

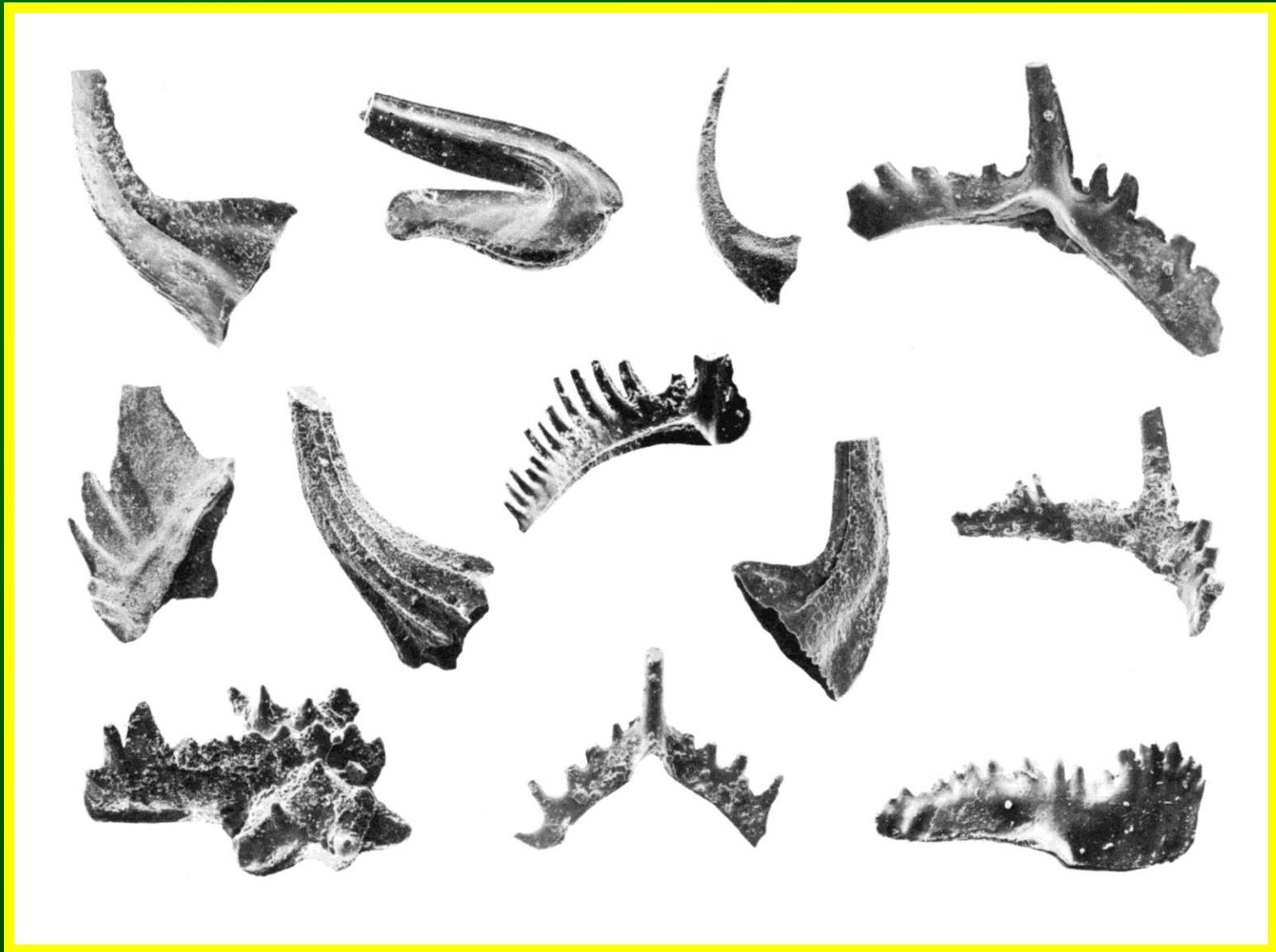
CONODONTI



Conodonti



Diverse morfologie di Conodonti



Distribuzione stratigrafica

Cambriano sup. - Triassico

Composizione mineralogica

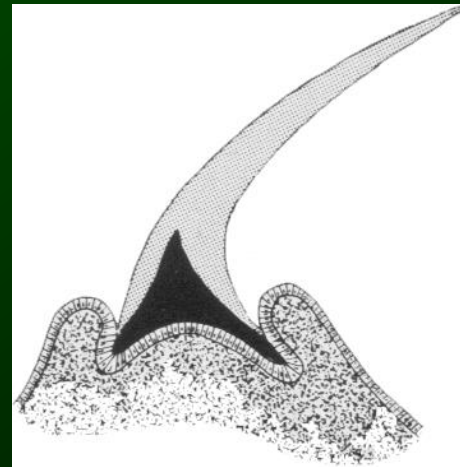
Apatite

Struttura del dente

Cartilagine basale

Smalto

Dentina



M
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CLASSIFICAZIONE ARTIFICIALE

Spathognathodus inclinatus inclinatus (Rhodes)

Ozarkodina media (Walliser)

Trichodella excavata (Branson & Mehl)

Neoprioniodus excavatus (Branson & Mehl)

Plectospathodus extensus (Rhodes)

Hindeodella equidentata (Rhodes)

