BASE METAL MINES AND PROSPECTS OF THE SOUTHWEST DUCKTOWN DISTRICT, GEORGIA

by

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INFORMATION CIRCULAR 78

Acknowledgements

The author would like to acknowledge the assistance and cooperation of Tennessee Chemical Company in providing access to core and historical records from the Southern Ducktown District. Tennessee Chemical Company geologists Randy Slater and Charles Acker provided information, field assistance and encouragement throughout the course of the project.

Access to the University of Georgia, Department of Geology, XRF Laboratory and assistance from Dr. James Whitney with the norms programs is greatly appreciated. The project also benefited from microprobe analyses by Sandra Whitney.

Special thanks are due to Gilles Allard, Randy Slater and Charles Acker for their thought-provoking discussions during the project and their review of the final manuscript, and to Sharon Pauley for her invaluable assistance in its final preparation.

Cover: Miners at the #20 mine, date unknown.
Photo courtesy of Georgia Department of Archives and History.

Publications Editor: Patricia Allgood

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Prepared as part of the Accelerated Economic Minerals Program

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Atlanta
1987

INFORMATION CIRCULAR 78

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BASE METAL MINES AND PROSPECTS OF THE SOUTHWEST DUCKTOWN DISTRICT, GEORGIA

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Abstract

Massive sulfide deposits of the Ducktown area, Tennessee, have been extensively studied and are recognized by recent workers to be volcanogenic sediment-hosted deposits. Less information is available for abandoned mines and prospects to the southwest in Fannin County, Georgia, which lie on trend with those at Ducktown. The southernmost deposits (#20, Mobile, Sally Jane, Jeptha Patterson, Bryant, Kellogg, etc.) lie within rocks of the Great Smoky Group and exhibit ore/host rock relationships similar to deposits at Ducktown. Previously active mines of Fannin County are spatially related to an amphibolite and banded iron formation. All deposits are associated with some form of alteration zone (magnesium-aluminum or aluminosilicate). As a result of folding, mineralized zones are repeated and form three nearly parallel linear trends consistent with the orientation of mineralized horizons to the northeast in the Ducktown area. Examination of drill core and logs (courtesy of Tennessee Chemical Company) reveals sulfides of pyrite and pyrrhotite may be less massive than those at Ducktown, but base metals of copper and zinc are present, in addition to trace amounts of silver and gold.

Introduction

Abandoned sulfide mines and prospects in Fannin County, Georgia, make up the southwestern portion of the Ducktown sulfide district. The Ducktown sulfide district forms a northeast-southwest trending belt, for approximately 13 miles (22 km) into the Epworth, Georgia 1:24,000 topographic quadrangle (Fig. 1). Ore deposits in the Ducktown district are located in the Blue Ridge geologic province within the late Precambrian, predominantly metasedimentary Great Smoky Group. The Great Smoky Group consists dominantly of clastic sedimentary units of metaconglomerate, metagreywacke, and schist with subordinate meta-igneous rocks. Ore deposits of the study area are confined to the lowermost portion of the Great Smoky Group, defined as the Copperhill Formation (Hurst, 1955). This report describes deposits predominantly within the southwestern portion of the Ducktown district and is chiefly confined to the area of the Epworth quadrangle.

Although much detailed work has been concentrated in the Ducktown basin (northeastern part of the district), ore horizons in the southwestern part of the Ducktown sulfide district, in Georgia, have received little attention in recent years. Detailed investigations by Emmons and Laney (1911, 1926) concentrated on the Ducktown-Copperhill area with cursory examinations of some of the mines and prospects in the southwestern portion of the district. LaForge and Phalen (1913) examined the geology of the southernmost Ducktown district, but generally relied upon Emmons and Laney's descriptions of the deposits. Shearer and Hull (1918), in a description of pyrite deposits of Georgia, described mines and prospects of the southwestern Ducktown district, but descriptions of most deposits were only cursory and their report did not include descriptions of all prospects of the area.

All earlier reports attributed origin of the Ducktown ores to limestone replacement. This interpretation resulted from the abundance of calcium silicates and calcite as gangue minerals. Recent workers (Addy and Ypma, 1977; Gair and Slack, 1980; Hutchinson, 1980; Slater, 1982; Fox, 1984; Abrams, 1985; and Slater and others, 1985) favor a premetamorphic or syngenetic origin for sulfide deposits in the Ducktown district.

In the Ducktown-Copperhill area (Ducktown basin) sulfides of the Copperhill Formation consist predominantly of pyrrhotite (60%) and pyrite (30%) with chalcopyrite, sphalerite, and magnetite making up most of the remainder (Magee, 1968). In the southwestern part of the district ore zones appear to be less massive than those to the northeast in the Ducktown basin.

Geology

The Ducktown sulfide district is located in the Blue Ridge geologic province in Georgia and Tennessee. The Blue Ridge is separated from the Valley and Ridge geologic province to the west by the Cartersville fault and from the northern Piedmont geologic province to the southeast by the Allatoona fault (McConnell and Abrams, 1984; Fig. 2). Ores of the Ducktown district are associated with the Copperhill Formation of the Great Smoky Group. King and others (1958) defined the Great Smoky as the uppermost group within a thick metasedimentary sequence known as the Ocoee Supergroup. Hurst (1955) and Hurst and Schlee (1962) mapped units of the Great Smoky Group in the Mineral Bluff and Epworth 1:24,000 topographic quadrangles and along Ocoee Gorge. In his work in the Mineral Bluff quadrangle, Hurst (1955) redesignated

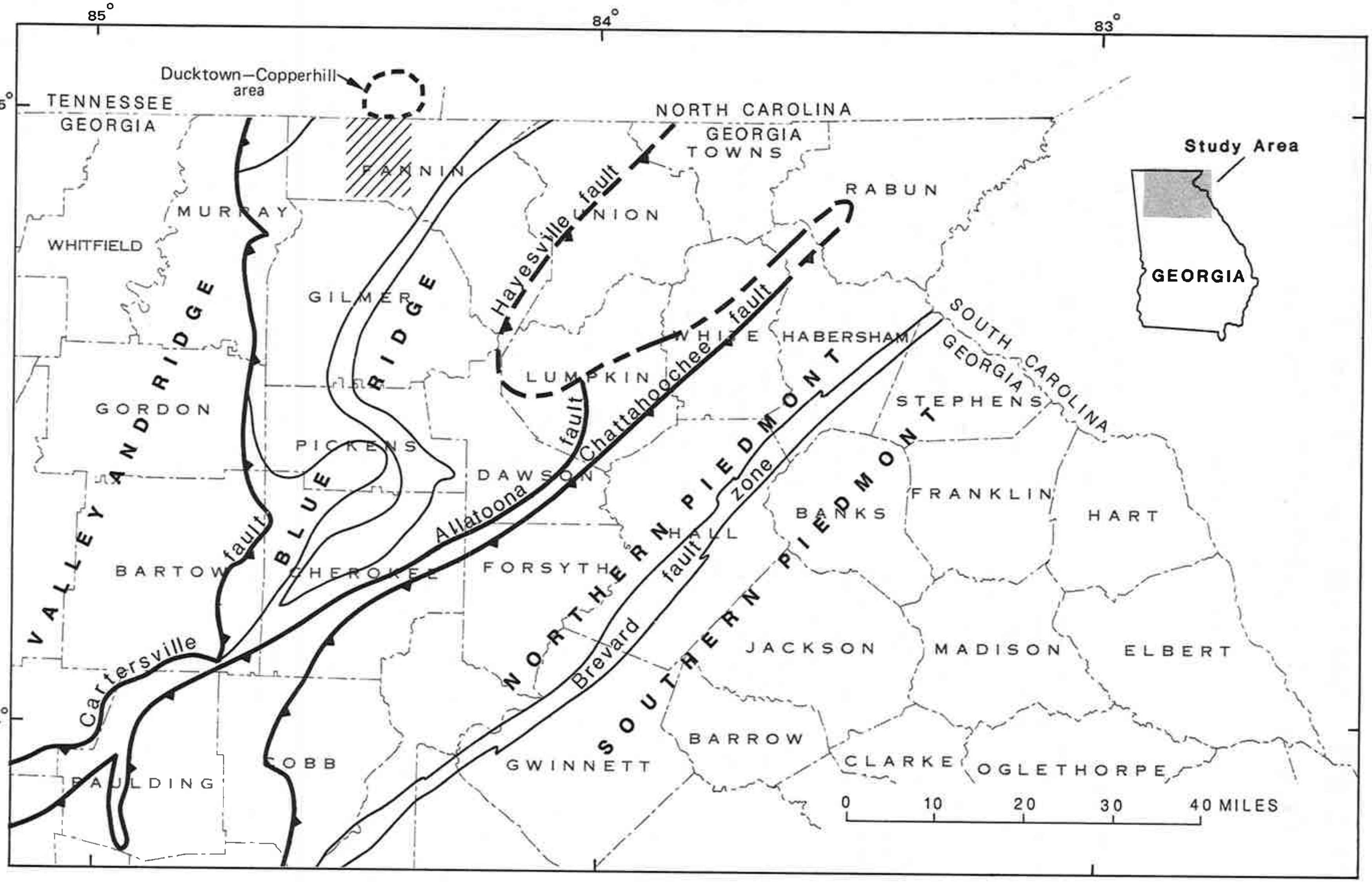


Figure 1. Location map. Epworth quadrangle is indicated.

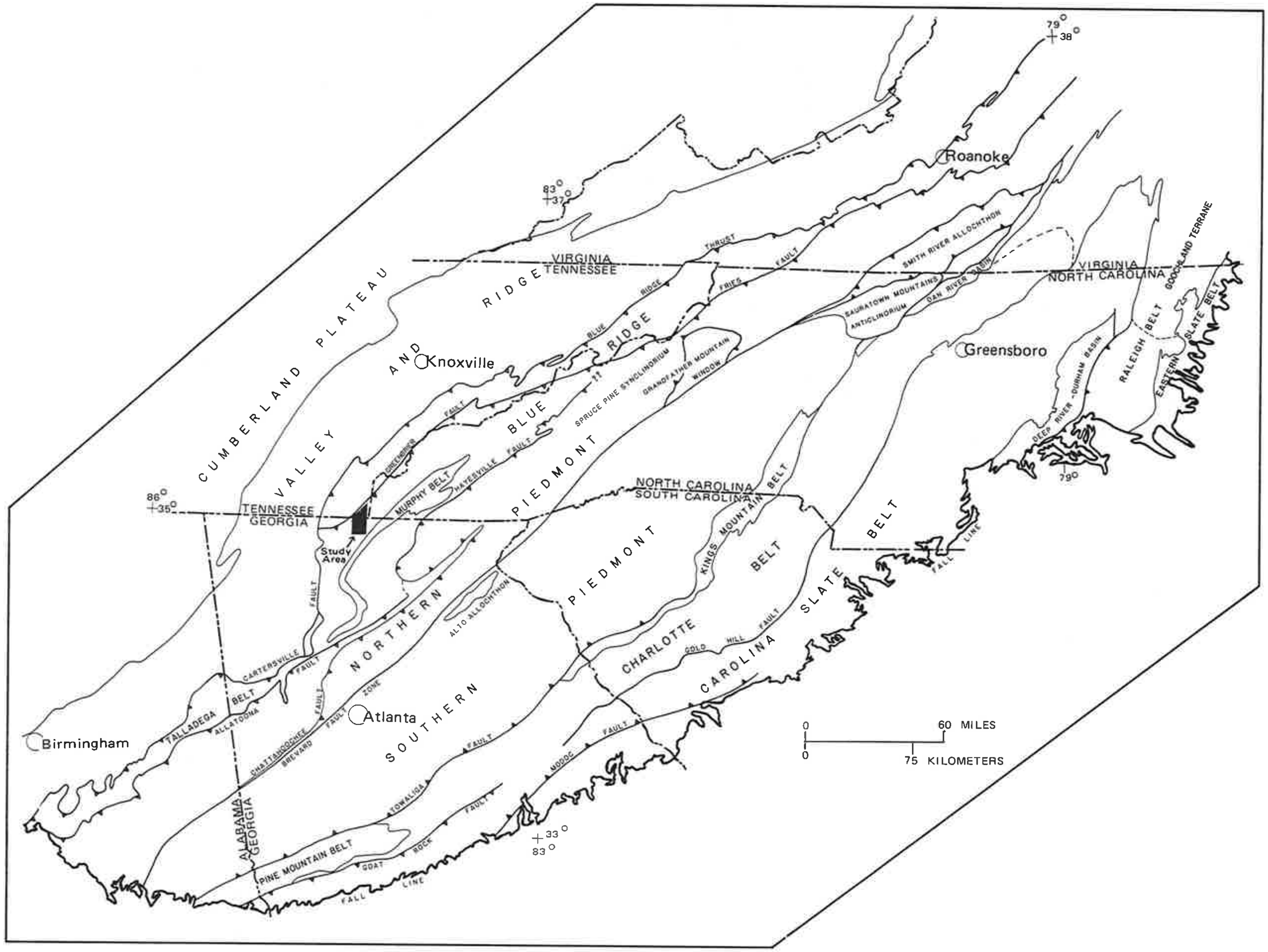


Figure 2. Regional map showing geologic features (modified after Williams, 1978).

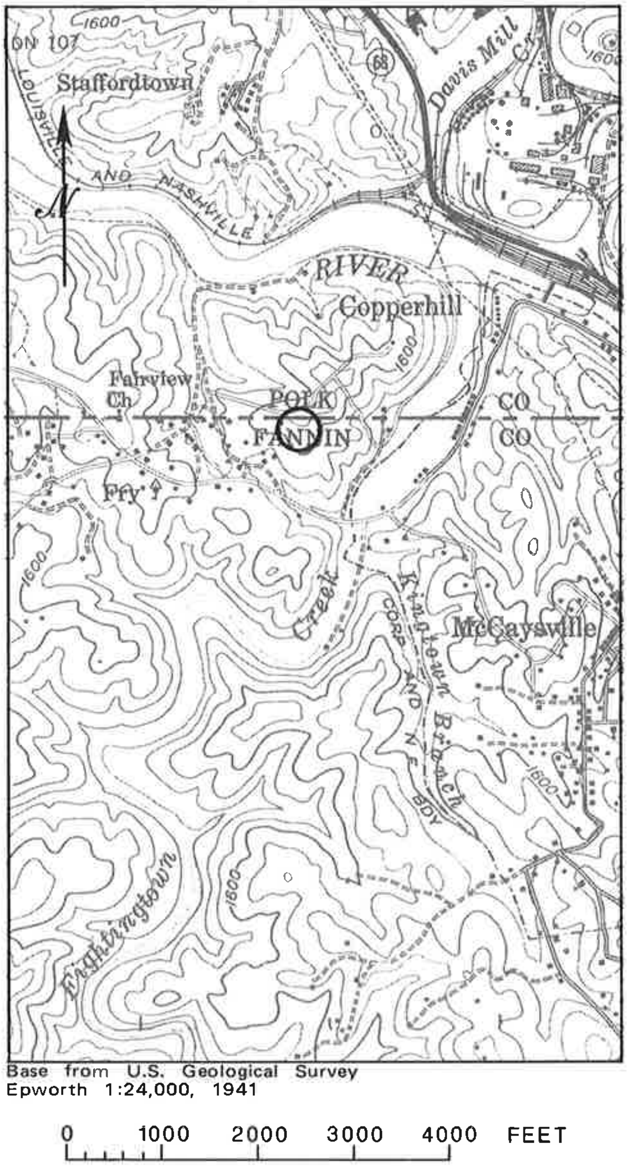


Figure 3. Type locality of the Fightingtown Creek Amphibolite.

the previously named Great Smoky Formation, the Great Smoky Group and subdivided it into the Copperhill, Hughes Gap, Hothouse, and Dean Formations. Of these the Copperhill was interpreted as the oldest formation.

Rocks in the southernmost Ducktown district consist dominantly of metamorphosed flysch facies conglomerate, greywacke, and pelite. Metaconglomerates are composed of quartz and feldspar clasts, usually no greater than 1/4 inch in diameter, within a finer matrix composed predominantly of quartz, feldspar and biotite with lesser amounts of muscovite and epidote. Metagreywackes are equigranular and contain a mineralogy similar to that of the metaconglomerate. Both lithologies are interlayered and in most cases are gradational into one another. Graded bedding is common in the metaconglomerate. Metaconglomerate also locally grades into metagreywacke layers. Schists (metapelites) vary from graphitic to nongraphitic muscovite-biotite schist ± garnet and staurolite. Near ore zones staurolite and garnet coarsen and garnets are rimmed by chlorite. Staurolite is altered to chlorite, garnet, muscovite, and quartz. Chlorite schist is common in the area, but appears to be chiefly associated with ore zones. Calc-silicate rock occurs as lenses, pods, or layers in metagreywacke. These calc-silicates consist mainly of quartz, hornblende, plagioclase and garnet, usually zonally arranged. Emmons and Laney (1926) interpreted this lithology to be metamorphosed calcareous concretions. Calc-silicates in the Ducktown basin and northern portions of the Epworth quadrangle commonly are podiform, but in the southern Epworth quadrangle the lithology is usually expressed as layers or lenses in metagreywacke. Mafic and felsic volcanic rocks are associated with and are parallel to ore zones. Felsic volcanic rocks include felsic gneiss and sericite schist. A mafic unit, herein termed the Fightingtown Creek Amphibolite (Newtown sill of Hurst, 1955) for exposures near Fightingtown Creek (Fig. 3), extends throughout the Ducktown district and is in close proximity to most recognized ore zones (Fig. 4; see detailed description in igneous rock section, this report).

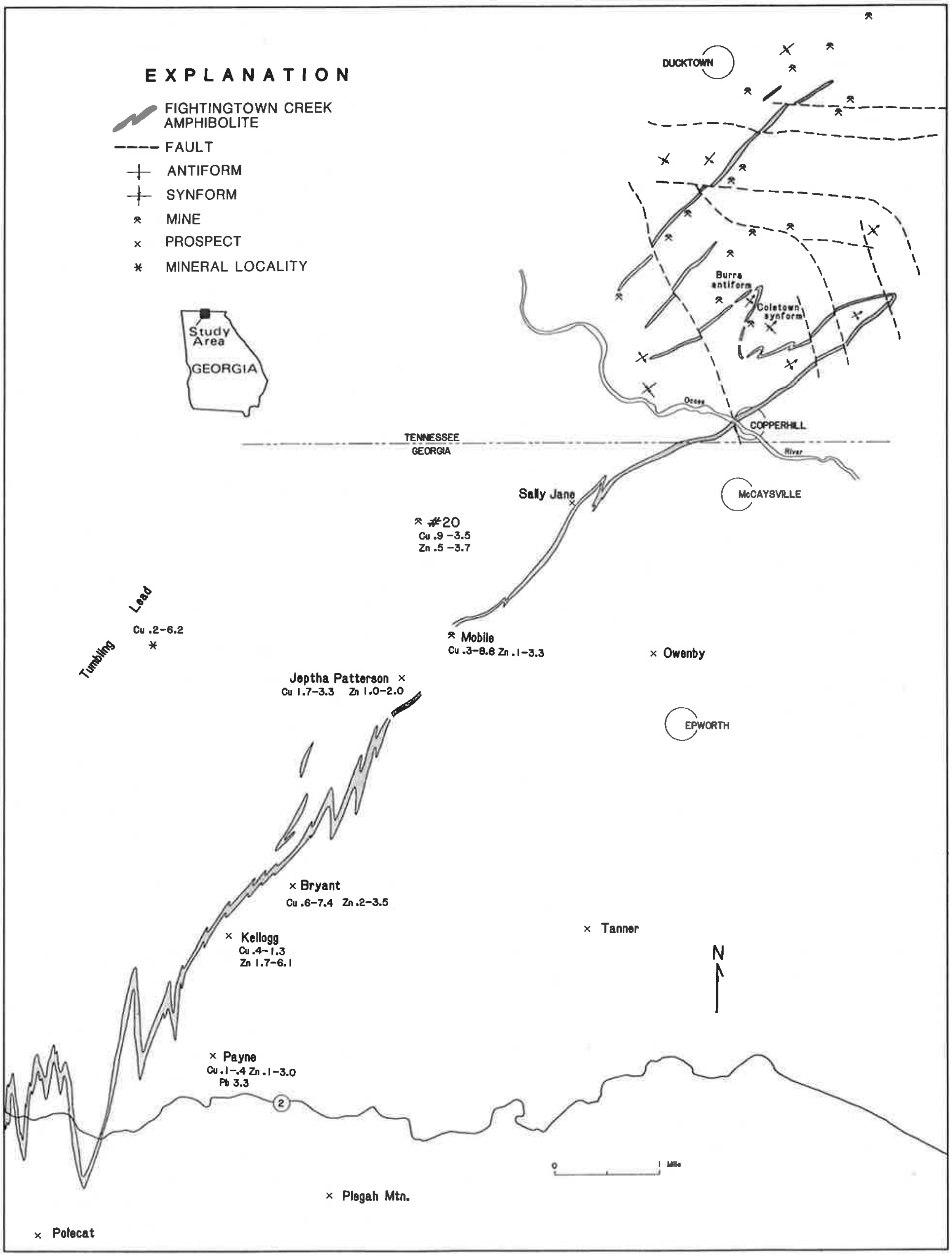
Metamorphism and Deformation

Multiple deformation and metamorphism, up to staurolite grade (Carpenter, 1970), have affected rocks of the Ducktown district. Alteration of staurolite is common through the study area. Coarse staurolite and chlorite are best developed adjacent to ore zones, and chlorite may not only result from retrogression, but also from alteration processes associated with ore zones.

