Preliminary geology of the southern Semenof Hills, central Yukon (105E/1,7,8)

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ABSTRACT

The volcano-sedimentary rocks of the Semenof block of central Yukon have not been closely studied in the past. Recent bedrock mapping in the southern Semenof Hills highlights the presence of possibly two exceptionally well preserved, undeformed and unmetamorphosed volcano-sedimentary sequences of Late Paleozoic age. The main sequence is composed, from bottom to top, of (1) 2- to 3-km-thick thinly bedded fragmental volcanic rocks interbedded with few limy intervals, (2) thick massive plagioclase- and clinopyroxene-phyric basaltic lava flows with clastic intervals, and (3) a 1- to 3-km-thick volcanic conglomerate. The other sequence, of lesser extent, consists of (1) a thin quartz-porphyritic felsic volcanic unit, less than 50 m thick, (2) 2- to 3-km of massive to pillowed fine-grained basaltic lavas, and (3) 100 m of fossiliferous Upper Carboniferous limestone. These two sequences sit in faulted contact on ~2 km of a deformed clastic sequence of unknown affinity.

RÉSUMÉ

Les roches volcano-sedimentaires du bloc de Semenof dans le centre du Yukon ont été sous-étudiées dans le passé. Une cartographie récente dans la partie sud des Semenof Hills vient tout juste de mettre au grand jour la présence potentielle de deux séquences volcano-sédimentaires d'âge Paléozoïque tardif non déformées et non métamorphisées. La séquence principale est composée, de la base au sommet, de (1) 2 à 3 km de roches volcaniques fragmentaires finement litées présentant quelques intervalles calcareux, (2) d'épaisses coulées de laves basaltiques porphyriques massives à phénocrystaux de clinopyroxènes et plagioclases présentant des intervalles clastiques et de (3) 1 à 3 km de conglomerat volcanique. La seconde séquence, de moindre importance, consiste en (1) une mince unité volcanique felsique porphyrique à phénocrystaux de quartz, (2) 2 à 3 km de laves basaltiques massives à coussinées finement grenues et (3) 100 m de calcaires fossilifères du Carbonifère supérieur. Ces deux séquences reposent en contact de faille sur environ 2 km d'une séquence clastique déformée d'affinité inconnue.

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INTRODUCTION

This report presents preliminary results from 1:50 000 scale bedrock mapping of the southern Semenof Hills (105E/1,7 and 8) in summer of 2002. Located approximately 60 km northeast of Whitehorse, the Semenof Hills form a band of north-trending rounded hills, between the Teslin and Big Salmon rivers in the Laberge map area (105E; Fig. 1). These hills extend for more than 100 km north to Little Salmon Lake, in Glenlyon map area (105 L; Fig. 1).

The Semenof Hills were previously mapped in the late 1970s-early 1980s at a scale of 1:250 000 by Tempelman-Kluit (1984). Tempelman-Kluit's work identified a sequence of Late Paleozoic volcano-sedimentary rocks, the Semenof block (Fig. 1), that lies between the Yukon-Tanana Terrane to the east and Stikine Terrane to the west. Two informal formations were recognized, the lower Boswell formation, mainly sedimentary rocks, and the upper Semenof formation, mainly volcanic rocks (Monger et al., 1991). The Boswell formation was about 1100 m and consisted of laterally interfingering units of slate, phyllite, chert, greenstone and limestone. Conodonts and fusulinids indicated an Early to mid-Pennsylvanian age (Monger et al., 1991). The Semenof formation was possibly 800 m thick, and consisted of massive mafic rocks mainly without structure, but in places showing faint pillow outlines, amygdules and layers of basaltic tuff. Augite phenocrysts were noted to be present locally. A carbonate lens in the formation contained fusilinids of Late Moscovian age (Monger et al., 1991).

