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MINERAL INVESTIGATIONS OF D-2 LANDS IN THE PHILIP SMITH MOUNTAINS AND CHANDLER LAKE QUADRANGLES

by

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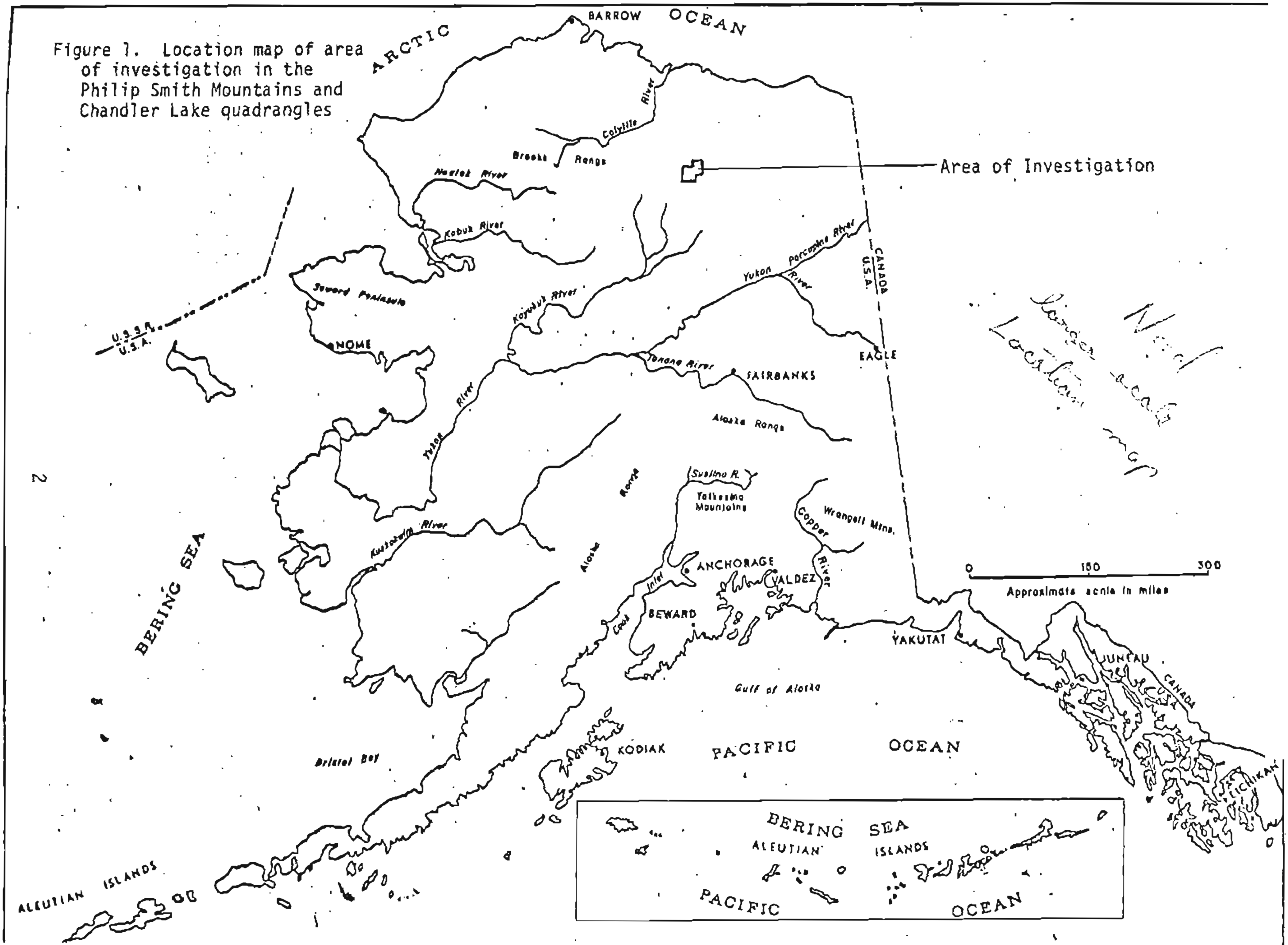
INTRODUCTION

Eight hundred and sixty-five stream sediment samples were collected over an area of approximately 2,120 square kilometers (828 square miles) in the Chandler Lake and Philip Smith Mountains quadrangles (Fig. 1). The samples were analyzed by atomic absorption methods for Cu, Pb, Zn, Ag and Mo. Statistical reduction of the data resulted in the definition of 86 anomalous samples. The majority of the anomalous samples were from streams draining either the Hunt Fork Shale, Kanayut Conglomerate, or the Lisburne Group. The anomalous samples are grouped in ten seperate areas; eight of these areas warrant additional field examination. The number of geochemical anomalies within the area indicates that region has good potential for copper, lead and zinc sulfide mineral deposits.

Figure 1. Location map of area of investigation in the Philip Smith Mountains and Chandler Lake quadrangles



OBJECTIVE

The objective of the investigation was to determine through stream sediment sampling the mineral potential of an area of approximately 2200 square kilometers (850 square miles) in the Philip Smith Mountains and Chandler Lake quadrangles.

PREVIOUS INVESTIGATIONS

Detailed geologic investigations in the area began as early as 1901 when F. C. Schrader of the U. S. Geological Survey traversed the area between Bettles and Barrow. Earlier work by several groups of explorationists along the northern coast of Alaska began as early as 1826 when the Earl of Bathhurst, Sir John Franklin decended the MacKenzie River to its mouth and explored westward to about the 149th degree of longitude (Schrader, 1904). Later work by Dease and Simpson around 1837 surveyed the general geography of the region. Their surveys also described some first geologic observations made during their traversing. Work by Leffingwell (1919) in the Canning River region contributed much to the early geographic and geologic information of the area. Detailed descriptions of permafrost conditions and periglacial processes that are active in the high arctic are included in Leffingwell's work. Geologic investigations in the region continued at a slow pace until about 1940 when the U. S. Geological Survey and the Department of the Navy undertook a program to evaluate the gas and oil potential of Naval Petroleum Reserve #4, now known as National Petroleum Reserve Alaska.

Recent work by Bowsher and Dutro (1957) of the U. S. Geological Survey in the Shainin Lake area has resulted in a better understanding of the stratigraphy and structure of the rock units in the region. Detailed geologic investigations east of Shainin Lake in the Shaviovik and Sagavanirktok Rivers region by Keller et al (1961) has resulted in detailed descriptions of the Mississippian to recent geologic section present in the area. The detailed rock descriptions contained in their report serve as a base from which much of the later work in the area is based. Geologic mapping and sampling by Patton and Tailleur (1964) in the Killik-Itkillik region, east of Shainin Lake has resulted in a regional geologic map and detailed stratigraphic data for the rocks in the area. Brosge et al (1962), produced the first good synthesis of the geologic setting and bedrock geology of the region between Galbraith Lake and the Canadian Border. Detailed geologic work by Porter (1965), in the Anaktuvak Pass region contributed much to the understanding of the geologic history and structural evolution of the rock sequences on the north-flank of the Brooks Range. Detailed mapping and structural interpretations by Reed (1968), in an area of the northeast Brooks Range near Peters Lake, resulted in a good treatment of the bedrock geology of the area. Geologic investigations, by Tourtelot and Tailleur (1971), on the Shublik Formation in northern Alaska described the unit, and it's depositional and diagenetic history as well as it's trace and major elemental compositions. Similar work by Wood and Armstrong (1975) on the Lisburne Group limestones resulted in the most complete description of the Lisburne Group, its stratigraphy and its diagenetic history.

Armstrong and Mamet (1975), have studied eight carboniferous stratigraphic sections in north-east Alaska and have described the biostratigraphy of these rocks. Detterman et al (1975) conducted detailed investigations of the post-carboniferous rocks in north-eastern Alaska that resulted in a complete description of these rock units.

REGIONAL GEOLOGY AND PETROLOGY

The north-central Brooks Range is underlain by a thick sequence of highly deformed marine and non-marine detrital sedimentary and marine carbonate rocks of Paleozoic and Mesozoic age (Porter, 1965).

The oldest rocks that crop out in the southern Philip Smith Mountains quadrangle consist of discontinous outcrops of the middle and upper Devonian Skajit Limestone. The Skajit Limestone is represented by at least 610 meters (2,000 feet) of thin-to massive-bedded, light gray-to red-brown, recrystallized limestone and dolomitic limestone that is recrystallized. Chert constitutes a major portion of the Skajit Limestone in the Philip Smith Mountains quadrangle, unlike the Skajit Limestone in the Chandalar quadrangle, where chert is lacking and slate and minor sandstone make up a major part of the sequence. Unconformably overlying the Skajit Limestone in the southern part of the area is a sequence of silty shale, siltstone and sandstone that make up the lowest member of the Hunt Fork Shale. The shale and siltstone are generally dark-gray and weather dark yellow to red. The sandstones are characteristically gray-green, thin-bedded, very fine-grained, calcareous sandstones. Locally, beneath the lower member of the Hunt Fork Shale is an unnamed unit that is composed of brown to orange, gray and black, shale, sandstone, siltstone, conglomerate and limestone that may contain reef structures (Brosge et al, 1977). Minor shaly limestone, conglomeratic limestone, red and green shale, and phyllite are also present. At it's type section on Fire Creek, about 40 kilometers (25 miles) east of the Killik River, the Hunt Fork Shale is about 970 meters (3,200 feet) thick, the lowest 240 meters (800 feet) constitutes the lowest member.

The lowest member of the Hunt Fork Shale grades upward into a sequence of rocks composed of about 300 meters (1,000 feet) of silty shale and siltstone. The shale is generally gray to greenish-gray, dark yellow-red weathering shale with dark-gray silty concretions to 10 centimeters (4 inches) in diameter. Conformably overlying the shale-slate member is a sequence of about 379 meters (1,250 feet) of clay shale, siltstone and silty shale. The lower 76 meters (250 feet) of this member is distinctive because of the nonresistant nature of the clay shale horizons. The clay shales weather easily and usually form areas of lower topographic expression. The soils produced from the weathered clay shale is characteristically bright red, and are easily recognized. A characteristic feature of the Hunt Fork Shale is the relative abundance of anastomozing quartz veins. Pyrite and marcasite crystals are common with small amounts of galena (Chapman et al, 1964). Fossil marine brachiopods, pelecypods, gastropods and fish teeth found in the Hunt Fork Shale are mid Devonian in age (Chapman et al, 1964).

Conformably overlying the Hunt Fork Shale is the Kanayut Conglomerate, a dominantly non-marine sequence of interbedded chert pebble to cobble conglomerate, sandstone and shale. The Kanayut conglomerate has been subdivided into three members at it's type locality near Shainin Lake. The overall extent of the Kanayut conglomerate is not known, however, it has been recognized as far west as Feniak Lake in the western Brooks Range and as far east as the Sheenjek River on the eastern Brooks Range.

The total stratigraphic thickness of the Kanayut probably does not exceed 1,515 meters (5,000 feet). The unit apparently thins to the south, where Kayak Shale of lower Mississippian age lies directly on middle Devonian sandstones and shales possibly of the Hunt Fork Shale. The Kanayut also thins to the north, where it is not recognized in the northern belt of Paleozoic rocks. It may be absent or may be equivalent to a thin conglomerate unit named the Kekiktuk Conglomerate (Brosge et al, 1962). The lowest member of the Kanayut Conglomerate is composed of thin-bedded, fine-grained sandstone and interbedded shale. The sandstone is generally an olive-gray, red-brown weathering, quartzose sandstone that is cross-stratified and occurs in beds less than 0.3 meters (1 foot) thick. The intercalated shale is mainly composed of thin-bedded and cross-bedded, dark-green to black, platy, silty shale and shale. The contact between this lower unit of the Kanayut Conglomerate and the underlying Hunt Fork shale is conformable and appears to be gradational (Chapman et al, 1964). The maximum stratigraphic thickness of this lower unit is about 545 meters (1,800 feet), near Red Rock Mountain, southeast of Anaktuvak Pass (Porter, 1965). The middle member of the Kanayut Conglomerate constitutes the bulk of the unit and is characterized by the presence of conglomerate beds. The middle member exposed at Shainin Lake is composed of about 311 meters (1,026 feet) of conglomerate, sandstone and shale that are interbedded in a possible cyclic pattern throughout the member (Porter, 1965). Porter (1965) describes the cyclic sedimentation as a fining upward sequence of conglomerate or coarse sandstone to shale. Near the top of the conglomerate member (middle member) the amount of conglomerate decreases and is replaced by cross-bedded, platy sandstone. The conglomerate layers do not persist laterally for great distances, and generally are lensoid in shape with thicknesses ranging from 0.3 to 10 meters (1 to 30 feet) (Porter, 1965). Eighty-five percent of the pebbles in the conglomerates are composed of chert ranging to 5 centimeters (2.0 inches) in diameter. The chert varies widely in color with gray, white, black, bluish green, yellowish brown, and red varieties known. White quartz pebbles make up about 5 percent of the pebbles and the remaining 10 percent of the pebbles is composed of quartz sandstone, argillite and chert breccia. The pebbles lie in definite layers or are scattered throughout a finer-grained matrix of coarse-grained, quartz sandstone that constitutes between 50 and 80 percent of the rock. The primary cementing agents are silica and iron oxide. Where silica is the cementing agent, the rock is extremely compitent and cross-grain fracturing occurs. The sandstones of the middle member of the Kanayut Conglomerate range from poorly bedded units to well-bedded layers of brownish-gray to light olive-gray, medium-to coarse-grained, thin-bedded to massive, locally ferruginous quartzose sandstone. Locally, thin beds of black pyritic shale containing plant fragments are present (Porter, 1965).

The upper part of the Kanayut Conglomerate, known as the Stuver Member, consists mainly of conglomerate and sandstone. At it's type locality near Shainin Lake, the Stuver Member is composed of between 25 and 50 percent shale and 50 to 75 percent fine-grained sandstone and siltstone, and no conglomerate layers are present. The sandstone is usually massive and poorly bedded near the base of the member, and becomes well-bedded near the top of the section. The sandstone is normally a fine-grained, light gray, yellow-weathering sandstone. Shale interbeds are typically brownish-gray-to olive gray or black, platy shale. Raindrop impressions, mudcracks, ripple marks and worm trails are found on the bedding surfaces as well as well preserved plant fossils. The sandstones and shales of the Stuver member are gradational with the underlying conglomerate member. As much as 300 meters (1,000 feet) of Stuver Member rocks are present in the Anaktuvak Pass area and about 260 meters (860 feet) of section is represented at it's type locality near Shainin Lake, therefore Porter (1965) feels that the Stuver Member thickens to the southwest, which is the case for the entire Kanayut Conglomerate sequence.

