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Late Cenozoic geology, Ancient Pacific Margin NATMAP Project, report 6: glacial limits, Middle Pleistocene sediments, and placer gold in the Scroggie Creek basin, south Klondike placer region, Yukon Territory

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Late Cenozoic geology, Ancient Pacific Margin NATMAP Project, report 6: glacial limits, Middle Pleistocene sediments, and placer gold in the Scroggie Creek basin, south Klondike placer region, Yukon Territory

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Abstract: Gravel type and the distribution of erratics along the Walhalla–lower Scroggie Creek valley imply an all-time limit of glaciation between those proposed by previous researchers. Associated valley-train deposits fine downstream along Walhalla and Scroggie creeks. A depositional record potentially spanning two Middle Pleistocene stadial/interstadial cycles occurs along Mariposa Creek. Interstadials or interglacials are represented by organic sediments rich in wood detritus including branches and logs, whereas stades or glaciations are represented by interstratified stony colluvium that lacks organic content. Placer gold in the Scroggie Creek basin is typically coarse and difficult to procure by panning. An examination of gold recovered by placer mining suggests that at least two lode sources occur in the basin. The re-evaluation of the all-time limits of glaciation suggests that a large area of undisturbed terrain within the Scroggie Creek and Walhalla Creek basins may contain viable placer deposits.

Résumé : La nature des graviers et la répartition des erratiques le long des vallées des ruisseaux Walhalla et Scroggie (cours inférieur) permettent de situer le seuil de glaciation le plus bas jamais atteint à une position intermédiaire entre celles proposées par les chercheurs précédents. Au sein des traînées fluvioglaciaires associées dans les vallées des ruisseaux Walhalla et Scroggie, on observe une diminution de la dimension des débris vers l'aval. Une succession sédimentaire couvrant probablement deux cycles stadiaires/interstadiaires du Pléistocène moyen est présente le long du ruisseau Mariposa. Les interstades ou les interglaciaires sont représentés par des sédiments organiques riches en débris ligneux, dont des branches et des troncs, tandis que les stades ou les glaciations sont indiqués par des interstrates de colluvions caillouteuses dépourvues de matière organique. Dans le bassin du ruisseau Scroggie, l'or placérien est généralement grossier et difficile à extraire par lavage à la battée. L'examen de l'or récupéré lors de l'exploitation de placers révèle qu'au moins deux sources filoniennes d'or semblent exister dans le bassin. D'après la réévaluation de la position du seuil glaciaire le plus bas jamais atteint, il y a une grande zone de terrain non remanié dans les bassins des ruisseaux Scroggie et Walhalla qui pourrait contenir des placers rentables.

INTRODUCTION

Investigation of late Cenozoic sediments within the Stewart River map area (NTS 115-O and J) continued during the 2002 field season. The Scroggie Creek basin (1:50 000 maps NTS 115-O/1, -O/2, J/15, and J/16) was the focus of this portion of the project (Fig. 1). Goals for the 2002 field season included the following: 1) definition of the all-time limit of glaciation in the Scroggie Creek basin; 2) establishment of a late Cenozoic stratigraphy for the area based upon investigation of sediments exposed in placer mining pit faces and natural exposures; 3) investigation of heavy minerals in the gravels of Scroggie Creek basin; and 4) verification (ground truthing) of airphoto interpretation as a part of the surficial geology mapping component of the Ancient Pacific Margin NATMAP Project (Jackson et al., 2002).

Gold was first discovered on Scroggie Creek in 1898. Since then, placer mining in the Scroggie Creek basin has been relatively continuous. The all-time peak in production coincided with the peak in the price of gold between 1978 and 1982. Although many tributaries have been prospected in the past, placer mining has been confined largely to Scroggie Creek above the confluence with Walhalla Creek (henceforth referred to as 'upper Scroggie Creek') (Bostock, 1966; Reimchen, 1984; Duk-Rodkin, 1999; Jackson et al., 2002; Jackson and Huscroft, 2002). At present, quartz and placer claims cover much of the upper Scroggie Creek basin and placer mining is active in upper Scroggie Creek and its major tributary, Mariposa Creek (Lipovsky et al., 2001).

The all-time limit of glaciation within the Walhalla and Scroggie creek basins and the lower Stewart River valley is controversial. Duk-Rodkin (1999) concluded that glacial ice extended the entire length of Walhalla Creek and lower Scroggie Creek (below the Walhalla Creek confluence) and down the Stewart River valley to within approximately 5 km of its confluence with the Yukon River (Fig. 2). Bostock (1966) and Jackson et al. (2001) proposed the all-time limit as reaching only near the headwaters of Walhalla Creek (Fig. 2). This difference in findings prompted the present study, which will form the basis of the Master of Science thesis of the first author at the University of Western Ontario.

