MINERAL RESOURCE POTENTIAL OF THE GEE CREEK WILDERNESS, POLK AND MONROE COUNTIES, TENNESSEE

by

Jack B. Epstein[1], Gertrude C. Gazdik[2], and Paul T. Behum[2]

STUDIES RELATED TO WILDERNESS

Under the provisions of the Wilderness Act (Public Law 88-577, September 3, 1964) and the Joint Conference Report on Senate Bill 4, 88th Congress, the U.S. Geological Survey and the U.S. Bureau of Mines have been conducting mineral surveys of wilderness and primative areas. Areas officially designated as "wilderness," "wild," or "canoe" when the act was passed were incorporated into the National Wilderness Preservation System, and some of them are presently being studied. The act provided that areas under consideration for wilderness designation should be studied for suitability for incorporation into the Wilderness System. The mineral surveys constitute one aspect of the suitability studies. The act directs that the results of such surveys are to be made available to the public and be submitted to the President and the Congress. This report discusses the results of a mineral survey of the Gee Creek Wilderness, Cherokee National Forest, Polk and Monroe Counties, Tennessee. Studies extended outside the Wilderness into McMinn County. The area was established as a wilderness by Public Law 93-622, January 3, 1975.

SUMMARY

The Gee Creek Wilderness comprises 2,493 acres (nearly 4 square miles) in the Cherokee National Forest, Polk and Monroe Counties, Tennessee, about 4 miles (6 km) southeast of Etowah, Tenn., and about 20 miles northeast of Cleveland, Tenn. All of the surface in the wilderness is in U.S. Government ownership; mineral rights on nearly half of the land remain in private ownership. The study area is in the Blue Ridge physiographic province.

The major rock types in the wilderness area consist of sandstone, shale, and conglomerate of the Chilhowee Group of Cambrian and Cambrian(?) age. Faulting appears to have controlled the location of minor subeconomic iron deposits, but no potential mineral resources were detected by the present survey. Shales, useful for brick or lightweight aggregate, and sandstone, useful for crushed stone or sand, have little economic interest because these rock types are common throughout the region and are found closer to potential markets. The possibility of natural gas occurring in untested rocks structurally beneath the Chilhowee strata cannot be discounted. No potential was found for any other mineral resource.

INTRODUCTION

The Gee Creek Wilderness is in the Cherokee National Forest, Polk and Monroe Counties, southeastern Tennessee (fig. 1). The wilderness lies about 4 mi (6 km) southeast of Etowah, and about 20 mi (32 km) northeast of Cleveland, Tenn. Gee Creek, which drains the wilderness, parallels Starr and Chestnut Mountains, and cuts through the deep gap at the southwest end of Starr Mountain where it flows to the Hiwassee River. The area is steep and rugged, especially in the southern portions. Altitudes reach a maximum of 2,570 ft (785 m) on the crest of the Chestnut Mountain. Relief is about 1,530 ft (465 m). Access to the wilderness area is given by a gravel road, Forest Service Route 297, leading west from State Route 14, about 5 mi (8 km) north of Reliance (fig. 1). This road joins the wilderness boundary at Iron Gap on Chestnut Mountain and continues north along this boundary. The southern part of the wilderness area can be reached by traveling south 2.3 mi (4 km) from Wetmore to a gravel road that terminates a few hundred yards from the wilderness boundary. Recent logging has left several haulage roads that serve as trails into the interior. From Iron Gap, one haulage road leads south along the crest of Chestnut Mountain; another leads west to the junction of Gee Creek and its western tributary, Popular Springs Branch. Most other logging roads are overgrown. Steep hillsides, rhododendron thickets, slash from recent logging, and dense regrowth combine to make hiking rigorous through much of the area. Fishermen's trails provide access to most of Gee Creek, except for a short stretch in the interior of the wilderness.

