Geology and Drilling Results from Two of the Most Recently Discovered Oil and Gas Fields in Nevada, Noble's Humboldt and Huntington Oil and Gas Fields in Elko County, Nevada*

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Abstract

Between September of 2013 and November of 2014 Noble drilled 4 wells in the Elko Basin and completed two of the wells as producing oil wells in the Lower Tertiary Elko Formation. The wells are currently shut-in after short production testing. The Humboldt M2C-M2-21B was perforated between 7967ft and 8142ft in the Elko Shale and produced a total of 2782 bbls of oil over a period of 145 days. The Huntington K1L-1V well was tested in 2015 and has produced a total of 3833 barrels of oil from the Elko Shale between 8924ft and 9290ft. The areal extent of the ancestral Lower Tertiary Elko Basin is restricted primarily to Elko County, Nevada, and encompasses an area of nearly 8000 square miles. The Elko oil shale was first recognized by R.M. Catlin in 1875. Ultimately, an oil retort was built and operated from 1917 to 1924, producing approximately 12,000 barrels of oil. Estimates of the in-place shale-oil resources are approximately 600 million barrels in the 7 square mile outcrop area surrounding the Catlin Retort (Moore et al., 1983). The average pyrolitic oil yield of organic-rich sections in the Elko Shale are 25.4 gallons per ton and leaner shales yield 5 gallons per ton (Moore, 1983; Pool and Claypool, 1984; Solomon, 1992). Serious exploration efforts to develop the Elko Shale began in 1974 by Fillon Exploration. It was compared as an analog to producing oil fields in the Green River Basin of Utah and the Sheep Pass Basin in Nevada. However, this earlier exploration activity focused on conventional traps; whereas Noble Energy used Hydraulic Fracturing (HF) to develop the resource.

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Geology and Drilling Results from Two of the Most Recently Discovered Oil and Gas Fields in Nevada, Noble's Humboldt and Huntington Oil and Gas Fields in Elko County, Nevada

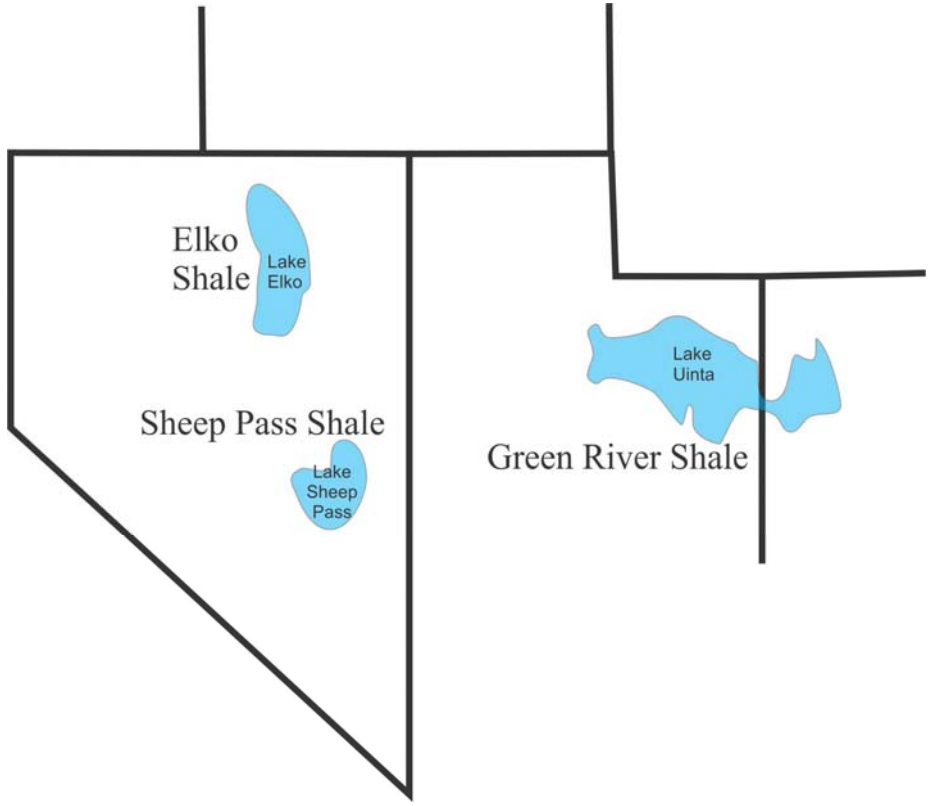
William J. Ehni

Ehni Enterprises, Inc., Carson City, NV

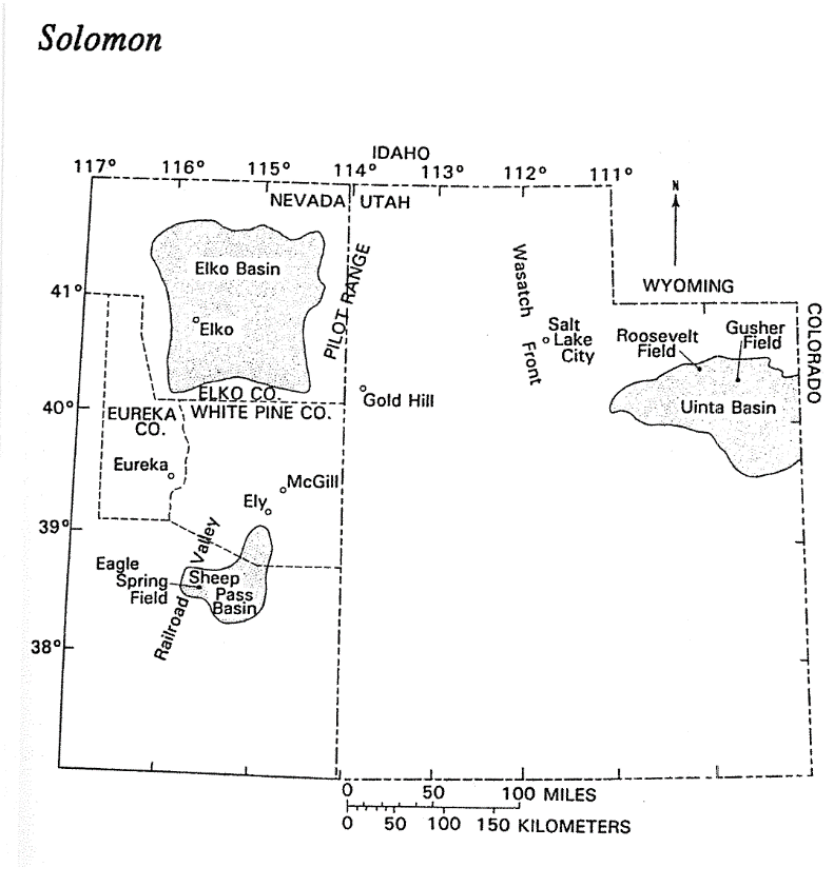
Between September of 2013 and November of 2014 Noble drilled 4 wells in the Elko Basin and completed two of the wells as producing oil wells in the Lower Tertiary Elko Shale.

The Elko Shale is Located in Northeastern Nevada

The estimated areal extent of the Elko Shale has evolved over time. In 1974 it was restricted to the west side of the Ruby Mountains and extended up to Bull Run Basin (Fillon Exploration). The Elko Shale is contemporaneous with the Green River and Sheep Pass shales, both of which have oil production associated with them.



In 1992 Barry Solomon modified a 1979 interpretation by Fouch et. al. of the Elko Basin and estimated that the areal extent of the Elko Basin was about 10,800 square miles.



A more restricted interpretation for the areal extent of the Elko shale was suggested by van de Kamp in 1992.

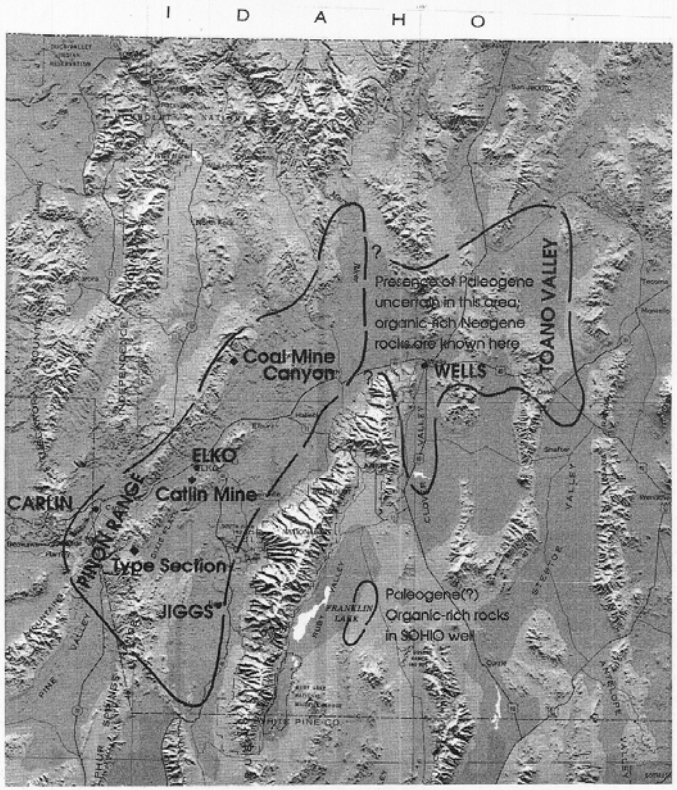


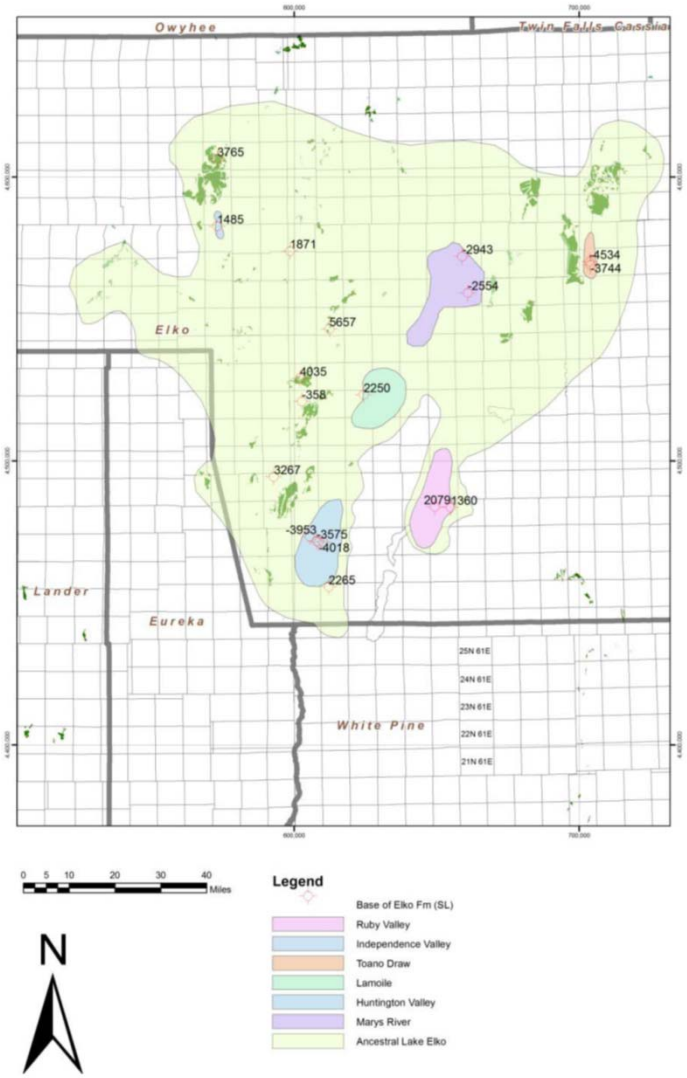
Figure 1. Index map showing the area in which the Elko Formation occurs (within the outlined area). The distribution of the Elko Fm. is indicated based on the geological map of Elko County by Coats (1987) and subsurface data in the files of the Nevada Bureau of Mines and Geology and the authors. The extent of the Elko Fm. east of Wells is uncertain; our interpretation is based on the occurrence of lithologies similar to those in the Elko Fm. in wells in Toano Valley. Significant outcrops of organic-rich facies are identified at the type section, Catlin Mine, and Coal Mine Canyon.

My interpretation of the ancestral Lake Elko, is based on outcrop and well control.

Outcrops of Lower Tertiary Paleogene, Elko Shale, or equivalent, are shown in dark green.

Neogene basins based on gravity are Identified in other colors.

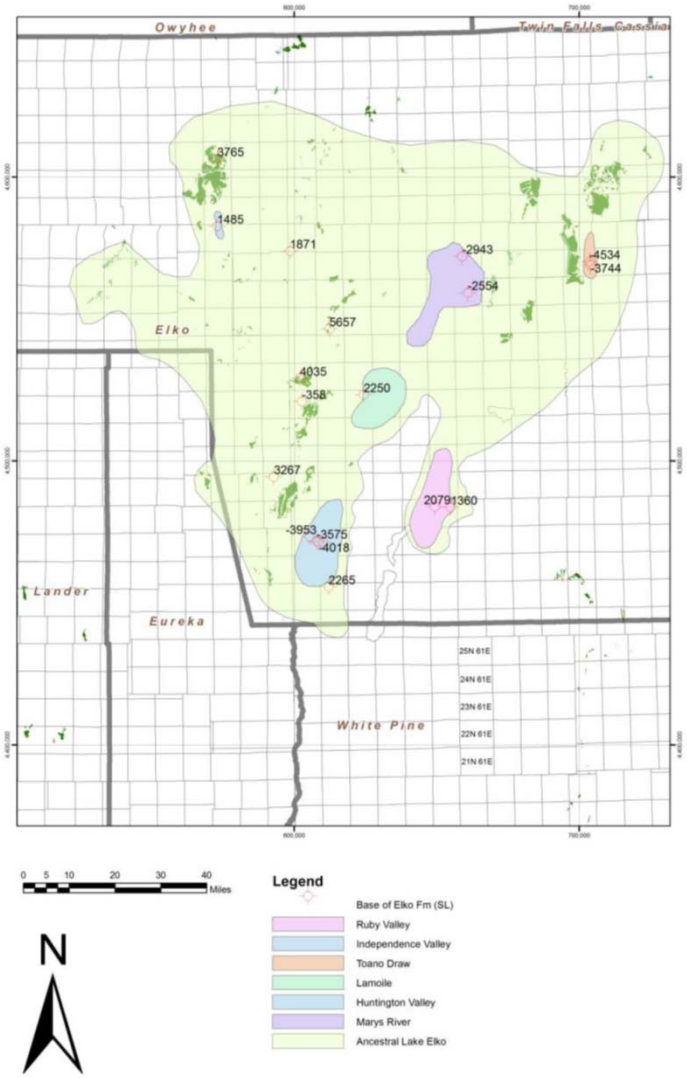
2007 USGS Digital geologic map of Nevada by Crafford and Harris



Prior to 2013 there had only been 18 wells that evaluated the Elko Shale. Two of these wells reported oil production.

