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Upper Permian (Changxingian) Radiolarian Cherts within the Clastic Successions of the "Karakaya Complex" in NW Anatolia

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Abstract: The arkosic sandstones with olistostromes within the "Karakaya Complex" in NW Anatolia to the south of Geyve include a thin layer of green chert with radiolaria. Based on the composition of Albaillellids, the radiolarian assemblage corresponds to the *Neoalbaillella ornithoformis* assemblage, and its age is assigned to the Changxingian (Late Permian). This is the first finding of synsedimentary radiolarian cherts within the Karakaya units and the indication of latest Permian rifting of the Karakaya basin within the Midian carbonate platform and its pre-Permian basement in the Sakarya Composite Terrane.

Key Words: Karakaya basin, radiolaria, Changxingian, rifting

Kuzeybatı Anadoluda "Karakaya Kompleksi"nin Kırıntılı Birimlerinde Geç Permiyen (Changxingian) Yaşlı Radyolaryalı çörtler

Özet: Geyve güneyinde, "Karakaya Kompleksi" içinde yaygın olarak yüzeylenen olistostomlu arkozik kumtaşı birimi içerisinde ince bir radyolaryalı çört tabakası yüzeylemektedir. Bu çörtlerden alınan örnek, içerdiği Albaillellid'lere göre *Neoalbaillella ornithoformis* Topluluk Zonu ile korele edilmekte ve Geç Permiyenin Çangzingiyen yaşını vermektedir. Karakaya birimleri içerisinde ilk kez belirlenen bu sinsedimanter oluşuk, Karakaya baseninin en geç Permiyen'de Orta Sakarya Kompozit Birliği'nin Midiyen Platformu ve Permiyen öncesi temeli üzerinde riftleşme ile açıldığını göstermektedir.

Anahtar Sözcükler: Karakaya baseni, radyolarya, Çanzingiyen, riftleşme

Introduction

The Karakaya Complex in the Sakarya Composite Terrane (Göncüoğlu *et al.* 1997) in NW Anatolia (Figure 1) comprises several tectonostratigraphic units each with characteristic lithologic, stratigraphic and structural features. These were separated and named by Okay *et al.* (1991, 1996) as the Nilüfer, Çal, Orhanlar and Hodul units. Pickett & Robertson (1996) included the Ortaoba Unit in the Edremit area in the Complex. The formation ages, tectonic settings and relationships of these units are a matter of debate.

From these, the Nilüfer Unit is mainly characterised by hot-spot related ocean island-type (Yalınız & Göncüoğlu 2002) or within-plate-type (Pickett & Robertson 1996) volcanic rocks and associated sediments with a questionable Middle Triassic (Kaya & Mostler 1992) depositional age. The age of metamorphism is assigned to the end of Triassic in Bandırma (Okay & Monié 1997) and north of Eskişehir (Okay *et al.* 2002). The Ortaoba Unit, on the other hand, is dominated by MORB-type pillow lavas (Pickett & Robertson 1996), micritic limestones and radiolarian cherts with Middle Triassic radiolarians (TPAO 1998, unpublished data).

The Orhanlar Unit is dominated by greywackes with blocks of only Lower Carboniferous (Visean–Serpukhovian, Leven & Okay 1996) limestones in its type

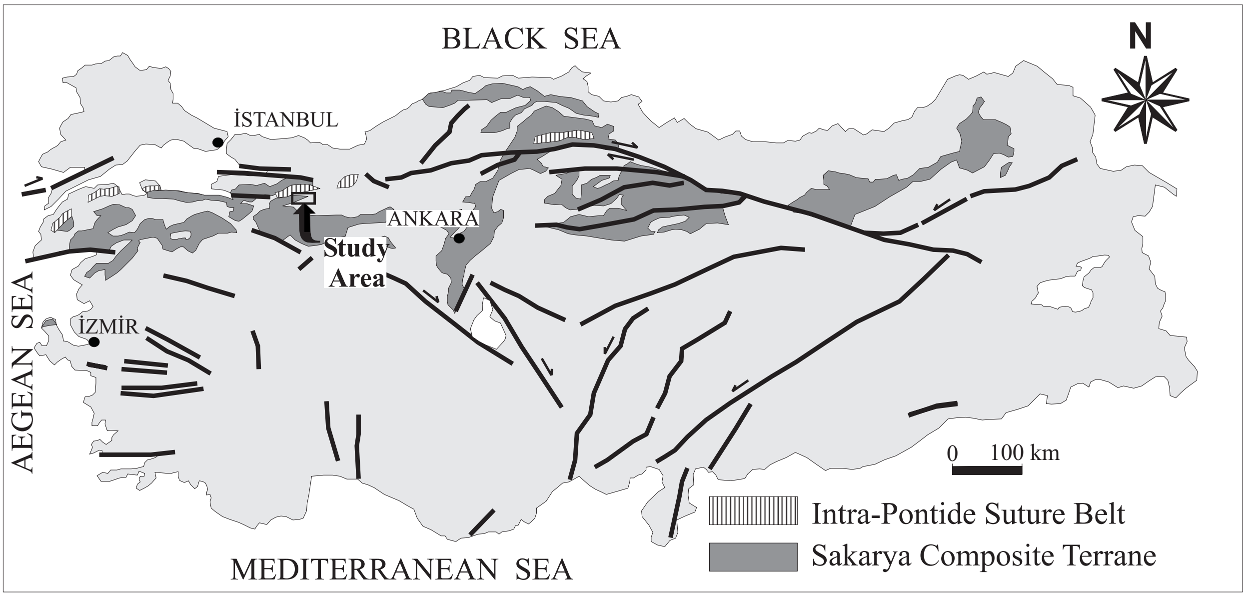

Figure 1. Distribution of the Sakarya Composite Terrane in northern Turkey (after Göncüoğlu *et al.* 1997) and location of the study area.

