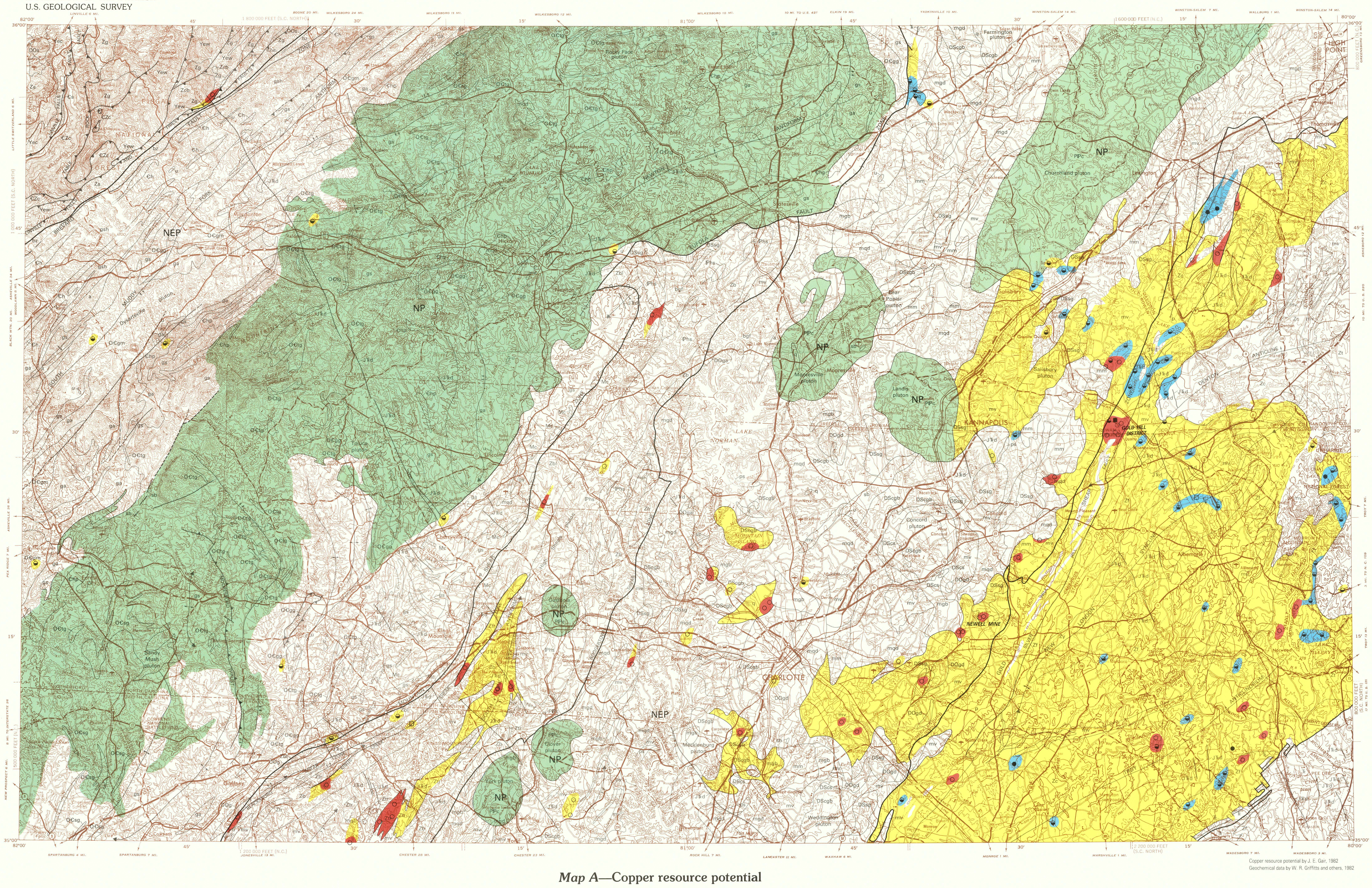
