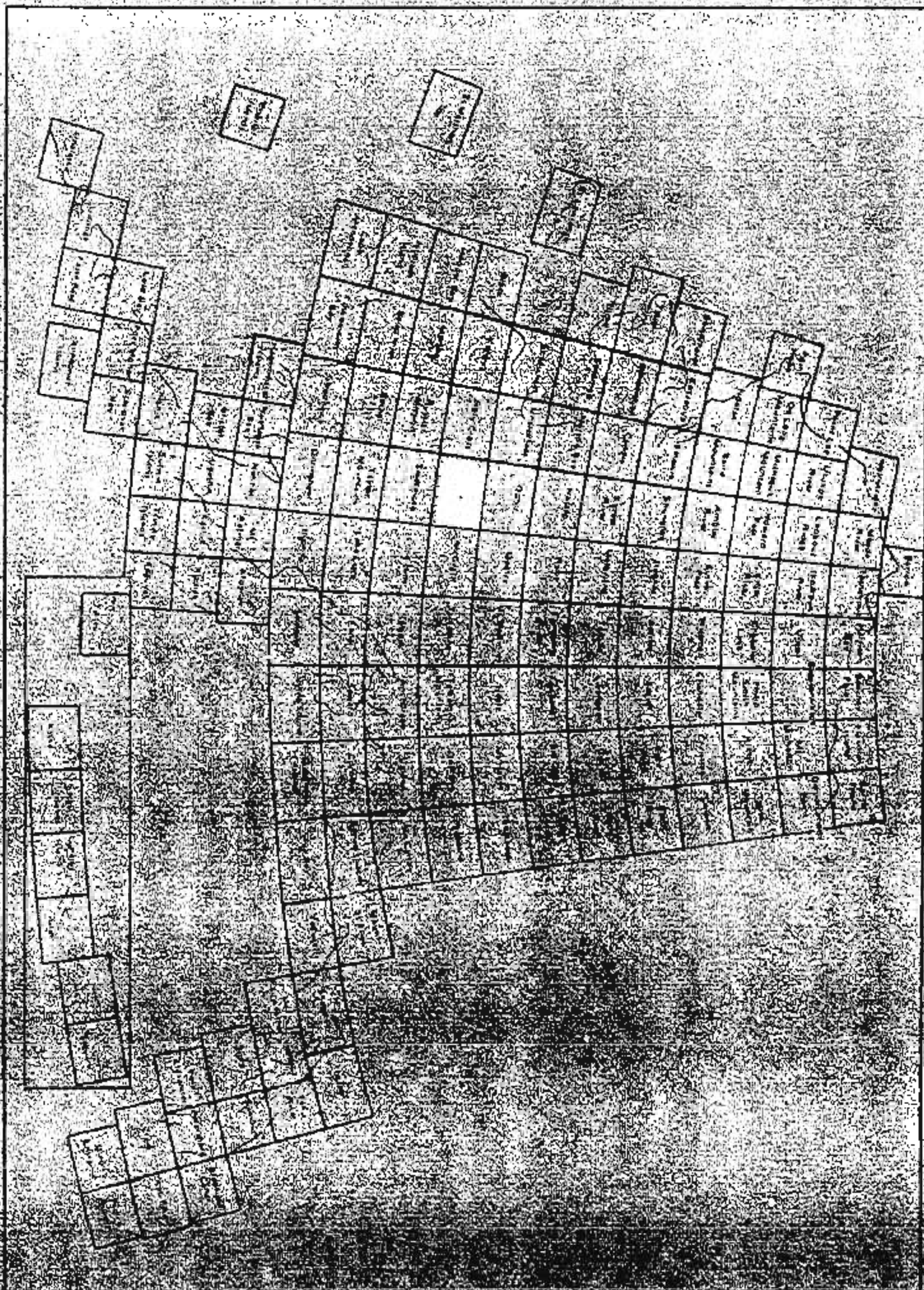

NATURAL RESOURCES

PROFESSIONAL REPORT 96

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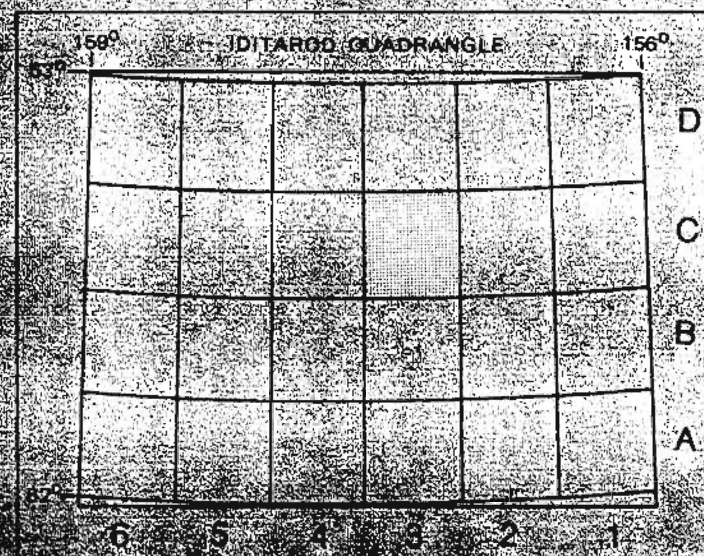
GEOLOGY OF THE IDITAROD C-3 QUADRANGLE, ALASKA



GEOLOGY OF THE IDITAROD C-3 QUADRANGLE, ALASKA

By T.K. Bundtzen, G.M. Laird,
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PROFESSIONAL REPORT 96

A summary of the geology and mineral resources along a 32 km (20 mi) segment of the Nixon-Iditarod fault in the central Kuskokwim Mountains of western Alaska

ALASKA DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS, FAIRBANKS: 1988

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INTRODUCTION AND ACKNOWLEDGMENTS

The Iditarod C-3 Quadrangle lies on the eastern edge of the Kuskokwim Mountains, a maturely dissected upland of accordant, rounded ridges and broad, sediment-filled lowlands. Elevations range from 800 ft near the Moore Creek gold mine to 3,009 ft at VABM Willow. The results presented here are a continuation of mapping completed to the northeast by Bundtzen and Laird (1982, 1983a, 1983b). This map is prepared in cooperation with the U.S. Geological Survey, who are conducting studies in the Iditarod Quadrangle under the Alaska Mineral Resource Assessment Program.

We thank Don Harris of McGrath for discussions of the Moore Creek gold placers, the Broken Shovel silver-gold deposit, and the general mining history of the map area; and J.T. Kline (DGGS) for spending several days with the field party during 1983 investigations. We appreciate the support of Joel Blum (formerly with DGGS), who provided potassium-argon radiometric ages (map sheet, table 2); Jim Barker (U.S. Bureau of Mines), who provided benefication studies of the chrome placers (map sheet, table 3); and M.K. Polly, M.R. Ashwell, T.A. Benjamin, and N.C. Veach (formerly with DGGS Minerals Laboratory), who provided timely geochemical and major-oxide analyses (map sheet, tables 1 and 5). Last, we would like to acknowledge Kline and Marti L. Miller (U.S. Geological Survey) for their thoughtful reviews of the manuscript.

BEDROCK GEOLOGY

The oldest unit in the map area is a thin structural sliver of radiolarian chert and tuffaceous sandstone (JPzc) near Deadwood Creek correlative with rocks of the Paleozoic through Jurassic Innoko terrane to the northeast (Chapman and others, 1982; Bundtzen and Laird, 1983a). Major stratigraphic units in the map area are poorly exposed sandstone, shale, and siltstone of the Kuskokwim Group (Cady and others, 1955), ranging in age from late Early to Late Cretaceous. In the study area, two different sections of the Kuskokwim Group are juxtaposed along the Nixon-Iditarod fault. Southeast of the fault, the section is composed of folded undifferentiated turbidites and shallow-marine and nonmarine clastic deposits, totaling at least 3,500-m thick; the sequence is not subdivided because of a lack of adequate bedrock control. Northwest of the Nixon-Iditarod fault, the Kuskokwim Group is 2,700-m thick and can be subdivided into mappable units. The northwesterly sequence is very similar to the stratigraphic section described by Bundtzen and Laird (1983a) 60 km to the northeast (map sheet, correlation diagram). All the Cretaceous units interfinger laterally and vertically.

