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GEOLOGY OF SKOOKUMCHUCK MAP AREA SOUTHEASTERN BRITISH COLUMBIA (82G/13W)

By G. Carter and T. Höy

INTRODUCTION

The Skookumchuck area lies directly northeast of Kimberley and west of the Kootenay River in southeastern British Columbia (Figure 3-3-1). It measures approximately 18 kilometres by 28 kilometres, an area of about 500 square kilometres. Topographic elevations range from 760 metres in the east to 2320 metres in the west. It is all below timberline and, as a result, outcrops are often scarce. The area occupies the northwest corner of Leech's (1960) Fernie west half preliminary map. Regional mapping was initiated in 1982 by T. Höy and L. Diakow and was completed during the 1986 field season by G. Carter.

The Skookumchuck west half map sheet is underlain by Proterozoic Belt-Purcell rocks in the Purcell anticlinorium (Figure 3-3-2). Prior to this paper correlation between the Dutch Creek Formation in the Purcell Mountains to the west and northwest, and the Gateway, Phillips and Roosville stratigraphy to the south and southeast lacked documentation, and the exact extension of the underlying Nicol Creek lavas west of Skookumchuck was unknown.

The purpose of this paper is to clarify and describe the nature and thickness of upper Purcell rocks, to document the transition from Gateway, Phillips and Roosville stratigraphy into Dutch Creek stratigraphy, and to trace the extent of the Nicol Creek lavas.

GENERAL GEOLOGY

Figure 3-3-2 shows the general geology of the study area and of the immediately surrounding areas. The Skookumchuck area lies west of the Rocky Mountain Trench fault, north of the St. Mary fault and Sullivan deposit, and east of the White Creek batholith. The major structure in the area is a broad open anticline cut by several westerly dipping normal faults. The anticline exposes Proterozoic Belt-Purcell Supergroup rocks from the middle Aldridge to the Mount Nelson Formations (Figure 3-3-3).

LOCAL STRATIGRAPHY

Descriptions of lower Purcell rocks to the south and east have recently been published (Höy, 1979, 1983, 1985; McMechan, 1981) and are only briefly reviewed here. Upper Purcell rocks and, in particular, the nature of the transition from Gateway, Phillips and Roosville into Dutch Creek are described in considerably more detail. Stratigraphic thicknesses were measured in the field and calculated and estimated on cross-sections. The total thickness of the stratigraphic succession from the basal contact of the upper Aldridge to the Dutch Creek-Mount Nelson contact is about 10 000 metres (Figure 3-3-4).

LOWER PURCELL STRATIGRAPHY

The upper Aldridge member, exposed in the southwest corner of the map area, is about 500 metres thick (Section C-C', Figures 3-3-3 and 3-3-7). The overlying Creston Formation has been divided into three members (Figure 3-3-4). The lower silty member ($P\epsilon c_1$) is about 700 metres thick, the middle quartzitic member about 1500 metres thick and the upper silty and quartzitic member has a thickness of about 500 metres. The total thickness of the Creston Formation is therefore about 2300 metres, compared with about 1600 metres in the Kimberley area (Höy, 1983), 2208 metres at Moyie Lake (Höy, 1985) and 1670 metres near Findlay Creek (Reesor, 1973). The overlying Kitchener Formation consists of a lower dolomitic siltstone member (±500 metres) and an upper dark grey carbonaceous dolomite and limestone member. The upper unit has conspicuous molar-tooth textures and is intruded, near its centre, by one or two gabbroic sills. The total thickness of the Kitchener Formation in the Skookumchuck area is approximately 2200 metres. To the west, near Cherry Creek, it is about 1430 metres thick (Reesor, 1958), east of the trench, 926 metres (Höy, 1985) and in the Kimberley area, approximately 2000 metres (Höy, 1983).

The Van Creek Formation has a variable thickness within the map area, but averages approximately 550 metres. It comprises laminated green siltstone and locally purplish sandstone. The Van Creek Formation is greater than 750 metres thick in the Bloom Creek area southeast of Cranbrook, and 926 metres thick at Cherry Lake, further south (*see* Sections 16 and 21 *in* Höy, 1985). West of the Skookumchuck area at Buhl Creek, Reesor (1958) measured 550 metres of Van Creek Formation. The formation is intruded by a dioritic sill near Ta Ta Creek.

The Van Creek is overlain by 60 to 130 metres of amygdaloidal basaltic volcanic flows of the Nicol Creek Formation. Near Echoes Lakes, Diakow (*in* Höy, 1985) described a polymictic conglomerate at the base of the Nicol Creek Formation which correlates with a similar conglomerate observed near Mount Baker, east of Cranbrook (Höy and Diakow, 1982). The conglomerate cuts down into the underlying Van Creek Formation, indicating the presence of a regional unconformity. The Nicol Creek lavas have been traced at regular intervals throughout the Skookumchuck area, from southwest of Reed Lakes (Figure 3-3-3) to the east bank of Bradford Creek (Section B-B', Figure 3-3-7.) The furthest previously recognized extent of Nicol Creek lavas was on Skookumchuck Creek, just west of Skookumchuck (Walker, 1926). This northwestern extension consists of two closely spaced flows separated by a thin sequence of fine tuffs and siltstone. A slightly younger sequence of thinly interbedded siltstone and lava 60 metres thick was recognized near Mount McMillan. Purple coarse sandstones have been encountered west of Bradford Creek at approximately the same stratigraphic level as the main lava flows. Further west on the ridge east of Buhl Creek, Reesor (1958) described 61 metres of volcanic tuff breccia and volcaniclastic rocks. The coarse purplish sandstones and basaltic tuffs indicate that the flows pinch out west of Bradford Creek, whereas tuffs extend over a somewhat larger area.

UPPER PURCELL STRATIGRAPHY

The upper Purcell stratigraphy comprises the Gateway, Phillips and Roosville Formations to the east, and the Gateway, Dutch Creek and Mount Nelson Formations to the northwest. A minimum of 1047 metres of upper Purcell rocks was measured near Echoes Lakes, whereas a minimum of approximately 3310 metres was estimated from map data and cross-sections near Larchwood Lake (Figure 3-3-5). Further thickening can be estimated from cross-sections to the northwest where the Dutch Creek Formation itself apparently reaches a thickness of over 4300 metres. A diagramatic

British Columbia Ministry of Energy, Mines and Petroleum Resources, Geological Fieldwork, 1986, Paper 1987-1.

sketch (Figure 3-3-6) indicates the subsidence and dramatic thickening of the upper Purcell sedimentary package to the northwest.

The Dutch Creek has not been subdivided west and northwest of the study area, except near MacDonald Creek (Freiholz, 1984) and its facies and geometry are usually only poorly understood. Walker (1926) first described the formation and although he combined all of the upper Purcell strata below the Mount Nelson Formation into the Dutch Creek Formation, he still recognized a lower member which is correlative with the lower Gateway Formation. Reesor (1973) estimated about 1220 metres of Dutch Creek stratigraphy in a folded zone in the Lardeau east half map area. Near Rose Pass, to the southwest, Rice (1941) estimated about 1310 metres of Dutch Creek stratigraphy.

