Core studies in Kansas—sedimentology and diagenesis of economically important rock strata in Kansas Wireline log zones and core description of upper part of the Middle Ordovician Viola Limestone, McClain and McClain SW fields, Nemaha County, Kansas by Craig D. Caldwell, Cities Service Oil and Gas Co., Tulsa, and Roger Boeken, Cities Service Oil and Gas Co., Oklahoma City

PENDLETON LAND AND EXPLORATION, McCLAIN #1, McCLAIN FIELD, NEMAHA CO., KANSAS

MCCLAIN FIELD, NEMAHA CO., KANSAS												
РТН	SCHEMATIC	TE 3.Y 962)		CLAS	STS		POROSITY PLOT	CO ANAL DA	YSIS	E ES	NOR	
DRILLING DEPTH IN FEET	PRESENTATION OF CORE	CARBONATE LITHOLOGY (DUNHAM, 1962)	ECHINODERMS	вкасніорорѕ	ANS	TYPES OF POROSITY	(CORE ANALYSIS)		Kmd	WIRELINE LOG ZONES	HYDROCARBON SHOWS	GENERAL DESCRIPTION
DRILLI		CAF	CHINO	RACHI	BRYOZOANS					MII LOG	HYDR. SI	
					ш		5 10 15			MAIN		VIII
_	/	PS/WS	C/VC	R		+ 111+22 . +12+		l	759 633	PORO. ZONE	STRONG PATCHY	
	704					**************************************			708		STAIN	Irregular-shaped layers and lenses of gray, coarsely crystalline dolomite alternating with greenish gray, argillaceous, medium crystalline dolomite. Depositional textures of both lithologies are difficult
	===-/=-							10.2				to distinguish due to pervasive dolomite. Coarsely crystalline dolomite areas are strongly oil stained and have fair to good porosity. The porosity appears
3505-						****/*********************************		8.4	281			to be mainly biomoldic and intergranular; fracture and vuggy porosities are also present. These areas were probably echinoderm packstone and grainstone with rare brachiopods. The argillaceous lenses and
		PS/WS				:+;.		6.2	13			layers were echinoderm wackestone with rare brachiopods. Argillaceous areas have negligible porosity and are not oil stained. The ratio of coarsely crystalline, porous layers and lenses to argillaceous ones is
		WS/PS	C/VC		R	/		6.6	3.5			3:7 below 3507' and 7:3 above.
	M = - Mw=/- 			R		****	$ \rangle $	8.6	13	TIGHT	STRONG PATCHY	
3510-	#== / ~~/	WS/PS		S		****		5.9	30	OTHEAN	STAIN	VII
	/~~~ / @)	GS	C	R				9.7	91		GOOD STAIN IN	
	/							9.2			PLACES	Light gray to gray, medium to coarsely crystalline dolomite with planar lamination and small-scale,
			?			**************************************		8.5	36		MINOR STAIN	low-angle cross-stratification. In places stratification is slightly deformed or undulous and rarely disrupted by vertical burrows. Greenish gray argillaceous material occurs as laminae in the lower part of the
3515-			0			†*************************************		14.6		LOWER	IN PLACES	unit and is concentrated along stylolites in the upper part. Porosity is fair to good and appears to include intergranular and moldic. Vugs and fractures
			0			····+/··+··+				PORO. ZONE		are rare in the lower part of the unit. In places (e.g., 3517'), molds are circular to slightly elliptical in cross section and may be leached ooids. In addition, ghosts of echinoderms are seen in the upper 2' of
	1		D S			******		16.9	620		MINOR STAIN	the unit. Elsewhere, however, grains can not be distinguished due to pervasive dolomite. The unit was probably a grainstone. Oil staining is patchy and increases upward in the unit.
	~~~/		?			+ H		5.5	3.1		IN PLACES	
3520-		GS		$\vdash$		++ ++		10.6				l vi
	7/~~~	PS/WS	VC			* ****		9.9	29 88		VERY FAINT STAIN	Light gray/gray, mottled, medium to coarsely crystalline dolomite locally with greenish gray argillaceous laminae. Light gray areas are coarser crystalline
	Onfund.		C?	R		H			2.7		STAIN	and have higher porosity (in places good); gray areas are medium crystalline generally with negligible porosity, thus resulting in the rock's mottled character. Porosity is poor to fair overall. Due to pervasive
	50					H		7.2	2.7			dolomite, grains and porosity types are difficult to distinguish. Most porosity is thought to be biomoldic, however, areas are seen in thin section that appear
3525-	49		VC?	R		+***		10.0	6.0			to have biomoldic and intergranular porosity. Fractures are generally hairline and vugs are rare. Echinoderms are rarely visible on the slabbed core surface but, in thin section qhosts of echinoderms are significantly
		PS/WS	C?	R				10.0				more numerous. The unit appears to have been an echinoderm wackestone/packstone.
