

Variations in the Stratigraphic Position and Character of the Base of the Mansfield Sandstone in Southern Indiana¹

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The eastern dissected fringe of the basal Pennsylvanian system of rocks overlaps northward and eastward on various formations of the Mississippian system in its passage across southwestern Indiana along the eastern margin of the Illinoian basin from Perry County on the Ohio River to Benton County in the northwestern part of the State. The basal aspects of the Pennsylvanian system in Indiana have been assigned to a single formation under the name of the Mansfield sandstone since the detailed studies by Hopkins in 1896. A single lithic name has been tolerated because it applies fairly well northward from Orange and Martin counties where its thickness only locally exceeds 100 feet or slightly more up to the Lower Block Coal of the Brazil series, which is defined as its upper limit. Southward, it appears to be divisible into several formations or stratigraphic units consisting of sandstones, local conglomerates, shales, coals, and rarely local limestones, all variable in thickness and lateral extent, and aggregating as much as 400 feet up to what may be recognized as thin representatives of the Brazil block coals. No detailed studies of these formations have been made. The local variations in thicknesses and the inconstant areal extents of the formations have discouraged stratigraphic designation, though local sequences have long been recognized. A massive, cross-bedded sandstone, and locally a coarse, gritty and pebbly sandstone, is prevalent at or near the base of the formation. Locally it digs deeply into the underlying formations along a pronounced erosional unconformity. It is usually quite unlike the underlying formations and is clearly identifiable as the basal phase of the Pennsylvanian system. As such, the name *Mansfield sandstone* is more fitting as a reference term than as a stratigraphic unit with a definite fixed bottom and top. It is not the purpose of the present paper, however, to present details of stratigraphic sequences in the Mansfield formation, but rather to discuss the stratigraphic position of the base of the formation and to call attention to some of the lithic variations at and near the base.

The unconformity at the base of the Pennsylvanian system in Indiana is very marked and is manifested in several ways. First, the base of the Pennsylvanian system overlaps the entire Mississippian system from south to north along the eastern edge of the Illinoian basin in Indiana. It rests on the Kinkaid limestone, the highest Mississippian formation in the Illinoian basin, along the Ohio River in Perry County, and on the New Albany shale of late Devonian age in an outlier near Remington of southern Jasper County, the northern most known occur-

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rence of the Pennsylvanian in Indiana. This is a stratigraphic overlap of 1,850 feet in 200 miles. Second, an easterly overlap of the Mansfield from younger to older formations is readily demonstrated northward from Perry County, locally amounting to several hundred feet. Third, the base of the Pennsylvanian system rests on an uneven topography, consisting of valleys and ridges with local reliefs up to 150 feet or more. Fourth, the Pennsylvanian formations dip in a westerly direction at rates slightly less than the underlying formations. The Mississippian formations have a westerly dip of 30 feet or slightly more to the mile, while those of the Pennsylvanian dip about 25 feet to the mile. The slighter dip of the Pennsylvanian formations, however, is not readily apparent in the Mansfield, because this formation does not have persistent stratigraphic units nor is bedding so uniform and dependable as in the underlying formations. Some aspects of these several expressions of the Pennsylvanian-Mississippian unconformity found in several southern Indiana counties constitute the chief contribution of this paper.

