SPE-199669

Early Identification of Drilling Collision Risk Using MWD Survey Quality Data

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Current Climate

- Increase in close approach drilling
- Diluted expertise
- Push for automation

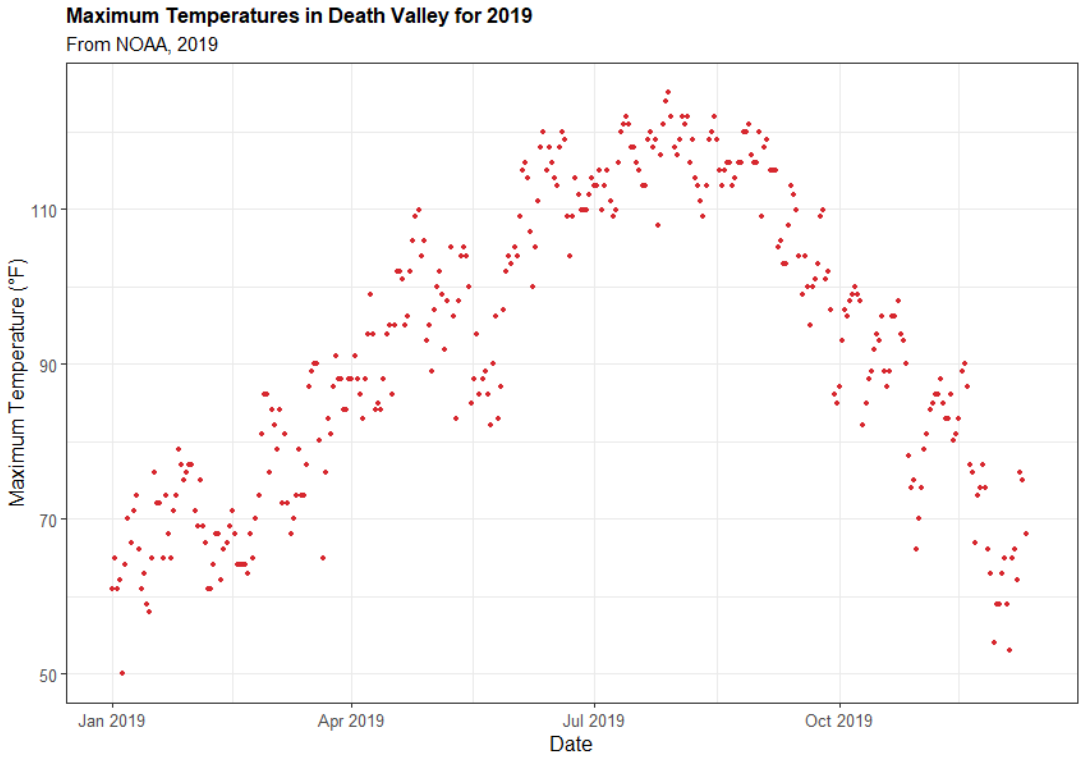
Overview of Concepts

- Management by exception
  - Remove need for active monitoring
  - Need to implement thresholds
  - Like smoke alarms
    - Need to know if action is required

- Escalation
  - Does an expert need to act?
  - Need a defined escalation workflow

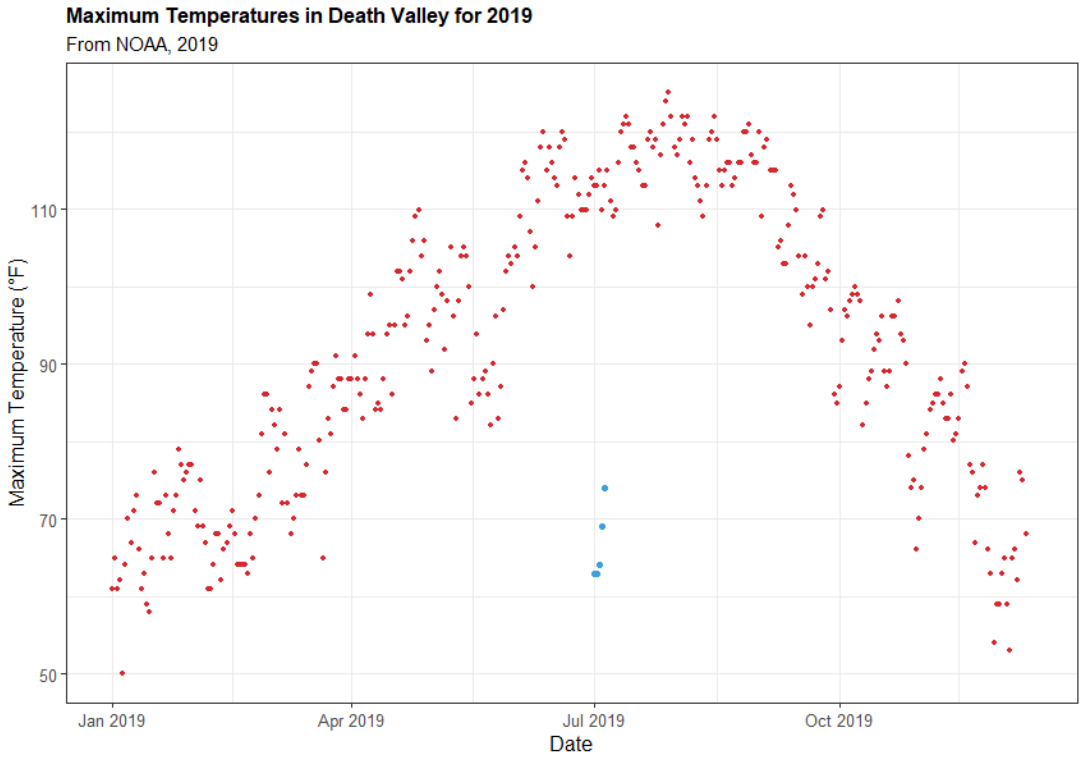
What is Considered “Out of the Ordinary”?