The eastern facies of the Gateway Formation has a north-south lithological continuity but thickens rapidly to the north, from 800 metres at Echoes Lakes to approximately 2400 metres at Larchwood Lake (Figure 3-3-5). The lower member of the formation is characterized by an assemblage of dominantly coarse-grained, quartz wackestone, often dolomitic and locally oolitic, and sandy dolomite. Light green laminated siltstone is commonly interbedded with coarse clastic and dolomitic packages. Massive stromatolitic dolomite, regularly interbedded with clean quartz wacke and quartz arenite, is more common toward the top of the lower Gateway. Recessive units throughout the formation usually consist of siltstone-argillite couplets. Scour and fill structures, ripple marks, crossbeds and less commonly salt casts are found in this member. The overlying upper Gateway is dominantly a silty unit that consists essentially of light green siltstone similar to siltstone in the lower unit, with lenticular layering and laminations as well as fine graded bedding. A thin unit of dark grey and black finely laminated siltstone and argillite is present slightly below the Phillips Formation. A similar microlaminite also occurs immediatly above the Phillips Formation. The lower Gateway is approximately 1800 metres thick at Echoes Lakes and about 1500 metres at Larchwood Lake.

The northwestern facies are similar to, but thicker than the eastern facies. The lower member of the Gateway Formation is often well exposed and generally easily identifiable. Its upper contact has been traced on the map and cross-sections. It comprises cycles of rounded and locally gritty quartz wackestone, overlain by oolitic, stromatolitic, or massive dolomite. These cycles sometimes contain a few thin purple argillite beds with mud cracks and locally, rip-up clasts. The cycles are overlain and interbedded with light green siltstone-argillite couplets, usually lenticular, laminated and graded. Paucity of outcrops, similarity of lithologies, and the absence of the overlying Phillips Formation make it difficult to determine the exact limit of the upper Gateway and the base of the overlying Roosville Formation. A lithologically similar unit has been recognized at MacDonald Creek in the Windermere area 46 kilometres to the northwest (unit 16 of Freiholz, 1984) indicating the extensive lateral extent of the distinctive lower Gateway Formation.

The Phillips Formation is a regional marker, recognized throughout the western Rocky Mountains. It is characterized by thin-bedded, maroon quartz siltstone, quartz wackestone and argillite. Ripple marks, cross-laminations and mud cracks are common sedimentary structures, and micaceous siltstone and argillite beds are diagnostic. It cannot be traced north of Larchwood Lake where it suddenly disappears. This discontinuity is attributed to a facies change that is probably related to subsidence in late Purcell time, as indicated by dramatic thickening of the underlying units. In the last recognized exposures of the Phillips Formation at Larchwood Lake, the maroon colouring is not as conspicuous as in exposures to the south and is restricted to specific beds. The Phillips Formation is underlain by several beds of white quartz arenite and quartz wacke. It is significant that the overlying Roosville Formation here has fewer beds with rip-up clasts and that these are now dominantly rounded rather than angular.

The Roosville Formation at Echoes Lakes has very distinct lithologies. A sequence of black siltite-argillite microlaminites underlies green siltstone beds with spectacular fine and coarse rip-up clasts, well-preserved mud cracks and graded bedding. Interbeds of dark oolitic dolomite appear towards the top of the exposed sequence and beds with rip-up clasts become rare. The northernmost exposures of beds with rip-up clasts in the Roosville Formation are seen further north at Larchwood Lake. Oolitic dolomite interbeds are common within light green and grey siltstone-argillite of the upper part of the Roosville Formation. Locally, lenses and pods of dolomite produce a conspicuous buff-weathering pattern in an otherwise light green-grey-weathering siltstone sequence. On the east slope of Lookout Mountain silty quartzite and oolitic or stromatolitic dolomite beds interbedded with green siltstone form the upper part of the Roosville Formation.

The upper part of the Dutch Creek Formation is discontinuously exposed north of Skookumchuck Creek. A carbonate marker bed approximately 200 metres thick occurs within the Dutch Creek Formation approximately 3000 metres above the Nicol Creek lavas. It has been mapped west of Sundown Creek and forms a small ridge north of Skookumchuck Creek. It is a massive cream to tan-weathering, thick to medium-bedded dolomite and limestone unit. Crypto-algal features are present locally. The top and the base of the unit consist mainly of argillaceous silty dolomite. It is included within the Dutch Creek rather than the Mount Nelson Formation as the basal quartzite typical of the Mount Nelson is not exposed below it. Furthermore, green siltstone, black argillite and thin oolitic dolomite interbeds higher in the section probably correlate with similar facies in the Roosville at Larchwood Lake. However, since the Phillips is absent here, this part of the section is shown as upper Dutch Creek.

About 400 metres of the overlying Mount Nelson Formation is exposed at Lookout Mountain. It was originally described by Walker (1926) who traced it north to the Windermere area. It has a gradational contact with the underlying Dutch Creek Formation; phyllitic black argillite-siltstone rocks become increasingly more quartzitic and the interbeds of quartz wacke become cleaner up-section. The basal quartzite of the Mount Nelson is a clean, well-rounded and well-sorted, medium-bedded orthoquartzite. It contains a few thin beds of sandy dolomite. The basal quartzite is overlain by a mixture of white, green and purple quartz arenite and dolomitic sandstone, locally gritty, as well as some purplish dolomite and argillite. Locally, the diagenetic character of these maroon beds is clearly demonstrated as the colouring crosscuts bedding planes and leaves spotty remnants of light green argillite. A buff-weathering sequence of dolomite overlies these quartz wacke, siltstone and argillaceous dolomite beds. This package is overlain by more green siltstone, and minor purple siltstone and argillite.

The section at Lookout Mountain beneath the Mount Nelson Formation is abnormally thin, due either to structural truncation or to initial deposition above a tectonic high. Alternatively, it is possible that the Mount Nelson Formation at Lookout Mountain correlates with the approximate stratigraphic position of the marker carbonate unit within the upper Dutch Creek further west. However, this is unlikely as the basal Mount Nelson quartzites are not recognized lower in the section.

STRUCTURAL GEOLOGY

Leech (1958b) briefly summarized the structure of the area: "The main structure on the west flank [of the Rocky Mountain Trench] is an anticline that plunges northward at about 25 degrees and whose limb becomes increasingly steep as it goes south." Structures are well illustrated by cross-sections A-A', B-B' and E-E' in Figure 3-3-7, and the geological map in Figure 3-3-3. In the northern part

TABLE 3-3-1. MINERAL OCCURRENCES IN THE SKOOKUMCHUCK WEST HALF MAP AREA

No.	Name	Commodities	Gangue	Type	Host
52	BBX	Au, Ag, Cu, Ba	Barite, quartz, siderite	Vein, shear	upper Dutch Creek Formation
64	Federal	Cu	Talcose material, limonite, pyrrhotite	Secondary enrichment sheared fault zone	lower Roosville Formation
65	McIntosh (Brenda)	Ag, Au, Cu, Ba	Barite, quartz, siderite	Vein, shear	upper Dutch Creek Formation
76	War Eagle	Co, Ni, Cu	———	———	Kitchener Formation
77	Lead (location uncertain)	Ag, Pb, Zn, Au	———	Vein fractures	upper Roosville or lower Mount Nelson Formation — granitic sill contact

of the Skookumchuck map area, the regional structure is dominated by two anticlines separated by a faulted syncline called the "McIntosh fault".

Within the Skookumchuck area, folds are essentially concentric or parallel and the refraction cleavage or fan cleavage is observable on outcrops as well as on cross-sections. Poles to cleavage, plotted on an equal-area net (Figure 3-3-8) are distributed within an elongate cluster illustrating a refraction cleavage pattern. Cleavage-bedding intersection lineations produce a rather scattered pattern, but generally trend north. Due to the open style of folding, no domain produced a complete bedding pole πgirdle as only a limb or minor dragfolds are represented in each domain.

