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Revision of the Stratigraphic Nomenclature and Classification of the Marmaton, Pleasanton, and Kansas City Groups in Kansas

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Marmaton Group

The Marmaton Group in Kansas is composed of nine formations listed in ascending order: Fort Scott Limestone, Labette Shale, Pawnee Limestone, Bandera Shale, Altamont Limestone, Nowata Shale, Lenapah Limestone, Memorial Shale, and Lost Branch Formation.

Fort Scott Limestone

The Fort Scott Limestone overlies the Cherokee Group and underlies the Labette Shale. It now comprises four members, in ascending order: Excello Shale Member, Blackjack Creek Limestone Member, Little Osage Shale Member (with newly recognized Morgan School shale bed), and the Higginsville Limestone Member.

Originally named by Swallow (1866), the original type section of the Ft. Scott Limestone (Bennett, 1896) was along a cut on the south side of a railroad, NE NW sec. 30, T. 25 S., R. 25 E. A new type section designated by Jewett (1941) in a quarry north of Ft. Scott, NE NW sec. 19, T. 25 S., R. 25 E., Bourbon County, Kansas, has recently been partially destroyed by road construction. A new reference section for the Fort Scott Limestone is located along US–59 south of Oswego, near center E/2 sec. 21, T. 33 S., R. 21 E., in Labette County (Knight, 1985).

Excello Shale Member

The Excello Shale Member overlies the Cherokee Group and underlies the Blackjack Creek Limestone Member. Named by Howe and Searight (1953) from Excello in Macon County, Missouri, it is mainly a black fissile shale 2–5 ft thick throughout Kansas. Previously considered part of the Cherokee Group, the Excello Shale Member is a major marine marker unit that is depositionally associated more closely with the overlying Fort Scott Limestone than with underlying Cherokee strata.

Blackjack Creek Limestone Member

The Blackjack Creek Limestone Member overlies the Excello Shale Member and underlies the Little Osage Shale Member. It was named by Cline (1941), from Blackjack Creek in Johnson County, Missouri. The Blackjack Creek Limestone Member consists primarily of marine skeletal calcilutite ranging from less than 1 ft (0.3 m) to over 40 ft (12 m) thick. It is capped locally by intraclastic, skeletal calcarenite (Knight, 1985).

Little Osage Shale Member

The Little Osage Shale Member overlies the Blackjack Creek Limestone Member and underlies the Higginsville Limestone Member. It was named by Jewett (1941) from the Little Osage River in Bourbon County, Kansas.

The Morgan School shale bed is a thin (<3 ft, 1 m), but distinctive gray shale and mudstone in the lower part of the Little Osage Shale Member. It contains nodular limestone, underclay, and the Summit coal bed at the top. Named as a member from Lucas County, Iowa (Ravn et al., 1984), the Morgan School shale bed thickens northward to 12 ft (4 m) or more in Missouri and 19 ft (6 m) in Iowa. Marine phosphatic black and gray shale, averaging 4 ft in thickness, characterizes the upper part of the Little Osage Shale Member in Kansas. The Iowa Geological Survey

has restricted the Little Osage Shale Member to the marine black and gray shale and limestone facies above the Summit coal (Ravn et al., 1984), hence to the strata above the Morgan School shale bed.

Higginsville Limestone Member

The Higginville Limestone Member overlies the Little Osage Shale Member and underlies the Labette Shale. It was named by Cline (1941) from Lafayette County, Missouri. In Kansas, it averages 15 ft of skeletal calcilutite with local chaetetid reefs. According to Knight (1985), it also includes beds equivalent to the Houx Limestone (Cline, 1941) and Blackwater Creek Shale (Greene and Searight, 1949) Members, also named from Missouri and recognized northward in Missouri and Iowa below the Higginsville.

Labette Shale

The Labette Shale overlies the Fort Scott Limestone and underlies the Pawnee Limestone. It was named by Haworth (1898) from the town of Labette in Labette County. The Labette Shale averages 30 ft in most of the outcrop region of Kansas and ranges up to 100 ft, rapidly thickening southward near the Kansas–Oklahoma border (Knight, 1985). It consists of gray and yellow clay shale, sandy and silty shale, sandstone, coal, and limestone beds. The Lexington coal bed lies near the top of the Labette in places. A persistent limestone, possibly the Wimer School bed of Oklahoma, occurs in the upper part. Coal is present also near the base. Several sandstones occur in the Labette Shale including the channel-filling Englevale sandstone bed, which is lowered from member status because of lenticularity. Sandstone found in subsurface drilling is referred to as the Peru sand.

Pawnee Limestone

The Pawnee Limestone overlies the Labette Shale and underlies the Bandera Shale. It was named by Swallow (1866) from Pawnee Creek in Bourbon County. The Pawnee Limestone is now revised to comprise, in ascending order, the Childers School Limestone Member, Anna Shale Member, Myrick Station Limestone Member (with newly recognized Frog Cemetery limestone bed), Mine Creek Shale Member (with newly recognized Joe shale bed), and Laberdie Limestone Member. The Mine Creek Shale Member interfingers southward with the newly defined Frog Cemetery limestone bed.

Childers School Limestone Member

The Childers School Limestone Member overlies the Labette Shale and underlies the Anna Shale Member. It was named by Alcock (1942) from a type exposure in a roadcut in SW sec. 6, T. 26 N., R. 17 E., south of Childers School, Nowata County, Oklahoma. Price (1981) relocated the exposure nearby in SE sec. 1, T. 26 N., R. 16 E. Jewett (1941) had included this limestone bed in the lower part of the Anna Shale Member. The Childers School is continuously developed in southeast Kansas as a 0.1–0.2-ft (2-5-cm) black slabby calcarenite, but it is missing locally northward.

Anna Shale Member

The Anna Shale Member overlies the Childers School Limestone Member and underlies the Myrick Station Limestone Member. It was named by Jewett (1941), from Anna in Bourbon County. The Anna Shale Member consists of 2–5 ft of largely fissile black phosphatic shale and is the most laterally persistent member seen along the entire outcrop.

Myrick Station Limestone Member

The Myrick Station Limestone Member was named by Cline (1941) from the Lexington area of Missouri. It overlies the Anna Shale Member and underlies the Mine Creek Shale Member and its southward extension, the Joe shale bed. The Myrick Station in Missouri and adjacent Kansas is 4 ft of dense skeletal calcilutite.

The Frog Cemetery limestone bed (amended from Price, 1981) is a distinctive southward lateral facies of the overlying Mine Creek Shale Member in Kansas and is lithologically included in the top of the Myrick Station Limestone Member. The reference section is 0.5 mi (0.8 km) south of Frog Cemetery in southwest Crawford County, Kansas, along the north bank of Hickory Creek in the southwest corner SE sec. 14, T. 30 S., R. 21 E. (Price, 1981). The Frog Cemetery limestone bed is composed of a lower chaetetid facies and an upper phylloid algal facies along its northern reaches near where it grades laterally into the Mine Creek Shale Member. A thin shale

separates the Frog Cemetery limestone bed from the main body of the Myrick Station Limestone Member below (Price, 1981). South of the Bourbon Arch, the thin shale disappears and the Frog Cemetery limestone bed cannot be distinguished from the rest of the Myrick Station Limestone Member. The entire member then pinches out at the convergence of underlying Anna and overlying Joe shales near the Oklahoma–Kansas line.

Mine Creek Shale Member

The Mine Creek Shale Member overlies the Myrick Station Limestone Member and underlies the Laberdie Limestone Member and its northward extension, the Coal City Limestone Member of Missouri and Iowa. The type Mine Creek Shale, named by Jewett (1941) from Mine Creek in Linn County, is 15 ft of gray deltaic shale there and northward. Most of the Mine Creek Shale Member grades southward from the type area into the upper part of the Myrick Station, specifically, the Frog Cemetery limestone bed in eastern Kansas.

The Joe shale bed was named by Price (1981). It is a distinctive and widespread thin dark-gray to black shale extending southward from the top of the Mine Creek Shale Member below the Laberdie Limestone Member and above the Frog Cemetery limestone bed of the Myrick Station Limestone Member. The reference section for the Joe shale bed is 1.3 mi (2 km) northwest of Joe triangulation station in northeast Labette County, located along the south side of section line road in the NW NE sec. 7, T. 31 S., R. 21 E. The Joe shale ranges from 0.2 to 1 ft (5 cm–0.3 m) thick and merges southward with the top of the Anna Shale near the Kansas–Oklahoma border (Price, 1981).

