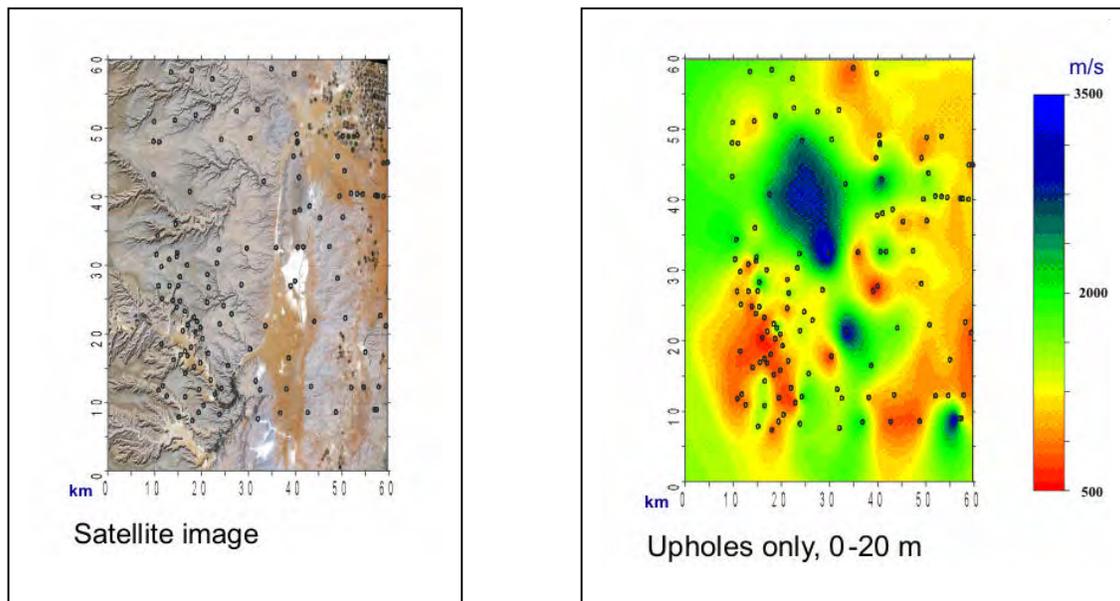


Geostatistical recipes for near surface modeling

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The near surface inhomogeneities encountered in the Arabian deserts cannot be modeled accurately, using conventional seismic data designed and acquired for deep targets. Sharp irregular boundaries of wadis and jebels divide formations with velocities varying from 600 to 3000 m/s. These are often also associated with abrupt elevation changes of tens of meters. The seismic spatial sampling of the near surface is insufficient both laterally and vertically for the purpose of modeling and correcting for the time distortion manifested in the deep target images. *Ad hoc* 3D reflection/refraction surveys can solve this problem in principle, but their cost in hostile environments of the Middle East can be prohibitive. For this reason, potential cost-effective alternatives such as satellite imagery, vibrator plate data, and others have become attractive.

With the goal of eliminating the lack of proper near surface sampling we introduce a few algorithms to complement the seismic with other geophysical data. The uphole contribution, while being too sparse in most cases, does constrain the main shallow structures at a regional scale, in terms of both vertical layering and defining the major velocity trend. Satellite imagery provides a minor contribution in delineating soil properties, while direct arrival analysis of seismic records yields the best estimate for the weathering velocity. The Plus/Minus method provides a robust estimate for velocity and depth from refracted arrivals, in a depth ranging from surface to 100 m. In the areas where it is not applicable, then co-kriging of other seismic attributes with Plus/Minus delay times and upholes can fill the gaps in 3D. The mentioned techniques are tested at two different fields in the Arabian Peninsula.



Satellite image of topography (left) and shallow velocity field (right) derived from upholes (black dots).