Glaciation, gravel and gold in the Fifty Mile Creek area, west-central Yukon

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ABSTACT

Previously unrecognized glacial erosional landforms (i.e., cirques, u-shaped troughs, truncated spurs and arêtes, in order of increasing doubt), and glacial depositional landforms (i.e., end moraine and possibly ground moraine) occur in the Fifty Mile Creek area, west of the pre-Reid Cordilleran glacial limit. The cirques and end moraine, representing the best evidence of glaciation, are similar to landforms in the adjacent Yukon-Tanana uplands of Alaska and formed during the Eagle glaciation (>40 ka, or Reid in age). Glaciation caused climate-controlled variations in runoff and cycles of aggradation and incision in the Fifty Mile Creek drainage. This resulted in the formation of upper- and lower-level terraces along Fifty Mile Creek and its tributaries. The terraces are composed of slightly muddy, sandy gravel of locally derived lithologies, and are fluvial in origin. Placer gold occurs along Fifty Mile Creek and several of its tributaries, as well as in the lower-level terraces. The upper-level terraces are potentially placer-gold bearing.

RÉSUMÉ

Des formes de terrain nouvellement reconnues, caractéristiques de l'érosion glaciaire (p. ex. des cirques, des vallées en U, des éperons et des arrêtes rocheuses tronquées, en ordre décroissant de confiance) et des formes de terrain associées aux dépôts glaciaires (p. ex. une moraine terminale et possiblement de la moraine de fond) sont présentes dans la région du ruisseau Fifty Mile, à l'ouest de la limite définie pour les glaciations qui ont précédé la période glaciaire de Reid dans la Cordillère. Les cirques et la moraine terminale, qui constituent les meilleurs indices de glaciation, sont similaires aux formes de terrain modelées pendant la glaciation de Eagle (il y a plus de 40 000 ans, soit d'âge Reid) dans les hautes terres du Yukon-Tanana de l'Alaska. La glaciation a causé des variations de ruissellement déterminées par le climat et la formation de cycles d'accumulation et d'érosion de sédiments dans le bassin versant du ruisseau Fifty Mile. Ces variations ont formé les terrasses supérieure et inférieure qui longent le ruisseau Fifty Mile et ses tributaires. Les terrasses, composées de graviers sableux et boueux d'origine locale, ont été formées en milieu fluvial. De l'or placérien est présent le long du ruisseau Fifty Mile, de plusieurs tributaires et dans les terrasses inférieures. Les terrasses supérieures pourraient renfermer de l'or placérien.

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INTRODUCTION

The Fifty Mile Creek area, located southwest of Dawson City in west-central Yukon (Fig. 1), forms the northwest corner of the Stewart River map sheet (115 O and N). The area lies west of the pre-Reid Cordilleran glacial limit and is adjacent to the Sixty Mile River placer area. Ralph, Cheryl and Al creeks are informally named (Fig. 2) and are all tributaries to Fifty Mile Creek. Despite the area's proximity to the Sixty Mile River area, no placer mining has occurred in the Fifty Mile Creek area and only limited exploration for placer deposits has been undertaken. Rudis (1998) reported that the area was prospected for placer gold during the 1960s and 1970s. This was followed by exploratory drilling (Woodsend, 1990) and several geophysical surveys along Fifty Mile Creek (Mollot, 1988a, 1988b, 1988c; McIntyre, 1989a, 1989b) with no success. Recently, RJAS Minerals conducted a trenching and bulk sampling program of gravel in the area. The Fifty Mile Creek area is characterized by previously unrecognized glacial landforms, terraces, and placer gold. This study represents the first systematic and detailed investigation of the Fifty Mile Creek drainage basin. The purpose of the study is to document evidence of glaciation, describe the gravel deposits comprising the terraces, and evaluate the placer potential of the area.

BEDROCK GEOLOGY

Tempelman-Kluit (1974) and Mortensen (1996) provide the most complete coverage of the bedrock geology in the Fifty Mile Creek area. The report by Cockfield (1921) is dated, but contains useful historical information. In the adjacent Sixty Mile River area, Glasmacher (1984) concluded that epithermal type and vein type mineralization were the primary sources of placer gold. The Yukon Minfile contains brief descriptions of the bedrock geology and lode mineral deposits in the Fifty Mile Creek area.

The Fifty Mile Creek area is underlain by mainly Paleozoic metasedimentary (i.e., Kondike Schist and Nasina Assemblage) and meta-igneous rocks belonging to the Yukon-Tanana Terrane (Mortensen, 1996). Minor amounts of altered ultramafic rocks occur locally and are assigned to the Slide Mountain Terrane. According to Mortensen (1990, 1996), these two pre-accretionary units were juxtaposed by regional-scale thrust faulting in Early Mesozoic time. The area was unconformably overlain by post-accretionary sedimentary and volcanic rocks during mid- to Late Cretaceous time.