The oldest recognized Cretaceous unit (Ksh) in the area consists of shale, siltstone, and fine-grained lithic sandstone deposited as turbidites in a lower- to mid-fan environment. Distinctive calcareous turbidites (Kslt and Ks), rich in plant fragments and *Inoceramus* shell fragments, overlie the fine-grained clastic turbidites (Ksh). Higher in the section are increasing amounts of volcaniclastic sandstone (Ksv) and flora-rich, pebble-bearing, medium- to coarse-grained lithic and sublithic sandstone (Ksc). These units (Ksv and Ksc) probably represent a coarse (perhaps inner) turbidite-fan depositional environment because of the presence of Bouma Tabc cycles (Bouma, 1962), sand-to-shale ratios that exceed 5:1, channelized sandstone bodies, and numerous flute casts.

Near the top of the section are relatively clean quartzose sandstone and plant-debris-rich shale of the Kssq unit. Lithologic characteristics, the absence of turbidity-current indicators, and the well-laminated nature of the quartz-rich sands suggest that this clastic sequence was deposited in a marginal- to shallow-marine (or nonmarine) environment, possibly near a storm-dominated(?) shoreline (Sharma and others, 1972). Similar units to the northeast and southwest contain leaf beds and thin, discontinuous coal seams (Mertie, 1936; Patton and others, 1976; Bundtzen and Gilbert, 1983).

Sparce paleocurrent data from high-energy flow-regime structures in the turbidite units (Kslt, Ks, and Ksc) suggest southwesterly or westerly current directions; however, paleocurrent directions from low-energy flow-regime indicators in the Kssq unit are dominantly northeasterly (table 6).

Overlying the Cretaceous clastic rocks is a 300- to 500-m-thick package of subaerial volcanic rocks that is part of a 400-km^2 volcanic field best exposed in the Beaver Mountains to the north (Bundtzen and Laird, 1982). The volcanic pile can be subdivided into five mappable units that range from rhyolite to basalt but predominate in porphyritic to nonporphyritic pyroxene andesite. The basal unit (Kvt), composed of altered andesite and dacite, contains interbedded sublithic sandstone and shale identical to lithologies in the underlying lithic to sublithic sandstone unit Ks. This relationship suggests conformity between the underlying Kuskokwim Group and the overlying volcanic rocks. The basal unit (Kvt) is successively overlain by intermediate volcanic rocks (Kvi), porphyritic andesite (TKvip), volcanic agglomerate (TKva), and mafic volcanic rocks (TKvm)---mainly olivine-augite basalt.

Table 6.[a] *Paleocurrent data*[b] *from selected Cretaceous sedimentary rocks, Iditarod C-3 Quadrangle, southwestern Alaska*

Map no.	Field no.	Azimuth corrected for tilt (degrees)	Grand mean (degrees)	Flow regime
1	83BT16	10	18.7	Lower
		20		
		15		
		30		
2	83BT11	70	50.6	Lower
		68		
		14		
3	83BT18	240	237.5	Upper
		235		
4	83BT86	160	144.2	Upper
		145		
		162		
		110		
5	83BT87	230	241	Upper
		225		
		245		
		240		
		265		
6	83BT61	210	200.5	Upper
		200		
		204		
		188		

[a]See map sheet for tables 1-5.
[b]Measured by T.K. Bundtzen on striations, groove casts, flow casts, and cross-beds.

Southeast of the Nixon-Iditarod fault, an enigmatic unit of agglomerate, chert, and brecciated volcanics (Kac) crops out from Moore Creek northeast to the head of Shoaty Creek. The stratigraphic position of the volcanic unit is uncertain; hence, it is unclear whether the unit is equivalent to the Late Cretaceous to early Tertiary Beaver Mountains volcanics or to older volcanics interbedded with the Kuskokwim Group.

