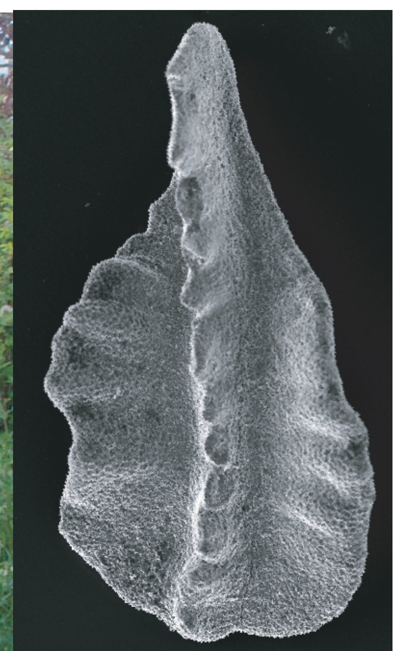
Permophiles

International Commission on Stratigraphy
International Union of Geological Sciences



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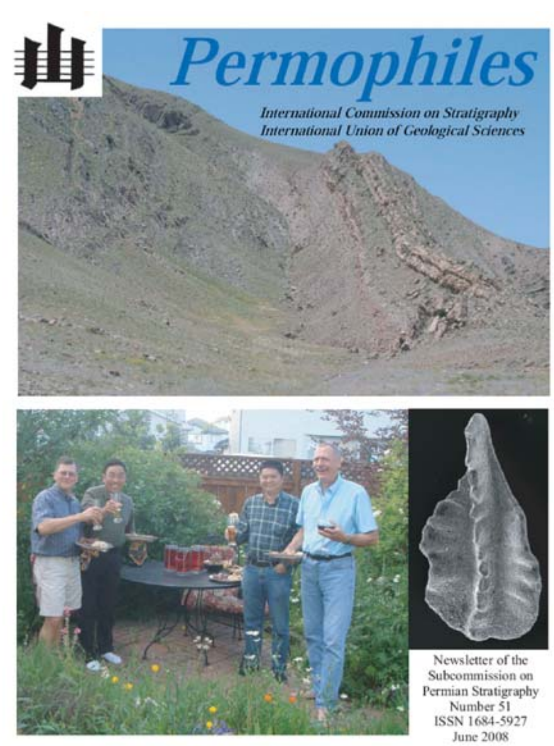

Explanation of Cover: **1.** Zal section in NW Iran (photo provided by Vladimir Davydov). **2.** from left to right: Charles Henderson, Shuzhong Shen, Shilong Mei and Bruce Wardlaw are having a pre-workshop barbeque in Charles's garden. **3.** *Clarkina nodosa* Kozur from the Zal section in Iran (photo provided by Bruce Wardlaw).

EXECUTIVE NOTES

Notes from the SPS Secretary

Shuzhong Shen

Introduction and thanks

First of all, I would like to thank Bruce Wardlaw, Charles Henderson, Shilong Mei for making the effort to attend the conodont workshop on the conodonts from NW Iran in Calgary sponsored by SPS. The age and correlation of the conodonts from different sections in Kuh-e-Ali Bashi area, Northwest Iran, has become one of the hotest issues we discussed recently. Bruce Wardlaw brought the conodonts from the Zal section, which is about 22 km to the south of the Kuh-e-Ali Bashi sections. Shilong Mei brought Teichert's *et al*. (1973) conodont collections, on loan from Walter Sweet, collected by Curt Teichert and Bernhard Kummel from localities 1, 2 and 4 at Kuh-e-Ali Bashi, NW Iran. I would like to thank Walter Sweet for his permission for us to examine the collections to clarify the correlation between Locality 1 and Locality 4 at Kuh-e-Ali Bashi, Iran. I also thank Bruce Wardlaw for making the important figure to solve the correlation among the sections at Kuh-e-Ali Bashi and Zal in Iran (see this issue, Henderson *et al*., fig. 5). Four of us all agree that Permian conodont species should be defined based on a sample-population approach and a distinct ontogenic growth series. Charles Henderson, Bruce Wardlaw and Mei Shilong helped to edit the papers/notes in this issue. We all thank Charles and his wife Elizabeth for their hospitality to entertain us with wonderful Canadian barbeque and spicy Sichuan food in Calgary.

I would thank Lucia Angiolini, Moosa Bagheri, M.N. Gorij, Charles Henderson, Mohd Shafeea Leman, E. Ja, Leven, Shilong Mei, Ian Metcalfe, N.B. Rasskazova, A.N. Reimers, Rahim Shabanian, Masatoshi Sone and Bruce Wardlaw who contributed reports and notes for inclusion in this 51st issue of *Permophiles*.

Previous and forthcoming SPS Meeting

There is no SPS business meeting held since the last issue was published. The next SPS business meeting will be held in conjunction with the 33rd International Geological Congress that will be held in Oslo between August 5-14, 2008. During the next SPS business meeting, the SPS Executive Committee will be confirmed. The current SPS executive will continue in their respective capacities. Unfortunately, I will not attend the 33rd IGC because it conflicts with my field trip in Russia. Charles Henderson will organize the SPS business meeting in Oslo. The planned SPS business meeting for 2009 will be during ICOS (International Conodont Symposium) in Calgary, Alberta, Canada during July 12-18, 2009 (see announcement in this issue). Reports from these meetings will appear in future issues of *Permophiles*, which has been recognized by ICS as an excellent subcommission newsletter; this excellence can only continue with thought-provoking contributions that stimulate us to continue to move forward. I encourage readers to contribute.

Future issues of *Permophiles*

The next issue of *Permophiles* is the 52nd issue of *Permophiles*. Charles and I plan to edit *Permophiles* #52 in Nanjing in January, 2009. We hope our colleagues in the Permian community can contribute papers, reports, comments and communications. The deadline for submission to Issue 52 is December 31, 2008. Manuscripts and figures can be submitted via my email address (szshen@nigpas.ac.cn or shen_shuzhong@yahoo.com) as attachments or by our SPS website (http://www.nigpas.ac.cn/permian/web/index.asp). Hard copies by regular mail do not need to be sent unless requested. However, large electronic files such as plates in Photoshop or TIF format may be sent to me on discs or hard copies of good quality under my mailing address below. Alternatively, large files can also be transferred via the submitting system on our SPS website. Please follow the format on Page 3 of issue 44 of *Permophiles*.

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Notes from the SPS Chair

Charles M. Henderson

Permophiles 51 was mostly prepared during a conodont workshop at the Department of Geoscience, University of Calgary during July 13-17, 2008. Bruce Wardlaw, Shuzhong Shen, and Shilong Mei are to be thanked not only for their valuable contributions to discussions on Upper Permian correlations and conodont taxonomy, but also for helping with the editing of this issue. We report elsewhere on the results of this workshop, which was a humbling experience for all. We discovered that each of us was a little right and a little wrong and in the end concluded that this was also the case for Teichert and Kummel (see Henderson et al. in this issue). Reaching this humbling reality was a difficult process and there were raised voices and disagreements along the way. Some of these brisk discussions were caused by misunderstandings of language, some by misunderstandings of scientific practices, and some by simple over-reactions (the latter, especially, in my case). However, we quickly recovered, probably because of long-term friendships among us, and got back to science. In the end, I believe we reached the best scientific consensus that we could, based on our current data. We were astonished that we actually ended up agreeing! It is interesting that it was a new tool called Google Earth that served as a catalyst to bring about this consensus. Not only science has been served, in my view, but also we have learned the value of precise communication and of keeping current with tools and practices within our discipline. I welcome comments from interested readers on the scientific merits of this paper.

There are other articles in this issue by Angiolini and Leven that provide new data on correlations within the Tethys. I wish to personally thank Lucia Angiolini and Yue Wang for developing our working group and getting 18 people to agree to work on

"Neotethys, Paleotethys, and South China Correlations".The ultimate aim of this working group is to develop a standard correlation between the International Permian Time Scale and the Tethyan Time Scale. Such standardization is essential if we are going move forward in our various stratigraphic disciplines and begin to answer questions of ancient climate change that demand high precision and accurate age control. It would be great if we could move toward similar standardization in taxonomic procedures and practices – especially with conodonts.

I will be leaving soon for the International Geological Congress in Oslo Norway where SPS and the International Commission on Stratigraphy will be holding business meetings.

REPORTS

Resolution of the reported Upper Permian conodont occurrences from northwestern Iran

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Introduction

The Subcommission on Permian Stratigraphy convened a workshop to try to resolve some hotly contested issues stemming from the reported conodont occurrences from northwestern Iran, specifically Kuh-e-Ali Bashi. This workshop was open to many, but ended up with just a few that could come at a time we would be assembling the next issue of Permophiles. The initial questions were:

Does *Clarkina orientalis* occur in the "*Paratirolites*" limestone beds from the material of Sweet (in Teichert *et* al., 1973)?

Is there a different robust form of *Clarkina* from the " *Paratirolites*" limestone beds as indicated by Kozur (2004)?

Is there any structural complexity that could disrupt the section at Kuh-e-Ali Bashi?

"Based on the resolution of the above questions what is the simplest explanation of the confirmed observations?".

To aid the deliberations, Mei Shilong brought all the material of Sweet (in Teichert *et al*., 1973) and that was reported on by Shen (2007). Wardlaw was nearing completion of documenting material from the entire Upper Permian section at Zal, some 22 km to the southeast of Kuh-e-Ali Bashi, that was very tightly sampled by Davydov and yielded well preserved and abundant conodonts. He brought many abundant samples from the section, especially for the upper few metres and his entire catalogue of SEM images already scanned from samples from the section. Google Earth has extremely high resolution imagery of the Kuh-e-Ali Bashi area (Fig. 1). This imagery clearly shows the localities of Teichert *et al*. (1973). In fact, it shows the same view of Locality 4 as seen in the photograph of Teichert *et al*. (1973, fig. 7) with the limestone ledges and cross-cutting small ravine (Fig. 1). So, not in the order of the questions posed, as much of this meeting went, it is clear that the answer to question 3 is that there is no major structural disruptions in the area. The imagery shows a few minor faults with a throw on the scale of a few metres and the outcrops can be traced throughout the region.

As to the questions of robust *Clarkina* species from the " *Paratirolites*" limestone beds there appears to be two separate morphotypes present in the material at hand, *Clarkina orientalis* and *C. abadehensis*.

History of the problem

Sweet (in Teichert *et al*., 1973) reported Late Permian conodonts from sections at four localities, some 500 m apart and on the east side of a strike valley in the Kuh-e-Ali Bashi area, NW Iran, based on samples collected by Teichert and Kummel (see Teichert *et al*., 1973). The four localities of Teichert *et al*. (1973) were named localities 1, 2, 3 and 4 (Fig. 2), and beds studied at these localities were described by Teichert and Kummel (in Teichert *et al*., 1973) as representing the Ali Bashi Formation (Fig. 2), a new lithological unit proposed by Teichert and Kummel (in Teichert *et al*., 1973) for a sequence of shale, sandstone and impure limestone between the underlying Julfa Beds with a typical Dzhulfian fauna and the overlaying Elikah Formation of Early Triassic age. The Ali Bashi Formation represents the youngest Permian sequence in this region, and has subsequently been assigned to the Changhsingian (Dorashamian). The top part of the Ali Bashi Formation is about 4 metres thick and forms a distinct lithological unit made up of greyish red limestone containing *Paratirolites*. This unit was referred to as the *Paratirolites* Limestone (Stepanov *et al*., 1969).

In October 1997, Mei restudied the conodonts from localities 1 and 4 with Sweet, based on a much refined, sample-population-based taxonomy developed from study of Late Permian conodonts from South China, and the results were reported in Sweet and Mei (1999a, 1999b). Neither Sweet nor Mei has visited these sections; however, based on the sample population taxonomy, Sweet and Mei (1999a, 1999b) discovered that the conodont sequence at Locality 4 is the same as that in the Wuchiapingian of South China, whereas that in the Ali Bashi Formation at Locality 1 is Changhsingian. Furthermore, samples 69SC-7L, 69SC-7M and 69SC-7U from Bed 7 at Locality 4, previously correlated by Teichert and Kummel with the *Paratirolites* Limestone, and sample 69SA-0 from the top of the Julfa Beds at Locality 1 both yielded abundant representatives of *Clarkina orientalis* (Barskov and Koroleva), a distinctive species of *Clarkina* whose elements can be easily recognized by a small cusp and a posterior platform brim that is consistent throughout most of the growth stages and exclusively dominate the population (see Shen, 2007, figs. 1-3). This species is absent in the Ali Bashi Formation at Locality 1, but abundant in the top bed of the underlying Julfa Beds at that locality. The dramatic difference in conodonts from these two sections, in combination with the differences in lithic and macrofossil content,

Fig. 1. Imagery from Google Earth, showing all of the Kuh-e-Ali Bashi region and location of localities 1-4 of Teichert et al. (1973) and a close-up of Locality 4, showing no major faulting in the area. Blue line represents line of section as interpreted in Figure 5.

even though they are separated by only about 500 m, caused Sweet and Mei (1999a, 1999b) to suggest that the lithic sequences at localities 1 and 4 of Teichert *et al*. (1973) may be the upper and lower parts, respectively, of a continuous succession, not laterally equivalent parts of the Ali Bashi Formation as Teichert *et al*. (1973) originally concluded. This led to a dramatically different correlation of rocks at Localities 1 and 4 from that made by Teichert and Kummel (in Teichert, *et al*., 1973). The difference between the correlations of Teichert *et al*. (1973) and Sweet and Mei (1999a, 1999b) was summarized by Shen (2007, fig. 6).

Sweet and Mei's (1999a, 1999b) discovery raised a puzzling problem, that is, how could Teichert and Kummel, two experienced geologists, have miscorrelated the sections at localities 1 and 4? Sweet and Mei (1999a, 1999b) left this question unanswered

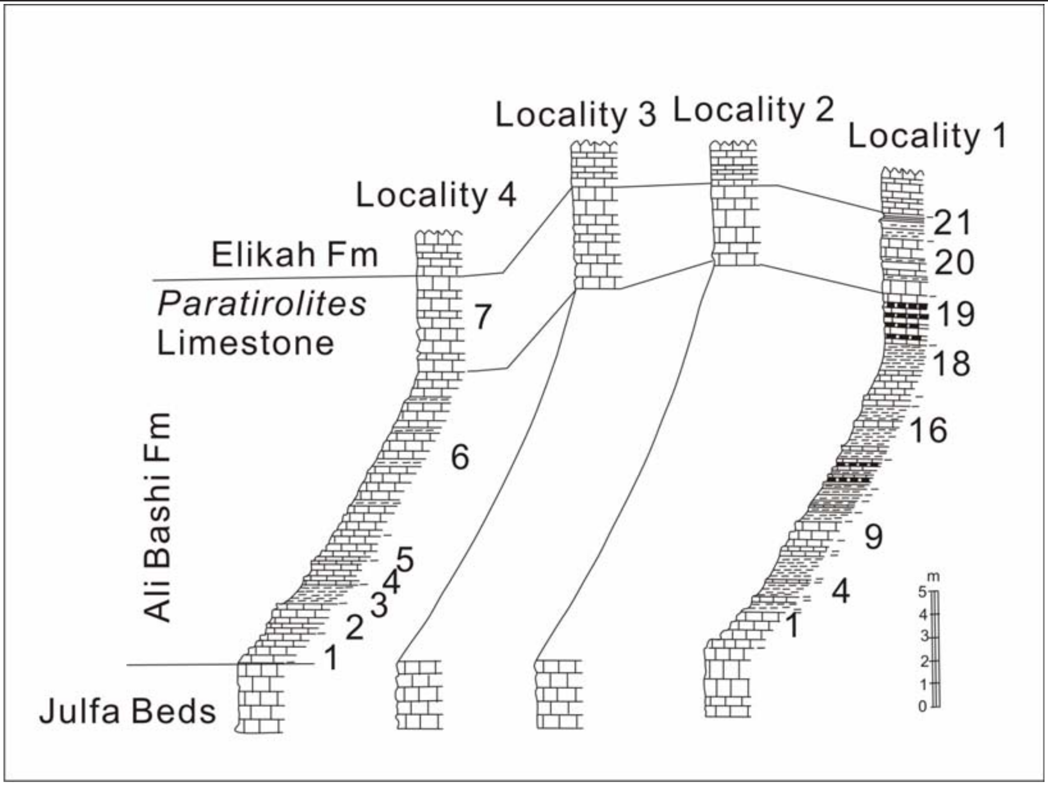


Fig. 2. Stratigraphic profiles of sections in the Kuh-e-Ali Bashi from Teichert et al. (1973)

because information available at that time was inadequate. They merely speculated that the beds with Wuchiapingian (or Dzhulfian) conodonts, *i.e*., the Julfa Beds, at Locality 4, might have been uplifted along an undetected fault so as to occupy a position that would suggest correlation with the Ali Bashi Formation at Locality 1 (Sweet and Mei, 1999a, p. 15, 1999b, p. 45).

Kozur (2004, p. 40) proposed a different interpretation for the conodonts studied by Sweet (in Teichert *et al*., 1973) and Sweet and Mei (1999a, 1999b). In Kozur (2004, p. 40), the conodont collection of Teichert *et al*. (1973) from Locality 4 was assigned to Changhsingian; one of the key species reported by Sweet and Mei (1999a, 1999b) from Bed 7 at Locality 4 (see Shen, 2007, fig. 2) as the latest Wuchiapingian, *C. orientalis*, was named as a new and homeomorphic species, *C. abadehensis*/*iranica*, and a latest Changhsingian age was assigned to *C. iranica* and *abadehensis*. However, this was not confirmed by Shen (2007) who illustrated for the first time elements of some of the key Wuchiapingian species from Locality 4, summarized all the reported occurrences of *C. orientalis* in the world, and confirmed most of Sweet and Mei's (1999a, 1999b) conclusions. Shen (2007) illustrated the specimens from Bed 7 at Locality 4 *sensu* Teichert *et al*. (1973) as *C. orientalis*, in combination with specimens from the topotype locality of *C. orientalis* (Shen, 2007, fig. 1) and some South China sections (Shen, 2007, fig. 3). Based on the identification of the specimens from Bed 7 at Locality 4 *sensu* Teichert *et al*. (1973) as *C. iranica* in Kozur (2004), Shen (2007) regarded *C. iranica* as a synonym of *C. orientalis*. At the same time, Henderson (2007) stated that if *C. orientalis* and *C abadehensis/iranica* are homeomorphs then each could have ranged from the late Wuchiapingian through the Changhsingian, but he also indicated that they were more likely distinctive with distinctly different ranges. In the past year, conodonts from Northwest Iran have become one of the mostly heated debates in Permian conodonts.

Taxonomic Notes

Based on the material reported by Kozur (2004) and the ranges reported in Kozur (2005) and the ranges and specimens observed in Wardlaw's material from Zal, we feel that *Clarkina abadehensis* and *C. iranica* are synonyomous. Because *C. abadehensis* has page priority, we will use that name for *Clarkina abadehensis/ iranica* in all further discussion.

C. orientalis and *C. abadehensis* are extremely similar in platform shape and presence of a distinct or apparent posterior brim, and it is difficult to distinguish them by these characteristics. However, the posterior denticulation of both species is very different. *C. orientalis* has an erect, conical cusp that is rounded, there is a slight gap between it and the first carinal denticle and the cusp is present in most specimens except rare, very large gerontic ones, where the cusp may be overgrown by the platform. *C. abadehensis*, however, has a very reclined, sharply pointed cusp, and low posterior carinal denticles that are progressively overgrown through ontogeny, so that the posterior carina and cusp "sink" into the platform through growth. In large forms, it is totally overgrown, appearing as a large brim with no cusp, just the posterior carina disappearing into the brim. All what is left of the cusp and posteriormost denticles is a streak of white matter going close to the posterior end of the platform. This is very different from the denticulation of *C. orientalis* and is sufficient to differentiate the species.

