PROJECT GEOLOGY

METALLIC INVESTIGATIONS

SOUTHEAST BRITISH COLUMBIA

TERTIARY STRATIGRAPHY AND RESOURCE POTENTIAL IN SOUTH–CENTRAL BRITISH COLUMBIA (82 E, L)

By B. N. Church

The interior of British Columbia is characterized by many fault-bounded Tertiary basins filled with felsic lavas and associated fluvial and lacustrine sedimentary rocks reminiscent of the Basin and Range Province of the southern Cordillera. The main volcanic and sedimentary rocks are of Eocene age and lie in a northwesterly trending belt about 160 kilometres wide, extending 800 kilometres northwest from the Republic Mining District in Washington state to the Babine Lake area of central British Columbia. Basal units are often shoe-string in plan and valley filling whereas upper formations are mostly sheet-like plateau lavas. Olivine basalt flows of Miocene and Pliocene age frequently overlie the Eocene volcanic units of acid or intermediate composition.

Current investigation of these rocks has been stimulated by recent uranium discoveries and renewed interest in sub-bituminous coal. Only scattered information is available on the composition, regional stratigraphy, structure, and history of the Tertiary assemblage and it is the purpose of the present study to expand on the existing data.

STRATIGRAPHY

The accompanying table of formations for the Okanagan–Boundary region is based on work performed by the writer intermittently during the period 1963 to 1978, and on detailed reports assembled for the various Tertiary sections in 1973 and 1975. The areas of special investigation include segments of the Penticton, Kelowna, Vernon, and Rock Creek areas covered by the Uranium Reconnaissance Program in 1976. Approximately 1 200 square kilometres was mapped in the 1977 and 1978 field seasons at 1:50 000 scale by way of 145 separate traverses and 2 675 geological stations.

Working laterally from the White Lake area between Keremeos and Penticton, the various Tertiary formations can be followed without much difficulty using stratigraphic subdivisions proposed by the writer in 1967 and 1973. A few new sedimentary units have been recognized in the Marron section but these are only locally important. The Springbrook basal conglomerate is largely missing in the northern part of the area where these rocks are replaced by rhyolite ash and breccia deposits that appear to have had their

