STATUS OF MINERAL RESOURCE INFORMATION FOR THE VENEITE LANDS, ALASKA

Administrative Report BIA-1980

by

U. S. Bureau of Mines

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SUMMARY AND CONCLUSIONS

According to recent mineral surveys, the Venetie Lands do not appear to possess high mineral potential. However, assessment of the Venetie Lands is not complete, and requires further investigation.

The western part of the Venetie Reserve was prospected during the early 1900's primarily by miners traveling to and from the Chandalar district. Small amounts of gold were detected on the East Fork of the Chandalar, and gold was mined on a very small scale by prospectors. The total production of the area apparently has been only a few ounces.

Occurrences of oil shale in the Northern Venetie Lands which are rich in hydrocarbon are sparsely distributed as isolated pods in a sandstone unit. Exploration by British Petroleum (BP) in 1977, suggests that the tonnage potential of these oil shales is low (Enns and Findlay, 1977, p. 30).

In 1976, C. C. Hawley sampled the Christian Complex and the western igneous-metamorphic terrane. Anomalous chromium and platinum were found in one location.

In 1977, BP performed reconnaissance mapping and sampled stream sediments of the Venetie Lands concentrating on possible Cu-Au massive sulfide deposits associated with mafic volcanics; copper-nickel, chromium, and platinum deposits in the mafic and ultramafic Christian Complex; and intrusive-related deposits associated with granitic plutons in the southwest corner of the Reservation. No significant mineral discoveries were made, and none of the previously known mineral occurrences, including the chromium-platinum anomaly, were considered by BP to be worthy of further exploration. Although the potential for massive sulfide deposits associated with mafic volcanic rocks, and copper-nickel deposits in mafic intrusive rocks appears to be poor, BP states that potential exists within the ultramafic rocks of the Christian Complex for podiform chromite deposits and platinum placers.

Areas of economic potential which have not been adequately investigated are: the oil, gas, coal, and uranium potential of the Tertiary basin; uranium and fossil fuels in the Devonian sedimentary units; stratiform barite deposits within chert and shale of the Christian Complex; and copper-zinc deposits in marine shales near the contacts with the Christian Complex.

INTRODUCTION

This report has been prepared for the U. S. Bureau of Indian Affairs (BIA) by personnel of the U. S. Bureau of Mines (USBM) under an agreement to compile and summarize available information on the geology, minerals, energy resources, and potential for economic mineral development of Indian lands. Primary sources of information were published and unpublished reports. No field work was done.

ACKNOWLEDGEMENTS

The Veneite Lands have never been studied in detail, and locally have complex geology which will take detailed work to resolve. Never-the less, reconnaissance work by Mertie, Brosge, and Reiser, all of the U. S. Geological Survey (USGS), provides a framework for the present and future studies.

Mertie (1926, 1927) was the first geologist to specifically survey the Venetie Lands, but this survey was incomplete and limited essentially to the river valley. The Paleozoic schists, Devonian sandstones, chert series, and mafic intrusives were recognized by Mertie, who also first reported an oil-shale occurrence subsequently examined by Ebbley (1944) and by Banister in 1976.

The general distribution of rocks was first outlined by Brosge and Reiser (1962) who also clarified the ages of certain rock units. In 1965 Reiser, Lanphere, and Brosge recognized that the mafic intrusive and extensive rocks first reported by Mertie were part of the eight-mile long unit termed by them the Christian Complex.

The Yukon Flats part of the Venetie Lands was reported on by Williams (1962), Barnes (1967) and Brosge. Brabb, and King (1970) have studied part of the area, by gravity and aeromagnetic methods, respectively, (Plate 3 and 2). A recent summary of all the older work was compiled by Forbes and Carver (1976) on BIA contract.

In 1976, C. C. Hawley sampled stream sediments and made a preliminary assessment on the mineral potential of the reservation (Hawley and Garcia, 1976) for the BIA. Reconnaissance mapping and further sampling and follow-up on selected locations were done by a BP mineral survey in 1977 (Enns and Findlay, 1977). One occurrence of oil shale was investigated by Baggs and Blasko (1978). The geologic setting of two occurrences of oil shale was investigated by M. Payne for the USBM in 1977 (Payne, 1977, p. 1-3).

A study of the Eastern brooks Range and Porcupine River drainage area by the Bureau of Mines in 1977-1978, revealed copper zinc deposits and bartie in units that continue into the Venetie Lands.

Geography

The Venetie Lands (the former Venetie Indian Reservation) have an area of about 2,200 square miles contained in a crudely diamond-shaped block 100 miles long and 50 miles wide in Northeast Alaska (Fig. 1). This land is owned by residents of the area at Venetie and Arctic Village. The Venetie Lands extend northerly from the Yukon River or Landing. The Chandalar River forms the southwest boundary of the diamond; the East Fork of the Chandalar, the northwest boundary; and the Christian River the southeast.

Settlements are located at Venetie and Arctic Village. Small settlements with a permanent population of 1 to 3 are located at Christian Village (which, according to Mertie, 1927, p. 138, had a population of approximately 20 in 1927) and on the East Fork of the Chandalar, about two miles north of Cornucopia Creek.

Access to the area is principally by air, but in open season river boats traverse all the Chandalar River system to Arctic Village, and in the winter snow machines follow elements of the old Fort Yukon-Christian-Arctic Village and Venetie-Christian trails. Most of the high tundra lands between Arctic Village and Christian and the East Fork-Chandalar junctions are also accessible by snowmobile.

The main air fields are at Venetie (4400 feet long) and Arctic Village (3000 feet long). A small airstrip suitable for a supercub is located on the East Fork of the Chandalar two miles north of Cornucopia Creek. This airstrip must be carefully monitored, as it can easily by damaged by flooding. There is also an airstrip at Christian which is presently at best, marginal for supercub traffic (Hawley and Garcia, 1976, p. 2-4).

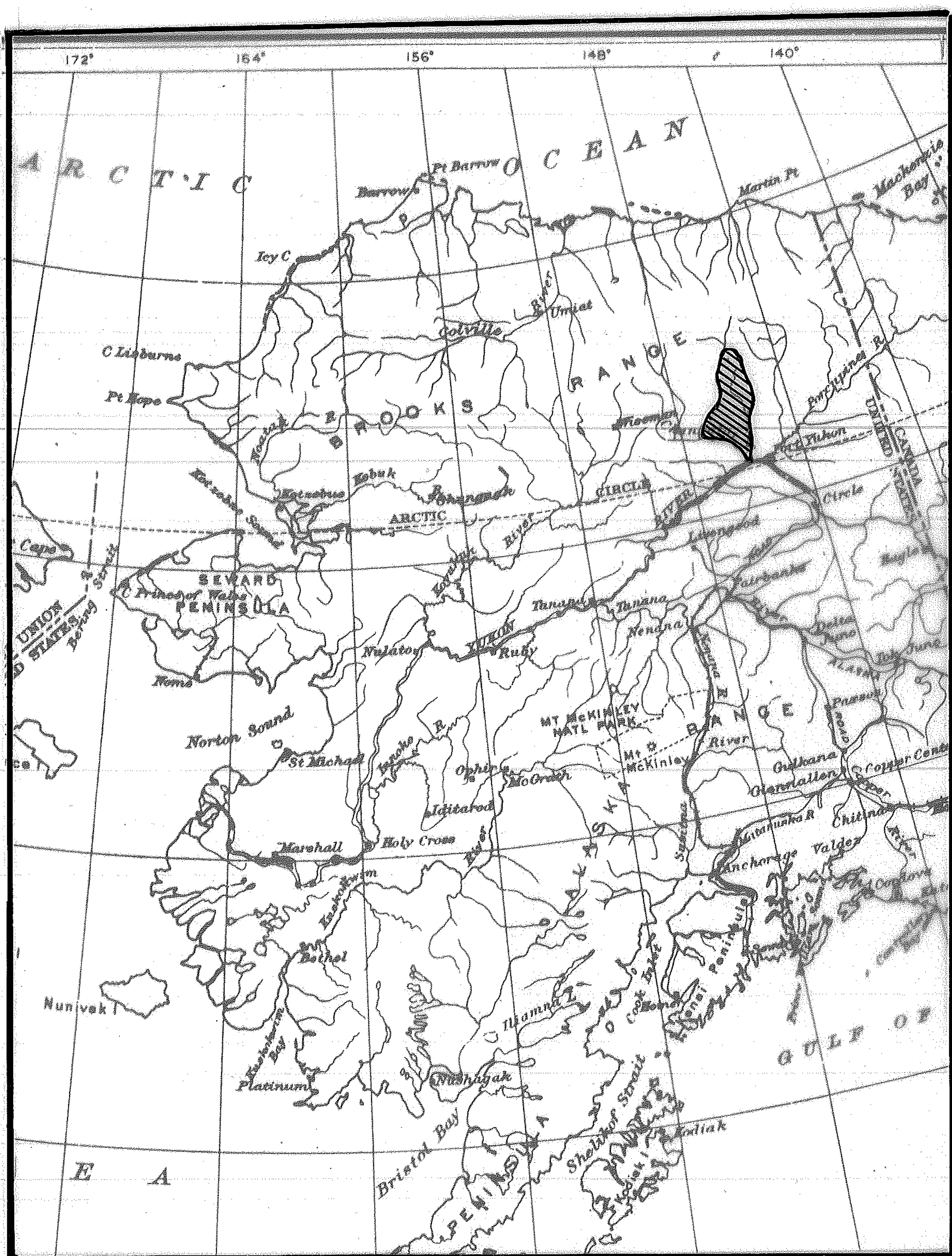

Figure 1. Index map of the Venetie Lands, Alaska.

Map Coverage

The Venetie lands are located mainly on the western half of the Christian quadrangle, and extend to the southern part of the Arctic quadrangle, northern part of the Fort Yukon quadrangle, and eastern part of the Chandalar quadrangle. Topographic map coverage of these quadrangles on a 1:250,000scale can be ordered from the Branch of Distribution, U. S. Geological Survey, Federal Center, Denver, Colorado 80225. Topographic maps on a 1:63,000 scale are available for the Arctic A-4, A-3, Christian D-3, and Fort Yukon C-4, D-4, D-5 sections (Fig. 2).

Geologic map coverage of the Venetie lands is available on a 1:1,000,000 scale in the USGS open file map 77-168A, Preliminary map of Central Alaska by Gassaway and Beikman 1977, and USGS open file map 77-166B, Geologic Map of the Brooks Range by Grybeck, Brosge, Tailleur and Mull (1977). Geologic map coverage is also available on a 1:250,000 scale in two reports written for the Bureau of Indian Affairs by Forbes and Carver (1976) and Hawley and Garcia (1976).

Physiography

The majority of the Venetie Reservation lies within the Porcupine Plateau physiographic province, and consists of relatively subdued uplands, whose average summit elevation decreases from between 3,000 and 3,500 feet in the north to between 2,000 and 3,000 feet in the south and southwest. Subdued, rolling terrain with broad swampy valleys and a local relief of less than 1,500 feet characterizes both the northern and southwestern parts of the Reservation. The east-central part of the Reservation, which is underlain largely by the Christian Complex of rocks, is somewhat more rugged, with a local relief of up to 2,000 feet

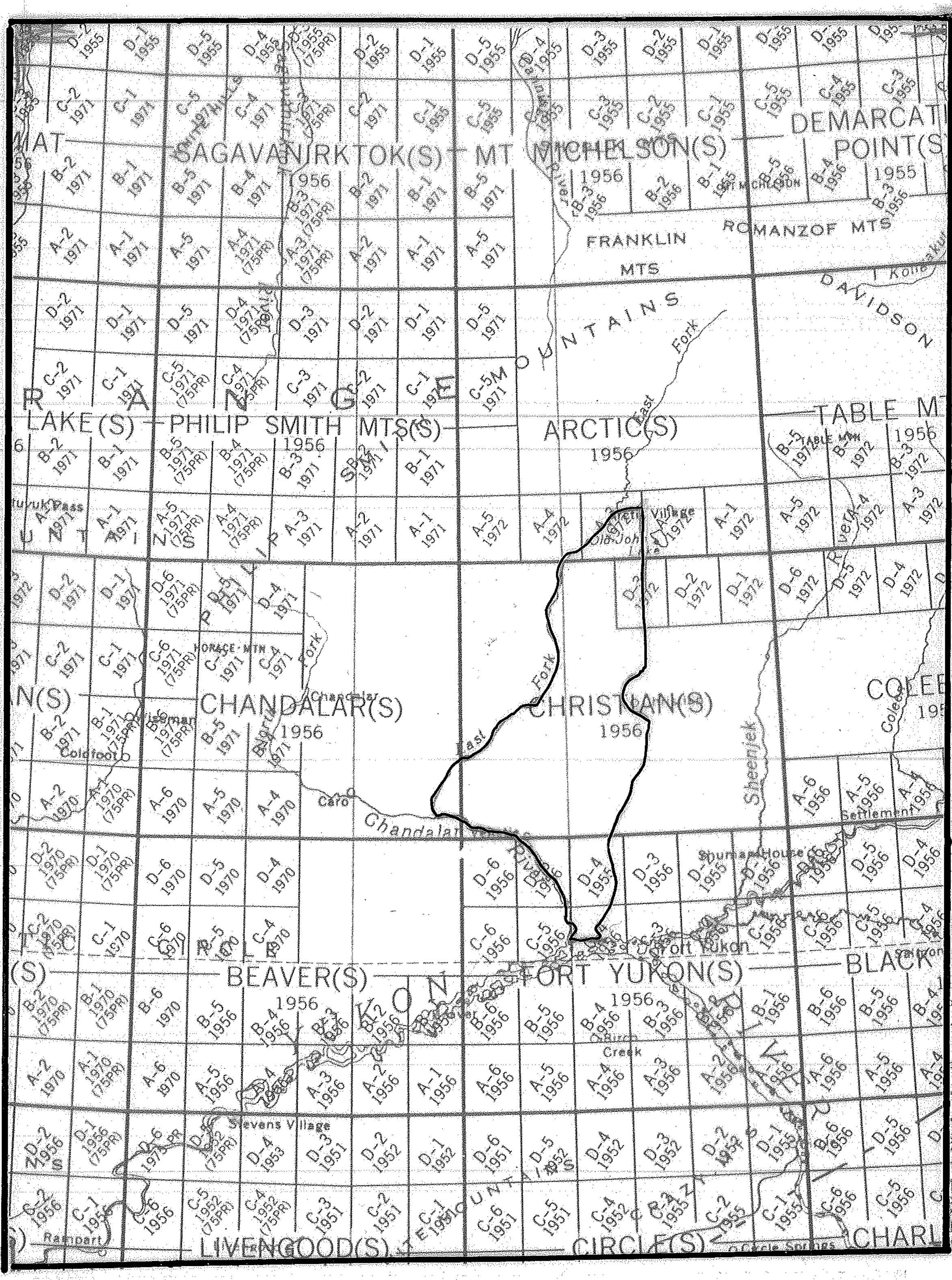

Figure 2. Index to topographic maps of the Venetie Lands, Alaska.

along the deep sided, deeply incised valleys of the Christian River and its tributaries, Otter Creek, and Timber Creek. In the south, the uplands pass moderately abruptly into the flat, swampy, alluvium covered Yukon Flats.