Taxonomy and Homeomorphy

C. orientalis and *C. abadehensis* are very similar in platform shape and especially by the presence of a distinct posterior brim. However, the two species evolved from different species at distinctly different times during the Late Wuchiapingian and Late Changhsingian respectively. Such homeomorphy is a relatively common phenomenon in all major fossil groups and the resulting pattern of apparent evolutionary repetition is often ascribed to iterative evolution and suggests that there may be specific

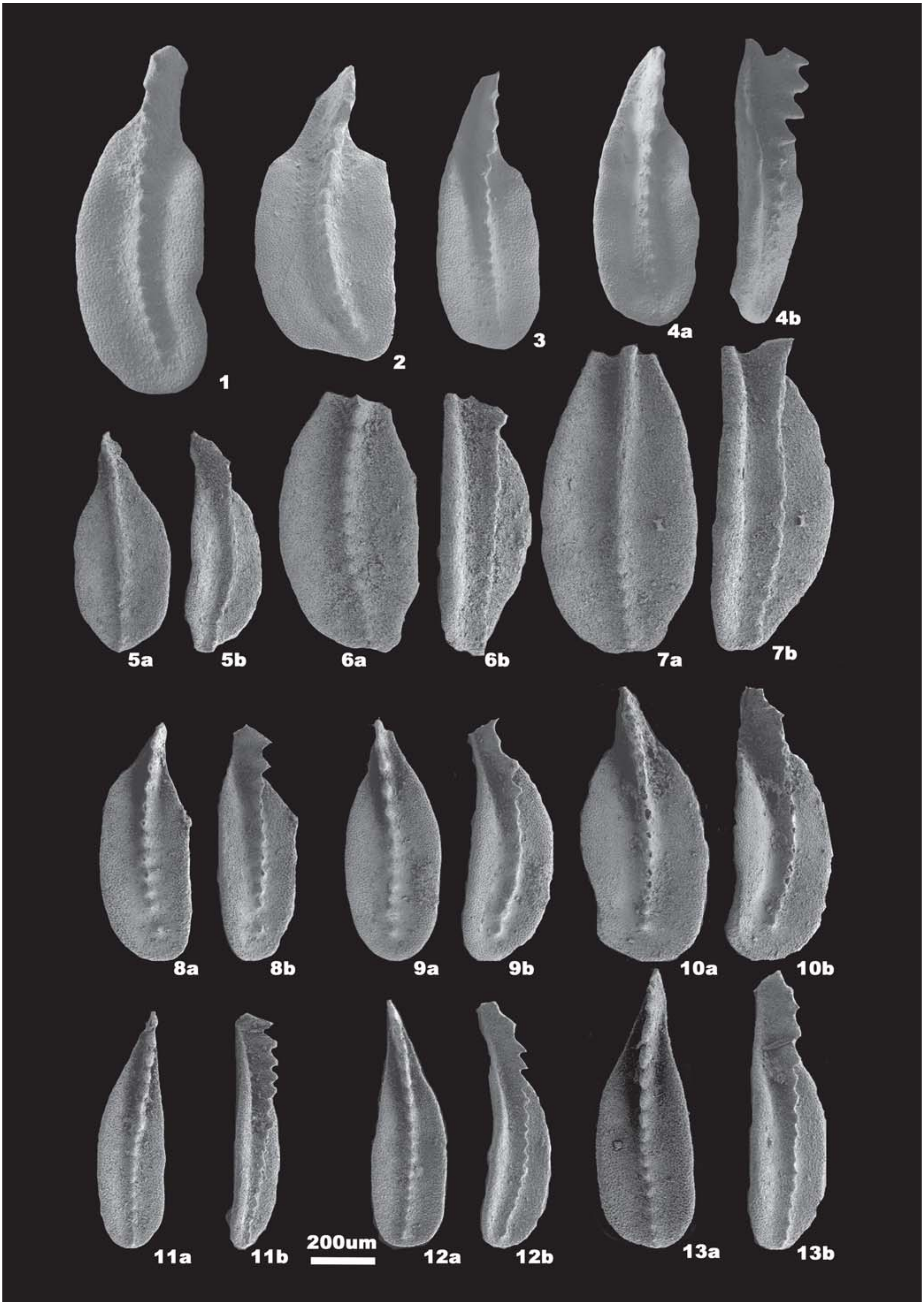

1
2
3
4a
4b
5a
5b
6a
6b
7a
7b
8a
8b
9a
9b
10a
10b
11a
11b
200um
12a
12b
13a
13b

Fig. 3.—Homeomorphism in conodonts from the Lopingian in NW Iran.
1-4, *Clarkina abadehensis* Kozur, 2004. 1, holotype of *Clarkina iranica* Kozur, 2004 (a synonym of *C. abadehensis* Kozur, 2004), from Zal section I, Sample Zal 16, Uppermost Ali Bashi Formation, 37 m above the base of the Zal section; 2, holotype, Section VI, Abadeh, Sample Aba 60, 18 cm below the top of the Hambast Formation; 3, Zal section I, Sample Zal 14, 37.32m above the base of Zal section (from Kozur, 2004).
5-7, *Clarkina jolfensis* Kozur, 2004. OSU53110-OSU53112, Sample 69SA-20M, Locality 1, Kuh-e-Ali Bashi (Sweet's collection).
8-10, *Clarkina orientalis* (Barskov and Koroleva, 1970). OSU53113-OSU53115, Sample 69SC-7U, Locality 4, Kuh-e-Ali Bashi (Sweet's collection).
11-13, *Clarkina liangshanensis* Wang, 1978. OSU53116-OSU53118, Sample 69SC-6, Locality 4, Kuh-e-Ali Bashi (Sweet's collection).

evolutionary and environmental niches controlling the pattern. Homeomorphy can be a significant problem for biostratigraphers because of the general tendency to recognize evolutionary lineages as being unique and non-repeating. However, recent developments in the field of evolutionary developmental biology clearly show that evolution can repeat itself. With careful analysis and independent evidence for age control, homeomorphs can usually be distinguished; that is clearly the case in this Late Permian conodont example based on the examination of the specimens from the topmost and middle part of the Ali Bashi Formation at the Zal section collected by Vladimir Davydov and processed by Bruce Wardlaw as well as other specimens from other localities discussed in this paper. Whether or not these successions observed in northwestern Iran are evolutionary they are certainly repetitive.

In the upper Julfa Beds, faunas are dominated by *Clarkina liangshanensis* which is characterized by an elongated platform outline as well as posterior downward deflection of the carinal profile and reduction in the size of posterior denticles including the cusp. It is followed by and overlaps with *Clarkina orientalis*, which is characterized by a distinct posterior brim. In *C. orientalis*, a cusp can be recognized throughout all growth stages except in rare and very gerontic specimens; in most specimens the small cusp is separated from the penultimate denticle by a slightly wider gap than those among the other posterior denticles. This succession mimics that which occurs in the Ali Bashi Formation stratigraphically above.

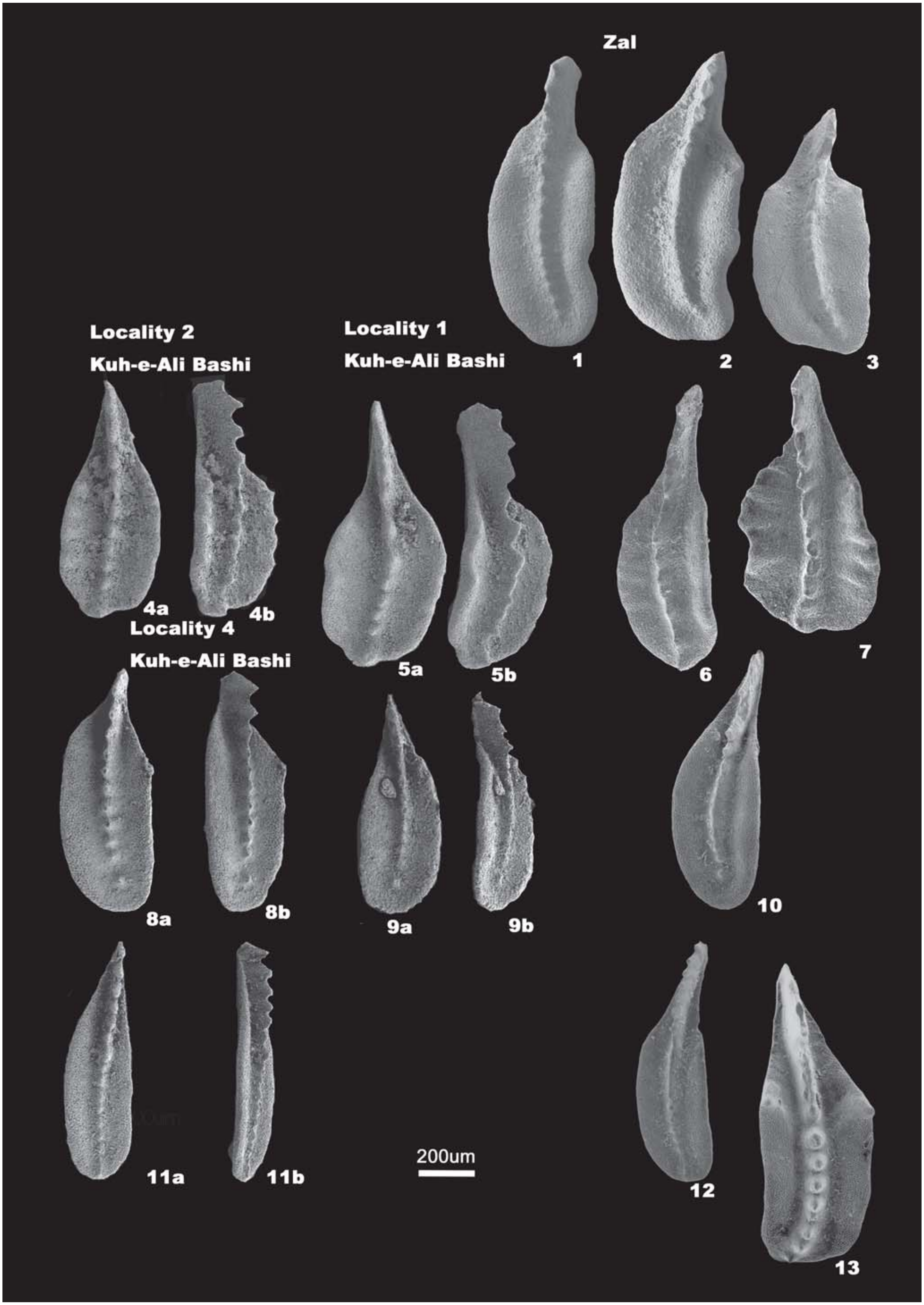
In the *Paratirolites* Limestone (Locality 1, Kuh-e-Ali Bashi, Zal section), *Clarkina jolfensis* is characterized by a tear-drop shaped platform as well as a posterior downward deflection of the carinal profile and reduction in the size of posterior denticles including the cusp. The platform outline and a slight indention on the posterolateral margin, which forms a spout-like platform extension around the end of the carina, distinguish this species from its homeomorph *C. liangshanensis*. *Clarkina jolfensis* led to the evolution of *Clarkina abadehensis*, which is characterized by a distinct posterior brim. In *C. abadehensis*, a cusp can be recognized only in the very early growth stages; in progressive growth stages, the cusp and the posterior-most denticles become a fused low ridge that is overgrown in young and adult specimens. This fused ridge can be seen in most specimens as a subtle whitish line partially buried under much of the posterior brim. This feature can be best seen when a specimen is wet and CAI of specimen is low and in many specimens the ridge cannot be recognized on SEM photos. The above mentioned differences are established on the basis of sample population taxonomic procedures that acknowledge that rare specimens may exhibit different features. For example, in rare specimens of the *C. orientalis* population, the cusp is closely spaced with the posterior-most denticle, and thus resembles the posterior carina of *C. abadehensis*. In rare specimens of *C. abadehensis* including those with an accessory deflected posterior carina, the cusp may not be overgrown by the posterior brim. These rare specimens are not assigned to different species.

Resolution

Though not always in agreement on evolution or even on the distinguishing characters of species it is clear to the workshop that the succession of conodonts illustrated for Locality 4 at Kuh-e-Ali Bashi (Sweet in Teichert *et al*., 1973; Shen, 2007) is distinguished by *C. liangshanensis* followed by *C. orientalis*. This succession is found in the lower part of the section at Zal, but not the lowest part (Figs. 4, 5). The lowest conodont from Locality 4 at Kuh-e-Ali Bashi based on newly illustrated material from Sweet from his sample 69SC-1 is a form that is very common at 10.6 mab at the Zal section. Therefore, the conodont succession at Locality 4 of Kuh-e-Ali Bashi (0.0-16.5m) matches the succession at Zal from 10.6 to 21.05 metres.

Clarkina nodosa has a fairly significant range (31.1-36.5 mab) at Zal. However, most of its range is represented by specimens with few or slight crenulations on the platform. Only at one horizon is it extremely crenulated in Wardlaw's material at 35.5 mab. In Kozur's material (Kozur, 2004) all his very crenulated specimens are from a single sample, Zal 19 (34.65 mab). It appears that the

Fig. 4. Succession of conodonts at Locality 4, 2, 1 at Kuh-e-Ali Bashi, and Zal, Iran.
1-3, *Clarkina abadehensis* Kozur, 2004. 1, holotype of *Clarkina iranica* Kozur, 2004, from Zal section I, Sample Zal 16, Uppermost Ali Bashi Formation, 37 m above the base of the Zal section; 2, Zal section I, Sample Zal 15, uppermost Ali Bashi Formation, 37.2 m above the base of the section; 3, holotype, Section VI, Abadeh, Sample Aba 60, 18 cm below the top of the Hambast Formation (from Kozur, 2004).
4-7, *Clarkina nodosa* Kozur, 2004. 4, OSU53119, Sample 69SB-2, Locality 2, Kuh-e-Ali Bashi Formation; 5, OSU53120, Sample 69SA-20L, Locality 1, Kuh-e-Ali Bashi Formation (Sweet's collection); 6, 31.1m above the base of the Zal section; 7, 35.5 m above the base of the section (Wardlaw's collection).
8-10, *Clarkina orientalis* (Barskov and Koroleva, 1970). 8, OSU53113, Sample 69SC-7U, Locality 4, Julfa Beds, 9, OSU53121, Sample 69SA-0, Locality 1, Julfa beds (Sweet's collection); 10, 21.05 m above the base of the Zal section (Wardlaw's collection).
11-12, *Clarkina liangshanensis* Wang, 1978. 11, OSU53116, Sample 69SC-6, Locality 4, Julfa beds (Sweet's collection); 12, 18.0 m above the base of the Zal section (Wardlaw's collection).
13, *Clarkina leveni* (Kozur, Mostler and Pjatakova, 1975). 1.5 m above the base of the Zal section (Wardlaw's collection).


Zal
Locality 2
Kuh-e-Ali Bashi
Locality 1
Kuh-e-Ali Bashi
1
2
3
4a
4b
Locality 4
Kuh-e-Ali Bashi
5a
5b
6
7
8a
8b
9a
9b
10
11a
11b
200um
12
13

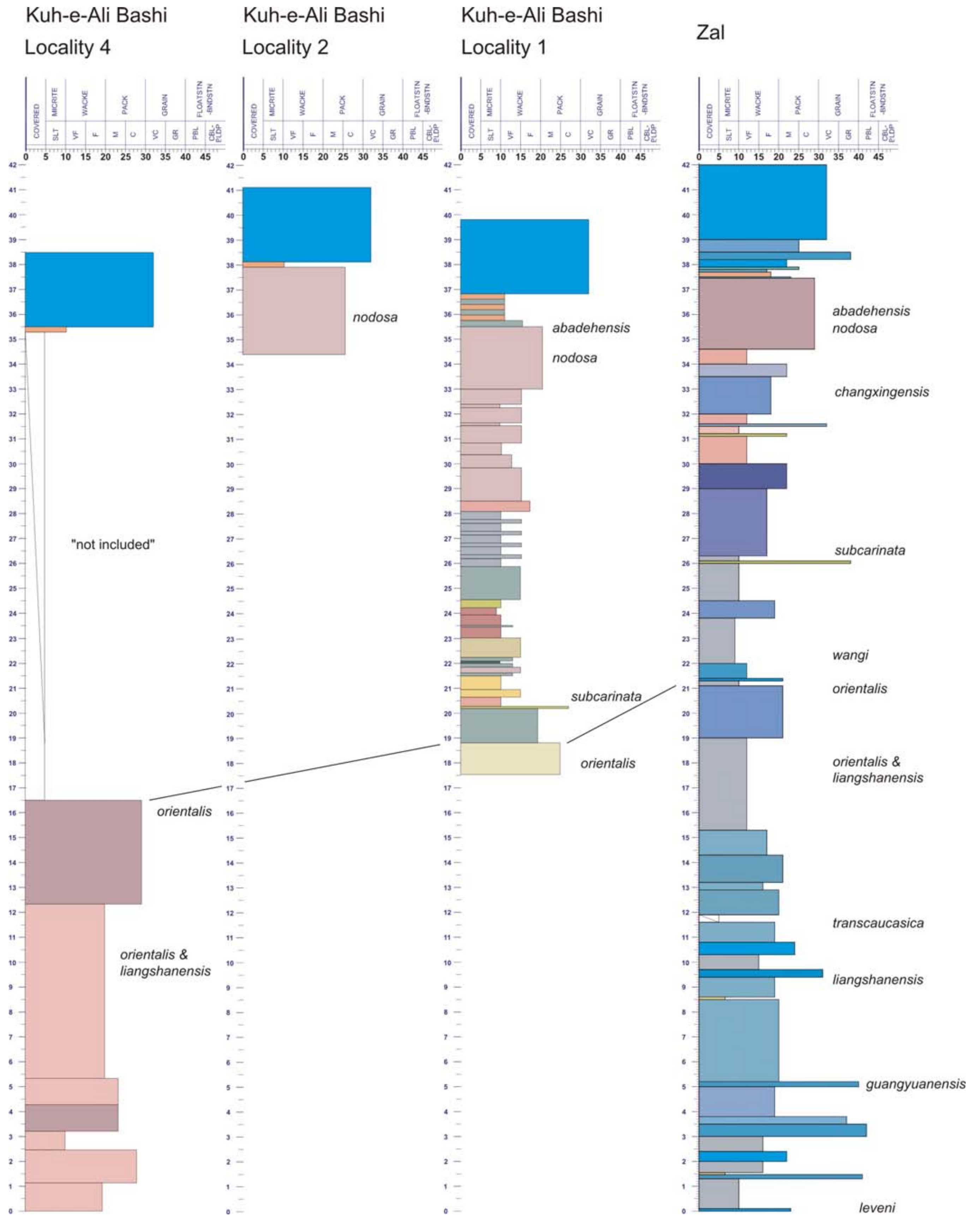


Fig. 5. Reinterpretation of the stratigraphic column at Locality 4, 2, and 1 at Kuh-e-Ali Bashi and the column at Zal, placed in a grain-sized format from Paleostrat.com and colours represent colours of the beds. Significant conodont occurrences placed where they are located in the section.

very crenulated morphotype has a very narrow range and essentially represents a correlatable horizon. Sweet (in Teichert *et al*., 1973) illustrated the very crenulate form from 69SB-2 from Locality 2 of Kuh-e-Ali Bashi (pl. 13, figs 1-3), which correlates that horizon with 34.65-35.5 mab at Zal. Sample 69SB-2 is 2 metres from the top of the *Paratirolites* limestone bed, 35.5 mab at Zal is 2 metres from the top of the Ali Bashi Formation.

Kozur (2004) showed a succession of *C. nodosa, C. jolfensis, C. abadehensis* in the *Paratirolites* limestone beds at Locality 1, Kuh-e-Ali Bashi in an interval of slightly more than two metres at the top of the limestone. We were able to confirm the presence of *C. nodosa* followed by *C. jolfensis* from reexamination of Sweet's material in samples 69SA-20L and 69SA-20M, respectively. Sweet's material above that was barren. Wardlaw's material from Zal shows the succession of *C. nodosa, C. jolfensis*, and *C. abadehensis* from 35.5 to 37.5 mab which matches well with Locality 1 (Fig. 5).

The conclusion is that the "*Paratirolites*" limestone at Locality 4 is not the "*Paratirolites*" limestone, but the Julfa limestone, the succession of conodonts matches well with the lower beds at Zal. The *Paratirolites* limestone beds at Locality 2 and Locality 1 contain an uppermost Permian conodont succession that matches well with the upper 2 metres of the *Paratirolites* limestone at Zal. It is further concluded that this discrepancy is not caused by stratigraphic displacement by a fault, but human error; Teichert and Kummel collected the distinctive bed at the top of the Julfa beds, but apparently did not finish the section at Locality 4, and somehow failed to show that in their notes or subsequent papers. Our reinterpretation of the sections, their correlation and the conodont successions are shown in Figures 4 and 5. One implication of this result is that the genus *Paratirolites* and in particular the species *P. kittli* is not restricted to the *Paratirolites* limestone, but actually ranges from mid-Wuchiapingian to Late Changhsingian. Henderson has a complete tightly sampled section at Kuh-e-Ali Bashi from Davydov that will be worked up over the next few months to serve as a test for this interpretation. This section begins near the section at Locality 4 and ends near the section at Locality 3.

Acknowledgements. We would thank Dr. Walter Sweet for his generosity to allow us to examine his conodont collection from Kuh-e-Ali Bashi. We also thank Vladimir Davydov for collecting conodont samples from Zal.

References

Henderson C.M., 2007. First Reply to "The conodont species *Clarkina orientalis* (Barskov and Koroleva, 1970) and its spatial and temporal distribution": A short comment. Permophiles, 50: 37-38.

Kozur, H.W., 2004. Pelagic uppermost Permian and the Permian–Triassic boundary conodonts of Iran. Part 1: taxonomy. Hallesches Jahrbuch Geowiss, Reihe B, Beiheft, 18, p. 39-68.

Kozur, H.W., 2005. Pelagic uppermost Permian and the Permian-Triassic boundary conodonts of Iran, Part II: Investigated sections and evaluation of the conodont faunas. Hallesches Jahrbuch Fur Geowissenschaften Reihe B: Geologie, Palaontologie, Mineralogie, , Beiheft 19, p. 49-86.

Kozur, H.W., 2007. Biostratigraphy and event stratigraphy in Iran around the Permian-Triassic boundary (PTB); implications for the causes of the PTB biotic crisis. Environmental and biotic changes during the Paleozoic-Mesozoic transition. Global and Planetary Change, 55(1-3), p. 155-176.

Shen Shuzhong. 2007. The conodont species *Clarkina orientalis* (Barskov and Koroleva, 1970) and its spatial and temporal distribution. *Permophiles* 50, 25-37.

Sweet, W.C., Mei, Shilong, 1999a. The Permian Lopingian and basal Trassic Sequence in Northwest Iran. Permophiles, no. 33: 14-18.

Sweet, W.C., Mei, Shilong, 1999b. Conodont succession of Permian Lopingian and basal Trassic in Northwest Iran. In: Yin, H., Tong, J. (Eds.), Proceedings of the International Conference on Pangea and the Paleozoic-Mesozoic Transition. Wuhan, China University of Geosciences Press. 154-156.

Teichert, C., Kummel, B., and Sweet, W. C. 1973. Permian-Triassic Strata, Kuh-E-Ali Bashi, Northwest Iran. Bull. Mus. Comp. Zool. Harvard Univ., V. 145, No. 8, 359-472.

New SPS Working Group Report

The following individuals have kindly accepted to join the SPS Working Group: "Neotethys, Paleotethys, and South China correlations" chaired by L. Angiolini and Yue Wang and announced in Permophiles 49 (2007):

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The purpose of the Working Group as directed by SPS Chair Charles Henderson is to investigate correlation problems of the Permian successions of the Neotethys, Paleotethys and South China, which are associated with bioprovinciality and taxonomy. To focus on the successions characterized by the co-occurrence of fusulinids and conodonts, as well as other fossil groups, to investigate in detail the correlation problems. To establish (at least intrabasinal) correlation through the application of graphic correlation.

