48th ISCWSA Meeting – Dallas, TX, USA – September 27, 2018

Introduction

(Jonathan Lightfoot)

- Had an opportunity to sit in front of the advisory board for the SPE. The WPTS is highly thought of at that level.
- Election of Secretary, Treasurer, Webmaster, and 2 Director at Large positions this meeting.
- Safety instructions.

Schedule and Program Review

(Ross Lowden)

- Overview of the agenda.
- Thanks to all the sponsors for this event, including Wellbenders for sponsoring coffee, Benchtree for sponsoring Lunch, and MagVAR for hosting a networking event.

Keynote Presentation – Education, Education, Education

(Angus Jamieson)

- One issue is that service companies go to clients to tell them what they need, but they are also selling the services. This can be a hurdle.
- Angus specializes in marine navigation, directional drilling, and wellbore positioning.
- In the future, it's likely that there will be a shift away form oil. Cheaper renewables, rising costs, limited reserves, and climate change will likely work together to cause this shift.
- How can a service company go in as an honest broker to convince the client of things they actually need, without being viewed as peddling unnecessary luxuries? If people don't understand what we do, why would we expect them to value what we do?
- The harsh reality is that the important people are just not that interested. We are not high enough on the radar. Unless we can show that good surveying leads to good production. We have preached this at ISCWSA for years, but we're preaching to the choir. How do we get that message out more effectively?
- The costs of bad surveying can be quite high. Consider the cost of an unplanned sidetrack, a proximity shut-in, a deep landing, a collision, etc.
- What happens when you hit another well? One example had stick slip recorded that just went away. Turns out they collided with another well, but there were no ramifications in that case. More commonly there is serious environmental damage and potential loss of human life. They are generally low probability/high impact events. How do you get someone to concentrate on that small corner of their risk assessment?
- The most common cause of colliding with another well is not getting the error model wrong. It's not knowing there's another well out there to collide with.

- There are 4 main corrections to reduce uncertainty: reference field correction, interference correction, sag correction, and depth correction.
- IFR will give you a more accurate declination in the field. Sag correction corrects for misalignment between the BHA and the borehole at the sensor location. Depth correction corrects for elongation of the drill pipe due to gravity and thermal loading.
- IFR measurements can be taken on the ground via theodolite, or via air or sea based magnetic surveys.
- Magnetic interference comes from magnetic components in the BHA. Single station axial corrections and multi-station corrections can be used to correct for it.
- How do we educate the client? One of the first things we did was create an e-book. It's had quite wide circulation. But for the clients that have to make the business decisions, it's far too much at 170 pages. It won't be read frequently enough by people who don't do this for a living.
- We also have a course at the University of the Highlands and Islands which is based on the e-book. There is a pipe laid in Loch Ness which creates an ideal test setup for surveying. It's a 2,000 foot, 6 inch pipe which has been acoustically surveyed. It's high inclination which is ideal for observing the build-up of survey errors.
- But what if the client doesn't want to learn? How about an independent source of free advice, such as the ISCWSA website? We could create a survey plan analysis app where the client can enter the well plan information for all the wells on the site and it will tell them what they should do survey-wise. (Some graphical examples of what could be done are included in the presentation.) It could show what surveying solutions could solve separation factor problems, for instance (gyros, IFR, survey corrections, etc.).
- A simple little app such as the one proposed may help convince people to use various survey services when needed, and also show them when they aren't needed.
- One comment from Roger Goobie was that it might be good to also tie-in how much oil could be left in the ground due to less vs. more accurate surveying.

(Questions)

- Robert Wylie – One of the things I see is that well plans are changed as soon as you start drilling. We might need to address that with such an app as well. Answer – One thing you can do is build in expected tortuosity and a gauge of how close your DD can get to target.
- Bill Allen – When people who need the education see those graphics, they see ellipses overlap and tend to think there's no real problem. If you were to stop extending the wells when the ellipses touch, that may be more impactful to them.
- Jonathan Lightfoot – Talking to the MWD companies I often encounter on the rigs, I find that sometimes Field Acceptance Criteria are overly large such that no survey can ever fail. Do you think it's worth putting a short one-pager together to hand out that describes what appropriate FAC values are? Answer – Yes that's something we have considered. Maybe a short list of critical success factors. It could be downloadable on the website. Ross Lowdon – It would also need to be tied to the error model that's in use. The FAC and error model should be intrinsically linked. Answer – As long as we keep in short, simple, and easy to use, yes, I think there's value.
- Michael Donahue – The drilling team worries about educating the field so much that they start making decisions without consulting the office. Is that a concern? Answer – It's not just the big decision makers who need to know the impact of getting it wrong.

