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GEOLOGIC SETTING OF THE LEAD AND ZINC DEPOSITS, DRENCHWATER CREEK AREA, HOWARD PASS QUADRANGLE, WESTERN BROOKS RANGE, ALASKA

By

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This report is preliminary
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ABSTRACT

Significant concentrations of galena, sphalerite, and minor barite are present in the Drenchwater Creek area, Howard Pass quadrangle, western Brooks Range, Alaska. Detailed geologic mapping indicates that galena, sphalerite and pyrite occur sporadically in a zone at least 1,830 m. long and 6-30 m. wide. The sulfides occur in tuff, or in dark chert and dark shale adjacent to tuff in the upper part of the Lisburne Group of Mississippian age. The sulfides, together with the tuff, dark shale, and dark chert host rocks probably are part of a stratiform, massive sulfide deposit that may have formed from volcanic exhalations. The stratiform occurrence of the sulfides is limited to a single thrust plate which is a part of a widespread tectonic breccia. The deposit may represent a fragment of a much more extensive stratiform deposit that was severely disrupted and dismembered by isoclinal folding, faulting and shearing. Other areas along the northern front of the Brooks Range particularly those associated with iron staining and the assemblage of dark chert, dark shale and tuff of the Lisburne Group should be examined for concentrations of galena and sphalerite. Because of the highly deformed nature of the terrain, further exploration should concentrate either on finding the edges of buried,

dismembered fragments of the original stratiform deposit or on geophysical techniques that may locate the dismembered fragments at depth.

INTRODUCTION

The geologic setting and controls of lead, zinc, and minor barium mineralization in the Drenchwater Creek area in the western Brooks Range, Alaska, (Fig. 1) are analyzed by detailed geologic mapping (Plate 1). The area is located in the western part of the Howard Pass quadrangle which was partially mapped by Tailleur and others (1966). During field work in 1950-1953, 1976 and 1977, I. L. Tailleur (oral comm., 1977) observed iron staining from weathered sulfide minerals, sphalerite, and minor barite in dark chert and shale of the Lisburne Group along Drenchwater Creek, within what is named the Drenchwater thrust plate (Plate 1) in this report. During field work in 1955 and 1968, Tailleur (1970) observed galena, sphalerite, and barite in similar rocks of the Lisburne Group along Red Dog Creek in the De Long Mountains, about 160 km. west of Drenchwater Creek. Because of the similarity of the sulfide occurrences and host rocks in the two areas, Tailleur (1970) suggested that other areas with prominent iron-stained dark cherts and shales of the Lisburne Group along the northern front of the Brooks Range might be the loci of lead, zinc, and barium mineralization of potential economic significance. Previously, the area had been considered to have a low potential for metallic resources.

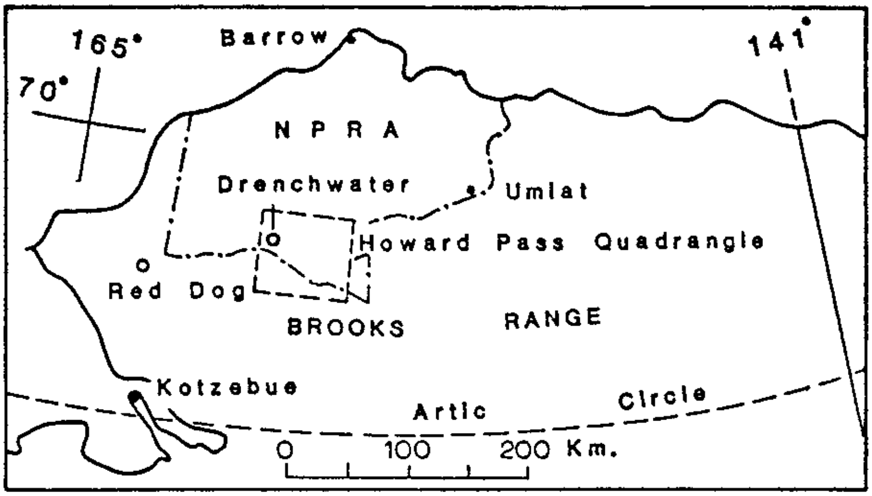

Figure 1. - Index map of northern Alaska showing location of Drenchwater Creek area in Howard Pass quadrangle.