-		мѕ						9.0	15			Y Gray to olive-gray, argillaceous dolomite with greenish gray, wispy, argillaceous laminae. Bioclasts are rare. Intercrystalline and fine moldic porosity may be present but are not readily visible on slabbed
	-//- -/ @@@/- (AAA) (AAA)	мѕ	R	R		/H A:		8.2	1.8			core surface. A domal shaped, compactional (?) feature is present in the upper part of the unit.  IV Light gray dolomite with negligible to poor
3530-		мѕ	R	R		1		5.0 4.8	1.6 2.6			porosity including biomoldic, intercrystalline, vuggy, and fracture. The unit was a lime mudstone with rare echinoderms and brachiopods. Sponge spicules are common in chert in the upper part of the unit.
	~/~	wˌs	мс	С		^		7.5	2.6			III Gray, mottled, medium crystalline dolomite. Mottling is due to bioturbation; horizontal burrows resemble those in underlying units. As below, light-colored
-	~~~ \forall \( \dots \)		мс	С	R	.:		9.5	0.6			areas are coarser crystalline and more porous than darker areas giving the rocks their mottled character. Overall, porosity is poor to locally fair and predom- inantly biomoldic. There is minor intercrystalline
	Farry Land	ws		С				6.4	11			porosity. The unit was a bioclast wackestone. Brach- iopods (some silicified) and echinoderms are moderately common. Bryozoans are rare.
3535-		MS	R	R		···		4.8	6.5			li l
	Ymmea •					H H .:		3.2	0.4			
		MS	R					4.5	3.4			
-						H A 3.		3.7	1.3			Gray, mottled, medium crystalline dolomite.
3540-		WS/PS	С			/ )	$   \rangle    $	7.0	26			Mottling is due to bioturbation; horizontal burrows, resembling those in Unit I., are also present. This unit is similar to Unit I. but overall is finer crystalline, less fossiliferous, and less porous. As
	7 (a) 7 (a)	MS	R	R		ν. • Δ		5.4	0.7			in Unit I., light-colored areas are coarser crystalline and more porous than darker areas. Overall, porosity is poor to negligible with the exception of a few thin beds with fair to good porosity. Porosity is
	~~~	PS/GS MS	R	C	С			5.1	3.8			thought to be predominantly biomoldic (molds are irregular-shaped) and minor intercrystalline. Fractures, generally hairline, and vugs (1/4" to 3/4" in length)
-	7/2	ws	" c	C		(H	$\ \rangle \ \ $	5.3 7.9	10			are also present. The unit was a lime mudstone with a few thin bioclast packstone and/or grainstone beds. Echinoderms and brachiopods (some silicified) are the only recognizable bioclasts with the exception
3545-	25 /	мѕ	R	R				5.1	3.0			of common bryozoans in the grainstone/packstone bed at 3541.5'. Chert nodules are present locally.
3345			R	R				6.4	17			
		WS/PS		MC				10.5				
	Day	MS	S	S		- An -		6.3	2.9			
			мс	s		*** - ****		7.7	4.1			ı
3550	7	ws	s	мс		100 A	$\ \langle \ $	6.4	6.3			
			мс	С				10	124			Gray, mottled, slightly argillaceous, medium crystalline dolomite. Mottling is due to bioturbation. Horizontal tube-shaped burrows occur throughout and are most commonly 1/8" in cross section. Light-colored
	-///		MC R	MC s		- A1	$\parallel / \parallel \parallel$	8.2	190			areas have higher porosity and are coarser crystalline than darker areas. Porosity is poor to fair overall but is good in some light-colored areas and negligible
	~/~	ws				A Vivi		7.0 6.6	5.3 52			in finer crystalline darker areas. Porosity is predom- inantly biomoldic. Pervasive dolomite replaces grains and matrix. Molds have irregular shapes which do not resemble leached bioclasts. There is some inter-
3555	100	MS/WS	MC	МС		*** ;··		7.0	2.4			crystalline porosity. Vuggy porosity (vugs 1/4" to 3/4" in length) is also present. Fractures are scarce and generally hairline. For the most part,
	- /5		R	s				6.4	14			the rocks were bioclast mudstone and wackestone with brachiopods (some silicified) and echinoderms being the most numerous bioclasts. Light-colored chert nodules are present and stylolites occur throughout.
