Journal of Asian Earth Sciences 105 (2015) 1–17

Contents lists available at ScienceDirect

Journal of Asian Earth Sciences

journal homepage: www.elsevier.com/locate/jseaes

Lower Permian fluvial cyclicity and stratigraphic evolution of the northern margin of Gondwanaland: Warchha Sandstone, Salt Range, Pakistan

Shahid Ghazi [a,b,*], Nigel P. Mountney [a], Sadaf Sharif [b]

[a] School of Earth and Environment, The University of Leeds, LS2 9JT, UK
[b] Institute of Geology University of the Punjab, Lahore 54590, Pakistan

A R T I C L E I N F O

Article history:
Received 14 May 2013
Received in revised form 22 February 2015
Accepted 1 March 2015
Available online 21 March 2015

Keywords:
Fluvial
Cyclicity
Stratigraphic evolution
Gondwanaland
Lower Permian
Warchha Sandstone
Salt Range

A B S T R A C T

During the Lower Permian (Artinskian), fluvial conditions prevailed in what is now the Salt Range of northern Pakistan. Deposits of the Warchha Sandstone are characterised by a range of fluvial facies and architectural elements that together record both the proximal and distal parts of a meandering river system that drained the northern margin of Gondwanaland. Stratigraphic units are arranged into vertically stacked fining-upward cycles represented by thin accumulations of channel-lag deposits at their bases, and sandstone-dominated channel fill and thicker accumulations of overbank mudstone at their tops. Sedimentary cyclicity records fluvial system development on a variety of spatial and temporal scales. Overall, the Warchha Sandstone preserves a series of three to ten vertically stacked fining-upward cycles that form part of a larger-scale, third-order sequence that is itself bounded by regionally extensive and laterally correlatable unconformities that were generated in response to combined tectonic and eustatic changes. The sequence-stratigraphic architecture reflects regional palaeogeographic development of the Salt Range region. The small-scale fluvial cycles originated through autogenic mechanisms, predominantly as a result of repeated channel avulsion processes that occurred concurrently with ongoing subsidence and the progressive generation of accommodation. Each erosively based fining-upward fluvial cycle is divided into three parts: a lower part of trough cross-bedded conglomerate and coarse sandstone; a middle part of tabular cross-bedded, ripple cross-laminated and horizontally laminated sandstone; and an upper part of predominantly horizontally laminated and massive mudstone. Overall, the Warchha Sandstone records the progradation of a wedge of non-marine strata into a previously shallow-marine depositional setting. The underlying marine Dandot Formation is terminated by a major unconformity that represents a type-I sequence boundary associated with a regional relative sea-level fall and a significant regression of the Tethyan shoreline. The overlying Warchha Sandstone represents the onset of the subsequent lowstand systems tract in which a northward-flowing meandering river system redistributed clastic detritus derived from a tectonically-active source area (the Aravalli and Malani ranges) that lay to the south. This episode of fluvial sedimentation was terminated by a widespread marine transgression recorded by an abrupt upward transition to estuarine and shallow-marine deposits of the overlying Sardhai Formation. This change marks the transition from lowstand deposits to a transgressive system tract.

© 2015 Elsevier Ltd. All rights reserved.

1. Introduction

The Salt Range of Pakistan forms part of the Sub-Himalayan Mountains, which stretch for more than 180 km in an east–west orientation between the Jehlum and Indus rivers, along the southern margin of the Potwar Basin (Fig. 1). Within the Salt Range, a thick sedimentary cover, consisting of Precambrian to recent deposits, unconformably overlies low-grade metamorphic and igneous rocks (Gee, 1989). Within this cover succession the Lower Permian Nilawahan Group of the Gondwana Realm is subdivided into the Tobra, Dandot, Warchha and Sardhai formations. The Warchha Sandstone represents the deposits of a fluvial system that passed northwards into a coastal plain and estuarine system at the margin of the Tethys Sea (cf. Valdiya, 1997; Ghazi, 2009; Ghazi

* Corresponding author at: Institute of Geology University of the Punjab, Lahore 54590, Pakistan.
E-mail address: ghazigeo6@gmail.com (S. Ghazi).

http://dx.doi.org/10.1016/j.jseaes.2015.03.001
1367-9120/© 2015 Elsevier Ltd. All rights reserved.