area. The Triassic age assigned to this unit is based on the presence of Permian blocks in the Bursa-Mustafakemalpaşa area. However, the rock units in this area are similar to the upper part of the Hodul Unit, where greywackes have also been reported (Okay *et al.* 1996). Hence, there is no evidence for the Triassic age in the Orhanlar Unit. The Çal Unit includes mainly debris-flow conglomerates, mafic volcanic rocks, and volcanogenic sandstones. The most typical feature of this unit is the presence of limestone blocks that range from a few centimeters to a few hundred meters in size (Okay *et al.* 1991). The deposition age of this unit is assigned to Early Permian to at least Middle Triassic (Leven & Okay 1996). The Hodul Unit consists of a several-km-thick package of quartzofeldspathic sandstones in its lower half. They are followed by *Halobia*-bearing shales of Norian age and finally by debris-flow conglomerates with limestone blocks of Middle Carboniferous to Late Permian ages. The depositional age is claimed to be Late Triassic (Norian) by Okay *et al.* (1996).

The tectonostratigraphic classification of the Karakaya units by Okay *et al.* (1991) had not been followed by various authors (e.g., Altıner & Koçyiğit 1993; Genç & Yılmaz 1995; Kozur & Kaya 1994; Altıner *et al.* 2000). They preferred a division of the "Karakaya Complex" on the basis of distinct lithostratigraphic units or formations, which display locally preserved stratigraphic contacts and both vertical and lateral gradational contacts to each other.

Unfortunately there is no chance for a comparison of the tectonostratigraphic (e.g., Okay *et al.* 1991) and lithostratigraphic (e.g., Altıner *et al.* 2000) units, and the confusion resulting from numerous names, differences in ages, and suggested primary relationships hinders any correlation of them and the construction of a reliable evolutionary scheme.

Along the Yenişehir-Geyve ridge (Figure 2) to the south of Geyve, the authors revisited the Karakaya units described previously by Göncüoğlu *et al.* (1987) and recognised almost all of the tectonostratigraphic and lithostratigraphic entities mentioned above. The most critical finding, however, was the presence of an *in situ* radiolarian chert layer within the arkosic sandstones, which can be assigned to the Kendirli Formation (Genç *et al.* 1986; Altıner & Koçyiğit 1993) or to the Hodul Unit of Okay *et al.* (1991). Therefore, no well-defined names had been utilised for the studied units in the Geyve area. The aim of this study will be restricted to defining the geological features, radiolarian fauna and age of this new finding and discussing the evolution of the "Karakaya Complex" within a general framework.

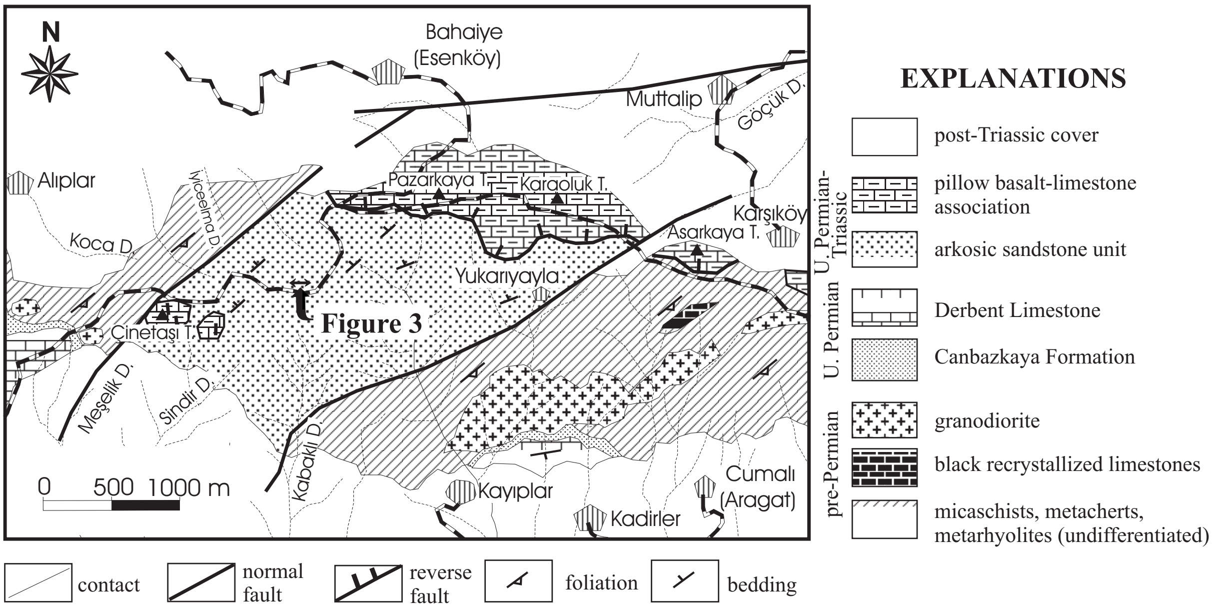

Figure 2. Simplified geological map of the study area and location of fossil finds.