Most of the area remained free of ice during the Quaternary glaciations, although eastward flowing meltwater from a large glacier which periodically occupied the valley of the East Fork, Chandalar River eroded outwash channels in the vicinity of Bob Lake, and at the headwaters of Kocacho Creek.

Timberline generally varies between 2,000 and 2,500 feet; the relatively high uplands in the northern part of the Reservation are largely treeless, whereas good stands of white spruce grow on the better drained ground in the central and southern parts of the Reservation. The ridges and plateaus above 2,500 feet are usually covered by tundra and felsenmeer, with only scattered outcrops. Permafrost underlies the whole area, with the exception of the steeper, south facing slopes at lower elevations (Enns and Findlay, 1977, p. 3).

General Geology

The rocks of the Venetie lands fall into 4 major groups by area. These are 1)Devonian metamorphic rocks in the westernmost part of the lands similar to schists of the southern Brooks Rangs; 2)Paleozoic sedimentary rocks locally capped by chert and shale in the northern Venetie Lands; 3)the Christian complex, a Mesozoic unit in the east-central Venetie Lands of interlayered mafic volcanics and cherts with local mafic and ultramafic intrusions; and 4)the Tertiary Basin underlying the Yukon Flats south of the metamorphic and Christian Complexes (Fig. 3).

Older Metamorphic and Sedimentary Rocks: Quartz-biotite schist and associated phyllite forms the metamorphic complex near the junction of the East Fork and Chandalar. Locally near the granite bodies, the schists are coarsened and contain andalusite, staurolite, and cordierite. In the Chandalar quadrangle (Brosge and Reiser, 1964, sheet 1 and 2) similar strata are considered to be regionally and thermally metamorphosed Devonian sedimentary rocks, although Mertie (1927, p. 110) thought they underlay Devonian (Silurian) strata. The relations of schist and the undoubted Devonian rocks were not determined in the Christian quadrangle, but schists give way northerly through phyllite to the Upper Devonian series of sandstone, siltstone, quartzite, graywacke, and shale.

Locally the Kanayut Conglomerate overlies Devonian fine clastic sediments in northern parts of the Venetie Lands near Arctic Village. The Kanayut Conglomerate grades from quartzite to a quartzitic conglomerate forming a coarse clastic wedge which pinches out toward the south. It may be about the same age as the Hunt Fork Shale which outcrops in western parts of the southern Brooks Range.

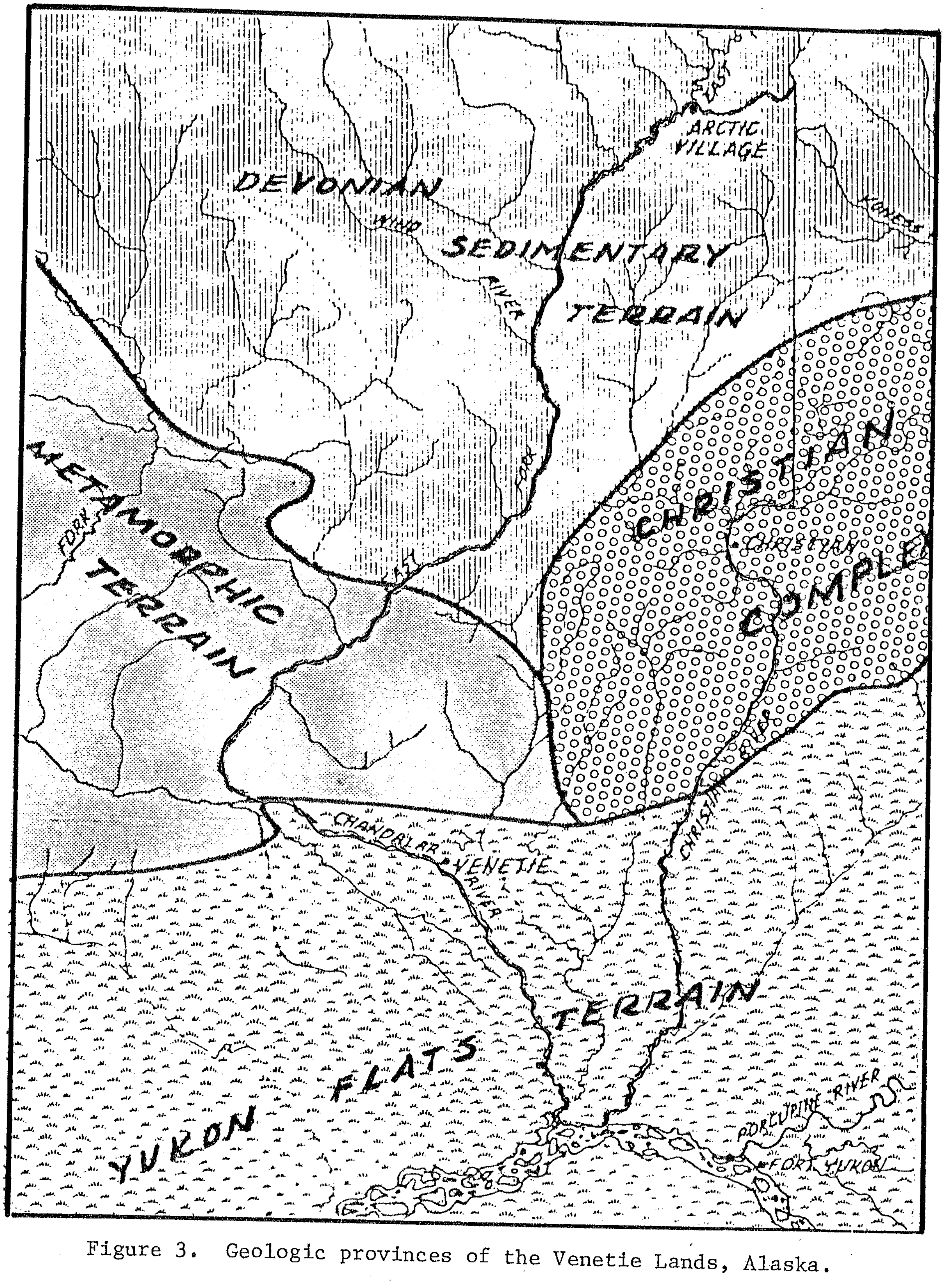

Figure 3. Geologic provinces of the Venetie Lands, Alaska.

A laminated chert-shale sequence consisting of bedded partly-radiolarian chert, vari-colored shale, and argillite outcrops in the northern and western portions of the Venetie Lands. The chert-shale sequence overlies the Devonian clastic rocks and is considered late Paleozoic to Triassic in age by Brosge and Reiser, 1962, sheet 1 and 2; Reiser and others, 1965, p. 68; Tourtelot and Tailleur, 1965, p. 6. However, studies of radiolarian chert from the Christian Complex indicate that the chert units may be Carboniferous to Permian (Brosge, W.P./personal communication). The layered argillite and chert crops out stratigraphically above the Devonian sequence between Willow House and Arctic Village. Apparently similar rocks form the northwest and southeast flanks of the Christian Complex and apparently dip underneath it. Sedimentary rocks also form major inclusions or interlayers in the Christian Complex. These rocks are dominantly sandstone--including graywacke, shale, argillite, and chert. Locally the interlayered sedimentary rocks also include oil-shale (Tourtelot and Tailleur, 1965).

Grantitic Rocks: Two medium sized granitic plutons have intruded shcists within the southwest corner of the Reservation, immediately north of Chuttoh Bluffs. Both plutons are composed of medium to coarse grained biotite granite and quartz-monzonite, together with lesser granodiorite. The granite and quartz monzonite have an average grain size of 3-5mm and commonly contain large K feldspar megacrysts, up to 10 cm long. Quartz and biotite content averages 20-30% and 10-20%, respectively. Garnet and tourmaline are local accessory minerals. The less abundant granodiorite is typically finer grained and more mafic, and contains hornblende as well as biotite; it appears to be more abundant near the intrusive margins. Diorite, monzonite, and aplite dikes are sparsely distributed.

The intrusive rocks locally contain pegmatite lenses and pods, whose coarse-grained quartz, feldspars, and muscovite are sometimes accompanied by tourmaline and garnet. In this respect they resemble the Brooks Range intrusives which are locally enriched in tin.

Intrusive margins are often quite complex, with schist along the contact being cut by numerous granitic dikes. Chiastolite of contact metamorphic origin is locally developed within schist along the contact; the more gneissic nature of the shcists near the two plutons is also, perhaps, a contact effect.

The two plutons may be connected at depth. The southern one is almost certainly the eastern extension of the large batholith which occupies an area of nearly 100 square miles southwest of Chuttoh Bluffs.

The Christian Complex: the Christian Complex of mafic and ultramafic igneous rocks and associated sediments underlies an area of at least 400 square miles in the east-central part of the Venetie Reservation and extends for at least 20 miles to the northeast. Two K-Ar age dates indicate a Jurassic age (Reise, Lanphere, and Brosge, 1965). The map units which make up the complex are divisible into two main groups:

- mafic volcanic rocks and marine sediments (mainly cherts)
- mafic and ultramafic intrusive rocks

The volcanic and sedimentary rocks form over two-thirds of the complex. The mafic and ultramafic intrusive rocks underlie a northeasterly trending lenticular area of at least 100 square miles, which is entirely enclosed by volcanic and sedimentary rocks. The structure of the complex and age relations of the various units are not known, since no informative contacts are exposed. A prominent fault forms the northwestern border of the complex along the Christian River in the vicinity of Brown Grass Lake. This complex was extensively studied by BP in 1977 (Enns and Findlay, 1977).

Tertiary Rocks: there are no outcrops of Tertiary rocks on the Venetie Lands, but sedimentary rocks or deposits of Tertiary age probably underlie much of the Yukon Flats, filling an ancient continental basin.

Based on comparison with other Alaskan Tertiary Basins, the sediments are sandy and clay-rich units with local interbeds of coal. The deposits are likely less magnetic than the older basement, and based on the assumption of lesser magnetism, the northwest boundary of the Tertiary Basin could trend north-northeast, crossing the south Christian quadrangle boundary near 146° west longitude. Again, based on aeromagnetic patterns which show a pronounced low southeast of Venetie, Tertiary rocks could have a maximum thickness in T42N, R10E.

The Tertairy rocks could be economically significant, as they are potential reservoirs of oil and gas, and could also contain deposits of coal and possibly uranium (Hawley and Garcia, 1976, p. 3-7).

Quaternary and Recent Deposits: most of the southern part of the Venetie Lands is covered with deposits of sand, gravel, and fine-grained wind-blown material--which range in age from the last glacial episode to the geologic recent.

Williams and others (1962, p. 289) have proposed that the area has been involved in four Pleisiocene periods of glaciation, with strong evidence in the Venetie Lands of the second and third periods(Williams and others, p. 308-310). According to Williams the oldest glaciers may have extended to the Yukon Flats via the Chandalar, Marten, and Sheenjek Valleys. Deposits of the next oldest glaciation extend down the East Fork to Coal Creek, and deposits of the third period to near Lush Creek. Extensive old alluvial fans of the Chandalar River, Marten, and Christian cover much of the ground near Venetie. These fans probably were synchronous with the glacial deposits of the East Fork. The more recent deposits are in the flood-plains and lowest terraces of the modern streams (Hawley and Garcia, 1976, p. 3-8).

Structural Geology: the geologic studies of the area have not been sufficiently studied to resolve major structural problems, such as the relation between shcistose and undoubted Devonian rocks. The Venetie Lands are southeast of the major belt of thrust faulting in the Brooks Range, and in general the structure seems to dip toward a synclinal basin centered on the Christian Complex. Southeast of Arctic Village, faults of northwest strike offset Paleozoic strata, and there is the possibility that the Christian Complex is thrust northwestward over the older strata (Hawley and Garcia, 1976, p. 3-8).

