

## NUSTIM™ SERVICE – ROCKY MOUNTAINS

### OPERATOR CHALLENGE:

A Rocky Mountain operator was faced with **inconsistent completion results** in Moffat County, CO where **multiple tight Lewis sands** in each wellbore must be **economically stimulated**. Erratic post fracture production results in the first four wells in a new field for the operator presented several questions:

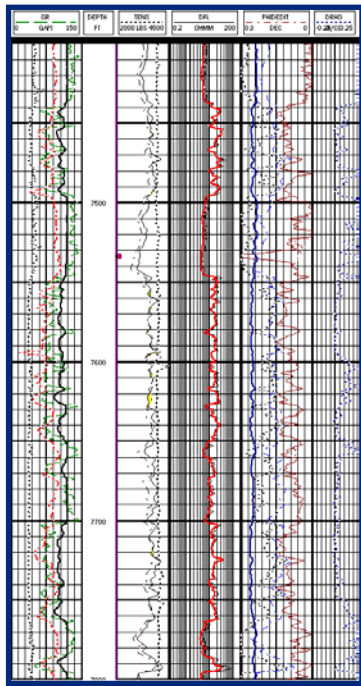


Figure 1: Conventional log data for Lewis well.

- Were the intervals as productive as first thought by conventional log interpretation and field analysis?
- Is it reasonable to use net ft of pay as a determination of stimulation treatment size?
- Is it good practice to compare net feet of measured porosity from the conventional log analysis as a measure of well performance?
- Is the current completion strategy adequate for all wells in the field?
- How could further completion optimization be economically realized in this tight sand play?

While all four wells appeared very similar based on conventional log response (net feet of porosity, Fig. 1), each responded differently. All four wells were stimulated using the same basic strategy, yet the **field results were noncommercial**. Current completion expenses were out-weighing the production gains and the future of the entire field development was in jeopardy.

Needing help to diagnose the differences in the well performances, the operator requested NuTech apply their petrophysical and stimulation services to diagnose the problem(s) and **aid them with the completion of future Lewis wells**. The operator provided the digital logging and past completion data on the four wells to NuTech for analysis. The operator **withheld the production data** in which to test NuTech's answers.

### NUTECH SOLUTION:

NuTech Energy Alliance employed its **NuLook Textural Vision™ (NTV) and NuStim™ processes** to properly evaluate the intervals, determine the capacity of each well, and identify the optimal completion strategy. NuTech evaluated all four previously completed wells with the NTV process which properly characterized the reservoir by identifying the quantity of bound and free fluids and describing the permeability distribution in the reservoir. NTV allowed for a **proper comparison of each of the wells' Lewis sand intervals**.

The NuLook NTV reservoir description included (Fig. 2):

- Log data normalization
- Clay volume determination
- Textural distribution
- Producing fluids
- Core calibrated permeability

With the normalization and reservoir description steps completed, NuTech applied the NuLook data via the NuStim process and determined the completion efficiency of each well.

Using sonic porosity measurements provided by the operator on two of the four wells, a **predictive sonic porosity relationship** for the area was successfully modeled. From that relationship, several rock mechanics curves were created and a detailed **in-situ stress profile** was generated and calibrated to the previous fracturing treatments on the Lewis intervals. The permeability distribution was further **calibrated to match the production** response for the area in concert with the leakoff profile from the pressure matched fracture dimensions.

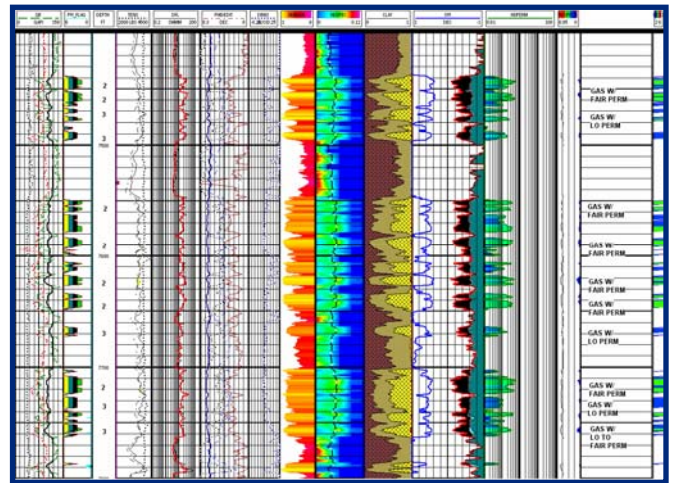


Figure 2: NTV analysis of Lewis well.

