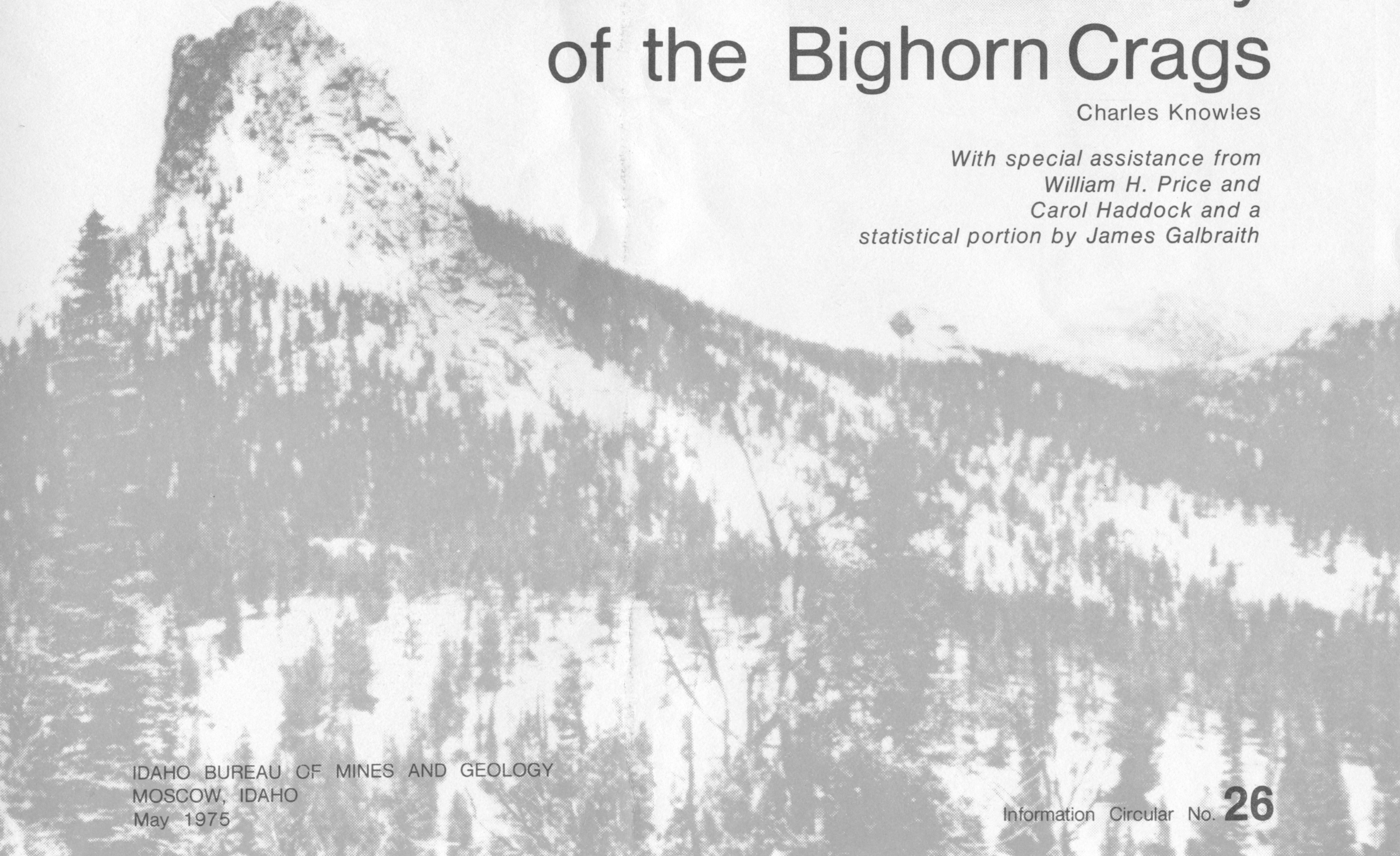
Reconnaissance Geochemistry of the Bighorn Crags

Charles Knowles

*With special assistance from
William H. Price and
Carol Haddock and a
statistical portion by James Galbraith*



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CONTENTS

LIST OF ILLUSTRATIONS

SUMMARY

Reconnaissance geochemical investigations of a large portion of the Bighorn Crags and adjacent areas has shown that several areas within the study area have mineral potential.

The Bighorn Crags study area covers approximately 120,000 acres in east-central Idaho. The area is bounded on the east by Panther Creek, north by the Salmon River and Middle Fork of the Salmon River, and the crest of the Bighorn Crags forms the western edge. This crest is the edge of the Idaho Primitive Area.

All first and second order east and north flowing streams in the Bighorn Crags were sampled. The sampling density was one sample every one-half mile. The sediments of approximately sixty miles of streams were sampled, determining pH, temperature, human contamination, stream turbidity and size.

The samples were analyzed on the University of Idaho College of Mines atomic absorption instrument to determine trace amounts of silver, gold, cobalt, copper, molybdenum, lead and zinc. These values are tabulated and plotted on concentration maps.

Chemical contamination effecting the results was identified as drainage from an inactive mine area and a recent forest fire. These date were removed from the evaluation.

Several regions in the study area show anomalously high concentrations of Co, Cu, Zn (see fig. 6). These high concentration areas indicate mineralization and a detailed soil sampling and drilling program in these areas is suggested to determine mineral potential.

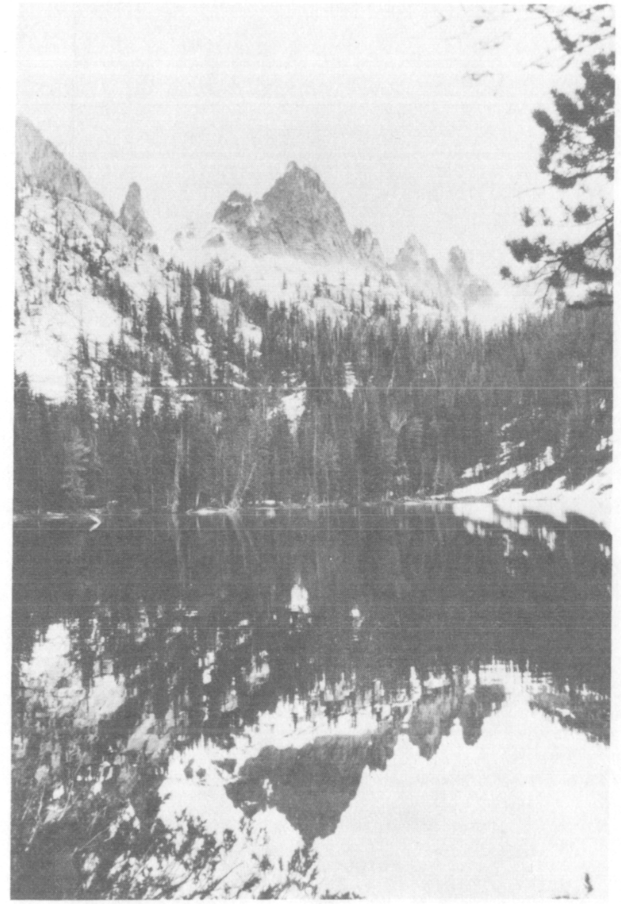


Fig. 1 Fish Fin Ridge - Crags Pluton

INTRODUCTION

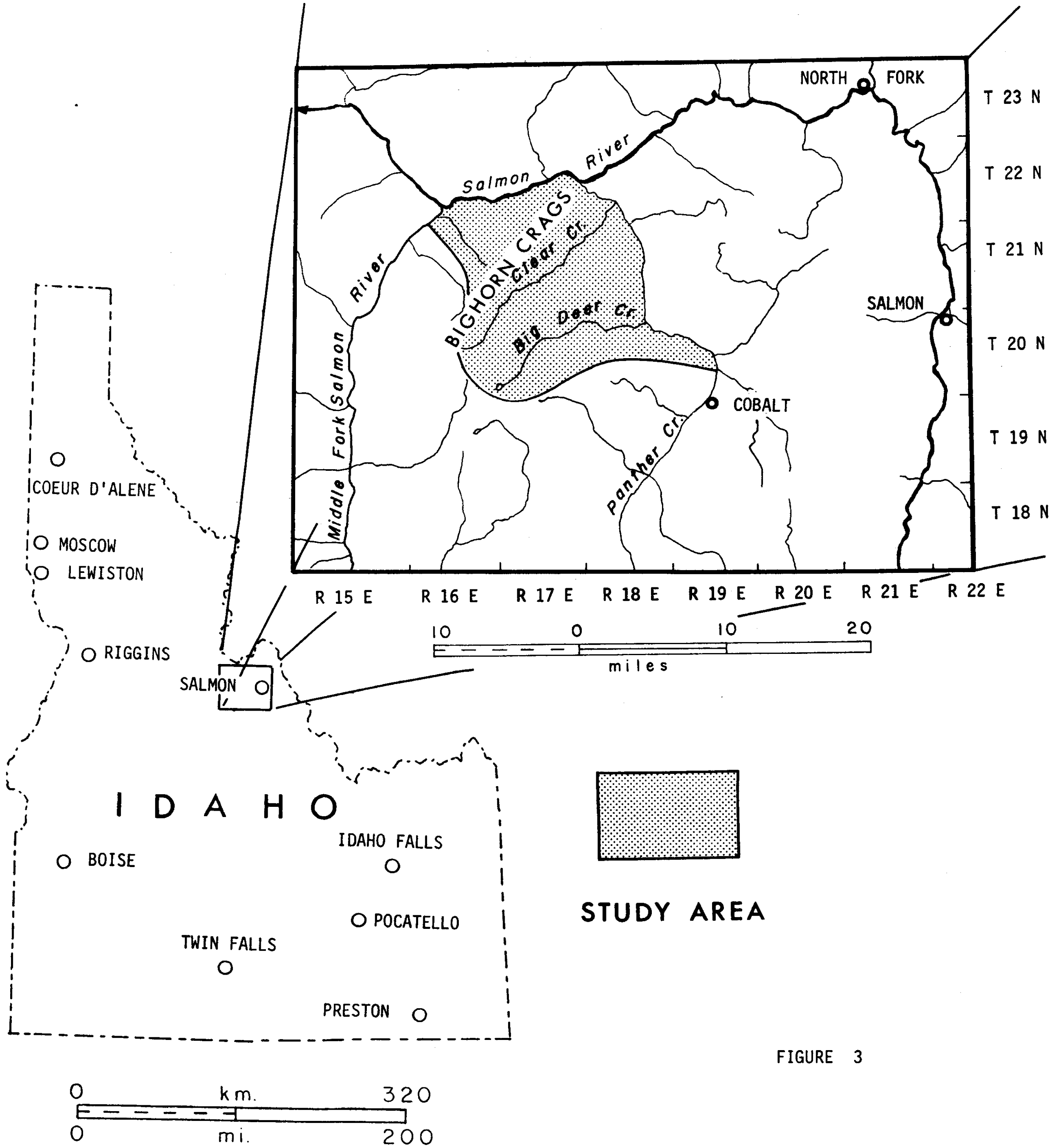
Fig. 2 Cathedral Rock - Crags Pluton

The Bighorn Crags study area is located in the western portion of Lemhi County and covers about 120,000 acres in rugged terrain (Fig. 3). The area is adjacent to the Idaho Primitive Area and part of the study area is being considered as an addition to the proposed Idaho Wilderness Area as outlined in a recent Forest Service Publication (Yurich, 1973).

At the time this study started (September, 1972) there was no supporting data of the mineral potential within the proposed addition. The U.S. Geological Survey recently released the results of a study which covered a portion of the same area (Cater et al., 1973a) however, it is not as detailed in analysis, sampling and area covered.

This report, "Mineral Resources of the Clear Creek-Upper Deer Creek Study Area, Contiguous to the Idaho Primitive Area, Lemhi County, Idaho," will be referred to as USGS-Crags Study. The study summarized "....nothing was found that indicates the presence of lode deposits or valuable metals."

The report was received by us too late for the data to be incorporated in our statistical reduction, however, we find some similarities in our data. We also support the statement made in the USGS-Crags Study, "Therefore, we think that the samples of stream sediments would easily indicate the presence of moderately large mineral deposits.....".



NORTH FORK
T 23 N
T 22 N
T 21 N
T 20 N
T 19 N
T 18 N
Salmon River
BIGHORN CRAGS
Clear Cr.
Big Deer Cr.
River
Middle Fork Salmon
SALMON
COBALT
Panther Cr.
R 15 E
R 16 E
R 17 E
R 18 E
R 19 E
R 20 E
R 21 E
R 22 E
10 0 10 20
miles
COEUR D'ALENE
MOSCOW
LEWISTON
RIGGINS
SALMON
I D A H O
BOISE
IDAHO FALLS
POCATELLO
TWIN FALLS
PRESTON
0 km. 320
0 mi. 200
STUDY AREA

FIGURE 3

GEOGRAPHIC SETTING

The Crags are rugged peaks rising to 10,052 feet at Mount McGuire with many peaks over 9500 feet. The Crags are bounded on the north by the main Salmon River, the west by the Middle Fork of the Salmon River and the east by Panther Creek (Fig.3 The extension of the Crags blends with the Salmon River Mountains and have moderate dissection by Yellowjacket and Camas Creek on the south.

The Crags are a quartz monzonite stock called the Crags Pluton (Cater et al., 1973b). The rock weathers to form jagged peaks such as Fish Fin Ridge and Cathedral Rock (see Figs. 1 and 2). These craggy peaks form many cirque lakes that are the headwaters of numerous streams dissecting the region. These streams are the main vehicle of this investigation (see drainage map in Appendix).

The climate in the study area is determined primarily by elevation. The valley floors are semiarid; this gives way to humid-temperate on the mountain flanks to subarctic at the crests. The lower areas have milder winters with less snow and moisture than the upper elevations. Snow will appear in July in most years, whereas the lower elevations (2500 feet) will have little snow accumulation. During the summer months the lower elevations may be without moisture for months and temperatures over 100^{o} are not uncommon.

The vegetation in the area reflects the climatic changes with elevation. In the canyons and low hills are small cacti, sage brush and grasses. With increasing elevations the plant life changes to conifers: Douglas fir, Engleman spruce,Lodgepole pine, Ponderosa pine.

On the upper elevations the tree population is scantily distributed and at the lower elevations is limited to stream edges. Yurich, (1973) indicated the timber in the Crags addition (which is approximately one-half of the timber region of our study area) has nearly 20 million board feet of timber. Our study area would contain closer to 50 million board feet of timber -- primarily Douglas fir and pine.

Very little grazing is done in the area due to heavy forest cover at upper elevations and sparse vegetation at the lower elevations. Some cattle are grazed near Panther Creek and Clear Creek confluence. Near the area is the ghost town of Leesburg and the sparsely populated mining town of Cobalt. The Forest Service maintains a ranger station halfway between the townsite of Forney and Cobalt.

The core of the study area has no permanent residents; however, a few ranches and summer homes exist along the extreme edge of the area of Panther Creek.

Most mining operations in the past were located along Blackbird Creek with a few on Little Clear Creek. There were as many as 86 claims filed along these creeks with 16 active mines. Details of these mine workings can be found in Reed and Herdlick (1947), who state that cobalt minerals occured over an area of 36 square miles, extending from West Fork of Blackbird Creek on the south to two miles above the mouth of Indian Creek on the north. Many cobalt bearing outcrops were found, and they believe that "...many other cobalt bearing zones are masked by the deep overburden that covers most of the district."

The Blackbird mine is the only major mine near the study area. Mineralization in the Blackbird mine area was discovered in 1893 (Umpleby, 1913). The initial claims were made for gold and subsequently prospected about 1900 for cobalt, copper and nickel in 1901. After the original peak operation for gold in 1893 to 1901 and another small burst of activity in 1915, mining activity slowed until the Second World War when renewed interest in strategic minerals served to invigorate cobalt production at the Blackbird mine. After a brief operation the mine was closed. Studies are underway at this writing to reopen the mine if environmental impact considerations can be met.

Recent exploration near the Blackbird mine has shown some uranium mineralization. A drilling program was conducted south of the mine on Musgrove Creek during the summer of 1973.

GEOLOGIC SETTING AND MINERALIZATION

The study area is underlain cheifly by gneiss, schist and quartzite, with higher elevations composed of quartz monzonite and granodiorite forming the crags pluton (Cater et al., 1973b). This local tertiary intrusion metamorphosed the Precambrian quartzite (Belt Supergroups) of the Yellowjacket Formation and the Hoodoo Quartzite near its contacts. Regionally the Precambrian sediments were also intruded and metamorphosed by the Idaho batholith (Mesozoic) prior to the crags pluton and more recently contact metamorphism has been produced by a series of dikes scattered throughout the pluton and quartzite.

The rocks in the area are described rather completely by Cater et al., (1973b). In summary: Precambrian rocks of complex gneiss, schist and quartzite crop out along the Salmon River as far south as Big Deer Creek. At the confluence of Panther Creek and the Salmon River an augen gneiss, which is most likely metamorphosed quartz monzonite, occures near road level. An obricular granite crops out on Garden Creek and east of its confluence with the Salmon River toward Shoup. The gneiss is banded light and dark with quartz, plagioclase, potash, feldspar and biotite. Garnets from the gneiss were recovered by panning near the confluence of Garden Creek and Panther Creek. The schist is coarse grained, is highly micaceous, and contains some garnets. The quartzite is massive and is sometimes micaceous in exposures along the lower reaches of Garden and Clear Creeks.

The quartzite reflect the deformation of the area and is folded strongly, the fold axes are north-south and plunging roughly in both directions.

Cathederal Rock and Mt. McGuire are the highest elevation points in the Crags pluton. The pluton is a medium to coarse grained quartz monzonite that grades to a granodiorite near the margins. Radiometric ages reported in the USGS-Crags Study were determined on mica using the K-Ar method. A minimum age of 44.2-47.5 million years was established.

There are numerous basalt dikes and a few pegmatite dikes near the margins of the contact aureole. The basalt dikes may be related to tertiary challis volcanics which occur just out side the crags area. These volcanics are younger than the Crags Pluton, probably oligocene.

The cobalt occurs as fine to coarse grained lenses and stringers with dissemination of cobaltite and chalcopyrite along zones of shearing and fracturing in the phyllite and quartzite. Mineralized zone are associated with quartzite brecciation and tourmaline visible in the breccia. Evidence of this material other than at the mine was found as float only along Big Deer Creek and along Clear Creek.

Although we were sampling only for reconnaissance purposes, we collected heavy concentrates at each sample site in addition to composite stream sediments. No gold was found in the region. The heav fractions recovered by panning were mostly ilmenite-magnetite with some garnet in the black sands derived from the schist and gneissic rocks near the confluences of Clear Creek and Garden Creek with Panther Creek.

The USGS-Crags Study did a very detailed gold placer study, and I have included their table titled "Principal Gold Placer Deposits" as Table 14 in the Appendix.

FIELD SAMPLING METHODS

In order for two individuals to sample 120,000 acres on foot, a scheme of systematic sampling had to be selected which permitted the maximum amount of information gathered for the least amount of time spent in the field. The method chosen was stream sediment sampling of all first order streams and most second order streams.

The study area varies in elevation from 10,000 feet at the crest of the crags to 2500 feet at the Panther Creek-Salmon River boundary. It is dissected by several large streams (Big Deer Creek, Clear Creek, Garden Creek, Lake Creek, and Goat Creek) and by several lesser streams some of which do not flow the full year (Little Deer Creek, Quartz Creek, Shell Creek, Bear Gulch, Squaw Camp Creek and three creeks that have no names).

In our sampling procedure we collected the fine fraction of the sediments on both sides and near the center of the stream channel trying to get only the finest material in eddys or bars wherever possible. At the mouth of each tributary, samples were collected in the lesser branch as well as from the main stream both above and below the confluence.

This sampling method yielded only recently eroded material, from which we could determine those areas having the highest mineral potential. The method has a weakness; the material collected has been transported a very short distance. With this in mind we tried to sample every one-half mile in the second order streams and to sample up stream of the mouth of the smaller first order streams.