Economic Geology

A geochemical comparison of copper, lead, zinc, chromium, and nickel in the various geologic terranes was done by Enns and Findlay 1977 (Appendix VII). This comparison suggests that the areas of highest copper, lead, zinc, chromium and nickel are the Christian Complex volcanic rocks and the granitic-metamorphic terrane.

Chromium, nickel and copper in granitic-metamorphic terrane: The granitic-metamorphic complex of the western Venetie Lands is similar to the mineralized metamorphic terrane near Chandalar and other ultramafic complexes which contain chromium, nickel and copper. Based on stream sediment sampling by C. C. Hawley, 1976, there is no significant mineralization in this terrane.

Chromium and platinum deposits in ultramafic rocks: According to Hawley and Garcia, the part of the Christian Complex most favorable for metallic deposits is a peridotite zone exposed near the head of Timber and Marten Creeks. In this zone the peridotitic or dunitic ultramafics are indicated by a characteristic yellow soil color and sparse vegetation. Low concentrations of anomalous chromium and detectable platinum metals were found in this soil by C. C. Hawley and G. Garcia, 1976, p. 4-10. Although the platinum metal content of the rock samples is low, Hawley and Garcia speculate that the topography and drainage of the area could have produced local placer concentrations of platinum metals.

The more important lode platinum deposits are associated with large, layered mafic-ultramafic intrusions, rather than with alpine type ultramafic intrusions - which the Christian Complex ultramafic rocks are considered most likely to be. Rock chip sampling by Hawley and Garcia, 1976, Table 1, did not suggest that the ultramafic rocks are unusually rich in platinum, although the confidence of this interpretation is limited by the small number of samples collected. Platinum in alpine type ultramafic intrusions most often occurs in disseminated native form, and may be concentrated in placer deposits by stream or beach processes during erosion. Some potential for placer platinum deposits must exist in the Christian Complex, but not

Table 2. <u>Summary of platinum rock geochemistry</u>

Location	Sample #	Pt (ppm)	Pd (ppm)	Cr %	$^*Cr_2O_3$ %	Fe %	
Levi Peak	2546	.1	.02	4.8	7.0	15	"high graded" Cr-bearing magnetite
	2547	.1	.015	4.9	7.2	16	"high graded" Cr-bearing magnetite
	2548	.07	.02				15' trench sampling in situ Cr-bearing magnetite
	2549	.05	.015				20' trench sampling in situ Cr-bearing magnetite
	2550	.07	.02				12' trench sampling in situ Cr-bearing magnetite
	2593	.07	.01	2.9	4.2	7.6	"high graded" Cr-bearing magnetite
	2553	.015	<.1				fresh dunite
	2554	.02	<.01				fresh dunite
	2555	.01	<.01				fresh black pyroxenite
	2556	<.01	<.01				fresh black pyroxenite
T30N,R10E SW¼	2557	.05	.01				fresh peridotite
	2558	.07	.01				fresh peridotite
Timber Crk.	2559	<.01	<.01				fresh peridotite
	2560	<.01	<.01				fresh peridotite
T29N,R10E Hill 1910T	369	.02	<.01				fresh pyroxenite
	370-379	≤.01	<.01				fresh pyroxenite and peridotite
	380	.05	.01				peridotite
	381	.01	<.01				fresh pyroxene (?) gabbro
	382	.015	<.01				fresh pyroxene (?) gabbro
	383-387	≤.01	<.01				fresh peridotite
	388	.02	.01				fresh peridotite
VABM Ann	394-396	<.01	.01				fresh hornblende gabbro
	397	.015	<.01				fresh hornblende gabbro
	398	.015	<.01				fresh hornblende gabbro
	399-403	.01	.01				fresh pyroxenite and peridotites

Total 44 bulk samples

*recalculated to equivalent % chromite

enough is known about the overall platinum content of the rocks, or the history of stream erosion in the area, to adequately evaluate this.

The probable identity of the ultramafic rocks of the Christian Complex as alpine type ultramafic intrusions indicates a potential for podiform chromite deposits. Several occurrences of chromium-bearing magnetite were found in the ultramafic rocks, mainly associated with dunite, but the most significant occurrance, at Levi Peak, is very small and shows a low Cr:Fe ratio (approximately .35:1) identifying it as a high iron type (Enns and Findlay, 1977, p. 40).

Copper-Gold Massive Sulfide Deposits in Mafic Volcanic Rocks: The marine basalts, of possible ophiolite affinity, could be a possible host for Cu-Au massive sulfide deposits of the Cyprus type. However, no mineralization of massive sulfide character was found in these rocks, either in outcrop or in float. Trace amounts of chalcopyrite were observed in basalt in a few localities, but these occur either disseminated, or localized along fractures and veinlets. Such mineralization is quite likely the cause of the weakly anomalous copper values found in a few streams draining the basalts. The absence of any substantial copper or copper-zinc anomalies in streams draining these rocks, together with the lack of massive sulfide type mineralization, suggests that the potential for massive sulfide deposits is poor.

Copper-Nickel Deposits in Mafic Intrusive Rocks: The consideration of mafic intrusive rocks as a possible host for copper-nickel sulfide deposits was based on the hope that these rocks occurred in the form of differentiated, layered intrusions, with associated mineralization of the type found in the Duluth Gabbro, or at Brady Glacier, Alaska. Geological investigation, however, has shown that neither the hornblende gabbro, nor the gabbros and diabases occur as layered intrusions. The Upper Martin Creek copper occurrence is the only significant sulfide occurrence in either of these units, and it appears to be very small; elsewhere sulfides are notably absent. No significant copper-nickel anomalies were found in streams draining the mafic intrusive rocks, so that the potential for nickel-copper sulfide deposits in these rocks must also be considered poor.

Shale hosted marine copper zinc mineralization: In the Upper Koness River approximately 20 miles northeast of the Venetie Lands copper-zinc mineralization is suggested by minor malachite and moderately high copper, zinc, barium, manganese and lead geochemical anomalies. This mineralization occurs within interbedded green and red shales and argillites of probable Permian or younger age. The anomalous zinc concentrations range from 250-710 ppm, and copper values range from 70-200 ppm. Manganese values greater than 7000 ppm have also been found in this area. The sedimentary units may be transitional to the Christian Complex and are of deep water origin (Barker 1980A, p. 69). The sedimentary unit bordered to the south by the Christian Complex, extends into the Venetie Lands and may also be mineralized. These rocks were only briefly examined by C. C. Hawley in 1976 and the 1977 BP mineral survey, and should be investigated.

Stratiform sedimentary barite: In the Coleen quadrangle east of the Venetie Lands Upper Paleozoic to Lower Mesozoic shales and cherts associated with the Christian Complex appear to have high potential as host rocks for stratiform barite deposits. Fragments of white massive barite and high barite concentrations in stream sediment and pan concentrate samples were found 35 miles east of the Venetie Lands. Barite was also found as beds that occur up to 18 feet thick and are exposed for 100 feet along strike of the chert, and shales. Sulfides do not appear to be associated with this barite. The quality of the barite is unknown but would tend to be improved by the lack of sulfides. (Barker, 1980a, p. 70).

Intrusive related deposits: The two main types of intrusive related deposits which were sought in the granitic terrane were:

- porphyry Cu-Mo within granitic rocks
- base metal tactite deposits in altered limestone near granitic contacts

Multiple intrusions with porphyritic phases, dike complexes, large areas of pyritized and hydrothermally altered rock, and occurrences of disseminated or stockwork copper and molybdenum sulfides are geological features commonly associated with porphyry deposits. None of these features were found in the Venetie granitic plutons, and no significant mineral occurrences were discovered. Stream sediment sample results offer little encouragement, except for an isolated value of 10 ppm Mo. Values for other metals in this sample are not anomalous, however; and another sample collected 1 mile downstream has a normal molybdenum content. No limestones were diecovered in the vicinity of the granitic plutons, and none of the streams draining the contact zones of these plutons contain anomalous metal values. Thus, the potential for porphyry and tactite deposits associated with the granitic intrusives seems to be poor (Enns and Findlay, 1977, p. 41).

Oil shale deposits: Occurrences of oil shale are found in float in the paleozoic sedimentary units in the Northern Venetie lands. The oil shale is of the Tasmanite variety with a high oil content and also occurs in the Brooks Range to the west.

The Tertiary basin which is inferred to underlie much of the Yukon Flats is a potential reservoir of oil and gas. Based on comparison with other Alaskan Tertiary Basins, the Tertiary sediments are sand and clay-rich units with local interbeds of coal (Hawley and Garcia, 1976, p. 3-7).

MINERAL RESOURCES

Metallic Minerals

The western part of the Venetie Reserve was prospected during the early 1900's primarily by miners traveling to and from the Chandalar district. Small amounts of gold were detected on the East Fork of the Chandalar and gold was mined on a very small scale by prospectors in Crater and Cornucopia Creeks (John Frank, personal communication). The total production of the area apparently has been only a few ounces.

Eight stream sediment samples from the Venetie lands were analyzed by the USGS for 30 elements between 1960 and 1966 (Brosge, Reiser, and Moore, 1977, p. 1).

In 1976, 140 samples from the igneous metamorphic complex and the Christian complex were analyzed for metals including copper, lead, zinc, silver, gold, nickel, and chromium (Hawley and Garcia, 1976, p. 4-2). These samples include stream sediments, pan concentrates, soils, and chip samples of rock units.

Stream sediment samples and rock chips underlain by the Christian Complex, and near 2 granite plutons in the igneous metamorphic terrane were analyzed by BP in 1977 for chromium (Enns and Findlay, 1977). These areas were covered by reconnaissance type sampling as thoroughly as drainage conditions allowed at 1/2-1/4 mile intervals along the active streams (Enns and Findlay, 1977, p. 32). Possible mineralized areas suggested by previous studies were investigated, and 5 new areas of anomalous samples were found. These 5 new anomalous areas are located 6 miles west of Christian, northeast of VABM Bend, East VABM-Ann, south of Sharkedge Mountain, and east of Bob Lake. British Petroleum considers these areas as medium priority and does not consider any of them sufficiently attractive to merit follow up in the future (Enns and Findlay, 1977, p.39). All mineralized areas are summarized in Table 2 with their locations shown on Fig. 4. Selected areas are discussed below.

Levi Peak Chromium Occurrence

Chromium was discovered at Levi Peak by C. C. Hawley in 1976. The chromium occurs within a body of dunite at least 100 feet wide, along the crest of a ridge which is underlain by peridotite and pyroxenite, together with minor dunite. Fragments of black chromium bearing magnetite make up somewhat less than 10% of the rubble over an area of approximately 60 feet by 40 feet. Three large composite samples of chromium bearing magnetite were collected from this area of rubble (Enns and Findlay, 1977, p. 30). Results are shown below in Table 3.

Table 3. Analysis of "high-graded" Chromium bearing magnetite - Levi Peak

Sample #	Cr %	*Cr_2O_3 %	Fe %
2546	4.8	7.0	15.0
2547	4.9	7.2	16.0
2593	2.9	4.2	7.6

*recalculated to equivalent % chromite

The chromium bearing magnetite occurs within dunite as irregular bands and lenses, whose thickness is generally less than one inch thick and nowhere exceeds four inches. Examination of the three shallow trenches excavated in the source area of the most abundant magnetite rubble fragments suggests that a body of dunite with magnetite lenses, only a few feet wide, is the major source of this rubble.

TABLE 2. DESCRIPTION OF MINERALIZED AREAS IN THE VENETIE LANDS, ALASKA

Name	Location	Commodity	Description and remarks
* 1 Christian River Sheer Zone	T32N, R9E, Sec 33	Copper Zinc	See text.
2 Cornucopia Creek	Exact location unknown	Gold	Small amounts of gold were mined on a very small scale in the early 1900's.
3 Crater Creek	A tributary of the East Fork South of Crater Creek	Gold	Small amounts of gold were mined on a very small scale in the early 1900's. In 1976 a stream sediment sample detected gold.
4 Three miles east of Bob Lake	T37N, R11E	Copper Zinc Nickel	Two samples with weakly anomalous Cu, two with weakly anomalous Zn, and one with weakly anomalous Ni. Area underlain by basalt, diabase, and chert. Sparse outcrop.
5 E of VABM Ann	T30N, R10E	Chromium Copper	Three samples with weakly anomalous Cu. One sample with definitely anomalous Cr. Low Ni values not encouraging for Ni-Cu deposits. Area underlain largely by hornblende gabbro with minor ultramafics. Cu anomaly may be caused by minor chalcopyrite disseminated in gabbro-this seen elsewhere.
6 Levi Peak Chromium Occurrence	T30N, R9 & 10E, Sec 25 A hill with elevation	Chromium Platinum	See text.
7 Oil Shale occurrences	Area A T34N, R11E, Sec 25 Area B T31N, R9E, Sec 28 reported Area C T33N, R11E reported in creek float	Oil Shale	See text.
8 NE of VABM Ben	T30N, R11E	Chromium Copper	Weakly anomalous Cu in one sample, with definitely anomalous Cr in another. Geology of these drainages not mapped. Forested area, but good outcrop likely along the steep slopes.
9 S of Shark Edge Mt.	T31N, R9E	Zinc	Two samples with definitely anomalous Zn. Area underlain by Devonian siltstone with interbedded shale. Very little outcrop.
10 Six miles West of Christian	T29N, T30N, R10 & 11E	Copper Zinc	Two adjacent small drainages, one with weakly anomalous Cu, the other with moderately anomalous Zn. Near the hornblende gabbro (map unit 4) in area of basalt and chert. Forested area with extensive overburden.
11 Upper Martin Creek	T29N, R10E	Copper	Very minor chalcopyrite occurs within oilivine bearing pyroxene gabbro near the headwaters of Martin Creek. 3 soil samples collected over the gabbro contain copper and nickel. This type of mineralization is too low grade to be of further interest (BP, 1977).

