**Transport of Gas-phase Radionuclides in a Fractured, Low-permeability Reservoir**

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The U.S. Atomic Energy Commission (predecessor to the U.S. Department of Energy, DOE) oversaw a joint program between industry and government in the 1960s and 1970s to develop technology to enhance production from low-permeability gas reservoirs using nuclear stimulation rather than conventional means (e.g., hydraulic and/or acid fracturing). Project Rio Blanco, located in the Piceance Basin, Colorado, was the third experiment under the program. Three 30-kiloton nuclear explosives were placed in a 2,134-m-deep well at 1,780, 1,899, and 2,039 m below the land surface and detonated in May 1973. Although the reservoir was extensively fractured, complications such as radionuclide contamination of the gas prevented production and subsequent development of the technology. Two-dimensional numerical simulations were conducted to identify the main transport processes that have occurred and are currently occurring in relation to the detonations, and to estimate the extent of contamination in the reservoir. Minor modifications were made to TOUGH2, the multiphase, multicomponent reservoir simulator developed at Lawrence Berkeley National Laboratories. The simulator allows the explicit incorporation of fractures, as well as heat transport, phase change, and first-order radionuclide decay. For a fractured, two-phase (liquid and gas) reservoir, the largest velocities are of gases through the fractures. In the gas phase, tritium and one isotope of krypton are the principal radionuclides of concern. However, in addition to existing as a fast pathway, fractures also permit matrix diffusion as a retardation mechanism. Another retardation mechanism is radionuclide decay. Simulations show that incorporation of fractures can significantly alter transport rates, and that radionuclides in the gas phase can preferentially migrate upward due to the downward gravity drainage of liquid water in the pores.

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