



Supplementary material: The Middle to Late Triassic of Central Saudi Arabia with emphasis on the Jilh Formation. Part I: lithostratigraphy, facies and paleoenvironments, palaeontology and biostratigraphic age calibration from outcrop studies

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A. Correlation of simplified lithostratigraphic sections of the Jilh Formation [modified from Le Nindre *et al.*, 1987, 1990a], completed by the Mudarraaj-Didah section and by the marker fossils

Location and list of the key fossils with given age

Colours for fossil types (tables):

Molluscs (ammonoids, *Myophoria*)

Conodonts

Flora, Palynomorphs

Other (forams)

Colours for ages (samples):

Norian

Carnian undifferentiated (*P. polygnathiformis*)

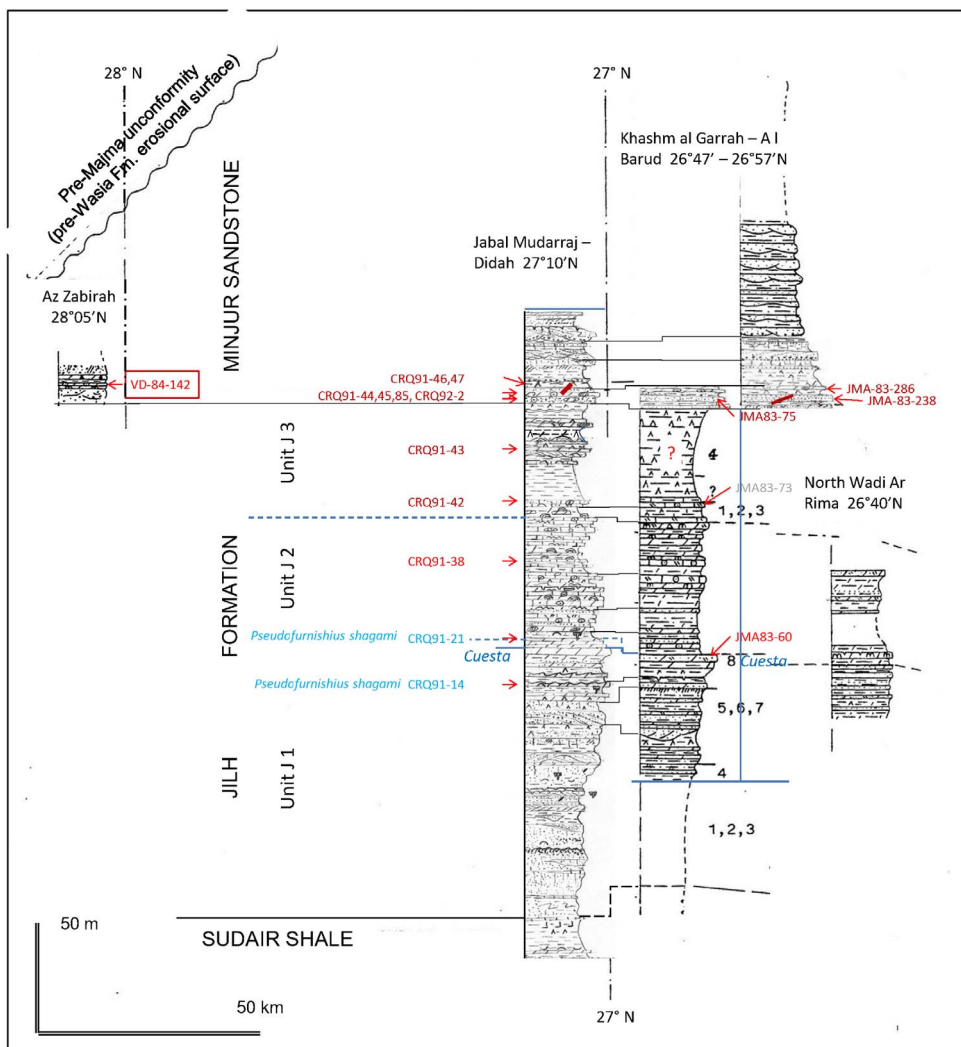
Tuvalian

Julian

(Early and Late) Ladinian—(*Pseudofurnishius*)

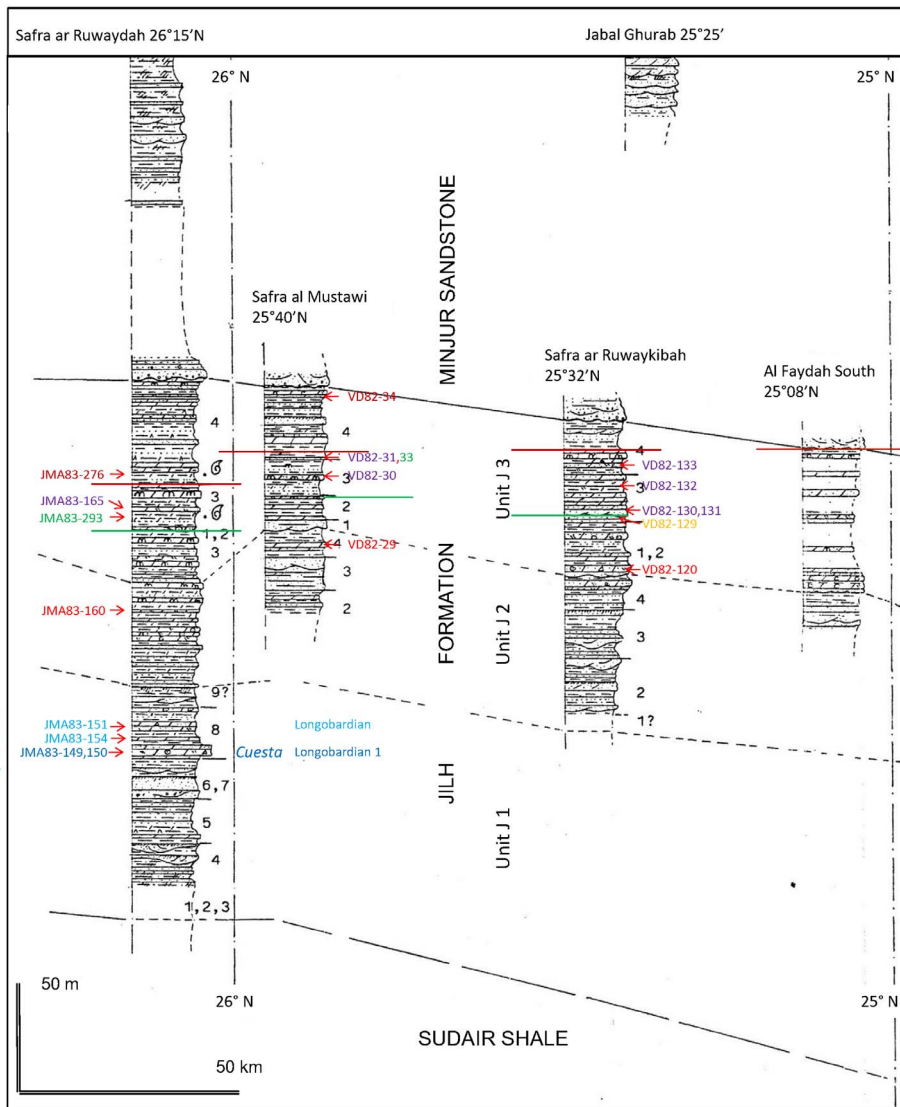
(Late) Ladinian—(*Budurovignathus*)

Anisian (Palynoflora)



