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# Distribution of zinc heavy-mineral-concentrate 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, 1980).

The Charlotte quadrangle provides a nearly complete section across the Piedmont: its northwestern corner is in the Blue Ridge, its southwestern 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 Slate Belt and to amphibolite facies farther west. Both premetamorphic and post metamorphic intrusive rocks are present. The rocks have been weathered to rather permeable saprolite reaching depths of 200 feet (60 meters) in the Inner Piedmont. Because of the thorough leaching, the prevalent 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. By keeping the size of the drainage basin small, 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 identical. 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 material at the sample site with a gold pan. The concentrates were passed through a 20-mesh sieve to remove large grains that would choke equipment used in subsequent laboratory operations. 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 cleaned heavy-mineral concentrate 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.

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.

Each sample 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 members) 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 metals that are mentioned in this report are, in parts per million; zinc, 500; cadmium, 50; copper, 10; silver, 1; and tin, 20.

All analytical data for samples other than concentrates are taken from reports by Heffner and Ferguson (1978) and 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 cleaning up the 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.

Zinc is found in all three mangetic fractions of the concentrates and therefore must be contained in a variety of minerals. We have identified sphalerite only in the northeastern and northwestern corners of the quadrangle. Spinel is the most widespread zinc-rich mineral, and it is in both the NM and the M1 concentrates. That in the NM concentrates is generally blue and that in the M1 concentrate is generally green; the change in color and magnetic properites reflect a difference in iron content. Zincian staurolite is found in the M1 fraction mainly in the Kings Mountain Belt.

No single pattern of distribution of zinc consistently indicates where the rocks have been mineralized. Coincidence of moderate- to high-zinc content in two or more sample media combined with some other favorable geologic features is indicative. The "other favorable geologic features" may be high contents of some other metal, fractures, particular minerals, favorable rocks, or exposures of ore minerals.

The most conspicuous feature in the distribution of zinc is a large zinc-rich area at and near the western boundary of the Kings Mountain Belt. Both magnetic (M1) and nonmagnetic (NM) concentrates contain zinc in this area, but the areas with highest zinc contents in the two sample media do not coincide exactly. The zinc-rich NM samples were largely obtained within the Kings Mountain Belt in the general area of iron prospects near Blacksburg and of the gold deposits in Keith and Sterrett's (1931) Bessemer granite. Zinc-rich M1 concentrates are found in a broader area that includes much of the Cherryville pluton and some of the adjacent area to the west that yields tin-rich samples. Zinc-rich M1 concentrates were also found in much of the Kings Mountain Belt, with a cluster of especially rich (3000 ppm) sample sites near the north end of the belt, an area with widely distributed gold. The only zinc-rich minerals found in the concentrates in this northern area are spinel and staurolite. Inasmuch as both minerals are results of metamorphism, any zinc mineralization that provided the metal in this area must have taken place before the metamorphism.

The cluster of zinc-rich NM sample sites in the northeastern corner of the quadrangle is of special interest because of the large number of associated metals and because yellow sphalerite was identified in some of the samples. The pale color implies a low content of iron, which usually indicates crystallization at a low temperature. The zinc is spacially associated with concentrates rich in copper (NM + M1), tin (NM), lead (150 to 3000 ppm in 10 NM samples), cadmium (50 to 200 ppm in 5 NM samples), and silver (2 NM samples). Sphalerite also was found in a concentrate near the northwestern corner of the quadrangle, an area in which the Shady dolomite is known to have been mineralized. The larger number of metal-rich samples obtained from the northeastern corner of the study area suggests that the mineralization there was stronger and more extensive than that in the Shady dolomite. The northeastern sphalerite probably occurs as veins in silicate rocks. The sphalerite is much paler than that at the Silver Hill mine, 15 miles (20 km) to the south, which suggests that the mineralization was different.

The mineralization of the Gold Hill area is shown by moderate- to high-zinc contents in NM concentrates and in the -100-mesh sediment. The zinc content of the M.5 concentrate is not high. The zinc is associated with high copper values in the NM concentrate, but the lead contents are moderate; only one NM sample is rich in lead.

The lead-zinc-silver mineralization in the Silver Hill-Silver Valley-Cid area shows rather well in the zinc contents of the -100-mesh sediment, but only one NM concentrate, taken near the Silver Valley mine, has a high-zinc content. Copper contents of samples are not high and lead contents are moderate. Hence, this highly productive area is poorly identified in the geochemical data.

Gold mineralization in the Uwharrie Mountains, along the eastern edge of the quadrangle, is reflected in high-zinc contents in either the NM or the M.5 concentrate, but not in both concentrates at the same site. Zinc contents of the -100-mesh sediments are low to moderate.

An area along the Gold Hill fault zone near the southern edge of the map, near Unionville, yields -100-mesh samples with high-zinc contents, along with several NM samples with high contents of copper and zinc, M1 concentrates with molybdenum, and NM concentrates with moderate to high contents of lead. These varied features may indicate mineralization, possibly related to small mafic intrusives.

A little to the north of the last mentioned area and along the Gold Hill fault zone is an area in which the zinc content is moderate to high in the -100-mesh sediment and high in the M.5 concentrates. Copper contents are high in the NM concentrates there. This area, too, must be mineralized.

## References

Ferguson, R. B., 1979, Athens, Charlotte, Greenville, and Spartanburg NTMS 1° x 2° quadrangle areas: Supplemental Data Release: U.S. Department of Energy, Grand Junction, Colo., Open-File Report GJBX 73(79), 124 p.

Grimes, D. J., and Marranzino, A. P., 1968, Direct-current arc and alternating current spark emission spectrographic field methods for the semiquantitative analysis of geologic materials: U.S. Geological Survey Circular 591, 6 p.

Heffner, J. D., and Ferguson, R. B., 1978, Charlotte NTMS area, North Carolina and South Carolina: Preliminary Data Release: U.S. Department of Energy, Grand Junction, Colo., Open-File Report GJBX 40(78).

Motooka, J. M., and Grimes, D. J., 1976, Analytical precision of one-sixth order semiquantitative spectrographic analysis: U.S. Geological Survey Circular 738, 25 p.

Wilson, F. A., and Daniels, D. L., 1980, Simple Bouguer gravity map of the Charlotte 1° x 2° quadrangle, North Carolina and South Carolina: U.S. Geological Survey Miscellaneous Investigations Series Map I-1251-A.