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Authors' addresses

L.E. Jackson, Jr. *(ljackson@NRCan.gc.ca)*
K. Shimanura *(kshimanu@NRCan.gc.ca)*
Terrain Sciences Division
Geological Survey of Canada
101-605 Robson Street
Vancouver, B.C. V6B 5J3

C.A. Huscroft *(chuscroft@nrcan.gc.ca)*
Department of Earth Sciences
Simon Fraser University
Burnaby, B.C. V5A 1S6

Late Cenozoic geology, Ancient Pacific Margin Natmap Project, report 3: a re-evaluation of glacial limits in the Stewart River basin of Stewart River map area, Yukon Territory[1]

Lionel E. Jackson, Jr., Kazuharu Shimamura, and Crystal A. Huscroft
Terrain Sciences Division, Ottawa

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Abstract: Investigation of stream-gravel lithology, distribution of erratics and high terraces, and natural exposures of terrace gravels along Stewart River have generally corroborated the all-time limits of glaciation mapped by H.S. Bostock in the Stewart River basin of the Stewart River map area. Stream gravels beyond these limits completely lack lithologies associated with the Selwyn Basin. Placer deposits beyond these glacial limits formed from fluvial concentration of gold sources occurring in those basins. The upper reaches of streams spanning glacial limits may contain undisturbed placers, whereas lower reaches may contain placers formed following glaciation, and buried placers. Bostock's unpublished notes have proven to be a valuable aid in mapping the surficial geology of the area.

Résumé : L'étude de la lithologie des graviers alluvionnaires, la répartition des blocs erratiques et des hautes terrasses et les affleurements naturels de graviers de terrasse le long de la rivière Stewart corroborent en général les limites de glaciation de tous les temps cartographiées par H.S. Bostock dans le bassin de la rivière Stewart dans la région cartographique de la rivière Stewart. Les graviers alluvionnaires rencontrés au-delà de ces limites ne comportent aucune unité lithologique associée au bassin de Selwyn. Les placers présents au-delà de ces limites se sont formés suite à la concentration fluviatile de l'or provenant de sources présentes dans ces bassins. Les tronçons amont des cours d'eau se trouvant à l'intérieur de la limite maximale d'avancée glaciaire pourraient contenir des placers non remaniés alors que les tronçons aval pourraient contenir des placers formés après la glaciation et des placers enfouis. Les notes inédites de Bostock se sont avérées être une aide précieuse pour cartographier la géologie de surface de la région.

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[1] Contribution to the Ancient Pacific Margin NATMAP Project

INTRODUCTION

Regional surficial geology mapping and investigation of the late Cenozoic stratigraphy of Stewart River map area (115-O and N) and the immediately adjacent areas of Stevenson Ridge map area (115 J and K) continued during the 2000 field season. One of the goals of the 2000 field season was to resolve the all-time limit of former glacial cover in the portion of the Stewart River basin contained in Stewart River map area centered on 1:50 000 NTS map areas 115-O/6 to115-O/11 (Fig. 1 and 2).

Placer gold has been mined from Stewart River tributaries such as Barker, Black Hills, Maisy May, and Scroggie creeks for up to 100 years (Cairnes, 1916). Investigation of the distribution of glacial erratics and the composition of placer gravels in the Barker Creek area during the 1999 field season indicated that this area was never invaded by the Cordilleran Ice Sheet (Jackson and Huscroft, 2000). This conclusion contradicts glacial limits mapped in this area by Duk-Rodkin (1999; and glacial limits *in* Gordey and Makepeace (1999)), but corroborates those established by Bostock (1966). Figures 2a and b are plots of these conflicting glacial limits.

Glaciation has the capability of either destroying placer deposits through erosion, or preserving them through burial. An understanding of the geomorphic history of the Stewart River map area, including glaciation, is essential to understanding the origin and evolution of gold placers and exploration for new placer resources. This paper describes field investigations of glacial limits in the portion of the Stewart River basin contained in the Stewart River map area.

