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PALEONTOLOGY

Using conodont elements to distinguish Permian-Triassic boundary disconformity near Haftad Gholleh, central Iran

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ABSTRACT

The present study focuses on the stratigraphy of the Permian-Triassic boundary in the Haftad Gholleh area in eastern Arak and north of Mahallat,located in central Iran. This boundary of erosional unconformity or disconformity and as in other Iranian sequences related to the Permian period, contains dolomitic limestone and shale and sandstone disconformably located below the Triassic sequence. A detailed measured stratigraphic section has provided conodonts from the Permian–Triassic boundary (PTB) sequences in the area being studied. Three conodont areas have been recognied which place the PTB in this section by precise biostratigraphy. One of the most upper Permian sequences belongs to the Guadalupian period. The Triassic sequence consists of vermiculate limestone layers with coloured shale inter beds belonging to the Early Triassic period; unconformity at the Permian-Triassic boundary therefore represents a hiatus of about 10 million years.

Key words: Conodont, Haftad Gholleh, Permian-Triassic, stratigraphy.

RESUMEN

El presente estudio se enfoca en la estatigrafía del Límite Pérmico-Triásico en el área de Haftad Gholleh, al este de Arak y al norte de Mahallat, centro de Irán. Este límite de discordancia erosiva, al igual que en otras secuencias iraníes relacionadas al período Pérmico, contiene calizas dolomías, esquistos y areniscas discordantes localizadas debajo de la secuencia Triásica. En una medida estratigráfica detallada del área de estudio se encontraron conodontas del Límite Pérmico-Triásico (PTB, por sus siglas en inglés). Se reconocieron tres áreas de conodontas, lo que ubica esta sección del PTB como bioestatigráfica precisa. Una de las secuencias superiores del Pérmico pertenece al período Guadalupiense. La secuencia Triásica consiste en calizas con capas vermiculitas coloreadas de esquisto que pertenecen al período Triásico temprano. La discordancia del Límite Pérmico Triásico, entonces, representa un lapso cercano a los 10 millones de años.

Palabras clave: Conodont, Haftad Gholleh, Permian-Triassic, stratigraphy.

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Introduction

The end of the Palaeozoic period and the beginning of the Mesozoic saw the greatest of all extinctions in the Phanerozoic causing mass mortality in the marine environment (up to 96% of species, 83% of genera and 55% of families) (Sepkoski, 1990; Raup, 1991) and a nearly equally large loss of life on land (Erwin, 1993). Important P/T boundary sections are located in Iran (NW, NE and Central Iran, Alborz region, belonging to the Iranian Plate, and the Zagros fold belt, belonging to the Arabian Plate), Oman, Southern China, Japan, Pakistan, Afghanistan, Turkey, Greenland, Austria, Italy, South Africa and Antarctica. The Permian sea's last regression period occurred at the end of this system, which is why the upper boundary of the Permian strata in Iran is commonly discontinuous but has a type of parallel unconformity (disconformity). Nevertheless, evidence of continuous sedimentation from the Permian to Triassic been reported in many regions of Iran (Julfa, Kandovan, Amol, Shahreza and Abadeh). The recommended, but somewhat controversial, chronostratigraphical Permian scale is summarised here, according to Jin et al., (1997) and Wardlaw (1999), but correlated with Leven's alternative

classification (Leven, 1992; Kotlyar and Pronina, 1995). The names Midian (eventually Abadehian) for Capitanian, Dzhulfian for Wuchiapingian and Dorashamian for Changhsingian have been preferred concerning Iran's stratigraphy (Fig. 1).

Due a lack of macroscopic and microscopic fossils, especially Foraminifera, some uncertainties in conodonts' biostratigraphy have not been studied and clarified. This research thus attempts to study conodonts, the disconformity interval and the Permian-Triassic boundary's paleoecology in the area being studied.

