DEVELOPING EFFICIENT METHODS TO LOCATE LEGACY OIL & GAS WELLS

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ABSTRACT

The purpose of this project is to develop an efficient method to locate legacy oil and gas wells using an Overhauser magnetometer. Extensive research has shown that legacy/abandoned oil and gas wells can be potentially hazardous to the environment by leaking methane to the surface and/or contaminating shallow groundwater. In Arkansas, most plugged wells have all surface equipment removed leaving no visible trace at the surface and thus making the environmental assessment of these wells difficult. Using a magnetometer, magnetic anomalies from the metal casing can be detected in the general areas of suspected wells. In order to assess large numbers of wells, the typical anomaly size is critical to minimize magnetometer field work time. Little information exists on the size of these associated anomalies, therefore the primary purpose of this project was to define the typical anomaly size so as to optimize transect spacing and limit excessive time in the field. Here we show the results of five wells with a survey grid at two meter spacing. The average anomaly size was determined and transects with wider spacing were used to create additional grids to test the maximum transect size that can still detect the anomaly. Our preliminary results indicate that magnetometer surveys are an efficient tool to locate abandoned wells.

Results

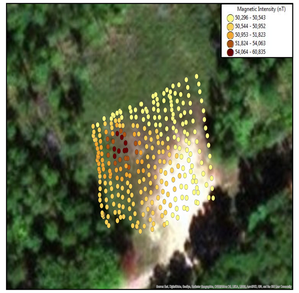


Figure 3.
Well Permit 23519 with 2 and 20 meter spacing

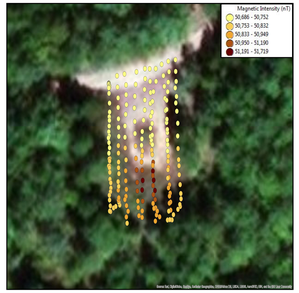


Figure 4.
Well Permit 34225 with 2 and 20 meter spacing

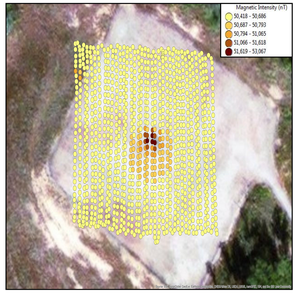


Figure 5.
Well Permit 44836 with 2 and 20 meter spacing

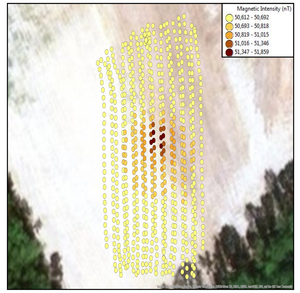


Figure 6.
Well Permit 44835 with 2 and 20 meter spacing

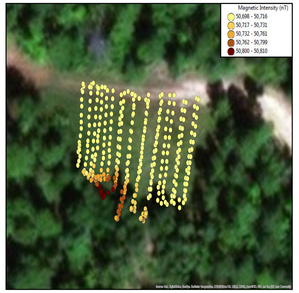
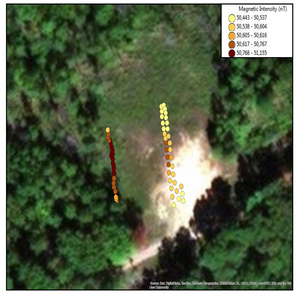
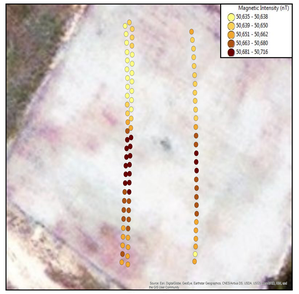
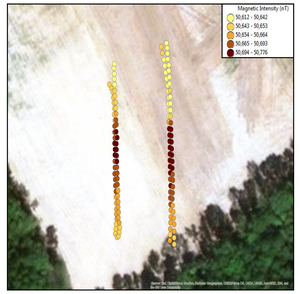
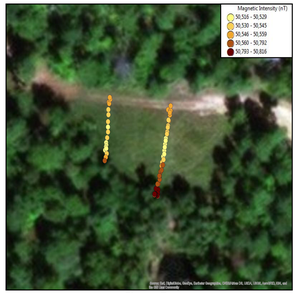


