

NORTH DAKOTA STRATIGRAPHIC COLUMN

North Dakota Geological Survey
Geologic Investigations No. 231



RED RIVER SUMMARY

DRILL STEM TESTS AND PRODUCTION MAPPING

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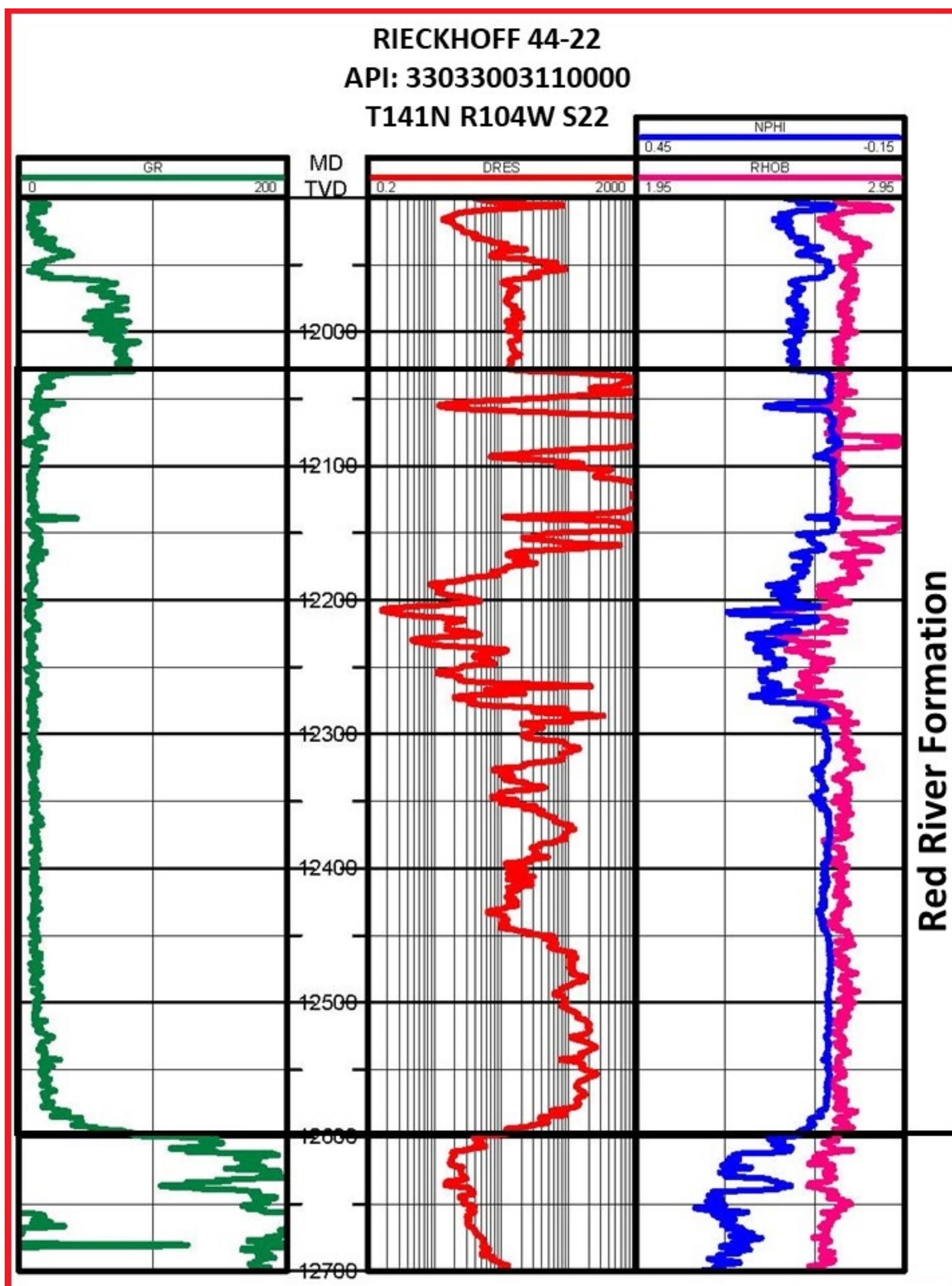
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2020

In order to better facilitate petroleum exploration and development in the Williston Basin, the North Dakota Geological Survey (NDGS) has published a series of production-related maps and corresponding data sets. These maps sets include production and drill stem test (DST) results with an accompanying spreadsheet for easy data extraction. The primary goal of this project is to create a database showing the distribution of hydrocarbons within each productive unit.

