SUMMARY OF DGGS INVESTIGATIONS AT LIVENGOOD, ALASKA: GEOLOGY, MINERAL POTENTIAL, AND REGIONAL CORRELATIONS WITH EAST-CENTRAL YUKON

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INFORMATION

As part of a program to reexamine mineral resource potential of Interior Alaska Mining Districts, Alaska Division of Geological and Geophysical Surveys (DGGS) personnel mapped and geochemically sampled approximately 2000 square kilometres in the Livengood B-3, B-4, C-3, and C-4 Quadrangles, Alaska.

According to Alaska Statute 41, the Alaska Division of Geological and Geophysical Surveys (a branch of the Department of Natural Resources within the Alaska State government) is charged with conducting "geological and geophysical surveys to determine the potential of Alaska lands for production of metals, minerals, fuels, and geothermal resources; the locations and supplies of ground water and construction materials; the potential geologic and seismic hazards to buildings, roads, bridges, and other installations and investigations as will advance knowledge of the geology of Alaska."

The results of the DGGS investigation at Livengood, Alaska include bedrock geologic maps (Robinson, 1983; Smith, 1983; Bundtzen, 1983; and Albanese, 1983), a surficial geologic map (Waythomas, 1984), a detailed prospect examination (Allegro, 1984), and analyses of about 2000 stream-sediment, pan-concentrate, and rock samples (Albanese, 1983). The geology and mineral potential of the Livengood area, as well as regional correlations with east-central Yukon are summarized in this report.

GEOLOGIC UNITS

The bedrock geology of the study area is generalized in Figure 1. The rock units generally occur in northeast-trending belts and range from Late Precambrian (?) and Lower Cambrian to Cretaceous. Bedrock units are complexly deformed and outcrop exposure is poor. Contacts, when exposed, are commonly bounded and stratigraphic relationships are difficult to determine.

The oldest rocks comprise an interlayered sequence of maroon and green argillite, black shale and limestone, vitreous quartzite and several types of bimodal quartz sandstone (informally known as the 'Grit Unit' of Chapman and others, 1971). This unit contains Oldhamia, a trace fossil of probable Late Precambrian (?) to Early Cambrian age (Churkin and Brabb, 1965). These rocks are bordered on the north and perhaps overlain by a northeast-trending belt of orthoquartzite, chert, maroon or green shale to phyllite, amygdaloidal greenstone, diorite, and gabbro. These younger rocks may represent a sediment-rich facies of the Fossil Creek Volcanics of Middle Ordovician age (Church and Dufree, 1961) which occurs northeast of the map area in the White Mountains (Bundtzen, 1983).

The 'Grit Unit' appears to be in thrust contact with an extensive Chert terrane composed of variegated chert, gray and tan chert, chert conglomerate, quartzite, dolomitic limestone, and minor felsic tuff and greenstone. This unit includes the Livengood Dome Chert of Chapman and others (1980). The age of the chert terrane is believed to be Ordovician to Silurian based primarily on stratigraphic and fossil evidence including graptolites (Chapman and others, 1980), conodonts, brachiopods, and corals (Florence Weber, U.S. Geological Survey, pers. comm., 1982, and Robinson, 1983).

The Chert Terrane is bordered by a Paleozoic clastic and chert unit consisting of quartzite, maroon and green argillite, lithic sandstone and siltstone, grey chert, limestone, and limestone breccia. This unit may represent a transitional phase between the underlying Ordovician and Silurian Chert terrane and a Devonian clastic sequence which occurs stratigraphically or structurally above the Paleozoic clastics and chert unit.

The Devonian clastic sequence, informally called the Cascaden Ridge Unit (Weber and others, 1985, p. 11) is a turbidic sequence composed of a basal conglomerate containing locally derived rounded chert and pebble clasts in a sandy matrix overlain by a thick section of thinly layered shale, siltstone and sandstone with very minor carbonate layers. Although turbidite features such as flute casts and graded beddings are very rare, debris flows occur near the base of the conglomerate (Weber and others, 1985, p. 22-23). This unit is associated with a wide variety of rock types including volcanic rocks. This complex appears to be tectonically mixed with the clastic rocks (Robinson and others, 1983). Fossil evidence from the Cascaden Ridge unit (primarily gastropods and pelecypods) indicates a Middle Devonian (Eifelian) age and represents a near-shore subtidal or intertidal (?) environment (R. Blodgett, pers. comm., 1982). The upper part of the Tolovana Limestone, exposed as a thrust slice in the Livengood B-3 Quadrangle may represent a shelf-facies equivalent of the Devonian clastic sequence.