#### NuList Parameters: Lewis

Pay Ft	AVE Rank	PHIE <sub>AVE</sub>	Perm <sub>ABS</sub>	Perm <sub>ABS</sub> Ft
134	2.6	11.3 %	0.198 md	26.5 md Ft

From the evaluation of the Lewis completions, the process showed that two of the wells had **dramatically different reservoir qualities** than the other two. NuStim predicted the production from the current completion of the four wells and determined that a **single completion strategy for the entire field was ineffective**. Now with a calibrated in-situ stress and permeability profile, the NuStim process easily pointed to the **unique optimal completion techniques** in each of the wells.

### THE RESULTS:

The NuStim process **accurately predicted the initial production** response from each of the stimulation treatments in the data set, and evaluated the well economics with the current field completion strategy and determined it to be uneconomic for two of the four wells in the study. The operator was completing the Lewis in a two stage fracturing operation, which dramatically increased the completion costs over a single stage operation.

By shutting in the bottom zone to allow stimulation of the upper stage, NuStim showed that significant production in the lower interval was lost due to capillary effects in the reservoir. The NuStim process illustrated that, if properly designed, a single stage fracturing treatment would positively impact the economics of the field, making **all four wells commercial**.

A single stage fracturing treatment not only **reduced completion expenses**, but also helped alleviate the loss of production due to the shut in of the lower half of the Lewis interval. NuTech's advanced modeling properly identified the stress profile in each well and allowed for a complex limited entry design to be conceived for each wellbore.

The limited entry technique limits the number of perforations in a completion interval to promote the development of perforation friction during a stimulation treatment. If designed properly the perforation friction allows the simultaneous entry of fracturing fluid into multiple zones of varying in-situ stress states throughout the stimulation treatment. The implementation of limited entry techniques requires a high degree of control over the bottomhole treating pressure, but can result in a significant **reduction in completion costs and time**.

As a result of combining the NTV and NuStim processes, **accurate limited entry designs** (Fig.5) become possible. All productive pay intervals in the wellbore are identified by the NTV analysis. Through the NuStim in-situ stress profile, the perforation design can be conceived such as to allow the simultaneous entry of fracturing fluid into multiple zones of varying in-situ stress states. In order to ensure the proper distribution of the fracturing fluid throughout the entire treatment several factors must be accounted for. Perforation erosion effects, wellbore friction changes, hydrostatic column changes, pump rate variations, fluid viscosity, sand mesh size and concentration all effect the progressive increase in hole diameter that occurs during a fracturing treatment. Only by modeling these changes throughout the job, not simply in the PAD, can the **inter-zonal rate redistribution** be identified and accounted for. Not modeling perf erosion correctly is the main reason why limited-entry hydraulic fracturing techniques frequently result in screenout.

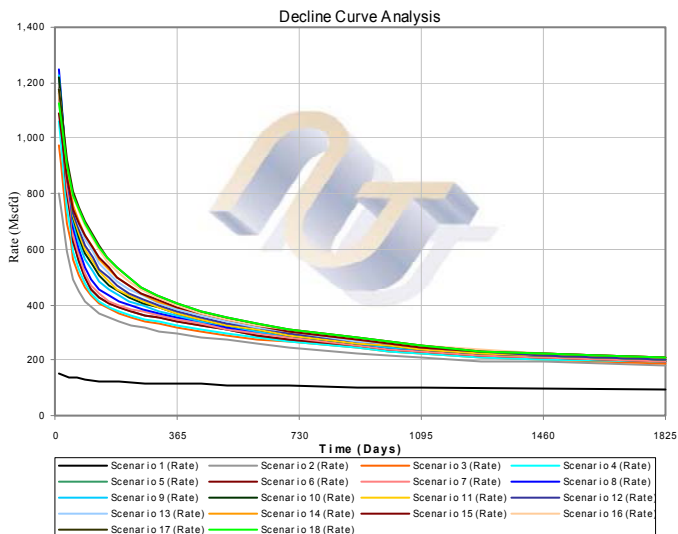


Figure 3: Decline curve analysis for Lewis well.