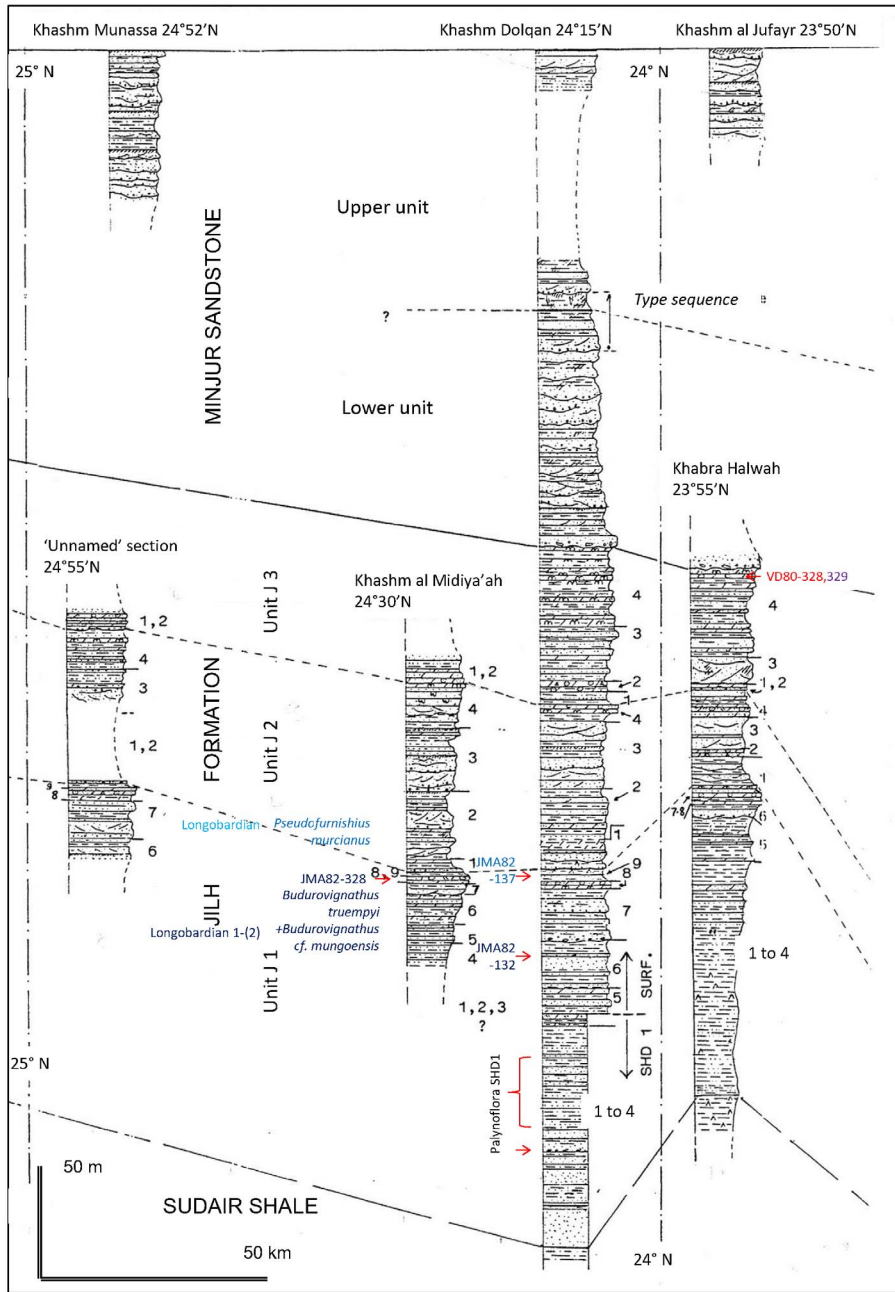
Estimated age	Sample number	Microfauna /flora
Norian	CRQ91-46,47	<i>Camerospores tenuis</i> , <i>Ovalipollis pseudoalatus</i> , and <i>Spiritisporites spirabilis</i>
	JMA-83-238	Site of tree trunks deposit
Alaunian (Late?)	VD-84-142	<i>Epigondolella abneptis</i> (Huckriede)
	JMA-83-286	<i>Epigondolella abneptis</i> and some ichthyoliths
Alaunian 1	CRQ91-45	<i>Ancyrogondolella praeslovakensis</i> , <i>A. ex gr. uniformis</i> , <i>Epigondolella abneptis</i>
	CRQ91-42,43,44,85, CRQ92-2	<i>Ancyrogondolella praeslovakensis</i> Kozur, Masset & Moix, and <i>A. ex gr. uniformis</i>
Reworked from Carnian in Norian	JMA83-75	<i>Involutina eomesozoica</i> (Oberhauser) (eq. CRQ91-44)
(eq. CRQ91-42)	JMA83-73	Rich fauna with <i>Nodosariidae</i> (eq. CRQ91-42)
Late Early Carnian	CRQ91-38	<i>Mazzaella carnica</i> ((<i>Krystlyn</i>))
Early Mid to Late Ladinian	CRQ91-21	<i>Pseudofurnishius shagami</i> (Benjamin & Cheepstow-Lusti)
	CRQ91-14	<i>Pseudofurnishius shagami</i> (Benjamin & Cheepstow-Lusti)
Reworked from Permian in Ladinian	JMA83-60	<i>Globivalvulina</i> sp., " <i>Nodosaria</i> " sp., and <i>Glomospira</i> sp. ("cf <i>Meandrospira</i> ")

Plate A.1. Correlation of lithostratigraphic sections and key fossils from latitudes 28°05'N to 26°30'N (Qibah and Buraydah north quadrangles).