Past Investigations

Safford (1856) included the rocks of the Chilhowee Group in his "Formation III" in an early geologic map of Tennessee. Willis (1886) investigated the iron ores in the Gee Creek area in connection with his survey on the status of the mineral industry for the 10th U.S. Census. The geology of the wilderness was included in regional reports of Hayes (1895) and Rodgers (1953). In the 1940's, during the War Minerals project, the U.S. Bureau of Mines investigated two brown iron ore localities which are now within the wilderness, but no report was published. Phillips (1952) prepared a detailed map of the area, but his conclusions, as well as those of Hayes (1895) and Rodgers (1953), differ in some detail from the stratigraphic and structural interpretation presented in this report and companion maps. Stratigraphy of the Chilhowee Group near Parksville, Tenn., 12 miles (19km) south of the Gee Creek Wilderness was discussed by Milici (*in* Hatcher and others, 1978).

Present Investigations

U.S. Geological Survey investigations were conducted by Jack B. Epstein during three weeks in the fall of 1978 and spring of 1979. Ellen Compton assisted in the mapping in 1978. A total of 61 bulk stream-sediment samples, 26 rock samples, and 26 soil samples were collected and analyzed by semiquantitative spectrographic, atmoic absorption, and spectrofluoremetric methods for 34 elements, including the common metals having the greatest economic importance, in

