[PS]Regional Structural Framework of Gabon, Derived from Public Source Gravity Data*

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Abstract

This regional interpretation of western Gabon is based on satellite-derived gravity data offshore, a bathymetry/topographic grid, and a compilation of published data offshore and onshore. Local features of primary exploration interest include a series of basins and high blocks trending subparallel to and subnormal to the coastline. Fault/fracture zones extend northeast from oceanic crust of the South Atlantic onto the offshore shelf and the onshore coastal areas of Gabon.

Gabon's coastal plain is flanked to the east by basement outcrop from the Gabon-Congo border to the Gabon-Equatorial Guinea border. It widens northward and is subdivided north-south into two main structural provinces by the N'Komi fault/fracture zone. It contains five basins, two of which extend into the offshore, and five high blocks, one of which extends into the offshore. Gabon's offshore shelf contains five significant basins and five major high blocks.

An interpreted oceanic-continental crust boundary lies offshore, trending northwest parallel the shoreline and along an alignment of residual gravity maxima. It is locally offset by northeast-southwest shears, has a major dextral offset at the N'Komi, and then trends north along another alignment of residual maxima as far as the Gabon-Equatorial Guinea border.

The Atlantic Hinge Zone, or shelf-slope break, south of N'Komi Fault Zone can be correlated with the seaward edge of a northwest-southeast residual gravity maximum trend. Similar gravity anomalies suggest that a hinge zone continues north of the N'Komi before either turning northeast between Loiret and Fang Fault Zone or trending north to the Equatorial Guinea border. While interpretation of satellite-derived gravity can provide a regional geologic framework, integration with other data sets is necessary to produce a map with more immediate exploration value.

Overview

This regional interpretation of western Gabon is based on our interpretation of satellite-derived gravity data offshore, digital topography onshore, and a compilation of published data both offshore and onshore. Two maps are shown for comparison and correlation: Figure 1 displays the regional geologic features over-posted on an isostatic residual gravity map. Important features include a series of basins and high blocks trending subparallel to and subnormal to the coastline. Numerous fault/fracture zones are seen to extend northeast from oceanic crust areas of the South Atlantic onto the offshore shelf and the onshore coastal areas of Gabon. One major fault/fracture zone, the N'Komi, divides coastal Gabon into two main structural provinces: the south and the north.

The coastal plain widens northward from the Gabon-Congo border to the Gabon-Equatorial Guinea border and is bounded to the east by basement outcrop. It contains five named basins, two of which extend into the offshore. The coastal plain is also the site of five named high blocks, one of which extends into the offshore.

Gabon's offshore shelf contains five significant basins and five major high blocks. Those closest to the coastline are poorly defined by satellite-derived gravity due a normal loss of resolution close to shore. Northeast-trending gravity anomalies or anomaly offsets confirm and/or further define the fault/fracture zones noted in much of the literature, although location of some features has been modified from the literature on the basis of our gravity interpretation. A major hinge zone and the ocean-continent crust boundary are interpreted from the gravity data. Six high-amplitude gravity maxima in northern Gabon are interpreted as volcanic plugs, two of which are named.

Figure 2 shows the horizontal gradient of free-air gravity plus the onshore shaded relief topography. As expected, the strong linear gradient trends correlate well with offshore fault and hingeline trends. The onshore topography correlates well with the various outcropping basement terranes described in the literature.

Geophysical and Geological Data

Primary input data for the interpretation consisted of public source (Sandwell version 16.1) satellite-derived free air gravity and bathymetry-topography grids (Sandwell 10.1). The free air gravity was reduced to Bouguer gravity and we then computed a Moho-Effect (isostatic compensation) gravity grid from a 3D gravity inversion model using the Airy-Heiskanen computation method. This grid was then subtracted from the Bouguer grid to produce the isostatic residual gravity (residual) map. By use of both Bouguer and Airy computations, anomalies due to seafloor topography and to the crust/mantle interface have been attenuated, and the resulting residual maps have enhanced anomalies of geologic interest. A horizontal gradient operator was applied to the free-air gravity data to generate a map which could emphasize geologic boundaries or major faults.