- Neil Bergstrom – We've all seen wellbore collisions, but the average drilling engineer has never seen or heard about them because it's not something you want to publicize. So a big problem is the secrecy surrounding collisions. We've wanted to create an anonymous data collection method for a while, but it never comes to fruition due to lack of backing from senior management.
- Pete Clark – Very nice tool. One of the barriers that I have is that we tend to speak only to the worst case, 3-sigma event. What I've started to do is reshape that conversation to not be the worst case, but to frame it in terms of the expected outcome. What's the 50/50 outcome? Do they expect to be 70 feet off from plan at TD due to their surveying practices, for instance? Answer – Probability of success is a potentially good way of framing things.
- Mike Attrell – Is there an effort to report probabilities of collision rather than separation factor. It may be more effective for communicating to drilling engineers. Answers – One of the problems is that if we relate probability of collision to the error model, then it encourages the use of the worst error model due to the extremely large distribution of potential outcomes. Probability of recovering the asset is probably a more useful way of framing the conversation in that it encourages better surveying practices.

Sub-Committee Activity Report: Collision Avoidance

(Steve Sawaryn)

- SPE 187073 (the Separation Rule paper) is likely to be published in December of 2018. SPE 184730 (Management and Practices) is likely to be published in March of 2019.
- The next tasks for the group are listed in the presentation. They are:
    - A revision control process for the work we do
    - Adoption of global error model terms to improve the probability calculations
    - Create a common collision avoidance report, capable of being exchanged electronically
    - Creation of a collision avoidance presentation pack (for management buy-in)
    - Tighter collaboration between the collision avoidance and error model groups
- Website suggestions were also discussed with the Webmaster.

(Questions)

- Ed Stockhausen – Can you explain how the API RP 78 effort will affect companies. Will it be voluntary or regulatory? Answer – The API sets a standard that it recommends, but it's up to local jurisdictions to decide whether it is adopted.
- Pete Clark – The API is there for industry self-regulation. The industry can have its own common rule so that the regulator does not need to intervene.

SPE Drilling Advisory Committee Meeting Review

(Jonathan Lightfoot)

- Revisited the mission for the group to ensure the WPTS has a clear role and that other sections don't create redundant work.
- Sharing a list of topics for which the WPTS should be the SPE authority (included in the slides).
- If you think we need to add any subjects to the list, contact Jonathan.

(Questions)

- None.

Sub-Committee Activity Report: Error Model Maintenance

(Andy McGregor)

- Course Length models (XCL term): this has been a topic of discussion for a while. We added new terms to grow the EOU when course lengths are excessive. They were inclination and azimuth weighting function terms. Some initial issues were uncovered that were addressed.
- Yesterday, we discussed reasons why these terms are not behaving quite like we want them to. It was decided that we need to revise the terms as errors directly applied to the survey positions. They are not angular errors. Jerry Codling will define the math for that and will then circulate it around to the other software vendors.
- As a result, revision 5 is currently on hold.
- Relative correlation between global error terms is also an ongoing topic of discussion. This can impact anti-collision scans through the geomagnetic terms. The impact can be on the order of 30% in terms of the EOU. Whether the impact is positive or negative depends on the relative direction of the wells.
- We've been looking for a software solution that is minimally impactful to the software. A favored proposal involves breaking the global geomagnetic terms out into main field, crustal commission, and crustal omission errors. This is moving forward to software implementation as well.
- The only drawback is that this approach would be incompatible with current error models.
- Total has made great progress in creating a WITSML format for transferring of error models. A draft release is expected this year. Scott.farmer@total.com is the contact for this.
- Borehole misalignment errors: these are viewed as potentially overly conservative in top-hole. Jerry Codling has been doing a lot of work analyzing data to come up with away of handling the misalignment that better fits the data.
- Another outcome of this focus is the detection of what appears to be a low inclination sag terms that we are not currently modeling.
- Steve Grindrod developed a gyro model for Stockholm Precision involving complex mode changes and re-initialization. The question was raised concerning whether or not model changes were required (not favored at the moment).

