

TBL # 2: High-Resolution Magnetic Survey in Locating Abandoned Brine Wells in Hutchinson, Kansas: Xia and Williams

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Overview

Many improperly abandoned wells exist in Canada and the US. They are difficult to find as they are often covered by soil so they are not visible by eye. Their small diameter makes them difficult to locate by direct probing of the ground. In this case study, the authors use magnetic surveys to locate abandoned wells.

Instructions

Answer the following questions within the context of the 7 step framework. Your answers should be brief, and point form can be used where appropriate.

Resources

- [GPG Magnetics](#)

Setup

Q1. What (a) motivated the study? and (b) was the primary objective of the geophysical study?

Q2. The authors gathered background information about the problem at hand. Name two of the sources or methods they used.

Physical Properties

Q3. Which physical property is used as the primary diagnostic physical property? Why is it diagnostic in this setting?

Q4. An electromagnetic (EM) method was also considered.

a. (i) Which physical property is EM most sensitive to? (ii) Why would this physical property potentially be diagnostic?

b. Why is uniquely identifying an EM anomaly in a historical salt mining site a challenging task?

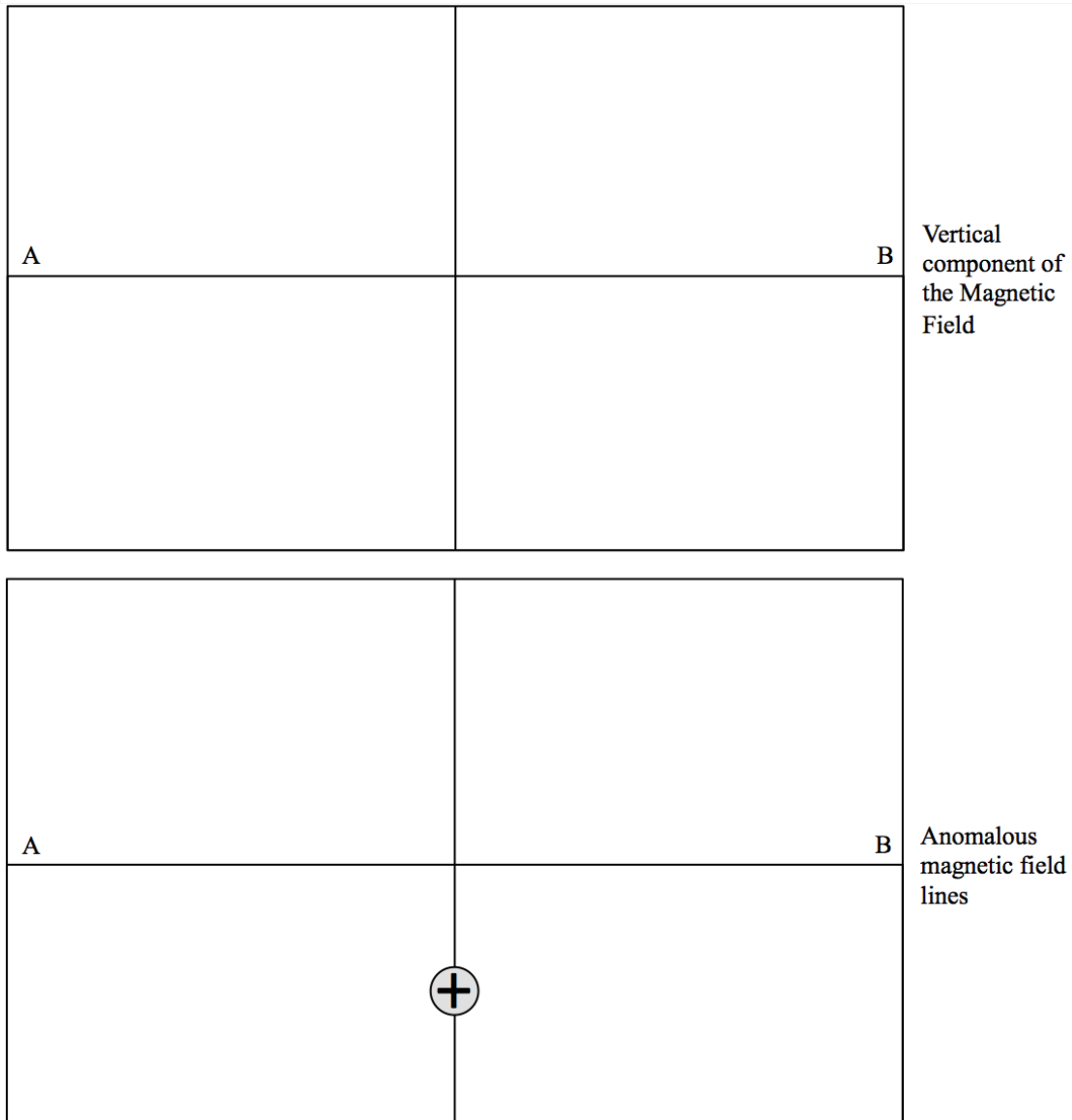
Geophysical Survey

Q5. What instrument was used and what was measured?

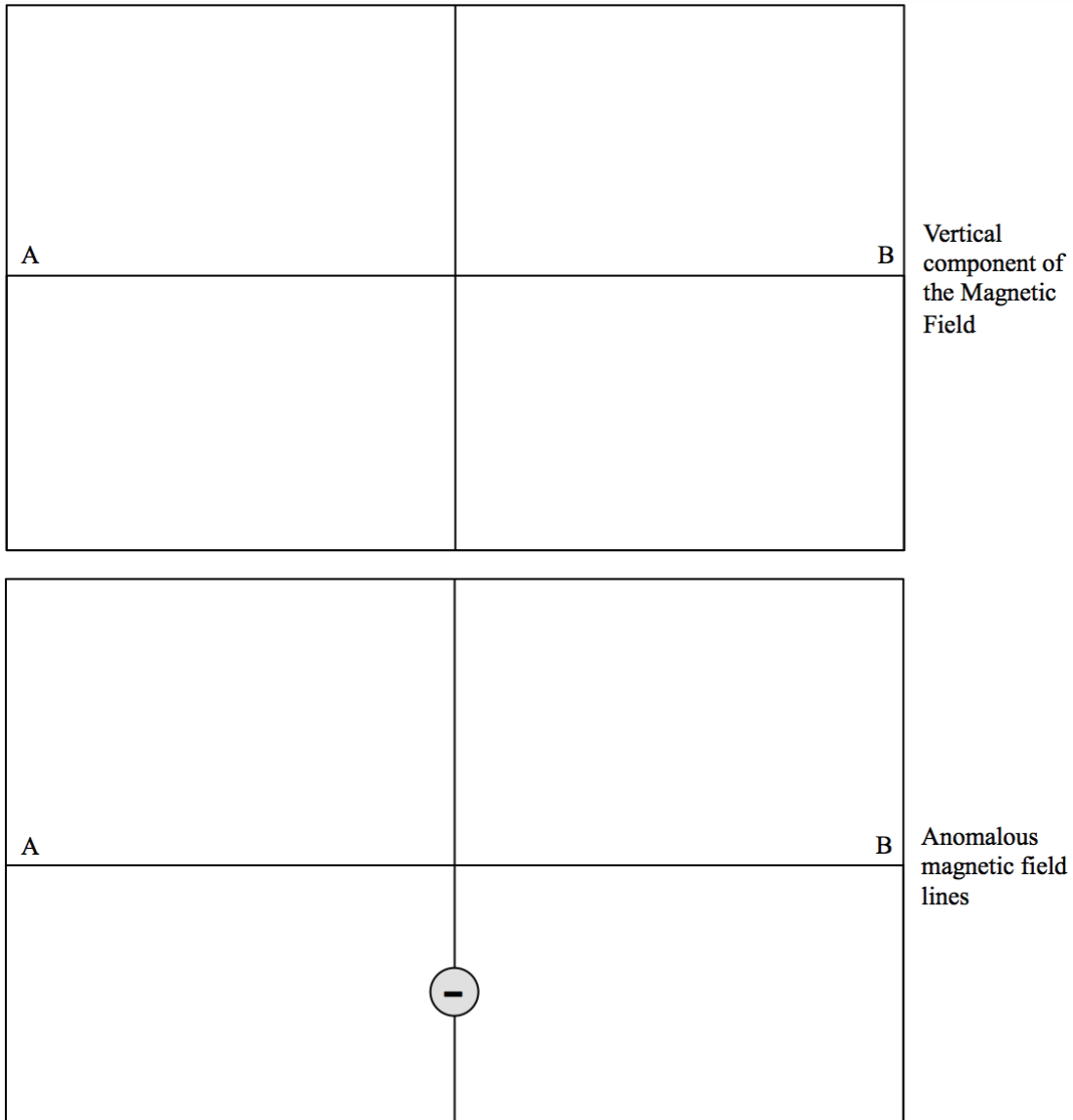
Q6. The sensitivity of the magnetometer is 0.01nT, but the overall accuracy they consider the magnetic measurements to be on the order of 1nT. Is this justified? Why or why not?