2. Geological setting

The Haftad Gholleh area is a small part of central Iran, located between volcanic belts at Urmia Kerman Sanandaj Sirjan. The Soltanieh Dolomites, Zagun, Lalun, Mila and Permian sequence deposits in the region are known as Palaeozoic facies. Soltanieh grey dolomite is overlain by a green to red shale formation containing little sand and mica, becoming converted locally into fine-grained sandstone. Shale thickness varies from 100 to 200 metres (Zagun formation). Overlying the shale are about 50 metres of dense, hard lightcoloured quartzite sandstone which has been assigned to the Lalun Formation. This formation is overlain by light to dark dolomite containing coral, sand and crinoids, having less than 100 m thickness.The dolomite gradually changes from bottom to top from light grey to light green limestone, bearing trilobite fragments; such dolomite and limestone are assigned to the Mila Formation. This different kind of facies (Permian) is located directly on older formations. No Ordovician to Carboniferous sequences thus occurred in the area being studied. Permian deposits are mainly dolomite. In some locations, the base consists of Lalun sandstone. The base of the Permian deposits in some parts is calcareous shale associated with red sandstone and conglomerate. Permian lithology mainly consists of thick bedded dolomite (light grey) (Fig. 2).

Lithostratigraphy

The Upper Permian sedimentary sequence in the area being studied included limestone continuing with dolomite; limestone has been assigned to the Jamal Formation. All deposits were isoclinal, indicating marine transgression in the studied area (Permian). One sequence, having several meters of shale and sandstone, lacking fossils, had such adistinctive colour that it could be applied as a key bed. There were several metres of thin to medium-bedded Claraia vermicular limestone inter-bedded with coloured shale above the key bed; this belonged to the Early Triassic, based on a study of conodont fragments. It has thus been concluded that Early Triassic deposits in the study area consisted of two parts: clastic (lower part) and carbonate (upper part), generally being equivalent to the Shotori Formation. The carbonate part included dolomite inter-bedded with coloured shale. There were few fossils in the sequence. Based on the stratigraphic situation, lithological similarities and lithocorrelation, it has been assigned to the Anisian age Shotori Formation (Figs. 3 and 4).

Biostratigraphy

Apart from the studied section's base part (related to the Permian rock sequence) having few benthic foraminifera, other layers in the studied rock sequence were very poor in terms of fossil content (foraminifera). Biological biozoning studies were thus based on conodont elements in the studied section's complete rock sequence. elements in the studied section were biozoned according to standard Kozur biozonation (1977). Conodont elements known from Permian time would be as follows: *Hindeodus minutes, Streptognathodus barskovi, Sweetognathus whitei, Neostreptognathodus pequopensis, Hindeodus excavates and Merrillina divergens.*

Conodont elements known to be related to the Triassic age would be as follows: *Prioniodella Prioniodellides, Hindeodella multihamata, Hindeodella nevadensis, Lonchodina nevadensis, Hindeodella triassica, Ligonodina triassica, Diplodella lautissima, Pachycladina oblique, Hadrodontina anceps,*

