PLACER DEPOSITS OF THE YUKON: OVERVIEW AND POTENTIAL FOR NEW DISCOVERIES

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Abstract

Historic placer mining areas in Yukon can be grouped into ten areas: Klondike; Sixtymile; Fortymile; Clear Creek; Moosehorn Range; Stewart River; Whitehorse South; Mayo; Dawson Range and Livingstone Creek. Each area has its own geomorphic setting and depositional history which is related to its glacial history. Several Quaternary glacial advances have been described in Yukon, and these are generally divided into three episodes, commonly known as the pre-Reid, Reid and McConnell, in order of oldest to most recent.

Placer deposits in the unglaciated Klondike, Sixtymile, Fortymile and Moosehorn drainages occur in valley-bottoms, alluvial fans, in gulch gravels and as high level terraces. Placer deposits in glaciated areas occur in variably reworked and buried valley-bottom, bench and gulch settings, in auriferous glacial till and glaciofluvial gravels, and in non-glacial gravels which were deposited on top of glacial drift.

Targets for new placer deposits in unglaciated areas include drainages such as Stewart, North Ladue and Yukon rivers which lie outside of the pre-Reid glacial limits. These deposits may occur in abandoned channels, oxbows and point bars, high level terraces, and in tributary gulch and valley bottom placers.

Within glaciated areas, placer deposits may be discovered buried in valleys beneath terraces of pre-Reid glacial drift along the margins of the pre-Reid glacial limit. Mineable placer deposits may also have formed on top of pre-Reid glacial drift and may be buried in valleys beneath Reid-age non-glacial alluvium. Prospective areas of this type are drainages which are near lode gold deposits in the Clear Creek area and in drainages near felsic volcanics in the Dawson Range. At the limits of both the Reid and McConnell glaciations, auriferous pre-glacial or interglacial gravel can often be buried by glacial and glaciofluvial deposits. Low-grade auriferous glaciofluvial gravel can also be derived from the reworking of pre-glacial gold-bearing gravel. Prospective areas for these types of placer deposits are the South McQuesten River valley and the creeks draining the Ruby Range on the east side of Kluane Lake. Within the McConnell glacial limits, placer deposits may be found in valleys oriented obliquely to the paleoflow direction of the glacial ice. Economic to sub-economic placers may also be found along meltwater channels within the McConnell ice limit. Prospective areas of this type of deposit are the drainages which lie to the north of Livingstone placer camp.

The possibilities for new placer mining areas within glaciated areas must be investigated, and new placer gold reserves will undoubtedly be found within these areas. These potential gold deposits may be explored by techniques such as surficial mapping, airphoto interpretation and bulk sampling of potential gold-bearing units.

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Introduction

Although the Yukon has been glaciated at least four times, much of central Yukon escaped the effects of the Cordilleran ice sheets, which generally moved into the Yukon from southeast to northwest. The historically rich Klondike placer deposits in central Yukon were preserved from the scouring effects of the ice sheets which affected southern Yukon.

Placer deposits in the Yukon occur in both glaciated and unglaciated areas, although the vast majority of placer gold mined has been derived from the unglaciated areas. Aside from these major geographic subdivisions, placer deposits occur within a number of different stratigraphic and geomorphic settings.

The presence of economic placer concentrations of gold in any one geographic area depends on a number of variables, such as how recently the area has been glaciated, the age of the deposits, the number of changes in drainage or base level, and of course the presence, absence and nature of lode gold in the local bedrock.

The potential for new placer discoveries in the Yukon remains high, as past exploration for placer deposits has focused mainly on traditional (unglaciated) areas and only the most accessible drainages have seen extensive examination and testing. The search for new placer deposits, in the presence of diminishing reserves in traditional areas, is important in order for the placer mining industry to survive. By expanding our present knowledge of placer deposits and applying it to other areas we may be able to discover new sources of placer gold in settings where the potential has not yet been fully realized.

