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Exploration of Water pH Shift When Influenced by Short Exposure to Magnetotelluric Anomaly

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Abstract: ***The methodological challenges of analyzing possible influence on water pH from a magnetotelluric anomaly are explored. The results indicate both overall applicability of the method and considerable shift in pH when water is exposed to a magnetotelluric anomaly for short duration of time.***

Keywords: Stray Current, Magnetotelluric Anomaly, Water, pH

1. Introduction

During research projects undertaken in the past couple of years we have documented the existence of magnetotelluric anomalies related to underground propagation of stray current in conductive strata of subsoil [1]. We have furthermore developed a magnetic survey methodology enabling detection of such magnetotelluric anomalies [2]. Anecdotal evidence from farmers whose farms are located in the vicinity of such magnetotelluric anomalies often mentions detrimental effects on water, which provided the inspirational background for earlier research documenting substantial shift in impedance characteristic for the spectrum between 10MHz and 6GHz for water exposed to a magnetotelluric anomaly [3]. This method is, however, very laborious and requires extremely high attention to details during physical manipulation of the parallel-plate capacitor measurement fixture in order to produce repeatable and reliable data. It was therefore suggested to explore other alternatives for obtaining increased accuracy in the research. One such alternative is measurement of pH.

2. Literature Survey

While the problem of stray current affecting water distribution systems is the subject of quite intensive research projects [4] and commercial interest [5] the prospect of analyzing the impact stray current has on water structure itself is, as far as can be located by searching both academia databases and the internet, a novel perspective outside of the earlier analysis published as a part of this project [3]. Using pH measurements as a proxy for water structure is, however, established procedure [6], [7].

3. Problem Definition

By this study we aim to conduct a preliminary analysis of possible measurable effects on water pH from stray current and at the same time develop an initial assessment of the applicability of the pH-measurement methodology for investigating effects conferred upon water by stray current propagated through electrical conductive strata in the sub-soil.

4. Methodology

a) Magnetotelluric anomaly

The extent and orientation of the utilized magnetotelluric anomaly is surveyed and charted using the methodology described in [2].

b) pH measurement

pH is measured with HI2020 edge® Multiparameter pH Meter (Hanna Instruments, www.hannainst. com) equipped with HI-11310 digital pH electrode (Hanna Instruments, www.hannainst. com). The instrument is equipped with automatic temperature compensation.

Water samples are measured in 30ml polyethylene beakers, with the tip of the probe submerged 2cm.

Each sample is measured for 15 minutes to reach stability. After reaching stability the instruments "Accurate Log" function is utilized to obtain 5 consecutive readings. The values reported are the mean of these readings. As the aim of this study primarily is exploration of applicable methodology for conducting this type of analysis in future projects, such procedure was chosen to obtain valuable knowledge about the limits of the accuracy of the instruments capability, as the variability of the individual readings from the same sample indicate both the accuracy and reliability of the methodology.

The instrument was 5-point calibrated daily during the measurements.

c) Chemical composition

Chemical composition of the sample water is checked with HI-733 (Ammonia), HI-707 (Nitrite), HI-713 (Phosphate), HI-746 (Iron) and HI-708 (Nitrite), all from Hanna Instruments (www.hannainst. com)

d) First measurement series

The first measurement series was conducted using tap water sourced from a neutral location.2 x 300ml water was stored in 2 x 500ml Simax borosilicate Erlenmeyer flasks, one ("Exposed") placed in the middle of a magnetotelluric anomaly and one ("Control") placed outside the magnetotelluric anomaly. For measurement purposes 30ml of the sample was transferred to aforementioned 30ml polyethylene beakers. The samples was exposed for 15 minutes and afterwards stored indoor until measurement.

e) Second measurement series
Exact methodology as first series, except for using boiled and cooled water from a neutral location.

f) Third measurement series
2 x 300ml distilled water (Frederiksen Scientific, www.frederiksen-scientific. dk) was transferred to 2 x 500ml Simax borosilicate Erlenmeyer flasks. One ("Exposed") was placed in the middle of a magnetotelluric anomaly and one ("Control") was placed nearby, but outside the magnetotelluric anomaly. The samples was exposed for 15 minutes and afterwards stored indoor until measurement.

g) Fourth measurement series
7 x 300ml tap water obtained on location was transferred to 7 x 500ml Simax borosilicate Erlenmeyer flasks and positioned with 50cm interval perpendicular to a magnetotelluric anomaly. The samples was exposed for 15 minutes and afterwards stored indoor until measurement.