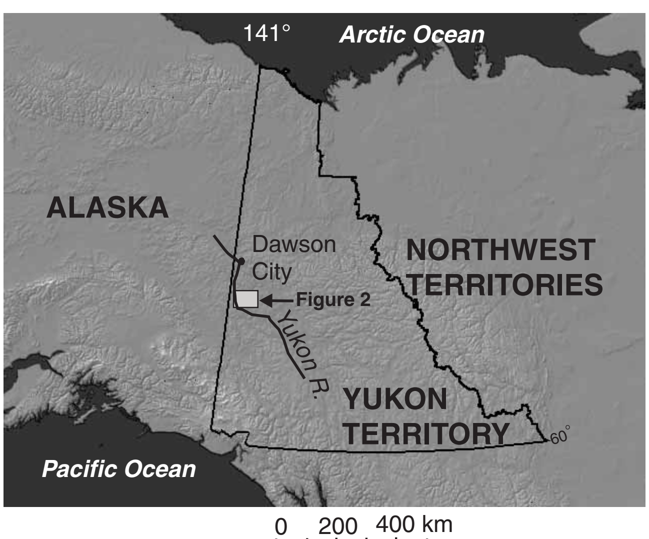

Figure 1. Location of the study area detailed in Figure 2.

SETTING

The Scroggie Creek basin includes the area drained by Scroggie Creek and its major tributary, Walhalla Creek. Local relief in the basin is 600 to 700 m, with Pyroxene Mountain (1380 m) being the highest point. This basin is underlain by high-grade metamorphic rocks, typically grey and felsic gneiss, medium-grade metamorphic rocks, (commonly mica-quartz schist), granitic intrusions, and ultramafic bodies of pyroxenite. The pyroxenite bodies are likely the source of the placer platinum that has been reported in the region (Reimchen, 1984). Naturally occurring bedrock exposures are rare because of thick overburden deposits. However, exposures can be found along roadcuts and in placer mine pit faces. Colluvium is the most abundant overburden deposit, covering hillsides, ridge tops, and valley bottoms. Fluvial and glaciofluvial sediments, loess, and organic deposits are also very common overburden deposits, specifically in areas of multilevel terraces and valley bottoms. Terraces ranges in height from 10 to 70 m above the valley bottom.

Vegetation is dominated by dense boreal forest, making for difficult traversing. Fortunately, a network of mine roads, the Yukon Quest Trail (Fig. 3), and exploration cutlines run the entire length of Scroggie and Walhalla creeks, as well as along numerous tributaries. These transportation routes cross valley bottoms, terraces, and ridge tops, providing access to many types of terrain.

Regional glaciation has occurred numerous times in the central Yukon Territory since the late Pliocene (Froese et al., 2000). The glacial limits discussed in this paper are associated with an ice sheet that formed in the Cordillera during the most extensive of the pre-Reid glaciations (Bostock, 1966; Duk-Rodkin, 1999). This glaciation likely occurred between 2 and 3 Ma BP (Froese et al., 2000); its exact age is yet to be determined.

METHODS

Traverses during the 2002 field season were done using a combination of foot, boat, truck, all-terrain vehicle, and helicopter transportation. Figure 3 shows the general areas where traverses were carried out. Three types of terrain were examined within and proximal to the Scroggie Creek basin: 1) terraces of various elevations, 2) highland environments, including ridge tops, saddles, and valley slopes above terrace level, and 3) valley bottoms, specifically recent exposures cut by modern streams and drainage anomalies.