Previous Work

Previous Yukon researchers in placer and glacial geology include R.G. McConnell (1905, 1907), H.S. Bostock (1948, 1966), O.L. Hughes (1969, 1987; Hughes et al. 1969, 1972, 1989), A. Duk-Rodkin (Duk-Rodkin et al., 1995), L. Jackson (1993), T. Giles (1993), F.J. Hein (Morison and Hein, 1987), S.R. Morison (1983, 1985, 1989), R.L. Hughes (1986), and E. Fuller (1994, 1995). R.G. McConnell first described the gold-rich White Channel Gravels in the Klondike area, while H.S. Bostock originally defined multiple glacial episodes in central Yukon. O.L. Hughes described detailed glacial limits which expanded upon Bostock's research. Several surficial geology mappers have maintained an interest in placer geology including Dr. A. Duk-Rodkin and Dr. L. Jackson of the Terrain Sciences Division of the Geological Survey of Canada. These researchers have improved our understanding of glacial limits and processes in the Yukon over the last several years. In addition, several graduate theses have been completed documenting Yukon placer deposits, including those of S.R. Morison, R.L. Hughes and W.P. LeBarge, all of which were supervised by Dr. F.J. Hein (University of Calgary). Government personnel involved in the recent studies of Yukon placer deposits include S.R. Morison and W.P. LeBarge (Mineral Resources Directorate, Northern Affairs Program) and E. Fuller (Canada/Yukon Geoscience Office). This summary paper draws somewhat loosely upon the work of these scientists and apologies are given for the lack of exact specific references to their excellent work.

Glacial History of Yukon

It is important to understand something about the glacial history of a prospective placer area, as glaciations generally disperse, rework and bury placer deposits. Several glacial advances have been described in Yukon, and these are generally divided into three episodes, commonly known as the pre-Reid, Reid and McConnell, in order of oldest to most recent (Figure 1). Many Quaternary researchers have used soil characteristics to differentiate between these glacial deposits of different ages (Foscolos et al., 1977; Smith et al., 1986; Tarnocai, 1987)

The pre-Reid glaciations are believed to be the oldest and most extensive Cordilleran ice advance (Bostock, 1966; Hughes, 1987), reaching into the Yukon as far as the Dawson area, and in fact within the Tintina Trench the ice probably extended past Dawson City (Duk-Rodkin and Froese, 1995). Some glaciofluvial outwash gravels (locally known as the 'Klondike Wash' or 'Klondike Gravels') from the pre-Reid ice sheet overlie the White Channel Gravels along Hunker and Bonanza Creeks in the Klondike (Naldrett, 1981; Hughes et al., 1972).

Recent research (Duk-Rodkin et al., 1995) has indicated the possibility of four or more separate glaciations occurring prior to the Reid glaciation, although because of limited pr_Cervation and exposure and the difficulty in correlation these old glacial advances are often collectively referred to by researchers as the pre-Reid.

Glacial features of the pre-Reid advances are very subdued and deposits are difficult to recognize on airphotos, often having been reworked by subsequent glacial and fluvial processes and covered by colluvium (slope deposits).

The Reid glaciation was less extensive than the earlier pre-Reid glaciations and more extensive than the later McConnell glaciation. Recent age dating of