A
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CLASSIFICAZIONE NATURALE

Anteriore ↑

ELEMENTI DISCERNENTI

SIMMETRIA

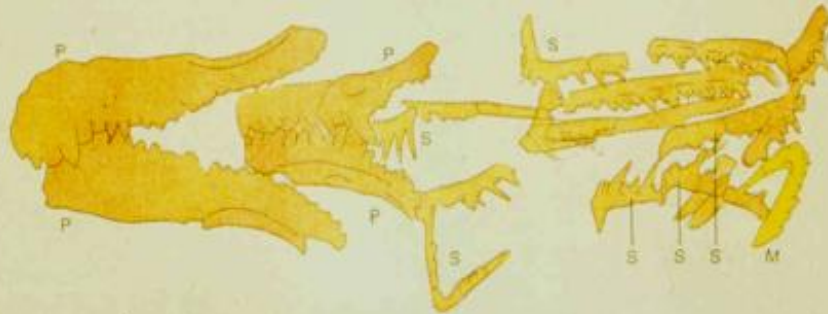
ELEMENTI CONTUNDENTI

Wurmiella excavata (Branson & Mehl)

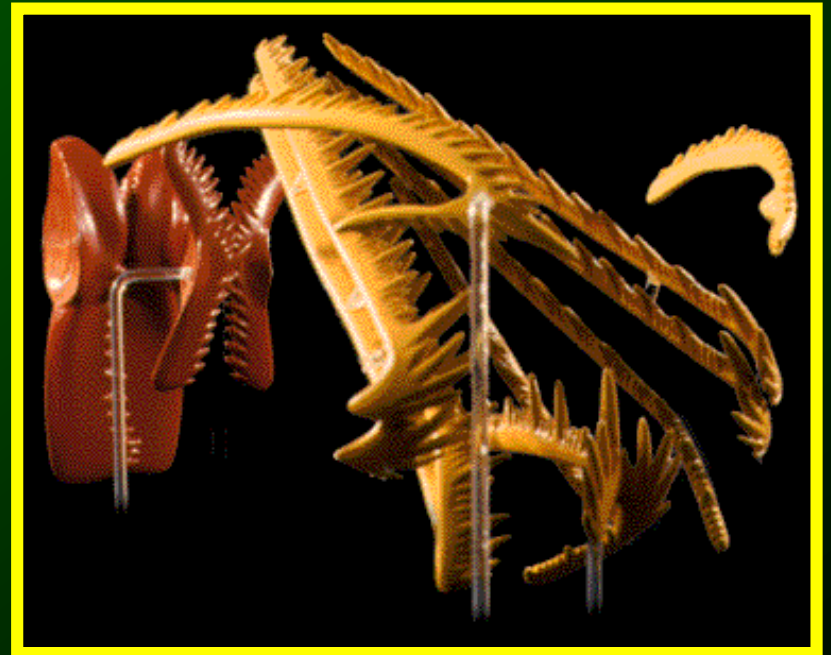
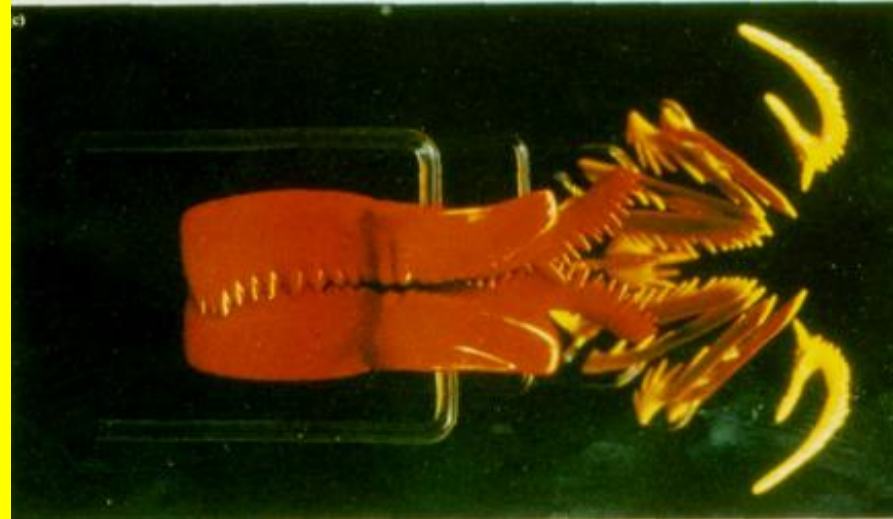
Conodonti



