Minutes of the Fifteenth Meeting of the

Industry Steering Committee on
Wellbore Survey Accuracy

Gatwick, U.K.
21st March 2001

Present:

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* Retiring Chairman
** Chairman + Minutes

1 Introductions

Chris Chia and Hugh Williamson welcomed the group to Schlumberger's Victory House office at Gatwick, U.K and introduced the agenda for the day.

2 Election of new ISCWSA Chairman

Hugh Williamson announced his retirement from the committee as Chairman. Hugh moves on to develop his career within Risk Management. One of Hugh's last acts as Chairman was to describe briefly to the committee the process that had been undertaken in order to establish a successor.
The committee agreed that chairmanship for the moment would be best served from an Operator position. Matthew Rhodes was proposed as the new Chairman.

3 Continuous MWD – Case Studies (Ed Stockhausen & Bill Lesso)

Ed Stockhausen & Bill Lesso presented findings from a recent study into the effect of survey frequency on wellbore TVD. To date they have looked at data from over 20 wells. They found that problems arise due to the nature of slide and rotate sequences, performed while drilling down stands. Aggressive build or drop rates during slide sequences, at the start of a stand of pipe, may go unaccounted for in the surveying sequence when surveys are taken every 100ft or so. The group agreed this would not be a problem with rotary steerable systems. Ed presented a simple spreadsheet demonstrating the TVD difference between continuous inclination and conventional (definitive) inclination generated surveys. A number of case studies were presented along with geo-steering plots and models. Continuous gyro data and additional image data proved that it was difficult to ream out the effects of the slide/rotate curvature.
Angus Jamieson pointed out that stabilizers would have an effect upon the sensor alignment.
The group agreed that as it was difficult to QA the continuous data at the moment then it was unwise to incorporate the readings in the definitive survey.
Ed asked was the solution to TVD discrepancies to increase survey frequency.
Group consensus was that slide/rotate effect could be averaged through taking surveys at different depths, i.e. pulling further off bottom to take a survey.

4 TVD Uncertainty & BHA Sag Modelling (Angus Jamieson)

Angus Jamieson highlighted the various systematic and random error components and proposed a method of high precision surveying. Current techniques of correcting the various error components were discussed during which Angus demonstrated a new sag correction program incorporating rigorous finite element analysis.
Angus suggested to the committee that it might be possible to improve TVD accuracy using improved knowledge of the earth's magnetic vector as a statistical benefit for vertical reference. A request was put to the Operator representatives present for statistical data, namely raw MWD data overlapped by inertial grade gyro surveys.

Note: Later during the lunch break the use of the earth's magnetic vector for improving TVD accuracy was acknowledged as inconclusive and therefore there was no further requirement for data.

High precision surveying is a method by which all available data is used. Angus suggested the committee should concentrate on using more information rather than modelling errors.

5 Combining Survey Unc. & Geophysical Unc. (Oddvar Lotsberg)

Oddvar Lotsberg presented a new method for defining the driller's target area through utilising both geophysical uncertainty and survey uncertainty.

Using a vertical well as the simplest example he explained how traditionally the driller's target had been defined. Firstly, through reducing the geological target to take account of geological and interpretational uncertainty and then by removing the survey uncertainty.

Oddvar went on to demonstrate the new method whereby geometrical relationships are taken into account. In addition to using survey uncertainty the new method incorporates an enhanced means of accounting for geological uncertainty through geophysical uncertainty, interpretation uncertainty and acceptable miss probability.

Means of increasing the drillers target size, such as; increasing acceptable miss probability, (reducing confidence), decreasing survey uncertainty and, reducing wellbore inclination were also presented.

Qn – Is it desirable to place miss probability values on the defining edges of the target?
Ans (Lotsberg) – absolutely. Especially when dealing with faults, lease-lines etc…

Qn – Why have a sweet spot in the driller's target?
Ans (Lotsberg) – because a DD likes to have an actual point to aim for.

Hugh Williamson suggested weighting the value of the target. Creating a contour map of values for the target.

Ed Stockhausen suggested using a higher marker and then adjusting the plan accordingly. He went on to propose that there was no substitute for having a geosteering, geophysical and drilling engineer at the rig making real-time decisions.