*Numbers correlate with locations on Figure 4.

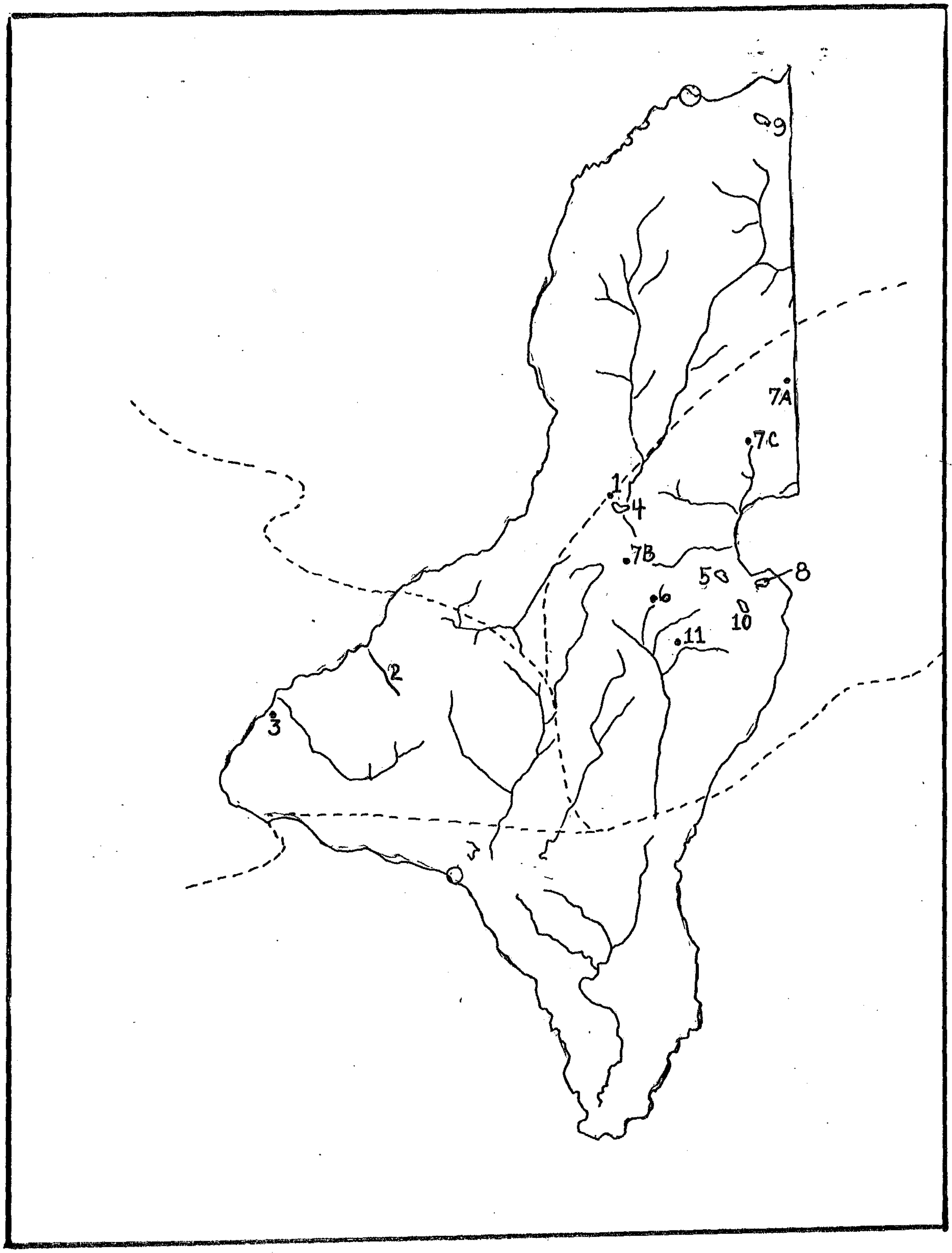

Figure 4. Mineralized areas, Venetie Lands, Alaska

Six samples of chromium bearing magnetite from the Levi Peak occurrence were analysed for platinum and show an enrichment of approximately tenfold over background for ultramafic rocks. These samples, which average .8 ppm platinum, give similar results to those collected by Hawley in 1976 from this occurrence. Samples of chromium bearing-magnetite from Levi Peak were combined into a bulk sample which was subjected to mechanical separation testing by Hazen Research. The results of these tests are summarized in Appendix VI, and indicate that the platinum in the chromium-bearing magnetite is not amenable to concentration by gravity methods. According to the BP report by Enns and Findlay (1977, p. 30), the occurrence at Levi Peak is both too samll and far too low grade to be of further interest.

Christian River Shear Zone

C. C. Hawley collected a talus soil sample containing moderatley anomalous copper and zinc in 1976 from a shear zone which cuts diabase and argillites on the north side of the Christian River, east of Brown Grass Lake (Hawley, 1976, p. 4-10). The 30 feet wide northeast striking shear zone cuts slate, chert, and argillite, and is accompanied by several dikes of highly fractured, weathered diabase. Both fractured diabase and slate locally contain several percent pyrite, whose weathering has produced abundant limonite stain. Although no copper or zinc sulfides were observed, such sulfides localized along this shear zone are considered by Enns and Findlay (1977, p. 29) to be the most likely cause of the soil anomaly.

Non-Metallic Mineral resources

Sand and Gravel

Alluvial sands and gravels are readily available along the valleys of the Chandalar, Christian, and Sheenjek Rivers. Large reserves are present north and northwest of Venetie in the alluvial fans of the three rivers where they enter the Yukon. A valuable reference and geologic map, describing the nature and distribution of the Yukon Basin deposits, has been published by the U. S. Geological Survey (Williams, 1962).

Potash and Soda ash

Some dry lake beds large enough to be readily visible on satellite imagery of the Yukon Flats are mantled with soda ash minerals. A sample from one mile west of Ohtig Lake (T. 20 N., R. 18 E.) contained thermonatrite, feldspar and trona. Similar occurrences of calcium carbonate, feldspar and quartz wouthwest of Ft. Yukon appeared to have been formed in conjunction with degassing of the substrata, and ground water-fed lakes that intermittently dry up (Barker, 1980b, p. 55).

In 1926, potash salts were discovered in small lakes north of Fort Yukon. Because some of these lakes did not freeze thoroughly in the winter, water samples of 3 lakes were analyzed (Mertie, 1926, p. 123). Three samples were obtained. Their locations are as follows:

1. North of Fort Yukon, on the Alexander (Indian) trail;
2. Eight miles northeast of No. 1;
3. Ten miles east of No. 1.

Analysis of these samples are listed below in Table 4.

Table 4. Analysis of potash in water samples (after Mertie, 1926)

Sample No.	per cent of soluble soils	per cent of K_2O in soluble salts
1	0.008	10.65
2	.58	4.82
3	.28	3.91

Sources and geologic significance of these minerals are uncertain, but one interpretation might be to suggest remobilization of various marine and non-marine evaporite sequences that may be found at depth; e.g. gypsum, soda ash and potash. Origin of the sodium and potassium minerals perhaps is more likely associated with the extensive Tertiary felsic and intermediate volcanism to the north of the Yukon Flats (Barker, 1980b, p. 55).

ENERGY RESOURCES

Petroleum, natural gas, coal and uranium are diverse substances but they may occur in the same geologic environment. One such common environment is that of a continental or perhaps marginal marine basin receiving continental sediments. There are two environmental zones with some potential for petroleum accumulation in the area; one of these is the Tertiary basin which underlies part of the Yukon Flats; the second is the Devonian sandy sequence northwest of the Christian Complex.

Oil and Natural Gas (Yukon Flats Province)

The geology of the Yukon Flats province of the Venetie Lands is poorly understood as rocks of the basin are mainly covered by thick alluvial and aeolian deposits (Williams, 1962). Nevertheless sparse exposures and some drill holes indicate that rocks or poorly consolidated sediments of Tertiary age do underlie at least part of the area.

Several private individuals and 3 oil companies hold lease applications on considerable amounts of land surrounding the southern borders of the Venetie Lands (Fig. 5).

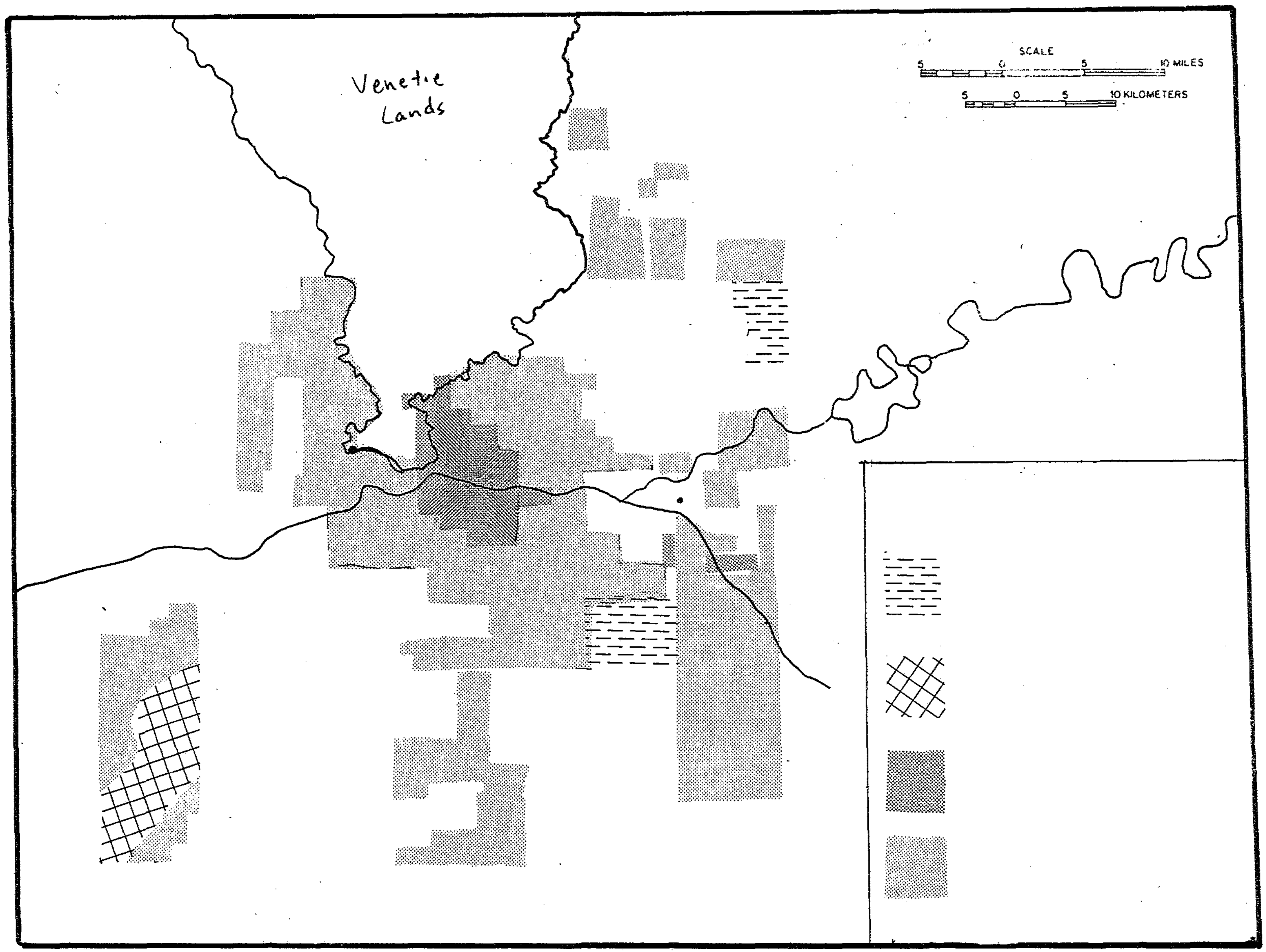

Fig 5 Oil and gas lease application map

According to Barker, (1980b, p. 59), the southwest part of the Yukon Flats, which is south of the Venetie Lands, has the highest gas and oil potential, based on preliminary gravity and density studies.

Oil Potential (Paleozoic Sedimentary Rocks)

These rocks are well cemented quartzitic units through graywackes to sandstones which locally could have the necessary porosity for an oil reservoir sand. An oil seep in Paleozoic sandstone near Bob or Brown Grass lake has been reported. The oil potential of the Paleozoic units should be further investigated.

Uranium and Thorium

A brief examination of the Paleozoic sediments which underlie the northern part of the Reservation was carried out in order to assess their potential as a host for sandstone type of uranium deposits. Since these sediments are probably entirely marine, they are not considered to have significant uranium potential.

The Yukon Flats Tertiary basin has uranium potential. Numerous stream sediment samples from areas along the Porcupine River in the Yukon basin were found to have medium-high thorium values up to 50 ppm (Barker, 1980b, p. 59). Minor values of uranium in mudstone and water lain ash bedrock samples from the Coal Creek area of the Dall River. These rock units are interbedded with porous sandstone (frequently containing abundant plant trash and locally oxidized), conglomerate and coal (McDermott, 1979, p. 14).

