I N T E G R A T E D G E O P H Y S I C S C O R P O R A T I O N

FOOTNOTES ON INTERPRETATION

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Importance of the Correct Map

Choose the Proper Regional Gravity Map

This West Florida Shelf example compares free-air, Bouguer, and isostatic residual maps---all developed from the same basic data---with published regional geology of the West Florida Shelf. The comparison illustrates how only one map, the isostatic residual, can be readily interpreted to agree with the identified geologic features.

Introduction

Regional gravity maps are often used to interpret regional trends and structures of the subsurface geology. To someone not reasonably familiar with gravity data, it may seem immaterial whether such maps represent free-air, Bouguer, or isostatic residual gravity data. In any offshore area, each data type has important advantages and disadvantages in terms of cost, convenience, and suitability. But in final analysis, the most important consideration should be use of the gravity data which provide the soundest geologic interpretation.

Free-air Gravity

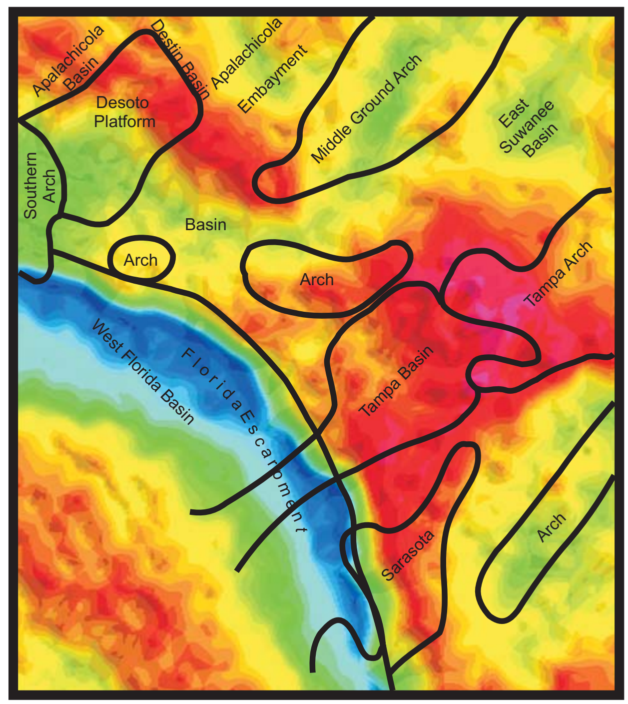
Free-air gravity, especially covering marine areas, has been preferred for years by the academic community. Why? Perhaps because it can be considered relatively "pure" data, untainted by the interpretation factors required to correct for bathymetry and for crustal geometry. More recently, with the advent of low-cost satellite-derived free-air gravity data, the use of such data for hydrocarbon exploration purposes has been heavily promoted by commercial interests. Is this a viable shortcut to meaningful interpretation?

Satellite-derived free-air gravity has several important **advantages** as a database: 1) it is readily available at very modest cost, and 2) it covers virtually all marine areas with a reasonably dense and consistent grid. The economics can seem compelling.

Its inherent **disadvantages** include: 1) lower quality data along coastlines and at very high latitudes, and 2) relatively poor resolution of low amplitude (<5 mGal) and/or short wavelength anomalies (<20 km). Unfortunately, the coastal areas and the smaller gravity anomalies are most often those of keen exploration interest. Some improvement in resolution through added-cost processing has been claimed but not yet widely accepted.

The "purity" of free-air data may also be its greatest weakness from an interpretation standpoint. For example, in a typical marine area there are three primary sources of gravity anomalies: density contrasts and structure at 1) the water/sediment interface, 2) within the subsurface sediments and crust, and 3) the crust/mantle interface. Therefore, unless both the water/sediment (bathymetry) and crust/mantle (Moho) surfaces are relatively smooth, at least one of them will produce large gravity anomalies which will effectively mask or distort the subsurface anomalies of exploration interest.

The West Florida Shelf free-air map is complicated by major regional gravity anomalies caused by the rugged bathymetry and by crustal geometry. The Shelf is bounded to the west by the Florida Escarpment and is underlain by a steeply-dipping Moho surface that plunges eastward.