Deadman Creek discovered in 1997 has produced a total of 367 barrels of oil to date.

Toano Draw discovered in 2007 has produced a total of 1964 barrels of oil to date.



A measured section of the Elko formation at the type section in the Pinon Range (T31N R53E) is over 2075 feet thick, as described by Smith and Ketner in USGS professional paper 867-B. The base is unexposed at this location. Smith and Ketner speculated that the maximum thickness for the Elko formation in this area is about 2500 feet.

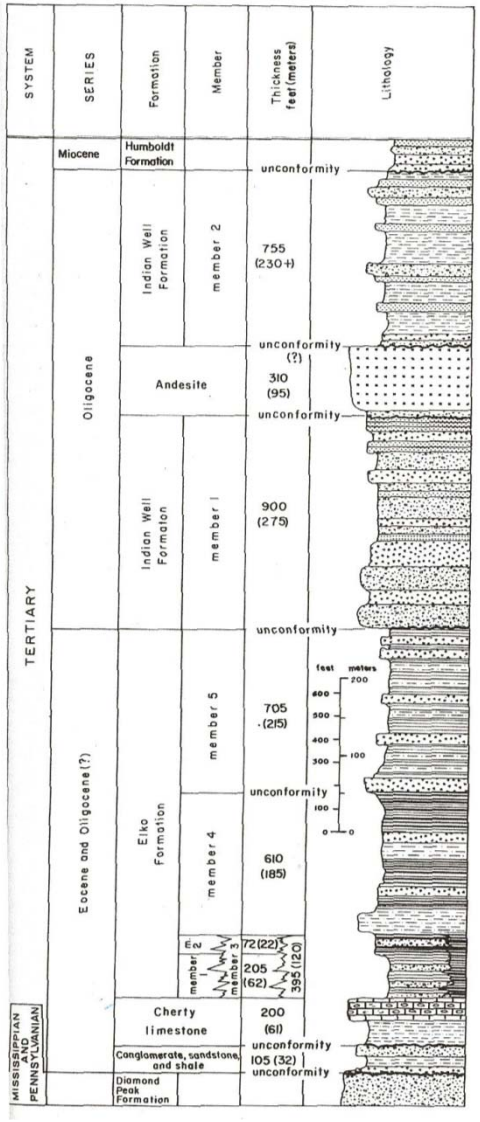
Outcrops of the Elko Shale weather a very light gray, and the fresh surface grades from very dark gray to chocolate brown.

Photo of Elko shale from the Type Section on the north end of the Pinon Range.

Solomon et. al., 1979 Stratigraphy

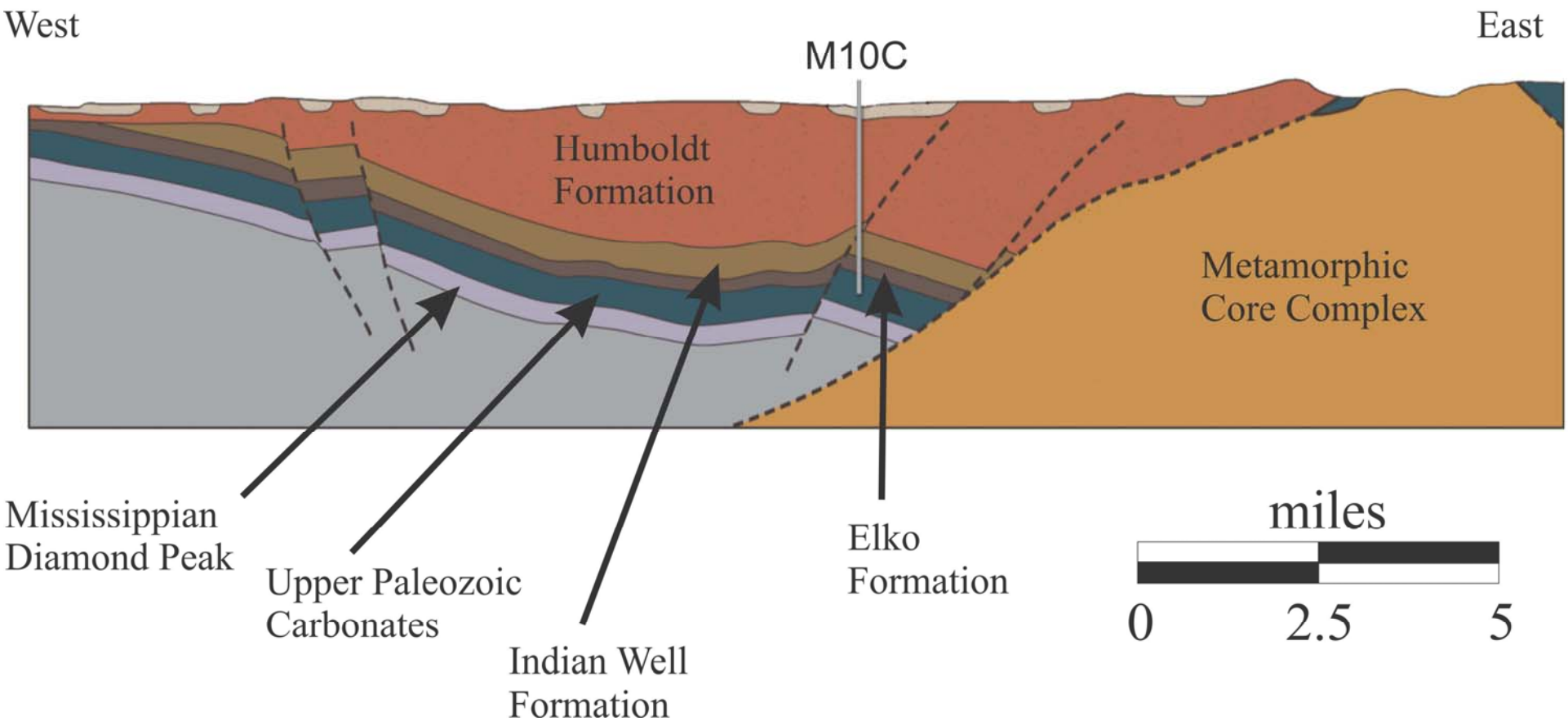
Solomon, B. J. et. al.; 1979; Eocene and Oligocene Lacustrine and Volcanic Rocks near Elko, Nevada; in 1979 Basin and Range Symposium RMAG and UGA, Newman and Goode Editors.

Solomon reported that the Elko Formation is about 1710 feet thick near Elko, Nevada.
Organic content increases with depth.
Most of the oil shale is located in the lower 400 feet of this section.



Geologic Cross Section

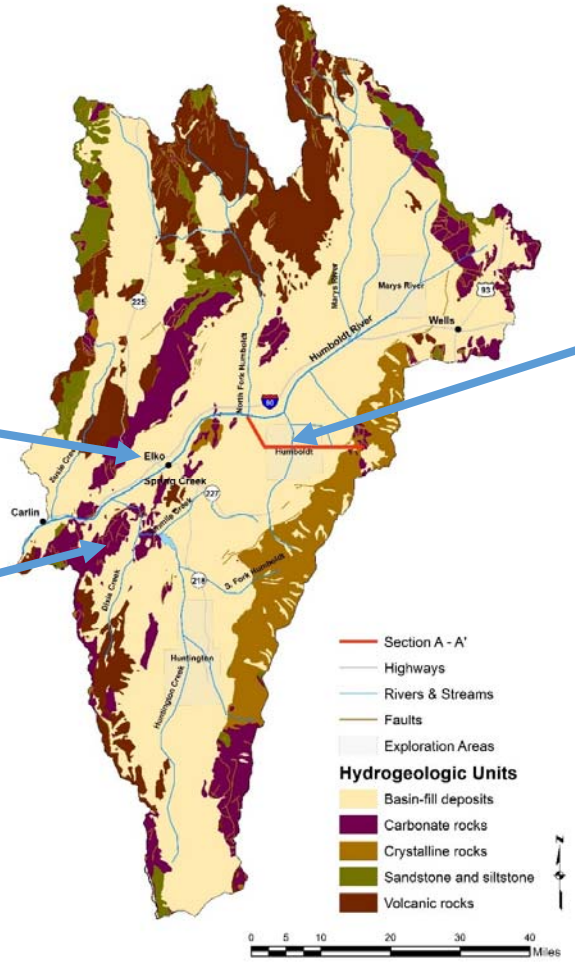
used by DRI for hydrologic studies



http://www.dri.edu/component/content/article/102-research-and-publications/projects/4598-aquifer-quality-assessment-program

Elko

Type Section
In the Pinon Range



Location of
Cross Section

Geologic Map

Modified from Pohll et. al.

http://www.dri.edu/component/content/article/102-research-and-publications/projects/4598-aquifer-quality-assessment-program

Looking west from the top of Secret Peak toward the Humboldt prospect.
Metamorphic rocks at the top of Secret Peak

Abandoned Catlin retort and outcropping Elko Shale.

Poole and Claypool (1984) reported TOC values up to 37.1% from samples collected at the Catlin retort site

Fischer assays of the Elko oil shale at the Catlin site ran as high at 73.9 gallons of oil per ton of shale.
(Smith and Ketner 1976; USGS professional paper 867-B)

Solomon in 1978 reported a yield of 85.5 gallons per ton from the Elko Shale

A full pickup load of shale has the potential to produce about two barrels of oil.

Between 1917 and 1924 the Catlin oil retort produced approximately 12,000 barrels of oil.
(Garside, L., 1983 NBMG OFR-83-5)

Remains of the Catlin retort (2014)

The average pyrolytic oil yield of organic rich sections in the Elko shale is 25.4 gallons per ton. Leaner shales yield 5 gallons per ton (Moore 1983, Pool and Claypool 1984, Solomon 1992).

Noble Drilling Campaign in the Elko Basin

October 2013

- Humboldt M2C : TD 11,689 feet
- Producer – shut in

December 2013

- Humboldt M10C : TD 9,100 feet
- Idle

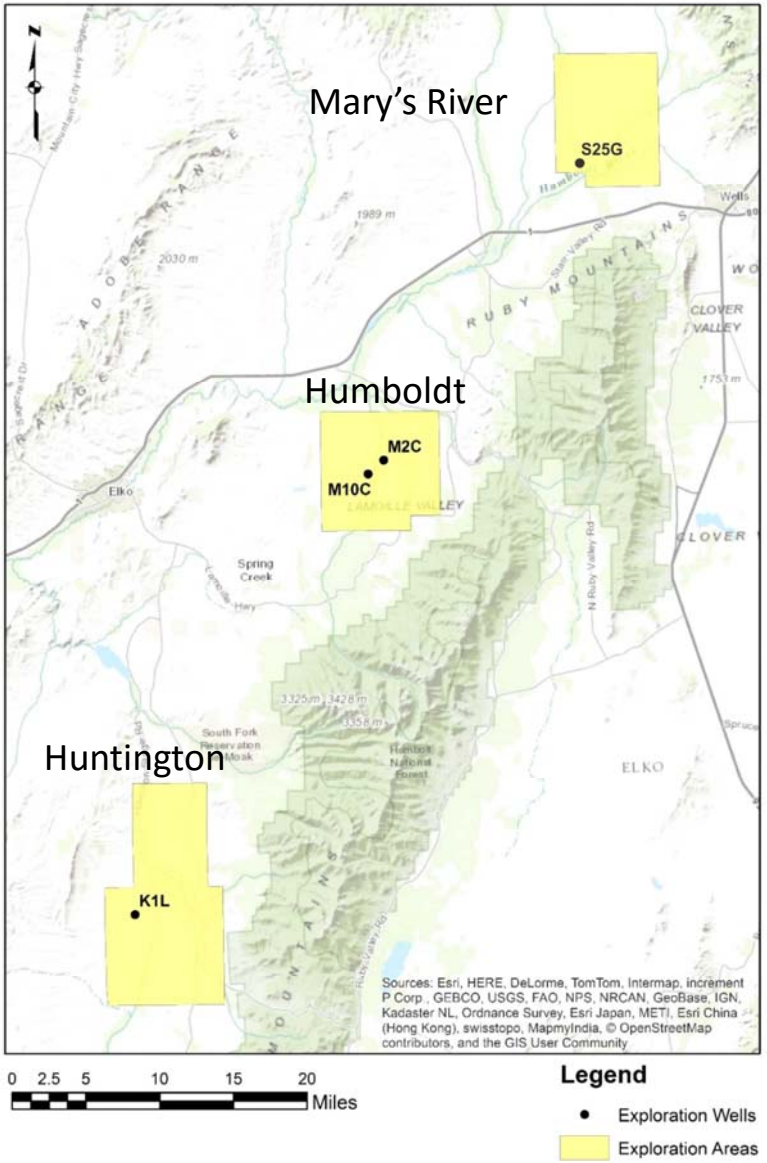
October 2014

- Huntington K1L : TD 9693 feet
- Producer – shut in

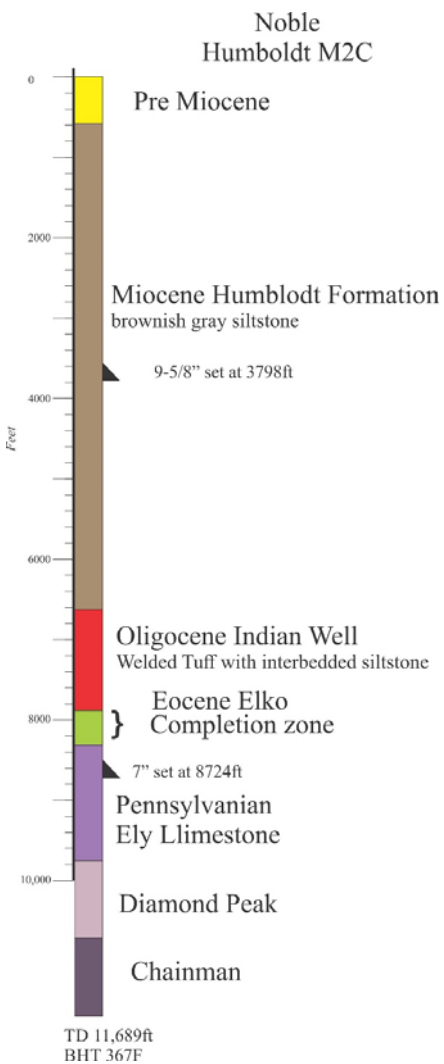
November 2014

- Mary's River S25G : TD 11,136 feet
- Idle

All 4 wells are vertical



Map Modified from G. Pohll et al.