Rocks trend predominantly to the northeast and dips are variable due to large scale folding. First generation folding was isoclinal and has axial planes coincident with S_1 foliation. Second generation folding is responsible for map patterns and major structures of the district. The Burra antiform and Coletown synform (Fig. 4) in the Ducktown-Copperhill area represent second generation folds (Holcomb, 1973; Granath, 1978). Limbs of first generation folds are transposed and ore zones lie parallel to axes and are stretched out along limbs of second generation folds. Third generation folding complicates structural interpretation and deforms ore horizons, but deformation associated with post F_2 folds was not intense enough to remobilize ore zones.

Mineralized Areas

Ore zones, as defined by mine locations and Tumbling Lead in the southwestern Ducktown district, are conformable to the surrounding rocks and occur as stratabound discontinuous lenses which extend southwestward along



Base from U.S. Geological Survey
Epworth 1:24,000, 1941

Figure 4. Map of the Ducktown District showing locations of mines and prospects and the Fightingtown Creek Amphibolite. Amphibolite as shown is based on surface and subsurface exposures.

strike from the Ducktown basin in three nearly parallel zones (Fig. 4). The southeasternmost of these zones contains the Pisgah Mountain and Tanner Prospects; the central zone contains the Mobile Mine and the Kellogg and Bryant Prospects; and the northwesternmost zone is defined by the presence of chalcopyrite, pyrite and pyrrhotite along Tumbling Lead. The three sulfide zones or "belts" are believed to result from folding and probably represent repetitions of the same stratigraphic horizon. Smaller scale folds further disrupt the continuity of ore zones.

Ore/host rock relationships observed at mines and prospects are similar to those seen at Ducktown. Ore zones are surrounded by sericite and chorite schists, plagioclase-rich gneiss, actinolite/tremolite schists, and horizons rich in epidote, quartz and calcite. These lithologies are enclosed within metasediments of the Copperhill Formation. Pyrite and pyrrhotite are the most abundant sulfides present in ore zones. Pyrrhotite is greatest in abundance, followed in abundance by pyrite, chalcopyrite and sphalerite. Magnetite makes up a small portion of the ore horizon and minor occurrences of gahnite have been recognized at several abandoned mines and prospects. Alteration associated with ores is intense, but is localized in limited areas adjacent to the ore zones. Alteration zone mineralogy commonly includes large radiating masses of actinolite or tremolite with fine, disseminated pyrite and pyrrhotite, tremolite-talc schist, and/or sericite-tålc schists with coarse to fine epidote, quartz and calcite.

As previously stated, descriptions of sulfide deposits of the southwestern Ducktown district are few and limited in scope. LaForge and Phalen (1913) and Shearer and Hull (1918) briefly described the workings and geology at the #20 and Mobile Mines and Pisgah Mountain, Jeptha Patterson, and Sally Jane Prospects. Later, Emmons and Laney (1926) also briefly described several of the same deposits of the southwestern Ducktown district. However, in contrast to the limited nature of published reports, Tennessee Chemical Company's records show that two mines and nine prospects were worked in the southwestern Ducktown district. Tennessee Copper Company drilled many of these localities from 1920 to the 1970's.

The #20 and Mobile are the only mines located in the southwest part of the district. In addition to the three prospects described by Laforge and Phalen (1913) and Shearer and Hull (1918), prospects previously not described include the Kellogg, Bryant, Tanner, Owenby, Payne, Polecat, and other unnamed prospects.

#20 Mine

The #20 Mine (Figs. 5 and 6) has the most extensive workings of the area. Shafts, pits and trenches lie on a low ridge approximately three miles southwest of Copperhill, Tennessee. Production of copper and sulfur ores from the #20 occurred through most of the Civil War (Shearer and Hull, 1918). The mine was reopened in the late 1870's and operated sporadically until the end of 1918 (Emmons and Laney, 1926). Ores from the #20 were shipped by rail to the smelter at Copperhill until the #20 mine closed.

The ore body at the #20 strikes to the northeast and dips steeply to the southeast. Ore minerals include pyrrhotite, pyrite, chalcopyrite, sphalerite and minor amounts of galena. Gold and silver are present in varying amounts. Assays from the #20 (Tennessee Chemical Company records) showed up to 4.6% copper, 3.7% zinc and .55 oz/ton silver (Table 1). Ores are disseminated to massive and appear brecciated in some samples. Shearer and Hull (1918) reported that large amounts of chalcocite or "black ore" averaging 10% copper were removed in the early stages of mining at the #20 site.

LaForge and Phalen (1913), Shearer and Hull (1918), and Emmons and Laney (1926) believed ores at the #20 mine formed due to post-metamorphic replacement of limestone. McCallie (unpublished report, date unknown) interpreted the ores as deposited along fault planes in the country rock. McCallie's interpretation may have been due to the presence of chlorite and alteration of staurolite adjacent to ore zones.

A northwest-southeast trending fault was interpreted to offset the ore zone at the #20 (Tennessee Chemical records). Three pits and a trench are offset from the main trend at the #20 and are located north of the major workings (Fig. 5). An alternate interpretation is that the apparent offset of the ore zone in this area is a reflection of folding of the ore horizon.

Banded iron formation (exhalite) is present adjacent and parallel to the #20 ore zones. Due to metamorphism the unit is now expressed as a banded quartzite with narrow bands of sulfides (pyrite and pyrrhotite) or limonite after pyrite alternating with cherty or sugary quartz (Fig. 7). This lithology is also found in one of the three pits located north of the main ore trend.

Other dump material and outcrops adjacent to the ore zones consist of sericite-chlorite schist, sericite-quartz schist ± disseminated sulfides, garnet-sericite schist, biotite schist, and coarse- to medium-grained tremolite, actinolite and/or cummingtonite granofels ± disseminated sulfides. Talc, calcite and abundant quartz are also present as gangue minerals. A zone of staurolite-bearing schist lies parallel to and structurally overlies the ore zones. Amphibolite is not present in surface exposures, but a zone of chalcopyrite and pyrrhotite bearing amphibolite was intersected in core drilled by Tennessee Copper Company at the #20 mine (Tennessee Chemical Company records, Appendix A). The ore and enclosing alteration zone are narrow in extent and are surrounded by metagreywacke and schists of the Copperhill Formation.

Mobile Mine

Workings at the Mobile Mine are less extensive than

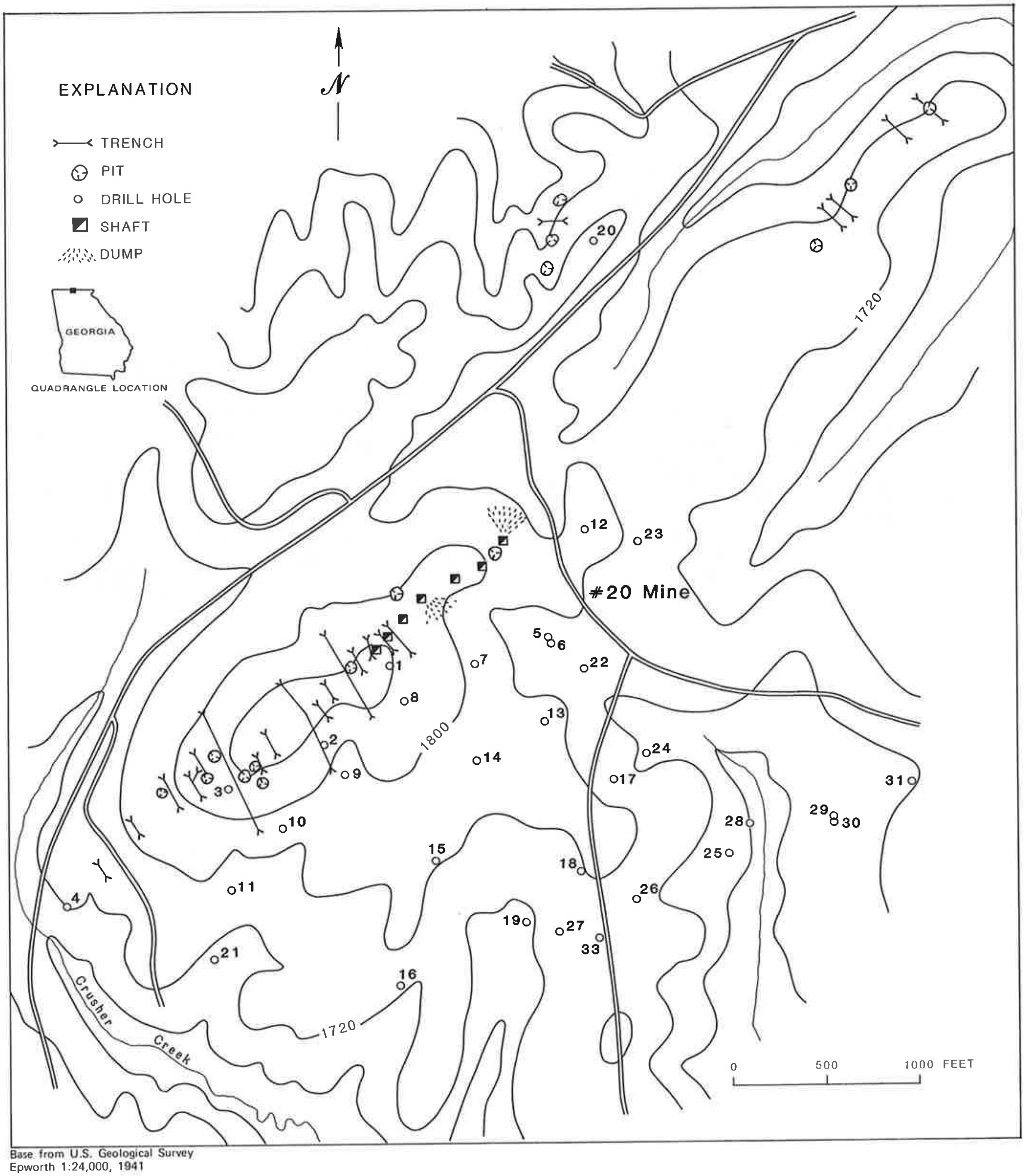


Figure 5. Map of the #20 Mine (modified from Tennessee Chemical Company records) showing mine workings and locations of drill holes by Tennessee Copper Company.

Figure 6. The #20 Mine, date unknown. Georgia State Archives photograph.

Table 1. Assays from Mines and Prospects of the southwestern Ducktown District.

	Sample no.	Cu(%)	Zn(%)	Au oz/ton	Ag oz/ton	Pb(%)
# 20 mine						
	20-13-1091			tr	3.0	
	20-7			tr	0.4	
	20-7-555	1.55	1.20	tr	0.13	0.11
	20-13-1099	1.90	0.86	tr	0.18	0.12
	20-17-1572	1.80	1.35	tr	0.21	0.96
	20-21-60	0.83	2.30	tr	0.12	0.19
	20-26-51	4.65	2.35	0.001	0.55	0.19
	20-5-596*	1.53	0.50	tr	tr	
	20-5-599*	1.15	1.22	tr	tr	
	20-6-771*	1.46	1.03		0.30	0.10
	20-7-551*	1.94	1.03	tr	tr	
	20-8-527*	0.73	1.28			
	20-8-532*	1.97	1.74			
	20-8-537*	0.65	0.40			
	20-8-542*	1.27	0.44			
	20-8-546*	1.06	1.64			
	20-9-586*	0.33	0.78			
	20-10-490*	0.24	0.49			
	20-10-500*	0.51	0.53			
	20-10-502*	0.47	0.43			

Table 1. Assays from Mines and Prospects of the southwestern Ducktown District. (cont'd.)

	Sample no.	Cu(%)	Zn(%)	Au oz/ton	Ag oz/ton	Pb(%)
	20-10-430*	0.34	0.14	tr	tr	
	20-11-556*	3.50	3.70			
	20-11-569*	1.00	2.20			
	20-13-1101*	1.96	1.15			
	20-14-934*	1.89	0.85			
	20-17-1564*	2.60	1.29			
	20-18-1751*	2.25	1.34			
	20-19-1712*	1.33	1.12			
	20-22-1141*	1.98	2.40	tr	tr	0.31
	20-24-1630*	1.94	1.55			
	20-24-1701*	0.98	2.33			
	20-26-2205*	1.28	0.57			
	20-26-2180*	2.08	1.11			
	20-26-2150*	6.90	1.02			
	20-27-1912*	2.02	1.19			
	20-28-2265*	1.67	0.80			
Mobile Mine	2-265*	1.80	0.87			
	4-179*	0.85				
	5-373*	2.78	3.27			
	6-674*	1.89	0.13	tr	tr	
	6-730*	2.42	0.10	tr	tr	
	7-104*	8.80	0.61	0.02		
Bryant Prospect	2-142*	3.64				
	3-130*	2.26				
	3-141*	1.66				
	3-143*	1.36				
	4-268*	1.07				
	4-270*	1.15				
	4-272*	1.68				
	5-197*	0.73	0.69			
	5-202*	1.64				
	6-205*	0.58	0.14			
	7-431*	1.35	0.04			
	10-284	3.30	3.50			
	10-298*	7.38	2.12			
	12-472*	0.67	0.25			
	12-498*	0.64	3.46			
	13-275*	1.01	1.72			
	13-279*	2.30	1.54			
	16-165*	2.23	0.79			
Kellogg Prospect	1-182*	0.86	2.18			
	1-193*	0.77	2.32			
	2-166*	1.15	1.65			
	3-205*	0.40	2.19			
	4-187*	1.21	1.70			
	5-194*	1.27	2.04			
	6-490*	0.36	6.15			
	6-502	2.26	2.50			
	6-496*	0.74	5.20			
	10-522*	0.38	1.95			

Table 1. Assays from Mines and Prospects of the southwestern Ducktown District. (cont'd.)

	Sample no.	Cu(%)	Zn(%)	Au oz/ton	Ag oz/ton	Pb(%)
	12-1197*	0.04	0.42			
Payne	1-20*	1.00	0.15			
Prospect	1-300*	0.13	0.76			
	2-65*	0.34	0.29			
	6-585*	0.48	1.47			
	8-969*	0.43	3.02			3.32
	9-967*	0.79	0.24			
Jeptha	1-218*	1.17	tr			
Patterson	2-160*	1.72	0.35			
Prospect	3-428*	3.25	2.06	tr		
	6-419*	0.86	0.70			

* Tennessee Chemical Company records

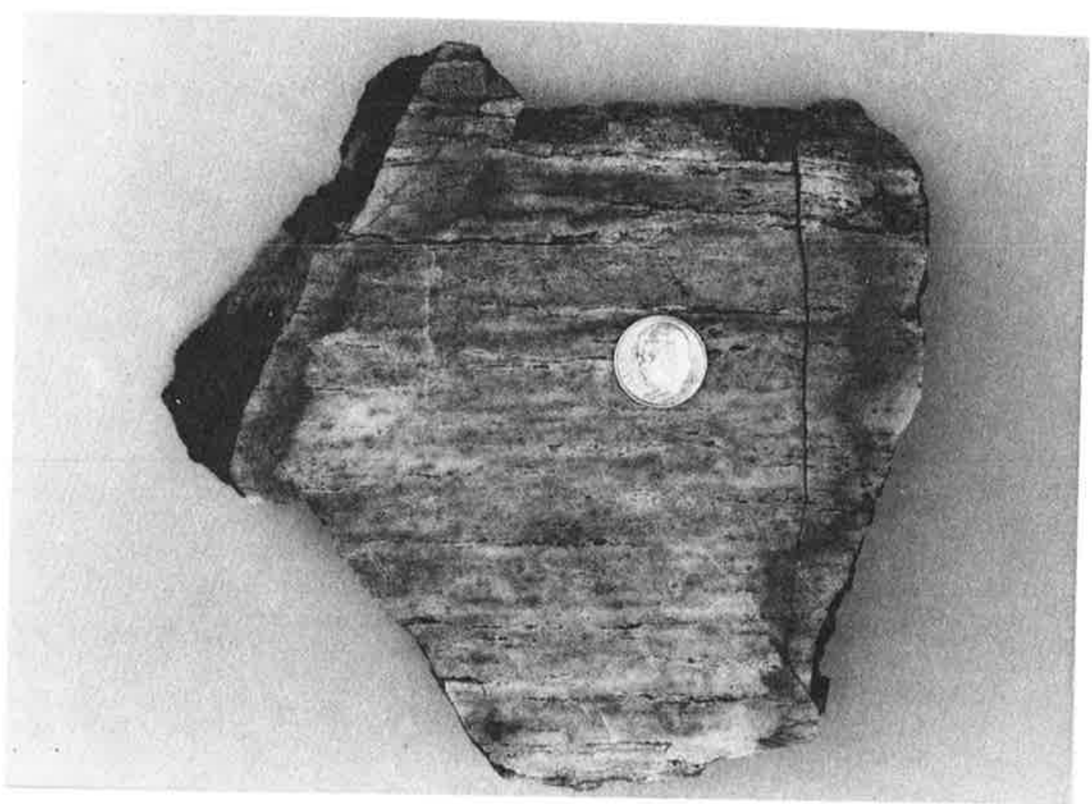


Figure 7. Banded iron formation (exhalite) with layers of limonite (after pyrite) and quartz.

those at the #20. The Mobile Mine was opened in 1858 and was worked until 1861 (Shearer and Hull, 1918) for sulfides in the production of sulfur and for copper ore. Later attempts to reopen the mine failed and shafts were flooded and caved by 1912 (Shearer and Hull, 1918). Workings at the Mobile Mine consisted of four shafts with connecting drifts (Fig. 8). The Mobile Mine also had its own smelter, but no production figures are available.

The ores and alteration zone at the Mobile Mine are similar to those seen at the #20. Pyrrhotite and pyrite are the most abundant ore minerals with lesser amounts of chalcopyrite and sphalerite. Assays from the Mobile Mine (Tennessee Chemical Company records) range as high as 8.8% copper, 3.3% zinc, .3 oz/ton silver and trace amounts of gold (Table 1). The ore zone strikes to the northeast and is surrounded by country rock of metagreywacke and mica schist. A zone of staurolite schist structurally overlies ores. Chlorite schist is associated with zones of disseminated sulfides as seen in core drilled from the Mobile Mine area (Appendix A). Dump material includes felsic gneiss, chlorite-sericite schist, sericite-quartz schist ± garnet, and tremolite, actinolite and/or cummingtonite quartz granofels.