Unconformably overlying the Kanayut Conglomerate is the Kayak Shale of lower Mississippian age. Bowsher and Dutro (1957) subdivided the Kayak Shale into five informal members near Shainin Lake. Total thickness of the Kayak Shale is about 290 meters (960 feet), however, due to it's incompetent nature, the shale is extremely deformed. The basal sandstone member consists of about 40 meters (130 feet) of poorly-bedded, grayish-brown siltstone and a more competent medium-gray to brown-gray, very fine-grained quartzose sandstone. The sandstones are ripple marked and worm trails are present locally. The lower black shale member overlying the basal sandstone, is grayish-black, hard, fissile, yellow-weathering shale. The shale contains a strong, well developed axial-plane cleavage (Porter, 1965). The argillaceous limestone member of the Kayak Shale is a bluish-gray, coarsely crystalline, argillaceous, bioclastic limestone. The total thickness of the limestone member is about 30 meters (100 feet). Intercalated shale horizons contain abundant limonite that gives the rock a red-yellow coloration. The upper shale member is composed of dark-gray, calcareous shale and medium-dark gray, slightly argillaceous, bioclastic limestone that weathers dusty red and reddish brown, and is about 43 meters (141 feet) thick. Conformably overlying the upper shale member is a very distinctive, reddish weathering, ferruginous, fine-to medium-grained bioclastic limestone. The limestone layer ranges between 0.3 and 5 meters (1 and 15 feet) thick and is an easily recognized unit marking the upper limit of the Kayak Shale.

Unconformably overlying the Kayak Shale in northern Alaska are rocks of the early and late Mississippian Lisburne Group. The Lisburne Group was first described by Schrader (1904) as the Lisburne Formation, and has since been upgraded to the group status. The Lisburne Group is subdivided into three formations, the Wachsmuth Limestone of early Mississippian age and the Alapah Limestone of late Mississippian age and the Wahoo Limestone of Pennsylvanian and Permian age. The Wachsmuth Limestone has been subdivided into four members at it's type locality near Shainin Lake. The lowest member of the Wachsmuth Limestone at Shainin Lake is a unit that is much the same as the upper part of the underlying Kayak Shale and consists of dark-gray to olive-gray, fine-grained, shaly, argillaceous, nodular limestone and shale. The dominance of the carbonate content of this member is the marked difference between this unit and the underlying Kayak Shale. This sequence of rocks probably represents a continuation of quiet, open-water marine sedimentation that persisted during the deposition of the Kayak Shale (Wood and Armstrong, 1975). The shaly limestone member of the Wachsmuth Limestone is about 6 meters (18 feet) thick at the type locality. Conformably overlying the shaly member of the Wachsmuth Limestone is a richly fossiliferous member that is composed of medium-to dark gray, medium-to coarse-grained, crinoidal limestone in which the bioclastic content is as high as 20 percent. The crinoidal limestone member of the Wachsmuth Limestone is about 55 meters (180 feet) thick at its type locality and like the entire Wachsmuth Limestone member, it thins to the northeast and is entirely absent in the Peters Lake section, in the Romanzof Mountains (Reed, 1968).

Conformably overlying the crinoidal limestone members of the Wachsmuth Limestone is a fairly thick sequence of light-gray to white, medium-to coarse-grained, slightly argillaceous, bioclastic, dolomitic limestone, that is about 171 meters (564 feet) thick at the type locality at Shainin Lake. Locally within the member, thin, discontinuous layers of chert are present. The dolomitic phase of the middle member of the Wachsmuth Limestone has been recently interpreted as resulting from sedimentation in a subkha-type environment near the margin of a semi-restricted marine stable platform, sometime in the early Mississippian (Armstrong et al ,1975 p. 1). The chert of this member is usually present throughout the section, however, the amount of chert appears to decrease toward the top of the section. Locally, in the lower quarter of the middle member, the chert constitutes as much as 40 to 50 percent of the section. The upper banded chert member of the Wachsmuth Limestone is a 130 meter (429 foot) thick section of thin-banded limestone and chert. The chert is usually a thin-bedded, light gray to dark gray, thin laminated-to nodular chert. Minor dolomitic limestone layers also occur, interbedded with medium-gray to light-gray, fine-to medium-grained, evenly and irregularly bedded, bioclastic limestone (Patton, 1957). Fossils are fairly common in all of the members of the Wachsmuth Limestone and include crinoids, brachiopods, rugose corals, colonial corals, cephalopods and bryozoans. Total thickness of the unit at the type locality is about 373 meters (1,230 feet), and about 409 meters (1,350 feet) of Wachsmuth Limestone has been measured to the west near Anaktuvak Pass (Porter, 1965). The entire Wachsmuth Limestone is absent to the east near Peters Lake (Reed, 1968). In two measured sections south of Shainin Lake, the banded limestone-chert member may be as much as 90 meters (300 feet) thinner than at Shainin Lake (Brosge et al, 1962). Therefore, the Wachsmuth Limestone unit appears to thin to the east and south.

Conformably overlying the Wachsmuth Limestone is Alapah Limestone, the late Mississippian component of the Lisburne Group. The

Alapah Limestone has been subdivided into nine members at Shainin Lake. Most of the member can be recognized to the east, however, many investigators have lumped the members into three units for ease of geologic mapping. The lower four members of the Alapah Limestone unit at Shainin Lake have been lumped by Porter (1965) and others into a lower Alapah member that is composed of a thick section of limestone and chert. The lower part of this member consists of a basal sequence of dark-gray, fine-grained shaly limestone and minor interbedded black chert overlain by a thick sequence of dark-gray, fine-grained, argillaceous, massive and thin-bedded, cherty, bioclastic limestone. Next, a sequence of light brown to gray, fine-to medium-grained, fossiliferous limestone is present. The limestones exhibit a coarsening upward habit, with fine-grained limestone grading into medium-grained limestone near the top of individual limestone beds. This sequence is in turn overlain by a member that is composed of brownish-gray, fine-to medium-grained bioclastic limestone. The middle member of the Alapah Limestone is composed of about 76 meters (250 feet) of non-resistant, dark-gray, calcareous shale and grayish-black chert. Minor interbeds of dense, hard, dark-gray, platy limestone that is interbedded with light olive-gray shale and dark-gray argillaceous phosphorite (Porter, 1965). The limestones contain well-developed cross-laminations. The upper lumped unit of the Alapah Limestone consists of the upper four members of the Alapah at it's type locality. The upper member is composed of light-gray, fine-grained limestone with interbeds of dark and lightgray, thin-bedded chert; thick bedded, light gray, fine-grained limestone that contains abundant brachiopods and a coral assemblage including lithostrotionella. This unit is wide-spread and quite distinctive and is invariably found a short distance above the base of the upper member (Porter, 1965). Gigantoproductus, a productid brachiopod, is quite common near the top of the upper limestone member. Specimens of Gigantoproductus to 10 centimeters (4 inches) across have been found in the Galbraith Lake area, in a thin limestone bed believed to be part of the upper limestone member of the Alapah Limestone.

Total thickness of the Alapah Limestone at the type locality near Shainin Lake is about 294 meters (970 feet) thick (Bowsher and Dutro, 1957), and it is about 704 meters (2,325 feet) thick near Anaktuvak Pass. The unit thins to the east near Galbraith Lake, where about 182 meters (600 feet) of Alapah Limestone is present and then thickens to the east near Wahoo Lake, where 590 meters (1,947 feet) of section is present. The Alapah thins northward along the northeast front of the Brooks Range (Brosge et al, 1962).

Conformably overlying the Alapah Limestone in the northeastern Brooks Range is the Wahoo Limestone of Pennsylvanian and lowest Permian Age (Armstrong, 1970). The Wahoo Limestone is absent near Galbraith Lake and thickens to 414 meters (1,367 feet) in the easternmost Brooks Range. Brosge et al (1962) have subdivided the Wahoo into two informal members, the upper member and a lower member. The lower member of the Wahoo limestone is characteristically a medium-gray, fine-to coarse-grained, limestone with minor chert. The upper member of the Wahoo Limestone is similar in composition to the basal crinoidal limestone member of the Wachsmuth Limestone. The rocks commonly consist of coarse-grained crinoidal limestone with minor interbeds of shale and thin-bedded shaly limestone. The upper member is distinguished from the lower member by a zone of black nodular chert that occurs at the base of the upper member. Dolomite is lacking in both members, and coarse-grained limestone constitutes as much as 65 percent of the upper member. At Galbraith Lake, the upper member of the Wahoo Limestone is missing and rocks of the Permian Siksikpuk Formation rest unconformably on rocks of the lower member. The upper beds of the lower member are pyritic, where they underlie rocks of the Siksikpuk Formation.

Disconformably overlying rocks of the Mississippian Lisburne Group and disconformably underlying rocks of the Triassic Shublik Formation is a Permian sequence of shale, siltstone and minor chert known as the Siksikpuk Formation. At the type locality on Skimo Creek, west of Chandler Lake, the Siksikpuk Formation consists of about 107 meters (354 feet) of variegated green, gray and dark-red, calcareous, cherty, locally ferruginous, shale and siltstone. The shale and siltstone occur in beds that vary from thin and fissile to massive beds as much as 15 centimeters (6 inches) thick. The unit is easily recognizable because it weathers a characteristic red-yellow color. Minor limestone interbeds occur in the section and calcareous cannon-ball concretions are found in and interbedded with the shale and chert. The Siksikpuk Formation in the Galbraith Lake area is at least 181 meters (600 feet) thick and probably as much as 300 to 600 meters (1,000 to 2,000 feet) of section may be present (Brosge et al, 1962). Structural thickening, crumpling, thrust faulting and isoclinal overturned folding in the Atigun Canyon area has obscured the true thickness of the Siksikpuk Formation. The lower part of the Siksikpuk Formation is richly pyritic and thin zones and concretions of pyrite are present. Bladed barite concretions and discontinous zones of barite are present throughtout the Atigun Canyon section. Stratigraphically, the Siksikpuk Formation is equivalent to the Echooka Formation, the lowest formation in the Sadlerochit Group. The Echooka Formation is not recognized in the Galbraith Lake section and the Siksikpuk is considered the lower member of the Sadlerochit Group. The rocks of the Siksikpuk Formation contain an abundant assemblage of fossils including brachipods, corals, and some gastropods, that yield an early Permian age (Brosge et al, 1962).

East of the Sagavanirktok River, the Siksikpuk Formation is not recognized (Yochelson and Dutro, 1960) and the lower member of the Sadlerochit Group that is recognized is the lower part of the Echooka Formation. The Echooka Formation is equivalent in age to the Siksikpuk Formation but differs lithologically. The Echooka Formation has been subdivided into two members; the Joe Creek Member, composed of about 112 meters (371 feet) of thin-bedded, poorly indurated, calcareous my siltstone and shale, minor chert interbeds and some quartzose sandstone occurs locally. The sandstones are glauconitic in part and generally consist of detrital quartz and some calcite. The lower 60 meters (200 feet) of the Joe Creek Member is predominantly a dusky-yellow, calcareous mudstone and calcareous siltstone. The rest of the Echooka Member is dominantly quartzose sandstone, quartzite and quartzitic siltstone. The upper member of the Echooka Formation, the Ikiakpaurak Member, is composed predominantly of orthoquartzite, quartzitic sandstone and siltstone. The Ikiakpaurak Member is about 85 meters (280 feet) thick at it's type locality and is composed of dark, quartzose sandstones and siltstones that are interbedded with minor orthoquartzites, that are glauconitic in part. The Ikiakpaurak Member is not recognized in the Galbraith Lake section (Detterman et al, 1975).

Conformably and locally unconformably overlying the Echooka Formation is the Ivashak Formation, an early Triassic sequence of silty shale, siltstone, massive sandstone and shale, that is considered the upper formation of the Sadlerochit Group. The Ivashak Formation has been subdivided into three members. The lowest member, the Kavik Member, is composed of thinly laminated to thin bedded, silty shale and siltstone that are composed for the most part of alternating layers of detrital quartz grains and dark bands of sericitic clay. Quartz constitutes as much as 40 percent of the rock. Conformably overlying the Kavik Member is the middle, Ledge Sandstone Member of the Ivashak Formation. The Ledge Sandstone Member commonly forms prominant hogback ridges and questas, due to its resistant nature. The Ledge Sandstone is composed of 58 meters (190 feet) of medium-grained, massive, quartz arenite. The arenite is composed of 30 percent to 40 percent chert fragments and 50 to 60 percent quartz in subrounded and well-rounded grains. Minor detrital tourmaline, plagioclase feldspar, zircon and pyrite are also present. Locally, the sandstone is conglomeratic and the conglomerates occur in well defined zones in the upper part of the member. The conglomerates are composed of sub-angular to well-rounded granules and pebbles of quartz and chert up to 2.5 centimeters (1 inch) in diameter. A few thin siltstone and silty shale beds are intercalated with the sandstone beds. The upper 33 meters (110 feet) of the Ivashak Formation is composed of thin-bedded to massive siliceous siltstone and minor silty shale and argillaceous sandstone of the Fire Creek Member (Detterman et al, 1975). The siltstones are predominantly composed of 40 to 80 percent mineral grains in a siliceous clay matrix. The mineral grains are all well-rounded and are composed of 40 to 60 percent quartz and as much as 20 percent chert. Calcite and pyrite occur locally and minor garnet and zircon are present (Detterman et al, 1975).

Recent work by Detterman (1976) on rocks of the Permian and lower Triassic Sadlerochit Group has shown that at least some of the rocks of Permian age in the north eastern Brooks Range are volcanic rocks. At two localities, one on the Ivishak River and the other near Porcupine Lake, Detterman has identified tuffs, volcanic breccias and flows that exhibit some pillow structures. The tuffs near the Ivishak River are light-to dark-green, fine-grained, amygdaloidal flows. The section near Porcupine Lake is part of a major thrust complex that rests on lower Cretaceous strata (Detterman, 1976). The volcanics are light grayish-green, fine-to medium-grained flows. Dutro et al (1977) have shown that some of the rocks of the upper Devonian sequence in the central Brooks Range include volcanoclastic rocks and flows and include mafic pillow lavas that Dutro believes marks the onset of deeper water deposition in Frasnian (late upper Devonian) time. Sporadic volcanic activity from the Devonian to the Permian in north-central Alaska may have resulted in the deposition of tuffaceous sedimentary sequence as well as still unrecognized volcanic sequences within the predominantly marine sedimentary sequence of the north-central Brooks Range. Tailleur (personal communication, 1977) believes that much of the shale and siltstone present in the north-central Brooks Range may in fact be tuffaceous sedimentary rocks.

