The RMOTC Data Management Project:

An Update on a Long-Term Project of Modernizing the U.S. Department of Energy, Teapot Dome Oilfield Database

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Outline

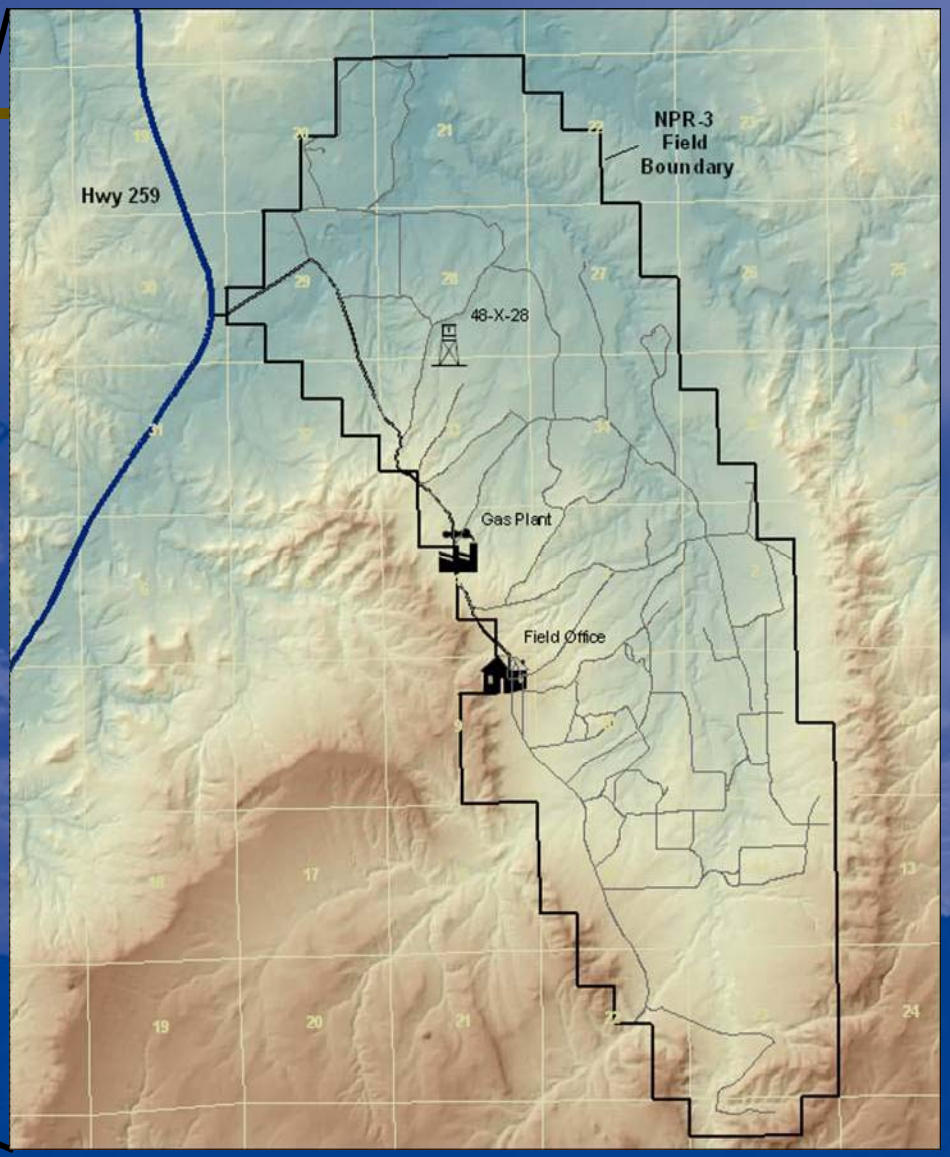
- What is RMOTC?
- Data Management Problem
- Project Overview
- What We've Done
- Sharing Data With Partners
- Moving Forward
- Conclusions

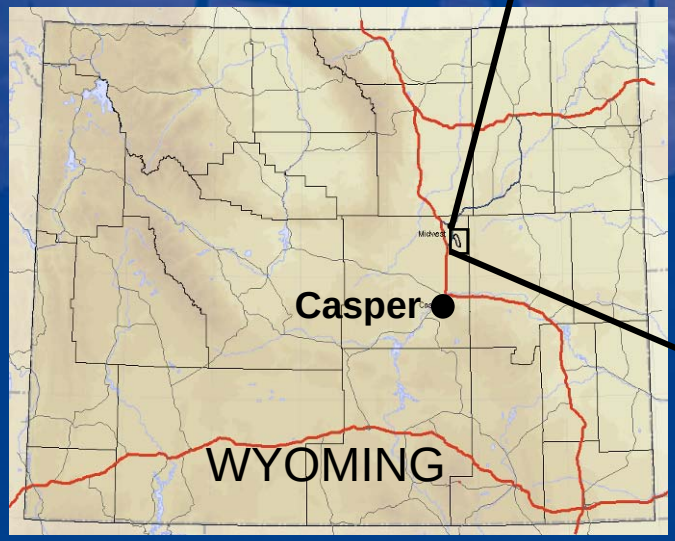
What is RMOTC?

The Rocky Mountain Oilfield Testing Center (RMOTC), is an operating oil field focusing on environmentally-balanced energy technologies and alternatives, and is the premiere energy testing and demonstration field in the nation.

Field Location

- RMOTC is located at Teapot Dome Oilfield within the Naval Petroleum Reserve No. 3 (NPR-3)
- Town offices are located in Casper, WY





RMOTC Provides

Operations and Testing Facilities include:

- Drilling & Service Rigs
- Administrative Services, Engineers, Scientists, & Support Staff
- Support Equipment
- Bio-Treatment Facilities
- Soil Remediation Facilities
- Field Laboratory
- Gas Processing Facilities
- Production Facilities
- Tanks & Pipelines
- Aquaculture & Hydroponic Greenhouse Facilities

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Unique Location

- Remote, federally-owned and secure site
- 10,000-acre operating oil field
- Full complement of onsite facilities and equipment
- Approximately 1350 well bores; 600+ active wells
- Nine producing reservoirs
- Depths from 250-7000 ft.
- Real world field testing
- Producing, non-producing, and new well drilling opportunities
- Industry experienced specialists
- Varied terrain & weather conditions

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Teapot Dome Oil Field History

- Production began in the early 1900's
- By 1927 over 80 wells had been drilled.
- The field was shut down in 1927 and no wells were drilled until the 1950's.
- The field was opened to full production in the mid 1970's and has been producing oil and gas since.

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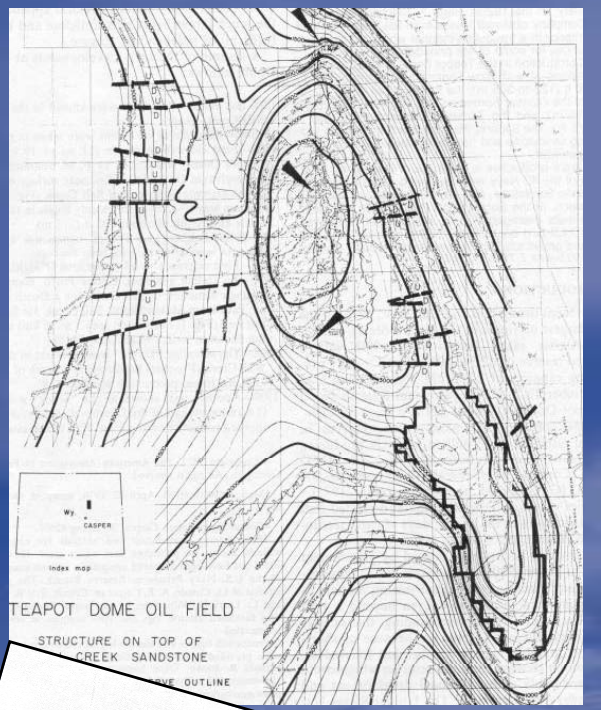
Data Management Problem

