Journal of African Earth Sciences 129 (2017) 675–682

Contents lists available at ScienceDirect

Journal of African Earth Sciences

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

The Oligocene carbonate platform of the Zagros Basin, SW Iran: An assessment of highly-complex geological heritage

Tahereh Habibi [a], Dmitry A. Ruban [b, *]

[a] Department of Earth Sciences, Faculty of Science, Shiraz University, Shiraz, 71454, Iran
[b] Southern Federal University, 23-ja linija Street 43, Rostov-na-Donu, 344019, Russia

ARTICLE INFO

Article history:
Received 21 November 2016
Received in revised form
27 January 2017
Accepted 1 February 2017
Available online 1 February 2017

Keywords:
Geological heritage
Carbonate platform
Foraminifera
Zagros Basin
Oligocene

ABSTRACT

North Africa and the Middle East possess rich geological heritage, but the latter is yet to be fully identified and described. The Oligocene carbonate platform of the Zagros Basin in southwest Iran, which corresponds to the lower part of the Asmari Formation, has significant potential for geoconservation and geotourism. The types of the geological heritage, their value, and the possible geosites have been assessed. The studied deposits are interesting because of lithology (carbonate rocks), fossils (larger foraminifera, other microfossils, diverse marine invertebrates, fish microremains, and trace fossils), biostratigraphical developments, facies (homoclinal carbonate ramp) and signature of global events (glacioeustatic fluctuations), and outstanding hydrocarbon resources. The five main geological heritage types are sedimentary, palaeontological, stratigraphical, palaeogeographical, and economical, from which the palaeontological, palaeogeographical, and economical types are of global rank. The Khollar and Kavar sections in the Fars Province of Iran are recommended as geosites suitable for research, education, and tourism. The high complexity of the geological heritage linked to the Oligocene carbonate platform of the Zagros Basin implies the phenomenon of geodiversity should be understood with regard to the relationships between types and their values.

1. Introduction

The past decades has been marked by the growth of interest of the international geoscience community to research in geological heritage and geological tourism (Wimbledon, 1996; Prosser et al., 2006, 2011; Dowling, 2011; Henriques et al., 2011; Wimbledon and Smith-Meyer, 2012; Gray, 2013; Erikstad, 2013; Prosser, 2013; Ruban, 2015; Brilha, 2016; Necheş, 2016; Thomas, 2016). It is clear that natural and artificial outcrops exhibiting peculiar minerals, rocks, tectonic structures, fossils, dynamic phenomena, etc. need identification (this means necessity of assessment of their heritage value), protection, and use for social purposes (education and tourism). North Africa and the Middle East possess very rich geological heritage, the importance of which has been realized recently (Enniouar et al., 2014; Errami et al., 2015; Moufti and Németh, 2016; Plyusnina et al., 2016a). However, our knowledge of this heritage remains still insufficient. Particularly, the opportunities of geoconservation and geotourism in Iran has been considered by several specialists (Jones, 2008; Farsani et al., 2011, 2012, 2014; Ghazi and Ghadiri, 2012; Ghazi et al., 2013), but the full potential of this country is yet to be realized. Moreover, the present archaeological findings (Franciscus and Churchill, 2002; Tsanova, 2013; Ghasemi and Watson, 2014) permit to extend the vision of the geological heritage of this country.

The objective of the present paper is description of the geological heritage linked to the Oligocene carbonate platform of the Zagros Basin in southwest Iran. The importance of this study is determined by two reasons. First, this is an example of the highly-complex geological heritage, assessment of which facilitates methodological developments. For instance, Bruno et al. (2014) proposed a detailed classification of the palaeogeography-related geological heritage, but this requires testing on the real examples. Second, the present study focuses on the geological formation that has been studied intensively in the past years and attracted attention of the international research community. Judgment of it in the terms of geological heritage can make the entire geological heritage of Iran sounding on the international scale.

* Corresponding author. P.O. Box 7333, Rostov-na-Donu, 344056, Russia.
E-mail addresses: taherehhabibi@gmail.com (T. Habibi), ruban-d@mail.ru (D.A. Ruban).

http://dx.doi.org/10.1016/j.jafrearsci.2017.02.003
1464-343X/

2. Geologic setting

The Zagros Mountains is a lengthy chain in southwest Iran (Fig. 1). Geologically, it corresponds to the Zagros fold-thrust belt, the structure of which is described comprehensively by Sepehr and Cosgrove (2004), Alavi (2007), Agard et al. (2011), and Wen et al. (2015). This belt evolved actively throughout the entire Cenozoic, as confirmed by the recent global plate tectonic reconstructions (Seton et al., 2012; Matthews et al., 2016). This tectonic activity was resulted from the interactions of the Arabian Plate and the Iranian tectonic blocks that formed the Sanandaj-Sirjan margin of Eurasia (Golonka, 2004); and the links to the tectonic events in the other regions can be established (Yin, 2010; Rodriguez et al., 2016).

In the Oligocene–Miocene, a marine basin existed on the study territory, and carbonate sedimentation prevailed there (Golonka, 2004). These carbonates with a total thickness of several hundreds of meters are known as the Asmari Formation, which has been studied intensively in the past two decades (Table 1) (Davoudzadeh et al., 1997; Seyrafian, 2000; Seyrafian and Hamedani, 2003; Alavi, 2004; Sepehr and Cosgrove, 2004; Sadeghi et al., 2009, 2011; Vaziri-Moghaddam et al., 2010; Seyrafian et al., 2011; Sooltanian et al., 2011; Avarjani et al., 2015; Hoseinzadeh et al., 2015; Moghaddam and Khanjai, 2015; Shabafrooz et al., 2015; Adabi et al., 2016; Habibi, 2016a,b; Kakemem et al., 2016). However, the studies have begun yet in the early 20th century (see historical review in Seyrafian et al., 2011). The both thickness and age of this formation change laterally. These deposits bear a lot of fossils, including well-studied foraminifers, the depositional environment is interpreted as carbonate platform of ramp type (Habibi, 2016b).