1 mm

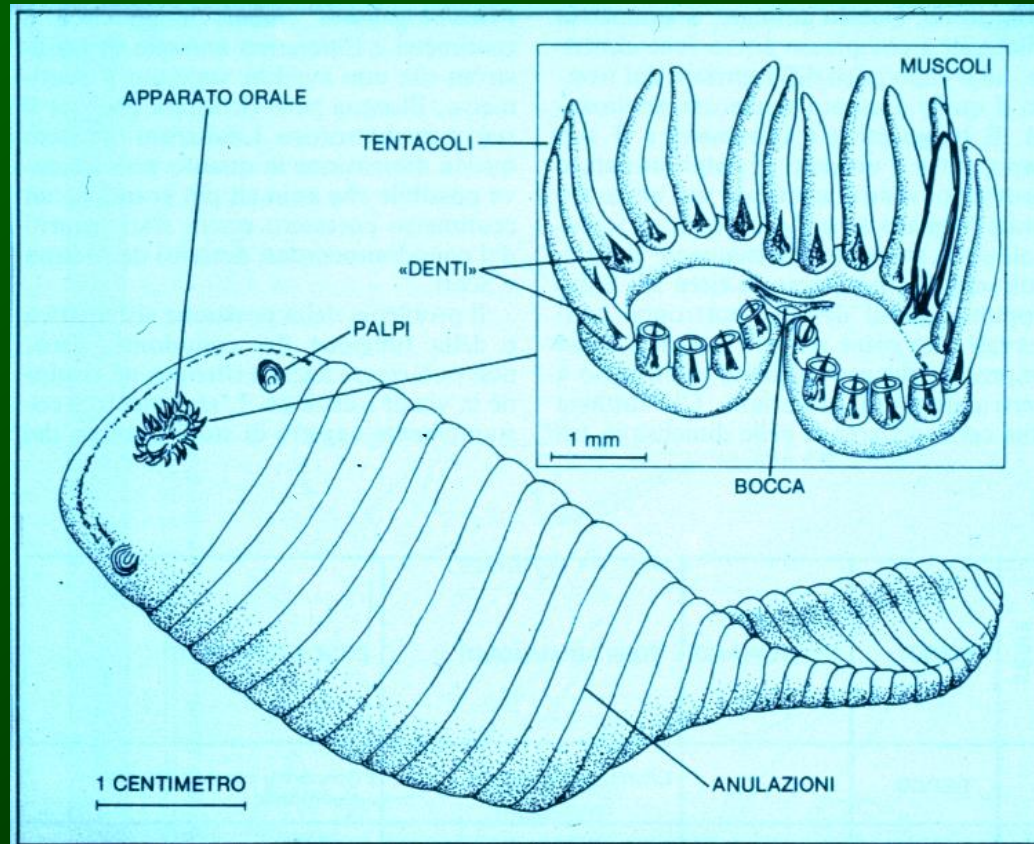


Idiognathodus sp.
Carbonifero sup. - USA



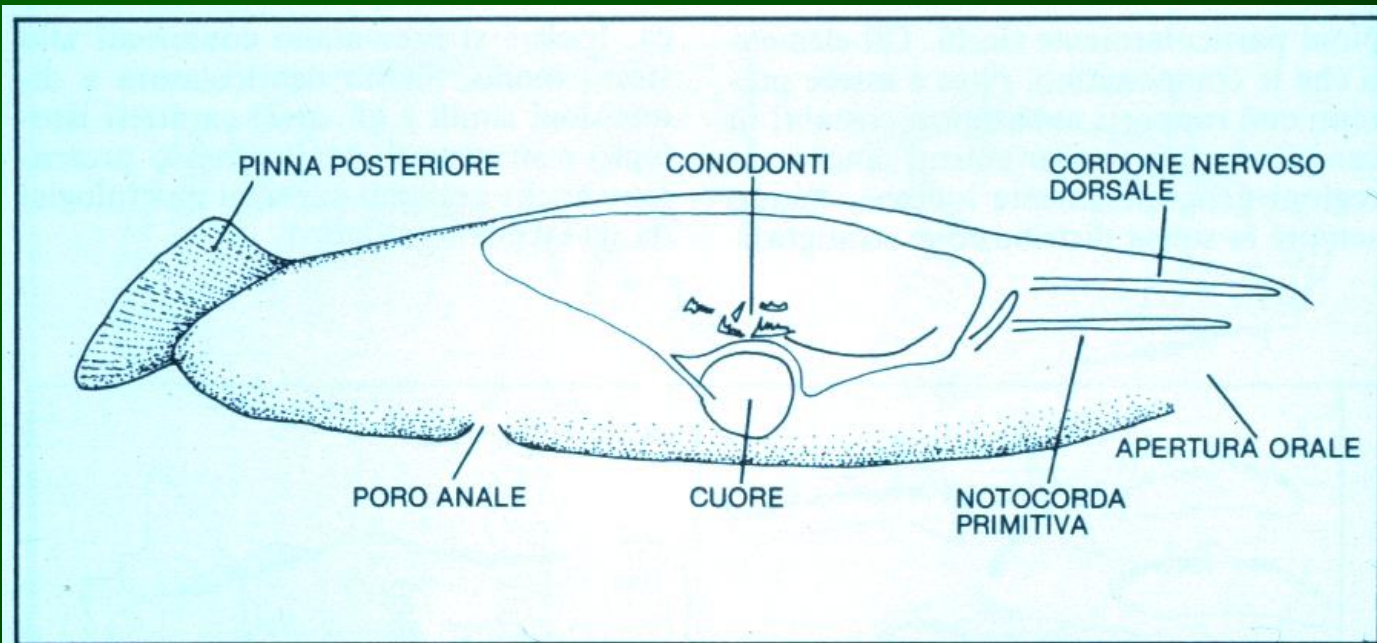
"Il problema delle affinità zoologiche di questo gruppo di organismi rimane ... uno dei problemi più affascinanti e di difficile soluzione della paleozoologia" (F.H.T. Rhodes, 1954)

Ipotesi errate



"Il problema delle affinità zoologiche di questo gruppo di organismi rimane ... uno dei problemi più affascinanti e di difficile soluzione della paleozoologia" (F.H.T. Rhodes, 1954)

Ipotesi errate



Ricostruzione e interpretazione della morfologia di *Lochriea wellsi* eseguita da W. Melton e H.W. Scott nel 1973. Questo animale, interpretato come conodontoforo, contiene singoli conodonti disposti irregolarmente all'interno di un probabile apparato digerente. Gli autori della ricostruzione hanno lavorato su materiale proveniente da formazioni carbonifere del Montana.

Ipotesi sulla affinità biologica

COELENTERATA

1973 Bischoff Conularia

TENTACULATA

1973 Lindström related to Brachiopoda

1976 Conway Morris

ARTHROPODA

1861 Harley cf. *Ceratiocaris*
(Malacostraca,
Phyllocarida)1867 Barrande *et al.* Crustacea and others
lower animals,
including trilobites

MOLLUSCA

1861 Owen "naked mollusks"?

1867 Owen Nudibranchia?

1875 Morse progenators of
Nudibranchia1875 Stimpson lingual teeth of Mollusca
1894 James mollusks1898 Woodward Nudibranchia or
Cephalopoda?