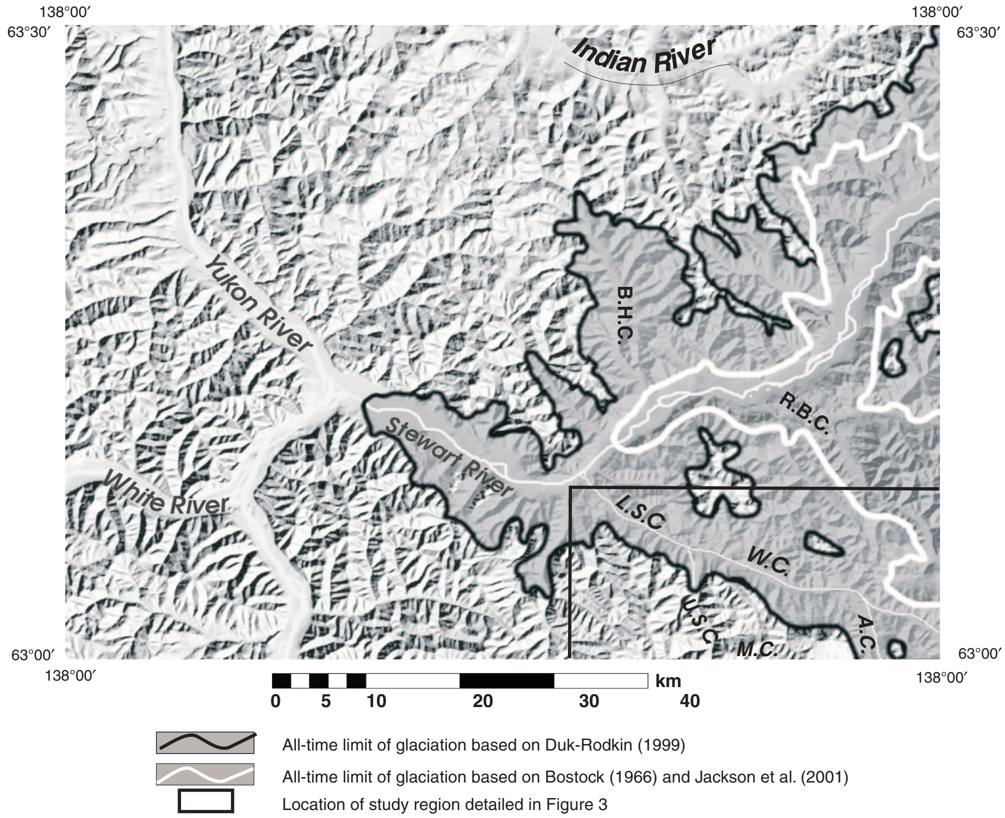

Figure 2. *Glacial limits in and around the Scroggie Creek basin,* from *Bostock (1966), Duk-Rodkin (1999), and Jackson et al. (2001). L.S.C., lower Scroggie Creek; U.S.C., Upper Scroggie Creek; W.C., Walhalla Creek; M.C., Mariposa Creek; A.C., Alberta Creek; B.H.C., Black Hills Creek; R.B.C. Rosebud Creek.*

Erratic types

Rock types such as chert, chert-pebble conglomerate, and basalt do not occur in the bedrock of the Scroggie Creek basin. Basalt flows can be found in drainage basins to the east and southeast, and chert and chert-pebble conglomerate are derived from the Selwyn basin of the east-central Yukon Territory. The presence of these foreign rock types is indicative of a past incursion of Cordilleran ice sheets and associated meltwater streams.

Fluvial gravel and colluvium were sampled throughout the Scroggie Creek basin in order to identify rock types native to this basin and to search for the occurrence of erratic types that would indicate past incursions of Cordilleran ice sheets. Each pebble sample consisted of approximately 100 pebbles from 3 to 10 cm in size. Stratigraphic location, UTM co-ordinates, and elevation were recorded for all samples. Twenty-nine pebble samples were taken from throughout the Scroggie Creek basin and will be added to the pebble lithology database already reported on by Jackson et al. (2001). In addition, tailings piles and prospecting pits were examined visually for the presence of any foreign rock types.

Heavy minerals

Heavy minerals were sampled from throughout the Scroggie Creek basin to test for 1) significant changes in mineralogy that might reflect glacial incursion or proximity to lode gold sources, 2) the presence of gold and its textural variation, 3) the shape of gold grains as an indication of travel distance from lode source (*see* Knight et al., 1999), and 4) the trace-element composition of gold as an indication of types of lode deposits in the basin.

Heavy mineral samples were taken at many of the same locations as pebble lithology samples. Samples were taken from gravel and bedrock where placer gold and heavy minerals are usually most concentrated. Approximately 10 to 12 L of sediment were removed and panned. After panning, heavy mineral concentrate samples typically amounted to about 100 mL. Samples have been sent to the Geological Survey of Canada's Sedimentology laboratory for further concentration. The mineralogy of these samples will be studied further in the coming months.