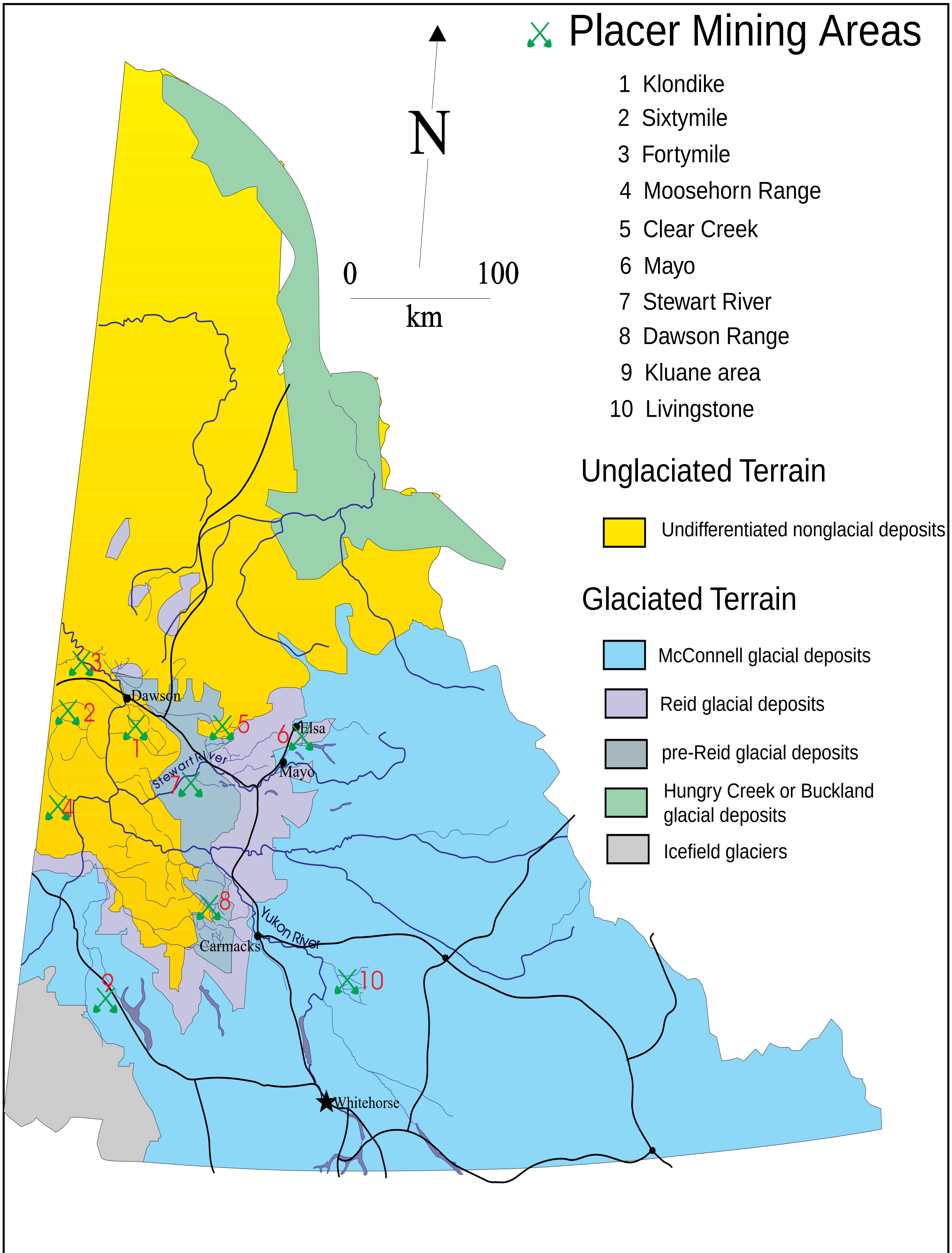

Figure 1: Glacial Limits and Placer Mining Areas (modified after Hughes, 1987)

Sheep Creek tephra, a volcanic ash which overlies Reid glacial drift in the Ash Bend site, Stewart River, are in the range of 200 Ka (Berger, 1994; Ward, 1993). Thus the Reid ice began retreating from its maximum extent prior to that time. Deposits of the Reid glaciation outside of the McConnell glacial limits are relatively unchanged and are fairly easily recognized on airphotos.

The McConnell glaciation was the least extensive of all Cordilleran glaciations, as well as the most recent. The onset of McConnell glaciation has been recently dated as less than 29 Ka. and dates for the retreat of McConnell ice are in the range of 10.3 Ka. (Hughes et al., 1989). Deposits of McConnell glacial drift are easily recognizable on airphotos and on the ground, having been only minimally reworked by fluvial and colluvial processes.