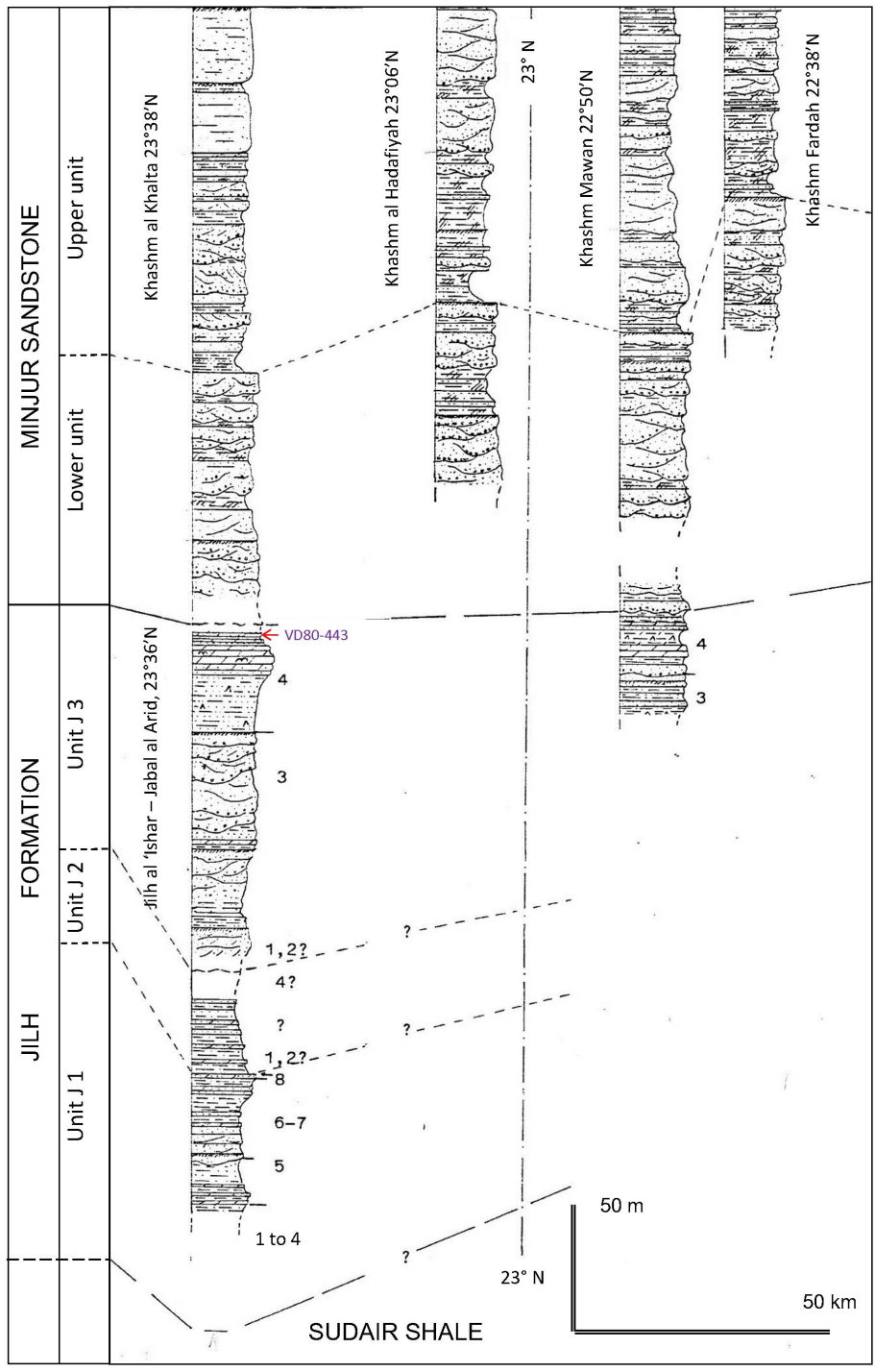
Estimated age	Sample number	Micro/macrofauna /flora
Middle Norian /Alaunian 1	JMA83-276	<i>Anatibetites kelvini</i> Mojs., <i>Paratibetites cf geikiei</i> Mojsisovics sp.
Norian	VD82-34	<i>Epigondolella abneptis</i> (Huckriede)
Tuvalian 1-2/1	JMA83-293	<i>Pleurotropites sp.ind.</i> , <i>Sirenites sp.</i> , <i>Shastites sp</i>
Tuvalian 1-2/1	YLN16-056 (lateral)	<i>Pleurotropites sp.</i>
Tuvalian 2	VD82-33	<i>Carnepigondolella carpathica</i> (Mock), <i>Quadralella polygnathiformis</i>
Carnian	VD82-30,31	<i>Quadralella polygnathiformis</i> (Budurov and Stefanov)
Carnian	VD82-130,131,132,133	<i>Quadralella polygnathiformis</i> (Budurov and Stefanov)
Carnian	JMA83-165	<i>Quadralella polygnathiformis</i> (Budurov and Stefanov), echinoderms, bryozoa
Julian	JMA83-160	<i>Mazaella carnica</i> (Krystyn), <i>Quadralella polygnathiformis</i>
Julian	VD82-29	<i>Mazaella carnica</i> (Krystyn)
Julian	VD82-129	<i>Metapolygnathus aff. auriformis</i> (Kovacs), <i>Quadralella polygnathiformis</i>
Julian	VD82-120	<i>Mazaella carnica</i> (Krystyn)
Late Ladinian	JMA83-154,151	<i>Pseudofurnishius murcianus</i> Van Den Boogaard
Late Ladinian	JMA83-149,150	<i>Budurovignathus truempyi</i> (Hirsch)
		*Conodonts from Safra ar Ruwaykibah associated with foraminifers and ichtyoliths

Plate A.2. Correlation of lithostratigraphic sections and key fossils from latitudes 26°30'N to 25°00'N (Buraydah south and Al Faydah quadrangles).



Estimated age	Sample number	Micro/macrofauna /flora
Carnian	VD80-329	<i>Quadralella polygnathiformis</i> (Budurov and Stefanov)
Julian	VD80-328	<i>Paragondolella inclinata</i> Kovacs, <i>Quadralella polygnathiformis</i>
Late Ladinian	JMA82-328	<i>Budurovignathus truempyi</i> (Hirsch), <i>Budurovignathus cf. mungoensis</i> (Diebel)
Ladinian	JMA82-137	<i>Pseudofurnishius murcianus</i> Van Den Boogaard
Anisian	JMA82-132	<i>Myophoria goldfussi</i> (Alberti)
Anisian	J1-4 SHD1	<i>Densoisporites nejburgii</i> (Schulze) Balme, <i>Alisporites cf. opti</i> Daguerty, <i>Camerospirites cf. pseudoverrucatus</i> Scheuring, <i>Platysaccus cf. queenslandii</i> De Jersey.

Plate A.3. Correlation of lithostratigraphic sections and key fossils from latitudes 25°00'N to 23°45'N (Darm and Ar Rayn north quadrangles).



Estimated age	Sample number	Micro/macrofauna /flora
Carnian	VD80-443	<i>Quadrellela polygnathiformis</i> (Budurov and Stefanov)

Plate A.4. Correlation of lithostratigraphic sections and key fossils from latitudes 23°45'N to 22°30'N (Ar Rayn and Al Mulayh north quadrangles).

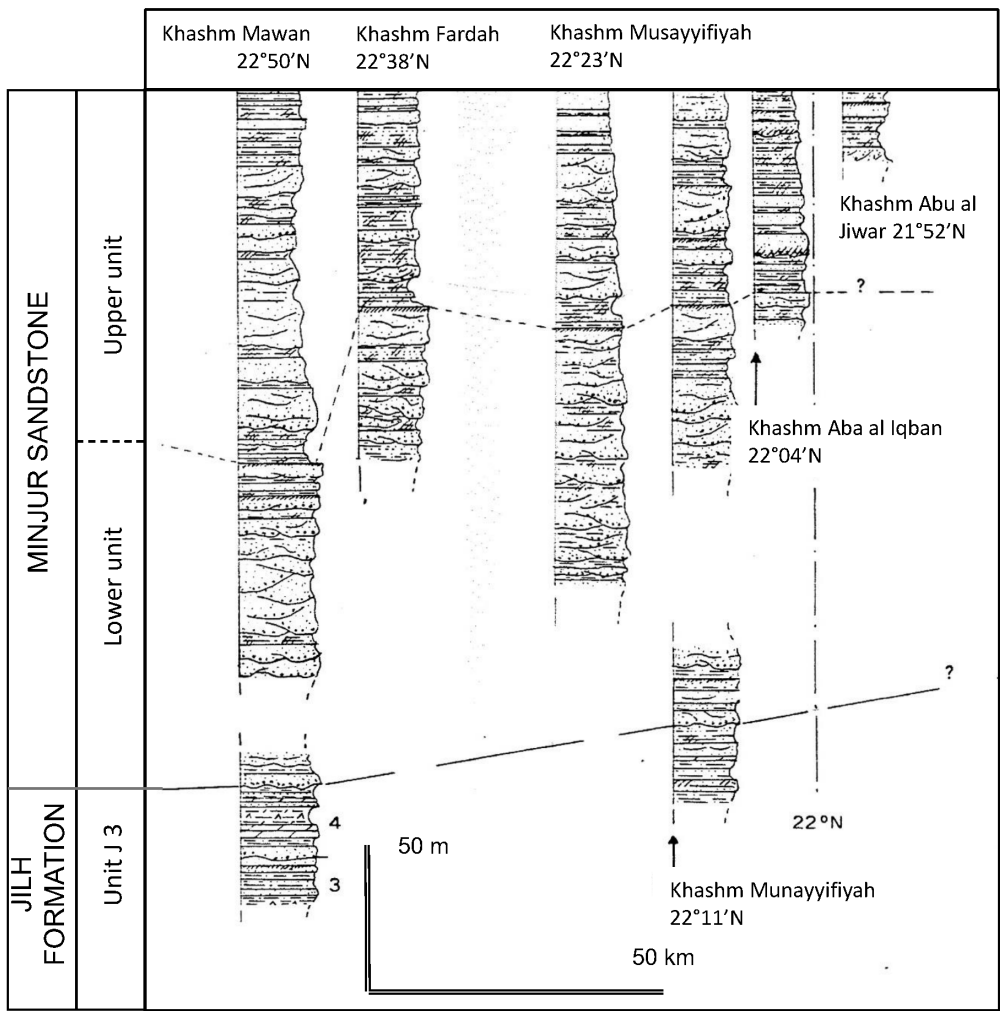


Plate A.5. Correlation of lithostratigraphic sections from latitudes 22°50'N to 21°50'N (Al Mulayh and Sulayyimah north quadrangles).