Laberdie Limestone Member

The Laberdie Limestone Member overlies the Mine Creek Shale Member and its southern extension, the Joe shale bed, and underlies the Bandera Shale. It was named by Jewett (1941) from a quarry near Laberdie Creek in SW sec. 6, T. 23 S., R. 25 E., 1 mi (1.6 km) west of Prescott, Linn County, Kansas. The unit is equivalent northward to the Coal City Limestone Member defined by Cline (1941, p. 64) from a locality in Iowa. The Laberdie is approximately 15 ft (4.5 m) thick in Kansas, but thickens to 50 ft (15 m) in Oklahoma where it becomes the main part of the Oologah Limestone (Price, 1981).

Bandera Shale

The Bandera Shale overlies the Pawnee Limestone and underlies the Altamont Limestone. It was named by Adams et al. (1903) from Bandera Station in Bourbon County. It ranges from 20 to 75 ft of shale, mudstone, and sandstone. The Bandera Quarry sandstone bed is lowered in rank from member status. The Mulberry coal bed lies in the lower part of the Bandera Shale from Bourbon County northward. A post-Mulberry marine horizon overlies the Mulberry coal and consists of limestone in some places (e.g., near Marmaton in Bourbon County) and fossiliferous shale northward in Missouri.

Holdenville Subgroup

The Holdenville Shale was defined by Taff (1901) in southern Oklahoma. The name was applied by Jewett (1959) to just the shale overlying the Lenapah Limestone and underlying the Hepler Sandstone in Kansas because of correlations by Oakes (1952) now known to be incorrect (see Heckel, 1991). The term Holdenville Subgroup is now used in Kansas to include the Altamont Limestone, Nowata Shale, Lenapah Limestone, Memorial Shale, and Lost Branch Formation. This is because ammonoid and conodont faunas suggest that the type Holdenville Shale of Oklahoma is equivalent to the interval from the base of the Altamont Limestone to the top of the Lost Branch Formation (Heckel, 1991).

Altamont Limestone

The Altamont Limestone, named by Adams (1896) from Altamont, Kansas, overlies the Bandera Shale and underlies the Nowata Shale. The members consist in ascending order of the Amoret Limestone (Greene and Searight, 1949), Lake Neosho Shale (Jewett, 1941), and Worland Limestone (Cline, 1941). Although studied in detail by Schenk (1967), no changes are made in classification or nomenclature.

Nowata Shale

The Nowata Shale, named by Ohern (1910) from Nowata, Oklahoma, overlies the Altamont Limestone and underlies the Lenapah Limestone. It ranges from 1 or 2 ft of shale and mudstone up to 50 ft of shale and sandstone at the Kansas–Oklahoma border. The Walter Johnson sandstone bed within the Nowata Shale is lowered in rank from member status because of only local development.

Lenapah Limestone

The Lenapah Limestone, named by Ohern (1910) from Lenapah in Nowata County, Oklahoma, overlies the Nowata Shale and underlies the Memorial Shale. The formation consists, in ascending order, of the Norfleet Limestone, Perry Farm Shale, and Idenbro Limestone Members.

Norfleet Limestone Member

The Norfleet Limestone Member overlies the Nowata Shale and underlies the Perry Farm Shale Member. It was named by Jewett (1941) from a farm near Mound Valley in Labette County. It ranges from 1 to 5 ft of limestone, typically sandy and calcarenitic in the base and calcilutitic above. This unit thickens southward to 12 ft in the Lenapah type area in Oklahoma and is equivalent to Eleventh Street limestone of Tulsa, Oklahoma, area (Heckel, 1991).

Perry Farm Shale Member

The Perry Farm Shale Member overlies the Norfleet Limestone Member and underlies the Idenbro Limestone Member. Named by Jewett (1941) from a farm west of Angola in Labette County, it is 12 ft of gray shale in the type area. The upper part grades northward into sandstone in Bourbon County and joins the base of the Memorial Shale where overlying Idenbro Limestone Member disappears in central Linn County (Heckel, 1991). The Perry Farm mostly grades southward into the top of the Norfleet Limestone Member in the Lenapah type area in Nowata County, Oklahoma, and thickens southward to 60 ft of shale and sandstone as the lower member of the type Memorial Shale in the Tulsa area (Heckel, 1991).

Idenbro Limestone Member

The Idenbro Limestone Member overlies the Perry Farm Shale Member and underlies the upper member of the Memorial Shale in Kansas. Named by Jewett (1941) from a locality southwest of Parsons in Labette County, it averages 5 ft of skeletal calcilutite in the type area and southward to Nowata County, Oklahoma. The Idenbro thins northward and pinches out into the Memorial Shale in central Linn County, Kansas (Heckel, 1991).

Memorial Shale

The name Memorial Shale introduced by Dott (1941) from the Tulsa area was reinstated and redefined by Heckel (1991) to include the shale interval overlying the Lenapah Limestone (Eleventh Street limestone member) and underlying the Lost Branch Formation. It contains strata equivalent to the Perry Farm Shale and Idenbro Limestone Members of the Lenapah Limestone inthe Tulsa area. Its unnamed upper member ranges from 2 to 3 ft of gray mudstone above the Idenbro Limestone Member in Labette and Neosho counties, where it contains the Dawson coal bed (named from Tulsa) at the top. Northward it thickens to 8 ft in Bourbon County and to about 23 ft along the Marais des Cygnes River in Linn County, where it overlies the Norfleet Limestone Member of the Lenapah and includes strata equivalent to the Perry Farm Shale and Idenbro Limestone Members of the Lenapah in its lower part (Heckel, 1991), just as in its type area around Tulsa.

Lost Branch Formation

The Lost Branch Formation overlies the Memorial Shale and underlies the Hepler Formation of the Pleasanton Group. The Lost Branch is a new formation (Heckel, 1991) equivalent, in part, to what was previously considered Holdenville Shale. The type locality is an exposure 15 ft (4.5 m) thick along a cutbank on the west side of Lost Branch, near center NE NE NE sec. 10, T. 33 S., R. 18 E., just southwest of Mound Valley, Labette County, Kansas (Heckel, 1991).

The base of the formation locally is the thin Sni Mills Limestone Member, named from Missouri and extending a short distance into east-central Kansas. The Sni Mills is overlain by the distinctive 1-ft-thick phosphatic Nuyaka Creek black shale bed, named from Oklahoma by Bennison (1981), which extends along the entire Kansas outcrop. Above this is 5–14 ft of unnamed gray shale. This shale is capped locally in southern Kansas by the Glenpool limestone bed, named from Oklahoma by Bennison (1984). Biota in the Lost Branch include the youngest known midcontinent occurrence of the conodont *Neognathodus*, the brachiopod *Mesolobus*, and several typically Desmoinesian ammonoid genera (Boardman and Mapes, 1984).

Upper Pennsylvanian Series
Missourian Stage

Pleasanton Group
by P. H. Heckel and W. L. Watney

The Pleasanton Group overlies the Lost Branch Formation (the top of the Marmaton Group) and is overlain by the Hertha Limestone at the base of the Kansas City Group. It is named for exposures near Pleasanton in Linn County, Kansas. The Pleasanton Group is approximately 100 ft (30 m) thick near the Missouri border and thins to less than 30 ft (9 m) thick in Neosho and Labette counties. The Pleasanton Group is redefined to include two new formations, the Hepler Formation overlain by the Shale Hill Formation. The Pleasanton previously comprised, in ascending order, the Seminole Formation (including the Hepler Sandstone and South Mound Shale Members), Checkerboard Limestone, and Tacket Formation. The Seminole Formation contained two members, the Hepler Sandstone and South Mound Shale. The Seminole Formation had been extended from Oklahoma into Kansas by Jewett and others (1965), but it is probably equivalent to just the lower part of the Hepler Formation of the Pleasanton Group and is dropped from use in Kansas. The Checkerboard Limestone is lowered from formation to member status and is included in the Tacket Formation. The Tacket is now recognized to be the southern equivalent of both the upper Pleasanton (Shale Hill Formation), and the Hertha through Swope formations of the Kansas City Group. Therefore it includes strata above the Pleasanton as well as the southern equivalent of the upper Pleasanton Group, and it is treated separately as part of the Coffeyville Group.

