

# Discovery of Trace Fossils from Lower Odania Member of Lathi Formation of Jaisalmer Basin, Akal area, District- Jaisalmer, Western Rajasthan, India

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**Abstract:** The Lathi Formation is the oldest lithostratigraphic unit unconformably overlying rocks of Malani Igneous suites, Birmania Formation, Marwar Supergroup and Bhadhura Formation and overlain by lower Hamira Member of Jaisalmer Formation of the Jaisalmer Basin. It is well developed mainly in the vicinity of Lathi, Odania, Thaiat and Akal area and divided into two members viz; Lower Odania Member and Upper Thaiat Member. The present investigations here documented eight trace fossils namely *Thalassinoides suevicus*, *Thalassinoides paradoxica*, *Ophiomorpha nodosa*, *Ophiomorpha borneensis*, *Palaeophycus heberti*, *Palaeophycus tubularis*, *Gyrocrate* and *Phycodes palmatum* from grayish yellow coarse to medium grained calcareous sandstone of Lower Odania Member of Lathi Formation of Jaisalmer Basin in Akal area. The trace fossils bearing Akal section is located about 18km south of Jaisalmer city on NH-15. The complete section is about 22m thick comprises glauconitic sandstone at the base, calcareous sandstone, petrified wood bed and ferruginous sandstone with box works and concretionary structures. These trace fossils are well -preserved and abundant in nature in Akal area and ethologically they represents domichnia and fodinichnia. The ichnological and sedimentological investigations suggest near-shore to shallow marine depositional environment of trace fossils bearing calcareous sandstone of Akal area. No age can be assigned on the basis of these trace fossils as they have long range (Precambrian to Recent).

**Key words:** Trace fossils, Odania Member, Lathi Formation, Jaisalmer Basin and Western Rajasthan

## 1. Introduction

Jaisalmer Basin is the mainly Mesozoic -Tertiary basin which is floored by Malani igneous suite, Marwar Supergroup, Bhadhura Formation on surface (Pareek, 1984 and Roy & Jakhar, 2002) and Permo-Triassic Bhuana Formation in sub-surface (Bhandari, 1999 and Roy & Jakhar, 2002). The sediments of the Jaisalmer

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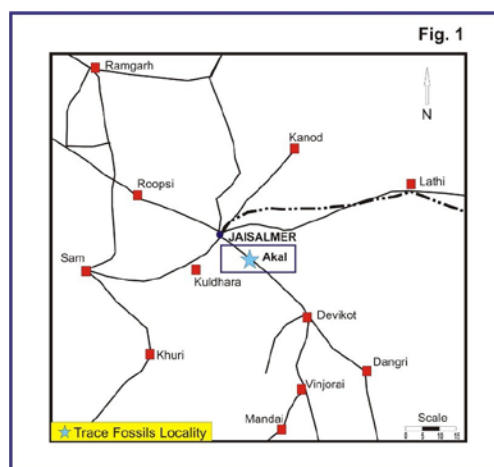
Basin are classified into nine formations viz; Lathi Formation, Jaisalmer Formation, Baisakhi Formation, Bhadesar Formation, Pariwar Formation, Habur Formation, Sanu Formation, Khuiala Formation, Bandah Formation and Shumar Formation (Dashgupta, 1974 and Roy & Jakhar, 2002). The Lathi Formation is represented by glauconitic sandstone at the base, calcareous sandstone, ferruginous sandstone with boxworks and concretionary structures, bands of sandstone and siltstone grading to limestone with tree trunks, trace fossils and dinosaurs footprints (Dashgupta, 1974, Pienkowski et. al., 2015, Parihar et. al., 2016 and Parihar, 2016), the Jaisalmer Formation consists of alternations of marine argillaceous limestone and calcareous sandstone with a fossiliferous oolitic bed at top (Dashgupta, 1974, Roy & Jakhar, 2002), the Baisakhi Formation comprises marine shales alternating with sandstone and ammonites, the Bhadesar Formation consists of coarse to fine grained sandstone, the Pariwar Formation is represented by sandstone and shales alternations with plant fossils, the Habur Formation is dominantly composed of marine coquinooidal limestone and sandy limestone, the Sanu Formation is represented by poorly consolidated beds of cross bedded, reddish, glauconitic sandstone, silty sandstone and cementing limestone and marl, the Khuiala Formation is represented by shale and foraminiferal limestone, the Bandah Formation is represented by shaly limestone, calcareous sandstone, ferruginous sandstone and whitish limestone and the Shumar Formation is represented by boundary argillaceous limestone shale and calcareous sandstone (Dashgupta, 1974, Pareek, 1984 and Roy & Jakhar, 2002). Many trace fossils have been already reported from the rocks of the Jaisalmer Basin by various researchers such as Paranjale et. al., (2013), recorded *Lockeia cunctator*, *L. siliquaria*, *P. rugosa*, *Ptychoplasma vagans* along with *Palaeophycus tubularis*, *P. striatus*, *Heliophycus* and *Lophoctenium* from Bada Bag Member of Jaisalmer Formation; Borkar and Kulkarni, (2006), recorded *Thalassinoides*, *Planolites*, *Ophiomorpha* and *Rhizocoralium* from Baisakhi Formation; Sudan et. al., 2005 reported *Gyrochorte*, *Didymaulichnus* and *Planolites* from Bhadesar Formation whereas *Ancorichnus ancorichnus*, *Conichnus conicus*, *Gyrochorte comosa*, cf. *Jamesonichnites heinbergi*, *Imponoglyphus kevadiensis*, *Laevicyclus mongraensis*, *Monocraterion tentaculatum*, *Ophiomorpha nodosa*, *Palaeophycus tubularis*, *P. bolbiterminus*, *Phycodes palmatus*, *Planolites beverleyensis*, *Rhizocoralium*, *Rosselia rotatus*, *R. socialis*, *Teichichnus rectus* reported from Bhadesar Formation by Desai and Saklani, 2014 and *Acanthorhaphis* isp., *Asteriacites* isp., *Cylindrichnus*, *Keckia annulata*, *Laevicyclus mongraensis*, *Ophiomorpha borneensis*, *O. nodosa*, *Paleomendron*, *Palaeophycus heberti*, *P. tubularis*, *Planolites annularis*, *P. beverleyensis*, *P. montanus*, *Thalassinoides horizontalis*, *T. paradoxicus*, *T. suevicus*, *Skolithos verticalis* from the Mesozoic marine sediments of the Jaisalmer basin reported by Mude et. al.,(2012). The present paper here reports with detailed study of trace fossils viz; *Thalassinoides suevicus*, *Thalassinoides paradoxica*, *Ophiomorpha nodosa*, *Ophiomorpha borneensis*, *Palaeophycus heberti*, *Palaeophycus tubularis*, *Gyrochorte* and *Phycodes palmatum*

