U.S. GEOLOGICAL SURVEY
OPEN FILE MAP
76-191

GEOLOGY

The now largely abandoned Willow Creek mining district, located in the southwestern Talkeetna Mountains of south-central Alaska, produced nearly $18 million in gold and minor Ag between 1909 and the early 1950's (Ray, 1954). Production came from mineralized quartz veins, most of which occur in Late Cretaceous to early Tertiary granodiorite of the Talkeetna Mountains batholithic complex (Ray, 1954; Csejtey, 1974). Some of the quartz veins occur in a schist terrane of uncertain age which borders the granodiorite on the southwest. The contact between the granodiorite and the schist is not well exposed, but it may be a fault. Tertiary sedimentary rocks southeast of the batholithic complex are not mineralized. The gold-bearing veins occupy shear zones and joints in the host granodiorite and schist. The veins are cut by several postmineralization faults, and during mining, many of the lodes were lost because of this faulting.

The gold-bearing veins contain sulfide and sulfosalt mineral assemblages. Pyrite, galena, chalcopyrite, and sphalerite occur in the productive veins, whereas pyrite, chalcopyrite, molybdenite and arsenopyrite occur in the "barren" veins (those that contain subeconomic amounts of gold) (Ray, 1954). The association of gold-silver and base-metal sulfides in the productive and barren veins suggests relatively high levels in a mineralized hydrothermal system. The gold and silver, associated with base-metal sulfides, are suggestive of trace-metal zoning patterns frequently found associated with porphyry copper deposits (Jerome, 1966). Metamorphosed roof pendants and chalcedonic gossan zones along the northern border of the Talkeetna Mountains batholithic complex suggest that erosion has exposed only the top portions of the complex (Csejtey, 1974). In the eastern Alaska Range, lithologically similar but more deeply eroded granitic batholiths contain many porphyry-type, disseminated copper deposits (Richter and others, 1975a, b). To evaluate the possibility of copper mineralization at depth in the Willow Creek area, 2 weeks were spent in the summer of 1975 carrying out a reconnaissance geochemical sampling program. Approximately 100 samples of vein quartz, and sheared and altered granodiorite were collected from mines, prospects, mine dumps, and outcrop. Due to the extreme steepness of the topography and inaccessibility of most of the underground workings, a detailed sampling program could not be carried out in the available time.

ANALYSES

All samples were prepared and analyzed under the supervision of R. M. O'Leary at the U.S. Geological Survey's Field Services laboratory at Anchorage, Alaska. Cu, Pb, Zn were analyzed by atomic absorption methods (Ward and others, 1969) by M. Criswell. Semiquantitative spectrographic analyses for 30 elements were also done on all samples. Selected results of these analyses will be reported subsequently. Most of the samples consisted of quartz vein material.

RESULTS

The distribution of Cu, Pb, and Zn are shown on the accompanying maps. Enrichment factors for Cu and Pb defined as Cu/(Cu+Pb+Zn) and Pb/(Cu+Pb+Zn) are also shown. These ratios were calculated to attempt to show areas of relative copper enrichment. The technique has proven useful in locating exploration targets for copper mineralization where moderate to strong base-metal anomalies exist (Silberman and others, 1974).

Copper content ranges from 0 to 0.8 percent. It is consistently highest in the northern part of the sampled area, in the vicinity of the Black and the Holland prospects, and near the Schroff-O'Neil and Marion Twin mines at the head of Craigie and Purches Creeks. Samples with Cu contents greater than 1,000 ppm occur only here and at one other location, about 1 km east of the Gold Cord mine. Copper is moderately high (as much as 700 ppm) in several samples from near the head of upper Willow Creek, and in two samples from the large mines in the east fork of Fishhook Creek (up to 500 ppm).

Lead ranges from 0 to about 0.5 percent, and is generally lower than copper. It is highest (as much as 5,000 ppm, but generally lower than 1,000 ppm) in samples from the large mines in the east fork of Fishhook Creek. In the northern area where copper is highest, lead values do not occur above the crustal average for intermediate rocks, about 30 ppm (Parker, 1967). Low, but still anomalous amounts of lead are found in a few samples near the eastern and western margins of the mining district.

Zinc content is low, with the highest values of 600 to 700 ppm in two samples from the large mines in Fishhook Creek. Only three other samples, towards the eastern and southwestern margins of the mining district, have Zn greater than crustal average for intermediate rocks, about 70 ppm (Parker, 1967).

