46. ON THE USEFULNESS OF WATER SAMPLES IN RECONNAISSANCE SURVEYS FOR URANIUM IN THE YUKON TERRITORY

Project 740081: Uranium Reconnaissance Program

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Introduction

The search for uranium occurrences in the Yukon Territory is a recent development in the mineral exploration of that region. Until recently published reports gave very few indications of the possible presence of uranium in economic quantities.

In July 1975, the authors conducted a series of pilot geochemical studies in the southern part of the Yukon Territory with a view to investigating the feasibility of mounting low density reconnaissance, helicopter-supported surveys to define uraniferous areas.

One of the objectives of the project was to ascertain the usefulness of collecting stream and spring water samples to complement data derived from a conventional stream sediment survey.

Areas that were given priority included those underlain by Tertiary sedimentary rocks and acid intrusions, fluorite-bearing granitic rocks, Paleozoic black shale units and Precambrian sedimentary rocks, (Fig. 46.1).

Waters were collected unfiltered and shipped unacidified to the Geological Survey laboratories in Ottawa where they were subsequently analyzed for Zn, Cu, Pb, (MIBK - extraction of APDC complexes followed by AAS determination), Fe, Mn (direct aspiration AAS), U (fluorimetric), F, Cl, SiO_2 and $SO_4^{=}$.

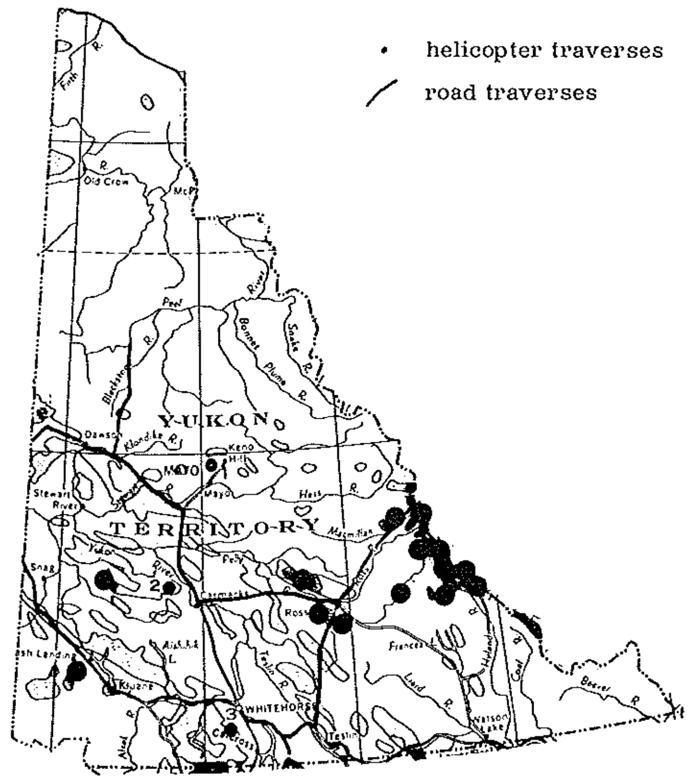

Figure 46.1. Sample location map.

Results and Discussion

Results for truck mounted reconnaissance traverses are presented in tabular form according to NTS map-sheet number. More detailed stream drainage basin studies are described in both tables and figures.

Table 46.1 summarizes results for stream and spring waters from a number of different locations in southern Yukon. Quick inspection of the data suggests that of the elements studied U, F and Zn would appear to be immediately useful in defining anomalous areas with Cu and S (as $SO_4^{=}$) proving useful under certain conditions of hydrogeochemistry. Tables 46.2 and 46.3, present data which further support this contention. Underlined values are considered anomalous.

Stream sediment data, which are used here merely to illustrate the coincidence of certain types of element anomalies within water samples, will be the subject of a later, more detailed discussion (Jonasson and Gleeson, in prep.).

Faro area (105 K)

Although one sample of a spring water at Mt. Mye revealed little of significance, the Cretaceous granites of this region remain of interest in prospecting for uranium.

Flat Lake area (105 I)

In this area pyritic Ordovician shales and baritic Devonian shales have been described by Blusson (1976). Zinc occurrences are also known. The single water sample collected in a narrow gorge which cuts through these rocks strongly indicated the presence of Zn, Fe and sulphides. U and F are low, a feature which proved to be uncharacteristic of waters draining similar rocks elsewhere. It is worth noting that pH is generally around 7.5 in such settings. The ubiquitous presence of carbonate in rocks of all types has a dominant influence on the water chemistry and therefore supports the dispersion of Zn and U at the expense of elements such as Cu, Pb or Ag. High values for Fe and Mn accompanying high Zn and U should be interpreted in

