

PS New Achievement in the Effect of Clay Mineral on the Movement of Hydrocarbons in the Source Rock

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Abstract

The Pabdeh Formation represents organic matter enrichment in some oil fields which can be considered as source rock. The effect of clay minerals on early migration in this formation was studied in an unknown well in Karanj oil field. Based on the results of the Rock-eval and the XRD as well as the electron microscopy imaging before and after heating of the samples and creation of artificial thermal maturation, it was found that the illitization process could play an important role in the development and opening of microfractures in this source rock. In fact, by maturing the immature source rock in the laboratory, it was shown that during the illitization process by releasing water and creating pore fluid pressure, the micro-fractures indicate particularly in shales with high smectite/illite content and could thus explain primary migration in Pabdeh source rock in Karanj oil field.

Keywords Primary migration, Microfracture, Illitization, Artificial maturation, Pabdeh Formation, Karanj oil field

Reference

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New achievement in the effect of clay mineral on the movement of hydrocarbons in the source rock

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Introduction

Experimental studies have shown that the conversion of smectite into illite under pressure generates microfractures, and their propagation is influenced by the rock's anisotropy and mechanical properties.

Methods

- **Rock-Eval 6 data**
- **XRD**
- Selected 4 **samples were heated** to study the effect of clay (especially smectite mineral) on the development of microfractures.
- **SEM** images captured before and after heating

Result

- **Rock-Eval**

Fig.1 A-TOC vs. S1 diagram used to separate migrated hydrocarbons from non-migrated ones. **B-** HI against depth, determining the type of hydrocarbon produced from the studied samples. **C-** Plot of hydrogen index (HI) vs. Rock-Eval Tmax for the studied samples indicating that the Pabdeh Formation has lower maturity. **D-** TMAX against PI used to estimate the thermal maturity of the source rock (Saberi et al, 2023, Saberi et al, 2021, Saberi et al, 2021).

- **XRD**

Based on the XRD results (**Table. 1**), we found that the mineral percentage of quartz, illite/smectite, dolomite, and pyrite increases. This heterogeneous distribution of minerals in different sizes and shapes during the layering of the source rock makes anisotropy cause microfracturing and hydrocarbon movement (Fouad et al., 2010).

- **Itroscan**

Itroscan sample 18 (5/3039), with the highest amount of TOC, indicates that this sample has produced hydrocarbons during the heating. Since shale formations have small pore throats, they act as barriers preventing the escape of produced hydrocarbons in the source rock. As a result, it leads to the accumulation of pore pressure until it reaches the fracture threshold of the rock (Cunfei et al, 2017).

Depth	Quartz	Calcite	Smectite	Kaolinite	I-S	Chlorite	Clays	Carbonate
3026	8.81	51.19	0.00	19.44	12.28	0.00	31.73	56.34
3039.5	10.91	51.67	0.00	9.54	18.70	0.00	28.24	56.00