In southern Perry County near the Ohio River the Mansfield formation intermittently rests on the Kinkaid limestone formation over an area of several square miles, chiefly along and near Little and Big Deer creeks. The altitudes of the base are quite variable, ranging from 750 feet on the high ridge near State Road 66 four miles west of Rome to as low as 435 feet on Caney Creek two and one-half miles northeast of Cannelton in the area of the outcrop of the unconformity. The Kinkaid limestone, previously described by the writer (3) under the name of Negli Creek limestone, is the highest described formation of the Chester series and the Mississippian system in and about the margins of the Illinois basin. Locally, in the area of the outcrop of the Kinkaid limestone, the base of the Mansfield cuts deeply below into various Chester formations and rests either on the *Degonia* sandstone (Mt. Pleasant), Clore shales, Palestine sandstone (Bristow), or Menard limestone and shales (Siberia), more than 100 feet below the Kinkaid. At and near Lafayette Spring and Rock Island in the Ohio River nearby, along State Road 66 about three miles east of Cannelton, the base of the Mansfield is composed of a massive, cross-bedded, gritty and pebbly sandstone up to 60 feet in thickness which rests on the Menard formation at an altitude of about 380 feet, considerably below high water level of the Ohio River. One-half mile north of Lafayette Spring a stratigraphically higher phase of the Mansfield sandstone rests on the Kinkaid limestone at an altitude of 480 feet, 100 feet higher than the base at and near Lafayette Spring. Eastward across the wide valley of Deer Creek and only about one and one-half miles from Lafayette Spring, the base of the Mansfield is above the Kinkaid limestone at an altitude slightly in excess of 600 feet. The great difference in the altitudes of the base of the Mansfield on the two sides of Deer Creek is accounted for in part by the difference in the stratigraphic position of the base, in part by a fault with an upthrow on the east of approximately 100 feet, and in part by the normal westerly dip of the rock

systems. Farther eastward along the wooded bluff north of the Ohio River, the base of the Mansfield cuts down through the upper Chester formations to an altitude of 520 feet within one mile, approximately 100 feet below the Kinkaid limestone. As the base of the formation descends to lower levels, the white, milky-quartz pebbly phase of the Mansfield appears and thickens to a bed 55 feet thick. A thin streak of coal and a sandy fire-clay occurs 15 feet above the base in the conglomerate about one mile east of the mouth of Deer Creek. The pebbly phase of the Mansfield is topped by 50 feet of coarse, cross-bedded, friable sandstone which reaches to the upland level some 250 feet above the Ohio River. The Lafayette Spring locality is one of the most prominent occurrences of the pebbly phase of the Mansfield, and here, as elsewhere, it occurs where the base digs deeply below its normal stratigraphic position for the locality.

Some six miles north of the Lafayette Spring locality, the base of the Mansfield is normally below the Kinkaid limestone, except for one known small area along State Road 37 one mile northwest of the village of Leopold, where the base is sufficiently high to permit the Kinkaid limestone to show at an altitude of about 685 feet. Elsewhere through the middle and northern parts of Perry County, the Mansfield rests on the Degonia, Clore, and Palestine formations, and in the extreme north, locally on the Menard formation. At no place north of the Lafayette Spring locality in Perry County does the pebbly sandstone phase occur more than a few feet in thickness, nor does the base cut deeply below its normal stratigraphic position. In Perry County there is only a slight easterly overlap of the base of the Mansfield. It is much less apparent than the easterly overlap farther north. The most easterly exposures of the Mansfield are near the village of Oriole, east of Oil Creek valley in the northeastern part of the county, where a sprangling outlier of massive, cross-bedded, loosely-bound, locally gritty sandstone caps the ridges below the Degonia sandstone at an altitude of about 775 feet. It occurs in mound-like hills east of Mt. Pleasant which rise 50 feet or more above the flat, expansive plain developed on the Degonia sandstone. A similar loose sandstone is present in the vicinity of St. Croix some 75 feet lower stratigraphically, and a short distance east of the town iron oxide occurs in peculiar twisted ribbons in the soft sandstone above the upper Chester shale, probably Menard, upon which it rests.

Along State Road 37 on the ridge west of Branchville and north of Bandon, the Mansfield is exposed in the road cuts where cross-bedding resembles layers of rock which appear to be dipping steeply southward. The underlying Chester formations, consisting of the Degonia, Clore and Palestine formations belie the appearance of a strong southward dip of the Mansfield beds. The Mansfield descends to the level of the valley floor of Anderson Creek near Adyeville, some three miles up stream from St. Meinrad, at an altitude of about 440 feet, resting close above the Palestine sandstone. In the westward stretch of some 15 miles from Oriole to the vicinity of St. Meinrad, the base

of the Mansfield changes little from its stratigraphic position, resting on the Degonia sandstone with no evidence of an easterly overlap.

