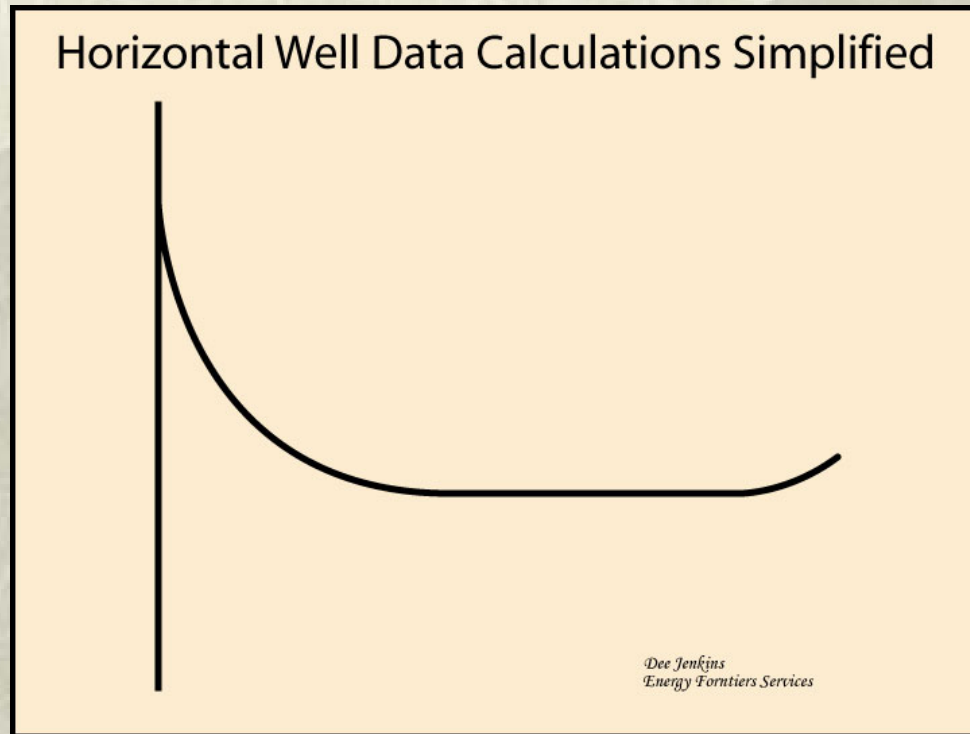


A Short Set of HNAV Examples



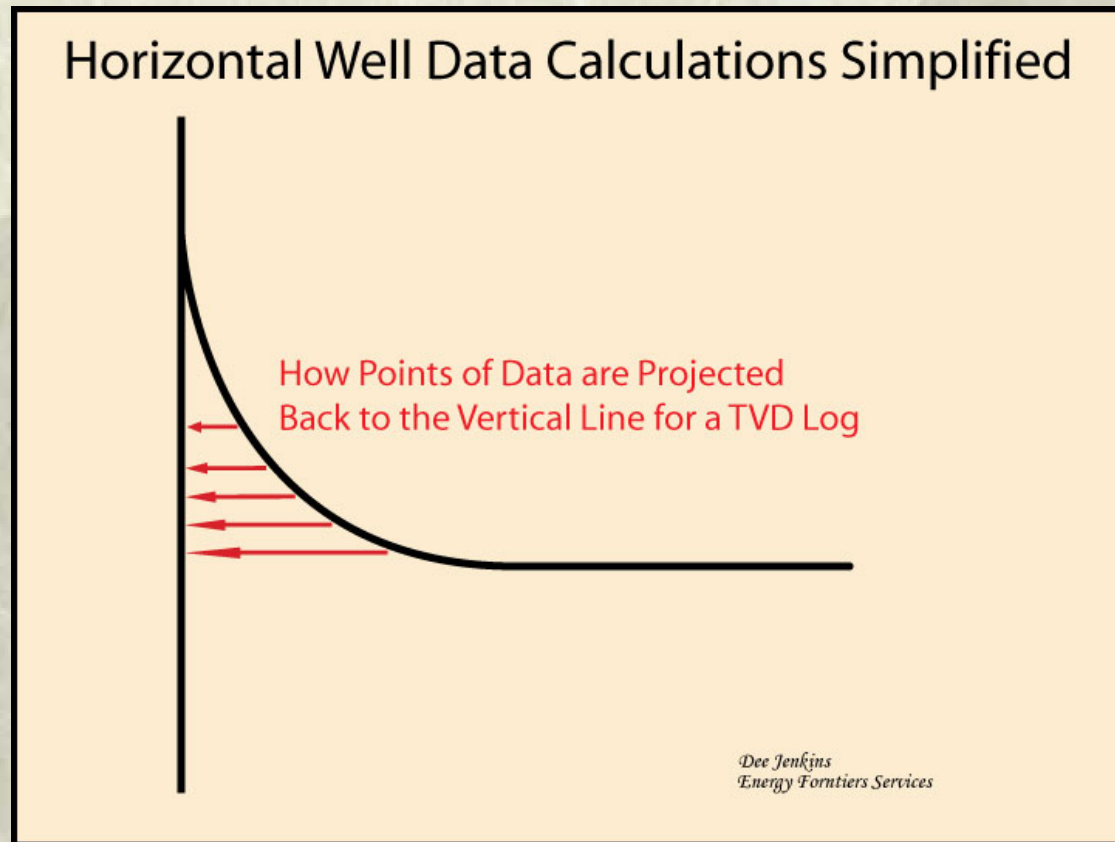
Why Geo-Navigation is Important in
Your Every-Day Horizontal Wells

