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GOLD IN THE HEAVY MINERAL CONCENTRATES OF STREAM SEDIMENTS, KENO HILL AREA, YUKON TERRITORY

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There's gold, and it's haunting and haunting;
It's luring me on as of old;
Yet it isn't the gold that I'm wanting
So much as just finding the gold.

Robert Service
The Spell of the Yukon.

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ABSTRACT

The gold contents in the heavy mineral concentrates of stream sediments in the Keno Hill area reflect the presence of four northeast-trending vein systems, two being known and two being suspected from the data presented. These vein systems comprise an early gold-bearing pyrite-arsenopyrite assemblage and late pyrite-galena-sphalerite-freibergite lodes. In some systems the former predominate; in others the latter are well developed.

All of the known gold placers of the area are indicated by high gold contents in the sediments. Some streams, not known to contain placers, have relatively high gold values; these should receive further investigation.

RÉSUMÉ

Les teneurs en or présentées par les concentrés de minéraux lourds des alluvions de la région de Keno Hill reflètent la présence de quatre systèmes filoniens à direction nord-est, dont deux sont connus, les deux autres sont présumés d'après les données. Ces systèmes filoniens comprennent un ancien assemblage de pyrite-arsénopyrite aurifère et de nouveaux filons de pyrite-galène-sphalérite-freibergite. Le premier prédomine dans certains systèmes; dans d'autres, les derniers sont bien formés.

Tous les placers connus de la région sont indiqués par les fortes teneurs en or des alluvions. Certains cours d'eau connus pour ne contenir aucun placer, ont des valeurs aurifères relativement élevées; ils méritent un examen plus approfondi.

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INTRODUCTION

During the summer of 1964 the Geological Survey of Canada carried out their first helicopter-supported, integrated, reconnaissance stream and spring sediment, water, heavy mineral, and rock geochemical survey over some 1, 900 square miles centred on Keno Hill, Yukon. The results of the water and stream sediment analyses have been published by Gleeson (1964, 1966-67), and the heavy mineral analyses for a number of elements, including gold have been placed on open file in the Geological Survey of Canada (Open file report 46).

The present paper discusses the distribution of gold in the heavy mineral concentrates from the streams and creeks of the area.

FIELD PROCEDURES

Generally one sample of heavy mineral concentrate per site was obtained by panning active sediments and gravels from the stream and creek beds of the area. The panned concentrates, weighing between one and two pounds, were shipped to the Geological Survey Laboratories in Ottawa where they were separated into a light and heavy fraction using methylene iodide of specific gravity 3. 3.

LABORATORY PROCEDURE

The heavy fraction of the samples was dried and split, and half of it was analyzed for gold in the laboratories of Bondar-Clegg and Company, Limited, Vancouver. Their analytical procedure was as follows:

1. The sample was weighed and a bead obtained by a fire assay method. Silver inquarts were used to facilitate collection of gold in the bead.
2. The bead was dissolved in nitric acid followed by aqua regia.
3. A small volume of water was added, the solution was warmed to coagulate $AgCl$ and then cooled to allow the silver chloride to settle.
4. The supernatant solution was then analyzed by atomic absorption spectroscopy.

The procedure calls for 10 grams of sample which results in a detection limit of 10 ppb (parts per billion). The detection limit is inversely proportional to the sample weight used.

Because the size of the sample used varied considerably due to the vagaries of the distribution of heavy minerals in the streams, the detection limit has, likewise, varied. Some samples were relatively small, and the detection limits are hence correspondingly high, often 1, 000 ppb or more.

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This is, however, not particularly troublesome with a heavy mineral such as gold since the merest speck of gold is retained in the heavies of the pan regardless of how much dross is included. In this respect the values recorded on the map are actually only qualitative at best. However, they do indicate the presence of gold, regardless of its mode of occurrence (i.e. native or in sulphides, etc.) since the assay bead method collects all of the gold present in the sample. In passing, it should perhaps be emphasized that future work of this type can be made more quantitative by taking a standard weight of heavy minerals and referring the result back to the amount of gravel from which the sample was obtained. The method we have used is simply that employed by the old prospectors who counted colours. We have used analytical procedures in the place of colours, a feature that gives a much higher sensitivity.