Four small (2- to 4-km^2) monzonite to quartz monzonite plutons intrude the volcanic rocks near Maybe, Willow, and Moore Creeks, and a fifth pluton intrudes the Cretaceous section on the south flank of Camelback Mountain. Hornfels aureoles extend about 0.5 km from the contact zones of the plutons. The three northernmost plutons are crudely aligned in a 12-km-long, north-trending zone that extends from the Nixon-Iditarod fault at Moore Creek to Moose Creek, suggesting emplacement along a cross-fracture system.

Results of major-oxide analyses and CIPW normative mineralogy for igneous rocks in the map area (map sheet, table 5) are similar to results previously published for igneous rocks to the north (Moll and others, 1981; Bundtzen and Laird, 1982, 1983a, 1983b). Andesite, rhyolite, and quartz monzonite show broad calc-alkaline trends; monzonitic stocks and plutons are subalkaline and silica saturated. Basalt and basaltic andesite have higher than average alkali content and usually contain both normative and modal olivine and occasionally normative nepheline. Corundum-normative dacite to alaskite domes or sills intrude the Nixon-Iditarod and Moore Creek fault zones both within and north of the map area. Bundtzen and Swanson (1984) suggested that, overall, the suite is alkali-calcic and represents a transition from calc-alkaline to alkaline rocks.

Potassium-argon dates obtained from biotite, hornblende, plagioclase, and whole-rock samples in the map area ranged from 58 to 71 m.y. (map sheet, table 2), typical of ages reported from coeval volcanic and plutonic units in the Medfra (Moll and others, 1981) and Innoko-Takotna areas (Bundtzen and Laird, 1982, 1983a).

QUATERNARY GEOLOGY

Quaternary deposits were subdivided by photogeology and ground reconnaissance. Most of the study area was not glaciated during Pleistocene time; however, the 2,700- to 3,000-ft uplands at the headwaters of Montana Creek on Camelback Mountain and of Maybe and Moore Creeks north of Camelback Mountain were probably occupied by at least three small valley glaciers. Modified cirque morphology suggests correlation with the early Wisconsin Bifurcation Creek glaciation in the nearby Beaver Mountains (Bundtzen, 1981).

Tertiary through Quaternary uplift along the Nixon-Iditarod fault accelerated erosion of old pediment surfaces and terrace alluvium. On Fourth of July and Willow Creeks, extensive aprons of alluvium and colluvium were deposited where streams emerged from upland source areas. Evolution of a fan-terrace complex (Qctf) along the trace of the Nixon-Iditarod fault may have important significance for concentration of heavy-mineral placers near Moore Creek. Widespread deposits of organic silt are presently accumulating over lowland areas; however, thermokarst processes are modifying these and other Quaternary deposits in the study area.

STRUCTURAL GEOLOGY

The Nixon-Iditarod fault, the major structural feature in the map area, is a high-angle, transcurrent fault that juxtaposed the volcanic and sedimentary rocks to the northwest against the turbidite-dominated clastic deposits to the southeast. Between 65 and 69 million years ago, bodies of rhyolite were emplaced along the fault; thus the age of the system is at least Late Cretaceous. Aerial photograph analysis of the fault system indicated that a prominent escarpment cuts Quaternary fan-terrace (Qctf) and undifferentiated (Qu) deposits from Moore Creek to Fourth of July Creek, suggesting tectonic activity in Pleistocene---possibly Holocene---time. Aerial photograph interpretation also indicated distinctive right-lateral drag along the trace of the Moore Creek fault, which is evidenced by deformed bedding near Banner Creek.

Volcanic and sedimentary rocks northwest of the Nixon-Iditarod fault have been folded into broad, northeast-trending synclines and anticlines with amplitudes of 2 to 3 km; plunge directions of these folds are unknown. Extensive Quaternary cover prevented detailed fold analysis southeast of the Nixon-Iditarod fault; however, structural trends and bedding attitudes determined from aerial photographs suggest significant compressional stress directed at the wedge-shaped block between the Moore Creek and Nixon-Iditarod faults.