Our sampling procedure and measurements made at each site were as follows: approximately one-half pound of composited very fine stream sediment was collected from the sides and center of the stream and combined to form a composite sample. Only the top fraction of silt and fine sand was collected at each site. The pH of the water was taken and the air and water temperatures were recorded. Observations on water turbidity, stream size, oxides or algae present on the stream bottom and apparent contamination from either animal or human sources were made. Each sample site was noted on the field map and upstream geologic conditions, such as faulting, glaciation, mass wasting, and rock types were recorded.

A total of 147 samples was collected over the area, (see sample locations in Appendix).

LABORATORY ANALYTICAL METHODS

Stream sediment samples were dried thoroughly at low temperatures and screened. The minus 100 mesh fraction was selected for analysis.

The digested fine fraction was as described below using the procedure outlined by Tindall (1965, 1966) for the analysis of silver, lead, zinc, copper, cobalt, molybdenum and gold. Although the procedure called for the extraction of gold from the acidic solution using methylisobutyl ketone the direct determination was attempted first. We found that some interference was caused by the iron present and the gold analysis was rerun, with the necessary step added.

The procedure was to digest 6-10 g of the sample in 25 ml of conc. HCl in a 400 ml beaker. Cover and heat for 20 minutes. Then add 15 ml concentrated HNO_3 and 10 ml conc. HCl and digest for 30 minutes. Boil to dryness until no HNO_3 odor remains. Cool and add 25 ml conc. HCl, filter and bring to 100 ml in volume with distilled H_2O. Standards were prepared by the appropriate dilution of the standard stock solution using 25% HCl. In addition, blanks were made and duplicate samples were run.

A Perkin Elmer Model 303 atomic absorption spectrophotometer with recorder output was used for all of the analyses. The spectrophotometer was equipped with a flat burner head with a 2" slot used for zinc and a nitrous oxide burner head was used for the molybdenum determination. A three slot burner was used for all the other elements.

The analytical results are in Table 1 Appendix.

STATISTICAL DISCUSSION

The following section reviews the general statistical treatment of the geochemical data and its application in the search for mineralization. Although the detail may seem extreme, it is recorded here so that subsequent similar studies by the Idaho Bureau of Mines and Geology may refer to the section as a model.

Table 1 lists the coordinates and concentrations of elements determined in sediment samples collected in the Bighorn Crags study area. The coordinates are in millimeters on a base map of 1" to the mile and were derived relative to an origin taken southwest of Cathedral Rock. The coordinates were later used to make location maps and isoplethic contour maps based on statistically treated data with the aid of the Cal-Comp plotter.

This statistical treatment provided an impartial identification of possible mineralized localities in the study area.

The complete set of data in Table 1 was used to determine the overall mean, variance, standard deviation, skewness and kurtosis of the distribution for each element in the study area. The mean is the center of gravity or central value for the element and is determined by:

$$\bar{X} = \Sigma \; X_i \int n$$

where χ is the mean, χ_i is an observation and n is the number of samples. The variance, S^2, is a measure of the spread of the data about its mean and is given by:

$$S^2 = \left[\Sigma \; (X_i - X)^2\right] \int (n-1)$$

The standard deviation, S, is the square root of the variance and gives the spread of the data in terms of the element units (in this case ppm). The skewness, A_3, gives an indication of the symmetry of the data for a given element about its mean:

$$A_3 = \left[\Sigma \; (X_i - \bar{X})^3\right] \int ns^3$$

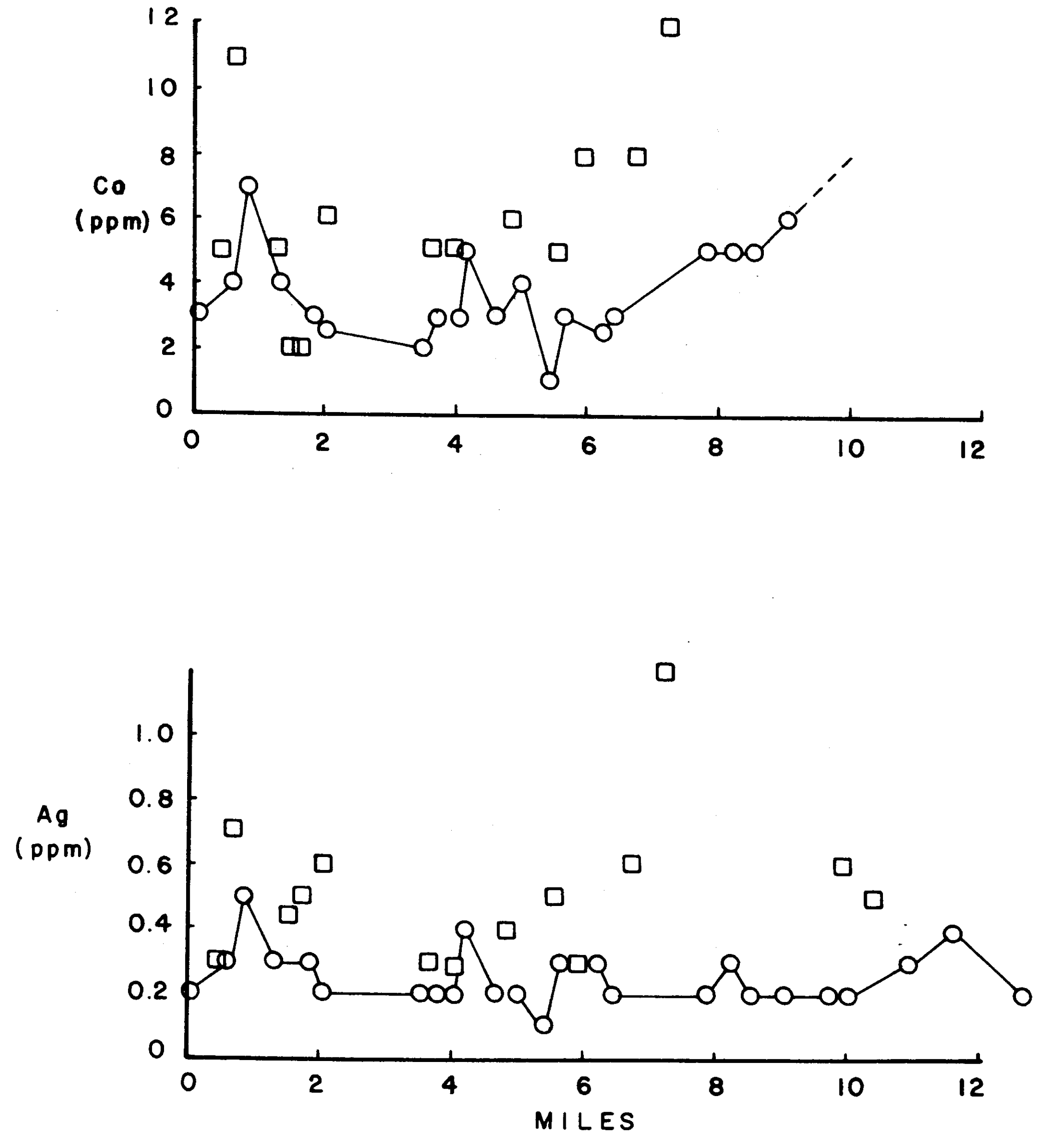
For a normal distribution, $A_3 = 0$ (that is mirror images on each side of the mean); for a distribution skewed to the right, $A_3 > 0$, and for a distribution skewed to the left $A_3 < 0$. The kurtosis, A_4, is a measure of the peakedness of the distribution:

$$A_4 = \left[\Sigma \; (X_i - \bar{X})^4\right] \int ns4$$

For the normal distribution, $A_4 = 3$ (or $A_4 - 3 = A'_4 = 0$). For a distribution which has a peak, $A'_4 > 0$, and for a flat distribution $a'_4 < 0$.

Geochemical data are usually skewed positively (Ahrens, 1953, 1954a, 1954b, 1957) and as a consequence require a log transformation to make the distribution normal. After a log transformationthere is still some skewness, and this is a good indication of the presence of two or morepopulations in the one data set,.. that is a lack of homogeneity of rock type or ion source in the area where the samples were collected (Lepeltier, 1969). This lack of homogeneity can be the result of localized mineralization. Tables 2a and 2b show the results of the determinations of the above statistics after a log transformation and with no transformation respectively. It may be noted that for all the elements there is a considerable decrease in skewness and kurtosis after the log transformation, and for the elements Ag, Au, Mo, Pb and Zn the reduction is such that their values are very nearly zero. The elements Cu and Co have a large skewness and kurtosis due to several samples which came from streams draining an area known to have cobalt contamination due to old mine workings.

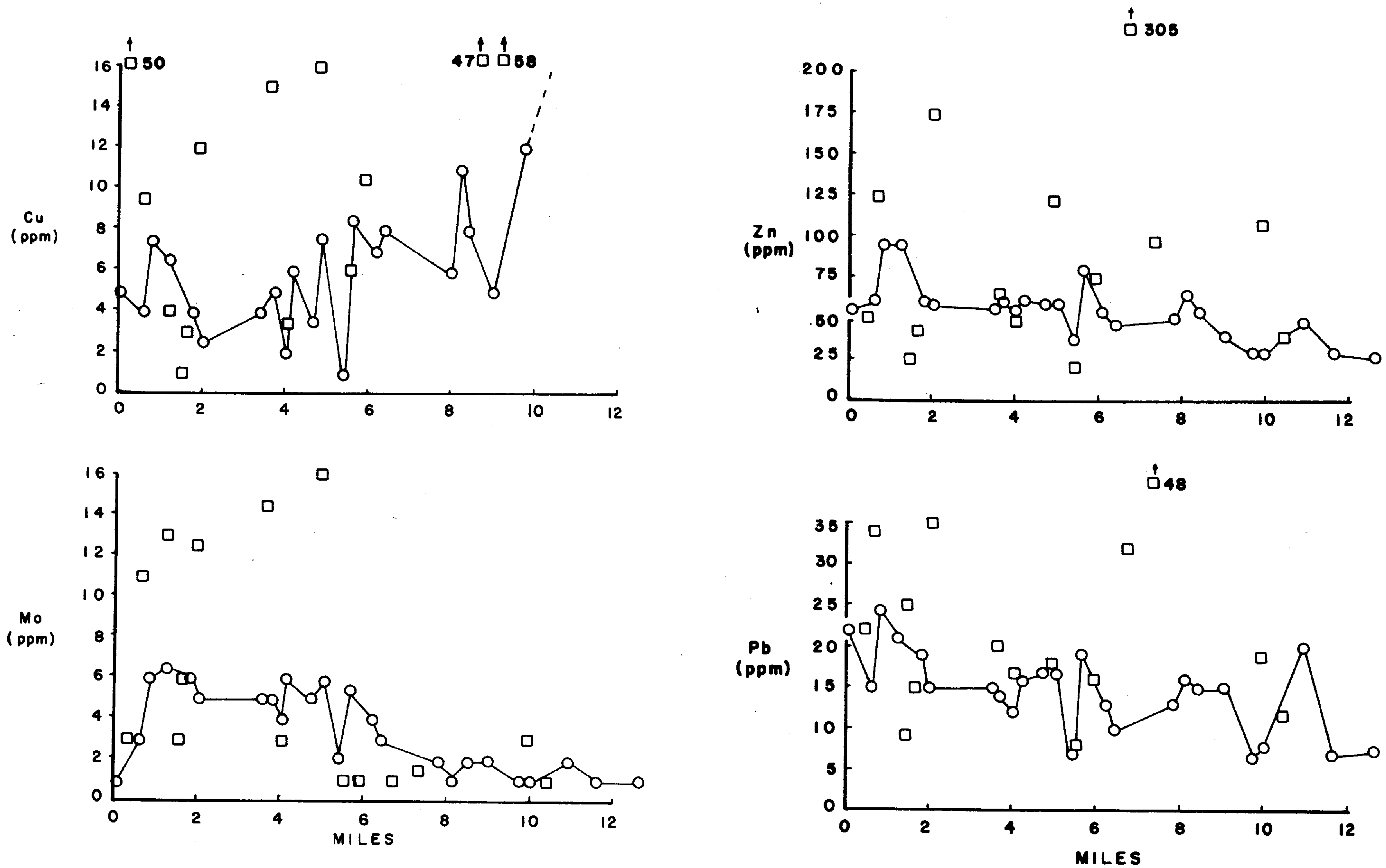
It might be possible to use threshold values for mineralization as determined from these data if the lithologies in the area have uniform trace-element concentrations. However, if the various lithologies have trace element concentrations which are substantially different it would be possible, using threshold values alone, to miss anomalies in the area with low trace-element content. In order to avoid this condition, samples were grouped according to lithology and the statistics were redetermined. There are three predominant lithologic units in the study area; quartz monzonite of the Crags pluton, quartzite and gneiss from precambrian. Within each of these groups very high analytical values known to be due to mining activity were removed in order to keep the threshold at a realistic value. Samples which came from main streams which drained an area greater than 5 square miles were not used because of the dilution effect from contributions upstream. It can be shown that main stream samples will reflect nearby units with high trace element content, but on the average the concentration is lower.



(a)

○ - main stream sediment samples
□ - tributary samples

Fig. 4 Relation between trace-element content of sediments from Big Deer Creek and its tributaries



(b) (c)

Fig. 4 Relation between trace-element content of sediments from Big Deer Creek and its tributaries

Figure 4 shows a comparison between the trace -element content of sediments from Big Deer Creek and those sediments which come from tributaries to this creek. In all cases the tributary samples are as high or much higher in trace-element content than a corresponding sample taken at its mouth in the main stream. Although samples were taken along the main stream, this study shows that because of the large dilution factor sampling of the main tributary is unnecessary and unsatisfactory for recognizing mineralized zones.

Table 3 lists nineteen samples taken from streams that drain areas of quartz monzonite (n=19) with their corresponding corrdinates and trace-element concentration. Table 4 is a similar list for areas where the rock is quartzite (n=26). There are too few samples from the gneissic unit to prepare a meaningful table. Tables 5a and 5b show the statistics for log transformed and nontransformed data respectively for samples derived predominantly from quartz monzonite. Tables 6a and 6b show those for samples representing quartzite. For log transformed data of quartz monzonite derived samples only Au shows positive skewness, but because the Au values are too high as the result of analytical factors noted previously no conclusions will be made based on this element. It should be noted for Mo, however, that even after log transformation there is still some kurtosis in the distribution. Knowing that the presence of ferfomagnesian minerals in the bedrock increases the background of trace-elements(and thereby setting a high threshold value which could obscure mineralization) it still may be inferred that if there were a second population of high Mo values due to mineralization and if the average value for the second population were near that of the (quartz monzonite) there would be more values near the center of the distribution than would otherwise be expected. Thus, a high kurtosis as observed above, may result.

For log transformed date for quartzite derived samples there is a signigicant skewness for the elements Co, Cu, Mo, and Pb indicating the presence of a population with high trace-element concentration not necessarily due to quartzite alone (Lepeltier, 1969). It is more likely that this area contains mineralization of some kind; these may be found by using the threshold value calculated from the mean plus two standard deviations. In the quartzite area the thresholds for Ag, Co, Cu, Mo, Pb, and Zn are: 0.8; 50; 90; 5.5; 30; and 110 ppm respectively. For the quartz monzonite area thresholds are: 1.4; 10; 40; 20; 45; and 240ppm. From this and the previous discussion of quartz monzonite, it is obvious that if threshold data for Ag in the quartz monzonite area were used over the entire region, possible ore deposit in quartzite could easily be overlooked. Based on threshold and kurtosis values, several areas that should be studied in depth are south of Garden Creek at the head of Rancherio Creek and Cathedral Lake to the N.W. The first area should have priority owing to the strong indication of the presence of mineralization in the quartzites by the skewed distributions of the trace-elements. It is expected that this area will have Cu and Co mineralization similar to that near the South Fork of Deer Creek. In the Cathedral Lake area it is expected that there is Mo mineralization because of the kurtosis of the distribution.

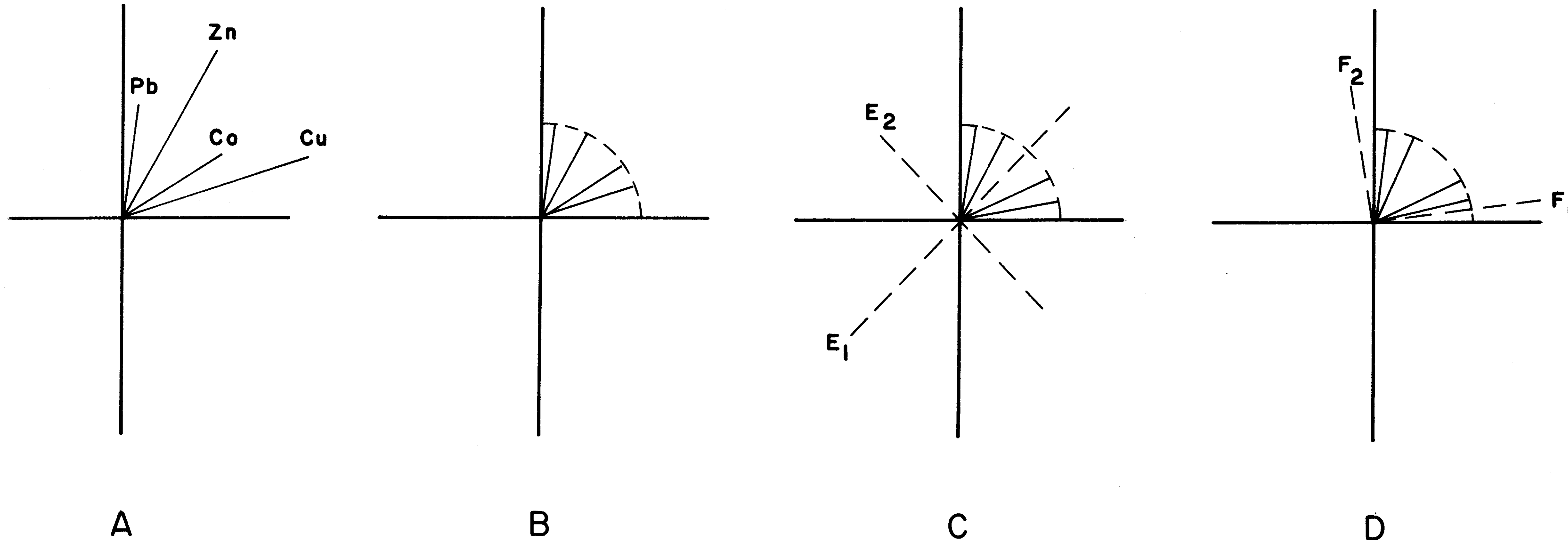


Fig. 5 Representation of Elements as Vectors

R-Mode Factor Analysis

Factor analysis is a procedure whereby information given by a large number of variables is condensed so that most of it can be obtained with fewer components or new variables. Consider the situation where two samples are analyzed for Co, Cu, Pb and Zn (Fig. 5). If sample 1 represents the X-axis and sample 2 the Y-axis as in Figure 5a, then the elements may be represented as vectors in space (here 2 dimensions because they are only 2 samples).

Mathematically it is possible to reduce the element vectors to unit legnth as in Fig. 5b. There are a number of ways in which the relationship of the element vectors might be compared. One is to find the cosine of the angle between each pair of element vectors to give a matrix of values. Another is to use a distance criterion, and still another is to use the correlation between every pair of elements. In every case a matrix of values is attained.

The next step is to find factors or new vectors which will explain the information available. The amount of information explained by each new vector must diminish from vector to vector until the remaining vector explains the least. In every case m-factors will explain all available information. A constraint on the vectors is that they must be orthogonal as in Fig. 5c. The new vectors are termed eigenvectors or characteristic vectors and the length of these vectors are eigenvalues.

