FIELD TRIP NO. 1 East Tennessee Marble District

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The field trip into the marble district will traverse parts of two major physiographic and geologic provinces of the Appalachian region. The trip will go from the Blue Ridge province at Gatlinburg northwest into the Valley and Ridge province at Knoxville.

Gatlinburg is 1292 feet above sea level; the Tennessee River (Fort Loudoun reservoir) at Knoxville is 813 feet; and downtown Knoxville is at an average of 900 feet above sea level. To the south and east of Gatlinburg the crest of the Blue Ridge attains elevations over 6000 feet. The highest ridge crests near Knoxville are approximately 1200 feet.

The highway distance from the National Park Service Headquarters to Knoxville is 40 miles via U. S. Hwy. 441.

Blue Ridge Province

The formations of the portion of the Blue Ridge province traversed on this trip are composed chiefly of metasedimentary rocks of the Ocoee Series.

The Ocoee Series is a thick sequence of clastic rocks that rests unconformably on an older complex of crystalline rocks in the eastern Great Smokies. The Precambrian Ocoee Series is overlain by the Lower Cambrian Chilhowee Series, conformably or with slight disconformity; however in nearby

areas of exposure the Chilhowee-Ocoee contact is commonly tectonic.

The Ocoee Series consists of a thick sequence of terrigenous clastic sedimentary rocks with minor intercalations of carbonates, and has yielded no fossils. Many of the rocks are coarse grained, poorly sorted, and form monotonous sequences without key beds. In much of the area the top and base of the Ocoee are not visible (King, 1964, p. 15).

King and others (1958) have divided the Ocoee into three major groups containing twleve named formations. However, no single area has a complete sequence. For convenience, the Series may be viewed as containing a topographically lower "Foothills sequence," and a "Mountain sequence" that underlies the higher land forms. In general, the "Foothills sequence" is finer grained and less resistant to erosion than the coarser-grained, tougher "Mountain sequence." These two sequences are invariably in fault contact and their interrelationship is obscure. King believes the "Mountain rocks" are older than the "Foothill" beds. The alternative to this view is that the two sequences are facies equivalents (King, 1964).

The metamorphic grade of the Ocoee sedimentary rocks increases southward across the Smoky Mountains. The biotite isograd passes near Gatlinburg, and from there northward the metamorphic effects are diminished (Hadley and Goldsmith, 1963).

Rocks of the Chilhowee Series have been divided into six formations (King, 1964). The series consists of clastic rocks with quartzose sandstones and conglomerates separated by shale

and siltstone units. The sandstones and conglomerates underlie steep, even-crested ridges, the most westerly of which are prominent topographic highs along the eastern side of the Valley and Ridge (e.g. Chilhowee Mountain).

The Chilhowee rests on the Ocoee without obvious discordance. Its top is gradational into the first major carbonate unit in the Southern Appalachians, the Shady Dolomite. As King says, "The Chilhowee group . . . (was) clearly the initial deposit of a marine cycle of sedimentation which continued into later Cambrian time; they were the basal unit of the Paleozoic Appalachian miogeosyncline" (1964, p. 77).

The Chilhowee is essentially unmetamorphosed. Its younger beds contain the oldest identifiable fossils in the Southern Appalachians. Based on lithologic, stratigraphic and paleontologic evidence the base of the Chilhowee is commonly believed to be the base of the Cambrian in East Tennessee.

Valley and Ridge Province

The Valley and Ridge-Blue Ridge boundary is virtually everywhere a fault surface on which Blue Ridge rocks have been thrust over the younger Valley formations. The trace of this boundary is crossed by U. S. Hwy. 441 approximately two miles northwest of Pigeon Forge.

The Valley and Ridge province in East Tennessee is underlain by sedimentary rocks, generally of Early Paleozoic age. In only a few places units of the Mississippian and Pennsylvanian Systems are preserved in synclines, and over 95 percent of the exposed rocks are either Cambrian or Ordovician in age.

The Valley and Ridge rocks are, in contrast to the Ocoee Series, unmetamorphosed, contain major units of carbonates, and are generally fossiliferous. The sequence is folded and broken by overthrust faults to form strike belts that repeat stratigraphic sequences. Most geologists familiar with the area believe these faults are stratigraphically or lithologically controlled low-angle faults that do not extend into subjacent basement crystallines.