Let's Talk About the Weather



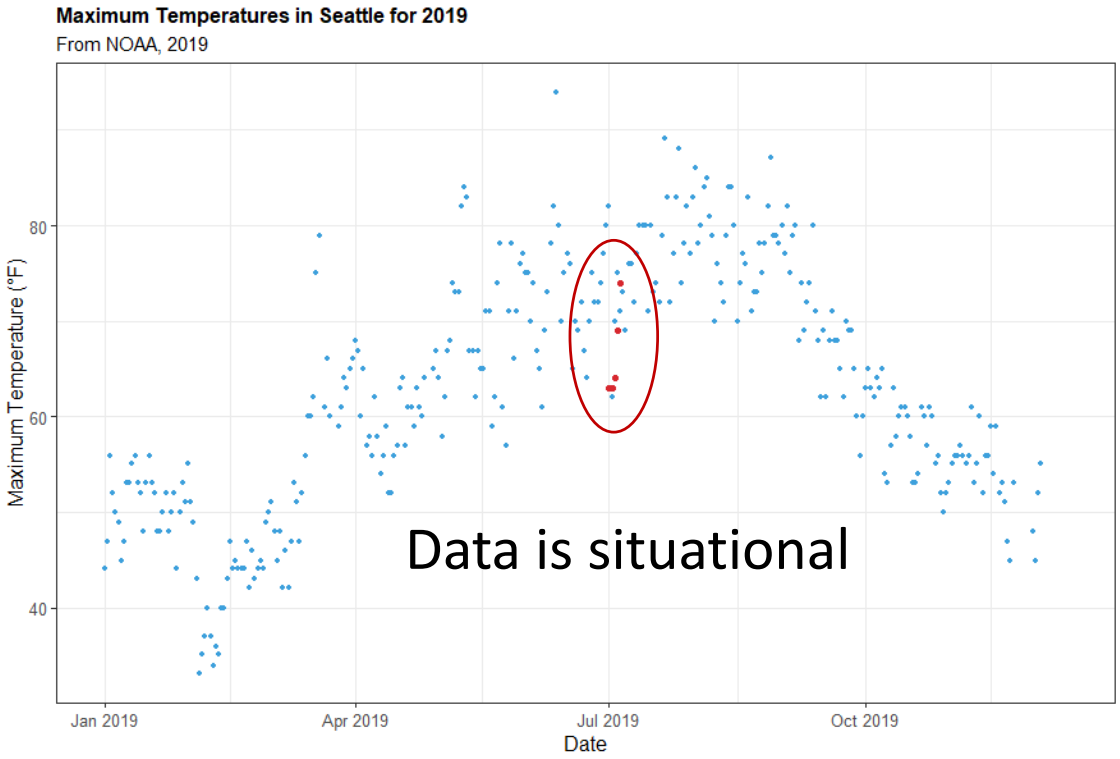
- Death Valley Maximum Temperature

Let's Talk About the Weather



- Death Valley Maximum Temperature
- Unknown Data

Let's Talk About the Weather



- Expected Data
- Seattle Maximum Temperature

Background on Downhole Magnetic Data

- MWD tools measure physical properties to determine BHA orientation
  - E.g. Magnetic Field
- References are used to know how much we “should” be measuring
- Expected errors are defined by an “error model”
- Anything external (i.e. offset casing) can cause “unexpected” errors

MWD QC Data With Signs of Interference

- Data may be *expected* to fail traditional QC
- Data may look nominally “good”
- Data may not need continued monitoring

Escalation to an Expert

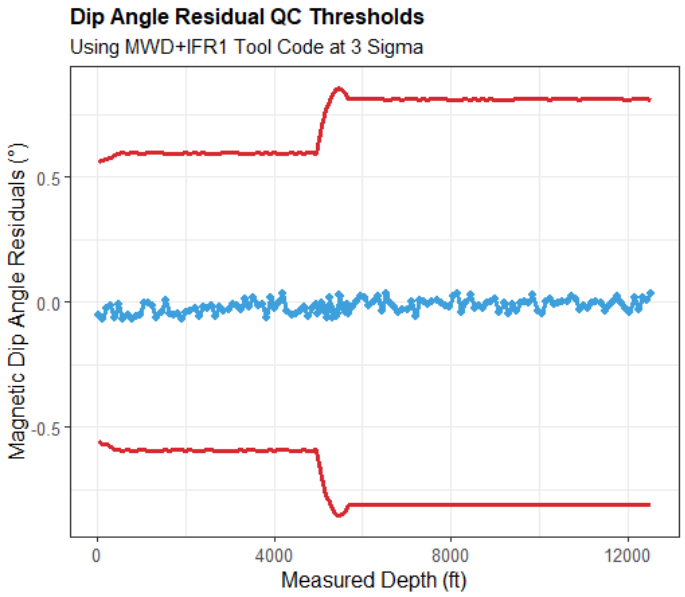
- Need for escalation should be **clear**
- Escalation should be **immediate**
- **Duration** for active monitoring should be apparent