Conformably overlying the Fire Creek Siltstone Member of the Sadlerochit Group in northeastern Alaska is the Shublik Formation of middle and late Triassic age. The Shublik Formation has been informally subdivided into three members, based on changes in lithology. The basal siltstone member is composed of 21 meters (70 feet) of thin-bedded, organic-rich, phospathic siltstone. Phosphatic concretions and grains with quartz nuclei are fairly common, and detrital grains of plagioclase and sericite are present. The middle member of the Shublik Formation is composed of 100 meters (300 feet) of thin-to thick-bedded, light-gray, silty, fossiliferous limestone and dolomite. The limestone is phosphatic in part and contains small phosphate pebbles and green-gray and black chert grains. Locally, chert layers are interbedded with thin interbeds of silty shale. The remaining 27 meters (90 feet) of the Shublik Formation, at the type locality, is composed of a very soft, incompetent, sequence of fissile, calcareous shale. The shale contains limestone and phosphatic concretions. Locally, the Shublik Formation near Galbraith Lake, in Atigun Canyon, is represented by a sequence of folded and faulted, highly fractured silty shale, chert and limestone. The contact with the underlying Siksikpuk Formation may be a fault and local disconformable relationships are present.

Conformably and locally unconformably overlying the Shublik Formation in northeastern Alaska is the Kingak Shale of lower to upper Jurassic Age (Detterman et al, 1975). The Kingak Shale is not recognized east of the Lupine River, and apparently thickens and thins irregularly over short distances. Near the Canning River, as much as 900 meters (3,000 feet) of section that is most likely Kingak Shale is present (Detterman et al, 1975). However, folding and faulting of the rocks in the area may have resulted in structure thickening of the incompetent shaly horizons. The lower part of the Kingak Shale is represented by at least 181 meters (600 feet) of very fissile paper shale that decomposes into small fragments generally less than 2 centimeters (1 inch) in diameter. Overlying the fissile shale interval is a thin zone of clay shale that is inturn overlain by a section of fissile shale and siltstone about 303 meters (1000 feet) thick. The siltstone is composed of 70 to 80 percent rounded quartz grains and siderite constitutes as much as 10 percent of the siltstone. Minor detrital grains of plagioclase, zircon, pyrite, glauconite, and phosphate are present. The matrix of the siltstone is mainly siliceous clay. Rocks believed to be part of the Kingak Shale in the Atigun Canyon area, near Galbraith Lake, are mainly dark gray to black fissile shale that disconformably overlie the upper limestone member of the Shublik Formation. Fossil fragments were found in rocks believed to be Kingak Shale, however no definitive fossile identifications have been made.

Disconformably overlying rocks of Shublik Formation, Kingak Shale and Ivashak Member of the Sadlerochit Group in northern Alaska is a lower Cretaceous sequence of quartz arenite, clay shale and greywacke sandstone, known as the Kongakut Formation. The contact between the Kongakut Formation and the underlying strata marks a major early Cretaceous unconformity in northern Alaska (Detterman, 1975). The Kongakut Formation has been subdivided into one formal and three informal members. The clay shale member is the lowest member of the Kongakut Formation and is composed of 106 meters (350 feet) of clay shale. Conformably overlying the clay shale member is the Kemik Sandstone Member, a sequence of very fine-grained quartz arenite with minor amounts of glauconite, phosphate, sericite, and zircon. Overlying the Kemik Sandstone Member is the pebble shale member that is 158 meters (520 feet) thick. The pebble shale member contains a section of about 53 meters (175 feet) of highly manganiferous beds of silty shale. The manganese beds are uniformly black with small pellets and thin beds of manganese carbonates (Detterman et al, 1975). Conformably overlying the pebble shale member is the siltstone member composed of a thick sequence, 291 meters (690 feet) of thin-bedded siltstone with minor interbeds of sandstone.

The Okpikruak Formation, named by Gryc et al (1951, p. 159) is exposed along the Okpikruak River in the Chandler River area west of Anaktuvak Pass, and is present in the Atigun Canyon area. The formation was extended to the eastern Brooks Range by Detterman (1963, p. 195), who defined the base of the Okpikruak Formation as the base of the Kemik Sandstone Member of the Kongakut Formation, therefore the two formations are at least in part equivalent correlatable units. In the Atigun Canyon area, the unit is composed of several hundred meters (feet) of clay shale and minor siltstone and fine-grained sandstone.

Unconformably overlying rocks of the Okpikruak Formation and rocks of the Kongakut Formation is a fairly thick sequence of marine sandstone, siltstone, shaly limestone, clayey shale and conglomerate of the Fortress Mountain Formation of lower Cretaceous age. The conglomerate and sanstones are typically greywacke-type sedimentary rocks that contain abundant clasts and fragments of black and green chert, feldspar and angular mafic igneous rock fragments, all set in a green mudstone matrix (Keller et al, 1961). At it's type section, the Fortress Mountain Formation is about 3,000 meters (10,000 feet) thick, however, the type locality is probably the thickest section of Fortress Mountain Formation exposed on the north-flank of the Brooks Range, and exposures of 1,500 meters (5,000 feet) of section are common.

The Torok Formation of lower Cretaceous age is believed to be the lateral equivalent of the Fortress Mountain Formation (Keller et al, 1961). The Torok Formation is predominantly dark-gray and dark-bluish-gray, fissile to platy, soft, silty shale and clay shale.

Locally, lenticular bodies of sandstone, as much as 242 meters (800 feet) thick, occur in the shale sequence. The base of the Torok Formation is not exposed, however, 1,820 meters (6,000 feet) of section is present at the type locality.

Keller et al (1961) believe that a lateral facies change and major interfingering between the two formations accounts for the lithologic differences between the two units.

Unconformably overlying rocks of the Kongakut Formation, Torok Formation and Fortress Mountain Formation in the northern foothills belt of the Brooks Range are rocks of the Nanushuk Group of early Cretaceous age. The Nanushuk Group contains both marine and non-marine rocks and has been subdivided into two formations. The Tuktu Formation is a marine sequence of interbedded, thin-bedded, fine-grained, greenish-yellow, calcareous sandstone, dark siltstone and shale. The sandstone contains abundant sole markings, mainly flute casts, skip and drag marks, and flame structures, all of which are suggestive of deep water turbidite deposition. The Tuktu Formation may be as thick as 515 meters (1,700 feet), but exposures of about 212 meters (700 feet) thick are common. Conformably overlying the Tuktu Formation are rocks of the non-marine Chandler Formation. The Chandler Formation is composed of 1,447 meters (4,775 feet) of cyclically deposited polymictic conglomerate, salt and pepper sandstone, siltstone and shale. The sequence is entirely non-marine and contains abundant features of fluvial deposition including; cut and fill structures, crossbedding, channel deposits, and fine-grained shaly siltstones containing abundant plant fragments. The shaly siltstones are interpreted as being overbank fluvial deposits. Coal is a fairly common feature in the Chandler Formation.

STRUCTURAL GEOLOGY

The structural geology of the north central Brooks Range is dominated by imbricate thrust faults; high-angle normal faults; anticlines and synclines of various sizes; and large, tight, overturned folds. Thrust faulting throughout the north-flank province of the Brooks Range has juxaposed rock units into structural rather than stratigraphic sequences. Rock units that contain a large percentage of incompetent rock such as shales and siltstones have reacted differently to the regional stresses than the rock units with more competent rocks such as cherts, silicificed limestone and conglomerate. Incompetent rocks make up the bulk of the Kayak Shale, Hunt Fork Shale and Siksikpuk Formation. These units have been compressed into tight folds and are cut by many small faults. The shale horizons also tend to localize faults parallel to their bedding (Porter, 1965). Porter (1965) believes that the shale sequences have acted as lubricating zones that decrease the frictional resistance of faulting. The Kanayut Conglomerate on the other hand is a fairly competent rock unit and has been folded into anticlines and synclines of various sizes. Locally, the folds are overturned, and in the Atigun River valley, spectacular overturned folds about a thousand meters (3,000 feet) in amplitude are present.

The Lisburne Group limestones are generally competent rocks that are also folded into large-scale structures. The limestones do exhibit extensive deformation where stresses on the rocks cause them to react plastically.

Locally, rocks of the Lisburne Group have been tightly folded and large north-vergent folds are present. Subsequent thrust-faulting along the axial trace of one such overturned fold, in Atigun Canyon, has thrust older rocks of the Mississippian Lisburne Group over rocks of the Siksikpuk Formation of Permian age. Porter (1965) believes that the Hunt Fork Shale may represent the base of a zone of de'collement involving the late Paleozoic section of north-central Alaska. The predominence of east-west striking structures in the Philip Smith Mountains quadrangle indicates that the major tectonic pressures were directed in a north-south direction. The presence of north vergent structures throughout the region may indicate that most of the tectonic stresses were released to the north (Porter, 1965).

GEOCHEMISTRY

Geochemical sampling was limited to stream sediments collected from active stream channels. An attempt was made to obtain silt sized or finer material on a sample density of one per 2.56 square kilometers (one per square mile). Eight hundred and sixty five samples were collected. The samples were all collected above tree line and thus they were generally organic-free. The finer fractions were probably mechanically broken rock material. The samples were dried and screened and the minus 80-mesh fraction was analyzed by atomic absorption methods at the U.S. Bureau of Mines Laboratory in Reno, Nevada.

The samples were analyzed for Cu, Pb, Zn, Ag, and Mo. All of the Mo analyses were below the detection level of 15 ppm and all of the Ag analyses were at or below the detection limit of 3 ppm except samples DT 502, and DT 583. For the above reasons, the Ag and Mo analyses were excluded from the statistical analysis of the data.

The sample values and statistical reductions are included in an appendix to this report. Anomalous samples are defined as those concentrations greater than the sample mean plus 1.645, 2.00, and 2.33 standard deviations for the 90, 95, and 98 percent confidence levels respectively. Table I lists the anomality for copper, lead, and zinc in the stream sediment samples. Due to the high detection level for lead (15 ppm) the 20 ppm samples are of questionable anomality. Table II is a tabulation of anomalous samples, the elemental concentrations, and a description of the sediments. The bedrock units that were sampled included the Hunt Fork Shale, the Kanayut Conglomerate, the Kayak Shale, the Wachsmuth and Alapah Limestones, and the Siksikpuk and Shublik Formations.

TABLE I: Levels of anomality for copper, lead, and zinc in the stream sediment samples.

	90%	95%	98%
Cu	≥48.95 ppm	≥53.16 ppm	≥57.08 ppm
Pb	≥17.34 ppm	≥19.94 ppm	≥22.35 ppm
Zn	≥159.35 ppm	≥172.56 ppm	≥184.83 ppm

TABLE II: Anomalous samples, concentrations, and descriptions of rock types.

Sample Number	Concentration (ppm) Cu	Pb	Zn	PH	Rock Descriptions
DT 017			180	6.5	Sandstone, dark gray shale
DT 022		40	240		Sandstone, chert
DT 023		20		7.8	Lisburne Group, Kanayut Conglomerate
DT 024		25		7.3	Lisburne Group, Kanayut Conglomerate
DT 025			240	7.6	Lisburne Group, Kanayut Conglomerate
DT 031		40		8.1	Kanayut Conglomerate
DT 046	58			7.7	Kanayut Conglomerate
DT 055		30		7.8	Kanayut Conglomerate
DT 088			180	6.2	Kanayut Conglomerate, gray shale
DT 097		25		8.2	Lt. gray Lisburne Group, black shale
DT 098		60		7.9	Kanayut Conglomerate
DT 151			175		Lisburne Group
DT 156		20			Lisburne Group
DT 159		20			Lisburne Group
DT 160		20			Lisburne Group

TABLE II: Anomalous samples, concentrations, and descriptions of rock types (continued)

Sample Number	Concentration (ppm) Cu	Pb	Zn	PH	Rock Descriptions
DT 162		20			Lisburne Group
DT 168		20			Lisburne Group
DT 174		25			Lisburne Group
DT 175		20			Lisburne Group
DT 188		20			Kanayut Conglomerate, Lisburne Group
DT 206		40			Kanayut Conglomerate
DT 209		40			Kanayut Conglomerate
DT 229	55	25			Kanayut Conglomerate (Hunt Fork?)
DT 261			335		Kanayut Conglomerate
DT 262			225		Kanayut Conglomerate
DT 264			175		Kanayut Conglomerate
DT 266			185		Kanayut Conglomerate
DT 303		20			Black Lisburne Group, Kanayut Conglomerate
DT 305			200	6.9	Lt. gray Lisburne Group
DT 311		20		7.1	Kanayut Conglomerate, Lisburne Group, black shale
DT 319			180		Kanayut Conglomerate, black shale
DT 332		20		8.0	Lt. gray Lisburne Group
DT 333		20		7.8	Lt. gray Lisburne Group
DT 355	54			7.5	Siksikpuk, Lisburne Group, Kanayut Conglomerate
DT 356	54		370	7.7	Lisburne Group, Siksikpuk, (Fe - Strain)
DT 357	77			7.1	Kanayut Conglomerate, black shale (Siksikpuk?)
DT 380		25		7.1	Kanayut Conglomerate, black shale (Hunt Fork?)