High values for the copper enrichment factor (greater than 0.75) are found in the northern part of the sampled area, in an area of about 5 km^2. The highest copper values occur near the heads of Craigie and Purches Creeks, and near the north end of the east fork of Fishhook Creek, northeast of the large mines. Another and probably separate area of copper enrichment is at the head of Upper Willow Creek, where copper content is moderately high. Copper enrichment ratios appear to drop off to the east and southwest of the highs in this calculated value. Two samples from outside these high copper areas yielded high copper enrichment ratio values, but very small amounts of total base metals. Accordingly, the high copper ratios of these samples should be considered unreliable.

Lead enrichment ratios are erratic, but are consistently above 0.5 largely in samples from the mines in the east fork of Fishhook Creek. Areas of lead and copper enrichment do not overlap, and there is a suggestion that lead enrichment occurs peripherally to the copper, in the central and northeastern parts of the sampled area.

CONCLUSIONS

Porphyry-type copper deposits frequently display a zoning pattern of copper enrichment in the center which is gradually replaced outward by lead and zinc, and finally by peripheral precious metals (Jerome, 1966; Theodore and Nash, 1973). At Willow Creek, similarities to this pattern exist. The high copper content of samples in the northern part of the sampled area drops off peripherally. Lead content appears to be highest south of the main copper anomaly. Because of the restricted sample coverage, it cannot yet be demonstrated that a complete zoning pattern exists, but our data suggest that the potential for disseminated copper mineralization is present, and further evaluation of the probability for it should be made. Surface sampling should be extended to the north of the present copper anomaly in the headwaters of Purches and Peters Creeks and the Kashwitna River drainage to the north of the mapped area. More samples to the east and west of the present copper anomaly should be collected to better define its areal extent.

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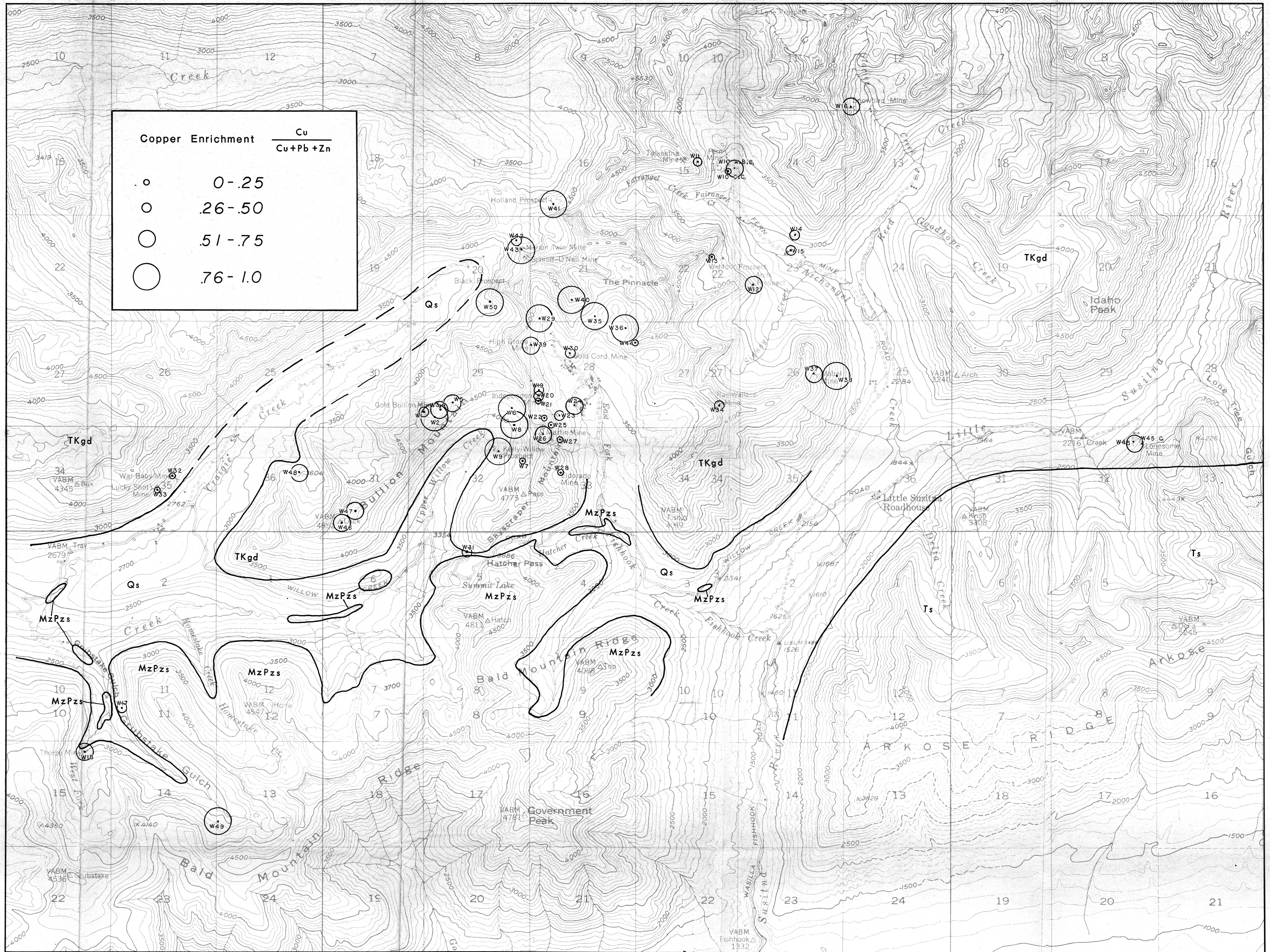


