Kikuchi, 1971). High total radioactivity is observed at this exposure (greater than 65 ur) but no recognizable uranium minerals are present; rather the uranium occurs as intergranular coatings on grains and cobbles in the conglomerate and in small carbonaceous silty lenses. A bulk channel sample of this showing assayed 527 and 1670 ppm U for minus 6 and minus 80 mesh material respectively.

Drilling on the northern part of the Cup Lake basalt by the Power Reactor and Nuclear Fuel Development Corporation (Japan) has outlined a paleochannel of high radioactivity. Estimated assays from down hole logging (7 holes) range from 0.02 to 0.3% U_3O_8 (Okuno, 1972). The radiometric anomalies, which occur over strata some 3 m thick, are present in the basal part of the fluvial sediments.

The discovery of concealed mineralization under the basalt capping north of Lassie Lake (Blizzard property) prompted an intensive drilling program which is presently being carried out by Norcen Energy Resources (optioned from Lacana Mining Corp.). Uranium mineralization in the form of autunite, saleeite and unidentified radioactive minerals associated with carbonaceous material occurs in a basal channel structure composed of unconsolidated sandstones with intercalated mudstones (pers. comm., T. Turner; Norcen Energy Resources). Intersections containing up to 140 lb/ton U_3O_8 have been reported (Northern Miner, 1978). The basalt covering this deposit is mantled with glacial till and does not outcrop.

Similar uranium mineralization in Miocene sediments also occurs in the Hydraulic Lake area, 30 km northwest of the present study area (B.C. Department of Mines and Petroleum Resources, Assessment Reports 4629, 5090, 5115, 5570, 5582, 6611, 6116, 6217 and 6243). The basic difference between the two mineralized areas is really one of mineralogy; uranium in the Hydraulic Lake area being associated mainly with authigenic iron sulphides in the form of marcasite whereas no sulphides of great significance have been recognized in the Lassie Lake occurrences.

Sampling Techniques

All major streams and their tributaries were sampled; the sampling distribution being outlined in Figures 52.2 and 52.3. Unacidified water samples were collected in 250 ml polypropylene bottles and stream sediments were dried and sieved to pass minus 80 mesh.

Pliocene uplift and glacial erosion have taken the basaltic outliers and their underlying Miocene sediments out of the hydrologic regime under which uranium mineralization would have formed and these deposits can therefore be classed as 'wasting deposits', although some are still well preserved under the basalts (e.g. Blizzard deposit, Fig. 52.2 and 52.3). An examination of the present hydrological regime showed that the basalt cappings, because of their topographic relief, store meteoric waters which eventually move downward and laterally outward, emerging at their base of slope. It was felt, therefore, that base of slope drainage sampling could be an effective way of differentiating productive from unproductive cappings. With this in mind detailed traverses, sampling all springs and seeps were carried out around known basalt formations.

Table 52.3

Pearson Correlation Coefficients ($\log_{10}$ transform) for Lassie Lake data (149 samples)

