Boundary Project: McKinney Creek (NTS 82E/03) and Beaverdell (NTS 82E/06E, 07W, 10W, 11W) Areas, South-Central British Columbia

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KEYWORDS: Quesnellia, Paleozoic, Knob Hill Complex, Anarchist schist, Wallace Formation, McKinney Creek, Beaverdell

INTRODUCTION

The Boundary Project was initiated in 2005 with the purpose of better characterizing the lithological and geochemical variations within and between the various Paleozoic sequences in the southern Okanagan region along the United States border. These occur within the Quesnel Terrane, which is dominated by such Paleozoic mafic volcanic and pelitic sedimentary rocks, unconformably overlain by Triassic and Jurassic volcanic and sedimentary rocks. In the Boundary district, these are exposed between down-faulted blocks of Tertiary volcanic and sedimentary cover rocks preserved in structural keels between gneissic domes (Fig 1).

The individual Paleozoic sequences of the Boundary district have had a variety of names depending upon their location and appear to form three north-south belts. They are called the Knob Hill Complex and Attwood Formation in the Greenwood area; the Anarchist schist (or Group) in the Osoyoos – Rock Creek and Beaverdell areas; and the Kobau Group in the area between Oliver and Keremeos. The terms Kobau and Anarchist have also been used in Washington, though not always for directly correlatable rock packages.

The Paleozoic rocks of the Greenwood – Rock Creek area are preserved in a series of north-dipping thrust sheets (Little, 1983; Fyles, 1990). Many of the bounding thrusts are marked by serpentinite layers or pods. Tertiary extensional faulting has disrupted and modified the thrust sheets and makes correlation difficult between the Greenwood and Rock Creek areas. However, mafic volcanic flows and chert in the Johnstone Creek area are contiguous with similar outcrops of the Knob Hill Complex on the east side of the Kettle River valley (Fyles, 1990; Massey, 2007a). Massey (2007b) thus proposed to extend the Knob Hill Complex designation to these rocks. The term Anarchist schist was retained for the sequence of metasedimentary and metabasaltic rocks south of Highway 3, between Osoyoos and Rock Creek. It was also proposed to apply the Anarchist schist designation to similar rocks in the Greenwood area, which Fyles (1990) had included in the Knob Hill Complex.

Following these revisions in nomenclature of the Paleozoic rocks of the Greenwood – Rock Creek area, the regional map now appears to show an east-west pattern, in keeping with pre-Tertiary structural grain, rather than the previous north-south pattern. Continuing this pattern further to the west led Massey (2007b, Fig 15) to suggest that the McKinney Creek area may be underlain by rocks of the Knob Hill Complex. Scattered serpentinite occurrences just south of the McKinney Creek pluton could possibly mark the bounding thrust, now intruded and hidden by the pluton. Mapping in the McKinney Creek area was designed to test this hypothesis.

The relationship of the Paleozoic rocks east of Beaverdell to the sequences in the south is uncertain due to extensive Mesozoic and Tertiary intrusive bodies. Mapping in this area was focused on better documenting these rocks and their possible relationships and correlations.

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MCKINNEY CREEK AREA

Previous Work

The McKinney Creek area has a mining history dating from the discovery of vein gold deposits at Camp McKinney in 1887. The first geological report, by Bauerman (1885), was done as part of the Boundary Commission Expedition of 1859–1861. Regional mapping has been undertaken by Cairnes (1940), Little (1957, 1961), and Tempelman-Kluit (1989a, b). Detailed investigations of the lode gold mineralization at Camp McKinney were undertaken by Cockfield (1935), Cairnes (1937) and Hedley (1940). Much of the southern, lower lying parts of the area are covered by extensive glaciofluvial and moraine deposits (Kowall, 1986c).

Pre-Jurassic Rocks

The suggested extension of the Knob Hill Complex into the McKinney Creek area proved to be unfounded. Although outcrop is limited in many areas due to extensive Quaternary cover, all observed outcrops of Paleozoic rocks belong to the Anarchist schist (Fig 2). The age of the Anarchist schist is still poorly determined, as no paleontological or geochronological data are available. Rubidium-strontium geochronology in the Osoyoos area only records Tertiary metamorphic ages (Ryan, 1973). In the McKinney map area, the rocks of the Anarchist schist are intruded by plutons and smaller bodies of Jurassic and Eocene age.

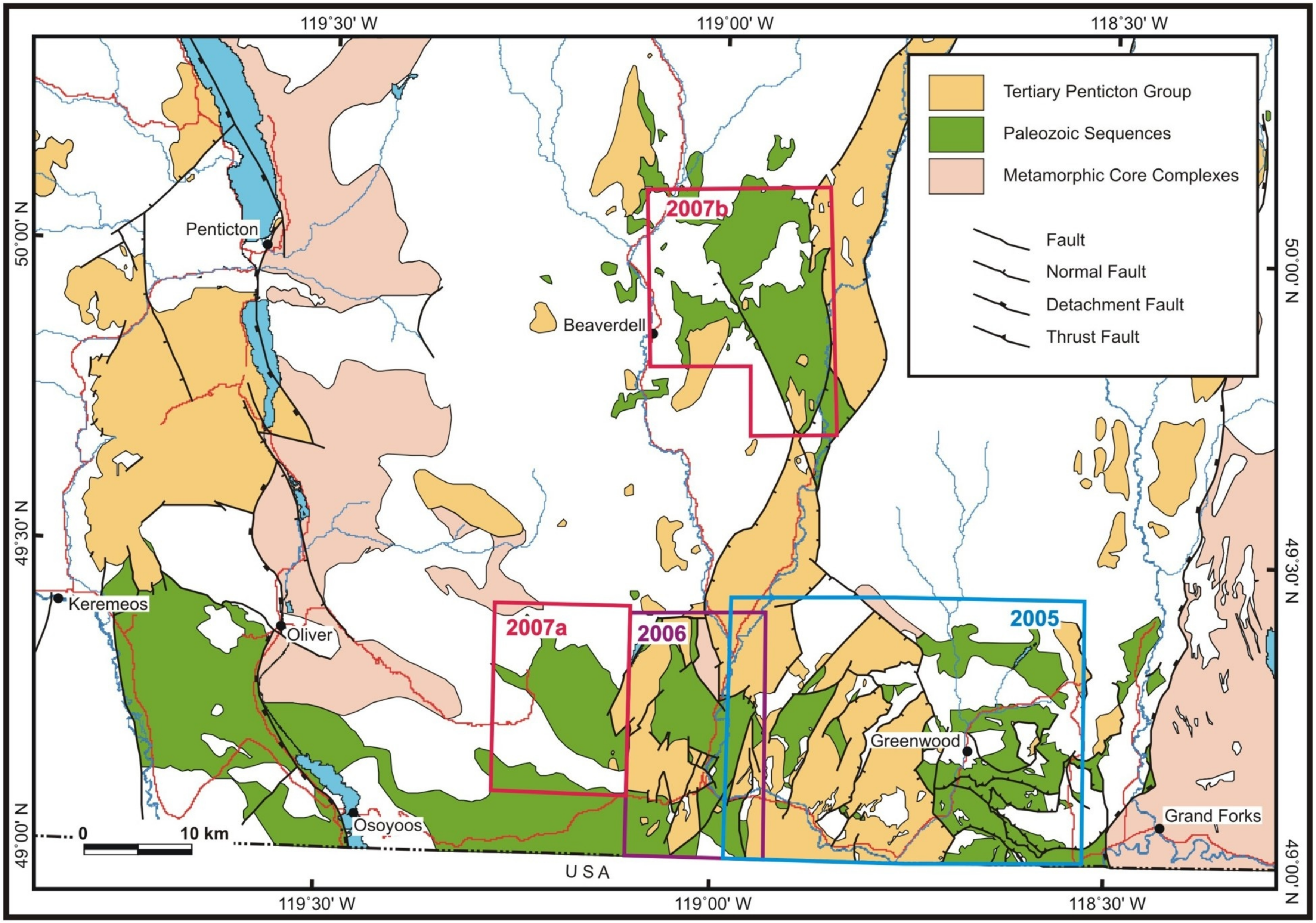

Figure 1. Distribution of Paleozoic Quesnellian rock suites in the boundary district (south-central part of NTS 82E), amended from Massey et al. (2005). Boxes outline the areas studied in 2005 (Greenwood), 2006 (Rock Creek) and 2007 (a, McKinney Creek; b, Beaverdell).