1936 Loomis Gastropoda

1937 Pilsbury molluscan teeth

1986 Tiller & Cuif Aplacophora

Ipotesi sulla affinità biologica

ANELLIDA

CHETOGNATHA

1861 Owen	Anellida?	1973 Rietschel	related to Chaetognatha
1867 Owen	Anellida?	1982 Szaniawski	Chaetognatha
1878 Ulrich	Anellida		
1886 Zittel & Rohon	Anellida		
1898 Woodward	Anellida?		
1934 Scott	anellid jaws	1969 Durden	class of Gnathostomulida
1934 Dubois	Anellida	1969 Ochielli & Cailleux	cf. Gnathostom.
1952 Rhodes	tend to support association with Anellida	1699 Rodgers	group of Gnathostom.

GNATHOSTOMULIDA

ASCHELMINTHES

PLANTS

1944 Denham	copulatory structures of Nematoda	1964 Fahlbusch	algae
1973 Missarzhevsky	Priapulida	1969 Nease	vascular plants, Conodontophyta
1974 Hofker	dental apparatus of Aschelminthes		

Ipotesi sulla affinità biologica

CHORDATA

1856 Pander	fishes	1954 Gross	Agnatha
1875 Newberry	teeth of Cyclostomi	1954 Rhodes	wormlike creatures or primitive vertebrates
1875 Agassiz	teeth of Selachii	1957 Rhodes & Wingard	primitive vertebrates related to <i>Archeognathus</i>
1879 Hinde	low type of fishes	1964 Schmidt	fishes
1882 Rolle	related to <i>Amphioxus</i>	1968 Halstaed	planktonic protovertebrates
1885 Clarke	myxinoid fish	1969 Scott	Agnatha
1921 Bryant	primitive type of fish	1973 Melton & Scott	Conodontochordata
1923 MacFarlane	Cyclostomata	1986 Aldridge <i>et al.</i>	close to hagfish
1926 Ulrich & Bassler	Pisces	1987 Nowlan & Carlisle	Cephalochordates
1928 Holmes	Pisces	1990 Kreisa <i>et al.</i>	Cyclostomes
1929 Kirk	Ostracodermi	1993 Aldridge <i>et al.</i>	close to hagfish
1932 Stauffer & Plummer	primitive fish	1995 Long	Protochordates
1934 Schmidt	Placodermi	1995 Purnell <i>et al.</i>	close to petromizontids
1936 Branson & Mehl	fish affinities	1995 Janvier	close to osteostracans
1939 Delmanet	<i>Coelacantus lepturus</i> (Crossopterygii)	1996 Kemp & Nicoll	close to cephalocordates
1949 Beckmann	fishes	1998 Aldridge <i>et al.</i>	sister group to hagfish
1950 Schmidt	Aphetohyoidea (Placodermi)	1998 J. Bergström <i>et al.</i>	segmented chordates

PHYLUM INDIPENDENTE

- 1981** **Clark**
- 1983** **Briggs *et al.***
- 1983** **Gould**
- 1987** **Clark**
- 1988** **Sweet**

OXFORD MONOGRAPHS ON
GEOLOGY AND GEOPHYSICS NO. 10

The Conodonta
Morphology, Taxonomy, Paleoecology,
and Evolutionary History
of a Long-Extinct Animal Phylum

