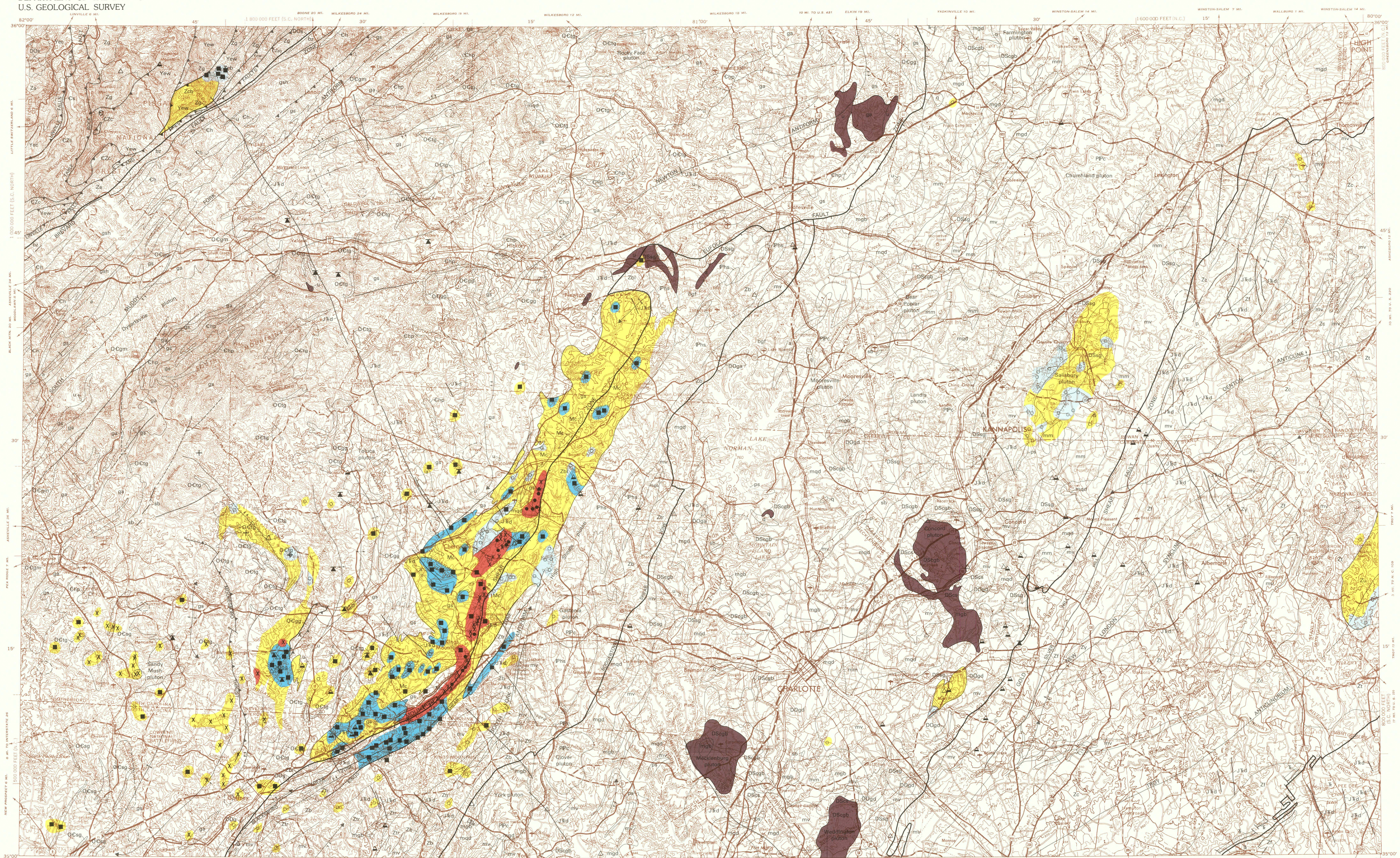


MAP A—Tin resource potential

Tin resource potential by J. E. Gair, 1982; geochemical and heavy-mineral data by W. R. Griffitts and others, 1984; 1984 a, b; J. P. D'Agostino and Whitlow, 1985