Columnar jointing in some outcrops of the andesite (TKva) and basalt (TKvm) units indicates that volcanic flows were deposited in a subaerial environment that postdated marine deposition of the Kuskokwim Group.

ECONOMIC GEOLOGY

Mineral deposits of economic significance in the area include the gold-cinnabar-chromite placer deposits on Moore, Fourth of July, and Deadwood Creeks, the Broken Shovel silver-gold lode, and sand- and-gravel deposits in tailings along Moore Creek. Geochemical results of a reconnaissance chip-sampling program are reported in table 1 (see map sheet); samples are from ferricrete gossan in volcanic and plutonic rocks, mineral prospects, and fault zones. We emphasize that most of the sampling was neither uniform nor representative; however, chip-channel samples collected at the Broken Shovel lode are believed to be fairly representative of parts of the mineralized system. The sampling effort revealed subtle mercury, silver, and lead anomalies in the gossan zones of the altered andesite and dacite unit (Kvt). Pervasive alteration in the unit may be wholly stratigraphic in origin or may have been thermally induced by emplacement of the plutons on Maybe and Willow Creeks.

The Broken Shovel lode (map sheet, geologic sketch and table 1, site 33) is a tetrahedrite-arsenopyrite-quartz-tourmaline vein ± scheelite, hosted in a shear zone of altered monzonite of the Moore Creek pluton. It was discovered and explored by Warner Stewart of Flat, Alaska, sometime prior to World War II and remained dormant until 1981 when the deposit was crosscut by two large exploration trenches. The vein is 1- to 4-m thick, dips steeply to the southeast, and has sharp contacts with the enclosing monzonite. Although obscured by vegetation and colluvium at both ends, it can be traced along strike for at least 100 m. The mineralized vein includes 5- to 10-percent total sulfides. Arsenopyrite is commonly altered to scorodite, and tetrahedrite grains are generally surrounded by malachite stains. Fluid-inclusion homogenization temperatures from quartz in the shear zone range from 254 to 380 °C and average 297 °C (N = 14). In mineralogy, structural style, and metal content, the vein is similar to the Cirque and Tolstoi deposits 45 km north (Bundtzen and Laird, 1982) and to the Golden Horn deposit at Flat, 60 km to the southwest (Bundtzen and Gilbert, 1983). All of these deposits contain copper, silver, gold, tungsten, and minor bismuth or tin and are localized in recently unroofed cupolas of differentiated, sub-alkaline plutons or stocks that intrude the Cretaceous clastic section (Bundtzen and Swanson, 1984).

A 300-m^2 area of agate and distinctive green to light-blue chalcedony veins cuts altered volcanic rocks (Kvt) near the head of Moose Creek (map sheet, table 1, sites 10, 11 and 13). The veins vary from 2- to 20-cm wide but cannot be traced along strike because much of the material is contained in frost-riven rubble. Samples of the agate and blue chalcedony have been polished in tumblers and form handsome stones suitable for show or jewelry. (Additional agate localities are indicated on the map.)

Anomalous copper, lead, zinc, and silver occur in fault breccias and contact zones in hornfels near the Camelback Mountain pluton (map sheet, table 1, sites 35, 37, and 38). No placer-gold concentrations, however, are known downstream of these mineralized areas.

Virtually all mineral production in the study area has been derived from gold placers on Moore Creek (map sheet, placer-site 4). These placers, and those on Nevada Gulch, were initially hand mined in 1913, constituting the first gold discoveries in this subunit of the Iditarod mining district. During the twenties, thirties, and forties, Finnish immigrants Utilla and Kuturi mined the lower benches and modern stream alluvium on Moore Creek for a distance of nearly 2 km. About 20,000 oz (622,000 g) of placer gold were recovered, mainly from 1935 to 1943. During the fifties and sixties, Joe and Jules Stuver mined bench gravels near the modern-day gold camp on Moore Creek.