The eigenvalue E_1 gives the largest amount of information with E_2 less than E_1. These new vectors E_1 and E_2 are usually not positioned on the graph in such a way that a geologically valid interpretation can be made of the results. If these vectors are rotated orthogonally so that the first vector has highloadings (i.e. one vector projected on another) from as few element vectors as possible and low loadings from the rest then the vectors F_1 and F_2 in Fig. 5 are obtained. This is carried out mathematically by means of a varimax rotation (Kaiser, 1959; Harman, 1960; and Imbrie, 1963). In Fig. 5 both Cu and Co have a high loading on Factor F_1, while Pb and Zn have weak loadings, whereas in the case of factor F_2, Pb and Zn have high loadings but Co and Cu do not. It is clear in this situation that Co and Cu are highly positive correlated to each other as are Pb and Zn, whereas Co or Cu are poorly correlated with Zn and Pb. In real situations a loading onto a factor could be negative while another element has a positive loading. This simply shows an inverse correlation between the two elements.

A better situation is if F_2 fell between Pb and Zn in which case F_1 and F_2 would no longer be orthogonal, i.e., they would have some correlation, but it might give a better geologic picture.

In this study an orthogonal rotation is made by the varimax procedure. This program used is M03 from the Biomedical center at UCLA. The program was modified to be compatible with the IBM 360/40 at the University of Idaho.

Tables 7 a, b, and c are correlation matrices for all the data for samples from quartz monzonite areas, and for samples from quartzite areas respectively. These were obtained after a log transformation of the original data. In the case of quartz monzonite the trace-elements have a high correlation with each other with Co and Cu showing a correlation of 0.84. These correlations are probably due to the association of the elements with the mafic minerals in the quartz monzonite. In the case of the quartzite, Cu and Co have the highest correlation.

Factor scores or factor measurements may be obtained for each sample. Like the concentration of an element in a sample it is possible to find a "concentration" of a factor in the sample where the factor is made up of various weights of the elements. Therefore, the greater the loading of an element vector on a factor, the greater the weight of that element. In the example cited, F_1 has high loadings of Cu and Co, therefore, the values or scores for F_1 will reflect the combined concentrations of Cu and Co (and to a lesser extent Zn and Pb) in that sample.

Table 8 is a listing of the factor scores for samples from streams draining quartzite.

Table 9 is the factor matrix which shows the loadings of each of the elements on their respective factor. These two factors explain a total of about 59 percent of the available information. Factor 1 is composed of mostly Pb, Ag, Zn and Mo and factor 2 of predominantly Co and Cu. Those areas with high positive factor 2 and low negative factor 1 are areas for further search for Co mineralization. This is indicated by the sample LD-2 which drains the Blackbird Mine area.

Figures 6 (a-f) are isoplethic maps which indicate the distribution of the trace-elements Ag, Co, Cu, Mo, Pb and Zn respectively. Slight adjustments have been made to the raw date shown in Table 9 in order to reduce the influence of contaminated material from the Blackbird Mine area. Hence, in the cases of Cu and Co the highest values used were 40 and 25 ppm respectively. This also facilitated the preparation of isoplethic maps by the computer because there were no upper and lower bounds for the isopleths used, (that is, if the highest value of Cu were 100 ppm and the isoplethic interval was 10 ppm then up to 10 isopleths would be drawn around that site thereby cluttering the map.

The isoplethic map of Co in Figure 6b may be presented in a form which is more amenable to interpretation. Figure 7 is a three dimensional view of the distribution of Co in the study area. The "ridge" of high tenor Co which begins near the Blackbird Mining area in the southeast clearly extends to the northwest within the quartzite. It is this northwest-southeast zone which deserves more detailed geochemical exploration for Cu-Co mineralization.

In general, it may be noted that the elements Ag, Co, Cu, Mo, Pb and Zn are high in the region of the quartz monzonite demonstrating the presence of ferromagnesian material in that area. Without this knowledge it might be assumed that there is probably mineralization of all types in this area. However, as has already been indicated, the statistics show that there is only a high probability that Mo is concentrated in the area. In the area of quartzite there are high tenors of Cu, Co, Pb and Zn which are related to possible ore deposits in that area.

