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Computers & Geosciences 31 (2005) 589–597

COMPUTERS & GEOSCIENCES

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MODMAG, a MATLAB program to model marine magnetic anomalies ☆

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Received 22 April 2004; received in revised form 12 November 2004; accepted 15 November 2004

Abstract

Identifying marine magnetic anomalies is the most common way to date the ocean floor. Although the technique of magnetic anomaly identification has not changed since the 1960s, a forward modeling software that is easy to use, fast and automatic, without abstruse parameters, was lacking. We present a user-friendly MATLAB-based interface, called MODMAG, which allows one to perform forward modeling of marine magnetic anomalies resulting from several successive spreading periods with different spreading rates and asymmetric spreading possibly alternating with axial jumps. The main advantage of our program is that the management of the magnetized bodies resulting from such successive spreading periods is not the user's responsibility. Spreading parameters can be set easily for the picking of the marine magnetic anomalies. Non-specialist geophysicists or geologists can therefore easily identify marine magnetic anomalies with the help of MODMAG.

Keywords: Magnetic anomalies; Forward modeling; Mid-oceanic ridges; MATLAB

1. Introduction

In the late 1950s magnetic surveys over the oceans revealed remarkable striped patterns of alternately positive and negative magnetic anomalies over large areas of oceanic crust. A few years later, Vine and Matthews (1963) formulated a landmark hypothesis that explains the origin of the oceanic magnetic anomaly patterns. This hypothesis was based on the generation of oceanic crust by seafloor spreading when the Earth's magnetic field reverses intermittently. For the last 40 years, most of the ocean basins have been dated using these anomalies, allowing the history of these basins and the surrounding continents to be reconstructed up to 190–195 Ma (e.g. Sahabi et al., 2004). Dating the ocean floor has far-reaching implications not only for plate tectonics but also for economic geology and paleoceanography. The presence of noise of various origin (local tectonic complexity, variations of the external magnetic field, etc.) does not allow an easy application of magnetic anomaly automatic identification procedures, although some pattern recognition techniques have been tried with moderate success (Zhizhin et al., 1997). The technique of magnetic anomaly identification has thus not changed since the 1960s: the total field anomaly over a series of rectangular bodies of an assumed magnetization may be calculated using two-dimensional forward modeling and then compared with the observed total

☆Code on server at http://www.iamg.org/CGEditor/index.htm

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doi:10.1016/j.cageo.2004.11.007

field anomaly. The process is repeated with changes in spreading rates until the most geological reasonable model is obtained. A common practice is to generate a series of profiles of magnetic anomalies modeled with a set of spreading rates and then choose the one which fits the best with the observed. However, a serious pitfall in analyzing marine magnetic data is the assumption that all seafloor spreading is symmetric; if this idea is accepted, such interesting features as propagating rifts, axial jumps and asymmetric spreading may create confusion. The lack of a forward modeling software that is easy to use, fast and automatic, without abstruse parameters, motivated the programming of a user-friendly MATLAB-based interface. We present here a software called MODMAG which allows one to perform forward modeling of marine magnetic anomalies resulting from several successive spreading periods with different spreading rates and asymmetric spreading possibly alternating with axial jumps. The main advantage of our program is that the management of the magnetized bodies resulting from such successive spreading periods is not the user's responsibility. Non-specialist geophysicists or geologists can therefore easily identify marine magnetic anomalies with the help of MODMAG.

2. Overview of the program

MODMAG is a set of scripts and functions written for use with the MATLAB software. It runs with MATLAB 6 under Windows or Linux without any additional toolbox. It also works on Unix platforms. Fig. 1 illustrates the flow chart of these scripts and functions and their main goals. The user launches the program by running the script MODMAG which creates the user interface (Fig. 2). The user can load a

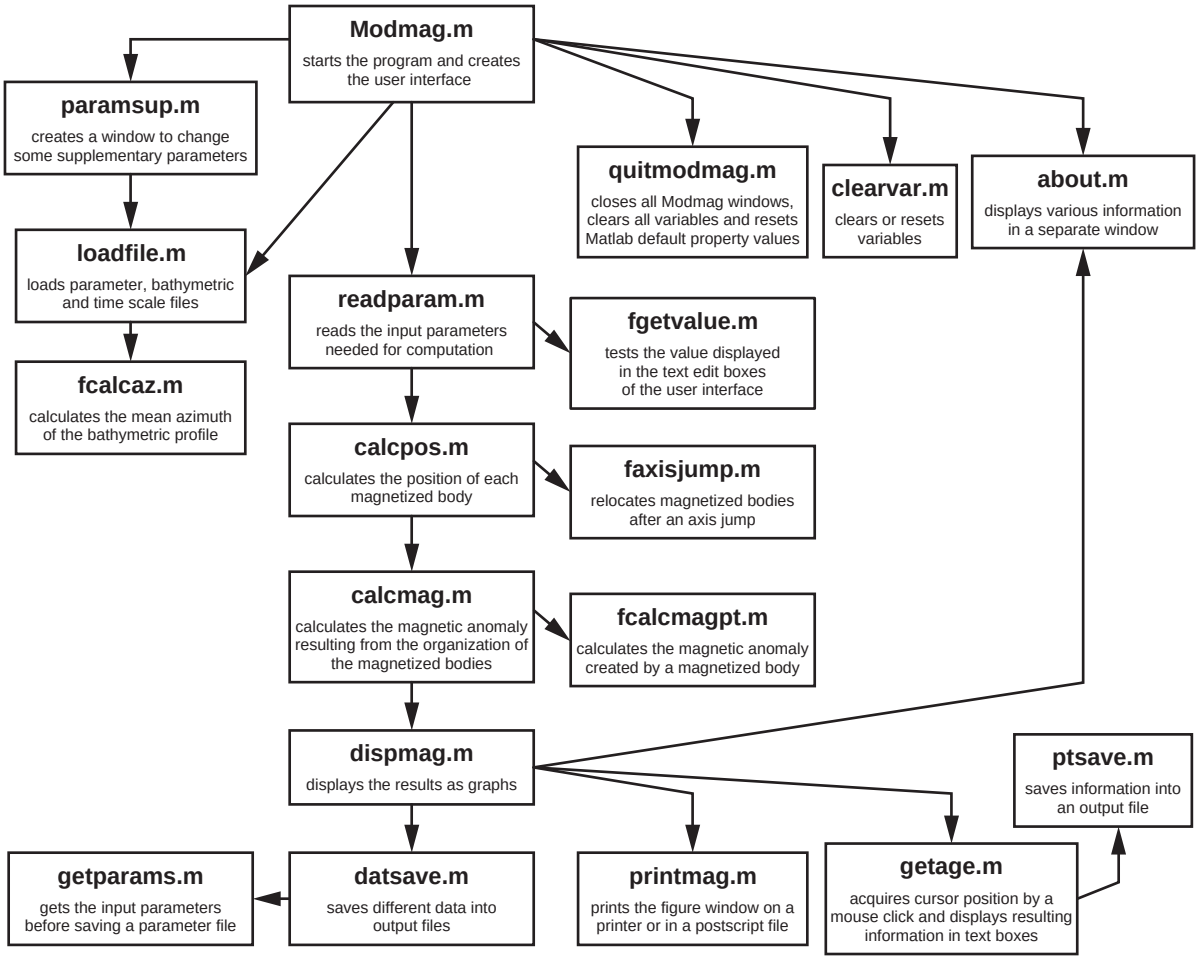

Fig. 1. Flow chart and goals of MODMAG scripts and functions. Code was written for MATLAB 6 without additional toolbox.