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The International DECOVALEX Model Comparison Project - 25 Years of Coupled Processes Research

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This presentation provides an overview of an international research collaboration for advancing the understanding and modeling of coupled thermo-hydro-mechanical-chemical (THMC) processes in geological systems. The creation of the international DECOVALEX Project, now running for over 25 years, was initially motivated by the recognition that prediction of these coupled effects is an essential part of the performance and safety assessment of geologic disposal systems for radioactive waste and spent nuclear fuel. Later it was realized that these processes also play a critical role in other subsurface engineering activities, such as subsurface CO_2 storage, enhanced geothermal systems, and unconventional oil and gas production through hydraulic fracturing. Research teams from radioactive waste management organizations, national research institutes, regulatory agencies, universities, as well as industry and consulting groups have participated in the DECOVALEX Project, providing a wide range of perspectives and solutions to these complex problems. Analysis and comparative modeling of state-of-the-art field and laboratory experiments have been at the core of the collaborative work, with an increasing focus on characterizing uncertainty and blind prediction of experimental results. Over these 25 years, many of the major advances in this field of research have been made through DECOVALEX, as evidenced by three books, seven journal special issues, and a good number of seminal papers that have emerged from the DECOVALEX Project. Examples of specific research advances will be presented in this paper to illustrate the significant impact of DECOVALEX on the current state-of-the-art of understanding and modeling coupled THMC processes. These examples range from the modeling of large-scale in situ heater tests representing mock-ups of nuclear waste disposal tunnels, to studies of fluid flow and chemical-mechanical coupling in heterogeneous fractures, and the numerical analysis of controlled-injection meso-scale fault slip experiments.