Prospects

Prospects of the southwestern Ducktown district include

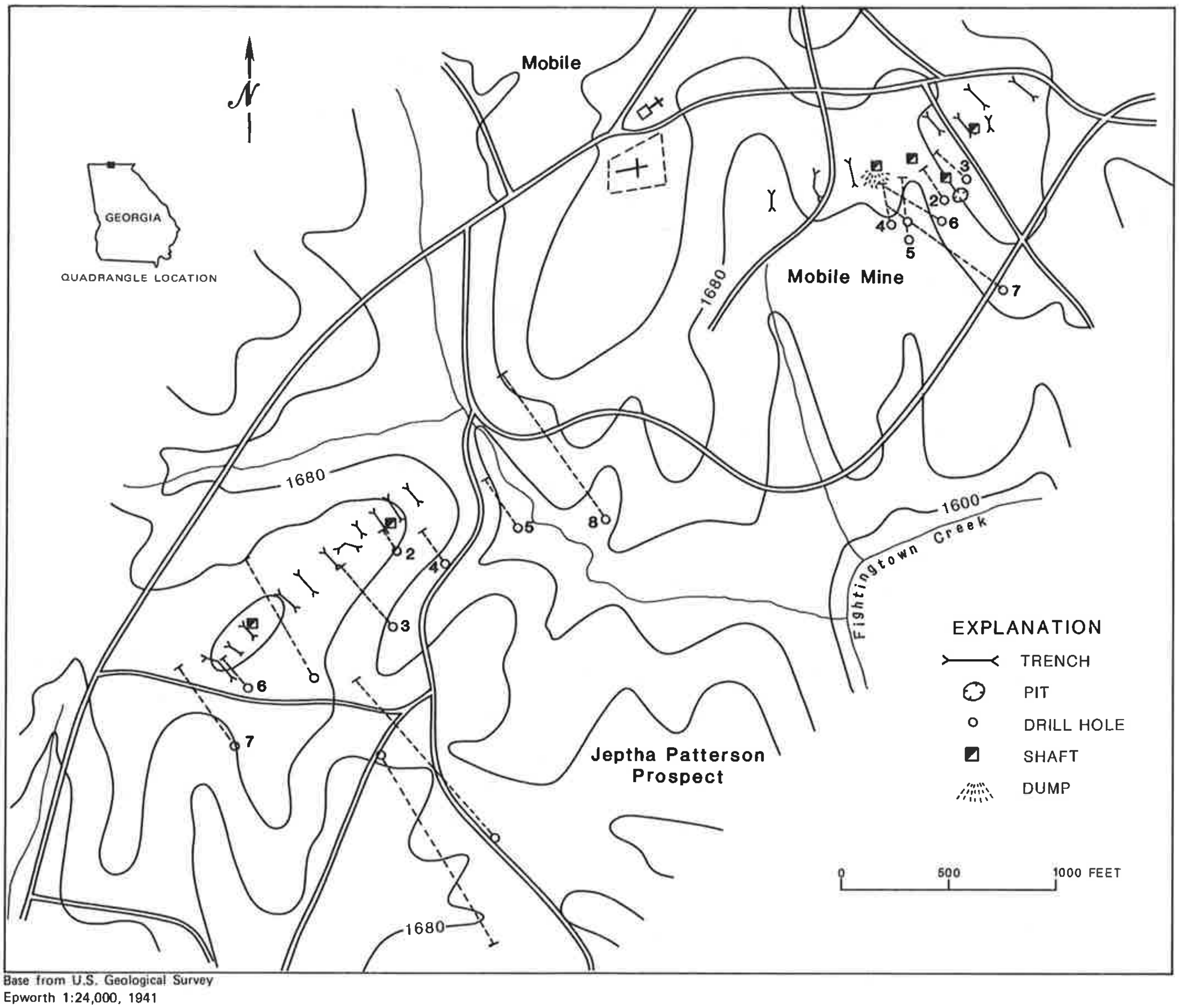


Figure 8. Map of the Mobile Mine and Jeptha Patterson Prospect (modified from Tennessee Chemical Company records) showing abandoned workings and locations of holes drilled by Tennessee Copper Company.

Pisgah Mountain, Bryant, Kellogg, Payne, Sally Jane, Jeptha Patterson, Tanner, Owenby, Polecat and several unnamed prospects. Many of these prospects were worked extensively and are well-preserved. The Pisgah Mountain Prospect (Fig. 9) is one of the best preserved and is located on the top of Pisgah Mountain, approximately nine miles (14.5 km) southwest of Copperhill. Shearer and Hull (1918) reported prospecting began at the Pisgah Mountain site in the 1850's and continued sporadically until approximately 1917. Workings are extensive and consist of two partially caved adits and several shafts (one of which is flooded) and pits in metagreywacke and mica schists. Chlorite schist, staurolite, garnet and tourmaline are common in exposures in shafts and pits. The extent of the workings would seem to indicate significant ore mineralization at the Pisgah Mountain Prospect; however, no ore, either massive or

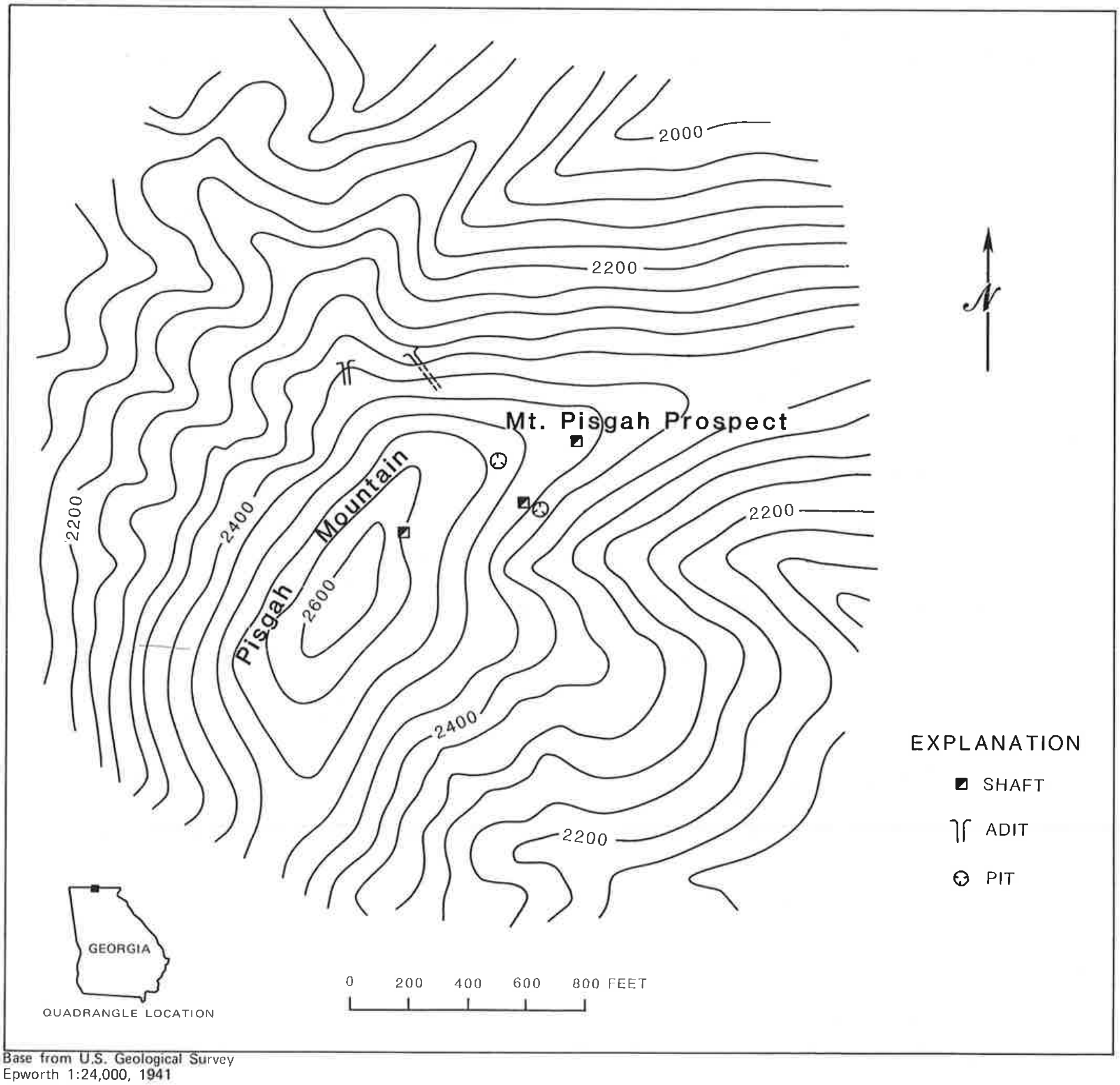


Figure 9. Map of the Mt. Pisgah Prospect (modified from Tennessee Chemical Company records) showing abandoned workings.

disseminated, is present at the site. Sulfide staining and a few fine grains of sulfide and gahnite are the only indication of mineralization. Shearer and Hull (1918) noted that a test shipment from the Pisgah Mountain Prospect to Tennessee Copper Company's smelter averaged 4% copper, but those authors suggest that the sample was high-graded and report no observable sulfides at the prospect. No core drilling was done at the Pisgah Mountain Prospect.

The Bryant and Kellogg Prospects are located along a northeast trending ridge approximately four miles southwest of the Mobile Mine. The Bryant workings (Fig. 10) lie along the northeast end of the ridge top and consist of numerous trenches and three pits. The Kellogg Prospect (Fig. 10) lies to the southwest of the Bryant and includes eight trenches, a caved shaft and three pits located on the west flank of the same ridge. Exposures along the ridge consist chiefly of a muscovite-chlorite-quartz-plagioclase gneiss/schist which, in this report, is interpreted as an altered felsic volvanic rock. At the Bryant Prospect, float and exposures in trenches and pits include gossan, actinolite/tremolite-talc granofels ± chlorite, chlorite schist, tremolite-chlorite schist, chlorite-sericite schist ± garnet, sericite schist and muscovite-biotite-chlorite schist. Altered staurolite is common in schists and structurally overlies the ore zone. Ores observed in core from both the Kellogg and Bryant Prospects occur as both massive and disseminated sulfides of pyrrhotite, pyrite, chalcopyrite, and sphalerite (Appendix A).

Rock interpreted as banded iron formation is exposed at the Kellogg workings. The banded iron formation is of two types: silicate and sulfide facies. Sulfide facies resembles the banded iron formation at the #20 Mine and is represented by a sugary quartzite with narrow bands of limonite after pyrite and fine amphibolite revealed by microprobe analysis to be cummingtonite. Silicate facies is a dense cherty quartzite with layers or clusters of fine cummingtonite. Other rock exposed as float or in trenches and pits at the Kellogg Prospect includes gossan, tremolite/actinolite granofels and chlorite-quartz-plagioclase gneiss (interpreted as a felsic volcanic).

The Payne Prospect (Fig. 11) is located less than two miles south of the Kellogg on the south side of a ridge. Workings consist of only two well-developed shafts through exposures of chlorite-quartz-plagioclase gneiss/schist. The chlorite gneiss/schist at the Payne Prospect represents an extension of the altered felsic gneiss associated with the Bryant and Kellogg Prospects. No ore was observed at the Payne around either shaft, but ore zones observed in core (Appendix A) consist of disseminated pyrite, pyrrhotite, chalcopyrite, sphalerite and galena. The Payne Prospect is of particular note, as one assay yielded 3.3% lead (Tennessee Chemical Company, Table 1).

No sulfide mineralization is apparent in pits and trenches at the Jeptha Patterson Prospect (Figs. 4 and 8); although, LaForge and Phalen (1913) reported small amounts of ore similar to ore from the Mobile Mine. Exposures of rock in and surrounding the workings at this site include chlorite schist ± coarse staurolite and garnet, and muscovite-chlorite-quartz schist ± garnet. Drill records and core drilled by Tennessee Copper Company from 1930 to 1971 show the ore zone consists of disseminated pyrite, pyrrhotite, chalcopyrite and sphalerite. Examination of core from the Jeptha Patterson Prospect reveals that ore zones are generally associated with or bounded by altered staurolite-chlorite schist ± garnet, sericite-chlorite-quartz schist, sericite schist, and chlorite-sericite-tremolite granofels. Country rock, which trends to the northeast and dips to the southeast, includes metagreywacke, metaconglomerate, and schist common to the Copperhill Formation. Amphibolite is exposed just to the southeast of and parallel to the workings and sulfide-bearing amphibolite was encountered in drill core interlayered or infolded with schist and metagreywacke.

Exposures at the Sally Jane Prospect, like those at the Jeptha Patterson, do not appear to contain sulfide mineralization. LaForge and Phalen (1913) reported chalcocite at the Sally Jane workings (Fig. 12), but they reported no other ore. There are three pits and six trenches at the site. Staurolite schist, sericite schist and biotite-chlorite schist are exposed in and around trenches and pits. Amphibolite is exposed to the southeast approximately 200 yards from the workings. Core drilling done by Tennessee Copper Company in 1930 failed to encounter any massive or disseminated ore (Tennessee Chemical Company records; Appendix A).

Three shallow pits make up what is called the Polecat Prospect (Fig. 4; Tennessee Chemical Company records). The pits are located along the north slope of a dissected ridge. Surrounding rock includes metagreywacke, sericite phyllite and biotite-muscovite schist ± graphite. No sulfide mineralization is visible at this site and Tennessee Chemical Company's records indicate no core drilling, geochemistry or geophysics done at the Polecat locality.

The Tanner and Owenby Prospects lie southeast of the main zone of mineralization on which the Mobile and #20 Mines and other prospects are located (Fig. 4). No drilling was done at either the Owenby or Tanner Prospects. Magee (1961, unpublished) reported that electromagnetic, self-potential, and magnetic surveys were conducted at the Tanner site in the late 1950's. As a result of these surveys a SP anomaly was recognized, but magnetic and electromagnetic surveys yielded no significant anomalies. The Tanner Prospect (Fig. 13) included two shafts, 40 and 20 feet deep, and an adit, all now caved or slumped. Magee (1961, unpublished) described weathered and iron-stained actinolite/tremolite rock and vein quartz in one of the shafts. Exposures in the area of the prospect include chlorite-garnet-staurolite-sericite schist, sericite schist, gossan and metagreywacke. Staurolite is altered to garnet, quartz and muscovite. Local zones of tourmaline are pres-

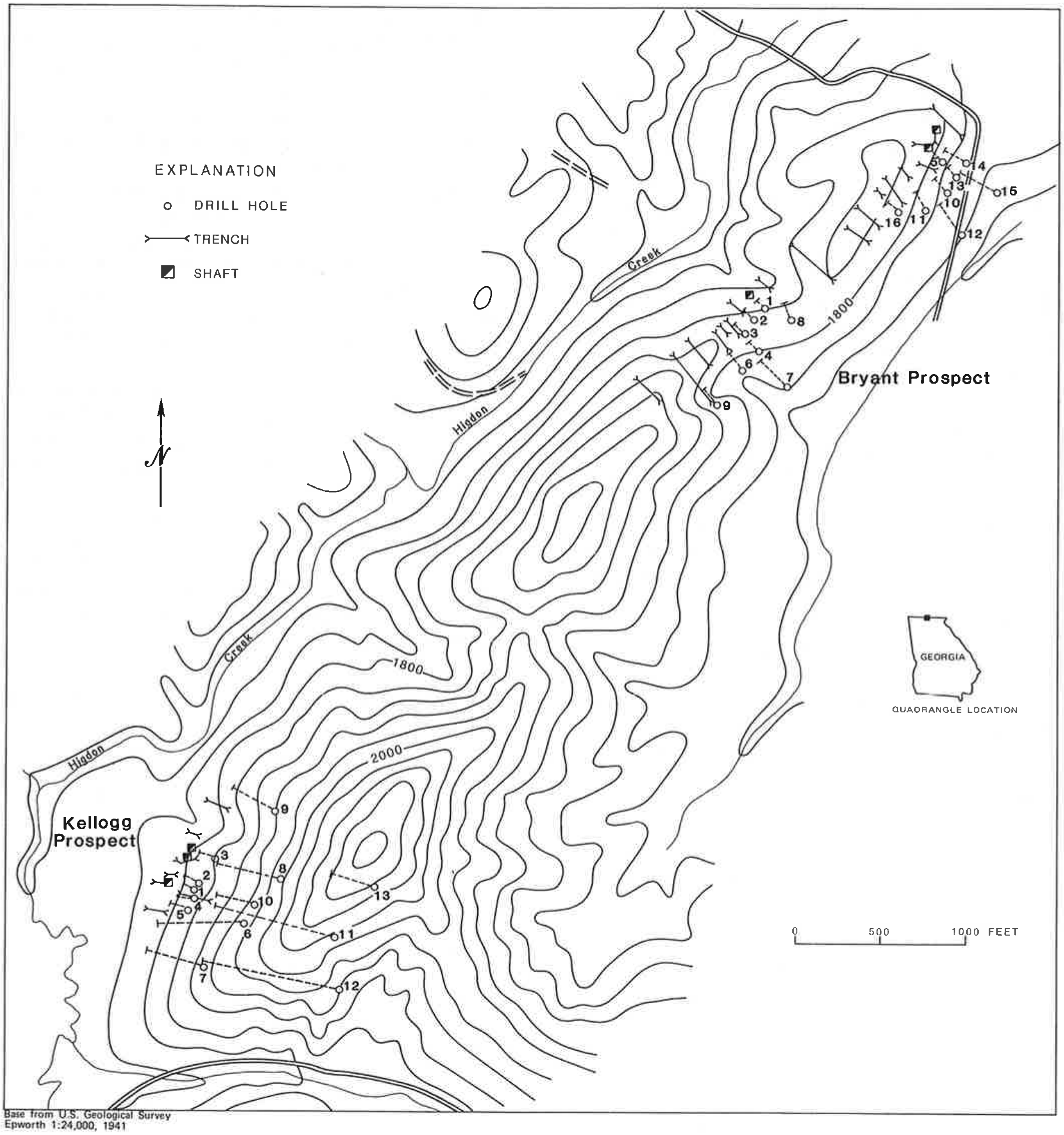
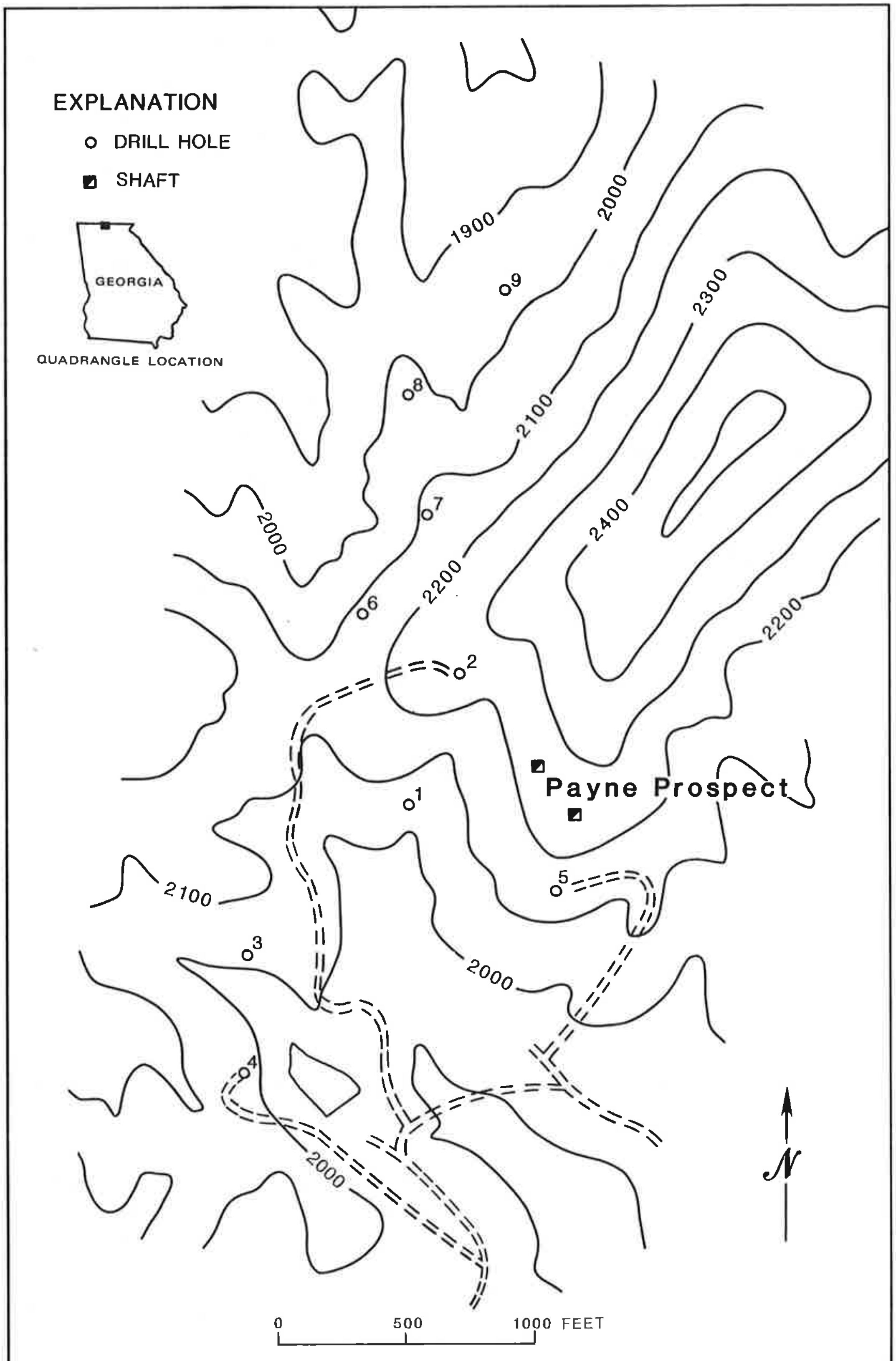


Figure 10. Map of the Bryant and Kellogg Prospects (modified from Tennessee Chemical Company records) showing abandoned workings and locations of holes drilled by Tennessee Copper Company.



