UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

July 1957-December 1960

By Claire B. Davidson, Ellen L. Markward,

and John Cieslewicz

Volume 3

(Abstracts 372-505 and Subject index)

Open-file report

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Geochemical Prospecting Abstracts, July 1957-December 1960

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A compilation of 505 abstracts of papers on geochemical prospecting and applicable analytical techniques

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372 Safronov, N. I., 1957, Opyt geokhimicheskikh poiskov na krainem severo-vostoke SSSR [Geochemical prospecting in the extreme northeast part of the USSR]; in Krasnikov, V. I., ed., Geokhimcheskii Poiski Rudnykh Mestorozhdenii v SSSR; Moscow, Gosgeoltekhizdat, p. 236-241.

In the extreme northeast part of the U.S.S.R., the detrital Quaternary deposits are very coarse because of mechanical weathering. Mineral surveys--consisting of panning, trenching and schlich examination--are the principal prospecting methods employed together with geological mapping. Schlich surveys are carried out during geologic mapping on a scale of 1:50,000 or larger. With this method, the deposits of both permanent and intermittent streams are sampled. The examination of eluvial and glacial deposits for the presence of mechanical dispersion halos requires detailed work including mapping on a scale of 1:25,000 or larger. Long-line trenching is used for the detection of prospective targets on the slopes; and short-line or network trenching, for more detailed work. Metallometric surveys, for tin and molybdenum have been used.--Referat. Zhur. Geol., 1959, v. 9, abs. 19182.

373 Safronov, N. I., 1958, Kompleksirovanie poiskovykh metodov rabot primenitelno k osnovnym tipam mestorozhdenii tsvetnykh metalov [Selection of methods for complex studies in prospecting for principal types of nonferrous ore deposits]: Sovetskaya Geologiya, no. 8, p. 158-169.

The selection of different methods of prospecting for the principal types of nonferrous and rare-metal ores, covered by a layer of unconsolidated sediments not more than 10 m thick is discussed. The selection of a particular prospecting method or combination of methods for various types of ore deposits is determined by the following criteria: (1) the association of ore deposits with silicic-ferromagnesian intrusive rocks, (2) characteristic mineral composition, (3) ore-bearing tectonic structures, (4) development of mechanical or geochemical dispersion halos, (5) alteration of the country rock surrounding the ore deposit, (6) amount of electrical conductivity, magnetism, and radioactivity of ore. The sequence of use of different prospecting methods and specific scales for detailed prospecting work are recommended.--Referat. Zhur. Geol., 1959, v. 11, abs. 23754.

374 Safronov, N. I., Polikarpochkin, V. V., and Trushkov, Yu. N., 1960, Kompleksnye poiski mestorozhenii zolota [Complex methods of prospecting for gold deposits]: Sovetskaya Geologiya, no. 4, p. 92-110. [Russian, English summary]

Geophysical and geochemical methods used to discover primary and placer type gold deposits are discussed. The following geochemical methods have been proved useful: gold content survey [panning], tracing dispersion halos of gold in silt-clay fractions of water sediments, use of primary dispersion halos, hydrochemical and biogeochemical methods.--C.B.D.

375 Safronov, N. I., Polikarpochkin, V. V., and Utgof, A. A., 1958, Opytno-metodicheskie raboty po zoloto-metricheskoi semke v Vostochnom Zabaikale [Experimental work on gold survey methods in Eastern Zabaikal]: Sovetskaya Geologiya, no. 7, p. 130-137.

Experimental work to develop a practical method for gold surveys was conducted. The ore deposit selected for study consisted of a series of steeply dipping quartz veins in granite. These veins were as much as 50-200 m long and not more than 0.5 m thick. The gold content of the veins amounted to several grams per ton, occasionally attaining 20-30 g/t. The individual gold grains were 0.01-0.02 mm in size. A complex chemical-adsorption-spectral analysis was found to be the most effective metallometric method in searching for gold dispersion halos. The technique that was developed follows:

Using aqua regia, dissolve the gold in the sample, then extract it from the solution by adsorption on activated carbon. Burn the carbon adsorbent to an ash, and complete the gold determination by spectral analysis of the ash. This method has high sensitivity; it can detect gold in hundredth parts of 1 g/t. Furthermore, it is simple and adequately efficient for practical use; one person can analyse as many as 50 samples in 8 hours.

Safronov, N. I., Polikarpochkin, V. V., Utgof, A. A., 1958, Opytno-metodicheskie raboty po zoloto-metricheskoi semke v Vostochnom Zabaikale [Experimental work on gold survey methods in Eastern Zabaikal], continued

Gold dispersion halos were detected by this method in the soils and in the eluvial-glacial deposits overlying gold-bearing veins. The concentration of gold within the halos commonly amounts to hundredth or tenth parts of 1 g/t, occasionally attaining 1-50 g/t. The width of the halos is at least 50-60 m. Gold tends to accumulate in the finer size fractions (<1 mm; especially, <0.01 m) of eluvial-glacial sediments and soils. The analysis of plant ash indicates that gold tends to concentrate in woody plants (e.g., birch, larch); gold accumulations are not found in the grasses. Thus biogeochemical methods may be useful in prospecting for gold deposits.--Referat. Zhur. Geol., 1959, v. 9, abs. 19183.

376 Safronov, N. I., Polikarpochkin, V. V., and Utgof, A. A., 1958, Spektrozolotometricheskaya syemka kak metod poiskov zolotrudnykh mestorozhdeny ne soprovozhdayemykh mekhanicheskimi oreolami (rossypyami): Novoye Metodike i Tekhniki Geologorazvedochnykh Rabot, Sbornik 1, Leningrad, p. 100-108 (1960, English translation entitled Spectrographic aurimetric surveying as a method of prospecting for gold ore deposits not accompanied by mechanical halos (placers)): Internat. Geology Rev. v. 2, no. 3, p. 254-258.

At present, metallometric surveying is employed in prospecting for most of the commercially useful metals; for gold, however, this method had not been found practical. It has been assumed that all gold deposits are identifiable, by gravimetric survey, from their mechanical dispersion halos; and, in that gold is inert, identifiable in the supergene zone by its resistance to chemical change and migration. In addition, there have been available no analysis methods comparable in sensitivity and efficiency to those of gravimetric survey. Analysis methods for gold must show content of at least 0.05 grams per ton ($5x10^{-6}$ percent); and a safety factor, in addition, of twice that amount, or 2-$3x10^{-6}$ percent. Standard emission-spectral analysis has proven inadequate as has chemical analysis with respect to time consumption, expense, and degree of sensitivity. A combined chemical-adsorption spectral analysis of metallometric gold samples tested by VITR [All Union Scientific Research Institute for Prospecting Methods and Equipment] in 1956 was found to have the sensitivity (0.03 grams per ton, or $3x10^{-6}$ percent) as well as economy of operation necessary for general use. Essentially, this analysis process involves enrichment, accomplished in two stages, of a sorbent material with gold from analysis samples. The gold-enriched sorbent is analyzed

Safronov, N. I., Polikarpochkin, V. V., and Utgof, A. A., 1958,

Spektrozolotometricheskaya syemka kak metod poiskov zolotrudnykh mestorozhdeny ne soprovozhdayemykh mekhanicheskimi oreolami (rossypyami): <u>continued</u>

by ISP-22 or ISP-28 quartz spectrograph, and the results interpreted visually by comparison of spectra with those of the standard specimen (prepared immediately preceding the analysis process). In 1956, VITR completed a successful field-control test of this combined-analysis method in eastern Transbaikal; gold dispersion halos, undetected previously by the usual spectral-analysis method (without the concentration process), were located near the deposit. Concentration of gold in these halos was 0.05 grams per ton. Further investigation may make it possible to prospect for gold by testing certain plant species; thus utilizing the data on gold content of plants.--<u>D</u>.<u>D</u>. <u>Fisher</u>

377 Safronov, N. I., and Sergeev, E. A., 1958, Geokhimicheskie rudnopoiskovye metody i perspektyvy ik razvitiia [Geochemical methods of prospecting for ore and the outlook for their future development]: Vses. Nauchno-Issled. Inst. Metodiki i Tekhniki Razvedki Trudy v. 1, p. 22-39.

The effectiveness of geochemical prospecting methods can be improved as follows: (1) Increase the sensitivity for analytical determinations; (2) Increase the depth of sampling in metallometric surveys beyond the present limit of 5-10 m by possible use of radioactivation analysis; (3) Make better and more extensive use of laboratory facilities in metallometric surveys; (4) Broaden the scope of geochemical investigations to include studies of the relationship between ore mineralization and the distribution of elements in rocks.--Referat. Žhur. Geol., 1959, v. 11, abs. 23762.

378 Safronov, N. I., and Sergeev, E. A., 1960, Geochemical search methods for ore in the Soviet Union, in Geol. Rezul'taty Priklad. Geokhim. i Geofiz., pt. 1, Geokhimiya: Moscow, Gosgeoltekhizdat, p. 21-25. [Russian, English summary]

Geochemical prospecting methods, developed in the U.S.S.R. in the thirties, were first used in metallometric surveys and later were widely and successfully used in the search for metallic ore deposits, mainly molybdenum, lead, tin, and copper. At the present time secondary dispersion halos and indicator elements are the geochemical techniques most used in the search for ore deposits, for the concepts of primary dispersion halos are as yet in their initial stage. Hydrogeochemical and biogeochemical sampling methods are used less than systematic rock and soil sampling.

In 1958, 8.5 million samples were collected. Spectrographic analyses production (used more than chemical methods) results in 500 or more samples per shift per installation. The sensitivity of analyses approaches and often is below clarke values as much as 1 or 2 orders of magnitude. In the future the U.S.S.R. wants to develop prospecting methods for deep seated deposits, especially blind deposits fully concealed by enclosing rocks.--C. B. D. from authors' English summary.

379 Sakanoue, Masanobu, 1960, Geochemical studies on the radioactive sediments. II. Uranium content of natural waters from the Ningyo-Pass mining area: Jour. Chem. Soc. Japan, v. 81, p. 896-898. (English abstract in, Chem. Abs., 1960, v. 54, col. 22221)

380 Sakowitsch, W., 1958, Microchimique prospection du tungstène dans le Limousin /Microchemical prospecting for tungsten in Limousin/ /abs./: Geochim. et Cosmochim. Acta, v. 14, p. 164. /French/

In the course of investigations carried out by the B.R.G.G.M. /Bureau de Recherches Géologiques et Géophysiques/ in the Blond range (northwest of the Central Massif) on tungsten mineralized veins, systematic determinations of the tungsten content in soils were made by the dithiol method. The sampling techniques were as follows: (a) For detailed prospecting samples are taken 5 or 10 m apart on traverses 10 to 20 m apart perpendicular to the strike of the veins. (b) For reconnaissance prospecting samples are taken 20 m apart on traverses 80 m apart, but in zones of high content intermediate traverses are located 40 m apart. With this method four-fifths of a 2 sq km area was eliminated from further prospecting, and target areas were delineated.--Author's abstract freely translated by C.B.D.

381 Salmi, Martti, 1958, Soiden peittämän kallioperän vaikutus turpeiden pH-arvoihin [The pH values of peat as affected by underlying bedrock covered by peat bogs]: Geol. Tutkimuslaitos Geoteknillsiä Julkaisuja, no. 61, p. 29-39. [Finnish, English summary]

The relationship between pH of peat and underlying rocks was investigated in several peat bogs in Finland. Variations in mineralized bedrock are sharply reflected in the pH values of the overlying peat resulting in changes in types of peat bogs. Results indicate that pH measurements of peat can be used in prospecting for economic mineral deposits.--C. B. D.

382 Salmi, M., 1959, On peat-chemical prospecting in Finland: Internat. Geol. Cong., 20th, Mexico City, 1956, Symposium de Exploracion Geoquimica, v. 2, p. 243-254. (See U.S. Geol. Survey Bull. 1098-B, abs. 211.)

383 Salmon, M. L., and Hawkes, H. E., 1959, Fluorescent X-ray spectrographic analysis in geochemical prospecting [abs.]: Mining Eng., v. 11, no. 1, p. 40.

Analysis of samples collected in geochemical prospecting surveys calls for a high degree of economy and speed as well as adequate sensitivity and precision. Most geochemical surveys in North America have been serviced by the rapid methods of colorimetric analysis developed in the laboratories of the U.S. Geological Survey. These methods are capable of high productivity for samples requiring only a simple acid treatment. High productivity is not possible, however, where fluxing or ashing the samples is necessary.

Fluorescent X-ray spectrographic analysis provides a method of determining the individual concentrations of several elements in organic or inorganic and solid or liquid samples without destruction of the sample. This reduces the analytical processing of the samples to three steps: 1) sieving or pulverizing solid samples, 2) loading into individually sealed cartridges, and 3) X-ray spectrographic analysis by bombardment of the samples with a high energy X-ray beam and measurement of the intensity of the characteristic fluorescent X-ray of the element. The intensity of the fluorescent X-ray from the element is proportional to the concentration of the element in the bombarded sample. A continuous chart recording of the intensities (concentrations) for a sequence of samples provides a direct indication of relative concentrations. The chart can be obtained for about 30 cents per sample on a routine basis. Special modifications of the instrumental procedure make it possible to achieve a detection limit of about 10 ppm for copper and zinc. This is adequate for most cases.

Salmon, M. L., and Hawkes, H. E., 1959, Fluorescent X-ray spectrographic analysis in geochemical prospecting [abs.], continued

An application of this procedure to the analysis of peat muck overlying a sulfide deposit in eastern Canada is described.--Authors' abstract.

384 Saukov, A. A., 1958, Aktualnye zadachi geokhimii. (O dalneishem razvitii geokhimicheskikh metodov poiskov rud) [Present tasks of geochemistry. (Regarding further development of geochemical methods in prospecting for ore deposits)]: Akad. Nauk SSSR Vestnik, no. 3, p. 29-32.

Studies should be made of primary and secondary dispersion halos surrounding ore deposits to determine the composition, size, and morphology of the halo as well as the influence of geologic and climatic factors. Several little-understood problems in geochemical work should be investigated further: (a) The forms of occurrence of some ore elements in rocks and dispersion halos; (b) The diffusion and effusion of natural gases through rocks of different lithologies and their solubilities in different types of natural waters; and (c) The nature of dispersion halos in natural waters and solid phase migration of ore elements.

Geochemical provinces should be established in the U.S.S.R. to determine the background values of elements and to select the geochemical prospecting method most suitable for a specific geologic and topographic environment.--Referat. Zhur. Geol., 1959, no. 4, abs. 7344.