- Over 80 years of drilling, maintenance, and regulatory data
- Many well locations not surveyed correctly, some locations unknown
- Poor field data capture
- Paper copies of well files only, poorly maintained, several misfiles
- Old hand-drawn maps
- Paper-copy well logs
- Multiple production databases
- Surface facility maps not in real world coordinates



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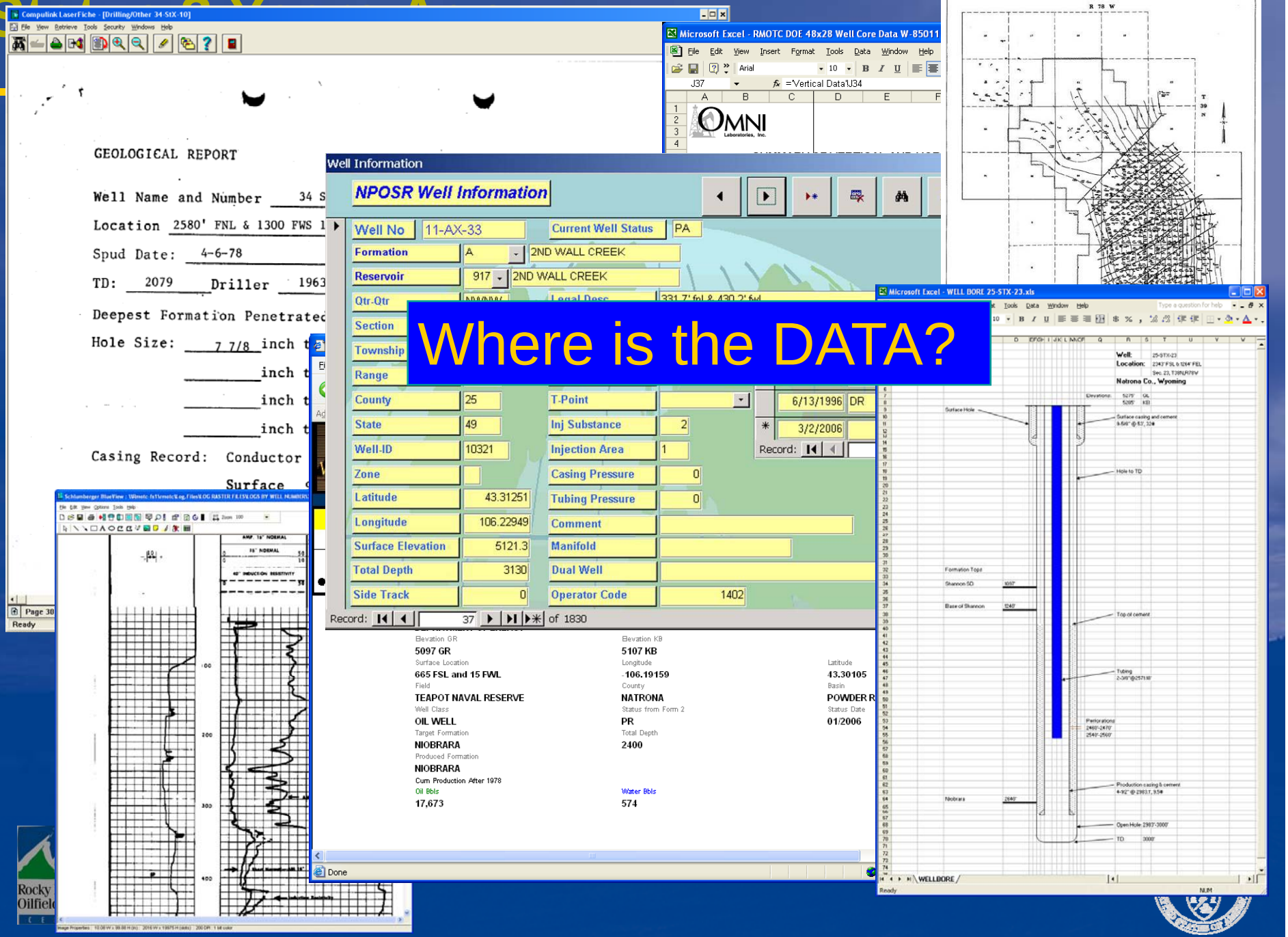
Where is the DATA?



Status 3 Years Ago

- Well files had been scanned into a LaserFiche system.
- Paper logs scanned to raster .tiff images
- Most data were not digital, and therefore could not be used “as-is” in building a geological model or in numerical analysis
- The data were poorly organized and catalogued
- There was poor access, especially outside RMOTC for project partners
- No modern subsurface modeling existed
- We didn’t have true GIS capabilities

The Data Management Project Was Born

- Mission of Data Management project
  - Update the NPR-3 database to maximize the true value of the data as an asset and a fundamental part of RMOTC and provide access of the data to RMOTC partners.

- Objectives:
  - Attract new business beyond the traditional drilling and production tool testing into reservoir modeling projects
  - Provide the tools needed for RMOTC and NPR-3 to identify and capture additional reserves, as well as potentially increase production and extend the life of the field
  - Provide support for the carbon management activities at NPR-3

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The Data Management Project Was Born

The Original High-Level Task List

- Meet with existing partners to define roles & responsibilities
- Digitize logs from “deep wells”
- Import wells and logs into GeoGraphix system
- Build cross sections
- Create structure maps
- Do full 3D integrated seismic interpretation of multiple key horizons and faults
- Do seismic depth conversion
- Special geoscience analysis
- Build a 3D geocellular model
- Run dynamic flow simulation, perform history match and tune model for fit
- Load production history and completions data into production mgmt system
- Implement real-time production data capture and surveillance
- Load (historic) drilling data into a system to enable improved drilling operations, planning and design
- Instrument drilling rig for real-time operational data capture

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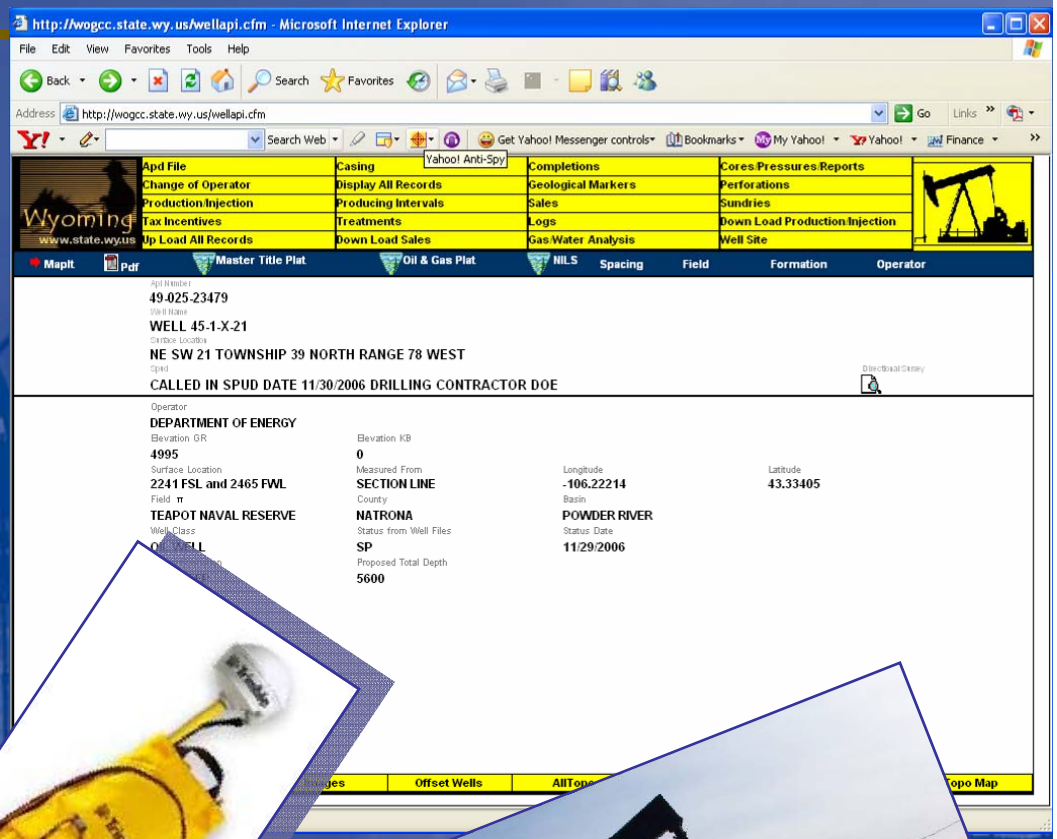
The Data Management Project Was Born