Geological Setting

The study area is located on the eastern part of the E–W-trending Yenişehir-Geyve ridge to the south of Geyve (Figure 2) in NW Anatolia. On both margins of the ridge, the Upper Cretaceous–Lower Tertiary Gölpazarı Group unconformably overlies a complex consisting of metamorphic rocks and granitoids, Permian limestones, Karakaya-type sedimentary and volcano-sedimentary successions, and their Liassic cover (Saner 1978). The detailed geology of the basement rocks and their Midian (Upper Permian) cover with the Canbazkaya and Derbent formations is already given in Turhan *et al.* (2004). Therefore this paper will mainly deal with the rock units of the "Karakaya Complex".

Karakaya Units

Considering the difficulties discussed in the Introduction, the Karakaya units in the study area are informally named the "arkosic sandstone unit" and the "pillow basalt-limestone association".

Arkosic Sandstone Unit

Along a NE–SW-trending zone in the central part of the Yenişehir-Geyve ridge, an internally disrupted unit with predominant arkoses and arkosic sandstones is exposed. Toward the south, this unit is juxtaposed with basement rocks and their Upper Permian cover along a normal fault (Figure 2); therefore the primary relation of this unit with the pre-Permian basement or its autochthonous Permian cover could be observed. To the south of ridge around Pazarkaya and Karaoluk hills (Figure 2), the "pillow basalt-limestone association" rests with a tectonic contact above highly sheared and mylonitic arkosic sandstones.

The unit as a whole is extremely disrupted, and sheared; boundaries separate sedimentary packages of variable thicknesses. Thus, the unit displays the typical appearance of a "broken formation". The more-or-less comprehensive packages, up to 110-m thick, exhibit intact internal stratigraphy. The tectonic boundaries in some cases follow the periphery of the distinct rock packages, but can also be located within the same lithological package. This feature is indicative of a sedimentary mélange character for the original deposition.

Along the section between Yukarıyayla and Pazarkaya Hill (Figure 2), the lowermost package includes several tens-of-meters-thick debris-flow conglomerates. The pebbles are more-or-less rounded and range from a few millimeters up to 15 centimeters in length. A large block of recrystallised limestone occurs within the conglomerates to the SW of Yukarıyayla. The pebbles are mainly slightly recrystallised Lower and Upper Permian limestones, deformed granitoids, quartz schist and black metachert. All of these were derived from the pre-Karakaya metamorphic basement and its Permian cover.

The next slice, almost 80 meters thick, includes basaltic lavas interlayered with grey, micritic limestones and red-violet mudstones. The volcanic rocks are amygdoidal, clinopyroxene-phryic pillow and massive lavas with well-developed flow texture. The intra-pillow voids are filled with red radiolarian mudstone and hyaloclastites. Up to 1-m-thick red-violet mudstones with thin chert bands are present between the lava sheets. The limestones here are typically dark grey to grey and include cm-thick, pink-red chert bands. Thin basaltic veins cross-cut the limestone layers.

The third slice consists of a very thick package of quartzofeldspathic sandstones with a few levels of olistostromal conglomerates and rare olistoliths of recrystallised limestone. In detail, the unit includes light grey-yellowish grey, medium- to coarse-grained arkosic sandstone, interlayered with quartz sandstone. No distinct grading or other sedimentary features are observed. Under the microscope, the sandstones are slightly deformed with scaly cleavage. The predominant rock fragments are deformed granitoids and rhyolite. Clasts of strained quartz, plagioclase, biotite, microcline, muscovite, tourmaline, sericite schist and metachert are cemented by clayey matrix. Fine sericite flakes occur as the only metamorphic phase along weakly developed cleavage planes. In the studied section, olistostromal levels are present at only two locations. The location on the forest road from Esenköy to Çinetaşı Forest Tower (Figure 2) is the most critical one because it includes a chert layer with dated radiolarian fauna and that will be described in detail in the next chapter.

Pillow Basalt-Limestone Association

This unit occurs as a separate thrust slice to the north of the study area covering the Pazarkaya, Karaoluk and Asarkaya hills, and as klippen around Çinetaşı Tepe (Figure 2). Its lower contact with the arkosic sandstone unit is a thrust surface, along which the arkoses are converted to cataclasites.

