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Editorial

Geofluids and Energy for the XXI Century

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1. Motivations and Background

This special issue entitled "Geofluids and Energy for the XXI Century" focuses on cutting edge research findings in the fields of geology, rock physics, petrophysics, geomechanics, and numerical modelling. In particular, specific problems regarding the management of underground resources are tackled in terms of their exploration, production, and environmental vulnerability and sustainability. The present volume contains contributions following the scientific session entitled "Georesources and Energy for the XXI Century" held in 2018 during the annual meeting of the Italian Geological Society, which included 30 oral and poster communications [1]. The main topic covered by the presentations dealt with the great uncertainty associated with the assessment of the effective properties of subsurface reservoirs of geofluids, in particular to the complex distribution of the inner heterogeneities due to depositional [2–4], diagenetic [5, 6], and/or tectonic processes [7–11]. Along these lines, the present volume includes scientific articles dealing with three main topics including conventional hydrocarbons, unconventional hydrocarbons and methane recovery from coal beds, and geothermal systems.

2. Contents of the Special Issue

This special issue received 19 manuscripts, 10 of which were accepted for publication.

Most of them were based on the numerical simulations and experimental work on selected rock types, whereas others dealt with the geological characterization of exhumed fault zones. The first topic of conventional hydrocarbons includes five contributions. M. Zambrano et al. presented a research article entitled "Analysis of Fracture Roughness Control on Permeability Using SfM and Fluid Flow Simulations: Implications for Carbonate Reservoir Characterization," wherein the authors tackled the control exerted by fracture roughness on the computed values of permeability. They presented a complete protocol for fracture surface mapping, roughness evaluation, fracture modelling, fluid flow simulation, and permeability estimation. This protocol included laboratory-based, high-resolution, structure-from-motion photogrammetry of selected fracture surfaces, power spectral density surface evaluation, synthetic fracture modelling, and fluid flow simulation using the Lattice-Boltzmann method. S. Kim et al. presented a research article entitled "History Matching of a Channelized Reservoir Using a Serial Denoising Autoencoder Integrated with ES-MDA." There, the authors report the results of analyses conducted by means of a serial denoising autoencoder composed of two neural network filters, which utilized the machine-learning algorithm for relieving noise effects in the process of ensemble smoother-multiple data assimilation (ES-MDA) improving the overall history-matching performance. H. She et al. presented a review article entitled "Recent Advance of Microbial Enhanced Oil Recovery (MEOR) in

China," in which the authors summarize the recent progress in laboratory studies and microbial flooding recovery field tests. Biotechnology was employed to investigate microbial flooding recovery mechanisms on a molecular level. Particular, attention was paid by the authors on both emulsification and wettability alternation due to microbial effects. Y. Lin et al. presented a research article entitled "Mechanical Properties and Statistical Damage Constitutive Model of Rock under a Coupled Chemical-Mechanical Condition." The authors focused on the chemical corrosion that might affect the mechanical properties of rocks by investigating selected sandstone samples subjected to coupled chemical-mechanical conditions. In particular, they discussed the results of conventional triaxial compressive tests performed on specimens under the effect of chemical corrosion to improve a pre-existing statistical damage constitutive model, which was established by using the Drucker-Prager strength criterion. H. Riegel et al. presented a research article entitled "Petrophysical Properties and Microstructural Analysis of Faulted Heterolithic Packages: A Case Study from Miocene Turbidite Successions, Italy." The authors focused on the results of field survey, optical microscopy, petrophysical analysis, and X-ray microtomography of hand specimens collected along fault zones cropping out in peninsular Italy. The studied fault zones crosscut turbidite deposits of Miocene age, which underwent similar tectonic evolutions and burial histories. Results of this multidisciplinary work highlighted the role exerted by the amount of clay and their distribution throughout the sedimentary successions on the cross-fault fluid flow properties of natural fault zones.

