Palaeoenvironment and Sedimentation Settings during Asselian – Sakmarian Reorganizations in Harzand area (North of Marand)

Mousa Bagheri

Corresponding author: Department of Geology, Urmia Campus, Islamic Azad University, Urmia, Iran.
E-mail address: geo.bagheri@yahoo.com

Abstract

Several major transgressive cycles can be recognized within the Permian sequences in Northwest of Iran. The first transgression begins with conglomerate, microconglomerate, litharenite, sublitharenite and quartzarentie sandstone, siltstone, mudestone and shale with Asselian to Sakmarian age. This clastic sequence is lying with disconformity and hiatus on the older formations with a various ages. Outcrops of the Lower Permian (Dorud Formation) have been studied in Harzand area to determine their facies, sedimentary enviroments and their sequences. Continental and clastic deposits in the study area, having a thickness over 120m, are divided into three units on the basis of their vertical sequential changes and lithologic characteristics. On the basis of stratigraphic and sedimentologic features of the Lower Permian continental sequence, six facies and three sub facies were defined in the study basin. Siliclastic facies of the Dorud Formation are related to meandering river environment. The occurrence of reworked clasts in conglomerate and microconglomerate lag deposits, indicate that they were derived from the grains contained in blocks of floodplain deposits. This facies association is interpreted as fluvial channel deposits. Petrographically, the sandstone is formed of monocrystalline quartz grains which form more than 75% of the rock content (quartz arenite). The grains range in size from very fine to medium sands. Locally, ferruginous cement constitutes the major cement where the pores are completely plugged with iron-oxides. It is dominated by flat-bedding and planar cross-bedding with minor trough cross-bedding and ripple marks. This facies was deposited in a meandering fluvial system in channels with lateral accretion movements in which point bars formed. The sand bodies composed of planar and trough cross bedding and ripple cross-lamination are interpreted as low-sinuosity channel fill deposits. The most floodplain lithofacies in the study area is shale and silty mudstone, which exists in intervals up to 5 m thick and constitutes 30–40% of logged sections. The vertical arrangement of these facies types is indicative of repetitive, fining-upward cycles of fluvial origin. Each of these upward fining cycles is marked, from oldest to youngest, in the lithologs. In the present study, the sequence stratigraphic interpretation is based on analysis of the unconformities and other stratigraphic surfaces together with the macroscopic and petrographic studies of the enclosing sediments and their stratal geometry. The lowstand fluvial deposits marking the base of the Durod formation clastic facies are overlain by middle-upper Permian carbonate succession. Sequence stratigraphyic analysis indicate the presence of lowstand system tract in the Dorud Formation that are related to river environment. The lower and upper boundary of the sequence is a type 1 Unconformity.

Key words : *Dorud Formation, facies, sequence stratigraphy, meandering river, lower Permian.*

Introduction:

In the vicinity of the town of Marand, in the Northwest of Iran, Cisuralian form a thick sequence of Durod Formation of predominantly siliciclastic deposits. During the Lower Permian, a meandering fluvial system developed on Gondwana continental crust adjacent to

the Iran Shield. Permian rocks are widely distributed in Northwest Iran, including Azarbaijan. The stratigraphical data are based on (Stepanov et al. 1969 [1] , Shabanian and Bagheri, 2008 [2], Asseroto , 1963 [3]). The Permian rocks can be divided into four lithostratigraphic units and including Dorud (Asselian-Sakmarian), Ruteh Formation (Kubergandian - Murgabian) Nesen Formation (Midian - early Dzhulfian) and Ali bashi Formation (Late Dzhulfian - Dorashamian) respectively. The Permian rocks underline nonconformitably by Pre-Permian intrusive rocks and overlain Paraconformably by Elika Formation of Early- Middle Triassic age. The Durod Formation is transgressively overlain by a carbonate sequence of the Ruteh Formation.

Geological and stratigraphic setting:

The Early Permian deposits of in Harzand area (South of Julfa) include the Dorud Formation. Outcrops of Permian succession in the Harzand section have been studied to determine their facies and depositional environments. In the study area, the Dorud Formation (120 meters) consist of red sandstone, shale and conglomerate (Fig. 1). Field investigations and laboratory works show that this continental and clastic sediment was deposited in a meandric river. Because of absence of fossils of foreminifera, the age of the sequence can't be determined.