B. Lithostratigraphic sections of the Jilh Formation at Jabal Mudarra-j-Didah, 27°10'N, 43°44'E, reference section of the Jilh Formation for the Qibah quadrangle (27G) and Ar Rubay'iyah, 26°23'N, 44°14'E, Buraydah quadrangle (26G)

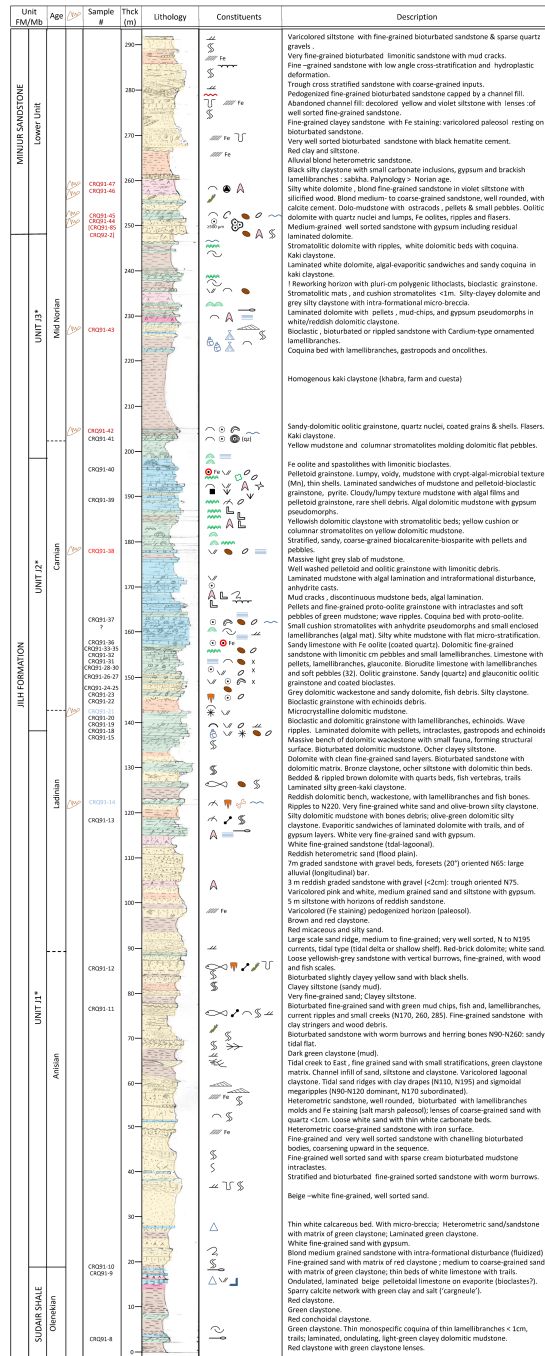


Plate B.1. Continued on next page.

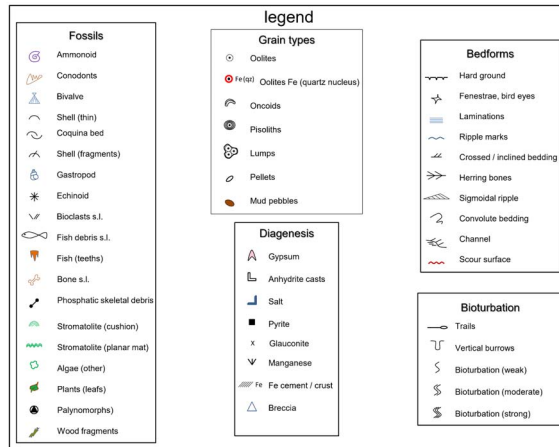


Plate B.1 (cont.). Reference lithostratigraphic section of the Jilh Formation for the Qibah quadrangle (27G) at Jabal Mudarraġ-Didah 27°10'N, 43°44'E to 27°09'N, 44°02'E. Measured by Y. M. Le Nindre, C. Robelin, D. Janjou, J. Gouyet, December 1991.