REGIONAL SETTING

The portion of the Stewart River basin within the Stewart River map area is underlain by high-grade metamorphic rocks, intrusions or structurally emplaced bodies of ultramafic rock, and erosional remnants of regionally erupted mafic lava of the Carmacks Group (Bostock, 1942). Bedrock exposures are rare. Thick, residual, colluvial overburden covers hillsides and most ridge tops, and gravel, loess, and organic fills have accumulated in many valley bottoms. Permafrost is nearly continuous throughout the area. Vegetation is dominated by dense boreal forest and brush that mantles most slopes from toe to ridge-top. This thick vegetation commonly makes foot traversing difficult and helicopter landings nearly impossible over much of the area.

Cordilleran ice sheets have formed numerous times in central Yukon Territory since the late Pliocene (Froese et al., 2000). Most never reached the Stewart River map area (Bostock, 1966; Duk-Rodkin, 1999). The glacial limits discussed in this paper are associated with presumably the earliest and most extensive of the pre-Reid glaciations. The precise age of this glaciation has not been established. Current evidence places it between 2 Ma and 3 Ma (Froese et al., 2000).

METHODS

Much of this investigation was carried out as a part of the ground-truthing of airphoto interpretation as a part of surficial geological mapping of the Stewart River map area. Figure 2b shows traverses (utilizing transport by combinations of foot, boat, truck, helicopter and all terrain vehicle) carried out during the 1999 and 2000 field seasons that are relevant to establishing glacial limits.

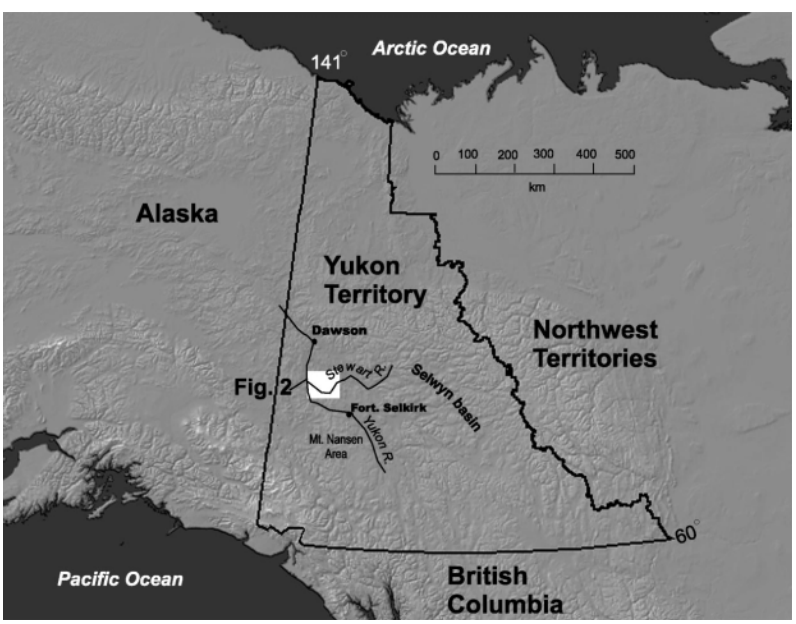

Figure 1.

Location of study area detailed in Figures 2 and 3.

Unpublished notes of Dr. H.S. Bostock

The original notes of Dr. H.S. Bostock and members of his field parties from the 1935 and 1936 field seasons were consulted in order to supplement and complement our traverses. Notebooks from these field seasons contain traverse routes plotted on the same planetable contours that appear on the1942 Ogilvie geology map (Bostock, 1942). This made location of traverse routes and observations easy and accurate (Fig. 2b). These field notes proved to be an invaluable resource with respect to surficial geology. The general lack of outcrop throughout the area forced Bostock and his colleagues to faithfully note float occurrences. Consequently, glacial erratics and the limits of drift cover were routinely recorded. Bostock had a keen interest in the origin of the gold placers in the area. He routinely noted the provenance of placer gravels and investigated stream terraces and drainage anomalies. Many of these features were sketched in notebooks.

Investigation of gravel lithology and erratics

Sedimentary rocks such as chert, chert-pebble conglomerate, and quartz arenite do not occur in the bedrock of the Stewart River basin in the Stewart River map area. Such lithologies are plentiful in the Selwyn basin of east-central Yukon Territory and have been carried westward by Cordilleran ice sheets during several glaciations spanning the Pleistocene (Jackson, 1994, Fig. 13; Jackson, 2000; Ward and Jackson, 2000). The presence of these lithologies in modern and terrace gravel (or bench gravels, a term commonly used by placer miners), or as isolated erratics, indicates past incursions of Cordilleran ice sheets or meltwater streams flowing from them.