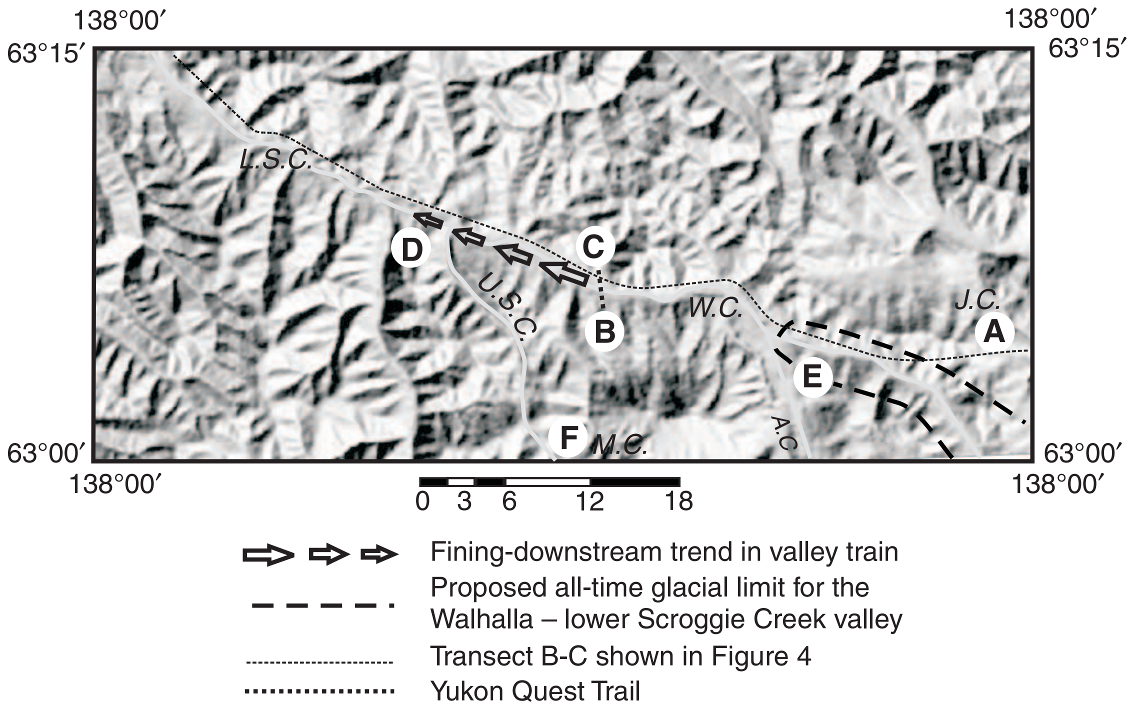

***Figure 3**. Sites described in this paper. A, saddle between Jane Creek and Walhalla Creek; B, C, D, and E, locations of erratics; F, Mariposa Creek site; L.S.C., lower Scroggie Creek; U.S.C., upper Scroggie Creek; M.C., Mariposa Creek; W.C., Walhalla Creek; A.C., Alberta Creek; J.C., Jane Creek.*

GLACIAL LIMITS

Well developed paleosols with characteristics similar to those of the early Pleistocene Wounded Moose soils (e.g. Smith et al., 1986; Tarnocai and Schweger, 1991) occur on glaciofluvial terraces within the Walhalla Creek basin. They indicate that the last incursion of a Cordilleran ice-sheet margin most likely occurred before the early Pleistocene. Glacial deposits left after this old glaciation have been extensively eroded. Consequently, mapping of glacial limits on the basis of the distribution of glacial sediments is difficult. The most compelling evidence for the all-time limit of glaciation is the distribution of glacial erratics and kame and outwash gravel. Identification of other geomorphic features potentially related to the limit of glaciation, such as meltwater channels, can be problematic in the west-central Yukon Territory, as is discussed below.

Meltwater channels

Meltwater channels have been used to map the all-time limit of glaciation throughout the Yukon Territory (Bostock, 1966; Duk-Rodkin, 1999; Jackson et al., 2002). In areas last glaciated during the pre-Reid glaciations, erosion has reduced meltwater channels to individual saddles on ridges or discontinuous saddle-like features aligned along adjacent spurs. However, in the study area, many of these aligned saddles have proven to be unrelated to glaciofluvial erosion. Rather, they were formed by fluvial erosion exploiting linear geological structures and are unrelated to glaciation. The complexity of investigating possible glaciofluvial channels is illustrated in the following important example. A saddle crosses the ridge separating the valleys of Jane Creek and Walhalla Creek (Fig. 3, A; UTM 0648217E 6992838N). Bostock (1966) first investigated this feature. From the lack of glacial drift within it, he concluded that it was nonglacial in origin and above the all-time limit of glaciation. Jackson et al. (2001) briefly revisited this site and found erratic pebbles along and immediately adjacent to the Yukon Quest Trail (Fig. 3), which runs directly through the base of the saddle, and therefore reclassified it as a meltwater channel associated with the all-time limit of glaciation. However, after further investigation during the 2002 field season, this saddle appears to be nonglacial in origin, in accordance with Bostock (1966). The erratic pebbles (schist, gneiss, granite, chert-pebble conglomerate, chert, and basalt) were found only over a 10 m length of the trail and only on its surface. Fifteen pits were hand dug to depths ranging from 20 to 80 cm in a traverse that crossed the floor of the saddle, including the Yukon Quest Trail. Each pit reached the colluvium–bedrock contact. The pits yielded a total of ten small pieces of angular quartz, originating from the granite bedrock. The present Yukon Quest Trail was formerly the Dawson stage road that was the primary winter transport route for people and supplies between Whitehorse and Dawson. It remains the primary winter route for transportation of mining equipment into the Scroggie