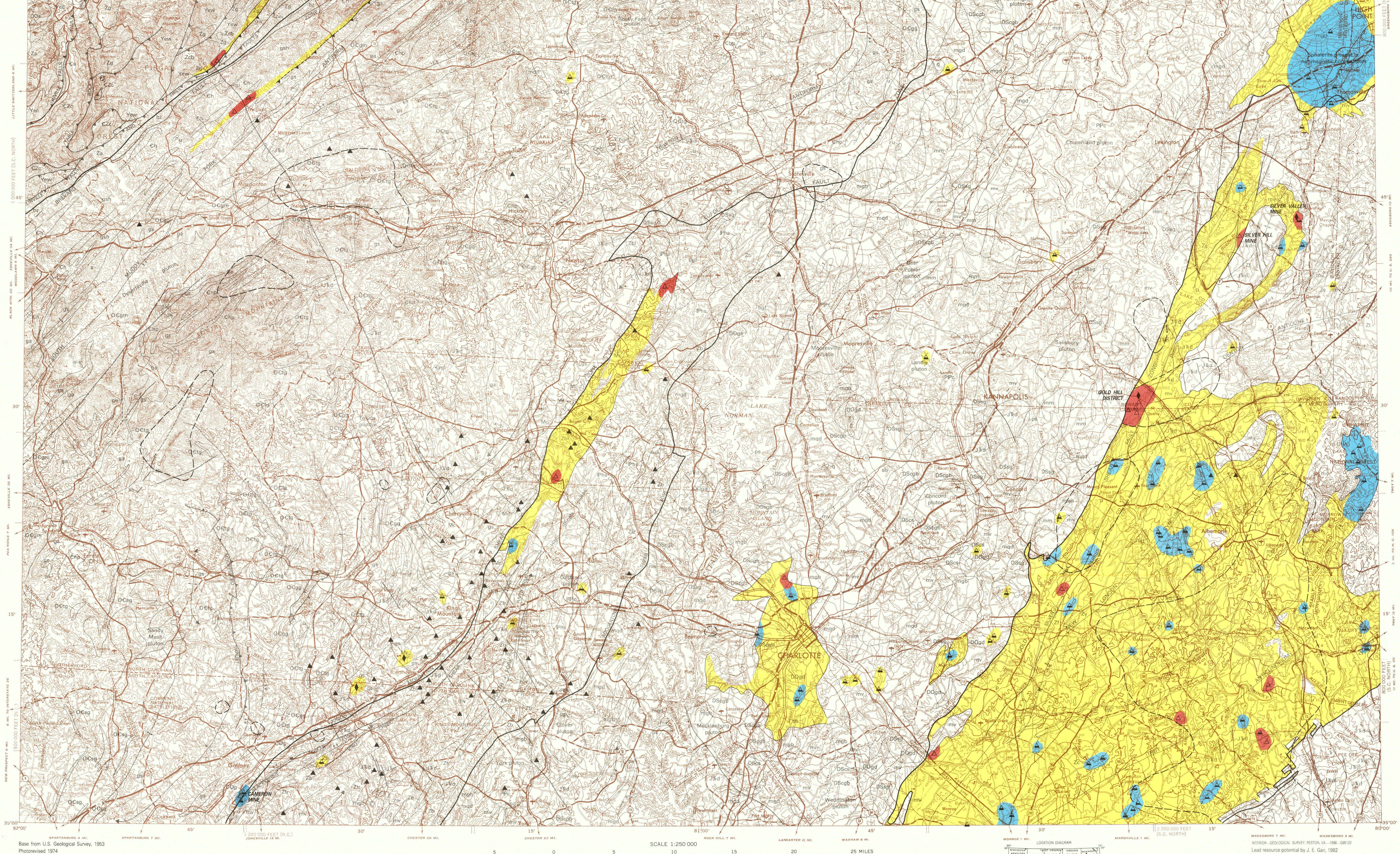