5. Results & Discussion

a) First Series
Results, expressed as the mean and standard deviation, for the first measurement series are shown in table 1

Table 1: Results from first measurement series indicates significant change in pH for water exposed to a magnetotelluric anomaly

	"Exposed"	"Control"
Mean	7, 063	7, 0496
SD	0, 0012	0, 0015
T-test $P_{(two\text{-}tailed)}$ at alpha=0, 05: 0, 000005		

Once stability has been reached, the readings taken with the instruments "Accurate Log" function shows very little fluctuation.

b) Second Series
To test whether unknown forces could influence the water (and thereby act as confounders to the experiment) before exposure, we repeated the first measurement series with exact same methodology, except for using boiled (and cooled) tap water from a neutral location, as boiling should “re-set” any unknown structure conferred upon the water by unknown processes.

The results from the second series are shown in table 2.

Table 2: Results from second measurement series confirms measurements from first series.

	"Exposed"	"Control"
Mean	7, 1784	7, 1724
SD	0, 0005	0, 0005
T-test $P_{(two\text{-}tailed)}$ at alpha=0, 05: 0, 000045		

The results basically confirms the results from the first series of measurements. The "Exposed" water sample exhibits small, but significant, increase in pH value.

The chemical composition of the water used for series 1 and 2 is shown in table 3

Table 3: Overall chemical composition of the water sample used in first and second series

NO_3^-	4, 3	ppm
NH_4^+	0, 7	ppm
NO_2^-	0, 2	ppm
PO_4^{---}	0, 5	ppm
Fe	0, 04	ppm

None of the values in table 2 seems out of place or hints at a specific composition making this water sample vulnerable to effects from time-varying magnetic fields.

c) Third Series
To test whether the influence committed to the water by the magnetotelluric anomaly was related to mineral content in the water, the experiment was repeated with distilled water. The results are shown in table 3.

Table 4: Results from test done with distilled water confirms the results from the previous experiments.

	"Exposed"	"Control"
Mean	6, 908	6, 8492
SD	0, 0008	0, 0004
T-test $P_{(two\text{-}tailed)}$ at alpha=0, 05: 0, 00000001		

By using distilled water we have excluded any unknown effects on mineral content of tap water from the magnetotelluric anomaly. The results from Third Series of experiments therefore strongly indicates that the effect conferred upon the water samples from the magnetotelluric anomaly is related to the structure of the water itself and not to any foreign mineral contamination in the water

d) Fourth Series
In order to attempt to elucidate possible dose/response correlation we established the third measurement series as a line survey perpendicular to the general orientation of the magnetotelluric anomaly with samples placed for each 50cm. Results are shown in table 4

Table 5: First row indicates the placement of the sample, second row states the mean of the 5 consecutive readings taken by the instruments "accurate log" function, third row states the standard deviation and the fourth row indicates the difference between the mean of the exposed samples and the mean of the control sample

-1, 5m	-1, 0m	-0, 5m	Middle	+0, 5m	+1, 0m	+1, 5m
6, 9222	6, 9198	6, 9076	6, 8938	6, 9084	6, 9046	6, 9558
0, 0009	0, 0007	0, 0008	0, 0004	0, 0004	0, 0004	0, 0008
0, 0902	0, 0878	0, 0756	0, 0618	0, 0764	0, 0726	0, 1238

When viewed graphically the difference between sample mean and control mean indicate some degree of dose/response relationship, as seen in figure 1.