(Questions)

- Phil Harbidge – What are we calling rev 5 error models? ISCWSA or OWSG? Answer – Both are on hold presently. We are not ready to release it. Phil – The gyro model, is it ISCWSA or OWSG?

Answer – The ISCWSA creates an error model framework. We don't generally do models for specific tools. The OWSG have created a large number of models that you can use. It's up to the service provider to recommend a model for their tools, but these can be OWSG models.

- Ed Stockhausen – On the survey frequency term, I'd like to see some examples of what it looks like and how you improve by surveying more frequently. What course length represents the point of diminishing returns. Answer – Jerry and I have looked at some of that in the past. Jerry has done an SPE paper on this topic (in San Antonio I think). A problem is that you don't know what you don't measure. So you have to make some assumptions, but there is no way to know for sure what your well is doing between large course length. The recommendation is still to survey regularly. Ed – Have you made any progress on using continuous surveys to fill the gaps between stationary surveys? Answer – We've done a little bit of work on that, but they are generally not used as definitive.
- Robert Wylie – No one that I know of at the moment is using continuous surveys for approved surveys. We are moving that way.
- Phil Harbidge – I've used continuous data outside of the US in conjunction with specific QC methods. They are typically noisy, but they are invaluable in filling in the gap between static surveys. Answer – Chad Hanak did create an error model framework for continuous rotating surveys.

Declination Error at Depth: A Comparison Study of Gyro vs. MWD Surveys

(Chad Hanak)

- Declination error at depth presentation – Case Study of Survey QC Workflow. Superior QC President. PhD in Aerospace Engr, formally with BHGE. Why are you re-correcting survey? Question. Why would we do that? When you do survey corrections you are doing that run as a whole. If you add another survey, and you get better info, that new data affects all the data and past corrections in that well. It can bite you, if you have a planned lateral and you are in a turn. As we drill the turn curve we get more insight on the potential errors. It is a real thing and if we don't manage it in real-time you can be significantly off once you re-process at the end of the run. Especially if you run AC scans, if you select an MSA error model, you can't really use that while drilling if you only do this at the end of the run. Charts are used to explain AMI & Twist Estimates Gain in Observability in a Turn. Being able to see sensor twist through the turn can provide good value while drilling. Managing the corrections while drilling and updating while drilling is important for accurate well placement. Declination Error at Depth – Main case to share. For a Standard MWD, we get a Raw Mag Azimuth and then we reference to True North using Declination. The most common thing we do is call this BHA magnetic interference. Chad explains a common flow chart of the survey correction and reviews the reference errors. The example uses IFR. Also, Grid convergence is listed for the Grid convergence corrections.
- Question – How accurate is IFR data when projected down, say to 14K ft TVD. Common way to check it is at ground level. The question is does it truly match what we see down in the reservoir. There are three error buckets. Error in the MWD correction, Error in the Declination and Error in the Gyro. Only one is global to all wells, the global declination error. IFR declination error is estimated as 0.28 at depth. Eight sights were reviewed. Explained the azimuth of the

example comparisons. These are the number. The 1sigma value in the error model is 0.16deg. Chi Squared method to test the see the probability of the errors shown in the test data for all 8 sites. This shows significant low probability. Use a cumulative distribution function to fit the data. Chad showed the results for the full dataset and the dataset with the worst point removed. Conclusions; BGGM may be optimistic for this area. IFR shows a bit better than BGGM. IFR error models appear to be about (?)x times the BGGM. IFR seems to be optimistic based on downhole data. Uncertainty may be 3x times the modeled value. Stefan Maus explains overall the accuracy in IFR modeling does propagate while looking deeper. In most, cases these things are well behaved. But there is some chance that there can be large error. Benny Poedjono describes that this is not simple but described that QC of the data and understanding the correlation with ground measurements. Bill Allen asked about the Gyros and Sag Corrections and commented on the overall presentation. Mix of Gyros, used the appropriate error models

(Questions)

- (Secretary was presenting)

Treasurer's Report

(Robert Wylie)

- Revenue from the 47th meeting was $14,965, with a net income of $13,919. Thank you to our sponsors.
- The attendance for today is a little over 95 (95 were registered as of yesterday).
- Thank you to Wellbenders, MagVAR, and BenchTree for sponsoring.
- Our net income for this meeting will be smaller ($790 estimated).
- The meeting space was arranged by SPE.
- Our bank balance is around $115,000. We are looking to spend some money on the website for improvements and also at some things with the Education Sub-committee to spend the money appropriately.

