

Late Permian brachiopoda fauna in north-western Iran

Mostafa Yousefirad¹, Touran Khamooshi² and Rahim Shaabani²

¹ Department of Geology, Faculty of Earth Sciences, Payame Noor University, Tehran, Iran

² Department of Geology, Faculty of Earth Sciences, Payame Noor University, Tabriz, Iran
radyousefi@yahoo.com Mobile: 00989183638957

ABSTRACT

Key words: brachiopoda, Late Permian, Iran

The Late Permian marine sequence in the north-west of Iran, in eastern Azerbaijan province in the Zal stratigraphic section, was selected for studying brachiopods. Samples were collected from the Ali Bashi and Jolfa Formation. Twenty-seven species from 13 brachiopoda genera were recognised in this study. The recognised fossil community was compared to brachiopod communities in some regions of Iran and the Tethyan region, suggesting the Late Dzhulfian period as the age for the deposits being studied. Recognized brachiopods belong to the orders Athyris, Rhynchonellida, Productida and Strophomenida. Keywords: brachiopoda, Late Permian, Iran.

RESUMEN

Palabras clave: Braquiópodos, Pérmico Superior, Irán

La secuencia marina del Pérmico superior en el noroeste de Irán y el este de Azerbaiyán, sección estratigráfica de Zal, fue seleccionada para este estudio de braquiópodos. Las muestras fueron tomadas en las formaciones Ali Bashi y Jolfa. Se reconocieron 27 especies de 13 géneros de braquiópodos en este análisis. Las muestras recolectadas fueron comparadas con sus similares de otras regiones de Irán y de la región del Tetis, lo que sugirió el período de tardío de Dzhulfan como la proveniencia de estos depósitos. Los braquiópodos reconocidos en este trabajo pertenecen a las familias de Athyris, Rhynchonellida, Productida y Strophomenida.

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1. Introduction

Marine Permian deposits are exposed in many parts of eastern and western Azerbaijan, in north-western Iran (Shabanian and Bagheri 2008). The Zal stratigraphic section, (40,45' eastern longitude and 38,43' latitude), is located in north-eastern Azerbaijan (Figure 1); this section is part of the Abade-Jolfa deposit sequence, having a general northwest-southeast trend. The Permian deposit sequence in the region being studied consists of the Vajnan Formation (Baghbani, 1997; Shabanian and Bagheri, 2008) (or Doroud Formation), the Surmaq Formation (Iranian-Japanese research group, 1981), the Jolfa Formation (Parto Azar, 1997) and Ali Bashi Formation (Parto Azar, 1997; Tiechert, 1973). The Permian deposit in the Zal section, (having igneous nonconformity), is located on an igneous rock series before the Permian age and is itself covered by constant transition to Clararia limestone, vermiculite and the Elika Formation, caused by middle and early Trassic aging.

The 46-meter-thick Ali Bashi Formation was examined in this research to enable a paleontological study of brachiopods.

The Permian sequence in southwest Jolfa was comprehensively studied for the first time by Stepanov *et al.*, in 1969. They divided the Permian and Triassic beds in the Ali Bashi mountain section into 8 separate

stone units; units A and B were from the Guadalupian age, C-D from the Dzhulfian age, E transitional stages, F a Paratirolites horizon with early Triassic age and H and G introduced the Elika Formation in to the section being studied. Tiechert *et al.*, then examined the Ali Bashi section and made seminal changes to the divisions of Stepanov *et al.*, (1967); the according to them, E and F belonged to the highest part of the Permian division, i.e. the Dorashamian stage and they called it the Ali Bashi Formation. Re-examining the section, Parto Azar made some changes in Permian borders and lithostratigraphic units names. According to him, the lower part of unit A was the Surmaq Formation, the upper part and all of unit B consisted of the Jolfa Formation and the 52 meters thickness C, D, E, and F were introduced as the Ali Bashi formation. Based upon brachiopod fossils, (cephalopods and conodonts), the age of the Jolfa Formation has been classified as being Late Dzhulfian in terms of Permian stages in the Tethyan region (Chen *et al.*, 2005).