Hepler Formation

The Hepler Formation is redefined to include all strata between the top of the Lost Branch Formation and the base of the Exline Limestone Member of the overlying Shale Hill Formation. The Hepler Formation comprises nonmarine sandy shales, sandstones, and mudstones with a coal bed ("Hepler"), and includes the marine South Mound Shale Member at the top in southern Kansas.

The Hepler was originally named as a sandstone by Jewett (1940) based on a type section in southern Bourbon County. Recent work by Sutton (1985), Bennison (1985), and Heckel (1991) has shown that sandstone that had been called Hepler is developed at three stratigraphic horizons in Bourbon County, Kansas. The original Hepler type section of Jewett (1940) is actually a sandstone facies of the older Perry Farm Shale Member of the Lenapah Limestone. A neostratotype for the Hepler at its traditional stratigraphic position in all the rest of Kansas is designated at an exposure of sandstone and shale along Kansas Route 39 at SE corner sec. 4 and NW corner sec. 10, T. 27 S., R. 22 E., approximately 2 mi (3.2 km) northwest of the original type Hepler. The boundaries of the formation are delimited in the nearby Prong Creek core (Heckel, 1991, p. 41–43).

South Mound Shale Member

The South Mound Shale Member is a distinctive marine shale unit in the top of the Hepler Formation in southern Kansas. It overlies the "Hepler" coal bed and locally sandstone in the lower part of the Hepler and underlies the Exline Limestone Member of the Shale Hill Formation or the Checkerboard Limestone Member of the Tacket Formation where the latter is present in extreme southern Kansas. The South Mound Shale was named by Jewett et al. (1965), who designated the type section just south of Mound Valley in Labette County, Kansas (center SE SW sec. 2, T. 33 S., R. 18 E.). Reference sections have been designated by Heckel (1991) in SW NE sec. 10, T. 33 S., R. 18 E. near the Lost Branch stratotype and along the north line of NE NE NW sec. 15, T. 30 S., R. 20 E., near the village of South Mound in sourthern Neosho County. The South Mound Shale Member consists mainly of marine shale with thin argillaceous limestone at the base and local thin sandstone or coal at the top. It ranges in thickness from 12 ft at South Mound to 28 ft at Mound Valley.

Shale Hill Formation

The Shale Hill Formation overlies the Hepler Formation and underlies the Mound City Shale Member of the Hertha Limestone. It comprises, in ascending order, the Exline Limestone Member, Unity Farm Shale Member, Critzer Limestone Member, and Guthrie Mountain Shale Member. The latter two members were formerly part of the Hertha Limestone. The Shore Hill was named by Howe (1982) from a complete exposure in a brick pit in Shale Hill at Utica, west of Chillicothe, Livingston County, Missouri, and is redefined to correlatable boundaries for use in Kansas.

Exline Limestone Member

The Exline Limestone Member overlies the Hepler Formation, including the South Mound Shale Member to the south, and underlies the Unity Farm Shale Member. The Exline was named by Cline (1941) from a stream bed exposure south of Exline, Iowa, just north of the Missouri border. The Exline ranges from argillaceous limestone to calcareous crinoid-rich shale, rarely more than 1 ft thick and generally poorly exposed in Kansas. The best reference section for the Exline Limestone Member in Kansas is in a roadcut east of Turkey Creek, 3 mi (5 km) northeast of Uniontown in Bourbon County (north side, in center NW NW NW sec. 12, T. 25 S., R. 22 E.).

Unity Farm Shale Member

The Unity Farm Shale Member lies above the Exline Limestone Member and below the Critzer Limestone Member. It was named by Howe (1982) from Jackson County, Missouri, and its upper boundary is extended upward to a correlatable horizon in Kansas. It constitutes most of the Pleasanton Group in northern Linn County, Kansas, where it is at least 100 ft (30 m) thick. The shale is gray with various thicknesses of sandstone in the upper part locally toward the north. The upper part is well exposed along a road extending down a hill west of the north end of Pleasanton (near N-line NW NW sec. 34, T. 21 S., R. 24 E.). The complete Unity Farm interval is partially exposed in the northern K–69 roadcut 4 mi south of Pleasanton (center west line of sec. 19, T. 22 S., R. 25 E.), where it is 25 ft thick.

Critzer Limestone Member

The Critzer Limestone Member overlies the Unity Farm Shale and underlies the Guthrie Mountain Shale Member. It was named by Jewett (1932) from a type locality in sec. 17, T. 22 S., R. 23 E., just south of the former town of Critzer, 5 mi (8 km) west of Mound City in Linn County. It was considered the lower member of the Hertha Limestone (Moore, 1949), but is now included as a member of the Shale Hill Formation in the Pleasanton Group because of closer stratigraphic relations. Reference sections include the hill west of the north end of Pleasanton (near center N line SW, sec. 34, T. 21 S., R. 24 E.), and a roadcut northwest of Xenia (south line SW SE SE sec. 20, T. 23 S., R. 22 E.) in northwesternmost Bourbon County. It is largely brown-weathering fine skeletal calcarenite. Thicknesses in east-central Kansas range from 9 ft (2.7 m) in Bourbon and central Linn counties to commonly 1 or 2 ft (0.3 or 0.6 m) of shaly nodular limestone to the north.

The Bourbon flags are a facies of the Critzer Limestone. They consist of alternating 0.3–1-ft (0.1–0.3 m)-thick beds of flaggy calcilutites and gray silty shales in places gradational with the top of the Unity Farm Shale Member. This unit occurs along a restricted area of rapid southeastward thinning of the underlying Unity Farm Shale Member in southeastern Linn County and north-central Bourbon County. The flags are thought to be a slope facies of the Critzer Limestone Member, which is typically developed north of the flags. Maximum thickness of the Bourbon flags is approximately 35 ft (10.6 m). Good reference sections are along the northern US–69 roadcut 4 mi south of Pleasanton (west line NW NW SW sec. 19, T. 22 E., R. 25 E.), the spillway to Hidden Valley Lake 4 mi west of Mapleton (SE SW SE sec. 23, T. 23 S., R. 22 E.), and nearby roadcuts.

Guthrie Mountain Shale Member

The Guthrie Mountain Shale Member lies above the Critzer Limestone Member and below the basal black shale bed of the Mound City ShaleMember of the Hertha Limestone. It is newly named (Heckel, in prep.) for a stratigraphically distinct shale unit previously included as the lower portion of the Mound City Shale Member, but which had been identified as the upper part of the Pleasanton Group where it is thick in southern Linn County and most of Bourbon County. The type section is designated in a good exposure along the road near center NW sec. 8, T. 24 S., R. 23 E., 1.5 miles southwest of Guthrie Mountain, south of Mapleton in Bourbon County, where it is

70 ft (21 m) thick. It thins southward through 15 ft south of Uniontown, to 1 or 2 ft in the base of the Tacket Formation. It thins northward to 2 to 4 ft (0.6 to 1.2 m) of gray blocky mudstone (underclay) capped by the Ovid Coal in Missouri. A reference section to the north is the second roadcut along US–69 north of LaCygne Junction in Linn County, where a complete section of the thin shelf facies (3 ft [0.9 m]) of the Guthrie Mountain Shale Member is exposed below the black facies of the Mound City Shale.

Coffeyville Group

by P. H. Heckel and W. L Watney

The Coffeyville Formation was named by Schrader and Haworth (1905) after Coffeyville, Kansas. The name has been used mainly in Oklahoma, but is extended as a group into southern Kansas in view of its usefulness in delineating a dominant siliciclastic stratigraphic interval equivalent to the top of the Pleasanton and base of the Kansas City Groups. It is defined here to include in ascending order the Tacket Formation (redefined), Ladore Shale, Mound Valley Limestone (reinstated), and Galesburg Shale. The group is restricted to an area in southern Kansas where the upper portion of the Pleasanton Group thins nearly to disappearance and most of the overlying Bronson Subgroup of the Kansas City Group becomes predominately siliciclastic. Locally thick sandstones occur in the Galesburg Shale between the Mound Valley Limestone below and the Dennis (Hogshooter) Limestone above. Formations above the Tacket are discussed under the Bronson Group.

