40th ISCWSA Meeting – Amsterdam, The Netherlands – October 30, 2014

Introduction

(Pete Clark)

- Need to list meeting rooms on agenda and invites for the next meeting.
- Officers were introduced.
- Covered the agenda.
- Discussed elections process. Each organization (company) limited to 3 votes by the ISCWSA constitution.

SPE 2014-2015 Distinguished Lecturer Series: Wellbore Position, Quality Control, Gross Errors, and Error Models

(Eduardo Ruiz)

- Gave some examples of how weather (rain) and natural events (volcanic ash) can contribute to gross errors.
- Covered topic of wellbore positioning: best estimate of where the wellbore is, but not know exactly. Spoke to types of inclination and azimuth measurement devices, both historical tool types and modern tool types.
- Roll tests on site have failed due to high iron content in the soil (which results from being in close proximity to a volcano in Argentina).
- Showed a plot of continuous inclination vs. discrete measurements from an MDW tool. Said aliasing can matter sometimes.
- 3 ways to measure azimuth are magnetically (sensors stable but reference is not), via rate gyros, and continuous gyros (dependent on one initialization point).
- For magnetic tools, QC can use total field and dip angle measurements. Can also use rotation shots to check for misalignment.
- For rate gyros, horizontal Earth rate serves as a QC measure, as well as comparison of in-run and out-run surveys.
- Gross error example: Collision even though surveys were in spec. Wellhead position of first well was incorrect.
- Gross error example: Large divergence between magnetic and gyro measured azimuth histories due to a 90 degree quadrant conversion omission.
- Conclusions: internal QC checks are necessary but not enough; surveys should be screened for gross errors prior to being used in error models. Comparison with an overlapping survey is the most reliable way to detect gross errors.

(Questions)

- Ton Loermans – You mentioned depth is not controlled. What do you mean? Answer – Wireline depth is not in tension all the time. Not as much effort is put into QC-ing depth compared to inclination and azimuth.

- Pete Clark – You gave this talk to several SPE sections. How well received was it? Answer – I'm going to start next Monday.
- Anas Sikal – Good survey programs not executed the right way or bad survey program design from the beginning. Which is more common? Answer – Usually the problem is that there is no survey program design at all.

Recent Developments in Modelling the Internal Magnetic Field of the Earth

(Susan Macmillan, Laurence Billingham)

- New satellite data is available from the ESA Swarm mission. Three satellites launched together to measure the Earth magnetic field. Star tracker used for orientation. Two types of magnetometers carried on board: 1) a scalar magnetometer (can also measure the vector field in burst mode) and 2) a vector magnetometer which is co-located with the star tracker.
- The launch occurred on November 22, 2013. Released into near polar orbit at 490 km. Final orbit will be slightly different.
- Global coverage of data was available within a few days. Almost all sensors working to specs.
- Eventually will be able to resolve Lithospheric magnetic field down to 350 km wavelengths.
- INTERMAGNET is an observatory standards organization. About 175 observatories can release high quality time-tagged data close to real time. Spatial coverage is not as good as satellites, but the ability to separate spatial from temporal effects is better.
- More of the crustal field is being included in global models; however, damping must be smartly applied or short wavelength noise can cause the results to blow up.
- Laurence up to discuss existing Fourier techniques as compared to the new IFR-EQS technique for crustal anomaly calculation.
- Crustal field is approximately 2% of B total and is due to magnetite bearing rocks in the crust and upper mantle.
- You need vector data at a variety of depths in order to calculate the crust field variations.
- Equivalent Source model uses dipoles. You can write the magnetic field equation as a linear equation in the dipole source vectors, which allows inversion if you have enough observations.
- Solution is not unique. Care must be taken to choose a good answer for the myriad of possibilities.
- EQS solution fits the input data very well, which is not surprising. Comparison of predicted downhole vectors to those resulting from Fourier results show good agreement at a high level, but also more fine structure, some of which may be over-fitting the noise in the data set.
- Not yet enough evidence to support supplanting Fourier techniques.