Prior to this project, over 55% of the DST results in the state did not have an associated geologic interval. The NDGS utilized a series of filters in Petra and Excel to unite formation tops with DST results. Now over 95% of DST results are associated with a geologic interval. After removing failed (misrun) DSTs, the remaining DST results were then separated into three groups. The first group (Positive DSTa) contains wells that have recovered oil or gas (in either the drill pipe or the sampler), or those that list oil or gas as the primary component of the fluid/gas mixture (e.g. 10' mud cut oil) in the description. Secondly, Positive DSTb wells display results for oil or gas as the secondary component of the fluid/gas mixture (e.g. 50' gas cut mud). Although Positive DSTb wells do show signs of hydrocarbons, the hydrocarbon signal is considered weaker than those in the Positive DSTa group. Lastly, the Negative DST results have no indication of hydrocarbons. Detailed information for each DST (time-pressure data, interval depths, fluid and gas recovery information) can be accessed through the well file database maintained by the North Dakota Industrial Commission (NDIC) Oil and Gas Division.

Production for each well was determined using the NDIC's Production Pools and associated monthly production totals. The production pools utilized are shown on the Production Map for each interval. Cumulative production for each well was calculated through September 2019.

This project is a summary of the Red River Formation's production and drill stem test results. Map sets include a production map, cumulative production map and DST results in North Dakota's portion of the Williston Basin. The Red River Formation is highlighted by the red box on the North Dakota Stratigraphic Column on the left. A representative log of the Red River Formation is shown below along with a map showing the well's approximate location.