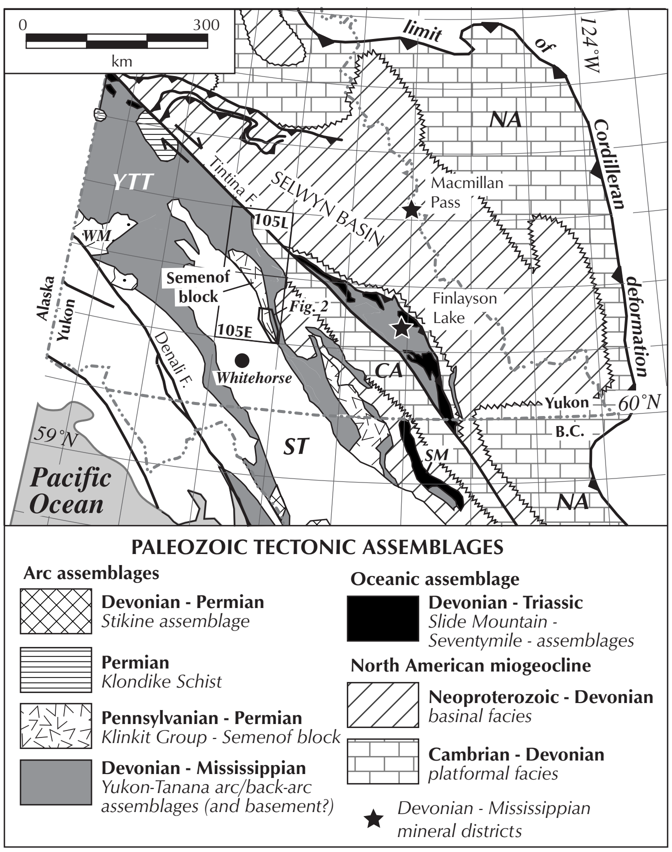


***Figure 1**. Location map of Late Paleozoic volcano-sedimentary rocks of the Semenof block, central Yukon, with respect to the distribution of other Paleozoic tectonic assemblages of the northern Canadian Cordillera (modified from Wheeler and McFeely, 1991). NA – Ancient North America, ST – Stikine Terrane, YTT – Yukon-Tanana Terrane, SM – Slide Mountain Terrane, WM – Windy-McKinley Terrane.*

To date, no detailed work has been done on those rocks and informal units of Tempelman-Kluit (1984) have yet to be defined. As a result, the stratigraphy and tectonic affinity of the Semenof block remain enigmatic. It has previously been assigned to the Slide Mountain Terrane (Monger et al., 1991), then to Quesnel Terrane (Gordey and Makepeace, 2000), and its relationship to the Yukon-Tanana Terrane is not clear (Colpron and Yukon-Tanana Working Group, 2001).

Bedrock mapping in summer of 2002 focused on the southern part of the Semenof Hills, from east of Livingstone, on Mason Landing ridge, southward to Mount Peters and Moose and Boswell mountains (Fig. 2). These areas provide good alpine exposures, which offer the opportunity to study these rocks in detail. Stratigraphic, geochemical, biostratigraphic and geochronological studies will characterize this volcano-sedimentary sequence, as part of a PhD project at Dalhousie University, Halifax. The goal is to clarify its relationship to other known Late Paleozoic volcano-sedimentary sequences of the northern Canadian Cordillera, like the Little Salmon and Little Kalzas successions (Colpron, 2001; Colpron and Reinecke, 2000; Colpron, 1999) of central Yukon, the Klinkit Group (R.-L. Simard, work in progress, 2002) of northern British Columbia and southern Yukon, and the Lay Range Assemblage (Ferri, 1997) of central northern British Columbia.

STRATIGRAPHY

The general stratigraphy of the southern Semenof Hills shows thick continuous subvertical to steeply dipping volcanic and sedimentary units trending southeast (Fig. 2).

The sedimentary rocks in the eastern part of the study area, along the South Big Salmon River, consist of limestone and clastic units. The main ridges, mainly above tree-line, expose two distinct volcanic packages intercalated with minor sedimentary units. The western part of the hills was not mapped during this field season, but will be the focus of the 2003 field season.

The volcanic and sedimentary rocks of the area are generally undeformed and unmetamorphosed. Local brittle deformation zones as well as epidote veins are observed in places. Pristine primary textures are preserved in most of the exposures, and top indicators, mostly to the southwest, were observed throughout the sequence. Stratigraphic units are described below and presented in four sections from east to west (Figs. 2,3). This stratigraphy is preliminary, assumes undisturbed upright stratigraphic sequences, and may be revised after further field, biostratigraphic, geochemical and geochronological studies are completed.

CLASTIC UNITS

Unit A

The lowermost unit of the stratigraphy in the Boswell and Moose mountains area, unit A, consists predominantly of greenish-beige, well bedded subarkosic to arkosic sandstone beds (Figs. 2,3). These sandstones typically occur in 5- to 15-cm-thick beds and have ~15% rounded quartz grains from 0.5 to 3 mm in diameter (Fig. 4). These clastic beds are interbedded with minor chloritic schist beds. Toward the top, scattered limestone lenses are observed. Unlike the other units of the southern Semenof Hills, unit A shows a well developed foliation dipping steeply to the south-southwest and gentle folding of the bedding.