Walter C. Sweet

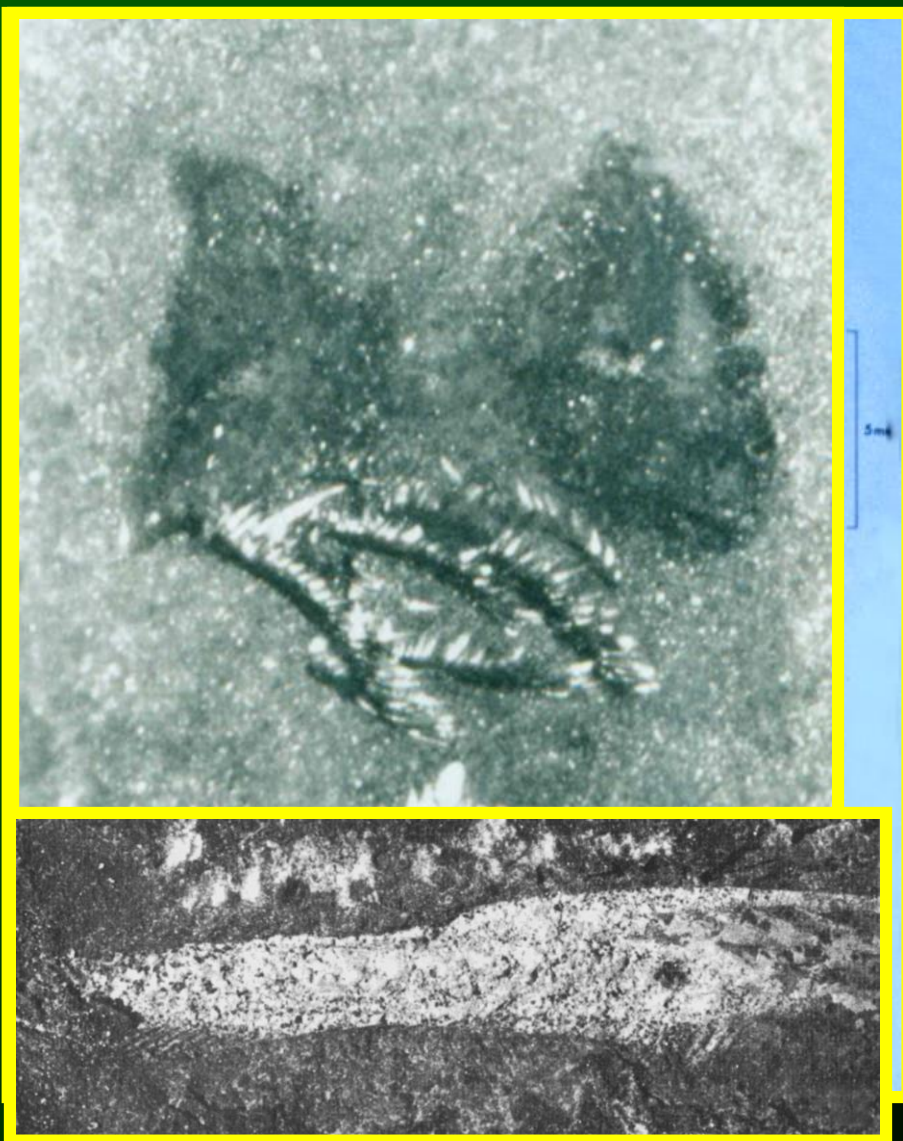
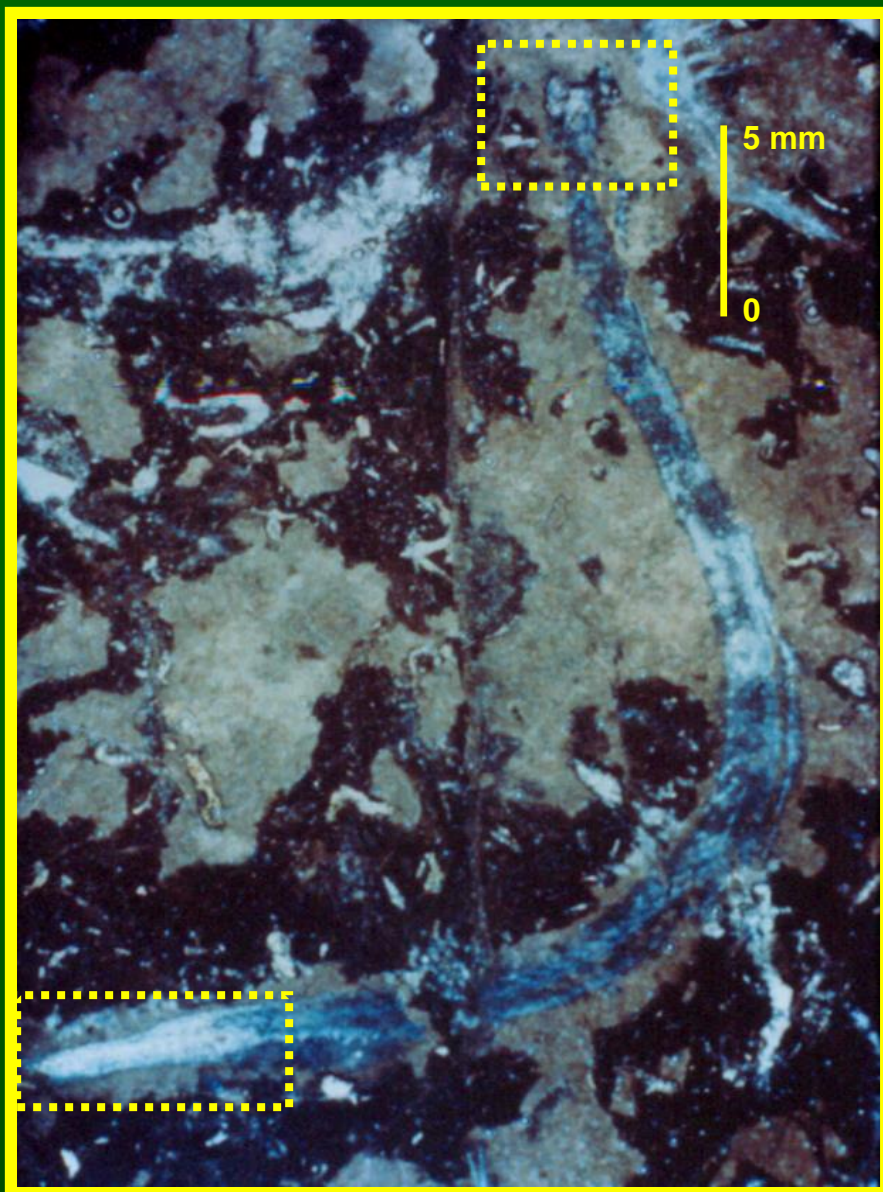
1988

