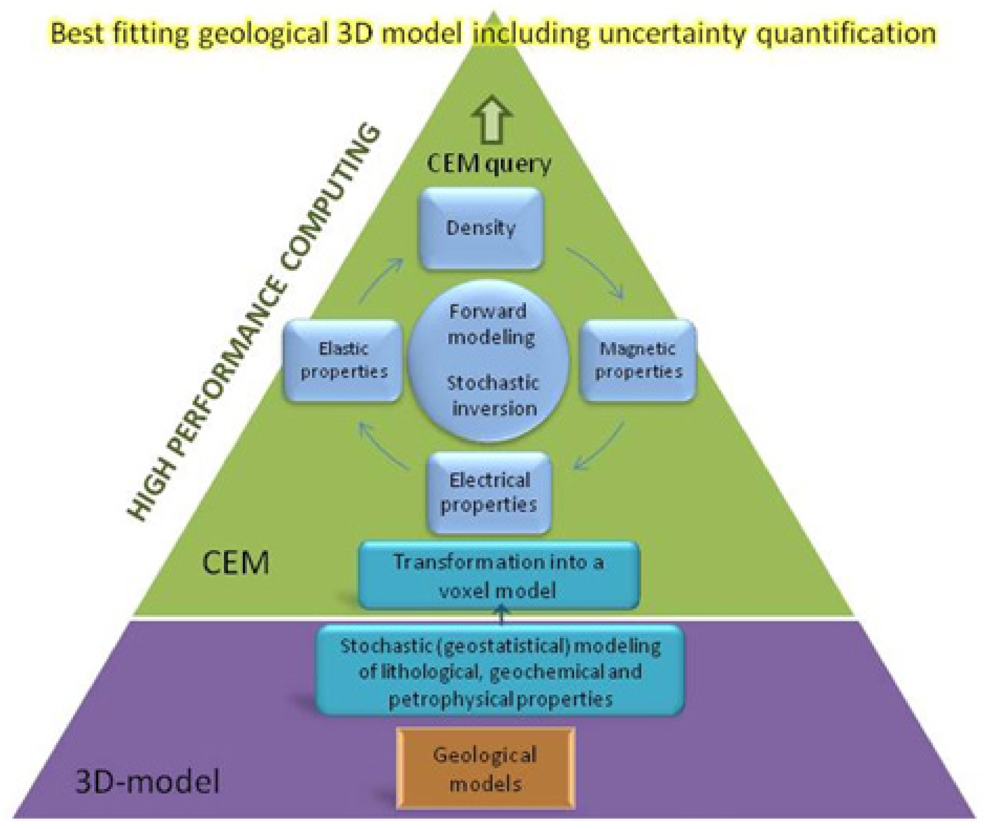
# High-performance geoscientific computing in multi-scale mineral potential studies

## Introduction

A central task in mine site evaluation and 3D mineral potential studies is to collect data on multiple spatial scales and then use inverse methods to infer the location and extent of economically interesting mineral deposits. Datasets comprise, for example, airborne and ground geophysical data, drill hole data, geological maps and cross sections, drill core logs, and geochemical data. Directly observed geological information is often sparse (e.g. drill holes) and subsurface geology has to be inferred through interpretation and inversion of measured geophysical data.

