

## GEOLOGY OF THE PEBBLES QUADRANGLE, ADAMS COUNTY, OHIO<sup>1</sup>

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**ABSTRACT.** The rock sequence exposed in the Peebles quadrangle, Adams Co., Ohio, consists of over 240 m of Ordovician through Mississippian age rocks. These carbonate rocks, shales, and sandstones have been subdivided into 13 formations. Units which have been recently recognized in this area include the Bull Fork Formation (Upper Ordovician), the Preachersville Member of the Drakes Formation (Upper Ordovician), the Drowning Creek Formation (Silurian), and the Three Lick Tongue of the Chagrin Member of the Ohio Shale (Upper Devonian). These strata generally dip 6–8 m per km to the east, but the dip increases to 10–11 m per km in the southeast portion of the quadrangle. The increase in dip is due to the Adams Co. monocline. The monocline is thought to be the result of draping of Paleozoic rocks over a possible basement fault.

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### INTRODUCTION

A thorough understanding and documentation of an area's geology is of prime importance to the explorationist and geologist. The data can be effectively used in planning for recreational facilities, waste disposal dumps, and industrial complexes. Furthermore, these data are critical in detecting water and mineral resources, as well as engineering hazards. The combination of a thorough literature search and a detailed field mapping program provides this information most accurately.

Published information concerning the bedrock geology of Adams Co., Ohio, is surprisingly meager considering that the county has abundant bedrock exposures and only minor glacial cover. Rocks within this area are of diverse ages, lithologic types, and have significant regional and local structural trends. The Peebles quadrangle located in northeast Adams Co. (fig. 1) has all of these characteristics which allow for an exceptionally productive study of the area's geology. Documenting the geologic setting within the

Peebles quadrangle will contribute to a better understanding of Adams Co. geology.

Existing published bedrock investigations on Adams Co. are limited to portions of the stratigraphic section, with only a few exceptions. John Locke studied Adams Co. geology and produced the first county geologic map in the state of Ohio in 1838. More recent mapping projects within Adams Co. include the geologic maps of the Maysville East quadrangle (Weiss et al. 1972) and the Serpent Mound cryptoexplosion structure (Bucher 1936, Reidel 1975). Unpublished geologic maps include the Peebles quadrangle (Swinford 1983) and the northwestern portion of Adams Co. (Kaufmann 1964). Other studies which address a substantial portion of the stratigraphic section of the area include Bowman's (1956) study of the Niagaran rocks of Highland County, Rexroad et al. (1965) study of the Silurian of southern Ohio and northern Kentucky, and Kallio's (1976) study of the Silurian along Ohio Brush Creek in Adams Co. The soil survey of Adams Co. (Taylor 1938) provides additional information on the presence of bedrock and its effect on soil and topography.

### METHODS AND MATERIALS

Traditional techniques and instruments were utilized in gathering data on the rocks of the Peebles

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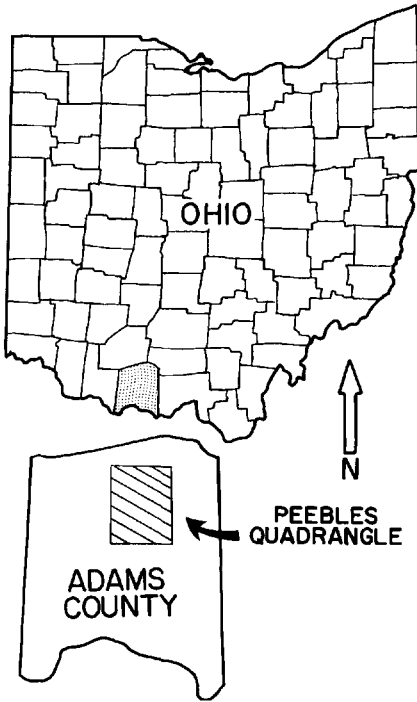


FIGURE 1. Location of the Peebles quadrangle, Adams Co., Ohio.

quadrangle. Instruments used in the field were a Paulin Terra altimeter, hand level, Brunton compass, and base maps of the Peebles and surrounding quadrangles. The elevation of 714 data points was documented with an altimeter. Numerous stratigraphic sections within the Peebles quadrangle were measured with a hand level or rule. Unusually thick sections (particularly in homogenous shales) were also measured with an altimeter to confirm hand level estimations. Elevation of data points and formation thicknesses of measured sections were used to produce structure contour and isopach maps at a 1:24,000 scale. Aerial photographs were also used to delineate terrace and alluvial deposits along streams. A geologic map was constructed from this data and is on file at the Ohio Department of Natural Resources, Division of Geological Survey.

### DISCUSSION

Two physiographic regions occur within the Peebles quadrangle, the Appalachian Plateau and the Interior Low Plateau. The Appalachian Plateau region occurs in the southeast edge of the quadrangle. This topography consists of high narrow ridges with steep-walled valleys having an average relief of 61–122 m. The remainder

and majority of the Peebles quadrangle consists of the Interior Low Plateau region. This topography contains low rolling hills with some moderately steep-walled valleys which have 30–61 m of relief. The abrupt change of the rugged topography of the Appalachian Plateau to the landforms of the Interior Low Plateau creates a boundary called the Appalachian Escarpment. The escarpment is present in the southeast portion of the Peebles quadrangle as a north-east-trending lineament.

