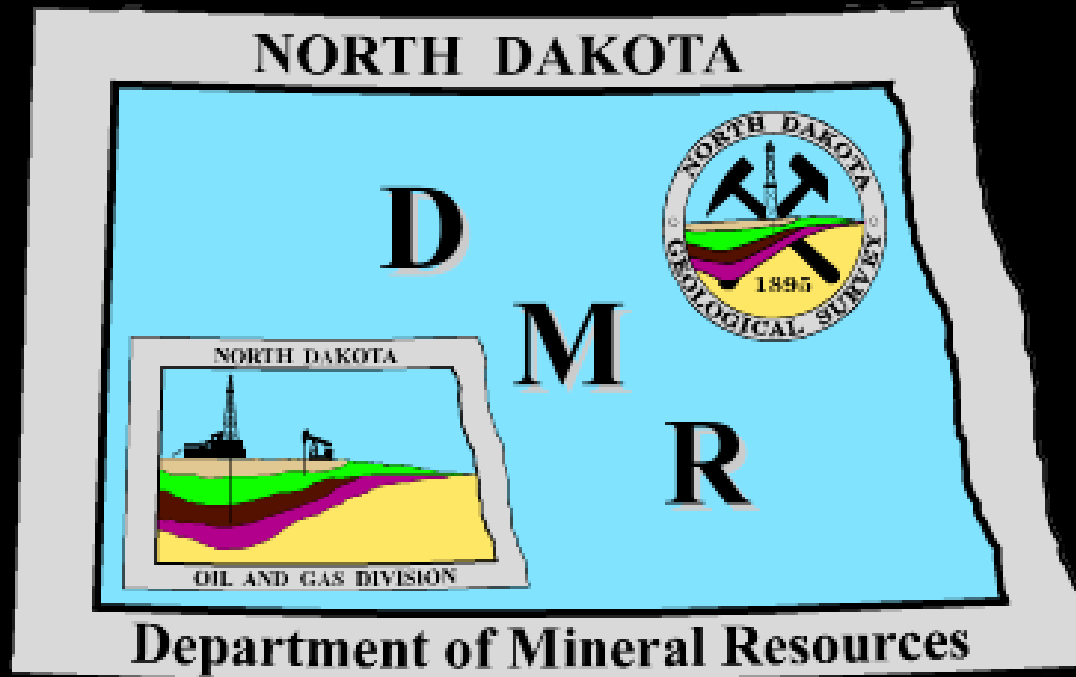


North Dakota Department of Mineral Resources



<http://www.oilgas.nd.gov>

<http://www.state.nd.us/ndgs>

600 East Boulevard Ave. - Dept 405

Bismarck, ND 58505-0840

(701) 328-8020

(701) 328-8000

What's New – What's Next

UAS for Reclamation and Pipeline Inspection

Electrokinetic Spill Desalination

Underground Pipeline Location and Leak Detection

Dual – Frac

Frac sand Transport

Electromagnetic Ranging

EOR Field Tests

Resource Assessment / Competition

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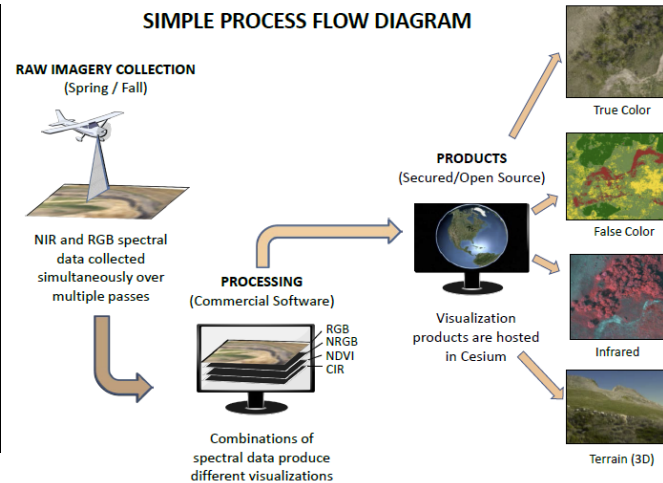
Remote Sensing Trends