Northeast-trending normal faults (Figure 3-3-7) produce an apparent sinistral fault movement on the map. These faults dip steeply to the northwest, with the west side down-thrown. A minor strike-slip component may also produce the sinistral displacement. The largest of these faults, the Mather Creek fault, juxtaposes lower Kitchener rocks against middle Creston strata. Further northwest, the large normal displacement on the fault is accommodated by a set of small north-trending normal faults. Their position and sense of movement are known with confidence due to measured displacement of the Nicol Creek lavas. Locally, the faults are marked by a zone of intense, coarse hematitic alteration, most commonly displayed in the light green siltstone-argillite units of the Gateway Formation. Several regional thrust faults and listric reverse thrust faults merge to the south of the Canal Flats map sheet. One of them, the Buhl Creek fault, transects the northwest corner of the Skookumchuck map area and places lower to middle (?) Dutch Creek strata above upper Dutch Creek stratigraphy. Further west, the "Copper Lake" thrust fault carries an overturned package of Creston to lower Dutch Creek (?) stratigraphy over Dutch Creek rocks. Stratigraphic and structural interpretation north of 50°N latitude are based on Leech's (1958a) map and Foo's (1979) study (Section A-A', Figures 3-3-3 and 3-3-7).

Structural deformation in the Skookumchuk area consists of several phases. Tilting, possibly associated with penecontemporaneous block faulting, occurred during or immediately following deposition of the Nicol Creek lavas and produced a low-angle regional unconformity. Movement along these block faults may have persisted through Gateway into Roosville time. Tilting also occurred after deposition of the Mount Nelson Formation; north of the study area, the Mount Nelson Formation has been irregularly eroded prior to deposition of the Hadrynian Toby Formation (Reesor, 1973; Foo, 1979).

Broad open folding, in part controlled by stratigraphy and earlier fault structures, developed during the Columbian orogeny. The axial planes of these folds became the loci of northeast-trending normal faults. The latest deformation involved eastward thrusting and folding that is particularly prominent in the northwest part of the area.

MINERAL OCCURRENCES

Mineral occurrences are located on Figure 3-3-3 and tabulated in Table 3-3-1 above. Most are veins in shear zones. Data on these occurrences are from the British Columbia Ministry of Energy, Mines and Petroleum Resources MINFILE, augmented by visits during the course of mapping.

DISCUSSION

The upper Aldridge, Creston, Van Creek and Nicol Creek Formations of the lower Purcell succession, are readily traceable throughout the southern and western part of the Skookumchuck area. They are similar lithologically and in thickness to exposures to the south in the Kimberley and Cranbrook areas. The upper Purcell succession can be traced northward from the Kimberley map area to southwest of Skookumchuck. Apparent facies changes, generally subtle and taking place over long distances elsewhere in Belt-Purcell rocks, are dramatic and rocks subdivided into three formations to the south, the Gateway, Phillips and Roosville, have been lumped together as the Dutch Creek Formation (Walker, 1926). Detailed mapping and structural analyses indicate that this change is due to two factors: facies changes in upper Purcell rocks, the most prominent being the relatively abrupt transition of characteristic maroon siltstone and argillite of the Phillips Formation into green siltstone which is similar to green laminated siltstone and argillite in both overlying Roosville and underlying Gateway Formations; and, a marked thickening of the Gateway succession.

Rocks correlative with the lithologically distinct lower Gateway can be recognized to the western limit of the map area, south of the Buhl Creek fault. The upper Gateway is not as distinctive; without the marker Phillips Formation it cannot be separated from the overlying Roosville and must therefore be included as part of the Dutch Creek Formation. North of the Buhl Creek fault, Purcell rocks are totally isolated within thrust panels and upper Purcell rocks, lacking diagnostic marker units, are called the Dutch Creek Formation. However, it is probable that detailed mapping in the southwestern Canal Flats area would permit further subdivision of Dutch Creek rocks here as well.

The Mount Nelson Formation lies with a gradational contact on Roosville rocks on Lookout Mountain. Restored sections can only accommodate a considerably thinner upper Purcell succession beneath the Mount Nelson here. It is possible that a tectonic break has removed part of this succession but, as it could not be recognized in the field, it has not been shown on the map or cross-sections. This suggests that upper Purcell rocks here were deposited on a local tectonic high within the basin.

A simplistic model for deposition of upper Purcell rocks is illustrated in Figure 3-3-9. The thickening and related facies changes near Larchwood Lake suggest that foundering of the Purcell plat-