from grayish yellow coarse to medium grained calcareous sandstone of Lower Odania Member of Lathi Formation of Jaisalmer Basin in Akal area.

### Geology of the Study Area:

The Lathi Formation is the oldest lithostratigraphic unit unconformably overlying rocks of Malani Igneous suites, Birmania Formation, Marwar Supergroup and Bhadhura Formation and overlain by lower Hamira Member of Jaisalmer Formation of the Jaisalmer Basin. It is well developed and well exposed mainly in the vicinity of Lathi, Odania, Thaiat and Akal area. The Lathi Formation is more than 350 m thick and thickness increases towards northwest (Roy and Jakhar, 2002). It is divided into two members viz; Lower Odania Member and Upper Thaiat Member (Dasgupta, 1975). The lithology of the lower Odania Member of Lathi Formation are white and maroon sandy siltstone, coarse grained sandstone, glauconitic sandstone, calcareous sandstone, dark ferruginous sandstone, coarse ill-sorted arkosic sandstone and petrified wood bed having cross bedding and other sedimentary structures. The upper Thaiat Member is best exposed in scrap sections near Thaiat village and other area and its lithology are bands of sandstone and siltstone grading to limestone having cross bedding (Table 1). The present trace fossils bearing Akal section is the part of Lower Odania Member of Lathi Formation and located about 18km south of Jaisalmer city on NH-15 (Fig. 1). The complete section is about 22 m thick comprises glauconitic sandstone at the base, calcareous sandstone, petrified wood bed and ferruginous sandstone with boxworks and concretionary structures. The *Thalassinoides suevicus*, *Thalassinoides paradoxica*, *Ophiomorpha nodosa*, *Ophiomorpha borneensis*, *Palaeophycus heberti*, *Palaeophycus tubularis*, *Gyrocrote* and *Phycodes palmatum* found in grayish yellow coarse to medium grained calcareous sandstone of Lower Odania Member of Lathi Formation of Jaisalmer Basin in Akal area (Fig. 2).

Fig. 1: Location map of the Akal Section of Lower Odania Member of Lathi Formation of Jaisalmer Basin showing trace fossils locality.



198 **Discovery of Trace Fossils from Lower Oдания Member of Lathi Formation of Jaisalmer Basin, Akal area, District- Jaisalmer, Western Rajasthan, India**

Fig. 2: Generalized lithostratigraphic section of Akal area of Lower Oдания Member of Lathi Formation of Jaisalmer Basin

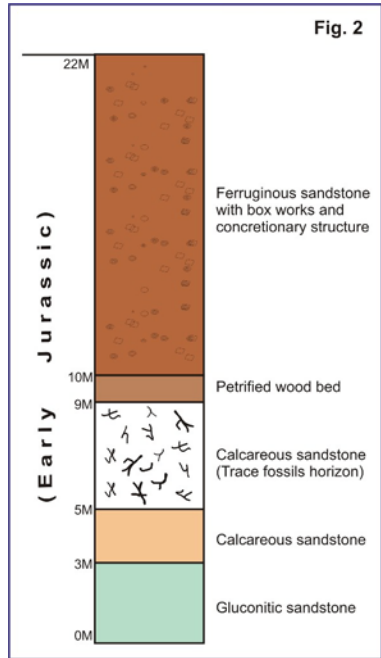


Table: 1. Generalized Geological Succession of the Lathi Formation.