Table 1. XRD data of Pabdeh Formation of Karanj oilfield

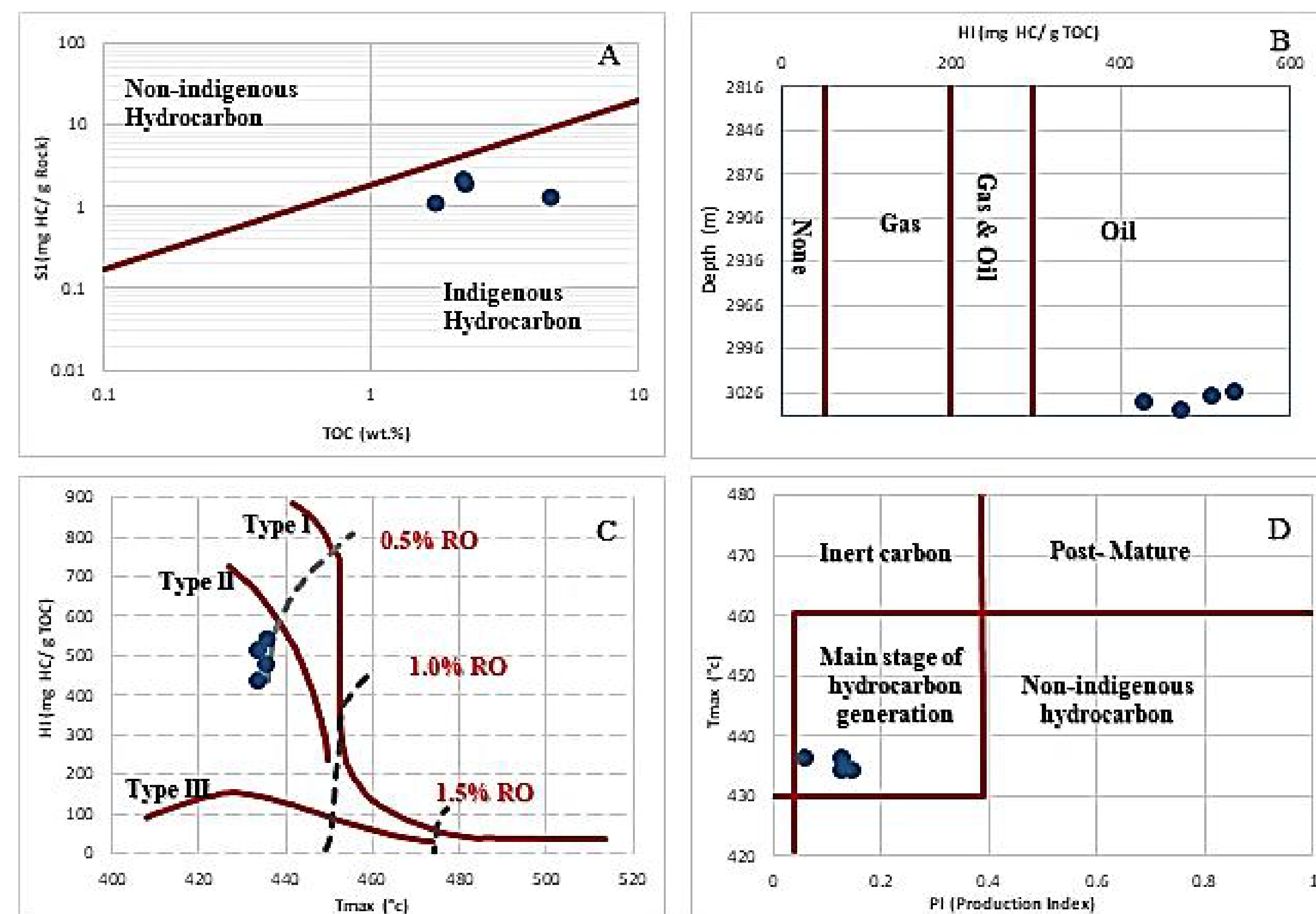


