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Fractures System within Brum Granitic Rocks, an Extend of Subsurface Fractured Basement Reservoir, Sabatyan Basin, Yemen

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Abstract

Fractured granitic basement in Sabatyan Basin, Yemen has been defined as a host rock for hydrocarbon resources. Brum granitic rock, NW of Mukalla may represent an extend analog outcrop of such fractured basement reservoir in Sabatyan basin. This study characterizes the fractures system associated with Brum granitic rock. Fractures attitude were determined in the field and lineaments representing major fractures were also defined from satellite images. Four major trends were defined within Brum granitic rock, N-S, NW-SE, NE-SW and E-W. The fracture trends represent longitudinal, cross cutting and inclined fractures that are related to the cooling and emplacement of granitic body. Major normal faults trending mostly NE-SW are also cross cutting the granitic body and extend for few kilometres and may be related to later tectonic events. Those faults can also be traced and defined in satellite images.

Lineaments traced from satellite images demonstrated compatible trends with the fracture trends. Lineaments analysis also indicates the extension of the major normal faults to great distance. Moreover, those major normal faults may have also associated with local fracturing and brecciation and May also affected the pre-existing fractures related to igneous body.

The outcomes of this study can help to understand the nature and behaviour of the subsurface fractured granitic basement hosting hydrocarbon in Sabatyan basin. Moreover, findings of this study can be used for reservoir characterization and hydrocarbon recovery in the area.

Introduction

Sabatyan basin isa NW oriented pull apart basin which formed during the late Jurassic time when NW-SE trend of Najd fault system has been rejuvenated (Garzic, et al., 2011). This basin occurred in the interior of Yemen and extend from Al-Jauf area in the SW till Mukalla area in the SE(figure 1)(As-Saruri, et al, 2010).Basement grain in Sabatyan basin exposed at south eastern part near Mukalla city which consist mainly of Andesitic metavolcanic core with large intrusion body of granite assigned as Brum granite(Figure 2). Brum granitic rockoverlain by late cretaceous sandstone of Mukalla Formation which in turn overlain by early tertiary massive carbonate of Umm Er Redhema Formation. Brum granite characterized by heavy fractures with different orientation including; N-S, NW-SE, NE-SW and E-W. Fractures with NW-SE trend considered as the main fracture trend with high density. Brum granitic rock cross cut by several NE-SW normal faults. This study aimed to study the fractures system in Brum granitic rock in outcrop as an extend of the fractured basement reservoir in subsurface in Sabatyan Basin.

Methodology

Field investigation has been carried out to measure and record the attitude of fractures in the study area by using Brunton compass and GPS instruments. Digital camera has been used to take photographs of fractures in the field. Fractures measurements have been plotted in rose diagrams to show the direction of fractures system in the studied granite body. Satellite images and shaded-relief

DEMs used to study the lineaments in Mukalla basement core including Brum granite body as a tool to define the major fractures in study area.

Results and Discussion

field observation and lineament study showed four trend of major fractures characterized Brum granitic rock includingN-S, NW-SE, NE-SW and E-W. However, NW-SE trend considered as the main fractures trend which characterized by high density and extend for large distance(figure 3).

The three types of fractures; longitudinal, inclined and cross cutting have been observed (figure4 and 5). These types of fractures are related to cooling and emplacement of the granitic body. In addition to these types of fractures, major normal faults cut across Brum granitic rock with strike N30E and dipping 45 degree (figure6). Furthermore, two set of a vertical and horizontal joint has been observed in Brum granitic rock (figure 7).

Fractures with N-S and NW-SEtrend which have been observed in Brum granitic rock also extend to sedimentary rock. These trends have been clearly observed in the massive carbonate of Umm Er Redhuma Formation in the study area as set of fractures with regular space (figure 8).

The existence of longitudinal inclined and cross cutting fractures formed as a result of cooling and emplacement of the igneous body. However, normal faults may initiated by tectonic event followed the emplacement of igneous body. The extension regime that initiated such faults may related to Afar triple junction and opening of Gulf of Aden and Red sea which caused uplifting of study area. Extend of two fractures trend to sedimentary rock above Brum granitic rock indicates the effect of later tectonic event. This event may be a reactivation of Najid Fault system or opening of Gulf of Aden.

Conclusions

In conclusion, fractures system in Brum granitic rock showed the ability of this type of igneous body to be a good reservoir for hydrocarbon in subsurface. The intensity of major fractures in Brum granitic rockenhances the capability of such igneous body to be conduits for hydrocarbon in subsurface. The three types of fractures which occurred in Brum granitic rock including; longitudinal, inclined and cross cutting are related to cooling and emplacement of the igneous body. However, the normal faults that cut across this body may related to later tectonic event such as opening of Gulf of Aden and Red sea. Extend of two major trends of fractures to sedimentary rock above Brum granitic rock indicate later tectonic event.

References

1. As-Saruri, M. A., Sorkhabi, R., & Baraba, R. (2010). Sedimentary basins of Yemen: their tectonic development and lithostratigraphic cover. Arabian Journal of Geoscience (3), 515-527.