In the upper 200 metres of unit A, the increasing intensity of the foliation and the presence of abundant quartz veins as well as an oxidized zone in the last metres suggest a faulted contact with the overlying limestone.

Unit B

Unit B is found on the west side of the Boswell and Moose mountains. It consists mainly of grey conglomeratic litharenite with minor argillaceous beds and conglomeratic intervals (Figs. 2,3). The conglomeratic litharenite beds consist of non-sorted medium- to coarse-grained sandstone with 10-30% granules containing mainly angular black argillite fragments, and quartz and feldspar grains. A few metres of clast-supported, non-sorted polymictic conglomerate with mainly angular black argillaceous clasts up to 15 cm in diameter are observed in this unit and characterize its base. About 15 m of finely bedded to massive black argillite occur in the upper part of unit B.

Unit C

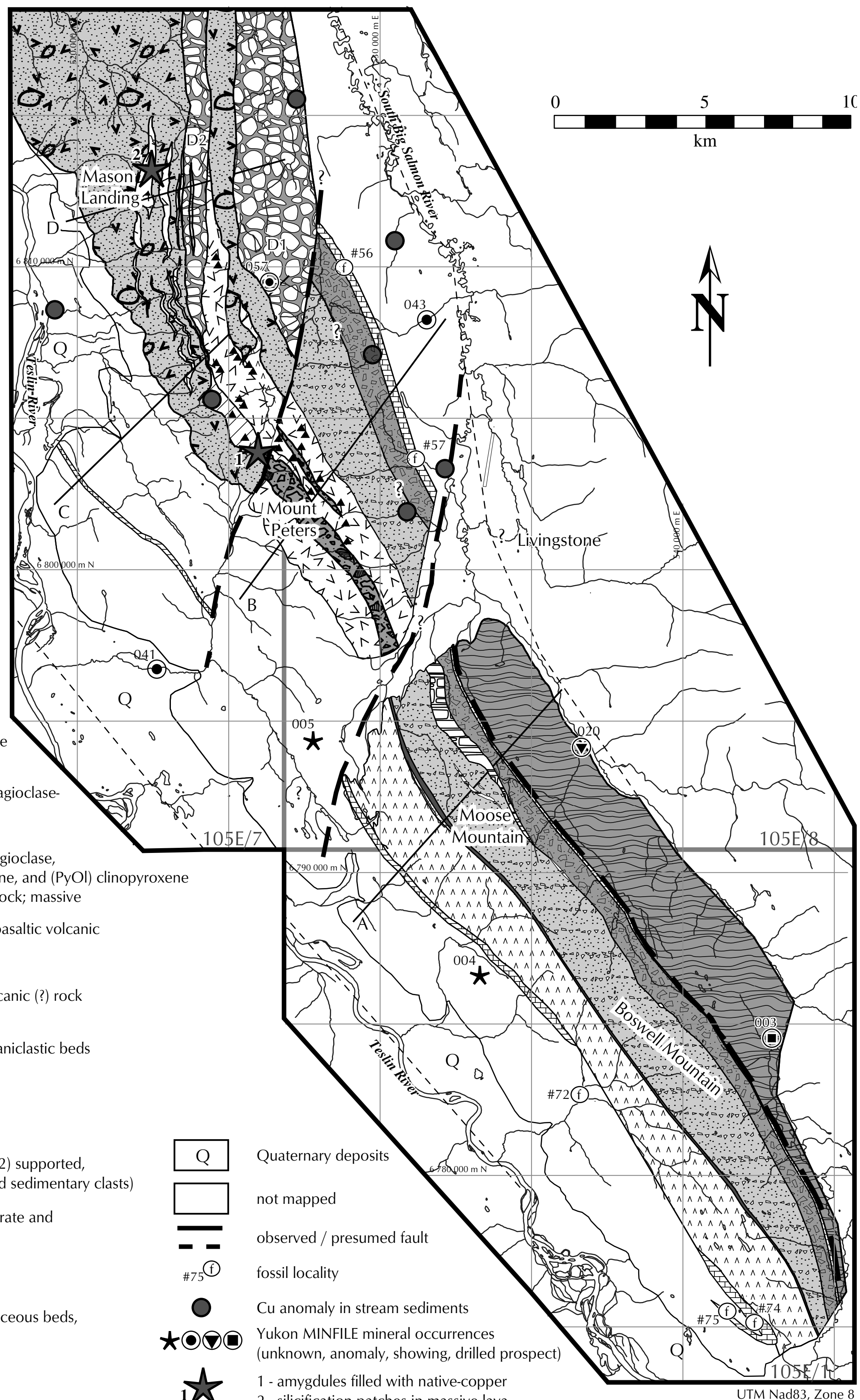
Unit C is found in the Mount Peters area as thick intervals in the massive volcanic rocks. It is mainly composed of massive, dark polymictic conglomerate and litharenite beds. The westernmost exposures consist predominantly of massive, non-sorted, granule- to pebble-polymictic conglomerate containing subrounded black and dark green chert, angular black argillite, angular limestone, coral, and subrounded clinopyroxene-plagioclase porphyritic volcanic fragments. Minor conglomeratic litharenite intervals are found in the southern part of this unit. The eastern exposures are mainly composed of litharenite beds with minor argillaceous and conglomeratic litharenite intervals. This finer facies of unit C is richer in volcanic fragments and lacks limy clasts. South of Mount Peters, graded beds indicate that the top of the section is toward the southwest.