Let Us Begin with Some Basics



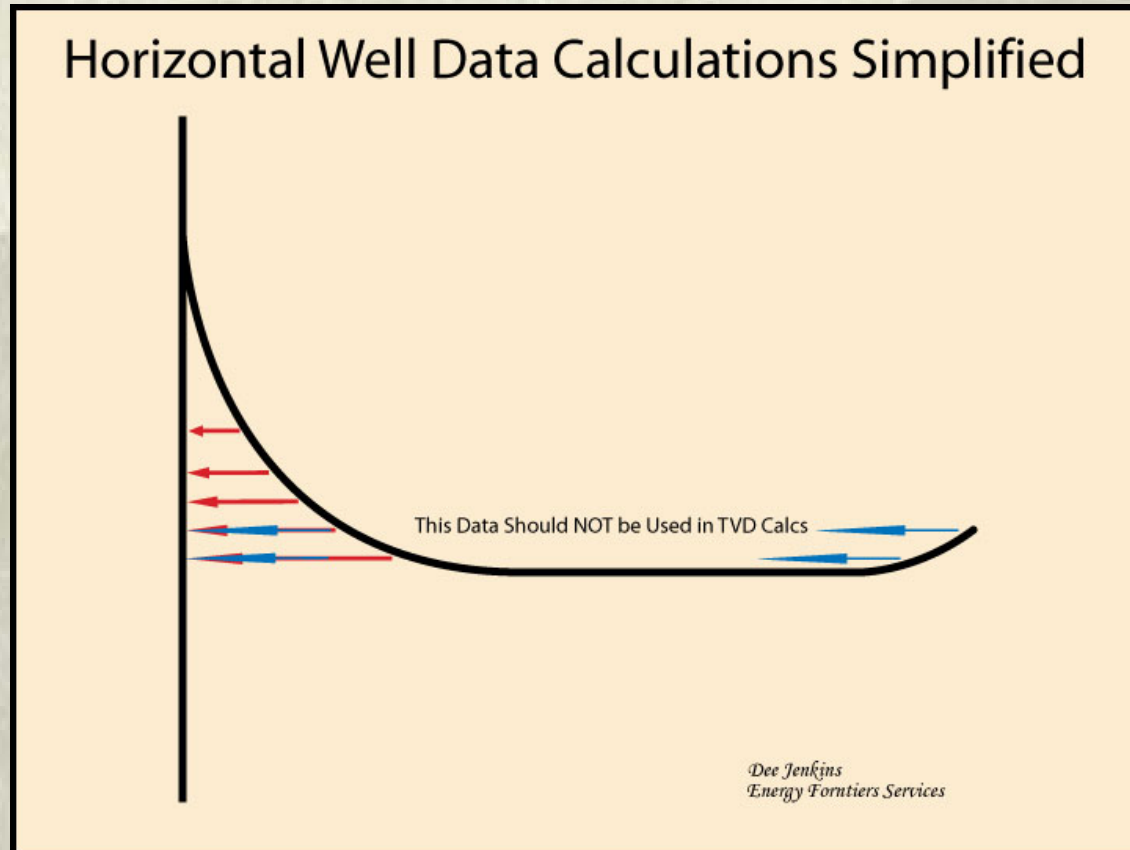
- ❖ A Vertical Pilot Hole and Lateral with a “Hook” at the End

How Most People Construct a TVD Log



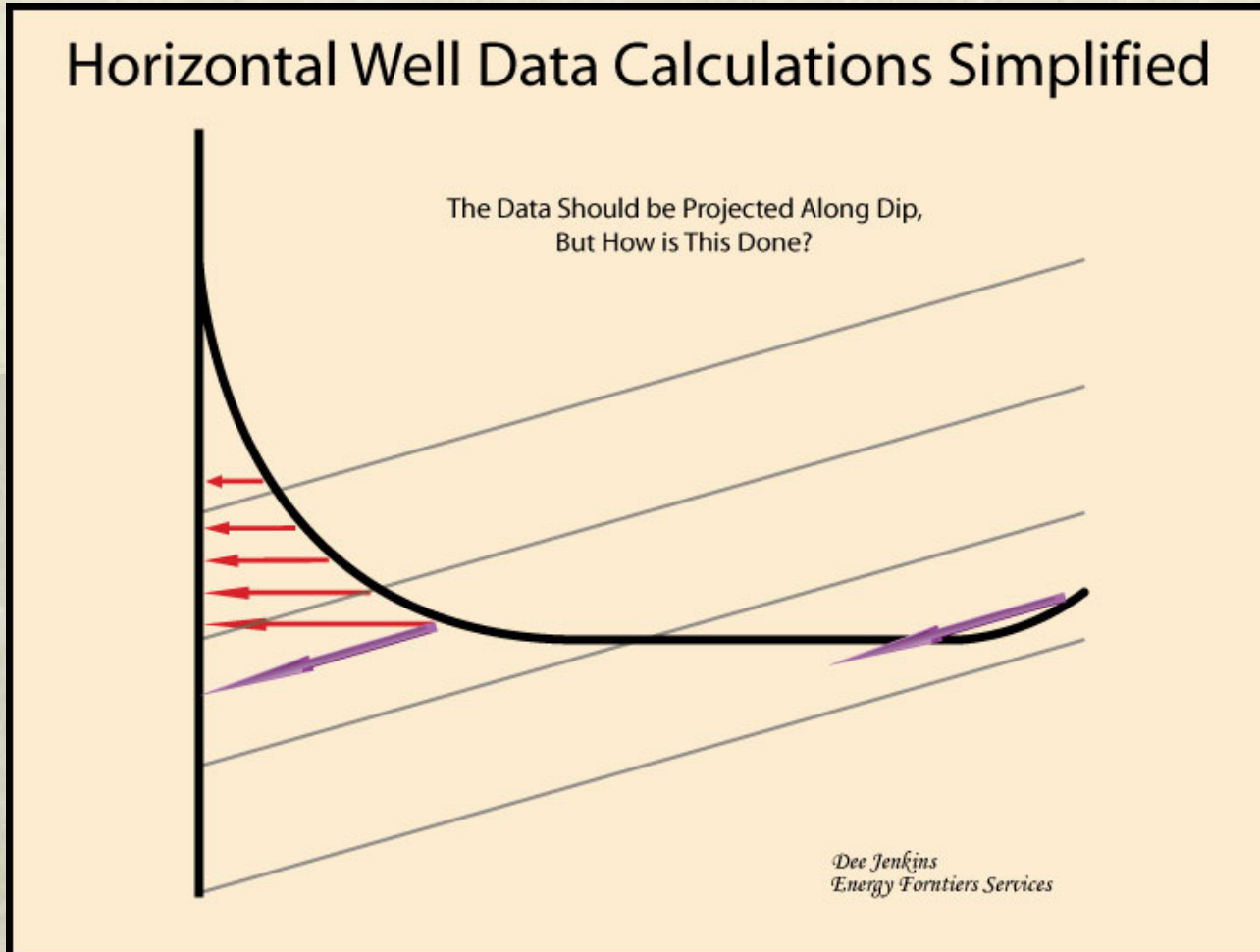
- ❖ Points in the Curve are Projected into the Vertical

