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Oil-source Rocks Correlation of Biodegradation Oil in Wen'an Slope, Baxian Depression, Bohai Bay Basin, China

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Introduction

Bohai Bay Basin is one of the most petroliferous basin in China. However, shallow reservoirs in this basin suffer from varying degrees of biodegradation. Biodegradation has major impact on economics and makes oil-source correlation harder. Wen'an slope, Baxian depression develope in ideal circumstance for biodegradation, where temperature is less than 80℃ corresponding depth <2000m, genetic relationships among the biodegradation oils and their source rocks have remained speculative. From an operation point of view the most significant affect of biodegradation is the removal of the less structurally complex molecules first and then removal of the more complex molecules in a fairly well defined sequence. This sequence has been summarized in various publications. The most commonly used table is that by Peters and Moldowan, 1992.

Samples and Methods

25 crude oil samples in Wenan slope were collected and analyzed quantitatively using gas chromatography (GC) and gas chromatography-mass spectrometry (GC-MS). Geochemical data of source rocks and other necessary data for oil-source correlation were collected too.

Results

GC and GC-MS analysis were carried out on 25 oil samples. The abundance of n-alkanes, isoprenoids, terpenoids, steranes and porphyrins were tested quantitatively.

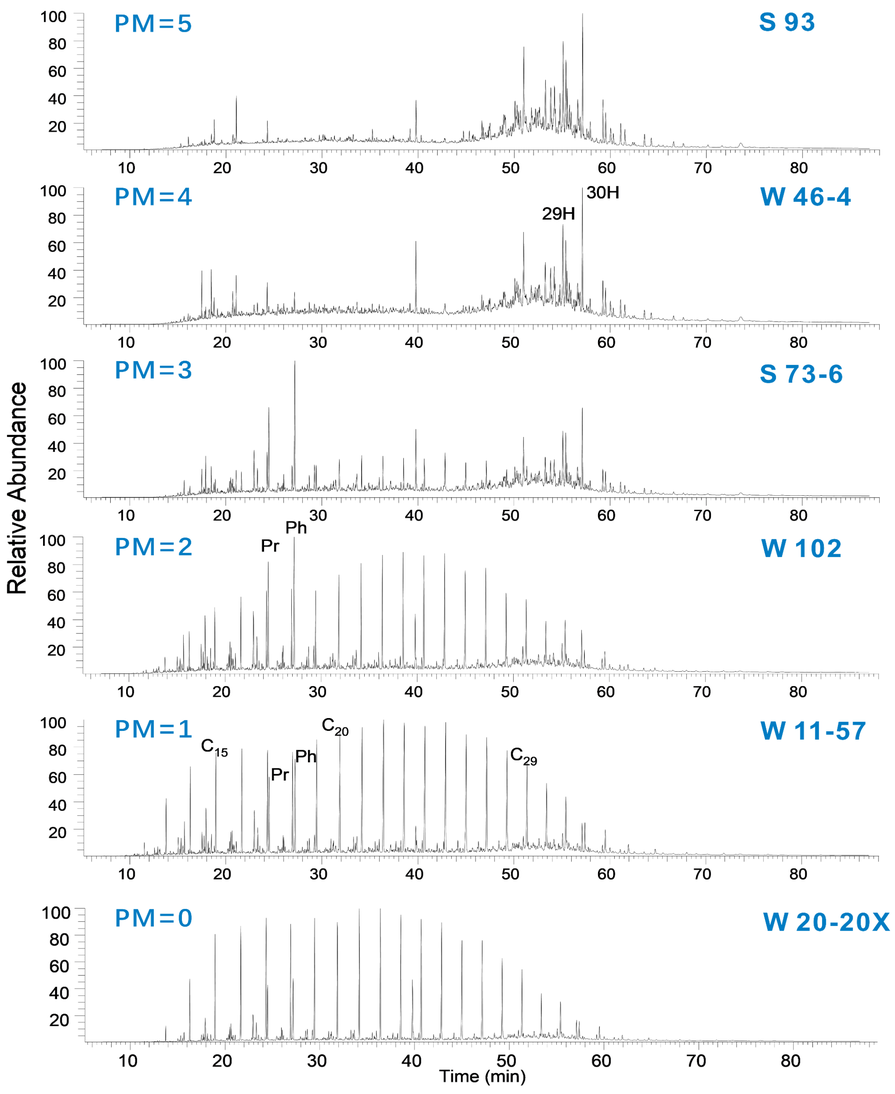


Figure 1. *Total ion chromatogram(TIC) of oil samples with PM biodegradation scale range from 0-5*