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Table 46.1

Spring and Stream waters from parts of the southern Yukon

NTS	Sample	Type	pH	F	SiO_2	Cl	Mn	Fe	Cu	Zn	Ag	Pb	U	$SO_4^=$	Comments
105 K	74.3057	SPWT	7.37	108	5.00	0.19	2.5	5.0	0.2	1.0	0.2	1.3	0.80	8.0	Faro area
105 I	74.3087	STWT	7.60	55	1.35	0.29	2.5	26.8	0.2	86.0	0.2	1.3	0.20	22.7	Creek into Flat Lake
105 O	75.3089	STWT	3.72	65	3.28	0.38	43.8	699	37.5	26.5	0.2	1.3	2.00	33.1	Tom Creek (Fig. 46.2)
105 O	75.3090	STWT	4.55	29	3.55	0.12	19.8	8.4	4.4	3.1	0.2	1.3	0.42	6.4	Tom Creek
105 O	75.3091	STWT	3.77	56	3.15	0.19	38.6	279	47.8	68.0	0.2	1.3	1.38	31.1	Tom Creek
105 O	75.3092	STWT	3.84	110	2.80	0.12	58.9	797	64.0	234	0.2	1.3	1.66	40.3	Tributary Tom Creek
105 O	75.3093	SPWT	5.18	315	3.51	0.11	882	867	1150	4250	0.2	16.7	12.20	164	Tom Adit flow
105 O	75.3094	STWT	5.07	28	1.91	0.12	19.3	5.0	6.5	20.5	0.2	22.5	0.22	5.3	Tributary Tom Creek
105 O	75.3096	STWT	5.89	115	2.50	0.10	31.9	63.2	2.0	101	0.2	1.3	0.64	34.0	South MacMillan River 8 miles downstream
115 P	75.3137	STWT	6.20	145	5.91	0.12	2.5	5.0	0.2	1.0	0.2	1.3	0.44	17.2	Henry Gulch
115 P	75.3138	STWT	6.35	120	3.82	0.05	26.2	1291	5.5	1.5	0.5	1.3	0.34	12.9	Clear Creek
115 P	75.3139	STWT	6.40	112	4.41	0.10	2.5	8.1	0.2	1.0	1.0	1.3	0.40	42.3	Barlow Creek
116 B	75.3149	STWT	7.21	115	2.05	0.05	2.5	5.0	0.2	18.5	0.2	1.3	0.24	65.2	East Blackstone River
116 B	75.3150	STWT	7.13	74	3.12	0.05	2.5	5.0	0.2	11.0	0.5	1.3	0.14	24.0	North Klondike River
116 G	75.3140	STWT	6.62	275	2.01	4.00	2.5	125	0.2	57.0	0.5	1.3	4.60	115	Big Creek at Ogilvie River
116 G	75.3141	STWT	6.77	375	2.40	3.25	65.2	818	0.2	206	0.2	1.3	6.40	141	Big (Engineer) Creek
116 G	75.3143	SPWT	6.86	1175	5.70	112	7.7	11.2	0.2	6.0	0.2	1.3	2.40	372	Sulphur spring, Big Creek
116 G	75.3144	SPWT	6.61	700	1.75	0.43	543	1753	0.2	684	0.2	1.3	0.70	308	Iron springs, Big Creek
116 G	75.3145	STWT	6.91	350	2.50	3.25	58.4	660	0.8	98.5	0.2	1.3	7.20	158	Big Creek
116 G	75.3146	STWT	6.98	460	2.92	3.63	119	2368	0.5	256	0.2	1.3	4.80	199	Red Creek at Big Creek
115 G	75.3182	STWT	6.93	165	2.85	0.05	2.5	51.2	0.2	0.5	0.2	1.3	1.80	15.5	Amphitheatre Mountain

Notes:
1. SiO_2, Cl^- and $SO_4^=$ are in ppm; others are in ppb.
2. STWT = stream water, SPWT = spring water
3. Underlined values are considered worthy of comment
4. Detection limits for certain elements in this and the other tables are as follows (ppb):

Mn = 0.5 Fe = 10.0 Cu = 0.5 Zn = 1.0 Ag = 0.4 Pb = 2.5

terms of originating from a common source rather than as controlling the mechanical dispersion of each metal by some adsorptive process. Elevated sulphate values generally accompany the metals under these conditions.

MacMillan Pass area (105 O)

In this area seven water samples were collected from terrain underlain mostly by Upper Devonian black shales. The area is best known for the presence of a bedded Pb-Zn-barite deposit (TOM, Hudson Bay Mining and Smelting Co.) which reportedly contains 10 million tons of 15 per cent Pb-Zn.

Samples were taken from Tom Creek and its tributaries, all of which drain through the zone of known mineralization (Fig. 46.2). One sample was collected from the South MacMillan River about eight miles downstream from the confluence of Tom Creek.