Map A—Copper resource potential

Copper resource potential by J. E. Gair, 1982
Geochemical data by W. R. Griffitts and others, 1982



Base from U.S. Geological Survey, 1953
Photorevised 1974
100,000-foot grids based on North Carolina coordinate system and South Carolina coordinate system, north zone

SCALE 1:250 000
5 0 5 10 15 20 25 MILES
5 0 5 10 15 20 25 30 35 KILOMETERS

CONTOUR INTERVAL 100 FEET
WITH SUPPLEMENTARY CONTOURS AT 50 FOOT INTERVALS
NATIONAL GEODETIC VERTICAL DATUM OF 1929

LOCATION DIAGRAM

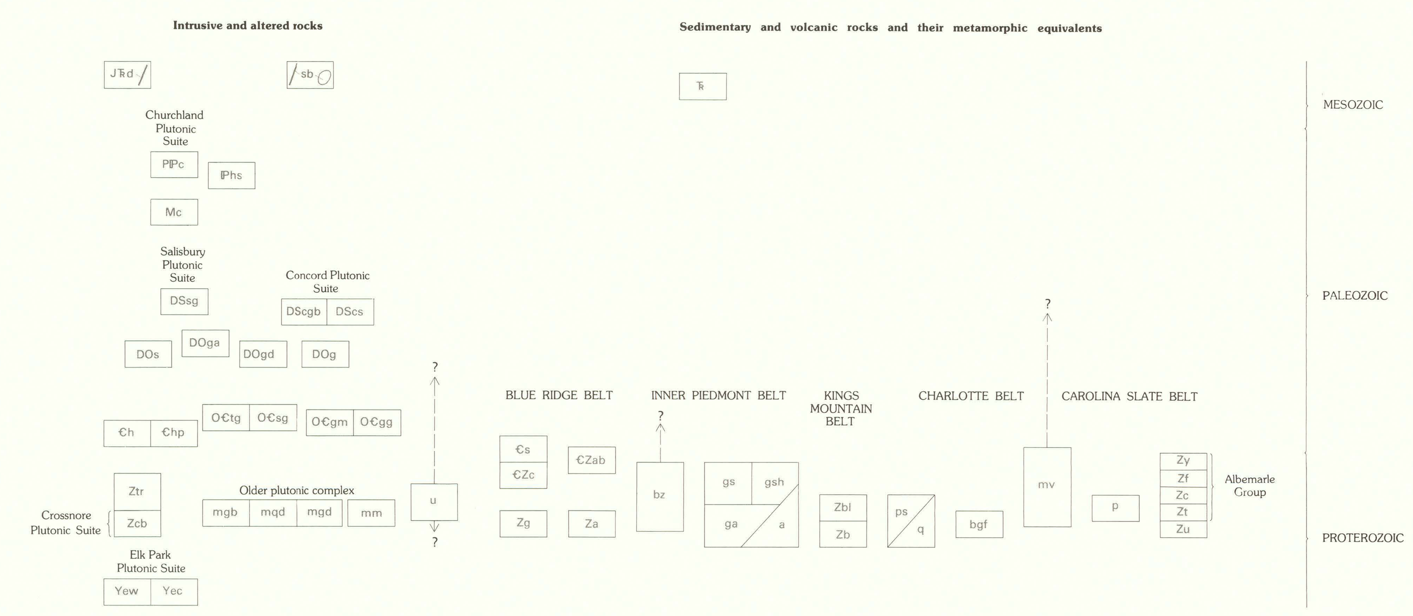
INTERIOR—GEOLOGICAL SURVEY, RESTON, VA.—1986—G85122

Lead resource potential by J. E. Gair, 1982
Geochemical data by W. R. Griffitts and others, 1982
Geologic base modified from Goldsmith and others (in press)

Map B—Lead resource potential

Note: The following correlation, description, and geologic symbols are for the Geologic map shown in gray

CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

This map is generalized from Goldsmith and others (in press) in order to make an appropriate base for mineral-resource assessment as part of a project in the Conterminous United States Mineral Assessment Program. Most of the plutonic rock units and all localities of ultramafic rock are shown. Minor stratiform rock units and subdivisions of major stratiform rock units have not been shown.