Best regards
Lucia Angiolini and Yue Wang

New fossil findings and discovery of conodonts in the Guadalupian of Jebel Tebaga de Medenine: Biostratigraphic implications

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Introduction

The Permian outcrops of Jebel Tebaga de Medenine (S Tunisia) are well known since 1950s for their rich and well preserved

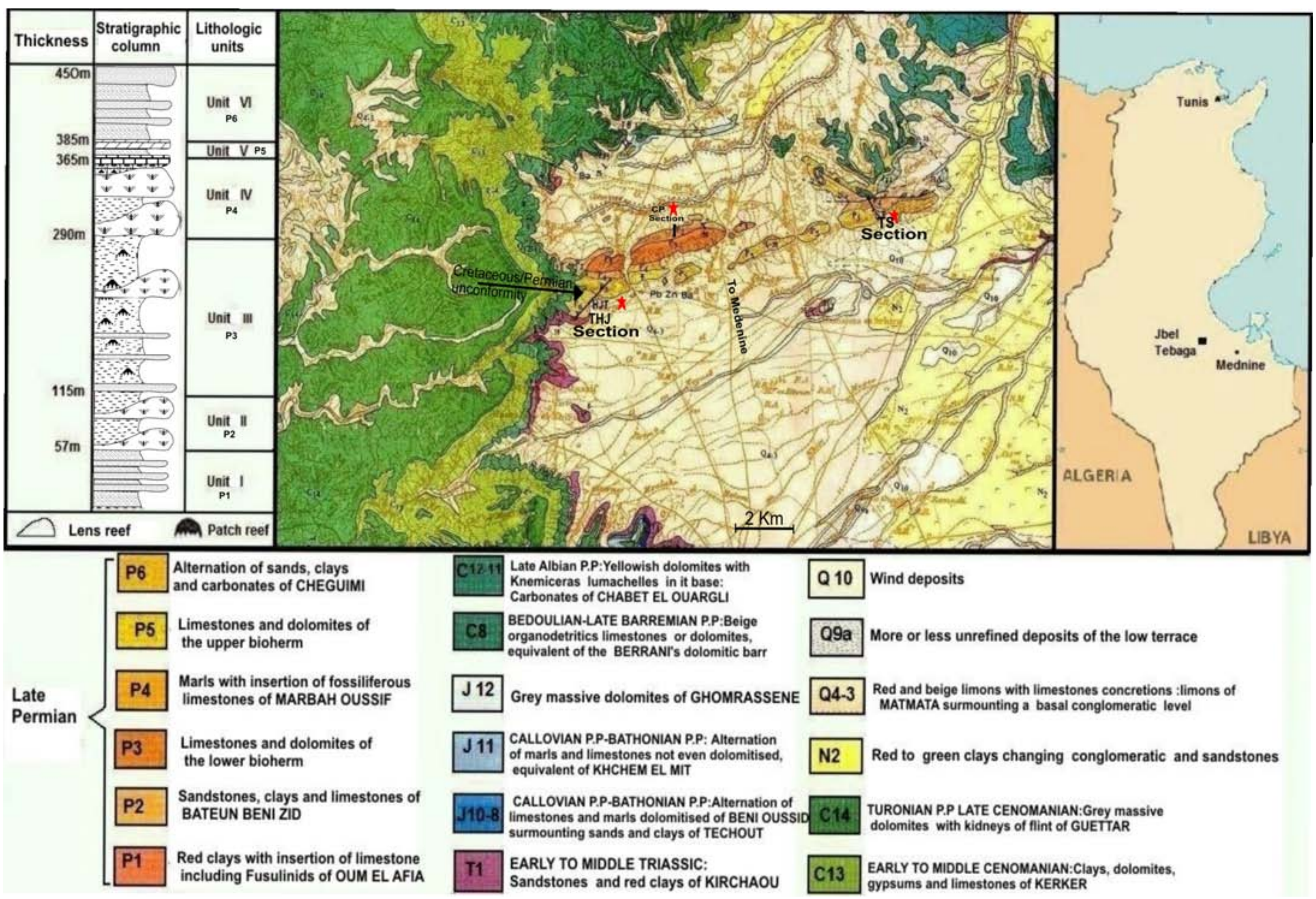

Fig. 1. Geologic map showing the location of the measured stratigraphic sections. HJ: Halq Jemel, CP: Jebel Tebaga *s.s.*, TS: Souinia.

Mathieu 1949 Baird 1967	Newell et al. 1976	Termier et al., 1977	Memmi et al., 1986	Chaouachi, 1988
Cheguimi sandstone	Cheguimi Sandstone Facies		Cheguimi Sandstone	Unit VI
Bellerophon limestone	"Bellerophon limestone"	Oudja el Rhar series	Bellerophon Limestone	Unit V
		Jebel Seikra series	Upper bioherm / Jebel Seikra bioherm	Unit IV
Upper Tebaga dolostone	Upper Biohermal Complex	Merbah el Oussif series	Middle muddy facies	Unit III
Middle limestone	Middle Shaly Facies (Merbah el Oussif)			
Bateun Beni Zid dolostone	Lower Biohermal Complex (Bateun Beni Zid) ? / Saikra Biohermal Complex ?	Bateun Beni Zid series	Lower bioherm	Unit II
Bateun Beni Zid sandstone and limestone			Bateun Beni Zid sandstone	Unit I

Fig. 2. Lithostratigraphic subdivisions of the Jebel Tebaga de Medenine succession through time

Fig. 3. The Halq Jemel section. In the background the unconformably overlying Jurassic-Cretaceous succession.

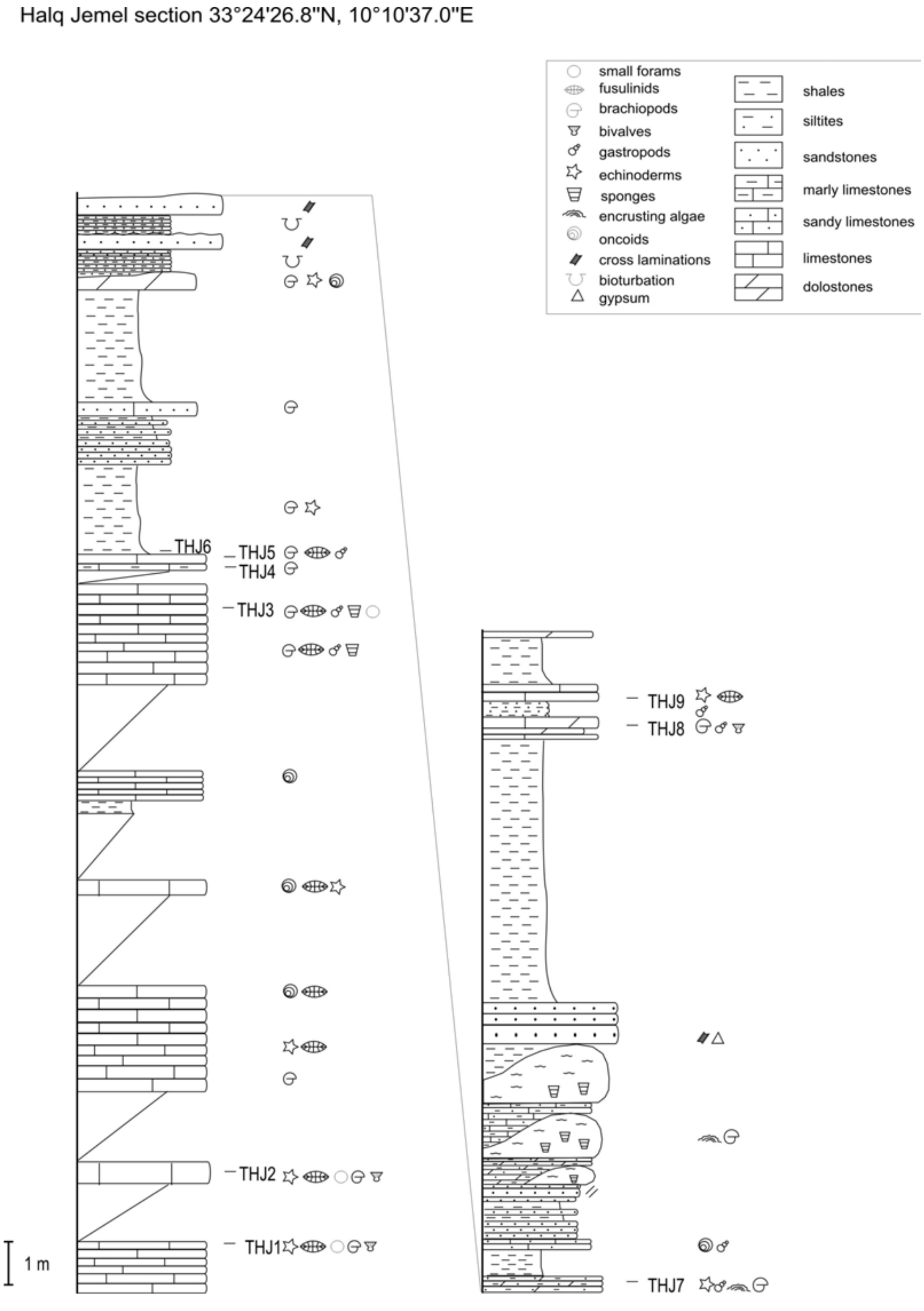

Fig. 4. Stratigraphic log of the Halq Jemel section.

fossils. They offer excellent exposures near the village of Dhilet Toujane, 30 km W-NW of Medenine, where they form an E-W monoclinal structure, which is 15 km long and gently dipping (30°) to the S-SE. The Permian succession is separated from the overlying flat lying Jurassic to Cretaceous rocks by a spectacular angular unconformity.

Permian marine rocks in southern Tunisia was first discovered by Douvillé *et al.* (1933). Mathieu (1940, 1949) provided the stratigraphic framework; the geology of the southern Tunisian Permian has been later summarized by Baird (1967). The first studied fossils are fusulinids and were regarded as Permian (Douville, 1193; Ciry, 1948, 195; Glintzboeckel and Rabaté, 1964; Skinner and Wilde, 1967; Lys, 1988 and Vachard and Razgallah, 1993). Very rich assemblages of micro- and macrofossils have been described by Miller and Furnish (1957), Newell *et al.* (1976), Termier *et al.* (1977), Driggs (1977), Boyd and Newell (1979), Lane (1979), Senowbari Daryan and Rigby (1988), Vachard *et al.* (1989), Lethiers *et al.* (1989), Toomey (1991) and Wendt (1993).

However, notwithstanding the numerous paleontological studies which aimed to establish a precise biostratigraphic zonation (Vachard and Razgallah, 1993), the age of the succession is still not well constrained. Indeed, the succession has been generally ascribed to the Wordian-Capitanian (Newell *et al.*, 1976), to the Murgabian-early Midian (Vachard and Razgallah, 1993) or to the Capitanian (Vachard *et al.*, 2002).

To precisely constrain the age of the Jebel Tebaga outcrops and correlate the Tethyan Middle Permian stages to the International Time Scale (Gradstein *et al.*, 2004), new field work was carried out in Jebel Tebaga de Medenine in November 2007 by L. Angiolini, C. Chaouachi, M. Soussi, V. Verna and L. Carabelli. Of the detailed stratigraphic sections measured and sampled with a bed by bed approach, the Halq Jemel section (Figs.1, 3, 4) led to the discovery of both fusulinids and conodonts which are here reported and discussed.

Lithostratigraphy of the Permian succession of southern Tunisia

The lithostratigraphy of the Permian outcrops of Jebel Tebaga de Medenine has been presented by Mathieu (1949), Baird (1967), Newell *et al.* (1976) and Termier *et al.* (1977), on which the works of Khessibi (1985) and Memmi *et al.* (1986) are based (Fig. 2). A more detailed stratigraphic subdivision has been proposed by Chaouachi (1985, 1988) (Fig. 1). The latter has been used by Vachard and Razgallah (1993) in their discussion on the age of the fusulinids of Jebel Tebaga and it is followed in the present report (Fig. 2).

The total thickness of the exposed Permian rocks is estimated to be 800 metres (M'Rabet *et al*,. 1994). It has been divided by Chaouachi (1988) into six distinct lithologic units in ascending order as follows:

Unit I (Bateun Beni Zid sandstone) consists of 40 metres of shallow water channelized sandstone with carbonate and shale intercalations; the carbonate consists of bioclastic limestone, oncoidal limestone and oolitic limestone. According to Chaouachi (1988), this unit represents the lowermost part of the outcropping succession.

Unit II (lower reef complex) comprises 70 metres of dolomitized algal bioherms and bioclastic limestone. It forms the first cliff of Jebel Tebaga and comprises four decametric bioherms constructed by encrusting algae. The bioherms are laterally delimited and vertically overlain by green shale and channelized fine sandstone.

Unit III (intermediate shale) is 190 m-thick and has a very articulated and laterally variable lithostratigraphic framework with sandstone bodies intercalated with diversified sponge and algal bioherms and well bedded bioclastic limestone; at its top green shale with sponge patch reefs dominate.

Unit IV consists of 120 metres of algal bioherms and bioclastic limestone; it forms the second cliff of Jebel Tebaga and comprises three decametric bioherms laterally and vertically delimited by shale, well bedded limestone and sandstone.

Unit V (only at Halq Jemel) comprises 40 metres of rich bioclastic limestone, dolomitic limestone, shale and fewer algal and sponge patch reefs. The upper part of the unit is mainly composed of sandstone cross stratifications, current ripples and wood fragments.

Unit VI (Cheguimi sandstone) consists of claystone and sandstone; this unit starts with red sandstone and shale displaying herringbone bedding, wave ripples and burrows indicating a marginal marine to coastal depositional environment. This sandstone is overlain by red sandy beds and shale thought to be formed in fluvial meandering channels.

These facies were deposited on a shallow marine shelf characterized in its inner part by mixed channelized siliciclastics and oolitic/bioclastic carbonates. Towards the north and the northeast, the shelf comprises progressively patch reefs behind a prominent barrier reef delimited by a slope and a relatively deep basin. By the end of the Permian, the shelf was progressively covered by the Cheguimi prograding siliciclastics.

The Permian succession crops out along a series of discontinuous hills with considerable facies and thickness changes making difficult the correlation between the different units. Units I to III (Bateun Beni Zid, Jebel Tebaga s.s., Merbah el Oussif) represent a continuous stratigraphic succession which can be easily followed laterally. These units are capped by thick dolostone attributed to Unit IV (Chaouachi, 1988). The outcrops of Souinia and Saikra are considered to represent also Unit IV; however the succession of Sounia is slightly different, comprising well bedded bioclastic limestone, lateritic beds, sandstone with dolostone at the top. Unit V at Halq Jemel is separated by a major fault from the rest units and shows quite different sedimentologic characteristics; it is overlain by sandstone and shale of Unit VI which are thought to be the uppermost part of the Permian succession.

Previous biostratigraphic studies

Fusulinids from southern Tunisia are abundant and were the first fossils to be studied. As the provincial Permian scale in the Tethys (Leven, 1980) is based on fusulinids and they are very important along with conodonts for solving the correlation between the International (Global) and the regional scales, the history of the previous studies in the region is here discussed.

Jebel Tebaga fusulinids were discovered and first studied by Douvillé (1934) who described them as "*Neoschwagerina*" (=*Yabeina*) and "*Fusulina*" (= *Chusenella*). Later Ciry (1948) described from this area a new species, *Dunbarula mathieui*, that is the type for his new genus *Dunbarula*.

The most comprehensive fusulinid studies in the region have been performed by Glintzboeckel and Rabaté (1964) and particularly by Skinner and Wilde (1967). The later workers thoroughly

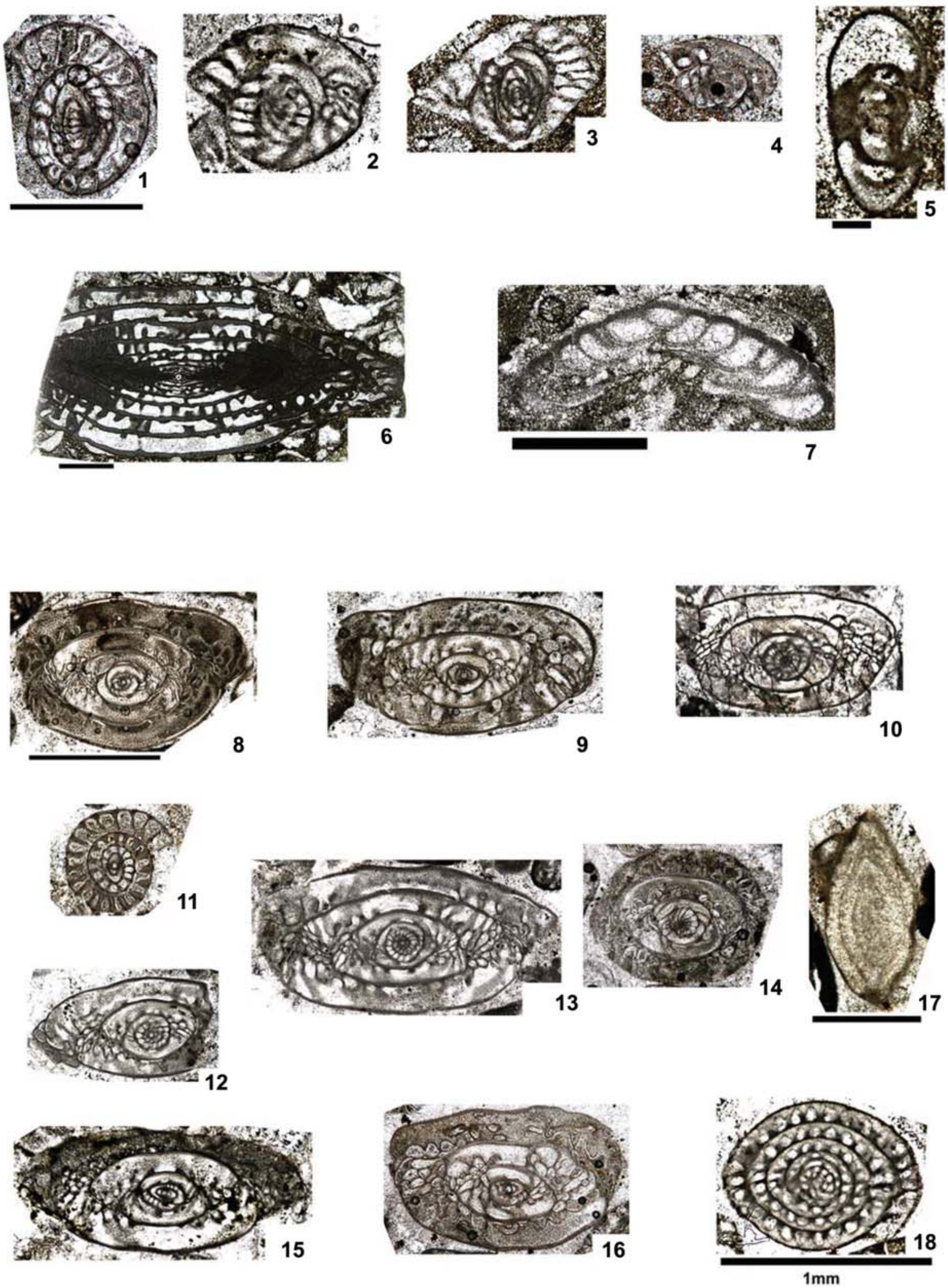

Fig. 5. Fusulinids from Halq Jemel section. 1-4 *Dunbarula* ex gr. *nana* Kochansky-Devidé e Ramovs, 1955. Scale 0.5mm for figures 1-4. 1: THJ1-2, x 50. 2: THJ2-5a, x 50. 3: THJ2-3c, x 50. 4: THJ2-1a, x 50. 5 *Neoendothyra* sp. THJ2-2b, scale 0.1mm, x 80. 6 *Chusenella rabatei* Skinner and Wilde, 1967. THJ2-3a, scale 1 mm, x 10. 7 *Tetrataxis* sp. THJ2-2a, scale 1 mm, x 50. 8-16 *Dunbarula mathieui* Ciry, 1948. Scale 1 mm for figures 8-15. 8: THJ3-1a, x 25. 9: THJ3-6a, x25. 10: THJ-3-3a, x25. 11: THJ3-7a, x25. 12: THJ3-6c, x25. 13: THJ3-8a, x25. 14: THJ3-8b, x25. 15: THJ3-2a, x25. 16: THJ3-10b, scale 0.5mm, x40. 17 *Staffella* sp. THJ3-10b, scale 1mm, x25. 18 *Neoschwagerina* aff. *glintzboeckeli* Skinner and Wilde, 1967. THJ3-12a, scale 1mm, x40.

