PLACER GRAVELS OF MILLER CREEK, SIXTYMILE RIVER AREA, 116 B,C

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MEMORIAL

Rhys Hughes died in a tragic accident during the summer of 1986. Rhys worked for the Geology Division for three summers studying the geology of placer deposits in the Klondike, Sixtymile and Big Creek areas. He completed a Master of Science thesis on placer deposits in the Sixtymile area, and as a result has produced new insights to alluvial sedimentation and placer deposit information in unglaciated areas in Yukon Territory. He was a diligent and reliable worker who was well liked by his colleagues at Northern Affairs and by the placer miners whom he worked with. He will be missed.

INTRODUCTION

Miller Creek and four other small tributaries of the Sixtymile River drainage basin (Fig. 1) were the sites of rich placer discoveries in 1892 (Gilbert, 1983). The first important geological report on the Sixtymile River was by Cockfield (1921) who described regional geology, stratigraphy and location and value of placer gold recovered by the early miners. At that time, total gold production by hand mining and a small dredge operation was 50 million U.S. dollars, at $30.00 per ounce.

The distribution of gold-bearing gravelly sediments in the Sixtymile area is related to geomorphic history, gravel stratigraphy and fluvial sedimentology. This report relates the distribution of placer gold to Quaternary depositional environments of gravelly sediments in the Miller Creek area. It is hoped that this report will enhance results and interpretations from exploration and testing programs in the Sixtymile River placer area.

PREVIOUS WORK

In the Sixtymile River area, Cockfield (1921) provided notes on general stratigraphy of the gravel exposures in pits and shafts. Debicki (1983) described the locations, mining methods and general stratigraphy of active placer mining properties in the Sixtymile River area. Glasmacher (1984) and Glasmacher and Friedrich (1985) described the bedrock geology, petrology, mineralization, general placer settings and heavy minerals suites.

GENERAL GEOLOGY AND STRATIGRAPHY

The study area is within Yukon Cataclastic Complex, which is comprised of three assemblages of highly sheared and metamorphosed rocks that are thrust over less deformed strata of the Nasina Shelf and Cassiar Platform (Tempelman-Kluit, 1981).

The Pelly Gneiss (a foliated muscovite-biotite granodiorite of assumed Paleozoic age), and the Klondike Schist (a chlorite-muscovite schist) outcrop immediately south of the study area. In the Sixtymile River area, metamorphosed Nasina Series basement rocks are not dated, but elsewhere are traceable into the Lower Ordovician to possibly Mississippian sedimentary rocks of the Cassiar Platform (Tempelman-Kluit, 1981).

Nasina Series rocks are overlain by volcanic rocks of the Carmacks Group (Tempelman-Kluit, 1974) of late Cretaceous age (Nelson, 1985). These andesites, dacites and tuffs underlie gravelly sediments at Sections 3 to 7 in the Sixtymile River valley, and Section 8 in the Glacier Creek valley (Fig. 1). Locally along the Sixtymile River, sandstone, shale and conglomerates underlie and are interbedded with Carmacks volcanic rocks (Tempelman-Kluit, 1973; Lowey, 1982). Carmacks volcanics are overlain by flat-lying alkali-olivine flow basalts of the Quaternary Selkirk Group.

PHYSIOGRAPHY, QUATERNARY DEPOSITS AND LANDFORMS

The Sixtymile placer area is in the unglaciated portion of the western Yukon Plateau or the Klondike Plateau (Bostock, 1948). This rolling upland landscape formed during the Tertiary after deposition of the Carmacks Group volcanics and before the onset of White Channel valley-fill deposition (Bostock, 1948, Cockfield, 1921). The general physiography of the Sixtymile River area is an accordant surface with elevations up to 1,300 metres that has been deeply dissected by stream erosion (Cockfield, 1921). Tempelman-Kluit (1980) suggests that this plateau surface was incised and eroded after the Eocene and before the Pliocene. Prior to the Pliocene, the Sixtymile River was a tributary of the paleo-Yukon River system which drained southerly. Drainage diversions to the north began with differential uplift of the Yukon Plateau, and were completed during the Pleistocene as a result of galcial advances and ice-damming (Tempelman-Kluit, 1980).