Fig 1. The results of the pyrolysis of samples

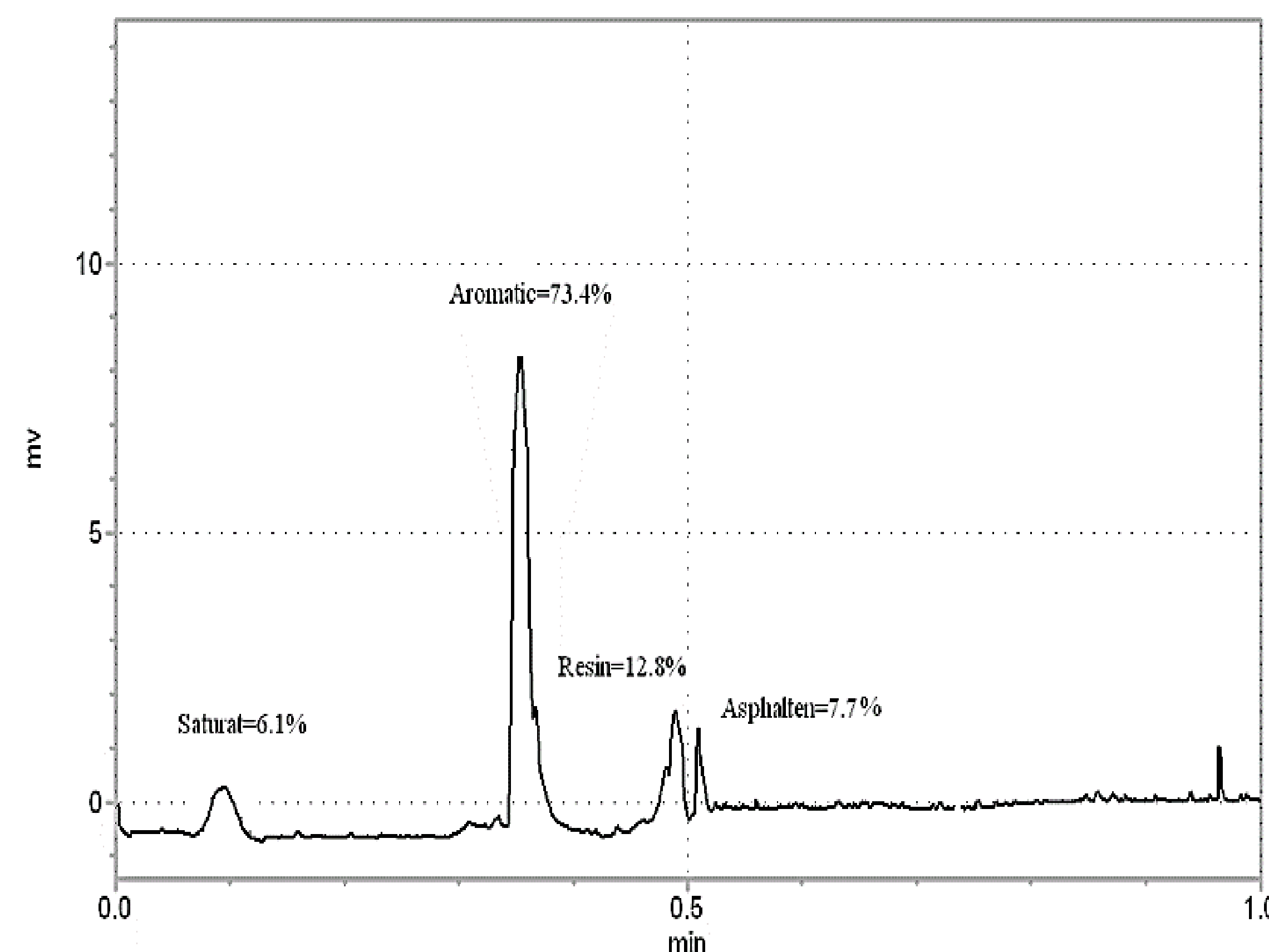
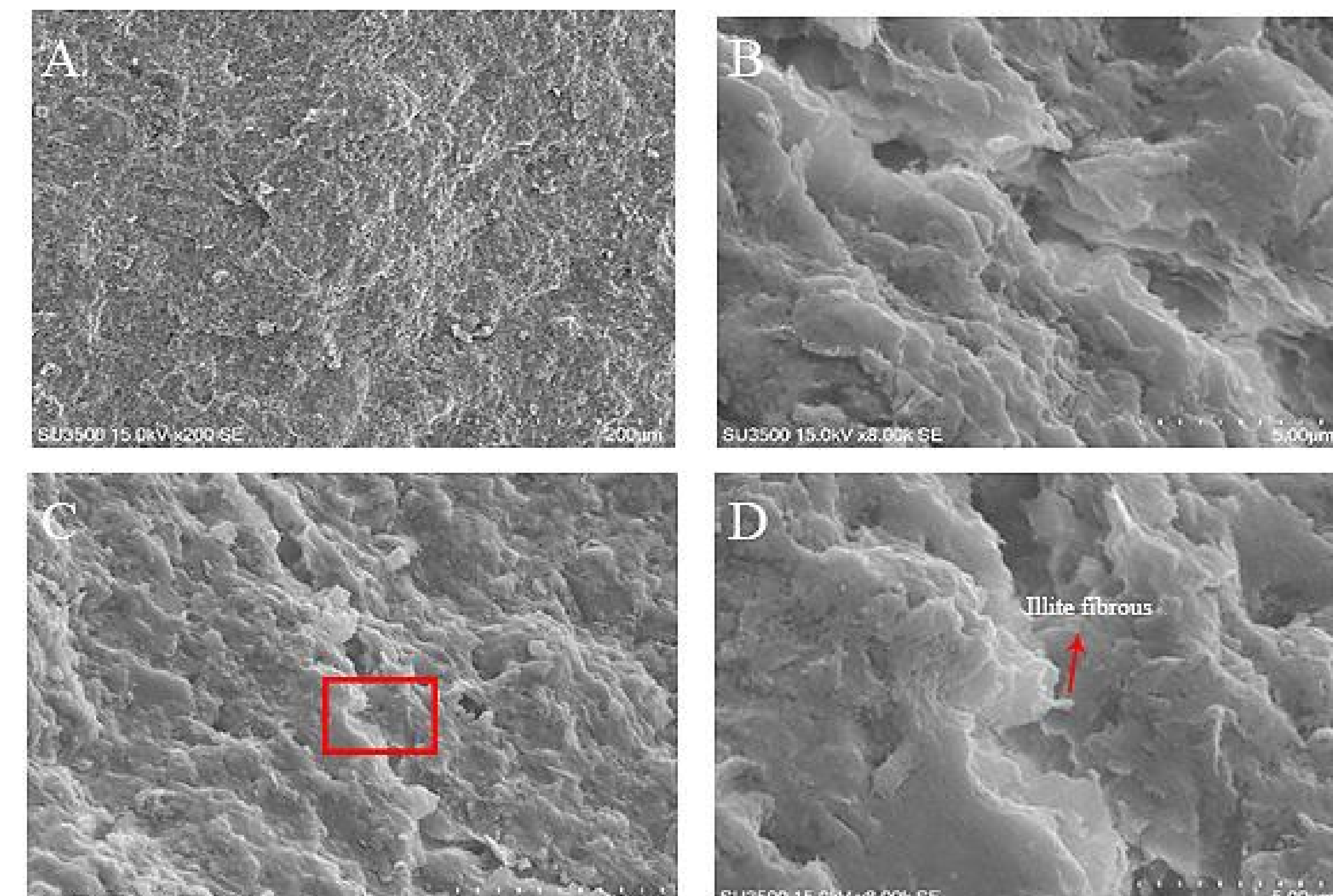