Limitation of TVD Logs in a Repeated Section



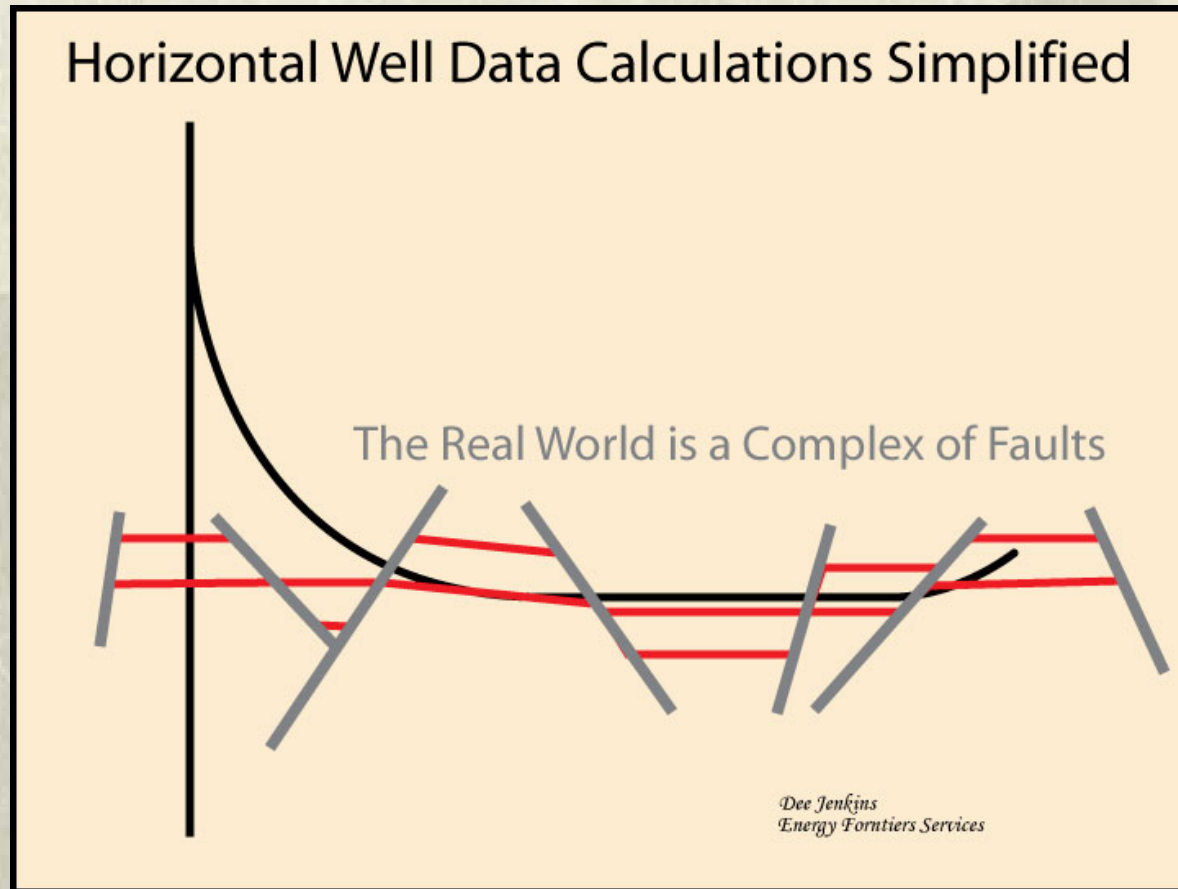
- ❖ Notice the Blue Arrows WOULD Overlay the Red
- ❖ These Points of Data are NOT Normally Included