SURFICIAL GEOLOGY

Bostock (1966) and Hughes et al. (1969) provide a regional framework for the surficial geology and glacial history of the Stewart River map sheet. No surficial geology mapping has been done in the Fifty Mile Creek area, although mapping is planned as part of a proposed NATMAP project (Lionel Jackson, pers. com., 1998). In the adjacent Sixty Mile River area, Cockfield (1921) provides a historical account of the surficial geology and placer deposits, while Hughes (1986) describes the sedimentology of the placer deposits. Limited information on the type of surficial geology units present in the area can be obtained from the Dawson map sheet (located immediately to the north of the Stewart River map sheet), which was mapped by Vernon and Hughes (1966) and more recently by Duk-Rodkin (1996).

The Fifty Mile Creek area, thought to be a mature, subdued landscape by Miocene time, underwent a period of uplift and erosion in the Pliocene (Tempelman-Kluit, 1980). The area was not covered by glacial ice during the Cordilleran pre-Reid (latest Pliocene in age) or later glaciations, although there is evidence of alpine and valley glaciation.

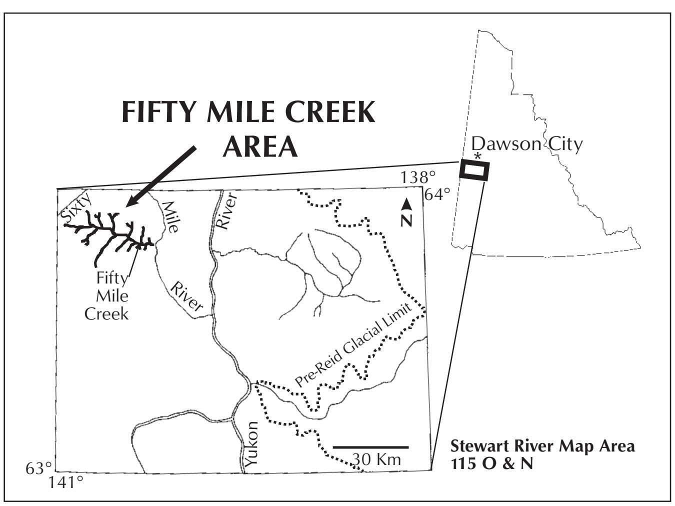

Figure 1. *Location map of the Fifty Mile Creek area, west-central Yukon.*

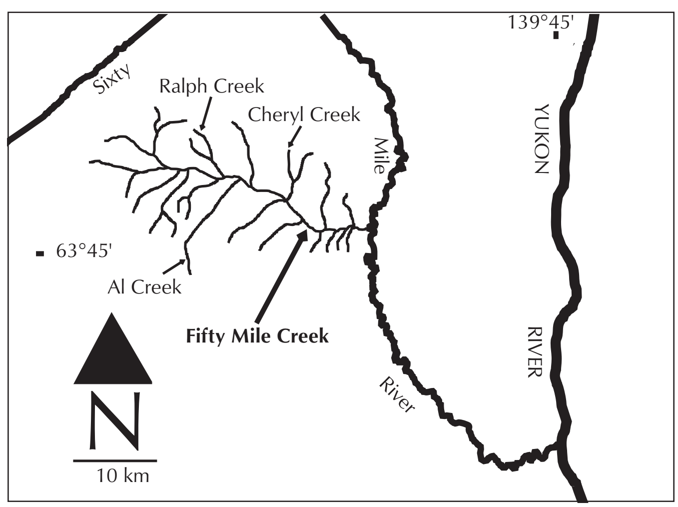

Figure 2. *Principal streams in the Fifty Mile Creek area.*

METHODS

This study is based on fieldwork and preliminary laboratory analyses. Seven days of fieldwork were spent in the Fifty Mile Creek area in August, 1999. During this time, outcrop profiles of the deposits were constructed according to the method outlined by Miall (1996), and representative samples were collected for grain size, heavy mineral, palynological, and radiometric analysis. Ongoing laboratory work includes determining grain size distribution (following the classification of Blair and McPherson, 1999) and clast lithology of gravel samples, heavy mineral analysis of panned concentrates, palynological analysis of fine-grained sand and silt samples, and radiometric age dating of tephra and organic samples. Outcrop profiles are tentatively correlated by lithocorrelation (c.f., Schoch, 1989) which will be confirmed by chronocorrelation once radiometric age dates are available.

GLACIATION

The Fifty Mile Creek is located within the Klondile Plateau, west of the Cordilleran glacial limits (i.e., the pre-Reid, Reid and McConnell). Bostock (1948, p. 69) describes the plateau as "cut into segments by the valleys of the master streams that traverse it, and its striking characteristic is the topographic similarity of all these segments, a similarity that may largely be due to the lack of glaciation of the plateau...The topography is a maze of deep, narrow valleys, separated by long, smooth-topped ridges whose elevations are very uniform...". However, the headwaters of Fifty Mile Creek are an exception to this generalization: approximately 140 km^2, or one-fifth of the Crag Mountain map sheet (115N/15) is above 1200 m in elevation with peaks up to 1820 m in elevation; similarly, approximately 140 km^2, or one-fifth of the Borden Creek map sheet (115N/10) is above 1200 m in elevation with peaks up to 1862 m in elevation. Both glacial erosional landforms and glacial depositional landforms occur within these mountainous uplands.

