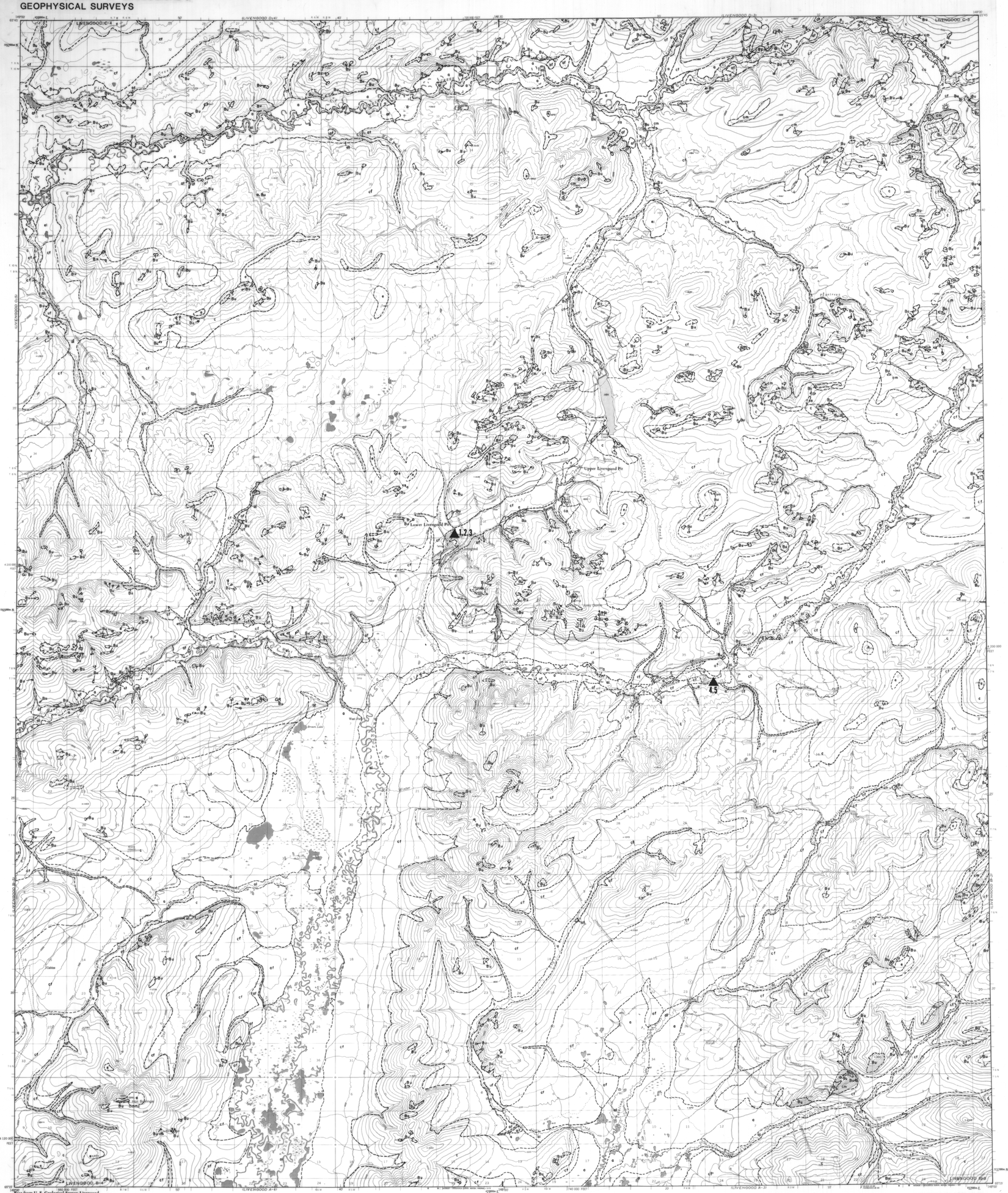

Base from U. S. Geological Survey Livengood B-3 (1951), B-4 (1953), C-3 (1953), and C-4 (1951) quadrangles, Alaska. Livengood B-3, B-4, and C-4 Quadrangles were updated in 1975.

