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Metrology, Aetiology and Mitigation of a Vortex Field Emitting Magnetotelluric Anomaly

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Abstract: ***Utilizing newly developed instruments, it is now possible to directly measure both the precise location and absolute intensity of a vortex field emitted from a magnetotelluric anomaly. Tracking the magnetotelluric anomalies through the landscape offers new opportunities for analyzing the aetiology of these phenomenons, while newly developed instruments allow objective and fully quantifiable measurements of the effectiveness of methodologies implemented for active mitigation.***

Keywords: Magnetotelluric Anomaly, Stray Current, Water, Vortex, Field Sentry

1. Introduction

In prior research we introduced a new hypothesis based on phased-delayed waveforms combining to form a vortex-like 3-dimensional field [1] and provided experimental evidence for its effect on both water structure and biological systems.

Vortex fields of such composition has been observed in correlation to stray-current conducting magnetotelluric anomalies, and their negative bioreactivity in relation to farming has been documented in earlier research [2,3].

2. Literature Survey

Even though extensive efforts have been made, we have been unable to locate any prior publication analyzing or even mentioning the concepts explored in this study.

We therefore, at least tentatively, approach the results achieved in this study as a novel development.

The results are, however, based on research and analysis conducted since 2018 [4,5,6], where continued refinement of analysis of structure of water subjected to the effects of a stray current conducting magnetotelluric anomaly provided the empirical grounds for development of the vortex hypothesis.

3. Problem Definition

This study aims to document the details and effectiveness of a new metrology methodology for both positional mapping and gauging intensity for the hypothesized vortex field emitted from magnetotelluric anomalies. Conclusively we aim to utilize the newly developed instruments to objectively and quantifiable document the effectiveness of a specific mitigation methodology.

4. Methodology

a) Positional mapping

The parallel-plate-antenna described in [1] has shown to be field applicable, and thereby – via data logging of measurements combined with GPS-data – enabling positional mapping and tracking of a specific magnetotelluric anomaly through the landscape.

b) Frequency composition and spectral analysis

By connecting abovementioned data acquisition instrument to a spectrum analyzer in a suitable frequency range it becomes possible to analyze the spectral composition of the vortex field. We hope that this methodology, when fully developed, will allow measurements for easy determining of the origin of the disturbance through pattern recognition.

c) Gauging intensity

When using surveyor lasers for positional measurements when conducting field work we have noted a change in diffraction of a laser beam when it passes above a magnetotelluric anomaly. We decided to test whether this phenomenon could be used as a means to gauge the intensity of the hypothesized vortex field.

The measurement setup consists of a laser unit, which beam is adjusted to the center of a small (3x3cm) photovoltaic array positioned on a portable structure 1,5 meter from the laser emitter. Data from the photovoltaic unit is read by an Arduino and is datalogged automatically together with GPS data. To adjust for voltage shifts caused by voltage regulator instability or other external influences, the data from the laser beam exposed to the magnetotelluric anomaly is compared to data from an identical setup, electrically supported by the same regulator, but shielded from the effects from the magnetotelluric anomaly.

We have tentatively dubbed this arrangement the "Differential Laser Diffraction Method".

d) Quantifying mitigation methodology effectiveness

By utilizing the Field Sentry mitigation methodology described in [1] and doing before-and-after measurements with the Differential Laser Diffraction Method is is possible to objectively quantify effectiveness of the Field Sentry mitigation methodology.

e) Magnetotelluric anomalies and stray current
In order to further the understanding of the role played by stray current in relation to the formation of magnetotelluric anomalies we conduct a number of gradient analysis measurements, whereby the general direction of stray current in the soil surface can be rudimentary mapped.

5. Results & Discussion

a) Positional tracing and mapping
Utilization of the instrument-based mapping methodology provided the means to track magnetotelluric anomalies through the landscape.

For the first implementation we choose two magnetotelluric anomalies, which for years has caused adverse biological reactions for livestock in the affected farms.

The magnetotelluric anomalies was traced from the point they entered the farm buildings and to the source.

