

R. I. 4361

OCTOBER 1948

UNITED STATES
DEPARTMENT OF THE INTERIOR
J. A. KRUG, SECRETARY

BUREAU OF MINES
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REPORT OF INVESTIGATIONS

INVESTIGATION OF THE RAINY CREEK MERCURY PROSPECT
BETHEL DISTRICT, KUSKOKWIM REGION
SOUTHWESTERN ALASKA



BY

F. A. RUTLEDGE

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By F. A. Rutledge^{2/}

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INTRODUCTION AND SUMMARY

The Rainy Creek deposits lie at the western base of the Kilbuck Mountains, about 80 miles southeast of Bethel, in southwestern Alaska.

The deposits were brought to the attention of the Bureau of Mines by placer miners on Rainy Creek after cinnabar concentrates were recovered by their gold-mining operations.

In August 1947 the Bureau excavated 1,500 feet of dozer trenches totaling 2,547 cubic yards. Further hand trenching in the bottoms of the dozer trenches on the surface totaled 1,440 linear feet, or 40 cubic yards. Nineteen samples were taken for analyses.

ACKNOWLEDGEMENTS

The chemical analyses contained in this report were made at the Salt Lake City Experiment Station of the Bureau of Mines under the general supervision of S. R. Zimmerley, chief, Salt Lake City Experiment Station, Metallurgical Division. Analyses were made by Heber E. Peterson, chemist, Metallurgical Division.

^{1/} The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from Bureau of Mines Report of Investigations 4361."

^{2/} Mining engineer, Juneau, Alaska.

Field investigations were under the general direction of R. S. Sanford, acting chief, Alaska Branch, Mining Division. Acknowledgment also is made to Burr S. Webber, mining engineer of the Bureau of Mines, who made the preliminary examination of the deposit.

Special mention is made of the information and assistance obtained from Al Jones, owner of the Al Jones Airways, Bethel, Alaska, and operator of the placer operation on Rainy Creek.

LOCATION AND ACCESSIBILITY

The Rainy Creek deposits lie at the western base of the Kilbuck Mountains about 7 miles northwest of Mt. Oratia (figs. 1, 2, and 3) in southwestern Alaska. The deposits are on Arsenic Creek just above its junction with Rainy Creek and about 3-1/2 miles above the confluence of Rainy Creek with the North Fork of the Eek River (fig. 3), and the area is near the headwaters of the Eek River at longitude 160° 10' west, latitude 59° 59' north.

Bethel, which is at the head of ocean traffic on the Kuskokwim River and the commercial center of the district, is about N. 45° W. and approximately 78 miles distant airline from the deposit.

A winter tractor trail estimated to be 120 miles long has been established between Rainy Creek and Bethel. Freighting of general supplies and placer equipment from Bethel has averaged about \$40 a ton.

During 1945 and 1946, a prospecting outfit, including two tractors (a D-2 and a D-6), went from Goodnews Bay to Bethel, Alaska, via Rainy Creek, Canyon Creek, Cripple Creek, and Aniak. Equipment used during the Bureau program was moved from Cripple Creek, Alaska, during July 1947 over part of approximately the same trail. (See fig. 2.)

It would be possible to reach this area during high water by ascending the Eek River from the Kuskokwim. This would not be practical because of the time required and the necessity for using a canoe or small poling boat on the upper reaches of the river. The exact distance has not been determined but is estimated to be not less than 200 miles.

An emergency landing strip in the valley of the North Fork of the Eek River is about 4 miles from the Rainy Creek camp by tractor trail and can accommodate small planes. The landing strip is on the right limit of Eek River approximately 2 miles above the mouth of Rainy Creek. Ordinarily, it is necessary to charter airplane service to Rainy Creek from Bethel at a minimum of 2 hours flying time. Present charter rates range from \$60 to \$75 an hour for planes of 4 to 6 passenger capacity.