This unit consists of white, algal-pisolitic shallow-marine limestones and pillow lavas. It differs from the slice of limestones and basic lavas within the "arkosic sandstone unit" by the absence of cherts and red-violet mudstones, and the dominance of white shallow-marine limestones. The volcanic rocks, mainly pillow basalts in this unit, are closely associated with the deposition of the limestones, indicative of contemporaneous formation. The pillow basalt-limestone association resembles the Abadiye formation of Genç *et al.* (1986), Bahçecik formation of Koçyiğit *et al.* (1991, in Altıner & Koçyiğit 1993) and the Ortaçaltepe limestone of Göncüoğlu *et al.* (1996). Similar rock associations were considered by Okay *et al.* (1991) to be a part of the Çal Unit. A Middle Triassic age had been assigned to the limestones on the basis of conodont (Genç *et al.* 1986) and foraminifer (Altıner & Koçyiğit 1993) faunas.

Detailed Description of the Succession with Dated Fossils

On the forest track to the Çinetaşı Forest Tower to the southwest of Pazartepe Hill (GPS location: 72326/80059 on 1/25,000 scale topographic map H24b1), the authors came across an olistostromal level within the arkosic sandstone unit. This level is approximately 8-meters thick (Figure 3) and includes a variety of rocks not observed in other parts of the clastic unit. From the bottom to the top, the succession includes (Figure 3): (1) arkosic sandstones (level A); (2) 80-cm-thick, yellow, medium-bedded recrystallised dolomite. The dolomite band contains clasts of basic volcanic rocks that range between 0.2 and 1cm (level B); (3) 150-cm-thick basaltic breccia. The fragments of vesicular basalt and hyaloclastite are angular and variable in size. They are embedded in matrix of fine-grained, non-vesicular basalt (level C); (4) Olistostromal conglomerate with rounded-subrounded basalt pebbles. The matrix is composed of medium- to fine-grained volcanogenic sandstone with subordinate clasts of dolomite (level D); (5) 170-cm-thick blocky olistostromal conglomerate. The rounded blocks, up to 25 cm thick are pillow basalts embedded in a finer-grained matrix completely made up of angular clasts of basalt (level E); (6) Recrystallised dolomite with rare basalt clasts (level F); (7) 45-cm-thick, red to pink, medium-grained massive sandstone with subrounded clasts of basalt and hyaloclastite (level G); (8) 25-cm-thick wedge of red-pink mudstone with very fine clasts of

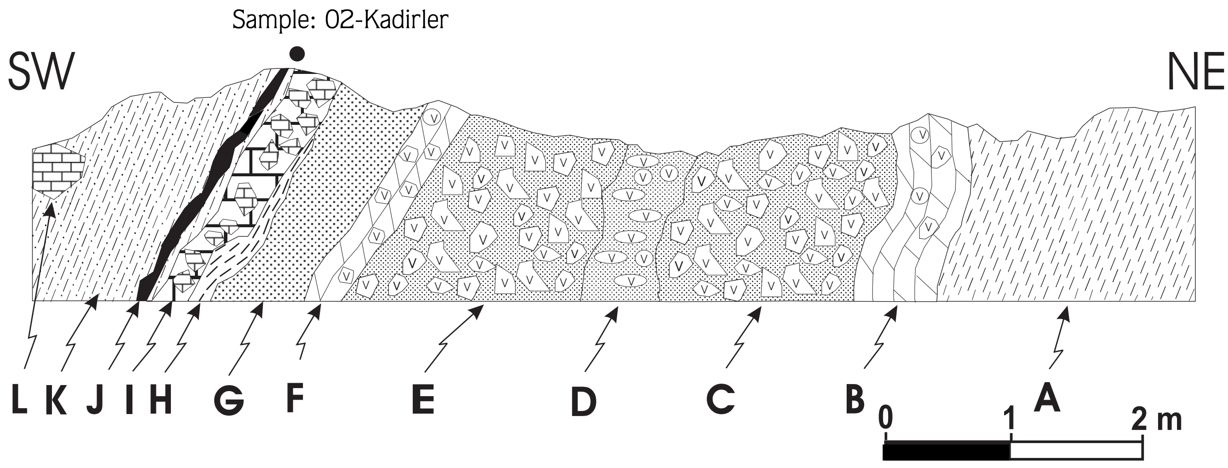

Figure 3. Detailed cross-section of the studied succession. A– Grey, yellowish grey arkosic sandstone, siltstone, B– yellow dolomite with volcanic clasts (calciturbidite), C– volcanic breccia, D– debris-flow conglomerate and conglomeratic sandstone with basaltic detritus, E– blocky mass flow with basaltic pillow lava, F– calciturbidite, G– purple-red volcaniclastic sandstone, H– red-pink mudstones, I– limestone with pebbles of recrystallised limestone, J– green chert (02-Kadirler-1 sample with abundant Chanxingian radiolarians), K– grey, mica-rich arkosic sandstones and siltstones, and L– recrystallised limestone olistolith.

basalt and volcanic glass (level H); (9) 40-cm-thick, yellowish grey dolomitic limestone with subrounded pebbles of white and pink recrystallised limestone and subordinate rounded basalt pebbles (level I); (10) 10-cm-thick arkosic siltstone with subrounded clasts of granite, rhyolite, mica schist, quartz schist, quartz, muscovite, plagioclase and biotite; (11) Pale green radiolarian chert layer. The thickness varies between 5 and 9 cm. The contacts are conformable with the underlying and overlying arkosic rocks (level J); (12) The upper part of the succession (level K in Figure 3) is again characterised by arkosic sandstones and siltstones. It resembles level A, but is relatively rich in white mica. The thin-bedded sandstones display lamination. Bedding planes include sedimentary structures typical of proximal turbidite deposition. The unit includes a 4-m olistolith of recrystallised limestone (unit L).