TABLE II: Anomalous samples, concentrations, and descriptions of rock types (continued)

Sample Number	Concentration (ppm) Cu	Pb	Zn	PH	Rock Descriptions
DT 432		25			Lisburne Group, Kanayut Conglomerate
DT 433	25	25			Lisburne Group, Conglomerate, black shale
DT 437		20			Lisburne Group and black shale
DT 496	210		180		Lt. gray Lisburne Group
DT 502			185		Lisburne Group
DT 505		20			Lisburne Group
DT 522		25			Kanayut Conglomerate
DT 540		20			Kanayut Conglomerate
DT 566		30	275		Kanayut Conglomerate
DT 573			175		Kanayut Conglomerate
DT 575			220		Lisburne Group and black shale
DT 576			240		Lisburne Group
DT 578			290		Lisburne Group
DT 579			250		Lisburne Group
DT 581			190		Lisburne Group
DT 582		20			Lisburne Group
DT 583			350		Lt. gray Lisburne Group
DT 584		20			Lt. gray Lisburne Group
DT 587			195		Lt. gray Lisburne Group - Fe strain, pyrite
DT 588		20			Lt. gray Lisburne Group - Fe strain
DT 589		20			Lt. gray Lisburne Group
DT 592		20			Lt. gray Lisburne Group

TABLE II: Anomalous samples, concentrations, and descriptions of rock types (continued)

Sample Number	Concentration (ppm) Cu	Pb	Zn	PH	Rock Descriptions
DT 709		25		7.6	Lt. gray Lisburne Group and Kanayut Conglomerate
DT 726		25		6.8	Kanayut Conglomerate
DT 731		20			Black shale and Kanayut Conglomerate
DT 738			215	7.4	Kanayut Conglomerate
DT 740			300		Black shale and Kanayut Conglomerate (Fe strain)
DT 746			305		Black shale and Kanayut Conglomerate
DT 751		20	180		Black shale
DT 762		20		7.7	Black shale and Conglomerate
DT 766			190	6.8	Black shale - fossils
DT 776			185	7.4	Kanayut Conglomerate
DT 779		20		7.5	Kanayut Conglomerate
DT 782		20		7.4	Kanayut Conglomerate
DT 830		20			Green Conglomerate and siltstone
DT 1104		20			Hunt Fork Shale (black shale and qtz. veins)
DT 1107		20		7.1	Hunt Fork Shale (fossiliferous black shale, quartz veins)
DT 1109		30		7.4	Hunt Fork Shale (Fe stained black shale, quartz veins)
DT 1117		25		7.1	Hunt Fork Shale (black shale)
DT 1118		25		7.2	Hunt Fork Shale (black shale, phyllite, calcareous sandstone phyllite)
DT 1124		20		6.9	Hunt Fork Shale (black shale and qtz. veins)
DT 1126		25		7.1	Hunt Fork Shale (black shale and phyllite)
DT 1128			180	7.1	Hunt Fork Shale (black shale and phyllite)

TABLE II: Anomalous samples, concentrations, and descriptions of rock types (continued)

Sample Number	Concentration (ppm) Cu	Pb	Zn	PH	Rock Descriptions
DT 1129	61	50		6.9	Hunt Fork Shale (black shale and phyllite)
DT 1131		20		7.0	Kanayut Conglomerate
DT 1134		20			Kanayut Conglomerate
DT 1162			190		Lt. gray Lisburne Group
DT 1198			190		Black shale with quartz veins(Hunt Fork Shale?)
DT 1509		20			Lt. gray Lisburne Group and Kanayut Conglomerate

MINING ACTIVITY AND ECONOMIC GEOLOGY

Remoteness and the lack of adequate infrastructure in the past have limited the amount of mineral exploration in the area. The only known mineral claims in the area are located near the head of the Wind River in the Philip Smith Mountains quadrangle, where massive sulfide float samples were found. The U. S. Geological Survey also reports the presence of mineralized quartz veins in the area between the Middle Fork of the Chandalar River and the Wind River. The vein and stockwork deposits contain chalcopyrite, galena and sphalerite (Grybeck, 1977). Stream sediment samples collected by the U. S. Geological Survey during their AMRAP program in the Wind River area contain anomalous concentrations of lead,zinc, copper, barium and vanadium. The bedrock in the area has been mapped (Brosge et al, 1977) as part of the Hunt Fork Shale unit, of mid and upper Devonian age. Some exposures of Skajit Limestone are also known in the area. Rocks mapped as Hunt Fork Shale in the Pipeline Corridor to the east of the area are mainly shaly siltstones that are phyllitic locally. These rocks contain numerous anastomozing quartz veins and Chapman (1964) has reported the presence of pyrite and marcasite crystals and minor galena in some of these quartz veins. No sulfide minerals were seen in Hunt Fork Shale however, the massive sulfide occurrences in the Wind River area, coupled with the anomalous stream sediment geochemistry in areas where the bedrock is known to be Hunt Fork Shale indicate that the Hunt Fork Shale may contain stratabound or strataform massive sulfide deposits of copper, lead, zinc, vanadium and barium affinities, and may also have some potential for vein type mineral deposits.

Rocks of the Kanayut Conglomerate reflect a change in depositional environment from the open-marine deposition of the Hunt Fork Shale to an environment of deposition characteristic of near shore and deltaic conditions. Most of the Kanayut Conglomerate is considered non-marine and the source of the sediments that constitute the bulk of the unit were derived from a northerly source area. The sediments were introduced into a locally reducing environment in which pyrite and possibly other sulfide minerals were accumulating. Locally, the Kanayut Conglomerate does contain disseminated pyrite and galena and near the top of the unit, black pyritic shales constitute the dominate rock type. Therefore, there may be some potential for black shale hosted base-metal sulfide accumulations in the upper part of the Kanayut Conglomerate. To the east in the Romanzof Mountains, the Kanayut Conglomerate may have some uranium potential. The core of the Romanzof Mountains is dominated by a Precambrian(?) and lower Paleozoic sequence of shales, limestones and conglomerates that are intruded by Devonian(?) granitic intrusives (Sable, 1965). The granites are stanniferous granites and contain a higher than background content of uranium and thorium (Donald Grybeck, U. S. Geological Survey, Personal Communication, 1977), and could be a good source for uranium accumulations in the younger sedimentary rocks. The Kanayut Conglomerate near Atigun Pass, in the Pipeline Corridor is very well indurated. The siliceous cementation of the conglomerate has resulted in a tight rock with low porosity and permeability. No anomalous uranium concentrations were found in these rocks and the potential for finding sedimentary uranium accumulations in the Kanayut Conglomerate seems low.

Unlike the rocks of the Kanayut Conglomerate, rocks of the overlying Kayak Shale are dominantly marine shales and limestones that were deposited in a marine stable-shelf environment. Both the shales and carbonaceous limestones of the Kayak unit contain disseminated pyrite, indicating that a reducing, sulfide-producing environment was present locally. Stream sediment samples collected by the U. S. Geological Survey in areas where the dominant rock types is Kayak Shale, contain anomalous concentrations of copper, lead, zinc, barium and silver. One stream-sediment sample from a stream in the Atigun Valley, draining rocks of the Kayak Shale contains at least 500 ppm lead and another sample contained 100 ppm zinc. The potential for finding bedded lead-zinc deposits of stratabound or stratiform lead and zinc affinities seems high for the rocks of the Kayak Shale unit. Near the top of the Kayak Shale, the unit contains a large proportion of anastomozing quartz veins. Porter (1965) reported the presence of quartz veins, near Anaktuvak Pass, that contain chalcopyrite, bornite, azurite and malachite. The probability of finding other such mineralized veins near the top of the Kayak Shale unit seems high.

Rocks of the Lisburne Group, although composed largely of bioclastic limestone, have good potential for base-metal sulfide and barite deposits. The Lisburne Group rocks in the eastern Brooks Range were deposited in part in a subkha-type environment (Armstrong, 1975). The accumulation of fine-grained sediments and limestone in a restricted, stable-shelf, marine environment that impinges on some sort of deltaic complex in a semi-arid climate, where a high rate of evaporation is present, often results in the deposition of subkha-like sequences of sediments. The movement of ground waters and ocean waters containing complexed metal ions, through the Subkha interface, which usually contains a large amount of decaying organic material that produces a reducing environment, may result in the precipitation of sulfides in the subkha. If the interpretation of subkha-type environment of deposition for some of the rocks in the Lisburne Group is correct, the potential for finding base-metal sulfide deposits of the subkha-type in the Lisburne Group is high.

At Drenchwater Creek, in the Howard Pass quadrangle, west of the Pipeline Corridor (T10S, R1E Kateel River Meridian) the U. S. Geological Survey has recognized submarine volcanic rocks that are believed to be part of the Lisburne Group. The volcanics are mainly tuffs that may be genetically associated with black shales and chert that are the host of "significant" base-metal sulfide mineralization. The U. S. Geological Survey believes that the base-metal sulfide mineralization may be syngenetic and stratiform. Further work is needed to understand fully the genetic relationship between the volcanic rocks and the fine-grained sediments in the region. The massive sulfide occurrence at Drenchwater Creek indicates that the Lisburne Group contains volcanogenic massive sulfide deposits of stratiform or stratabound lead, zinc and barite affinities.

West of Shainin Lake, the Lisburne Group contains a marked increase in the amount of black shale and chert. A thin, generally continous zone of black chert and paper shale near the top of the Alapah Limestone contains phosphate concentrations as high as 35.8 percent P205 (Patton and Matzko, 1959). The phosphate-bearing horizon in the Alapah Limestone has been traced from the Kiruktagiak River, approximately 64 kilometers (40 miles) northeast of Anaktuvak Pass, to Shainin Lake, about 32 kilometers (20 miles) northeast of Anaktuvak Pass, a distance of about 80 kilometers (50 miles). The black chert and shale member is not recognized east of Shainin Lake, and no phosphate accumulations of significance have been found east of the Shainin Lake locality. At the Skimo Creek locality, about 24 kilometers (15 miles) northwest of Anaktuvak Pass, the entire black-chert and shale horizon of the Alapah Limestone is exposed (Patton and Matzko, 1959). The phosphate-bearing zone is 11 meters (36 feet) thick and one zone 1 meter (40 inches) thick contains an average of 21 percent P205. The phosphatic beds vary in thickness from 5 to 23 centimeters (2 to 9 inches) and contain up to 35.8 percent P205. Trace amounts of vanadium, copper, barium, lead, manganese and uranium have been detected in samples from the black chert and shale members. If an eastern extension of the black chert and shale member can be found east of Shainin Lake, the potential for finding phosphate deposits in the study area seems high. However, the Alapah Limestone in the study area apparently contains only minor shale and chert and is composed predominantly of massive bioclastic limestone.

Rocks of the Siksikpuk Formation of Permian age and rocks of the Echooka Formation of mid Permian and lower Triassic age have moderate to high potential for barite and base metal sulfide deposits of stratiform or stratabound lead, zinc and barite affinities. Detterman (1976) has for the first time recognized volcanoclastics in the Permian Echooka Formation of the northeastern Brooks Range. The presence of volcanic rocks indicates that there may be a high probability of finding volcanogenic base-metal sulfide deposits associated with the flows, breccias and tuffs. Stream sediment samples, highly anomalous in base metals and barium, collected by the U. S. Geological Survey along the north-flank of the Brooks Range indicate that the region contains a high background of metal concentrations and may contain base-metal and barite deposits of unknown size and distribution. Barium concentrations as high as 1,000 ppm; zinc concentrations as high as 300 ppm; lead concentrations as high as 70 ppm and vanadium concentrations as high as 200 ppm are not uncommon for stream sediment samples. Rocks of the Siksikpuk Formation in the study area contain thin to moderately-thick, discontinous zones of barite and disseminated as well as concretionary forms of pyrite. The rocks are dominantly shale, siltstone and thin-bedded carbonaceous chert. The barite occurs in concordant layers that pinch and swell along strike. Layers as much as 0.3 meters (1 foot) thick are present throughout the Siksikpuk section in Atigun Canyon. No lead or zinc mineralization has been found in the area, however, stream sediment samples from the area contain anomalous concentrations of lead and zinc. The Atigun Canyon occurrence may or may not be of economic significance, however, the occurrence of bedded barite reinforces the probability of finding stratiform and stratabound base metal and barite deposits in the Permo-Triassic of northern Alaska.

The Shublik Formation contains phosphate concentrations near Chandler Lake. Minor occurrences of phosphate are known in the Pipeline Corridor, and samples of shale collected in Atigun Canyon contain phosphorous concentrations as high as 2 percent. The occurrence of phosphate-bearing siltstone and shale to the west indicates that the unit may contain phosphate deposits of unknown size and distribution. Pyrite is commonly found in rocks of the Shublik Formation and occurs as concretions and as rhombs and irregular masses of solid pyrite. The overall mineral potential of these rocks seems high, and further work on the Shublik Formation is clearly needed. Rocks of the Shublik Formation in the Atigun Canyon contain higher than background radioactivity when tested with a hand-held scintillometer. Readings on the order of 200 to 300 counts per second were detected. No deposits of uranium are known in rocks of the Shublik Formation, however the unit may have some uranium potential.

SUMMARY AND CONCLUSIONS

Of the 865 samples collected, 86 were anomalous in one or more elements and 8 samples were anomalous in two elements. The anomalous samples often contain rock fragments from several rock units however from Table II the following tabulation can be made:

A. Streams draining, in part, the Hunt Fork Shale contain one copper, nine lead, and seven zinc anomalies.

B. Streams draining, in part, the Kanayut Conglomerate contain five copper, twenty five lead, and seventeen zinc anomalies.

C. Streams draining, in part, the Kayak Shale contain five lead and one zinc anomaly.

D. Streams draining, in part, the Lisburne Group contain two copper, twenty six lead, and fifteen zinc anomalies.

E. Streams draining, in part, the Siksikpuk Formation contain two copper and three lead anomalies.

F. No anomalies in the study area can be attributed definitely to the Shublik Formation.

The larger number of the anomalies in the Hunt Fork Shale, Kanayut Conglomerate, and Lisburne Group as compared to the other rock units may be a function of area of outcrop. The Kayak Shale, Siksikpuk Formation and the Shublik Formation have relatively small outcrop areas compared to the other units.

The anomalies are found in rock units representing a significant period of geologic time and diverse geologic environments. The anomalies are also generally represented by clustered samples. These clusters are widely distributed throughout the study area.

Four of the eight anomalous copper samples were found along the west side of the Itkillik River in T12S, R9E. Nine lead and zinc anomalous samples were found east of the Itkillik River in T12S, R10E. Three lead and zinc anomalies were found on the upper drainages of the Itikmalak River in T13S, R11E. Nine anomalous lead samples were recovered north of Thibodeaux Mountain (T13S, R9E) however the highest concentration in this cluster was 25 ppm. Five lead and zinc anomalous samples were found in T14S, R9E and another cluster of weakly anomalous lead concentrations were located in T14S, R10E. A large zinc anomaly was found on the Anaktuvuk River south of Fan Mountain in T15S, R5E. The streams on both sides of the continental divide near Limestack Mountain contain strongly anomalous zinc and moderately anomalous copper and lead concentrations. The area includes T15S, R6E and T16S, R6E. Kenunga Creek yielded three samples strongly anomalous in zinc (T16S, R5E). The last major cluster of anomalous samples was found around Oxadak Mountain in T16S, R8E. There are two moderately anomalous copper samples and ten anomalous lead samples.

In conclusion, ten anomalous areas were found during the investigation. Of these ten areas, eight warrant further investigation. The rock units that are producing the major stream sediment anomalies are the Hunt Fork Shale, the Kanayut Conglomerate, and the Lisburne Group. These rock units are hosts to copper, lead, and zinc geochemical anomalies and sulfide mineralization in other areas of northern Alaska. The number of geochemical anomalies within the area indicates that region has good potential for copper, lead and zinc sulfide mineral deposits.

