

# **Devonian to Basal Permian Lithostratigraphy in Southwestern Hakkari: A Perspective from Northern Arabian Mixed Carbonate-Siliciclastic Platform\***

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## **Abstract**

The Middle Devonian-Lower Carboniferous succession in the Amanos Mountains to the west and in the Hakkari area to the east of the Hazro High are known as the Zap Group, divided into the Yiginli (Middle-Late Devonian) and Köprülü formations (Late Devonian-Early Carboniferous). The Group is overlain by the Late Permian Gomanibrik Formation. The thickness of the Yiginli Formation, in the Hakkari-Çukurca area, ranges between 200 and 300 m. The vertebrate and microflora remains indicate a Famennian age for the top of the Yiginli Formation. Brachiopod samples recently collected from the Zap River Valley area allow to establish an Upper Givetian age for the upper middle part of the Yiginli Formation which was until now considered as Famennian on the basis of its micropaleontological contents. In particular, the presence of Atrypids excludes an age younger than Lower Frasnian.

Studied brachiopods come from shell concentrations of various clayey-silty levels. The Köprülü Formation represents a variety of marine environments ranging from agitated shallow marine to muddy shelf conditions – below fair weather wave base – and then a return to more restricted shallow marine facies in the upper part. The Köprülü Formation was measured and investigated along the Zap 1 and Zap 2 sections located on the north-east of Köprülü village, 8 km northwest of Cukurca. The Köprülü Formation can be subdivided into three new members. The lower member is composed of dark to grayish limestone and sandy limestone representing the transgressive phase covering the continental deposits of the Yiginli Formation. The corals described here were collected in this member. The coral assemblage is mainly composed of small non-dissepimented solitary corals belonging to the genera *Rotiphyllum*, *Zaphrentes*, cf. *Gorizdronia*, gen. et sp. indet. and *Amplexizaphrentis*, including a new species, *A. zapense*, and the dissepimented coral *Caninia* aff. *cornucopiae*. The middle member is composed of thinly laminated dark grey calcareous shales and siltstones; several sandstone layers are also intercalated. The upper part of this middle member is characterized by carbonate concretions embedded in sandy limestone. The fossils, including bivalves are well preserved in this member. The

myalinid bivalves, with a few posidonid bivalves have been observed in dark grey calcareous shale horizons. The upper member is dominated by massive grayish sandy/dolomitic limestone with some dark shale intercalations.

### **Selected References**

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# Devonian to Basal Permian Lithostratigraphy in Southwestern Hakkari: A Perspective from Northern Arabian Mixed Carbonate–Siliciclastic Platform

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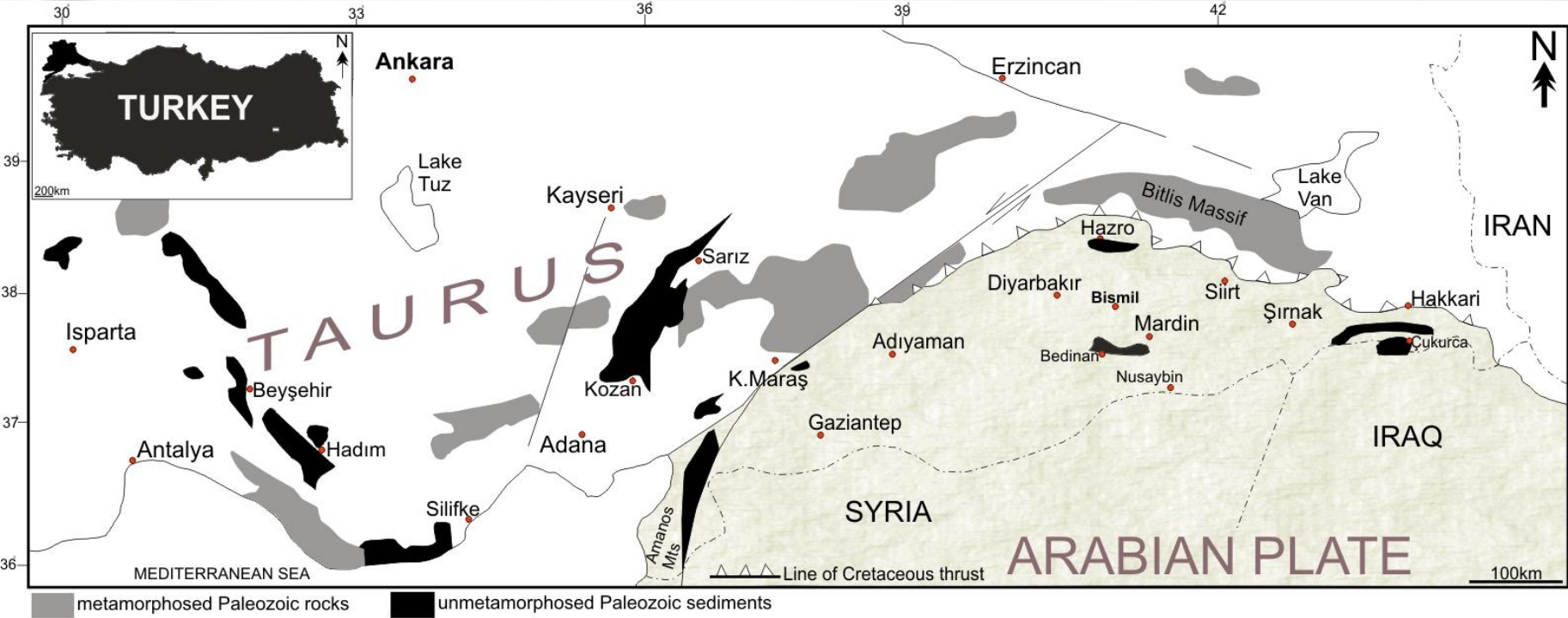
**Rémy Gourvennec**

*CNRS Domaines Oceaniques IUEM, Université de Bretagne Occidentale, Brest, France.*



**Julien Denayer**

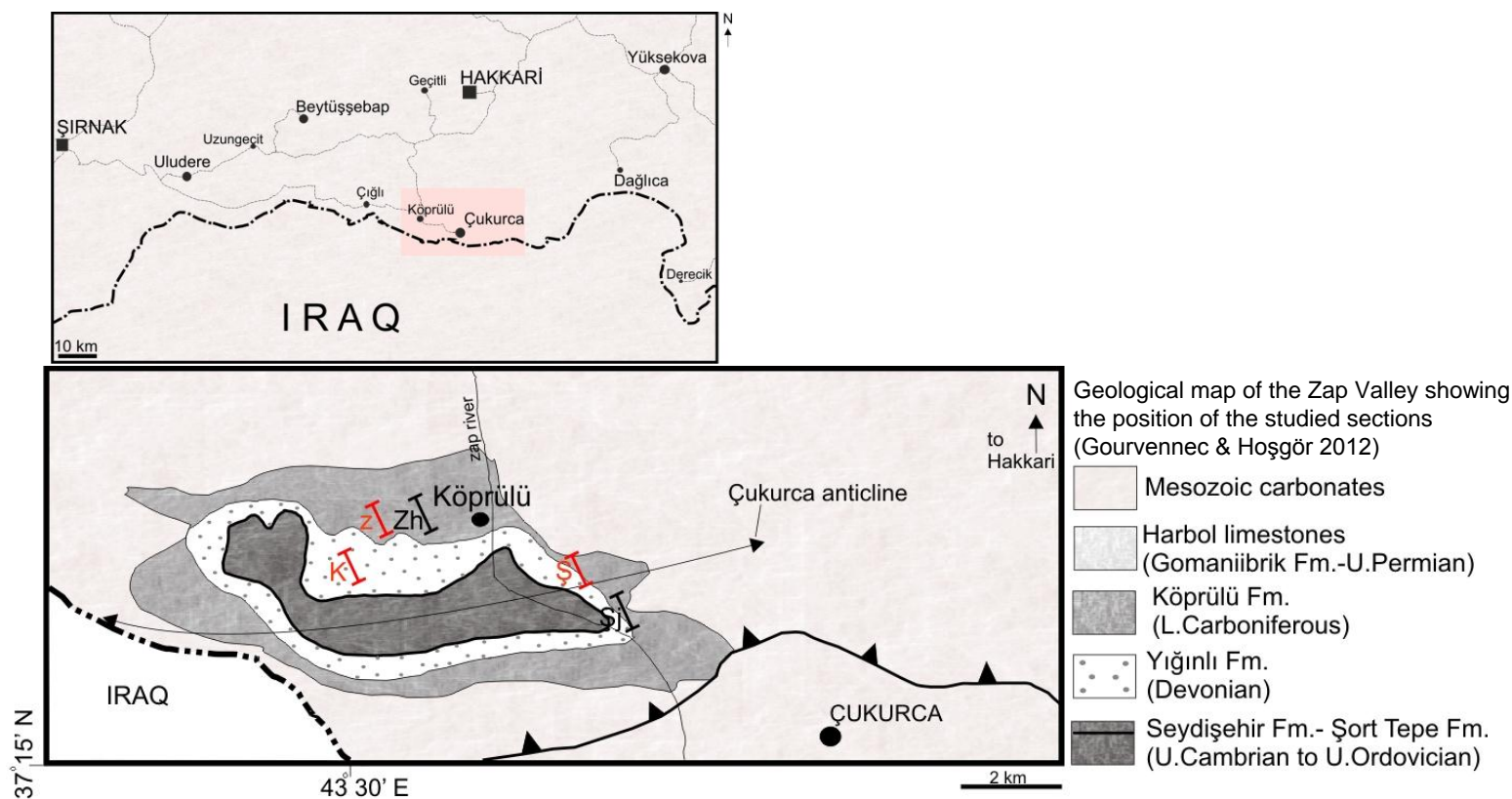
*Département de Géologie, Université de Liège, Belgium*



My presentation is divided into three main vital points concerning the study.

1. The first part is the introduction where the locations and field observation data about the sections are presented [(Köprülü (Devonian) ,Zap and Şort Dere (Carboniferous))].
2. The second part is giving few examples of the faunal analysis that are used to construct the lithostratigraphy and the other staff for the Devonian and Carboniferous successions.
3. The third part is the results and conclusions derived from this study.

## Devonian to Basal Permian Lithostratigraphy in Southwestern Hakkari: A Perspective from Northern Arabian Mixed Carbonate–Siliciclastic Platform



**new sections**

- §I Şort Dere section (Denayer & Hoşgör 2014) → Lower Carboniferous rugose corals- Köprülü Fm.
- zI Zap sections (Zap 1 & Zap 2) (Hoşgör et al., 2012) → Lower Carboniferous bivalvs- Köprülü Fm.
- kI Köprülü section (Gourvenec & Hoşgör 2012) → Middle Devonian brachiopods-Yığınlı Fm

**old sections**

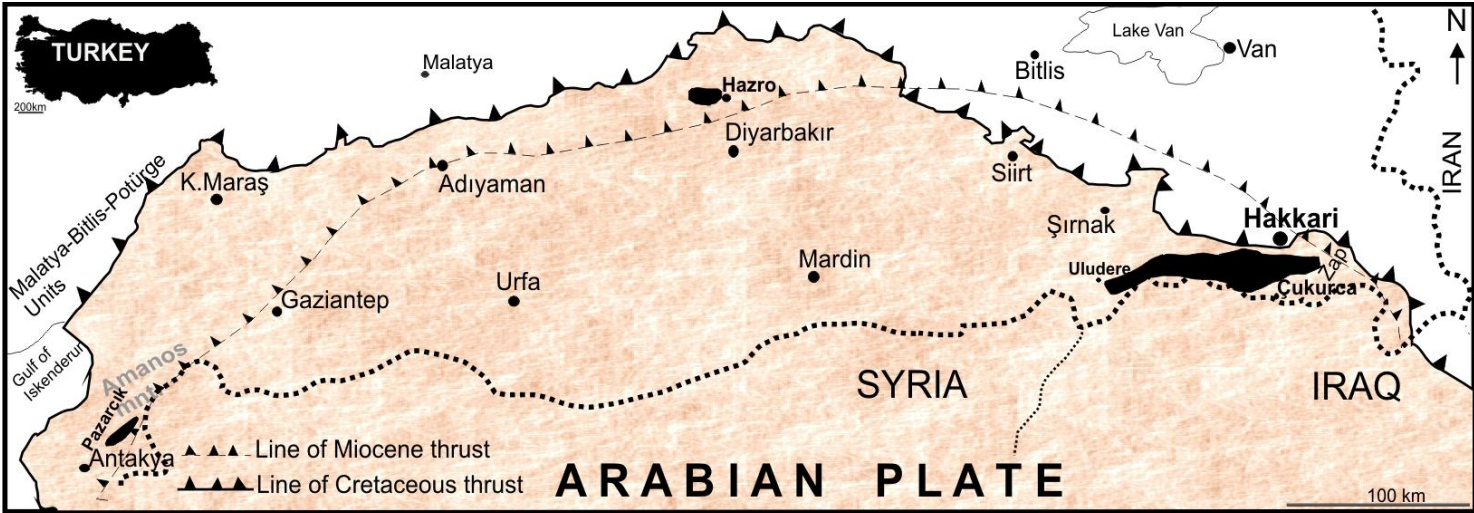
Zh Zap section (Higgs et al., 2002) → Devonian-Lower Carboniferous microfloras- Yığınlı and Köprülü Fm.