(Questions)

- None.

Forecasting the magnetic disturbance-storm-time (Dst) index using machine-learning

(Manoj Nair)

- Dst stands for "Disturbance Storm Time" Index. Solar wind interaction with the Earth magnetic field generates electric currents. Dst is a measure of the "ring currents" in the magnetosphere.
- Dst is calculated using 4 low latitude geomagnetic observatories. An hourly index is generated.
- Why estimate Dst? The ring current is one of the primary magnetosphere current. It's a critical input to magnetospheric magnetic models.

- Operational Dst forecasts can provide early warning of magnetic disturbances.
- Forecasting of Dst using solar wind is less accurate, but you don't need an observatory and it provides lead-time. There are empirical relationships and physics-based models which can be used. This presentation covers an alternate machine learning approach.
- An artificial neural network mimics the function of the brain. It is a universal non-linear approximator. Here we are using supervised learning.
- There is a brief description of an artificial neural network in the presentation.
- For training, observed Dst values from Kyoto were used, along with observed solar wind values from NASA. The data covered 1997-2016.
- The aim is to generate one step (hour) ahead forecast of Dst using solar wind data. Some results for 2003 are depicted in the presentation. During geomagnetic storms, it was show to have good predictive power.
- The Machine Learning (ML) model was compared to an existing LASP model. The predictions were very similar. The extreme storm of 2003 was predicted a little bit better by ML than LASP.
- Further improvement is gained by ingesting past data.
- They are working on making this service publicly available, including real-time validation against observatory data (website included in the presentation).

(Questions)

- Robert Estes – I like the hour-by-hour prediction. Is there any hope for minute-by-minute predictions for real-time corrections rather than just advanced warning? Answer – One of the problems in using the solar wind is that the magnetosphere acts as a low-pass filter. The best that can be done due to this with satellite data is 15 minutes.
- Phil Harbidge – There's discussion about the data being more relevant in equatorial regions vs. high latitude. Have you looked at that? Answer – These models are specifically for low latitude predictions. They are not for high latitude predictions. And we have worked with SLB to validate with MWD data.
- Stefan Maus – Thanks for continuing to improve these models. With the Dst Index, it's importance to realize that the ring current primarily creates a North/South disturbance, which doesn't affect declination much. Also, the model documentation indicates the ionospheric effect is captured, but only a small portion is modeled. Also, with only a few observatories near the equator, the predictions may suffer in quality. Answer – The way I look at this is going from a main field model to an IFR model. There are many different flavors of these improved models. I agree that this doesn't effect declination much where the field is North/South. I disagree that this is not a magnetic disturbance model.
- Mike Attrell – Your modeling is based on the observatories and satellites, correct? So are you modeling at places distant from those locations like an IFR model? Answer – Not like an IFR model. Spatial distribution is a potential issue.

Webmaster's Report

(Phil Harbidge)

- Our SPE membership continues to grow, upwards of 2,000 members now.

- We have good coverage in all regions of the world. The Middle East and Gulf Coast/North America and the two regions with the largest representation.
- The largest age contingent is the 35 and under crowd.
- The largest number of website visits come from Google+Bing. The second largest number of visits are direct visits. Other sources are much smaller in terms of numbers.
- We are engaging in a website remodel. There will be a focus on search engine optimization. This will cost some money for the work, but it will allow all our content to be searchable from Google for instance.
- This website design team is a marketing web development team, rather than an engineering team designing a website. That should improve the appearance and active content.
- We are going to have to re-do our email list to be compliant with anti-spam rules. That will require people to explicitly agree to receive emails from us.