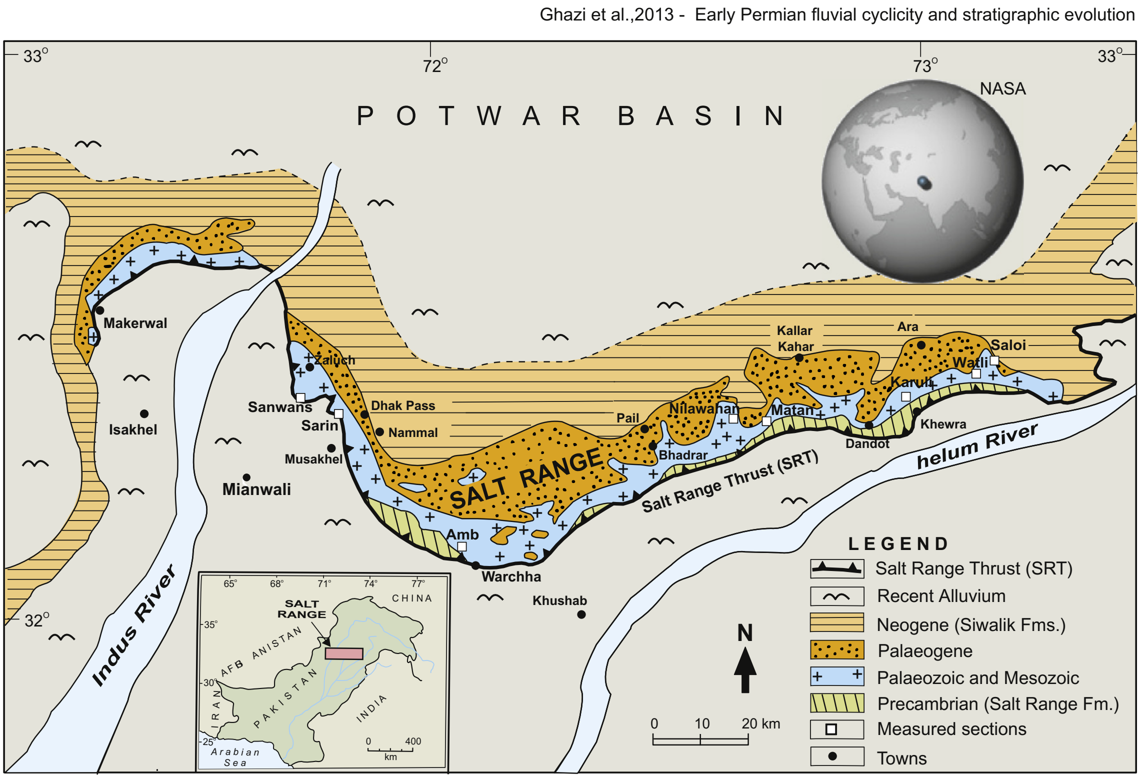

Fig. 1. Location map showing the location of measured sections of the Warchha Sandstone in the Salt Range, Pakistan.

and Mountney, 2012a, 2012b). The Warchha Sandstone forms a clastic wedge of fluvial strata bounded both below and above by marine deposits of the Dandot and Sardhai formations, respectively (Ghazi and Mountney, 2009, 2012a), and as such records a major episode of nonmarine progradation. Overall, the Warchha Sandstone comprises a series of repeating fining-upward cycles with capping palaeosols (Figs. 1 and 2), which comprise part of a larger-scale depositional sequence. The Warchha Sandstone is one of many palaeosol-bearing alluvial successions characterised by a hierarchical record of depositional cycles that originated in response to the combined effect of autogenic and allogenic processes (e.g., Shanely and McCabe, 1994; McCarthy and Plint, 1998; Kraus and Aslan, 1999; Kraus, 2002; Atchley et al., 2004; McLaurin and Steel, 2007).

The aim of this study is to account for the origins of the Warchha Sandstone in terms of the wider palaeogeographic evolution of the Salt Range region during the early Permian. Specific objectives are: (i) to account for the style and nature of deposition recorded within a succession of meandering fluvial facies; (ii) to assess the origin of prominent decametre-scale depositional cycles within the Warchha Sandstone; (iii) to identify and correlate key surfaces of sequence stratigraphic significance at a larger-scale; (iv) to account for origin of the large-scale stratal packages that accumulated during the early Permian in terms of the regional palaeogeographic evolution of part of the northern margin of Gondwanaland.

2. Methodology

Sedimentological data were collected from eight measured stratigraphic sections of the Lower Permian succession of the Salt Range (Figs. 1 and 2). In each section, numerous depositional cycles and fluvial facies associations have been recognised (Fig. 3). Lithofacies were identified in the present study (Table 1) based on the widely adopted classification scheme of Miall (1996), and extended from that of Ghazi and Mountney (2009). The cyclical arrangement of facies within the Warchha Sandstone is herein described based on a modified version of the classification scheme of Atchley et al. (2004).

3. Regional sequence stratigraphic framework

The regional stratigraphic framework and depositional setting of the non-marine Warchha Sandstone provides a record of the history of base-level change and its effects in governing sequence accumulation and preservation in a mixed terrestrial to marginal-marine depositional system.

One of the first comprehensive and widely adopted sequence stratigraphic models for prediction of stacking patterns in continental fluvial successions was that of Shanely and McCabe (1994) who accounted for large-scale variations in architectural style based on systematic variations in controlling processes. Their conceptual model is based on the notion of base-level fall and rise controlling fluvial behaviour by adjusting the graded equilibrium profile of the fluvial system to generate incised valleys during episodes of base-level fall and the subsequent filling of these valleys with stacked fluvial channel complexes during episodes of subsequent base-level rise. Ethridge et al. (1998) revised the model and discussed the complexity of multiple feedbacks that govern processes known to influence fluvial sequence development. Catuneanu (2002, 2006) emphasized the importance of stratigraphic base level as a mechanism for maintenance of an equilibrium between erosion and deposition, whereby sediment accumulation occurs at sites where accommodation is generated in response to base-level rise. The interplay between base-level change and rate of sediment supply (sediment influx) controls whether a coastal fluvial system experiences transgression or regression (Bhattacharya, 2011).

Download English Version:

https://daneshyari.com/en/article/4730482

Download Persian Version:

https://daneshyari.com/article/4730482

Daneshyari.com