For petrographic studies and microfacies controls over 105 samples from Harzand stratigraphic section spanning Lower Permian strata were taken in Marand and Julfa regions. Middle and Late Permian limestones are characterized by medium to thick bedded skeletal limestone that includes abundant skeletal organisms such as fusulinids, smaller foraminifers, bryozoans, rugose corals, echinoderms, thin-shelled bivalves, gastropods, ostracodes, and dasycladacean algae. he thickness of the wackstone-packstone horizons decrease upwards and is finally replaced by massive, reefoidal limestone in the upper portion of the Surmaq Formation and terminates with bioclastic and oolithic limestone and dolomites; it is overlain by marly limestone of Julfa Formation. The various carbonates rocks record major depositional sequences, and are a sedimentary expression of variations in the depositional environment.

Methods of study:

Three stratigraphic sections of the Dorud Formation were measured at Harzand, North of Marand. Stratigraphic sections, measured at a centimeter scale, record grain-size variations, sedimentary structures, paleocurrent directions, and bedding geometries (Figs. 1 and 2). This study is based on field observations and laboratory analysis of thin sections. Oriented specimens, cut perpendicular to bedding (along a growth direction), were then prepared for making thin sections. The lithological terminology of Folk , (1964) [4] and Tucker, (2001) [5] was used.

Sedimentation Settings:

The lower Permian (Dorud formation) Reorganizations has a mean thickness of 120 m. A 10m thick basal quartzose conglomerate overlies the Permian unconformity. Planar–tabular cross-bedded sandstones make up most of the unit. The sandstones are fine to medium grained quartzarenites and sublitharenites arranged in 20m thick bodies formed by cross-

bedding sets defined by internal erosion or reactivation surfaces. The palaeocurrent distributions show a constant N trend.

Detailed petrographic investigations led to the recognition of several microfacies which contain four environmental belts, including channel, point bar and floodplain. Obtained data from interpretation of these facies suggest that clastic sediments in Dorud Formation were deposited in a meandering river setting.

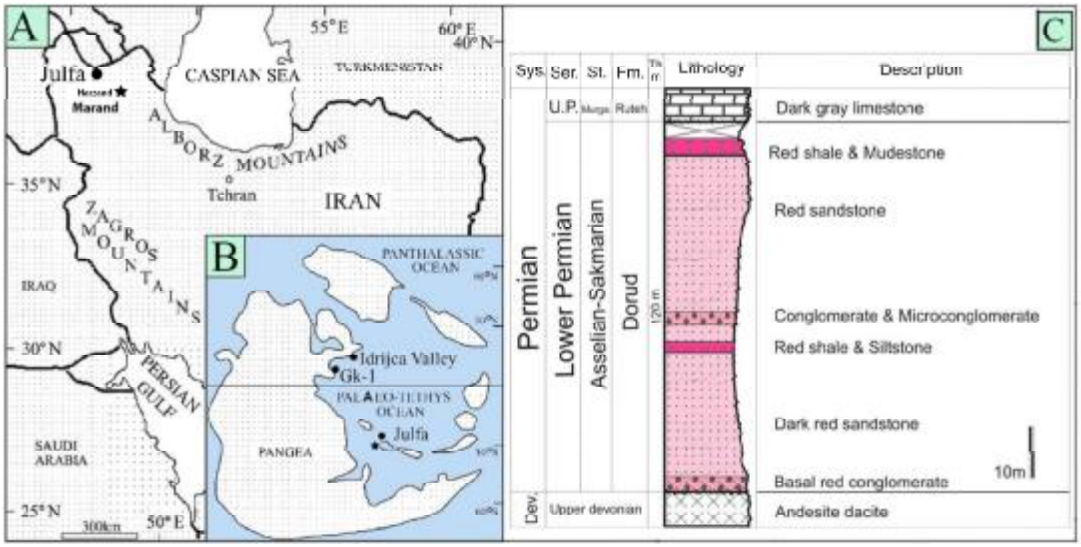

Fig. 1. **A: Index map showing the location of Marand, Julfa and Harzand section. B: Paleogeographic map showing the supposed locations of Julfa, Gk- 1 core and Idrijca Valley sections. The map is modified from (Scotese, 1997 [6]). C: Lithostratigraphy and Stratigraphic column of the Asselian–Sakmarian sequence in the study area.**