PHYSICAL FEATURES AND CLIMATE

Rainy Creek and its tributaries drain the rolling highland below the foothills flanking the western side of the Kilbuck Mountains. Though peaks in the vicinity rise to more than 2,000 feet, the area generally is about 400 feet

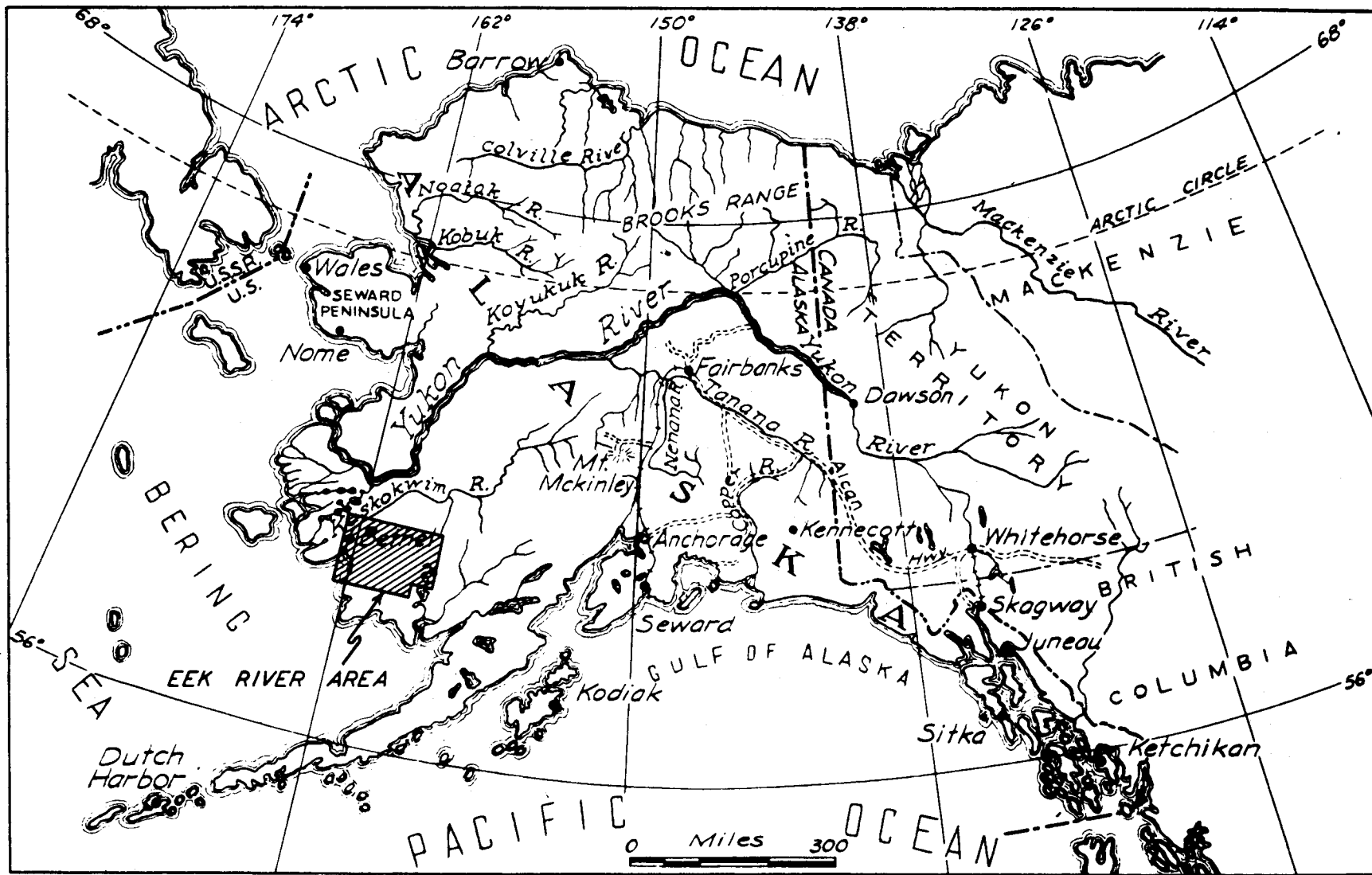


Figure 1. - Index map of Alaska.