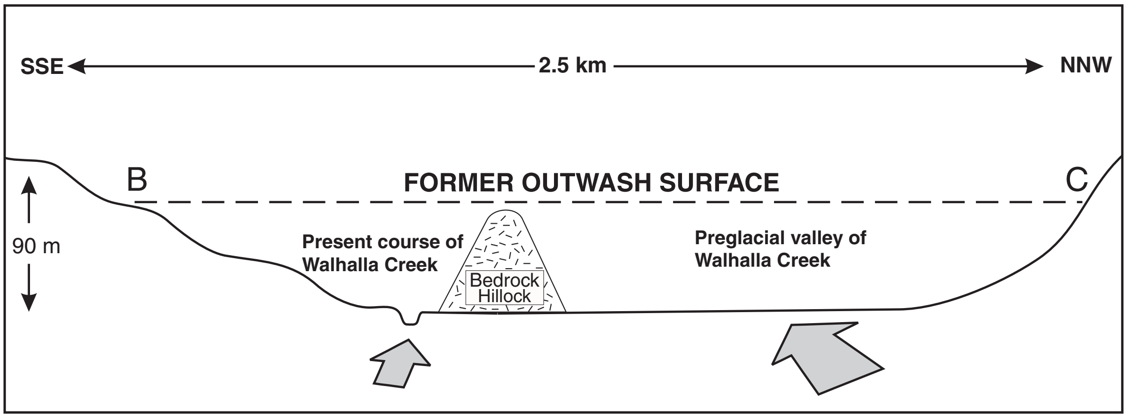

Figure 4. *Preglacial and postglacial valleys of Walhalla Creek along transect B-C (Fig. 3); line B-C approximates a former outwash surface.*

Creek basin. The ‘erratic’ pebbles are likely products of the regular transport of equipment and supplies back and forth from mining camps and for trail maintenance. All these rock types occur in abundance along the extensively glaciated Jane Creek valley a few kilometres north of this site (Bostock, 1966; Jackson et al., 2002). The demonstration that the crest of the ridge at site A (Fig. 3) was above the limit of glaciation leads us to conclude that glacial ice entered the Walhalla Creek valley only from a low saddle at the upper (south) end of the valley, as mapped by Jackson et al. (2002).

Distribution of erratics

Erratics occur in abundance within the Walhalla–lower Scroggie Creek valley beyond Bostock’s (1966) glacial limit and within Duk-Rodkin’s (1999) glacial limits (Fig. 3). They were used to determine the all-time glacial limits. Chert and chert-pebble conglomerate from the Selwyn basin are the most common and diagnostic erratics. Far less common are well preserved basalt clasts. The outwash gravels associated with the all-time glacial limit are deeply weathered. The majority of clasts within these ancient outwash deposits have completely disintegrated into sand- and/or granular-sized particles. Disintegrated material makes up 30 to 50 per cent of the matrix supporting the unweathered clasts. Only cobble-sized clasts of the most resistant rock types remain intact, namely chert, chert-pebble conglomerate, and quartzite.

Outwash gravels in the Walhalla–lower Scroggie Creek valley fine downstream (Fig. 3). Unfortunately, a clearly bouldery, ice-proximal outwash gravel facies could not be identified because of very poor to nonexistent exposures. However, the coarsest outwash gravels were found in the course of digging soil on the slopes of the Walhalla Creek valley (Fig. 3). At site B (area of UTM 0629405E 6996906N), on the south slope above Walhalla Creek (Fig. 3, B), large, cobble-sized (mean diameter ~10 cm), subangular clasts of chert and basalt were removed from deeply weathered outwash gravel. The site is 55 to 60 m above the modern Walhalla Creek on a mid-level, terrace-like feature. Sampling on the slopes above this site yielded no evidence of gravel or erratic deposition. Furthermore, a large chert cobble was found 55 to 60 m above Walhalla Creek along the north side of the Walhalla Creek valley (Fig. 3, C). The deposition of erratics on both valley slopes at approximately the same elevation suggests that an extensive fill of cobble gravel was once deposited in this area (Fig. 4). The prior existence of this fill presents an explanation for a drainage anomaly in this area. Between sites B and C (Fig. 3), Walhalla Creek abandons its wide ancestral valley and flows through a narrow valley segment south of a bedrock hillock. The deposition of a thick fill within its preglacial valley apparently buried a bedrock spur. Subsequent incision through this glacial outwash fill caused Walhalla Creek to abandon its ancestral valley and cut its way through the spur, isolating its northern end as a hillock (Fig. 4). Evidence for this ancient valley train also exists approximately 13 km downstream (Fig. 3, D (area of UTM 0618075E 7001789N)). There, a large number of pebble- to small cobble sized chert and chert-pebble conglomerate clasts (mean diameter ~3 cm) occur within a pebble-cobble terrace gravel deposit. Sites B, C, and D (Fig. 3) are remnants of the same valley-train deposit and apparently graded to a glacial limit located near the mouth of Alberta Creek (Fig. 3). Fabric measurements from site D (Fig. 3) suggest that meltwater associated with the all-time limit of glaciation flowed west-northwest (Fig. 5). This is consistent with the direction of flow suggested by the fining-downstream trend in erratic rock types and the approximate location of the glacial terminus near the mouth of Alberta Creek. The proposed limit is not based solely on the fining-downstream trend recognized in the outwash sediment. A chert-pebble conglomerate erratic (intermediate axis 8 cm) was excavated on the ridge that separates Walhalla Creek and Alberta Creek (Fig. 3, E; UTM 0636863E 6994917N). The site is approximately 100 m above adjacent Walhalla Creek. The erratic was encased within a deeply weathered soil having Wounded Moose colouration and thickness. It was not associated with a discernible fluvial deposit. Despite extensive searching, no erratics were found above this elevation downstream from this site along the Walhalla–lower Scroggie Creek valley.