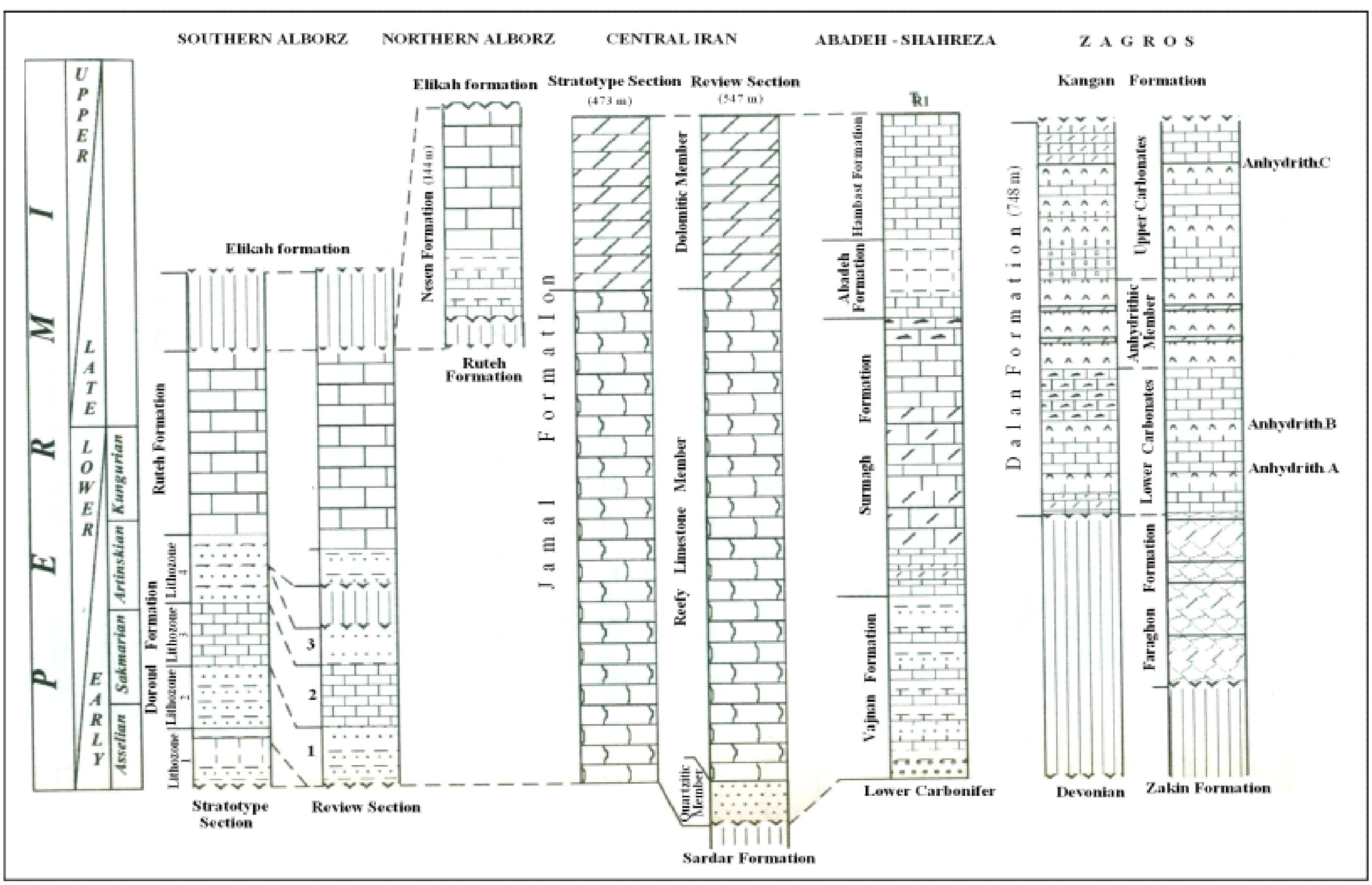

Figure 1. Permian-Triassic boundary in different areas of Iran (Aghanabati, 2004)