Sedimentary and volcanic rocks and their metamorphic equivalents

TR	Sandstone, siltstone, and conglomerate
Ꞓs	Shady Dolomite (Early Cambrian)
ꞒZc	Chilhowee Group (Early Cambrian to Late Proterozoic)—Quartzite, arkosic quartzite, and phyllite
ꞒZab	Alligator Back Formation (Early Paleozoic and/or Late Proterozoic)—Laminated quartzofeldspathic gneiss, mica schist, and amphibolite
bz	Rocks of the Brevard zone—Variably sheared biotite gneiss, mica schist, quartzite, metavolcanic rocks, phyllite, and marble. Includes rocks of several formations
gsh	Muscovite schist, layered biotite gneiss, and subordinate quartzite and amphibolite; contains narrow zones of Henderson Gneiss
gs	Biotite gneiss, biotite-muscovite schist, sillimanite mica schist, and subordinate layers of calc-silicate rock, quartzite, metaconglomerate, and many small masses of granite and pegmatite
bgf	Fine-grained biotite gneiss—Strongly foliated but commonly massive rock of granitic to tonalitic composition. Minor amphibolite and muscovite schist. Probably metamorphosed intermediate volcanic rock
ga	Biotite gneiss, amphibolite and hornblende gneiss; minor sillimanite and mica schist, and many small masses of granite and granite gneiss locally forming migmatite
a	Amphibolite
ps	Phyllite and mica schist; minor quartzite
q	Quartzite; subordinate mica schist and phyllite. Probably includes both metamorphosed sandstones and metamorphosed hydrothermally leached and silicified rock
mv	Metavolcanic rocks, undivided—Includes mafic, intermediate, and felsic volcanic rocks and Flat Swamp Member of the Cid Formation and metavolcanic rocks of the Battleground Formation.
Zg	Grandfather Mountain Formation (Late Proterozoic)—Arkose, siltstone, phyllite, conglomerate and felsic volcanic rocks
Za	Ashe Formation (Late Proterozoic)—Muscovite-biotite gneiss, commonly sulfidic; mica schist, and amphibolite
Zy	Yadkin Formation (Late Proterozoic)—Graywacke
Zf	Floyd Church Formation (Late Proterozoic)—Siltstone and argillite
Zc	Cid Formation (Late Proterozoic)—Mudstone member
Zt	Tillery Formation (Late Proterozoic)—Laminated siltstone and mudstone
Zu	Uwharrie Formation (Late Proterozoic)—Felsic volcanic rocks
p	Phyllite (Late Proterozoic)—Probably equivalent to Tillery Formation (Zt) and Cid Formation (Zc)
Zbl	Blacksburg Formation (Late Proterozoic)—Sericite phyllite or schist and subordinate beds of marble, micaceous quartzite, and amphibolite
Zb	Battleground Formation (Late Proterozoic)—Quartz-sericite schist and phyllite, and subordinate beds of quartz-pebble conglomerate, quartzite, kyanite or sillimanite quartzite, and manganiferous schist. Metavolcanic rocks of the Battleground Formation are included in mv

Intrusive and altered rocks

JTRd	Diabase (Jurassic and Triassic?)
sb	Silicified breccia zones
PIPc	Churchland Plutonic Suite (Permian and Pennsylvanian)—Predominantly porphyritic granite containing microcline phenocrysts
IPhs	High Shoals Granite (Pennsylvanian)—Porphyritic gneissic granite
Mc	Cherryville Granite (Mississippian)—Biotite-muscovite granite; some associated pegmatites contain spodumene
DSsg	Salisbury Plutonic Suite (Devonian and Silurian)—Leucocratic granite
DScgb	Concord Plutonic Suite (Devonian and Silurian)—Gabbro, norite, gabbro-norite, and hornblende gabbro
DScs	Syenite of Concord Plutonic Suite
DOga	Alaskitic granite, fine-grained
DOgd	Granodiorite, non- to weakly foliated
DOg	Gneissic metagranite—Medium- to coarse-grained gneissic biotite granite
DOs	Spruce Pine Alaskite (Early Devonian to Late Ordovician)—Biotite-muscovite granite and granodiorite; associated pegmatites are a source for feldspar and muscovite
OꞒtg	Toluca Granite (Early Ordovician and Cambrian)—Medium-grained gneissic to non-gneissic granite and granodiorite; garnet and monazite common accessories
OꞒsg	Granite of Sandy Mush—Porphyritic gneissic granite probably genetically related to the Toluca Granite
OꞒgm	Migmatitic granitoid gneiss and quartz-diorite gneiss containing inclusions and screens of biotite gneiss, amphibolite and metagabbro, and masses of gneissic and non-gneissic granite to quartz diorite similar to the Toluca Granite
OꞒgg	Granitoid gneiss—Layered gneissic biotite granite to hornblende-biotite quartz diorite
Ꞓh	Henderson Gneiss (Cambrian)—Inequigranular, granitic to granodioritic biotite gneiss. Typically contains lensoid microcline mega crysts and microcline-plagioclase aggregates parallel to foliation
Ꞓhp	Garnetiferous phase of Henderson Gneiss—Granitic to granodioritic biotite gneiss containing tabular to lensoid feldspar megacrysts in garnetiferous matrix
Ztr	Metamorphosed trondhjemite and biotite tonalite (Late Proterozoic)
mgb	Metamorphosed gabbro, diorite, and diabase
mqd	Metamorphosed quartz diorite, diorite, and tonalite; locally porphyritic
mgd	Metamorphosed granodiorite; locally porphyritic
mm	Mafic and ultramafic complex—Metamorphosed gabbroic and ultramafic intrusives, hypabyssal and probably extrusive basalts
u	Ultramafic rocks, variably altered to soapstone and serpentinite
Zcb	Brown Mountain Granite (Late Proterozoic)—Medium- to coarse-grained leucocratic granite, locally blastomylonitic
Yew	Wilson Creek Gneiss and Blowing Rock Gneiss (Middle Proterozoic)—Equigranular granite to diorite gneiss; coarse-grained granite augen gneiss
Yec	Cranberry Gneiss (Middle Proterozoic)—Equigranular granite and layered granite, granodiorite, and biotite gneiss

