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# PETROGRAPHY OF KIMMERIDGIAN SEDIMENTS EXPOSED IN TAPKESHWARI TEMPLE SECTION, KACHCHH BASIN GUJARAT, INDIA

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**ABSTRACT**

*This paper explains the provenance of Upper Jurassic (Kimmeridgian sediments) exposed in the Eastern part of the Kachchh Basin (Tapkeshwari temple section) western India, on the basis of petrographic study of rock samples and fossils (Trace fossils) found in the field. This study also investigates the compositional variation of the sandstone with reference to the evolution of the Kachchh Basin, which commenced as a rift basin during the Late Triassic and emerge into a passive margin basin in the end of Cretaceous. This study analyzes sandstone samples of Tapkeshwari temple section, trace fossils and other structures found in the field. According to petrography study of Tapkeshwari temple section it has been observed that sandstone is mostly medium grained and laminated, shale beds also present with intercalations, quartz grains are mostly subrounded to subangular, packing of grains is generally moderately to well packed, trace fossils found in lower beds of the section. Cementing material is mostly Ferruginous. Ripple marks present and Ophiomorpha trace fossils found. Ophiomorpha trace fossil assemblages is characterised by moderate bioturbation and low trace fossil diversity. Ophiomorpha ichnofossil indicates continent to sea shore environment.*

***Keywords:*** *Petrographic Study, Trace Fossils, Ophiomorpha Ichnofossil, Sea Shore Environment*.

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## Introduction

Composition of major and accessory heavy minerals in sandstone provide decisive knowledge regarding to provenance of sedimentary basins (Armstrong -Altrin et al. 2012, 2015, 2017; Arribas et al. 2000; Caracciolo et al. 2012; Critelli and Ingersoll 1994; Critelli and Le Perra 1994; Critelli et al. 2003; Le Perra and Critelli 1997; Paikary et al. 2008; Saha et al. 2010). Petrographic studies of sandstone is widely used to give information about tectonic setting, source rock composition, transportation and environment of deposition (Dickinson 1970, 1985; Dickinson and Suczeck 1979; Dickinson et al. 1983; Ingersoll and Suczeck 1979; Le Perra and Arribas 2004; Le perra et al. 2001; Zuffa 1985,1987). The main objective of this study is to understand the source of sediments deposited in eastern part (Tapkeshwari temple section) of the Kachchh Basin and infer the tectonic setting of the basin during deposition of these sediments based on petrographic studies and fossil found in research area.

## Geological setting of Kachchh Basin


Fig. Map showing research area in Kachchh Basin (Tapkeshwari temple section).

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The study area, Tapkeshwari temple section of Kachchh Basin is situated in western margin of Indian peninsula. The coordinates of the research area are N23°11'14" and E69°40'16". The Jurassic rocks of Kachchh are oldest known sediments exposed in this locality. The Kachchh basin represents shelf part of Indus Baluchistan geosyncline. Upper Jurassic rocks are generally fossil rich in this region. Lithologically sandstone and shale are exposed prominently. The Kachchh Basin was formed by the Late Triassic- Late Jurassic rifting during India's northward drifting and post Gondwanaland breakup (Biswas 1982, 1987, 2005). Biswas (1987) considered the Kachchh Basin as a Pericratonic rift Basin. The Kachchh basin consists of about 3000 m. of siliciclastic and carbonaceous sediments from Late Triassic to Early Cretaceous (Biswas 1987). The boundaries of the Kachchh Basin marked by Nagar Parkar fault (NPF) to the north, the North Kathiawar fault (NKF) to the south, the Radhanpur Arch (Radhanpur-Barmer Arch) to the east and converge with the continental shelf to the west.

During the Kimmeridgian (Late Jurassic) the basin recorded shoreline transgression, resulting in deposition of late syn-rift sediments in most parts of the Kachchh Basin. Lithologically the Kimmeridgian succession consists of mainly sandstones and shale. According to Biswas (2005) Mesozoic succession of Kachchh Basin consists of poorly exposed continental sediments of Late Triassic, Marine sediments of Middle to Late Jurassic representing syn-rift stage, and Fluviomarine sediments of Late Jurassic to Early Cretaceous corresponding to Late syn-rift to post rift stage.