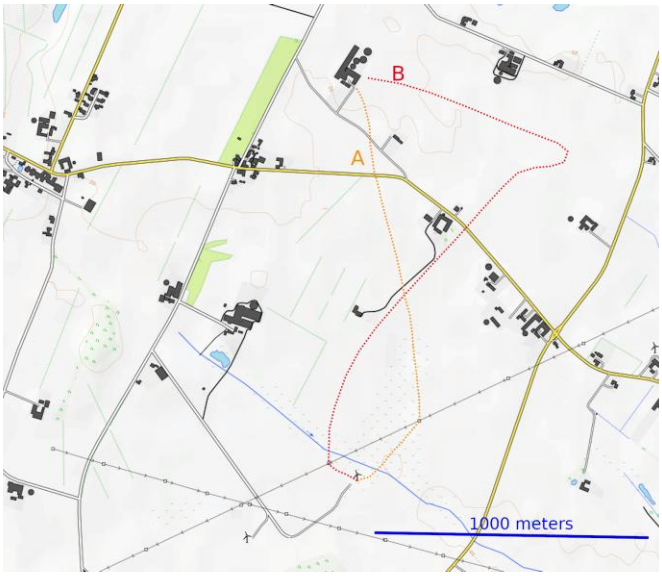

Figure 1: Red and orange dashed lines denotes two different magnetotelluric anomalies. There are no obvious reasons as to their path through the landscape, with the single exception that the path of both magnetotelluric anomalies are strongly perturbed by steel lattice pylons for the 285kV “Kontiscan” HVDC-line between Sweden and Denmark. Both magnetotelluric anomalies have their origin at a 3MW wind turbine. Map data: © OpenStreetMap-Mitwirkende, SRTM | Kartendarstellung: © OpenTopoMap (CC-BY-SA)

By tracing the magnetotelluric anomalies trough the landscape determining the source and origin of the disturbance is a simple matter of following the magnetotelluric anomalies to a point or structure where no further signal can be found.

The wind turbine in question emitted a total of 22 identifiable and traceable magnetotelluric anomalies. Of these, only the two shown on the map was traced fully.

The other wind turbine on the map emitted a total of 102 magnetotelluric anomalies.

At present time we have no explanation either for the process by which these magnetotelluric anomalies are emitted or the considerable difference in number between the two identical 3MW wind turbines. The main question is whether the difference in number of emitted magnetotelluric anomalies are caused by soil characteristics unrelated to the wind turbine construction or it is directly related to some unknown details in the construction of the wind turbine.

The experiment was repeated in another part of Denmark, some 180km from the first location.

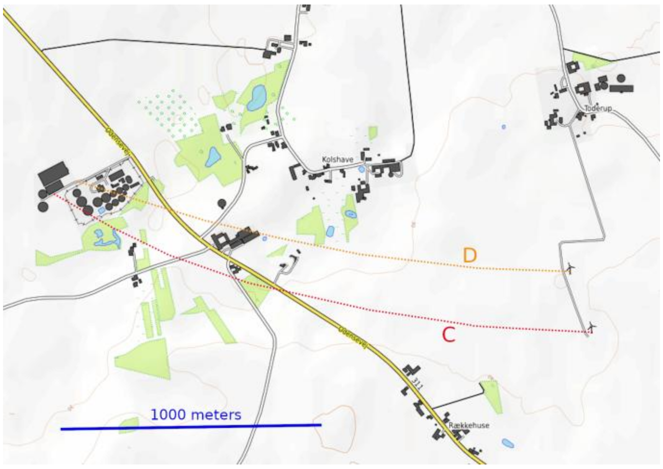

Figure 2: Red and orange dashed lines denotes two different magnetotelluric anomalies. We note that there is evidence of significant perturbation of their paths by storage tanks at a biogas plant located east of the farm buildings. Map data: © OpenStreetMap-Mitwirkende, SRTM | Kartendarstellung: © OpenTopoMap (CC-BY-SA)

We note that the magnetotelluric anomalies has their origin at two identical 800kW wind turbines.

Technical measurement capability for tracking magnetotelluric anomalies through the landscape provides crucially important information for determining the aetiology of the magnetotelluric anomalies. It is too early to conclude that wind turbines always are the cause of such disturbances, but the investigations point to the importance of conducting further measurements with even greater accuracy.

b) Frequency composition and spectral analysis
Oscilloscope and spectrum analyzer readings from the instrument described in [1] enables a deeper analysis of the waveforms and spectral composition.