Ohio Brush Creek and Scioto Brush Creek are the main drainage basins within the Peebles quadrangle. Ohio Brush Creek, centrally located within the quadrangle, flows southward toward the Ohio River. Ohio Brush Creek and tributaries of this stream are responsible for a majority of the topographic dissection of the study area. Creeks flowing eastward in the southeastern portion of the quadrangle drain into Scioto Brush Creek which lies 10 km east of the study area.

**STRATIGRAPHY.** The entire rock stratigraphic section within the Peebles quadrangle consists of more than 244 m of Ordovician, Silurian, Devonian and Mississippian age rocks. Thirteen separate formations and four unconformities were identified within the stratigraphic section (fig. 2). Rocks within the study area can be separated into general lithologic groups according to their age. Upper Ordovician and Lower Silurian rocks are dominantly thin-bedded limestones and shales. Middle and Upper Silurian rocks are thick, uninterrupted sequences of carbonates or clay shales. Devonian rocks are mainly dark, petroliferous shales with some greenish-gray shales. Lower Mississippian rocks are silty shales and sandstones. Each of the units will be described with other rock units of similar geologic age.

**ORDOVICIAN.** The oldest rocks exposed in the Peebles quadrangle are Upper Ordovician age carbonates and shales. Peck (1966), in conjunction with the Kentucky geologic mapping program, described and defined rocks of Richmondian age in the

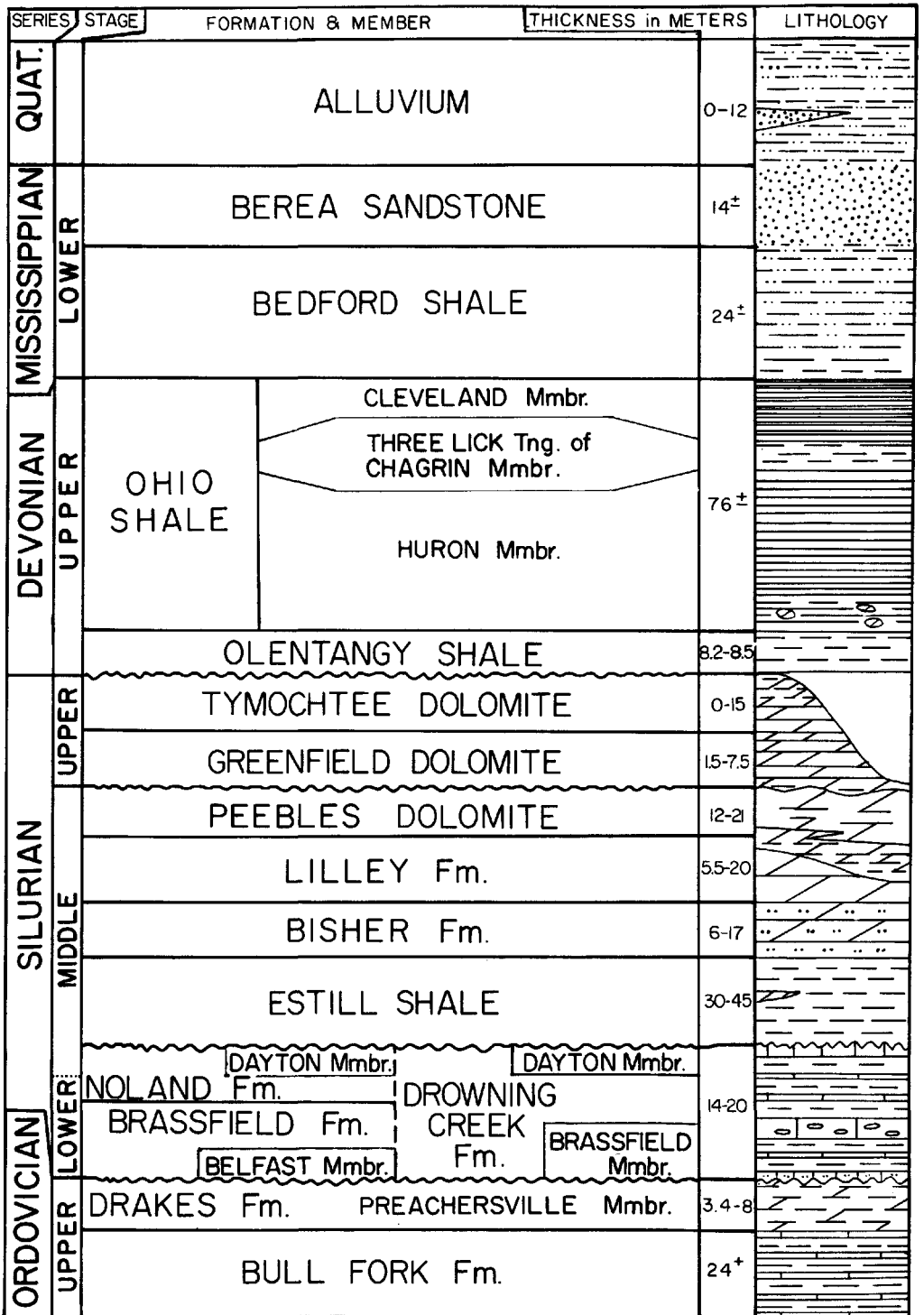


FIGURE 2. Generalized stratigraphic column of the rocks found within the Peebles quadrangle.

vicinity of Maysville, Kentucky. These units were mapped in the Ohio portion of the Maysville East quadrangle (Weiss et al. 1972) in Adams and Brown counties. The use of Peck's nomenclature is accepted within the Peebles quadrangle and includes the Bull Fork Formation and the overlying Preachersville Member of the Drakes Formation.