Placer Gold Production

Most historic mining areas in the Yukon, such as the Klondike and Sixtymile districts, lie beyond the limit of Pleistocene Cordilleran glaciations. Although the majority of past and current production of placer gold has been derived from these unglaciated areas, reserves in these areas are slowly being depleted. Gold production in recent years has been variable, declining from a modern day production record of 169,345 crude ounces in 1989 to a recent low of 101,061 ounces in 1992. Production has rebounded by approximately 8% per year since, reaching 127,143 crude ounces in 1995 (van Kalsbeek, 1996). Annual direct employment in the placer mining industry totals 700 to 800 people in an average of 200 operations, most of which are small family-owned and operated mines.

Placer Mining Areas in Yukon

Placer mining areas in Yukon are generally divided into two categories: deposits in unglaciated areas and deposits in glaciated areas. There are ten areas with current mining activity: Klondike; Sixtymile, Fortymile; Clear Creek; Moosehorn Range; Stewart River and its tributaries; Whitehorse South; Mayo; Dawson Range; and Livingstone Creek area.

Placer Deposits in Unglaciated Areas

Klondike/Sixtymile/Fortymile

Placer deposits in these areas share a number of characteristics including glacial history, type of lode gold source, overall weathering history and the main geomorphic setting of the placers. Placer deposits in these unglaciated areas occur in valley-bottoms, alluvial fans, in gulch gravels and as intermediate level terraces - e.g. Klondike Valley gravel terraces (Froese and Hein, this volume) to high level gravel terraces - e.g. White Channel Gravels (Morison, 1985; Morison and Hein, 1987). There are several local point sources of gold, mainly quartz veins in Paleozoic metamorphic rocks (Klondike Schist and Nasina series) although for some areas the lode source of many of the placer gold deposits remains problematic (Knight et al., 1994). Since these areas are unglaciated, alluvial sediments have undergone an extensive period of weathering and fluvial reworking, essentially since the Tertiary period. This has allowed a continuing cycle of uplift and erosion to concentrate and reconcentrate placers in rich pay streaks in valley bottoms, valley side alluvial fans and bedrock terraces (Figure 2).

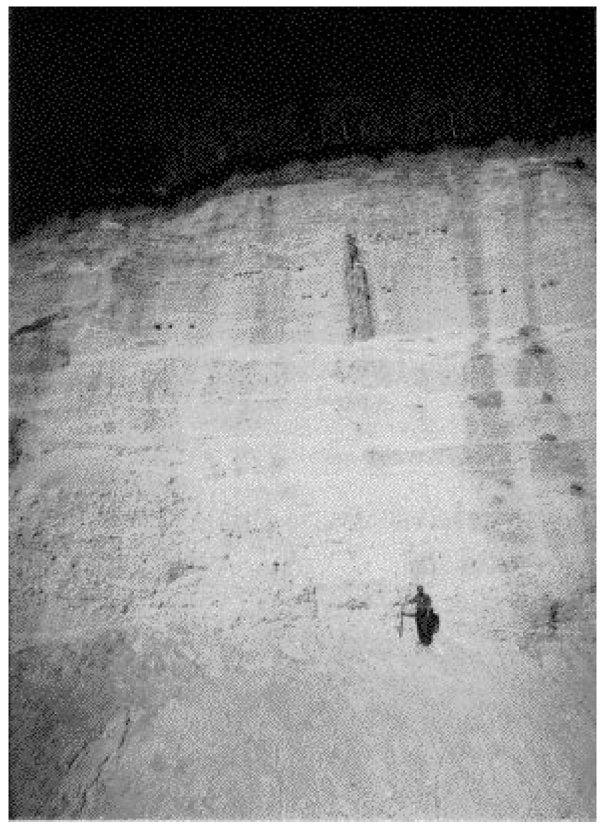

Figure 2: The late Tertiary age White Channel Gravels in the Klondike area are terrace deposits which represent an ancient non-glacial fluvial system. Placer gold in these rich gravels was reworked to form the world-class placer deposits which were found along the valleys of Bonanza, Eldorado and Hunker Creeks.