Several reports have been concerned with the palaeontology of foraminifera, corals, brachiopods, conodonts and cephalopods of the Ali Bashi Formation and formations from the same stage in Alborz and Abade. First information to be published on Iran's brachiopods dates back to 1916, (Stayonov). Stayonov *et al.*, (1916) released a comprehensive report on the Permian and Permo-Triassic border in the Ali Bashi section

in southern Jolfa and studied its brachiopods. Restudying the Ali Bashi section, Tiechert *et al.*, (1973) and Baud (2008) introduced many of its macrofossils, including brachiopods. An Iranian-Japanese research group (Iranian-Japanese research group, 1981) introduced brachiopods from the Hambast Formation in Abade; and research into Late Permian brachiopods was published by Fantini-Sistin, in 1965, Fantini-Sistini & Glaus in, 1966 and Angiolini in, 2010. Biostratigraphy and event stratigraphy in Iran around the Permian-Triassic boundary (PTB) has been published by Kozur (2007).

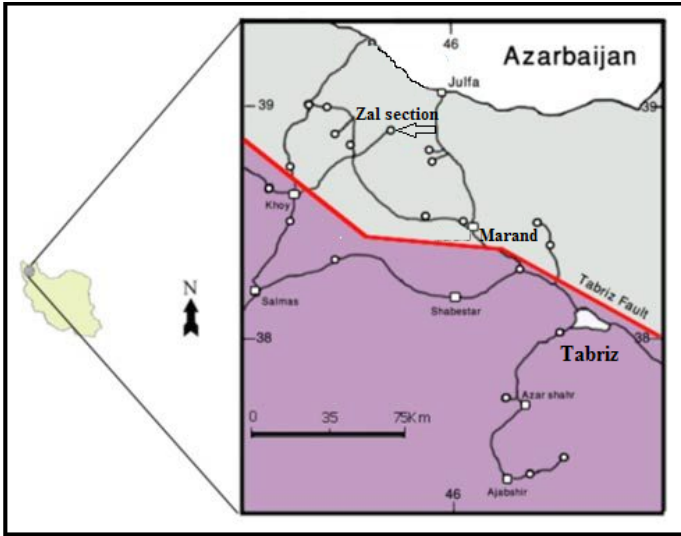


Figure 1: Position of study area

The present research was aimed at introducing Late Permian brachiopods in stratigraphic section so as to determine their age and stratigraphic correlation as well as stratigraphically examining the value of recognising brachiopod fossils (Figure 2).

Methodology

Systematic sampling was used for recognising and studying Permian brachiopods in the Zal Stratigraphic Section.; 60 samples were collected, along with corals and bryozoans, 13 genera and 27 species being recognised in the 15-meter thick section. An attempt was made to determine change in their age and size, based on brachiopods.

Discussion

The Ali Bashi Formation in the Zal stratigraphic section is 50 meters thick and includes thin layers of limestone, shale, marl and middle layers of limestone (Khamooshi 2012). An accurate field study has revealed brachiopod, separate rugose and colonial coral, bryozoan, crinoids and cephalopod macrofossil frequency. 27 species from 13 genera regarding Late Permian brachiopods were recognized in the present research work, Theost significant brachiopod families, in terms of frequency and variety, included Productida, Strophomenida, Rhyconellida and Athyris.

Studies were based upon external shell features, including shell, length, thickness and width, examining features such as pedicle valve, brachial valve, hinge line, foramen development or non-development, delthyrium (notch) status, shell shape, umbo (posterior extremity) shape, commissure line shape, existence or non-existence of fold and sulcus, their development and type of decoration. According to brachiopod stratigraphic dispersion in the Zal stratigraphic section and comparison to a recognized Late Permian fossil community in Iran and other parts of the Tethyan region, Late Dzhulfian to Dorashamian has

been introduced as the age of the Ali Bashi Formation. This research resulted in 13 genera and 27 species belonging to 5 different families being recognized, as follows:

Spinomarginifera helica(Abich), *S.spinilicata*(Arthaber), *Orthotetina* cf. *persica* (Schewien)

Orthotetina cf. *persica* (Schewien), *O.eusarkos*, *O. ex.gr eusarkos*, *Araxilevis intermedius* (Abich)

Tschernyschewia typica (Stoyanow), *Compresoproductus dzhulfensis* (Stoyanow), *Permophricodothyris ovata* (Pavlova), *Araxathyris protea* (Abich), *A. quadrilobata* (Abich)

A. lata (Grunt), *A. lata minor* (Grunt), *A. araxensis* (Grunt), *A. araxensis minor* (Grunt),

A. aff. ogbinensis, *Wellerella dorashamensis*, (Sokolskaja), *Pseudowellerella araxensis* (Sokolskaja), *Haydenella* sp.

