NEWS ANALYSIS

SURFACE LOGGING

To efficiency and beyond

Surface Logging can provide cost savings and drilling efficiency through the use of innovative interpretation models and modern technology from a readily available low-cost data set

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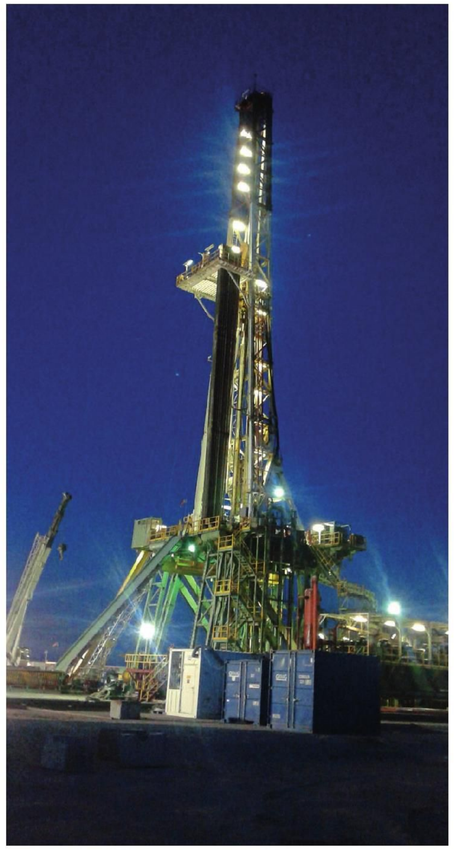
A Surface Logging unit collects a vast amount of data that can not only assist with the drilling process in real-time and near real-time but can have a direct impact on future exploration and development decisions.

This article describes some applications where real-time surface data can help in making effective drilling decisions and have valuable geoscience benefits to reduce non-productive time (NPT). NPT is commonly addressed through the reduction of failures, through maintenance or engineering, but Invisible Lost Time (ILT) is present in all well construction processes, either in the use of unnecessary processes, or perhaps in the use of expensive methods when cheaper, fit for purpose alternatives, are readily available.

The ever-increasing rate of development and the integration of technologies and their data sets are finding new applications that are helping improve drilling efficiency, safety and at the same time generating new reservoir insights, which all lead to helping to reduce drilling costs.



> "THE USE OF LARGE DATA SETS TO PERFORM ANALYSES ON BOTH TIME AND DEPTH-BASED DATA AT A GRANULARITY NOT USUALLY AVAILABLE WITH STANDARD REPORTING METHODS ALLOWS FOR THE OPTIMIZATION OF WELL CONSTRUCTION PROCESSES AND DRILLING EVENTS."

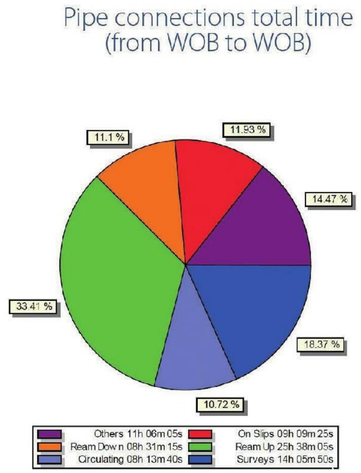
↑ NPT is commonly addressed through the reduction of failures, but (ILT) is present in all well construction processes.

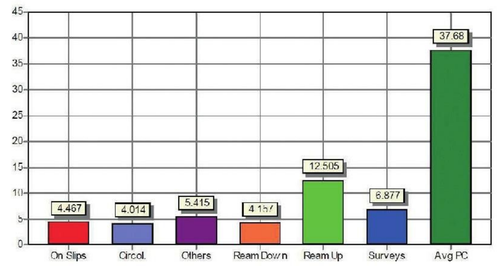
Background

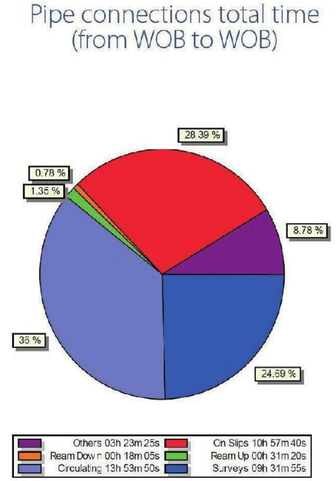
Surface Logging has traditionally offered a service tailored towards drilling safety, through the monitoring of pit levels, return flow and hazardous gas levels at surface, which was aimed directly at the onsite drilling team.