The main feature of the data lies in the record of very acidic pH values, presumably a result of oxidizing pyrite within the sulphidic shale units and the ore body itself. Sampling of Tom Creek was restricted to tributaries and upstream from an adit and rubble piles. Below this point, fresh metal-rich iron oxide precipitates have contaminated the stream bed to such an extent that iron stains persist for several miles down the South MacMillan River.

Further descriptions of the mineralization at Tom Creek and of the effects of acid waters on geochemical sediment surveys can be found in Fletcher and Doyle (1974).

The effects of acidic stream waters are apparent. All waters contain high levels of Mn, Fe, Cu, Zn, $SO_4^=$, as well as some local highs of U and Pb. Iron oxide-charged waters (3093) gushing from an adit on the property are loaded with high quantities of all the elements noted above. It is interesting to observe that pH is actually lower above the adit than below it perhaps due to increased amounts of carbonate in the ores. It is also lower at stream sites which are updrainage from the strike of known mineralization. It is possible that the ore zone is more widely distributed than previously recognized. As might be expected, the acid waters have caused a marked depletion of some metal levels in the fine stream silts (-80 mesh). Zn ranges from 5 to 57 ppm, Pb from 51 to 358 ppm, U from 3.5 to 6.5 ppm, Cu from 16 to 77 ppm and Ag from 0.9 to 4.0 ppm.

Zn in stream silts from such an environment is clearly not a good indicator element — the more immobile Pb and Ag may offer a better contrast between mineralized zones and barren zones. It is clear however that water analyses provide a very useful clue to the presence of Pb-Zn black shale-hosted mineralization at Tom Creek. It is also clear that further work is required to characterize the chemical controls operating on the waters of this stream system.

The hydrogeochemistry of this system will be discussed in detail in a future publication. Uranium, as at Flat Lake, is present in both stream waters and sediments and its increased abundance is reflected in certain metaliferous pyritic black shales. It is possible that such rocks could host a large tonnage of low

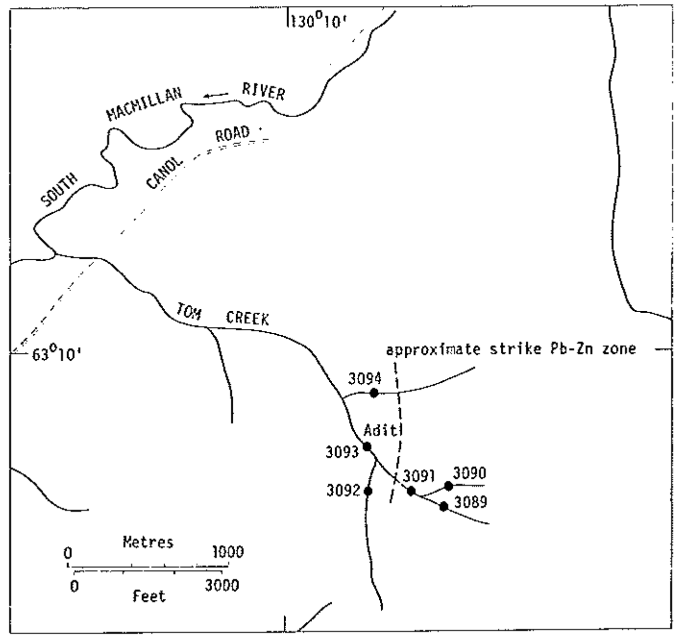

Figure 46.2. Tom Creek (105 O/1). Waters and sediments.

grade U minerals in similar rocks elsewhere in the Yukon, particularly where other metals such as P, V, Mo, Zn are also abundant.

The water sample (3096) taken from the south MacMillan River about eight miles downstream indicates than an acid pH is maintained (5.9). The presence of high Zn, Fe, U(?), Mn and $SO_4^=$ suggests two possibilities; that the dispersion of acid waters from TOM is indeed spread over eight miles, or that there are some metal-rich sources contributing within the intervening distance.

The "immobile" element Cu is depleted in the water (3096) suggesting that the source is not close by. On the other hand, the sediment contains significant quantities of Zn (610), Pb (60), Ag (1), U (10.7), Cu (77) and low Fe (3.69%). The last value suggests that iron precipitates have not been primarily responsible for transporting the other metals to this site; i.e., solution transport is the likely pathway. Under these circumstances, it is advisable to collect both sediments and waters in order to appreciate more fully the nature and extent of the metal dispersion patterns.

Clear Creek area (115 P)

Work centred on Henry Gulch because of a report that an airborne radiometric anomaly was related to uranium mineralization in a coarse grained granite (Barlow dome area). In 1975 some 200 claims (Ura) were staked by Beach-gold Mines (Northern Miner; July 24, 1975) to cover this anomaly.

Table 46.1 indicates that U was present in stream waters at background levels only. Waters showed pH at levels typical of granite terrain and metal levels were considered low except for a small Cu (Fe and Mn) feature in Clear Creek. This may be a result of the fact that Clear Creek was very muddied from upstream gold placer operations.