(Questions)

- Mahmoud – The differences between the two techniques is about 4 to 8 nT. Does that justify changing techniques. Answer – the 4 to 8 nT corresponds to the accuracy with which you can fit the input data. Mahmoud – How much improvement would I get? Answer – Without clean downhole data we can't answer that. Mahmoud – Will Swarm data improve the global model? Answer – Yes, but right not the accuracy is similar to the Champ data.

- Neil – How long will the Swarm mission last? Answer – Hopefully at least 10 years.
- Stefan Maus – When we make crustal models, it's always a global model with very high local resolution. How do you ensure you're accurately modeling the entire field with only a local model? Answer – We use ground-based vector data which contains the global information.

Sub-Committee Activity Report: Collision Avoidance

(Steve Sawaryn)

- Sticking to the timeline we came up with 2 years ago. We have a full day meeting tomorrow after a half day yesterday.
- Working on management practices to support implementation of anti-collision rules.
- Also working on getting the relevant principles together in a large group so a smaller group can put together a document for presentation to the ISCWSA as a whole in 2015.
- One principle is that we need to only base recommendations on published/publically available calculations.

(Questions)

- None.

Assessment of the Validity of Assigning MSA-Variant Error Models to the ISCWSA Test Wells

(Chad Hanak)

- (no notes due to the fact that the secretary was presenting)

(Questions)

MWD Systems Overview in Relation to Data Quality

(Steve Grindrod)

- Began with a schematic overview of magnetic MWD systems, down to the sensor level. Defined real raw data as the sensor data immediately after being converted to digital. Calibration is the next step and generates raw data. Derived values such as azimuth, B total, dip, etc… are calculated next.
- A minimum survey includes inclination, toolface, azimuth, and a data quality flag (i.e. a QC check should be included in a minimum survey).
- A long survey entails the transmission of all the raw data (3 components of acceleration and magnetic field).
- Probably 60% of US Land surveys use +/-5000 nT for a B total error threshold and +/-5 degrees for a dip threshold. Even changing it in the surface system may be thwarted by firmware settings.

- Older rigs can have mud pulse transmission rates as low as 1 bit per second, and connections can take as long as 30 minutes, especially if the telemetry system has lost sync.
- There can be memory limitations such as only saving off magnetic readings to the nearest 10 nT.
- There can also be an issue with "Frankentools", where the sensors, electronics, and/or power supply have been changed out without any observable documentation.
- B total and dip QC tests may reject what would otherwise be acceptable surveys (for instance when there is high axial magnetic interference, but the well is pointed North), while allowing bad surveys.
- Spoke about some limitations of applying MSA (for instance, surveys close to a casing shoe should be removed from an MSA analysis), as well as the effects of magnetic mud.

(Questions)

- David Gibson – I was helping someone troubleshoot an off the shelf MWD tool. The dip angle tolerance was set to +/-6 degrees. This is still happening; it is sometimes overlooked. Answer – Some of the sensor manufactures don't realize that their QC limits are too high for our applications.
- Bill Allen – Would you say the challenge is awareness, behavior, missing documentation, technical? What is the low hanging fruit? Answer – With the smaller providers (US Land) they don't have the full technical capability. They assume the equipment manufacture knows what they are talking about, and many times they don't. Roughly 60% of US Land jobs are using these overly high levels.
- Robert Wylie – One of the problems with small MWD companies is looking at buying sensors from companies based on marketing specs that are not achievable in field operations. You must also consider the effects of the entire system (for example power supplies can provide different voltage levels to sensors, which can affect the readings). Answer – The market is getting flooded with plug-in equivalents from China, many of which come with no calibration.
- Anas Sikal – Do you think we have a solid calibration process today? Answer – The sensor manufacturers usually have robust practices in place. However, the field offices do not always do things correctly, either due to lack of hardware or procedures.
- Benny Poedjono – You should also focus on the gravity measurements which factor into azimuth calculations.
- Mahmoud Elgizawy – Do you think the standard limits are good enough for drilling East-West? Answer – You can still sometimes pass QC with bad surveys.
- Andy Brooks – There's a misconception that you can do QC on a station-by-station basis. The reality is that if you start to get failures, you really need to re-evaluate the entire survey log.

Sub-committee Activity Report: Education

(Steve Mullin)

- Two main tasks currently being undertaken: 1) A series of applied technology workshops through SPE, and 2) taking over the management and further development of the wellbore surveying e-book.