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

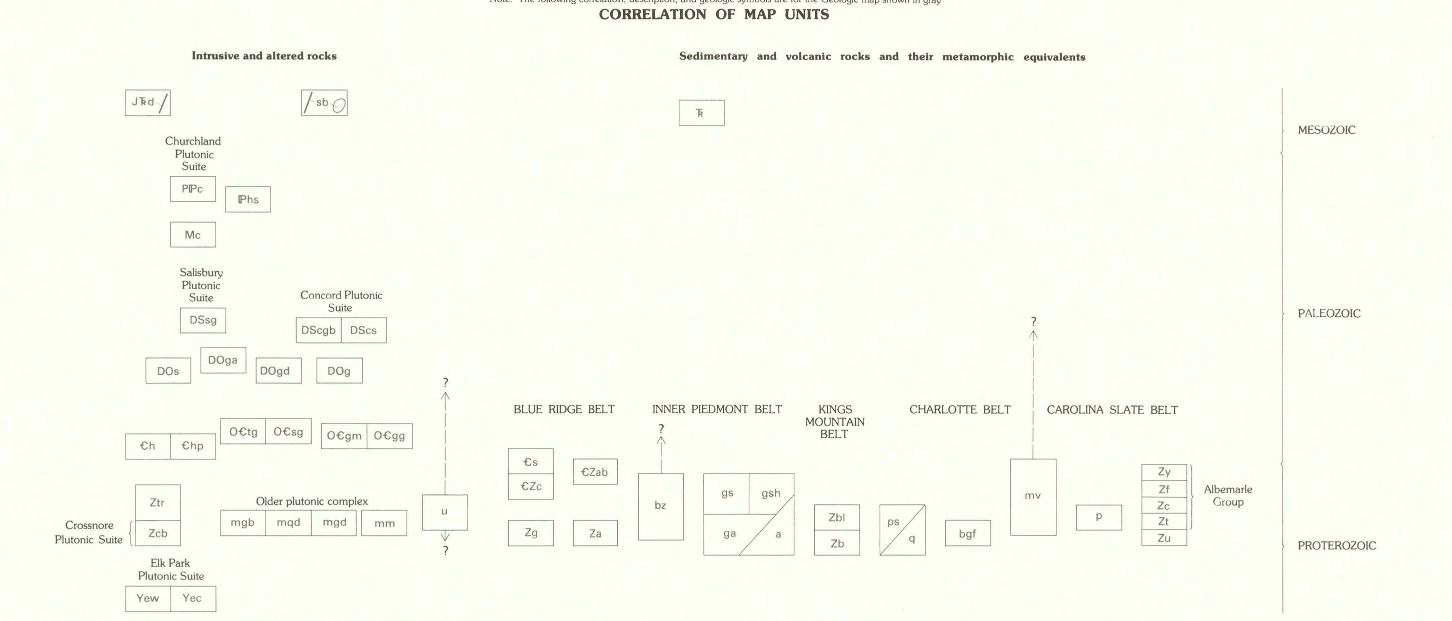
INTERIOR—GEOLOGICAL SURVEY, RESTON, VA.—1986—G84247

Geologic base modified from Goldsmith and others, in press
Tungsten resource potential by J. E. Gair, 1982; Geochemistry by W. R. Griffitts, J. W. Whitlow, K. A. Duttweiler, D. F. Siems and L. O. Wilch, 1982

MAP B—Tungsten 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

- **Ŧ** Sandstone, siltstone, and conglomerate
- **Єs** Shady Dolomite (Early Cambrian)
- **ЄZc** Chilhowee Group (Early Cambrian to Late Proterozoic)—Quartzite, arkosic quartzite, and phyllite
- **ЄZab** 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, meta-conglomerate, 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

- **JŦd** 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
- **OЄtg** Toluca Granite (Early Ordovician and Cambrian)—Medium-grained gneissic to non-gneissic granite and granodiorite; garnet and monazite common accessories
- **OЄsg** Granite of Sandy Mush—Porphyritic gneissic granite probably genetically related to the Toluca Granite
- **OЄgm** 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
- **OЄgg** Granitoid gneiss—Layered gneissic biotite granite to hornblende-biotite quartz diorite
- **Єh** Henderson Gneiss (Cambrian)—Inequigranular, granitic to granodioritic biotite gneiss. Typically contains lensoid microcline megacrysts and microcline-plagioclase aggregates parallel to foliation
- **Єhp** 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