The described succession within the arkosic sandstone unit as a whole represents alternating intervals of debris-flow deposition with exotic detritus. The arkosic rocks (levels A and K) represent proximal turbidites with muscovite-rich detritus transported from a crystalline source, probably reflected by the pre-Permian basement of the Sakarya Composite Terrane. The following dolomites (level B as well as level F farther up in succession) represent turbiditic shallow-marine deposition (calciturbidite) with basaltic detritus from a nearby source area. The volcanic breccia (level C) is either a monoblock, emplaced by gravity sliding or an *in situ* lava flow from a nearby submarine eruption. It neither includes any reworked material, nor exotic material from a distant source. The presence of major vesiculation could be indicative of eruption in a shallow-marine environment. The overlying debris-flow conglomerates (level D) mainly include reworked pebbles from the underlying basaltic rocks. Level E with large pillow-basalt blocks and relatively undisturbed internal structure suggests short-distance transportation from a nearby submarine eruption by gravity sliding. The overlying fining-upward units, F and G, represent a period of quiescence. The sorting of rounded detritus of volcaniclastic origin and fine lamination are suggestive of transportation from a distant source. Level I is characteristic of renewed gravity sliding. Similar to levels B and F, it includes a carbonate matrix, but the pebbles are composed of rounded exotic limestones of unknown origin.

The most important level in this succession, the green radiolarian chert layer (level J), can be followed along strike for a few meters and displays conformable contact relations with the surrounding clastic rocks. By this, it is interpreted as a synsedimentary formation and its age would correspond to the deposition age of the arkosic units of the “Karakaya Complex”.

Biostratigraphy

The carbonate rocks in the succession do not include any fossils but from several samples taken from the green radiolarian chert layer, sample 02-Kadirler-1, yielded the following radiolarian fauna: *Albaillella* cf. *angusta* KUWAHARA, *Albaillella levis* ISHIGA, KITO & IMOTO, *Albaillella* spp., *Copicyntroides* ? sp., *Entactinia* ? spp., *Entactinosphaera* ? spp., *Gustefana obliqueannulata* KOZUR, *Gustefana* sp., *Ishigaum* sp., *Latentifistula* sp. S sensu KUWAHARA & YAO, *Latentifistula* sp. T sensu KUWAHARA & YAO, *Latentifistula* ? spp., Latentifistularia incertae sedis D sensu KUWAHARA & YAO, Latentifistularia incertae sedis E sensu KUWAHARA & YAO, Latentifistularia incertae sedis I sensu KUWAHARA & YAO, Latentifistularia incertae sedis, *Raciditor* cf. *gracilis* (DE WEVER & CARIDROIT), *Raciditor* cf. *inflata* (SASHIDA & TONISHI), *Raciditor* cf. *scalae* (CARIDROIT & DE WEVER).

Sample 02-Kadirler-1 is correlated to the *Neoalbaillella ornithoformis* Assemblage Zone (Kuwahara *et al.* 1998) based on the composition of Albaillellids (Figure 4), and the age is assigned to Changxingian. The Japanese radiolarian biostratigraphy had been settled through the comparison of Albaillellaria (e.g., Ishiga 1990), and the age control mainly depended on the coincident conodonts. Recently, conodont biostratigraphy has been investigated in detail in the Chinese Upper Permian, and the correlations of radiolarian and conodont zones are available. Upper Permian (in the sense of tripartite classification) radiolarian zones of southwest Japan were correlated with the conodont zones (Yao *et al.* 2001) and the *Neoalbaillella ornithoformis* and *Neoalbaillella optima* assemblage zones were assigned to the Changxingian.

Kozur (1999) reported the first Late Permian radiolarian assemblage from red radiolarites of the Çal Unit of the Karakaya Complex. The assemblage includes *Imotoella (=Albaillella) excelsa*, *Imotoella levis* and *Imotoella triangularis* with some Latentifistularia. The age of Kozur's assemblage was assigned to Dorashamian (=Changxingian). The radiolarian assemblage from sample 02-Kadirler-1 is of somewhat similar composition to Kozur (1999)'s assemblage. Both samples include *Albaillella levis*. While Kozur's assemblage includes *Albaillella excelsa*, sample 02-Kadirler-1 contains many specimens of *Albaillella levis*, but no *Albaillella excelsa* and *Albaillella triangularis*. Abundance of *Albaillella* could differentiate the age of these two assemblages. Based on the abundance of *Albaillella*, sample 02-Kadirler-1 is correlative with the *Albaillella levis* Abundance Zone, and Kozur's fauna could be correlated with the *Albaillella excelsa* Abundance Zone (Kuwahara 1997; Kuwahara *et al.* 1998). Therefore, the assemblage of sample 02-Kadirler-1 may be a little older than that of Kozur's assemblage.

