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GEOLOGICAL SURVEY

LEAD-, ZINC-, AND BARITE-BEARING SAMPLES FROM THE WESTERN BROOKS RANGE, ALASKA

By

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With a section on petrography and mineralogy,

by G. D. Eberlein and Ray Wehr

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Abstract

Concentrations of base metal and barite of potential economic significance may be present in the western De Long Mountains, northwestern Alaska. Greater than 2 percent lead and 1 percent zinc were detected semiquantitatively in sulfide-bearing hand samples from one locality, and more than 10 percent lead was analyzed in a related stream sediment sample. The base metals as sulfides, along with barite, have been concentrated in Paleozoic and(or) Mesozoic sedimentary chert. Several other localities at which sulfides appear to be weathering are present within a 100-square-mile area. Systematic prospecting should determine if the mineralization has regional significance and has resulted in deposits of possible economic importance.

Introduction

Anomalous lead and zinc values have been analyzed in samples from a site of sulfide mineralization in the western De Long Mountains (fig. 1), a region that heretofore was considered to have a low potential for base metals. Weathering at the site is distinctive and similar weathering at other localities within a hundred-square-mile area suggests that sulfide minerals may have been concentrated at other sites.

The analyses and the pertinent known and speculative geology are reported here. The petrography and mineralogy of the samples are described in an accompanying section by Eberlein and Wehr.

The samples were collected during reconnaissance regional mapping of the De Long Mountains 1:250,000-scale quadrangle. Fieldwork in 1955 was supported logistically by the U.S. Army 30th Engineer Battalion; fieldwork in 1968 was supported indirectly by the U.S. Navy Office of Petroleum and Oil Shale Reserves and logistically by the Naval Research Laboratory (Barrow) under contract to the Office of Naval Research.

Location

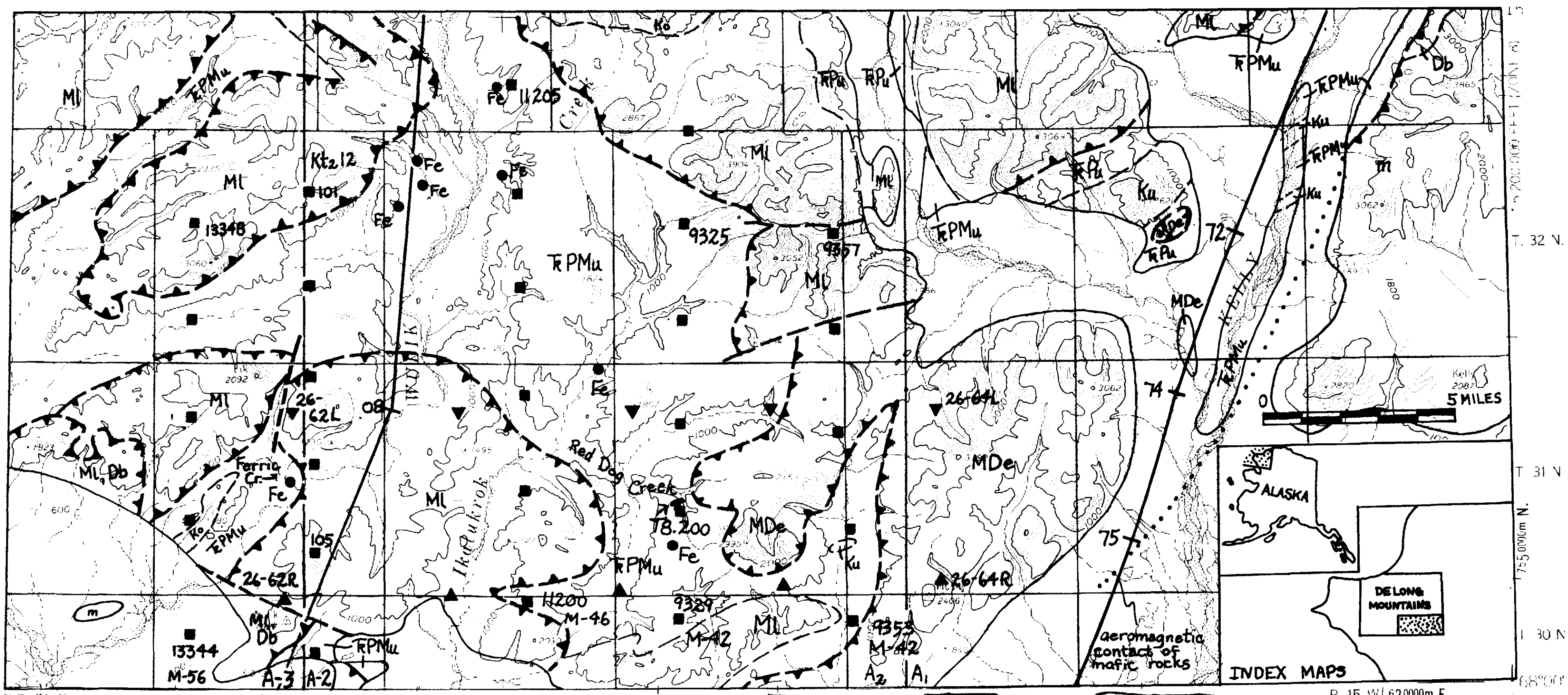
Most of the sites at which sulfide minerals appear to be weathering occur within an ill-defined topographic basin in the south half of the western end of the De Long Mountains (fig. 1). Drainages to the Wulik River and Ikalukrok Creek have eroded the rocks in the basin to broadly smooth hills and wide valleys and the more resistant surrounding rocks into rugged ridges and mountains. The sampled site (68 T200, fig. 1) is on Red Dog Creek (new name), a west-flowing tributary to Ikalukrok Creek.

