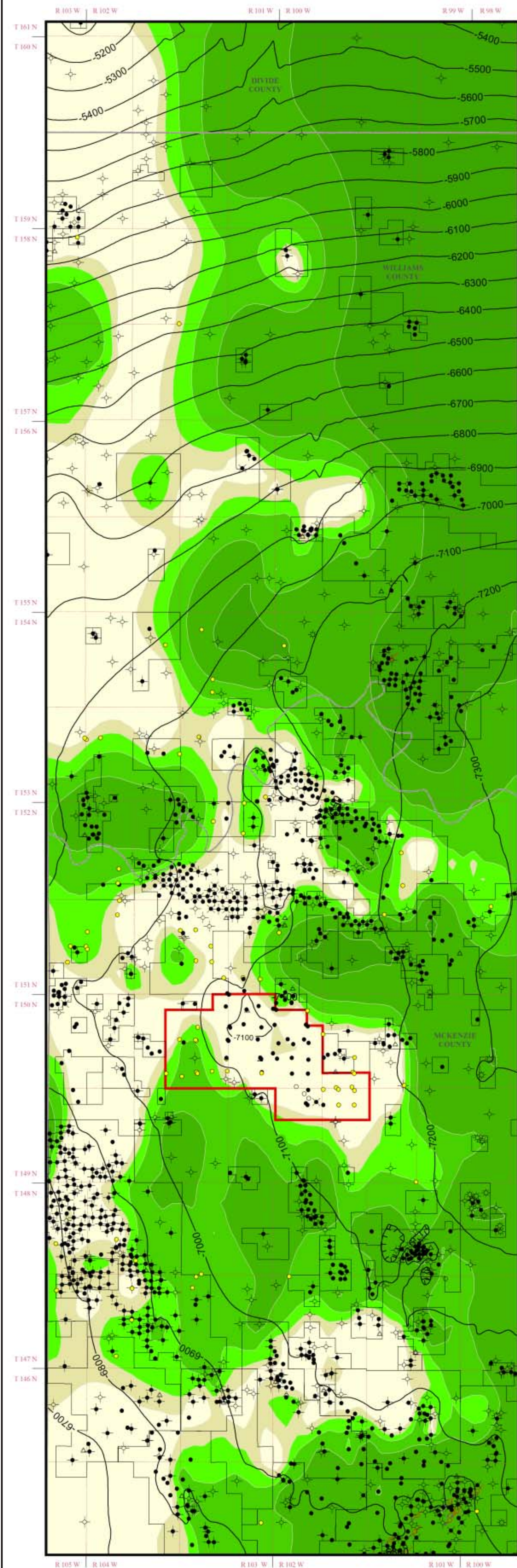


# Stratigraphic and Structural Framework of Recent Ratcliffe (Mississippian, Charles Fm) Production in Western North Dakota

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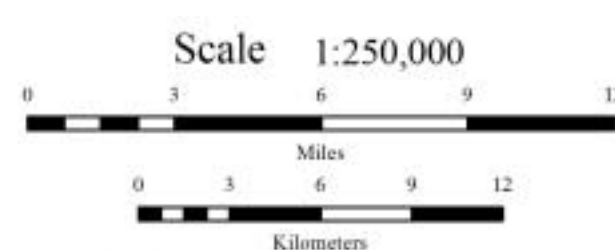


## EXPLANATION

- Contours**
- Structure on 'A' marker (MSL Elevation)
- Isopach of the Flat Lake 'Anhydrite'**
- 0 - 2 Feet
  - 2 - 4 Feet
  - 4 - 8 Feet
  - 8 - 16 Feet
  - 16 - 32 Feet
  - > 32 Feet
- Oil & Gas Fields**
- Foreman Butte Field
  - Oil & Gas Field Boundary
- Well Symbols**
- Gas Well
  - Oil Well
  - Dry Well
  - Oil or Gas P&A
  - Oil or Gas Inactive
  - Permitted Location
  - Saltwater Disposal
  - Injection Well
  - Confidential
- Other Symbols**
- County Boundaries
  - Township Boundaries