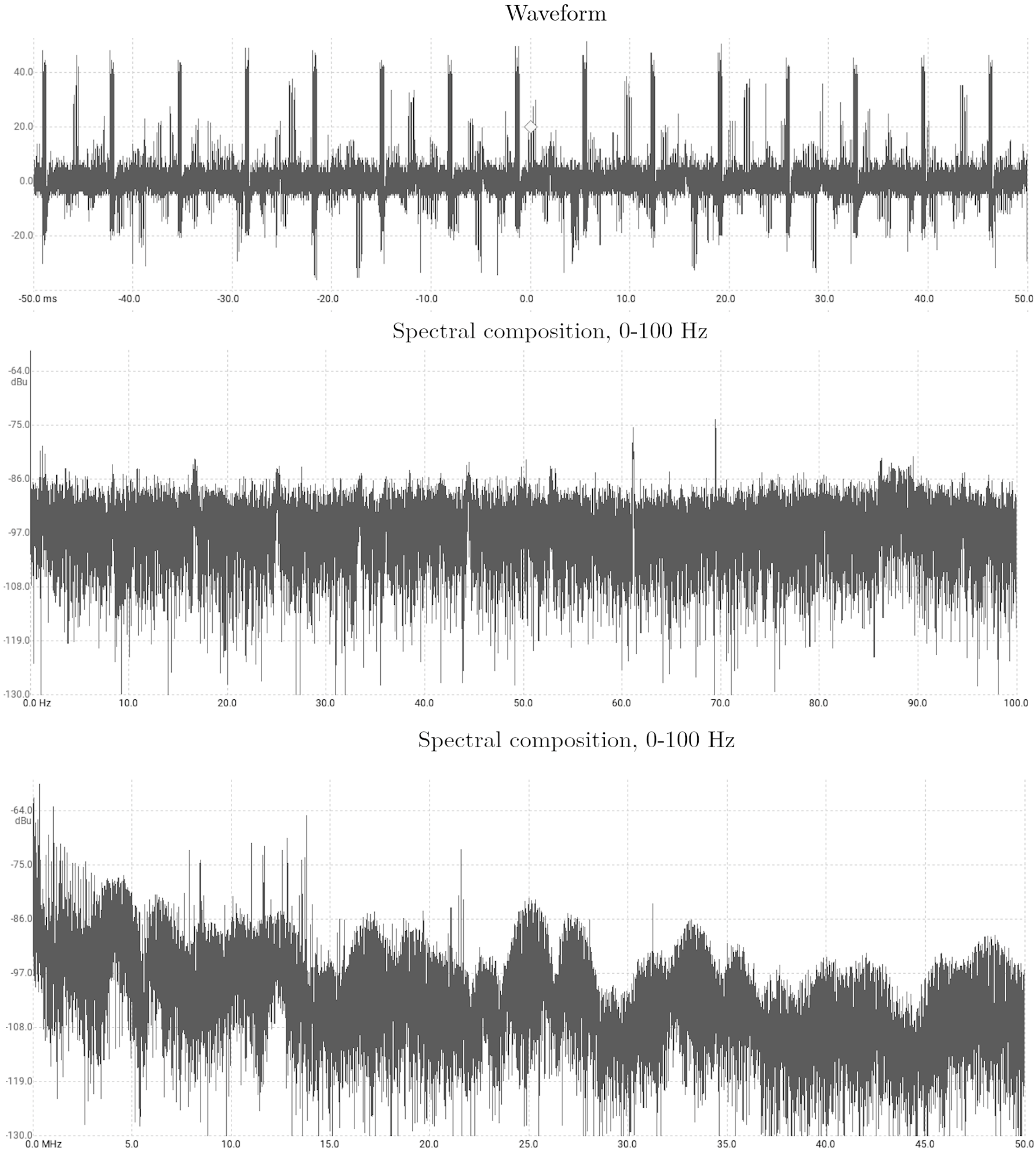

Figure 3: The waveform composition is, per present empirical observations, unique for each source of magnetotelluric anomalies. We note that the waveform often contains artifacts with a plausible origin stemming from leak current patterns from electrical infrastructure or appliances with a pulse-modulated current intake.

