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Gravity tomography for determination of the location and extent of interior structures of the Earth via wavelet transforms; case study: gravity tomographic map of the oil reservoirs

M. Shirzaii, **A. Ardalan**

Department of Surveying & Geomatics Engineering, University of Tehran
(m_shirzaii@engineer.com, ardalan@ut.ac.ir)

The mapping the 3-Dimensional (3-D) Earth's interior structures from tomography is the subject of interest in variety of Earth sciences. It is specially due to the fact that tomography enables the scientists to have comprehensive information about the interior structure of the Earth. So far the common tool for tomographic mapping has been seismic data, which requires gathering extensive amount of seismic data and huge computational demand. The seismic data required for deep structures could only be come available through Earthquake; therefore the position of the source and the production time of the data would be out of our control. Even for the structures, which can be detected by manmade vibrations, tedious and expensive operations have to be conducted. On the other hand the norm of gravity vector observed by gravimeters provides us with an abundant source of information about the masses within the Earth. Owing to the aforementioned fact we have tested the possibilities of using gravity data for deriving tomographic maps of the interior structure of the Earth especially for the determination of the location and extend of oil reservoirs. In this approach we have solved the inverse problem of "given" the gravity "find" the extension and position of the source. The key point in our approach is the dependence of the spectrums of the gravity field to the depth of source mass. As the mathematical apparatus we have used wavelet multi-resolution analysis and wavelet multi-scale edge detection. The multi-resolution analysis is used to correlate the gravity spectrum to the depth of signal, i.e. gravity masses. Multi-scale edge detection is introduced to position the mass discontinuity boundaries as each depth. Finally, the results of the two aforementioned

wavelet analysis are used to derive the 3-D map of the boundaries of mass discontinuities within the Earth's crust. As the case study the method is applied to find the extent and location of the oil reservoir/ oil traps of one of the Iranian's oil fields. Considering the efficiency of the method which has been tested via simulated problems it can be concluded that a new approach to develop tomographic maps of the inner structures of the Earth with is more powerful than the seismic method and yet by far cheaper in the observation and computational expenses.