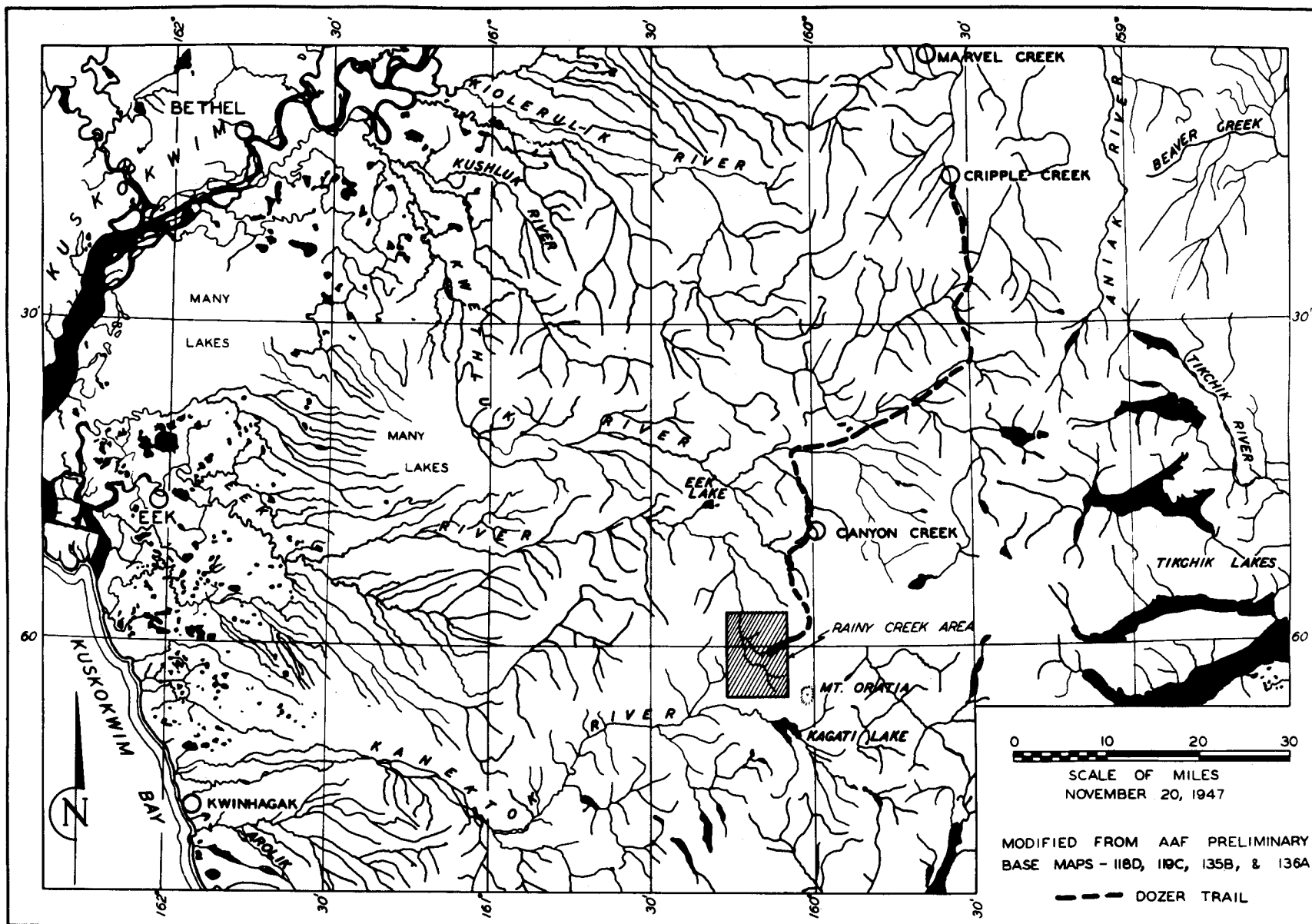


Figure 2. - Eek River area.