The spectral composition in the ELF-region is, still pr present empirical observations, dominated by patterns which seems to be rather comparable in main structure between different magnetotelluric anomalies. We note that the spikes in the lower part of the spectrum quite possibly overlaps with the Schumann resonance and related harmonics.

The spectral composition in the region of higher frequencies seem, so far, to be unique for each source. This could possibly prove to be of utmost importance, as this permits tracking of single observations to a specific point source.

c) Gauging intensity

Diffraction of a laser beam changes measurably when the beam transverses the vortex field from a magnetotelluric anomaly.

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By quantifying the amount of diffraction by measuring the output of an array of PV-cells it is possible, at least rudimentary, to gauge the intensity of the vortex field from a magnetotelluric anomaly.

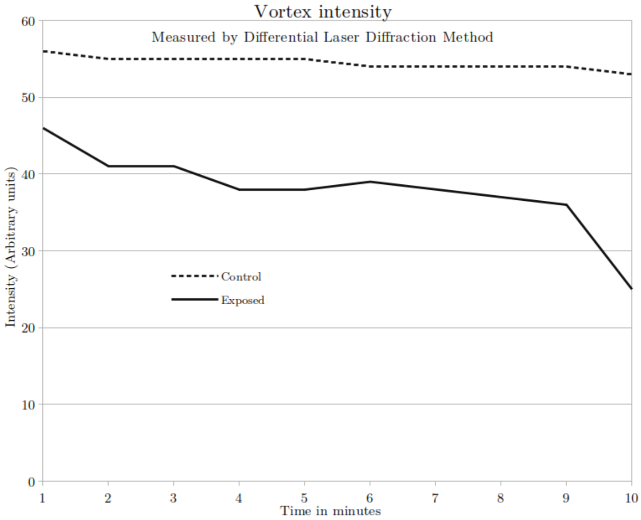

Figure 4: Both laser beams are projected onto similar PV-arrays and subjected to the same data acquisition and analog/digital conversion. Only difference is that the exposed beam traverses the magnetotelluric anomaly, whereas the "control" does not. The two graphs will naturally start at different values, as the PV array and laser beam adjustment cannot be completely identical, but any difference between the two graphs beyond that will therefore signify the influence of the vortex field upon the laser beams

While the possibility of a technical, quantifiable methodology for gauging intensity of the hypothesized vortex field is a major milestone, we note that this is an indirect measurement, with the limitations such an approach warrants. It is, at present time, not possible to verify that the relationship between laser diffraction and vortex field intensity is linear. This characteristic should therefore be noted when analyzing such measurements. These reservations does, however, not diminish the potential for this technique in establishing objective verification of the efficacy of implemented mitigation methodologies.

d) Quantifying mitigation methodology effectiveness

In order to analyze the efficacy of the Field Sentry mitigation methodology we prepared the Differential Laser Diffraction unit across magnetotelluric anomaly "A" and made a full run of measurements (10 minutes). Afterwards we installed a set of Field Sentry units in the exact locations where the magnetotelluric anomaly exits the wind turbine tower, after which another full run of measurements (10 minutes) was recorded. The results can be seen in figure 6.

By comparing the two graphs it is evident that the effects of the vortex field emitted from the magnetotelluric anomaly, as measured by the Differential Laser Diffraction Method, has been neutralized.

As far as known, this is the first time that the efficacy of a mitigation protocol for magnetotelluric anomalies has been demonstrated objectively by technical means.

