OPTIMIZING PRODUCTION EQUIPMENT PLACEMENT USING DATA FROM HIGH-DENSITY WELLBORE TORTUOSITY LOGS

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Digital technology and large quantities of relevant data are driving a major change in the oil and gas industry. What is necessary for a true evolution of the way the industry does business is to understand the value of using data specific to an application in a way that enables operational and financial benefit. Often, the industry has fallen into the pattern of using catch-all words like "big data" and "digital" without truly examining how to implement solutions in either realm, trying instead to capitalize on these terms' recognizability. Progress cannot be made when efforts are so fragmented and superficial. What is necessary is that companies, especially on the service side, actively develop data-driven solutions to real-world problems.

Wellbore tortuosity is of significant concern in the modern oil field. Efficiency gains from continued innovation during and after the downturn drove down the time to drill a well, but prioritizing speed can lead to wellbores of inferior quality. This phenomenon has presented a problem in recent years with operating companies finding out that completing and producing their wells is now a challenging prospect due to the way they were originally drilled. In scenarios where wellbores are particularly tortuous, placement of downhole production equipment requires very precise positioning to eliminate the risk of damage or reservoir production issues. In line with using data to solve a real-world problem, the introduction of a novel high-density wellbore tortuosity logging solution has made it possible to obtain data at 1-ft intervals, revealing tortuosity that would never have been visible with surveys at each stand. For cased hole applications, this represents a step-change in how the industry approaches artificial lift equipment placement and production declines.

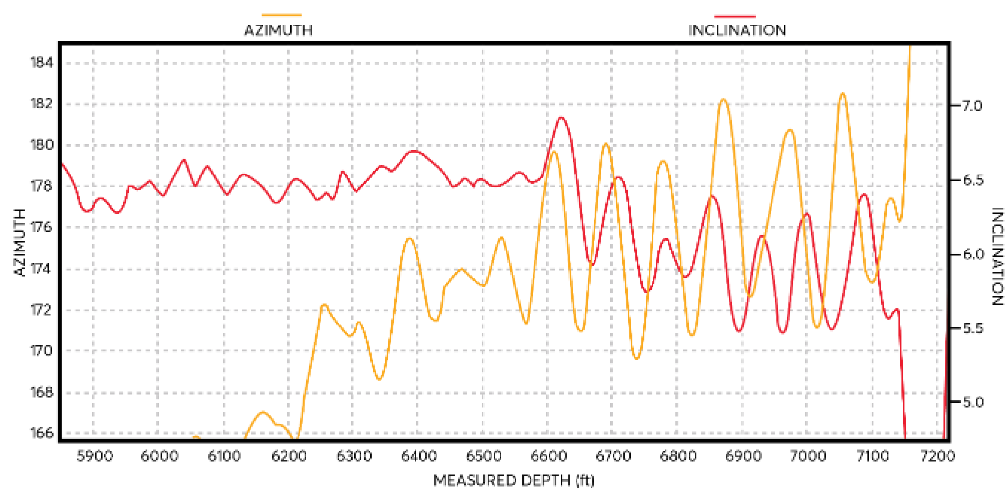

Fig. 1—As the red and yellow lines began to diverge at each high point and the casing quickly deteriorated from sinusoidal into helical buckling, it became clearer that the well would not accommodate production equipment.

The high-density tortuosity logs are obtained by running the system downhole with a survey tool to obtain data from a plurality of survey stations. The data is obtained from gyroscopic tools, magnetic instruments, or a combination thereof. In addition, the system defines reference lines for the wellbore path based on the received data and determines displacements of the wellbore path from the reference lines. Through a series of calculations based

