DESCRIPTIVE NOTES

The southern Stewart River map area is underlain by polydeformed and metamorphosed Paleozoic rocks of the Yukon-Tanana terrane, younger plutonic rocks, and minor young volcanic and sedimentary rocks (Ryan and Gordey, 2002, 2001a, 2001b). Recognition of the region from Kirkman Creek in the south, to north of Shamrock Creek in the northwest as an extensive metavolcanic terrane rather than a siliciclastic continental margin succession as previously interpreted (Wheeler and McFeeley, 1991) implies a new and favourable potential for volcanic-hosted massive sulphide (Cu-Zn-Pb) deposits as seen elsewhere in the terrane (e.g. Murphy, 1998). The source of historically and currently produced placer gold along Thistle, Kirkman and Frisco creeks remains unresolved.

The only previous geological mapping was by H.S. Bostock from 1934-1936 (Bostock, 1942) who produced a 1:253 440 scale coloured map for the eastern two-thirds of the Stewart River map area (NTS 115N&O). D.D. Cairns (1917) provided descriptive notes related to the setting of placer gold deposits along Scroggie, Barker, Thistle and Kirkman Creek. As noted by Bostock, most of the Stewart River area is unglaciated (Bostock, 1942; Jackson and Huscroft, 2000; Jackson et al., 2001). Bedrock is obscured by a thick (~1 m) soil veneer, thick gravel and loess deposits in valley bottoms and by thick cover of forest, moss and lichen. Surficial geology of the Stewart River area is being mapped concurrently at 1:50 000 (Jackson et al., in prep). The best natural bedrock exposures are on the highest ridge crests (particularly south-facing slopes). Excellent manmade exposures lie along placer mining benches and their access roads. The use of float is critical in locating bedrock contacts, particularly for the younger granites which tend to be more deeply eroded than the schists and gneisses.

GEOLOGICAL UNITS Metasedimentary rocks (units 1-5)

Unit 1 comprises a thick sequence of grey to white, banded quartzite. It is strongly recrystallized, with a metamorphic grain size in excess of 1 mm. Varieties range in colour from black to rusty brown. Although largely fault bounded, quartzite members are demonstrably interstratified with quartz-mica schist, and a metaconglomerate (unit 2); stratigraphic younging cannot be deciphered there due to structural transposition. Elsewhere the quartzite tends to be impure with between 5% and 20% content of minerals other than quartz, such as mica and feldspar, and usually grades into psammite. In high-strain zones, the quartzite can take on a highly fissile character, and more correctly termed quartz mylonite. Rhythmic layering in some quartzite is reminiscent of that observed in ribbon chert, and a chert origin for some of this

Unit 2 comprises metaconglomerate, observed at one locality along the Yukon River. It is strongly deformed, as evidenced by isoclinal folds of granite veins that cut it, but clasts are clearly recognizable in a matrix of quartzofeldpathic schist. The conglomerate is matrix supported, and clasts are well rounded. Clasts are generally less that 10 cm in diameter, and composed chiefly of white quartzite (probably derived from eroded veins). Less common clasts of tonalite are as large as 20 cm in diameter. The conglomerate grades locally to impure quartz arenite, and is adjacent to an occurrence of grey

Unit 3 includes mica-quartz (muscovite and biotite) schist and paragneiss of psammitic, semipelitic, and rare pelitic origin. Although transposed, primary compositional layering is generally preserved. These mica-bearing metasedimentary rocks almost ubiquitously contain garnet, whereas other index minerals such as staurolite or aluminum silicate minerals are very rare. Unit 4 consists of quartz-mica schist, and differs from unit 3 by a much higher quartz content. It is interstratified with, and commonly grades into unit 3, and across much of the map, units 3 and 4 are undifferentiated. The quartz-mica schist, which was probably derived from siliceous siltstone, is also interstratified with amphibolite, and includes finely interlayered horizons of garnet-metapelite. Some beds

grade to white- or beige-weathering micaceous quartz arenite. More locally, this variety of the quartz-mica schist is associated with white to grey, banded quartzite. Marble of unit 5 forms a minor component in the southern Stewart River area. The unit is dominated by coarse-grained (~5 mm) marble, with lesser calc-silicate schist. Where recrystallization has been less severe, bedding is locally preserved. Marble horizons are generally less than 20 m thick, with a couple of exceptions east of Scroggie Creek and north of the Stewart River where 75 m or more are