Figure 2: A chart of brachiopod biozonation in the Zal section and stratigraphic column for the Zal section

Brachiopods, in terms of biostratigraphy value, can be categorized into two assemblage areas (Figure 2):

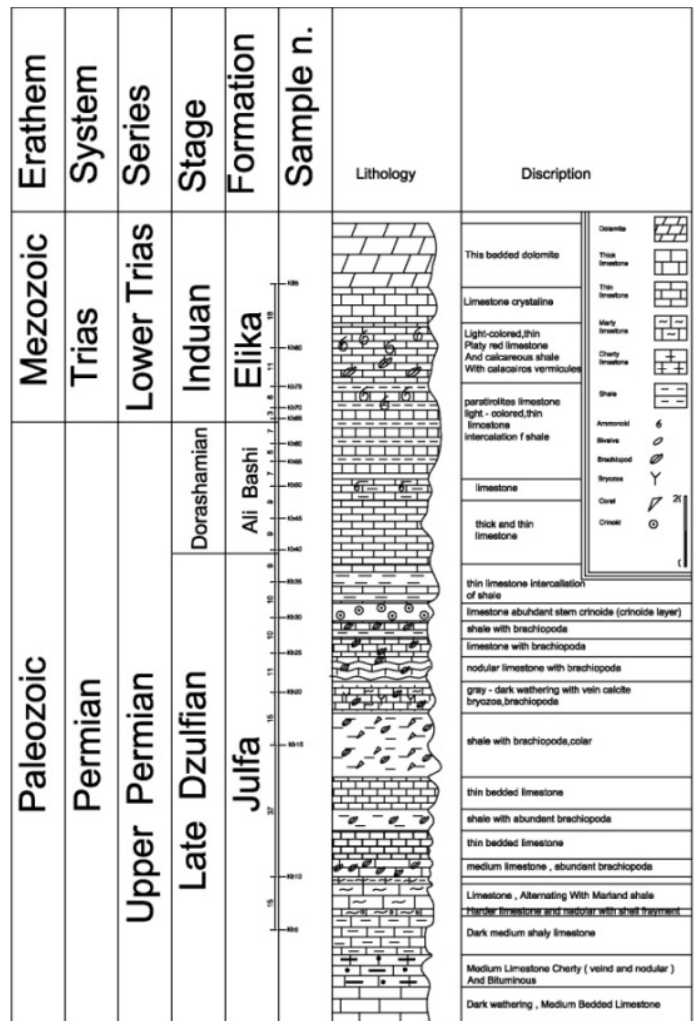


Figure 2.Stratigraphic column of the Zal section

The Araxilevis – Orthotetina assemblage biozone

This biota association was 10 metres thick. The zone began with the appearance of Araxilevis, Tschernyschewia, Spinomarginifera and end with appearance of Compresoproductus, Orthotetina. The biozones had many huge brachiopods, among which Productidae and Arthotetins were remarkable.

some of the most frequently recognized productidae are given below:

Spinomarginifera helica (Abich, 1878), *Araxilevis intermedius* (Abich, 1878), *Tschernyschewia typica* (Stoyanow, 1910), *Haydenella* sp., *Compresoproductus dzhulfensis* (Stoyanow, ..).

Huge (*Araxilevis*) and moderate productida, such as *Tschernyschewia*, *Compresoproductus*, and huge *Orthotetina* such as *Orthotetina eusarkos* (Abich), along with the coral *Pleramplexus leptoconicus* (Abich 1878) and the crinoid *Erisocrinus araxensis* (Yakovlev and Ivanov, 1965) represent significant fossils from this biota association.

Permohricodothyris – Araxathyris assemblage biozone:

This biota association was 12 metres thick. This biozone began with the appearance of *Compresoproductus dzhulfensis* (Stoyanow), *Orthotetina eusarkos* (Abich) Other brachiopods from this biota association were: *Compresoproductus dzhulfensis* (Stoyanow), *Araxilevis intermedius* (Abich), *Tschernyschewia typica* (Abich), *Permohricodothyris ovate* (Pavlova). *Spinomarginifera helica* (Abich), *Araxathyris araxensis* minor (Grunt), *Araxathyris* cf. *protea* (Abich) and *Araxathyris quadriloba* (Abich; coral type *Pleramplexus leptoconicus* (Abich) has also been found in this biota association (Figure 3).