385 Saukov, A. A., 1958, Hydrogeochemical method for mineral deposit prospecting [abs.]: Internat. Geol. Cong., 20th, Mexico City 1956, Symposium de Exploracion Geoquimica, v. 1, p. 221. (See U.S. Geol. Survey Bull. 1098-B, abs. 213.)

386 Saukov, A. A., 1960, Migration of chemical elements as a theoretical basis for geochemical search methods, in Geol. Rezul'taty Priklad. Geokhim. i Geofiz., pt. 1, Geokhimiya: Moscow, Gosgeoltekhizdat, p. 5-14. [Russian, English summary] (See abs. 387)

387 Saukov, A. A., 1960, Migration of chemical elements as a theoretical basis of geochemical search methods: Internat. Geol. Cong., 21st, Copenhagen 1960, Geological results of applied geochemistry and geophysics, pt. 2, proc. sec. 2, p. 28-37.

1. As results of a migration of chemical elements during the formation or destruction of deposits, syngenetic and epigenetic dispersion aureoles and flows are formed around them within which concentrations of elements (c) are higher as compared with a natural background (N), i.e. for them the abnormality ratio is $K = \frac{c}{N} > 1$.

2. These aureoles are formed as a result of a migration of elements in gas, liquid and solid phases; of great importance are here effects of filtration and diffusion of gases and solutions, dissolution processes, gas exchange with the atmosphere etc. Depending upon a number of geological, physical-chemical and climatic factors are the scale of migration and sizes of aureoles and fluxes, which are always much in excess of the volume of the deposits themselves. This is of special interest from the point of view of their use in a search for deposits, including those which have no outcrops.

3. Of great interest is the behavior during migration processes of accompanying elements, which, in a number of cases, are more convenient indirect indicators of deposits than the direct indicators.

4. A great role is played in the formation of secondary aureoles and dispersion fluxes by physical and geographical conditions; that is why methods of geochemical exploration should take into consideration geochemical features of the landscape and the thickness of young loose deposits (various categories of exposure).

(continued)

Saukov, 1960 -- continued

5. Considerable experience in the study of dispersion aureoles in the USSR, summarized at a number of past conferences, has shown that these aureoles are actually indicators of deposits and can, depending upon their specific features, be established by certain methods of gas, bituminological, hydrogeochemical, metallometric or biogeochemical surveys. The report will quote examples of practical results obtained by geochemical exploration.--Author's abstract.

388 Saukov, A. A., and Perelman, A. I., 1957, Geokhimicheskie metody poiskov mestorozhdenii poleznykh iskopaemykh [Geochemical methods of prospecting for mineral resources]: Vses. Mineralog. Obshch. Zapiski, v. 8b, no. 2, p. 267-280.

This is essentially the same information as in abs. 348 .--Referat. Zhur. Geol., 1959, no. 5, abs. 10183.

389 Savadskii, O. A., 1958, O perspektivnoi otsenke oreolov rasseianiia polimetallicheskikh mestorozhdenii v Vostochnom Zabaikal'e [Concerning appraisal of the potential value of dispersion halos accompanying polymetallic ore deposits in Eastern Zabaikal]: Vses. Nauchno-Issled. Inst. Metodiki i Tekhniki Razvedki Trudy, v. 1, p. 40-45.--Referat. Zhur. Geol., 1960, v. 6, abs. 11512.

390 Schroll, E., 1958, Das Aufsuchen von Erzlagerstätten mit Hilfe geochemischer Methoden [Investigations of ore deposits by geochemical methods]: Tschermaks Mineralog. Petrograph. Mitteil., v. 6, no. 4, p. 429-432 [German]

391 Schrön, Werner, 1960, Anwendung der Dithizonchemie bei der geochemischen Prospektion [The use of dithizone chemistry in geochemical prospecting]: Zeitschr. Angew. Geologie, v. 6, no. 8, p. 395-397. [German, English summary]

Dithizone chemistry is a most suitable quantitative method of determination for geochemical prospecting. The dithizone method is distinguished by a very high sensitivity and considerable accuracy and, compared to spectral analysis and other methods, has the advantage of being usable as a field method. As dithizone chemistry makes great demands on the cleanliness of chemicals and equipment, the desired result is only obtainable by scrupulously clean operating techniques and precise observance of directions for procedure.--Author's summary

392 Science News Letter, 1957, Geochemical prospecting spots uranium deposit: Sci. News Letter, v. 71, no. 14, p. 213.

Geochemical prospecting methods were used to locate an underground uranium deposit in eastern Washington.—C.B.D.

393 Scott, R. C., and Barker, F. B., 1958, Radium and uranium in ground water of the United States: Internat. Conf. Peaceful Uses Atomic Energy, 2nd, Geneva 1958, Proc., v. 2, no. P/778, p. 153-157.

The normal background concentrations of radium and uranium in water from some of the principal water-bearing formations have been evaluated for 486 samples collected from places throughout the United States. The evaluation was expressed in 2 ways: the actual concentrations found in the samples, and a concentration ratio - the ratio of uranium (in ppb) and radium (in micromicrocuries per liter) to the dissolved-solids concentration in each sample. The medians and ranges of the concentrations and concentration ratios are shown for each geotectonic region of the United States. The United States has been divided into 10 major geotectonic regions: Gulf Coastal Plain, Atlantic Coastal Plain, Appalachian Paleozoic orogenic belt, Canadian shield, Ozark-Ouachita system, Eastern Central stable region, Western Central stable region, Rocky Mountain Cretaceous-Cenozoic orogenic belt, Colorado Plateau, and Pacific Paleozoic-Mesozoic-Cenozoic orogenic belt. The smallest median uranium concentrations were found in the Gulf and Atlantic Coastal Plains and the Ozark-Ouachita system. The smallest median uranium concentration ratios were in the Gulf and Atlantic Coastal Plains and Eastern Central stable region. The greatest median uranium concentration and concentration ratios were found in the Western Central Stable region and the Canadian shield, respectively. The smallest median radium concentrations and concentration ratios were in the Pacific Paleozoic-Mesozoic-Cenozoic orogenic belt, and the largest medians were found in the Ozark-Ouachita system.

Scott, R. C., and Barker, F. B., 1958, Radium and uranium in ground water of the United States: Internat. Conf. Peaceful Uses Atomic Energy, 2nd, Geneva 1958, continued

The concentrations of radium and uranium occurring naturally in ground water are determined by (1) the physical and chemical characteristics of the water and (2) the availability of the elements in the rocks through which the water has passed. Inferences concerning the geochemical cycles of these elements are drawn from their concentrations, the chemical characteristics of the water, and the geology of each geotectonic region. A threshold of significant concentration is suggested for hydrogeochemical prospecting in each geotectonic region.--Authors' abstract, in Geo. Sci. Abs., 1959, v. 1, abs. 1-919.

394 Seigel, H. O., Winkler, H. A., and Boniwell, J. B., 1957, Discovery of the Mobrun Copper Ltd. sulphide deposit Noranda Mining district, Quebec, in Methods and Case Histories in Mining Geophysics, Commonwealth Mining Metall. Cong., 6th, 1957, Montreal, Mercury Press Company, p. 237-245.

The Mobrun sulphide deposit was discovered by geophysical methods in an area which has been prospected intensively for forty years. The initial discovery was made by vehicle-borne electromagnetic instruments, and the conductor was determined to be of interest by virtue of a 1.3 milligal gravity anomaly with which it correlated. After the discovery, detailed electromagnetic, gravimetric, resistivity, magnetometric, spontaneous polarization and geochemical soil surveys were employed to give additional information. Quantitative interpretation of the results of the electromagnetic, gravimetric and resistivity surveys enabled accurate estimates of the following features of the sulphide body to be made prior to the drilling:

(a) Depth of cover;

(b) Average percentage of sulphide content in the central sections;

(c) Length, width and attitude;

(d) Total tonnage of sulphides.

The magnetometric, spontaneous polarization and soil sampling surveys gave no useful results as the body is non-magnetic and buried under the permanent water table beneath a shallow mantle of lacustrine clay. The nearest outcrop, non-mineralized rhyolite, is 1,600 feet distant from the sulphide body.--Authors' abstract

395 Serebrennikov, V. S., 1959, Seasonal variation in the uranium content of ground water: Akad. Nauk SSSR, Materialy Geol. Rudnykh Mestorozhdeniĭ, Petrog., Mineral. i Geokhim., p. 218-223. (English abstract in, Chem. Abs., 1960, v. 54, col. 20708)

396 Sergeev, E. A., and Stepanov, P. A., 1957, Spektral'nyi analiz metallometricheskikh prob [Spectral analysis of metallometric samples], in Krasnikov, V. I., ed., Geokhimicheskii Poiski Rudnykh Mestorozhdenii v SSSR: Moscow, Gosgeoltekhizdat, p. 329-385.--Referat. Zhur. Geol., 1960, v. 10, abs. 21111.

397 Shacklette, H. T., 1958, Biogeochemical sampling in Alaska [abs.]: Geol. Soc. America Bull., v. 69, p. 1756; 1958 in Science in Alaska: Alaskan Sci. Conf. ~~95h~~ 9th, College, Alaska.

Some results of research on methods of biogeochemical prospecting by the U. S. Geological Survey in Alaska during the summer 1957 are presented, and partial interpretations are given. Additional evidence indicates that planta accumulate metallic elements in far greater concentration than is found in the substratum.

The ability to absorb metallic elements varies with the species of plant; some species average 15 times as much (expressed in ash percentage) as others. Variations also exist in absorption of different elements within a single species; some average low in copper, lead, and zinc, others average high in these elements, and some average high in one element and low in others. Different parts or ages of growth show characteristic percentages of metallic-element accumulation, with very young and more than 2-year-old tissues showing the lowest. Variabilities of metallic-element accumulation within each species are presented as ratios of high to low concentration. All combinations of variability are found.

Shacklette, H. T., 1958, Biogeochemical sampling in Alaska [abs.]: continued

Ash yield, based on percentage of dry weight, ranges from 0.8 to 36 per cent. The more woody a tissue, the lower percentage ash yield. Correlation of metallic-element accumulation in plants with that found in the soil on which they are growing was made for 838 specimens. Positive correlations are common, particularly at the higher concentration levels in plants, but often the comparisons show no correlation. The complexity of interaction of the many factors involved presents difficulties which more extensive data, being gathered this current summer, may materially clarify.—*Author's abstract*.

398 Shacklette, Hansford T., 1960, Soil and plant sampling at the Mahoney Creek lead-zinc deposit, Revillagigedo Island, Southeastern Alaska in Geological Survey Research 1960: U.S. Geol. Survey Prof. Paper 400-B, p. 102-104.

Soil and plant samples were taken along 5 traverse lines that cross the vein of sphalerite and galena at Mahoney Creek. It was found that both classes of samples accurately reflect the known location of the mineral vein.--Author's abstract, in GeoSci. Abs., 1960, v. 2, no. 12, pt. 1, abs. 2-3540, p. 63.

399 Sharkov, Yu. V., 1956, O neobkhodimosti ucheta regionalnykh faktorov gipergennoi migratsii elementov pri geokhimicheskikh poiskakh na territorii Vostochnoi Sibiri i Dalnego Vostoka [Consideration of regional factors influencing supergene migration of elements in geochemical prospecting in Eastern Siberia and the Far East territories]: Materialy Soveshchaniia Geologov Vostochnoi Sibiri i Dalnego Vostoka po Metodike Geologo-Semochnykh i Poiskovykh Rabot, Chita, p. 575-579.

Different geochemical prospecting methods were used in Eastern Siberia and the Far East territories because the geography of the area is so varied. In the dry steppe area of Zabaikal, where brown soils are typical, the mobility of ore elements is very limited especially vertically, therefore, soil samples are collected from 15-20 cm during metallometric surveys. In the forest-steppe region where gray forest soils, and black soils are developed, such mobile elements as uranium, molybdenum, copper, zinc are easily leached out from the upper soil horizons. Although some less soluble elements such as lead, tungsten, tin are not removed, surface sampling is not advisable. However, hydrochemical methods can be employed in this region with good results. In the Siberian forest zone acidic, podzol, brown forest soils form, and ore elements, which are leached from the upper 30-40 cm of soil, accumulate in the "B" zone where samples are taken. Dispersion halos of soluble salts may also form under these conditions; furthermore, in areas free of permafrost biochemical methods can be applied with good results.--Referat. Zhur. Geol., 1957, no. 11, abs. 16109.

400 Sharkov, Yu. V., 1957, O neobkhodimosti uczeta pri metallometricheskikh poiskakh istorii razvitiia vtorichnykh oreolov rasseianiia [Importance of considering developmental history of secondary dispersion halos in metallometric prospecting]; in Krasnikov, V. I., ed., Geokhimicheskii Poiski Rudnykh Mestorozhdenii, v SSSR; Moscow, Gosgeoltekhizdat, p. 191-197.

A rare-metal ore deposit in Tertiary continental (Miocene and Pliocene) and Quaternary unconsolidated deposits was investigated. The highest concentration of ore elements was found in Miocene clays deposited under arid climatic conditions. In the upper horizons of the present soils the metal content decreases because of leaching resulting in halos of limited extent. The leaching of ore during Early Quaternary time took place at the erosion surface of the bedrock and may be responsible for the decrease of metal concentration within the present zone of weathering. Drill cores should be examined carefully when mapping buried dispersion halos.--Referat. Zhur. Geol., 1959, no. 7, abs. 14579.

401 Shatrov, B. B., 1959, Pervichnyi oreol rasseianiia Ekaterino-Blagodatskogo mestorozhdeniia /Primary dispersion halo of Ekaterino-Blagodatskoe ore deposit/: Novoye v Metodike i Tekhniki Geologorazvedoch. Rabot, Sbornik 2, p. 140-153. Referat. Zhur. Geol. 1960, no. 2, abs. 3309. (English abstract in, Chem. Abs., 1961, v. 55, col. 6273)

402 Shaw, W. H. R., 1960, A biogeochemical periodic table. The data, pt. 1 of Studies in biogeochemistry: Geochim. et Cosmochim. Acta, v. 19, p. 196-207.

Information of interest in biology, geology, and chemistry has been collected from the literature and summarized in a biogeochemical periodic table. Available data on abundance, geochemical character, nutritional importance, electronegativity, complexing tendency, oxidation state, covalent and/or ionic radius, ionic potential and ionization potential are reported for each element.--Author's abstract.

403 Shcherbina, V. V., 1957, Behavior of uranium and thorium in the sulfate-carbonate and phosphate environments of the supergene zone: Geochemistry, no. 6, p. 579-597.

