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Structural analyses of sedimentary basins using gravity anomaly and gravity gradient tensor data

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Seismic exploration and gravity surveys have often been employed to estimate subsurface structures, and gravity surveys have been used most often as rough surveys because they can cover a wide area in a short period with low cost. In addition, gravity surveys have other advantages regarding data interpretation; it is possible to interpret their map data intuitively and easily. For example, we could interpret low-gravity areas as thick sedimentary layers or low-density layers/materials with much accuracy. We can obtain detailed information on subsurface structures, such as density distribution and shape, by quantitative analyses. However, these analyses require a lot of time and prior information on subsurface structures (e.g., basic subsurface structure and density contrast) for solving problems.

In such a situation, semi-automatic interpretation methods, which are considered as intermediate methods between quantitative analyses and qualitative interpretations, can be used. In this method, structural boundaries are identified from gravity anomalies without constraint conditions on geology and geophysics. Types of high-pass filtering such as horizontal first derivative and vertical first derivative are well-known techniques.

In recent years, gravity-difference surveys have been carried out worldwide, and filtering and semi-automatic interpretation techniques using gravity gradient tensor have been developed and suggested. For example, Shape Index defined by xy components of gravity gradient tensor expressing curvature of gravity field (e.g., Cevallos, 2013), Dimensionality Index defined by combination of eigenvalues of the tensor (e.g., Perdersen and Rasmussen, 1990; Beiki and Pedersen, 2010), and a technique that estimates locations of causative source using eigenvectors of the tensor (e.g., Beiki and Pedersen, 2010; Beiki, 2013).

In general, it is necessary to obtain gravity gradient data with a gradiometer for performing analyses using gravity gradient tensor. However, these data can be derived by combining integration and differential of surface gravity anomalies in the Fourier domain (e.g., Mickus and Hinojosa, 2001).

In this presentation, the author will show derivations of all components of gravity gradient tensor from surface gravity-anomaly data using the Fourier method and will report results obtained by applying techniques using the tensor to structural analyses of structural basins.

[References]
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