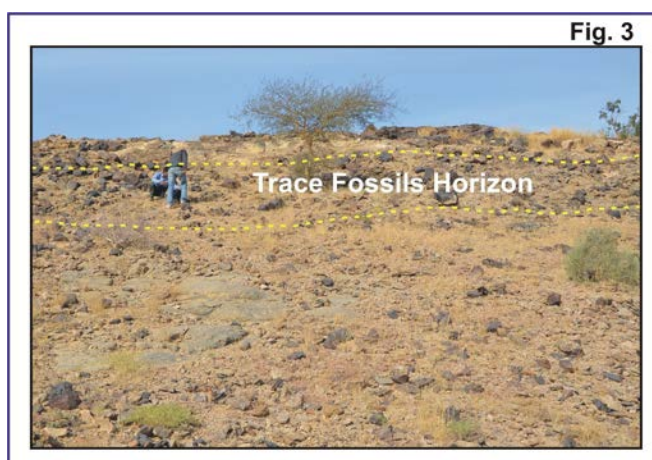
<b>J A I S A L M E R F O R M A T I O N</b>		
<b>Lathi Formation (Early Jurassic)</b>	<b>Upper Thaiat Member</b>	Inter bedded sequence of Mudstone, shale, siltstone and fine to medium grained sandstone grading to limestone.
	<b>Lower Oдания Member</b>	Ferruginous Sandstone with box works and concretionary structures. Petrified wood bed. <b>Calcareous Sandstone with trace fossils.</b> Gluconitic Sandstone at the base
<b>S H U M A R W A L I F O R M A T I O N</b>		

## Palaeontology:

### Trace Fossils:

The present paper here reports eight trace fossils from greyish yellow coarse to medium grained calcareous sandstone of Lathi Formation of Jaisalmer Basin. They are identified as *Thalassinoides suevicus*, *Thalassinoides paradoxica*, *Ophiomorpha nodosa*, *Ophiomorpha borneensis*, *Palaeophycus heberti*, *Palaeophycus tubularis*, *Gyrocrote* and *Phycodes palmatum*. All these trace fossils are well-preserved and abundant nature in Lower Odania Member of Lathi Formation of Jaisalmer Basin in Akal area (Fig. 3).

Fig. 3: Field photograph showing outcrops of Akal section of Lower Odania Member of Lathi Formation showing trace fossils bearing horizon



## 2. Methodology

The sedimentological, ichnological variation and responses of trace fossils to sediments have been studied from the present Lathi Formation at Akal Section in the field and accordingly lithostratigraphic section has been prepared. All the measurements of the trace fossils have been done in the field. All ichnological interpretations are based on field observations and collected specimens kept for repository in our palaeontology lab. The present study of ichnology follows the Treatise on invertebrate Palaeontology (Hantzschel, 1975). The morphological classification of Simpson, (1975), ethological classification of Seilacher, (1964) and facies classification of Seilacher, (1964, 1967) are adopted.

### Systematic Ichnology:

**Ichnogenus:** *Thalassinoides*, (Ehrenberg, 1944).

**Ichnospecies;** *Thalassinoides suevicus isp.*, (Reith, 1932), (Plate 1A & B)

200 **Discovery of Trace Fossils from Lower Odania Member of Lathi Formation of Jaisalmer Basin, Akal area, District- Jaisalmer, Western Rajasthan, India**

**Material:** Specimen Nos. DG/JNVU/LF/TF/201,202.

**Description:** *Thalassinoides suevicus* trace fossils are Y – shaped branching, full relief, smooth wall tubes, horizontal to slightly oblique three dimensional burrow system (displaying a network of triple junction), burrow tubes length varying from 12-14cm and diameter of burrow tube from 2-3cm. Normally burrow tubes are filled with calcareous sediments.

**Remark:** *Thalassinoides* are typically recorded in shallow facies including beach, near-shore and shelf where as *Thalassinoides suevicus*, (Rieth, 1932) characterizes shallow marine environments as three- dimensional systems (Mangano and Buatois, 1991; Fursich & Oschmann, 1993; Giannetti & Monaco, 2004 and Parihar et. al., 2016). They are mainly produced by crustaceans (Frey *et. al.*, 1978, 1984 and Monaco & Garassino, 2001) and considered as a feeding burrow system created in water saturated cohesive substrate under oxygenated and energetic environments (Ekdale, 1992). The crustaceans producing *Thalassinoides* may survive transport in turbidity currents and produce burrow anoxic conditions for a limited time.

**Occurrences:** Greyish yellow coarse to medium grained calcareous sandstone, Lathi Formation, Jaisalmer Basin, Akal Area, Jaisalmer.

**Ichnospecies; *Thalassinoides paradoxica isp.*, (Woodward, 1830), (Plate 1C).**

**Material:** Specimen Nos. DG/JNVU/LF/TF/203.

**Description:** *Thalassinoides paradoxica* trace fossils are T-shaped branching, smooth wall tubes, horizontal to slightly vertical burrow system, burrow tubes length varying from 10-12cm and diameter of burrow tube from 2-3cm. Normally burrow tubes are filled with calcareous sediments.