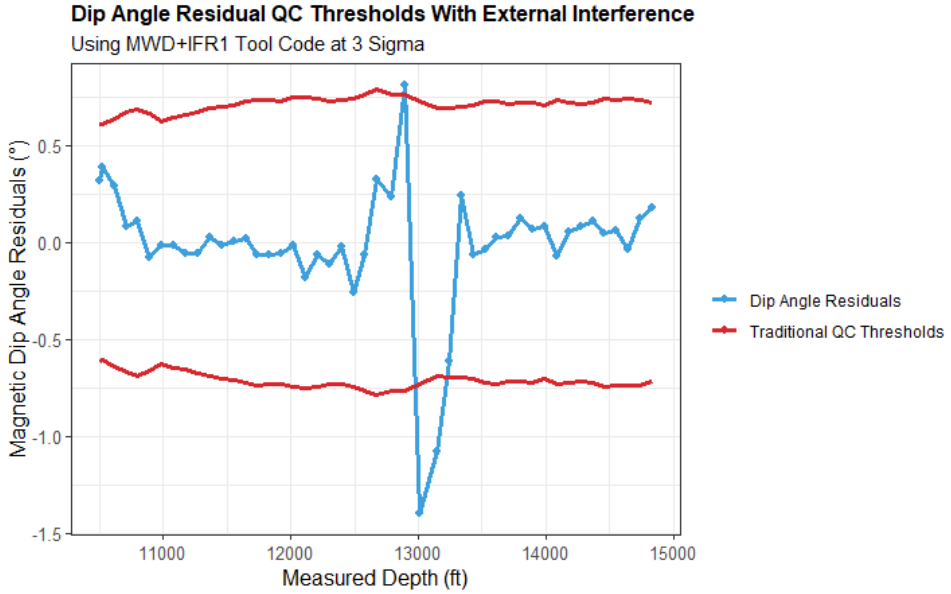
What is Considered “Out of the Ordinary”?

“Marginal Sigma” can help detect unexpected behaviors within a dataset

SPE-194179 (Marc Willerth and Stefan Maus, H&P Technologies)

Example Scenarios

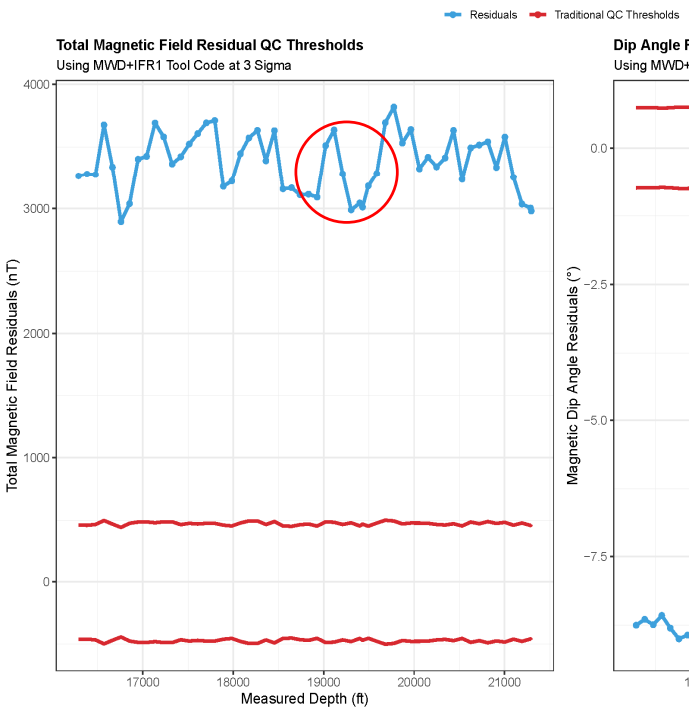


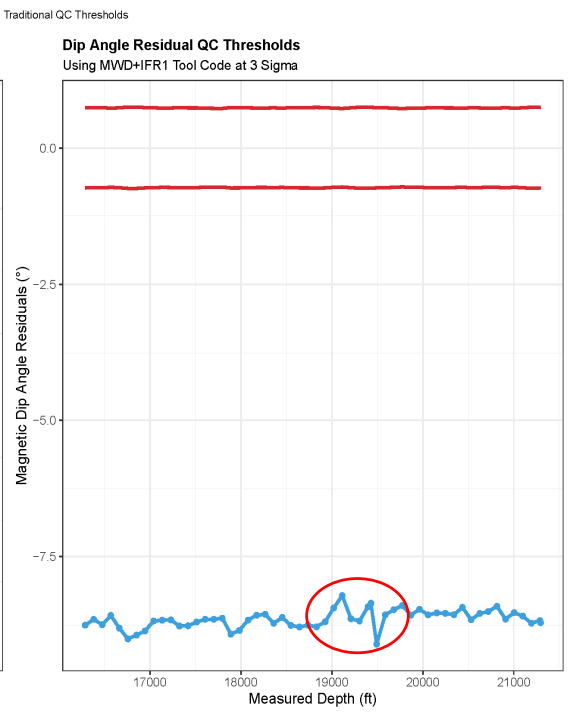


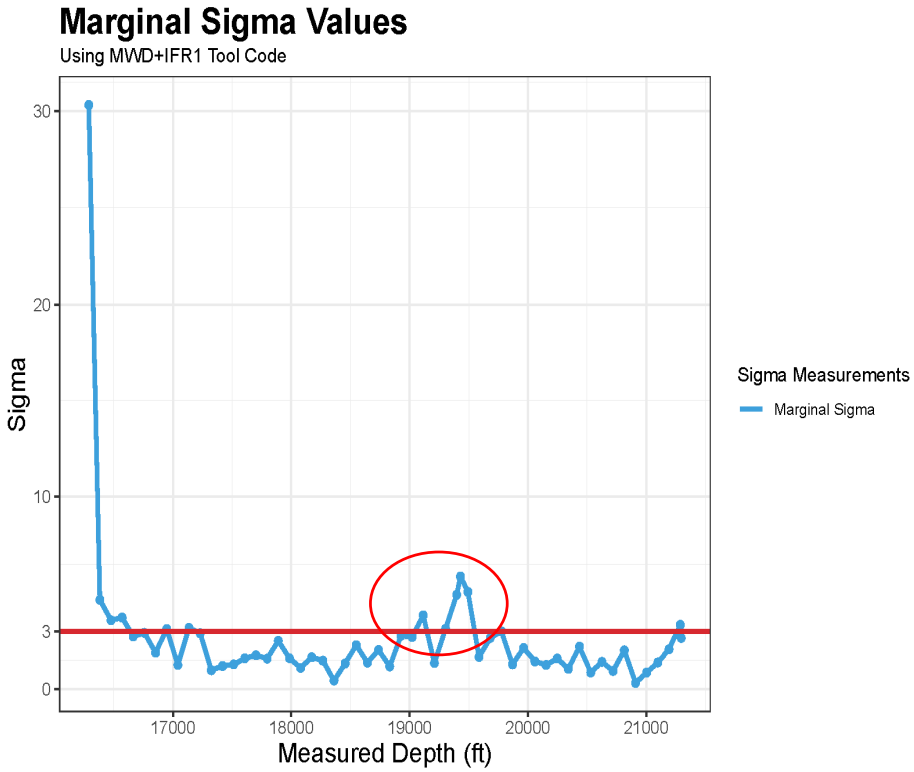
Collision Avoidance Case Studies

- Pad drilling
- Sidetracks and downhole fish
- Lateral parallel wells
- Excluded:
  - High angle of incidence (perpendicular); Unobservable with MWD QC data