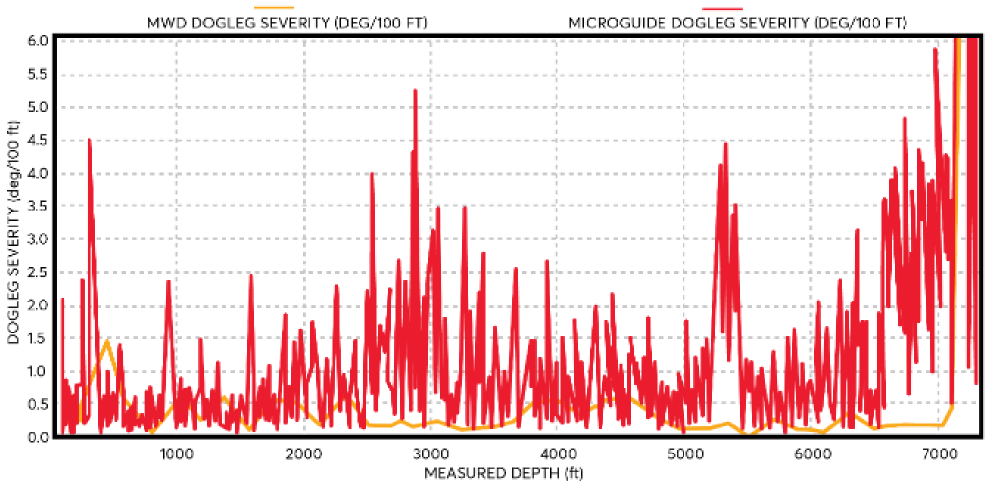

Fig. 2—The yellow line shows the dogleg severity as measured by the traditional MWD equipment, with only one significant spike at around 7,100-ft MD. Data from high-density tortuosity logs tells another story, with there being high tortuosity levels throughout the section and multiple dogleg severity spikes above 4.0°/100 ft.

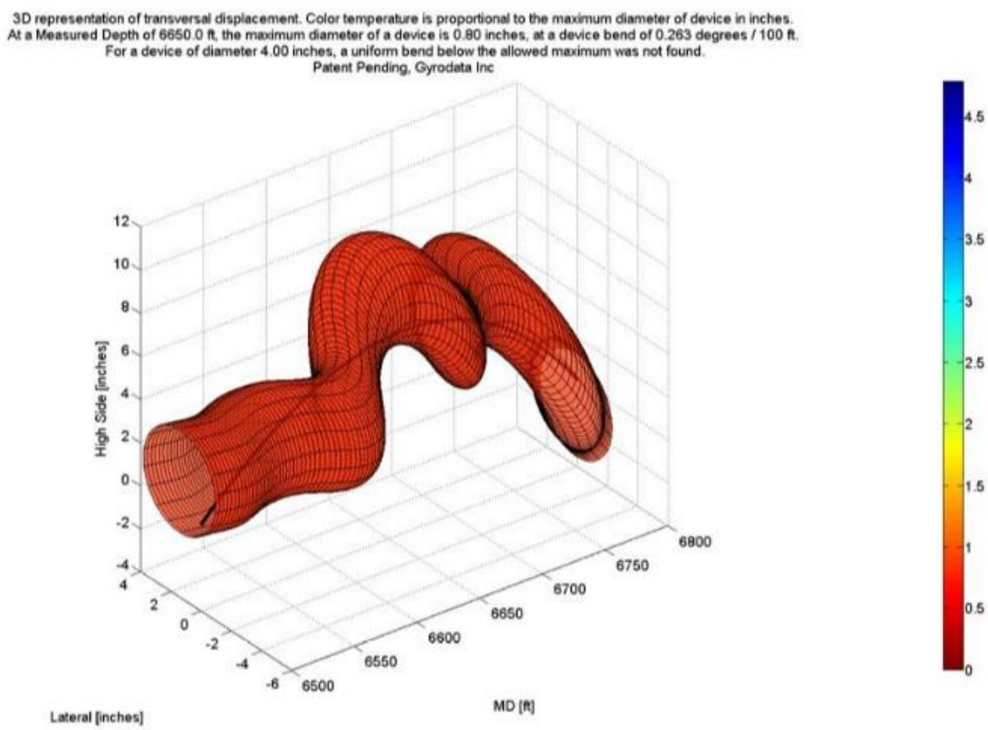

Fig. 3—The 3D model of the wellbore shows extreme buckling, making it impossible to place a device with a uniform bend below the threshold.

on this incoming information, the wellbore shape can be rendered and visualized in 3D as the physical system is run in hole and the data is sent to surface. By understanding wellbore geometry with this level of detail and accuracy, operating companies can make data-driven decisions on wellbore trajectory before casing is run and where to place production equipment after casing is run. Making these types of decisions with previous systems involved so many assumptions and so much guesswork that it ultimately resulted in a substantial amount of unpredicted failures.

Interesting scenarios where the high-density logs revealed previously unseen problems with wellbore tortuosity are readily available. In Fig. 1, the inclination and azimuth measurements as seen with the tortuosity logs spike upward and downward inverse to one another around 6,600-ft MD. This suggested that the 5½-in. casing was beginning to helically buckle as the compressive force against the casing passed through the sinusoidal buckling phase and exceeded the modelled helical buckling limit.

