



Organic geochemistry, palynofacies and petroleum potential of the Mukalla Formation (late Cretaceous), Block 16, eastern Yemen



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ABSTRACT

The late Cretaceous Mukalla Formation of the Mahra Group is present in the subsurface of eastern Yemen. The palynofacies, thermal maturation and hydrocarbon potential of this formation recorded from three exploratory wells in the Qamar Basin are discussed. Two of the wells are in the offshore part of Block 16 and one is in the onshore part. Both organic geochemical and palynofacies analyses indicate that the formation contains oil- and gas-prone kerogen. Rock-Eval pyrolysis and gas chromatography data show a peak thermal maturation stage for organic matter types II/III and III and good conditions for hydrocarbon generation and expulsion. Three major palynofacies types are identified through the succession. These indicate open marine, marginal- to shallow-marine and fluvio-deltaic environments, reflecting multiple marine transgressive and regressive phases during the period of deposition of the formation, which took place in a humid, subtropical to tropical climate.

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1. Introduction

Until the late 1980s, little was known about the geology of Yemen apart from the structural elements recognized from surface studies, such as the Hadramawt Arch and Jiza Trough, and the stratigraphic work of Wetzel and Morton during 1948–1950, who surveyed the area between Mukalla in eastern Yemen and the frontier with Oman (Beydoun, 1964) (Fig. 1). Since then, gravity and magnetic surveys carried out by the Technoexport Petroleum Company have provided a subsurface framework for the Mesozoic basins in the former South Yemen (Isaev, 1987). Paul (1990) produced a schematic map of structural units in the southern and eastern parts of Yemen on the basis of unpublished geophysical data. Further studies of Mesozoic basins in Yemen have been carried out by Redfern and Jones (1995) and Ellis et al. (1996), who identified structural highs and lows (horsts and grabens) based on the 1994 geophysical surveys by Simon Petroleum Technology, and Bosence (1997), who analysed the structure of Mesozoic basins from composite seismic sections.

The Mesozoic basins in Yemen include Sana'a, Siham-Ad-Dali', Sab'atayn, Balhaf, Say'un-Masilah, Jiza and Qamar (Fig. 1). These formed as a result of Late Jurassic rifting between east Africa and western India. The pre-rift sequence in the basins is represented by the Middle Jurassic Kuhlan Formation (Fig. 2). This consists of a basal transgressive unit of poorly sorted coarse-grained fluvial sandstones that fill topographic lows in the peneplaned basement (Beydoun et al., 1998). Overlying it unconformably are platform carbonates of the Shuqra Formation, which accumulated during the Callovian–Oxfordian.

Two phases of rifting in Yemen are recognised: Kimmeridgian–Berriasian and Hauterivian–Barremian (Redfern and Jones, 1995; Ellis et al., 1996; Sharland et al., 2001). The first phase began in the early Kimmeridgian in western Yemen, in the mid-Kimmeridgian–early Tithonian in the centre of the country, and a little later in the east (Beydoun et al., 1998; As-Saruri et al., 2010). Synrift deposits include thick carbonates and shales of the Madbi Formation (Fig. 2). The organic-rich intervals in this formation have been regarded hitherto as the main source rocks in the Sab'atayn and Masilah hydrocarbon-producing basins (Alaug et al., 2008, 2011; Hakimi et al., 2011a,b).

The carbonates and clastics deposited during the later phase of rifting include the Sa'ar and Qishn formations (Fig. 2). In the latest Early Cretaceous, late synrift carbonates were deposited in eastern Yemen (Fartaq Formation of the Mahra Group) while paralic clastics