- Multiple capabilities available at varying levels of efficacy to accomplish imaging for enduring capabilities
 - Not all capabilities and expertise are equal
 - Requirements are poorly defined as the industry and regulatory agencies attempt to balance leading edge capability with business case
- Extensive expertise and COTS software available to accomplish imagery analysis
 - Not all expertise and software are equal – there is a wide variation available on the market
 - The more comprehensive the analysis the more complex the expertise & software required and greater the expense
- This industry is evolving at a pace similar to Mohr's law
 - Capabilities are improving in less than 24 months with lower pricing and greater availability of what was niche technology yesterday
- ND test site is now testing BLOS UAS operations
 - This will provide potential opportunities for cost reductions in the future over manned aircraft and satellites

Imaging

- RGB Imaging should generally be accomplished with the highest sun angles possible, but with 40° as a minimum to minimize contrast and improve the quality of light
 - However, lower sun angles increase shadows which aids infrastructure determination especially in the high vegetation environment
 - Requirements are poorly defined as the industry and regulatory agencies attempt to balance leading edge capability with business case
- Late spring/early summer imagery maximizes data capture for vegetation and land cover mapping
 - NIR provides better mapping and allows for better qualitative/quantitative analysis than straight RGB due to vegetation spectral reflectance
- Position accuracy, vehicle/imager motion, and concurrent imaging across spectral bands must be accounted for to maximize effectiveness of the collection and subsequent processing
 - Processing must evaluate and determine if the captured imagery meets the minimum requirement for production of final products

SIMPLE PROCESS FLOW DIAGRAM



Resolution

- RGB at 10 cm is sufficient for vegetation/land cover mapping
- RGB at 3 cm is most effective for re-contouring analysis and infrastructure/man-made object detection
 - As resolution of RGB decreases from 3 to 10 cm, analysts ability to discern individual anomalies dropped by 50 to 80%
- NIR will produce more accurate classification than RGB (NDVI)
 - This is key for the finding of anomalous features and also provides additional contamination detection capabilities
 - RGB at 3 cm was insufficient to provide speciation of vegetation
- LIDAR will provide better data for point cloud development and DSM production, but is significantly higher in cost
- Hyperspectral has the potential to improve the vegetative analysis, but is significantly higher in cost
- RGB at 3 cm has limited change detection capability

Processing

- Raw data needs to be at or below 3 cm for RGB
- Need to capture point cloud and use it to process DTM
 - The point cloud rendered from 3 cm RGB imager is sufficient for the analysis, but a LIDAR imager allows for effective change detection
- NIR will produce more accurate classification than RGB, especially for anomalous features and will also provide additional contamination detection
- Automated analysis has multiple advantages over manual interpretation and/or ground surveys
 - It is repeatable, it reduces subjectivity in human manual analysis and is faster and cost effective
 - However, it is also heavily software driven and can be expensive to create if no COTS solution is immediately available

Drone Technology



Drones currently being utilized to take pictures and/or video. EERC Phase III efforts are looking at adding different sensors to the drone, such as ground penetrating radar, LIDAR, or thermal diagnostics.

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Electrokinetic desalination

Uses electrode wells and a source of high current capacity DC power.

The chloride and sodium ions are attracted to the anode and cathode, respectively, where they can be extracted.

Migration rate of the ions is proportional to the applied voltage gradient.

Used in-situ and as an alternative to excavation.



First EK desalinization pilot test is performing well.

Installed in a slough contaminated by a brine release near the well pad.

Electrodes were emplaced on a hexagonal grid with 10 foot spacing.

Each hexagon has a central cathode surrounded by 6 anodes.

Typical operation conditions are 25-30 volts and 400-600 amps. The system power is controlled to limit the heat build-up due to resistive heating. As the system is desalinated, the voltage can be slowly increased as the soil conductivity decreases.

As of fall 2016, the system had been operated for 110 days and the chloride content had been reduced by 41%.

