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Conodonts of the Mississippian/Pennsylvanian boundary interval in Central Iran

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ABSTRACT

The record of conodonts related to the Mississippian/Pennsylvanian boundary interval was investigated in four sections in Central Iran from two different structural units. Two sections from the Sanandaj–Sirjan trend zone (Asad-abad, and Darchaleh sections) and two from the East-Central Iran Microplate (Shesh-angosht and Kale-Sardar sections) exhibit a nearly complete record previously described across the Mississippian/Pennsylvanian boundary in Iran. The investigated sections can be subdivided in three formations (Ghaleh-, Absheni-, and Zaluda Formation) which belong to the Sardar Group. The mid-Carboniferous boundary was defined by the occurrence of *Declinognathus noduliferus s.l.*. Bio-event characteristics of the Carboniferous conodont fauna (Mississippian genera *Gnathodus* and *Lochriea* have been replaced by Pennsylvanian genera *Declinognathus* and *Idiognathodus*) as well as sedimentological changes within overall shallow water deposits were located approximately 33° S of the paleoequator and suggest sea-level changes within the framework of the Late Paleozoic Ice Age (LPIA). Furthermore, a widespread crinoid marker horizon previously described from two localities in Iran can be subdivided into three units of different ages.

1. Introduction

Four sections in Iran, each spanning the Mid-Carboniferous boundary interval were studied on the Sanandaj–Sirjan zone and on the East-Central Iran Microplate. During the Paleozoic, Iran was part of the northern margin of Gondwana. Marine conditions occurred in northern and Central Iran from the Middle Devonian to early Frasnian and persisted into the Early Pennsylvanian. A widespread uplift in the latest Carboniferous led to continental environments before the onset of a new marine cycle during the Early Permian. Major overviews on stratigraphy, facies patterns and paleogeography of the entire area of northern, central and southeastern Iran have been published by Wendt et al. (2002, 2005). The main Paleozoic successions of Central Iran occur in the North–South trending Tabas block which is bounded by the Kalmard strike-slip fault to the West and Naybandan fault to the East (Alavi, 1991, Fig. 1b). Carboniferous and Permian deposits in Central Iran occur most completely in the area of Tabas (Shotori range, Shirgesht area, and Ozbak-Kuh areas) and have been described earlier in a series of publications (Korn et al., 1999; Partoazar, 1995; Ruttner et al., 1968; Stepanov, 1971; Stöcklin, 1971; Stöcklin et al., 1965; Wendt et al., 2002; Wendt et al., 2005).

The entire sequence of Carboniferous – Permian deposits is divided into three lithostratigraphic units: the Shishtu Formation (Devonian-Viséan), the Sardar Group (Viséan-earliest Permian) and the Jamal Formation (Permian). Recent fieldwork included sampling of the sediments yielded: (1) poorly studied fusulinids (Leven and Gorgij, 2006, 2007, 2009; Leven and Taheri, 2003; Leven and Vaziri, 2004; Leven et al., 2006; Sohrabi, 2006) and (2) detailed suite of conodont samples by Yazdi (1999) and Boncheva et al. (2007). According to Yazdi (1999) the Bahram Formation is considered to be mainly of Frasnian age. The Shishtu Formation reaches into the Viséan and is overlain by the Ghaleh Formation (Boncheva et al., 2007).

The Late Palaeozoic Ice Age (LPIA) has been considered as one of the most prominent ice ages spanning much of Late Devonian to Permian time, when ice sheets waxed and waned across southern Gondwana (Veevers and Powell, 1987). It is clear that the LPIA consisted of several discreet icehouse climates with warmer periods of glacial minima. Intervals of glacial minima and maxima have been reported from low-latitudes (e.g., Bishop et al., 2009, 2010; Frakes et al., 1992; Heckel, 1986, 1994; Soreghan and Giles, 1999) as well as in high-latitudes (e.g., Caputo et al., 2008; Isbell et al., 2008a,

