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# RECONNAISSANCE OF TATONDUK RIVER RED BEDS



by A. L. Kimball

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UNITED STATES DEPARTMENT OF THE INTERIOR

Walter J. Hickel, Secretary

BUREAU OF MINES

John F. O'Leary, Director

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# RECONNAISSANCE OF TATONDUK RIVER RED BEDS

by

A. L. Kimball[1/]

## ABSTRACT

Hematitic red beds of Cambrian to Precambrian age are exposed in the Tatonduk River valley 17 miles north of Eagle, Alaska, the nearest habitation.

Reconnaissance was conducted briefly by Bureau of Mines engineers in June 1962 and in September 1963. Access was gained by small river boat traveling 28 miles down the Yukon River from Eagle, thence 8 miles up the Tatonduk.

The red beds are dominantly hematitic tuffaceous shales and conglomerates having an estimated thickness of 1,800 feet and an exposure area of more than 6 square miles.

Nearly 800 feet of stratigraphic thickness was chip sampled in a series of discontinuous sections that assayed 4.73 to 24.7 percent soluble iron. Assays of 20.10 percent soluble iron for a 133-foot thickness, and 21.85 percent soluble iron for a 200-foot thickness are the highest obtained for significant thicknesses. A 3/4-inch thick slaty bed assayed 33.4 percent soluble iron, the maximum assay obtained.

Analyses of five bulk samples show the iron occurs as extremely fine, earthy hematite with only a trace of magnetic material and is not amenable to simple magnetic or gravity concentration.

## INTRODUCTION

Hematitic red beds have been known for many years along the lower Tatonduk River north of Eagle, Alaska. An 1,800-foot thickness of hematitic rocks, dominantly tuffaceous shale, and conglomerate of Cambrian to Precambrian age, is intermittently exposed along the river for nearly 2 miles and extends to the high country on both sides.

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Work on manuscript completed May 1968

Some readily accessible sections of the red bed sequence were examined in June 1962 and others in September 1963 by Bureau of Mines engineers to establish some measure of iron content and the amenability of the material to simple methods of upgrading by concentration.

This report presents pertinent background information, sample results, and a brief description of the work done.

## LOCATION AND ACCESSIBILITY

The Tatonduk River red bed occurrences lie 17 miles north of Eagle, Alaska, and 3 miles west of the International Boundary in the southeast corner of the Charlie River (A-1) quadrangle (figs. 1, 2). The central portion is at approximately 65°01' N latitude and 141°06' W longitude.

Eagle, the nearest habitation, is served by summer highway and year-around air service. The Yukon River also serves as an avenue of transport. The Tatonduk River enters the Yukon 28 river miles downstream from Eagle and may be ascended by small river boat 8 miles to the red bed exposures except at extreme high and low water. The Tatonduk is occasionally subject to flash floods.

It is unlikely that fixed-wing bush aircraft could be landed closer than the Yukon River surface.

## PHYSICAL FEATURES AND CLIMATE

The Tatonduk River rises in the western part of the Ogilvie Mountains of Yukon Territory with less than 10 percent of its drainage area in Alaska. A swift stream amid rugged terrain with glaciers in its headwaters, it flows westward entirely through uninhabited country to its confluence with the Yukon River 10 airline miles west of the International Boundary.

Bare white 5,000-foot limestone ridges lie just north of the red bed area whereas to the south, hills are lower and covered with vegetation. The Tatonduk River flows from an impressive limestone canyon just west of the Canadian boundary westward through the red bed area where the valley broadens and is lined with river bars and marginal terraces.

Altitudes of red bed exposures range from 900 feet in the river bottom to approximately 3,300 feet 2 miles north. Bedrock exposures are largely limited to river banks, steep upper slopes, and ridge tops. Elsewhere rocks are obscured by spruce and aspen forest, willow, alder, and muskeg.

Weather records have been kept at Eagle for most of the period since the turn of the century. Average January, July, and annual temperatures are: minus 12.4° F, 59.7° F, and 25.1° F, respectively. Extremes of 95° F and minus 75° F have been recorded. Annual precipitation is just under 11 inches, with the high months usually in summer.