- High
- Moderate—Combined high values of tin, beryllium, and niobium
- Moderate—High values of tin (≥1000 ppm) only
- Low
- No evident potential
- No potential

Boundary of major lithotectonic belt

Area of anomalous tungsten—Boundary of area in which tungsten ≥100 ppm in minus 100-mesh stream sediment samples collected during National Uranium Resource Evaluation (NURE) (Ferguson, 1979). May be associated with tin mineralization

● **Site of past production of tin**

Mineral occurrences

- X Cassiterite
- ▽ Columbite
- △ Scheelite ≥1 percent in mineral concentrates

Anomalous amounts of elements

- ○ Tin ≥1000 ppm in nonmagnetic fraction of pan concentrate; may occur with niobium
- \+ Niobium ≥700 ppm in nonmagnetic fraction of pan concentrate; may occur with tin
- ▲ Tungsten ≥100 ppm in nonmagnetic fraction of pan concentrate
- ▲ Tungsten ≥100 ppm in magnetic fraction of pan concentrate
- ■ Combined tin, beryllium, and niobium in pan concentrate: tin ≥300 ppm, beryllium ≥20 ppm; niobium ≥ 200 ppm

EXPLANATION FOR MAP B

Areas for resource potential—Formations, plutons and their bordering zones, and other areas which have resource potential for tungsten; no production history

Low potential—Grouped according to major geologic belt

- Blue Ridge belt
  - Wilson Creek Gneiss (Yew)
- Inner Piedmont belt—Plutons and smaller intrusive bodies (which may be offshoots of subjacent plutons); greisen zones (not shown) associated with intrusive bodies may contain tungsten
  - Cherryville Granite (Mc)
  - Toluca Granite (OЄtg)
  - Other granite bodies (DOg)
- Charlotte and Kings Mountain belts
  - Porphyritic granite (PIPc)
  - Syenite (DScs)
  - Granite (DSsg)
  - Granodiorite (DOgd)
  - Metagranodiorite (mgd)
  - Metamorphosed quartz diorite, fine-grained (mqd)
  - Metavolcanic rocks, felsic and mafic, undivided (mv)
- Carolina slate belt
  - Gold Hill shear zone

Moderate potential

- X[1] Scheelite occurrence at Furniss and Phoenix mines
- X[2] Scheelite occurrence at Cline mine

Boundary of major lithotectonic belt

Boundary of area containing anomalous tungsten in fine-grained stream sediment—10–87 ppm tungsten in minus 100-mesh stream sediment sampled during National Uranium Resource Evaluation (NURE) (Ferguson, 1979)

Occurrences in pan concentrates

- ● Tungsten ≥100 ppm in nonmagnetic fraction
- ○ Tungsten ≥100 ppm in magnetic fraction (at 0.5 ampere)
- □ Scheelite >2 percent in nonmagnetic fraction
- □ Scheelite <2 percent in nonmagnetic fraction
- △ Tungsten ≥100 ppm in nonmagnetic fraction and Scheelite <2 percent in nonmagnetic fraction
- ▲ Tungsten ≥100 ppm in magnetic fraction and Scheelite <2 percent in nonmagnetic fraction

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, on heavy-mineral occurrences seen in pan concentrates or detected by geochemical 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).

TIN RESOURCE POTENTIAL

The mineral-resource assessment for tin utilizes data about favorable geologic formations and zones, localities of past production (D'Agostino and Rowe, in press), occurrences of the tin mineral, cassiterite, and anomalous concentrations of tin (and associated beryllium and niobium, in places) detected by spectrographic analysis of pan concentrates (Griffitts, Duttweiler, Whitlow, Siems, and Hoffman, 1984; Griffitts, Whitlow, Duttweiler, Siems, and Wilch, 1984 a, b, in press). Also shown on the map are the locations of pan concentrates which do not contain anomalous amounts of tin, but contain anomalous amounts of niobium and (or) anomalous amounts of the niobium mineral, columbite, and the tungsten mineral, scheelite (both of which commonly occur in lode-tin deposits). The occurrences of columbite and scheelite shown on the map might serve as an exploration aid, but do not provide any measure of potential with the assessment method used here.