- We have successfully run the collision avoidance and well interception workshop 3 times. The Istanbul location was undertaken to attract people from Middle East companies, but that didn't quite work out as we had hoped. SPE US has asked us to repeat the workshop next year. It will happen in Galveston, TX in the first week of November of 2015 (at the Hotel Galvez).
- Another desired workshop is to look at the effect on the estimates of reserves in place of surface and sub-surface positioning errors. We've had some trouble contacting geophysics and finance people. There's still considerable interest however, so the day after hits and misses (Nov.2015) we will hold a 1 day workshop on this topic. There will be two registration options for this event.
- There will be a topical lunch at ACTE in Houston next year on the reserves in place topic.
- We now have a prioritized list of additional chapters for the e-book. We've decided to take these 7 priority chapters have the University of the Highlands and Islands manage their development. We will be asking for funding from the committee officers, per previous agreement. We will be able to get dollar-for-dollar matching from the EU (or does UHI get the additional funds?).
- Angus Jamieson – Motivation for new survey courses was oil companies asking where to pick up specialists in surveying. Courses will contain mathematics of surveying, principles of surveying, geodesy and mapping, surface surveying, marine and underwater surveying, and downhole surveying. The last three classes will include applied learning.
- The modules will be online, but you must come to campus for the 3 practical courses.
- If there are folks that would like to contribute a chapter to the e-book, let Angus know. The gate-keeper is actually the education sub-committee. Anything that goes into it will be completely public domain.
- There have been around 3000 downloads of the e-book worldwide already.

(Questions)

- Carol Mann – The committee members would have liked to achieve the goal of having more folks from the Middle East, but from an SPE perspective it was considered a success with 52 attendees (in Istanbul).
- Ludovic Macresy – When will the master program start? And how much does it cost? Answer – We think that most students will come from industry. It's about 20,000 pounds for the year-long course, due in part to the expensive equipment. We have a lot of names from industry already line up. January 2016 will be the start of the first course.

Wireline Depth Corrections - How to implement and update on SPWLA Industry Efforts

(Harald Bolt, Ton Loermans)

- Depth is one of the top uncertainty factors in FDPs (Field Development Programs). The Net Present Value of FDPs is highly sensitive to depth uncertainty.
- The most extreme case is 1 billion bbl per 1 ft change in depth uncertainty in GOC.
- Accuracy and precision are needed to accurately locate fluid contacts. A few feet difference has a major impact.

- Current practice – wireline along hole depth is usually stretch corrected. LWD logs are drillers' depth, which are usually not stretch corrected: the errors are not consistent. If driller's depth errors were consistent, it would not be too bad.
- Random field example: Out of 25 wells, 4 wells were resurveyed to confirm significant depth problems (errors from -12 to +28 feet in wells less than 10,000 feet in length).
- According to a Saudi Aramco survey, 1 in 4 wells have potentially erroneous wireline depth.
- There is a depth problem consequences diagram in the presentation.
- Causes of the problems are inadequate QC by service companies and lack of audit trail/documentation.
- Quest for Depth started in mid-1990s to improve QC and audit trails.
- QC is not the main problem (QC improvements did not yield great improvements in results). Often the correction methods fall short: Stretch profile is more complicated than assumed for vertical wells.
- New schemes for stretch correction seem to be a major step forward.
- There is a disconnect between the use of the word depth at the rig site and its use in the offices where the values of the fields are assessed.
- Recommends calibrating the cable by marking it in known intervals. This helps to calculate tension in the cable. Usually the marks are magnetic marks on the cable. Surface tension plus line tension allows calculation of total stretch.
- The difference between intermark distances in the measurewheel encoder responses should be logged and compared. This distance will depend on tension and the stretch coefficient. Analyzing the differences can also help detect problems with the measure head.
- There is a good slide on stretch correction basics in the presentation.
- The stretch coefficient varies as a function of temperature and as a function of the tension applied. It is not a single number. It can be calculated in situ using an equation in the presentation. It can also be derived from magnetic marks.
- There is a True Along Hole (TAH) Depth Consortium. It's a joint activity between survey companies and operators.
- The thought is that 2/10,000 levels of accuracy are achievable with magnetically marked cable.

