COBALT INVESTIGATIONS IN THE LIVENGOOD AREA

By D. D. Southworth

Critical and Strategic Minerals in Alaska -

Livengood Project

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UNITED STATES DEPARTMENT OF THE INTERIOR

James G. Watt, Secretary

BUREAU OF MINES

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INTRODUCTION

A brief mineral investigation of reported cobalt occurrences and geochemical anomalies in the Livengood area (figure 1) was made by the Alaska Field Operations Center, U. S. Bureau of Mines. The work was part of an Alaska-wide assessment of 'critical and strategic' minerals, and it follows up on brief reports of cobalt mineralization by the U. S. Geological Survey (USGS), previous Bureau of Mines investigations of the Alyeska pipeline corridor and local miners. The following manuscript is a summary of field work in 1981, and it will be updated as additional work is completed. Specific objectives of this investigation were to re-examine the previous reports of mineralization and to evaluate the potential for economic cobalt mineralization in the area.

While the Livengood mining district has been heavily prospected for gold and silver, and to a lesser extent for copper, lead, zinc, molybdenum and nickel, there has been no known attempt in the past to evaluate cobalt in the study area (shown on figure 2).

HISTORY AND PREVIOUS INVESTIGATIONS

The Livengood area (figure 1) has been the scene of considerable placer gold mining activity since the discovery of gold in the Fairbanks district in the early 1900's.

Some of the more recent work by the USGS includes a preliminary geologic map of the Livengood quadrangle compiled by Chapman, Weber, and Taber (1971)(2), investigation of potential for lode deposits in the area (Foster, 1968)(4), and geochemical analyses of bedrock and stream sediment samples from the Livengood quadrangle (Chapman and Weber, 1972)(1). Other investigators from the USGS and the Alaska Division of Geological and

Geophysical Survey, too numerous to list here, have compiled studies pertaining to the geology, geomorology, and geophysics of the Livengood area. Their work is listed in the publication files of those agencies.

A recent report entitled "Evaluation of the Mineral Resources of the Pipeline Corridor" by Robinson and Metz, done for the Bureau in 1979 (6), observed that meta-sedimentary rocks near the head of Shorty Creek contain clots and kidney shaped zones of massive sulfide as much as five inches thick in vein material. These zones were reported to contain strongly anomalous amounts of cobalt.

A now inactive block of 80 claims on the hills surrounding Ranney Hollow (figure 3) was investigated by private industry (written communication, C. F. Herbert, 1980)(5) in the early 1970's. Drilling and detailed soil sampling was conducted on the block in 1972. Soil sampling revealed a copper anomaly averaging 277 ppm over an area 11,500 ft by 6,000 ft. Molybdenum averaged 35 ppm in an area 10,000 ft by 3,000 ft, which was largely coincident with the region of high copper values. Drilling showed an average of 950 ppm Cu and 40 ppm Mo over the main part of the copper anomaly and 410 ppm Cu and 100 ppm Mo over the main part of the molybdenum anomaly. Eighty samples taken at 10 ft intervals from four of the drill holes were assayed for silver and gold. Silver content was generally less than 0.1 ounces per ton, with a few samples containing as much as half an ounce per ton. Gold values of from 0.05 - 0.06 ounces per ton were reported from thirteen of the eighty samples. Analyses were not made for cobalt. Eleven of the 17 holes drilled were wholly or largely in igneous rock roughly intermediate between a granodiorite and quartz diorite porphyry. The company felt that mineralization was a "porphyry type" and of too low a grade to warrant further work. The claims were dropped.

A review of mining claims in the Livengood area revealed several (inactive) claims in the vicinity of milepost 62 of the old Elliot Highway which list cobalt as a principal commodity.

OWNERSHIP

Virtually all of the locations visited are on active or inactive claims. The U.S. Bureau of Land Management controls the pipeline corridor and the Alyeska Pipeline Company has a 54 ft. right-of-way. The hills surrounding Ranney Hollow in sections 2, 3, 10, 14, and 15 (figure 2) are within an inactive claim block of 80 claims. At present, although some Alaska state land selections are pending, the area is under the jurisdiction of the Bureau of Land Management.

PHYSIOGRAPHY

The report area lies in the Yukon-Tanana upland. Topographical relief is modest. Maximum elevations in the Livengood vicinity are generally about 1,500 to 2,000 ft above sea level.

The principal drainage system for the area is the Tolovana River, a meandering river replete with cut-off channels, oxbow lakes, sloughs, etc. The floor of the Tolovana River valley immediately south of Livengood attains a width of approximately three miles. Secondary creek drainages, such as those of Shorty and Ranney Creeks, tend to be steep for a short distance in their upper reaches and become relatively slow, wandering streams upon encountering the flood plain of the Tolovana. Flood plain sediments consist of former till and material reduced by the actions of the tributary creeks. Much of the low-lying area is underlain by permafrost.

Climate is sub-arctic. Winters tend to be long and cold, contrasting with the relatively short, sometimes warm summers. The snow-free period generally extends from May through September.

Vegetation consists of spruce and birch trees on the well-drained slopes, thick growths of willow and alder brush in the ravines, and tundra and stunted black spruce in the low-lying areas. The vegetation matte is continuous throughout the area. There are no natural outcrops although a few local areas of rubble are found on the steeper slopes.

ACCESS

Access to the headwaters of Ranney and Shorty Creeks, five miles from the Manley Hot Springs Road, was via motor bikes along the Alyeska pipeline pad. Permits to use the right-of-way must be obtained from Alyeska security. The Ranney Hollow claim block was reached on foot via heavily overgrown cat trails. Ranney Hollow itself was reached on foot by crossing the Tolovana River (which can be waded) at the end of a mining road along Olive Creek. All other areas were adjacent to the Elliot Highway.

REGIONAL GEOLOGY

The Livengood area south of the northeast trending Victoria Creek fault is underlain by clastic sedimentary rocks of a variety of lithologies. In age they range from Cambrian/Precambrian argillite, quartzite and shale, through upper Ordovician cherts, Devonian limestone, siltstone and shale, to Cretaceous graywackes, conglomerate and quartzite (3).