[1]U.S. Geological Survey
[2]U.S. Bureau of Mines

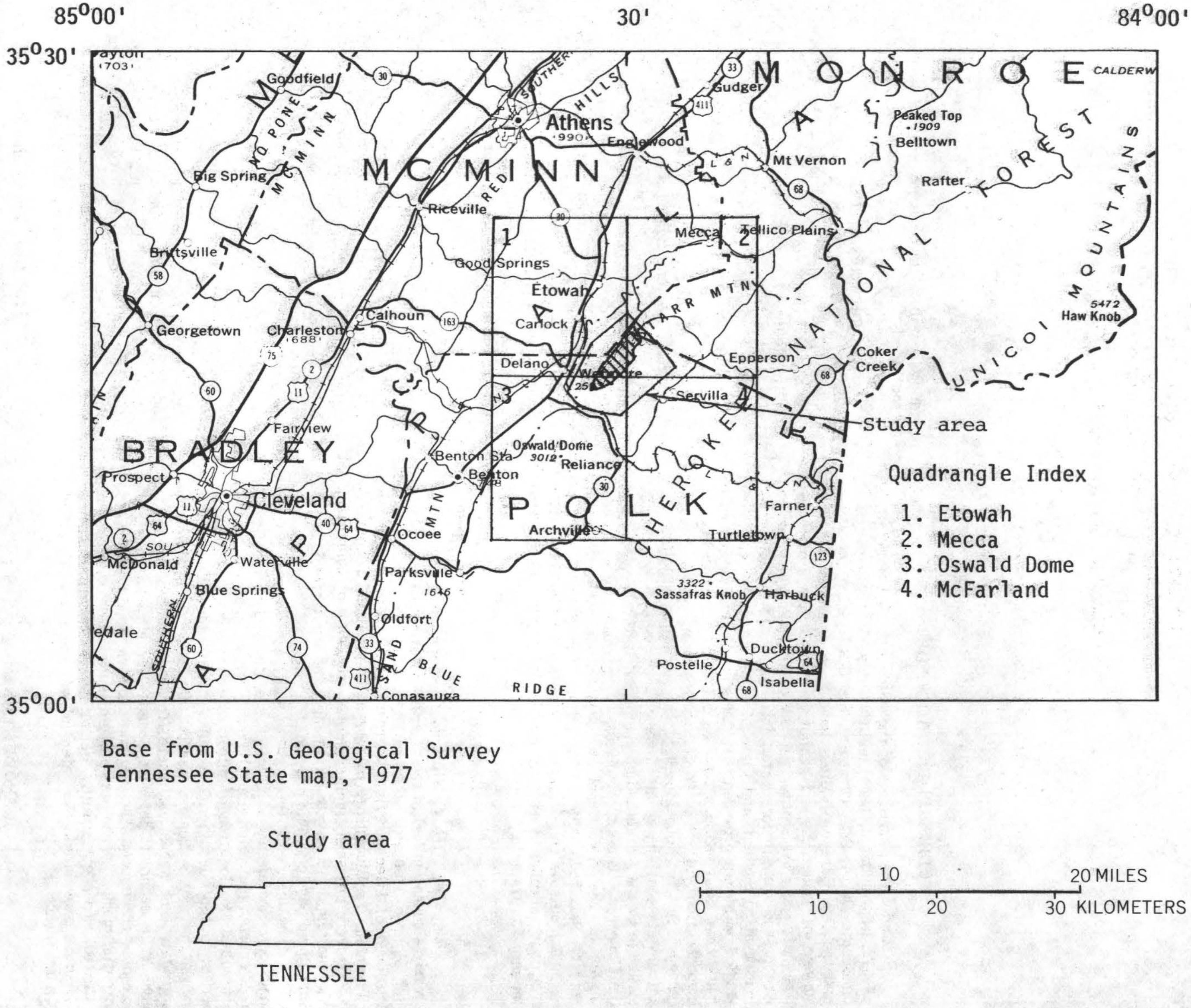

Figure 1.—Index map showing location of Gee Creek Wilderness (striped) and surrounding study area.

U.S. Geological Survey laboratories, Denver, Colo., and by contract with Specomp Services, Inc., Hayden, Colo., and Geoco, Inc., Wheat Ridge, Colo.

U.S. Bureau of Mines field investigations were conducted by Gertrude C. Gazdik and Paul T. Behum in the spring of 1978. Twenty-one samples of iron-rich rocks and sandstones were submitted to the Bureau's Reno Metallurgy Research Center, Reno, Nev., for semiquantitative spectrographic analyses for 40 elements. Additional testing by atomic absorption, neutron activation, and wet chemical techniques was performed for selected elements on some samples. Two shale samples were evaluated for ceramic properties and lightweight aggregate potential by the Bureau of Mines at the Tuscaloosa Metallurgy Research Center, Tuscaloosa, Ala. During the field investigation, exposures and abandoned prospects and mines in and near the wilderness were examined and sampled.

This report summarizes the results of the present investigation of the mineral resource potential of the Gee Creek Wilderness. In addition, details of the geology are discussed in Epstein (1983a), geochemical data are presented in Epstein (1983b), and information on iron mines and prospects and evaluation of nonmetallic deposits is given in Gazdik and Behum (1983).

Acknowledgements

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LAND AND MINERAL OWNERSHIP

In 1916, the U.S. Government purchased a large block of land from the Ocoee Timber Company for inclusion in the Cherokee National Forest. Mineral ownership and the right to mine these minerals were retained in perpetuity by the company on 1,920 acres (777 hectares) of the 1916-purchase land. Nearly half the encumbered land is included in the Gee Creek Wilderness (fig. 2). There are no other outstanding surface or mineral rights within wilderness area boundary.

GEOLOGY

The Gee Creek Wilderness lies at the westernmost limit of the Blue Ridge physiographic province. About 2,000 ft (600 m) of sandstone, siltstone, and shale of Cambrian(?), Cambrian, and Ordovician age are exposed in the wilderness (Epstein, 1983a). These comprise four formations of the Chilhowee Group, which are, from youngest to oldest, Hesse Sandstone and Murray Shale (Cambrian) and Nebo Sandstone and Nichols Shale (Cambrian?). In the immediate surrounding area a greater thickness of rock, including additional conglomerate and limestone, is exposed. These make up the underlying Cochran Conglomerate (Cambrian?) of the Chilhowee Group, the Sandsuck Shale of Proterozoic Z age, the overlying Knox Dolomite of Cambrian and Ordovician age, and Conasauga Shale of Cambrian age. Quaternary alluvium is found along many of the streams, and Quaternary landslide deposits are found along several of the steeper slopes.

The wilderness is in an open syncline that has been broken by the Gee Creek fault, a low-angle thrust with a displacement of at least 2,000 ft. (610 m). Subsidiary folds and faults are common. These rocks of the Blue Ridge province are thrust for many miles along the Great Smoky fault over the folded and faulted rocks of the Valley and Ridge province. Further stratigraphic and structural information on the geology of the Gee Creek Wilderness is given in Epstein (1983a).

GEOCHEMICAL SURVEY

The reconnaissance geochemical survey of the Gee Creek Wilderness included the collection of 26 rock, 26 soil, and 61 bulk stream-sediment samples (Epstein, 1983b). These were analyzed for 34 elements, among which are the more common metals that potentially could occur in economic concentrations.