Base from U.S. Geological Survey
Epworth 1:24,000, 1941

Figure 11. Map of the Payne Prospect (modified from Tennessee Chemical Company records) showing abandoned workings and locations of holes drilled by Tennessee Copper Company.

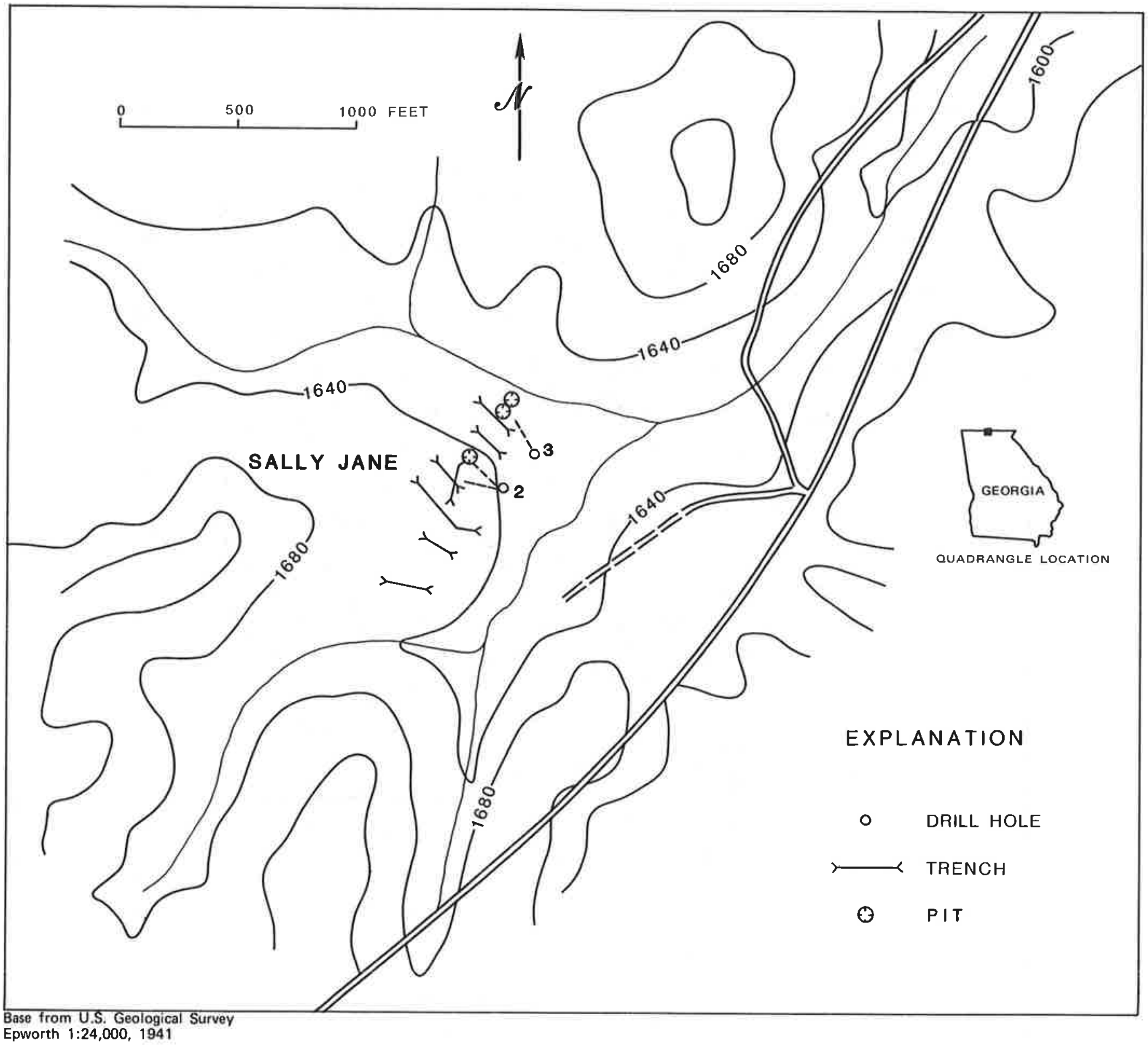
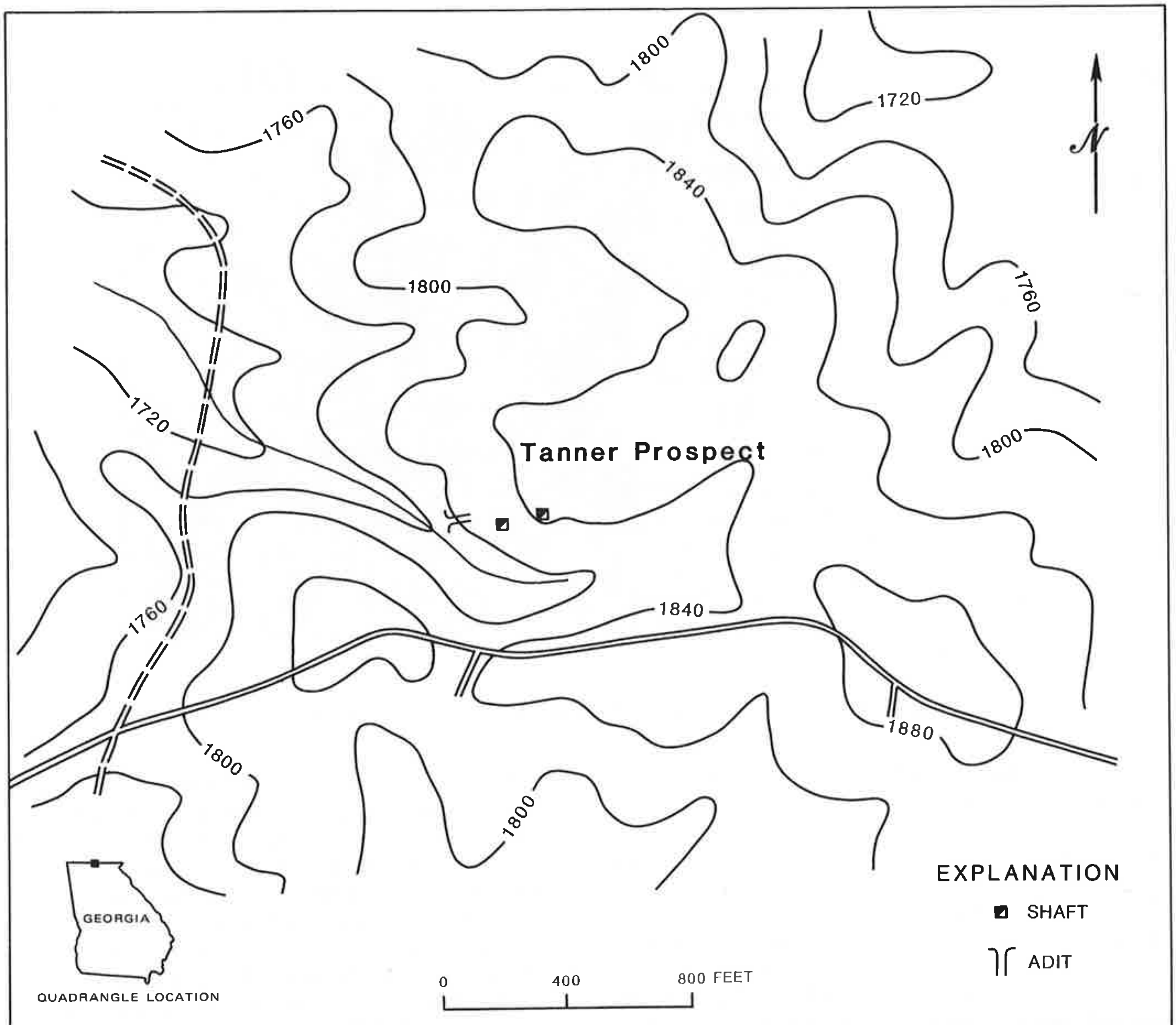


Figure 12. Map of the Sally Jane Prospect (modified from Tennessee Chemical Company records) showing abandoned workings.

ent in schist. The rock is folded and crenulated and the main area of the workings is located along the axis of a northeast trending fold. No sulfide mineralization is apparent at the workings.

At the Owenby Prospect (Fig. 4) exposures are chiefly of a biotite-chlorite-muscovite-quartz-plagioclase schist with clots of chlorite which are referred to as metacrysts in Tennessee Chemical Company records. Some small exposures of gossan are also present. Workings consist of a large cut into a massive exposure of quartz. Tennessee Copper Company at one time used local quartz for flux (Randy Slater, 1984, personal communication). The Owenby and several unnamed prospects in the area, also located in massive quartz, may have been prospected as sources of flux rather than as potential sources of sulfides.

Samples collected from Tumbling Lead ridge (Fig. 4), in the northwestern portion of the study area, yielded .2 to 6.2% copper (unpublished data, Georgia Geologic Survey mineral files). Samples were from what appear to be local zones of sulfides within interlayered metagreywacke, metaconglomerate, and schist. Rocks forming Tumbling Lead are on trend with ore bearing units at Ducktown and may make up a limb of the folded ore horizon extending from the Ducktown area. There is no historical record of



Base from U.S. Geological Survey
Epworth 1:24,000, 1941

Figure 13. Map of the Tanner Prospect (modified from Tennessee Chemical Company records) showing abandoned workings.

prospecting on Tumbling Lead and no pits or other workings were located on the ridge.

Alteration Zones

All mines and prospects of the Ducktown district are associated with some form of alteration zone. Several mines and prospects are associated with tourmaline-bearing rock units and/or banded iron formation. Alteration zones vary in mineralogy, chemistry and extent. Coarse staurolite and chlorite and sericite alteration are common adjacent to ore horizons. Types of alteration include Al/Si ± Fe assemblages and Mg/Al + Ca assemblages. These alteration assemblages or zones have formed as a result of footwall hydrothermal alteration associated with the sulfide ore body. Regional metamorphism has further altered these assemblages to their present mineralogy, retaining those alteration products such as chlorite which are stable through metamorphism. Al/Si ± Fe assemblages are characterized by the presence of staurolite and/or garnet; microprobe analyses reveal Mg/Al + Ca assemblages characterized by tremolite and/or actinolite, in addition to talc, chlorite and calcite. Coarse staurolite

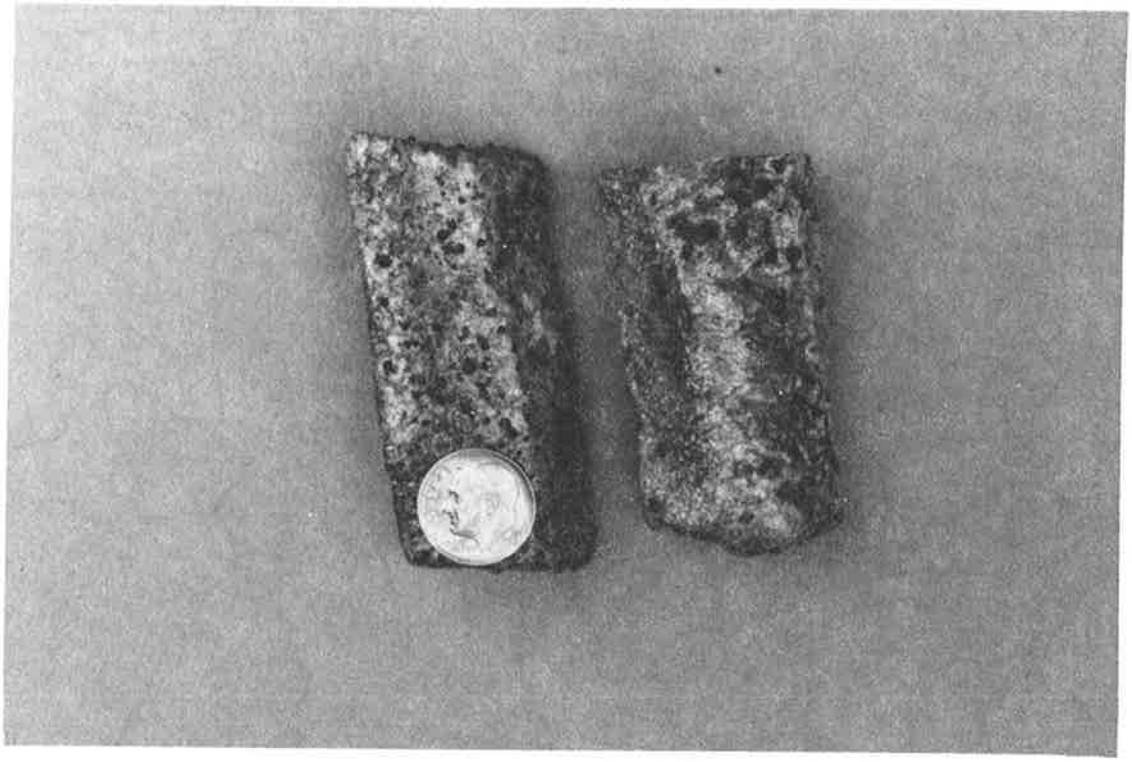


Figure 14. Coarse staurolites from the southwestern Ducktown district.

zones within schist are spatially associated with all mines and prospects of the southwest Ducktown District and with most mines in the northern part of the district. Staurolites vary from 1 to 6 inches in length (Fig. 14) and are rarely twinned. They are usually partially altered and alteration to chlorite, garnet, muscovite and quartz is common. In deeply weathered areas, where alteration due to weathering or retrograde metamorphism is extensive, it is sometimes difficult to recognize the completely altered staurolites within schist. Coarse garnet occurs near ore zones of the Ducktown district and garnets up to 5 inches in diameter have been reported from the southwest Ducktown district (Cook, 1978) on strike with known deposits. The increased abundance and size of staurolite and garnet on strike or adjacent to ore zones is significant, and these Al/Si ± Fe assemblages represent ore zone hydrothermal alteration similar to alteration associated with mineralized zones in the northern Piedmont (Abrams and McConnell, 1984). The use of Al/Si ± Fe assemblages as an exploration tool was noted by Carpenter and Allard (1982). Those authors believe these assemblages are typical of footwall alteration associated with sulfide deposits. If this footwall relationship is correct, then the structural position of the staurolite horizon at the #20 and Mobile Mines and Kellogg and Bryant Prospects (overlying the ore zone) would indicate that the rock sequence, at least in those areas, is overturned.

Chlorite and sericite alteration adjacent to and on strike with ore horizons is common throughout the Ducktown district. Slater (1982, p. 4) noted the importance of these zones at the mines in the Ducktown area and interpreted them as "alteration zones produced during the syngenetic deposition of the deposits as submarine exhalative brines." Drill core examination reveals chlorite and/or sericite alteration occurs in both the hanging and footwalls of many deposits of the southwest Ducktown district.

The importance of magnesium-aluminum alteration zones in the Abitibi Greenstone belt was noted by Riverin and Hodgson (1980). Like Al/Si ± Fe rich zones, Mg/Al assemblages commonly occur in footwall alteration zones (Carpenter and Allard, 1982). Throughout the Ducktown district these zones are typically also Ca-rich and in addition to chlorite, contain tremolite and/or actinolite, cummingtonite, talc and calcite (Fig. 15). These Mg/Al alteration assemblages are interpreted as primary features or feeder pipes for ore bearing solutions. These assemblages are particularly well-developed at the #20 and Mobile Mines and the Bryant and Kellogg Prospects and are characterized by tremolite/actinolite granofels ± chlorite and talc.

Iron Formation and Tourmaline

Banded iron formation occurs locally throughout the Ducktown district, closely associated with ore deposits. In the northern portion of the district iron formation is characterized by a coarsely banded rock of quartz, magnetite,

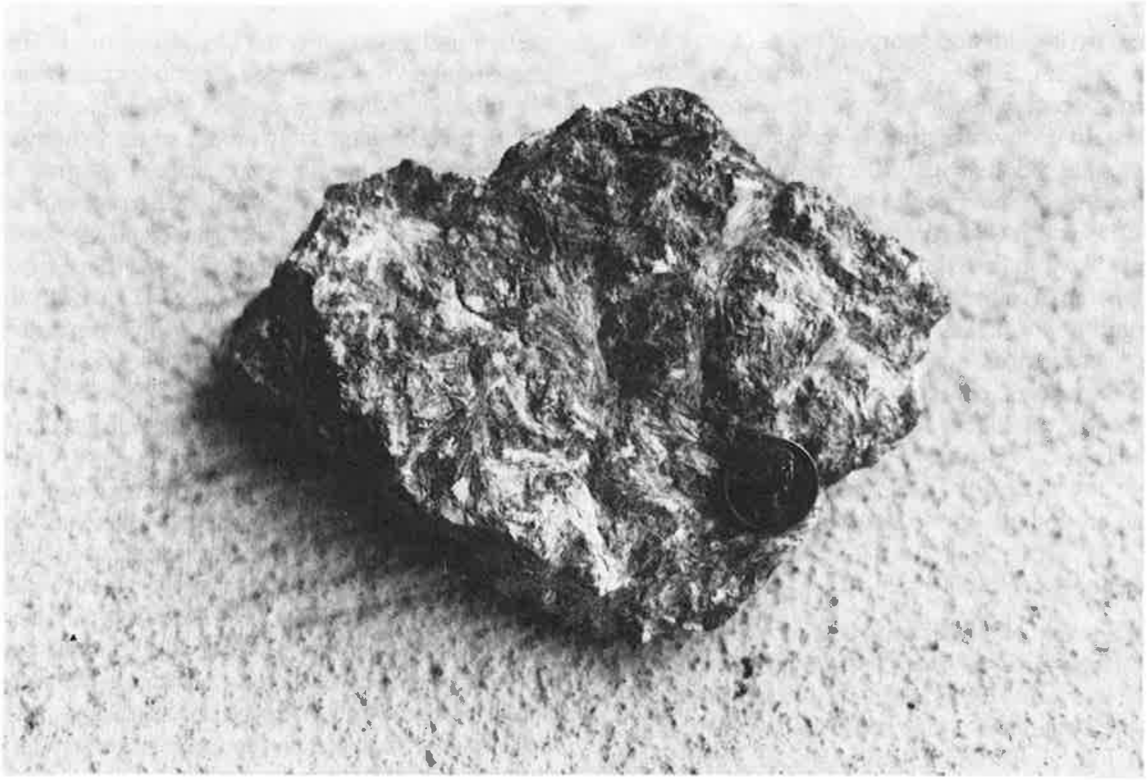


Figure 15. Mg/Al alteration zone rock showing radiating tremolite.