Total mineral production from Moore Creek is estimated at 54,000 oz (1,679,400 g) of gold and 12,500 oz (388,750 g) of silver based on examination of unpublished U.S. Mint returns through 1968 and discussions with Don Harris, current owner of the claims. Gold fineness averages 758 with silver and copper as major impurities. Gold size is generally coarse; in recent years, nuggets have ranged to 19 oz (591 g).

The Moore Creek placers occur in terrace, fan-terrace, and modern stream alluvium that varies from 1- to 5-m thick and averages about 2-m thick. Rounded stream-gravel clasts average 30-cm diam and consist of augite basalt (60 percent), silicified sandstone (20 percent), monzonite (10 percent), and minor shale (10 percent); heavy minerals include magnetite, chromite, and zircon, minor cinnabar, and traces of scheelite, native silver, and tetrahedrite. The bedrock surface of the paystreak is Cretaceous shale and sandstone, containing local iron-rich concretions to 20-cm diam (map sheet, table 1, site 34).

The source of the Moore Creek placers is probably the deeply dissected monzonite plug that crops out on the hillside 2.5 km northwest of Moore Creek placer camp. The monzonite plug hosts numerous crosscutting, mineralized sulfide-quartz veins, including the Broken Shovel silver-gold lode previously described. During earlier years, the modern streams draining the monzonite were mined for placer gold.

The Nixon-Iditarod fault forms the southern structural boundary of the Moore Creek pluton and has experienced right-lateral strike-slip movement of up to 90 km since Cretaceous time (Grantz, 1966; Patton and others, 1984). We speculate that through Tertiary and Quaternary time the placer deposits were offset from their lode source by the right-lateral fault movement so that the deposits become progressively younger to the northeast. Therefore, older, undiscovered bench placers may occur farther to the southwest (text, fig. 1).

Placer gold was discovered and developed on Fourth of July Creek (map sheet, placer-site 3) in 1915 (Donald Harris, oral commun., 1984). Recent exploration and development activity continues. No past production figures are available, but Robert and Manzie Magnuson of McGrath recovered modest amounts of gold during the 1982-83 field seasons. Two mine-concentrate samples from the creek, analyzed by the DGGS Minerals Laboratory, yielded fineness values of 853 and 899.

The Fourth of July Creek deposits appear to be contained entirely in Holocene alluvium that consists of rounded clasts of basalt, hornfels, and monzonite to 1-m diam. The large size of the boulders has presented a recovery problem during placer-mining activities. In addition to free gold, heavy-mineral concentrates in the creek include chromite, cinnabar, free mercury, and polybasite. Bedrock consists of decomposed andesite and tuff of the Kvt unit, which is probably a poor catchment surface for placer gold. The present placer cut is in a high-energy part of the stream with hydrologic gradients to 250 m/km. Better prospective pay could possibly be found 2 to 3 km below the present operation at the canyon breakout, where the bedrock surface is Cretaceous clastic rock and the hydrologic gradient is more mature, averaging 80 m/km. The probable source of gold in Fourth of July Creek is at the southern contact of Maybe Creek pluton. At the northern contact of the pluton on Maybe Creek (placer-site 2), pan-concentrate samples from our studies have revealed consistent gold anomalies.

During the 1984 mining season, Don Harris began developing a large, shallow, low-grade placer-gold deposit near the head of Deadwood Creek (map