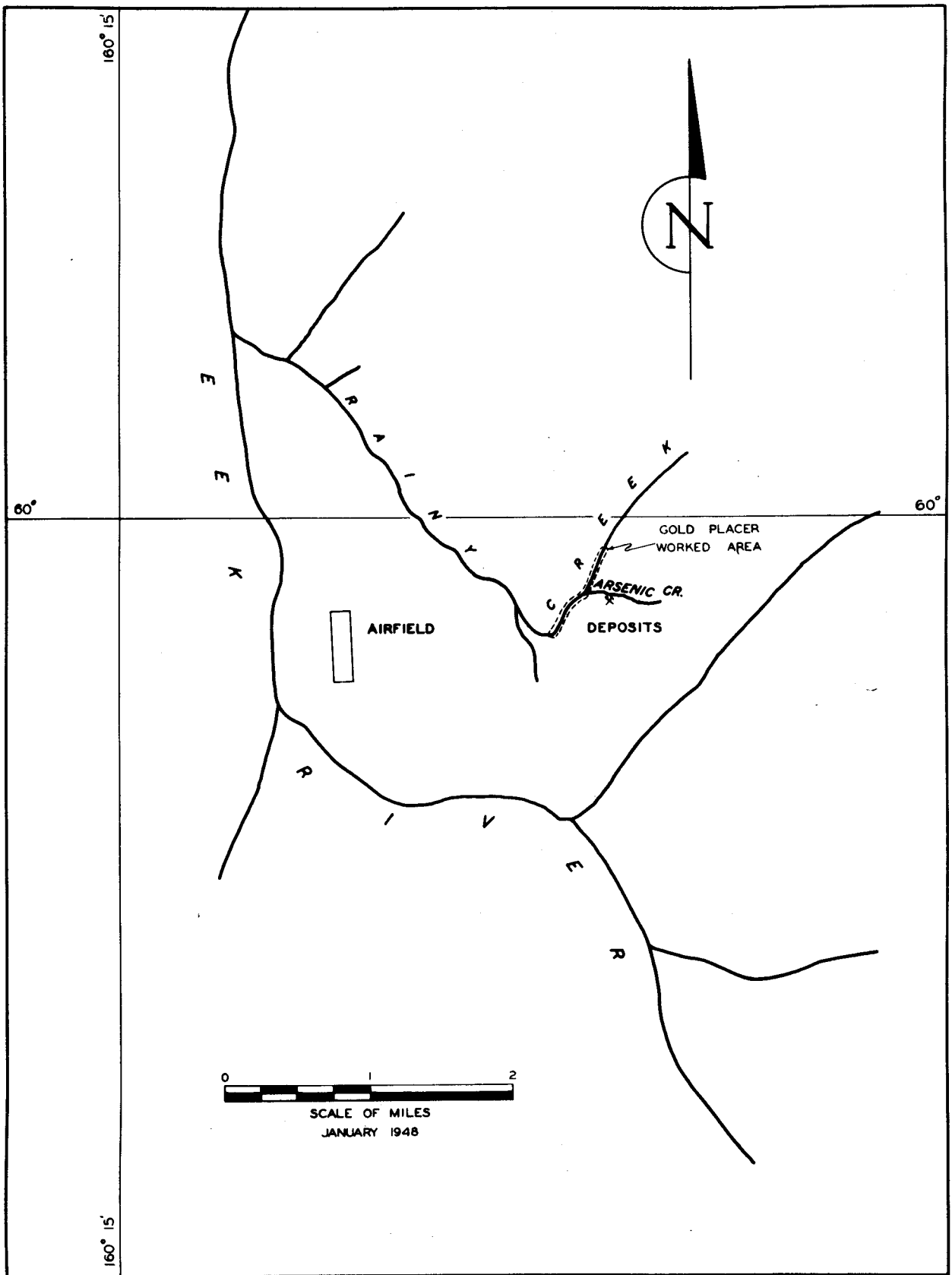


Figure 3. - Rainy Creek area.

lower. Drainage lines often coincide with contacts between softer sediments and sandstones or conglomerates, and the peaks are composed of the coarse, more resistant clastics.

The immediate area is not glaciated, though glacial moraine was noted a few miles eastward.

Except for numerous thickets of willows along the streams, vegetation consists solely of the usual tundra plants. Spruce suitable for mine use could be obtained in the Eek and Kwethluk River Basins about 30 miles west of Rainy Creek. These trees do not attain sawlog dimensions.

Climatic records from the Rainy Creek area are not available. The nearest Weather Bureau station is at Bethel, which, because of its position on the Kuskokwim River at an altitude of only 22 feet, may be expected to have a milder climate with a longer open season than Rainy Creek. Over a period of 17 years prior to 1940, the average annual precipitation at Bethel was 17.81 inches. The seasonal snowfall of 1939-40 was 12.0 inches. Maximum and minimum temperatures at Bethel in 1940 were 75° F. and -29° F., respectively. The open season in that year was April 24 to October 23.

HISTORY AND PRODUCTION

The deposits are believed to have been discovered between 1910-20 by Ed McCann of Bethel, Alaska, who sampled the outcrop of massive realgar. During the following decade a little attention was given Deposit I by Neal Corrigan, of Bethel, Alaska, in connection with his exploration of placer-gold deposits in the region. Corrigan staked the deposit and made a small cut in the face of the main showing. Subsequently he allowed the location to lapse, and it is now a part of the public domain.

Production of quicksilver from the area has been solely from cinnabar concentrates recovered during the course of gold-placer operations along Rainy Creek. All but a small fraction of the 2,000 pounds of high-grade concentrate shipped was obtained from that part of Rainy Creek below the mouth of Arsenic Creek.