The Asmari Formation is well-known for its hydrocarbon potential, and exploitation of this reservoir facilitates development of the Iran oil industry. The intense research of these deposits also brought a lot of micropalaeontological and biostratigraphical data (see references above). However, the importance of the geological heritage of the Asmari Formation is yet to be realized.

3. Method

The present assessment of the geological heritage linked to the Oligocene carbonate platform in the Zagros Basin is based on the field investigation of two representative sections of the lower part (Oligocene) of the Asmari Formation, namely the Khollar Section and the Kavar Section (Fig. 2). These are located in the Fars Province of Iran in the vicinities of the cities of Shiraz and Kavar. The detailed geological descriptions of these sections are published by Habibi (2016a,b). The information about the Asmari Formation from the other sections considered by different authors (Davoudzadeh et al., 1997; Seyrafian, 2000; Seyrafian and Hamedani, 2003; Alavi, 2004; Sepehr and Cosgrove, 2004; Sadeghi et al., 2009, 2011; Vaziri-Moghaddam et al., 2010; Seyrafian et al., 2011; Sooltanian et al., 2011; Avarjani et al., 2015; Hoseinzadeh et al., 2015; Shabafrooz et al., 2015; Adabi et al., 2016; Kakemem et al., 2016) is also taken into account.

Methodologically, this paper is based on the general ideas of geoconservation (Prosser et al., 2006), and it employs the classification of geological heritage features proposed by Ruban (2010), Ruban and Kuo (2010), and Bruno et al. (2014). The assessment is realized in three steps, which include recognition of the geological heritage types linked to the Asmari Formation (1), establishment of their value (rank) (2), and identification of geological heritage sites (geosites) that can serve for the purposes of this heritage display (3). According to Ruban (2010), there are two dozens of geological heritage types, namely stratigraphical, palaeontological, sedimentary, igneous, metamorphic, mineralogical, economical, geochemical, seismical, structural, palaeogeographical, cosmogenic, geothermal, geocryological, geomorphological, hydrological and hydrogeological, engineering, radiogeological, neotectonical, pedological, and geohistorical types (there is also complex type when two and more types co-occur). The geological heritage rank may be local, regional, national, or global (Ruban, 2010). It can be established with regard to the uniqueness of a given geological feature on the local, regional, national, and global scales respectively. When several types exist in the same geological object, the relevant heritage is complex, and the types with the highest value are the dominant types (Ruban, 2010). The complexity of the geological heritage increases together with the number of types.

Sometimes, the number of types linked to any given object is big, whereas not all features of this object are really precious from the geoconservation point of view. For instance, a sedimentary formation may be distinguished by rocks and facies, which permits to recognize sedimentary and palaeogeographical types. Each rock consists of minerals, and, thus, mineralogical type can be also suggested in the same case. But if these minerals are obvious and well-known (e.g., calcite in the case of limestones or quartz in the case of sandstones), it is not sensible to distinguish the mineralogical type. That is why the only main (characteristic) types have to be considered. Such a principle is used in the present assessment.

4. Results

From the known geological heritage types, several can be assigned to the Asmari Formation. The main are the sedimentary, palaeontological, stratigraphical, palaeogeographical, and economical types.

The *sedimentary* type is constituted by the sedimentary rocks of the Asmari Formation, which include chiefly carbonate rocks: thin, medium to thick-bedded limestones (mudstone, wackestone, packstone, grainstone, rudstone, and floatstone) and dolomites intercalated with marls, marly limestones, and locally anhydrites and sandstones (Motiei, 1993). Diagenetic processes (dolomitization, stylolitization, dissolution) are also established (Aqrawi et al., 2006; Seyrafian et al., 2011). Although these rocks are well-represented in the natural sections of the Asmari Formation, which can be considered as typical localities, these are very common rocks distributed widely in Iran and globally. The only more or less specific feature is the presence of nummulitic limestones (common *Nummulite* species are *N. vascus*, *N. fichteli*, and *N. intermedius*). That is why the geological heritage value of this type is only local.

The *palaeontological* type is determined by the fossil assemblages established in the Asmari Formation (Fig. 3). Larger foraminifera, ostracods, coralline read algae, and other microfossils, echinoids, bivalves, gastropods, bryozoans, corals, brachiopods, fish microremains, and trace fossils (worm tubes) are found in these deposits. Such richness (high diversity and high abundance) of the assemblages, the presence of some specific elements – e.g., larger foraminifera described by Rahaghi (1978) and Habibi (in press), which are very specific representatives of microfauna (McGowran, 2005; Murray, 2006; Jones, 2012), and importance of the local palaeontological data for understanding of the Oligocene biotic evolution (Habibi, 2016b) permits to assign global rank to this geological heritage type.

The *stratigraphical* type is linked, first of all, to the biostratigraphical developments based on the studies of foraminifera and other microfossils from the Asmari Formation (e.g., Avarjani et al., 2015; Habibi, 2016b; Kakemem et al., 2016). For instance, the strontium isotope dating and the biostratigraphical zonation based on larger foraminifera permitted to differentiate the Rupelian from the Chattian (Laursen et al., 2009; Van Buchem et al., 2010).