Serpentinites of uncertian (probably Devonian) age form an eastward to northeastward trending belt of outcrops. These are believed to have originally been emplaced as subhorizontal sheets associated with regional thrust faulting (4). Commonly associated with the serpentinites are peridotite, metadiorite, metabasalt and rocks formed by the hydrothermal alteration of ultramafic rocks.

Numerous dikes, sills and small intrusive bodies of monzonite, quartz diorite, granodiorite, to granite cut the clastic rocks and are thought to cut both the serpentinite and the Devonian limestones and cherts (4). These intrusives are Upper Cretaceous to Tertiary in age (2).

WORK BY THE BUREAU

FIELD WORK

A brief investigation of the Ranney Hollow/Shorty Creek area was made in June, 1981. Work was conducted by a two-person team working on foot and from motor bikes along the Alyeska access road. A total of five days were spent working the area, which included mapping, geochemical sampling and examination of mineralized exposures and float. An additional day was spent in the Livengood area sampling along Olive Creek, which had been reported by Foster (4) to contain anomalous values of cobalt (100 ppm). At the same time, mining claims, which the Alaska State Kardex Files list as having cobalt as a principal commodity, were investigated in the vicinity of milepost 62 of the Elliot Highway.

SAMPLING AND ANALYTICAL PROCEDURES

Stream sediment samples (table 1) were collected with a steel shovel from the finer sandy portion of the active channel or deepest most active part of a dry creek bed. Organic-rich material was avoided. Samples were put in water-resistant paper sample bags and air-dried before screening at -80 mesh. Float-rock and stream characteristics were noted and recorded at each sample station.

Soil samples (table 2), taken from the "B" (often missing) or the "C" horizon, were dried and sieved at -80 mesh.

Pan concentrate samples (table 3) were collected to enhance recognition of resistant minerals with high specific gravity such as those containing tin, tungsten, chromium, gold, etc.. Generally these minerals are not easily detected using routine stream sediment sampling and analysis procedures. As with the stream sediment samples, the pan samples were collected with a steel shovel from the silty, poorly sorted material in the active channel. A 14 in. pan was filled, panned to approximately a 40 gram sample and carefully washed into a plastic bag.

Pan concentrate samples were further reduced by panning in Fairbanks until each sample approximated 30 grams in weight. Samples were then sent to Juneau where they were preconcentrated to a fire assay bead which was then analyzed by inductively coupled plasma analysis (ICP) for Au, Pt and Pd. These analyses were performed by TSL Laboratories of Spokane, Washington.

Rock samples (table 4) were usually taken as random chip samples across a geologic unit of interest; for example, a suspected mineralized area or a zone of alteration. The outcrop characterisitics of the area covered by the chip sample was recorded. If a sample consisted of an individual high-graded rock or float material of unknown origin, this was also noted. Samples collected approximated 1-2 pounds in weight.

A pulverized fraction of each crushed rock sample and a pulverized -80 mesh portion of each stream sediment and soil sample collected was analyzed by standard atomic absorption methods for Cu, Pb, Zn, Mo, Co, Sb, As, and Ni. Ag and Au were analyzed by fire assay. These analyses were made by TSL Laboratories of Spokane, Washington.

MINERALIZATION

Prior to and during the field work, three basic models were evolved as potential targets for cobalt mineralization. The investigation was oriented to examine evidence of each of these:

1. Hydrothermal vein deposition of sulfide minerals (including cobalt minerals) within metamorphosed sandstones/siltstones adjacent to a granodioritic intrusive body. In a recent contract report to BOM by the Mineral Industry Research Laboratory (MIRL)(5, p. 130), sulfide-bearing veins containing clots and kidney-shaped zones of massive sulfides as much as five inches thick were described occurring within the metasiltstone country rock along a bedrock cut where the pipeline pad crosses the hilltop south of Shorty Creek. Sample splits reanalyzed during this study contained cobalt concentrations to 0.83%.

During the present study a visit to the location described by MIRL was made. The cut examined in 1981 (figure 3) is approximately 250 feet long and is comprised of orange-colored metasiltstones and sandstones which strike northeast. This unit contrasts sharply with the dark gray siltstone and shale elsewhere along the pipeline pad. High angle quartz veins up to one inch wide were noted in at least three locations within the deteriorating bedrock. Figure 4 shows locations of samples from this area. Visible mineralization including chalcopyrite proves to be associated with anomalous concentrations of cobalt (#17370). The essentially vertical quartz veins strike approximately N.60 E. to N.80 E. One mineralized vein (#16739, 17371) parallels a two-foot wide zone of fault gouge and breccia, and analyses of grayish clay-like material from another gouge zone (#16728) revealed strongly anomalous concentrations of copper (4.8%) and silver (10.9 ppm). This evidence suggests that mineralization is vein or fault controlled.

A series of soil samples (#16730d-16738d) taken across the tundra above the outcrop were moderately anomalous for copper and silver, and very weakly anomalous for zinc and cobalt (average 70 ppm Zn, 30 ppm Co).

The predominant lithology encountered in the scattered areas of "rubble crop" on the hillsides is a sometimes iron-stained siliceous metasiltstone and quartzite. Also present is an often argillic-altered feldspar prophyry. The latter is light colored and possibly of dacitic composition. In one location (#17375) it is intruded by a dark colored andesitic (?) feldspar porphyry.

2. Cobalt mineralization associated with 'porphyry-type' copper/ molybdenum occurrence. Although the copper and molybdenum anomalies reported by industry in the vicinity of Ranney Hollow were duplicated, no evidence of significant cobalt mineralization was found either in the diorites or in the metasedimentary rocks which make up the hills around Ranney Hollow. A breccia composed of the light-colored porphyry and gossan contained 1.34% copper (#17382) but only 15 ppm cobalt. Sample locations are shown in figures 5 and 6.