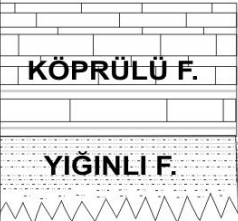

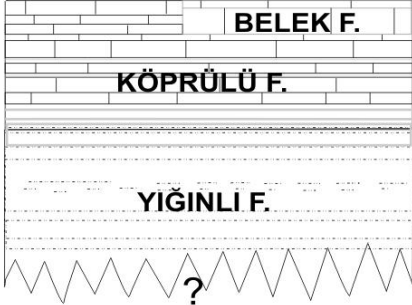
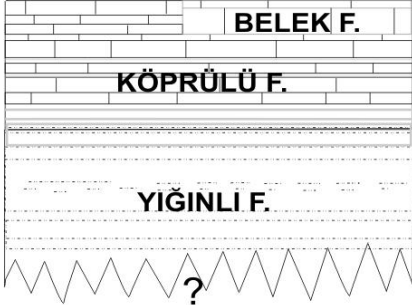
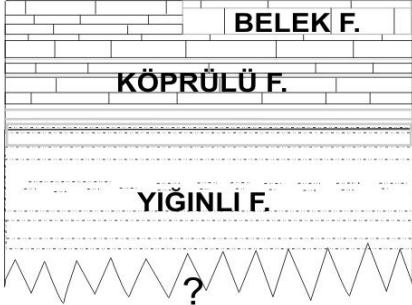
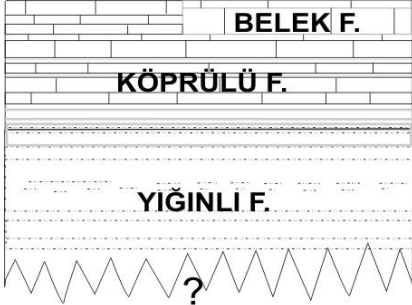
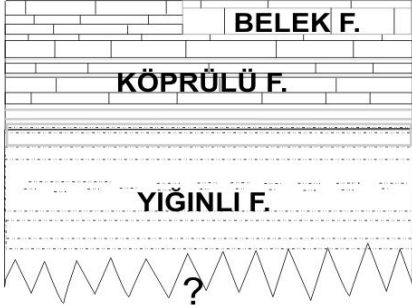
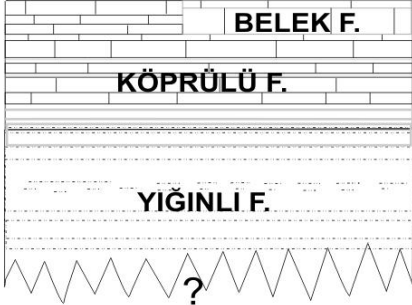
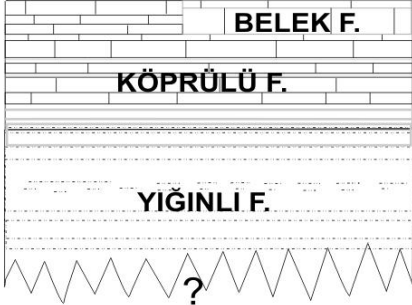
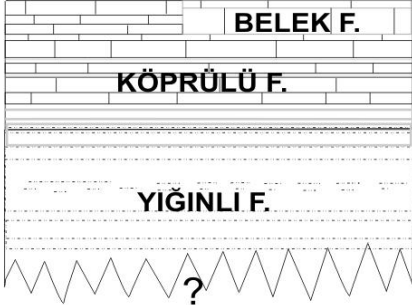
Şj Şort Dere section (Janvier et al., 1984) → Devonian-Lower Carboniferous Vertebrate Fauna- Yığınlı and Köprülü Fm.



Devonian to Basal Permian Lithostratigraphy in Southwestern Hakkari: A Perspective from Northern Arabian Mixed Carbonate–Siliciclastic Platform

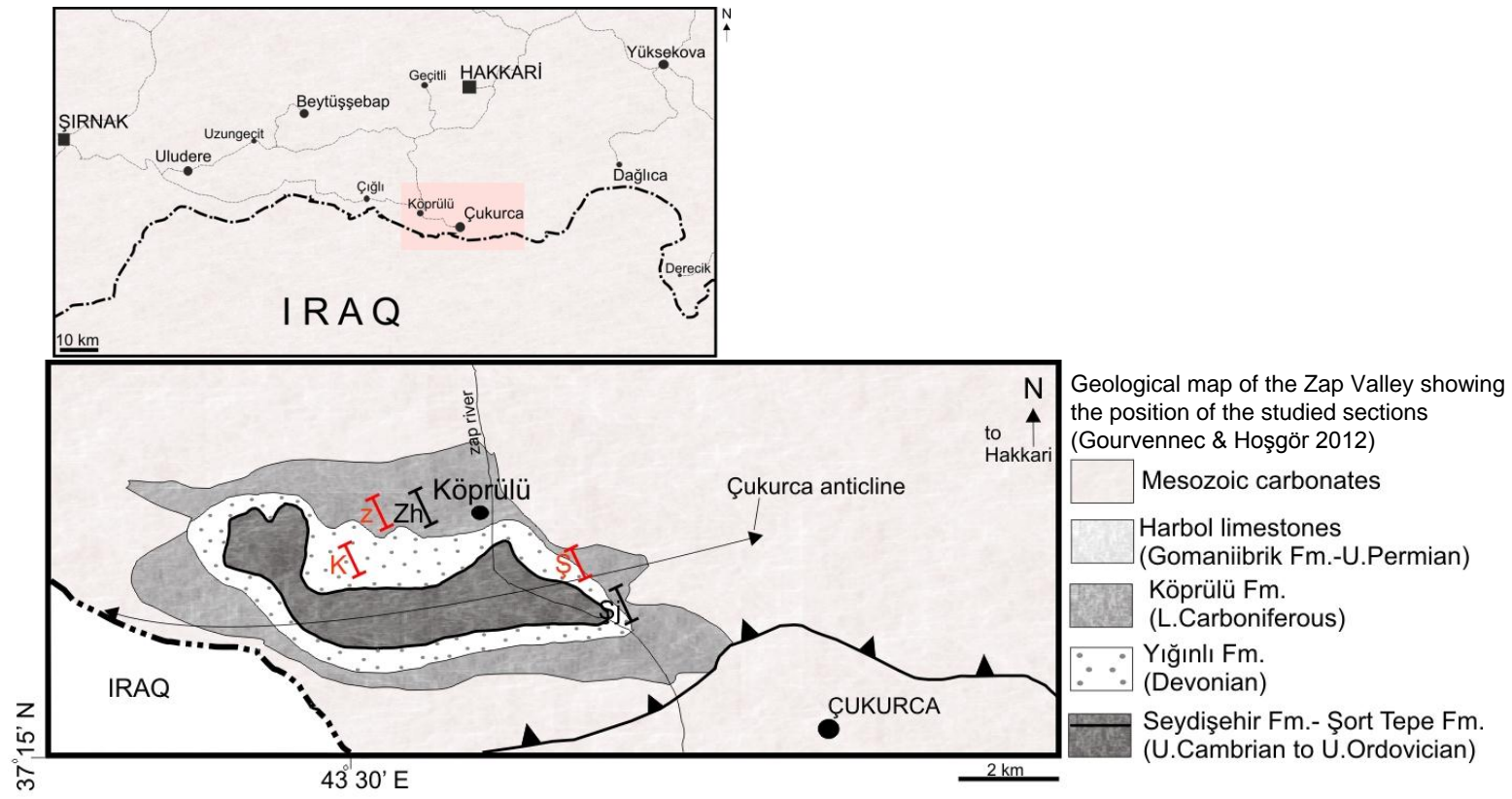
The Devonian and Lower Carboniferous of the Arabian Plate is represented in Southeastern Anatolia by sedimentary sequences observed from west to east in the Amanos Mountains, Hazro High and Hakkari area



DİARBAKIR	Z A P	GROUP	A G E		Region	Amanos-Pazarcık (N. of Antakya)	Hazro-Diyarbakır	Uludere-Şırnak	Zap Valley	Çukurca-Hakkari																																																										
			Devonian	Carboniferous																																																																
			Low.	Mid.	Upp.	Low.	Visean																																																													
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	KÖPRÜLÜ F.	YIĞINLI F.	HAZRO F. DADAŞ F.																																																																	

Sketch map of Turkey showing location of the studied area on the North Arabian Plate. • Generalized stratigraphic sections of the Devonian to Carboniferous rocks in southeastern Turkey (after Janvier *et al.* 1984, Yılmaz & Duran 1997, Gourvennec & Hoşgör 2012, Hoşgör *et al.* 2012, Denayer & Hoşgör 2014).

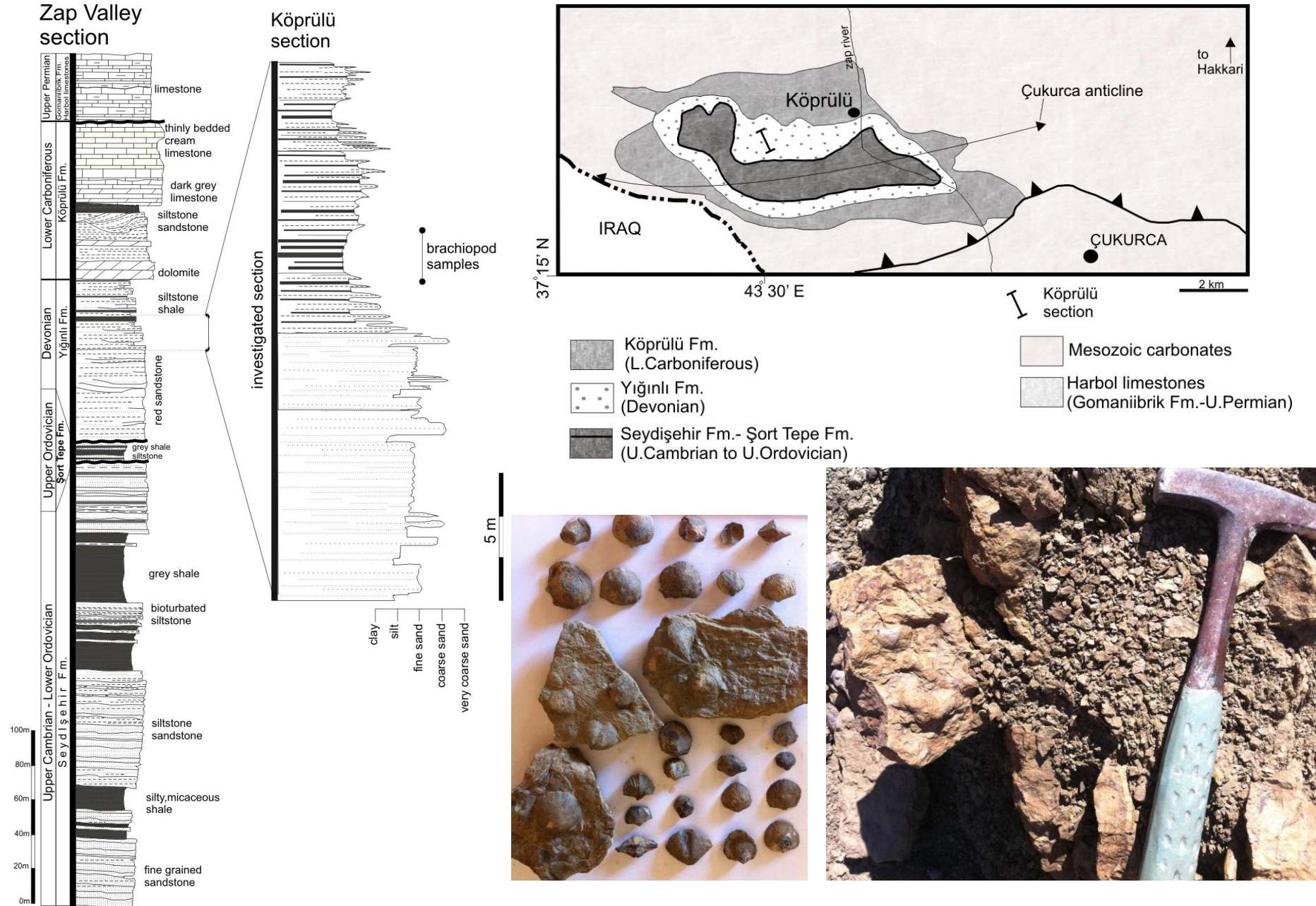
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new sections	ŞI	Şort Dere section (Denayer & Hoşgör 2014) —> Lower Carboniferous rugose corals- Köprülü Fm.
	ZI	Zap sections (Zap 1 & Zap 2) (Hoşgör et al., 2012) —> Lower Carboniferous bivalvs- Köprülü Fm.
	KI	Köprülü section (Gourvennec & Hoşgör 2012) —> Middle Devonian brachiopods-Yığınlı Fm
old sections	Zh	Zap section (Higgs et al., 2002) —> Devonian-Lower Carboniferous microfloras- Yığınlı and Köprülü Fm.
	ŞI	Şort Dere section (Janvier et al., 1984) —> Devonian-Lower Carboniferous Vertebrate Fauna- Yığınlı and Köprülü Fm.

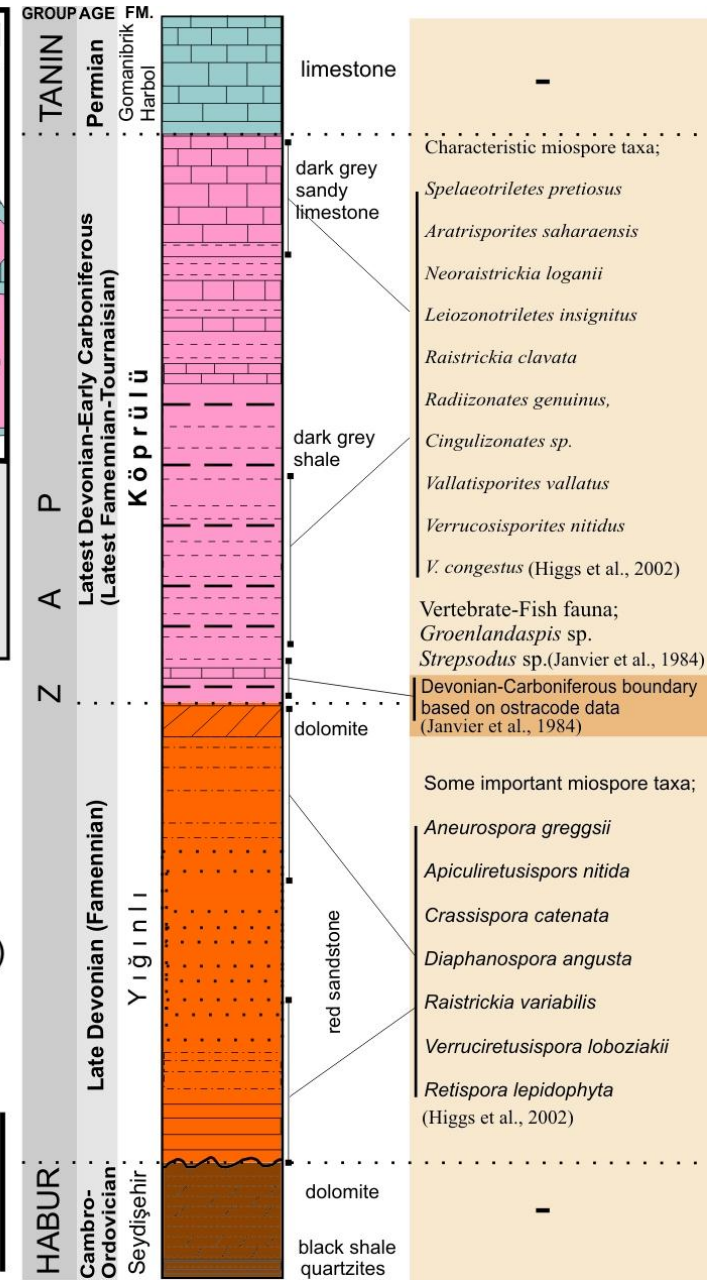
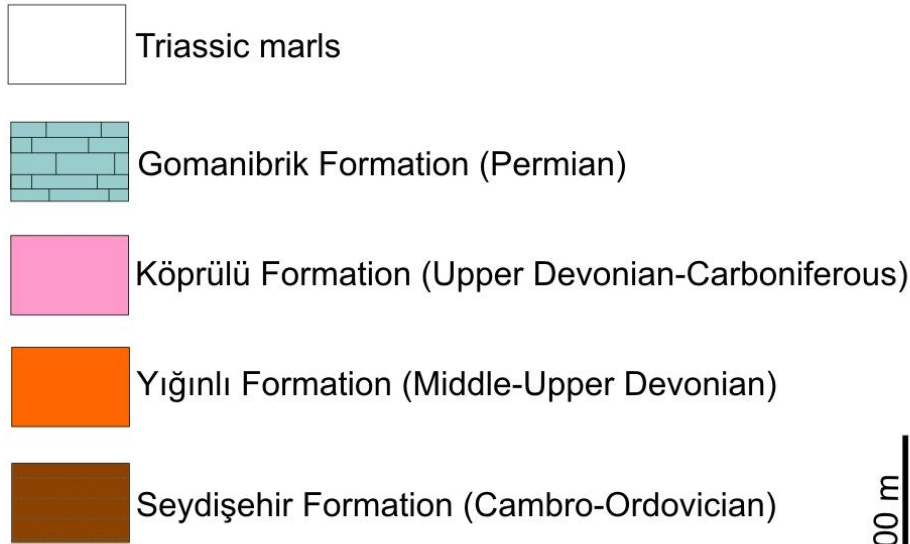
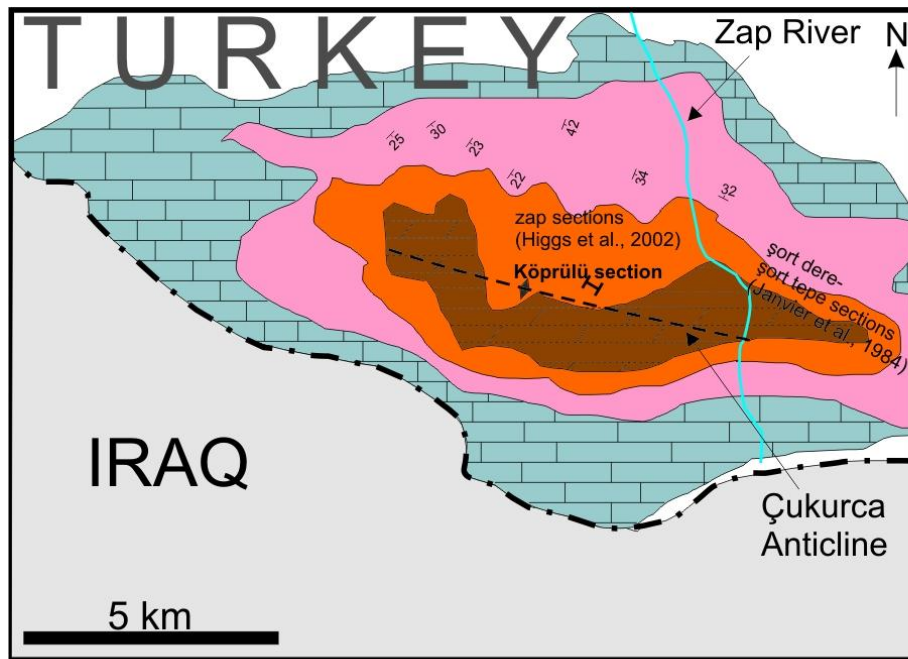