Study Area, Western North Dakota



## Introduction

The recent development of the Foreman Butte field in western North Dakota demonstrates that there is still considerable potential for new production from low permeability carbonate reservoirs within the Madison group using horizontal drilling methods. Between its discovery in late 2004 and the beginning of 2007, the Foreman Butte field (T150N-R102W and R103W) has produced 1.8 million bbls of oil and 1.2 MMCF gas from some 38 wells drilled to a TVD of approximately 9300'. Initial production has been as high as 680 bbls oil per day. Production is obtained from horizontal laterals that tap an oolitic/pisolitic shoal island complex within the Alexander and Flat Lake subintervals of the Ratcliffe. This reservoir typically has porosities in the range of 5 to 10 percent with total reservoir thicknesses that are less than 20 feet.

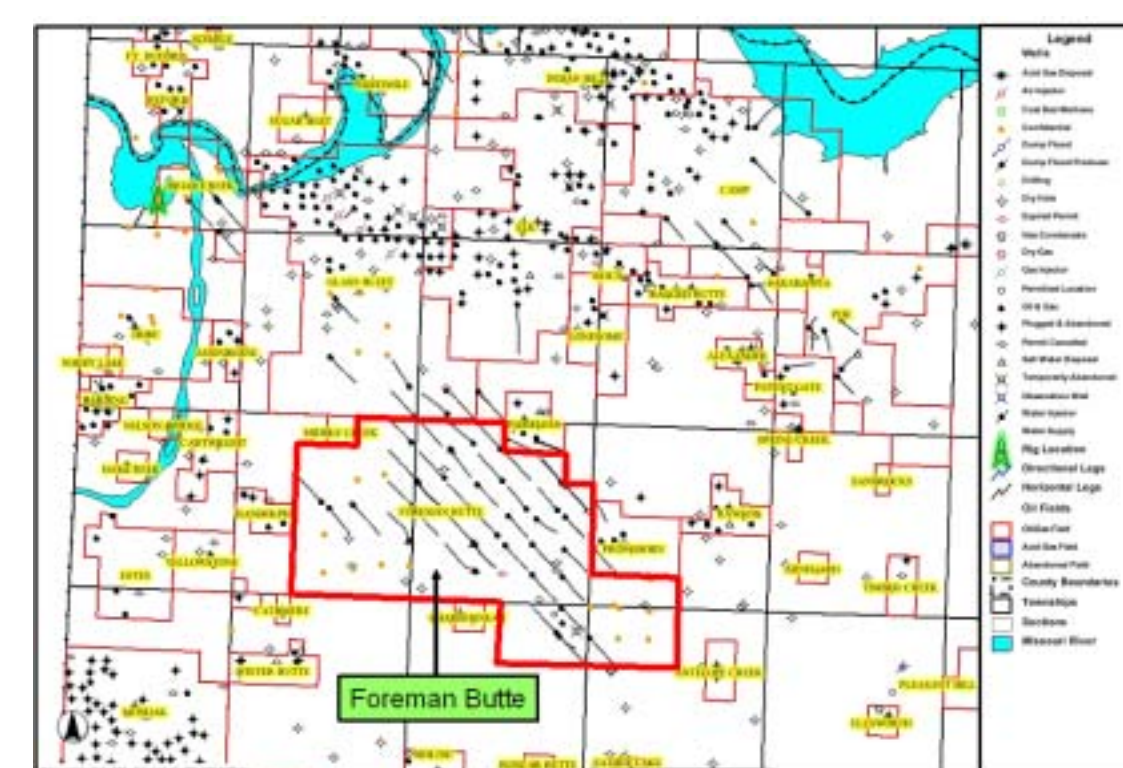
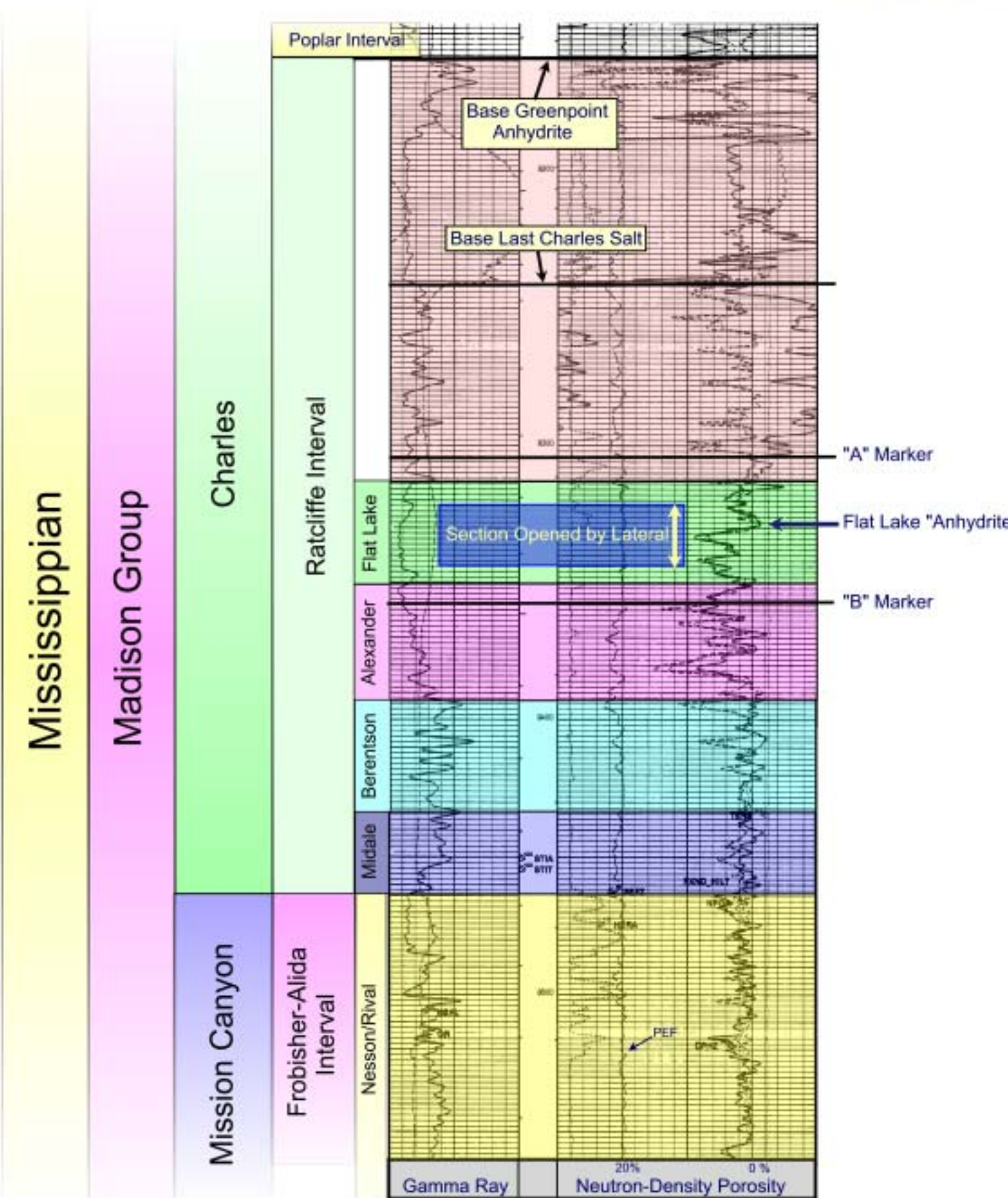
The Foreman Butte field lies on the west flank of the Williston basin within a broad homoclinal flexure that probably produces no more than 10 feet of structural closure within the Foreman Butte field. Production extends well beyond the limits of this structure thereby suggesting that closure alone is not a prerequisite for production.