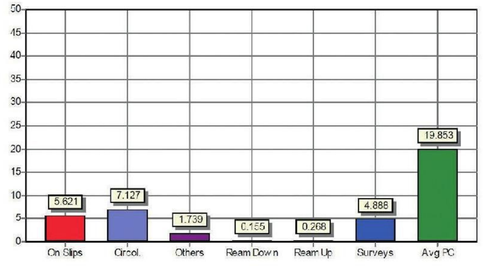
This is usually provided as a discrete application, distinct from the reservoir evaluation service provided through physical and visual examination of cuttings, monitoring total gas and chromatographic evaluation of the basic C1-C5 components to determine a first assessment of hydrocarbon presence.

All of these components of the surface logging service are still valid, and, through the implementation of improved technology have themselves become more reliable in terms of data accuracy and quality. With the target of improving drilling efficiency, through evaluation and analysis of the many factors that can lead to NPT and assisting in making better informed reservoir decisions, operators are deriving as much value as possible from a data set that comprises many direct measurements that are often a by-product of the drilling process and are largely available only once, while actually drilling.









ID-ing of invisible lost time

Uncovering ILT through the measurement of real-time operations using high resolution surface drilling data, analyzed through sophisticated software allows for the optimization of processes and events, therefore uncovering ILT.

The use of large data sets to perform analyses on both time and depth-based data at a granularity not usually available with standard reporting methods allows for the optimization of well construction processes and drilling events.

Figure 1 shows an analysis of events during a West African deep-water drilling operation. After reviewing hole conditions, the extensive reaming and back-reaming operations were greatly reduced. The change in procedures displayed in Figure 2 saved 36 hours of rig time.

Other applications where surface data improves decision making are:

- Borehole Stability issues are a major cause of NPT in drilling operations. Geomechanical studies help identify best theoretical drilling directions and angles but the results of drilling need accurate real-time monitoring to measure progress and ensure success.

↖ Figure 1

↑ Figure 2

- Fractured reservoirs create challenges for drilling and evaluation alike. Their identification and interpretation are required throughout the life of a well. This evaluation starts when they are first drilled and their presence identified through surface events.
- Maintaining the most effective rate of penetration to acquire data and drill efficiently requires the drill bit to maintain an effective "cutting" action. A method has been developed that helps identify this.

Borehole stability

Borehole cleaning has been monitored in various ways over

the years, from visually identifying caving's and making subjective assessments through to the current best practice of measuring the volume/weight of cuttings being returned from the wellbore and comparing that to expected volumes/weights from theoretical borehole volume calculations.

Through specialised services which weigh the returned cuttings from the wellbore, processing the data through software which incorporate sophisticated algorithms, it is possible to provide real-time feedback to the drilling team, ensuring improvement in cuttings removal through implementation of successful practices and removal of ineffective processes.

By implementing accurate flow, fluid property and cuttings retrieval measurements, an accurate assessment of the hole cleaning occurring at any given time is possible. This is another application that can be further enhanced through the integration of additional data sets.

By incorporating mineralogical analysis, better lithological assessments can be determined which in turn can help to elaborate not only the fact that caving's are occurring, but help to give an indication of their source and hence identify the problematic formations more readily.

This allows for specific solutions to be developed to resolve the borehole cleaning issue at the time of drilling and avoid costly remedial activities.

Numerous examples exist where accurate monitoring of borehole cleaning results have helped improve drilling practices and reduced the time required between drilling and logging or casing operations.

Open fracture identification

Effective fracture identification, through refinements in return flow measurements, are now possible and these can be further integrated with downhole logs and images.

Experience of flow meter installation, through bypass and flow line modifications and the ability to implement these technologies effectively through sensor selection, installation design and final implementation, has allowed for the accurate identification of the full range of losses to the formation, from major cavernous total lost circulation to subtle micro-losses.

Software is required to incorporate the detailed interpretation of the pattern, timing and magnitude of these losses, so that they can be used to help give excellent qualitative knowledge to understand the fracture system type.

Successful implementations range from conventional carbonate reservoirs in Europe and the Middle East as well as clastic reservoirs in Europe, North Africa and Latin America. In North America, an application in unconventional plays has resulted in the service being used to aid in the running of smart completions.