Quaternary deposits of the Sixtymile River drainage basin include valley bottom alluvial plains and terraces, gulch alluvium, colluvial veneers and blankets, and scattered debris flows (Fig. 1). The youngest Quaternary deposits include active colluvium, valley bottom gulch alluvium and the broad alluvial plain in the Sixtymile River valley. Older alluvial deposits include the higher terrace levels in the upper reaches of Miller and Glacier Creeks, the second terrace level in the lower reaches of Miller Creek, and the broad terrace found on the north side of the Sixtymile River valley, both upstream and downstream from Miller Creek (Fig. 1).

Miller Creek and Glacier Creek are both in asymmetric valleys which contain high level terraces on the northeast side (looking upstream) of the valley slope (Fig. 1). In the upper reaches of these creeks, narrow terraces are found approximately 20 metres above the valley floor. These terraces are underlain by alluvial-fill sequences up to 10 metres thick. In the lower reaches of Miller Creek, a second terrace level is contained by a bedrock topographic high, and is underlain by 20 metres of alluvium (Fig. 2). This tributary terrace system was deposited as a confined alluvial fan which prograded into the main Sixtymile valley. Only an eroded remnant of a similar terrace exists in the lower part of Glacier Creek. The third, and largest terrace within the study area is found on the north side of the Sixtymile River valley (Fig. 1). The main Sixtymile terrace system was initially deposited as a braidplain sequence before incision. Hughes (1970) suggests that inci-