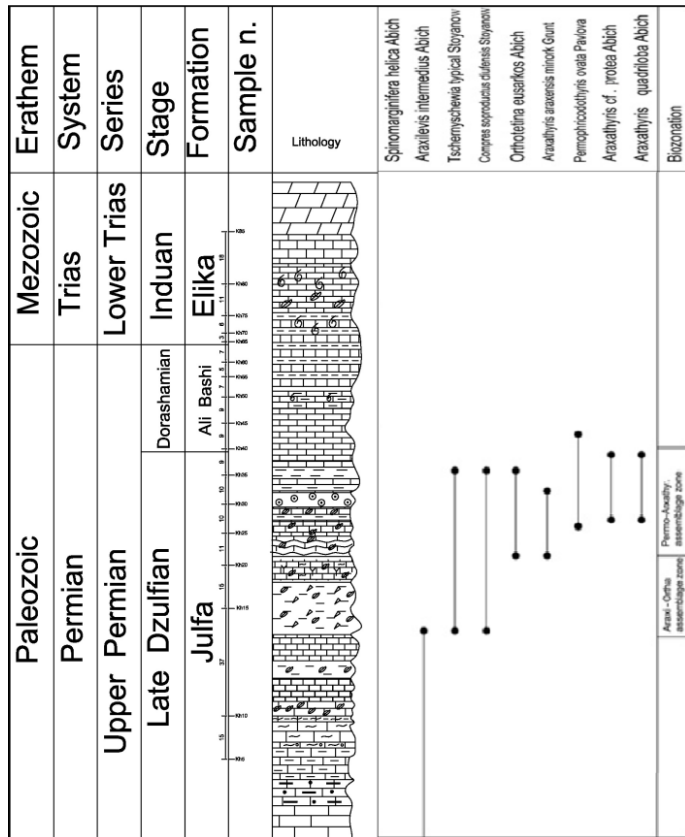


Figure 3. Biozonation of the Zal section based on brachiopod fauna

Systematic classification of brachiopods

13 genera and 27 species were recognized In this research in the Zal section (Plates 1-5). Comparing the recognized fossil community with other brachiopod communities other parts of Iran and Tethyan region suggested Late Dzulfian as of the age of deposits being studied. Different Late Permian brachiopod genera were found in the Zal section. Some of the recognized species and genera were as follows (based on Moore, 1965):

- Phylum Brachiopoda
- Class Articulata Huxley, 1869
- Order Spiriferida Waagen, 1883
- Suborder Athyrididina Boucot, Johnson & Staton, 1964
- Superfamily Athyridacea McCoy, 1844
- Subfamily Spiriferellinae Grunt, 1955
- Genus *Araxathyris quadriloba*, Abich, 1878.

Description:

Shell shape was convex-convex, dimensions being almost the same, its width a little being a little bit more than its length, The pedicle valve had a sulcus lying from the umbo to the front side, and the brachial valve had a huge, lifted-up fold. The commissure line was uniplicate. The most sulcus depression was in the front 1/3 of the shell. It was 3.1 cm thick, 3.9 cm long and 3.2 cm wide.

- Geographical spread: Shahreza, Caucas, Alborz – Balade.
- Order Strophomenida Opik, 1934
- Suborder Strophomenidina Opik, 1934
- Superfamily Davidsonicea King, 1850
- Family Meekellidae Stehli, 1954 (lamp shell)
- Subfamily Meekellinae Stehli, 1954
- Genus *Orthotetina eusarkos* Abich, 1878

Description:

Shell shape was convex – convex, with direct hinge line. The delthyrium could be seen. Interarea was obvious. The commissure line was plain. Decorations were thorny. It was 2.3 cm thick, 4 cm long and 5 cm wide.

- Suborder Productidina Waagen, 1883
- Superfamily Productacea Gray, 1840
- Subfamily Marginiferidae Stehli, 1954
- Subfamily Marginiferinae Stehli, 1954
- Genus *Spinomarginifera helica* Abich, 1878
- PL1, fig 2a-2e.

