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SMART MAPPING

Hydrocarbon Projects

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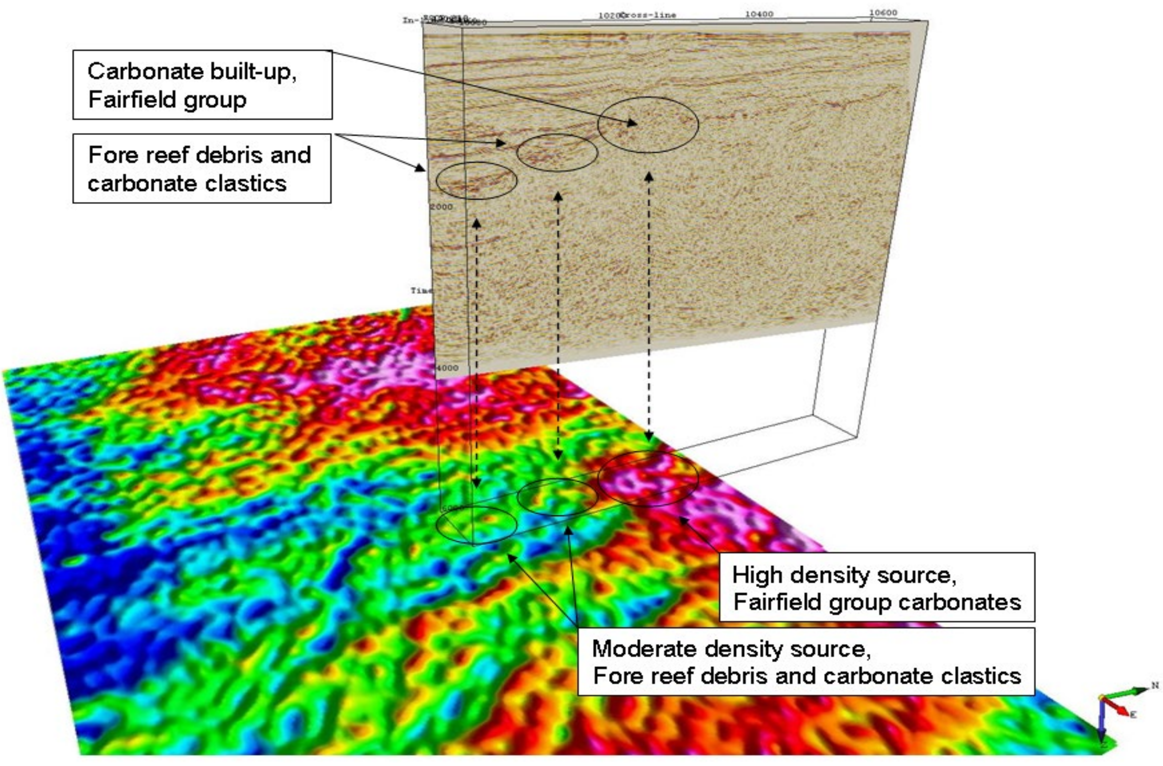
3D integrated basin model with FALCON® - Joint interpretation of FALCON®, magnetic, 2D seismic and well data, King Sound, Canning Basin, NW Australia.

An integrated interpretation of FALCON® AGG, magnetic and seismic data was used to generate a 3D geological model of the sediments and basement in the King Sound region of the Canning Basin in northern Western Australia. The area comprises carbonate, carbonate-clastic and siliciclastic rocks. Comparison of the FALCON® AGG data with the 2D seismic profiles shows that the high-density areas coincide with carbonate build-ups on the margin of the shelf, the intermediate density areas coincide with fore-reef debris and carbonate-clastic, and the low-density areas coincide with siliciclastic and turbidites.

Therefore, the distribution of carbonate, carbonate-clastic and siliciclastic rocks along with intra sedimentary structures were mapped. Basement structures were mapped using the magnetic data collected concurrently with FALCON® AGG data.



