EINPRESSWIRE

Unlocking subsurface geoenergy and storage potential using machine learning

FAYETTEVILLE, GA, UNITED STATES, March 20, 2026 /EINPresswire.com/ -- Using machine learning regression models, we predict porosity (measure of potential storage volume) and permeability (measure of fluid flow property in porous media) based on petrographic thin section analysis. Histogram-based Gradient Boosting algorithms successfully predict porosity (RMSE=2.23%) and permeability (RMSE=0.64 (orders of magnitude)) based on textural mineralogical properties recorded in petrographic samples. This may in the future allow to reduce the amount of resource- and

Based on the microscopic assessment of rock microstructures from four reservoir lithologies with different compositions and their associated measured porosity and permeability , a machine learning model was trained to predict porosity and permeability.

time-intensive retrieval of core material in certain use cases, as the same methods can be applied to cuttings, produced as a by-product of any drilling operation worldwide.
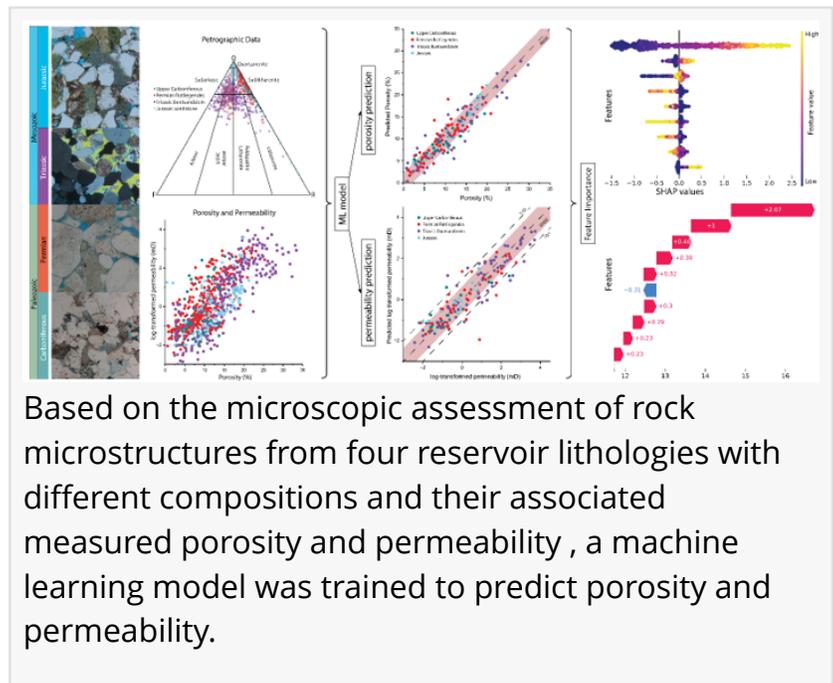
Geologists at the Institute of Applied Geosciences at KIT, Germany, presented a novel machine learning regression approach to derive the porosity and permeability, based on the microscopic assessment of 30 μm thin rock slices. Their findings are reported in Artificial Intelligence in Geosciences.

"Porosity quantifies the volume available for fluids and gases in rocks, whereas permeability characterizes the potential of a porous rock to transmit these fluids," explains lead and corresponding author Benjamin Busch. "Both properties are relevant for geoenergy production (e.g., geothermal, hydrocarbons) and storage scenarios (hydrogen, natural gas or CO_2)."

As the distribution, contents, and textures of minerals recorded in these thin sections can classically be related to the physical rock properties, machine learning regression, capturing non-linear and multivariate relationships, was selected by the researchers as the central method to test if this hypothesis works

"Applied to a dataset containing data from 51 wells, covering four major reservoir lithologies in central Europe, collected over 25 years, prepared by at least 21 petrographers, the models show a strong predictive performance with R^2=0.87 (porosity model) and R^2=0.82 (permeability model)," shares Busch. "Given the large dynamic range of data and variable, even non-unified, data acquisition, the associated errors (RMSE=2.23% (porosity) and RMSE=0.64 (permeability, orders of magnitude)) are very acceptable for reservoir characterization."

As different subsurface use cases have different economic margins to operate, cost-limiting factors are explored wherever they can. "Therefore, the cost- and time-intensive retrieval of core material from the subsurface is often reduced, limiting the access to undisturbed rock material for detailed laboratory analyses to confirm the storage and production potential (reservoir quality)," says Busch.

As differences in cement contents can clog available pore spaces and the shape of minerals grown in the pores affect reservoir quality, their microscopic analysis has classically been paramount in understanding the distribution of high reservoir quality intervals. "Ultimately, understanding the distribution of cements and compaction structures, in a framework of the development of pressures, temperatures, and chemical conditions over millions of years, should lead to an improved prediction framework for unknown areas," adds Busch.

In the future, the presented approach may be extended to include the microscopic assessment of cutting fragments. These are mm-sized fragments of rock material produced as a by-product at every drill-site worldwide. Assessing the type and texture of individual minerals and assessing the optically visible porosity, may still enable prediction of key reservoir properties based on these materials, and may reduce costs in future drilling operations.

References
DOI
10.1016/j.aiig.2026.100202

Original Source URL
https://doi.org/10.1016/j.aiig.2026.100202

Lucy Wang
BioDesign Research
email us here

This press release can be viewed online at: https://www.einpresswire.com/article/900613063