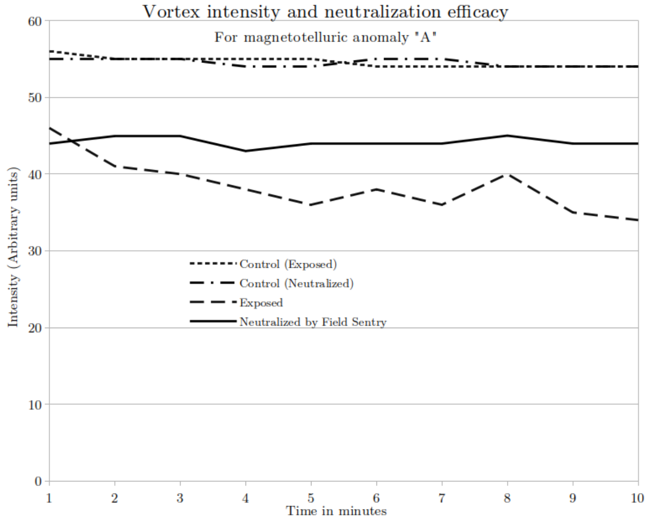

Figure 5: The effects of the vortex field emitted from the magnetotelluric anomaly are indicated by the difference between the graph for the exposed and the graph for the control pertaining thereto. If no effect is registered these two graphs should be parallel. Any deviation from parallel denotes that an effect has been registered. Conversely, we note that the graphs for the neutralized and the associated control are nearly completely parallel, indicating a successful mitigation.

The same procedure was followed for magnetotelluric anomaly "B", yielding similar results, as can be found in figure 7.

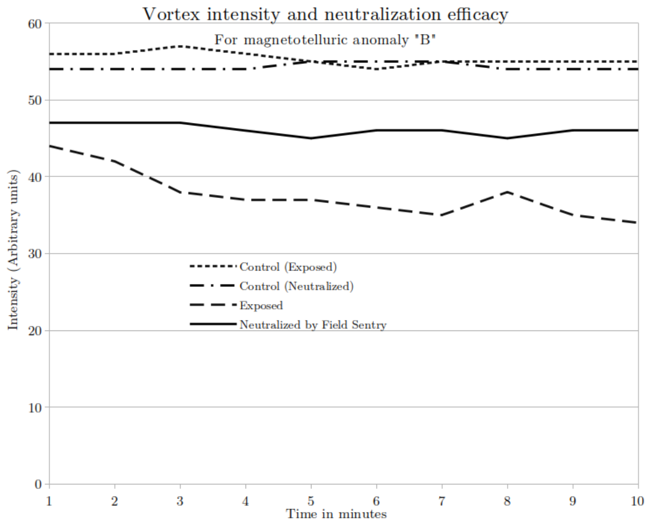

Figure 6: The graphs for the exposed measurement run are non-parallel, indicating that the effects of the vortex field has been registered. The graphs for the measurement run with the magnetotelluric anomaly neutralized are nearly parallel, indicating a successful mitigation.

An identical approach was followed at the other location, with the exception that some of the tracking and mapping was done with a magnetometer.

The setup for evaluating the efficacy of the Field Sentry mitigation methodology was, however, completely identical between the two locations.

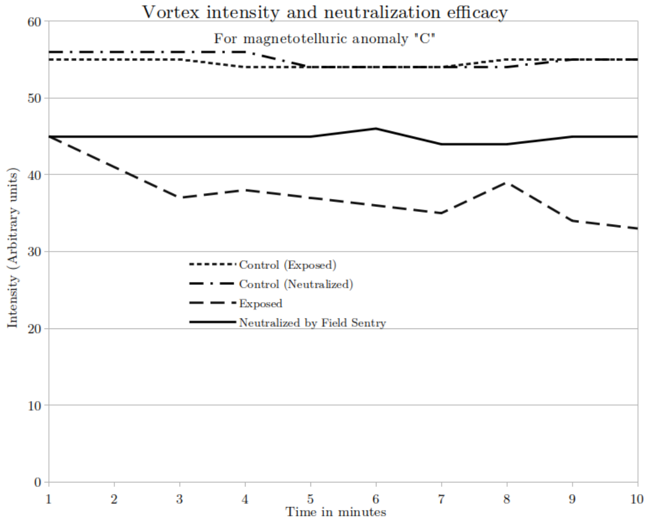

Figure 7: Efficacy of the implemented mitigation is again indicated by the parallel graphs for the "Neutralized" and the associated "Control".

An identical implementation of the Field Sentry mitigation methodology was carried out at another wind turbine, thereby effectively neutralizing the vortex field emitted from magnetotelluric anomaly "D", as shown in figure 9.