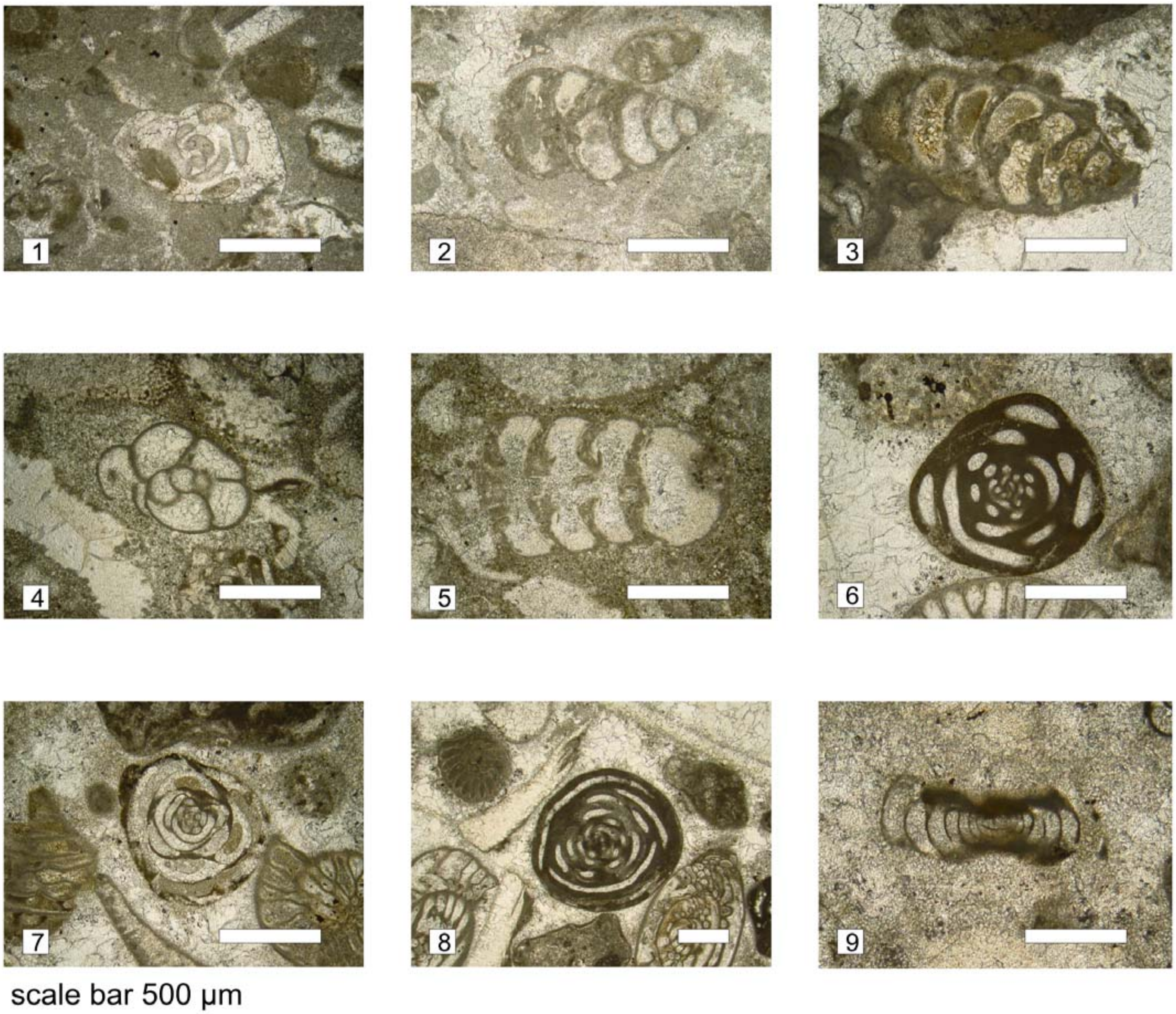

Fig. 6. Smaller foraminifera from Halq Jemel section. 1 *Neodiscus* sp. Sample THJ 1. 2,3 *Climacammina* cf. *C. grandis* Reitlinger, 1950. Sample THJ1. 4 *Globivalvulina* sp. Sample THJ 2. 5 *Climacammina* cf. *C. tenuis*. Sample THJ2. 6-8 *Glomomidiellopsis*? n. sp. Sample THJ3. 9 *Brunsispirella linae* (Vachard and Galliot, 2005).

described many taxa including 10 new species with many illustrations of well-oriented thin-sections. They divided the succession into two parts: (1) a lower succession (units I-III) containing *Kahlerina africana* Skinner and Wilde, 1967, *Dunbarula nana* Kochansky-Devide and Ramovs, 1955, *Neoschwagerina glintzboeckeli* Skinner and Wilde, 1967, *N. tabagensis* Skinner and Wilde, 1967, *Yabeina punica* (Douvillé,, 1934) and *Y. syrtalis* (Douville, 1934); (2) the upper part (units IV-VI) comprises, in addition to most of previously listed species, advanced *Dunbarula mathieui* Ciry, 1948, *Chusenella rabatei* Skinner and Wilde, 1967, and *Neoschwagerina fusiformis* Skinner and Wilde, 1967. The major difference between these two assemblages is that *D. nana* appears in lower assemblage and does not range into upper assemblage. Skinner and Wilde (1967) assigned the entire succession to the *Yabeina* Zone.

Vachard and Razgallah (1993) listed many smaller foraminifera and algae from different units. Although they also listed some fusulinids, in most cases their taxonomy is based on non-oriented sections and therefore very doubtful. For example, on plate 2, fig. 1 of Vachard and Razgallah (1993) they identified *Yabeina syrtalis* and *Chusenella*, but the first taxon can be identified at generic level only and second one at family level. Consequently, their taxonomy requires extensive re-evaluation. Assuming that they possess best pictures for their taxonomy in the plates (although figures are poor in quality and often way too small) the following emended classification can be proposed:

Vachard and Razgallah (1993), Plate 2: fig. 1, *Yabeina* sp., Schwagerinidae; fig. 3, *Yabeina* sp., *Neoschwagerina* sp., *Dunbarula* sp. (with four volutions and intensive septal fluting), fig. 4, *Yabeina* sp., Schwagerinidae with heavy axial fillings, fig. 5,

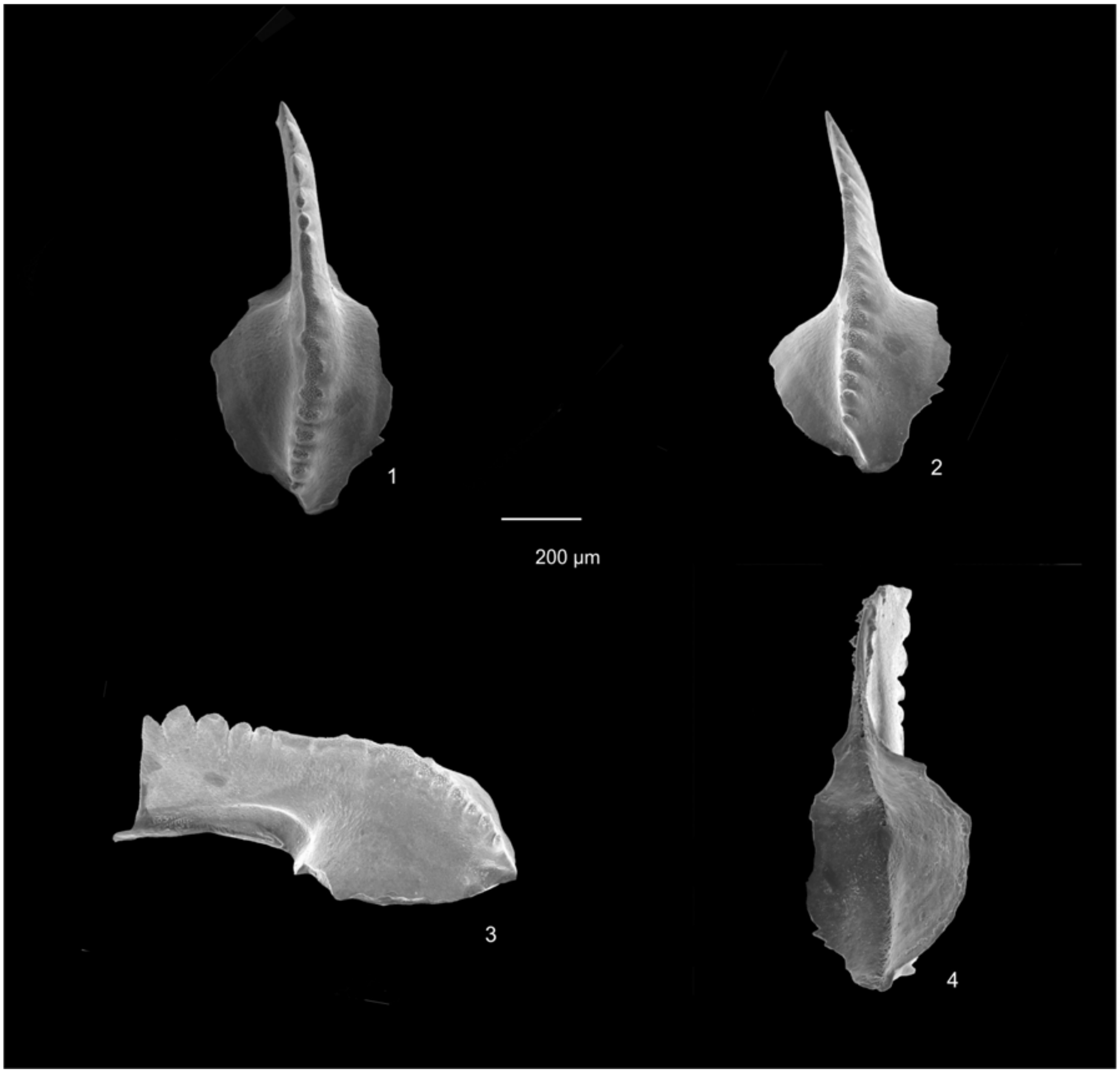

Fig. 7. Conodonts from Halq Jemel section. *Sweetognathus iranicus hanzhongensis* (Wang, 1978). 1: upper view. 2: upper-oblique view. 3: lateral-oblique view. 4: lower view.

Dunbarula sp. (with four volutions and intensive septal fluting), fig. 6 Schwagerinidae with axial fillings.

Vachard and Razgallah (1993), Plate 3: fig. 1, *Sumatrina* ? sp., fig. 2, *Neoschwagerina*? sp., fig. 4, *Reichelina*? sp., fig. 5, *Reichelina*? sp., figs. 7-8, advanced *Neoschwagerina* sp.

Vachard and Razgallah (1993) established two biozones for the exposed part of the Permian succession at Tebaga that were eventually recognized from analyses of Skinner and Wilde's (1967) data. The lower one, the *Dunbarula nana* Zone, corresponds to Unit I (sandstone and limestone of Baten Beni Zid, and dolomite of Baten Beni Zid of Skinner and Wilde, 1976), and the upper *Dunbarula mathieui* Zone corresponds to their units III-V. The position of Unit II is not considered due to lack of fusulinid fauna there. Both biozones have been proposed to be Late Murgabian (pre-Midian) in age because of the lack of *Lepidolina* (Lethiers *et al.*, 1989, Vachard and Razgallah, 1993). Later, however, Vachard reconsidered the age of the Tebaga succession and proposed it is equal to entire Midian. Consequently, he correlated units I-III with the lower Midian Arpa Formation and units IV-VI with the upper Midian Khachik Formation of Transcaucasia (Vachard *et al.*, 2002), with no explanation given. The beds with *Afghanella robbinsae* Skinner and Wilde, 1969 that appears below the exposed successions at Tebaga were interpreted to be pre-Midian in age. However, Leven (1993) proposed *Afghanella robbinsae* as an-index species of his lower Midian biozone and therefore these beds are most probably Midian in age. Vachard *et al.* (2002) then correlated the entire Tebaga succession with the Capitanian of the International Time Scale.

Halq Jemel Section

This section has been measured in Unit V (Chaouachi,1988), at 33°24'26.8''N, 10°10'37.s0''E (Figs. 3-4). It corresponds to Newell's*et al.* (197,6) section B beds 22 to 35 that include (Upper Biohermal Complex, "Bellerophon lmst" and lower part of Cheguimi sandstone facies of the authors).

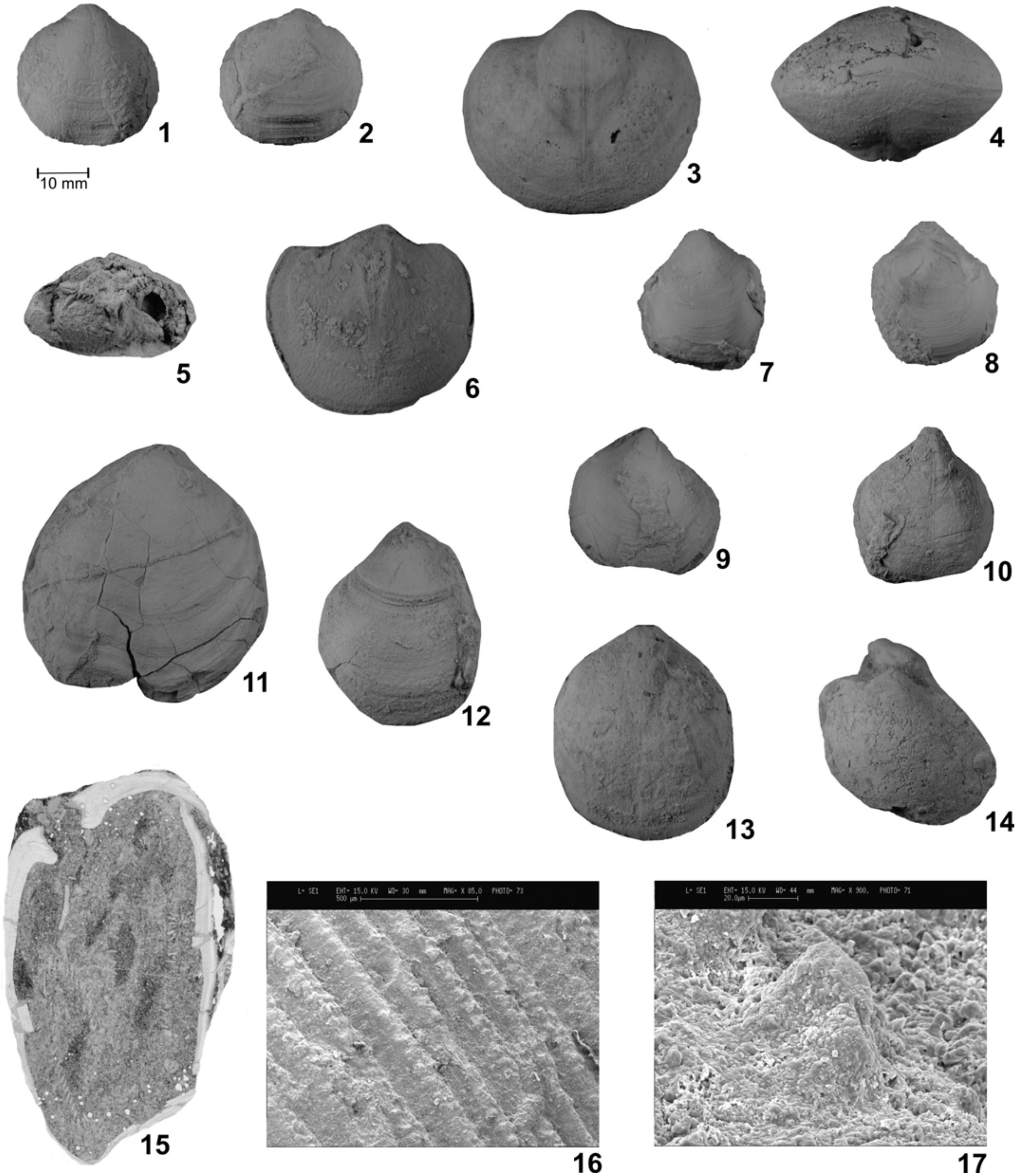

Fig. 8. Brachiopods from Halq Jemel section. 1-6 *Permophricodothyris affinis* (Gemmellaro, 1899). 1-2: specimen THJ5-125, v.v. and d.v., x1; 3-4: specimen THJ7-3, ventral and anterior views of an internal mould, x 1; 5: specimen THJ7/2-38, anterior view of an internal mould showing spiralia, x1; 6: specimen THJ7-4, internal mould of d.v., x 1. 7-10 *Permophricodothyris caroli* (Gemmellaro, 1899). 7-8: specimen THJ5-93, v.v. and v.d., x1; 9: specimen THJ5-86, v.v., x1; 10: specimen THJ7/2-39, internal mould of v.v., x1. 11-14 *Permophricodothyris inaequilateralis* (Gemmellaro, 1899). 11: specimen THJ5-81, d.v., x1; 12: specimen THJ5-100, v.v., x1; 13: specimen THJ7/2-32, internal mould of v.v., x1; 14: specimen THJ7-21, d.v., x1. 15 *P. inaequilaterals* (Gemmellaro, 1899), specimen THJ5-11, peal of median section showing spiralia, x2. 16-17 *P. caroli* (Gemmellaro, 1899). 16-17: specimen THJ5-37, concentrically arranged bifid spine bases and a single bifid spine base at SEM. Scale 10 mm for figures 1-14.

The lower part of the succession comprises well bedded bioclastic limestone (mostly packstone) with echinoderms, fusulinids, smaller foraminifera, algae, brachiopods, gastropods, bivalves, sponges (THJ1-2) and oncoids at the top. This marker bed is followed by a covered interval, with sporadic occurrence of bioclastic and oncoidal limestone and claystone.

Above, the series continue with few metres of well bedded bioclastic limestone (grainstone) with abundant fusulinids and brachiopods, associated to smaller foraminifera, algae, echinoderms, bivalves, sponges, conodonts (THJ3). These beds are overlain by marly limestone and then by a succession of silty/sandy limestone, sandstone and claystone, particularly rich in brachiopods (THJ6-7).

Small sponge patch reefs laterally interfingering with dolomitized silty limestone, bioclastic limestone and lenses of red claystone follow, capped in turn by quartz sandstone with wood logs, lithoclasts and low angle cross laminations and claystone. The upper part of the section is represented by dolomitized bioclastic limestone with brachiopods, gastropods, bivalves, fusulinids (THJ8-9) which are followed by continental red sandstone and shale.

The investigatedqz micro- and macrofossils are fusulinids, smaller foraminifera, conodonts and brachiopods.

Fusulinids. Samples THJ1 and THJ2 yield one specimen of *Chusenella rabatei* Skinner and Wilde, 1967 that was originally described from Tunisia, south slope of Jebel Saikra (Bellerophon limestone), and *Dunbarula* ex gr. *nana* Kochansky-Devidé and Ramovs, 1955 (Fig. 5). The latter species is very characteristic for the lower Midian and upper Wordian; it occurs in many places with upper Wordian ammonoids and conodonts in many sections throughout the Tethys. Sample THJ3 yield many *Dunbarula mathieui* Ciry, 1948, and few *Staffella* sp. and *Neoschwagerina* aff. *glintzboeckeli* Skinner and Wilde, 1967. Sample THJ 9 contains *Dunbarula mathieui* Ciry, 1948.

Dunbarula nana is a very primitive representative of the genus, whereas *D. mathieui* Ciry, 1948 is the most advanced species in this lineage. There is no transitional forms in between the two recorded in the Halq Jemel section.

Smaller foraminifera. Rare foraminifers such as *Neodiscus* sp. and *Climacammina grandis* Reitlinger, 1950 in association with rare fusulinids occur in THJ1. Foraminifers are still rare in THJ2, where they are represented by *Globivalvulina* sp. and *Climacammina* cfr. *C. tenuis* Lin, 1978 (Fig. 6). Both samples consist of packstone with abundant echinoid fragments, thick shelled bivalves and brachiopods, bryozoans and algal lumps. The presence of the dominant biseriamminid genera *Climacammina, Globivalvulina* in association with scarce and small sized miliolids indicates the leeward shoals as stated by Insalaco *et al.* (2005).

There is a significant change in THJ3, characterized by grainstone with thick shelled brachiopods, Dasycladacean algae bioclasts in association with abundant fusulinids and diversified porcelaneous foraminifers such as *Glomomidiellopsis*? sp., *Neodiscus* sp., *Neodiscopsis* sp., *Hemigordius* spp., *Multidiscus* sp., *Midiella* sp., *Brunsispirella linae* (Vachard and Galliot, 2005) (Fig. 6).

The microfaunal assemblage of THJ3 is characterized by fusulinids in association with mainly large representatives of the porcelaneous family Hemigordiopsidae generally represented by big forms. This assemblage can be referred to as the sandwaves shoals and oolitic shoals *sensu* Insalaco *et al.* (2005). Fusulinida are generally dominant and porcelaneous forms (Miliolida) represent the subordinate microfauna. The absence of ooids allows referring the assemblage to the former paleoenvironment of sandwave shoals.

Conodonts. Conodonts have been searched for and never reported from the Permian of Tunisia. Thanks to our recent investigations, they have been found for the first time in Halq Jemel section within bed THJ2 (Fig. 4). They are represented by the species *Sweetognathus iranicus hanzhongensis* (Wang, 1978) (Fig. 7). According to Mei *et al.* (2002), the species is present in the Equatorial Warm Water Province during the Guadalupian.

Brachiopods. Three species of the genus *Permophrycodothyris* have been recorded in THJ3 to THJ7 (Fig. 8). Mostly articulated, but not in life position nor oriented, they probably indicate wash-over fans in a proximal, more protected environments (lagoons). The species *Permophricodothyris affinis* (Gemmellaro, 1899) has been found in THJ3 (2 specimens), THJ4 (11 specimens), THJ5 (42 specimens) and THJ7 (90 specimens). *P. caroli* (Gemmellaro, 1899) has been collected in THJ5 (13 specimens), THJ7 (25 specimens), as *P. inaequilateralis* (Gemmellaro, 1899) in THJ5 (17 specimens) and THJ7 (14 specimens). It is worth noting the progressive increase in number of the specimens of *P. affinis* from THJ3 to THJ7, where it dominates the assemblage.

Permophricodothyris affinis, P. caroli and *P. inaequilateralis* have been found at Pietra di Salomone, at Rocca di San Benedetto and at Rupe del Passo del Burgio along the Sosio river near Palermo, Italy (Gemmellaro, 1899). *P. inaequilateralis* also occurs in the Upper Productus Limestone of the Salt Range (Reed, 1944), in the Productus Limestone of Cambodia (Mansuy 1913) and in the Lopingian of South China (Huang, 1933).

Age. The new fossils collected from Halq Jemel section, in addition to the discovery of conodonts for the first time, yield more accurate dating.