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OMNI MARKER™ | Electronic Marker

APPLICATIONS:

The Tempo Omni Marker provides an improved method to electronically mark and locate underground facilities. Unlike other marking devices that use just a single coil, the Omni Marker contains three orthogonal tuned circuits. When excited by any standard marker locator, these passive circuits produce a uniform, spherical RF field in every direction. Because of their unique patented design, the Omni Marker offers benefits that are superior to any other electronic marking system.

Easily located up to five feet away - The Omni Marker provides 25% greater range than traditional 4-inch ball markers. It produces a wider field that is easy to find months or years later, with a signal peak directly above the marker for precise location within inches. This wider field and better range means faster and more reliable locates in any terrain.

No need to stay level when buried - Because it produces a spherical field, the Omni Marker does not require any particular orientation when buried. As a result, there's no need for the Omni Marker to be level in the ground like flat-style electronic markers. Just toss the Omni Marker in the trench or excavation and cover it up with normal backfill. Additionally, the Omni Marker's unique shape allows it to fit easily into a standard 4-inch trench with no extra digging.

Lightweight, with no hazardous chemicals - The Omni Marker contains no floating or moving parts or chemicals. This eliminates the need for material safety data sheets. Plus, the Omni Marker's durable, lightweight design keeps your shipping and storage costs low while giving you years of reliable service.

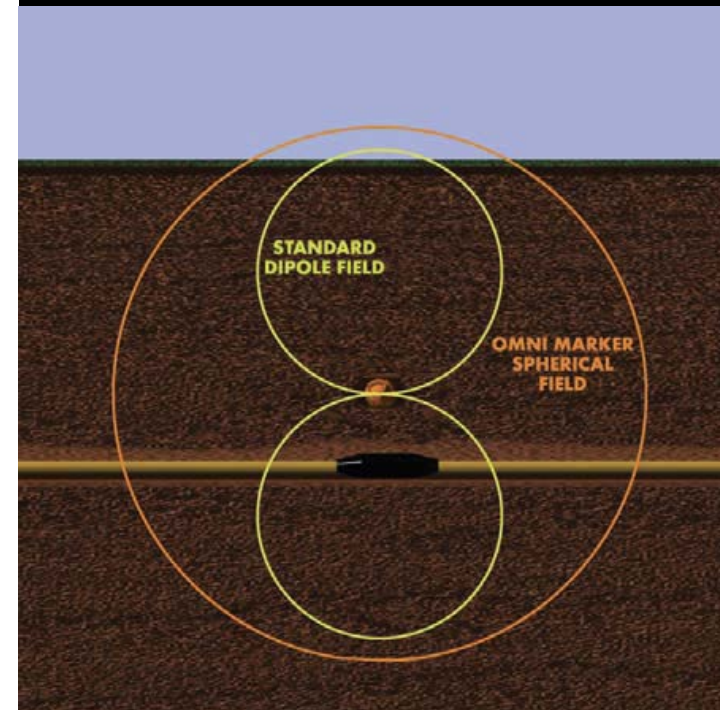
Passive, high reliability design assures many years of service - The Omni Marker contains no batteries or active components, and the proven high reliability design means these markers will last as long as your buried plant.

Compatible with all marker locators - Because Omni Markers use industry standard frequencies, they will work with any electronic marker locating devices. Ask your sales representative about the EML100 Marker-Mate™ locator.

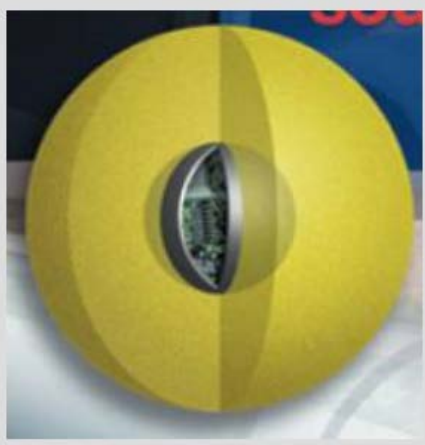


Use the Omni Marker to mark and find:

- buried splices and load coils
- buried service drops
- pipe ends
- conduit stubs
- road crossings
- cable paths
- fiber optic facilities
- manholes under pavement or grade changes
- snow-covered installations
- military caches
- survey points
- septic installations
- repair points
- non-metallic lines



Free Floating Leak Detection Systems



- Free floating leak detection systems consists of small ultrasonic sensors that send ultrasonic signals and also collect the reflected sound waves.
- The sensor can be inserted into the pipeline and flows with the fluid and collects sound disturbances along the pipe.
- The sensor can be retrieved at the end of the pipeline.
- EERC Phase III currently looking at the potential for free floating Nano sensor technology.