The Bull Fork Formation consists of very fossiliferous interbedded limestones and shales. The limestones are light to bluish gray, medium to coarse grained, in beds 9–30 cm thick and are dolomitic. A particularly good exposure reveals thin limestones grouped into continuous bands 30–39 cm thick separated by shale beds approximately 9 cm thick.

The Bull Fork is discontinuously exposed along Ohio Brush Creek and western tributaries of this stream. The best exposures of these rocks occur in the Little East Fork 0.4 km south of the intersection with State Route 32 where the uppermost 3.1 m are exposed (fig. 3, locality 1).

The lack of exposure of the lower contact of the Bull Fork Formation prohibits determination of its thickness within the study area. The upper contact of the Bull Fork with the overlying Preachersville Member of the Drakes Formation is conformable and gradational over a 0.3-m interval. The contact is placed at the top of the highest continuous fossiliferous limestone layer of the Bull Fork Formation (Peck 1966).

The Preachersville Member of the Drakes Formation, hereafter referred to as the Drakes Formation, consists chiefly of mudstone with thin discontinuous dolomite beds less than 6 cm thick. The mudstone is greenish gray to dusky red, calcareous to dolomitic, locally silty and fissile to platy. The dolomite beds are light gray, calcareous in places, sparsely fossiliferous and argillaceous. The upper 45 cm of the formation consist of thin beds (less than 3.0 cm thick) of interbedded limestone and shale. These limestones are medium gray, finely crystalline and dolomitic. The shales are light gray, fissile and slightly dolomitic.

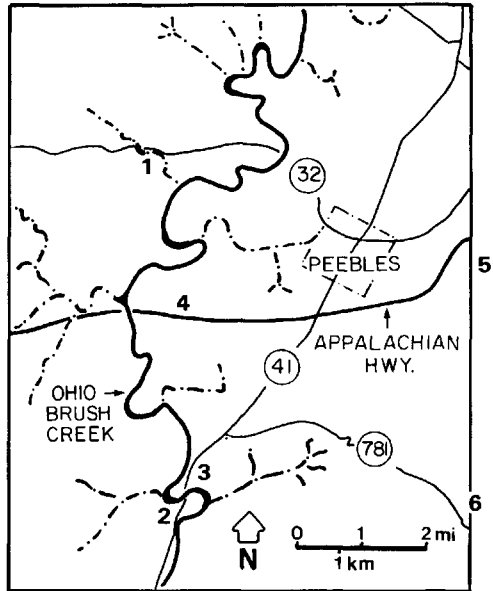


FIGURE 3. Location of best exposures for rocks found in the study area. Locality 1: Bull Fork Fm. (upper portion), Drakes Fm., and Drowning Creek Fm. (lower portion). Locality 2: Drakes Fm. (upper portion), and Drowning Creek Fm. Locality 3: Drowning Creek Fm. (Dayton Mmbr.), Estill Shale, Bisher Fm., and Lilley Fm. Locality 4: Estill Shale (upper portion), Bisher Fm., Lilley Fm., and Peebles Dolomite (transitional zone). Locality 5: Bisher Fm., Lilley Fm., Peebles Dolomite, Greenfield Dolomite, and Tymochtee Dolomite within Plum Run Quarry. Locality 6: Greenfield-Tymochtee Dolomites, Olen tangy Shale, Ohio Shale, Bedford Shale, and Berea Sandstone.

The Drakes Formation appears as discontinuous exposures along Ohio Brush Creek and tributaries of the stream much the same as the Bull Fork Formation. It can easily be recognized by the distinctive dusky-red color which appears in the overlying soil. The best total section within the study area is located within the Little East Fork just south of the intersection with State Route 32 where an estimated 7.6 m are exposed (fig. 3, locality 1).

The Drakes Formation ranges from 3.4 to 8.2 m in thickness within the study area. The uppermost 46 cm of the Drakes Formation grade into a resistant argillaceous limestone of the Silurian Brassfield Formation. This upper contact is thought

to be unconformable, however the author did not encounter any evidence of erosion along the Drakes-Brassfield contact. This contact is unconformable at an exposure 3.4 km northwest of West Union, Ohio (Grahn and Bergstrom 1985) which suggests it is also unconformable in the study area. Therefore, despite the lack of physical evidence, the Drakes-Brassfield contact in the Peebles quadrangle will be considered unconformable.