THJ1-2 beds, yielding *Chusenella rabatei* Skinner and Wilde, 1967 and *Dunbarula* ex gr. *nana* Kochansky-Devidé and Ramovs, 1955 are most probably analogue to Rupe del Passo di Burgio (Sicily) and *Waagenoceras* and *Yabeina* beds at Cache Creek (British Columbia) localities which contain late Wordian (early Midian) conodonts and ammonoids (Kozur and Davydov, 1996, Stevens *et al.*, 1997, Kobayashi *et al.*, 2007) (Fig. 9). The occurrence of the conodont *Sweetognathus iranicus hanzhongensis* (Wang, 1978) in sample THJ2 suggests a Roadian (probably upper Roadian) to

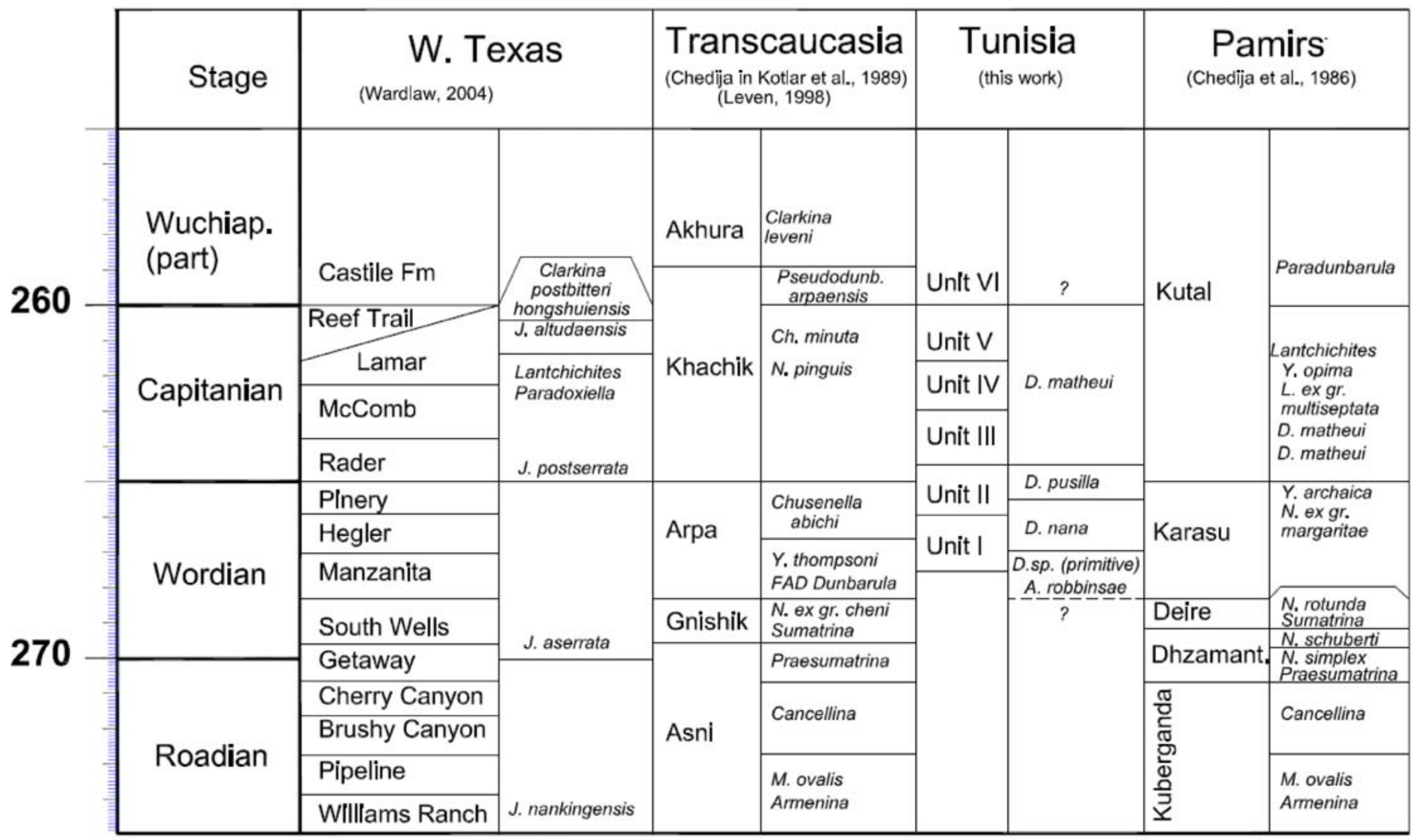

Fig. 9. Correlation of Guadalupian stages in the Neotethys/Paleotethys.

middle Capitanian (Guadalupian) age range, but the specimens are very similar to lower Capitanian forms from Dukou section in South China (Mei *et al.* 2002).

The beds from THJ3 to THJ9 are instead Capitanian in age, based on the occurrence of *Dunbarula mathieui* Ciry, 1948 that in South Pamirs co-occurs with advanced *Yabeina* and *Lepidolina* of Capitanian age (Chedia *et al.*, 1986).

Brachiopods support a Guadalupian age through correlation with the Sosio outcrops; however they are long ranging species, and some of them occurring also in the Lopingian.

Discussion and Conclusion

The finding of fusulinids and conodonts in the same bed in the Halq Jemel section is of great interest as it provides a tool of correlation between the International (Global) and the Tethyan regional scale that still remains unresolved, particularly for the Guadalupian part.

The Tethyan scale is based on shallow water successions using primarily fusulinids (Leven, 1980). Middle to Late Permian in the Tethys has been divided into the Kubergandian, Murgabian, Midian, Dzhulfian and Dorashamian stages.

The Midian Stage was proposed by Leven (1980) with type section in Transcaucasia (Armenia and Azerbaijan), as the rock unit of Arpa and Khachik Formations, equal to the *Yabeina-Lepidolina* fusulinid genozone. The latter was established in Japan (Y. Ozawa, 1927; Honjo, 1959; T. Ozawa, 1975) and has also been well documented in South China and Russian Far East (Sheng, 1963; Xiao *et al.*, 1986; Sosnina, 1978; Kotlyar *et al.*, 1989). The base of the stage was defined by FAD of *Yabeina* and *Lepidolina*, as well as *Dunbarula*, *Codonofusiella*, *Reichelina*, *Parareichelina*, *Sichotenella*, *Rauserella*, *Lanchechites*, *Paradoxiella*, *Kahlerina*, *Pseudokahlerina*, *Rugososchwagerina*, *Colania* and *Metadoliolina* genera.

Other typical Midian fusulinids are *Yangchienia*, *Chusenella*, *Parafususlina*, *Skinnerella*, *Monodiexodina*, *Polydiexodina*, *Neoschwagerina*, *Sumatrina*, *Afghanella*, *Gufuella*, *Pseudodoliolina*, *Verbeekina*, *Minojapanella*, *Boultonia*, *Wutuella* which however first appear in pre-Midian time.

The base of the overlying Dzhulfian Stage has been placed by Leven at the base of *Clarkina leveni* conodont zone (Leven, 1980). In terms of recent chronostratigraphy it is the fourth conodont zone above the base of Wuchiapingian (Kozur, 2004). Therefore, the Midian Stage as originally defined includes approximately the lower half of the Wuchiapingian Stage.

The Midian Stage was proposed to be divided into provisional fusulinid zones (upwards): (1) *Yabeina ozawai-Lepidolina igoi*, (2) *Yabeina globosa-Lepidolina multiseptata* and (3) *Lepidolina kumaensis* (*sensu stricto*) (Leven 1996) that are known mostly in the eastern Tethys. Neither index species of these zones were found, however, in the type area of Midian in Transcaucasia.

In the type area of the Midian Stage, the Arpa Formation (lower Midian Stage) is divided into the *Yangchienia thompsoni* and *Chusenella abichi* fusulinid zones approximately equal in thickness (40-120 m). The major part (100-200 m) of the Khachik Formation (upper Midian Stage) is characterized by the *Chusenella minuta* fusulinid zone. In the uppermost 3-15 m of the Khachik Formation, the Chanakhchi beds belong to the *Pseudodunbarula arpaensis* fusulinid zone (Kotlyar *et al.*, 1989). The latter authors included this zone into Dzhulfian that makes this stage equivalent to the Wuchiapingian Stage of the Global scale.

In the Halq Jemel section *Chusenella rabatei* Skinner and Wilde, 1967 and *Dunbarula* ex gr. *nana* Kochansky-Devidé and Ramovs, 1955 co-occur with *Sweetognathus iranicus hanzhongensis* (Wang, 1978). The latter is a quite long ranging conodont species spanning the Roadian to middle Capitanian (Guadalupian), whereas the FAD of the fusulinid *Dunbarula* ex gr. *nana* is early Midian. This finding may support the correlation of the lower Midian Stage of the Tethyan scale to the upper Wordian of the Global scale of the Permian (Davydov, 1994; Kozur and Davydov, 1996; Stevens *et al.*, 1997; Kobayashi *et al.*, 2007).

Nine metres above this assemblage, the advanced *Dunbarula mathieui* Ciry, 1948 has been found. The genus *Dunbarula* shows a significant development from late Wordian through Wuchiapingian and the species *D. mathieui* elsewhere co-occurs with *Yabeina* and *Lepidolina* of Capitanian age (Chedia *et al.*, 1986). *D. mathieui* indicates a most probable Capitanian age of the succession starting from bed THJ3 through bed THJ9 in the Halq Jemel section.

More conodont sampling along the Halq Jemel section integrated with fusulinid occurrences may help to better constrain the debated correlation.

Acknowledgements

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References

Baird D.W., 1967. The Permo-Carboniferous of Southern Tunisia. In Martin L. (Ed), 9th Ann. Field Conf., Guidebook to the Geology and History of Tunisia. Petroleum Exploration Soc. Libya, Holland-Breumelhof N.V., Amsterdam, 293 pp.

Boyd D.W. and Newell N.D., 1979. Permian Pelecypods from Tunisia. Amer. Mus. Nat. Hist. Novitates, 2628, p. 1-22, New York.

Chaouachi M.C., 1985. Contribution à l'étude des paléoenvironment et de la diagenèse carbonate dela Série permienne du Jebel Tebaga de Medenine (Sud Tunisien). D.E.A. Fac. Sc. Tunis, 104 pp., Tunis.

Chaouachi M.C., 1988. Etude sédimentologique des séries du Permien supérieur du Jebel Tebaga de Medenine (Sud-East de la Tunisie); genèse, diagenèse et potentiel réservoir des corps récifaux. Thèse 3e cycle, Fac. Sc. Tunis, 285 pp., Tunis.

Chedia I.O., Bogoslovskaya M.F., Davydov V.I. and Dmitriev V.Yu., 1986. Fusulinids and ammonids in the type section of Kubergandian Stage (South-Eastern Pamirs). Transactions of Paleontological Society of USSR, Leningrad, 29, p. 28-53 (in Russian).

Ciry R., 1948. Un nuveau Fusulinidé permien: *Dumbarula mathieui*. Bull. Scient. Bourgogne, 11 (1946-1947), p. 103-110.

Ciry R., 1954. A propos de *Neoschwagerina syrtalis* Douvillé. Bull. Soc. Sc. Nat. Tunisie, 7, p. 111-122.

Davydov V.I., 1994. Murgabian Midian fusulinid Zonation and the problem of Correlating the Murgabian/Midian Boundary on Global Scale. - Abstracts and Programm Internet. Symp. Perm. Stratigr., Environments and Resources. Guiyang, China, p. 5 6.

Douvillé H., Solignac M., and Berkaloff E., 1933. Découverte du Permien marin au Djebel Tebaga (Extrême-Sud Tunisien). C.R. Ac. Sc., 196, p. 21-25, Paris.

Douvillé H., 1934. Le Permien marin de l'Extreme-Sud Tunisien, II, Les fusulinidés de la Tunisie. Mém. Service Carte Géol. Tunisie, n. s., 1, p. 79-90.

Driggs A.F., 1977. The Petrology of three Upper Permian Bioherms, Southern Tunisia. Brigham Young University Geol. Studies, 24, 1, p. 37-53, Provo (Utah).

Gemellaro G.G., 1899. La fauna dei calcari con fusulina della Valle del fiume Sosio. Giornale di Scienze Naturali ed economiche di Palermo, 24, p. 231-338, Palermo.

Glintzboeckel C. and Rabaté J., 1964. Microfaunes et microfaciès du Permo-Carbonifère du Sud-Tunisien. E.J. Brill Edit., p. 1-45, Leiden.

Gradstein F., Ogg J., Smith A., 2004. A Geological Time Scale. Cambridge University Press, 589 pp.

Honjo S., 1959. Neoschwagerinids from the Akasaka limestone (a paleontological study of the Akasaka limestone (a paleontological study of the Akasaka limestone, 1st report). Hokkaido Univ., Fac. Sci. J., 4, 1, p. 111-161.

Huang T.K., 1933. Late Permian brachiopod fossils of south-western China, Part 1. Palaeontologia Sinica Series B, 9, 2, p. 1-172, Beijing.

Insalaco E., Virgone A., Courme B., Gaillot J., Kamali M., Moallemi A., Lotfpour M., Monibi S., 2006. Upper Dalan Member and Kangan Formation between the Zagros Mountains and offshore Fars, Iran: depositional system, biostratigraphy and stratigraphic architecture. GeoArabia, 11, p. 75-176, Manama.

Khessibi M., 1985. Etude sédimentologique des affleurements permiens du Djebel Tebaga de Médenine (Sud-Tunisien). Bull. Centres Rech. Explor.-Prod. Elf-Aquitaine, 9, 2, p. 427-464, Pau.

Kobayashi F., Ross C.A. and Ross J.R.P., 2007. Age and generic assignment of *Yabeina columbiana* (Guadalupian fusulinacea) in southern British Columbia. Journal of Paleontology, 81, p. 238-253.

Kotlyar G.V., Zakharov Yu.D., Kropatcheva G.S., Pronina G.P.,Chedija I.O. and Burago, V.I., 1989. Evolution of the latest Permian biota B Midian regional stage in the U.S.S.R. Nauka Publishing House, Leningrad, 185 pp. (in Russian with English summary).

Kozur H.W. and Davydov V.I., 1996. The importance of the Permian of the Sosio Valley (western Sicily, Italy) for Guadalupian stratigraphy. Guadalupian II, Alpine, Texas, April 10-13, 1996, Abstracts, p. 11-12, 15, Washington.

Lane N.G., 1979. Upper Permian Crinoids from Djebel Tebaga, Tunisia. Journ. Paleont., 53, 1, p. 121-132, Tulsa.

Lethiers F., Razgallah S., Colin J.P. and Vachard D., 1989. Micropaleontology of the Permian marls of Merbah el Oussif (Jebel Tebaga, Tunisia) with special emphasis on the Ostracods. Journ. Micropaleont., 8, 2, p. 227-238, London.

Leven E.Ya., 1980. Explanatory notes on the Startigraphic Scale of the Tethyan Permian. Transactions of VSEGEI, p. 3-51 (in Russian).

Leven E.Ya., 1993. Filogeniya sumatrinid i voprosy zonalnogo raschleneniya murgabskogo i midinskogo yarusov permi (Sumatrinid phylogeny and the questions of the zonal subdivision of the Murgabian and Midian stages in the Permian): Paleontologicheskii Zhurnal, 1993, 3, p. 23-29 (in Russian, with English abstract).

Leven E.Ya., 1996. The Midian Stage of the Permian and its boundaries. Stratigraphy and geological correlation, 4, 6, p. 20-31 (in Russian and English).

Lys M., 1988. Biostratigraphie des dépôts marins du Carbonifère et du Permien du Sud-Tunisien; micropaléontologie (Foraminifères) et paléobiogéographie. Bull. Centres Rech. Explor.-Prod. Elf-Aquitaine, 12, 2, p. 601-659, Pau.

Mansuy H., 1913. Faunes des Calcaires a Productus de l'Indochine. Mem. du Serv. Geol. Indochina, 2, 4, 133 pp.

Mathieu G., 1940. Les plissements du Permien de Toujane et les ondulations de la couverture secondaire dans la région de Médenine. C.R. Ac. Sc., 211, 5, p. 122-125, Paris.

Mathieu G., 1949. Contribution à l'étude des Monts Troglodytes dans l'Extrême-Sud tunisien. Ann. Mines Géol., 1, 4, p. 1-82, Tunis.

Mei S., Henderson C.M. and Wardlaw B.R., 2002., Evolution and distribution of the conodonts *Sweetognathus* and *Iranognathus* and related genera during the Permian and their implication for climate change. Palaeogeography Palaeoclimatology Palaeoecology, 180, p. 57-91, Amsterdam.

Memmi L., Burrolet P.F. and Viterbo I., 1986. Lexique stratigraphique de la Tunisie. Pt. 1. Précambrien et Paléozoïque. Notes Serv. Géol. Tunisie, 53, p. 1-66, Tunis.

Miller A.K. and Furnish W.M., 1957. Permian Ammonoids from Tunisia. Journ. Paleont., 31, 4, p. 705-712, Tulsa.

M'Rabet A., Dridi M. and Ben Hassine K., 1994. Examples of Upper Permian and Triassic reservoir in southeastern Tunisia. Field Trip Guide book. The 4th Tunisian Petroleum Exploration Conference, Tunis, May 4th-7th, 1994.

Newell N.D., Rigby J.K., Driggs A., Boiyd D.W. and Stehli F.G., 1976. Permian Reef complex, Tunisia. Brigham Young Univ. Geol. Studies, 23, 1, p. 75-112, Provo (Utah).

Ozawa Y., 1927. Stratigraphical studies of the Fusuline limestone of Akasaka, Province of Mino. Journal of College of Science Imperial University of Tokyo, 2, 3, p. 121-164.

Ozawa T., 1975. Evolution of *Lepidolina multiseptata*; Permian foraminifer, in East Asia. Memoirs of the Faculty of Science, Kyushu University, Series D: Geology, 23, 2, p. 117-164.

Reed F. R. C., 1944. Brachiopoda and Mollusca from the Productus Limstones of the Salt Range. Palaeontologica Sinica, 23, 596 pp., Beijing.

Senowbari Daryan B. and Rigby J.K., 1988. Upper Permian Segmented Sponges from Djebel Tebaga, Tunisia. Facies, 19, p. 171-250, Erlangen.

Sheng J.C., 1963. Permian Fusulinids of Kwangsi, Kueichow and Szechuan. Acta Paleontologica Sinica. New series B, 149, 10, p. 1-128 (Chinese), p. 129-247 (English).

Skinner J.W. and Wilde G.L., 1967. Permian Foraminifera from Tunisia. Univ. Kansas Paleont. Contrib., 30, p. 1-22, Lawrence.

Sosnina M.I., 1978. Foraminifers of Chandalaz Horizon of Late Permian in southern Primorie. In Poyarkova Z.N. (ed.). Upper Paleozoic of North-Eastern Asia, p. 24-43, Vladivostok.

Stevens C. H., Davydov V.I. and Bradley D.C., 1997. Permian Tethyan Fusulinina from the Kenai Peninsula, Alaska. Journal of Paleontology, 71, p. 985-994, Tulsa.

Termier H., Termier G. and Vachard D., 1977. Monographie paléontologique des affleurements permiens du Djebel Tebaga (Sud-Tunisien). Palaeontographica A, 156, p. 1-109, Stuttgart.

Toomey D.F., 1991. Late Permian reefs of Southern Tunisia: facies patterns and comparison with the Capitan Reef, Southwestern United States. Facies, 25, p. 119-146, Erlangen.

Vachard D. and Razgallah S., 1993. Discussion sur l'age Murgabien ou Midien de series Permiennes du Jebel tebaga (Sud de la Tunisie). Rivista Italiana di Paleontologia e Stratigrafia, 99, 3, p. 327-359, Milano.

Vachard D., Gargouri-Razgallah S. and Chauachi M.C., 1989. Sur les biohermes a algues Solenoporacees et phylloides du Permien superieur de Tunisie (Murghabien du Djebel tebaga) et sur les incidences de la diagenese carbonate sur la systematique algaile. Revue de Paleobiologie, 8, 1, p. 121-141, Geneve.

Vachard D., Hauser M., Martini R., Zaninetti L., Matter A., and Peters T., 2002. Middle Permian (Midian) Foraminiferal Assemblages From The Batain Plain (Eastern Oman): Their Significance to Neotethyan Paleogeography . Journal of Foraminiferal Research, 32, p. 155-172.

Wendt J., 1993. Solenoporacean Stromatolites. Palaios, 8, p. 101-110, Tulsa.

Xiao W., Zhang L., Wang H. and Dong W. 1986. Early Permian Stratigraphy and faunas in Southern Guizhou. Peoples Publishing House, Guizhou, p. 1-364.

New data about the Permian section and fusulinids in the Kalmard area (Central Iran, Yazd Province)

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The sections on the northern and southern slopes of the Tangale-Mokhtar valley, Halvan Mountains to the east of the Halvan village (Fig. 1) were examined. Previously Davydov and Arefifard (2007) studied a section neighbouring that under consideration. They referred the entire Permian sequence to the Khan Formation which was established by Aghanabati (1977) further to the south. Fusulinids from the lower third of the formation were considered to represent a single assemblage correlative with the Sakmarian (Lower Artinskian?) Kalaktash assemblage of the Central Pamirs.

Our studies show that the Permian section can be divided into three distinct parts separated by unconformity surfaces and horizons of red laterites bearing bauxites locally. Each part constitutes an independent formation (from the base upward): Chili (84 m), Sartakht (79 m), and Hermez (83.8 m). The formations are united into the Khan Group embracing the entire Permian section (Figs. 2, 3). They reflect large cycles of sedimentation and are similar in structure. Basal laterites are overlain by quartzitic sandstone, siltstone, and mudstone, which are succeeded by detrital limestone and dolostone.

Fusulinids were found at two levels and comprise two different assemblages (Plate 1). The lower assemblage is confined to the Chili Formation and appears several metres above the basal sandstone. It consists of numerous species of *Nonpseudofusulina* and *Eoparafusulina* including *N. pamirensis* (Leven), *N. karapetovi* (Leven), *N. tezakensis* (Leven), *N. curteum* (Leven), *N. insignis* (Leven), *N. psharti* (Leven), *N. inobservabilis* (Leven), *N.* ex gr. *pedisequa* (Vissarionova), *N.* aff. *mirabilis* (Rauser-Chernousova), *N.* ex. gr. *indigaensis* (Grozdilova and Lebedeva), *N.* sp. nov., *E. regina* (Nie and Song), *E. acuta* (Grozdilova and Lebedeva). Most of the listed species are known from the Kalaktash assemblage of the Central Pamirs. Some new species are represented by single specimens. It is of interest that the assemblage contains the forms similar to Sakmarian and Early Artinskian taxa of the Urals and Timan. These are *N.* ex gr. *indigaensis* characteristic of the Tastub Beds of Timan and *N.* ex gr. *pedissequa* typical of the Artinskian base of the Urals. All the forms derived from the Khan Group sections including the southernmost section of the Kalmard Pass are components of this assemblage (Kahler, 1977; Davydov and Arefifard, 2007; Leven and Gorgij, 2007).

