First experience with high power EM towards the energy transition

K. Strack[1], S. Davydycheva[1], T. Hanstein[1], A.Y. Paembonam[1,2], V. Pronenko[3], M. Smirnov[1,4], P. Soupios [5], X. Xu[1]

(1) KMS Technologies, Houston, Texas, USA
(2) Sumatera Institute of Technology, Indonesia
(3) Lemi LLC, Lviv, Ukraine
(4) Lulea Technical University, Sweden
(5) King Fahd University of Petroleum and Minerals, Dhahran, Saudi Arabia

During the energy transition, key applications for electromagnetics (EM) (including magnetotellurics - MT and controlled source electromagnetics - CSEM) are CO2 monitoring, geothermal exploration and monitoring, enhanced oil recovery (EOR & EOR+) monitoring, and lithium exploration. The most important of these is monitoring, which is required to measure time-lapse anomalies in the subsurface to be better than 0.5%. This requires a completely different approach to hardware, survey design, workflow, and interpretation.

To maintain the accuracy and controllability of the hardware, special care must be taken about sensors, the continuous recording of transmitter performance, and the monitoring of changes with time and temperature. We used the system in -200 C as well as +500 C with the entire range included in the system specification. The survey design usually requires a 3D anisotropic model-based exercise, including on-site noise measurements, well logs to define the resistivity variation before and after fluid injection, and petrophysical analysis. The results from this are optimized receiver spacing and the recording times for the magnetotelluric and CSEM measurements. Even though it is not immediately included, it also impacts the processing and interpretation design.

For monitoring CO2, geothermal or hydrocarbon reservoirs, we must always consider that for repeat measurements, everything could be changed (equipment, environmental noise conditions, and geophysical processing algorithms). Thus, we must minimize the impact of these on any baseline data to the point where we almost exclusively rely on average statistics.

For effectiveness and efficiency, we usually acquire MT during the night and CSEM during the day unless weather conditions demand differently. Thus, both methods and their results will be compared to the 3D anisotropic well log for calibration and they must be consistent within their resolution capabilities. The case histories from the US and Saudi Arabia used the Cloud to support near real-time quality assurance during the acquisition. We compare the inversion results with the 3D anisotropic log-based model response and include the seismic horizons. If everything is done correctly, the match allows us to certify even the baseline measurements based on the 3D model response. This significantly reduces the risk and provides us confidence in further time-lapse measurements.