This report has not received final editing and review. The author is solely responsible for its content and will appreciate candid comments on the accuracy of the data as well as suggestions to improve the report.

ALASKA

STUDY AREA

SCALE 1:63,360

1 0 1 2 3 4 MILES

1 0 1 2 3 4 5 KILOMETERS

CONTOUR INTERVAL 100 FEET

DATUM MEAN SEA LEVEL

APPROXIMATE MEAN DECLINATION, 1955

TRUE NORTH
MAGNETIC NORTH

Surficial geology by C.F. Waythomas, N.W. Ten Brink and D.F. Ritter, 1982.

SURFICIAL GEOLOGIC MAP OF THE LIVENGOOD B-3, B-4, C-3, AND C-4 QUADRANGLES, YUKON TANANA UPLAND, ALASKA

By

C.F. Waythomas, N.W. Ten Brink, and D.F. Ritter,

1984

EXPLANATION

DESCRIPTION OF MAP UNITS

STREAM DEPOSITS

a ALLUVIAL DEPOSITS—Formed primarily by streams, slope wash, rill wash, and overbank deposition during floods. Predominantly stratified silt and sand with local point-bar gravels that contain moderately to well-sorted pebbles and cobbles. Locally mantled by colluvial silt, especially near lateral margins of flood plains. Locally subject to flooding.

af ALLUVIAL-FAN DEPOSITS—Consist predominantly of moderately to poorly-sorted gravel, with a sand and silt matrix and subangular to subrounded pebbles, cobbles, and boulders. Silt lenses and very poorly sorted, angular debris-flow deposits are locally present. Locally subject to flooding. Potentially auriferous, especially in apices and basal strata of fans around Amy Dome and Money Knob.

at STREAM-TERRACE ALLUVIUM—Represents former valley floors no longer subject to flooding. Materials consist of moderately to well-sorted and rounded pebble and cobble gravels with a predominantly granule and sand matrix, but silt lenses and silt-rich matrices occur locally. Locally terrace deposits are slumped and colluviated and are often mantled with a thin veneer of colluvial silt or loess, or both. Most terrace gravels are potentially auriferous, especially in basal strata.

al FLOOD-PLAIN ALLUVIUM—Includes low terraces, channel deposits, point bars, and slough fillings. Materials consist of moderately to well-sorted, interlayered sand, gravel, and silt. Subject to frequent flooding. Locally mantled with thin colluvium, especially along outer margins of flood plains.

MASS-WASTING DEPOSITS

ca COLLUVIAL-ALLUVIAL-FAN DEPOSITS—Materials transported downslope by a combination of gravity-driven mass-movement processes and alluvial processes. Fan-shaped deposits consist predominantly of poorly sorted, angular clasts in a silt-clay matrix. Interbedded lenses of rounded clasts and laminated sand and silt with alluvial characteristics occur locally. Subject to local flooding. Potentially auriferous, especially in basal strata and apices of fans around Amy Dome and Money Knob. Mapped on the basis of distinct fan shape on colluvial slopes. May be gradational with alluvial-fan material.

cm COLLUVIAL DIAMICTON—Materials characterized by poorly sorted, angular pebbles, cobbles, and boulders derived from local bedrock and supported in or coated by a silt-clay matrix, or both. Very hard, compact and well indurated when dry. Deposits often grade upslope into frost-shattered bedrock and locally are overlain by colluvial silt. Potentially auriferous near Amy Dome and Money Knob.

cf FINE-GRAINED COLLUVIUM—Reworked eolian or fluvial silt, locally mixed with sand and angular clasts, usually cryoturbated, frozen, organic rich, and devoid of sedimentary structures or strata that can be traced over a significant distance. Thermokarst features and patterned ground are commonly developed on the surface of these deposits.

cs SOLIFLUCTION DEPOSITS—Distinct units of unsorted, silt-rich colluvium with clearly discernable lobate boundaries that indicate past or present downslope movement of the unit as a water-saturated mass at relatively slow rates, or both. Deposits with angular clasts and sand, as well as debris-flow and avalanche colluvium, may be included locally.

c COLLUVIUM, UNDIFFERENTIATED—A heterogeneous, usually very silty mixture (but including rock fragments, sand, and gravel) deposited primarily by mass-wasting processes with local reworking by streams. Deposits are mapped as undifferentiated colluvium when specific criteria for other colluvial units were not identified.