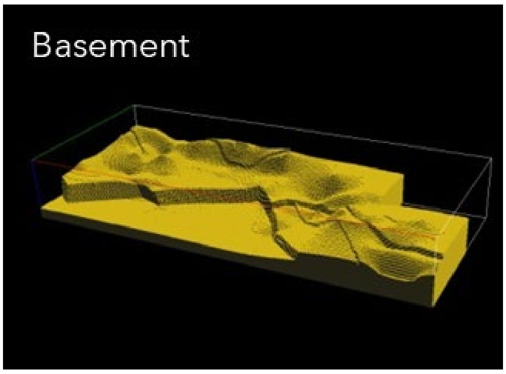
FALCON® GDD image showing the relative position of a 2D seismic line in King Sound, Canning Basin (NW Australia). The location of different lithotypes matches on both gravity gradients and seismic data, respectively.

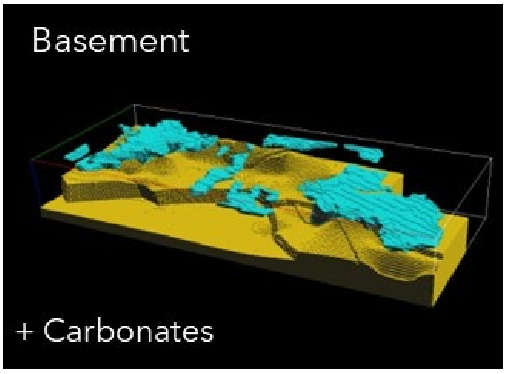
The 3D geological model for King Sound was constructed from interpreted geological interfaces and faults and honours all the available data. The lithostratigraphic column was used to define the geological relationships and a geological knowledge of the area was used to constrain time sequences of fault systems, their kinematics and to estimate fault throws.

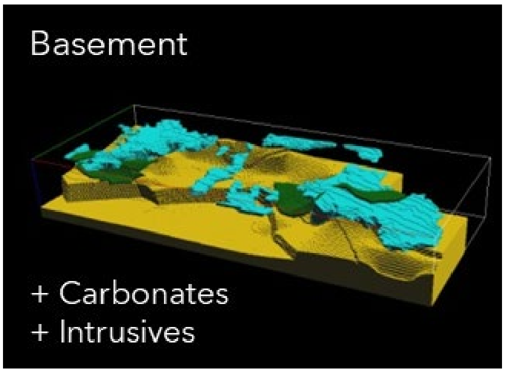
King Sound model construction started with production of the basement surface. The depth to the basement was derived from Euler and Werner Deconvolution methods using well control.

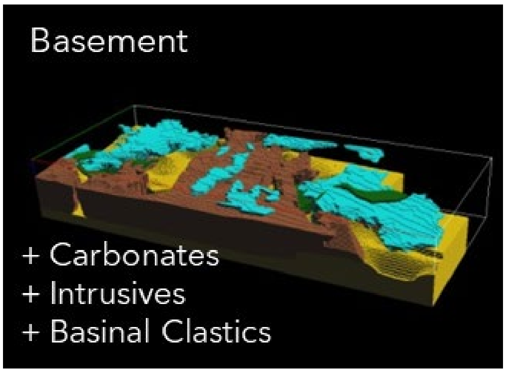
A basement surface was constructed from these depth estimates and interpolated where no depth solutions were available. Intrusive units were interpreted from the magnetic data and well intersections and surfaces were created to represent them.

The top surfaces of the siliciclastic formations of the upper section of the basinal fill were constrained from the available 2D seismic data. Faults and lower parts of the basinal sedimentary sequence (Devonian reef system and Fairfield Group of rocks) that directly overlie the basement were interpreted from the gravity gradiometer and magnetic data. Depth slices of the GDD data and 2D seismic data were used to interpret their depths.









