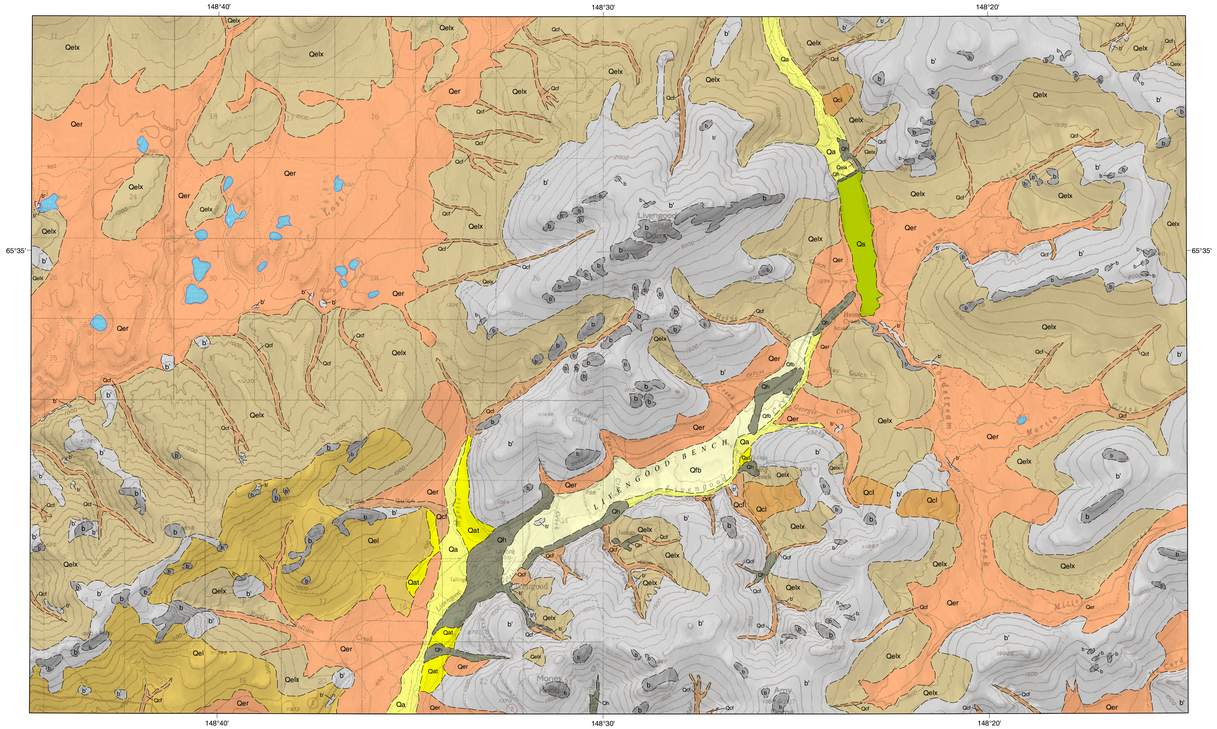
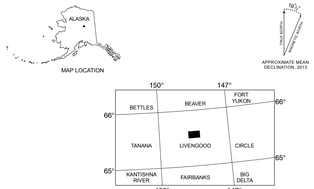



# SURFICIAL-GEOLOGIC MAP OF THE LIVENGOOD AREA, CENTRAL ALASKA

by

R.D. Reger[1] and P.A.C. Burns[2]

2013




Location of Map Area

SCALE 1:50000

1 1/2 0 1 2 3 4 MILES

3000 0 3000 6000 9000 12000 15000 18000 21000 FEET

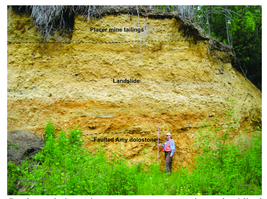
1 .5 0 1 2 3 4 5 KILOMETERS

CONTOUR INTERVAL 100 FEET
SUPPLEMENTARY COUNTOUR INTERVAL 50 FEET
LIVENGOOD C-3 — DATUM IS MEAN SEA LEVEL
LIVENGOOD C-4 — NATIONAL GEODETIC VERTICAL DATUM OF 1929

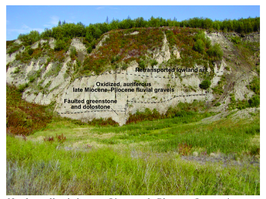
**Affiliation:**

[1] Reger's Geologic Consulting, PO Box 3326, Soldotna, Alaska 99669-3326
[2] Alaska Division of Mining, Land, and Water, 3700 Airport Way, Fairbanks, Alaska 99709-4699
[3] Alaska Division of Geological & Geophysical Surveys, 3354 College Road, Fairbanks, Alaska 99709-3707
[4] Baseline Geoconsulting, LLC, PO Box 82293, Fairbanks, Alaska 99708-2293