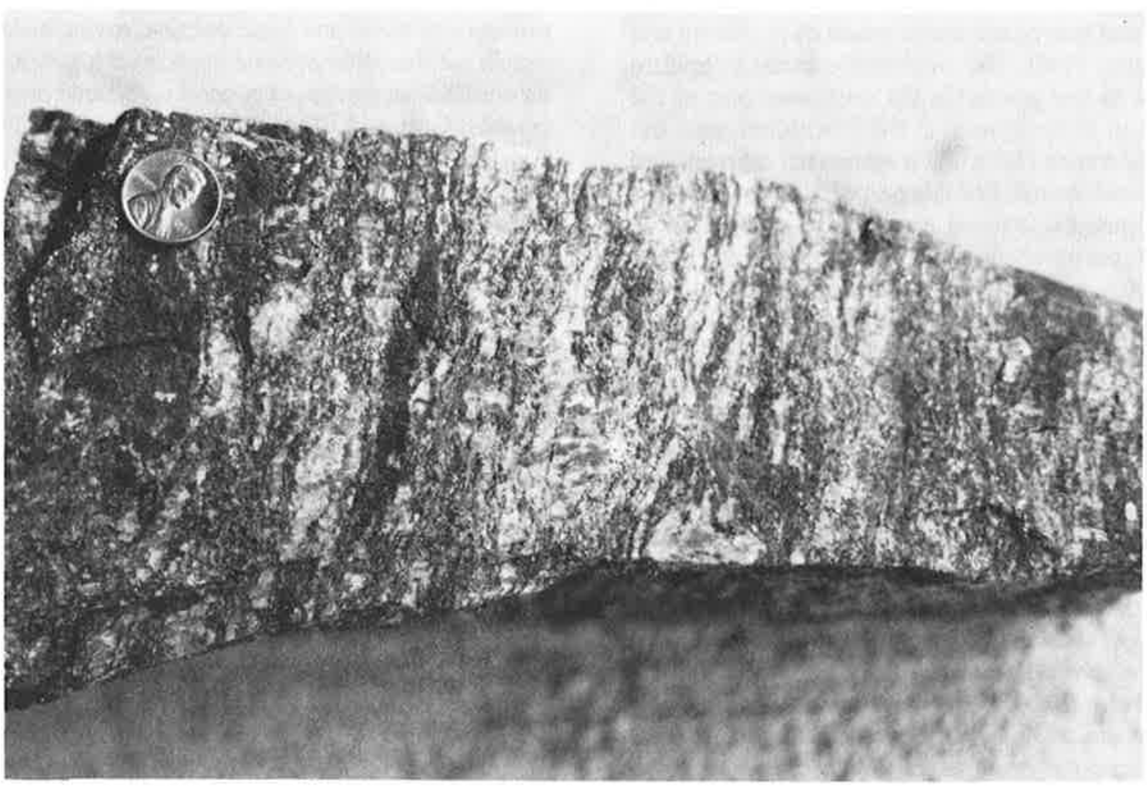


Figure 16. Banded iron formation (exhalite) from the Ducktown area. Rock contains layers of sulfides, magnetite, and quartz.

pyrrhotite and pyrite with accessory actinolite (Slater and others, 1985; Fig. 16). Slater (1982) interpreted this lithology as a chemical precipitate or exhalite. Iron formation in the southwest Ducktown district is less impressive in appearance and is generally a sugary to cherty quartzite with sulfide and/or cummingtonite layers (Fig. 7). Where observed in the southwestern part of the district these lithologic units are thin (less than 4 feet).

The relationship of tourmaline and its importance as an indicator to ore deposits was noted by Slack (1982). No rock which can be termed "tourmalinite" has been observed in the Ducktown district, but tourmaline is associated with at least three of the prospects of the southwest Ducktown district. The Tanner, Pisgah Mountain and Payne Prospects contain tourmaline crystals, up to 1 1/4 inches in length, in and around abandoned workings.

Associated Igneous Rocks

Amphibolite is spatially associated with most mines and prospects of the Ducktown district. The unit, termed the Newtown Sill by Hurst (1955), is herein termed the Fightingtown Creek Amphibolite for exposures near Fighting-Town Creek, Fannin County, Georgia (Fig. 3). The Fightingtown Creek Amphibolite can be traced throughout the entire Ducktown district (Fig. 4) where it is folded and concordant to surrounding rocks. The unit varies in thickness from several inches to tens of feet and is composed predominantly of hornblende and andesine with accessory clinozoisite and quartz and minor amounts of chlorite and sulfides (Hurst, 1955). The amphibolite varies in texture from coarse to fine grained in the southwest part of the district, but to the northeast in the Ducktown area, the textural appearance of the unit is somewhat different and resembles a metabasalt. For this part of the amphibolite, a flow origin may be a more appropriate interpretation. Allard (1984, personal communication) recognized possible amygdyles in amphibolite samples from the area around Ducktown. Hurst (1955) favored a basalt flow origin for the amphibolite although he termed the body a "sill" and suggested that the amphibolite is chemically indistinguishable from a diabase, gabbro or basalt.

Results of whole rock geochemistry of amphibolite samples from the southwest Ducktown district are presented in Table 2 (samples prefixed EP). These analyses, along with plots of trace element analyses (Fig. 17) from the amphibolite, indicate that data from the unit plot in both the abyssal tholeiite and island arc and continental margin fields. Figure 17 shows trace element plots for amphibolites of the southwestern Ducktown district in comparison to plots from metabasalts of the northern Piedmont of Georgia. These chemical analyses, along with the presence of volcanic textures, suggest that some form of volcanic activity occurred in conjunction with ore deposits in the rocks of the Ducktown district.

Gair and Slack (1980) suggested a volcanic origin for certain rocks bounding the Ducktown ore bodies. In this interpretation they included chlorite-rich schists as possible tuffs, quartzite as metachert or exhalite, and amphibolite as metabasalt. Slater (1982) similarly suggested that thick zones of chlorite and sericite schist may represent metamorphosed volcanics or alteration zones. Plagioclase-rich rock is known to be associated with ore bodies at the Cherokee Mine in the Ducktown area (Nesbitt, 1979); the #20 and Mobile mines; and Kellogg, Bryant, and Payne Prospects in the southwest Ducktown district. Thin section examination reveals this plagioclase-rich rock contains plagioclase and quartz with accessory sericite, fine sulfides and tremolite and is herein interpreted to be a felsic volcanic. Tremolite (identified by microprobe analysis) occurs as single grains or in radiating clusters. A single chemical analysis (sample from the Cherokee Mine, Ducktown area) indicates the rock closely resembles a dacite (Table 2). Samples of this lithology from the Ducktown area contain quartz eyes and features which may be interpreted as flattened pumice (Fig. 18). If the plagioclase-rich rocks, sericite schist, chlorite schist, quartzite and amphibolite all represent lithologies of volcanic origin, then there is a sizeable volcanic component associated with and hosting ores of the Ducktown district.

Summary

The stratabound nature of the ore bodies suggests a syngenetic origin for deposits of the Ducktown basin. The presence of mafic and felsic volcanic rocks, exhalite, and significant alteration zones in the form of Mg/Al and Si/Al $\pm$ Fe enriched assemblages suggest a volcanic origin for ore genesis. Gair and Slack (1980), Hutchinson (1980), and Fox (1984) have suggested a Besshi model for the Ducktown area with a thick sequence of continentally derived sediments enclosing volcanics and ore. Sangster (1980) and Slater and others (1985) favor a Sullivan model characterized by thick clastic sediments with a minor volcanic component. The presence of felsic and mafic volcanics enclosing ores at Ducktown would favor a Besshi model. Whichever model best fits, deposits of the Ducktown district probably resulted from some form of volcanogenic process at a time of rifting. A more accurate model (Fig. 19) may be one which includes characteristics of both Sullivan and Besshi. The Ducktown district, like many ore districts, does not precisely fit any predetermined model.

Table 2. Whole rock analyses* of selected rocks of the southwesternmost Ducktown District.

Sample no.	Ep 150	Ep 200	Ep 202	Ep 71	Ep 206
SiO_2	41.61	42.85	47.75	48.43	46.25
Al_2O_3	16.90	15.17	15.62	14.51	14.34
Fe_2O_3	3.69	3.88	3.15	3.66	3.64
FeO	8.60	9.04	7.35	8.54	8.49
MgO	7.92	9.30	7.10	6.61	7.95
CaO	14.80	13.41	13.44	13.09	14.16
Na_2O	1.11	2.70	1.60	1.27	1.62
K_2O	0.14	0.20	0.13	0.23	0.36
TiO_2	1.75	1.52	1.47	1.88	1.49
MnO	0.25	0.20	0.18	0.22	0.26
P_2O_5	0.23	0.19	0.16	0.20	0.17
LOI	1.34	0.88	1.63	1.24	1.09
Total	98.34	99.34	99.58	99.88	99.82

*XRF analyses by author, University of Georgia Laboratory

CIPW NORMS

	Ep 150	Ep 200	Ep 202	Ep 71	Ep 206
qz			1.60	4.85	
co					
or	0.83	1.18	0.77	1.36	2.13
ab	6.48	6.77	13.54	10.75	13.71
an	40.72	28.68	35.06	33.21	30.79
ne	1.58	8.71			
di	25.30	29.61	24.75	24.77	31.11
hy					5.04
ol	12.90	14.55	14.50	14.36	7.46
mt	5.35	5.63	4.57	5.31	5.28
il	3.32	2.89	2.79	3.57	2.83
ap	0.54	0.45	0.38	0.47	0.40
H_2O/loi	1.34	0.88	1.63	1.24	1.09
Total	98.36	99.35	99.59	99.89	99.84

Table 2. Whole rock analyses* of selected rocks of the southwesternmost Ducktown District. (cont'd.)

Sample no.	Ep 298	Ep 298a	Felsic
SiO_2	47.53	47.66	72.59
Al_2O_3	15.69	17.52	8.92
Fe_2O_3	3.15	3.02	1.23
FeO	7.32	6.71	2.86
MgO	7.25	6.29	2.37
CaO	13.66	14.18	4.35
Na_2O	1.59	1.83	3.28
K_2O	0.15	0.13	0.07
TiO_2	1.48	1.33	0.54
MnO	0.19	0.17	0.08
P_2O_5	0.16	0.13	0.37
LOI	1.38	1.02	1.27
Total	99.55	99.99	97.93

CIPW NORMS

	Ep 298	Ep 298a	Felsic
qz	0.89	0.04	41.95
co			
or	0.89	0.77	0.41
ab	13.45	15.49	27.76
an	35.23	39.21	9.41
ne			
di	25.47	24.53	7.94
hy	14.48	11.73	5.53
ol			
mt	4.57	4.38	1.78
il	2.81	2.53	1.03
ap	0.38	0.31	0.88
H_2O/loi	1.38	1.02	1.27
Total	99.55	100.01	97.96

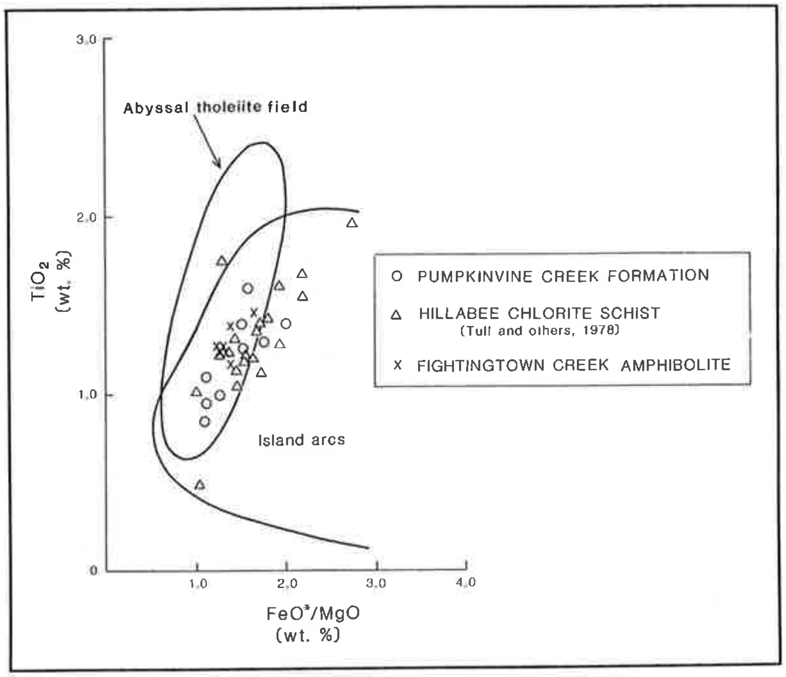


Figure 17a. Discrimination of volcanic rock types based on TiO2 vs FeO*/MgO (after Miyashiro, 1975). A=Calc-alkalic series; B=Calc-alkalic and tholeiitic series; and C=Tholeiitic series (o=Pumpkinvine Creek Formation after McConnell, 1980; Δ=Hillabee Chlorite Schist after Tull and others, 1978; and x=Fightingtown Creek Amphibolite, this report).

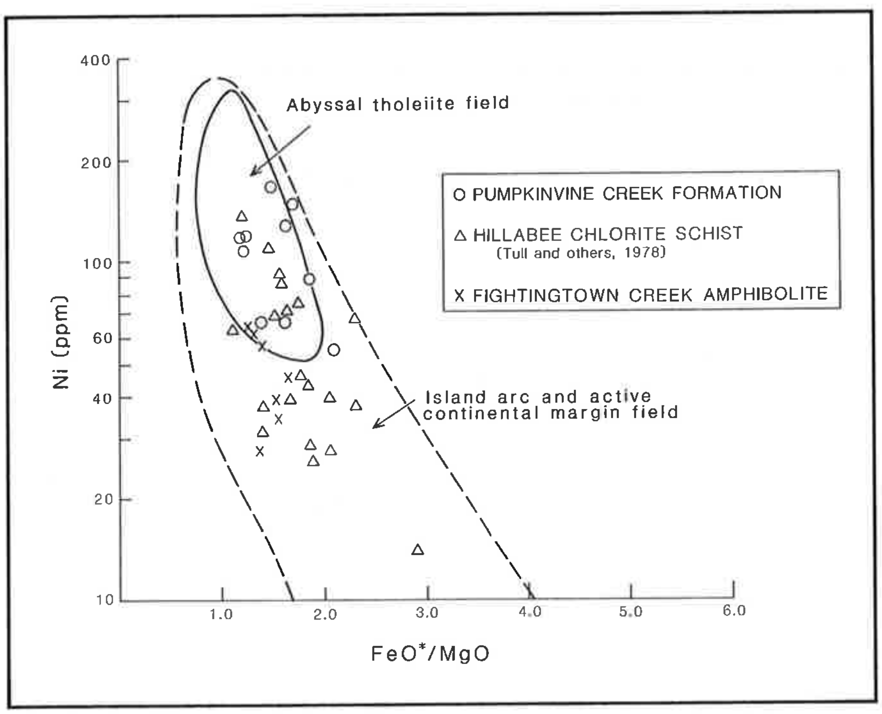


Figure 17b. Discrimination of volcanic rock series based on Ni vs FeO*/MgO relationship (after Miyashiro and Shido, 1975; o=Pumpkinvine Creek Formation after McConnell, 1980; Δ=Hillabee Chlorite Schist after Tull and others, 1978; and x=Fightingtown Creek Amphibolite this report).

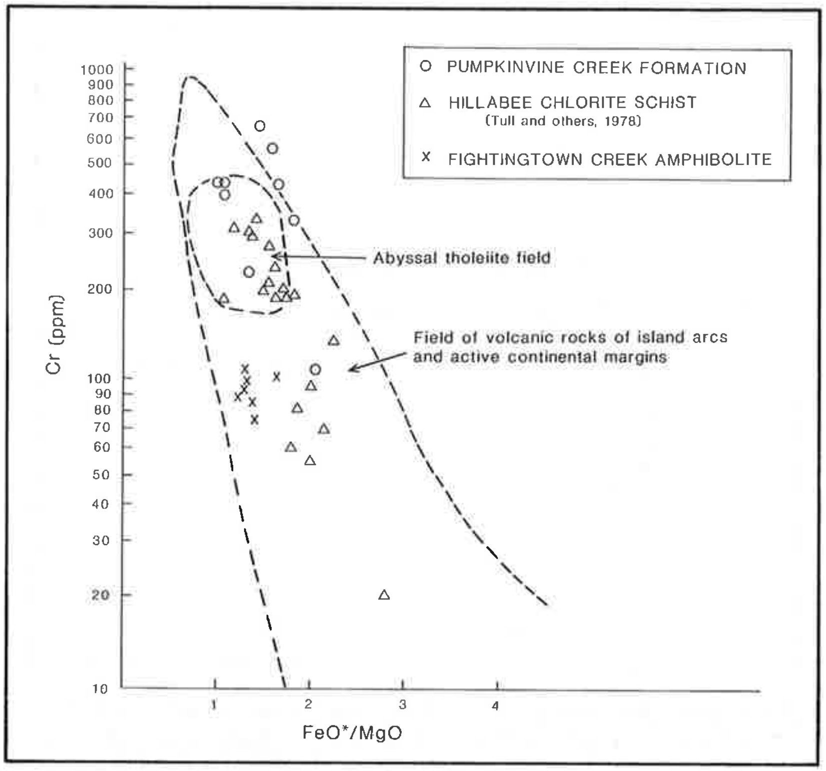


Figure 17c. Discrimination of volcanic rock series based on the Cr vs FeO*/MgO relationship (after Miyashiro and Shido, 1975; o=Pumpkinvine Creek Formation after McConnell, 1980; Δ=Hillabee Chlorite Schist after Tull and others, 1978; and x=Fightingtown Creek Amphibolite this report).

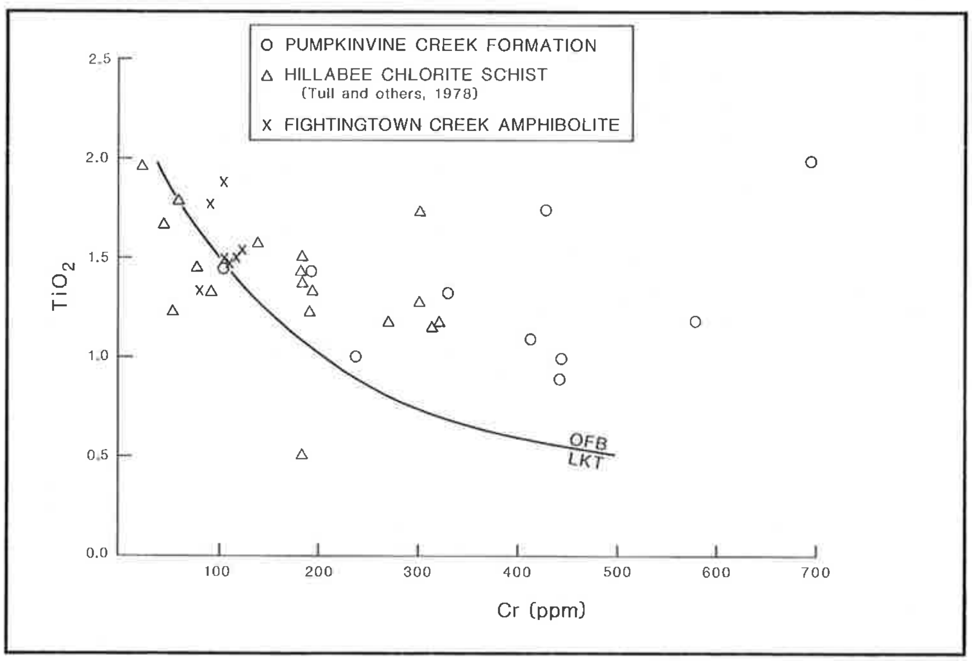


Figure 17d. Discrimination of ocean floor basalts (OFB) vs low potassium tholeiites (LKT) on the basis of Cr vs TiO2 (after Pearce, 1975; o=Pumpkinvine Creek Formation after McConnell, 1980; Δ=Hillabee Chlorite Schist after Tull and others, 1978; and x=Fightingtown Creek Amphibolite this report).