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Dual – Frac

Hydraulic fracture (plug and perf) each set of perfs twice.

Three sets of perfs in a 200' interval

Fracture all three sets

Pump diverter

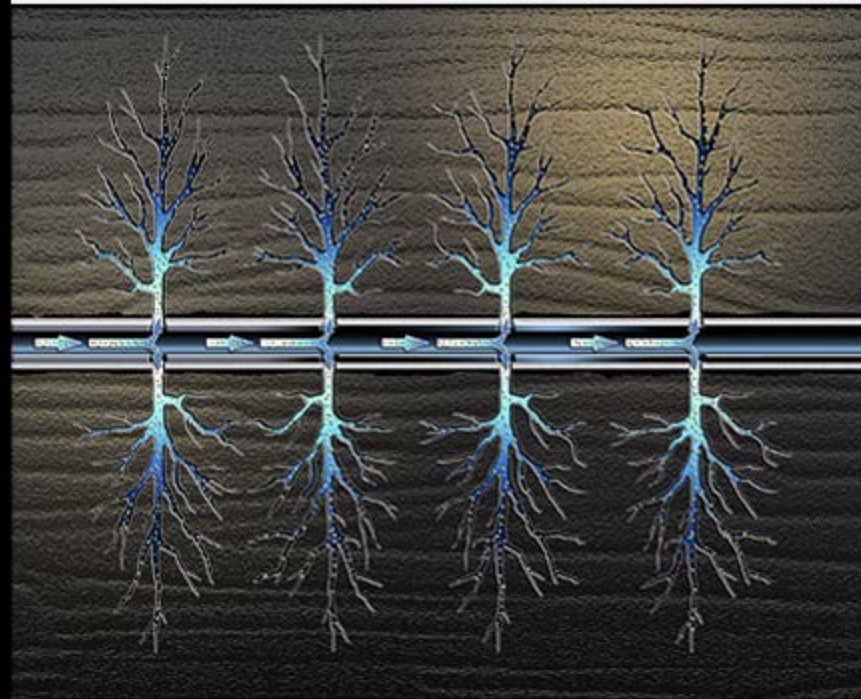
Fracture again

Have seen increases in pressure (new/different fractured reservoir) and haven't seen pressure in their offset wells.

Better near well bore fracturing with increased production over wells without diverter.

Halliburton technology.

Hydraulic Fracturing: Mixture of water, sand and chemicals pressurized and pumped into the well to form microscopic fractures in shale.



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Advantages of Sand box Logistic

- Sand is shipped and used in one container.
- Less exposure to Silica Dust.
- Effective on site storage.
- Can be loaded and unloaded with a Forklift.



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Electro-Magnetic Ranging

- MWD
 - Reduced drill time
- Wellbore Separation:
 - Close-proximity drilling / collision avoidance
 - Ghost hole detection
- Intercept:
 - Proper P&A
 - Regain production (fish)
 - Relief well (blowout)
- Secondary Recovery
 - Twinning
 - Example: SAG-D in oil sands