**Remark:** *Thalassinoides* are typically recorded in shallow facies including beach, near-shore and shelf where as *Thalassinoides suevicus*, (Rieth, 1932) characterizes shallow marine environments as three- dimensional systems (Mangano and Buatois, 1991; Fursich & Oschmann, 1993; Giannetti & Monaco, 2004). They are mainly produced by crustaceans (Frey *et.al.*, 1978, 1984 and Monaco & Garassino, 2001) and considered as feeding burrows.

**Occurrences:** Greyish yellow coarse to medium grained calcareous sandstone, Lathi Formation, Jaisalmer Basin, Akal Area, Jaisalmer.

**Ichnogenus: *Ophiomorpha*, (Lundgren, 1891).**

**Ichnospecies: *Ophiomorpha nodosa isp.*, (Lundgren, 1891) (Plate 2A).**

**Discovery of Trace Fossils from Lower Odania Member of Lathi Formation of Jaisalmer Basin, Akal area, 201  
District- Jaisalmer, Western Rajasthan, India**

**Material:** Specimen Nos. DG/JNVU/LF/TF/204.

**Description:** Vertical and horizontal, branched and unbranched, cylindrical tunnel or burrow systems, ovoid or irregular polygonal pellets, (Frey *et.al.*, 1978). The diameter of burrow tube is about 1-3cm while length is about 11-12cm. The interior walls of burrow tubes are smooth whereas the burrow tubes are covered by elongated or irregular fecal pellets. The burrow tubes were filled with calcareous sediments.

**Remark:** *Ophiomorpha* is feeding and dwelling burrow which normally occur in shallow water near-shore deposits (Weimar and Hoyt, 1964; Frey *et.al.*, 1978), but also has been reported from deep-sea deposits (Kern and Warne, 1974; Crimes, 1977; Crimes *et.al.*, 1981; Uchman, 1988, 1989, 1990, 1995), since the Mesozoic (Bottjer *et.al.*, 1987). It is mainly produced by crustaceans, shrimps and ghost shrimps where as it is also formed by shrimps comparable to recent callianassids in the Mesozoic -Cenozoic sediments (Weimar and Hoyt, 1964; Frey *et.al.*, 1978). The present burrows are much similar to that of *Ophiomorpha nodosa* Lundgren and has been discovered by various workers from the Indian subcontinent (Chiplonkar and Ghare, 1975; Kundal *et.al.*, 2005; Kundal and Dharashivkar, 2006; Kundal and Mude, 2008, Mude *et.al.*, 2012, Parihar, et. al., 2016).

**Occurrences:** Greyish yellow coarse to medium grained calcareous sandstone, Lathi Formation, Jaisalmer Basin, Akal Area, Jaisalmer.

**Ichnospecies:** *Ophiomorpha borneensis* isp., (Keij) (Plate 2B).

**Material:** Specimen Nos. DG/JNVU/LF/TF/205.

**Description:** Vertical and slightly horizontal to inclined, branched and unbranched, cylindrical tunnel or burrow systems with regular bi-lobed pellets, having diameter of burrow tube is about 4cm and length is about 10-11cm. The interior walls of burrow tubes are smooth whereas the burrow tubes are covered by dense regularly distributed bilobed fecal pellets. The burrow tubes were filled with calcareous sediments.

**Remark:** These are horizontal and inclined burrows and its burrows wall consists of dense regularly distributed bilobed pellets hence these are placed under *Ophiomorpha borneensis*, Keij (Frey *et.al.*, 1978). They are interpreted as feeding and dwelling burrows and mainly produced by crustaceans, shrimps and ghost shrimps where as it is also formed by shrimps comparable to recent callianassids in the Mesozoic -Cenozoic sediments (Weimar and Hoyt, 1964; Frey *et.al.*, 1978). This ichnospecies has been also correlated to *Ophiomorpha borneensis* found from different stratigraphic horizons from Indian Subcontinent (Kundal and Dharashivkar, 2006; Kundal and Mude, 2008, Mude et. al., 2012 and Parihar, et. al., 2016).

**Occurrences:** Greyish yellow coarse to medium grained calcareous sandstone, Lathi Formation, Jaisalmer Basin, Akal Area, Jaisalmer.

**Ichnogenus:** *Palaeophycus*, (Hall, 1847).

**Ichnospecies:** *Palaeophycus heberti* isp., (Hall, 1847) (Plate 2C).

**Material:** Specimen Nos. DG/JNVU/LF/TF/206.

202 **Discovery of Trace Fossils from Lower Odania Member of Lathi Formation of Jaisalmer Basin, Akal area, District- Jaisalmer, Western Rajasthan, India**

**Description:** Thickly lined, horizontal to oblique, unbranched and can be branched, disposed parallel to the bedding plane, smooth to sometime irregularly wall and having thick walled. The diameter of burrow tube is about 4cm and length of about 13-14cm. The burrow tubes were filled with calcareous matrix.