- First Steps
  - Load in known existing well header information
    - Well Coordinates
    - Total Depths
    - Ground Elevations
    - Kelly Bushing Elevation (if known)
    - Well Status
    - API number
    - Spud Dates
    - Well Name and Number



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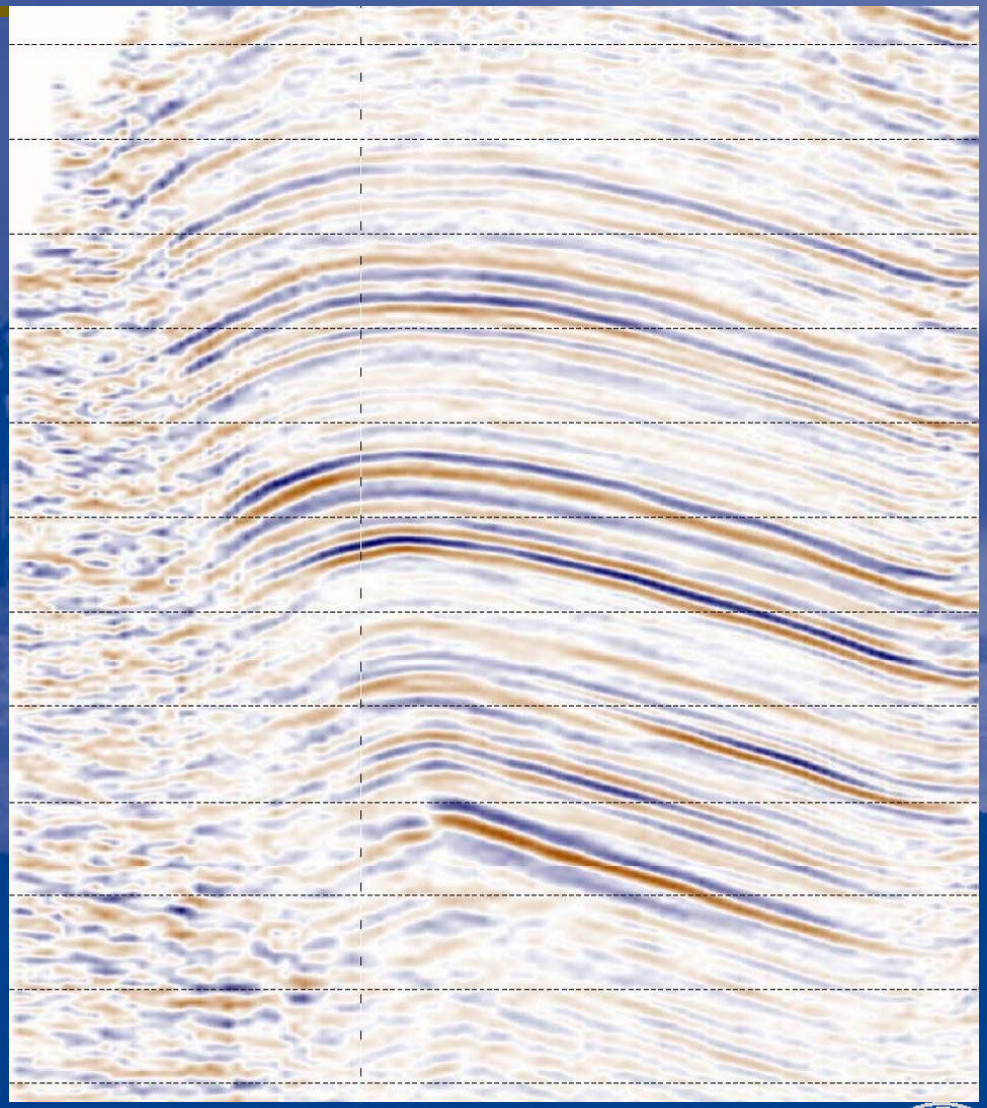
The Data Management Project Was Born

- First Steps
  - Load Seismic Data
    - Load 3D Seismic using correct cartographic reference system
    - Digitize 2D shotpoints from old Maps
    - Load 2D data into interpretation systems
    - Load interpreted 3D horizons



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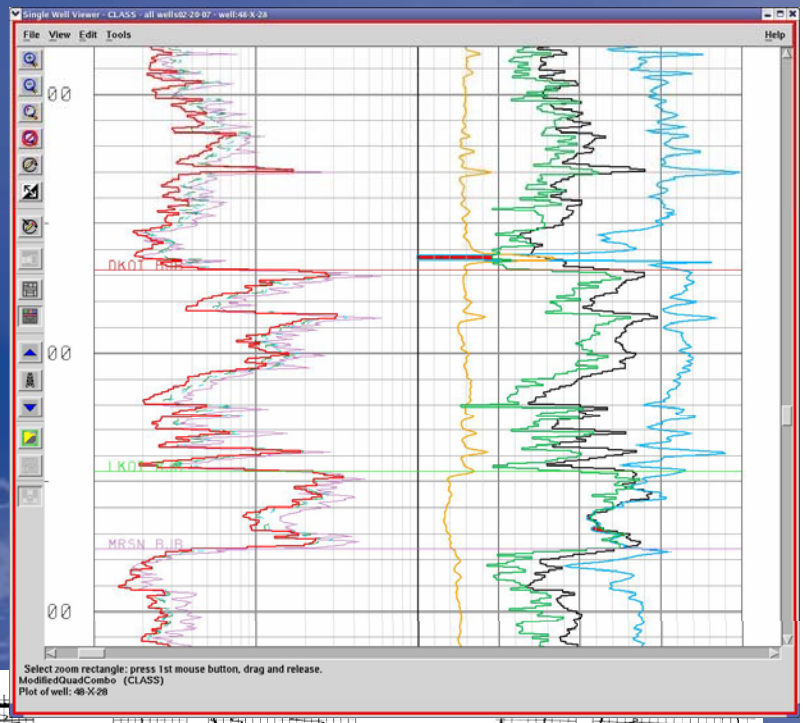
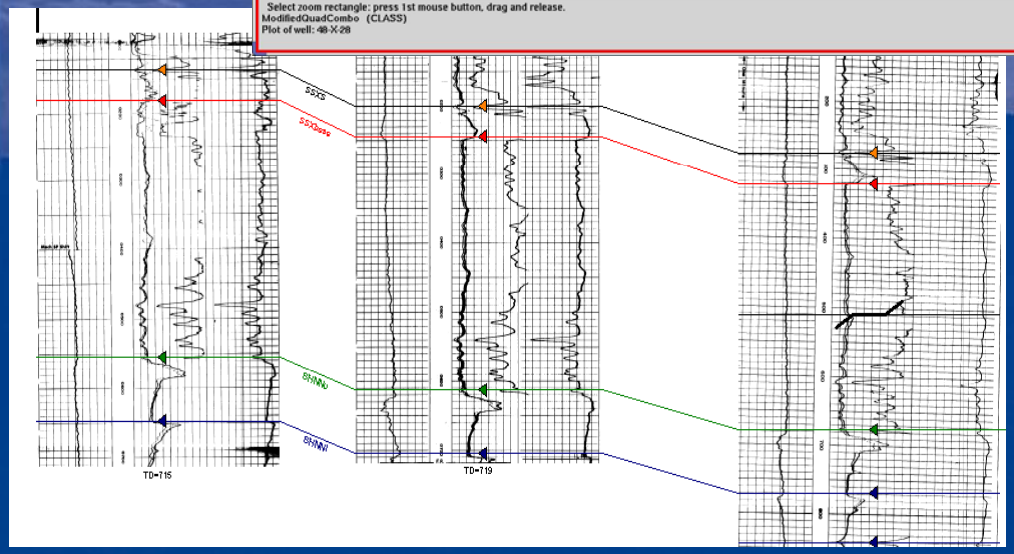
The Data Management Project Was Born