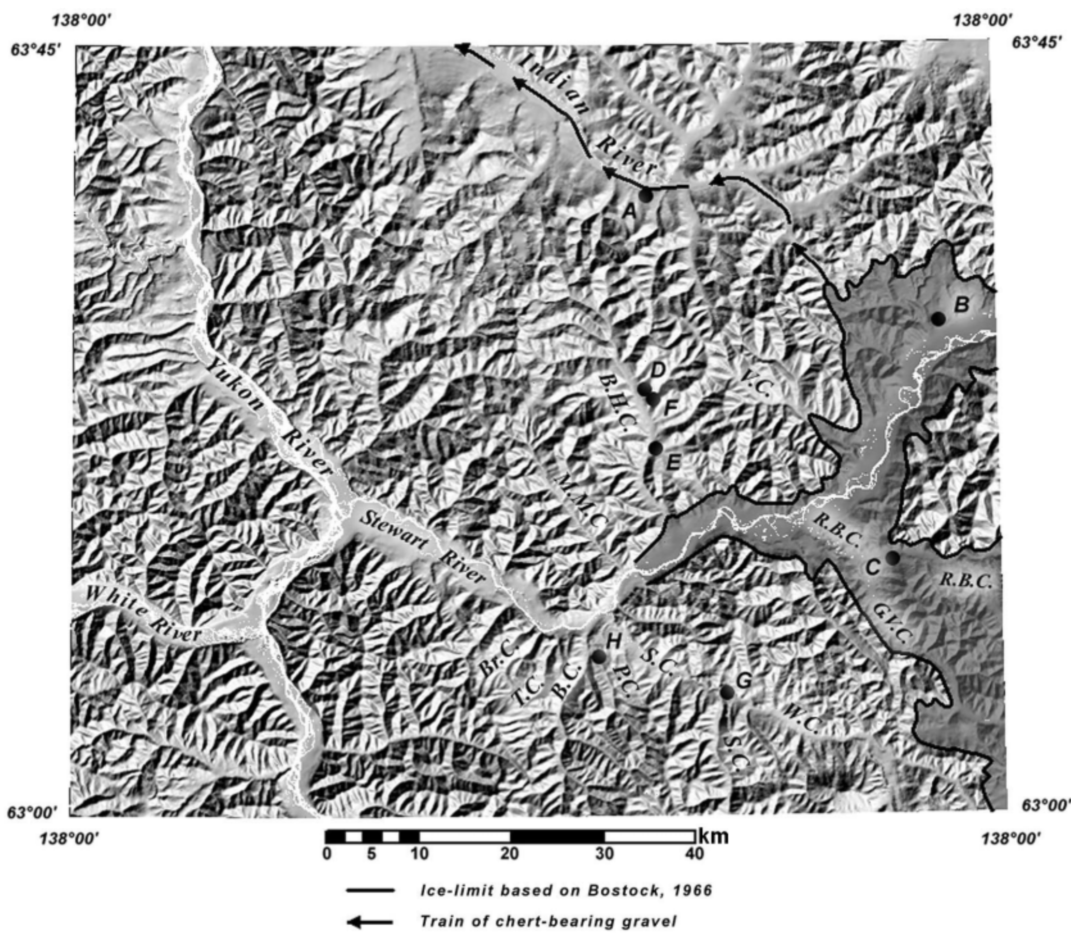

Figure 2a. *Glacial limits in and around the portion of the Stewart River basin contained in Stewart River map area (115 N and O) from Bostock (1966). Letters indicate the location of representative histograms of stream and bench gravel lithologies shown in Figure 3. Br.C.–Brewer Creek, T.C.–Telford Creek, B.C.–Barker Creek, P.C.–Preacher Creek, S.C.–Scroggie Creek, W.C.–Walhalla Creek, V.C.–Valley Creek, B.H.C.–Black Hills Creek, M.M.C.–Maisy May Creek, R.B.C.–Rosbud Creek, G.V.C.–Grand Valley Creek, CG–cliff gravel site.*