Tungsten in greater-than-crustal abundance commonly is associated with concentrations of tin in nature. Therefore, sites of pan concentrate samples containing anomalous amounts of tungsten are shown on the map, as well as areas in which minus 100-mesh stream sediments collected during the National Uranium Resource Evaluation (NURE) likewise contain 100 ppm tungsten or more (Ferguson, 1979). Such anomalous tungsten may be unrelated to tin mineralization, and so is not used here as a measure of tin resource potential, but is presented on the map as a possible aid in exploration for tin.

The favorable geologic formations are those, as mapped by Goldsmith and others (in press), that underlie areas from which a high proportion of pan concentrates yield anomalous amounts of tin or cassiterite. The principal areas of favorable geology are (1) a zone along the southeast side of the Inner Piedmont belt, corresponding largely to the tin-spodumene belt of Kesler (1942), which is underlain by the Cherryville Granite pluton and mica schists intruded by tin-bearing pegmatite and associated tin-bearing greisen, (2) two poorly defined areas underlain by biotite gneiss and sillimanite-mica schist intruded by small bodies of Toluca Granite west and southwest of Shelby, North Carolina, (3) the Brown Mountain Granite pluton in the Blue Ridge belt in the northwestern part of the quadrangle, and (4) the Salisbury Granite pluton of the Salisbury Plutonic Suite and a 2-km-wide bordering zone, south of Salisbury, N.C.

The areas of favorable geology may contain zones of high, moderate, or low potential for tin resources. Areas of high potential show combinations of favorable geology with known tin mineralization (sites of former tin production or occurrences of cassiterite) with or without anomalous geochemical values for tin. Favorable geochemistry is defined here as either high values for tin (1000 ppm or more) or moderate to high values for tin (as low as 300 ppm) in association with high values for beryllium and (or) niobium. Areas of low potential consist of favorable geologic zones without other favorable factors in the immediate areas being considered, or favorable geochemistry alone, or isolated occurrences of cassiterite.

Areas of no evident potential reflect either an absence of data or insufficient data, whereas areas of no potential reflect negative data, which generally means that the rock underlying the classified area is of a type that does not contain tin deposits.

TUNGSTEN RESOURCE POTENTIAL

The mineral-resource assessment for tungsten utilizes data which were obtained during CUSMAP for the distribution of the tungsten mineral, scheelite, in pan concentrates of stream sediments, and for anomalous values of tungsten in pan concentrates, as determined by semiquantitative analysis (Griffitts, Whitlow, Duttweiler, Siems, and Wilch, 1984 b). The map shows the distribution of scheelite and anomalous tungsten values in pan concentrates as well as areas of slight to moderate concentrations of tungsten in minus 100-mesh stream-sediment samples collected during the National Uranium Resource Evaluation (NURE) (Ferguson, 1979). There has been no record of tungsten production from the quadrangle and only a few bedrock occurrences of scheelite are known.

The data from the pan concentrates suggest that the sources of much of the scheelite and anomalous tungsten values are the various granitic plutons in the Charlotte and Inner Piedmont belts, the Wilson Creek Gneiss in the Blue Ridge belt (also see Crandall and others, 1982), and the phyllite and metavolcanic rocks of the Gold Hill shear zone along the west side of the Carolina slate belt (for geologic reference, see Goldsmith and others, in press).