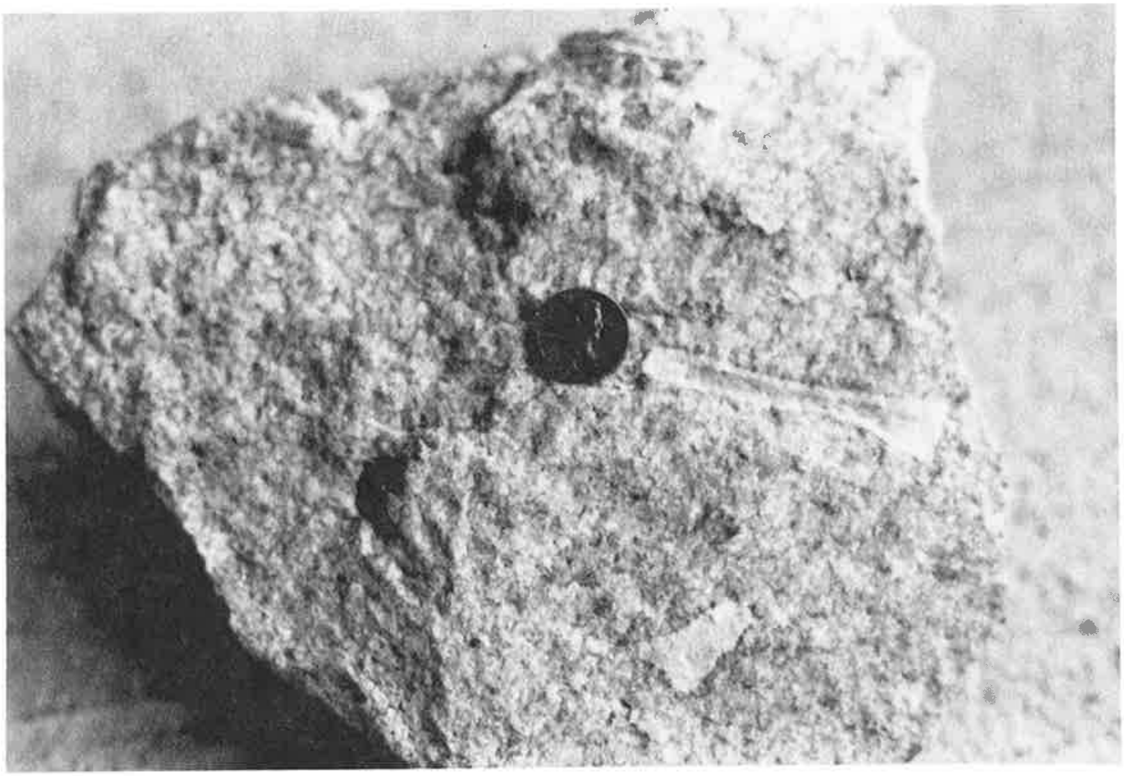


Figure 18. Felsic volcanic rock from the Cherokee Mine, Ducktown, Tennessee.

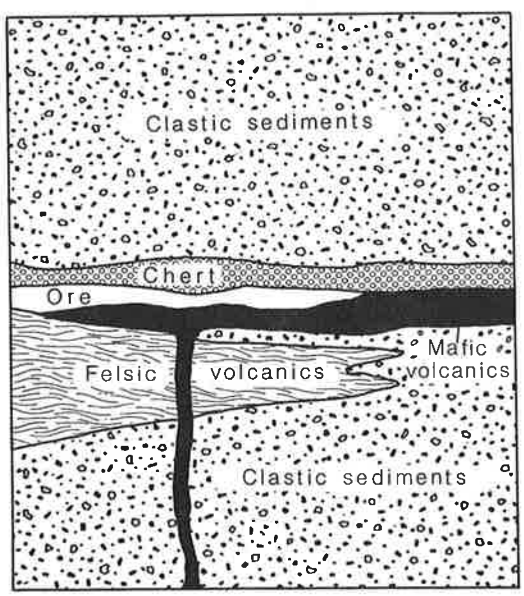


Figure 19. Generalized model for the Ducktown District.

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Appendix A

CORE LOG DESCRIPTION

Mine:	**PAYNE**	hole:	1	bearing:	N60W	angle:	45
date drilled:	April and May, 1969	depth:	350′	310′	N62W		23

depth (ft) **description**

0-350 metagreywacke and biotite muscovite schist ± garnet and chlorite

	Cu	Zn
19-20′	1.0	.15
298-300′	.13	.76
310-315′	.27	.36

disseminated sulfides

Mine:	**PAYNE**	hole:	2	bearing:	N60W	angle:	60
date drilled:	May, 1969	depth:	400′	347′	N42W		36

depth (ft) **description**

0-400 metagreywacke and biotite schist ± muscovite, chlorite, and garnet

	Cu	Zn
37-125′	.18	.26
37-85′	.29	.37
37-65′	.38	.27
55-65′	.34	.29

disseminated sulfides

350-355′ conglomeratic zone

Mine:	**PAYNE**	hole:	3	bearing:	N60W	angle:	60
date drilled:	May and June, 1969	depth:	445′	310′	N67W		44

depth (ft) **description**

0-445 biotite muscovite schist and metagreywacke

75′ and 373′ fault ?

	Cu	Zn
45-70′	--	--
120-270′	.06	.22

disseminated sulfides

Mine:	**PAYNE**	hole:	4	bearing:	N60W	angle:	70
date drilled:	June and July, 1969	depth:	893′	287′	N55W		65
				575′	N61W		47
				880′	N40W		40

depth (ft) **description**

0-893 metagreywacke and biotite muscovite schist

264′ and 347′ fault ?

CORE LOG DESCRIPTION (Cont'd.)

230-580' disseminated sulfides; chalcopyrite, pyrite, pyrrhotite, sphalerite
416-440' calc-silicate; ± actinolite, garnet

Mine:	**PAYNE**	hole:	5	bearing:	N60W	angle:	80
date drilled:	July and August, 1969	depth:	1383'	112'	N59W		79
				298'	N54W		76
				655'	N66W		56
				914'	N72W		41
				1171'	N74W		32

depth (ft)	description
0-17	overburden
17-21	sericite quartzite
21-68	metagreywacke and biotite muscovite schist ± chlorite
68-90	biotite chlorite schist and quartzite
90-105	metagreywacke and biotite muscovite quartz schist
105-122	biotite quartzite ± chlorite 108-111' Cu .1, Zn .08; disseminated sulfides
122-269	chloritic metagreywacke and biotite muscovite schist
269-290	biotite chlorite quartzite and schist with chlorite metacrysts (staurolite pseudo-morphs?)
290-989	metagreywacke and biotite muscovite quartz schist ± chlorite and chlorite metacrysts
989-1383	metagreywacke and biotite muscovite quartz schist 1176-1370' Cu .16, Zn .66; disseminated sulfides

Mine:	**PAYNE**	hole:	6	bearing:	S60E	angle:	45
date drilled:	January and February, 1970	depth:	772'	150'	S52E		32
				450'	S62E		5

depth (ft)	description
0-578	biotite muscovite quartz schist and metagreywacke
578-633	metagreywacke, calc-silicate and biotite muscovite quartz schist with disseminated sulfides

	Cu	Zn
585-585.5'	.48	1.47
585-609'	.21	.17

depth (ft)	description
633-698	metagreywacke, calc-silicate and biotite muscovite quartz schist
698-743	chloritic metagreywacke and chlorite biotite muscovite quartz schist
743-772	metagreywacke, biotite muscovite schist

Mine:	**PAYNE**	hole:	7	bearing:	S60E	angle:	60
date drilled:	February and March, 1970	depth:	1716'	135'	S51E		52
				375'	S57E		38
				800'	S73E		10
				1270'	S77E		5

CORE LOG DESCRIPTION (Cont'd.)

depth (ft)	description
0-31	overburden
31-1076	metagreywacke and biotite muscovite quartz schist ± garnet
1076-1407	metagreywacke, biotite muscovite quartz schist ± chlorite 1135-1145′ Cu .03, Zn .12; trace sulfides 1170′ and 1290′ trace sulfides
1407-1518	metagreywacke, biotite muscovite quartz schist with biotite metacrysts 1490′ disseminated sulfides
1518-1525	quartzite ± biotite, with chlorite metacrysts
1525-1617	metagreywacke and biotite muscovite quartz schist
1617-1716	chloritic metagreywacke and biotite muscovite quartz schist 1625′ disseminated sulfides

Mine: **PAYNE** hole: 8
date drilled: April, 1970 depth: 1135′

bearing:		angle:
	S60E	60
125′	S58E	54
395′	S65E	39
740′	S80E	18
1120′	S77E	1

depth (ft)	description
0-1075	metagreywacke, biotite muscovite quartz schist ± chlorite and garnet 571′ and 744′ fault ?

	Cu	Zn	Pb
964-964.5′	.11	.22	.12
969-969.5′	.43	3.02	3.32

disseminated sulfides; chalcopyrite, pyrrhotite, pyrite, sphalerite, galena, actinolite

depth (ft)	description
1075-1135	chlorite metagreywacke and chlorite biotite muscovite quartz schist ± garnet

Mine: **PAYNE** hole: 9
date drilled: May, 1970 depth: 1368′

bearing:		angle:
	S60E	70
126′	S54E	70
262′	S58E	66
471′	S45E	59
588′	S71E	54
669′	S51E	50
895′	S79E	26
1120′	S89E	9

depth (ft)	description
0-644	metagreywacke, muscovite biotite quartz schist
644-655	quartzite ± biotite
655-731	metagreywacke and biotite muscovite schist
731-742	quartzite, siliceous metagreywacke with trace sulfides
742-807	metagreywacke, biotite muscovite quartz schist
807-812	quartzite with trace sulfides

CORE LOG DESCRIPTION (Cont'd.)

812-888	metagreywacke, biotite muscovite quartz schist
888-915	quartz metaconglomerate, quartzite with trace sulfides
915-1135	metagreywacke, biotite muscovite quartz schist 966-967′ Cu .79, Zn .24; disseminated sulfides
1135-1150	chloritic metagreywacke, chlorite biotite muscovite quartz schist with trace sulfides
1150-1273	metagreywacke, biotite muscovite quartz schist
1273-1286	sericite chlorite quartz schist ± biotite, garnet, and epidote
1286-1368	sericite chlorite quartz schist and metagreywacke

Mine: **SALLY JANE** hole: 1 bearing: N45W angle: 60
date drilled: 1930 depth: 225′

depth (ft)	description
0-25	weathered overburden
25-58	siliceous mica schist
58-70	metagreywacke
70-120	siliceous mica schist
120-155	metagreywacke
155-195	siliceous mica schist
195-214	metagreywacke
214-225	siliceous mica schist

Mine: **SALLY JANE** hole: 2 bearing: N82W angle: 60
date drilled: 1930 depth: 250′

depth (ft)	description
0-40	overburden
40-45	siliceous mica schist
45-70	metagreywacke
70-175	metagreywacke with interlayered siliceous mica schist
175-190	metagreywacke
190-225	siliceous mica schist
225-230	metagreywacke
230-250	siliceous mica schist

Mine: **SALLY JANE** hole: 3 bearing: N35W angle: 60
date drilled: 1930 depth: 275′

CORE LOG DESCRIPTION (Cont'd.)

depth (ft)	description
0-52	overburden
52-185	siliceous mica schist with metagreywacke layers
185-215	metagreywacke
215-262	siliceous mica schist
262-275	metagreywacke

Mine: **BRYANT** hole: 1 bearing: N55W angle: 60
date drilled: 1929 depth: 227′

depth (ft)	description
0-18	overburden
18-90	chlorite muscovite schist
90-100	quartz
100-160	chlorite muscovite schist and siliceous muscovite schist ± chlorite
160-220	metagreywacke, calc-silicate, siliceous biotite muscovite schist
220-227	garnet mica schist

Mine: **BRYANT** hole: 2 bearing: N62W angle: 60
date drilled: 1929 depth: 207′

depth (ft)	description
0-11	overburden
11-55	weathered biotite chlorite muscovite schist
55-75	siliceous chlorite schist
75-138	chlorite schist
138-145	tremolite chlorite schist 140-142′ Cu 3.64, Zn 0.0; chalcopyrite, pyrite, pyrrhotite, sphalerite
145-207	siliceous chlorite biotite muscovite schist

Mine: **BRYANT** hole: 3 bearing: N55W angle: 60
date drilled: 1929 depth: 169′

depth (ft)	description
0-13	overburden
13-38	chlorite schist
38-40	quartz vein
40-125	chlorite schist

CORE LOG DESCRIPTION (Cont'd.)

125-134	actinolite / tremolite chlorite schist 125-130' Cu 2.26; chalcopyrite, pyrite, pyrrhotite, sphalerite. Zinc not assayed.
134-139	siliceous mica schist
139-143	actinolite chlorite schist 139-141' Cu 1.66; 141-143' Cu 1.36: chalcopyrite, pyrite, pyrrhotite, sphalerite. Zinc not assayed.
143-169	siliceous mica schist

Mine: **BRYANT** hole: 4 bearing: N55W angle: 60
date drilled: 1929 depth: 300'

depth (ft)	**description**
0-19	overburden
19-190	chlorite biotite muscovite schist with quartz stringers
190-195	vein quartz
195-225	biotite chlorite schist
225-256	siliceous biotite muscovite schist and chlorite schist 255' disseminated sulfides
256-300	siliceous biotite chlorite muscovite schist

	Cu
266-268'	1.07
268-270'	1.15
270-272'	1.68
272'	1.09

chalcopyrite, pyrite, pyrrhotite, sphalerite

Mine: **BRYANT** hole: 5 bearing: N55W angle: 60
date drilled: 1929 depth: 220'

depth (ft)	**description**
0-18	overburden
18-146	tremolite chlorite schist
146-163	siliceous tremolite chlorite schist 150-160' disseminated sulfides
163-194	tremolite chlorite schist
194-210	siliceous tremolite chlorite schist

	Cu	Zn
196-197'	.73	.69
197-200'	.53	--
200-202'	1.64	--

chalcopyrite, sphalerite, pyrite, pyrrhotite

210-220	siliceous chlorite biotite muscovite schist

CORE LOG DESCRIPTION (Cont'd.)

Mine: **BRYANT** hole: 6 bearing: N52W angle: 60
date drilled: 1930 depth: 300'

depth (ft)	description
0-35	overburden
35-170	chlorite schist
170-175	biotite chlorite schist
175-196	chlorite schist
196-200	siliceous chlorite biotite muscovite schist
200-205	chlorite schist Cu .58, Zn .14; chalcopyrite, pyrite, sphalerite, pyrrhotite
205-250	siliceous chlorite biotite muscovite schist 240-250' trace sulfides
250-300	metagreywacke, siliceous biotite muscovite schist

Mine: **BRYANT** hole: 7 date drilled: 1930 depth: 600'

bearing	angle
N50W	60
200'	47
300'	37
400'	29
500'	27
600'	25

depth (ft)	description
0-74	muscovite chlorite schist with chlorite metacrysts, metagreywacke
74-82	siliceous biotite muscovite schist, metagreywacke
82-230	garnet chlorite quartz schist and siliceous metagreywacke
230-387	siliceous biotite muscovite schist ± chlorite
387-395	siliceous metagreywacke, calc-silicate
395-515	siliceous biotite muscovite schist 424-431' Cu 1.35, Zn .04; chalcopyrite, pyrite, pyrrhotite, sphalerite
515-525	metagreywacke
525-550	siliceous biotite muscovite schist ± chlorite
550-600	metagreywacke, calc-silicate

Mine: **BRYANT** hole: 8 bearing: N43W angle: 60
date drilled: 1930 depth: 300'

depth (ft)	description
0-156	biotite chlorite muscovite quartz schist
156-225	biotite chlorite muscovite quartz schist with cross biotites and quartz veins

CORE LOG DESCRIPTION (Cont'd.)

225-260	biotite quartz feldspar gneiss and biotite muscovite quartz schist ± chlorite 235-250′ trace sulfides
260-300	metagreywacke

Mine: **BRYANT** hole: 9 bearing: N63W angle: 60
date drilled: 1930 depth: 200′

depth (ft)	**description**
0-60	overburden - altered schist
60-165	siliceous sericite chlorite schist ± tremolite 145′ and 155-160′ trace sulfides
165-180	chlorite biotite schist
180-200	siliceous biotite muscovite schist

Mine: **BRYANT** hole: 10 bearing: N52W angle: 60
date drilled: 1930 depth: 330′

depth (ft)	**description**
0-30	overburden
30-195	siliceous biotite muscovite schist 190′ disseminated sulfides
195-296	chlorite schist 279-284′ Cu 3.3, Zn 3.5; chalcopyrite, pyrrhotite, pyrite, sphalerite
296-301	biotite muscovite schist 298′ Cu 7.38, Zn 2.12; chalcopyrite, pyrrhotite, pyrite, sphalerite. Assay from sludge, no core.
301-330	siliceous biotite muscovite schist 305-325′ trace sulfides

Mine: **BRYANT** hole: 11 bearing: N38W angle: 60
date drilled: 1930 depth: 300′

bearing	angle
N38W	60
100′	57
200′	42
300′	38

depth (ft)	**description**
0-75	weathered mica schist and metagreywacke
75-200	siliceous biotite muscovite schist 180′ disseminated sulfides
200-235	siliceous chlorite schist 210-225′ disseminated sulfides; pyrite, pyrrhotite
235-275	tremolite chlorite schist
275-300	siliceous chlorite schist, biotite muscovite schist

CORE LOG DESCRIPTION (Cont'd.)

Mine: **BRYANT** hole: 12 bearing: N43W angle: 60
date drilled: 1930 depth: 500'

depth (ft)	**description**
0-40	overburden
40-186	siliceous muscovite biotite schist
186-233	metagreywacke
233-425	siliceous biotite muscovite schist and metagreywacke
425-475	chlorite schist ± tremolite

	Cu	Zn
460-462'	.27	.03
470-472'	.67	.25

pyrrhotite, sphalerite, chalcopyrite, pyrite

depth (ft)	**description**
475-500	siliceous biotite muscovite schist 496-498' Cu .64, Zn 3.46

Mine: **BRYANT** hole: 13 bearing: N61W angle: 60
date drilled: 1930 depth: 325'

depth (ft)	**description**
0-50	overburden
50-85	altered siliceous biotite muscovite schist
85-128	siliceous biotite muscovite schist
128-132	quartz vein
132-155	muscovite biotite quartz feldspar gneiss
155-207	siliceous biotite muscovite schist ± chlorite 202-207' disseminated sulfides
207-240	biotite muscovite chlorite schist
240-279	chlorite muscovite quartz schist ± tremolite and cummingtonite 250' trace sulfides

	Cu	Zn
267-275'	1.01	1.72
275-279'	2.30	1.19
267-279'	1.44	1.54

chalcopyrite, pyrrhotite, pyrite, sphalerite

depth (ft)	**description**
279-325	biotite muscovite quartz feldspar gneiss

Mine: **BRYANT** hole: 14 bearing: N67W angle: 60
date drilled: 1930 depth: 300'

depth (ft)	**description**
0-50	overburden

CORE LOG DESCRIPTION (Cont'd.)

50-108	biotite muscovite quartz plagioclase gneiss / schist ± chlorite
108-110	chlorite schist
110-270	biotite muscovite quartz plagioclase gneiss / schist ± chlorite
270-300	metagreywacke and calc-silicate

Mine: **BRYANT** hole: 15 bearing: N74W angle: 60
date drilled: 1930 depth: 500'

100'	41
200'	21
300'	21
400'	23
500'	21

depth (ft)	description
0-50	overburden
50-331	muscovite biotite quartz plagioclase gneiss / schist ± chlorite and garnet
331-336	chlorite muscovite schist
336-430	siliceous biotite muscovite schist ± chlorite
430-435	metagreywacke
435-460	siliceous biotite muscovite schist
460-468	chlorite schist
468-490	siliceous biotite muscovite schist
490-500	metagreywacke

Mine: **BRYANT** hole: 16 bearing: N57W angle: 60
date drilled: 1930 depth: 254'

depth (ft)	description
0-53	overburden
53-198	siliceous biotite muscovite schist 160-165' Cu 2.23, Zn .79; chalcopyrite, pyrite, pyrrhotite, sphalerite
198-204	vein quartz
204-224	chlorite muscovite schist
224-254	siliceous biotite muscovite schist 235' trace sulfides

Mine: **KELLOGG** hole: 1 bearing: N17W angle: 60
date drilled: 1930 depth: 220'

depth (ft)	description
0-95	overburden

CORE LOG DESCRIPTION (Cont'd.)

