*Geophys. J. Int.* (1993) **115**, 604

# Comment on 'A spectral analysis of geoid undulation and gravity-anomaly data computed with Pratt's isostasy theory applied to Moho depth variations in Fennoscandia', by T. Nord and L. E. Sjöberg

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Accepted 1993 April 20. Received 1993 April 8; in original form 1992 November 16

In Fennoscandia the lithospheric structure is unusual compared to Phanerozoic Europe. All available data show that even though the topography is low, the crustal depth is in some places well below 50 km and the lithospheric thickness has been estimated to be about 200 km. This structure leads to a density distribution that can be expected to have an impact on the potential field anomalies. The key parameter, however, is the compensating mass balance inside the lithosphere. Seismic profiling generally indicates high lower crustal density, but does not reveal high-density mass distributions inside the crust or in the uppermost part of the lithosphere needed to locally balance the Moho depth undulations. It can be expected that small-balancing density contrasts are distributed to rather great depth. From a geophysical point of view, taking a compensation depth of 30 or 50 km (inside the crust) to be responsible for all compensation is not realistic. In general, for a better understanding of the compensating mass distribution, one has to take into account the topography and the internal structure of the crust and the lithosphere.

The important raw data set for the study by Nord & Sjöberg is a Moho map for Fennoscandia. The problem here is that any Moho map is based on a very limited number of seismic reflection or refraction profiles. The exact Moho depth for each profile can only be estimated with an accuracy of about 2 to 5 km in limited parts along the profile. Thus it is easy to imagine that any Moho depth map can only give a rough estimate on the real variations of the crust–mantle boundary and is critically dependent on the imagination of the person who draws the isolines or on the algorithm of the applied computer program. In Fennoscandia in particular, areas exist where no or very few data are available. This is true for most of the continent–ocean transition for SW Norway, for the southern Baltic Sea, and for the entire SE part of the area of investigation.

Nord & Sjöberg used a Moho depth map from Luosto (1990), which differs in some way from maps published earlier (e.g. Meissner, Wever & Flüh 1987). The map by Luosto includes new data for Finland but not for the rest of the Baltic area.

While it seems reasonable to me to use such a map trying to correlate it with a map of potential field anomalies, this is no longer the case if one digitizes such a map and works in the spectral domain. The benefit of the profiles to give reliable information in limited areas is destroyed by the transformation. Long-wavelength contributions, particularly, seem to be very questionable.

Nord & Sjöberg calculated the geoid and gravity anomalies from the Moho depth variations and made a spherical harmonic analysis including all degrees and orders between 4 and 100 and setting all values of $\Delta N$ and $\Delta g$ outside the area of interest to zero. Here one has to keep in mind, that degree and order 4 to 100 means wavelengths between 400 and 9000 km, while a characteristic maximum length for their area of investigation is on the order of 2000 km. Nord & Sjöberg argue that since the power spectra for gravity and geoid calculated with the OSU89B data set for Fennoscandia does not agree with the one calculated with the Moho depth variation, contributions from the Moho undulation can be dismissed. However, no cross-correlation was explicitly computed and the misfit of two spectra does not disprove the causal relation. Furthermore by inspecting the Moho map by Luosto one clearly recognizes that this map contains strong-amplitude contributions with wavelengths less than 400 km. Since to my understanding of the paper by Nord & Sjöberg no 2-D low-pass filter was applied to the digitized Moho depth data (or related gravity and geoid anomalies) critical aliasing contamination can be expected in the spectral domain which has much more impact on the gravity anomaly than on the geoid, since gravity is sensitive to short-wavelength density anomalies. Nord & Sjöberg developed a set of equations in spherical harmonic notation relating boundary undulations to $\Delta N$ and $\Delta g$. These equations can be useful for this kind of problem if the boundary undulations are well constrained and the wavelength ranges considered are appropriate for the area under investigation. In its present form this paper is not very helpful in understanding the contributions of different sources to the potential field anomalies in Fennoscandia.

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