Description:

Shell shape was concave – convex, its width being greater more than its length. Raised umbo. Pedicle was little and compressed and the ears not distinct. Sulcus was replaced, brachial valve depressed and edged at the front. Rear decoration was thorny. The shell was 1 cm thick, 1.7 cm long and 1.8 cm wide.

Geographical spread: Shahreza, Jolfa, Balade, Zal

- Suborder Productidina Waagen, 1883
- Superfamily Productacea Gray, 1840
- Subfamily Marginiferidae Stehli, 1954
- Subfamily Marginiferinae Stehli, 1954
- Genus *Araxilevis intermedius*. Abich, 1878

Description:

Shell shape was convex – convex. Pedicle valve had sulcus from umbo to the end of the shell. Brachial valve was convex, hinge line curved, commissure line antiplicate, umbo raised, development line delicate and unicentric. The shell was 2.5 thick, 4.4 long and 4.2 wide.

- Suborder Productidina Waagen, 1883
- Superfamily Productacea Gray, 1840
- Family Productidae Gray, 1840
- Genus: *Tschernyschewia typica* Stoyanow, 1910

Description:

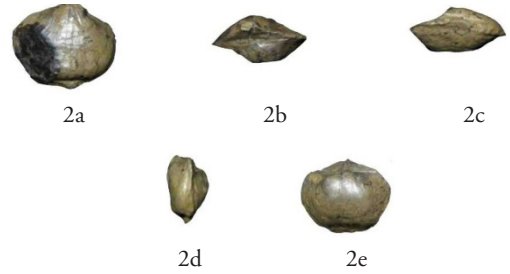
The shell was convex – concave and large. Umbo was convex and raised. Hinge line was direct, the beak obvious, and decorations had radial lines and were thorny. The shell is 2 cm thick, 3.5 long and 4 cm wide.

Suborder Productidina Waagen , 1883
 Superfamily Productacea Gray , 1840
 Subfamily Marginiferidae Stehli , 1954
 Subfamily Marginiferinae Stehli , 1954

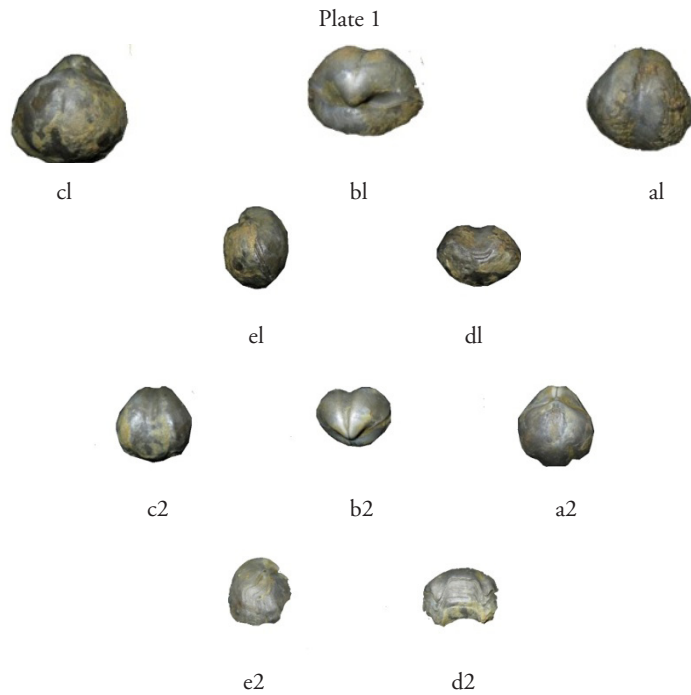
Genus: *Araxilevis intermedius*, (Abich, 1878)

Description:

The shell was convex – convex. Pedicle valve had sulcus from umbo to the end of the shell. Brachial valve was convex, hinge line curved, commissure line antiplicate, umbo raised and , development line unicentric and delicate. The shell was 2.5 cm thick, 4.4 cm long and 4.2 cm wide.



1. *Araxathyris araxensis minor* (Grunt 1965). 1a:ventral, 1b:dorsal, 1c:lateral, 1e:posterior.
 2. *Orthotetina eusarkos* (Abich 1878). 2a:ventral, 2b:posterior, 2c:anterior, 2d:lateral, 2e:dorsal.