The transition between conglomeratic rocks of unit C and the surrounding volcanic facies is marked by the gradual increase in amount and size of the volcanic components.

Unit D

Unit D is found in the Mason Landing area. It consists of massive polymictic conglomerate. Two main facies are observed. The easternmost facies (D1; Figs. 2,3) is characterized by red and green, massive, matrix-supported, non-sorted, polymictic pebble conglomerate showing various subangular porphyritic volcanic clasts and subrounded fine-grained sedimentary clasts. Clast sizes are commonly between 2 mm and 2 cm in diameter, with a maximum diameter of 12 cm. Several clasts have centimetre-sized oxidation rims. The westernmost facies (D2; Figs. 2,3) consists of brownish, massive, clast-supported, non-sorted, polymictic pebble- to cobble-conglomerate containing both porphyritic volcanic and fine-grained sedimentary clasts (Fig. 5). This coarser facies is very extensive and can be followed for several kilometres along strike, forming the resistant crest of Manson Landing.

Figure 2. *Preliminary geological map of southern Semenof Hills (105E/1,7-8). Map shows transects A-D, from which the stratigraphic sections in Figure 3 were created. Fossil localities from Tempelman-Kluit, 1984 and Poulton et al., 1999. Numbers 003, 004, 005, 020, 041, 043 and 057, and symbols refer to mineral occurrences in 105E (Yukon MINFILE 2002). Location of copper anomaly in stream sediments from Hornbrook and Friske (1989).*