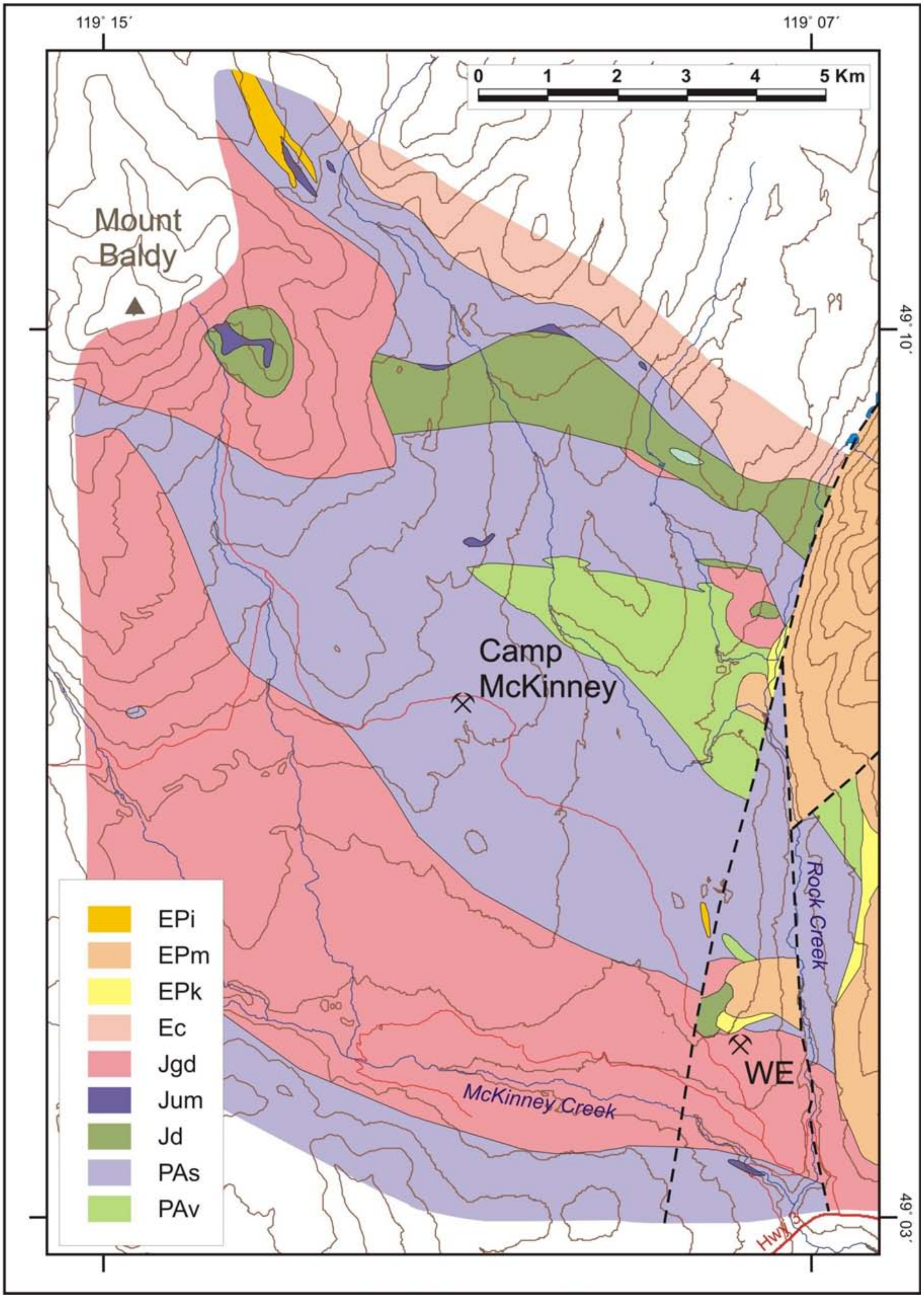

Figure 2. Geological sketch map of the McKinney Creek area. Extent of coloured polygons shows the limit of area mapped in 2007. Abbreviation: WE, War Eagle (Dayton Property). Legend: PAv, metavolcanic unit of Anarchist schist; Pas, metasedimentary unit of Anarchist schist; Jd, diorite-gabbro intrusions; Jum, pyroxenite and serpentinite intrusions; Jgd, granodiorite intrusions (Nelson suite); Ec, K-feldspar megacrystic granite (Coryell suite); EPk, Kettle Valley Formation; EPm, Marron Formation; Epi, minor porphyry intrusions consanguineous with Marron Formation.

ANARCHIST SCHIST

The Anarchist schist can be subdivided into a metasedimentary unit and a metavolcanic unit, delineated on the dominant rock types within them. The stratigraphic relationship between the units is uncertain. Deformation of the schist involves at least two phases of deformation. Schistosity generally trends southeast with medium to steep southwesterly dips in the northern part of the map area, and steep northeasterly dips in the south. The Camp McKinney area is also marked by northeasterly trending schistosities with moderate southeasterly dips. Secondary spaced cleavages in quartzite and crenulation cleavage in quartzite (Fig 3a) and meta-argillite also trend north to northeast. Small-scale folds of foliations generally tend to plunge southwest with shallow dips. The general map pattern of the metasedimentary and metavolcanic units seems to define a major northwesterly trending fold (Fig 2). However, the lack of conclusive way-up structures and stratigraphic relationship precludes determining if the fold is antiformal or synformal.

Metasedimentary unit

The metasedimentary unit is dominated by quartzite, argillaceous quartzite, and meta-argillite with minor metabasalt and limestone. Quartzite is metachert that is variably recrystallized with a fine to medium-grained sugary texture (Fig 3b), and typically has a white to pale grey or darker bluish grey colour. Beds are usually 1 to 2 m thick (Fig 3c) but can vary up to 10 m, and may show a knobby or irregular weathered surface. They may be massive or show dark and light laminations and banding (Fig 3d). Ribbon bedding is rarely preserved.

Phyllitic to schistose argillaceous metasedimentary rocks are darker, with fine-grained black chlorite or biotite schist layers interlayered with lighter quartz-rich layers. Epidote laminae and bands suggest fine-grained tuffaceous interbeds. The schistosity is commonly crenulated and contorted (Fig 4a). Quartz veining may also be contorted, disrupted and augened. Some thicker, less siliceous meta-argillite beds are carbonaceous. Minor limestone beds vary from one to two centimetres (Fig 4b) up to 10 m thick (Fig 4c). They are white to grey in colour, fine to medium grained and recrystallized.

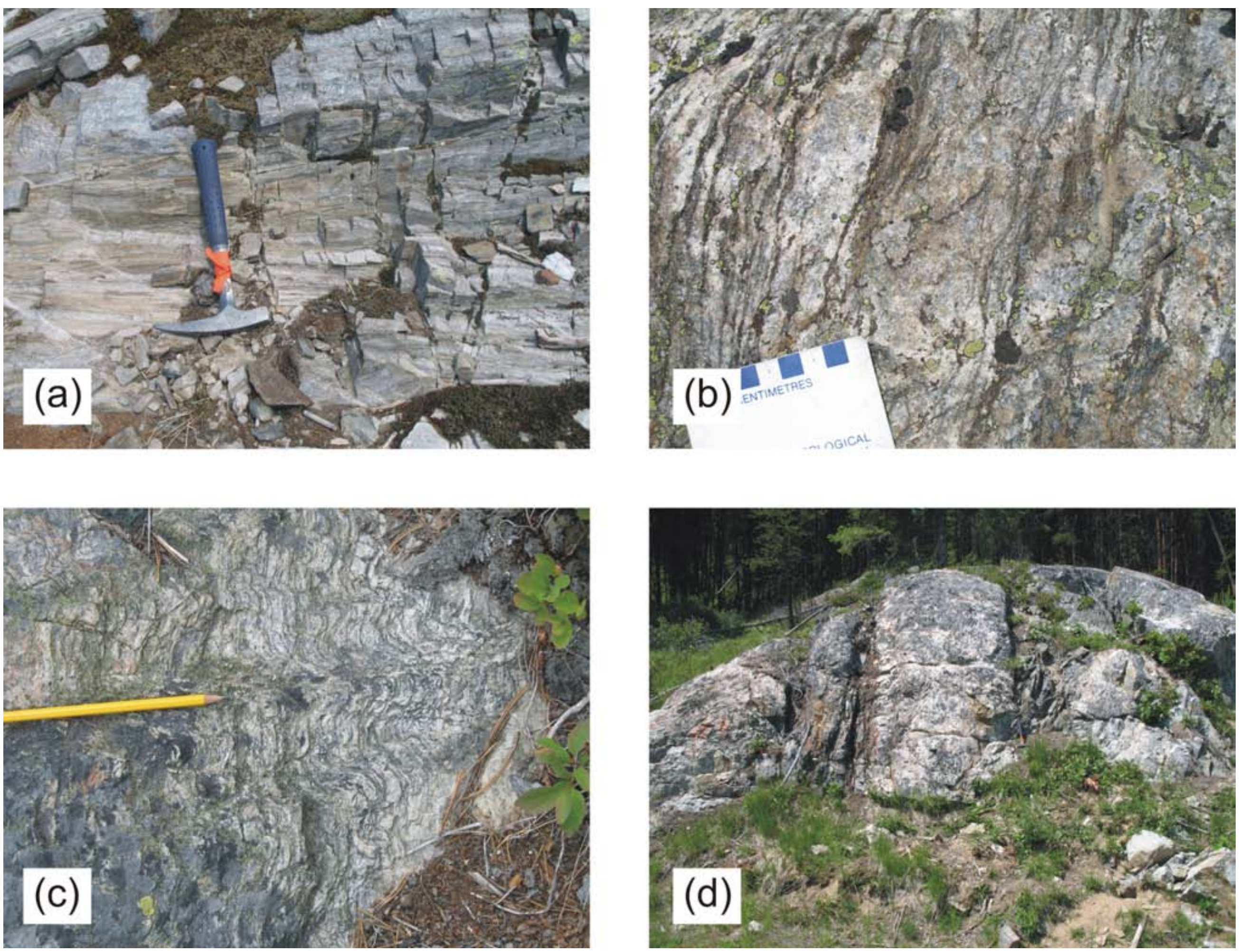

Figure 3. Quartzite of the Anarchist schist: a) crenulation cleavage (s_2) developed in a foliated quartzite (s_1 parallel to s_0) (07NMA07-17; UTM Zone 11, 5443051N, 338954E, NAD83); b) recrystallized quartzite (07NMA11-12; UTM Zone 11, 5442153N, 339187E, NAD83); c) quartzite beds with meta-argillite (chlorite-quartz schist) interbeds (07NMA02-14; UTM Zone 11, 5444292N, 344895E, NAD83); d) laminated quartzite (07NMA01-10; UTM Zone 11, 5450727N, 337896E, NAD83).

Metavolcanic unit

The metavolcanic unit comprises greenstone flows with minor breccia ,tuff and metasedimentary rocks. Greenstone flows are massive and medium to dark grey or black in colour. They are fine grained and generally aphyric, though rare feldspar and pyroxene crystals are seen. Chlorite±epidote alteration is common, along with veining of quartz±chlorite±calcite. Chlorite and brown to black oxides are present on fractures. Tuffaceous interbeds are altered to green quartz–chlorite±sericite schist with epidote pods and laminae (Fig 4d).

Jurassic Intrusions

Intrusive rocks rim the McKinney Creek area on its north, west and south sides (Fig 2). These comprise two major bodies — the McKinney Creek and Mount Baldy granodiorites — as well as an unnamed suite of ultramafic and mafic intrusions. The granodiorites have been correlated with the mid-Jurassic Nelson Intrusions and the Jura-Cretaceous Okanagan batholith, respectively (Little, 1961; Tempelman-Kluit, 1989a, b), though geochronological data are lacking. The mafic rocks may be an older phase of the Nelson Intrusions and are intruded by granodiorite and included as xenoliths in granodiorite.

Diorite-gabbro

A belt of diorite occurs along the northeastern edge of the map area, intruding the Anarchist schist (Fig 2). Medium to coarse-grained diorite to gabbro is black to grey, weathering dark greenish grey. It comprises varying quantities of equigranular greenish black hornblende and white feldspar and occasional minor quartz (Fig 5a). Shear zones are common, accompanied by flattening and stretching of minerals (Fig 5b), white veinlets of feldspar and quartz, and chloritization. Pegmatitic diorite veins are also found (Fig 5c). The belt is a composite body with fine-grained chilled contacts between different diorite phases (Fig 5d). These fine grained chilled contacts can be difficult to distinguish from basaltic dikes in small outcrops.

Ultramafic intrusions

Significantly, there are several ultramafic intrusions spatially associated with the belt of diorite, and presumably

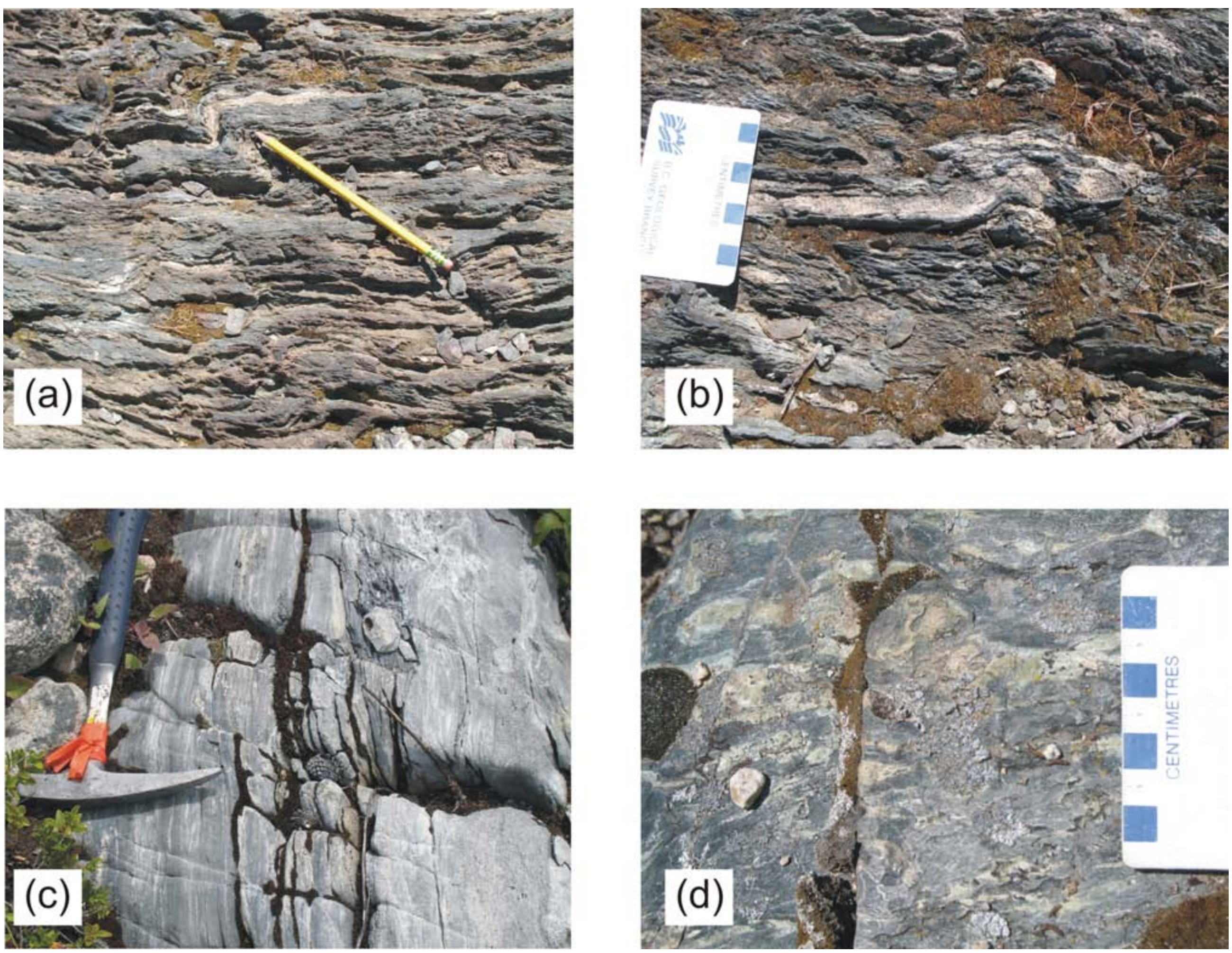

Figure 4. Less siliceous rocks of the Anarchist schist: a) chlorite-quartz schist (meta-argillite), pencil along axis of minor s-folding of foliation (07NMA05-12; UTM Zone 11, 5446337N, 341735E, NAD83); b) calcareous band within chlorite-quartz schist (07NMA05-12; UTM Zone 11, 5446337N, 341735E, NAD83); c) laminated marble (07NMA06-06; UTM Zone 11, 5448311N, 341637E, NAD83); d) quartz-chlorite schist with epidote pods (metatuff) (07NMA04-06; UTM Zone 11, 5447546N, 342904E, NAD83).

genetically related. These are pyroxenite, feldspathic pyroxenite and melanogabbro with grain sizes up to two to three centimetres. They are black to greenish black or grey and commonly weather orange-brown with a knobbly, uneven surface (Fig 6a). They are partially to completely altered to serpentinite and, in one case, to talc and soapstone. Serpentinite is variably foliated. Black seams of magnetite (Fig 6b) and chromite up to several centimetres occur in some bodies and have received some attention in the past for their Cr and Ni potential.

This belt of diorite and ultramafic rocks is probably correlative with diorite seen on the Dayton property and may form the western extension of the belt that hosts the Old Nick deposit just east of Bridesville. It may also be contemporaneous with Jurassic ultramafic intrusions in the Greenwood area, e.g., on the Sappho property (Nixon, 2002).

Granodiorites

The McKinney Creek granodiorite is composed of two distinct phases — an early biotite granodiorite and a later porphyritic granodiorite. The biotite granodiorite is coarse grained, up to 4 mm, and white to grey (Fig 7a). It is equigranular with typical salt and pepper texture made up of white feldspar, translucent quartz and black biotite plates. Biotite also forms clots up to 1 cm in size. Colour index averages 25. Small rounded amphibolite xenoliths are common (Fig 7b). Chlorite is often developed on fractures and joints.

The porphyritic granodiorite contains large white feldspar phenocrysts up to 2 cm in size (Fig 7c). The phenocrysts are euhedral laths or square in shape and show good twinning. The phenocrysts, which vary in amount from a few to 25%, are set in a coarse grained groundmass of white tabular feldspar, irregular translucent quartz and platy biotite. Biotite is less abundant than in the biotite granodiorite. Mafic xenoliths were observed but are not common. The porphyritic granodiorite intrudes the biotite granodiorite with good chilled contacts (Fig 7d). Pegmatite and aplite veins crosscut both granodiorite phases.

A smaller stock of granodiorite also crops out northwest of Fish Lake. It is medium to coarse grained, massive, pale grey to white, and generally equigranular, with euhedral white feldspar, rounded to irregular grey translu-

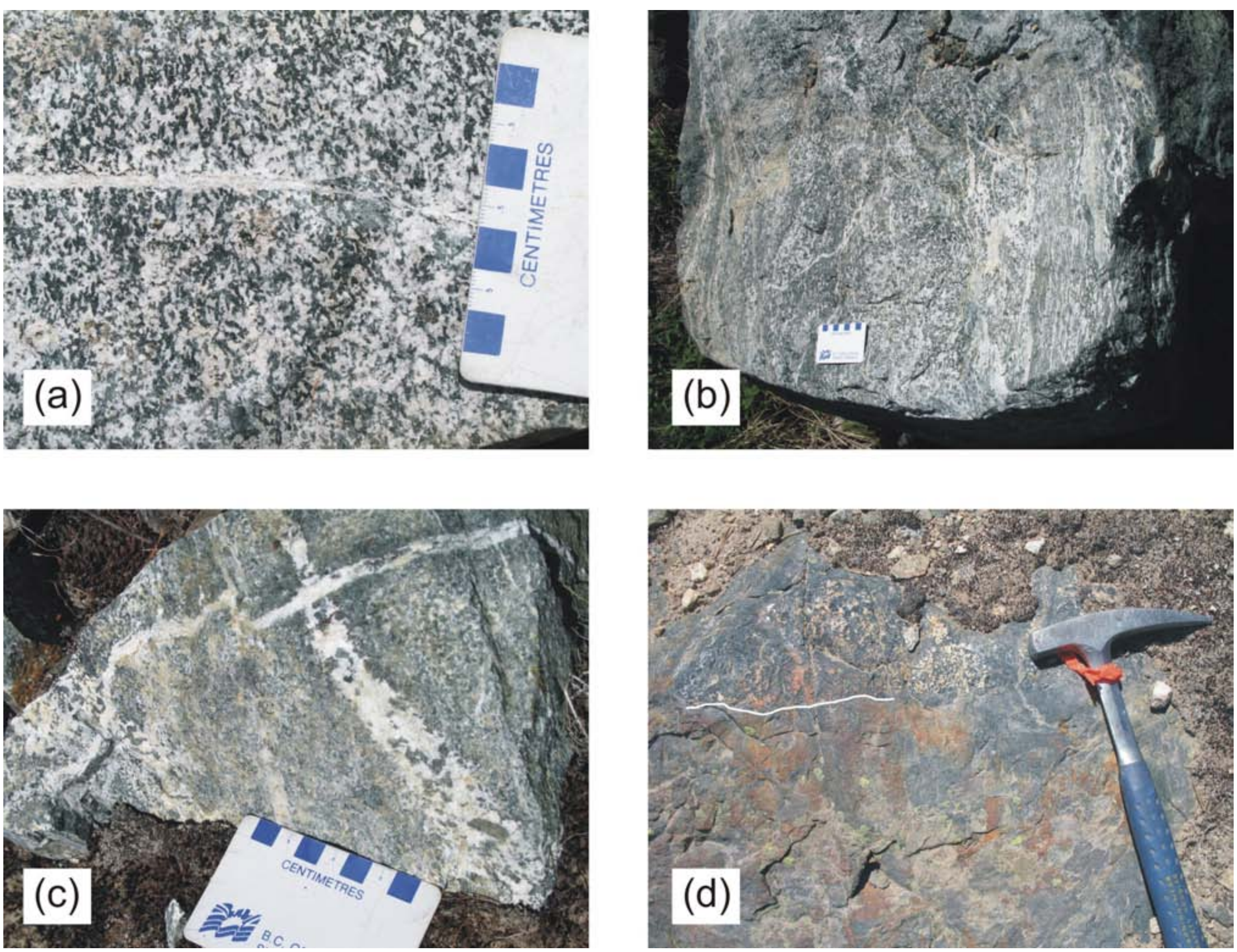

Figure 5. Jurassic diorite: a) typical coarse grained diorite (07NMA05-15; UTM Zone 11, 5447025N, 342198E, NAD83); b) shearing in diorite (07NMA01-03; UTM Zone 11, 545042N, 337675E, NAD83); c) hornblende-feldspar pegmatitic veins crosscutting diorite (07NMA05-15; UTM Zone 11, 5447025N, 342198E, NAD83); d) fine-grained chilled contact between two diorite phases, white line is emphasizing part of the contact (07NMA04-13; UTM Zone 11, 5446751N, 342696E, NAD83).

cent quartz, acicular greenish black hornblende and flakes of biotite. The colour index varies from 5 to 15. This granodiorite contains xenoliths of diorite and amphibolite. A similar body is found on the southern part of the Dayton property, though it tends to be finer grained and has a higher mafic content (colour indices ranging up to 25). Hornblende may occur as phenocrysts up to 1 cm in size.

The Mount Baldy granodiorite is medium to coarse grained, ranging from 2 to 5 mm, showing an equigranular, phaneritic texture. It is light grey to dark grey. It comprises euhedral white feldspar, irregular grey quartz and black tabular biotite. There is some chlorite alteration within the rock. The granodiorite is crosscut by feldspar porphyry dikes, assumed to be Tertiary in age. Isotropic, lath-shaped hornblende may be developed in the granodiorite around some porphyry dikes.

Tertiary Intrusions

The northeastern margin of the map area is marked by a white to pinkish potassium feldspar megacrystic granite intrusion typical of the Coryell Suite. Euhedral, lath to square-shaped phenocrysts of pink K-feldspar are commonly 3 to 4 cm in size, though they range up to 8 cm. They are set in a coarse-grained groundmass of white and pink subhedral feldspar and polycrystalline quartz eyes up to 1 cm in size. Biotite is commonly less than 5%.

Pyroxene-feldspar porphyry, feldspar porphyry, and hornblende-feldspar porphyry dikes intrude all older rocks throughout the map area. These probably were feeders to the volcanic rocks of the Eocene Marron Formation.

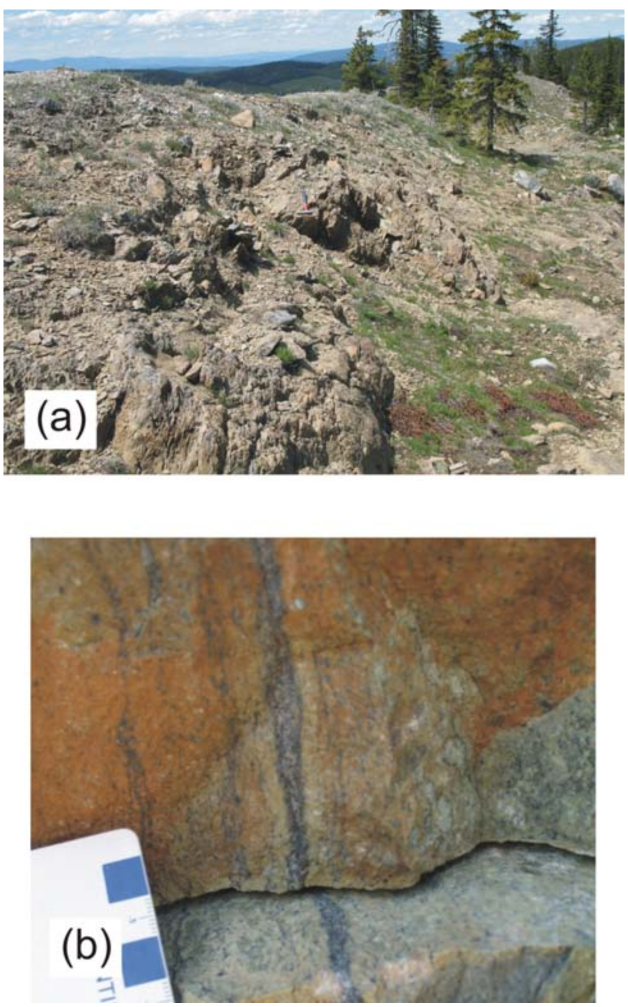

Figure 6. Jurassic ultramafic rocks: a) typical orange-brown outcrop of serpentinized pyroxenite (07NMA01-11; UTM Zone 11, 5450754N, 337817E, NAD83); b) magnetite seam in pyroxenite (07NMA01-14; UTM Zone 11, 5450311N, 338058E, NAD83).

BEAVERDELL AREA

Previous Work

The first and still only detailed regional map of the Beaverdell area is that of Reinecke (1915). He assigned the oldest stratified rocks to the Wallace group and correlated them, in part, with other Paleozoic sequences to the south, including the Anarchist schist and the Attwood 'Series'. Little (1957, 1961) and Tempelman-Kluit (1989a, b) extended this work to the east and west, including the older rocks in the "Anarchist Group". Detailed work on the mineral deposits of the area, including the silver-lead-zinc veins of the Beaverdell camp and the gold veins of the Carmi camp, has been reported by White (1949), Kidd and Perry (1957), Christopher (1975a, b; 1976), Peatfield (1978), Watson et al. (1982), Godwin et al. (1986) and Church (1995). Mathews (1988) reported on the Neogene volcanic rocks of the area while Kowall (1986a, b) mapped the Quaternary deposits.

Pre-Jurassic Rocks

The pre-Jurassic rocks of the Beaverdell area (Fig 8) differ significantly from the type Anarchist schist to the south. They are dominated by fine to medium-grained clastic sedimentary rocks which are essentially unmetamorphosed, though they do show extensive hornfelsing from Jurassic plutons. Limestone and greenstone members occur in the Crouse Creek area, and are the lowest exposed units. Significantly, no chert is developed in the sequence. Except for one small area, to the west of Crouse Creek, no penetrative deformation was observed.

Continuing correlation of these rocks with the Anarchist schist seems to be ill advised. It is proposed here to revert to Reinecke's original term — "Wallace" — for these rocks, though at the formation rather than group level. It should, however, be noted that not all of the area originally mapped as Wallace by Reinecke (1915) is actually underlain by pre-Jurassic rocks. There is a significant amount of younger intrusive material. In particular, a lot of the so-called pyroxene-phyric 'volcanics' in Reinecke's Wallace prove to be porphyry dikes of Tertiary age and, in one area east of Collier Lake, flows of the Eocene Marron Formation.

No geochronological or paleontological data are presently available for the Wallace formation rocks, though limestone samples have been collected for potential conodont determinations. Correlation of the Wallace is thus difficult. It is lithologically dissimilar to any of the Paleozoic sequences to the south. It does, however, show some similarities to parts of the Middle Triassic Brooklyn Formation of the Greenwood area or the Franklin Camp, though lacking the distinctive basal sharpstone conglomerate, perhaps due to non-exposure.

WALLACE FORMATION

Larse Creek limestone member

A significant limestone unit occurs in the Larse Creek area, forming the lowest exposed unit in the Wallace formation. Contact with the overlying greenstone member is not exposed, but the limestone is estimated to be at least 100 m thick. It is grey on weathered surfaces, varying from black to grey to white on fresh surfaces. It is massive to well bedded and laminated (Fig 9a, b). Thin siliceous and minor calcsilicate veins weather positively. Macrofossils appear to be absent.

Fine to medium grained, grey to light blue marble occurs in the Trapping Creek area as xenoliths and pendants in the Jurassic granodiorite. These may be derived from the Larse Creek limestone member. However, their isolated position and metamorphism preclude certainty in correlation.

Crouse Creek greenstone member

A greenstone unit overlies the limestone member in the Crouse Creek area. This comprises mostly massive mafic flows, though amygdules are occasionally seen. The flows are medium to dark green-grey, bluish green or black. They may show bright green epidosite patches up to 30 cm across (Fig 10a) and veins of quartz-chlorite±epidote±calcite. Many flows are fine grained and aphyric, but feldspar-phyric and pyroxene-feldspar-phyric flows are also common. Phenocrysts are approximately 1 to 2 mm in size. Volcanic breccia, lapilli tuff, pyroxene lapilli tuff and chloritic metatuff (Fig 10b, c, d) are also found interbedded in the flows, as is laminated limestone. Some volcanic breccias also contain limestone and clastic sedimentary rock clasts.

Clastic sedimentary rocks

Most of the exposed Wallace formation is typically interbedded and laminated siltstone-argillite (Fig 11a). Siltstone beds are light coloured, buff to pale grey, while argillite beds are dark grey. Weathered surfaces may be broken with a coating of rusty oxides. Individual beds can range up to 3 cm thick with laminations about 1 to 2 mm

Figure 7. McKinney Creek granodiorite: a) typical biotite granodiorite (07NMA14-17; UTM Zone 11, 5437528N, 338967E, NAD83); b) rounded feldspar-amphibolite xenolith in biotite granodiorite 907NMA14-04; UTM Zone 11, 5437967N, 337557E, NAD83); c) porphyritic granodiorite phase, note sun glinting on feldspar twin plane in upper right (07NMA14-17; UTM Zone 11, 5437528N, 338967E, NAD83); d) chilled contact of porphyritic granodiorite against biotite granodiorite (07NMA14-17; UTM Zone 11, 5437528N, 338967E, NAD83).

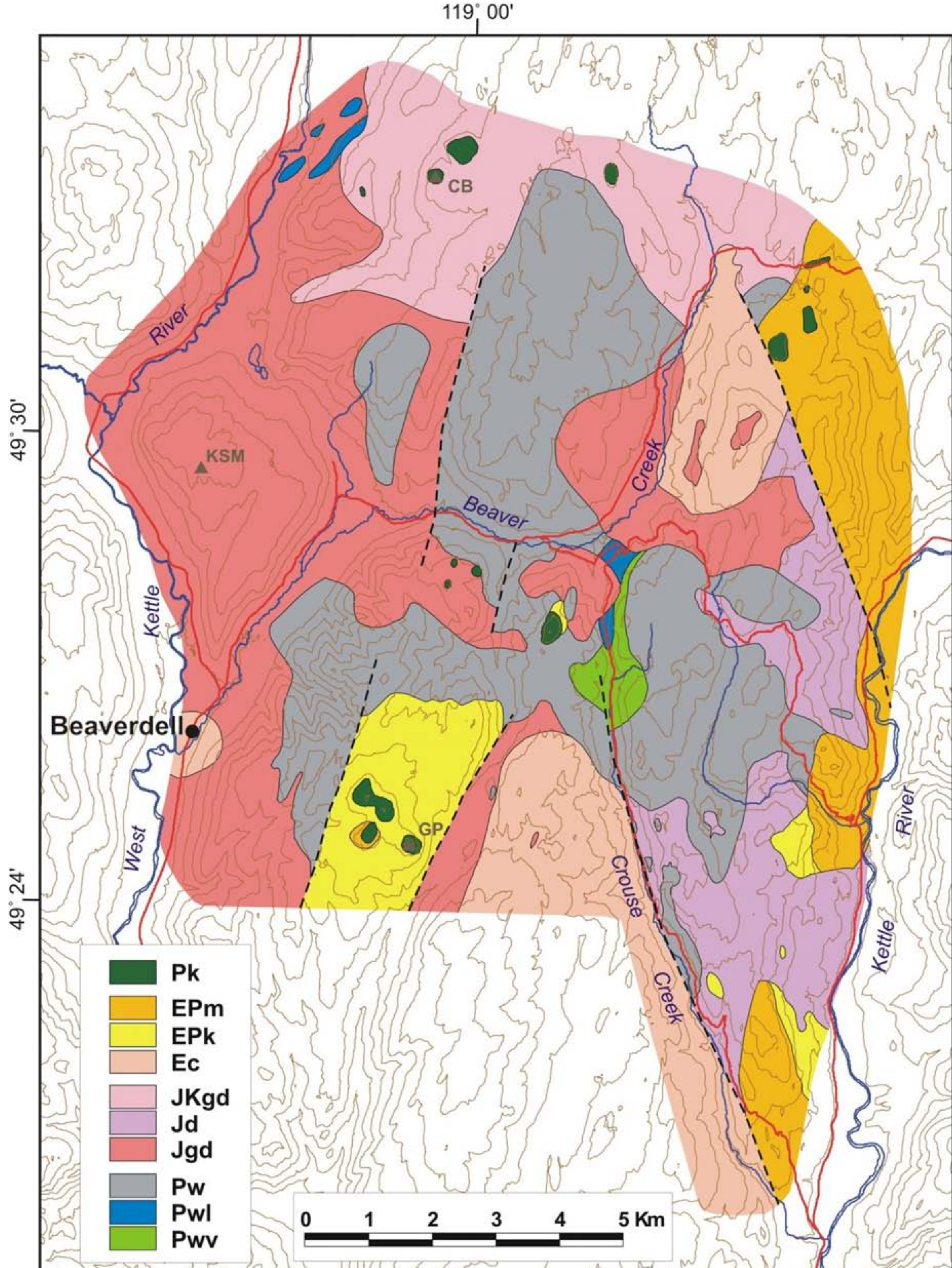

Figure 8. Geological sketch map of the area east of Beaverdell. Extent of coloured polygons shows the limit of area mapped in 2007. Abbreviations: CB, China Butte; GP, Goat Peak; KSM, King Solomon Mountain. Legend: Pw, Wallace formation; Pwl, Larse Creek limestone member of the Wallace formation; Pwv, Crouse Creek greenstone member of the Wallace formation; Jgd, granodiorite intrusions (Westkettle batholith, Nelson suite); Jd, diorite-quartz diorite intrusions (?Westkettle batholith, Nelson suite); Ec, K-feldspar megacrystic granite (Coryell suite); EPk, Kettle Valley Formation; EPm, Marron Formation; Pk, Kallis Formation.

thick. The sedimentary units are often siliceous or porcelaneous and may be recrystallized due to hornfelsing by Jurassic intrusions.

Coarser clastic beds are also found, though less common than the siltstone-argillite interbeds. Sandstone beds are grey, medium to coarse grained and generally massive. Hornfelsed sandstone is recrystallized to feldspar-quartz-amphibole assemblages that can be difficult to discriminate from microdiorite or microgranodiorite in the field. Conglomerate and pebbly sandstone have matrix-supported, rounded to subangular clasts (Fig 11b). The clasts are dominantly of siliceous siltstone and argillite, but also can include limestone, usually larger. All clasts appear to be intraformational and no exotic rock types have been observed.

Occasional white, tan or grey limestone interbeds vary from several centimetres up to five metres thick (Fig 11c). The limestone interbeds are massive and may be sparry or recrystallized due to hornfelsing, or may be variably silicified and skarned (Fig 11d).

Post-Triassic intrusions

Intrusive rocks envelope the Wallace formation in the Beaverdell area (Fig 8). These comprise several major granodiorite plutons and stocks in the western and central parts of the map area, designated the Westkettle batholith (Reinecke 1915) and probably correlative with the mid-Jurassic Nelson Intrusions (Little, 1961; Tempelman-Kluit, 1989a, b). Tempelman-Kluit (1989a, b) has also ascribed some of the granodiorite bodies to the north of the area as being part of the Jura-Cretaceous Okanagan batholith. No geochronological data are available for these rocks in the area.

Megacrystic granite of the Coryell suite forms two intrusions in the east and south of the map area, as well as the small Beaverdell stock. Tertiary-age porphyry dikes abound through the area, intruding all older rocks. The Beaverdell stock has yielded a biotite K-Ar date of 58.8 ±2.0 Ma (Godwin et al., 1986). Crosscutting dikes have been dated at 50.6 ±1.5 Ma and 61.9 ±2.2 Ma by whole-rock K-Ar methods by Watson et al. (1982). The latter also report biotite K-Ar dates for the Eugene Creek and Tuzo Creek stocks, west of Beaverdell, of 54.5 ±1.9 Ma and 49.5 ±2 Ma, respectively. A biotite K-Ar age of 49.4 ±0.7 Ma has also been obtained from the megacrystic granite of the Margranite quarry, south of Beaverdell (Church, 1995).