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APPENDIX

Geochemical Data

IINERAL INDUSTRY RESEARCH LABORATORY

ANALYTICAL METHOD ATOMIC ABSORPTION SPECTROPHOTOMETRY

SAMPLE TYPE	FIELD NUMBER	CU (PPM)	PB (PPM)	ZN (PPM)
STRM SD	DT 001	9.000	0.	165.000
	DT 002	9.000	10.000	170.000
	DT 003	10.000	15.000	150.000
	DT 004	11.000	10.000	89.000
	DT 005	20.000	5.000	120.000
	DT 006	10.000	10.000	110.000
	DT 007	13.000	0.	120.000
	DT 008	15.000	10.000	110.000
	DT 009	7.000	15.000	85.000
	DT 010	19.000	10.000	125.000
	DT 011	12.000	15.000	92.000
	DT 012	43.000	0.	82.000
	DT 013	39.000	0.	110.000
	DT 014	43.000	0.	92.000
	DT 015	31.000	10.000	92.000
	DT 016	37.000	15.000	60.000
	DT 017	40.000	5.000	180.000
	DT 018	34.000	0.	85.000
	DT 019	37.000	0.	82.000
	DT 020	33.000	0.	78.000
	DT 021	23.000	5.000	89.000
	DT 022	13.000	40.000	240.000
	DT 023	25.000	20.000	165.000
	DT 024	9.000	25.000	110.000
	DT 025	17.000	5.000	240.000
	DT 026	20.000	5.000	82.000
	DT 027	43.000	15.000	89.000
	DT 028	20.000	5.000	82.000
	DT 029	20.000	10.000	89.000
	DT 030	12.000	0.	150.000

SAMPLE TYPE	FIELD NUMBER	CU (PPM)	PB (PPM)	ZN (PPM)
STRM SD	DT 031	31.000	40.000	92.000
	DT 032	14.000	15.000	100.000
	DT 033	18.000	0.	110.000
	DT 034	37.000	0.	85.000
	DT 035	28.000	0.	85.000
	DT 036	31.000	0.	85.000
	DT 037	29.000	10.000	89.000
	DT 038	33.000	5.000	85.000
	DT 039	32.000	0.	99.000
	DT 040	37.000	0.	78.000
	DT 041	27.000	0.	71.000
	DT 042	11.000	10.000	92.000
	DT 043	32.000	0.	57.000
	DT 044	13.000	5.000	92.000
	DT 045	15.000	0.	96.000
	DT 046	58.000	5.000	140.000
	DT 101	39.000	0.	110.000
	DT 102	39.000	0.	85.000
	DT 103	39.000	0.	89.000
	DT 104	38.000	0.	89.000
	DT 105	41.000	0.	89.000
	DT 106	39.000	0.	92.000
	DT 107	39.000	0.	92.000
	DT 108	27.000	0.	75.000
	DT 109	33.000	0.	78.000
	DT 110	12.000	0.	57.000
	DT 111	33.000	0.	75.000
	DT 112	29.000	0.	57.000
	DT 113	13.000	0.	39.000
	DT 114	47.000	5.000	110.000

SAMPLE TYPE	FIELD NUMBER	CU (PPM)	PB (PPM)	ZN (PPM)
STRM SD	DT 115	39.000	0.	64.000
	DT 116	41.000	0.	71.000
	DT 117	25.000	0.	60.000
	DT 118	38.000	0.	71.000
	DT 119	31.000	0.	82.000
	DT 120	35.000	0.	78.000
	DT 121	34.000	0.	89.000
	DT 122	34.000	0.	71.000
	DT 123	32.000	0.	82.000
	DT 124	34.000	0.	82.000
	DT 125	39.000	0.	67.000
	DT 126	31.000	0.	85.000
	DT 127	34.000	0.	87.000
	DT 128	41.000	0.	89.000
	DT 129	38.000	0.	71.000
	DT 130	31.000	0.	80.000
	DT 131	34.000	0.	87.000
	DT 132	33.000	0.	87.000
	DT 133	34.000	5.000	91.000
	DT 134	32.000	0.	80.000
	DT 135	33.000	0.	73.000
	DT 136	33.000	0.	82.000
	DT 137	28.000	5.000	120.000
	DT 138	30.000	0.	57.000
	DT 139	31.000	5.000	130.000
	DT 140	32.000	10.000	130.000
	DT 141	30.000	5.000	120.000
	DT 142	29.000	5.000	93.000
	DT 143	30.000	5.000	120.000
	DT 144	28.000	10.000	120.000

SAMPLE TYPE	FIELD NUMBER	CU (PPM)	PB (PPM)	ZN (PPM)
STRM SD	DT 145	26.000	5.000	130.000
	DT 146	31.000	5.000	125.000
	DT 147	30.000	0.	80.000
	DT 148	29.000	10.000	110.000
	DT 149	27.000	10.000	120.000
	DT 150	23.000	5.000	93.000
	DT 151	41.000	0.	175.000
	DT 152	30.000	5.000	100.000
	DT 153	26.000	5.000	91.000
	DT 154	33.000	0.	91.000
	DT 155	30.000	5.000	96.000
	DT 156	7.000	20.000	75.000
	DT 157	27.000	5.000	96.000
	DT 158	33.000	0.	77.000
	DT 159	5.000	20.000	68.000
	DT 160	11.000	20.000	110.000
	DT 161	32.000	0.	91.000
	DT 162	5.000	20.000	79.000
	DT 163	29.000	0.	88.000
	DT 164	28.000	5.000	84.000
	DT 165	24.000	0.	76.000
	DT 166	29.000	5.000	84.000
	DT 167	20.000	10.000	110.000
	DT 168	5.000	20.000	99.000
	DT 169	15.000	15.000	110.000
	DT 170	28.000	10.000	84.000
	DT 171	18.000	10.000	76.000
	DT 172	25.000	10.000	82.000
	DT 173	28.000	5.000	76.000
	DT 174	10.000	25.000	100.000

SAMPLE TYPE	FIELD NUMBER	CU (PPM)	PB (PPM)	ZN (PPM)
STRM SD	DT 175	11.000	20.000	110.000
	DT 176	7.000	15.000	84.000
	DT 177	21.000	10.000	135.000
	DT 178	13.000	15.000	110.000
	DT 179	8.000	15.000	87.000
	DT 180	12.000	15.000	96.000
	DT 181	23.000	5.000	160.000
	DT 182	13.000	15.000	99.000
	DT 183	15.000	5.000	100.000
	DT 184	15.000	0.	140.000
	DT 185	11.000	15.000	88.000
	DT 186	15.000	10.000	140.000
	DT 187	11.000	10.000	96.000
	DT 188	10.000	20.000	82.000
	DT 189	14.000	5.000	97.000
	DT 190	9.000	15.000	82.000
	DT 301	12.000	10.000	135.000
	DT 302	8.000	15.000	80.000
	DT 303	6.000	20.000	74.000
	DT 304	13.000	10.000	100.000
	DT 305	16.000	10.000	200.000
	DT 306	8.000	15.000	84.000
	DT 307	8.000	15.000	67.000
	DT 308	10.000	15.000	84.000
	DT 309	20.000	10.000	130.000
	DT 310	44.000	0.	100.000
	DT 311	19.000	20.000	120.000
	DT 312	43.000	5.000	100.000
	DT 313	41.000	5.000	110.000
	DT 314	47.000	10.000	120.000

SAMPLE TYPE	FIELD NUMBER	CU (PPM)	PB (PPM)	ZN (PPM)
STRM SD	DT 315	47.000	0.	77.000
	DT 316	37.000	0.	81.000
	DT 317	36.000	10.000	95.000
	DT 318	32.000	0.	77.000
	DT 319	33.000	0.	180.000
	DT 320	42.000	0.	91.000
	DT 321	34.000	0.	91.000
	DT 322	37.000	0.	70.000
	DT 323	38.000	0.	91.000
	DT 324	42.000	0.	86.000
	DT 325	7.000	15.000	91.000
	DT 326	30.000	0.	86.000
	DT 327	11.000	15.000	93.000
	DT 328	15.000	0.	72.000
	DT 329	21.000	5.000	75.000
	DT 330	20.000	5.000	130.000
	DT 331	20.000	5.000	84.000
	DT 332	6.000	20.000	86.000
	DT 333	9.000	20.000	100.000
	DT 334	6.000	15.000	61.000
	DT 335	16.000	0.	120.000
	DT 336	37.000	0.	160.000
	DT 337	11.000	5.000	91.000
	DT 338	20.000	5.000	95.000
	DT 339	6.000	10.000	61.000
	DT 340	10.000	10.000	52.000
	DT 341	7.000	10.000	54.000
	DT 342	30.000	0.	59.000
	DT 343	17.000	10.000	120.000
	DT 344	6.000	10.000	60.000

SAMPLE TYPE	FIELD NUMBER	CU (PPM)	PB (PPM)	ZN (PPM)
STRM SD	DT 345	27.000	0.	67.000
	DT 346	30.000	5.000	84.000
	DT 347	36.000	0.	84.000
	DT 348	35.000	0.	98.000
	DT 349	32.000	0.	86.000
	DT 350	29.000	0.	60.000
	DT 351	27.000	0.	60.000
	DT 352	28.000	5.000	72.000
	DT 353	27.000	10.000	91.000
	DT 354	11.000	5.000	91.000
	DT 355	54.000	5.000	110.000
	DT 356	54.000	5.000	370.000
	DT 357	77.000	15.000	150.000
	DT 358	39.000	10.000	140.000
	DT 359	21.000	10.000	110.000
	DT 360	24.000	15.000	130.000
	DT 361	46.000	5.000	100.000
	DT 362	22.000	5.000	140.000
	DT 363	25.000	15.000	140.000
	DT 364	26.000	5.000	60.000
	DT 365	26.000	5.000	81.000
	DT 366	31.000	5.000	60.000
	DT 367	28.000	5.000	55.000
	DT 368	23.000	10.000	58.000
	DT 369	28.000	0.	70.000
	DT 370	27.000	5.000	74.000
	DT 371	25.000	5.000	70.000
	DT 372	26.000	5.000	72.000
	DT 373	24.000	0.	72.000
	DT 374	24.000	0.	67.000

SAMPLE TYPE	FIELD NUMBER	CU (PPM)	PB (PPM)	ZN (PPM)
STRM SD	DT 375	25.000	0.	53.000
	DT 376	23.000	0.	55.000
	DT 377	23.000	0.	65.000
	DT 378	23.000	0.	62.000
	DT 379	23.000	0.	70.000
	DT 380	36.000	25.000	86.000
	DT 381	38.000	10.000	93.000
	DT 382	27.000	0.	80.000
	DT 383	29.000	0.	80.000
	DT 384	24.000	0.	77.000
	DT 385	28.000	0.	110.000
	DT 386	32.000	0.	85.000
	DT 387	31.000	0.	83.000
	DT 388	27.000	0.	77.000
	DT 389	32.000	0.	100.000
	DT 390	35.000	5.000	83.000
	DT 391	42.000	0.	69.000
	DT 392	32.000	0.	77.000
	DT 393	24.000	0.	61.000
	DT 394	24.000	0.	72.000
	DT 395	44.000	0.	51.000
	DT 047	27.000	5.000	140.000
	DT 048	27.000	10.000	140.000
	DT 049	20.000	0.	110.000
	DT 050	25.000	0.	130.000
	DT 051	24.000	0.	130.000
	DT 052	16.000	0.	140.000
	DT 053	30.000	10.000	160.000
	DT 054	31.000	0.	67.000
	DT 055	35.000	30.000	82.000

SAMPLE TYPE	FIELD NUMBER	CU (PPM)	PB (PPM)	ZN (PPM)
STRM SD	DT 056	31.000	0.	93.000
	DT 057	30.000	0.	67.000
	DT 058	39.000	0.	72.000
	DT 059	26.000	0.	61.000
	DT 060	23.000	5.000	75.000
	DT 061	27.000	5.000	69.000
	DT 062	27.000	0.	82.000
	DT 063	39.000	5.000	91.000
	DT 064	31.000	0.	82.000
	DT 065	36.000	0.	93.000
	DT 066	30.000	0.	83.000
	DT 067	37.000	0.	93.000
	DT 068	35.000	5.000	88.000
	DT 069	33.000	0.	68.000
	DT 070	33.000	0.	80.000
	DT 071	29.000	0.	71.000
	DT 072	28.000	0.	64.000
	DT 073	32.000	0.	73.000
	DT 074	33.000	0.	66.000
	DT 075	31.000	0.	73.000
	DT 076	29.000	0.	91.000
	DT 077	34.000	10.000	93.000
	DT 078	29.000	0.	75.000
	DT 079	36.000	0.	73.000
	DT 080	36.000	0.	77.000
	DT 081	30.000	0.	80.000
	DT 082	30.000	5.000	80.000
	DT 083	29.000	10.000	91.000
	DT 084	37.000	10.000	95.000
	DT 085	32.000	5.000	84.000

SAMPLE TYPE	FIELD NUMBER	CU (PPM)	PB (PPM)	ZN (PPM)
STRM SD	DT 086	27.000	5.000	84.000
	DT 087	27.000	5.000	73.000
	DT 088	43.000	0.	180.000
	DT 089	40.000	0.	91.000
	DT 090	29.000	5.000	73.000
	DT 091	34.000	0.	82.000
	DT 092	25.000	5.000	73.000
	DT 093	41.000	0.	84.000
	DT 094	28.000	0.	77.000
	DT 095	27.000	5.000	75.000
	DT 096	39.000	10.000	100.000
	DT 097	43.000	25.000	140.000
	DT 098	30.000	60.000	82.000
	DT 099	22.000	5.000	68.000
	DT 100	33.000	15.000	120.000
	DT 191	32.000	10.000	95.000
	DT 192	32.000	5.000	100.000
	DT 193	24.000	15.000	110.000
	DT 194	10.000	15.000	120.000
	DT 195	31.000	5.000	91.000
	DT 196	14.000	15.000	120.000
	DT 197	34.000	5.000	97.000
	DT 198	7.000	15.000	81.000
	DT 199	51.000	10.000	93.000
	DT 200	42.000	10.000	110.000
	DT 201	14.000	15.000	70.000
	DT 202	35.000	10.000	130.000
	DT 203	16.000	15.000	120.000
	DT 204	31.000	15.000	115.000
	DT 205	29.000	15.000	150.000

