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Mapping of Basement Faults with Gravity and Magnetic Data at NE Mexico

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Northeast Mexico is essentially the juncture of two distinctly different tectono-stratigraphic provinces, the eastern Gulf of Mexico (Coastal Plane, Sierra Madre Oriental) province and the western Pacific Mexico (Rivera plate, Meso-American trench, Sierra Madre Occidental) province (Goldhammer & Johnson, 2001). Tectonic evolution in northeast Mexico is dominated by divergent-margin development associated with the opening of the Gulf of Mexico and overprinted by non-igneous Laramide orogenic effects (Pindell et al., 1988). The structural grain of northeast Mexico consists of Triassic to Liassic fault-controlled basement blocks, the development of which reflects in part late Paleozoic orogenic patterns of metamorphism and igneous intrusion (Wilson, 1990). There are different tectonic provinces which are recognized interpreting the basement and sediment cover of this area: Coahuila block, La Popa sub-basin, Sabinas basin, Burgos basin, Sierra Madre Oriental (Monterrey trough), and Parras basin. Mojave-Sonora megashear and San Marcos fault (Chavez-Cabello et al., 2007) are two principal fault zones crossing the northeast Mexico in NW-SE direction.

This paper is presented the integral analysis of the gravity and magnetic data in the northeast Mexico. Complementing with a Digital Model of Elevations (DME) that combined with the review of previous geological studies it serves to compare the surface structures and blocks of basement in this area. Also the separation of the most important tectonic blocks was done, and 2.5D geological-geophysical model was finally developed. This model represents in a general way the principal structural characteristics of northeast Mexico.

Gravity and magnetic data analysis was used with purpose to study the structure of the substrata in order to allow modeling of the basement structure and its relation with the sedimentary cover features. The Bouguer gravity and the total field aeromagnetic data were supplied by Geological Survey of Mexico, published data (Mickus et al., 1999), and author's field works (Yutsis et al., 2009, Tamez et al., 2011, Yutsis et al., 2011).

The total-field magnetic data were used, with the International Geomagnetic Reference Field removed. The sedimentary cover in the northeast Mexico is generally considered to be almost non-magnetic, and the anomalies are sourced overwhelmingly in the crystalline basement. Local intra-sedimentary anomaly sources may be related to depositional concentrations of magnetic minerals in some clastic rocks, or to secondary magnetization of sedimentary rocks by circulating brines.

Steep, straight faults are commonly expressed as subtle potential-field lineaments, which can be gradient zones, alignments of separate local anomalies of various types and shapes, aligned breaks or discontinuities in the anomaly pattern, and so on. Many large magnetic and gravity anomalies represent the ductile, ancient, healed basement structures, obscuring the desirable subtle features. Subtlety of the desirable lineaments necessitates detailed data processing, using a wide range of anomaly-enhancement techniques and display parameters. So data processing includes Fourier transformation, wave-length filters, upward and down ward continuation, vertical and horizontal derivates, analytic signal analysis, etc.