Q7. Often it is useful to think about magnetizable objects as having magnetic “charges” or “poles”, where the North pole is a positive magnetic charge and a south pole is a negative charge. In each of the following questions, you will make two sketches: 1) sketch the field lines in the bottom panel and 2) sketch the amplitude of the z-component of the magnetic field as would be measured along the collection line.

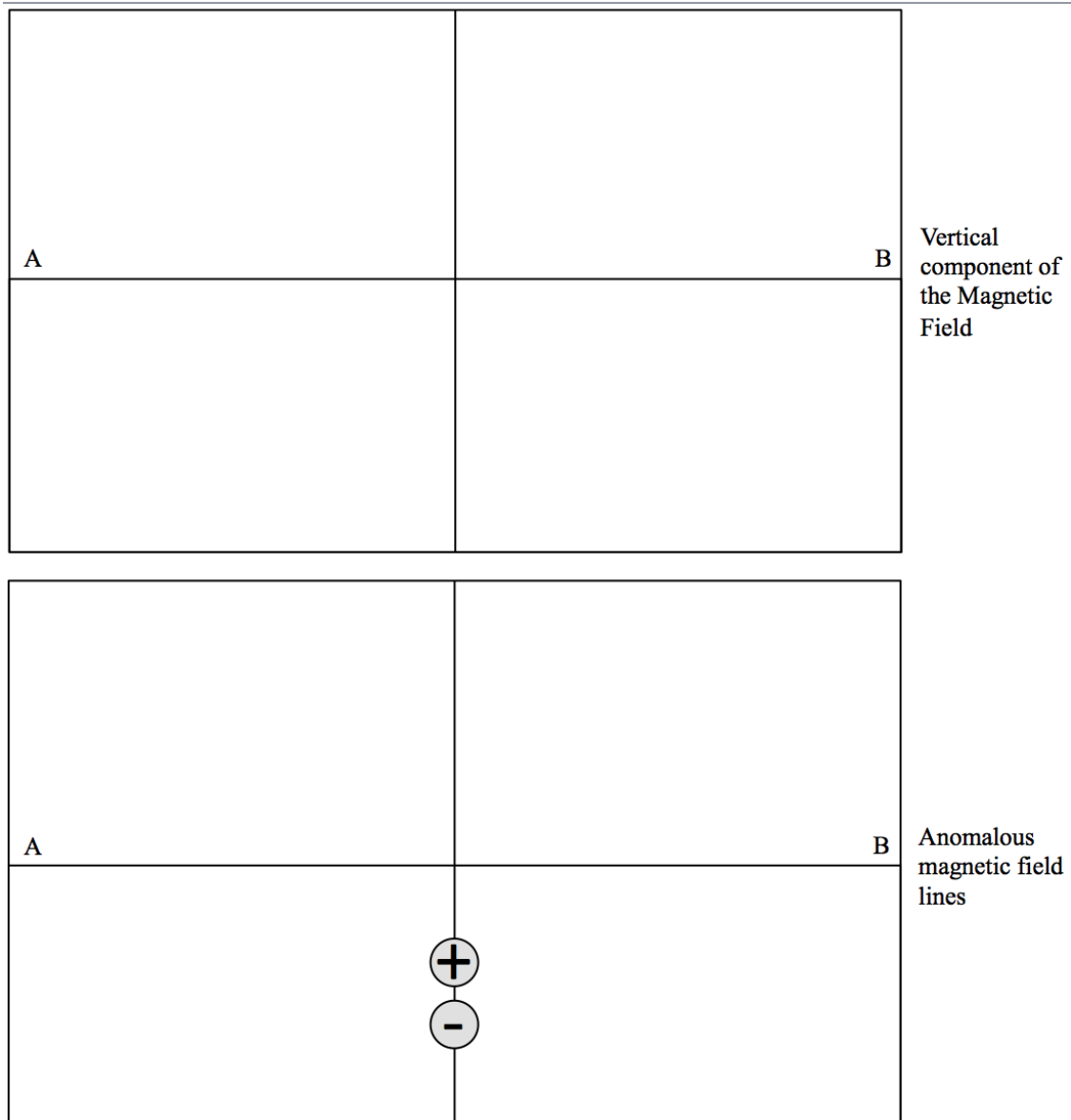
a. Sketch the field lines due to a single positive magnetic charge