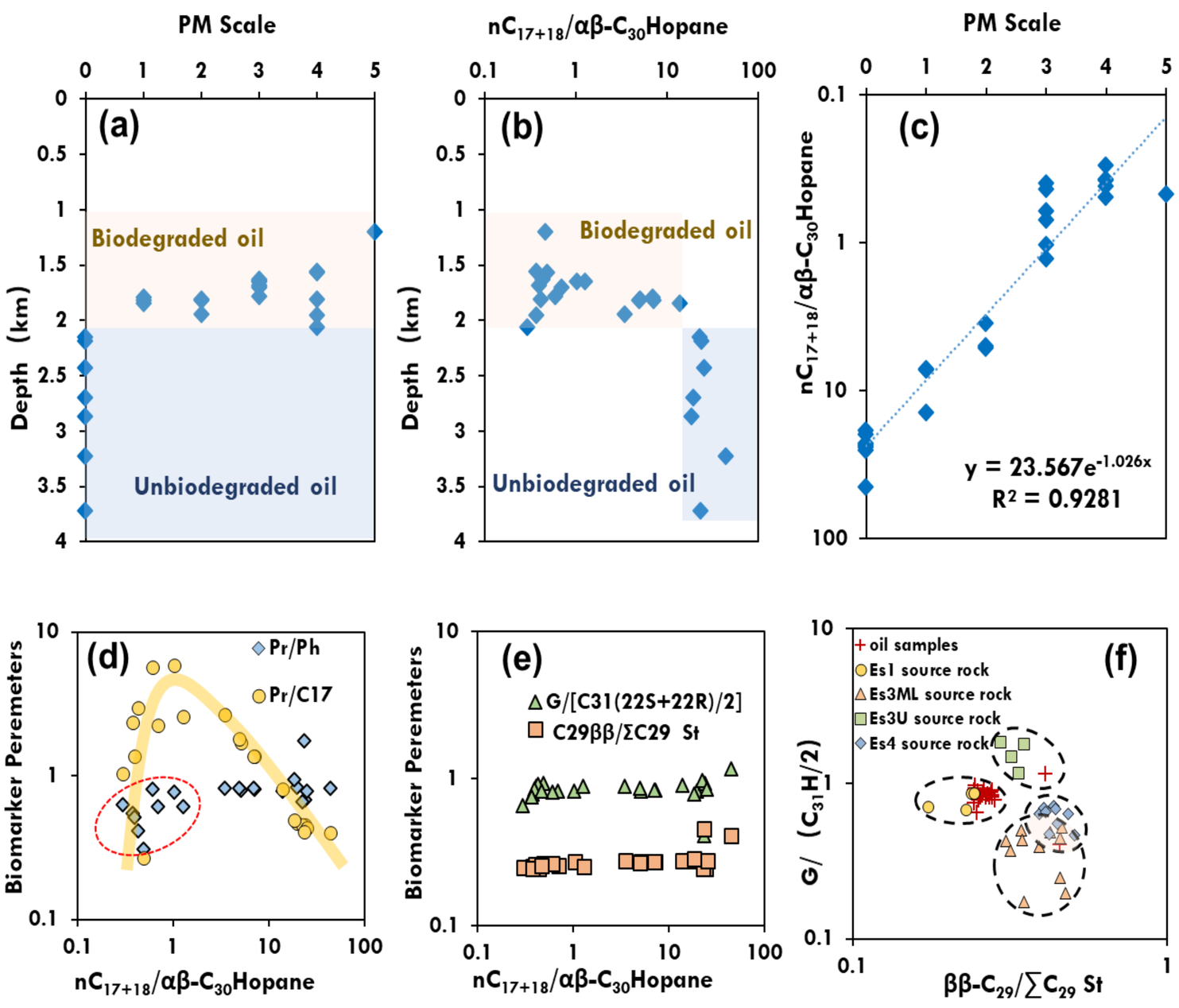


Figure 2. *(a) Oil samples above 2000m show biodegradation ranks of 1 to 5 in PM scale. (b) Biodegradation consume more C_{17} and C_{18} n-alkanes than C_{30} Hopane, leads to reduce of the biodegradation parameter. (c) $nC_{17+18}/\alpha\beta$-C_{30}Hopane shows good negative correlation with PM scale. (d) Pr/Ph and Pr/nC_{17} change along biodegradation extent. (e) Gammacerane/(C_{31}hopane/2) and $\beta\beta$-$C_{29}/\sum C_{29}$Sterane do not change along biodegradation extent. (f) Anti-biodegradation biomarker parameters separate crude oil samples into three families on Scatter plot.*

Discussion

PM biodegradation scale (Peters and Moldowan, 1992) used to research the extent of oil biodegradation (Figure1). Eighteen of twenty-five oil samples in Wen'an slope show light-moderate biodegradation ranks (Figure2, a). As PM scale is not sequential, a sequential biodegradation parameter, $nC_{17+18}/\alpha\beta$-C_{30} Hopane, is proposed newly to help to select anti-biodegradation biomarker parameters. This new parameter gets lower when biodegradation extent changes from light to severe (Figure2, b) and shows good negative correlation with PM scale (Figure2, c). It is worth noting that, this new parameter may lose efficacy when C_{17} and C_{18} n-alkanes consume away in heavy- severe biodegradations. Biodegradation susceptible biomarker parameters such as Pr/Ph and Pr/nC_{17}, show dramatically change along with the $nC_{17+18}/\alpha\beta$-C_{30}Hopane (Figure1,d), while anti-biodegradation biomarker parameters such as gammacerane/(C_{31}hopane/2) and $\beta\beta$-$C_{29}/\sum C_{29}$ Sterane, remain almost unchanged (Figure 2, e). Twenty anti-biodegradation biomarker parameters were selected for oil-source rocks correlation. Their crossplot can distinguish oils with different sources.(Figure2, f)

Conclusions

1) $nC_{17+18}/\alpha\beta$-C_{30} Hopane is an effective sequential biodegradation parameter when PM < 5; 2) Twenty-three oil samples may come from Es1 source rock; one oil sample is a product of Es3U source rock ; the rest one is a mixture of Es_3ML and Es_4 source rocks.