The name *Nonpseudofusulina* is used for the forms, which were previously referred to *Pseudofusulina* in accordance with the initial generic diagnosis of Dunbar and Skinner (1931). Later Skinner and Wilde (1965, 1966) changed the diagnosis based on the fact that the type species has a furrowed, "rugosity" tectum; this feature has not been noticed by Dunbar and Skinner. However, it was incorrect to assign the forms with smooth wall to this genus; many specialists continued to identify the genus as *Pseudofusulina*, which correspond to the former diagnosis, but not to the new one. To avoid confusion, the name *Nonpseudofusulina* is suggested for the smooth-walled *Pseudofusulina*-like forms.

The second assemblage was found in the limestone pebbles and unrounded fragments of conglomeratic breccias. They form inconsistent interbeds (up to 1 m) inside the bauxite-bearing laterites separating the Chili and Sartakht formations. The pebbles are lithologically uniform (packstones and floatstones in micritic, biomicritic and biosparitic cement). The fusulinid assemblage is also uniform (Plate 1): *Pseudoendothyra* sp., *Palaeostaffella* sp., *Schubertella* cf. *paramelonica* Suleimanov, *Biwaella* sp., *Benshiella yazdensis* sp. n., *Eozellia elongata* (Saurin), *E. falx* (Rauser-Chernousova), *E. muongthesis* (Deprat), *Globifusulina* aff. *parva* (Beljaev), *Nonpseudofusulina fecunda* (Shamov et Scherbovich), *N. diferta* (Shamov), *N. exuberata macra* (Shamov), Ñ*uniculinella partoazari* (Davydov and Arefifard), *Eoparafusulina postpusilla* (Bensh), *E. regina* (Nie and Song). The presence of the characteristic species of *Eozellia*, *Globifusulina* and *Nonpseudofusulina* indicates the Asselian (Late Asselian) age of the assemblage.

Among the listed forms there is a new genus *Benshiella*, which includes the species referred previously to *Pseudofusulina* and then to *Rugosofusulina* with "rugosity" tectum and well pronounced axial fillings. The type species is "*Pseudofusulina*" *stabilis* Rauser-Chernousova, 1938. Such species are common in the Asselian deposits and frequent in the Sakmarian ones.

The age of the Sartakht Formation is still unclear. The occurrence of big Staffellidae in the lower third of the formation suggests that the larger part of the formation belongs to the Yangsingian Series of the Lower Upper Permian. The supposed age of the Hermez Formation is Lopingian.

References

Aghanabati, A., 1977. Etude geologique de la region de Kalmard (W. Tabas). Geol. Surv. of Iran. Rep. 35: 1-230.

Davydov, V. I. and Arefifard, S. 2007. Permisn fusulinid fauna of Peri-Gondwanan affinity from the Kalmard region, East-Centrak Iran and its significance for tectonics and paleogeography. Palaeontologia Electronica. 10(2): 1-40.

Dunbar, C. O. and Skinner, J. W., 1931. New fusulinid genera from the Permian of West Texas. Amer. J. Sci. Ser. 5, 22: 252-268.

Kahler, F., 1977. Bemerkenswerte Fusuliniden-Funde im ostmediterranen und iranischen Raum. N. Jb. Palaont. Mh. 4: 199-216.

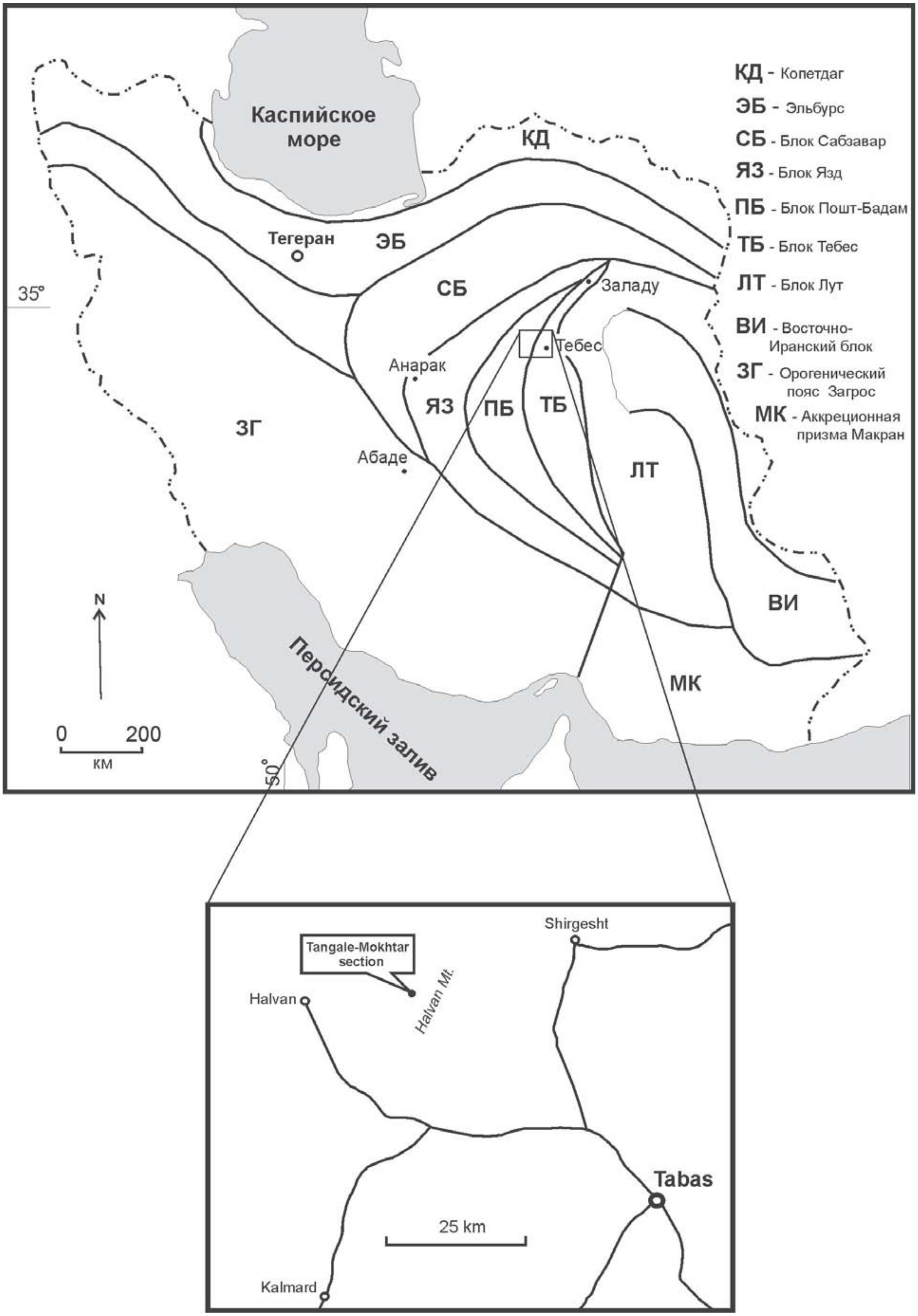

Fig. 1. Index map with location of studied section

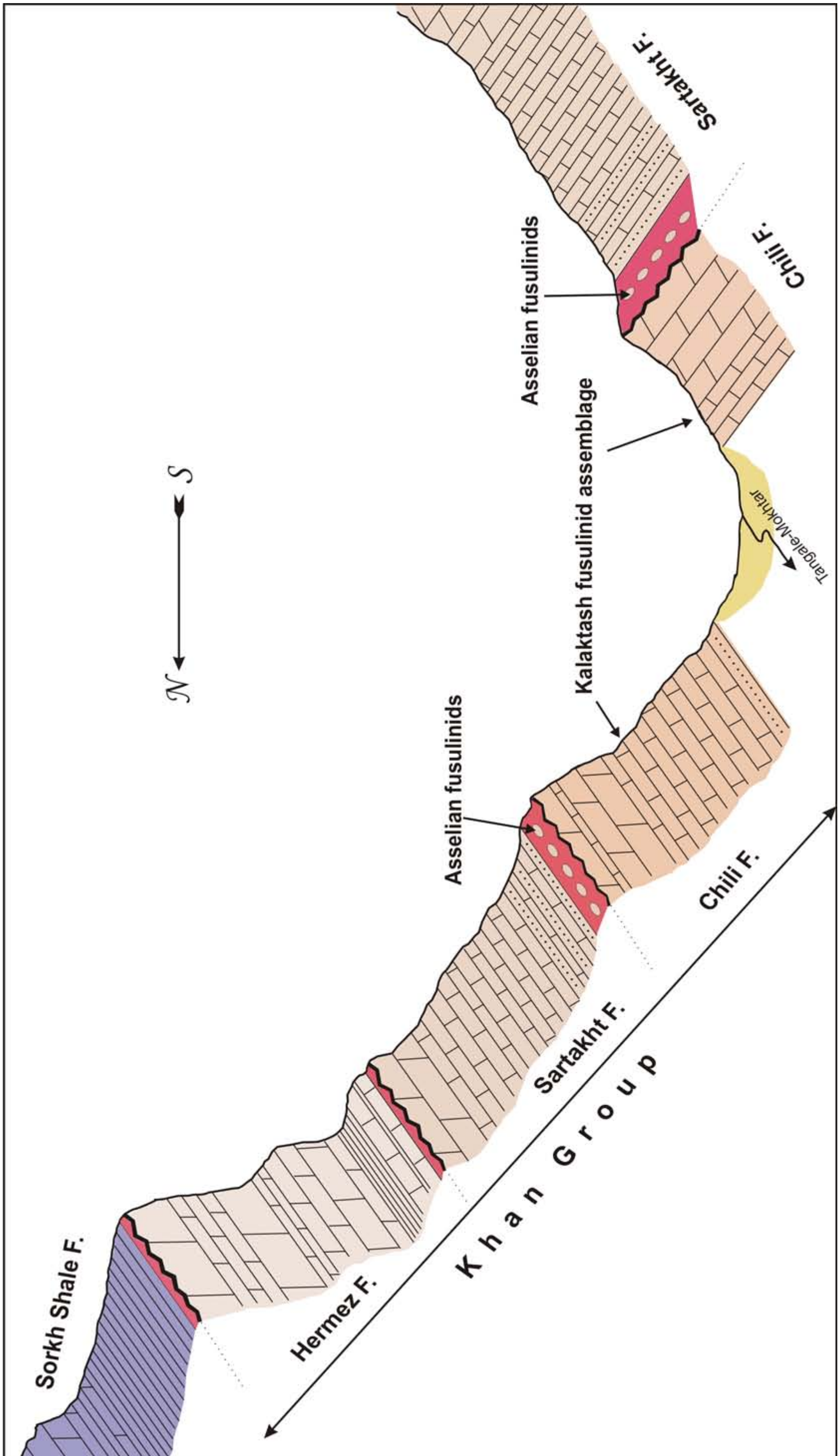

Fig. 2. Tangale-Mokhtar section

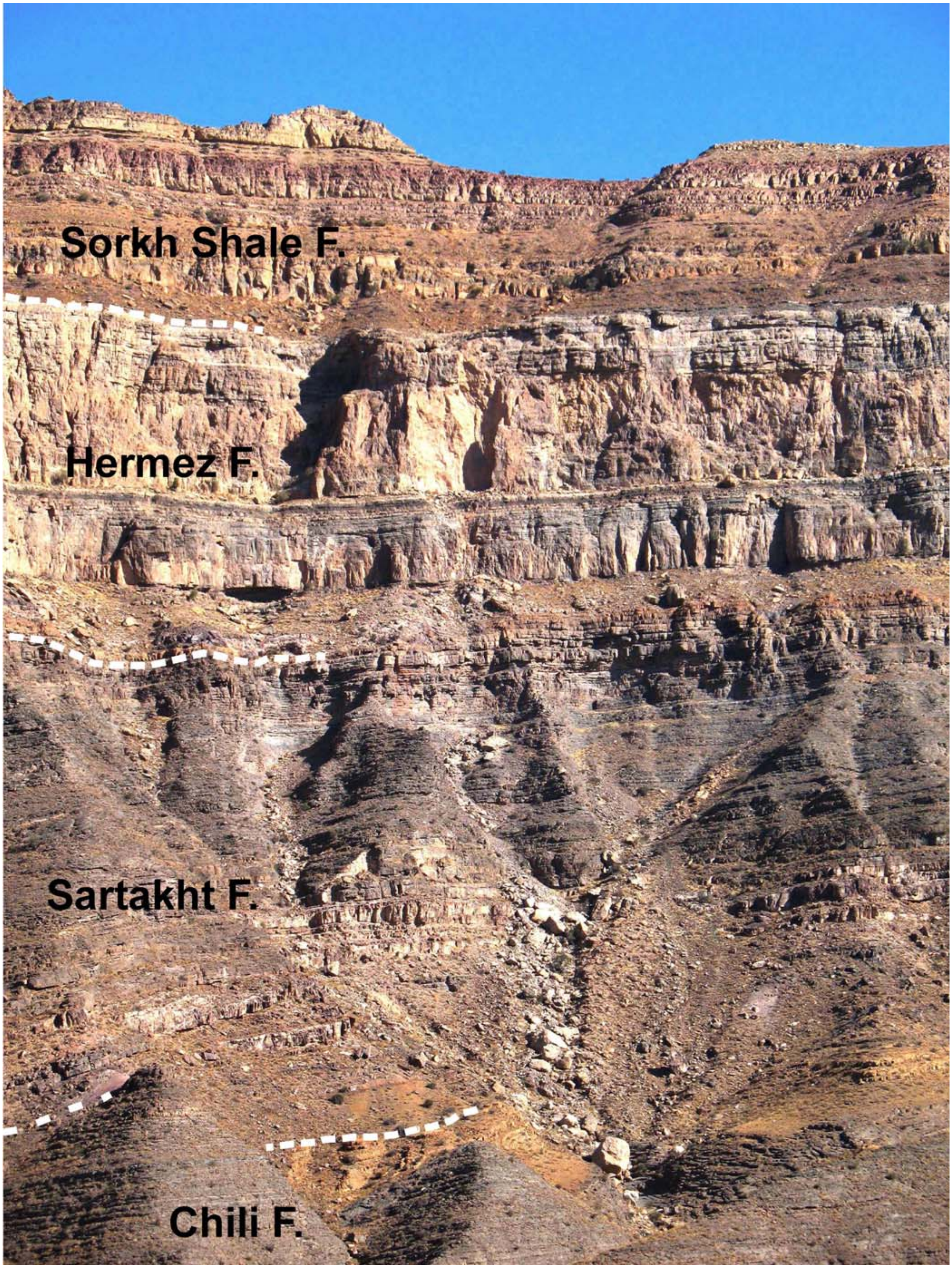

Fig. 3. Photo of northern side of Tangale-Mokhtar valley

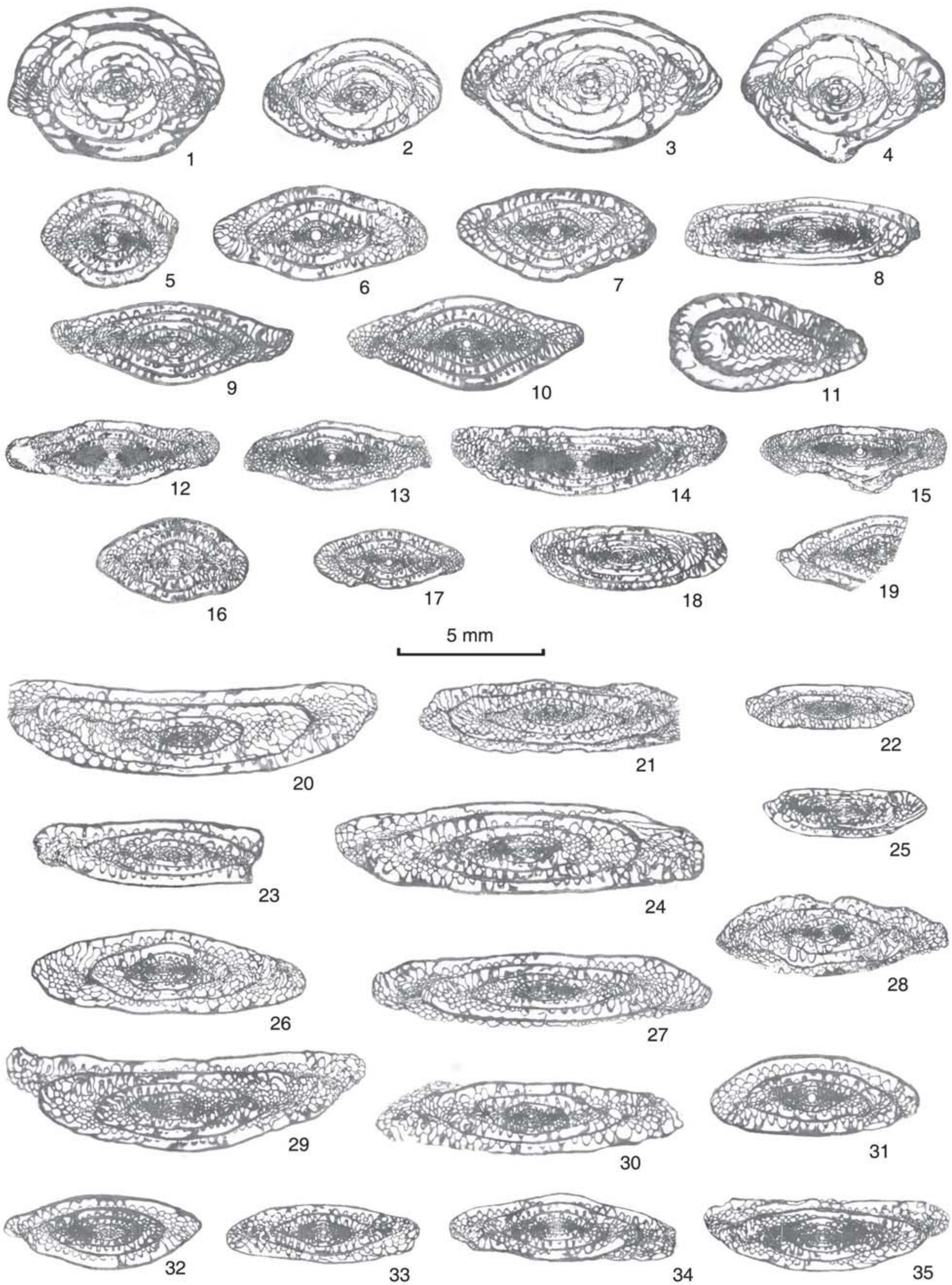
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Plate 1. 1-19–Asselian assemblage: 1- *Eozellia falx*; 2- *Eozellia muongthensis*; 3, 4- *Eozellia elongatà* ; 5- *Nonpseudofusulina* sp. 1; 6, 7- *Nonpseudofusulina fecunda*; 8- *Eoparafusulina postpusilla;* 9-11 - *Cuniculinella partoazari*; 12, 13- *Benshiella yazdensis*; 14, 15- *Benshiella halvanensis*; 16- *Globifusulina* aff. *parva*; 17-*Nonpseudofusulina diferta*; 18- *Eoparafusulina regina*; 19- *Nonpseudofusulina exuberata macra*. 20-35 - Sakmarian (Kalaktashian) assemblage: 20, 24, 27- *Nonpseudofusulina pamirensis;* 21- *Nonpseudofusulina* ex. gr. *indigaensis;* 22- *Nonpseudofusulina inobservabilis;* 23- *Nonpseudofusulina karapetovi;* 25- *Eoparafusulina regina;* 26- *Nonpseudofusulina insignis;* 28- *Nonpseudofusulina curteum;* 29- *Nonpseudofusulina* ex gr. *pedisequa;* 30- *Nonpseudofusulina psharti;* 31- *Nonpseudofusulina granuliformis;* 32- *Nonpseudofusulina* aff. *mirabilis;* 33- *Nonpseudofusulina tezakensis;* 34- *Nonpseudofusulina* ex gr. *kalmardensis;* 35- *Nonpseudofusulina kalmardensis.*

Leven, E. Ja. and Gorgij, M. N., 2007. Fusulinids of the Khan formation (Kalmard region, eastern Iran) and some problems of their paleobiogeography. Russian Journ. of Earth Sciences. 9: 1-10.

Skinner, J. W. and Wilde, G.L., 1965. Permian biostratigraphy and fusulinid faunas of the Shasta Lake Area, Northern California. Article 6: 98.

Skinner, J.W. and Wilde, G. L., 1966. Type species of Pseudofusulina Dunbar et Skinner. Univ. Kansas. Paleontol. Contrib. Paper 13: 1-7.

New finds of Permian conodonts in Iran

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Conodont specimens were obtained from the samples sent by M.N. Gorgij for foraminiferal analysis. The material remaining after preparation of slides was dissolved and yielded some conodont fragments. Although scarce and poorly preserved, these specimens are of great significance because no conodonts have been previously found in the Iranian Permian deposits of such a low stratigraphic horizon other than the Dzhulfian and Dorashamian.

Sweetognathus anceps Chernikh and *S. inornatus* Ritter are of prime interest because they are interpreted to be ancestors of *Sweetognathus whitei* (Rhodes); the first appearance of which defines the Artinskian lower boundary. They were found together with fusulinids of the Kalaktash assemblage and hence confirm its Sakmarian age for this fusulinid assemblage. However, we cannot exclude an Early Artinskian age because these species may range across the Sakmarian-Artinskian boundary. Both species were obtained from the Chili Formation of the Tangale-Mokhtar section (see the article of Leven and Gorgij in this issue). One of them is figured as Figs. 1, 2 in Plate 1, whereas the other was destroyed in the process of photographing. A sample from the upper part of this section includes tooth-like fragments of *Stepanovites* (Plate 1, Figs. 5-7). Although recorded in the upper Lower Permian this genus is common in Upper Permian deposits. Its occurrence in the Hermez Formation is the first evidence of Upper Permian deposits in the region.

Samples from the Kaviz section to the south of the town of Sirjan (Leven and Gorgij, in press) contained fragments of *Sweetognathus whitei* (Rhodes) and *Hindeodus minutus* (Ellison) (Plate 1, Figs. 3, 4) in combination with Bolorian fusulinids (*Misellina termieri*, *M. megalocula*, *Skinnerella schucherti*). These conodont species are typical of Artinskian deposits, and their occurrence in the Upper Bolorian, which is usually correlated to the Kungurian is not quite clear. *Sweetognathus guizhouensis* Bando et al. (Plate 1, Fig. 1) was obtained from the basal Kubergandian beds with fusulinids (*Misellina ovalis*, *Armenina salgirica*, *Kubergandella insolita*). This species was first described from the lower part of the Chihsia Formation of South China, which can be correlated by fusulinids to the Upper Bolorian–Lower Kubergandian deposits.