M2C

Spud : 2 September 2013

Miocene Humboldt Formation	580 ft
Oligocene Indian Well Formation	6,662 ft
Eocene Elko Formation	7,884 ft
Paleozoic Limestone (Ely)	8,312 ft
Mississippian Diamond Peak	9,752 ft
Mississippian Chainman	10,710 ft

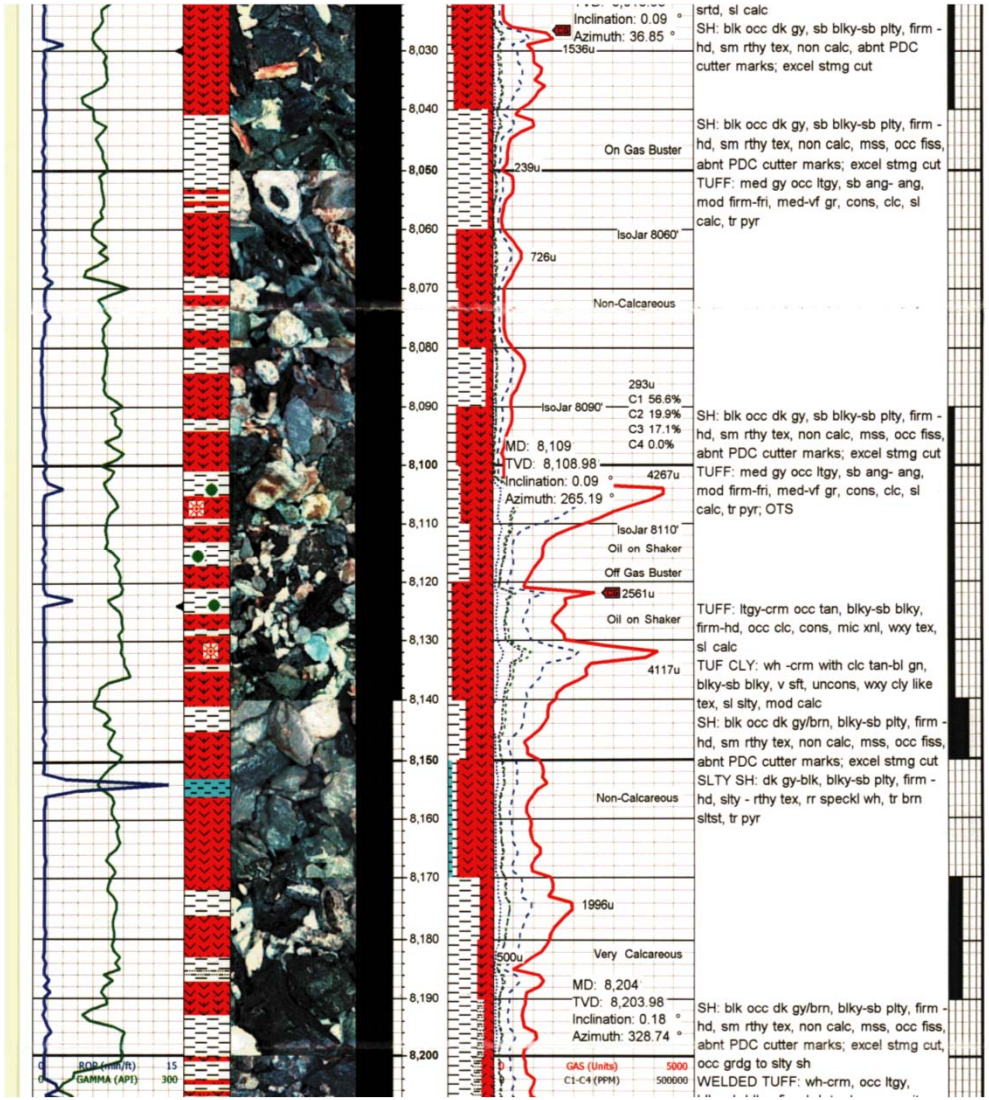
TD 11,689 feet (24Oct2013)

52 days drilling

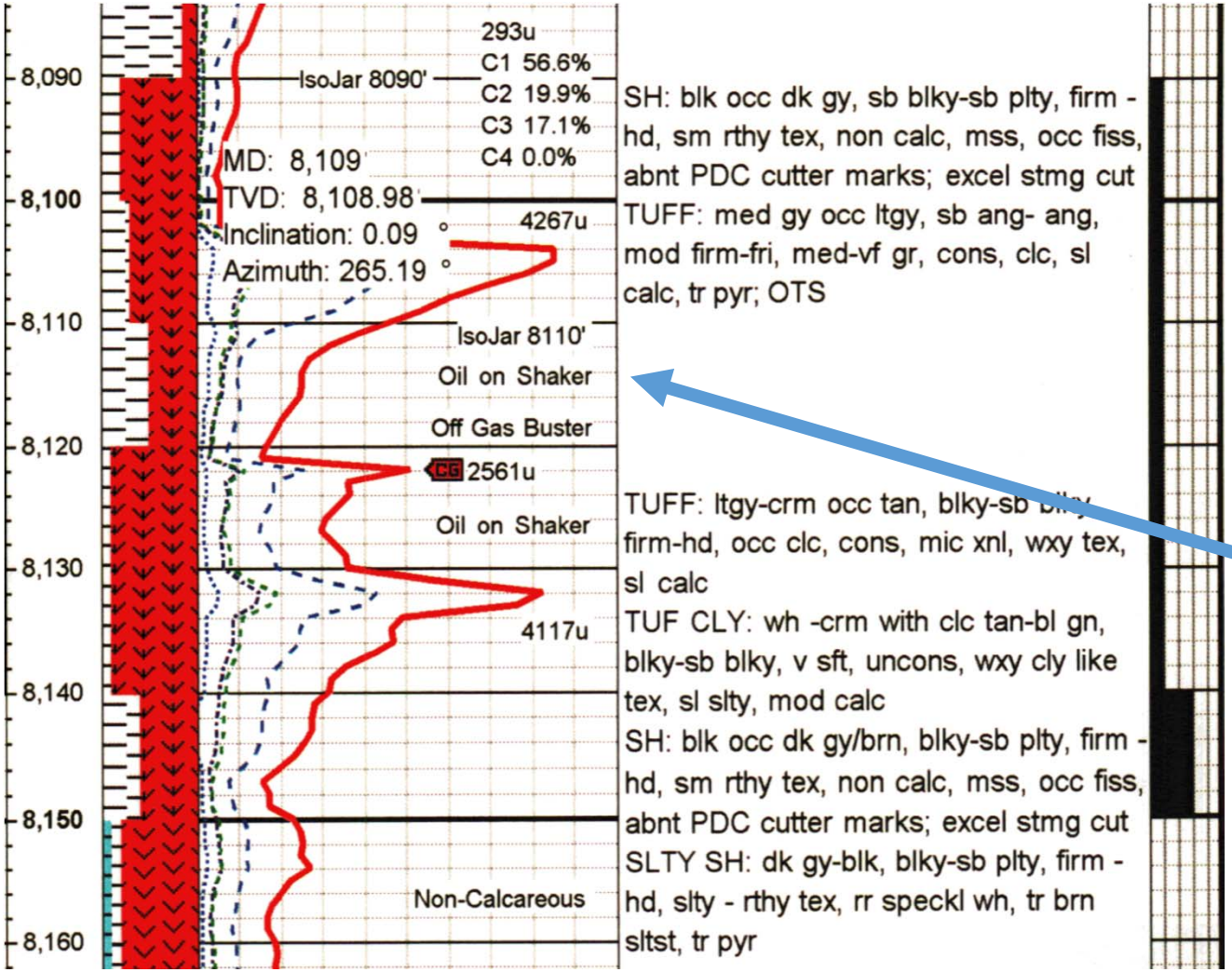
Elog BHT : 367F

Status : Producer – shut in

Production Zone in M2C 7906’ to 8210’ (Elko Fm)



NOBLE M2C



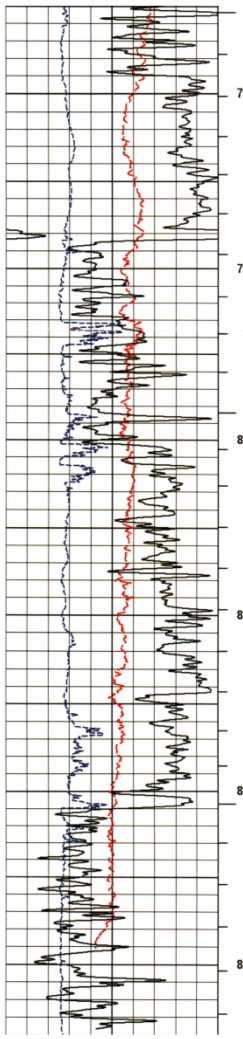
Oil on Shakers at 8110’ MW 9.1ppg

M2C Gamma Log

7884 ft top of
Elko Fm

Total Thickness
of the Elko Formation in the M2C well
is 428 feet

8312 ft top of
Paleozoic limestone



Indian Well
Volcanic Rocks

7900’

8000’

8100’

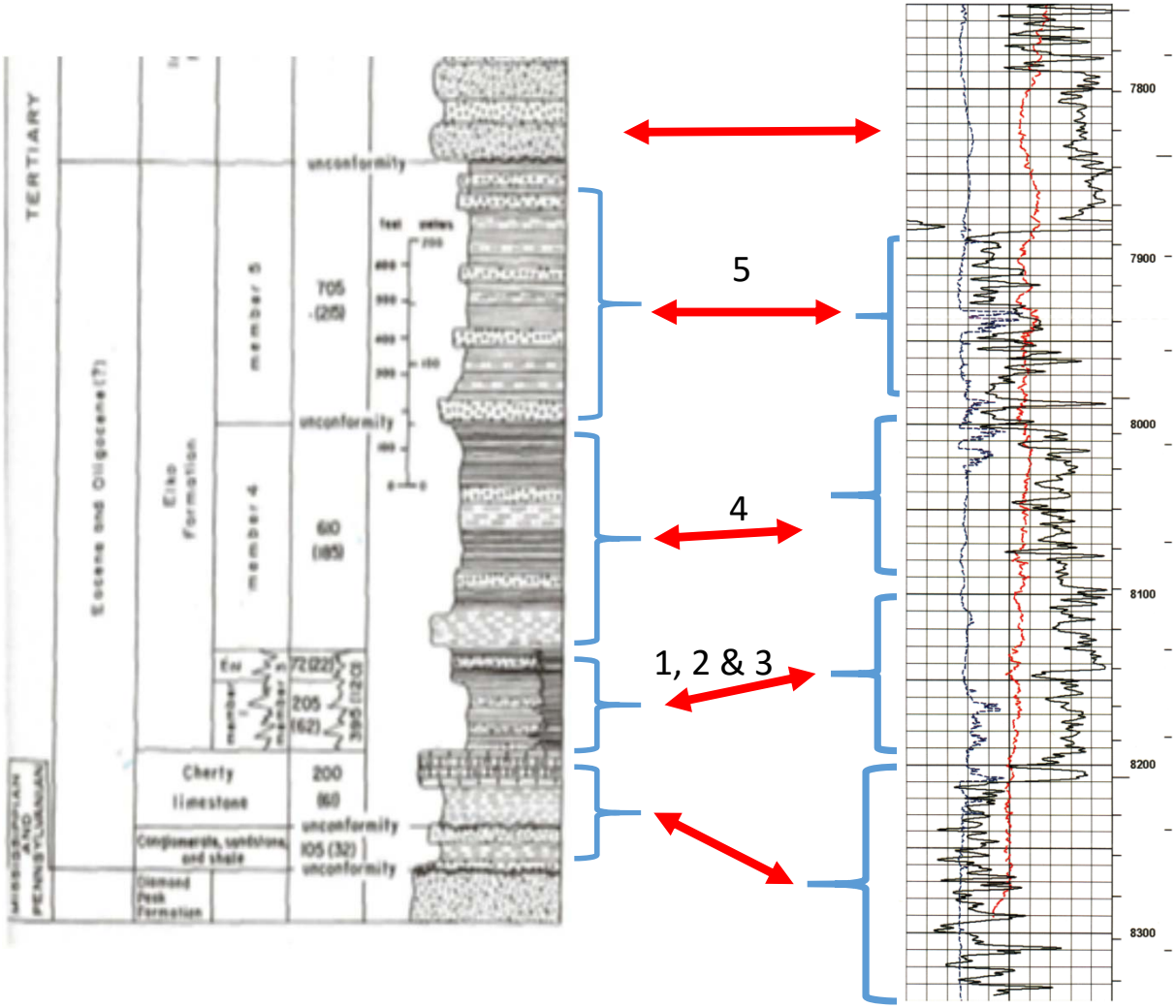
8200’

8300’

Production zone
7906ft to 8210ft

210 feet of high gamma
(organic rich) section
In the Elko Fm.