Gravel and colluvium were investigated and sampled where exposures occurred, in order to determine provenance and to look for erratic lithologies. In addition, piles of worked placer gravel within placer mines were combed in order to search for erratic lithologies. Many thousand coarse-gravel- and cobble-sized clasts were examined in this way. Samples were taken in many places from natural gravel and worked placer gravel. Samples consisted of approximately 100 pebbles between 2 and 6 cm. The lithologies of these pebbles were determined and counted. Where natural or artificial exposures were available, the stratigraphic succession of surficial deposits was logged and sampled. Study of these samples continues and enlarges the gravel-pebble lithology investigation reported on by Jackson and Huscroft (2000) for this region.

Comparison of glacial limits

Bostock's (1966) glacial limits were replotted for comparison (Fig. 2a) as follows: glacial limits were digitized and overlain on a 1:250 000 scale hill-shade relief map. The original glacial limits map had a scale of 1:506 880, the map projection was not reported, and the contour interval was about 300 m (1000 feet). Therefore, limits had to be adjusted so that

1. they fell on the correct sides of ridges when draped on the hill-shade model, and
2. they were accordant with contours and elevations where Bostock (1966, Fig. 1) indicated that meltwater crossed ridges or ice did not reach low points along ridges.

The accuracy of these limits is estimated at ± 500 m in a horizontal sense and ±100 m in the vertical sense. Duk-Rodkin's (1999) ice limits mapped at 1:250 000 were directly transferred from digital files contained in Gordey and