Fluoride levels were elevated but are likely typical of streams within such terrain. Stream sediments confirmed the relative absence of U in the area (unless it is at depth in a deeply-leached profile). U ranged from 4.0 to 5.3 ppm.

South Dempster Highway (116 B)

Two stream waters, one from the East Blackstone River and another from the North Klondike River, were sampled. Aside from a small Zn anomaly there was little of interest in them. The fact that sulphate contents are also elevated to match Zn suggests that Ordovician black shales in the area may well be the source rocks. Zn also appears in the stream sediments (275 140 ppm).

Table 46.2

Stream waters from NTS 105 F: McConnell River and Bacon Creek areas (Pelly Mountains)

Sample	pH	F	SiO_2	Cl	Mn	Fe	Cu	Zn	Ag	Pb	U	$SO_4^=$	Comments
75.3051	7.01	155	4.58	0.10	2.5	9.4	0.2	0.5	0.2	1.3	34.0	340	Glacier Cr, Canol Road
75.3058	7.48	155	1.65	0.05	2.5	9.4	0.2	1.0	0.2	1.3	1.18	11.0	McConnell River (Fig. 46.3)
75.3059	7.44	212	2.30	0.05	2.5	6.3	0.2	0.5	0.2	1.3	1.28	10.0	McConnell River
75.3060	7.50	218	2.40	0.05	2.5	5.0	0.2	0.5	0.2	1.3	1.22	10.4	McConnell River
75.3061	7.50	370	3.25	0.05	2.5	5.0	0.2	1.2	0.2	1.2	0.78	63.5	McConnell River
75.3062	6.51	120	2.50	0.19	2.5	12.2	0.2	1.2	0.2	1.3	1.52	34.4	McConnell River
75.3063	7.66	94	2.20	0.05	2.5	5.0	0.5	0.5	0.2	1.3	1.02	21.2	White Creek
75.3064	7.75	142	2.60	0.10	2.5	5.0	0.2	1.2	0.2	1.3	1.32	32.5	McConnell River
75.3065	7.80	69	2.12	0.05	2.5	5.0	0.2	0.5	0.2	1.3	1.30	21.1	White Creek
75.3066	7.87	46	2.05	0.29	2.5	5.0	0.2	0.5	0.2	1.3	0.66	16.8	White Creek
75.3067	7.87	36	2.00	0.29	2.5	5.0	0.2	0.5	0.2	1.3	0.58	11.5	White Creek
75.3068	7.86	59	2.12	0.10	2.5	5.0	0.2	0.5	2.0	1.3	1.40	32.0	White Creek
75.3069	7.93	51	1.98	0.10	2.5	5.0	0.2	0.5	1.5	1.3	1.48	42.5	White Creek
75.3070	8.08	57	2.19	0.19	5.7	6.9	0.2	0.5	0.2	1.3	1.22	33.9	McConnell River
75.3071	8.08	115	2.70	0.19	2.5	5.0	0.2	0.5	0.2	1.3	1.20	43.5	McConnell River
75.3072	8.13	57	2.39	0.19	2.5	5.0	0.2	0.5	0.2	1.3	0.98	30.3	McConnell River
75.3073	8.02	205	2.26	0.19	2.5	5.0	0.2	0.5	0.5	1.3	1.34	98.0	McConnell River
75.3074	8.09	112	2.65	0.05	6.2	8.4	0.2	0.5	1.2	1.3	0.78	37.9	McConnell River
75.3075	8.08	200	2.80	0.10	6.9	5.0	0.2	0.5	0.2	1.3	0.44	58.7	McConnell River
75.3076	809	67	2.59	0.10	2.5	5.0	0.2	0.5	0.2	1.3	0.96	27.5	McConnell River
75.3077	8.27	82	2.12	0.10	2.5	5.0	0.2	0.5	0.2	1.3	0.62	15.0	McConnell River
75.3078	7.92	69	2.85	0.19	2.5	5.0	0.2	0.5	0.2	1.3	0.54	10.0	Bacon Creek (Fig. 46.4)
75.3079	7.89	70	3.25	0.19	2.5	5.0	0.2	0.5	0.2	1.3	0.28	7.1	Bacon Creek
75.3080	8.23	34	2.30	0.29	2.5	5.0	0.2	0.5	0.5	1.3	0.26	6.4	Bacon Creek
75.3081	8.15	42	2.00	0.29	2.5	5.0	0.2	0.5	0.2	1.3	0.30	6.1	Bacon Creek
75.3082	8.00	48	2.25	0.10	2.5	5.0	0.2	0.5	0.5	1.3	0.34	9.6	Bacon Creek
75.3083	7.93	53	2.55	0.29	2.5	6.9	0.5	0.5	0.2	1.3	0.64	9.2	Bacon Creek
75.3084	7.67	65	2.60	0.10	2.5	7.6	0.2	0.5	0.2	1.3	0.82	12.5	Bacon Creek
75.3085	7.83	64	2.71	0.05	2.5	11.1	10.7	0.5	0.2	1.3	0.58	10.2	Bacon Creek

Notes:
1. SiO_2, Cl^- and $SO_4^=$ are in ppm; others are in ppb.
2. Underlined values are considered worthy of comment.