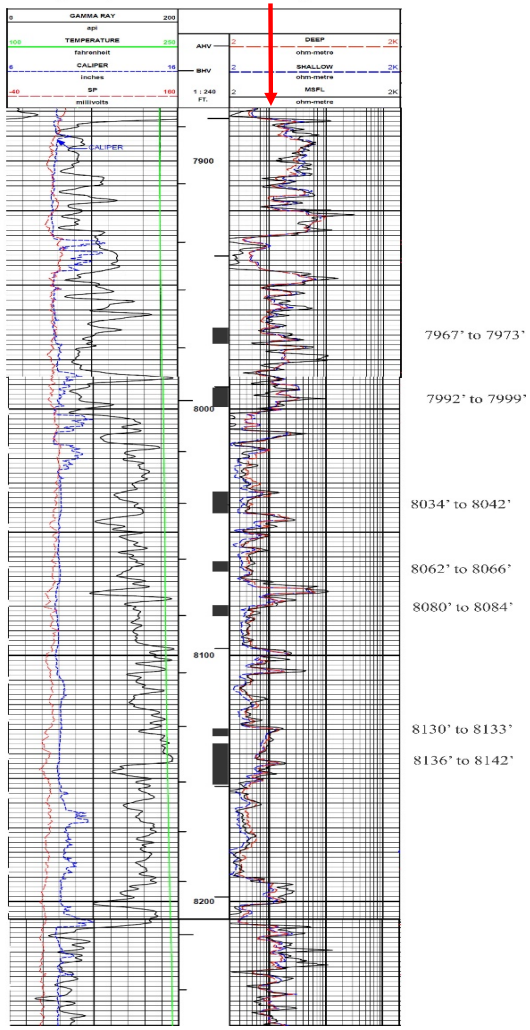
lower basal conglomeritic
and cherty limestone



Correlation of M2C GR log with Solomon's Stratigraphic Section showing "member" designation.

M2C Wireline Log
showing perforation intervals
between 7967 ft and 8142 ft
In the Elko shale

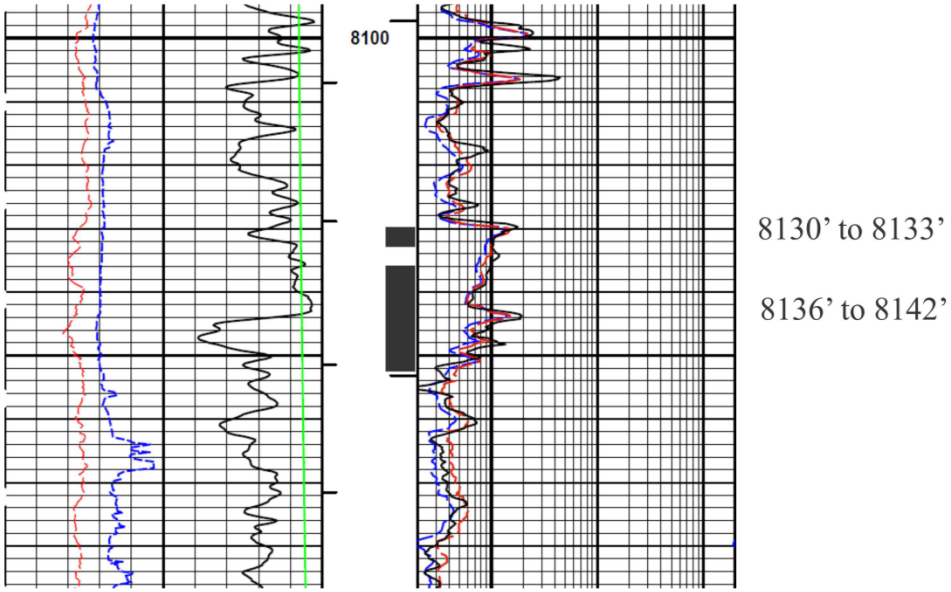
M2C
comingled production from 7 perforation zones



Red arrow at 10 Ohm-meters

M2C
Stage 1

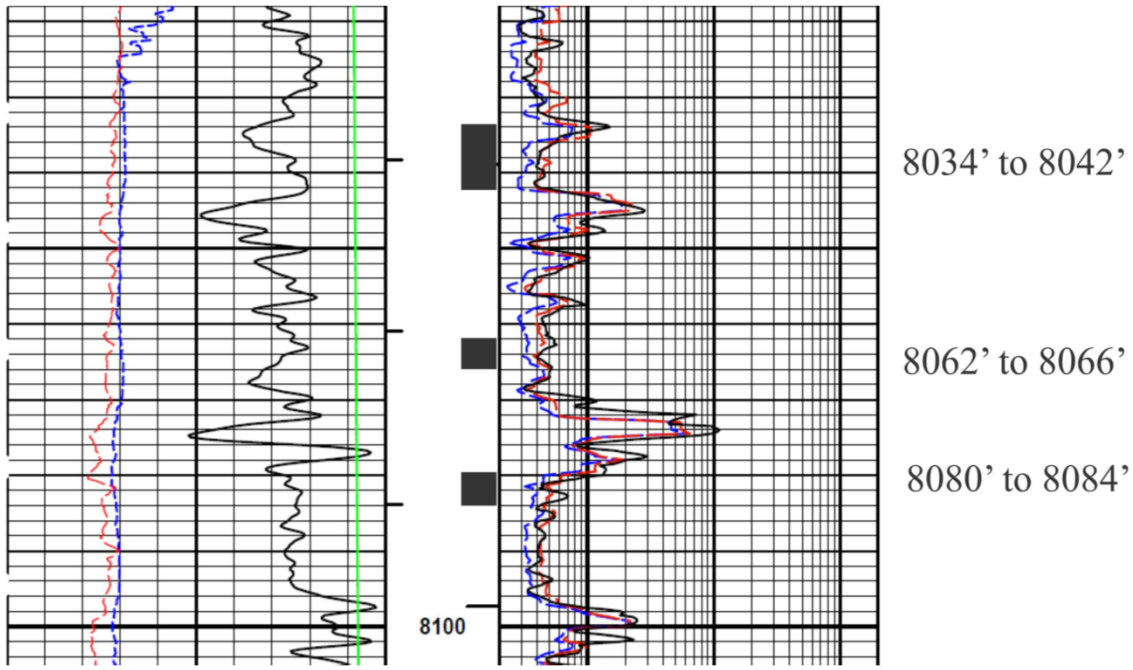
9 feet of
Perforations



67,000 Gals of water
55,000 lbs sand
(3/18/2014)

M2C
Stage 2

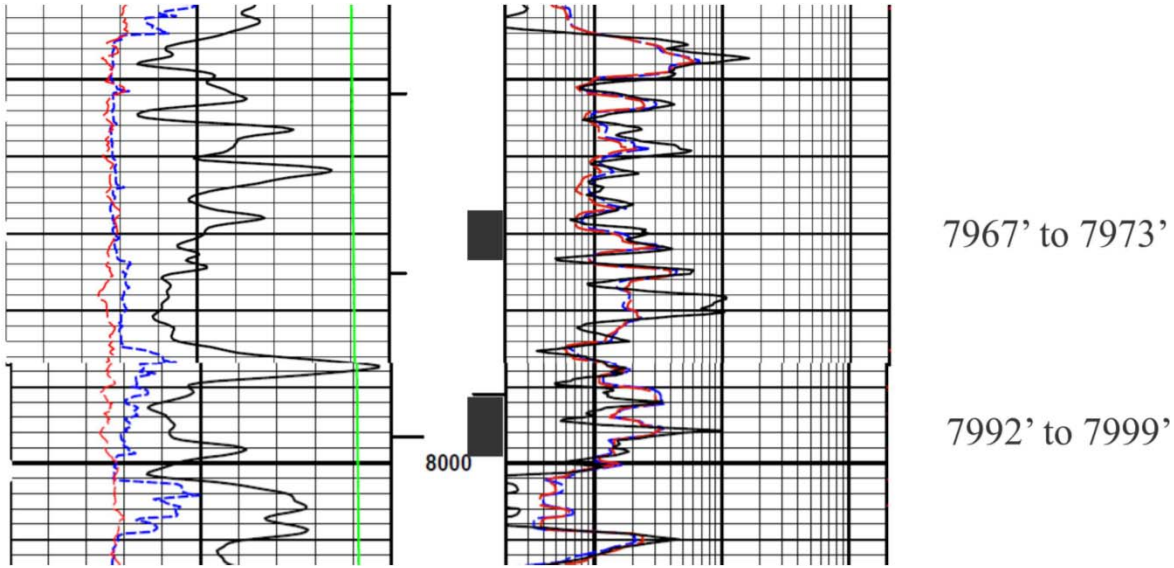
16 feet of perforations



85,500 Gals of water
108,000 lbs proppant
(3/21/2014)

M2C
Stage 3

13 feet of perforations



97,000 Gals of water
plus sand
(3/24/2014)

Humboldt Field : well M2C

Spud : 2 September 2013

24 October 2013 : TD 11,689 feet

52 days drilling

(includes 223 RSWC)

Total thickness of the Elko : 428 feet

Production interval 7973’-8136’ (Elko Fm)

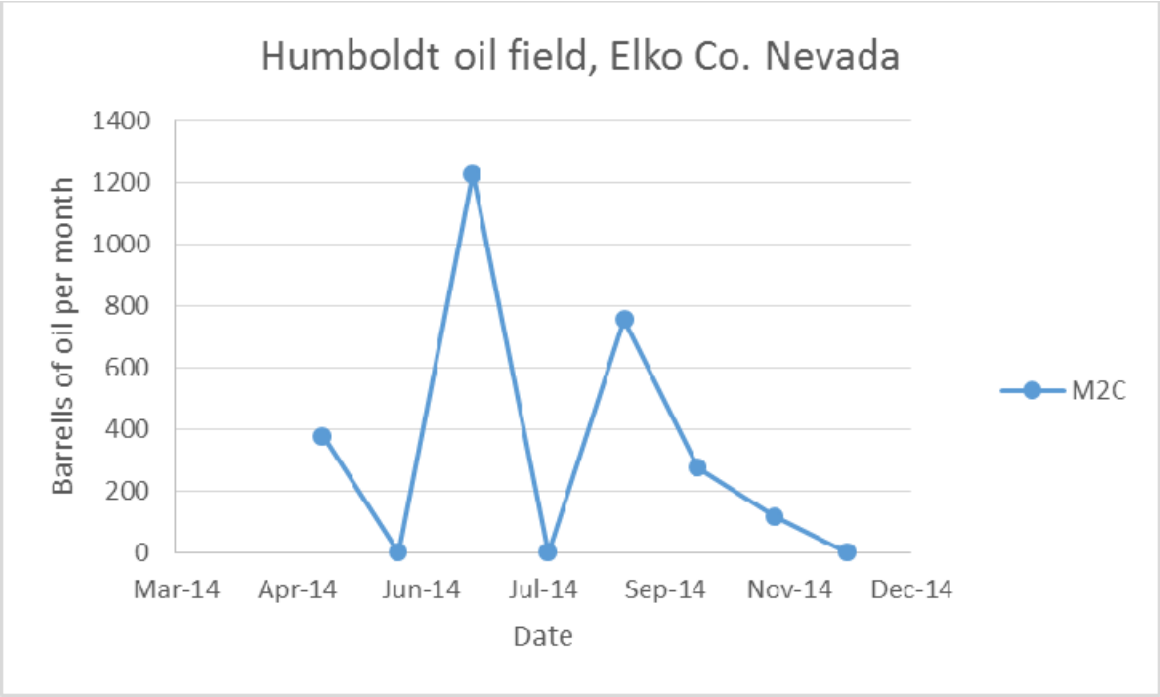
Three stage vertical fracture stimulation

First production in May 2014

Total oil production to date:

2755 barrels of oil (36 API gravity)