The overthrusts were imposed upon a body of rocks deposited in shallow marine environments and are approximately parallel to the geosynclinal axis. Therefore, although notable facies variations occur both along and normal to the northeast trending regional strike, the predominant changes are from southeast to northwest across regional strike. The resulting complexity is especially noteworthy in the rocks of Middle Ordovician age. As a consequence, this sequence contains no less than forty "formations" named from East Tennessee type localities by various geologists, not to mention names employed in East Tennessee but derived elsewhere. The stone quarried and sold as marble occurs in this stratigraphically complex sequence. See Figure 1.

The Marble Deposits

The Tennessee marble is an unmetamorphosed but recrystallized, coarsely grained, high calcium limestone. Commonly the rock is abundantly fossiliferous with echinoderms, bryozoans, and brachiopods predominating. The deposits occur throughout the Middle Ordovician in various stratigraphic positions in

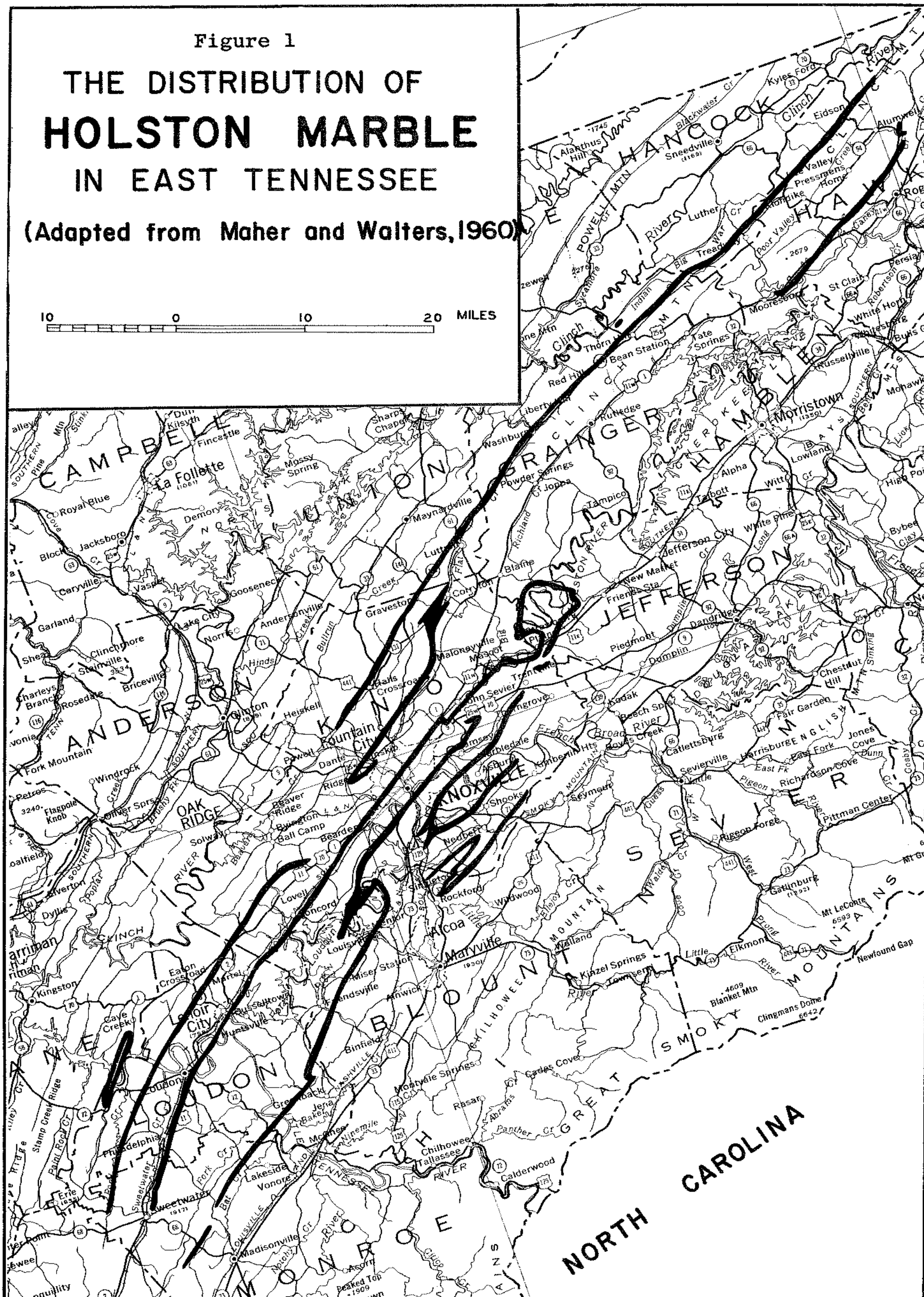

Figure 1
THE DISTRIBUTION OF
HOLSTON MARBLE
IN EAST TENNESSEE
(Adapted from Maher and Walters, 1960)

