

NORTH DAKOTA STRATIGRAPHIC COLUMN



RED RIVER SUMMARY

DRILL STEM TESTS AND PRODUCTION MAPPING

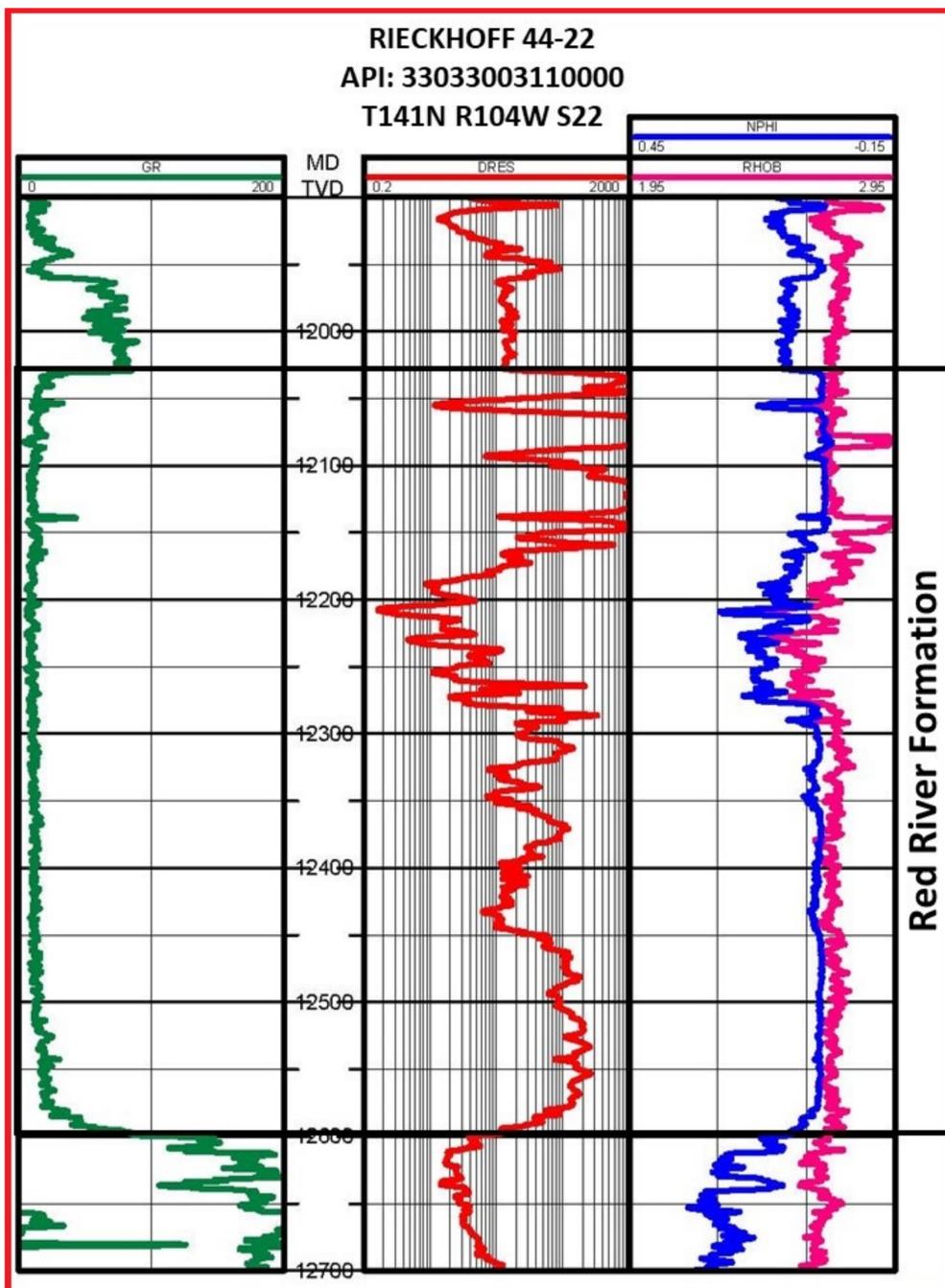
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In order to better facilitate petroleum exploration and development in the Williston Basin, the North Dakota Geological Survey (NDGS) has published a series of production-related maps and corresponding data sets. These maps sets include production 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.