The Rampart Group, a heterogenous assemblage of rocks consisting of gabbro, pillow basalt, diorite, chert, conglomerate, sandstone and shale is present in the northern part of the map area. The Rampart Group is considered to be Permian to Triassic based on Permian pelecypods and bryozoans (Brosge and others, 1969) and a recent Upper Triassic radiolarian age date (D. Jones, pers. comm.). In addition to the fossil evidence is a K-Ar age data average of 205 $\pm$ 6 m.y. on hornblende from gabbro in the unit (Brosge and others, 1969). The Rampart Group appears to be in fault contact with older rocks to the south (Robinson and others, 1983) and is not considered to be part of the Livengood stratigraphic section.

A thick sequence of clastic Jurassic to Cretaceous flysch unconformably overlies the Grit Unit in the southeastern part of the map area, and the Devonian clastic sequence near Livengood (Robinson and others, 1983). Paleocurrent and point count data collected by Bundtzen (1983) suggest that the Devonian clastic sequence was, in part, the source rock for the Mesozoic flysch.

Felsic to intermediate plutons and dykes of presumed Tertiary to Cretaceous age (Chapman and others, 1971) intrude rocks of both the Mesozoic flysch sequence and the Devonian clastic sequence near Livengood. The intrusions generally range from monzonite to quartz monzonite, with minor syenite phases north of Tolovana Hot Springs Dome. Some appear to be structurally controlled along north-south-trending faults paralleling the Tolovana River Valley.

REGIONAL CORRELATIONS

Chapman and others (1979) proposed correlations between Livengood stratigraphy and stratigraphy in the Charlie River Quadrangle, and suggested right lateral displacement along the Tintina Fault of about 300 km (Fig. 2). The correlation of the Livengood Dome chert (part of terrane) with the Road River Formation extends this correlation from Livengood to the Selwyn Basin in east-central Yukon (Chapman and others, 1979). Addi-