EOLIAN DEPOSITS

e EOLIAN SILT AND FINE SAND—Massive or finely laminated, very well sorted fine sand and silt that show little or no evidence of fluvial or colluvial origins. Often contains plant stems in growth position and laterally continuous soil or organic strata. These deposits usually are restricted to generally flat upland areas, are frozen to within 3.3 ft (1 m) or less of the surface, and locally display thermokarst features. Some eolian map units may be partly retransported by colluvial and fluvial processes.

DEPOSITS THAT RESULT FROM MINING ACTIVITY

t TAILINGS—Includes mine tailings, excavated overburden, siltation-pond fillings, ditches, active surface-mining pits, and borrow pits. Most deposits are coarse gravel or angular-bedrock rubble; heterogeneous mixtures that range from silt to boulders are included.

DEPOSITS OF UNKNOWN ORIGIN WITH DISTINCT TOPOGRAPHIC FORM

uf FAN-SHAPED DEPOSITS, UNDETERMINED ORIGIN—May have characteristics of alluvial or colluvial fans, or both, as described above.

cr BENCH-SHAPED RUBBLE-SHEET DEPOSITS—Consist primarily of bench-shaped deposits of bedrock and shattered bedrock; includes cryoplanation surfaces on ridge crests.

el WELL-SORTED SILT—Bench-shaped loess(?) deposits.

ur Ridge-shaped deposits that consist of materials of unknown characteristics and origins.

BEDROCK

Bu BEDROCK—Outcrop and rubble crop that show little or no evidence for transport.

Table 1. *Radiocarbon dates from Livengood B-3 and C-4 Quadrangles, Alaska (see plate and fig. 1 for location and stratigraphic position.) Analyses by Beta Analytic Laboratories, Inc., Coral Cables, Florida, 1983.*

Lower Livengood placer pit
(T. 8 N., R. 5 W., sec. 10, Livengood C-4 Quadrangle)

Map no.	Lab no.	Radiometric age (yr B.P.)	Remarks
1	Beta 6026	28,470 ± 600	Sample from upper part of gravel unit; may date end of gravel accumulation.
2	Beta 6025	29,460 ± 480	Sample from silt just above gravel-silt contact; dates transition from gravel to silt deposition.
3	Beta 6027	26,410 ± 540	Sample from 33 ft (2 m) below top of exposed silt section; probably reworked, older wood.

Bank of Tolovana River
(T. 7 N., R. 4 W., sec. 1, Livengood B-3 Quadrangle)

Map no.	Lab no.	Radiometric age (yr B.P.)	Remarks
4	Beta 6028	5,780 ± 70	Sample from 33 ft (10 m) depth near base of ice wedge.
5	Beta 6029	4,090 ± 80	Sample from 4.9 ft (1.5 m) depth near top of ice wedge.

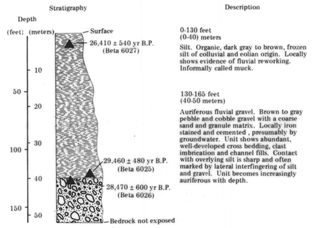

Figure 1. Stratigraphy and radiocarbon dates from the east wall of the lower Livengood placer pit (see table 1 for location and sample data).

▲2 Radiocarbon dating sample locality and map number

CONTACT – All contacts are approximately located and querried where questionable.