Discussion and Conclusions

The uppermost Permian rocks within the Karakaya units were already known in previous studies (e.g., Tekeli

Harland et al. 1990		*Western Tethys*	*China*	*Radiolarian zones of SW Japan*	*This study*
Lopingian	Changxingian	Dorashamian	Changxingian	*N. optima*	
				N. ornithoformis	sample 02-Kadirler-1
	Longtanian	Djulfian	Wujiapingian	*F. charveti-A. yamakitai*	
				F. scholasticus-F. ventricosus	
				N.: Neoalbaillella; F.: Follicucullus; A.: Albaillella	

Figure 4. Subdivision of Upper Permian stages in western Tethys and China and radiolarite zones with the location of the radiolarian-bearing sample from the study area.

1981). Changxingian pelagic conodonts were first described by Kozur & Kaya (1994) from a limestone pebble in a limestone olistolith within the quartzofeldspathic sandstones of the Dışkaya Formation (Hodul Unit of Okay *et al.* 1991) in the Biga area. This finding was assigned to the Dzhulfian rifting of the Cimmerian Ocean in NW Turkey. The second finding of Changxingian fauna was by Kozur (1999) from an olistolith with red and green, thin- to medium-bedded radiolarian chert with thin shale interbeds within the siliceous shales of the Çal Unit reported by Okay & Mostler (1994). This discovery was assigned by Kozur (1999) to the opening of a "Karakaya oceanic basin" within the Sakarya Continent of Şengör *et al.* (1984). However, in contrast to Şengör *et al.* (1984), Kozur (1999) suggested that the "Karakaya Ocean" had opened as a back-arc basin above a northward subducting Tethyan oceanic branch (Paleotethys *sensu*; Stampfli 2000) located to the south of the Sakarya Continent. The third finding of the uppermost Permian is from Leven & Okay (1996), who report a shallow-marine fusulinid fauna of Dorashamian age in a limestone block within the Hodul Unit. Altıner *et al.* (2000), on the other hand, testified that shallow-marine carbonate deposition in their Northern Biofacies Belt (including the northern Taurides and the Sakarya units) was continuous during the Dzhulfian to Dorashamian, as depicted from the foraminiferal fauna found in olistoliths of northwestern Turkey. To sum up, uppermost Permian has been recorded in previous studies only in exotic blocks, and its deposition was attributed to the opening of a deep basin.

The arkosic sandstone unit with olistostromes and interstratified rocks in the study area are interpreted as submarine slide, debris-flow and sediment gravity-flow deposits of a proximal fan environment. This environment probably developed at the proximal slope of a rift basin. The volcanic detritus and blocks in the olistostromal levels were mainly derived from nearby eruptions within the shallow-marine platform, whereas the granitic/rhyolitic and metamorphic clasts were transported from the basement to fan deltas, and subsequently incorporated into the proximal fan environment by gravity-flow deposits. The larger olistoliths of Upper Permian shallow-marine limestones were probably derived from the scarps of normal faults and transported by sliding into the proximal turbidites. The uppermost Permian limestone blocks reported by Leven & Okay (1996), on the other hand, were probably deposited in reefs and provided the source of the detritus (calciturbidites) and blocks. Intervals of tectonic quiescence are represented by deposition of relatively well-sorted sandstones and laminated mudstones (levels F to G).

The synsedimentary deposition of the relatively thin green chert (level J) within the arkosic siltstones is also attributed to an interval of tectonic quiescence. Its formation was possibly not controlled by water depth but triggered by excess silica in the depositional environment due to coeval volcanism. Submarine slide, debris-flow and sediment gravity-flow deposits of a proximal fan environment associated with volcanism observed in the studied succession are typical features of rift basins that evolve to continental margin basins (Einsele 1992; Bailey *et al.* 1989). A very similar case is known from the Upper Jurassic of the Eastern Alps (e.g., Schlager & Schlager 1973), where radiolarites interfinger with proximal turbidites including clasts of neritic limestones and basic volcanic rocks. The deposition of these units is ascribed to submarine fans bordering tectonically uplifting palaeohighs.

Although based on limited data, the alkaline geochemistry of the volcanic rocks within the Abadiye Formation (Genç 1993; Genç & Yılmaz 1995) supports this interpretation. Similar rift-related models for the evolution of the Karakaya units were previously proposed by various authors (e.g., Bingöl *et al.* 1975; Okay *et al.* 1991; Altıner & Koçyigit 1993; Genç & Yılmaz 1995; Göncüoğlu *et al.* 2000). The present finding of the synsedimentary radiolarian chert within the proximal turbidites and olistostromes of the "Karakaya Complex" confirms these suggestions. Moreover, it indicates that the rifting of this basin within the Sakarya Composite Terrane was achieved between the deposition of the Midian platformal carbonates (e.g., Turhan *et al.* 2004) and Changxingian rift-related sediments and volcanism. This idea should be further investigated through detailed palaeontological work on the pelagic sediments and geochemistry of the associated volcanic rocks within different tectonostratigraphic units of the "Karakaya Complex".