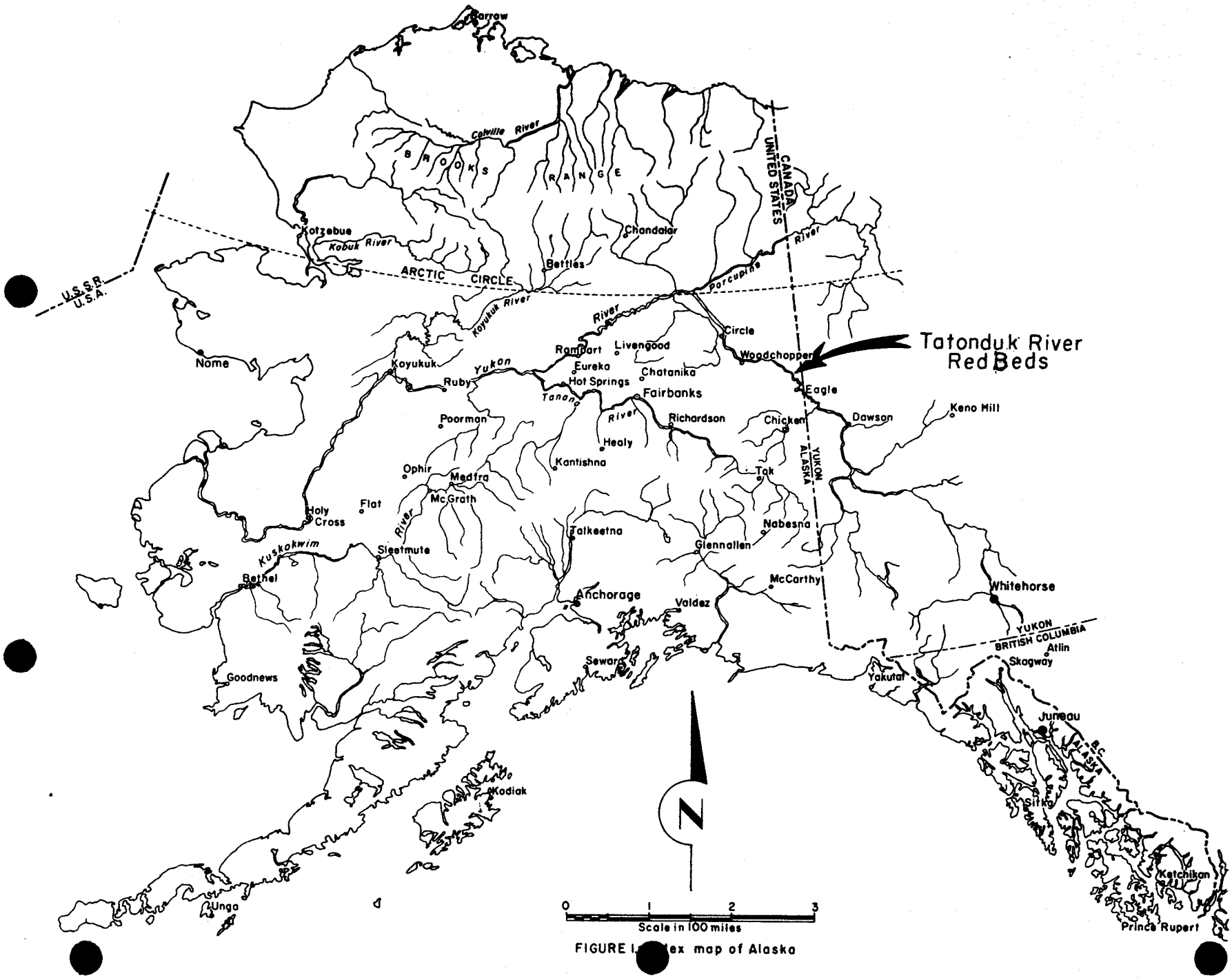


FIGURE 1. Index map of Alaska

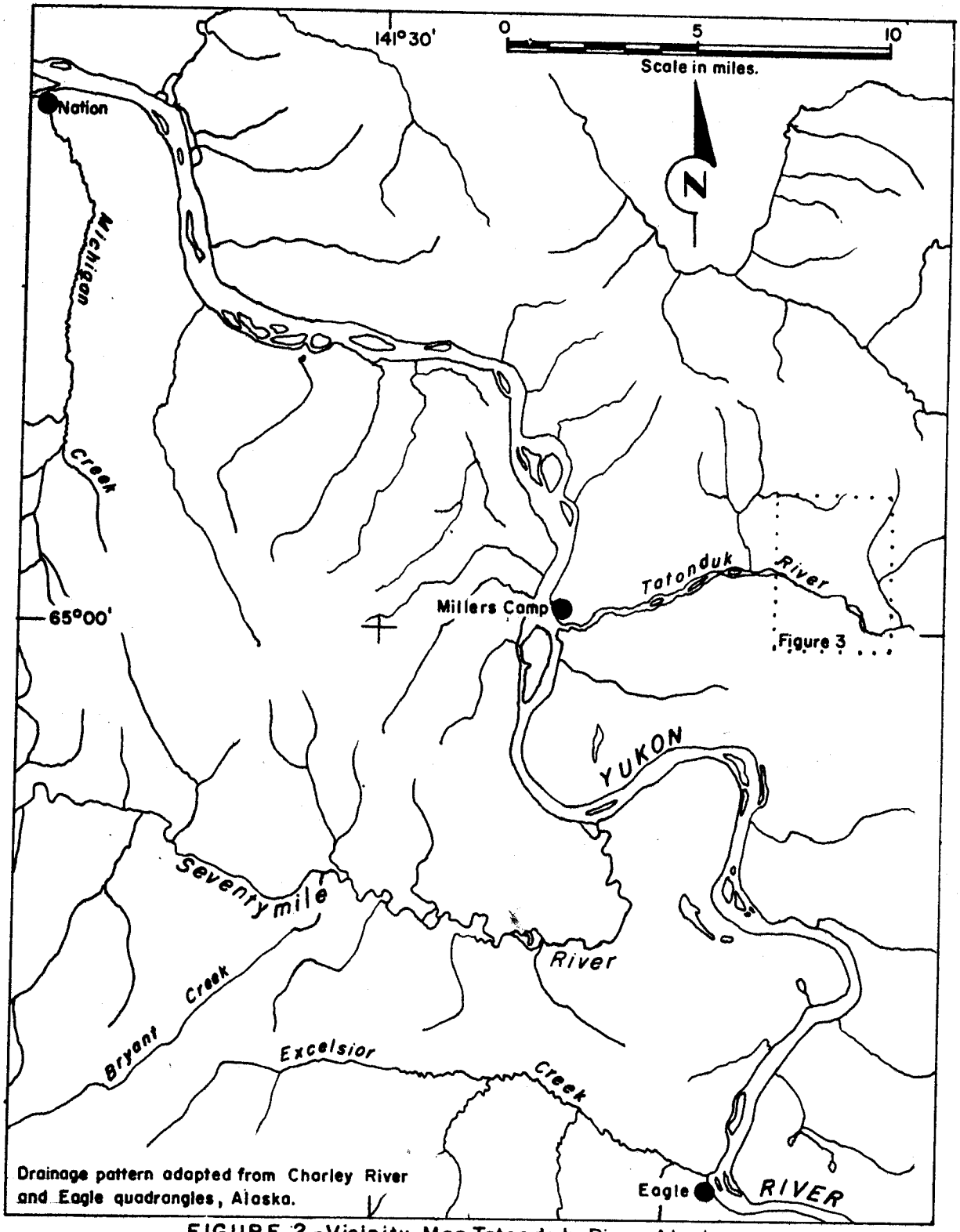


FIGURE 2.-Vicinity Map Tatonduk River, Alaska.

## GENERAL GEOLOGY

The general geology of the Tatonduk River and adjacent areas west of the Canadian boundary has been mapped and discussed by Mertie[2/] and Brabb.[3/] The rocks of this area are largely mid-Paleozoic to Precambrian sediments with a few volcanics and include limestone, dolomite, slate, conglomerate, chert, quartzite, etc. They lie in the southern part of the Kandik area where rocks are less deformed and metamorphosed than to the south of the Yukon River where more intrusive activity has occurred.