GLACIAL LANDFORMS

The glacial erosional landforms include cirques, u-shaped troughs, truncated spurs and arêtes, in order of increasing doubt. The cirques are located near the headwaters of Fifty Mile Creek at approximately 63°45'N, 140°35'W and 63°51'N, 140°53'W and their morphometric characteristics are summarized in Table 1. Generally, the cirques are well defined (Fig. 3) and face north-northeast (Fig. 4). The cirques typically occur at an elevation of 1415 m, and are 140 m high, 750 m wide and 1760 m long. The altitude, orientation and form of the cirques provide information on the paleoenvironmental conditions at the time of their formation. For example, using an atmospheric lapse rate of 6°C/1000 m (Hidore and Oliver, 1993) and assuming a current July freezing isotherm at 2700 m altitude in west-central Yukon, the formation of cirque glaciers in

Figure 3. *Photograph of cirque #7, looking east.*

Figure 4. *Photograph of cirque #7 headwall, looking south.*

Figure 5. *Photograph of u-shaped trough (in foreground), looking east.*

the Fifty Mile Creek area would have required a summer temperature depression of approximately 8°C below modern day values. Several u-shaped troughs (Fig. 5) are located down-stream from cirques and in valleys oriented east-west at approximately 63°45'N, 140°35'W. Landforms interpreted as truncated spurs (Fig. 6) occur along Al Creek at approximately 63°45'N, 140°35'W and arêtes(?) occur along the headwalls of several of the cirques.

The glacial depositional landforms include an end moraine and possibly ground moraine. The end moraine (Fig. 7) is located in a u-shaped trough and downstream from a cirque at approximately 63°45'N, 140°30'W. It is sharp-crested, approximately 3 m high, and partly eroded (Fig. 8). The ground moraine(?), preserved as a concentration of large lag boulders, is located in the valley of Al Creek at approximately 63°47'N, 140°35'W.

Table 1. *Cirque morphometric characteristics, Fifty Mile Creek area, west-central Yukon.*

Cirque	Location (Latitude, Longitude)	Grade[1]	Aspect[2] (°)	Altitude[3] (m)	Height[4] (m)	Width[5] (m)	Length[6] (m)	Headwall slope[7] (°)	Floor inclination[8] (°)	Length: Height Ratio	Length: Width Ratio	Headwall: Floor Slope Ratio	Cirque Volume[9] (km^3)
1	63°51'30" 140°53'50"	4	55	1395	120	600	1500	11	6	12.5	2.5	1. 8	0.05
2	63°51'10" 140°52'10"	4	5	1365	150	750	1250	17	9	12.5	2.5	1.9	0.07
3	63°47'30" 140°44'30"	3	30	1305	150	1000	1750	17	5	11.6	1.7	3.4	0.13
4	63°47'10" 140°40'30"	3	35	1485	90	750	1600	14	7	17.8	2.2	2.1	0.05
5	63°45'50" 140°39'30"	2	15	1375	45	750	1250	8	4	27.8	1.7	1.9	0.02
6	63°45'30" 140°37'40"	1	-25	1455	240	650	2000	18	8	8.3	3.1	2.2	0.16
7	63°44'30" 140°38'30"	1	-40	1455	180	700	2500	20	4	13.9	3.6	5.0	0.15
8	63°44'50" 140°35'00"	1	60	1515	150	800	2250	17	6	15.0	2.8	2.8	0.13
	Total												**0.76**
	Average	2	10	1415	140	750	1760	15	6	-	-	-	-

[1]Grade follows classification of Evans and Cox (1995), whereby 1 = classic, with all textbook attributes, 2 = well-defined, with headwall and floor clearly developed and headwall curves around cirque floor, 3 = definite, with no debate over cirque status, but one characteristic may be weak, 4 = poor, some doubt, but well-developed characteristics compensate for weak ones, 5 = marginal, with cirque status and origin doubtful.
[2]Aspect is direction faced by central headwall perpendicular to long axis of cirque measured to nearest 5° azimuth (negative values from 360° to 180°).
[3]Altitude measured as most obvious break in slope denoted by contour lines.
[4]Height measured from top of headwall to break in slope denoted by contour lines (to nearest 5 m).
[5]Width measured from top of sidewall to top of opposite sidewall (to nearest 5 m).
[6]Length measured from top of headwall to cirque mouth, or where sidewalls abruptly end or drop in altitude (to nearest 5 m).
[7]Headwall slope measured from top of headwall to break in slope denoted by contour lines (to nearest 5°).
[8]Floor inclination measured from break in slope denoted by contour lines to cirque mouth, or where sidewalls abruptly end or drop in altitude (to nearest 5°).
[9]Volume calculated by: (height x width x length)/2.