The Alexander and Flat Lake subintervals are shallowing upward peritidal shoal island complexes consisting of restricted subtidal to supratidal limestones, partially dolomitized limestones and anhydrite. The productive oolitic/pisolitic shoal facies contains significant primary intergranular, fenestral porosity and local solution enhanced secondary porosity. In general porosity has been significantly reduced by compaction and multiple episodes of cementation. Even though the porosities are low and the productive interval is thin, the distribution of lateral porosity is extensive within the shoal facies. Cross-sections illustrate that the porous zones within the shoal complexes grade rapidly into anhydritic carbonates and anhydrites. In several instances, anhydrite signatures on porosity logs mark the edge of production or a significant decrease in production. Apparently, this happens when porous peritidal shoal facies change into nonproductive sabkha facies dominated by impermeable anhydrites, anhydritic limestone or dolostone. The geographic distribution of anhydrite within the Alexander/Flat Lake subintervals suggest that coalesced shoal island complexes form an anhydrite "free" limestone corridor. This corridor is locally more than 6 miles across and extends north-south along depositional strike for more than 60 miles. The carbonates of the Alexander/Flat Lake subintervals pinch out into thick massive anhydrite to the east and presumably landward of the shoal complex. West of the shoal complex, thinner anhydrites are locally present possibly reflecting inter-island playa deposits formed during minor drops in sea-level. These "playa" anhydrites lie updip of the shoal complexes and may therefore play important roles in the formation of individual traps.

Ruth 1-23  
NW, NW Sec. 23  
T150N, R102 W

Initial Production:  
400 bbls Oil  
225 MCF Gas  
372 bbls Water

## Reference Section



## Explanation

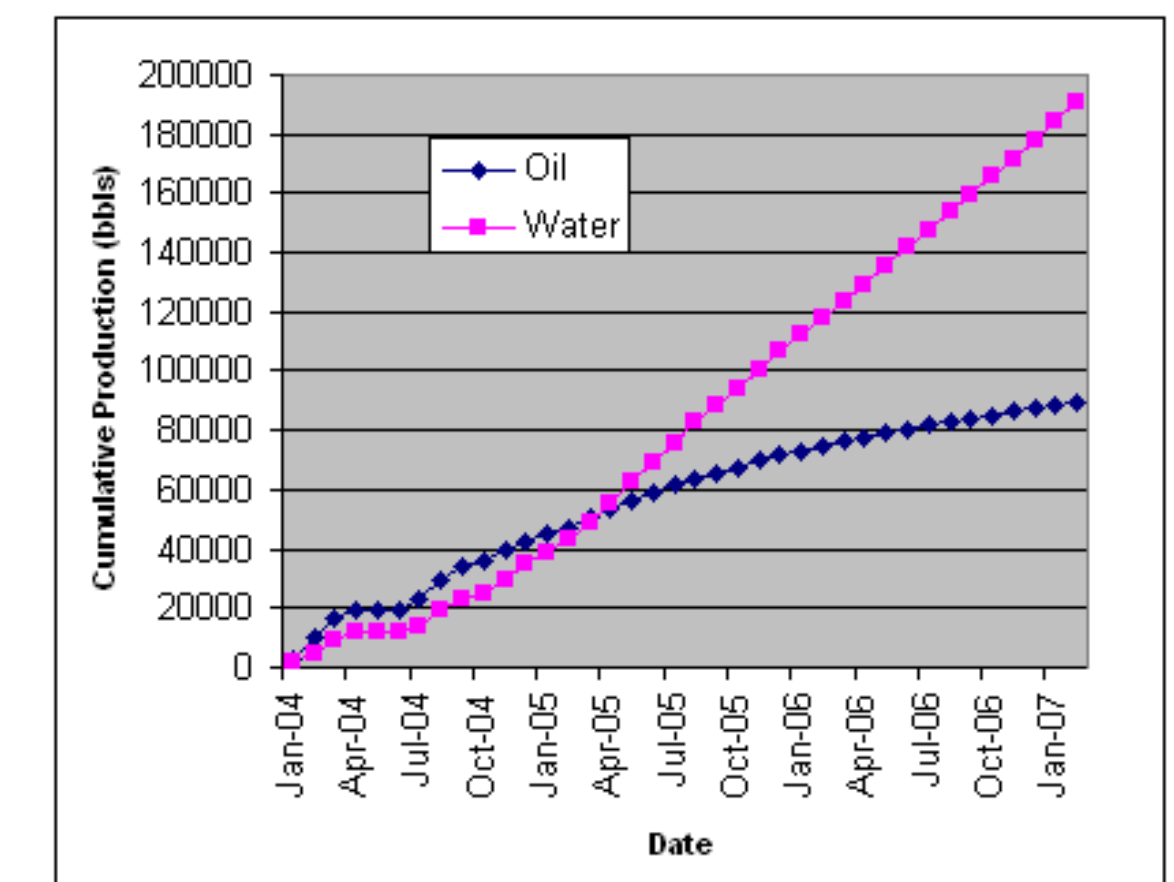
The accompanying map illustrates the regional structure of the Ratcliffe interval and the regional distribution of anhydrite that is present within the producing interval found in the Foreman Butte Field. The structure contour map is constructed from the mean sea-level elevation of the informal "A" marker that lies within the Ratcliffe interval just above the Flat Lake subinterval. Shaded contours are used to represent the thickness of anhydrite present within the interval defined by the base of the uppermost anhydrite in the Flat Lake interval and the informal "C" marker (See Reference Section). Anhydrite is presumed to be present in those intervals that have negative porosity values on the bulk density log (limestone matrix).