PLACER POTENTIAL OF THE LIVENGOOD AREA, A DISCUSSION OF SELECTED GEOMORPHIC DEPOSITS

INTRODUCTION

During the 1982 field season, the Alaska Division of Geological and Geophysical Surveys conducted a program of geological mapping and geochemical sampling of about 1,000 mi² (2,950 km²) centered on the town of Livengood. As a part of that program, surficial geology was studied in an effort to better understand the source and distribution of gold mineralization in the Tolovana mining district. The Livengood area consists of rolling upland terrain, interrupted by broad, relatively gently sloping valleys. Maximum relief in the area is approximately 1,970 ft (600 m), and the highest summits reach elevations of 2,350 ft (716 m) (Tolovana Hot Springs Dome) and 2,340 ft (787 m) (Livengood Dome). The region is covered by boreal forest and intermittent muskeg lowlands of sufficient density to obscure many geologic relationships.

General surficial geology

The present geomorphology of the Livengood district developed through a sequence of erosional and depositional events associated with widely varying climatic regimes. Periglacial mass wasting and the fluvial activity of streams are the most prevalent active geomorphic processes. Loess, derived from the Yukon or Tanana River valleys (or both) blankets the upland areas. The loess is highly susceptible to downslope movements especially if it has been frozen and later thawed. This study has established that most of the Livengood area is covered by a thick mantle of locally frozen, colluvial, alluvial, and eolian silt, and angular to subrounded colluvial gravel that often exceeds 164 ft (50 m) in thickness, especially in valley bottoms.

The map portrays the distribution of colluvial, eolian, and fluvial deposits in the Livengood B-3, B-4, C-3 and C-4 Quadrangles. Wood samples were collected from several of these deposits for radiocarbon dating. Dated organic material from a placer cut in the lower Livengood bench indicates that deposition of auriferous gravel ended about 30,000 yr B.P. and was followed by a period of silt accumulation of uncertain duration. In the Tolovana valley, radiocarbon dates on wood from colluvial and eolian silt associated with well-developed ice wedges suggest a period of ice-wedge growth between 6,000 and 4,000 yr B.P. Accumulation rates of valley-bottom muck for the Tolovana valley are on the order of 0.28 to 1.97 in. (7 to 50 mm)/yr, assuming the radiocarbon dates are valid.

Placer deposits

Three types of auriferous, or potentially auriferous, deposits are recognized in the Livengood area. *Type I* deposits consist of gold-bearing fluvial gravels overlain by frozen colluvial silt such as those exposed, and currently being mined, in the lower Livengood bench. *Type II* deposits, found along Hess, Fish, and Lost Creeks, are composed of old, poorly preserved, potentially auriferous, high-level terrace deposits. *Type III* deposits consist of gold-bearing alluvial- and colluvial-fan deposits and gravels, such as those on Amy Dome and Money Knob.

TYPE I DEPOSITS: FLUVIAL GRAVELS BURIED BY COLLUVIAL SILT

Lower Livengood Placer Pit

The most significant gold-bearing, fluvial-gravel deposits are exposed and being mined on the lower Livengood bench (loc. 1). Twelve to fifteen ft (3.6 to 4.5 m) of brown- to grey-weathering, cross-bedded, pebble and cobble gravel, with imbricate cobbles and channel fills is well exposed in the lower wall of the pit. The base of the gravel section was not excavated at the time of our visit, but the total gravel thickness appears to exceed 20 ft (6 m). The gravel has a coarse sand and granule matrix and is locally cemented and stained with iron oxides, particularly lower in the section. It is composed of approximately 60 percent chert, 30 percent mafic and ultramafic lithologies, and 10 percent assorted lithologies that include sandstone, slate, and felsic volcanic rocks. The richest pay zones occur in basal gravels just above bedrock, although gold-bearing horizons occur throughout the gravel section (Dan Howard, Livengood Joint Ventures, oral commun., 1982). The lower Livengood gravels are interpreted to have been deposited over bedrock within a paleochannel of Livengood Creek. Gold along the gravel-bedrock contact may have been concentrated during erosion and incision of the bedrock floor of Livengood valley. Distribution of gold in alternating barren and pay strata, within a considerable thickness of gravel, suggests a complex history of gradual aggradation associated with reworking of parts of the gravel fill.