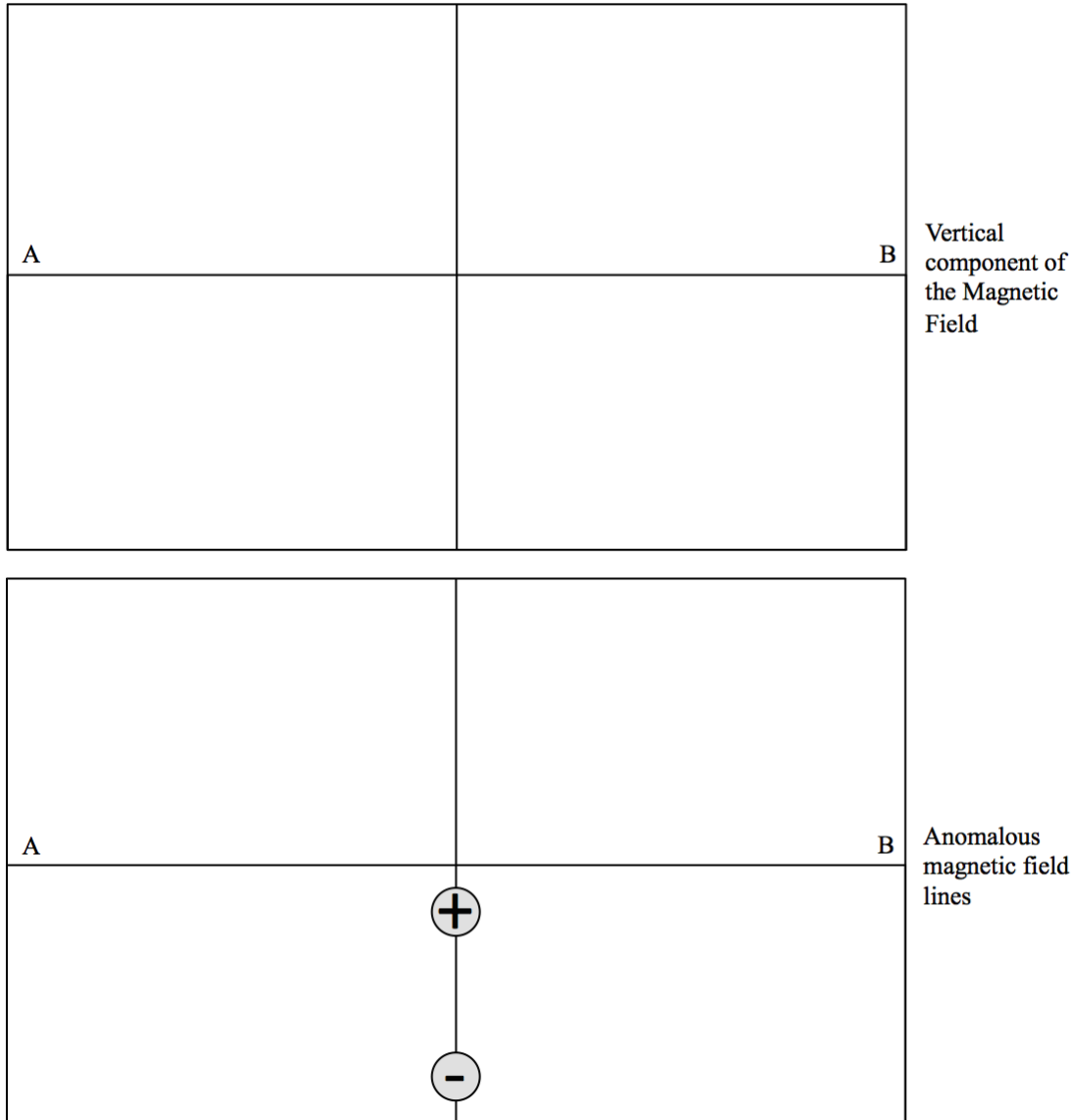
b. Sketch the field lines due to a single negative magnetic charge.



- c. Sketch the field lines due to a dipole, that a positive and negative magnetic charge.

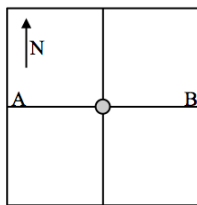


- d. Now, if the distance between the positive and negative charges is increased, sketch the expected fields and responses.

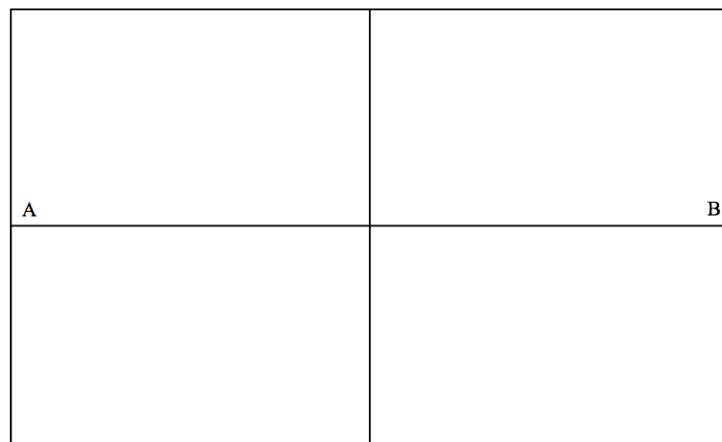


Q8. Buried, magnetizable objects, can be thought of as being composed of magnetic charges. In each of the following, you will sketch 2 diagrams:

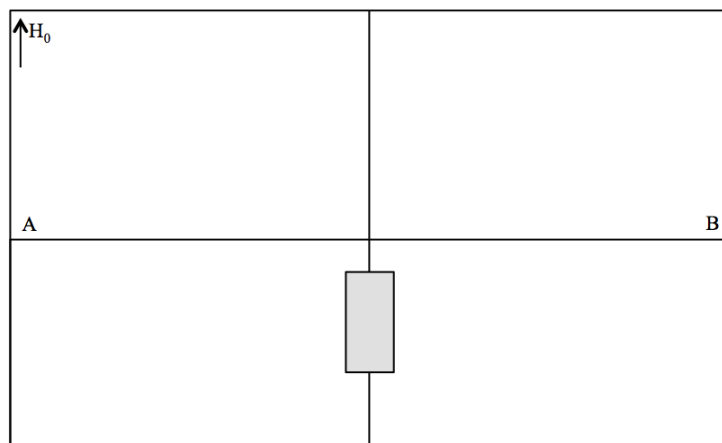
- Anomalous magnetic field lines (bottom plot)
 - include the location of the magnetic charges within the pipe
 - show the magnetization direction
- Profile of the total field anomaly that goes directly over the pipe (top plot)
 - a. Provide the requested sketches for a survey over a short segment of vertical pipe in which the inducing field is directed vertically upwards.