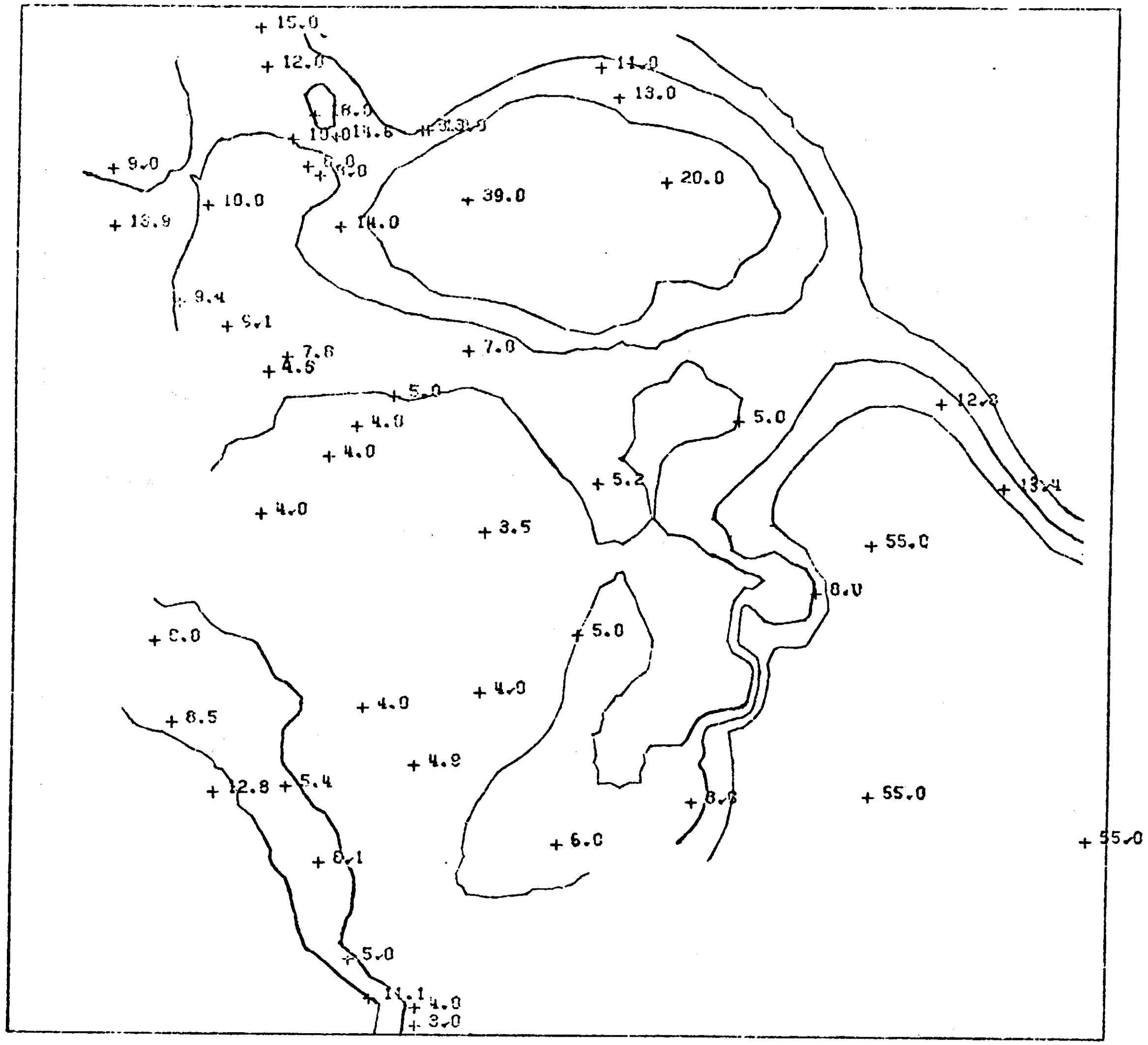


Fig. 6a Isopleths of Cobalt in stream sediments at Bighorn Crags

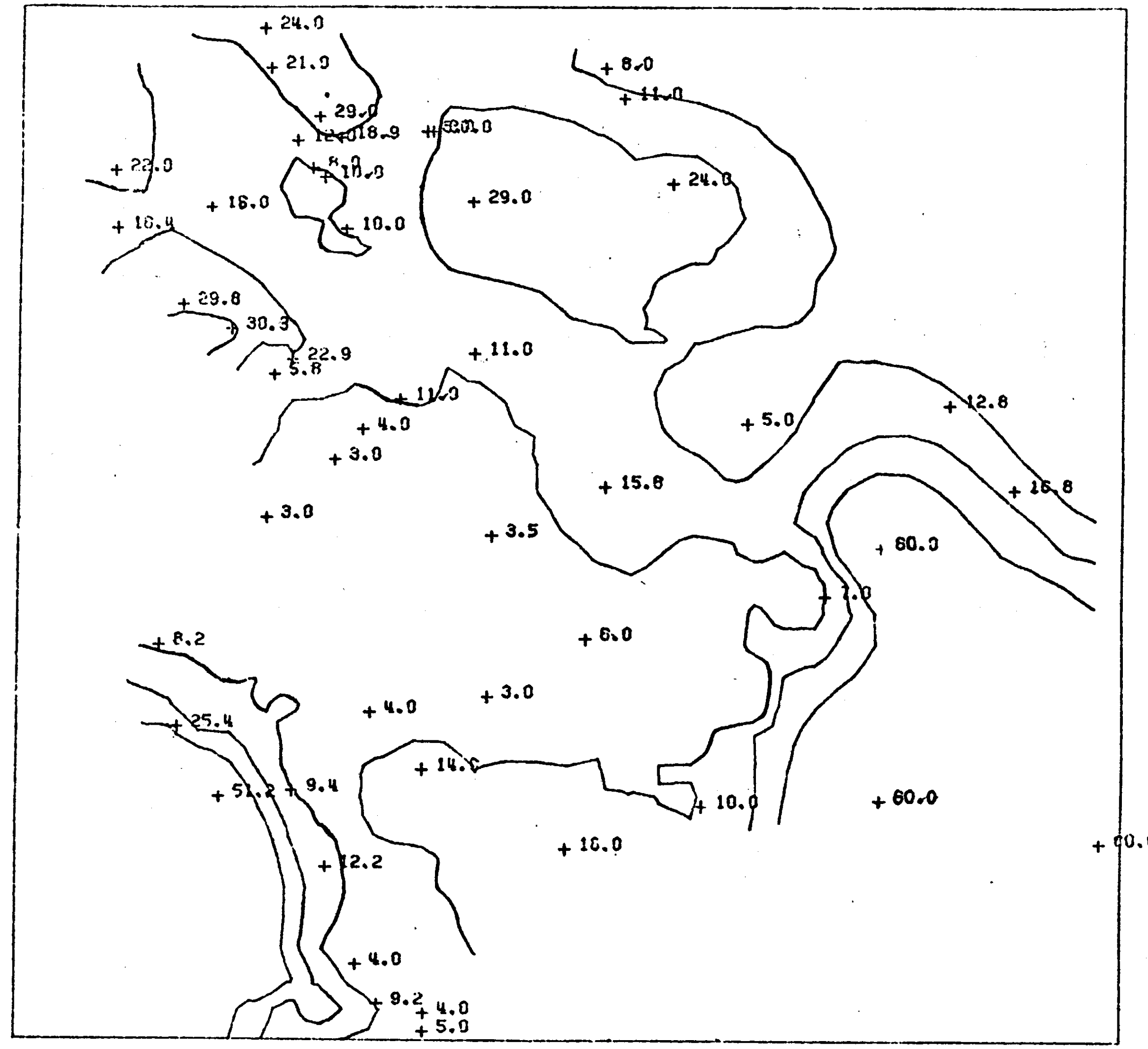


Fig. 6b Isopleths of Copper in stream sediments at Bighorn Crags

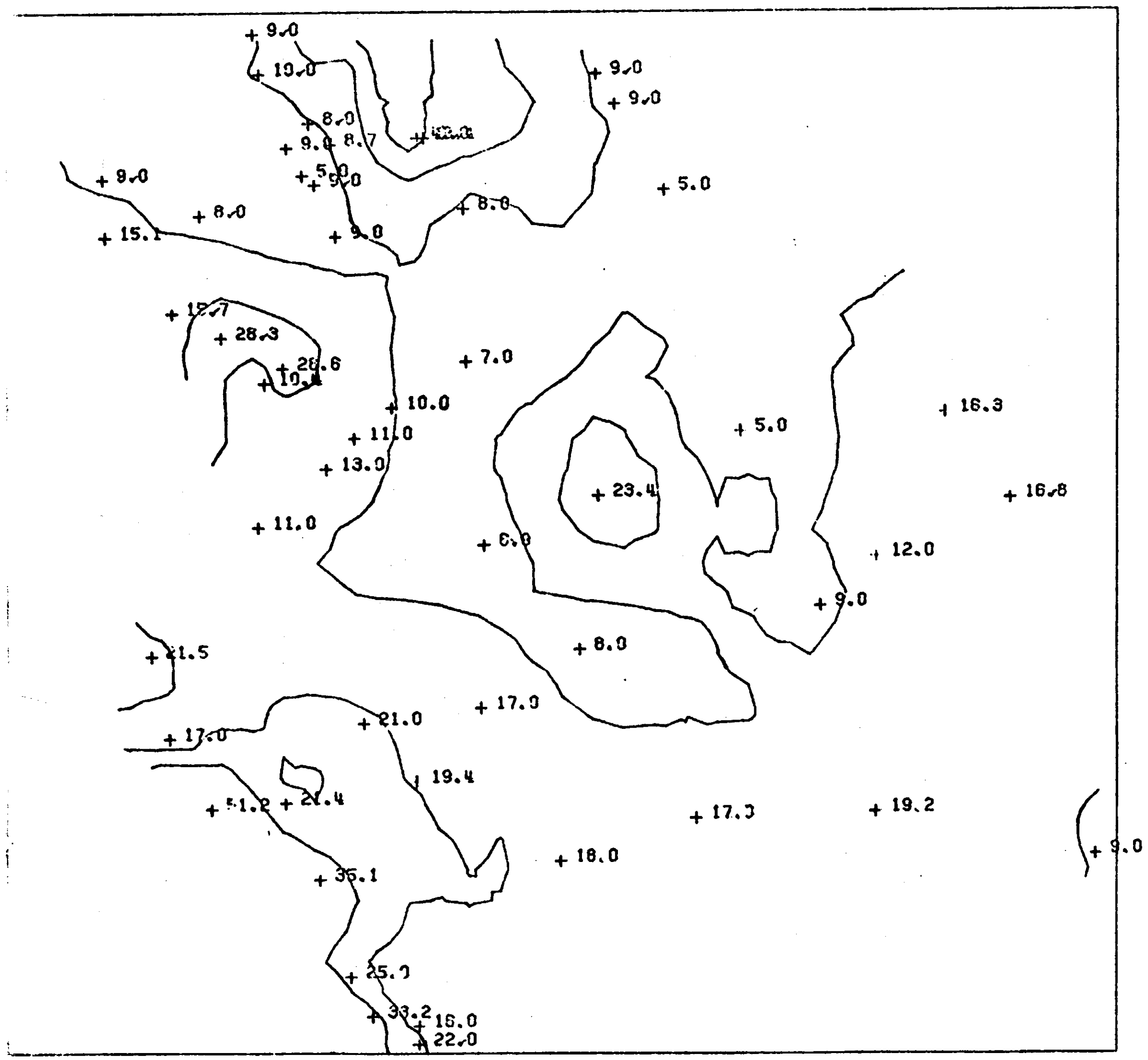


Fig. 6c Isopleths of Lead in stream sediments at Bighorn Crags

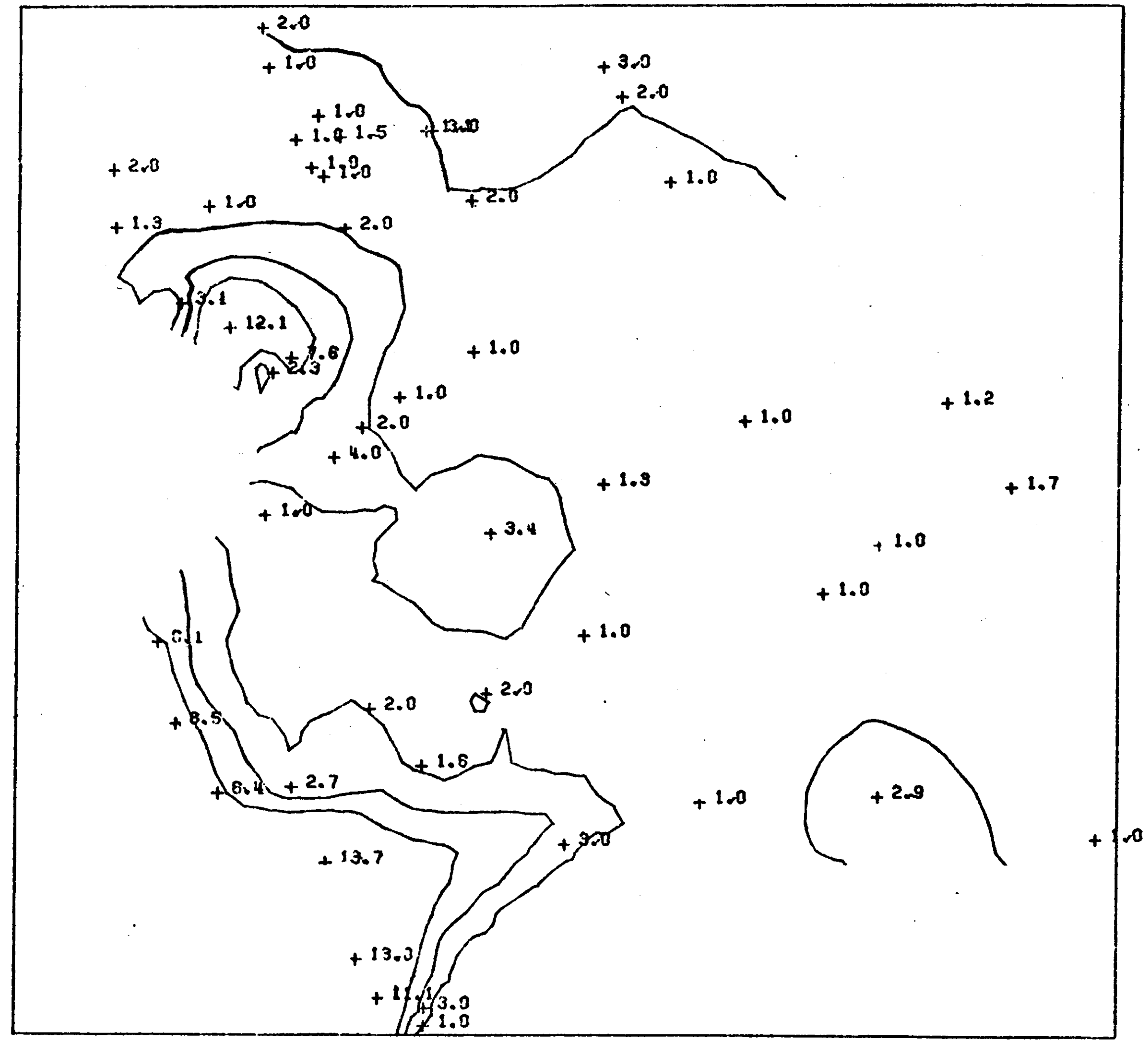


Fig. 6d Isopleths of Molybdenum in stream sediments at Bighorn Crags

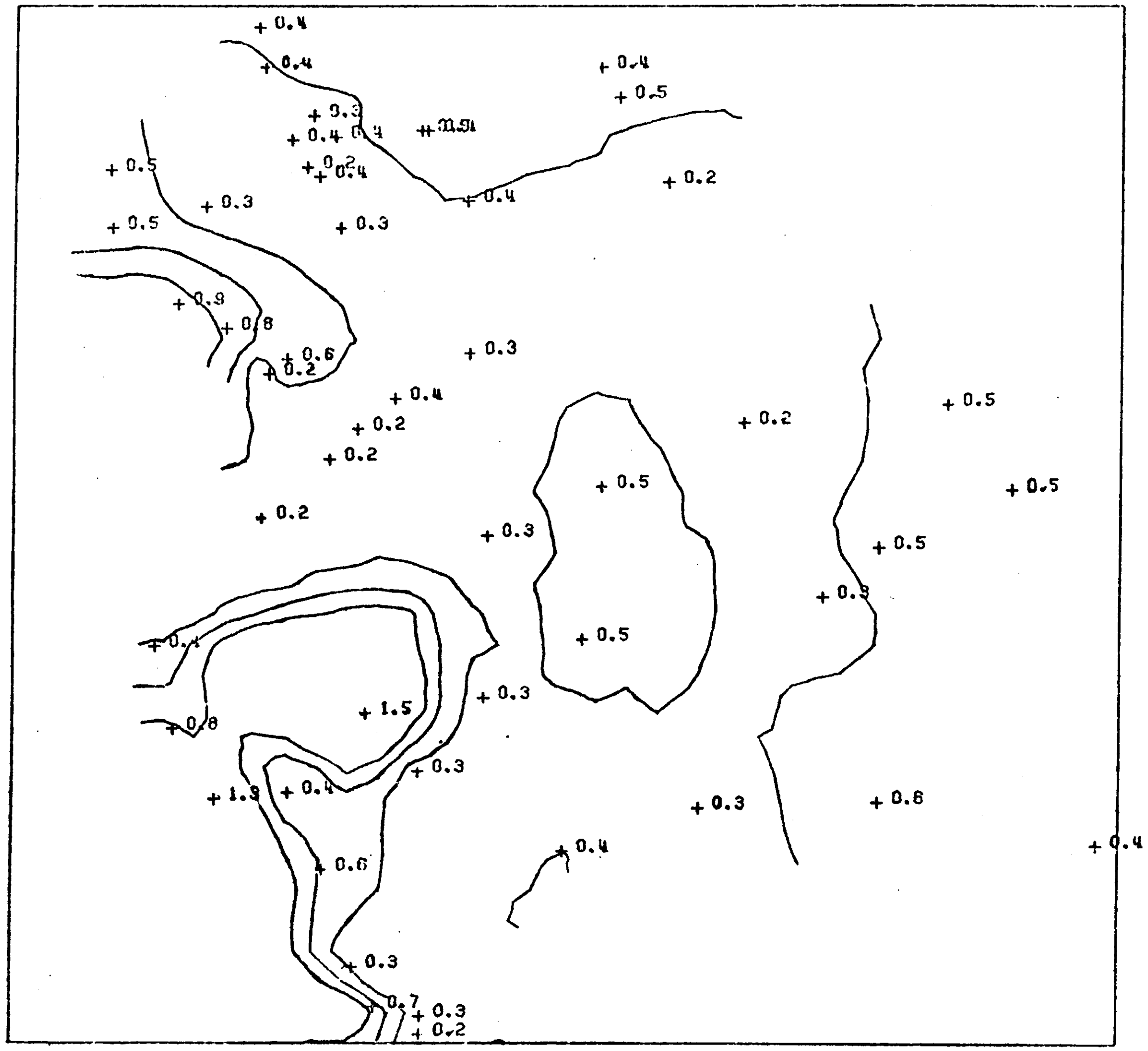


Fig. 6e Isopleths of Silver in stream sediments at Bighorn Crags

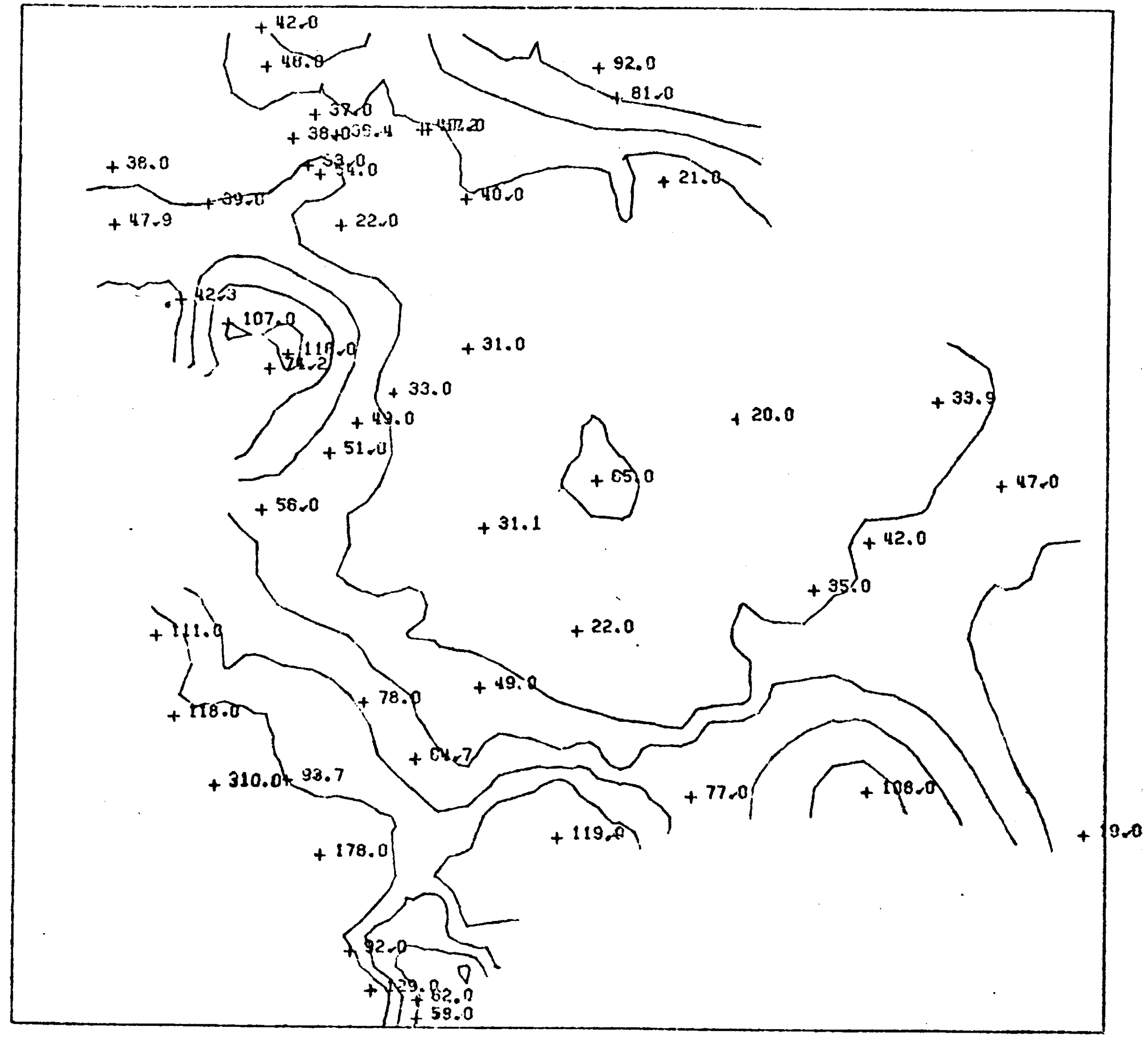


Fig 6f Isopleths of Zinc in stream sediments at Bighorn Crags

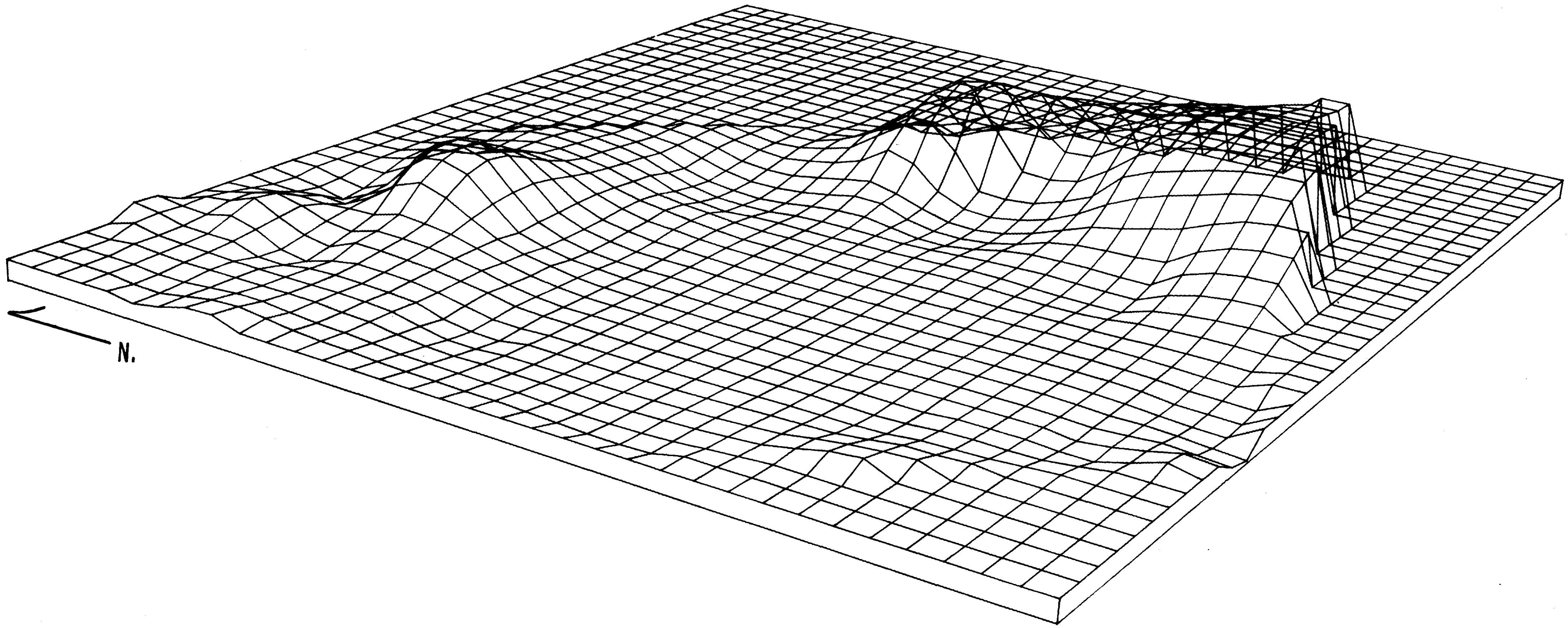


Fig. 7a Three dimensional view of the distribution of Cobalt in the Bighorn Crags study area.

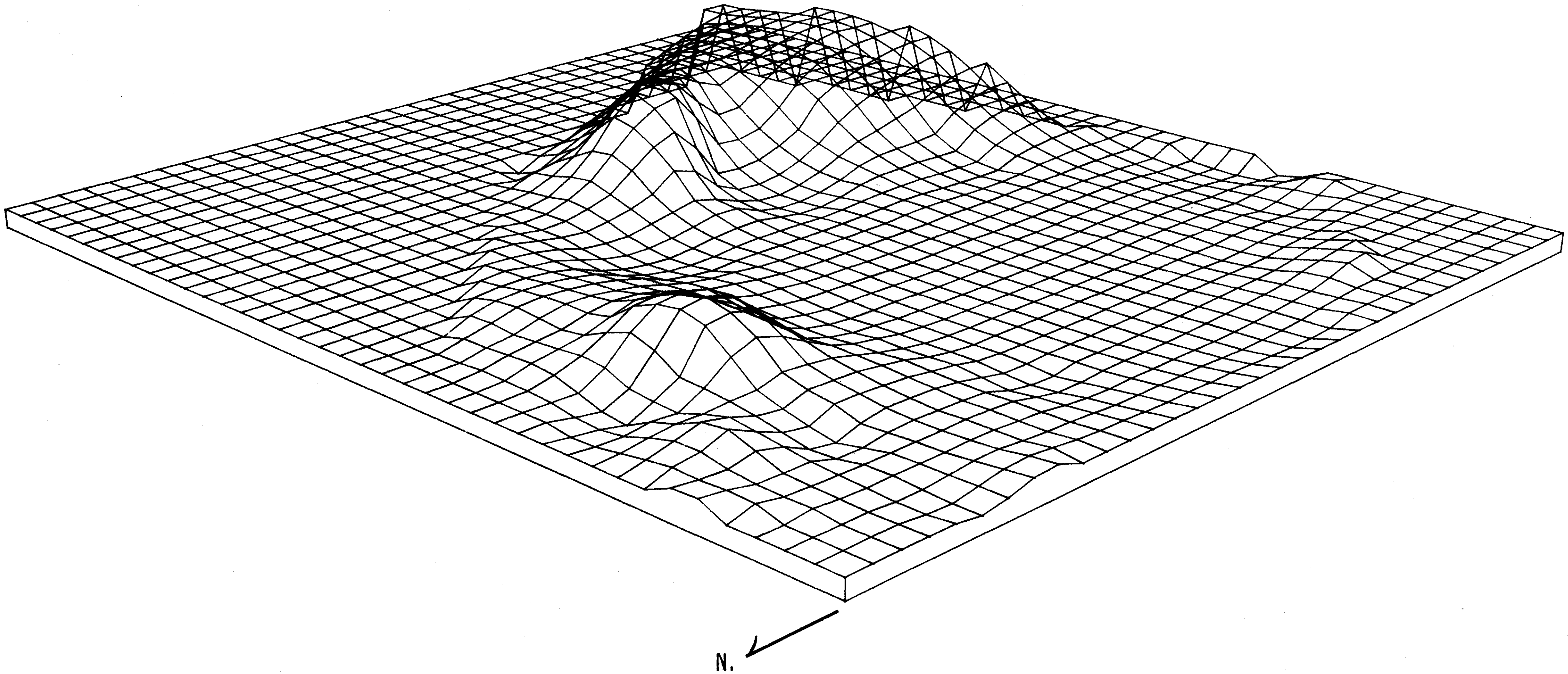


Fig. 7b Three dimensional view of the distribution of Cobalt in the Bighorn Crags study area.

Field Observations

In order to determine if certain secondary features affected the trace-element content at a given site, a number of observations were made in the field during sample collection. As described previously, these characteristics were water temperature, air temperature, topography presence of organic material, sand content, combined silt and clay content, stream width and depth, catchment area, linear drainage distance, pH, probable bedrock type (based on presence of outcrops and/or float), precipitates, contamination and location of the sample in the stream. Of these 15 characteristics, 10 were quantified. This enabled the application of statistical techniques to make comparisons, and define the various distributions with statistical moments. Table 10 is a list of the 10 characteristics, and Table 11 shows the statistics for each of them. On the average, the samples consisted of about three fourths sand and up to about one fifth fine material. The average pH appears to be slightly above normal, however, this value is affected by the large number of main stream samples collected downstream from the Blackbird Mine area which causes the water to have a pH near 8. The correlation matrix in Table 13 demonstrates the effect of catchment area on the trace-element content. For Ag, Au, Mo, Pb and Zn the larger the catchment area the lower the trace-element content. Also it appears that values of Ag, Mo and Pb are greater for samples from areas of higher topographic relief. This probably reflects their higher concentration in the quartz monzonite in the Crags and to the west of the area. For the most part, temperature does not significantly affect the trace-element content. As expected there is a positive correlation between organic content and clay and silt content demonstrating the presence of trace-elements in organic complexes, and hydrolozates. The width, depth, and linear drainage distance are all intimately related to the catchment area and so show a similar correlation with the trace-elements. This demonstrates cause and effect, that is the trace-element content is low because the catchment area is large (dilution) not because the stream width is large. The elements Au, Co, and Cu have higher trace-element content where the pH is higher and this is probably due to the presence of contamination in the area from the Blackbird Mine. However, Pb and Zn decrease in content as the pH increases.

The interrelationships of these variables may be better seen by applying R-mode factor analysis. Table 13 shows the loadings of the variables on six factors. As each factor is entered about 28, 43, 53, 63, 69, and 72 percent of the available information is explained. Factor 1 shows the interrelations between catchment area, total linear drainage distance, stream depth, stream width, temperature, and organic content. The loadings of the first five variables are negative whereas the loading of organic content is positive. Therefore, the organic content in streams with a large catchment area is usually smaller than in streams with a small catchment area. The variables which load highest on factor 2 are sand, silt and clay, and organic content. The signs indicate (or confirm) that as the sand content increases the silt and clay, and organic content decreases. Also, the organic content of sediments is high where the silt and clay content is high. The trace-elements have some weak loadings on this factor demonstrating that on the average there is some influence of organic content and silt and clay content on the amount of trace-element present. The elements most affected are Ag, Mo, and Co.

Factor 3 has high positive loadings of Pb and Zn and moderately high positive loadings of Ag and topographic relief. There may be some association of these three elements in the area, but there are no known Pb-Zn-Ag deposits nearby. Also, the association among these elements is mainly in regions of high relief, possibly in the area where quartz monzonite is prevalent or at the contact where some alteration has occurred.

Factor 4 has high positive loadings of Cu and Co and a weak, but possible significant positive loading of pH. This Cu-Co relationship is due to the association of these two elements in sulfides. Since the mineralization in the Blackbird Mine is cobaltite and chalcopyrite we assume the same mineral relationships exist elsewhere. The correlation between the elements and pH is probably only due to the mining activity in that area.

Factor 5 shows high loadings of Cu, temperature, and pH and again this is probably because of the influence of samples near the Blackbird mining district.

Factor 6 shows the relationship between the element Mo and topographic relief. It might be that Mo, too, is located in areas of high relief, which contains only quartz monzonite, but separately from areas where Pb, Zn and Ag are found associated. It does not necessarily mean that Mo is of economic significance in these areas because Mo could simply have a high tenor in quartz monzonite units.

CONCLUSIONS

Three regions in the study area deserve additional attention to evaluate their mineral potential. They are the Goat Lake region, Cathedral Lake area and Gant Ridge.

Silver anomalies exist near Cathedral Lake and in the area near Goat Lake and Horse Heaven. The highest anomaly found was near Cathedral Lake. Cobalt and copper have large anomalies near Horse Heaven and to a lesser extent along Gant Ridge near Indian Point.

Molybdenum, lead and zinc seem related to alteration at the contacts of the Crags pluton and would not likely be of any extent.

Although details were not obtained as to ore possibilities these several geochemical anomalies suggest that a more detailed soil sampling and mapping program would be the next step.

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A P P E N D I X

TABLE 1a COORDINATES AND TENORS OF TRACE ELEMENTS IN SEDIMENTS FROM STREAMS WITH ANY SIZE CATCHMENT AREA, BIGHORN CRAGS.