		SEDIMENTS											WATERS										
		U	Zn	Cu	Pb	Ni	Co	Ag	Mn	Fe	Mo	L.O.I.	U	F	pH	Na	K	Cl	COND	HCO_3	SO_4	Ca	Mg
SEDIMENTS	U	1.00																					
	Zn	.10	1.00																				
	Cu	.17	.59	1.00																			
	Pb	.28	.62	.63	1.00																		
	Ni	.02	.54	.79	.47	1.00																	
	Co	-.06	.62	.41	.48	.64	1.00																
	Ag	.21	.51	.70	.44	.44	.12	1.00															
	Mn	.17	.47	.15	.43	.21	.68	.07	1.00														
	Fe	-.02	.58	.39	.47	.45	.72	.24	.56	1.00													
	Mo	.27	.18	-.02	.30	-.11	.18	.02	.40	.26	1.00												
	L.O.I.	.37	.30	.54	.66	.32	.22	.37	.26	.22	.29	1.00											
WATERS	U	.44	-.12	.00	-.03	.04	-.12	-.05	-.13	-.07	-.04	.08	1.00										
	F	.06	.04	-.11	-.03	-.14	-.04	.02	.03	.13	.27	.04	-.03	1.00									
	pH	-.25	.22	.48	.01	.50	.11	.41	-.11	.20	-.34	-.02	.00	-.05	1.00								
	Na	-.14	-.06	.11	.08	.25	.17	-.06	-.03	.18	-.03	.16	.19	.02	.26	1.00							
	K	-.12	.03	.23	.10	.28	.13	.06	-.07	.11	-.10	.14	.09	-.03	.36	.47	1.00						
	Cl	.05	-.09	.02	.16	-.06	-.03	-.04	-.03	.07	.20	.25	.06	.17	-.04	.47	.61	1.00					
	COND	-.38	.20	.46	.07	.50	.19	.35	-.08	.25	-.26	.09	-.08	.07	.81	.42	.55	.25	1.00				
	HCO_3	-.35	.18	.47	.06	.51	.20	.33	-.07	.28	-.28	.11	-.11	.03	.84	.41	.51	.18	.95	1.00			
	SO_4	-.19	-.13	-.13	-.11	.10	-.03	-.08	.02	-.04	.03	.01	.11	-.12	.00	.25	-.02	.05	.05	.05	1.00		
	Ca	-.40	.27	.53	.09	.52	.20	.42	-.04	.24	-.29	.05	-.20	.05	.82	.21	.36	.06	.91	.91	.00	1.00	
	Mg	-.40	.07	.38	-.03	.51	.20	.23	-.10	.24	-.34	.05	-.02	-.04	.79	.48	.45	.11	.90	.93	.15	.82	1.00
		U	Zn	Cu	Pb	Ni	Co	Ag	Mn	Fe	Mo	L.O.I.	U	F	pH	Na	K	Cl	COND	HCO_3	SO_4	Ca	Mg
		SEDIMENTS											WATERS										

Table 52.4

Uranium and base metal content of matrix material (-80 mesh) from Miocene basal sediments, Okanagan region (all values are in ppm except Fe which is in wt %)

Location	U	Zn	Cu	Pb	Ni	Co	Ag	Mn	Fe	Mo	V	Remarks
Fuki Donen Showing, Lassie Lake	1670.0	72	21	17	21	24	0.2	122	1.30	6	97	mineralized channel deposit
Hydraulic Lake DDH-NT46												
40.27 - 41.27 m	252.0	64	11	7	3	4	0.2	48	2.09	17	13	mineralized channel deposit, marcasite present
41.27 - 42.27 m	366.0	10	6	16	1	1	0.2	48	4.44	29	6	
42.27 - 43.27 m	531.0	24	6	15	1	1	0.4	40	17.82	239	2	
43.27 - 44.27 m	412.0	16	5	11	1	1	0.2	31	9.51	249	3	
44.27 - 45.27 m	135.0	9	4	10	1	1	0.2	26	1.10	1	2	
45.27 - 46.27 m	159.0	5	4	7	1	1	0.2	26	0.64	1	5	
46.27 - 47.27 m	292.0	7	4	8	1	1	0.2	34	1.34	5	5	
47.27 - 48.27 m	1250.0	48	13	23	22	30	0.2	132	1.36	67	20	
48.27 - 49.27 m	1610.0	31	5	21	1	1	0.4	48	24.64	97	3	
West Kettle River (Venus Claims)												
oxidized layer	23.5	88	33	12	115	53	0.2	2040	11.63	2	152	slightly mineralized sediments
unoxidized layer	56.5	140	48	18	85	40	0.2	856	5.13	1	196	
silty layer	32.5	101	27	7	63	33	0.2	273	2.50	3	92	
Myra Station, Southwest of Kelowna	5.0	50	11	11	8	6	0.2	186	2.28	1	56	unmineralized channel deposits
	4.9	61	11	7	9	4	0.2	371	2.34	1	77	
	2.9	37	7	7	6	6	0.2	287	0.15	1	39	
Southwest of Lumby	7.2	310	86	7	131	37	0.2	6240	18.22	3	452	unmineralized sediments
	7.8	101	58	6	34	20	0.4	1392	5.13	5	112	
	11.0	180	105	15	115	50	0.7	2520	11.63	6	235	
	2.2	170	22	6	23	37	0.2	3950	8.50	1	116	
	1.0	75	22	1	20	48	0.2	5480	7.23	1	110	
West of Winfield												
unoxidized material	2.5	11	5	8	2	1	0.2	90	0.52	3	16	unmineralized sediments
oxidized material	6.6	210	42	11	213	44	0.2	736	7.37	1	46	