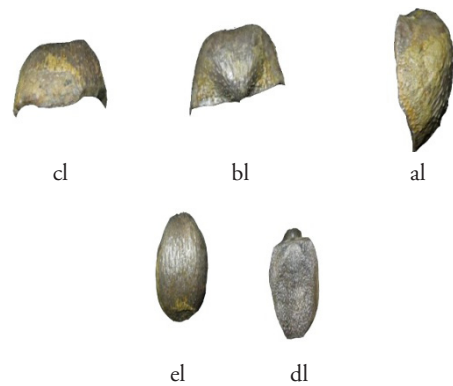
1: *Araxathyris quadrilobata* (Abich, 1878). 1a: dorsal, 1b: posterior, 1c: ventral, 1d: lateral, 1e: anterior.
 2: *Anaxathyris cf. protea* (Abich, 1878). 2a: ventral, 2b: posterior, 2c: dorsal, 2d: lateral, 2e: anterior.

Plate 3



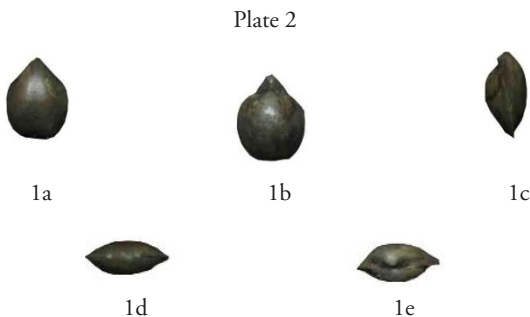
1.: *Spinomarginifera helica* (Abich, 1878). 1a: dorsal, 1b: lateral, 1c: ventral, 1d: anterior, 1e: posterior.
 2.: *Araxilevis intermedius* (Abich, 1878). 2a: anterior, 2b: lateral, 2c: ventral, 2d: dorsal, 2e: posterior.

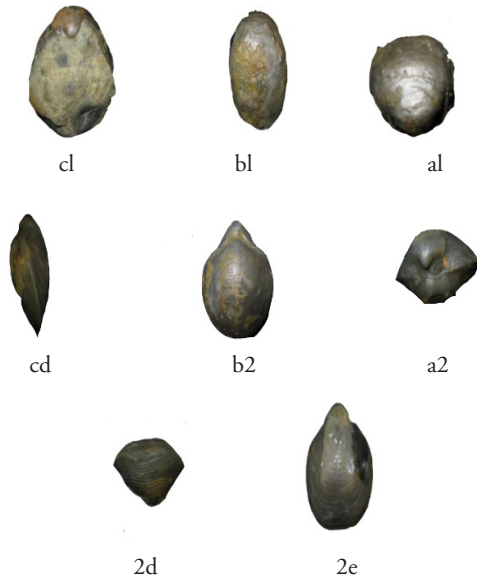
Plate 4



1.: *Tschernyschewia typica* (Stoyanow, 1910), 1a: anterior, 1b: posterior, 1c: lateral, 1d: ventral, 1e: Dorsal.
 2.: *Haydenella* sp.,. 2a: posterior, 2b: dorsal, 2c: lateral.

Plate 5





1.: *Sarytchevinella diulfensis* (or *Compresoproductus dahulfensis* lamp shell) (Stoyanow, 1910). 1a: dorsal, 1b: ventral, 1c: posterior.
 2.: *Permophricodothyris ovate* (Pavlova, 1965). 2a: lateral, 2b: dorsal, 2c: posterior, 2d: anterior, 2e: Ventral

Conclusion

Field study led to 27 species from 13 genera being examined, thereby revealing that brachiopods having large shells, belonging to the Productidae and Spiriferida families, like Permian- *Sphaeroidothyris*, *Araxilevis* and *Orthotetina*, were more frequent and the shells were bigger in the lower and middle parts of the sequence being studied.

The shells become smaller towards the head of the sequence, that shapes having small shells belonging to the *Athyris* and *Rhynchonellida* families (like *Werella* and *Pseudowerella*) were more frequent during the Late Dzhulfian and Dorashamian ages.

The studies indicated that changes in brachiopod frequency and dimensions suggested their dependency upon deep environmental changes. Based upon brachiopods, stratigraphic dispersion, the sequence being studied was determined to be Late Permian to Dorashamian in terms of Tethyan Permian stage.

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