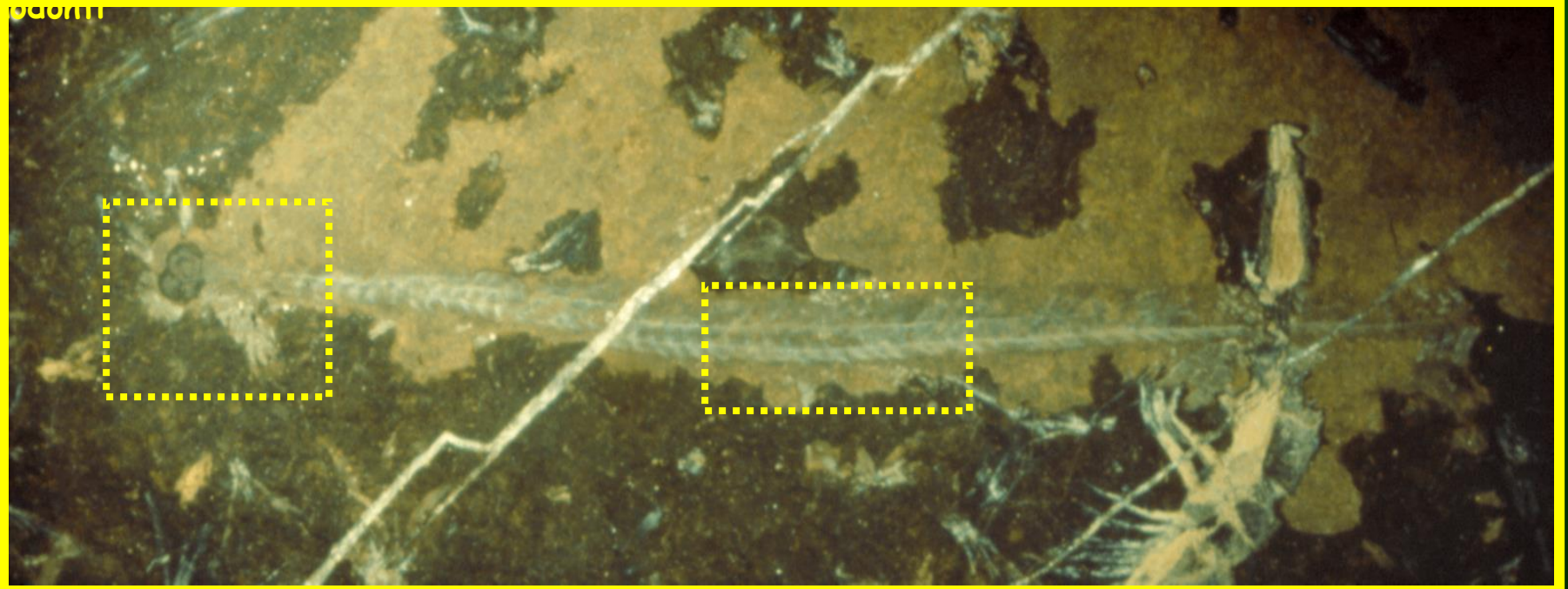


Conodonti

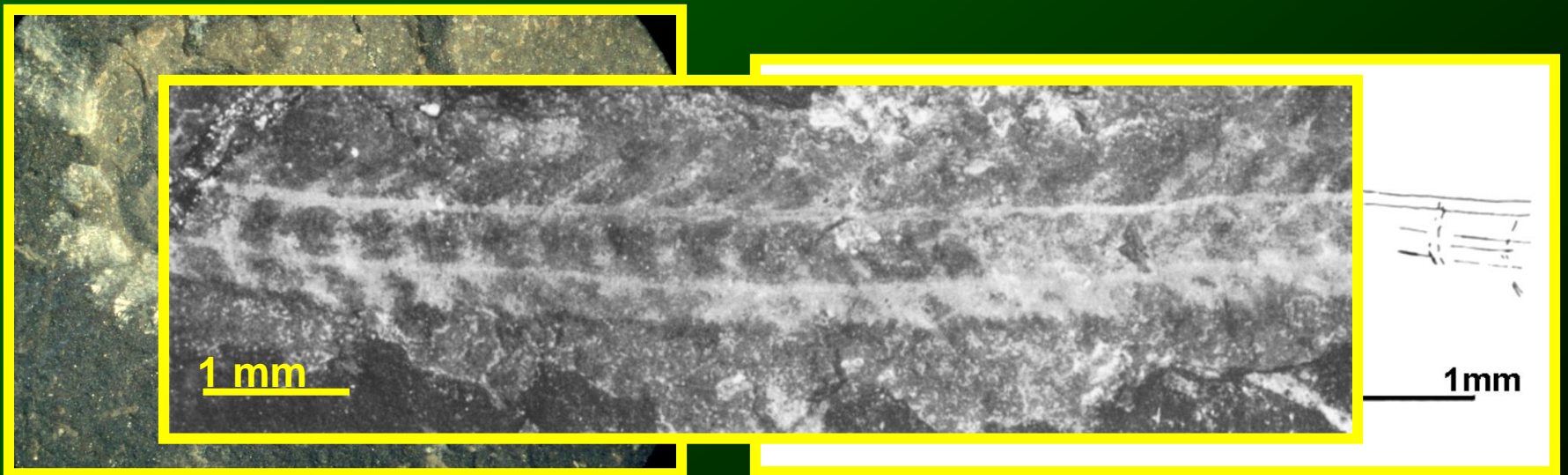
Clydagnathus windsorensis

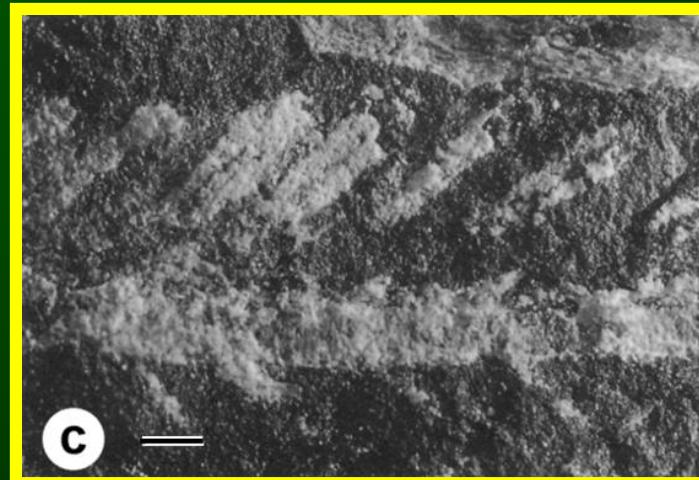
(esemplare 1) Carbonifero inf. - Scozia





Clydagnathus windsorensis - (esemplare 5), Carbonifero inf. - Scozia