NOTE: Cd and Bi concentrations are less than 0.2 ppm for all samples

Analytical Techniques

Unacidified water samples were analyzed for U, F, Cl, Na, K, Ca, Mg, $SO_4^=$, HCO_3^-, pH and conductivity. The following analytical techniques were employed:-

U	– Standard fluorometric method as described by Smith and Lynch (1969).
F	– Orion specific ion electrode after buffering 1:1 with total ionic strength adjustment buffer (TISAB).
Cl	– Standard colorimetric method using thiocyanate; read at 460 nm.
Na,K, Ca,Mg	– direct aspiration into atomic absorption spectrometry system.
$SO_4^=$	– colorimetric method using 2-amino-pyrimidine, read at 305 nm.
HCO_3^-	– standard titrimetric method using weak H_2SO_4.
pH	– pH meter and standard buffers.
Conductivity	– Y.S.I. conductivity bridge (Yellow Springs Instruments).

Stream and spring sediments (-80 mesh) were analyzed for U, Cu, Pb, Zn, Fe, Mn, Ag, Co, Ni, Mo and loss-on-ignition (L.O.I.). Uranium was determined by delayed neutron activation analysis at Atomic Energy of Canada Laboratories using methods described by Boulanger et al. (1975). For the determination of the base metals a 1 gm sample was digested in 6 ml of a 4:1 mixture of HNO_3 and HCl. The samples were diluted to 20 ml and the elements determined using a standard atomic absorption technique with the required background corrections. Loss-on-ignition (L.O.I.), expressed as a percentage, is equal to the weight differential between a 1 gm sample dried for 2 hours at 120°C and the same sample ignited for 4 hours at 450°C. The organic content of the sample is considered to be directly proportional to the percentage loss on ignition (Coker and Nichol, 1975).

Results and Discussion

General statistics ($\log_{10}$ transformed data) for all of the elements in waters and sediments are presented in Tables 52.1 and 52.2. The mean uranium contents of waters and sediments in the study area are 0.49 ppb and 12 ppm respectively (149 samples). These results may be compared to the regional means of 0.29 ppb and 6.8 ppm respectively for NTS map area 82E (1546 samples). Based subjectively on the means and standard deviations, class intervals for uranium in waters and sediments (Fig. 52.2 and 52.3) have been chosen to best represent the anomalous groupings within the data. For waters and sediments the uranium content varies from 0.07 to 74 ppb and 0.8 to 178 ppm respectively. Distribution symbol plots for uranium are presented in Figures 52.2 and 52.3.

Pearson correlation coefficients for the data set are given in Table 52.3. Uranium in sediments shows no significant correlation with any of the base metals, Zn, Cu, Pb, Ni, Co, Ag, Mn, Fe and Mo. The uranium and base metal contents of some of the mineralized and unmineralized Miocene basal sediments in the Okanagan region are presented in Table 52.4. Base metals are often associated with certain U deposits (e.g. hydrothermal, skarn, sandstone types); for the Okanagan region, however, only Mo exhibits enrichment in the mineralized sediments, and this may only be indicative of the Hydraulic Lake occurrence. In fact the base metals, excepting Mo, would appear to be depleted in these deposits. It is evident both from the poor correlations in Table 52.3 and the analyses in Table 52.4 that, with the exception of perhaps Mo, base metals would be of very little value as pathfinders in drainage surveys directed at locating this type of deposit.