Coal

In 1927, deposits of coal from the valley of the Christian River in the same general area of the oil shale occurrences were reported to Mertie (1927, p. 139) who was unable to locate the coal. Several coal occurrences have been found in the Yukon Flats to the south, southwest, and southeast of the Venetie Lands. These include: a continuous strata of coal at least 18' thick on Coal Creek on a tributary to the Dall River; boulders of coal on the Ray River adjacent to the Trans Alaska Pipeline; 2 occurrences of lignite and reports of subbituminous coal found on the Hodzane River; and boulders of coal along four or five miles of the Tozitna River Valley (McDermott, 1979, p. 14).

Oil Shale

Area A: One oil shale occurrence is exposed 2 miles west of VABM Blown where some oil shale is exposed in felsenmeer along the crest and shallow upper slopes of a broad, bare ridge. The oil shale was examined by Enns, 1944. The Enns, 1944 report is summarized in Appendix IV. In 1976, the USBM excavated several pits in this area. BP examined the occurrence in 1977, and excavated several more fresh pits, in the vicinity of USBM excavations "cut. no. 6" and "pit no. 3".

This oil shale consists of dark brown to black, earthy, petroliferous material, which burns continuously on ignition. The shale is typically crenulated, fractured, and commonly slickensided, and appears to occur as fracture fillings and small irregular masses only a few inches across, in a narrow fine-grained sandstone unit. Earthy petroliferous material locally coats individual grains in this sandstone. According to Enns and Findlay (1977, p. 30) the sandstone unit is underlain by chert and overlain by dark green andesite, and appears to strike to the east-northeast, with a southerly dip.

In 1977, a study on the geology in the immediate vicinity of this oil shale occurrence was done by M. Payne. According to Payne (1977, p. 2), the oil shale is bounded on the south by a diabasic greenstone which produces a topographic high. The rocks to the north are indurated sandstones and bedded cherts with minor thin greenstones. The oil shale occupies the southeast side of a saddle area and extends eastward as float until it disappears beneath tundra. Relatively little is known about these and older sedimentary rocks just to the north. The contact between the dominatly igneous Christian Complex and surrounding sedimentary rocks may be conformable, disconformable, or faulted. Although Hawley (1976) interpreted the contact as being the leading edge of a thrust, (the Venetie Thrust), insufficient data does not allow a reliable test of this interpretation (Payne, 1977, p. 2).

The relationship of the oil shale to the mafic rocks is not obvious. It may be a conformable or a faulted contact; evidence for both can be inferred from the limited exposures. The evidence for faulting is:

1- the topographic sag along the oil shale zone could be due to weathering along a fault plane.

2- the abrupt change from phaneritic, mafic, igneous, rocks to unaltered oil shales.

However, the existence of a conformable contact would account for the close association of mafics to cherts and shales. This is somewhat supported by the presence of basalts interbedded with cherts in the immediate area. An alternate interpretation would call for the basalts and other mafics to be shallow intrusives. Accurate dating of the cherts and mafics is the best way to resolve the question (Payne, 1977, p. 3).

The oil shale has been identified as to be of the Tasmanite variety. Analysis of the shale have shown that it carries between 88 and 136 gallons of oil per ton as assayed by the USBM in 1976 (Appendix V) as compared to Colorado shales under consideration for mining which average 25-30 gallons of oil per ton.

Tasmanites commonly contain anomalous metal values. The results for five soil samples collected over the oil shale and adjacent area are shown in Table 5.

TABLE 5. Metal Comparison of oil shale soils with background soils

Sample #	Cu	Pb	Zn	Ag	Mo	U	(all ppm)
2513	160	15	150	.2	6	2	Soils over oil shale
2514	125	15	105	.2	2	2	Soils over oil shale
2515	120	10	95	.2	4	2	Soils over oil shale
2516	200	5	95	.2	2	2	Andesitic background soil
2517	130	5	90	.2	2	2	Cherty background soil

These results indicate that the oil shale does not contain significantly higher metal values than the surrounding rocks, except a slight increase in molybdenum (Enns and Findlay, 1977, p. 30).

According to Enns and Findlay, 1977, p. 30, the oil shale does not occur as a persistent stratigraphic unit but as generally small isolated pods less than 1 foot wide which appear to be quite sparsely distributed. Because of this distribution, Enns and Findlay suggest that although this oil shale is apparently rich in hydrocarbons, it does not seem to offer substantial tonnage potential.

Area B: Another occurrence of oil shale is located 24 miles to the southwest. This area was studied by Payne in 1977 to determine the geologic setting os a reported oil shale occurrence. Payne reports that the location occurs along a hummocky ridge and is characterized by the same rock types found in area A except shale which is locally thicker and better developed. The reported occurrence was not located but may occur within a fairly wide bleb of black, silty, bedded shales with associated diabasic greenstone float. This would differ from Area A where oil shale is associated with sandstones and cherts.

Other rock types include red weathering, gray shale, buff weathering cherts, and red, silty argillites. Mafics are common but not as thick as in Area A (Payne, 1977, p. 2).

There is no evidence of faulting along the ridge. Instead, the rock associations suggest sedimentary rocks with mafic interbeds of either extrusive or shallow intrusive character. Oil shale, if present, is probably associated with the black shales (Payne, 1977, p. 2).

Area C: One additional occurrence of oil shale was reported in creek float approximately eight miles southwest of Area A. No additional information is available for this occurrence.

RECOMMENDATIONS FOR FURTHER WORK

1. Detailed mapping of the Paleozoic sedimentary rocks and Christian Complex contact and stream sediment sampling of the Paleozoic sedimentary rocks on the northern border of the Christian complex for copper and zinc.

2. Sampling of the chert and shale units of the Christian Complex for barite.

3. Analysis of the tertiary basin in the southern Venetie Lands using drill holes and geophysical studies for oil, gas and coal potential including a scintillometer survey for uranium.

4. Further sampling of the ultramafic rocks of the Christian Complex for podiform chromite deposits and platinum placers.

5. Subsurface analysis of the Devonian sediments for oil, coal, and gas.

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APPENDIX I

APPENDIX I

Geochemical analysis, Venetie Lands

SS = stream sediments, S = soil, P = pan concentrates, C = chip sample of rock formation; all results in parts per million. For location of samples see Plate 1. For description of samples, see Appendix II. Samples with field numbers beginning with VHx, VG, VC, CR, Ch were collected by geologists G. Garcia, C. C. Hawley and C. Hale. Samples collected by USBM engineer D. Banister and geologists R. Lambeth and U. Jansons begin with DB and LBM respectively. (-) = less than.

Map #	Field No.	Type	Cu	Pb	Zn	Ag	Au	Ni	Cr
1	VG---1---	SS	25	5	105	-.2	-.02		
2	VHx--24---	S	5	10	105	-.2	-.02		
3	VG---7---	SS	15	5	90	-.2	-.02		
4	VG---8---	SS	10	-5	75	-.2	-.02		
5	VHx--25---	SS	10	5	90	.4	-.02		
5A	VHx--25P--	P	20	-10	-200	-1	----		
6	VC---1---	S	70	20	220	-.2	-.02		
7	VC---2---	SS	10	-5	85	-.2	-.02		
8	VC---3---	SS	5	-5	75	-.2	-.02		
9	VG--39---	C	5	70	500	-1	----	5	100
10	C-632---	SS	30	30	75	-.5	----	50	100
11	C-630---	SS	20	30	80	-.5	----	30	70
12	C-625---	SS	30	30	90	-.5	----	50	100
13	C-622---	S	20	15	85	-.5	----	30	70
14	VG---6---	S	30	5	80	-.2	-.02		
15	VG---5---	S	55	10	125	-.2	-.02		
16	VG---2---	S	20	10	110	-.2	-.02		
17	VG---3---	S	10	-5	45	-.2	-.02		
18	VG---4---	S	80	20	140	-.2	-.04		
19	VC---5---	SS	30	5	80	-.2	-.02		
20	VC---6---	SS	10	-5	40	-.2	-.02		
21	VC---7---	SS	35	5	105	-.2	-.20		
22	VC---8---	SS	25	10	90	-.2	.09		
23	VC---9---	SS	30	5	95	-.2	-.20		
24	C-720---	SS	30	30	95	-.5	----	30	70
25	VC--10---	SS	15	5	105	-.2	-.02		
26	VG--38---	SS	15	10	110	-.2	-.20		
26A	VG--38P--	P	15	-10	-200	-1	----	20	150
27	VG--36---	SS	15	5	110	-.2	-.04		
28	VG--37---	SS	15	-5	120	-.2	-.02		
29	VG--35---	SS	20	5	90	-.2	-.02		
30	VG--34---	SS	15	10	105	-.2	-.02		
31	VG--33---	SS	5	-5	60	-.2	-.02		
31A	VG--33P--	P	5	-10	700	-1	----	10	150
32	VG--32---	SS	20	5	115	-.2	-.04		
33	VG--31P--	P	7	-10	-200	-1	----	10	100
34	VG--30---	SS	10	-5	60	-.2	-.02		
35	VG--19---	SS	15	-5	90	-.2	-.02		
36	VG--18---	SS	20	10	115	-.2	-.04		

Map #	Field No.	Type	Cu	Pb	Zn	Ag	Au	Ni	Cr
37	VG--17---	SS	20	10	100	-.2	-.04		
38	VG--16---	SS	5	5	50	-.2	_.04		
38P	VG--16P--	P	2	-10	-200	-.5	----	10	100
39	VG--14---	SS	20	10	120	-.2	-.02		
40	Vg--15---	SS	10	5	125	-.2	-.02		
41	CH---6---	S	35	5	100	-.2	-.1		
42	CH---7---	S	75	5	165	-.2	-.04		
43	CH---8---	S	75	5	150	-.2	-.1		
44	VHx--28---	SS	5	5	95	-.2	-.02		
45	VHx--27---	SS	15	5	115	-.2	-.02		
46	VHx--26---	SS	15	-5	135	-.2	-.04		
47	VC--11---	SS	20	5	130	-.2	-.04		
48	VG---9---	SS	10	5	105	-.2	-.02		
49	VG--10---	S	15	10	90	-.2	-.04		
50	VG--11---	S	15	5	80	-.2	-.04		
51	VHx--29---	SS	25	-5	180	-.2	-.02		
52	VHx--30---	SS	15	10	120	-.2	-.02		
53	VHx--31---	S							
54	VHx--32---	SS	15	10	95	-.2	-.02		
55	VHx--18---	SS	25	---	----	---	----	35	300
56	VHx---8---	SS	15	-5	115	-.2	-.20		
57	VHx--33---	S	110	5	205	-.2	-.02		
58	VHx--34---	S	55	5	85	-.2	-.02		
59	CR--20---	S	60	---	----	---	----	220	880
60	CR--19---	S	48	---	----	---	----	460	1,800
61	VHx--35---	C	30	---	----	---	----	340	1,000
61A	VHx--35---	S	10	---	----	---	----	540	45,000
62	CR--15---	S	220	---	----	---	----	92	440
63	CR--16		110	---	----	---	----	100	120
64	CR--17		230	---	----	---	----	160	400
65	CR--18---	S	220	---	----	---	----	120	360
65A	DA--28---	S	300	---	----	---	----	110	280
66	VHx--19---	C	200	---	----	---	----	45	160
67	VHx---2---	S	10	---	----	---	----	5	50
68	VHx---1---	SS	55	---	----	---	----	40	140
68A	VHx---1P--	P	100	-10	700	1	----	100	2,000
69	VHx---1B--	SS	30	---	----	---	----	25	90
70	VHx--20---	C	5	---	----	---	----	735	500
71	VHx---3---	SS	35	---	----	---	----	40	300
72	CH---1---	S	35					30	90
73	CH---2---	S	70	---	----	---	----	25	70
74	CH---3---	S	65					25	30
75	CH---4---	S	20	---	----	---	----	15	60
76	CH---5---	S	25					10	50
77	VHx---5P--	P	50	-10	700	-1	----	50	1,500
78	VHx---4---	SS	55	---	----	---	----	35	160
78A	VHx---4P--	P	100	-10	700	-1		100	1,500
79	VG--24---	SS	40	---	----	---	----	35	200
80	VG--21---	C	70					30	80
80A	VG--22---	S	55	---	----	---	----	110	120
80B	VG--23---	C	195			_.2	.03	50	