Metavolcanic and volcaniclastic rocks (units 6-8) Unit 6 comprises amphibolite schist and/or gneiss of highly variable composition and state of strain. Amphibolite units generally contain the mineral assemblages hornblende-plagioclase or garnethornblende-plagioclase ± quartz ± epidote, with local chlorite-biotite. Ryan and Gordey (2001a) reported that amphibolite occurs in two main associations: 1) interstratified with the metasedimentary rocks described above, and 2) with an orthogneissic complex (units 9 and 10). The amphibolite units were intensely tectonized, and underwent extreme grain-size coarsening during regional metamorphism, making it difficult to discern the protolith. They are proportionally more abundant in the Thistle Creek area. Preserved volcanic textures that might shed light on their origin are rare; a mafic volcanic to volcaniclastic protolith is likely. Some amphibolite horizons are more clearly derived from sills or dykes of diabase, gabbro, or diorite. They are generally boudinaged, and locally preserve contacts oblique to layering. Some coarse grained mafic amphibolites are more gneissic than schistose. These may reflect more extreme metamorphic conditions, or a protolith of gabbroic or dioritic intrusions.

Spectacular examples of more intermediate varieties of amphibolite were mapped southwest of Scroggie Creek, west of Black Hills Creek, and in the Shamrock dome region. These contain large hornblende porphyroblasts that commonly exhibit spectacular decussate texture, or occur as spaced rosettes that are as large as 15 cm, in a matrix of plagioclase, epidote, and quartz. For these rocks an intermediate composition metavolcanic and volcaniclastic protolith is likely. Complete gradation is seen between the mafic and intermediate compositions of amphibolite, and some grade locally to mafic psammitic schist, probably derived from greywacke. Unit 7 comprises quartz-sericite schist or metafelsite, possibly derived from felsic volcanic rocks or hypabyssal intrusions. Phenocrysts have been obliterated by strain and metamorphism. At one locality east of Thistle Mountain, a metafelsite horizon readily traceable for 3 km carries abnormally large and abundant garnet porphyroblasts. The interfingered metafelsites and amphibolites are consistent with

bimodal volcanism, possibly in an arc setting. Unit 8 is a conspicuous mafic schist observed only around Thistle Mountain. It is composed of biotite-hornblende ± plagioclase-quartz, with blocky books of biotite. The rock is charcoal-grey weathering, and has a distinct pitted appearance where biotite has weathered out. The rock is laced with quartz veins, giving it a gneissic appearance.

Unit 9 comprises an intrusive complex of intermediate to mafic orthogneiss of variable state of strain. It is composed chiefly of grey-weathering tonalite to diorite sheets (commonly 5-50 cm thick) and veinlets, giving the rock an intensely layered and banded appearance. More homogeneous bodies of tonalite and diorite are grouped with the orthogneiss, but perhaps would be better referred to as strongly foliated rather than truly gneissic. We interpret the orthogneiss complex as subvolcanic intrusions to the volcanic pile(s)

Orthogneissic rocks (units 9-11)

represented by amphibolite (unit 6) with which it is intimately associated, essentially forming a volcanoplutonic complex. Where exposure was too poor, or interlayering was at too fine a scale, units 6 and 9 are undivided. Regional correlation suggests the orthogneiss complex may be late Devonian or early Mississippian in age. Felsic to intermediate orthogneiss of Unit 10 is composed of pink- to orange-weathering granite to granodiorite sheets and veinlets. In detail, these crosscut the diorite and tonalite sheets, with which they were transposed. Gneissic granitic sheets observed outside of the intrusive complex are presently

grouped in unit 10, although a similar age is not proven. Potassic feldspar augen granitic orthogneiss comprises unit 11. This unit is pink- to greyweathering, and forms one of the more texturally distinct rock types across the area. For the most part, these rocks are highly strained, but low-strain vestiges of porphyritic monzogranite do occur. At high strain, the augen granite can be confused with metasedimentary schist, if not for the feldspar porphyroclasts.

Unit 11 is regionally widespread, and a variety of mid- to Late Paleozoic ages could be represented; however, a Permian age is suggested (M. Villeneuve, unpub. data, 2001) for one body near Kirkman Creek. Matic and ultramatic rocks (units 12-13) A diverse assemblage (or complex) of mafic to ultramafic rocks make up unit 12 (Ryan and Gordey, 2002). It is dominated by highly deformed, amphibolite-facies metagabbro, with lesser associated

metapyroxenite, and rare serpentinite and talc-siderite schist. Hornblende is the chief metamorphic mineral in the metagabbro, whereas the metapyroxenite is made up almost exclusively of coarse-grained, randomly oriented (0.5-10 cm) actinolite. The bulk of the mafic-ultramafic rocks occur as boudins or flatlying sheets at high elevation west of the Yukon River, north of Los Angeles Creek, and on the west side of Mount Stewart, south of Frisco Creek. They lie structurally above metasedimentary rocks of units 3 and 4, and their contact appears to have predated gneissosity development. The easterly sheet also contains a body of highly magnetic, brown- to bright green-weathering serpentinite. These units appear texturally and compositionally distinct from the relatively fresh-looking, coarse grained pyroxenite body exposed on Pyroxene Mountain immediately southeast of the map area. The origin of the complex is unclear, and may represent intrusions into the siliciclastic rocks, or may represent fragments of oceanic crust. Unit 13 comprises rare metagabbro bodies. Some gabbros contain garnet porphyroblasts,

indicating that they have undergone the regional metamorphism. Less-metamorphosed examples crosscut the regional foliation. Younger granitoids (units 14-16)

Unit 14 includes a variety of monzogranite, granodiorite and quartz monzonite intrusions. These crosscut the regional gneissosity, but are themselves moderately to strongly foliated. Their lesser state of strain relative to the orthogneiss units (units 9, 10, and 11) suggests a younger age ((?)Permian to (?)Jurassic). Unit 15 includes a variety of intrusions ranging from chlorite-altered hornblende to biotitebearing granodiorite and monzogranite, quartz monzanite, and monzodiorite. These bodies have little to no tectonic fabric. Their age is not known with certainty, but intrusions of similar composition and character dated elsewhere in the Yukon-Tanana terrane are Jurassic (Mortensen, 1992; and J.K. Unit 16 comprises a suite of syenogranite to monzogranite plutons, and/or dykes which are massive, unmetamorphosed, and locally cut unit 14. These may be Jurassic to Cretaceous.

Cretaceous-Eocene rocks (units 17-19) Unit 17 comprises a conglomerate horizon exposed 1.25 km west of the west edge of NTS 115-O/4, and lies below Carmacks Group rocks (Unit 18). The conglomerate is unmetamorphosed, largely clast supported, and contains rounded to angular clasts of dominantly vein quartz and foliated quartzite. Unit 17

may correlate with the Tantalus Formation of Early Creatceous age as described by Lowey and Hills (1988). Unit 18 consists of volcanic rocks of the late Cretaceous Carmacks Group, and is dominated by rhyodacite, dacite, rhyolite, with lesser andesite and basalt. Locally, primary fabrics such as flow banding in rhyodacite or flattened vesicles in andesitic basalt demonstrate their extrusive origin. The distribution of the Carmacks Group is largely controlled by faults synchronous with and postdating eruption. Unit 19 comprises a number of localized occurrences of quartz and/or potassic feldspar phyric rhyolite commonly exposed in small, blocky felsenmeer rather than intact bedrock. Quartz phenocrysts from 1-5 mm, but as large as 12 mm, vary from clear, to smoky grey, and smoky blue-grey. Most occurrences appear to be dykes rather than flows, a few of which are measured as north trending and

subvertical. They are probably of Tertiary age.