The pH of the waters is considered normal and U levels are also regarded as normal. The latter are matched by values of U at 4.4 and 4.6 ppm from a shaley sediment. Water-borne Zn could be used in this terrain as a prospecting aid for bedded Pb-Zn ores.

Central Dempster Highway (116 G)

In this area sampling centred around an outstanding geochemical feature along Big (Engineer) Creek which drains to the Ogilvie River. Seven water samples from springs and streams were collected. The area is underlain predominantly by sediments (shales and carbonates) of the Ordovician Road River Formation.

Stream sediments in Big Creek from Red Creek to Ogilvie River, a distance of fifteen miles, are stained extensively with red iron oxides originating from the oxidation of pyritic black shales. Waters were slightly acidic in spite of the local presence of considerable amounts of carbonates interbedded with black shales. They contain above normal quantities of Zn, Fe, Mn, F, Cl, $SO_4^=$ and U in steadily decreasing levels from Red Creek to the Ogilvie River.

At Red Creek there are two springs perhaps 100 feet apart, one precipitating sulphur and relatively devoid of metal ions but rich in anionic species such as $SO_4^=$, Cl^-, F^- and silicate, the other precipitating iron oxides and which is relatively enriched in Zn, Fe, Mn but poor in Cl^-, F^- and silicate. U is richer in the sulphur spring; anionic complexes of fluoride or carbonate (not determined) may be responsible for this. Undoubtedly there is a source of heavy metals within the shales contributing these high levels and further study is clearly warranted.

However, the presence of these metals provides some opportunity to look into the processes of water-borne uranium dispersion.

The two springs are prime sources of the elements found farther down Big Creek. U remains roughly constant, as do Cl^-, F^- and $SO_4^=$ over the fifteen miles to the Ogilvie River. On the other hand, Zn and Fe fall off quite noticeably. These observations support the contention that anionic complexes, probably of UO_2^{++} are likely involved in the transportation of U. The same patterns are reflected in the sediments for Fe, Zn, but U also tends to decline from source area (18 ppm) to sink (9.5 ppm). Moreover U levels are higher in the precipitates of the iron spring (26 ppm) than in those from the sulphur spring (5.7 ppm). Thus, precipitating iron oxides have a definite scavenging effect on water-borne U but it certainly is not overwhelming as evidenced by the persistent U in water dispersion down river.

Amphitheatre Mountain (115 G)

One water sample was collected from an area underlain by Tertiary sandstones, conglomerates and coal measures. It contains above normal Fe, F and U. Matching stream sediments yielded U in the range 2.5-3.6 ppm; similar values to those found in the rocks and coal themselves. There appears to be little U present in these formations.

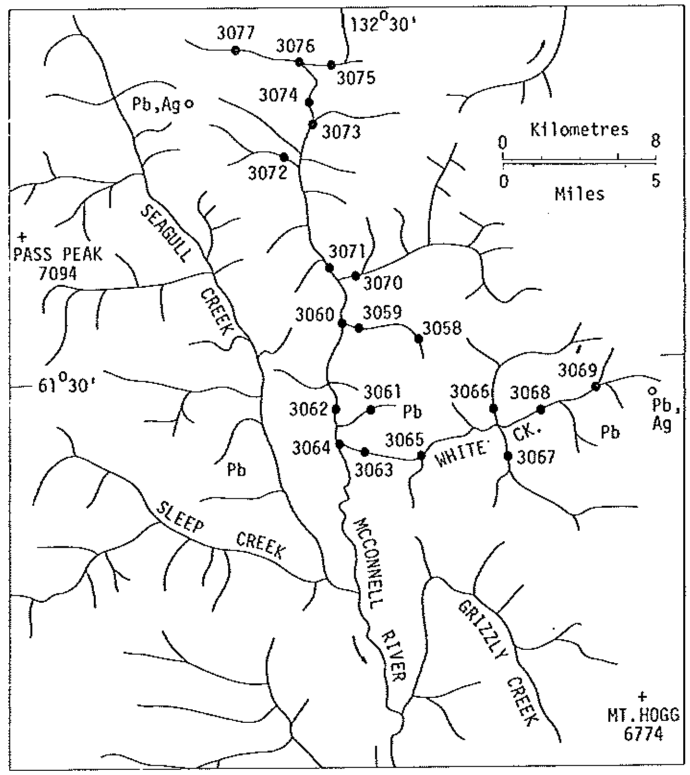

Figure 46.3. McConnell River-White Creek (105 F/7-10). Waters and sediments.