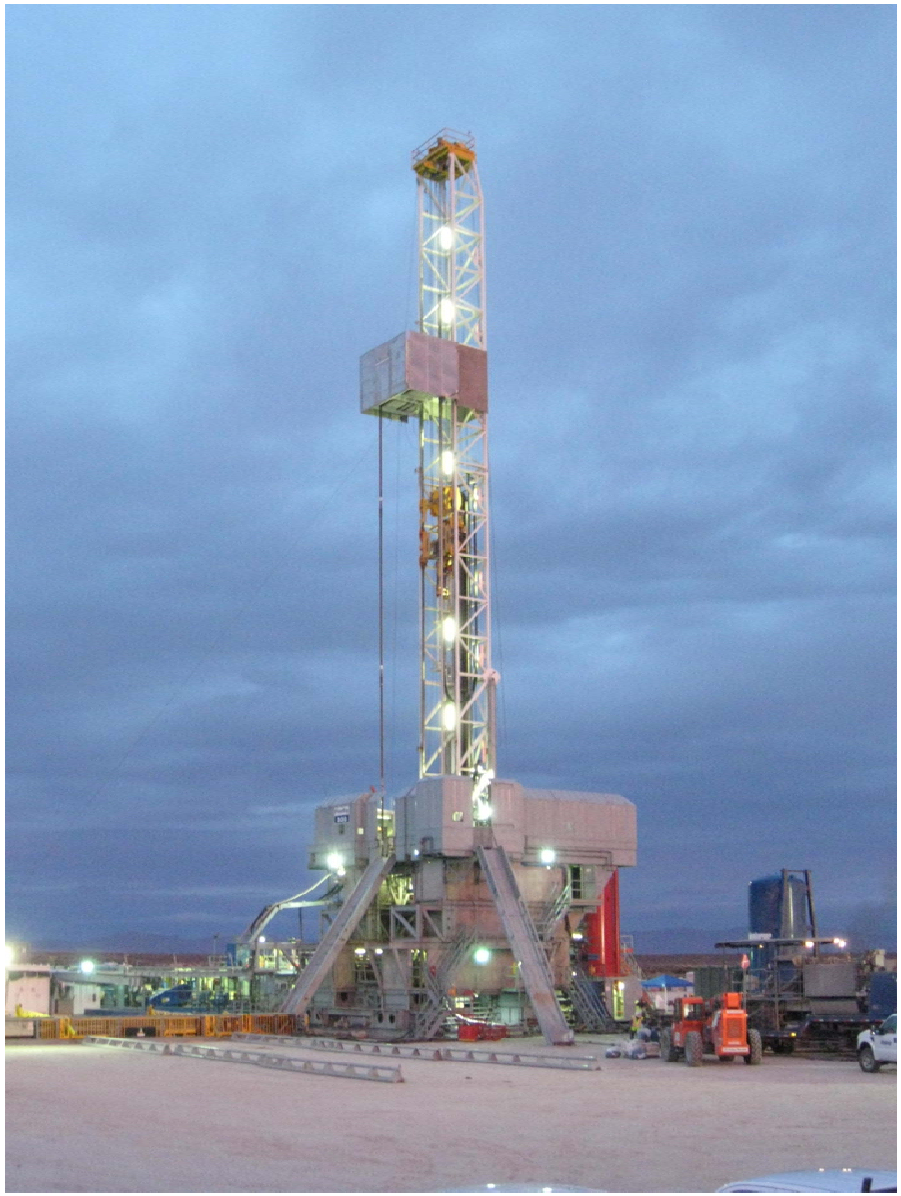
M2C cumulative oil production 2755 bbls of oil (no water)

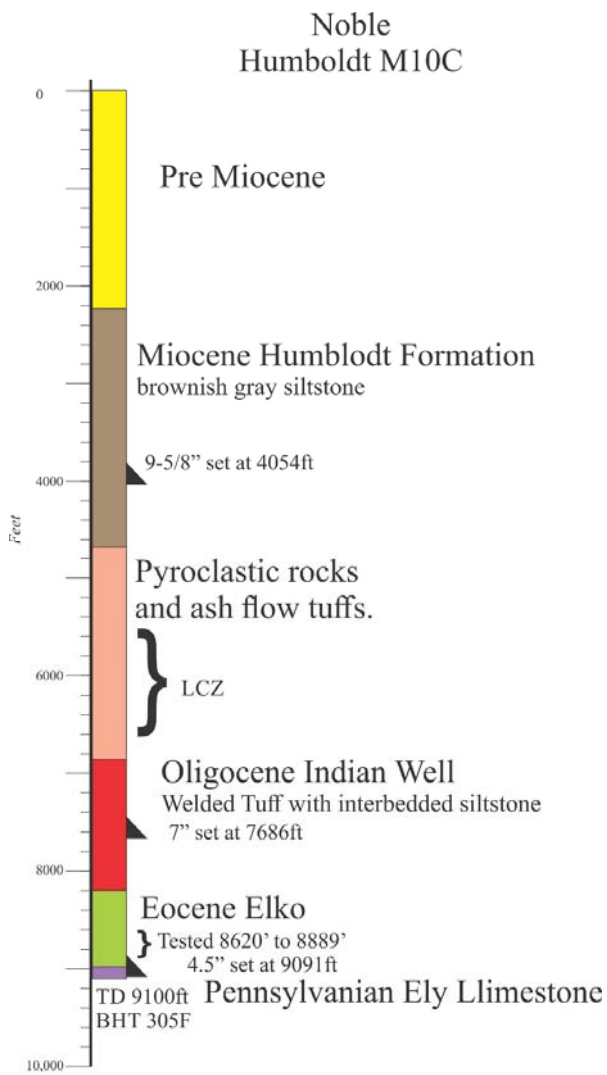


First Production May 2014

H&P Rig 330

After drilling the M2C Noble moved the drill rig over to the M10C Drill pad.





M10C

Spud : 6 November 2013

Oligocene Indian Well Formation	6,857 ft
Eocene Elko Formation	8,198 ft
Paleozoic Limestone (Ely)	8,977 ft

TD 9,100 feet (20 Dec 2013) 45 days of drilling

Elog BHT : 305F

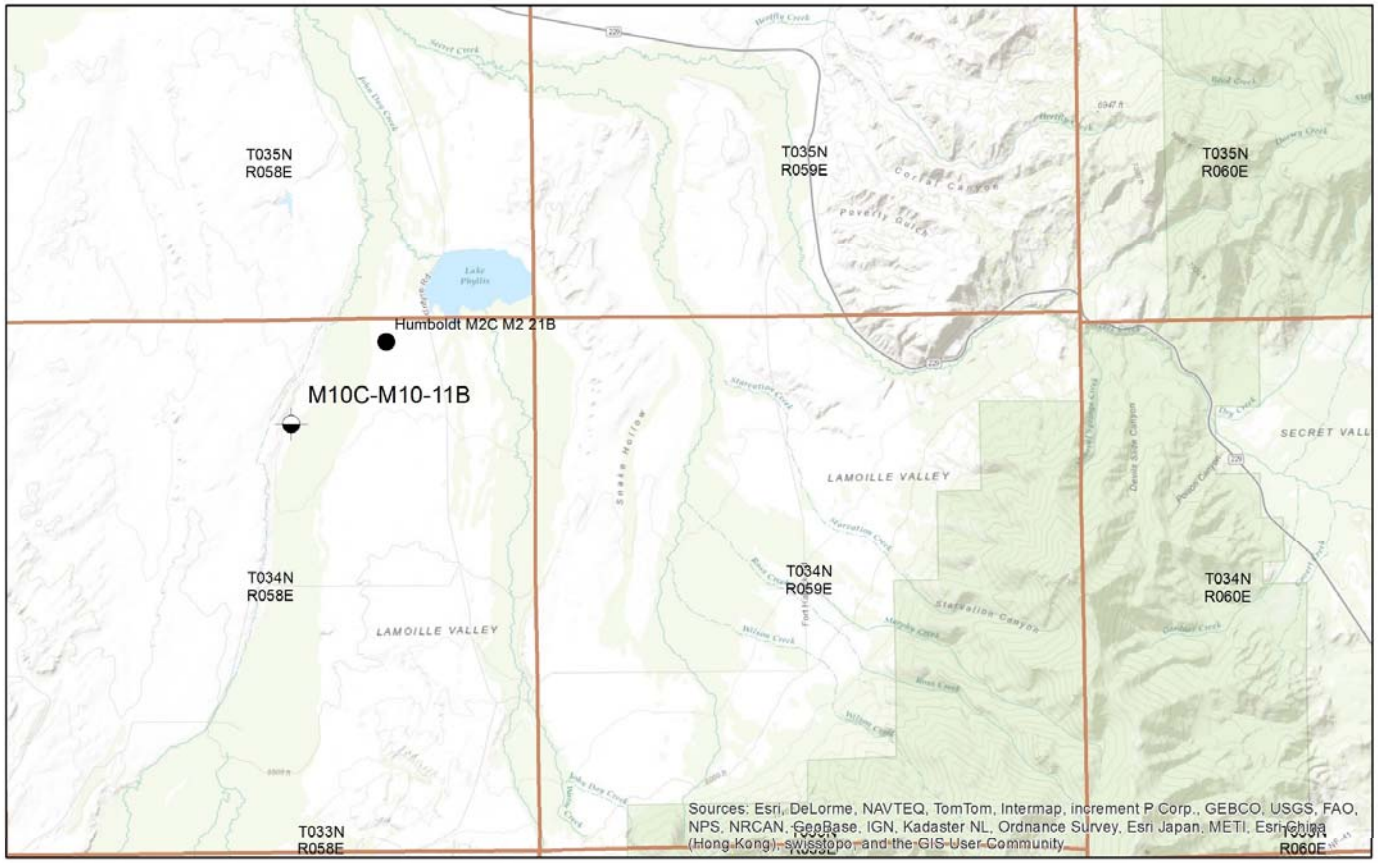
Elko formation in the M10C is 779 feet thick

Perforated 150’ of Elko Formation from 8620’ to 8889’

Hydraulically stimulated

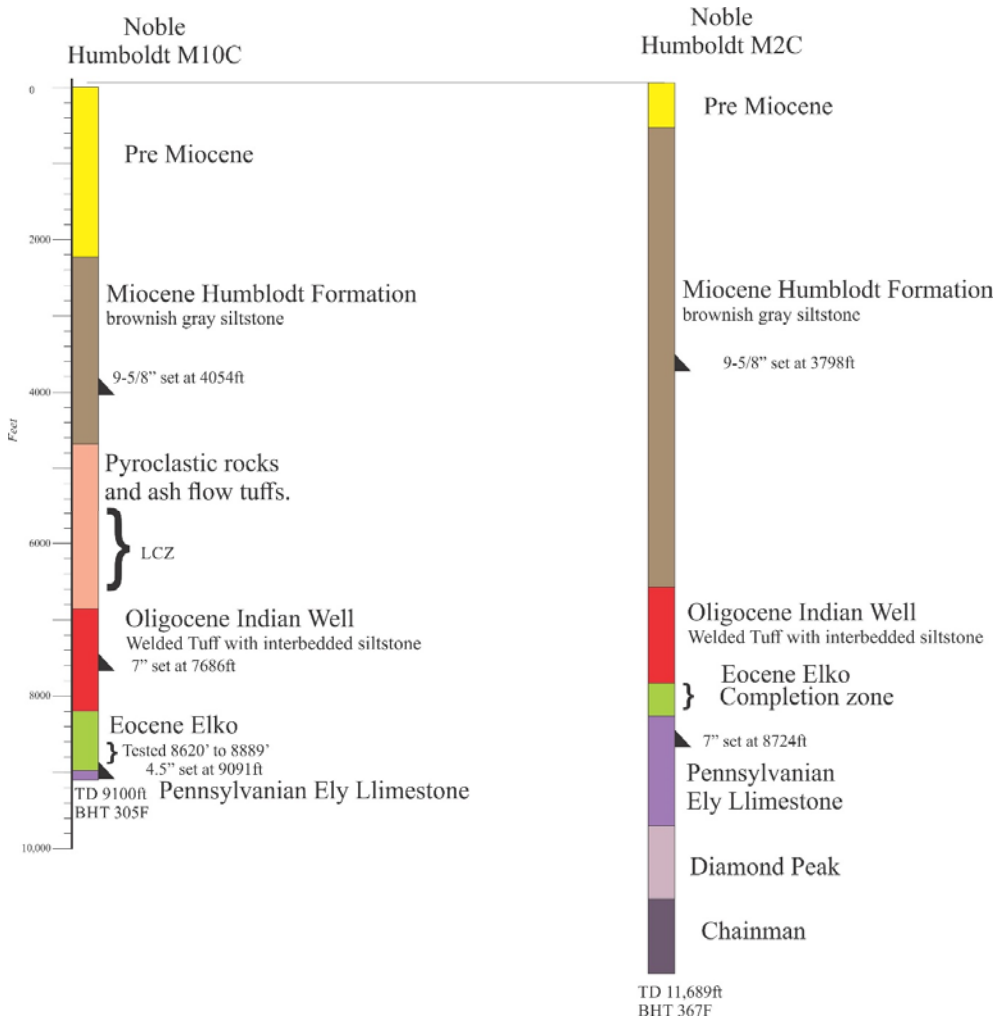
Recovered 1% oil

Status : Idle



N

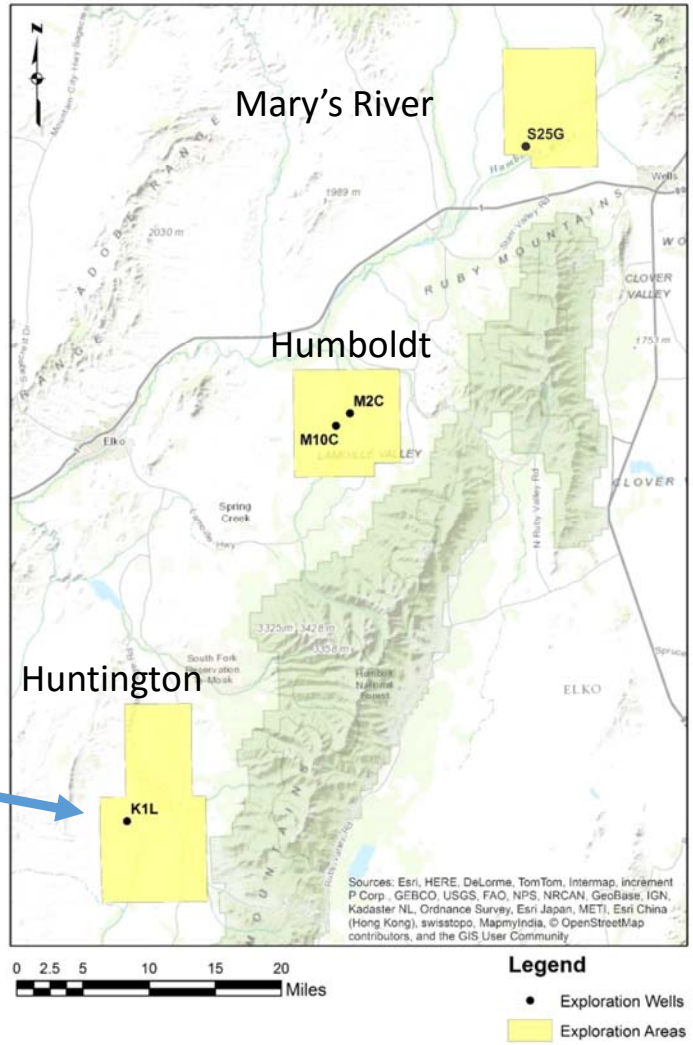
0 0.5 1 2 3 4 Miles


Noble
Humboldt M10C
Noble
Humboldt M2C
Feet
0
2000
4000
6000
8000
10,000
Pre Miocene
Miocene Humblodt Formation
brownish gray siltstone
9-5/8" set at 4054ft
Pyroclastic rocks
and ash flow tuffs.
LCZ
Oligocene Indian Well
Welded Tuff with interbedded siltstone
7" set at 7686ft
Eocene Elko
Tested 8620' to 8889'
4.5" set at 9091ft
TD 9100ft
BHT 305F
Pennsylvanian Ely Llimestone
Pre Miocene
Miocene Humblodt Formation
brownish gray siltstone
9-5/8" set at 3798ft
Oligocene Indian Well
Welded Tuff with interbedded siltstone
Eocene Elko
Completion zone
7" set at 8724ft
Pennsylvanian
Ely Llimestone
Diamond Peak
Chainman
TD 11,689ft
BHT 367F

October 2014

Huntington K1L : TD 9693 feet

Producer



Map Modified from G. Pohll et. al.

