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GEOLOGICAL SURVEY

Distribution of cobalt in heavy-mineral-concentrate samples from the Charlotte 1° x 2° quadrangle, North Carolina and South Carolina

by

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This map is a product of a geochemical survey of the Charlotte 1° x 2° quadrangle, North Carolina and South Carolina, begun in 1978 that is part of a multidisciplinary study to determine the mineral potential of the area. Correlative studies are the completion of a geologic map of the quadrangle and aeromagnetic, aeroradiation, and gravity surveys (Wilson and Daniels, 1981).

The Charlotte quadrangle provides a nearly complete section across the Piedmont: its northwestern corner is in the Blue Ridge, its southeastern corner is over a basin of Triassic sedimentary rocks only a few miles from the Coastal Plain. All of the quadrangle except the southeastern corner is underlain by crystalline rocks of Precambrian and Paleozoic age metamorphosed to greenschist facies in the Carolina Slate Belt and to amphibolite facies farther west. Both premetamorphic and post metamorphic intrusive rocks are present. The rocks have been weathered to permeable saprolite reaching depths of 200 feet (60 meters) in the Inner Piedmont. Because of the thorough leaching, most soils are acidic.

In making the geochemical survey, we took samples of sediment within a few miles of the heads of major streams and of the tributaries of these streams, keeping the size of the drainage basin small. By doing so, we usually reduce the variety of rocks that contribute detritus to the sample, thus facilitating a correlation between sample composition and the geology of the drainage basin. At the same time, we reduce the chance that a localized cloudburst has buried the sample site with sediment from a small part of the drainage basin, thus reducing the validity of the sample as an approximate composite of the rocks of the whole basin. Nevertheless, the samples are not all geologically and geochemically equivalent. For instance, at some sites in the mountainous area in the northwestern part of the quadrangle, many clasts in the stream sediment are several yards (meters) across and collection of fine detritus suitable for a sample required a 1/2-hour search. Not far to the east, the finer sediment was abundant.

In the Piedmont, the usual procedure was to sample rather coarse sediment--pebble- or cobble-containing gravel--and to dig deeply to the bottom of the alluvial bed or to a compact clay layer. The coarsest particles in the gravel--boulders, cobbles, and coarse pebbles--were excluded from the sample, which then consisted of about 10 lbs (4 1/2 kg) of clay to granule or fine gravel sized material. The heavy minerals were extracted from this unsifted material at the sample site with a gold pan. Samples taken in the same manner on earlier projects were also used to get better coverage of the Inner Piedmont than we would have had otherwise.

The quartz, feldspar, and other minerals of specific gravity below 2.89 were removed from the pan concentrate by floating them with bromoform. The heavy-mineral concentrate cleaned in that way was then separated magnetically into four fractions. The first was removed with a hand magnet, or an equivalent instrument, and not studied. The remaining concentrate was passed through a Frantz Isodynamic Separator at successive current settings of 0.5 ampere and 1 ampere with 15° side slope and 25° forward slope. The material removed from the sample at 0.5 ampere and 1 ampere will be referred to as the M-5 and M1 concentrates or fractions, respectively, and the nonmagnetic material at 1 ampere will be referred to as the NM concentrate or fraction. Most common ore minerals occur mainly in the NM fraction, making them and their contained metals easier to find and to identify. The NM fraction also contains zircon, sillimanite, kyanite, spinel, apatite, sphene, and the TiO_2 minerals. It is generally the most useful fraction. The M1 fraction is largely monazite in the Inner Piedmont. Because of interferences caused by cerium during spectrographic analysis and the high content of radiogenic lead in the monazite, it was necessary to remove it from the bulk concentrates to improve the quality of analyses and to permit recognition of lead, possibly derived from mineral deposits, in the NM and M-5 fraction. East of the Inner Piedmont the M1 concentrate contained very abundant epidote, clinozoisite, mixed mineral grains, including ilmenite partly converted to leucoxene, staurolite, and locally abundant spinel. The M-5 concentrate contains abundant garnet in the Inner Piedmont, dark ferromagnesian minerals in the Charlotte Belt, and ilmenite in most provinces.

Mineral proportions in each magnetic fraction were estimated using a binocular microscope. Minerals of special interest were identified optically or by X-ray diffraction. The time available did not permit a thorough mineralogic study of all concentrates. Metal-rich minerals were sought in all samples that were shown by the spectrograph to contain metal in unusually high concentrations. After establishing the presence of a metal-rich mineral, the variations in metal contents among the concentrates were inferred to indicate variations in the content of metalliferous minerals.

