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GEOLOGICAL SURVEY

Distribution of copper 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 elements that are mentioned in this report are: copper, 10 ppm; gold, 20 ppm; lead, 20 ppm; and zinc, 500 ppm.

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, J. D. Hoffman, and T. L. Marceau. Most mineral distribution maps were plotted by K. A. Duttweiler.

Copper is found in many samples, both concentrate and silt. The values are low, especially in the silt, in which the mode is between 5 and 10 parts per million of copper; the highest value in 1238 samples is 150 ppm.

These low values probably result from the thorough leaching of copper from the prevalent acidic soils before the clay and silt were washed into the streams.

In the Inner Piedmont Belt a large crescentic copper-rich area lies northward along the northwestern flank of South Mountain, bending eastward to a terminus east of Hickory. This area is delimited by samples that contain 10 ppm or more of copper. The western part of this area overlaps the eastern part of the South Mountain gold mining area, and gold has been found in much of the rest of the crescentic copper area, conforming to the long known association of copper with gold (Emmons, 1940, p. 280). Gold is not restricted to the copper area, however, but is found farther north in an area with scattered copper values of 10 to 30 ppm but with no concentration of cupriferous sample sites at gold sites. The lineament along Henry Fork is related to the distributions of both copper and gold. Six samples collected near that lineament contained visible gold: a cluster of copper-rich sample sites is near the eastern end of the lineament and another cluster, centered on the old placer district at Brindletown, is along the westerly projection of the lineament. In the western Piedmont copper and gold structural control of mineralization is evident inasmuch as are commonly associated with fractures that persist for miles but may have produced little or no displacement, so they may not be major faults.

Cuprite, the only copper mineral recognized in the concentrates, was found in samples from 57 localities. In most places cuprite forms thin red flakes, some of which are stained green on one side. The central layer of the flakes is coarser grained than the outer parts and may be darker and brighter in luster, characteristics that help distinguish it from hematite. Cuprite also forms crusts on bits of copper wire or replaces wire completely to form tiny red cylinders. This cylindrical cuprite, resulting from contamination, is not shown on the map, but flaky, presumably natural cuprite is shown at seven places where it was found in concentrates with copper wire.

Both cuprite and copper values of 50 ppm or more are found in NM concentrates from most mineralized areas east of the Inner Piedmont Belt. Thus, they may be useful in outlining mineralized districts and in finding new districts in the central and eastern Piedmont. Copper values of 50 to 100 ppm in NM concentrates are also sparsely distributed southwest and northwest of the South Mountain gold district. This gold district as a whole has values of copper of 10 to 30 ppm in NM concentrates.

Copper contents of M.5 concentrates also reflect mineralized rocks, as is indicated by their association with gold. Clusters of sites yielding M.5 concentrates with more than 100 ppm copper are around Gold Hill and along the western side of the Uwharrie Mountain gold belt at the eastern edge of the quadrangle. The South Mountain gold district is rather well outlined by samples with 50 to 100 ppm copper. No copper mineral was recognized in M.5 concentrates--the copper is assumed to be contained in grains of manganese and iron oxides.

In general, high copper values in silt, NM, and M.5 concentrates are indicators of copper-gold mineralization, and less consistently, of lead-zinc mineralization as in the northeastern corner of the quadrangle. The M.5 concentrates contain more copper than the silts and NM concentrates and may therefore be easier to work with.

References

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