2. Bosworth, W., Huchon, P., & McClay, K. (2005). The Red Sea and Gulf of Aden Basins. Journal of African Earth Sciences (43), 334-378.

3. Garzic, E., L'Hamaide, T., Diraison, M., Géraud, Y., Sausse, J., Urreiztiete, M., et al. (2011). Scaling and geometric properties of extensional fracture systems in the Proterozoic basement of Yemen. Tectonic interpretation and fluid flow implications. Journal of Structural Geology (33), 519-536.

4. Natural resource project, Ministry of oil and mineral resources. (1990). Geological map of Mukalla, Sheet 14J. (1:250000).

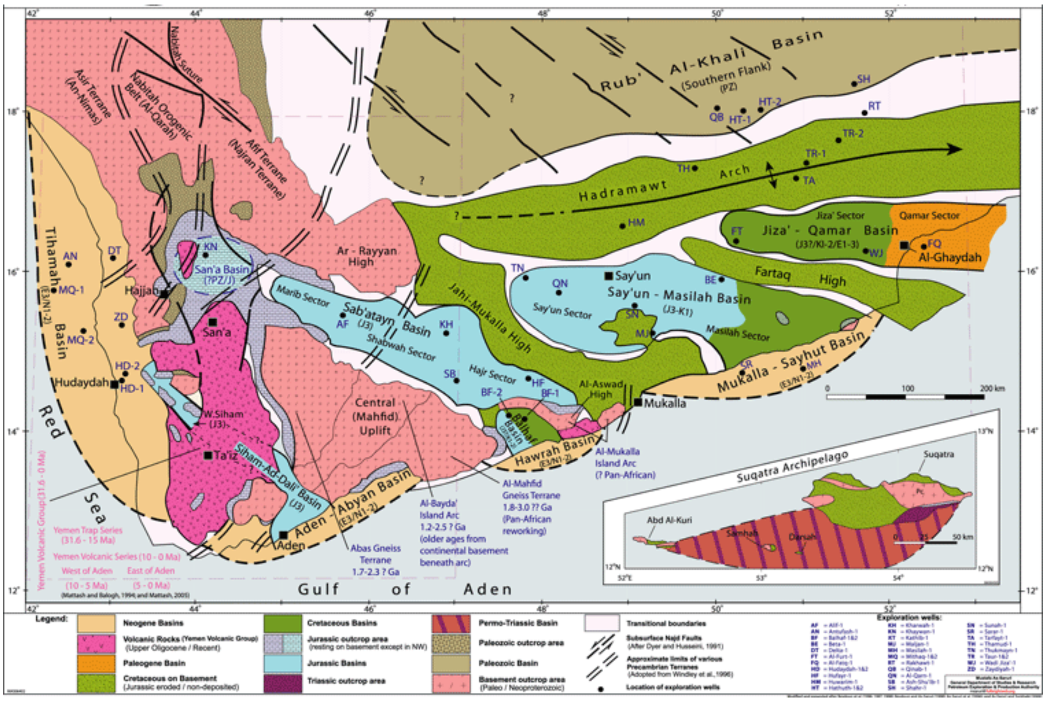

Figure 1: Map shows the sedimentary rift basin in Yemen (after As-Saruri, 2010)

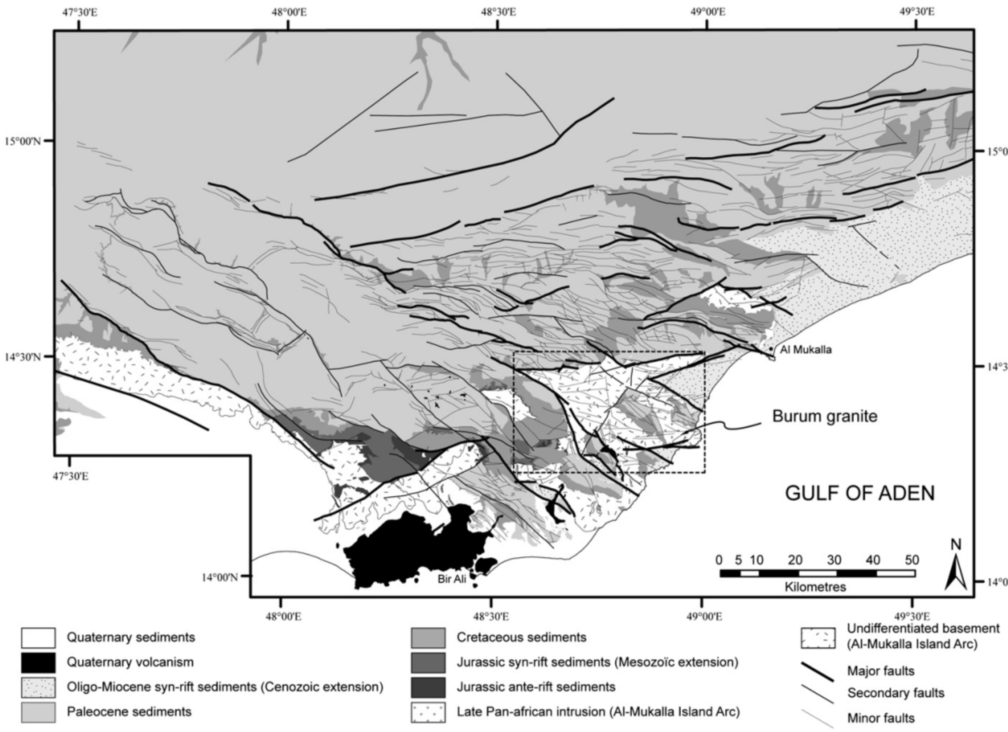

Figure 2: Geological and structural map of Mukalla horst (Garzic, et al., 2011).