**Remark:** *Palaeophycus* is considered as a combined dwelling and feeding burrows formed by worm like animals. The present burrows have thick walled therefore, they are described under *Paleophycus heberti* (Saporta) (Pemberton and Frey, 1982). This *Palaeophycus heberti* also correlated to from Bagh Group of Madhya Pradesh, (Badve, 1987 and Kundal & Sanganwar, 1998), Kalyanpur Limestone of Dwarka Formation (Kundal and Dharashivkar, 2006) and Bhuj Formation of Kachchh Baisn (Mude *et.al.*, 2012), Mandai Formation of Barmer Basin (Parihar, *et. al.*, 2016).

**Occurrences:** Greyish yellow coarse to medium grained calcareous sandstone, Lathi Formation, Jaisalmer Basin, Akal Area, Jaisalmer.

**Ichnospecies:** *Palaeophycus tubularis isp.*, (Plate 3A & B).

**Material:** Specimen Nos. DG/JNVU/LF/TF/207, 208.

**Description:** Thinly lined, horizontal to oblique, unbranched thick walled burrows, disposed parallel to the bedding plane, smooth to sometime irregularly walled and borrow show tube-like appearance. The diameter of burrow tube is about 1-2cm and length of about 4-8cm. The burrow tubes were filled with calcareous sediments.

**Remark:** *Palaeophycus* is considered as a combined dwelling and feeding burrows formed by worm like animals. The present burrows have thick walled with tube like appearance therefore, they are described under *Paleophycus tubularis* (Pemberton and Frey, 1982). This ichnospecies also correlated to *Paleophycus tubularis* from Bagh Group of Madhya Pradesh (Badve, 1987 and Kundal & Sanganwar, 1998) from Babaguru Formation at Gujarat (Kundal *et. al.*, 2005) and from Positra Limestone of Dwarka Formation (Kundal and Dharashivkar, 2006) and from the Bhuj Formation, Kachchh (Mude *et.al.*, 2012) and Mandai Formation of Barmer Basin (Parihar, *et.al.*, 2016).

**Occurrences:** Greyish yellow coarse to medium grained calcareous sandstone, Lathi Formation, Jaisalmer Basin, Akal Area, Jaisalmer.

**Ichnogenus:** *Gyrochorte*, (Heer, 1865) (Plate 3C & 4A).

**Material:** Specimen Nos. DG/JNVU/LF/TF/209.

**Description:** Sinuous and curved, long parallel bi-serially arranged burrow tubes, horizontal trails consist of plaited ridges, usually more or less horizontal or parallel to bedding plane. The burrow system shows length of about 18-20cm and the diameter is 3-4cm wide whereas each burrow having diameter of about 1-2cm. The burrow tubes are filled with calcareous sediments.

**Remark:** *Gyrochorte* is considered as a feeding burrow produced by worms like animals, probably annelids that created a bi-loped, vertically penetrating and sometimes plaited meandering trace (Gibert and Benner, 2002).



**Occurrences:** Greyish yellow coarse to medium grained calcareous sandstone, Lathi Formation, Jaisalmer Basin, Akal Area, Jaisalmer.

**Ichnogenus:** *Phycodes*

**Ichnospecies:** *Phycodes palmatum isp.*, (Hall, 1852) (Plate 4B).

**Material:** Specimen Nos. DG/JNVU/LF/TF/210.

**Description:** Bundled splayed or broom-like pattern, horizontal burrow originating from a central base point. Its burrow system is long, palmately branching close together, with branches terminating in fan-shaped structure. The burrow system shows length of about 26cm and the branch diameter is 13-14cm wide where as each burrow having diameter of about 3-4cm. The burrow tubes are filled with calcareous sediments.

**Remark:** *Phycodes* is considered as a feeding burrow made by repeated probes by a marine organisms such as worms into the sediments. *Phycodes palmatum* is characterized by its branching and fan-shaped structures or pattern (Hall, 1852). This ichnospecies has been also correlated to *Phycodes palmatum* of Kaladongar Formation of Patcham Island, Kachchh, (Joseph *et.al*, 2012).

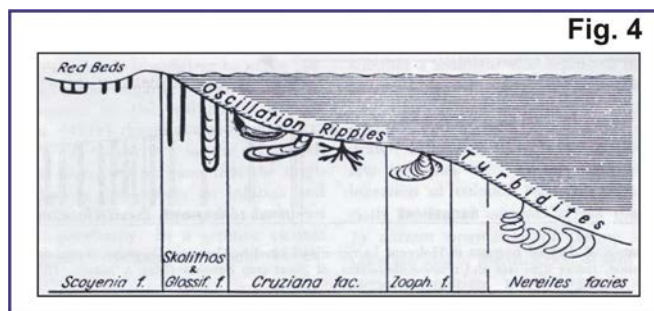
**Occurrences:** Greyish yellow coarse to medium grained calcareous sandstone, Lathi Formation, Jaisalmer Basin, Akal Area, Jaisalmer.