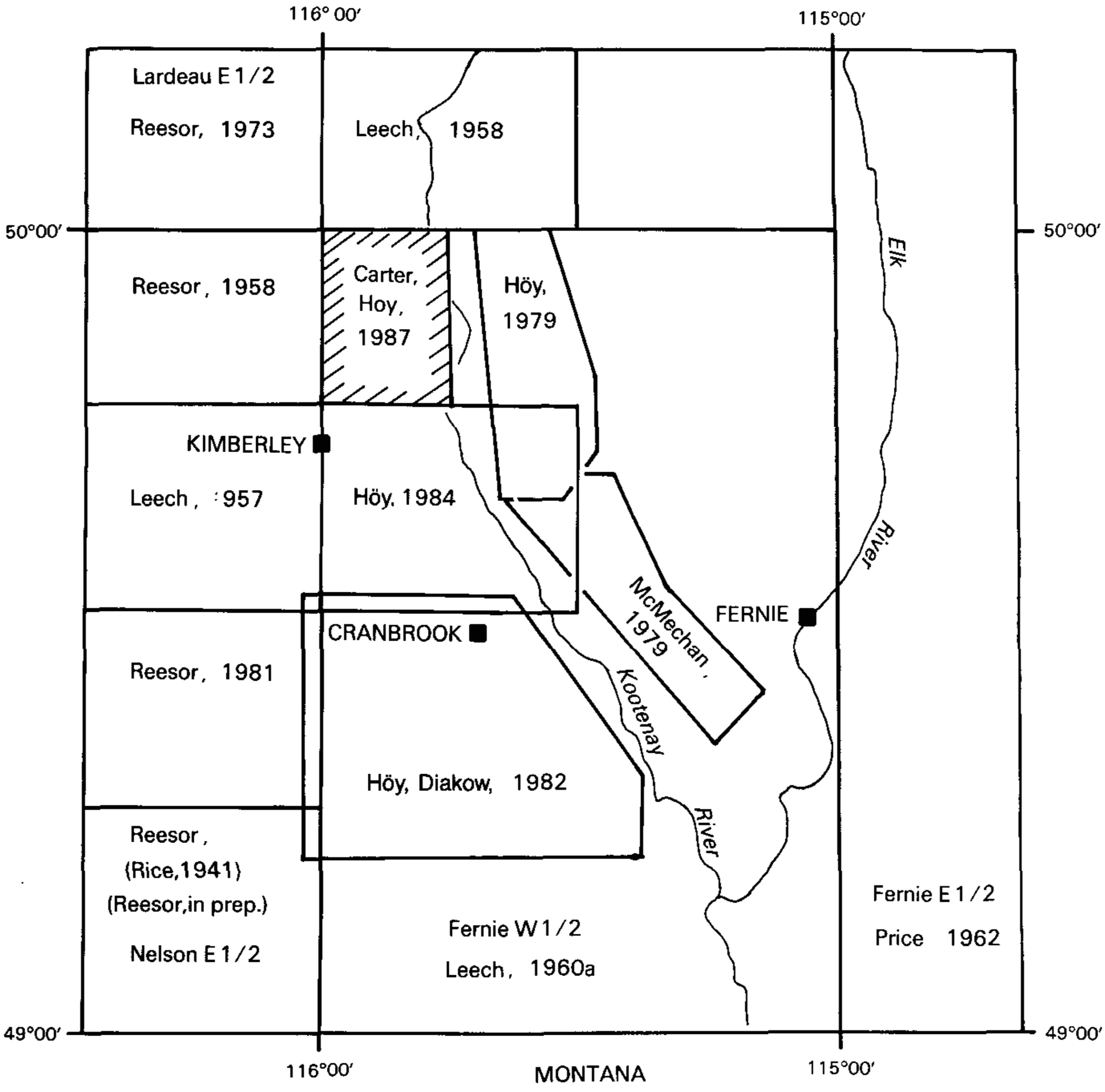

Figure 3-3-1. Location map showing published geological maps in the vicinity of the Skookumchuck area.

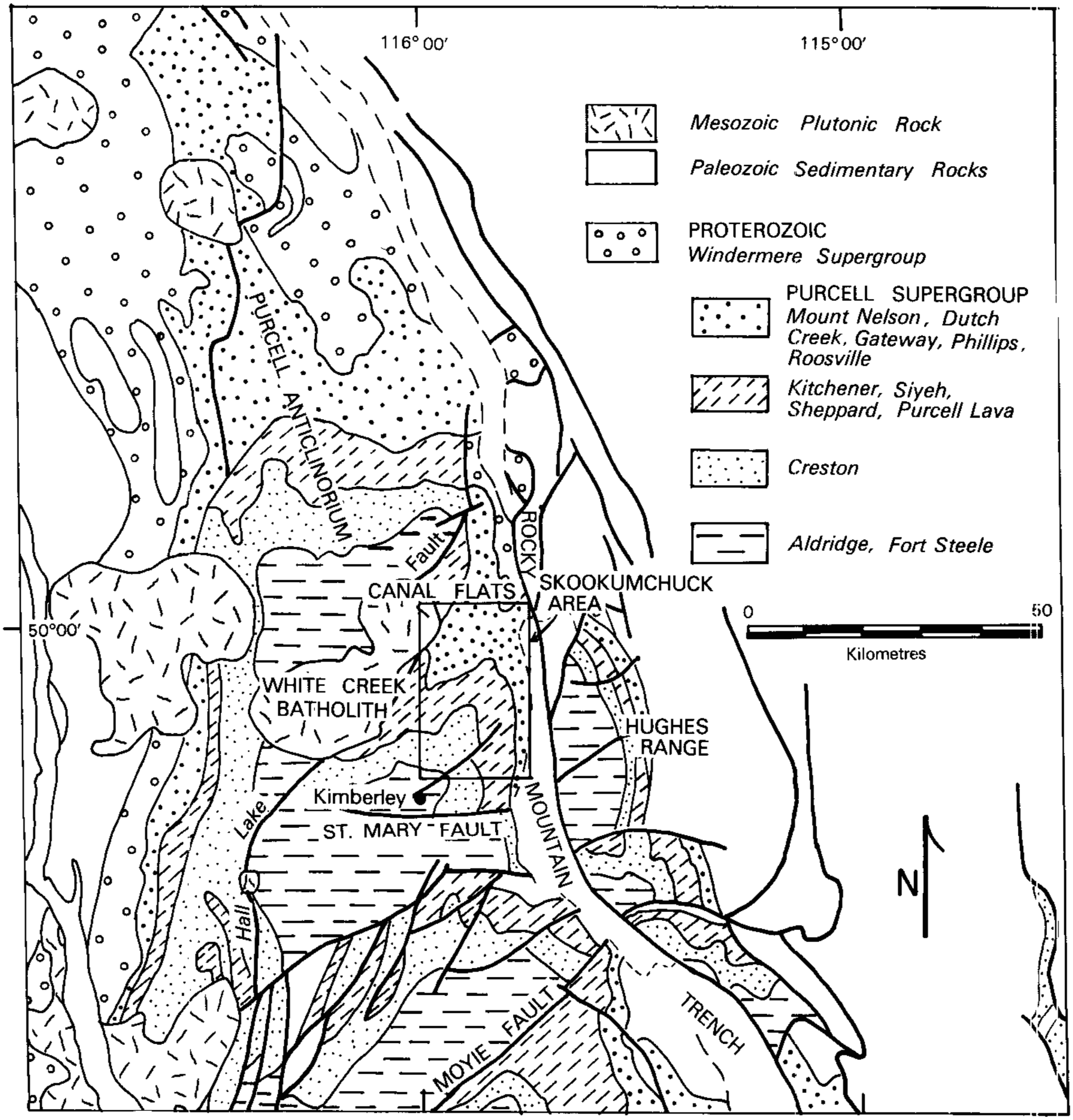

Figure 3-3-2. Regional geological map showing location of Skookumchuck area.