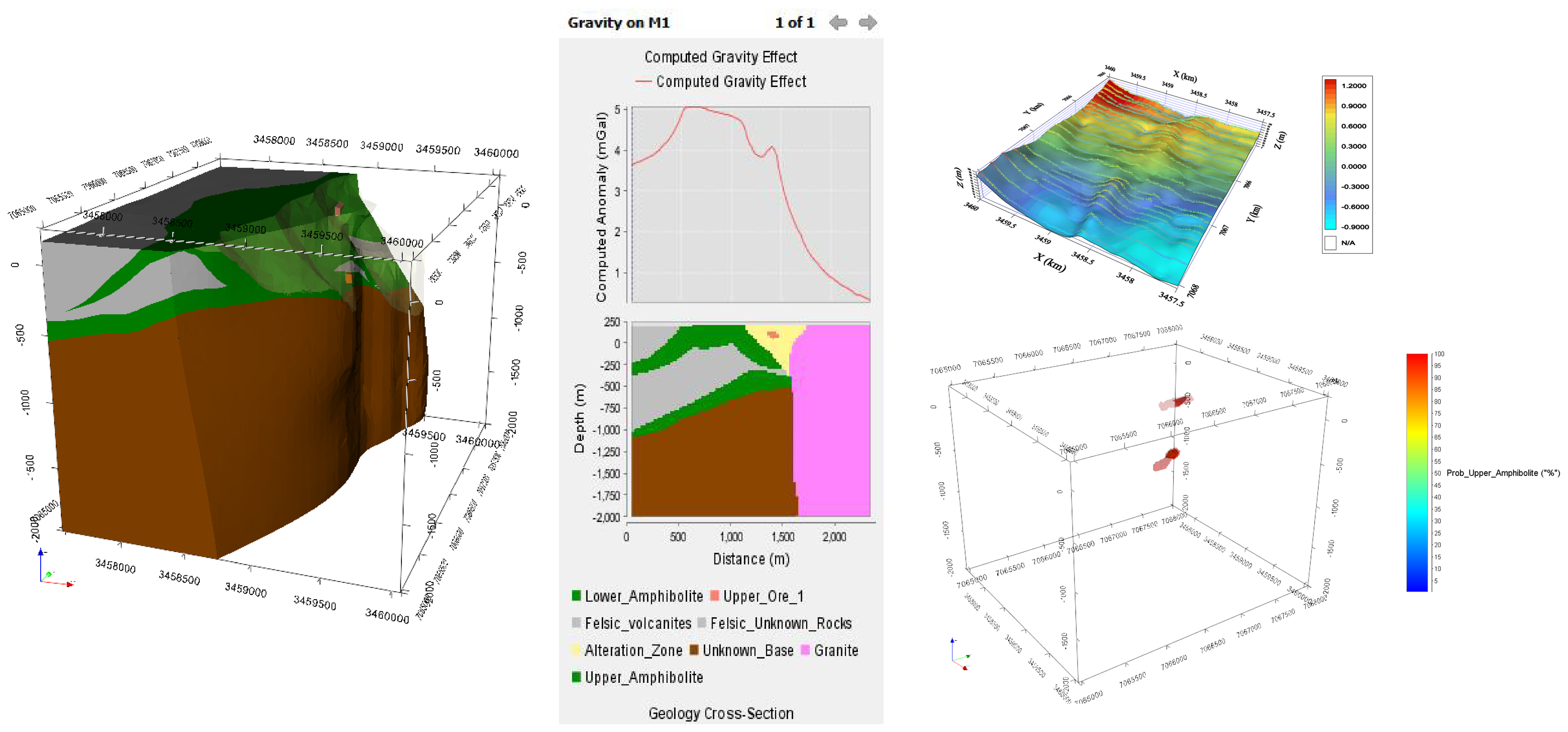
Project GECCO combines expertise in high performance computing and geomodelling, and aims to develop tools for faster geological modelling in a powerful computing environment.




*Common earth model (CEM) is a new concept in multidisciplinary integration of data and work processes. Modern 3D earth modelling software enables sharing common digital 3D representations of the subsurface and rapidly incorporating new information into existing models. 3D models and all geoscientific data can be included in the same CEM model.*