The regional foliation (ST) in the area is characterized by high-strain transposition of layering in gneisses and schists, with abundant intrafolial isoclinal folds that are commonly rootless. Primary compositional layering (So) in [metasedimentary rocks,

unit contacts (e.g., dyke margins), and a pre-existing foliation (S₁) can be recognized around closures of the transposition folds, indicating that these closures are at least F2 structures. The F2 folds are generally recumbent to shallowly inclined, close to isoclinal, long-wavelength structures. Associated with the folds is an intensely developed regional extension lineation (L2) that is parallel to the F2 axes. Surprisingly, even at these

high strains, there is little development of an axialplanar fabric to F2; rather, ST is characterized by the complete reorientation of, and strain intensification of, So and S1. Although ST is largely defined by pre-existing layering, its present geometrical surface is considered a second generation feature. This geometry is conceptualized in the adjacent diagram. The intensity of strain within the regional foliation locally grades to mylonite; however, the amount of displacement along these mylonitic bands is unknown. Spacing between mafic boudins in the gneisses indicates extension on the order of 1000%. Some F2 folds are doubly closing, which may indicate

a sheath-like geometry, further attesting to the high strain in these rocks. F3 folds are open, moderately inclined (with shallow to steep varieties), shallowly plunging structures. They have weak axial-planar fabric where developed in schistose layers, and have no associated extension lineation. They fold the L2 lineation. Tighter examples of F3 folds can be difficult to distinguish from more open F2 folds. Some localities show a moderately inclined, to upright spaced S3 cleavage (spaced 1-3 cm), overprinting F₂ isoclines without the apparent development of outcrop-scale or smaller F3 folds. F3 structures appear to postdate regional metamorphism.

The map area is affected by faults of various significance. Most of these could not be observed directly, but are interpreted to help explain abrupt changes in rock type, and/or structural grain. Some of these are also well delineated by prominent physiographic and aeromagnetic lineaments. Locally, fault breccia and slickensides provide direct evidence of fault contacts (e.g., upper Lulu Creek). Mapping across the White and Yukon rivers shows no appreciable change in bedrock composition across these valleys, ruling out any significant offset along them. Future mapping will test the significance of the pronounced lineament trending northwestward from Scroggie Creek, through the Stewart, Yukon, and Sixty Mile rivers.

The relative timing between metamorphism and fabric development based on field observations is complex and the subject of further investigation. Locally, garnet (of the peak metamorphic assemblage) is wrapped by ST (the transposed foliation), whereas in other places ST appears overgrown by garnet. There is also local evidence for two populations of hornblende. An older set appears to define the lineation, whereas the second population, made up of rosettes, radiate within, and locally across, the foliation plane. At a locality north of Thistle Creek, large hornblendes that radiate in the ST foliation plane appear to overprint ST, and yet are deformed. This complexity is brought about largely as a function of ST being defined mainly by reoriented S1 and So. Porphyroblasts have overgrown S1, but whether they were wrapped by ST was dependant upon how strongly the S1 foliation was reactivated during the F2 transposition episode. If a layer rotated passively without accommodating internal strain, porphyroblasts that overgrew S₁ could survive F₂ deformation with little to no F₂ strain. It is also possible that the rocks have undergone polymetamorphism, or that fabric development was diachronous.