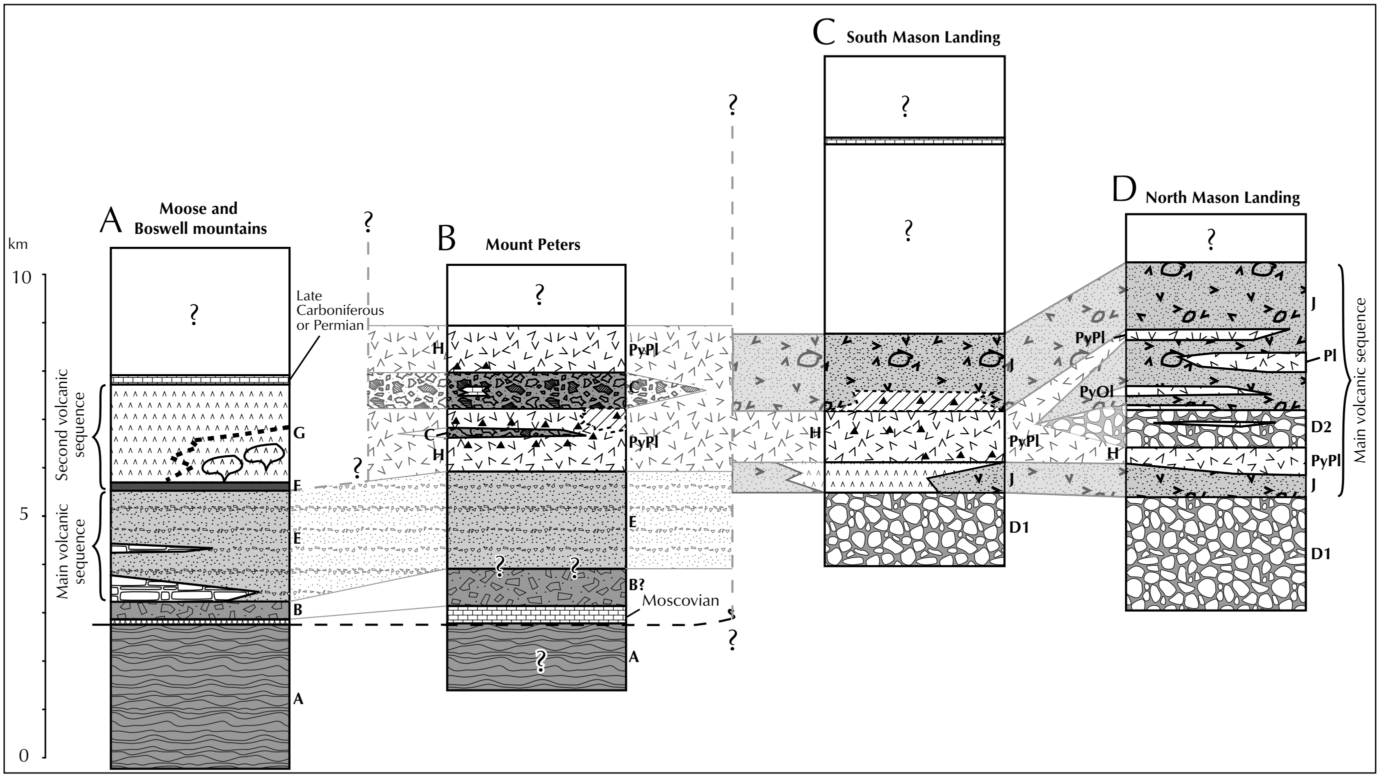


Figure 3. *Correlative stratigraphic sections of southern Semenof Hills (105E/1,7-8). Shaded patterns in between columns used to show possible correlative units in the main volcanic sequence. Legend is same as for Figure 2.*

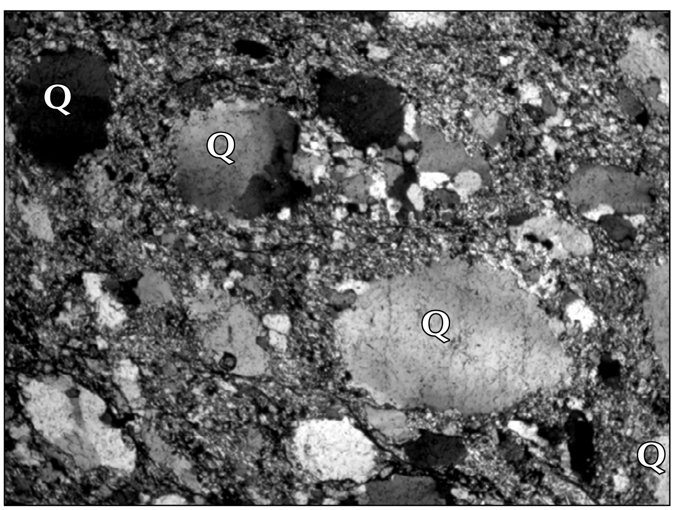


Figure 4. *Subarkose of unit A. Note the roundness of the big quartz grains (Q). Microphotograph 2.3 mm across.*

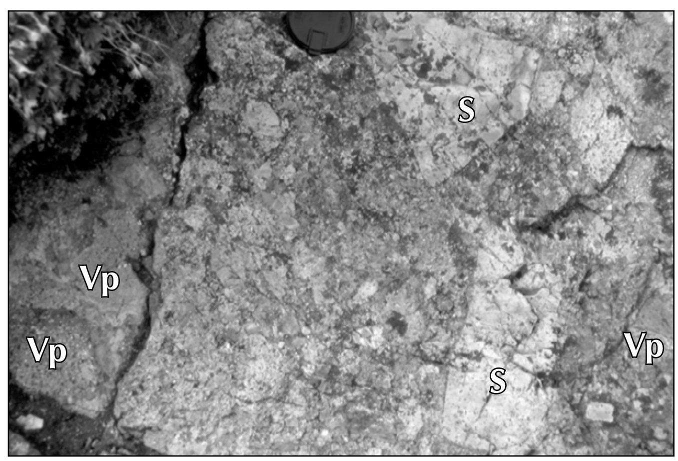


Figure 5. *Massive, clast-supported, non-sorted, polymictic pebble- to cobble-conglomerate D2 of Mason Landing showing rounded porphyritic volcanic (Vp) and angular fine-grained sedimentary (S) clasts. Lens cap, 55 mm across.*

LIMESTONE UNITS

Boswell and Moose mountains

The lowermost limestone unit in the Boswell and Moose mountain area, to the east, is a grey, massive, highly recrystallized ~30-m-thick limestone. It shows metre-width stratification characterized by thin intervals of pinkish muscovite schist. Quartz veins and quartz boudins are common, especially in its lower part. The base of this limestone is faulted against the deformed clastic unit A.