Scheelite has been found in quartz veins at the Furniss gold mine and at the Phoenix and Cline copper mines in the eastern part of the Charlotte belt southeast of Concord, N.C. In places, the tungsten-bearing quartz veins also contain chalcopyrite, siderite, calcite, and barite (Hickman, 1948; Jones and Peyton, 1950; Espenshade, 1950; Carpenter, 1976, p. 29, 30, 33). Samples from the Phoenix mine dump contain small amounts of tungsten (0.11 to 0.19 percent tungsten oxide) (Jones and Peyton, 1950, p. 4) The veins there occur in metavolcanic rocks which have been intruded by a variety of plutonic rocks. The tungsten-bearing veins may be cogenetic with the metavolcanic rocks; that is, they may have formed during the initial volcanism or during the metamorphism of the volcanic rocks; or, they may be offshoots of plutonic rocks. Minor amounts of scheelite have been observed in vein quartz at the Newell (Dixie Queen) mine about 8 km southwest of the Furniss and Phoenix mines, in marble at the Kings Mountain (N.C.) gold mine, and in limestone at the Campbell limestone quarry near Gaffney, S.C. (Espenshade, 1950, p. 64–65). In addition, many other occurrences of scheelite and anomalous tungsten in pan concentrates are scattered over all the major geologic belts of the quadrangle. These occurrences are not clearly related to any specific geologic formation, but are probably derived from minor mineralization in various types of bedrock.

Since there has been no production history for tungsten, the resource potential in the Charlotte quadrangle has been qualified as either low (almost everywhere) or moderate. The only areas of moderate potential are at the Furniss, Phoenix, and Cline mines. The areas of moderate potential for tungsten resources therefore are in metavolcanic rock. The other geologic formations (lithologies) which appear to contain geochemically anomalous amounts of tungsten and (or) concentrations of scheelite are assigned a low potential for tungsten resources: the Wilson Creek Gneiss in the Blue Ridge belt, the Toluca Granite and Cherryville Granite of the Inner Piedmont belt, various granitic plutons of the Charolotte belt (including granodiorite and quartz-diorite bodies) a syenite intrusive body in the Charlotte belt, the unit of undivided felsic and mafic metavolcanic rock at the east side of the Charlotte belt (except near gold and copper mines where the potential is moderate), and phyllite-metavolcanic rocks of the Gold Hill shear zone in the Carolina slate belt.

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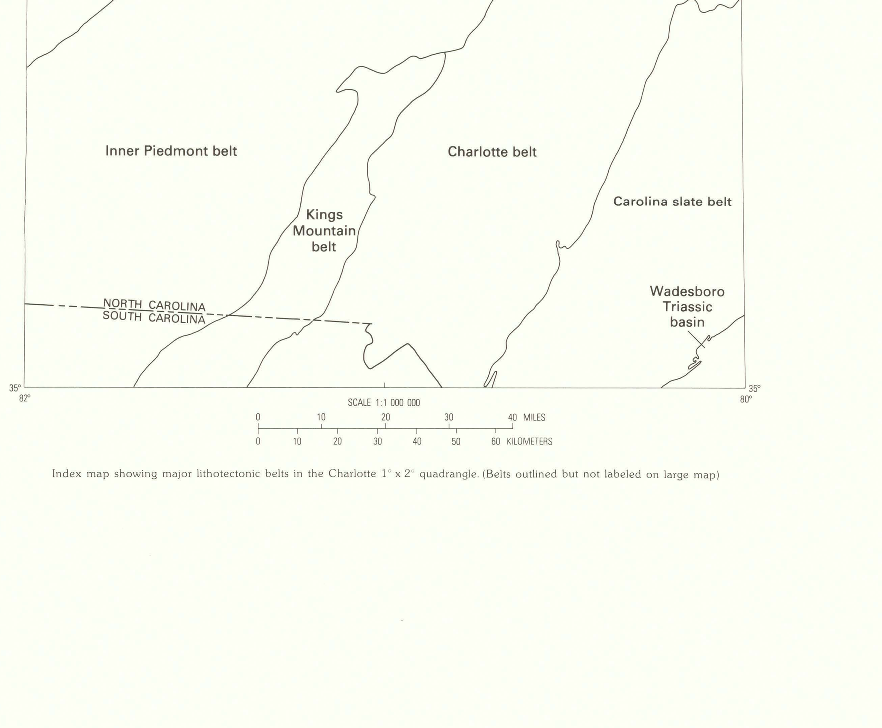

Index map showing major lithotectonic belts in the Charlotte 1° x 2° quadrangle. (Belts outlined but not labeled on large map)

MINERAL RESOURCE POTENTIAL FOR TIN AND TUNGSTEN IN THE CHARLOTTE 1° x 2° QUADRANGLE, NORTH CAROLINA AND SOUTH CAROLINA

By
Jacob E. Gair
1986

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