Hugh Williamson warned that sometimes there was a real danger of losing sight, or even ignoring, any good pre-drilling uncertainty analysis.

6 Marine Magnetic Mapping Survey (Toby Clark & Angus Jamieson)

Angus Jamieson introduced the background to the recent North Sea marine magnetic mapping voyages.
He pointed out that to date 38 fields had been mapped within the N.Sea region. The initial target had been to bring MWD accuracy in line with that of current gyro technology.
With that in mind, accuracies of;

- Total Field Strength better than 50nT
- Declination better than 0.2° and
- Dip better than 0.1°

were sought.

Angus handed over to Toby Clark to describe the procedure in more detail.

Toby briefly described the equipment necessary for marine mapping, namely;

- Non-magnetic vessel
- Tri-axial fluxgate magnetometer
- Analogue to digital converter for the magnetometer
- POSMV – attitude and heading sensor
- Equipment Frame
- Scalar Magnetometer

Angus intervened at this point to highlight the capabilities of the vessel TSMY Adventurer, a 30m fibreglass trimaran.
He went on to say that although strictly speaking this was a non-magnetic vessel it was found to generate an interference field of c.200nT. This was removed by means of swinging the ship through 360°. This enabled a comparison measurement to be made.

Toby discussed the various project steps including the equipment tests, assembly and calibration, during which he talked briefly of the relationship between the fluxgate outputs P, Q & R and the X, Y & Z components of the geomagnetic field. He then went on to describe the technique adopted for mapping an individual field. Presentation of the external field variation, sensor outputs and geomagnetic field contour map were given.

Toby concluded that the initial accuracies were not quite achieved and the actual errors were estimated at;

- 20nT in Total Field
- 0.25° in Declination and
- 0.07° in Dip

He added that crustal corrections to the BGGM would be valid for subsequent versions, for the life of the field and also that the data was of sufficient quality to be used in IFR techniques.

Qn – What grid spacing across each field was required?
Ans (Clark / Jamieson) – 10km x 10km at 2km spacing was chosen for practical reasons. This was due to speed limitations and accuracy. A 10x10 grid was estimated to take around 7Hrs. A larger spacing may not pick up shorter wavelength anomalies and inversely using 1km spacing would not necessarily generate any increased accuracy.

Qn – Did any shipwrecks show up as anomalies?
Ans (Jamieson) – Wrecks and pipelines did show up. Anchors also showed up as blips of c.15nT. Seabed furniture does not really present a problem. The most important factor was to maintain a minimum distance from the platform or structure.

Qn – What about downward continuation (Depth variation) of correction?
Ans – (Clark) – Cannot use the 10kmx10km magnetic grid for this technique. A much larger area of data is required and then a downward continuation technique can be applied.

Qn – Can the marine magnetic mapping results be used for QC of larger unknown quality aeromagnetic surveys?

Ans (Clark) – Yes. The historical aeromagnetic data could be unravelled using this technique and then a downward continuation technique be applied.

7 MWD Format Conversions (Chris Chia)

Chris Chia described a simple Excel spreadsheet he had been producing. He handed out paper examples of the spreadsheet and promised to e-mail an electronic version to all those interested. His objective was to standardize conversion of the various survey company magnetic raw data output formats. To date the spreadsheet contained conversions for Schlumberger Anadrill, Baker Hughes INTEQ, Halliburton and Champ EMS.

Chris requested further input from all the other companies on data conversions and formats.

8 Use of Local Scale Factors and E.P.S.G. Definitions (Steve Grindrod)

Steve Grindrod put the question, “Should we use local scale factor or not?” to the committee. Steve’s argument being that it was difficult to ascertain when it had been applied and when it had not.
He went on to describe how an error of up to 0.75m can occur in transforming local coordinates to UTMs if knowledge of scale factor application is not known.
This may not sound large but when dealing with equity disputes requiring a resolution of 0.1m it was vast.

Angus Jamieson voiced his opinion that he was against all forms of scale factor.

Hugh Williamson quoted Bp’s Wytch Farm ERD wells where not taking into account scale factor could result in an error of c.9m.