#### **Palaeoenvironmental Significance:**

Trace fossils are biogenic structures preserved on or within the sediments by an organism during their various movements such as dwelling, feeding, resting etc. They are widely used for the interpretation of the palaeoenvironment of the sediments/rocks. Accordingly, Hantzshel, 1975; Seilacher, 1964, 1967; Frey and Howard, 1982 and Simpson, 1975, trace fossils have palaeoenvironmental significance. The sediments of Lower Odania Member of Lathi Formation are examined for ichnological investigation and their role during the deposition of those sediments. Eight trace fossils viz; *Thalassinoides suevicus*, *Thalassinoides paradoxica*, *Ophiomorpha nodosa*, *Ophiomorpha borneensis*, *Palaeophycus heberti*, *Palaeophycus tubularis*, *Gyrocrote* and *Phycodes palmatum* have been reordered, analyzed, described and used for palaeoenvironment interpretation. Palaeoenvironment of marine sediments can be interpreted by investigating lithology, primary sedimentary structures, and faunal elements. The typical trace fossil assemblages occur in different location in sediments of different ages and that assemblage belongs to a particular marine environment and is composed of typical association of trace fossils, constituting ichnofacies (Seilacher, 1954; Hantzschel, 1975). Seilacher, (1967b), has introduced the ichnofacies classification and he has grouped all known trace fossils into six ichnofacies namely, *Scoyenia Facies* (non-marine commonly red beds), *Skolithoes Facies* (littoral; rapid sedimentation), *Glossifungites Facies* (littoral; with erosional surface), *Cruziana Facies* (deeper shallow water, below the true littoral zone), *Zoophycus Facies* (transitional to bathyal zone) and *Nereites Facies* (bathyal to abyssal; pelagic sediments and turbidites (Fig. 4). All these trace fossil species are belongs to *Skolithoes* and *Cruziana* facies which indicate that sediments of the Lower Odania Member of Lathi Formation of the Jaisalmer Basin were deposited in shallow water under high to moderate energy conditions. Thus the ichnological investigations suggests near-shore to shallow marine depositional environment of trace fossils

bearing greyish yellow coarse to medium grained calcareous sandstone of Lower Odania Member of Lathi Formation of the Jaisalmer Basin of Akal Area.

Fig. 4: Bathymetric zonation of trace fossils assemblages (F. Facies) Seilacher (1967b)



### 3. Discussion and Conclusion

1. The following trace fossils *Thalassinoides suevicus*, *Thalassinoides paradoxica*, *Ophiomorpha nodosa*, *Ophiomorpha borneensis*, *Palaeophycus heberti*, *Palaeophycus tubularis*, *Gyrocrota* and *Phycodes palmatum* are identified which reflect the presence of suspension and feeding animals. The trace fossils of the Lower Odania Member of Lathi Formation of Jaisalmer Basin are well-preserved and abundant in nature in Akal area. All these trace fossil species belong to *Skolithos* and *Cruziana* facies which indicate that sediments of the Lower Odania Member of Lathi Formation of Jaisalmer Basin were deposited in shallow water under high to moderate energy conditions. The ichnological and sedimentological investigations suggest near-shore to shallow marine depositional environment of trace fossils bearing calcareous sandstone of Lower Odania Member of Lathi Formation of the Jaisalmer Basin of Akal Area.

2. All these above mentioned trace fossils have been already recorded from different stratigraphic sequences of USA, Russia, Austria, Poland, Australia, Canada, Italy, Germany, Spain and including India. No age can be assigned on the basis of these trace fossils as they have a long range from Cambrian to Recent (Hantzschel, 1962, 1975 & Wetzel, 1983). However, the presence of petrified wood from Lower Odania Member and Dinosaur foot-prints from upper Thaiyat Member of Lathi Formation (Pienkowski et. al., 2015 and Parihar et. al., 2016), can be assigned Early Jurassic age of Lower Odania Member of Lathi Formation of Jaisalmer Basin.

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206 **Discovery of Trace Fossils from Lower Odania Member of Lathi Formation of Jaisalmer Basin, Akal area, District- Jaisalmer, Western Rajasthan, India**