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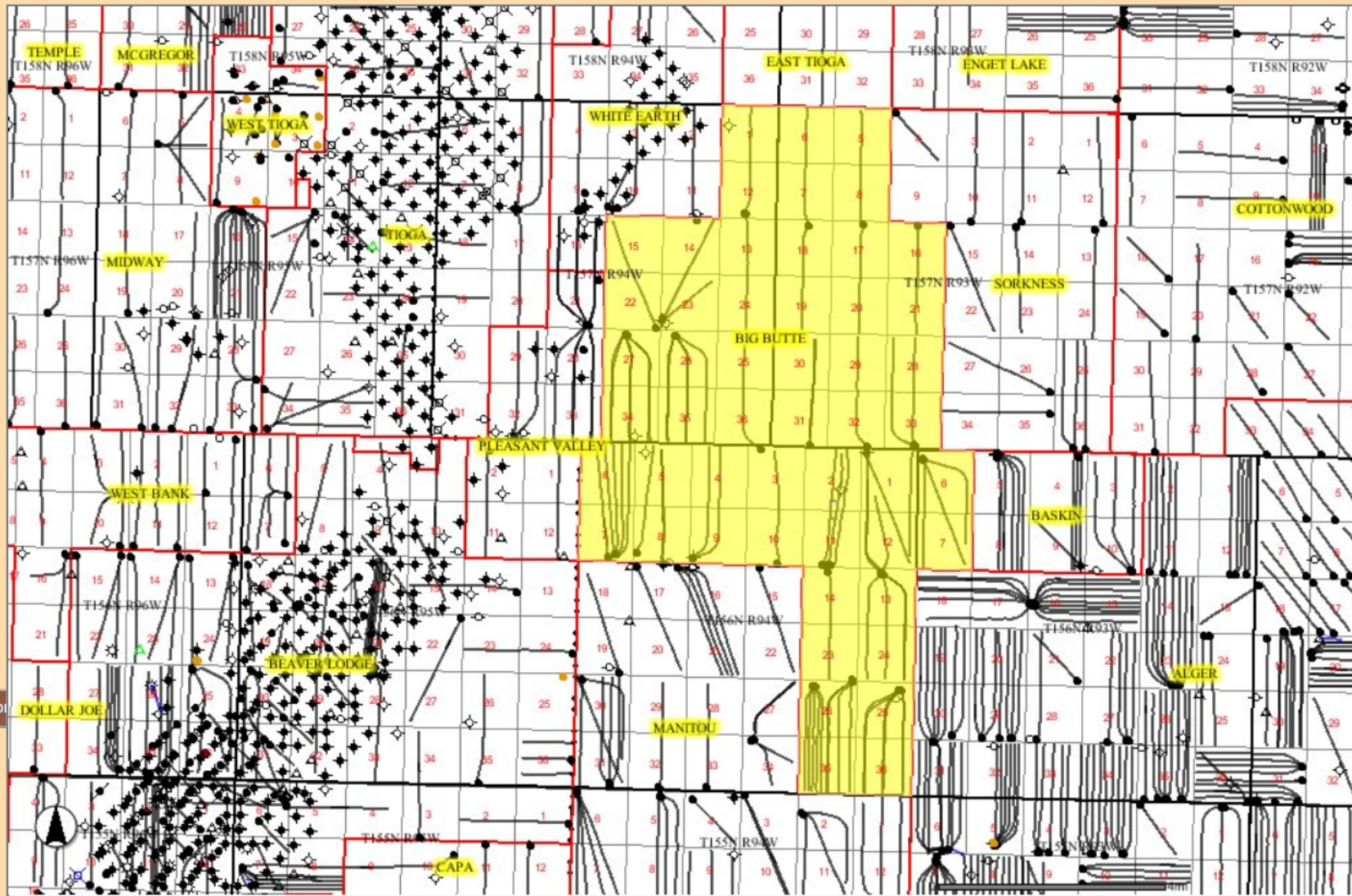
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Resource Assessment / Competition

Oil and Gas Subscription: ArcIMS Viewer

- Legend / Layers
- Overview Map
- View Entire State
- Previous View
- Clear Selection
- Search
- Create PDF
- Zoom In
- Zoom Out
- Pan
- Rect Identify
- Select Object
- Buffer
- Distance
- Find Well
- Find Field / Unit
- Find Section
- Browser Settings Suggestion