- First Steps
  - Digitize all logs from approximately 400 of the deeper wells
  - Begin loading raster logs from shallow wells into interpretation software
  - Correlate well logs to pick formation tops and fault cuts
  - Procure and Install newly acquired Landmark software, servers, and other IT infrastructure





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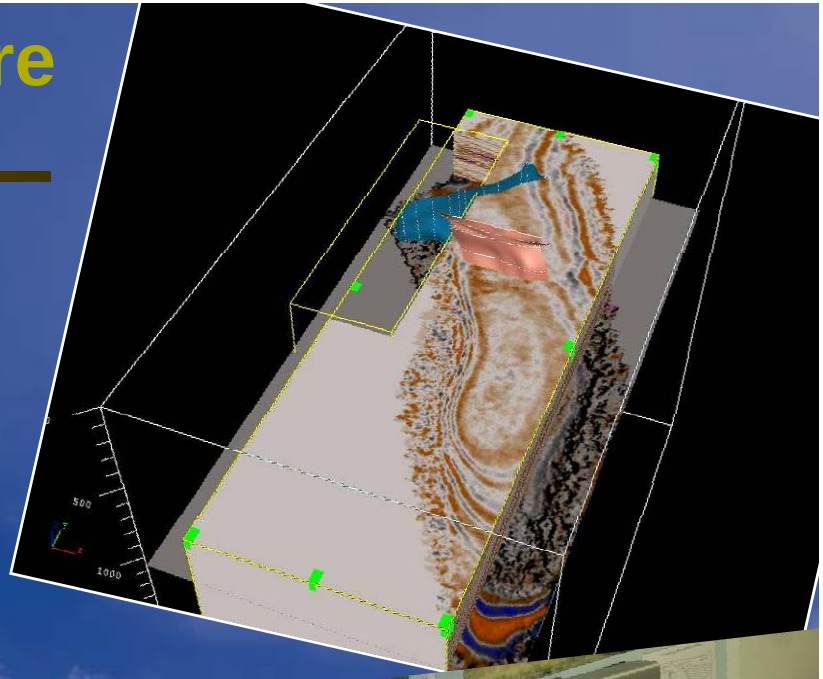
New Workstations and Software

- RMOTC received $2 million+ software grant from Landmark Graphics in G&G, production, drilling, and engineering software.
- Upgraded and installed new hardware and IT infrastructure.
- Hired additional IT staff position for Data Management project
- Procured and installed ESRI ArcGIS for GIS capabilities
- Setup a Citrix environment for application hosting
- Received other software grants for specialized applications



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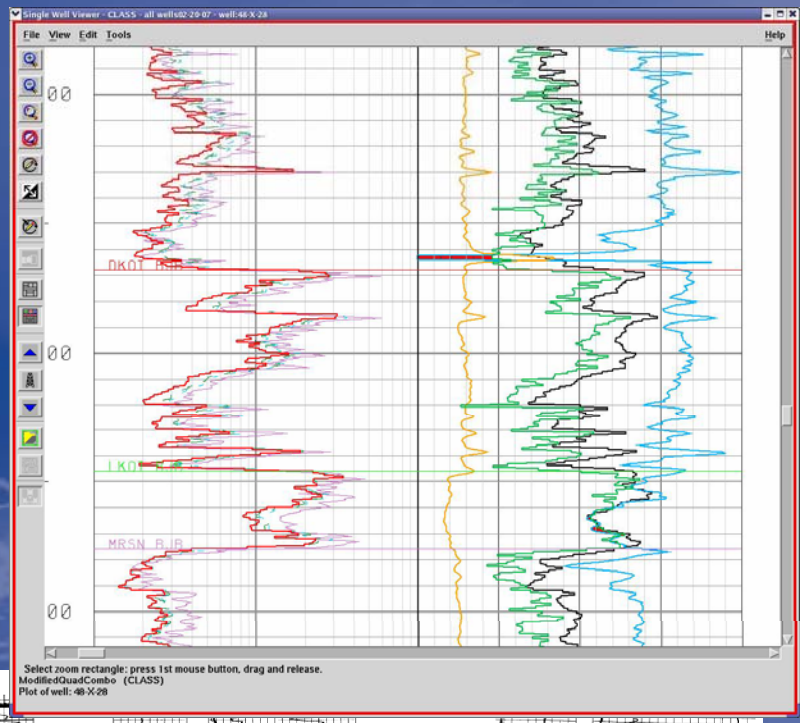
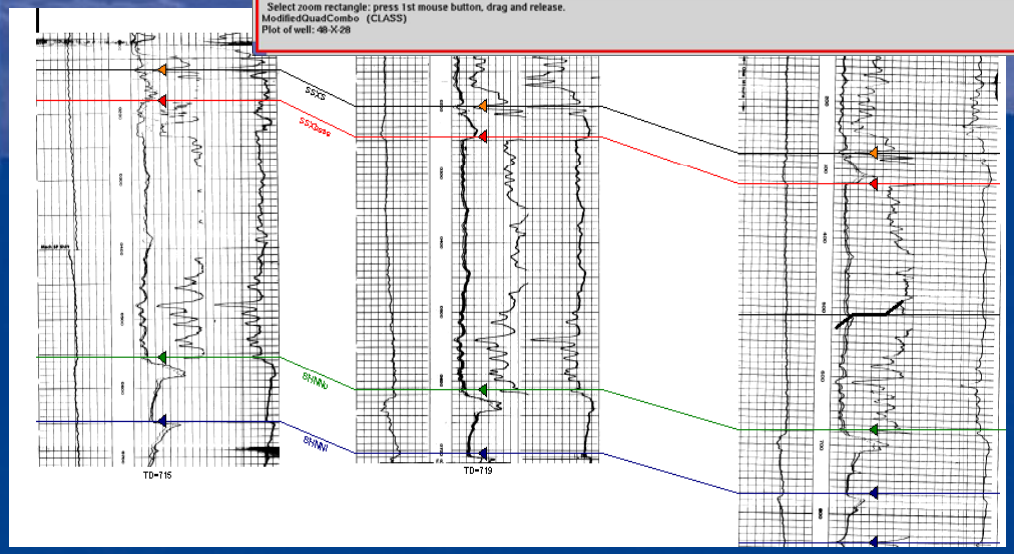
Project Quality Check

- Work completed on initial log digitization
- Preliminary structural maps of selected formations
- QC well locations to identify bad coordinates, missing wells, etc.
- Identify any problems with digital log files