(Questions)

- Bill Burch – The first log in the hole is considered the standard. On LWD we don't technically measure pipe. We measure the turns in the draw works encoder. Also, these problems have been known for 15 years, but the industry has been ok with them. I'm interested to see if you get traction with your consortium.
- Benny Poedjono – I think this is good work, but some of the companies are doing corrections. Also, I don't see a temperature correction in your work, which makes wireline cables shorter. We published a paper covering depth accuracy in 2005. Answer – We didn't focus on everything. We are trying to focus on something and move forward from where we are. Also, go ask the manufacturers what the thermal expansion coefficient is for the wireline cable. You likely will not get an answer. I would be very happy see something published that characterizes the thermal behavior of the various types of cable, as some of them do get longer. Benny – SLB will release the data if asked.

A New Look at Tool Misalignment

(Jon Bang)

- Proposed is a new, simpler misalignment model that should not affect the end result of the calculations.
- Misalignment is typically fairly important in top-hole (low inclination) sections. Also in long survey sections with fixed toolface (sliding).
- Covered existing methods of modeling the effects of misalignment.
- A new model will consist of 1 term. Error propagation skips the conversion to depth, inclination, and azimuth versions, and goes straight to errors in northing, easting, and TVD. This eliminates a vertical singularity.
- Mathematics of the method are outlined in the presentation.
- The new model formulation is consistent with SPE 90408. There is only one scaling changed needed in the existing ipm files, and that is to use a factor of sqrt(2).
- Reduces risk for wrong application in error models. Intent is to simplify error models.

(Questions)

- Angus Jamieson – In several of the slides the multiplier is sqrt(2), which would imply that the code dimension is 50% bigger than the ipm value. Answer – If you take the value from the ipm file you have to multiply that by the square root of 2 to get my input value. You have to look at the calculations.
- Laurence Macrae – Alpha is constrained to be a small angle. Answer – Yes it is usually only a fraction of a degree. The method doesn't have a restriction on alpha.
- Ludovic Macresy – In the original model, the original terms was toolface dependent. Then we moved to toolface independent models for simplicity. Does your simplicity depend on this toolface independence? Answer – The way I average out toolface can be handled in many other cases where there is a dependency on toolface. Ludovic – Would you have a model that could be toolface dependent with only one misalignment term? Pete - Decision to leave the question hanging.
- Gary Skinner – What if we want to use the depth, inc, and az weighting terms? Answer – You should use the physical angles, but that brings back the singularity in vertical wells.

Managing MWD Survey Logs

(Harry Wilson)

- This is the third in a series of ad hoc presentations from Harry. It's aimed at the operations people who attend these meetings.
- There's some confusion as to when you start a new survey log. A survey log is a sequence of successive survey stations acquired with the same surveying tool and the same processing.
- The well path is the concatenation of several survey logs. Each successive survey is "tied-on" to the previous survey.

- What if all runs in a well are MWD runs? Should they be treated as separate logs? The answer can have a significant impact on position uncertainty. The effect arises from the coefficient terms that are introduced by the error propagation modes. Systematic errors are not correlated from one survey log to the next.
- Now Harry is wandering in the desert, but he has a compass.
- A tie-on is only fully valid when are systematic error sources are changed due to changing hardware.
- You would not want to initiate a new survey log mid-BHA run, or at a bit trip (even though it may alter the axial magnetic interference to an extent). After an MWD tool change you might want to do it. After a BHA change you would likely want to do it.
- Recall that error models do not magically ensure that the survey data conform to the model. We must assure that the data matches the assumptions.
- Regarding behavior at tie-ons: only terms common to both error models matter; and of those, only the systematic terms matter.
- Rule of Thumb: New MWD log for each hole section, but then you have to avoid running the same tool into the deeper hole section. Avoid changing corrections within a hole section.