The facts presented indicate that the Iranian Permian sections are very promising in regards to conodont content and need to be studied in detail. The combination of conodonts and fusulinids may provide a solution to many correlation problems.

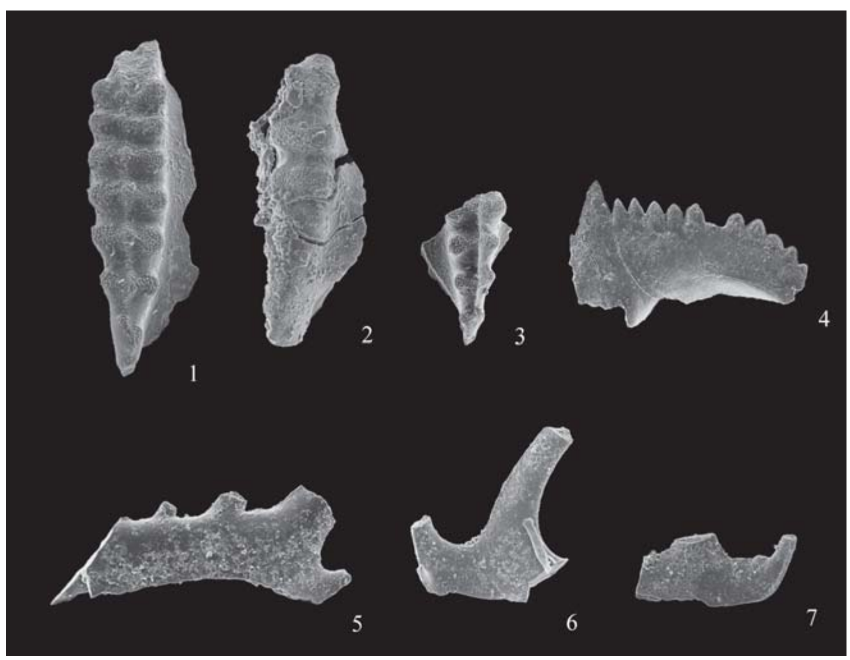

Plate 1. 1, *Sweetognathus guizhouensis* Bando et al.; 2, *Sweetognathus anceps* Chernikh; 3, *Sweetognathus whitei* (Rhodes); 4, *Hindeodus minutus* (Ellison); 5-7. *Stepanovites* sp. (All X 55)

Permian in Northwest of Iran

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Introduction

To clarify more precisely the details of Permian strata in Northwestern part of Iran (East and West Azerbaijan), five stratigraphic sections located in Qareh-zia-o-din, Khoy, Julfa, Tabriz and Ajabshir area were measured and sampled. Characteristics of Permian sequences in Ajabshir and neighboring areas indicate that during Middle Permian time, this area was thoroughly distinct from the other four areas.

Due to deposition of bauxite and laterite sediment and igneous flow in Midian time the Ajabshir section is in striking contrast to those of the other sections. Lithologic and microfacies analysis show that the Middle and Upper Permian limestone of the studied area have been deposited in a shallow carbonate platform (ramp setting). The analysis of faunal content, foraminifers and algae of strata show that the duration of the Permian platform in Julfa, Khoy and Qarehzia-o-din area was longer than the two other areas. Because Permian carbonate sequences in these three sections begins from Kubergandian and in the two area, viz Tabriz and Ajabshir, the base of Permian carbonate strata have a foraminifer assemblage of late Kubergandian-Murgabian age. In all studied areas, Middle and Upper Permian limestone lie transgressively on the clastic and deltaic sediments of lower Permian.

Three major transgressive cycles can be recognized within the Permian sequences in Northwest Iran. The first transgression begins with conglomerate, sandstone and shale with an Asselian to Sakmarian age. This clastic sequence is overlying with disconformity on the older formations with various ages. This phase started in Asselian and ended in Sakmarian. The second phase of transgresive begins in early Kubergandian, in some areas early Murgabian, so that the carbonate rocks have been deposited on the lower Permian strata with a great hiatus at the top.

The third transgressive event occurred in the base of Dzhulfian stage and caused the deposition of deep and basin marine sediment in Julfa and Qarehzinodin area.

The Permian in the northwest of Iran have been investigated for many years. Riben (1933) was the first geologist who mentioned two outcrops of Permian strata in his report.

Stepanov *et al*. (1969) published a complete report on the Permian of Ali Bashi mountains, a section of Permian and Permo-Triassic sequence in southwest of Julfa. On the basis of brachiopods, corals and cephalopods, they attributed that sequence to Gaudalupian to Dzhulfian.

Stepanov *et al*. (1969) divided the Permian sequence into six units, viz A to E. The units A and B correspond to Genishik and Khachik beds in Transcaucasia, respectively. Units C and D or Julfa beds were given a Dzhulfian age. Unit E was subdivided into four Cephalopoda biozone–and called Permian-Triassic transition zone. And finally, a red nodular limestone unit with *Paratirolites* was named unit F with an early Triassic age by Stepanov *et al*. (1969).

Teichert *et al*. (1973) presented a detailed description of Permian in Ali Bashi and introduced a new formation, viz Ali Bashi Formation with a Dorashamian age. This formation consists of units E and F introduced by Stepanov *et al*. (1969).

In recent years, more detailed examinations of the Permian deposites, chiefly upper Permian in Ali Bashi area have been conducted by Altiner *et al*. (1980), Partoazer (1995), and Baghbani (1996).

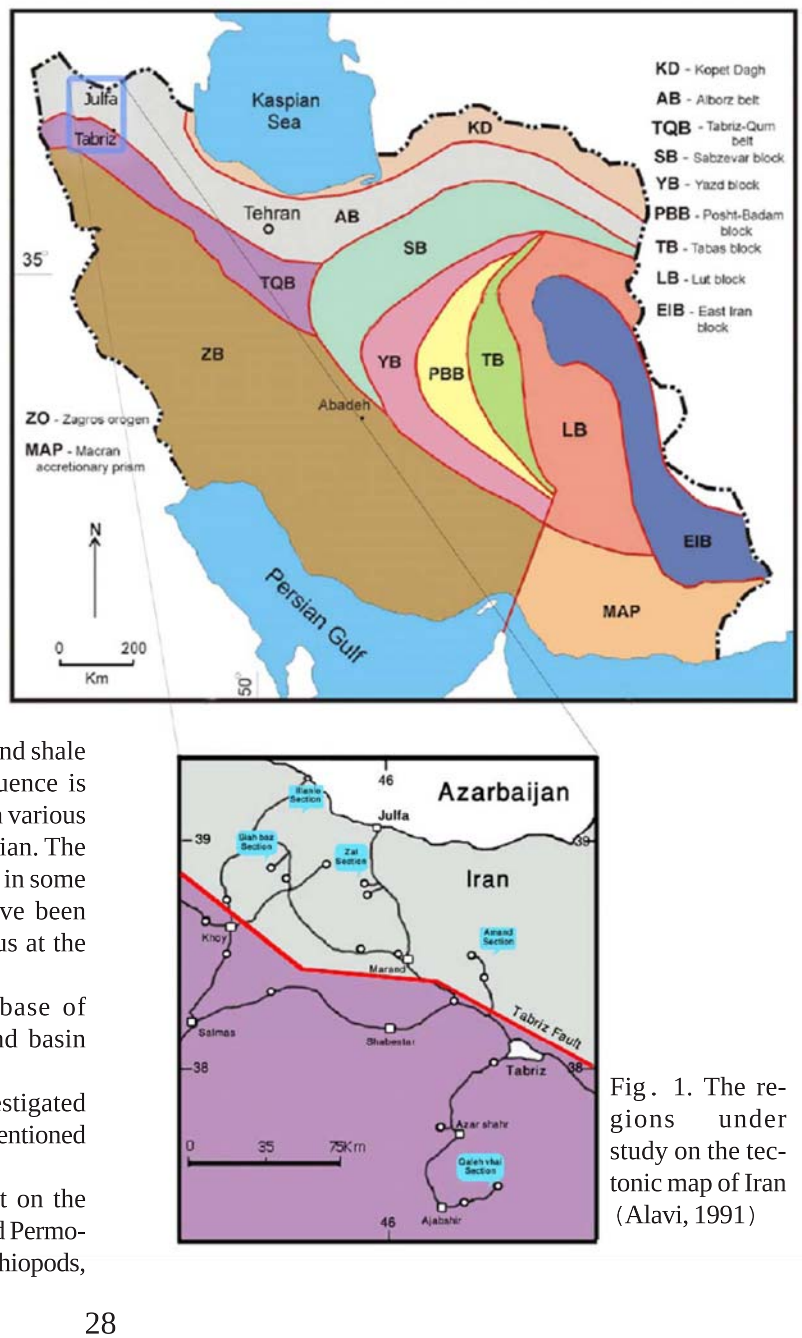

Fig. 1. The regions under study on the tectonic map of Iran (Alavi, 1991)

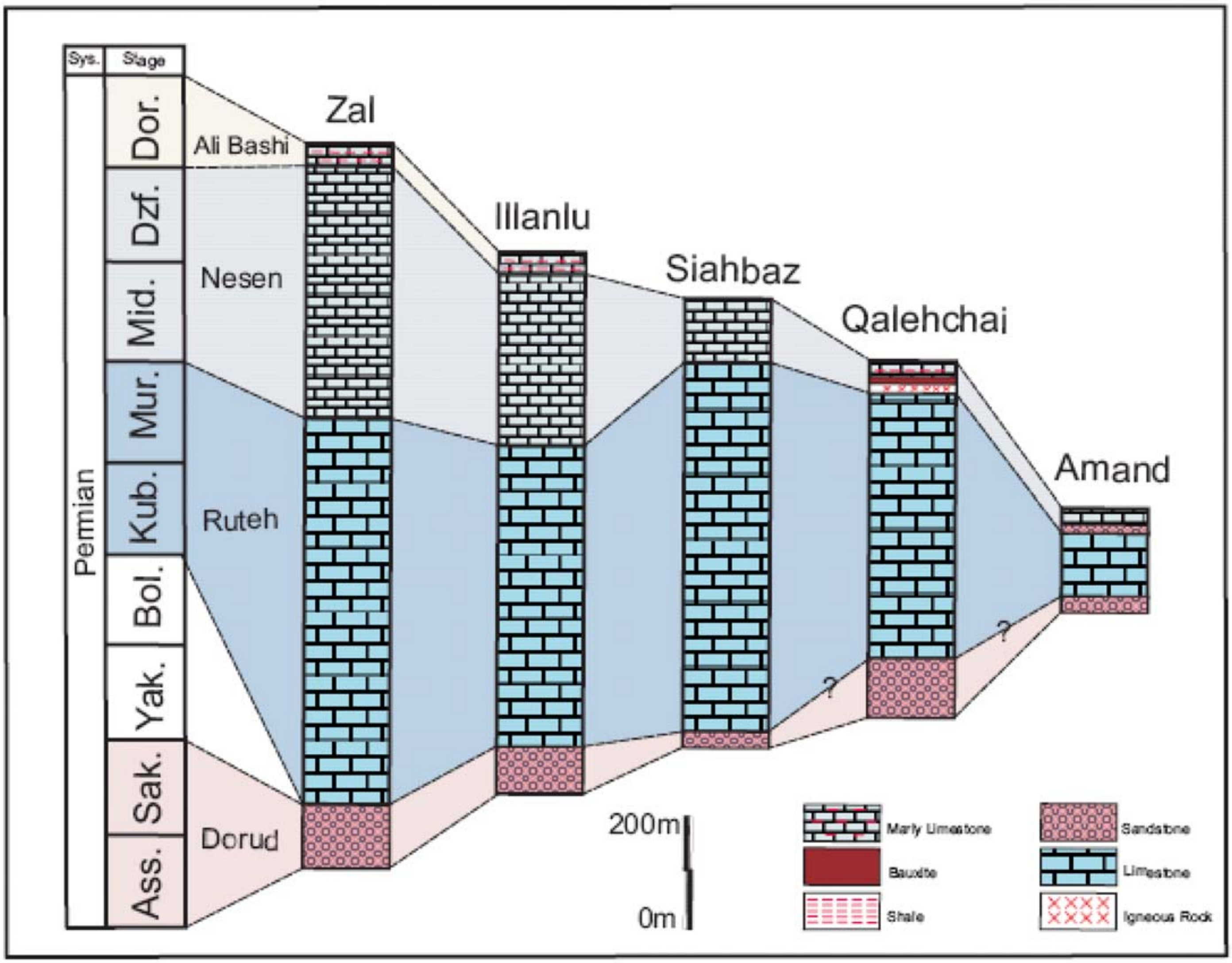

Fig . 2. Stratigraphic columns in the studied area

Despite the fact that numerous outcrops of Permian deposits are widely distributed in NW Iran, only the Ali Bashi section have received investigation by stratigraphers and paleontologists. Because of the conspicuous differences among the data which have been published by various authors, We have selected five stratigraphic sections in five separate geographical areas to help resolve some ambiguities.

The purpose of this paper is (1) to summarize stratigraphy of Permian strata in Nw of Iran. (2) to determine a precise age for Permian successions.

Geolgical setting

Iran can be divided into various tectonic provinces, each with its own distinct characteristics and tectonic evolution. Eleven geological provinces can be recognized.

These provinces are 1) Zagros 2) Tabriz – Qum belt 3) East Iran block 4) Alborz 5) Kopt Dogh 6) Macran 7) Sabzevar blok 8) Yazd block 9) Posht badam block 10) Tabas block and 11) Lut block (Alavi, 1991) (Fig.1)

Each of them has experienced distinct stratigraphy, sedimentary and tectonic histories, but from Precambrian to Permian, there are similarity in lithology and faunal content in most provinces. These segments had been located in the north eastern part of Arabian platform and belong to Gondwana land. During Triassic time, the Iranian block including Central Iran, Alborz Mountains and Kopt dagh as well as Azerbaijan rifted northward and collided with southern Eurasia, Stocklin (1968) Berberian and King (1981).

The outcrops of Permian deposits are extensively distributed in most parts of Azerbaijan, but due to sea level changes, erosional phases and tectonics events, their thicknesses vary in different sections of the studied area.

Asselian to Sakmarian sediments

The Asselian to Sakmarian sequences consist of medium to coarse arkosic sandstone, litharenite and quartzarentie sandstone, siltstone and shale overlaying the formations with different ages. The thickness of clastic formation in the research area varies from 5 m to 120 m from one place to another. Field investigations and laboratory works show that this continental and clastic sediment was deposited in a meandering fluvial and deltaic system to shoreline (Fig.2).

Because of absence of fossils of foraminifera, the age of the sequence can't be determined. Comparing these deposits with other Permian calstic sediments in Iran, for example, Dorud Formation in Alborz (Asserto, 1963), Bahg Vang Formation in central Iran (Partoazer, 1995), and Vazhnan Formation in Abadeh

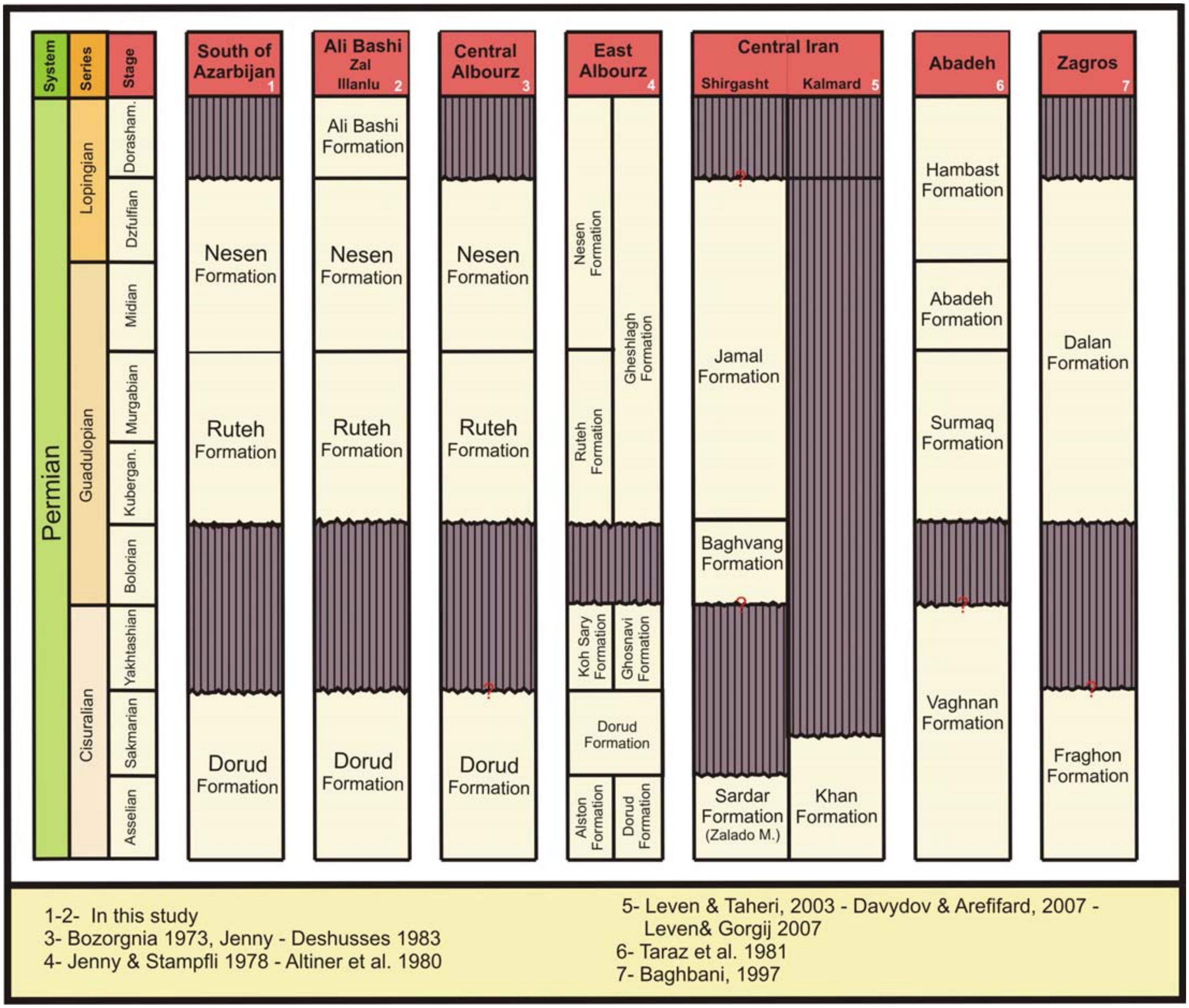

Table 1. Correlation chart of main Permian sections in Iran.

area (Baghbani, 1997), the age can be referred to as Asselian to Sakmarian age (Table 1).

Kubergandian- Murgabian strata:

The Middle Permian sequence in Azarbaijan is composed of grey to dark grey, medium- to thick-bedded bituminous fossiliferous limestone. Some layers of shale and marl are present.

In some parts of the sequences, chiefly the upper ones, nodules of chert are irregularly distributed. The fossil content of Kubergandian and Murgabian is dominated by smaller foraminifers, fusulinids, algae, brachiopods, bryozoans, crinoids, bivalves, corals and gastropods. The analysis of fusulinid and smaller foraminifer assemblages suggest Kubergandian to late Murgabian stages.

These sequences are underlain by clastic deposits without visible angular unconformity, but there is a significant hiatus between them.

Bioclastic packstone and mudstone are the most common microfacies in the area. Microfacies and lithologic characteristics of stratigraphic sections indicate deposition within a homoclinal ramp platform, including tidal flat, lagoon, bar and basin.

Comparing these carbonate sequences with other Kubergandian and Murgabian sequences in Iran. They correlate with Ruteh Formation in Alborz (Asserto, 1963), Unit A in the Ali Bashi section (Stepanov *et al*.,1969), the lower part of Jamal Formation in central Iran (Stocklin *et al*.,1965) and the Surmaq Formation in Abadeh (Iranian- Japanese Research Group, 1981).

Midian and Dzhulfian strata

The Middle Permian limestone is overlain by Midian and Dzhulfian strata which have two completely different aspects. In the northern part, it consists of dark grey to grey bitominous, thin to medium fossileferous limestone, in some parts, especially in the lower parts of the sequences, layers of shale and marl increase, and bounds of chert are present. Bioclastic wackstone and packstone are very common microfacies throughout the sequences in Midian and Dzhulfian time. Smaller foraminifers and small fusulinids are very common.

Other fossil contents include algae, brachiopods, corals, gastropods, (mostly *Bellerophon*), crinoids and bryozoans. The passage of Middle Permian to Midian and Dzhulfian strata is transitional and without noticeable lithologic changes. These sequences are comparable with the Nesen Formation in Alborz (Glaus , 1964), upper part of Jamal Formation, Abadeh and lower part of Hambast Formation in Abadeh area, and units B, C, and D in Ali Bashi section.

In the southern flank of Azerbaijan, Permian sequence of Midian-Dzhulfian age starts with a thick igneous sill and bauxite layers. The age of this part of Permian sequence is Midian.

The Dzhulfian stage in the mentioned area is represented by a sequence of shale, sandstone shaley and clayey limestone with Dzhulfian foraminifers.

The analysis of lithology and microfacies of Midian to Dzhulfian limestone indicates a ramp platform including tidal flat, instricted lagoon, bar and basin.

Dorashamian sequence

A sequence of grey, green to brown shale, marl and red nodular limestone with a thickness about 22 m are exposed on the top of Permian sequence in the north flank of Azerbaijan. Its fossil content include smaller foraminifers, cephalopods, brachiopods, crinoids, conodonts and corals. This sequence was correlated with the Ali Bashi Formation in Ali Bashi Mountain (Teichert *et al*., 1973). Foraminiferal content is not a typical Dorashamian fauna compared to those reported from Tethyan realm so far. The Dorashamian strata is comparable with upper part of Hambast Formation in Abadeh area. On the basis of cephalopods, conodonts, a Dorashamian age can be assigned.