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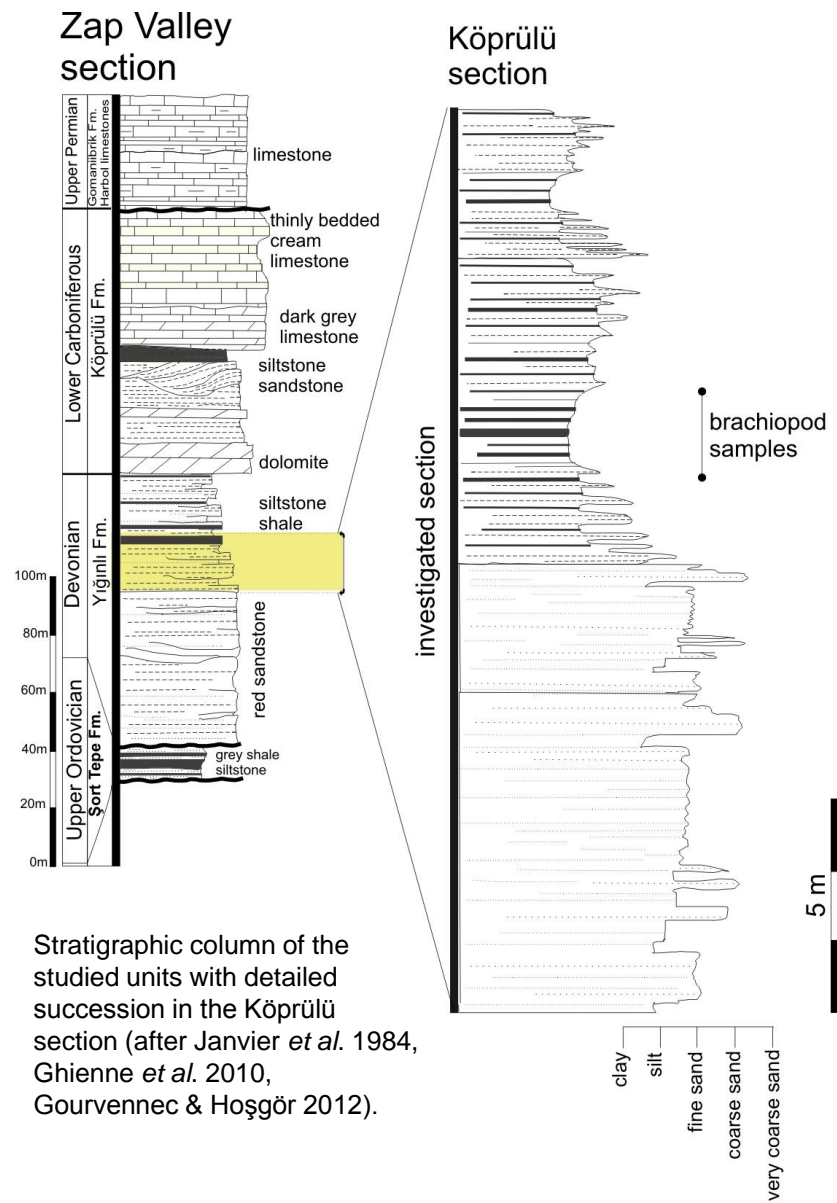
Stratigraphic column of the studied units with detailed succession in the Köprülü section (after Janvier *et al.* 1984, Ghienne *et al.* 2010, Gourvennec & Hoşgör 2012).





Stratigraphic column of the Devonian-Carboniferous units with detailed succession in the Zap and Şortdere-Şorttepe sections (after Janvier *et al.* 1984, Higgs *et al.*, 2002).

Devonian to Basal Permian Lithostratigraphy in Southwestern Hakkari: A Perspective from Northern Arabian Mixed Carbonate–Siliciclastic Platform

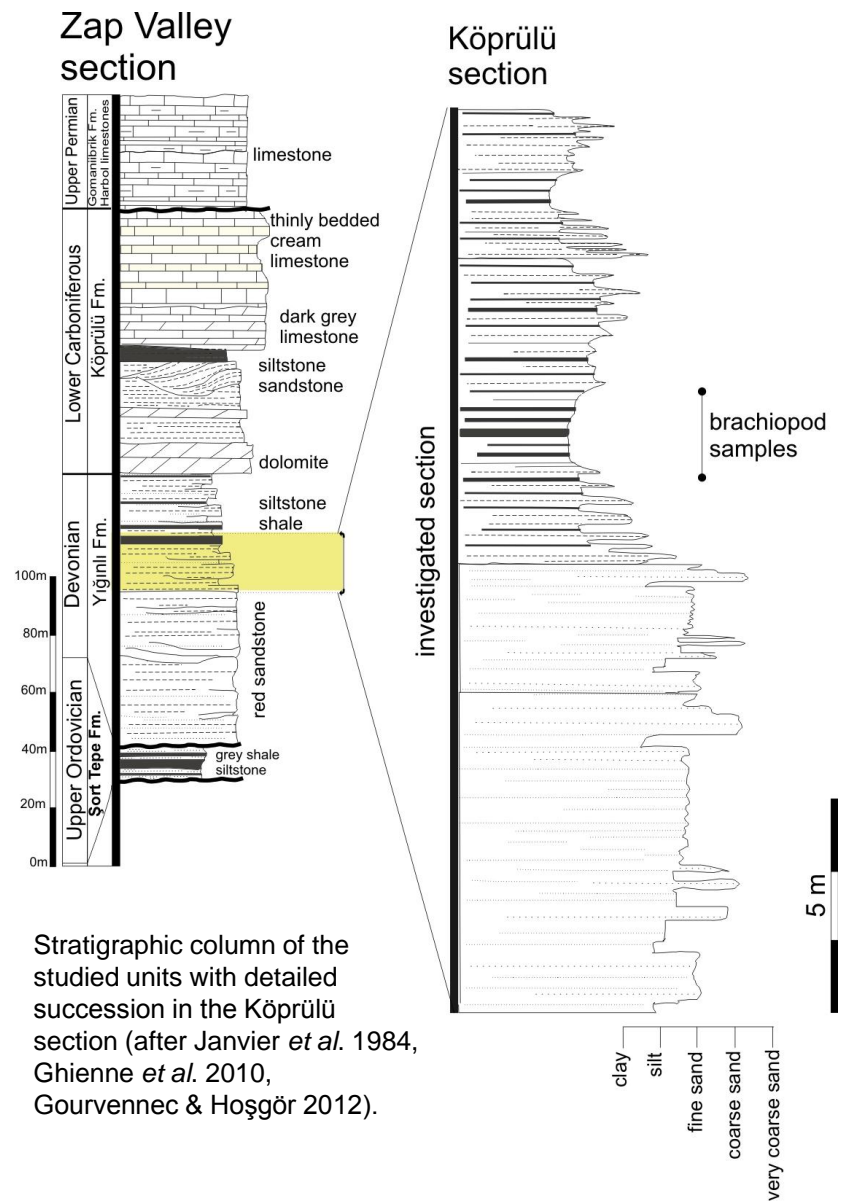


Stratigraphic column of the studied units with detailed succession in the Köprülü section (after Janvier *et al.* 1984, Ghienne *et al.* 2010, Gourvennec & Hoşgör 2012).

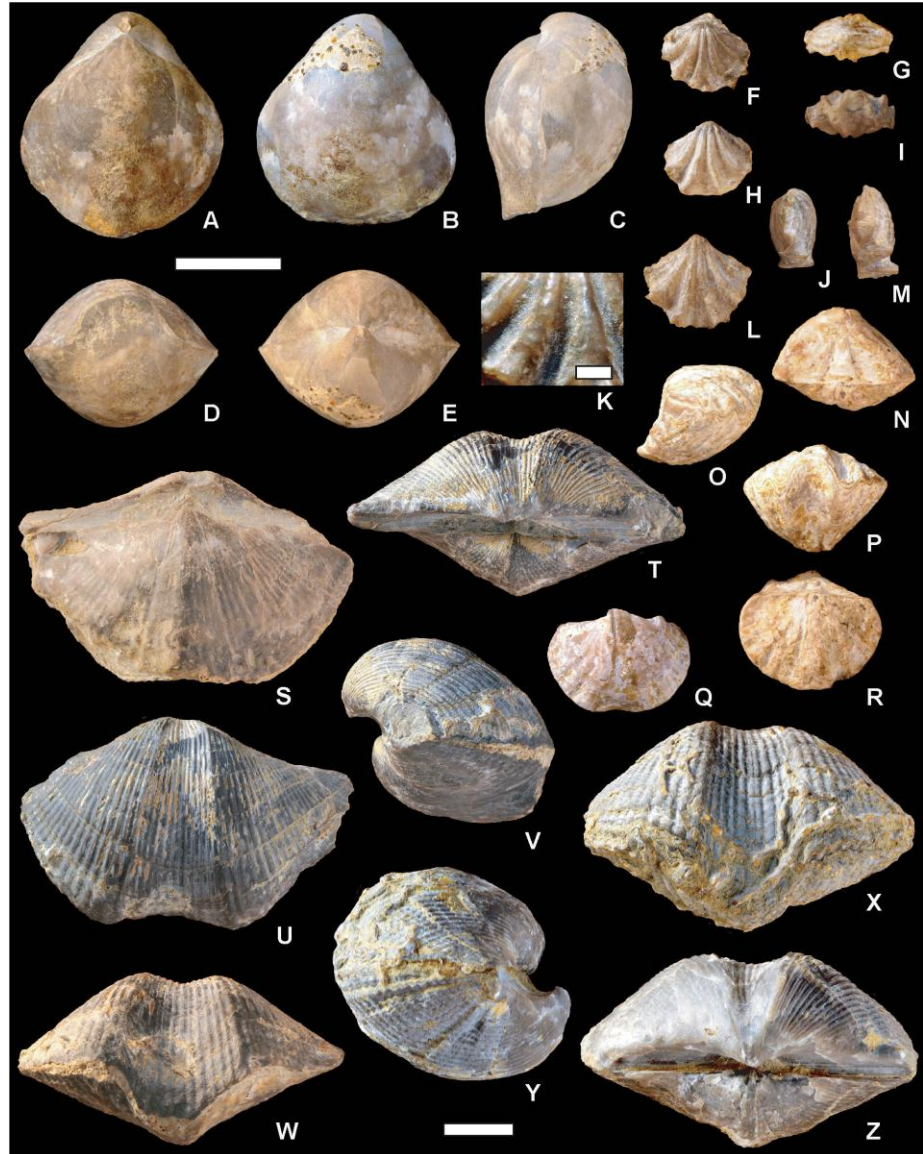


A–D – *Dagnachonetes?* sp. • E–I – *Isospinatrypa aspera* • J–O – *Desquamatia?* • P–T – *Variatrypa* sp. • U–Y – *Athyris concentrica* - Scale bar = 1 cm