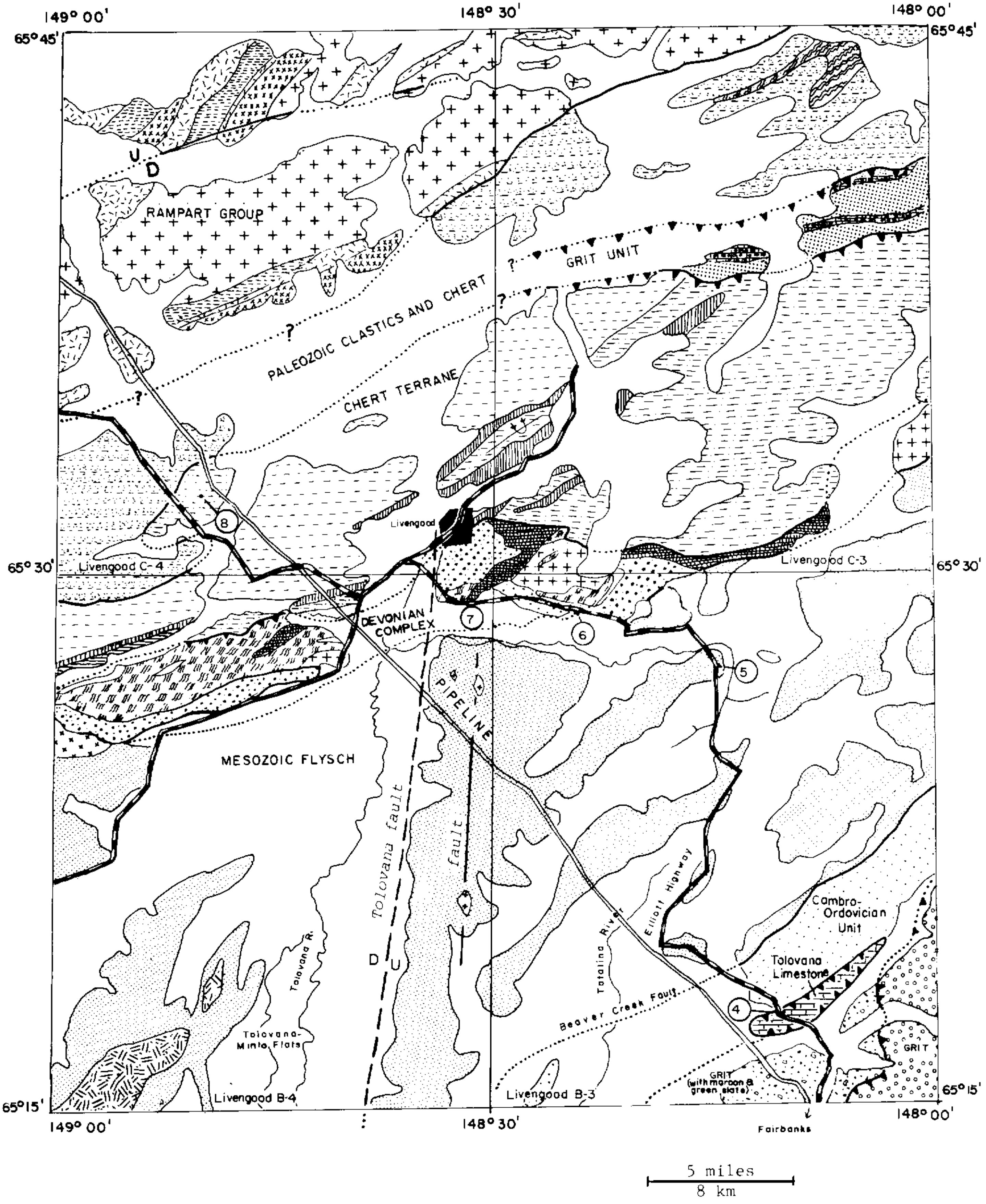
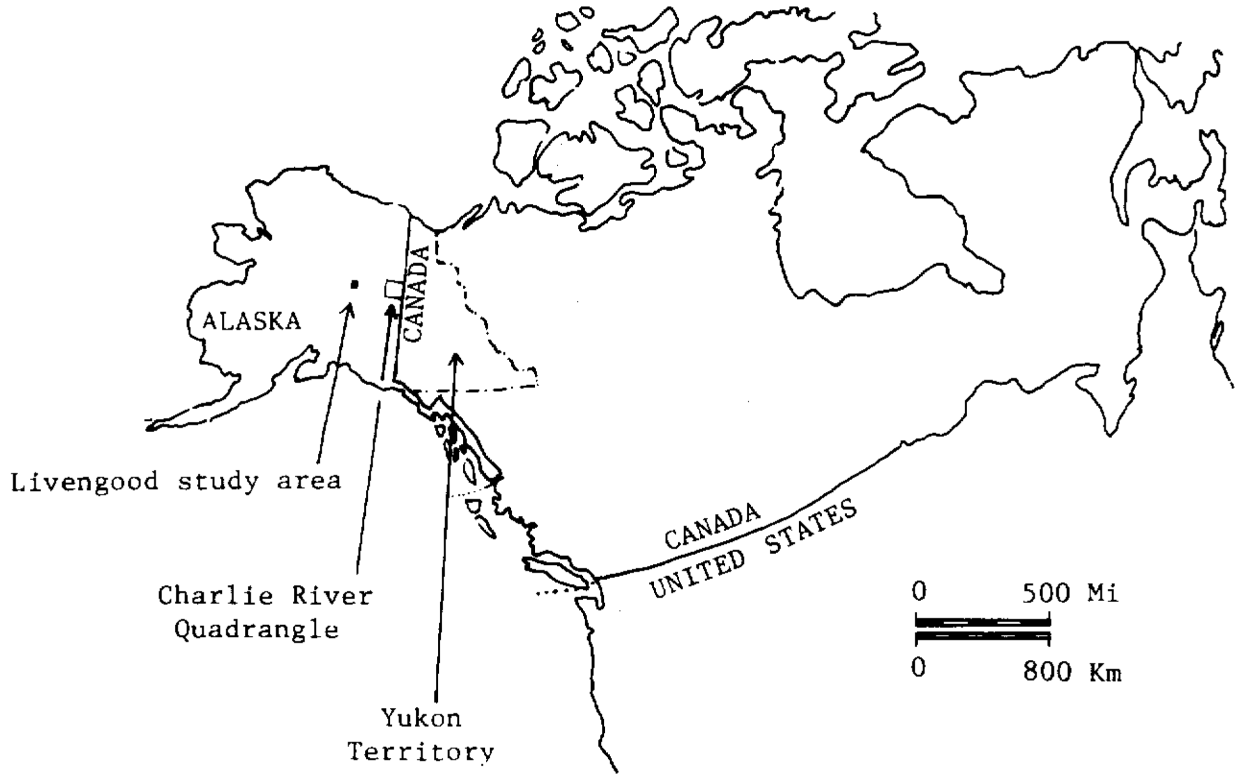


Figure 1. Geology of the Livengood B-3, B-4, C-3 and C-4 Quadrangles, Alaska. Generalized from Albanese, 1983; Bundtzen, 1983; Robinson, 1983; and Smith, 1983 (continued on following page).



