Viséan-Asselian (Early Carboniferous-Early Permian) foraminiferal faunas from the Sanandaj-Sirjan Zone (Shahreza and Abadeh Regions), Iran

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Abstract

The Viséan-Asselian (Early Carboniferous-Early Permian) foraminiferal faunas and biostratigraphy were studied in three sections of the Shahreza-Abadeh regions, in the Sanandaj-Sirjan Zone, in Iran. These sections with a thickness of about 528-1180 m are mainly composed of the siliciclastics and carbonates. The succession consists of the Shishtu and Sardar groups of the Carboniferous and the Anarak Group of the uppermost Carboniferous-Lower Permian. The sequence under studied contains 217 species belonging to 75 genera within the six foraminiferal zones; namely, (1) the Uralodiscus rotundus - Glomodiscus miloni Zone of a late early Viséan age, (2) the Plectostaffella jakhensis - Eostaffella pseudostruveli Zone of a Voznesenkian (earliest Bashkirian) age, (3) the Tikhonovichiella tikhonovichi - Profusulinella (Depratina) prisca - Aljutovella spp. Zone of a Melekessian-Vereian (latest Bashkirian-earliest Moscovian) age, (4) the Beedeina ex gr. samarica - Taitzehoella mutabilis Zone of a late Kashirian age, (5) the Fusulinella (Fusulinella) pseudobocki Zone of an early Podolskian age, and (6) the Praepseudofusulina kljasmica Zone of a latest Gzhelian-Asselian age. Among the identified foraminifers, 21 genera and 39 species are reported for the first time in the Sanandaj-Sirjan Zone. The foraminiferal zones and their characteristic index species allow to correlate the Viséan-Asselian sequence in the Sanandaj-Sirjan Zone with the foraminiferal biozonation acknowledged for the Viséan-Asselian in the Russian Platform, Southern and Northern Urals, South China; Istanbul Terrane and Central Taurides (Turkey), and the Western Europe. These new foraminiferal faunas, furthermore, share some common species with the concurrent faunas of the Alborz, East Iran, and Central Iran. In this study, the foraminiferal assemblages of the Voznesenkian (earliest Bashkirian) age, the Melekessian-Vereian (latest Bashkirian-earliest Moscovian) age, and the Biozone MFZ11B (late early Viséan) are reported for the first time in the Sanandaj-Sirjan Zone.

Keywords: Sanandaj-Sirjan Zone, Iran, Shishtu Group, Sardar Group, Vazhnan Formation, foraminifers, biostratigraphy.

Introduction

This study is devoted to enhance the understanding of the Viséan-Asselian (Lower Carboniferous-Lower Permian) biostratigraphy in the Shahreza-Abadeh regions of the Sanandaj-Sirjan Zone in Iran. For this purpose three stratigraphic sections; namely, the Banarizeh, Asad Abad II, and Tang-e-Darchaleh sections have been measured (Fig. 1). These
three sections belong to a belt of the Carboniferous and Permian strata that distribute almost continuously from Esfahan to Sirjan along the Sanandaj-Sirjan Zone [1].

Fig.1: Map of the Shahreza-Abadeh areas showing the location of the three sections under studied in this research (modified after [2]).

Results and discussions

The Viséan-Asselian succession in the Sanandaj-Sirjan Zone consists of the Shishtu and Sardar groups of the Carboniferous and the Anarak Group of the uppermost Carboniferous-Lower Permian. In the Sanandaj-Sirjan Zone, except for the Tournaisian, Serpukhovian, and Kasimovian Stages, the characteristic foraminiferal assemblages of the Early Carboniferous-Early Permian age exist in the almost entire Viséan-Asselian sequence. The sequence under studied contains 217 species belonging to 75 genera within the six foraminiferal zones; namely, (1) the Uralodiscus rotundus - Glomodiscus miloni Zone of a late early Viséan age, (2) the Plectostaffelle jakhensis - Eostaffella pseudostruevi Zone of a Voznesenkian (earliest Bashkirian) age, (3) the Tikhonovichiella tikhonovichi - Profusulinella (Depratina) prisca - Aljutovella spp. Zone of a Melekessian-Vereian (latest Bashkirian-earliest Moscovian) age,
Definitions of the Recognized Foraminiferal Zones

