

Magnetic Mud

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Speaker Information

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Speaker Bio

- PhD at University of Stavanger, Norway
- Applied physics for the Oil&Gas
- Previously:

Geophysicist, ENI

Material Engineer, MediaLario

Physicist, valves design, ATV

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- www.uis.no
- Areas of expertise:
 - Offshore engineering
 - Enhanced oil recovery
 - Multiphase flow
- Petroleum Physics group: provide mathematical and physical expertise to engineering challenges

The magnetic drilling mud

- When the drilling mud is contaminated by magnetic materials, it become itself magnetic
- A magnetic mud alters the geomagnetic field at the MWD assembly
- Thus inducing an error in the magnetic measurement
- The problem is known since 20 years, SPE71400, SPE87169, SPE113206, etc.
- Many gaps in understanding the effect and in predicting the error

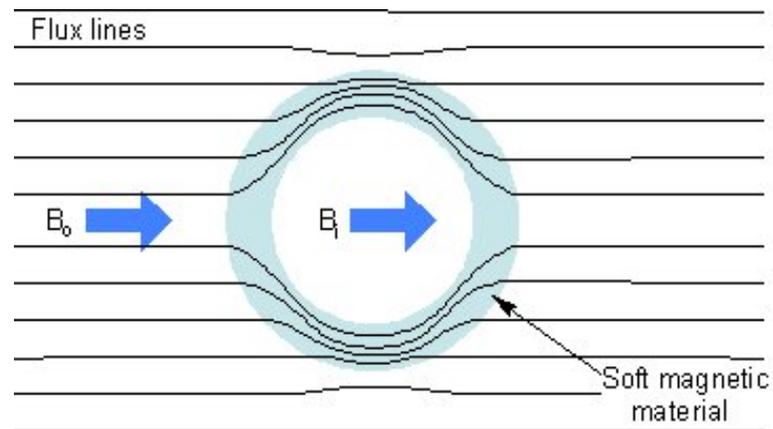


Image: physics.stackexchange.com

Occurrence

- **Only when doing magnetic survey..**
- **Magnetic ingredients in the mud recipe (Ilmenite, Hematite, contaminated batches)**
- **Heavily used mud**
- **Error enhanced when drilling at high latitudes**

Size of the error:

- 2.7 % attenuation of the magnetic field (SPE87169)
- 0.24° Azimuth error (OMAE2016-54044)

Best model so far

- Known the concentration of contaminants, the susceptibility should be $\chi=3\delta$
- All being centered, the only effect is an attenuation of the cross-axial component of the field, $S=1/4\chi^2$. A more precise relation duable for different BHA.
- The bias in measured field can be translated in Azimuth bias. (es. SPE71400)

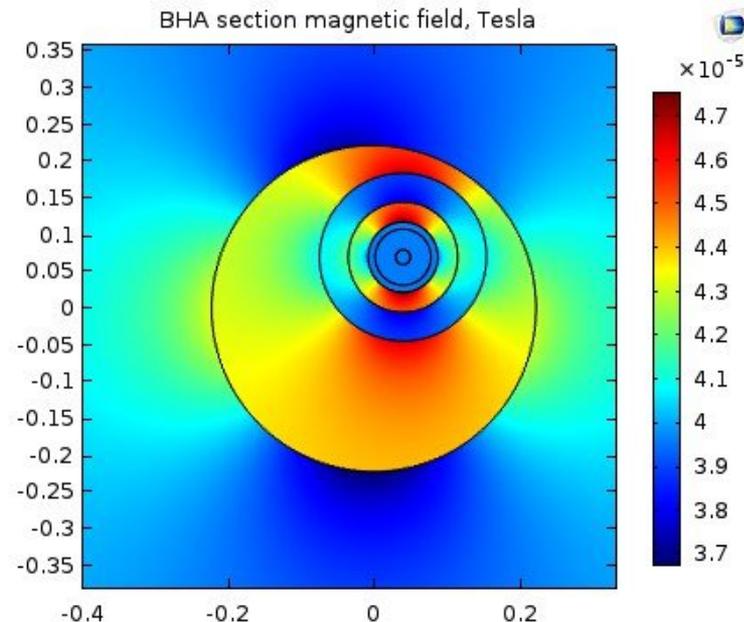


Image: OMAE2016-54044

Gaps / 1

- **Mud contamination and susceptibility are never measured (done only in the lab, after the drilling)**
- **And mud susceptibility will vary with time; main contribution today is steel swarf from abrasion of casing and drillpipe**
- **Install a sensor on each mud system?**

