

## SHORT COMMUNICATION

### Micro Scale Cross Laminations in the Sandstone of Khari Nadi Formation (Aquitania) from Laiyari Area, Southwestern Kachchh

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**Abstract:** The asymmetric micro scale cross ripple laminations formed under unidirectional traction current are noted from the Aquitania sandstone of Laiyari area of south western Kachchh, Gujarat. The micro facies of micro scale cross laminations represent lower velocity migration at shallow depth waves in littoral and marine environments. Asymmetric ripples signify net landward unidirectional transport of shallow marine water.

**Keywords:** Sandstone, Cross-laminations, Khari Nadi Formation, Kachchh, Gujarat

#### INTRODUCTION

Laiyari village is located 4 km of south west of Aida. About 2 km west of the Aida village, a very long hill range is present which exposes the all lithologies of Khari Nadi Formation. From these lithologies, micaceous sandstone which is underlain by yellow calcareous sandstone shows presence of micro scale cross laminations (Fig 1).

Cross bedding is one of the most important and common features of sedimentary rocks. Traction current deposits silt and mud in different environmental conditions. Asymmetric wave and its relations with current ripples have been deduced by Leeder (1982), Lindholm (1987), Harms et al (1975, 1982), Selley (2000) and Murkute (2004).

Micro scale cross laminations are based on interaction with very small ripples where thickness of each set is 1-2 mm. The relationship between wave currents and ripples has been analyzed for the first time from the sandstone of Laiyari locality of southwestern Kachchh (Fig 1). Biswas (1992) interpreted micaceous sandstone of Laiyari area as part of Khari Nadi Formation with Aquitania age, which has been deposited into littoral to foreshore shallow marine waters. A modified version of the geological map showing the study area is reproduced in Fig 1 (after Biswas and Raju, 1973, Biswas, 1992).

#### SEDIMENTARY STRUCTURE

The asymmetric wave current ripples are formed in shallow water near the breaker zone. Landward transportation of water may have superimposed upon some

surficial waves which resulted into the development of micro scale cross laminations. These laminations are similar with current ripples in geometry but differ in dimensions. In Laiyari area, migration of very small ripples having height (amplitude) less than 125-750  $\mu\text{m}$  (0.125 – 0.750 mm) and wavelength less than 1000 – 2750  $\mu\text{m}$  (1-2.7 mm), is responsible for the production of these micro scale cross laminations with 2-3 sets (Fig 2). The upper bedding surface and sole converge and merge in down flow direction while upper bedding surface makes an angle of about 15° with cross laminae.

#### Lateral and Vertical Microfacies

The presence of micro scale ripple laminations in this sandstone indicates deposition in shallow flowing marine waters. A complex alternation of internal cross laminations has been formed in the environments of periodic net landward flow. The lateral extension of most of the bodies of sediments are related to their thickness and possesses top surface area and somewhat planar bottom (Collinson and Thompson, 1989). Similar physical conditions and supply of sedimentary material have been observed in the studied units. It includes texture, composition and internal structure from top and bottom of these sediments (Fig 2, Fig 3a). On the basis of lithology, depositional environments are depicted as a general indicator. Therefore, for deducing the environmental interpretation, particle composition of sedimentary rocks plays vital role than gross lithology. Thus, the microfacies are the small scale characteristics of rocks that can be recognized in thin sections or hand specimens. Collinson and