In searching for radioactive ores, the method of dissemination halos in unconsolidated deposits and the evaluation of endogenetic ore formation according to the oxidation zones of the deposit are now more and more widely used. For solving these problems it is necessary to know the geochemical behavior of uranium and thorium in the supergene zone. The following types of halos are known: (1) Halos of a small radius with a sharp drop in the concentration gradient (high precipitability of uranium and thorium compounds); (2) a considerable dissemination halo at a distinct concentration gradient (intensive weathering of the deposit, good precipitability of compounds of the radioactive elements, a favorable relief); (3) a large dissemination halo with a small concentration change is usually produced by weak precipitability of uranium under the given conditions and a low relief; (4) halos are essentially absent--uranium and thorium are carried in the form of easily soluble compounds not precipitated by the surrounding rocks.

Shcherbina, V. V., 1957, Behavior of uranium and thorium in the sulfate-carbonate and phosphate environments of the supergene zone, continued

Depending on the conditions and the composition of the primary minerals of the ore deposit and the composition of the rocks, uranium may be transferred into the oxidation zone 1) in the form of relatively easily hydrolyzable sulfate--UO_2SO_4 (at pH <4.2); 2) in the form of colloid solutions (sols)--$[UO_2(OH)_2]n$ (at pH = 4.5-7.5); 3) in the form of complex uranocarbonate ions of the composition $[UO_2(CO_3)_3]^{4}$ stable at pH 7.5-10.9; 4) in the form of easily soluble (usually complex) compounds with organic soil oxides. Uranium precipitates from these solutions in consequence of the following reactions: 1) hydrolysis; 2) reduction of easily soluble hexavalent compounds to almost insoluble compounds (pitchblende); 3) formation of nearly insoluble salts (phosphates, arsenates, vanadates, molybdates, silicates); 4) destruction of easily soluble complex ions; 5) selective sorption by colloid minerals and organic compounds.

Thorium may be transferred in the form of the sulfate, dioxide sols and in the form of carbonate complexes. The capacity of migration of thorium is considerably less than that of uranium. Radium is transferred in the form of elementary cations Ra^{2+} and coprecipitates with nearly insoluble sulfates ($BaSO_4$) or is selectively sorbed by a number of colloid minerals. These data are of use in searching for uranium deposits by means of dissemination halos and oxidized outcrops.--Author's abstract.

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404 Shea, F. S., 1960, Exploration along the Windsor-Horton Contact, Nova Scotia: Canadian Mining Jour., v. 81, no. 4, p. 105-108.

Extensive geochemical surveys by the Geological Survey of Canada have indicated high concentrations of metallics in stream sediments and soils in areas underlain by the Windsor-Horton series (Mississippian). These surveys have recorded in stream sediments up to 2,500 ppm lead, 1,500 ppm zinc, and 256 ppm copper. Anomalous amounts of silver have been found in soils and stream sediments, particularly around old iron, manganese and barite deposits, and in amounts up to 100 times normal for sedimentary rocks in certain sections along the contact.--Excerpted by C.B.D.

405 Shiikawa, Makoto, 1960, Studies on the bedded limonitic iron-ore deposits in Japan with special reference to their genesis and minor elements: Mining Geology [Japan], v. 10 (2), no. 40, p. 65-84 [Japanese, English abstract].

The bedded limonitic iron-ore deposits found in Japan are genetically classified into two major types, i.e., the hypogene type and the supergene type. Furthermore, the hypogene type may be subdivided into the simple hypogene and the complex hypogene type, and the supergene type may be subdivided into the secondary-enrichment supergene and the concentration supergene type.

Though all the ores from any of these deposits types are mainly composed of goethite, the types are characterized by the minor elements. Some of these elements are useful as indicators in prospecting for iron-sulphide deposits under or near the limonitic iron-ore deposits.

Around many volcanic craters, the following zonal arrangement can be observed outward from the center: solfatara, sulphur deposits, strongly acidic hot springs, limonite deposits of the simple hypogene type, ferruginous springs, moderately to weakly acidic hot springs, and neutral or weakly alkalic hot springs. This arrangement is a useful geologic tool in discovering new limonite deposits of the simple hypogene type.

As plants - particularly the living bryophyta - are considered to play a more important role than iron-bacteria, the writer describes the mechanism of iron-ore deposition from the botanical point of view.

(continued)

The limonitic iron-ore bed of the Kamikita mine was sampled systematically along the Okuno-sawa valley. This bed is of the secondary-enrichment supergene type. The samples were analyzed spectrographically for minor elements, and the behaviour of these elements is explained from the viewpoint of their ion-potential.-- Author's abstract.

406 Shima, Makoto, 1957, Geochemical prospecting method for uranium deposits. I. Autoradiography: Sci. Research Inst. Repts. [Tokyo], v. 33, p. 165-167.

Geiger and scintillation counters, and autoradiography are used in prospecting for uranium deposits.--C. B. D.

407 Shima, Makoto, 1958, Geochemical prospecting method for ore deposits. II. Inside prospecting method. III. Interpretation of the result: Inst. Phys. and Chem. Research Sci. Papers [Tokyo], v. 52, p. 229-241.

Discusses the application of geochemical prospecting methods to analysis of the distribution of trace elements in the hanging and footwalls and elsewhere in the vicinity of ore deposits, citing the results of such exploration in the country rock of several Japanese mines.--Annot. Bibliography of Econ. Geology, 1959, v. 32, p. 120.

408 Silman, J. A., and Garrels, R. M., 1959, Solubility of copper in natural waters and its application to geochemical prospecting [abs.]: Mining Eng., v. 11, no. 12, p. 1232.

The stability of azurite, malachite, brochantite, and langite ($Cu_4(OH)_6\ SO_4 \cdot 1.3\ H_2O$) in water at 25°C. and 1 atmosphere total pressure were determined by solution and precipitation techniques. Their standard free energies of formation from the elements at 298°K and 1 atmosphere total pressure are: azurite -343.73 ± 0.08 kcal, malachite -216.44 ± 0.05 kcal brochantite -434.62 ± 0.02 kcal, langite -505.1 ± 0.1 kcal.

Analysis of the solubility data permit calculation of the following dissociation constants:

$$\frac{[Cu^{++}][Co_3{}^{--}]}{[CuCO_3{}^{\circ}]} = 10^{-6.8}$$

$$\frac{[Cu^{++}][CO_3{}^{--}]^2}{[Cu(CO_3)_2{}^{--}]} = 10^{-10}$$

$$\frac{[Cu^{++}][CO_3{}^{--}][OH^-]^2}{[CuCO_3(OH)_2{}^{--}]} = 10^{-15}$$

The preceding data permit calculation of approximate maximum solubilities of copper in natural surface waters containing chiefly sulfate and bicarbonate as anions. Diagrams showing solubility as a function of pH, sulfate, and CO_2 species demonstrate that in many natural waters the chief soluble species below pH7 is Cu^{++}, between pH 7 and 10 is $CuCO_3{}^{\circ}$, and above pH 10 is $Cu(CO_3)_2$. The absolute solubilities appear to be so low that detection of copper by current geochemical prospecting techniques in waters with pH values higher than 7 is unlikely. Exceptions may occur in highly saline waters.--*Authors' abstract*.

409 Slavina, G. P., 1957, O vozmozhnosti ispolzovaniia mikroorganizmov pri poiskakh rudnykh mestorozhdenii [Concerning the possibility of using microorganisms in prospecting for ore deposits]; in Krasnikov, V. I., ed., Geokhimicheskii Poiski Rudnykh Mestorozhdenii v SSSR; Moscow, Gosgeoltekhizdat, p. 320-305.

The relationship between the chemical composition of organisms and their environment can be used in biogeochemical prospecting. Usually higher plants are examined in biogeochemical prospecting for lead, zinc, and molybdenum deposits. However, bacteria may also be used because their growth can be stimulated or inhibited by different amounts of metal salts. Field and laboratory investigations were conducted to study and experiment with several different types of microorganisms. Heptano-oxidizing bacteria grow in concentrations of 0.00001-0.001 percent of molybdenum, tungsten or manganese, 0.0001 percent of zinc, and up to 0.001 percent of lead. Copper in any concentration and lead in concentrations exceeding 0.001 percent are toxic. Molybdenum stimulates the growth of the nitrogen bacteria. The fungus Asperillus is favored by the presence of molybdenum and lead in concentrations of about 0.00001 percent.

The investigations showed that heptano-oxidizing bacteria are most suitable for this kind of biogeochemical prospecting work. The results of microbiological studies and metallometric work conducted on several ore deposits in Zabaikal and Kazakhstan were compared. Dispersion halos of molybdenum coincided with areas of increased bacterial growth. In several areas microbiological studies detected anomalous zones overlooked in previous metallometric work.--Referat. Zhur. Geol., 1959, no. 7, abs. 14583.

410 Slawson, W. F., and Nackowski, M. P., 1957, Lead in potassium feldspars associated with ore deposits [abs.]: Geol. Soc. America Bull., v. 68, p. 1796.

The information in this abstract is essentially the same as abs. 412.

411 Slawson, W. F., and Nackowski, M. P., 1958, Lead in potassium feldspars from basin and range quartz monzonites [abs.]: Geol. Soc. America Bull., v. 69, p. 1644.

The information in this abstract is essentially the same as abs. 412.

412 Slawson, W. F., and Nackowski, M. P., 1959, Trace lead in potash feldspars associated with ore deposits: Econ. Geology, v. 54, p. 1543-1555.

The amount of trace lead in potash feldspars can be correlated with the lead ore deposits associated with igneous rocks. The lead content of potassium feldspars separated from several quartz monzonite intrusives of the Basin and Range province has been determined spectrochemically. Samples were collected from the Tintic, West Mountain (Bingham), Park City-Little Cottonwood, and Iron Springs mining districts in Utah, and from the Robinson mining district and the Whitehorse Pass area in Nevada.

A spectrochemical precision of ±12% was obtained using an internal standard of bismuth. The accuracy of selected analyses were checked independently.

Each mining district or area sampled belongs to a different trace lead population. The mean lead concentrations and the standard deviations are:

1. Robinson mining district, 14 ± 6 ppm lead,
2. Iron Springs mining district, 15 ± 3 ppm lead,
3. Tintic mining district, 29 ± 10 ppm lead,
4. Whitehorse Pass area, 41 ± 8 ppm lead,
5. Park City-Little Cottonwood mining district, 47 ± 20 ppm lead,
6. West Mountain (Bingham) mining district, 61 ± 20 ppm lead.

Slawson, W. F., and Nackowski, M. P., 1959, Trace lead in potash feldspars associated with ore deposits: continued

The potassium feldspars from lead mining districts have a higher trace lead content than those from areas where there is no lead production, or where lead production is not significant.

The potassium feldspars from hydrothermally altered intrusives contain less lead than spatially related unaltered intrusives.--Authors' abstract.

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413 Smirnov, S. I., 1958, K voprosu o gidrogeokhimicheskikh kriteriiakh poiskov rudnykh mestorozhdenii v Iuzhnom Primor'e [Concerning criteria of hydrogeochemical prospecting in the Southern Coastal region]: Voprosy Gidrogeol. i Inzh. Geol., Moscow, p. 24-33.--Referat. Zhur. Geol., 1961, v. 3, abs. G522 (English abstract in Chem. Abs., 1961, v. 55, col. 6277)

414 Smith, Arthur Y., 1960, Heavy-metal (Zn, Pb, Cu) content of stream sediments of part of Westmorland County, New Brunswick: Canada Geol. Survey Paper 59-12, ~~12~~ 8 p.

The results of the investigation indicate that the amounts of total extractable zinc, lead, and copper in the stream sediments of the area are low. Anomalous amounts of zinc are more widespread than those of lead and copper, and appear to have less meaning. Copper and lead anomalies are clustered within the Dorchester area, particularly in the vicinity of the old Dorchester copper mine. Some of these are definitely related to the dumps of this mine; others in the area, however, are well removed from known dumps and may indicate other deposits of the Dorchester type.

Elsewhere, anomalous amounts of lead and copper occur in isolated samples in the areas of low background. These must be regarded as real features, particularly where the sample is anomalous for more than one metal. In assessing such anomalies the nature of the known deposits, such as their small size and sporadic distribution in the bedded sedimentary rocks, must be considered.-- From lc ~~A~~uthor's introduction.

415 Smith, G. H., and Chandler, T. R. D., 1958, A field method for the determination of uranium in natural waters: Internat. Conf. Peaceful Uses Atomic Energy, 2nd, Geneva 1958, Proc., v. 2, no. P/298, p. 148-152.

A simple method has also been developed for field use in geochemical prospecting. It is based upon the formation, at a pH of about 6, of the yellow-colored uranium dibenzoylmethane complex which is extracted from the water sample with carbon tetrachloride. The organic phase is separated from the water, and its color intensity compared visually with that of a set of standards. In this way it is possible to detect amounts of uranium down to 1 µg U_3O_8. The dibenzoylmethane is added to the water sample as a 0.5 percent w/v solution in a 1:1 v/v pyridine-water mixture containing 0.6 percent w/v ethylenediaminetetra acetic acid (disodium salt) to complex interfering metallic ions. Ascorbic acid is also added to the water sample to eliminate the interference otherwise caused by ferric iron. It was found that many waters contained organic matter that caused emulsification and orange-brown colors in the carbon tetrachloride layer. To remove this interference, several types of adsorbent material were examined including silica gel, activated alumina, kaolin, precipitated manganese dioxide, and several grades of activated charcoal. Of these, certain grades of activated charcoal proved to be the most satisfactory. The adsorbent is added to the acidified water sample which is then filtered and neutralized with alkali before proceeding with the method. It was found that the addition of 2 percent v/v of silicone fluid to the carbon tetrachloride helped to prevent emulsification, as does the addition of sodium chloride to the aqueous phase.--Authors' abstract, in Geo. Sci. Abs., 1959, v. 1, no. 4, abs. 1-975.

416 Sochava, V. B., 1954, Geobotanicheskaya karta SSSR: Priroda, no. 10, p. 36-42. (1960, English translation entitled Geobotanical map of the U.S.S.R.: Internat. Geology Rev., v. 2, no. 4, p. 311-321).

A newly compiled geobotanical map of the U.S.S.R. scale 1:4,000,000 is described. Two hundred and ten categories of vegetation are mapped, classified under 15 major groups. The relation of the mapped vegetation units to climate, soil, ground condition (permafrost), watersheds, and major geomorphic features is emphasized.--M. Russell

417 Sochevanov, N. N., 1958, Oprobovanie rykhlykh otlozhenij po vertikali na stadii predvaritelnoi razvedki [Vertical profile sampling of unconsolidated bedrock-cover in the preliminary stages of exploration]: Razvedka i Okhrana Nedr, no. 1, p. 12-21.

