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Research paper

Microbially originated wrinkle structures on sandstone and their stratigraphic context: Palaeoproterozoic Koldaha Shale, central India

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Abstract

Wrinkle structures on sandstone beds are abundant and present in diverse forms in the Palaeoproterozoic Koldaha Shale, Vindhyan basin, central India. The inferred palaeogeography of sedimentation ranges from offshore marine to terrestrial, the wrinkled sandstones belonging to the relatively deeper marine part. Good preservation of ultramicroscopic microbial elements within these sandstones strongly supports a microbial mat origin of the wrinkles, which was facilitated by development of an oxygen depleted condition immediately beneath the sediment–water interface, as depicted in early pyrite growth. Later, impermeable shale encasing the sandstone beds arrested further scope for destruction of the microbial elements. Trapping of fine detritus by microbial filaments is documented by the invariable occurrence of a silty clay veneer on the wrinkled surfaces, and by its characteristic texture.

Wrinkle morphology has been classified and an attempt has been made to understand the origin of each of the varieties, and to visualize the processes that acted upon the microbial mats to produce the wrinkle structures in their specific palaeogeographic context. The general palaeogeographic bias in occurrence of the sandy wrinkles is well reflected in their concentration in the lower part of the highstand systems tracts (HST's), one superposed above the other, comprising the Koldaha Shale. The smaller-scale palaeogeographic control is indicated by compartmentalization of two wrinkle varieties in the upper and the basal intervals of the HST's, and overlapping occurrence of other varieties in the medial interval with apparent preference for either the upper or the lower levels.

Keywords: Palaeoproterozoic sand wrinkles; Microbial mat; Genetic process; Stratigraphic context; Koldaha Shale

1. Introduction

Microbial mat growth must have been far more widespread in the Proterozoic than at present, but is seldom reported from siliciclastic rocks in their

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stratigraphic context. Ancient microbial signature is generally difficult to recognize in siliciclastic sedimentary rocks and is better known from carbonates. The absence of early cement in the former renders microbial remains readily degradable and makes characteristic microbial textures unrecognizable within the first few hundred years of burial (Park, 1977; Krumbein and Cohen, 1977). Diagenesis also commonly obliterates microbial mat structures in siliciclastic sediments. Growth, metabolism, physical destruction and decay of microbial mats may, nonetheless, leave indirect signatures (Schieber, 1998a, 1999, 2004; Gerdes et al., 2000; Noffke et al., 2001) recognizable in the field. Features indicative of microbial mats in sandstones include wrinkle structures (Hagadorn and Bottjer, 1997, 1999; Pflüger, 1999; Bouougri and Porada, 2002; Banerjee and Sarkar, 2002; Pruss et al., 2004), cracks (Pflüger, 1999; Porada and Löffler, 2000; Bouougri and Porada, 2002; Prave, 2002), roll-up structures (Eriksson et al., 2000; Sarkar et al., 2004), sand chips (Pflüger, 1999; Gerdes et al., 2000), gas domes (Schieber, 1999; Bouougri and Porada, 2002; Noffke et al., 2001), petee structures (Krumbein et al., 1994), palimpsest ripples (Pflüger, 1999; Seilacher, 1999), multidirectional ripple marks (Noffke, 1998), mat fragment impressions and micro fault sets (Pflüger, 1999). Recently Schieber (2004) and Sarkar et al. (2004) tried to categorize the microbial mat features in siliciclastic sediments and sedimentary rocks. Furthermore, Sarkar et al. (this volume) discussed how microbial mats may have influenced sequence stratigraphic architecture of Precambrian clastic sediment depositional settings.

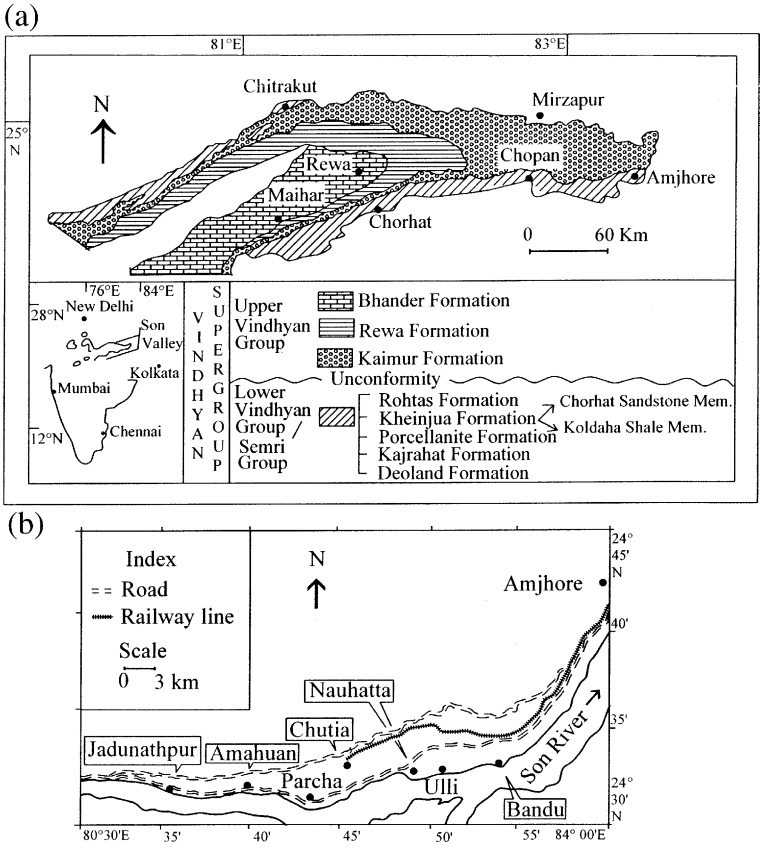

Fig. 1. (a) Geological map showing outcrop distribution of the Vindhyan Supergroup in the Son Valley area, with necessary stratigraphic elaborations (modified after Auden, 1933; Bose et al., 2001). The present paper deals with the findings from the Semri Group from the easternmost end of the Vindhyan basin, near Amjhore (map of India within inset). (b) Location map of the study area.