(Questions)

- Manoj Nair – Thanks for the website work. It looks very good. Is the ISCWSA LinkedIn account official? Answer – It's not to replace the website, it's just an additional marketing tool.
- Mike Attrell – Will you have RSS functionality? Answer – Yes.

Anti-Collision Best Practices Developed for Horizontal Drilling Across Pre-existing Horizontal Wellbores

(Erin Britton & Rachel Grande)

- This presentation details work done in the Williston Basin.
- Anti-collision rules typically take the approach of total avoidance or azimuth avoidance. What do you do when that's not an option?
- Wells are drilled over other wells with different azimuths, as close as 10 feet.
- Some constraints on the anti-collision program are that the formations are laterally continuous, well control, good quality data, and clear steering markers.
- The first thing that has to happen is a reinterpretation of everything from a stratigraphic perspective.
- Risk management is handled via a risk vs. probability risk assessment.
- We had to work through the impact vs. probability process as it applied to surveying best practices. The geology was viewed as a help because there are very distinct stratigraphic markers. This led to an assumption that TVD uncertainty was not growing once we began viewing the geometric position in light of the geo-markers.
- A stoplight approach was derived that allowed for a very controlled operational approach. For instance, part of this was a directive to slow down in high alert/red areas to make sure surveys had time to telemeter up and be corrected.
- The first well was drilled 32 feet about the existing wellbore.
- Case Study B had 3 well crossings, with the closest being 8 feet below an existing well.
- Case Study C also featured 3 well crossings, as close as 15 feet.
- This approach is needed because the number of anti-collision wells in a basin grows as the basin matures.

(Questions)

- Jonathan Lightfoot – There is an SPE paper that was presented in Ft. Worth on this.
- Benny Poedjono – Are you reducing the lateral uncertainty as well by calibrating off the formation dip angle as measured? Answer – That is incorporated during planning/reanalysis of the existing wells.
- Ed Stockhausen – How do you reconcile survey calculated TVD displacements vs. stratigraphic calculated displacement? Answer – (smart geologic talk and I didn't understand well enough to summarize.)
- Neil Bergstrom – Why were the new wells drilled in a different direction than the old wells? Answer – There has recently been a lot of testing concerning optimal direction, and the view is that the original direction was not optimal.
- Mike Attrell – Did you see any interference during the crossings? Answer – We really didn't see more than a 2 to 3 foot range, always in the down direction. And there was always a strong gamma marker separating the two wells, which added a factor of safety. Mike – Where is the gamma? Answer – This is bulk gamma, so not azimuthal near-bit.
- ??? – Usually with Geosteering you run multiple correlations. How did you handle that? Answer – This is not something that can be used in all areas. You have to have very distinct markers. We do have a primary and secondary interpretation running, but the distinct markers help reduce discrepancy.
- Robert Estes – Did you do any ranging after the fact to verify the separation? Answer – No. We did a look-back but no ranging.
- Pete Clark – One tool we used was tracking incidence angle when we approached a similar problem. Did you use that? Answer – Not in this scenario, but we are considering that for upcoming wells in the Eagleford.
- AADE National Conference will be held in Denver April 9-10, 2019. Call for papers is currently open.

Wellbore Positioning Pub Quiz Contest

(Angus Jamieson & Carol Mann)

- Check slides for quiz.

(Questions)

- None.

Sub-Committee Activity Report: Survey QA/QC

(Phil Harbidge)

- Original group created 3 SPE papers.

- This instantiation took on two initial tasks. The first is to create a checklist that indicates data that would be needed to QA/QC as wellbore. This enables one to verify the data and potentially use it with new analysis techniques at a later date.
- The second task was an effort to reduce the MWD, Gyro, and Depth QA/QC sections in RP 78 down by about 80% each. We split the teams up and assigned responsible people to shepherd this process. Roger Goobie is the QA/QC section lead for the API RP 78 effort. He is also providing direction for this effort. The following people are leading this internal effort for the various areas:
    - Chad Hanak - MWD
    - Ben Hawkinson - Gyro
    - Mahmoud El Gizawy - Depth

(Questions)

- None.

