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Distribution of garnet and other metamorphic minerals 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, 1980).

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 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, 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 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 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.

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.

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.

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.

Garnet and aluminous metamorphic minerals discussed here are more useful as environmental indicators than as exploration targets in their own right, even though kyanite and corundum have been mined in the region. The use of sillimanite, garnet, staurolite, and kyanite to infer the degree of metamorphism of rocks is well known. In many places where those index minerals are not major components of rocks, the metamorphic isograds may be delineated more accurately with heavy-mineral concentrates than from observations on rocks.

The minerals can also be used for recognizing allocthonous sediments that contribute modern stream sediments as they are washed from old terraces or other surfaces. Most of the staurolite, garnet, and kyanite, in the Carolina Slate Belt are recycled in that way. The nearly complete blanket of these minerals in the eastern part of the Charlotte quadrangle may well represent a "micro-lag-gravel" remaining after erosion of an inland extension of the Coastal Plain.

Kyanite is present in many of the rocks of the Kings Mountain Belt. It has been mined on a large scale from quartzite at Henry Knob, and kyanitic quartzite is present in many other places in the Belt (Espenshade and Potter, 1960). Some of the known kyanitic quartzite deposits are unlikely to be mined; such as those on Crowders Mountain, which are now in a State Park, and that at Stanley Mountain, which provides support for a radio antenna. Kyanitic phyllite has remained unexploited except for a small amount that was interlayered with quartzite at Henry Knob and was mined with it. Nonmagnetic heavy-mineral concentrates from streams that drain potential kyanite deposits have more than usual amounts of kyanite, which is coarser than in most other places, and usually have rutile in larger and more abundant grains than elsewhere. Thus, by processing samples that are moderately uniform in size and granularity, the derived mineralogic data can permit the selection of areas for further study during a search for kyanite deposits. This method of exploration cannot as readily be used in and near the Carolina Slate Belt because of the coarse rounded kyanite grains that have entered the modern streams from older sediment, thus were not derived from local bedrock. East of the Charlotte quadrangle kyanite may be a guide to pyrophyllite deposits, near which it may be present and might be associated with topaz, corundum, andulasite, or chloritoid.

Sillimanite is found in most of the Inner Piedmont Belt, where it is a major component of many schists and a minor component of granitic and gneissic rocks as well. It was carried eastward across the Piedmont Plateau, so the eastern boundary of the sillimanite area is irregular. During stream transport, the sillimanite grains break in a short distance into tiny pieces because of the good cleavage and slender shape of the original crystals. Because of this small size, the grains may have been overlooked in some concentrates from the Charlotte and Carolina Slate Belts. Elongated areas with sillimanitic concentrates probably mark former routes of transport across the plateau and may be useful in working out ancient drainage systems. East of the Inner Piedmont Belt, sillimanite occurs near granitic plutons as a contact-metamorphic mineral. Espenshade and Potter (1960) pointed out that kyanitic quartzite of the Kings Mountain Belt became sillimanitic quartzite within half a mile of the Yorkville granite.

Staurolite is indigenous to most of the Kings Mountain Belt and the Blue Ridge Belt. It encroaches on the Inner Piedmont Belt from both the east and the west. In contrast, at least part of the staurolite in the western Piedmont was carried by streams eastward from the bedrock sources in the mountains. Staurolite is locally present in bedrock in the Inner Piedmont Belt sillimanitic rocks (Overstreet, Yates, and Griffitts, 1963). In the Shelby area, it was found in saprolite only in the general vicinity of young pegmatites that yield sheet mica (Griffitts, 1958) as a product of retrograde metamorphism synchronous with the formation of those pegmatites and of the Cherryville quartz monzonite and related materials. The cluster of sites with minor amounts of staurolite near Gaffney may be of that origin. It follows, then, that the distribution of staurolite in the Inner Piedmont Belt may be a guide to clusters of sheet mica deposits or to deposits of tin that are much younger than the regional sillimanite level of metamorphism. Minor amounts of staurolite in concentrates are more useful indicators of localized retrograde metamorphism than dominant staurolite.

Staurolite is widespread in the Carolina Slate Belt, where it is largely or entirely allocthonous, brought eastward from its original bedrock hosts.

Garnet is the most widespread of the metamorphic minerals, being indigenous to the Blue Ridge, Inner Piedmont, and Kings Mountain Belts. It also is associated with a few gold deposits in the eastern part of the Charlotte Belt.

Garnet grains in the Piedmont acquire, by weathering, a brown limonitic crust, below which the garnet is strongly etched in a manner that is characteristic of saprolitic or lateritic terranes. The crust breaks off during transportation and is missing from the recycled garnet found over much of the Charlotte and Carolina Slate Belts.

Corundum is a local accessory mineral in sillimanite schist of the Inner Piedmont Belt and in a white mica rock in the Kings Mountain Belt near Nanny Mountain. At Nanny Mountain, where corundum is more prominent than elsewhere in the Charlotte quadrangle, the mineral forms clusters of dark-gray plates that are embedded in a nonfoliated white mica rock, which is stained red or brown by iron oxide in some places. In pan concentrates, this corundum is light red. In other places, corundum is gray, blue, or white. Rarely is it in small hexagonal prisms. Artificial corundum was recognized in several places, probably where abrasive grain or paper had been thrown into creeks. The synthetic corundum is in sharp-edged angular red-brown grains, darker in color than most of the natural corundum. Some grains contain veils similar to those in artificial gems (Anderson, 1979). The hardness and resistance to weathering of corundum permits it to be carried for long distances by running water. Hence, much of that found in the Carolina Slate Belt is recycled from old sediment on the Piedmont Plateau.

Andalusite was found as pink crystals with white mica in vein quartz a few miles northwest of Bessemer City and as gray crystals embedded in moderately coarse white mica schist. In both modes of occurrence it was very near the boundary between the Inner Piedmont and Kings Mountain Belts. In thin section, andalusite crystals can be seen to include crenulated schist; hence, it crystallized after the folding, possibly at about the same time as staurolite, crystals of which tend to lie with long axes transverse to the folia of the enclosing schist. Andalusite is in many stream sediments in the Kings Mountain Belt. The detrital grains are colorless to white, rather uncommonly pink, and commonly are translucent to transparent. Black inclusions are common.

Scheelite may well have formed as a metamorphic mineral in the Inner Piedmont Belt and as a vein mineral in the gold districts east of Charlotte. It will not be discussed here because its distribution features are presented on the tungsten sheet. Likewise, spinel is a metamorphic mineral that is the most widespread host of zinc in our samples and therefore is discussed with zinc.

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