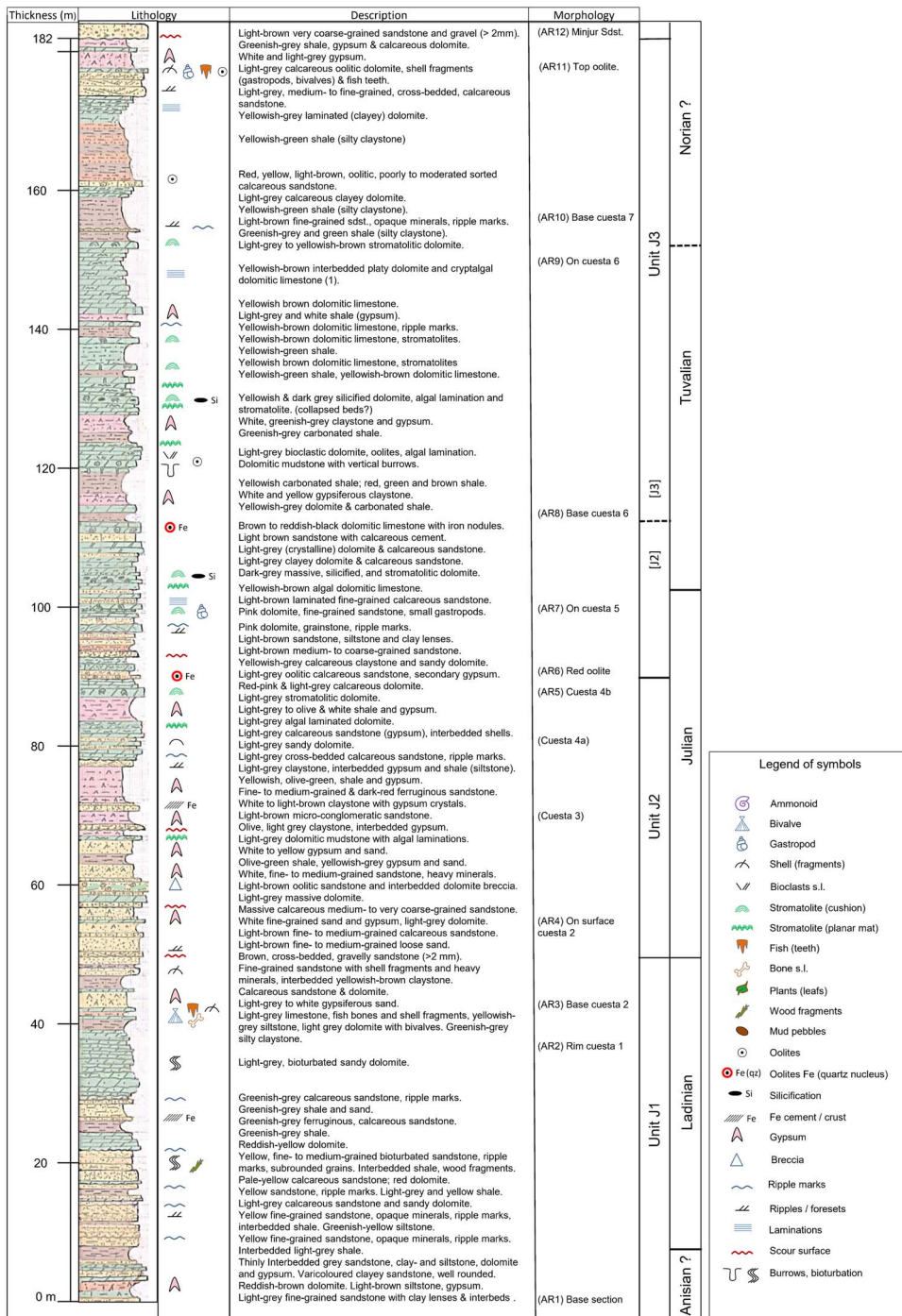


Plate B.2. Lithostratigraphic section of the Jilh Formation at Ar Rubay'iyah, 26°23'N, 44°14'E, Buraydah quadrangle. Measured in 2016 by Saudi Geological Survey (A. Memesh, S. Dini and A.Nabhan) logged at 1:500 by Y. M. Le Nindre.

C. Paleontological Plates

Plates C.1 to C.3: Tuvalian Tropitidae of the Buraydah quadrangle YLN16-056 and JMA83-293

Plate C.4 to C.6: Norian Tibetitidae of the Buraydah quadrangle JMA83-276

Plate C.7: Specimens of the Ladinian conodont *Pseudofurnishius murcianus*

Plate C.8: Ladinian conodonts of the Qibah quadrangle CRQ91-14 and CRQ91-21

Plate C.9: Carnian conodonts of the Qibah quadrangle CRQ91-38

Plate C.10: Norian conodonts of the Qibah quadrangle CRQ91-42 and CRQ91-45

The final identifications of ammonoids specimens were done by Leopold Krystyn (this study).

The specimens examined by Edward Timothy (Tim) Tozer are from the collection of NRCan, thanks to James W. Haggart Geological Survey of Canada, Vancouver, British Columbia, and from the collection of the Université Claude Bernard, Lyon, France. Comparable specimens, not photographed, were also examined by Leopold Krystyn.



Plate C.1. Sample YLN16-056. (Jilh J3, Saudi Arabia). Tropitid collected in the field in November 2016— $26^{\circ}21'37.00''\text{N}$, $44^{\circ}20'10.00''\text{E}$. Lateral and ventral views: *Pleurotropites* sp., (Tuvalian 1, *Tropites dilleri* zone) determination by Leopold Krystyn. Photographs by Y. M. Le Nindre. (Thanks to Saudi Aramco for providing field access). Previously identified by Prof. Dr. Hugo Bucher (Paläontologisches Institut und Museum, Universität Zürich) as ?*Discotropites* (Late Carnian). This specimen may be compared to the very similar JMA83-293 labelled by Tozer as “*Rectitropites*”.

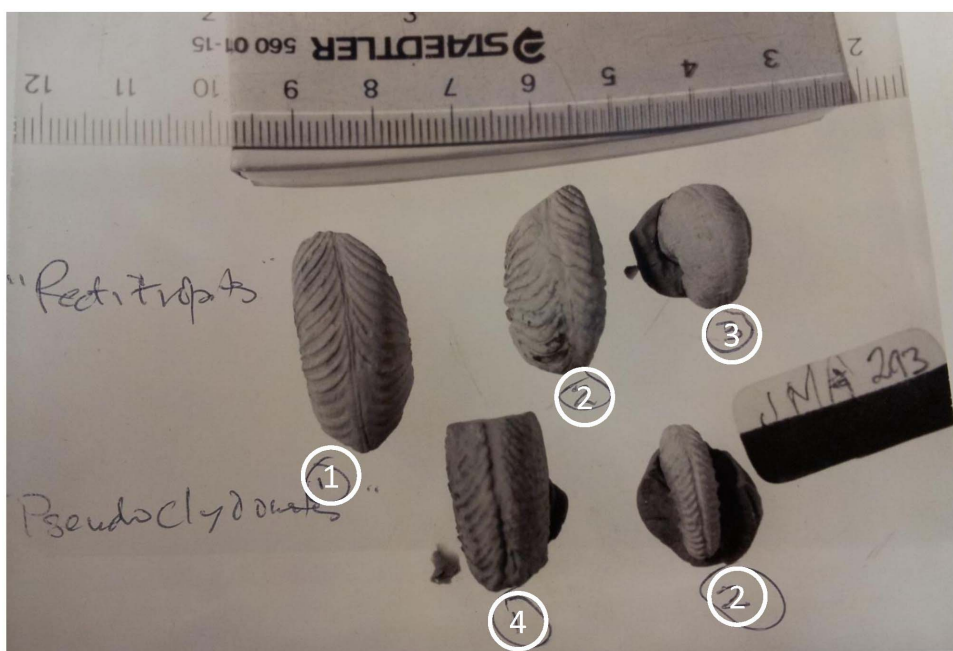
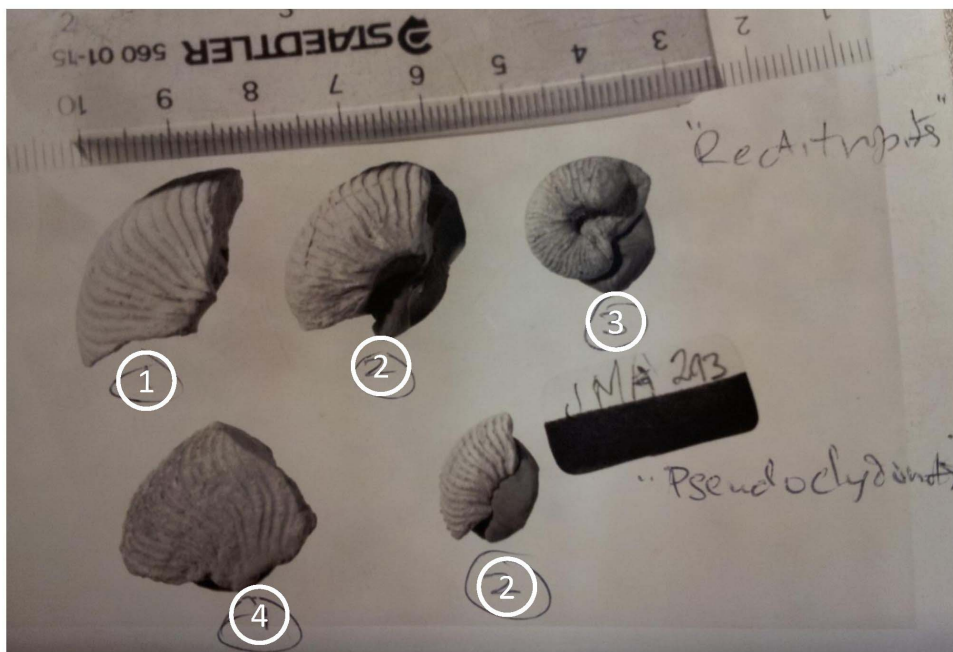


Plate C.2. Sample JMA83-293. (Jilh J3, Saudi Arabia, Arabia ~18 m under JMA83-276, ~60 m under top formation). Tropitids fauna ("Clydonites-like", Carnian) from the Tozer collection annotated by the author. Lateral and ventral views. (Photographs by James W. Haggart, NRCan, Geological Survey of Canada, Vancouver, British Columbia). 1, 3: *Pleurotropites* sp.; 2, 4: *Shastites* sp. ind. (Tuvalian 1, *Tropites dilleri* zone). Determination by Leopold Krystyn.