SAMPLE TYPE	FIELD NUMBER	CU (PPM)	PB (PPM)	ZN (PPM)
STRM SD	DT 206	27.000	20.000	84.000
	DT 207	48.000	15.000	140.000
	DT 208	31.000	5.000	68.000
	DT 209	37.000	40.000	100.000
	DT 210	23.000	0.	70.000
	DT 211	30.000	5.000	66.000
	DT 212	32.000	5.000	110.000
	DT 213	31.000	0.	70.000
	DT 214	24.000	0.	62.000
	DT 215	27.000	0.	66.000
	DT 216	24.000	0.	64.000
	DT 217	22.000	0.	70.000
	DT 218	23.000	0.	75.000
	DT 219	33.000	0.	73.000
	DT 220	28.000	0.	70.000
	DT 221	27.000	0.	66.000
	DT 222	24.000	0.	70.000
	DT 223	31.000	0.	64.000
	DT 224	30.000	0.	66.000
	DT 225	35.000	0.	64.000
	DT 226	27.000	0.	68.000
	DT 227	31.000	5.000	86.000
	DT 228	41.000	10.000	99.000
	DT 229	55.000	25.000	120.000
	DT 230	40.000	5.000	110.000
	DT 231	47.000	15.000	110.000
	DT 232	41.000	0.	110.000
	DT 233	37.000	0.	105.000
	DT 234	41.000	0.	115.000
	DT 235	41.000	5.000	110.000

SAMPLE TYPE	FIELD NUMBER	CU (PPM)	PB (PPM)	ZN (PPM)
STRM SD	DT 236	38.000	10.000	100.000
	DT 237	40.000	0.	110.000
	DT 238	33.000	0.	95.000
	DT 239	39.000	0.	115.000
	DT 240	37.000	0.	110.000
	DT 241	42.000	0.	115.000
	DT 242	42.000	5.000	115.000
	DT 243	37.000	0.	105.000
	DT 244	36.000	5.000	95.000
	DT 245	39.000	0.	110.000
	DT 246	43.000	0.	110.000
	DT 247	43.000	5.000	115.000
	DT 248	41.000	0.	110.000
	DT 249	29.000	0.	85.000
	DT 250	36.000	15.000	115.000
	DT 251	48.000	15.000	120.000
	DT 252	36.000	0.	110.000
	DT 253	36.000	5.000	110.000
	DT 254	37.000	5.000	98.000
	DT 255	39.000	0.	95.000
	DT 256	27.000	10.000	85.000
	DT 257	39.000	0.	105.000
	DT 258	38.000	15.000	95.000
	DT 259	31.000	5.000	115.000
	DT 260	37.000	5.000	120.000
	DT 261	31.000	10.000	335.000
	DT 262	32.000	10.000	255.000
	DT 263	22.000	10.000	100.000
	DT 264	34.000	5.000	175.000
	DT 265	39.000	5.000	115.000

SAMPLE TYPE	FIELD NUMBER	CU (PPM)	PB (PPM)	ZN (PPM)
STRM_SD	DT 414	31.000	0.	88.000
	DT 415	38.000	0.	75.000
	DT 416	40.000	5.000	130.000
	DT 417	36.000	0.	90.000
	DT 418	39.000	0.	80.000
	DT 419	36.000	0.	80.000
	DT 420	35.000	0.	80.000
	DT 421	37.000	0.	90.000
	DT 422	32.000	0.	80.000
	DT 423	43.000	0.	100.000
	DT 424	32.000	5.000	110.000
	DT 425	12.000	15.000	150.000
	DT 426	30.000	5.000	110.000
	DT 427	33.000	10.000	125.000
	DT 428	32.000	5.000	110.000
	DT 429	19.000	10.000	125.000
	DT 430	23.000	10.000	150.000
	DT 431	23.000	10.000	135.000
	DT 432	26.000	25.000	140.000
	DT 433	30.000	25.000	110.000
	DT 434	33.000	15.000	145.000
	DT 435	35.000	15.000	150.000
	DT 436	34.000	5.000	110.000
	DT 437	26.000	20.000	150.000
	DT 438	30.000	10.000	120.000
	DT 439	26.000	15.000	155.000
	DT 440	25.000	10.000	125.000
	DT 441	26.000	10.000	110.000
	DT 442	27.000	10.000	130.000
	DT 443	36.000	5.000	95.000

SAMPLE TYPE	FIELD NUMBER	CU (PPM)	PB (PPM)	ZN (PPM)
STRM SD	DT 444	35.000	10.000	100.000
	DT 445	34.000	15.000	95.000
	DT 446	38.000	5.000	85.000
	DT 447	30.000	5.000	80.000
	DT 448	32.000	10.000	100.000
	DT 449	30.000	15.000	110.000
	DT 450	28.000	5.000	100.000
	DT 451	40.000	15.000	135.000
	DT 452	35.000	10.000	80.000
	DT 453	32.000	0.	65.000
	DT 454	44.000	15.000	110.000
	DT 455	35.000	0.	75.000
	DT 456	41.000	10.000	110.000
	DT 457	35.000	0.	75.000
	DT 458	31.000	5.000	95.000
	DT 459	28.000	0.	65.000
	DT 460	26.000	0.	50.000
	DT 461	30.000	5.000	85.000
	DT 462	37.000	0.	70.000
	DT 463	46.000	5.000	115.000
	DT 464	33.000	5.000	110.000
	DT 465	39.000	5.000	110.000
	DT 466	27.000	5.000	80.000
	DT 467	34.000	0.	85.000
	DT 468	32.000	5.000	90.000
	DT 469	30.000	5.000	85.000
	DT 470	31.000	5.000	88.000
	DT 471	32.000	0.	85.000
	DT 472	29.000	0.	85.000
	DT 473	31.000	0.	95.000

SAMPLE TYPE	FIELD NUMBER	CU (PPM)	PB (PPM)	ZN (PPM)
STRM SD	DT 474	29.000	0.	88.000
	DT 475	26.000	0.	75.000
	DT 476	29.000	0.	80.000
	DT 477	30.000	5.000	90.000
	DT 478	35.000	0.	75.000
	DT 479	33.000	0.	75.000
	DT 480	33.000	0.	80.000
	DT 481	30.000	10.000	90.000
	DT 482	29.000	0.	85.000
	DT 483	28.000	0.	85.000
	DT 484	31.000	0.	80.000
	DT 485	30.000	0.	85.000
	DT 486	32.000	10.000	85.000
	DT 487	29.000	5.000	85.000
	DT 488	33.000	0.	85.000
	DT 489	25.000	0.	70.000
	DT 490	38.000	0.	100.000
	DT 491	36.000	10.000	105.000
	DT 492	39.000	15.000	100.000
	DT 493	33.000	5.000	110.000
	DT 494	46.000	10.000	150.000
	DT 495	31.000	0.	95.000
	DT 496	210.000	10.000	180.000
	DT 497	8.000	15.000	155.000
	DT 498	34.000	0.	70.000
	DT 499	45.000	10.000	65.000
	DT 500	30.000	0.	75.000
	DT 501	36.000	10.000	105.000
	DT 502	14.000	10.000	185.000
	DT 503	35.000	10.000	115.000

SAMPLE TYPE	FIELD NUMBER		CU (PPM)	PB (PPM)	ZN (PPM)
STRM SD	DT	504	31.000	15.000	135.000
	DT	505	25.000	20.000	140.000
	DT	506	18.000	10.000	68.000
	DT	507	26.000	0.	70.000
	DT	508	27.000	0.	70.000
	DT	509	33.000	5.000	110.000
	DT	510	41.000	5.000	100.000
	DT	511	33.000	0.	80.000
	DT	512	27.000	0.	65.000
	DT	513	31.000	0.	83.000
	DT	514	42.000	0.	105.000
	DT	515	37.000	0.	70.000
	DT	516	36.000	10.000	125.000
	DT	517	44.000	5.000	155.000
	DT	518	36.000	0.	85.000
	DT	519	36.000	0.	90.000
	DT	520	30.000	10.000	90.000
	DT	521	24.000	0.	65.000
	DT	522	39.000	25.000	100.000
	DT	523	23.000	0.	65.000
	DT	524	37.000	0.	80.000
	DT	525	16.000	0.	55.000
	DT	526	20.000	0.	50.000
	DT	527	28.000	0.	70.000
	DT	528	19.000	0.	65.000
	DT	529	24.000	5.000	75.000
	DT	530	33.000	5.000	85.000
	DT	531	32.000	0.	85.000
	DT	532	35.000	0.	90.000
	DT	533	28.000	0.	85.000

SAMPLE TYPE	FIELD NUMBER	CU (PPM)	PB (PPM)	ZN (PPM)
STRM SD	DT 534	31.000	0.	80.000
	DT 535	32.000	0.	80.000
	DT 536	31.000	0.	83.000
	DT 537	22.000	0.	85.000
	DT 538	30.000	0.	80.000
	DT 539	29.000	0.	85.000
	DT 540	42.000	20.000	105.000
	DT 541	29.000	5.000	80.000
	DT 542	32.000	10.000	95.000
	DT 543	28.000	0.	85.000
	DT 544	36.000	5.000	90.000
	DT 545	44.000	5.000	95.000
	DT 546	34.000	5.000	85.000
	DT 547	32.000	10.000	85.000
	DT 548	37.000	0.	105.000
	DT 549	41.000	0.	105.000
	DT 550	36.000	0.	100.000
	DT 551	40.000	0.	105.000
	DT 552	36.000	0.	100.000
	DT 553	31.000	0.	90.000
	DT 554	11.000	15.000	100.000
	DT 555	29.000	15.000	130.000
	DT 556	18.000	5.000	125.000
	DT 557	19.000	10.000	95.000
	DT 558	29.000	10.000	140.000
	DT 559	32.000	10.000	105.000
	DT 560	29.000	5.000	140.000
	DT 561	19.000	5.000	115.000
	DT 562	19.000	10.000	125.000
	DT 563	21.000	10.000	130.000

SAMPLE TYPE	FIELD NUMBER	CU (PPM)	PB (PPM)	ZN (PPM)
STRM SD	DT 564	37.000	10.000	125.000
	DT 565	26.000	15.000	115.000
	DT 566	38.000	30.000	275.000
	DT 567	39.000	15.000	140.000
	DT 568	26.000	5.000	120.000
	DT 569	12.000	15.000	90.000
	DT 570	21.000	10.000	115.000
	DT 571	29.000	0.	100.000
	DT 572	26.000	10.000	115.000
	DT 573	29.000	10.000	175.000
	DT 574	25.000	15.000	120.000
	DT 575	47.000	5.000	220.000
	DT 576	21.000	10.000	240.000
	DT 577	12.000	15.000	110.000
	DT 578	33.000	10.000	290.000
	DT 579	29.000	10.000	250.000
	DT 580	15.000	10.000	120.000
	DT 581	18.000	15.000	190.000
	DT 582	13.000	20.000	100.000
	DT 583	31.000	15.000	350.000
	DT 584	16.000	20.000	165.000
	DT 585	13.000	10.000	130.000
	DT 586	16.000	15.000	150.000
	DT 587	48.000	10.000	195.000
	DT 587D	34.000	15.000	145.000
	DT 588	18.000	20.000	105.000
	DT 589	14.000	20.000	105.000
	DT 590	12.000	15.000	95.000
	DT 591	12.000	15.000	100.000
	DT 592	13.000	20.000	140.000

SAMPLE TYPE	FIELD NUMBER	CU (PPM)	PB (PPM)	ZN (PPM)
STRM SD	DT 593	12.000	15.000	130.000
	DT 594	6.000	10.000	95.000
	DT 595	8.000	5.000	135.000
	DT 596	13.000	10.000	140.000
	DT 701	29.000	0.	80.000
	DT 702	27.000	0.	80.000
	DT 703	32.000	0.	60.000
	DT 704	36.000	0.	70.000
	DT 705	35.000	0.	75.000
	DT 706	28.000	0.	80.000
	DT 707	28.000	5.000	80.000
	DT 708	41.000	5.000	105.000
	DT 709	7.000	25.000	90.000
	DT 710	30.000	0.	70.000
	DT 711	31.000	0.	75.000
	DT 712	25.000	0.	60.000
	DT 713	31.000	0.	75.000
	DT 714	28.000	0.	95.000
	DT 715	31.000	0.	70.000
	DT 716	29.000	0.	75.000
	DT 717	32.000	5.000	80.000
	DT 718	30.000	0.	70.000
	DT 719	38.000	0.	70.000
	DT 720	38.000	0.	90.000
	DT 721	30.000	10.000	55.000
	DT 722	30.000	5.000	60.000
	DT 723	28.000	5.000	60.000
	DT 724	29.000	10.000	60.000
	DT 725	28.000	5.000	65.000
	DT 726	46.000	25.000	140.000

SAMPLE TYPE	FIELD NUMBER	CU (PPM)	PB (PPM)	ZN (PPM)
STRM SD	DT 727	36.000	0.	80.000
	DT 728	29.000	0.	70.000
	DT 729	39.000	0.	75.000
	DT 730	25.000	15.000	140.000
	DT 731	26.000	20.000	155.000
	DT 732	30.000	0.	75.000
	DT 733	27.000	10.000	120.000
	DT 734	26.000	0.	95.000
	DT 735	23.000	0.	65.000
	DT 736	30.000	0.	65.000
	DT 737	36.000	0.	95.000
	DT 738	38.000	0.	215.000
	DT 739	39.000	10.000	135.000
	DT 740	37.000	15.000	300.000
	DT 741	31.000	0.	105.000
	DT 742	22.000	0.	75.000
	DT 743	29.000	5.000	90.000
	DT 744	19.000	0.	75.000
	DT 745	39.000	5.000	110.000
	DT 746	33.000	10.000	305.000
	DT 747	29.000	0.	70.000
	DT 748	35.000	5.000	145.000
	DT 749	43.000	15.000	150.000
	DT 750	38.000	0.	125.000
	DT 751	36.000	20.000	180.000
	DT 752	35.000	0.	105.000
	DT 753	37.000	5.000	125.000
	DT 754	30.000	0.	90.000
	DT 755	43.000	5.000	120.000
	DT 756	36.000	10.000	110.000

SAMPLE TYPE	FIELD NUMBER	CU (PPM)	PB (PPM)	ZN (PPM)
STRM SD	DT 757	44.000	15.000	100.000
	DT 758	44.000	15.000	170.000
	DT 759	29.000	10.000	135.000
	DT 760	35.000	5.000	105.000
	DT 761	40.000	0.	115.000
	DT 762	47.000	20.000	165.000
	DT 763	49.000	15.000	165.000
	DT 764	27.000	10.000	120.000
	DT 765	30.000	10.000	155.000
	DT 766	32.000	10.000	190.000
	DT 767	32.000	0.	70.000
	DT 768	33.000	15.000	110.000
	DT 769	28.000	0.	90.000
	DT 770	30.000	5.000	100.000
	DT 771	30.000	5.000	85.000
	DT 772	27.000	5.000	85.000
	DT 773	35.000	10.000	105.000
	DT 774	33.000	0.	105.000
	DT 775	32.000	0.	100.000
	DT 776	35.000	5.000	185.000
	DT 777	36.000	0.	95.000
	DT 778	41.000	0.	95.000
	DT 779	26.000	20.000	75.000
	DT 780	22.000	0.	50.000
	DT 781	23.000	5.000	70.000
	DT 782	33.000	20.000	80.000
	DT 783	24.000	5.000	80.000
	DT 784	25.000	5.000	90.000
	DT 785	21.000	0.	65.000
	DT 786	28.000	0.	55.000