NUMBER	COORDINATE X	Y	AG	AU	CO	CU	MO	PB	ZN
BD-01	134	3	0.2	3.0	3.0	5.0	1.0	22.0	59.0
BD-02	139	14	0.3	2.0	5.0	50.0	3.0	22.0	52.0
BD-03	135	20	0.3	3.0	4.0	4.0	3.0	16.0	62.0
BD-04	133	21	0.7	7.4	11.1	9.2	11.1	33.2	129.0
BD-05	134	23	0.5	3.0	6.0	7.5	6.0	24.1	88.8
BD-06	130	31	0.3	4.0	5.0	4.0	13.0	25.0	92.0
BD-07	133	35	0.3	3.7	3.7	6.4	6.4	21.2	87.5
BD-08	138	40	0.4	2.0	2.0	1.0	3.0	9.0	24.0
BD-09	140	43	0.5	2.0	2.0	3.0	6.0	15.0	42.0
BD-10	137	49	0.6	3.0	6.1	12.2	13.7	35.1	178.0
BD-11	139	47	0.3	3.0	3.0	4.0	6.0	19.0	65.0
BD-12	141	51	0.2	2.5	2.5	2.5	4.9	14.8	62.7
BD-13	156	88	0.3	3.2	4.9	14.6	1.6	19.4	64.7
BD-14	158	85	0.2	3.0	2.0	4.0	5.0	15.0	55.0
BD-15	160	89	0.2	2.9	2.9	4.9	4.9	13.8	60.0
BD-16	166	97	0.3	3.0	4.0	3.0	2.0	17.0	49.0
BD-17	167	94	0.2	3.0	3.0	2.0	4.0	12.0	54.0
BD-18	170	97	0.4	4.0	4.0	6.0	6.0	15.9	61.6
BD-19	189	101	0.2	2.5	2.5	3.7	4.9	17.2	59.0
BD-20	191	99	0.4	3.0	6.0	16.0	3.0	18.0	119.0
BD-21	194	104	0.2	3.8	3.8	7.6	5.7	17.2	59.1
BD-22	204	108	0.1	2.2	1.1	1.1	2.2	6.7	36.9
BD-23	205	110	0.5	2.0	5.0	6.0	1.0	8.0	22.0
BD-24	209	109	0.3	2.8	2.8	8.4	5.6	19.6	78.4
BD-25	223	113	0.3	4.0	8.0	10.0	1.0	17.0	77.0
BD-26	219	113	0.3	2.7	2.7	6.8	4.1	13.5	59.6
BD-27	223	117	0.2	3.0	3.0	8.0	3.0	10.0	46.0
BD-28	228	121	0.6	4.0	8.0	47.0	1.0	32.0	305.0
BD-29	231	123	1.1	4.1	12.4	58.0	1.4	48.3	96.7
BD-30	249	131	0.2	2.0	5.0	6.0	2.0	12.0	50.0
BD-31	259	133	0.3	3.0	5.0	11.0	1.0	16.0	65.0
BD-32	269	132	0.2	2.0	5.0	8.0	2.0	15.0	55.0
BD-33	280	126	0.2	2.0	5.0	5.0	2.0	15.0	46.0
BD-34	292	116	0.2	3.0	6.0	12.0	1.0	7.0	30.0
BD-35	295	112	0.6	4.4	710.0	******	2.9	19.2	108.0
BD-36	299	117	0.2	3.0	28.0	430.0	1.0	8.0	31.0
BD-37	294	119	0.5	7.0	186.0	390.0	1.0	12.0	42.0
BD-38	320	120	0.3	4.0	107.0	2500.0	2.0	20.0	50.0
BD-39	339	120	0.4	3.2	67.0	1520.0	1.0	7.0	30.0
BD-40	361	129	0.2	2.0	76.0	1550.0	1.0	8.0	29.0
CC-02	80	89	1.3	12.8	12.8	51.2	6.4	51.2	310.0
CC-03	85	90	1.7	3.2	9.6	18.1	4.3	30.9	57.5
CC-04	97	106	0.7	13.3	6.6	6.6	6.6	26.6	166.0
CC-05	93	98	0.4	5.4	5.4	9.4	2.7	21.4	93.7
CC-06	98	115	0.3	5.1	5.1	6.9	3.4	15.4	120.0
CC-07	102	115	1.5	4.0	4.0	4.0	2.0	21.0	78.0
CC-08	95	120	0.7	6.7	11.8	18.5	67.3	18.5	53.8
CC-09	79	121	0.8	17.0	8.5	25.4	8.5	17.0	118.0
CC-10	76	123	0.4	4.0	6.0	8.2	6.1	21.5	111.0
CC-11	100	125	0.4	4.3	4.3	7.4	17.0	13.5	30.9

NUMBER 1b	COORDINATE X	Y	AG	AU	CO	CU	MO	PB	ZN
CC-12	104	130	0.5	5.3	5.3	8.0	5.3	16.0	42.5
CC-13	107	140	0.3	2.7	2.7	5.5	8.2	10.9	39.6
CC-14	111	141	0.3	5.2	3.4	3.4	3.4	12.1	65.5
CC-15	116	156	0.2	3.0	4.0	3.0	1.0	11.0	56.0
CC-16	119	152	0.3	4.1	5.4	4.1	6.8	15.0	81.6
CC-17	118	160	0.2	3.9	5.9	3.9	3.9	15.8	71.0
CC-18	125	183	0.2	3.0	4.0	3.0	4.0	13.0	51.0
CC-19	121	158	0.4	3.3	4.4	7.8	11.1	15.5	58.7
CC-20	126	179	0.2	3.5	3.5	1.2	4.7	14.0	56.1
CC-21	129	184	0.2	2.1	4.2	3.2	3.2	10.6	65.5
CC-22	127	191	0.5	6.1	7.6	7.6	9.1	18.3	80.7
CC-23	130	192	0.2	3.0	4.0	4.0	2.0	11.0	49.0
CC-24	131	189	0.3	4.1	4.1	2.7	4.1	12.3	63.1
CC-25	134	190	0.3	3.9	3.9	3.4	5.2	15.5	78.8
CC-26	142	191	0.3	6.1	6.1	6.1	3.0	15.2	67.0
CC-27	147	198	0.4	2.0	5.0	11.0	1.0	10.0	33.0
CC-28	148	195	0.3	3.9	3.9	2.6	3.9	11.7	48.0
CC-29	153	196	0.2	4.0	4.2	6.3	2.1	12.5	66.7
CC-31	170	204	0.3	3.5	4.4	5.3	3.5	15.9	63.5
CC-30	166	199	0.3	6.9	3.5	3.5	3.4	6.9	31.1
CC-32	165	206	0.3	3.0	7.0	11.0	1.0	7.0	31.0
CC-33	164	202	0.3	4.0	5.0	5.0	3.0	13.0	57.0
CC-34	179	215	0.2	3.0	5.0	5.0	3.0	10.0	44.0
CC-35	183	214	0.5	2.6	5.2	15.6	1.3	23.4	65.0
CC-36	186	221	0.2	3.0	6.0	5.0	2.0	13.0	59.0
CC-37	195	223	0.3	4.0	6.0	9.0	2.0	11.0	47.0
CC-38	205	227	0.2	3.0	5.0	6.0	2.0	10.0	40.0
CC-39	212	228	0.2	3.0	5.0	5.0	1.0	5.0	20.0
CC-40	214	234	0.2	3.0	5.0	6.0	2.0	10.0	42.0
CC-41	236	271	0.2	4.0	20.0	24.0	1.0	5.0	21.0
CC-42	235	267	0.2	3.0	17.0	20.0	2.0	5.0	20.0
CC-43	239	270	0.1	2.1	1.0	1.0	1.0	2.1	6.2
CC-44	243	272	0.8	3.9	7.8	9.7	1.9	7.8	35.0
CC-45	258	283	0.2	2.0	7.0	7.0	1.0	6.0	35.0
CC-46	273	276	0.3	5.0	8.0	7.0	1.0	9.0	35.0
CC-47	278	279	0.3	4.0	9.0	8.0	2.0	7.0	37.0
CC-48	272	279	0.2	3.0	9.0	8.0	2.0	6.0	43.0
CC-49	285	294	0.2	4.0	8.0	8.0	2.0	6.0	44.0
CC-50	299	317	0.2	4.0	8.0	5.0	3.0	8.0	37.0
CC-51	316	335	0.3	7.0	7.0	6.0	2.0	10.0	43.0
GT-01	89	228	0.2	2.3	4.6	5.8	2.3	10.4	74.2
GT-02	89	236	0.6	5.7	7.6	22.9	7.6	28.6	116.0
GT-03	80	245	0.8	5.1	9.1	30.3	12.1	28.3	107.0
GT-04	84	243	0.6	3.1	7.8	21.8	3.1	21.8	85.6
GT-05	81	250	0.7	4.7	9.4	27.0	7.0	25.8	108.0
GT-06	62	252	0.8	5.5	11.0	28.6	4.4	27.5	89.2
GT-07	57	258	0.9	4.7	9.4	29.8	3.1	15.7	42.3
GT-08	56	262	0.6	5.1	11.6	24.4	3.9	18.0	64.3
GT-09	51	265	0.3	5.0	10.0	16.0	1.0	8.0	39.0
GT-10	48	266	0.4	4.0	9.3	17.2	2.6	13.2	58.2
GT-11	36	281	0.4	3.1	8.2	15.4	2.1	9.3	45.2

NUMBER 1c	COORDINATE X	Y	AG	AU	CO	CU	MO	PB	ZN
GT-12	36	289	0.5	4.0	9.0	22.0	2.0	9.0	38.0
GT-13	36	296	0.4	3.0	8.0	13.0	2.0	9.0	43.0
GT-14	34	303	0.4	4.0	8.0	16.1	2.7	14.7	52.2
GT-15	27	307	0.3	3.0	9.0	17.0	1.0	5.0	36.0
GT-17	12	317	0.3	3.0	7.0	13.0	1.0	7.0	41.0
GT-18	4	326	0.2	3.0	7.4	11.1	1.2	7.4	46.8
LC-01	100	300	0.4	5.0	10.0	12.0	1.0	9.0	38.0
LC-02	104	296	0.2	3.0	6.0	8.0	1.0	5.0	33.0
LC-03	102	292	0.4	3.0	8.0	10.0	1.0	9.0	54.0
LC-04	116	292	0.3	3.0	14.0	10.0	2.0	9.0	22.0
LC-05	120	299	0.5	2.3	6.9	8.0	1.1	49.4	40.2
LC-06	123	299	0.4	7.0	13.0	30.0	3.0	9.0	37.0
LC-07	116	300	0.3	5.0	37.0	43.0	1.0	7.0	26.0
LC-08	116	303	0.3	5.0	14.0	26.0	1.0	8.0	32.0
LC-09	115	304	0.4	5.8	14.6	18.9	1.5	8.7	36.4
LC-10	117	306	0.4	3.7	14.7	17.2	1.2	8.6	30.7
LC-11	117	311	0.3	4.0	14.0	19.0	1.0	7.0	31.0
LC-12	116	314	0.3	4.0	14.0	15.0	1.0	9.0	28.0
LC-13	115	316	0.3	4.0	12.0	43.0	1.0	7.0	35.0
LC-14	113	312	0.3	6.0	18.0	29.0	1.0	8.0	37.0
LC-15	119	331	0.3	5.0	16.0	20.0	1.0	7.0	35.0
LC-16	119	341	0.3	5.0	11.0	16.0	1.0	6.0	37.0
LC-17	118	354	0.3	5.0	12.0	17.0	2.0	7.0	37.0
GC-01	175	321	0.4	5.0	39.0	29.0	2.0	8.0	40.0
GC-02	182	326	0.4	5.0	37.0	28.0	2.0	8.0	40.0
GC-03	185	326	0.3	4.0	22.0	17.0	2.0	9.0	39.0
GC-04	187	329	0.3	4.0	22.0	17.0	2.0	8.0	35.0
GC-05	187	325	0.3	4.0	16.0	12.0	1.0	6.0	28.0
GC-06	190	326	0.4	6.0	11.0	8.0	3.0	9.0	92.0
GC-07	192	323	0.5	10.0	13.0	11.0	2.0	9.0	81.0
GC-08	190	322	0.4	6.0	11.0	7.0	3.0	8.0	91.0
GC-09	191	329	0.4	6.0	19.0	13.0	2.0	10.0	62.0
GC-10	194	331	0.3	6.0	18.0	10.0	2.0	8.0	45.0
GC-11	200	332	0.3	5.5	17.7	13.3	1.1	7.8	43.2
GC-12	208	333	0.3	5.0	10.0	8.0	1.0	8.0	31.0
GC-13	209	343	0.3	4.0	9.0	7.0	1.0	8.0	33.0
GC-14	233	368	0.3	4.0	6.0	5.0	1.0	6.0	17.0
GC-15	249	372	0.2	4.0	9.0	4.0	1.0	7.0	20.0
LD-01	385	109	0.6	8.0	187.0	490.0	1.0	10.0	20.0
LD-02	379	88	0.4	7.0	163.0	370.0	1.0	9.0	19.0
LD-03	386	88	0.4	7.0	50.0	59.0	1.0	10.0	23.0
S-01	82	336	0.4	4.0	12.0	21.0	1.0	10.0	48.0
S-02	81	355	0.4	5.0	15.0	24.0	2.0	9.0	42.0
A-01	351	193	0.5	5.0	13.4	16.8	1.7	16.8	47.0
B-01	354	273	0.5	7.6	13.9	16.4	1.3	15.1	47.9
G-01	350	209	0.5	7.0	12.8	12.8	1.2	16.3	33.9

TABLE 2a STATISTICS FOR LOG TENCRS OF TRACE ELEMENTS IN SEDIMENTS FROM STREAMS WITH ANY SIZE CATCHMENT AREA, BIGHORN CRAGS.

OF SAMPLES = 147

VARIABLE	MEAN	STANDARD DEV.	VARIANCE	SKEWNESS	KURTOSIS
AG	-0.4727	0.2056	0.0423	0.66	1.01
AU	0.5924	0.1718	0.0295	0.66	1.02
CO	0.9146	0.4108	0.1687	1.53	4.28
CU	1.0795	0.6018	0.3622	2.07	6.52
MO	0.3707	0.3400	0.1156	0.91	1.12
PB	1.0761	0.2264	0.0513	0.28	0.34
ZN	1.6946	0.2333	0.0544	0.24	1.92

MEAN	THRESHOLD
0.3368	0.8680
3.9124	8.6313
8.2149	54.4716
12.0081	191.8906
2.3480	11.2358
11.9158	33.7999
49.5009	144.9350

TABLE 2b STATISTICS FOR TRACE ELEMENTS IN SEDIMENTS FROM STREAMS WITH ANY SIZE CATCHMENT AREA, BIGHORN CRAGS.

OF SAMPLES = 147

VARIABLE	MEAN	STANDARD DEV.	VARIANCE	SKEWNESS	KURTOSIS
AG	0.3816	0.2329	0.0542	2.80	10.57
AU	4.2626	2.0871	4.3559	2.76	11.63
CO	18.7245	63.5242	4035.3254	9.12	93.27
CU	147.7775	1076.8105	*********	10.82	122.00
MO	3.5170	5.9841	35.8095	8.42	85.17
PB	13.7354	8.2908	68.7366	2.04	5.55
ZN	57.8422	40.6347	1651.1780	3.54	17.66

TABLE 3 COORDINATES AND TENORS OF TRACE ELEMENTS IN SEDIMENTS DRAINING QUARTZ MONZONITES, BIGHORN CRAGS.

NUMBER	COORDINATE X	COORDINATE Y	AG	AU	CO	CU	MO	PB	ZN
BD-01	134	3	0.2	3.0	3.0	5.0	1.0	22.0	59.0
BD-03	135	20	0.3	3.0	4.0	4.0	3.0	16.0	62.0
BD-04	133	21	0.7	7.4	11.1	9.2	11.1	33.2	129.0
BD-06	130	31	0.3	4.0	5.0	4.0	13.0	25.0	92.0
BD-10	137	49	0.6	3.0	6.1	12.2	13.7	35.1	178.0
BD-13	156	88	0.3	3.2	4.9	14.6	1.6	19.4	64.7
BD-16	166	97	0.3	3.0	4.0	3.0	2.0	17.0	49.0
BD-20	191	99	0.4	3.0	6.0	16.0	3.0	18.0	119.0
CC-02	80	89	1.3	12.8	12.8	51.2	6.4	51.2	310.0
CC-05	93	98	0.4	5.4	5.4	9.4	2.7	21.4	93.7
CC-07	102	115	1.5	4.0	4.0	4.0	2.0	21.0	78.0
CC-09	79	121	0.8	17.0	8.5	25.4	8.5	17.0	118.0
CC-10	76	123	0.4	4.0	6.0	8.2	6.1	21.5	111.0
CC-15	116	156	0.2	3.0	4.0	3.0	1.0	11.0	56.0
CC-19	125	183	0.2	3.0	4.0	3.0	4.0	13.0	51.0
CC-23	130	192	0.2	3.0	4.0	4.0	2.0	11.0	49.0
CC-27	147	198	0.4	2.0	5.0	11.0	1.0	10.0	33.0
GT-01	89	229	0.2	2.3	4.6	5.8	2.3	10.4	74.2
GT-02	89	236	0.6	5.7	7.6	22.9	7.6	28.6	116.0

TABLE 4 COORDINATES AND TENORS OF TRACE ELEMENTS IN SEDIMENTS DRAINING QUARTZITES, BIGHORN CRAGS.

NUMBER	COORDINATE X	COORDINATE Y	AG	AU	CO	CU	MO	PB	ZN
BD-23	205	110	0.5	2.0	5.0	6.0	1.0	8.0	22.0
BD-25	223	113	0.3	4.0	8.0	10.0	1.0	17.0	77.0
CC-30	166	199	0.3	6.9	3.5	3.5	3.4	6.9	31.1
CC-32	165	206	0.3	3.0	7.0	11.0	1.0	7.0	31.0
CC-35	183	214	0.5	2.6	5.2	15.6	1.3	23.4	65.0
CC-39	212	228	0.2	3.0	5.0	5.0	1.0	5.0	20.0
CC-41	236	271	0.2	4.0	20.0	24.0	1.0	5.0	21.0
CC-46	273	276	0.3	5.0	8.0	7.0	1.0	9.0	35.0
GT-03	80	245	0.8	5.1	9.1	30.3	12.1	28.3	107.0
GT-07	57	258	0.9	4.7	9.4	29.8	3.1	15.7	42.3
GT-12	36	289	0.5	4.0	9.0	22.0	2.0	9.0	38.0
LC-01	100	300	0.4	5.0	10.0	12.0	1.0	9.0	38.0
LC-02	104	296	0.2	3.0	6.0	8.0	1.0	5.0	33.0
LC-03	102	292	0.4	3.0	8.0	10.0	1.0	9.0	54.0
LC-04	116	292	0.3	3.0	14.0	10.0	2.0	9.0	22.0
LC-05	120	293	0.5	2.3	6.9	8.0	1.1	49.4	40.2
LC-06	123	299	0.4	7.0	13.0	30.0	3.0	9.0	37.0
LC-09	115	304	0.4	5.8	14.6	18.9	1.5	8.7	36.4
LC-14	113	312	0.3	6.0	18.0	29.0	1.0	8.0	37.0
GC-01	175	321	0.4	5.0	39.0	29.0	2.0	8.0	40.0
GC-06	190	326	0.4	6.0	11.0	8.0	3.0	9.0	92.0
GC-07	192	323	0.5	10.0	13.0	11.0	2.0	9.0	81.0
GC-09	190	322	0.4	6.0	11.0	7.0	3.0	8.0	91.0
S-01	82	336	0.4	4.0	12.0	21.0	1.0	10.0	48.0
S-02	81	355	0.4	5.0	15.0	24.0	2.0	9.0	42.0
LD-02	379	88	0.4	7.0	163.0	370.0	1.0	9.0	19.0

TABLE 5a STATISTICS FOR LOG TENORS OF TRACE ELEMENTS IN SEDIMENTS DRAINING QUARTZ MONZONITES, BIGHORN CRAGS.

OF SAMPLES = 19

VARIABLE	MEAN	STANDARD DEV.	VARIANCE	SKEWNESS	KURTOSIS
AG	-0.3991	0.2707	0.0733	0.63	-0.71
AU	0.6045	0.2409	0.0580	1.27	0.71
CO	0.7304	0.1637	0.0268	0.81	-0.22
CU	0.9012	0.3573	0.1277	0.53	-0.80
MO	0.5344	0.3766	0.1419	0.14	-1.36
PB	1.2831	0.1928	0.0372	0.30	-0.68
ZN	1.9230	0.2304	0.0531	0.53	-0.10

MEAN	THRESHOLD
0.3989	1.3874
4.0229	12.1994
5.3750	11.4208
7.9653	41.2945
3.4232	19.3957
19.1922	46.6312
83.7469	241.9494

TABLE 5b STATISTICS FOR TRACE ELEMENTS IN SEDIMENTS DRAINING QUARTZ MONZONITES, BIGHORN CRAGS.