Our Log Needs a Correction for Dip



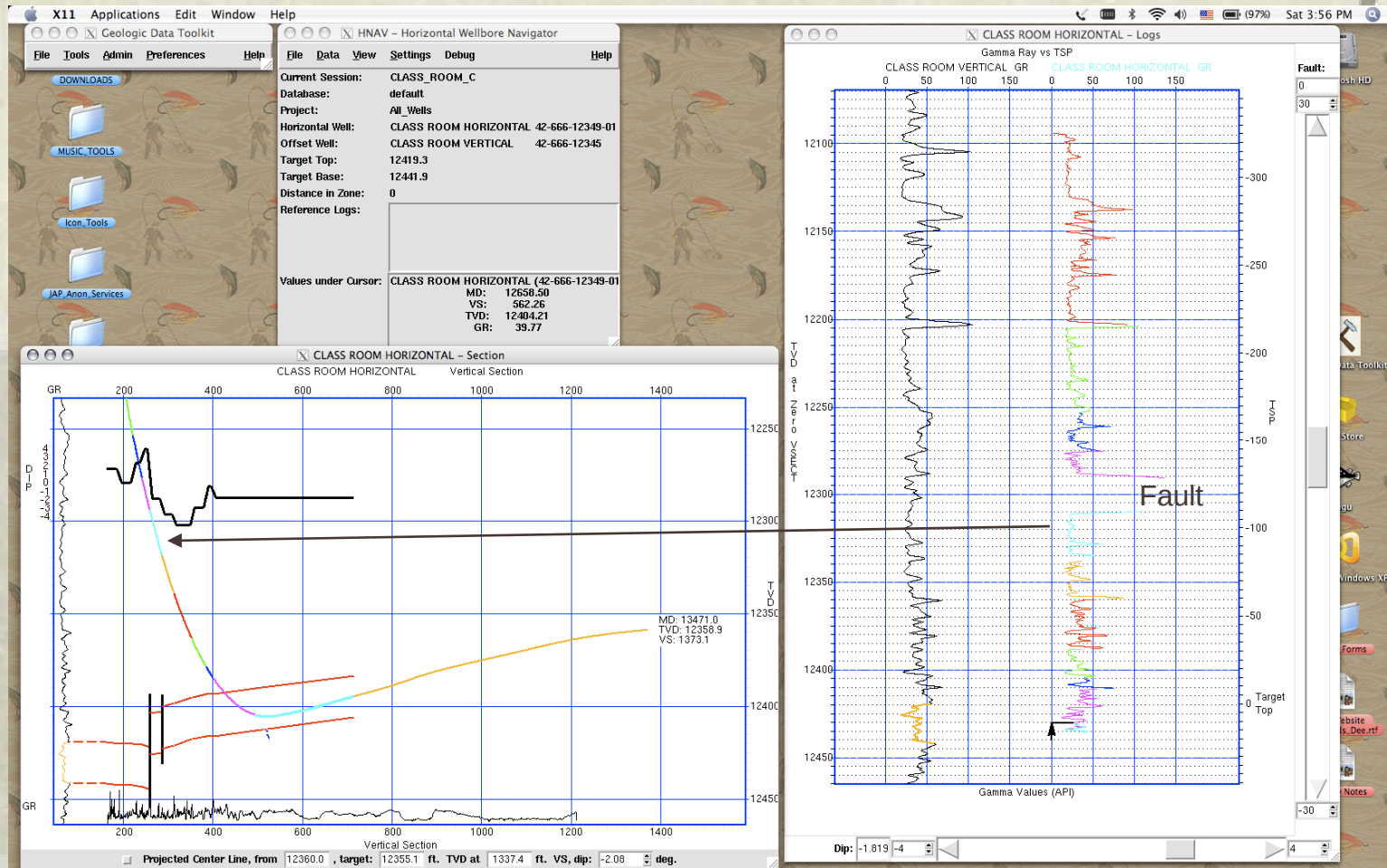
- ❖ Data SHOULD be Projected Back Along Dip
- ❖ How do We Decide What is the Correct Dip?
 - The Answer lies in Finding Correlable Horizons

Our Application Will Tell Us the Real Story and Define Dips and Faults



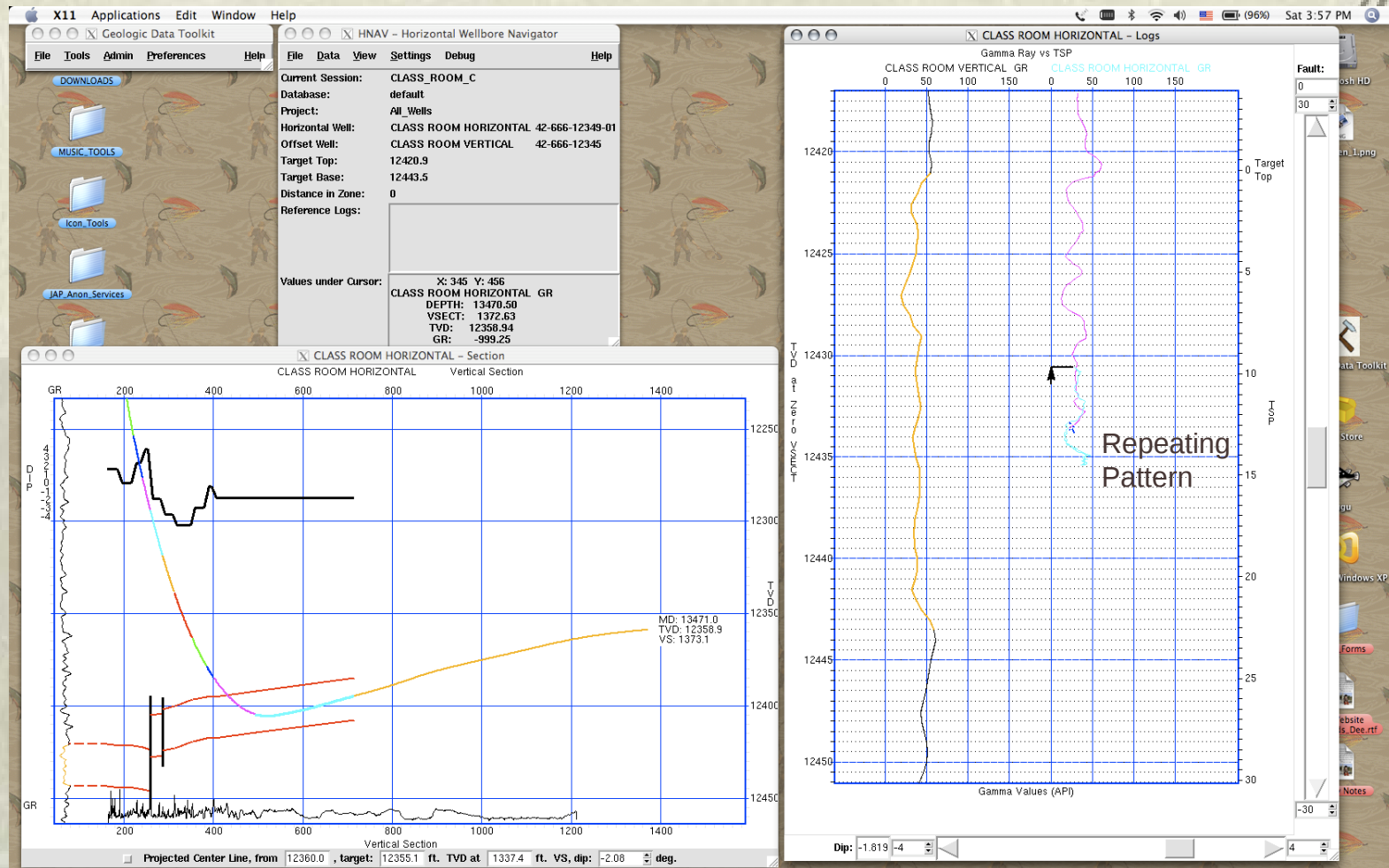
- ❖ Let the Data “Speak” to Us with a Data Visualization Tool

