A note on the neoclassical approach to the free-air anomaly

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The author has proposed a new concept of the generalized Bouguer anomaly, which is defined upon the datum level of an arbitrary elevation (e.g. Nozaki, K. (2004), submitted to EPS). In this manuscript, the author presents the geophysical meanings and geodetic perspectives of the generalized Bouguer anomaly. The main subject lies in the new interpretation of the free-air anomaly. The main viewpoints are: (1) How should be the reference gravity/density field of the geophysical gravity anomaly?, (2) What is the relation between the equation of the generalized Bouguer anomaly and the fundamental equation of geodesy?, etc.

The main purpose of introducing the idea of the generalized Bouguer anomaly is to supplement the defects of the classical Bouguer anomaly (e.g. Heiland, 1946), in which the comparison between the observed and the reference gravities is done on a common datum level of the geoid; while the normal gravity (Heiskanen and Motitz, 1967) has been adopted as the reference gravity in defining the Bouguer anomaly today, in which the comparison is done at two distinct levels: the geoid and the normal ellipsoid. Hence, the geophysical meaning of the Bouguer anomaly today, which was originally aimed at investigating subsurface density anomaly, is in confusion.

In defining a so-called 'anomaly', one can choose in a sense any one of references according to the purposes. From a view point of geophysical gravity anomaly that is aimed at dealing with the density anomaly, it is natural to select a reference density field with a mean/constant density, separating the actual earth's density field into the mean and the deviatoric. Accordingly, the reference gravity field of the generalized Bouguer anomaly is to be the Prey-reduced one within the mean density field, in which the values on the normal ellipsoid surface coincide with those of the normal gravity field. By adopting the Prey-reduced reference gravity field, one can define a specific datum level of gravity reduction (i.e. density-free datum level), and can realize the density-free Bouguer anomaly upon the density-free datum level, that is, the generalized Bouguer anomaly becomes free from the Bouguer reduction density at the density-free specific datum level. The author demonstrates, in the presentation, this fact leads to the results that (1) the idea of the generalized Bouguer anomaly removes the ambiguities in the definition of the Bouguer anomaly and (2) the generalized Bouguer anomaly at the density-free datum level is consistent with the geodetic frame, which totally mediate between the geophysical and geodetic gravity anomalies.

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