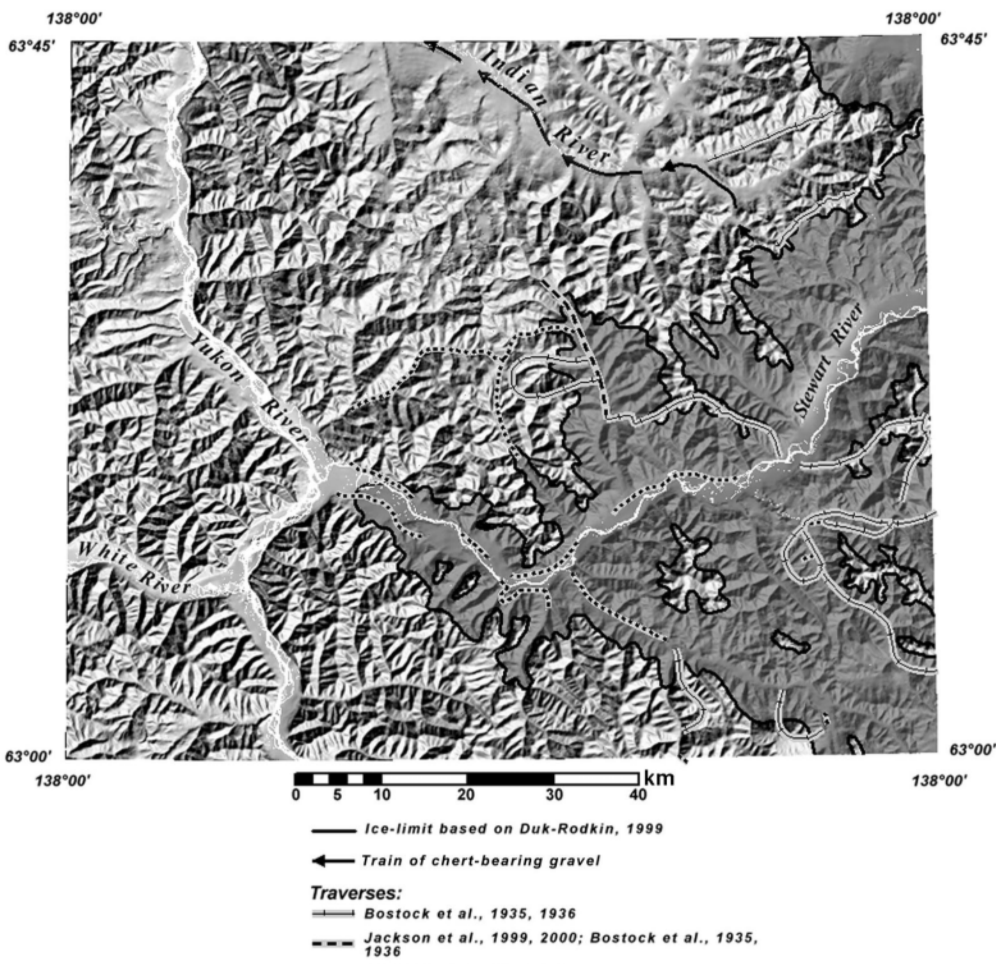

Figure 2b. *Glacial limits in and around the portion of the Stewart River basin contained in Stewart River map area (115 N and O) from Duk-Rodkin (1999). The locations of key segments of traverses completed in 1999 and 2000 as a part of the present study (Jackson et al., unpub. notes) and those of Bostock's field parties in 1935 and 1936 (unpub. notes) are shown.*

Makepeace (1999) and overlaid on the hill-shade model. These did not require adjustment. Both sets of ice limits descend to the northwest and west of the area encompassed by Figure 2. However, along the southern boundary of Figure 2, Duk-Rodkin's ice limits are estimated to be between about 100 to 200 m higher than those established by Bostock. Although the plotting of Bostock's glacial limits was crude, the significant difference between his and Duk-Rodkin's make them adequate for comparison.

RESULTS

The distribution of erratic lithologies in stream and terrace gravel, distinctive geomorphic features, and stratigraphic evidence found during the 1999 and 2000 field seasons generally corroborate Bostock's original glacial limits in the Stewart River basin.

Gravel lithology

Figure 3 shows histograms of pebble counts done on gravels from several drainage basins within and beyond Bostock's (1966) glacial limits. They corroborate the results reported by Jackson and Huscroft (2000) for the Barker Creek area. Plots A–C (sample locations shown on Fig. 2a) are from gravels lying within Bostock's glacial limits and from the extensive valley-train gravels along Indian River (plot A). The valley-train deposit which now forms terraces 30 m above Indian River (Fig. 2a and 2b). This outwash was deposited when meltwater, flowing along the margin of the most extensive (pre-Reid) Cordilleran Ice Sheet, spilled north across the divide between Stewart River drainage and Indian River drainage (Bostock, 1942, 1966, p. 8). This gravel (plot A) is dominated by chert, quartz arenite, and crystalline quartz that is typical of pre-Reid outwash in the Stewart River valley (plot B). Gravel overlying basalt along Rosebud Creek (Plot C) also shows a dominance of chert and quartz arenite.

In contrast, stream and bench gravels beyond Bostock's glacial limits do not contain chert or quartz arenite. In the course of traverses during the 1999 and 2000 field investigations, neither of these lithologies has been found beyond Bostock's glacial limits, with the exception of the Indian River valley train and terrace gravels immediately along Stewart River or sediments reworked from them. Gravel fills within valleys tributary to the Stewart River valley beyond Bostock's (1966) glacial limits, such as the valley of Barker Creek, are graded to and merged with the highest terraces along the Stewart River valley. However, the gravels within these tributary valleys are entirely derived from within their drainage basins (Jackson and Huscroft, 2000).

One area not yet traversed by our field parties is the Walhalla Creek valley. This area could not be visited due to flood conditions prevailing during the rainy summer of 2000. However, although Bostock (1966, p. 7) found no indication of glaciation in the Walhalla Creek valley, Duk-Rodkin (1999, pers. comm., 2000) reported erratics in it. Apparently, passes that Bostock (1966, Fig. 1) mapped as having escaped glaciation between upper Walhalla and Grand Valley creeks were breached by glacial ice or meltwater streams. This area will be visited during the 2001 field season.