Figure 6. *Photograph of truncated spurs along Al Creek, looking north.*

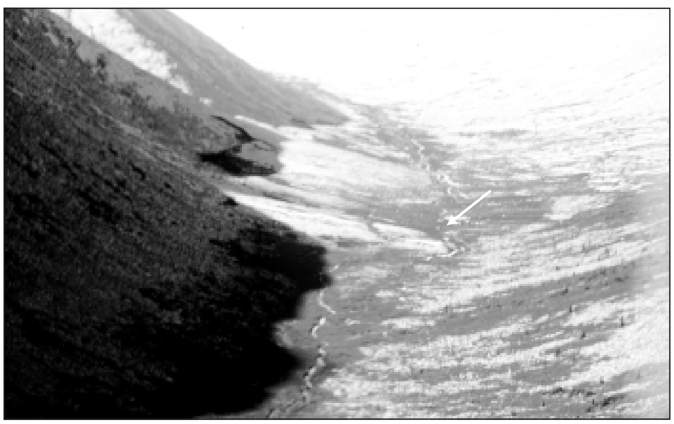

Figure 7. *Photograph of end moraine, looking west.*

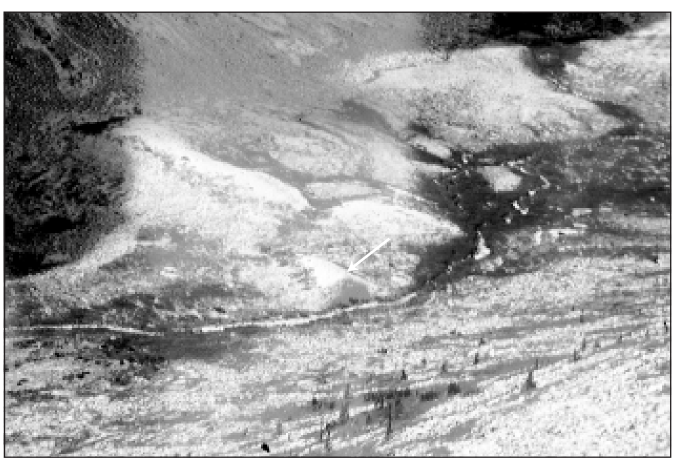

Figure 8. *Photograph of end moraine, looking south.*

AGE AND CORRELATION OF GLACIATION

The cirques and end moraine, representing the best evidence of glaciation, are similar to landforms in the adjacent Yukon-Tanana uplands of Alaska (Weber, 1986) that formed during the Eagle glaciation (>40 ka; Hamilton, 1994). The Eagle glaciation is generally correlated with the penultimate or Reid glaciation in the Yukon. A detailed examination of the end moraine is planned for next year; organic matter (if present) will be collected for radiocarbon dating, in order to obtain a precise age estimate of the glaciation.

AFFECT OF GLACIATION ON BASE LEVEL

The documentation of alpine and valley glaciation in the Fifty Mile Creek area is important from the perspective of placer geology since this glaciation controlled the base level of Fifty Mile Creek. Base level is the level to which a stream erodes its base and this determines the accommodation space, or space made available for potential sediment accumulation (Miall, 1996). Changes in base level (and related changes in accommodation space) are caused by changes in tectonics, sea level and climate. Very little is known about the neotectonics of the Fifty Mile Creek area, and the area is considered too far inland to have been affected by changes in sea level. However, Vandenberghe (1993) has shown that climate-controlled variations in runoff and sediment supply, due to cycles of glacial and interglacial phases, result in cycles of stream aggradation and incision. For example, a change from the initiation of glaciation to the maximum glacial phase causes a relative increase in runoff and a dramatic increase in sediment supply (as vegetation disappears and slopes become unstable), resulting in aggradation (Vandenburghe, 1993). As another example, a change from a glacial to interglacial phase causes a dramatic increase in runoff and a decrease in sediment supply (as limited amounts of vegetation reappear and slopes become stabilized), resulting in incision (Vandenburghe, 1993). Hence, glaciation in the Fifty Mile Creek area led to a relative increase in runoff and an increase in sediment supply, corresponding to a rise in base level and an increase in accommodation space. This resulted in aggradation or deposition of the gravel and

Figure 9. Photograph of terraces along Fifty Mile Creek, looking southeast.

accompanying placer gold. Conversely, deglaciation in the Fifty Mile Creek area led to an increase in runoff and decrease in sediment supply, corresponding to a lowering of base level and a decrease in accommodation space. This resulted in incision or erosion of the gravel and subsequent formation of the terraces.

GRAVEL

Deposits of gravel occur along Fifty Mile Creek, its tributaries, and on several levels of terraces. This report deals only with the terraces, which are assigned to an upper- and lower-level. Upper-level and lower-level terraces occur along Fifty Mile Creek (Fig. 9); lower-level terraces also occur along several tributaries to Fifty Mile Creek (i.e., Ralph and Cheryl creeks; Fig. 2). All of the terraces are cut into bedrock and are capped by a relatively thin veneer of gravel (Fig. 10). The upper-level terraces have scarps up to 20 m high and treads up to 100 m wide; lower-level terraces have scarps up to 2 m high and treads up to 300 m wide.

UPPER-LEVEL TERRACES

The upper-level terraces are restricted to the right limit of Fifty Mile Creek where they are cut into granitic orthogneiss (Fig. 11) of the Fifty Mile batholith (Mortensen, 1996). The terraces have not been extensively explored and no trenches are present, however several trails cut by bulldozers provide limited exposure of the gravel capping the terraces (Fig. 12). The gravel is up to 2 m thick, poorly horizontally bedded, and is classified as lithofacies Gh (Fig. 13). Texturally, it is a clast supported, rounded, moderately sorted, muddy, sandy, cobbly, medium to very coarse pebble gravel. The gravel, dominated by metamorphic clasts locally derived from the Fifty Mile batholith, was deposited by a paleocurrent flowing towards the east.

