Information technology

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"Virtual Experience Simulation for Drilling—The Concept"

There is a way to retain and transfer specific drilling experiences via computer simulation. This could be called "Virtual Experience Simulation for Drilling". Another nomenclature is heuristic drilling simulation.

Unlike general drilling simulation, which solves a set of discreet mathematical equations, heuristic simulation relies on processed data sets from actual drilling results. The philosophy of the simulation is to duplicate what has been experienced and recorded while drilling a sequence of wells in a geological area (field). The reality check of the simulation is acceptance by the "local experts", who participated in the drilling of the wells.

The three principal components of the heuristic simulator are the (1) processed data elements, (2) the simulation engine, (3) the ergonomics (man - simulator interaction/feedback).

Actual data from various captured results i.e. daily drilling wires, mud/bit/BHA reports, wire line electric lop, MWD and LWD data, etc. am analyzed to build various clement sets. These sets could relate actions like tripping and ROP testing, or penetration results through the different formations, or specific problems encountered while tripping or drilling.

The benefits of this approach are as follows: (1) After a set of wells are drilled (3 or mom) the "virtual experiences" can be captured and retained, (2) this virtual experience can be used to improve drilling performance (3) the heuristic simulator can be used to transfer experience to other drilling personnel (engineers, operations people and support personnel), (4) the "virtual experience simulator" can be used in real time to query the most probabilistic outcome of a particular action while drilling or doing an action for a future well (in a given geological domain).

It is the authors' belief: What reservoir simulation is to reservoir engineering, heuristic drilling simulation could be for drilling engineering.

This paper presents the concept of the Virtual Experience Simulator as it applies to drilling.

—K K Millheim, Univ of Leoben

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"Drilling Performance Guidelines: A tool for Sharing Drilling-Related Knowledge and Experience"

The cost and complexity of drilling operations are higher than ever, time there is a real shortage of knowledgeable and experienced drilling personnel. A major operator and a service company have collaborated to produce an on-line knowledge-base with the objective of helping their personnel achieve consistent good drilling performance.

The knowledge-base is a highly structured electronic manual which provides a tool for drilling engineers to use in day-to-day operational work, a training aid for new engineers, and a one-stop reference source for drilling engineers, geologists and petroleum technology workers. It is a "living document", updated to reflect advances in technology and understanding.

There are over 700 individual documents in the knowledge-base. These range in size from as little as one or two paragraphs to over 10 pages of text, photos and graphics. A number of pre-defined views present the documents relating to a particular task or topic. These views include Planning, Drilling, Post-Well Analysis, Drillability Problems, Operating Practices, Data Sources, Parameters, and Dull Grading. The documents in a view are layered with each successive layer giving progressively more detail. There are many do links that allow the user to jump from one document to another in order to follow a path through the knowledge-base that is appropriate to the specific task in hand.

Over 50 different drillability problems are described in a common format covering each problem's mechanism and how it can be diagnosed, prevented and cured. A structured search facility assists the user to diagnose drillability problems. Detailed examples drawn from the operators' experience illustrate many of the problems

This paper describes the knowledge-base structure, content and mode of use, demonstrates its advantages over a conventional paper manual, and shows it to be a powerful tool for capturing and sharing drilling performance-related knowledge and experience.

—D A Curry, Hughes Christensen Co
–A V Singelstad, Statoil
–D Bowden, Transition Assocs

SPE/IADC 52805

"Formation Evaluation in Ultra Deep Wells"

Deep water oil and gas exploration in the Gulf of Mexico has recently been the focus of much attention due to the untapped potential of such a vast area. The Garden Banks area is of particular interest where sedimentary structures have been mapped using surface and borehole seismic techniques to depths greater than 30,000 ft (9,144 M). Formation evaluation at depths approaching 30,000 ft has necessitated the development of new technology in the areas of tool conveyance and high pressures and temperatures. Recently these new technologies have been put to the test in the logging of the deepest well ever drilled in the Gulf of mexico, Garden Banks 386. This well, located in 2,663 ft (812 M) of water reached the Lower Pliocene and Miocene reservoirs at a depth of 27,864 ft (8,493 m) MD and 26,969 ft (8,220 m). the challenges faced at this depth included tool conveyenace and exceeding the pressure limitation of conventional wireline logging tools.

The operating company worked closely together with the service company in preparation for the logging operation months in advance. The resultant technology and equipement included Array Induction, sonic, and ingtegrated Lithology and Porosity tools rated to 500° F (260 C) and 25,000 psi (172 Mpa) for wireline formation evaluation, extra strength logging cables in excess of 36,000 ft (11,000 m) for tool conveyance, surface mounted Wireline Dual Drum Capsian for surface tension reduction and the Tough Logging Conditions (drillpipe/wireline conveyance system) used in conjunction with wireline fluid sampling tools to sample the formation fluids downhole.

Utilizing these new technologies resulted in the successful evaluation of several hydrocarbon bearing sands in both the Lower Pliocene and Miocene sections. These new techniques and equipment will ensure proper evaluation of the continually increasing number of ultra deep wells.

—I J Henkes, Schlumberger Oilfield Services

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"Compresion of Downhole Data"

Measurement while drilling MWD services support drilling decisions and efficiency; therefore, their tools are becoming a standard on well sites. Downhole MWD equipment usually consists in a power supply system (e.g. batteries), a computer-controlled set of sensors, s storage unit where signals are recorded (e.g. flash memories) and, in some cases, a surface uplink.

Usually, measured data are mud-pressure, torque on bit, weight on bit, bending, accelerations, RPM and

temperature. Signals can be processed and stored in the internal memory or they can be transmitted to the surface using mud-pulse telemetry to monitor the drilling process in real-time.

Presently, the main drawbacks of the system are the limited memory capacity *(e.g.* hundreds of Mbytes) and me very low bit-rate of the telemetry system (e.g., tens of bits/sec). In fact, with standard acquisition parameters (e.g. 12 channels, 16 bit/sample, 250 Hz sampling rate) the memory is filled up in only a few hours.

Moreover only a small part of the acquired signals can be transmitted in real-time to the surface by using mud pulse telemetry.

In this paper we study the possibility of compressing the data downhole using a wavelet based compression algorithm. Numerical tests based on real data achieve compression ratios up to 15:1 without noticeable signal degradation (SNR > 10-15 dB with white or almost white residuals). This means a significant increase in downhole time acquisition and in realtime information that can be transmitted through mud-pulse telemetry.

The algorithm is very simple but effective and can be coded on the original downhole equipment without hardware modifications. In the paper we describe the algorithm, its performances in terms of compression rates and residual characteristics and finally we show the results on real data with different signals and drilling parameters.

—G Bernasconi, Politecnico de Milano, et al