The closest villages are Kivalina on the coast, 50 miles to the west, and Noatak on the Noatak River, 30 miles to the south. The regional center is at Kotzebue, 80 miles to the south.

Helicopters and possibly the smallest fixed-wing airplanes are the only effective access to the area in the summer. Movement on the frozen surface is practicable in the winter. Except across the timbered lowland along the Noatak River, a route to bargehead could follow high barren ground where the obstacles of permafrost would be most manageable.

Geologic setting

Mapping of the De Long Mountains quadrangle is incomplete so that the regional geology is known only generally and the geology at the sites of sulfide weathering is practically unknown.



Ku	TRPu	Ml	Db
Cretaceous rocks, undivided Fine-grained wacke and mudstone. Albian(?)	Triassic and Permian rocks, undivided Chert, shale, and limestone. Includes Permian Siksikpuk and Middle and Upper Triassic Shublik Formations	Lisburne Group Light- and dark-colored carbonate and chert. Lower and Upper Mississippian possibly younger locally	Baird Group Carbonate. Upper Devonian, possibly Middle Devonian and older

Ko	TRPMu	MDe	m
Okpikruak Formation conglomerate, wacke, and mudstone, Neocomian	Triassic, Permian, and Mississippian rocks, undivided Chert, carbonate, and shale. Includes Mississippian Lisburne Group in addition to Shublik and Siksikpuk Formations. Cretaceous rocks probably included locally.	Endicott Group Quartzite, conglomerate, arenite, siltstone, and shale. Upper Devonian and Lower Mississippian.	Mafic igneous rocks Mafic extrusive and intrusive rocks underlying(?) layered mafic - ultramafic rocks dated at 150-160 m.y.

Generalized contact between bedrock and surficial deposits

Inferred contact between map units

Inferred fault, teeth on upper plate of flat thrust

•Fe — T8.200

Location of sample and/or prominent iron-staining

A2|A1

1:63,360-scale quadrangle

08

Line of aeromagnetic profile

▲ Twinplex Approximate ■ Vertical Photo-centers

Figure 1. Generalized geologic map of southeastern De Long Mountains quadrangle

Grossly, the western De Long Mountains consist of a deformed stack of broad thrust plates. The geologic record reflects ordinary, stable sedimentation for the 200 million years of Devonian to Jurassic time and orogeny or mountain-building for the 70 to 100 million years of Jurassic and Cretaceous time.