## The Foreman Butte Field

The Foreman Butte field was discovered by Zinke and Trumbo, Inc. in December of 2003 when the Ruth 1-23 well was horizontally drilled into the Flat Lake subinterval. During drilling of the vertical pilot hole, well site reports indicated the presence of poor interparticle and intercrystalline porosity that yielded a "very faint slow streaming yellow cut" through the Ratcliffe interval. A DST of this show produced 1260 feet of gas above the fluid in the drill stem and 492 feet of gas cut mud (reverse circulated). The sampler contained 2200 cc of mud, less than .05 cc of gas and just a trace of oil. In spite of the rather meager well site show, wireline logs suggested that within the Flat Lake subinterval there was a 12 foot section of limestone that contained an average of 5% porosity that was about 70% saturated with hydrocarbons.

A horizontal well was subsequently drilled into the porous zone to a total length of 13400 feet at a true vertical depth of about 9330 feet. The lateral was completed as an open hole with no stimulation. This well initially produced 400 bbls of oil, 225 MCF gas and some 372 bbls of water per day. Total production from this well between January 2004 and February 2007 is almost 90,000 bbls of oil, 55 MMCF gas and 190,000 bbls of water.

Currently, about 38 horizontal wells on 640 acre spacing are producing from the Flat Lake subinterval within the Foreman Butte field. As of February 2007, at least 1.96 million bbls of oil, 1.3 MMCF gas and 4.5 million bbls of water have reportedly been produced from the Foreman Butte field.



## Foreman Butte Monthly Production

Source: NDIC Oil and Gas Division

Date	BBLS Oil	BBLS Water	MCF Gas	Wells Producing
Feb-07	45554	187372	35072	38
Jan-07	51900	201218	38565	38
Dec-06	55650	209602	39229	38
Nov-06	52169	187234	37823	38
Oct-06	62505	225701	44814	38
Sep-06	62587	204143	47906	36
Aug-06	67342	189343	50306	36
Jul-06	74836	198271	53112	35
Jun-06	73865	200266	49828	34
May-06	77760	196831	46035	34
Apr-06	70739	158961	41829	32
Mar-06	79074	175307	38875	33
Feb-06	70661	144671	36377	32
Jan-06	70381	129692	40417	30
Dec-05	75396	188076	54481	29
Nov-05	83795	182323	61142	27
Oct-05	77271	188681	58143	27
Sep-05	58956	157084	44614	25
Aug-05	59919	148944	44782	23
Jul-05	65204	145775	47551	22
Jun-05	63415	137930	46483	21
May-05	65306	120766	45739	20
Apr-05	65795	113218	46742	18
Mar-05	68624	98949	48374	17
Feb-05	48690	62514	35059	16
Jan-05	49264	51934	35886	12
Dec-04	58629	55465	45079	12
Nov-04	60695	56232	47823	10
Oct-04	47389	41656	34933	8
Sep-04	35909	35405	27824	7
Aug-04	30754	33074	18488	4
Jul-04	8279	7353	6662	4
Apr-04	3078	2926	0	1
Mar-04	5970	4416	0	1
Feb-04	7160	3052	0	1