The Uralodiscus rotundus - Glomodiscus miloni Zone (late early Viséan Age)

The sediments bearing the Uralodiscus rotundus - Glomodiscus miloni Zone are represented by quartz arenitic sandstone, mudstone, bioclastic wackestone, packstone, grainstone, and oolitic grainstone. The foraminiferal assemblage in this biozone is dominated by the species of Parathuramminites, Pseudoammodiscus, Brunsia, Lapparentidiscus, Viseidiscus, Uralodiscus, Glomodiscus, Paraarchaediscus, Planoarchaediscus, Forschia, Endothyra, Laxendothyra?, Endolaxina, Omphalotis, Rhodesinella?, Endothyranopsis, Plectogiranopsis, Eogloboenothyra, Dainella, Bessiella, Pojarkovella, Inflatoendothyra, Mediocris, Tetrataxis, Valvulinella, and Eoparastaffella. Characteristic for this biozone is the first appearance of the species of Glomodiscus and Uralodiscus rotundus (Chernysheva) which are among the index smaller foraminifers to define the Viséan age (e.g. [3], [4]). The contact of the lower part of this interval is not exposed, and the top of this zone is limited by an unconformity followed by sequence belonging to the earliest Bashkirian (Voznesenkian) age. This biozone is correlated with the foraminiferal biozonation acknowledged for the late early Viséan in the Western Europe (e.g. [5], [3]), Eastern European Platform [6], Urals (e.g. [7], [8]), South China [9], and Istanbul Terrane in northwest Turkey [4]. This new foraminiferal fauna, furthermore, shares some common species with the concurrent fauna of the Alborz in Iran (e.g. [10], [11], [12]).

The Plectostaffella jakhensis - Eostaffella pseudostruvei Zone (Voznesenkian Age)

The sediments bearing the Plectostaffella jakhensis - Eostaffella pseudostruvei Zone are represented by quartz arenitic sandstone, sandy oolitic grainstone, mudstone, bioclastic wackestone, packstone, and grainstone. The foraminiferal assemblage of the Voznesenkian age differs from the previous one in appearance of the first fusulinid taxa of the earliest Bashkirian age. One of them is Plectostaffella jakhensis Reitlinger which is among the meaningful species to define the earliest Bashkirian age in sections of the Russian Platform and Urals [13]. In addition to Plectostaffella jakhensis Reitlinger this assemblage is dominated by species of Eostaffella, Planensothyra, Endothyra, Mediocris, Paraarchaediscus, Earlandia, Globivalvulina, Biseriella, Howchinia, Tetrataxis, Pseudoglomospira, Consobrinella, Deckerella, Koskinotextularia, Palaeotextularia, and Climacammina. The biozone in question is correlated with the fusulinid biozonation acknowledged for the earliest Bashkirian in the Russian Platform, Turkey, Donets Basin, and Southern Urals (e.g. [14], [15], [16], [17]). On the other hand, the Voznesenkian fusulinids in Iran are correlated with the concurrent assemblages in the Alborz and East Iran (e.g. [18], [19], [20]). The biozone under consideration is overlain unconformably by the Tikhonovichiella tikhonovichi - Profusulinella (Depratina) prisca - Aljutovella spp. of a latest Bashkirian-earliest Moscovian age.
The Tikhonovichiella tikhonovichi - Profusulinella (Depratina) prisca - Aljutovella spp. Zone (Melekessian-Vereian Age)

