Integrating gravity and electromagnetics with seismic for near surface characterization in Saudi Arabia
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Near surface conditions in Saudi Arabia represent the major challenge for acquisition of reliable and meaningful land seismic data. In Saudi Aramco, a major effort is underway to investigate the benefits of integrating gravity and electromagnetic data with seismic data to better estimate near surface velocities for processing large 3D seismic volumes. In 2010 a gravity and electromagnetic acquisition program was carried out in three areas characterized by different near surface geologic conditions. The type of methodologies being employed consist of dedicated high-end electromagnetic and gravity acquisition specifications, geophysical data integration via simultaneous joint inversion, and seismic processing with advanced imaging workflows such as pre-stack redatuming (time) and pre-stack depth migration. Well log analysis in shallow boreholes provides the local petrophysical relationships among velocity, resistivity and density to be used in a simultaneous joint inversion scheme. Given the shallow targets, the resolution offered by the electromagnetic and gravity data is typically within the wavelength of the velocity anomalies affecting seismic imaging. Therefore, near surface non-seismic data act as an ideal complementary dataset to seismic.

Results obtained to date reveal density and resistivity anomalies correlated with regions of poor seismic data quality. EM and gravity data analysis and inversion are being carried out in a single-domain approach as well as by applying quantitative simultaneous joint inversion schemes with seismic travel-time data. The generated near surface multi-parameter models are used to correct the seismic data with successive reprocessing in time and depth domains. Encouraging results are being observed from the reprocessing indicating that the multi-physics data and the quantitative integration schemes are succeeding in addressing the near surface velocity estimation problem.