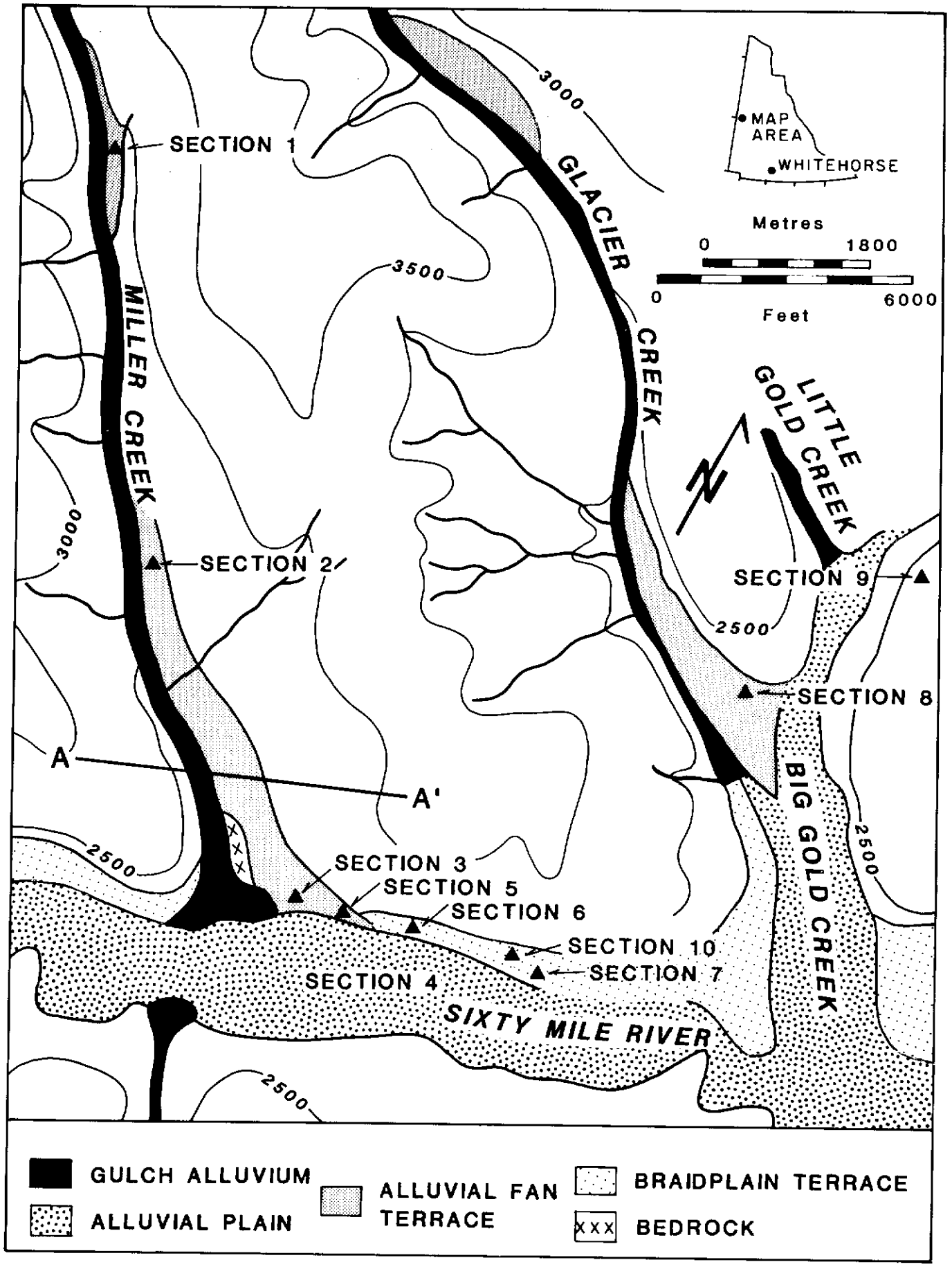


Figure 1. Location map for study area, showing section locations and types of placer deposits.

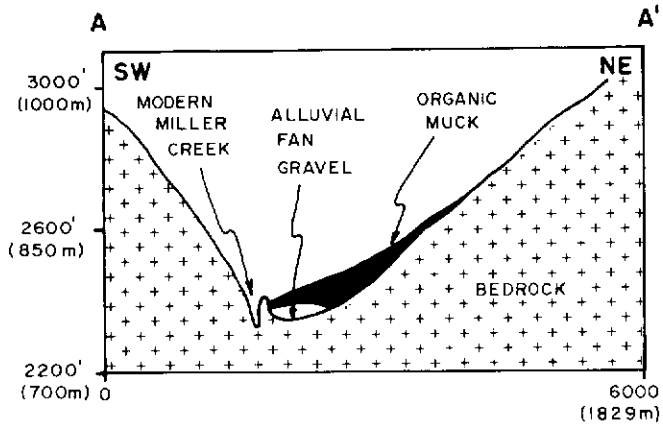


Figure 2. Cross-section A-A' of lower Miller Creek showing relative position of the modern channel to the alluvial fan terrace gravel and the colluvial blanket of organic muck.

sion and preservation of these terraces is the result of Pliocene-Pleistocene uplift in the Klondike area.

CHRONOLOGICAL HISTORY OF INCISION AND VALLEY-FILL AGGRADATION AT MILLER CREEK

After reaching a local base level, paleo-Miller Creek underwent a period of valley widening through the initiation of alluvial fan sedimentation (Fig. 3a). This widening resulted in the deposition of discontinuous placer concentrations over a broad paleo-Miller Creek valley bottom. Within the main Sixtymile River valley, braided river alluvium was also depositing discontinuous concentrations of placer minerals. Lateral widening of the main Sixtymile River valley was accompanied by headward migration of the paleo-Miller Creek alluvial fan. Aggradation of the paleo-Miller Creek alluvial fan was accompanied by progradation into the Sixtymile River valley (Fig. 3b). At the confluence of the broad Sixtymile braidplain and paleo-Miller Creek valley, erosion of distal Miller Creek fan gravel by Sixtymile braided alluvium may have significantly contributed to point sources of placer gold in Sixtymile alluvium. This may explain placer gold enrichment on bedrock in this location (M. Brisbois, pers. comm.).

Radiocarbon dates from *in situ* wood interbedded within Miller Creek fan gravel (GSC-4032), and *in situ* peat above upper fan gravel (GSC-3934) indicates that Miller Creek fan sedimentation was complete before 40,000 years ago.

A radiocarbon date (Beta-13870) from wood in muddy sediments (Section 7; Fig. 1) indicates that by 26,000 years ago, surficial processes were dominated by debris flow sedimentation. Also, during this time Miller Creek alluvial fan and Sixtymile braidplain aggradation was complete and active incision with terrace development was occurring. During incision of the Sixtymile braidplain, the stream environment changed to a single channel meandering system (Fig. 3c). Timing for the incision and formation of the modern channel of Miller Creek is difficult to judge, but may have occurred concurrently with the change in the channel pattern of the Sixtymile River.

After terrace development in the Sixtymile drainage basin, continued debris-flow and loess sedimentation dominated surficial processes (Fig. 3d). Minor vertical aggradation of stream gravel and valley widening in the modern Miller Creek channel occurred during the Holocene.

