Deadwood Formation (Cambrian/Ordovician) of North Dakota

A Core Atlas

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GEOLOGIC INVESTIGATION NO. 265

NORTH DAKOTA GEOLOGICAL SURVEY Edward C. Murphy, State Geologist Lynn D. Helms, Director Dept. of Mineral Resources



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INTRODUCTION

The North Dakota Geological Survey (NDGS) is currently conducting studies of the Cambro-Ordovician Deadwood Formation (Deadwood) because of the increased interest in CO2 storage in underground saline aquifers. This document presents the results of these studies to help establish a detailed stratigraphic framework for the Deadwood. See GI-266 for stratigraphic cross-sections and extent map that may be used in conjunction with this report. The Deadwood Formation consists of marginal and shallow marine sedimentary units; dominantly thick, porous, and permeable sandstone and limestone that are present at great depths and thus are ideal for CO2 storage.

The Deadwood Formation represents two 3rd-order depositional sequences deposited in an overall 2nd-order transgressive-regressive cycle in the Late Cambrian and Early Ordovician Periods (Figs. 1 and 2). In general, the lower sequence (member A) represents the initial sea-level rise during the Cambrian (Fig. 1A) and consists of fluvial-deltaic and eolian deposits that give way to more marginal marine (Fig. 1B) (member B) and nearshore progradational deposits (members C-F) that shallow upwards as represented by 4 parasequences of the highstand normal regression of the upper sequence (Fig. 1C; Sarnoski, 2015).

This document presents detailed lithologic descriptions from three Deadwood Formation rock cores and one set of chips from the state of North Dakota (NDIC #6624, NDIC #37672, NDIC #6264, NDIC #38594, and NDIC#155; Fig. 3). Core was viewed and described at the Wilson M. Laird Core and Sample Library in 2014, November 2020, August—October 2021, and March—June 2022. Core profiles including: 1) well information; 2) log responses for gamma-ray, resistivity, neutron porosity, and density porosity (Fig. 2); 3) detailed lithology graphic with generalized description; 4) sequence stratigraphic interpretation; and 5) core photographs, are presented. The logs are best viewed using a computer for optimal viewing and printing on 11x17 paper is recommended for readable graphics.



Figure 1. Cambro-Ordovician paleogeographic maps of North America showing transgression and regression of seaway during Deadwood deposition in North Dakota.

REFERENCES

Blakey, R., 2013, North America paleogeography: http://cpgeosystems.com/nam.html.

Sarnoski, A. H., 2015, The stratigraphy and depositional history of the Deadwood Formation, with a focus on Paleozoic subsidence of the Williston Basin: University of North Dakota Theses and Dissertations, https://commons.und.edu/theses/1957.



Figure 2. Geophysical logs for the J-ROC1 1 well showing sequence stratigraphic relations and members of the Deadwood Formation.

Legend

	Sandstone		Erosion surface
	Siltstone		Herring-bone cross bedding
:==:	Shale	4*5	Karst
0000	Conglomerate	000	Lag
	Limestone	~~	Mud crack
	Dolostone	\sim	Planolites
	Schist	~	Ripple cross-lamination
A	Anhydrite nodule	/	Rip-up clast
ς	Burrow	\bigcirc	Thalassinoides
	Carbonaceous	\sim	Unconformity
	Chondrites	~~~~	Wavy bedding
$\sum_{i=1}^{n}$	Crinoid	\sim	Wavy lamination
//	Cross bedding		
Obi	Ordovician Black Island Formation	Divide Burk	a dette

- p-C Precambrian
- FS Flooding surface
- HST Highstand systems tract
- LST Lowstand systems tract
- MFS Maximum flooding surface
- MRS Maximum regressive surface
- PS Parasequence
- TST Transgressive systems tract
- S Sequence
- SU Subaerial unconformity
- WRS Wave ravinement surface



Figure 3.

Explanation
6624 Well Location with NDIC number



Figure 3. Index map showing well locations.





		Orth - Level										
Operat Sh	ell O	il Co	mpany									Page 3 of 3
^{Тор} 9293	3 ft							Bottom 9310.2	ft			
Well Na	erberg	22N	-1					SENW	Sec. 1, T161N, F	R85W		
Jeff	Bade	r and	Anthony Sarnosł	ĸi				11/14 a	nd 11/20			
Willi	ston							33-075	-00763-00-00			
6624 кв	ļ.							Wildcat	t			
1715 Latitude	5 ft							9509 Longitude				
48.8	02903	3					<u> </u>	-101.64	2301	>		
Box Number	Formation	member	Gamma Ray	Log Depth (Feet)	Depth (Feet)	Core Description Profile	Neutron 0.3 (Lin Density I	Porosity ne) -0.1 Porosity	Resistivity	Sequence Stratigraph	Notes	Core Photographs
	hood	В		9300-	9300-					S2 LST (Part) S1 HST	Siltstone Subaerial unconformity Sandstone, reddish brown, very-fine- to coarse-grained, poorly sorted, subangular to subround, massive to thin-bedded, oxidized	G
	р <mark>-С</mark> Deac	A		9310-	9310					S1 TST S1 LST	Sittsone Conglomerate, light to medium brown, very fine- to coarse-grained, poorly sorted, subangular to subround, quartzose Regional unconformity/Basement Gneiss	1-inch

