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OPTIMAL GEOTHERMAL HEAT EXTRACTION USING CO_2

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Carbon dioxide (CO_2) capture and storage (CCS) systems alleviate global climate change through the subsurface storage of CO_2 emission. This CCS technology can be costly, but CO_2 Capture, *Utilization*, and Storage (CCUS) approaches can decrease the cost of CCS, because sequestered CO_2 is used to produce an economically viable commodity. In one CCUS application, CO_2 that is sequestered in sedimentary basins during the CCS process can be used to extract geothermal heat that can then be used to generate a profit[1,2]. These CO_2-geothermal systems rely on the temperature of the reservoir—and thus the temperature of the heat extraction fluid that is produced to the surface—but these temperatures can decrease if the rate at which heat is extracted from the reservoir exceeds the rate at which the natural geothermal heat flux increases the temperature. Sustainability in this context is often synonymous with extracting heat at a rate that does not deplete the temperature in the reservoir[3,4]. This perspective of sustainability focuses on the physical/environmental performance of the geothermal reservoir, but keeping heat in the reservoir may not be economically sustainable. As such, environmental and economic performance are interconnected, and CCUS systems must consider both of these metrics of sustainability.

We present a natural resource economics model for the optimal management of a geothermal resource using CO_2 as a heat extraction fluid. Natural resource economic approaches have been extensively studied for managing fisheries and forests[5,6], but no such models exist for the management of geothermal resources. Our model determines the optimal time-varying mass flowrate to extract heat, given the profit that can be made and the natural rate at which the reservoir temperature renews. We used the Non-isothermal Unsaturated- saturated Flow and Transport (NUFT) code to simulate a sedimentary basin geothermal reservoir under a variety of geologic conditions, such as reservoir depth, reservoir thickness, temperature gradient, permeability, and mass flowrate. Results suggest that the time-varying mass flowrate is sensitive to economic parameters, such as discount rate. For example, the mass flowrate will be small when the discount rate is small so that heat remains in the reservoir into the future. In contrast, the mass flowrate will be large when the discount rate is large because heat left in the reservoir in the future has little value in present terms.

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