Chiefly open-marine carbonates with subordinate restricted-marine rocks and nearshore clastics, interfingered from the north, were deposited in the old sedimentary basin during the Devonian to Mississippian. Thin or "condensed" marine shale, chert, limestone, and oil shale were deposited during the Permian, Triassic and earliest Jurassic.

Sedimentation in the south part of the basin was interrupted by mafic volcanics and mafic-ultramafic intrusions in the Jurassic. The resulting uplift shed detritus northward into a marine trough in the earliest Cretaceous. Broad plates of the rocks near the earth's surface were then thrust relatively northward over--or relatively southward under--one another (Tailleur, 1969). The original north-south extent of the rocks was foreshortened about half and an ancestral Brooks Range geanticline resulted. This uplift shed detritus to successor basins on either flank during the mid-Cretaceous. Most of the present Brooks Range fold belt was constructed in Late Cretaceous and early Tertiary time.

Deformation produced metamorphism and was accompanied by granitic plutonism in the south part of the Brooks Range but only folding and faulting in the De Long Mountains in the north. Mafic and ultramafic rocks (m on fig. 1) in the structurally highest thrust plate are the only igneous rocks exposed in the western De Long Mountains and no igneous rocks at depth are reflected on the two low-altitude aeromagnetic profiles

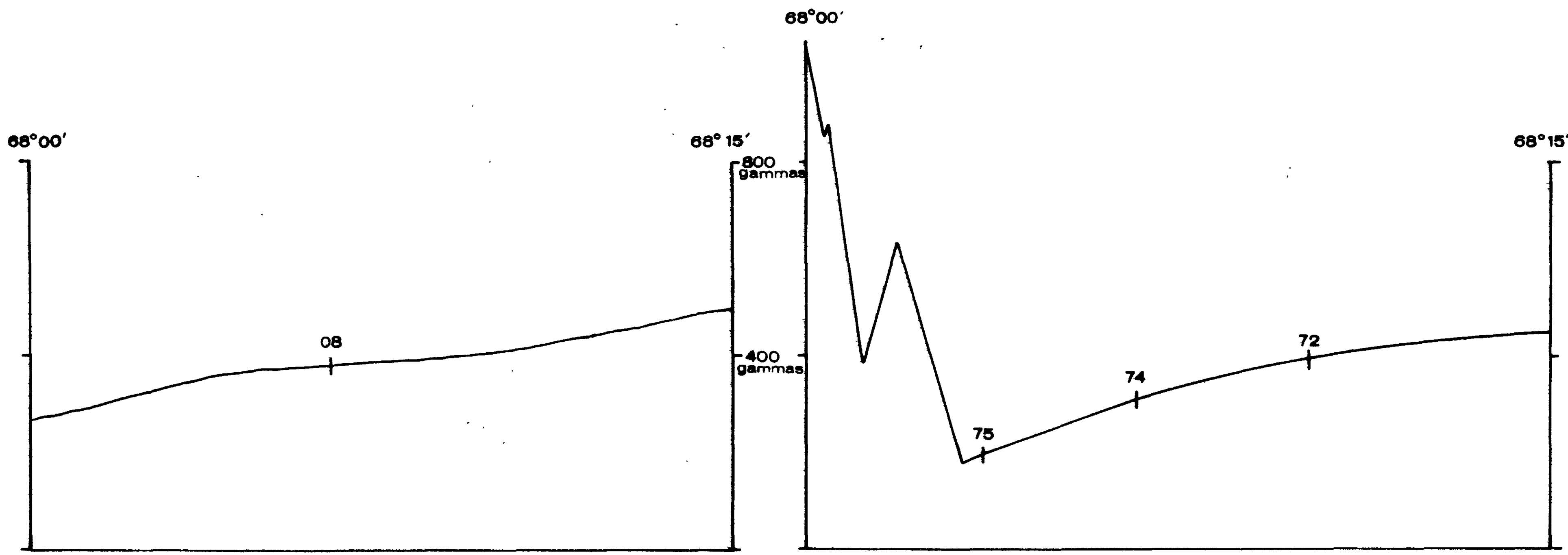


Figure 2.--Low-Altitude aeromagnetic profiles along the Wulik and Kelly Rivers as shown on Figure 1

(figs. 1 and 2) across the area (other aeromagnetic profiles are available commercially) or by gravity stations spaced 4 to 6 miles apart along the Wulik River (Barnes, 1967).

Bedrock in the topographic basin which contains the sulfide-weathering sites is a deformed assemblage of chert, shale and limestone that apparently is lowest structurally. Most of the assemblage is probably correlative with the Mississippian Lisburne Group, the Permian Siksikpuk Formation, the Triassic Shublik Formation, or Cretaceous units as mapped in the Cape Thompson area, 75 miles to the west (Campbell, 1967). It is overlain by at least one thrust plate that consists largely of thick carbonates of the Lisburne Group and another one that consists mostly of thick clastics of the Devonian and Mississippian Endicott Group. These older rocks have been eroded from upfolds to expose the younger, subthrust beds in the cores.

Red Dog Creek sample site

The locality in Red Dog Creek was selected for inspection solely because it was closer to the helicopter path than any other at the time. It was examined hastily along a foot traverse eastward from the tundra-covered divide, along the bright-colored spur, and down to the main creek.