00000	1895											
Operat	or nko:	ta D	ower Cooper	ativ	o In	6						Page 1 of 5
Top 936	i ft			auv		0.		Bottom 9445 ft				-
Well N	me & No DC1 1							Location SWNW	Sec. 4, T141N,	R83W		
Logged Jeff	^{by} Bade	r and	John Lake					Date 8/21-10)/21			
Basin Willi	ston							^{UWI №.} 33-065-	00020-00-00			
376	2							Wildcat				
2029 Latitud) ft							9817 Longitude				
47.0	62776	6						-101.21	2964	~		
Box Number	Formation	member	Gamma Ray	Log Depth (Feet)	Depth (Feet)	Core Description Profile M W Pm Pg G B ç ş 10 mi mü çi çu vçi vçi QR	Neutron 0.3 (Lin Density 0.3 (Lin	Porosity ne) -0.1 Porosity ne) -0.1	Resistivity0.22000	Sequence Stratigraph	Notes	Core Photographs
	bi								\backslash		Black Island Formation,	A
	0					A		ļi —	2			in the second
					9370 -			(Deadwood Formation at 9,369.7 ft	
		-		9390 -							Sandstone, grayish yellow green to greenish gray, fine grained, well sorted, sub-rounded, quartzose, silica cement, burrow mottled throughout (planolites)	100
		Г 		9400 -	9380 -	B					Starved ripples Siltstone, greenish gray, mottled,	В
		E		9410 -	9400 -					S2	planar laminated to thin-bedded Sandstone, dark greenish gray, locally conglomeratic Limestone (mudstone to packstone), medium light gray to medium dark gray, locally conglomeratic, mud cracks Shale, dark gray, fissile, grades to	
	Deadwood			9420 -	9410 -			S.		HST (PS-4)	limestone (mudstone to wackestone), medium gray to medium dark gray, laminated to thin-bedded,	
				9430 -	9420						calcareous, rip-up clasts, pyritizeo locally, flaser bedding, crinoids, chondrites Organic rich	
		D		- 9440 - - - -							Rip-up clasts to 3-inches	0.110.0
				9450 -	9430 -							9419.9
				9460 -	9440 -			$\langle \rangle$		S2 HST (PS-3) (Part)		







		and a state											
Opera Mir	tor	ita P	ower Cooper	ativ	e Ir	10							Page 5 of 5
^{Тор} 968	5 ft				0 11	10.			Bottom 9745.2 f	t			
Well N J-R	ame & No OC1	». 1							Location SWNW	Sec. 4, T141N,	R83W		
Logged Jeff	^{i by} Bade	er and	l John Lake						Date 8/21–10	/21			
Basin Willi	iston								0001 No. 33-065-0	0020-00-00			
376	^{NO.}								Wildcat				
2029	9 ft							 	9817				
47.0	6277	6			1	1			-101.212	2964			1
Box Number	Formation	member	Gamma Ray	Log Depth (Feet)	Depth (Feet)	Core Des	Pm Pg	Neutron 0.3 (Lin Density 0.3 (Lin	Porosity ne) -0.1 Porosity ne) -0.1	Resistivity	Sequence Stratigraphy	Notes	Core Photographs
		в		9710 -	9690	Mr==+=					S2 LST (Part)	Sandstone, grayish green, very fine-grained	M
				9720 -	- - - - - - - - - - - - - -						S1 HST	Subaerial unconformity Limestone (mudstone), brownish gray, calcareous, planar laminated, calcite cement filling voids Karst	N
	Deadwood	A		9730 -	9710						S1 TST		
	Deadwo	A		9740 -	9720						S1 LST	Glauconitic to base	0 9748
	Э́С			9760 -								Regional unconformity/Basement Gneiss	laa