Base from USGS 1:63,360 Topo Series: ANCHORAGE (C-6) 1951, 50 ft. and 100 ft.; (C-7) 1950, 50 ft. and 100 ft.; (D-6) 1950, 100 ft.; (D-7) 1951, 100 ft.; ALASKA. Compiled Menlo Park Base Map Section, (1975) (19-30) SILBERMAN.

Geology modified from Ray (1954)

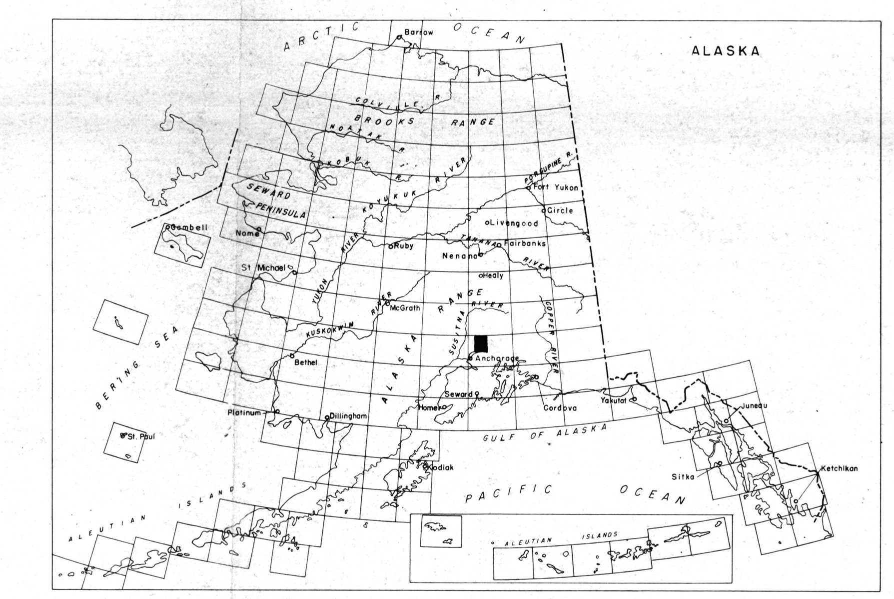
LEGEND

Qs	Quaternary alluvium and sediments
Ts	Tertiary sedimentary rocks
TKgd	Late Cretaceous to early Tertiary granodiorite
MzPzs	Mesozoic or Paleozoic schist

Contact

Contact-approximately located

•W48 Sample locality



INDEX MAP SHOWING LOCATION OF MAP AREA

Scale 1:24,000

0 1 2 Km

GEOCHEMICAL ANOMALIES IN THE WILLOW CREEK MINING DISTRICT, SOUTHERN TALKEETNA MOUNTAINS, ALASKA

SHEET 4--COPPER ENRICHMENT $\left[\frac{Cu}{Cu+Pb+Zn}\right]$ IN THE WILLOW CREEK MINING DISTRICT

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1976