JURASSIC

The Westkettle batholith is composed of granodiorite, quartz diorite and microgranodiorite with minor aplite and pegmatite. The granodiorite is white to light grey, medium to coarse grained equigranular with a typical salt-and-pepper texture (Fig 12a). Weathered surfaces are white to grey but can be greenish or slightly pink. The rock comprises white subhedral feldspar, translucent irregular quartz, greenish black tabular hornblende and black biotite flakes. Pink feldspar is minor. Quartz contents vary from about 5 to 20%, or may be absent in dioritic phases. Colour index is about 10 to 15, but may range up to 25 in diorite and quartz diorite. Chlorite and epidote occur in veins; chlorite and iron oxides, on fracture surfaces. Xenoliths of amphibolite and microdiorite are occasionally seen.

Bodies of diorite, quartz diorite, microdiorite and microgranodiorite intrude the sedimentary rocks of the

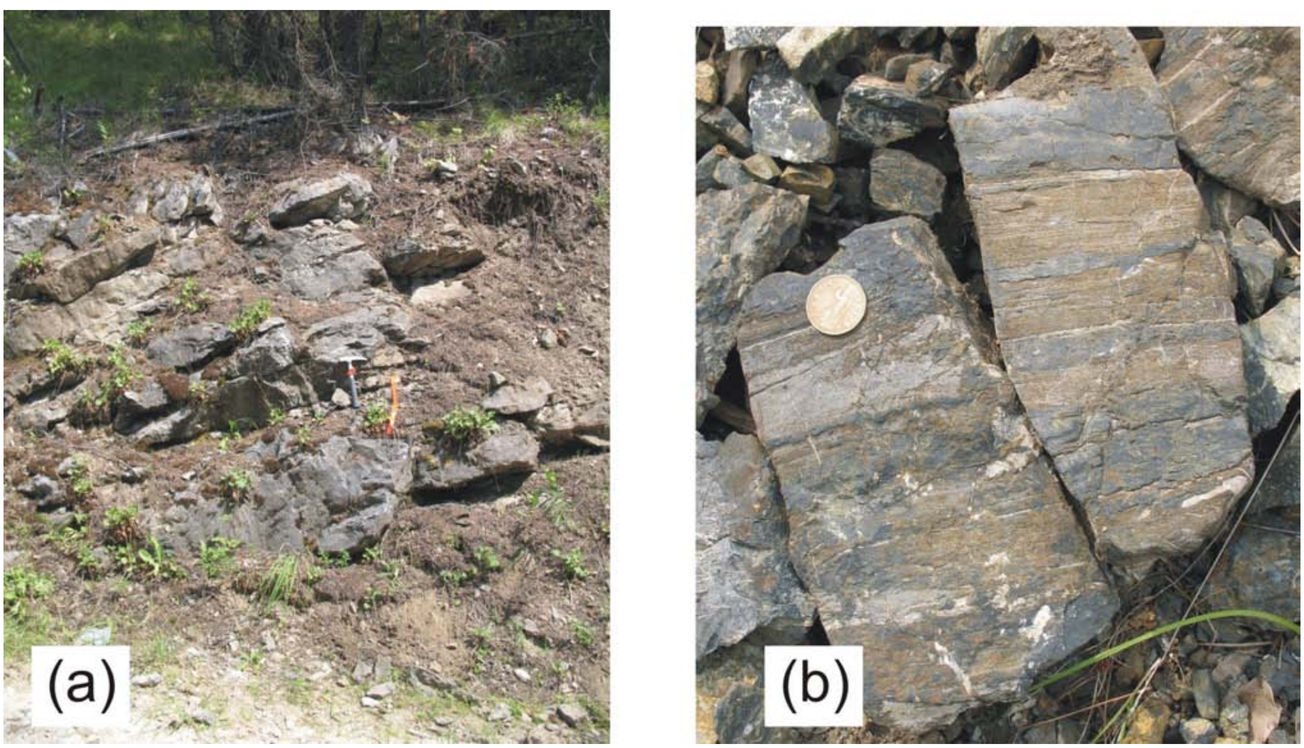

Figure 9. Larse Creek limestone member of the Wallace Formation: a) bedded limestone (07NMA21-13; UTM Zone 11, 5482534N, 358653E, NAD83); b) close up of laminations in limestone (07NMA22-04; UTM Zone 11, 5481427N, 357652E, NAD83).

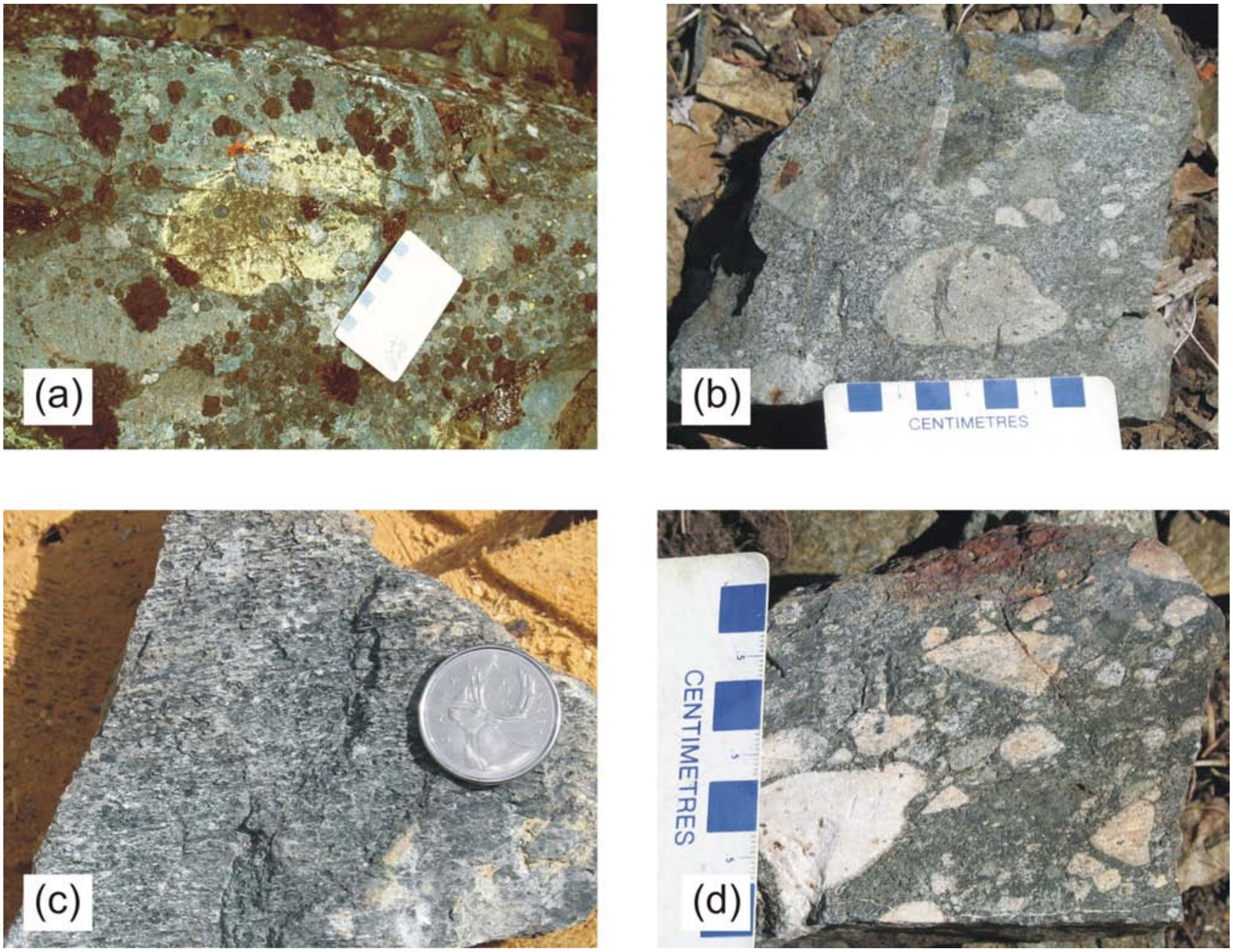

Figure 10. The Crouse Creek greenstone member of the Wallace Formation. a) epidosite patch in massive greenstone (07NMA31-01; UTM Zone 11, 5479991N, 358567E, NAD83); b) pyroxene crystal lapilli tuff (07NMA32-04; UTM Zone 11, 5479062N, 358777E, NAD83); c) pyroxene-feldspar crystal tuff (07NMA33-02; UTM Zone 11, 5479283N, 357806E, NAD83); d) pyroxene crystal lapilli tuff with rhyolite clasts (07NMA32-04; UTM Zone 11, 5479062N, 358777E, NAD83).