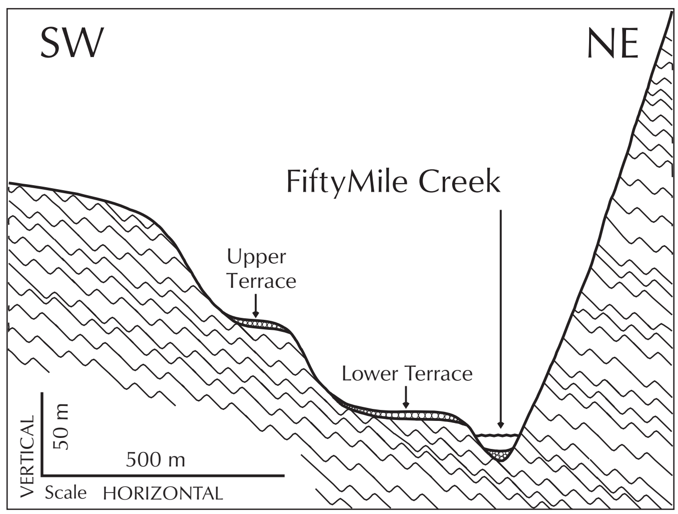

Figure 10. Schematic cross-section of terraces along Fifty Mile Creek.

Figure 11. Photograph of the upper-level terrace and exposed bedrock, looking southeast.

LOWER-LEVEL TERRACES

The lower-level terraces are restricted also to the right limit of Fifty Mile Creek. The terraces are cut into quartz-muscovite schist of the Nasina Assemblage (Fig. 14) and granitic orthogneiss of the Fifty Mile batholith (Mortensen, 1996). The terraces have been extensively explored and several trenches provide limited exposure of the gravel capping the terraces (Fig. 15). The gravel is up to 3 m thick, poorly horizontally bedded, and is classified as lithofacies Gh (Fig. 16). Texturally, it is a clast-supported, slightly organized (i.e., a/t, b/i, with the long axis of clasts horizontal and transverse to slope, and the intermediate axis of clasts imbricate), rounded, moderately sorted, slightly sandy, cobbly, medium to very coarse pebble gravel. The gravel, dominated by metamorphic clasts locally derived from the Nasina Assemblage and Fifty Mile batholith, was deposited by paleocurrents flowing towards the east. Minor amounts of planar bedded sand (lithofacies Sp) also occur in the gravel.

Figure 14. *Photograph of the lower-level terrace and exposed bedrock, looking south.*

Figure 12. *Photograph of a bulldozer trail exposing gravel on the upper-level terrace, looking south.*

Figure 15. *Photograph of an exploration pit in the lower-level terrace, looking southeast.*

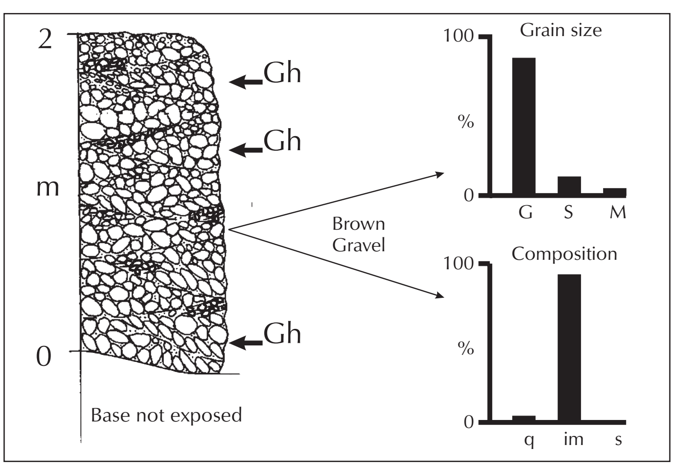

Figure 13. *Sedimentological section of the upper-level terrace (Gh=horizontally bedded gravel) and typical grain size distribution and composition of gravel (G=gravel, S=sand, M=mud, q=quartz vein clasts, im=igneous and metamorphic clasts, s=sedimentary clasts).*

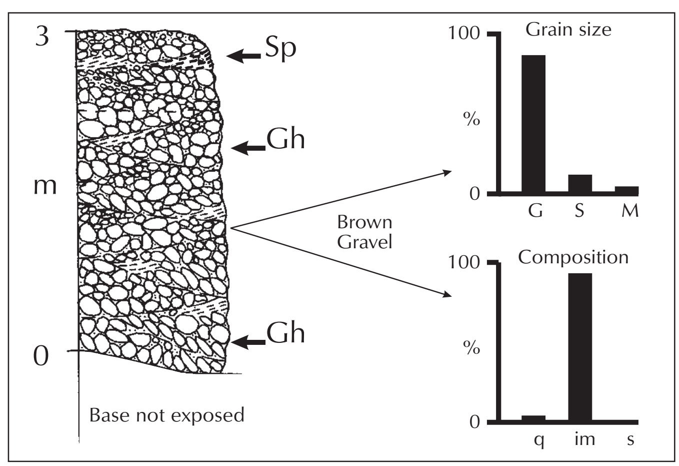

Figure 16. *Sedimentological section of the lower-level terrace (Gh=horizontally bedded gravel, Sp=planar bedded sand), and typical grain size distribution and composition of gravel (abbreviations in Figure 13).*