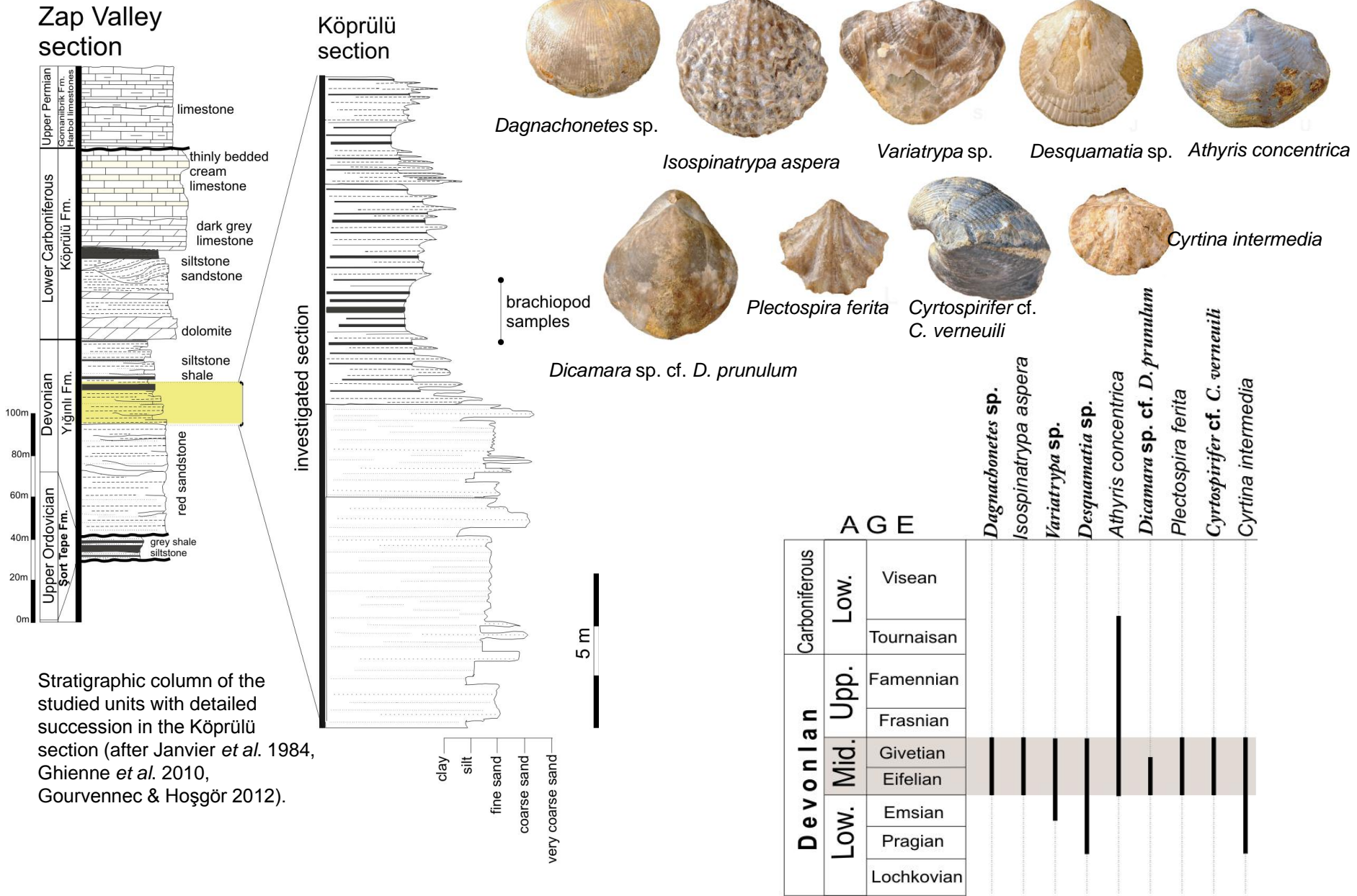
Stratigraphic column of the studied units with detailed succession in the Köprülü section (after Janvier *et al.* 1984, Ghienne *et al.* 2010, Gourvennec & Hoşgör 2012).



A–E – *Dicamara* sp. cf. *D. prunulum* • F–M – *Plectospira ferita* • N–R – *Cyrtina intermedia* • S–Z – *Cyrtospirifer* cf. *C. verneulli*- Scale bar = 1 cm



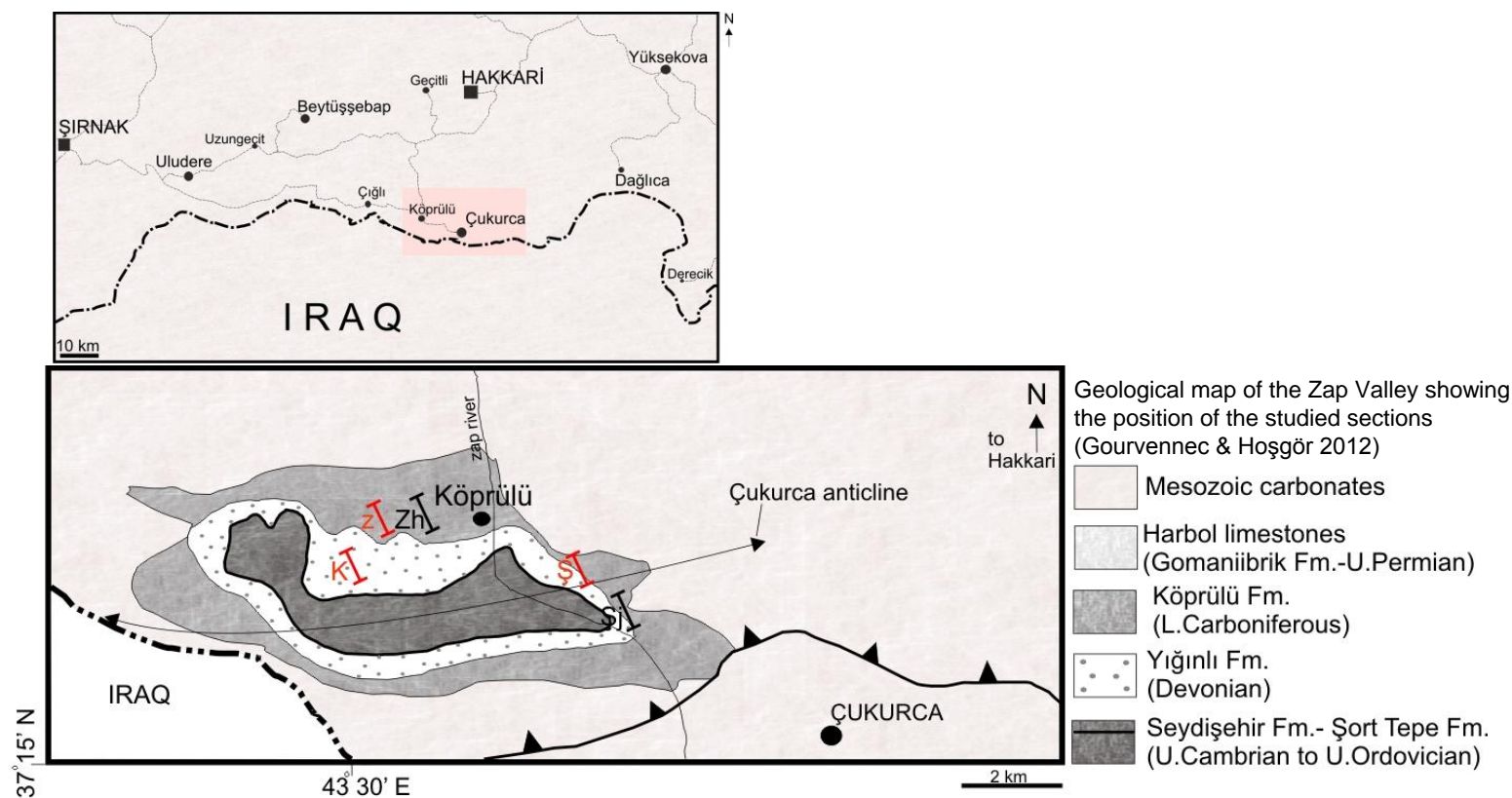
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The Hakkari province (SE Turkey) provides some sections through the Paleozoic of the Arabian Plate and thus a good occasion to collect and analyze Lower Carboniferous corals and bivalvs (posidonid and myalinids) in order to constrain the palaeobiogeographic settings of this poorly known area of Middle East as a key location at the transition between the eastern and western parts of the Palaeotethys Ocean.

## Devonian to Basal Permian Lithostratigraphy in Southwestern Hakkari: A Perspective from Northern Arabian Mixed Carbonate–Siliciclastic Platform



**new sections**

- §I Şort Dere section (Denayer & Hoşgör 2014) → Lower Carboniferous rogoose corals- Köprülü Fm.
- zI Zap sections (Zap 1 & Zap 2) (Hoşgör et al., 2012) → Lower Carboniferous bivalvs- Köprülü Fm.
- kI Köprülü section (Gourvenec & Hoşgör 2012) → Middle Devonian brachiopods-Yığınlı Fm

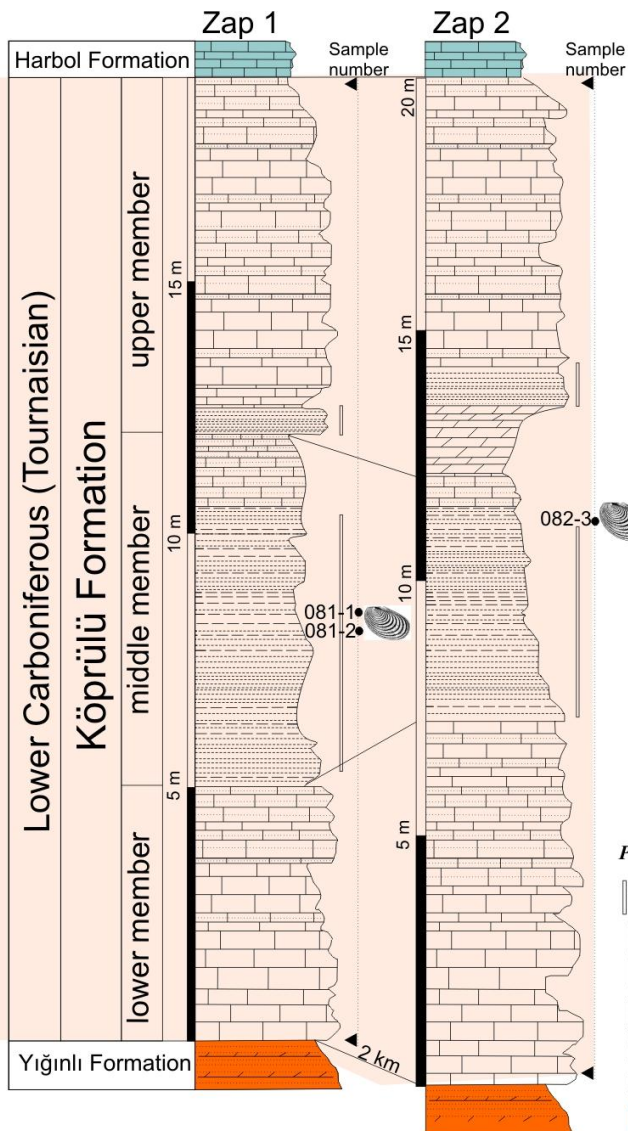
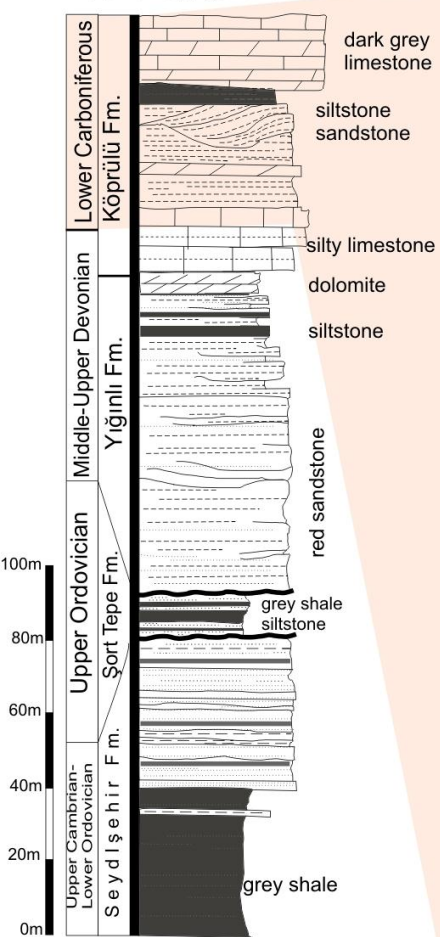
**old sections**

Zh Zap section (Higgs et al., 2002) → Devonian-Lower Carboniferous microfloras- Yığınlı and Köprülü Fm.

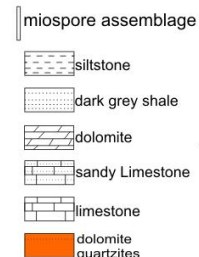
Şj Şort Dere section (Janvier et al., 1984) → Devonian-Lower Carboniferous Vertebrate Fauna- Yığınlı and Köprülü Fm.



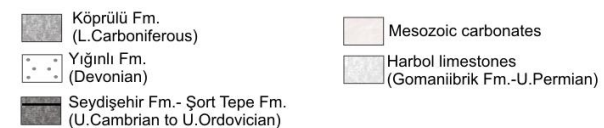
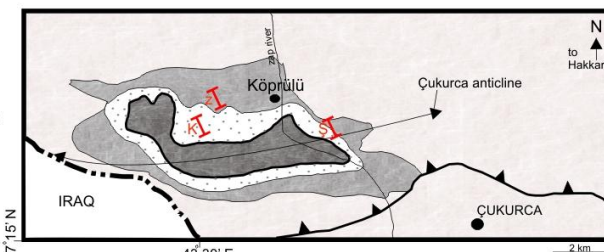
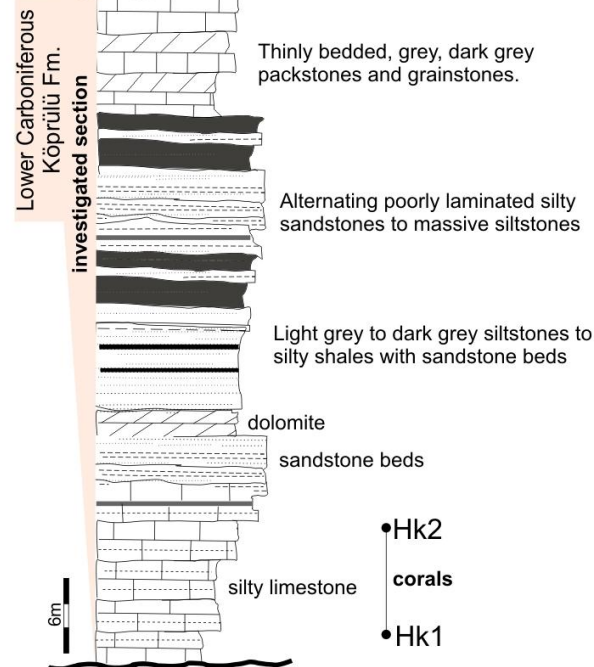
# Generalized stratigraphic columnar section of the Zap Valley, Çukurca.