EXPLANATION OF MAP SYMBOLS

- Contact
- High angle fault, dashed where inferred
- Reverse fault, teeth on upthrown plate, dashed where inferred
- Reverse fault, overturned
- Thrust fault, teeth on overriding plate, dashed where inferred
- Anticline or antiform, showing direction of plunge
- Syncline or synform, showing direction of plunge
- Overturned anticline, or antiform showing direction of dip of limbs
- Overturned syncline or synform, showing direction of dip of limbs

EXPLANATION FOR MAP A

Areas of resource potential—Areas of resource potential occur both within identified geologically favorable formations and at isolated sites where anomalous geochemical values or known mineral occurrences are not associated with specific geologic formations

- High
- Moderate
- Low
- NEP — No evident potential
- NP — No potential

Boundary of major lithotectonic belt

Location points

- ○ Past producer of copper
- ◒ Copper ≥100 ppm in magnetic fraction of pan concentrate (0.5 ampere setting of magnetic separator)
- ● Copper ≥100 ppm; lead ≥1000 ppm
- □ Copper ≥100 ppm; zinc ≥1500 ppm
- ■ Copper ≥100 ppm; lead ≥1000 ppm; zinc ≥1500 ppm

INTRODUCTION

The mineral resources of the Charlotte 1° x 2° quadrangle, North Carolina and South Carolina, were assessed between 1978 and 1982 under the Conterminous United States Mineral Assessment Program (CUSMAP). The mineral-resource assessments were made on the basis of geologic and geophysical investigations, the presence of existing or abandoned mines, mapped mineral occurrences, and, where appropriate, heavy-mineral occurrences seen in pan concentrates or geochemical data detected by analysis of pan concentrates. The data sources and resource assessments for all commodities studied are listed in a U.S. Geological Survey Circular (Gair and others, in press).

MAP A—COPPER RESOURCE POTENTIAL

The mineral-resource assessment for copper utilizes knowledge of past-production localities (D'Agostino and Rowe, in press), and information on anomalous concentrations of copper associated in places with lead and zinc. Such favorable factors, alone and in combination, help identify geologically favorable areas from among the formations mapped in the Charlotte quadrangle by Goldsmith and others (in press).

On the map, the boundaries of geologically favorable areas coincide, in many places, with the mapped contacts of formations. In other places, the boundaries are drawn arbitrarily across or within a mapped formation in order to project favorable zones only a limited distance beyond the actual locations of sample sites where copper occurs. These areas generally are not projected more than 15 km along the trend of the formation and a few kilometers across the trend from such a sample site.

The geologically favorable areas are designated as having high, moderate, or low potential for copper resources. Areas of high potential are areas of favorable geology which contain previously exploited copper deposits. These areas thus possess definite evidence of copper mineralization, which may or may not be accompanied by favorable geochemical values for copper in nearby stream sediments. The Gold Hill district is one such area which has both copper mineralization and high geochemical values for copper (and for lead and zinc as well).

Areas of moderate resource potential are those for which the only direct indications of copper are favorable geochemical values for copper alone, or for combinations of copper, lead, and zinc.

Areas of low resource potential are marked only by one type of favorable data. This may include either 1) parts of a favorable mapped rock unit projected from an area of higher potential to a locality where there are neither mineral occurrences nor favorable geochemical values present, 2) isolated copper deposits, or 3) the presence of geochemical values and an absence of an identified favorable geologic unit.

Areas of no evident potential reflect either insufficient data or a lack of data for copper resources, but cannot be fully discounted as having no potential. Areas of no potential are underlain by types of rock that are unlikely to contain copper deposits.

