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Editorial: Quantitative characterization and engineering application of pores and fractures of different scales in unconventional reservoirs

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Editorial on the Research Topic
Quantitative characterization and engineering application of pores and fractures of different scales in unconventional reservoirs

In recent years, with the depletion of conventional oil and gas resources (typically represented by tight sandstone, shale, carbonate, volcanic rock, coal, gas hydrate and so on), unconventional oil and gas exploration and development has become a new hot field (Yin et al., 2019a; Yin et al., 2019b; Yin and Ding., 2019; Yin and Gao., 2019; Li et al., 2022a; Li et al., 2022b; Li et al., 2022c; Fan et al., 2022). Unconventional oil and gas reservoirs have low porosity, low permeability, strong heterogeneity, and complex diagenesis. Therefore, the quantitative characterization of pores and fractures at different scales has become the focus and challenge of high-efficiency reservoir discovery. Pores and fractures of different sizes not only affect the storage and migration capacities of unconventional oil and gas reservoirs, but also have an important impact on safe drilling and oil and gas development programs (Li et al., 2019; Yin et al., 2020a; Yin et al., 2020b; Li et al., 2020; Yin and Wu, 2020; Li et al., 2021; Li, 2022a). The set of 23 studies in this Research Topic aimed to bring together quantitative characterization and engineering application of pores and fractures of different scales in unconventional reservoirs, with the general goal of understanding multi method quantitative characterization of the tight reservoir pore and fracture systems, as well as providing a general framework for future research efforts.

The development of fine and quantitative characterization of pore structures is an effective measure to achieve efficient development of tight reservoirs (Liu et al., 2020; Xu and Gao, 2020; Xu et al., 2020). This topic covers a large number of recent advances in the study of pores and fractures at different scales. For example, He et al. systematically studied the relationship between pyrite and nano-pores in marine shale of the Longmaxi Formation; Li et al. (2022d) analyzed the effect of water saturation on the pore structures of middle and large pores in limestone reservoirs through experiments; Lv et al. systematically studied the effects of high-temperature, overpressure, and CO_2-Charging conditions on the pore structures of sandstone; Jiao et al. studied the influencing factors and evolution law of pore development in coal measure reservoirs; Chen et al. carried out fine logging evaluation of core-scale fractures in tight oil sandstones of the Yanchang Formation, Ordos Basin; Li analyzed the coupling characteristics of fractures and faults in strike-slip fault zones. Quantitative characterization of pores and fractures at different scales can provide a basis for the prediction of sweet spots in tight reservoirs.

The combination of macro and micro research methods is an important means to realize the continuous development of pore and fracture coupling research at different scales in unconventional oil and gas reservoirs. This topic reports a large number of related studies, for example, Cheng et al. analyzed the development characteristics of different fluid components and physical properties of carbonate gas genesis; Cai et al. analyzed the coupling relationship between rock mechanical parameters and *in-situ* stress in tight sandstone. *In-situ* stress and rock mechanics parameters are the external constraints for rock deformation and rupture; He et al. systematically studied the lithofacies and microscopic pore structure characteristics of deep shales; the fault is the largest scale fracture form and Lv et al. studied the plane heterogeneity of strike-slip faults and its influence mechanism on reservoir physical properties; Tang et al. elucidated the heterogeneity of microscopic pore structures of tight sandstones using a variety of experimental methods; Wang et al. analyzed the fracture development characteristics and influencing factors of buried hill reservoirs; Xu et al. optimized the lithofacies types of continental shales; Zhang et al. analyzed the development characteristics of pores and fractures in fracture—cavity desorption in the buried hill.

The numerical simulation and engineering evaluation of pores and fractures at different scales have also made some important progress in recent years. For example, Liao et al. reported an optimized fracturing and well trajectory design model for tight oil sandstones; Luo et al. proposed a stress sensitivity evaluation model considering the starting pressure gradient; Qian et al. carried out the full inversion of complex structures concealed around a horizontal hydraulic fracturing well using perforation seismic data; Sun et al. constructed a new evaluation system of volcanic rock reservoirs based on the constraints of Energy Storage Coefficient. Yang et al. carried out numerical simulation research on the contact optimization of hydraulic and natural fractures; Yin et al. constructed the 3-D model of carbonate reef and shoal facies based on UAV oblique photogrammetry data.

We appreciate the opportunity to present this Research Topic, and hope that readers will benefit from the breadth and scope of research. This Research Topic has introduced the latest developments in the quantitative characterization and engineering application of pores and fractures of different scales in unconventional reservoirs. It is a hot Research Topic in unconventional oil and gas exploration, which has been supported by many researchers. Therefore, we applied for the Volume II of this Research Topic. We invite researchers to contribute to the new work (Volume II), which will be extended to explore as many aspects as possible in the evaluation of pores and fractures of different scales.