The relatively common assemblage of garnet and hornblende in mafic rocks (units 6 and 12) suggests metamorphic conditions of at least middle amphibolite facies. Kyanite has been observed in the very eastern part of the map area, on Grizzly Dome and along the southern extension of Scroggie Creek. For the most part, peak assemblage minerals like garnet and hornblende are stable and well preserved. Locally, hornblende is retrograded to biotite and chlorite and garnet to chlorite-quartz or plagioclase. Plagioclase retrogression is generally manifest as rims around garnet, but complete replacement was also noted. The breakdown of garnet to plagioclase may be evidence for an isothermal decompression reaction. The state of strain and metamorphic grade are suggestive of deformation and metamorphism at mid-crustal levels. Regional considerations suggest a Permo-Triassic age.

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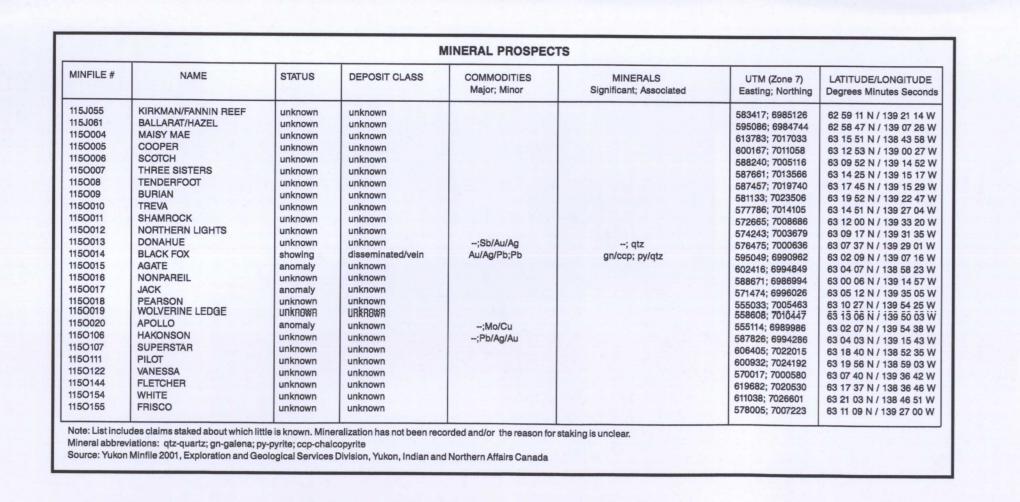
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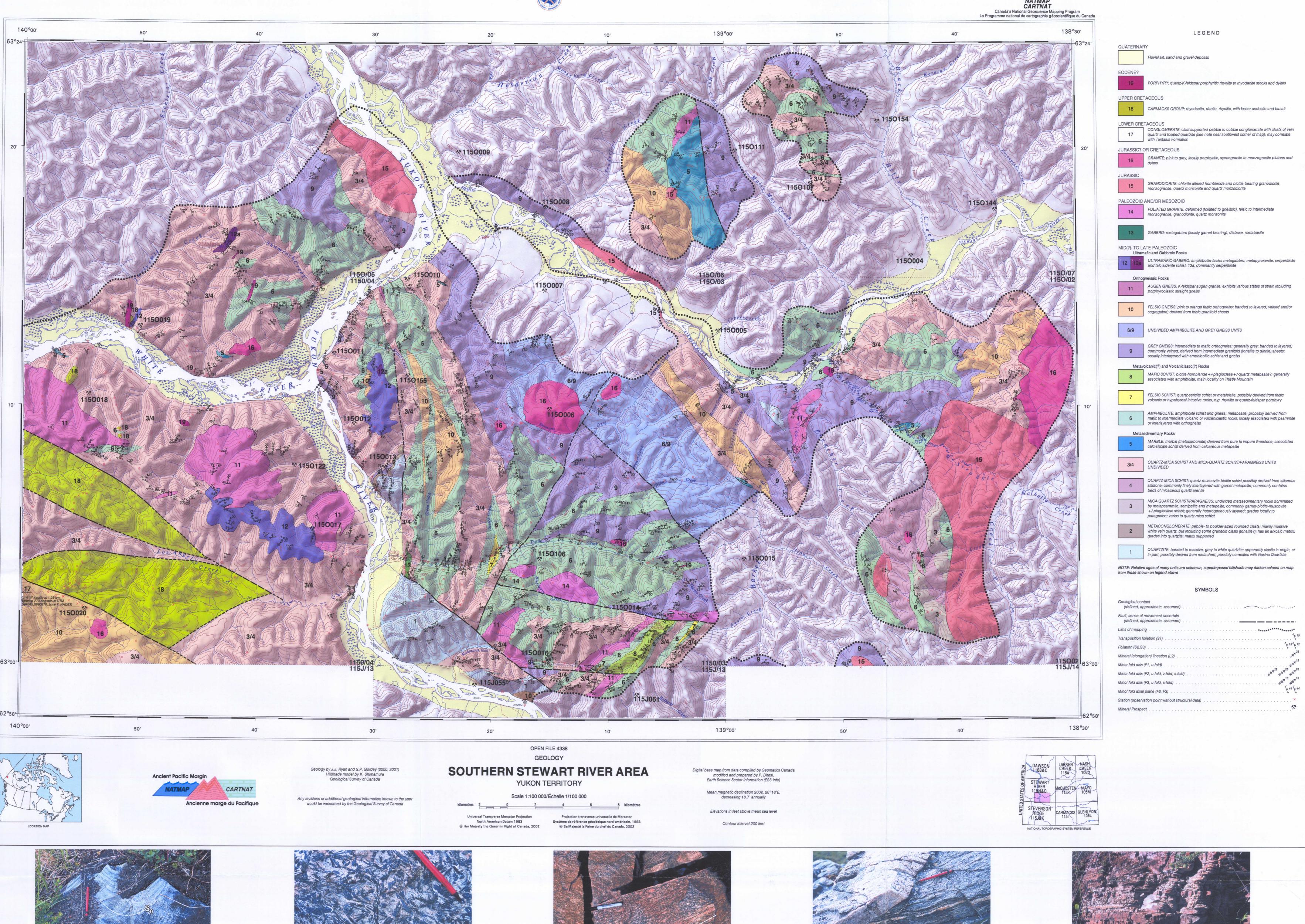