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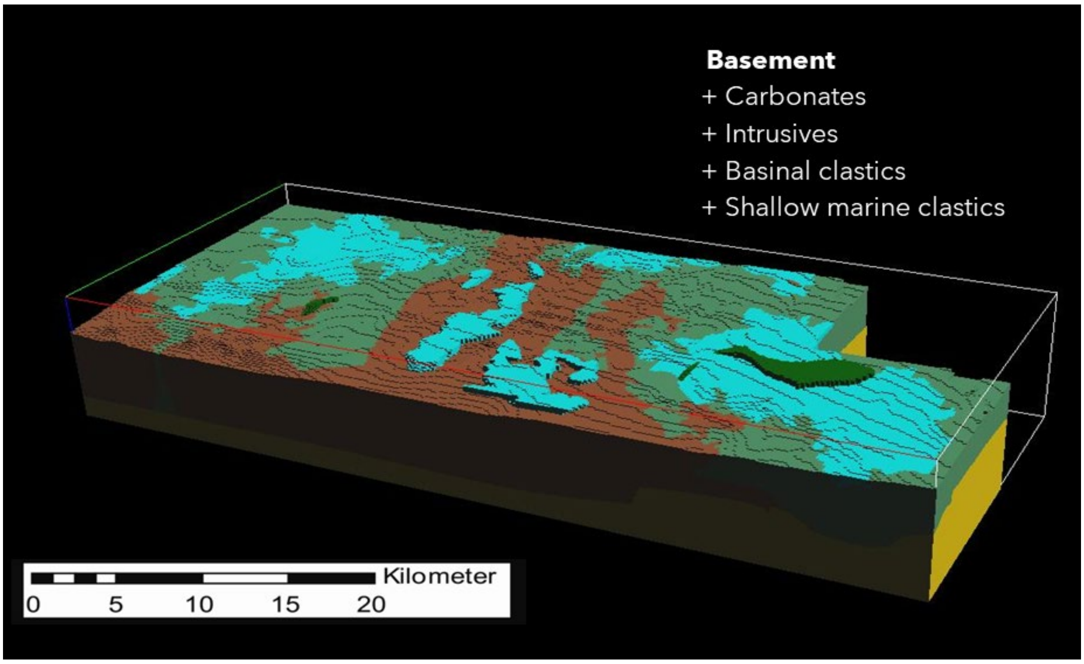


RESOLVE® and HELITEM® for Oil Sands/Heavy Oil and Shallow Gas

Geological complexity and relatively shallow depths of investigation necessitate the use of innovative, proven, and cost-effective methods for exploring and developing surface mineable and in situ heavy oil sand leases in the Athabasca Basin near Fort McMurray, Alberta.

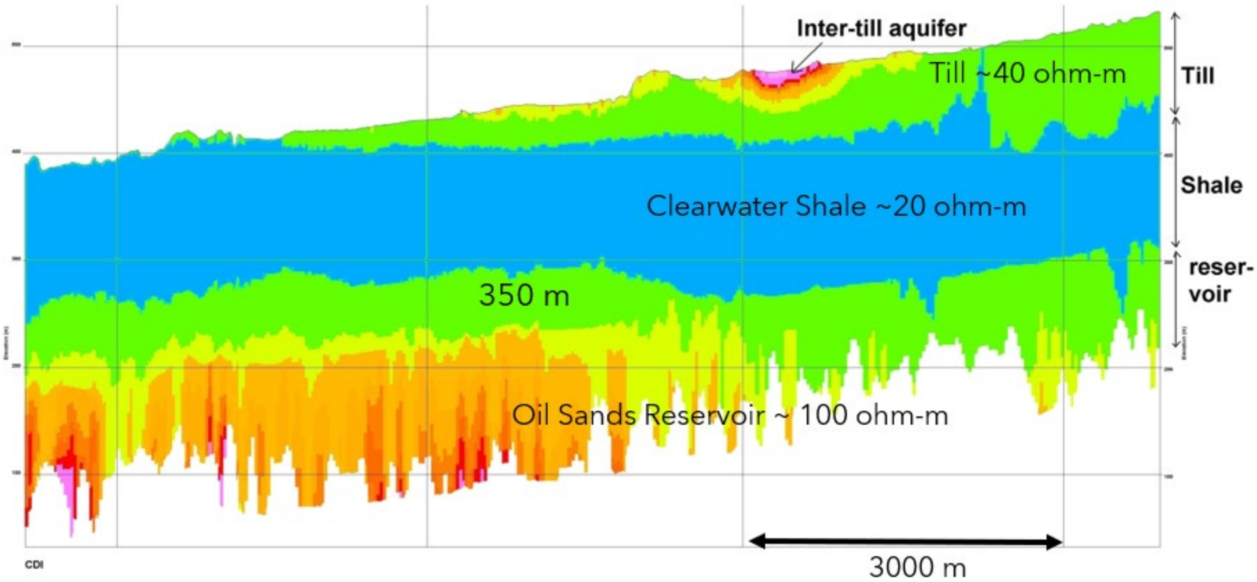
Although vertical and spatial resolution are lower than borehole and ground geophysical methods, when integrated with ground-based methods by geologists, geophysicists, and engineers, AEM can yield:

- Heavy oil reservoir quality.
- Presence, thickness and extent of clay or shale (such as the clearwater shale).
- Delineation of rich oil sands.
- Mapping of surface sand, gravel, and aquifers for environmental investigations.
- Overburden characteristics and drilling hazards.
- Shallow gas reservoir delineation.
- Mapping soils and overburden for facilities site investigation and engineering purposes

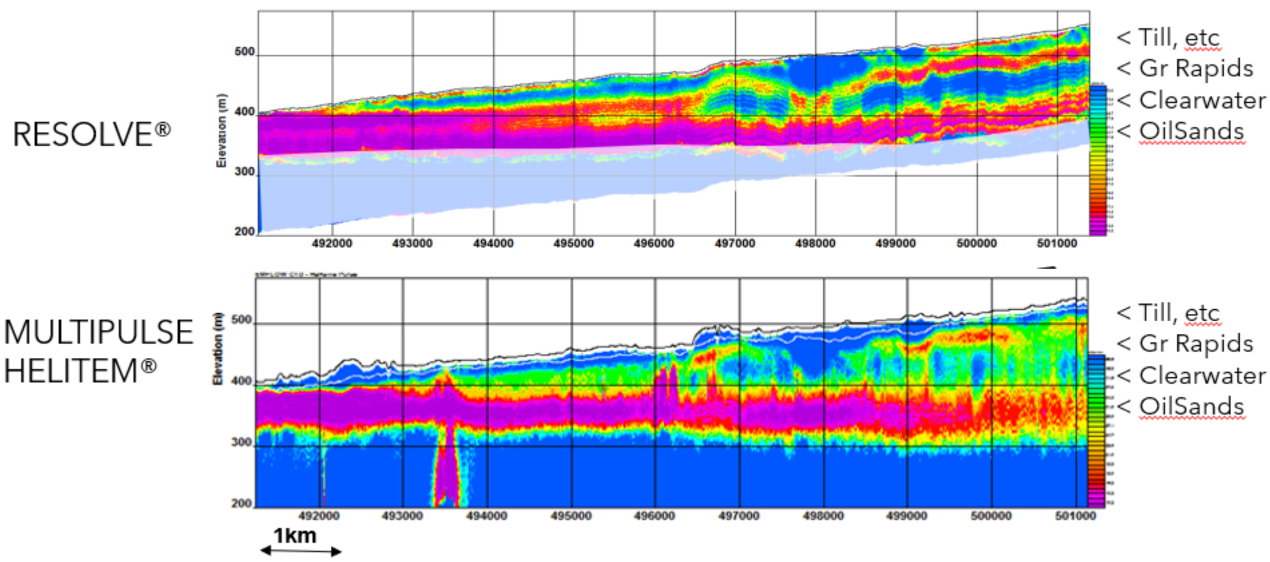
Forward modelling using the available well logs can help determine if the exploration or development objectives can be achieved using AEM.

The McMurray formation is a groundwater host with some areas hosting bitumen oil sands. These oil sand reservoirs are characterized by higher resistivities and are clearly detected and mapped by the HELITEM® system at a depth of 350 meters.

The HELITEM® data is presented as a B-Field conductivity depth transform inversion section (CDI). The thickness of each unit is clearly represented and confirmed by borehole investigation. A near-surface water bearing aquifer appears as a resistor at the top of the section. Moderately conductive Quaternary glacial till sediments cover the section with a varying depth of 0 to 100 meters. The Cretaceous Clearwater shale is a conductive unit which caps the Cretaceous McMurray sandstone and shale reservoir unit.



Fort McMurray Oil Sands Reservoir Detection.



RESOLVE® Survey at the same location, which allows a further check on the validity of MULTIPULSE™ HELITEM® test results.