Most of the copper produced in the quadrangle area is from the stratabound massive and nearly massive sulfide deposits in the Carolina slate belt volcanic-sedimentary rocks. The host rocks in most places in the belt are felsitic volcanic rocks. The deposits are probably syngenetic with them. Some sulfide deposits were enriched to ore grades (greater than 3 to 5 percent copper) by weathering and were not mined below the zone of weathering. The deposits in the slate belt are the most productive in the Charlotte quadrangle, but production from these deposits is small compared to national production. Small, copper-bearing quartz veins, which are probably epigenetic, and other minor occurrences of uncertain relationship to enclosing quartz-mica schist and metavolcanic rocks have been mined in a few places to the west of the slate belt.

Low-grade deposits at the Newell mine occur in quartz veins within a stockwork in quartz monzonite plutonic rock. These deposits average 0.03 to 0.04 percent copper and are classified as porphyry-type copper (and molybdenum) mineralization by Worthington and Lutz (1975). Some copper-bearing veins in or near other granitic plutonic rocks west of the slate belt may be of the same type. Some minor occurrences of copper in metagabbroic rock and quartzite have been exploited in the Charlotte belt, but the nature of the mineralization in relation to the enclosing rocks is uncertain.

Griffitts, Whitlow, Siems, and Botinelly (1984) note the association of weak copper anomalies (10 to 30 ppm in silt samples and less than 100 ppm in pan concentrates) with gold in quartz veins in the South Mountains and vicinity. Such anomalies may serve as an aid in targeting areas for gold exploration, but they appear to have no significance in the evaluation of copper resource potential.

The total production of copper metal from the quadrangle (1901–43) was about 1,200 tons, of which 95 percent was from mines in the slate belt and 91 percent from the Gold Hill district alone (DeYoung and others, 1985).

MAP B—LEAD RESOURCE POTENTIAL

The mineral-resource assessment for lead utilizes knowledge of past production localities (D'Agostino and Rowe, in press), and information on anomalous concentrations of lead in pan concentrates of stream sediments. Areas sampled during the National Uranium Resource Evaluation (NURE) that show slightly anomalous levels of lead in the minus 100-mesh fraction of stream sediments (Ferguson, 1979) are also shown as a possible exploration aid. Anomalous amounts of zinc not associated with anomalous lead also are shown as a possible aid in exploration for lead. Such features alone or in combination help to identify geologically favorable areas from among the formations mapped in the Charlotte quadrangle by Goldsmith and others (in press).

Favorable geologic areas are those which 1) contain a high proportion or all of the known lead mines in the area, or 2) have a high proportion of pan-concentrate samples containing anomalous geochemical values. On the map, the boundaries of geologically favorable areas coincide, in many places, with the mapped contacts of formations. In other places, the boundaries may cross formation contacts or are drawn within a formation, so that a favorable zone may include more than one formation or extend only a limited distance within a formation beyond the nearest lead data points (generally not more than 15 km along the trend of a formation and a few kilometers across the trend from data sites).

The geologically favorable areas are designated as having high, moderate, or low resource potential. Areas of high potential are areas of favorable geology where there are previously exploited lead deposits, which is direct evidence of lead mineralization. These areas may or may not contain favorable geochemical values for lead (Griffitts, Whitlow, Duttweiler, Siems, and Wilch, 1984). Areas of high resource potential within the Gold Hill district and in the vicinities of the Silver Valley and Silver Hill mines do contain anomalous lead values as well as anomalous zinc values.

Areas of moderate resource potential are areas of favorable geology which contain only favorable geochemical values for lead or lead and zinc.

Areas of low potential are marked only by one type of favorable data. Such a favorable feature might be 1) an extension of a favorable geologic unit, projected from an area of higher potential to a locality where there is no supporting geochemical data or mineral occurrence, or 2) isolated occurrences of anomalous lead (mineral or geochemical) which are not identified with a favorable geologic unit.

The major area of lead resource potential is in the Carolina slate belt. While most of the belt is of low resource potential, about 99 percent of the lead produced (1910–1938) in the quadrangle (DeYoung and others, 1985) is from the stratabound massive-sulfide and concordant vein deposits in that region. Almost all of this production has come from the Silver Hill and Silver Valley deposits. Only a small amount of by-product lead has been produced in the Gold Hill district; the resource potential of this district, although high by the criteria used here, is less than that near the Silver Hill and Silver Valley deposits. The host rocks in the Carolina slate belt are sequences of argillite and interbedded meta-andesite to metarhyolite (Nitze and Hanna, 1896; Carpenter, 1976; Indorf, 1981). The lead content of the deposits ranges from about 5 to 19 percent (Nitze and Hanna, 1896; Indorf, 1981).

