Consistent removal of regional fields in gravity gradiometry

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The gravity gradiometry based upon modern instrumentation is advancing the filed of gravity exploration with its high resolution, high accuracy, and multi-component data. However, the age-old problem of regional-residual separation in potential-field methods is surfacing with a new challenge. Although there are five independent components of gravity gradients at each spatial point, they are all related to the underlying gravity potential. Given the data in a large area, different components are linearly related to each other and they satisfy a set of inherent relations. It is then important that any processing applied to the data must be consistent from component to component. Especially crucial is the consistency in removing a regional field from these multi-component data, since an inconsistent regional removal will yield resultant residuals whose components will represent different anomalies. Before any other numerical processing, modeling, or inversion algorithm is applied to extract and utilize the information content in these data, a regional field must be removed consistently from each of the five components.

In this presentation, we discuss four different approaches to the consistent estimation and removal of regional fields from multi-component gradiometry data:

(1) Consistent filtering in the wavenumber domain: a set of field relations is imposed on the filters applied to different components.

(2) Consistent processing of equivalent sources: the regional-residual separation is applied to a constructed equivalent source and residual fields are then calculated from the processed equivalent source.

(3) Multi-scale inversion of gradiomtery data: consistent regional fields are calculated from density distribution that is inverted from large-scale data and located in regions deeper and farther away from the region of interests.

(4) Regional gradients from gravity data: stable conversion of gravity data to gradients is applied to large-scale gravity data to construct the regional fields for gradiometry data.

We will present the details of these four methods, illustrate them with numerical examples, and provide a comparison of the results. The numerical computation and additional data required for, and the quality of residual data extracted by, each method will vary greatly. The choice of method to be applied depends primarily upon the processing and interpretation techniques one intends to use subsequently and upon the availability of auxiliary data. We will also discuss these issues.