The Asselian–Sakmarian succession comprises six facies and three sub facies. Fluvial Channel facies association is made up of several, 15 to 45 cm thick conglomerate and microconglomerate with sandstone bodies. The occurrence of reworked clasts in conglomerate and microconglomerate lag deposits, indicate that they were derived from the grains contained in blocks of floodplain deposits. This facies association is interpreted as fluvial channel deposits. A >2-m-thick basal quartzose conglomerate overlies the Permian unconformity.

Floodplain lithofacies One floodplain lithofacies is recognized in the Dorud Formation in the western side of the study basin: (1) silty mudstone.

Silty mudstone: The most abundant floodplain lithofacies in the Dorud Formation is silty mudstone, which exists in intervals up to 5 m thick and constitutes 30–40% of logged sections. The mudstone is primarily red, although rarely there are thin (< 2 m) intervals that are greenish gray or mottled red and greenish gray. This lithofacies is interpreted to have been deposited by floods in which clay and silt settled from suspension in standing or gently draining waters on floodplains away from active channel belts and their associated crevasse-splay and levee complexes(Reading, 1991 [7]).

Planar–tabular cross-bedded sandstones make up most of the unit. The sandstones are medium to coarse-grained quartzarenites arranged in 5-m-thick bodies formed by cross-bedding sets defined by internal erosion or reactivation surfaces. Individual sets may reach 5 m in thickness, most of them consisting of simple foreset, that on occasions may be interrupted by internal erosion or reactivation surfaces. The characteristics of the sandstone beds of this unit indicate that its deposition took place in a point bar system (Visher, 1969[8] ; Collinson,1991[9]).

These bodies are up to 60 m thick and less than 80 m wide, and are made entirely of intraformational conglomerates accumulated in small channels originated within the floodplain. Locally, ferruginous cement constitutes the major cement where the pores are completely plugged with iron-oxides. It is dominated by flat-bedding and planar cross-bedding with minor trough cross-bedding and ripple marks (fig.2). This facies was deposited in a meandering fluvial system in channels with lateral accretion movements in which point bars formed. The sand bodies composed of planar and trough cross bedding and ripple cross-lamination are interpreted as low-sinuosity channel fill deposits.