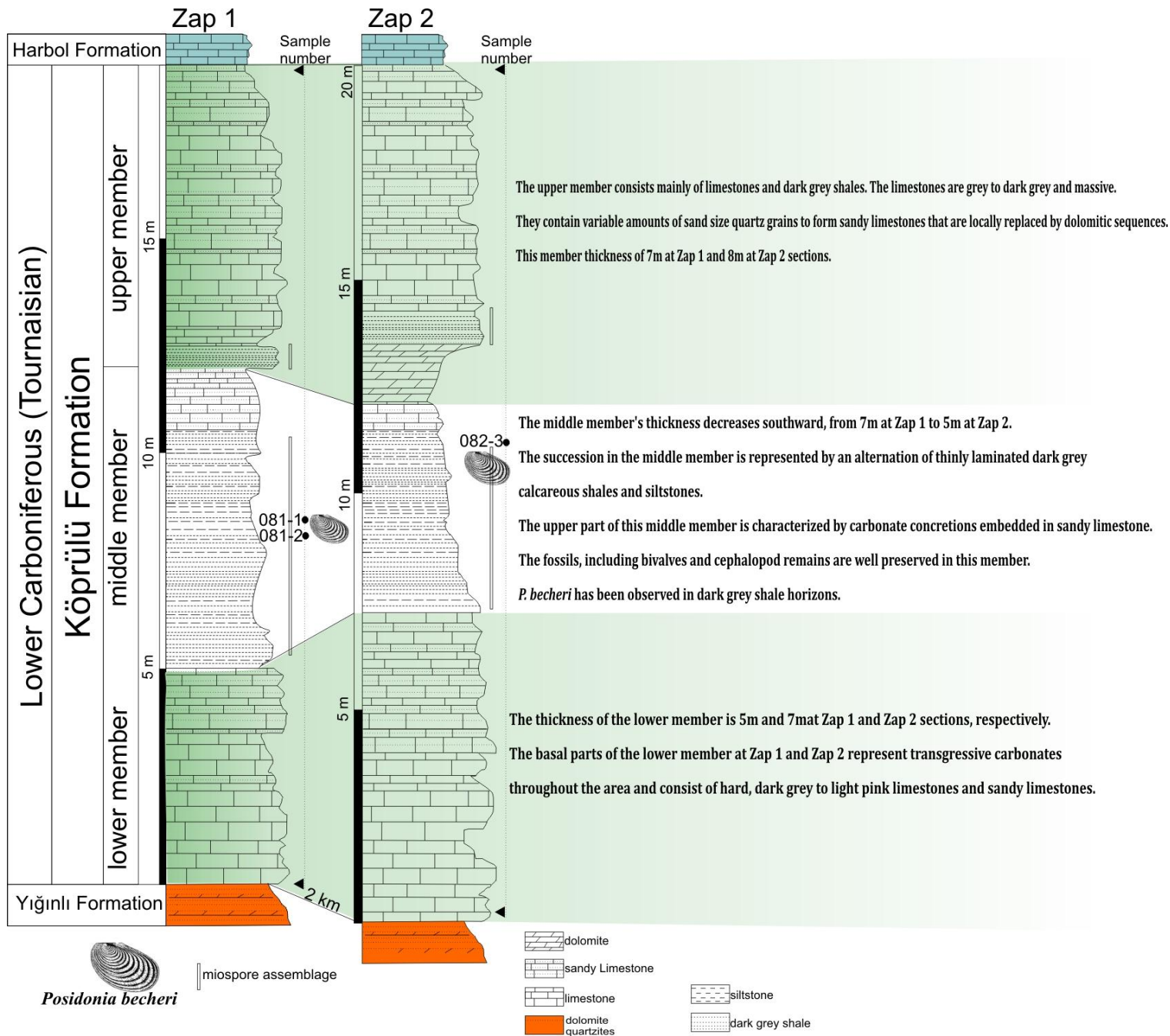


## *Posidonia becheri*

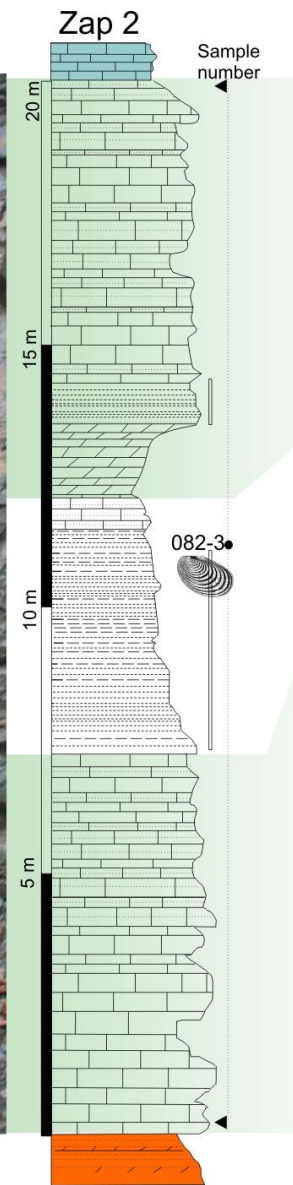
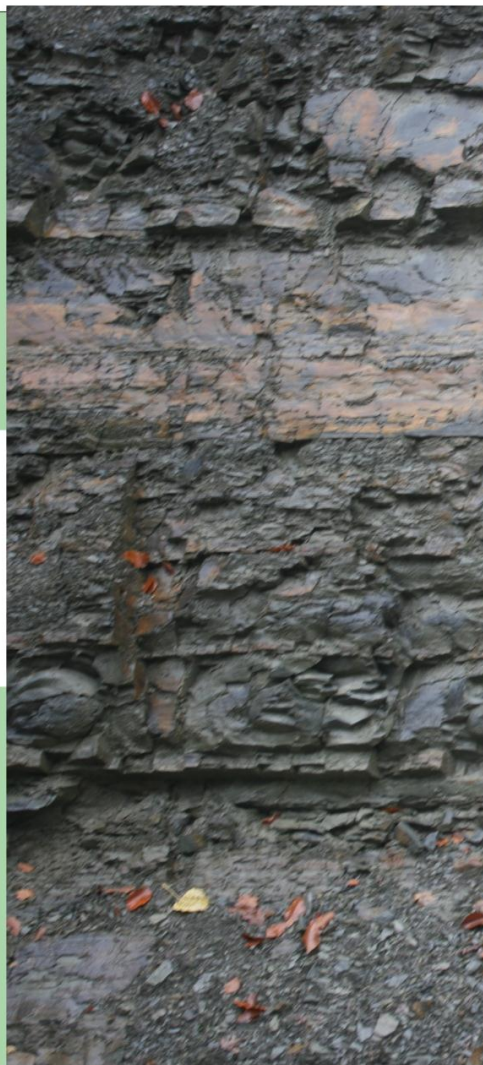
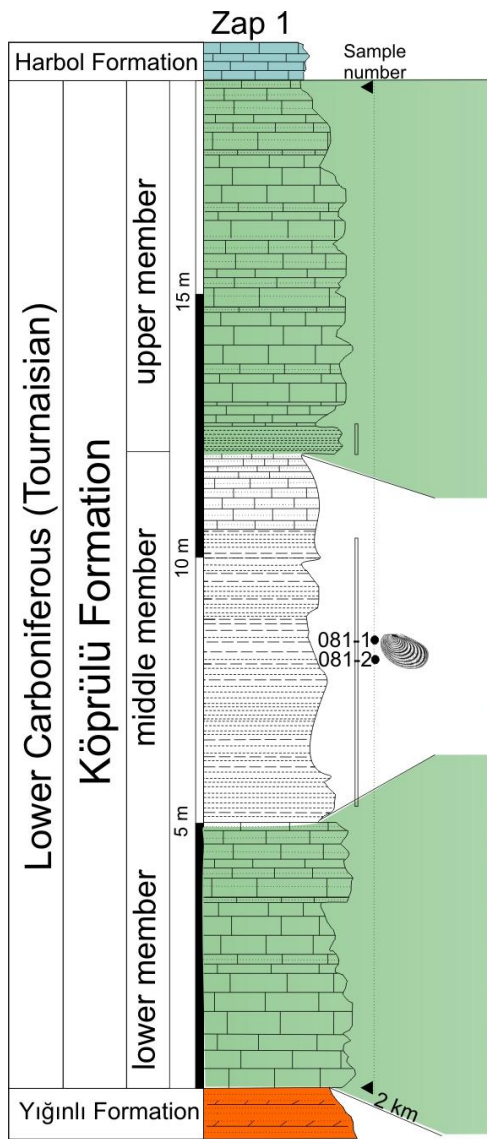


## Şort Dere section









*Posidonia becheri*

miospore assemblage

dolomite

sandy Limestone

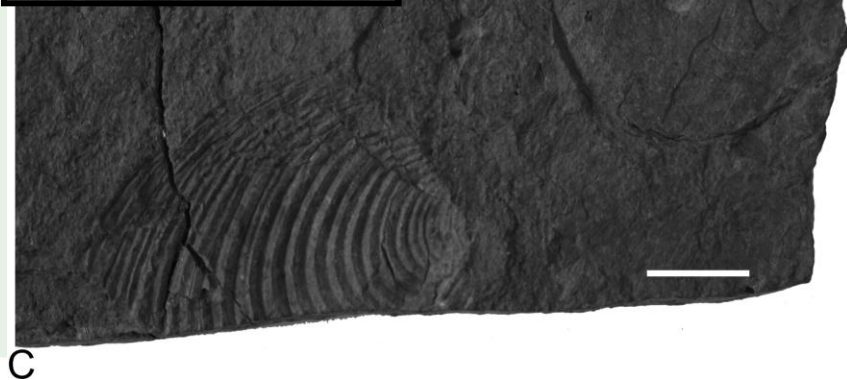
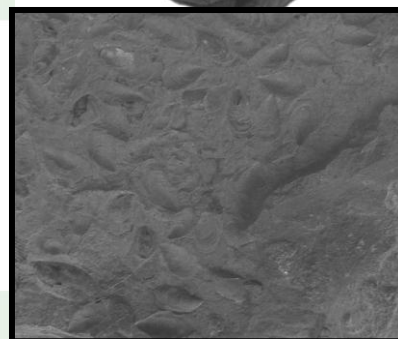
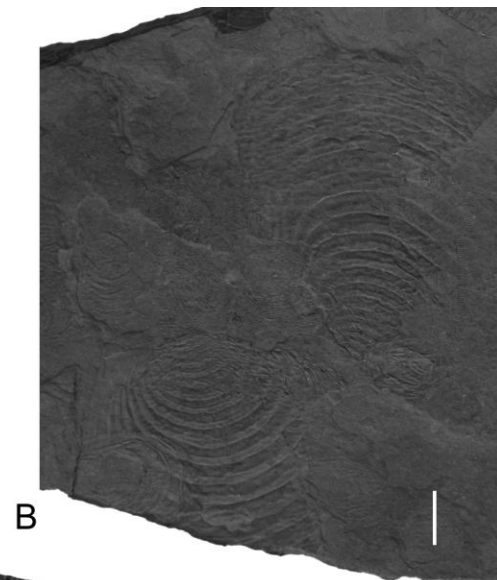
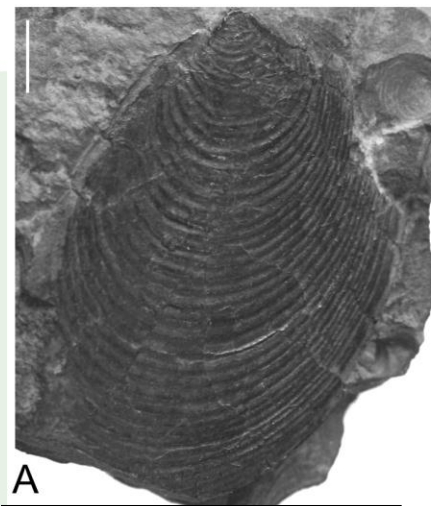
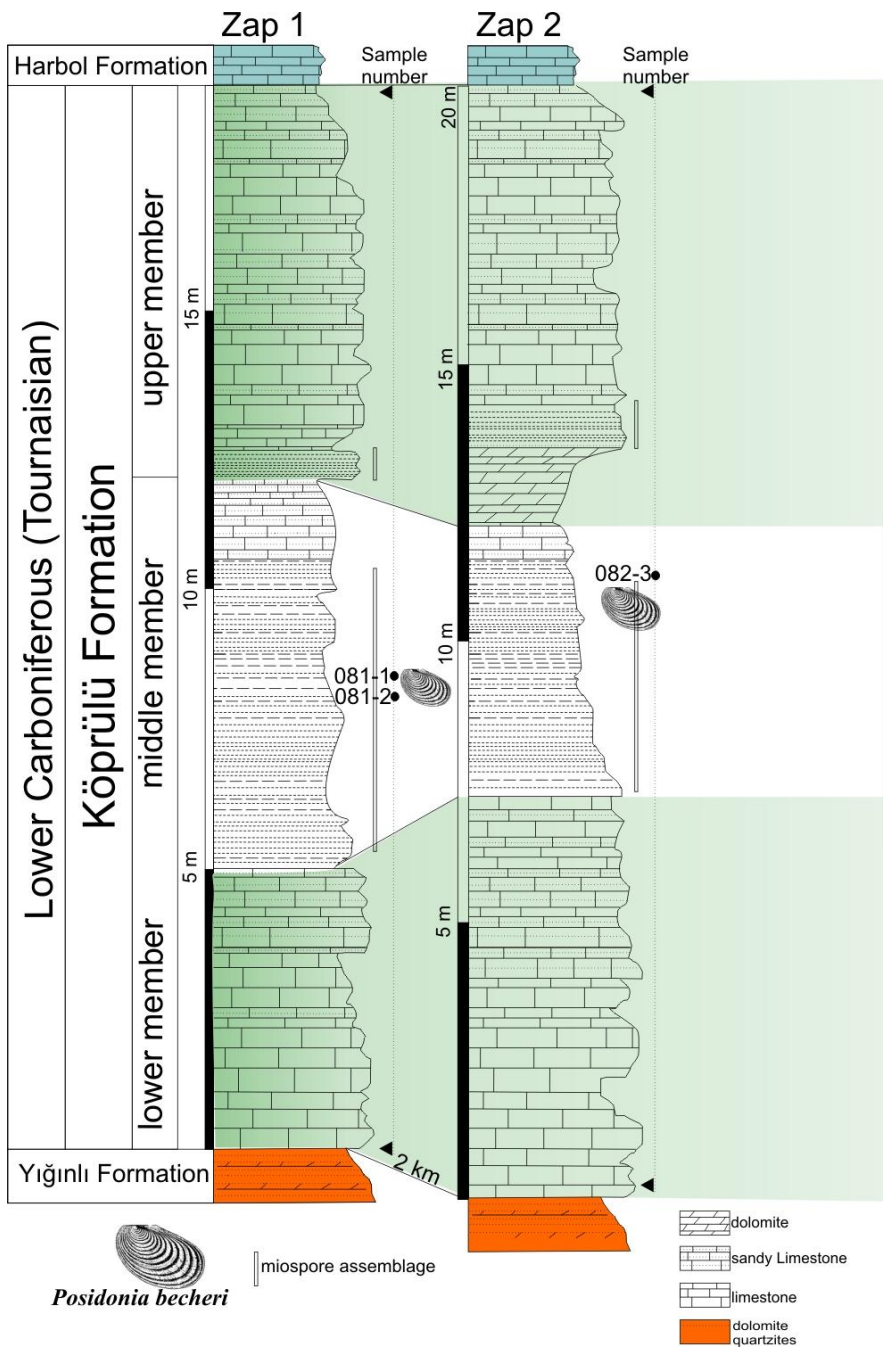
limestone