Plate C.3. Sample JMA83-293. (Jilh J3). 1: *Pleurotropites* sp., lateral and upper views; 2: *Shastites* sp., lateral and upper views; (Tuvalian 1, *Tropites dilleri* zone) determination by Leopold Krystyn. Labelled by Tozer as possible “Pseudoclydonites” and “Rectitropites” (fragment of whorl), from the collection of the Université Claude Bernard, Lyon, France (FSL 179 143 & FSL 179 138). Photographs by Raymond Enay.

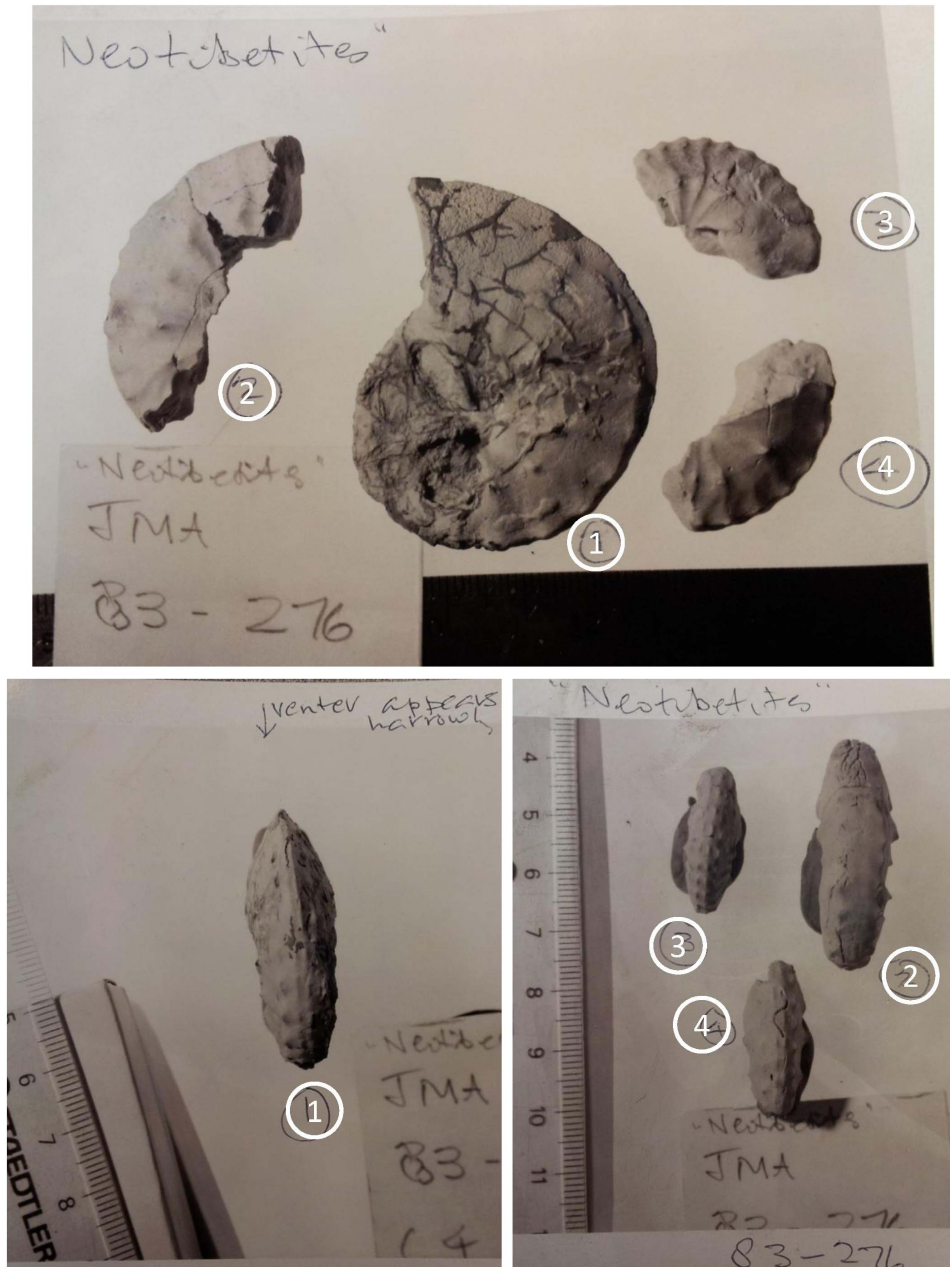


Plate C.4. Sample JMA83-276. (Jilh J3, Saudi Arabia, ~42 m under top formation). Specimens from the Tozer's collection annotated by the author as possible "Neotibetites", lateral and ventral views. (Photographs by James W. Haggart, Geological Survey of Canada, Vancouver, British Columbia). 1: *Paratibetites* cf. *geikiei* Mojsisovics; 2: *Anatibetites* cf. *kelvini* Mojsisovics; 3, 4: *Paratibetites* sp. Ind. Determination by Leopold Krystyn.