Northward from the massive, pebbly sandstone of the Lafayette Spring locality of southern Perry County to perhaps as far as the French Lick locality in western Orange County, the basal Mansfield shows no unusual aspects. It is usually composed of medium to coarse sandstone at the base which is more or less highly impregnated with iron-oxide from a few inches to a few feet. At places the coarse sandstone base is succeeded by a light-colored sandy shale or fire-clay and a thin coal seam some few feet above the base. The coal is commonly followed by medium-grained, cross-bedded, massive sandstone. Where the sandstone is massive it dominates the outcrops along the steep-sided valleys. Considerable shale and shaly sandstone is present in the formation. The more massive and thicker beds of sandstone show locally in great cliffs along the sides of the valleys and ravines, but rarely do single sandstone cliffs exceed 75 feet in height. Even in the spectacular bluffs at and near Lafayette Spring on the Ohio River, detailed sections show that much of the Mansfield is composed of shales. In the towering bluff from which a large mass of sandstone has fallen into the Ohio River to create Rock Island, an historic island marker in the Ohio River near Lafayette Spring, five beds of sandstone, aggregating 122 feet in thickness, and four intervening beds of shale, totalling 103 feet in thickness, composed the measured 225 feet of rock in the bluff. At Lafayette Spring a short distance away, two beds of sandstone 80 feet thick and two beds of shale of the same total thickness form the measured bluff of exposed rock at this historic spot.

In the extreme northern part of Perry County the base of the Mansfield rests on or near the Menard (Siberia) limestone, having descended stratigraphically approximately 110 feet in 25 miles north of the Ohio River at Lafayette Spring. Near Birdseye in eastern Dubois County, the massive basal sandstone of the Mansfield rests on or near the Menard limestone at an altitude of about 660 feet and about 175 feet above the well known Glen Dean limestone. In southern Crawford County, near the fire-tower in the vicinity of West Fork, the Mansfield rests on the Waltersburg formation at an altitude of about 800 feet. West of English the eastern fringe of the main body of the Mansfield is down on the massive Tar Springs sandstone, a position it holds northward through much of southwestern Orange County to near French Lick.

Crawford County has a very notable but small outlier of the Mansfield surprisingly far east of the eroded fringe of the main formation. Pilot Knob, a high isolated hill, six miles south of Marengo and seven miles southeast of English, in the northeast one-fourth Sec. 36, T. 2 S., R. 1 E., is capped by a remnant of coarse, cross-bedded, iron-impregnated sandstone, containing local gritty streaks and infrequent small white quartz pebbles. Pilot Knob is the highest point in Crawford County, reaching an altitude of about 925 feet. It rises 100 feet or more above the general upland surface and forms a land mark

observable for miles about. The Mansfield cap is not over 100 yards across and has a thickness of about 25 feet. It rests on Chester shale equivalent to the Tar Springs at an altitude of about 900 feet and about 60 feet above the Glen Dean limestone which outcrops nearby. This position is somewhat lower stratigraphically than the position of the base of the main body of Mansfield two or more miles west of English and approximately 10 miles west of Pilot Knob, where it rests on or slightly above the Tar Springs sandstone about 90 feet above the Glen Dean limestone. From the Birdseye locality in eastern Dubois County to Pilot Knob, a distance east and west of 19 miles, the base of the Mansfield overlaps eastward about 115 feet, ranging from the Menard limestone 175 feet above the Glen Dean limestone to within the Tar Springs formation 60 feet above the Glen Dean.

