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### ► To cite this version:

Quentin Vitale, Lionel Darras, Christophe Benech, Julien Thiesson. WuMapPy an open-source software for geophysical prospection data processing: 2019 milestone. 13th International Conference on Archaeological Prospection, Aug 2019, Sligo, France. pp.293-295. hal-04316244

**HAL Id: hal-04316244**

**<https://hal.science/hal-04316244>**

Submitted on 7 Dec 2023

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# WuMapPy an open-source software for geophysical prospection data processing: 2019 milestone

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## Introduction

In the last few years, Python has shown a growing importance in the geophysical community, with an increasing number of available packages and plugins for general geophysical modelling and inversion (PyGIMLI — Cockett *et al.* 2015, SimpEG — Rücker *et al.* 2017) or more specifically dedicated to archaeological applications (ArchaeoPy — Pope-Carter *et al.* 2014, AGT plugin for QGIS — Hulin *et al.* 2017). In 2015, Marty *et al.* introduced WuMapPy, an open-source software implemented in the Python language for visualization and processing of near-surface geophysical data. It is the outcome of successive software developments initially achieved by the *Centre de Recherche Géophysique de Garchy* (that successively became the UMR 7619-Sisyphé and now the UMR 7619-METIS). WuMapPy is the successor of Wumap (implemented in Fortran, developed by Jeanne Tabbagh), whose development stopped in the late 2000s. WuMapPy's development started in 2015 by UMR 7619-METIS and UMR 5133-Archéorient. Since 2017, the main development has been taken over by Geo-Heritage, a partnership between the research laboratory UMR 5133-Archéorient and Éveha international, an archaeological research and investigations company.

## Features and usage

WuMapPy benefits from the advantages of the Python language. It is entirely open-source, with an easy-to-read source code. Each processing step is documented with references to the corresponding scientific literature (Fig. 1). One can see how a specific processing step is implemented, modify it, or adapt it if needed. It is freely distributed on the “pypi.python.org” website and is cross-platform (Windows, Linux, MacOS, etc.). It can be upgraded with the variety of scientific packages freely available by the large “Python community” on the “pypi.python.org” website.

The image shows a screenshot of the GeophPy documentation for the `ploughfilt` function. It is divided into several sections:

- Principle:** Describes the directional feature filtering in the spectral domain using the combination of a Gaussian low-pass filter and a Gaussian directional filter. It includes the mathematical formula: 
$$F(\rho, \theta, f_c) = \mathcal{F}_{GLP}(\rho, f_c) * \mathcal{F}_{DIR}(\rho, \theta)$$
$$= e^{-(\rho/f_c)^2} * (1 - e^{-\rho^2 \sin^2(\theta - \theta_0)})$$
- Parameters:** Lists parameters like `apod`, `azimuth`, `cutoff`, `width`, and `valfilt`.
- Code:** Shows the Python function definition for `ploughfilt` and its implementation, including comments and references to other modules like `genop` and `fft2`.
- References:** Cites Tabbagh J. 2001, "Filtre directionnel pour l'optimisation et la modélisation de la géophysique".
- Examples:** Shows how to use the function in a Jupyter notebook environment.

Annotations on the image include a blue arrow pointing to the source code with the text "view source code" and a green arrow pointing to the code block with the text "processing reference".

Fig. 1. Extract from GeophPy's documentation.

While still in active development, WuMapPy currently integrates a large number of processing and display features partly inherited from Wumap. Typically, you can:

- Import data files from ASCII Delimiter-Separated Values (.csv, .dat, .xyz, etc.) or binary format (NetCFD and Surfer grid).
- Grid the data using different interpolation algorithms (linear, cubic, etc.) or process the un-gridded data directly.
- Display the data with different plot types (scatter-plot, 2D-surface, contour-plot, etc.), colour scales (linear or logarithmic) and colour maps.
- Enhance the data using general processing such as data thresholding, data destaggering, outlier removal, median filtering, data destriping, directional filtering (anti-ploughing filter), FFT spectrum computation, regional trend elimination, contrast enhancement via Wallis filtering.
- Use specific filters for the magnetic method such as reduction to the pole, 3-D analytical signal computation, magnetic source depth estimation using Euler deconvolution, upward and downward continuation, conversion between different sensor configurations (total field, total field gradient and fluxgate).
- Georeference the data using GPS control points (for instance local grid corners with known GPS positions).
- Export the processed dataset in .kml, .png+tfw, .grd, .asc or other raster formats so it can be imported into GoogleEarth or other GIS software (ArcGis, QIS) without requiring third party application.