The analytical results indicate that no well-defined anomalous areas are apparent in the Gee Creek Wilderness. The quantities of all elements in the analyses, including those for copper, lead, and zinc, for example, have a normal distribution (Epstein, 1983b, fig. 3), and do not exceed amounts present in average sedimentary rocks (Turekian and Wedepohl, 1961; Pettijohn, 1963). Many of the elements have slightly higher concentrations in the southwest part of the area (Epstein, 1983b, figs. 4, 5, and 6), and apparently are related to proximity to several faults (see fig. 3), a fact which also controls the location of small iron deposits (Gazdik and Behum, 1983).

ASSESSMENT OF MINERAL RESOURCE POTENTIAL

There are presently no known mineral resources of high economic potential in the Gee Creek Wilderness. Iron ore was formerly mined along Gee Creek, but has little current economic value. Figure 3 shows the location of these subeconomic resources. Shale, which shows suitability for brick or lightweight aggregate, and sandstone, which could be utilized for crushed stone or sand, are also found closer to potential markets, so they too have little economic value. Limestone was formerly quarried one mile (1.6 km) northwest of the wilderness but does not occur within its boundaries. The possibility of natural gas from carbonate rocks of the Valley and Ridge province below the Great Smoky fault underlying the wilderness cannot be discounted.

Iron

Deposits of iron oxides have been mined west of the wilderness boundary (fig. 3), and two prospects, Gee Creek and Wetmore, have been described within the wilderness. Other prospects and limonite occurrences are also common (Gazdik and Behum, 1983). The limonite occurs as hard, lumpy, vesicular boulderlike masses with an irregular red, yellow, and black mottling on fresh surfaces. It is surrounded by red and yellow clayey soil. Voids are filled with a loose yellow sandy material, or less commonly, manganese oxide. War Minerals studies by the Bureau of Mines during World War II indicated little development potential for either the Gee Creek or the Wetmore prospects. Primary detrimental factors cited were small size, inaccessibility, and high phosphorous content. Field studies conducted for the present investigation (Gazdik and Behum, 1983) corroborated these earlier findings. Analyses of random chip samples from the Gee Creek prospect, for example, indicate that the limonite, although high in iron, has a phosphorous content too high to be acceptable in the present iron market. The abundance of limonite float suggests that iron concentrations may be common along the Gee Creek and Iron Gap faults. The thickness and areal extent has not been determined for any of these deposits. If they are of greater size or extent than now presumed, they may have some value as a resource for the future.

Sandstone

Sandstones from the Hesse and Nebo Sandstones are well exposed and hold up prominant ridges in the wilderness area (fig. 3). Neutron activation analyses (Gazdik and Behum, 1983, table 2) and microscopic examinations (Epstein, 1983b, fig. 5) indicate that, except for a few scattered beds, the silica content is too low and impurities of iron, feldspar, and mica are too high to be acceptable for glass making. In addition, sandstones in the wilderness are generally too well cemented to crush to the uniformity of grain size required for glass sand. Only one sample (GC-6, table 2, Gazdik and Behum, 1983) represents an outcrop of equigranular, friable sandstone that, with beneficiation, might meet glass sand