At the railway tunnel three miles southwest of French Lick in southwestern Orange County, the Pennsylvanian rests on the massive Tar Springs sandstone about 60 or 70 feet above the Glen Dean limestone. Farther north appearances of the Tar Springs are rare. No Tar Springs sandstone is known to occur north of Shoals in Martin County. Hence all of the upper Chester formations, consisting of the Kinkaid, Degonia, Clore, Palestine, Menard, Waltersburg, Vienna and Tar Springs, and aggregating about 290 feet, have been overlapped one by one in about 50 miles north of the Ohio River. The Mansfield rests on the Glen Dean limestone or on the Golconda limestone to as far north as the Orange-Lawrence county line. In Martin County the Glen Dean is usually present along the western outcrop of the Chester series except locally, and continues present into southeastern Greene County, where it is intermittently present in the southern parts of Township 6 North nearly to the village of Koleen. The Mansfield rests on three to five feet of the bottom part of the Glen Dean limestone in the western part of the abandoned railway tunnel beneath the Mansfield ridge just west of Owensburg at an altitude of about 760 feet. The base of the Mansfield here is composed of a few inches of sandy iron ore followed by cross-bedded sandstone. A local coal in the Mansfield has been mined in the ridge about 50 feet above the base here. The northernmost known occurrence of the Glen Dean limestone is in a small valley near the center of Sec. 12, T. 6 N., R. 5 W., about four miles southeast of Bloomfield. Here about five feet of the Glen Dean limestone are exposed with the base of the Mansfield resting on it at an altitude of about 540 feet. The base is composed of a few inches of sandy iron ore followed by a shaly sandstone. Since much of the eastern fringe of the Mansfield sandstone north from southern Perry County occupies the ridge crests of a soil-covered mature to old age topography of a much dissected upland, the base of the formation is nearly everywhere obscured and extended exposures are rare. While local exposures are common, good sections of the formation are difficult to obtain.

An unusual lithic aspect and a special phase of sedimentation are exhibited near the base of the Mansfield just below the high ridges of the eastern fringe of the formation in local areas of western Orange

County, where some 10 to 20 feet of the formation have been quarried in the past for the manufacture of whetstones. The localities of known occurrence and the special features of these beds in the Mansfield have been set forth in detail by Kindle in the Twentieth Annual Report of the Indiana Department of Geology and Natural Resources for 1895 (1). One outstanding locality is in and near Sec. 32, T. 2 N., R. 2 W., about two and one-half miles west of French Lick, and another is in and near Sec. 23, T. 3 N., R. 2 W., about four miles northwest of Orangeville. The whetstone rock is composed of very fine-grained, compact, angular quartz sand. The quartz grains are about 0.02 millimeter in size. The well compacted sand is arranged in well defined layers from less than one inch in thickness to layers of one foot or more. Some of the layers are laminated and may be split readily. The whetstone layers are disposed horizontally in some of the old quarries and in others are distinctly composed of cross-bedding, departing from the horizontal 10 to 15 degrees. The layers have very smooth surfaces. In a number of the quarries standing trunks of *Lepidodendron* trees are described as rising through the layered whetstone rock. These tree trunks are from a few inches to two feet or more in diameter, and are composed of the same fine-grained sand, but unstratified, and have a rough bark composed of coal. They are reported as standing on a thin coal which immediately underlies the whetstone rock. The coal bed apparently is near the very base of the Mansfield. Fossil ferns also occur in the whetstone beds, and some of the layers are marked by trails made by crawling and walking animals, though the latter are rare. The base of the Mansfield with the coal near the bottom is at a normal position stratigraphically. Northwest of Orangeville the base is on the Golconda shale at an altitude of about 800 feet, and the whetstone beds begin not more than 10 or 15 feet above the base. The conditions of sedimentation were quiet and stagnant, permitting a coal swamp to exist, and later the vegetation of the coal swamp was rather quietly buried with trees still standing in the swamp. The currents of the inundating sea at first brought in only the very fine sand, apparently in localized, protected areas. A secondary peculiarity of the whetstone beds is the presence of intersecting joints developing various sized diamond-shaped blocks of stone, about which iron-oxide has accumulated and penetrated from one to several inches, frequently producing a striking pattern in the white stone.