**SILURIAN.** The oldest Silurian age rocks in the area are the limestones, shales, and dolomites of the Brassfield Formation. The Brassfield ranges in thickness from 14.3 to 19.8 m and within this interval, five units are recognized (Kaufmann 1964).

The basal unit, or Belfast Member, (Rexroad et al. 1965) consists of 1.5–1.8 m of massive limestone which is bluish gray, fine grained, silty and dolomitic. This basal unit is gradationally overlain by a 1.5–2.7-m thick interbedded limestone and shale facies. The limestone is medium gray to bluish gray, thin bedded, medium crystalline, and argillaceous. The shales are greenish gray, 3–6 cm thick and silty. These limestones and shales grade upward over a 0.3 m interval into a chert-rich facies.

The cherty facies consists of massive resistant cherty limestone, which is light to medium gray, medium to fine grained, thin to nodular bedded with zones of glauconite and fossil hash. The total unit is 1.5–2.1 m thick and forms a distinct resistant ledge. The cherty facies grades upward into an upper interbedded limestone and shale facies. Also present within this facies are limestone layers, which are 21–46 cm thick, brown to dark red, coarse grained, friable, oolitic and which contain crinoid stem plates and abundant glauconite. The upper interbedded limestone and shale facies ranges in thickness from 9.5 m to an estimated 15.5 m. The upper contact with the uppermost facies or bead bed, is sharp and rarely exposed. The bead bed consists of a single limestone bed

which is medium to light gray, medium to very coarse grained, argillaceous and crinoidal with bedding dominated by megaripples. The bead bed represents a consistent physical marker at the top of the Brassfield Formation (Rexroad et al. 1965).

The Brassfield Formation crops out within the study area along most of Ohio Brush Creek and the western tributaries of this stream. The best exposure within the quadrangle is located on the west side of State Route 41 immediately south of a bridge crossing Ohio Brush Creek approximately 1.6 km south of Jacksonville (fig. 3, locality 2).

The Noland Formation (Rexroad et al. 1965) consists of two separate lithologies within the Peebles quadrangle. The lower lithotype consists of limestone medium to dark gray, medium to coarse grained and moderately fossiliferous, interbedded with bluish-gray shale. The upper lithotype, or Dayton Member (Rexroad et al. 1965), is yellowish-gray to grayish-pink limestone, fine to cryptocrystalline, with thin to moderately thick beds having irregular surfaces. The Dayton Member is distinct and a useful mapping unit because of the resistant ledge-forming nature.

The Noland Formation ranges in thickness from 1.2 to 4.9 m within the study area. The formation thins to the north mainly at the expense of the lower lithotype, which thins from 2.4 to 0.4 m in thickness. The Noland crops out along the valley of Ohio Brush Creek and the western tributaries of this stream. It is well exposed at locality 2, but steepness of the section precludes close examination of the Noland Formation (fig. 3, locality 2). Better exposures of the Noland, although less accessible, can be found on the west-facing slope of Wheat Ridge along Ohio Brush Creek.

The upper contact with the Estill Shale is disconformable and generally sharp. The disconformity is indicated by a glauconitic zone within the basal Estill Shale and by a biostratigraphic break between the Dayton

Member and the Estill Shale (Rexroad et al. 1965, Rexroad 1967).

Individually, the Noland is too thin to be mapped at a 1:24,000 scale and therefore was combined with the Brassfield to form a single mapped unit. The Belfast Member of the Brassfield Formation and the Dayton Member of the Noland Formation provide distinct lithologic boundaries for this mapped interval. Recently, McDowell (1983) examined this same interval in northern Kentucky and southern Ohio and found the Noland-Brassfield contact marker, the bead bed, to be a faunal zone. This zone is repeated in the section and rises rapidly upsection northward into Ohio. He concluded therefore that the bead bed is too difficult to locate in the field and is not useful or desirable as a formational boundary. The formation names of Brassfield and Noland were dropped and the combined interval was renamed the Drowning Creek Formation, consisting of, in ascending order: The Brassfield Member, a middle undifferentiated interval, and the Dayton Member north of Bath Co., Kentucky. This reclassification conforms with boundaries the author mapped in the Peebles quadrangle and also with those mapped in northern Kentucky in the Kentucky mapping program. Detailed mapping proves the Drowning Creek Formation is a useful division within the Silurian System locally and should be adopted for the Adams Co. area.

Disconformably overlying the Noland or Drowning Creek Formation is the Estill Shale (Rexroad et al. 1965). The Estill consists primarily of soft reddish-brown to greenish-gray shale. Thin dolomite stringers, which are dark yellow, discontinuous, silty and argillaceous, become abundant in the upper one half of the formation, yet only constitute a small percentage of the total lithology. A basal glauconitic zone is present throughout the study area. It occurs near the base as either pelloidal glauconite stringers or as a 0.3–0.5-m thick shale layer with disseminated glauconite.

The entire Estill Shale ranges in thickness from 30 to 45 m and averages about 37 m within the study area. The best and most complete exposure of the Estill Shale within the Peebles quadrangle is in a roadcut on the east side of State Route 41, about 0.4 km south of Jacksonville (fig. 3, locality 3).