The Tikhonovichiella tikhonovichi - Profusulinella (Depratina) prisca - Aljutovella spp. Zone is marked by the first appearance of species of families Profusulinidae and Aljutovellidae including Profusulinella (Depratina) prisca (Deptay), Tikhonovichiella tikhonovichi (Rauser-Chernousova), and Aljutovella cf. aljutovica Rauser-Chernousova. These species are indicative of the uppermost fusulinid zone of the Bashkirian (i.e., the Melekessian Substage) and the lowermost zone of the Moscovian (i.e., the Vereian Substage) in many sections of the Urals and the East European Platform (e.g. [21], [22]). The sediments bearing the latest Bashkirian-earliest Moscovian foraminiferal assemblage are represented by bioclastic wackestone, and grainstone. The smaller foraminifers in this assemblage are very rare and the fusulinids in this interval are dominated by species of Aljutovella, Tikhonovichiella, Profusulinella, Pseudostaffella, and Ozawainella. The fusulinid zone and its characteristic index species allow correlating the Bashkirian-Moscovian transition layers in the Sanandaj-Sirjan Zone with the fusulinid biozonation acknowledged for the latest Bashkirian-earliest Moscovian in the Russian Platform, Southern and Northern Urals, and Central Taurides (e.g. [14], [21], [23], [24], [25], [26], [27], [28]). On the other hand, fusulinids from the T. tikhonovichi - Pr. (Depratina) prisca - Al. spp. zone in this report can be partly correlated with the Vereian assemblages of Central and East Iranian blocks [19], [20]. Besides, the biozone identified in the Sanandaj-Sirjan Zone is partly correlative with the coeval assemblage identified in the Alborz (e.g. [18], [29]). The sediments bearing this assemblage are overlain unconformably by sediments of a late Kashirian age.

The Beedeina ex gr. samarica - Taitzehoella mutabilis Zone (Late Kashirian Age)

The sediments bearing the late Kashirian foraminiferal assemblage are represented by sandstone, oolitic grainstone, bioclastic wackestone, packstone, and grainstone. The rare smaller foraminifers in this assemblage are characterized by species of Earlandia, Palaeotextularia, and Globivalvulina. Fusulinids in this interval are distinguished by species of Taitzehoella, Beedeina, Ozawainella, Pseudostaffella, Millerella, and Fusiella. An important feature of this assemblage is the first appearance of fusulinids with four layered spirotheca, which implies a new phase in their evolution [20]. Aljutovella with three layered spirotheca gives place here to Beedeina with four layers. Another meaningful component in our Kashirian fusulinid assemblage is the species of Taitzehoella. In sections of the Russian Platform, the boundary between the Vereian and Kashirian substages is tentatively determined by the first occurrence of Taitzehoella, Aljutovella priscoidea, and Hemifusulina (e.g. [1], [20]). As the Melekessian-Vereian fusulinid assemblge, fusulinids of Pseudostaffella are significant components of the Kashirian interval. Representatives of Ozawainella and Profusulinella have also been identified in the assemblage. The biozone in question can be correlated with the standard fusulinid biozonation acknowledged for the Kashirian Substage in the Russian Platform (e.g. [30], [31], [32]), Turkey [33], and Darvaz [34]. The sediments
bearing this assemblage are overlain unconformably by the sediments of an early Podolskian age.

**The Fusulinella (Fusulinella) pseudobocki Zone (Early Podolskian Age)**

The sediments bearing the early Podolskian foraminiferal assemblage are represented by sandstone, mudstone, oolitic grainstone, bioclastic wackestone, packstone, and grainstone. Fusulinid species supporting the early Podolskian age for this assemblage are relatively abundant representatives of the *Fusulinella* known from many sections of the Podolskian Substage in the Russian Platform and Southern Urals [20]. Since some *Profusulinella* species, which are atypical of the Moscovian upper part, are also found here, the assemblage is attributed to the basal part of the Podolskian Substage. In this assemblage, the number of fusulinids with four layered structure of the spirotheca gradually increases. In addition to listed taxa, this interval is dominated by the species of *Taitzehoella, Fusiella, Schubertella,* and *Ozawainella.* The sparse smaller foraminifers are characterized by the species of *Tetrataxis* and *Globivalvulina.* The fusulinid zone and its characteristic index species allow correlating the early Podolskian assemblage in the Sanandaj-Sirjan Zone with the fusulinid biozonation acknowledged for the Podolskian Substage in the Russian Platform (e.g. [30], [31], [32]), Spain [35], and Turkey [36]. The sediments bearing this assemblage are overlain unconformably by the sediments of latest Gzhelian-Asselian age.