McConnell River area (105 F)

Table 46.2 presents a summary of the water chemistry of the McConnell River drainage basin, (Fig. 46.3). The area was systematically sampled using a Hughes 500C helicopter and landing in the stream beds where possible. It was selected because of the presence in the region of fluorite-bearing syenitic rocks of Mississippian age. There are also a number of small occurrences of galena which commonly are found in quartz-fluorite veins within the syenite.

The pH of the water samples is generally in the range 7.44 to 8.27, except in the upper McConnell River where it is 6.51. This value is supported by an elevated Fe level (12.2 ppm) and suggests an Fe sulphide source nearby. However, in general, pH would seem to be controlled by carbonate which is present in veins everywhere. Alkaline pH would be expected to restrict dispersion of Fe, Pb, Ag and Cu, and this does appear to be so. Occasional appearances of Ag in White Creek are worth a second look as they seem to reflect known showings of galena in the area.

Strong relationships between F(?), $SO_4^=$ and U are recognizable especially in upper tributaries where Pb veins and fluorite can be found. The mineralogical relationship of U to these elements is at present uncertain. Analyses of stream sediments confirm the validity of the water-borne anomalies. Pb, Zn, Fe, Mn and U show coincident anomalies in the upper reaches of the McConnell River whilst the Ag anomaly on White Creek is reinforced by above normal Cu and Pb in sediments.

Table 46.3

Stream water samples from NTS 115 J: Nisling River and Klotassin River areas (Dawson Ranges)

Sample	pH	F	SiO_2	Cl	Mn	Fe	Cu	Zn	Ag	Pb	U	$SO_4^=$	Comments
75.3161	7.50	210	3.62	0.05	2.5	5.0	0.2	3.9	0.5	7.5	0.14	1.6	All samples are from two stream systems which drain to the Klotassin River and Nisling River respectively (Fig. 46.5).
75.3162	7.40	235	5.39	0.25	2.5	10.3	0.2	1.0	0.2	1.3	1.26	1.6	
75.3163	7.40	315	5.00	0.19	2.5	12.8	0.2	3.5	0.2	1.3	0.94	3.1	
75.3164	7.27	225	5.39	0.10	2.5	28.1	0.2	0.5	0.2	1.3	0.48	4.6	
75.3165	6.98	365	5.55	0.10	2.5	14.3	0.2	0.5	0.2	1.3	1.18	2.7	
75.3166	6.96	640	5.60	0.19	2.5	10.3	0.2	0.5	0.5	1.3	0.86	2.7	
75.3167	6.96	460	5.91	0.10	2.5	16.5	0.2	0.5	0.2	1.3	1.24	3.5	
75.3168	6.96	975	6.50	0.05	2.5	25.6	0.2	0.5	0.2	1.3	0.98	7.1	
75.3169	6.88	580	5.81	0.10	2.5	13.4	0.2	0.5	0.2	1.3	1.60	3.5	
75.3170	6.98	385	5.55	0.19	2.5	9.7	0.2	0.5	0.2	1.3	0.10	5.5	
75.3171	7.00	650	6.03	0.05	2.5	17.1	0.2	0.5	0.2	1.3	0.54	3.5	
75.3172	7.04	450	5.75	0.10	2.5	11.9	0.2	0.5	0.2	1.3	0.34	2.5	
75.3173	7.00	740	6.35	0.12	2.5	14.7	0.2	1.0	0.2	1.3	0.46	3.4	
75.3174	7.06	640	6.71	0.10	2.5	19.1	0.2	2.5	0.2	1.3	0.24	1.8	
75.3175	7.05	670	4.50	0.10	2.5	6.7	0.2	3.2	0.2	1.3	0.18	2.5	
75.3176	7.00	750	4.91	0.10	2.5	5.0	0.2	2.0	0.2	1.3	0.26	2.0	
75.3177	6.95	910	4.75	0.05	2.5	5.0	0.2	3.1	0.2	1.3	0.40	1.5	
75.3178	6.80	940	3.31	0.05	2.5	6.4	0.2	5.0	0.2	1.3	5.80	2.3	
75.3179	6.93	1000	4.70	0.10	2.5	5.0	0.2	3.5	0.2	1.3	1.12	2.3	
75.3180	6.97	860	4.95	0.05	2.5	10.7	0.2	0.5	0.2	1.3	0.78	2.5	
75.3181	6.96	780	4.39	0.05	2.5	13.9	0.2	0.5	0.2	1.3	1.24	5.2	

Notes:
1. SiO_2, Cl^- and $SO_4^=$ are in ppm; others are in ppb.
2. Underlined values are considered worthy of comment.

