ANOMALOUS URANIUM IN THE SUMMERLAND CALDERA
(82E/12)

By B. N. Church

INTRODUCTION

Anomalous uranium values in streams in the southern part of the Okanagan Valley were detected by the 1976 Federal/Provincial Uranium Reconnaissance Program and delineated further during the course of exploration by private individuals and mining companies. The principal zone of uranium concentration, as shown on Figure 6.4a of the Ministry's recent Brief to the Uranium Commission, is on the west side of the Okanagan Valley between Summerland and Oliver. Some very high values in the range 2.3 to 17.5 ppm* uranium were previously reported in pond waters from this area (*Geological Fieldwork, 1977*, p. 10). In the light of these discoveries the Ministry has initiated a water monitoring program focus in part on the Summerland district (*see* Brief, pp. 57-67).

GEOLOGICAL SETTING

An association of uranium deposits with volcanic calderas has been established in the American southwest. Well-known examples are Valles caldera, New Mexico, the McDermitt caldera in Nevada, and the Silverton—Lake City cauldron complex of Colorado. At Valles, uranium has apparently been derived from late hydrothermal activity associated with ring fracturing. Here the mineralizing solutions are trapped along the numerous angular unconformity surfaces formed during caldera collapse. Intracaldera lake sediments with carbonaceous trash horizons are favoured targets for mineralization in the McDermitt caldera. At the Silverton caldera, uranium is concentrated in cracks in the basement rock below the volcanic pile.

Ash deposits associated with calderas may provide both source material and suitable traps for uranium. The Nopal deposit of Peño Blanco in Chihuahua province of Mexico is an example. Devitrification of acidic tuffs by hydrothermal solutions is thought to be important in mobilizing the uranium. The characteristic stacking of alternate permeable and impermeable, nonwelded and welded ash flow members in the Nopal Formation provides suitable trap and cap rock structures for the deposition and preservation of orebodies.

The general structure, stratigraphy, and lithology of the Summerland basin seems to conform to the caldera model although only the central and western segments of this small Tertiary outlier have survived major faulting and erosion. The basin is obscured on the east by Okanagan Lake and truncated on the southeast by the Summerland fault (Fig. 2). Nevertheless, it retains a subcircular plan with beds dipping inward toward Giants Head which is a centrally located hill of relatively young Marama dacite lava, dated 48 Ma by K/Ar whole rock analysis. Other Eocene units form the basal and intermediate layers in the basin below the dacite. Granite boulder conglomerate and breccias assigned to the Kettle River Formation are exposed over a small area at the base of the section on the western margin of the Tertiary outlier. This is overlain by a local deposit of feldspathic lava belonging to the Kitley Lake member of the Marron Formation. The Nimpit Lake member of the Marron Formation lies above this and consists of a thick and widespread sequence of trachyandesite ash flows and some intercalated lava. The youngest units are well exposed along Highway 97 north of Summerland where Marama lava overlies Nimpit Lake ash flows. Uppermost in the Eocene succession is a clastic assemblage of conglomerate, sandstone, and shales correlated with the sedimentary member of the White Lake Formation (Church, 1973).

*ppm — parts per million; ppb — parts per billion.

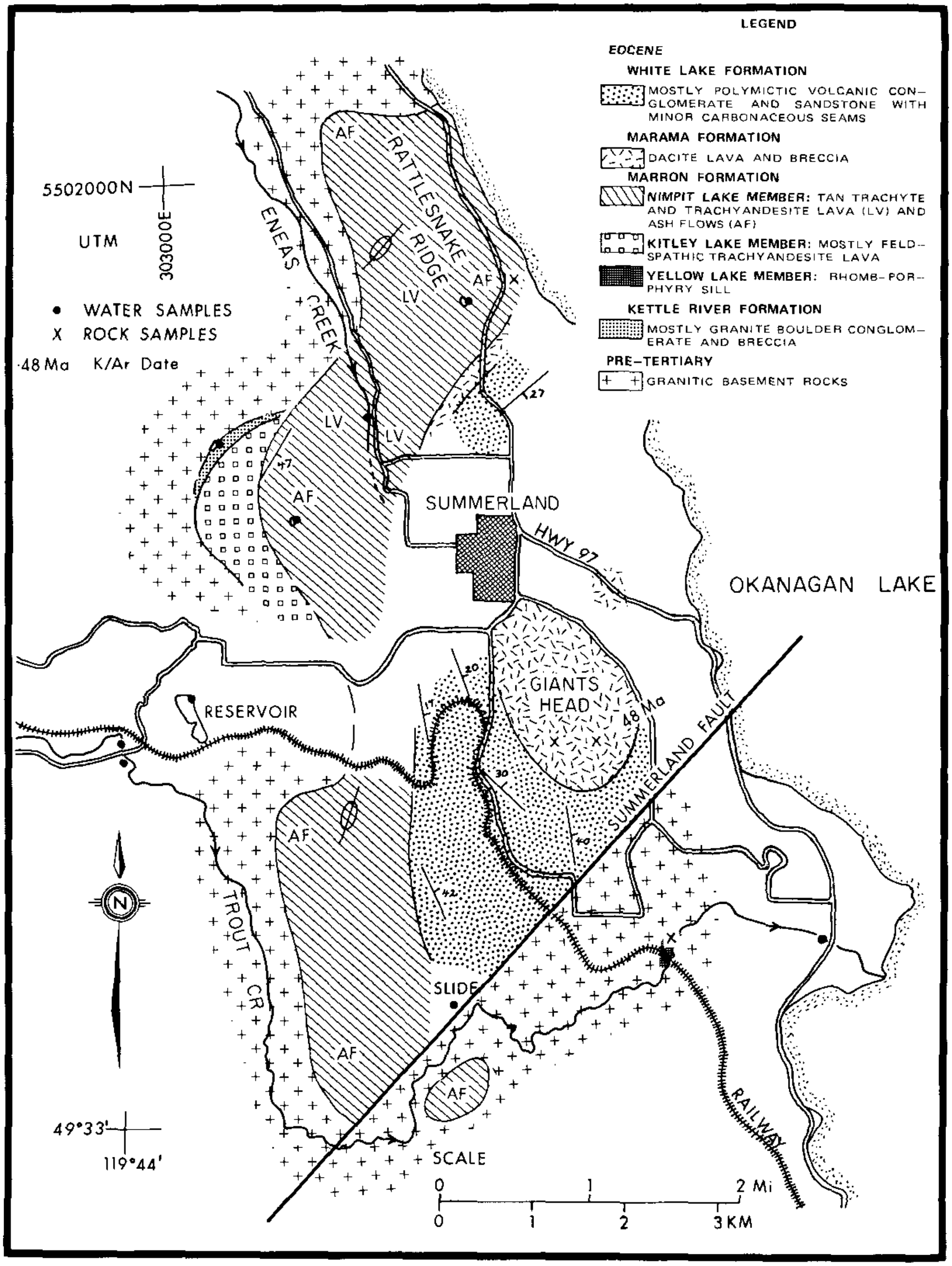

Figure 2. Geology of the Summerland caldera.

The prime source of the ash flows is believed to lie within the Summerland basin, this facies of the Nimpit Lake unit being absent in adjacent Eocene sections. The consequence of emplacement of ash flows, in keeping with current theory, is caldera collapse, the suspected origin of the Summerland basin. Similarly, the Marama dacite forming Giants Head is viewed as a resurgent volcanic dome completing the caldera cycle of eruption.

CHEMICAL RESULTS

The results of water analyses in the Summerland area are given in the following table. The data show a wide range of uranium values and a positive, although not rigorous, correlation between U, F, and pH levels.

ANALYSES OF WATERS IN THE SUMMERLAND AREA

		U *ppb*	F *ppb*	pH
(1)	Spring, slide area south of Summerland			
	SUM 008, July 12, 1977	43.00	930	8.0
(2)	Spring near bridge by Trout Creek, west of Summerland			
	MAG 078, June 22, 1979	0.66	80	7.3
	SMD 003, August 27, 1979	0.44	140	7.3
(3)	Pond, north Summerland			
	SUM 007, July 12, 1977	2 500.00	1 170	9.8
(4)	Pond, northwest Summerland			
	SUM 006, July 12, 1977	11.00	555	8.1
(5)	Pond, northwest Summerland			
	SUM 005, July 12, 1977	5.60	1 210	9.2
(6)	Summerland reservoir			
	MAG 075, June 22, 1979	1.11	72	7.4
	SMD 002, August 27, 1979	1.10	120	7.8
(7)	Eneas Creek, Summerland			
	SMD 001, August 27, 1979	23.00	430	8.0
	SUM 009, July 12, 1977	23.00	410	8.2
(8)	Domestic well, near mouth of Darke Creek			
	MAG 077, June 22, 1979	18.00	335	7.6
(9)	Upper section of Trout Creek			
	MAG 082, July 14, 1979	1.19	107	7.4
(10)	Lower section of Trout Creek			
	MAG 087, July 14, 1979	5.60	305	8.5

LOCATIONS

UTM coordinates	Easting	Northing
No. 1	305850	5493150
No. 2	302700	5496000
No. 3	306150	5500800
No. 4	303400	5499200
No. 5	304300	5498300
No. 6	303100	5496500
No. 7	305100	5499400
No. 8	299100	5499300
No. 9	302500	5496010
No. 10	309800	5493800

The highest reading for uranium (2.5 ppm) was obtained on alkaline water (pH 9.8) from a small pond in an area underlain by ash flows near Highway 97 north of Summerland. Similar anomalous results were previously reported from the 'Oliver ponds' in *Geological Fieldwork, 1978,* page 10. According to Culbert and Leighton (1978, p. 104), the combination of unusual source rocks and climatic conditions is responsible for these anomalies. In the Okanagan region, rapid evaporation rates from ponds in closed depressions can lead to super-enrichment of uranium.

Relatively high uranium concentrations in flowing water, such as shown by analyses of Eneas Creek (23 ppb), are not readily explained. The seepage of uraniferous groundwater into the drainage system from mineral-enriched strata or fault zones is a possibility.

Trout Creek partly encircles the Summerland caldera on the south on its course to Okanagan Lake. The upper section of this stream and tributaries, immediately west of Summerland and the source of water for municipal use, is relatively pure having less than 1.2 ppb uranium at the time of sampling. However, a *several-fold increase in uranium is observed downstream near the mouth of Trout Creek. This increase* appears to be due to the seepage of uranium-charged groundwater into the creek from the Summerland basin. The spring containing 43 ppb uranium south of Summerland is an example of such seepage (Fig. 2).

A probable primary source of uranium is believed to be the Tertiary volcanic and effusive rocks. It has been shown that the Yellow Lake member of the Marron Formation having above-average uranium levels could yield important amounts of this element under suitable leaching or weathering conditions (*Geological Fieldwork, 1978,* pp. 12-14; *Western Miner,* 1978, No. 5, pp. 33, 34). An example of these rocks in the Summerland basin is the rhomb porphyry intrusion near Trout Creek which assays highest in uranium (13 ppm) when compared with other major rock types (*see* the following table). The apparent limited occurrence, however, would seem to preclude the Yellow Lake rocks as a likely source in this instance, unless of course, such rocks in fact subcrop extensively.