The economic advantage of AEM is that it provides a multi-purpose, 3D data set, comprising geoelectrical information between sparse and more expensive ground-based investigations. When acquired early in a project, AEM can be used to make future drilling and surface geophysical programs more effective by increasing the probability of successfully intersecting pay zone or engineering related targets and by early identification of areas with unfavorable horizons that do not require further investigation.

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HELITEM® for near-surface velocity modelling and corrections

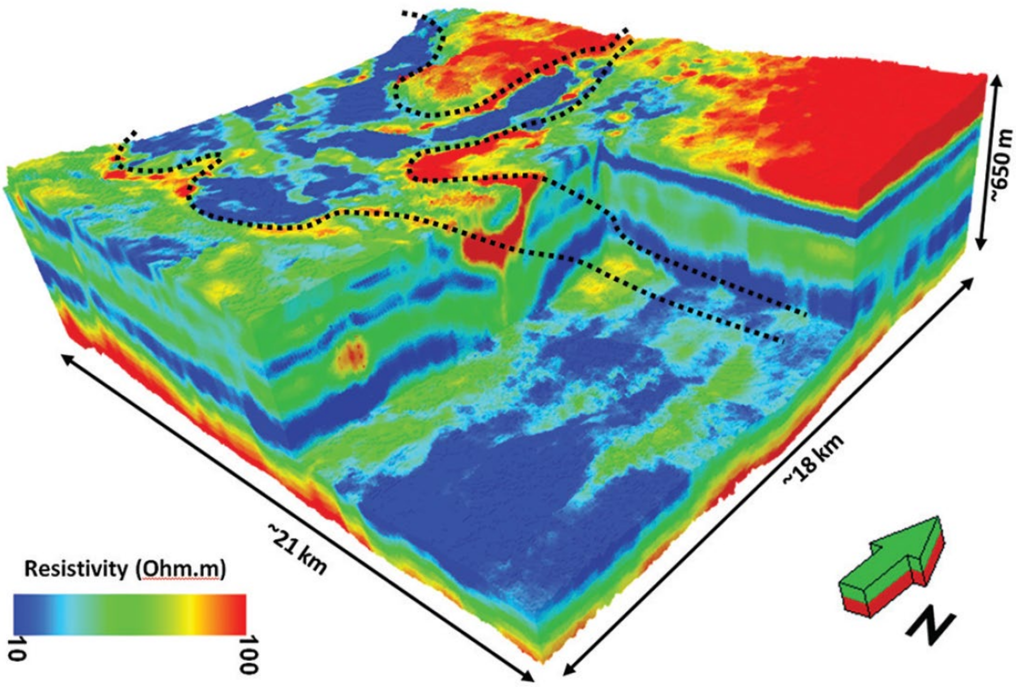
HELITEM® was selected from a suite of non-seismic methods for multiparameter velocity-model building to enhance the velocity estimation for the Central Saudi Arabia.

HELITEM® is ideally suited to deliver an accurate and cost-effective near-surface characterization based on the resistivity parameter distribution.