An 1,800-foot thickness of red beds is exposed intermittently for nearly 2 miles along the Tatonduk River. These rocks are largely hematitic, tuffaceous shale and conglomerate with some basalt, jasper, tuff, and dolomite. They are part of the Tindir group of Cambrian to Precambrian age, probably lying just above Birch Creek schist or equivalent in the stratigraphic column. They also include several hundred feet of hematitic basal conglomerate which is not exposed along the river banks.

The best red bed exposures seen were those washed clean by the river. Beds in downstream exposures dip west to northwest and are conformably overlain by nonhematitic sandstone and conglomerate. They become more deformed upstream toward their easterly fault contact with Ordovician and Cambrian limestone. On heights north of the river the few red bed attitudes that could be measured were not correlative with relatively simple structure apparent along the river.

Higher iron assay values were obtained from rocks that were red rather than reddish brown. So far as known, these rocks lie in the upper (younger) parts of the section.

## WORK BY THE BUREAU OF MINES

The hematitic red beds are best exposed for sampling along the Tatonduk River banks where they have been scoured and washed by river action. Red beds outcrop intermittently for nearly 2 miles along the river with gaps in stratigraphy on one bank often balanced by exposures on the opposite bank. Some portions of the north bank consist of 20- to 30-foot-high bluffs of jointed crumbling shale above swift or deep water, and are not readily accessible.

None of the beds were seen for any distance along their strike and no horizon was sampled at more than one point so far as known. However, the red bed hematite probably formed in a strongly oxidizing environment occurring intermittently during deposition, so that grade may reasonably be expected to persist along a given horizon.

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2/ Mertie, J. B., Jr. The Tatonduk-Nation District, Alaska. U.S. Geol. Survey Bull. 836-E, 1932, pp. 347-443.

3/ Brabb, Earl. Preliminary Geologic Map of Part of the Charlie River Quadrangle, East Central Alaska. U.S. Geol. Survey Open-File Report, 1962, map only.