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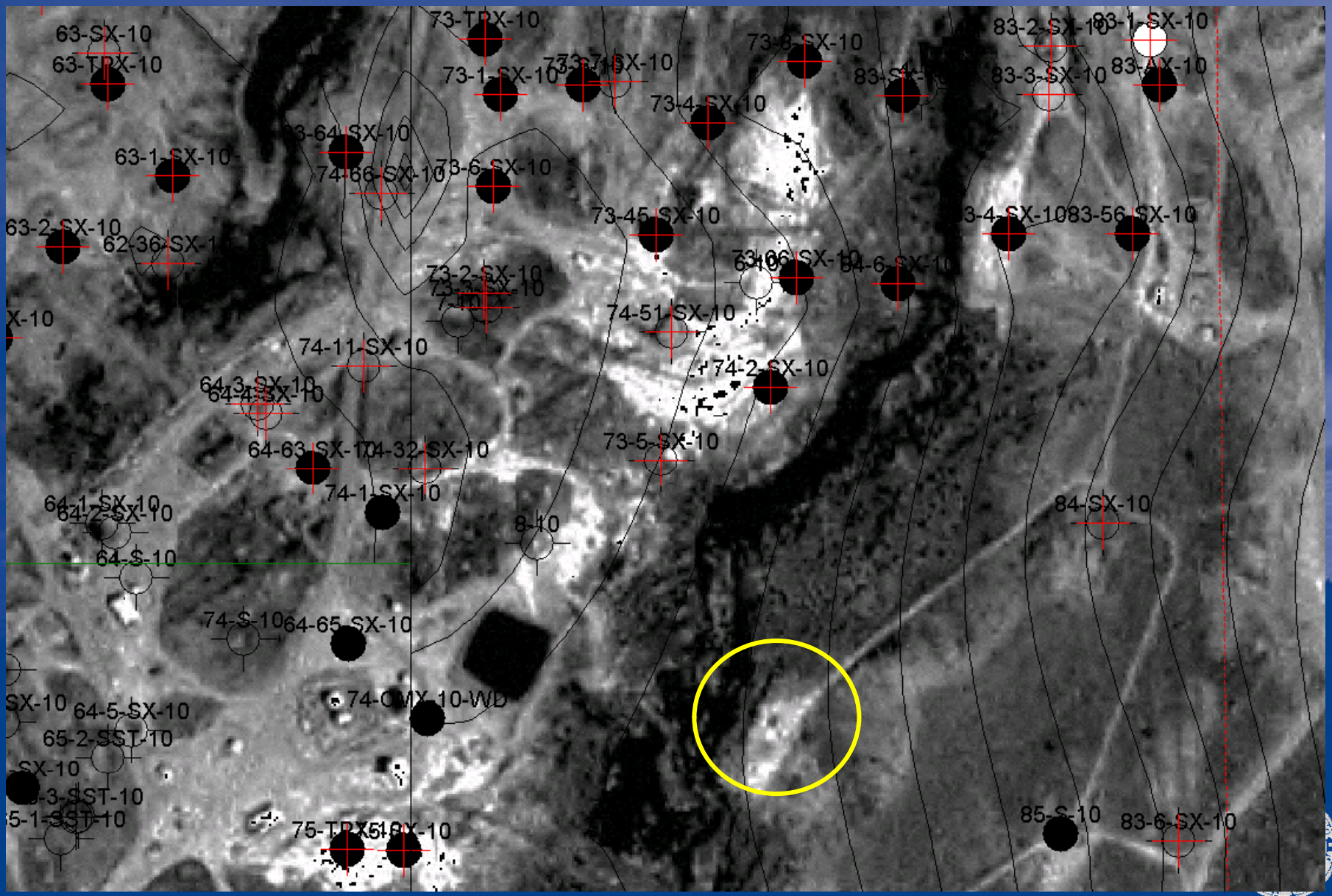
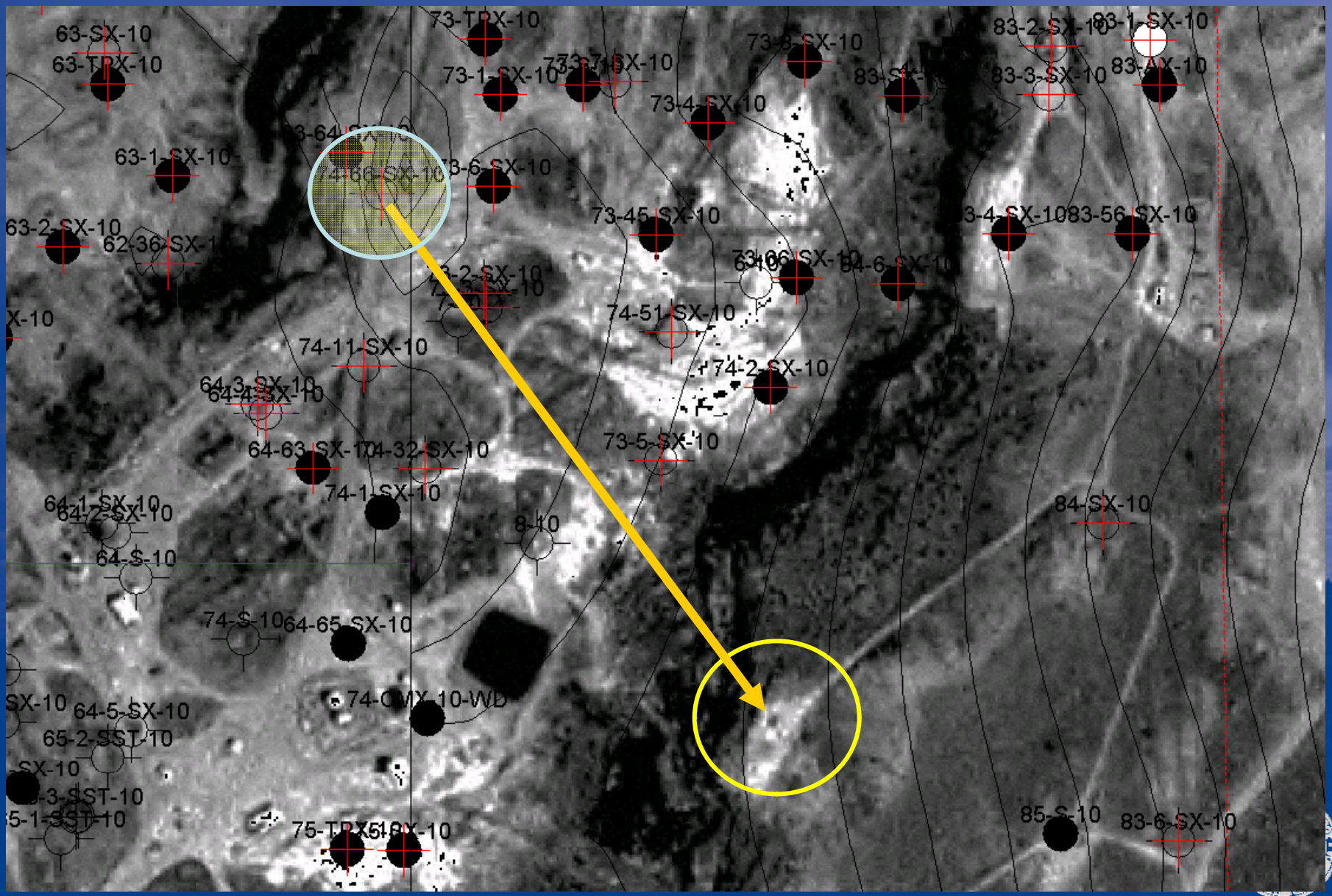
Examples of QC – Wrong well locations



Data QC - Wrong well locations



Data QC - Bad LAS data

```
 STRT.F                0.0000:    START
 STOP.F             5600.0000:    STOP
 STEP.F                0.5000:    STEP
 NULL.              -999.2500:
 COMP. LAWRENCE ALLISON AND
 WELL. LAWRENCE "X" #62-3:
 FLD .                    NPR:
 LOC .          S3 T38N R78W:
 CNTY.                 NATRONA:
 STAT.                 WYOMING:
 CTRY. UNITED STATES OF AME
 SRVC.         DRESSER ATLAS:
 DATE.           08-NOV-1985:
 API .       49025110330000:
~CURVE INFORMATION
#MNEM.UNIT          API CODE
#----------     ------------
 DEPT.F                     :
 NPHI.DEC      42 890 01 00:
 TEND.LBS      45 635 01 00:
 RHOB.G/C3     45 350 01 00:
```

```
 VERS.
 WRAP.
~WELL
#MNEM.U
#-----
 STRT.
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 NULL.
 COMP.
 WELL.
 FLD .
 LOC .
 CNTY.
 STAT.
 CTRY. UNI
 SRVC.
 DATE.
 API .
~CURVE INF
#MNEM.UNIT
#---------
 DEPT.F
 NPHI.DEC
 TEND.LBS
 RHOB.G/C3
 CORR.DEC      45 356 01 00:    CORRECTION
```

Well ID	490251103300	Operator	U.S. DOE	Status	PR
Name	NPR-3			#	62-AX-3
Northing	960434	Easting	802464.1	Footage	
TD	3380.00	Datum Elevation	5160.00	Reference	KB
Logs:	Vector	Raster		Elevations...	
T/R/S	TWP: 38 N - R	Display:	English		

Header | Formations | Zones | Faults | Survey | DST | Core | Completion | Velocity | IP | Production T

