ICCES, 2025, vol.33, no.3

Tech Science Press

DOI: 10.32604/icces.2025.011889

PROCEEDINGS

A Deep-Learning Based Model with Intra- and Inter-Well Constraints for Intelligent Identification of Stratigraphic Layers

Jinghua Yang[1] and Bin Gong[1, 2, *]

[1]China University of Geosciences, Wuhan, 430074, China

[2]Tracy Energy Technologies, Hangzhou, 310000, China

[*]Corresponding Author: Bin Gong. Email: yangjinghuaswpu@sina.com

ABSTRACT

Geological stratification interpretation divides geological strata based on acquired well-logging data, providing comparative analysis results for strata and structures. This process serves as a fundamental framework for subsequent drilling and development design plans, making it a crucial step in oil exploration and development process. Traditional geological stratification interpretation methods are based primarily on geological, logging, and experimental data, with manual determination of strata boundaries to obtain interpretation results. However, manual interpretation is characterized by strong subjectivity and reliance on experience, which may compromise the quality and consistency of the results. To eliminate the dependency on manual expertise and ensure the accuracy of geological stratification, this study proposes a refined geological stratification algorithm based on the Multilayer Perceptron (MLP) algorithm. The effectiveness of this algorithm is tested and analyzed based on the coalbed methane blocks in the Ordos Basin. The method first employs Principal Component Analysis to analyze the well-logging parameters, reducing the computational overhead caused by irrelevant parameters while ensuring that the main influencing factors are preserved. This analysis selected well location, depth, and depth-related parameters such as drilling time, gamma ray logs, and lithological logs as input features for the model. Subsequently, based on the MLP framework, the loss function incorporates both inter-well and intra-well constraints to train the geological stratification prediction model. Furthermore, this study segmented the gas well positions using distance metrics, dividing the data set into several distinct regions to separately evaluate the model's interpolation prediction ability and its extrapolation generalization capability. The results show that the proposed model achieves a prediction accuracy of 95.04% within regions of stratigraphy that resemble the distribution seen in the training data. As the distance between the prediction well and the nearest point in the training dataset increases, the prediction accuracy gradually decreases. When the distance reaches approximately 1500–2000 meters from the nearest training data point, the model still maintains an accuracy of 85.36% for the block. Therefore, the model proposed in this paper not only provides reliable predictions for subsequent infill wells in the block but also serves as a useful tool assisting the development of new wells away from original block.

KEYWORDS

Well-logging interpretation; geological stratification; multilayer perceptron; inter-well constraints; intra-well constraints; generalization capability

Acknowledgement: We would like to express our gratitude to the National Key R&D Program (Geological Resource Intelligent Prediction and Exploration Development Geological Risk Assessment Theory Models and Methods, Project No. 2022YFF0801202) for providing significant research funding and technical support, and we would also like to thank Tracy Energy Technologies for providing computing and data resources for this study.

Copyright © 2025 The Author(s). Published by Tech Science Press.
This work is licensed under a Creative Commons Attribution 4.0 International License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Funding Statement: The author(s) received no specific funding for this study.

Conflicts of Interest: The author(s) declare(s) no conflicts of interest to report regarding the present study.