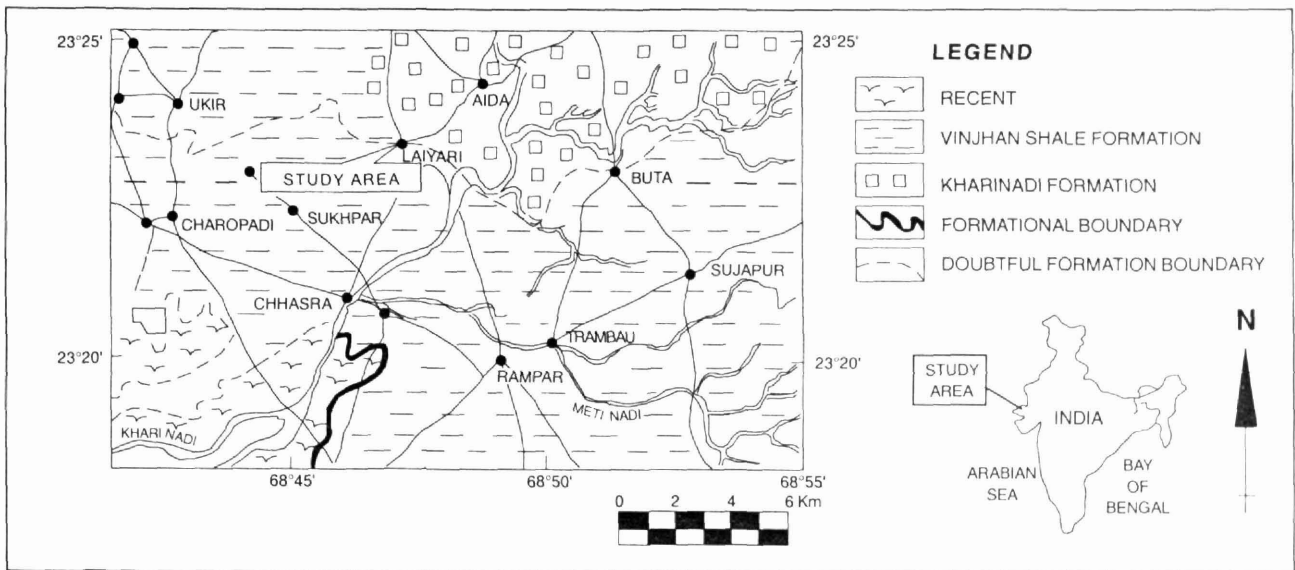


Fig.1. Geological map of Southwestern Kachchh, Gujarat, India (after Biswas and Raju, 1973).

Thompson (1989) described Walther's principle of the succession of facies. It states that facies developed laterally may also occur in vertical sequences.

The micro scale cross ripple laminations in the Laiyari sandstone shows deposition of fine particles like silt, mica

flakes and some mud in many sets with particular direction of orientation (Fig.2). Davies and Ethridge (1975) suggested that the relative abundance and size of individual siliciclastic particles recorded the depositional environments in siliciclastic sediments. Sediments enriched in quartz have

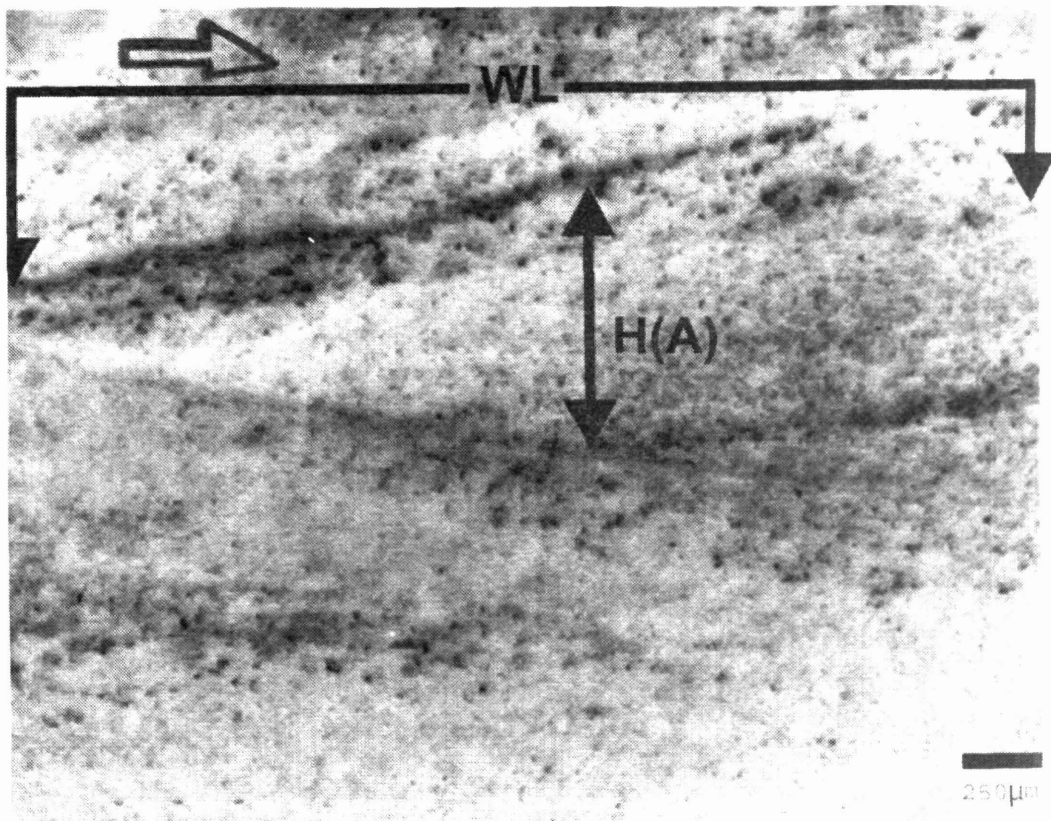
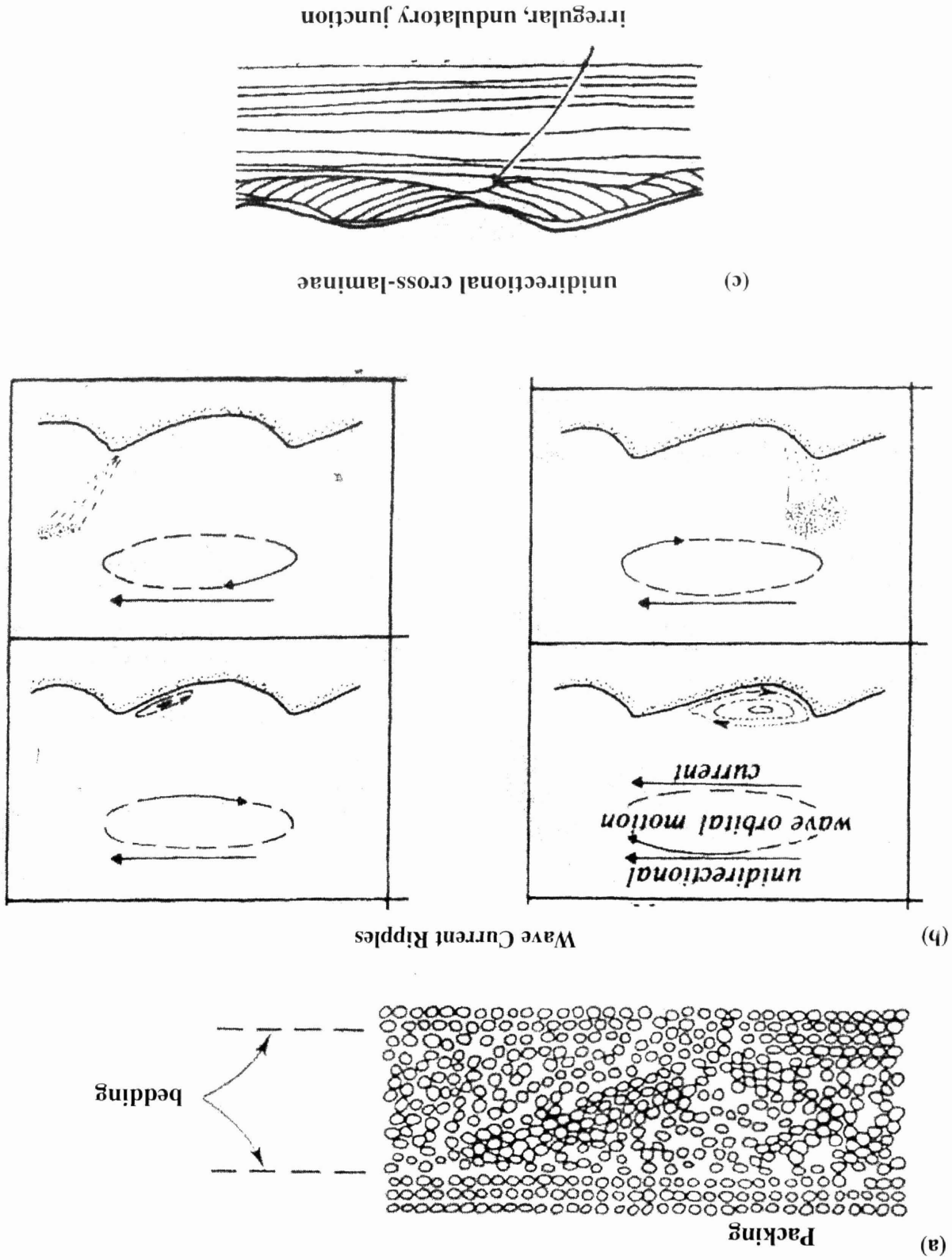