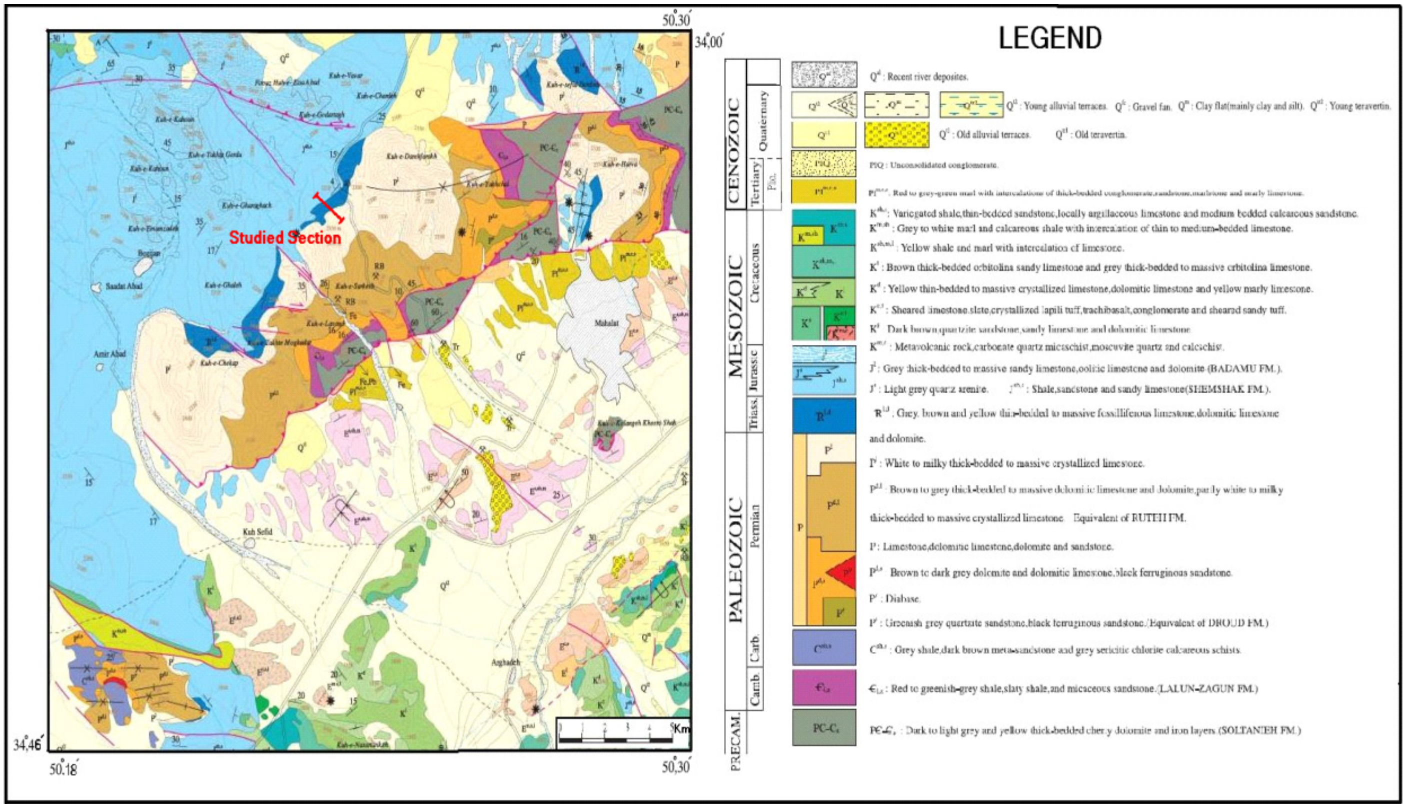

Figure 2. The studied area's geological setting

Ellisonia triassica, hibardella subsymmertica, Parachirognathus geiseri, Prioniodella decrescens, Enantiognathus bitortus, Chirognathus sp., Xaniognathus sp., and Anchiognathudos sp. (Fig. 5).

Pachycladina oblique (Staesch), posterior view, X90, early Triassic (early Triassic) - 1

Sweetognathus whitei (Rhodes), lateral view, X80, middle Permian (Guadalupian) - 2

Hindeodella nevadensis (Muller), lateral view, X80, early Triassic (early Triassic) - 3

Hindeodus minutes (Ellison), lateral view, X80, upper Permian - 4

Hindeodella multihamata (Huckriede), lateral view, X95, middle Triassic (Anisian) - 5

Chirognathus sp., lateral view, X80, early Triassic (Scythian) - 6

Neostreptognathodus pequopensis (Behnken), outer view, X80, upper Permian - 7

Ligonodina triassica (Muller), lateral view, X80, early Triassic (early Triassic) - 8

Enantiognathus bitortus (Bender), outer view, X120, early Triassic (early Triassic) - 9 - 10

Hindeodella triassica (Muller), lateral view, X80, middle Permian - lower Triassic - 11

Hindeodus excavatus (Behnken), lateral view, X150, middle Permian (Guadalupian) - 12

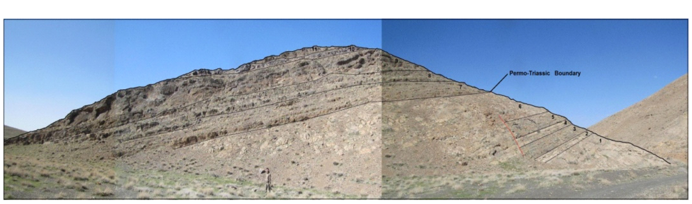

Figure 3. Studied section near Haftad Gholleh

Streptognathus barskovi (Kozur), lateral view, X80, middle-upper Permian - 13

Xaniognathus sp., lateral view, X80, lower Triassic - 14

Prioniodella prioniodellides (Tatge), lateral view, X120, middle Triassic (Anisian) - 15

Lonchodina nevadensis (Muller), lateral view, X110, early Triassic (early Triassic) - 16

Merrillina divergens (Bender & Stopple), lateral view, X80, (Guadalupian) - 17

Parachirognathus geiseri (Clarck), lateral view, X95, (early Triassic - Anisian) - 18

Ellisonia triassica (Muller), lateral view, X80, early Triassic (early Triassic). - 19

Following precise paleontological studies, including conodont recognition and taxonomy regarding samples from the studied section, each fossil's biozone was identified on the Table showing the extent of fossils, based on their presence in each rock sample. Two assemblage zones and one acrozone for Permian deposits and two assemblage zones for Triassic deposits were identified based on the emergence, decline and expanding stratigraphic accumulation index for conodonts having known elements.