GENERAL GEOLOGY

Sediments ranging from conglomerate through sandstone to black shale constitute the observed country rock in this area. Regional strike is north of east, and dips, usually high, are toward the southeast. In the vicinity of the deposit the strike ranged from N. 20° E. to N. 31° E. and the dip averaged 72° southeast.

On the basis of similarity with a succession of clastics in the nearby Goodnews Bay region, tentatively assigned to the Permian by the Federal Geological Survey^{3/}, a like age is suggested for the sediments in the Rainy Creek area.

^{3/} Smith, Philip S., Areal Geology of Alaska: U. S. Geol. Surv. Prof. Paper 192, 1939, p. 33.

Type specimens of each of the vein materials and host rocks were submitted to the Microscopic Laboratory of the Bureau of Mines at Salt Lake City for petrographic analyses. Tests were performed by Lamar G. Evans, engineer, Metallurgical Division, Bureau of Mines, Salt Lake City, with the following results:

Sandstone

No. 426-A is composed of fine, angular quartz grains and quartzite fragments cemented with chalcedony and calcite. These quartz grains are approximately 0.20 mm. in diameter. The chalcedony and calcite have minute inclusions of carbonaceous material and iron oxide giving the rock a gray color. A few sporadic grains of muscovite and microcline were observed in microscopic-grain studies. Qualitative tests for mercury were negative.

Conglomerate and Grits

Nos. 426-B and C. These two samples are alike in texture and composition. Microscopic studies of thin sections show that these samples are composed of oval igneous rock fragments cemented in an aggregate mass of chalcedony, altered feldspars, quartz, oligoclase, muscovite, and iron oxide. The oval igneous fragments have approximately the same orientation in the rock.

Tests for mercury by the ultraviolet lamp and the Willemite screen were negative.

Shale

Examination of No. 426-D shows that it is a shale. The shale has calcite disseminated through it. There are also a few quartz and orthoclase fragments scattered sporadically throughout the sample. The blackness of the sample is due to minute inclusions of iron oxide and a trace of carbonaceous material. Qualitative tests for mercury were negative.

Vein Quartz Along Bedding Plane

Sample No. 426-E is composed of a fine-grained gray quartz coated with limonite. This sample is cut by a vein of white quartz, which contains a few sporadic red inclusions of realgar and cinnabar. Gray fragments of the host rock are also scattered throughout the quartz vein.

The realgar is the bright-red inclusion, whereas the cinnabar grains are a dark, dull red.

Based upon mercury tests with the ultraviolet lamp and Willemite screen, this sample has a low mercury content.

Specimen of Mineralization from Sheared Zone

Microscopic tests prove sample No. 426-F is composed of fragments of fine-grained gray quartz, vein quartz, realgar, cinnabar, and orpiment. The realgar is the most abundant sulfide mineral, and the cinnabar occurs as inclusions in it. The only visual difference is the shade of red between the realgar and cinnabar.