REGIONAL DISTRIBUTION OF PLACER GOLD

Based on the historical records provided by Cockfield (1921) and samples collected during the field season, the highest concentrations of placer gold appear to be in the tributary terrace levels of Miller and Glacier Creeks (Fig. 4). Lode sources for placer gold include structurally controlled vein systems and Tertiary epithermal mineralization (Glasmacher, 1984; Glasmacher and Friedrich, 1985).

Historical records (Cockfield, 1921) indicate the presence of a poorly defined paystreak at the base of the upper terrace level at Miller Creek (Fig. 4). This paystreak is found in massive, angular gravels which have a preferred a-axis upstream imbrication type (Sections 1,2; Fig. 1). These characteristics suggest local gravelly sedimentation in the form of hyperconcentrated flood flows. In contrast, gravelly beds interpreted as proximal talus and colluvium at the same sites are barren of gold. The associated hydrodynamics

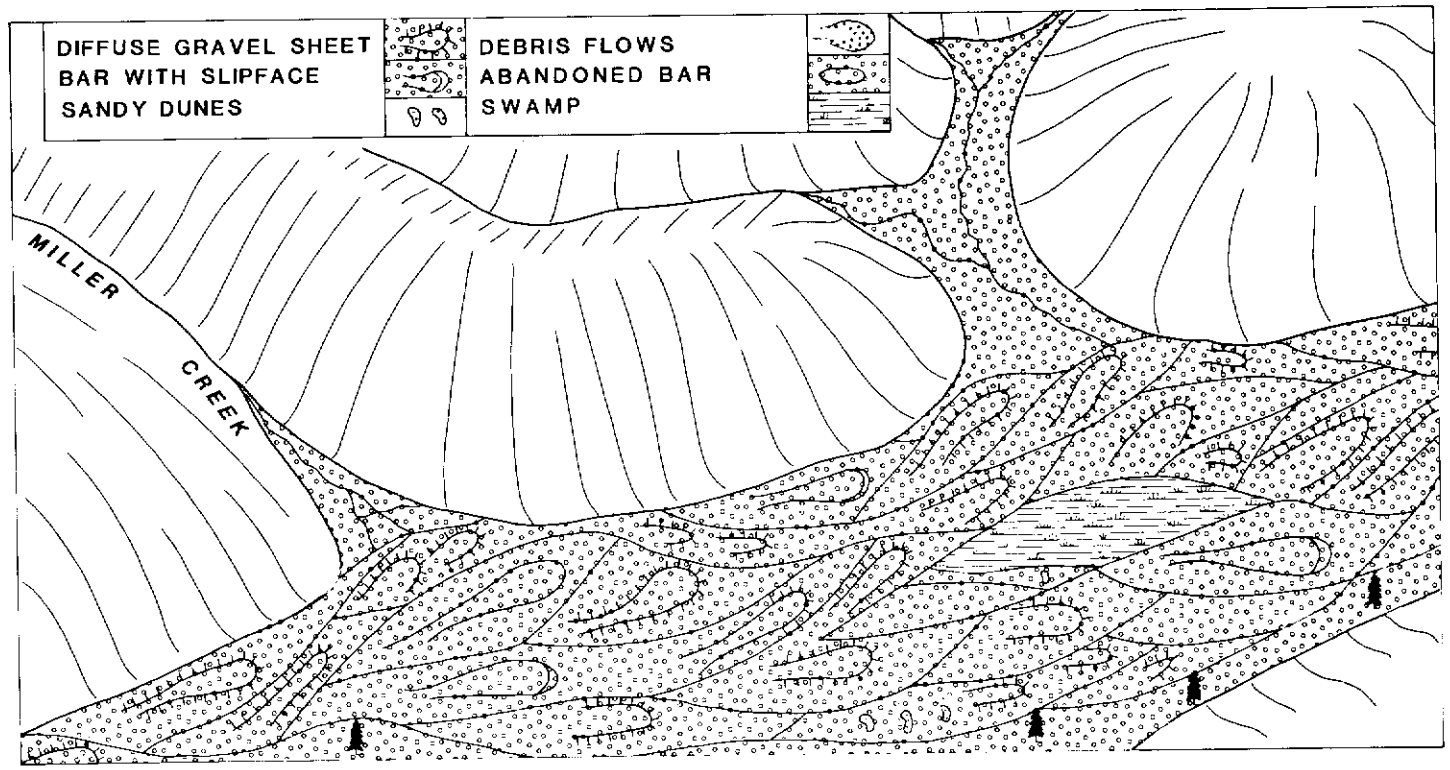


Figure 3a. Sketch showing sedimentary environments of the Sixtymile River and Miller Creek prior to fan aggradation. Note the initiation of tributary valley widening and braidplain environment of the main valley which has a stream flow direction from left to right.