The contact of the Estill Shale with the overlying Bisher Formation undulates locally as much as 18 cm. The basal 15–21 cm of the Bisher Formation are very argillaceous dolomite indicating a conformable transition from shale to silty dolomite deposition. This is the most consistently exposed contact within the study area because of the prominent overhangs and significant breaks in slope created by the resistant Bisher Dolomite. Numerous springs further accentuate this contact.

The Bisher Formation (Foerste 1923) consists of dolomite that is light to medium gray, fine grained, silty, argillaceous, calcitic, and locally contains chert nodules and rip-up clasts. The Bisher is thin bedded in the lower one-third of the formation, very thickly bedded in the upper two-thirds, and weathers to a distinct brownish-orange color. An additional lithofacies consist of a fine to coarse-grained, light-gray, irregularly bedded, calcitic dolomite containing abundant fossils dominated by the brachiopod, *Cryptothyrella cylindrica* (Bowman 1956).

This lithofacies lies between 0.76 and 2.6 m above the base of the Bisher and is consistently present as a single unit 30–45 cm thick. It has also been observed as three separate layers within a 1.5-m interval. The *Cryptothyrella cylindrica* lithofacies maintains the same stratigraphic relationship throughout Highland and Adams counties and may represent a time-stratigraphic marker (Bowman 1956).

In the study area, the thickness of the Bisher Formation ranges from 6 to 17 m and averages about 9 m. This fluctuation in thickness is due to the undulatory nature of the top of the Bisher.

The Bisher Formation crops out along

Ohio Brush Creek and the major tributaries of this stream. It forms a caprock for many bluffs and is a resistant ledge-former. A complete exposure of Bisher is present along the Appalachian Highway 1.6 km west of the intersection of the highway with State Route 41 (fig. 3, locality 4).

The contact with the overlying Lilley Formation is difficult to discern on a fresh outcrop but is easily recognized on a weathered surface. The Bisher weathers to a smoother-surfaced rock, whereas the Lilley Formation weathers to a rough, commonly vuggy surface. A series of thin shales mark the top of the Bisher, but are not always present (Foerste 1935).

The Lilley Formation (Foerste 1923) consists of two main lithofacies in the Peebles area, a crinoidal-carbonate and an argillaceous-carbonate lithology (Bowman 1956). The crinoidal-carbonate lithofacies consists of light- to medium-gray, fine-grained dolomite which is thin to thick bedded, and contains abundant fossil fragments dominated by crinoid stem plates. The argillaceous-carbonate lithofacies is not everywhere present within the study area as seen 0.4 km southwest of the Steam Furnace Cemetery, but where present it overlies the crinoidal-carbonate lithofacies.

The Lilley Formation ranges in thickness from 5.5 m to possibly as much as 19.8 m within the study area and averages about 9.1–10.7 m. The thickness of the Lilley Formation fluctuates rapidly. Observations suggest that as the Lilley thickens, the Bisher correspondingly thins (Bowman 1956). The Lilley Formation occurs as the dominant rock on many bluffs above the Ohio Brush Creek and tributaries of the stream and is associated with karst topography. An exposure of the entire Lilley Formation is present in a roadcut along the Appalachian Highway 1.6 km west of the intersection with State Route 41 (fig. 3, locality 4).

The Peebles Dolomite intertongues with the Lilley Formation over an estimated 3.1–6.2-m thick transitional zone. The transitional zone may consist of distinct beds of medium-gray, argillaceous

Lilley lithology sharply interfingering with a light-gray, pure dolomitic Peebles lithology. This zone may also contain a fine-grained, silty, thick-bedded, vuggy dolomite, which appears to be a mixture of both Peebles and Lilley lithologies, and may represent a distinct transition lithology.

The Peebles Dolomite (Foerste 1923) is light gray to bluish gray, fine grained to microcrystalline, with thick bedding that is poorly developed in the lower portion. The formation has well-developed fossil molds and solution cavities giving the unit a pock-marked appearance.

The Peebles Dolomite crops out almost exclusively east of Ohio Brush Creek and the weathered surface creates broad rolling plains. Plum Run Quarry, located approximately 1.6 km east of the study area provides the best exposure of the Peebles (fig. 3, locality 5). The poorly developed bedding of the Peebles Dolomite can be readily distinguished from the distinct even bedded Greenfield Dolomite above. On weathered or partially covered exposures, the very light-gray, soft, equidimensional particles of the Peebles contrast with the darker, harder, more hackly-fractured Greenfield Dolomite.

The Peebles ranges between about 12–21 m in thickness. The exact determination of the Peebles' true thickness is not possible because of the nature of the lower contact with the Lilley, and lack of exposure. An additional tongue of dense, micritic Peebles lithology enters the quadrangle from the north and west (R. S. Bowman, pers. comm.). This upper tongue possibly explains the unusually thick sequence of Peebles present in the east-central portion of the study area. The Peebles is unconformably overlain by the Greenfield Dolomite. The unconformable surface has only 0.91 m of relief within Plum Run Quarry.