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PLATE 1

Scanning electron microscope photomicrographs of radiolarians from the chert level in the Karakaya Complex of the Kadirler area. All specimens are from sample 02-Kadirler-1 of Changxingian age. Length of scale bar = number of micrometers (μm) for each figure.

1. *Albaillella* cf. *angusta* KUWAHARA, Scale bar = 110 μm.
2-6. *Albaillella levis* ISHIGA, KITO & IMOTO, Scale bar = 80, 80,100,100 and 80 μm, respectively.
7-17. *Albaillella* spp. Scale bar = 100, 75, 80, 100, 100, 75, 80, 80, 80, 80 and 80 μm, respectively.
18. *Copicyntroides* ? sp., Scale bar = 130 μm.
19-20. *Entactinia* ? spp., Scale bar = 100 and 80 μm, respectively.
21-22. *Entactinosphaera* ? spp., Scale bar = 100 and 100 μm, respectively.

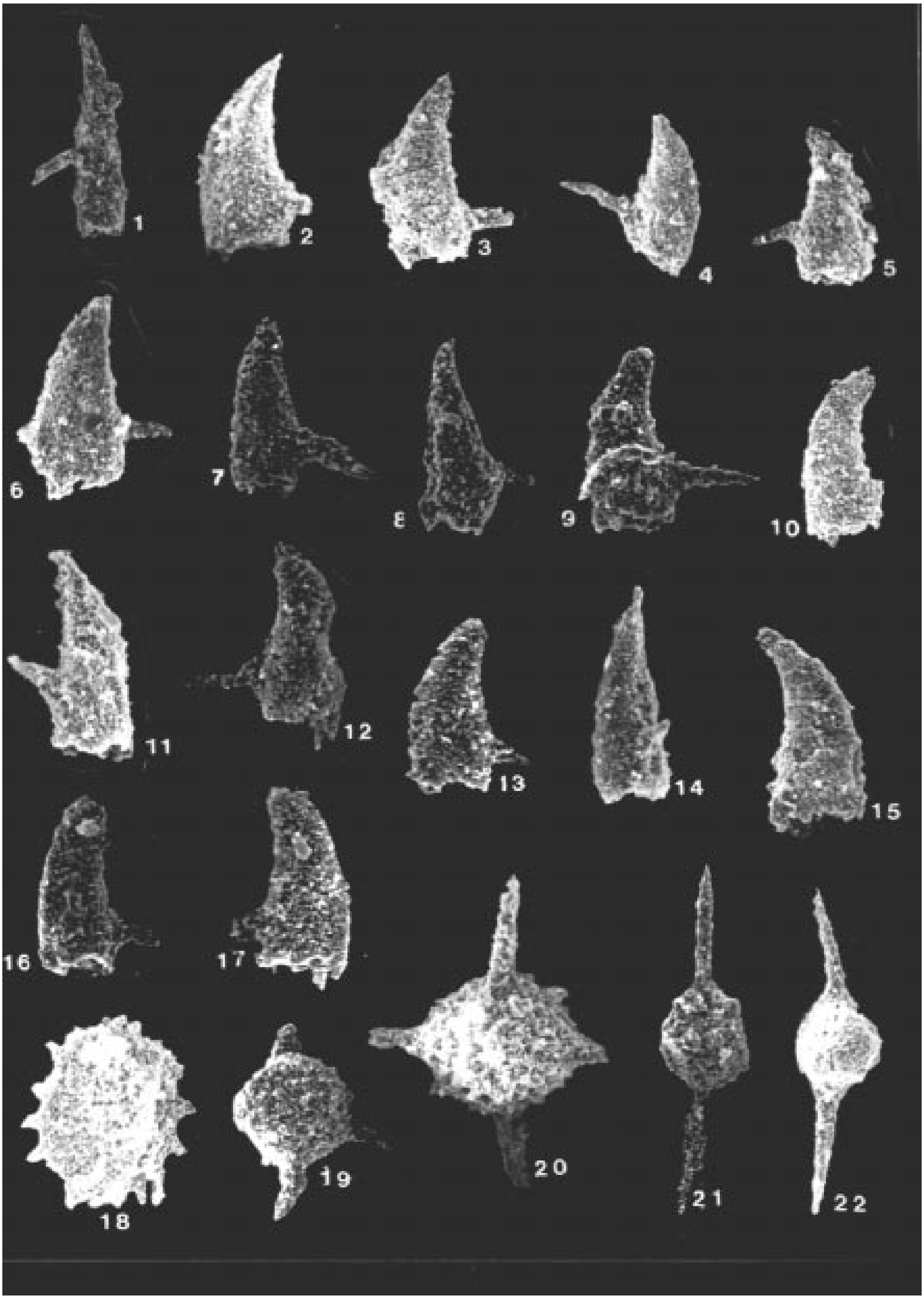
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PLATE 2

Scanning electron microscope photomicrographs of radiolarians from the chert level in the Karakaya Complex of the Kadirler area. All specimens are from sample 02-Kadirler-1 of Changxingian age. Length of scale bar = number of micrometers (μm) for each figure.