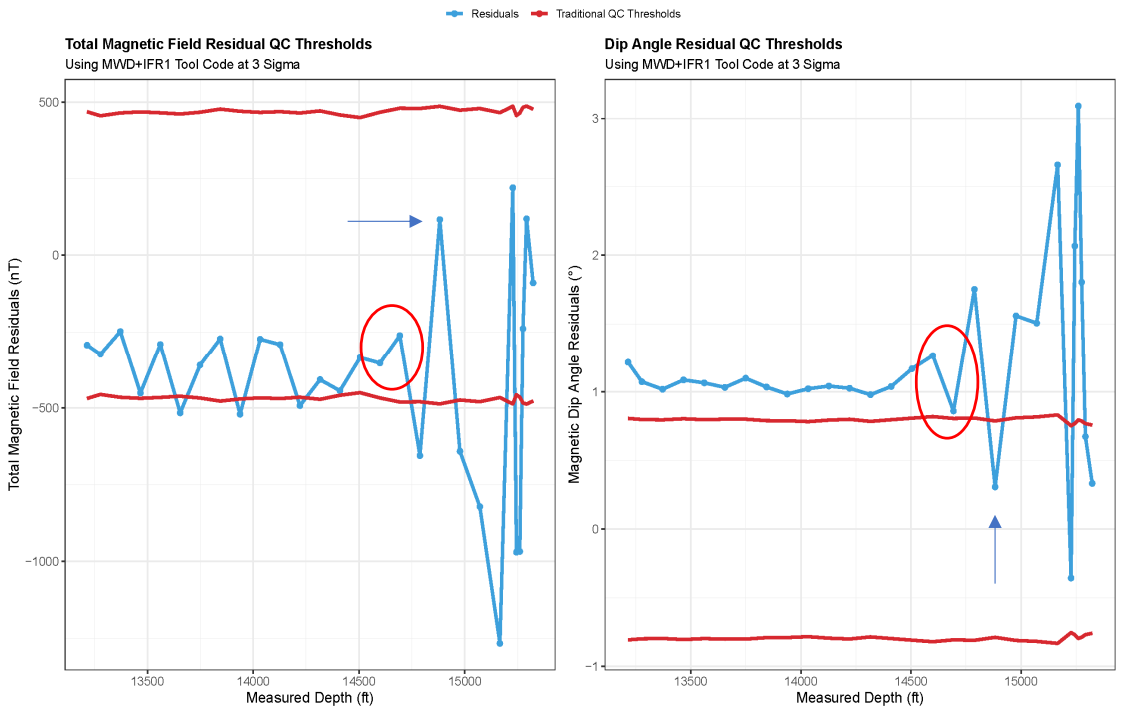
Escalation Should be Clear

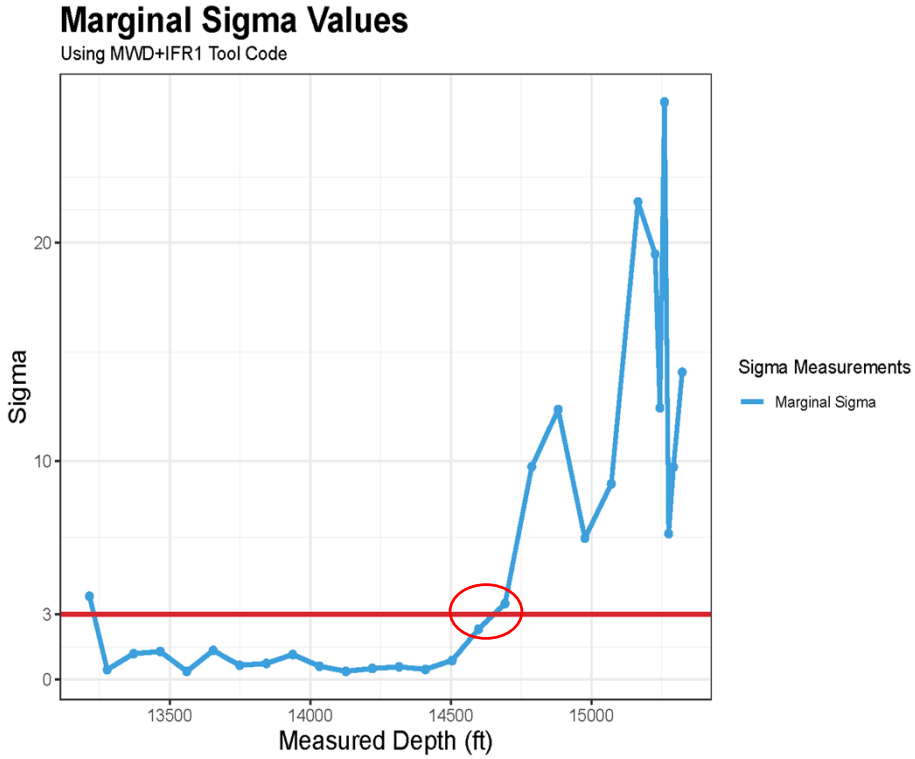






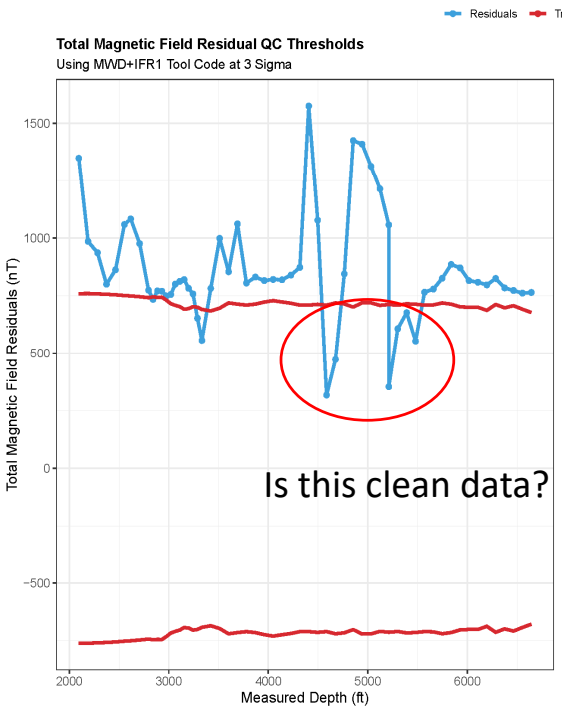
Escalation Should be Immediate

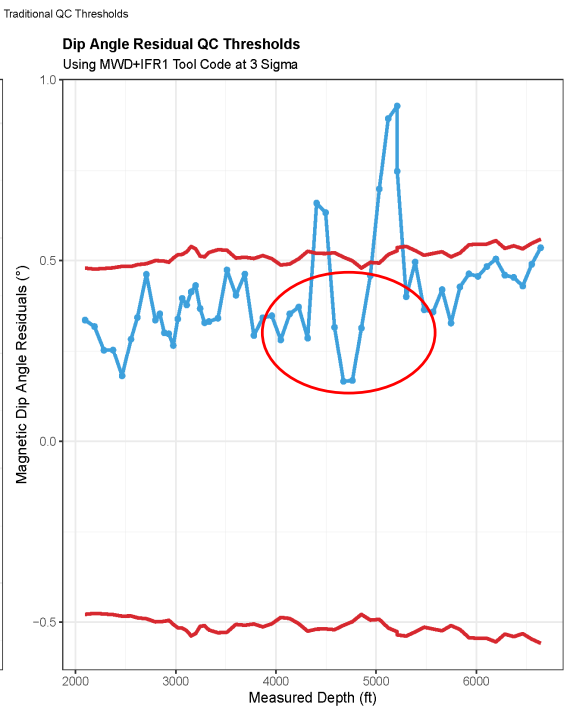


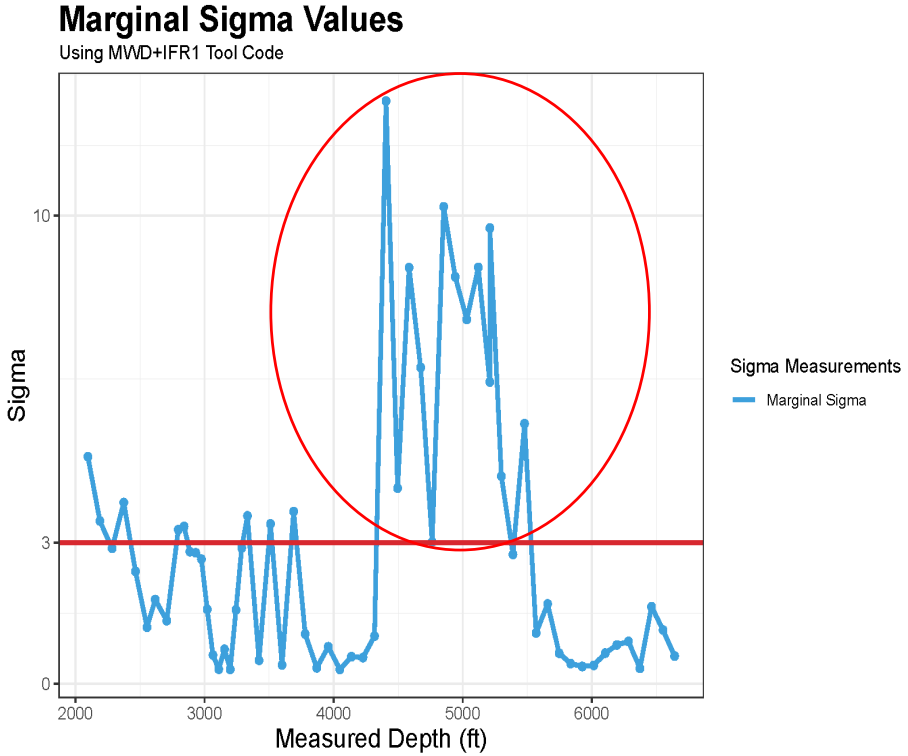


When should escalation begin?

How Long is Monitoring Needed?







