



HAL
open science

Know Your Enemy: Parameterising The Description Of Noise In Geophysical Measurements For Archaeology

Michel Dabas, Armin Schmidt, Apostolos Sarris

► To cite this version:

Michel Dabas, Armin Schmidt, Apostolos Sarris. Know Your Enemy: Parameterising The Description Of Noise In Geophysical Measurements For Archaeology. Reflecting on the experience, NTNU, Apr 2023, Trondheim (Norvège), Norway. hal-04373652

HAL Id: hal-04373652

<https://cnrs.hal.science/hal-04373652v1>

Submitted on 5 Jan 2024

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



SAGA Workshop, Trondheim-Norway
18 -19 April 2023

KNOW YOUR ENEMY: PARAMETERISING THE DESCRIPTION OF NOISE IN GEOPHYSICAL MEASUREMENTS FOR ARCHAEOLOGY

Armin SCHMIDT¹ (a.schmidt@GeodataWIZ.com), Michel DABAS² (michel.dabas@ens.psl.eu), Apostolos SARRIS³ (asarri01@ucy.ac.cy)

¹ Dr Schmidt – GeodataWIZ, Remagen, Germany

² École Normale Supérieure - PSL, Paris, France

³ University of Cyprus, Nicosia, Cyprus

Keywords: noise; geostatistics; variogram; spectral analysis; filtering

Topic: Topic 2 - Modelling archaeological environments and geophysical responses

Prior to the interpretation of archaeological geophysical survey results it is beneficial to minimise unwanted data ('noise'). To decide what processing can be applied, such noise has to be characterised quantitatively first. This contribution describes some parameters that can be used.

Geophysical measurements contain the sought after 'signals' and a 'background' against which the signals stand out as anomalies. Both components may be affected by noise. The latter can hence be considered a third component of the geophysical measurements. It may be (i) internal, related to the instrumentation, (ii) caused by variations in the use of the instruments (e.g. while walking with a magnetometer), (iii) created by external signals entering the measurements (e.g. magnetic storms), or (iv) produced by the ground's spatial variability, usually referred to as 'soil noise' (Schmidt, et al., 2020). Once noise forms part of the measurement data it can be very difficult to remove. Therefore, all avoidable sources (e.g. (ii) – poor use of instruments) should be eliminated during survey planning and execution.

To select processing methods and parameters that help minimising noise, or to recognise and ignore it during interpretation, requires its characterisation. Some authors categorised unwanted data components as 'errors' that can be corrected and 'noise' that is unpredictable (Ghezzi, et al., 2019). Others preferred to base their discussion on the spatial appearance distinguishing between correlated and uncorrelated noise (Graham & Scollar, 1976). For the current discussion we consider all unwanted signals to be noise and focus on four particular forms: (a) random noise, (b) spatial noise, (c) non-stationary noise and (d) sampling noise.

Geostatistics is based on models of spatial data variation ('variograms') that can also be used to examine the similarity of neighbouring measurements which is related to the level of random noise. For this study, such variograms were calculated for fluxgate gradiometer data from two sites (Figure 1).



