Palynofacies characterization of the Upper Jurassic Madbi Formation in the Kharir oilfield and their relation to oil generation potential

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The Upper Jurassic Madbi Formation, a principal petroleum source rock, consists of organic-rich shales in the Masila Basin, Eastern Yemen (Hakimi et al., 2010). Organic-rich shales from one oilfield in the East Shabowah, Masila Basin (Kharir oilfield; Figure 1) were studied in order to evaluate source rock and oil generation potential. Oil generation potential of these sediments is evaluated based on petrographic analysis (palynofacies and thermal alteration index (TAI) of spores/pollen colouration) and geochemical analysis (Rock Eval pyrolysis).

Palynofacies can be used to help not only for establishing the depositional environment but also to evaluate the hydrocarbon generation potential. The palynofacies analysis of the Madbi Formation in the area reveals rich-organic matter and the main palynofacies identified are structured organic matter (SOM) and structureless (amorphous) organic matter (AOM). The structured organic matter contains phytoclasts and palynomorphs (spores, pollen and marine microfossils). The Madbi shale samples reveal a more marine organic matter according to palynofacies observations. This composition is characterised by a higher proportion of amorphous organic matter (AOM) and presence of marine microfossils. Amorphous organic matter is predominating in the total kerogen residues. The amorphous organic matter appears well aggregated (flaky), yellow-brown, and granular textured under normal white light (Figure 2). Ultraviolet light excitation, distinct fluorescence intensities were observed corresponding to amorphous organic matter assemblages (AOM) (Figure 2). Terrestrial organic matter (spores, pollen and woody fragments; Figures 3d and e) were found in lesser amounts. Marine microfossils are rare (dinoflagellates and microforaminifers linings; Figures 3a-c).

The TAI value for the organic matter in these sediments has been ascertained as 2.6-3.00, corresponding to a palaeotemperature range of 60–120°C. These are the optimum oil-generating strata.

Rock-Eval pyrolysis results support the petrographic composition of organic matter in the Madbi shale sediments. The Madbi shales contain algal Type II with minor Type I. This is suggested by high hydrogen index values in the range of 302-834 mg HC/ g TOC.

Based on this study, the Madbi shale sediments have very good source rock generative potential for significant oil prone as supported by high amounts of organic matter predominantly Type II kerogen and Type I kerogen with rich fluorescent amorphous organic matter of marine origin.

Our results also revealed that the Upper Jurassic Madbi shales have high amounts of organic matter mainly due to good preservation of marine organic matter in suboxic-anoxic conditions.

Figure 1: Main sedimentary basins map in Yemen showing location of the Masila Basin and the study area.
Figure 2: Photomicrographs of amorphous organic matter in the marine shales of the Madbi Formation under white and UV transmitted light and SEM; (a) amorphous organic matter appears well aggregated (flaky); (b) as (a) under ultraviolet light excitation, distinct fluorescence intensities corresponding to amorphous organic matter assemblages; (c) Yellow brown amorphous organic matter associated with spores; (d) as (c) under ultraviolet light.

Figure 3: Photomicrographs of palynofacies organic matter in the marine shales of the Madbi Formation, Masila Basin under white transmitted light; (a-c) Marine microfossils (a. microforaminifers linings ; b and c. dinoflagllates); (d) Spore and pollen species; (e) Structured phytoclasts (woody tissue).
Geoart: An innovative tool to promote geology and geotourism

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Geology has gained public attention and interest in recent years due to catastrophic events such as tsunamis, earthquakes, volcanic eruptions and landslides. The public interest in geology should be sustained in order to build a scientific community as outlined in the country’s 2020 vision. One of the tools to sustain the interest is through the introduction of geological arts (or geoarts) to the public. A proper study on geoarts has never been carried out before and this study attempt to identify, characterize and introduce the geological masterpieces to the public. This study is an innovative method to stimulate interest and to popularize the subject of geology among the non-geoscientist public. Geoart is defined by the author as an artistic piece or three dimensional object which is related to geologic and geomorphologic interest and crafted by natural processes. Geoart could be in scale of atoms, landscapes or the whole universe. Geoart is based on the principle that by looking with both artistic and scientific eyes, people could appreciate geologic knowledge that could benefit either art or geological enthusiasts. It could arouse interest in geology and its related processes and be used as tool to observe, describe and understand the physical world and to convey concepts and knowledge to the non-geoscientists. Geoarts which have scientific, aesthetic, recreational and cultural values are important geoheritage assets that should be protected. For the same reasons, geoarts could be promoted for geotourism development.