OCCURRENCES OF GOLD IN THE KENO HILL AREA

Research by the senior author over several years shows that gold in the Keno Hill area occurs in the following forms:

1. In the various rocks, mainly in syngenetic pyrite and other sulphides. Pyrite, separated from graphitic schists and other sedimentary rocks of similar nature, contains from 1 to 2 ppm Au; the silver content ranges from <5 to 50 ppm.
2. In certain sulphide-bearing (mainly pyrrhotite) skarn zones and layers near granitic intrusives. Such bodies may contain up to 0.1 oz. gold/ton (3 ppm).
3. In boudins, blows, and veinlets of quartz throughout the sedimentary sequence of rocks. These quartz bodies are thought to be of secretion origin, formed during the general regional metamorphism of the area. The gold in these quartz bodies occurs in the native form and in an unknown manner in pyrite. Assays of these quartz bodies may be as high as 0.1 oz. Au/ton (3 ppm), but most are much lower.
4. In quartz-wolframite-scheelite stringers in and near intrusive bodies of granodiorite, etc., as in the Dublin Gulch area. Such occurrences carry only traces of gold in the range 0.001 to 0.005 oz. Au/ton (0.03-0.17 ppm).
5. In early quartz veins containing pyrite, arsenopyrite, jamesonite, and a variety of other sulphosalts. These veins have been extensively studied in the Dublin Gulch and Keno Hill area (Boyle, 1965). The near surface parts of these veins are deeply weathered in places to pulverulent masses composed mainly of limonite, scorodite, and beudantite. Assays of the primary vein materials average about 0.2 oz. Au/ton (7 ppm). Most veins are low in silver, averaging about 3 ounces per ton. Assays of the oxidized material are highly variable in gold content, ranging from 0.015 to 0.30 oz. Au/ton (0.5-10 ppm). Flakes and wires of native gold can generally be panned from the oxidized outcrops, but some of the gold is chemically bound in the scorodite and beudantite.
6. In late siderite-galena-sphalerite-chalcopyrite-pyrite lodes that cut and cement the veins described in (5) above. The gold content is

low in these lodes, averaging about 0.02 oz. Au/ton (0.6 ppm); the silver values of some lodes, average more than 50 ounces per ton. Most of the gold in these lodes is present in freibergite (10 ppm) with minor amounts in pyrite (1-6 ppm), sphalerite (0.3-0.5 ppm), and galena (0.2-1.5 ppm). Native gold is not seen in these lodes. The near surface oxidized parts of the lodes range in gold content from 0.015 to 0.03 oz. Au/ton (0.5-1 ppm). Most of this gold appears to be in the lattices of beudantite, bindheimite and jarosite and as finely divided native gold dust.

7. In eluvial and alluvial placers:

So far as is known the eluvial placers are not of economic importance. Those studied occur in the Dublin Gulch area on the flanks or at the heads of some of the pups (creeks subsidiary to the main streams). In these the native gold occurs in the weathered debris, derived mainly from granodiorite and schists, as small nuggets, wires, crystals, and dust. Associated minerals are abundant scheelite and less commonly wolframite together with the various other heavy minerals noted below as occurring in the stream placers. The gold content of these placers (or more precisely of the weathered debris) is only rarely greater than 1 ppm (0.03 oz. Au/ton).

The stream placer deposits of the area including Duncan Creek, Haggart Creek, Dublin Gulch, and a number of other creeks (<u>see</u> Fig. 1) have been adequately described in other reports, and the details need not be repeated (Keele, 1905; Bostock, <u>in</u> Little, 1959; Skinner, 1962; Green and Godwin, 1963, 1964; Boyle, 1965; Green, 1965; and Findlay, 1967, 1969).

The gold in Duncan Creek occurs in glacial sands and gravels that clog the whole of the Duncan Creek valley. In and below the canyon on the creek the gold occurred mainly on the bedrock and was present as flattened and rolled particles without quartz. Above the canyon the gold was found embedded in a blue clay just above bedrock, where it was very coarse, nuggets about the size of lima beans being common. The nuggets were worn smooth and contained no quartz.

According to Bostock, the area immediately around Dublin Gulch is beyond the limit of the last well-marked Pleistocene glaciation, but evidence of an earlier glaciation is present. The stream in Dublin Gulch and Haggart Creek have entrenched parts of their courses in deep overburden forming terraces with old modified profiles. The gold, accompanied by scheelite and wolframite, occurs near the bedrock in gravel and weathered debris in Dublin Gulch and mainly in sand and gravel in Haggart Creek. Most of the gold is present as fine dust, scales, wires, crystals, and small nuggets. Larger nuggets about the size of hickory nuts have been found, but are rare. Most of the nuggets are worn and pitted.

Heavy minerals accompanying gold in the stream placers and present in the stream sediments of the area are mainly hematite, garnet, magnetite, and pyrite. In the Dublin Gulch area there are in addition scheelite, wolframite, arsenopyrite, jamesonite, native bismuth, and cassiterite. In Duncan Creek and other creeks on Galena Hill and Keno Hill gold is frequently accompanied by arsenopyrite, pyrite, galena and anglesite.

The fineness of the gold in the various placers of the area is shown below:

Placer	Gold fineness
Dublin Gulch	830 - 929
Haggart Creek	890 - 900
Lightning Creek	833
Duncan Creek	794

RESULTS OF THE SURVEY

The gold content of some 400 heavy mineral concentrates from the stream sediments of the area is recorded on Figure 1, together with a histogram and cumulative distribution curve of the data. Both curves indicate distinctive distributions, permitting certain groupings to be used on the figure. The median value has been taken at 100 ppb and the gold contents grouped as follows: less than 100 ppb; 101-1,000 ppb; 1,001-4,000 ppb; and greater than 4,000 ppb. The following features are evident.

1. The distribution of gold in the creeks and streams of the area is widespread, particularly in the western half of the map-area where the majority of the values from 1,000 to greater than 4,000 ppb are located.
2. The distribution of gold in the creeks and streams exhibits no marked regional relation to rock types or rock units in the area. In the vicinity of Dublin Gulch the high gold values exhibit a relationship to the granitic plugs and their metamorphic aureoles. Elsewhere, there is a weak correlation of high gold values with the rocks of the Keno Hill Quartzite and the underlying Lower Schist Formation. These two relationships may, however, be entirely due to the presence of gold-bearing veins in these rocks (<u>see</u> 5 below).
3. The creeks and streams with the richest, longest, and most persistent trains of gold are generally those filled with abundant till, gravel, boulders, and weathered debris. Most of these appear to have escaped severe glaciation and are bottomed by sediments and gravels thought to be derived from pre-glacial erosion (e.g. Dublin Gulch, Lynx Creek, Haggart Creek, Duncan Creek, and Thunder Gulch).
4. The known placers of the area are marked by the highest concentrations of gold (> 4,000 ppb) a feature that would be expected. Some streams, in which placers are not known, have moderate to short trains of relatively high gold contents (500-4,000 ppb) that require further investigation (e.g. Lynx Creek, Skate Creek and their various tributaries; the stream system immediately south of Lynx Creek; and various other creeks throughout the area).
5. The dispersion trains of gold in Dublin Gulch, Haggart Creek, Lynx Creek and their various tributaries show a distinct relationship to the known northeast-trending gold-bearing pyrite-arsenopyrite-jamesonite-quartz veins that occur along the divide between Dublin Gulch and Lynx Creek and extend to the northeast and southwest. The trains in the creeks draining into the South McQuesten River, immediately south of Lynx Creek, suggest that a parallel series of gold-bearing veins may

occur along the divide between Lynx Creek and the South McQuesten River and may project northeastward into the Davidson Range where lead-zinc-silver mineralization is known on Stand-to Hill, Forbes Hill, and Mount Cameron.

6. The dispersion trains of gold in Duncan and Lightning Creeks and their southeast-flowing tributaries, Erickson Gulch, Faro Gulch, and other streams draining the north slope of Keno Hill appear to be related to the numerous gold-bearing quartz-pyrite-arsenopyrite-sulphosalt veins that strike northeast through Galena Hill and Keno Hill, particularly the latter. The gold trains in the streams that flow northwestward into Lightning and Duncan Creek and southeastward into Mayo Lake and Granite Creek suggest that a northeast-striking series of gold-bearing veins may occur along the divide formed by the Gustavus Range and may project northeastward into the Patterson Range. In recent years exploration in the vicinity of Mount Hinton has uncovered gold-arsenopyrite-scorodite veins along this trend.
7. Referring to the geochemical maps of the stream sediments of the area published by Gleeson (1966-67) one notes that the anomalous gold contents in the stream sediments are generally coincident with anomalies in boron, arsenic, antimony, and silver, the four most common elements accompanying gold in its epigenetic deposits in the area. The coherence of gold and arsenic is particularly marked. Anomalies in tungsten are coincident in Dublin Gulch and Lynx Creek, in a few streams on Mount Haldane, and in the tributary draining southwest into Edwards Creek. Tin and gold anomalies exhibit a coherence in Dublin Gulch, Haggart Creek, and one of the tributaries that drains southward into Granite Creek. There is no particular relationship between molybdenum and gold. Gold anomalies in the stream sediments are coincident with those of copper, lead, zinc, and manganese in only some streams, particularly those draining areas containing lead-zinc-silver lodes. This is not unexpected since the early gold-bearing pyrite-arsenopyrite-sulphosalts veins often occupy the same fracture systems as the later lead-zinc-silver lodes (Boyle, 1965).