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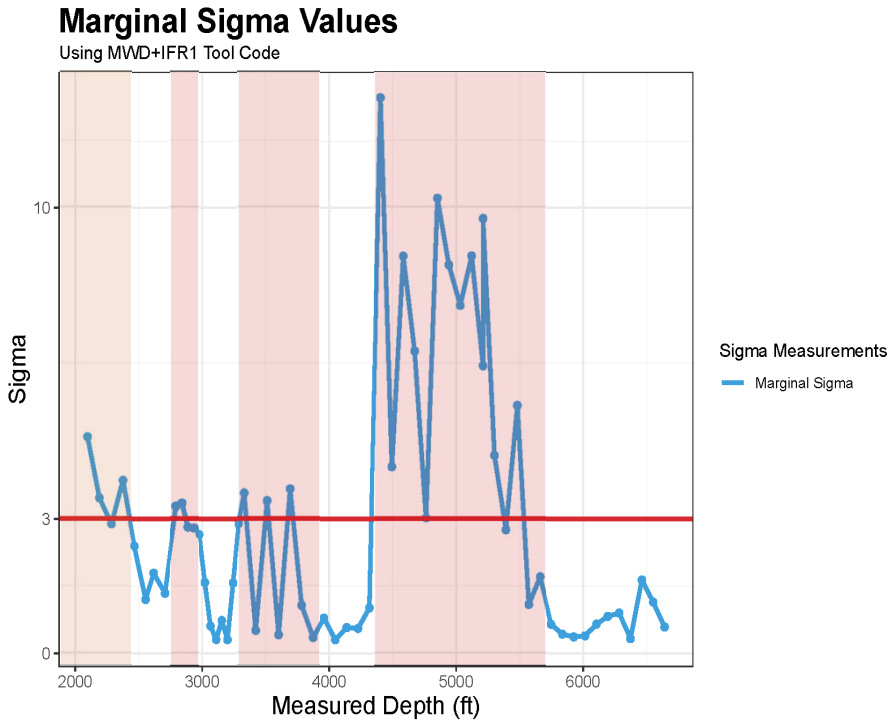


51st Meeting – 5th and 7th May 2020

Recap

- Marginal sigma defines a “conditional expectation” for survey QC data
- Clear & immediate warnings in a variety of close approach scenarios
- Works even in challenging cases for humans
- Suitable for a collision avoidance management by exception system

Acknowledgements / Thank You / Questions

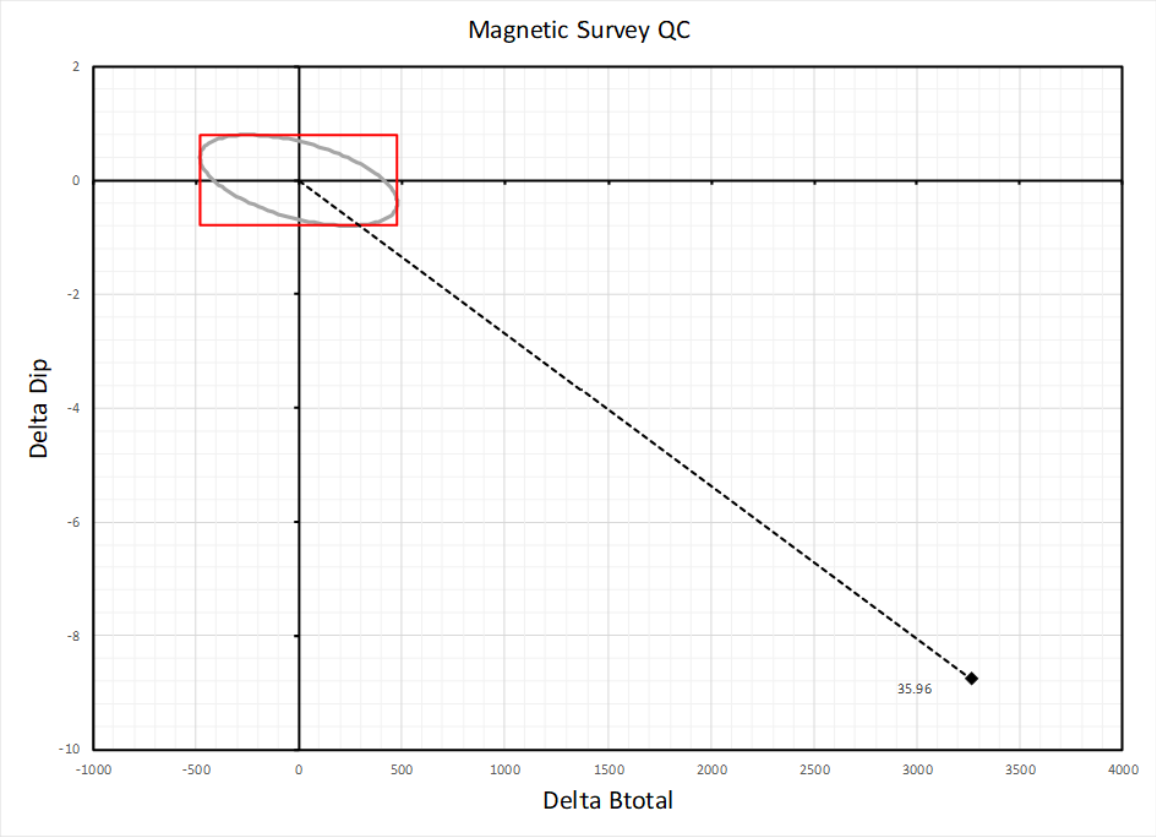
Thank you to H&P Technologies, the H&P Technologies Denver Real-Time Center and ISCWSA

