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Re-examination of late Early Permian fusulinids in North Tabas, East-central Iran and their palaeotectonic, palaeoclimate and palaeobiogeographic applications

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Abstract

The upper Yakhtashian to Bolorian Bagh-e Vang Formation was studied in two stratigraphic sections in north Tabas, east-central Iran. The examination of fusulinids and small foraminifers of the Bagh-e Vang Formation in two studied sections led to the identification of the new fusulinid and small foraminifer genera and species which are recovered from the upper Yakhtashian and Bolorian strata of Iran for the first time. Based on identified fusulinids, three biozones including upper Yakhtashian *Pamirina darvasica-Sakmarella* spp., lower Bolorian *Chalaroschwagerina vulgarisiformis* and upper Bolorian *Misellina termieri* in the Bagh-e Vang section and two biozones containing lower Bolorian *Misellina (Brevaxina) dyhrenfurthi-Chalaroschwagerina vulgarisiformis* and upper Bolorian *Misellina* cf. *termieri* in the Shesh Angosht section were recognized. Paleomagnetic data and time of volcanic activities in Cimmerian microplates along with fusulinid appearance in Late Paleozoic reveal that the Neotethys opening in these blocks did not happen at the same time and in the northern blocks (like Iran, south and central Afghanistan and southeast Pamir) was faster than those in the southern blocks (like Qiangtang and Baoshan blocks). The reason for the occurrence of warm water subtropic to tropic palaeoequatorial fusulinid fauna of verbeekinds and neoschwagerinids during the Bolorian in Cimmerian microplates is not only because of the northward drift of its blocks but also factors such as global warming in the Bolorian and warm water oceanic currents were effective.

Keywords: Bolorian fusulinids, Bagh-e Vang Formation, Central Iran, Permian palaeobiogeography, Cimmerian microplates

Introduction

The Permian platform deposits in the Shirgesht (north of Tabas) and Shotori (east and southeastern Tabas) areas are known as the Jamal Formation. This formation was first studied in the southern part of the Shotori Mountains by Stöcklin et al. (1965) and in the Shirgesht area by Ruttner et al. (1968). The lower Permian strata in the basal part of the Jamal Formation introduced as Bagh-e Vang Member (Leven and Vaziri Moghaddam 2004) and later were named Bagh-e Vang Formation of Shirgesht Group (Leven and Gorgij 2006). Several fusulinid species of the Bolorian age in the lower part of the Jamal Formation were recognized by Kahler (1974).

According to foraminiferal assemblage of the Bagh-e Vang Formation, it was assigned to Asselian–Sakmarian by Partoazar (1995). The first detailed fusulinid biostratigraphy of the Bagh-e Vang Formation at the Bagh-e Vang section was led to the identification of three fusulinid biozones including Yakhtashian–Bolorian *Pamirina-Mesoschubertella* Zone, Bolorian *Misellina-Chalaroschwagerina-Paraleeina* Zone and Kubergandian *Misellina-Armenina* Zone and recognition of the two new fusulinid genera *Iranella* and *Paraleeina* (Leven and Vaziri Moghaddam 2004). Arefifard et al. (2006) distinguished *Pamirina-Chalaroschwagerina-Mesoschubertella* assemblage zone in the Bagh-e Vang