Wallace formation to the east of Crouse creek. These tend to be medium to coarse-grained, equigranular rocks composed of white feldspar, green-black hornblende and variable amounts of quartz. One distinctive unit, termed the "hornblende crowded feldspar diorite" by Grieg and Flasha (2005), underlies much of the GK Property. This is characterized by abundant, subrounded to subhedral, lath-shaped, white feldspar crystals in a finer grained black groundmass of acicular hornblende and feldspar (Fig 12b). Tabular hornblende phenocrysts may also be developed. Quartz is rare or absent. The diorite is variably mineralized with up to 5% disseminated pyrrhotite, lesser pyrite and rare arsenopyrite (Greig and Flasha, 2005). The relationship of the dioritic rocks to the Westkettle granodiorite is presently unknown, though they are suspected to be correlative.

Foliated granodiorite occurs in the China Creek area in the northern part of the map area. This granodiorite comprises varying amounts of rounded sugary quartz, euhedral white feldspar, biotite and isotropic, lath-shaped hornblende. Minor pyrite can also be seen in hand sample. The grain size varies from fine to medium grained. Foliation is marked by dark and light colour banding due to varying mineral proportions and alignment of biotite plates. Foliations show an average trend of 134°/73° but are not continuous throughout the area. Tempelman-Kluit (1989a, b) assigned the foliated granodiorite to the Jura-Cretaceous Okanagan batholith. However, the foliated granodiorite is never seen in contact with the massive Westkettle granodiorite and relative age relations are unknown.

EOCENE

Megacrystic K-feldspar granite and quartz monzonite form three intrusions in the area — the Crystal Mountain, Collier Lake and Beaverdell stocks. Typical of Coryell intrusions, they have euhedral, lath to square-shaped phenocrysts of pink K-feldspar that are commonly 3 to 4 cm in size, though they range up to 8 cm (Fig 12c). They are set in a coarse-grained groundmass of white and pink subhedral feldspar and quartz. Quartz occurs as polycrystalline quartz eyes up to 1 cm in size or as irregular patches interstitial to the groundmass feldspars. Biotite is usually minor, varying from 5 to 10%. The Collier Lake stock differs to the other stocks in having lower quartz contents, less than 5%, and a medium-grained porphyritic microquartz monzonite chill phase (Fig 12d).

Pyroxene-feldspar porphyry, feldspar porphyry, hornblende-feldspar porphyry and K-feldspar megacrystic porphyry dikes occur throughout the map area. These are offshoots from the Coryell intrusions or feeders to the volcanic rocks of the Eocene Marron Formation. Orange to brown weathering dikes of black olivine basalt and aphyric basalt occur in the western part of the map area and are related to the Neogene Kallis Formation plateau basalts (Mathews, 1988).

REGIONAL CORRELATION OF PALEOZOIC SEQUENCES

The Paleozoic rocks of the Greenwood area are preserved in a series of northward-dipping thrust sheets (Little, 1983; Fyles, 1990) with many of the bounding thrusts being marked by serpentinite layers or pods. Despite disruption and modification of the thrust sheets by Tertiary extensional faulting, Massey (2007a) traced the Knob Hill Complex and Anarchist schist westward from the Greenwood area into the Johnstone Creek and Bridesville areas. Mapping in 2007 has identified all the Paleozoic rocks of the McKinney Creek area as being Anarchist schist and not Knob Hill Complex. Correlation of the belt of Jurassic diorite and ultramafic rocks with similar rocks underlying the Old Nick property and east to Rock Creek suggests dextral motion of about 10 km on the Conkle Lake fault (in addition to eastward downdrop). Rocks of the Knob Hill Complex west of the Conkle Lake fault would thus have to be displaced northwards (Fig 13). However, this area is underlain by Jura-Cretaceous intrusions, apart from minor outcrop areas of greenstone and chert in the Ripperno Creek area (Church, 1980), probably the furthest west remnants of the Knob Hill Complex. The Anarchist schist extends further westwards before passing into the granitic gneiss of the Okanagan batholith (Ryan, 1973; Tempelman-Kluit, 1989a, b).

West of the Okanagan fault, the Kobau Group is lithologically similar to the Anarchist schist and also has a complex deformational history (Okulitch,1973; Mäder et al., 1989). Its direct correlation with the Anarchist schist is however unclear due to the intervening Okanagan Fault. To the south, in Washington State, the Kobau Group structur-

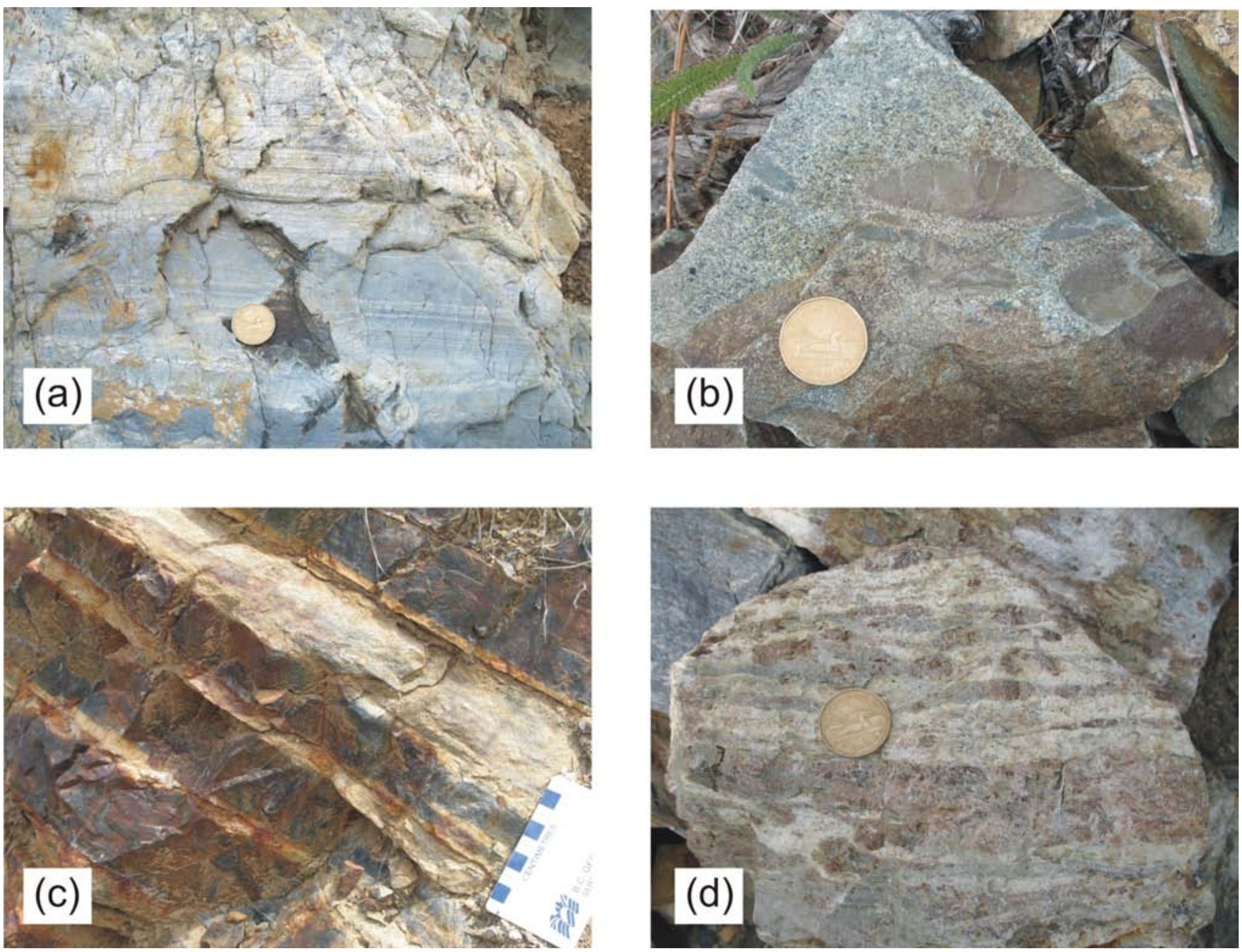

Figure 11. Clastic sedimentary rocks of the Wallace formation. a) laminated argillite-siltstone overlain by fine-grained sandstone bed (07NMA20-15; UTM Zone 11, 5479573N, 356006E, NAD83); b) pebbly sandstone (07NMA42-17; UTM Zone 11, 5476122N, 361189E, NAD83); c) limestone interbed in siltstone-argillite (07NMA21-06; UTM Zone 11, 5481228N, 356427E, NAD83); d) garnet skarn (07NMA33-08; UTM Zone 11, 5478697N, 358233E, NAD83).

ally overlies the Palmers Mountain Greenstone. The bounding thrust is probably marked by serpentinite in the Chopaka Mountain area (Rinehart and Fox, 1972) but has been poorly defined elsewhere in the Loomis map area.

The Palmer Mountain Greenstone comprises mafic flows and pyroclastic rocks with variably textured gabbro ('amphibolite' of Rinehart and Fox, 1972) that can be correlated with the Knob Hill Complex. These, in turn, structurally overlie the Anarchist Group along the Chesaw thrust (Cheney et al., 1994), though the 'Anarchist Group' of Rinehart and Fox (1972) includes much undeformed sharpstone conglomerate, limestone and finer clastic sedimentary rocks that are probably Brooklyn Formation equivalent.

If the suggested correlations and structural interpretations are correct, the thrust model developed in the Greenwood area by Fyles (1990) is thus apparently traceable west to the Loomis and Oliver areas. Throughout the Boundary district, the ophiolitic Knob Hill Complex is sandwiched between more complexly deformed quartzite-schist-greenstone sequences — the Anarchist to the south and Kobau to the north. In the Greenwood area, the latter is represented by the quartzite and schist of the Eholt Creek valley and Mount Roderick Dhu (Massey, 2006; see also Fig 13). However, it is still unclear how the Kobau Group and Anarchist schist correlate with each other, or with the Knob Hill Complex. They may be the same package structurally repeated or, perhaps, represent opposite sides of an oceanic basin (the Knob Hill Complex) that is now closed and telescoped. It is hoped that continuing petrochemical studies will help shed some light on this problem.