Moosehorn Range

The placer gold deposits of the Moosehorn Range have undergone a similar weathering history as the placer deposits of the Klondike and Sixtymile areas. The lode gold source has been identified as the high-grade gold-quartz veins which cut the granodiorite batholith on the ridge above the creeks. The placer deposits consist of gulch gravels in the higher reaches and alluvial fans in the lower reaches. The gulch gravels have discrete pay streaks while the alluvial fans have more scattered and irregular pay streaks, except at their apex where a more continuous placer accumulation can be expected.

Stewart River

The Stewart River crosses an area from the McConnell glacial limit, to the Reid glacial limit, to the pre-Reid glacial limit, into unglaciated terrain. Throughout these reaches placer gold occurs on active point and channel bars along the current course of the river, and along abandoned channels and oxbows in areas where the stream course has shifted. This placer gold has mainly been transported during flood events from a number of dispersed sources of gold, from tributaries such as Clear Creek and McQuesten River and from glaciofluvial sediments on bedrock terraces adjacent to the Stewart River. Tributaries of the Stewart river in the unglaciated areas contain placer gold deposits along valley-bottoms, in narrow gulches, within alluvial fans and on intermediate level bedrock terraces (Fuller, 1994; 1995).

Placer Deposits in Glaciated Areas

Clear Creek

The Clear Creek area lies within the pre-Reid glacial limit, just outside the limit of the major Reid valley glaciation but including areas which may have been subject to alpine glaciers during the Reid episode. Surficial deposits include Tertiary (Pliocene?) gravels similar to the White Channel deposits, pre-Reid glacial drift which has covered the Tertiary gravels, Reid alpine drift, Quaternary valley-bottom and buried placers, and colluvial deposits (Morison, 1983). The lode source of gold is probably related to the numerous intrusions in the area and associated gold-quartz veins.

Mayo Area

The placer gold deposits in the Mayo area lie at the margins of both the Reid and the McConnell glaciations, which depending on topography and elevation may be only be a few kilometres apart.

The Dublin Gulch/Haggart Creek area lies within the Reid glacial limits. Placer deposits consist of valley bottom, gulch and colluvial sediments which have formed since the Reid glaciation, since the McConnell ice did not reach into this area.

Mayo Lake tributaries, including Duncan Creek and the surrounding areas lie on the edge of the McConnell glaciation but entirely within the Reid glacial limits. Most of the Mayo Lake placer deposits lie at the apex of fan-deltas which have built into the lake since the McConnell episode (Figure 3).

Figure 3: Economic placer gold deposits in the Mayo area have been mined at the apex of fan-deltas which have built into Mayo Lake. Most of these fans such as this one on Anderson Creek have formed since the end of the last glaciation.

Some of the placer deposits in the Duncan Creek area consist of gold-bearing glaciofluvial gravels and glacial till of probable Reid age. These formed by scouring and reconcentrating gold from a number of sources including pre-existing placers and bedrock. Valley-bottom, alluvial fan and gulch placers also incorporate reworked gold from pre-existing non-glacial gravels, glacial till and glaciofluvial gravels.

The bedrock source of gold in the area is likely related to intrusions and quartz veins which cut the local Paleozoic schist and quartzite.

Kluane area

Kluane area placer deposits generally occur in two settings which are geographically divided by Kluane Lake. The Kluane area has been glaciated several times, with each successive glaciation being less extensive than the previous one. The east side of Kluane Lake (e.g. Gladstone Creek) was last covered by glacial ice during the second most recent glaciation (Reid equivalent), when valley glaciers originating in the St. Elias Range formed piedmont lobes which extended across Kluane Lake (Mueller, 1967; Hughes et al., 1972).

Placer deposits in the Gladstone Creek area consist of auriferous glaciofluvial and recent stream gravels which have reconcentrated gold above bedrock on top of glacial till and glacial lake sediments. Part of this reconcentration may be the result of meltwater action at the end of the last local glaciation, and part may be due to fluvial reworking and reconcentration since that time. The placer gold is likely derived from a number of sources in bedrock and pre-glacial or interglacial gravels.