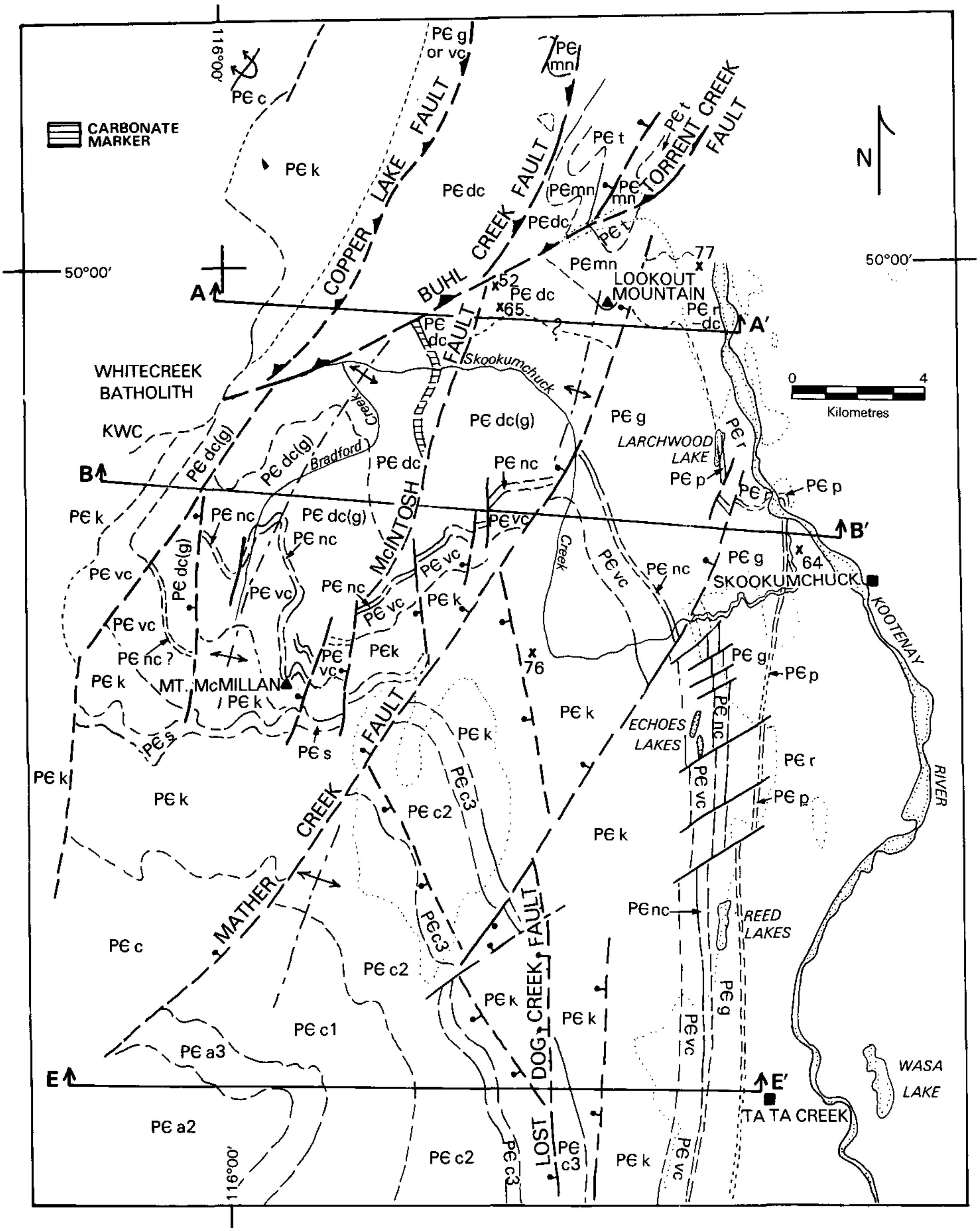

Figure 3-3-3. Geology of Skookumchuck area after G. Carter, T. Höy (this paper). Area north of 50°00'N modified after Leech (1958), Foo (1979); area west of 116°00'W modified after Reesor (1958); southwest corner modified after Paul Ransom (personal communication, 1986).

LEGEND

TERTIARY, PLEISTOCENE AND RECENT

[ ] *Unconsolidated sand and gravel*

MESOZOIC

CRETACEOUS

KWC — *WHITE CREEK BATHOLITH*

PROTEROZOIC

HADRYNIAN

PЄt — *TOBY FORMATION*

HELIKIAN

PURCELL SUPERGROUP

PЄs — *Diorite sill/dyke*

PЄr	*ROOSVILLE FORMATION*	PЄmn	*MOUNT NELSON FORMATION*
PЄp	*PHILLIPS FORMATION*	PЄdc	*DUTCH CREEK FORMATION*
PЄg	*GATEWAY FORMATION*		

PЄnc — *NICOL CREEK FORMATION (PURCELL LAVAS)*

PЄ vc — *VAN CREEK FORMATION*

PЄk — *KITCHENER FORMATION*

PЄc — *CRESTON FORMATION*

- PЄc3 — *Upper Creston*
- PЄc2 — *Middle Creston*
- PЄc1 — *Lower Creston*

PЄa — *ALDRIDGE FORMATION*

- PЄa3 — *Upper Aldridge*
- PЄa2 — *Middle Aldridge*

SYMBOLS

Thrust Fault ....

Normal Fault ....

Strike-slip Fault ....

Prospect (see text) .... x form was probably due to block faulting which, in the Skookumchuck area, was concentrated near Larchwood Lake (Figure 3-3-9B). Initiation of block faulting was marked by the outpouring of basic flows and tuffs of the Nicol Creek Formation. The "high" in the vicinity of Lookout Mountain may be due to an uplifted block of lower Purcell rocks. The model implies that a number of the faults in the Larchwood Lake area (Figure 3-3-3) are early growth faults. These cut and offset Nicol Creek lavas but do not appear to continue through the Gateway into the overlying Phillips Formation. A number of these faults became the loci of late Mesozoic structures, including strike-slip faults and the prominent S-shaped fold northeast of Larchwood Lake.

Tectonic instability in late Purcell time was of a regional extent; Nicol Creek lavas are exposed along the entire eastern margin of the Purcell anticlinorium and western Rocky Mountains. Further evidence of instability includes the pronounced unconformity at the base of the Gateway Formation in the Cranbrook area (Höy and Diakow, 1982). Here the base of the Gateway is locally marked by a fluviatile conglomerate that cuts into the Nicol Creek Formation and removes the upper flows and underlying siltstone sequence.

CONCLUSIONS

The main conclusions of the study are summarized below:

(1) The Creston Formation has been subdivided into three informal members: a lower silty unit, a central quartzite-rich unit and an upper silty and quartzite unit.

(2) The Nicol Creek lavas can be traced throughout the Skookumchuck west half map area. They grade westward into basic tuffs and volcaniclastic rocks mapped by Reesor (1958).

(3) Individual formations in the upper Purcell succession can be traced northward to Skookumchuck Creek with little apparent facies or thickness changes.

(4) In the vicinity of Skookumchuck Creek, the upper Purcell succession thickens dramatically and facies changes are apparent; the most noticeable is a transition from maroon siltstone and argillite of the Phillips Formation into green siltstones of the Dutch Creek Formation.

(5) The Mount Nelson Formation at Lookout Mountain rests with a gradational contact on a relatively thin Dutch Creek succession.

(6) These relationships suggest that the tectonic instability, marked regionally by an outpouring of basic volcanics and locally by a pronounced unconformity was manifest in the Skookumchuck area by growth faults initiated in late to post-Nicol Creek time and continued active through Gateway time. Some of these early faults have been reactivated and are the loci of late faults and folds in the Larchwood Lake area.