Tacket Formation

The Tacket Formation (named by Jewett et al., 1965) is redefined to include the dark shale-dominated equivalents to the stratigraphic interval extending from the Checkerboard Limestone or the position of the Exline Limestone Member of the Shale Hill Formation of the Pleasanton Group up through the Bethany Falls Limestone Member of the Swope Limestone. Recent lithostratigraphic and biostratigraphic recorrelations have warranted this redefinition (Pavlicek, 1986; Heckel, in prep.). Members constituting the redefined Tacket Formation include in ascending order: Checkerboard Limestone, Lower Tacket Shale (largely equivalent to the Mound City Shale), Middle Tacket Limestone, Upper Tacket Shale (largely equivalent to the Hushpuckney Shale), and Bethany Falls Limestone Member.

The Checkerboard Limestone Member, as recognized in extreme southern Kansas, overlies the South Mound Shale Member of the Hepler Formation and underlies the lower Tacket Shale Member. Named from Okmulgee County, Oklahoma (Oakes, 1940), the type Checkerboard is probably equivalent to the South Mound Shale Member as well (Heckel, in prep.). The best exposure in Kansas is along the top of the high bank of Pumpkin Creek in SW NE sec. 10, T. 33 S., R. 18 E. in Labette County, Kansas, where it is about 1 ft thick, consisting of dense skeletal calcarenite (Heckel, 1991, p. 45).

Because the type exposure of the Tacket Formation designated by Jewett et al. (1965, p. 7–8) along west side of sec. 17, T. 32 S., R. 19 E. is poorly exposed, a neostratotype is established on the northeast side of Tacket Mound (near NE corner of SW sec. 7, and creek bank in SW SW NE sec. 7, T. 32 S., R. 19 E.) in Labette County, Kansas. The interval consists of dark-gray shale to black shale with thin limestone beds and nodule horizons lying above the South Mound Shale Member of the Hepler Formation. The Tacket Formation is overlain by the Ladore Shale. The Tacket ranges from 40 ft (12m) thick in the south to 30 ft (9m) in central Neosho County. Northward the interval thickens as the various units to which it is equivalent (Shale Hill Formation, Hertha Limestone, Elm Branch Shale, Swope Limestone) appear and thicken.

The considerable attenuation of both siliciclastics and carbonates and the predominance of organic-rich shale in the Tacket Formation is attributed to deposition in deeper water in a low shelf to basin margin setting (Watney et al., 1989). Water depth apparently remained great enough through various sea-level fluctuations to limit carbonate sedimentation, at a time while the area of southern Kansas and northeastern Oklahoma remained sufficiently distant from siliciclastic sources to limit their contribution.

Kansas City Group

by P. H. Heckel and W. L. Watney

Bronson Subgroup

The Bronson Subgroup of the Kansas City Group consists of the following formations in northeastern Kansas in ascending order: Hertha Limestone, Elm Branch Shale, Swope Limestone, Galesburg Shale, and Dennis Limestone. In southern Kansas, the Ladore Shale and Mound Valley Limestone intervene between the Swope Limestone and the Galesburg Shale.

Hertha Limestone

The Hertha Limestone overlies the Shale Hill Formation of the Pleasanton Group and underlies the Elm Branch Shale. Originally named by Adams et al. (1903) from exposures around the former town of Hertha situated at center south line, sec. 29, T. 29 S., R. 20 E., in Neosho County, the type locality of the Hertha Limestone as stabilized by Moore (1936) was incorrectly correlated (Heckel, in prep.). The limestone at this locality is actually the Bethany Falls Limestone. Thus a new principal reference section (neostratotype) for the Hertha is defined nearby (center N/2 NE sec. 32, T. 29 S., R. 20 E.) along a western tributary to Bachelor Creek. The Hertha Limestone is also redefined to include only the Mound City Shale and Sniabar Limestone Members.

Mound City Shale Member

The Mound City Shale Member of the Hertha Limestone overlies the Guthrie Mountain Shale Member of the Shale Hill Formation (Pleasanton Group) and underlies the Sniabar Limestone Member. It was named by Jewett (1932) as the shale between the Critzer and Sniabar Limestones. The Guthrie Mountain Shale is now removed from the lower part (Heckel, in prep.), and the base of the Mound City is redefined as the base of the distinctive black to dark-gray phosphatic shale bed (including underlying thin lenticular limestone); the phosphatic shale bed is traceable across eastern Kansas from Iowa to Oklahoma. Above the black shale, the Mound City includes a thin earthy to crinoidal limestone overlain by thick gray shale in southeastern Linn and central to western Bourbon counties. Good Mound City reference sections include the second US–69 roadcut north of LaCygne Junction and a roadcut northwest of Xenia in northwestern Bourbon County, Kansas (SW SE SE sec. 20, T. 23 S., R. 22 E.) where it is thin, and the Uniontown roadcut, 1 mi south of Uniontown on K–3, where it is 40 ft (12 m) thick. The basal black shale bed of the Mound City Shale Member is continuous with the black shale in the Lower Tacket Shale in extreme southern Kansas.

Sniabar Limestone Member

The Sniabar Limestone Member overlies the Mound City Shale Member and underlies the Elm Branch Shale. It was named by Jewett (1932) from a locality in Jackson County, Missouri. In Kansas, it is commonly a massive ledge of skeletal calcilutite ranging in thickness from 2 to 20 ft (0.6–6 m). Well-exposed reference sections include the second US–69 roadcut north of LaCygne Junction where it is 4 ft thick, and the Uniontown roadcut, where it is about 20 ft of algal mound facies. From there it thins southward to a few feet of cherty skeletal calcilutite in northeastern Neosho County, and to less than 1 ft of argillaceous calcilutite at the Hertha neostratotype.

Elm Branch Shale

The Elm Branch Shale overlies the Hertha Limestone (Sniabar Limestone Member) and underlies the Swope Limestone (Middle Creek Limestone Member). The name Elm Branch is reinstated for the unit previously called Ladore Shale in east-central and northeastern Kansas, as the result of the correction of the northward miscorrelations of the type sections of the Hertha Limestone, Ladore Shale, and Mound Valley Limestone in Neosho and Labette counties (Heckel, in prep.).

The name Elm Branch Shale was proposed by N. D. Newell (as mentioned by Jewett, 1932), but not formally adopted. Because the originally intended type section of the Elm Branch is only partly exposed, a roadcut 1 mi southwest of Fontana in Miami County is selected as the principal reference section (E line SE SE NW sec. 10, T. 19 S., R. 23 E.). Thickness ranges from 1 ft to 12 ft (0.3–3.6 m) in east-central Kansas and northward, but is in excess of 40 ft (12 m) thick with local sandstone in Neosho County.

Swope Limestone

The Swope Limestone overlies the Elm Branch Shale. It underlies the Galesburg Shale in northeast to east-central Kansas and the Ladore Shale in southeastern Kansas (Heckel, in prep.). The term Swope Limestone from Swope Park in Kansas City, Missouri, was first used by Moore (1932) and stabilized by Newell (1935). The unit comprises three members, in ascending order: Middle Creek Limestone, Hushpuckney Shale, and Bethany Falls Limestone.

Middle Creek Limestone Member

The Middle Creek Limestone Member is a thin dense limestone that overlies the gray Elm Branch Shale and underlies the black Hushpuckney Shale Member. It was named by Jewett (1932) and defined by Newell (1935, p. 26, 148) from exposures east of Middle Creek with a type section on the highway 3 mi east of LaCygne (W of SE corner sec. 36, T. 29 S., R. 24 E.) in Linn County, Kansas. It is a dense skeletal calcilutite about 2 ft (0.6 m) thick in eastern Kansas, and it thickens southward to 4 or 5 ft (1.2–1.5 m) in western Bourbon County before it pinches out in Neosho County.

Hushpuckney Shale Member

The Hushpuckney Shale Member overlies the Middle Creek Limestone Member and underlies the Bethany Falls Limestone Member. The name was introduced by Jewett (1932) and defined by Newell (1935, p. 27) from Hushpuckney Creek in south-central Miami County. The principal reference section is in the roadcut along the center east line SW sec. 34, T. 19 S., R. 23 E., 5 mi west of La Cygne; another good section is on U.S–169 south of Pleasanton (NE corner sec. 25, T. 22 S., R. 24 E.). The Hushpuckney ranges from 1.5 to 5 ft (0.45–1.5 m) of gray and black phosphatic shale. The unit merges southward with the black shale in the Upper Tacket Shale in southern Kansas.