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Formation at the Bagh-e Vang section and assigned it to the late Yakhtashian–Bolorian. The conodont-based biostratigraphy of the Bagh-e Vang Formation at Bag-e Vang section was carried out by Leven et al. (2007) and conodont species of the Bolorian age such as *Rabeignathus binodosus*, *R. bucuramangus*, and *Mesogondolella shindyensis* were identified. Recently, conodonts were found in the lowermost portion of the Bagh-e Vang Formation both at the Bagh-e Vang and Shesh Angosht sections which include *Mesogondolella manifesta*, *M. monstra*, *Streptognathodus* aff. *lanceatus*, *S. postconstrictus*, *S. postfusus*, and *Sweetognathus* aff. *binodosus* indicating a Sakmarian age (Balini et al. 2015). The basal part of the Bagh-e Vang Formation at Shesh Angosht section is younger than its equivalent part at the Bagh-e Vang section based on the Brachiopod *Costispinifera* sp. of Early Permian in age and conodont *Sweetognathus guizhouensis* assignable to Artinskian–Kungurian (Balini et al. 2016). Tabulate corals of the Bagh-e Vang Formation show a Sakmarian to Kungurian age (Niko et al. 2018) and the identified bryozoans of this formation are dated to the Artinskian–Kungurian (Ernst et al. 2006). Therefore, given the available information, different age determination for the Bagh-e Vang Formation has been reported based on fusulinids, brachiopods, conodonts, corals, and bryozoans. Foraminifera such as fusulinids are the index fossils to date Permian strata, thus fusulinid-based biostratigraphy of another upper Lower Permian section beside Bagh-e Vang section and their correlation with each other will provide more precise age determination of the Bagh-e Vang Formation. In this study, the Bagh-e Vang Formation has been measured and sampled in both Bagh-e Vang Mountain and western side of the Shesh Angosht Mountain for fusulinid biostratigraphic study. Another topic that will be discussed in this research is to review the end Lower Permian events and their influence on fusulinid palaeobiogeographic in Iran and its comparison with other Cimmerian blocks.

Materials & Methods

For fusulinid biostratigraphy, Bagh-e Vang Formation was measured and sampled in two stratigraphic sections, i.e. Bagh-e Vang and Shesh Angosht sections. To have a better age determination, sampling was done in close intervals from limestone and calcareous limestone of this formation. A total of 46 and 53 samples were collected from Bagh-e Vang and

Shesh Angosht sections, respectively. The precise study of the fusulinids was carried out by preparing 230 oriented thin sections from the specimens.

Discussion of Results & Conclusions

The fusulinid zonation of the Bagh-e Vang Formation at the Bagh-e Vang and Shesh Angosht sections revealed the late Yakhtashian to late Bolorian age for this formation. The basal part of the Bagh-e Vang Formation is younger in the Shesh Angosht section and no late Yakhtashian fusulinid was found in this section. The distribution of the fusulinid assemblages during late Early Permian in other Cimmerian blocks shows that the appearance of the warm water fusulinids in different Cimmerian blocks was not contemporaneous. In southern blocks such as Baoshan and Qiangtang, verbeekinids occurred later than those northern blocks including Iran, south Afghanistan, southeast Pamir, and Karakorum during late Early Permian. It was first speculated that the asynchronism of the warm water fusulinid occurrences in northern and southern Cimmerian blocks was only as the result of Neotethys opening at different times and the subsequent movement of these blocks toward low latitudinal belts. Therefore, the northern Cimmerian blocks became closer to the subtropical and tropical latitudes than those blocks in southern parts and warm water fusulinids appeared in northern blocks in earlier times in late Early Permian than those in southern parts. However, new finding obtained from high-resolution oxygen isotope records of upper Lower Permian conodont apatite showed that the icehouse to greenhouse transition in Late Paleozoic happened in mid-Bolorian (Chen et al. 2013) instead of previous suggested time, i.e. late Sakmarian time (Fielding et al. 2008, Zheng et al. 2012). Thus, it can be concluded that mid-Bolorian was the time of climate warming. The appearance of fusulinids in southern Cimmerian blocks and increased diversity and abundance of warm water fusulinids in northern Cimmerian blocks in the late Yakhtashian and Bolorian can be attributed to not only the northward movement of these blocks toward high latitudes but also to the global warming. Furthermore, the significance of oceanic palaeocurrent flows as another factor cannot be ignored which might have facilitated the fusulinid faunal exchanges from equatorial waters toward cool water of higher latitudes in Gondwanan margin.