ACKNOWLEDGMENTS

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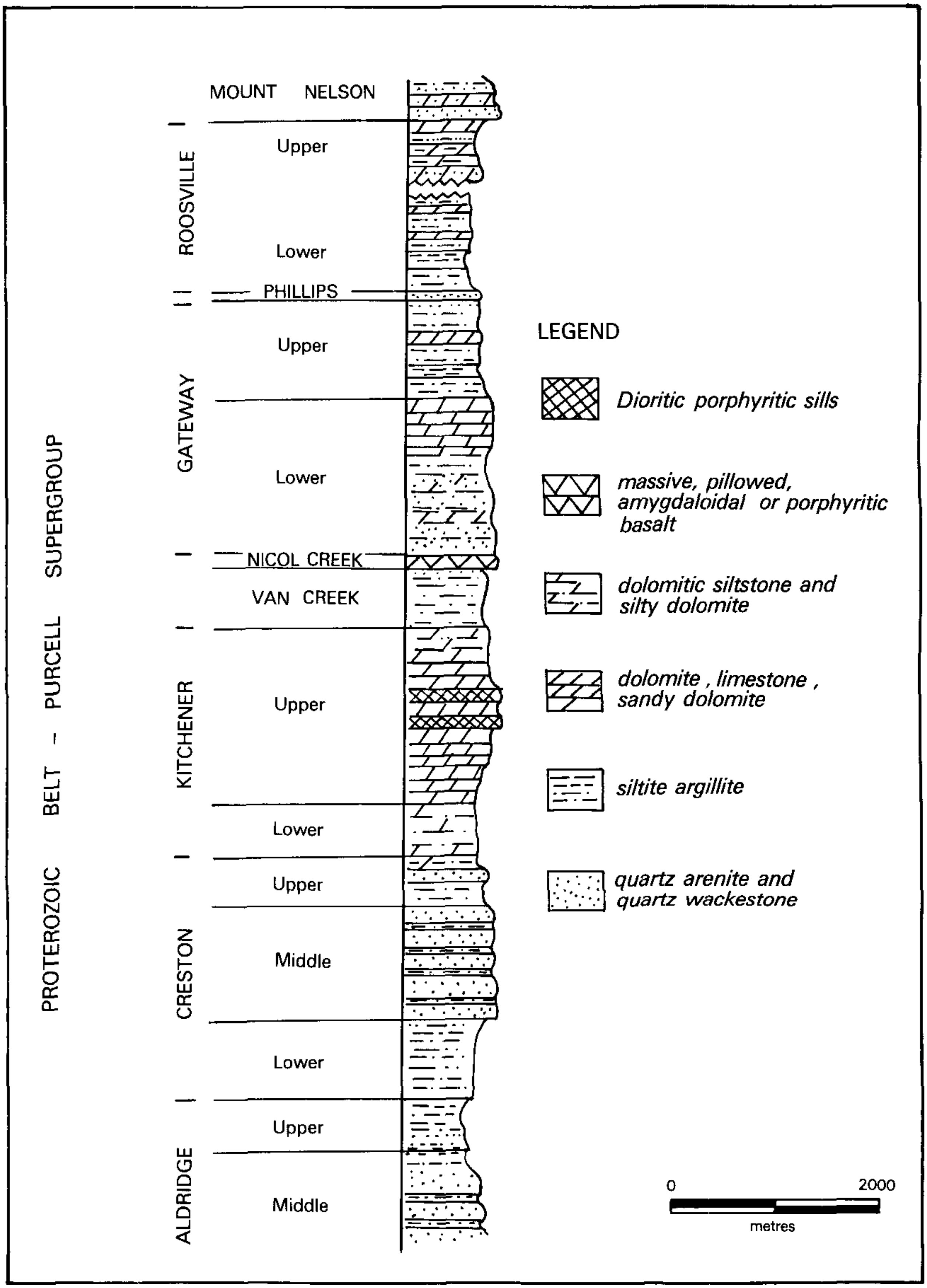

Figure 3-3-4. Generalized composite stratigraphic section of Skookumchuck map area; after Carter and Höy (this paper), Höy (1985), Leech (1960), Reesor (1958), Ransom (personal communication, 1986).

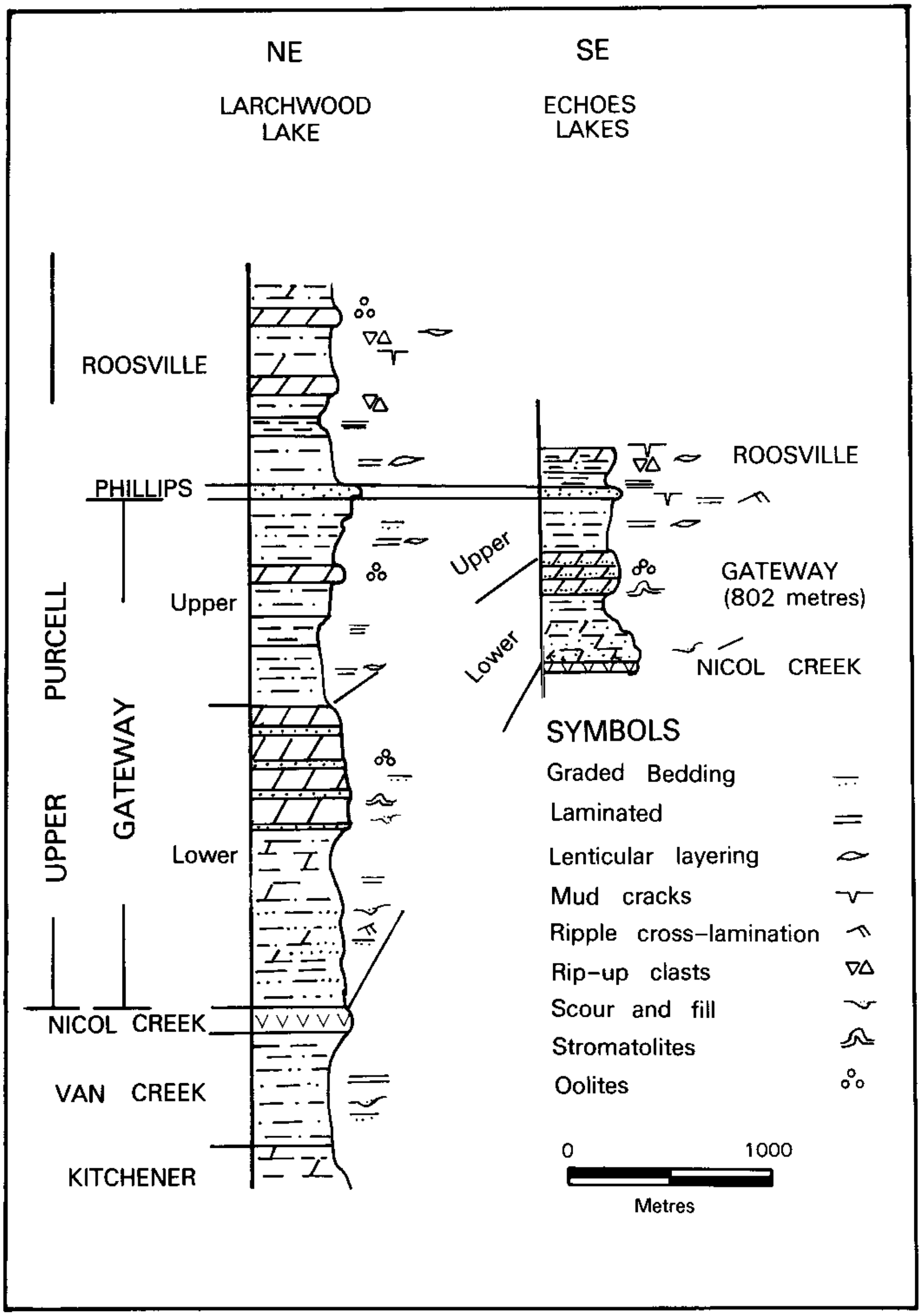

Figure 3-3-5. North-south correlation of Gateway and Roosville formations as estimated near Larchwood Lake and measured near Echoes Lakes.