Bethany Falls Limestone Member

The Bethany Falls Limestone Member overlies the Hushpuckney Shale Member, and underlies the Galesburg Shale in northern Kansas and the Ladore Shale in southern Kansas. The Bethany Falls Limestone Member was named by Broadhead (1868) from exposures at the falls in Big Creek near Bethany in northwestern Missouri. The principal reference section in Kansas is in the roadcut northwest of Xenia (center S line SE sec. 20, T. 23 S., R. 22 E.) in Bourbon County. It averages 15 to 35 ft (4.5–10.6 m) thick from central Kansas northward and includes a lower, often conspicuously mottled, skeletal calcilutite commonly overlain by an oolitic grainstone at the top. The Bethany Falls Limestone Member thins to about 4 ft of skeletal calcilutite in extreme southern Kansas where it becomes the upper member of the Tacket Formation.

Ladore Shale

The Ladore Shale was named by Adams (1896) from the former town of Ladore in southern Neosho County. In its type area, the Ladore overlies the Bethany Falls Limestone Member and underlies the Mound Valley Limestone (reinstated, see below). Because of early miscorrelation of both these limestones respectively with the Hertha Limestone and Bethany Falls Limestone in northeastern Kansas, the Ladore has been mistakenly correlated northward with the unit now known to be the Elm Branch Shale (Heckel, in prep.). The type Ladore consists of up to about 60 ft of gray shale in southern Kansas and pinches out northward in western Bourbon County. The principal reference section is the exposure of the upper two-thirds of the unit in the spillway of Parsons Lake (NW NW NE sec. 33, T. 30 S., R. 19 E.), about 1 mi (1.6 km) southwest of the type section designated by Moore (1936).

Mound Valley Limestone

The Mound Valley Limestone overlies the Ladore Shale and underlies the Galesburg Shale in southern Kansas. The name Mound Valley was applied by Adams (1896) to limestone capping the hills northwest of Mound Valley in Labette County. It was later discarded by Moore (1936, p. 86), who believed the limestone to be equivalent to the Bethany Falls Limestone. Recent surface and subsurface investigations show that the Mound Valley Limestone occurs in southern Kansas above the Bethany Falls Limestone (Heckel, in prep.), a concept supported early by

Haworth and Bennett (1908). The stratotype is designated as exposures at the top of Dixon Mound along the road near center of south line SE sec. 27, T. 32 S., R. 18 E., about 1 mi (1.6 km) northwest of Mound Valley. Here it consists of 6–8 ft (1.8–2.4 m) of skeletal calcilutite. It thins northward to a few feet of oolite above greatly thinned Ladore Shale and locally rests upon the often oolitic top of the Bethany Falls. It thins southward to 1 or 2 ft of argillaceous limestone at the Oklahoma border.

Galesburg Shale

The Galesburg Shale overlies the Mound Valley Limestone in southern Kansas and the Bethany Falls Limestone from central Bourbon County northward; it underlies the Dennis Limestone everywhere. It was named by Adams et al. (1903) from Galesburg in Neosho County, where it makes the slope south of town (Moore, 1936). It is mainly thin (2–12 ft) gray mudstone from Bourbon County northward, but ranges up to 70 ft southward where sandstone becomes dominant. The most complete reference section is in the bank of Canville Creek, south of the US–59 bridge (NE corner sec. 22, T. 27 S., R. 20 E.), where it is 16 ft thick. The Cedar Bluff coal bed is developed near the middle of the Galesburg Shale southward. The Dodds Creek sandstone is lowered from member to informal bed status. Sandstones above the coal are referred to as upper Dodds Creek and below the coal as lower Dodds Creek. These are often referred to as the Layton sandstones in the subsurface.

Dennis Limestone

The Dennis Limestone overlies the Galesburg Shale and underlies the Cherryvale Formation. It was named by Adams et al. (1903) from exposures near Dennis in northwestern Labette County. The formation comprises three members in ascending order: Canville Limestone, Stark Shale, and Winterset Limestone. The principal reference section is a roadcut 1 mi (1.6 km) southwest of Dennis (center E line NE sec. 21, T. 31 S, R. 18 E.), where all three members are exposed.

Canville Limestone Member

The Canville Limestone Member overlies the Galesburg Shale and underlies the Stark Shale Member. It was named from Canville Creek in northern Neosho County by Jewett (1932). The principal reference section is an exposure along US–59, 1.7 mi (3 km) west of Stark (S line SW SE SW sec. 13, T. 27 S., R. 20 E.). The Canville Limestone Member typically consists of 2 to 3 ft (0.6–0.9 m) of dense skeletal calcilutite in Neosho and Bourbon counties, but thins northward to disappearance in northern Linn County.

Stark Shale Member

The Stark Shale overlies the Canville Limestone Member and underlies the Winterset Limestone Member. It was named from the town of Stark in northeastern Neosho County by Jewett (1932). The principal reference section is established along US–59 less than 1.7 mi (3 km) southwest of Stark, in the same roadcut as that of the Canville Limestone (S line SW SE SW sec. 13, T. 27 S., R. 20 E.). The Stark Shale in its type region and generally throughout Kansas ranges from 1 to 4 ft (0.3–1.2 m) of mostly black fissile phosphatic shale overlain by gray fossiliferous shale.

Winterset Limestone Member

The Winterset Limestone Member overlies the Stark Shale Member and underlies the Cherryvale Formation (Fontana Shale Member). It was named by Tilton and Bain (1897) from Winterset, Iowa. The principal reference section of the Winterset Limestone in Kansas is a complete exposure in a roadcut along US–69 by Jingo (along W line SW SW SE sec. 31, T. 18 S., R. 25 E.) in Miami County. Here the unit is 34 ft (10.3 m) thick, mostly bedded skeletal calcilutite.

Here also, the lower two-thirds comprise three shallowing-upward minor cycles, the lower capped with thin oolite, the middle capped with peritidal calcilutite, and the upper capped by a mottled subaerial exposure surface (Heckel and Watney, 1985). Oolite and phylloid algal mound facies become more dominant southward. The upper one-third of the Winterset Limestone Member above the exposure surface is a separate cycle of deposition. It displays similarities to the lower Winterset southward, but northward becomes dark and cherty in the Kansas City area. The upper and lower units of the Winterset Limestone Member separated by the exposure surface can be distinguished across the outcrop region from the northern shelf toward the basin margin in southern Kansas (Heckel,

in prep.). The upper Winterset unit appears to be equivalent to most of the Hogshooter Limestone, named by Ohern (1910) from a locality east of Bartlesville in Washington County, Oklahoma.

Linn Subgroup

The Linn Subgroup of the Kansas City Group is redefined to include the following formations in ascending order: Cherryvale Formation, Nellie Bly Formation (newly extended into Kansas), Dewey Limestone (newly recognized in Kansas), and Chanute Shale. The Iola Limestone is now included in the overlying Zarah Subgroup because of its closer association with those strata.

Cherryvale Formation

The Cherryvale Formation overlies the Dennis Limestone and underlies the Nellie Bly Formation throughout Kansas. Named by Haworth (1898) from bluffs around Cherryvale in Montgomery County, usage and subdivision was stabilized by Moore (1948, 1949). The Cherryvale in northeastern Kansas now comprises four members, in ascending order: Fontana Shale, Block Limestone, Wea Shale, and Westerville Limestone. All terms originated from northeast Kansas except for the Iowa term Westerville. The Quivira Shale once included above the Westerville is now recognized as a member of the Dewey Limestone (see below).

In parts of southern Kansas the Cherryvale succession comprises, in ascending order: Lower Shale Member, Middle Flaggy Limestone Member, and Drum Limestone Member. The Drum Limestone is now included as a member of the Cherryvale Formation in southern Kansas because it is stratigraphically closely related to the underlying members and is now recognized to occupy the same stratigraphic position as the Westerville Limestone Member in northeast Kansas (Heckel, ms. in prep.). The Lower Shale and Middle Flaggy Limestone Members are recognized in Montgomery County where the Block Limestone and Wea Shale Members are not differentiated.