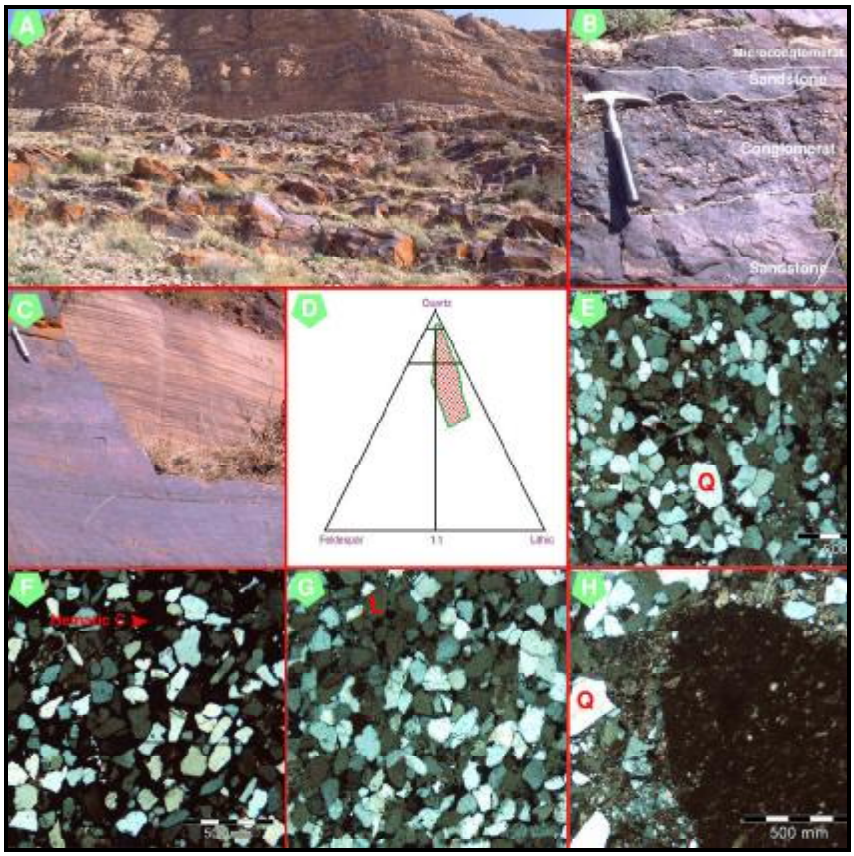

Fig. 2. Photomicrographs & Photographs of typical textures and Some facies nad in this study: (A) Horizontal-stratified red sandstone and other clastic rock. (B) Stratified-sandstone interbedded with conglomerate and cross-stratified microconglomerate. (C) Even lamination of red sandstone facies. (D) Classification of sandstone using Folk (1964) scheme. (E) Sublitharenite subfacies with some coarse quartz -Q grains. (F) Quartzarenite subfacies with hematitic cement. (G) Litharenite subfacies. (H) Microconglomerat facies.

Petrographically, the sandstone is formed of monocrystalline quartz grains which form more than 80% of the rock content (quartz arenite & Sublitharenite). The grains range in size from fine to medium sands. They are subangular to rounded and display close-packed fabric where the grains have point, tangential and concave-convex contacts. This reflects that the sandstone had undergone a change in texture and fabric, as well as a considerable loss of its primary porosity as a result of compaction.

The vertical arrangement of these facies types is indicative of repetitive, fining-upward cycles of fluvial origin. Each of these upward fining cycles is marked, from oldest to youngest, in the lithologs. The lowstand fluvial deposits (meandering river) marking the base of the Durod formation clastic facies are overlain by middle-upper Permian carbonate succession (fig.3).

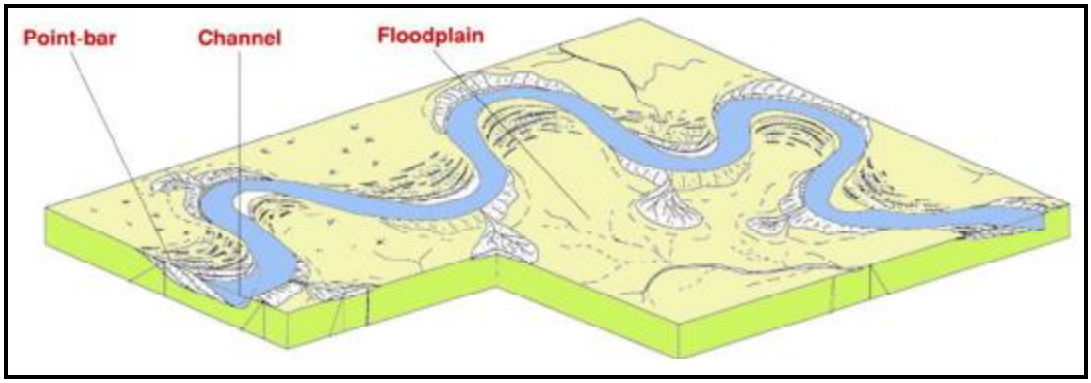

Fig. 3. Depositional model for the meandering river of the lower Permian, Harzand area.

Conclusions:

The Asselian–Sakmarian sequence in the Harzand area cosists mainly of clastic (Sandstone) rocks with iron-oxides in the Dorud formation. Clastic sediments in Dorud Formation were deposited in a meandering river environment. Sequence stratigraphyic analysis indicate the presence of lowstand system tract in the Dorud Formation that are related to river environment. The lower and upper boundary of the sequence is a type 1 Unconformity.

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