GroundMetrics was hired to conduct a Full-Field Resistivity Survey for an oil and gas producer that needed to make crucial decisions to drive profitability at the location. The results saved them hundreds of thousands and identified a new drilling opportunity.

**MATURE FIELD RESISTIVITY SURVEY**

When GroundMetrics was hired to conduct a survey for the producer in East Texas, the customer had been producing oil from a particular field for nearly two decades. They faced one dry well, increasing water cut in other wells, and uncertainty about possible new drilling opportunities. They turned to GroundMetrics for better insight into the oilfield’s potential.

Before seeing the survey findings, the client planned on drilling new infill wells. Instead, the results uncovered an opportunity for a new offset location on the oilfield.

**KEY FINDINGS**

- Identified a possible new offset location where the customer is currently exploring drill options.
- Discovered that the client could have saved up to $500,000 from not drilling a dry infill well.
- Discovered the opportunity to revisit seismic mapping in conjunction with resistivity to create a comprehensive view of the subsurface.
- Confirmed that the producing zone is now at a high water cut.

The production zone included five wells, four of which were producing. The client planned to drill infill wells, but needed more data before moving forward. They hired GroundMetrics to design and implement a survey that would accomplish several goals: explain the absence of net pay in their dry hole, identify potential infill or offset locations, and validate their approach against traditional resistivity and seismic technology for use in future projects. The GroundMetrics team conducted a survey, after which they processed the raw data through DSEMI-3D™ inversion software to produce actionable recommendations for the client.

**WHO WE ARE**

GroundMetrics is a full-service survey and monitoring company and the world leader in land-based resistivity sensor systems. We help engineers and geoscientists make better drill and field development decisions by producing Full-Field Resistivity Images from data processed through our DSEMI-3D™ inversion software.

Want to learn more? Contact us at sales@groundmetrics.com.
PROJECT OVERVIEW

Since the early 1990s, the customer had been producing oil from a sand formation approximately 5,000 feet (1,500 meters) deep at the Paluxy layer. Before they commissioned the GroundMetrics survey, their development plan had been to drill infill wells where they would be structurally high to the estimated oil-water contact. However, with Well 12 being wet, the operator was unsure of the reservoir geometry and wanted to see if there was offset pay in the formation. GroundMetrics was asked to perform a Full-Field Resistivity Survey at this point.

MAIN GOALS

+ Explain why the dry holes didn’t encounter pay in the reservoir
+ Determine any possible new drilling locations in the oilfield

SECONDARY GOALS

+ Image oil-water contact to show GroundMetrics’ ability to assist with IOR/EOR
+ Ground truth image around producers, dry holes, and logged wells to validate technology

WHY GROUNDMETRICS?

GroundMetrics surveys show resistivity data over 10,000 ft (3,000 m) deep, and a lateral range of 2 mi (3 km) from the borehole. We are the only solution that can provide you with resistivity data between and beyond wellbores, giving you the data you need to make confident oilfield development decisions.

PRODUCTION ZONE

+ Five wells had been drilled, four of which (Wells 4, 6, 7, and 11) produced oil and one of which (Well 12) was a dry hole.
+ Well 4 has the highest cumulative production in the upthrown fault block at 87 million barrels of oil (MBO).
+ Well 6 produced 31 MBO over a seven-year period, “watered out” and was subsequently converted to an injection well due to low oil production and high water cut.
+ Well 7 produced 53 MBO and due to casing problems and low oil price was plugged and abandoned (P&A).
+ Well 11 was drilled as a replacement to Well 7 and has produced 14 MBO.

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SURVEY FINDINGS

After GroundMetrics conducted its survey, the data was processed through DSEMI-3D™ inversion software. The inversion was completely unconstrained and blind— to ensure an unbiased result, the team running the inversion did not know which wells were dry or producing or the water cuts of the producing wells. The findings were interpreted at several depths and compared to seismic maps and induction logs to help make drill decisions and validate the technology for future projects.

FINDINGS AT DEPTH:
4,934 FEET (1,503 METERS)

+ As is typical, resistivity decreased from original levels as a result of formation water encroachment.

+ Higher levels of resistivity point to a possible anomaly to the northwest of Well 4.

+ Well 12 has low resistivity at 2.5 Ohm-m, indicating a dry hole.

The first finding is crucial—Well 12 is dry, and should never have been drilled. The operator could have saved approximately $500k by running the Full-Field Resistivity Survey before drilling.
FINDINGS AT DEPTH:
4,978 FEET (1,517 METERS)

+ Resistivity of Wells 4, 7 and 11 stay constant with findings from 4,934 ft (1,503 m).

+ The amplitude northwest of Well 4 is increasing and nears the original resistivity levels of 10 Ohm-m, indicating hydrocarbons.