A few outcrops rise from the tundra in the upper part of the spur, bright orange-red soil forms the crest and slope of the middle part, and ledges and talus form the foot of the spur.

The upper outcrops and rubble consist of dull-toned, varicolored chert, cherty shale, and shale that produce olive gray soil and scars; they probably represent the Shublik and Siksikpuk Formations. The lower outcrops and talus consist of moderately thick-bedded black chert and brownish-gray impure chert which produce dark-colored and silvery gray slopes and scars.

They represent the Tupik Formation, a restricted-marine unit of the Lisburne Group. Some deformed bedding and highly fractured rocks were noted; the older rocks appeared to lie below and east of the younger.

Intense weathering is evident. The orange and hematite-red soil appear to have derived from baritic and siliceous rocks like those in fragments on the surface. Some of the fragments have been leached to siliceous cinders. Minute grains of dark sulfide were discernible on freshly broken surfaces of the baritic rock. The black chert near creek level is highly iron-stained and is locally strongly leached.

Stream beds are coated with limonitic gel.

Samples and analytical results

Hand specimens of float were collected to represent the various rock types. Nine samples, including one of the stream sediment in Red Dog Creek, were submitted for semiquantitative spectrographic analysis. The silver and gold contents were obtained by atomic absorption methods. The results presented in Table 1 show a range in lead content from 0.5 to more than 2.0 percent, accompanied by values of zinc that range in excess of 1.0 percent. All samples show anomalously high barium, doubtless attributable to barite which is megascopically visible in all cases.

Because of the unusually high value reported for lead in the stream sediment sample from Red Dog Creek, that sample was reanalyzed for lead by atomic absorption. The result indicates in excess of 10 percent (>100,000 ppm) Pb.

Other localities

Similar bright-colored soil or limonitic-stained streams were seen from the air at a number of other sites within the basin. Those plotted on aerial photographs in the field are shown on figure 1.

Table 1. Semiquantitative spectrographic and atomic absorption (AA) analyses of samples from locality T8.200 in western De Long Mountains

As, Au, Bi, Sb, and W not detected. Spectrographic analyses No. 1873 - E. F. Cooley, 4/23/69. Atomic absorption analyses:

Ag - Z. C. Stephenson, 12/13/68; Au - J. G. Frisken, 12/5/68.