Fig.2. Micro-scale cross laminations showing Height/amplitude ( $H/A$ ) and wavelength of currents ( $WL$ ).

Fig.3. (a) Bedding planes showing Upper bedding surface, Sole and cross laminae (modified after Collinson and Thompson, 1989). (b) The wave formed current ripples with unidirectional cross laminae (after Leeder, 1982 from original data of Inman and Bowen, 1963). (c) Diagnostic internal features of wave formed ripples (after Raaf et al. 1977).



intense winnowing indicates high resistance to mechanical abrasion in high energy environments, whereas less quartz and more fine size matrix material are deposited in low energy environments (Boggs, 1987). Hence, the present micro scale cross laminations suggest low energy environments.

Coarse micas have been used also to indicate position within the basin. These coarse mica flakes have been commonly deposited in the tidal flat, near shore environments (Doyle et al. 1968). The dominance of mica flakes in marine Laiyari sandstone indicates either tidal flat or near shore continental slope environments.

Deposition on a sub horizontal surface by settling of silt and clay size particles from suspension also produces planar stratifications (Harms et al. 1982). Waves in orbital motion under unidirectional current forms cross laminae and irregular junctions with somewhat planar laminations at base, developed under high shear stresses (Figs.3b, c; Raaf et al. 1977).

Vertical variations within each beds are often due to changing composition, internal structure or texture. This

micro scale ripple laminations bears homogenous lithology such as silt and heterogeneous as silty mudstone (Fig.2b; Collinson and Thompson, 1989).

## CONCLUSIONS

It is surmised that presence of micro scale cross laminations in the micaceous sandstone of Laiyari area of Kachchh indicates shallow flowing marine waters. It implies low energy tidal flat or near shore continental slope environment. The unidirectional wave current ripples suggest net landward transport of marine waters which resulted in asymmetric wave current ripples.

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