4.1. Neostreptognathodus pequopensis - Hindeodus minutes assemblage zone

The start of this base's biozone was consistent with the occurrence of Neostreptognathodus pequopensis conodont genus and species and its end with the occurrence of Merrillina divergens conodont genus and species. Conodont elements contained in this biozone were assigned to the following: Hindeodus minutes, Hideodus excavatus, Sweetognathus whitei, Hindeodella triassic and Neostreptognathodus pequopensis.

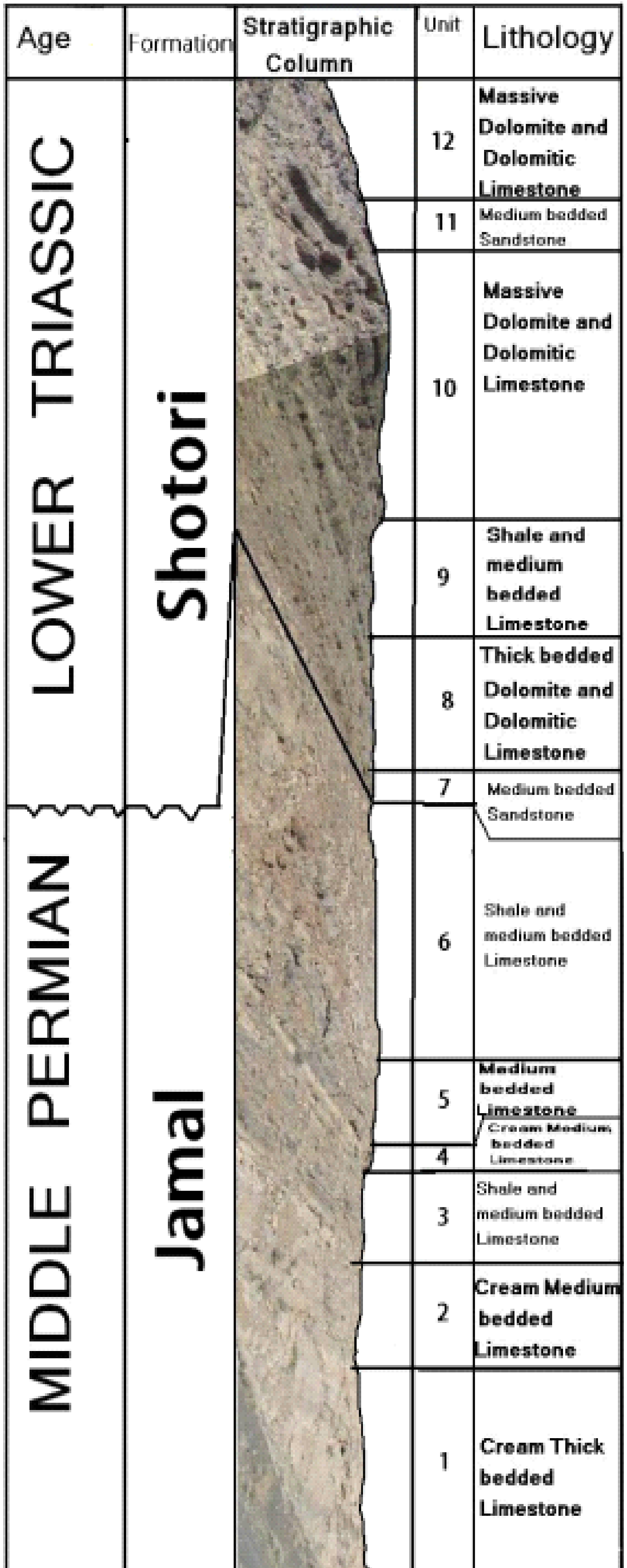

Figure 4. Stratigraphic column of the section being studied near Haftad Gholleh

Biozone age was Artin-skian, based on the standard Kozur biozoning (1977), proposed as being equal to the Neostreptognathodus pequopensis biozone.

