

## Geochemical characteristics of the Permian mudstone in the Songliao Basin, Northeastern China

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The Jurassic and Cretaceous are principal source beds for oil accumulations in the Daqing Oilfield, Songliao Basin (NE China). Current discoveries indicate that Permian mudstone may be also potential source rock for deep-buried Carboniferous-Permian petroleum system. This study aims to carry out comprehensive research on the geochemical characteristics of the Permian mudstone.

The rock samples are characterized by relatively higher TOC content of 0.43%-2.79%, lower (S<sub>1</sub>+S<sub>2</sub>) of 0.01-0.55 mg/g and EOM (extractable organic matter) of 0.0012%-0.0166%. Due to the high to over maturity of the most samples with *R*<sub>o</sub> of 1.81%-5.60%, the potential hydrocarbon generation is low with HI of 1-50 mg/g and most *T*<sub>max</sub> values are unreliable with a range of 354-435 °C, causing the difficulty of distinguishing kerogen type by HI-*T*<sub>max</sub> diagram.

Most of the samples show characteristic of the predominance of C<sub>29</sub> regular steranes over C<sub>27</sub> and C<sub>28</sub>, the bimodal distribution patterns of *n*-alkanes, relatively higher values of C<sub>24</sub>TeT/(C<sub>24</sub>TeT+C<sub>26</sub>TT) and extended tricyclic terpane ratio with high abundance of triaromatic dinosteroids, suggesting a mixed input of terrigenous higher plants with the presence of aquatic organic matter. The Permian mudstone is featured by relatively lower pristane/phytane ratios, higher gammacerane indices and high abundance of dibenzothiophenes relative to dibenzofurans, indicating an anoxic brackish lacustrine depositional environment.

The C<sub>29</sub> sterane maturity parameters 20S/(20S+20R) and ββ/(αα+ββ) show a reverse trend, and C<sub>31</sub> homohopane 22S/(22S+22R) ratio has reached equilibrium, which may result from the high to over maturity of organic matter. The Ts/(Ts+Tm) ratio remains basically constant with the increase of *R*<sub>o</sub>, reflecting it is not controlled by maturity. *R*<sub>o</sub> of the samples have a good negative linear correlation with MPI-1 and no obvious correlation with MNR and TNR-1 at higher maturity (*R*<sub>o</sub>: 2.23%~5.60%), suggesting MPI-1 may be a potential molecular maturity parameter within high to over mature stage.