Map with profile line

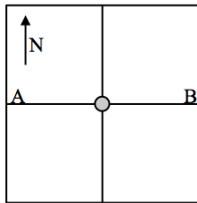


Profile of the total field response

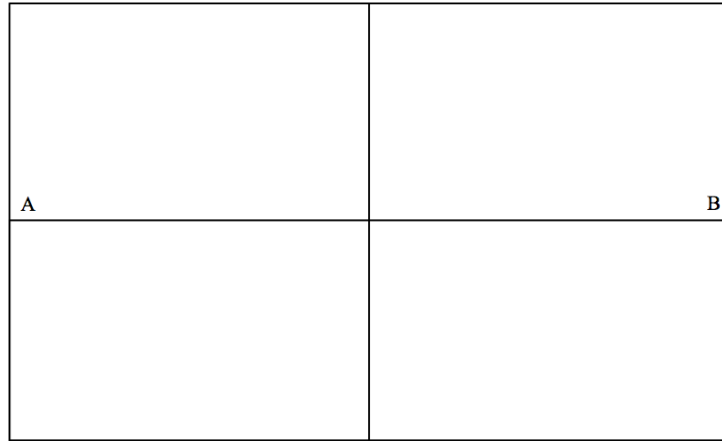


Anomalous magnetic field lines

- b. Provide the requested sketches for a survey over an abandoned well which extends to depth when the inducing field is directed vertically upwards.



Map with profile line



Profile of the total field response



Anomalous magnetic field lines

- c. Why is the anomaly referred to as a monopole anomaly?

Data Collection

Q9. What was the acquisition strategy for the data collected?

Q10. Why was a base station not deemed necessary?

Q11. What is a Kp Index?

Data Processing

Q12. Prior to gridding the data, the authors mention 3 processing steps.

a. What are those steps?

b. Using Figure 1b as a reference, explain why the sensor location on odd vs even lines may need to be shifted relative to one another?

Q13. What does it mean to “grid” the data?

Q14. Once the data were gridded, how were anomalies picked?

Data Interpretation

Q15. What other objects had an anomalous magnetic signature, but were identified as false positives (i.e. not a target of interest)? Name three:

Q16. For each of the figures identified in the table below, record the maximum anomaly amplitude, the half-width, your calculation of the depth to the top of the well and the value reported in the paper. Assume the magnetometer is at a constant height of 3ft (1m) above the surface. For a monopole anomaly, the depth from the magnetometer to the top of the object is $z = 1/2x_{1/2}$, where $x_{1/2}$ is the distance from half-max to half-max, as shown in Figure below

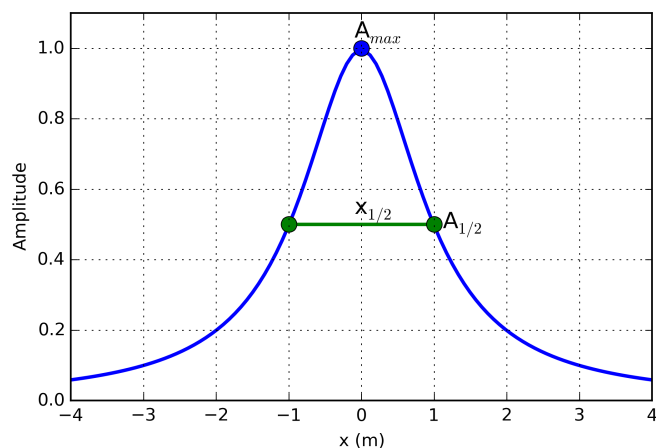


Fig #	Max Anomaly Amp(nT)	Half-Width (ft)	Calc. Depth (ft)	Reported Depth (ft)
6				
7				
8				
10				

Synthesis

Q17. Were the objectives of the study met?

Q18. Once the survey has been completed, the question to be asked is: “Have you found all of the brine wells?,” Can you defend a position that all of the brine wells on the areas surveyed were discovered?

Q19. In some cases the anomalies were more complicated than that of a single monopole. If you were in charge of the digging, would you recommend that digging proceed anyway, or save time / money by moving to the next target with a monopole-like signature.

In the team TBL...

You will be estimating the depth to the top of the wells for several of the examples shown in the paper. Be sure that at least one team member brings:

- a ruler
- a laptop able to run the [Jupyter Notebook](#) and instructions are provided [here](#)