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Petrography and geochemistry of sandstones succession of the Qal'eh Dokhtar Formation (Middle-Upper Jurassic), east central Iran: Implications for provenance, tectonic setting and palaeoweathering

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ABSTRACT

Sandstones of the Qal'eh Dokhtar Formation west of Boshrouyeh, Central Iran, were analyzed for Petrographic and geochemical (major and selected trace elements) to infer their provenance, intensity of palaeoweathering of the source rocks and tectonic setting. This formation is composed mainly of alternating marine sandstones, laminated greenish to light gray shales with well bedded gray limestones. Texturally, these sandstones are fine grained, subangular to subrounded and moderately to well sorted. Based on the petrographic study, modal analysis and geochemical data, they can be classified as quartzarenites and sublitharenites. The provenance and tectonic setting of theses sandstones have been assessed using integrated petrographic and geochemical studies. Petrographic data suggest that the sediments were derived from plutonic rocks. Petrographic analysis reveals recycled origin and craton interior setting were the dominate source. The geochemical investigations are recommended that these rocks were originated from quartzose sedimentary source. Chemically, major and trace element concentrations in the sandstones indicate deposition in a passive continental margin setting. Average CIA, CIW and PIA values (69%, 75%, and 72%, respectively) imply moderately to high degree of chemical weathering, which may reflect humid climate condition in the source area. The petrographic analysis, geochemical data and palaeogeographical models confirm that the Qal'eh Dokhtar Formation sandstones generally consequent from mature recycled continental sedimentary rocks and deposited on the passive margin alongshore setting of the Neotethys Ocean.

1. Introduction

Sandstone provenance studies have shown that different tectonic settings contain evolutionary trends in their detritus and exhibit specific compositional ranges during re-deposition (Dickinson et al., 1983). Thus, clastic detrital components preserve detailed information on provenance and pattern in which the sediments were transported, especially after modification of the original detritus by the interaction of physical and chemical processes such as weathering, erosion, transportation and paleoclimate (Oghenekome et al., 2016). Clastic sedimentary rocks also contain important information for interpreting both the compositional tectonic setting and evolution of the continental crust that can be linked to the depositional environment (Jafarzadeh and Hosseini-Barzi, 2008). The combination of petrography and geochemical analysis of siliciclastic sediments can provide significant information about sediment provenance that can be used for reconstruction of tectonic setting, paleoclimate condition and geographic site of sedimentary basins (Bhatia, 1983; Basu, 1985; McLennan et al., 1993; Roser and Korsch, 1988; Jafarzadeh and Hosseini-Barzi, 2008; Avarjani et al., 2014; Tobia and Aswad, 2015). The geochemical composition of siliciclastic sediments is controlled by parent rock, relief, and climate, mechanisms of transport, deposition and diagenetic processes, which affected the sediments (Dickinson et al., 1983; Basu, 1985; Dickinson, 1985, 1988; McBride, 1985). Siliciclastic rocks provide essential data for the understanding of rock composition, tectonic setting and evolution of the continental crust (Cingolani et al., 2003; Jafarzadeh and Hosseini-Barzi, 2008; Banerjee and Banerjee, 2010; Oghenekome et al., 2016). The purpose of this study is to evaluate sandstones petrography and their major and trace elemental geochemistry of the Qal'eh Dokhtar Formation with the aim of understand their provenance, tectonic setting and weathering condition during Middle-Upper Jurassic time which is useful to reconstruct the palaeogeography of the region.