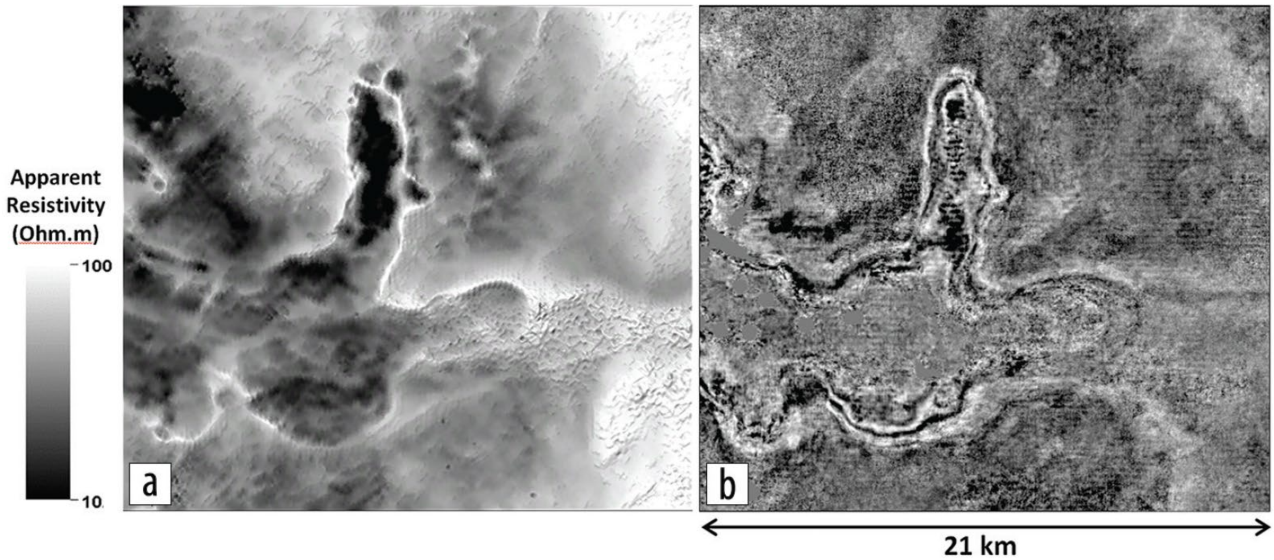
Accurate near-surface velocity modeling and corrections is the single most important step for correct seismic imaging to reduce exploration risk. Emphasis is placed on long-wavelength near-surface features that often cannot be resolved with conventional 3D seismic acquisition geometries that severely under-sample the near surface.

Robust joint-inversion approaches provide the tools for multiphysics data integration to obtain high-resolution velocity models of the near surface.

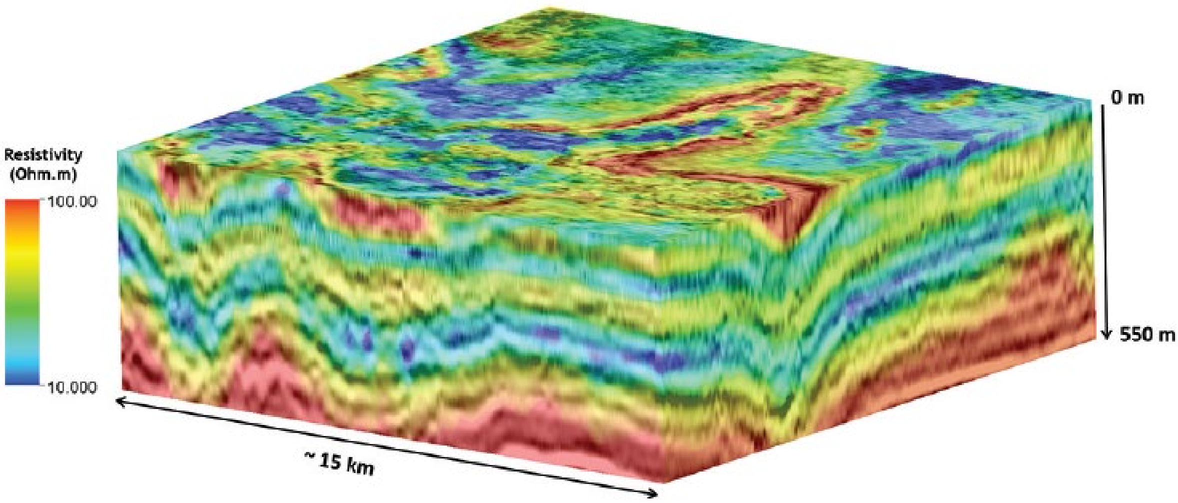
Joint inversion of seismic and HELITEM® data provides superior imaging results in both time and depth, compared to a single-domain tomographic approach.



HELITEM inversion results in Saudi Arabia. Dashed line indicated the study area. (Colombo et al., 2016).



Comparison between (a) an apparent resistivity transform of early-time HELITEM data with (b) a seismic time slice at 164 ms (Colombo et al., 2016).



Seismic cube from 3D prestack depth migration with co-rendered resistivity from HELITEM inversion. The resistivity distribution provides the fine description of the near-surface structures and layering as inferred from the depth-domain seismic images (Colombo et al., 2016).