THE IMPORTANCE OF GRM GRAVITY OBSERVATIONS IN CONTINENTAL REGIONS

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Fifteen years ago most geophysicists believed that the major hot upwelling regions in the upper mantle were beneath ridge axes. It slowly became apparent that this view was not compatible either with our understanding of the fluid dynamics of convection at high Rayleigh numbers, or with the evolution and structure of spreading ridges. Both lines of reasoning required the geographical position of the ridges to be independent of the circulation below, which should consist of a number of rising and sinking regions whose horizontal scale is small compared with that of the larger plates.

These ideas were not widely accepted until the two altimetric satellites clearly showed the existence of gravity anomalies with wavelengths between 1500 km and 3000 km which correlated with residual depth anomalies. More recently Haxby and Weissel have suggested that there is also an even smaller scale convective circulation with a wavelength of less than 500 km. Numerical experiments and Seasat profiles demonstrate that similar small scale circulation must also exist near fracture zones. The mantle therefore must contain at least three scales of circulation. One is comparable to the plate dimensions, known as the large scale circulation, which returns material from the Island arcs to the ridges. Another of an intermediate scale comparable to the depth of the upper mantle and a third with a small scale comparable to the thickness of the asthenosphere. This picture has been established using observations of gravity and bathymetry in oceanic regions. It is not yet clear whether the circulation beneath the continents is similar to scales of circulation beneath the continents. The orbit will not be low enough to detect the small scale circulation. Also the amplitude and wavelength of flexural and other plate signals will be comparable to that of the intermediate scale of the circulation, from which it will not be possible to separate them without additional information. It is important to map the mantle circulation beneath the continents because its evolution can then be easily and cheaply investigated by field geologists. Such studies are severely limited by cost in oceanic regions.