An anomaly found in a metallometric survey may not always indicate an ore body. Often the origin of the anomaly is obscure. This is particularily true of anomalies found in weathered deposits in place and in glacial deposits more than 3 m thick. It is necessary to determine the distribution of the trace metals through a vertical section to interpret the anomaly. Samples should be obtained from the walls of trenches or prospecting pits. Sampling can be cursory or systematic. Cursory sampling is most effective for early prospecting work and for preliminary examination of located deposits. Systematic sampling is used to trace the strike of outcrops, of ore bodies, or ore-bearing strata.--Referat. Zhur. Geol., 1958, no. 10, abs. 18104.

418 Sokolov, I. Yu., 1957, Laboratornaia apparatura dlia geokhimicheskikh issledovanii [Laboratory equipment for geochemical research], in Krasnikov, V. I., ed., Geokhimicheskii Poiski Rudnykh Mestorozhdenii v SSSR: Moscow, Gosgeoltekhizdat, p. 381-383.--Referat. Zhur. Geol., 1960, v. 7, abs. 12970.

419 Solodov, N. A., 1960, Distribution of alkali metals and beryllium in the minerals of a zoned pegmatite in the Mongolian Altai: Geochemistry, no. 8, p. 874-885.

Samples of microcline, albite, muscovite, spodumene, quartz, beryl, lepidolite, garnet and tourmaline, selected from various zones of strongly differentiated pegmatite were analyzed for K, Na, Li, Rb, Cs with the aid of the flame photometry method and by the spectral method for Be. As a result it was determined that the Rb and Cs content increases in all the minerals from the periphery to the center of the vein, the Be content decreases, and Li behaves irregularly.--Author's abstract.

420 Solovov, A. P., and Kunin, N. Ya., 1960, Metallometricheskai͡a s'emka po potokam rasseianii͡a v gornykh raionakh [Metallometric survey by following dispersion streams - in mountainous regions]: Sovetskaya Geologiya, no. 5, p. 32-46.--Referat. Zhur. Geol. 1961, v. 2, abs. G543. (*English translation in*, Internat. Geology Rev., 1961, v. 3, no. 11, p. 998-1010. See Geochemical Prospecting Abstracts, January 1961-December 1962)

421 Solow, Herbert, 1959, Geochemistry: The prospector's new tool: Fortune, v. 59, no. 2, p. 126-129, 176, 178, 182, 184.

The first step in producing anything with a metal component is to find the metal. Yet, the technological revolution that has come to every phase of the metal industry is coming last of all to prospecting. Geochemical methods are an important part in the technological revolution in mineral prospecting.

Basically, geochemical prospectors determine for a given region a normal trace amount of a particular element. They then sample for anomalous amounts of the element, which may or may not lead to an ore deposit. Among deposits so found are: an extension of a know antimony deposit near Ketchikan, Alaska; the Colorado Plateau Yellow Cat uranium district; Utah's Chief lead mine extension in the Tintic district; and the Murray Brook, New Brunswick, base-metals deposit; a copper-iron deposit in British Columbia; also many foreign deposits.

Geochemical prospecting, tried 1500 years ago in China, and much later developed by Agricola (De Re Metallica, 1556), became an important exploration tool in Soviet mineral exploration under A. E. Fersman in the 1930's. It was also used in Sweden and Finland. The U.S. Geological Survey created the Geochemical Exploration Section at Denver in 1946. This is today, outside the U.S.S.R., the main center of the new prospecting technology.

Solow, Herbert, 1959, Geochemistry: The prospector's new tool:

Fortune, v. 59, no. 2, p. 126-129, 176, 178, 182, 184, continued

The use of geochemical methods has been made practical by the development of new testing procedures that can be carried out quickly and economically in the field. These include colorimetry, paper-chromatography, emission spectroscopy, biogeochemistry, and geobotany, and are generally crude but cheap.

Many problems in geochemical prospecting remain unsolved, and results are not always as they might appear. Geochemical prospecting will never be a substitute for geology or geophysics, but it is now and will continue to be an important tool in the prospector's kit.--G. E. Denegar, in GeoSci. Abs., 1959, v. 1, abs. 1-957.

422 Stanton, R. E., 1959, The application of white spirit in field dithizone colorimetry: Econ. Geology, v. 54, no. 8, p. 1577-1578.

Discussion of a paper by V. G. Hill. (See abs. 188). In colorimetric determinations for copper, lead and zinc, benzene or toluene are preferable to white spirit as solvents of dithizone because they form more stable solutions.--C.B.D.

423 Stanton, R. E., and Coope, J. A., 1958, Modified field test for the determination of small amounts of nickel in soils and rocks: Inst. Mining Metallurgy Trans. [London], v. 68, pt. 1, p. 9-14.

A modification of methods already in use for the determination of minute amounts of nickel salts in soils is described. A nickel furildioxime complex extracted with benzene is used in colorimetric comparisons with a series of standards similarly prepared.

1. Weigh 0·2 g of sieved sample into a borosilicate test tube.
2. Mix with 1 g of potassium bisulphate (fused, powder).
3. Fuse until frothing has ceased, and heat for a further 2 min.
4. Allow the melt to cool, and then add 5 ml of N-hydrochloric acid.
5. Digest on a sand-tray until the melt has disintegrated.
6. Pipette an aliquot of 2 ml into a test tube containing 5 ml of buffer solution.
7. Add 1 ml of α-furildioxime solution.
8. Cork the tube and shake vigorously for 2 min.
9. Compare the intensity of yellow in the solvent phase with a set of standards.
10. If the unknown has a greater intensity than the highest standard, dilute with a known volume of benzene until it is within the range of the standards.

Stanton, R. E., and Coope, J. A., 1958, Modified field test for the determination of small amounts of nickel in soils and rocks, continued

11. The nickel content in parts per million is obtained from the expression

$$\frac{b \times v \times d}{w \times a}$$

where b = matching standard (g)

v = volume of solvent phase (ml)

d = volume of leach solution (ml)

w = weight of sample (g)

a = aliquot taken (ml)

- Authors' synopsis and procedure.

424 Starikov, V. S., 1960, Opyt primeneniia gidrokhimicheskogo oprobovaniia na primere Kakadur-Khanikomskogo mestorozhdeniia v Severnoi Osetii [Application of hydrogeochemical sampling of the Kakadur-Khanikomsk deposit in Northern Osetiia]: Vyssh. Ucheb. Zavedenii Izv., Tsvetnaia Metallurgiia, v. 3, p. 8-11.

Hydrogeochemical studies of the Kakadur-Khanikomsk polymetallic deposit in Northern Osetiia proved that increased concentrations of the sulfate ion can be used as a prospecting indicator. The background concentration of SO_4^{--} in the waters ranges from 3 to 9 mg/l. However, sharp anomalies of 32 to 82 mg/l of SO_4^{--} are recorded 450-500 m downstream from the points where waters draining polymetallic ore deposits enter the streams. In big rivers this halo is less distinct and extends only 100 m downstream. Sodium-potassium hydrocarbonate waters contaminated with H_2S may be related to concealed deep-seated tectonic fractures.--Referat. Zhur. Geol., 1961, v. 1, abs. G536.

425 Straczek, J. A., and Ganeshan, K., 1960, Geochemical studies in the Zawar zinc-lead area, Udaipur district, Rajasthan, India: Internat. Geol. Cong., 20th, Mexico City 1956, Symposium de Exploracion Geoquimica, v. 3, p. 555-584. (See U. S. Geol. Survey Bull. 1098-B, abs. 228.)

426 Straczek, J. A., Srikantan, B., and Adyalkar, P. G., 1960, Geochemical prospecting in the Khoh-Dariba copper area, Alwar District, Rajasthan, India: Internat. Geol. Cong., 20th, Mexico City 1956, Symposium de Exploración Geoquimica, v. 3, p. 501-520. (See U.S. Geol. Survey Bull. 1098-B, abs. 229.)

427 Stremyakov, A. Ya., 1958, The application of hydrochemical methods of prospecting for ore deposits in permafrost environments: Razvedka i Okhrana Nedr, v. 24, no. 3, p. 46-47. English translation in Associated Tech. Services, Inc., RJ-1571, 3 p.

The hydrochemical method of exploration is possible where ore bodies crop out in the areas of seasonal thaw in permafrost regions. The sulfate ion can be used as a prospecting indicator in areas of sulfide ore outcrops because of increased sulfate ion content in surface water, but it is most useful in mountainous areas. Further studies of the SO_4/HCO_3 ratio may be desirable in areas in which increased sulfate content is not influenced by the presence of ore bodies.--C. B. D.

428 Stubles, Morris F., 1958, Geochemical problems as student projects: Jour. Chem. Education, v. 35, no. 10, p. 557-558.

Students at the New Mexico Institute of Mining and Technology, Socorro, carried out a biogeochemical investigation in the Copper Flat area, near Hillsboro, New Mexico, to determine if desert plants could be utilized to detect anomalous amounts of copper. Studies indicated the plants Spanish Bayonet, Prickly Pear and Emory Oak might be used as copper concentration indicators.--C. B. D.

429 Sveshnikov, G. B., 1957, Opyt gidrokhimicheskikh issledovanii v Priirtyshskom raione Rudnogo Altaia [Hydrochemical investigations in the Pri-Irtish region of Rudnyi Altai]; in Krasnikov, V. I., ed., Geokhimicheskii Poiski Rudnykh Mestorozhdenii v SSSR; Moscow, Gosgeoltekhizdat, p. 280-285.

Rocks in this region consist of schists, granites, gneisses and tuffs. The Belousov sulfide deposit containing pyrite, sphalerite, galena, tetrahedrite and chalcopyrite is found at a depth of 80 m. A well-developed oxidation zone consisting of limonite and supergene copper and lead minerals penetrates to a depth of 50 m. The ore deposits are covered with Quaternary sediments from 25-125 m in thickness. In this study water samples were collected from mine pits and wells both in the area of ore deposits and in the country rock for background content. It was determined that the water came from the contact zone between the bedrock and the overlying Quaternary rocks. Analytical methods for determining the chemical composition of water samples are given.

The following background values of the region were established: copper, 4×10^{-6} g/l; lead, $6\text{-}8 \times 10^{-6}$ g/l; and zinc, $1\text{-}1.2 \times 10^{-5}$ g/l. The total mineralization of subsurface water was as high as 10 mg-equiv/l when pH ranged from 7.15 to 7.8. Analyses of well samples showed that several chemical changes occurred in the subsurface water with increased depth: (a) The concentration of the sulfate ion decreased from 3.9 to 1.7 mg-equiv/l; (b) the concentration of the chloride ion increased from 0.8 to 2.1 mg-equiv/l; (c) the pH changed from 7.45 to 8.05; the zinc and lead content varied from 5×10^{-4} to 2×10^{-5} g/l and from 5×10^{-5} to 1×10^{-5} g/l respectively.

Sveshnikov, G. B., 1957, Opyt gidrokhimicheskikh issledovanii v Priirtyshskom raione Rudnogo Altaia [Hydrochemical investigations in the Pri-Irtish region of Rudnyi Altai], continued

Anomalous values of zinc and copper concentrations were recorded both in pit and well-water, for a distance of 2 km from the ore bodies. Generally, redox potential fluctuates between 260 and 435 mv, but in the waters circulating through the ore bodies it ranged from 575 to 650 mv. Increased concentrations of zinc, copper, and lead were recorded at a distance of 8-11 km from the No. 2 ore deposit.--Referat. Zhur. Geol., 1959, no. 5, abs. 10192.

430 Sveshnikov, G. B., 1958, Gidrokhimicheskie issledovaniia v osmovnykh polimetallicheskikh raionakh Rudnogo Altaia [Hydrochemical studies in the basic-polymetallic regions of Rudnyi Altai]: Vses. Nauchno-Issled. Inst. Metodiki i Tekhniki Razvedki Trudy, no. 1, p. 74-99.--Referat. Zhur. Geol., 1959, v. 7, abs. 14582 (English abstract in, Chem. Abs., 1961, v. 55, col. 258.)

431 Sveshnikov, G. B., 1960, Electrochemical solution of sulfide ores and its role in the formation of heavy-metal dispersion halos, _in_ Geol. Rezul'taty Priklad. Geokhim. i Geofiz., pt. 1, Geokhimiya: Moscow, Gosgeoltekhizdat, p. 71-77.

Ore-forming elements are not present in ground water in the same proportion in which they occur in ore bodies through which the water circulates. The author attributes this phenomenon to the combined effect of oxidation and electrochemical solution. The role of electrochemical solution is responsible for the formation of halos in deep-seated ore bodies where chemical oxidation is mostly absent. The ores studied were: (1) pyrite, chalcopyrite, galena and sphalerite; (2) sulfide-nickel-ores containing pyrrhotite, pentlandite, and chalcopyrite; and (3) copper-molybdenum ores consisting of molybdenite, chalcopyrite, and pyrite.--C. B. D.

432 Swingle, George D., and Maher, Stuart W., 1958, Exploration for radioactive deposits in Northeast Tennessee [abs.]: Geol. Soc. Amer. Bull., v. 69, no. 12, pt. 2, p. 1718.

Recent investigations by the Tennessee Division of Geology of anomalously radioactive areas in Northeast Tennessee have revealed a variety of radioactive deposits. The deposits occur in the Precambrian crystalline rocks and in the basal clastic rocks which overlie them. The deposits in the sediments are heavy-mineral concentrations of limited areal extent, but which occur in various stratigraphic zones. Uranium- and thorium-uranium-bearing pegmatite vein deposits occur in the crystalline complex.

Geologic guides for the pegmatite and vein deposits are fracture zones and altered rocks which occur in the Beech granite-Cranberry granite contact.

Radioactivity of the deposits in most natural exposures is due to the presence of the resistate thorium-bearing materials.

Analyses of surface waters for uranium indicate that the average background in the region of the deposits is 0.20 ppb or less, whereas values above this represent anomalies.--Authors' abstract

433 Takimoto, Kiyoshi, Okuda, Taizo, and Hikotani, Naoji, 1958, Geochemical prospecting for manganese by soil analysis: Mining and Metall. Allumni Assoc. Trans. [Kyoto Univ.], v. 13, p. 669-672. (English abstract in, Chem. Abs., 1959, v. 53, col. 13908)

434 Tanner, A. B., 1958, Increasing the efficiency of exploration drilling for uranium by measurement of radon in drill holes: Internat. Conf. Peaceful Uses Atomic Energy, 2nd, Geneva 1958, Proc., v. 3, no. P/1908, p. 42-45.