TRIBUTARY CREEK TERRACES

Lower-level terraces also occur along Ralph and Cheryl creeks and several other unnamed tributaries. They are cut into quartz-muscovite schist and amphibolite (Fig. 17) of the Nasina Assemblage (Mortensen, 1996). Several of the terraces have been explored and trenches provide limited exposure of the gravel capping the terraces (Fig. 18). The gravel is up to 1 m thick, poorly horizontally bedded, and classified as lithofacies Gh (Fig. 19). Texturally, it is a clast supported, slightly organized (i.e., a/t, b/i, with the long axis of clasts horizontal and transverse to slope, and the intermediate axis of clasts imbricate), rounded, moderately sorted, muddy, sandy, medium to very coarse pebble gravel. The gravel, dominated by metamorphic clasts locally derived from the Nasina Assemblage, was deposited by paleocurrents flowing towards the south. The gravel is overlain by interbedded sand (lithofacies Sh) and mud (lithofacies Fl) that are horizontally laminated.

Figure 17. *Photograph of the tributary creek terrace and exposed bedrock, looking north.*

Figure 18. *Photograph of an exploration pit in the tributary creek terrace, looking southeast.*

ENVIRONMENT OF DEPOSITION

The deposits of gravel comprising the terraces are characterized by a vertical assemblage of lithofacies Gh. This assemblage is classified as element GB and interpreted as gravel bars. The gravel bars formed in a fluvial system, most likely a braided river environment. Lithofacies Sp is interpreted as small sand bars within the gravel, and lithofacies Sh and Fl are interpreted as overbank deposits.

GOLD

HEAVY MINERAL ANALYSIS

A panned sample of gravel (approximately 1/150th of a cubic metre) from the lower-level terrace contained a heavy mineral assemblage dominated by magnetite, garnet, hornblende, hematite and pyroxene (enstatite; Fig. 20). Approximately 15 gold colours were recovered in the assemblage and classified as follows (Macdonald, 1983): 2 fine-grained colours (the largest gold particle was 1 mm long), 9 very fine-grained colours, and at least 5 flour-sized colours. According to the method outlined by Macdonald (1983), the colours are estimated to weigh 6.16 mg, or represent almost 1 gram of gold per cubic metre of gravel (equivalent to 0.024 oz/yd). The heavy mineral assemblage is consistent with derivation from magnetite-pyroxene skarns present in the area (i.e., Yukon Minfile, 1997, 115N 042). Gold has not been reported from the skarns, but up to 4.0 g/t Au was

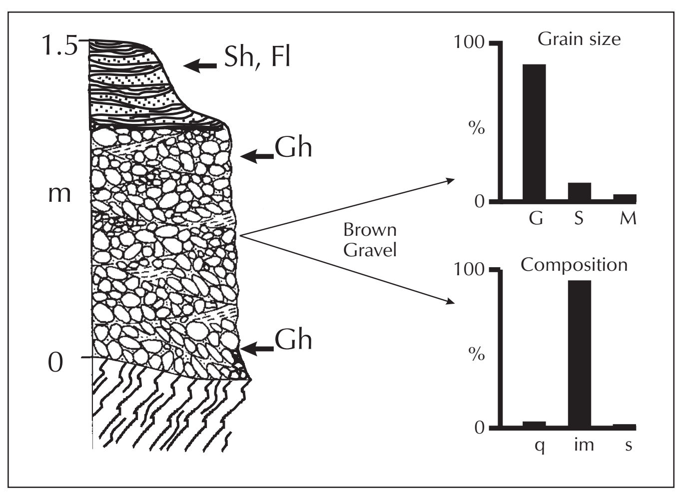

Figure 19. *Sedimentological section of the tributary creek terrace (Gh=horizontally bedded gravel, Sh=horizontally bedded sand, Fl=laminated mud), and typical grain size distribution and composition of gravel (abbreviations in Figure 13).*

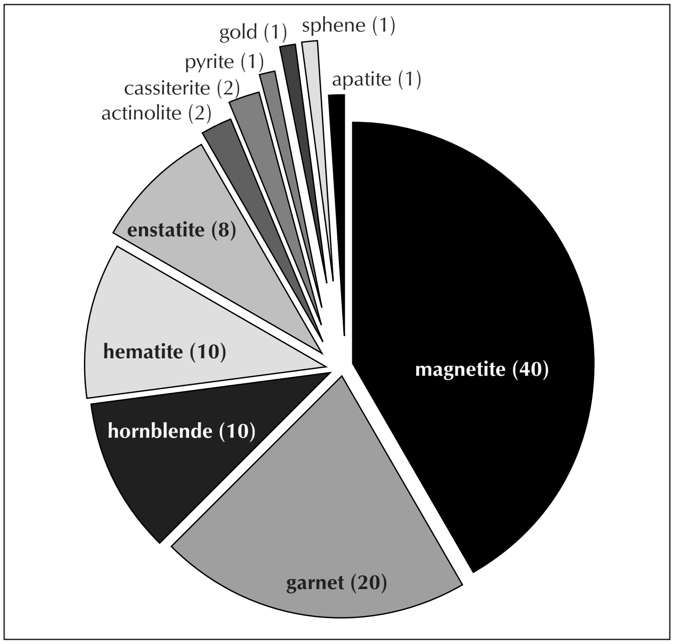

Figure 20. *Heavy mineral analysis of a panned sample (GL99-55) from the lower-level terrace (values in percent run clockwise from 40%=magnetite, garnet=20%, etc.)*

