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UNIVERSITY OF ALASKA

GEOL. 532

AN EXPERIMENT IN GEOCHEMICAL PROSPECTING

FOR GOLD-SILVER VEINS,

FAIRBANKS DISTRICT, ALASKA

by

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INTRODUCTION

In March, April, and May, 1952, as part of the course in Mining Geology, (Geol. 532), Bond Taber, instructor, and Robert H. Saunders, student, studied several recent publications describing experiments in geochemical and geobotanical prospecting. Most of the experiments that were studied were conducted near deposits of lead, zinc, or copper. Most of the experiments were based on a chemical test in which the metals sought reacted with a solution of dithizone, (diphenylthiocarbozone) in carbon tetrachloride.

Table II shows which of the common metals will react with dithizone. This table is based on information contained in the publications that were studied.

Table I is a list of those publications. The experiments show that many hidden ore-bodies are surrounded by a "halo" of soil or plants that are rich in the metals contained in the ore-bodies. The best results were obtained near zinc deposits. Most of the writers found that the metals could be detected if they were present in the amount of four parts per million or greater.

As a final part of the course in Mining Geology, an experiment was undertaken to determine if the methods used could be adapted to the search for gold-silver bearing quartz veins.

SAMPLING

Samples were taken by scraping off two or three inches of vegetation and scooping up about 200 gms of soil. Sample No. 9 was taken from

TABLE I

SOME RECENT PUBLICATIONS ON GEOCHEMICAL AND GEOBOTANICAL PROSPECTING

Econ. Geol., Vol. 45, No. 4, 1950; SPECIAL FIELD APPLICATIONS OF A CONFIRMATORY TEST FOR LEAD by S. E. Jerome.

Econ. Geol., Vol. 44, 1949; GEOCHEMICAL PROSPECTING FOR ORES; A PROGRESS REPORT by H. E. Hawkes.

Econ. Geol., Vol. 46, No. 6, 1951; GEOCHEMICAL TECHNIQUES AS APPLIED IN RECENT INVESTIGATIONS IN THE TINTIC DISTRICT, UTAH by Hy Almond and H. T. Morris.

Econ. Geol., Vol. 46, No. 5, 1951; A SENSITIVE FIELD TEST FOR DETECTING HEAVY METALS IN SOIL OR SEDIMENT by Lyman C. Huff;

Econ. Geol., Vol. 45, No. 6, 1950; BIOGEOCHEMICAL INVESTIGATIONS IN THE TRI-STATE DISTRICT by John W. Harbaugh.

Econ. Geol., Vol. 45, No. 7, 1950; PROSPECTING FOR ZINC USING SEMI-QUANTATIVE CHEMICAL ANALYSES OF SOIL by Robert B. Fulton.

Econ. Geol., Vol. 46, No. 7, 1951; GEOLOGICAL INVESTIGATIONS AND GEOCHEMICAL PROSPECTING EXPERIMENT AT JOHNSON, ARIZONA by John R. Cooper and Lyman C. Huff.

Econ. Geol., Vol. 44, 1949; FIELD METHOD FOR THE DETERMINATION OF ZINC IN SOILS by H. W. Lakin, R. E. Stevens, and Hy Almond.

Econ. Geol., Vol. 30, No. 4, 1935; QUANTATIVE STUDY OF ORE ZONING, AUSTINVILLE MINE, VIRGINIA by W. H. Brown.

Econ. Geol., Vol. 43, 1948; HEAVY METALS IN ALTERED ROCK OVER BLIND ORE-BODIES, EAST TINTIC DISTRICT, UTAH by T. S. Lovering, V. P. Sokoloff, and H. T. Morris.

Econ. Geol., Vol. 43, 1948; A SENSITIVE FIELD TEST FOR HEAVY METALS IN WATER by Lyman C. Huff.

Econ. Geol., Vol. 49, 1947; THE ZINC CONTENT OF PLANTS ON THE FRIEDENSVILLE ZINC SLIME PONDS IN RELATION TO BIOGEOCHEMICAL PROSPECTING by W. O. Robinson, H. W. Lakin, and Laura E. Reichen.

G. S. A. Bulletin, Vol. 58, 1947; BIOGEOCHEMICAL PROSPECTING FOR COPPER AND ZINC by H. V. Warren and C. H. Howatson.

TABLE II
METALS THAT WILL REACT WITH DITHIZONE

METAL	pH OR ACIDITY OF SOLUTION	COLOR
1. bismuth	2.5 or less	orange-yellow
2. cadmium	neutral to basic	red
3. cobalt	?	?
4. copper	2.5 to basic	violet to yellow-brown
5. gold	2.5 or less	yellow
6. indium	?	?
7. ferrous iron	6 to 7	violet-red
8. lead	basic	cinnabar red
9. manganese	?	?
10. mercury	2.5 to basic	orange-yellow to purplish red
11. nickel	neutral to basic	brownish gray
12. palladium	2.5 or less	brownish red
13. platinous platinum	?	?
14. silver	2.5 or less	yellow
15. thallium	neutral to basic	red
16. stannous tin	5 to basic	red
17. zinc	5 to basic	purplish red

The metals that will not react include: antimony, arsenic, chromium, molybdenum, platinic platinum, stannic tin, tungsten, and uranium.

the top of a small ridge so that it was up the slope from the known veins in the vicinity. The other samples were taken down the slope from known veins. Sample No. 9 was intended to be a "barren" sample; it was expected to have a gold-silver content representative of any soil in the district not near a gold-silver vein. The other samples were taken down the slope from the estimated position of the apex of the Adit vein. The Stay veins and the Bluebird vein are up the slope from the Adit vein. There may be other veins on the ridge not yet discovered. The map in the appendix shows the location of the samples and the location of faults and the vein encountered in the underground workings (which are now inaccessible).