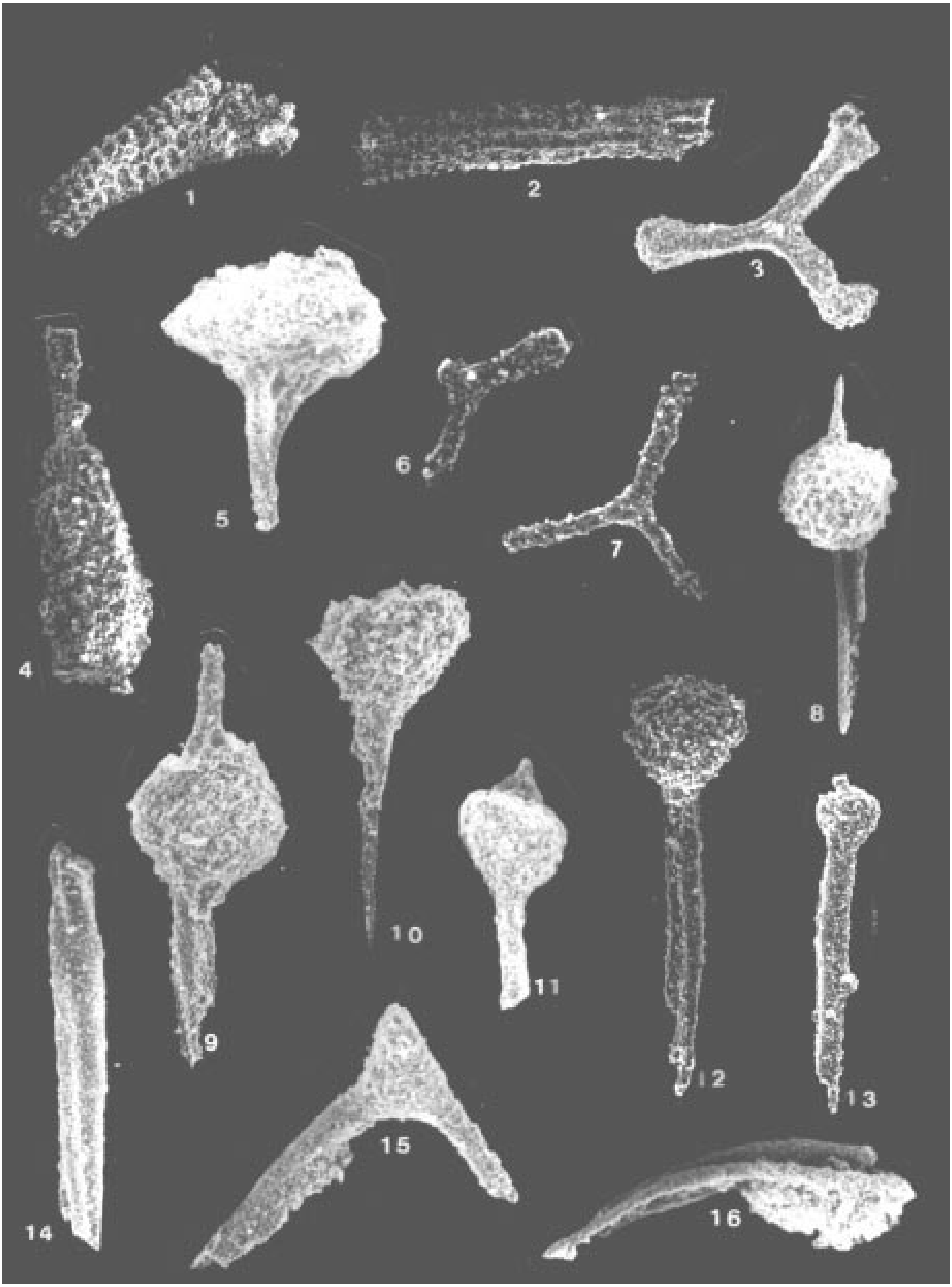
1. *Gustefana obliqueannulata* KOZUR, Scale bar = 250 μm.
2. *Gustefana* sp., Scale bar = 290 μm.
3. *Ishigaum* sp., Scale bar = 130 μm.
4. *Latentifistula* sp. S sensu KUWAHARA & YAO, Scale bar = 130 μm.
5. *Latentifistula* sp. T sensu KUWAHARA & YAO, Scale bar = 80 μm.

6-7. *Latentifistula* ? spp., Scale bar = 120 and 115 μm, respectively.

8-9. Latentifistularia incertae sedis D sensu KUWAHARA & YAO, Scale bar = 80 and 100 μm, respectively.

10-11. Latentifistularia incertae sedis E sensu KUWAHARA & YAO,, Scale bar = 100 and 80 μm, respectively.

12. Latentifistularia incertae sedis I sensu KUWAHARA & YAO, Scale bar = 125 μm.
13. Latentifistularia incertae sedis, Scale bar = 150 μm.
14. *Raciditor* cf. *gracilis* (DE WEVER & CARIDROIT), Scale bar = 100 μm.
15. *Raciditor* cf. *inflata* (SASHIDA & TONISHI), Scale bar = 80 μm.
16. *Raciditor* cf. *scalae* (CARIDROIT & DE WEVER), Scale bar = 100 μm.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