association with argillaceous limestones, calcareous shales, and calcareous quartzose sandstones, and are undoubtedly facies variations of no specific stratigraphic age. The relation of the marble deposits to adjacent rocks, their textures, and geometry clearly establish them as reef and associated reef detritus assemblages. Figure 2 outlines the known areas of potential economic importance of the marble.

The appearance of the stone is diverse, even in a single quarry, owing to its mode of formation. This feature is a problem to the quarry operator in producing a large volume of matching stone. Other operating problems arise from the structural deformation of the stone, solution effects, and incipient fractures or shale partings in the stone.

Because the stone is to be used for dimension purposes no explosives are employed in quarrying. The "mill blocks" (rectilinear masses averaging 7 x 4 x 6 feet) are freed by drilling and wedging. Owing to defects in the stone, termed "unsoundness" by the operators, quarrying losses are high.

The fabrication consists of sawing the mill block into slabs on multibladed gang saws, further shaping on coping saws, and a series of polishing steps. High losses are sustained in these operations, too. Despite the relatively high costs of production and fabrication Tennessee marble continues to be widely used. This popularity arises from several desirable properties it possesses relative to other available marbles. Foremost among these properties is the impenetrability to liquids of the finished stone. Laboratory tests of absorption

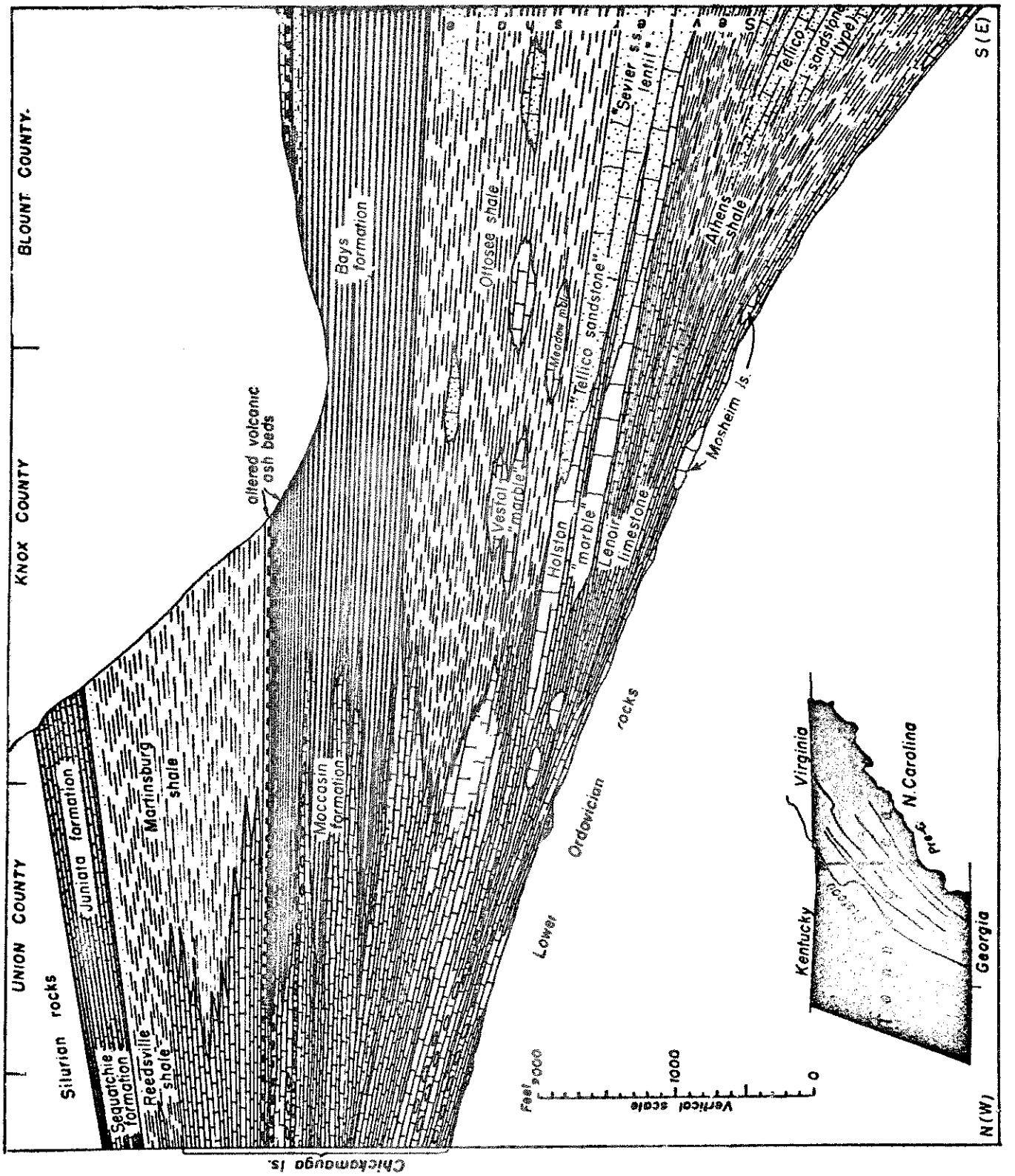

Fig. 2 Facies relationships among middle Ordovician formations in central East Tennessee (modified from Rodgers, 1953, fig. 4)

show values of 0.035 to 0.091 percent for Tennessee marble whereas Italian marbles average 0.47 percent. Low absorption means preservation of appearance in use, and ease of maintaining an aseptic sterile surface in sanitary installations. Equally important is the stone's high durability to wear and weather. Still another attractive property is its high crushing strength. Measurements by the Bureau of Standards resulted in crushing strengths ranging from 14,900 to 18,200 pounds per square inch.

It appears that these physical properties result from the random orientation and size of the component calcite crystals and fossil materials. A stone possessing this fabric is unusually impermeable and resists wear or compression uniformly. The durability is further enhanced by mineralogic homogeneity.