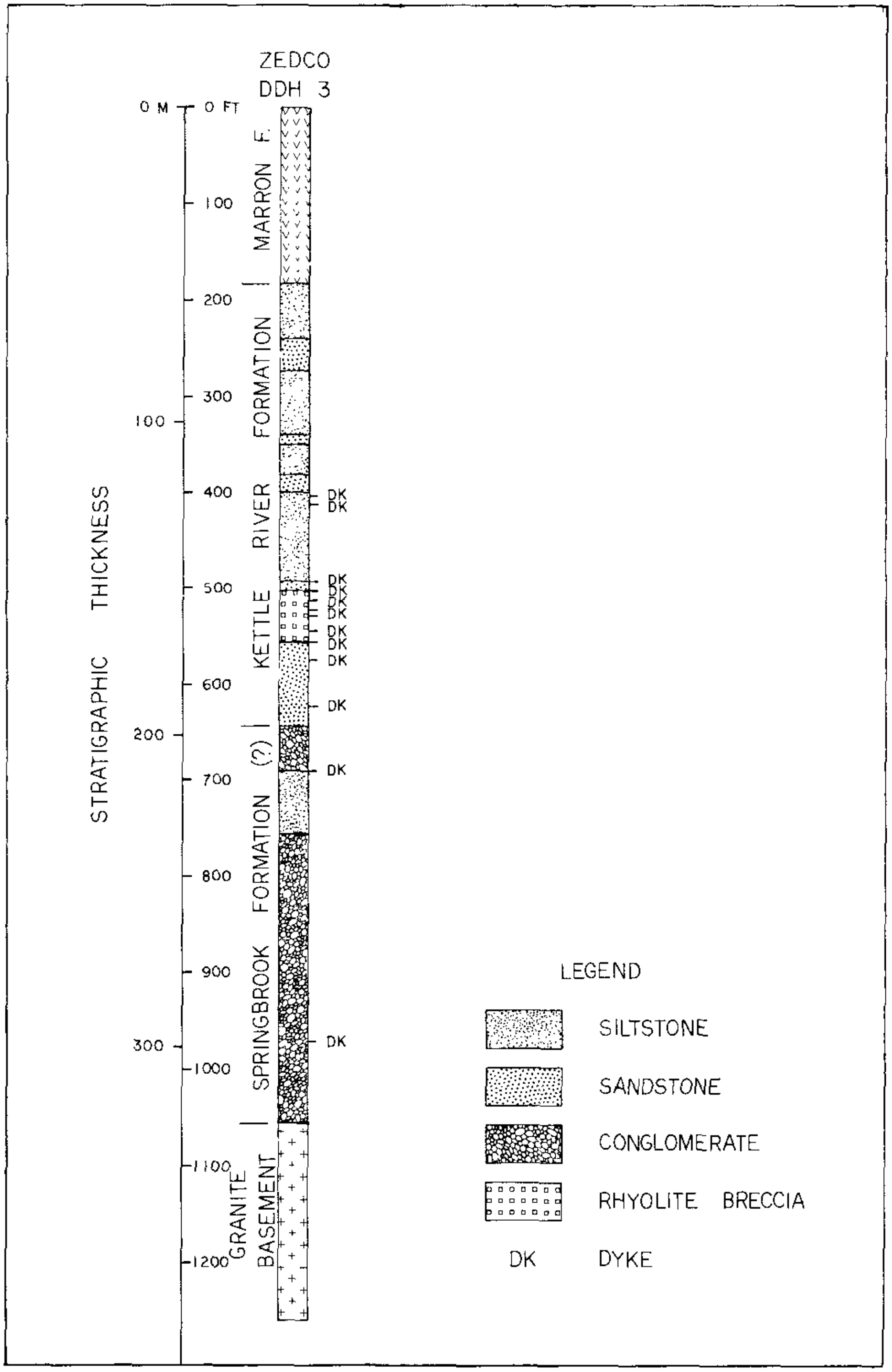

Figure 1. Diamond-drill section of the basal Tertiary units 6.5 kilometres north of Midway.

source in the Shingle Creek stock. Above this unit and extending to Riddle Creek, west of Penticton, are radioactive mafic phonolites and rhomb porphyry lavas of the Yellow Lake member. The tan trachyte belonging to the Nimpit Lake member in the middle part of the Marron Formation extends beyond Summerland where the lavas are replaced by ash flow deposits of the same composition.

The Marama dacite was traced north along the axis of the Okanagan Valley from the south end of Skaha Lake to Giants Head at Summerland and Mount Boucherie in the Kelowna area. These lava accumulations form an array of well-developed domes of apparent contemporaneous age. A whole rock K/Ar age determination obtained on dacite from the upper north slope of Giants Head gives a middle Eocene age of 46.8±l.6 Ma.

The Tertiary stratigraphy in the Kelowna (Westbank) area is relatively straightforward although modified somewhat from the Penticton section. The Trepanier rhyolite breccia, a possible equivalent of the Shingle Creek rhyolite, occurs at the base of the volcanic pile accompanied locally by some polymictic conglomerate similar to the Springbrook Formation. The Marron Formation overlies Trepanier rhyolite but only the Nimpit Lake and Kitley Lake members are present. Yellow Lake mafic phonolites and rhomb porphyry lavas, widespread to the south, are unknown in the Kelowna area. The age of the Kitley Lake member has been established as Eocene, by two identical dates of 51.6 Ma and on K/Ar analyses of biotite from trachyandesite lava flows in the Kelowna and Penticton areas.

The youngest units in the volcanic succession are olivine basalts on Lambly Creek, dated as Pleistocene (0.742±0.115 Ma) and on Carrot Mountain, dated Miocene (11.5±0.4 Ma) by K/Ar whole rock analysis.

The Tertiary geology between Rock Creek and Midway is almost a repetition of the Marron section in the White Lake basin near Penticton 70 kilometres to the northwest (Church, 1973). Missing from the middle part of the section here is the Kearns Creek member; added is a hornblende andesite unit accompanying the Park Rill member.

Above the Marron Formation, equivalents of the Marama and White Lake beds were not found, however east of Midway in the area of the headwaters of Norwegian Creek a slide breccia melange (Monger, 1966 and Pearson, 1977) may correlate with the Skaha Formation, the youngest Tertiary beds in the Penticton area.

