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PREFACE: GEO-ENERGY AND GEO-RESOURCES: MODELING AND APPLICATION

Efficient usage of underground resources is becoming increasingly important, as it is linked with the principle of sustainable development. Underground geological formations contain significant amounts of oil, gas and heat and can also be used for storage of carbon dioxide, natural gas or radioactive waste. Development of technologies to utilize these underground resources and spaces requires appropriate understanding of geological and hydrological processes controlling injection, extraction or interaction with subsurface fluids (Mousavi Nezhad, 2010; Mousavi Nezhad et al., 2011, 2018, 2019; Mousavi Nezhad and Javadi, 2011).

This special issue is devoted to the new trends in geo-energy and geo-resources modeling and applications, the main subject of the FREFRAC workshop that was organized during the 3rd United Kingdom InterPore Conference held at the University of Warwick on September 4–5, 2017.

1. NUMERICAL MODELING AND SIMULATION

In the first paper, Praseeja and Sajikumar (2019) highlighted recent advances in numerical modeling of multiphase flow processes in unsaturated porous media. They attempted to analyze and track the evolution of the modeling methods over the last decades, mostly within the realm of hydraulic fracturing, revealing their transformation, motivation and recent trends. Pulse hydraulic fracturing (PHF) technology is a new technology for enhancing the efficiency of fracking; Vahab et al. (2019) developed a hydraulic fracture model based on X-FEM theory and simulated PHF in an infinite impermeable domain with different strengths. From their results, it was concluded that PHF can activate underground perforations. Formation of fracture networks in underground reservoirs depends on the behavior of fluid, and Hardcastle et al. (2019) investigated the effects of compressibility of injecting fluid on the efficiency of fracking methodology. They have developed a coupled computational model within the concept of continuum damage theory for simulation of hydraulic fracturing.

2. MEASUREMENT METHODOLOGY

Despite progress in modeling of hydraulic fracturing processes and underground reservoir behaviors, it is crucial to develop reliable measurement strategies for collecting data from the reservoirs in several space and time scales. Marshall et al. (2019) showed that inaccuracy in flow measurements causes failure in interpreting well testing data and estimation of the recoverable reserves. Sidig (2019) studied the significant importance of using data measured under reservoir conditions for investigation of the hydraulic characteristics of reservoirs, and concluded that the usage of data measured from non-reservoir conditions can lead to underestimation of the reservoirs' production by about 20%. Ozturk et al. (2019) proposed a new strategy for detecting fracture patterns in granular materials using high-speed imaging technology and digital image analyses. This technique allows detection of features of multiphase fracture patterns, including local granular compaction that induces stick-slip behavior and creates a compacted zone surrounding the fractures which can arrest other neighboring fractures.

3. SUBSURFACE RESERVOIRS AND ENVIRONMENTAL IMPACT

Subsurface contamination due to spillage of oil and gas from underground reservoirs is another immense challenge that needs to be investigated. Effective treatment methods are required to remediate such contaminated zones. Tasca et al. (2019) investigated capacities of specific sorbents for the treatment of wastewater generated from the oil and gas industrial sector. Artificial porous media were developed using stereolithographic 3D printing technology, and interactions between sorbents and organic chemical compounds during movement through the porous media at low

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temperatures and under ambient pressures were studied. In the next paper, Kumar et al. (2019) presented analytical solutions for modeling the flow of a viscous fluid over a super-linear stretching sheet embedded in a porous medium and studied the influence of controlling hydrodynamic parameters on the flow behavior. To protect the subsurface environment, preventing contamination movement is required. Within this context, Abidoye and Das (2019) studied the application of a silicone membrane-sensor system for monitoring of subsurface gases leaking from CO_2 reservoirs. The influence of geological conditions of the reservoirs in several depths on the performance of the silicone membrane-sensor system was also investigated. Rathnaweera et al. (2019) reviewed the influence of CO_2 injection on the chemical and mineralogical environment of underground rock reservoirs and investigated the hydro-mechanical interaction of rocks. Furthermore, Pourmalek and Shariatipour (2019) studied the effects of subsurface temperature and salinity gradients on CO_2 dissolution into the reservoirs and investigated the effects of distance traveled by the CO_2 on the total amount of its storage.

We would like to thank all the authors and reviewers who have contributed greatly to the success of this special issue. We hope that you enjoy reading the papers and will provide additional discussions for the benefit of advancing the fast growing geo-energy and geo-resources knowledge that will be crucial to serve the needs of future energy requirements worldwide. Lastly, we would like to acknowledge the financial support provided by Monash-Warwick Alliance Seed Fund that helped in organizing the PREFRAC Workshop.

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