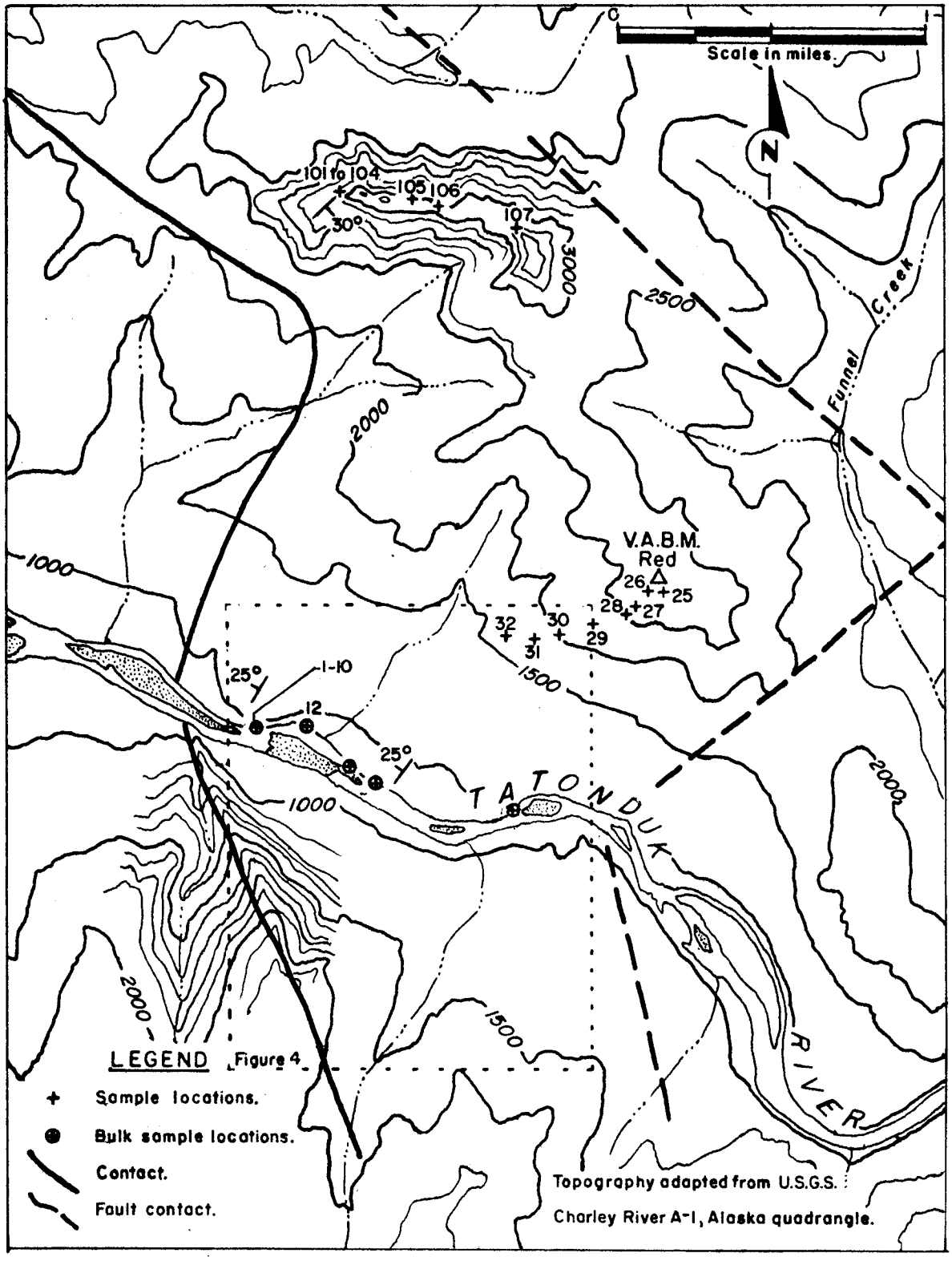


FIGURE 3.-Sample locations, Tatonduk River Red Beds.