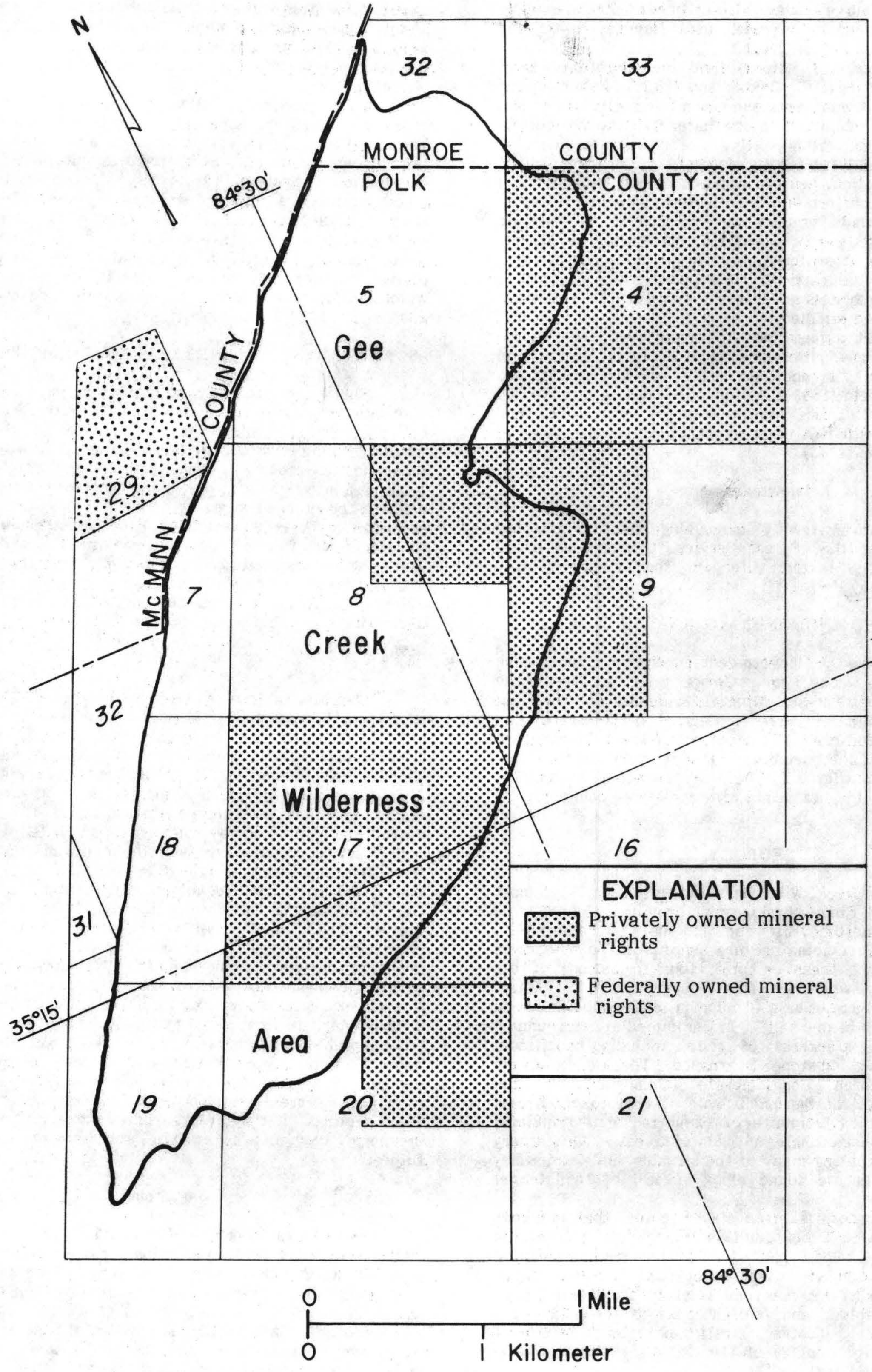

Figure 2.--Mineral rights in the Gee Creek Wilderness and vicinity. Surface rights owned by the U.S. Government. The part of lot 29 with stippling is not in USFS land.