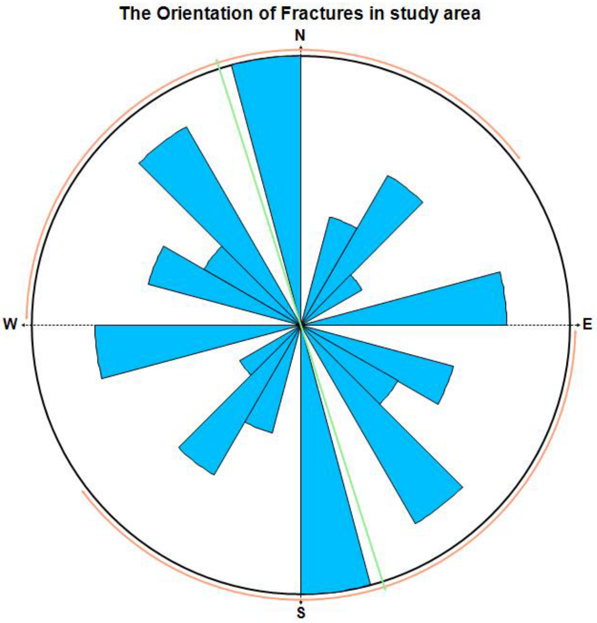

Figure 3: Rose diagram shows direction of major fractures.

Figure 4: Longitudinal fractures oriented N-S.

Figure 5: Inclined fractures oriented NE-SW.

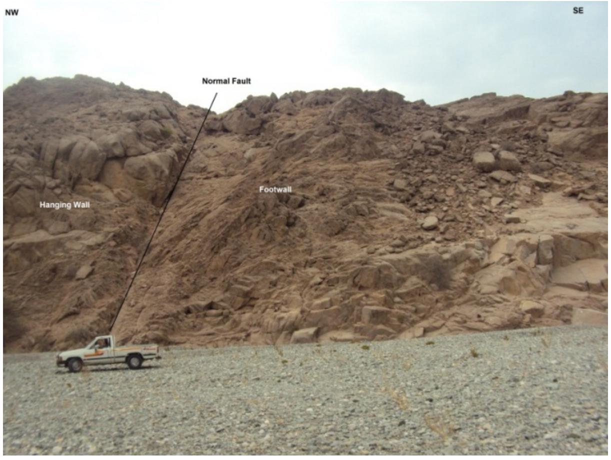

Figure 6: Major normal fault cut across Brum granitic rock.

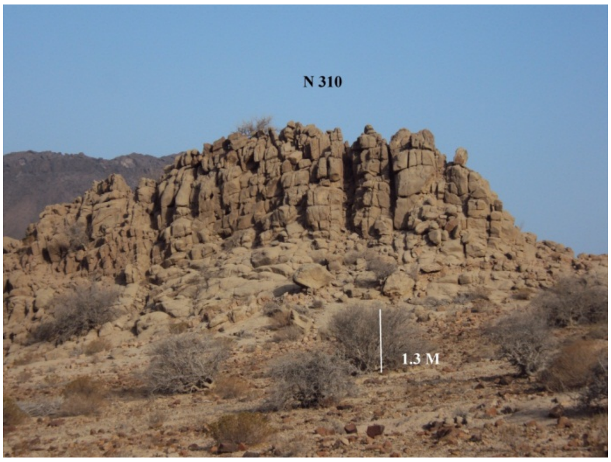

Figure 7: Vertical and horizontal joints sets.

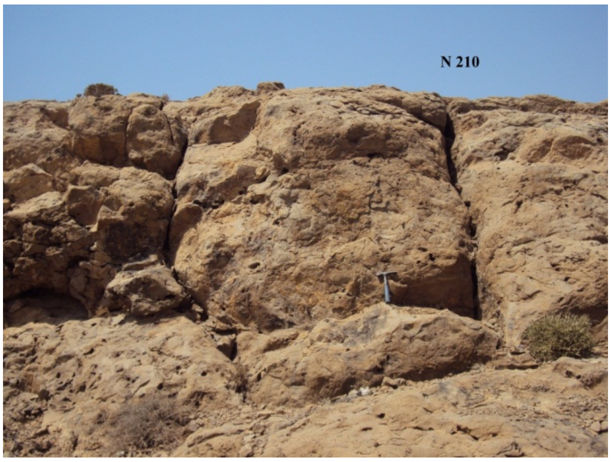

Figure 8: Fractures set in Umm Er Redhuma carbonate.