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Development of a site-screening method for hydrogen storage purposes and its application to an industrial dataset of Italian reservoirs

Riccardo Maria Ridolfi[1], Salvatore Azzaro[2], Stan E. Beaubien[1], Andrea Da Pra[2], Marco Pontiggia[2], and Sabina Bigi[1]

[1]University of Rome La Sapienza, Department of Earth Sciences, Rome, Italy
[2]Eni S.p.A., San Donato Milanese, Italy

The use of hydrogen as an energy carrier will require effective storage solutions, and depleted hydrocarbon reservoirs offer a safer and cheaper large-scale option compared to other possibilities. The selection of a site for underground hydrogen storage (UHS) entails considerable responsibilities and expenses, and specific tools should be employed to facilitate and optimize the decision process. Thus, a site-screening method was developed to rank depleted and almost depleted hydrocarbon reservoirs for UHS, with subsequent testing on a confidential dataset of 48 production sites from Italy provided by Eni. A set of 27 screening parameters was selected from a wider dataset and a weight for each one was defined by reproducing the Analytic Hierarchy Process (AHP) in Microsoft Excel and gathering expert judgements from both academic and industry following the Delphi technique. This was performed from the points of view of HSE (health, safety, and environment), geotechnical performance (GP) and economic performance (EP), dividing the individual parameters among these three supergroups and normalizing the diverse kinds of dataset records to be used in the calculation procedure. The method resulted in three preliminary rankings based on the sites' HSE, GP and EP scores and a comprehensive ranking obtained through the aggregation of these three scores for each site, with penalties applied if specific, adverse features exist for UHS purposes. For sites with incomplete data, an estimation of the potential score was derived based on average values calculated from the dataset and attached as additional information to the screening scores without affecting the ranking. The AHP results highlighted a major role for Faulting Description, Mineralization Type, Onshore/Offshore, Wells Number, Reservoir Architecture, Datum Depth and Initial Pressure at Datum, even though other factors made significant contributions. The result consists of a set of scores ranging from 29 to 72 out of 100. To assess the reliability of the method, two blind tests were conducted on a minor proprietary dataset containing well-known sites from North Africa, the first involving a subset of the sites and the second using all sites. The results yielded a good match with the existing ranking performed by Eni. The developed method can be adjusted for a variety of decision-making scenarios, to accommodate changes in the screening purposes or advancements in research. In this configuration, it consists of a highly effective tool for an objective and transparent screening of sites for UHS purposes.