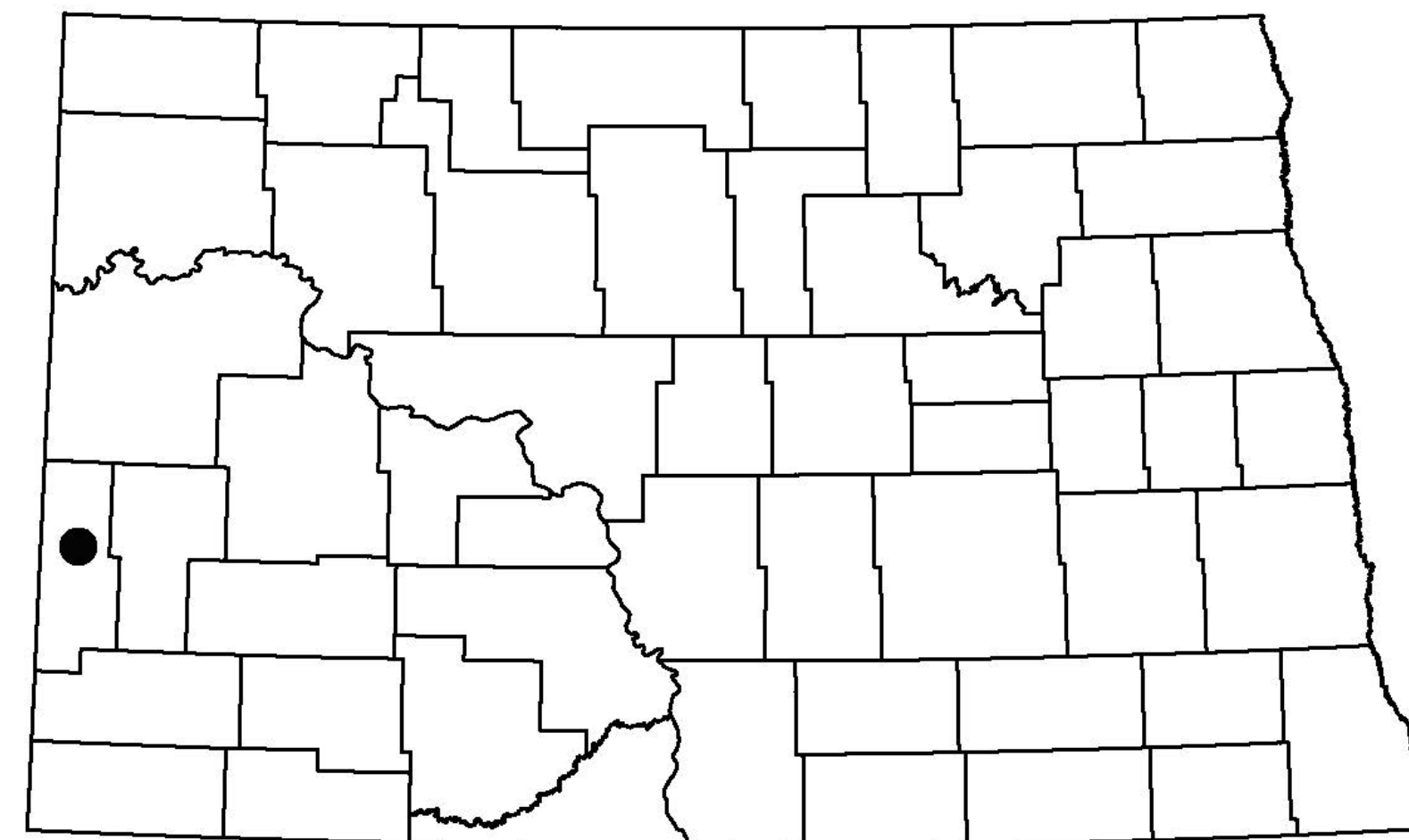


References

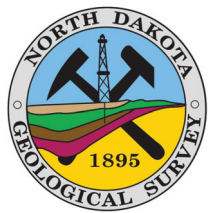
Murphy, E.C., Nordeng, S.H., Juenker, B.J., and Hoganson, J.W., 2009, North Dakota Stratigraphic Column, North Dakota Geological Survey, MS-91, 1p.

North Dakota Industrial Commission, Department of Mineral Resources, Oil and Gas Statistics, retrieved October 2019, <https://www.dmr.nd.gov/oilgas/>