**Topographic base map from:**
U.S. Geological Survey topographic maps
Livengood C-3 (1954)
Livengood C-4 (1952 - photorevised 1975)
**Projection:**
Universal Transverse Mercator Zone 6 North
**Datum:**
North American Datum of 1927
**Geologic field investigations by:**
C.L. Browne[3], L.A. Staft[3] (2003), P.A.C. Burns[2] (2003, 2011), R.D. Reger[1] (2011)
**Geologic interpretation by:**
P.A.C. Burns[2] (2003, 2011), R.D. Reger[1] (2011)
**Airphoto interpretation by:**
P.A.C. Burns[2] (2003, 2011), R.D. Reger[1] (2011)
**Technical review of geology by:**
T.D. Hubbard[3] and D.N. Solie[3] (2012)
**Geologic GIS layers created by:**
P.A.C. Burns[2], L.A. Staft[3] (2003, 2004), D.S.P. Stevens[3] (2012), and J.R. Weakland[3] (2013)
**Cartography by:**
J.R. Weakland[3] (2013)
**Cartographic review by:**
P.E. Gallagher[3] (2013)
**Editorial review by:**
P.K. Davis[3] (2013)




*Southwest-facing mine-cut exposure at terminus of oxidized landslide deposits overlying thrust-faulted Amy dolostone in lower valley of Amy Creek, southwestern Livengood C-3 Quadrangle. Scale rod is 2 m long (photograph taken 06/19/2011 by R.D. Reger[1]).*




*North wall of former Livengood Placers, Inc., mine cut, showing retransported lowland silt overlying oxidized auriferous stream gravels containing late Miocene–Pliocene pollen above faulted greenstone and silicified dolostone (Karl and others, 1988), southwestern Livengood C-4 Quadrangle (photograph taken 08/20/2003 by P.A.C. Burns[2]).*

**State of Alaska**
**Department of Natural Resources**
**DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS**

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**ALASKA DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS**
3354 College Road ♦ Fairbanks, Alaska 99709-3707
Phone 907-451-5010 ♦ Fax 907-451-5050
email: dggspubs@alaska.gov
website: www.dggs.alaska.gov

## EXPLANATION

This map shows the distribution of unconsolidated deposits and undifferentiated bedrock in parts of the Livengood C-3 and C-4 quadrangles, Tolovana mining district. Units were mapped by interpreting 1:63,360-scale, false-color infrared aerial photographs taken in August 1978 and August 1986, and verified during five days of field checking in 2003 and two days in 2011. Tailings were mapped in the western Livengood Creek area on 1:6,000-scale aerial photographs taken in 2001; additional disturbed ground is expected as exploration and mining continue. Bedrock geology was mapped by Athey and Craw (2004) and Athey and others (2004a,b).

## DESCRIPTION OF MAP UNITS

### UNCONSOLIDATED DEPOSITS

#### ALLUVIAL DEPOSITS

**Qa** — UNDIFFERENTIATED ALLUVIUM—Chiefly moderately to well-sorted, stratified, polymictic pebble, cobble, and boulder gravel, sand, and silt comprising channel and overbank deposits of generally small streams. Clasts of the local bedrock are rounded to subangular. Locally auriferous. Unfrozen to discontinuously frozen with low to moderate ice contents[f].

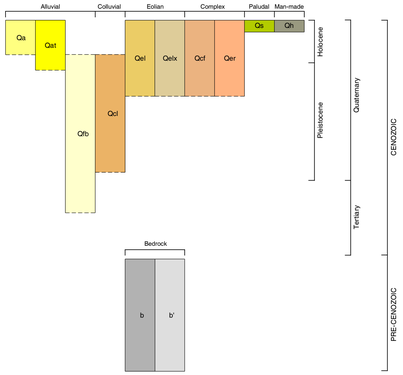
**Qat** — TERRACE ALLUVIUM—Chiefly moderately to well-sorted pebble and cobble gravels with some silty sand and local silt lenses no longer flooded by the streams that deposited the alluvium, which is locally auriferous. Covered by 1 to 2 m of overbank silts and sands. Locally covered by several meters of retransported silt and lowland loess. May include several levels. Locally subject to inundation by seasonal slope and stream icings. Continuously to discontinuously frozen with low to moderate ice contents.