Hebron; Achieving the First Oil

(Benny Poedjono)

- The construction of the Hebron Platform was an international project. Benny's team was charged with making sure they could get the oil, safely, and on time.
- It's a 64 slot project, divided between 2 rigs. Then in 2017 they found more oil. So the team was approached to see if the structure could be expanded. The answer was yes, and the number of slots was increased.
- Wellbore design, platform placement, and anti-collision were all things that had to be managed. A nudge bin process was used to map bottom hole locations to slots in the structure. This was then fed into the "escape plan" to separate the wellbores under the platform.
- The BHA design contained 2 sensors to get the EOU down as small as possible (images in the presentation).
- The rig equipment was designed with the wellbores in mind to ensure that the wells would be drillable. The point being, this involved more than just designing the wellbores. This information also informed the hardware design.
- There were more than 2000 people working on this project, and startup was successful and ahead of schedule.

(Questions)

- Roger Goobie – The assumption is that the wells are going to go where you plan them. As you drill the uncertainty in the geology will change. How do you handle that? Answer – The Escape plan was key. Once you drill the first well, the next well can have more deviation from plan because now you know where the first one is.

Sub-Committee Activity Report: Operator Wellbore Survey Group (OWSG) & Update on API RP78

(Pete Clark)

- OWSG had a meeting at the Omni Hotel Tuesday, September 25th.
- An anti-trust statement was read and is always read at the beginning of these meetings.
- The vision is to promote practices that provide confidence that reported wellbore positions are within their stated uncertainty.
- The OWSG expectation is to write that anti-collision rule into API RP 78.
- You will note a number of 3.5 in the anti-collision recommendation. At first glance it may appear that the anti-collision rule is becoming more conservative (many people will be used to numbers like 2.79 or 3.0). In fact, that is not the case as long as the original confidence level in use is 2.5 or greater. There is a detailed explanation as to why this is true in the slides.
- The OWSG error models are described in SPE 178843. These models are in need of a home. The candidates are either the ISCWSA website or the IOGP website (preference for the ISCWSA website).
- The initial draft of API RP78 is complete, and is available to contributors from the API SharePoint site. Several sections are being actively worked:
    - QA/QC to slim down
    - Process, 5.1-5.4
    - 6.1 Plots or Outputs,…
- Next steps are to review and revise. Target 1st draft for general review at the end of 2018.
- Current document size is 200 pages. We need to slim it down if we hope people to find it useful.
- The core of the API RP 78 document is the anti-collision standard, but everything else is needed to ensure the anti-collision rule has meaning.
- There was also a discussion regarding boundary lines issues. This is not ready for primetime, but is ongoing. The intent is to draft a guidance document.

(Questions)

- Steve Sawaryn – The comparison that was made between the two anti-collision models doesn't contain some of the tweaks that will make a difference. So they aren't definitive, they are just a rough comparison. Answer – Agreed.

Distinguished Service Award

(Pete Clark)

- Harry Wilson is the recipient of the award at this meeting.
- Harry was at the very first meeting of the ISCWSA. There were only 15 people at that meeting. Harry was one of the founders of the ISCWSA.
- He led the collision-avoidance group from 2006-2015, which included a lot of the foundational work that is seeing results today through Steve Sawaryn's efforts.
- There are few people who can argue with themselves in public. Harry is one of them.
- He is not here today, but is still very active in the ISCWSA.
- Andy Sentence received the award on Harry's behalf. (so, Harry, if you're wondering where it is, you know who to call)

Non-Mag Spacing with Axial Corrections

(Neil Bergstrom)

