Measuring and modeling fault density for CO_2 storage plume-fault encounter probability estimation

GCCC Publication Series #2013-10

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Keywords: structural, monitoring

Cited as:

Jordan, P.D., C.M. Oldenburg, and J.-P. Nicot, 2013, Measuring and modeling fault density for CO_2 storage plume-fault encounter probability estimation, GCCC Publication Series #2013-10, originally published in *AAPG Bulletin*

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Abstract

Emission of carbon dioxide (CO_2) from fossil-fueled power generation stations contributes to global climate change. Capture of CO_2 from such stationary sources and storage within the pores of geologic strata (geologic carbon storage) is one approach to mitigating anthropogenic climate change. The large storage volume needed for this approach to be effective requires injection into pore space saturated with saline water in reservoir strata overlain by cap rocks. One of the main concerns regarding storage in such rocks is leakage via faults. Such leakage requires, first, that the CO_2 plume encounter a fault and, second, that the properties of the fault allow CO_2 to flow upward. Considering only the first step of encounter, fault population statistics suggest an approach to calculate the probability of a plume encountering a fault, particularly in the early site-selection stage when site-specific characterization data may be lacking. The resulting fault encounter probability approach is applied to a case study in the southern part of the San Joaquin Basin, California. The CO_2 plume from a previously planned injection was calculated to have a 4.1% chance of encountering a fully seal offsetting fault and a 9% chance of encountering a fault with a throw half the seal thickness. Subsequently available information indicated the presence of a half-seal offsetting fault at a location 2.8 km (1.7 mi) northeast of the injection site. The encounter probability for a plume large enough to encounter a fault with this throw at this distance from the injection site is 25%, providing a single before and after test of the encounter probability estimation method.