After a thorough examination of the distribution of glacial erratics and potential ice-marginal geomorphology, we are confident of the following: 1) the all-time limit of glaciation within the Walhalla–lower Scroggie Creek valley was in the area of the confluence of Walhalla and Alberta creeks (Fig. 3); 2) ice thickness in the Walhalla Creek valley above the glacial limit was no more than 160 m, based on the lack of erratics at the summit of the Yukon Quest Trail (Fig. 3, A); and 3) the all-time limit of glacial ice cover in upper Walhalla Creek makes the rest of the Scroggie–Walhalla basin prospective for placers that have formed without glacial disturbance since the Tertiary.

MIDDLE PLEISTOCENE STRATIGRAPHY ALONG MARIPOSA CREEK

An investigation of exposures created by placer mining of valley-bottom and terrace gravels within unglaciated portions of the Scroggie Creek basin identified a sediment succession that apparently preserves vegetation, insect fossils, and periglacial sediments deposited during Middle Pleistocene interglacial and glacial periods. Interstadial or interglacial intervals are represented by organic sediments rich in wood detritus, including branches and logs; stades or glaciations are represented by cryoturbated stony colluvium that lacks organic content. The site is near the confluence of Mariposa Creek with upper Scroggie Creek (Fig. 3, F; UTM 0624475E 6987209N). The succession is exposed in the wall of an active placer mine (Fig. 6). A Middle Pleistocene or older age for the sediments exposed in this section is inferred from their location beneath a fluvial terrace. The sediments are described below from the oldest to the youngest units (Fig. 6).

Unit G2 is the lowest unit exposed in the section. It is a coarse gravel bed composed of local rock types including mica schist, granitoid intrusives, and gneiss. Clasts are rounded and range in size from 8 to 50 cm along their intermediate axis. Many are oxidized with very few showing any signs of disintegration. Unit G2 has an abrupt lateral contact with unit G1, an abrupt contact with unit O2 above, and is underlain by schistose bedrock.

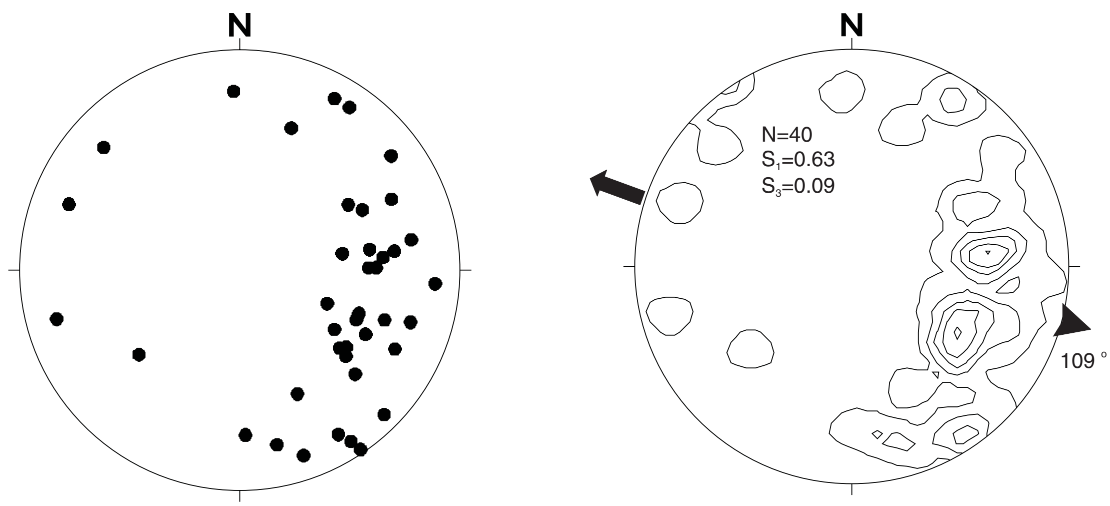

Figure 5. Gravel imbrication at site D (Fig. 3). Scatter plot of the long-axis azimuth and plunge of 40 clasts (left) and contoured equivalent (right). The left arrow on the contour plot is the inferred direction of meltwater flow. The right arrow on the contour plot is the principal eigenvector.