95-182	siliceous biotite muscovite schist, calc-silicate 176-182′ Cu .86, Zn 2.18; chalcopyrite, pyrite, sphalerite, pyrrhotite
182-193	metagreywacke 192-193′ Cu .77, Zn 2.32; chalcopyrite, pyrite, sphalerite, pyrrhotite
193-220	siliceous biotite muscovite schist

Mine: **KELLOGG** hole: 2 bearing: N70W angle: 60
date drilled: 1930 depth: 200′

depth (ft)	description
0-80	overburden
80-200	siliceous biotite muscovite schist / metagreywacke 165-166′ Cu 1.15, Zn 1.65; chalcopyrite, pyrite, pyrrhotite, sphalerite

Mine: **KELLOGG** hole: 3 bearing: N70W angle: 60
date drilled: 1930 depth: 250′

depth (ft)	description
0-60	overburden
60-90	siliceous biotite muscovite schist / metagreywacke
90-95	biotite muscovite schist
95-250	siliceous biotite muscovite schist / metagreywacke 202-205′ Cu .4, Zn 2.19; chalcopyrite, pyrite, sphalerite, pyrrhotite

Mine: **KELLOGG** hole: 4 bearing: N70W angle: 60
date drilled: 1930 depth: 225′

depth (ft)	description
0-111	overburden
111-131	siliceous mica schist
131-150	metagreywacke
150-174	siliceous mica schist
174-198	chlorite sericite schist 187′ Cu 1.21, Zn 1.70; chalcopyrite, sphalerite, pyrite, pyrrhotite
198-210	siliceous mica schist
210-225	metagreywacke

Mine: **KELLOGG** hole: 5 bearing: N70W angle: 60
date drilled: 1930 depth: 250′

CORE LOG DESCRIPTION (Cont'd.)

depth (ft)	description
0-121	siliceous biotite muscovite schist
121-151	metagreywacke
151-209	siliceous biotite muscovite schist 194′ Cu 1.27, Zn 2.04; pyrite, pyrrhotite, chalcopyrite, sphalerite
209-235	metagreywacke
235-250	siliceous biotite muscovite schist

Mine: **KELLOGG** hole: 6 bearing: N70W angle: 60
date drilled: July, 1957 depth: 699′ 300′ 44
522′ 31

depth (ft)	description
0-477	metagreywacke and interlayered biotite sericite schist ± garnet, chlorite schist and calc-silicate
477-487	quartz sericite schist
487-502	disseminated and breccia ore zone- quartz sericite schist with sphalerite, chalcopyrite, pyrrhotite, and pyrite

	Cu	Zn
487-502′	.9	2.41
487-490′	.36	6.15
500-502′	2.26	2.50
495-496′	.74	5.2
496-500′	.74	1.25

depth (ft)	description
502-699	biotite sericite schist and metagreywacke

Mine: **KELLOGG** hole: 7 bearing: N70W angle: 60
date drilled: August, 1957 depth: 500′ 300′ 41

depth (ft)	description
0-500	metagreywacke, mica schist and calc-silicate 196′, 259′, 374′, 416′ and 420′ disseminated pyrrhotite

Mine: **KELLOGG** hole: 8 bearing: N70W angle: 75
date drilled: August, 1957 depth: 570′ 395′ N80W 35
405′ N73W 35

depth (ft)	description
0-570	metagreywacke, mica schist ± garnet and calc-silicate 145′ trace chalcopyrite and pyrrhotite

Mine: **KELLOGG** hole: 9 bearing: N60W angle: 60
date drilled: August, 1957 depth: 538′ 290′ 43

CORE LOG DESCRIPTION (Cont'd.)

depth (ft)	description
0-260	metagreywacke, calc-silicate and mica schist ± garnet
260-353	metagreywacke, calc-silicate and chlorite biotite muscovite schist ± garnet
353-538	metagreywacke, calc-silicate and mica schist ± garnet 455', 461', 491' and 516' trace pyrrhotite

Mine: **KELLOGG** hole: 10 bearing: N73W angle: 80
date drilled: August and September, 1957 depth: 572' 410' N74W 51

depth (ft)	description
0-502	metagreywacke, mica schist and calc-silicate
502-530	biotite muscovite quartz schist ore zone- pyrrhotite, pyrite, sphalerite, chalcopyrite

	Cu	Zn
516.5-519'	.15	--
519-522.5'	.38	1.95

depth (ft)	description
530-572	metagreywacke, mica schist and calc-silicate

Mine: **KELLOGG** hole: 11 bearing: vertical angle: 90
date drilled: September, 1957 depth: 1400'

bearing		angle
164'	N44W	86
463'	N84W	70
921'	N71W	41

depth (ft)	description
0-438	metagreywacke, mica schist, calc-silicate
438-448	chloritic metagreywacke, chlorite biotite muscovite schist
448-638	metagreywacke, mica schist, calc-silicate
638-779	chloritic metagreywacke, chlorite biotite muscovite schist
779-1400	metagreywacke, mica schist and calc-silicate 1336' metadiabase with trace sulfides

Mine: **KELLOGG** hole: 12 bearing: N70W angle: 85
date drilled: October and November, 1957 depth: 1262'

bearing		angle
400'	N73W	61
900'	N81W	35
1255'	N76W	27

depth (ft)	description
0-235	metagreywacke, mica schist, calc-silicate
235-282	chloritic metagreywacke, chlorite muscovite schist
282-723	metagreywacke, biotite muscovite schist
723-726	metadiabase

CORE LOG DESCRIPTION (Cont'd.)

726-756	muscovite biotite schist
756-760	metadiabase
760-767	muscovite biotite schist
767-768	metadiabase
768-1190	metagreywacke, mica schist, calc-silicate
1190-1203	biotite muscovite quartz schist 1196-1197′ Cu .04, Zn .42; pyrite, pyrrhotite, sphalerite, chalcopyrite
1203-1262	metagreywacke, mica schist

Mine: **KELLOGG** hole: 13 bearing: N70W angle: 60
date drilled: November, 1957 depth: 304′

depth (ft)	description
0-304	chlorite sericite quartz schist 157′, 291′ and 303′ trace sulfides Note by R.Slater in log book - hole is mislocated on file map, actually is on northwest side of hill.

Mine: **JEPTHA PATTERSON** hole: 1 bearing: N45W angle: 60
date drilled: 1930 depth: 250′

bearing	angle
N45W	60
110′	64
150′	63
190′	60

depth (ft)	description
0-60	overburden
60-195	siliceous mica schist / metagreywacke
195-213	muscovite chlorite schist
213-218	chlorite schist Cu 1.17, trace Zn; chalcopyrite, pyrite, pyrrhotite, sphalerite
218-250	muscovite chorite schist

Mine: **JEPTHA PATTERSON** hole: 2 bearing: N50W angle: 60
date drilled: 1930 depth: 200′

depth (ft)	description
0-65	overburden
65-148	siliceous mica schist
148-160	chloritic siliceous mica schist 160′ Cu 1.72, Zn .35; chalcopyrite, pyrite, pyrrhotite, sphalerite
160-180	chlorite schist / chlorite tremolite
180-200	chlorite muscovite schist

CORE LOG DESCRIPTION (Cont'd.)

Mine: **JEPTHA PATTERSON**	hole: 3	bearing: N40W	angle: 70
date drilled: September, 1970	depth: 737'	136' N46W	67
		346' N43W	57
		675' N50W	47

depth (ft) — **description**

0-33 overburden

33-270 metagreywacke and mica schist

270-375 chloritic metagreywacke and muscovite schist ± garnet
332-346' disseminated sulfides

375-407 metagreywacke and sericite schist

407-421 chlorite sericite schist

421-428 chlorite sericite quartz tremolite schist

	Cu	Zn	Au
425-428'	3.25	2.06	.02
421-428'	1.7	1.03	--

chalcopyrite, pyrite, pyrrhotite, sphalerite

428-443 chlorite sericite quartz schist

443-462 chlorite quartz schist

462-555 chlorite sericite quartz schist

555-611 chlorite sericite quartz schist with metagreywacke interlayers

611-622 muscovite quartz schist / metagreywacke

622-737 chlorite sericite quartz schist / metagreywacke
670-671' Cu .06, Zn .1; chalcopyrite, sphalerite, pyrite, pyrrhotite, quartz

Mine: **JEPTHA PATTERSON**	hole: 4	bearing: N40W	angle: 70
date drilled: September & October, 1970	depth: 440'	326' N41W	61

depth (ft) — **description**

0-50 overburden

50-137 metagreywacke / mica schist

137-140 metagreywacke and garnet mica schist

140-160 staurolite chlorite schist ± garnet (staurolite altered)

160-307 sericite chlorite quartz schist
204-210' Cu .14, Zn .06; disseminated chalcopyrite, sphalerite, pyrite, pyrrhotite

307-322 sericite quartz schist

322-361 metagreywacke ± chlorite and chlorite sericite schist
322' and 345' trace sulfides

361-381 metagreywacke ± chlorite and chlorite sericite schist

381-440 metagreywacke and mica schist

CORE LOG DESCRIPTION (Cont'd.)

Mine:	**JEPTHA PATTERSON**	hole:	5	bearing:	N40W	angle:	70
date drilled:	October 1970	depth:	511′	417′	N48W		46

depth (ft)	description
0-8	overburden
8-18	metagreywacke and mica schist
18-78	metagreywacke and chlorite sericite schist
78-117	metagreywacke and staurolite sericite chlorite schist ± garnet
117-211	metagreywacke and sericite schist 149′ trace sulfides
211-297	metagreywacke and chlorite sericite schist
297-437	metagreywacke and sericite schist 402′ trace sulfides
437-442	conglomeratic metagreywacke
442-511	metagreywacke and schist ± chlorite and sericite

Mine:	**JEPTHA PATTERSON**	hole:	6	bearing:	N40W	angle:	70
date drilled:	October & November, 1970	depth:	986′	300′	N45W		56
				800′	N61W		31

depth (ft)	description
0-134	overburden
134-352	metagreywacke, biotite muscovite schist
352-415	metagreywacke, biotite chlorite sericite schist
415-472	chlorite sericite tremolite schist 415-419′ Cu .89, Zn .7; disseminated chalcopyrite, sphalerite, pyrite, pyrrhotite
472-659	chlorite sericite schist ± biotite with metagreywacke layers 579′ and 607′ disseminated sulfides
659-862	biotite muscovite schist / metagreywacke
862-986	biotite sericite chlorite quartz schist

Mine:	**JEPTHA PATTERSON**	hole:	7	bearing:	N40W	angle:	60
date drilled:	November, 1970	depth:	670′	212′	N49W		50
				620′	N55W		28

depth (ft)	description
0-71	overburden
71-345	biotite muscovite schist, metagreywacke
345-441	biotite chlorite muscovite schist, metagreywacke 392′ fault ?
441-452	conglomeratic metagreywacke
452-478	biotite chlorite sericite quartz schist and metagreywacke

CORE LOG DESCRIPTION (Cont'd.)

478-526	biotite sericite quartz schist and metagreywacke
526-670	biotite muscovite schist and metagreywacke 557' and 571' trace pyrrhotite

Mine:	**JEPTHA PATTERSON**	hole:	8	bearing:	N40W	angle:	60
date drilled:	December, 1970	depth:	1100'	320'	N44W		44
				770'	N52W		28

depth (ft)	description
0-785	biotite chlorite sericite schist and metagreywacke 581' and 739' trace sulfides
785-797	garnet biotite chlorite sericite schist
797-848	biotite chlorite sericite schist and metagreywacke 838' trace sulfides
848-855	garnet biotite chlorite sericite schist
855-1100	biotite chlorite sericite schist and metagreywacke 865-866' trace sulfides 894-967' disseminated sulfides 982' trace sulfides 1086-1093' disseminated sulfides

Mine:	**JEPTHA PATTERSON**	hole:	9	bearing:	S40E	angle:	50
date drilled:	February, 1971	depth:	1517'	245'	S34E		54
				440'	S33E		50
				681'	S35E		43
				968'	S40E		34

depth (ft)	description
0-64	overburden
64-938	biotite chlorite quartz schist and chlorite biotite quartz feldspar gneiss (metagreywacke)
938-991	amphibolite with epidote ± biotite
991-998	biotite quartz schist and siliceous metagreywacke ± epidote and hornblende
998-1010	amphibolite
1010-1239	metagreywacke and biotite muscovite quartz schist
1239-1241	amphibolite with disseminated sulfides
1241-1255	metagreywacke, mica schist, calc-silicate
1255-1288	amphibolite 1255-1260' disseminated sulfides
1288-1307	biotite schist, metagreywacke ± hornblende 1290' disseminated sulfides
1307-1332	amphibolite with disseminated pyrrhotite
1332-1336	siliceous metagreywacke

CORE LOG DESCRIPTION (Cont'd.)

1336-1363	amphibolite with disseminated pyrrhotite
1363-1371	siliceous metagreywacke, calc-silicate
1371-1382	amphibolite
1382-1399	siliceous metagreywacke, calc-silicate
1399-1404	hornblende gneiss
1404-1409	mica schist / metagreywacke
1409-1422	amphibolite
1422-1432	metagreywacke
1432-1441	amphibolite
1441-1446	metagreywacke
1446-1476	amphibolite
1476-1517	metagreywacke, mica schist

Mine: **JEPTHA PATTERSON** hole: 10
date drilled: March, 1971 depth: 1922'

	bearing	angle
	N40W	80
82'	N28W	84
182'	N37W	82
295'	N44W	78
604'	N44W	65
954'	N48W	58
1212'	N55W	45
1650'	N55W	29

depth (ft)	**description**
0-82	overburden
82-190	amphibolite
190-1495	metagreywacke, mica schist
1495-1573	chlorite sericite quartz schist and metagreywacke
1573-1662	metagreywacke, biotite muscovite schist
1662-1753	chlorite sericite quartz schist and metagreywacke

1724-1727' graphite

	Cu	Zn
1675-1680'	.08	.12
1680-1685'	.09	.08
1700-1710'	.07	.08
1710-1720'	.1	.12
1720-1725'	.08	.12
1725-1730'	.06	.10

disseminated sulfides

1753-1838	chlorite quartz schist / metagreywacke ± sericite
1838-1922	biotite muscovite schist / metagreywacke

CORE LOG DESCRIPTION (Cont'd.)

Mine: **#20** hole: 1 bearing: N57W angle: 60
date drilled: May, 1930 depth: 200'

depth (ft)	description
0-30	overburden
30-160	siliceous biotite muscovite schist 140-145' trace sulfides
160-165	metagreywacke
165-170	siliceous biotite muscovite schist
170-200	metagreywacke and calc-silicate 173' trace sulfides

Mine: **#20** hole: 2 bearing: N40W angle: 60
date drilled: 1930 depth: 175'

depth (ft)	description
0-55	overburden
55-139	biotite muscovite quartz schist
139-149	chlorite schist 143' trace sulfides
149-153	biotite muscovite schist 152' trace sulfides
153-165	metagreywacke and calc-silicate
165-175	biotite muscovite schist

Mine: **#20** hole: 3 bearing: N33W angle: 60
date drilled: June, 1930 depth: 231'

depth (ft)	description
0-18	overburden
18-150	siliceous mica schist
150-170	biotite mica schist quartz within schist; quartz bands; disseminated sulfides
170-205	mica schist - biotite and chlorite
205-211	talcy chlorite schist 210' trace sulfides
211-220	amphibolite, trace sulfides
220-225	talcy chlorite schist, trace sulfides
225-231	metagreywacke with interlayered mica schist

CORE LOG DESCRIPTION (Cont'd.)

Mine:	**#20**	hole:	4	bearing:	N45W	angle:	60
date drilled:	1930	depth:	210'				

depth (ft)	description
0-75	saprolite, altered schist
75-95	biotite muscovite quartz schist
95-210	metagreywacke and biotite muscovite quartz schist

Mine:	**#20**	hole:	5	bearing:	N30W	angle:	60
date drilled:	June, 1967	depth:	752'	300'	N40W		24
				720'	N44W		10

depth (ft)	description
0-87	overburden
87-267	chlorite sericite quartz gneiss
267-561	chlorite biotite metagreywacke
561-622	sericite schist and chlorite biotite metagreywacke 593-600.5' ore zone: chalcopyrite, pyrite, pyrrhotite, sphalerite

	Cu	Zn	Au	Ag
596'	1.53	.5	trace	trace
599'	1.15	1.22	trace	trace
593-600.5'	1.45	.64		

622-752	metagreywacke, calc-silicate and biotite-sericite schist ± garnet 665' fault? 677' disseminated sulfides

Mine:	**#20**	hole:	6	bearing:	vertical	angle:	90
date drilled:	June, 1967	depth:	883'	143'	N67W		84
				326'	N57W		68
				455'	N61W		53
				604'	N52W		28

depth (ft)	description
0-295	metagreywacke, biotite muscovite quartz schist ± chlorite and calc-silicate
295-410	metagreywacke biotite muscovite quartz schist and calc-silicate 340' fault?
410-550	metagreywacke, chlorite biotite muscovite quartz schist, calc-silicate
550-750	
750-785	biotite sericite quartz schist 758-774' ore zone: mainly chalcopyrite and pyrrhotite

	Cu	Zn	Pb	Mo	Ag
758-774'	1.14	1.12	--	--	--
763-771'	1.46	1.03	.095	.02	.3

785-883	metagreywacke and biotite muscovite quartz schist

CORE LOG DESCRIPTION (Cont'd.)

Mine: **#20**		hole: 7	bearing: vertical	angle:	90
date drilled:	July, 1967	depth: 802'	180' N58W		84
			424' N52W		56
			800' N40W		35

depth (ft)	description
0-542	metagreywacke and biotite / chlorite sericite quartz schist seritization increasing with depth
542-556	ore zone: chalcopyrite and pyrrhotite

	Cu	Zn	Au	Ag
542-556'	1.57	.91	trace	trace
547-551'	1.94	1.03	trace	trace

556-802	metagreywacke and biotite / chlorite sericite quartz schist seritization decreasing with depth 632' and 743' fault gouge

Mine: **#20**		hole: 8	bearing: vertical	angle:	90
date drilled:	August, 1967	depth: 598'	300' N47W		71
			590' N47W		51

depth (ft)	description
0-480	interlayered metagreywacke and sericite schist 201' + chlorite
480-488	siliceous metagreywacke
488-499	siliceous sericite schist 493-499' disseminated sulfides
499-522	siliceous metagreywacke and schist 499-508' disseminated sulfides
522-546	massive sulfides: pyrrhotite, chalcopyrite, sphalerite, magnetite

	Cu	Zn
522-527'	.73	1.28
527-532'	1.97	1.74
532-537'	.65	.40
537-542'	1.27	.44
542-546'	1.06	1.64

546-598	metagreywacke and sericite schist

Mine: **#20**		hole: 9	bearing: vertical	angle:	90
date drilled:	September, 1967	depth: 800'	300' N21W		74
			600' N32W		60

depth (ft)	description
0-800	chlorite sericite quartz schist ± biotite and chlorite metagreywacke 13' fault ? 411' tremolite or actinolite

CORE LOG DESCRIPTION (Cont'd.)

429' calcite
433-434' actinolite
580-586.5' Cu .33, Zn .78; pyrrhotite, chalcopyrite, sphalerite, quartz, chlorite
588-621' calc-silicate in metagreywacke
650' one foot of quartzite

Mine: **#20**		hole: 10	bearing: vertical	angle: 90
date drilled:	September, 1967	depth: 582'	150' N23W	83
			300' N45W	79
			340' N37W	74

depth (ft)	**description**
0-394	biotite chlorite sericite quartz schist and metagreywacke 83-85' fault
394-418	chlorite sericite schist
418-431	chlorite schist 418-430' Cu .34, Zn .14, Au trace, Ag trace
431-442	quartzite
442-502	biotite chlorite quartz schist

	Cu	Zn
489-490'	.24	.49
495-500'	.51	.53
500-502'	.47	.43

502-582	metagreywacke and schist ± chlorite

Mine: **#20**		hole: 11	bearing: vertical	angle: 90
date drilled:	October, 1967	depth: 900'	310' N29W	77
			630' N41W	62
			900' N43W	48

depth (ft)	**description**
0-900	metagreywacke and schist (sericite, chlorite) 249' quartz conglomerate

	Cu	Zn
555-569'	.67	1.00
555-556'	3.5	3.7
568-569'	1.0	2.2

Mine: **#20**		hole: 12	bearing: N30W	angle: 80
date drilled:	November, 1967	depth: 955'		

depth (ft)	**description**
0-133	metagreywacke and biotite quartz schist ± chlorite
133-144	graphitic schist

CORE LOG DESCRIPTION (Cont'd.)