Some of the variabilities of the altitudes of the base of the Mansfield formation in the western part of Lawrence County were shown by the writer in 1946. The eastern edge of the much eroded fringe of the main body of the base of the Mansfield has an altitude generally about 800 feet, which is some 70 feet higher than the Buddha outlier 10 miles or more to the east. It is certain that the Buddha outlier is an isolated remnant of the pebbly phase of the Mansfield deposited in a pre-Pennsylvanian valley trough which cut deeply below the normal position of the Mansfield base. It appears too deep to be wholly accounted for by a pre-Mansfield valley and is thought to represent a truncation of an easterly

overlap, suggesting some aspects of a pre-Mansfield Chester escarpment not greatly unlike the one which today marks the eastern boundary of the Crawford Upland. No other locality in Indiana is known to have such a great stratigraphic range in the overlap of the base of the Mansfield sandstone.

The main body of the Mansfield in the southwestern part of Lawrence County has considerable variation in the altitudes of its base, especially west of the eastern fringe where data on the base are more readily available. The normal stratigraphic position of the base in Lawrence County is on the Cypress and Golconda formations, but in the Bryantsville-Huron area the base digs deeply below its normal stratigraphic position, in places coming below the Beech Creek limestone, and has a local relief in excess of 100 feet. On U.S. Highway 50, one and one-half miles southwest of Bryantsville, the base rests on the Elwren shale at an altitude of 765 feet. At the abandoned kaolin mines three miles west of Bryantsville, the Mansfield base of coarse, cross-bedded, massive sandstone is at the horizon of the Beech Creek limestone about 700 feet in altitude. Two miles southwest of the kaolin mines, the base of the Mansfield is at its normal position on the Golconda formation at an altitude of 760 feet. These altitudes not only represent the westerly dip of all the formations of some 30 feet per mile, but they show a variation in stratigraphic position as well.

In the locality west of Williams, Lawrence County, the Mansfield bites most deeply into the Chester formations. Here, a loose, pebbly phase of the Mansfield rests on or near the Beaver Bend limestone at an altitude of 595 feet, stratigraphically 120 and 165 feet below the tops of the Cypress and Golconda formations. The loose, pebbly Mansfield has been dug or quarried for road material just north of the overhead bridge across the railway on State Road 450. Some redeposited iron-stained clay derived from the pre-Mansfield clay residue of the Beaver Bend limestone occurs in the base of the Mansfield in the quarry pits, along with some fragments of redeposited white kaolin. The pebbly phase of the Mansfield here occupies a pre-Mansfield valley as much as 150 feet below the nearby pre-Mansfield uplands. This old pre-Mansfield valley with its pebbly fill of the Mansfield formation extends west and southwest some four miles to the well developed, pebble-filled pre-Pennsylvanian valley in the Indian Springs and Trinity Springs localities, mapped and described in 1931 by the writer.

In the Huron area, at altitudes varying around 675 to 700 feet or slightly more, local beds or basin-like pockets of white kaolin, often referred to as Indianaite, have been developed. While some white kaolin has been found elsewhere at the base of the Mansfield and some of the Chester sandstones, the Huron deposits are the largest and most abundant and some exploitation of them has occurred there. No white kaolin is known to occur at any place above the Beech Creek limestone, and only traces are known below the horizon of the Beaver Bend limestone. The deposits of the Huron locality are not believed by the writer to belong to the Mansfield formation, but represent a weathered, leached,

and altered residuum and colluvium of the sedentary clays derived from the Beech Creek limestone, and not removed before the deposition of the Mansfield sandstone upon them. The pre-Mansfield Beech Creek residual clays called mahogany clays by various geologists are far more widespread than the locally developed basins of white kaolin from these sedentary clays. The white kaolin deposits are confined to areas in the Huron locality where the Mansfield has been deposited upon them in pre-Mansfield depressions or valleys cut below the normal position of the base of the Mansfield of the locality. The Mansfield in such localities is a coarse, cross-bedded, massive sandstone, occasionally containing grit and a few small pebbles. Also, in places it contains kaolin fragments aligned along the cross-bedding, indicating erosion and redeposition of the pre-Mansfield white kaolin.

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