## CEM

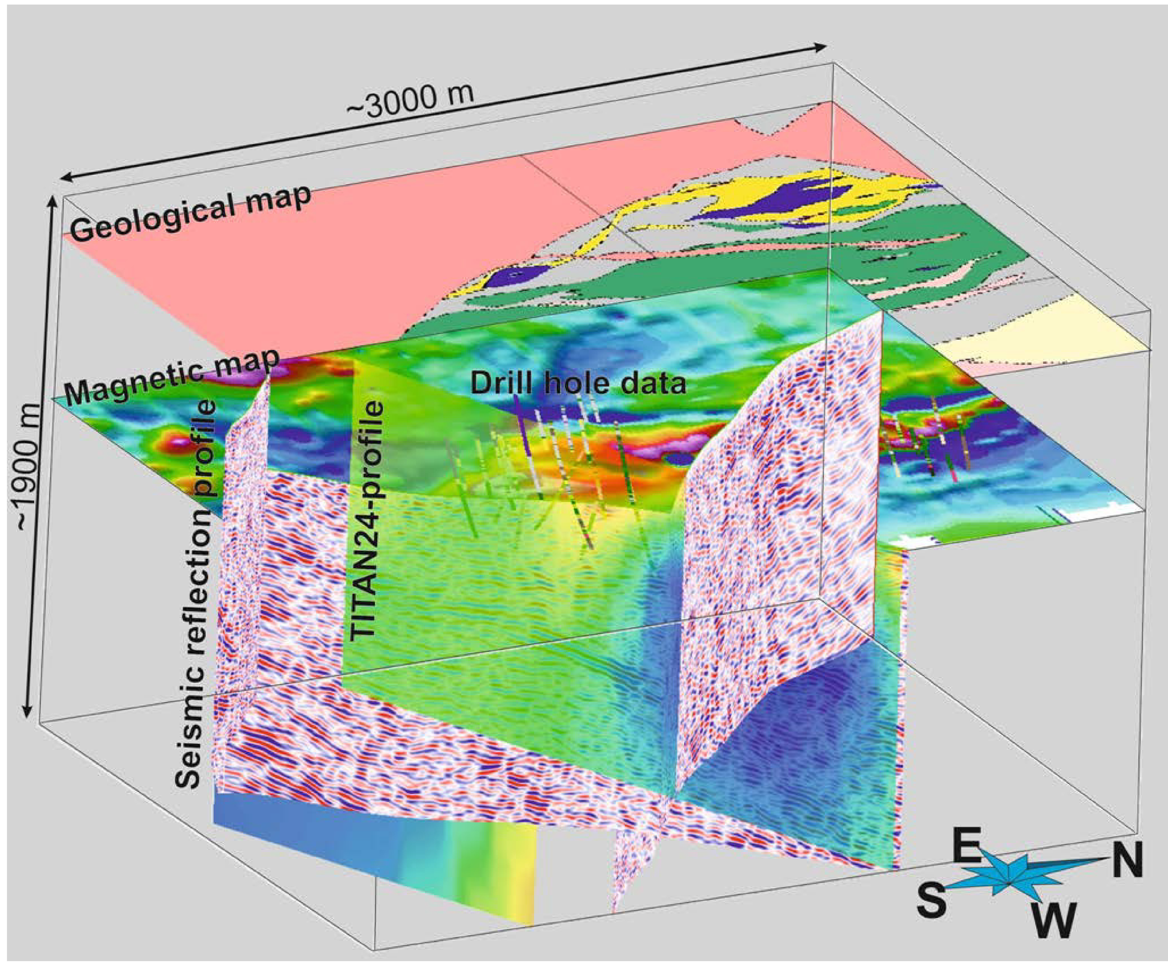
Lithological, geochemical and geological properties in the CEM fullfill geological and geophysical constraints. Geological constraints include geological 3D models, geological maps, geohemical data and geological rules inferred from structural geological observations.




*a) Mullikkoräme 3D model; b) the calculated gravity anomaly across the alteration zone; c) the kriged gravity measurements; d) the inversion result of the upper Zn ore and the lower pyrite ore at Mullikkoräme (pink refers to the inversion result and red to the initial model, the initial ore models were built too small by purpose). The used software was Intrepid GeoModeller.*