How Our Software Looks



- ❖ We Can Zoom in Any Window
- ❖ The Repeating Section at the Start of this Well is Very Important Because it Gives an Accurate Dip
- ❖ The Colored Segment on the Log is the Same Piece as on the Section

How Our Software Looks



- ❖ Section View and Log View with Control Mouse Driven Pop-Up Menu
- ❖ Notice the Repeating Section on the Log Where the Well “Loops” Through the Strata

A “Live” Example

Barnett Shale Example



Cross Section View
Horizontal Traverse Through Section

- ❖ Following Post-Drill Appraisal, Operator Initiated “Live” Navigation on All Wells
- ❖ This Well was a Success for Four Sevens - Did not Drill Too Far, Did Not Cone Water, Good Rate of Production

“Life is Harsh”

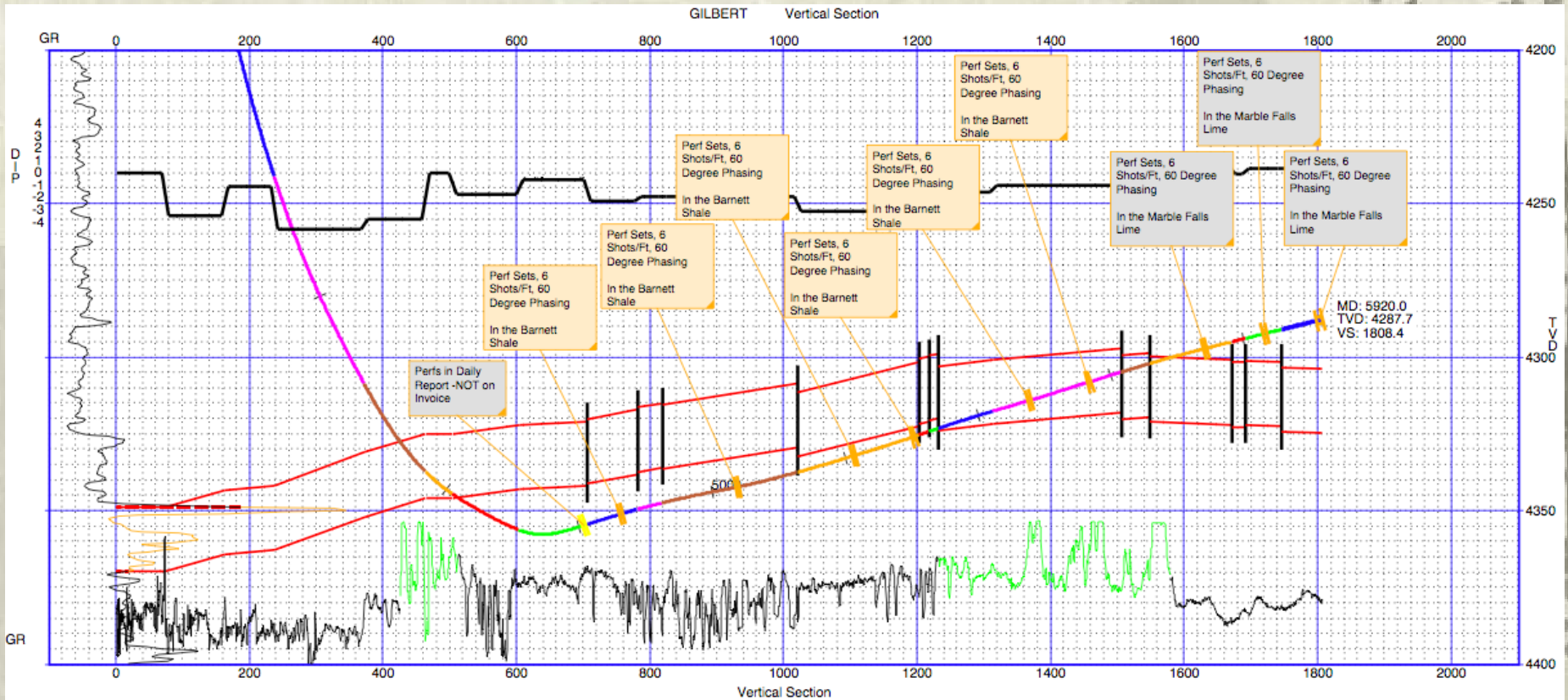


❖ Your Geo-Navigation Shouldn't Be

Another Operator's Lessons in Parker, Palo Pinto, and Erath Counties, Texas

- ❖ Small Investor Funded Public Company
- ❖ Drilled \$15 MM Worth of Hz Wells (4)
- ❖ Have 1 Producer
- ❖ History:
 - Started with Gilbert 1 H Interpretation
 - Did Post-Completion Evaluations on All Other Wells
 - Remediation and Redrills Justifying Round II of Financing