3. Lode cobalt mineralization within diorite and/or serpentinites. Several lode claims listing cobalt as a principal commodity are reported in the Alaska state Kardex system files. All are located in the vicinity of mile 62 of the <u>old</u> Elliot Highway, and as best determined are in the vicinity of the BLM recreational cabin known as the Fred Blixt

cabin. Rock types encountered included diorites and magnetite-bearing serpentinties (#16697) on the ridge north and west of the Blixt cabin. A small barrow pit (sample location #16698) is comprised of diorite and magnetite-bearing peridotite, both showing signs of shear and containing numerous quartz veinlets. One sample of the peridotite (#16699) contained anomalous silver values (31 ppm). R. L. Foster (4) has reported cobalt geochemical "anomalies" in Ruth (70 ppm), Ester (70 ppm), and Olive (100 ppm) creeks which drain the general vicinity. All three creeks drain areas that include mafic/ultramafic rocks which probably are the source of the marginally anomalous Co values. This is further suggested by results of the present study which indicates background Co values of up to 72 ppm in the peridotite of Amy Dome (16704, 16723, 16724). An intensely altered outcrop (#16700) 100 feet east of Olive Creek on the old road was sampled and proved to be weakly anomalous in Pb (115 ppm) and Zn (125 ppm). Cobalt values were 11 ppm. This outcrop is composed of limonite, clay and a vuggy light gray rock which was possibly once a volcanic or hypabyssal rock.

SUMMARY AND RECOMMENDATIONS

Examination of the Livengood area has not located any mineralized deposits of cobalt approaching economic tenor.

No evidence of the 'lode' claims containing cobalt in the vicinity of mile post 62 was found. No indication of cobalt mineralization was revealed in the analyses of samples from this area.

The "porphyry-type" copper/molybdenum occurrence at Ranney Hollow does not appear to have potential for associated cobalt. In light of present results and those of the previous sampling and drilling by industry, this area can probably be eliminated as a cobalt resource.

While the very high cobalt values from veins within the metasedimentary rocks at the head of Shorty Creek were not duplicated, mineralized quartz veins within this unit were located, and anomalously high cobalt values were obtained. These veins also contain anomalously high values of copper, silver, lead, zinc and gold. It is suspected that the mineralized quartz veins are related to the dioritic intrusion of the Ranney Hollow area 2 miles to the northwest. Due to the amount of vegetative cover between these two areas, however, this is pure conjecture. The vein-type mineralization is suggestive of low tonnages, even if economic metal grades were discovered to persist in the area.

Should further work be undertaken here by BOM, however, it is recommended that the extent of the mineralization within the fault zones and quartz veins in the sedimentary rocks be determined. The dark gray shales, as well as the orange/tan colored metamorphosed siltstones, contain mineralized quartz veins. The area further to the southeast along the pipeline should be examined for these veins. Additional soil grids and study of color and false color photography may be useful in determining the extent of the mineralization observed in the present study.

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4. Foster, R. L. Potential For Lode Deposits In The Livengood Gold Placer District, East-Central Alaska. U.S. Geol. Survey Circ. 590, 1968, 18 pp.

5. Herbert, C. F. Written communication to James C. Barker, June, 1980. Correspondence on file at U.S. Bureau of Mines Office, University of Alaska, 206 O'Neill Res. Bldg., Fairbanks, Alaska 99701.

6. Robinson, M. S. and P. A. Metz. Evaluation Of The Mineral Resources Of The Pipeline Corridor-Final Report, 1979. Submitted to U.S. BuMines, Alaska Field Operations Center, Juneau, Alaska, June 1, 1979.

TABLE 1. - Geochemical analyses of stream sediments (in ppm)

Map No.	Field No.	Ag	As	Co	Cu	Mo	Ni	Pb	Sb	Zn
	Li16703S	0.7	NA	15	28	NA	79	14	NA	160
	Li17372S	----	NA	19	66	<2	NA	13	<1	93
	Li17704S	----	---	30	170	3	NA	NA	--	NA
	Li17705S	----	---	22	225	4	NA	NA	--	NA
	Li17707S	----	---	32	91	3	NA	NA	--	NA
	Li17708S	----	---	14	150	<2	NA	NA	--	NA
	Li17710S	----	---	12	165	2	NA	NA	--	NA
	Li17711S	----	---	12	145	4	NA	NA	--	NA
	Li17716S	<0.1	17	7	930	<2	NA	NA	<1	NA
	Li17717S	<0.1	42	--	---	12	NA	NA	2	NA
	Li17718S	<0.1	570	12	405	<2	NA	NA	4	NA
	Li17720S	<0.1	<10	9	29	<2	NA	NA	6	NA
	Li17723S	<0.1	---	10	67	<2	NA	NA	5	NA
	Li17724S	0.7	13	20	215	<2	NA	NA	6	NA
	Li17726S	----	14	16	18	<2	NA	NA	6	NA
	Li17733S	1.2	<10	17	205	<2	NA	NA	12	NA
	Li17734S	----	13	16	320	<2	NA	NA	6	NA
	Li17736S	----	12	18	---	--	NA	NA	3	NA
	Li17737S	----	18	13	335	<2	NA	NA	5	NA
	Li17738S	1.3	<10	22	265	<2	NA	NA	5	NA

TABLE 2. - Geochemical analyses of soil samples (in ppm)