Analyses (ppm except as noted)

Sample Field Number	Description of hand specimen	Pb	Zn	Ag	Au	Ba	Cu	Cd	Sr	Fe	Mg	Ca	Ti	Mn	B	Be	Co	Cr	La	Mo	Nb	Ni	Sc	Sn	V	Y	Zr
				AA oz./ton	AA oz./ton					%	%	%	%														
68ATr200.6	Black silty chert	20,000	200	0.14	L	1000	10	N	50	3	.07	L	.07	10	10	L	L	70	50	5	L	30	L	L	150	N	70
200.4	Incipiently leached medium light-gray chert	15,000	700	0.13	0.001	3000	10	N	50	1.5	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	N	N
200.1	Medium-gray barite	>20,000	3,000	0.11	L	>5000	30	N	3000	.5	L	L	L	L	L	L	L	L	L	L	L	L	N	L	L	N	N
200.2	Medium light-gray, fine-grained siliceous rock, sulfide grains	7,000	500	0.11	0.0006	2000	5	N	50	.5	L	L	L	L	L	L	L	L	L	L	L	L	N	L	10	N	N
200.3	Incipiently leached brecciated siliceous rock, sphalerite? veinlet	10,000	10,000	0.17	.002	3000	20	N	50	1.5	L	L	L	L	L	L	L	L	L	L	L	L	N	L	30	N	N
200.5	Medium dark-gray leached chert	20,000	>10,000	0.28	0.08	3000	150	500	50	.7	L	L	L	20	L	L	10	L	L	L	L	L	N	10	10	N	N
$200C_1$	Leached "cinder"	20,000	700	0.32	0.0006	>5000	10	N	100	2	L	L	.005	L	L	L	10	L	L	7	L	5	N	50	L	N	L
$200C_2$	Leached "cinder"	5,000	700	0.32	0.001	>5000	30	N	70	5	L	L	.01	L	L	L	10	L	L	7	L	5	N	50	L	N	L
200.0	Stream sediment	*20,000	2,000	0.12	0.001	>5000	150	N	200	7	.7	.1	.3	700	70	1	20	200	50	30	10	10	15	10	200	20	150

* >100,000 AA

Results are reported in the series 1, 0.7, 0.5, 0.3, 0.2, 0.15, 0.1, etc.

L = Detected but below limit of determination.

N = Not detected

Most of the orange or red soils likely are weathering from sulfides like those at the Red Dog Creek locality. In most places, the bright soil was associated with bluish-gray slopes suggesting the same rock or stratigraphic interval as at the new sample locality. However, some of the limonitic stained creeks may be draining sulfide mineral concentrations of a different type.

In 1955, the bed of Ferric Creek, a tributary to the Wulik River 10 miles west of the sampled locality, was found to be so highly stained with limonite as to prompt the name. Here, weathering of iron sulfide in thin layers and disseminated through 90 feet of black mudstone or shale, presumably within the Shublik Formation, was the source of limonite carried by the stream. Semiquantitative spectrographic analyses of channel and composite samples (Table 2) show markedly lower base metal values compared to those from the Red Dog Creek locality and the indicated barium contents do not depart significantly from the average for crustal rocks of this lithology.

Conclusions and suggestions for prospecting

The restricted and reconnaissance nature of the observations reported here make it unwise to more than speculate on the possible origin and significance of the new mineral occurrences. Nevertheless, the following comments are offered in the interest of prospector guidance, especially since the area is one heretofore considered to have a low base metals resource potential.

The regional geologic and geophsyical information presently available fails to identify any exposed or buried plutonic igneous rocks to which the base metal sulfide and barite might be hydrothermally related.

Table 2. Semiquantitative spectrographic analyses and iron-sulfur assays of sulfide layers and black shale on Ferrous Creek

As, Bi, Pt, Sb, Th, U, W also not detected. Plate W-116(2) - H. J. Rose, Jr.) 3/19/57. Iron-sulfur analyses - S. M. Berthold, 11/1/56.

