



## Research paper

## Petroleum source-rock potential of the Piranj oil field, Zagros basin



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## ABSTRACT

Zagros basin constitutes one of the most prolific hydrocarbon producing habitats and the second largest basin in the Middle East. The Piranj oil field is part of The Middle Cretaceous–Early Miocene Petroleum System in Zagros basin and southwest of Iran. This study mainly focuses on organic matter characterization and thermal history of two potential source rock's name Gurpi and Pabdeh formations. To evaluate the candidate source rocks, 50 cuttings and core samples of these rock units from well M-11 (the only well drilled up to the probable source rocks) were analysed, using Rock-Eval pyrolysis and organic petrography. In addition, 1D basin modelling and reconstruction of burial history were applied to analyse the thermal history of these source rocks. The green shale, limestone and marls of Pabdeh formation with average 2.52%wt Total Organic Matter (TOC) and Hydrogen Index (HI) higher than 250 is more favourite source rock in comparison with dark shale and limestone of Gurpi formation by 1.8%wt and HI < 300. Moreover, Pabdeh formation can be classified generally as fair to very good source rocks, with kerogens of type II, while Gurpi formation contain mostly kerogens of type II/III. The average values of Vitrinite reflectance ( $V_R$ ) (from 0.44% to 1.23%) indicate that samples from the well M-11 have reached maturities corresponding to early to peak oil generation. Reconstruction of the thermal history suggests various steady heat flow values (53–91 mW/m<sup>2</sup>) resulted in the best fit between the observed and the calculated bottom hole temperatures (BHT) and Vitrinite reflectance ( $V_R$ ) in the model. Rock-Eval pyrolysis results and Vitrinite reflectance ( $V_R$ ) suggest that the most of samples are in the early mature to mature stage of hydrocarbon generation. Furthermore, according to the modelling results, petroleum generation from the studied source rocks has began after deposition of related seal-rocks and formation of traps which ensures entrapment and preservation of migrated hydrocarbon.

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## 1. Introduction

The Piranj oil field lies in the southern part of Lorestan Province and the north-western part of Khuzestan Province (SW Iran). The oil-field trends NW–SE and is 98 km long and 5–12 km wide. The oil field's total area is approximately 350 km<sup>2</sup> (Fig. 1). The first geologic survey of the basin was conducted in 1997, but extensive exploration and development of this basin did not begin until 2000. In 2000, the first well was conducted to a depth of 2200 m, and the first economic testing was performed in 2005. A total of four wells (exploration and development) were drilled from time period of 2000–2004, and two of them were tested to yield commercial oil flow. However, only one well (M-11) drilled to the source rocks, and one failed to reach to any petroleum (M-5). Drilling reports show that a great part of the oils, variously reservoirized in Asmari