Map No.	Field No.	Ag	As	Au	Co	Cu	Mo	Pb	Sb	Zn
	Li16730d	1.5	NA	0.03	14	170	NA	10	2	80
	Li16731d	2.1	NA	0.08	29	195	NA	17	<1	64
	Li16732d	2.1	NA	0.02	30	195	NA	14	<1	57
	Li16733d	10.7	NA	0.19	37	255	NA	22	<1	47
	Li16734d	1.8	NA	0.15	21	105	NA	12	<1	79
	Li16735d	7.6	NA	0.21	30	200	NA	17	1	65
	Li16736d	----	NA	----	5	98	NA	15	<1	52
	Li16737d	1.4	NA	0.03	25	72	NA	22	<1	105
	Li16738d	0.8	NA	0.04	20	61	NA	12	<1	51
	Li16740d	0.6	NA	0.01	20	39	NA	18	<1	75
	Li16741d	0.5	NA	0.01	20	34	NA	18	<1	105
	Li16742d	0.3	NA	0.01	10	18	NA	12	<1	59
	Li17377d	0.3	NA	0.01	5	18	NA	5	<1	58
	Li17378d	0.8	NA	0.02	15	21	<2	15	<1	56
	Li17380d	0.7	NA	0.02	13	62	<2	16	<1	63
	Li17407d	----	NA	----	15	21	NA	14	<1	275
	Li17410d	----	NA	----	3	18	NA	9	<1	130
	Li17413d	0.2	NA	0.01	5	27	NA	11	<1	16
	Li17414d	0.3	NA	0.01	4	10	NA	10	<1	83
	Li17713d	1.5	77	NA	10	48	<2	NA	<1	NA
	Li17719d	0.3	130	NA	10	76	<2	NA	7	NA
	Li17721d	0.6	18	NA	9	29	<2	NA	6	NA
	Li17727d	<0.1	<10	NA	11	21	<2	NA	8	NA
	Li17728d	----	73	NA	17	45	<2	NA	13	NA
	Li17729d	----	<10	NA	10	21	<2	NA	1	NA
	Li17730d	----	<10	NA	9	20	<2	NA	3	NA
	Li17731d	----	<10	NA	11	24	<2	NA	1	NA

TABLE 3. - Geochemical analyses of pan concentrate samples (oz/ton)

Map No.	Field No.	Au	Pt	Pd
	Li17706p	.048	.008	<.002
	Li17709p	.120	<.003	<.003
	Li17725p	.034	<.009	<.009

TABLE 4. - Geochemical analysis of rock samples (ppm)

Map No.	Field No.	Ag	Co	Cr	Cu	Mo	Ni	Pb	Sb	Zn	Field Description
	Li16696R	0.6	19	115	89	NA	30	16	NA	51	'Typical' diorite from large outcrop below Amy Dome Ridge.
	Li16697R	0.6	16	175	88	NA	39	11	NA	5	Diorite similar to (16696), but with bright blue stain on surface.
	Li16698R	0.4	18	125	69	NA	34	9	NA	41	1/2 in wide quartz vein in quartz diorite in road cut.
	Li16699R	31.0	34	1,320	73	NA	215	9	NA	21	Magnetite-bearing peridotite with blue stain on fracture surfaces.
	Li16700R	0.8	11	11	5	NA	7	115	NA	125	Heavy limonite rind on gray quartzite. Visible sulfide minerals.
	Li16701R	0.5	12	10	6	NA	11	115	NA	230	Similar to (16700) but with a white 'salt' on weathering surface.
	Li16702R	0.7	8	4	4	NA	9	24	NA	195	Dark gray porphyritic volcanic cut by quartz veins with limonite vugs.
	Li16704R	0.3	72	1,225	5	NA	1,580	10	NA	16	
	Li16723R	0.3	68	1,340	31	NA	1,450	9	NA	19	Peridotite with small (<1mm) veinlets of asbestos.
	Li16724R	0.3	53	1,260	28	NA	260	6	NA	17	Abundant magnetite in peridotite.
	Li16725R	1.0	8	105	21	NA	58	9	NA	71	Calcareous siltstone. Some iron staining.
	Li16726R	0.7	9	NA	100	NA	NA	7	1	45	Quartz vein material found in shales. Iron stained.
	Li16727R	3.5	14	NA	295	NA	NA	5	1	11	Shale which hosts material of (16726).
	Li16728R	10.9	40	NA	4,800	NA	NA	28	7	8	Grayish white clay from gouge zone in shale. Contains small chert pebbles.
	Li16729R	4.3	87	NA	180	NA	NA	9	3	7	Visible metallic gray mineralization with abundant green-stained quartz.
	Li16739R	7.0	22	NA	70	NA	NA	115	18	885	2-3 foot wide gouge zone in shale. Same zone as (17371).
	Li17366R	11.0	32	NA	740	4	NA	22	21	14	High-graded rubble. Brecciated shale and siltstone. Heavy limonite stain.

Geochemical analyses of rock samples - Continued

Map No.	Field No.	Ag	Co	Cr	Cu	Mo	Ni	Pb	Sb	Zn	Field Description
	Li17367R	1.0	11	NA	235	<2	NA	7	<1	43	Iron-stained quartz vein in shale.
	Li17370R	1.3	270	NA	565	<2	NA	7	3	46	Fe-stained siltstone with high angle quartz veins to 1" wide. Chalcopyrite & dark gray metallic mineral.
	Li17371R	0.5	35	NA	60	4	NA	1,400	14	1,085	Bright orange fault gouge from black shale 2 feet from (16739).
	Li17373R	1.0	24	NA	58	3	NA	12	1	83	Float from pipeline pad. Fine-grained diorite with secondary Cu minerals.
	Li17375R	0.6	5	NA	39	2	NA	4	4	6	Very fine disseminated sulfides in high-graded light gray volcanic rock float.
	Li17376R	0.7	6	NA	85	<2	NA	10	2	87	Shale/siltstone from beneath tundra cover. Not high-graded. Moderate iron stain.
	Li17381R	6.1	4	NA	37	<2	NA	185	<1	16	Argillic-altered porphyry.
	Li17382R	1.3	15	NA	1,340	<2	NA	14	51	98	High-grade gossan breccia.
	Li17406R	0.3	19	NA	31	NA	NA	9	1	48	Rubble crop. Black shale.
	Li17408R	0.5	20	NA	29	NA	NA	11	<1	330	Tan-weathering black shale.
	Li17409R	10.6	11	NA	1	NA	NA	11	<1	300	Quartz-diorite near contact with shale.
	Li17411R	0.1	13	NA	18	NA	NA	12	<1	1,150	Quartz-diorite rubble-crop.
	Li17412R	4.2	15	NA	41	NA	NA	10	<1	565	Quartz-diorite rubble-crop.
	Li17714R	0.3	42	NA	610	<2	NA	6	NA	60	Limonite stained metasediments. Visible sulfides.
	Li17715R	15.6	4	NA	25	3	NA	24	NA	31	Similar to (17714) but less altered. Appears 'fresher'.
	Li17722R	0.1	19	NA	23	<2	NA	8	1	71	Pebbles of shale from same location as (17721d).