**The Praepseudofusulina kljasmica Zone (Latest Gzhelian-Asselian Age)**

The youngest foraminiferal biozone appearing in the Viséan-Asselian interval in the Sanandaj-Sirjan Zone is identified as the *Praepseudofusulina kljasmica* Zone of a latest Gzhelian-Asselian age. The sediments bearing this assemblage are represented by sandstone, mudstone, bioclastic wackestone, packstone, and grainstone. This assemblage is dominated by fusulinids with tectum and kerothecal wall structure. They are the species of *Praepseudofusulina, Pseudoschwagerina?, Nonpseudofusulina, Anderssonites,* and others. The species *Praepseudofusulina kljasmica* (Sjomina) is the meaningful component of this assemblage. In many sections of the Russian Platform and the Southern Urals, this species is characteristic of the uppermost Gzhelian and Asselian stages [37]. Besides the listed fauna, the assemblage includes the species of smaller foraminifers such as *Nodosinelloides, Pseudovidalina, Rectogordius, Cornuspira, Eolasiodiscus, Pseudoacutella, Hemigordius, Globivalvulina, Hemidiscus, Pseudoagathammina, Protonodosaria, Geinitzina, Syzrania,* and *Hemigordiellina.* The fusulinid zone and its characteristic index species allow correlating the latest Gzhelian-Asselian transition layers in the Sanandaj-Sirjan Zone with the fusulinid biozonation acknowledged for the latest Gzhelian-Asselian in the Russian Platform, and the Southern Urals (e.g. [20], [38], [39]). This new foraminiferal fauna, furthermore, shares some common species with the concurrent fauna of the Central and East Iran (e.g. [19], [20], [40]), and Alborz [18]. The sediments bearing the assemblage in question are overlain unconformably by the Surmaq Formation, corresponding in age to the upper Lower Permian-Middle Permian.
Conclusions

The Viséan-Asselian successions in Sanandaj-Sirjan Zone of the Shahreza and the Abadeh regions have been studied in three sections. Based on the foraminiferal assemblages the following conclusions can be drawn:

• The Viséan-Asselian interval in this study contains 217 species belonging to 75 genera within the six foraminiferal zones; namely, (1) the Uralodiscus rotundus - Glomodiscus miloni Zone of a late early Viséan in age, (2) the Plectostaffelle jakhensis - Eostaffella pseudostruvei Zone of a Voznesenkian (earliest Bashkirian) in age, (3) the Tikhonovichiella tikhonovichi - Profusulinella (Depratina) prisca - Aljutovella spp. Zone of a Melekessian-Vereian (latest Bashkirian-earliest Moscovian) in age, (4) the Beedeina ex gr. samarica - Taitzehoella mutabilis Zone of a late Kashirian age, (5) the Fusulinella (Fusulinella) pseudobocki Zone of an early Podolskian in age, and (6) the Praepseudofusulina kjasmica Zone of a latest Gzhelian-Asselian in age.

• The foraminiferal zones and their characteristic index species allow to correlate the Viséan-Asselian sequence in the Sanandaj-Sirjan Zone with the foraminiferal biozonation acknowledged for the Viséan-Asselian in the Russian Platform, Southern and Northern Urals, Istanbul Terrane and central and eastern Taurides (Turkey), and Western Europe (e.g. [3], [4], [5], [14], [15], [16], [17], [20], [21]. [23], [24], [25], [26], [27], [28], [38], [39]).

• The new foraminiferal faunas, furthermore, share some common species with the concurrent faunas of the Alborz, East Iran, and Central Iran (e.g. [18], [19], [20], [40]).

• In this study, the foraminiferal assemblages of the Voznesenkian (earliest Bashkirian) age, the Melekessian-Vereian (latest Bashkirian-earliest Moscovian) age, and also the Biozone MFZ11B (late early Viséan) are reported for the first time in the Sanandaj-Sirjan Zone.

REFERENCES