NORTH DAKOTA LOCATION MAP

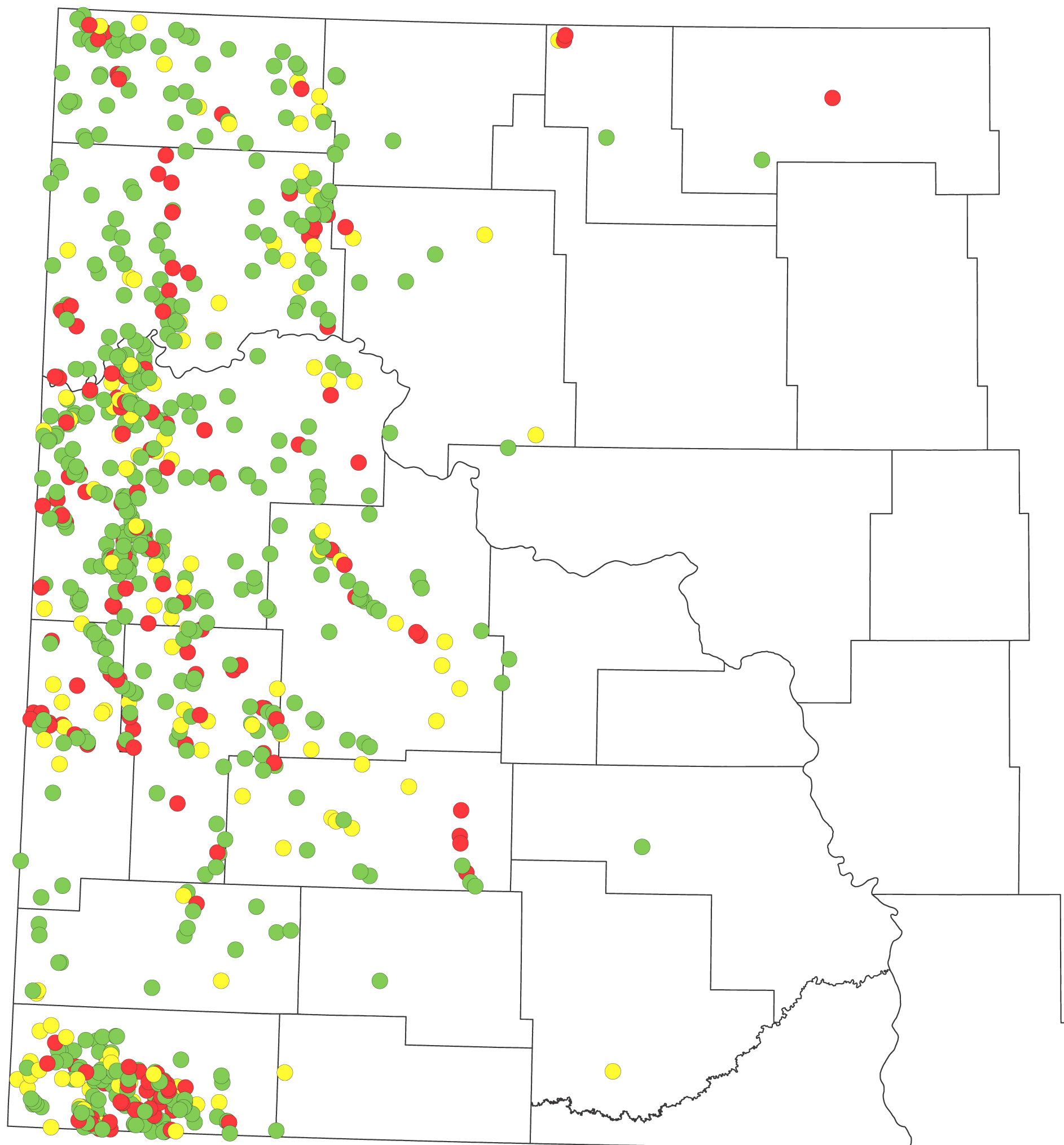




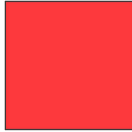
AGE MILLIONS OF YEARS BEFORE PRESENT	SYSTEM		SEQUENCE	ROCK UNIT						
	ERATHIEM	SERIES		GROUP	FORMATION	MEMBER				
0.01	QUATERNARY	Holocene	TEJAS	OAHE	RIVERDALE PICK CITY AGOR BROWN MALLARD ISLAND					
		Pleistocene		COLEHARBOR	WEST CENTRAL EASTERN SIBLACK SUGAR RIDGE SIBSONA FACECREEK HIGHT ARGEVILLE WYER RED LAKE FALLS NO. WILLIAMS MARBROCK					
2.6	NEOGENE	Pliocene	TEJAS	(Unnamed Unit)						
5.3		Miocene		ARIKAREE						
23.0		Oligocene		BRULE						
33.9	Eocene		WHITE RIVER	SOUTH HEART CHALSY BUTTES						
55.5			GOLDEN VALLEY	CAMELS BUTTE BEAR DEN						
65.5	TERTIARY PALEOGENE	Paleocene	FORT UNION	SENTINEL BUTTE						
				BULLION CREEK						
				SLOPE						
				CANNONBALL						
				LUDLOW						
				65.5	CRETACEOUS	Upper	MONTANA	HELL CREEK	BRIEN COLGATE & LINTON HILLHEAD TIMBER LAKE TRAIL CITY	
								PIERRE	ODANAH DEGEEY GREGORY PEMBINA GARDNER	
								COLORADO	NIORRARA	
									CARLILE	
								GREENHORN		
BELLE FOURCHE										
DAKOTA	MOWY									
	NEWCASTLE									
SKULL CREEK										
INVAN KARA										
96.6	CRETACEOUS	Lower	MONTANA	SWIFT						
				RIERDON	BOWEN FREMONT TAMPCO					
				PIPER	SCENE PICARD FOE DUNHAM					
				SPEARFISH	SAUDE					
					PINE	BELFIELD				
				MINNEKAHTA						
				OPECHE						
				BROOM CREEK	AMSDEN	ALASKA BENCH				
					TYLER					
				BIG SNOWY	OTTER					
KIBBEY										
318	CARBONIFEROUS MISSISSIPPIAN		MADISON	CHARLES						
				MISSION CANYON						
				LODGEPOLE						
				BAKKEN	THREE FORKS					
					BIRDBEAR					
				JEFFERSON	DUPEROW					
				MANITOBA	SOURIS RIVER					
					DAWSON BAY					
				ELK POINT	MOUNTAIN					
					PRAIRIE	BELLE PLAINE ESTERHAZY				
WINNIPEGOSIS										
ASHERN										
416	SILURIAN		BIG HORN	INTERLAKE						
				STONEMOUNTAIN	GUNTON STOUGHTON					
				RED RIVER						
				ROUGHLOCK						
444	ORDOVICIAN		WINNIPEG	ICEBOX						
				BLACK ISLAND						
488	CAMBRIAN		SAUK	DEADWOOD						
542	PRECAMBRIAN		WYOMING PROVINCE	STRUCTURAL PROVINCES TRANS-HUDSON OROGEN SUPERIOR PROVINCE						