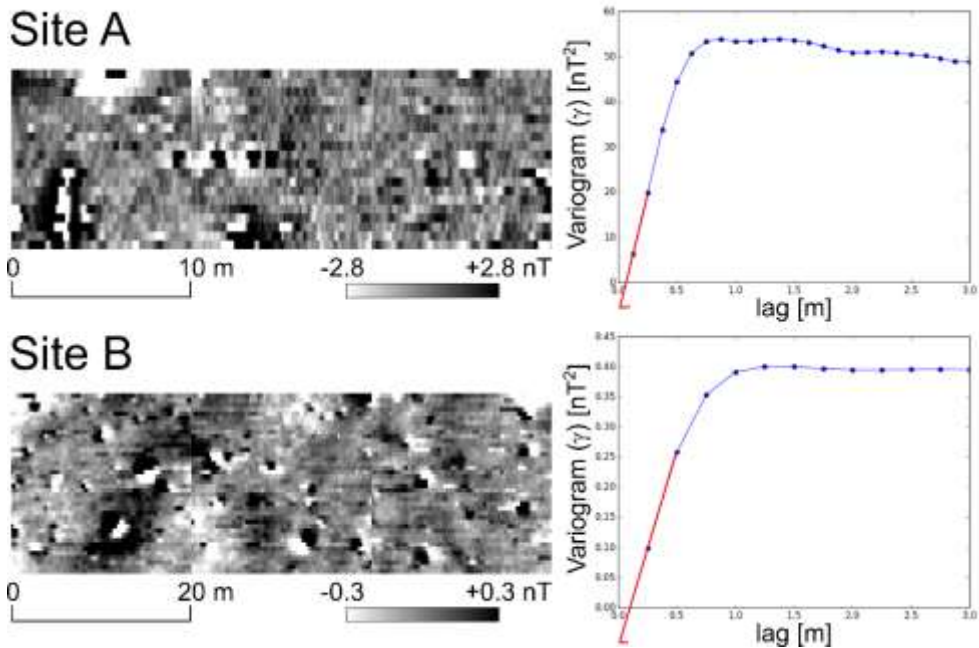


Figure 1: Variograms calculated along the horizontal (x-) axis for data from two sites.

The negligible nugget effect (vertical intercept) and a range value of 0.8 m and 1.4 m (level of correlation) for sites A and B, respectively demonstrate the minimal contribution of random instrument noise to the data and that measurements are consistent over the typical size of small scale anomalies.

A different approach to the analysis of noise uses the calculation of spatial frequencies (Figure 2). Given sufficiently high sampling rates small-scale variations generated by spatial noise can be seen as spikes of high wave-numbers and removed with a suitable low-pass filter, which is not possible if the data are under-sampled.

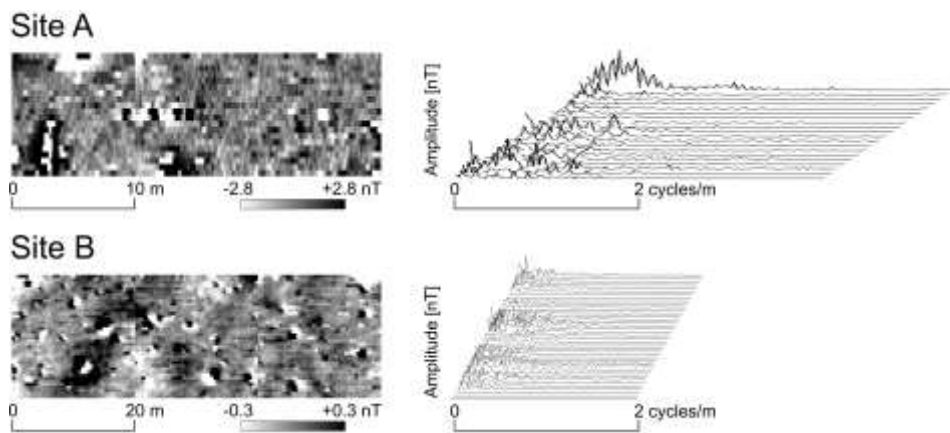


Figure 2: Spatial frequencies calculated along the horizontal (x-) axis for data from two sites.





Acknowledgments

This work is based on a STSM funded by COST Action SAGA: The Soil Science & Archaeo-Geophysics Alliance—CA17131 (www.saga-cost.eu), supported by COST (European Cooperation in Science and Technology).

References

Ghezzi, A., Schettino, A., Tassi, L., Pierantoni, P. P., 2019. Magnetic modelling and error assessment in archaeological geophysics: the case study of Urbs Salvia, central Italy. *Annals of Geophysics*, 62, (4): GM451.

Graham, I. D. G., Scollar, I., 1976. Limitations on Magnetic Prospection in Archaeology Imposed by Soil Properties. *Archaeo-Physika, Technische und Naturwissenschaftliche Beiträge zur Feldarchäologie*, 6: 1-124.

Schmidt, A., Dabas, M., Sarris, A., 2020. Dreaming of Perfect Data: Characterizing Noise in Archaeo-Geophysical Measurements. *Geosciences*, 10, (10): 382.