The dogleg severity graph (Fig. 2) reinforced the understanding that the data from the conventional MWD equipment was lacking versus that of the high-density logs. Taking logs at stand-length intervals eliminates an immense amount of critical information that could be used to understand the wellbore's true condition along its full trajectory. Having this information makes placing production equipment downhole significantly less challenging.

Fig. 3 shows the 3D uniform bend of the well. The extreme buckling starting around 6,650-ft MD would have made placing any production equipment downhole virtually impossible as the casing began to buckle, and the trajectory corkscrewed downward. If only using data from conventional MWD equipment, it would not have been possible to make this decision. Instead, the production equipment would have been placed in that area and failed or been damaged prematurely after it went online.

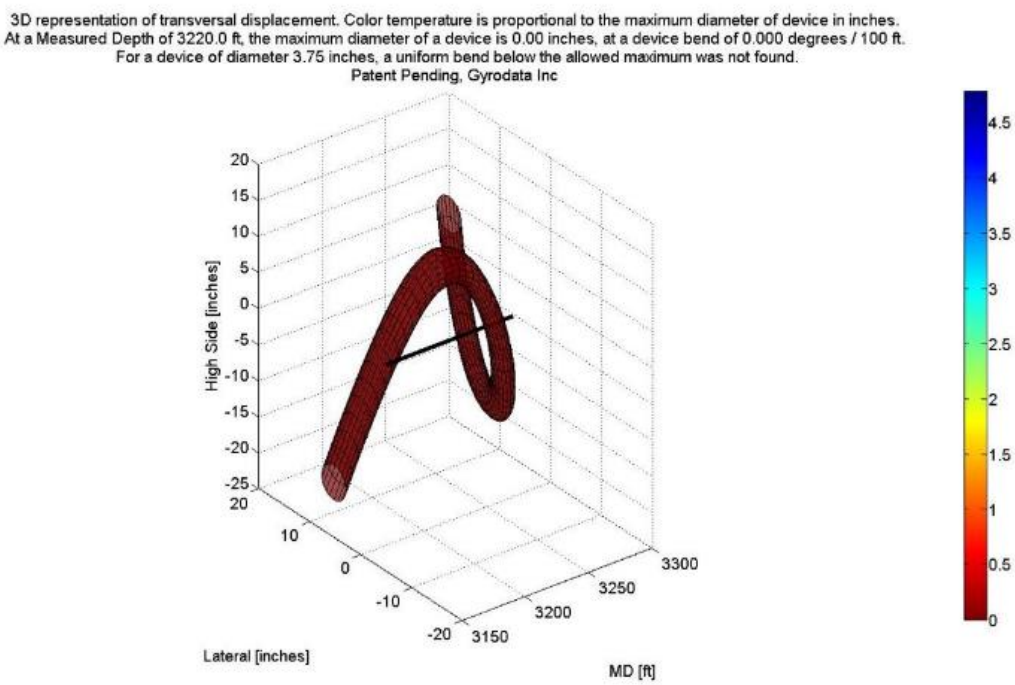

Fig. 4—The 3D model shows how extreme the helical buckling was in this scenario.

In another application, casing was run and set in compression, unlike in typical well design. This caused the casing to helically buckle, as shown in Fig. 4. To straighten the casing, it was necessary to latch onto the casing and pull with approximately 2 million pounds of force, which stretched the casing to approximately 30 inches. Another high-density tortuosity log was run, validating the results from the original data. Had this data been available and understood in the original plan, the problem could have been avoided, and production equipment could have been positioned downhole in the optimal location.

"Digital" and "data-driven" solutions must provide real-world value to oil and gas companies, lest they be no more than buzzwords thrown about at random. Using technology to better understand a known problem and provide operators with the tools necessary to overcome those problems is how the industry will move forward. The potential is massive for this to change the way business is done. All the industry needs to do is get the implementation right.

Rob Shoup

Rob Shoup is currently the operations technical support manager for Gyrodata. In this role, he works with engineering, product line, and operations to develop new technologies and solutions designed to overcome the challenges of the modern oil field. Mr. Shoup has held a number of positions over the past 32 years, including VP special projects, North American regional manager, global technical services manager, and senior technical advisor. He spent 5 years in the field running gyroscopic surveys and orientations and integrating Gyrodata's technology with various service providers' offerings. Rob is also an active member of the Society of Petroleum Engineers and the Industry Steering Committee on Wellbore Survey Accuracy. Mr. Shoup graduated from the Institute of Electronic Science at Texas A&M University."