

Simulation of a Micro-gravity surveying

WS0607

Dr. Laurent Marescot

Locate a flooded cave system

The data come from the University of Keele (UK)

<http://www.esci.keele.ac.uk/geophysics/Research/Gravity/>

Locate a flooded cave system

Remember...

The magnitude of gravity depends on 5 factors:

- Latitude
- Elevation
- Topography of the surrounding terrains
- Earth tides
- Density variations in the subsurface

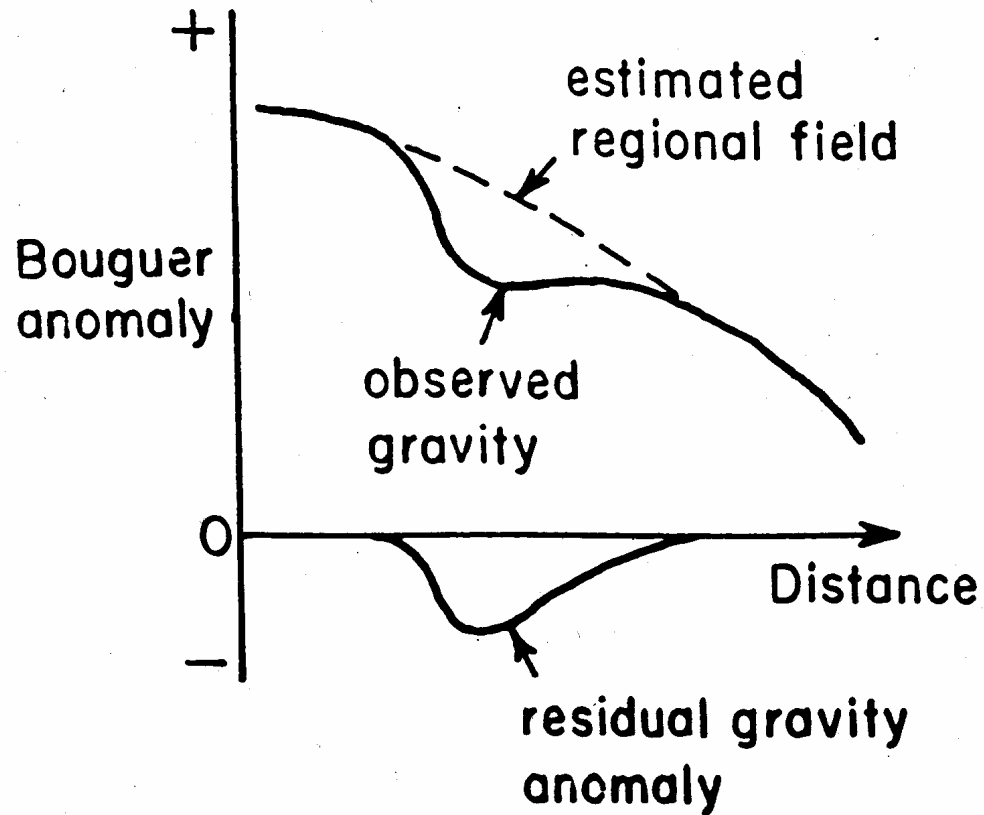
Locate a flooded cave system

$$BA = g_{obs} - g_{model}$$

$$g_{model} = g_{\phi} - FAC + BC - TC$$

- g_{model} model for an on-land gravity survey
- g_{ϕ} gravity at latitude ϕ (latitude correction)
- FAC free air correction
- BC Bouguer correction
- TC terrain correction

Locate a flooded cave system



Locate a flooded cave system

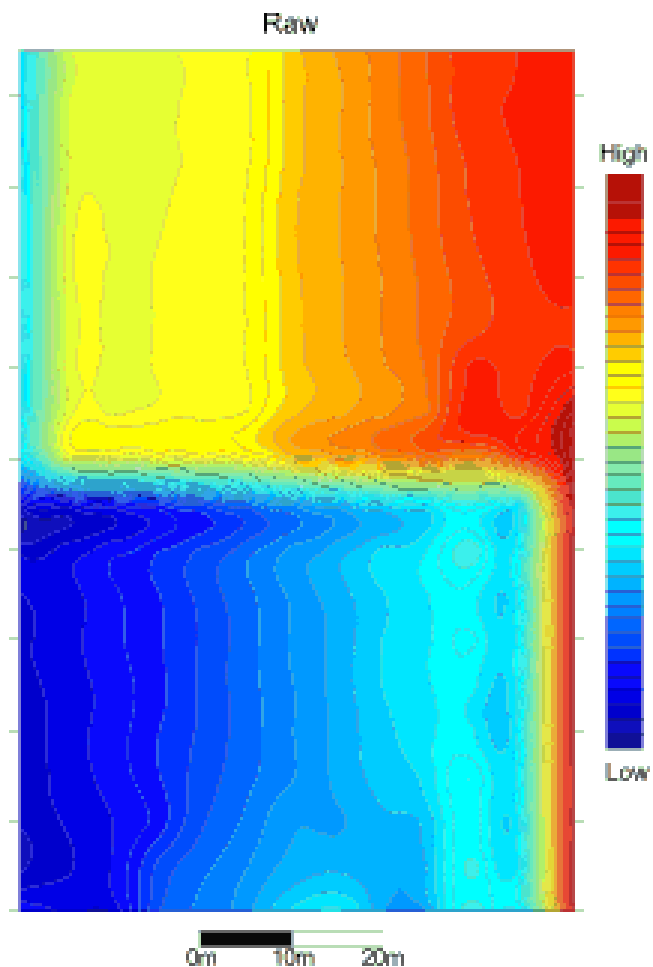
Problem: Locating sink holes on the possible expansion area for a container port



Survey site: 60 m x 95 m
300 stations on a 5-m orthogonal grid



Locate a flooded cave system



These are the raw data: how can you explain the main features on the raw gravity map?

Hint: the survey was conducted in two days...

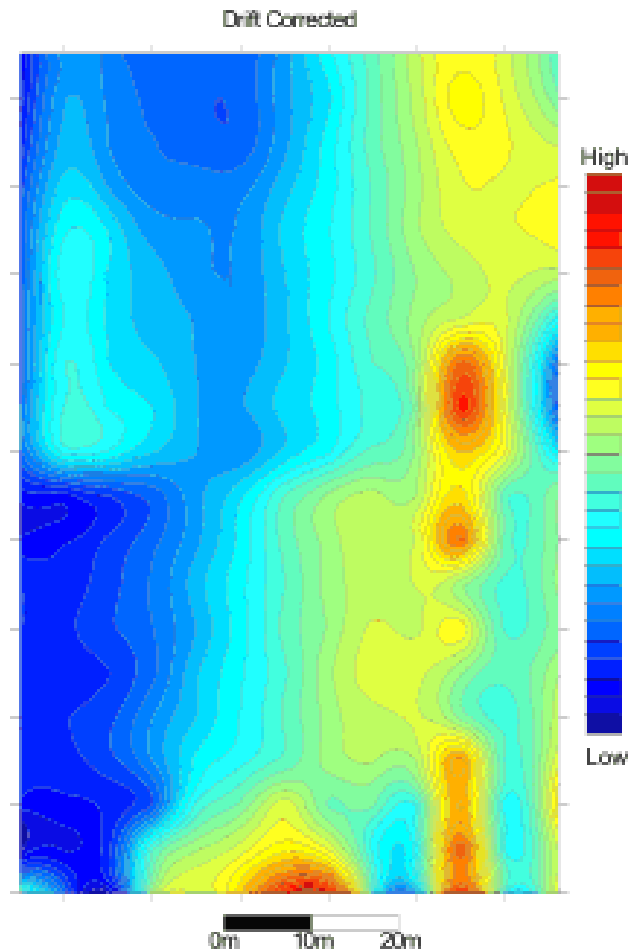
Locate a flooded cave system

Solution:

The raw data shows the overriding influence of the regional gravity trend but is also split due to acquisition taking place over two separate days. The **instrument drift** is clearly separating the two days data.

The application of the drift correction, determined from on-site testing of the gravimeter and interpolation between base station readings, brings the data nearer to a common datum.

Locate a flooded cave system



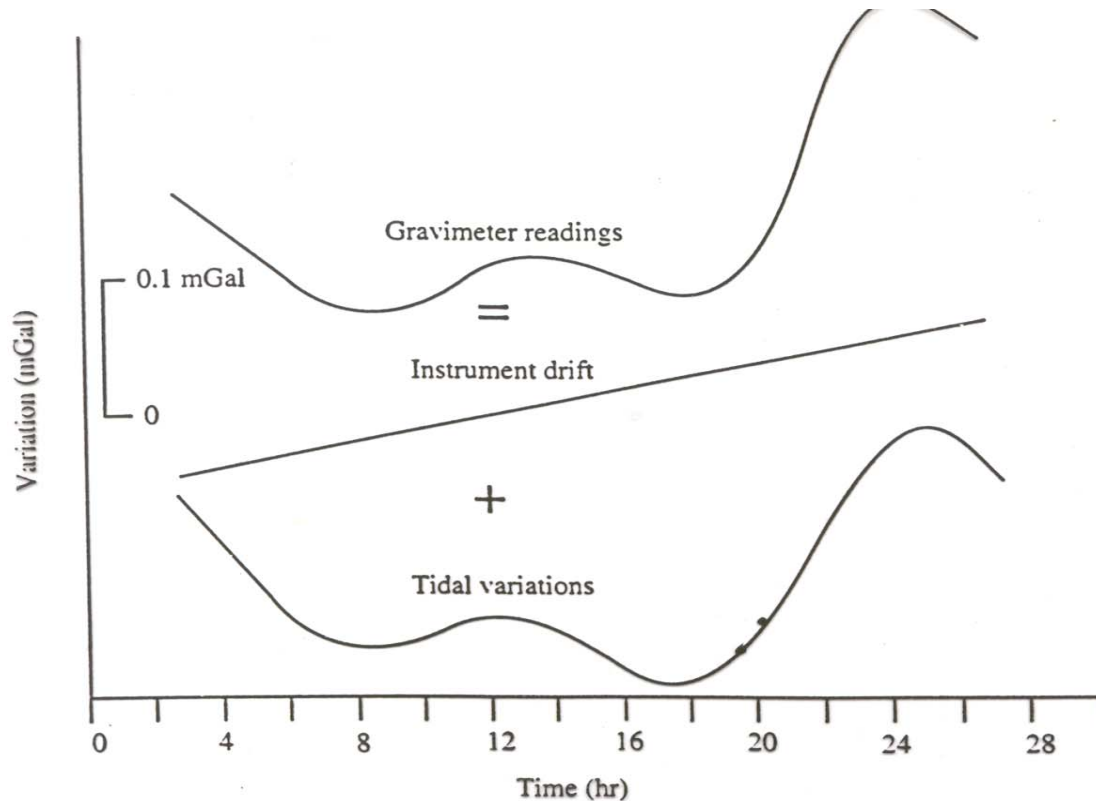
A small shift still exists across the data due to time variation (up to approximately 250 microgals/day).

What is this shift?

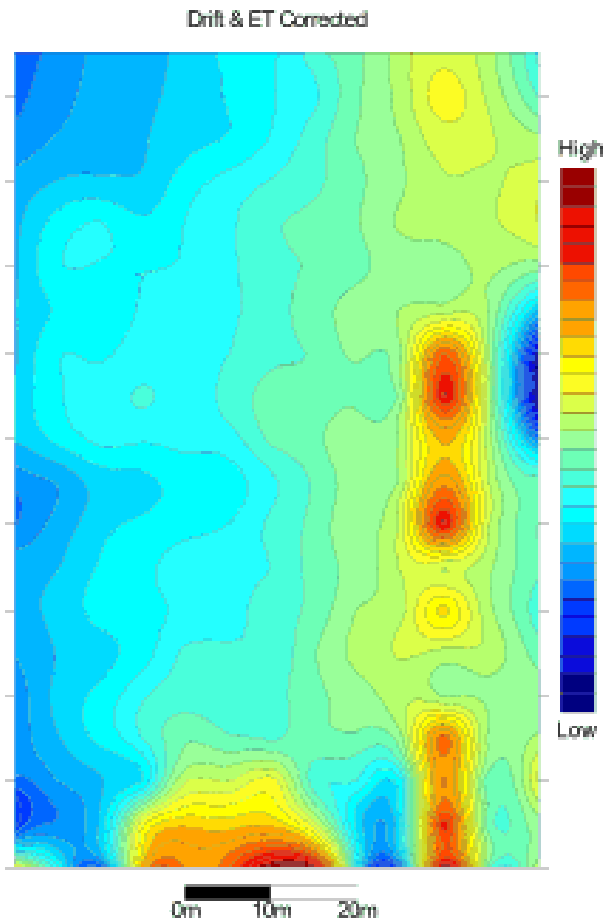
Locate a flooded cave system

Solution:

Shift in the Earth's gravity caused by the **Earth Tides** alone.



Locate a flooded cave system



The data is now consistent across the site and interesting features are evident:

A N-S trend of higher gravity and a region of higher gravity along the southern edge of the map.

What could be the cause of so regular anomalies?

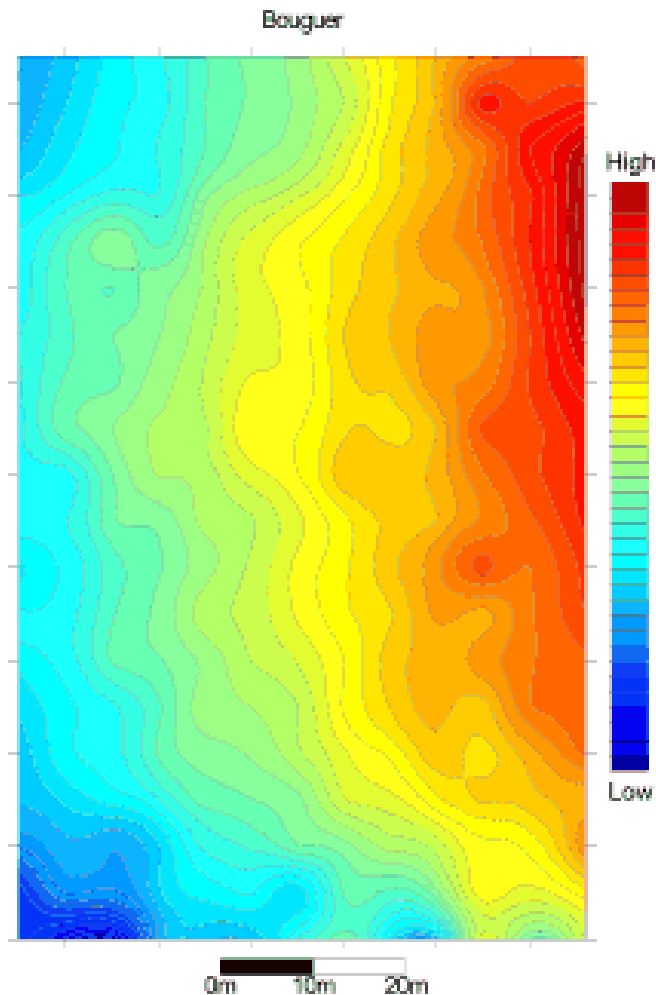
Locate a flooded cave system

Solution:

Gravity increases with decreasing elevation.

On site, there are elevations effects on stations that fell in the bottom of a 1.5m deep drainage ditch, and the nearby launching slipway to the harbour. These areas were lower than the surrounding topography and therefore without the application of an **elevation correction** are clearly seen in the data set.

Locate a flooded cave system



With the elevation correction applied, together with the **free air correction**, the plot now looks sensible and represents the regional gravity together with any much smaller scale features that we are interested in.

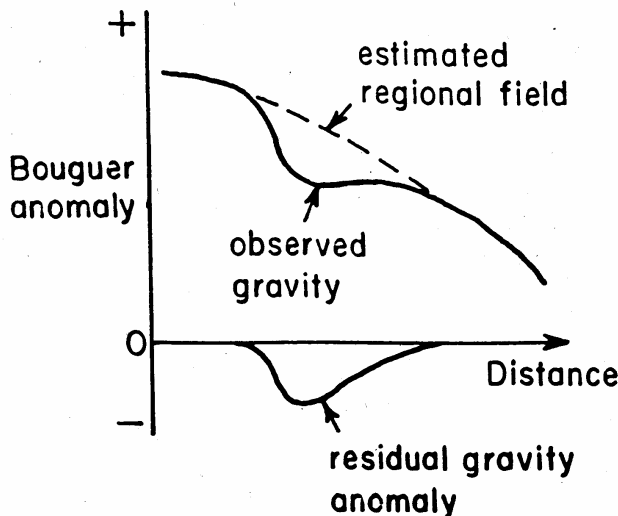
How can we extract this information?

Locate a flooded cave system

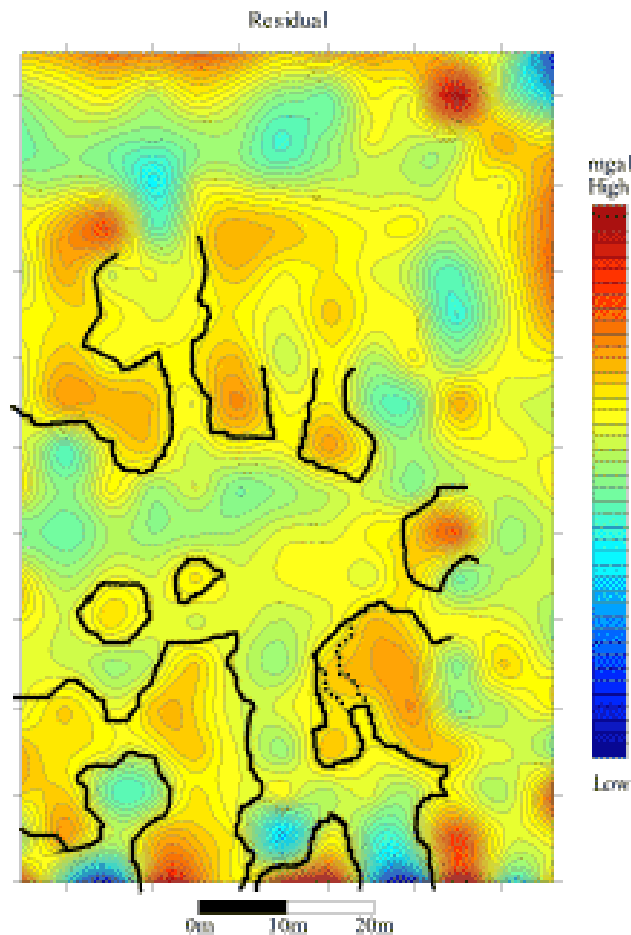
Solution:

In order to examine the small scale features within the entire gravity data set, a three dimensional polynomial surface must be mathematically subtracted from the data.

The skilled removal of this surface is termed residualising.



Locate a flooded cave system



The removal of a polynomial surface results in the production of the **residual map**.

The location and trends of the cave systems are now clearly visible.

Locate a flooded cave system



In conventional surveys the anomalies identified would usually be investigated by drilling. Here, a cave-diver was employed, who reported good agreement between the subterranean mapping and the gravity plan.