**Qfb** — Includes BENCH ALLUVIUM (Qfb)—Locally auriferous, oxidized alluvial gravels that are present on bedrock benches well above local streams as a result of a long and complex history of stream piracy and tectonic deformation in the Livengood area (Mertie, 1918, 1937; Cobb, 1973; Athey and Craw, 2004). On Livengood Bench, 3 to 15 m of crudely bedded, moderately to well-sorted, subrounded, oxidized, polymictic pebble and cobble gravels with some sand; contains organic and inorganic silt lenses up to 8 m long and 0.5 m thick with scattered fossilized wood fragments and stumps up to 0.3 m in diameter. One silt lens contained late Miocene to Pliocene pollen (Karl and others, 1988). The bench gravels are 15 to 25 m above the modern drainage and are overlain by 15 to 40 m of frozen, retransported silt and lowland loess. The age of the thick, fine-grained overburden is bracketed by the ages of two samples of wood from the base of the silt, which are dated at 28,470 ± 600 RC yr B.P. (Beta-6026) and 29,460 ± 480 RC yr. B.P. (Beta-6025), and a single wood date from 2 m below the top of the exposed frozen silt that dated 26,410 ± 540 RC yr. B.P. (Beta-6027) (Waythomas and others, 1984). Continuously to discontinuously frozen with low to moderate ice contents.

#### COLLUVIAL DEPOSITS

**Qcl** — LANDSLIDE DEPOSITS—Matrix-supported silty diamicton with numerous angular to subangular pebbles, cobbles, and boulders of Amy Creek dolomite and limestone and Amy Creek siliceous mudstone and chert east of lower Amy Creek. Previously mapped as debris fan and reworked loess by Athey and others (2004a,b). Slide in the vicinity of lower Amy Creek measures l.37 km long by up to 1.1 km wide, and the 3.5-m-thick slide deposit is composed of three 0.8- to 1.5-m-thick, very pale brown (10YR8/3) to reddish yellow (7.5YR7/6), massive, horizontal beds that could indicate a history of three failure events. In that section, the slide overlies thrust-faulted Amy Creek dolomite and limestone bedrock (Athey and others, 2004a,b) that is altered to dark yellowish brown (10YR6/8) to white (10YR8/1) and contains lenses of rotated, angular fragments of dark gray Amy Creek siliceous mudstone and chert. The slide is overlain by ~1.3 m of artificially emplaced silty mining debris. The slide on the western flank of the bedrock ridge between Lucky and Goldstream creeks is deeply dissected, and the slide headwall at ~530 m (~1,750 ft) elevation is subdued, indicating the antiquity of the deposit. Discontinuously frozen with low to moderate ice contents.

## CORRELATION OF MAP UNITS




## EXPLANATION OF MAP SYMBOLS

— — — — Contact—Identity and existence certain, location approximate

### EOLIAN DEPOSITS

**Qel** — LOESS—A blanket generally <1 m thick of massive, very well sorted eolian silt with thin, local, oxidized weathering profiles and traces of organic material covers ridge crests and upper south-facing slopes. Small, frost-jacked angular rock fragments are locally present close to underlying weathered bedrock. Sections exhibit lamination parallel to the ground surface resulting from the formation of thin, ground-ice lenses during seasonal freezing. Permafrost is absent. Dissected by concave-floored gullies separated by parallel to subparallel, rounded, low ridges where loess is thicker (Kreig and Reger, 1982, plate 12, fig. 8). Tree cover is a forest of closely spaced, mixed paper birch and white or black spruce or pure stands of paper birch, except on steep, dry, south-facing slopes where stands of quaking aspen dominate a woodland of scattered, mixed white birch and white spruce. Includes unit Qe of Athey and others (2004a).

**Qelx** — FROZEN LOESS WITH CONSIDERABLE GROUND ICE—On north-, east-, and west-facing upper and middle slopes, a blanket 1.5 to 14 m thick of massive to laminated, very well sorted eolian silt typically contains soil horizons and organic layers (Kreig and Reger, 1982, plate12). Transitional on middle slopes with retransported silt and lowland loess covering lower slopes. Thickness increases from Livengood northward toward the main source of eolian sediments in the Yukon River lowland (Williams, 1962; Brown and Kreig, 1983; Muhs and Budhan, 2006). Perennially frozen to within ≤1 m of ground surface and locally contains massive ground ice (Kreig and Reger, 1982, plate 12, table 18). Dissected by dendritic, pinnate gullies with convex walls and narrow floors (Kreig and Reger, 1982, plate 12, fig. 8). Tree cover is dominantly black spruce forest mixed with scattered paper birch; large black spruce trees and willow shrubs follow drainages, where perennially frozen ground is deeper. Includes unit Qe of Athey and others (2004a).

