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PROVENANCE OF EOCENE SEDIMENTS IN NORTHWESTERN TENNESSEE

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ABSTRACT

Heavy minerals of the Wilcox-Claiborne (Eocene) sediments in northwestern Tennessee were studied to determine their provenance. Samples from 52 sites were examined. Identification of approximately 300 grains of each sample indicates a heavy mineral suite consisting of ilmenite, leucoxene, zircon, kyanite, tourmaline, staurolite and rutile. These minerals were derived from uplifted igneous and metamorphic rocks of the southern Appalachian Mountains, nearby Paleozoic sedimentary rocks and Cretaceous and Paleocene coastal plain formations, all of which were weathered and eroded in a subtropical climate.

INTRODUCTION

The heavy minerals of the Wilcox-Claiborne (Eocene) sediments in northwestern Tennessee were studied to determine their provenance. Fifty-two samples were collected in adjacent parts of Henry, Weakley and Carroll counties, encompassing an area of approximately 900 square miles (Fig. 1). The samples cover the area geographically from east to west and stratigraphically from the lowest to the highest strata (Clark, 1973, Fig. 12 and Table 11).

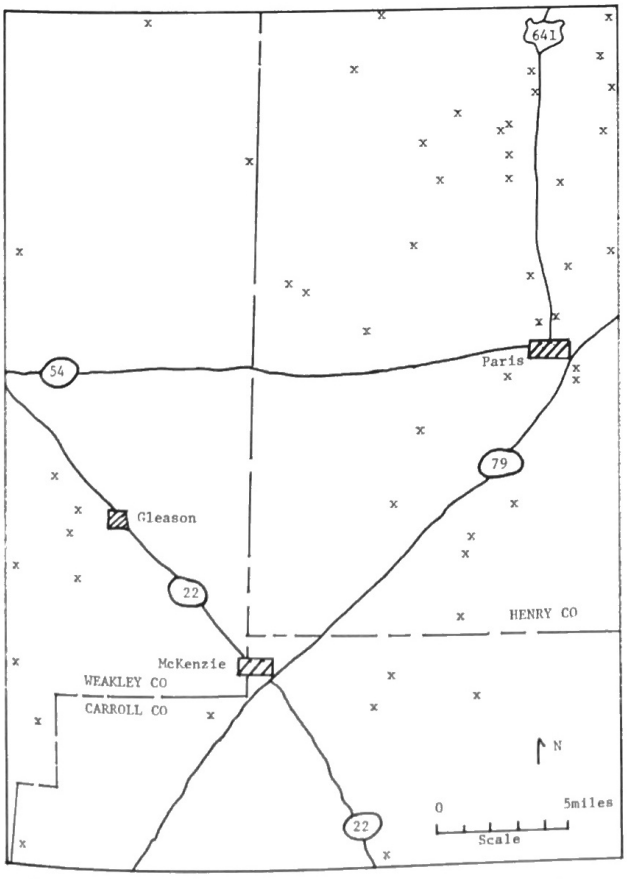

FIG. 1: *Location map of Wilcox-Claiborne heavy mineral sample sites.*

PROCEDURES

Heavy minerals in the 1.5-4.0 phi size classes were separated from the light fraction using bromoform, following the procedures outlined in Krumbein and Pettijohn (1938, p. 343). The heavy mineral grains were then mounted on slides in Canada balsam. At random locations on each slide representative of each sample site, all grains in the field of view were counted and identified using the petrographic microscope. The location of each field of view was determined using a mechanical stage and was recorded in order to prevent overlap when a new location was selected. Enough fields of view were used to obtain a count of approximately 300 grains on each slide.

MINERALS IDENTIFIED

Heavy minerals identified include ilmenite, leucoxene, zircon, tourmaline, kyanite, staurolite and rutile. Their relative abundances are summarized in Table 1 and given by sample site (Clark, 1973, Table 13). Opaque grains constitute 61.6 percent of the heavy mineral suite and nonopaque grains 38.4 percent. Though a few long, fibrous grain fragments on several of the slides appeared to be sillimanite, its presence was not confirmed. X-ray powder diffraction was used to confirm the identification of ilmenite, leucoxene and zircon. Heavy mineral separations were tested with a strong magnet for magnetite before mounting, but none was found.