dolomite  
quartzites

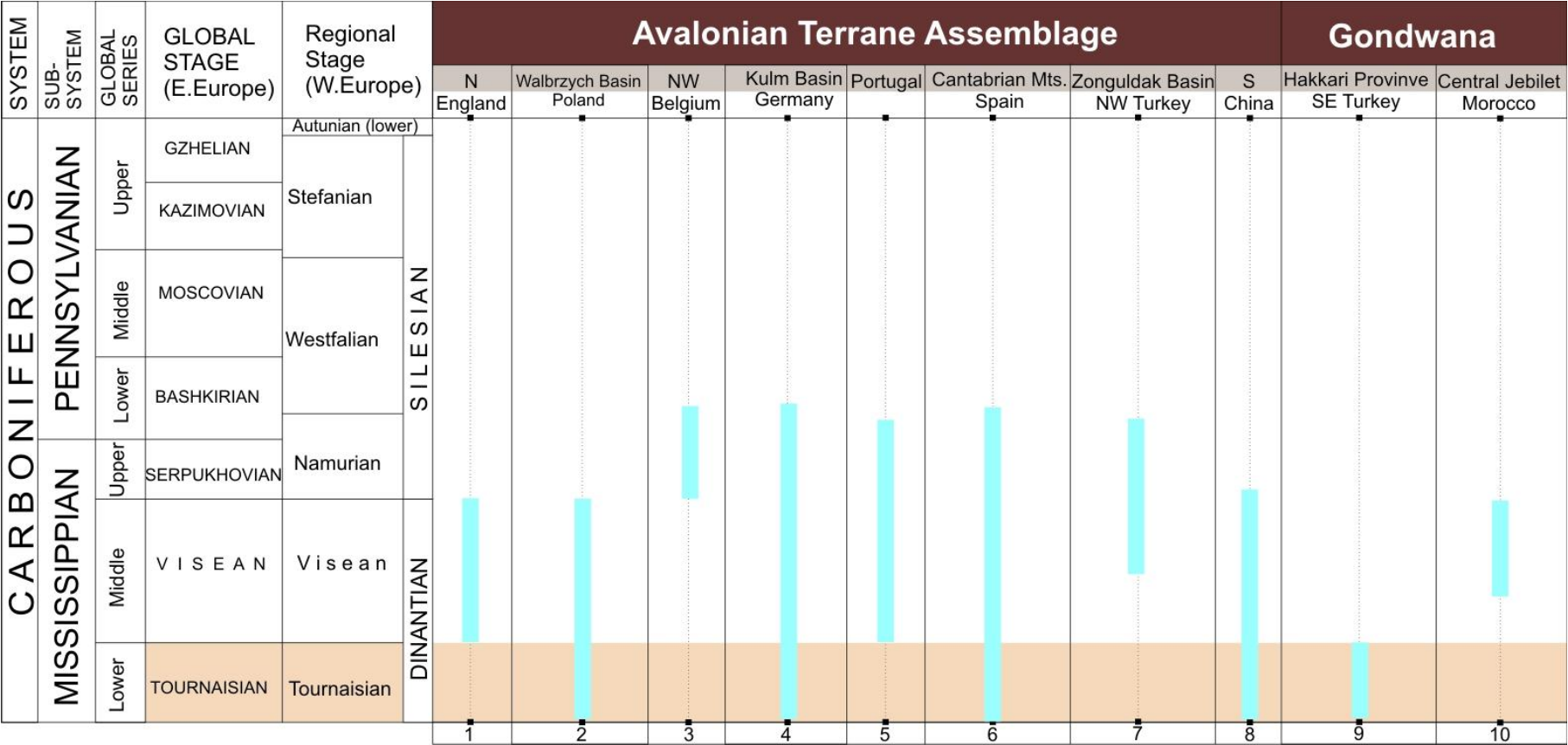
siltstone

dark grey shale





# *Posidonia becheri* Bronn, 1828 from the Tournaisian of SE Turkey: A palaeobiogeographical implications



The distribution of *P. becheri* was restricted to the Early Carboniferous of South China (Renjie and Daoping, 1993), NW Belgium (Demanet, 1938), North England (Hind, 1901), Germany (Kulm Basin) (Amler, 2004; Koenen, 1879; Nicolaus, 1963; Paul, 1939, 1941; Roemer, 1854), Poland (Walbrzych Basin) (Nicolaus, 1963; Zakowa, 1958), Portugal (Roemer, 1876), Spain (Cantabrian Mountains) (Amler and Winkler Prins, 1999), and NW Turkey (Zonguldak Basin) (Okan and Hosgör, 2007) and is regarded as a good indicator for tropical and sub-tropical climatic conditions. All of these localities are considered Peri-Gondwanan and/or Avalonian terranes that were rifted off the NW Gondwanan margin and collided with Baltica by the closure of the Rheic Ocean.

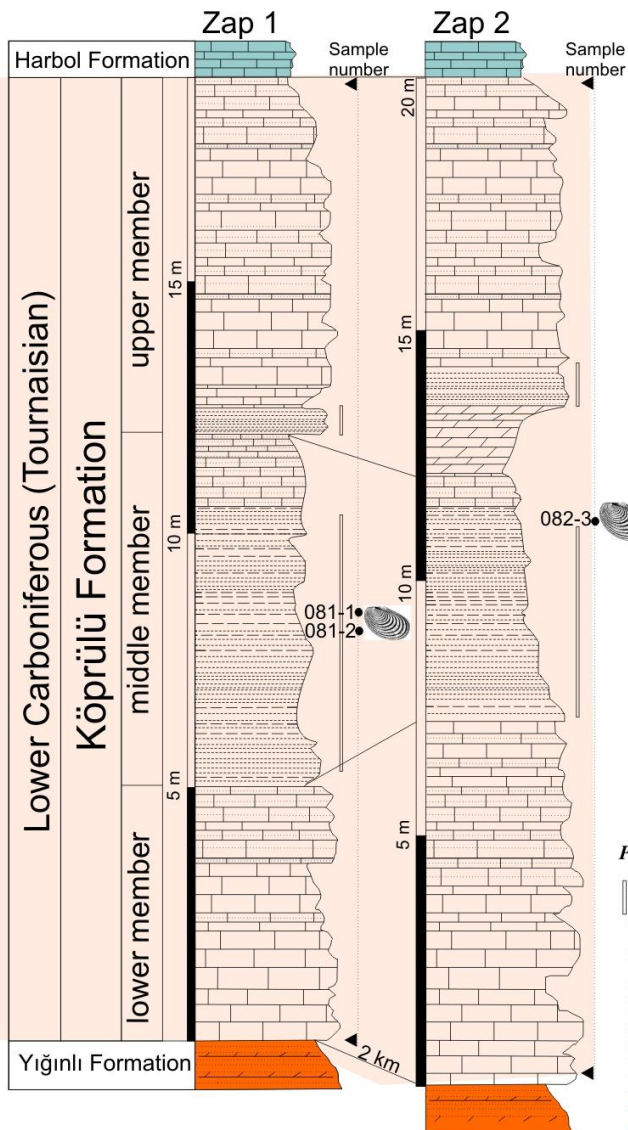
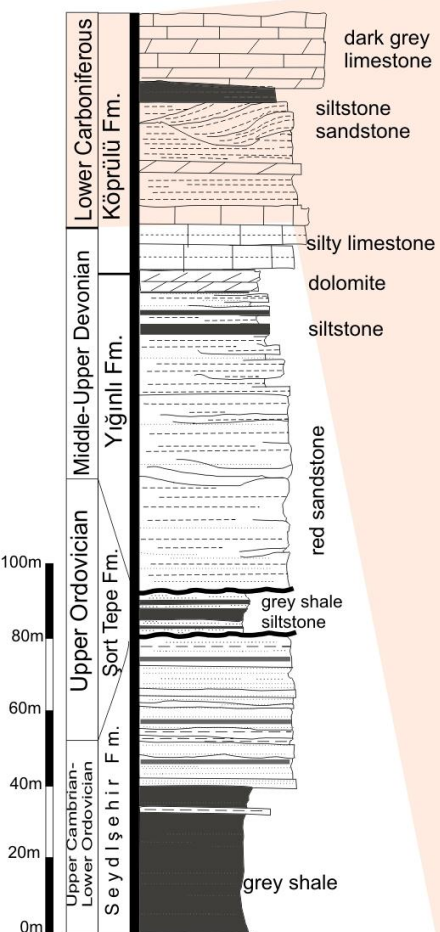
# ***Posidonia becheri* Bronn, 1828 from the Tournaisian of SE Turkey: A palaeobiogeographical implications**



During the Late Devonian-Early Carboniferous, these terranes were located to the North of Palaeotethys and the northern shelf of the Palaeotethys covered vast areas in central Europe. The Istanbul-Zonguldak terrane assemblage the Zonguldak Basin was attached to the central and SE European terrane assemblages. The SE Anatolian terrane, on the other hand, was located southeast of the former and attached to Arabia. Based on these data, together with a single finding from Morocco our specimens from SE Turkey are the only occurrences from the northern platform of Gondwana at the southern Palaeotethyan margin, as shown in

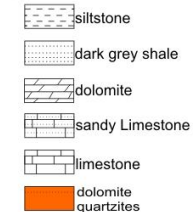


# Generalized stratigraphic columnar section of the Zap Valley, Çukurca.

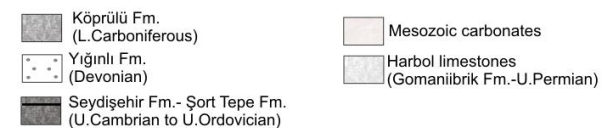
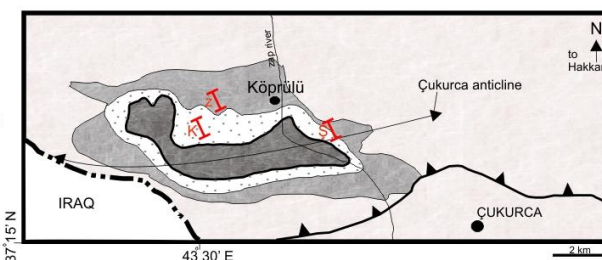
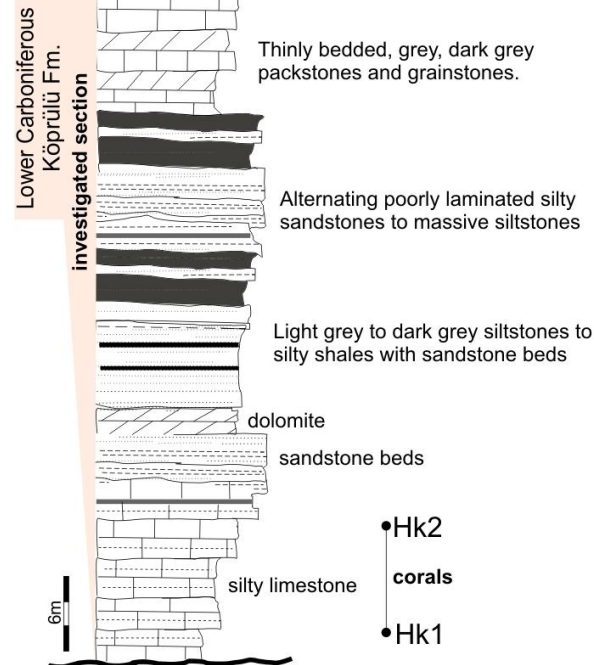


## *Posidonia becheri*

miospore assemblage

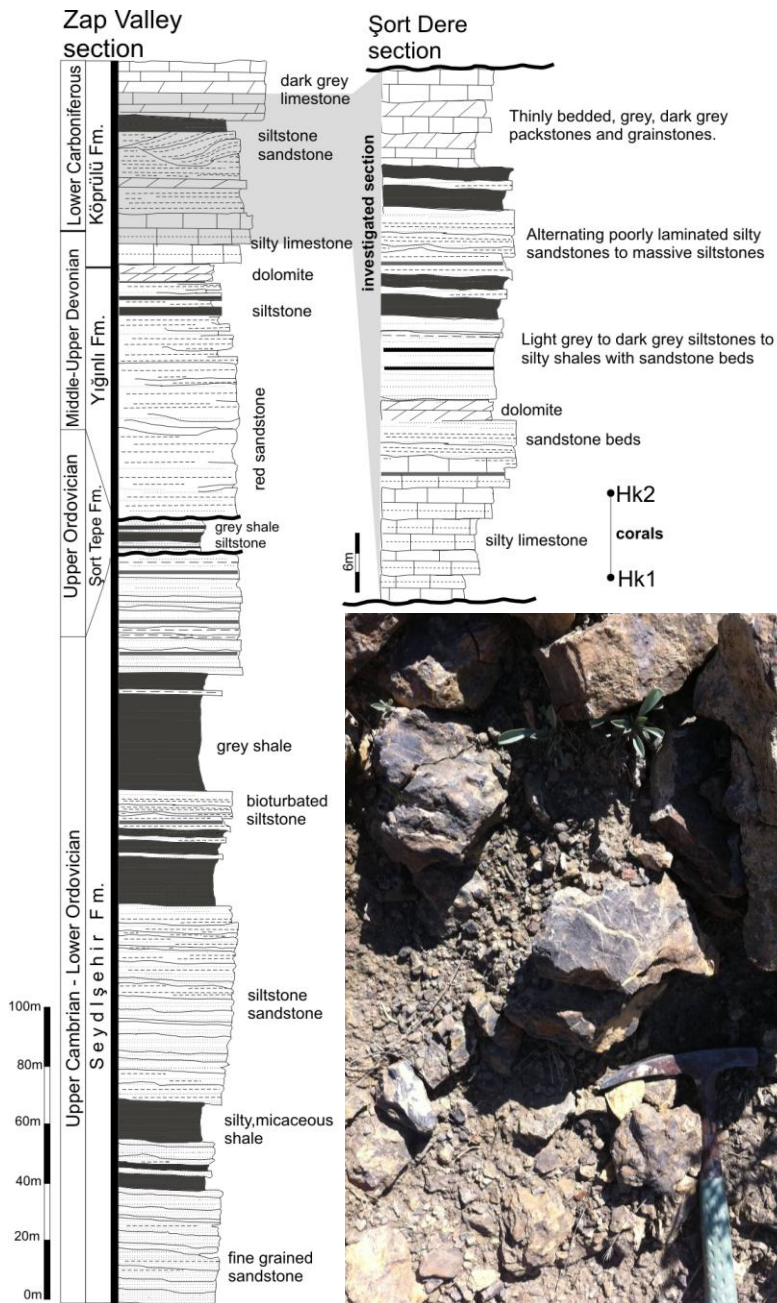


## Şort Dere section



**new sections**

- Şort Dere section (Denayer & Hoşgör 2014) → Lower Carboniferous rugose corals- Köprülü Fm.
- Zap sections (Zap 1 & Zap 2) (Hoşgör et al., 2012) → Lower Carboniferous bivalvs- Köprülü Fm.
- Köprülü section (Gourvenec & Hoşgör 2012) → Middle Devonian brachiopods- Yiğimli Fm



**The Şort Dere section** (GPS 37\_17'05.08"N 43\_32'25.78"E) is situated on the southern limb of the Çukurca Anticline, cropping out along the northern flank of the valley and exposes the Yığınlı and Köprülü formations. About 50 samples were collected near the base of the Köprülü Formation. The fossil material comes from two bioclastic silty limestone levels where solitary rugose corals are numerous, together with brachiopods, sponges spicules and bryozoans.