Geomorphic features and erratics

Extensive flights of high terraces occur within Bostock's limits of glaciation and are completely lacking beyond them in the Stewart River basin. The best examples of these are found in the area of the mouth of Rosebud Creek, and can be traced up Rosebud and Grand Valley (also called 'South Rosebud') creeks where the terraces rise to approximately 300 m above the valley floor (Fig. 4). Similar terraces and extensive drift-covered surfaces occur along the north side of the Stewart River valley upstream of the mouth of Valley Creek. Gravels forming these terraces contain Selwyn basin lithologies (Bostock, 1966, p. 7). A basalt erratic from the Yukon valley to the south was found 240 m above the floor of Rosebud Creek near the upper limit of these terraces (H.S. Bostock, unpub. field notes, 1935, 1936). Consequently, they undoubtedly are glaciofluvial in origin. Bostock's unpublished notes and summer 2000 traverses indicate that erratics are absent above the level of the highest of these terraces in the area of the confluence of Rosebud and Grand Valley creeks. Consequently, ice was probably never more than about 300 m thick in the area of the confluence of Rosebud Creek and Grand Valley Creek.

Sedimentological evidence

A 12 m coarse, clastic, fining-upward sequence occurs atop a 20 m bedrock cliff along the north side of the Stewart River, several hundred metres downstream from the confluence of Rosebud Creek (CG, Fig. 2a; referred to as the cliff gravel). The lower 4 m consist of a disorganized cobbly boulder gravel and cobble gravel (Fig. 5). Boulders along the lowest 1.5 m average approximately 30 cm in mean diameter and many clasts have mean diameters of 50 cm. The largest clast seen has an intermediate diameter of 70 cm. Bouldery gravel such as these are indicative of ice-marginal sedimentation in valley trains (Boothroyd and Nummedal, 1978). All other gravel sequences that we have seen underlying terraces along the Stewart River downstream of this exposure are stratified pebble gravel or cobble-pebble gravel. These are indicative of more distal valley-train environments (Boothroyd and Nummedal, 1978; Wightman, 1986). Thus, indicators of ice-proximal glaciofluvial sedimentation are confined to Bostock's (1966) glacial limits along the Stewart River valley.

The lithological makeup of the cliff gravel is similar to that of the Indian River valley train. Chert, chert-pebble conglomerate, silicified siltstone, and cherty sandstone make up 39 per cent of the gravel and crystalline quartz makes up 26 per cent. The remainder of lithologies are all quartz rich, including metaquartzite and quartz arenite. The makeup of the cliff gravel and the Indian River valley train is consistent with mature, nonglacial stream gravels which evolved under the temperate climate that persisted through much of the Tertiary. They are similar in this respect to the lower White