	-7-	MS				→ , , ,		3.6	0.1			
		ws	R	МС		,, ., v		6.2	0.6			
		1	1	1	1	1	1	1	1	1		

FIGURE 4—Schematic drawing and description of the Pendleton McClain #1, McClain field, Nemaha County, Kansas.

PETRO LEWIS, POTTS #1, McCLAIN FIELD, NEMAHA CO. KANSAS

	NEMAHA CO., KANSAS												
Ŧ	SCHEMATIC	53	вю	CLAS	тѕ		POROSITY PLOT	CO	YSIS.	S	z		
DRILLING DEPTH IN FEET	PRESENTATION OF CORE	CARBONATE LITHOLOGY (DUNHAM, 1962)	ECHINODERMS	вваснюрорз	BRYOZOANS	TYPES OF POROSITY	(CORE ANALYSIS)		TA Kmd	WIRELINE LOG ZONES	HYDROCARBON SHOWS	GENERAL DESCRIPTION	
3460		GS WS WS/PS WS/PS MS	VC? VC? C C C VC? MC C C	S 3 3			5 10 15	14 12.3 15.8 7.3 5.2 8.5 12.1 9.3 6.8 7.8 10.8 5.1	278 159 42 38 4.7 137 310 123 11 33 12 1.1	MAIN PORO. ZONE TIGHT STREAK	STRONG PATCHY STAIN STAIN STRONG PATCHY STAIN	Gray, medium crystalline dolomite with darker	
3470		PS GS/PS GS/PS PS/GS	vc? vc			* * * * * * * * * * * * * * * * * * *		6.3 11.4 11.1 15.3		LOWER		gray, irregular and discontinuous, argillaceous lenses and layers (bioturbated?). Porosity, good in the lower part of the unit and fair above that, is intergranular and moldic (predominantly intergranular?). Ghosts of echinoderms are visible in thin section and, the rock appears to have been an echinoderm grainstone or perhaps locally packstone. Again, pervasive dolomite has made depositional textures difficult to distinguish. The upper 1' of Unit V is an echinoderm wackestone with poor to negligible biomoldic porosity.	
		GS	VC			***************************************				PORO. ZONE		Light gray, medium to coarsely crystalline dolomite	
3475		GS PS/GS PS/GS	vc?			+ + + + + + + + + + + + + + + + + + + +						displaying low-angle cross-lamination, planar or horizontal lamination, and deformed horizontal lamination. Grains and types of porosity are difficult to distinguish due to pervasive dolomite. Porosity is fair to good and thought to be predominantly biomoldic and intergranular. Ghosts of echinoderms are visible in thin section and the unit was probably a (echinoderm?) grainstone. In places stratification is absent, perhaps due to bioturbation, and the rock is a mottled echinoderm packstone/grainstone with good to negligible, patchy porosity (e.g., 3477' 11" to 3480').	
3480		GS GS MS	VC?	R		**************************************						Light gray, faint parallel laminated, finely crystalline dolomite. Upper 6" of unit has red stain	
2405	P	MS MS	R	R								and in places fitted clasts (collapse breccia). Porosity is intercrystalline and fine moldic generally not visible on the slabbed core surface. The unit was a lime mudstone with rare brachiopods.	
3485	(A)	BR MS MS BR	R	R ————————————————————————————————————								Light gray, finely crystalline dolomite with large, white to light gray, chert nodules. Porosity appears poor to negligible on slabbed core surface, however, log porosity is fair to good suggesting significant intercrystalline and very fine moldic porosity are present. Fractures are common in the lower part of the unit. The unit was a lime mudstone. Red staining is present in the lower part of the unit. Echinoderms and small shell fragments, probably brachiopods, are rare. There are two collapse breccias with angular, unsorted, dolomite mudstone clasts, up to 2" in length, in a coarser crystalline dolomite matrix. In places clasts display a fitted fabric.	
3495		ws ws ms	R	MC S MC	R R							Mottled, medium crystalline dolomite. Mottling is probably due to bioturbation. Porosity is poor overall but, its distribution is patchy. Tan areas have fair to good porosity and gray finer crystalline areas poor to negligible porosity. For the most part, porosity is biomoldic. Molds are irregular-shaped, however, and noteasily identified as leached bioclasts. Vuggy porosity is present locally and, there is minor fracture and intercrystalline porosity. Grains are generally indistinguishable due to dolomitization and leaching but, the unit was probably a bioclast mudstone and wackestone.	

