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Identifying Depleted Reservoirs as Pore Space for Energy Storage or Carbon Dioxide Sequestration Through Well Data Analysis

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Abstract

With governments incentivizing and industry moving to decarbonize the energy sector, energy storage and carbon dioxide (CO_2) sequestration are increasingly relevant. The transition to sometimes intermittent renewable power sources or lower carbon intensive natural gas may be more effective if energy can be stored during periods of high supply and delivered during periods of high demand. Furthermore, decarbonization may be more permanent if captured carbon can be geologically sequestered. Geologic formations, and more specifically depleted hydrocarbon reservoirs, are regularly touted as available pore space for sequestering CO_2 or temporarily storing energy in the form of natural gas, hydrogen, thermal waters, or compressed fluids. Prior work on characterizing amenable depleted reservoirs has focused on case studies and critical criteria. Nevertheless, there is no consensus definition for a depleted reservoir, though economic constraints, production levels, and pressure depletion have been suggested as cut-offs. This study identifies depleted reservoirs based by analyzing well level data, such as long-term gaps in production or wells with no associated entity (i.e., producing formation) for the United States (U.S). These domestic production records come from a commercial database licensed by the U.S. Geological Survey (USGS) Energy Resources Program. The database is queried (i.e., through Java programming) to match entity level or lease level production data with unique wells (i.e., by unique well identifier or UWI) and to find wells without any historical production data. When no associated production or a significant gap (e.g., five years) is found in the production record, a well is labeled as abandoned. Abandoned and active well locations are mapped along with State level petroleum field outlines. Fields or reservoirs for which all wells show abandonment are identified as depleted and may be available for energy storage or carbon sequestration. Our approach is flexible because the production gap query can be adjusted, though we found that for a gap of greater than five years, the fraction of wells labeled as abandoned did not drop additional percentage points. Furthermore, the percentage of abandoned vs. active wells can be adjusted based on additional production or economic forecast models. Though the application of these models is beyond the scope of this study, they may allow additional fields or reservoirs to be identified as abandoned. Our depleted reservoir identification method is powerful because the Java query is run consistently on a large national dataset. Initially it is applied to selected basins in the midwestern and western U.S. as part of this presentation. Additional interpretation by USGS assessment geologists for favorable reservoir properties (e.g., porosity and pressure) is warranted to confirm if a depleted field or reservoir is amenable for energy storage or carbon sequestration.