Hosgör et al. (2012) subdivided the Köprülü Formation in three informal members. The lower member (5–7 m-thick) is made of limestone and sandy limestone, dark to grayish in color, representing the transgressive phase covering the continental deposits of the Yığınlı Formation. The corals described here were collected in this member. The middle member (5–7 m-thick) is composed of calcareous shale and siltstone, usually laminated and dark-colored. Several sandstone layers are intercalated within this mudstone unit. The upper member is dominated by massive grayish limestone, often sandy or dolomitized, with some dark shale layers. This last member is 1– 8 m-thick.

This study is based on c. 150 thin sections made through 51 mainly completed, rock-free small solitary corals.



**Solitary non-dissepimented rugose corals  
from the Şort Dere section.**

1–5: *Amplexizaphrentis zapense* Denayer & Hoşgör, 2014

6a–d: *Zaphrentes parallela* (Carruthers, 1910),

7: *Amplexizaphrentis* sp.,

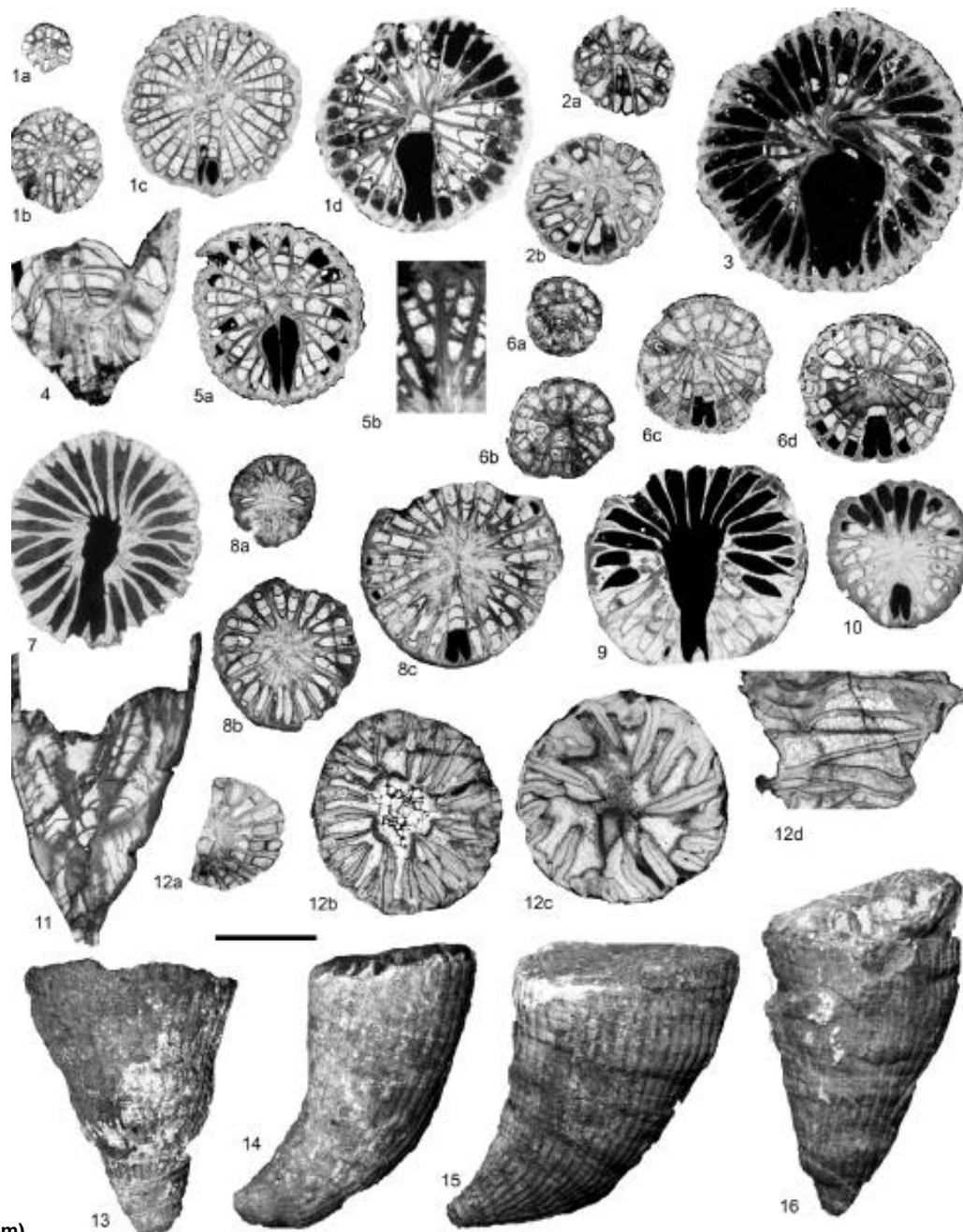
8–11: *Rotiphyllum* cf. *simulatum* Fedorowski 2009

12a–d: Gen. et sp. indet., specimen

13, 16: *Amplexizaphrentes zapense* Denayer & Hoşgör, 2014., external view

14: *Zaphrentes parallela*, ex.v., specimen

15: *Rotiphyllum* cf. *simulatum*, ex.v.,specimen



(scale bar: 10 mm)

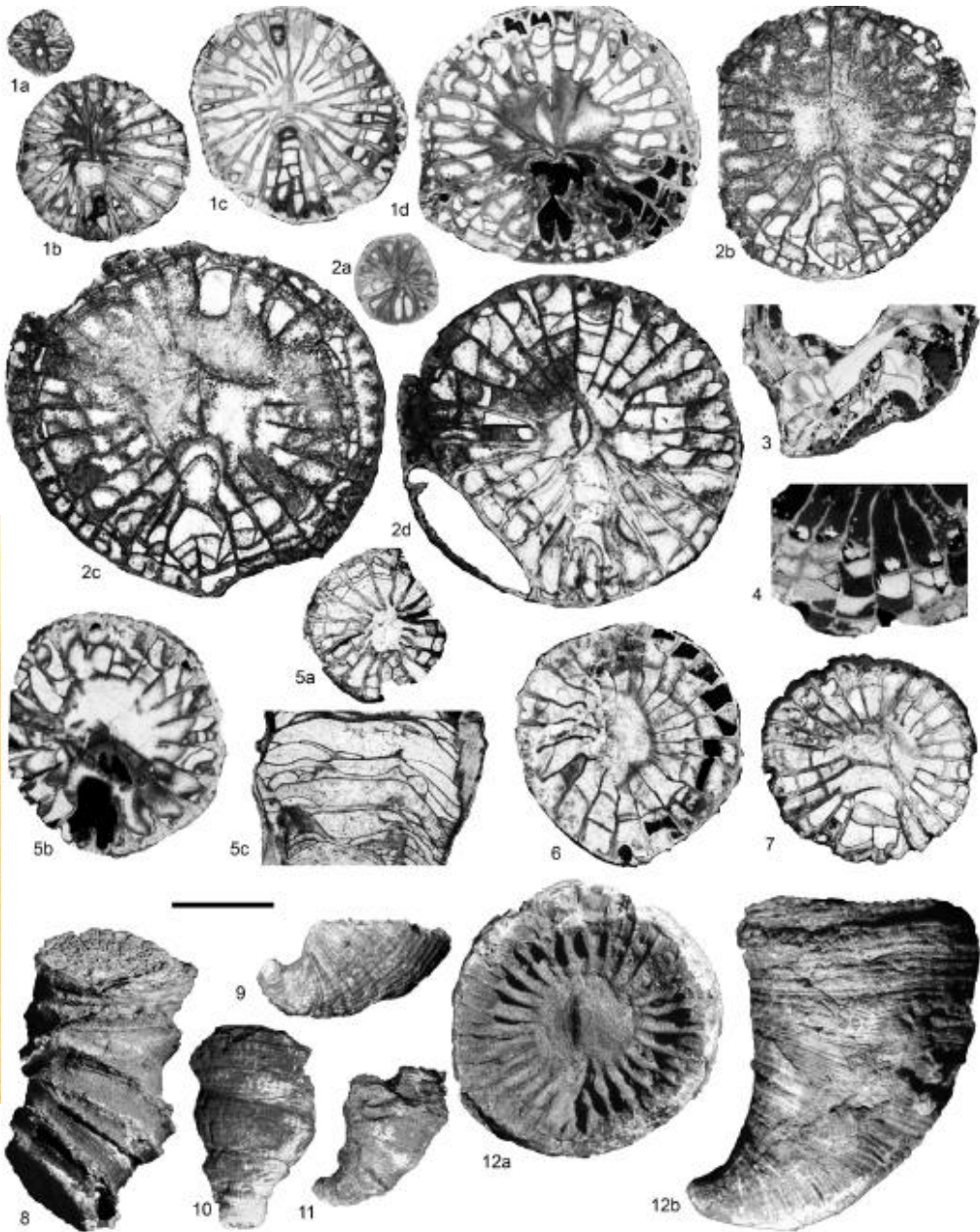


**Solitary dissepimented and non-dissepimented rugose corals from the Şort Dere section**

1–4: *Caninia aff. cornucopiae* Michelin in Gervais 1840.

5–10: cf. *Gorizdronia* sp.

11–12: *Caninia aff. cornucopiae* Michelin in Gervais 1840.



(scale bar: 10 mm)

## Faunal assemblage and Palaeobiogeography

Small solitary horn-shaped non-dissepimented corals are common in mixed carbonate–siliciclastic facies, independent of the age or palaeogeographical position. Table 1 summarize the diversity of such assemblage in some well studied localities. Usually, the number of taxa is low and the ratio number of species/number of genera is close to 1, indicating a weak disparity. The presence of columellate and/or dissepimented taxa is occasional, witnessing the ability of some “complex” coral (e.g. *Caninia* aff. *cornucopiae*) to colonize less favorable environments.

**Table 1**

Age, location and diversity of some well studied Upper Palaeozoic “*Cyathaxonia* fauna”.

Age	Locality	Facies	Nb. sp./ gen.	Dispt. taxa	References
Emsian	Anti-Atlas (Morocco)	Deep-water mound	19/12	2	<a href="#">Berkowski (2008)</a> ; <a href="#">Berkowski (2004)</a>
Late Emsian–early Eifelian	Istanbul area (NW Turkey)	Deep-water siliciclastic	5/5	0	<a href="#">Kullmann (1973)</a>
Givetian	Anti-Atlas (Morocco)	Deep-water mound	4/4	0	<a href="#">Berkowski (2006)</a>
Early Famennian	Harz (Germany)	Deep water carbonate	4/4	0	<a href="#">Weyer (1991)</a>
Early Famennian	Thuringia (Germany)	Deep water mixed carbonate–siliciclastic	5/5	0	<a href="#">Weyer (2004)</a>
early Famennian	Sauerland (Germany)	Deep water mixed carbonate–siliciclastic	8/6	0	<a href="#">Weyer (2004)</a>
Early Famennian	Namur-Dinant Basin (Belgium)	Shallow water siliciclastic	4/4	2	<a href="#">Denayer et al. (2012)</a>
Late Famennian	Sinkiang (NE China)	Deep water carbonate	11/9	2	<a href="#">Soto and Liao (2002)</a>
Latest Famennian–early Tournaisian	Rhenish Massif (Germany)	Deep-water siliciclastic and carbonate	17/13	1	<a href="#">Weyer (1994)</a> , <a href="#">Korn and Weyer (2003)</a>
Early Viséan	Hakkari (SE Turkey)	Mixed carbonate–siliciclastic	7/6	1	<a href="#">DENAYER AND HOŞGÖR (2014)</a>
Early-mid. Viséan	Sinai (NE Egypt)	Mixed carbonate–siliciclastic	9/6	1	<a href="#">Kora (1989, 1992, 1995) and Kora and Jux (1986)</a>
Late Tournaisian–early Viséan	Baltic coast (NE Germany)	Mixed carbonate–siliciclastic	9/7	1	<a href="#">Weyer (1993)</a>
Late Tournaisian–early Viséan	Montagne Noire (S France)	Deep-water carbonate	9/7	1	<a href="#">Semenoff-Tian-Chansky (1988)</a>
Late Serpukhovian	Arkansas (USA)	Reefal (thrombolite) limestone	9/8	1	<a href="#">Webb (1987)</a>
Late Serpukhovian	Oklahoma and Arkansas (USA)	Siliciclastics	11/5	0	<a href="#">Webb and Sutherland (1993)</a>
Lower Pennsylvanian	Texas (USA)	Carbonate and siliciclastic	24/10	3	<a href="#">Moore and Jeffords (1945)</a>
Moscovian	Cantabrian Mountains (N Spain)	Carbonate	31/18	0	<a href="#">Rodríguez and Kullmann (1999)</a>
Late Moscovian	South Urals (Russia)	Warm water carbonate	7/6	0	<a href="#">Kossovaya (2007)</a>
Late Moscovian (top)	South Urals (Russia)	Mixed carbonate–siliciclastic	7/5	1	<a href="#">Kossovaya (2007)</a>
Moscovian–Gzhelian	Central USA	Carbonate	24/3	0	<a href="#">Jeffords (1947)</a>
Cisuralian	Subpolar-Northern Urals (Russia)	Shallow cool water siliciclastic	19/10	0	<a href="#">Kossovaya (2007)</a>
Cisuralian	Central Urals (Russia)	Deep cool water siliciclastic	8/7	0	<a href="#">Kossovaya (2007)</a>
Cisuralian	South Urals (Russia)	Warm water reefal carbonate	8/6	0	<a href="#">Kossovaya (2007)</a>
Guadalupian	Arctic Canada	Carbonate	8/6	0	<a href="#">Fedorowski and Bamber (2001)</a>

