GRAVITY, GEOID AND THE OCEANIC LITHOSPHERE

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The Earth's gravitational field has proved one of the principal methods by which to determine the structure of the ocean basins and the continental margins. Early studies led to the development of commonly accepted models for the crustal and upper mantle structure of mid-ocean ridges, seamounts and oceanic islands, island arc-deep sea trench systems, fracture zones, and passive continental margins. These studies provided information on the mass distribution that could cause a gravity or geoid anomaly. However, they provided little information on the geological processes occuring at these features. As a result, the Earth's gravitational field was not one of the principal observations on which the concept of plate tectonics was based. This concept was based instead primarily on observational data from earthquake seismology, marine magnetism, and paleomagnetism.

During the 15 years since the development of plate tectonics there has been considerable progress in studies of the Earth's gravitational field. In acquisition, the development of forced feed-back accelerometers, satellite navigation, and satellite radar altimetry have significantly improved the accuracy and coverage of gravity data over the oceans. In interpretation, gravity and geoid anomalies have been used to determine information on the thermal and mechanical properties of the oceanic lithosphere and the forces that drive plate motions.

In this lecture, we will review the contributions that have been made by studies of the Earth's gravitational field to our understanding of the oceanic lithosphere. Particular emphasis is given to studies of the thermal and mechanical properties of oceanic lithosphere. There are two main reasons for this: a) the thermal and mechanical properties of the lithosphere contribute to most of the energy in the short-wavelength gravity and geoid spectrum, b) the thermal and mechanical properties and their variation with age have important implications for studies of the tectonic setting of bathymetric features on the ocean floor, the evolution of sedimetary basins, the origin of fracture zone topography, bathymetric prediction, the separation of mean ocean currents from satellite radar altimeter data, and mantle convection. Moreover, a number of missions are planned in the future (e.g., TOPEX, GRM, satellite gradiometry) in which the Earth's gravitational field will be measured to a much greater temporal and spatial resolution.