Appendix

- Different ways to visualize Marginal Sigma data

Another Way to Look at the Data

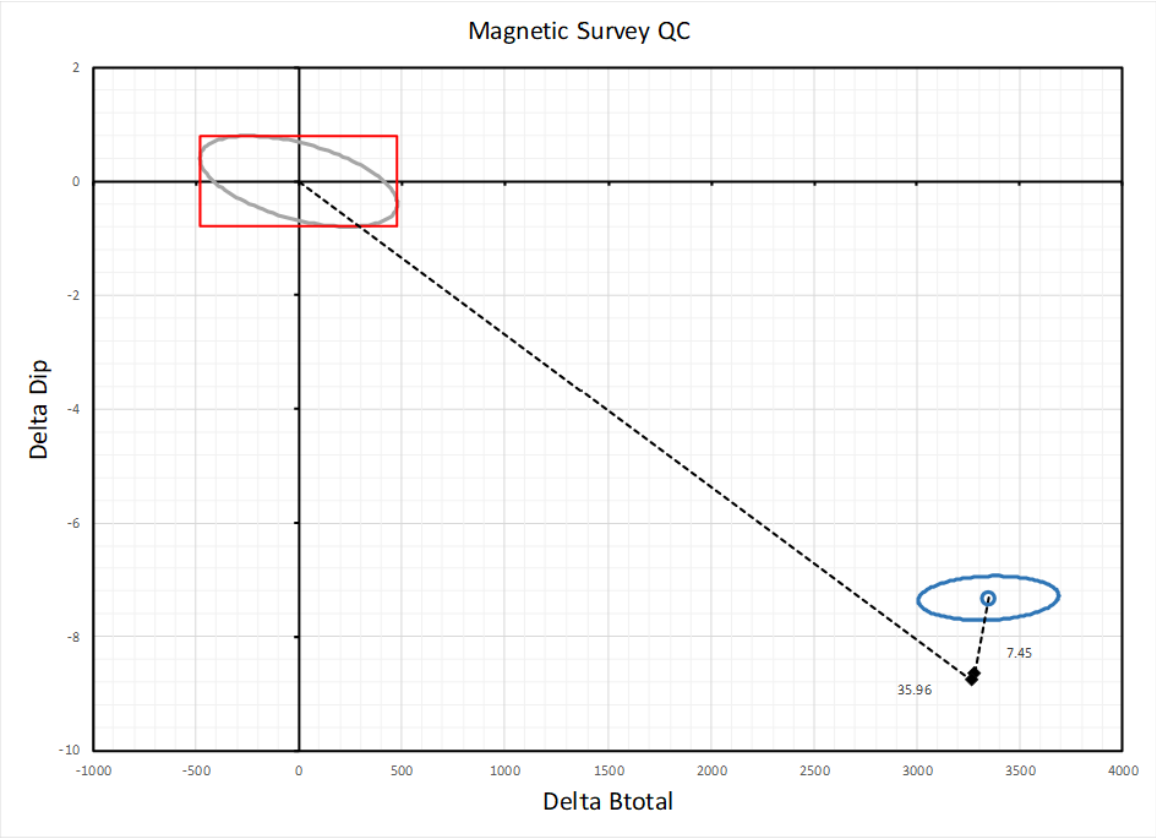
- First survey of the run
  - What does the tool code expect?
- "Box" is traditional tolerance
- Ellipse is conditional error covariance
- Is this systematic or random?