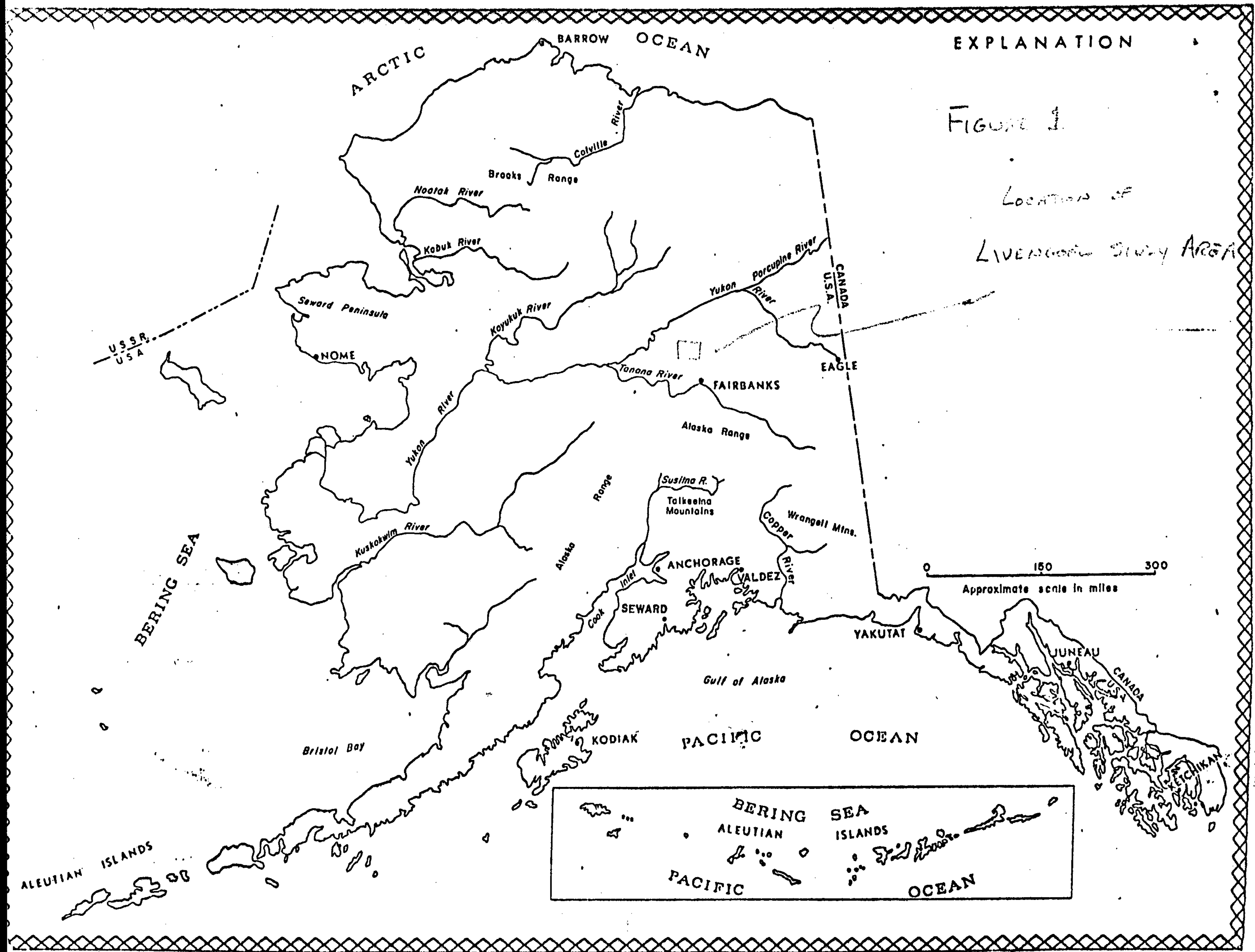
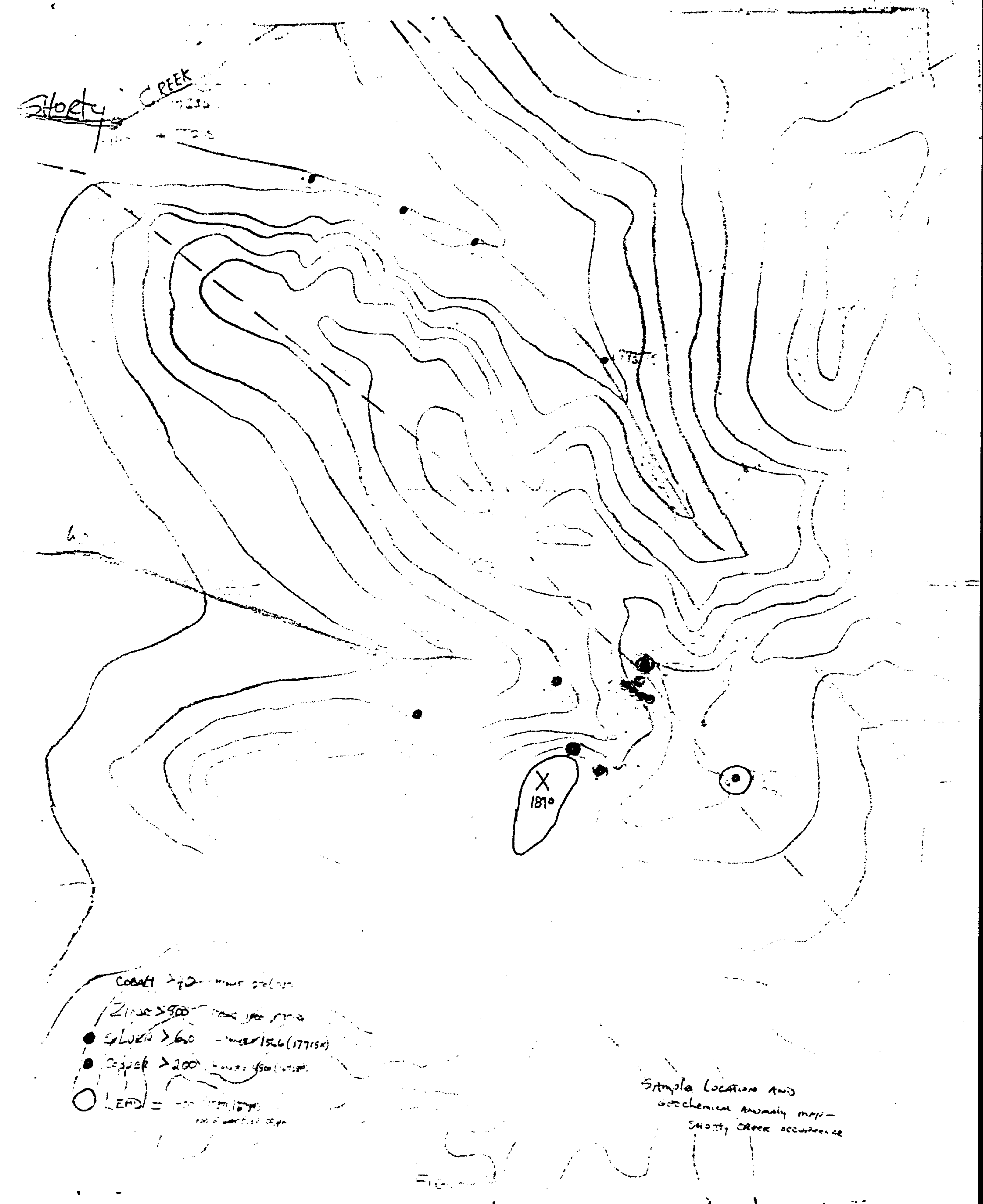