Sedimentary rocks penetrated by a diamond-drill hole approximately 6.5 kilometres north of the village of Midway are recognized, in the upper part, as the Kettle River Formation. This is a mixed succession of feldspathic wacke and grey carbonaceous mudstones, 140 metres thick, with a thin band of rhyolite breccia, about 15 metres thick, near the base. A well-indurated older polymictic conglomerate unit intercepted below the Kettle River Formation may be a correlative of the Springbrook Formation known in the Penticton area, or possibly, a yet older Mesozoic formation (Fig. 1).

West of Okanagan Lake in the Vernon area the Tertiary assemblage is again fairly diverse. The following newly defined section (top to base) holds throughout the Terrace Mountain—Bouleau Lake region:

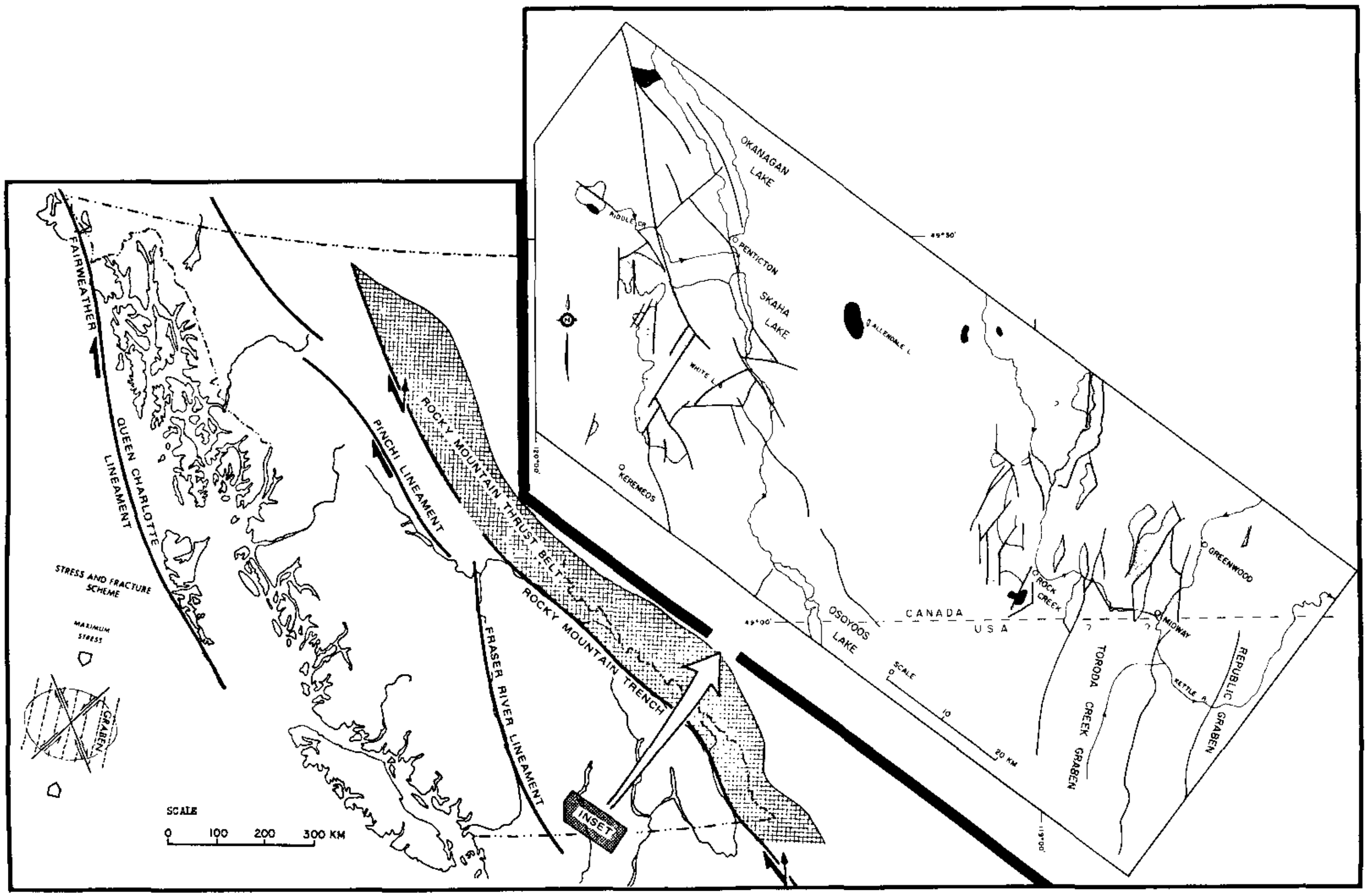

Figure 2. Proposed Early Tertiary stress and fracture scheme for British Columbia and (inset) distribution of downfaulted alkaline Marron volcanic rocks (stippled) and Coryell source intrusions (grid).

TAHAETKUN BASALT is the youngest unit in the section. Feeder dykes and remnants of olivine basalt lava assigned to this formation are found scattered on numerous hillsides and ridge tops.

NASWHITO CREEK FORMATION consists of a thick succession of mostly dacite lava (about 300 metres thick) exposed extensively in the area drained by the headwaters of Naswhito Creek near Bouleau Lake.

BOULEAU RHYOLITE forms a distinctive marker unit of breccia and glassy lava, 15 to 60 metres thick, viewed mostly on the bluffs north of Bouleau Lake and on the upper slopes of Terrace Mountain.

KITLEY LAKE MEMBER (MARRON FORMATION) occurs as a belt of feldspar porphyry lava and breccia, about 300 metres thick, extending north and south from a Coryell-type stock exposed on Whiteman Creek – a probable source vent for these rocks.

