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# Evaluating Innovations in Geophysical Acquisition

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## Summary

Accurate subsurface imaging forms a critical part of all exploration and production projects with seismic acquisition being the most common method utilized on traditional energy projects. Seismic data is also beginning to provide significant value on emerging clean energy projects where it can be used for everything from geothermal well place, the tracking of lithium brines, identification of critical mineral deposits, wind farm placement, and for delineation and monitoring of CO2 plumes on carbon capture utilization and storage (CCUS) projects.

Although these projects require similar high-resolution, target-specific survey parameters as are regularly acquired for oil and gas exploration, the perceived project ROI may be less or may occur over a longer timeframe. Unfortunately, this perception can result in the acquisition of suboptimal seismic data due to prioritizing cost over data quality. Additionally, traditional high-density seismic programs often require the movement of significant amounts of equipment and regularly require the preparation (e.g., plowing/flattening for vibroseis) or clearing of seismic lines (e.g., tree cutting in forested regions for drill/recording equipment access) for safe equipment deployment. As we focus on reducing GHG emissions via alternative energy sources and CCUS, we also need to focus on preserving biodiversity. New innovative seismic acquisition methods can help achieve both these goals, but it is important to ensure that new methods are fully validated for use through the full geophysical lifecycle of a project.

## Theory

Successful seismic acquisition can be defined in many ways, but typically includes good quality data that was acquired on time and on budget. The quality of the seismic data is dependent on three factors: geometry sampling, source energy, and recording sensor. This can most easily be understood from the perspective of frequency content. The geometry must be selected to accurately sample the frequencies of interest, and there must be sufficient broadband source energy reflected back from the target to the surface (or downhole) recording sensors, which must have sufficient dynamic range to accurately record the seismic signal. Without all three of these areas being properly designed, a seismic survey may result in suboptimal data, leading to ambiguity in results and potentially more risk as development of the project progresses.

Technologies such as miniaturized source and recording equipment, innovative cutting techniques, and alternative geometries can all help to reduce the environmental impact of acquiring seismic data (Vermeulen et al 2022). However, all new seismic acquisition technologies need to be validated through the full geophysical analysis cycle, which includes seismic acquisition, processing, interpretation, and quantitative analyses such as inversion.

## Results

In 2020, the collaborative EcoSeis research project was started to examine alternative seismic acquisition solutions. Here we show results from this work where alternative EcoSeis geometries and both conventional and miniaturized seismic equipment have been evaluated through processing tests, seismic interpretation, and inversion analyses. Although combining all novel sampling, source, and sensor technologies may provide the most reduction in land footprint, significant reduction can also be achieved just by optimizing the geometry and acquiring the data with conventional seismic equipment. Given the success of the initial processing tests where a greater than 50% reduction in land footprint was achieved (Naghizadeh et. al., 2023), the first EcoSeis program was successfully acquired in Q4 2022 (Crook et. al., 2023). This program is currently undergoing a similar evaluation process including processing tests, interpretation comparisons, and inversion. It is recommended that all new seismic acquisition technologies undergo this type of rigorous testing.

## Additional Information

Innovation is required in order to develop and implement new sustainable methods for seismic data acquisition. This is only possible through collaboration as the costs to test and validate multiple technology solutions can be prohibitive. Additionally, multiple solutions are often required to address the different challenges such as program accessibility, surface exclusions, and environmental constraints that may occur on a seismic acquisition project. The EcoSeis project demonstrates the success of a collaborative and innovative approach to developing new sustainable seismic solutions.

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