SUBDUCTION DYNAMICS: CONSTRAINTS FROM GRAVITY FIELD OBSERVATIONS

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At present, satellite systems do the best job of resolving the long-wavelength components of the earth's gravity field. Over the oceans, satellite-borne radar altimeters such as SEASAT provide the best resolution observations of the intermediate-wavelength components (4000 km > λ > 200 km). It is, therefore, not surprising that satellite observations of gravity have contributed substantially to our developing understanding of the dynamics of subduction. Recall that large, long-wavelength geoidal highs generally occur over subduction zones. These highs are attributed to the superposition of two effects of subduction: (i) the positive mass anomalies of subducting slabs themselves, and (ii) the surface deformations such as the trenches (largely negative mass anomalies) convectively inducted by these slabs as they sink into the mantle. Models of this subduction process suggest that the mantle behaves as a non-Newtonian fluid, i.e., its effective viscosity increases significantly with depth, and that large positive mass anomalies may occur beneath the seismically-defined Benioff zones.

Interpretation of intermediate-wavelength gravity or geoid anomalies over subduction zones remains a problem. In order to solve this problem lithospheric and crustal effects must be carefully separated from those of flow-induced surface deformation. GRM should provide a large amount of new information about the intermediate-wavelength component of the gravity field particularly over continents such as Asia and South America which lack surface gravity coverage. Note that these two continents are bordered by major subduction/convergence zones.

Future satellite gravity missions such as GRM, Topex, Geosat and/or their successors could resolve temporal variations in the gravity field. In particular, the earthquake deformation cycle at convergence zones, specifically the major dip-slip earthquakes should give rise to variations in the geoid which have amplitudes as large as 5 cm or even more and wavelengths of several hundred kilometers. Such variations are predicted by simple dislocation models. Observations of these temporal variations in the gravity field could prove useful; they should not be overlooked in designing future satellite gravity missions.