Spectral Analysis of Gravity Data of NW Himalaya

A. Chamoli $^1$ and V.P. Dimri $^2$

$^1,2$ National Geophysical Research Institute, (CSIR), Hyderabad, India

Summary
The Bouguer anomaly and topography across the NW Himalaya are analyzed by different spectral methods. The power spectrum of Bouguer anomaly is calculated to derive the mean depth of the interfaces. The spectral analysis suggests three layer interfaces in the lithosphere at 68, 34 and 11 km mean depths corresponding to the Moho, the Conrad discontinuity and the Himalayan décollement thrust, respectively. The coherence function is calculated and interpreted to derive the effective elastic thickness (EET) and configuration of relative folding of the crustal layers. The admittance and cross spectra are calculated and correlated to understand the folding of the layers and the presence of a decoupling zone.

Introduction
The tectonic setting of Himalaya is complex due to the convergence and stacking of northern margin of the Indian plate with the Eurasian plate. The intracrustal thrusts originated due to these processes are associated with the seismic activity in the region. The transformation of potential field into spectral domain gives additional information about the sources of anomaly. The Bouguer anomaly along a ~450 km long (projected) transect from the Sub-Himalaya in the south to the Karakoram fault in the north across Indus-Tsangpo Suture Zone (Figure 1), is modeled using spectral analysis. The Bouguer anomaly and elevation data used are shown in Figure 2. In the present study, the constrains are derived in spectral domain to understand the crustal structure across NW Himalaya.

Methodology
Power spectrum analysis (Dimri 1992; Blakely 1995) estimates the mean depth of the interfaces considering the log of power of the Bouguer gravity spectrum as a function of wave number/frequency assuming uncorrelated distribution of sources (Spector & Grant 1970) or scaling nature of sources (Pilkinson et al. 1994; Maus & Dimri 1994; 1995; 1996). The spectrum of gravity anomaly due to layered source is separated into multiple segments in frequency domain that can be interpreted in terms of mean depth of the interface. The half of the slope of the segments gives the mean depth of the interfaces (Figure 3).

The coherence, admittance and cross spectra of Bouguer anomaly and topography is calculated and interpreted in terms of isostatic response and relative folding in the layers.
**Figure 1**- Tectonic map of Himalaya showing principal structural element (Modified after Gansser, 1964; Valdiya, 1980).

**Figure 2**- Observed Bouguer gravity anomaly and station elevation along the Kiratpur-Manali-Leh-Panamic profile across the NW Himalaya. Note the segments of the profile with different average gradient of gravity anomaly.
**Figure 3** - Power spectrum showing log of power of Bouguer gravity spectrum as a function of wavenumber giving the fitted linear segments corresponding to ~ 67.6, 33.9, 11.5, 1.7 km depth of interfaces.

**Figure 4** - Observed and predicted Coherence function and the RMS error of fitting between these showing $T_e \sim 31$ km.
Figure 5- (a) Admittance and (b) cross spectra between the gravity and topography.

Conclusions
Power spectrum of the Bouguer anomaly indicates a three layered structure in the lithosphere with the mean depth of interfaces at 11, 34 and 68 km corresponding to the Main Himalayan Thrust, Conrad discontinuity and Moho respectively. The average estimate of effective elastic thickness calculated using coherence method is 31 km. The coherence function shows some anomalous values different from the theoretical values of elastic plate model in some wavelength bands, which is also observed in the admittance and cross spectra plots. The two dominant wavelengths of folding are interpreted. The lithospheric folding can be explained by the existence of a weak decoupling layer between the upper crust and the upper mantle. The results are discussed in constraining the tectonic setting of NW Himalaya.

References


Maus, S., and Dimri, V.P. (1996), Depth estimation from the scaling power spectrum of potential field?, Geophys. J. Int. 124, 113–120.