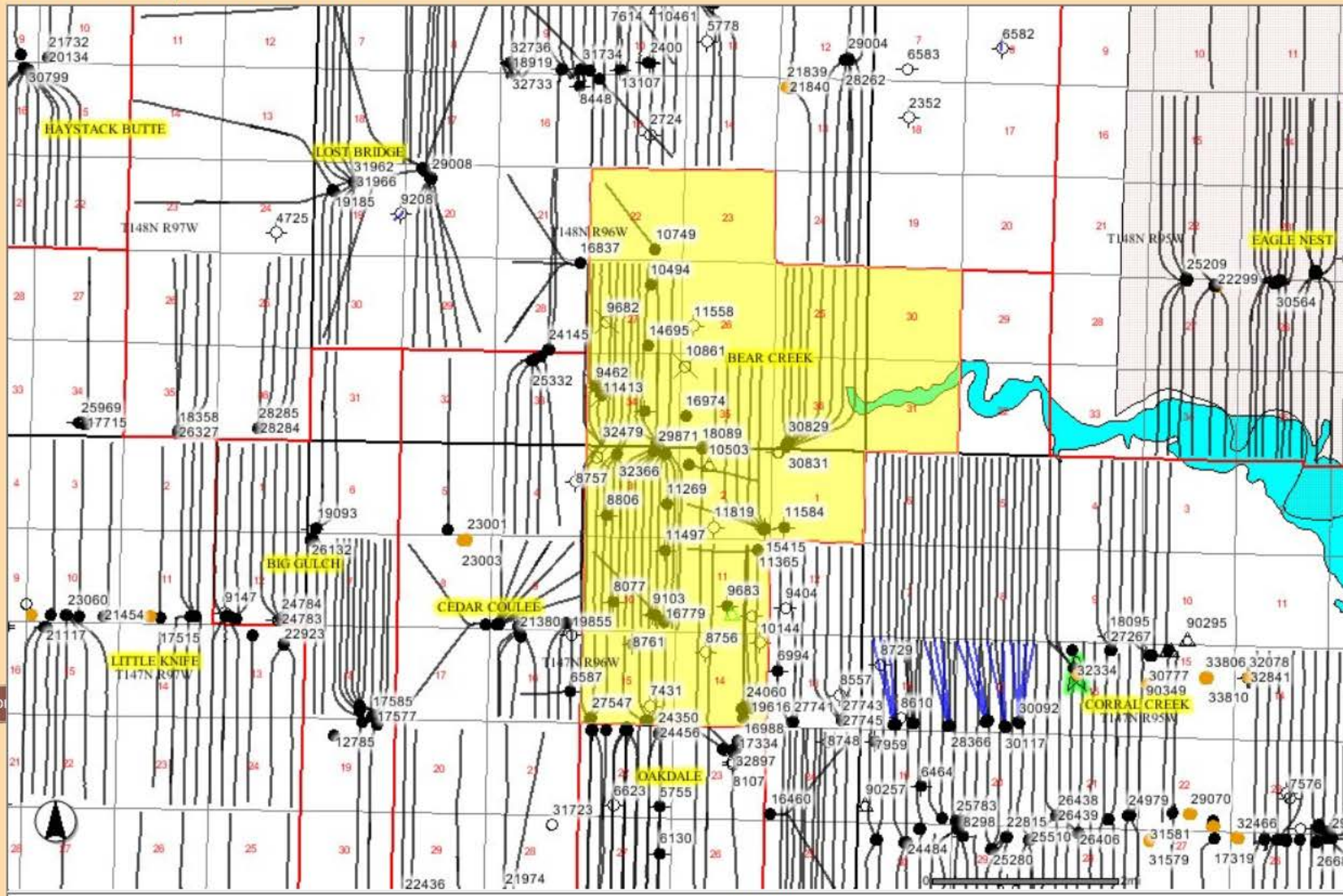


Oil Fields

Rec	Name	Type
1	BIG BUTTE	oilGas