### COMPLEX DEPOSITS

**Qcf** — MIXED COLLUVIUM AND ALLUVIUM—Primarily elongate, massive to poorly stratified, generally inorganic silt (loess) mixed with locally auriferous, sandy, angular to subangular, pebble and cobble gravels with scattered boulders derived from weathered bedrock uplands. Deposited in the upper drainages of small tributaries by debris flows and hyperconcentrated flows produced during brief, intense, local summer storms. Grades downvalley into retransported silt and lowland loess and stream terraces at the margins of lowlands. Colluvial processes > fluvial processes. Surface slightly uneven. Discontinuously to continuously frozen with low to moderate ice contents.

**Qer** — RETRANSPORTED SILT AND LOWLAND LOESS—Chiefly massive to laminated organic silt and silt with trace to some fine sand, lenses and tongues of locally derived gravel, and scattered to numerous angular rock fragments (particularly in upper valleys of small, ephemeral streams). Deposited primarily by hyperconcentrated flows (Tuck, 1940; Taber, 1953, 1958; Costa, 1988; Fraser and Burn, 1997) draining weathered bedrock slopes thinly covered by upland silt (loess) and generated by thawing ice-rich perma-frost or during brief, intense summer rainstorms. Complexly mixed with gelifluction and debris-flow deposits in upper stream drainages and primary airfall loess in lowland sites (Kreig and Reger, 1982). Transitional on middle slopes with frozen loess containing considerable ground ice. Fluvial processes >> colluvial processes. Lowland surfaces fairly smooth with scattered open-system pingos and local thermokarst pits, ponds, and lakes. Erosion on slopes by ephemeral drainages produces subparallel gullies separated by linear ridges and ellipsoidal and triangular remnants that are generally shallowly frozen, except beneath well developed aspen and birch on upper south-facing aspects (Kreig and Reger, 1982, plate 11). May be subject to seasonal stream and slope icings. Locally contains fossil remains of late Pleistocene mammals. Continuously to discontinuously frozen with moderate to high ice content; locally contains considerable massive ground ice (Kreig and Reger, 1982, plate 12) (yedoma of Kanevskiy and others, 2011). Includes unit c of Waythomas and others (1984) and units Qcfl, Qcfu, and Qe-c of Athey and others (2004a).

### PALUDAL DEPOSITS

**Qs** — SWAMP DEPOSIT—Elongate deposit of silt and organic material in impoundment basin behind Hess Creek dam, which was filled to seasonally supply water for mining purposes until 1984 and drained in winter to allow embankments and related structures to refreeze (Brown and Kreig, 1983). A photograph taken on 07/22/2011 during an aerial survey by DNR personnel revealed that the impoundment basin is drained.

### MAN-MADE DEPOSITS

**Qh** — PLACER TAILINGS AND ARTIFICIAL FILLS—Chiefly gravel mixed with angular to subangular rock rubble, sand, and silt in placer-mine tailings, ditches, active surface-mine pits, and borrow pits for road construction or heterogeneous fine-grained excavated overburden and fillings of siltation ponds. Extents determined on 1978 and 1986 aerial photography, except in western Livengood Creek area, determined on 2001 aerial photography. Includes fluvial deposits in valley bottoms and fluvial–colluvial sediments in upper drainages that were mined for placers (Mertie, 1918; 1937; Cobb, 1973; Karl and others, 1988).

### BEDROCK

**b** — EXPOSED BEDROCK—Outcrop and rubble crop that show no evidence of downslope displacement.

**b'** — THINLY COVERED BEDROCK—Subcrops covered by <0.9 m of loess and frost-rived and weathered bedrock. Bedrock structures visible through thin veneer of surficial debris.

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*[f] The extent of perennially frozen ground is continuous where permafrost underlies >90 percent of the area, is discontinuous where it underlies 50–90 percent of the area, is sporadic where it underlies 10–50 percent of the area, or consists of isolated masses where it underlies <10 percent of the area (Ferrians, 1965; Jorgenson and others, 2008). Ice content is assumed to be low where estimated gravimetric soil moisture is <25 percent relative to dry weight, low to moderate where estimated gravimetric soil moisture is 25 to 50 percent relative to dry weight, and moderate to high where estimated gravimetric soil moisture is 50 to >1,000*