Gilbert 1H Example

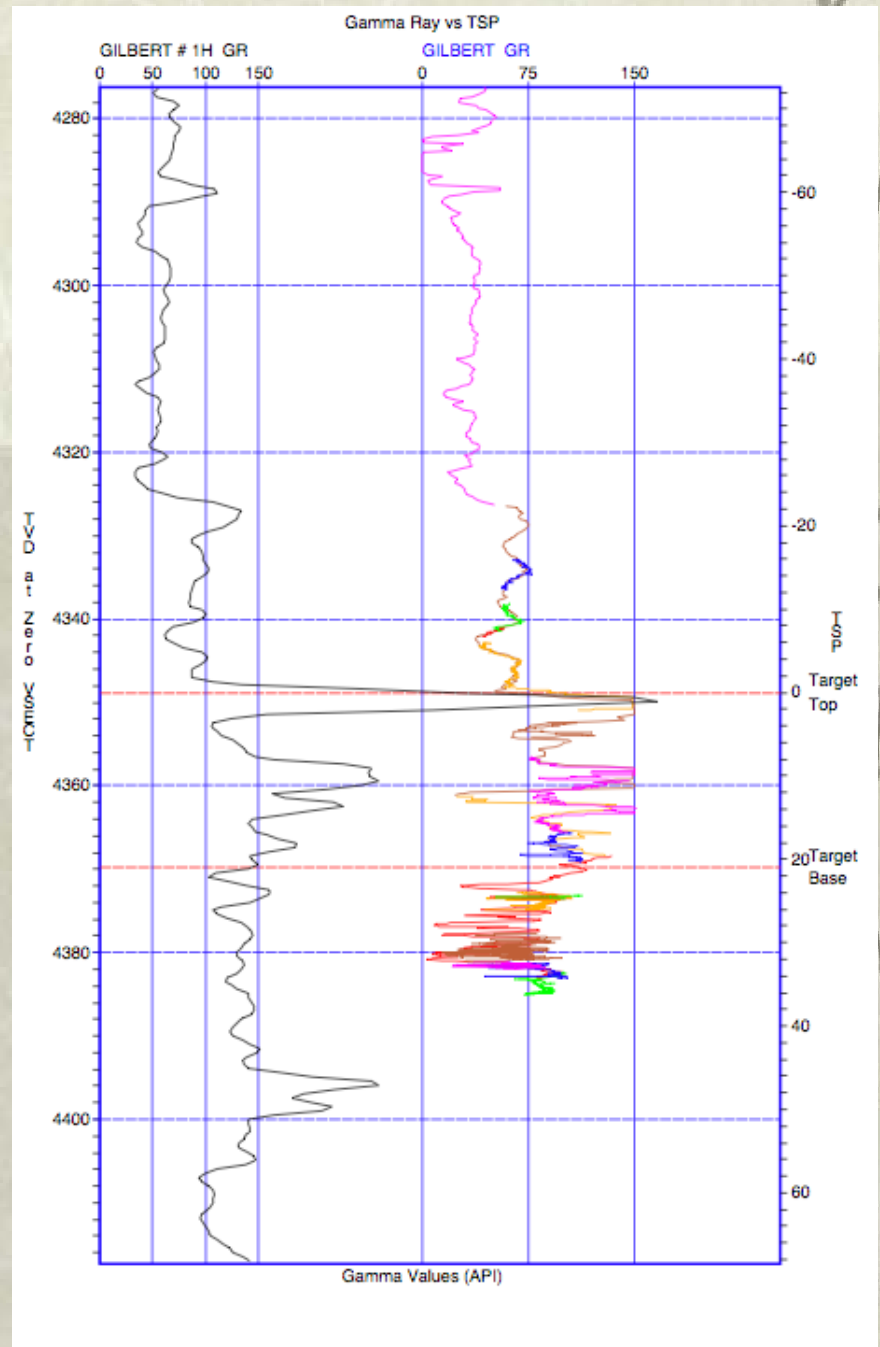


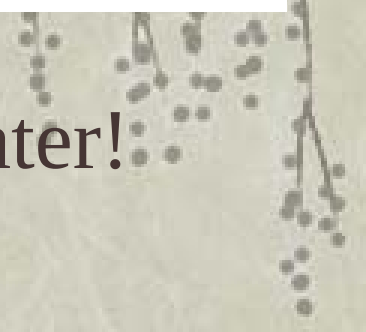
- ❖ Produced Gas with Slugs of Water Until Well Loaded Up - Note Well is in Marble Falls and has Perfs on the Faults

Gilbert 1H Logs

Let's Review:

- ❖ We Build a TSP Log that Correlates to an Offset Log or Pilot Hole
- ❖ Take Small Segments & View Them at a Low Angle
- ❖ OR, Shift Them Up & Down for Faults
- ❖ Match Them to the Pattern on the Offset Log