To ease maintenance and address different users' needs, the software is split into two sub-projects: the GeophPy module, where all the processing is actually done, and the WuMapPy module that gathers all the GUI features.

On one hand, users can use the available commands in GeophPy to create their own routines, scripts or notebooks to process and display the data.

On the other hand, non-programmers can work with WuMapPy's user-friendly GUI to process their data (Fig. 2). The GUI is multilingual and, even though only French and English are available at the moment, the use of a simple dictionary file eases future translations.

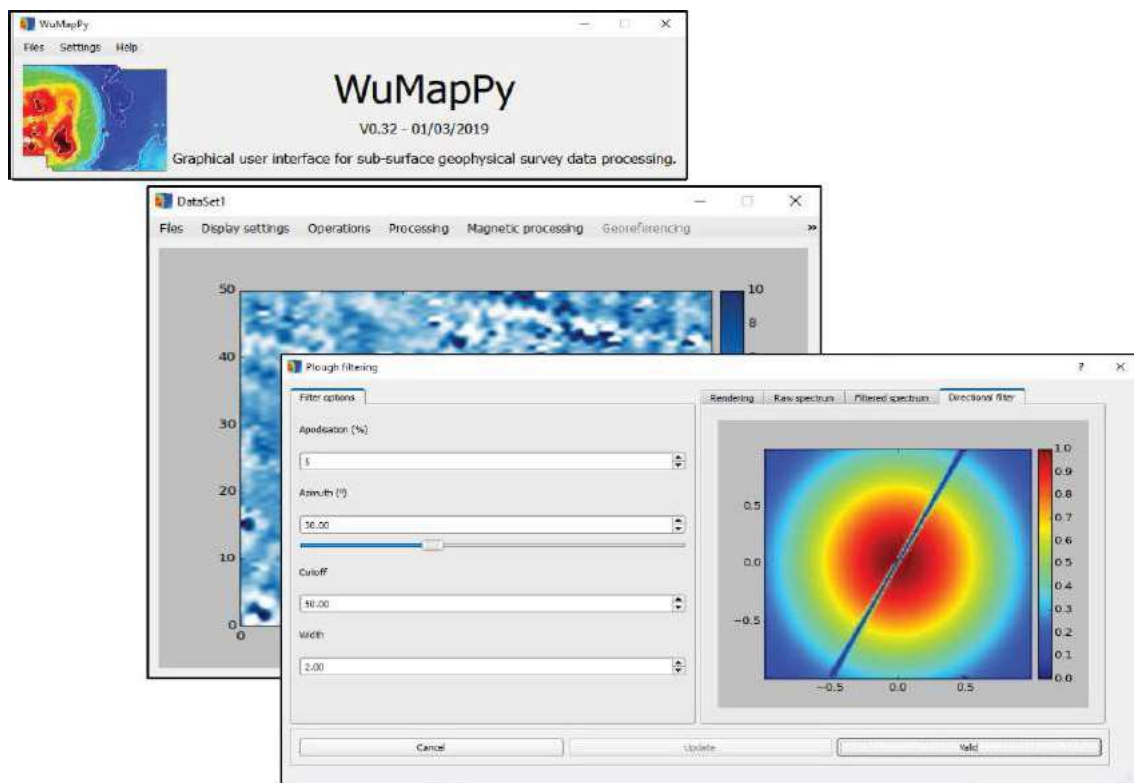


Fig. 2. Example of the WuMapPy graphical interface.

## Future work and perspectives

Although one can process various types of data (magnetic, EM, resistivity) via the available general processing, WuMapPy is mainly devoted to process magnetic data for now, as only filters specific to the magnetic method have been implemented so far. To enrich the software scope, other method-specific filters such as the transformation of raw EM in-phase and quadrature data into physical properties (electrical conductivity, magnetic susceptibility, etc.) or 1-D resistivity sounding inversion will be added in the near future.

One of WuMapPy's objectives is to provide an accessible processing software that unveils the black box by revealing the scientific content; it is hence suited for students in their academic work.

WuMapPy is an open-source and multi-platform software project to display, process and georeference surface and sub-surface geophysical survey data in a user-friendly manner. It can be used by anyone wishing to post-process geophysical datasets, or just perform basic processing and display the geophysical image in a mapping application.

## Acknowledgements

WuMapPy is a collaborative project whose development greatly benefits from all the feedback from the scientific community. The authors thank all the individuals that help through their advice, reviews, enhancement ideas and beta-testing.

Special thanks to Claire Bouligand from the University of Grenoble and her students, who recently tested the software during a geophysical tutorial class.

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