Our detailed geologic mapping and sampling was completed during July 1977 as part of a mineral resource assessment of the northern foothills of the Brooks Range within the National Petroleum Reserve of Alaska. This assessment is part of the land-use study required by section 105(c) of the National Petroleum Reserves Act of 1976. About 44 man-days were required to complete the geologic mapping and sampling. The geologic mapping is compiled on an uncontrolled photo mosaic base, using the BAR 346 series of aerial photographs. The centers and numbers of each photograph are shown on the geologic map (Plate 1).

Drenchwater Creek flows north from the crest of the Brooks Range, which is only a few kilometers south of the mapped area, into the Kiligwa River, a tributary of the Colville River. The area is one of moderate relief with low hills and ridges rising a few tens to a few hundreds of meters above the major drainages. Southward, the crest of the Brooks Range varies in elevation from 1,500 to 2,000 meters. Although vehicle movement is practicable in the winter, helicopters provide the only effective access to the area in the summer. The closest significant communities are Kotzebue, about 240 km. to the southwest, and Umiat, about 280 km. to the northeast.

GEOLOGIC SETTING

Stratigraphy

The bedrock of the Drenchwater Creek area consists of the Lisburne Group (Mississippian), Siksikpuk Formation (Permian), Shublik Formation (Triassic), Okpikruak Formation (Cretaceous), and minor diabase dikes (Tailleur and others, 1966). The Mississippian through Triassic units consist mainly of chert and shale, with volcanic and volcaniclastic rocks in the Lisburne Group in the Drenchwater thrust plate, and reflect stable, deep-sea sedimentation. The graywacke, siltstone, and mudstone of the Cretaceous Okpikruak Formation are tectonically interleaved with all older units. In other parts of the Brooks Range, the Okpikruak Formation unconformably overlies all older rocks and apparently indicates initial uplift of the ancestral Brooks Range geanticline which was formed in the late Mesozoic (Tailleur, 1969, 1970). No stratigraphic unit is fully exposed in the Drenchwater Creek area because of intense folding, and faulting. Tailleur and others (1966) indicate that each of the Mississippian through Triassic formations or groups is relatively thin, with a maximum thickness of 153 m. The thickness and lateral extent of units in the Drenchwater Creek area are quite variable, with many discontinuous lenses of various formations (Plate 1).

In the Drenchwater Creek area, there is a rare occurrence of tuff, tuffaceous sandstone, shallow sills or flows of dacite, and green agglomerate in the Lisburne Group (Plate 1). Biotite from the dacite has been dated by K-Ar methods as 319 m. y. or Late Mississippian (Springerian) (Tailleur and others, 1977). Similar volcanic and volcaniclastic rocks also occur in the Red Dog Creek area, about 160 km. west, in conjunction with galena and sphalerite mineralization (Tailleur, 1970).

The tuffs consist of equigranular, fine-grained to aphanitic groundmass composed mostly of quartz, feldspar, and sparse biotite, and 1/2-1 mm. fragments of dark chert. Outcrops of the tuffs are strongly iron stained from weathered pyrite. The coarser tuffs and tuffaceous sandstones consist of medium-grained quartz, feldspar, and biotite, and calcite cement. In the area just west of Wager Creek, the tuffaceous units grade into tuffaceous, calcareous sandstones, suggesting a submarine sedimentary and volcanic environment. The dacite porphyry which forms sills or flows in the center of the Drenchwater thrust plate, consists of coarse-grained potash feldspar phenocrysts, medium-grained biotite phenocrysts, and a light gray, fine-grained to aphanitic matrix.

In the Drenchwater Creek area, sulfide mineralization is associated with the tuffs. Galena and sphalerite occur either in tuffs, as on the west side of Drenchwater Creek, or in dark cherts and dark shales interbedded with the tuffs, as along Drenchwater Creek, and east of the creek (Plate 1). The sulfides may occur in more than one unit of tuff, dark chert, and dark shale; however, the intense folding and faulting, and poor exposures in the area preclude any precise determination of number of mineralized horizons.