Plate 1: Banded grey quartzite (unit 1), exhibiting well-preserved bedding (S₀). This unit is generally several metres thick, and interpreted as a metaclastic rock. Quarztite beds also occur in Unit 4. Pencil for scale (13.5



Plate 2: Garnet-amphibolite in a mafic variety of Unit 6, where some garnet are altered to plagioclase. In

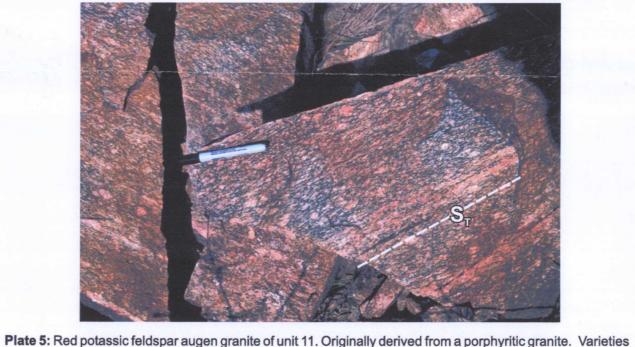
general, garnet appears to be in disequilibrium, producing plagioclase-hornblende rims. Pencil for scale (13.5

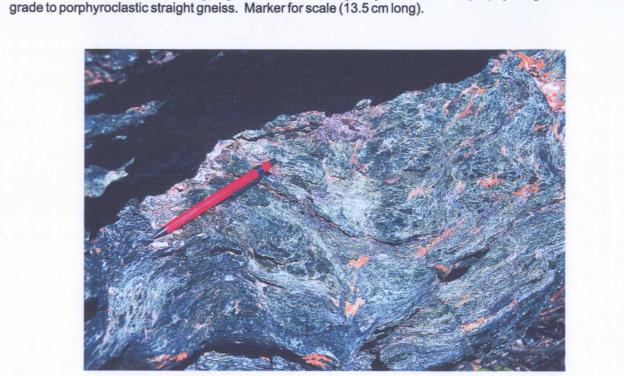
Plate 3: Large rosettes of hornblende radiating on the foliation surface of an intermediate amphibolite (unit 6). The decussate hornblende crystals sit in a matrix of plagioclase, quartz and epidote. Pencil for scale (13.5 cm

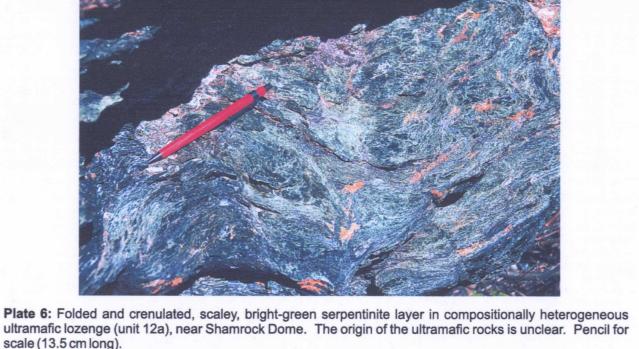
Plate 4: Typical heterogeneously layered grey orthogneiss (unit 9) composed of diorite, tonalite and

granodiorite (in sequence of intrusion). Strongly flattened resorbed amphibolite xenoliths (e.g. short black

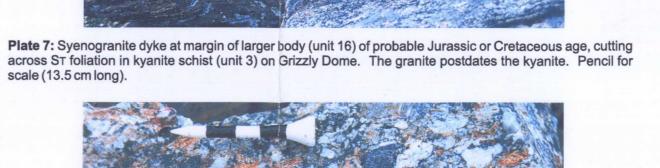
arrows) demonstrate the host rock. Pencil for scale (13.5 cm long).

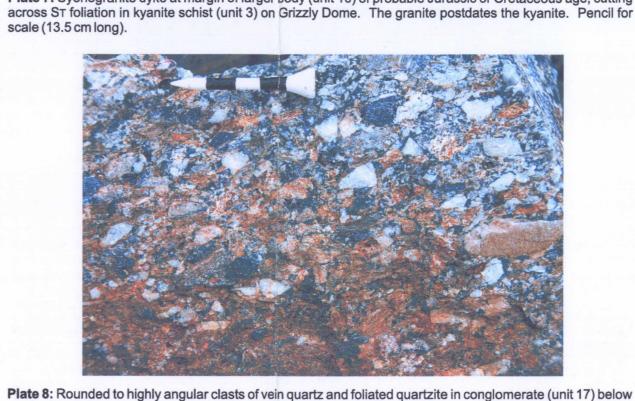












Carmacks Group. It probably correlates with the Tantalus Formation as described in Lowey and Hills (1988).

Golf tee for scale (marked in cm).

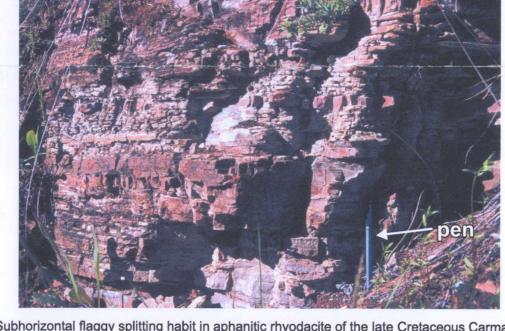


Plate 9: Subhorizontal flaggy splitting habit in aphanitic rhyodacite of the late Cretaceous Carmacks Group (unit 18), reflecting cryptic primary flow fabrics. Pen for scale (14 cm long approx.)

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