144-955	metagreywacke and schist ± chlorite with interlayered quartzite 862-895′ chlorite metacrysts 945′ disseminated sulfides

Mine: **#20** hole: 13 bearing: vertical angle: 90

date drilled: January, 1968 depth: 1240′

300′	N38W	87
600′	N58W	68
900′	N52W	42
1200′	N58W	23

depth (ft)	**description**
0-227	metagreywacke and biotite sericite schist 173′ fault ?
227-1032	metagreywacke, biotite sericite quartz schist ± chlorite 240-317′ disseminated sulfides 344′ fault? 371-375′ disseminated sulfides
1032-1038	quartz and pyrrhotite
1038-1090	seritized metagreywacke and sericite schist
1090-1106	ore zone: chalcopyrite, pyrrhotite, pyrite, sphalerite, galena, tremolite, quartz, minor biotite

	Cu	Zn
1090-1106′	1.53	1.71
1100-1106′	1.96	1.15

1106-1240	siliceous metagreywacke

Mine: **#20** hole: 14 bearing: vertical angle: 90

date drilled: February, 1968 depth: 991′

300′	N65W	79
600′	N60W	63
880′	N52W	40

depth (ft)	**description**
0-925	metagreywacke and sericite schist ± chlorite and quartz 251′, 821′, and 914′ faults?
925-991	metagreywacke and sericite schist ± biotite and quartz 929-934′ Cu 1.89, Zn .85: predominately pyrrhotite with chalcopyrite, sphalerite, pyrite; sericite and sericite quartz biotite breccia

Mine: **#20** hole: 16 bearing: S30E angle: 87

date drilled: March and April, 1968 depth: 1463′

300′	S86W	87
770′	S70W	45
975′	S68W	33
1320′	S71W	27

CORE LOG DESCRIPTION (Cont'd.)

depth (ft)	description
0-105	metagreywacke and biotite sericite quartz schist
105-645	metagreywacke and sericite quartz schist ± chlorite 177', 356', and 420' faults ?
645-655	graphitic schist
655-1463	metagreywacke and sericite quartz schist ± biotite, chlorite disseminated sulfides

	Cu	Zn
1175-1210'	.11	.29
1418-1443'	.3	.33

Mine: **#20**		hole: 17	bearing:	S30E	angle:	85
date drilled:	April and May, 1968	depth: 1595'	300'	S68W		87
			600'	N62W		70
			875'	N74W		42
			1200'	N79W		26

depth (ft)	description
0-1595	metagreywacke, biotite sericite schist ± chlorite and quartz 94' and 130' staurolite 414' fault ? 567-587' amphibolite 625-627', 630-636', and 668' disseminated sulfides 762' fault ? 1533-1554' biotite sericite schist, calcite, pyrrhotite, and chalcopyrite

	Cu	Zn
1151-1554'	.46	.73
1554-1564'	2.6	1.29

1564' calc-silicate

Mine: **#20**		hole: 18	bearing:	N90E	angle:	84
date drilled:	June and July, 1968	depth: 1787'	294'	N16W		84
			600'	N42W		44
			640'	N30W		41
problem at 645' - too flat hole, restarted at 400'			400'	S26W		83
			450'	N44W		72
			500'	N44W		67

depth (ft)	description
0-934	metagreywacke and chlorite sericite schist 258' fault 717' graded bedding
934-1140	metagreywacke and biotite sericite quartz schist
1140-1787	metagreywacke, biotite sericite quartz schist ± chlorite

CORE LOG DESCRIPTION (Cont'd.)

	Cu	Zn
1745-1748.5′	1.16	.43
1748.5-1751	2.25	1.34

disseminated sulfides; pyrrhotite, chalcopyrite, sphalerite, pyrite, quartz, calcite

Mine: **#20** | hole: 19 | date drilled: September and October, 1968 | depth: 1899′

bearing:		angle:
	N90E	85
225′	N80E	86
362′	N22E	85
542′	N30W	80
825′	N37W	59
1100′	N42W	47
1408′	N51W	30
1800′	N50W	30

depth (ft)	description
0-1689	metagreywacke and sericite schist ± chlorite
1689-1709	sericite schist
1709-1718	pyrrhotite, pyrite, chalcopyrite, sphalerite, quartz, sericite, biotite
1718-1899	metagreywacke and calc-silicate

	Cu	Zn
1709-1712′	1.33	1.12
1712-1718′	.34	.68

Mine: **#20** | hole: 20 | date drilled: November, 1968 | depth: 821′

bearing:		angle:
	N70W	80
270′	N69W	71
530′	N65W	57
821′	N62W	45

depth (ft)	description
0-655	metagreywacke and biotite muscovite schist ± chlorite 246-250′ disseminated sulfides
655-721	metagreywacke and graphitic biotite muscovite schist 713-716′ disseminated sulfides
716-821	metagreywacke and chlorite muscovite schist

Mine: **#20** | hole: 21 | date drilled: February, 1969 | depth: 1353′

bearing:		angle:
	vertical	90
210′	N64W	82
594′	N60W	68
909′	N74W	53
1353′	N78W	36

depth (ft)	description
0-815	metagreywacke and biotite chlorite muscovite schist
815-869	chlorite sericite schist ± tremolite and epidote, diopside? disseminated sulfides

CORE LOG DESCRIPTION (Cont'd.)

869-993	metagreywacke and schist with chlorite and/or biotite metacrysts
993-1319	metagreywacke and biotite muscovite schist 1183′ fault
1319-1353	metagreywacke and chlorite muscovite schist

Mine: **#20** hole: 22 bearing: vertical angle: 90

date drilled: March, 1969 depth: 1212′

depth (ft)	description
0-1089	metagreywacke and chlorite sericite / muscovite schist with chlorite metacrysts 55-65′, 343′, and 917′ faults
1089-1107	muscovite schist
1107-1130	metagreywacke and chlorite sericite / muscovite schist with chlorite metacrysts
1130-1141	ore zone: actinolite, quartz, calcite, diopside (?), muscovite, chalcopyrite, pyrrhotite, sphalerite, galena

	Cu	Zn	Pb	Au	Ag
1130-1135′	1.98	2.4	.28	trace	trace
1130-1141′	1.10	2.14	.31	trace	trace

1141-1212	metagreywacke and chlorite sericite / muscovite schist with chlorite metacrysts

Mine: **#20** hole: 23

date drilled: April, 1969 depth: 1422′

	bearing	angle
	N15W	88
160′	N21E	85
254′	N14W	84
469′	N35W	75
794′	N46W	56
1085′	N51W	46

depth (ft)	description
0-465	chloritic metagreywacke and schist with chlorite metacrysts
465-475	graphitic biotite muscovite schist
475-1422	chloritic metagreywacke and schist with chlorite metacrysts 1405-1410′ Cu .32, Zn .2; disseminated pyrite, pyrrhotite, sphalerite, and chalcopyrite

Mine: **#20** hole: 24

date drilled: May, 1969 depth: 1657′

	bearing	angle
	S60E	87
127′	S60E	85
213′	S83E	86
377′	N06E	83
607′	N15E	75
954′	N54E	62
1305′	N56E	50

depth (ft)	description
0-1657	chloritic metagreywacke and chlorite muscovite quartz schist with chlorite metacrysts

CORE LOG DESCRIPTION (Cont'd.)

567-604', 857-862', 930-935' disseminated sulfides
1562' actinolite rosettes; no chlorite metacrysts below this depth
1621-1624' biotite muscovite schist breccia ore zone: quartz, actinolite, cite, chalcopyrite, biotite, pyrrhotite, sphalerite

	Cu	Zn
1624-1657'	1.13	1.35
1624-1630'	.1.94	1.55

metagreywacke and calc-silicate underlie ore

Mine: **#20**	hole: 24A	bearing:	angle:
date drilled: July, 1969	depth: 1746'	763' N29W	72
casing on hole 24 pulled and NX core started again at 607'		916' N40W	68
		1196' N48W	61
		1566' N52W	50

depth (ft) **description**

607-1676 chloritic metagreywacke and chlorite muscovite quartz schist
618', 827' 920', 979', and 1512' faults ?
1022-1047' + chlorite metacrysts
1063-1135' + chlorite metacrysts
1261-1338' + chlorite metacrysts
1347-1363' + chlorite metacrysts
1497-1523' + chlorite metacrysts
1590-1596' + chlorite metacrysts

1676-1701 ore zone, breccia ore with quartz, muscovite, biotite metacrysts, pyrrhotite, chalcopyrite, actinolite, garnet, sphalerite bands, zoisite (?) associated with biotite muscovite quartz schist, actinolite is very coarse

	Cu	Zn
1672-1701'	.72	1.24
1691-1701'	.98	2.33

1701-1746 chloritic metagreywacke and schist with calc-silicate

Mine: **#20**	hole: 25	bearing: vertical	angle: 90
date drilled: July, 1969	depth: 2236'	2100' N56W	29

depth (ft) **description**

0-1998 chloritic metagreywacke, chlorite biotite muscovite schist ± chlorite metacrysts
652-658' and 740-761' disseminated sulfides

1998-2007 actinolite in chloritic biotite quartz schist

2007-2205 chloritic metagreywacke and chlorite biotite muscovite quartz schist
2052-2064' disseminated sulfides
2190-2205' chalcopyrite, pyrite, sphalerite, pyrrhotite

	Cu	Zn
2190-2205'	.83	.57
2190-2195'	1.23	--
2190-2195'	1.28	--

2205-2236 sericite biotite quartz schist

CORE LOG DESCRIPTION (Cont'd.)

Mine:	**#20**	hole:	26	bearing:	S60E	angle:	87
date drilled:	October and November, 1969	depth:	2684′	250′	vertical		90
				1950′	N48W		36

depth (ft)	description
0-824	metagreywacke and mica schist with chlorite metacrysts
824-935	muscovite quartz schist, chlorite metacrysts (altered staurolite?) ± biotite and chlorite
935-946	garnet muscovite quartz schist ± biotite and chlorite
946-958	actinolite chlorite schist
958-2123	metagreywacke and mica schist with chlorite metacrysts
2123-2145	biotite quartz schist, muscovite biotite quartz schist ± chlorite and calcite
2145-2167	quartz, tremolite, actinolite, calcite, zoisite, chlorite, garnet
2167-2180	biotite quartz schist ± sericite
	2123-2180′ disseminated and massive sulfides: chalcopyrite, pyrite, pyrrhotite, sphalerite

	Cu	Zn
2123-2180′	1.20	.69
2167-2180′	2.08	1.11
2145-2150′	6.9	.29
2150-2155′	2.57	1.02
2155-2161′	1.15	.70

depth (ft)	description
2180-2230	biotite sericite quartz schist, metagreywacke and calc-silicate
2230-2555	metagreywacke and biotite muscovite schist with chlorite metacrysts
	2377-2389′ disseminated sulfides
2555-2622	graphitic biotite muscovite schist and metagreywacke
2622-2684	metagreywacke, biotite muscovite quartz schist ± chlorite metacrysts
	2679-2684′ disseminated sulfides

Mine:	**#20**	hole:	27	bearing:		angle:	90
date drilled:	March and April, 1970	depth:	1986′	217′	vertical		90
				676′	N54W		75
				937′	N45W		64
				1290′	N44W		53
				1650′	N45W		44
				1970′	N50W		37

depth (ft)	description
0-436	metagreywacke and muscovite / sericite quartz schist ± biotite
436-531	chloritic metagreywacke, chlorite sericite quartz schist
531-661	metagreywacke, sericite quartz schist ± biotite
	639-650′ disseminated pyrite, pyrrhotite
661-732	chloritic metagreywacke and chlorite sericite quartz schist
732-1040	metagreywacke, sericite quartz schist ± biotite

CORE LOG DESCRIPTION (Cont'd.)

1040-1271	chloritic metagreywacke and chlorite sericite quartz schist
1271-1880	metagreywacke, sericite quartz schist ± biotite
1880-1912	ore zone: disseminated sulfides 1880-1910' in sericite quartz schist ± biotite; 1910-1914' chalcopyrite, pyrite, sphalerite, actinolite, and rounded quartz

	Cu	Zn
1904-1912'	.92	.66
1910-1912'	2.02	1.19

1912-1986	chloritic metagreywacke with disseminated pyrrhotite and abundant calc-silicate

Mine: **#20** hole: 28

date drilled: May, 1970 depth: 2326'

bearing:		angle:
	S60E	87
100'	S60E	90
156'	S60E	90
296'	N64W	85
474'	N72W	80
776'	N71W	75
1066'	N60W	64
1446'	N65W	49
1846'	N63W	39

depth (ft)	description
0-586	
586-905	chloritic metagreywacke and chlorite mica schist
905-1322	metagreywacke and mica schist ± chlorite
1322-1332	hornblende chlorite biotite schist
1332-1446	metagreywacke and muscovite biotite schist
1446-1961	chlorite metagreywacke and chlorite sericite quartz schist
1961-2169	metagreywacke and sericite quartz schist ± biotite
2169-2198	chloritic metagreywacke and chlorite sericite quartz schist
2198-2207	biotite sericite quartz schist with disseminated sulfides ± chlorite and graphite
2207-2215	ore zone: chalcopyrite, sphalerite, pyrite, pyrrhotite, quartz, tremolite, calcite, sericite 2207-2216' Cu .79, Zn .70
2215-2224	biotite sericite quartz schist and disseminated sulfides
2224-2245	metagreywacke and chlorite sericite quartz schist, disseminated sulfides
2245-2256	biotite quartz sericite schist ± chlorite and disseminated sulfides
2256-2265	ore of chalcopyrite, sphalerite, pyrite, pyrrhotite, tremolite, quartz, calcite, biotite

	Cu	Zn
2256-2265'	1.25	.84
2260-2265'	1.67	.80

2265-2293	metagreywacke and mica schist ± chlorite, sericite
2293-2307	sericite schist ± chlorite
2307-2326	chloritic metagreywacke and schist

CORE LOG DESCRIPTION (Cont'd.)

Mine: **#20**	hole: 29	bearing: SE	angle: 87
date drilled: June, 1970	depth: abandoned at 683'		

depth (ft)	**description**
	no ore all metagreywacke with interlayered mica schist ± chlorite

Mine: **#20**	hole: 30	bearing: vertical	angle: 90
date drilled: July, 1970	depth: abandoned at 545"		

depth (ft)	**description**
	no ore metagreywacke and mica schist ± chlorite

Mine: **#20**	hole: 31	bearing: N60W	angle: 86.5
date drilled: August, 1970	depth: 1216'		

depth (ft)	**description**
0-746	metagreywacke and mica schist with chlorite metacrysts
746-752	quartz, biotite, sericite and chlorite with disseminated pyrite, pyrrhotite, chalcopyrite, sphalerite
752-1216	metagreywacke and mica schist with chlorite metacrysts

Mine: **#20**	hole: 32	bearing: N60W	angle: 87
date drilled: October, 1970	depth: 1546'		

depth (ft)	**description**
	no ore metagreywacke and mica schist

Mine: **#20**	hole: 33	bearing:	angle:
date drilled: October, 1970	depth: abandoned 752'		

depth (ft)	**description**
	no ore biotite chlorite sericite schist and metagreywacke

Mine: **MOBILE**	hole: 1	bearing: N31W	angle: 60
date drilled: 1930	depth: 347'	147'	51
		247'	34
		347'	30

CORE LOG DESCRIPTION (Cont'd.)

depth (ft)	description
0-30	overburden
30-130	chlorite sericite quartz schist 120-130′ trace sulfides
130-142	quartz with chlorite schist bands 142′ sulfide veins
142-259	siliceous mica schist ± chlorite with calc-silicate 160′ trace sulfides
259-269	metagreywacke
269-295	siliceous mica schist with trace sulfides
295-337	chlorite sericite schist
337-347	metagreywacke

Mine: **MOBILE** hole: 2 bearing: N52W angle: 60
date drilled: 1930 depth: 310′

depth (ft)	description
0-30	overburden
30-143	siliceous chlorite schist 135-138′ trace sulfides 140′ quartz with trace sulfides
143-153	biotite muscovite schist
153-165	siliceous muscovite schist
165-215	biotite muscovite schist ± chlorite
215-222	chlorite schist with disseminated sulfides
222-260	siliceous muscovite schist and metagreywacke
260-265	Cu 1.8, Zn .87; pyrite, pyrrhotite, chalcopyrite, sphalerite, quartz
265-305	metagreywacke
305-310	siliceous mica schist

Mine: **MOBILE** hole: 3 bearing: N65W angle: 60
date drilled: 1930 depth: 350′

depth (ft)	description
0-18	overburden
18-140	siliceous chlorite muscovite schist
140-145	chlorite schist with trace sulfides
145-180	siliceous muscovite schist ± chlorite
180-200	chlorite muscovite schist with trace sulfides
200-225	siliceous muscovite schist

CORE LOG DESCRIPTION (Cont'd.)

225-240	metagreywacke
240-350	siliceous muscovite schist and metagreywacke

Mine:	**MOBILE**	hole:	4	bearing:	N33W	angle:	60
date drilled:	1930	depth:	350'	150'			37
				250'			28
				350'			25

depth (ft)	description
0-33	overburden
33-80	muscovite mica schist
80-155	siliceous mica schist
155-158	chlorite muscovite schist with disseminated sulfides
158-174	siliceous mica schist
174-220	siliceous mica schist, chlorite schist

	Cu	Zn
174-179'	.85	0
210-220'	.26	0

220-240	siliceous mica schist
240-248	quartz with chlorite
248-350	siliceous mica schist and metagreywacke

Mine:	**MOBILE**	hole:	5	bearing:	N31W	angle:	80
date drilled:	1930	depth:	500'	100'			69
				200'			47
				289'			36

depth (ft)	description
0-32	overburden
32-40	siliceous chlorite muscovite schist
40-60	siliceous mica schist
60-100	metagreywacke
100-152	siliceous mica schist
152-174	siliceous chlorite muscovite schist
174-250	siliceous mica schist
250-373	siliceous mica schist, chlorite schist 370-373' Cu 2.78, Zn 3.27; quartz, muscovite, chlorite, chalcopyrite, sphalerite, pyrite, pyrrhotite
373-500	siliceous mica schist / metagreywacke

Mine:	**MOBILE**	hole:	6	bearing:	vertical	angle:	90
date drilled:	June, 1970	depth:	894'	87'	S66W		86
				234'	N81W		82

545'	N67W	59
870'	N58W	41

depth (ft)	description
0-65	overburden
65-94	metagreywacke and mica schist
94-646	biotite sericite chlorite quartz schist ± garnet and leucocratic metagreywacke 526', 550', and 566' trace sulfides
646-670	metagreywacke and mica schist
670-673	quartz vein
673-685	metagreywacke and mica schist 673-674' Cu 1.89, Zn .13, Au trace, Ag trace
685-865	metagreywacke with minor schist zones 729-730' Cu 2.42, Zn .10, Au trace, Ag trace, chalcopyrite, sphalerite, pyrite, pyrrhotite
865-894	quartz feldspar porphyry

Mine: **MOBILE** hole: 7

date drilled: July and August, 1970 depth: 1616'

bearing:		angle:
	N40W	88
135'	N03W	88
289'	N13W	88
414'	N52W	87
613'	N56W	79
825'	N61W	64
1150'	N66W	51
1580'	N62W	35

depth (ft)	description
0-705	metagreywacke and muscovite schist ± chlorite, staurolite at 198' 103-104' Cu 8.8, Zn .61, Au .02
705-1290	siliceous feldspathic metagreywacke and schist - QFP?
1290-1616	metagreywacke with mica schist layers

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