Chris Chia asked if it was not within the capability of the ISCWSA to standardize the application.

The question was voiced as to whether seismic data included scale factor?

Angus argued that if SF were applied then a vertical component should be applied as well as a variable convergence.

Torgeir Torkildsen suggested approaching the software developers and asking them to incorporate all known and able corrections into the software.

Steve moved on to raise his concerns over the state of the EPSG database, (European Petroleum Survey Group Geodetic Parameter Data Set). He described how the functionality and navigation around the database was poor and questioned why there was no relationship between Compass and the data set.

The committee agreed and a decision to invite Roger Lott (Bp), a member of the EPSG to speak at the next meeting was auctioned on the new Chairman.

9 BGGM Model and the BGS (David Kerridge)

David Kerridge provided the group with an update on activity within the BGS with particular emphasis on the latest BGGM model.

He described how the ORSTED satellite was still functioning longer than expected and a result of this was that knowledge of secular variation would be greatly improved in the 2002 BGGM.
The model would span 1945-2004 and incorporate an entire year of ORSTED data; additionally this data had been verified using the separate SAC-C and CHAMP satellites. All estimates post dating 1995 would be more accurate

David reported some teething problems with the CHAMP satellite. This satellite had 2 star cameras and was in a closer orbit to the earth but calibration of the vector data had been problematic. At the moment it is providing an independent check on the long-lived ORSTED readings!

David finished with stating the main objectives for the coming year were solving main field and secular variation from satellite data simultaneously. He announced that the BGGM 2002 model would be released in May.

10 Reporting Position Uncertainty & Biases / Collision Risk Calculations & their Implementation (Hugh Williamson)

Hugh Williamson presented a couple of topics on behalf of Harry Wilson (BHI) who was unable to attend the meeting.

Hugh started by presenting the case for standardizing error ellipse reporting. He suggested that by standardizing the manner by which EOU were reported this would lead to reduced misinterpretation and aid like for like analysis.

Wayne Philips expressed the difficulty by which 3D properties of an ellipse could adequately be reported.

Whilst on the subject of reporting Hugh asked the committee what they thought about the idea of correcting surveys for bias (depth) and removing the bias terms from the error model(s)?

The consensus of opinion was to maintain survey data ‘AS’ measured and not correct the data to incorporate any bias. Chris Chia and Patrick Knight were whole-heartedly agreed on this point.

Phil Gurden questioned how TVD bias was applied in real time, if at all.

Hugh moved on to discuss anti-collision rules. He re-visited the proposal made in Denver for risk based separation factors. The committee was asked to decide upon a confidence level for the combined ellipses, what the validation / assurance criteria should be and whether the rule should be adopted and promoted by the industry at all.

Rob Innes asked if the Operators knew what they wanted. He argued that it was often the contractor’s task to come up with the standard.

Wayne Philips suggested it would be a starting point for the committee to come up with the confidence level that is associated with SF=1 (1 in 10000??). This he added would be a good statement to come from the group.

Rob Innes thought that the Operators should decide themselves.

Hugh argued that the bulk of expertise now laid in the service companies and as a group they, the ISCWSA, should decide on the confidence level.

Patrick Knight added that unfortunately some companies were not even interested in collision avoidance.

Phil Gurden thought it was a good idea for the ISCWSA to come up with some standard and if a certain operator wished to ignore it then that was their choice.

Chris Chia agreed with Phil but thought that it was not as straight forward as simply picking a confidence level.

It is clear that this is an area for much needed refinement prior to the next meeting.

11 AOB

Rob Wiley asked the group if there would be any interest in a relatively cheap mud permeability / resistivity meter.

Patrick Knight voiced concerns over the effect of constant vertical section and tool face having erroneous effects on ellipse dimensions during the planning stage of a well. This was perceived as a software problem. Chairman to follow up with software developers.

Angus Jamieson gave thanks on behalf of the group for Hugh Williamson's outstanding contribution as Chairman of the ISCWSA. Thank you Hugh and I am sure we all wish you well in your Risk Management pursuits.

12 Next Meeting

Scientific Drilling agreed to hold the next meeting on most probably the 3rd October 2002. The venue, to be confirmed later, is likely to be in San Antonio.