CHEMICAL ANALYSES OF VOLCANIC AND EFFUSIVE ROCKS

	1	2	3	4
Oxides recalculated to 100				
SiO_2	55.72	58.27	65.58	68.28
TiO_2	0.99	1.10	0.72	0.56
Al_2O_3	18.23	16.73	16.19	15.49
Fe_2O_3	2.98	3.27	1.85	3.76
FeO	2.88	2.68	2.72	0.18
MnO	0.11	0.10	0.09	0.04
MgO	3.54	3.08	2.00	1.03
CaO	5.88	4.11	4.17	2.93
Na_2O	4.12	3.73	3.72	3.68
K_2O	5.55	6.93	2.96	4.05
	100.00	100.00	100.00	100.00
Oxides as determined				
H_2O+	1.72	1.02	2.90	0.50
H_2O-	0.20	0.90	1.31	0.83
CO_2	0.25	2.32	0.25	0.25
S	0.01	0.01	0.003	0.01
P_2O_5	0.37	0.21	0.14	0.10
BaO	0.21	0.17	0.13	0.13
SrO	0.28	0.09	0.07	0.05
U (ppm)	13	6	4	3
Th (ppm)	62	20	9	10
RI	1.548	1.538	1.524	1.515

KEY TO CHEMICAL ANALYSES

1 — Rhomb porphyry sill, Trout Creek canyon.

2 — Partly welded trachyandesite ash flow, Nimpit member of Marron Formation, rock cut on Highway 97.

3 — Columnar dacite dyke, feeder to Marama lavas, quarry on west side of Giants Head.

4 — Banded dacite lava, Marama Formation, peak of Giants Head.

NOTE: Analyses have been provided courtesy of Dr. W. M. Johnson, Analytical Laboratory, British Columbia Ministry of Energy, Mines and Petroleum Resources.

An alternative source is the Nimpit Lake member which is a widely exposed unit containing 6 ppm uranium. Much uranium could be released to groundwater by devitrification of unstable potassium-rich glass in these partly welded rocks by process of lithification or hydrothermal alteration.

The possibility of formation of secondary deposits from uranium-enriched waters in the Okanagan area has been discussed by Culbert and Leighton (1978, p. 109). This could be achieved by absorption of uranium on clay, zeolites, or organic sediments with the aid of reducing conditions produced by carbonaceous material, sulphide mineralization, or bacterial action. It is shown that the degree of concentration and rate of accumulation of uranium under natural conditions can be significant in creating deposits of economic potential in young sediments.

The White Lake beds may offer favourable exploration targets for secondary deposits. At Summerland these are mostly wedging coarse clastic intracaldera sedimentary rocks with some carbonaceous mudstones and thin coaly seams. Silicification viewed at several points in Marama dacite indicates a period of late hydrothermal activity that may also have introduced mineralization in the White Lake rocks in the form of uranium-fixing sulphides or uranium directly.

An important factor to be balanced against the search for ore deposits here is the reality that much of the area is either residential or farm land, and therefore precluded from location of mineral claims.

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PURCELL PROJECT

(82G/5)

By T. Höy

Regional mapping at a scale of 1:25 000 of an area centred on Moyie Lake in the Purcell Mountains in southeastern British Columbia was initiated in 1979. The area is underlain primarily by rocks of the Purcell Supergroup of Helikian/Hadrynian age. The project is a continuation of a regional study of the Purcell Supergroup that is emphasizing the depositional environment of these rocks in order to determine the relationships between sedimentation, tectonics, and stratiform sulphide deposits. Two recently published preliminary maps with reports have been released describing the structure, stratigraphy, and depositional environment of Purcell rocks in the Hughes and Lizard Ranges on the east side of the Rocky Mountain Trench. The first, by McMechan (1979), includes the area south of the Wild Horse River; the second (Höy, 1979), located north of Wild Horse River, is an extension of a previously released map (Höy, 1978).

The Moyie Lake project will continue in 1980 and will extend mapping north to Cranbrook, east to Gold Creek, and south to approximately 49 degrees 10 minutes north. It will concentrate on subdivision of the Aldridge Formation, location of the Lower–Middle Aldridge contact, and the relationship of the Moyie fault to Precambrian and younger tectonics. Detailed stratigraphic section measurements and studies of lead-zinc deposits (such as the St. Eugene deposit) will augment the project.

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