State/Prov	Wyoming	Ground elev	5148.00	Permit #	
County	Natrona	Plugback depth	3170.00	Permit date	

```
#MNEM.UNIT          DATA TYPE     INFORMATION
#----------     ------------     ---------------------
 STRT.F                0.0000:    START DEPTH
 STOP.F             5600.0000:    STOP DEPTH
 STEP.F                0.5000:    STEP LENGTH
 NULL.              -999.2500:    NO VALUE
 COMP.     LAWRENCE ALLISON:      COMPANY
 WELL.    LAWRENCE 62TPX 10:      WELL
 FLD .              NPR NO 3:     FIELD
 LOC .         S10 T38N R78W:     LOCATION
 CNTY.               NATRONA:     COUNTY
 STAT.               WYOMING:     STATE
 CTRY. UNITED STATES OF AMERICA:    COUNTRY
 SRVC.         DRESSER ATLAS:     SERVICE COMPANY
 DATE.           08-NOV-1985:     LOGDATE
 API .       49025110490000:      API NUMBER
~CURVE INFORMATION
#MNEM.UNIT          API CODE      CURVE DESCRIPTION
#----------     ------------     ---------------------
 DEPT.F                     :
```

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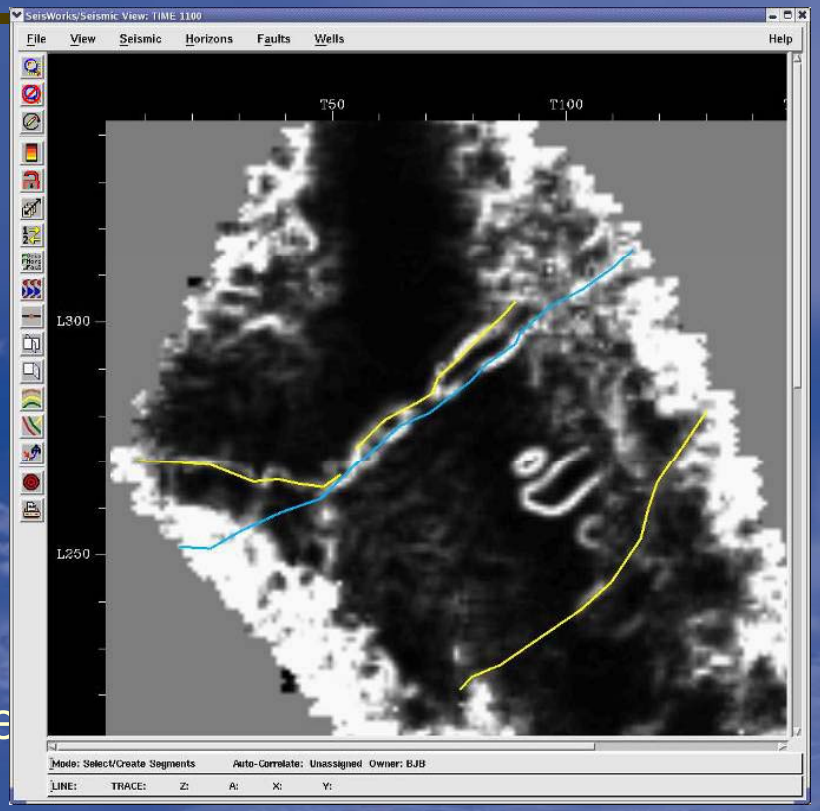
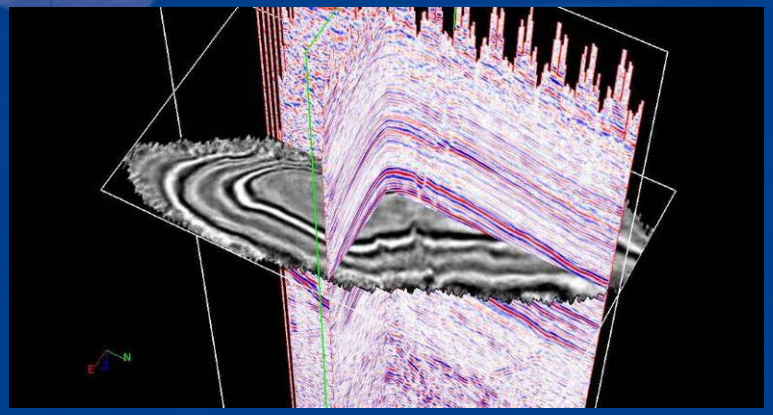
Data Management Status Update

- Completed digitization of all known well logs for NPR-3.
  - There are now 1175 wells with digital log curves (up from 29 three years ago).
- RMOTC drill rig is instrumented to broadcast real-time drilling data over a secure internet connection
- Interpreted work on seismic data is underway including time to depth conversion of data, seismic attribute analysis, and fault interpretation.
- Employees being trained on new software
- New geological understanding on faulting relationships in field
- GIS system has been installed, and is now being used as the primary field mapping system for surface facilities, roads, drainages, wells, flowlines, digital elevation model, etc. replacing an antiquated AutoCad system.





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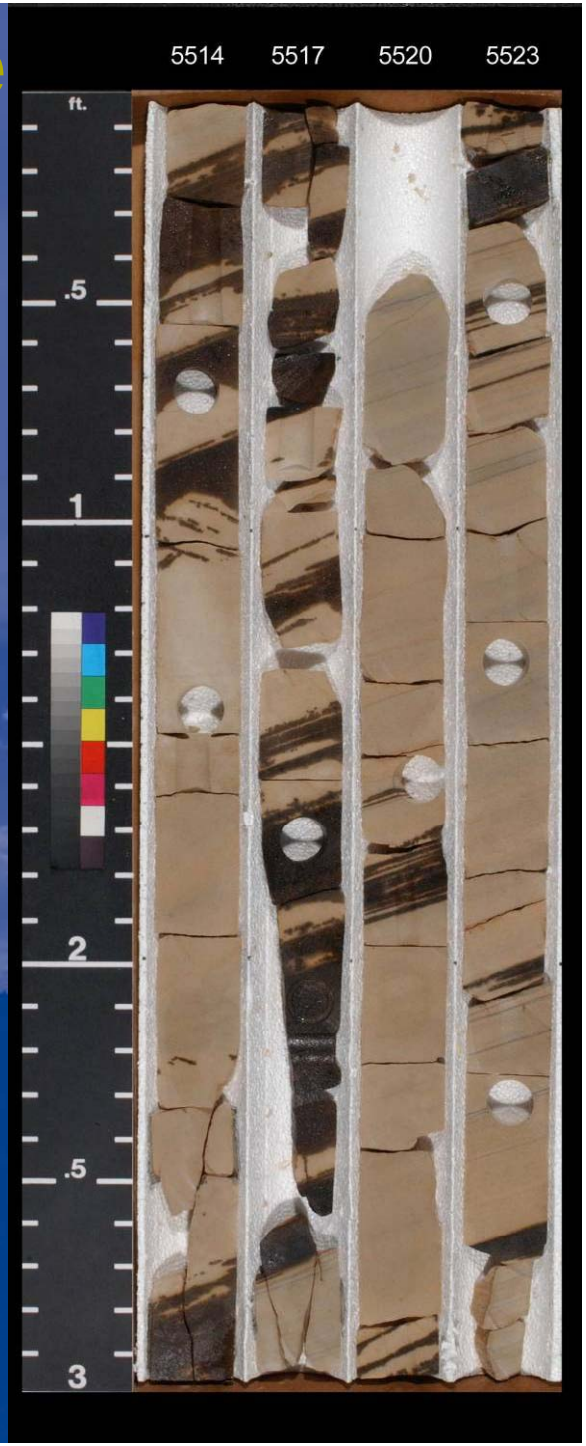
Data Management Status Update

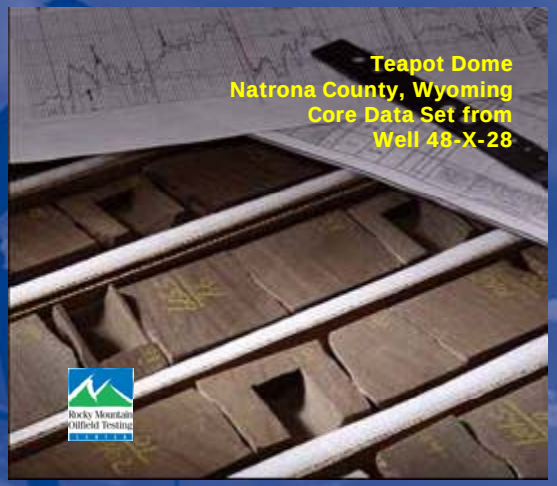
- Formation tops have been picked in 1071 wells out of 1370
  - most remaining wells do not have available logs
  - Faults cuts have been identified from log data in 283 wells
- Historical production data is being loaded into an Oracle relational database to be used in conjunction with other engineering and geological software.
- Core data for deeper wells (Tensleep) has been compiled and is being loaded into interpretation systems
- DST pressure data has been compiled for Tensleep wells
- There are now 1175 wells with digital log curves (up from 29 three years ago).
- Data sharing has enabled RMOTC to develop new business relationships with universities, technology companies, and traditional oilfield service and production companies.