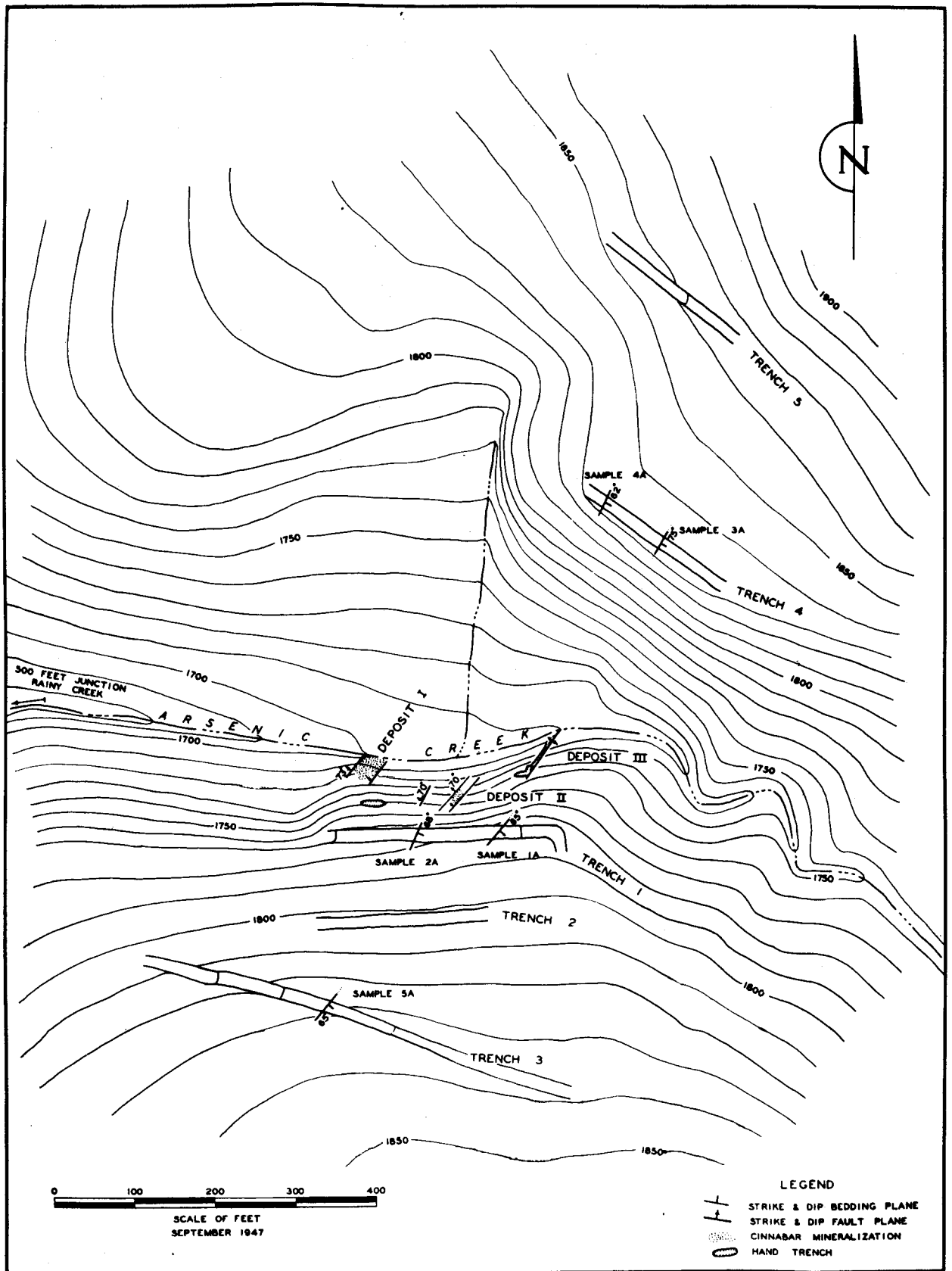


Figure 4. - Rainy Creek deposits.