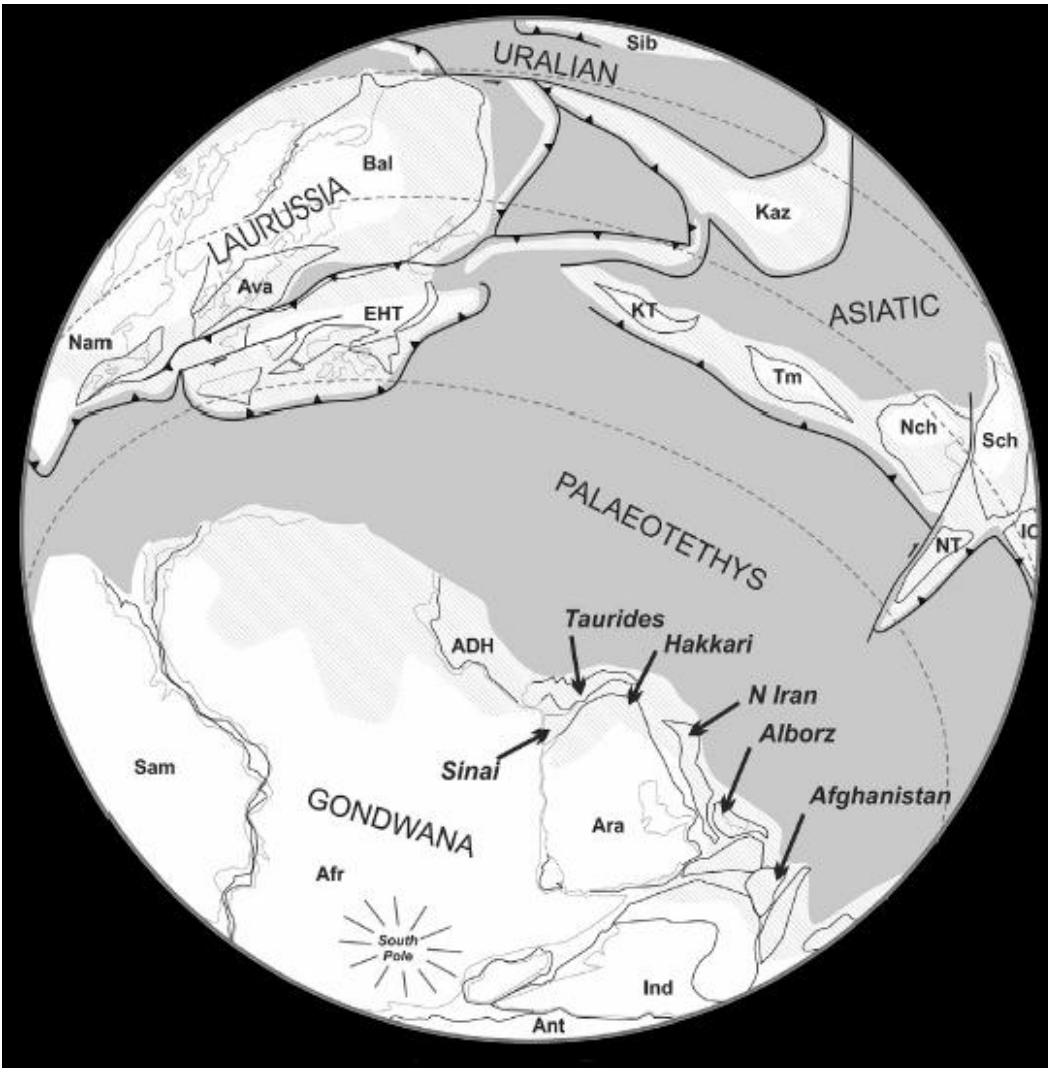
## Faunal assemblage and Palaeobiogeography

Early Carboniferous (c. 340 Ma) reconstruction of the Palaeotethys Ocean and its margins (modified from Stampfli et al. (2002)) with position of the discussed areas along the northern margin of the Gondwana.

As stated in the introductory part, the Hakkari area forms the northern part of the Arabian Plate which belongs to the northern margin of the Gondwana continent during Early Carboniferous times.

The Turkish Taurides, Iran and Afghanistan areas are easily comparable from a faunal point of view, composed of both non-disseminated and disseminated solitary rugose corals.

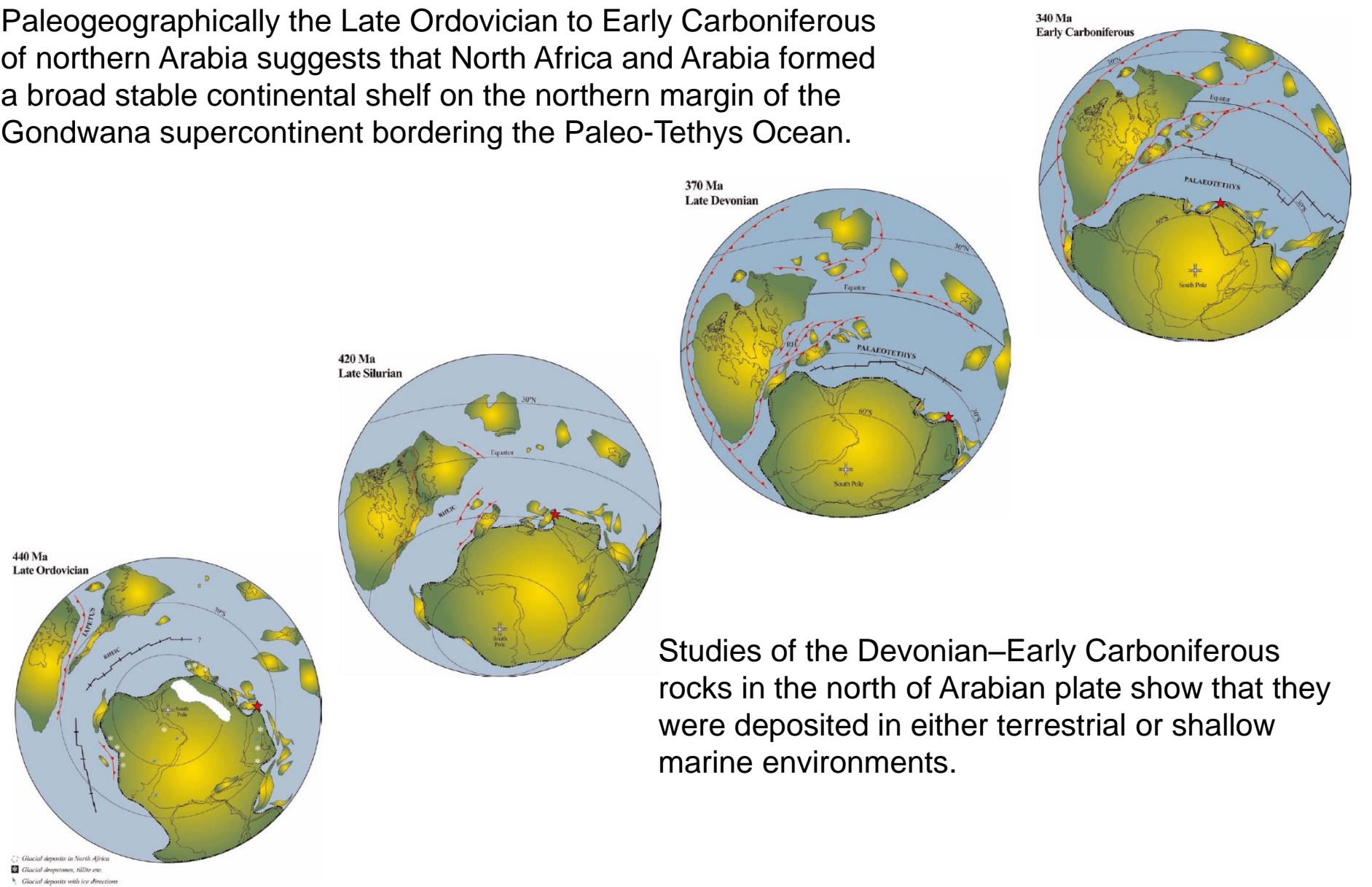
The Sinai and Hakkari assemblages show a strong similarity, both being dominated by small solitary non-disseminated corals.



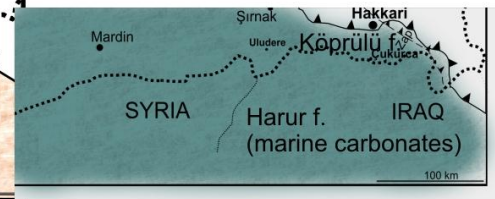
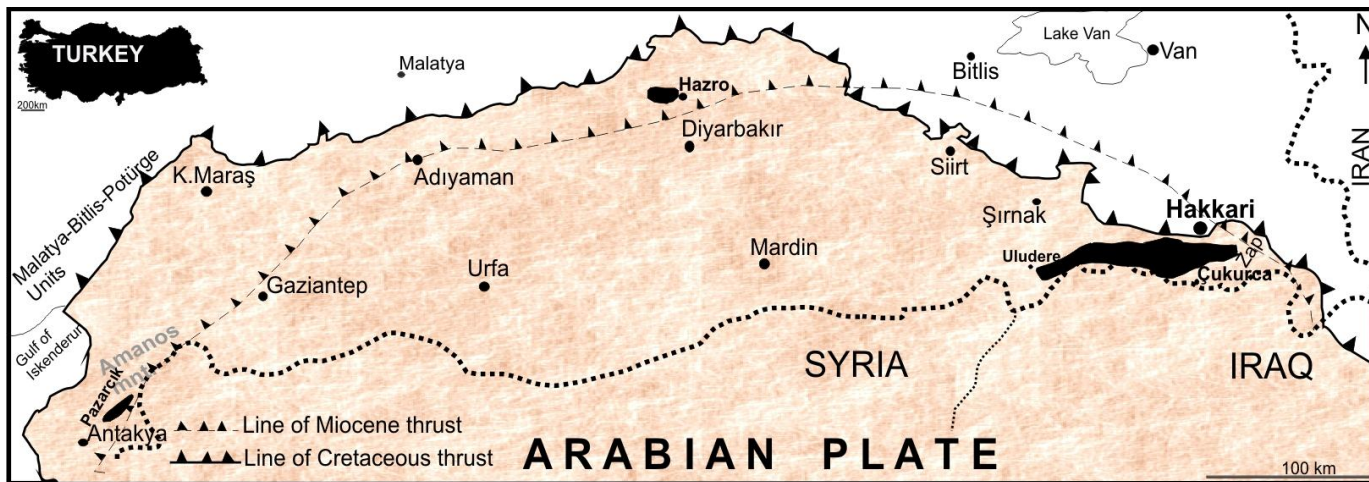
Legend: ADH: Apulia–Dinarids–Hellenids group of terranes, Afr: Africa, Ant: Antarctica, Ara: Arabian Plate, Ava: Avalonia, Bal: Baltica, EHT: group of European Hunic Terranes (including Armorica, Aquitania, Ossa-Morena, Cantabria, Adria, Anatolia, etc., see Stampfli et al., 2002 for details). IC: Indochina, Ind: India, Kaz: Kazakhstan, KT: Karakum-Turan, Nam: North America, Nch: North China Block, NT: North Tibet, Sam: South America, Sch: South China Block, Sib: Siberia, Tm: Tarim.



Paleogeographically the Late Ordovician to Early Carboniferous of northern Arabia suggests that North Africa and Arabia formed a broad stable continental shelf on the northern margin of the Gondwana supercontinent bordering the Paleo-Tethys Ocean.



Studies of the Devonian–Early Carboniferous rocks in the north of Arabian plate show that they were deposited in either terrestrial or shallow marine environments.



GROUP	A G E			Region	Amanos-Pazarcık (N. of Antakya)	Hazro-Diyarbakır	Uludere-Şirnak	Zap Valley	Çukurca-Hakkari	Iraq	Syria
	Z A P	Carboniferous	Low.								
DIARBKIR	Devonian	Low.	Visean								
			Tournaisian								KÖPRÜLÜ F.
			Famennian								YİĞİRLİ F.
			Frasnian								
			Givetian								
		Mid.	Upp.	Eifelian							
				Emsian							
				Pragian							
				Lochkovian							



Typical shallow-marine deposits- mixed siliciclastic-carbonate facies-are recorded in southern Turkey, northern Syria and northern Iraq. The Kaista Formation is composed mostly of sandstones with minor shales and carbonates. The Ora Formation consists of marine shales and minor carbonates in most parts of Iraq, except around the type area of Ora, where the carbonates are thicker. Towards Syria the formation becomes dominated by sandstone. The Harur Formation consists of shallow marine carbonates and clastics, thickest in Syria (200 m). (Juboury & Hadidy, 2008; Gourvennec & Hoşgör, 2012, Hoşgör et. al, 2012).



# Conclusions

- Brachiopods recently collected from the Zap River Valley area –Köprülü section (SE Turkey) allow to establish a Middle Devonian (upper Givetian) age for the upper middle part of the Yığınlı Formation which was until now considered as Famennian on the basis of its micropaleontological contents and of its relative position in the series.
- In the Hakkari area (SE Turkey), the Early Carboniferous, represented by the Köprülü Formation, crops out in the Zap sections and Sort Dere section in the Zap river valley. The Köprülü Formation was measured and investigated along the Zap 1 and Zap 2 sections located on the north-east of Köprülü village. The Köprülü Formation can be subdivided into three new members.
- The lower member is made of dark to grayish limestone and sandy limestone representing the transgressive phase covering the continental deposits of the Yığınlı Formation. The corals described here were collected in this member. The coral assemblage is mainly composed of small nondissepimented solitary corals belonging to the genera *Rotiphyllum*, *Zaphrentes*, cf. *Gorizdronia*, gen. et sp. indet. and *Amplexizaphrentis*, including a new species, *A. zapense*, and the dissepimented coral *Caninia* aff. *cornucopiae*. The middle member is composed of thinly laminated dark grey calcareous shales and siltstone. Several sandstone layers are also intercalated. The upper part of this middle member is characterized by carbonate concretions embedded in sandy limestone. The fossils, including bivalves are well preserved in this member. The myalinid bivalves, with a few posidonid bivalves have been observed in dark grey calcareous shale horizons. The upper member is dominated by massive grayish sandy/dolomitic limestone with some dark shale intercalations.
- At the generic level, the taxa from Zap Anticline are known in many other areas of the world, a situation that was expected in the context of increasing cosmopolitanism observed during the Givetian and later.
- The coral assemblage is similar to that described from the Sinai Peninsula (NE Egypt). The Sinai and Hakkari area were part, during the Early Carboniferous, of the northern margin of the Gondwana, and edged northward by a carbonate platform, today dismembered and incorporated in the Alpino-Himalayan orogen within the Turkish Taurides, northern Iran and Afghanistan. Those areas contain coral assemblages sharing several taxa with the Hakkari and Sinai but have a higher diversity. The Köprülü Formation gives an idea of the coral fauna that lived in the southern Arabian mixed carbonate–siliciclastic platform.
- The remaining genera are worldwide distributed. These data are consistent with the closure of the Rheic between Gondwana and Laurussia at this time and with a relatively narrow, incipient Palaeotethys.