OF SAMPLES = 19

VARIABLE	MEAN	STANDARD DEV.	VARIANCE	SKEWNESS	KURTOSIS
AG	0.4895	0.3680	0.1354	1.54	1.39
AU	4.8316	3.8387	14.7356	2.08	3.35
CO	5.7895	2.5686	6.5976	1.43	1.11
CU	11.3632	11.7061	137.0323	2.09	4.30
MO	4.8421	4.1281	17.0414	0.93	-0.57
PB	21.1474	10.2750	105.5758	1.29	1.41
ZN	96.9789	63.0546	3975.8857	1.99	4.14

Table 6a: Statistics for log transformed data of elements in stream sediments from Quartzite at Bighorn Crags.

n=26

Statistic	Element						
	Ag	Au	Co	Cu	Mo	Pb	Zn
Mean	-0.4178	0.6413	1.0366	1.1693	0.2067	0.9929	1.6123
Std. Dev.	0.1571	0.1705	0.3260	0.3941	0.2659	0.2277	0.2126
Variance	0.0247	0.0291	0.1063	0.1553	0.0707	0.0518	0.0452
Skewness	0.20	-0.11	1.84	1.57	1.48	1.48	0.33
Kurtosis	0.43	-0.60	4.80	4.14	2.38	2.17	-0.65
Mean(ppm)	0.38	4.38	10.88	14.77	1.61	9.84	40.95
Threshold	0.79	9.60	48.82	90.68	5.48	28.07	109.02

Table 6b: Statistics for trace elements in sediments draining quartzites, Bighorn Crags.

OF SAMPLES = 26

VARIABLE	MEAN	STANDARD DEV.	VARIANCE	SKEWNESS	KURTOSIS
AG	0.4077	0.1598	0.0255	1.41	2.26
AU	4.7077	1.8350	3.3671	0.76	0.47
CO	17.0654	30.5721	934.6514	4.18	16.99
CU	29.2346	70.0838	4911.7461	4.41	18.50
MO	2.0577	2.2058	4.8657	3.59	13.56
PB	11.6692	9.3748	87.8861	2.74	7.61
ZN	46.1538	24.3941	595.0745	1.04	-0.07

Table 7a: Correlation Matrix for Elements Determined in Stream Sediments fron Big Horn Crags. (n = 147)

	Ag	Au	Co	Cu	Mo	Pb	Zn
Ag	1.00						
Au	0.49	1.00					
Co	0.31	0.43	1.00				
Cu	0.34	0.26	0.88	1.00			
Mo	0.26	0.14	-0.32	0.23	1.00		
Pb	0.56	0.13	-0.12	0.06	0.55	1.00	
Zn	0.42	0.24	-0.15	-0.01	0.55	0.78	1.00

Table 7b: Correlation Matrix for Elements Determined in Stream Sediments Collected Over Quartz Monzonite at Big Horn Crags (n = 19)

	Ag	Au	Co	Cu	Mo	Pb	Zn
Ag	1.00						
Au	0.67	1.00					
Co	0.68	0.78	1.00				
Cu	0.61	0.64	0.81	1.00			
Mo	0.46	0.56	0.68	0.39	1.00		
Pb	0.66	0.58	0.65	0.56	0.65	1.00	
Zn	0.67	0.69	0.80	0.70	0.73	0.84	1.00

Table 7c: Correlation matrix for Elements Determined in Stream Sediments Collected Over Quartzite at Big Horn Crags (n = 26)

	Ag	Au	Co	Cu	Mo	Pb	Zn
Ag	1.00						
Au	0.13	1.00					
Co	0.04	0.45	1.00				
Cu	0.29	0.34	0.85	1.00			
Mo	0.55	0.43	-0.05	0.06	1.00		
Pb	0.66	-0.19	-0.12	0.10	0.28	1.00	
Zn	0.48	0.30	-0.19	-0.14	0.51	0.47	1.00

Table 8: Factor scores for samples from streams draining quartzites at Bighorn Crags.

Sample	Factor 1	Factor 2
BD-23	0.07	-0.93
BD-25	0.46	-0.44
CC-30	-0.75	-1.65
CC-32	-0.48	-0.39
CC-35	1.54	-0.46
CC-39	-1.36	-1.04
CC-41	-1.42	0.75
CC-46	-0.45	-0.65
GT-3	2.07	0.19
GT-7	1.46	0.23
GT-12	0.32	0.10
LC-1	-0.10	-0.19
LC-2	-1.22	-0.64
LC-3	0.06	-0.35
LC-4	-0.54	0.01
LC-5	1.98	-0.69
LC-6	-0.02	0.45
LC-9	-0.17	0.30
LC-14	-0.46	0.69
GC-1	-0.42	1.26
GC-6	-0.16	-0.35
GC-7	-0.01	-0.15
GC-8	-0.31	-0.41
S-1	0.17	0.28
S-2	-0.04	0.48
LD-2	-0.23	3.59

Table 9: Loadings of Elements on Factors Determined After an Orthogonal Rotation

Element	Factor 1	Factor 2
Ag	0.76	0.13
Au	-0.13	0.36
Co	-0.13	0.93
Cu	0.16	0.92
Mo	0.35	-0.03
Pb	0.85	-0.04
Zn	0.47	-0.19

TABLE 10a COORDINATES AND GEOMORPHOLOGIC OBSERVATIONS AT SAMPLE STATIONS FOR SEDIMENTS FROM STREAMS WITH ANY SIZE CATCHMENT AREA, BIGHORN CRAGS.

NUMBER	COORDINATE X	Y	RELF	TEMP	ORG	SAND	STCY	WDTH	DPTH	AREA	TLDD	PH
BD-01	134	3	7650.0	6.0	0.0	9.0	1.0	1.5	2.0	0.3	0.3	7.0
BD-02	139	14	7600.0	6.0	0.0	9.0	1.0	1.0	2.0	0.4	0.5	7.0
BD-03	135	20	7003.0	7.5	0.0	9.0	1.0	3.0	4.0	0.8	0.9	7.0
BD-04	133	21	7000.0	9.0	0.0	9.0	1.0	3.0	2.0	0.8	1.0	7.0
BD-05	134	23	7000.0	7.5	0.0	9.0	1.0	4.0	4.0	1.6	2.0	7.0
BD-06	130	31	6750.0	8.0	0.0	9.0	1.0	8.0	3.0	1.2	1.0	7.0
BD-07	133	35	6600.0	8.0	0.0	9.0	1.0	12.0	6.0	3.0	3.4	7.0
BD-08	138	40	6600.0	8.0	1.0	0.0	9.0	0.5	1.0	0.5	0.6	7.0
BD-09	140	43	6600.0	8.0	0.0	9.0	1.0	2.0	2.0	0.5	0.8	7.0
BD-10	137	49	6500.0	9.0	0.0	9.0	1.0	3.0	2.0	3.3	2.5	7.0
BD-11	139	47	6500.0	9.0	0.0	9.0	1.0	12.0	18.0	3.4	3.0	7.0
BD-12	141	51	6500.0	9.0	0.0	9.0	1.0	12.0	18.0	6.7	5.5	7.0
BD-13	156	88	6380.0	9.0	0.0	9.0	1.0	4.0	3.0	1.4	1.8	7.0
BD-14	158	85	6370.0	9.0	0.0	9.0	1.0	30.0	12.0	8.8	7.0	7.0
BD-15	160	89	6400.0	9.0	0.0	9.0	1.0	30.0	12.0	10.2	8.8	7.0
BD-16	166	97	6300.0	8.0	0.0	9.0	1.0	1.0	8.0	1.1	1.1	7.0
BD-17	167	94	6300.0	9.0	0.0	9.0	1.0	20.0	36.0	10.5	9.0	7.0
BD-18	170	97	6300.0	9.0	0.0	9.0	1.0	20.0	36.0	11.6	10.1	7.0
BD-19	189	101	5900.0	9.0	0.0	9.0	1.0	15.0	24.0	12.2	10.9	7.0
BD-20	191	99	5900.0	8.5	0.0	9.0	1.0	3.0	6.0	3.3	2.8	7.0
BD-21	194	104	5900.0	9.0	0.0	9.0	1.0	15.0	24.0	15.4	13.6	7.0
BD-22	204	108	5700.0	10.0	0.0	9.0	1.0	10.0	12.0	16.1	14.1	7.0
BD-23	205	110	5700.0	10.0	0.0	9.0	1.0	1.0	2.0	1.8	2.3	7.0
BD-24	209	109	5700.0	10.0	0.0	9.0	1.0	10.0	12.0	17.8	16.4	7.0
BD-25	223	113	5600.0	9.0	0.0	9.0	1.0	3.0	4.0	3.8	3.8	7.0
BD-26	219	113	5600.0	10.0	0.0	9.0	1.0	12.0	18.0	18.4	16.9	7.0
BD-27	223	117	5600.0	10.0	0.0	9.0	1.0	12.0	18.0	22.2	20.6	7.0
BD-28	228	121	5550.0	10.0	3.0	0.0	7.0	1.0	1.0	1.0	1.0	7.0
BD-29	231	123	5600.0	10.0	3.0	0.0	7.0	0.5	1.0	1.0	1.0	7.0
BD-30	249	131	5480.0	14.0	0.0	9.0	1.0	15.0	18.0	26.1	23.6	7.0
BD-31	259	133	5450.0	14.0	0.0	9.0	1.0	20.0	18.0	27.2	24.0	7.0
BD-32	269	132	5440.0	14.0	0.0	9.0	1.0	10.0	12.0	27.9	24.4	7.0
BD-33	280	126	5180.0	14.0	0.0	2.0	8.0	20.0	24.0	28.8	24.9	7.0
BD-34	292	116	5170.0	10.0	0.0	9.0	1.0	20.0	24.0	29.8	25.5	7.0
BD-35	295	112	5180.0	10.0	2.0	2.0	6.0	3.0	6.0	6.0	6.0	8.0
BD-36	299	117	5180.0	10.0	0.0	9.0	1.0	20.0	24.0	39.2	35.3	7.8
BD-37	294	119	5180.0	10.0	2.0	6.0	2.0	2.0	4.0	3.3	3.8	7.0
BD-38	320	120	4980.0	10.0	0.0	9.0	1.0	20.0	24.0	40.6	36.2	7.5
BD-39	339	120	4950.0	10.0	0.0	9.0	1.0	20.0	24.0	42.0	37.0	7.5
BD-40	361	129	4300.0	10.0	0.0	9.0	1.0	20.0	24.0	43.4	38.0	7.5
CC-01	73	82	8160.0	15.0	0.0	9.0	1.0	3.0	8.0	0.6	0.5	7.3
CC-02	80	89	7500.0	16.0	0.0	9.0	1.0	3.0	8.0	0.8	0.9	7.3
CC-03	85	90	7650.0	16.0	3.0	0.0	7.0	1.5	2.0	0.2	0.3	7.3
CC-04	97	106	7280.0	13.0	0.0	9.0	1.0	5.0	10.0	2.2	2.5	7.3
CC-05	93	98	7550.0	13.0	2.0	5.0	3.0	1.5	2.0	0.4	0.6	7.3
CC-06	98	115	7120.0	11.0	0.0	9.0	1.0	10.0	10.0	2.4	2.8	7.5
CC-07	102	115	7120.0	9.0	1.0	8.0	1.0	6.0	8.0	0.8	1.4	7.5
CC-08	95	120	6960.0	9.0	3.0	0.0	7.0	1.0	2.0	0.2	0.3	7.5
CC-09	79	121	7080.0	14.0	0.0	9.0	1.0	6.0	12.0	1.9	1.5	7.5
CC-10	76	123	7080.0	14.0	0.0	9.0	1.0	10.0	6.0	2.3	2.5	7.3

10b

NUMBER	COORDINATE X	COORDINATE Y	RELF	TEMP	ORG	SAND	STCY	WDTH	DPTH	AREA	TLDD	PH
CC-11	100	125	6880.0	7.0	3.0	0.0	7.0	1.0	2.0	8.5	9.4	7.5
CC-12	104	130	6980.0	7.0	3.0	0.0	7.0	1.0	2.0	0.4	1.3	7.5
CC-13	107	140	6840.0	6.5	1.0	7.0	2.0	1.0	4.0	0.4	1.3	7.5
CC-14	111	141	6840.0	8.5	0.0	9.0	1.0	30.0	12.0	9.9	10.1	7.5
CC-15	116	156	6760.0	5.0	1.0	8.0	1.0	5.0	8.0	2.6	3.5	7.5
CC-16	119	152	6750.0	8.0	0.0	9.0	1.0	25.0	6.0	10.2	10.6	7.5
CC-17	118	160	6740.0	7.0	0.0	9.0	1.0	25.0	6.0	12.9	14.1	7.5
CC-18	125	183	6640.0	6.0	0.0	9.0	1.0	3.0	2.0	0.9	1.7	7.5
CC-19	121	158	6780.0	7.0	2.0	7.0	1.0	1.0	2.0	0.2	0.3	7.5
CC-20	126	179	6640.0	7.0	0.0	9.0	1.0	25.0	12.0	14.3	14.9	7.5
CC-21	129	184	6635.0	7.0	0.0	9.0	1.0	25.0	12.0	15.2	16.5	7.5
CC-22	127	191	6480.0	7.0	1.0	8.0	1.0	0.7	2.0	0.1	0.3	7.5
CC-23	130	192	6120.0	7.0	0.0	9.0	1.0	5.0	6.0	0.7	1.3	7.5
CC-24	131	189	6090.0	9.0	0.0	9.0	1.0	25.0	6.0	15.5	17.0	7.5
CC-25	134	190	6050.0	9.0	0.0	9.0	1.0	25.0	6.0	16.2	18.3	7.5
CC-26	142	191	5700.0	10.0	0.0	9.0	1.0	15.0	18.0	16.5	18.6	7.5
CC-27	147	198	5450.0	8.0	2.0	5.0	3.0	3.0	2.0	1.4	1.3	7.5
CC-28	148	195	5450.0	10.0	0.0	9.0	1.0	15.0	18.0	16.6	18.9	7.5
CC-29	153	196	5450.0	10.0	0.0	9.0	1.0	15.0	18.0	18.1	20.3	7.5
CC-30	166	199	5100.0	9.5	0.0	9.0	1.0	4.0	6.0	3.3	2.5	7.5
CC-31	170	204	5090.0	10.0	0.0	9.0	1.0	20.0	24.0	23.1	24.8	7.5
CC-32	165	206	5100.0	8.5	0.0	9.0	1.0	2.0	6.0	1.4	1.3	7.5
CC-33	164	202	5100.0	10.0	0.0	9.0	1.0	20.0	2.0	18.3	20.8	7.5
CC-34	179	215	4600.0	12.5	0.0	9.0	1.0	30.0	18.0	24.2	25.5	7.5
CC-35	183	214	4600.0	7.5	1.0	8.0	1.0	3.0	3.0	2.1	1.9	7.5
CC-36	186	221	4600.0	13.0	0.0	9.0	1.0	30.0	18.0	26.5	27.6	7.5
CC-37	195	223	4640.0	7.5	1.0	8.0	1.0	0.5	2.0	0.3	0.3	7.5
CC-38	205	227	4590.0	12.0	0.0	9.0	1.0	15.0	24.0	27.9	27.5	7.5
CC-39	212	228	4600.0	10.0	0.0	9.0	1.0	3.0	3.0	3.6	2.5	7.5
CC-40	214	234	4560.0	13.5	0.0	9.0	1.0	20.0	12.0	31.9	30.7	7.5
CC-41	236	271	4400.0	10.0	1.0	8.0	1.0	1.0	2.0	1.6	1.6	7.5
CC-42	235	267	4400.0	13.0	0.0	9.0	1.0	15.0	24.0	36.4	34.7	7.5
CC-43	239	270	4350.0	13.0	0.0	9.0	1.0	15.0	18.0	38.0	36.6	7.5
CC-44	243	272	4320.0	10.0	0.0	9.0	1.0	15.0	24.0	38.1	36.8	7.5
CC-45	258	283	4160.0	10.0	0.0	9.0	1.0	10.0	24.0	39.2	37.5	7.5
CC-46	273	276	4000.0	11.5	1.0	8.0	1.0	1.5	2.0	3.8	4.0	7.5
CC-47	278	279	3940.0	15.0	0.0	9.0	1.0	20.0	24.0	44.0	42.8	7.5
CC-48	272	279	4000.0	15.0	0.0	9.0	1.0	20.0	24.0	39.9	38.0	7.5
CC-49	285	294	3680.0	15.0	0.0	9.0	1.0	20.0	24.0	45.3	44.6	7.5
CC-50	299	317	3600.0	15.0	0.0	9.0	1.0	20.0	24.0	47.9	48.1	7.5
CC-51	316	335	3440.0	15.0	0.0	9.0	1.0	20.0	24.0	49.0	49.1	7.5
GT-01	89	228	7960.0	9.0	0.0	5.0	5.0	8.0	3.0	0.4	0.5	7.0
GT-02	89	236	7800.0	9.0	0.0	9.0	1.0	4.0	6.0	0.8	0.9	7.0
GT-03	80	245	6000.0	7.0	0.0	9.0	1.0	3.0	2.0	0.7	1.0	7.0
GT-04	84	243	6000.0	7.0	0.0	9.0	1.0	8.0	3.0	1.1	1.2	7.0
GT-05	81	250	6000.0	7.0	0.0	9.0	1.0	8.0	3.0	2.0	2.8	7.0
GT-06	62	252	5680.0	9.0	0.0	5.0	5.0	10.0	6.0	3.0	4.5	7.0
GT-07	57	258	5600.0	9.0	1.0	4.0	5.0	3.0	6.0	0.7	1.3	7.0
GT-08	56	262	5600.0	9.0	0.0	5.0	5.0	10.0	6.0	4.0	6.0	7.0
GT-09	51	265	5000.0	6.0	1.0	4.0	5.0	10.0	6.0	0.4	0.5	7.0
GT-10	48	266	4900.0	9.0	0.0	9.0	1.0	6.0	6.0	4.5	6.9	7.0