SAMPLE TYPE	FIELD NUMBER	CU (PPM)	PB (PPM)	ZN (PPM)
STRM SD	DT 787	35.000	0.	95.000
	DT 788	39.000	10.000	90.000
	DT 789	37.000	0.	75.000
	DT 790	30.000	0.	50.000
	DT 791	37.000	0.	140.000
	DT 792	26.000	0.	70.000
	DT 793	37.000	5.000	105.000
	DT 794	38.000	5.000	105.000
	DT 795	27.000	0.	90.000
	DT 796	39.000	0.	90.000
	DT 797	23.000	0.	55.000
	DT 798	38.000	5.000	100.000
	DT 799	30.000	5.000	90.000
	DT 800	33.000	5.000	80.000
	DT 801	23.000	0.	45.000
	DT 803	9.000	15.000	75.000
	DT 804	12.000	10.000	110.000
	DT 805	14.000	10.000	115.000
	DT 806	16.000	10.000	120.000
	DT 807	9.000	10.000	55.000
	DT 808	5.000	15.000	50.000
	DT 809	8.000	15.000	55.000
	DT 810	8.000	10.000	60.000
	DT 811	9.000	15.000	60.000
	DT 812	6.000	10.000	60.000
	DT 813	28.000	5.000	135.000
	DT 814	7.000	15.000	130.000
	DT 815	22.000	15.000	105.000
	DT 816	46.000	0.	75.000
	DT 817	23.000	0.	65.000

SAMPLE TYPE	FIELD NUMBER	CU (PPM)	PB (PPM)	ZN (PPM)
STRM SD	DT 818	23.000	0.	95.000
	DT 819	48.000	0.	105.000
	DT 820	46.000	5.000	110.000
	DT 821	38.000	0.	80.000
	DT 822	42.000	0.	75.000
	DT 823	34.000	0.	70.000
	DT 824	33.000	0.	80.000
	DT 825	34.000	0.	75.000
	DT 826	36.000	0.	70.000
	DT 802	36.000	5.000	85.000
	DT 827	33.000	0.	70.000
	DT 828	29.000	0.	70.000
	DT 829	36.000	0.	55.000
	DT 830	15.000	20.000	135.000
	DT 831	25.000	0.	60.000
	DT 832	21.000	0.	50.000
	DT 833	28.000	0.	65.000
	DT 834	27.000	0.	50.000
	DT 835	23.000	0.	45.000
	DT 836	20.000	0.	60.000
	DT 837	44.000	0.	110.000
	DT 838	40.000	0.	105.000
	DT 839	52.000	0.	120.000
	DT 840	7.000	0.	65.000
	DT 841	8.000	0.	70.000
	DT 842	7.000	0.	65.000
	DT 843	34.000	0.	100.000
	DT 844	28.000	0.	70.000
	DT 845	23.000	0.	55.000
	DT 846	16.000	0.	25.000

SAMPLE TYPE	FIELD NUMBER	CU (PPM)	PB (PPM)	ZN (PPM)
STRM SD	DT 847	22.000	0.	55.000
	DT 848	20.000	0.	50.000
	DT 849	36.000	0.	85.000
	DT 850	44.000	0.	100.000
	DT 851	37.000	0.	100.000
	DT 852	41.000	0.	80.000
	DT 853	44.000	0.	85.000
	DT 854	44.000	0.	80.000
	DT 855	41.000	0.	85.000
	DT 856	40.000	0.	70.000
	DT 857	40.000	0.	80.000
	DT 858	27.000	0.	100.000
	DT 859	32.000	0.	130.000
	DT 860	35.000	0.	120.000
	DT 861	31.000	0.	115.000
	DT 862	33.000	0.	90.000
	DT 863	34.000	0.	80.000
	DT 864	33.000	0.	100.000
	DT 865	38.000	0.	100.000
	DT 866	29.000	0.	65.000
	DT 867	21.000	0.	130.000
	DT 868	29.000	0.	125.000
	DT 869	37.000	0.	100.000
	DT 870	43.000	0.	65.000
	DT 871	23.000	0.	115.000
	DT 872	31.000	0.	70.000
	DT 873	35.000	0.	120.000
	DT 1101	36.000	0.	105.000
	DT 1102	37.000	0.	110.000
	DT 1103	31.000	0.	155.000

SAMPLE TYPE	FIELD NUMBER	CU (PPM)	PB (PPM)	ZN (PPM)
STRM SD	DT 1104	49.000	20.000	120.000
	DT 1105	40.000	0.	105.000
	DT 1106	34.000	0.	95.000
	DT 1107	30.000	20.000	90.000
	DT 1108	34.000	15.000	100.000
	DT 1109	41.000	30.000	110.000
	DT 1110	33.000	0.	95.000
	DT 1111	23.000	0.	115.000
	DT 1112	22.000	0.	70.000
	DT 1113	19.000	0.	70.000
	DT 1114	18.000	0.	70.000
	DT 1115	17.000	0.	65.000
	DT 1116	19.000	0.	65.000
	DT 1117	36.000	25.000	105.000
	DT 1118	38.000	25.000	105.000
	DT 1119	31.000	0.	95.000
	DT 1120	31.000	15.000	100.000
	DT 1121	28.000	0.	90.000
	DT 1122	29.000	0.	85.000
	DT 1123	33.000	0.	105.000
	DT 1124	35.000	20.000	100.000
	DT 1125	31.000	0.	100.000
	DT 1126	40.000	25.000	105.000
	DT 1127	35.000	0.	105.000
	DT 1128	35.000	15.000	180.000
	DT 1129	61.000	50.000	160.000
	DT 1130	22.000	0.	50.000
	DT 1131	32.000	20.000	70.000
	DT 1132	35.000	15.000	140.000
	DT 1133	38.000	15.000	160.000

SAMPLE TYPE	FIELD NUMBER	CU (PPM)	PB (PPM)	ZN (PPM)
STRM_SD	DT 1134	31.000	20.000	90.000
	DT 1135	38.000	0.	120.000
	DT 1136	24.000	15.000	55.000
	DT 1137	30.000	0.	70.000
	DT 1138	24.000	0.	55.000
	DT 1139	10.000	0.	100.000
	DT 1140	10.000	0.	155.000
	DT 1141	25.000	0.	120.000
	DT 1142	7.000	0.	65.000
	DT 1143	48.000	15.000	135.000
	DT 1144	19.000	0.	110.000
	DT 1145	34.000	0.	60.000
	DT 1146	20.000	0.	100.000
	DT 1147	46.000	0.	160.000
	DT 1148	26.000	0.	130.000
	DT 1149	32.000	0.	60.000
	DT 1150	30.000	0.	60.000
	DT 1151	28.000	0.	65.000
	DT 1152	30.000	0.	60.000
	DT 1153	26.000	0.	65.000
	DT 1154	20.000	0.	50.000
	DT 1155	30.000	0.	60.000
	DT 1156	28.000	0.	65.000
	DT 1157	28.000	0.	60.000
	DT 1158	21.000	0.	60.000
	DT 1159	23.000	0.	70.000
	DT 1160	34.000	0.	60.000
	DT 1161	37.000	0.	130.000
	DT 1162	12.000	0.	190.000
	DT 1163	11.000	0.	120.000

SAMPLE TYPE	FIELD NUMBER	CU (PPM)	PB (PPM)	ZN (PPM)
STRM SD	DT 1164	22.000	0.	65.000
	DT 1165	25.000	0.	80.000
	DT 1166	36.000	0.	95.000
	DT 1167	0.	0.	0.
	DT 1168	27.000	0.	85.000
	DT 1169	37.000	0.	105.000
	DT 1170	25.000	0.	120.000
	DT 1171	25.000	0.	90.000
	DT 1172	50.000	0.	100.000
	DT 1173	13.000	0.	50.000
	DT 1174	16.000	0.	45.000
	DT 1175	27.000	0.	75.000
	DT 1176	47.000	0.	105.000
	DT 1177	23.000	0.	140.000
	DT 1178	22.000	0.	130.000
	DT 1179	13.000	0.	125.000
	DT 1180	37.000	15.000	105.000
	DT 1181	17.000	0.	145.000
	DT 1182	26.000	0.	120.000
	DT 1183	3.000	0.	45.000
	DT 1184	22.000	0.	20.000
	DT 1185	12.000	0.	15.000
	DT 1186	11.000	0.	45.000
	DT 1187	24.000	15.000	80.000
	DT 1188	9.000	0.	60.000
	DT 1189	13.000	0.	105.000
	DT 1190	35.000	15.000	100.000
	DT 1191	28.000	0.	80.000
	DT 1192	32.000	0.	85.000
	DT 1193	38.000	0.	95.000

SAMPLE TYPE	FIELD NUMBER	CU (PPM)	PB (PPM)	ZN (PPM)
STRM SD	DT 1194	38.000	0.	100.000
	DT 1195	35.000	0.	80.000
	DT 1196	36.000	0.	80.000
	DT 1197	19.000	0.	65.000
	DT 1198	32.000	0.	190.000
	DT 1199	26.000	0.	80.000
	DT 1200	38.000	0.	85.000
	DT 1501	25.000	0.	90.000
	DT 1502	33.000	0.	80.000
	DT 1503	39.000	0.	95.000
	DT 1504	38.000	0.	100.000
	DT 1505	34.000	15.000	90.000
	DT 1506	34.000	15.000	80.000
	DT 1507	23.000	0.	60.000
	DT 1508	31.000	0.	125.000
	DT 1509	38.000	20.000	135.000
	DT 1510	33.000	0.	75.000
	DT 1511	22.000	0.	120.000
	DT 1512	20.000	0.	130.000
	DT 1513	31.000	0.	100.000
	DT 1514	22.000	0.	115.000
	DT 1515	30.000	0.	120.000
	DT 1516	39.000	15.000	115.000
	DT 1517	25.000	0.	120.000
	DT 1518	33.000	0.	125.000
CONTINENTAL CRUSTAL AVE		55.0	12.5	70.0

ATOMIC ABSORPTION SPECTROPHOTOMETRY

STREAM SEDIMENTS

ELEMENT = CU

NUMBER OF SAMPLES	=	865
SUM OF SAMPLES	=	25461.000
SUM OF SQUARES OF SAMPLES	=	871061.000
MEAN OF SAMPLES	=	29.435
VARIANCE OF SAMPLES	=	140.769
MINIMUM VALUE	=	0.
MAXIMUM VALUE	=	210.000
THE RANGE	=	210.000
STANDARD DEVIATION	=	11.865
TWICE STANDARD DEVIATION PLUS MEAN	=	53.164

NINETY % = 48.95 NINETY-FIVE % = 53.16 NINETY-EIGHT % = 57.08

FIELD NO.	VALUE PPM	FIELD NO.	VALUE PPM	FIELD NO.	VALUE PPM
				DT 046	58.00
		DT 355	54.00		
		DT 356	54.00		
				DT 357	77.00
DT 199	51.00				
		DT 229	55.00		
DT 272	50.00				
DT 273	49.00				
DT 276	51.00				
				DT 496	210.00

DT 11[illegible]	49.00	DT 1129	61.00
DT 1172	50.00		

ATOMIC ABSORPTION SPECTROPHOTOMETRY

STREAM SEDIMENTS

ELEMENT = PB

NUMBER OF SAMPLES	=	865
SUM OF SAMPLES	=	4580.000
SUM OF SQUARES OF SAMPLES	=	70550.000
MEAN OF SAMPLES	=	5.295
VARIANCE OF SAMPLES	=	53.588
MINIMUM VALUE	=	0.
MAXIMUM VALUE	=	60.000
THE RANGE	=	60.000
STANDARD DEVIATION	=	7.320
TWICE STANDARD DEVIATION PLUS MEAN	=	19.936

NINETY % = 17.34 NINETY-FIVE % = 19.94 NINETY-EIGHT % = 22.35

FIELD NO.	VALUE PPM	FIELD NO.	VALUE PPM	FIELD NO.	VALUE PPM
				DT 022	40.00
		DT 023	20.00		
				DT 024	25.00
				DT 031	40.00
		DT 156	20.00		
		DT 159	20.00		
		DT 160	20.00		
		DT 162	20.00		
		DT 168	20.00		
				DT 174	25.00

		DT 024	25.00
		DT 031	40.00
DT 156	20.00		
DT 159	20.00		
DT 160	20.00		
DT 162	20.00		
DT 168	20.00		
		DT 174	25.00
DT 175	20.00		
DT 188	20.00		
DT 303	20.00		
DT 311	20.00		
DT 332	20.00		
DT 333	20.00		
		DT 380	25.00
		DT 055	30.00
		DT 097	25.00
		DT 098	60.00
DT 206	20.00		
		DT 209	40.00
		DT 229	25.00
		DT 432	25.00
		DT 433	25.00
DT 437	20.00		
DT 505	20.00		
		DT 522	25.00
DT 540	20.00		
		DT 566	30.00
DT 582	20.00		
DT 584	20.00		
DT 588	20.00		

DT [illegible]8	[illegible].00		
DT 589	20.00		
DT 592	20.00		
		DT 709	25.00
		DT 726	25.00
DT 731	20.00		
DT 751	20.00		
DT 762	20.00		
DT 779	20.00		
DT 782	20.00		
DT 830	20.00		
DT 1104	20.00		
DT 1107	20.00		
		DT 1109	30.00
		DT 1117	25.00
		DT 1118	25.00
DT 1124	20.00		
		DT 1126	25.00
		DT 1129	50.00
DT 1131	20.00		
DT 1134	20.00		
DT 1509	20.00		

ATOMIC ABSORPTION SPECTROPHOTOMETRY

STREAM SEDIMENTS

ELEMENT = ZN

NUMBER OF SAMPLES	=	865
SUM OF SAMPLES	=	84929.000
SUM OF SQUARES OF SAMPLES	=	9533395.000
MEAN OF SAMPLES	=	98.184
VARIANCE OF SAMPLES	=	1382.803
MINIMUM VALUE	=	0.
MAXIMUM VALUE	=	370.000
THE RANGE	=	370.000
STANDARD DEVIATION	=	37.186
TWICE STANDARD DEVIATION PLUS MEAN	=	172.556