4.2. Merrillina divergens acrozone

The base of this biozone started with Merrillina divergens and terminated with M. divergens. Conodont elements contained in this biozone were identified as follows: *Merrillina divergens, Hindeodella triassic, Hideodus excavates.*

This biozone's age, according to conodonts, was Guadalupian. According to standard Kozur biozonation (1977) this zone was the biozone equivalent of *Merrillina divergens.*

4.3. Lonchodina nevadensis - Ellisonia triassica assemblage zone

The base of this biozone index was the presence of *Lonchodina nevadensis and Ellisonia triassica* and the top of the biozone consisted of *Pachycladina oblique* and *Hadrontina anceps.* Conodonts from elements contained in the biozone were assigned to the following: *Prioniodella prioniodellides, Hindeodella multihamat, Hindeodella nevadensis, Lonchodina nevadensis, Hindeodella triassica, Ligonodina triassica, Diplodella lautissima, Pachycladina oblique, Hadrodontina anceps, Ellisonia triassica, Hibardella subsymmertica, Parachirognathus geiseri, Prioniodella decrescens, Enantiognathus bitortus, Chirognathus sp. and Xaniognathus* sp.

According to conodonts, this biozone's age was Scythian. Based on Kozur's standard biozones (1997), this biozone was the equivalent of the *Isarcicella isarcica* biozone.

4.4. Hindeodella multihamata - Prioniodella Prioniodellides assemblage zone

This biozone included conodonts such as *Diplodella lautissima, Prioniodella decrescens, Hindeodella multihamata, Prioniodella Prioniodellides, Hindeodella triassica* and *Xaniognathus* sp.

The identified conodonts indicated that it was Anisian (Fig. 5).

Conclusions

The Permian-Triassic boundary located near Haftad Gholleh is an erosional unconformity or disconformity, as in other parts of Iran, where