ATTENBOROUGH CREEK FORMATION is a widely distributed assemblage of thinly bedded, fine-grained andesite and dacite lavas. A complete section of these rocks, about 450 metres thick, is exposed on Shorts Creek and its tributary Attenborough Creek.

SHORTS CREEK FORMATION is a wedge of brown and grey fossiliferous sandstones, shales, and coarse polymictic conglomerates (8 to 30 metres thick) exposed at the base of the Tertiary section in Shorts Creek canyon.

Correlation of the principal volcano-stratigraphic units much beyond the area of immediate study does not appear to be feasible. There is good evidence that the alkaline volcanic province of the Okanagan–Boundary region, manifest in the Marron Formation, does not extend much beyond the Vernon area on the north and northwest nor the Washington state border on the south and southeast.

STRUCTURE

As indicated by previous studies (Church, 1973, 1975) the Tertiary basins have been influenced during their course of development by major normal faults – some of which show vertical displacement in the order of several hundreds of metres.

In general, structural control of the Tertiary outliers seems to relate to a herringbone pattern of conjugate shears of northeast and northwest orientation (Fig. 2). These appear to be important elements in a north/south stress scheme responsible for the many northerly trending graben structures extending across the interior of the Province from the Fraser River lineament to the Rocky Mountain Trench.

The period 45 to 53 Ma witnessed intense volcanic and tectonic activity, according to Mathews (1964), including major disturbances in the Rocky Mountains. It is interesting to note here that this interval corresponds rather well with the period of northerly movement of the Pacific plate (41 to 55 Ma, Rona, *et al.*, 1978).