U ranges from 6.0 to 12.3 ppm over a background of about 3 ppm. Within the McConnell River system, some samples of syenites, in places fluoritic, contained U between 13.9 and 25.7 ppm. The same samples were also anomalous in Pb and Zn. Quartz veins with visible galena contained much less U at about 5 ppm.

Bacon Creek area (105 F)

The Bacon Creek drainage is underlain by late Precambrian (Windemere) phyllitic rocks and quartzites. Eight waters were sampled (Fig. 46.4). The pH of waters is generally alkaline in the range commonly buffered by carbonate equilibria. Uranium content is quite low averaging about 0.5 ppb. Fluoride is also low as is sulphate. Except for one sample in the lower reaches of Bacon Creek which contains a little Fe (11.1 ppb) and an unusual quantity of Cu (10.7 ppb), the data of Table 46.2 are relatively featureless. It is suggested that because of the alkaline pH (7.83) of this sample, the Cu source is likely nearby. This section of the Windemere does not appear to be promising for the discovery of U occurrences by hydrogeochemistry. The absence of indicator elements is also discouraging although some rocks samples were found to contain up to 22.5 ppm U.

Nisling River — Klotassin River area (115 J)

Twenty-one water samples were collected (Fig. 46.5). The sample area is underlain by a Tertiary miarolitic granite in which fluorite and molybdenite occur. The area forms part of the Dawson Ranges and is unglaciated, a fact of some geochemical significance. The first point of interest is the virtually invariable pH value which is always close to 7.00. Carbonate is apparently not present in the rocks and this is reflected in the near neutral pH levels of drainage waters. Thus low values for U are to be expected. Normal levels would seem to be around 0.5 ppb with anomalous levels reaching 5.80 ppb. Fe levels are surprisingly high, perhaps an indicator of the presence of considerable amounts of nontronite, a ferrous montmorillonite, in the exposed granites. In places, extensive iron staining is visible. Fluoride is abnormally high everywhere and reaches 1000 ppb. These are matched by high silicate concentrations. Thus, although carbonate is probably insignificant as a transporter of U and $SO_4^=$ is very low, F^- is possibly the prime mobilizing agent for U (as UO_2^{++}). The only other feature in the water data is one pair of above normal Pb and Zn analyses. By contrast, the stream sediments contained between 13.8 and 33.8 ppm U in anomalous zones. The water-borne anomalies observed are matched by sediment U, but perhaps the best indication of U presence is with F. Analysis of granitic chips in these areas reveals little or no U. There seems to be no other elemental associations of possible significance.

The fact that the sample area is unglaciated may well be an important reason for the absence of surface indications of radioactivity. Deep leaching or weathering of surface rocks has probably removed much of the radioactivity which might be expected from granites which yield U in such significant quantities in stream sediments. U is clearly present but is in complete disequilibrium with its radioactive daughters. A search for and sampling of fissure waters, seeps or springs for U and F in combination with stream sediment surveys seems to be the best approach to prospecting in such terrain. Targets would include zones of secondary enrichment as well as radioactive fluorite granites, syenites and alaskites.

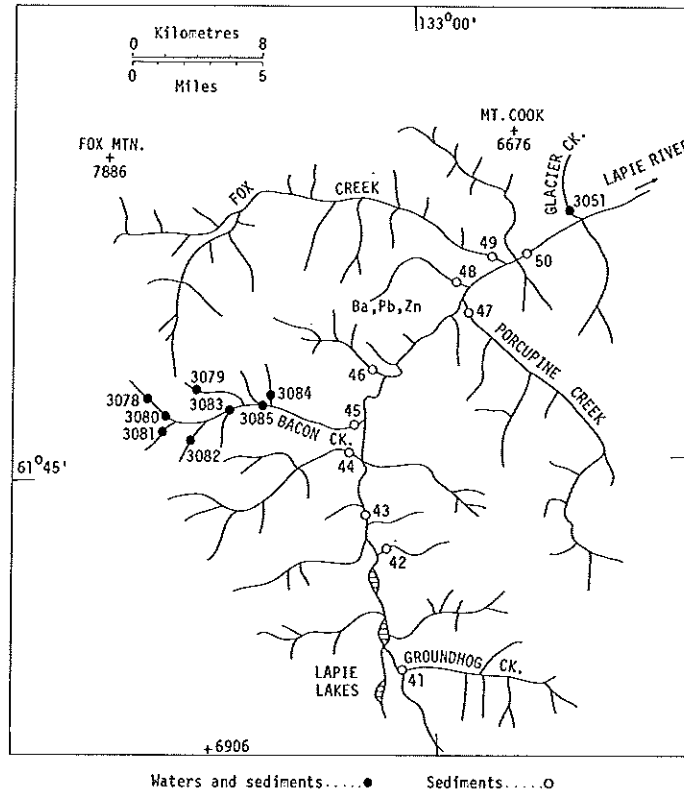

Figure 46.4. Bacon Creek-Lapie River (105 F/14).