Map #	Field No.	Type	Cu	Pb	Zn	Ag	Au	Ni	Cr
81	VG--20---	C	20	---	----	---	----	15	60
82	VHx---7---	SS	60					35	140
83	VHx---6---	SS	50	---	----	---	----	40	90
84	VHx--23---	SS	20					20	90
85	VHx--22---	S	205	-5	280	-.2	-.02		
86	VHx--21---	SS	45	---	----	---	----	30	100
87	VHx---9---	SS	25	5	125	-.2	-.2		
88	VHx-110---	S	150	-5	120	-.2	-.04		
89	VHx-120---	S	20	20	120	-.2	-.04		
90	VHx-130---	SS	30	15	155	-.2	-.02		
91	VHx-140---	S	5	10	65	-.2	-.04		
92	LBM--11---	SS	10	10	125	-.2	-.02	30	60
93	LBM--12---	SS	15	15	110	-.2	-.02	30	70
94	LBM--13---	SS	15	15	190	-.2	-.02	25	60
95	LBM--14---	SS	30	20	270	-.2	-.10	40	60
96	VHx--11---	SS	30	5	115	-.2	-.04		
97	LBM--18---	S							
99	LBM--16---	SS	15	15	125	-.2	-.04	25	50
100	LBM--15---	SS	15	30	130	-.2	-.02	25	50
101	LBM---7---	SS	10	15	100	-.2	-.02	25	80
102	VHx--12---	SS	20	-5	110	-.2	-.02		
103	LBM---6---	SS	10	15	90	-.2	-.02	20	100
104	LBM---5---	SS	20	25	125	.4	-.02	30	80
105	LBM---4---	SS	15	15	100	-.2	-.02	25	60
106	VHx--17---	S	75	-5	85	-.2	-.04		
107	VHx--16---	S	70	5	95	-.2	-.04		
108	VHx--15---	S	40	-5	75	-.2	-.04		
109	VHx--14---	C	20					25	90
110	LBM---3---	SS	25	25	150	-.2	-.02	25	50
111	LBM---2---	SS	40	15	150	-.2	-.04	30	110
112	VHx--13---	S	25	-5	90	-.2	-.02		
113	LBM---8---	SS	10	15	90	-.2	-.02	20	90
114	LBM---9---	SS	15	15	180	-.2	-.04	35	70
115	LBM--10---	C							
116	DB76V---7---	SS	55	20	80	-.2	-.02	25	70
117	DB76V---6---	SS	25	15	105	-.2	-.02	25	80
118	DB76V---4---	SS	15	15	125	-.2	-.02	25	70
119	DB76V---5---	SS	20	20	140	-.2	-.02	25	70
120	DB76V---2---	SS	20	20	125	-.2	-.02	25	50
121	DB76V---8---	SS	30	20	100	-.2	-.02	25	60
122	DB76V---9---	SS	30	.0	50	-.2	-.02	30	50
123	DB76V---1---	SS	20	25	210	.2	-.04	35	50
124	DB76V---3---	SS	20	20	110	.4	-.02	20	50

APPENDIX II

SAMPLE DESCRIPTIONS

The following is a description of samples collected June 15 through June 21, 1976, in the Venetie area by geologists Geof Garcia, C. C. Hawley, Carl Hale, and field assistant, Charlotte Kautzer, and of the samples collected by U.S. Bureau of Mines engineers and geologists D'Arcy Banister (DB), U. Jansons, and Robert Lambeth (L-BM).

Map No. (fig. 3.1)	Field No.	Description
1	VG-1	Stream sediment. No bedrock exposed.
16	VG-2	Soil sample. Near greenstone feldspar porphyry dike in quartz monzonite (30% quartz, 30% orthoclase, 30% plagioclase, 10% biotite) also pink orthoclase mega crysts.
17	VG-3	Chip sample. Quartz monzonite as above.
18	VG-4	Soil sample. Biotite quartz gneiss with limonitic casts possible tourmaline.
15	VG-5	Soil sample near white aplite dike (red garnets visible) red rutilated quartz along top of ridge.
14	VG-6	Soil sample. Bluish-grey quartzite with biotite casts contact between quartz biotite schist and quartz monzonite.
3-4	VG 7-8	Stream sediment samples. No bedrock seen. Quartz monzonite and quartz biotite schist alluvium.
6	VC-1	Chip sample. Quartz mica schist with sillimanite (?). Soil sample taken also.
7	VC-2	Stream sediment sample. Quartz biotite schist outcrop. Predominant alluvium quartz monzonite.
8	VC-3	Stream sediment sample. No outcrop. Granitic alluvium.
	VC-4	No sample taken. Fine-grained quartz-muscovite-biotite schist.
19	VC-5	Stream sediment sample. Outcrop muscovite-quartz-biotite schist. No granitic rocks in alluvium.

Map No. (fig. 3.1)	Field No.	Description
20	VC-6	Stream sediment sample. Outcrop. Garnetiferous, quartz-mica schist. Chip sample taken.
21	VC-7	Stream sediment sample. Quartz mica schist. Some phyllite in alluvium.
22	VC-8	Stream sediment sample. Outcrop quartz biotite schist. Fine-grained quartz-chlorite schist in alluvium.
23	VC-9	Stream sediment sample. Quartz biotite schist outcrop. Quartz-chlorite schist in alluvium.
25	VC-10	Stream sediment sample. Quartz biotite schist outcrop. Numerous pyritic, garnetiferous, olivine peridotites in alluvium.
47	VC-11	Stream sediment sample on Cornucopia Creek. Grey phyllites, quartzites, and well-rounded glacial rocks in alluvium.
48	VG-9	Stream sediment sample. No bedrock visible. Organic sample. Silt clinging to moss.
49	VG-10	Soil sample. Grey green phyllite with augen quartz.
50	VG-11	Soil sample. Same rock as above.
	VG-12	Stream sediment sample. Grey phyllite outcrop. Augen quartz.
	VG-13	Soil sample. Grey phyllite with augen quartz.
	VC-12	White aplite dike with tourmaline crystals. Chip sample.
	VC-13	Chip sample. Andesite breccia. Quartz phenocrysts.
81	VG-20	Chip sample near Christian. Dark green serpentine (Otter Creek).
80	VG-21	Chip sample. Ferruginous zone between anorthosite and serpentine.
80A	VG-22	Soil from fault zone containing white precipitate and iron stain.
80B	VG-23	Chip. Anorthosite.
79	VG-24	Sediment sample of tributary of Otter Creek near Simons Cabin. Serpentine present.
39	VG-14	Sediment sample. Tributary of Crater Creek. Organic silt. No outcrop.
40	VG-15	Organic soft silt in Crater Creek.

Map No. (fig. 3.1)	Field No.	Description
38	VG-16	Sediment sample, sandy with large chunks of sugary quartz.
37	VG-17	Sediment sample. Phyllite and quartz biotite schist in stream bed.
36	VG-18	Sediment. Sillimanite pelitic schist in stream bed.
35	VG-19	Sediment. Organic silt.
34	VG-30	Sediment. Stream bed contains quartz-biotite schist and garnet muscovite aplite dike rocks.
33	VG-31P	Pan concentrate in Crater Creek.
32	VG-32	Sediment. Organic. Sillimanite quartz biotite schist in nearby outcrop.
31	VG-33	Sediment. Sillimanite quartz biotite schist in stream entering near old cabin.
31A	VG-33P	Pan concentrate from above stream.
30	VG-34	Sediment. Swampy. No outcrop.
29	VG-35	Sediment. Swampy organic glop.
27	VG-36	Sediment. Quartz biotite schist in stream bed.
28	VG-37	Sediment. Sugary quartz-biotite schist in stream bed.
26	VG-38	Sediment. Silt in Crater Creek.
26A	VG-38P	Pan concentrate from same location. Garnets present.
88	VHx 110	Chip sample (grey phyllite outcrop). Soil sample taken.
89	VHx 120	Soil sample.
90	VHx 130	Soil sediment sample (grey phyllite outcrop).
91	VHx 140	Soil sample (grey silicified limestone outcrop).
	VHx 150	Soil sample (same rock as VHx 140).
	VHx 150	Chip sample.
9	VG-39	Quartz monzonite.
61A	VHx 35	Weakly magnetic nodules in soil on peridotite.
72	VH-1	Ridgetop soil in fine-grained fractured basalt, chert, and breccia.
73	CH-2	Soil same.
74	CH-3	Soil same.
75	CH-4	Soil. Medium to coarse grained andesite or diorite dike.
76	CH-5	Soil. Chert.
41	CH-6	Soil on ridge in layered sandstone and siltstone (sometimes schistose) with some quartz augen in syenite (?) dike.

Map No. (fig. 3.1)	Field No.	Description
42	CH-7	Soil. Andesite porphyry and sandstone and quartzite float, also diorite--gabbro (no outcrop).
43	CH-8	Soil. No outcrop. Schist and quartz in float.
68A	VHx-1P	Pan concentrate.
68	VHx-1SS	Stream sediment sample. Rock type - gneissic hornblende diorite. Some rocks grading to anorthosite-hornblende pegmatite.
69	VHx-1BSS	Main Christian River.
67	VHx-2	Serpentinitized rocks. Black-greenish.
71	VHx-3	Stream sediment sample. Very small panned concentrate.
78A	VHx-4A	Panned concentrate (chert, diabase).
78	VHx-4B	Stream sediment.
77	VHx-5P	Panned concentrate (chert, diabase).
56	VHx-8	Stream sediment sample.
87	VHx-9	Stream sediment sample.
	VHx-10	Soil-graywacke/quartz veins - 80 cts/sec.
96	VHs-11	Contact: graywacke - quartz sandstone/red shale, grey shale - some Mn stained material in shale - 60 cts/sec up to 120 cts/sec over boggy areas. Bedding Red SL N20° E, 25° NW.
102	VHx-12	Stream sediment - graywacke 80 cts/sec.
112	VHx-13	Soil sample. Sandstone - graywacke.
100	VHx-14	Gabbro, medium-grained, alt. act., ilm = 8-10%. Outcrop has crude banding. Suggests layering N; 45° E 45 cts/sec 14_s - soil sample.
108	VHx-15	Sticky soil on hummocky terrain in saddle 38 cts/sec.
107	VHx-16	Soil sample (on chert).
106	VHx-17	Soil sample (on chert near top).
55	VHx-18	Stream sediment. Swampy.
66	VHx-19	Massive, fine-grained ultramafic, probably peridotite.
70	VHx-20	Brown weathering, altered, partially serpentinized ultramafic - probably dunite.
86	VHx-21	Stream sediment (B) panned concentrate (P) mostly olivine, minor limonite.

Map No. (fig. 3.1)	Field No.	Description
85	VHx-22	Shale N, 40° E black, sheared, baked.
84	VHx-23	Stream sediment sample.
	VHx-24	Biotite quartz monzonite.
2	24A	Soil. 160 cts/sec.
5	VHx-25	Stream sediment.
5A	25P	Panned concentrate.
	25S	Soil sample. Some tourmaline crystals. No Au.
46	VHx-26	Stream sediment. 120 cts/sec. Quartz-phyllite.
53	VHx-31	Green argillite in burn: $N60^{\circ}E$, 35° NW/chert.

Map. No. (fig. 3.1)	STREAM SEDIMENT SAMPLES
123	L-BM-1: Far from source, stream drains muskeg bog. Contains medium organics. Limestone in alluvium-glacial? Drains hills of black slate and snadstone.
111	L-BM-2: Contains medium organics. Drains area of upper Jurassic intrusives, Paleozoic cherts and shales, and the contact zone.
110	L-BM-3: Contains medium organics. Drains through muskeg bog. Drains areas of Devonian slate and sandstone and Paleozoic cherts and shales.
105	L-BM-4: Contains medium organics. Taken at mouth of small stream. Drains areas of Devonian slates and sandstone and Paleozoic cherts and shales.
104	L-BM-5: Contains medium organics. Taken at mouth of small stream. Drains areas of Devonian slates and sandstone.
103	L-BM-6: Contains medium organics. Stream flows through muskeg bog and drains areas of Devonian slates and sandstone.
101	L-BM-7: Contains medium to high organics. Very little fines in stream. Stream flows through muskeg bog and drains areas of Devonian slates and sandstone.
113	L-BM-8: Contains high organics. Flows through muskeg bog and drains areas of Devonian slates and sandstone and Paleoozoic cherts and shales.
114	L-BM-9: Contains medium to high organics. All tributaries flow through muskeg bogs. Stream drains areas of Devonian slates and sandstone and Paleozoic cherts and shales.
92	L-BM-11: Contains medium organics. Stream drains from lake and muskeg bog. Drains areas of Devonian slates and sandstone and Paleozoic cherts and shales.

Map. No. (fig. 3.1)	Stream Sediment Samples (continued)
93	L-BM-12: Contains medium organics. Drains areas of Devonian slates and sandstone and Paleozoic cherts and shales.
94	L-BM-13: Contains medium organics. All tributaries flow from lakes or through bogs. Stream contains algae and is sluggish. Drains areas of Devonian slates and sandstone and Paleozoic cherts and shales.
95	L-BM-14: Contains medium organics. All tributaries flow from lakes or through bogs. Stream is sluggish. Drains areas of Devonian slates and sandstone and Paleozoic cherts and shales.
100	L-BM-15: Contains medium organics. Taken from dry bed of stream draining Devonian slates and sandstones and Paleozoic cherts and shales. Sediment may have been deposited during flood stage.
99	L-BM-16: Contains medium organics. Stream drains Devonian slates and sandstone and Paleozoic cherts and shales.
120	DB76V2: Contains very high organics. Drains Devonian slates and sandstone.
124	DB76V3: Contains very high organics. Drains Devonian slates and sandstones.
118	DB76V4: Contains very high organics. Drains Paleozoic cherts and shales.
119	DB76V5: Contains very high organics. Drains Paleozoic cherts and shales and Devonian slates and sandstone.
117	DB76V6: Contains very high organics. Drains Paleozoic cherts and shales and Pzc-Ds fault contact.
116	DB76V7: Contains very high organics. Drains Paleozoic cherts and shales.
121	DB76V8: Contains very high organics. Stream drains a lake and bog. Drains Paleozoic cherts and shales.
122	DB76V9: Contains very high organics. Far from ion source. Drains Paleozoic cherts and shales (?).

Map. No (fig. 3.1)	Background control samples:
115	L-BM-10: Acidic sandstone from Devonian Kanayut Conglomerate?
98	L-BM-17: Mafic sandstone from brown-weathering Devonian slate and sandstone.
97	L-BM-18: Acidic sandstone from Paleozoic chert and shales.
	DB76V1: Gray-green chert from Paleozoic cherts and shales.