Figure 7.
Well Permit 25547 with 2 and 20 meter spacing









Background

Abandoned oil and gas wells are potential environmental hazards because they are a passageway for methane to leak out into the atmosphere, shallow subsurface, or deeper subsurface fluids to shallow groundwater (Davies et al., 2014). This problem is more common as wells get older (Boothroyd et al., 2016). Methane is a very potent greenhouse gas, many times more effective than carbon dioxide, so any amount getting into the atmosphere is a cause for concern. Many towns and cities have neighborhoods that get built on top of old wells that no one knows about because of the lack of surface expression. Any spark near methane that has built up in the subsurface can lead to dangerous oil and gas situations. Regulations in Arkansas state that after plugging, the well site location should be returned to land capable of cultivation. This has been interpreted by operators to mean the well head must be cut off below ground surface (usually 3-6 feet), which makes finding the wells after some time a challenge. It is important to know the specific location of these wells, but no literature exists stating that maximum transect spacing that can be used to locate a well. This research focuses in on determining the optimal methods of locating these wells.

Profiles

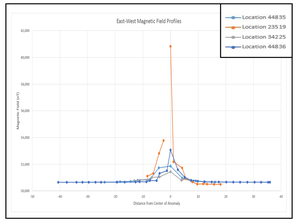


Figure 1.
E-W Magnetic field profiles for each well location

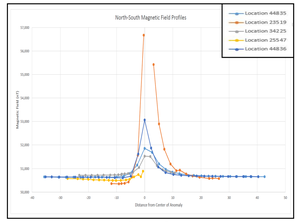


Figure 2.
N-S Magnetic field profiles for each well location

Methods

The general locations of these wells were located by looking at data from the Arkansas Oil and Gas Commission using kmz files on Google Earth. Wells were chosen based on the qualifications that they were in the Ozark National Forest, lacked surface expression, and accessible. Once the approximate location of the well was determined, a magnetometer was used to more accurately locate the well by using a two-meter spacing transect, north to south, for an approximately 20 by 20-meter area. Transects were laid out using stakes and rope from each end to ensure that they were straight. Afterwards, the data collected from the wells was then imported into ArcGIS for visualization and interpolation. In addition, to better visualize the size of the anomaly, N-S and E-W profiles where developed in Microsoft Excel (Figures 1 and 2). These profiles were centered around the highest reading detected on each line. The data was further analyzed by removing the transect lines to create maps with various spacing to determine how large the spacing could be and still lo-

Results/Conclusions

After surveying the locations and analyzing the legacy well locations, the largest anomaly found was approximately 6,100 nanoteslas (nT) above background, while other well anomalies ranged from approximately 700-1200 nT. The width of the anomalies ranged from approximately 20 to 30m. Although more research is needed to define why the variations exist in the size of the anomalies, from this limited data set it appears that the optimal transect spacing to pinpoint magnetic anomalies associated with legacy wells is approximately 20 meters. Once the well is known to be between two transects, smaller spacing transects can be used to find a more exact location of the anomaly. With some wells, vegetation and rugged topography made locating the well using the 2-meter grid spacing difficult (see well permit 25547). In addition, the Overhauser magnetometer employed for this survey would not record locations in high gradient areas (immediately over some wells), marked by a gap in the profile of well permit 23519. Even with this error, the well was still able to be located with ease. Also, as a side note, the wells do have a dipole nature,

References

Boothroyd, I.M., Almond, S., Qassim, S.M., Worrall, F., and Davies, R.J., 2016, Fugitive emissions of methane from abandoned, decommissioned oil and gas wells: The Science of the total environment, v. 547, p. 461-469.

Davies, R.J., Almond, S., Ward, R.S., et al., 2014, Oil and gas wells and their integrity: Implications for shale and unconventional resource exploitation: Marine and Petroleum Geology, v. 56, p. 239-254.

Acknowledgements

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