Burwash Creek and nearby creeks were affected by the most recent ice advance which was confined to the west side of Kluane Lake. Prior to the latest glacial episode the Slims river actually drained in the opposite direction (southward) into the Kaskawush River (Bostock, 1969). Glacial diversions of streams by ice-damming and the subsequent release of meltwaters resulted in a large amount of fluvial downcutting (in many cases to bedrock) and caused reworking of sediments when streams were forced to adjust to new base levels and cut new channels. Recent fluvial activity, most active during flood stages, continues to concentrate placer gold in gravel bars along and adjacent to the present stream channel.

Mt. Freegold/Mt. Nansen

Placer deposits of the Dawson Range lie within the pre-Reid glacial limits. Gold has been found in pre-Reid glacial till and glaciofluvial gravels, as well as in non-glacial gravels which were deposited after and on top of pre-Reid glacial and glaciofluvial deposits. Gold was preserved in the glacial material because the pre-Reid glaciation that affected the area was of an alpine nature, which resulted in only limited dispersion of pre-existing fluvial placers. These gold-bearing sediments were then incorporated into the glacial till (LeBarge, 1993; 1995). This type of process has also been documented in the Cariboo placer district in British Columbia (Eyles and Kocsis, 1989). Normal fluvial processes have subsequently concentrated gold above bedrock on top of the glacial till which acted as a “false bedrock” which was resistant to downcutting. The gold is likely derived from lode sources within the numerous felsic intrusions and related vein systems in the area (Carlson, 1987; Jackson, 1993).

Livingstone/South Big Salmon Area

Placer deposits in the Livingstone placer camp lie well within the McConnell glacial limit, the most recent glacial advance. Auriferous interglacial gravels formed between the Reid and the McConnell glaciations occupy east-west trending valleys which are transverse to the direction of ice movement. These placers were buried by several metres of glacial drift (Figure 4), which protected them from the erosive action of the ice which later scoured the ridges as the ice sheet moved northwestward (Levson, 1992). The gravels were later re-exposed by a large amount of fluvial downcutting at the end of the glaciation and during a period of post-glacial fluvial reworking. The source of gold in the Livingstone area is most likely tellurides and free gold in small quartz veins which cross-cut local graphite schist bedrock (Stroink and Friedrich, 1992).

Figure 4: Thick McConnell glacial drift has covered interglacial gold-bearing gravels in the Livingstone Creek area. This deposit on Little Violet Creek was partially reworked and diluted by glaciofluvial gravels prior to the infilling of the valley which protected it from erosion by advancing glacial ice.

Whitehorse South (Moosebrook, Pennycook) and Quiet Lake (Sidney/Iron Creek) Areas

The placer gold-bearing gravels of Quiet Lake and Whitehorse South areas (Moosebrook, Pennycook, Sidney, and Iron creeks) lie completely within the McConnell glacial limits, and are generally poorly understood as little scientific work has been done in the area. They may be similar in genesis to the placer