APPENDIX III

APPENDIX III

British Petroleum's 1978 Summary list of geochemical anomalies within the Venetie Lands. Those anomalies with moderate priority are discussed in this text.

Location	Results	Remarks	Priority
C-A6 T27N,R5E Centre Headwaters Crater Creek	#424: 60,25,115,65Ni	Ridge to southeast phyllites. Only weakly anom., no associated Pb or Zn.	Low
C-A6 T28N,R5E,SW 1/4 Headwaters Cornucopia Ck	#367: 15,45,120	Small trib. Phyllite 2 mi. NE. Only weakly anom., no associated Pb-Zn.	Low
C-A6 T28N,R4E,E 1/2 Headwater Cornucopia Ck	#901: 25,15,205	Main Ck. single sample weakly anom. No associated Cu Pb.	Low
Ch-A1 T27N,R2E,E 1/2	#881: 35,30,80,10Mo	Weakly anom. single sample. Next sample downstream is one mile away.	Moderate
C-B3 T29N,R11E,NW 1/4 T30N,R10E,SE 1/4	#723: 35,5,460,100Ni,50Cr #249: 120,10,90,25Ni,200Cr	Both small drainages have common headwaters basalt w/chert near basic intrusion contact. Cu prob. anom., Zn is definitely anom.	Moderate
C-B3 T30N,R11E Centre	#1283: 115,5,90,85Ni,180Cr #1279: 115,10,100,75Ni,140Cr #1277: 60,5,80,50Ni,350Cr	3 samples of east stream, and 2 samples headwater of adjacent stream weakly anom. in Cu. No geol. mapped here. Associated Pb or Zn lacking.	Moderate
C-B3 T30N,R10E,NE 1/4	#1274: 155,10,65 #757: 105,5,70,75Ni,60Cr #756: 120,5,70,30Ni,80Cr #1271: 40,5,70,100Ni,600Cr #1021: 140,10,50,25Ni,120Cr	All off same creek. 3 samples indicate weakly to probably anom. Cu. Extreme upper sample (#1271) quite likely reflects ultramafic residuum. Ni values not encouraging. Could reflect Cpy. diss. in leucocratic gabbro.	Moderate

Location	Results	Remarks	Priority
C-B3 T31N,R11E,SW 1/4	#15: 135,15,65,70Ni,60Cr #13: 310,15,80,55Ni,70Cr #2595: 100,25,60,75Ni #17: 105,15,55,45Ni,90Cr #2596: 180,25,55,60Ni #18: 125,15,60,60Ni,80Cr #2597: 70,25,60,85Ni	In hbld. gabbro adjacent to dunite/ peridotite contact just south. #2595-97 samples to confirm #13-18. All downgraded except #2596. Probably diss. cpy. in leuco gabbro. No encouragement from Ni values.	Low
C-B3 T31N,R10E,SE 1/4	#12: 75,10,80,125Ni,20Cr #28: 65,20,205,110Ni,70Cr	Both single values weakly and probably anom. Within andesitic volcaniclastic unit.	Low
C-B4 T29N,R8E,NE 1/4	#746: 15,10,305,50Ni,100Cr	Single value probably anom. No Cu & Pb. No geol. Very swampy and bushy.	Low
C-B4 T30N,R10E,NE 1/4	#422: 135,25,105,60Ni #2002: 180,15,75,40Ni,70Cr	Two samples. Mapped cherts and silicified lavas. Short trib. No associated Pb, Zn or Ni.	Low
C-B4 T30N,R10E,Ne 1/4	No #: 40,10,155,230Ni,180Cr	Single sample. No associated Cu. Silicified and carbonated lavas mapped.	Low
C-B4 T31N,R10E,SW 1/4	#210: 30,10,145,110Ni,300Cr #2183: 40,25,135,105Ni #212: 30,15,85,700Ni,400Cr #213: 40,10,130,150Ni,80Cr	Three values from main creek. Weakly to definitely anom. in Ni. Small trib. highly anom. in Ni and Cr. Cu very low. Area mapped as basalt, minor red cherts and ash tuffs.	Low
C-B4 T31N,R9E,SE 1/4	#1002: 125,10,95,55Ni,80Cr	Single value of probable amon. Cu. No Zn. Mapped as cherts.	Low
C-B4 T31N,R9E,South	#920: 30,15,85,160Ni,27Cr	Single value. No Cu support. Mapped basalt minor chert w/gabbro (diabase dyke?)	Low

	Location	Results	Remarks	Priority
C-B4	T31N,R8E Centre	#738: 125,5,150,35Ni,200Cr	Single value. No Zn support. Swampy stream. Nearby diabase & chert mapped.	Low
C-B5	T31N,R8E,SW 1/4	#746: 15,10,305,50Ni,100Cr	Single value. No Cu support. Swampy brushy area.	Low
C-C3	T31N,R10E,NE 1/4	#778: 50,15,140,110Ni,180Cr #1109: 70,15,140,120Ni,100Cr	Two small streams w/common headwater in chert terrain. Weakly anom. Ni but unencouraging Cu.	Low
C-C3	T32N,R11E,SE 1/4	#1063: 30,15,105,80Ni,250Cr	Single high Cr. Basalt mapped nearby.	Low
C-C3	T32N,R11E,SE 1/4	#1060: 20,15,100,80Ni,350Cr	Single high Cr. Further downstream Cr values 200 ppm. Mapped basalt/andesite, lapilli tuff.	Low
C-C3	T32N,R11E,South	#84: 55,15,110,110Ni,200Cr #85: 60,10,100,105Ni,200Cr #113: 50,15,110,105Ni,250Cr	Three individual short tributaries. Mapped basalt. Copper unencouraging. Ni only weakly. Anom.in each case.	Low
C-C3	T32N,R11E,North	#241: 150,15,90,105Ni	Single weakly anom. Ni and definitely anom. copper. Samples upstream and downstream offer no support.	Low
C-C3	T32N,R10E,SE 1/4	#152: 120,20,120,105Ni,100Cr	Single value. Weakly anom. in Cu & Ni. Chert & basalt mapped nearby.	Low
C-C3	T32N,R10E,SE 1/4	#161: 125,20,105,75Ni,100CR	Single value weakly to probably anom. Cu. Drains basalt & chert.	Low

	Location	Results	Remarks	Priority
C-C3	T33N,R10E,SE 1/4	#841: 145,5,35,60Ni,70Cr	Single value. Probably anom. No association w/Pb or Zn.	Low
C-C4	T31N,R10E,West	#565: 120,5,80,65Ni,180Cr	Weakly anom. Cu at extreme headwater of 2 mile tributary. Diabase gabbro & chert.	Low
C-C4	T31N,R9E,NE 1/4	#252: 45,15,115,85Ni,450Cr	High Cr in second order tributary. No geology. Prabably ultra basics in sequence.	Low
C-C4	T31N,R0E, North	#555: 145,5,65,50Ni,50Cr #557: 10,25,205,60Ni,100Cr #558: 40,5,245,60Ni,40Cr #563: 100,10,130,165Ni,80Cr	All from same tributary to Christian R. Mapped basalt & diabase. Weak Cu & Zn anom. Ni definitely anom. from sample at mouth but cause unknown.	Moderate
C-C4	T32N,R9E	#518: 120,10,105,65Ni,120CR	Short 1/2 mi. trib. to Christian R. Mapped basalt. Weakly anom.Cu.	Low
C-C4	T32N,R9E	#525: 150,15,175,75Ni,80Cr #1490: 110,30,200,125Ni	Short 1/2 mi. trib. to Christian R. Mapped chert. Probably anom. Cu follow-up by #1490. Downgraded it to weakly anom.	Low
C-C4	T32N,R9E,SE 1/4	#419: 165,20,110,100Ni #651: 145,10,90,55Ni,160Cr	Two samples of same small tributary show probably to definitely anom. Cu. No geology. Ni rather erratic. Probably minor Cpy. in epidote-qtz calcite veined basalt (?).	Low

Map No.	Location	Results	Remarks	Priority
	C-C4 T32N,R9E Centre	#650: 125,10,100,85Ni,180Cr #1256: 65,15,115,110Ni,400Cr #1257: 65,15,125,110 Ni,350Cr	All on same short (less than 1/2 mile) tributary. Mapped basalt, chert and diabase. Source of Ni and Cr. Values unknown.	Low
	C-C4 T32N,R10E,SW 1/4	#421: 225,25,95,105Ni #118: 200,20,90,100Ni	Mapped basaltic geology. Minor cpy. mineralization noted in epidote-qtz. Calcite veining in basalt.	Low
	C-C4 T32N,R10E,NW 1/4	#2528: 120,35,105	Single weakly anom. Cu from basalt.	Low
	C-C4 T32N,R10E,NW 1/4	#641: 50,10,290,55Ni,140Cr	Single probably anom. Zn from chert (?) No Cu encouragement.	Low
9	A-A3 T16S,R30E,NW 1/4	#913: 25,15,345 #915: 35,30,330	2 samples definitely anom. from Devonian sediments.	Moderate

APPENDIX IV

APPENDIX IV

OIL SHALE DATA FROM EBBLEY 1944 REPORT

Occurrence of Deposit

A total of six trenches were excavated endeavoring to locate the oil shale in place. This work was not successful and was discontinued as the area where the float is found is too large and the small pieces of float too sparsely scattered to justify continued work by hand methods. Figure 2 is a sketch map of the area where the float is found.

The natives reported that about 30 years ago the oil shale float was quite plentiful on top of the round dome and covered the eastern slope of the mountain. The natives while hunting caribou in the fall, camped along this ridge, it being an excellent vantage point, and burned the "oil-rock" for fuel, the nearest wood being about six miles away. During the course of many years the oil shale float became scarce, only small scattered pieces now remaining.

No float was found on the west slope, but some small pieces were uncovered directly on top of the round dome. There is a reasonable probability, of course, that these small fragments found on top of the dome may have been carried there by the natives as this high point would naturally be the best "lookout" for hunting. As indicated in Figure 2, the area where the most float was found along the slope does not correspond with the erosion depression line, but instead swings around the sidehill toward the south. Thus, it would appear that the apex of the oil shale outcrop may cut diagonally across the hill about east and west, the theoretical strike then being northeasterly.

Character of Shale

The principal form of occurrence of the Christian River oil shale deposit, as evidenced by the float found, would be termed "curly" shale. In general the pieces found, especially where concentrated on bedrock, were contorted and polished, in many instances having slickenside faces. A longitudinal section through one of the trenches is shown on Figure 3 and illustrates the occurrence of the shale. The pieces of float manifested their high oil content by curling to the knife and by burning readily when in contact with a lighted match giving off an oil odor. The better specimens resembled tough, dark, leathery wood and were very light in weight, weathering to a grey color. No fossils were observed.

It should be noted that none of the shales from the United States previously listed show a yield of much more than 60 gallons a ton, whereas all of the samples of shale from the Christian River deposit are above this figure. Furthermore, the A.P.I. gravities of the Christian River shale are higher than the gravities reported in this other group. This indicates that the Christian River shale would have a relatively high yield of light distillate from which gasoline could be made. This shale does not have the general appearance of typical Green River shales in Colorado and is considerably less dense. 11/

Observation of the spent shale in the assay retorts indicates that the Christian River shales would have a definite tendency to coke--sufficient perhaps to cause trouble in retorting in the present type retorts. All of the samples were crushed to 8-14 mesh and retorted. The samples contained some moisture, but no attempt was made to dehydrate them and the yield figures are reported on the basis of the samples as received. On a moisture free basis the actual yield a ton would be increased slightly. 12/

Trench No.	Length	Width	Depth	Cubic Yards	Material	Bedrock
1	20.0	2.5	4.0	7.5	No oil shale	Hard sandstone and quartz.
2	32.0	2.0	3.0	7.0	No oil shale	Hard sandstone and quartz.
3	8.0	2.0	4.0	2.5	Much oil shale float	Decomposed grey-green slate. Frost 4 ft.
4	8.0	2.0	4.0	2.5	No oil shale float	Hard diorite, greenstone and quartz.
5	3.0	3.0	4.5	1.5	Much oil shale float	Decomposed sandstone frozen.
6	6.0	2.5	4.0	2.0	Much oil shale float	Greenstone and diorite?Rubble.