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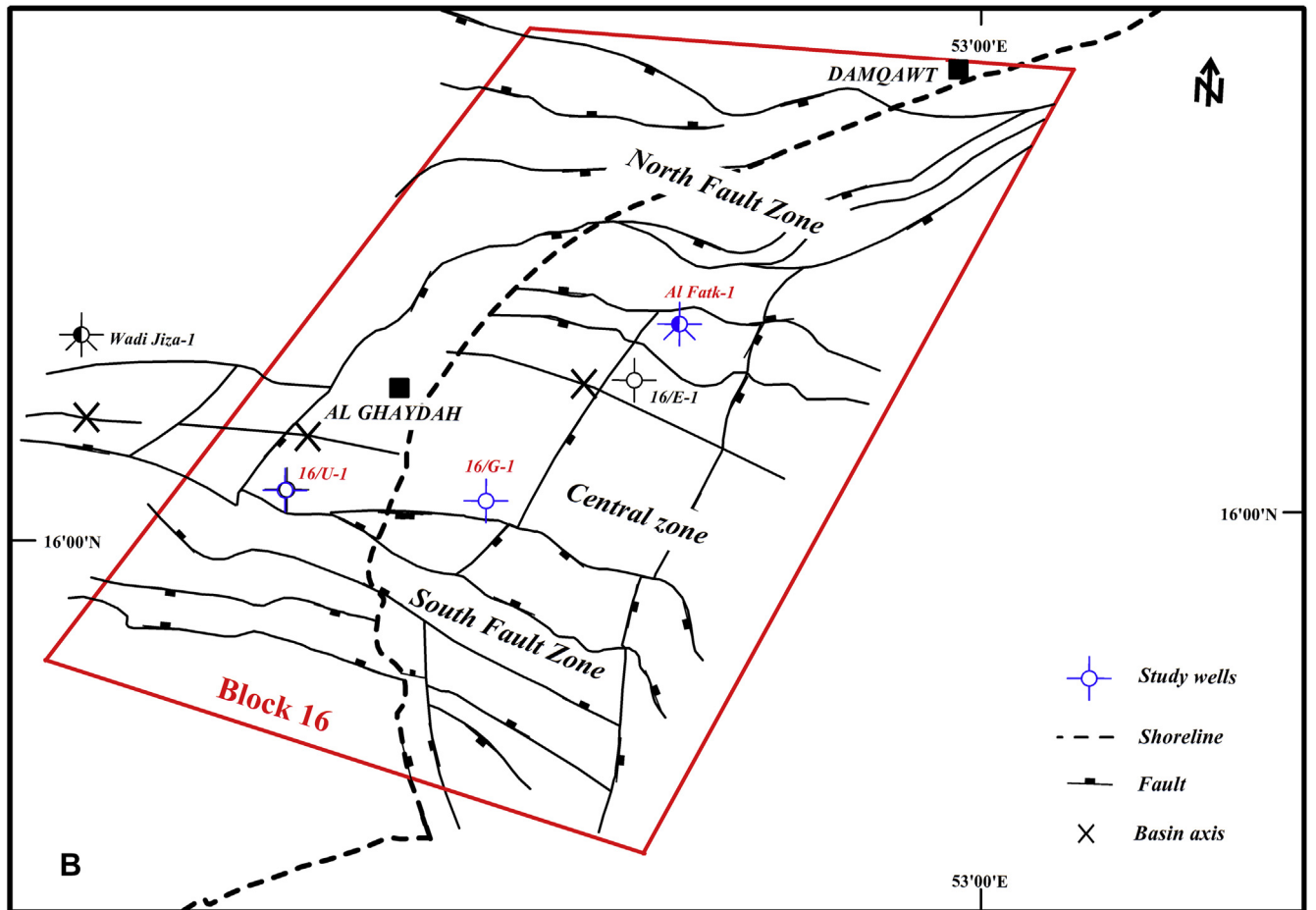
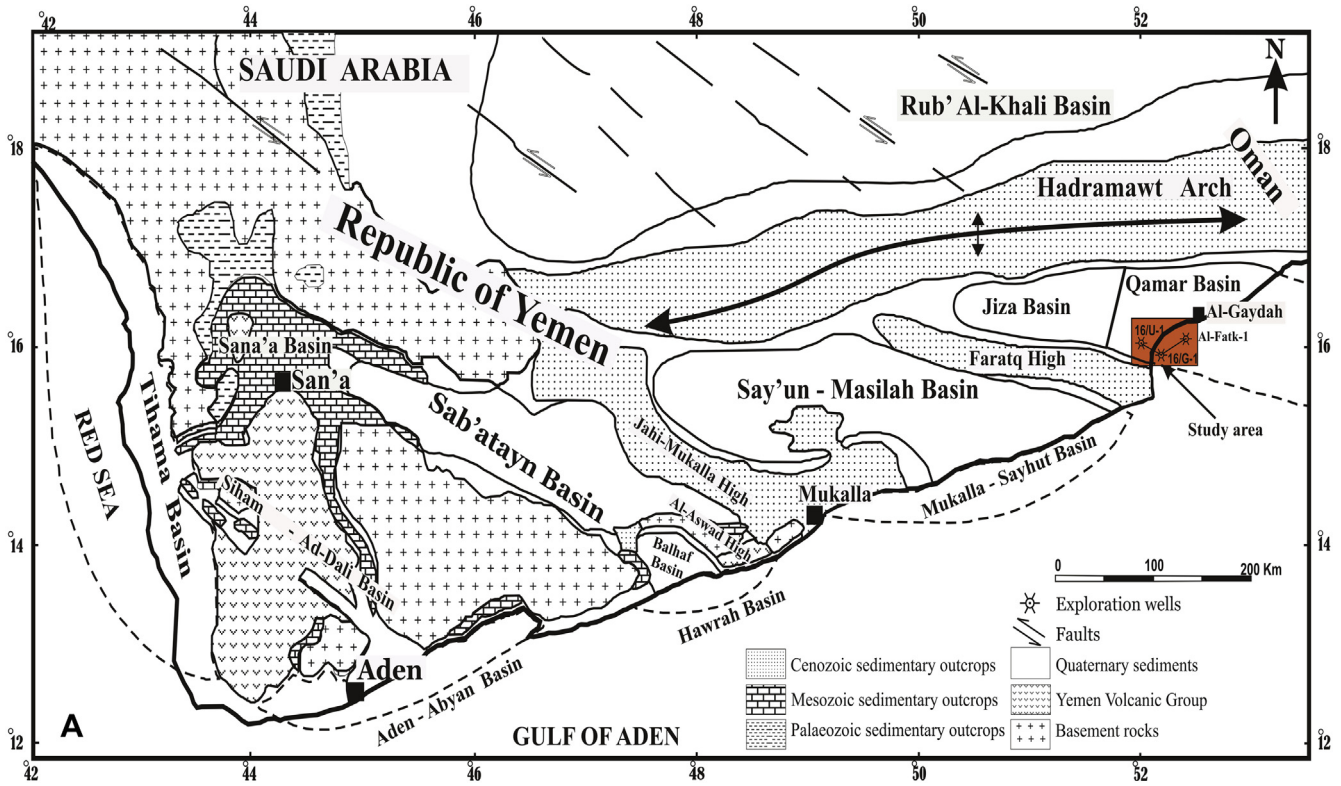


Figure 1. A, B, location maps of the research area showing the Qamar Basin and the wells studied (modified after Beydoun et al., 1996; Brannan et al., 1997; Beydoun et al., 1998).

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