Diversified Well Logging Geosteering Program

Diversified Well Logging works with its clients estimating well path position within a given geologic setting and making recommendations to keep the client within the desired target pay zone beneath the surface. Defining multiple zones of interest (e.g., formation tops as well as the target zone), DWL models these throughout the drilling process to provide independent feedback and analysis of your position beneath the surface and maximize time spent drilling within the pay zone.

DWL uses SES Software by Stoner Engineering in combination with DWL proprietary data tracking spreadsheets and processes and are able provide customers the following as requested:

- Real time monitoring of drilling parameters and MWD/LWD data by trained, degreed geologist logging engineers
- Remote Monitoring (PA or LA)
- On site Monitoring
- Emailed reports in PDF format (may also be uploaded if requested to a rig-monitoring server)
- Critical Updates @ customer request
- Comparison of MWD/LWD data to pilot or offset log data for precise correlation of subsurface geology
- Generate a new plan based on what the formation / target is really doing, output in standard drillers directions.
- Modeling of subsurface targets as requested (formation tops, target intervals), including distance from bit, dip inclination and azimuth
- Target Zone projection
- Well path as drilled modeled in subsurface
- Formation Tops annotated on plot planned and actual
- Graphical cross sections of the well path can depict gamma ray data and drilling parameters (ROP, Gas/chromatograph plot)
- Data and graph files will be available at end of well for final presentation which will include all data files used in the steering and reporting of your well burned to a disk.
Diversified Well Logging (DWL) understands that there is no one-size-fits-all geosteering process for each operator. However, through effective and proactive communications with Geological and Engineering departments, DWL works with operators to meet their geosteering goals.

**Effective Planning**
- Management and team leads communicate with your geological and engineering groups to conduct a thorough review of your well goals and needs.

**Readiness and Preparation**
- Review of your well goals along with other data such as geological prognosis, drilling program, seismic data, maps, type logs and any other pertinent information available for your planned well.
- Early communication is established with the company point person/geologist and with mud loggers and MWD/directional drillers on site to ensure an effective team working environment is in place.
- Geo-steering services are provided either on or off location. If an onsite person is required the DWL well-site geologist / geo-steering consultant generally mobilizes to the well site shortly before kick-off to increase the level of success and communication prior to drilling the curve and lateral sections.

**Effective, Proactive Communication - DWL Delivers the Data You Need**
- Effective communication in both the curve and horizontal to ensure the target window is hit at the planned angle, or changes are made to the drill plan in a timely manner.
- Reports are tailored to the customer’s needs so that you get the information you want, when you need it most.
- Pertinent information is provided in numerous ways, via graphics, charts and in written reports on every report and update.

**Responsible Professionals**
- Incoming down hole data, rig information and mudlogging samples are continuously monitored, and reporting at regular intervals keeps everyone informed of potential problem areas (e.g., evidence of variable stratigraphy, faults and well path deviations).
- Due diligence is our first priority: As anomalies are discovered or the drill path wanders out of the target zone, extensive analysis of the gamma ray, mud log samples and other geological information is conducted to ensure changes to the drill plan, if needed, are made with the best information possible.
- DWL geo-steering teams monitor your well data 24/7, and are always available to answer questions and provide updates.
- Overlap in steering schedules ensures pertinent data is transferred to all team members throughout the day.

**Produces the Results You Need**
- When the well is complete, DWL produces and provides final correlated graphs and associated data of the drilling path and other significant variables such as gamma ray, gas and rate of penetration.
- All of your data is exported and delivered for your review. Data reports can be formatted to meet your needs.

*Need another reason why Diversified Well Logging, Inc. is a highly recommended team with the ability to meet your geosteering needs?*

**Superior Strength in the Field**
- Education and experience are essential. Our team members have backgrounds in geology (ranging from B.S. to Ph.D.) and both training and experience working in your basin play.
- All team members have field experience working in mudlogging on rig sites.
- Teams are courteous and trained to work with various groups and personalities through effective communication to provide you the results you need.
Expanded Overview of Utilizing SES Software

The SES software is used for horizontal and directional well bore drilling. It allows the user to plot actual trajectory of the well while drilling, which combined with other information like Total Gas, Gamma Ray, Resistivity, ROP, etc. will be a valuable tool to help the customer remain in the target zone while drilling the horizontal section.