CONCLUSIONS

All of the known gold deposits (both vein and placer) are indicated by the dispersion trains of gold in the heavy mineral concentrates from the stream sediments of the area. Four northeast-trending vein systems (Fig. 2) are suggested by the secondary dispersion pattern of gold as well as that of boron, arsenic, antimony, lead, zinc, etc. (Gleeson, 1966-67). Two of these systems are relatively well defined; the other two require further investigation. A number of streams with relatively high gold contents in their stream sediments, but not known to contain placers, should be investigated.

ACKNOWLEDGMENTS

We wish to acknowledge the assistance of Miss R.J. Arora and Mr. C.C. Durham in plotting the analytical data.

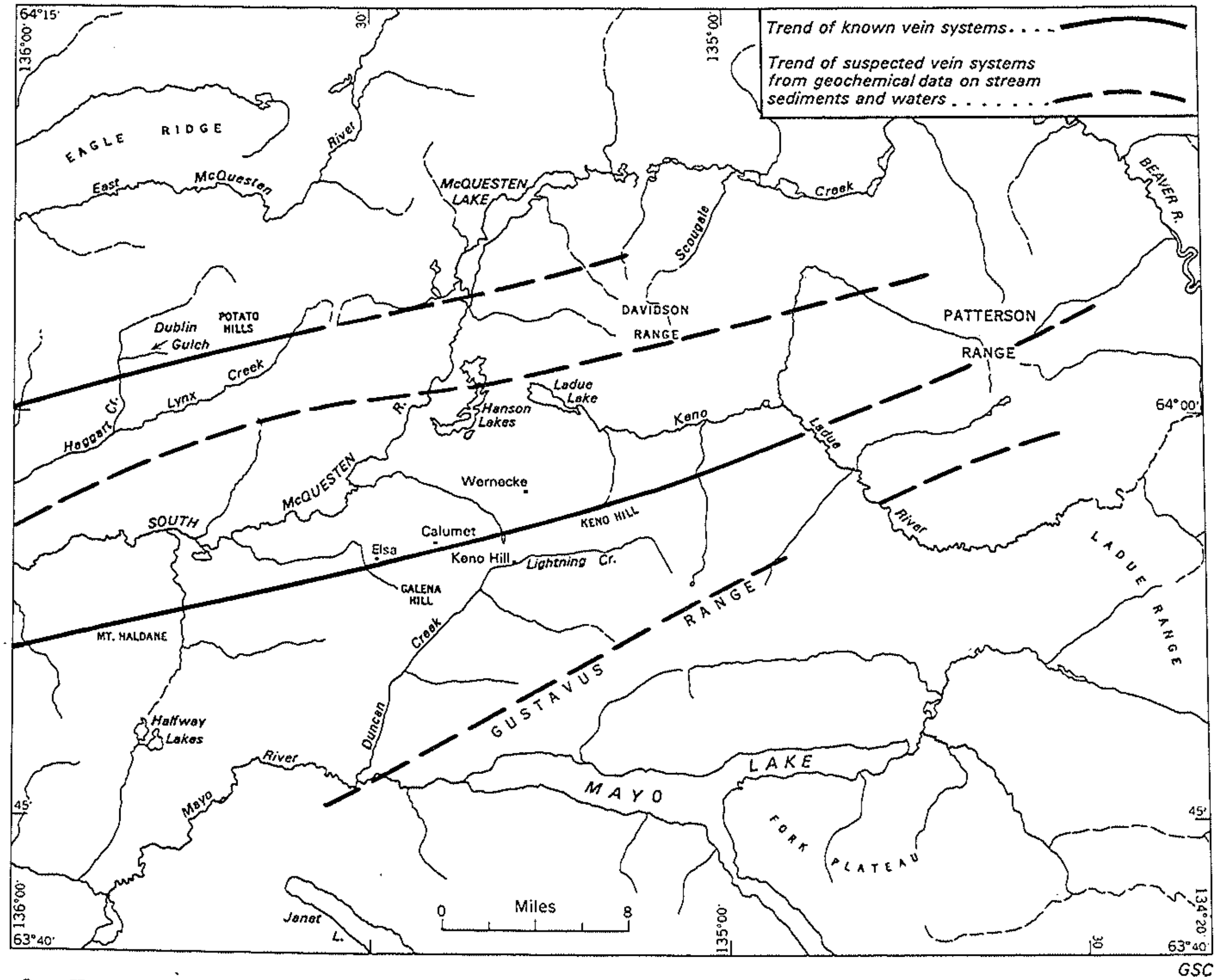

Figure 2. Trends of vein systems as suggested by geochemical surveys, Keno Hill area, Yukon Territory.

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Figure 2. Trends of vein systems as suggested by geochemical surveys, Keno Hill area, Yukon Territory.

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