Available data suggests the fluvial gravels in the lower Livengood pit extend up Livengood valley to near the mouth of Amy Creek. The downstream extent and distribution of these gravels is uncertain; however, their presence in the subsurface has been documented (R.D. Reger, oral commun., 1982). Mertie (1918, p. 249) commented that the ancient gravels in Livengood valley extend downstream and deepen considerably in the vicinity of the Myrtle Creek - Livengood Creek confluence. Thickening of the gravel section and the sharp drop in the bedrock valley floor near the mouth of Myrtle Creek may have been caused by increased erosion below the confluence of the creeks or by faulting during or after deposition of the gravels. This zone of thickening is on strike with a north-south-trending normal fault along which the Tolovana valley block was apparently downdropped. If faulting occurred after deposition of the basal auriferous Livengood gravels, the downstream extension of the pay streaks should be preserved at depth near the bedrock interface.

The gravels exposed in the lower pit are overlain by 75 to 125 ft (22.5 to 38.0 m) of ice-rich, organic silt (muck) of colluvial, fluvial, and eolian origin. The muck thins southward toward the present channel of Livengood Creek. This wedge of silt represents reworked loess that was transported downslope by fluvial and colluvial processes in response to fluctuating periglacial conditions.

Three wood samples collected from the fluvial gravels and silts exposed in the lower pit yielded radiocarbon ages of 29,460 ± 480; 28,470 ± 600; and 26,410 ± 540 yr B.P. (Beta 6025, 6026 and 6027; table 1; fig. 1). The older two dates suggest that gravel deposition ceased about 30,000 yr B.P., followed by a period of silt accumulation of unknown duration. Assuming the dates are correct, they represent maximum limiting ages of the upper portion of the gravel section. However, if the dated wood has been reworked from older deposits, the gravels could be younger. The 26,410 ± 540 yr B.P. date was determined from wood collected 6.7 ft (2 m) below the top of the silt unit. The dated wood was probably reworked from older organic-bearing deposits, which indicates the silt cannot be older than about 26,400 yr B.P.

Upper Livengood Pit

Another placer excavation, the upper pit, is present in the Livengood valley approximately 3.5 mi (5.6 km) upvalley from the lower pit. Gold-bearing gravels were mined at the upper pit, but were not exposed when visited by the authors. Nuggets recovered from this pit are subangular to rounded, apparently a result of fluvial transport.

Gravels exposed in the upper pit consist of light-brown, iron-stained, cobble and pebble gravel in a silty-clay matrix. This unit is well indurated and exhibits primary sedimentary structures such as low-angle cross-bedding, clast imbrication, and plane bedding. The gravel deposit is texturally immature and contains subrounded to angular chert clasts that comprise greater than 90 percent of the lithologies in the gravel. This deposit probably originated as an alluvial or colluvial fan derived from the chert-rich uplands to the north. Although the relationship between this 'fanglomerate' unit and the auriferous gravels could not be determined, it is significant that lithologies characteristic of the Money Knob/Amy Dome area (such as mafic igneous rocks) are apparently absent from tailings at the upper pit.

Other Fluvial Gravels

In addition to the gravel deposits in Livengood valley, several other buried Type I fluvial gravels probably occur in major valleys of the region. Although most valleys are mantled by thick sequences of silt and muck, significant thicknesses of stream-laid gravels, some of which may contain gold, probably occur beneath the silts and lie directly on bedrock. Available subsurface data suggests the existence of buried valley-floor gravels. For example, drill records at the crossing of the Tolovana River by the Trans-Alaska Pipeline show that thick gravel underlies the massive surficial silt fill (R.D. Reger, oral commun., 1982).