- How much non-magnetic spacing do you really need when you are using axial corrections?
- Magnetometers have to be spaced far away from ferromagnetic parts. There will still be some degree of axial magnetic interference. The key here is that the amount of allowable interference has to be consistent with the error model being applied.
- The magnetization of the drill string comes from the remnant magnetism (often due to magnetic inspection), and from induced magnetization. The latter is a much smaller effect that is usually ignored.
- Non-magnetic collars will always be needed for magnetic MWD.
- Why reduce non-magnetic spacing? Reduced bit-to-sensor spacing makes steering easier (shorter projections to bit). It also allows earlier detection of external interference. Also, if you have shorter required non-magnetic spacing, you have more flexibility about where to put your sensor. Saving on the cost of non-magnetic collars is also a driver.
- The drawback of reduced non-magnetic spacing is that you have more axial interference.
- The interference is usually modeled as a combination of magnetic monopoles.
- In the e-book, there is some guidance on the calculation of the amount of required non-mag, but it doesn't really apply to the more recent versions (rev 4 and later) of the error models, or to axial correction models.
- The equations for calculating azimuth error due to axial interference is included in the slides.
- The most common method is to use 3 monopoles. One at each end of the non-magnetic section, and one at the bit with an opposite sign of the one on top of the motor.
- Common estimates of the pole strength might be 800 microWebbers on the bottom of the drill pipe, and 500 microWebers on top of the motor and at the bit. Generally, the polarity is assumed to be worst case (constructive rather than destructive interference).
- The presentation details how the treatment of axial magnetic interference has changed over the years. The Rev. 4 models require the same amount of non-magnetic spacing, regardless of the direction you are drilling. Axial corrections are the way to get around this.
- A limitation of this axial correction approach is that as you approach East/West, the correction errors become much larger than even the initial uncorrected errors.
- 10 feet above and below the sensor is about as low as you want to go.
- Real world data indicates that the standard deviation of the non-magnetic spacing is much larger than the allowance from the error model (775 nT vs 220 nT). Only 75% of the estimated drill string interference values is within the limit of the 3-sigma error model limits. The distributions are skewed negative by about 200 nT.
- A handheld Gaussmeter can be used to check pole strengths directly. The drill pipe usually has a North (+) pole at the end of the magnetic section. This is consistent with induced magnetization when drilling vertically in the Northern Hemisphere. The motor tends to have completely random polarity.
- One recommendation is to degauss your BHA components. AC works better than DC methods.
- There is an explanation of magnetic domains and remnant magnetism in the slides.

- Also refer to ISCWSA #35, Presentation #12.

(Question)

- Adrian Ledroz – Is it common practice to share direct measurements of BHA magnetism with 3rd party correction providers? Answer – No that is not common.
- Frank Gilmore – If you are doing corrections to account for this, is that not good enough? Where's the limit if you're doing MSA? Answer – Don't drive the z-axis magnetometer off the scale. A lower limit is preferable though.
- Roger Goobie – As we go into automation, is there any type of digital gaussmeter that can be installed on the rig to measure this as you run in and out of hole? Or is that not a good idea? Answer – I can't see a good automated way to do it, but there could be better instrumentation to do that. Roger – Maybe you should think about whether or not we should make recommendations in this space. Answer – The appropriate place to do degaussing is after particle inspection, and that would probably be a good way to reduce this problem.
- Robert Wylie – A lot of magnetometers are calibrated in Earth field only. Have you considered the nonlinearity of the magnetometer toward the top of the range when that's not typically calibrated. Answer – Yes, that could be an issue.

Officer Elections

(Ross Lowdon)

- The positions up for election are:
    - Secretary
    - Treasurer
    - Webmaster
    - 2 Directors at Large
- The election results are as follows:
    - Treasurer: Robert Wylie
    - Webmaster: Phil Harbidge
    - Secretary: Ryan Kirby
    - Director at Large 1: Chad Hanak
    - Director at Large 2: Anas Sikal

Drone Magnetic Site Surveys to Verify Wellhead Locations

(David Velozzi)

- Devon conducted a major study verifying over 10,000 well locations with GPS. There was a mean distance offset of 67 feet, and a 95% confidence interval of 200 feet. The recommendation was to assume 200 feet of uncertainty for any well location that has not been verified.

- There has been a lack of historical location of well locations, which leads to an incomplete well database.
- This is an attempt to identify unreported wells via their magnetic signature.
- The drone dangles a housing that contains the magnetometer sensor. The drone flies at an altitude of 35 meters above ground, with the sensor 5 meters below that.
- The main lines are flown at 15 meter spacing in the North/South direction. Tie lines are flown East/West at 35 meter spacing.
- The result is a map of total magnetic intensity. The first thing that happens is a "reduced to pole" analysis. The first thing to do is eliminate all the culture. A nonlinear filter approach is used to remove the shorter wavelength surface structure signals. These short wavelength anomalies are pinpointed and then verified in the field on the ground. Then the well-based culture is separated from the other surface culture.
- There are two examples of this process in the presentation.
- In the first study, 18 point magnetic anomalies were identified. When the results had the reported well locations overlain, there was quite a bit of location error evident.
- A mean offset of 38 meters was found, with a maximum of 73 meters. Older wells tend to have poorer location knowledge. The younger wells had an average distance difference of around 13 meters.
- Several unreported P&A wells were suggested in one of the studies. Ground verification can help reduce false positives. In this study the average offset from reported locations was 9.4 meters, with a maximum of 17.7 meters.
- There is the intent to add more sensors to the drone to enable more capability.