Analyses (ppm except as noted)

Sample Number Field (Laboratory)	Sample Description	Pb	Zn	Ag oz./ton	Au	Ba	Cu	Cd	Sr	Fe %	Mg %	Ca %	Ti %	Mn	B	Be	Co	Cr	La	Mo	Nb	Ni	Sc	Sn	V	Y	Zr	Fe_2O_3	S
55ATr91-7 (148978)	Composite grab of sulfide layers across 65 feet	30	Not reported	0.29	N	300	10	N	100	30	.003	3.0	.001	300	30	Not reported	N	30	N	10	N	N	N	N	10	N	N	36.92	14.53
55ATr91-2 (148974)	Channel upper 8.5 feet	N	--	0.29	N	300	3	N	100	.1	.03	.003	.01	10	30	--	N	100	N	10	N	10	N	N	10	N	30	.40	.35
55ATr91-3 (148975)	Channel 5.2 feet iron-rich interval	N	--	0.09	N	300	30	N	100	3	3	10	.003	3000	10	--	N	300	N	N	N	100	3	N	30	3	30	4.34	1.36
55ATr91-4 (148976)	Channel middle 32 feet shale and mudstone	N	--	0.29	N	300	10	N	100	.3	.03	.3	.003	10	10	--	N	30	N	N	N	10	N	N	10	N	30	.62	1.03
55ATr91-5 (148977)	Channel lower 19 feet	N	--	0.29	N	1000	3	N	300	1	.03	1	.01	10	30	--	N	30	N	N	N	N	3	N	10	10	30	4.03	4.73

N = Not detected

Furthermore, the analytical data, and results of petrographic and mineralogic studies on samples from the Red Dog and Ferrous Creek localities do not provide unequivocal evidence in support of such an origin. An alternative and probably more plausible working hypothesis is that rocks of the sedimentary sequence were the ultimate source of the metals and sulfur which have been remobilized and concentrated during post-depositional deformation. By analogy, important resources of base metals and barite are identified with such syngenetic deposits elsewhere in the world in a geologic environment not unlike that present in this sector of the western Brooks Range. The bedded lead-zinc and barite deposits of Meggen, Germany and, though apparently lacking in base metals, the recently discovered barite deposits in siliceous eugeosynclinal rocks of Ordovician age in Nye County, Nevada (Shawe, D. R., et al., 1969) may be cited as examples.

From a prospecting standpoint, the possibility of exploitable barite resources with or without significant concentrations of galena and sphalerite should not be overlooked, especially in view of the current petroleum drilling activity in arctic Alaska. Testing the suggested hypotheses in this geologically little known region should be guided by an awareness that both stratigraphic and structural ore mineral controls likely may be involved. All areas of limonitic staining should be examined and sampled not only for their inherent potential economic value, but also in an attempt to correlate anomalous base metals and/or barium concentrations with distinctive host rock lithologies that may be traceable even in rubble away from localities of obvious alteration by weathering. Systematic regional geochemical soil and stream sediment sampling would be a logical supplement to site sampling and examination, especially to facilitate the identification and tracing of zones of anomalously high barite concentration that otherwise might go unrecognized.

References cited

Barnes, D. F., 1967, Four preliminary gravity maps of parts of Alaska: U.S. Geol. Survey open-file report (most of Arctic slope at 1:3,300,000).

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Shawe, D. R., Poole, F. G., and Brobst, D. A., 1969, Newly discovered bedded barite deposits in East Northumberland Canyon, Nye County, Nevada: Econ. Geol., v. 64, p. 245-254.