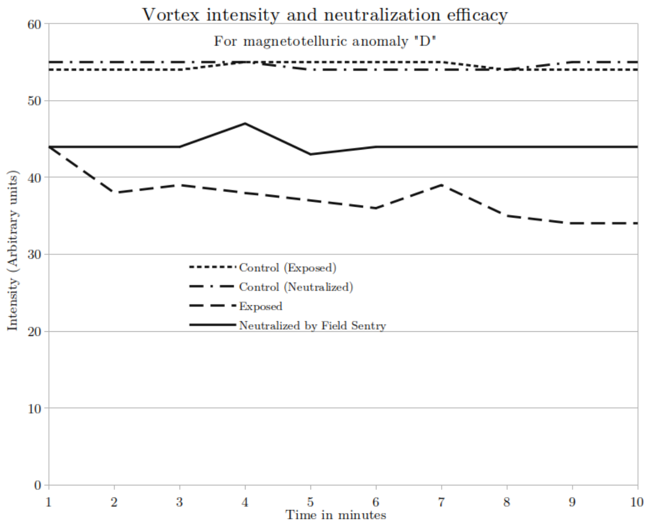

Figure 8: The last of the mitigation experiments, indicating a efficacy on par with the other results obtained in the other experiments.

Problems arising from stray current propagated along magnetotelluric anomalies has troubled farmers for years and classical electrotechnical measurements has been unable to locate the cause. With the recent developments described in this and the previous paper [1] we finally have a working hypothesis describing the phenomenon, and we have reliable technical means for both documenting, analyzing and mitigating the problems arising from these phenomenon.

e) Magnetotelluric anomalies and stray current

At present it is difficult to explain the rather strange paths the mapped magnetotelluric anomalies travels through the landscape.

We presume that the driving force behind these phenomenon is leak current or stray current from electrical infrastructure. We cannot at present time conclusively prove this idea, but there is plenty of circumstantial evidence indicating the need for further analysis in this regard.

Figure 9: A series of measurements was conducted on a wind turbine, with the aim of understanding the level of leak current produced. We measured close to 3A leak current in each of the four earthing conductors inside the wind turbine tower. Supplemental measurements with magnetometer confirmed that a substantial current, besides the current measured through the earthing system, runs in the superstructure of the tower and is led to earth through the ring of bolts fastening the wind turbine tower to the foundation. Unfortunately, we found no meaningful way of quantifying the amount of leak current led to ground by wind turbine superstructure.

To further understand the role of stray current propagating through the landscape we carried out a number of gradient analysis for the wind turbine and HVDC pylons mapped as a source of magnetotelluric anomalies "A" and "B".

Gradient analysis shows that both the wind turbine and the HVDC pylons are point sources of stray current leaking out through conductive strata in the surrounding landscape.

Current direction is, per convention, from plus to minus, but since the electron is negative electron flow is from minus to plus. We have therefore normalized all measurements in the following figures, so that negative numbers means electron flow to the central location, while positive numbers indicate electron flow from the central location.

AC current values were not recorded as broad electromagnetic noise from the wind turbine caused unstable measurements, but the levels were stable enough to allow voltage measurement and electron flow direction measurements by determining the phase difference between capacitively and inductively coupled sensors.

		North		
		717mV DC 248 mV AC 194 uA DC		
	752 mV DC		787 mV DC	
West	199mV AC	Wind Turbine	343 mV AC	East
	487 uA DC		322 uA DC	
		815mV DC 297 mV AC 548uA DC		
		South		

Figure 10: Measurements indicate the wind turbine as a point source of both AC and DC leak current, thereby facilitating the propagation of stray current though conductive strata or aquifers in the subsoil.

		North		
		705mV DC 168 mV AC 294 uA DC		
	608 mV DC		656 mV DC	
West	144mV AC	HVDC PYLON (west)	44 mV AC	East
	142 uA DC		302 uA DC	
		687mV DC 157 mV AC 337uA DC		
		South		

Figure 11: The HVDC pylon is a point source of both AC and DC leak current, although supplemental measurements with differential magnetometer indicates that a large (but unquantifiable with present technology) part of the leaked stray current originates from the wind turbine.

		North		
		709mV DC 153 mV AC 304 uA DC		
	647 mV DC		701 mV DC	
West	164mV AC	HVDC PYLON (east)	54 mV AC	East
	252 uA DC		354 uA DC	
		672mV DC 176 mV AC 376uA DC		
		South		

Figure 12: The second HVDC pylon is also a point source of both AC and DC leak current. As for the other pylon, we conducted supplemental differential magnetometer measurements, indicating a large current travel from the wind turbine to the HVDC pylon, indicating that the leak current measured from the HVDC pylon had its original source in the wind turbine.