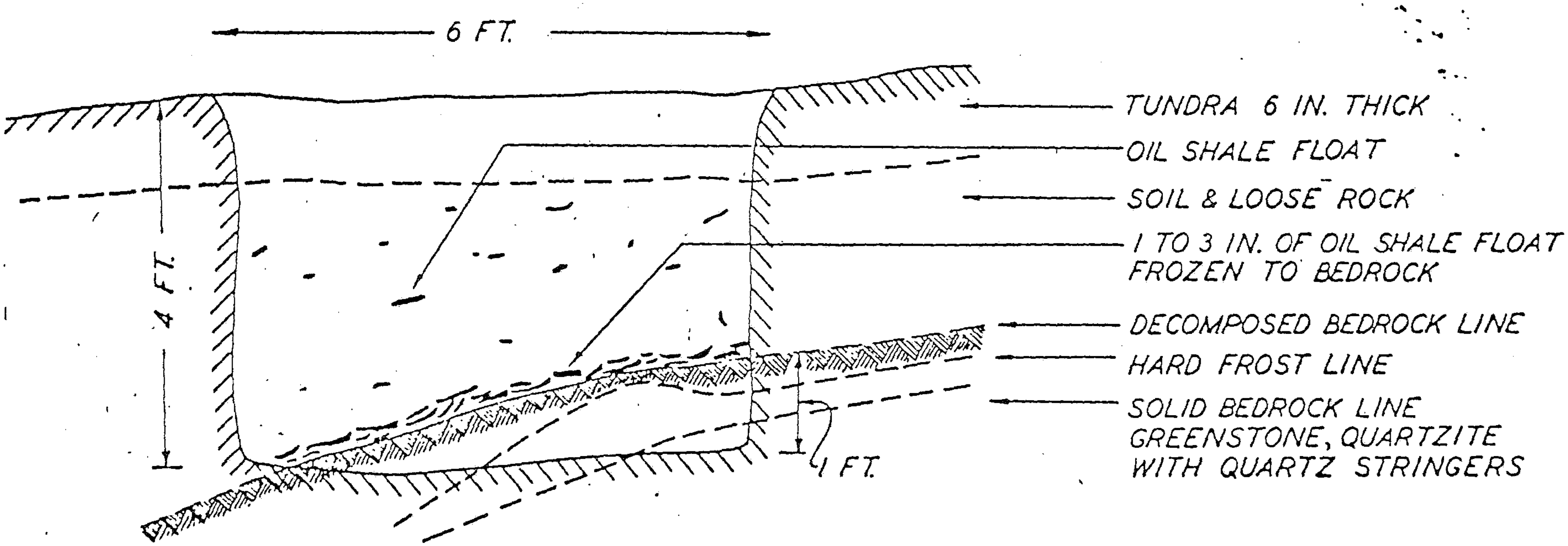
11/ Gardner, E. D., Bell, Charles W., "Proposed Methods and Estimated Costs of Mining Oil Shale at Rulison, Colorado," Bureau of Mines Information Circular 721B, November 1942.

12/ Smith, N.S.C., Supervising Engineer, Bureau of Mines Petroleum Experiment Station, Bartlesville, Oklahoma. Written communication.

Sampling and Analyses

Bureau of Mines laboratories reported the following results of distillation of samples of the Christian River deposit.

Sample No.	Description	Analysis Gal.a ton	Sp.Gr. 60/60	Gravity °API
300	General sample from float taken from entire area. Small pieces, soft, tough, dark grey to black, and very light weight. Considerably weathered. Burns readily.	107.0	0.862	32.7
301	Same as 300.	88.8	0.865	
302	Sample of a large piece of float found on surface. Size 12 by 8 by 4 inches. Leathery, light weight, grey colored.	118.0	0.868	31.4
303	Same as 302.	123.8	0.870	
304	Small pieces of oil shale taken from Trench No. 3. Extremely light weight, leathery, curly, black, slickensided generally. Does not appear to be greatly altered by weathering.	76.0	0.865	32.1
305	General sample of surface float taken from extreme easterly portion of float area. Found after original area was marked.	60.5	0.870	31.1
306	Sample taken from bedrock concentration in Trench No. 6. This material is the soft black variety, tough, slickensided and curly. Does not appear to be greatly altered and covers bedrock in this trench to a depth of from 2 to 3 inches. Material is light weight and was generally frozen to the greenstone rubble bedrock. See Figure 3.	77.5	0.862	32.7
307	Not oil shale. Float sample of a hard, heavy rock shot through with thin sheets of quartz. This rock burns when in a very hot fire, but will not ignite with a match. It resembles a fine-grained diorite or a black fine-grained sandstone or quartzite; probably is a hard carboniferous sandstone. Resembles bedrock found in several of the cuts but the bedrock does not burn and has greenish and purple-colored areas; otherwise appears the same in the hand specimen. Specific gravity about the same as quartzite. When experiments proved this rock to burn it was a surprise to the Indians who had apparently never tried it before. Oil content apparently very low.	5.7	0.880	29.3
308	Same as 307	5.0		
309	Extra sample of float taken from entire surface area. These samples cleaned up all the visible float in the area. The bulk of this sample came from ground squirrel holes.	77.5	0.858	33.4



(SAMPLE NO. 306 COLLECTED FROM TRENCH NO. 6 SOFT, BLACK, TOUGH, LIGHT, MATERIAL)

LONGITUDINAL SECTION THROUGH TRENCH NO. 6

APPENDIX V

APPENDIX V

Oil Shale Data from Banister and Lambeth 1980 Report
Oil-Shale Assays by Modified Fischer Retort Method

Surface samples collected at the Chandalar Oil Shale Deposit near the north end of the Venetie Reservation, Alaska; at an elevation of 2900 feet MSL in the SW1/4, sec. 24, T 34 N, R11 E, Fairbanks Principal Meridian.
Submitted by R. H. Lambeth, USBM, Anchorage

Sample number		Yield of product: Weight percent				Yield of product: Gal per ton		Specific gravity of oil at 60°/60° F	Properties of spent shale	Remarks
Laramie	Their	Oil	Water	Spent shale	Gas + loss	Oil	Water		Tendency to coke	
SBR76-1008x	DA-30	50.5	4.0	36.8	8.7	136.0	9.6	0.891	Heavy	
SBR76-1009x	DA-32	32.4	3.1	58.8	5.7	88.4	7.5	.879	Heavy	
SBR76-1010x	DA-33	48.7	2.5	42.1	5.7	132.4	6.0	.882	Heavy	

Description of samples:

Country rock is Devonian cherts and shales.

DA-30: Sample of high grade, brown weathering oil shale taken from Pit #1 dug 108' and N5° E of old Ebbley Pit #6. The pit stopped in greenstone bedrock at a depth of two feet.

DA-32: Sample of high grade oil shale from the vicinity of Pit #3 dug 20' southeast of Ebbley Pit #6. This pit was dug to a depth of 3'. Oil shale was found only in the upper 2'. The bottom foot contained primarily light colored sandy soil with very little oil shale. Bedrock was not intersected.

DA-33: Sample of high grade oil shale dug from Pit #2.

Samples received October 6, 1976; assays made on air-dried samples

Laramie Energy Research Center, Laramie, Wyoming Illustration No. SBR-4858P Sheet 1 Of 1 October 7, 1976

APPENDIX VI

APPENDIX VI

Mechanical Concentration by Hazen Research

The five best samples from Levi Peak were selected for further tests to see whether platinum occurs in a form that can be concentrated by gravity as would be the case in a stream bed.

Following samples from Levi Peak were sent to Hazen Research, Inc., Denver, Colorado:

2546	0.10 ppm Pt
2547	0.10 ppm Pt
2548	0.07 ppm Pt
2549	0.05 ppm Pt
2550	0.07 ppm Pt.

The samples were combined to give a total weight of 30.87 kg (68.07 lbs), crushed and pulverized to pass a 65 mesh screen and concentrated on a Deister Laboratory concentrating table. Concentrates were separated into magnetic (magnetite) and non-mangetic fractions. Concentrating results are summarized:

Heads	30.87 kg	100 %
Tails	29.09 kg	94.2 %
Concentrate	1.784kg	5.78 %
Magnetic Frac.	1.745kg	5.676%
Non-magnetic Frac.	0.032kg	0.104%

The non-magnetic fraction was further concentrated by careful panning and examined under a low-power microscope. No discrete platinum particles were identifiable.

The entire non-magnetic fraction was returned to Hazen Research for fine assay/atomic absorption assay. Results were:

Pt	0.02 ppm
Pd	0.02 ppm

Since the head assay on the combined samples (by calculation) was 0.08 ppm and the concentrate assay was 0.02 ppm, it is evident that the samples tested are not amenable to concentration of platinum by gravity methods.

APPENDIX VII

Geochemical comparison of various geological provinces

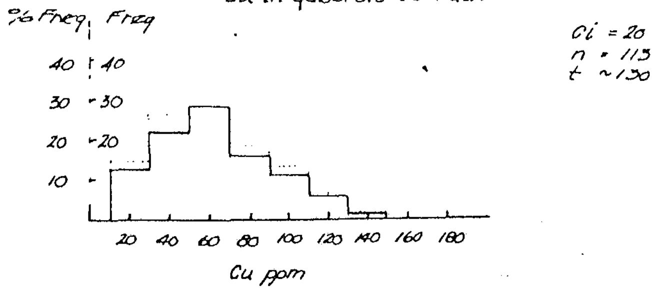
	granitic & metamorphic	Christian Complex volcanic	Christian Complex gabbroic	Devonian sediments
Copper				
n	184	250	85	25
$\bar{x}$	12.6	50.6	59.5	21.8
s	7.4	22.9	21.8	13.2
$\bar{x}$+2s	27.4	96.5	103.1	48.3
$\bar{x}$+3s	35.0	119.4	124.9	61.5
$\bar{x}$+4s	42.2	142.2	146.7	74.6
weak. anom.	> 60 ppm	>100 ppm		> 60 ppm
prob. anom.	>100 ppm	>125 ppm		>100 ppm
def. anom.	>150 ppm	>150 ppm		>150 ppm
background	10-15 ppm	40-70 ppm		15-20 ppm
Lead		both terrains		
n	100	150		25
$\bar{x}$	12.4	12.2		20.8
s	5.4	7.6		7.9
$\bar{x}$+2s	23.2	27.4		36.5
$\bar{x}$+3s	28.6	35.0		44.4
$\bar{x}$+4s	34.0	42.6		52.4
weak. anom.	> 40 ppm	> 40 ppm		> 40 ppm
prob. anom.	> 60 ppm	> 60 ppm		> 60 ppm
def. anom.	> 80 ppm	> 80 ppm		> 80 ppm
background	10-15 ppm	10-15 ppm		20-25 ppm
Zinc				
n	185	250	85	22
$\bar{x}$	94.0	129.5	73.0	115.2
s	24.8	26.3	22.1	37.7
$\bar{x}$+2s	143.6	182.2	117.2	190.6
$\bar{x}$+3s	168.3	208.5	139.3	228.3
$\bar{x}$+4s	193.2	234.7	161.4	266.0
weak. anom.	> 200 ppm	> 200 ppm	> 140 ppm	> 200 ppm
prob. anom.	> 250 ppm	> 250 ppm	> 200 ppm	> 250 ppm
def. anom.	> 300 ppm	> 300 ppm	> 250 ppm	> 300 ppm
background	90-100ppm	100-170ppm	60-80 ppm	100-120ppm
Chromium				
n		230	85	
$\bar{x}$		114.5	116.9	
s		46.0	43.3	
$\bar{x}$+2s		206.5	203.5	
$\bar{x}$+3s		252.5	246.8	
weak. anom		> 250 ppm	> 250 ppm	
prob. anom.		> 300 ppm	> 300 ppm	
background		70-90 ppm(?)	120-140ppm	
Nickel				
n		260	85	
$\bar{x}$		56.6	53.8	
s		17.1	20.4	
$\bar{x}$+2s		90.7	94.6	
$\bar{x}$+3s		107.8	115.0	
$\bar{x}$+4s		125.0	135.4	
weak. anom.		> 100 ppm		
prob. anom.		> 125 ppm		
def. anom.		> 150 ppm		
background		30-60 ppm		

Thresholds are shown underlined

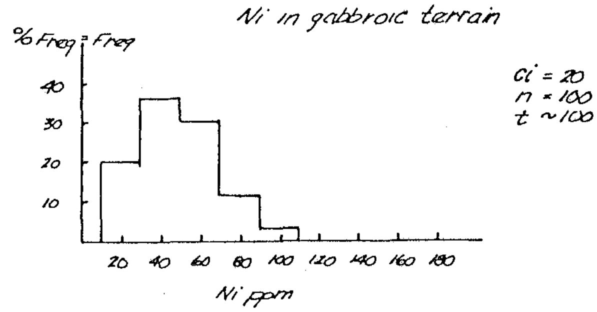
Histograms

Note : — denotes % frequancy of samples
···· denotes actual frequency of samples

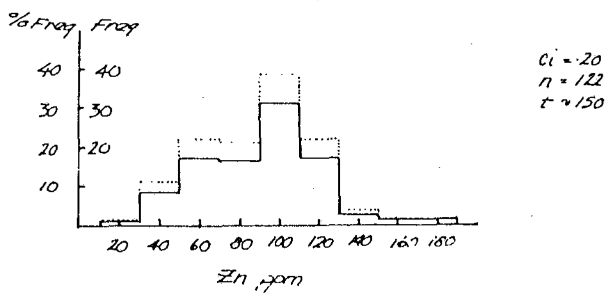
Cu in gabbroic terrain



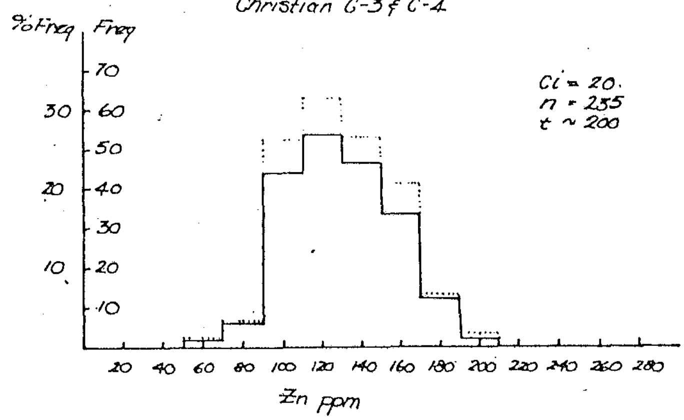
Ni in gabbroic terrain



Zn in gabbroic terrain



Zn in volcanic terrain
Christian C-3 & C-4



Cr in Christian Complex