NINETY % = 159.35 NINETY-FIVE % = 172.56 NINETY-EIGHT % = 184.83

FIELD NO.	VALUE PPM	FIELD NO.	VALUE PPM	FIELD NO.	VALUE PPM
DT 001	165.00				
DT 002	170.00				
		DT 017	180.00		
				DT 022	240.00
DT 023	165.00				
				DT 025	240.00
		DT 151	175.00		
DT 181	160.00				
				DT 305	200.00

DT [illegible]6	[illegible].00			DT 356	370.00
DT 053	160.00				
		DT 088	180.00		
				DT 261	335.00
				DT 262	255.00
		DT 264	175.00		
				DT 266	185.00
		DT 496	180.00		
				DT 502	185.00
				DT 566	275.00
		DT 573	175.00		
				DT 575	220.00
				DT 576	240.00
				DT 578	290.00
				DT 579	250.00
				DT 581	190.00
				DT 583	350.00
DT 584	165.00				
				DT 587	195.00
				DT 738	215.00
				DT 740	300.00
				DT 746	305.00
		DT 751	180.00		
DT 758	170.00				
DT 762	165.00				
DT 763	165.00				
				DT 766	190.00
				DT 776	185.00
		DT 1128	180.00		
DT 1129	160.00				
DT 113[illegible]	160.00				

DT 584	165.00
DT 758	170.00
DT 762	165.00
DT 763	165.00
DT 1129	160.00
DT 1133	160.00
DT 1147	160.00

DT 573	175.00
DT 751	180.00
DT 1128	180.00

[illegible]	
DT 566	275.00
DT 575	220.00
DT 576	240.00
DT 578	290.00
DT 579	250.00
DT 581	190.00
DT 583	350.00
DT 587	195.00
DT 738	215.00
DT 740	300.00
DT 746	305.00
DT 766	190.00
DT 776	185.00
DT 1162	190.00
DT 1198	190.00

ALL ANOMALOUS VALUES PER SAMPLE

		ZN	
DT	017	180.00	
		PB	ZN
DT	022	40.00	240.00
		PB	
DT	023	20.00	
		PB	
DT	024	25.00	
		ZN	
DT	025	240.00	
		PB	
DT	031	40.00	
		CU	
DT	046	58.00	
		ZN	
DT	151	175.00	
		PB	
DT	156	20.00	
		PB	
DT	159	20.00	
		PB	
DT	160	20.00	
		PB	
DT	162	20.00	
		PB	
DT	168	20.00	
		PB	
DT	174	25.00	
		PB	
DT	175	20.00	
		PB	
DT	188	20.00	

PB
DT 174 25.00

PB
DT 175 20.00

PB
DT 188 20.00

PB
DT 303 20.00

ZN
DT 305 200.00

PB
DT 311 20.00

ZN
DT 319 180.00

PB
DT 332 20.00

PB
DT 333 20.00

CU
DT 355 54.00

CU ZN
DT 356 54.00 370.00

CU
DT 357 77.00

PB
DT 380 25.00

PB
DT 055 30.00

ZN
DT 088 180.00

PB
DT 097 25.00

PB
DT 09[illegible] [illegible]

DT 055 30.00

ZN

DT 088 180.00

PB

DT 097 25.00

PB

DT 098 60.00

PB

DT 206 20.00

PB

DT 209 40.00

CU PB

DT 229 55.00 25.00

ZN

DT 261 335.00

ZN

DT 262 255.00

ZN

DT 264 175.00

ZN

DT 266 185.00

PB

DT 432 25.00

PB

DT 433 25.00

PB

CU ZN
DT 496 210.00 180.00

ZN
DT 502 185.00

PB
DT 505 20.00

PB
DT 522 25.00

PB
DT 540 20.00

PB ZN
DT 566 30.00 275.00

ZN
DT 573 175.00

ZN
DT 575 220.00

ZN
DT 576 240.00

ZN
DT 578 290.00

ZN
DT 579 250.00

ZN
DT 581 190.00

PB
DT 582 20.00

ZN
DT 583 350.00

PB
DT 584 20.00

ZN
DT 587 195.00

PB
DT 588 20.00

DT	583		350.00		
DT	584	PB	20.00		
DT	587	ZN	195.00		
DT	588	PB	20.00		
DT	589	PB	20.00		
DT	592	PB	20.00		
DT	709	PB	25.00		
DT	726	PB	25.00		
DT	731	PB	20.00		
DT	738	ZN	215.00		
DT	740	ZN	300.00		
DT	746	ZN	305.00		
DT	751	PB	20.00	ZN	180.00
DT	762	PB	20.00		
DT	766	ZN	190.00		
DT	776	ZN	185.00		
DT	779	PB	20.00		
		PB			

		ZN	
DT	766	190.00	
		ZN	
DT	776	185.00	
		PB	
DT	779	20.00	
		PB	
DT	782	20.00	
		PB	
DT	830	20.00	
		PB	
DT	1 104	20.00	
		PB	
DT	1 107	20.00	
		PB	
DT	1 109	30.00	
		PB	
DT	1 117	25.00	
		PB	
DT	1 118	25.00	
		PB	
DT	1 124	20.00	
		PB	
DT	1 126	25.00	
		ZN	
DT	1 128	180.00	
		CU	PB
DT	1 129	61.00	50.00
		PB	
DT	1 131	20.00	
		PB	
DT	1 134	20.00	
		ZN	
DT	1 162	190.00	

	PB
DT 1 131	20.00
	PB
DT 1 134	20.00
	ZN
DT 1 162	190.00
	ZN
DT 1 198	190.00
	PB
DT 1 509	20.00

CUMULATIVE FREQUENCY DISTRIBUTION FOR CU ,

IN STREA

CLASS LIMITS UPPER - LOWER (PPM)	FREQ
1200000 - 830000	0.
830000 - 560000	0.
560000 - 380000	0.
380000 - 260000	0.
260000 - 180000	0.
180000 - 120000	0.
120000 - 83000	0.

CUMULATIVE FREQUENCY DISTRIBUTION FOR CU , AS ANALYZED BY ATOMIC
IN STREAM SEDIMENTS

CLASS LIMITS UPPER - LOWER (PPM)	FREQ	FREQ (PCT)	CUM FREQ (PCT)
1200000 - 830000	0.	0.	0.
830000 - 560000	0.	0.	0.
560000 - 380000	0.	0.	0.
380000 - 260000	0.	0.	0.
260000 - 180000	0.	0.	0.
180000 - 120000	0.	0.	0.
120000 - 83000	0.	0.	0.
83000 - 56000	0.	0.	0.
56000 - 38000	0.	0.	0.
38000 - 26000	0.	0.	0.
26000 - 18000	0.	0.	0.
18000 - 12000	0.	0.	0.
12000 - 8300	0.	0.	0.
8300 - 5600	0.	0.	0.
5600 - 3800	0.	0.	0.
3800 - 2600	0.	0.	0.
2600 - 1800	0.	0.	0.
1800 - 1200	0.	0.	0.
1200 - 830	0.	0.	0.
830 - 560	0.	0.	0.
560 - 380	0.	0.	0.
380 - 260	0.	0.	0.
260 - 180	1.	0.12	0.12
180 - 120	0.	0.	0.12
120 - 83	0.	0.	0.12
83 - 56	3.	0.35	0.46
56 - 38	160.	18.52	18.98
38 - 26	444.	51.39	70.37
26 - 18	134.	15.51	85.88
18 - 12	60.	6.94	92.82
12 - 8.3	30.	3.47	96.30
8.3 - 5.6	27.	3.13	99.42
5.6 - 3.8	4.	0.46	99.88
3.8 - 2.6	1.	0.12	100.00
2.6 - 1.8	0.	0.	100.00
1.8 - 1.2	0.	0.	100.00
1.2 - 0.83	0.	0.	100.00
0.83 - 0.56	0.	0.	100.00
0.56 - 0.38	0.	0.	100.00
0.38 - 0.26	0.	0.	100.00
0.26 - 0.18	0.	0.	100.00
0.18 - 0.12	0.	0.	100.00
0.12 - 0.083	0.	0.	100.00
0.083 - 0.056	0.	0.	100.00
0.056 - 0.038	0.	0.	100.00
0.038 - 0.026	0.	0.	100.00
0.026 - 0.018	0.	0.	100.00
0.018 - 0.012	0.	0.	100.00
0.012 - 0.0083	0.	0.	100.00

TOTAL DATA VALUES 864.

CUMULATIVE FREQUENCY DISTRIBUTION FOR PB , AS ANALYZED BY ATOMIC
IN STREAM SEDIMENTS

CLASS LIMITS UPPER - LOWER (PPM)	FREQ	FREQ (PCT)	CUM FREQ (PCT)
1200000 - 830000	0.	0.	0.
830000 - 560000	0.	0.	0.
560000 - 380000	0.	0.	0.
380000 - 260000	0.	0.	0.
260000 - 180000	0.	0.	0.
180000 - 120000	0.	0.	0.

CUMULATIVE FREQUENCY DISTRIBUTION FOR PB , AS ANALYZED BY ATOMI

IN STREAM SEDIMENTS

CLASS LIMITS UPPER - LOWER (PPM)	FREQ	FREQ (PCT)	CUM FREQ (PCT)
1200000 - 830000	0.	0.	0.
830000 - 560000	0.	0.	0.
560000 - 380000	0.	0.	0.
380000 - 260000	0.	0.	0.
260000 - 180000	0.	0.	0.
180000 - 120000	0.	0.	0.
120000 - 83000	0.	0.	0.
83000 - 56000	0.	0.	0.
56000 - 38000	0.	0.	0.
38000 - 26000	0.	0.	0.
26000 - 18000	0.	0.	0.
18000 - 12000	0.	0.	0.
12000 - 8300	0.	0.	0.
8300 - 5600	0.	0.	0.
5600 - 3800	0.	0.	0.
3800 - 2600	0.	0.	0.
2600 - 1800	0.	0.	0.
1800 - 1200	0.	0.	0.
1200 - 830	0.	0.	0.
830 - 560	0.	0.	0.
560 - 380	0.	0.	0.
380 - 260	0.	0.	0.
260 - 180	0.	0.	0.
180 - 120	0.	0.	0.
120 - 83	0.	0.	0.
83 - 56	1.	0.24	0.24
56 - 38	4.	0.97	1.21
38 - 26	3.	0.73	1.94
26 - 18	46.	11.14	13.08
18 - 12	89.	21.55	34.62
12 - 8.3	118.	28.57	63.20
8.3 - 5.6	0.	0.	63.20
5.6 - 3.8	152.	36.80	100.00
3.8 - 2.6	0.	0.	100.00
2.6 - 1.8	0.	0.	100.00
1.8 - 1.2	0.	0.	100.00
1.2 - 0.83	0.	0.	100.00
0.83 - 0.56	0.	0.	100.00
0.56 - 0.38	0.	0.	100.00
0.38 - 0.26	0.	0.	100.00
0.26 - 0.18	0.	0.	100.00
0.18 - 0.12	0.	0.	100.00
0.12 - 0.083	0.	0.	100.00
0.083 - 0.056	0.	0.	100.00
0.056 - 0.038	0.	0.	100.00
0.038 - 0.026	0.	0.	100.00
0.026 - 0.018	0.	0.	100.00
0.018 - 0.012	0.	0.	100.00
0.012 - 0.0083	0.	0.	100.00

TOTAL DATA VALUES 413.

CUMULATIVE FREQUENCY DISTRIBUTION FOR ZN , AS ANALYZED BY ATOMI

IN STREAM SEDIMENTS

CLASS LIMITS UPPER - LOWER (PPM)	FREQ	FREQ (PCT)	CUM FREQ (PCT)
1200000 - 830000	0.	0.	0.
830000 - 560000	0.	0.	0.
560000 - 380000	0.	0.	0.
380000 - 260000	0.	0.	0.
260000 - 180000	0.	0.	0.
180000 - 120000	0.	0.	0.
120000 - 83000	0.	0	0

LATIVE FREQUENCY DISTRIBUTION FOR ZN . AS ANALYZED BY ATOMI

IN STREAM SEDIMENTS

CLASS LIMITS UPPER - LOWER (PPM)	FREQ	FREQ (PCT)	CUM FREQ (PCT)
1200000 - 830000	0.	0.	0.
830000 - 560000	0.	0.	0.
560000 - 380000	0.	0.	0.
380000 - 260000	0.	0.	0.
260000 - 180000	0.	0.	0.
180000 - 120000	0.	0.	0.
120000 - 83000	0.	0.	0.
83000 - 56000	0.	0.	0.
56000 - 38000	0.	0.	0.
38000 - 26000	0.	0.	0.
26000 - 18000	0.	0.	0.
18000 - 12000	0.	0.	0.
12000 - 8300	0.	0.	0.
8300 - 5600	0.	0.	0.
5600 - 3800	0.	0.	0.
3800 - 2600	0.	0.	0.
2600 - 1800	0.	0.	0.
1800 - 1200	0.	0.	0.
1200 - 830	0.	0.	0.
830 - 560	0.	0.	0.
560 - 380	0.	0.	0.
380 - 260	7.	0.81	0.81
260 - 180	22.	2.55	3.36
180 - 120	156.	18.06	21.41
120 - 83	365.	42.25	63.66
83 - 56	277.	32.06	95.72
56 - 38	34.	3.94	99.65
38 - 26	0.	0.	99.65
26 - 18	2.	0.23	99.88
18 - 12	1.	0.12	100.00
12 - 8.3	0.	0.	100.00
8.3 - 5.6	0.	0.	100.00
5.6 - 3.8	0.	0.	100.00
3.8 - 2.6	0.	0.	100.00
2.6 - 1.8	0.	0.	100.00
1.8 - 1.2	0.	0.	100.00
1.2 - 0.83	0.	0.	100.00
0.83 - 0.56	0.	0.	100.00
0.56 - 0.38	0.	0.	100.00
0.38 - 0.26	0.	0.	100.00
0.26 - 0.18	0.	0.	100.00
0.18 - 0.12	0.	0.	100.00
0.12 - 0.083	0.	0.	100.00
0.083 - 0.056	0.	0.	100.00
0.056 - 0.038	0.	0.	100.00
0.038 - 0.026	0.	0.	100.00
0.026 - 0.018	0.	0.	100.00
0.018 - 0.012	0.	0.	100.00
0.012 - 0.0083	0.	0.	100.00

TOTAL DATA VALUES 864.

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 *    *    *****   ****    ******    *
 *    *    *    * *    *        *   **
 *    *    *****       *       *     *        ****      ****
 * ** *    *   *    ***       *      *
 **  **    *    *  *         *       *
 *    *    *    *  ******   *       ***
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DATE 12-15-78 TIME 14.005 ID = W1 U-OF-A