(Questions)

- Mike Attrell – What was the confidence level of your measurements in terms of meters? Answer – There was an uncertainty of +/-4 meters between the airborne interpretation or the ground interpretation. We don't necessarily have to do a ground interpretation, but for the second case study the customer needed elevation.
- Ed Stockhausen – There could be a lot of legal ramification for what you are doing in terms of finding missing wells. Also, are you legally allowed to fly over someone's property. Answer – We are licensed, which means you can fly a drone as long as there is no one out underneath it. We relied on our client for that part of it. Part of the area was over a housing area, so we started with the less populated farming area.
- Pete Clark – You said when you went out with a magnetometer there was sometimes nothing there. Would those have been vehicles? Answer – Yes, they were spudding one of the wells, so there was vehicle activity in the area. There is an interpretation component.
- Mike Attrell – Do you have survey plat consultants in your group that do the processing? Answer – If we get to that point, we will subcontract that out.
- Steve Sawaryn – What do you do after you've found these offsets? Do you report them or anything similar? Answer – It's up to the client in terms of what they want to do with the data. We just provide interpretation and data.
- Carol Mann – You mentioned the older wells have a larger offset than younger wells. What was the age limit for the younger wells? Answer – 30 years and younger. In the second case study, I didn't show it because the wells were fairly new.

- Manoj Nair – What's your accuracy for altitude determination? Because the signal decays fairly quickly with distance? Answer – Not really sure.

Sub-committee Activity Report: Education

(Carol Mann)

- Steve Sawaryn is our SPE Distinguished Lecturer. He is booked in 5 cities so far, all in the US. Please contact your local chapter and request Steve visit as a Distringuished Lecturer.
- Webinars: We have done three to date. Looking to do 2 to 4 per year. We have one brewing, but a date in November has tentatively been selected. The topic will be the economic impact of wellbore positioning errors.
- Pete Clark's arm is also being twisted to present on RP78.
- The SPE is no longer allowing us to do topical lunches, so that's why one didn't happen this time.
- We did participate in the half day special session with DSATS.
- We have done Applied Technology Workshops. We have a small task group looking at creating a cross disciplinary workshop with the topic of how wellbore positioning affects the bottom line.
- The PowerPoint slides are done and will soon be available to distribute. They describe the purpose of the ISCWSA.
- Phil mentioned the proposed website changes. We are working with him to update the content. Short videos are a high priority, and Ross Lowdon is spearheading this effort.
- Version 2 of the ranging e-book is under work. Send comments to Carol, Roger Goobie, or Benny Poedjono.

(Questions)

- None.

Ranging E-Book

(Roger Goobie)

- In the first week after launching the book, we had about 7000 hits. To date, we are at about 20,000 hits.
- We received a large amount of feedback and some additional graphics that can be used to enhance the e-book.
- We should be able to roll out the updated one in the Spring.

(Benny Poedjono)

- Some recent updates have occurred in the active and passive ranging sections. Also new developments in acoustic ranging were added. There is also a new section on resistivity-based ranging that is being added.

Secretary's Report

(Chad Hanak)

- Email distribution will be changing per SPE's request. Please be responsive if you get correspondence requesting approval to receive emails from the ISCWSA.

(Questions)

- None.

Closing Statement

(Jonathan Lightfoot)

- Thanks to all of the sponsors (MagVAR, Wellbenders, and BenchTree) and attendees for participating.
- Thanks to the officers for helping to put this event together, and to those who submitted abstracts for presentations.
- Also, thanks to the individual companies that supported your attendance at this meeting.
- The next meeting is a bit unclear yet (somewhere in Europe). Check the website.
- The 50th meeting will be in Calgary, Alberta, Canada.