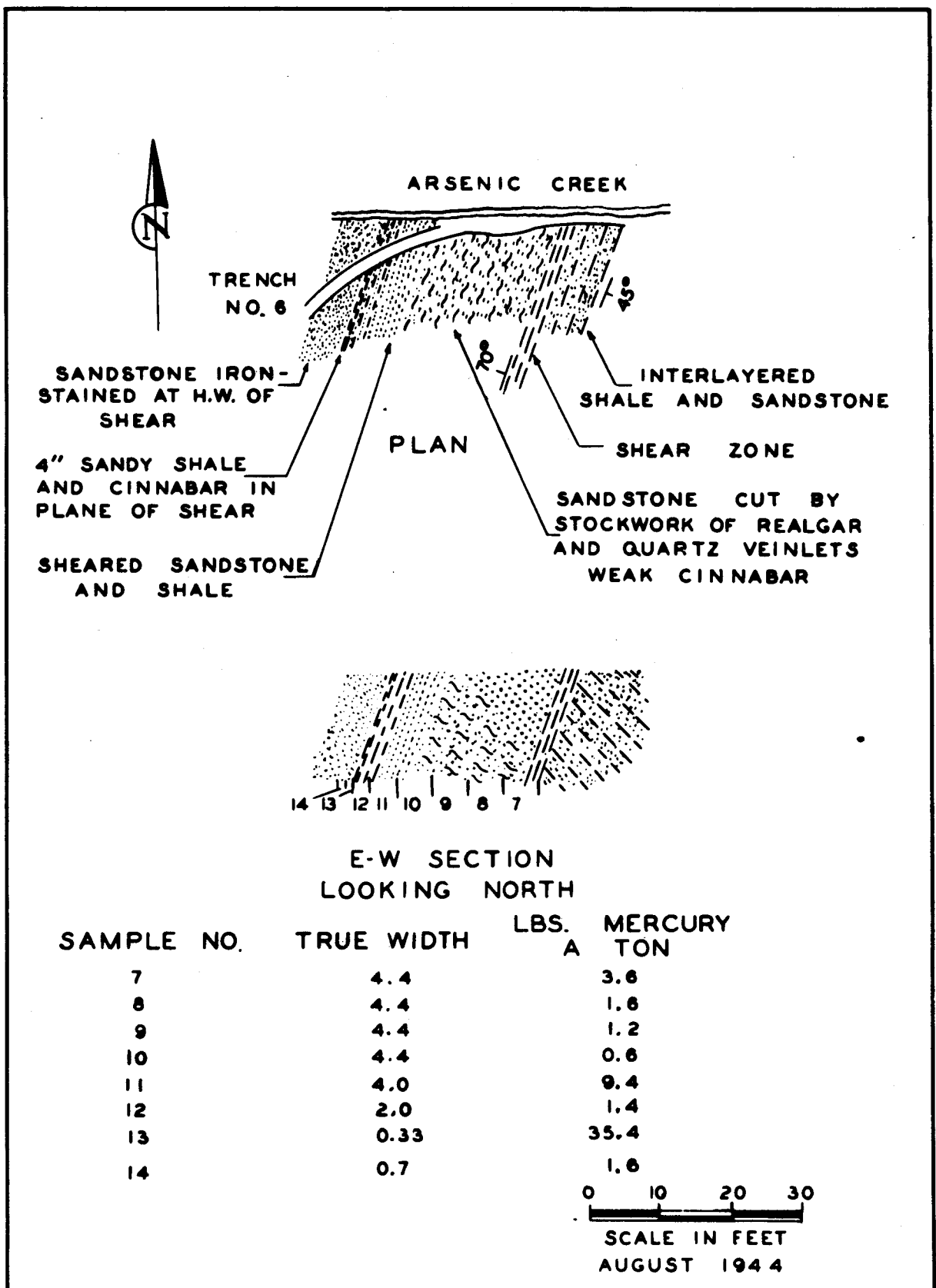


Figure 5. - Deposit No. 1, Rainy Creek area.

DESCRIPTION OF THE DEPOSITS

The Rainy Creek mercury prospect outcrops in the bluffs along the left limit of Arsenic Creek, about 1,000 feet above its confluence with Rainy Creek (fig. 4). Cinnabar mineralization is of two types - those deposits associated with fault planes roughly parallel to the bedding of the sediments, but dipping to the northeast, and deposits along the bedding planes dipping southeast. The main occurrences are of the first type.

Deposit No. I

Deposit No. I is of the first type. It outcrops at creek level and is exposed through a vertical height of 14 feet. Mineralization has been localized between two shears striking N. 30° to 35° E. and dipping 70° southwest and parallel bedding planes dipping 45° southeast. (See figs. 4 and 5)

Mineralization by realgar, cinnabar, and quartz occurs within and between the two shear zones separated by 16 feet of thoroughly fractured sandstone. Mineralization of the enclosed sandstone has a stockwork structure, and the individual seams of quartz and arsenic sulfide generally conform in attitude to that of the bedding or of the shearing. No mineralization was observed in the footwall sandstone, but an 8-inch width of the hanging-wall sandstone adjacent to the upper shear zone contains 1.6 pounds of quicksilver per ton and 0.2 percent arsenic (sample 14).

Mineralization within the footwall shear zone and the stockwork is uniformly weak. Samples 7 to 10, inclusive, represent this 17.6-foot section, which has an average mercury content of 1.8 pounds per ton and 0.9 percent arsenic. The lower 4 feet of the upper shear zone contains numerous pods of massive realgar and is represented by sample 11 containing 9.4 pounds of mercury per ton and 9.4 percent arsenic. The succeeding 2-foot section of the upper shear zone is lightly mineralized, containing 1.4 pounds of mercury a ton and 0.4 percent arsenic (sample 12). A 4-inch seam of sandy and shaly material marks the hanging wall of the upper shear zone. This sample, No. 13, contains 35.4 pounds of mercury per ton and 0.2 percent arsenic. A weighted average of this 6.33-foot cross section of the upper shear zone represented by samples 11 to 13, inclusive, is 8.22 pounds of mercury per ton and 6.08 percent arsenic.

The deposit is a rhombohedral parallelepiped with mineralization confined to a short segment of a favorable sheared sandstone bed by the two faults. To the southwest the deposit can be seen plunging under the overlying sediments. Trenching along the projected strike of the deposit to the northeast failed to reveal either the faults or associated mineralization.