TYPE II DEPOSITS: HIGH-TERRACE GRAVELS

Type II gravels form old, poorly preserved, high-level fluvial terraces along Hess, Fish, and Lost Creeks. Along the south side of Hess Creek, discontinuous or partly colluviated terrace gravel crops out and is locally overlain by colluvial silt. These exposures form accordant, low noses and shoulders covered by yellow and white reindeer moss (*Cladonia*). The gravels are composed almost entirely of subangular to subrounded chert and minor gray sandstone and quartzite in a fine-granule to coarse-sand matrix. Maximum thickness of the gravels is unknown. The gravel terraces along Hess Creek contain a predominance of chert clasts and lack mafic lithologies that are present in nearby bedrock exposures. If the Hess Creek gravels were deposited by a stream with the same general course as modern Hess Creek, the absence of mafic clasts could be explained by attrition and fluvial abrasion of the less resistant lithologies. However, abundant mafic rocks occur in the modern point-bar gravels of Hess Creek and do not appear to be any smaller than the more resistant chert and quartzite. Also, clasts in terrace gravels along Hess Creek are noticeably smaller than clasts in modern point bars, which suggests deposition by a river no larger than modern Hess Creek. The source of the older gravels appears to be an extensive chert terrane south and east of the Hess Creek drainage. It is unlikely that erosion of mafic igneous rocks exposed north of Hess Creek occurred during formation of these deposits, perhaps due to higher base-level conditions.

Gravels similar to those of the Hess Creek terraces are also exposed along the south side of Fish Creek in the northwestern corner of the Livengood C-4 Quadrangle. At this locality, incised gravel noses (small ridges or spurs extending toward the main valley axis from the valley wall) occur up to 200 ft (61 m) above the modern channel of Fish Creek. The terrace deposits are composed of orange, iron-stained, chert-pebble gravel with a coarse-sand and granule matrix, similar to the Hess Creek terrace gravels. The lateral extent of the Fish Creek gravels and their true thickness are unknown.

Like the Hess Creek terrace gravels, the Fish Creek gravels are 95 to 99 percent chert with minor sandstone and quartzite and no apparent mafic lithologies. Prominent, bench-like notches cut into the face of the exposed Fish Creek gravels may represent remnant strath or cut terraces developed during incision through these gravels.

Gold is present in some chert-rich terrace gravels and may occur in all terrace gravels. Chert-breccia horizons with gold contents up to 1.3 ppm have been identified in the bedrock chert terrane to the south and east; thus gold in terrace gravels may have been derived from the extensive chert-rich terrane exposed in the region.

A third occurrence of Type II terrace gravels is within a Trans-Alaska Pipeline access-highway road cut, along the upper north valley wall of Lost Creek, approximately 3 mi (4.8 m) above the confluence of Lost Creek and the West Fork of the Tolovana River. Gravel clasts are subangular to subrounded and appear to be fluvial in origin. However, no sedimentological indicators of fluvial deposition are present. Most clasts are covered by silty-clay skins and coatings that would probably not survive long-distance fluvial transport. Pedogenic alteration of the gravels is possible but unlikely because the present environment would not favor formation of clay coatings on the clasts. These gravels are probably of local origin.

Similar terrace gravels are exposed upstream where the Trans-Alaska Pipeline crosses Lost Creek valley. In contrast to the road cut gravels, these exposures reveal better rounded and sorted gravels that are associated with fluvial sedimentary structures. These gravels may represent terrace remnants associated with an undetermined fluvial system.

TYPE III DEPOSITS: ALLUVIAL- AND COLLUVIAL-FAN

The sedimentary characteristics of Type III deposits are described in detail on the accompanying plate. Only the fans around Amy Dome and Money Knob are known to be auriferous. If other lode sources are defined, alluvial and colluvial fans of streams draining such areas would be potentially auriferous. Favorable zones of potential placer deposition within the fans would be: a) along the colluvium-bedrock interface, b) at the fan apex, and c) along interfan-bedding contacts (Schumm, 1977, p. 221-233).

According to local miners, the bedrock-fan contact zone and the interfan-bedding contact zones are producing fairly rich gold concentrations in the Money Knob - Amy Dome area. In these known gold-bearing fans, it is possible that the fan apices would also produce good yields. The potential of the fan apices is apparently unexploited, but these areas should be considered as potential gold prospects in the Livengood area.

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