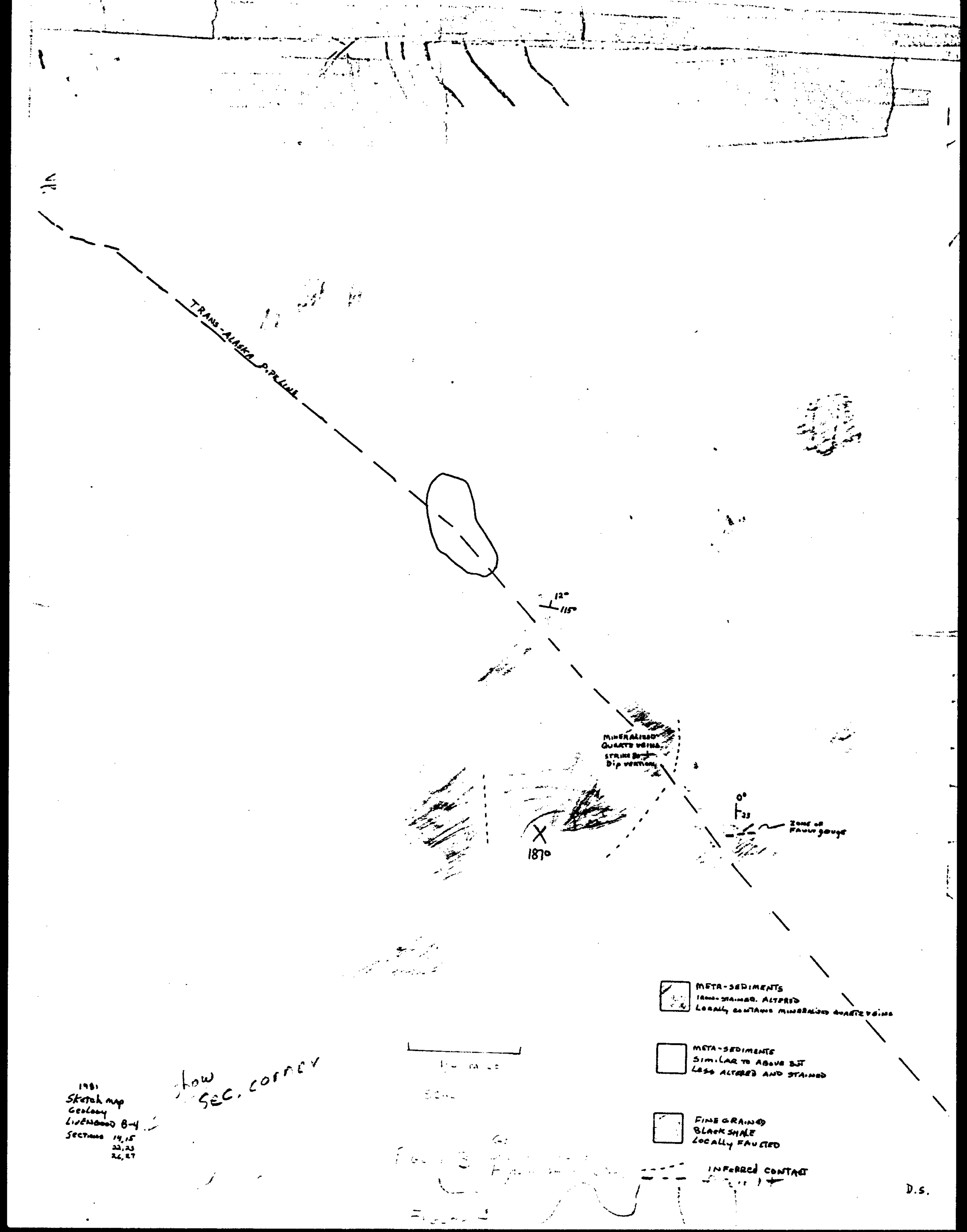
Figure 1

Location of

Livengood Study Area



Sample Location and geochemical anomaly map – Shorty Creek occurrence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12°
115°
MINERALIZED QUARTZ VEINS
STRIKE
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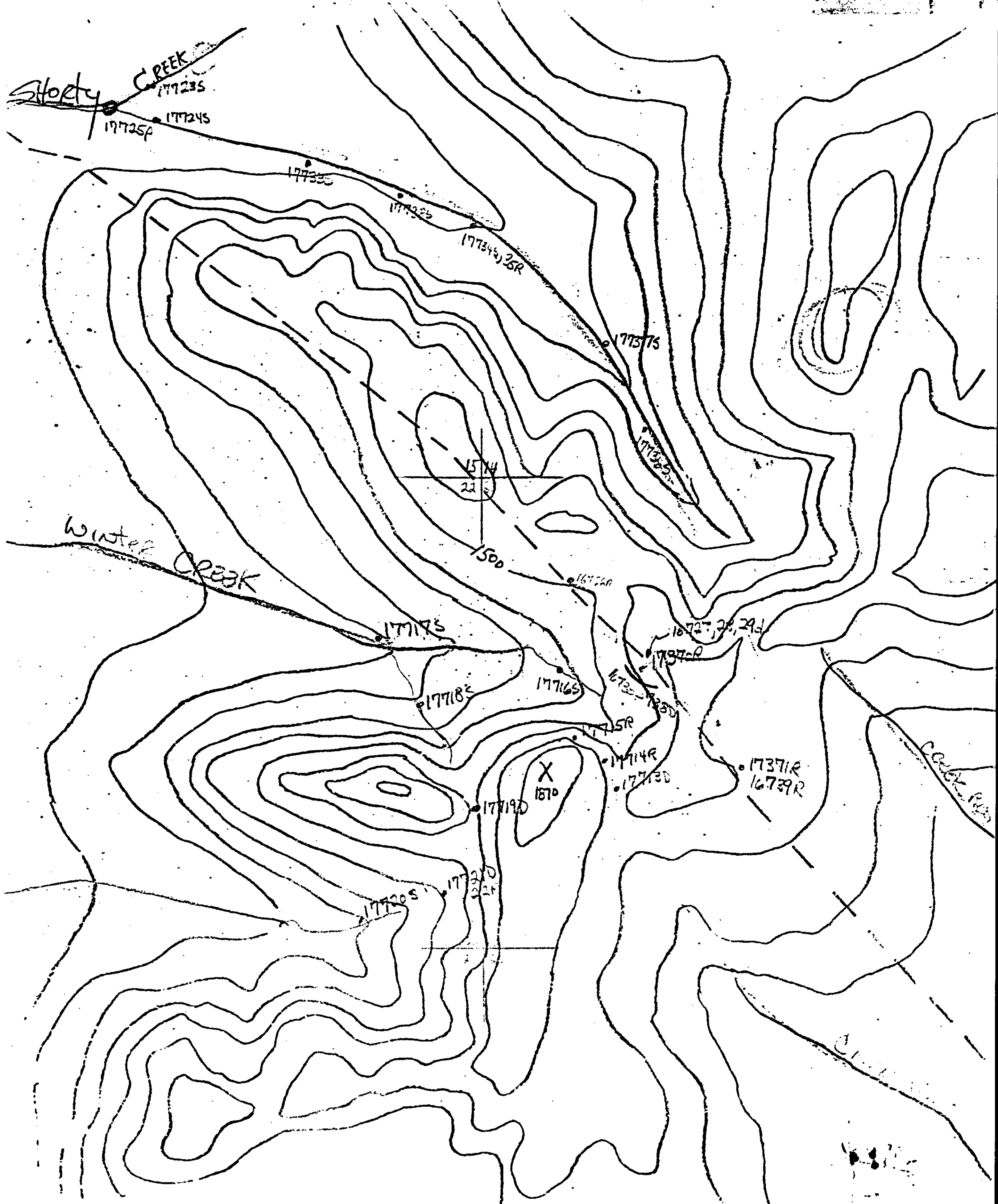
187°
0°
23
ZONE OF FAULT GOUGE
META-SEDIMENTS
ALTERED
LOCALLY CONTAINS MINERALIZED QUARTZ VEINS
META-SEDIMENTS
SIMILAR TO ABOVE BUT
LESS ALTERED AND STAINED
FINE GRAINED
BLACK SHALE
LOCALLY FAULTED
INFERRED CONTACT
1981
Sketch map
Geology
LIVENGOOD B-4
SECTIONS 14, 15
22, 23
26, 27
SEC. CORNER
D.S.