The correlation between U and F in waters is very poor and the distribution of F (not shown) bears little relation to the presence of uranium mineralization. These two elements, which are often associated in the primary environment, do not appear to be concentrated together the 'basal type' U deposits of the Okanagan. Fluorine is therefore not a good pathfinder for this type of mineralization.

Uranium in sediments shows a weak positive correlation with loss-on-ignition ($r=0.37$) and weak negative correlations with pH, conductivity and HCO_3^- in waters, suggesting that organic content and water chemistry have an effect on the concentration of uranium in sediments. The correlation between U in waters and their associated sediments is not strong ($r=0.44$) but when compared with the correlation coefficient for the regional data ($r=0.03$ for 82E, 1546 samples), the implication that secondary factors have less effect on the dispersion of U in the Lassie Lake area than the Okanagan area as a whole, seems valid. This is borne out by the poor correlation between U in waters and other water measured parameters (see Table 52.3) and by the much lower HCO_3^- and conductivity levels observed in this area compared with other areas in 82E. Lithology, structure and hydrology would seem to have more control on the dispersion of U and the patterns observed.

With few exceptions, the anomalous patterns for U in sediments and waters are reasonably coincident. The following anomalous areas merit further discussion:

a. the area around the basalt outlier north of Lassie Lake (Blizzard property, see Northern Miner, May 11, 1978).

b. the area northeast of the Blizzard property.

c. the anomaly around the southern part of the Cup Lake basalt.

d. the anomaly on the west side of the most southerly capping.

e. the area around the original Fuki showing at the top of Dear Creek.

The strongest anomalies in the area occur in springs and seeps emerging from the base of the Blizzard capping. Presently this property has the greatest potential for mineable reserves. The waters and sediments draining it range from 0.2 to 18.0 ppb and 4.5 to 178.0 ppm U respectively. Strong anomalies in waters and sediments are also observed just to the northwest of the capping. Drilling by Norcen Energy Resources indicates that the mineralized northwest trending channel structure is open in this direction and the anomalies may be related to the emergence at a steeper base of slope of more deep seated waters draining the basal sediments. They may also be associated with fissure controlled waters draining the Valhalla complex. This is almost certainly the case for the springs emerging at the base of the slope of the Valhalla, northeast of the Blizzard property. This type of false anomaly (fissure controlled) can sometimes be detected by more comprehensive water analysis (e.g. F, conductivity, $SO_4^{=}$), especially for larger fault zones, but geological reasoning encompassing structure, nature of bedrock and groundwater hydrology will also be key factors in their detection.

Strong anomalies occur on either side of the southern portion of the Cup Lake basalt. Waters and sediments range from 0.48 to 74.0 ppb and 16.3 to 118.0 ppm U respectively. One spring, located on the southeastern side, has a distinctly different water chemistry from other waters in the Lassie Lake area. It has much higher concentrations of Na and K and twenty times as much $SO_4^{=}$. It is not known whether this unique chemistry can be related to drainage of uraniferous basal sediments since no concentrations of sulphides similar to the Hydraulic Lake area, have as yet been reported for the Lassie Lake occurrences. The anomaly around the southern part of this capping may be attributed to one or a combination of two factors — 1) leaching of high background intrusive rocks (Coryell syenites) or 2) seepage from uraniferous basal sediments. The Coryell syenites have a higher uranium content than other rocks in this area, ranging from 3.7 to 14 ppm U and averaging about 6.7 ppm U (9 samples). This compares well with the regional mean for Coryell syenites of 6.2 (76 samples) for the Okanagan region. Streams and springs draining the Coryell in other parts of the Lassie Lake area and NTS map area 82E do not exhibit values as high as those at Cup Lake; the regional means and one standard deviation levels for waters and sediments draining the Coryell (147 sites) are 0.22 and 0.73 ppb and 11.2 and 25.4 ppm U respectively, well below the levels observed at Cup Lake. In addition, lake sediments from Cup Lake which may be considered to represent a composite of the drainage over the Coryell have uranium contents similar to other lakes in the area (Ballantyne, 1976). The fissure controlled waters and related sediments northeast of the Blizzard property, some of which appear to be related to Coryell syenites and pegmatite dyke swarms, exhibit anomalies similar to the aforementioned area and the possibility of this type of anomaly occurring cannot be ruled out. The stream sediments on the east side of the capping show a gradual increase in uranium content downstream, the element probably being added from seepage on the west side of the stream. The portion of the basalt south of Cup Lake, represented by this anomaly, has not been drilled as yet and the possibility of locating more mineralization, on the basis of the geochemistry, is therefore significant.