reported from galena-carbonate veins that are occur in the study area (i.e., Yukon Minfile, 1997, 115N 040 and 042). Although paleoplacer gold has been reported from Cretaceous and/or Tertiary conglomerate exposed in the area (Tempelman-Kuit, 1972), subsequent exploration has failed to find any gold in this unit (Yukon Minfile, 1997, 115N 044).

DISTRIBUTION

Placer gold occurs along Fifty Mile Creek and several of its tributaries (Ralph and Cheryl creeks), but the occurrence of this gold was not systematically investigated. Placer gold occurs also in the lower-level terraces along the right limit of Fifty Mile Creek (Fig. 21) and in the lower-level terraces along several tributaries to Fifty Mile Creek (i.e., Ralph and Cheryl creeks). The upper-level terraces along Fifty Mile Creek are similar (in terms of origin and composition) to the lower-level terraces, and therefore, they are potentially placer gold bearing. However, the lower-level terraces represent a larger volume of gravel than the upper-level terraces. In addition, placer gold, if it is present in the upper-level terraces, would probably be of lower grade than that in the lower-level terraces due to the erosion and re-concentration of gold from the upper-level terraces into the lower-level terraces. Hence, the lower-level terraces represent the best exploration target for large-scale placer mining.

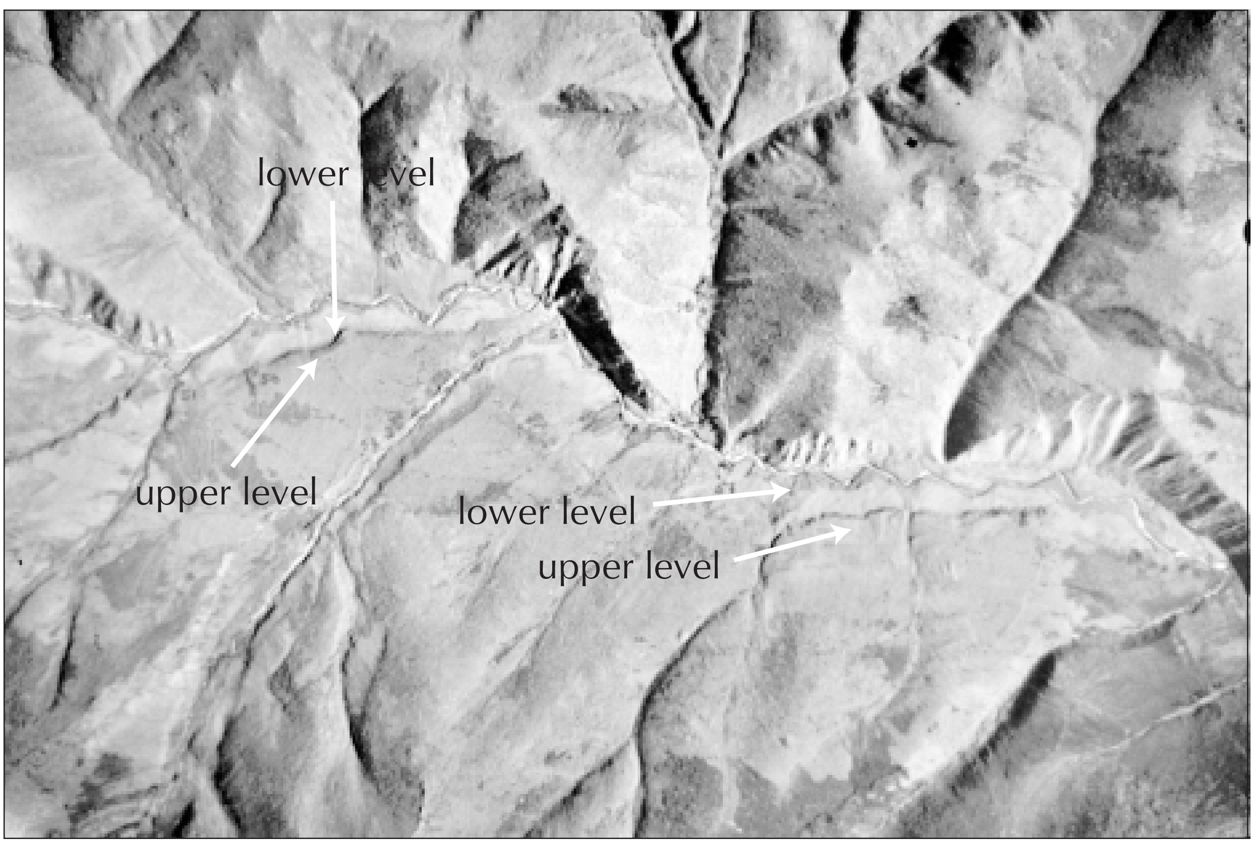

Figure 21. *Air photograph of terraces along Fifty Mile Creek.*

CLASSIFICATION OF PLACER DEPOSITS

Placer gold deposits in gravel capping the terraces are classified as alluvial bench placers (Table 2), and those in the present day Fifty Mile Creek and its tributaries are classified as creek placers.