In the north, several important limestone conglomerate lenses are found at the base of, and within, a volcaniclastic succession. They consist predominantly of clast-supported, limestone-pebble to -boulder conglomerate with less than 20% of angular chert and mafic volcanic fragments (Fig. 6). Crinoids and chain coral were observed in some limestone clasts.

The uppermost limestone unit, to the west, is a buff-weathered, light grey massive limestone containing abundant crinoid fragments. Poorly preserved brachiopods from this unit yielded Late Carboniferous to Permian ages (Tempelman-Kluit, 1984; fossil localities #72, 74, 75; Poulton et al., 1999).

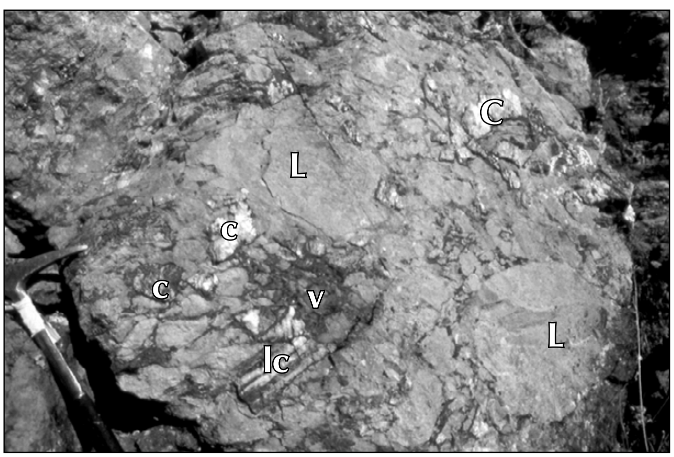


***Figure 6.** Limestone conglomerate on top of Moose Mountain. Note the presence of angular laminated chert (lc), white chert (c), and dark mafic volcanic (v) clasts mixed with the rounded limestone (L) clasts. Hammer for scale.*

Mount Peters

E.W. Bamber (in Tempelman-Kluit, 1984) describes the basal limestone of the Mount Peters succession as light grey grainstone and packstone, which contains lower Moscovian (Pennsylvanian) fusulinids (Tempelman-Kluit, 1984; fossil localities #56, 57; Poulton et al., 1999). This limestone may be laterally equivalent with the lower limestone unit on Boswell and Moose mountains (Figs. 2,3).

A pod of 30 x 40 m of massive, light grey, fetid, crinoid-rich limestone is present in the clastic rocks of unit C (Fig. 3).

VOLCANIC UNITS

Unit E – (volcaniclastic unit)

Unit E covers the main ridges of Boswell and Moose mountains and the easternmost side of Mount Peters (Figs. 2,3). It consists of a 1500- to 3000-m-thick succession of thinly bedded crystal- and lithic- tuffaceous mudstone and sandstone with minor conglomeratic intervals. The tuffaceous beds are mainly composed of rounded clinopyroxene- and/or plagioclase-phyric volcanic fragments up to 7 mm in diameter, and of euhedral plagioclase and clinopyroxene crystals. Thinly bedded tuffaceous 'sand-silt couplet' beds (Fig. 7) and graded beds are common in this unit, suggesting a resedimented origin, such as turbidite sequence.

***Figure 7.** Thinly bedded tuffaceous 'sand-silt couplet' beds in the volcaniclastic unit E. Lens cap, 55 mm across.*

Unit F – (felsic volcanic unit)

Unit F consists of a ~30-m-thick pinkish-beige massive quartz-phyric felsic volcanic rock. Unit F occurs only above the volcaniclastic unit E of Boswell and Moose mountains (Figs. 2,3).

Unit G – (mafic volcanic unit)

Unit G underlies most of the west side of Boswell and Moose mountains (Figs. 2,3). It consists of ~2 km of dark green, massive, fine-grained basaltic volcanic rock. It is locally plagioclase-phyric and vesicular. Pillow structures were observed in basalt on the west side of Moose Mountain (Fig. 8).