10c

NUMBER	COORDINATE X	COORDINATE Y	RELF	TEMP	ORG.	SAND	STCY	WDTH	DPTH	AREA	TLDD	PH
GT-11	36	281	4400.0	9.0	0.0	5.0	5.0	10.0	6.0	6.9	9.4	7.0
GT-12	36	289	4320.0	8.0	3.0	0.0	7.0	3.0	2.0	0.1	0.3	7.0
GT-13	36	296	4140.0	9.0	0.0	9.0	1.0	6.0	12.0	7.7	10.3	7.0
GT-14	34	303	4040.0	9.0	0.0	5.0	5.0	15.0	8.0	8.2	11.1	7.0
GT-15	27	307	3820.0	9.0	0.0	5.0	5.0	10.0	12.0	8.4	11.4	7.0
GT-16	19	316	4000.0	9.0	0.0	9.0	1.0	1.0	1.0	0.2	0.3	7.0
GT-17	12	317	3520.0	9.0	0.0	5.0	5.0	10.0	12.0	9.0	12.0	7.0
GT-18	4	326	3180.0	9.0	0.0	9.0	1.0	6.0	8.0	10.4	14.5	7.0
LC-01	100	300	5320.0	9.0	1.0	8.0	1.0	6.0	1.0	0.2	0.3	7.8
LC-02	104	296	5360.0	8.0	1.0	6.0	3.0	1.0	1.0	0.4	0.5	7.0
LC-03	102	292	5520.0	10.0	0.0	9.0	1.0	1.0	1.0	0.2	0.3	7.0
LC-04	116	292	5040.0	9.0	0.0	5.0	5.0	4.0	6.0	1.5	2.5	7.0
LC-05	120	299	5040.0	9.0	1.0	4.0	5.0	0.7	1.0	0.4	0.5	7.0
LC-06	123	299	5000.0	9.0	1.0	4.0	5.0	3.0	2.0	0.4	0.5	7.6
LC-07	116	300	4960.0	9.0	2.0	7.0	1.0	2.0	2.0	2.8	4.3	8.0
LC-08	116	303	4880.0	9.0	1.0	8.0	1.0	2.0	2.0	2.8	4.3	8.0
LC-09	115	304	4800.0	9.0	0.0	9.0	1.0	0.5	1.0	0.6	1.0	7.8
LC-10	117	306	4680.0	9.0	1.0	8.0	1.0	2.0	2.0	3.4	5.3	7.5
LC-11	117	311	4390.0	9.0	1.0	8.0	1.0	3.0	12.0	3.6	5.5	7.3
LC-12	116	314	4180.0	9.0	1.0	8.0	1.0	3.0	12.0	3.6	5.5	7.0
LC-13	115	316	4220.0	9.0	1.0	8.0	1.0	3.0	12.0	4.3	6.5	7.0
LC-14	113	312	4120.0	9.0	0.0	9.0	1.0	5.0	6.0	0.7	1.0	7.0
LC-15	119	331	3780.0	9.0	0.0	9.0	1.0	5.0	6.0	5.1	7.5	7.0
LC-16	119	341	3500.0	10.0	3.0	0.0	7.0	5.0	6.0	6.1	8.7	7.6
LC-17	118	354	3150.0	10.0	0.0	9.0	1.0	5.0	6.0	6.7	9.2	7.5
GC-01	175	321	5600.0	9.0	0.0	9.0	1.0	3.0	2.0	4.5	5.0	7.0
GC-02	182	326	5600.0	9.0	0.0	9.0	1.0	3.0	2.0	5.0	5.6	7.0
GC-03	185	326	5320.0	9.0	1.0	8.0	1.0	3.0	6.0	5.0	5.7	7.0
GC-04	187	329	5120.0	11.0	0.0	9.0	1.0	5.0	3.0	5.0	5.7	7.3
GC-05	187	325	4880.0	9.0	0.0	9.0	1.0	3.0	12.0	5.0	5.8	7.0
GC-06	190	326	4880.0	10.0	1.0	8.0	1.0	2.0	2.0	0.1	0.3	8.0
GC-07	192	323	4390.0	13.0	1.0	8.0	1.0	0.5	1.0	0.5	0.8	8.0
GC-08	190	322	4880.0	13.0	0.0	9.0	0.0	1.0	2.0	0.1	0.3	8.0
GC-09	191	329	4860.0	11.0	0.0	9.0	1.0	3.0	6.0	7.3	6.5	7.8
GC-10	194	331	4850.0	11.0	0.0	7.0	3.0	4.0	6.0	7.4	6.9	7.8
GC-11	200	332	4700.0	11.0	0.0	9.0	1.0	4.0	6.0	7.6	7.2	7.8
GC-12	208	333	4620.0	11.0	0.0	9.0	1.0	4.0	6.0	8.4	7.9	7.7
GC-13	209	343	4200.0	9.0	1.0	8.0	1.0	0.5	1.0	0.2	0.3	7.5
GC-14	233	368	4000.0	11.0	0.0	9.0	1.0	4.0	12.0	10.0	10.2	7.5
GC-15	249	372	3280.0	11.0	0.0	9.0	1.0	5.0	12.0	11.7	13.1	7.5
LD-01	385	109	4400.0	8.0	0.0	5.0	5.0	4.0	4.0	4.6	4.0	7.3
LD-02	379	88	4600.0	7.5	0.0	5.0	5.0	4.0	3.0	3.1	3.0	7.3
LD-03	386	88	4800.0	7.5	1.0	8.0	1.0	1.0	1.0	0.1	0.3	7.0
S-01	82	336	5520.0	8.0	1.0	8.0	1.0	3.0	1.0	1.1	0.8	7.3
S-02	81	355	3400.0	11.0	0.0	9.0	1.0	3.0	2.0	2.2	1.5	7.5
A-01	351	193	4000.0	11.0	1.0	8.0	1.0	3.0	3.0	2.9	2.8	7.4
B-01	354	273	3200.0	14.0	1.0	8.0	1.0	0.5	1.0	2.8	3.8	7.4
G-01	350	209	3900.0	14.0	1.0	8.0	1.0	2.0	2.0	3.4	2.8	7.4

TABLE 11 STATISTICS FOR GEOMORPHOLOGIC OBSERVATIONS AT SAMPLE STATIONS FOR SEDIMENTS FROM STREAMS WITH ANY SIZE CATCHMENT AREA, BIGHORN CRAGS.

OF SAMPLES = 149

VARIABLE	MEAN	STANDARD DEV.	VARIANCE	SKEWNESS	KURTOSIS
RELF	5413.0391	1168.4287	*********	0.19	-0.76
TEMP	9.7852	2.2907	5.2475	0.84	0.27
ORG	0.4362	0.8081	0.6530	1.96	3.11
SAND	7.6644	2.4786	6.1434	-2.04	3.18
STCY	1.8926	1.9282	3.7181	1.93	2.37
WDTH	8.4889	8.1716	66.7743	1.05	-0.03
DPTH	8.8725	8.1517	66.4498	1.14	0.42
AREA	9.5415	12.5297	156.9928	1.62	1.58
TLDD	9.6084	11.8687	140.8651	1.56	1.55
PH	7.2966	0.2953	0.0872	0.46	-0.24

Table 12: Correlations between Variables Observed During Sample Collection and Elements Analyzed in Stream Sediments, Bighorn Crags.

	Ag	Au	Co	Cu	Mo	Pb	Zn	Relf	Temp	Org	Sand	Stcl	Wdth	Dpth	Area	Tldd	pH
Ag	1.00																
Au	0.41	1.00															
Co	0.10	0.11	1.00														
Cu	--	--	0.94	1.00													
Mo	0.21	0.16	--	--	1.00												
Pb	0.60	0.18	--	--	0.26	1.00											
Zn	0.44	0.36	--	--	0.19	0.71	1.00										
Relf	0.29	--	--	--	0.36	0.53	0.47	1.00									
Temp	0.11	0.26	--	--	-0.11	--	0.12	-0.30	1.00								
Org	0.37	--	0.16	0.14	0.24	0.16	--	--	--	1.00							
Sand	-0.36	--	-0.21	-0.17	-0.22	-0.18	--	--	--	-0.77	1.00						
Stcl	0.31	--	0.20	0.16	0.19	0.17	--	--	--	0.58	-0.96	1.00					
Wdth	-0.35	-0.24	--	--	--	-0.13	--	--	0.22	-0.43	0.30	-0.20	1.00				
Dpth	-0.31	-0.21	--	--	--	-0.21	-0.14	-0.18	0.36	-0.40	-0.31	-0.22	0.69	1.00			
Area	-0.34	-0.25	--	--	-0.13	-0.28	-0.22	-0.35	0.50	-0.33	0.27	-0.20	0.69	0.80	1.00		
Tldd	-0.35	-0.24	--	--	-0.14	-0.30	-0.23	-0.38	0.49	-0.33	0.26	-0.20	0.70	0.78	0.99	1.00	
pH	--	0.26	0.19	0.22	--	-0.30	-0.12	-0.22	0.23	0.16	--	-0.15	--	--	0.17	0.18	1.00

- less than ± 0.10

Table 13: Loadings of Variables on Factors Determined After an Orthogonal Rotation.

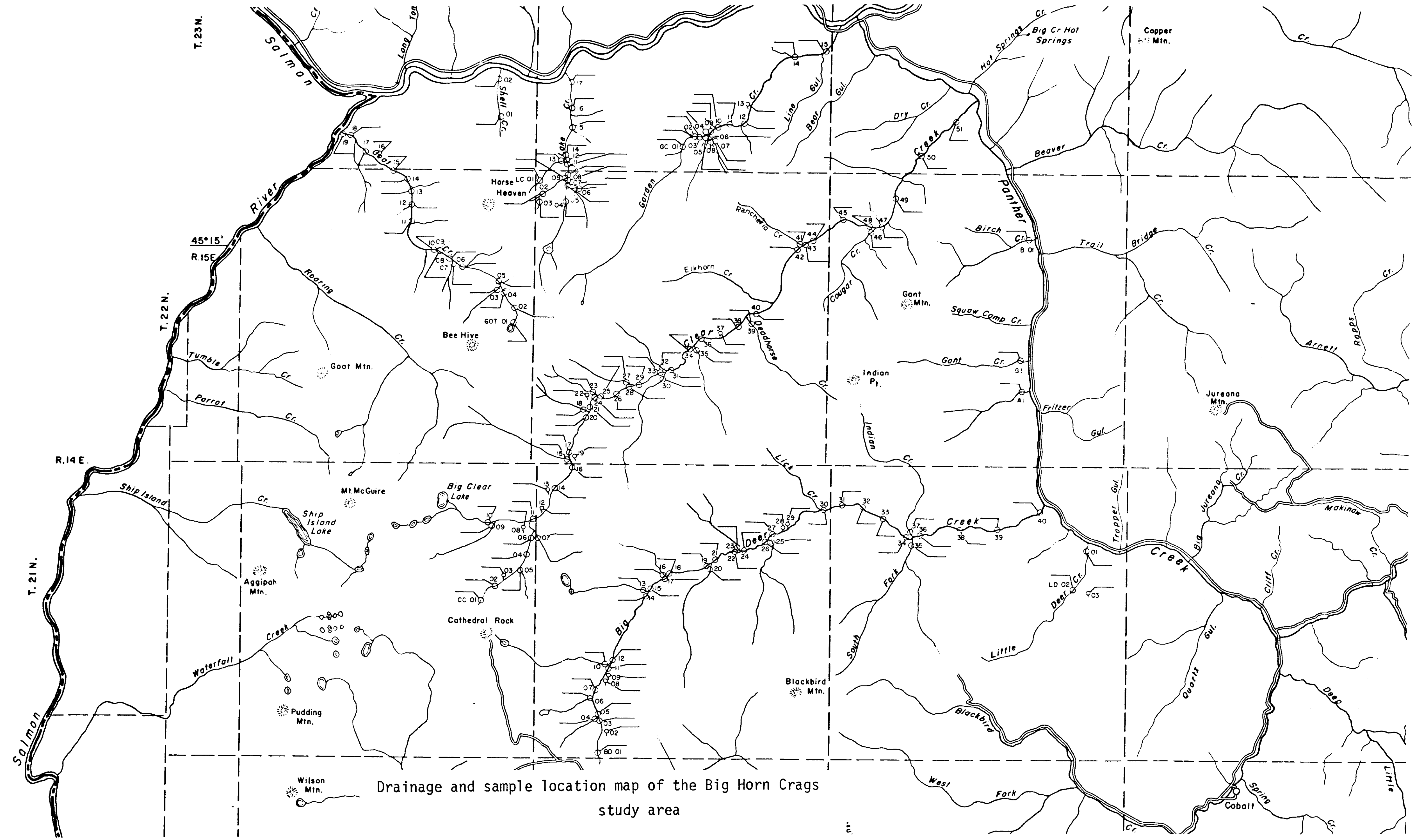
	Factor					
Variable	1	2	3	4	5	6
Ag	0.24	-0.29	0.62	0.02	0.26	0.02
Au	0.21	0.01	0.28	-0.02	0.61	0.05
Co	0.04	-0.12	0.00	0.95	0.10	-0.07
Cu	-0.05	-0.08	0.05	0.96	0.03	-0.01
Mo	0.04	-0.10	0.18	-0.05	0.08	0.53
Pb	0.11	-0.10	0.85	0.01	-0.11	0.14
Zn	0.06	0.06	0.80	0.04	0.13	0.16
Relf	0.18	0.06	0.48	-0.04	-0.24	0.51
Temp	-0.46	-0.01	0.14	-0.05	0.50	-0.28
DRG	0.31	-0.66	0.04	0.08	0.15	0.17
Sand	-0.17	0.96	-0.07	-0.10	0.03	-0.09
STCD	0.09	-0.96	0.07	0.10	-0.11	0.04
WDTH	-0.76	0.19	-0.07	-0.01	-0.13	0.16
DPTH	-0.83	0.15	-0.09	0.00	-0.06	-0.04
AREA	-0.05	0.09	-0.18	0.03	0.06	-0.15
TLDD	-0.95	0.08	-0.20	0.02	0.08	-0.16
pH	-0.07	0.06	-0.25	0.18	0.49	0.05

Table 14: Principal gold placer deposits in the study area*
(, less than shown; ---, not determined)

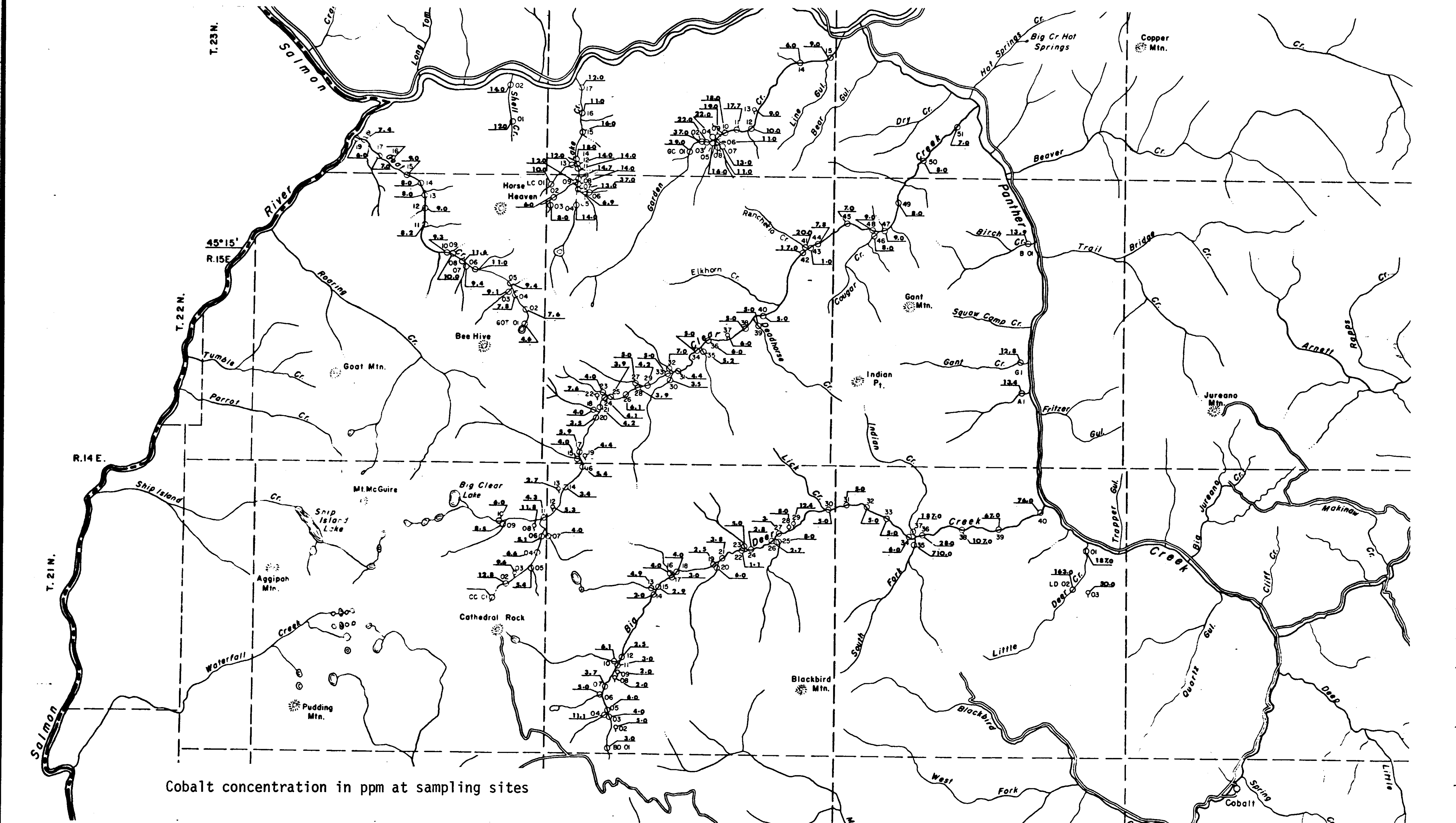
	Extent of deposit (acres)	Overburden (cubic yards)	River gravel (cubic yards)	Range of sample values from river gravel (cents per cubic yard)[1]
Bear Gulch	12.4	391,000	390,000	2
Blue Mine	.03	0	1,000	[3]5 - 73
Clear Creek (low bench)[4]	12.8	0	373,000	1
(high bench)[4]	10.9	0	879,000	1 - 171
Colson Creek	8.0	0	387,000	1 - 4
Ebeneezer	4.0	0	68,000	1 - 33
Garden Creek[4]	11.7	181,000	436,000	0 - 1
Golden Eagle	7.2	78,000	290,000	
Golden Queen	----	5	5	[3]7 - 15
Homestake (low bench)	32.2	774,000	1,919,000	6
(high bench)	21.3	0	359,000	9 - 106
Lake Creek (high benches)	25.5	0	3,506,000	1 - 4
Lower Owl Creek (low bench)	29.3	370,000	1,071,000	2
(high bench)	11.7	0	600,000	2
Poverty Flat	16.1	210,000	520,000	1 - 29
Shell Creek	11.2	129,000	595,000	3 - 93
Upper Owl Creek placer				
(low bench)	10.5	155,000	505,000	10 - 50
(high bench)	4.3	0	347,000	7

[1]Samples represent only part of the stratigraphic section of the deposits. Values calculated at $65.40 per ounce.
[2]Test pits and trenches did not penetrate through overburden.
[3]Reconnaissance samples.
[4]Includes only that part in the Clear Creek-Upper Big Deer Creek study area.
[5]Not estimated
[6]Overburden has values as much as 3 cents per cubic yard; river gravel was not sampled on the low bench. Values in top 6 feet of island were   1 cent per cubic yard.
[7]Not sampled.