Conclusions

Areas of potential interest can be outlined by water surveys using U, F, Zn and $SO_4^=$ in any combination. U itself is obviously the best indicator of U mineralization but the apparent close association between U and F strongly promotes the use of F as well. Measurements of pH and Fe are valuable for interpretative purposes; clues to the presence of oxidizing sulphides and knowledge of adsorption controls on dispersion processes for U would be the main benefits. Background levels for U in waters from all regions studied are generally in excess of 0.5 ppb, a convenient level for rapid routine analysis. Levels of F under normal conditions usually are greater than 50 ppb which puts them into the most useful range of a fluoride electrode. Anomalous levels for Zn are often in excess of 5 ppb over a background of 0.5-1.5 ppb depending on local geology.

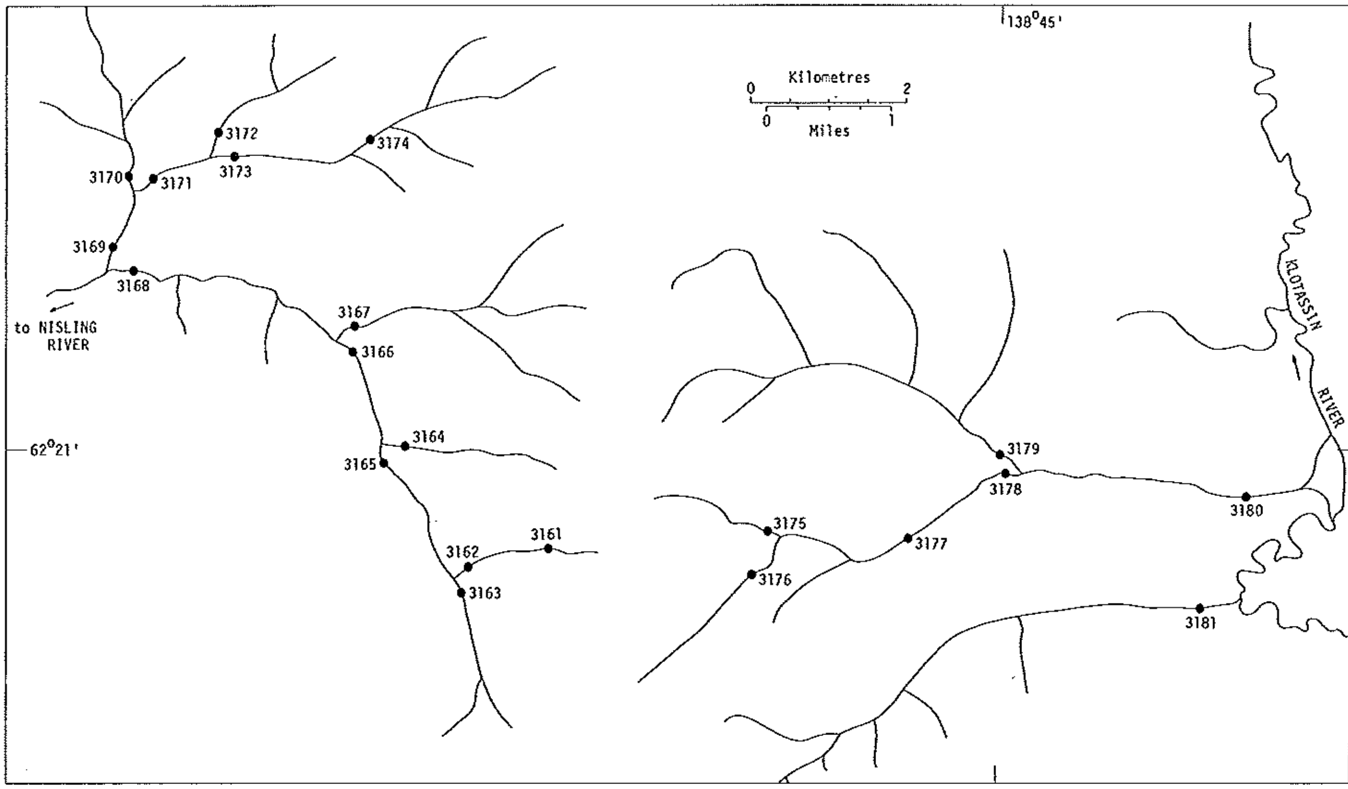

Figure 46.5. Nisling River-Klotassin River (115 J/7). Waters and sediments.

Analysis for $SO_4^=$ at the prospecting level, especially in areas underlain by black shales, may become a useful adjunct to data from Zn and U analyses.

Cu dispersion, normally severely limited by alkaline pH, can become useful when pH falls below 6. Analysis for Cu is not recommended under other conditions except in very local work when its presence may indicate proximity of source mineralization. Similar comments apply to Pb in waters.

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