After confirming the wind turbine as primary and the pylons as secondary source of the magnetotelluric anomalies "A" and "B" it was decided to make a more detailed examination of the precise locations where the magnetotelluric anomalies enters the buildings.

Magnetotelluric anomaly "A"'s entrance to the farm buildings was located in a very inconvenient spot for further analysis, as it covers the main driveway for entrance to the farm. Magnetotelluric anomaly "B" was therefore chosen for further examination.

By measuring the voltage potential and current between the magnetotelluric anomaly and the external ground clamp on a nearby 10kV/0,4kV electrical transformer we gain some insight as to what mechanism are governing their paths through the landscape.

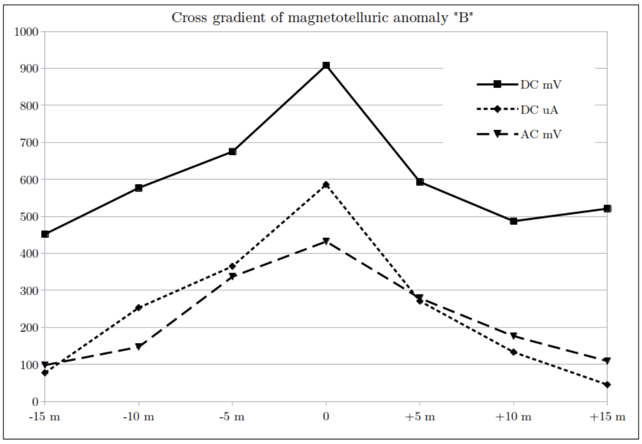

Figure 12: Cross gradient analysis for magnetotelluric anomaly "B" indicate a rather substantial current/voltage gradient from the magnetotelluric anomaly towards the ground clamp at the electrical transformer.

At present time we can not, unfortunately, present the precise and full explanation for the apparently chaotic paths the magnetotelluric anomalies propagate along through the landscape, but both the measurements indicating the wind turbine as primary source of leak current and the cross gradient measurements points to a rather simple mechanism, where the leak current chose the path of least resistance towards the star point of the transformer windings. The arguments for this rather simple mechanism was further strengthened as we dug a deep trench cross the magnetotelluric anomaly and discovered a aquifer of substantial volume about 6 meters below ground level.

Areas with subsoil strata or localized deposits of either water, ocher or carbon sometimes has an electrical conductivity approaching that of copper cable [2], which furthermore corroborate a simple explanation, where the magnetotelluric anomalies simply are areas whose electrical conductivity provides excellent pathways for stray current to return to the electrical infrastructure.

6. Conclusion

We have developed full technical capability to trace and map the exact path of a magnetotelluric anomaly through the landscape. By the same means, it has been possible to document the waveform and spectral composition of the vortex field emitted from the magnetotelluric anomaly.

We have furthermore developed and implemented a technical instrument for, at least rudimentary, gauging of the intensity of the vortex field hypothesized to be emitted from the magnetotelluric anomaly.

Both of these results are, as far as known, novel approaches, which no previous publications of similar nature. Although the accuracy of the developed intensity gauging methodology is subject to some reservations, it is nevertheless very valuable measurements as the methodology proves the effectiveness of the Field Sentry approach.

The demonstrated effectiveness of the Field Sentry corroborates earlier results [1], where the efficacy of Field Sentry mitigation methodology was demonstrated on biological systems.

7. Future Scope

On the basis of these measurements it is imperative to conduct further studies on the possible role of leak current from electrical infrastructure forming vortex-emitting magnetotelluric anomalies.

The role of wind turbines as possible sources of stray current forming magnetotelluric anomalies should likewise be further investigated.

With a move towards a "green" future, where a larger portion of the worlds energy consumption is to be produced via wind power, it becomes essential to understand and mitigate these phenomenon.

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Author Profile

Kim Horsevad is the owner and chief technical analyst at Horsevad Independent Technical Research & Analysis (www.horsevad.net). Current research aims for developing methods for quantifying interactions between electromagnetic fields and biological systems.