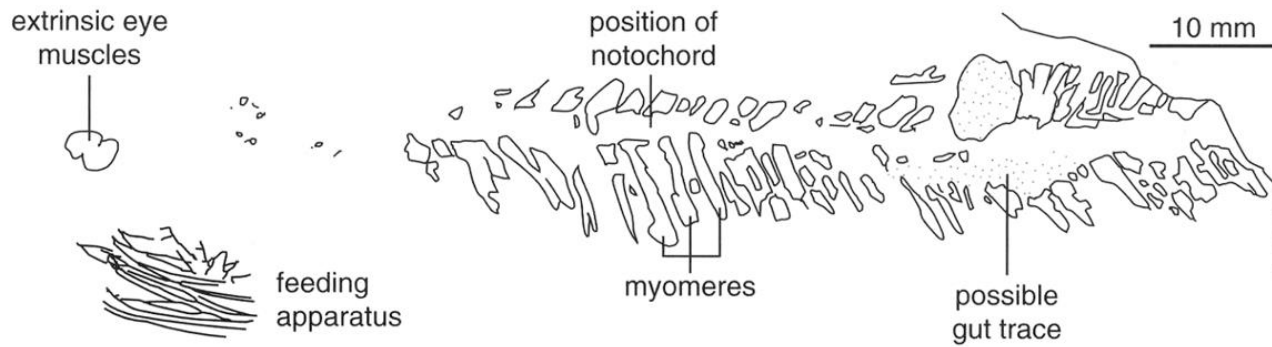
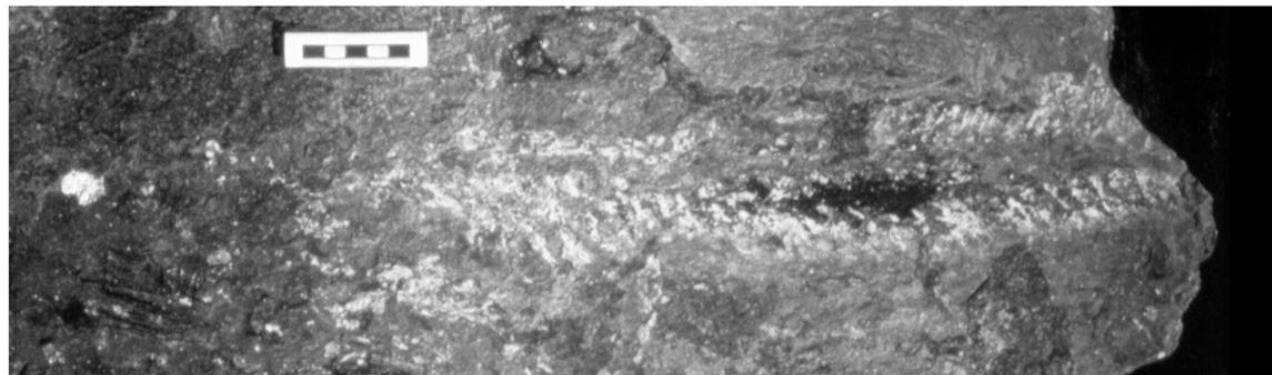
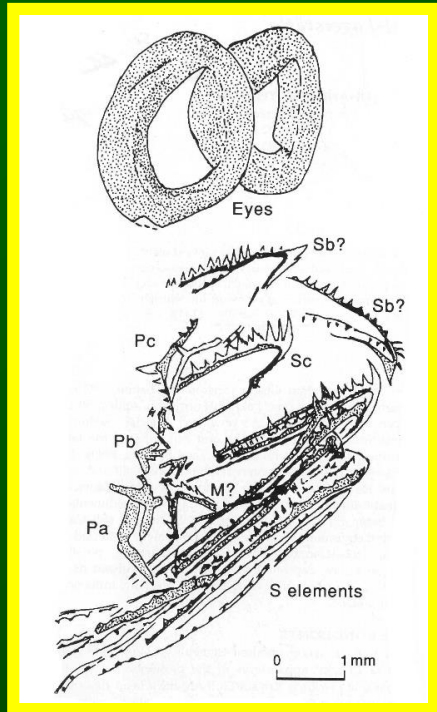


Clydagnathus windsorensis - (esemplare 7), Carbonifero inf. - Scozia.
Lunghezza delle barre: a) 2 mm; b, c) 0.5 mm