Participants on the marble trip will visit an area of quarrying six miles east of Knoxville known as the Forks of the River district. The geology of this district is shown on the U. S. Geological Survey's GQ-76 (Cattermole, 1955). The district's name derives from its location near the confluence of the Holston and French Broad Rivers to form the Tennessee River.

This district was developed on a substantial basis in 1872, and now contains nine openings, idle and active. The marble in the district is on the northwestern limb of an anticline with dips ranging from less than 5 degrees to over 30 degrees. Along strike to the northeast of the quarry the marble is thickened by a small fault. The marble is overlain by a calcareous quartzose sandstone, the Chapman Ridge Sandstone (Cattermole, 1955) or "Tellico" of older reports. The footwall is the Lenoir Limestone.

Stone quarried here is transported to fabricating and finishing mills in Knoxville by rail or truck, and some mill block is shipped to fabricators in other states. A large lime plant in the district is fed in part by scrap produced by the marble industry.

A tour of the nearby mill of the Tennessee Marble Company Division of Georgia Marble Company will show the procedures used in fabricating the product of the quarries.

References

Marble

Gordon, C. M., 1924, Marble Deposits of East Tennessee: Tennessee Div. Geology Bull. 28, 161 p.

Maher, Stuart W., and Walters, J. P., 1960, The Marble Industry of Tennessee: Tennessee Div. Geology Info. Cir. 9, 25 p.

Geology

Cattermole, J. M., 1955, Geology of the Shooks Gap quadrangle, Tennsseee: GQ-76, U. S. Geological Survey.

Hadley, J. B., and Goldsmith, R., Geology of the eastern Great Smoky Mountains, Tennessee and North Carolina: U. S. Geological Survey Prof. Paper 349-B, 118 p.

King, P. B., and others, 1958, Stratigraphy of Ocoee Series, Great Smoky Mountains, Tennessee and North Carolina: Bull. Geol. Soc. America, v. 69, p. 947-966.

_____, 1964, Geology of the central Great Smoky Mountains, Tennessee and North Carolina: U. S. Geological Survey Prof. Paper 349-C, 148 p.

Rodgers, John, 1953, Geologic Map of East Tennessee: Tennessee Div. Geology Bull. 58, Part II, 168 p.

Wilson, C. W., Jr., 1958, Guidebook to Geology along Tennessee highways: Tennessee Div. Geology Rept. Invs. 5, 115 p.