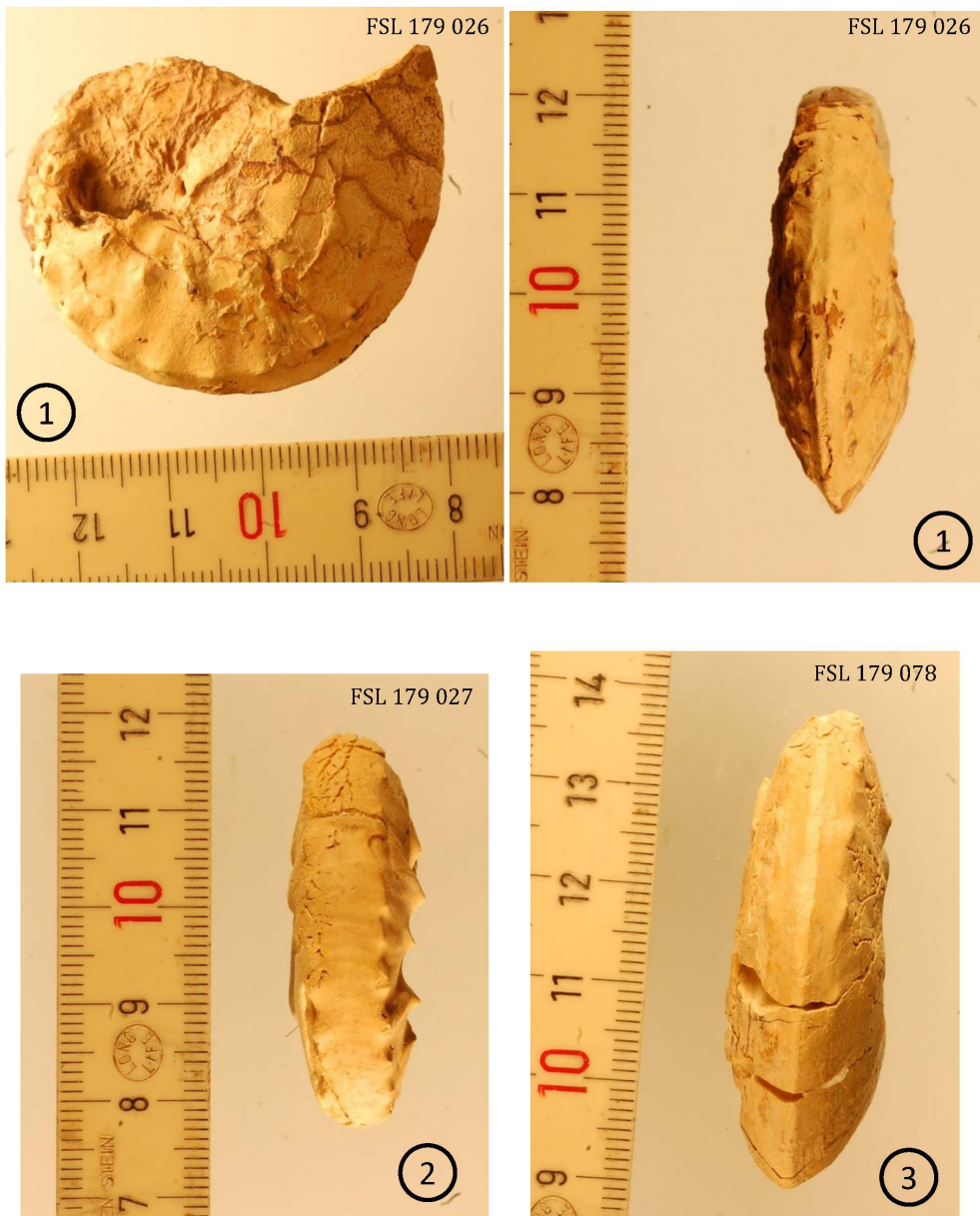


Plate C.5. Sample JMA83-276. (Jilh J3 Saudi Arabia, ~18 m above JMA83-293). Specimens from the collection of the Université Claude Bernard, Lyon, France (FSL 179 026, FSL 179 027; FSL 179 078). 1: *Paratibetites* cf. *geikiei* Mojs.; 2: *Anatibetites* cf. *kelvini* Mojs.; 3: *Paratibetites* sp. Ind. Middle Norian. Determination by Leopold Krystyn. To be compared with specimens of the same sample of the Tozer's collection, identified by the author as possible "Neotibetites" and "Tibetites" ("tuberculate with a more or less trapezoidal whorl section") late Mid Norian? (Lateral and ventral views—Photographs by Raymond Enay).



Plate C.6. Sample JMA83-276. (Jilh Unit J3, Saudi Arabia). Other specimens from the Tozer's collection, lateral and ventral views. (Courtesy NRCan, photograph by James W. Haggart, Geological Survey of Canada, Vancouver, British Columbia). *Metacarnites?* sp. ind. of probable Alaunian 1 (lower Middle Norian) age. Determination by Leopold Krystyn.

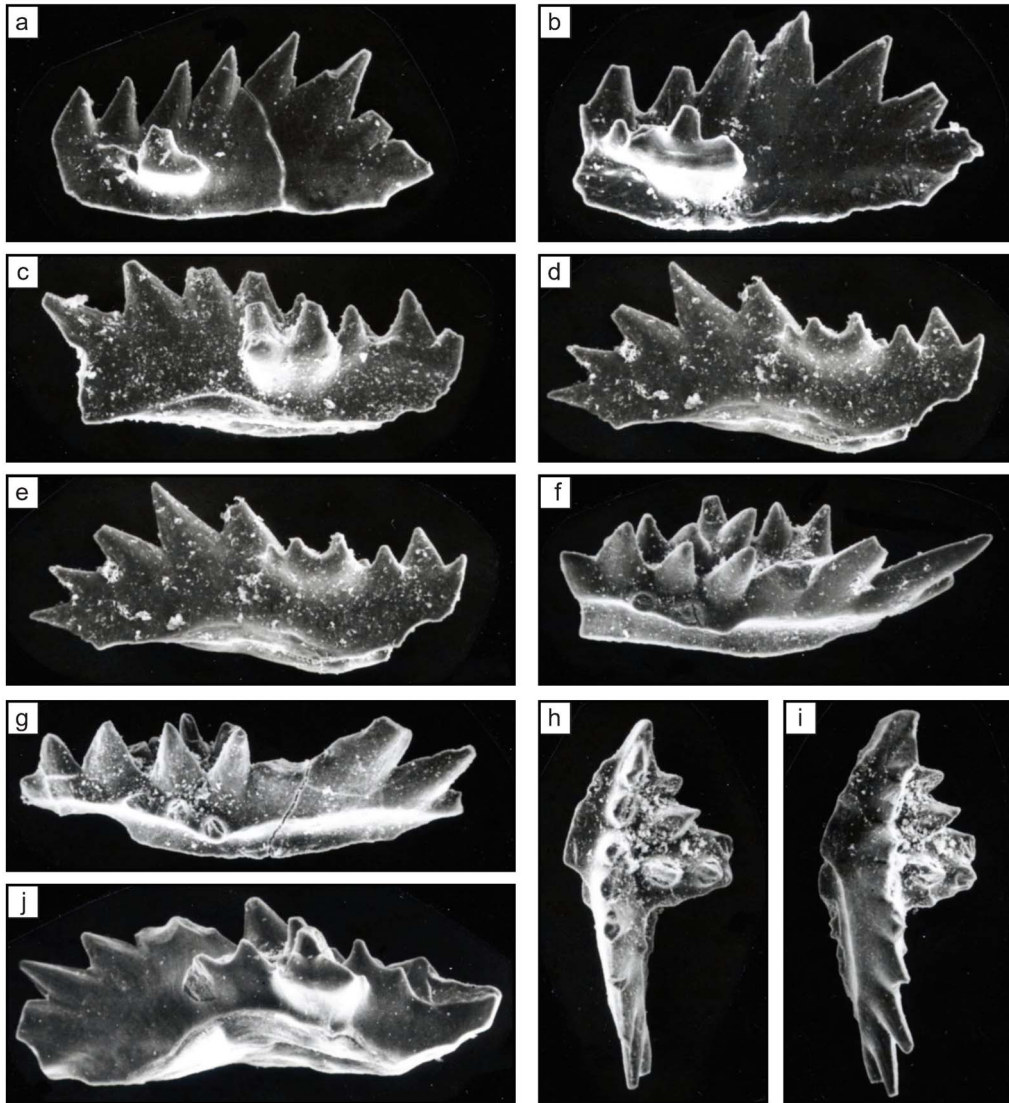


Plate C.7. Specimens of *P. murcianus* indicating quality, enlargement, specimen number in author archives, and field sample number. Photos by B. Vrielynck. (a) *Pseudofurnishius murcianus* Van Den Boogaard. Small form, lateral view. X 140. Specimen p1-10. Sample JMA83-151. (b) *Pseudofurnishius murcianus* Van Den Boogaard. Small form, lateral view. X 155. Specimen p1-5. Sample JMA83-151. (c) *Pseudofurnishius murcianus* Van Den Boogaard. Mature form, lateral view. X 130. Specimen p1-7. Sample JMA83-151. (d) *Pseudofurnishius murcianus* Van Den Boogaard. Mature form, lateral view. X 130. Specimen p1-4. Sample JMA83-154. (e) *Pseudofurnishius murcianus* Van Den Boogaard. Mature form, upper view. X 130. Specimen p1-7. Sample JMA83-151. (f) *Pseudofurnishius murcianus* Van Den Boogaard. Mature form, upper lateral view. X 130. Specimen p1-7. Sample JMA83-151. (g) *Pseudofurnishius murcianus* Van Den Boogaard. Mature form, upper lateral view. X 140. Specimen p1-8. Sample JMA83-151. (h) *Pseudofurnishius murcianus* Van Den Boogaard. Mature form, upper view. X 130. Specimen p1-12. Sample JMA83-151. (i) *Pseudofurnishius murcianus* Van Den Boogaard. Mature form, upper lateral view. X 130. Specimen p1-12. Sample JMA83-151. (j) *Pseudofurnishius murcianus* Van Den Boogaard. Mature form, lower lateral view. X 130. Specimen p1-1. Sample JMA82-137.