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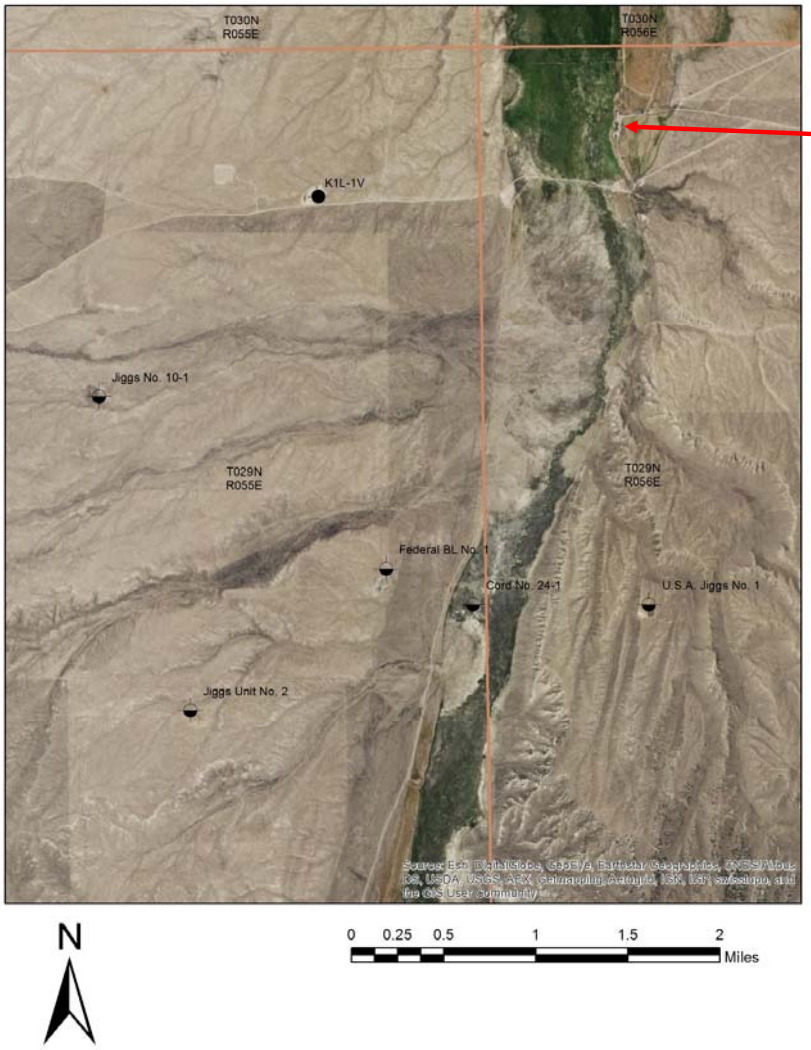
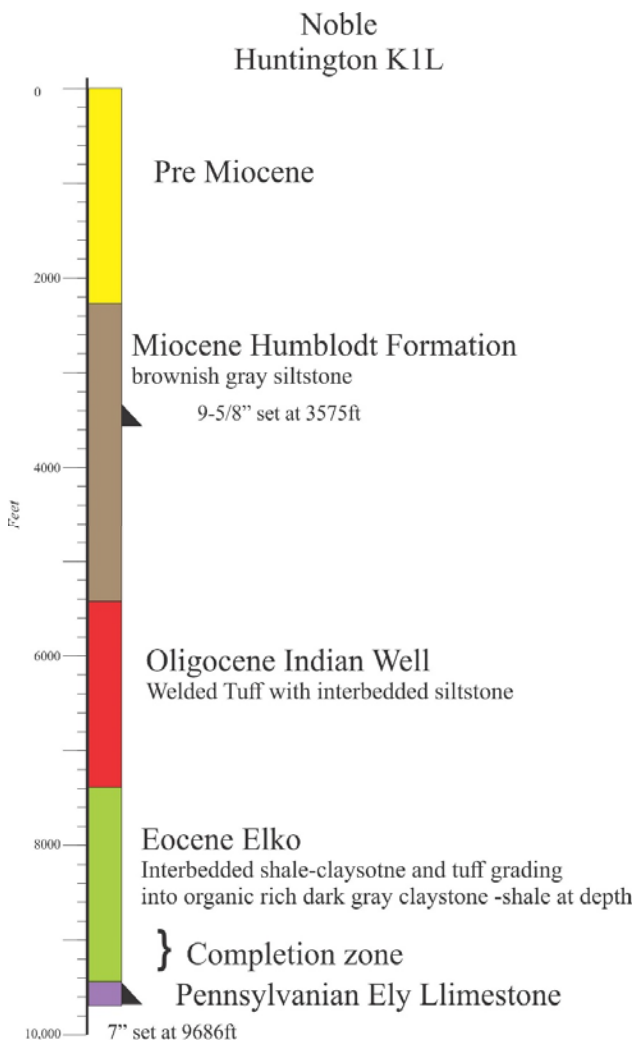


Jiggs Nevada



K1L

Spud : 24 September 2014

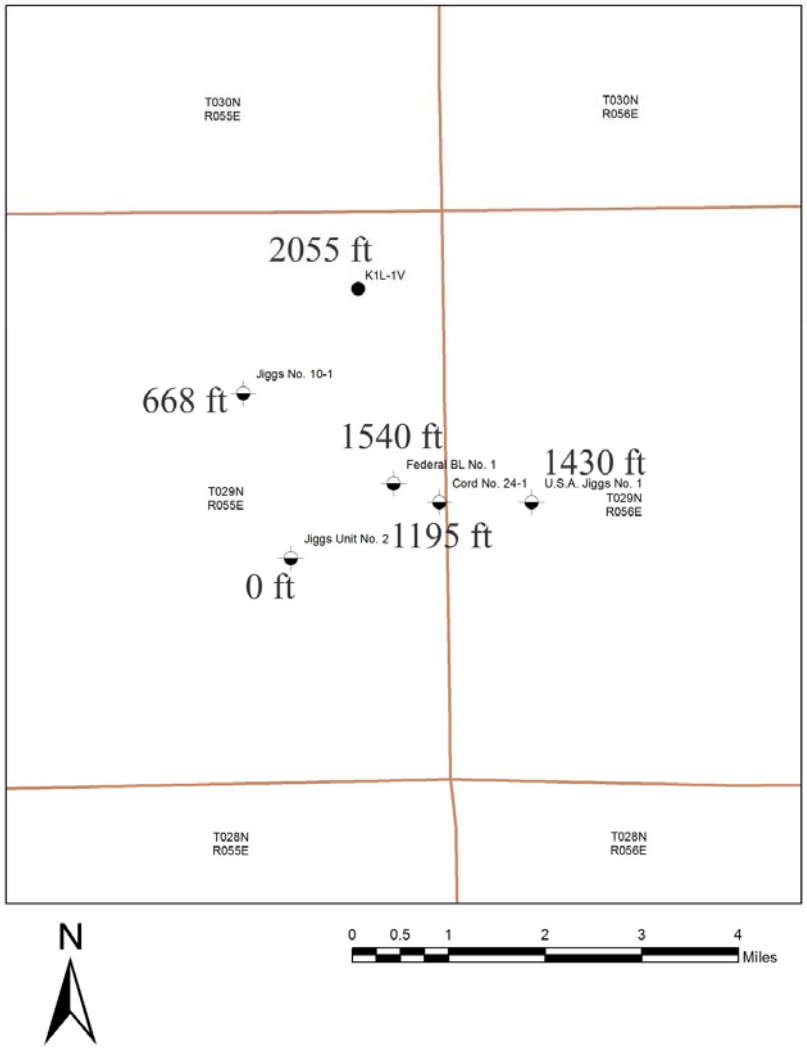
Miocene Humboldt Formation	2,270 ft
Oligocene Indian Well Formation	5,423 ft
Eocene Elko Formation	7,384 ft
Paleozoic Limestone (Ely)	9,439 ft

TD 9,693 feet (16 October 2014)
(22 days of drilling)

Elog BHT : 284F

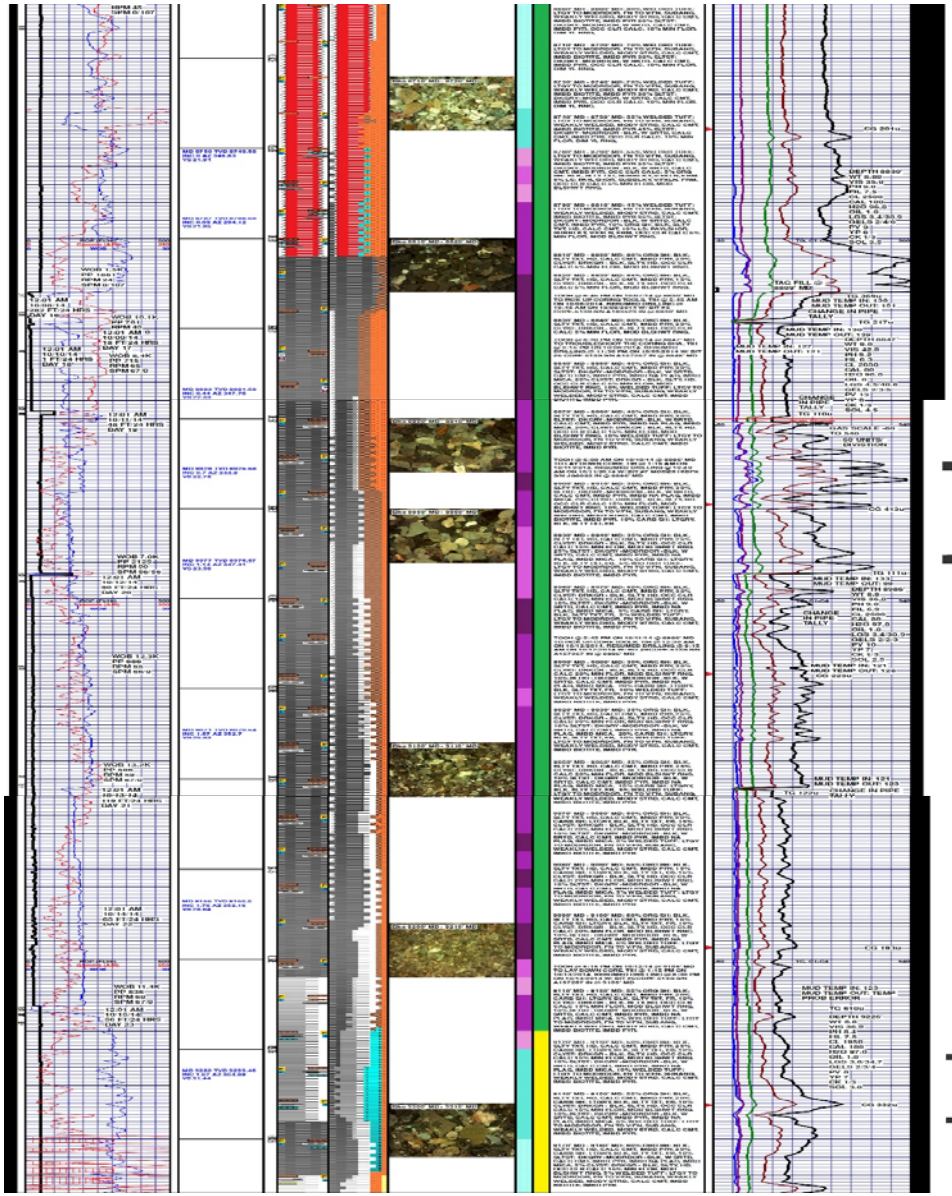
Status : Producer shut-in

Thickness of the Elko Fm from well control in the Jiggs area.