Under favorable conditions the emanation method (migration of radon-222) is recommended in the initial stages of exploratory drilling for uranium because of reduced cost and reliable results. Application of the method depends on the right atmospheric pressure and a geologic environment where the ore horizon is above the water table, and where there is sufficient fracturing or permeability of ore-bearing rock for radon migration of tens of feet into drill holes. Under these conditions the distance between drill holes may be increased without missing ore bodies because the radon samples are representative of a greater volume of rock than gamma ray logs and drill hole samples.--C. B. D.

435 Tanner, Allan B., 1960, Usefulness of the emanation method in geologic exploration, *in* Geological Survey Research 1960: U.S. Geol. Survey Prof. Paper 400-B, p. B111-B112.

Most emanation anomalies are probably produced by migration of radium rather than radon. For radon anomalies the maximum detectable depth is about 30 ft. if the overburden is dry and coarse and much less if it is moist or clayey.--Author's abstract, in Geo. Sci. Abs., 1960, v. 2, abs. 2-3419.

436 Tauson, L. V., 1958, Geochemistry of Pb and Zn in granitoids: Internat. Geol. Cong., 20th, Mexico City 1956, Symposium de Exploracion Geoquimica, v. 1, p. 47-62. [Russian] (See U.S. Geol. Survey Bull. 1098-B, abs. 232.)

437 Tennant, C. B., and White, M. L., 1959, Study of the distribution of some geochemical data: Econ. Geology, v. 54, p. 1281-1290.

An examination of geochemical data is made by statistical methods. Values are plotted on logarithmic probability paper. In most cases results suggest that more than one distribution may be present.

Examples and proposed interpretations are given for data for mineralization in rock and soil, for biogeochemical values, for iron in soil, and clay size material in soil.

It is suggested that such tests may be useful in exploration and in evaluation of some of the large amounts of collected geochemical data.--Authors' abstract.

Theobald, P. K., Jr., 1957, The gold pan as a quantitative geologic tool: U.S. Geol. Survey Bull. 1071-A, p. 1-54.

The gold pan or a similar device has been mentioned throughout recorded history as a valuable instrument for concentrating heavy minerals. The absence of quantitative studies of the accuracy of this tool led to the work presented here. A series of 26 samples of alluvium from the beds and banks of streams were separately panned into a tub and the tailings from each panning were repanned until the remaining concentrate was insignificant. The ratio of the weight of a mineral in the first concentrate from a sample to the total weight of the mineral in the concentrates from all the pannings of that sample, expressed as percent, is termed the recovery and is used as a measure of the accuracy of the gold pan.

The recovery of minerals is related to the type of material sampled, the grain size of the mineral, the shape of the grains, and the specific gravity of the mineral. The highest recoveries are from samples containing only small amounts of silt or clay. Samples with large proportions of silt and clay must be washed to remove these constituents before panning may be started, and a part of the heavy minerals is lost in suspension with the clay and silt. Elongate grains of about 65 mesh are most easily saved, and tabular or platy grains are the most difficult to save. There appears to be a direct relation between specific gravity and recovery. The greatest loss of heavy minerals is in the last part of the process of panning when the proportion of these minerals is greatest. Several suggestions are offered to reduce the effect of these factors and to improve the recovery.

The gold pan is an extremely satisfactory tool for concentrating heavy minerals, and with it much valuable information, of both economic and academic importance, can be obtained.--<u>Authors' abstract</u>.

439 Theobald, P. K., Hawkins, D. B., and Lakin, H. W., 1958, Composition of water and precipitates in the confluence of Deer Creek with Snake River, Summit County, Colorado [abs.]: Geol. Soc. America Bull., v. 69, p. 1651-1652.

Oxidation of disseminated pyrite in aluminous and relatively silicic schists and gneisses of the Snake River drainage basin provides abundant iron sulfate to ground and surface water. The acid water thus produced (pH near 3.5) dissolves large quantities of readily available elements, particularly aluminum, and surprisingly large quantities of elements that are not abundant in the drainage basin, such as magnesium and zinc. The adjoining drainage basin to the west, that of Deer Creek, is underlain by calcic and magnesian rocks, from which the water acquires a pH of near 8. Despite base- and precious-metal veins in its drainage basin, Deer Creek carries less copper and zinc than Snake River.

Chemical precipitates are abundant; the precipitate on the bed of Snake River is hydrated iron oxide containing small quantities of the other metals; in Deer Creek the precipitate is a hydrated oxide of manganese and iron that contains large quantities of the other elements. At the junction of these streams the pH stabilizes toward 6.5. Iron and manganese are precipitated from Snake River water within a few feet of the confluence, but aluminum is precipitated for several miles downstream. The aluminum precipitate contains other metals in concentrations slightly less than does the precipitate in Deer Creek.

Theobald, P. K., Hawkins, D. B., and Lakin, H. W., 1958, Composition of water and precipitates in the confluence of Deer Creek with Snake River, Summit County, Colorado [abs.]: *continued*

If carried to a larger scale, the natural processes observed in this junction could provide the mechanism for chemical formation of bauxite.

These environments illustrate extreme, potentially misleading complexities that may be encountered when water or stream-sediment analyses are used for geochemical exploration.--*Authors' abstract*.

440 Theobald, P. K., Jr., and Thompson, C. E., 1959, Geochemical prospecting with heavy-mineral concentrates used to locate a tungsten deposit: U. S. Geol. Survey Circ. 411, 13 p.

Rapid field chemical analysis of heavy-mineral concentrates panned from stream gravels provides a reconnaissance prospecting technique for many of the ore minerals that are resistant to chemical and mechanical decay. This technique involves three steps: areal reconnaissance by sampling the mouths of major streams to locate drainage basins with anomalous metal content; tracing an anomaly through a drainage basin by sampling the main stream and tributaries, proceeding upstream until the anomaly is terminated; and tracing the metal away from the stream to the bedrock source by conventional geologic or geochemical prospecting techniques. On the eastern slope of the central part of the Front Range, Colo., a previously unsuspected tungsten anomaly was traced through the Clear Creek drainage basin to West Fork Clear Creek and Woods Creek and was isolated in an avalanche slope on the southeast side of Red Mountain. The anomaly was traced by chemical analysis of the fine fraction of debris on the avalanche slope to a huebnerite deposit near the crest of the peak. Despite sampling and analytical problems this technique is valuable for locating mineralized ground because of its speed and low cost.--Authors' abstract.

441 Theobald, Paul K., Jr., and Thompson, Charles E., 1959, Reconnaissance exploration by analysis of heavy mineral concentrates [abs.]: Mining Eng., v. 11, no. 1, p. 40.

Gold-panning techniques combined with rapid field-chemical analyses of the concentrates provides a reliable method of regional reconnaissance for many metallic elements. Modern stream gravels provide a composite sample of the drainage basin; where contamination by artificially introduced metals or minerals is suspected, terrace gravels may be used as a supplement. Iron minerals of rocks near mineral deposits are enriched in metallic elements such as copper and zinc that may substitute for iron. These metallic elements may be sought by analysis of magnetite, which is universally distributed and may be easily separated from panned concentrates with a hand magnet. When the metallic element sought and its ore minerals are nonmagnetic, analysis of the magnetite avoids contamination. Many metallic elements form resistant, nonmagnetic minerals that may be sought by analysis of the nonmagnetic fraction of the concentrates.

Magnetic and nonmagnetic fractions of concentrates panned from Clear Creek in the Front Range of Colorado have been analyzed by rapid, field-chemical methods for zinc and tungsten respectively. In Clear Creek, values for both metals are 10 and 100-fold higher than in adjacent streams. High zinc values outline the zinc-rich part of the mineral belt in the southwestern part of the drainage basin. The tungsten is in wolframite from a deposit near Red Mountain at the west edge of the drainage basin and in scheelite in isolated small pockets in the crystalline rocks. The anomalous values are evident at the mouth of Clear Creek, more than 20 miles from the source rocks.--Authors' abstract.

442 Thompson, C. E., and Lakin, H. W., 1957, A field chromatographic method for determination of uranium in soils and rocks: U.S. Geol. Survey Bull. 1036-L, p. 209-220.

A simple and rapid field method for the semiquantitative determination of uranium in soils and rocks was needed to supplement the Geiger and scintillation counter techniques now used extensively in prospecting for uranium. In the proposed method an aliquot of a nitric acid-aluminum nitrate solution of the sample is placed on a special paper, and the uranium is separated from the other sample constituents by the upward flow of a solvent mixture through the paper.

The suggested procedure is applicable to samples containing 4 to 1,200 ppm of uranium, and with a slight modification it can be used for samples containing larger amounts.

By means of the proposed method relatively unskilled workers can use inexpensive and easily obtainable reagents and equipment to determine uranium in the field in at least 60 samples of soils and sedimentary rocks ground to 100 mesh during an eight hour day.--Authors' abstract.

443 Tkalich, S. M., 1956, Biogeokhimicheskii metod poiskov rudnykh mestorozhdenii [Biogeochemical methods of prospecting for ore deposits]: Materialy Soveshchaniia Geologov Vostochnoi Sibiri i Dalnego Vostoka po Metodike Geologo-Semochnykh i Poiskovykh Rabot, Chita, p. 86-101.

The biogeochemical method depends on the relationship of elements in plants and ~~in~~ in soils and rocks of an area. Plants can assimilate water soluble metals from an oxidized zone of an ore deposit, especially a sulfide deposit.

Elements occur in plant ash in varying amounts:

(1) Ca, S, P, K, Si, Mg, Fe, Na, Cl and Al are found frequently and in large amounts.

(2) Zn, Mn, Cu, Pb, Ti, V, Cr, Ni and Co are found in limited amounts.

(3) Au, Rb, Hg and Ra are found infrequently and in small amounts.

The content of elements in plants does not necessarily indicate the soil or rock composition. The iron and manganese content of the Shipilski ore deposit is 5.02 percent and 0.11 percent respectively, but the iron and manganese content in the ash of leaves of warty birch growing on the garnet-bearing skarns of the deposit is 0.64 percent and 4.47 percent respectively.

Plants will assimilate some ions in larger amounts if others are present; e.g., calcium ions are assimilated in the presence of boron ions, and molybdenum ions in the presence of cobalt ions. Plants of the same species and known accumulator and indicator plants should be sampled in a biogeochemical prospecting survey. Analytical data for plants which grow on ore deposits are compared with background values of the plants.--Referat. Zhur. Geol., 1958, no. 3, abs. 4893.

444 Tkalich, S. M., 1959, Prakticheskoe rukovodstvo po biogeokhimicheskomu metodu poiskov rudnykh mestorozhdenii [Practical guide in using biogeochemical methods of prospecting for ore deposits]: Moscow, Gosgeoltekhizdat, 52 p.--Referat. Zhur. Geol., 1960, v. 10, abs. 21118. (English abstract in, Technical Translations, 1962, v. 8, no. 1, p. 44. See Geochemical Prospecting Abstracts, January 1961-December 1962)

445 Tooms, J. S., 1959, Field performance of some analytical methods used in geochemical prospecting: Internat. Geol. Cong., 20th, Mexico City 1956, Symposium de Exploracion Geoquimica, v. 2, p. 377-388. (See U.S. Geol. Survey Bull. 1098-B, abs. 234.)

446 Tsigel'man, I. S., 1959, Application of radon survey for prospecting for polymetallic deposits: Leningrad. Gornogo Inst. Zapiski, v. 36, no. 2, p. 100-103. (English abstract in, Chem. Abs., 1960, v. 54, col. 22186)

447 Tugarinov, A. I., 1957, Izotopnyi sostav svintsa kak odin iz vozmozhnykh geokhimicheskikh poiskovo-otsenochnykh priznakov [Composition of lead isotopes as a possible geochemical criterion for prospecting and evaluation]; in Krasnikov, V. I., ed., Geokhimicheskii Poiski Rudnykh Mestorozhdenii v SSSR; Moscow, Gosgeoltekhizdat, p. 79-98.

Although the study of the composition of lead isotopes can not be considered as a geochemical prospecting method, it does give a number of supplementary indications useful in evaluating ore occurrences and prospective commercial deposits.

For example, in Central Asia, lead from ore deposits of the bedded and impregnation types found in Devonian and Carboniferous limestones has a characteristically uniform isotopic composition. In contrast, lead of skarn deposits, which formed at contacts with the intrusives of Variscan age, is more enriched with radiogenic isotopes and more variable in composition. The most important ore deposits are associated with lead belonging to the first group. The occurrence of lead having this type of isotopic composition is a good indication in prospecting for commercial lead deposits.

By studying lead isotopes it is possible to establish the age for each ore-bearing region and the genetic relationship between the mineralization and the intrusions.--Referat. Zhur. Geol., 1959, v. 11, abs. 23759.

448 Tyutina, N. A., Aleskovskii, V. B., and Vasil'ev, P. I., 1959, An experiment in biogeochemical sampling and the method of determination of niobium in plants: Geochemistry, no. 6, p. 668-675.

An increase of the niobium content in plants from 0-3 µg to 50-70 µg (per 5 g of dry plant material) may serve as an indication for search in geological-prospecting work.

It is found that in the region under examination *Rubus arcticus L.*, *Chamaenerium angustifolium L.*, *Vaccinium myrtillulus L.*, and *Rubus chamaemorus L.* show the greatest ability for niobium extraction from the soil.

Methods of the determination of niobium, both from ash and from dried plant material are worked out.—*Authors' abstract.*

449 Udodov, P. A., and Onufrienok, I. N., 1957, Opyt gidrokhimicheskikh issledovanii na territorii gornykh massivov zapadnoi Sibiri [Experimental hydrochemical studies in mountain ranges of western Siberia], in Krasnikov, V. I., ed., Geokhimicheskii Poiski Rudnykh Mestorozhdenii v SSSR: Moscow, Gosgeoltekhizdat, p. 256-265.

Hydrochemical prospecting for non-ferrous and rare metal deposits in the Sayan, Salair and Upper Altai Mountains of the Kuznetsk-Alatau region is described. Waters in these areas are differentiated into 3 categories: (a) Waters in the ore-mineralization zones; (b) streams draining the area of ore mineralization; and (c) any other waters in the area. The surface and ground waters that circulate in the oxidation-zone of the ore deposits are most useful in hydrochemical prospecting.

Several prospecting criteria were recognized: (a) Increased metal content in water by 4-5 times about background; (b) the presence of the same heavy-metal complex in the water as in the ore deposit; and (c) decreased pH values and increased sulfate concentration.

Several dispersion halos of W, Mo, Sn, Cu, Zn, Pb, Ag, Ni and Cr were detected in the course of this study.--Referat. Zhur. Geol., 1959, no. 2, abs. 3579.