+ Well 11, the highest on the formation, shows the highest saturation of remaining resistors (in yellow), an indicator that it's still producing at the lowest water cut.

FINDINGS AT DEPTH:
5,033 FEET (1,534 METERS)

+ At this depth, the resistivity of the spot NW of Well 4 is even more evident and at 10 Ohm-m. This is a clear hydrocarbon indicator in the northwest of the reservoir. This means there is potentially an offset well to be drilled, increasing the field extent.

Well 11 is still producing, while an anomaly approaching original resistivity levels to the northwest of Well 4 indicates a possible offset well.
FINDINGS AT SW-NE CROSS SECTION OVERLAID ON INDUCTION LOG

- Zones of interest are isolated and show the areas with high water saturation (in blue) compared to sands with higher oil saturation (in green and yellow).
- In the southwest to northeast cross section, the induction log shows resistivity change within the Paluxy at around 5,000 feet, correlating with GroundMetrics resistivity imaging.

GroundMetrics data correlates with traditional induction logs, confirming accuracy of our Full-Field Resistivity Imaging and providing further insight into ground truth.

FINDINGS AT NW-SE CROSS SECTION OVERLAID ON INDUCTION LOG

- In the NW to SE cross section, the amplitude in the sand to the NW of Well 4 increases.
- Based on the yellow area at the 5,000ft level, we confirm that Well 4 has produced from the reservoir.
- The blue area shows that water contact has occurred in Well 1, which correlates to induction log.
FINDINGS FROM 3D SEISMIC MAPPING

+ In the 3D seismic, the line from NW to SE falls across the zone of interest.

+ The NW side of the trapped fault where Well 6 penetrates the Paluxy sets up the productive zone for Wells 6, 11, 4 and 7. This seismic line confirms that the zones of interest are set up by fault.

+ Further to the NW, a second fault correlates with the amplitude set up by the first fault, indicating that the original seismic interpretation did not identify this secondary fault. Well 12 is not in the upthrown fault block as previously thought.

GroundMetrics resistivity data not only correlates with 3D seismic mapping, it both predicted a dry hole and identified an additional fault.
SURVEY DESIGN AND DEPLOYMENT

GroundMetrics geoscientists and engineers worked with the operator to design a survey that would acquire data on the dry holes, producers, and the predicted fault line. The planned survey area covered approximately half a square mile (1.3 square kilometer).

GroundMetrics surveys are far less disruptive and more environmentally-friendly than traditional methods. No large vehicles, less noise pollution, and a smaller footprint provides the outcomes without the major pitfalls.

Once the survey was designed, the GroundMetrics survey crew deployed to the site to conduct the land survey and collect resistivity data. The crew consisted of survey technicians charged with placing and moving survey equipment, a data observer who monitored and assured the quality of the data, a source operator, and a field operations manager. Data acquisition yielded over 2,100 channels of data collected. Health, Safety and Environment (HSE) procedures were followed to plan and included daily briefings for the entire crew.

VALIDATION OF GROUNDMETRICS SURVEY METHODOLOGY

Findings from the GroundMetrics Full-Field Resistivity Survey were validated by existing data on the oilfield, making further exploration with GroundMetrics viable.

- Resistivity contrast in the reservoir layer is consistent with known high water cut and seismic data.

- The inversion was validated from formation tops and resistivity logs at the wells.

- The inversion found the reservoir without constraining the model, showing the GroundMetrics’ results were not skewed.

SURVEY EQUIPMENT USED

- The eQube™, a highly accurate, broadband, stable capacitive electric-field sensor 100x more precise than competitive sensors

- Eos™ data recorders positioned strategically throughout the survey site

- Survey vehicles, including a small truck containing TCS-30™ source and monitoring equipment

- DSEMI-3D™ processing and inversion software
GroundMetrics is a full-service survey and monitoring company and the world leader in land-based resistivity sensor systems.

Surveys produce resistivity images by processing data through proprietary DSEMI-3D™ inversion software, helping engineers and geoscientists make better drill and field development decisions.

Benefits for GroundMetrics clients include:

- Optimize drill locations and increase drill success rates
- Find bypassed, offset, and undiscovered oil
- Determine well spacing and add infills or stepouts to extend reservoir
- Lower cost per barrel by optimizing operations in the field
- Calculate saturation levels by mapping Residual Oil Zone (ROZ) and identifying remaining oil saturations for water-floods

METHODOLOGY

GroundMetrics resistivity surveys employ a new method that uses existing oil, gas, water, steam, geothermal, or CO₂ wells to illuminate deep underground geologies. Data is collected and inverted through unique 3D mapping software to identify areas of resistivity. Complex algorithms eliminate geological noise, which increases confidence and cancels false negatives.

Ready to learn more? Contact us at sales@groundmetrics.com.