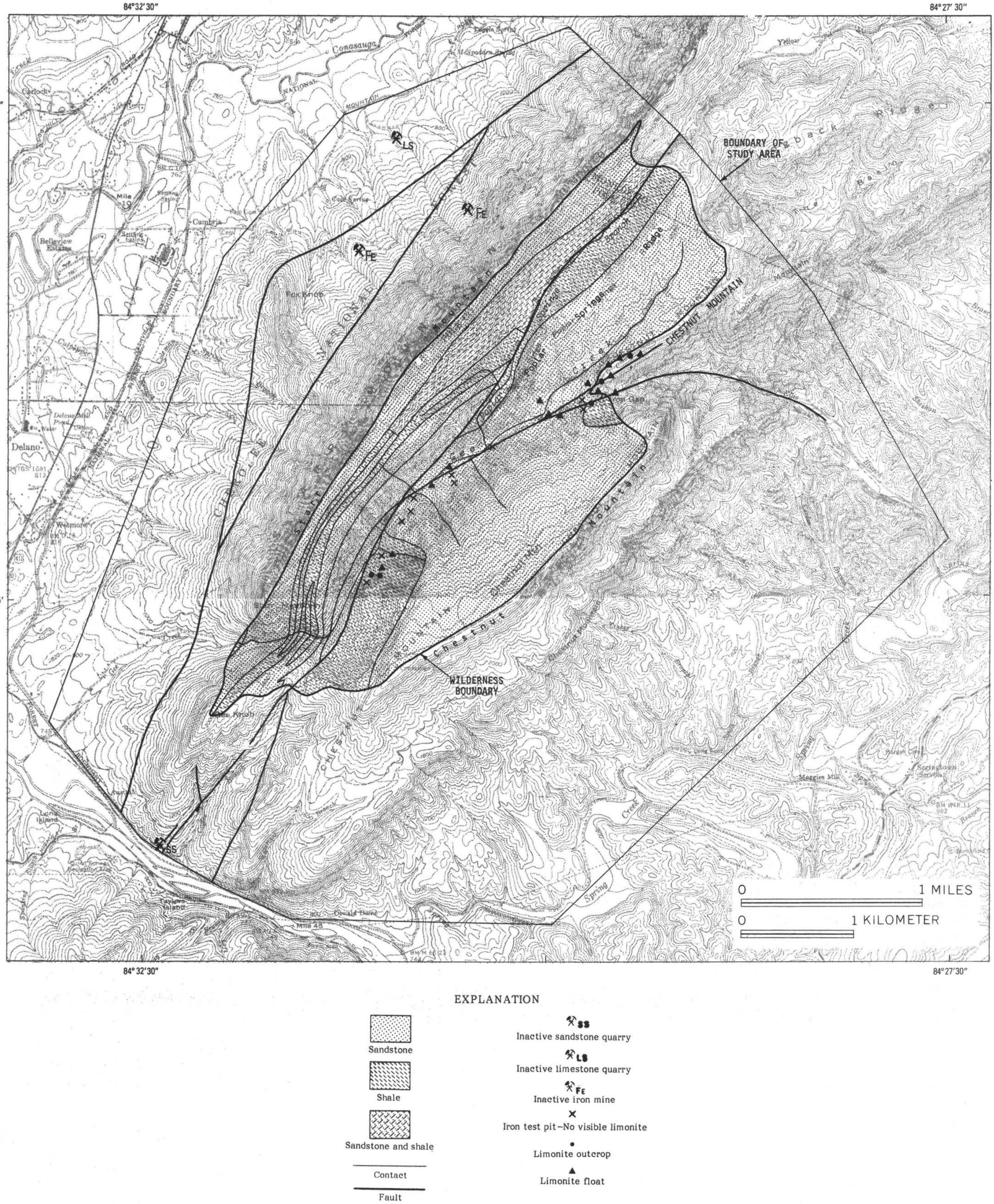

Figure 3.--Location of inactive iron mines and prospects, inactive sandstone and limestone quarries, and the distribution of sandstone and shale, as well as faults, in the Gee Creek Wilderness and surrounding area.

requirements. Quartzite was quarried many years ago from a locality along the Hiwassee River southeast of the Wilderness by the Tennessee Copper Company as fluxstone for use in their Ducktown smelters (Carter, 1968). This quarry is now abandoned. Much of the sandstone in the Gee Creek Wilderness could be crushed to produce sand, and the harder, better-cemented sandstones could be processed for road metal. However, these rock types are common near potential markets and there is no foreseeable reason to use those within the wilderness boundary.

Shale

Shales are common in the Gee Creek Wilderness (fig. 3) in the Nichols and Murray Shales. The ceramic properties and bloating characteristics were tested for two samples (GC-9 and GC-21, table 3, Gazdik and Behum, 1983). Both proved suitable for structural clay products. Sample GC-21 could be used for building or floor brick and fires satisfactorily for these at 1100°-1200°C.; sample GC-9 is suitable for building brick at kiln tempertatures of 1000°-1100°C. The latter sample bloated with good pore structure at 1200°-1250°C., and would be useful in lightweight aggregate. The shales in the wilderness have little development potential, however, because the same shales, presumably with similar ceramic characteristics, are found extensively outside the wilderness in areas closer to major markets.

ASSESSMENT OF OIL AND GAS POTENTIAL

Production of oil and gas depends in part on the degree of organic diagenesis reached in a rock. The level of this thermal maturity can be determined by the sequential change in color of conodonts, a microfossil made of apatite and some organic material (Epstein and others, 1977). Conodont alteration indices (CAI) in the Appalachian basin range from 1 to 5 and reflect changes in color from pale yellow, through brown, to black. A CAI of 2 appears to be the cutoff for oil production, whereas gas production occurs in rocks with a CAI up to about 4.