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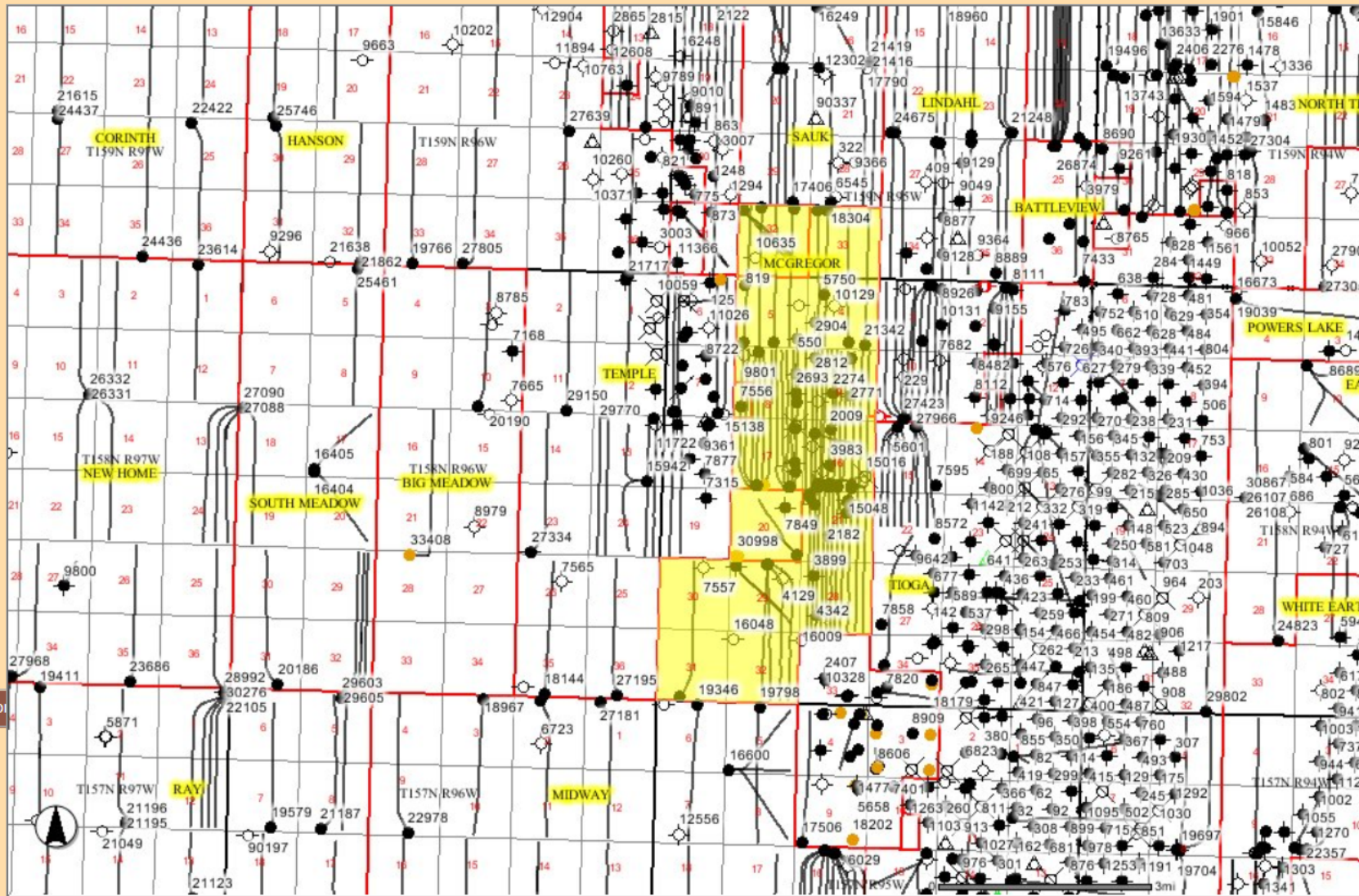