RED RIVER DRILL STEM TEST RESULTS

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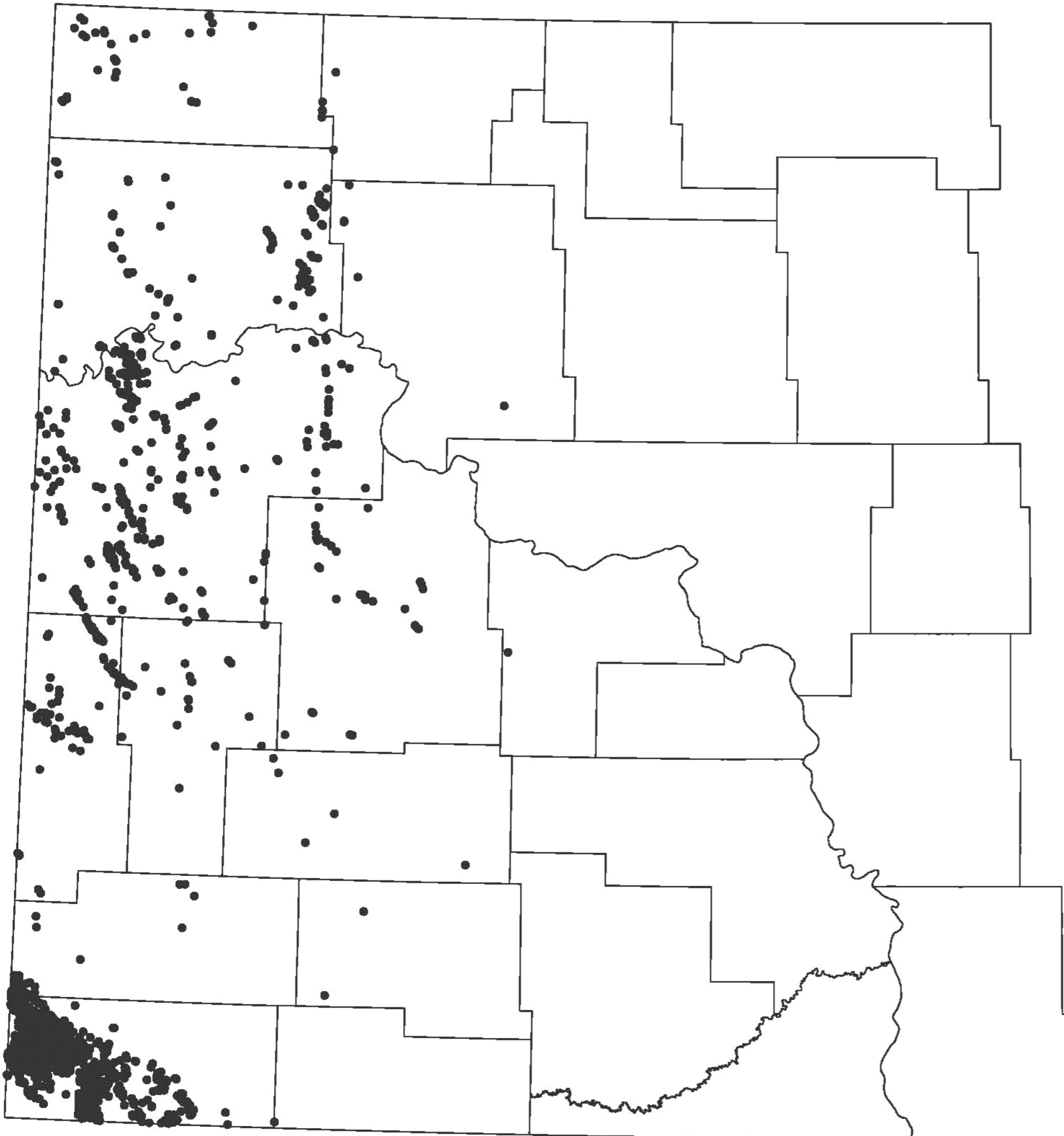
-  **POSITIVE DSTa**
 - (1) Oil or gas recovered in sampler and/or pipe (e.g. 275' Free Oil)
 - (2) Description with oil or gas as the primary component of fluid/gas mixture (e.g. 150' mud cut Oil)
-  **POSITIVE DSTb**
 - (1) Description with oil or gas as the secondary component of fluid/gas mixture (e.g. 150' Gas cut mud)
 - (2) Hydrocarbons present but a weak indication in DST
-  **NEGATIVE DST**
 - (1) No Oil or Gas reported