**Table 1: STRATIGRAPHIC SUCCESSION OF JURASSIC ROCKS OF KACHCHH BASIN**
(After Rajnath 1932)

| Formation | Sub-division | Lithology | Age |
|---|---|---|---|
| Bhuj Series | Exclusively characterised by plant remains | Coarse sandstone | Middle Cretaceous |
| | Zamia Beds | Shales | |
| Ukra Beds | | Calcareous Shales | Aptian |
| Umia | Unfoselliferous | Mainly shales | |
| | *Trigonia* Beds | Sandstone | |
| | Green Oolitic Beds | Oolitic bands of sandstone and shales | Tithonian |
| | ? ? ? | Mainly shales | |
| Katrol | Upper (e.g. at Gajansar) | Mainly shales | Portlandian |
| | Middle (e.g. at Katrol hills) | Mainly sandstone | Kimmeridgian |
| | Lower (e.g. at Wala Khawas) | Mainly shales | |
| Chari | Bed no. 1 Dhosa Oolite | Oolitic sandstone, green at the top | Argovian |
| | Bed No. 7, Zeilleria zone | shales and sandstones | Callovian |
| | Bed no. 1a to 21 | | |
| Patcham | Bed No. 22 | Green coloured dolomitic limestone | |
| | Bed No. 23 to 26, and probably more at the Patcham 'Island' | Sandstone | Bathonian |
| Base not seen | | | |

**Methodology**

This study based on petrographic analysis of rock samples and fossils collected in the field. For this purpose collect rock samples and fossils in research area,Tapkeshwari temple section (coordinates-N23°11'14" and E69°40'16). First of all we prepared slides in laboratory and study all the slides with the help of Leica dmrx advanced research polarizing petrological microscope. Lithologs and petrographic details of section tables prepared.

Fig.1: Panoramic view from top of the hill of Tapkeshwari temple section.


Fig.2: Wood fossil in Tapkeshwari temple section.

Fig.3: Ophiomorpha trace fossils found in bed at Tapkeshwari temple section.

**Table 2: Petrographic details of selective beds of Tapkeshwari temple section (Katrol formation) exposed at Bhuj city in Gujarat.**