TABLE 1: *Summary of heavy mineral analysis of the Wilcox-Claiborne sediments.*

Mineral	Range (Percent)	Average Value (Percent)	Standard Deviation	95 Percent Confidence
Ilmenite	13-66	41.9	14.2	4.0
Leucoxene	2-53	19.7	13.1	3.6
Zircon	4-40	20.1	7.8	2.2
Kyanite	1-26	8.7	4.6	1.3
Tourmaline	1-9	4.9	1.9	0.5
Staurolite	1-7	2.9	1.6	0.4
Rutile	1-4	1.8	0.8	0.2

PROVENANCE

Source Rock Compositions. A variety of source rock types is indicated by the heavy minerals of the Wilcox-Claiborne sediments: high-rank metamorphic rocks, acidic igneous rocks, pegmatites and sedimentary rocks. The presence of kyanite and staurolite indicates that high-rank metamorphic rocks were exposed to

erosion in the source area. The igneous complex in the source area probably included acid plutonic exposures which supplied angular grains of zircon, tourmaline and rutile. Angular grains of tourmaline also suggest pegmatites as a possible source. Rounded grains of zircon, tourmaline and rutile indicate that clastic terrigenous rocks were a part of the source area lithology.

Source Area Location. The possible major source areas for supplying detritus to the study area during the Eocene are: Precambrian rocks centered around the Lake Superior region of the Canadian Shield, the Ouachita Mountains of eastern Oklahoma and western Arkansas, the northern Appalachian Mountains, and the southern Appalachian Mountains. Each of these possible source areas has a distinctive lithology and contributes a characteristic mineralogy to its drainage system.

Precambrian rocks in the Lake Superior region consist chiefly of Keweenawan arkoses and interbedded extrusives. The heavy minerals carried from this area by the Mississippi River comprise Goldstein's Mississippi River province suite (1942, p. 81). The most characteristic minerals of this suite are amphiboles, pyroxenes, epidote, and dolomite. Since none of these minerals is found in the Wilcox-Claiborne suite, it is unlikely that the Lake Superior region is the source area of the sediments.

The Ouachita Mountains of eastern Oklahoma and western Arkansas are composed of regionally metamorphosed Paleozoic rocks of Cambrian through Pennsylvanian ages. Metamorphism is confined almost entirely to the chlorite-biotite grade (Goldstein & Reno, 1952). Streams eroding the Stanley and Jackfork Groups, the most widely exposed strata in the mountains, contain heavy mineral assemblages dominated by garnet, zircon, and magnetite (Bokman, 1953). The absence of garnet and magnetite from Wilcox-Claiborne heavy mineral assemblages eliminates the Ouachita Mountains as a possible source area. Also, any eastward-flowing streams eroding them would never have reached the study area but would have flowed instead into a stream of major size occupying the same general location as the present-day Mississippi River, referred to by Mann and Thomas (1968, p. 187) as the Ancient Mississippi River.

The northern Appalachian Mountains supplied clastic sediments to the western Tennessee area only during Mississippian and Pennsylvanian times (Potter & Pryor, 1961, p. 1226). Zircon and tourmaline are the principal heavy minerals in the rocks which formed from these sediments. Later, erosion of these rocks contributed some detrital material to the sediments in the study area. The northern Appalachian Mountains cannot be considered the major source area of the Wilcox-Claiborne sediments.

The Wilcox-Claiborne heavy mineral suite is similar to suites studied in southwestern Tennessee (Blankenship, 1956), Mississippi (Grim, 1936) and the East Gulf province (Goldstein, 1942). The source area in these studies is the southern Appalachian Mountains. The southern Appalachians are favored as the major source area for the Wilcox-Claiborne sediments. During Eocene time, some sediments came directly from the southern Appalachians; some came from nearby coastal plain sediments which had been derived, in turn, from the southern Appalachians during Cretaceous and Paleocene times. Thus, the southern Appalachians are the ultimate source for most of the Wilcox-Claiborne sediments. The northern Appalachians are considered a minor source, along with nearby Cretaceous and Paleocene coastal plain formations.

Source Area Relief and Climate. The ultimate source area which supplied detritus to the study area was characterized by active deformation, moderate relief, and humid climate (Berry, 1930). Uplift was epeirogenic and the area rose largely as a stable mass that did not undergo any significant deformation. The volume of sediments shed by the southern Appalachian Mountains spread as a large sheet over the Gulf Coastal Plain extending from Georgia to Texas (Todd & Folk, 1957, p. 2592). Moderate relief of the ultimate source area is suggested by the thickness of the Eocene sediments in western Tennessee which total approximately 2000 feet (Moore, 1965, p. 8). Uplift apparently had begun by Eocene time, for detritus produced by uplift was entering the study area during Wilcox time. The uplift probably reached its culmination by Claiborne time. The fact that kyanite-staurolite suites continue essentially undiminished throughout the Wilcox-Claiborne sediments testifies to continued downcutting by streams resulting from epeirogenic uplift in the ultimate source area.

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