The type section of the Cherryvale is designated in the exposure on a hillslope and road ditch just south of a road intersection north of center E line of SE sec. 32, T. 31 S., R. 17 E., 2 mi (3.2 km) north of Cherryvale. This exposure includes in ascending order, the upper 60 ft of the Lower Shale Member, 4 ft (1.2 m) of Middle Flaggy Limestone Member, and 2 ft (0.6 m) of Drum Limestone. A good reference section nearby for the Cherryvale Formation containing the Block Limestone, Wea Shale, and Drum Limestone Members is at a new roadcut east of US–160-169 junction, about 3 mi (4.8 km) south of Cherryvale along N line NE sec. 31, T. 32 S., R. 17 E.

Fontana Shale Member

The Fontana Shale overlies the Winterset Limestone Member and underlies the Block Limestone Member. It was named by Newell (1935) from exposures near Fontana in Miami County. The principal reference section is the US–69 roadcut along W line SW NE sec. 6, T. 19 S., R. 25 E., just south of the Winterset reference section by Jingo. The Fontana Shale in its type area ranges from 12 to 18 ft (3.6–5.5 m) of gray shale to mudstone with small carbonate nodules and, in upper part, scattered marine fossils. Northward in the Kansas City area, the unit thins to 5 ft (1.5 m), consisting of blocky mudstone overlain by marine shale with a thin sandstone.

Lower Shale Member

The informal Lower Shale Member is defined (Heckel, in prep.) where the Block Limestone is not recognized in parts of Montgomery County, Kansas. It overlies the Winterset Limestone Member, and thus is partly equivalent to the Fontana Shale Member. Its upper contact is gradational with the informal Middle Flaggy Limestone Member. The Lower Shale Member consists of about 95 ft (29 m) of unfossiliferous gray shale with scattered limestone concretions at the Cherryvale type section north of Cherryvale. It thins southward nearly to disappearance between the top of the Winterset and the overlying flaggy member in an outcrop west of Coffeyville.

Block Limestone Member

The Block Limestone Member overlies the Fontana Shale Member and underlies the Wea Shale Member. Named by Newell (1935), the type exposure is in the road ditch at center N line NW sec. 7, T. 18 S., R. 24 E., just east of the village of Block in Miami County. The Block Limestone Member averages 3 to 4 ft (0.9–1.2 m) of dense gray skeletal calcilutite in its type area and thins northward to 1 ft in Kansas City. In southern Kansas the Block Limestone occurs at the Cherryvale reference section south of Cherryvale where it is 1 ft of dense calcarenite. It may be identified locally within the Middle Flaggy Limestone southward (Heckel, in review).

Wea Shale Member

The Wea Shale Member overlies the Block Limestone everywhere, and underlies the Westerville Limestone Member in northeastern Kansas, the Nellie Bly Formation in east-central Kansas, and the Drum Limestone in southeastern Kansas (Heckel, in prep.). It was named by Newell (1935) from Wea Creek in northeastern Miami County. Because the Westerville Limestone is absent in this area and the original type sections expose only strata now known to belong to the Nellie Bly Formation above the position of the Westerville Limestone (Heckel, in prep.), two new principal reference sections are designated. One is above the type exposure of the Block Limestone given earlier where the Wea Shale interval is 27 ft (8.2 m) thick, overlain by sandstone assigned to the Nellie Bly. The other is 2 mi (3.2 km) to the west-northwest (along E line, S of NE corner sec. 3, T. 18 S., R. 23 E.), where the base consists of 3 ft (0.9 m) of gray shale, with thin crinoidal limestone 1 ft above the base. The Wea Shale ranges northward from 30 ft of gray shale along Tomahawk Creek in Johnson County to 7 ft of gray shale with thin limestones (often with conspicuous brachiopods) along the Kansas River in Wyandotte County.

Middle Flaggy Limestone Member

The informal Middle Flaggy Limestone Member overlies the Lower Shale Member and underlies the Drum Limestone Member where the Block Limestone Member is not recognized and the Wea Shale is not differentiated in Montgomery County, Kansas. The unit ranges in thickness from about 4 ft (1.2 m) of shale with scattered flaggy limestone beds at the type section of the Cherryvale Formation (given earlier) to around 20 to 30 ft (6–9.1 m) of interbedded flaggy limestone and shale in scattered outcrops along Clear Creek in sec. 28, T. 33 S., R. 16 E and in roadcuts north of Coffeyville. The flaggy limestone thins toward the southern border of Kansas where it is a 3-ft (0.9-m)-thick ledge of dense, laminated calcilutite above the Winterset Limestone in a roadcut west of Coffeyville, Kansas (NW corner sec. 5, T. 35 S., R. 16 E.) (Heckel, in prep.).

Westerville Limestone Member

The Westerville Limestone Member overlies the Wea Shale Member and underlies the recently recognized Nellie Bly Formation in northeastern Kansas. It forms the top of the Cherryvale Formation in northeastern Kansas and is now thought to be equivalent to the Drum Limestone of southern Kansas. The Westerville was named from Westerville, Iowa (Bain, 1898) and was grouped by Moore (1948, 1949) in the Cherryvale Formation. The principal reference section in Kansas is along the north side of I-70 between the 18th Street and Park Road exits (NW SE NW sec. 17, T. 11 S., R. 25 E) in Wyandotte County. The basal Westerville is about 8 ft of skeletal calcilutite; the middle is an oolite that ranges from a few inches to about 20 ft (6 m) at Leawood; the upper Westerville is up to 10 ft of shaly barren laminated calcilutite.

Drum Limestone Member

The Drum Limestone Member overlies the Wea Shale Member and the Middle Flaggy Limestone Member and underlies the Nellie Bly Formation in southern Kansas. It was named by Adams et al. (1903) from Drum Creek near Independence in Montgomery County. Its principal reference section is at the Cherryvale reference section south of Cherryvale (N line NE sec. 31, T. 32 S., R. 17 E.), where it consists of 2 ft of skeletal calcilutite overlain by 4 ft of oolite. Moore (1936, 1949) had correlated the Drum with the Cement City Limestone of Missouri and with the Dewey Limestone of Oklahoma. This correlation stood until A. P. Bennison found the Cement City Limestone and underlying Quivira Shale in a position 20 ft (6 m) above the Drum in its type region (in a ravine into the Verdigris River just north of center S line NE sec. 19, T. 32 S., R. 16 E). Thus the Drum Limestone Member occupies the same stratigraphic position as the Westerville Limestone Member of the Cherryvale Formation. The Quivira Shale has subsequently been found beneath the Dewey Limestone in Oklahoma, and accordingly the Cement City and Quivira are reclassified into the Dewey Limestone (see below). The Drum Limestone ranges from about 70 ft of mainly oolite just east of Independence thinning northward to 1 ft in southern Neosho County and thinning southward into the top of the Middle Flaggy Limestone Member north of Coffeyville. Surface and subsurface investigations by Feldman and Franseen (1991) characterize the stratal correlations and geometries in the area around Independence.

Nellie Bly Formation

The Nellie Bly Formation is now recognized to overlie the Cherryvale Formation (including both the Drum and Westerville Limestone Members) and to underlie the Dewey Limestone (Quivira Shale Member) in Kansas. The name was applied by Ohern (1914, unpublished ms.) and Gould (1925) to shale and sandstone above the Hogshooter (Dennis) Limestone and below the Dewey Limestone in northern Oklahoma. The type section was designated by Oakes (1940) in exposures along Nellie Bly Creek in secs. 28, 29, 31, 32, T. 24 N., R. 13 E. southwest of Ramona, Washington County, Oklahoma. In its type area the Nellie Bly ranges from 115 to 180 ft (35–55 m) of sandy shale to sandstone. The Nellie Bly had been considered by Moore (1948, p. 2,031) to be the southern equivalent of the Cherryvale Formation, but it now is known to overlie the Cherryvale, which thins southward and joins the top of the Hogshooter Limestone in Oklahoma (Heckel, in prep.).