K1L
Mud Log
showing
completion zones
in the lower
organic-rich Elko
Shale from
8924’ to 9290’

Core 8830’-9226’



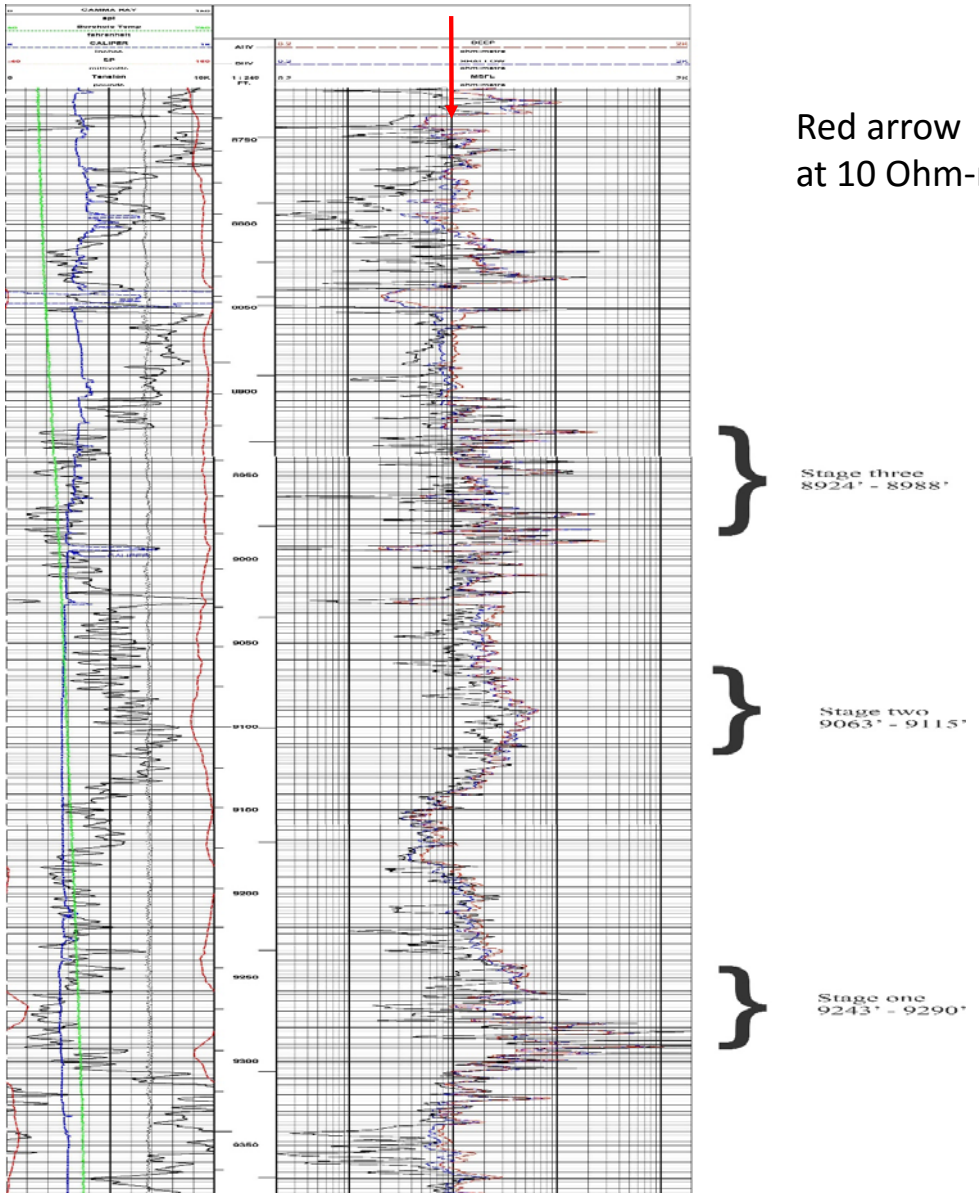
Top of Shale
At 8810ft

Stage three
8924' - 8988'

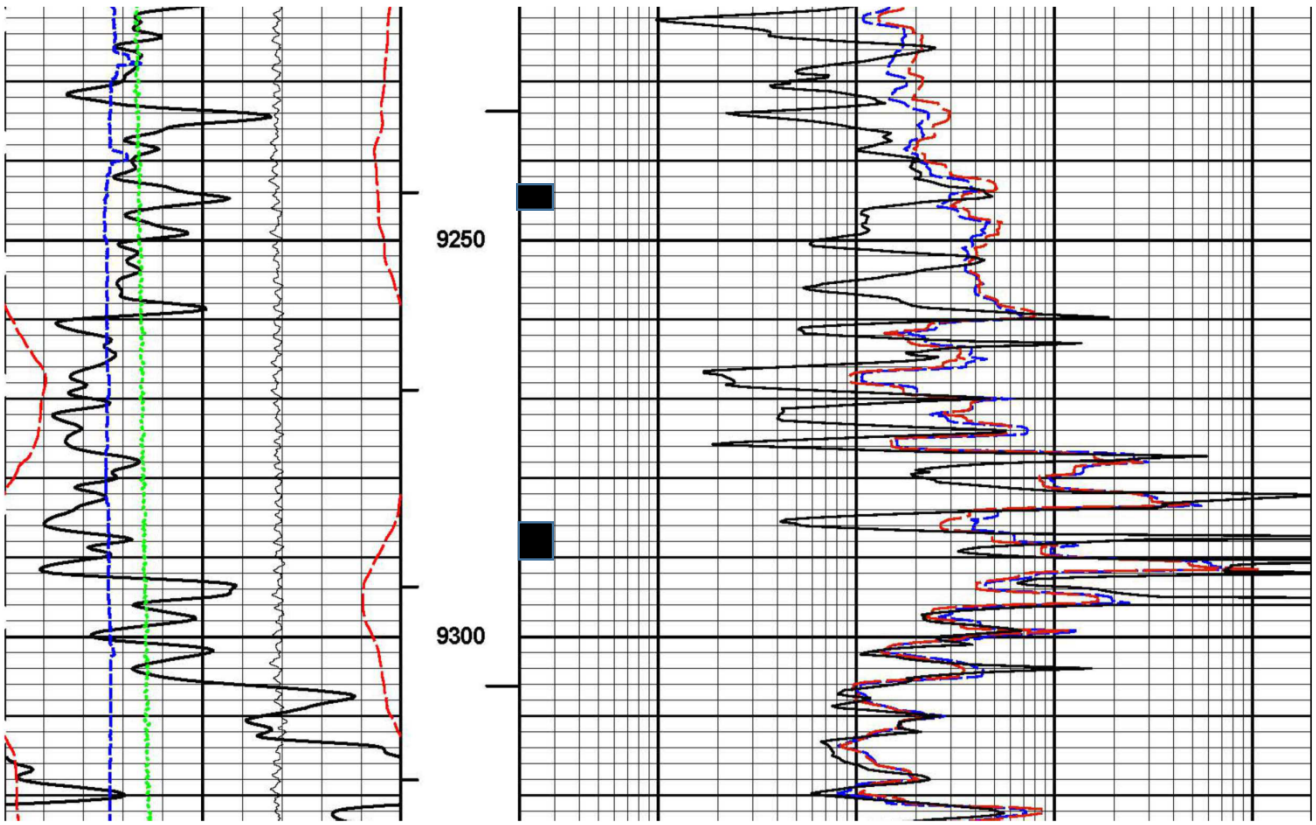
Stage two
9063' - 9115'

Stage one
9243' - 9290'

K1
Resistivity Logs showing completion zones in the Elko Fm from 8924’ to 9290’



K1L Stage one



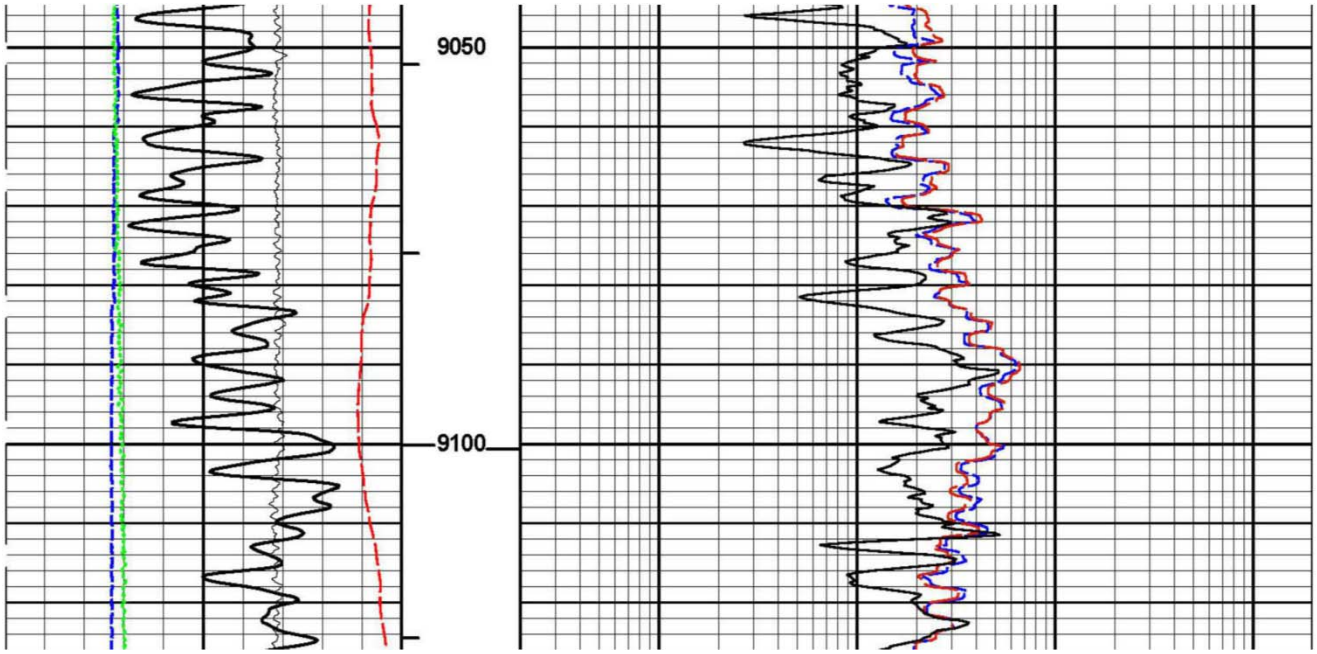
9243’ to 9245’

Stage one
9243’ - 9290’

100,009 Gals of water
66,000 lbs sand
(11/17/2014)

9287’ to 9290’

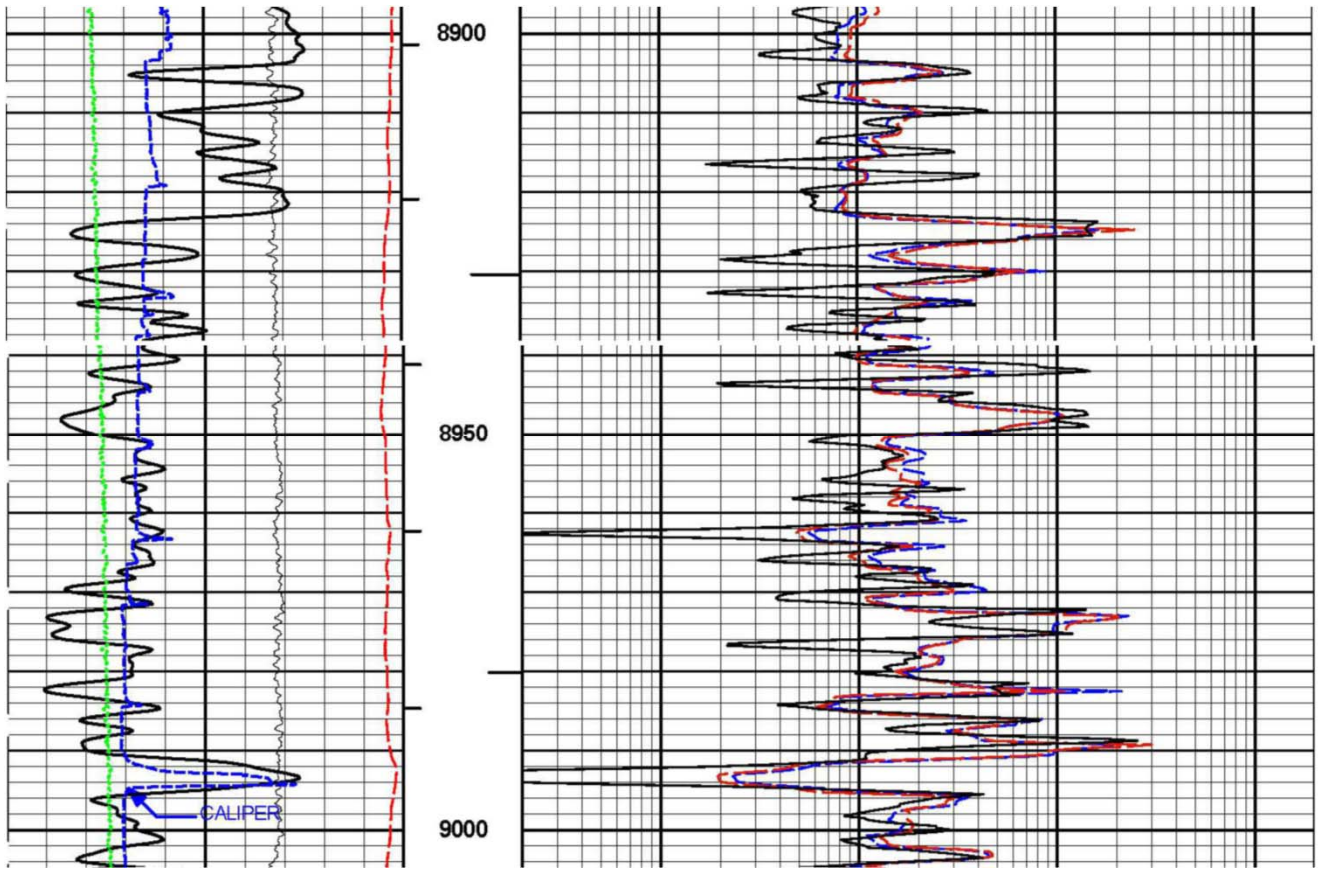
K1L Stage two



125,200 Gals of water
110,500 lbs sand
(12/5/2014)

