



Deformation Interpretation

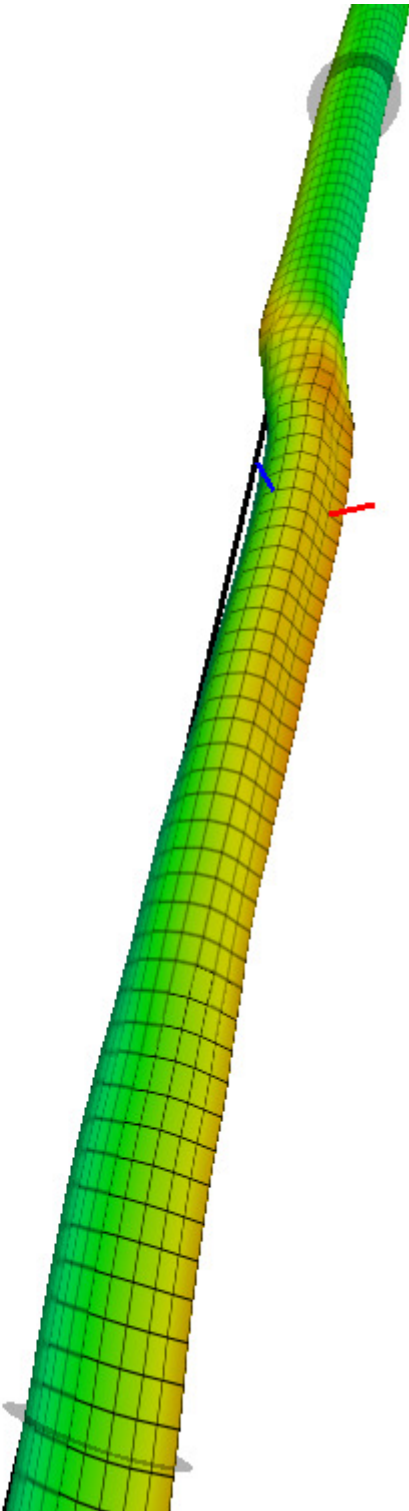
Background

Well structure deformations are becoming more common as the oil industry develops soft reservoirs, higher-pressure deposits and enhanced recovery techniques like thermal stimulation. All of these scenarios present new structural challenges. Understanding the deformations, the mechanisms that cause them and the functional limits of wells will guide future resource development. Nothing can replace good measurements for identifying new deformation mechanisms and calibrating the engineering models that clarify them. With the right processing, caliper measurements provide the most comprehensive deformation characterizations available.

Enhancing Well Integrity

Noetic provides specialized engineering services based on extensive experience in caliper data analysis and interpretation, and well tubular structural design for extreme service:

- **Optimized Tool Configuration:** Obtaining accurate and reliable data is fundamental to understanding well conditions. Tool configuration is critical for obtaining good caliper data and enabling advanced data analysis to fully characterize pipe deformations. It includes using an appropriate caliper tool, the correct number and placement of centralizers, adequate centralization force, mechanical decoupling within the tool string, and appropriate tool conveyance. Noetic provides guidance to operators and logging companies on tool string configuration to obtain high quality log data.
- **Advanced Data Analysis:** Noetic's Wellbore Inspector™ analysis algorithms calculate well curvature from caliper and survey data to generate a true 3D visualization of the wellbore cross-section and trajectory. This analysis extracts maximum value from log data by identifying restrictions due to local pipe bending, shear, or buckling deformations in addition to the cross-section ovalization/collapse deformations that can be found by conventional data analysis. Complementary data sets (e.g. CCL, GR) can be combined with the caliper data to enhance interpretation.
- **Deformation Interpretation:** Noetic combines its experience in log data analysis and well structure design to help operators identify the causes of tubular deformations and then find solutions to prevent, mitigate, or manage the deformations. We know the capabilities (and limitations) of log data analysis and the implications of tubular deformations on well integrity. Using this expertise, we work closely with well operators to discover what is happening downhole, why it is happening, and the solution.



