

Gravity & Magnetic Data Acquisition, Processing and Interpretation

What kinds of Geophysical Data should be used?

Various kinds of geophysical data are available, sometimes summarised as Multi-Physics data. Usually, they are separated into Seismic and Non-Seismic. Seismic is, without any doubt, the dominant method used in the energy industry. But Non-Seismic data (gravity, magnetics, electrical, electromagnetics, etc) is the main source of information in shallow subsurface applications (engineering, mapping pollution, archaeology, Geothermal Energy, CO2 sequestration). It is also used in the early reconnaissance of new basins and plays and in mapping prospects below salt/basalt (Magneto-Telluric). However, seismic has its limitations and therefore also non-seismic methods are used successfully as complementary tools in subsurface evaluation. In combination with seismic data, they can significantly reduce the uncertainty of subsurface models as they measure different physical properties of the subsurface.

The Course on the potential of gravity and magnetics.

The course is partly based on an EAGE publication (Advances in Gravity and Magnetic Processing and Interpretation by J. Derek Fairhead, ISBN 978-94-6282-175-0).

In the first part, various aspects of gravity will be discussed, such as the Earth gravity field, determining anomalies in the global field, establishing the depth of density anomalies, be it spherical or anticlinal and the resolution, which is limited because gravity is a “potential field”. Most promising is the development of gravity gradiometer, whereby gradients in the gravity field can be directly measured with great accuracy. These measurements are less sensitive to airplane and ship movement.

In the second part, the Earth’s magnetic field, also a “potential field” will be studied. Being due to the internal dipole source, the inherently more difficult interpretation is simplified by applying a transformation to a monopole field (Reduction to the Pole or Equator). As different causative sources can produce the same surface measurements, non-uniqueness is always present. However, promising developments to mitigate these issues will be shown. Finally, we will discuss and apply the “latest and greatest” that is Machine Learning, a part of Artificial Intelligence, which is step-changing the geoscience world. We will use a standard package called Weka and familiarise ourselves with the “ultimate” open-source software Keras and TensorFlow. Exercises will be done using Weka and Google Colab. After the course, you should be able to try out Machine Learning on your own data. In addition, we will investigate how useful ChatGPT is.

The course

Gravity and Magnetic applications will be discussed using lectures and videos and by doing many exercises. In addition, you will benefit from Moodle, facilitating interactions and discussions. To do the course you will have to install the open-source software packages Weka and TensorFlow (using Google Colab).

Learning methods and tools

The course uses a user-friendly Learning Management System, called Moodle. In Moodle different modules provide study material, videos, and exercises. Also, each part contains a quiz which is meant to reinforce the learning. The quiz uses the software package “Mentimeter”.