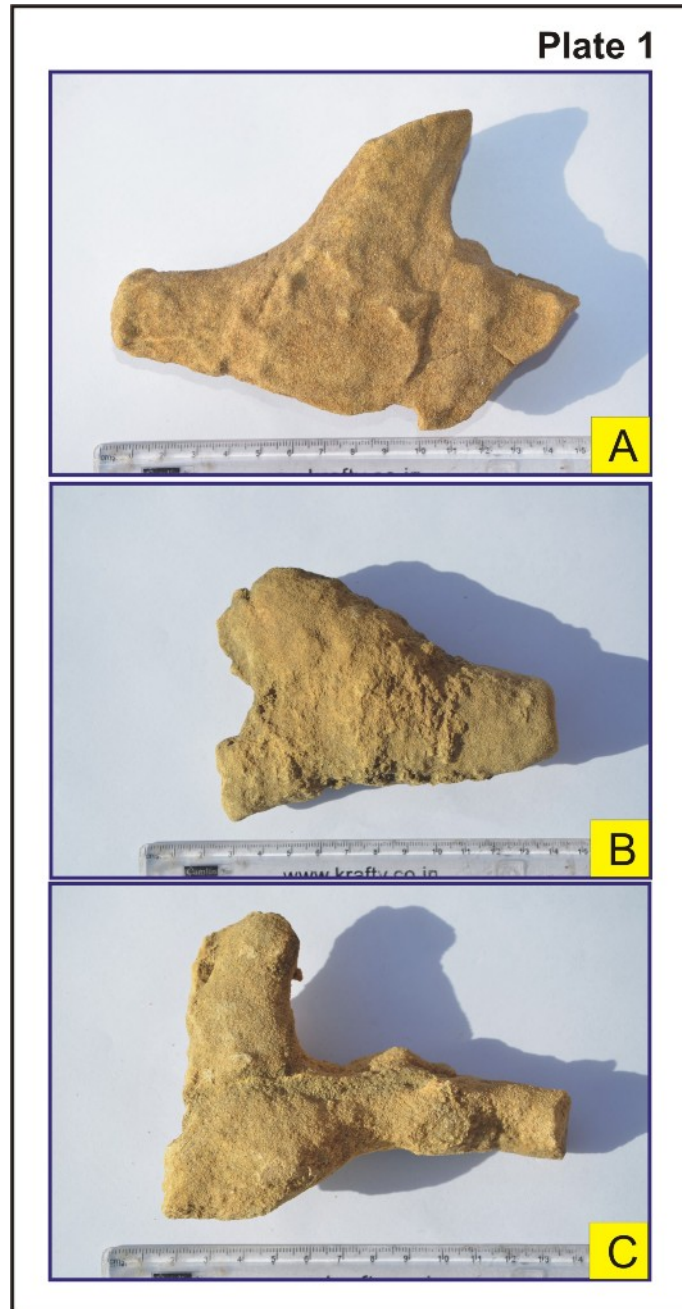
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**Discovery of Trace Fossils from Lower Odania Member of Lathi Formation of Jaisalmer Basin, Akal area, 207 District- Jaisalmer, Western Rajasthan, India**

**Plate 1: A.** *Thalassinoides suevicus* trace fossil preserved in grayish yellow coarse to medium grained calcareous sandstone.

**B.** Y-shaped *Thalassinoides suevicus* trace fossils are branching, smooth wall tubes and horizontal to slightly oblique three dimensional burrow system occurred in grayish yellow coarse to medium grained calcareous sandstone in various size.

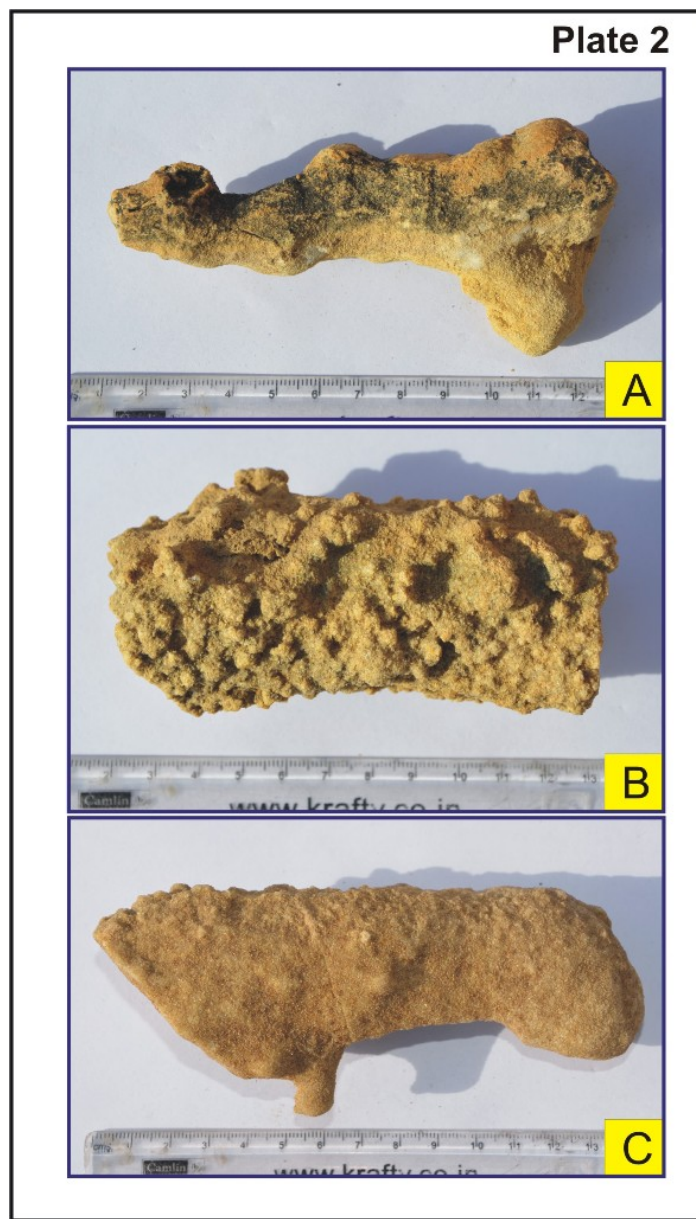
**C.** *Thalassinoides paradoxica* trace fossils are T-shaped branching, smooth wall tubes, horizontal to slightly vertical burrow system found in grayish yellow coarse to medium grained calcareous sandstone.