Seventy feet east of deposit No. I and 25 feet higher in elevation is a small lens of cinnabar and realgar mineralization associated with a fault plane striking N. 30° E. and dipping 70° to the northwest. No sample was taken at this location, as the occurrence was too small to warrant sampling.

Deposit No. II

Approximately 100 feet east of deposit No. I and 25 feet higher in altitude is another occurrence similar to No. I. Here two parallel fault planes strike N. 45° E. and dip 70° northwest to enclose, with bedding planes, another parallelepiped deposit. Concentration of mineralization is strongest adjacent to the four sides of the deposit.

Sample 1 was taken across the concentration along the footwall fault. This sample, 1.2 feet wide, contains 5.6 pounds of mercury per ton and 18.3 percent arsenic. The 3-foot cross section between the realgar and cinnabar concentrations along the fault planes is represented by sample 3. Sample 3 contains 1.6 pounds of mercury per ton and 0.2 percent arsenic. The concentration along the hanging-wall fault (sample 2) is 3 inches wide and contains 22.8 pounds of mercury per ton and 9.8 percent arsenic.

Concentration along the hanging-wall bedding plane is represented by sample 4. This sample, 6 inches of silicified shale, contains 44.6 pounds of mercury per ton and 0.6 percent arsenic. The adjacent 3-foot section (sample 5) contains 1.2 pounds of mercury per ton and 0.4 percent arsenic.

This deposit also plunges to the southwest under the overlying sediments. Trenching along the projected strike of the deposit to the northeast failed to reveal either the faults or associated mineralization.

Deposit No. III

Deposit III is situated 100 feet east of deposit II and is composed of three small lenses adjacent to a nearly perpendicular fault plane (fig. 4). Strike of the fault is N. 30° E.

The lower lens is 4 feet above the stream level and is 1 foot long, 6 inches high, and 3 inches thick. The second and largest lens is 16.5 feet slope distance above the first. It is 4 feet long, 3 feet wide, and 3 inches thick. The third lens was also 3 inches thick but has been mined out completely.

A composite sample representative of the three lenses (sample 6) contains 45.8 pounds of mercury per ton.

Trenching in both directions along the projected strike of this fault failed to reveal additional mineralization.

Additional Mercury Mineralization

Trenching along the projected strike of the three main occurrences failed to expose continuations of these deposits, but mercury mineralization was revealed in narrow quartz veins along bedding planes in the sediments. Though these veins were too narrow and of too low grade to be economically important, they were sampled and analyzed to complete evaluation of the prospect. Location of these samples in the dozer trenches is shown on figure 4, and the analyses follow:

Sample	Width, feet	Mercury, pounds per ton	Arsenic, percent
1 A.....	0.75	1.2	0.07
2 A.....	0.80	0.6	0.05
3 A.....	0.50	0.2	0.05
4 A.....	0.60	3.4	0.07
5 A.....	1.60	1.8	0.10

In addition to the quartz veins sampled, numerous thin quartz veins were exposed that were devoid of mercury mineralization. Most of these were along the bedding planes in the sediments, though several paralleled the faults dipping to the northwest and cut across the bedding.

Though most of the cinnabar recovered during placer-gold operations on Rainy Creek was found below the mouth of Arsenic Creek and undoubtedly derived from the described occurrences, a small amount was recovered above the confluence of the two creeks and came from another place. Attempts to trace this cinnabar to its source were unsuccessful. However, the probable source is quartz veins along the bedding planes in the sediments on the left limit of Rainy Creek about 1-1/4 miles above Arsenic Creek, though no quartz containing cinnabar was found in place.

THE ORE

Mercury is present as the sulfide cinnabar in sporadic red inclusions in white vein quartz associated with the fine-grained gray quartz that forms the veins along bedding planes. Realgar, arsenic sulfide, also is present.

In the larger deposits mercury occurs in the shear zones enclosed by faults and bedding planes. Mineralization includes fragments of fine-grained gray quartz, white-vein quartz, realgar, cinnabar, and orpiment. The realgar is the most abundant sulfide mineral, and the cinnabar occurs as inclusions in it.

WORK BY BUREAU OF MINES

The Bureau of Mines' program comprised 1,499 lineal feet of dozer trenching and 2,547 cubic yards of material excavated. Hand trenching in the bottom of the dozer trenches and small hand cuts totaled 1,439 feet with 40 cubic yards. Nineteen samples were taken for analyses.