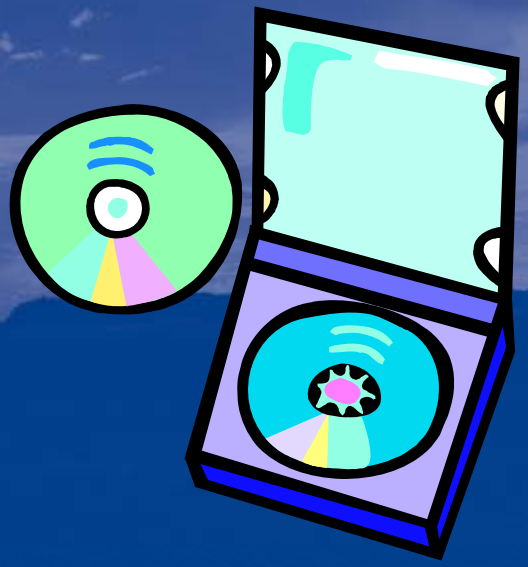
RMOTC Datasets

3D Seismic →

Core Data →

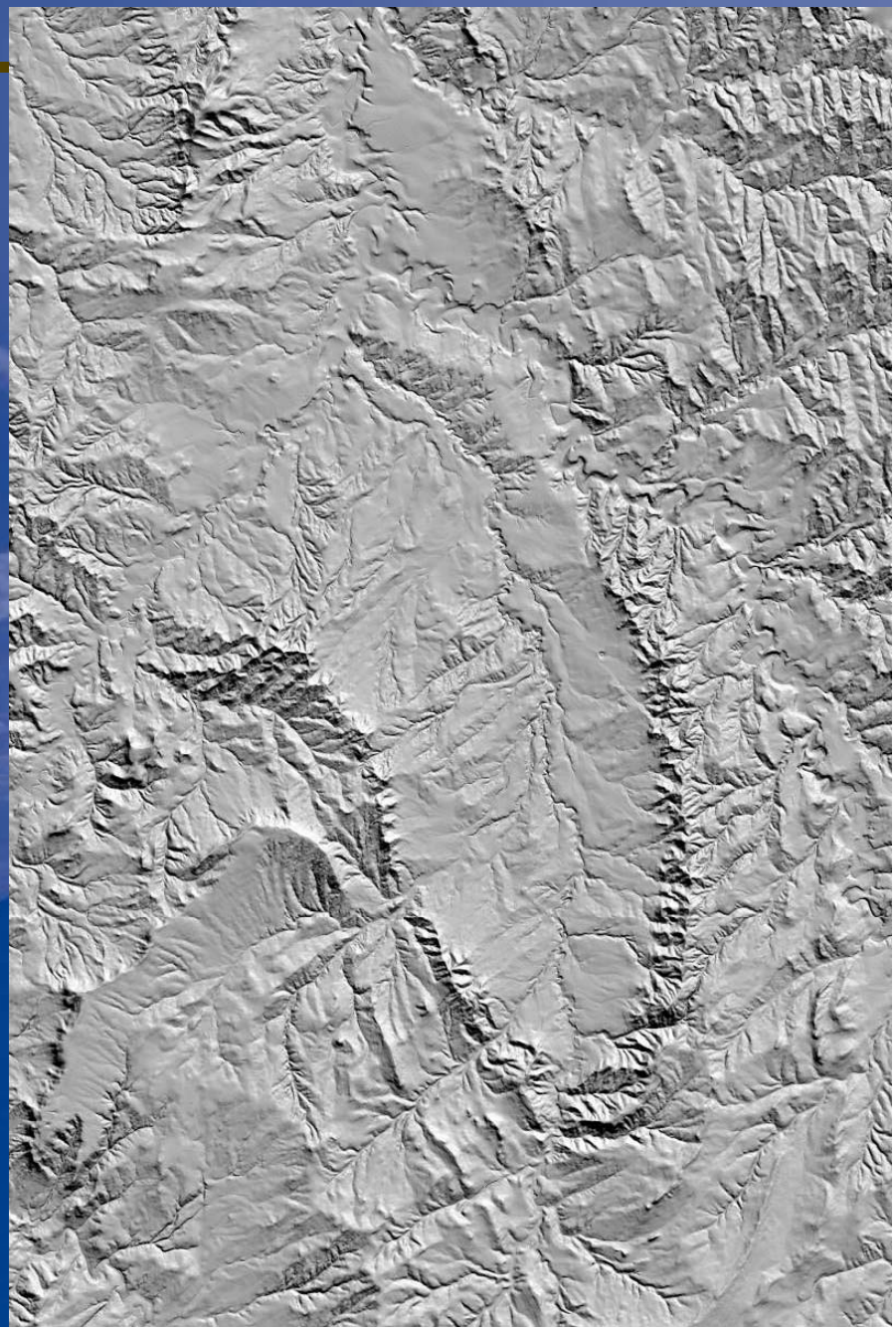


← Deep Wells
(LAS files)



Other Data Available (upon request)

- Raw pre-stack seismic data and gathers
- Interpreted and raw Formation Micro Imaging (FMI) log data
- Production data
- GIS data including air photos and digital elevation model
- Other data can be compiled as requested on a case by case basis.



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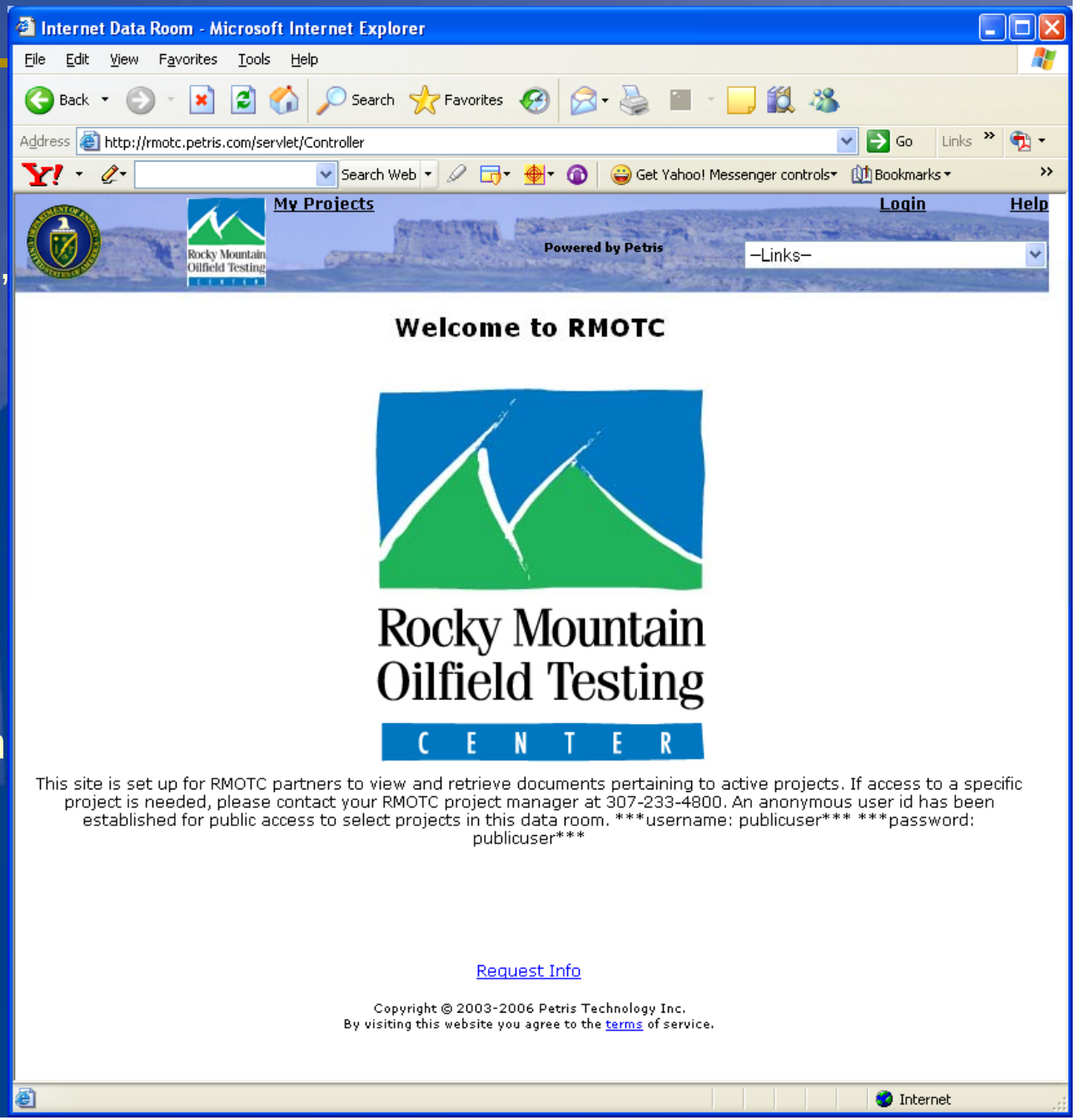
RMOTC Datasets