The principal reference section for the Nellie Bly Formation in Kansas is along the Verdigris River (north of center S line, NE sec. 19, T. 32 S., R. 16 E.) on the north side of Independence, where A. P. Bennison discovered it separating the Drum and Dewey limestones. Here the Nellie Bly consists of about 20 ft (6 m) of shale-parted sandstone above the Drum Limestone grading upward to sandy shale below the black Quivira Shale Member of the Dewey. The Nellie Bly is poorly exposed northward, where it is easily confused with the younger Chanute Shale because the Dewey Limestone is thin and often not exposed. In the Kansas City area, the Nellie Bly ranges from a few feet of gray blocky mudstone, typically with calcareous nodules and locally containing a thin coal that previously had been included in the Quivira, to nearly absent in places where the marine Quivira Shale lies directly upon the Westerville Limestone. The Nellie Bly is 0.5 ft thick at a reference section on K–32 (center W/2, SE SE sec. 12, T. 11 S., R. 24 E.) in Wyandotte County.

Dewey Limestone

The Dewey Limestone is now recognized in Kansas to comprise in ascending order the Quivira Shale Member and the Cement City Limestone Member. It overlies the Nellie Bly Formation and underlies the Chanute Shale. The Dewey Limestone was named by Ohern (1910) from exposures in the old cement plant quarry in sec. 26, T. 27 N., R. 13 E., east of Dewey in Washington County, Oklahoma. The principal reference section for the Dewey in southeastern Kansas is just above that for the Nellie Bly in the ravine along the west bluff of the Verdigris River, north of center S line, NE sec. 19, T. 32 S., R. 16 E., on the northern edge of Independence in Montgomery County. Previously, both the Cement City Limestone (named from Missouri) and the Dewey Limestone had been miscorrelated with and considered a member of the Drum Limestone of southern Kansas (see discussion in section on Drum Limestone Member of Cherryvale Formation).

Quivira Shale Member

The Quivira Shale Member overlies the Nellie Bly Formation (and locally the Westerville Limestone Member of the Cherryvale Formation) and underlies the Cement City Limestone Member. It was named by Newell (1932, 1935) from Quivira Lake in Wyandotte County, and was considered to be the top of the Cherryvale Formation by Moore (1948, 1949). Now that the Drum Limestone is considered equivalent to the Westerville, and the Nellie Bly is known to separate both those limestones from the Quivira, the Quivira is removed from the Cherryvale and placed in the Dewey Limestone. The Quivira Shale throughout Kansas is generally 2–5 ft of dark-gray to black shale with local PO_4 nodules and abundant conodonts. The principal reference section is along K–32 at the same locality as the principal reference section for the Nellie Bly Formation in Wyandotte County (center W/2 SE SE sec. 12, T. 11 S., R. 24 E.).

Cement City Limestone Member

The Cement City Limestone Member overlies the Quivira Shale Member and underlies the Chanute Shale everywhere in Kansas. It was named by Hinds and Greene (1917) from a locality northeast of Kansas City in Jackson County, Missouri. Because previous miscorrelation with Drum Limestone of southern Kansas has been rectified, the Cement City is now considered the upper member of the Dewey Limestone. It was previously classified as Corbin City Limestone Member of Drum Limestone. Good reference sections are along K–32 west of I–635 (SW SE SW sec. 7, T. 11 S., R. 25 E.) and along the north side of I–70 (N/2 sec. 17, T. 11 S., R. 25 E.) in Wyandotte County, where it ranges from 6 to 8 ft of skeletal calcilutite. It thins southward to 2–5 ft of brownish calcilutite with conspicuous crinoids. The reference section in southern Kansas is in the ravine on the west side of the Verdigris River north of Independence above the reference section for the Nellie Bly Formation.

Chanute Shale

The Chanute Shale overlies the Dewey Limestone (Cement City Limestone Member) and underlies the Iola Limestone (Paola Limestone Member). Named by Haworth and Kirk (1894) from exposures around Chanute in northwestern Neosho County, the mislocated type section given by Moore (1936) has been rediscovered 1 mi to the east along the center S line SE SE sec. 34, T. 26 S., R. 18 E., where the Chanute is about 20 ft of shale and sandstone, now poorly exposed. Northward, the Chanute is 6–15 ft of sandy shale with sandstone in the Kansas City region. The reference section for northern Kansas is along K–32 west of I–635 above that of the Cement City Limestone Member. Southward the Chanute thickens locally to over 200 ft in southern Kansas. Here it contains the Thayer coal bed (named from southern Neosho County) in the middle, the Noxie sandstone bed (named from Oklahoma) locally in the base in Montgomery County, and the Cottage Grove sandstone bed (named from Allen County) above the Thayer coal. Both sandstones are now reduced in rank from members because of their lenticularity.

Zarah Subgroup

The Zarah Subgroup is redefined to include the following formations in ascending order: Iola Limestone, Liberty Memorial Shale (reinstated), Wyandotte Limestone (redefined), and Lane Shale (redefined).

Iola Limestone

The Iola Limestone overlies the Chanute Shale; it underlies the Liberty Memorial Shale in northeastern Kansas and the Wyandotte Limestone in southeastern Kansas. It comprises three members in ascending order: Paola Limestone, Muncie Creek Shale, and Raytown Limestone. The Iola was named by Haworth and Kirk (1894) for prominent limestone underlying the town of Iola. The type section is at the now-abandoned and partly water-filled cement plant quarry in Iola (NE sec. 2, T. 25 S., R. 18 E.) (Moore, 1936, 1949).

The Iola had been considered to underlie the Lane Shale everywhere. However, it is now recognized that the Argentine Limestone Member of the Wyandotte Limestone descends over the southward pinchout of the shale previously called Lane at Kansas City to directly overlie the Iola below the type Lane Shale of western Miami County (Heckel, in prep.). The shale between the Iola and Wyandotte in the Kansas City area is now termed Liberty Memorial, a reinstated Missouri name (see below).

Paola Limestone Member

The Paola Limestone Member overlies the Chanute Shale and underlies the Muncie Creek Shale Member. It was named by Newell (1932, 1935) from Paola in Miami County. The principal reference section is on a road east of the US–169 underpass on the east side of Paola in NE NW NW sec. 22, T. 17 S., R. 23 E. About 1.5–2 ft of skeletal calcilutite in type area, the Paola thins northward to 1 ft in the Kansas City area, thickens southward to 4 ft in Anderson County, and then thins southward again to 1 ft or less in southern Kansas.

Muncie Creek Shale Member

The Muncie Creek Shale Member overlies the Paola Limestone Member and underlies the Raytown Limestone Member. It was named by Newell (1932, 1935) from Muncie Creek in Wyandotte County. The principal reference section of the Muncie Creek Shale Member is designated along K–32 west of I–635 overpass (SW SE SW sec. 7, T. 11 S., R. 25 E.). The Muncie Creek Shale is 3 ft (0.9 m) of black phosphatic shale overlain and underlain by thin dark-gray shale in the type area. It thins southward to a few inches of gray shale with abundant PO_4 nodules between southern Johnson County and southern Neosho County. Farther southward, it thickens again to 1–3 ft of black and gray phosphatic shale.

Raytown Limestone Member

The Raytown Limestone Member overlies the Muncie Creek Shale Member; it underlies the Liberty Memorial Shale in northeast Kansas and the Wyandotte Limestone in southeastern Kansas. Named by Hinds and Greene (1915) from Raytown in Jackson County, Missouri, a good reference section for the Raytown Limestone Member in Kansas is the roadcut on southbound I–435 offramp at Holliday road (NW NE NW sec. 6, T. 12 S., R. 24 E.) in northern Johnson County. The Raytown in the Kansas City area averages 7 ft of skeletal calcilutite and thickens

southward to about 40 ft (12 m) in Allen and northwestern Neosho counties where it forms a phylloid algal mound complex (Heckel and Cocke, 1969). Higher beds of limestone above shale once included in the Raytown in western Miami, Anderson, Allen, and Neosho counties are now recognized as the southern facies of the Wyandotte Limestone (see below).

Liberty Memorial Shale

The Liberty Memorial Shale overlies the Iola Limestone (Raytown Limestone Member) and underlies the Wyandotte Limestone (Frisbie Limestone Member) in northeastern Kansas. The name Liberty Memorial was originally applied to the shale above the Raytown Limestone and below the Frisbie Limestone Members in Jackson County, Missouri, by Clair (1943). This name was abandoned after Moore (1948) correlated the unit with the previously named Lane Shale. The name Liberty Memorial is now reinstated because recorrelation (Heckel, in prep.) shows that the type Lane Shale in Franklin County, Kansas, actually correlates with the shale interval above the Argentine Member of the Wyandotte Limestone in Kansas City.