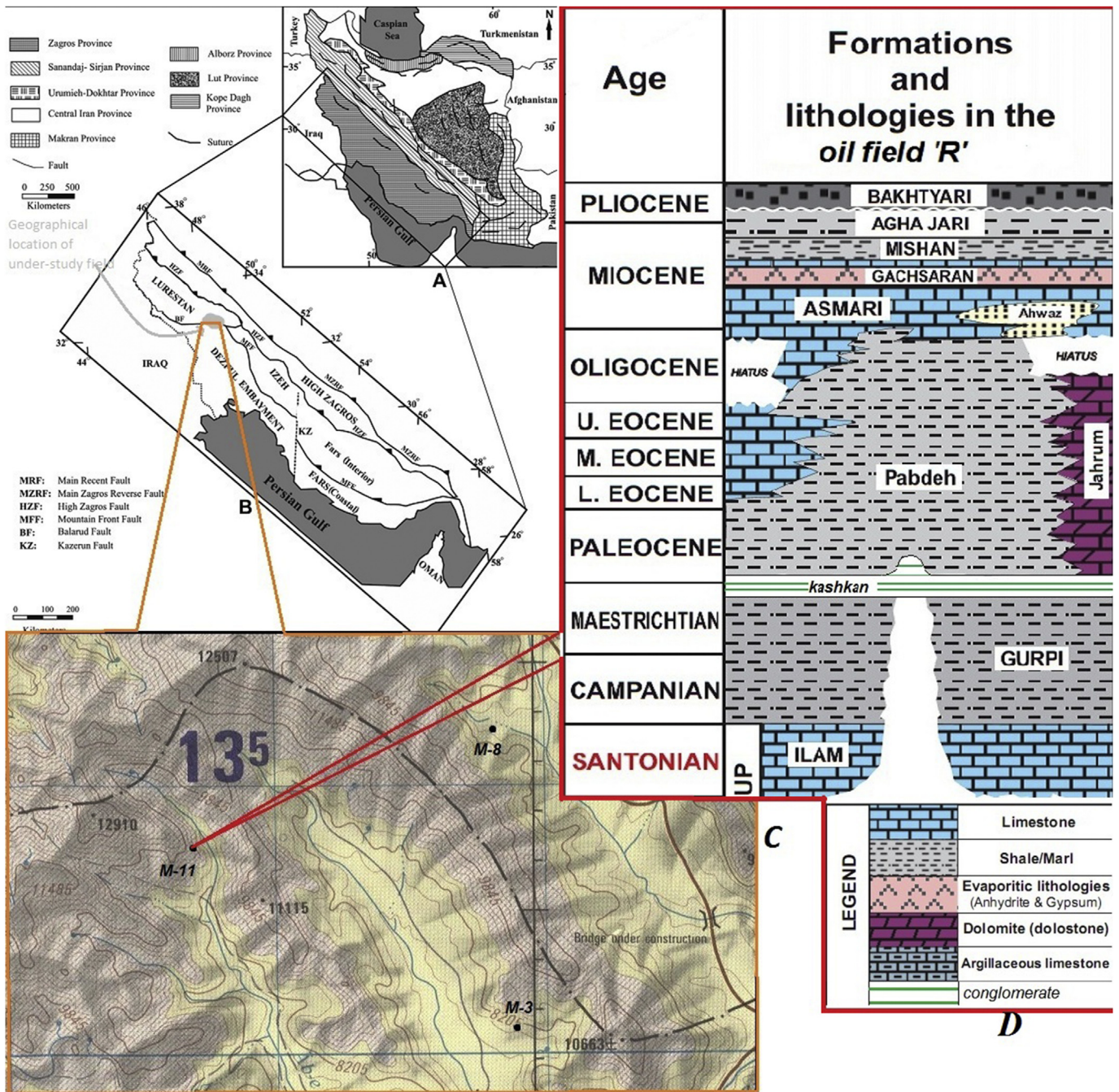
formation (Aali, 2006; Haji zadeh, 2002).

Although most of the drilled wells discovered oil in the Asmari Formation, there is doubt about the sources of this basin. Many believe that the Pabdeh Formation is the only major source of this basin (Bidehi and Ghaderi, 2001), but several experts argue that the Gurpi Formation can be a possible source-rock too (Agha-Khani and Heydary, 2003). However, all of those hypotheses are based on outcrops of beds. The primary objective of this study is to identify the main source rock(s) and estimate the source rock potential of the basin by evaluating the characteristics of organic matter (OM) through various types of geochemical analyses.

## 2. Geological background

The Piranj petroleum system is deposited and accumulated on a carbonate platform developed across the Zagros Basin (Fig. 1). The Zagros Basin, with an area of 553,000 km<sup>2</sup> is the second largest basin in the Middle East (Berberian and King, 1995; Szabo and

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**Fig. 1.** (A) General structural provinces of Iran, (B) six major tectonostratigraphic domains of the Zagros Basin and geographical location of understudy oil-field (C) location of understudy field and sample, (D) Lithology Schematic stratigraphic section showing the Asmari Formation within the Cenozoic rocks of the Zagros Basin.

Kheradpir, 1978). This basin extends from Turkey, north-eastern Syria and north-eastern Iraq through north-western Iran and continues into south-eastern Iran (Jafari, 2007).

The geological history of the Piranj includes long time subsidence and deposition interrupted by short time uplift. The folding process of the Zagros basin occurred in the Miocene and Pliocene and continued until the present, which formed long anticlines and most of the oil fields, as well as the understudy oil field, in this basin (Mottie, 1995).

According to Motiei (1994) classification, the Zagros Fold-Thrust Belt has been divided into the 3 different tectonic stratigraphic zones, which, from NW to SE, are:

- 1) Western Zagros or the Lurestan Province
- 2) Central Zagros or the Izeh Zone and Dezful Embayment
- 3) and Eastern Zagros or the Fars Province (Fig. 1).

The majority of previous studies (Alavi, 2004; Ziba-neshan, 2002) as well as drilling records revealed that the petroleum system in this oilfield contains 4 main formations namely:

- 1 Asmari (Oligocene to lowermost Miocene) (reservoir rock)
- 2 Pabdeh (Upper Palaeocene to lowermost Oligocene) this possible source rock is composed of two parts name downer pabdeh (also known as purple shale) and upper pabdeh

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