| Sample no. | Quartz ( sorting; size in mm; shape; angularity; special character) Pyrite, Feldspar, Mica | Packing | Contact | Fossils | Intra/ Pel/ Oo/ Bio | Cement/ Matrix/ Mud | Remarks/ Effervesence |
|---|---|---|---|---|---|---|---|
| RUC2018/2/ TT1 | Moderately sorted, subangular to angular quartz grains, max. grains 0.06-0.25mm. size, few grains less then 0.06 mm. size, Plagioclase feldspar and Muscovite present | Densly packed | Point contact | | | Ferruginous | Undulose extinction present, Effervesence present |
| RUC2018/2/ TT2 | Poorly sorted, subrounded to subangular quartz grains, max. grains 0.06-0.125 mm. size few grains less then 0.06 mm. size, Muscovite present | Densly packed | Point contact | | | Ferruginous cement | Undulose extinction present , Effervesence present |
| RUC2018/2/ TT3 | Well sorted, Subrounded to subangular, Max. grains 0.06- 0.25 mm. size few grains 0.125- 0.06 mm. size, Plagioclase feldspar present | Densly packed | Point contact | | | Ferruginous | Effervesence present |
| RUC2018/2/TT4 | Moderately sorted, max. grains 0.06- 0.125 mm. size | Densly packed | Floating contact | | | Ferruginous | Undulose extinction present, Effervesence present |
| RUC2018/2/TT5 | Moderately sorted, subrounded to subangular quartz grains, max. grains 0.06- 0.25 mm. size, few grains less then 0.125 mm. size | Moderately packed | Point contact | | | Ferruginous | Undulose extinction present, Effervesence absent |
| RUC2018/2/TT6 | Poorly sorted, subrounded to subangular quartz grains, max. grains 0.06-0.25mm. size few grains 0.06-0.125 mm. size | Densly packed | Floating contact | | | Ferruginous | Undulose extinction present, Effervence absent |
| RUC2018/2/TT7 | Moderately sorted, subrounded to subangular quartz grains, max. grains 0.125-0.25 mm. size, few grains 0.06- 0.125 mm. size | Moderately packed | Point contact | | | Ferruginous | Undulose extinction present, Effervesence present |
| RUC2018/2 TT8 | Moderately sorted, subrounded to subangular quartz grains, max. grains 0.06- 0.25 mm. size, few grains 0.06- 0.125 mm. size, Plagioclase feldspar present | Loosely packed | Point contact | | | Ferruginous | Undulose extinction present, Effervesence absent |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| RUC2018/2/TT9 | Poorly sorted, subangular to angular quartz grains, max. grains 0.125-0.25 mm. size, few grains 0.125-0.5 mm. size, Muscovite present | Moderately packed | Point contact | | | Ferruginous | Undulose extinction present, Effervesence absent |
| RUC2018/2/TT10 | Moderately sorted, subrounded to subangular quartz grains, max. grains 0.125-0.25 mm. size, few grains 0.06-0.125 mm. size, Muscovite present | Moderately packed | Point contact | | | Ferruginous cement | Undulose extinction present, Effervesence absent |
| RUC2018/2/TT11 | Moderately sorted, subrounded to subangular quartz grains, Max. grains 0.125-0.5 mm. size, few grains 0.125-0.25 mm. size, Muscovite present | Moderately packed | Point contact | | | Ferruginous cement | Undulose extinction present, Effervesence absent |
| RUC2018/2/TT12 | Moderately sorted, subrounded to subangular quartz grains, max.grains 0.125-0.25 mm. size, few grains 0.06- 0.125 mm. size Muscovite present | Moderately packed | Point contact | | | Ferruginous cement | Undulose extinction present, Effervesence absent |
| RUC2018/2/TT13 | Moderately sorted, subrounded to subangular quartz grains, max.grains 0.125-0.25 mm. size, few grains 0.06- 0.125 mm. size Muscovite present | Moderately packed | Point contact | | | Ferruginous cement | Undulose extinction present, Effervesence absent |