The rocks of the Chilhowee Group exposed in the Gee Creek Wilderness appear to have reached too high a level of thermal maturity to be candidates for oil and gas potential, because of the degree of regional deformation they have undergone. However, as shown in maps by Harris and others (1978), these rocks have been thrust along the Great Smoky fault over carbonate rocks of Cambrian and Ordovician age with a CAI range of 3-3.5. Gas has been produced from Ordovician carbonate rocks to the west in Tennessee (for example, Van Den Berg and others, 1978). Thus, while the limestones and dolomites underlying the Great Smoky fault beneath the Gee Creek Wilderness offer little potential for oil, it is possible that natural gas might be found in the Knox Dolomite and related rocks. Geophysical exploration would be necessary to determine the local structure at depth to properly evalute the potential for gas.

REFERENCES CITED

Carter, W. D., 1968, Silica, *in* Mineral Resources of the Appalachian Region: U.S. Geological Survey Professional Paper 580, p. 337-354.

Epstein, A. G., Epstein, J. B., and Harris, L. D., 1977, Conodont color alteration—an index to organic metamorphism: U.S. Geological Survey Professional Paper 995, 27 p.

Epstein, J. B., 1983a, Geologic map of the Gee Creek Wilderness, Polk and Monroe Counties, Tennessee: U.S. Geological Survey Miscellaneous Field Studies Map MF-1474-A in press .

Epstein, J. B., 1983b, Reconnaissance geochemical maps of the Gee Creek Wilderness, Polk and Monroe Counties, Tennessee: U.S. Geological Survey Miscellaneous Field Studies Map MF-1474-B, in press .

Gazdik, G. C., and Behum, P. T., 1983, Maps showing mines, quarries, prospects, and analyses of samples, Gee Creek Wilderness, Polk and Monroe Counties, Tennessee: U.S. Geological Survey Miscellaneous Field Studies Map MF-1474-C in press .

Harris, A. G., Harris, L. D., and Epstein, J. B., 1978, Oil and gas data from Paleozoic rocks in the Appalachian Basin; maps for assessing hydrocarbon potential and thermal maturity (conodont color alteration isograds and overburden isopachs): U.S. Geological Survey Miscellaneous Geologic Investigations Map I-917-E, 4 sheets, scale 1:2,500,000.

Hatcher, R. D., Jr., Merschat, C. E., Milici, R. C., and Wiener, L. S., 1978, A structural transect *in* the southern Appalachians, Tennessee and North Carolina, in Field trips in the southern Appalachians: Tennessee Division of Geology, Report of Investigation 37, p. 5-52.

Hayes, C. W., 1895, Description of the Cleveland sheet, Tennessee: U.S. Geological Survey Geologic Atlas, Folio 20, 11 p.

Pettijohn, F. J., 1963, Chemical composition of sandstones-Excluding carbonate and volcanic sands, Chapter S, in Fleischer, Michael, ed., Data of geochemistry: U.S. Geological Survey Professional Paper 440-S, p. S1-S21.

Phillips, H. E., 1952, The geology of the Starr Mountain area, southeast Tennessee: University of Tennessee, Knoxville, Tennessee, Master of Science thesis, 61 p.

Rodgers, John, 1953, Geologic map of east Tennessee with explanatory text: State of Tennessee, Division of Geology, Bulletin 56, pt II, 168 p.

Safford, J. M., 1856, A geological reconnaissance of the State of Tennessee: Tennessee Geological Survey, 1st Biennial Report, 164 p.

Turekian, K. K., and Wedepohl, K. H., 1961, Distribution of the elements in some major units of the Earth's crust: Geological Society of America Bulletin, v. 72, p. 175-191.

Van Den Berg, Jacob, Carpenter, G. L., Nosow, Edmund, and Statler, Anthony, 1978, Developments in East-Central states in 1977: American Association of Petroleum Geologists, Bulletin, v. 62, p. 1340-1354.

Willis, Bailey, 1886, Notes on the samples of iron ore collected in east Tennessee, *in* Report on the mining industries of the United States: U.S. 10th census, 1880, v. 15, p. 332.