SES allows the input of three-dimensional data to represent the target zone rocks encountered along the well path. Since a drilled well path is rarely a perfectly planar surface, DWL personnel likewise have to be able to model your well in the subsurface in an accurate way. The target zone is defined by geologic markers (usually the top and bottom of the payzone), and the target well path is constantly monitored from the onset of drilling to track the distance of the bit with respect to these marker beds. Our experienced geosteers communicate your location and distance to marker beds in order to assist in correctly landing the well, which is particularly helpful in areas where faulting and bedding dip cannot be accounted for in a well plan. Once in the lateral section, the target zone and thus bit location are modeled with a true bedding dip, a true dip direction azimuth, map coordinates corresponding to a MD along the actual well path, and a control point true vertical depth (TVD). Because DWL provide customers with a three dimensional model of the well as it is drilled, your data can be used for many other things including completions plans and improved drilling plans for future wells. To illustrate, DWL has used data from a horizontal well provided by a local operator. Our models start with the input of a type log for correlation purposes. For example, this could be gamma ray data from a pilot well or an offset well some distance away. SES allows direct visual correlation of M/LWD data obtained real time while drilling to that of a type log. This allows a quick and accurate projection and calculation of the location of the bit beneath the surface, assessment of bedding (geologic) dip, or tilt of the rocks beneath the surface, and location of anomalies such as faulting – all real time while you drill. DWL will start correlation before the landing depth, so, when the well is landed by directional drillers, DWL will already have an idea of the behavior of the pay zone.
While in the pay zone, DWL will continue comparing your data, and give the best hypothesis according to analysis of data provided, then make a recommended projection of the pay zone dip. With that projection DWL can advise the geologist and driller/directional driller with the recommended inclination necessary to remain in the target zone.

Survey data provided by the MWD will be recorded continuously throughout the drilling process. Survey data can be output into graphical displays to illustrate the position of the bit in vertical section, from plan view (northing and easting of the well head), or from a 3D display that can be fully manipulated to display in any orientation desired. These visual displays can be enlarged from the Surveys tab as shown for reporting purposes.
LWD data such as Gamma Ray, Resistivity, ROP, Total Gas, etc. can be input into SES. Entered along with measured depth and interpolated against survey data, this information is used to aid in correlation with a pilot or type log and is the basis for providing accurate estimates of dip angle and vertical depth to marker beds of interest.

DWL works with the customer to define multiple zones of interest (e.g., formation tops as well as the target zone, and can model these throughout the drilling process. As before mentioned, this is a 3-D model of the target zone(s) of interest, and each zone is mapped out in terms of top (TVD), location (coordinates), dip angle and dip direction azimuth.

In this example Gamma Ray and TVD data are used to map the top of the pay zone. DWL has the ability to analyze section by section as it is drilled to provide continuous monitoring.
Annotated cross sections can also be provided not only in reporting, but also as an easy to understand field tool to assist in explaining our position within the target to help advise the driller/directional driller appropriate drilling inclinations needed to stay in the pay zone.
Well Name Unit 1 1H_11040 MD_Geosteering_10_10_11

MD: 11040    INC: 91.5    AZM: 310.8    TVD: 7393.9

Target Center Line is ~0.9 ft. above the bit at the survey point.

<table>
<thead>
<tr>
<th></th>
<th>EST TVD</th>
<th>Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marcellus Top</td>
<td>7367.0</td>
<td>-26.9</td>
</tr>
<tr>
<td>Target Center Line</td>
<td>7393.0</td>
<td>-0.9</td>
</tr>
<tr>
<td>Onondaga Top</td>
<td>7418.0</td>
<td>24.1</td>
</tr>
<tr>
<td>Current Operation</td>
<td>Drilling Ahead</td>
<td></td>
</tr>
</tbody>
</table>

Formation dip is ~92.3 degrees.

Comments: Gamma is correlating fairly well with the pilot. Bedding appears to remain toe-up, with the bit just above the target center line, staying approximately parallel to formation bedding.

The TVD of the Target Center Line has moved up ~3 ft. from 7396 to 7393.

Analyst: