A preliminary attempt of a quasi-geoid for Saudi Arabia

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XXIV FIG International Congress 2010
Facing the Challenges - Building the Capacity
Sydney Convention & Exhibition Centre
11-16 April 2010

The Proposed Quasi-Geoid Project

- Undertake a national geoid (quasi-geoid) model study for Saudi Arabia
- To fully utilize the three dimensional location satellite technology
- Replace many aspects of conventional topographic surveying by accurate, rapid and cost effective satellite based methodology.
- The aims and scope of this study are to generate a high resolution geoid model for Saudi Arabia with suitable accuracy for rapid and efficient surveying methods related to Geodesy and Engineering (e.g. levelling for water distribution and flow, dams, roads and railways etc).
- The expected accuracy will be in Absolute: better than 0.5 m and relative: approximately 0.1cm per km

Geoid

- Geoid is the equi-potential surface of the
  Earth
  mea

- Is th
- It se
  the height system.
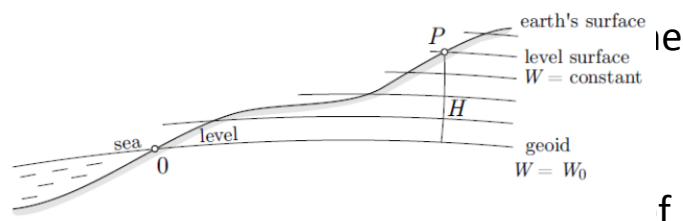
Why Quasi-Geoid

- Saudi Arabia is rough in the West and has large lateral density variations in crust.
- Using constant density value for the crust is a well-known assumption in determination of the geoid models, however:
- Large lateral density variation effect the geoid.

Regional Geology of the Arabian Shield
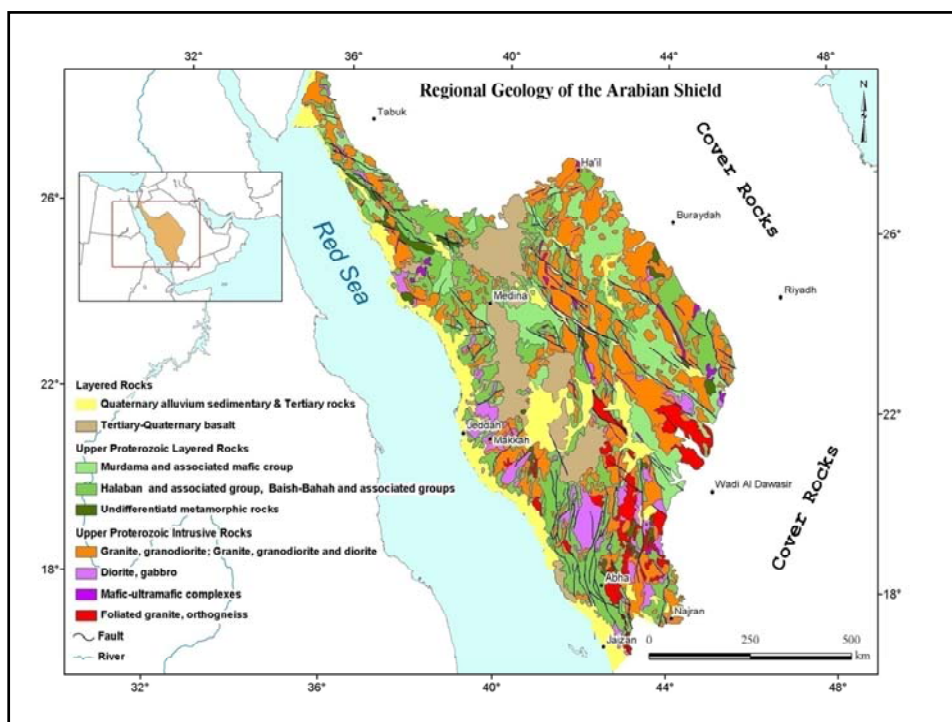
Methodology

- Helmert gravity anomaly computed from a compilation of all existing gravity
- In the computations, a reference field provided by a suitable geopotential model, like GRACE, will be removed from the anomalies. In the end the long wavelength component will be restored to the quasi-geoid heights using the same geopotential model.
- Once the geoid has been derived, it can be used with GNSS data to accurately estimate the normal height of a point very quickly and efficiently. This can eliminate the need for conventional levelling which is costly and time consuming.
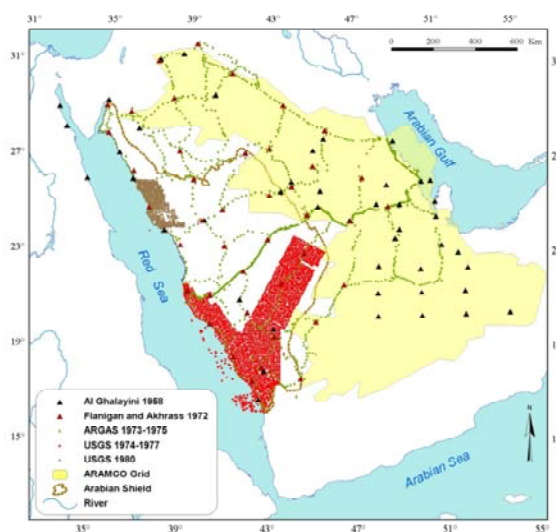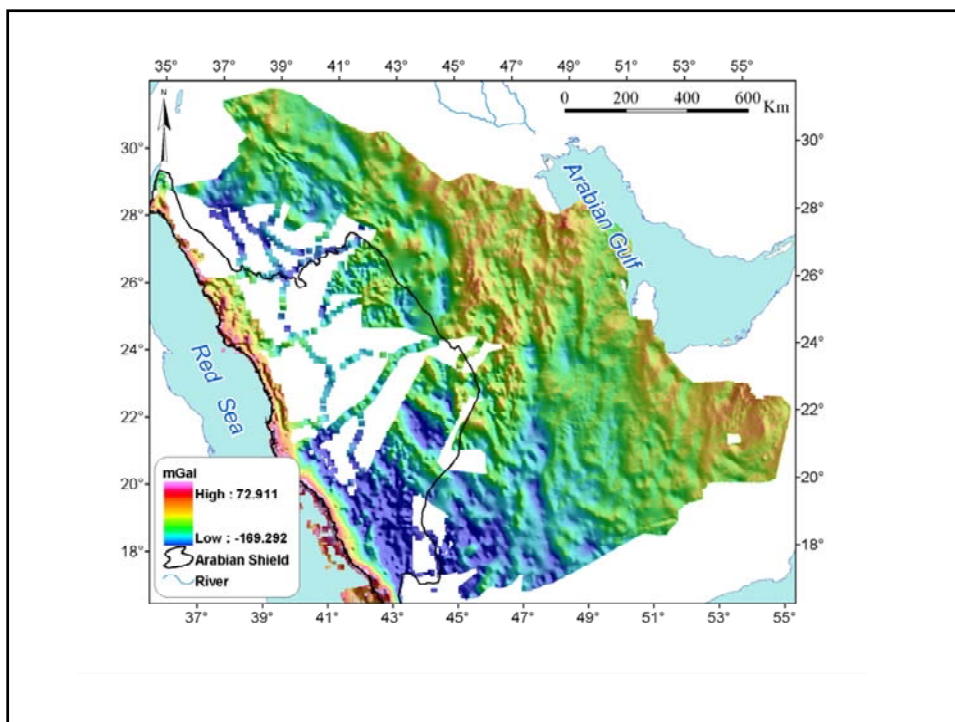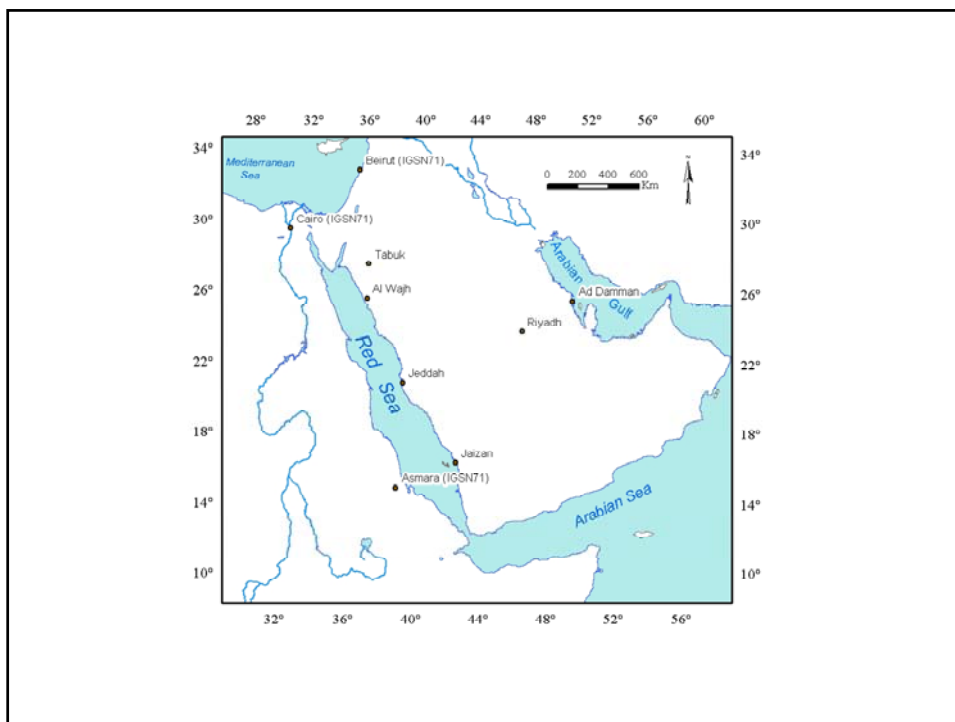
Quasi-Geoid

- Quasi-Geoid was implemented some countries as a practical alternative to geoid estimations **which is constrained by gravity lateral variations within the Earth** and therefore the orthometric height derived by geoid model requires a precise observation of gravity anomalies above the sea level which is practically undetectable.

- However, in the quasi-geoid modeling an approach was first introduced by **Molodensky** where he solved the geodetic boundary value problem by refereeing the gravity anomalies to the ground. This new Quasi-Geoid estimation approach was applied adequately in some countries:

- Iran (Kiamehr, 2008), and Belgium (Barzaghi et al., 2003). And New Zealand (Amos and Featherstone, 2009).

- This technique is an effective part of Dubai Virtual Reference System (Dubai VRS) that uses real time positioning from GPS satellites signals at the cm accuracy in major civil engineering applications. Coupled with the newly developed quasi-geoid model (El-Mowafy et al. 2006).
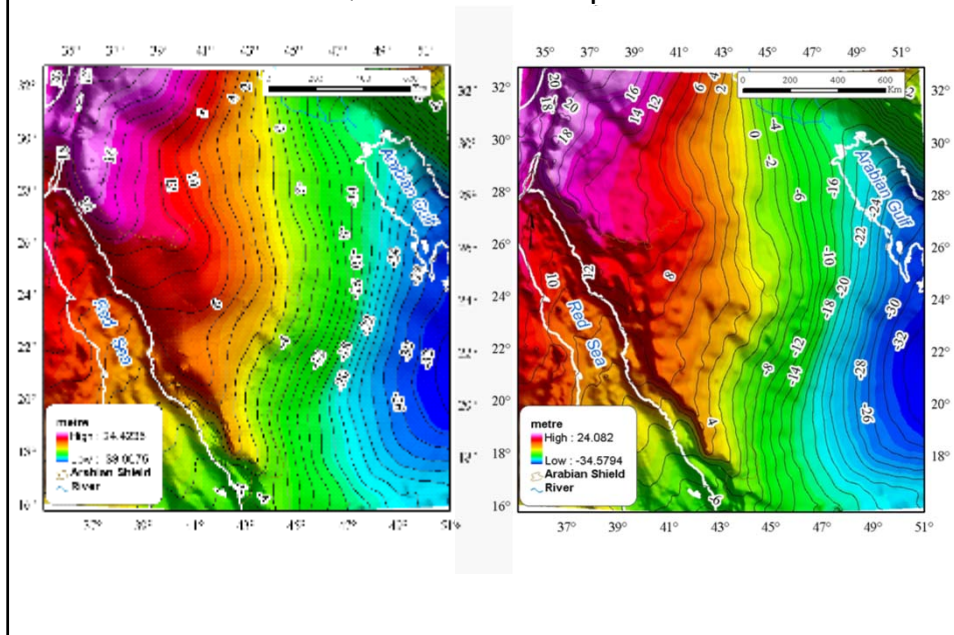
Gravity Coverage

ARGAS
- 1973 to 1975,
- Three Fundamental Gravity Base Stations (FGBS) were established in Riyadh, Jeddah and Jizan, and interconnected to three IGSN 1971 bases in Beirut, Cairo and Asmara.
- A total of 3579 readings were collected.
- 905 stations were re-observed showing a mean standard error of 0.048 mGal
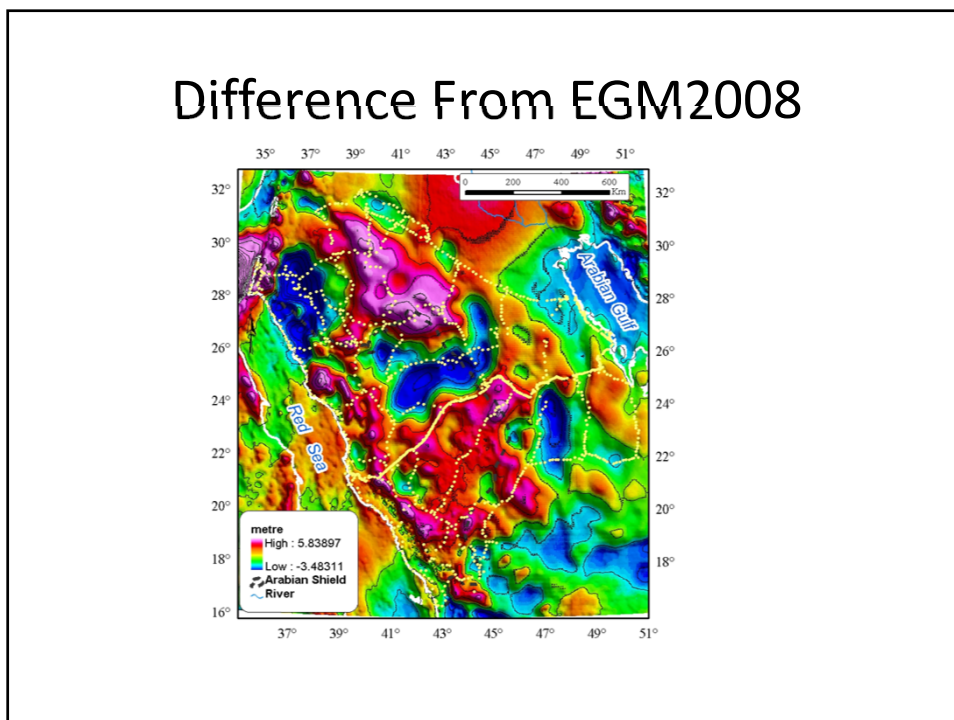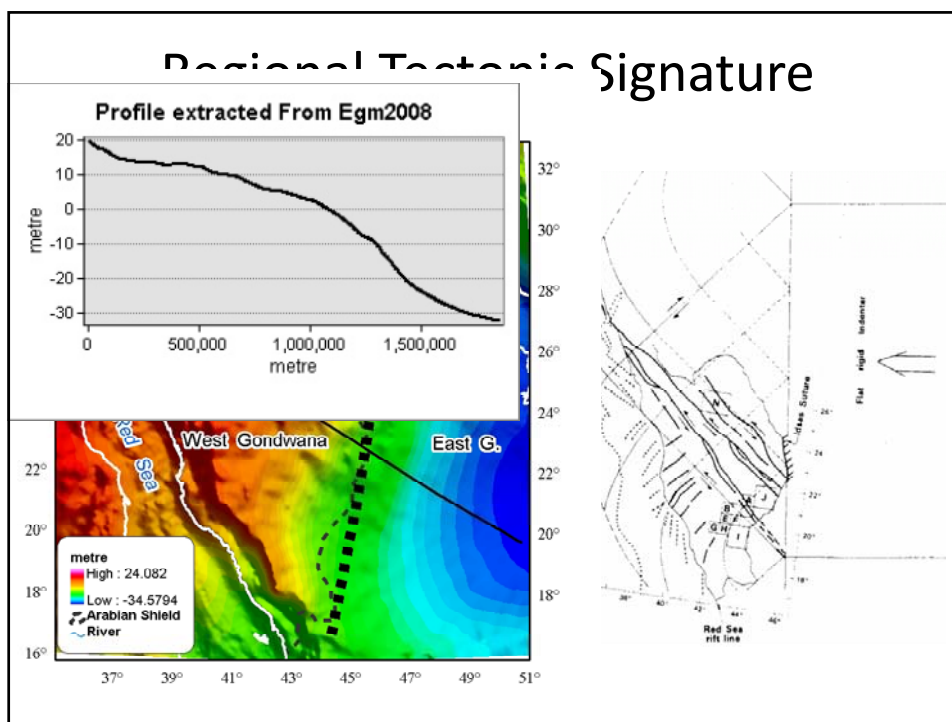- **USGS**
- Start 1974 to 1977.
- accuracy of ±0.15 mGal

The Resultant Quasi Geoid Compared To EGM2008

Difference From EGM2008

Regional Tectonic Signature

Results & Suggestions

- Poor resultant Geoid due to poor Gravity Coverage.
- Quasi-Geoid should be tested against GPS/Leveling.
- Establishing First-order Absolute-Gravity network using the Micro-g FGL or FG5 Absolute Gravimeter.
- Tying the existing networks of GPS and gravity with the new Absolute Gravity network.
- Densifing Gravity points in areas with no Gravity surveys like some part of the Arabian Shield.

Thank You

Orthometric Height

- The orthometric height*, is the length of the curved plumbline therefore the following should be known:*
- *The exact p...*
- The gravitati...   ...at plumbline n...
- Also knowle...   through the...
- However,
- these param...   not possible to c...   height, despite what many people seem to believe.

Normal Height

- The normal gravity field can be used to define a height that avoids Density Measurements
- It is defined geometrically as the distance along the ellipsoidal surface normal from the reference ellipsoid to the telluroid