



Product review

Paleomagnetism.org: An online multi-platform open source environment for paleomagnetic data analysis

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ABSTRACT

This contribution provides an overview of Paleomagnetism.org, an open-source, multi-platform online environment for paleomagnetic data analysis. Paleomagnetism.org provides an interactive environment where paleomagnetic data can be interpreted, evaluated, visualized, and exported. The Paleomagnetism.org application is split in to an interpretation portal, a statistics portal, and a portal for miscellaneous paleomagnetic tools.

In the interpretation portal, principle component analysis can be performed on visualized demagnetization diagrams. Interpreted directions and great circles can be combined to find great circle solutions. These directions can be used in the statistics portal, or exported as data and figures.

The tools in the statistics portal cover standard Fisher statistics for directions and VGPs, including other statistical parameters used as reliability criteria. Other available tools include an eigenvector approach foldtest, two reversal test including a Monte Carlo simulation on mean directions, and a coordinate bootstrap on the original data. An implementation is included for the detection and correction of inclination shallowing in sediments following TK03.GAD. Finally we provide a module to visualize VGPs and expected paleolatitudes, declinations, and inclinations relative to widely used global apparent polar wander path models in coordinates of major continent-bearing plates.

The tools in the miscellaneous portal include a net tectonic rotation (NTR) analysis to restore a body to its paleo-vertical and a bootstrapped oroclinal test using linear regressive techniques, including a modified foldtest around a vertical axis.

Paleomagnetism.org provides an integrated approach for researchers to work with visualized (e.g. hemisphere projections, Zijderveld diagrams) paleomagnetic data. The application constructs a custom exportable file that can be shared freely and included in public databases. This exported file contains all data and can later be imported to the application by other researchers. The accessibility and simplicity through which paleomagnetic data can be interpreted, analyzed, visualized, and shared makes Paleomagnetism.org of interest to the community.

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1. Introduction

Paleomagnetic data provide quantitative information on the paleolatitude and vertical axis rotation of rocks and are instrumental for paleogeographic and tectonic reconstructions. In particular, the behavior of the magnetic field known as paleo-secular variation, but also measurement uncertainties, induce scatter in paleomagnetic data (e.g., Butler, 1992; Johnson et al., 2008, Biggin et al., 2008, Tauxe et al., 2010, Deenen et al., 2011). Accurate statistical treatments of these data are therefore fundamental in paleomagnetism. In the paleomagnetic community it is common

practice to publish means of magnetic directions with a few standard statistical parameters. In many cases, the original data remain unavailable to the reader and are rarely included in public databases (e.g. MagIC, <http://earthref.org/MagIC>). We provide an accessible and intuitive online platform (Fig. 1) to interpret demagnetization data, perform standard statistical treatments, plot paleomagnetic data, and compare them against apparent polar wander paths. This software contribution builds upon, and is inspired by other software packages including PALDIR, Remasoft, PaleoMac, and the PmagPy library (Tauxe et al., 2016; <https://earthref.org/PmagPy/cookbook/>). The data used in our application can be exported to simple data files and shared freely with the community and included in public databases at will. This contribution serves as a manual for the use of, and describes the scientific background behind the current portals and modules on Paleomagnetism.org. Since we provide an open source

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Home Interpretation Portal Statistics Portal Miscellaneous Portal References Team and Code Contact

Welcome to Paleomagnetism.org **Portal links**

Version: ALPHA.1509.3

Note: This is an early alpha (test) version of the application. Your feedback and bug reports are appreciated.

Introduction

Paleomagnetism.org is an online application designed for the interpretation and statistical evaluation of Paleomagnetic data. The website promotes the ability to share Paleomagnetic data between researchers through a common online environment.

The website is divided in to three main portals as described below. The portals contain multiple modules that aid the analysis of your data.

For further information please refer to the manual (to be announced).

1. Interpretation Portal

The interpretation portal allows for the analysis of demagnetization data and interpretation using eigenvector analysis (Kirschvink, 1980). Currently, data can only be imported in the Utrecht format.

2. Statistics Portal

The statistical portal includes ways to visualize and evaluate paleomagnetic data (declination inclination pairs) using common procedures and tests.

3. Miscellaneous Portal

This portal includes a collection of tools with a distinctive input and output. Currently two tools are available:

- I. A Bootstrapped Oroclinal Test (Including an oroclinal foldtest)
- II. Net Tectonic Rotation Analysis

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Fig. 1. Homepage – Screenshot of the home page of Paleomagnetism.org. The three available portals can be used by clicking the respective menu links at the top of the page.

environment, it is foreseen that useful additions will appear in time.

In the interpretation portal, principle component analysis (Kirschvink, 1980) can be applied to fit great circles and directional set-points on demagnetization data visualized on Zijderveld diagrams (Zijderveld, 1967), equal area projections, and intensity decay diagrams. Great circle solutions can be found with or without independent set-points using the iterative procedure of McFadden and McElhinny (1988). Interpreted directions can be exported as a tabulated .csv file or as a custom .dir file that contains all data and interpretations made by the user. Interpreted magnetic directions can also be forwarded and imported to the statistics portal for further statistical analysis.

The statistics portal provides modules containing common

paleomagnetic tests for the statistical analysis on both directional and VGP distributions. These tests are contained within separate modules and include reversal, or common true mean direction tests (McFadden and McElhinny, 1990; Tauxe et al., 2010), the eigenvector approach fold test (Tauxe and Watson, 1994), a tool for the correction of inclination shallowing in sediments after the TK03.GAD field model (Tauxe and Kent, 2004; Tauxe et al., 2008), and a module to compare results with common apparent polar wander paths in the coordinates of the most important continent-bearing plates. For all data that is added to the application, a cutoff (none, Vandamme, or 45°) can be applied (Vandamme, 1994; Johnson et al., 2008) to the VGP distribution. Standard Fisher parameters (Fisher, 1953) are calculated and the data can be used in the other application modules. Data added to the statistics

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