Each fraction was analyzed semiquantitatively for 31 elements using a six-step, D.C. arc, optical-emission spectrographic method (Grimes and Marranzino, 1968). The semiquantitative spectrographic values are reported as one of six steps per order of magnitude (1, 0.7, 0.5, 0.3, 0.2, 0.15, and multiples of 10 of these numbers) and the values are the approximate geometric midpoints of the concentration ranges. The precision of the method has been shown to be within one adjoining reporting interval on each side of the reported values 83 percent of the time and within two adjoining intervals on each side of the reported value 96 percent of the time (Motooka and Grimes, 1976).

The lower limits of spectrographic determination for the 5 elements that are mentioned in this report are, in parts per million: cobalt, 10; gold, 20; niobium, 50; and tin, 20.

All analytical data for sample material other than concentrates are taken from a report by Ferguson (1979). Such sample material is referred to as "silt" in this report.

Most samples were taken by J. W. Whitlow and W. R. Griffitts. Lesser numbers were taken by D. F. Siems, A. L. Meier, and K. A. Duttweiler. The mineral analyses were made by W. R. Griffitts, K. A. Duttweiler, J. W. Whitlow, and C. L. Bigelow, with special mineral determinations by Theodore Botinelly. All spectrographic analyses were made by D. F. Siems, in part from plates prepared by K. A. Duttweiler. Steve McDanal and Christine McDougal were responsible for entering and editing the locality and spectrographic data in the RASS computer file. Many maps were subsequently plotted from this file by H. V. Alminas, L. O. Wilch, and J. D. Hoffman. Most mineral distribution maps were plotted by K. A. Duttweiler.

Cobalt is widespread in rather high concentrations in the M-5 concentrates and common but less widespread in the NM concentrates. It is particularly widespread in the Carolina Slate Belt. In much of the quadrangle, cobalt is so commonly associated with gold as to indicate that both were involved in common episodes of mineralization. Cobalt is not closely associated with mafic rocks, as is indicated by the high cobalt contents of magnesium-poor M-5 concentrates (plate 1). The M-5 magnetic fraction contains the dark silicate minerals in our concentrates; most of those minerals have magnesium as a major component, so their scarcity indicates that mafic rocks, rich in ferromagnesian minerals cannot be prominent in the drainage basins.

No cobalt minerals were recognized in our investigation. The abundance of manganese in the M-5 concentrates collected near Salisbury suggests that the cobalt may now be in black manganese oxide minerals, some of which are known to be cobalt accumulators.

A row of clusters of cobalt-rich sample sites passes west-northwest from near the southeastern corner of the quadrangle to the vicinity of Charlotte. The mineralized area near Charlotte has long been known and exploited for gold. The area near the southeastern corner of the quadrangle, in eastern Union County, has not been exploited for any minerals.

A cluster of cobalt-rich sample sites near Blacksburg also yields gold and high-zinc values. That general area contains gold-quartz veins and several kinds of iron deposits: gossans; layered quartz-hematite iron formation; and black oxides in skarn. The cobalt concentrations may be related to one or more of these types of deposit.

A series of 4 cobalt-rich samples were collected along a line that trends north-northeast about 5 miles southeast of Lexington. The trend is similar to the trends of faults at the northern end of the Gold Hill fault in the vicinity, so the cobalt may have been deposited in minor, unmapped, faults related to the major ones. The Gold Hill fault itself does not yield cobalt-rich samples.

An unusually large group of sites is found over and around a granite pluton south of Salisbury and extends as far west as Kannopolis. The cobalt here is associated with gold, as in most places in the quadrangle, but it also is accompanied by niobium and tin. The granite pluton is the source for the niobium and tin, but the sources of the cobalt and gold is unknown.

The cobalt content of nonmagnetic concentrates calls attention to some of the same areas as that of M-5 concentrates. The area south of Salisbury is not prominent in the values in nonmagnetic concentrates; the area near Blacksburg remains prominent.

The cobalt content of minus-100-mesh sediment is rather high in parts of the eastern Charlotte Belt and eastern and northern Carolina Slate Belt. Unlike the cobalt in M-5 concentrates, the high values in silt are not generally in gold areas, but are between gold areas.

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