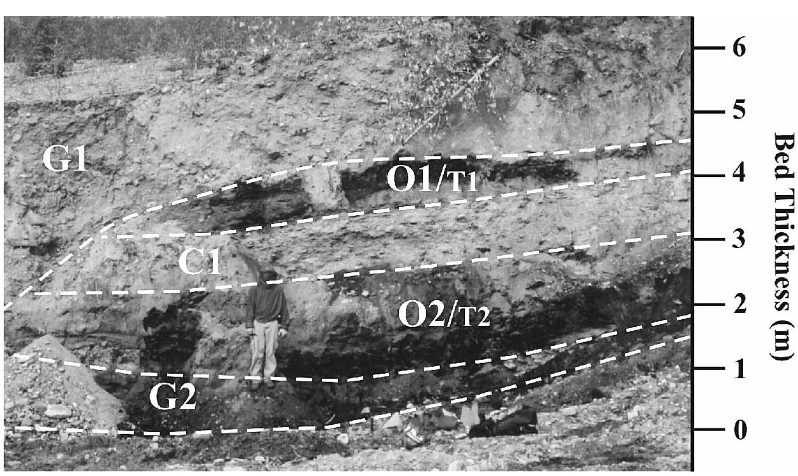

Figure 6.

Outlined are the five primary units at the Mariposa Creek site. Letters indicate the types of facies represented in the sequence. Note the erosional contact between G1 and the underlying units. G1, gravel 1; O1, organic 1; T1, tephra 1; C1, colluvium 1; O2, organic 2; T2, tephra 2; G2, gravel 2.

Unit O2 is an organic-rich sediment that contains colluvium in the form of disintegrated clasts, as well as a tephra horizon (T2). Its thickness varies between 1 and 2 m. It is confined laterally to the south by G1 and is overlain by C1. It contains tree trunks and is interpreted to be a buried forest floor.

Overlying unit O2 is colluvium unit C1. Mica schist (the local bedrock) is the only rock type present within this unit. Clasts are angular, tabular, and range in size from 4 to 8 cm along their intermediate axis. Extensive evidence of subaerial weathering occurs in this unit. Clasts are commonly disintegrated and have clay skins. Disintegrated clasts make up 20 to 30 per cent of the unit. An ice-wedge pseudomorph is also preserved within the unit. Bed thickness is relatively constant at about 1 m. Unit C1 has an abrupt lateral contact with unit G1 and abrupt contacts with overlying unit O1.

Unit O1 is a stony, organic-rich sediment that contains branches and large pieces of wood. The inorganic fraction consists of clasts of mica schist (the local bedrock), which are almost entirely unweathered. The unit is interstratified with what appears to be a tephra (unit T1). Its irregular thickness varies between 30 and 80 cm. It has an abrupt lateral and upper contact with unit G1, and is interpreted as a buried or partly resedimented forest floor.

Unit G1 is an unweathered fluvial gravel that caps the stratigraphic sequence and forms a terrace. It is composed of local rock types, namely mica schist, granite, and gneiss. Clasts are subrounded to rounded and range in size from 5 to 25 cm along their intermediate axis. Unit G1 thickens southward to form a channel fill and eventually truncates all underlying beds. It is thinnest (~1 m) near the base of the northern slope of the Mariposa Creek valley and thickest (~6 m) where it forms an escarpment along Mariposa Creek.

The paleoenvironmental record preserved at this site will be the subject of future research including macrofossil and pollen studies. The age of the succession will be established through identification of the tephras, which will be done in collaboration with John Westgate at the University of Toronto.

PLACER GOLD IN THE SCROGGIE CREEK BASIN

Attempts to obtain gold samples by panning in the Scroggie Creek basin were unsuccessful. After processing approximately 200 pans from throughout the basin, not one visible particle of gold was recovered. This was not unanticipated. Recovery of fine-grained gold by panning is uncommon in the Scroggie Creek basin. For example, near Mariposa Creek, gold reportedly occurred mainly as 1.6 to 8.2 g nuggets, with very little few under 0.4 g (Reimchen, 1984). Gold samples obtained from placer mining were provided by Mr. Zdenek Bidrman, who is currently placer mining in the Scroggie Creek basin (Fig. 7a, b, c). The gold from the confluence of Scroggie and Mariposa creeks ranges from rounded and equant to angular and irregular and shows extensive signs of hammering during fluvial transport (Fig. 7a). The coarse size of the grains exceeds the upper size range of gold flakes used