Several published papers map and describe a variety of geologic features from onshore basement outcrop to offshore oceanic crust. However, the existence, location and trend of some features are inconsistent from paper to paper, and not always consistent with data from the relatively new and complete satellite-derived gravity and its enhancements. These inconsistencies made the geologic compilation process more challenging, but in the end the best correlation to the gravity residual data took precedence for our interpretation.

Two researched papers include seismic data straddling the N'Komi Fault Zone. They provide depths from three seismic refraction profiles and sections from a deep seismic project and thereby contributed to our regional interpretation.

Structural Interpretation

The interpretation area lies southeast of the Cameroon Volcanic Zone and west of the interior Congo Craton. Coastal Gabon can be divided into two main structural provinces, south and north, separated by a major wrench or transfer system, the N'Komi Fault Zone. Several published studies propose that both provinces are dominated by rift tectonics, with rifting progressively younger from south to north. Our regional geologic features interpretation includes features common to both provinces, as well as local structures found in each.

Oceanic-Continental Crust Boundary

The crust boundary is interpreted as lying offshore, trending northwest parallel the shoreline and along an alignment of residual gravity maxima, from the Gabon-Congo offshore border to the N'Komi Fault Zone. From Congo to the N'Komi the crust boundary is locally offset by northeast-southwest shears. It has a major dextral offset (shoreward) at the N'Komi, then trends northerly along another alignment of residual maxima as far as the Gabon-Equatorial Guinea border. The boundary in the northern segment is also locally offset by northeast-southwest shear faults.

Atlantic Hinge Zone

The Atlantic Hinge Zone, or shelf-slope break, south of N'Komi Fault Zone can be mapped along the seaward edge of a northwest-southeast residual gravity maximum trend. It can also be traced along a high-amplitude trend of the horizontal gradient of free air gravity. Residual and gravity gradient anomalies offshore suggest that a hinge zone could continue north of the N'Komi before either turning northeast between Loiret and Fang Fault Zone or trending north to the Equatorial Guinea border.

Basement Outcrop and Subcrop

Basement outcrops on the eastern edge of the coastal plain from the Gabon-Congo border to the Gabon-Equatorial Guinea border. The outcrop areas include major provinces such as the Congo Precambrian Craton, Nyanga Precambrian Basin, Franceville Precambrian

Basin, Mayumba Range Fold Belt, and Eburnean Fold Belt. Although the province boundaries generally conform to features in the digital topography, further study might show that a closer fit is possible.

Our depth to basement contours increase seaward from 1 km (subsea) near outcrop to 8 km in both the northern and southern provinces. Much of the contouring is based on published maps, with subsequent local modifications where dictated by gravity interpretation. Ten discrete basement depth values, ranging from 6 to 12 km, were obtained from published refraction seismic data and provide additional depth control offshore.

South Gabon

The regional geologic interpretation highlights 13 major structures and features in South Gabon. They are the South Subbasin, Kaba High and M'Bya Terrace, Banio Graben, Lucina Uplift, Mayumba Spur, Vera Graben, Gamba-Bigorneau High, Sette Cama High, Dentale Trough, South Gabon Basin, Rembo Kotto-Ilongo High, and N'Komi Fault Zone.

North Gabon

The regional geologic interpretation highlights 14 major structures and features in the northern Gabon area. They include the Dianongo Trough, North Basin, Atlantic Basin, Lambarene Horst, Interior Basin, GLB Fault, Kobe Fault, Ekouata Fault, Loiret Plug, Gombe Plug, North Subbasin, Fang Fault Zone, Ascension Fault Zone, and Port Gentil Fault Zone. The locations of four apparent, but unnamed, igneous plugs are shown as questioned.

Conclusions

An important conclusion is that appropriately compiled, processed and interpreted public source data can be used to provide an early-stage and cost-effective aid to regional geologic understanding of a large area. Details can be verified, added, or reinterpreted as data from new and more intensive geologic/geophysical programs become available.