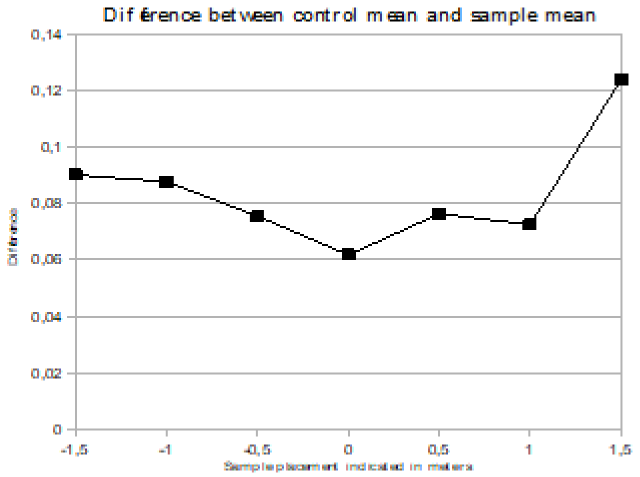

Figure 1: The "dip" in the middle is coincident with the measured middle of the magnetotelluric anomaly, yielding a figure hinting at a dose/effect relationship.

The chemical composition of the water used for the fourth series is shown in table 6

Table 6: Overall chemical composition of the water sample used in the fourth series of experiments

NO_3^-	4, 5	ppm
NH_4^+	0, 5	ppm
NO_2^-	0, 1	ppm
PO_4^{---}	0, 7	ppm
Fe	0, 05	ppm

The chemical composition is, at least for the measured parameters, basically identical with the samples used for the first and second series.

The measurements indicate a dose/effect relationship. It should, however, be noted that in all the previous series of measurements the exposed sample exhibited the numerically largest pH-value. In this series, the sample placed in the middle of the magnetotelluric anomaly exhibits the numerically lowest value. We can only hint at an explanation for this peculiar behavior.

In earlier analysis we have measured how both the voltage, current and polarity of the stray voltage running through the magnetotelluric anomaly suddenly changes both abrupt and drastically. If such a change occurred simultaneously with this series of the experiments it could possibly explain the observed difference.

The magnetotelluric anomaly was surveyed before the experiment. There was no continuously monitoring of the parameters of the magnetic field variations during the experiments. This shortcoming is, however, planned to be addressed in further experiments.

The chemical composition of the tap water used for the first two series and series 3 differs by a small amount. As it is shown that distilled water is affected it seems unlikely, but we do not know whether the small amount of difference in measured chemical composition (or difference in unmeasured contaminants) could influence the results.

6. Conclusion

The extremely small variation between the individual readings indicate a high degree of accuracy in the measurements and confidence in the overall methodology. On this basis it would seem prudent to enlarge the scope of the analysis in future projects, and thereby achieving larger validity and statistical robustness by analyzing a larger number of individually exposed samples.

The statistical results obtained in this study is, per chosen methodology, more a representative of the accuracy of the method than the accuracy of the actual pH variation. The results do, however, point to the conclusion that water pH is, at least when exposed by the chosen magnetotelluric anomaly, influenced by some currently unknown mechanism. Both the accuracy obtained, the overall conformity of the results and the dose/response seen in fourth series strongly indicate that pH-analysis is a worthwhile tool for assessing the effects conferred upon water by stray current, although the polarity issue between the fourth series and the other measurements remains to be resolved.

Achieving similar shifts in pH using both tap water bought in from a neutral location, tap water obtained on location and distilled water points to a phenomenon whereby the water structure itself, possibly by altered equilibrium constant for the self-ionization process, has been influenced by 15 min exposure to the magnetotelluric anomaly.

7. Future Scope

A more elaborate project to further investigate the findings is already in the planning stages.

To negate possible confounders related to transferring water between different containers, and to achieve higher degree of validity in the statistical processing, a larger amount of individually exposed and analyzed samples is planned.

The follow-up study will focus on two main experiments. Firstly we want to expand the study by utilizing a larger number of samples positioned on a larger number of magnetotelluric anomalies. By analyzing both variation and change in pH and compare these values with detailed logging of magnetometer readings obtained during exposure it might be possible to elucidate further knowledge about possible dose/response relationship between the properties of the magnetotelluric anomaly and the influence it confers upon the water. Secondly we want to expand the line surveys explored in the third series by using a larger amount of samples thereby expanding both resolution and geographical coverage.

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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 focuses on developing measurement tools for quantifying interactions between electromagnetic fields and biological systems.