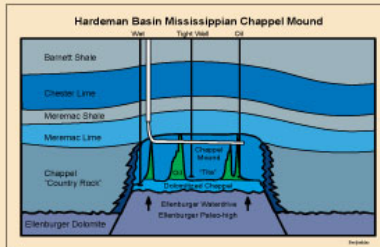


The HNAV Results for a Fayetteville Shale Play Test



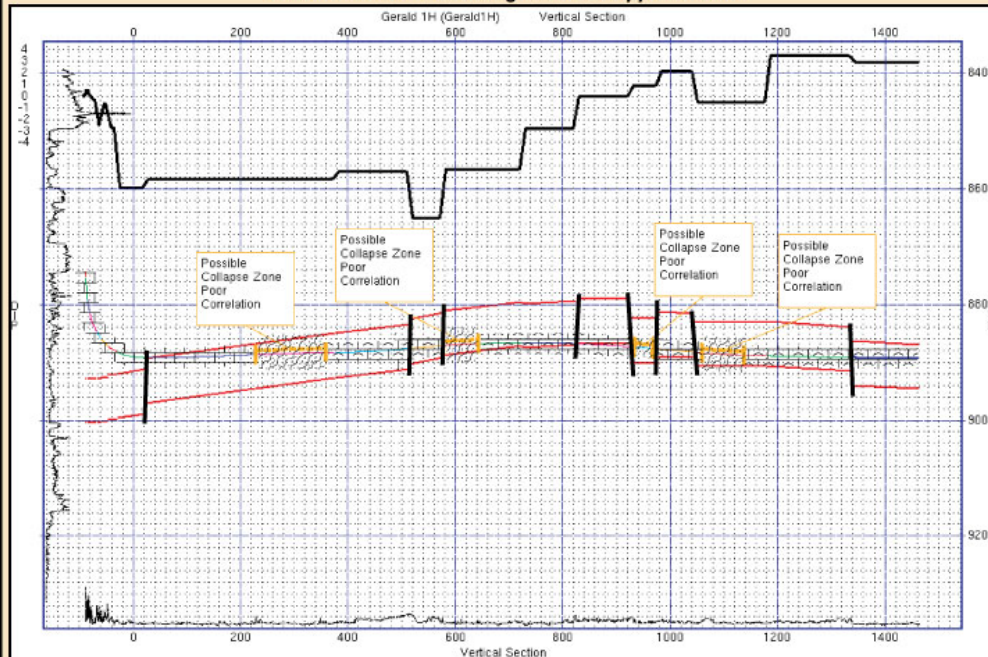
Fancy Example of a Mississippian Biohermal Reef, with Lithologies

The HNAV Process and Results

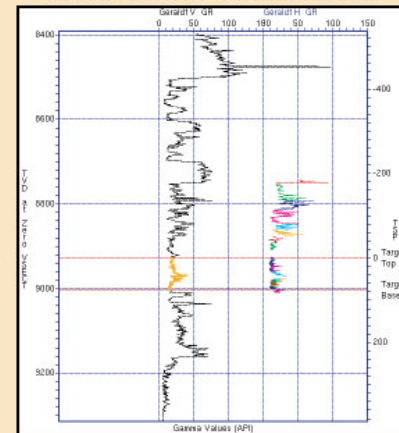


Pre-Drill Model:
Mississippian Mounds with Collapse Breccias
Mounds are 3D Defined
Oil and Gas Pay in Alteration "Chimneys"

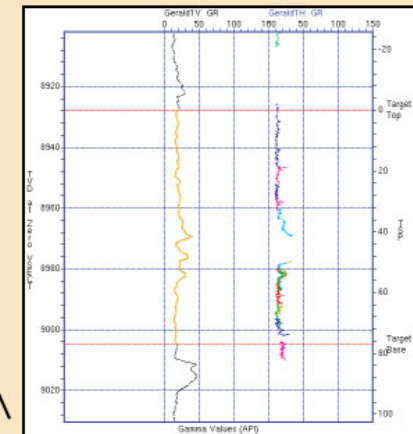
Cross Section View
Horizontal Traverse Through a Mississippian Mound



Gamma-Ray Correlation
Vertical Pilot Hole to Horizontal Data



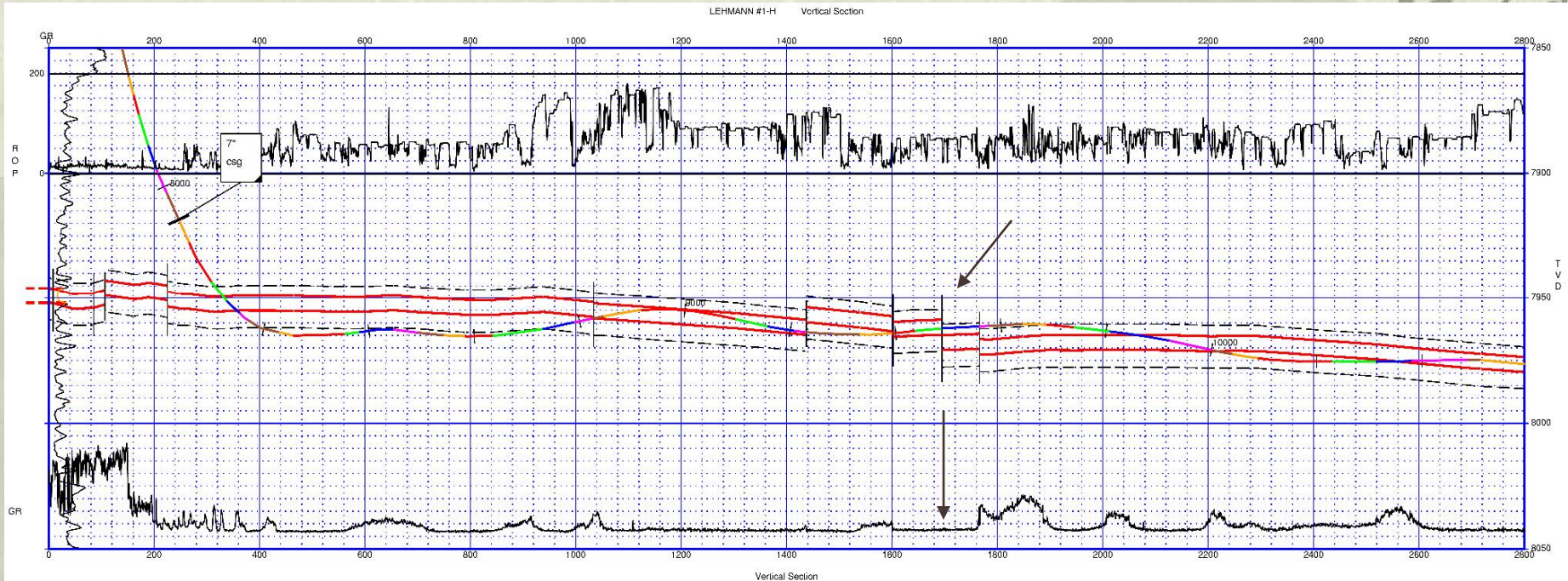
Zoomed In



- ❖ Hardeman Basin Miss Bioherm with Collapse Breccias and Shows

An Example of a Subtle Fault

Petrohawk Lehman 1H in James Lime of Nacogdoches County, East Texas



- ❖ Most Faults Can be Easily Discriminated, Just Looking at a Log
- ❖ But the Trick is Finding the Displacements of the Fault and Direction
- ❖ Here is a Clean Gamma to Clean Gamma Fault! Cooool...
- ❖ Note: Even With Faults, Navigator Kept it On Target