IDR site: http://rmotc.petris.com

- Over 150 RMOTC datasets have been distributed to partners, educational institutions, companies, and individuals over the past 2 years.

- Data is distributed via:
  - CD or DVD-ROM
  - Portable hard-drive
  - Via RMOTC/Petris Internet Data Room (IDR)
  - Email
  - External customer FTP site.



Conditions and use of RMOTC Data

- We ask that the following conditions are followed:
  - There is a legitimate use for the data such as –
    - Scientific research
    - Testing and demonstrating software
    - Training end-users
    - As an exploration/production analog
  - You provide your name and other contact information so RMOTC can keep a record of who has the data and how it is being used.
  - You acknowledge RMOTC and DOE in any presentations or publications that use the dataset.

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Universities Using RMOTC Data In Past 3 Years

- Colorado School of Mines- (LIDAR surface outcrop mapping, baseline soil gas studies)
- Texas A&M University- (reservoir modeling)
- Brigham Young University-(high res shallow seismic)
- West Virginia University- (fracture characterization)
- University of Houston- (seismic curvature attribute analysis and seismic processing)
- Manchester University, U.K.- (baseline noble gas study)
- Colorado State University- (fracture analysis using seismic data)
- University of Wyoming- (detailed core work, sequence stratigraphy)
- Stanford University- (reservoir sealing pressure studies)

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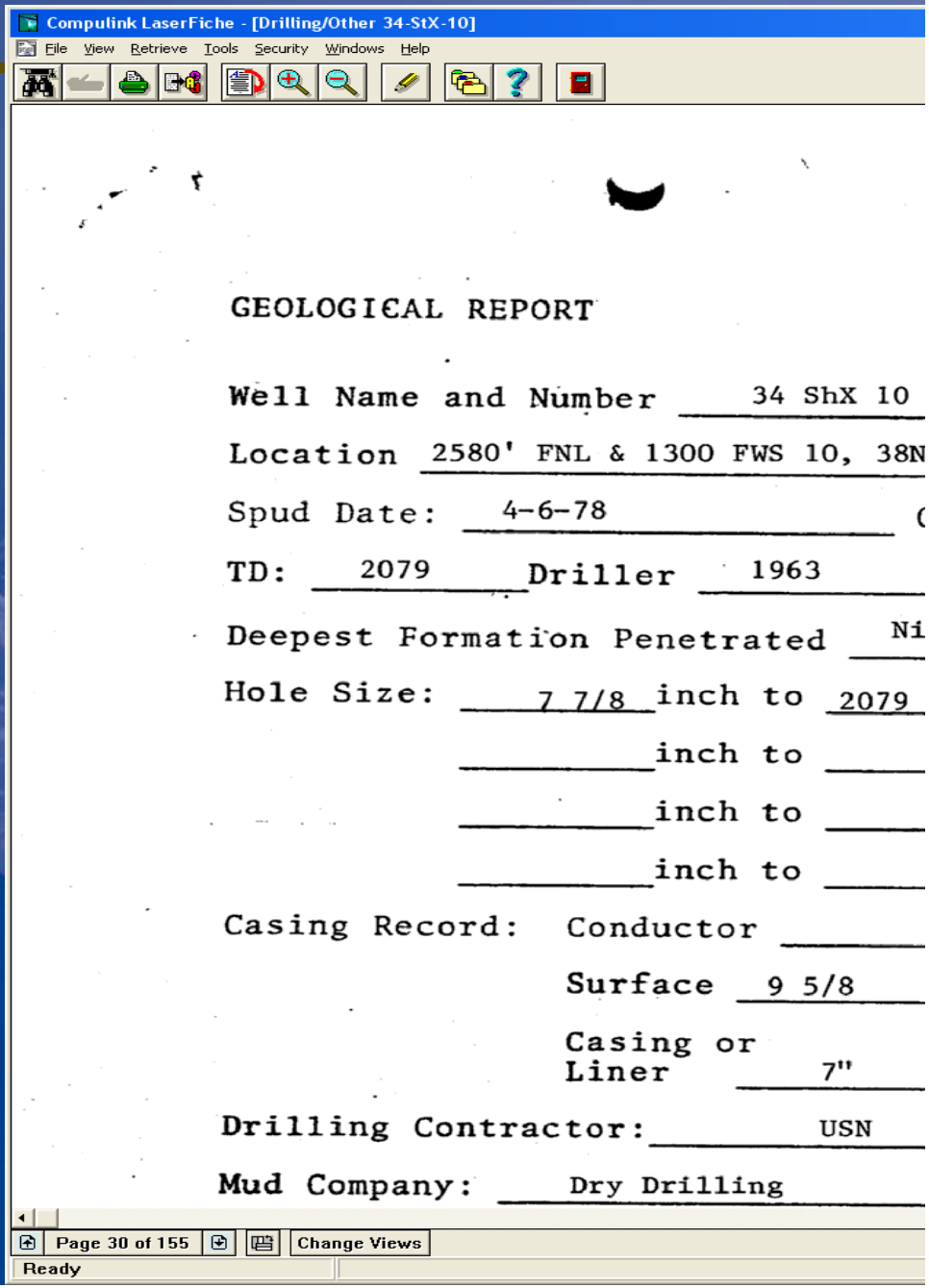
RMOTC, We have a problem

- New data often ends up in individuals offices, rather than a central repository
- The Well files are not organized in a useful manner
- Policies need to be made to govern well file management

- RMOTC Data Management team
  - Goal of team is to identify existing problems, come up with a new policy for managing well files.
  - Team Consists of Geologists, Engineers, and Technicians



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Moving Forward

- Continuing to map surfaces and faults at NPR-3.
- Complete full 3D integrated seismic interpretation of multiple key horizons and faults
- Seismic depth conversion of seismic to match well data
- Special geoscience analysis
- Build a 3D geocellular model
- Run dynamic flow simulation, perform history match and tune model for fit
- Continue loading production history and completions data into production mgmt system
- Implement real-time production data capture and surveillance
- Load (historic) drilling data into a system to enable improved drilling operations, planning and design
- Implement new strategies and policies for cleaning up the existing databases, and maintaining well files as new data is added

Yellow text means in progress, white is still to be done

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Conclusions

- The project is in its 3rd year and has strong support from management.
- The process is slow and tedious, but several milestones have been reached.
- RMOTC still has several issues that need to be resolved with data management.
- The RMOTC datasets have become a valuable contribution to the petroleum industry and are being applied in a variety of academic and industry-related applications.

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Questions?