FIGURE 5—Schematic drawing and description of the Petro Lewis Potts #1, McClain field, Nemaha County, Kansas.

† ∣	SCHEMATIC	E Y 62)		CLAS	STS		POROSITY PLOT	ANAL	RE YSIS TA	S	NO	
DRILLING DEPTH IN FEET	PRESENTATION OF CORE	CARBONATE LITHOLOGY (DUNHAM, 1962)	ECHINODERMS	BRACHIOPODS	BRYOZOANS	TYPES OF POROSITY	(CORE ANALYSIS)	Kmd	WIRELINE LOG ZONES	HYDROCARBON SHOWS	GENERAL DESCRIPTION
												VII
-												
3480-												Interlaminated, dark gray, slightly calcare shale and light gray, fine-grained sandstone. Be 3480' shale dominates and the rocks are paral
•												laminated. Above 3480' fine sandstone dominat vertical and horizontal, tube-shaped burrows (1/to 1/4" in cross section) are present and, the sandst is commonly rippled. This unit is the basal post to be weakers.
												of the Maquoketa Shale.
3485												
							5 10 1	5				
•		ws	мс	R—		•		6.3	.05 1.0		STRONG	VI
	~~~		MC/C					8.9	64		PATCHY STAIN	Gray, argillaceous, medium to finely crystal
3490			c					6.4	1.6	UPPER- MOST		dolomite with common horsetail stylolites and irregu discontinuous, argillaceous laminae. The uni bioturbated and, horizontal tube-shaped burrows ( to 146" in cross section) are common. Porosit
,						•		6.2	.09	VIOLA		negligible to poor and is predominantly biomol- There is minor intercrystalline porosity. Vugs rare and fractures essentially absent. The is an echinoderm wackestone, becoming progressi more argillaceous in the upper 0.5' where the r
	•	ws	МС					5.2	.02			have a disrupted appearance. Patchy oil stai occurs in the upper 4.5'. In places bioclasts silicified. Pyrite is rare, becoming more co in the upper 0.5'. A 1/2" layer of completely pyrit
3495		ws/ms	мс					8.1 4.1	.05			skeletal debris occurs at the contact with Unit (Maquoketa Shale).
3495		WS/MS	мс			• .		4.7	.02			
	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	PS	vc	S		· /+:\.		9.5	22		STRONG PATCHY STAIN	As below (i.e., Units I, III, and IV), areas of coars
	/~~~ ==================================	PS/WS	С					5.6	18		STAIN	crystalline dolomite with good to fair porosity or with areas of more finely crystalline dolomite w poor to negligible porosity resulting in the mott character of the rocks. Overall, porosity is p to locally fair. The more porous areas have biomol
3500		PS/GS	vc			 		5.9	1.9	PORO.	STRONG PATCHY STAIN	and intergranular porosity: areas of negligible
	=======================================					., • /4 .	A	4.9	.91			textures. The porous areas were probably echinoc packstone/grainstone and, the areas of poor poros were probably echinoderm wackestone. Brachiop occur throughout and are scarce. Porous patc
		PS/GS	vc	s		1.1.4. 1 12.1.		11.3 7.3	324			are strongly oil stained above 3501'. (Areas gray dolomite resembling that in Unit VI occur the upper 2' of this unit.)
3505		PS/GS	VC?			+ 12 + 12 + 12 + 12 + 12 + 12 + 12 + 12		11.4	40			
3303			vc	R/S		1 / 4		11.2		MAIN PORO.		Gray, mottled, medium to coarsely crystall
	- / -	PS/GS	VC?					10.9	192	ZONE		dolomite. Mottling is probably due to bioturbati Light-colored areas have better porosity and app to be coarser crystalline than darker areas. Porosi fair overall, has a patchy distribution reflect
		PS	С			1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1		11.2	57	 .		mottling and varies from poor (dark areas) to g (light areas). Porosity appears to be predominar biomoldic. In places intergranular porosity also be present. Fractures are moderately com locally (3505.5' to 3509.5') and vugs (1/8" to
3510						/H		7.9	11			in length) occur throughout. Minor intercrystall porosity is present. The lower few feet of U IV was probably an echinoderm wackestone; above the unit appears to be an echinoderm packstone
	1	GS/PS	VC?					15.8	162	TIGHT STREAM		grainstone. In thin section ghosts of echinode appear to be common to very common in the upper pof the unit. Brachiopods occur throughout and rare to scarce.