450 Udodov, P. A., and Onufrienok, I. P., 1958, Hydrogeochemical methods for prospecting for nonferrous metals and certain rare elements: Tomskogo Politekh. Inst. im S. M. Kirova Izv., v. 90, p. 158-164. (English abstract in, Chem. Abs., 1960, v. 54, col. 4279)

451 Valiashko, M. G., 1959, Geochemistry of bromine in halogenation processes and utilization of its content in salts as a criterion for genesis and prospecting: Internat. Geol. Cong., 20th, Mexico City 1956, Symposium de Exploracion Geoquimica, v. 2, p. 261-281. [Russian] (See U.S. Geol. Survey Bull. 1098-B, abs. 237.)

452 Van Wambeke, L., 1957, Les methodes de prospection de l'uranium et du thorium [Methods of prospecting for uranium and thorium]: Brussels, Centre d'Etude de l'Energie Nucléaire, Nov. 12, 1957, 92 p.

The problems connected with the prospecting for fissile materials are discussed in 3 parts: the geological and geochemical factors in the prospecting for uranium and thorium; radiometric prospecting for uranium and thorium; and geochemical prospecting for uranium and thorium. The report is based on data gathered during studies in the United States and Canada.--J.S.R., in Nuclear Sci. Abs., 1958, v. 12, abs. 8424.

453 Van Wambeke, L., 1957, Methodes de dosage de traces d'uranium en prospection geochimique [Methods of determination of traces of uranium in geochemical prospecting]: Brussels, Centre d'Etude de l'Energie Nucléaire, Aug. 1, 1957, 17 p. [French]

Two methods are presented:

1. Fluorimetry: By fusion with NaF the uranium salts give off a yellow-green fluorescence under ultraviolet light, and the intensity of the fluorescence is proportionate to the amount of uranium.

2. Paper chromatography: Uranium is extracted from the samples by nitric acid. Aluminum nitrate is added in order to complex the ions PO_4^{---}, F^-, and SO_4^{--}. After digestion a determined amount of the solution to be analyzed is placed with a micropipette near one of the ends of the strip of chromatographic paper. The end is placed in a dessicator containing a saturated solution of magnesium nitrate to maintain constant humidity. After a 1/2 hour the paper is removed, and the same end is placed in a small quantity of solvent (ethyl acetate); when the solvent almost reaches the other end, uranium is separated from other interfering elements, eg., iron. After drying, the chromatographic paper is moistened by an aqueous solution of ferrocyanide which produces a brown band characteristic of uranium. The color and the width of the band are proportionate to the quantity of uranium.--Excerpted and freely translated by C.B.D.

454 Van Wambeke, L., 1958, Application of X-rays to the investigation of radioactive mineralizations: Internat. Conf. Peaceful Uses Atomic Energy, 2nd, Geneva 1958, Proc., v. 3, no. P/106, p. 541-549.

A quick and accurate method for surveying radioactive minerals and mineralizations is presented. It rests on a combination of X-ray scatter and spectrography. It is applicable to all types of mineralizations, whether radioactive or not, to individual minerals, to polished sections and to alluvial concentrates. It can be used, in conjunction with microscopic observation, in a study of the parageneses.

The major or accessory chemical components can readily be determined from their X-ray spectra, and semi-quantitative evaluations can be made by means of suitable counters.

Structural analysis is carried out, preferably, by means of a spectrometer. The Guinier curved crystal technique was used for finer determinations of the structures.

The method has been applied with success to a study of the various types of radioactive mineralizations of the Congo, such as bastnaesite veins, a secondary mineralization in a pegmatite, and alluvial concentrates.

It has also been used for the determination of metamictic minerals and for dosages [determinations] in connection with geochemical prospection.--Author's abstract from Paper no. P/106.

455 Van Wambeke, L., 1959, Applications des rayons X à l'étude minéralogique et géochemique de la carbonatite de la Lueshe (Kivu) [Application of X-rays to the mineralogical and geochemical study of the carbonatites of the Lueshe (Kivu, Belgian Congo)], _in_ Contribution à l'étude de la minéralogie, de la géochimie et des méthodes de prospection des carbonatites à pyrochlore au moyen des rayons X [Study of mineralogy, geochemistry, and methods of prospecting in pyrochlore-bearing carbonatites by means of X-rays]: Soc. Belge Géologie, Paléontologie et Hydrologie Bull., v. 68, no. 2, pt. 1, p. 178-185. [French]

Minerals present in the carbonatites are calcite, aegirine, pyrrhotite, apatite, pyrochlore, and biotite (lipidomelane). Results of analyses by X-ray fluorescence are: calcite (8800 ppm SrO, 280 ppm Ba); aegirine (<0.5 percent Mn, 300-400 ppm Zr, 780 ppm Nb_2O_5); apatite (4000-6000 ppm Sr, 45 ppm Ba); pyrochlore (4000-7000 ppm Sr, <60 ppm Ba, 0.005-0.2 percent ThO_2, 0.01-1 percent U_3O_8); and zircon (100-300 ppm Nb_2O_5). The maximum Nb_2O_5 content found in 6 samples of carbonatite is 0.314 percent.--C. B. D.

456 Van Wambeke, L., 1959, Les méthodes de prospection des gisements de niobium liés aux carbonatites [Methods of prospecting for niobium deposits connected with carbonatites], in Contribution à l'étude de la minéralogie, de la géochimie et des méthodes de prospection des carbonatites à pyrochlore au moyen des rayons X [Study of mineralogy, geochemistry, and methods of prospecting in pyrochlore-bearing carbonatites by means of X-rays]: Soc. Belge Géologie, Paléontologie et Hydrologie Bull., v. 68, no. 2, pt. 2, p. 185-200. [French]

Prospecting for pyrochlore-bearing carbonatites was carried out in two phases, preliminary and detailed. In the preliminary phase a scintillometer was used to detect radioactivity in the carbonatites. Three geochemical studies to distinguish pyrochlore-bearing carbonatites from other carbonatites followed: (1) Prospecting for anomalous amounts of niobium, strontium, barium, rare earths, phosphorus, titanium and zirconium, which are characteristic of pyrochlore-bearing carbonatites, (2) Analysis of alluvium for high strontium, niobium, and niobium-tantalum ratio, (3) Analysis of soils and iron-manganese gossans for similar elemental associations. Detailed prospecting consisted of geochemical analysis for niobium and measurements of magnetic susceptibility.--C. B. D.

457 Van Wambeke, L., 1959, Méthodes de dosage du niobium utilisées pour la prospection géochimique et pour l'évaluation de gisements de niobium liés aux carbonatites [Methods for the determination of niobium utilized for geochemical prospecting and for the evaluation of niobium deposits connected with carbonatites], _in_ Contribution à l'étude de la mineralogie, de la géochimie et des méthodes de prospection des carbonatites à pyrochlore au moyen des rayons X [Study of mineralogy, geochemistry, and methods of prospecting in pyrochlore-bearing carbonatites, by means of X-rays]: Soc. Belge Géologie, Paléontologie et Hydrologie Bull., v. 68, no. 2, pt. 3, p. 201-225. [French]

A brief review is given of 4 methods: absorption, chromatography, extraction by solvents and optical spectroscopy. The X-ray fluorescence method is described in detail including the preparation of samples, the internal standard method, the dilution method, and direct methods. Tabulated data compare the efficiency, precision, and limits of detection of each method, and the advantages of the X-ray method are shown.--_C. B. D._

458 Van Wambeke, L., 1960, Geochemical prospecting and appraisal of niobium-bearing carbonatites by X-ray methods: Econ. Geology, v. 55, p. 732-758.

The main source of niobium at present is in granites and granitic pegmatites, and in alluvial or eluvial deposits derived from them. The future production of niobium probably will be primarily from carbonatite deposits.

A mineralogical and geochemical study of carbonatite samples from Lueshe, Kivu, Belgian Congo, by the combined X-ray diffraction-fluorescence method indicates that niobium is distributed in pyrochlore, pyroxene, and zircon. Strontium is also characteristic of these carbonatites.

Van Wambeke, L., 1960, Geochemical prospecting and appraisal of niobium-bearing carbonatites by X-ray methods-continued

The geochemical association of niobium and strontium as well as a high Nb/Ta ratio can be used in alkaline petrographic provinces as the basis of preliminary geochemical prospecting for niobium in carbonatites, their covering soils and the associated superficial manganese-iron ores. Rapid and semi-quantitative determination of niobium, strontium, barium rare earths, zirconium and titanium in mineral samples can be made by X-ray fluorescence. For a detailed geochemical prospecting and for the appraisal of niobium-bearing carbonatites two direct methods of X-ray fluorescence analysis have been developed. For rapid estimation of the niobium content both direct methods have an accuracy of less than 12 percent and a sensitivity of 5 to 20 ppm of niobium. Between 100 and 200 analyses can be made per day and per man. The only disadvantage of this method is that the measurements must be made in the laboratory.

Field measurements of radioactivity, paper chromatographic analyses used in conjunction with X-ray fluorescence determinations were used in discovering a niobium-bearing carbonatite in Kivu, Belgian Congo.--Author's abstract.

459 Vaughn, W. W., Wilson, E. E., and Ohm, J. M., 1960, Field instrument for quantitative determination of beryllium by activation analysis: U.S. Geol. Survey Circ. 427, 9 p.

A low-cost instrument has been developed for quantitative determinations of beryllium in the field by activation analysis. The instrument makes use of the gamma-neutron reaction between gammas emitted by an artificially radioactive source (Sb^{124}) and beryllium as it occurs in nature. The instrument and power source are mounted in a panel-type vehicle. Samples are prepared by hand-crushing the rock to approximately 1/4-inch mesh size and smaller. Sample volumes are kept constant by means of a standard measuring cup. Instrument calibration, made by using standards of known BeO content, indicates the analyses are reproducible and accurate to within $\pm$0.25 percent BeO in the range from 1 to 20 percent BeO with a sample counting time of 5 minutes. Sensitivity of the instrument may be increased somewhat by increasing the source size, the sample size, or by enlarging the cross-sectional area of the neutron-sensitive phosphor normal to the neutron flux.--Authors' abstract

460 Viktorov, S. V., 1960, Geobotanicheskie metody pri geologicheskom kartirovanii i pri poiskakh poleznykh iskopaemykh [Application of geobotanical methods to geological mapping and prospecting for ore deposits]: Metody Geog. Issledov., p. 248-255.

Lichen plants as geobotanical indicators were investigated. The lichen species, Aspicilia and Squamaria, form thick growths on rocks containing sulfur concentrations. Among the most widespread lichens is the gypsophile formation of Colema minor and Caloplaca bracteata. Using these plants as indicators it is possible to outline areas of gypsum bearing rocks even when the surface is covered with unconsolidated deposits. The formation of lithophile lichen, growing on outcrops of dense carbonate rocks, is easily recognized on aerial photographs by its bright color.--Referat. Zhur. Geol., 1961, v. 4, abs. G544.

461 Vinogradov, A. P, and Malyuga, D. P., 1958, The biogeochemical method for ore search and prospecting: Internat. Geol. Cong., 20th, Mexico City 1956, Symposium de Exploracion Geoquimica, v. 1, p. 201-220. [Russian] (See U.S. Geol. Survey Bull. 1098-B, abs. 243.)

462 Vinogradov, V. I., 1957, On the migration of molybdenum in the supergene zone: Geochemistry, no. 2, p. 144-155.

The sampling of ground and surface waters for molybdenum has shown that in the area of molybdenum deposits distinct water haloes of molybdenum dissemination are formed. If the background molybdenum content in the investigated areas usually does not exceed 3×10^{-6} g/l in the region of the molybdenum deposits the molybdenum content in waters rises to $n \times 10^{-5}$ to $n \times 10^{-2}$ g/l. Molybdenum may be carried in solution through oxidation of the primary molybdenum sulfide, molybdenite, and through solution of secondary molybdic minerals. Distinct molybdenum migration in the supergene zone may be utilized in prospecting for molybdenum deposits by means of water haloes of dissemination.—Author's abstract.

463 Vinogradov, V. I., 1957, Solubility of the secondary molybdenum minerals in the weak solutions of H_2SO_4 and Na_2CO_3: Geochemistry, no. 3, p. 279-286.

The formation of the secondary molybdenum minerals is one of the most important factors in determining the migration of molybdenum in the supergene zone. To provide a basis for hydrochemical prospecting for molybdenum deposits, it is necessary, therefore, to know the conditions of formation of these minerals and their stabilities in different environments. An approach to the solution of these problems was made by making a series of experiments on the solubility of molybdenum minerals and compounds.

Experiments on the dissolution of secondary molybdic minerals and corresponding chemical compounds have shown that ferrimolybdite is most stable at pH 3-4. Ferrimolybdite is readily dissolved in more acid solutions and undergoes electrolysis in more alkaline solutions. A precipitate of iron hydroxide is formed in this process, and molybdic acid is carried in solution. In attempting to precipitate calcium molybdate by neutralizing with calcium carbonate sulphuric or molybdic acid solutions of molybdenum, it has been discovered that intermediate molybdenum compounds (possibly calcium polymolybdates) are formed; these compounds are easily dissolved and relatively stable in neutral solutions. In dissolving wulfenite in distilled water, only 2×10^{-5} g/l of molybdenum has been carried in solution. The degree of dissolution of wulfenite increases in acid and alkaline solutions. These experiments show that molybdenum possesses good migrational properties in the supergene zone.—Author's introduction and abstract.

464 Vinogradov, V. I., 1959, Some problems of the hydrogeochemistry of molybdenum, _in_ Feodot'ev, K. M., ed., Akad. Nauk SSSR, Materialy Geol. Rudnykh Mestorozhdeniǐ, Petrog., Mineral. i Geokhim., p. 191-204. (English abstract in, Technical Translations, 1962, v. 7, no. 7, p. 415. See Geochemical Prospecting Abstracts, January 1961-December 1962)

465 Vlaicu, Valentina, 1958, Geochemical prospecting for new copper deposits in the Balan region: Rev. Minelor, v. 9, p. 570-575. (English abstract in, Chem. Abs., 1959, v. 53, col. 14854)

466 Volkov, I. D., 1959, Metodika kompleksnykh krupnomasshtabnykh poiskov skarnovykh volframovo-polimetallicheskikh mestorozhdenii v Severnom Primore [Complex methods of large-scale prospecting for skarn-type tungsten-polymetallic ore deposits in the Northern Maritime area]: Novoye v Metodike i Tekhniki Geologo-Razvedoch~~nykh~~ Rabot, Sbornik 2; [Leningrad] p. 113-120.