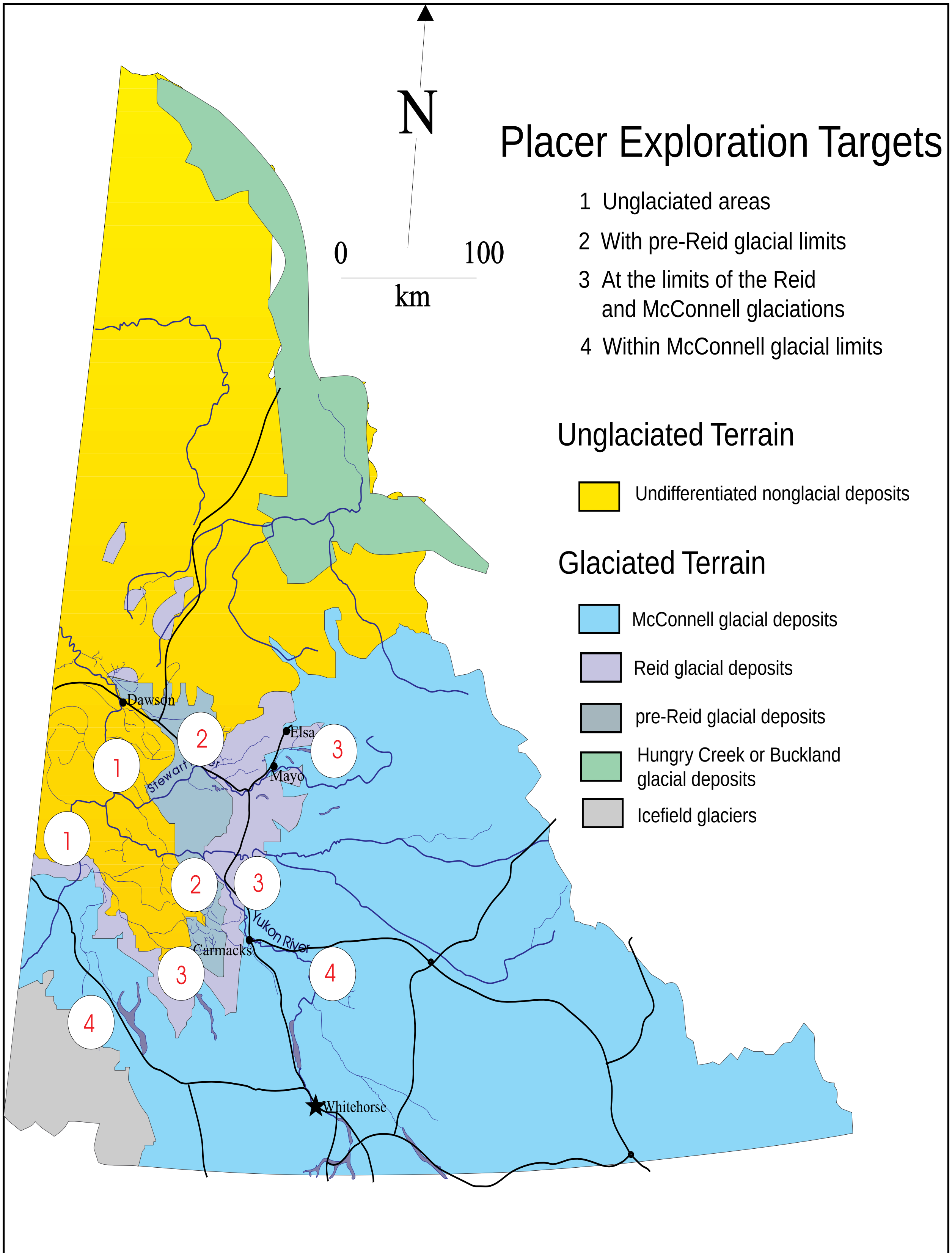

Figure 5: Glacial Limits and Placer Exploration Targets (modified after Hughes, 1987)

deposits on Livingstone Creek, where auriferous interglacial gravels formed during the long period of fluvial action between the Reid and the McConnell glaciations. Limited airphoto interpretation shows that the placers were not very well protected from the McConnell ice sheet, as glacial deposits fill the major valleys and tributaries. Sidney Creek was temporarily diverted to the west by glacial ice which blocked its confluence with Iron Creek. The placer deposits must therefore have formed from the reconcentration of gold from dispersed sources in the glacial material and the bedrock. This would have been accomplished by the action of glaciofluvial meltwaters at the end of the last glaciation, and subsequent fluvial action.

Placer Exploration Tools

Several points are evident from the preceding summary of the Yukon placer deposits. Primarily, it is obvious that it is necessary to study the glacial history of an area in order to understand how the placer deposit formed. Secondly, it is possible to explore for new placer deposits by describing the types of sediments which are gold-bearing and applying this knowledge to new areas.