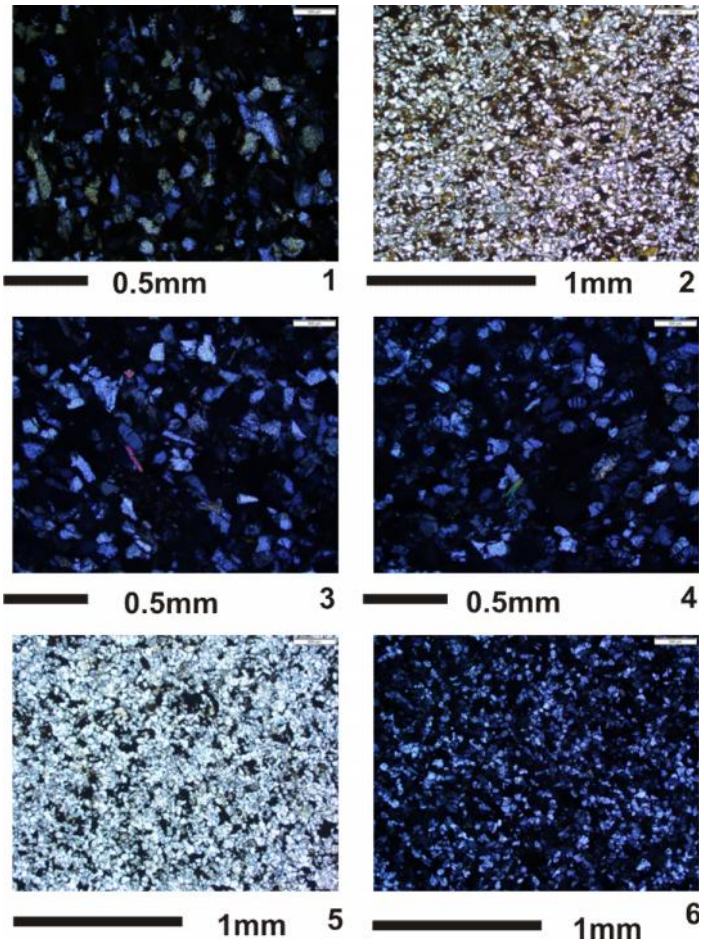
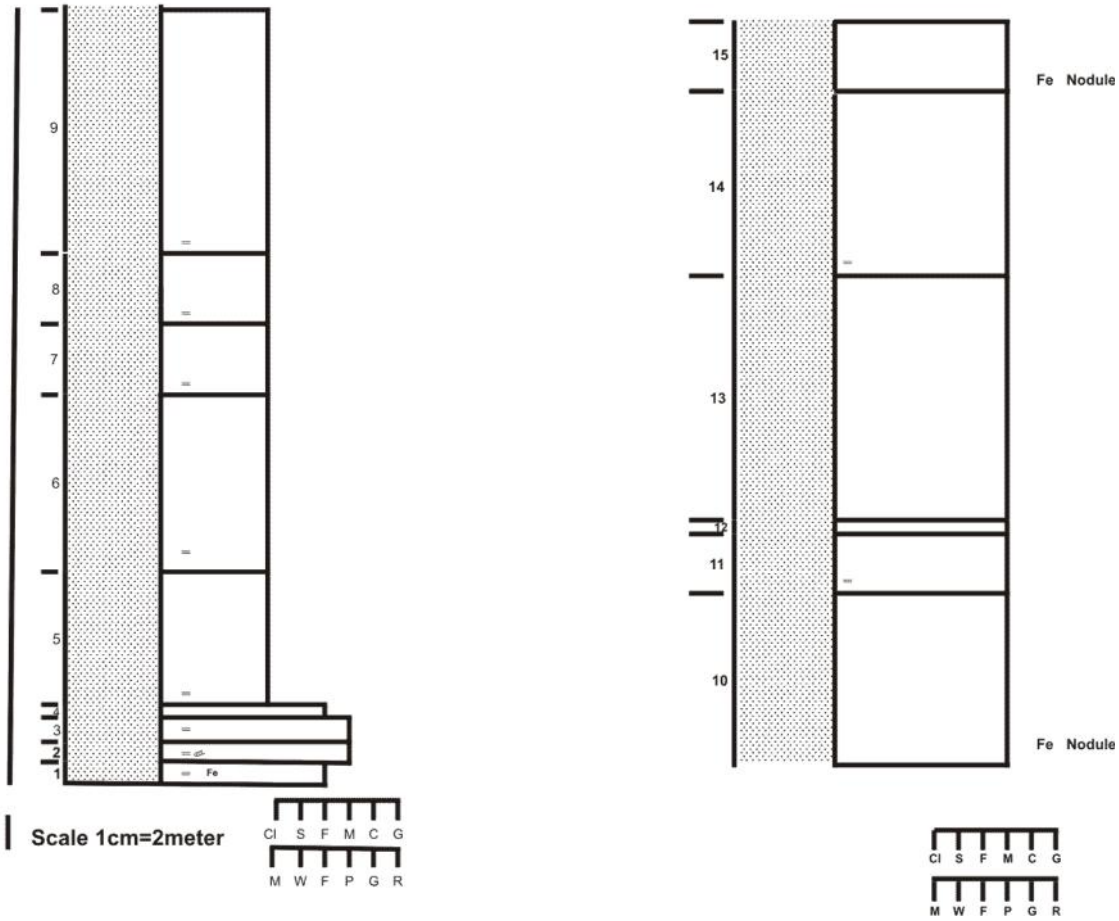



Fig.: Petrographic plate of research area showing quartz grains orientation, Muscovite present.

**Litholog**

**Litholog of Tapkeshwari temple section**




**Conclusion**

According to petrography study of Tapkeshwari temple section it has been observed that sandstone is mostly fine to medium grained, quartz grains subrounded to subangular, moderately to well packed sandstone, cement is ferruginous. Bioturbation present in beds, ripple marks present, Ophiomorpha trace fossils found. Most quartz grains are monocrystalline show undulose extinction.