Satellite-derived Free-air Gravity

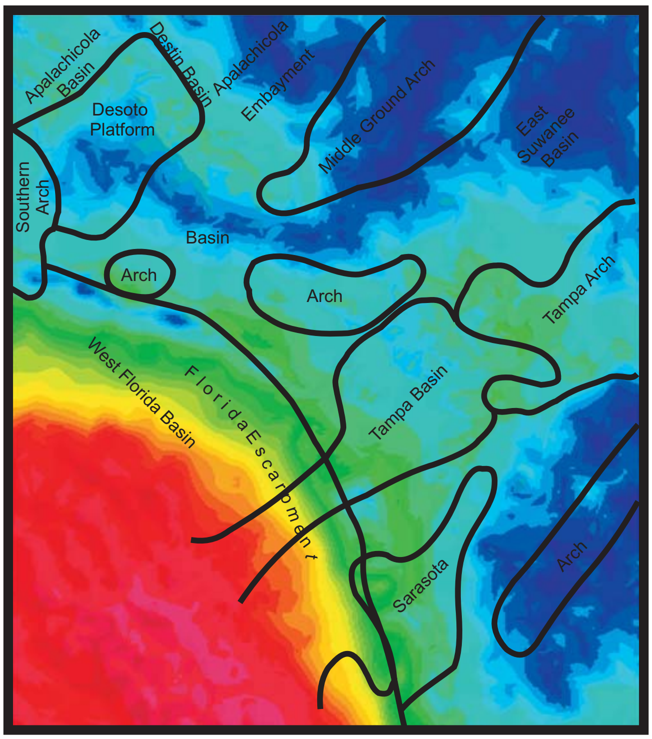
A simplistic conventional approach, interpreting gravity maxima as subsurface highs and minima as basins, fares badly here. Note that the Apalachicola and Tampa basins coincide with free-air maxima, not minima. The DeSoto Platform, the Southern and Middle Ground arches, and the east limb of the Sarasota Arch coincide with free-air minima, not maxima. Note also the strong maximum trend in the southwest corner of the map; it could be misinterpreted as a major stuctural high, but it is not. On the other hand, the East Suwanee Basin, the Tampa Arch, the west limb of the Sarasota Arch, and two smaller arches do have the more conventional gravity signature for structural highs and lows.

The difficulty in getting a consistent qualitative interpretation of the West Florida Shelf geology based on unconstrained free-air gravity is evident.

Why Not Bouguer Gravity?

A Bouguer gravity map is considered the industry standard for both onshore and offshore areas. Offshore, the Bouguer correction, together with 3D terrain corrections,can effectively remove gravity anomalies due to sea bottom topography. This essentially resolves one major problem with free-air data. It may be argued that a poor bathymetric database or a poor choice of density for the Bouguer reduction will introduce error. Granted, this could be a valid concern for prospect interpretation but for regional studies any such error is small relative to the bathymetry-related anomalies in free-air data.

Bouguer maps of marine areas were once necessarily restricted to areas where bathymetry could be collected concurrently with shipborne gravity or where navigation charts could provide relatively detailed water depth data. The advent of worldwide digital bathymetry databases such as ETOPO5 or ETOPO30 now make it feasible to calculate and apply Bouguer and terrain corrections to satellite-derived free-air gravity. The resulting Bouguer map has removed bathymetry-sourced anomalies, but not Moho-sourced anomalies.

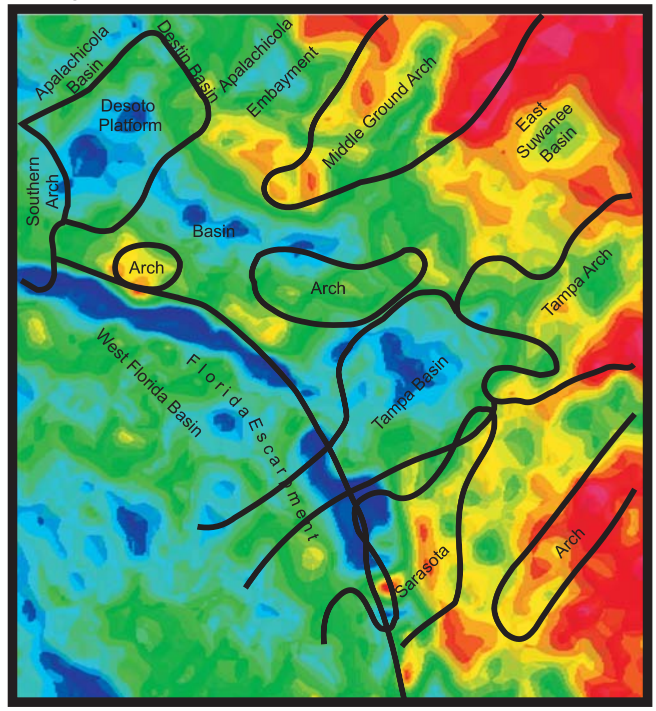


Terrain-corrected Bouguer Gravity

Note that the Bouguer correction to the West Florida Shelf free-air gravity results in a map with a very strong maximum area seaward (southwest) of the Florida Escarpment and a strong minimum area on the shelf. The remaining gravity effect of the Moho geometry has masked or distorted the anomalies of geologic interest, making a simplistic, conventional gravity interpretation difficult if not improbable. **Since there is still an apparent disconnect between the regional geology and expected gravity signatures, the Bouguer map is not a best-choice solution.**

IGC's Isostatic Residual Gravity

An isostatic correction continues the process of removing as many of the known effects as possible from the gravity field. Calculation of an isostatic residual involves additional assumptions, among which are the choice of crust/mantle density contrast and of compensation depth. Tests have shown that the process is sufficiently robust to allow variations in those assumptions without greatly changing the final regional interpretation. IGC uses an Airy-Heiskannen model to make isostatic corrections to the Bouguer data.



IGC Isostatic Residual Gravity

Even a casual inspection of the West Florida Shelf isostatic residual map reveals that it offers the closest conventional correlation to regional geology. Note that the Tampa, Middle Ground, and Sarasota arches now correlate with gravity maxima. The Tampa Basin and Apalachicola Embayment can be more clearly identified with minima. The De Soto Platform remains anomalous. In the West Florida Shelf area, IGC's isostatic residual can be seen as a far superior choice for regional interpretation than the free-air map or even the Bouguer map.

References

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