The Greenfield Dolomite, first named "stone" (Orton 1871), is light bluish, brownish or olive gray, fine grained, laminated, thin to thick bedded, hard, stylonitic, and contains thin, mesoporous vuggy

layers. Also present are discontinuously bedded, medium-gray dolomite layers with no visible porosity. The Greenfield is estimated to range in thickness from 1.5 to 7.9 m within the study area. The large range in thickness is due to the removal of a significant portion of the Greenfield and all younger Upper Silurian rocks by the Silurian-Devonian erosional episode.

The Greenfield is conformably overlain by the Tymochtee Dolomite. This contact is difficult to recognize due to similarities in lithology between the two units. In Plum Run Quarry, one of the best known exposures of the contact in southern Ohio, the contact is arbitrarily placed at a thick layer containing abundant primary structures (Schmidt et al. 1961, Butterman 1961, Miller 1955). Owing to the lack of exposure and subtle nature of the contact, as well as the irregularity of the contact surface, the Greenfield and Tymochtee were mapped as a single unit.

The Tymochtee Dolomite (Winchell 1873) contains two types of lithologies as exposed in the Plum Run Quarry. The lower portion is medium-gray to light-bluish-gray, fine-grained, hard dolomite which is thin to thick bedded with some vuggy zones. The upper portion is a light-gray, thin-bedded, argillaceous dolomite, with shale partings having well-developed mudcracks.

The Tymochtee Dolomite ranges in thickness from 0 to 15.2 m within the study area. The wide range in thickness is due to erosion along the Silurian-Devonian contact. The Tymochtee is rarely exposed within the Peebles quadrangle and is locally missing beneath the Silurian-Devonian unconformity. The best exposure of both the Greenfield and Tymochtee Dolomites is in Plum Run Quarry where 23 m of combined section can be observed (fig. 3, locality 5). A graben structure within the quarry has allowed an unusually thick section of Upper Silurian rocks to escape pre-Middle Devonian erosion. It is probable that the thickness of Upper Silurian rocks present in the quarry graben exceeds that found in the study area.

The high degree of erosion on the Silurian-Devonian erosion surface (up to 21.4 m), removed the entire Tymochtee Dolomite and allowed Devonian age rocks to directly overlie either the Greenfield or Tymochtee Dolomites. Regionally in Ohio, the Silurian-Devonian unconformity has a wide range of stratigraphic units at the boundary. The underlying units may be as old as Middle to Upper Silurian, while overlying units may be Middle to Upper Devonian in age (Summerson 1959).

Below this contact surface in the study area, a zone of highly weathered dolomite up to 0.46 m thick is underlain by unaltered rock. The zone is a soft, silty, calcitic dolomite containing individual laminae of glauconitic, carbonaceous material, and highly oxidized clay shales. The zone is well exposed in a ditch behind Turkey Creek Church in the southeast portion of the study area (fig. 3, locality 6). The Hillsboro Sandstone (Orton 1871) has been identified within this same interval in Highland Co. but was not observed in the study area (Carman and Schillhahn 1930, Rogers 1936).

**DEVONIAN.** The Olentangy Shale (Winchell 1874) is greenish gray to bluish gray, semi-lithified and contains black carbonaceous shale stringers. It weathers to a crumbly greenish-gray shale that becomes mucky when wet. It is believed to be the "Upper" Olentangy Shale as defined by Tillman in 1970 (Gable 1973).

The Olentangy Shale is consistently 8.2–8.5 m thick in several measured sections. The Olentangy is best exposed in road ditches behind the Turkey Creek Church in the extreme southeast portion of the study area (fig. 3, locality 6).

The Olentangy Shale can disconformably overlie the Tymochtee or Greenfield Dolomites within the study area. The Ohio Shale appears to conformably overlie the Olentangy Shale. The greenish-gray shale of the Olentangy abruptly grades upward into the black-fissile Ohio Shale.

The Ohio Shale (Shaler 1877) consists of black-carbonaceous shale with greenish-



gray shale rich zones and can be separated into three distinct members in the study area. In ascending order they are: the Huron Member, the Three Lick Tongue of the Chagrin Member, and the Cleveland Member.

The "Huron Shale" Member (Newberry 1870) is brownish-black to dark-gray, carbonaceous shale with carbonate concretions up to 0.5 m in diameter in the lowermost part. The Huron Member is estimated to be more than 52 m thick within the Peebles quadrangle.

Above the Huron Member, is a 6.1-m thick unit of brownish-black shale with greenish-gray shale interbeds. Provo et al. (1977) named this unit the Three Lick Bed of the Ohio Shale in a measured section along the Appalachian Highway at Tener Mountain, 9.6 km east of the study area. The Three Lick Bed has been used in Kentucky as a stratigraphic marker within the Devonian age black shale. Broadhead et al. (1982) recognized the Three Lick Bed in southern Ohio and Kentucky to be a distal equivalent or tongue of the Chagrin Member of the Ohio Shale. This unit is present throughout the study area and should be recognized within the nomenclature. Therefore, to better describe the lithology of the unit and to emphasize usefulness of the unit in correlating the black shale sequence in Ohio and Kentucky, the author has chosen to rename the interval the Three Lick Tongue of the Chagrin Member.