A second conclusion based on our interpretation is that in the offshore and coastal provinces of Gabon, as in many basinal areas, basement deformation has strongly influenced basin sedimentary structure and stratigraphy. Major geologic features, such as fault zones, structural highs, and depocenters - critical to forming a favorable environment for oil and gas accumulation - are seen as basement-related and are present both onshore and offshore Gabon. Our interpretation of the isostatic gravity residual and horizontal gradient of free-air gravity gradient and other data enhancement maps, when integrated with published maps and data, leads not only to a viable offshore extension of three distinctive onshore basement provinces, but also provides regional guidance for planning of future hydrocarbon exploration plays.

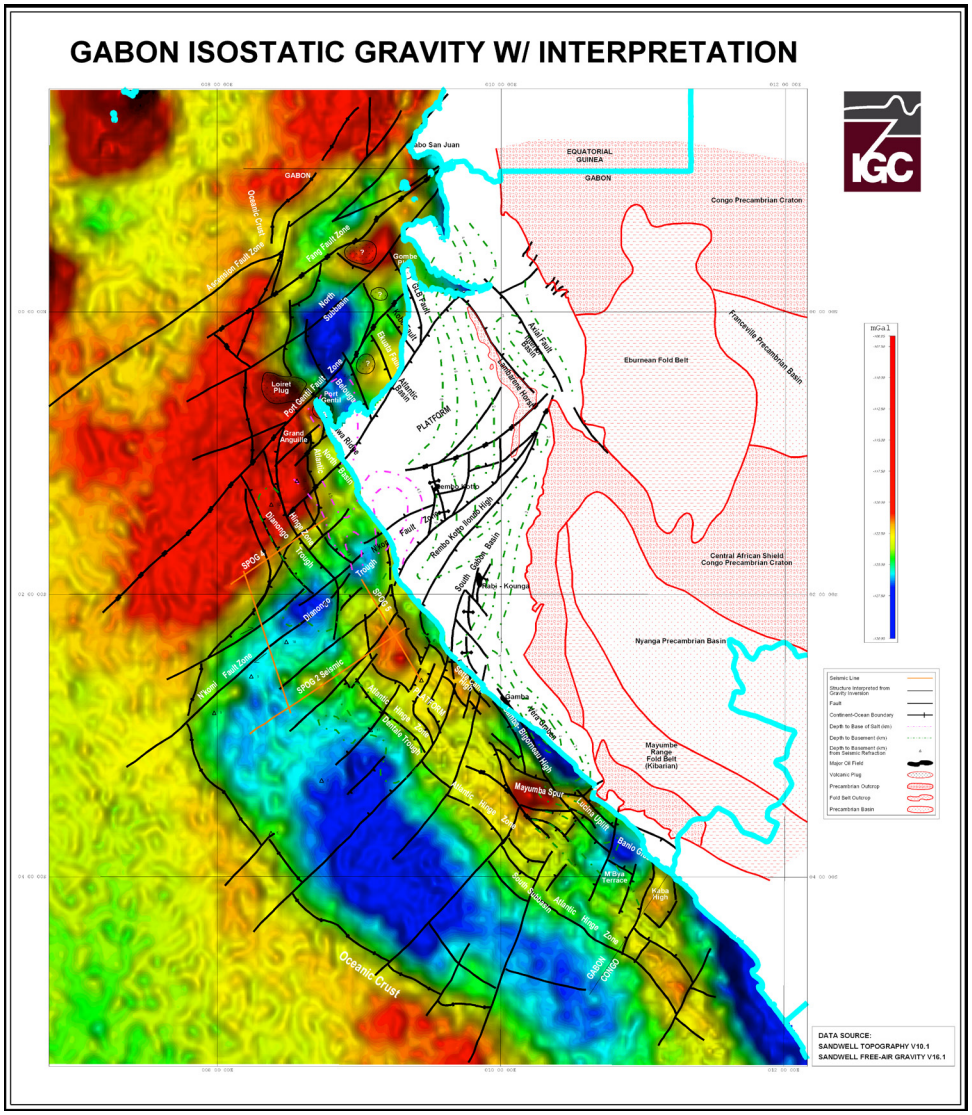

Figure 1. Regional geologic features over-posted on an isostatic residual gravity map of Gabon.

