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A new approach to precise upward and downward continuation and gridding land-based gravity data based on Hessian matrix computation, applied for exploration studies

Y. AllahTavakoli
National Iranian Oil Company, Exploration Directorate, Survey Department, Tehran, Iran

Precise (upward and downward) continuation and gridding of land-based gravity data require precise information about the all second derivatives of gravity potential field. Approximating Harmonic term of gravity potential and its derivatives and its (upward and downward) continuations in harmonic space can routinely be done by the solution of the involved GBVPs (Geodetic Boundary Value Problems) but it should not be disregarded that the potential has another non-Harmonic term which behavior is not as clear as Harmonic term. The non-Harmonic anomalies are usually ignored in geodetic studies after the topography corrections while they are so important in exploration studies and they have an essential role in detecting earth's mass-density anomalies of the geological structures. The precise continuations and gridding of the gravity data need precise approximating all terms of gravity potential. Hence, the paper presents a methodology for precise approximating complete Hessian Matrix of earth gravity potential (including all Harmonic and non-Harmonic terms). The paper shows that the Hessian matrix can connect the gravity data in each station with the gravity data in the other locations where the gravity data needs to be interpolated or upward continued to. Also, the paper performs an approximating method of all Hessian matrices in all gravity stations. This procedure is simultaneously done with the gridding and the continuations. Herein it is showed that this method can be implemented by least-squares collocation method. Least-squares collocation method needs knowledge about the correlation and cross-correlation matrices, so the Hessian Matrix can be employed to provide the correlation matrices. The author applied the methodology in a case study in coastal Fars of Iran for exploration studies. In the case study, it is required to detect geological salt structures by some land-based gravity data. For this purpose, the method is applied to downward continue the anomaly gravity data to Geoid and to upward continue to another new-defined surface called NREGS (Nearest Reference Equi-Gravitational Surface). The anomalies on these two surfaces are used to demonstrate the locations of the salt structures. Also, the accuracy of the gridding technique has been experienced in the case study.