FEASIBILITY OF USING THE GRAVITY GRADIENT FROM GOCE MISSION AT SATELLITE ALTITUDE (250 KM) TO STUDY MASS VARIATIONS WITHIN THE LITHOSPHERE AND/OR GEOLOGIC STRUCTURES IN AMAZON AND SOLIMÕES BASINS, BRAZIL

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This work aims to obtain new insights in the sedimentary basins of the Solimões and Amazon, Brazil, by the use of the gravity gradient data from the GOCE satellite. We use the observations along the tracks at satellite altitude for interpretation and comparison of these fields with simulated tensor gradients from the EGM2008 geopotential model at same altitude. GOCE (Gravity field and steady-state Ocean Circulation Explorer) is a dedicated gravity field mission. It combines the concept of satellite gravity gradiometry (SGG) and high-low satellite-to-satellite tracking (SST-hl) between GOCE and the satellites of the Global Positioning System (GPS). The mission objectives are to determine the Earth's gravity field globally, accurately and with best possible spatial resolution. Presently we have a representative GOCE-only model of the Earth's gravity field up to degree and order 250. Previous gravity field missions have contributed to determine the Earth's gravity field in the past decade: CHAMP was the first mission that combined SST-hl with 3-D accelerometry. The GRACE mission employed the concept of satellite-to-satellite tracking between two low orbiters (SST-ll). Thereby the two low orbiters follow each other in the same orbit at a distance of about 200 km. Their relative motion was measured very accurately. Both satellites carried a 3-D accelerometer. However, GOCE is the first to apply the principle of satellite gradiometry with spacecraft flying at altitude of about 250 km.

The most direct way to detect density anomalies is the study of the gravity potential field and its derivatives. The global availability and good resolution of the GOCE data coupled with the availability of terrestrial and/or airborne gravity surveys are ideal for the scope of intercomparison and classification of the large-scale Amazon, Solimões and Parnaíba sedimentary basins, Brazil. In geological terms the Amazon and Solimões basins are very old and classified as intracratonic or Paleozoic basins and on the whole have an area of almost 1,000,000 km^2 separated by the Purus Arch. The basins are an intracontinental rift system that straddles the border between Brazil and Guyana, covering some 4,500 km^2 of the Brazilian territory. Gradiometer, devices which measure the spatial derivatives of gravity, have improved remarkably in accuracy due to the development and refinement of accelerometers. A three-axis gravity gradiometer as the core instrument on board the satellite provides local gravity field information in terms of second order derivatives of the gravitational potential. The GOCE satellite is tracked by the global positioning system GPS, which provides the orbital position. Thus the GOCE Mission uses the concept of the unique capability of a gravity gradiometer to provide an accurate and detailed global model of the Earth's gravity field. Gravity gradient data are recorded in orbit at about 250 km height on board the satellite and detailed gradient maps are created after post acquisition. We calculate the gravity gradient tensor for the EGM2008 Geopotential Model and gravity terrestrial data performing upward continuation corresponding to heights of the orbit of the GOCE satellite.

This analysis will also be useful to indicate whether the GOCE data may be used to study mass variations within the lithosphere and geologic structures in areas where terrestrial data area scarce. We will calculate the gravity gradient tensor with a method based on the solution of the Laplace equation, the Fourier transform, and upward continuation of the observed gravity data to obtain a simulation of the gravity gradient at the same orbital altitude of the GOCE spacecraft. Here, we compare it with the true tensor gradiometer data of the GOCE satellite. Thus we will review the reverse process possibility of downward continuated SGG-GOCE data. We estimate the terrain correction by modeling the terrain effects with rectangular or spherical prisms. The terrain effect has amplitudes of the same order of magnitude as the gradient components due to density anomalies in the interior of the crust and mantle.

Gravity gradiometry data can provide an independent measure of 3D density distributions. The advantage of gravity gradiometry over other gravity methods is that the data are extremely sensitive to localized density contrasts within regional geological settings. Moreover, high quality data can now be acquired from either air- or ship-borne platforms over very large areas for relatively low cost. Amongst many applications, this makes the method ideally suited to delineating salt structures in hydrocarbon exploration, and for detecting kimberlite pipes in diamond exploration, and of course, intrusive rocks in the form of diabase sills and dykes. However due to the small amount of data and the lack of the terrestrial gravity, airborne gravity and gravity gradiometer data available in the study area, it is necessary to check the feasibility of the resolutions and quality of the gravity gradiometer data available from GOCE aircraft.

In particular we intend to use the GOCE second order derivatives to model the 3D lithospheric density structure, assuming some known geometries, as basement and Moho as initial constraint. In general the basins appear to have an anomalous isostatic state if we rely on the classic isostatic hypothesis which states that the topographical and sedimentary loads are sustained by crustal thickening or thinning. In some cases, the high density of the material in the lower crust or upper mantle has been supposedly an important component in the formation of sedimentary basins of large scale and in contributing to the isostatic equilibrium. In particular, we have the presence of possible diabase sills lying within or beneath the Amazon Basin since those units of igneous rocks have originated from late Triassic to early Jurassic, an event known as the Penatecaua magmatism. And so, these igneous rocks may have migrated in a natural way following the sedimentary beds down dip and showing a high density material that transects the Amazon Basin roughly coincident with the maximum thickness of the sedimentary rocks or trough of the basin. This can be primarily due to the presumed downward deflection of the crust/mantle boundary beneath the basin.

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