The Cleveland Member (Newberry 1870) is a homogenous, very petroliferous, black shale which weathers to light-gray, fissile chips. It is estimated that this member is about 18.3 m thick within the study area.

The Ohio Shale was measured by altimeter to be 76.5 m thick at a nearly complete section located behind the Turkey Creek Church along a road that ascends Peach Mountain (fig. 3, locality 6). This section represents the only reliable thickness taken near the study area.

The upper contact between the Ohio Shale and the overlying greenish-gray Bedford Shale represents the Devonian-

Mississippian systemic boundary (Pepper et al. 1954). In the study area, the contact is sharp with the uppermost 12 cm of the Ohio Shale becoming soft and claylike before abruptly changing to Bedford lithology.

MISSISSIPPIAN. The Bedford Shale (Newberry 1870) represents the lowermost Mississippian age rock present within the Peebles quadrangle. The lower two-thirds of the unit consists of a soft, greenish-gray shale which grades upward into a light-bluish-gray to medium-bluish-gray, hard, sandy siltstone. Well-developed oscillation ripple marks are abundant within the siltstone of the upper portion of the Bedford.

The Bedford Shale is estimated to be 24 m thick within the study area. It is best exposed behind Turkey Creek Church (fig. 3, locality 6). The upper contact of the Bedford Shale with the Berea Sandstone is gradational and arbitrarily placed where the upward increasing sand content begins to dominate the lithology (Hyde 1953).

The Berea Sandstone (Newberry 1870) is Lower Mississippian in age and is the youngest bedrock unit that occurs in the Peebles quadrangle. The Berea consists of medium to light-gray or light olive-gray, silty to shaly, medium-bedded sandstone with ripple marks in the lower portion. Silt and shale content decrease upward and the unit becomes a resistant sandstone in the upper portion.

The thickness of the Berea Sandstone was not determined within the study area due to poor exposure. However, 13.7 m were measured at Tener Mountain, 9.6 km east of the study area (Provo et al. 1977). The Berea Sandstone forms distinctive flat caps on hills just east of the study area.

QUATERNARY DEPOSITS. The Peebles quadrangle contains two levels of terraces above the present alluvial deposits which are associated with the Ohio Brush Creek and Little West Fork. A laterally extensive terrace plain occurs no higher than approximately 18 m above the present creek level. A second minor terrace level lies approximately 21 m above the present

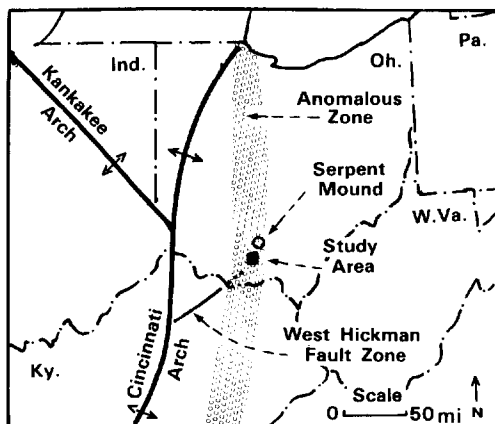


FIGURE 4. Map of regional structures and the geophysical zone influencing rocks of the Peebles quadrangle.

stream level. These terraces consist of clayey to silty loam (Taylor 1938) with no significant sand and gravel content.

**STRUCTURE.** The Cincinnati Arch represents the dominant regional geologic structure in southern Ohio (fig. 4). The arch is a broad, linear, structural high which extends northward from Tennessee to southern Ohio where it bifurcates to form the north-trending Findlay Arch and the northwest-trending Kankakee Arch. The Peebles quadrangle lies on the east flank of the Cincinnati Arch. The strata dip eastward at a uniform rate of 6–8 m per km, or 0.7 degrees, into the Appalachian Basin (fig. 5).

Strata in the southeast portion of the Peebles quadrangle increase in dip and change slightly in structural strike (fig. 5). Strata dip increases from 6 or 8 m per km to 10 or 11 m per km. Structural strike also deviates slightly from a north-south direction to approximately N10°E. The increase in structural dip is believed to be western-most evidence of warping associated with the Adams Co. monocline. The monocline represents a major deviation from the seemingly constant structural nature of the east flank of the Cincinnati Arch in the Peebles area. The monocline continues to influence rocks to the east as evidenced in Plum Run Quarry where dip

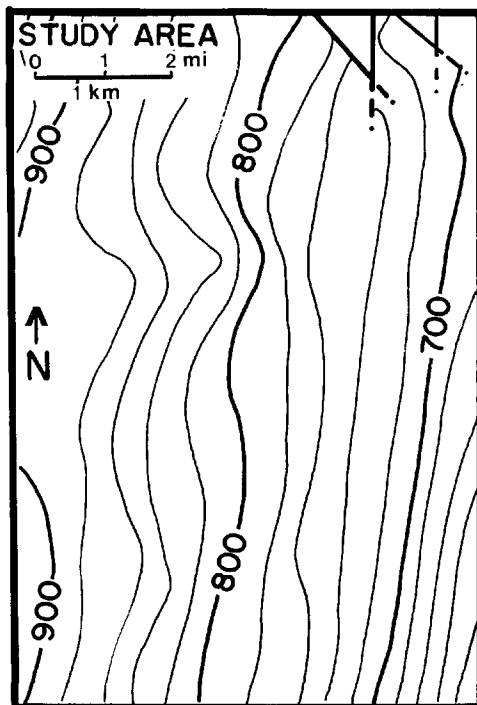


FIGURE 5. Structure contours of the Bisher-Estill contact. Note steepening surface in the southeast corner and faults in the northeast corner.

increases from 10 or 11 m per km to 15 m per km (R. S. Bowman, pers. comm.). The rather abrupt dip increases in the southeast Peebles quadrangle and in the Plum Run Quarry indicate the monocline may have multiple hinges.