	1895 ICAL	ALL CALL										
Opera	or mmi	+ C -	rhon Solution			<u>`````````````````````````````````````</u>						Page 1 of 6
Top 112	45 ft	102		15, 1		,		Bottom	ft			
Well N	ame & No on Fle	emme	er 1				1	Location NWNF	Sec 35 T141N	R88W		
	by Bade	r م						Date Mon M	av 2 2022	, 110011		
Basin	iston							UWI No. 33-057	-00041-00-00			
NDIC I	10. 94						1	Field Wildca	t			
кв 231	5 ft							TD 12009	ft			
Latitud 46.	9491	8						Longitude -101.79	92969			
Box Number	Formation	member	Gamma Ray	Log Depth (Feet)	Depth (Feet)	Core Description Profile	Neutron 1 0.3 (Lirr Density F 0.3 (Lirr	Porosity ne) -0.1 Porosity ne) -0.1	0.2 Resistivity 200	Sequence Stratigraphy	Notes	Core Photographs
	Deadwood	F		Core + + + + + + + + + + + + + + + + + + +						S2 HST (PS-4) (Part)	Black Island Fm. undivided Deadwood Fm. at 11,248.9 feet Regional unconformity Dolostone, greenish gray, crude horizontal bedding, minor moldic porosity Carbonaceous Carbonaceous Carbonaceous Carbonaceous Carbonaceous Limestone (wackestone), dark greenish gray to light olive gray, burrowed, contains some angular clasts near the top of the unit, some good moldic porosity Limestone (mudstone), medium dark gray to brownish gray, laminated to thin wavy beds, burrowed More significant burrowing Erosional surface Limestone (mudstone to wackestone), medium to dark gray, crude horizontal bedding, burrow mottled with vertical, skolithos-type burrows from 11,304.4 to 11,305.0 feet Thin, fossiliferous(?), packstone beds throughout	A
				- - - 11330 -	11320 -						Cross bedding, tidal bundles	











0000	1895											
	^{tor}	enta	l Oil Compan	v								Page 1 of 2
^{Тор} 599	0 ft	01110	en eenpan	,			во 6	ttom 070 ft				
	ame & No nen #	». •1					Loi		Sec. 9, T140N, F	R75W		
Logge Jeff	Bade	ər					Da T	ue Ma	ır 15 2022			
Basin Wil	iston						UV 3	^{vi №} . 3-015-	00004-00-00			
NDIC 155	No.						Fie V	^{⊪d} ∕ildcat				
кв 191	2 ft						1D 6	155				
Latitud 46.9	96483	7					Loi - 1	ngitude 100.14	1447		1	
Box Number	Formation	member	Gamma Ray	Log Depth (Feet)	Depth (Feet)	Chips Description Profile	Neutron Po (Lime) Density Por	rosity -0.1 rosity	0.2 Resistivity 2000	Sequence Stratigraphy	Notes	Photographs
	Obi			5080 - - - - - - - - - - - - - - - - - - -							Obi undivided Deadwood Formation at ~ 6,011 feet Claystone gravish green	
				6000 - - - - - - - - - - - - - - - - - -							interbedded with silty and sandy lenses	
	Deadwood	с		- - - - - - - - - - - - - - - - - - -	6040 -						Sandstone, green to brick red, fine grained, well sorted, glauconitic Becomes salt and pepper, fine- to medium-grained with silty interbeds from ~ 6040 to 6050 feet	
											Becomes sandy siltstone from ~ 6050 to 6060 feet	

•														
	perato	ting	onto	Oil Compon				Page 2	of 2					
To	p 070	ft	filla		у			Bottom 61/2 ft						
W L	ell Nar	ne & No en #	1					cation IENE Sec. 9, T140N, R75W						
Lo	eff I	» Bade	r					ie ue Mar 15 2022						
V	^{asin} Villis	ston						^{VI No.} 3-015-00004-00-00						
1	<u>55</u>).						Wildcat						
1 La	912 titude	ft						155 ngitude						
4	<u>6.96</u>	<u>5483</u>	7											
-	Box Number	Formation	member	Gamma Ray 0 200	Log Depth (Feet)	Depth (Feet)	Chips Description Profile	rosity 0.1 0.2 Resistivity 2000 00 Notes Photogr	aphs					
		Deadwood	c		Chips - 1	6 1120		01 0.2 0.2 01 0.2 0.3 1 0.2 0.3 1 0.2 0.3 1 0.2 0.3 1 0.2 0.3 1 0.2 0.3 1 0.2 0.3 1 0.2 0.3 1 0.3 0.3 1 0.3 0.3 1 0.3 0.3 1 0.3 0.3 1 0.3 0.3 1 0.3 0.3 1 0.3 0.3 1 0.3 0.3 1 0.3 0.3 1 0.3 0.3 1 0.3 0.3 1 0.3 0.3 1 0.3 0.3 1 0.3 0.3 1 0.3 0.3 1 0.3 0.3 1 0.3 0.3 1 0.3 0.3 1 <t< th=""><th></th></t<>						

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