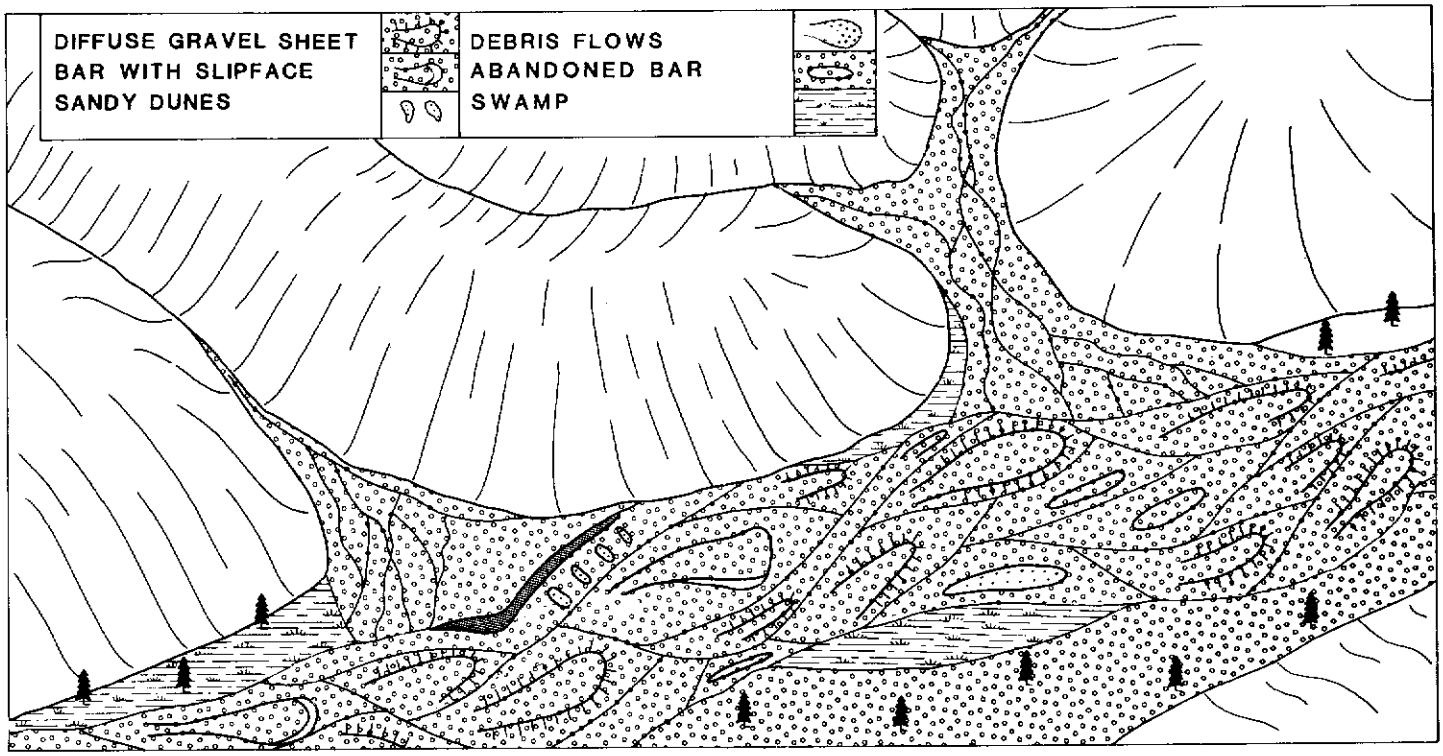


Figure 3b. Sketch showing aggradation of Miller Creek alluvial fan. Fan aggradation was complete before 40,000 years ago; and note the erosion of distal fan sediments by the Sixtymile River.