Conclusions

The lower Permian clastic sediment in NW Iran formed in a deltaic and meandering system and Middle to Late Permian carbonate deposits formed in a shallow platform environment. Biogenic, dark to grey limestone produced by benthic organisms, predominantly foraminifers, algae, brachiopods, crinoids, bryozoans, corals, bivalves and gastropods. On the basis of fossils assemblages the age of limestone sequence is Kubergandian to Dorashamian stages. In the southern flank of Azerbaijan, there was a change in sedimentary regime during Midian stage, instead of deposition of limestone, a sequence of bauxite, laterite and semi- intrusive sill were formed.

Three major transgressive cycles can be recognized within the Permian succession in NW Iran. The clastic deposits of Asselian to Sakmarian represents the first cycle that started in early Permian. The second phase starts in Kubergandian and extended into the end of Midian.

The third events occurred at the base of Dzhulfian and lasted to Dorashamian in some area.

Acknowledgment

The authors wish to thank Professor Daniel Vachard for his assistance in the identification of foraminifera.

References

Alavi, M. 1991. Tectonic Map of the Middle East, 60 pp.,Geol. Surv., Iran.

Altiner, D., Baud, A., Guex, Y. and Stampfli, G. 1980. La limite Permien-Triass dans quelques localites du Moyen- Orient: rechereches stratigraphiques et micropaleontologiques. Riv. Ital. Paleon.Start., 55(3), 683- 714.

Asserto, R. 1963. The Paleozoic Formations in central Elborz (Iran). Riv. Ital. Paleon. Strati., 69(4), 503-543.

Baghbani, D. 1996. Lithostratigraphy and biostratigraphy of Abadeh, Shareza and Julfa areas. PH.D., thesis, Open University, 168p. (In Farsi)

Baghbani, D. 1997. Correlation Chart of Selected Permian strata from Iran.Permophiles, No30,24-25.

Berberian ,M. and King, P.C.G. 1980: Towards a paleogeography and tectonic evolution of Iran. Canadian J. Earth Science. 18, 210-265.

Bozorgnia, F., 1973. Paleozoic forminiferal biostratigraphy of central and east Alborz Mountain, Iran. National Iranian oil company. Geological Laboratories publication. No. 4, 185 P.

Davydov, V, I., and Arefifard, S., 2007. Tectonics and Paleogeographic applications of peri-Gondwanan Permian fusulinid fauna from Kalmard Region, Easy-Central Iran, Permophiles, 49, 13-24.

Glaus, M., 1964 . Trias und Oberperm in zentralen Elburs (Persien).Eclogae geol.Helv., 57/2 , 497- 508.

Jenny- Deshusses, C., 1983. Le permina de l'Elbourz central et oriental. (Iran): stratigraphie et micropaleontology (foraminifers et algues). These uni. Genev. No 2103, 214p.

Jenny, J. and Stampfli, G. 1978: Lithostratigraphie du Permien de l'Elbourz oriental en Iran.Ecolog. Geol. Helv., 71(3), 551-580.

Leven, E., Ja. and Taheri, A. 2003. Carboniferous – Permian stratigraphy and fusulinids of east Iran.Rivista Italiana di Paleont. Strati., 109(3), 499-515.

Leven, E., Ja and Gorgij, M.N., 2007. Fusulinids of the Khan Formation (Kalmard region, eastern Iran) and some problems of their paleobiogeography, Russian Journal Of Earth Scinces, V. 9, 1- 10.

Partoazer, H. ,1995: Permian deposites in Iran. Treatise on the geology of Iran. Geol. Sur. Iran.22, 1-133, (in Farsi).

Rieben, H. 1934: Contribution a geological de l" Azerbeidjan persan, D. Soc. Neuchatel. Sci, Nat., 59, 19-144.

Stepanov, L. D., Gloshani, F. and Stocklin, J. 1969: Upper Permian and Permian- Triassic boundary of in north Iran. Geol. Sur. Iran. Re. n. 16, 72 p . + XV plate.

Taraz, H., Gloshani, F., Nakazawa, K., Shimuz, D., Bando, y., I shii, K., M.,Okimura, Y., Sakagami, S., Nakumura, K. and Tokuoka, T.

Iranian- Japanese Reserch Group. 1981. The Permian and Lower Triassic system in Abadeh region, central Iran. Memoirs of the Faculty of science, Kyoto University. Z, pp.61-133.

Stocklin, J., 1968: Structral history and tectonics of Iran. Am. Ass. Pet. Geol. Bull. 52, 1229-1258.

Stocklin, J., Efterkharnezhad, J. and Hushmand Zadeh, A. 1965 Geology of the Shotori range (Tabas area, east Iran). Geo. Sur. Iran. no. 3, 69p.

Teichert, C., Kummel, B. and Sweet, W., 1973. Permian – Triassic strata, kuh-e-Ali Bashi, northwestern Iran. Bull. Mus. Com. Zool., 145 (8), 359 – 47.

Search for the Permian-Triassic boundary in central Peninsular Malaysia: Preliminary report

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The Permian–Triassic boundary (PTB), despite decades of searching, has not been located precisely to date in Malaysia. We are currently focusing our search for the PTB in central Peninsular Malaysia as part of our contribution to the geological heritage scheme launched by the National University of Malaysia (Universiti Kebangsaan Malaysia) and as a contribution to the new IGCP 572 Project "Restoration of marine ecosystems following the Permian–Triassic mass extinction: Lessons for the present".

In central Peninsular Malaysia, there are several limestone karst hills which have yielded data indicating the possible presence of the PTB. Among them, Gua Bama has now emerged as the most prospective site, as it displays strata ranging from Upper Permian to Triassic. Its lithofacies is a thickly to massively bedded succession of limestones, with occasional tuffaceous layers.

Upper Permian colaniellid foraminifers are known from the base of Gua Bama (Lim and Abdullah, 1994). The Triassic nautiloid *Sibyllonautilus bamaensis* was recently reported from the top of the hill, confirming the presence of the Triassic (Sone *et al*., 2004). Thus, the Gua Bama limestone hill must include the Permian–Triassic transition. The nautiloid-bearing deposit includes abundant sponges and algae, which are extremely rare in the Early Triassic in general, and therefore we consider the uppermost part of the Gua Bama strata to be most likely Middle Triassic in age.

In addition to foraminifera, conodonts, brachiopods, and corals have recently been discovered from the basal part of Gua Bama. The conodonts include *Hindeodus typicalis* (Sweet), which is known to straddle the PTB, ranging from the upper Changhsingian through to the lower Induan (Lower Triassic) (e.g. Jiang *et al*., 2007; Yin *et al*., 2001) and gondolellids that indicate a probable Changhsingian age. The brachiopods include *Dongpanoproductus*, known elsewhere only from the upper Changhsingian of South China (He *et al*., 2005). We therefore interpret the lowest part of Gua Bama to most likely be of late Changhsingian age. This implies that the PTB is located some short distance above the conodont-brachiopod horizons. We are currently carrying out additional bed-by-bed systematic sampling and anticipate locating the PTB at Gua Bama in the near future.

At the base of Gua Bama, passage beds from the underlying shale (which extends down to the so-called Lyttoniid Shales of Muir-Wood, 1948) to the Gua Bama limestone are exposed (Leman, 1995; Sone *et al*., 2004). The shales often yield abundant brachiopods, which may include more than one fauna and were collectively interpreted to possibly range from Roadian to Wuchiapingian in age (Campi *et al*., 2002). However, our new biostratigraphic data from the lower part of Gua Bama implies that some brachiopod-bearing shales nearby Gua Bama may be as young as Changhsingian in age.

In addition, another limestone hill, Gua Sei located about 3 km east of Gua Bama, yields the conodonts *Isarcicella isarcica* and *Hindeodus parvus*, indicative of a basal Triassic age (Metcalfe, 1995). So far, it is uncertain whether the PTB is also present in Gua Sei. However, Paleozoic productoid brachiopods previously reported from Gua Sei imply the presence of the PTB. Our recent field survey in Gua Sei confirms that there are some

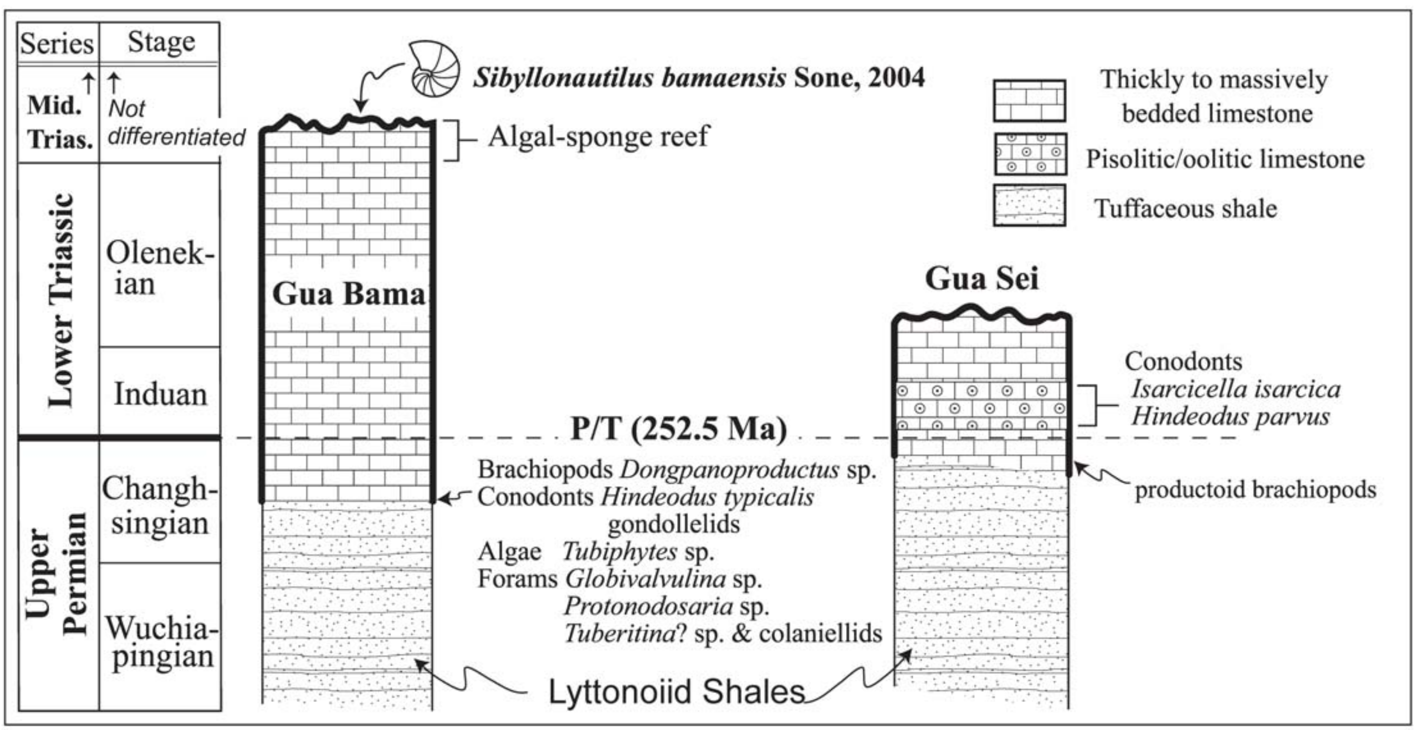

Fig. 1. Correlation chart between Gua Bama and Gua Sei (modified from Sone *et al*., 2004). PTB isotopic age from Mundil *et al*. (2004).

strata continuing below the conodont horizons, which may extend down into the Permian.

Furthermore, approximately 25–30 km east of Gua Bama and Gua Sei, there is another limestone unit called the Kenong limestone, which consists of some six major hills. As a whole, it also demonstrates a stratigraphic range from Wuchiapingian to Anisian (Middle Triassic) (Fontaine *et al*., 1994), yet the exact locality for the PTB is not known. All Gua Bama, Gua Sei, and Kenong limestones constitute parts of the same carbonate platform of the Late Permian–Triassic, which developed over a shallow-water basin of the East Malaya Terrane with Cathaysian affinity.

We are currently seeking co-researchers to undertake radio-isotopic dating (zircon U-Pb) of tuff layers close to the PTB and stable carbon and other isotopic analyses of carbonates for episodic environmental change across the PTB. We would appreciate hearing from any potential collaborators.

References

Campi, M.J., Shi, G.R., Leman, M.S., 2002. The *Leptodus* Shales of central Peninsular Malaysia: distribution, age and palaeobiogeographical affinities. Journal of Asian Earth Sciences, 20, p. 703–717.

Fontaine, H., Amnan, I., Khoo, H.P., Tiên, N.D. Vachard, D., 1994. The *Neoschwagerina* and *Yabeina-Lepidolina* zones in Peninsular Malaysia, and Dzhulfian and Dorashamian in Peninsular Malaysia: the transition to the Triassic. Geological Paper Volume 4, Geological Survey of Malaysia, Ipoh, 175 pp.

He, W.H., Shen, S.Z., Feng, Q.L., Gu, S.Z., 2005. A late Changhsingian (Late Permian) deepwater brachiopod fauna from the Talung Formation at the Dongpan Section, southern Guangxi, South China. Journal of Paleontology, 79, p. 927–938.

Jiang, H.S., Lai, X.L., Luo, G.M., Aldridge, R., Zhang, K.X., Wignall, P., 2007. Restudy of conodont zonation and evolution across the P/T boundary at Meishan section, Changxing, Zhejiang, China. Global and Planetary Change, 55, p. 39–55.

Leman, M.S., 1995. The significance of Permian volcanic activity towards faunal development in Padang Tengku area, Pahang. Sains Malaysiana, 24, p. 17–28.

Lim, K.K., Abdullah, N.T., 1994. Development of Permian volcaniclastics-limestone succession at Gua Bama, Pahang Darul Makmur. Warta Geologi, 20, p. 243–244.

Metcalfe, I., 1995. Mixed Permo-Triassic boundary conodont assemblages from Gua Sei and Kampong Gua, Pahang, Peninsular Malaysia. Courier Forschungsinstitut Senckenberg, 182, p. 487–495.

Mundil, R., Ludwig, K.R., Metcalfe, I. Renne, P.R., 2004. Age and timing of the Permian mass extinctions: U/Pb dating of closed-system zircon. Science, 305, p. 1760–1764.

Muir-Wood, H.M., 1948. Malayan Lower Carboniferous Fossils. British Museum (Natural History), London, 118 pp, 17 pls.

Sone, M., Leman, M.S. Metcalfe, I., 2004. Triassic nautiloid *Sibyllonautilus* from Gua Bama, Peninsular Malaysia and its regional stratigraphic implications. Alcheringa: An Australasian Journal of Palaeontology, 28, p. 477–483.

Yin, H.F., Zhang, K.X., Tong, J.N., Yang, Z.Y., Wu, S.B., 2001. The Global Stratotype Section and Point (GSSP) of the Permian-Triassic boundary. Episodes, 24, p. 102–114.

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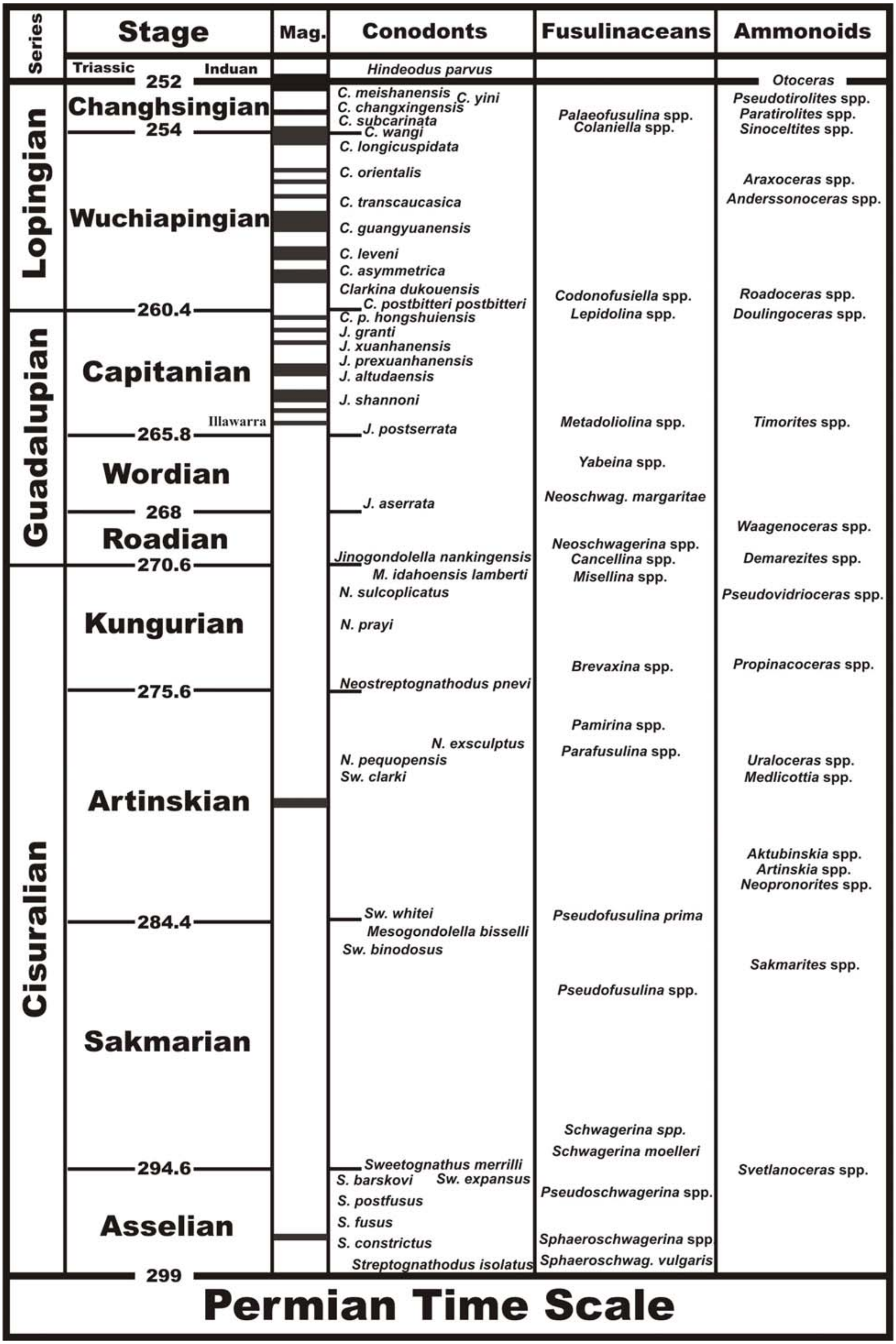

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ANNOUNCEMENTS

ICOS 2009

University of Calgary, Calgary, Alberta, Canada

The second International Conodont Symposium will be held in conjunction with the annual Pander Society meeting at the University of Calgary during July 2009. General information is provided below, but more detailed information will be provided on a website that will go live on July 1, 2008. Please check http://www.ucalgary.ca/conodont after July 1 2008 or contact Charles Henderson (Chairman of ICOS 2009) via email at charles.henderson@ucalgary.ca or cmhender@ucalgary.ca.

General Meeting Dates: July 12-17, 2009

- Icebreaker on University Campus: Sunday evening July 12, 2009
- Sessions at a Department of Geoscience theatre: July 13-14, 2009
- Workshops or day trip to Royal Tyrrell Museum of Palaeontology; July 15
- Sessions at a Department of Geoscience theatre; July 16-17, 2009
- Western style banquet; Thursday evening July 16, 2009 at either Heritage Park or Kananaskis Guest Ranch

Fieldtrips: (in preparation)

- A pre-meeting trip is still to be determined by the Chief Panderer
- Burgess Shale day trips; Saturday July 11 and July 18
- 3-4 day post-conference Rocky Mountain fieldtrip with overnights in the resorts of Banff and Jasper; mostly latest Devonian to Early Triassic units will be viewed with collecting opportunities including the Permian-Triassic boundary. There will also be a stop to see the glaciers on the Icefields Parkway.

Accommodation:

- A block of rooms have been reserved on campus; these are apartment style.
- A small block of rooms have been reserved at Village Park Inn close to campus
- More information will be provided by links in our website
- Room reservations and registration will be completed by Conference and Special Events Services on Campus

Getting to Calgary:

- There are two daily flights on Air Canada to Calgary from Frankfurt and London
- There are daily flights from Sydney, Hong Kong, Shanghai, Nanjing connecting through Vancouver
- There are numerous direct or connecting flights from the United States, especially from Chicago, Denver, Los Angeles, Minneapolis, Seattle and San Francisco.
- Direct flights from most major cities in Canada.

The University and City Attractions:

- The University has over 25,000 full-time students and has excellent facilities for our meeting including accommodation
- Calgary has a population of nearly 1.1 million and is the gateway to the southern Canadian Rocky Mountains
- Calgary is home of the greatest outdoor show on earth – the Calgary Stampede (July 3-12, 2009)

Possible Sessions:

- 2009 is the 100th anniversary of the discovery of the Middle Cambrian Burgess Shale lagerstatten; a session on early vertebrate evolution including conodonts would be appropriate
- 2009 marks the 200th birthday of Charles Darwin and 150th anniversary of publication of the Origin of Species so a session on "evolutionary tempo and mode of Class Conodonta" would be in order
- Conodonts are increasingly used in geochemical studies and I would propose a session on "high resolution stratigraphy integrating geochemistry, geochronology and biostratigraphy"
- A session on taxonomic philosophies that focuses on what constitutes a genus and species in the biological world of conodonts is being considered
- A session on Permian conodont taxonomy and correlations will be followed by a Subcommission on Permian Stratigraphy Bussiness Meeting.
- There will be a facility for workshops with microscopes including dual-viewing with video monitor
- The Scientific committee and I will be asking the community to make suggestions and start inviting speakers; if you have a session in mind please contact Charles Henderson by email

The composition of the scientific committee and many more details will appear on our website soon.

Charles Henderson, Chairman ICOS 2009

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