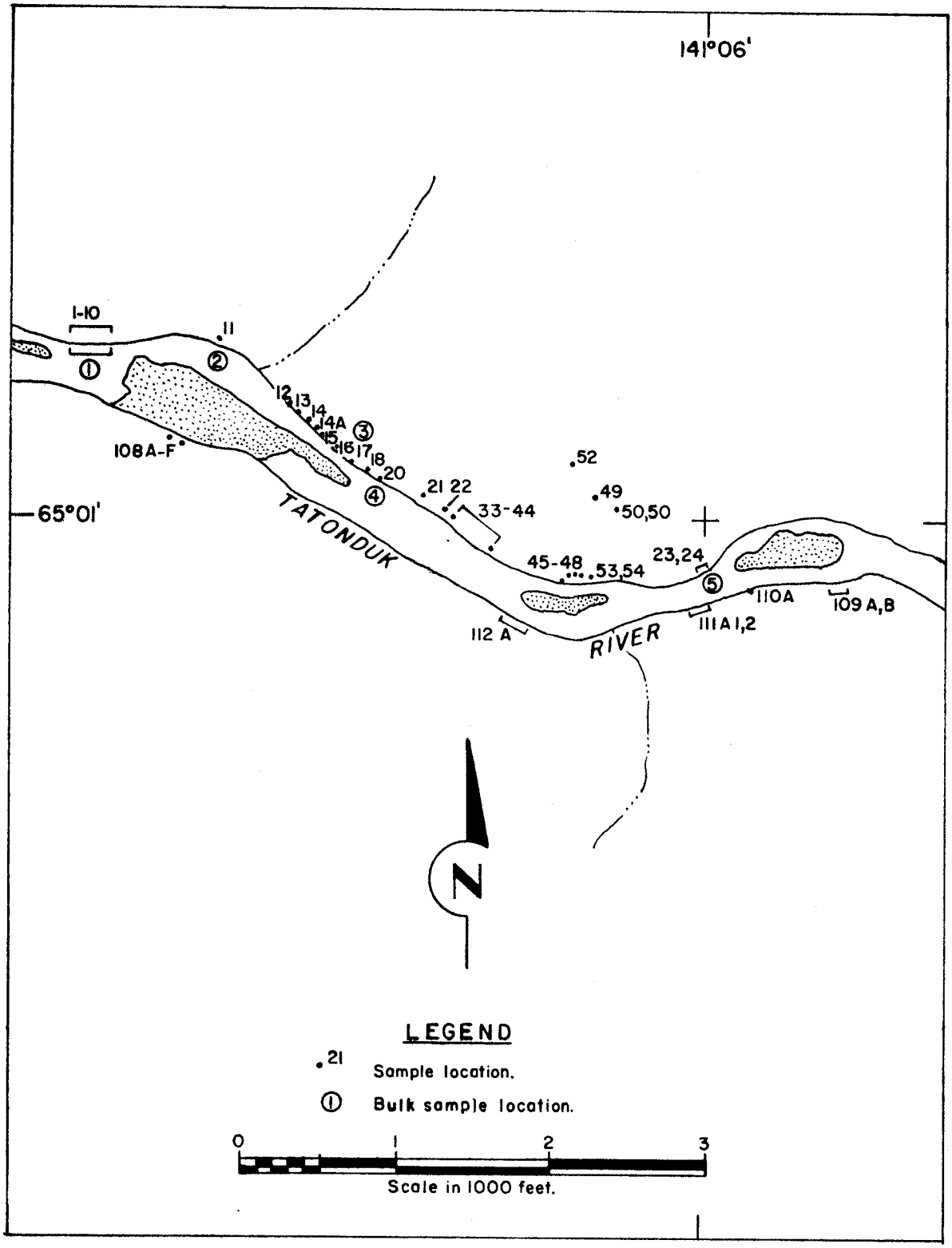


FIGURE 4.- Detailed sample location map, Tatonduk River Red Beds.

Nearly 800 feet of stratigraphic thickness was chip sampled (table 1 and figs. 3 and 4) along the river banks in a series of noncontinuous sections. Sections chip sampled on heights to the north of the river are not correlated with those along the river. Grab samples, selected for their abnormally high specific gravity, do not represent measured thicknesses except where noted.

Assays from chip sampled sections along the river varied from a low of 4.73 percent soluble iron from a 3-foot thickness to 24.7 percent soluble iron for a 9-foot thickness. Samples 1 to 10, covering a continuous section of 132.9 feet, had a weighted assay of 20.1 percent soluble iron.

A chip sample of a 200-foot section from the summit north of the river assayed 21.85 percent soluble iron, the highest assay for a significant thickness. This sample, however, was taken under poor sampling conditions and may not be as valid as the other chip samples.

The highest assay obtained from grab samples selected for their abnormally high specific gravity was 33.4 percent soluble iron, representing a bed only 3/4 inch thick.

Magnetometer reconnaissance along the north side of the river from the west to the east contact revealed one small anomaly over a thin altered andesite sill (?). Traces of magnetite were detected in it petrographically.

Laboratory tests to determine the liberation of ore minerals run on 75- to 100-pound bulk samples (tables 2 and 3) from five stratigraphic horizons show that magnetic separation and concentration is not feasible as only a trace of magnetic material is present. The iron occurs as extremely fine, earthy hematite and is not amenable to simple gravity concentration.

Chemical leaching or roasting in a reducing environment may be adaptable, but are not considered feasible under present economic conditions.

As sampling was of a reconnaissance nature, the results are not adequate to evaluate the red bed unit as a whole.

TABLE 1. - Assay results (chip and grab samples)

(See figures 3 and 4 for locations)

| Sample No. | Soluble iron assay, percent | Stratigraphic thickness | Remarks |
|---|---|---|---|
| 1 | 16.0 | 30.4 | Samples 1-10, largely hematitic shale, slate, and conglomerate with minor yellow chert and jasper. Weighted assay 20.1 percent soluble iron for the 132.9-foot continuous stratigraphic section. |
| 2 | 18.2 | 4.0 | |
| 3 | 21.8 | 20.6 | |
| 4 | 21.5 | 15.1 | |
| 5 | 21.4 | 18.0 | |
| 6 | 19.8 | 7.8 | |
| 7 | 15.5 | 12.2 | |