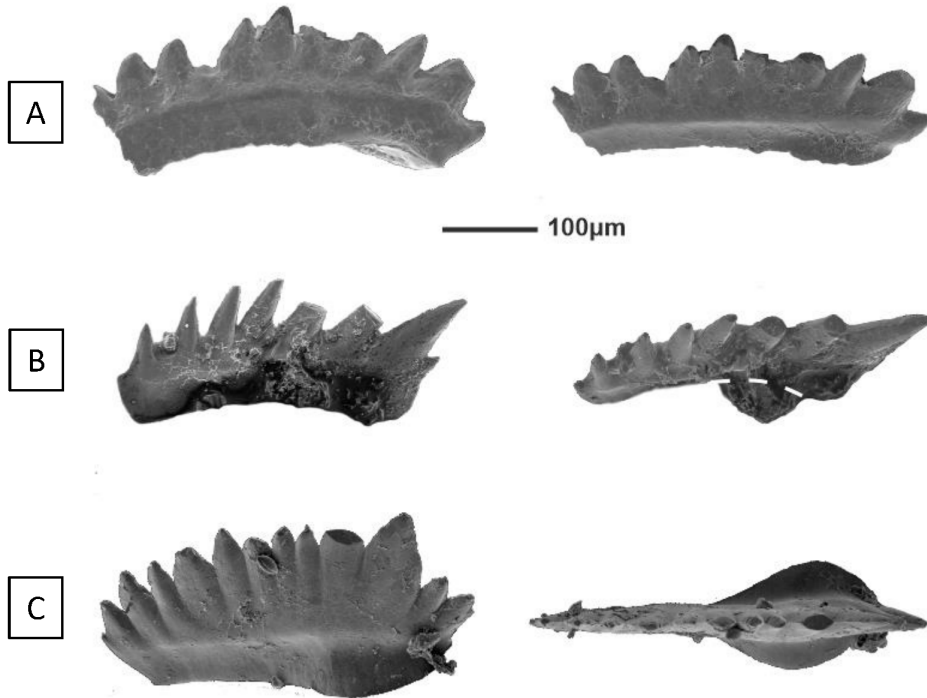


Plate C.8. Ladinian conodonts, Qibah quadrangle. (A) *Pseudofurnishius shagami* (Benjamin & Cheepstow-Lusti). Side and oblique views—Sample CRQ91-14. (B) *Pseudofurnishius shagami* (Benjamin & Cheepstow-Lusti). Side and oblique views—Sample CRQ91-21. (C) *Pseudofurnishius cf. shagami* (Benjamin & Cheepstow-Lusti). Transitional to *P. truempyi*. Side and oblique views—Sample CRQ91-21. (Photos by Leopold Krystyn, July 2022).

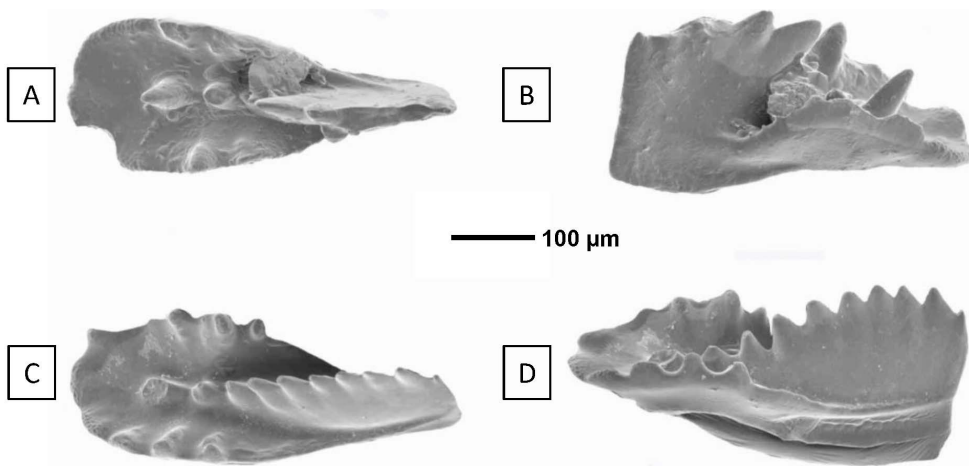


Plate C.9. Carnian conodonts, Qibah quadrangle. (A,C) *Mazzaella carnica* (Krystyn). Upper views—Sample CRQ91-38. (B,D) *Mazzaella carnica* (Krystyn). Side views—Sample CRQ91-38. (Photos by Leopold Krystyn, October 2022).

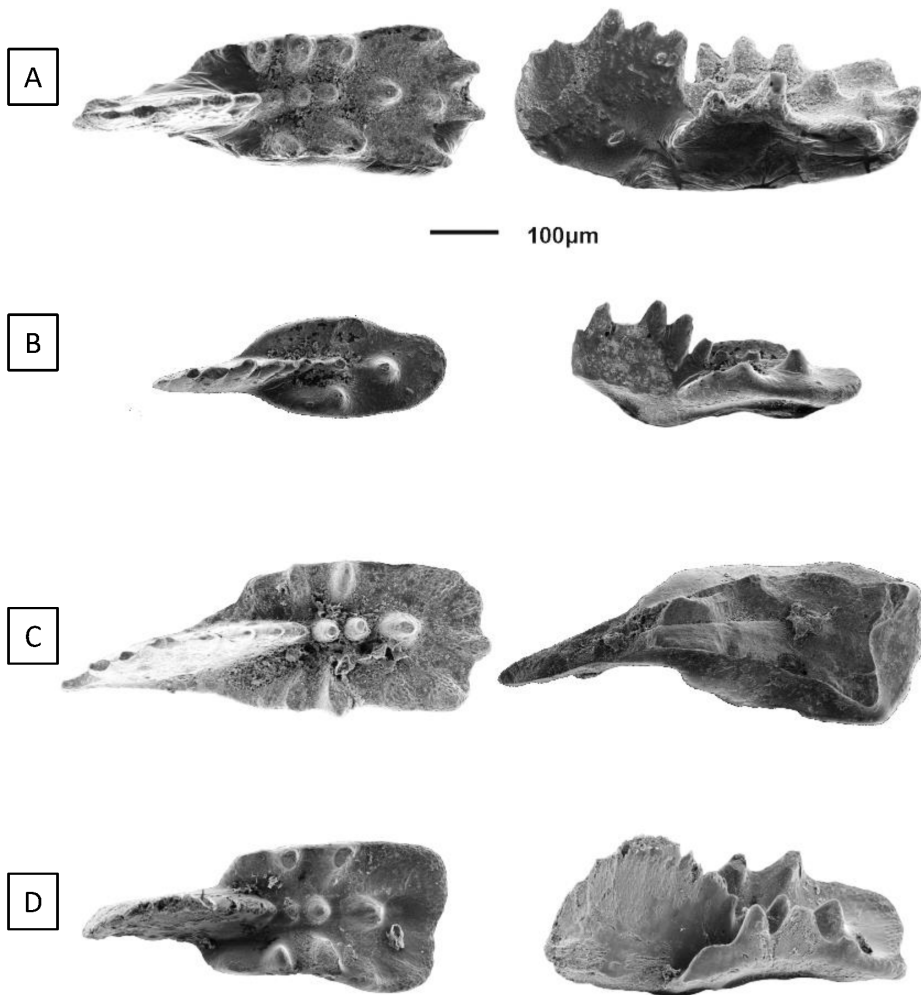


Plate C.10. Norian conodonts, Qibah quadrangle. (A) *Ancyrogondolella praeslovakensis* (Kozur, Masset & Moix). Upper and side view—Sample CRQ91-45. (B) *Epigondolella abneptis* (Huckriede) upper and side view—Sample CRQ91-45. (C) *Ancyrogondolella ex gr. uniformis* Orchard upper and lower view—Sample CRQ91-45. (D) *Ancyrogondolella ex gr. uniformis* Orchard upper and side view—Sample CRQ91-42. Photos by Leopold Krystyn, July 2022.