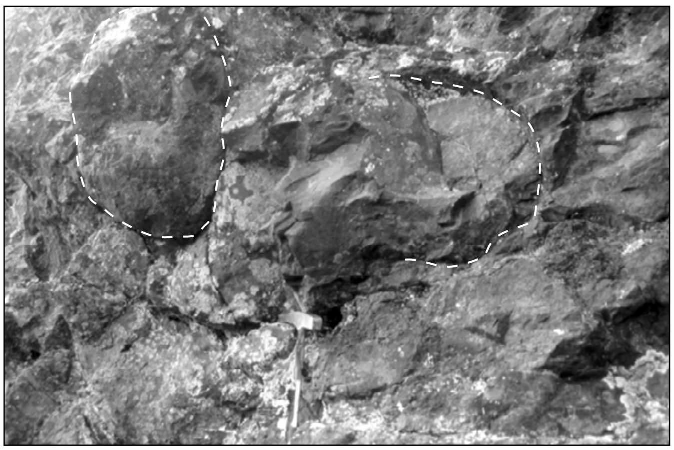


Figure 8. *Pillowed basaltic lava flow of unit G, west of Moose Mountain. Hammer for scale.*

Unit H – (porphyritic mafic volcanic unit)

Unit H consists of green to greyish, massive, plagioclase- and clinopyroxene-phyric basalt. It forms the crest of Mount Peters and the southern part of the Mason Landing ridge (Figs. 2,3). Euhedral plagioclase and clinopyroxene crystals (up to 7 mm and 4 mm in diameter, respectively) are set in a glassy matrix characterizing this unit. Unit H can be locally amygdaloidal.

Unit H is commonly brecciated, showing angular fragments of porphyritic material in a matrix of smaller fragments, and plagioclase and clinopyroxene crystals (Fig. 9). This brecciated facies is mainly localized along the margin of this unit. On the west side of Mount Peters and Mason Landing, at the head of St-Germain Creek, the upper part of unit H is red-purple and shows millimetre-size amygdules filled with native copper.

To the north, on Mason Landing ridge, the crystal nature and composition of unit H is more variable. Plagioclase-phyric, clinopyroxene- and plagioclase-phyric, and clinopyroxene- (and olivine-) phyric massive and brecciated facies are present (Figs. 2,3). They are locally oxidized (reddish in colour), and show large silicification patches (a few metres wide, Fig. 10) indicating the presence of hydrothermal fluid circulation.

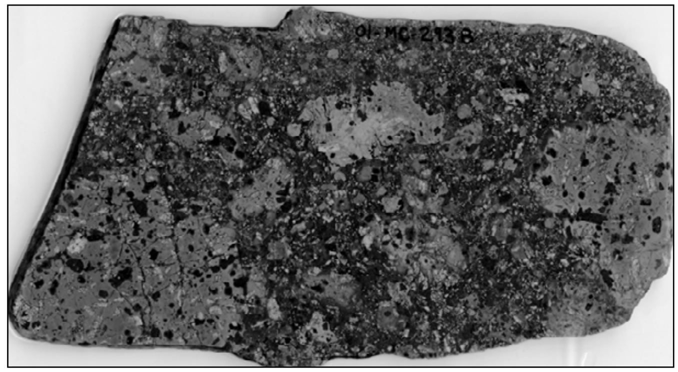


Figure 9. *Slab of vesicular brecciated clinopyroxene- and plagioclase-phyric volcanic rock of unit H from Mount Peters. Note the angularity of the fragments. Slab is 12 cm across.*

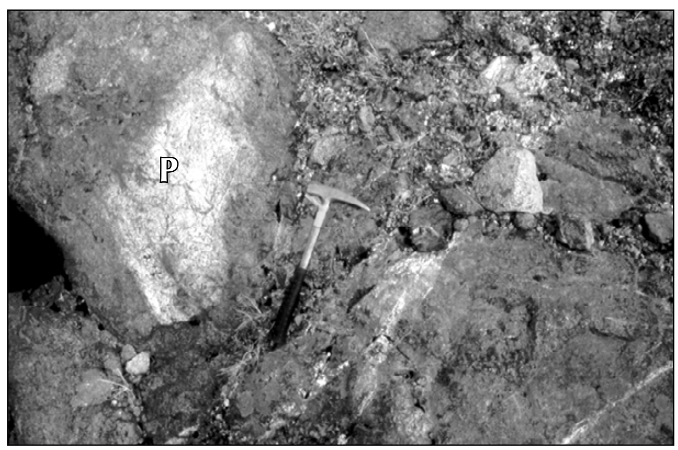


Figure 10. *Silicification patches (P) in massive volcanic lava of unit H, west of Mason Landing. Hammer for scale.*

Unit J – (volcanic conglomerate)

The massive volcanic flows of unit H are interbedded to the north with unit J, a massive, clast-supported, non-sorted, pebble to boulder conglomerate (Figs. 2,3,11). This conglomerate is composed of exclusively volcanic clasts. Although they are all volcanic in nature, they are very variable in composition and texture. The larger clasts are typically rounded and porphyritic. Smaller fragments in the matrix of the conglomerate are composed of angular, porphyritic and highly vesicular fragments, as well as crystals of clinopyroxene and plagioclase.