(Questions)

- Angus Jamieson – Have any runs been done of multiple MWD runs vs. gyro runs to see if assumed effects of changing MWD tools are actually realized? Answer – I'm not aware of any such study. There are probably one-off looks, but you'd need to accumulate them. Bill Burch – We often do that in deepwater for casing inspection runs. Harry – So what's the outcome? Bill – We don't typically see out of spec conditions. Harry – This is possibly a relatively small effect compared to other error sources. Angus – There might be a benefit to pulling out of hole to change BHAs to get the accuracy improvement. Bill – In deepwater we do a complete BHA change every time we pull out of hole to prevent failures downhole.
- Neil Bergstrom – MWD tools should record surveys into memory on the trips in and out so you have more overlapping data.
- Ludovic Macresy – Error models are based on assumptions. You can soundly randomize if you change the MWD and BHA at the same time (one of the assumptions). There was an idea to itemize terms that are systematic wrt BHA changes and wrt to MWD change. Answer – Can't recall that, but it's interesting. I don't think the software complication prevents that. I think it's operationally complex. I'm not against it, but it does add some process complexity.

Sub-Committee Activity Report: Error Model

(Steve Grindrod)

- Pete Clark – Andy McGregor will be the new chair going forward. We'd like to thank Steve for his 9 years of service as chair of this committee.
- Steve – We are currently at about 52 members.

- The first item we addressed was error model documentation. We need a single document. It should include implementation guidelines and validation limits for comparisons. We have a small group working on this.
- Drillstring magnetization: Desire is to remove AMIC and replace AMID with AMIL – value to be confirmed. The proposal is to retain the old model for historic data. (NOTE: OWSG uses AMIL.)
- The proposed change of adding inclination and azimuth cones was rejected because these can already be modeled with inclination terms.
- Do we want to make the ISCWSA models consistent with the OWSG models? The ISCWSA models are now in OWSG spreadsheet format.
- There has been a request for the models to also include the HDGM and IGFR models in addition to the BGGM.
- Proposed change was to eliminate the scale factor terms. Can be changed without greatly affecting the EOU. However, we need to check this further because the MSA programs use the scale factor terms.
- There's John Bang's alternate misalignment term, but it's not yet consistent with inclination only models.
- A vertical drilling system needs its own drilling model.
- Inclination only models assume TVD and MD are the same. This has been questioned, and options are being investigated.
- There is a proposal to include some missing random terms in the geomagnetic model, which affects the IFR2 model.

(Questions)

- Vote was undertaken on the proposal to adopt the AMIL term in place of the AMID and AMIC terms in the ISCWSA models (ushering in Rev. 4 of this model). The results were in favor of making the change by a significant margin. The vote was a raised hand vote.

Space Weather Conference Announcement: http://www.stce.be/esww11

- Contact Ellen Clarke (ecla@bgs.ac.uk) with questions.

Sub-Committee Activity Report: Operator Wellbore Survey Group (OWSG)

(Neil Bergstrom)

- The OWSG is not a decision making body. The mission statement is to promote practices that provide confidence that reported wellbore positions are within their stated uncertainty.
- There are currently more than 60 members on the mailing list, with typical meetings in Houston having between 12 and 20 members attending.
- Recent discussions have included positional uncertainty models and their implementation in commercial software. Also, probability of collision calculations, magnetic exclusion zones for MWD, allowable deviations from plan, TVD errors and SAG correction methods, pedal curve vs.

expansion method for separation factor (agreement that expansion method is preferable), and standardized survey operating and reporting procedures and survey QC.

- There is a list of current OWSG initiatives in the presentation.
- The LinkedIn group "Petroleum Industry Steering Committee for Wellbore Survey Accuracy" now as over 1240 members. Participation is encouraged as individuals, but not as official representatives of the ISCWSA.

(Questions)

- Ludovic Macresy – When can we have access to the recommendations on the website? Pete Clark – They haven't really been finished yet.
- Mahmoud Elgizawy – Why do we have two different sets of error models? Pete Clark – There is some conflict that still needs to be resolved. But primarily these error models cover a much wider range of survey tools than the standard ISCWSA models. It's a much larger set of error models.
- Bill Allen – The ISCWSA has models, but not what you would put in a computer to use (the error magnitudes are not blessed). The OWSG models have actual uncertainty magnitudes as part of the models.