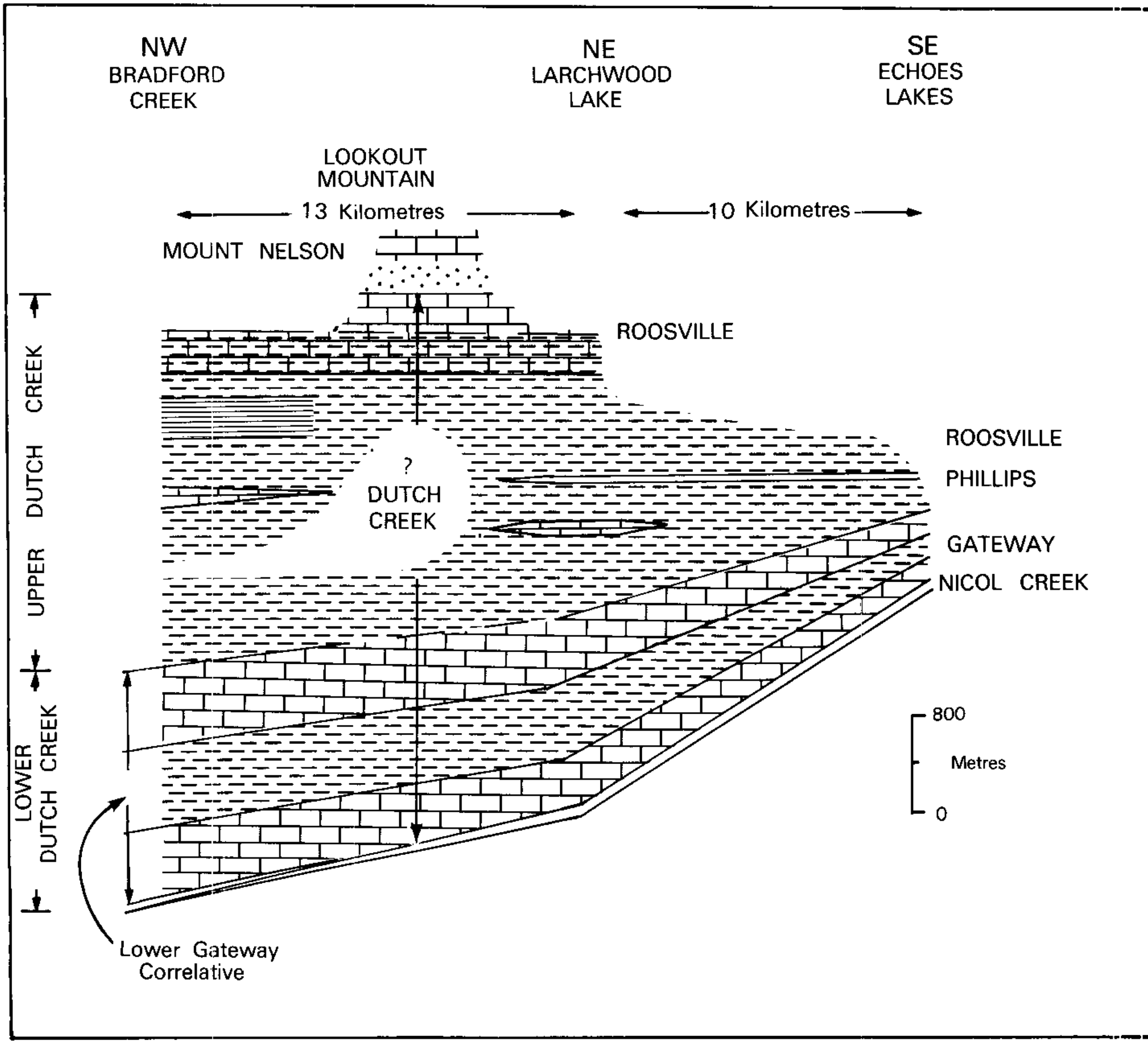

Figure 3-3-6. Schematic northwest to southeast facies relationship of the upper Purcell Supergroup, Skookumchuck area.

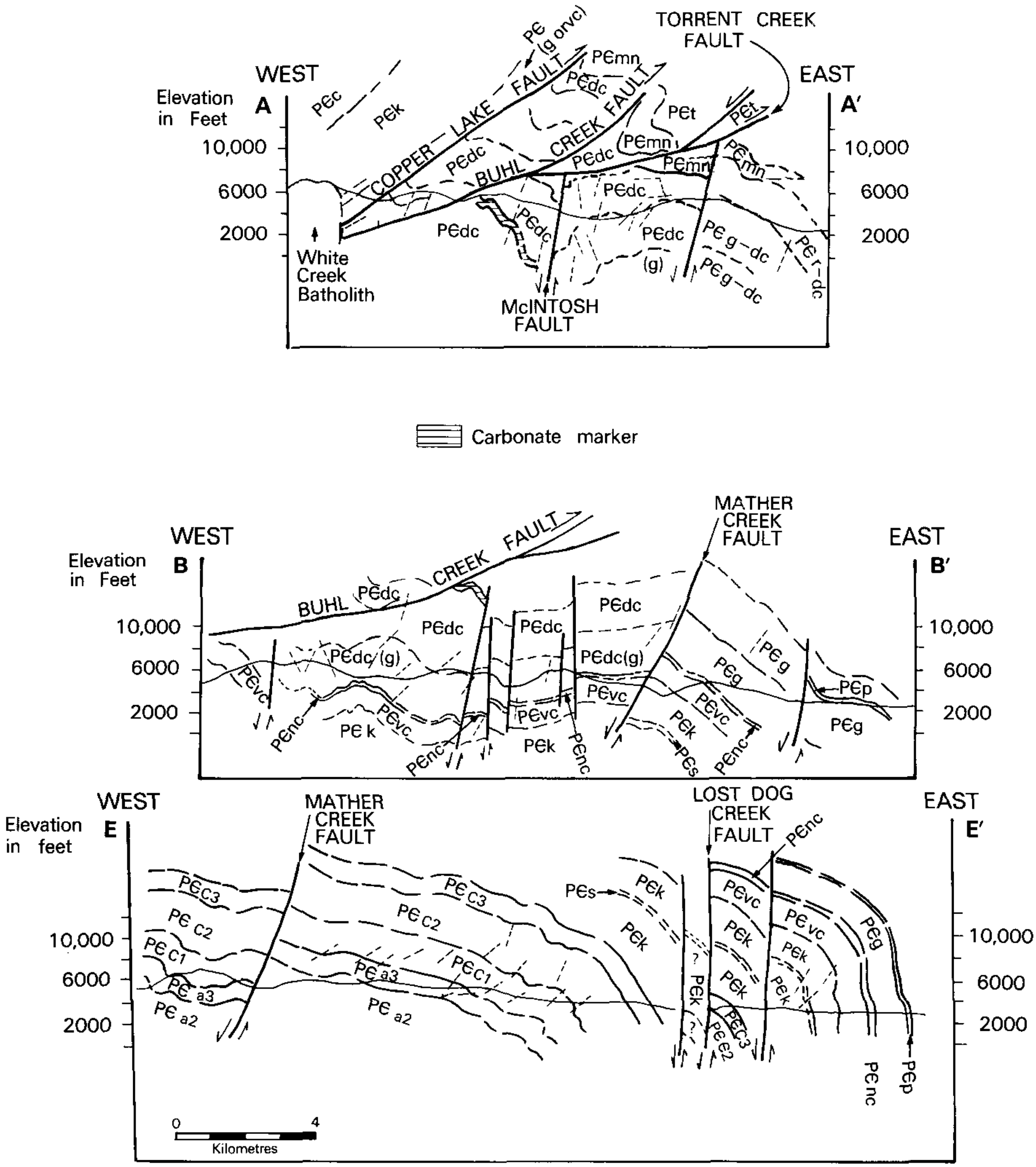

Figure 3-3-7. Vertical cross-sections through Skookumchuck map area. Upper part of A-A' modified after Leech (1958), Foo (1979); western part of C-C' modified after Reesor (1958) and Paul Ransom (personal communication, 1986).