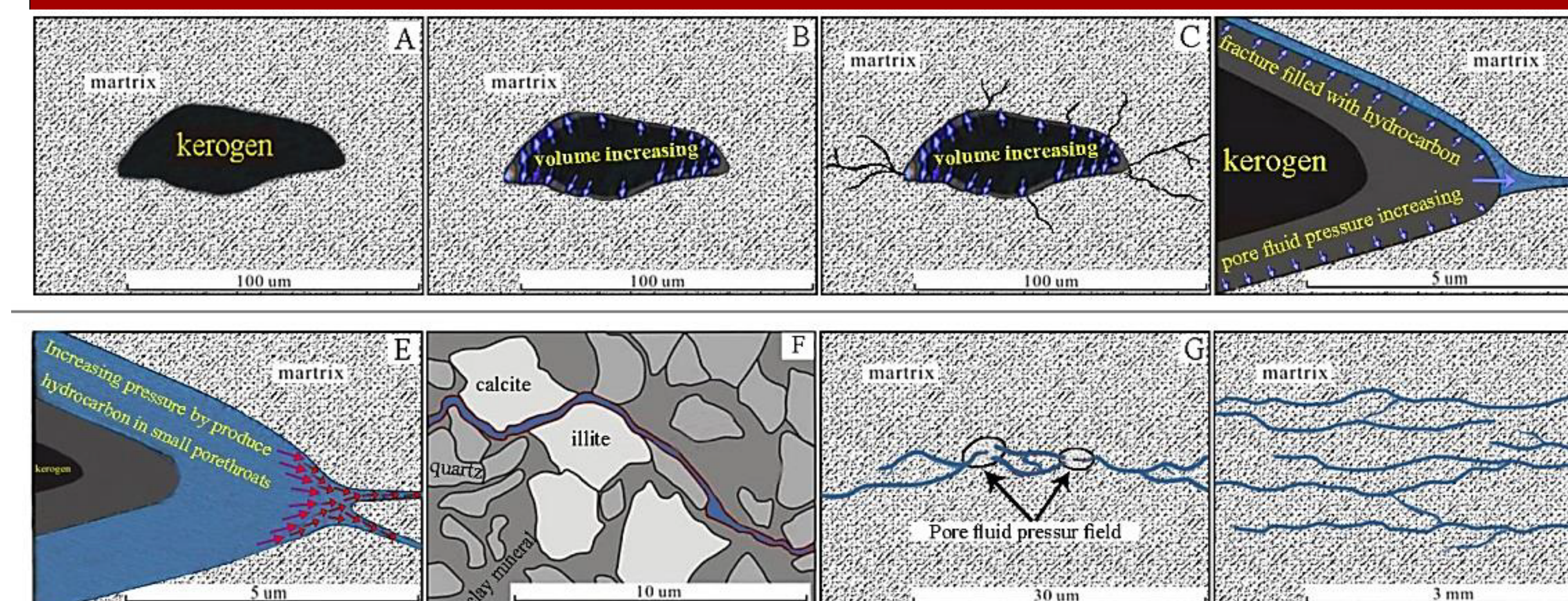
Fig 2. The results of the Itroscan of samples



- **SEM**

Fig 2 - Figure (A) shows the samples before heating, where no, microfractures are observed. Figures (B, C) represent the microscopic images of the heated samples, demonstrating the transformation of smectite platelet edges into illite flakes (the enlarged portion of C is indicated by the arrow), accompanied by the process of illitization. With the increase in fracturing property during hydrocarbon production and the creation of local pressure, fractures have propagated in these areas.

Conclusions



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