A New Technique for Determining In Situ Parameters of Argillaceous Deposits using Pore Pressure Responses

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Abstract

Laboratory consolidation tests are typically used to determine formation properties (vertical compressibility, α; specific storage, S_S; and vertical hydraulic conductivity, K_v) of claystone aquitards. However, when core samples are removed from the subsurface and re-equilibrate at surface pressure, the geotechnical properties of the sample may not be representative of in situ conditions. Here, we present a method to determine the in situ α and S_S of a thick sequence of Cretaceous aged claystone by estimating the loading efficiency (γ) of a formation from pore pressure responses to barometric pressure fluctuations. Ten vibrating wire pressure transducers were installed at depths varying between 25 and 325 m BG in a thick claystone aquitard and placed directly within the cement bentonite grout annulus. In the pore pressure records, barometric pressure changes, earth tides, and precipitation events can be clearly identified with a resolution equivalent to millimeter of hydraulic head. Analyzing the pore pressure response to known barometric fluctuation resulted in the calculation of γ (0.6-0.93), α (2.5×10^{-7} to 2.2×10^{-6} kPa^{-1}), and S_S (2.6×10^{-5} to $4.5 \times 10 \times 6$ m^{-1}), all of which decrease with depth. Laboratory analysis of core samples from the borehole provided estimates of α and Ss, which were as much as an order of magnitude greater than the in situ estimates. The findings suggest that the fully grouted transducer method can provide an accurate and reliable means to monitor pore pressure changes in deep aquitard systems, better define in situ parameters for over consolidated argillaceous deposits and help characterize caprock integrity.

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