The NuStim process allowed for the economics for **up to 30 individual fracturing scenarios** for each well to be compared and the optimal treatments to be determined. After comparing the simulated decline curves of all of the different treatment scenarios (Fig. 3) and applying the operator's economic data, a cost to benefit comparison was made for each of the scenarios (Fig. 4) leading the operator to the correct stimulation treatment size for that specific wellbore.

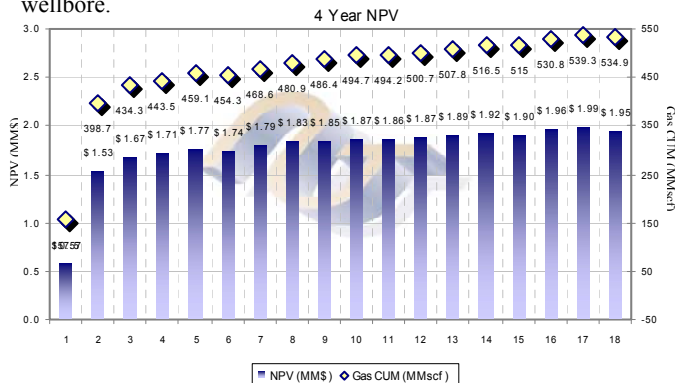


Figure 4: NPV analysis for Lewis well.

### CONCLUSIONS:

By utilizing the NuLook and NuStim technologies, the operator was able to establish the proper reservoir and completion parameters and **diagnose the true capacity of each well's potential**, and allowed them the ability to alter their completion strategy by effectively stimulating a larger pay interval in one trip to the wellhead. This information greatly influenced the operator's field wide completion strategy and dramatically **decreased the \$/Mscfe ratio**.

The revised completion strategy of one fracturing stage per wellbore, in addition to selecting the correct treatment size via the NuStim process, showed that true optimization could have been achieved. **An increase of \$4,971,000** for these four wells alone could have been achieved over the operator's past field-wide strategy in just four years, making the field an **economic success**.

Because the NuStim predictions **evolve after each completion**, the operator maximized the benefit of all lessons learned from the four wells studied. From the nature of the process, each well's formation properties are determined from the calibration coefficients identified from offsets in the area - in this case from the 4 wells studied. By calibrating to the logging parameters after normalization by NuLook, the process allows the operator to apply a **unique stimulation solution prior to the completion** of subsequent wells.

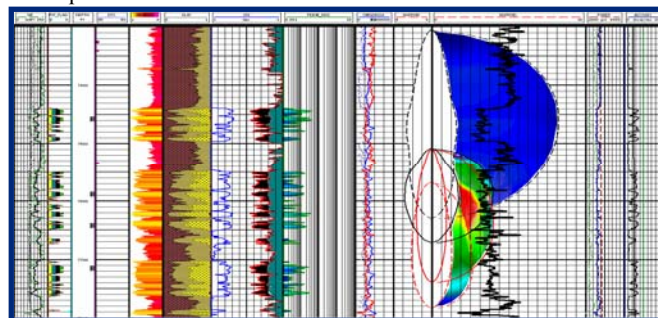


Figure 5: NuStim depiction of optimal limited entry treatment.



**For more information about how NuStim and NuLook TEXTURAL VISION can impact your bottom line, contact your local NuTech representative.**



7702 FM 1960 East • Suite #300  
Humble, TX 77346

www.nutechenergy.com  
1.866.NUTECH1