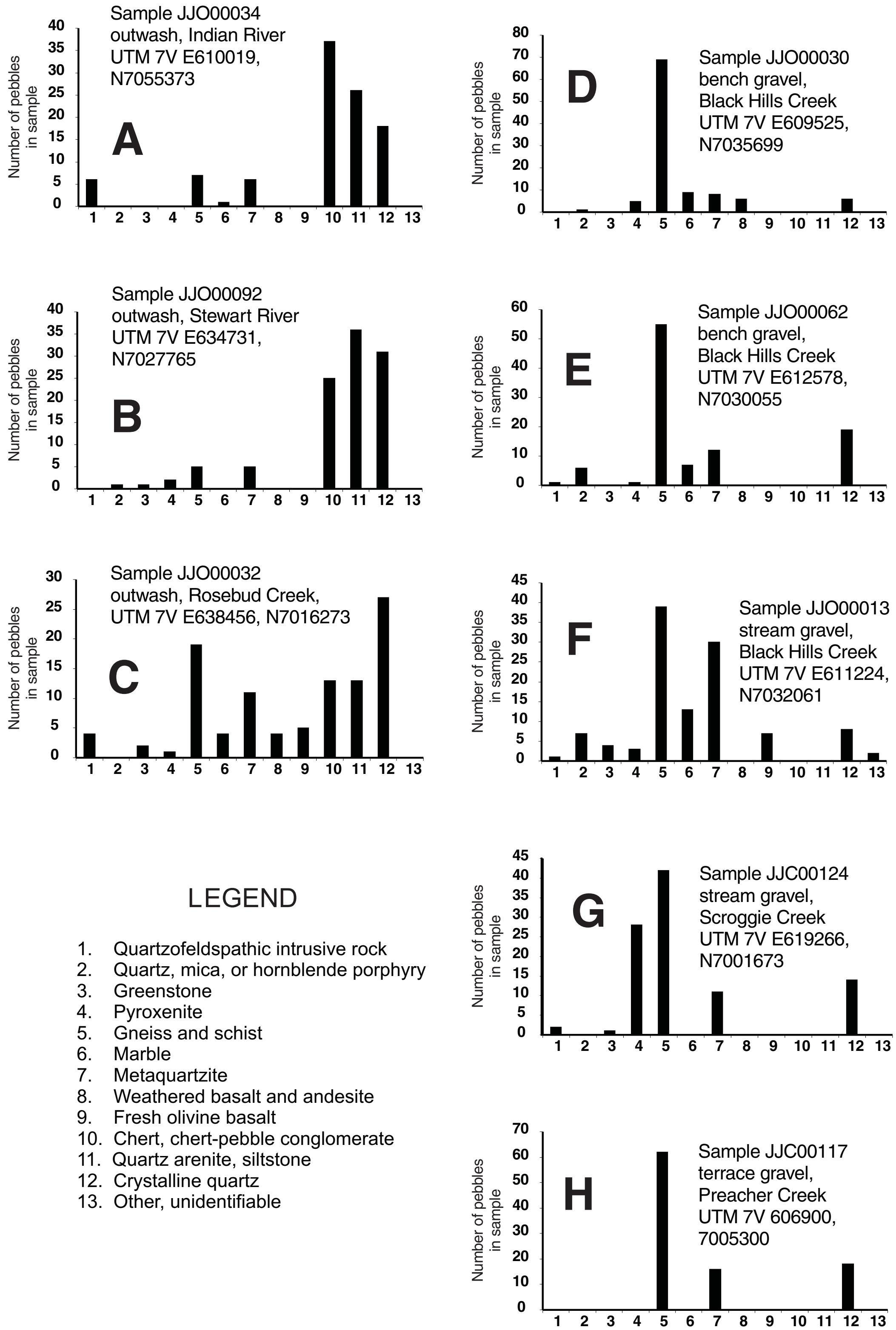

Figure 3. *Counts of pebbles sampled from gravel units within glacial limits mapped by Bostock (1966; histograms B–C) and beyond them but within limits mapped by Duk-Rodkin (1999; D–H). Histogram A was determined on a sample taken from a valley-train deposit along Indian River.*

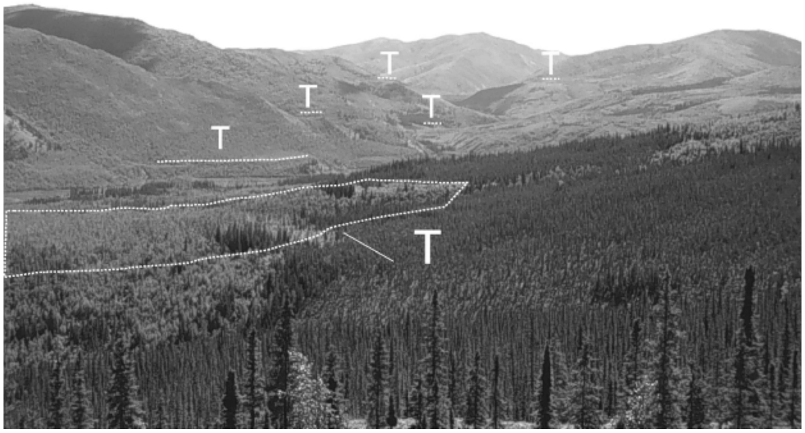

Figure 4.

View up Grand Valley (also called 'South Rosebud') Creek from UTM 7V E634986, N7010873 at approximately 790 m elevation and 335 m above the floor of Grand Valley Creek. Areas marked by 'T' are glaciofluvial.

Figure 5.

Subangular to subrounded, disorganized, clast-supported boulder gravel at the base of a fining-upward coarse clastic unit. This gravel occurs atop a 20 m bedrock cliff north of the confluence of Rosebud Creek and Stewart River. No similar deposits have been noted to the west (downstream) in the Stewart River valley.