Shorty Creek
177235
177245
177250
177335
177345, 35R
177377S
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1500
177175
177165
177185
177150R
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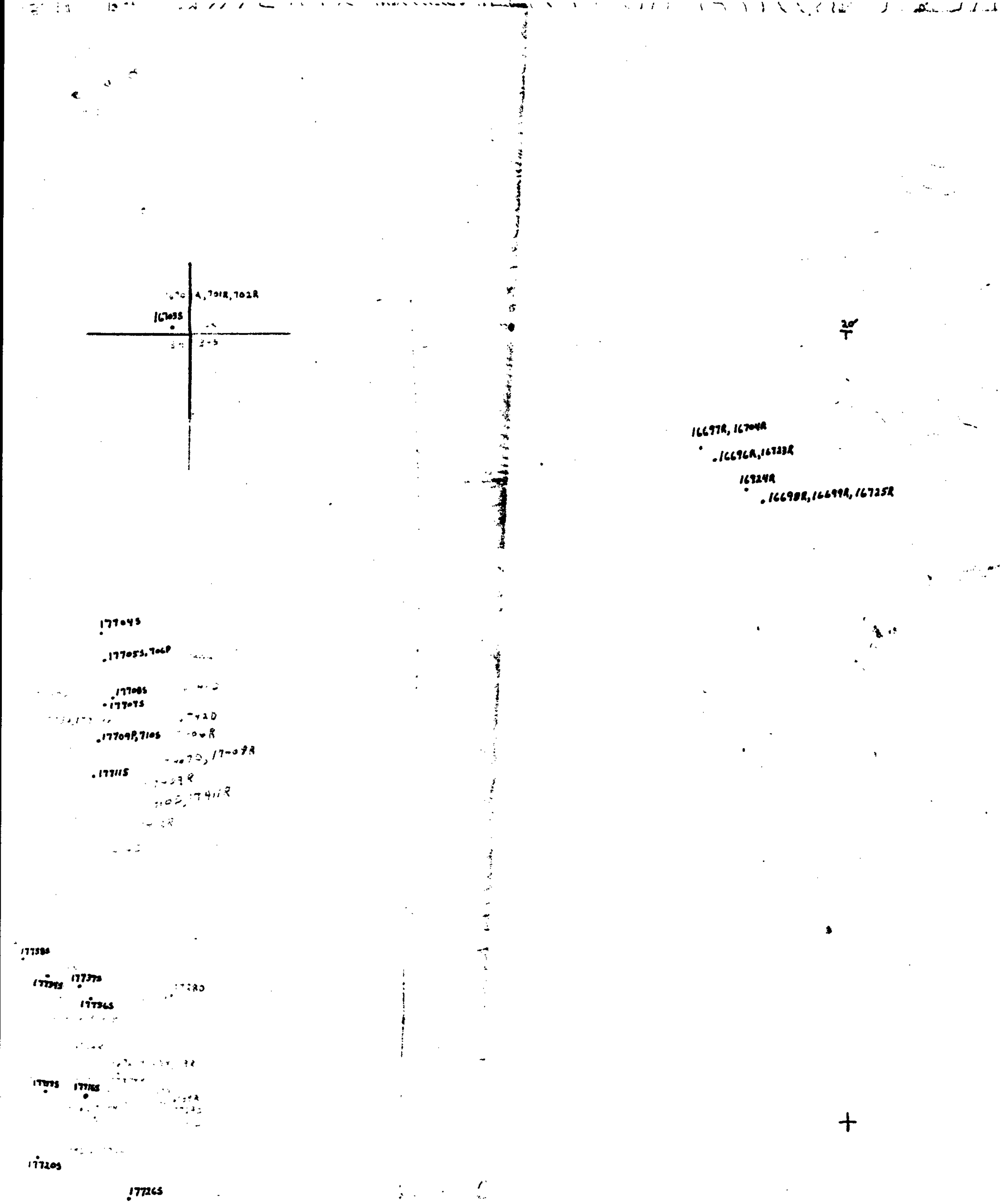
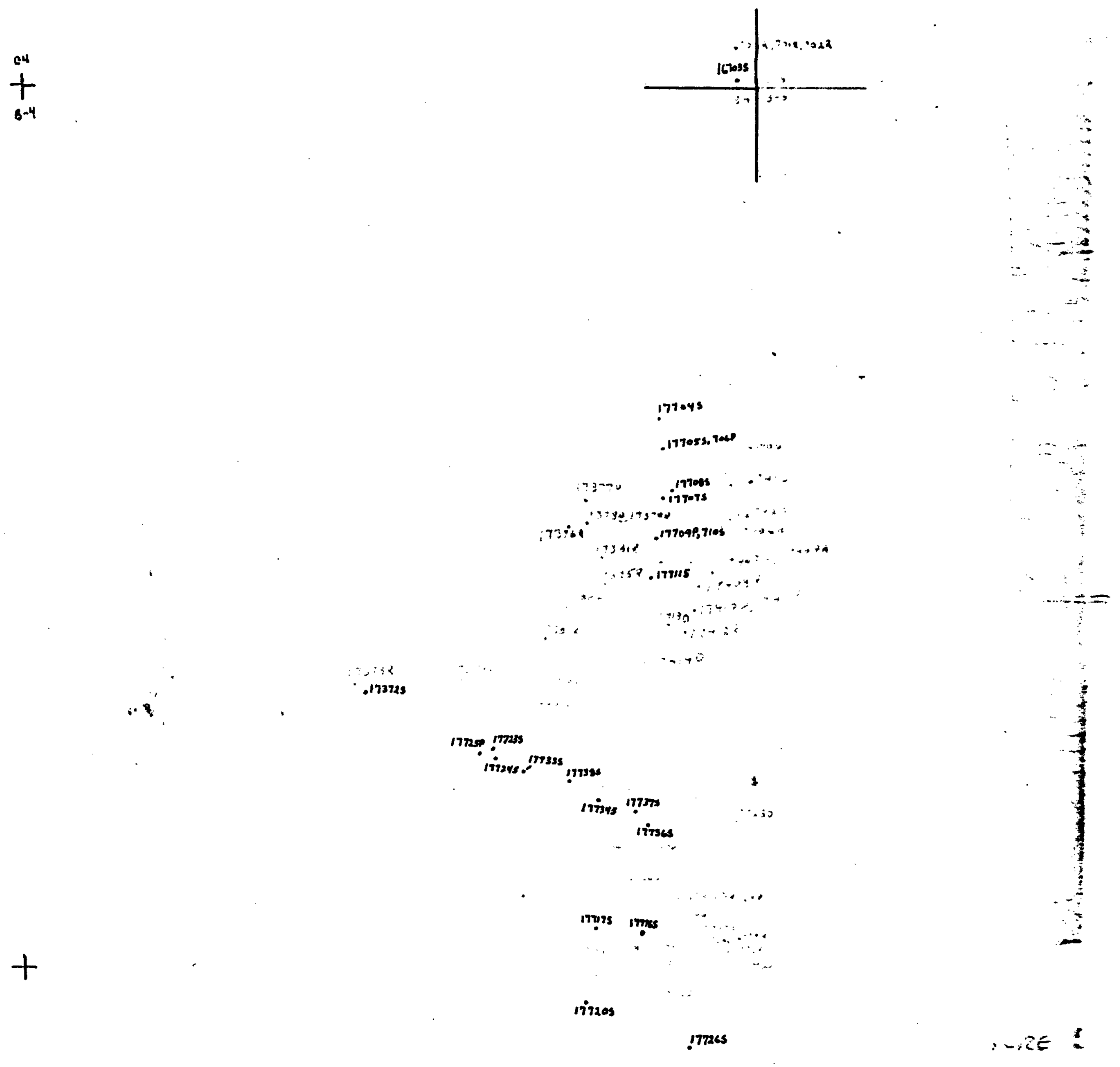
17371R
16739R
Winter Creek



AND SOIL SAMPLE LOCATION MAP
AND B-3, B-4, C-4 1981

D.S.



F

STREAM SEDIMENT SAMPLE (S) AND PAN CONCENTRATE SAMPLE (P)
LOCATION MAP
LIVENGOOD B-4 AND C-4
1981

D.S.