Structure

Major Structures

The prevailing bedrock structure of the Drenchwater Creek area is a coarse-grained tectonic breccia marked by interleaved, fault-bounded lenses of the various formations which pinchout within a few hundred meters. The heterogeneous mixture of lenses of various formations is quite evident in most portions of the geologic map (Plate 1), particularly in the central and southern parts of the area. Locally, large blocks of chert of the Shublik Formation and Lisburne Group are surrounded by a pervasively sheared matrix of shales of various formations. This structural pattern is also displayed on cross sections A-A' and B-B' (Plate 1). Most of the contacts are faults. However, faults are only designated on the geologic map and cross sections where extensive stratigraphic disruption exists. In the eastern part of the area, there is somewhat more continuity of units. However, in this and other parts of the Drenchwater Creek area, many units are thicker than in the type area (Tailleur and others, 1966). The increased thicknesses of the units are most readily explained as repetition due to asymmetrical folding and faulting.

Despite the intense deformation, discrete thrust plates can be separated. Each thrust plate is defined by distinct proportions of various formations and distinct structural domains. From north to south the thrust plates are defined as follows: (1) Mother Bear - a series of overturned, southward dipping, eastward plunging, asymmetrical folds developed mainly in the Lisburne Group and Siksikpuk Formation; (2) Two Cubs - the only occurrence of the Kogruk and Utukok Formations of the Lisburne Group with associated olivine gabbro and basaltic tuff; (3) Drenchwater - the principal occurrence of galena and sphalerite mineralization, tuffs, volcaniclastic sandstones, and dacite porphyry as a distinct facies of the Lisburne Group; (4) Spike Camp - a series of interleaved lenses of mainly the Siksikpuk and Shublik Formations with lesser amounts of the Okpikruak Formation; and (5) Gas Drum - a thickened sequence of cherts of the Lisburne Group and the Siksikpuk Formations. The thrust plates in turn may be larger tectonic slivers in an even coarser tectonic breccia.

The tectonic breccia exposed in the Drenchwater Creek area appears to extend at least several tens of kilometers to the west and perhaps many tens of kilometers to the east along the northern front of the Brooks Range. We observed interleaved lenses or blocks of various Paleozoic and Mesozoic formations westward into the central part of the Misheguk Mountain quadrangle as far as Nuka River and Chertchip Creek, and eastward into the Howard Pass quadrangle as far as Story Creek. The tectonic breccia is a new definition of the disturbed belt originally described by I. L. Tailleur (oral communication, 1977). In the Drenchwater Creek area, there is sparse evidence that the units are generally upright with south dips. In portions of the Shublik Formation where the pelecypod Monotis is abundant, the valves are usually convex upward and southward, indicating tops to the south. In coherent blocks of formations, the younger formations are usually towards the south (Plate 1).

Minor Structures

Minor structures mimic the major structures. All units exhibit a penetrative cleavage defined both by parting and by streaks of recrystallized clays, white mica, chlorite, and carbonaceous material. Bedding is largely obliterated by cleavage in many areas. The cleavage parallels the elongation of chert or graywacke lenses that are floating within a matrix of highly cleaved shale. Cleavage, dismembered lenses of various formations and the axial planes of sparse, isoclinal folds generally strike east and dip south (Plate 1). The cleavage, lenses of more resistant lithologies, minor isoclinal folds, major isoclinal folds, and large tectonic lenses or blocks appear to represent a single, homogeneous generation of structures formed in a single, distinct deformation.

The simplest explanation for the development of these structures and the tendency for south dipping tops is a single period of deformation involving both thrusting and asymmetrical folding with blocks from the north being thrust and folded under blocks to the south. Continued deformation resulted in shearing or faulting along the axial planes of asymmetrical folds, leaving stacks of disrupted limbs of the isoclinal folds. The deformation is either Late Cretaceous or younger because all of the Mississippian to Cretaceous formations were equally deformed.