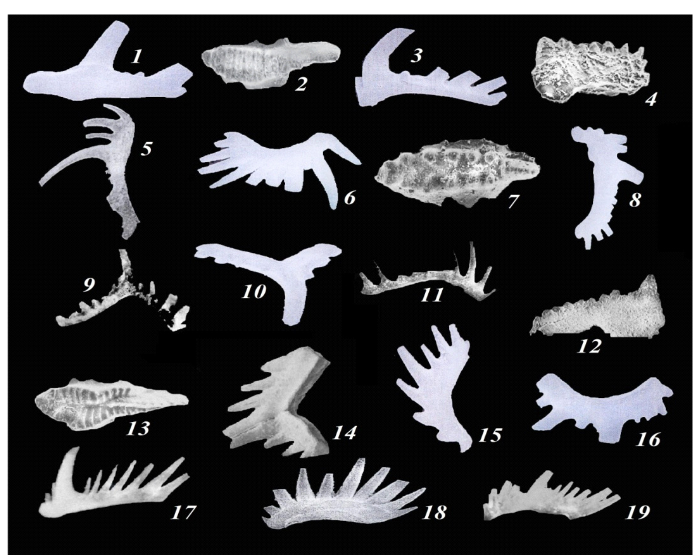

Figure 5. Conodont elements in the studied area

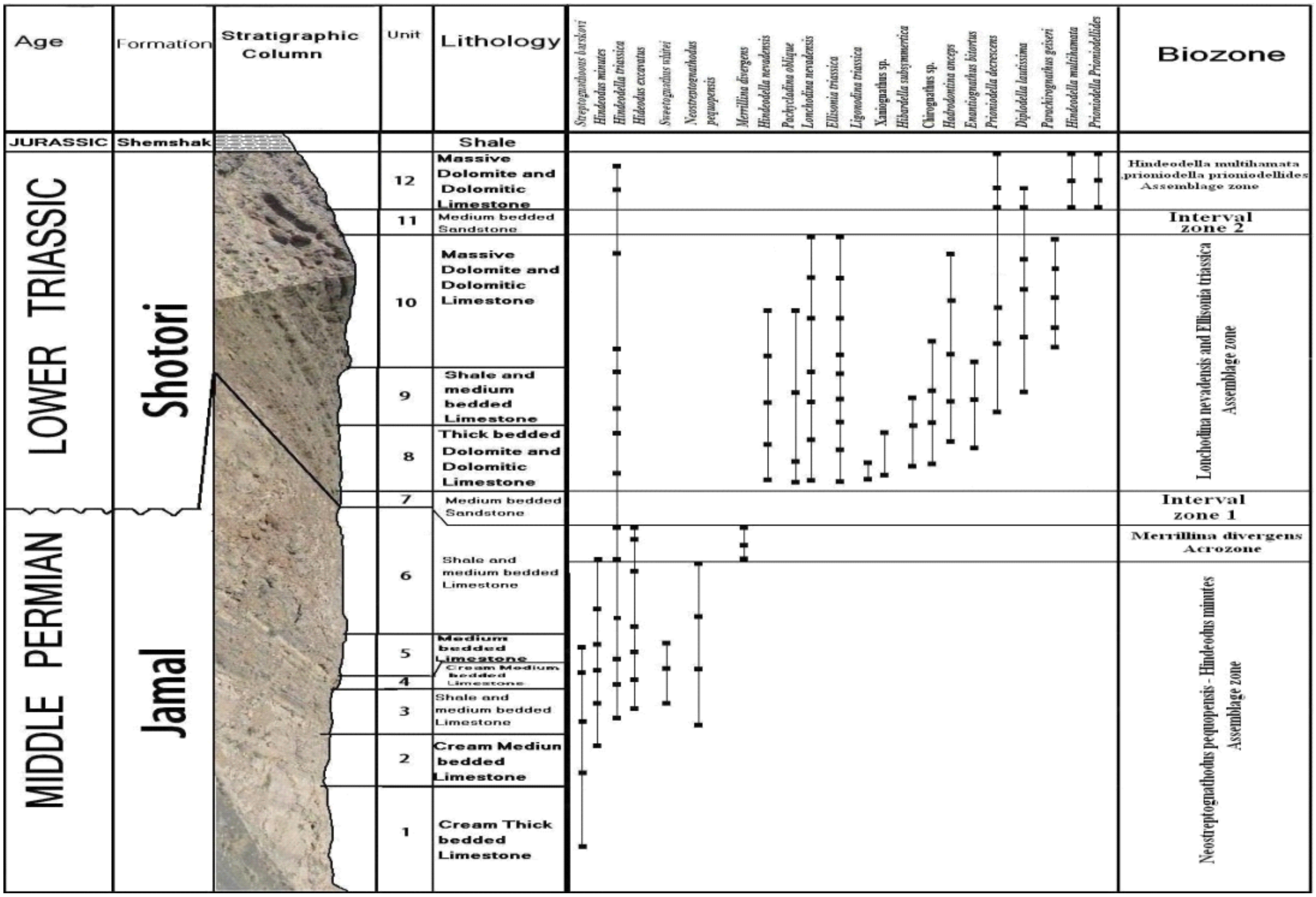

Figure 6. Distribution and biozonation of conodonts from the Permian-Triassic boundary of the area being studied

Permian sequences contain dolomitic limestone, shale and sandstone situated below the Triassic sequence at a disconformity.

Based on emergence, decline and expansion of index conodonts, one assemblage zone and one acrozone (Permian) and two assemblage zones (Triassic) were recognised as follows:

- *Neostreptognathodus pequopensis-Hindeodus minutes* assemblage zone (Artinskian);

- *Merrillina divergens acrozone* (Guadalupian);

- *Lonchodina nevadensis* and *Ellisonia triassica* assemblage zone (early Triassic); and

- *Hindeodella multihamata, Prioniodella prioniodellides* assemblage zone) Anisian).

The age of the uppermost Permian sequence thus belonged to the Guadalupian era. The Triassic sequence consisted of vermiculate limestone layers with coloured shale inter-beds that belonging to the Scythian era.

The conodont fauna indicated that the Permian-Triassic sequence from the studied area was deposited in a warm shallow sea having normal salinity. Most conodonts in the studied area were euryhaline (i.e. able to tolerate a wide range of salinity). Red clastic sediments at the base of the lower Triassic indicated that an erosion period started after sedimentation in the mid-Permian and has been dominant on land in the region. Disconformity thus occurred at the Permian-Triassic boundary in the studied area.

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