The second topic of unconventional hydrocarbons and methane production from coal beds includes three contributions. Y. Huang et al. presented a research article entitled "A Cause Analysis of the High-Content Nitrogen and Low-Content Hydrocarbon in Shale Gas: A Case Study of the Early Cambrian in Xiuwu Basin, Yangtze Region." The authors focused on the study of nitrogen concentration in shale gas of the Yangtze Region, China. By integrating gas component analysis, stable nitrogen isotope analysis, and permeability tests with core description, field surveys, and seismic interpretation, they showed that the nitrogen present in the lower Cambrian shale in Xiuwu Basin derived from the atmosphere and the deep crust-upper mantle. Due to bedding planes and deep faults, which formed pathways for shale gas migration and diffusion, the authors documented a mechanism that led to a significant exchange between shale gas and the atmosphere. Results were therefore discussed in light of well-known models of shale gas diffusion in complex tectonic areas. J. Xu et al. presented a research article entitled "Investigation of the Velocities of Coals of Diverse Rank under Water- or Gas-Saturated Conditions for Application in Coalbed Methane Recovery." The authors analyzed samples of lignite, bituminite, and anthracite prepared under both water and gas saturation conditions to investigate the residual water and gas in open cracks. For both water- and gas-saturated cores, the diverse velocity distributions were investigated Both longitudinal and transverse ultrasonic pulse velocities were considered to assess both dimension and geometry of opening-mode fractures and primary pores in coal samples. Y. Hong et al. presented a research article entitled "Variable Pore Structure and Gas Permeability of Coal Cores after Microwave Irradiation." The authors investigated the effect of microwave energy on pore structure and gas permeability of coal samples analyzing them by means of nuclear magnetic resonance. Results showed that the amount of water saturation significantly influenced the transverse relaxation time distribution only after a microwave energy treatment. In fact, the measured coal permeability increased after microwave energy irradiation, which was hence proposed as a tool to increase the degassing of coal seams.

The third topic of geothermal systems includes two contributions. P. Fulignati et al. presented a research article entitled "Structural and Mineralogical Characterization of a Fossil Hydrothermal System Located at the Outermost Front of the Southern Apennines Fold-and-Thrust Belt." The authors investigated the structural setting, mineral assemblage, and fluid inclusions of fossil hydrothermal systems cropping out along the outermost edge of the southern Apennines belt, Italy, specifically along the eastern flank of the inactive Vulture Volcano. There, the authors recognized three main stages of hydrothermal activity, which took place during the Middle Pleistocene-to-present day times. The first stage was due to the circulation of low pH ($pH \approx 3$-4) fluids with a relatively high SO4-activity, which determined the formation of alunite group minerals, jarosite in particular. These hydrothermal fluids were likely characterized by temperatures of ca. 200°-210°C. The second stage of hydrothermal circulation was recorded by opal A-rich veins, which precipitated from fluids characterized by lower temperature conditions with respect to the former ones. The third stage is currently taking place all along the study area flanking the Vulture Volcano, with goethite mineralization from groundwater-derived fluids at near surface temperatures. J. Vidal et al. presented a research article entitled "How Can Temperature Logs Help Identify Permeable Fractures and Define a Conceptual Model of Fluid Circulation? An Example from Deep Geothermal Wells in the Upper Rhine Graben." The authors focused on permeable fault zones crosscutting a granitic basement penetrated by deep geothermal wells. By considering the temperature log datasets acquired from these wells during production and at equilibrium, along with the associated flow logs, they were able to investigate the fluid circulation at borehole scales. Geothermal fluids localize within the fault-related open fractures. At thermal equilibrium, the water temperature was estimated with respect to the temperature of the surrounding host rock. Accordingly, the peaks of high temperature were associated with the dilated fault zones and hence used to estimate reliable models of geothermal fluid flow in the study area of the Upper Rhine Graben.

Conflicts of Interest

The editors declare that they have no conflicts of interest regarding the publication of this special issue.

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