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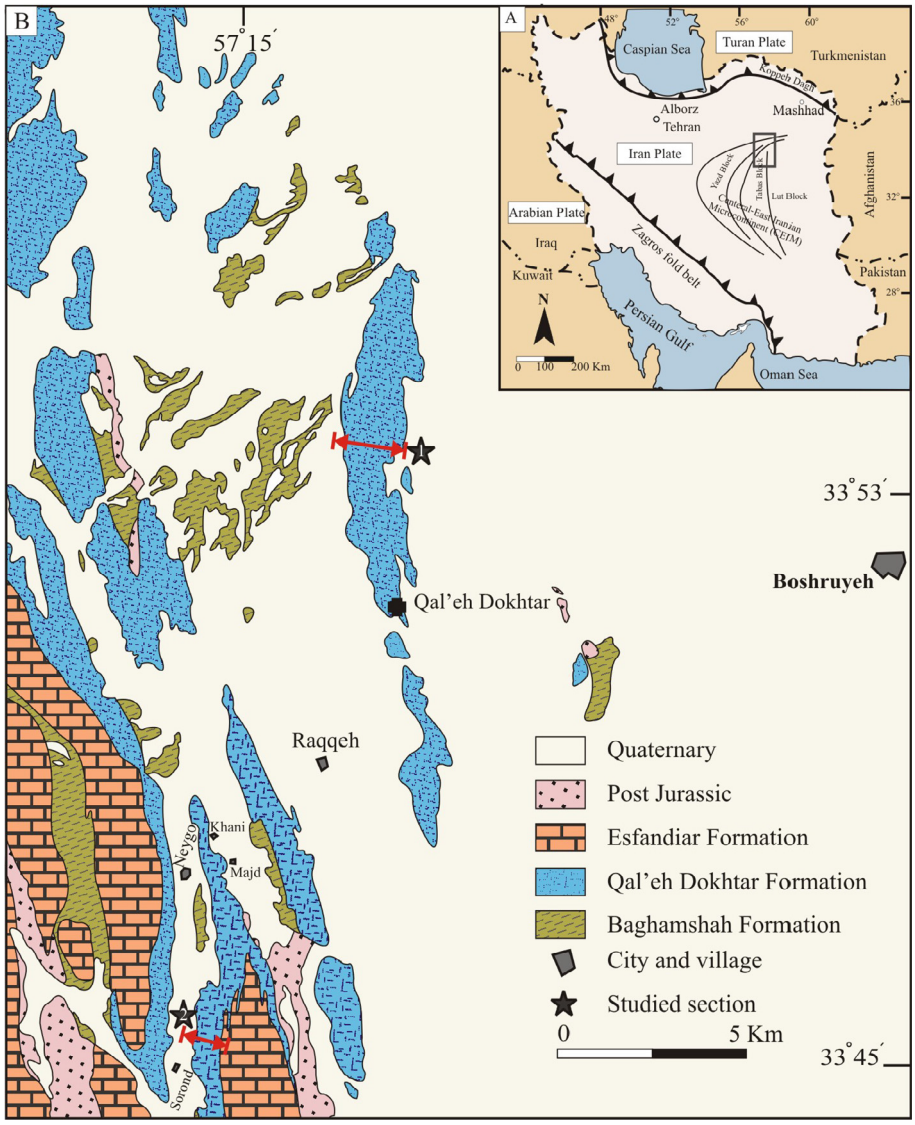

Fig. 1. (A) Structural, geological and geographic framework of Iran. (B) Simplified geological map of the study area showing studied sections (modified from Stöcklin et al., 1969). (1. Type section, 2. Sorond section).

2. Geological setting

The Iranian plate covers a numeral of continental terrains linked jointly alongside suture zones of ocean character (Berberian and King, 1981). These terrains are composed of Zagros, Alborz, Central Iran, Kopet- Dagh and Makran Basins (Fig. 1A). The study area is located in Central Iran Zone. Central Iran, beside with the Alborz Mountains of northern Iran, is situated between the Neotethys and Paleotethys suture zones of Iran, which was divided from the Gondwana super-continent during the Permian period (Scotese and Langford, 1995). The Central-East Iranian Microplate (CEIM) contains of three large faults, separated blocks of Lut, Tabas and Yazd (Fig. 1A). Structurally, the study area is positioned in the Tabas Block, east central Iran. Tabas block is bordered by the Great Kavir Fault (in the north), the Naini Fault (in the west and southwest) and the Nayband Fault (in the east). The Qal'eh Dokhtar Formation performance in the north-eastern part of the Shotori Range and in the west of Lut Block (Fig. 1B). We are measured and sampled two sections in detail at west of Boshrouyeh, NE Tabas Block, Central Iran (Fig. 1B). The Qal'eh Dokhtar Formation at the Type section overlies the marly-silty Baghamshah Formation but the contact is covered by alluvial deposits and the top is cut by fault (Stöcklin et al., 1965). In Sorond Section, this Formation is in unconformity contact overlying with the Baghamshah Formation and in conformity contact underlying with the Esfandiar Formation. The Qal'eh Dokhtar Formation consists of alternating fine to medium grained marine sandstones, laminated greenish to light gray shales with well bedded dark gray limestones (Fig. 2). The Qal'eh Dokhtar Formation contains ammonites such as *Indosphinctes*, *Larcheria* and *Amoebopltoceras* that are suggesting Middle Callovian to Late Oxfordian age, but the basal part may probably reach down to the Lower Middle Jurassic (Schairer et al., 2000). These sedimentary successions were deposited in the low- to high-energy environments of a mixed carbonate – siliciclastic ramp, including tidal-flat to beach, lagoon, barrier, and open marine (Sabbagh Bajestani et al., 2017). The sedimentary succession of the Qal'eh Dokhtar