EXPLANATION

Quaternary sediments

Intrusive rocks (Cretaceous-Tertiary)

- Quartz porphyry (small bodies controlled by N-S trending faults)
- Syenite
- Quartz monzonite

Mesozoic flysch (Jurassic-Cretaceous)

- Siltstone, sandstone, conglomerate

Rampart Group (Permian-Triassic)

- Basalt, andesite
- Greenstone
- Diorite
- Chert, shale, siltstone

Tolovana Limestone (Silurian-to-Middle Devonian)

- Limestone

Devonian clastic rocks (mid-Devonian) and mafic complex

- Sandstone, shale, conglomerate, chert
- Volcanic flows, agglomerate
- Diorite, gabbro, greenstone
- Serpentinized ultramafic mafic rocks

Paleozoic clastics and chert (Silurian-Devonian)

- Chert, maroon and green slate, sandstone, siltstone, limestone
- Quartzite

Chert terrane (Ordovician-Silurian)

- Gray and tan chert
- Variegrated chert
- Greenstone, mafic volcanic rocks
- Limestone, dolomitic limestone

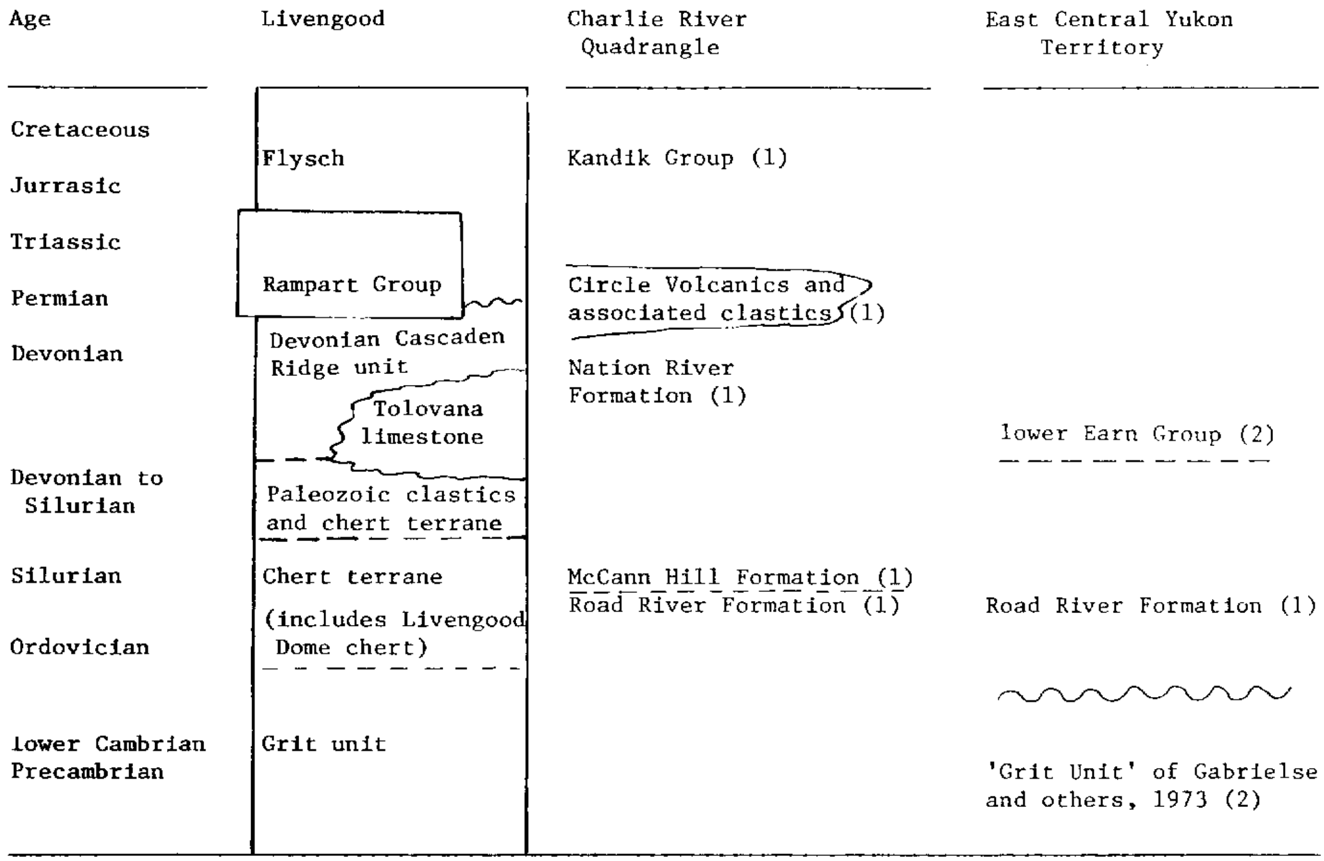
Cambro-Ordovician unit

- Orthoquartzite, mafic igneous rocks, phyllite, limestone, chert, and slate

Grit unit (Precambrian-Cambrian)