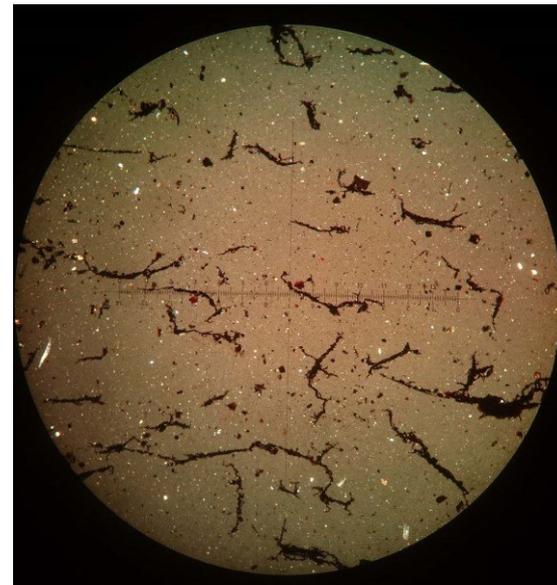
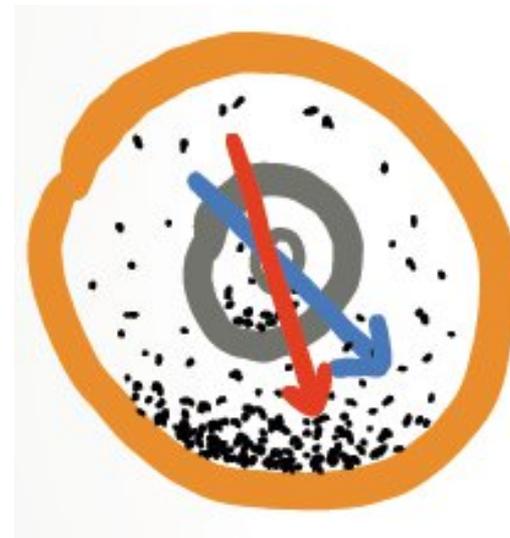


image: my phone

Gaps / 2

In horizontal wells, the heavy magnetic particles would likely settle on the bottom:

- Gives a strong tilt in the transverse magnetic field
- Settling hard to quantify
- A maximum effect (full settling) can be used for a conservative estimate



Gaps / 3

The relation between contaminant concentration and susceptibility is not so simple. Observed to depend on:

- Time
- Particles size
- Particles orientation
- Flow regime
- Mud viscosity, P, T, etc...

For a dipole model, the magnetization reads

$M=RL\delta$, $R=0.5$ Tesla, L somewhere between 0 and 1. Huge potential susceptibility.

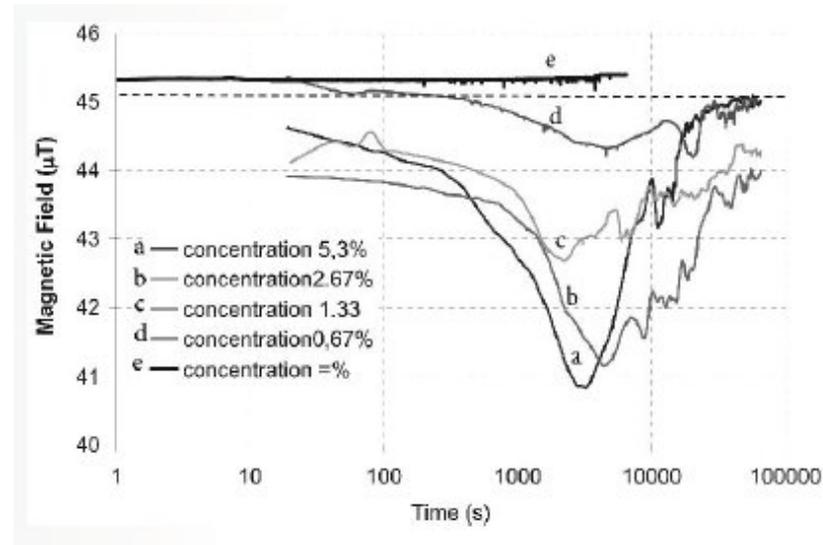


Image: Ding, S., Datta, B.K., Saasen, A. and Amundsen, P.A. 2010. Experimental Investigation of the Magnetic Shielding Effect of Mineral Powders in a Drilling Fluid. *Particulate Science and Technology*, 28: 86-94

Current practices

- **Ban of magnetic ingredients for the mud**
- **Use of ditch magnets in the mud system to try to remove contaminants**
- **Pumps on while measuring**
- **Magnetometer centered in the MWD tool**
- **Run a gyro survey**
- **Analyze the mud after the well**



Our research

- Model the mud, to get its susceptibility given the ingredients
- Mud in dynamic vs static conditions
- Effectiveness of the ditch magnets removal system

Target:

- Be able to always estimate the magnetic mud error
- Be able to remove the bias, when enough data are available
- Revise the usefulness of the current practices



Summary

- Magnetic mud affects the magnetic survey
- A base model: predictable cross-axial attenuation
- Difficult to apply
- Not included into the error model
- Some practices in place to avoid the problem
- I have 3 more years full-time to sort it out

Open questions:

- Is the issue worth further research?
- Why the first model have never been applied?
- Are the current practices effective?