- Second survey of the run
  - We expect certain behaviors

- Errors are large but systematic

- Define a new conditional center



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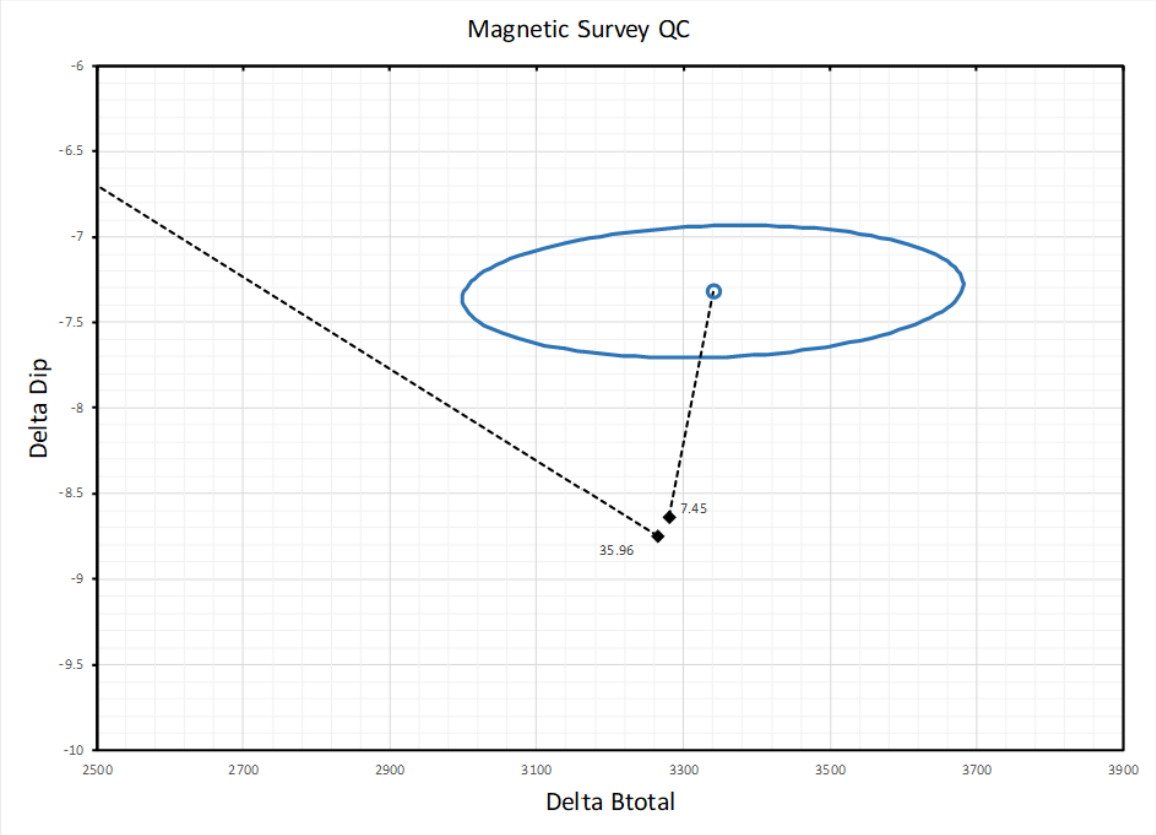
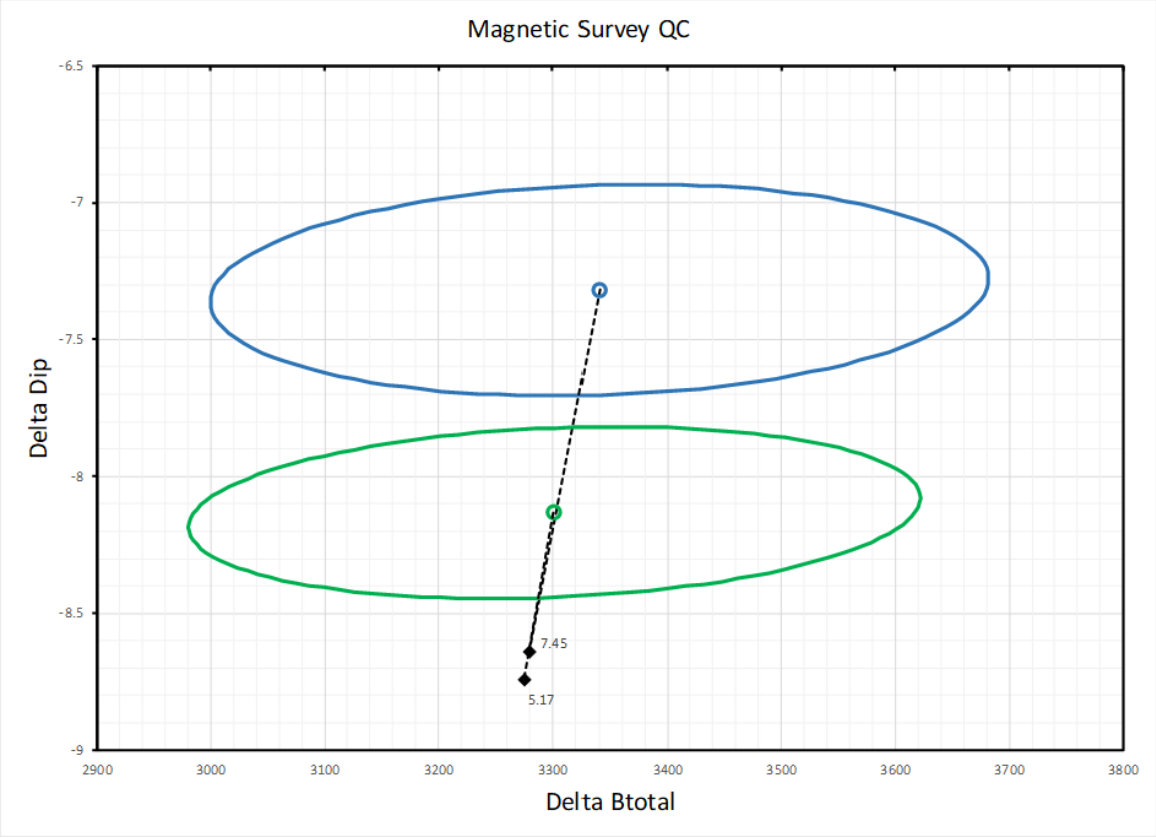
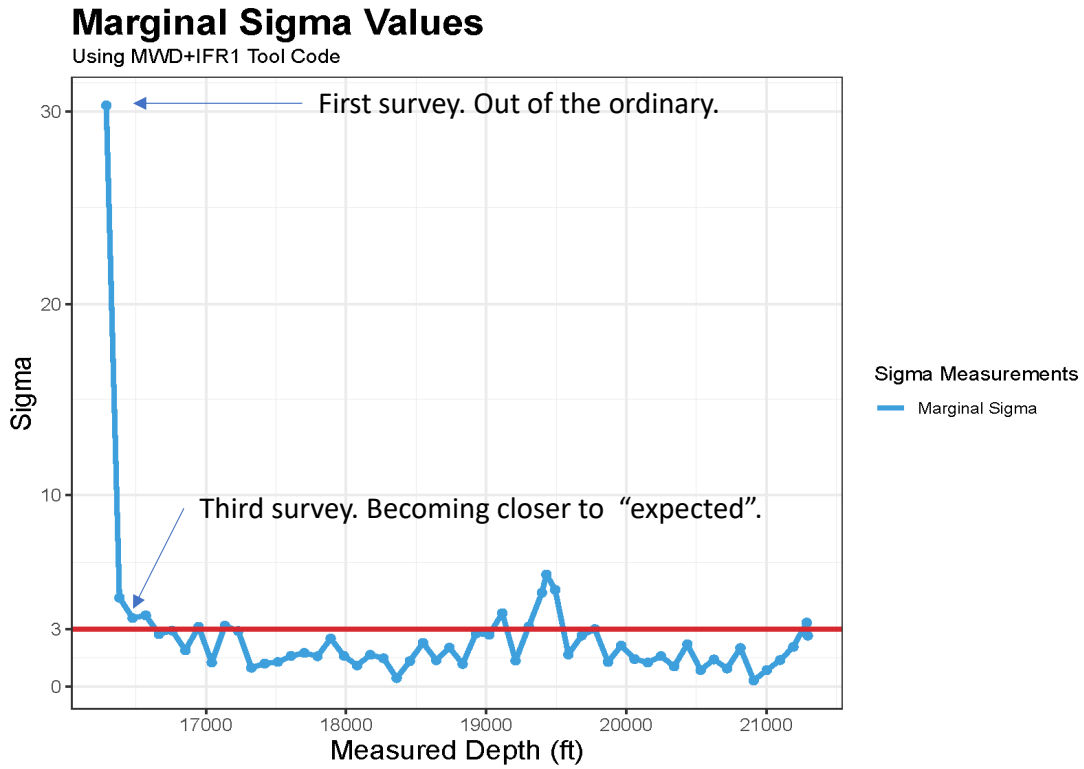


- Third survey of the run
  - We start to close in on a center

- With several more surveys we expect to start enveloping the data




Marginal Sigma Values
Using MWD+IFR1 Tool Code
First survey. Out of the ordinary.
Third survey. Becoming closer to "expected".
Sigma
30
20
10
3
0
17000
18000
19000
20000
21000
Measured Depth (ft)
Sigma Measurements
Marginal Sigma