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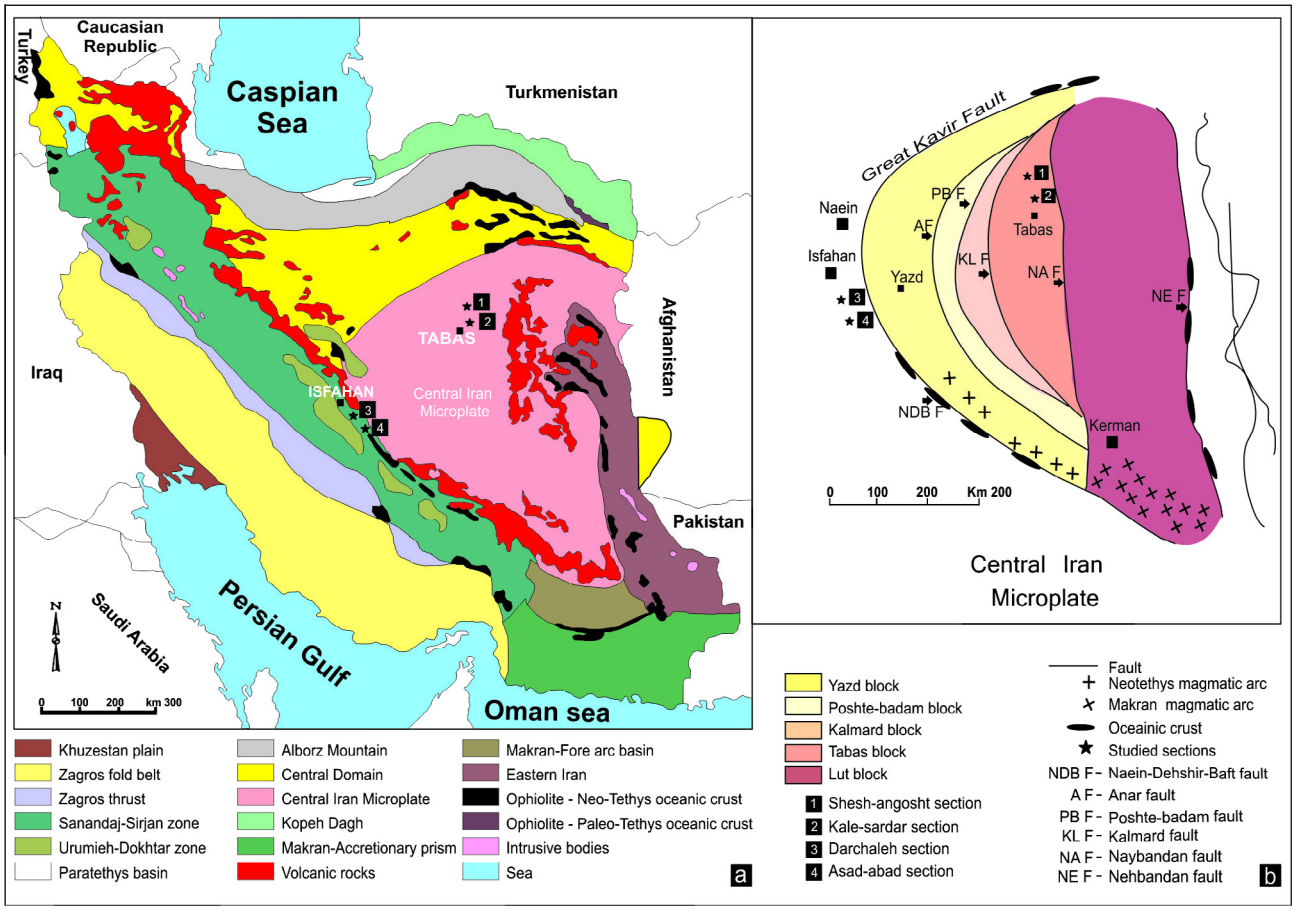

Fig. 1. (a) Structural units of Iran with position of the studied sections, 1: Shesh-angosht section (Shirgesht area – Northwest Tabas), 2: Kale-Sardar section (East Tabas), 3: Darchaleh section western margin of central – east Iran Microplate at the contact with the eastern margin of Sanandaj-Sirjan northwest trend zone, 4: Asad-Abad section (Ramsheh area); (b) Detailed structural units of the East Central Iran Microplate.

2008b). Geochemical proxies suggest a positive shift in δ18O at the Mississippian/Pennsylvanian boundary as a result of decrease in global temperatures (e.g., Joachimski et al., 2006; Mii et al., 1999). Furthermore, the Mississippian/Pennsylvanian boundary interval coincides with a major change in global climate combined with a shift in diversity dynamics (e.g. increasing endemism) and global extinction event (e.g., Heim 2009; Kelley and Raymond, 1991; Montanez et al., 2007; Powell, 2005, 2007; Raymond et al., 1990; Stanley and Powell, 2003).

It has been the aim of our study to investigate conodont assemblages across the Mississippian/Pennsylvanian boundary (Sardar Group) interval, to provide an overview of the sedimentological development and facies settings (a detailed sedimentology and facies analysis of the entire sections is not the scope of this paper due to ongoing research and will be published later), and to correlate the four selected sequences in Central Iran.

2. Regional geology

2.1. Tectonic and geologic setting

Paleozoic rocks are widespread in Iran but often they belong to different structural units and therefore correlation is difficult. Iran has been subdivided into several structural units, some of which are separated by suture zones (Alavi, 1991; Davoudzadeh, 1997; Stöcklin, 1968). The most important structural units are the (a) Zagros fold belt, (b) the Central domain, comprising the southern Alburz Mountains, northwestern Iran and the Binalud Mountains in eastern Iran, (c) the northern Alburz Mountains with the Caspian depression, and (d) the East-Central Iran Microplate (Fig. 1a). The Iran Microplate has been subdivided into five tectonic units based on its complex structural patterns: the Yazd block, the Posht-e Badam block, the Kalmard block, the Tabas block, the Lut block and part of the Sanandaj–Sirjan trend zone (Fig. 1b). The studied sections (1) Shesh-angosht, (2) Kale-Sardar, (3) Asad-abad, and (4) Darchaleh are located in two different structural units – the first two sections belong to the East-Central Iran Microplate and sections three and four belong to the Sanandaj–Sirjan northwest trend zone.

2.1.1. The East-Central Iran Microplate

The East-Central Iran Microplate is bounded by a series of faults: on the East by the Nehbandan fault, on the southwest by the Naein-Dehshir-Baft fault, and to the north by the Great Kavir fault (Alavi, 1991; Fig. 1b). During the Paleozoic the East-Central Iran Microplate was part of the northern margin of Gondwana. The main assembly phase of the Pangean supercontinent occurred during the Carboniferous subsequent to the initial collision of Gondwana and Laurussia in the latest Devonian. During Carboniferous times the East-Central Iran Microplate was situated approximately 33°S of the paleoequator (Blakey, 2007; Golonka, 2002; Fig. 2) in the western part of the Paleo-Tethys, covered by a large shelf sea and sediments were mainly formed in a shallow neritic environment (see overview by Wendt et al., 2002, 2005). As a result of tectonic movements related to the Hercynian orogeny, the extensive areas of the Iranian platform sustained erosion before the onset of a new marine cycle in the late Early Permian. Mississippian rocks in most areas of Iran are represented by carbonates, dark shales and marls, and siliciclastic rocks which