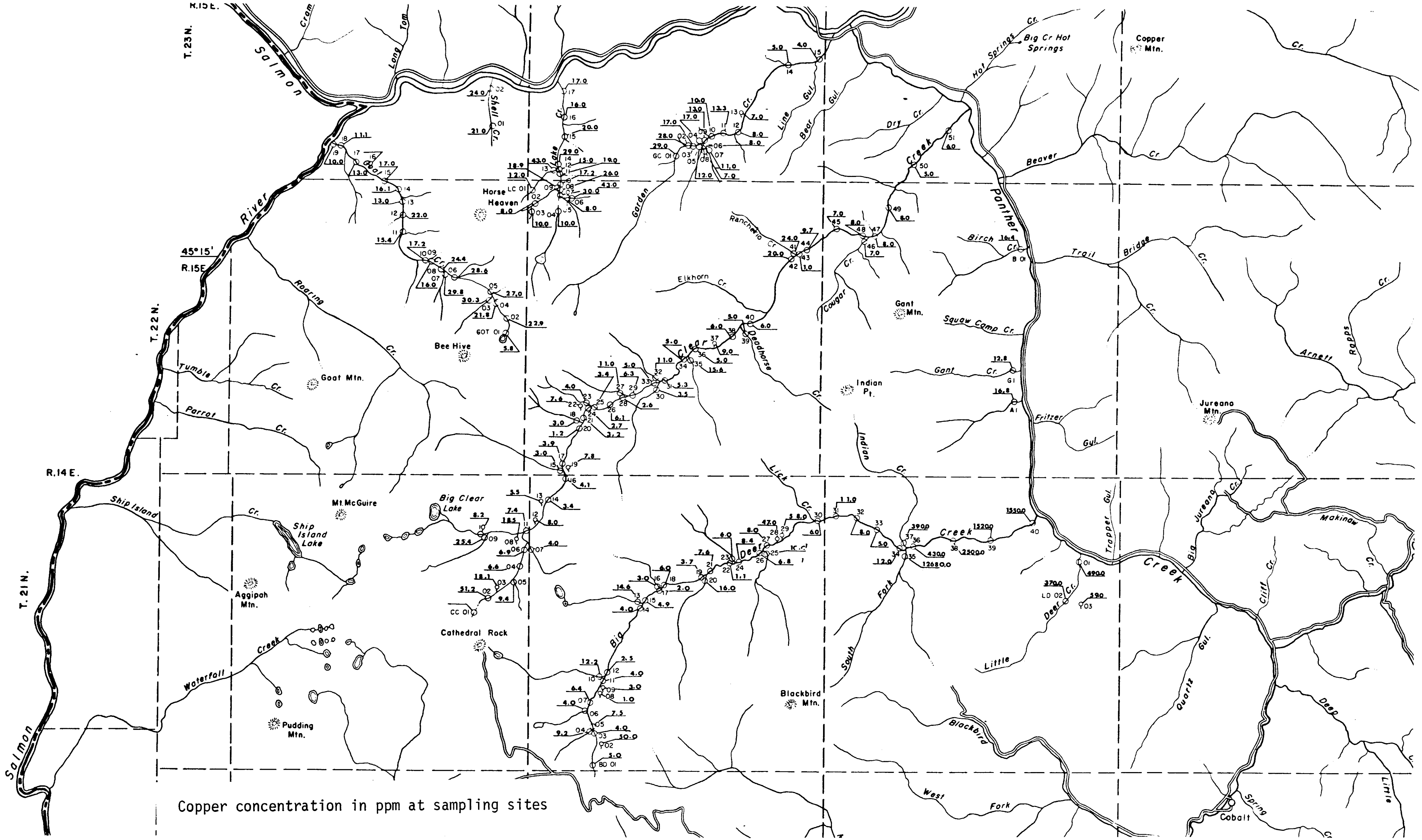
*(From U.S.G.S. - Crags Study)



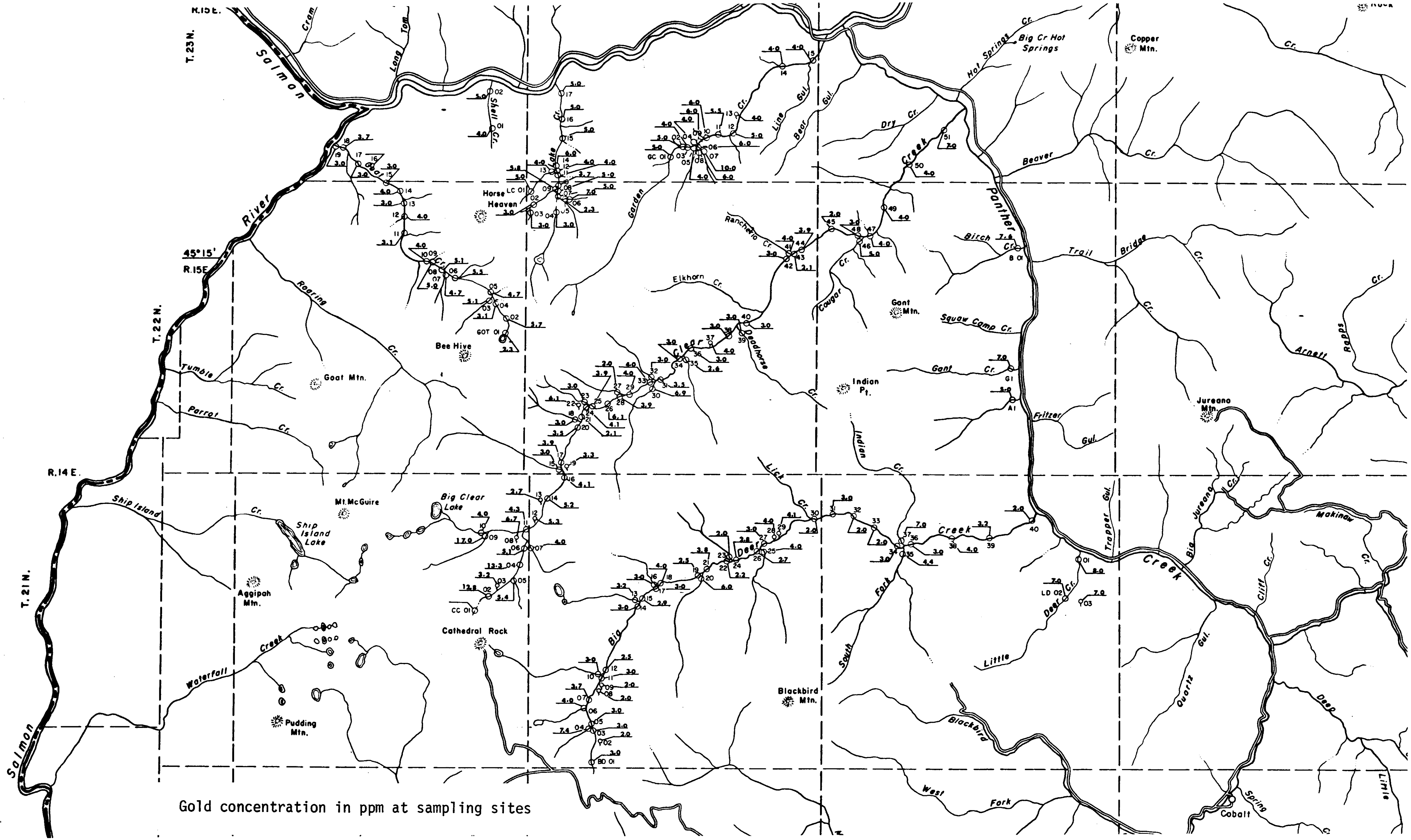
Drainage and sample location map of the Big Horn Crags study area



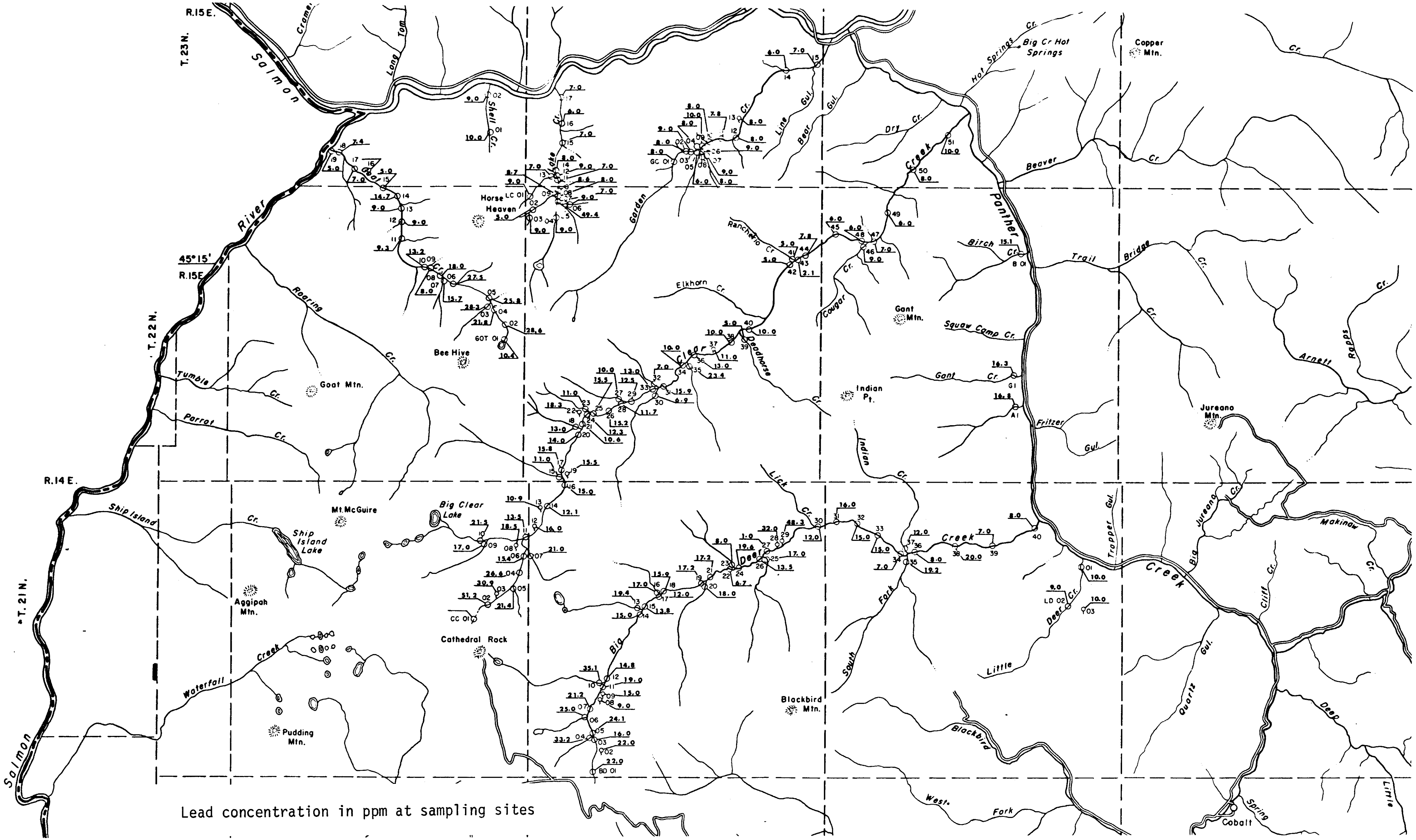
Cobalt concentration in ppm at sampling sites



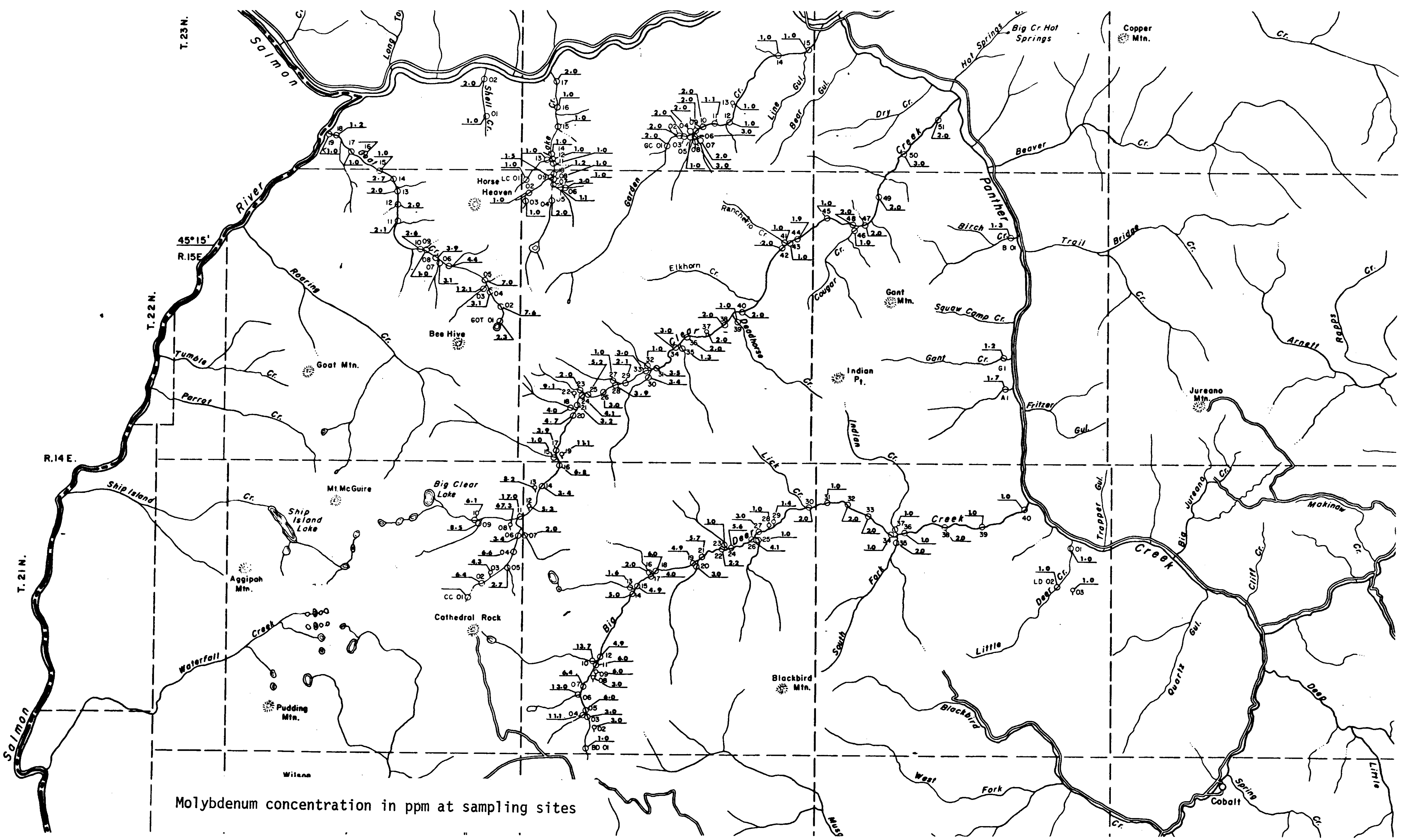
Copper concentration in ppm at sampling sites



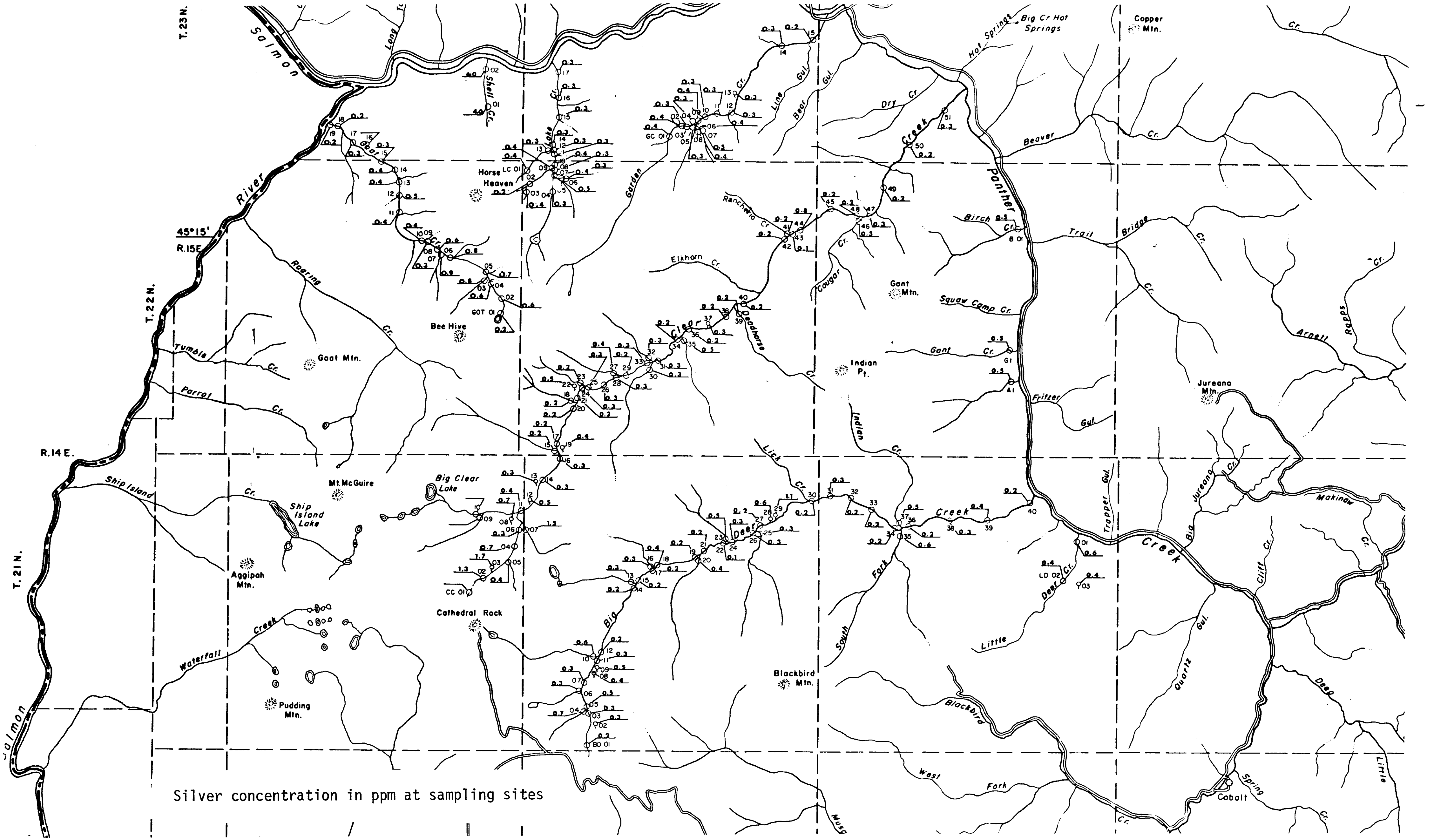
Gold concentration in ppm at sampling sites



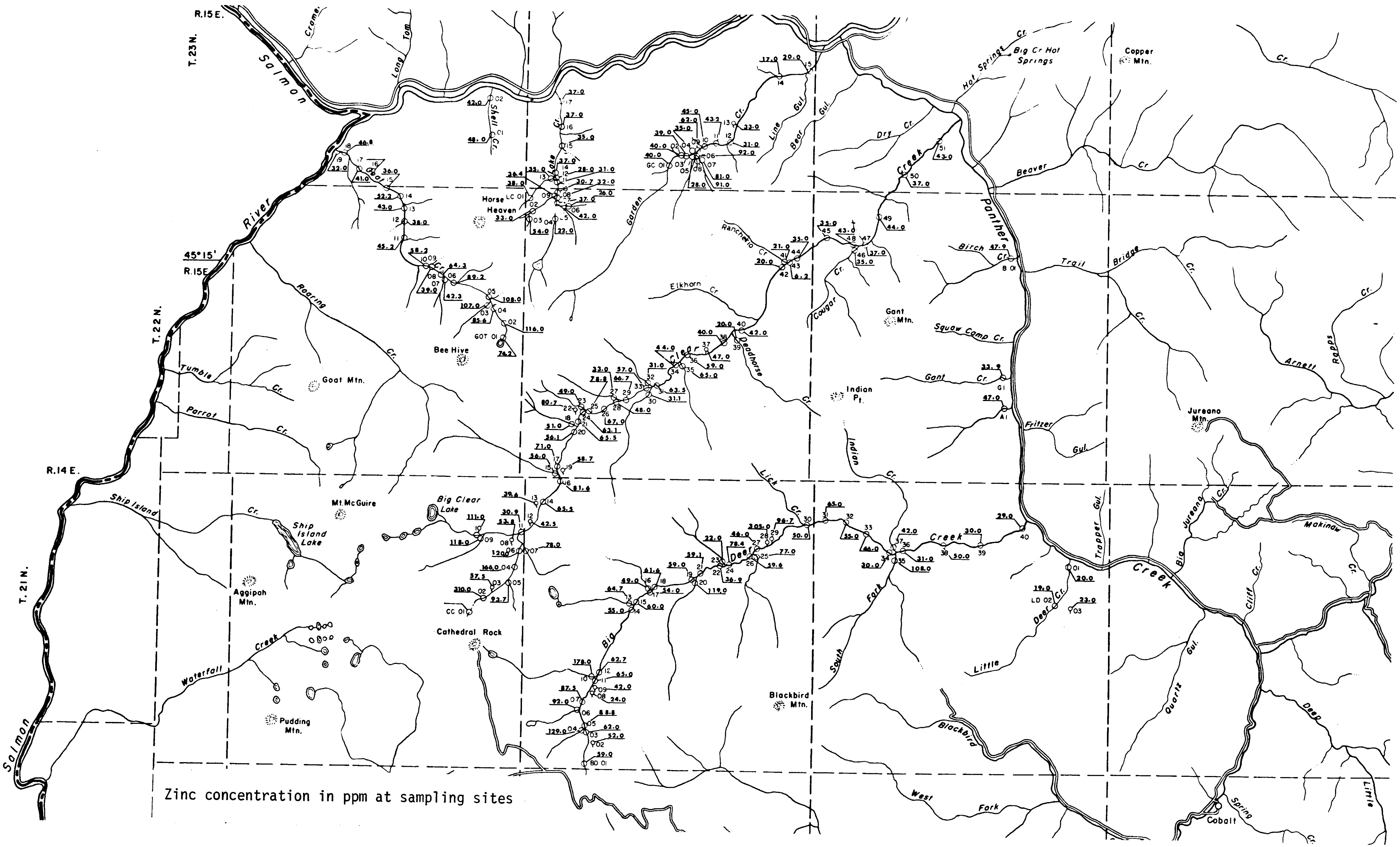
Lead concentration in ppm at sampling sites



Molybdenum concentration in ppm at sampling sites



Silver concentration in ppm at sampling sites



Zinc concentration in ppm at sampling sites