		PS	С	R/S		1000 1000 1000 1000 1000 1000 1000 100		9.9	.74 23			
3515	•							5.2	1.1			
3313		WS PS/GS	MC/C		H	PA: #550 **		4.4	.66		1	III Light gray, mottled, medium crystalline, argillacdolomite. Mottling is probably due to bioturbati
				мс				17.1	141	LOWER PORO.		Porosity has a patchy distribution but is fair good overall excluding the upper 8" of the unit wh it is negligible. Porosity probably includes int granular and biomoldic but, grains and types of poros
				R/S		#:+/ ₊ +:- ⁺ +		12.0		ZONE		are difficult to distinguish due to pervasive dolom Numerous fractures occur in the upper 1.5' of unit. Irregular-shaped, argillaceous lenses present and often have a green, yellow, or red ti The unit was probably a bioclast (echinoderm?) packs
3520	The same of the sa	PS/GS	VC?	R/S		+1: ***		8.9	16			and/or grainstone. There is rare white/light gr irregular-shaped chert and stylolites occur through Light gray, planar to low-angle cross-stratif
		GS/PS	VC?	R		++/ _H +.		8.6	12			medium to coarsely crystalline dolomite. Depositive textures are generally indistinguishable due to pervadolomite. Porosity is fair and includes moldintergranular, and fracture. Ghosts of echinode
		GS/PS	VC?	R		·· / ·)··/···		8.3	2007 1599			are visible in thin section suggesting the rock an echinoderm grainstone or packstone. Red stai occurs in the upper part of the unit.
3525	\$\alpha \alpha \rightarrow \ri	мѕ	s	R				6.3	20			
		ws	R	s		(, -) - , - , - , - , - , - , - , - , - , - 		7.0	1.1			
	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~					177 /H ▲ 1.450 1217		7.2	.5			Gray to light gray, mottled, medium crystall dolomite, in places with greenish gray lamin Mottling is due to bioturbation. Tube-shaped horizon
	•	мѕ				win		7.3	.15			burrows (1/8" to 1/4" in cross section) are prese Light gray areas have higher porosity, locally go and are more coarsely crystalline. Darker, genera finer crystalline areas have negligible or poor poros. Porosity is predominantly irregular-shaped mol
3530		WS/MS		s		("		9.1	.35			probably biomolds, not easily recognized as lead bioclasts. Overall, porosity is poor to fair ab 3531' and poor to negligible below. Fractures, genera hairline, are scarce becoming moderately common
			R	R		<b>)</b> ***		7.2	.05	-		more open in the upper 3' of the unit. Vuggy poros is scarce and there is some intercrystalline porosi Below 3535' the unit was an echinoderm wackest with rare brachiopods; above this the unit wa
	•	ws	мс			100 H 100 H		6.0	.03			lime mudstone and locally wackestone with rare scarce echinoderms and brachiopods. Bioclasts w probably more numerous but, they have been lead or can not be distinguished due to dolomitizati Stylolites occur throughout but are not comm
3535	AM A A		s	s		\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\		8.8	.83			White/light gray chert nodules are rare.
	D'5	ws	с/ма	R		/H - 1/4 A 14/4 A A AXX		4.1	.04			

CITIES SERVICE, WESSEL "A" #1,

McClain SW FIELD, NEMAHA CO., KANSAS

FIGURE 6—Schematic drawing and description of the Cities Service Wessel "A" #1, McClain SW field, Nemaha County, Kansas.

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TYPES OF POROSITY	A	Y STRUCTURES AND OLOGY	CARBONATE LITHOLOGY	PRESENCE OF BIOCLASTS	
MOLDIC  ++ INTERGRANULAR  ▲ INTERCRYSTALLINE  ∫  H  FRACTURE (H: HAIRLINE)	LOW-ANGLE CROSS-STRAT.  PLANAR (HORIZONTAL LAMINATION)  STYLOLITES  OO MOTTLED	UNDULOSE OR DEFORMED LAMINATION  PARALLEL LAMINATION  BRECCIA  CHERT  RED STAINING	GS- GRAINSTONE PS- PACKSTONE WS- WACKESTONE MS- MUDSTONE (BR)-(BRECCIA)	VC-VERY COMMON C- COMMON MC-MODERATELY COMMON S- SCARCE R- RARE	• THIN SECTION

BURROWS

VUGGY