TABLE 1. - Assay results (chip and grab samples)--continued

(See figures 3 and 4 for locations)

| Sample No. | Soluble iron assay, percent | Stratigraphic thickness | Remarks |
|---|---|---|---|
| 8 | 21.3 | 10.1 | |
| 9 | 24.7 | 7.0 | |
| 10 | 20.7 | 7.7 | |
| 11 | 10.5 | 22.0 | Red shale. |
| 12 | 24.7 | 9.0 | Red shale and slate with minor conglomerate. |
| 13 | 17.3 | 30.4 | Do. |
| 14 | 15.6 | 36.8 | Do. |
| 14A | 13.4 | Grab | Fault gouge. |
| 15 | 16.8 | 25.0 | Similar to sample 12. |
| 16 | 11.9 | 38.4 | Do. |
| 17 | 15.9 | 41.0 | Do. |
| 18 | 13.6 | 47.0 | Do. |
| 19 | 21.7 | Grab | High specific gravity bed vicinity of samples 17 and 18. |
| 20 | 8.95 | 36.6 | Thinly bedded red-brown shale. |
| 21 | 6.33 | 47.6 | Brown shale. |
| 22 | 6.38 | 31.0 | Do. |
| 23 | 6.84 | 17.6 | Do. |
| 24 | 6.69 | 16.0 | Do. |
| 25 | 15.5 | Grab | Red shale, jasper, and yellow chert. |
| 26 | 18.9 | Grab | Do. |
| 27 | 19.1 | Grab | Red conglomerate and chert. |
| 28 | 25.5 | Grab | Red shale. |
| 29 | 20.1 | Grab | Red shale and conglomerate. |
| 30 | 26.0 | Grab | Red shale. |
| 31 | 17.0 | Grab | Do. |
| 32 | 25.2 | Grab | Red slaty shale. |
| 33 | 6.53 | 3.0 | Brown shale. |
| 34 | 6.69 | 3.0 | Do. |
| 35 | 6.23 | 4.0 | Do. |
| 36 | 6.38 | 4.0 | Do. |
| 37 | 6.89 | 4.0 | Do. |
| 38 | 6.89 | 4.0 | Do. |
| 39 | 6.48 | 4.0 | Do. |
| 40 | 6.69 | 3.0 | Do. |
| 41 | 5.97 | 3.0 | Do. |
| 42 | 4.73 | 3.0 | Do. |
| 43 | 5.61 | 1.0 | Do. |
| 44 | 5.45 | Grab | Do. |
| 45 | 8.33 | 2.5 | Andesite sill (?). |

TABLE 1. - Assay results (chip and grab samples)--continued

(See figures 3 and 4 for locations)

| Sample No. | Soluble iron assay, percent | Stratigraphic thickness | Remarks |
|---|---|---|---|
| 47 | 8.23 | 2.5 | Andesite sill (?). |
| 48 | 8.49 | 2.4 | Brown shale. |
| 49 | 6.43 | 18 | Do. |
| 50 | 6.28 | 29 | Do. Bottom ) Continuous |
| 51 | 6.28 | 52 | Do. Top ) section. |
| 52 | 6.38 | Grab | Red-brown shale. |
| 53 | 8.85 | 4.0 | Hematitic Top ) Continuous |
| 54 | 8.13 | 3.0 | conglomerate Bottom ) section. |
| 57 | 33.4 | Grab, 3/4 inch bed | Richest red bed material assayed. (Sample 8 section.) |
| 101 | 21.85 | Approximately 200 feet | Red conglomeratic shale with jasper and limonitic siliceous nodules. |
| 102 | 18.89 | 33 | Do. |
| 103 | 21.73 | 4 | Do. |
| 104 | 18.85 | Grab | High specific gravity selection from section of 102 and 103. |
| 105 | 21.19 | 14 | Red shale with jasper and yellow chert. |
| 106 | 14.13 | 4 | Do. |
| 107 | 16.12 | Grab | High specific gravity selection (see fig. 2). |
| 108A | 7.40 | 5.6 | 108A through 108F, red shale, |
| 108B | 7.02 | 3.6 | continuous section. |
| 108C | 6.55 | 7.6 | |
| 108D | 5.99 | 6.3 | |
| 108E | 6.17 | 5.2 | |
| 108F | 6.64 | 4.2 | |
| 109A | 6.24 | 6.6 | Dark red shale. |
| 109D | 7.13 | 7.0 | Red shale. |
| 110A | 6.40 | 8.7 | Do. |
| $111A_1$ | 6.10 | 4.6 | Do. |
| $111A_2$ | 6.09 | 6.1 | Do. |
| $112A^2$ | 5.46 | 54 | Brick red shale with occasional coarser clastic beds. |