Channel Gravel (Froese et al., 2000). Apparently, the Tertiary stream gravels in the Stewart River basin were reworked by the advance of the first Cordilleran (pre-Reid) ice sheet. The makeup of these gravels contrasts with that of outwash gravel deposited during subsequent pre-Reid glaciations. These younger gravels contain significant amounts of less chemically resistant feldspathic and mafic rocks such as granitic intrusive rocks and greenstone, (Jackson, 2000, p. 22).

IMPLICATIONS FOR THE UNDERSTANDING AND EXPLORATION OF GOLD PLACERS IN THE STEWART RIVER MAP AREA

Gold placers in valleys tributary to the Stewart River valley beyond Bostock's (1966) glacial limits formed through erosion of local gold sources during the Tertiary without complications caused by incursion of glacial ice. Placers occurring in valleys joining the Stewart River valley within glacial limits have much more complicated histories. Upper reaches may contain undisturbed placers, whereas lower reaches may contain a combination of placers which formed following glaciation, or may contain buried placers. At least two million years of erosion have eliminated geomorphic features which could be used to accurately reconstruct glacial limits. Consequently, lines separating glaciated from unglaciated reaches of streams cannot be accurately drawn. However, this complication in the history of placers along these streams should be should be kept in mind when they are exploited.

Streams within glacial limits should not be written off for placer exploration. Because the last incursion of ice may have been more than two million years ago, there has been time for the formation of economically viable placers. This has been demonstrated in areas affected by pre-Reid glaciation elsewhere in Yukon Territory, such as the Mt. Nansen area (Fig. 1; LeBarge, 1995; Jackson, 2000).

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REFERENCES

Boothroyd, J.C. and Nummedal, D.
1978: Proglacial braided outwash: a model for humid alluvial fan deposits; *in* Fluvial Sedimentology, (ed.) Miall, A.D.; Canadian Society of Petroleum Geologists, Memoir 5, p. 641–668.

Bostock, H.S.
1942: Ogilvie, Yukon Territory; Geological Survey of Canada, Map 711A, scale 1:253 440.
1966: Notes on glaciation in central Yukon Territory; Geological Survey of Canada, Paper 65-56, 18 p.

Cairnes, D.D.
1916: Scroggie, Barker, Thistle and Kirkman creeks, Yukon Territory; Geological Survey of Canada, Summary Report for 1915, p. 2, 10–49.

Duk-Rodkin, A.
1999: Glacial limits of Yukon; Geological Survey of Canada, Open File 3694, scale 1:1 000 000.

Froese, D.G., Barendregt, R.W., Enkin, R.J., and Baker, J.
2000: Paleomagnetic evidence for multiple late Pliocene–early Pleistocene glaciations in the Klondike area, Yukon Territory; Canadian Journal of Earth Sciences, v. 37, p. 863–877.

Gordey, S.P. and Makepeace, A.J. (comp.)
1999: Yukon digital geology; Geological Survey of Canada, Open File D3826, 1 CD-ROM.

Jackson, L.E., Jr.
1994: Terrain inventory and Quaternary history of the Pelly River area, Yukon Territory; Geological Survey of Canada, Memoir 437, 47 p.
2000: Quaternary geology of the Carmacks map area, Yukon Territory; Geological Survey of Canada, Bulletin 539, 74 p.

Jackson, L.E., Jr. and Huscroft, C.A.
2000: Late Cenozoic geology, Ancient Continental Margins NATMAP 2: survey of placer gravel lithology and exploration of glacial limits along Yukon and Stewart rivers, Yukon, Territory; *in* Geological Survey of Canada, Current Research 2000, 7 p. (CD-ROM).

LeBarge, W.P.
1995: Sedimentology of placer gravels near Mt. Nansen, central Yukon Territory; Exploration and Geological Services Division, Indian and Northern Affairs Canada, Yukon Region, Bulletin 4, 155 p.

Ward, B.C. and Jackson, L.E. Jr.
2000: Quaternary geology of the Glenlyon map area, Yukon Territory; Geological Survey of Canada Bulletin 559.

Wightman, C.A.
1986: Variability of clast size and roundness in contemporary meltwater rivers at Okstindan, north Norway; *in* Clast Lithological Analysis, (ed.) D.R. Bridgland, Quaternary Research Association; Cambridge, p. 179-192.

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