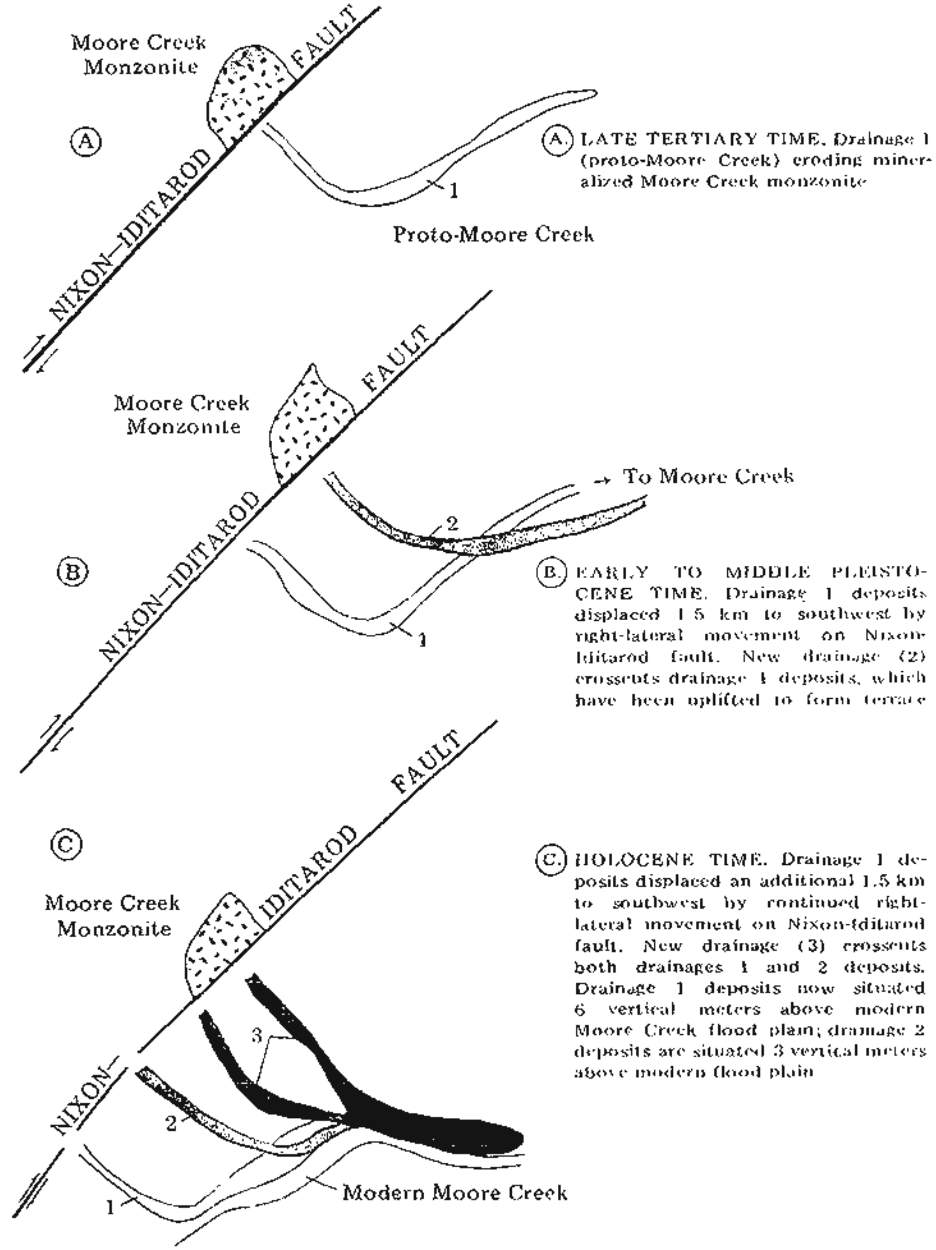

Figure 1. Speculative evolution of Moore Creek placer deposits, Iditarod C-3 Quadrangle, southwestern Alaska, showing successive displacement of drainages by right-lateral movement along the Nixon-Iditarod fault.

sheet, placer-site 1). According to Tovio Rosander (oral commun., 1983), the deposit was discovered in the late 1930s and consists of fine gold in shallow gravels 2- to 3-m thick with 1 to 3 m of muck overburden. The source of the gold may be a former stream (now captured) that drained the mineralized Maybe Creek pluton to the east.

Benefication studies of low-grade chromite placers at Moore and Fourth of July Creeks are summarized in table 3 (see map sheet). Table concentrations of 0.23-percent chromium were obtained at Moore Creek and 2.08-percent chromium at Fourth of July Creek. Both values are too low to be economically significant.

Sand-and-gravel deposits are widespread in terrace-alluvium, fan-terrace, and modern flood-plain deposits. At least 2 million tons of high-quality, washed-and-stacked aggregate exist in the placer tailings of Moore Creek.

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