Airphoto interpretation and the study of surficial maps, are important placer exploration tools which can indicate the presence of glacial deposits in the area, if there are high level terraces and buried channels or sometimes even if drainage diversions have occurred.

Finally, it is important to sample potential gold-bearing gravel in the prospective new placer area. This can be accomplished by auger or percussion drilling, test pits, and bulk sampling. Small, portable sluice boxes and hand-panning of concentrates can then be used to determine the gold content of the gravel.

Placer Exploration Targets

Unglaciated areas

Figure 5 shows several prospective areas for placer exploration. In unglaciated areas, new placer deposits will be found in hitherto inaccessible areas. Targets in these areas include abandoned channels, oxbows and point bars of major drainages, high level terraces of these major drainages, and gulch and valley bottom placers along tributaries of these major rivers. Prospective areas include the reaches of Stewart, North Ladue and Yukon rivers and their tributaries which lie outside of the pre-Reid glacial limits (Figure 6).

Figure 6: Much of the unglaciated western part of Yukon has had limited exploration due to poor access. Placer gold in known to occur in tributaries to the North Ladue River and further exploration in this area is warranted.

Within the pre-Reid glacial limits

Along the margins of, and just within, the pre-Reid glacial limits, new placer deposits may be discovered in valleys buried beneath terraces of pre-Reid glacial drift. Clear Creek is one example of an area where pre-Reid drift has buried and reworked pre-glacial fluvial placer deposits. Economic placers may also have formed on top of pre-Reid glacial and glaciofluvial deposits, or may be buried in valleys beneath Reid age non-glacial alluvium, such as in the Mt. Nansen area in the Dawson Range. Prospective new areas are drainages known near hardrock gold deposits in the Clear Creek area, (Vancouver, Thoroughfare creeks, McQuesten River and its tributaries) and in creeks which drain areas of felsic intrusive and volcanic rocks in the Dawson Range (e.g., Lonely Creek, Schist Creek).

At the limits of Reid and McConnell glaciations

At the limit of both the Reid and McConnell glaciations, depositional processes tend to be dominant. In this case, auriferous pre-glacial gravel is often buried by glacial and glaciofluvial deposits rather than scoured and dispersed. Low grade auriferous glaciofluvial gravel can also be derived from the reworking of pre-glacial gold-bearing gravel. Prospective areas for placer deposits are the McQuesten and South McQuesten River valleys and their related tributaries and creeks east of Kluane Lake. Economic to sub-economic placers may also be found along meltwater channels at the McConnell ice limit, for example Florence Creek in the Carmacks area.

Within McConnell glacial limits

Inside the McConnell glacial limits, special circumstances were required to form and preserve significant placer deposits. These deposits can be found in protected valleys which are oriented oblique to the direction of flow of the glacial ice. In these valleys the advancing ice sheet is less able to scour and remove the previously-formed (interglacial) placer deposits and the valleys are instead filled with glaciofluvial and glacial sediment. Prospective areas of this type of deposit are the drainages similar to Livingstone placer camp which lie to the north, such as D'Abbadie Creek and Teraktu Creek. Placers in this setting can also be found in valleys where meltwaters and fluvial action have reconcentrated gold from a number of dispersed sources into mineable deposits. One prospective area for this type of deposit is on the eastern flank of the Big Salmon Range, such as Sidney and Iron Creek.

Conclusions

It is evident that historic exploration for Yukon placer deposits has focused on unglaciated areas and easily-accessible drainages. In order for the placer mining industry to continue at present levels, new areas must be found. Potential placer deposits in less-accessible areas must be explored, and the possibilities for new placer gold reserves at the margins of and within glaciated areas must be investigated. New placer gold reserves will undoubtedly be found within these areas. The difficulties in finding these buried, pre-glacial or interglacial channels and prospective new placer gold deposits can be at least partially overcome by the use of more sophisticated exploration techniques, including surficial geological mapping, airphoto interpretation, heavy mineral studies and bulk sampling of potential gold-bearing units.

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