Lead occurrences west of the Carolina slate belt mark areas of mainly low resource potential. Most occurrences are in minor veins associated with 1) a body of granodiorite in the Charlotte belt near the city of Charlotte[1], 2) part of a sericite schist formation in the northern part of the Kings Mountain belt, 3) the contact zone between a sericite schist-quartzite unit and a biotite-gneiss unit in the northwest part of the Inner Piedmont belt, and 4) a felsic metavolcanic unit in the Blue Ridge belt.

Mineralization at the old Cameron lead mine south of Gaffney, S. C., in the Kings Mountain belt, is in small veins (Keith and Sterrett, 1931). Pan concentrates from a small area near the mine contain anomalous amounts of lead (Griffitts, Whitlow, Botinelly, Duttweiler, Siems, and Wilch, 1984). On the geologic map of the quadrangle, the most likely favorable feature with which to associate the Cameron deposit is the Kings Mountain shear zone. The area surrounding the Cameron deposit is designated as only of moderate potential, containing known mineralization and a geochemical anomaly, but no identified favorable geologic unit.

[1] Griffitts, Whitlow, Botinelly, Duttweiler, Siems, and Wilch (1984) attribute some of the anomalous lead near Charlotte, particularly west and south of the city, to contamination by artifacts.

EXPLANATION FOR MAP B

Areas of resource potential—Areas of resource potential occur both within identified geologically favorable formations and at isolated sites where anomalous geochemical values or known mineral occurrences are not associated with specific geologic formations

- High
- Moderate
- Low

Boundary of major lithotectonic belt

Boundary of area containing 15–100 ppm lead—Samples are minus 100-mesh fraction of stream sediment collected during National Uranium Resource Evaluation (NURE) (Ferguson, 1979)

Location points

- △ Lead mine (past producer)
- ◭ Lead ≥1000 ppm in magnetic fraction of pan concentrate (at 1 ampere setting of magnetic separator)
- ▲ Zinc ≥1500 ppm in magnetic fraction of pan concentrate (at 1 ampere setting of magnetic separator)
- ♦ Lead ≥1000 ppm; zinc ≥1500 ppm

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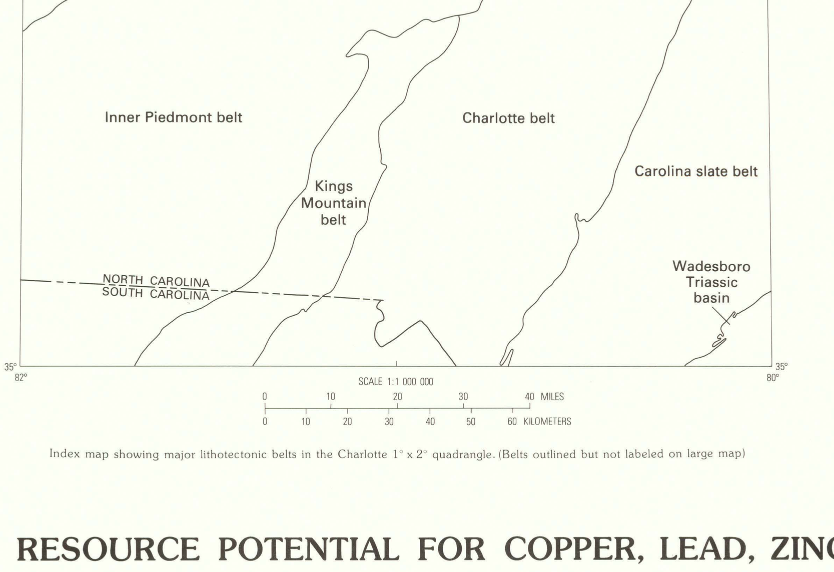

Index map showing major lithotectonic belts in the Charlotte 1° x 2° quadrangle. (Belts outlined but not labeled on large map)

MINERAL RESOURCE POTENTIAL FOR COPPER, LEAD, ZINC AND COMBINED BASE METALS IN THE CHARLOTTE 1° x 2° QUADRANGLE, NORTH CAROLINA AND SOUTH CAROLINA

By
Jacob E. Gair and Wallace R. Griffitts
1986

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