Oil Fields

Rec	Name	Type
1	BEAR CREEK	oilGas

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Oil Fields

Rec	Name	Type
1	MCGREGOR	oilGas

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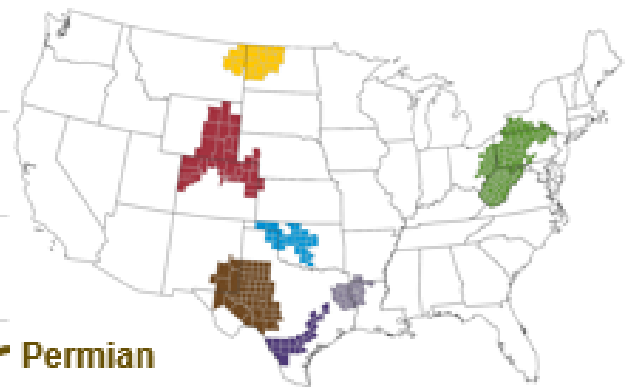
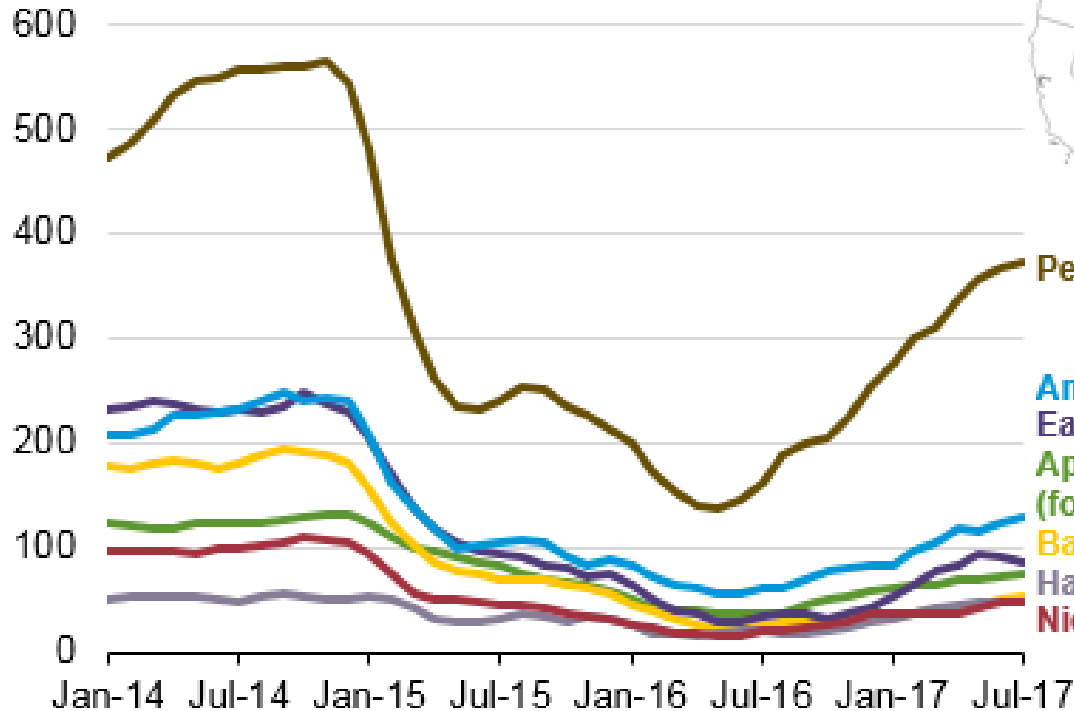
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Rig count in EIA's *Drilling Productivity Report* regions
number of active drilling rigs



Taxes

- Permian – 3.75% to 7.5%
- Anadarko – 7%
- Eagle Ford – 7.5%
- Appalachia – 0.2%
- Bakken – 10%
- Haynesville – 5% to 7.5%
- Niobrara – 3% to 6%

Federal & Tribal Lands

- Permian – <2%
- Anadarko – <2%
- Eagle Ford – <2%
- Appalachia – <2%
- Bakken – 9% to 30%
- Haynesville – 2% to 9%
- Niobrara – 36% to 48%

17 Potential unconventional resource Source Rock formations

- | | |
|----------------|------------------|
| Spearfish 1 | Charles 2 |
| Tyler 1 | Mission Canyon 2 |
| Lodgepole 1 | Bakken 2 |
| Birdbear 1 | Duperow 1 |
| Winnipegosis 1 | Stony Mountain 1 |
| Red River 2 | Winnipeg 1 |
| Deadwood 1 | |

