AAPG Datapages/Search and Discovery Article #90254 ©2016, GEO-2016, 12th Middle East Geosciences Conference & Exhibition, Manama, Bahrain, March 7-10, 2016

Helicopter-Borne Transient Electromagnetics for High-Resolution Near-Surface Characterization

Ersan Turkoglu[1], Diego Rovetta[1], Armando Sena[1], Daniele Columbo[1], Gary W. McNeice[1]

[1]EXPEC ARC, Saudi Aramco, Dhahran, SAUDI ARABIA

ABSTRACT

Wadi Sahba in Central Saudi Arabia has complex near-surface conditions that obscure seismic in the area. Improving the seismic imaging is of fundamental importance for delineating the main reservoirs occurring in the Mesozoic and Paleozoic sections. A 3D helicopter-borne transient electromagnetics (TEM) program was carried out over the full-fold area of recent 3D seismic surveys with the scope of enhancing the near surface velocity modeling by multi-parameter joint inversion. Electrical resistivity images of the wadi provide information of the subsurface unaffected by the near-surface complexities that distort the seismic data. The TEM survey provided dense sampling of the shallow geology with measurable resolution of 5-10 m in the horizontal direction and comparable resolution for the vertical direction in the shallow section. A careful tuning of the acquisition parameters, such as the transmitter moment and the repetition time, provided sensitivity to a depth of about 500 m from the surface, making the TEM dataset an excellent complementary tool for the analysis and characterization of the near surface. A pseudo-3D conjugate gradient iterative inversion scheme was developed for the interpretation of the data involving 1D TEM inversion and3D spatial regularization. The efficient forward algorithm can accommodate arbitrary transmitter source waveforms and irregular survey geometry as derived from variable wind directions during the flights. The forward algorithm was benchmarked against an existing 3D finite-element EM simulation code and acceptable accuracy and stability was confirmed. The developed inversion scheme coupled with a statistics-based outlier removal algorithm allowed the minimization of model instabilities, caused by reduced signal to noise ratio at longer decay windows and by cultural noise (pipelines, railway, farms, powerlines, etc.). Sharp details of the near surface geology were recovered showing high degrees of correlation with seismic.