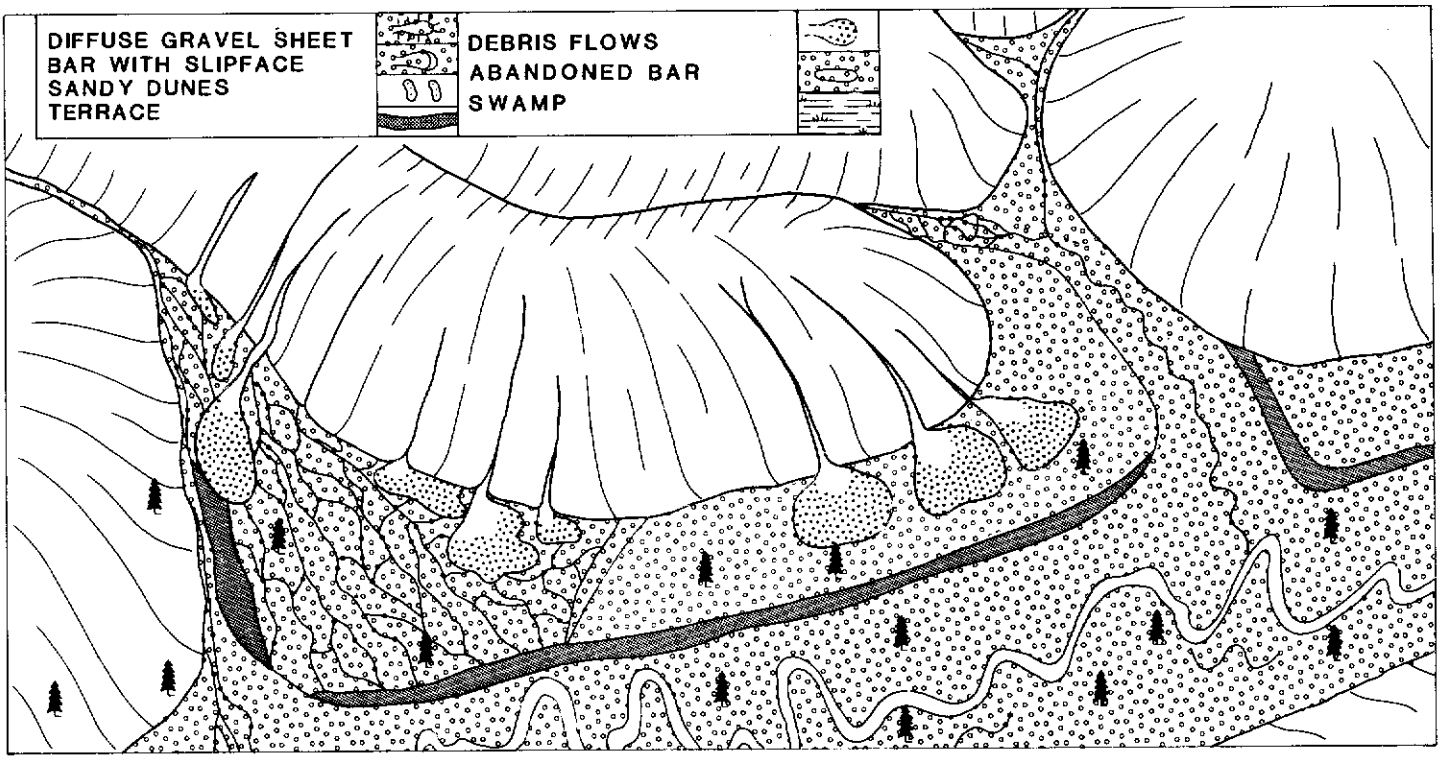


Figure 3c. Sketch showing debris flow sedimentation and terrace development 26,000 years ago. Note Miller Creek is being diverted to the SW side of the valley and is beginning to incise a new channel, and the Sixtymile River has changed channel pattern from braided to meandering.