The type locality of the Liberty Memorial Shale proposed by Clair (1943) is in Kansas City, Missouri, presumably near a monument of that name in Penn Valley Park (SW sec. 8, T. 49 N., R. 33 W.). The principal reference section for Kansas is established along the I–435 southbound offramp to Holliday Road (NW NE NW sec. 6, T. 12 S., R. 24 E.) in northern Johnson County. The Liberty Memorial Shale here consists of 40 ft (12 m) of gray shale with thin-bedded sandstone toward the top and a thin bed of fossiliferous limestone near the middle. The shale thins southward in northern Miami County to a few feet in quarries west of Paola, where it was included in the upper Raytown Limestone Member by previous workers. It is mostly absent to the south where the Wyandotte Limestone rests directly upon the Iola Limestone.

Wyandotte Limestone

The Wyandotte Limestone as redefined overlies the Liberty Memorial Shale in northeastern Kansas and the Iola Limestone (Raytown Limestone Member) from western Miami County southward; it underlies the Lane Shale (Island Creek Shale Member, reclassified) everywhere. The Wyandotte Limestone was named by Newell (1932, 1935) from Wyandotte County, where it forms prominent bluffs along the Kansas River. Moore (1936) indicated the type locality in cement plant quarries at the east edge of Bonner Springs (sec. 28, T. 11 S, R. 23 E.). Because of uncertain access, the principal reference section for the Wyandotte Limestone and all its currently recognized members is established along the southbound offramp from I–435 to Holliday road (NE NW sec. 6, T. 12 S., R. 24 E.) in northern Johnson County. The Wyandotte Limestone is now restricted to include only the Frisbie Limestone, Quindaro Shale, and Argentine Limestone Members. It previously included the Island Creek Shale and Farley Liemstone at the top. Recorrelation shows that the Island Creek Shale in the Kansas City area is equivalent to the Lane Shale in its type area in Miami County. This is because the Argentine Limestone Member also thins dramatically in Miami County as the underlying Liberty Memorial Shale thins southward; the Argentine then descends to overlie the Iola Limestone without an intervening shale in the Lane type area. The Island Creek Shale and Farley Limestone Members are now included with the overlying Bonner Springs Shale as members of the redefined Lane Shale.

Frisbie Limestone Member

The Frisbie Limestone Member is the basal member of the Wyandotte Limestone, lying above the Liberty Memorial Shale and below the Quindaro Shale Member. It was named by Newell (1932, 1935) for an outcrop east of Frisbie in north-central Johnson County, which is now poorly exposed. The principal reference section is at that for the entire Wyandotte Limestone along the southbound I–435 offramp to Holliday road. The Frisbie is generally a thin 1–3 ft (0.3–0.9 m)-thick dense skeletal calcilutite.

Quindaro Shale Member

The Quindaro Shale overlies the Frisbie Limestone Member and underlies the Argentine Limestone Member of the Wyandotte Limestone. It was named by Newell (1932, 1935) from exposures at Boyne's Quarry (NW sec. 30, T. 10 S., R. 25 E.) in Quindaro Township in Wyandotte County. The principal reference section is that for the entire redefined Wyandotte Limestone along the southbound offramp from I–435 to Holliday road in northern Johnson County. The Quindaro Shale Member is about 0.4 ft of fossiliferous dark-gray shale at the reference section and

ranges up to 1–2 ft locally, often of lighter gray shale in northeastern Kansas; it is usually not differentiated from the shaly Argentine Limestone in southern Kansas.

Argentine Limestone Member

The Argentine Limestone overlies the Quindaro Shale and underlies the Island Creek Shale Member of the Lane Shale as redefined. It was named by Newell (1932, 1935) for an exposure (south of center N line sec. 29, T. 12 S., R. 25 E.) near Argentine Station on the south side of Kansas City, in Wyandotte County. The principal reference section is that for the entire redefined Wyandotte Limestone along the southbound offramp from I–435 to Holliday road in northern Johnson County. The Argentine ranges from 25 to 35 ft (7.6–10.6 m) of algal-rich skeletal calcilutite in the Kansas City area. It thins abruptly southward to less than 10 ft of nonalgal skeletal calcilutite above the southward-thinning Liberty Memorial Shale in central Miami County. Farther southward it is a few feet of argillaceous limestone with conspicuous crinoid debris resting on top of the Raytown Member of the Iola Limestone, as exposed along new US–169 at Chanute (E line NW sec. 19, T. 27 S., R. 18 E.).

Lane Shale

The Lane Shale as redefined overlies the Wyandotte Limestone and underlies the Plattsburg Limestone throughout Kansas. Named by Haworth and Kirk (1894) and stabilized by Moore (1936), the Lane Shale is redefined to include in ascending order: the Island Creek Shale Member, Farley Limestone Member, and Bonner Springs Shale Member. Recorrelation has determined that the type Lane Shale as recognized by Moore (1936) is actually the Island Creek Shale between the Argentine and the Farley limestones (Heckel, in prep.); the Island Creek thickens as the Argentine thins dramatically southward into the type area of the Lane where the Argentine rests on top of the Iola Limestone.

Because complete exposures of the entire Lane Shale as redefined are not available in the type area, a neostratotype to encompass the entire 140-ft Lane interval is established in Miami County (5 mi northeast of Lane) along W line of sec. 28, T. 18 S., R. 22 E. from the top of the Wyandotte Limestone (center W line NW sec. 28, which rests on the Iola Limestone in a quarry in NW NE sec. 29, T. 18 S., R. 22 E.) up to the base of the Plattsburg Limestone (N of SW corner sec. 28, T. 18 S., R. 22 E.). Southward the Farley Limestone Member disappears near Greeley in northeastern Anderson County, and undivided Lane Shale (formerly termed Lane–Bonner Springs) extends into southeastern Kansas as 50–160 ft of sandy shale in prominent bluffs held up by overlying Plattsburg Limestone.

Island Creek Shale Member

The Island Creek Shale Member overlies the Argentine Limestone Member and underlies the Farley Limestone, as originally defined by Newell (1932, 1935) from a locality near Island Creek in northwestern Wyandotte County, which is now poorly exposed. An accessible reference section is along the southbound onramp from Holliday Road to I–435 (NW sec. 6, T. 12 S., R. 24 E.), where the Island Creek is 5 ft of sandy shale. It thickens northward to reported 40 ft in its type area, and thickens southward to 70–110 ft in the Lane Shale type area in western Miami and eastern Franklin County.

Farley Limestone Member

The Farley Limestone Member overlies the Island Creek Shale Member and underlies the Bonner Springs Shale Member in northeastern Kansas. It was named by Hinds and Greene (1917) from Farley in Platte County, Missouri, north of Kansas City as the middle part of the Lane Shale. With recent recorrelation of the Wyandotte Limestone in Miami County, the Farley is removed from the top of Wyandotte and placed back into the Lane Shale. The principal reference section in Kansas is along the southbound onramp from Holliday Road to I–435 (NW sec. 6, T. 12 S., R. 24 E.). Here, the lower Farley limestone is 8 ft thick, the middle Farley shale is 6 ft thick, and the upper Farley limestone is 9 ft thick; these three units are differentiated with varying thicknesses northward to the type area. Southward, the middle shale disappears, and the undivided limestone attains 40 ft as an algal mound complex in northwest Linn County before pinching out into the undivided Lane Shale in Anderson County.

Bonner Springs Shale Member

The Bonner Springs Shale Member overlies the Farley Limestone Member and underlies the Plattsburg Limestone in northeastern Kansas. It was named by Newell (1932, 1935) from Bonner Springs in western Wyandotte County; the principal reference section is in a roadcut on K–7 in SW SE NE sec. 29, T. 11 S., R. 23 E. Here it is 21 ft of gray shale with shaly, sandy conglomeratic limestone in the top. The Bonner Springs ranges from a few feet up to 25 ft in thickness and includes lenticular sandstones and reddish paleosols as well as the lenticular limestones.

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