↑ It is possible to provide real-time feedback to the drilling team, ensuring improvement in cuttings removal.

The entire range of functions provided by the integration of these surface monitoring and evaluation systems expands to deliver pump efficiency, correct fluid displacement during cementing/pumping operations, more accurate hydraulics assessments, accurate fluid volume monitoring, kick and loss detection, identification of well-bore ballooning and open fracture identification and an assessment of their permeability.

Further geological knowledge about the fracture system is determined when accurate elemental analyses of cuttings are incorporated into these interpretations that include possible mineralized closed fractures, mineralization along open fractures, chemostratigraphic zones and flow barrier estimation.

By adding in the gas compositional data and response signatures, which may range from zero gas due to total loss of circulation, all the way to significant gas peaks measured at surface in hydrocarbon filled fractured oil and gas reservoirs, the fracture system can be analysed in yet more detail.

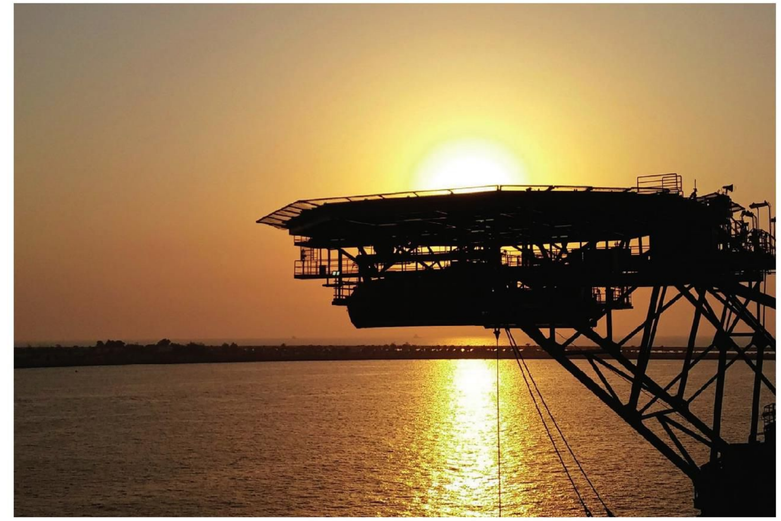
Measurements of noble gases such as helium identify further details of microfractures, while complex hydrocarbon compositional data can provide indications of formation connectivity through the fracture network.

This data is continuously added into the overall interpretation model to give a very comprehensive qualitative first indication of a fracture system. The interpretation is in itself enhanced as data points are delivered.

The earliest real-time drilling data provides the earliest indication of fracture systems, which are then potentially confirmed by the analysis of lagged cuttings and gas data, which in turn help to optimize the logging program and further enhance the overall interpretation of results.

Measuring bit wear

Whilst measurements such as rate of penetration can be reviewed to see if drilling is continuing at an optimum rate, equations such as Mechanical Specific Energy (MSE), the Corrected Drilling Exponent (DxC) and others are used to assess drilling efficiency.



No lithology independent method has previously been defined that captures the real-time state of the bit while drilling. Gas measurements have now been developed to incorporate the measurement and evaluation of a range of gases, generated by high temperature cracking of hydrocarbon-based mud components.

These temperatures are reached when a bit is worn and the cutting surfaces have been reduced, generating more of a frictional effect than an efficient cutting action and commonly results in metamorphosed cuttings. The gases are both an indication of bit wear and a contaminant to standard hydrocarbon evaluation, hence their evaluation through the use of new chromatographs is of use for both drilling efficiency and improving traditional formation evaluation. This type of service can easily be incorporated into a standard mud-gas acquisition system.

↑ Reaming and back-reaming operations were greatly reduced in a deep-water drilling operation thanks to ILT analysis, saving 36 hours of rig time.

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Conclusion

As technology and interpretive models improve, further opportunities for the rapid integration of data sets to improve interpretation of the results from drilling and well construction activities will be identified.

The integration of enhanced safety systems and geological data form an application being provided in numerous geographies.

Surface Logging companies that provide acquisition, analysis and the interpretation of a wide range of data sources, whilst actively researching applications that deliver value, are slowly eroding the traditional separation between "drilling services" and "geological services" as technology innovation is implemented more widely.