Geochemical and geophysical prospecting techniques were used in the Dzhaur ore deposit. The geochemical methods consisted of reconnaissance (1:200,000) and detailed (as much as 1:50,000) surveys using heavy mineral determinations and spectrographic analyses of samples. Further detailed work (1:10,000) was conducted in the areas of lead-zinc dispersion halos. Heavy mineral determinations were made of scheelite and wolframite in the alluvium of "dispersion streams".--Referat. Zhur. Geol. 1960, v. 3, abs. 5287.

467 Volobuyev, V. M., 1957, Opyt primeniya metallometrii pri poiskakh mednykh mestorozhdniy prozhilkovo-vkraplennogo tipa v tsentalnom Kazakhstane: Razvedka i Okhrana Nedr, no. 4, p. 31-33. (1959, English translation entitled Experimental application of metallometry in exploration for vein-disseminated (porphyry) type copper deposits in Central Kazkhstan): Internat. Geology Rev., 1959, v. 1, no. 3, p. 31-33.

The discovery of low-grade porphyry copper deposits by metallometric surveying is discussed. These deposits, often ill-defined on the surface, are characterized by copper and molybdenum dispersion halos, which are detectable when the copper content in the residuum is between .02-.04 percent and the molybdenum is as low as .001 percent. Wide spread sampling is followed by sampling on a grid system, spectrographic analysis and chemical analysis when needed.--C.B.D.

Vostokova, E. A., 1957, Botanichecki metody poiskov uranosoderzhashchikh rud [Botanical method of prospecting for uranium ores]: Razvedka i Okhrana Nedr, v. 23, no. 7, p. 33-34.

In the U.S.A. biogeochemical and botanical methods are employed in prospecting for uranium-bearing ores. The first method is based on the ability of plants both to assimilate and to concentrate radioactive elements. Species with strong, well developed roots, that penetrate down to the zone of ore deposition, appear to be best indicators. Although most of the uranium remains in the roots, the quantities present in the branches and in the leaves are also measurable. In reconnaissance work on the Colorado Plateau samples were obtained by cutting juniper branches from the same height around the tree-crown. By determining the uranium content in the ash, using the fluorometric method, it was possible to prepare maps showing dispersion halos. In the second method uranium deposition is inferred from the study of plant associations and from the presence of certain diagnostic plants. In Colorado, Se, V and S compounds were found invariably accompanying uranium bearing ores. Two species of astragalus (Astragalus preusii, Astragalus pattersonii) and one species of orache (Atriplex confertifolius) indicate the presence of these compounds in the bedrock. Among the plants there are also some "negative" uranium indicators (Artiplex canescens and Grayia spinosa). To check on the reliability of this botanical method, 1000 holes were drilled within a selected area under study. Eighty-one percent of all bore-holes that showed uranium mineralization were surrounded by the diagnostic plant species (plant-indicators). The third proposed botanical method of prospecting for uranium deposits is based on the study of biological effects of radioactive elements on the plant organism. It was determined that radioactive emanations cause disturbances in physiological processes of the living plants. As a result some plants become dwarfed; in other species (Sedum siebaldii, echeveria sp.) deformation of leaves and shoots can be observed; motley coloration of leaves or loss of color can also result (Tolmiaea menziesii, Fuchsia sp. and others). In applying this botanical method an attempt is made to infer the presence of uranium mineralization from certain diagnostic morphologically abnormal features of specific plant species.--Referat. Zhur. Geol. 1958, no. 4, abs. 6804.

469 Votavová, Zdeňka, 1957, Polarographic analysis in prospecting in the nickel ore deposit near Křemže in Southern Bohemia [Czechoslovakia]: Sborník Vysoké Školy Chem.-Technol. v Praze, p. 203-206. (English abstract in, Chem. Abs., 1959, v. 53, col. 1978)

470 Ward, F. N., and Bailey, E. H., 1960, Camp and sample-site determination of traces of mercury in soils and rocks: Am. Inst. Mining, Metall. Petroleum Engineers Trans., v. 217, p. 343-350; Mining Eng., 1958, v. 10, no. 1, p. 56 [abs.].

Camp and sample-site methods useful for determining about 0.5 to 16 ppm of mercury in soils and rocks have been devised to complement the analytical methods already widely used in geochemical prospecting. In the camp-site procedure the sample solution is obtained by digesting the finely powdered sample with hot nine-molar sulfuric acid and bromine, the latter generated in place. The solution is buffered at a pH of 4 and the mercury is extracted into a relatively small volume of an organic solvent. Estimations are made by comparing the color of the mercuric dithizonate extracted from the sample with that extracted from a standard. In the sample-site method the mercury is volatilized as the iodide and the latter is dissolved in a buffer solution from which the mercury dithizonate is extracted as in the camp-site method. The estimation is made by a similar comparison with standards or by comparing the color of the mercuric dithizonate with artificial standards prepared from Orange II, an azo dye. Except for the establishment of standards, the time required by an experienced analyst seldom exceeds 10 min for a camp-site determination and 5 min for a sample-site determination. Camp-site determinations are useful for commodity studies and intensive exploration programs; sample-site determinations are applicable to extensive and reconnaissance-type geochemical prospecting programs. The results obtained on samples taken along traverses above known mercury ore deposits in the California Coast Range and western Nevada demonstrate the usefulness of both methods in geochemical prospecting.--*Authors' abstract*.

471 Ward, Frederick N., Nakagawa, H. M., and Hunt, Charles B., 1960, Geochemical investigation of molybdenum at Nevares Spring in Death Valley, Calif., in Geological Survey Research 1960: U.S. Geol. Survey Prof. Paper 400-B, p. B454-B456.

Field colorimetric determinations show a 15-fold increase in Mo content of waters between the source spring and the edge of the salt pan where sulfate and carbonate precipitation occurs in the zone of maximum evaporation producing a Mo enrichment of the efflorescent salt.--Authors' abstract, in GeoSci. Abs., 1960, v. 2, no. 12, pt. 1, abs. 2-3462, p. 50.

472 Warren, H. V., and Delavault, R. E., 1957, Biogeochemical prospecting for cobalt: Royal Soc. Canada Trans., ser. 3, v. 51, sec. 4, p. 33-37.

The cobalt content of trees and shrubs growing above cobalt ore is high enough to be estimated by a relatively simple laboratory method on samples one gram in weight.

Most positive samples contain from one to three p.p.m. of cobalt in dry plant and from fifty to three hundred in ash. This appears to be from ten to one hundred times the amount encountered in vegetation from non-mineralized areas.--Authors' abstract.

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Warren, Harry V., and Delavault, Robert E., 1958, Rubeanic acid field test for copper in soils and sediments: Am. Inst. Mining Metall. Petroleum Engineers Trans., v. 211, p. 1186-1188; Mining Eng., 1958, v. 10, no. 11, p. 1186-1188, p. 1132 [abs.].

In normal soils there are usually 10 to 50 parts of copper in every million parts of soil. Only 0.2 to 5 percent of this copper can be found by any simple cold chemical attack. Now, with rubeanic acid reagent paper, a prospector or field geologist can detect as little as 4 ppm of readily available copper in soil. This degree of sensitivity is enough to determine the presence of copper anomalous areas and, eventually, to discover copper mineralization. (See abs. <u>477</u>)--<u>Authors' abstract</u>.

474 Warren, Harry V., and Delavault, Robert E., 1959, Geochemistry and prospecting, in Symposium on saturation prospecting: Canadian Mining Metall. Bull., v. 52, no. 561, p. 55-60.

The status of 3 branches of geochemistry and their application in exploration is reviewed. The advantages and disadvantages of hydrogeochemistry, lithogeochemistry and biogeochemistry are presented. Under the term lithogeochemistry 4 distinct fields are considered: glacial deposits, stream deposits, residual mantle (soils) and parent rocks.-C.B.D.

475 Warren, H. V., and Delavault, R. E., 1959, Pathfinding elements in geochemical prospecting: Internat. Geol. Cong., 20th, Mexico City 1956, Symposium de Exploracion Geoquimica, v. 2, p. 255-260. (See U.S. Geol. Survey Bull. 1098-B, abs. 258.)

476 Warren, H. V., and Delavault, R. E., 1959, Readily extractable copper in eruptive rocks as a guide for prospecting: Econ. Geology, v. 54, p. 1291-1297.

This investigation explores the possibility of ascertaining the mineral potentialities of an area around an outcrop of limited size using rock analyses involving a chemical attack of moderate intensity. By using hot aqua regia, which does not substantially attack silicates, wide variations in the copper content of plutonic rocks have been noted.

In general, our preliminary results suggest that, in the vicinity of mineralization, the readily extractable copper of plutonic rocks is from five to ten times greater than that from rocks unrelated to mineralization. This technique may prove useful in exploration and prospecting.--Authors' abstract.

477 Warren, H. V., and Delavault, R. E., 1959, Rubeanic acid field test: Western Miner and Oil Rev., v. 32, no. 1, p. 34-36.

The simplest method for detecting metal deposits which do not produce visible float or stains consists in making a simple test for metal in overlying soil, or in silt of a stream which may have picked some metal (on the way down). For copper, it may be done very easily by shaking with a strong acetic solution in a small test tube, and pouring the mud into a small filter, the tip of which rests upon a strip of reagent paper, impregnated with rubeanic acid (dithio-oxamide). When copper is present (and only for copper), a blue spot develops, the more copper, the darker. If the copper content is only the small amount present everywhere, there is a pale blue or hardly visible spot; if it is abnormally high, the spot will be dark. There are, of course, intermediate cases where the experienced geochemist cannot always tell offhand whether a medium strength spot represents rich agricultural soil, weak copper mineralization or distant rich copper mineralization. Reagents and material are inexpensive; the test may be easily done on the spot with a simple kit easy to pack and handle.--<u>Authors' abstract</u>.

478 Warren, H. V., and Delavault, R. E., 1960, Aqua regia extractable copper and zinc in plutonic rocks in relation to ore deposits: Inst. Mining Metallurgy Trans. [London], v. 69, pt. 9, p. 495-504.

A hot aqua regia attack on some rocks reveals wide variations in their content of copper and zinc. On the basis of the evidence presently available these variations seem to bear a direct relationship to whatever mineralization is known to occur in the vicinity.

This method of attacking representative samples of country rock shows promise of being able to provide a worthwhile prospecting tool.--Authors' synopsis.

479 Warren, H. V., and Delavault, R. E., 1960, Observations on the biogeochemistry of lead in Canada: Royal Soc. Canada Trans., ser. 3, v. 54, sec. 4, p. 11-20.

Workers in other countries have found lead in most vegetation which they have analysed, usually in the range of from 10 to 100 parts per million (p.p.m.) in ash.

In Western Canadian vegetation we have noted significant variations in the lead content of various species of trees and lesser plants growing in close association: obviously vegetal matter differs widely in its capacity to absorb lead.

Probably the most far-reaching result of our investigations has been to learn that some gasoline exhaust fumes are responsible for higher concentrations of lead in vegetation close to highways than any other cause yet encountered: concentrations of over 1000 p.p.m. in ash have been noted in vegetation from several localities. Only vegetation growing close to significant lead mineralization shows comparable concentrations.--Authors' abstract.

480 Warren, H. V., and Delevault, R. E., 1960, Trace element variations in related rocks: Internat. Geol. Cong., 21st, Copenhagen 1960, Geological results of applied geochemistry and geophysics, pt. 2, proc. sec. 2, p. 57-64.

For some time geologists have been concerned with the so-called "normal" amounts of various trace elements present in large masses of apparently undifferentiated rocks.

Geologists have been inclined to accept as a fact that almost every element could be found in every rock species, and that, in general, for every species there was a "normal" content from which there was not liable to be too great a deviation.

Today it would appear more pertinent to turn to investigations which emphasize differences within the same species of rock inside one geographical area. Interpreting the significance of these variations in relation to segregations, migrations, and concentrations of various elements under conditions of metamorphism, provides a challenge to geologists.

Preliminary to a more complete investigation of trace elements in plutonic rocks from an area of Southern British Columbia, the authors have concentrated on variations in the zinc and copper content of these rocks, with particular reference to the presence, or absence, of mineralization.

The results obtained suggest that there do exist within the larger and more generally recognized geochemical provinces smaller but even better contrasting areas which may well represent the metamorphosed product of various facies of sedimentary rocks.--Authors' abstract.

481 Warren, Harry V., Delavault, Robert E., and Cross, Christine H., 1957, Geochemical anomalies related to some British Columbia copper mineralization in Methods and Case Histories in Mining Geophysics, Commonwealth Mining Metall. Cong. 6th, 1957, Montreal, Mercury Press Company, p. 277-282.

Geochemical techniques were applied to prospecting for copper in three areas in the south part of British Columbia. Soil and vegetation samples were collected along profiles over strong, medium and weak copper mineralization. The analyses were plotted on profiles, and the mineralization, as determined by various methods, is shown. Large geochemical anomalies were obtained over the areas of significant copper mineralization. The ratios of the ppm of copper to the ppm of zinc present in the samples were computed and plotted as aids in interpretation. The techniques were found to be effective for exploration in the section of British Columbia under study.--Authors' abstract

482 Webb, John S., 1958, Notes on geochemical prospecting for lead-zinc deposits in the British Isles, in Technical aids to exploration, paper 19, Symposium on the Future of Non-Ferrous Mining in Great Britain and Ireland, London, Sept., 1958, Inst. Mining and Metallurgy [London], Letchworth, Hertfordshire, Garden City Press Limited, p. 23-40.

1. Primary and secondary geochemical dispersion patterns have been observed in rock, soil, stream sediment and stream waters in the vicinity of lead-zinc deposits in the British Isles.

2. For the most part, the anomalies present no unexpected features and are detectable by standard geochemical prospecting techniques, requiring only minor modifications to suit local conditions. The available data are concerned chiefly with lead and zinc but copper may also be determined.

3. The principal potential value of geochemical prospecting in this country lies (a) in the rapid reconnaissance of large areas by stream sediment surveys to delimit focal points; and (b) the use of soil sampling to test vein extensions, geophysical anomalies and other favorable areas where the geology is concealed by glacial overburden and peat bog.

4. Lesser applications may include (a) the analysis of rock, drill-core and sludge as an aid in subsurface exploration, and (b) the detection of primary leakage dispersions related to blind deposits. These latter dispersions, however, are notably inconsistent in their development and it is difficult to detect deeply buried ore deposits.