- Quartzite, maroon-green slate, chert, sandstone
- Limestone, limestone breccia
- Bimodal quartzite, maroon and green slate
- Bimodal quartzite (grit)

FIGURE 1 (cont.)



(1) indicates correlation of Champan and others, 1979

Figure 2. Inferred stratigraphic relationships.

(2) indicates correlation of Robinson and others, 1983

tional correlations between Livengood and Yukon stratigraphy have more recently been proposed. A comparison of the restored stratigraphic column of Livengood with Yukon stratigraphy is shown in Figure 2.

The Hadrynian 'Grit Unit' in east-central Yukon of Gabrielse and others (1973) can be compared to the Livengood grit unit. In east-central Yukon, the Grit Unit consists of gritty quartz arenite, pale brown-slate, and minor limestone overlain by maroon, purple, and green slates with lenses of fine-grained quartz-arenite and brown slate (Gordy, 1978). This lithology is notably similar to the grit unit of Livengood. The east-central Yukon Grit Unit and the Livengood grit are underlain by the Road River Formation and the equivalent Livengood Dome chert of the chert terrane, respectively. In addition to the lithologic and stratigraphic similarities of these two grit units, the age assigned to these units is also similar.

In addition to this correlation, the Lower Earn Group of east-central Yukon which consists of siliceous shale, chert, quartz, sandstone, grit, and chert pebble conglomerate and spans most of the Devonian (Gordy and others, 1982) exhibits lithologic and chronologic similarities to the Cascaden Ridge unit of Livengood. Stratigraphic similarities are also observed as the Lower Earn Group in part, conformably overlies the Road River Formation (Gordy and others, 1982), while the Cascaden Ridge unit overlies the unit that is transitional to the chert terrane. These correlations, first suggested by Robinson and others (1983) have been supported by Tempelman-Kluit (1984) and Hall and others (1984).

MINERAL POTENTIAL

Gold placers in the Livengood area have produced over 10,653,000 grams (375,000 ounces) of gold. There are three types of auriferous or potentially auriferous placer deposits in the Livengood area. These are: 1) gold-bearing fluvial gravels overlain by frozen colluvial silt such as those currently being mined in the lower Livengood bench on Livengood Creek; 2) poorly preserved, locally derived, potentially auriferous, high-level terrace deposits found along Hess, Fish and Lost Creeks; and 3) gold-bearing alluvial- and colluvial-fan deposits and gravels, such as those on Amy Dome and Money Knob, east of Livengood (Waythomas and others, 1984).

The best exposed lode gold occurrence in the area is the Old Smoky Prospect on Money Knob, 3 km southeast of Livengood. Gold-antimony mineralization occurs in sheared and hydrothermally altered contact zones between Devonian clastics and an intrusive suite composed of biotite monzonite, feldspar porphyry, and felsic dykes. Reported gold values of rock samples from the Old Smoky Prospect range from 0.1 to 29.8 ppm (Allegro, 1984).

Although these altered intrusions and associated vein deposits probably contributed heavily to the placer deposits, their volume at the present erosion surface may not be sufficient to constitute a viable source for all of the placer deposits, suggesting that at least a portion of the lode source for the gold was above the present exposure and has since been removed by erosion.

Other units containing mineral potential include the Chert Terrane which contains stratabound limonitic chert breccia zones with gold concentrations up to 1.3 ppm; the Paleozoic clastics and chert unit which contains zones of layered pyritic massive sulfides in quartzites in the northern part of the map area; the Rampart Group which contains minor copper mineralization in mafic igneous rocks; and the contact zone between the chert terrane and the Cascadan Ridge which contains significant stream-sediment zinc anomalies. It is important to note that these zinc anomalies are hosted within the units that are correlated with the lower and middle Paleozoic units of Yukon which host all of the known shale-hosted stratiform lead-zinc deposits of Yukon and northern British Columbia.

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