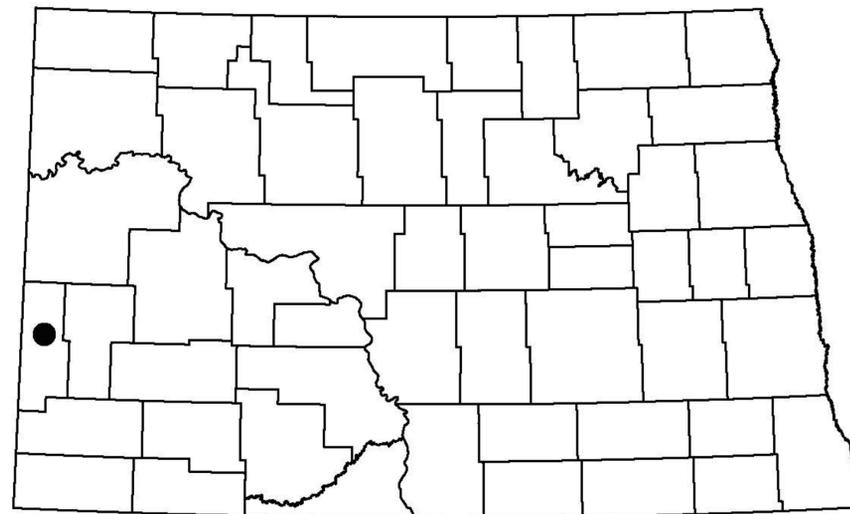


References

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 AIGER BROWN MALLARD ISLAND					
		Pleistocene		COLEHARBOR	WEST CENTRAL WESTERN SIBLACK SUGAR RIDGE SIBSONA FRACROCK HIGHT ARGEVILLE WYER RED LAKE FALLS NO. WILKINS MARBROCK					
2.6	NEOGENE	Pliocene	TEJAS	(Unnamed Unit)						
5.3		Miocene		ARIKAREE						
23.0		Oligocene		BRULE						
33.9	Eocene		WHITE RIVER	SOUTH HEART CHADRON	CHALSY BUTTE					
55.5				GOLDEN VALLEY		BEAR DEN				
65.5	TERTIARY PALEOGENE	Paleocene	ZUNI	FORT UNION	SENTINEL BUTTE					
					BULLION CREEK					
					SLOPE					
					CANNONBALL					
					LUDLOW					
					HELL CREEK					
					COLGATE & LINTON					
					FOX HILLS	TIMBER LAKE TRAIL CITY				
					MONTANA	ODANAH				
					PIERRE	DEGEEY				
96.6	CRETACEOUS	Upper	ZUNI	MONTANA	GREGORY					
					PEMBINA					
					GARDNER					
					NIORRARA					
					COLORADO	CARLILE				
					GREENHORN					
					BELLE FOURCHE					
					MOWY					
					NEWCASTLE					
					SKULL CREEK					
145.3	CRETACEOUS	Lower	ZUNI	DAKOTA	INVAN KARA					
					SWIFT					
					RIERDON	BOWEN FREMONT TAMPCO				
					PIPER	SCENE PICARD FOE DUNHAM				
					SPEARFISH	SAUDE PINE BELFIELD				
					MINNEKAHTA					
					OPECHE					
					BROOM CREEK					
					MINNELUSA	AMSDEN ALASKA BENCH				
					TYLER					
299.0	CARBONIFEROUS	MISSISSIPPIAN	KASKASKIA	MADISON	MISSION CANYON					
					LODGEPOLE					
					BAKKEN					
					THREE FORKS					
					BIRDBEAR					
					JEFFERSON	DUPEROW				
					MANITOBA	SOURIS RIVER DAWSON BAY				
					ELK POINT	MOONSHAL BELLE PLAINE ESTERHAZY				
					PRAIRIE					
					WINNIPEGOSIS					
416	CARBONIFEROUS	DEVONIAN	KASKASKIA	MADISON	ASHERN					
					INTERLAKE					
					STONWALL					
					STONY MOUNTAIN	GUNTON STOUGHTON				
					BIG HORN	RED RIVER				
					WINNIPEG	ROUGHLOCK ICEBOX BLACK ISLAND				
					SAUK	DEADWOOD				
					488	CAMBRIAN		SAUK		