**Plate 2: A.** *Ophiomorpha nodosa* trace fossil is vertical and horizontal branched and unbranched, cylindrical tunnel or burrow tubes which are covered by elongated or irregular fecal pellets occurred in grayish yellow coarse to medium grained calcareous sandstone.

**B.** *Ophiomorpha borneensis* trace fossil is vertical and slightly horizontal to inclined, branched and unbranched, cylindrical burrow systems with regular bi-lobed pellets found in grayish yellow coarse to medium grained calcareous sandstone.

**C.** *Palaeophycus heberti* trace fossil is having thick walled, horizontal to oblique, branched and unbranched, disposed parallel to the bedding plane, smooth burrow tube occurred in grayish yellow coarse to medium grained calcareous sandstone.

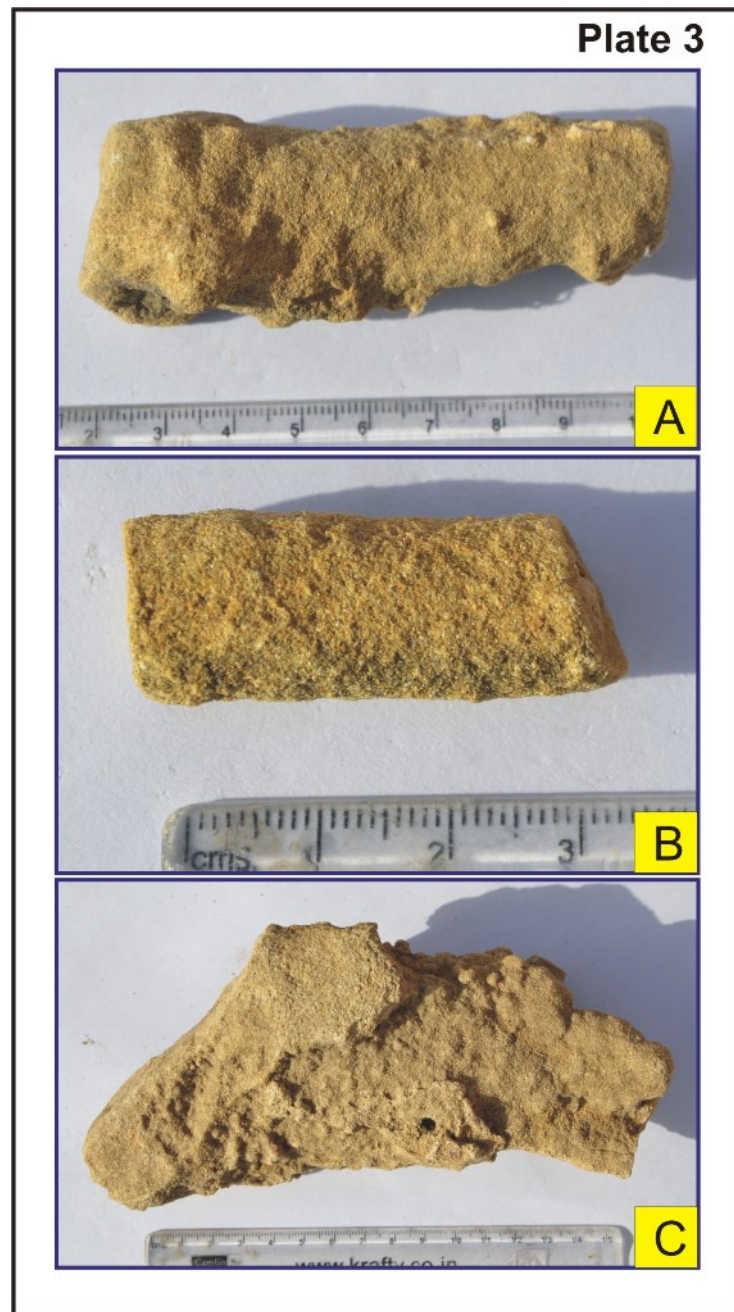


**Discovery of Trace Fossils from Lower Odania Member of Lathi Formation of Jaisalmer Basin, Akal area, 209  
District- Jaisalmer, Western Rajasthan, India**

**Plate 3: A.** *Palaeophycus tubularis* trace fossil is thick walled burrows, horizontal to oblique, branched and unbranched, disposed parallel to the bedding plane and smooth borrow shows tube-like appearance occurred in grayish yellow coarse to medium grained calcareous sandstone.

**B.** *Palaeophycus tubularis* trace fossil found in grayish yellow coarse to medium grained calcareous sandstone.

**C.** *Gyrocrote* trace fossils occurred in grayish yellow coarse to medium grained calcareous sandstone.



**Plate 4: A.** *Gyrocrote* trace fossils showing sinuous and curved, long parallel bi-serially arranged burrow tubes, horizontal trails consist of plaited ridges, usually more or less horizontal or parallel to bedding plane found in grayish yellow coarse to medium grained calcareous sandstone.

**B.** *Phycodes palmatum* trace fossil is bundled splayed or broom -like pattern, horizontal burrow originating from a central base point, palmately branching close together, with branches terminating in fan-shaped structure which is occurred in grayish yellow coarse to medium grained calcareous sandstone.