Occurrence of the Sulfide Deposits

The galena, sphalerite, and the barite mineralization observed in this and earlier work occurs in a relatively narrow zone that extends eastward along strike from Drenchwater Creek for about 1,830 m. with a width of about 6-30 m. The zone of sulfide mineralization is restricted to the Drenchwater thrust plate. The galena and sphalerite occur principally in dark cherts and dark shales, with lesser occurrences in the tuffs. Analyses of 24 rock, soil, and stream sediment samples from the zone of mineralization show zinc values of 0 to greater than 10,000 ppm with an average of about 200 ppm, and show lead values of 20-15,000 ppm with an average of about 200 ppm. Barite is rarer and occurs only in black chert along Drenchwater Creek and in undifferentiated yellow-green cherts of the Shublik or Siksikpuk Formations in the southwest part of the mapped area. Strongly developed iron staining also occurs in the zone of sulfide mineralization as a weathering product of pyrite which is disseminated in sparse amounts in the felsic tuffs. Stream sediments are also iron-stained downstream from the tuffs. Iron staining should <u>not</u> be used as the sole prospecting tool in this region as many areas of iron-stained bedrock contain no visible galena or sphalerite, and because galena and sphalerite, without accessory pyrite, weather to shades of dark gray to black.

Limits of the Deposits

The eastern and western limits of the zone of sulfide mineralization in the Drenchwater Creek area are probably defined by of the Drenchwater thrust plate. To the east, the Drenchwater plate thins and is absent east of Wager Creek (Plate 1). To the west, the Drenchwater plate also thins and is absent in the area of Rolling Pin Creek, about 2 km. west of Drenchwater Creek. Minor amounts of sulfide mineralization may occur further south in the central portion of the Gas Drum plate (Plate 1). In this area, a thin layer of iron-stained tuff occurs with local development of boxwork aggregates of weathered sulfide minerals, but no galena or sphalerite has been observed.

Petrology

Sphalerite and galena occur primarily as disseminated grains in undeformed fragments of rock. This texture strongly suggests that sulfide crystallization occurred coincidentally with, or just after sedimentation. Less commonly, sphalerite and galena occur in 1-2 cm. thick veins of massive sulfides in brecciated chert and shales. Locally the veins crosscut cleavage, suggesting a period of mobilization and redeposition of sulfides after deformation.

Sphalerite and galena occur sparsely in the zone of sulfide mineralization; in rare hand samples, the volume of galena and sphalerite varies from 1-10 percent with the average grain size of the sulfide minerals is 1/2-2 mm. Barite occurs mainly as beds, lenses, or nodules a few centimeters wide within black chert or shale. The barite is mostly massive, light to medium gray colored, and medium to coarse grained. In contrast to the Red Dog area (Tailleur, 1970), barite does not appear to be associated with galena and sphalerite. Galena is the only sulfide observed towards the east end of the zone of mineralization In this intensely weathered and low relief area, galena occurs as sparse relic grains in a chert boxwork.

GEOLOGIC CONTROLS FOR THE SULFIDE DEPOSITS AND GUIDELINES FOR EXPLORATION

There are two major geologic controls for the galena and sphalerite deposits in the Drenchwater Creek area. First, the unique association of galena and sphalerite with tuff or with dark chert and dark shale adjacent to tuff strongly suggests that: (1) sulfide mineralization is syngenetic or stratiform, i. e., that mineralization occurred simultaneously or just after sedimentation and volcanism; and (2) volcanic exhalations were the source of the mineralizing fluids. This origin is similar to that proposed by Tailleur (1970) for the Red Dog area. And second, intense deformation, including isoclinal folding, faulting, and dismembering of formations, has severely disrupted and dismembered the former stratiform deposit. A once more extensive stratiform sulfide deposit, occurring along a stratigraphic horizon possibly extending from the Red Dog Creek area to the Drenchwater Creek area, now probably consists of dismembered lenses either hidden at depth or rarely exposed at the surface as at Drenchwater Creek.

The geologic controls provide several guidelines for further exploration along the northern front of the Brooks Range. First, because of the stratiform nature of the sulfide deposition at Red Dog Creek, Tailleur (1970) suggested that all areas of iron staining along the northern front be examined for potential economic value. We further suggest that areas underlain by the assemblage of dark chert, dark shale and tuff of the Lisburne Group should be examined in detail. Second, iron staining should not be used as the sole prospecting tool because galena and sphalerite without accessory pyrite weather to shades of dark gray to black. Consequently, every dark chert and dark shale should be examined directly, or indirectly by geochemistry. Third, because of the highly deformed nature of the Drenchwater Creek area, future exploration should concentrate on detailed geologic mapping and geophysical or geochemical methods for locating dismembered lenses of the original stratiform deposit.

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