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Webb, John S., 1958, Notes on geochemical prospecting for lead-zinc deposits in the British Isles, in Technical aids to exploration, paper 19, Symposium on the Future of Non-Ferrous Mining in Great Britain and Ireland, London, Sept., 1958, continued

Analysis of residual soil could indicate suboutcropping deposits, but, because of shallow cover in residual soil areas and surface prospecting in the past, residual soil sampling is used mostly to search for "leakage" anomalies.

5. In most areas, serious contamination is local and should not affect the interpretation of geochemical data.

6. In summary, despite certain limitations and the need for further study, the geological and physical conditions in the lead-zinc districts of this country are favorable to the development of geochemical dispersion patterns. Detectable anomalies for tin, tungsten, and associated metals have also been shown to exist in rock, residual soil and vegetation near mineral veins in the West of England tinfield.--From author's conclusions

483 Webb, J. S., 1958, Observations on geochemical exploration in tropical terrains: Internat. Geol. Cong., 20th, Mexico City 1956, Symposium de Exploracion Geoquimica, v. 1, p. 143-173. (See U.S. Geol. Survey Bull. 1098-B, abs. 262.)

484 Webb, John S., 1959, Geochemical prospecting, _in_ Proceedings of the Society for Analytical Chemistry: Analyst, v. 84, no. 1000, p. 404-405.

A summary of a paper giving a general review of geochemical prospecting methods.--_C.B.D._

485 Webb, J. S., and Tooms, J. S., 1959, Geochemical drainage reconnaissance for copper in Northern Rhodesia; Inst. Mining and Metallurgy Trans. [London], v. 68, pt. 4, p. 125-144; Discussion, v. 68, pt. 7, p. 321-334, pt. 9, p. 459-460.

Exploratory studies in the Northern Rhodesian Copperbelt have shown that metal leached from weathering ore deposits accumulates in seasonal headwater swamps, or dambos, where the metal-bearing groundwaters debouch at the surface. The streams draining these swamps also carry anomalous metal in their active sediment and in the alluvial flood-plain dambos bordering the streams. Peak copper values in anomalous dambo soils and stream sediments are of the order of 1000-4000 ppm and 500-750 ppm, respectively, compared to the corresponding mean backgrounds of 80 ppm and 40 ppm; an even bigger contrast is given by cold-extractable copper, which ranges up to 1000 ppm in the swamps and 120 ppm in the stream sediments, as against mean background values of 10 ppm and 3 ppm, respectively.

Organic matter plays a prominent role in precipitating copper from groundwaters rising in the swamps. Erosion of the metal-bearing organic dambo soils and subsequent redeposition of this finely divided material is responsible in large measure for prolongation of the dispersion train in the sediment of the outlet streams. The origin and metal content of the stream banks and dilution consequent on confluence with barren streams are important factors in controlling the length of the dispersion trains, which often extend for thousands of feet or even a few miles down-drainage from mineralized ground.

Webb, J. S., and Tooms, J. S., 1959, Geochemical drainage reconnaissance for copper in Northern Rhodesia, continued

Drainage anomalies related to mineralization may be detected by simple rapid methods of analysis performed on small samples collected at wide intervals. Systematic sampling of dambos and stream sediment promises, therefore, to assist primary mineral reconnaissance in Northern Rhodesia and elsewhere.--Authors' synopsis.

486 Webber, G. R., 1959, Application of x-ray spectrometric analysis to geochemical prospecting: Econ. Geology, v. 54, p. 816-828.

X-ray spectrometry can be applied to the determination of variation of metallic elements in soils and related materials. This method of analysis is rapid, relatively inexpensive, nondestructive of sample and permits the detection of many elements. The accuracy obtained depends largely on standards available and the method of sample preparation used.

Various methods of sample preparation can be used to suit the purpose of the analysis; for example, direct use of the powdered sample, acid extraction and analysis of the resulting solution, or analysis of an evaporated concentrate from the acid extraction. Examples of applications of these techniques to analysis for zinc, iron, manganese, copper, lead, and nickel are given.--Author's abstract.

487 Wennervirta, Heikki, and Kauranen, Pentti, 1960, Radon measurement in uranium prospecting: [Finlande] Comm. Géol. Bull., no. 188, p. 23-40.

This is a preliminary report on radon measurements made in connection with uranium prospecting work in the Koli area in North-Karelia. The activated carbon method using a very simple apparatus was employed. A great number of radon anomalies have been found, ranging from 3 to 3000×10^{-10} curies/liter in intensity. The origin of radon in soil air is discussed and some examples of different types of radon anomalies are presented. A definite connection between a radon anomaly and uranium ore has been established in two cases. Authors' abstract.

488 White, M. L., 1957, The occurrence of zinc in soil: Econ. Geology, v. 52, p. 645-651.

This paper describes procedures for determining the form in which zinc is held in soil. The procedures involve removal of the iron oxide and determination of the associated zinc, a similar treatment of the clay size material to determine, indirectly, the lattice-held zinc, and an ammonium chloride extraction to determine the base-exchanged zinc. Values for the distribution of zinc in some Tennessee soil composites are given.--Author's abstract.

489 Williams, D., 1960, Researches in applied geochemistry at Imperial College, London: Internat. Geol. Cong., 20th, Mexico City 1956, Symposium de Exploracion Geoquimica, v. 3, p. 699-710. (See U. S. Geol. Survey Bull. 1098-B, abs. 263.)

490 Winogradow, A. P., and Maljuga, D. P. [Vinogradov, A. P., and Malyuga, D. P.], 1959, Biogeochemische Methoden der Erkundung von Erzlagerstätten [Biogeochemical method of prospecting for ore deposits]: Zeitschr. Angew. Geologie, v. 5, no. 9, p. 404-409. [German]

491 Wodzicki, A., 1959, Geochemical prospecting for uranium in the Lower Buller Gorge, New Zealand: New Zealand Jour. Geology and Geophysics, v. 2, no. 3, p. 602-612.

One hundred and fifty-six water samples from 17 localities in the Lower Buller Gorge were analysed for uranium.

The uranium content of surface waters was found to vary significantly with weather conditions, the peak uranium concentration occurring shortly after the onset of heavy rain following a dry period.

The method appears to be applicable for the identification of discrete areas that are comparatively rich in overall uranium content. Detection of localized concentrations of uranium is dependent on the presence of a small stream draining the critical area.

The method has little practical application in the Lower Buller Gorge area, where prospecting with a scintillometer is much simpler and more effective.--Author's summary

492 Wood, G. A., 1959, A rapid method for the determination of small amounts of tin in soils: Internat. Geol. Cong., 20th, Mexico City 1956, Symposium de Exploracion Geoquimica, v. 2, p. 461-474. (See U.S. Geol. Survey Bull. 1098-B, abs. 265.)

493 Yamagáta, Noboru, Murakami, Yukio, and Torii, Tetsuya, 1960, Biogeochemical investigation in serpentine-chromite ore district: Geochim. et Cosmochim. Acta, v. 18, p. 23-35.

Chemical analyses were made of stream and underground waters, soils and vegetation from a serpentine-chromite ore district. The distribution of several elements in plant and soil was examined statistically and soil-plant relationships were discussed. Of eighteen species of plant examined, Clethra and Castanea showed great accumulation of cobalt and manganese, respectively. Lognormal distribution was assumed in plant for several elements.--Authors' abstract.

494 Yamagata, Noboru, and Yamagata, Toshiko, 1957, Fundamental studies on biochemical prospecting for manganese: Chem. Soc. Japan Bull., v. 30, p. 900-904. (English abstract in, Chem. Abs., 1958, v. 52, col. 7040)

495 Yardley, D. H., 1956, Geochemical exploration for hidden ore deposits: Minnesota Acad. Sci. Proc., v. 24, p. 44-49 [1959]

Briefly outlines the principles, methods, and history of development of geochemical prospecting.--Annot. Bibliography of Econ. Geology, 1959, v. 32, p. 120.

496 Yardley, D. H., 1957, Distributions of trace elements in soil fractions, in Snelgrove, A. K., ed., Geological exploration, Inst. Lake Superior Geology, 1956: Houghton, Mich. Coll. Mining Technology Press, p. 76-85.

The distribution of copper and nickel in glacial materials in northern Minnesota was studied to determine whether or not soil samples would reflect the presence of a known mineralized zone below glacial till. The finer soil fractions (-80 mesh) were most useful in locating geochemical anomalies in the area.--C. B. D.

497 Yardley, D. H., 1958, Significance of geochemical distribution trends in soil: Mining Eng., v. 10, no. 7, p. 781-786, no. 1, p. 56, [abs.]; Am. Inst. Mining Metall. Petroleum Engineers Trans., 1958, v. 211, p. 781-786.

Differences in the nickel and copper content of various soil size fractions demonstrate the importance of correct selection of particle size of test material for a soil sampling program. The distribution trend curves of till show that the amount of heavy metal increases with decreasing size to about 80 mesh, but remains constant for smaller particle sizes. A _channel flow-stagnation zone_ concept of the movement of soil solutions is proposed to explain the failure of the metal content to increase with the increase of particle surface area available, and relates the geochemical distribution to the geologic history.

Similar tests of active stream sediments demonstrate that the heavy metal content increases in the smaller particle sizes roughly parallel to the free surface area available. The characteristic difference between the distribution trend curves of active stream sediments and till is explained by the channel flow concept and by the difference in their geologic histories.

An apparently anomalous increase in the heavy metal content of the coarser particle sizes is explained by a dominance of particles of mechanical origin in the coarser sizes and dominance of exchangeable ion in the smaller.--_Authors' abstract._

498 Zakirov, K. Z., Rish, M. A., and Ezdakov, V. I., 1959, Nakoplenie mikroelementov v rasteniiakh, proizrastaiushchikh v usloviakh rudnogo polia [Trace element content of plants growing in an ore field environment]: Uzbek. Biol. Zhur., no. 1, p. 15-20.

The trace-element-content of plants growing in the foothills zone of an ore field was investigated. Plant samples were collected near scheelite and tin deposits. Recorded concentrations of some elements in the plants from the Adyrov zone are as follows (percent of dry ash): Be 0.0003-0.0006; Mn 0.02-0.1; Pb 0.001-0.003; Mo 0.0003-0.006; Fe 0.1-2.0; Ti 0.01-0.3; V 0.001-0.002; Cu 0.002-0.01; Co 0.0005-0.001; Ni 0.003-0.006; Cr 0.001-0.003. Tungsten and tin are the principal elements found in the plants. Pb, Be, Bi, Zn and Co also accumulate, and the presence of these elements facilitates detection of dispersion halos associated with the ore deposit. Concentrations of certain elements are higher in the plant ash than in the upper soil horizons.--Referat. Zhur. Geol., 1960, v. 4, abs. 6531.

499 Zalashkova, N. E., Lizunov, N. V., and Sitnin, A. A., 1958, Metallometric survey for beryllium in a zone of beryllium-bearing pegmatites covered with alluvium: Razvedka i Okhrana Nedr., v. 24, no. 8, p. 9-14.

Soil and plant samples collected from a beryllium-bearing pegmatite zone covered with 3-4 m of alluvial-deluvial deposits were analyzed spectrographically and chemically. The leaves of trees and pine needles were the best indicators of beryllium.--C. B. D.

500 Zautashvili, B. Z., 1960, Le role de la geochimie des eaux souterraines dans la solution de quelques questions de metallogenie [The role of geochemistry in the solution of some metallogenic problems]: Prospection et Protection du Sous-Sol, no. 11, p. 37-43 [French]

501 Zheli͡azkova-Panaitova, M., 1959, Geokhimichni metodi na t'rsene rudni nakhodishcha [Geochemical methods of prospecting for ore deposits]: Minno Delo i Metalurgija, v. 14, no. 2, p. 70-79. [Bulgarian].--Referat. Zhur. Geol., 1961, v. 2, abs. G537.

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502 Živanović, Von Dušan, 1960, Biochemische Prospektion der Eisenerze in den Ostalpen in Stowenien/Krain, Jugoslawien [Biochemical prospecting of iron ore in the East Alps in Slowenien/Krain, Yugoslavia] [abs.]: Internat. Geol. Cong., 21st, Copenhagen 1960, Vol. , Abs. , p. 23. [German]

Geochemical investigations in 1952 and new geochemical prospecting in 1956-57 show a higher iron content (8.189 percent Fe) in the ash of green pine needles (Picea excelsa) in carbonaceous shales near the region of Ort Dovje (Presušnik Creek) on the left side of Sava Dolinka, and lower iron content in the Karst region of Postojinska Jama and Ilirska Bistrica (0.03 to 0.2 percent Fe) and in other regions from North and Westslowenien (to a maximum of 2.27 percent Fe from a total of 53 samples).—Author's abstract, freely translated by C. B. D.

503 Živanović, Von Dušan, 1960, Die Biogeochemische Untersuchung der Erdtonlagerstätten in Arandjelovac, Zentralserbien, Jugoslavien [Biogeochemical investigations of clay deposits in Arandjelovac, Zentralserbien, Yugoslavia] [abs.]: Internat. Geol. Cong., 21st, Copenhagen 1960, Vol. ______ abs. ______, p. 24. [German]

The clay deposits in Arandjelovac were discovered in 1952. In this region the electrical method was not employed. A biogeochemical investigation showed higher iron and aluminum content in background areas (0.84-1.34 percent Fe_2O_3 and 10.07-17.15 percent Al_2O_3) as opposed to lower iron and aluminum content in different parts of the mining areas (0.45 percent Fe_2O_3 and less, and eg. 3.1 percent Al_2O_3 in the ash of a green oak leaf _Quercus robur_). The appraisal of iron content by means of biogeochemical, geobotanical, biochemical and hydrologic analyses is especially important for raw material which was used in electro-porcellain production in the Žrbica-Bukovic mining area 4-5 km northwest of Arandjelovac.- _Author's abstract, freely translated by C. B. D._

504 Zwanović, [Von] Dušan, 1960, Ergebnisse und Anwendungsmöglichkeiten geochemischer Prospektionsmethoden auf Eisen-und Manganerze in den Karawanken (Ost-Alpen) (Jugoslawien) [Results and practical application of geochemical prospecting methods for iron and manganese ore in Karawanken (East Alps) (Yugoslavia)]: Internat. Geol. Cong., 21st, Copenhagen 1960, Programme, p. 26. [German]

505 Živanović, [Von] Dušan, 1960, Ergebnisse und Anwendungsmöglichkeiten geochemischer Prospektionsmethoden auf feuerfesten Erdtonen und Kaolin in Arandjelovac (Jugoslawien), [Results and practical application of geochemical prospecting methods for fireclay and kaolin in Arandjelovac (Jugoslavia)]: Internat. Geol. Cong., 21st., Copenhagen 1960, Programme, p. 46. [German]

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