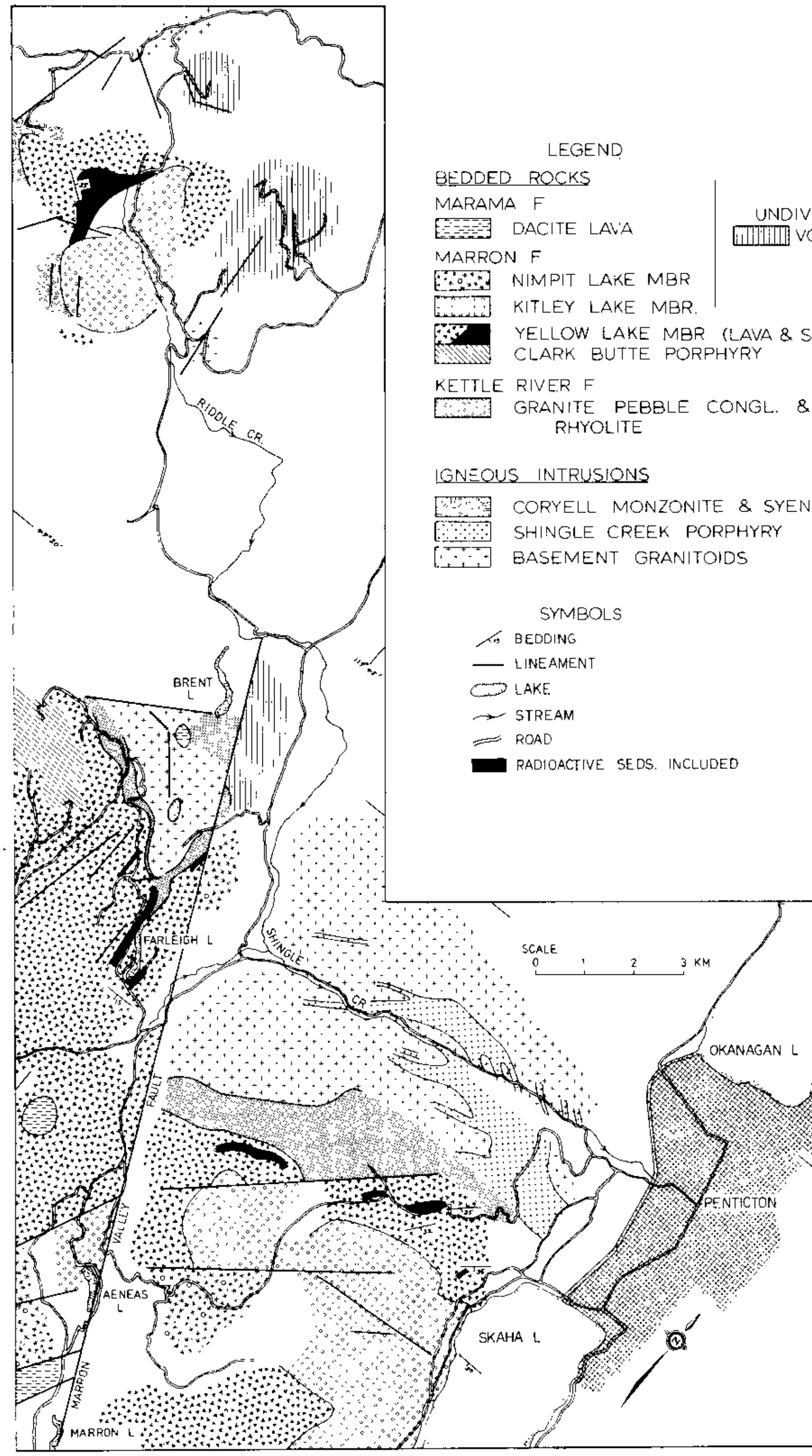

Figure 3. The Penticton Uranium–Thorium Belt.

This coincidence suggests that the same stresses acting on the Pacific plate may have been active in the Cordillera during the Eocene. A complex inter-relationship of shears, tension faults, and folds such as proposed by Brown (1928) and Illies, *et al.,* (1976) might also explain the simultaneous development of grabens and thrusting in the southern interior and eastern British Columbia.

URANIUM AND THORIUM IN THE ALKALINE VOLCANIC ROCKS

The Yellow Lake member of the Marron Formation is a major unit near the base of the Tertiary section comprising locally as many as 20 consecutive flows and attaining a thickness of 500 metres in a few places. It underlies approximately 600 square kilometres in the Okanagan–Boundary region (Fig. 2). Source of the lavas is believed to be the necks and composite stocks of Coryell monzonite, shonkinite, and syenite such as exposed near Rock Creek, Riddle Creek, and Allendale Lake.

Particular interest in the Yellow Lake lavas as a source of uranium was aroused when it was noted that these rocks displayed several times normal background radioactivity. Random testing during the course of the geological survey, using a model GRS-101 Exploranium scintillometer, gave an average reading of 164±32 cps for 127 stations. A few especially high readings, in excess of 1 000 cps, were obtained in the Penticton area.

A suite of 202 samples of Yellow Lake rocks was collected during the geological survey and submitted to the Government laboratory for quantitative uranium and thorium analyses. The results show a mean composition of 11.15±4.63 ppm uranium and 43.09±9.97 ppm thorium.

The actual presence of mobilized uranium was first detected in water samples by the 1976 Uranium Reconnaissance Program geochemical survey. This showed that Ingram Creek, which follows a strong Tertiary fault lineament near Midway, and similar streams associated with Tertiary rocks in the Penticton area, are enriched in uranium as are a number of nearby springs and alkaline ponds.

The release of uranium is probably achieved by weathering and leaching of the Yellow Lake volcanic rocks and associated intrusive formations and the comminuted equivalent in glacial drift. The mobilization of uranium would be enhanced by the simultaneous removal of alkalies from the host assemblage although thorium would probably remain fixed.

The large potential source area for uranium such as offered by the Yellow Lake lavas does not itself prove or necessitate a significant uranium concentration. This would require the interplay of suitable stratigraphic and structural factors with favourable climatic and weathering conditions. The concentration of uranium in ponds is interesting, if not commercially important, because this may reflect similar conditions recorded earlier in the local Tertiary stratigraphy. Possible traps for dispersed uranium are numerous and may be zeolite fillings or pyritiferous accumulations on fissures, manganese pitch on cracks in weathered source rocks, zeolitized tuff beds, or carbonaceous sediments, etc.

Current exploration work of some promise is located near Penticton (Fig. 3). Recent diamond drilling at Farleigh Lake by Pacific Petroleum Ltd. and Riddle Creek by Brinex, has intersected peculiar radioactive sedimentary rocks in the Yellow Lake member. The target is a pink feldspathic grit and volcanic conglomerate that appears to be mostly reworked volcanic breccias and ash flow material. The beds are commonly 10 to 25 metres thick and are often associated with grey volcanic wacke and coarse rhomb porphyry lava flows. At Farleigh Lake these rocks rest on rhyolite breccias and granite boulder conglomerate of the Kettle River Formation. In the Riddle Creek area, to the northwest, the radioactive sedimentary rocks are exposed on the flank of an alkalic volcanic centre that appears to be rooted on a partly exposed Coryell-type syenite intrusion. Similar radioactive pink grits have been found on the Penticton Indian Reserve occurring in a faulted somewhat discontinuous band between Farleigh Lake and the lower section of Skaha Creek. The full belt of radioactive anomalies extending between Skaha Lake on the southeast and the headwaters of Riddle Creek on the northwest is approximately 25 kilometres long.

Field testing of pink grits yield scintillometer readings in the range of 300 to 600 cps. Laboratory analyses of the same rocks show an excess of thorium over uranium in the ratio 210 ppm Th, 50 ppm U. Higher uranium values have been obtained on some samples with manganese stain and much higher values are reported from examination of certain carbonaceous seams associated with the grits. Further geochemical data and mineralogical studies await ongoing field and laboratory investigations.

CENOZOIC FORMATIONS IN THE OKANAGAN – BOUNDARY REGION

ERA	VERNON AREA (WEST)	KELOWNA AREA (WEST)	PENTICTON AREA	ROCK CREEK – MIDWAY AREA
PLEISTOCENE		LAMBLY CREEK BASALT		
PLIOCENE				
MIOCENE	TAHAETKUN BASALT (?)	CARROTT MOUNTAIN BASALT		
OLIGOCENE				
EOCENE	NASWHITO CREEK FORMATION (?)		SKAHA FORMATION	
	BOULEAU RHYOLITE (?)		WHITE LAKE FORMATION	
		MARAMA FORMATION	MARAMA FORMATION	
	MARRON FORMATION	MARRON FORMATION	MARRON FORMATION	MARRON FORMATION
			PARK RILL MEMBER	PARK RILL MEMBER
		NIMPIT LAKE MEMBER	NIMPIT LAKE MEMBER	NIMPIT LAKE MEMBER
			KEARNS CREEK MEMBER	
	KITLEY LAKE MEMBER	KITLEY LAKE MEMBER	KITLEY LAKE MEMBER	KITLEY LAKE MEMBER
	ATTENBOROUGH CREEK FORMATION		YELLOW LAKE MEMBER	YELLOW LAKE MEMBER
		TREPANIER RHYOLITE	KETTLE RIVER FORMATION	KETTLE RIVER FORMATION
	SHORTS CREEK FORMATION (?)	SPRINGBROOK FORMATION	SPRINGBROOK FORMATION	SPRINGBROOK FORMATION (?)

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