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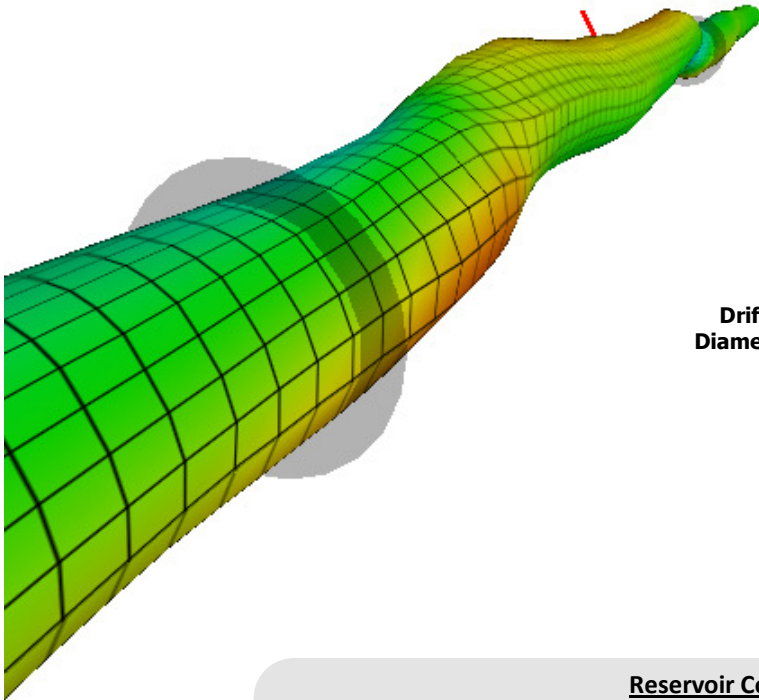
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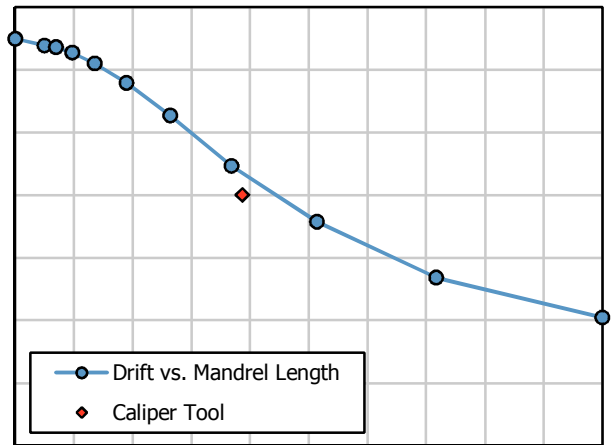
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Sample Pipe Deformation Interpretations



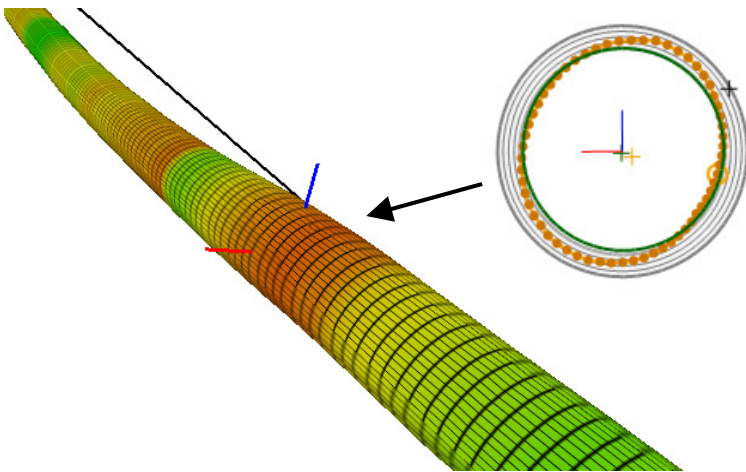
Drift Diameter



Drift Mandrel Length

Reservoir Compaction

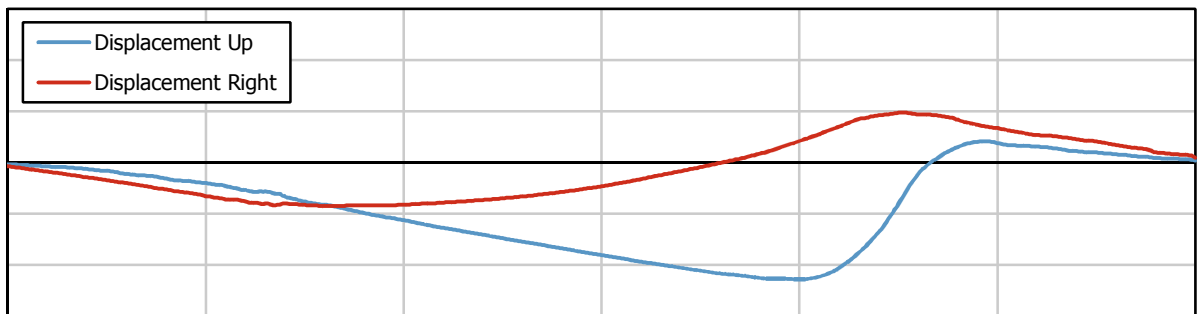
- 3D visualization of log data used to identify and assess pipe deformations caused by compaction of a chalk reservoir
- Calculated drift diameter as a function of mandrel length provides a measure of well accessibility past deformed interval



Formation Shear Movement

- Deformation visualization reveals the orientation of cross-section ovalization is consistent with the direction of local pipe bending caused by formation shear
- Calculated lateral displacement of pipe trajectory provides a quantitative measure of formation shear magnitude and direction

Pipe Trajectory Displacement



Measured Depth