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SATELLITE ALTIMETRY — A NEW GEOPHYSICAL PROSPECTING TOOL

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The force of the earth's gravitational attraction controls the shape of the sea surface. Normally, the sea surface is time-varying in amplitude because of the influence of winds, currents, tides, etc. However, the sea surface also has permanent undulations created by mass variations below the seafloor. Since the water of the sea adjusts to variations in the gravitational pull, the time-independent or static shape of the sea surface will reflect the distribution of mass below.

Satellite altimeters provide data which yield information about the height variations of the sea surface. Procedures have been developed which eliminate the time-varying factors affecting the sea surface and thus information about the static sea surface is achieved. The static sea surface is called a geoid and is also defined as a surface of constant gravity potential.

The satellite altimeters have further become important in determining short wavelength components of this geoid. So efficient are present day's altimeters that they can resolve short wavelength geoidal features with an accuracy of a few centimeters and with a resolution of some tens of kilometers. The short wavelength anomalies arise from shallow variations in the distribution of mass in the earth's outer crust. Other teams of investigators have shown these short wavelength anomalies to correlate with the topography of the ocean floor and of shallow crustal structures. These include spreading centers, deep-ocean trenches and seamount chains. Usually, the geoidal undulations are computed based upon absolute values. This can cause errors when, for instance, ocean tide models are used, especially near land.

In the present work, calculations of geoidal undulations are performed based upon relative values. Dynamic factors can very effectively be eliminated if geoidal waveforms are expressed in relative terms instead of absolute values. Irrespective of how all dynamic factors actually affect the sea surface, "foot-prints" caused by the static conditions will always be present in the sea surface. To obtain information about mass variations in the near sub-surface below the sea bottom, the high-frequency spectra of the geoid are studied after the sea bottom topography effect has been removed. During the last three years, extensive studies have been performed by the authors comparing the calculated relative geoidal undulations of the "residual" geoid to known hydro-carbon producing areas. A significant, empirical correlation has been obtained between known producing areas and depressions in the residual geoid above such hydrocarbon accumulations. Furthermore, no significant hydrocarbon accumulations have been found where bulges in the residual geoid are present.

Satellite altimeter measurements provide data for calculation of the residual geoid which can be used for mapping of density contrasts in the upper crust. This mapping is possible without special on-site work in the area of investigation. Altimeter data, thus processed and interpreted on its own, constitutes yet another cost-effective, geophysical tool.