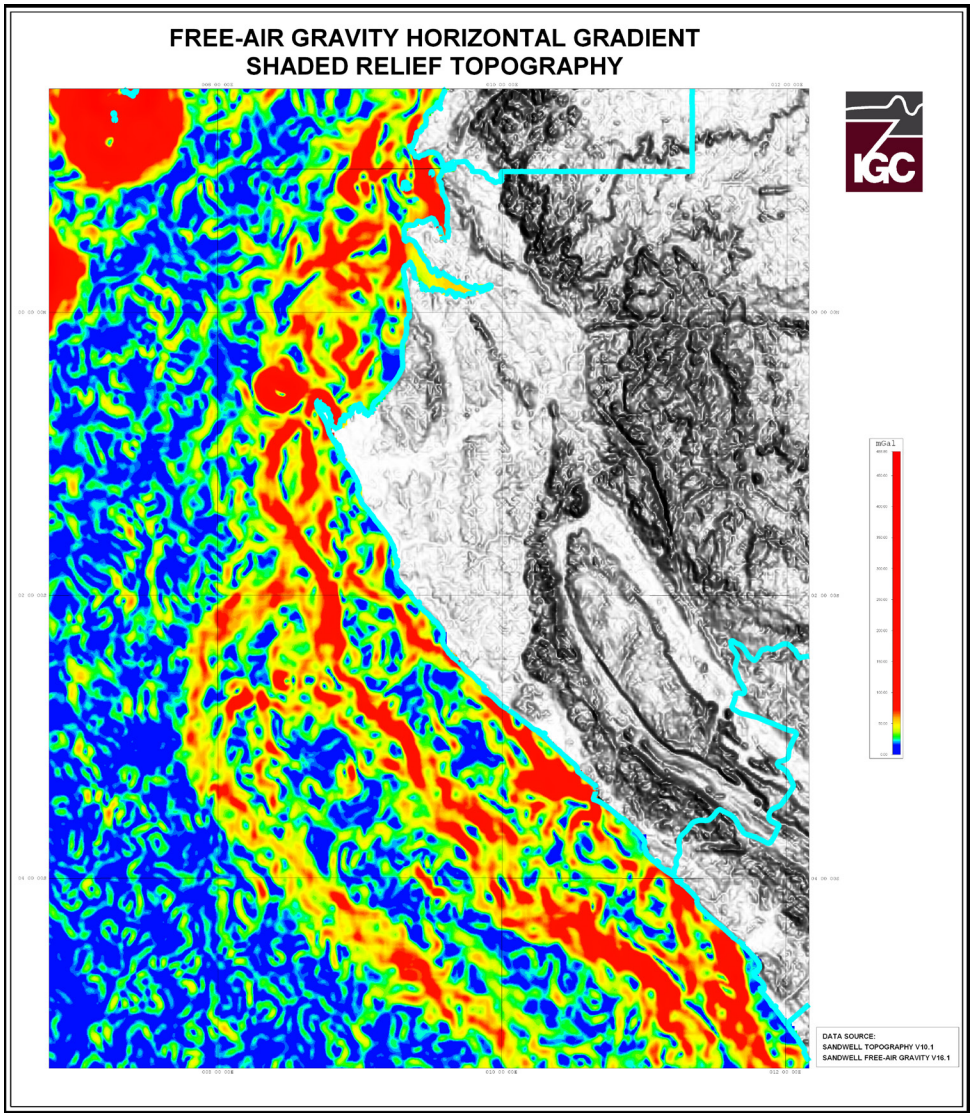

Figure 2. Horizontal gradient of free-air gravity plus the onshore shaded relief topography of Gabon.

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