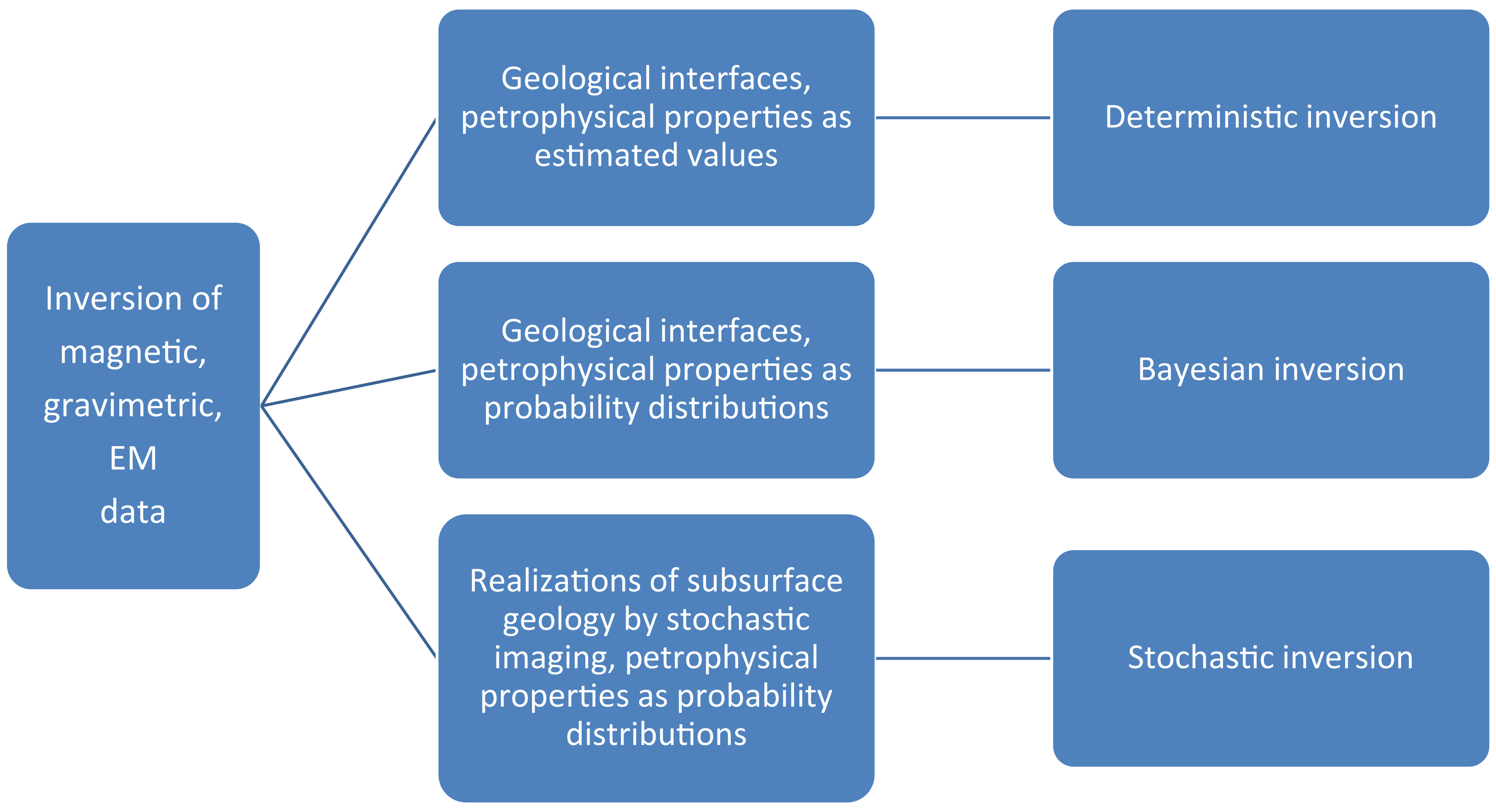
## Data

Example of abundant data at different scales from the Mullikkoräme area.




## Workflow for geophysical inversion

Stochastic geophysical inversion requires the computation of a large number of geophysical responses of geological realizations, which is possible with the increased computational capacity.




## Results

The increasing amounts of data has led to the need to use of high performance computing techniques in geosciences, with parallel computing and the use of modern accelerator technologies like graphical processing units GPUs to speed up calculations.

The first computational results show that GPUs can speed up the direct calculation of Newtonian gravitation by a factor of 215. For instance, a source grid 500x500x40 and a receiver grid 84x84 can be calculated in 5.2 secs. In addition, preliminary results also indicate that the use of the exact formula for the gravitational field of a cube will deviate from that of a spherical source by less than one percent.

## Acknowledgements


This study was funded by Academy of Finland (funding decision nos. 292481 (Åbo Akademi) and 292569 (GTK)). Pyhäsalmi Mine Oy is thanked for providing data for the use in the Gecco project.



## Geological Survey of Finland

Eevaliisa Laine[1], Jan Westerholm[2], Soile Aatos[1], Mats Aspnäs[2], Johan Grönroos[2], Suvi Heinonen[1], Kimmo Korhonen[1], Mira Markovaara-Koivisto[1], Ilkka Suppala[1]
[1])Geological Survey of Finland
[2]) Åbo Akademi University, High Performance Computing


Åbo Akademi

ACADEMY OF FINLAND

GTK
gtk.fi