The Adams Co. monocline, where projected southward, appears to join major faults mapped in Upper Ordovician rocks in northern Kentucky (Galbraith et al. 1975). This is the West Hickman Fault zone of the Kentucky River fault system (fig. 4). The soft Ordovician shales, found in the subsurface northward in Ohio, may have absorbed the energy of the fault zone causing it to evolve to a warp to the north. The Adams Co. monocline may be the surficial expression of that warp (Reidel et al. 1982). Further regional studies of the pre-Middle Devonian erosion on Upper Silurian age carbonates in Adams Co. may show that this monocline underwent initial activation prior to Devonian sedimentation.

The author was unable to confirm the position of the Adams Co. monocline axis in the proximity of the Ohio Brush Creek valley as suggested by Galbraith (1968). Four separate structure contour surfaces were drawn across his projected axis. They show that the strata dip eastward at a consistent rate of less than one degree with no anomalous dip increases.

Nearby, another significant local structure is the Serpent Mound cryptoexplosion structure. The cryptoexplosion structure is an intensely disturbed circular feature approximately 6.4 km in diameter located about 3.2 km north of the Peebles quadrangle. Rock displacement on the order of 107 m has occurred in the central portion of the structure (Schmidt et al. 1961), however, the deformation decreases rapidly outward (Galbraith 1968). Four faults mapped in the northeast portion of the Peebles quadrangle could be considered extensions of Serpent Mound deformation because these faults enter the quadrangle from the north and appear to die out in a southerly direction (fig. 5).

The West Hickman Fault zone, the Adams Co. monocline, and the Serpent Mound cryptoexplosion structure are features which lie within a band of gravity and magnetic anomalies. This anomalous geophysical zone, called the East Continent gravity high, trends in a north-south direction from Tennessee through Kentucky, to southern Ohio (fig. 4). The gravity high is believed to represent the failed arm of a Keweenawan age rift zone (Keller et al. 1982). Reactivated movement along basement faults, often associated with rift structures, may explain the presence of surficial faults, monoclines and even the cryptoexplosion structure in Adams Co. and the surrounding area.

### CONCLUSION

The complex geology of Adams Co., Ohio, is well-expressed in rocks exposed in the Peebles quadrangle. Investigations for production of a geologic map of the Peebles quadrangle revealed diversity in the stratigraphy and structure of the rocks. The exposed stratigraphic sequence con-

tains rocks of four Paleozoic Systems measuring over 240 m in thickness. The general structural trend of the rocks is regionally controlled by the Cincinnati Arch, whereas faults and folds are locally controlled.

The bedrock in the Peebles quadrangle consists of carbonates, shales and sandstones of Ordovician, Silurian, Devonian and Mississippian age. In ascending order, the rock units are: the Bull Fork Formation and the Preachersville Member of the Drakes Formation (Upper Ordovician), the Drowning Creek, Estill, Bisher, Lilley Formations and the Peebles, Greenfield and Tymochtee Dolomites (Silurian), the Olentangy and Ohio Shales (Upper Devonian), and the Bedford Shale and Berea Sandstone (Lower Mississippian). A combined Brassfield-Noland Formation coincides with the author's mapped interval and should be distinguished as the Drowning Creek Formation in Adams Co. (McDowell 1983).

Rocks of the Peebles quadrangle dip eastward 6–8 m per km, or 0.7 degrees, due to the east flank of the Cincinnati Arch. In the south-east corner of the study area, rocks increase in dip from 10 to 11 m per km, or one degree, due to a local structure called the Adams Co. monocline. This increase in dip may represent only the westernmost hinge or flexure related to the monocline which lies east of the study area. Faults in the north-east corner of the quadrangle appear to be extensions of deformation associated with the Serpent Mound cryptoexplosion structure located approximately 3.2 km to the north.

Detailed mapping of an area's geology generates data that can be immediately applied to industry's needs and provides the basis for further geologic investigations. The geologic map produced depicts areas of potentially thick Peebles Dolomite for mineral exploration and in addition, details shale rich units which are engineering hazards such as the Estill and Olentangy Shales and the Drakes Formation. For environmental studies, the map pinpoints zones of prominent water production for hydrologic studies, and also identifies the

position of karst prone formations like the Lilley, which is vital to locating a waste disposal site. Using the map as a basis, further geologic studies could include a regional investigation as to the nature of the Silurian-Devonian unconformity or the Adams Co. monocline.

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