An area of high radioactivity in basal sediments under the northwest part of the Cup Lake basalt was outlined by drilling and down hole radiometric probing (Inazami and Yokoyama, 1973). Assays estimated from the logs range from 0.02% to 0.70% U_3O_8. Drainage around this part of the basalt is limited and the area was not delineated by geochemistry.

A single water-sediment anomaly occurs in a spring on the western flank of the most southerly basalt cap. Although loss-on-ignition is 60% for the sediment both the waters and the sediment are anomalous and drainage could therefore be coming from a small pocket of uranium-bearing sediments under the basalt. Elsewhere springs draining this basalt are not anomalous. Three drillholes on the northern half of this basalt displayed only background radioactivity (Kikuchi and Kikuchi, 1970).

Around the original Fuki showing there is a good grouping of sediment anomalies but the waters generally have low uranium concentrations indicating the need to sample the two compatible media.

Good seepage occurs at the base of the basalt situated on the west side of Lassie Lake. No anomalies were found here and down hole logging of two drillholes indicated no significant radioactivity in the basal sediments (Inazumi, 1976).

Conclusions

To date, a number of outliers of Plateau Basalt have been discovered in the Okanagan region of British Columbia. These have been found either as outcroppings or, in drift covered areas, by boulder tracing or speculative drilling of topographic expressions. Uranium mineralization in fluvial sediments underlying these basalts has been discovered in two principle areas of the Okanagan (Lassie Lake and Hydraulic Lake). Because of the channel like nature of the mineralization a final assessment of the uranium potential of basalt formations by low density drilling alone is tenuous. For this reason it is important to have some indication of the type and magnitude of geochemical dispersion around 'fertile' cappings. In the Lassie Lake area strong uranium anomalies occur around known mineralization underlying basalts (e.g. Blizzard property) whereas basalt formations known from drilling to have no associated uranium mineralization display little or no anomalous expression. In some cases anomalies occur around untested portions of basalts capping radioactive sediments.

In the study area uranium in stream sediments displays no significant correlation with the base metals Cu, Pb, Zn, Fe, Mn, Ag, Co, Ni and Mo and its dispersion in waters and concentration in sediments is only weakly affected by water chemistry (e.g. pH, conductivity, HCO_3^-, $SO_4^=$) and sediment composition (L.O.I.). Interpretation of anomalies is, however, confused by such factors as high uranium values in waters and sediments associated with faults and small fracture zones or draining anomalous lithologies (e.g. alkaline intrusive and volcanic rocks). Although more detailed geochemical analysis can be helpful in these cases (e.g. F, conductivity, HCO_3^- content of waters and L.O.I. for sediments) sound geological interpretation will also be required to eliminate certain spurious anomalies.

The most effective means of geochemical exploration for this type of deposit should involve detailed sampling of drainage systems issuing at the base-of-slope of known or suspected basalt formations. For the Lassie Lake area both waters and sediments generate anomalies with high contrast. The length of the anomalous dispersion will naturally depend on the type of physiographic terrain being surveyed. For example in areas of moderate relief (e.g. Lassie Lake plateau) dispersion trains are short whereas in more openly drained areas they may be expected to be somewhat longer. Water chemistry and sediment composition also control the length of anomalous dispersion in certain cases. These factors tend to dictate the degree of detailed sampling required for successful discovery.

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