TABLE 2. - Petrographic and spectroscopic analyses of five bulk samples

| Bulk sample No..... | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Spectroscopic: | | | | | |
| K..... | X | X | X | X | X |
| V..... | N | T | T | T | T |
| Chemical: | | | | | |
| P..... | T | T | T | T | T |
| Rocks: | | | | | |
| Red beds[1]..... | C | - | C | C | C |
| Dolomitic red beds[1]..... | - | C | - | - | - |
| Minerals: | | | | | |
| Ankerite-siderite..... | N | N | N | N | N |
| Apatite..... | - | T | - | - | - |
| Calcite..... | F | T | M | S | S |
| Chlorite..... | - | - | - | M | S |
| Dolomite..... | M | A | N | N | N |
| Ilmenite..... | M | M | M | M | M |
| Hematite[2]..... | A | A | A | S | S |
| Hydromuscovite-chlorite. | A | S | A | - | - |
| Hydromuscovite-illite... | S | A | A | P | P |
| Magnetite..... | N | N | N | N | T |
| Quartz..... | M | T | T | T | F |
| Fluorescence..... | N | N | N | N | N |
| Radioactivity..... | N | N | N | N | N |

Legend: P - Predominant.....over 50 percent.
A - Abundant.....10 - 50 percent.
S - Subordinate.....2 - 10 percent.
M - Minor.....0.5 - 2 percent.
F - Few.....0.1 - 0.5 percent.
T - Trace.....less than 0.1 percent.
X - Detected in sample.
C - Rock classification.
N - Sought but not detected.

[1]The rocks have a sandy texture with cement of earthy hematite and grains in part composed of earthy hematite and the clay alteration products, hydrobiotite, chlorite, and illite, derived tentatively from volcanic rock or volcanic ash. Some fragments of the samples are composed of angular fragments several mm in diameter.

[2]Does not have reflectivity of specular hematite in polished section. Liberation of ore could not be determined.

TABLE 3. - Bulk sample assays[1]

(See figures 3 and 4 for locations)

| Bulk sample No..... | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Acid soluble iron..... | 19.51 | 14.50 | 17.88 | 6.26 | 6.41 |
| Insoluble iron..... | .91 | .99 | .95 | .93 | 1.13 |
| Calculated total iron.. | 20.42 | 15.49 | 18.83 | 7.19 | 7.54 |
| $TiO_2$..... | 1.23 | .50 | .89 | 1.08 | 1.18 |
| V..... | <.01 | <.01 | <.01 | <.01 | <.01 |
| P..... | .15 | .13 | .19 | .10 | .07 |
| S..... | .030 | .033 | .022 | .044 | .024 |
| Insoluble fraction..... | 51.70 | 47.38 | 53.54 | 71.02 | 70.38 |

[1]All figures in percent.

| Bulk sample No. | Description (general) |
|---|---|
| 1 | Hematitic shale, slate, and conglomerate with minor yellow chert and jasper. |
| 2 | Red shale. |
| 3 | Red shale and slate with minor conglomerate. |
| 4 | Thin-bedded red-brown shale. |
| 5 | Brown shale, largely thin-bedded. |

## CONCLUSIONS

Some conclusions may be drawn from the results of this examination.

1. The iron occurs as very fine, earthy hematite and virtually no magnetic material is present. The deposits are not amenable to:

A. Simple gravity concentration,

B. Simple magnetic concentration,

C. Delineation of higher grade zones by magnetic means.

2. A probable upper assay limit for significant thicknesses of material is in the vicinity of 25 percent soluble iron.

3. A maximum value for very limited quantities of material may be indicated by sample No. 57 (33.4 percent soluble iron for a 3/4-inch thickness).

4. There is some likelihood that values persist along beds.