RED RIVER OIL PRODUCTION

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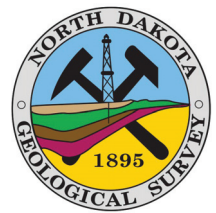


● Red River Production

NDIC Production Pools Utilized

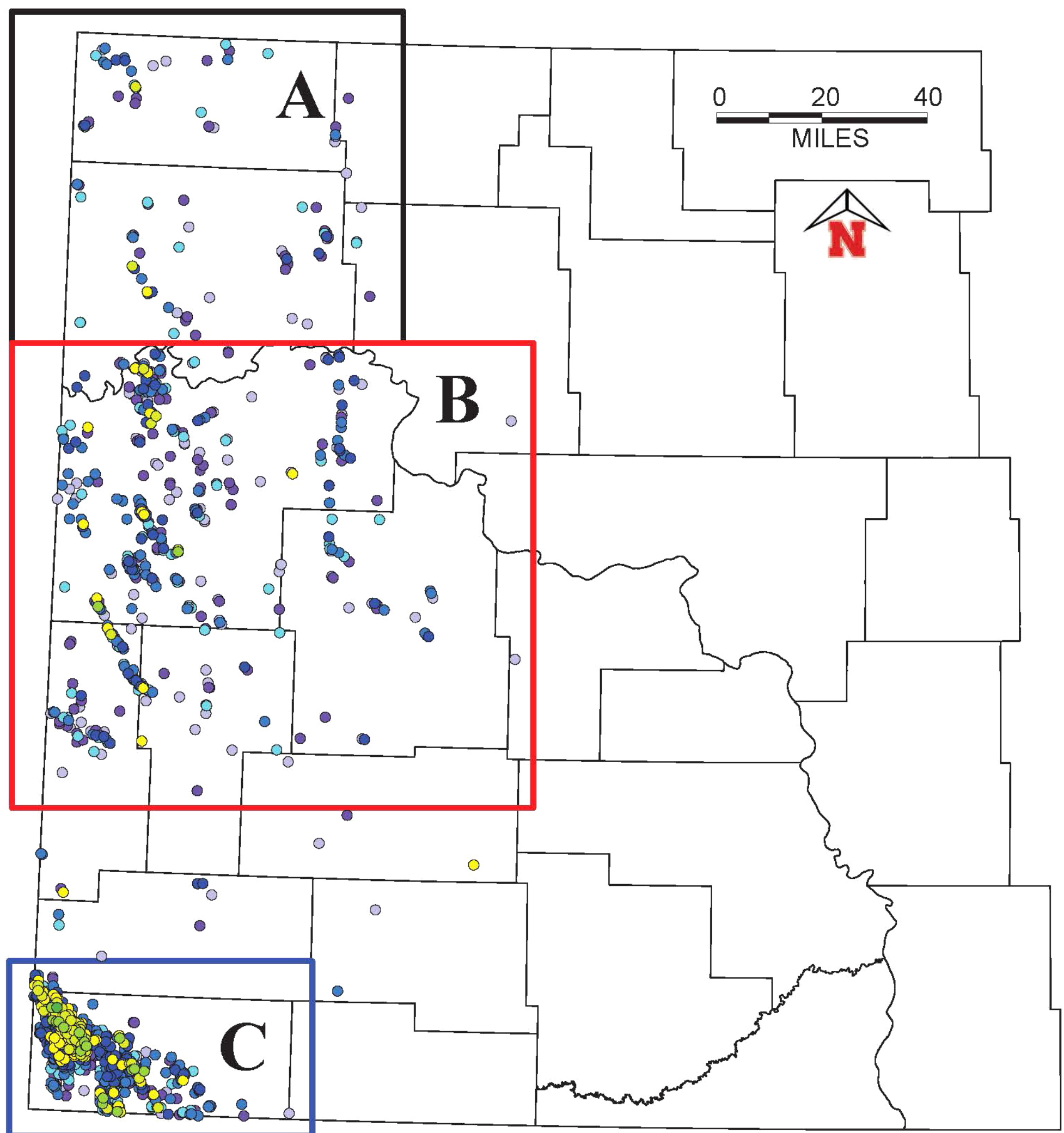
Red River
Red River Unit
Red River B
Red River C
West Red River
North Red River B
South Red River B
Ordovician





RED RIVER CUM OIL PRODUCTION

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CUM OIL
(BBLs)