CONCLUSIONS

Alpine and valley glaciation in the Fifty Mile Creek area, based mainly on the identification of cirques and an end moraine, is likely Reid in age. This glacial event caused fluctuations in runoff and sediment supply, thereby controlling the base level of Fifty Mile Creek. As a result, cycles of aggradation and incision ensued, resulting in the formation of terraces along Fifty Mile Creek and several of its tributaries. The terraces are capped by a relatively thin veneer of gravel that is pebbly to cobbly, locally derived, and fluvial in origin. Placer gold occurs in lower-level terraces located along Fifty Mile Creek and along several tributaries to Fifty Mile Creek. There is also potential for placer gold in upper-level terraces located along Fifty Mile Creek.

ACKNOWLEDGEMENTS

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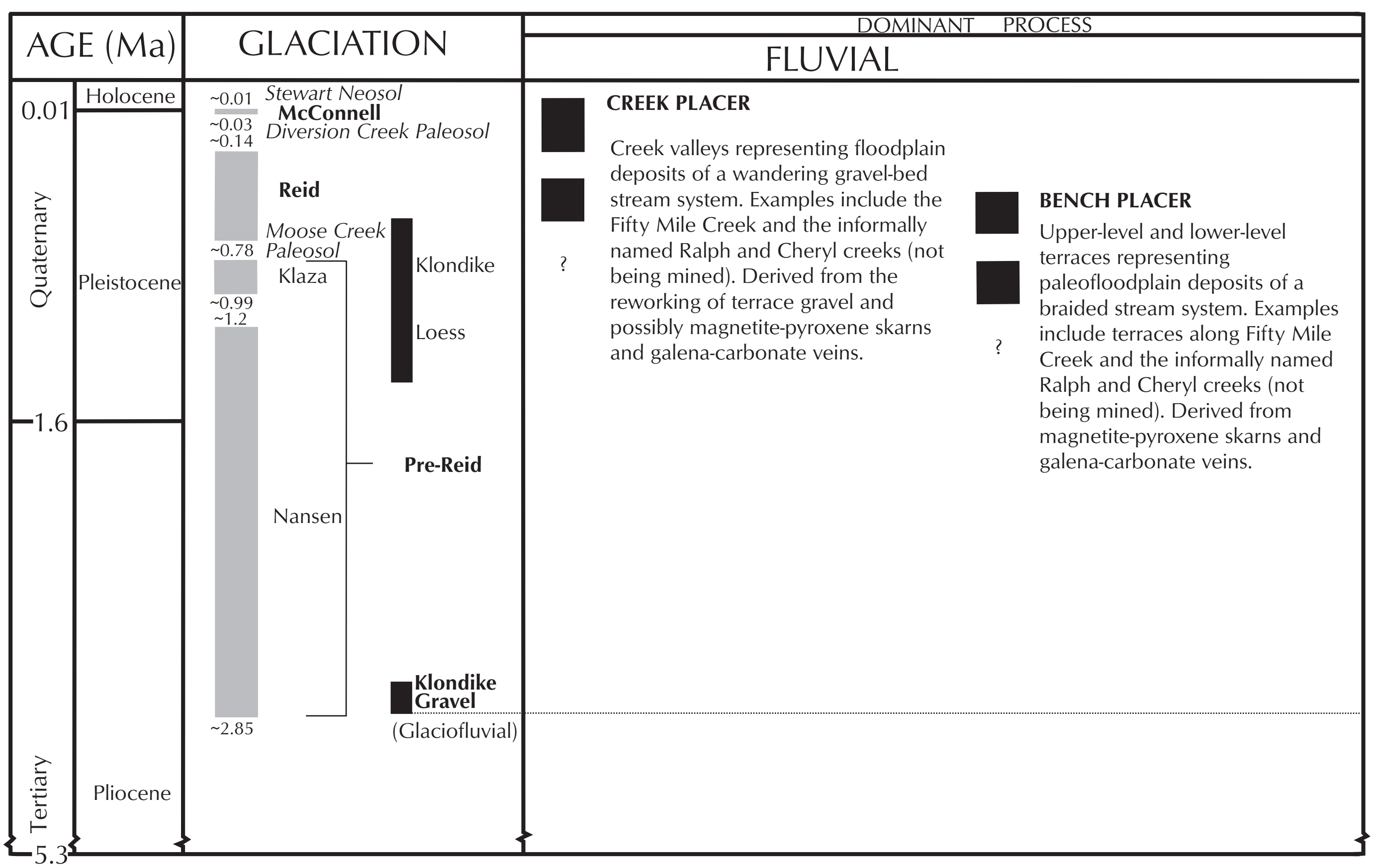
Table 2. *Classification of placer deposits in the Fifty Mile Creek area, west-central Yukon.*



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