Stage two
9063' - 9115'

K1L stage three

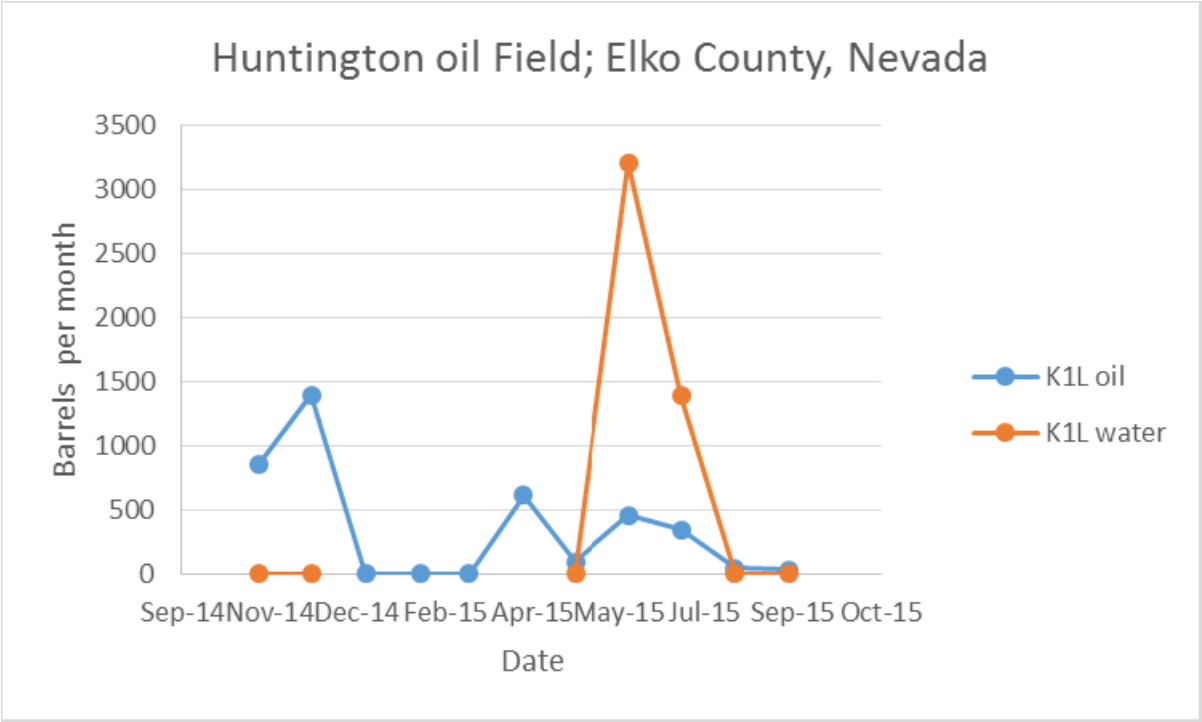


179,337 Gals of water
131,480 lbs sand
(12/5/2014)

Stage three
8924' - 8988'

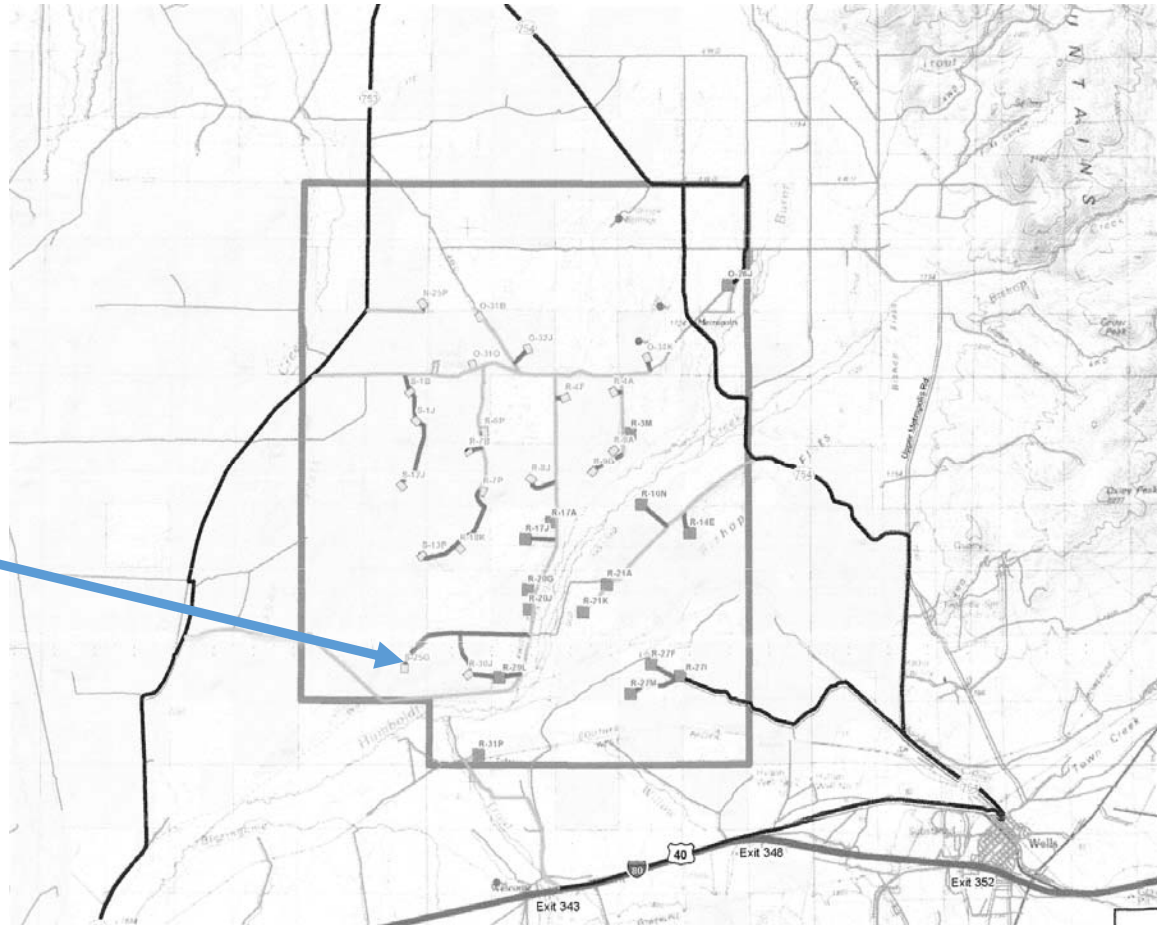
Huntington Field : well K1L
Spud : 24 September 2014
Completed : 16 October 2014
    TD 9693 feet
Production interval 8924’-9290’ (Elko Fm)
Three stage vertical fracture stimulation
    First production in November 2014
    Total oil production to date:
        3831 barrels of oil. (42.4 API Gravity)

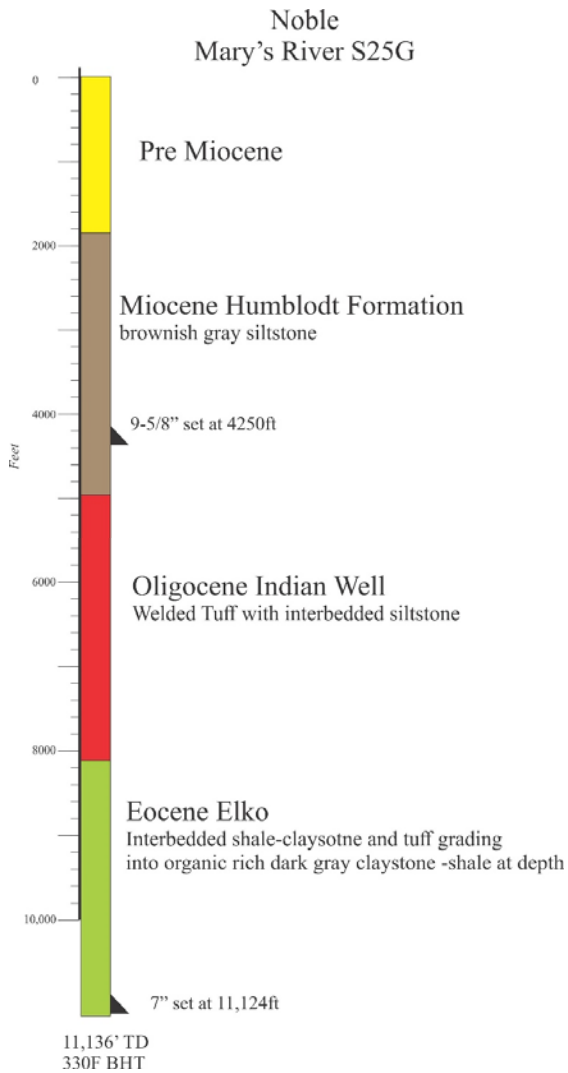
K1L cumulative oil production 3831 bbls of oil



Noble 3D survey area in the Mary's River area

S25G





S25G

Spud : 29 October 2014

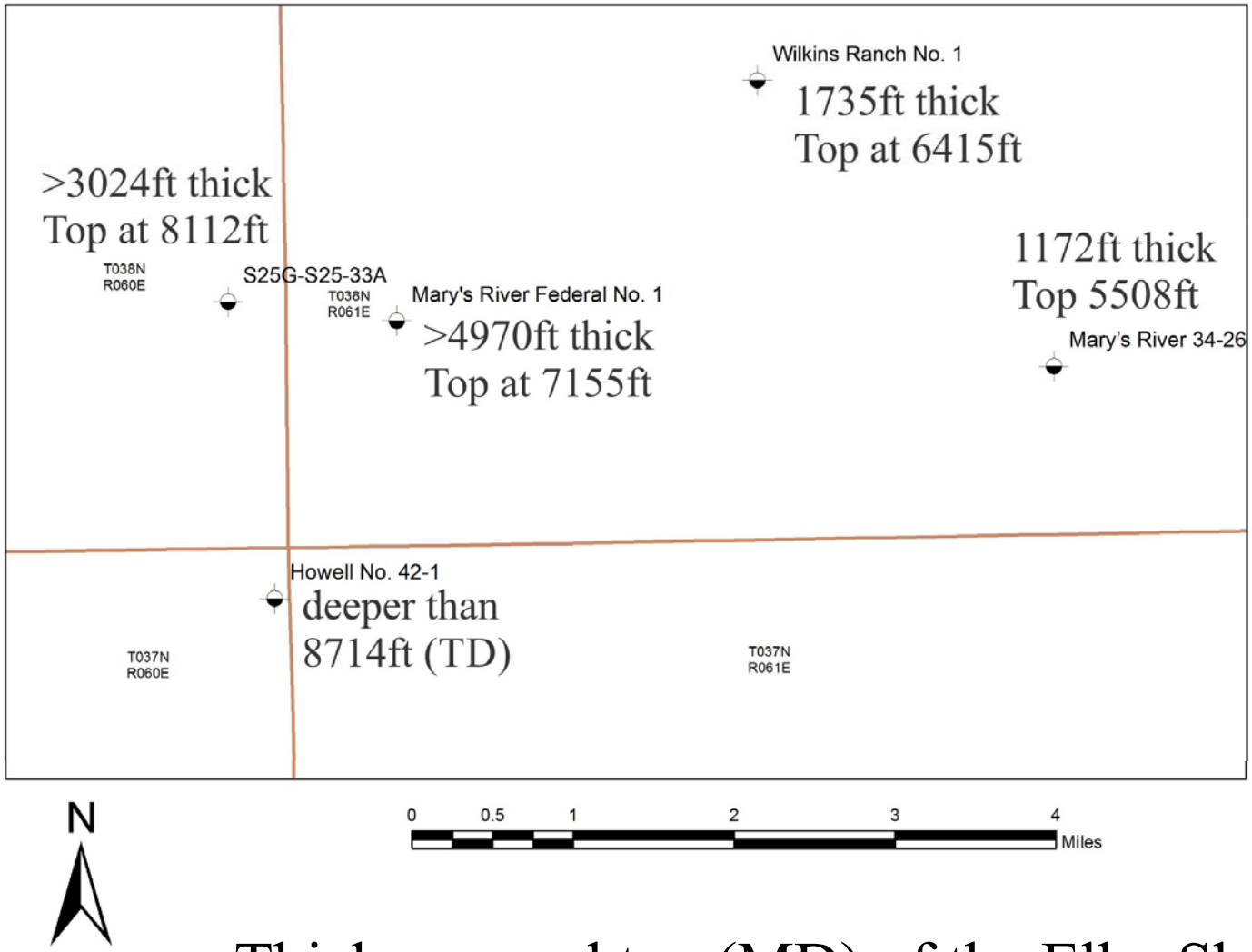
Oligocene Indian Well Formation	4,958 ft
Eocene Elko Formation	8,112 ft

TD 11,136 feet (11 November 2014)
(14 days of drilling)

Elog BHT : 330F

No Record of Hydraulic Fracturing (HF)

Status : Idle



Thickness and top (MD) of the Elko Shale

Noble drilled 4 wells in the Elko Basin
Two of the wells have produced and sold oil.

October 2013: Humboldt M2C : TD 11,689 feet
Producer – shut-in (428 feet of Elko Shale)
36 API gravity (pour point 95F)

December 2013: Humboldt M10C : TD 9,100 feet
Idle (779 feet of Elko Shale)

October 2014: Huntington K1L : TD 9,693 feet
Producer – shut-in (2,055 feet of Elko Shale)
42.4 API gravity (pour point 95F)

November 2014: Mary's River S25G : TD 11,136 feet
Idle (more than 3,024' of Elko Shale)

Oil samples from K1L and M2C

The geologic results from the Noble's exploration drilling suggest a bright future for the Elko Basin

Sunrise over Secret Peak
Looking east from the M2C well