Author contributions

HL, SY, and WD, edited the research topic of Quantitative Characterization and Engineering Application of Pores and Fractures of Different Scales in Unconventional Reservoirs. HL and SY wrote and revised the manuscript.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

References

Fan, C. H., Xie, H. B., Li, H., Zhao, S. X., Shi, X. C., Liu, J. F., et al. (2022). Complicated fault characterization and its influence on shale gas preservation in the southern margin of the sichuan basin, China. *Lithosphere* 2022, 8035106. doi:10.2113/2022/8035106

Li, H., Tang, H. M., Qin, Q. R., Zhou, J. L., Qin, Z. J., Fan, C. H., et al. (2019). Characteristics, formation periods and genetic mechanisms of tectonic fractures in the tight gas sandstones reservoir: A case study of xujiahe formation in YB area, sichuan basin, China. *J. Pet. Sci. Eng.* 178, 723–735. doi:10.1016/j.petrol.2019.04.007

Li, H., Qin, Q. R., Zhang, B. J., Ge, X. Y., Hu, X., Fan, C. H., et al. (2020). Tectonic fracture formation and distribution in ultradeep marine carbonate gas reservoirs: A case study of the maokou formation in the jiulongshan gas field, sichuan basin, southwest China. *Energy fuels* 34 (11), 14132–14146. doi:10.1021/acs.energyfuels.0c03327

Li, H., Wang, Q., Qin, Q. R., and Ge, X. Y. (2021). Characteristics of natural fractures in an ultradeep marine carbonate gas reservoir and their impact on the reservoir: A case study of the maokou formation of the JLS structure in the sichuan basin, China. *Energy fuels* 35 (16), 13098–13108. doi:10.1021/acs.energyfuels.1c01581

Li, J., Li, H., Yang, C., Wu, Y. J., Gao, Z., and Jiang, S. L. (2022a). Geological characteristics and controlling factors of deep shale gas enrichment of the wufeng-Longmaxi Formation in the southern sichuan basin, China. *Lithosphere* 2022, 4737801. doi:10.2113/2022/4737801

Li, H., Zhou, J. L., Mou, X. Y., Guo, H. X., Wang, X. X., An, H. Y., et al. (2022b). Pore structure and fractal characteristics of the marine shale of the Longmaxi Formation in the changning area, southern sichuan basin, China. *Front. Earth Sci.* 10, 1018274. doi:10.3389/feart.2022.1018274

Li, J., Li, H., Xu, J. L., Wu, Y. J., and Gao, Z. (2022c). Effects of fracture formation stage on shale gas preservation conditions and enrichment in complex structural areas in the southern Sichuan Basin, China. *Front. Earth Sci. (Lausanne).* 9, 823855. doi:10.3389/feart.2022.921988

Li, H., Wang, J., Wang, X., Liang, W., Xu, G., and Kang, Y. (2022d). Influence of water saturation time on microstructure and mechanical properties of jointed limestone. *Front. Earth Sci.* 10, 922683. doi:10.3389/feart.2022.922683

Li, H. (2022a). Research progress on evaluation methods and factors influencing shale brittleness: a review. *Energy Rep.* 8, 4344–4358. doi:10.1016/j.egyr.2022.03.120

Liu, Y., Xian, C., Li, Z., Wang, J., and Ren, F. (2020). A new classification system of lithic-rich tight sandstone and its application to diagnosis high-quality reservoirsfication system of lithic-rich tight sandstone and its application to diagnosis high-quality reservoirs. *Adv. Geo-Energy Res.* 4 (3), 286–295. doi:10.46690/ager.2020.03.06

Xu, N. Z., and Gao, C. (2020). Study on the Special Rules of Surface Subsidence Affected by normal Faults. *J. Min Strata Control. Eng.* 2 (1), 011007. doi:10.13532/j.jmsce.cn10-1638/td.2020.01.011

Xu, G., Yin, H., Yuan, H., and Xing, C. (2020). Decline curve analysis for multiple-fractured horizontal wells in tight oil reservoirs. *Adv. Geo-Energy Res.* 4 (3), 296–304. doi:10.46690/ager.2020.03.07

Yin, S., and Ding, W. (2019). Evaluation indexes of coalbed methane accumulation in the strong deformed strike-slip fault zone considering tectonics and fractures: A 3D geomechanical simulation study. *Geol. Mag.* 156 (6), 1052–1068. doi:10.1017/s0016756818000456

Yin, S., and Gao, Z. (2019). Numerical study on the prediction of "sweet spots" in a low efficiency-tight gas sandstone reservoir based on a 3D strain energy model. *IEEE Access* 7, 117391–117402. doi:10.1109/access.2019.2933450

Yin, S., and Wu, Z. (2020). Geomechanical simulation of low-order fracture of tight sandstone. *Mar. Petroleum Geol.* 100, 104359. doi:10.1016/j.marpetgeo.2020.104359

Yin, S., Xie, R., Wu, Z., Liu, J., and Ding, W. (2019a). *In situ* stress heterogeneity in a highly developed strike-slip fault zone and its effect on the distribution of tight gases: A 3D finite element simulation study. *Mar. Petroleum Geol.* 99 (1), 75–91. doi:10.1016/j.marpetgeo.2018.10.007

Yin, S., Han, C., Wu, Z., and Li, Q. (2019b). Developmental characteristics, influencing factors and prediction of fractures for a tight gas sandstone in a gentle structural area of the Ordos Basin, China. *J. Nat. Gas Sci. Eng.* 72 (12), 103032–103114. doi:10.1016/j.jngse.2019.103032

Yin, S., Tian, T., Wu, Z., and Li, Q. (2020a). Developmental characteristics and distribution law of fractures in a tight sandstone reservoir in a low-amplitude tectonic zone, eastern Ordos Basin, China. *Geol. J.* 55, 1546–1562. doi:10.1002/gj.3521

Yin, S., Dong, Li., Yang, Xia., and Wang, R. (2020b). Experimental investigation of the petrophysical properties, minerals, elements and pore structures in tight sandstones. *J. Nat. Gas Sci. Eng.* 76 (1), 103189–103214. doi:10.1016/j.jngse.2020.103189