Figure 11. *Volcanic pebble to cobble conglomerate, west of Mason Landing. Hammer for scale.*

REGIONAL CORRELATION

Figure 3 shows the regional correlation of the different units of the southern Semenof Hills.

Two volcanic sequences can be observed throughout the study area. The main sequence (Fig. 3) is composed of basal fragmental volcanic rocks (Units E, J) overlain by massive porphyritic lava flows (Unit H) and more fragmental volcanic rocks (Unit J). This sequence is exposed throughout the study area (Figs. 2,3). Notable lateral changes in unit thickness and grain size likely reflect facies changes and/or faulting in a volcanic environment.

The second volcanic sequence (Fig. 3) is restricted to the Boswell and Moose mountains area (Fig. 2,3). It comprises the felsic rocks of unit F and massive basalt flows (unit G). The relationship between rocks of unit G and those of the main volcanic sequence to the north is still unclear (Fig. 3). Late Carboniferous or Permian limestone is found just above unit G to the south (Figs. 2,3).

Finally, these volcanic sequences sit unconformably on the clastic units B and D, themselves sitting on Moscovian limestone.

The rocks of the Boswell/Moose mountains and Mount Peters areas are virtually undeformed, suggesting that the deformed clastic rocks of unit A to the east (Figs. 2,3) are not part of the same volcano-sedimentary sequence that characterizes most of the southern Semenof Hills.

ECONOMIC POTENTIAL

The current project highlighted the presence of amygdules filled with native copper in the oxidized facies of unit H at the head of St-Germain Creek, just north of Mount Peters (Fig. 2), and the presence of silicification patches in massive volcanic rocks of unit H ~15 km to the north on the east side of Mason Landing (Figs. 2,10). This suggests the presence of an active copper-bearing hydrothermal system in these rocks at one point. In the same area, copper anomalies are also reported in the stream sediments (Fig. 2; Hornbrook and Friske, 1989).

Seven Yukon MINFILE (2002) occurrences are also present in the mapping area, but were not visited. These are mainly copper and gold occurrences (Yukon MINFILE 2002; this reference is used for the occurrences listed in this section). Just east of Boswell Mountain, occurrence 105E 003, named Mink, Beaver and Loon through time, contains copper mineralization with gold in steeply dipping poorly defined silicified zones in chlorite-sericite-quartz schist and cherty quartzite (unit A; Fig. 2). East of Boswell Mountain, occurrence 105E 004, named Bee, reports rumors of magnetite and pyrrhotite with minor chalcopyrite in limestone and argillite. East of Moose Mountain, 105E 005, named Napua, shows an unmineralized pyritic gossan at the contact of limestone and argillite with mafic volcanic rock. West of Moose Mountain, occurrence 105E 020, named Sylvia, presents galena, sphalerite and chalcopyrite occurring in quartz veins in a shear zone between quartzite and volcanic rocks. On both sides of Mount Peters, occurrences 105E 041 and 105E 043, named Enof and Germ, were staked on gold geochemical anomalies between clastic and mafic volcanic rocks, and on mafic volcanic rocks, respectively. Finally, occurrence 105E 057, named Milner, reports an isolated outcrop of coal in a poorly exposed area east of Mason Landing in unit D1 (Fig. 2).

CONCLUSION

New regional mapping in the southern Semenof Hills identified possibly two very well preserved volcanic sequences sitting on clastic rocks. This undeformed volcano-sedimentary rock package is in faulted contact with a more deformed clastic unit to the east (unit A).

The volcanic sequences probably represent part of the Semenof formation of Tempelman-Kluit (1984). However, the sedimentary rocks of the Boswell formation are not recognized in the area.

Occurrences of volcanic rocks and their association with evidence for a copper-bearing hydrothermal system suggest good potential for mineral exploration in the area.

ACKNOWLEDGEMENTS

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