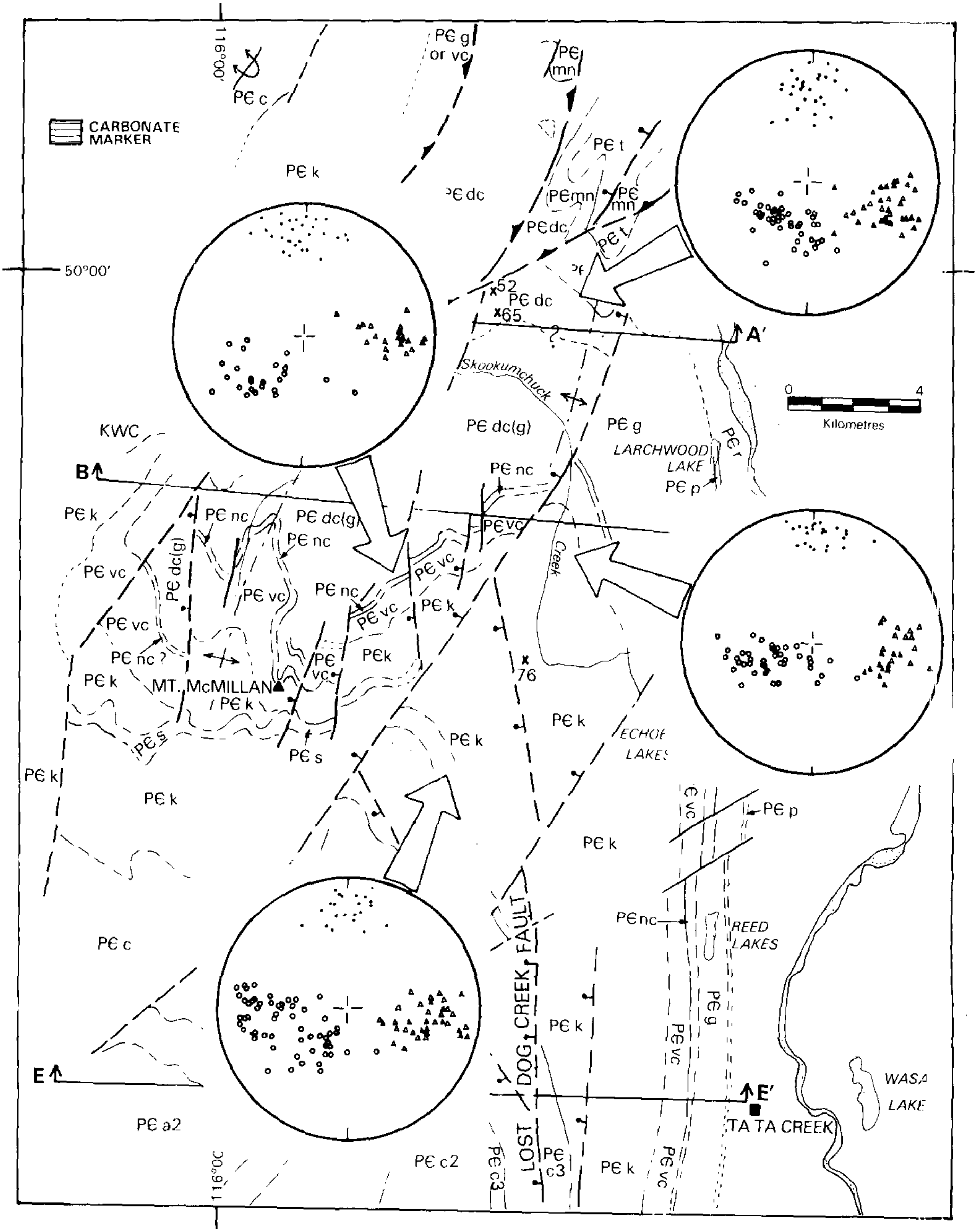

Figure 3-3-8. Distribution of lineations (dots), bedding poles (circles) and cleavage poles (triangles) for some of the domains of the Skookumchuck area, plotted on equal area stereonets.

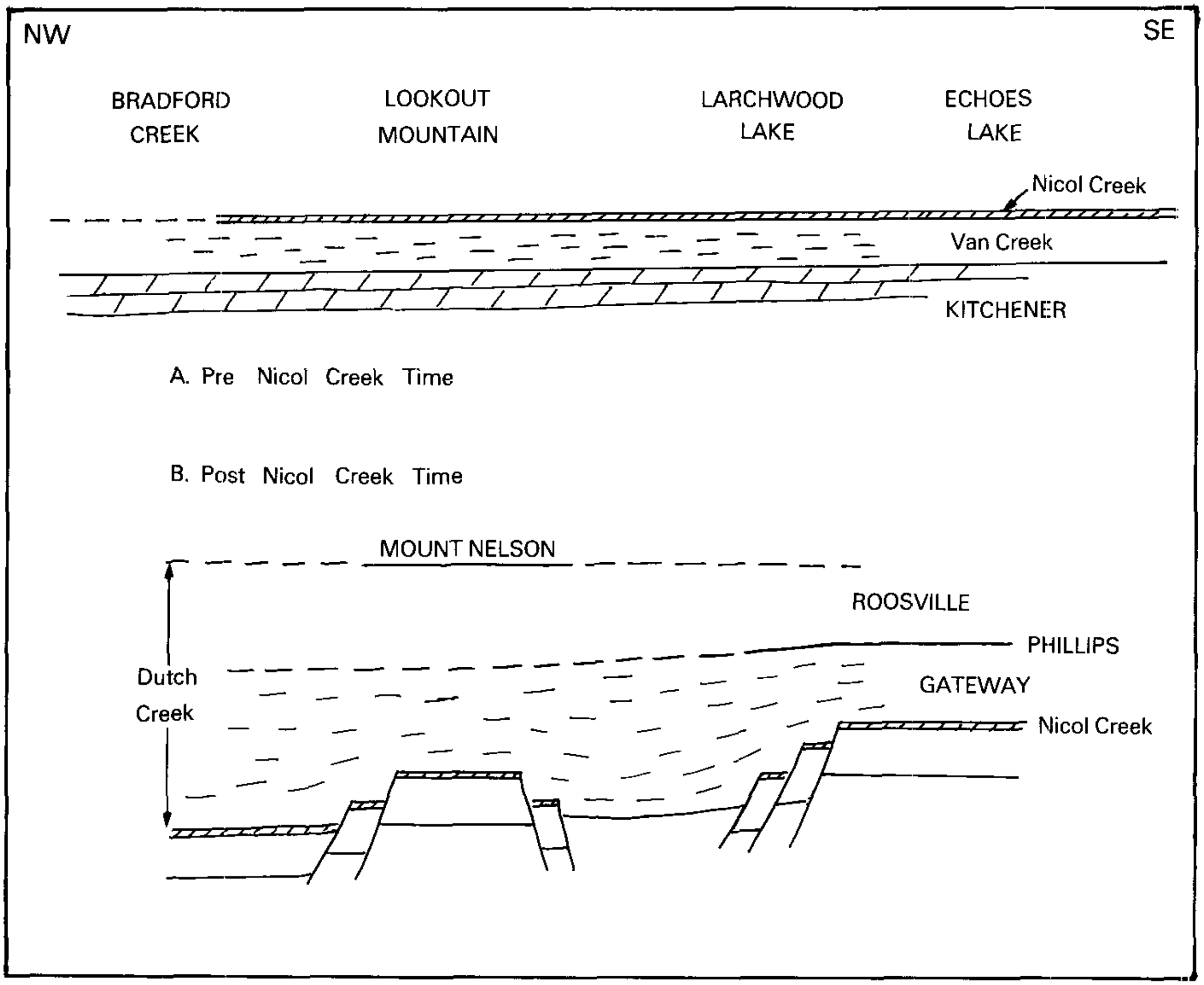

Figure 3-3-9. Postulated model for deposition of upper Purcell rocks, Skookumchuck west half map area.