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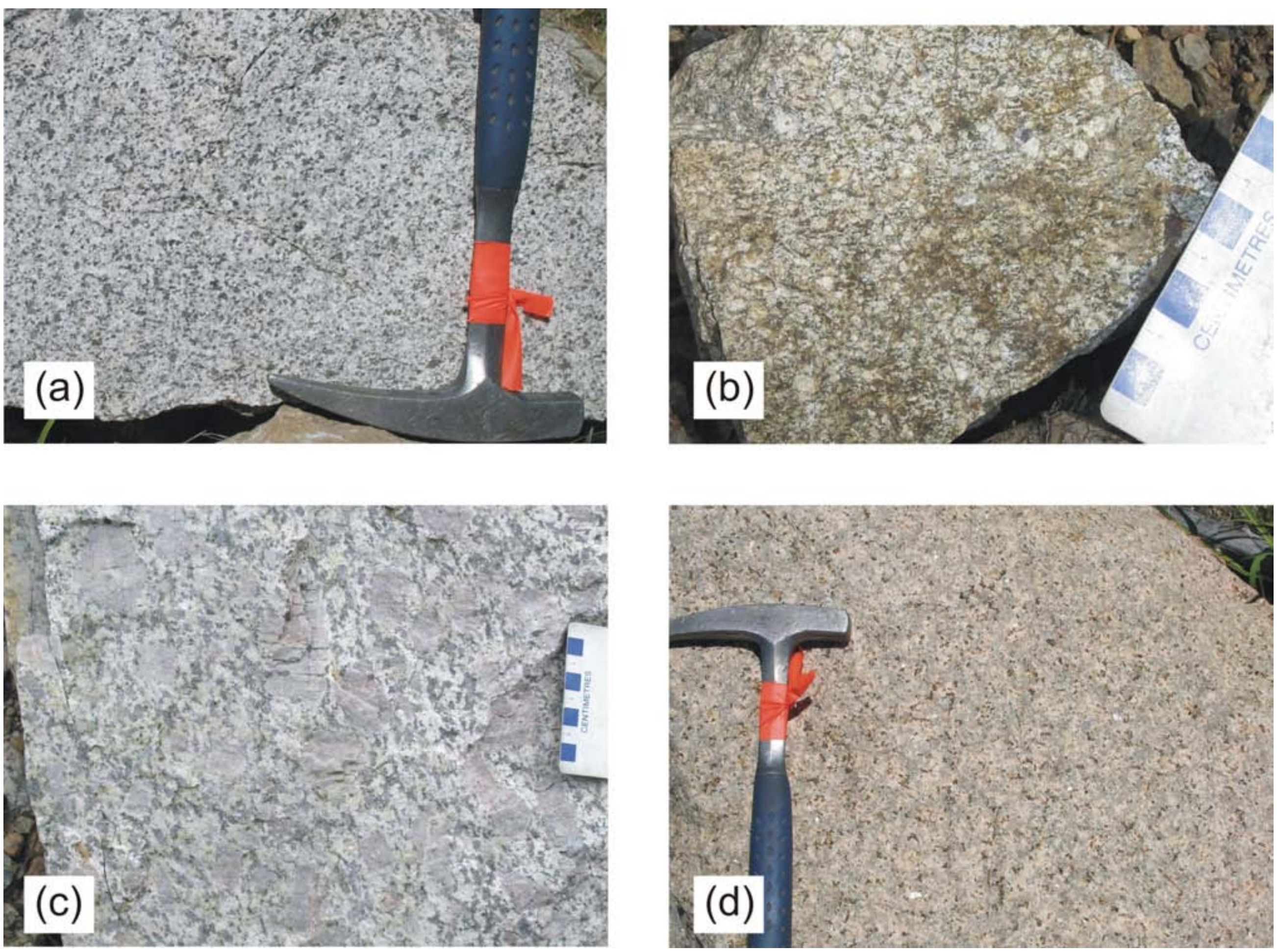

Figure 12. Intrusions of the Beaverdell area. a) hornblende-biotite granodiorite of the Jurassic Westkettle batholith (07NMA28-20; UTM Zone 11, 5484322N, 360440E, NAD83); b) hornblende crowded feldspar diorite (07NMA34-13; UTM Zone 11, 5474088N, 359662E, NAD83); c) typical K-feldspar megacrystic granite of the Eocene Coryell suite (07NMA45-09; UTM Zone 11, 5475024N, 355570E, NAD83); d) pink quartz monzonite of the Eocene Coryell suite (07NMA28-17; UTM Zone 11, 5486026N, 360995E, NAD83).

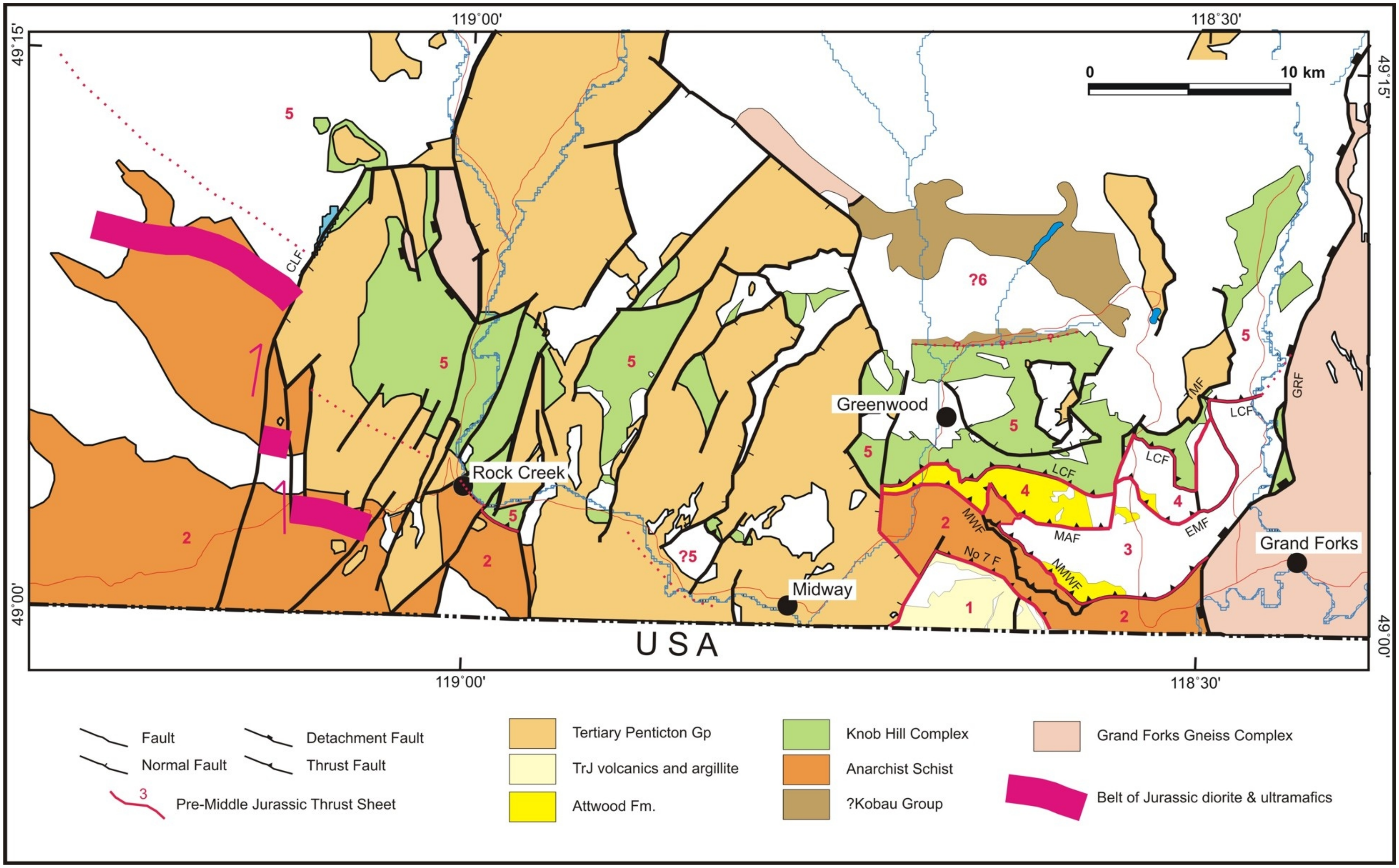

Figure 13. Main structural elements of the Boundary district, outlining the major thrust sheets (numbered 1–6) containing the Paleozoic and Mesozoic sequences (modified from Fyles, 1990; geology modified from Massey et al., 2005). Abbreviations: No 7 F, Number 7 fault; MWF, Mount Wright fault; NMWF, North Mount Wright fault; MAF, Mount Attwood fault; LCF, Lind Creek fault; EMF, Eagle Mountain fault; TMF, Thimble Mountain fault; GRF, Granby River fault; CLF, Conkle Lake fault. Jurassic diorite and ultramafic belt in the McKinney Creek area is shown diagrammatically as a thick magenta line. Arrows indicate relative lateral offsets along the Conkle Lake fault system.

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