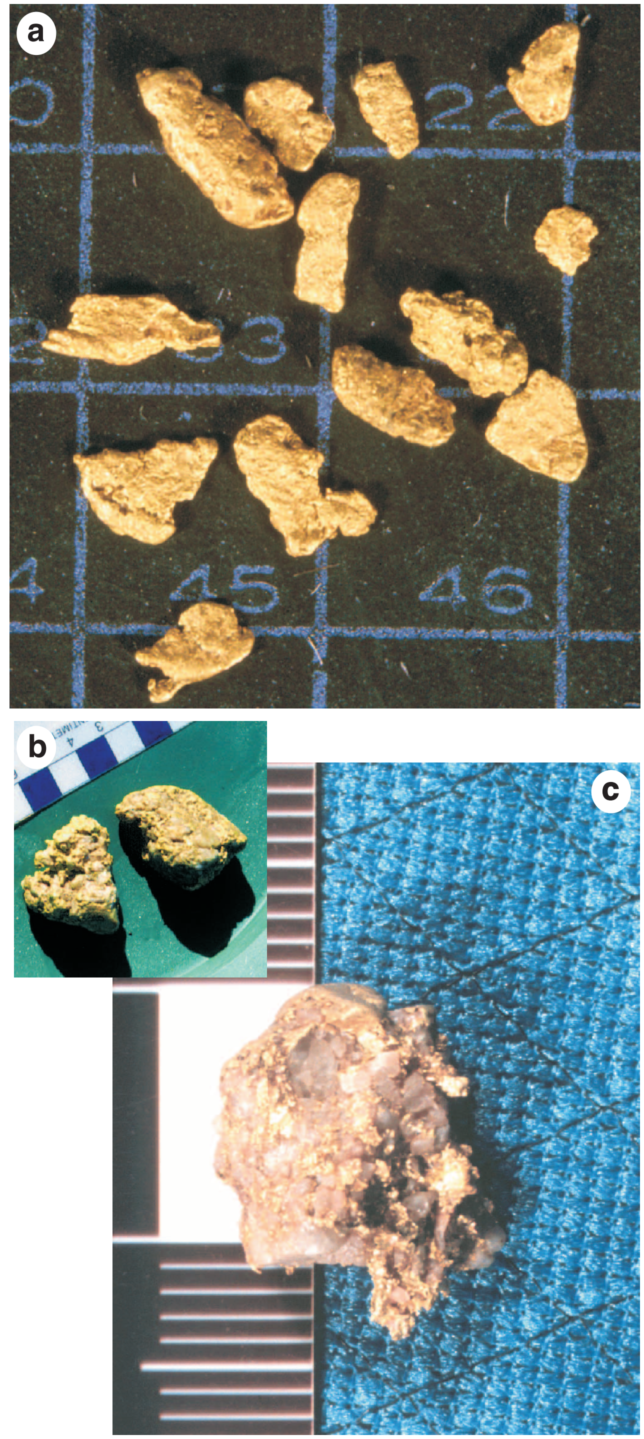

__Figure 7.__ Gold samples from Scroggie Creek above the confluence with Walhalla Creek. __a__) Angular to subangular fine nuggets mined from the area of the confluence with Mariposa Creek (Fig. 3, F). Scattered crystal faces are preserved on some grains. Grid is 4 mm x 4 mm. Size range is typical of the fine size range in this area. __b__) Angular to subrounded quartz clasts laced with crystalline gold mined from gravel along Scroggie Creek about 9 km downvalley from the samples shown in a). __c__) Detail of part of a clast showing delicate crystalline protuberances of gold on the surface of the clast.

in the shape-versus-transport studies reported by Knight et al. (1999) in the Klondike Placer District. Consequently, their transport-versus-shape plots cannot be applied to the coarser sample depicted in Figure 7a. However, the irregular shape of these grains, evidence of fluvial hammering, and the scattered partial preservation of crystal faces on some of them suggest that they have not travelled far from bedrock sources. This is expected because the placer mine site is less than 5 km from the nearest drainage divide and about 10 km from the farthest upstream limit of Scroggie Creek basin. Consequently, 5 to 10 km is the farthest distance that nuggets could have travelled from lode source(s). In contrast, large pebbles of quartz laced with crystalline gold were recovered by Mr. Bidrman from placer gravels approximately 10 km farther down-stream(Fig. 7b, c; UTM 6021715E, 6991843N). The fragility of the pristine gold crystals projecting from the clasts suggests that they were not transported far following their introduction into the fluvial system. Consequently, a source on adjacent hillsides is suggested. As gold-shape immaturity increases downstream, it can also be concluded that least two widely spaced lode sources of gold could exist within this part of the Scroggie Creek basin.

CONCLUSIONS

The all-time limit of glaciation within the Walhalla–lower Scroggie Creek valley is near the mouth of Alberta Creek. Ice entered the Walhalla basin from the south and did not cross the divide with Jane Creek. Areas downstream from the Alberta Creek confluence are prospective for the occurrence of placers that have accumulated without glacial disturbance since the Tertiary. Placer gold is coarse in the Scroggie Creek basin. Placer gold-grain shape indicates that at least two widely spaced lode sources of placer gold could exist in the Scroggie Creek basin above the Walhalla Creek confluence.

A succession of alternating organic-rich beds and stony colluvium along Mariposa Creek may record Middle Pleistocene stadial/interstadial or glacial/interglacial cycles.

FUTURE FIELD WORK

Field work is planned for the 2003 field season by the first author and will include examining the all-time limit of glaciation in the Stewart River valley, particularly around the confluences of Rosebud and Black Hills creeks with Stewart River (Fig. 2). Further investigations of Pleistocene stratigraphy in these areas will be carried out as a part of this work.

ACKNOWLEDGMENTS

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