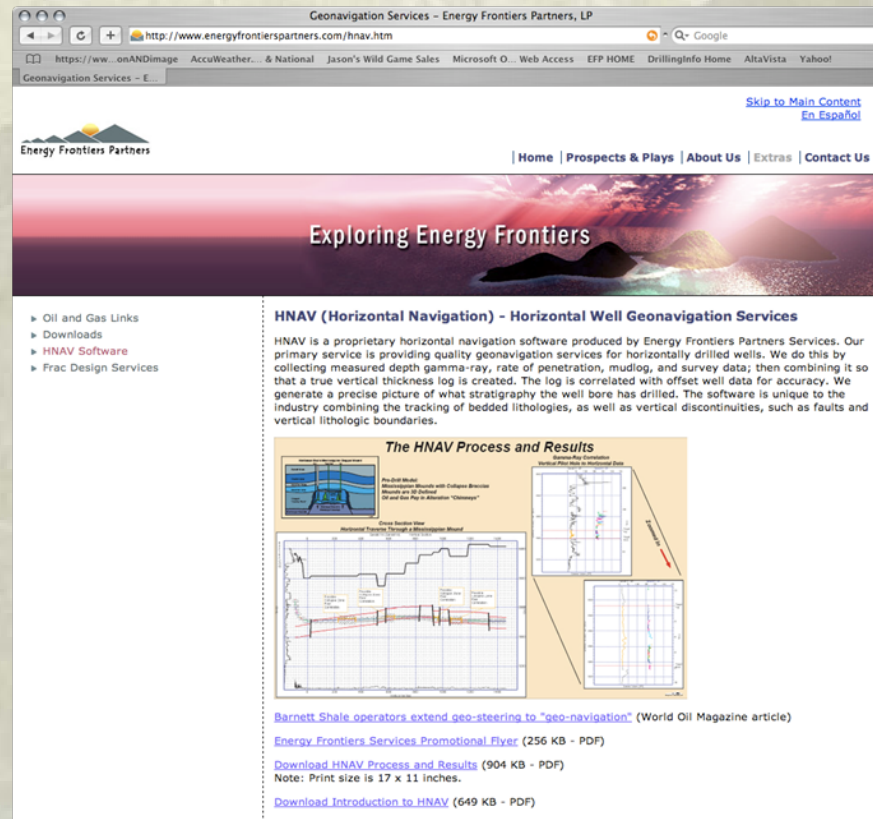
Conclusions

❖ Geo-Steering is Evolving into Geo-Navigation. Tracking Zones is Still Important, but -

- Knowing Locations of Faults is Critical
- Knowing Fault Magnitudes, and
- Perforation Planning is Critical

**HNAV is the ONLY Tool that
Can Define Fault Throw**

What? More Questions? Then Try the NHAV Link to More Info



The screenshot shows a web browser window displaying the Energy Frontiers Partners website. The browser's address bar shows the URL <http://www.energyfrontierspartners.com/hnav.htm>. The website has a navigation menu with links: Home, Prospects & Plays, About Us, Extras, and Contact Us. The main heading is "Exploring Energy Frontiers". On the left, there is a sidebar with links: Oil and Gas Links, Downloads, HNAV Software, and Frac Design Services. The main content area is titled "HNAV (Horizontal Navigation) - Horizontal Well Geonavigation Services". It describes HNAV as a proprietary horizontal navigation software produced by Energy Frontiers Partners Services, used for providing quality geonavigation services for horizontally drilled wells. Below the text is a section titled "The HNAV Process and Results" which includes three diagrams: a cross-section view of a well, a horizontal view of a well, and a vertical view of a well. At the bottom, there are links to download various documents: "Barnett Shale operators extend geo-steering to 'geo-navigation'" (World Oil Magazine article), "Energy Frontiers Services Promotional Flyer" (256 KB - PDF), "Download HNAV Process and Results" (904 KB - PDF), and "Download Introduction to HNAV" (649 KB - PDF).

Geonavigation Services - Energy Frontiers Partners, LP

<http://www.energyfrontierspartners.com/hnav.htm>

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Exploring Energy Frontiers

- Oil and Gas Links
- Downloads
- HNAV Software**
- Frac Design Services

HNAV (Horizontal Navigation) - Horizontal Well Geonavigation Services

HNAV is a proprietary horizontal navigation software produced by Energy Frontiers Partners Services. Our primary service is providing quality geonavigation services for horizontally drilled wells. We do this by collecting measured depth gamma-ray, rate of penetration, mudlog, and survey data; then combining it so that a true vertical thickness log is created. The log is correlated with offset well data for accuracy. We generate a precise picture of what stratigraphy the well bore has drilled. The software is unique to the industry combining the tracking of bedded lithologies, as well as vertical discontinuities, such as faults and vertical lithologic boundaries.

The HNAV Process and Results

The HNAV Process and Results section includes three diagrams illustrating the HNAV process and results:

- Horizontal View**: A cross-section view of a well showing the horizontal navigation path.
- Vertical View**: A vertical view of a well showing the horizontal navigation path.
- Horizontal View**: A horizontal view of a well showing the horizontal navigation path.

[Barnett Shale operators extend geo-steering to "geo-navigation"](#) (World Oil Magazine article)

[Energy Frontiers Services Promotional Flyer](#) (256 KB - PDF)

[Download HNAV Process and Results](#) (904 KB - PDF)

Note: Print size is 17 x 11 inches.

[Download Introduction to HNAV](#) (649 KB - PDF)

❖ All Information on Methods and **Examples**