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Petrography and Mineralogy of Lead and Zinc-bearing samples from the Western Brooks Range, Alaska

by G. D. Eberlein and Ray Wehr

Examination of thin sections prepared from hand specimens collected from the locality described in the preceding section indicates the prevalent host rocks probably are recrystallized light-colored chert or very fine grained metaquartzite and indurated dark-gray siliceous siltstone, cut by quartz veinlets of at least two generations. The microscopic characteristics of the veinlet quartz suggest it was for the most part deposited by circulating solutions in open fractures. Samples from areas of the most intense iron-staining contain ubiquitous barite as disseminated grains, irregular polycrystalline aggregates, and as a late-stage filling of the latest veinlet generation.

Most of the mineralized samples studied contain megascopically visible sphalerite, galena, pyrite and barite in a quartz vein host that commonly is iron-stained and porous due to surface weathering. Under the microscope the sulfide minerals are seen to occur mainly as irregular patches and disseminations that transect early quartz grain boundaries and are closely associated with the barite. The quartz gangue commonly is clouded with dustlike inclusions arranged in a concentric hexagonal motif that is interpreted to reflect growth stages as crystals of that mineral were being formed in open fractures or cavities. Under crossed-nicols, however, the quartz is seen to consist of more or less equant interlocking anhedra that range from 1.75 to 0.025 mm maximum diameter and whose outlines generally do not correspond to the original depositional forms. Furthermore, the quartz shows no apparent preferred optical orientation. These relationships suggest mild post-mineral recrystallization without significant stress. Local post-mineralization shearing, however, is evidenced by one sample (68ATr200.1) that consists mainly of sheared, strained, feathery aggregates of barite exhibiting twin gliding and containing streaks of sulfide minerals. The relatively high strontium content of that sample (Table 1, preceding section) suggests a composition intermediate between barite and celestite.

Discussion of stream sediment sample 68ATr200.0. The reported highly anomalous concentration of lead in excess of 100,000 ppm by atomic absorption analysis of stream sediment sample 68ATr200.0 (see Table 1) without visible galena prompted further mineralogical study of a portion of the material analyzed in an attempt to identify the lead-bearing phase. The -200 mesh split supplied by the laboratory was separated into magnetic and nonmagnetic fractions at 1.5 amps by means of a Frantz isodynamic separator and further classified into fractions greater and less than specific gravity 3.3 by use of methyline iodide. The possibility that significant lead is present as an intermediate member of the barite-anglesite series[1/] was quickly eliminated when the optical properties were

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1/ Plumbian barite, containing as much as 17.78 percent PbO, corresponding to a Pb:Ba ratio of about 1:4, has been reported from Shibukuro, Japan (Ohashi, 1920) and there probably is a continuous series between the end members in question.

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found to correspond very closely to those of the pure barium end member[2/].

[2]/The barite was found to be almost completely concentrated in the nonmagnetic @ 1.5 amp, SpG>3.3 fraction and to have the following optical properties in sodium light at 25°C:

$N_\alpha = 1.637$
$N_\beta = 1.639$
$N_\gamma = 1.648$
$+2V = 40°$
Disp. r<v weak

The separates were then subjected to X-ray fluorescence analysis, which demonstrated that the lead was preferentially concentrated with abundant iron and zinc in the magnetic, SpG>3.3 fraction. X-ray diffraction analysis of that fraction, using Fe/Mn radiation, yielded a diffraction pattern that indicates the presence of sphalerite and all the principal peaks for plumbojarosite [$PbFe_6(SO_4)_4(OH)_{12}$] except those corresponding to (101) and (220) reflections. This provisional identification of plumbojarosite is supported by the presence in the sample of numerous microscopic, highly birefringent, optically negative, dichroic brown to golden yellowish platelets.

Further confirmation of plumbojarosite would require additional more refined sample preparation and examination that was considered unwarranted in terms of the preliminary and reconnaissance nature of this investigation. Pending further study, the high lead content of the stream sediment sample (68ATr200.0) is tentatively attributed to plumbojarosite and to possible adsorption by hydrated ferric iron oxides ("limonite") which characterize the sample.

Reference cited

Ohashi, 1920: Min. Mag., 19, 73.