Petrographic study of rocks reveals environment and tectonic setting of the section, here sandstone is mostly fine to medium grained which indicates that provenance is not very far away, because we are not getting conglomerates and quartz grains are subrounded to subangular, which indicates that provenance is nearly the area of tectonic setting. Sandstone is moderately to well packed, which depicts that it is deposited in fresh water environment. Ripple marks present in sandstone beds indicates low level of bioturbation. Cement is Ferruginous between the grains of sandstone which is a result of downward leaching process in the area.

Ophiomorpha trace fossil assemblages is characterised by moderate bioturbation and low trace fossil diversity. Ophiomorpha ichnofossil indicates continent to sea shore environment. When we approaches towards sea shore marshy condition predominates which are called tidal flat. In tidal flat environment we are getting clay which is characeteristic of this environment. Here we found remnants of petrified wood fossils which shows low to moderate burning effect. Wood logs are also deposited here which generally leads to lignite formation.

**References**


~ Ahmad, A.H.M., and G.M. Bhat. 2006. Petrofacies, provenance and diagenesis of the Dhosa sandstone member (Chari formation) at Ler, Kachchh sub-basin, western India. Journal of Asian Earth Sciences 27 (6): 857-872.

~ Biswas, S.K. & Deshpande, S.V. 1968. The basement of the Mesozoic sediments of Kutch, western India. Bull. Geol. Min. Met. Soc. Ind., 40.

~ Biswas, S.K.1971. Note on the geology of Kutch. The Quarterly Journal of the Geological. Mining and Metallurgical Society of India, 43 no 4:223-235.

~ Biswas, S.K.1980. Mesozoic rock stratigraphy of Kutch, Gujarat.- The Quarterly Journal of the Geological. Mining and Metallurgical Society of India, 49 no. 3 & 4: 1-51.

~ Biswas, S.K. 1991. Stratigraphy and sedimentary evolution of the Mesozoic basin of Kutch, western India.- In: S.K. Tandon (ed.) Stratigraphy and sedimentary evolution of western india.: 54-103.

~ Biswas, S.K. 1982. Rift basins in western margin of India and their hydrocarbon prospects with special reference to Kutch Basin.- American Association of Petroleum Geologists Bulletin, 66: 1497-1513.

~ Fürsich, F.T. 1998. Environmental distribution of trace Fossils in the Jurassic of Kachchh (western Indian).- Facies, 39: 243-272.

~ Fürsich, F.T., Pandey, D.K., Callomon, J.H., Oschmann, W. & Jaitly, A.K. 1994a, Contributions to the Jurassic of Kachchh, Wesrtern Indi. II. Bathonian stratigraphy and depositional environment of the Sadhara dome, Pachchham Island.- Beringeria, 12: 95-125.

~ Fürsich, F.T., Pandey, D.K., Oschmann, W. Collomon, J.H. & Jaitly, A.K. 1994a. Contribution to the Jurassic of Kachchh, western India. II. Bathonian stratigraphy and depositional environment of Sadhara Dome, Pachchham Island. Beringeria, vol. 12: 95-125.

~ Fürsich, F.T., Pandey, D.K., Oschmann, W. Jaitly, A.K. & Singh,I.B. 1994b. Ecology and adaptive strategies of corals in unfavourable environments: Examples from the middle Jurassic of Kachchh basin, western India.- Neues Jahrb. Geol. Paläontol. Abhand., v. 286,: 269-303.

~ Fürsich, F.T.; Oschmann, W.; Singh, I.B. & Jaitly, A.K. 1992. Hard grounds, reworked concretion levels and condensed horizons in the Jurassic of Western India: Their significance for basin analysis.- Journal of Geological Society, London, 149: 313-331.

~ Fürsich, F.T.; Pandey, D.K. Oschmann, W.; Jaitly, A.K. & Singh, I.B. 1994. Ecology and adaptive strategies of corals in unfavourable environments: Examples from the Middle Jurassic of the Kachchh Basin, Western India., N. Jb. Geol. Palaont. Abh. 194, 2/3 , 269-303.

~ Fürsich, F.T.; Pandey, D.K.; Callomon, J.H.; Jaitly, A.K. & Singh, I.B. 2001. Marker beds in the Jurassic of the KachchhBasin, western India: Their depositional environment and sequence-stratigraphic significance.- Journal of Palaeontological Society of India, 46: 173-198.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