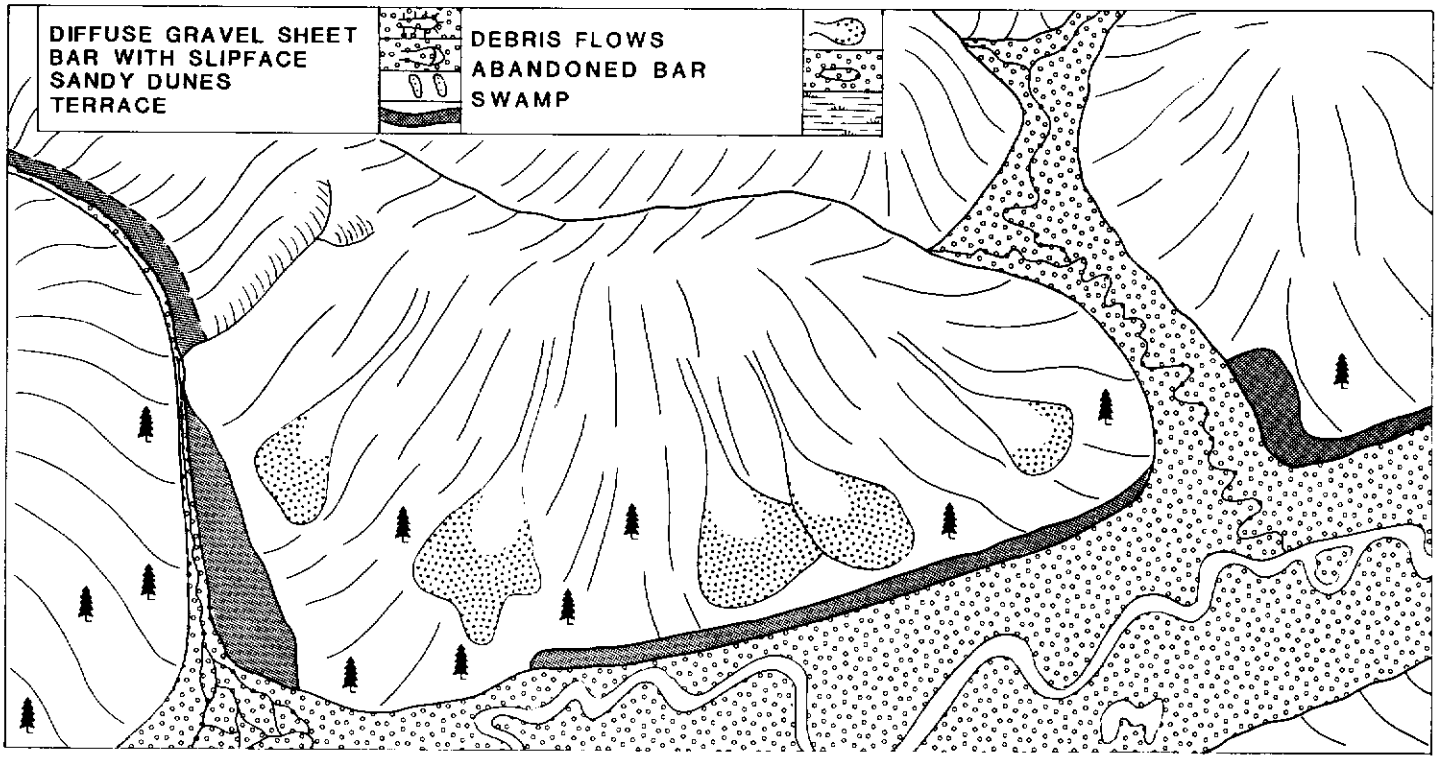
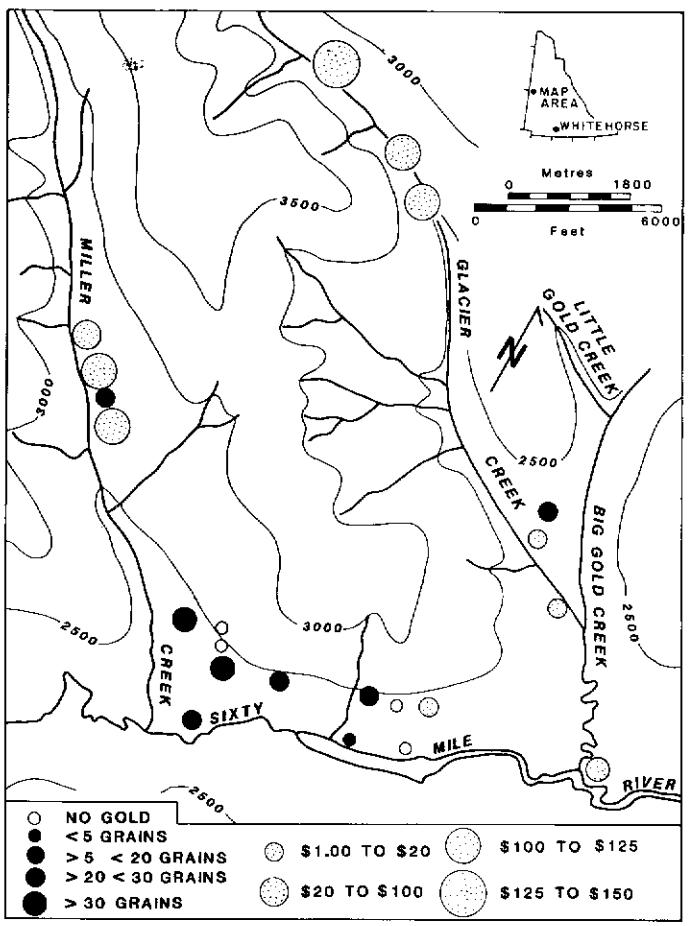


