6.2 USING ELECTROMAGNETIC FLUID IMAGING DURING THE ENERGY TRANSITION

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ABSTRACT

The controlled-source electromagnetic (CSEM) method provides critical information about reservoir fluids and their spatial distribution. This feature is ideal for carbon dioxide (CO_2) storage, enhanced oil recovery (EOR), geothermal, and lithium exploration applications. CSEM can be tailored to the specific reservoir target objectives by choosing the appropriate components of a multi-component system. First, whether the primary target reservoir is resistive or conductive must be understood. In the CO_2 monitoring case, the injected fluid is resistive. However, the monitoring must also consider the conductive reservoir parts when the injected reservoir is brine-saturated (water-wet) or oil-wet (carbon capture utilization and storage - CCUS). The data acquisition pre-survey is optimized by analyzing the target parameters and the sensitivity capability of multi-component CSEM. The essential tools are on-site noise measurements coupled with 3D anisotropic modeling. From our experience, subsequent surveys go smoothly and deliver robust measurements to meet scientific targets. Another critical element is to combine data acquisition real-time quality assurance with 3D modeling to fine-tune acquisition parameters such as acquisition time and required repeats. The data can be inspected on the fly for the information content of the subsurface while the acquisition is ongoing. As a result, a high-quality data set is usually obtained for processing and (first) interpretation with minimum user interaction. The sensitivity analysis in the inversion is used to verify that acquired data are sensitive to the expected depth range of the target reservoirs. A CO_2 storage site example from North Dakota, USA, describes these steps and shows how the surface measurements achieve log scale (appropriately upscaled) sensitivity. Further, the sensitivity of the CSEM method in other case histories, including EOR, geothermal, and lithium application examples where the target reservoirs are conductive, is presented and discussed.

KEYWORDS: CO_2 storage monitoring; fluid imaging; controlled source electromagnetics (CSEM); CCUS; EOR; geothermal monitoring; lithium exploration.