PROCEDURE

1. All samples were screened through a 60-mesh screen.
2. To 5 gm of each sample we added 20 ml aqua regia and heated the solution on a hot plate for two hours.
3. The solution was decanted to a graduate; the residue was rinsed with 10 ml distilled water, and the distilled water was added to the graduate; more distilled water was added to the graduate until the volume of solution was 40 ml.
4. Ammonium hydroxide was added until the pH of the solution was about two. Methyl violet paper was used as a pH indicator. About 2.5 ml ammonium hydroxide was required.
5. A dithizone solution was prepared by dissolving 0.16 mg dithizone in 100 ml carbon tetrachloride.
6. Portions of the sample solutions were added to 2 ml portions of the dithizone solution to determine the amount of sample solution

required to change the color of the dithizone from green to yellow in about two minutes.

A sample of a gold-silver bearing quartz vein was obtained from the Territorial Department of Mines. According to a fire assay, this sample contained 0.06 oz gold and 0.24 oz silver per ton. A standard or "known" solution was prepared from this sample by using the same procedure that was used in preparing the solutions from the other samples. We assumed that the amount of solution required to change the color of the dithizone was inversely proportional to the amount of gold and silver in the solution:

$$\frac{\text{ml known solution used}}{\text{ml unknown solution used}} = \frac{\text{oz per ton in unknown sample}}{\text{oz per ton in known sample}}$$

The color change was obtained with 2.0 ml of the known solution; 0.06 oz gold plus 0.24 oz silver equals 0.3 equivalent oz in the known solution. Substituting these figures in the preceding equation, we have:

$$\frac{2.0}{\text{ml unknown solution used}} = \frac{\text{oz per ton in unknown sample}}{0.3}, \text{ or}$$

$$\text{oz per ton in unknown sample} = \frac{0.6}{\text{ml unknown solution used}}$$

The figures thus obtained for "ounces per ton" are theoretical and are intended to indicate only the relative gold-silver content of the samples.

If the pH of the solutions was less than two, the solutions reacted more readily with the dithizone. We found, however, that the aqua regia alone reacted with the dithizone much the same as the gold-silver solutions. A blank solution made up of the reagents used reacted with the dithizone when no ammonium hydroxide was added, but

when ammonium hydroxide was added so that the pH of the blank solution was about two, 15 ml of the blank solution could be added to the dithizone with no perceptible color change.

Several times we obtained a color change from green to violet instead of a change from green to yellow. At a pH of two, copper will react with dithizone to give a violet color. The violet color did not appear consistently with any one sample. It seems likely, therefore, that the violet color was caused by minute quantities of copper from contaminated test tubes or bottles.

Table III shows the results of the chemical tests. Sample No. 4 was checked by a fire assay; it ran 0.04 oz gold and 0.21 oz silver per ton, or about one-third the value calculated from the dithizone test. It is likely that the metals in the soil are in a more readily soluble form than the metals in the quartz which we used for a standard. The two hour digestion in aqua regia might, therefore, dissolve nearly all the metals in the soil but only a part of the metals in the quartz. The calculated "equivalent oz" would probably have been more nearly correct if a soil sample had been assayed and used as a standard. Because it is the relative metal content of the samples that is important, the samples were not recalculated.

CONCLUSIONS:

Sample No. 9, which was supposed to be the "barren" sample, had a higher metal content than some of the samples that were taken down the slope from the veins. We do not know enough about the underground geology to be certain that this sample was not taken near a

TABLE III

SAMPLE NO.	ML OF SOLUTION USED	"EQUIVALENT OZ" PER TON
1	1.1	0.55
1A	1.5	0.40
2	1.8	0.33
2A	1.0	0.60
3	1.0	0.60
3A	1.3	0.46
4	0.7	0.86
4A	0.7	0.86
4B	0.6	1.00
5	1.3	0.46
5A	1.0	0.60
6	1.5	0.40
7	1.5	0.40
7A	1.3	0.46
7B	1.4	0.43
8	0.7	0.86
8A	1.1	0.55
8B	1.0	0.60
9	1.0	0.60

vein.

The results were consistent; that is, the same sample could be tested a number of times, and the volume required for the color change would not vary appreciably.

Samples No. 4, 4A, 4B, and 8 mark two areas of high metal content. Unfortunately, we do not know enough about the position and tenor of the veins to know whether or not these high samples are near any ore-shoots.

More work must be done before we are sure that these methods can be adapted to prospecting for gold-silver veins. We can conclude from this experiment:

- (1) that the metal content of the soil in this area is great enough to give a reaction with dithizone, and
- (2) that the metal content of the soil varies from place to place.