Figure 3d. Sketch showing post-terrace development with active debris flow sedimentation and valley widening at the mouth of Miller Creek.

of flood flow gravelly sediments suggests they are not favourable sites for heavy mineral concentration. However, rich accumulations of placer gold do occur in this setting, and thus point to the presence of local bedrock point sources.



Distal terrace levels in Miller Creek valley (Sections 3,5; Fig. 1) contain aggraded sequences of massive gravel sheets. The distinct lack of sedimentary structures and the poorly sorted nature of these distal gravelly sediments indicates lack of convergent or concentrating stream flow. However, limited sampling and historical records have shown that economic concentrations of placer gold are found at the bedrock surface (Fig. 4). It is also interesting to note that gold concentration levels appear to decrease distally in the Miller Creek fan sequence (Fig. 4). The above observations suggest a local gold provenance, which was depleted during aggradation of the fan. In a general sense, the preferred site of placer formation in Miller Creek fan gravel is at the bedrock surface where coarse-grained, massive lag gravel trapped gold particles.

The Sixtymile River terrace gravels (Fig. 1) are interpreted to be the product of a medial braidplain sequence. Economic gold concentrations are scattered (Fig. 4) and are typical for a braided environment where local point sources are discontinuous and stream flow patterns are variable (Smith and Minter, 1980).

None of the bulk samples from Sixtymile alluvial plain gravel (Fig. 4) contained an appreciable enrichment of placer gold, although there was an abundance of other heavy minerals in massive gravels found in contact with the bedrock surface. Possible explanations for the lower concentrations of gold in this setting include "flushing" of the heavy minerals (Adams et al., 1978) or change of gravel source areas during incision of the Sixtymile River to its present level.

SUMMARY

Within the Sixtymile River drainage basin, Quaternary placer deposits include tributary valley bottom gulch gravel, a broad main valley alluvial plain, and high level terrace systems in both tributary and main valley settings. After downcutting, paleo-Miller Creek underwent valley widening during alluvial fan erosion and sedimentation. During this time, the main Sixtymile River valley was

Figure 4. Distribution of placer gold in study area. Solid circles are samples collected by authors and patterned circles are values reported by Cockfield (1921). Cockfield's estimates refer to the amount of gold (at $20.67 U.S. per fine ounce) present in one sluice box length which is equivalent to 12 square feet.

also being laterally eroded during braidplain aggradation. Terrace development and incision through both fan and brainplain sediments coincided with significant debris flow sedimentation. The Sixtymile River changed from a braided environment to single channel meandering environment during terrace development. Incision of Miller Creek through the fan surface to present levels probably coincided with downcutting of the Sixtymile River. Economic concentrations of placer gold are found in: 1) the upper Miller Creek terrace where coarse-grained, massive and angular flood flow gravel forms a crude pay streak above the bedrock surface; 2) the distal Miller Creek terrace where discontinuous concentrations of gold were formed over a broad paleo-surface of lag gravel prior to fan aggradation; 3) laterally discontinuous pockets in the main Sixtymile valley terrace which was originally part of an aggraded braidplain sequence; and 4) lower, but still economic placer concentrations in gravels of the alluvial plain in the main Sixtymile valley.

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