Received: 28 March 2024 | Accepted: 1 April 2024
DOI: 10.1111/1365-2478.13521
Geophysical Prospecting EAGE European Association of Geoscientists & Engineers
Special Issue Article

Introduction to special section on the rock physics contribution to the energy transition challenge

Ismael Himar Falcon-Suarez[1] | **Ludmila Adam**[2,3] | **Hector Marin-Moreno**[4] | **Giorgos Papageorgiou**[5] | **Lucas Pimienta**[6]

[1]Ocean Biogeoscience Research Group, National Oceanography Centre, European Way, Southampton, UK
[2]Dodd-Walls Centre for Photonic and Quantum Technologies, Auckland, New Zealand
[3]Physics of Rocks Laboratory, School of Environment, University of Auckland, Auckland, New Zealand
[4]School of Ocean and Earth Science, University of Southampton, Southampton, UK
[5]School of Geosciences, Edinburgh University, Grant Institute, Edinburgh, UK
[6]Laboratory of Experimental Rock Mechanics, Ecole Polytechnique Fédérale de Lausanne, Lausanne, Switzerland

KEYWORDS
Rock physics, Petrophysics, Reservoir geophysics, Theory, Energy transition

Rock physics connects with geophysics, petrophysics and geomechanics to adequately characterize geological reservoirs, optimize monitoring operations in the field, interpret in situ and laboratory test data, and develop accurate predictive models for extraction/injection activities. The application of rock physics is crucial to achieving net-zero carbon emissions worldwide, as we need to combine large-scale mitigation technologies like carbon capture usage and storage, together with an increasing use of renewables such as geothermal and underground hydrogen storage (UHS).

In this special section, we introduce the role of rock physics on the energy transition challenge. The papers presented herein are representative of the topics discussed during 6th International Workshop in Rock Physics (6iWRP) that took place in A Coruna, Spain, between 13 and 17 of June 2021 (Delgado-Martín et al., 2022). This biannual event gathers rock physicists from all over the world to discuss, beyond the state of the science, experimental and theoretical rock physics topics covering spatial scales from grain to sample to basin scale. The 6iWRP focused on energy transition and climate change mitigation topics, such as CO_2 storage in geological formations, H_2-based energy storage in porous rocks and geothermal energy. Other topics covered in the conference included homogeneous/heterogeneous materials with different degrees of anisotropy and fracturing and their influence in fluid flow in fractured porous media, the coupled phenomena associated with rock-fluid interaction under reservoir conditions, data analysis and interpretation using combined rock physics models and machine learning models.

This special section was proposed to encourage submissions of papers from pure, fundamental research to more applied demonstrations and integrated case studies around the topics covered during the 6iWRP. This call resulted in five papers accepted from 12 submitted manuscripts. The research presented in these papers demonstrates the potential of rock physics to contribute to meeting net-zero goals timely. We would like to express our gratitude to all the contributors and reviewers for their substantial efforts and significant contributions to this special section. Find below a brief summary of the published contents.

Deheuvels, Faucher and Brito proposed a novel approach to determining the frequency-dependent attenuation of low-attenuation materials, with application to inversion analysis in viscoelastic media. They apply a Gaussian filter to infer frequency-dependent attenuation from a multiple wave reflection source, using relative amplitude decay in the seismogram. They tested the method experimentally in aluminium and dry Fontainebleau sandstone at ultrasonic frequencies.

Falcon-Suarez, Dale and Marin-Moreno presented dual experimental research on the physical and transport properties of salt rocks in the context of artificial salt caverns for UHS. The study includes a characterization of the stress dependency of the elastic properties and permeability of several rock samples, together with two controlled dissolution tests being monitored with ultrasonic waves and electrical resistivity. They show promising results towards the potential of using geophysical methods to site selection and monitoring of the caverning process and gas storage operations.

Gupta, Periyasamy, Hofmann, Prakash and Yalavarthy presented a novel two-step denoising pipeline for micro computed tomography scans of rock samples that combines adaptive morphological filtering with non-local means smoothing. The new method improves denoising performance with respect to traditional filtering methods, which in turn enhance the estimate of porosity and permeability from image analysis. This approach might provide more accurate inputs for modelling multiphase fluid flow in porous media and so potentially enhance estimates of storage capacity and injectivity of underground storage reservoirs.

Wu, Guo, Ji, Huang and Ding quantified the anisotropy of the vertical transverse isotropy coal seam, inverting the horizontal primary (P) and secondary (SH) wave velocities using a theoretical estimation of the fracture density while keeping vertical P- and SH-waves as constrained parameters. Their approach combines the Mori–Tanaka model and the Brown–Korringa formula and provides promising results to improve the characterization of subsurface coal seam structures from full waveform logging data.

Yang, Stovas, Y. Wang, Y. Wang and Z. Wang proposed a modification of the method to infer the seismic normal incidence reflect coefficient. The proposed formula offers a clearer relationship between moduli and density, and it is verified through modelling that it accounts for the differential effect of water and CO_2 in the interlayer between seal-like (mudstone) and reservoir (sandstone) formations. These results might contribute to improving the detection of gas/fluid interfaces during CCS or UHS operations.

DATA AVAILABILITY STATEMENT

There are no data reported.

ORCID

Ismael Himar Falcon-Suarez https://orcid.org/0000-0001-8576-5165
Hector Marin-Moreno https://orcid.org/0000-0002-3412-1359
Giorgos Papageorgiou https://orcid.org/0000-0001-7995-8825
Lucas Pimienta https://orcid.org/0000-0003-2047-4812

REFERENCE

Delgado Martín, J., Muñoz-Ibáñez, A. & Falcón-Suárez, I.H. (2022) 6th International workshop on rock physics: a Coruña, Spain 13 -17 June 2022: book of abstracts. In: Martín, J.D., Muñoz-Ibáñez, A., Falcón-Suárez, I.H. (Eds.) *A Coruña: Universidade da Coruña*, vol. 2022. Servizo de Publicacións, A Coruña p. 134. Available from: https://doi.org/10.17979/spudc.000005

How to cite this article: Falcon-Suarez, I.H., Adam, L., Marin-Moreno, H., Papageorgiou, G. & Pimienta, L. (2024) Introduction to special section on the rock physics contribution to the energy transition challenge. *Geophysical Prospecting*, 1–2. https://doi.org/10.1111/1365-2478.13521