Sub-Committee Activity Report: Well Intercept

(Chad Hanak standing in for Mike Long)

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(Questions)

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Systematic and Random Contributions to the Disturbance Field (IFR 2)

(Stefan Maus)

- Two aims of the study: 1) Investigate systematic disturbances and their applicability to tool codes, and 2) develop a full set of coefficients in the error models to be able to properly compute QC parameters for B total and dip.
- Performed an analysis of global geomagnetic observatory data.
- The 3 main contributions to the disturbance field are 1) the magnetosphere, 2) the ionospheric current system, and 3) the induced fields (which is a secondary effect). The secondary magnetic fields make up about 1/3 of the disturbance field.
- There are systematic contributions to the disturbance field.
- The presentation contains some links to relevant works.
- The study is meant to verify the error model terms DECG, DBHG, DECR, and DBHR for the IFR1 and IFR2 tool codes. It also aims to fill in some missing random values in all of the error models. The missing random parameters should feed into survey QC calculations.

- Methodology included “drilling” simulated wells at each observatory station and obtaining statistics for azimuth variation. Data time range was 1995 to 2006.
- Results showed high latitude systematic error of ~800 nT for declination. Systematic and random values were also presented for B total and dip (see presentation for numbers).
- Also looked at variations during magnetically disturbed times.
- Over long duration drilling operations the disturbance field averages out, but the decay is very gradual. For durations of 10 – 100 days, the systematic errors can be significant.
- Proposed increasing the declination error component that is dependent on the horizontal magnetic field magnitude. Proposed magnitude is 3,000 nT*deg.
- Another study had to do with trying to determine how much of the disturbance field can be corrected via IFR2. Presented a graph of residual error vs. distance from the magnetic observatory. The relationship appears highly linear. At high latitudes, a distance of 600 km appears to be the cutoff after which an IFR2 correction has no value (and may even hurt accuracy). 60 km or less was determined as an ideal distance from an observatory for the purpose of applying IFR2 corrections.

(Questions)

- Laurence Billingham - Does the direction of the 60 km baseline matter? Answer – When it’s East-West it’s more favorable than when it’s North-South, but it’s not a huge difference.
- Susan Macmillan – When are your reference values straight lines? Answer – The plots show the residuals against the reference.
- Adrian Ledroz – How much do the IFR1 EOUs increase with this proposal? Answer – There is virtually no increase due to the random terms that have been added.
- Andy Brooks – I can go along with being on the edge of my QC limit in B total if it’s a straight well as long as the dip residuals are not also on the edge.

Webmaster's Report

(Phil Harbidge)

- Gave a brief overview of the websites. They are:
  - www.iscwsa.net
  - www.iscawsa.org
  - www.spe.org/Wellbore_Positioning
  - There is also a link to a University of the Highlands and Islands webpage containing the e-book (see the presentation)
- Issues: would like an RSS feed, highlighting new and hot documents. Not yet done due to site upgrade. Data will be moved to the spe.org site during the upgrade. Steve Grindrod’s site will also have the data.
- There’s a desire to put our meeting announcements on LinkedIn (Neil Bergstrom has been doing this), and possibly Twitter (no significant response when this was tried).
- Send Phil and email with any suggestions (PHarbidge@exchange.slb.com).

- There was quite a bit of discussion about how to consolidate websites. Discussion had to be tabled.

Treasurer's Report

(Robert Wylie)

- The Long Beach meeting ran a surplus.
- The current meeting, with about 83 registrations, will approximately break even. The SPE provides the meeting space when we meet in conjunction with ATCE.
- About $30,000 is requested for updates to the e-book. Steve Mullin will put a proposal together to put to the committee for approval.
- Question from Ben Hawkinson about breaking sponsorship up into more manageable chunks. Robert agreed that's probably a good idea going forward. It's an item to look at for the next meeting.

Closing Statement

(Pete Clark)

- Appreciation was expressed to the participants, presenters, and sub-committee chairpersons.
- The next meeting is a blank slate. Obvious suggestions are London, Iceland, and Oklahoma City. Next year we are obliged to hold the fall meeting with the ATCE in Houston. As a consequence, the next meeting should probably be held in Europe to keep up our alternating pattern.
- There was an offer by BenchTree to sponsor a meeting in Austin.
- All other sponsorship offers should be sent to Pete Clark (peterjclark@chevron.com).