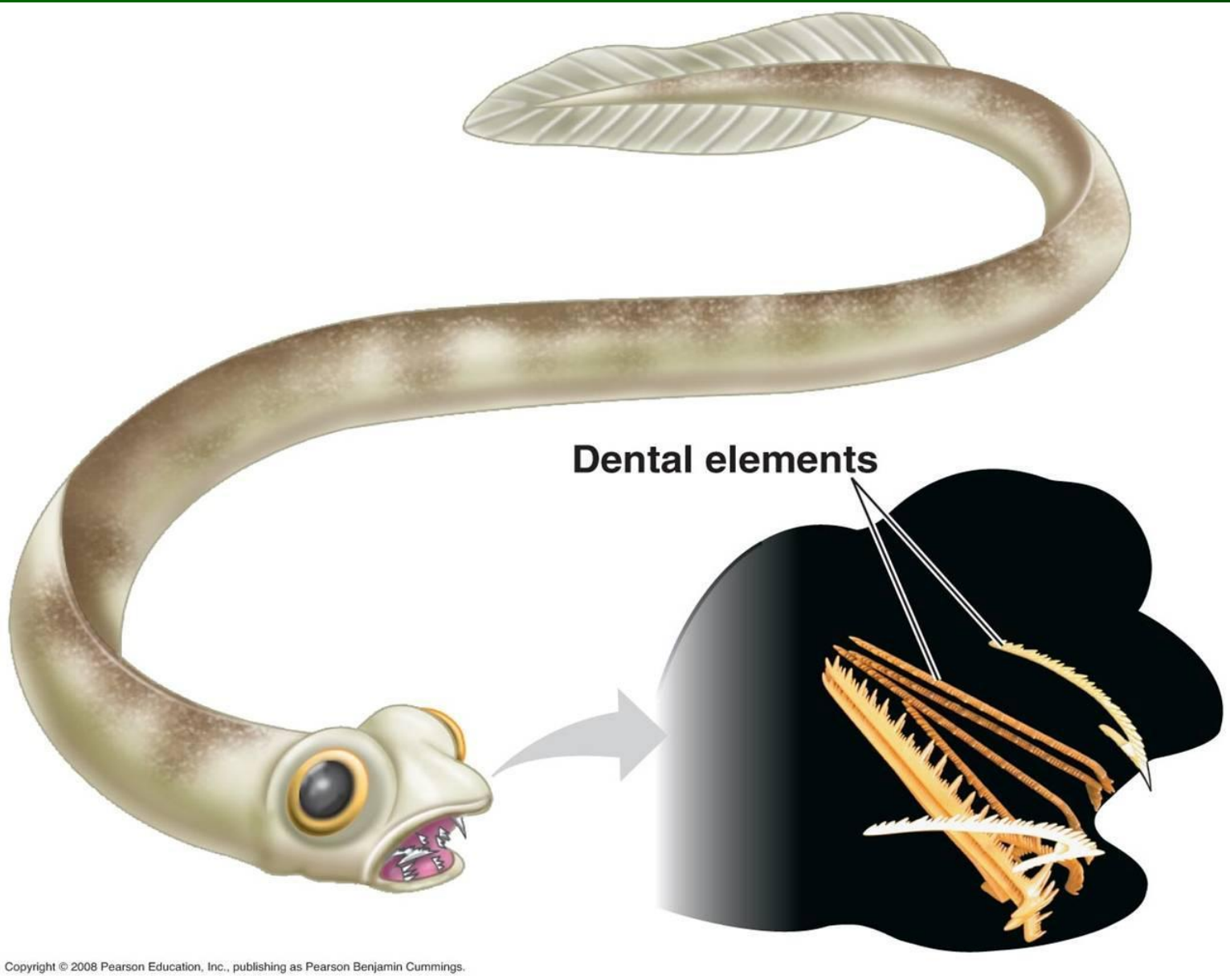


Promissum pulchrum

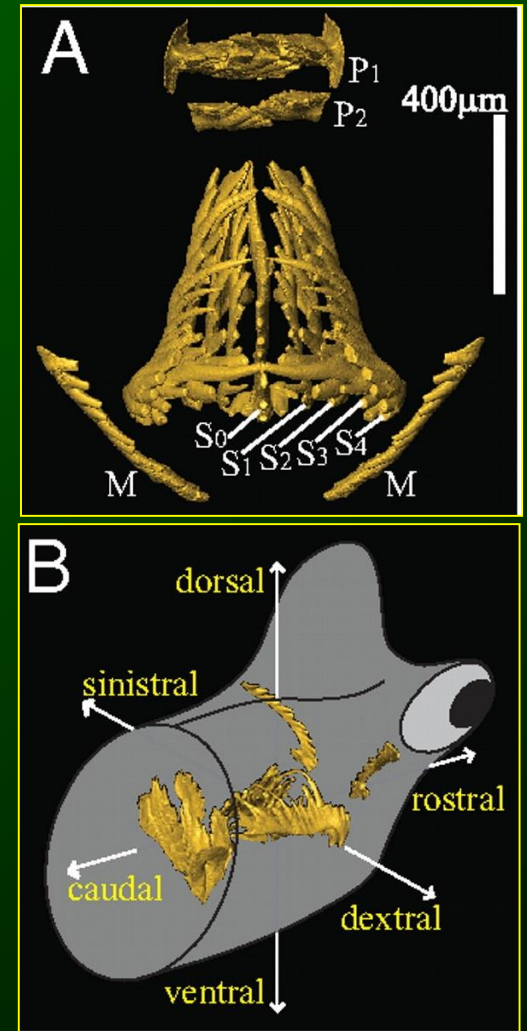
Ordoviciano sup. - Sud Africa



Conodonti

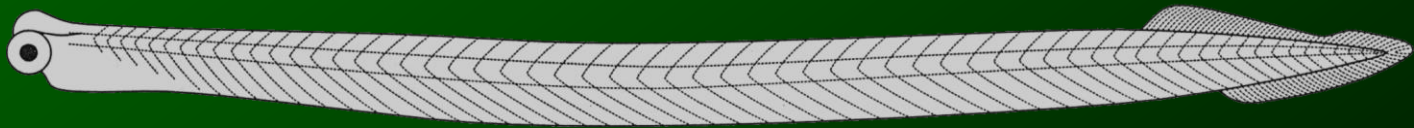


Conodonti



Caratteristiche dei conodonti sono:

- la notocorda;
- la muscolatura divisa in miomeri a forma di V;
- la coda con una pinna;
- la simmetria bilaterale del corpo.



Queste sono anche le caratteristiche dei
CORDATI

Quindi:

“i Conodonti sono certamente dei Cordati”.

Il phylum Chordata

comprende tre subphyla:

1. *Gli Urochordata (Tunicata);*
2. *I Cephalochordata;*
3. *I Craniata (meglio noti come Vertebrati).*

I Conodonti vanno collocati tra i Vertebrati (Craniata) per una serie di caratteri tra i quali:

- la testa posta anteriormente alla notocorda;
- la pinna caudale con supporti seriali;
- la presenza di una coppia di occhi ben sviluppati;
- la muscolatura esterna dell'occhio;
- la presenza di capsule otiche;

(strutture relative ai sensi della vista e dell'udito presuppongono che essi avessero anche un cervello di complessità sufficiente per "processare" le informazioni raccolte da queste strutture)

- la presenza di denti (in apatite);
- il modo di crescita del tessuto osseo e della dentina;
- l'istologia delle parti dure mineralizzate.

I Vertebrati sono un gruppo estremamente ampio e quindi la domanda successiva è:

“dove si collocano i Conodonti all'interno dei Vertebrati?”

I Vertebrati si dividono in:

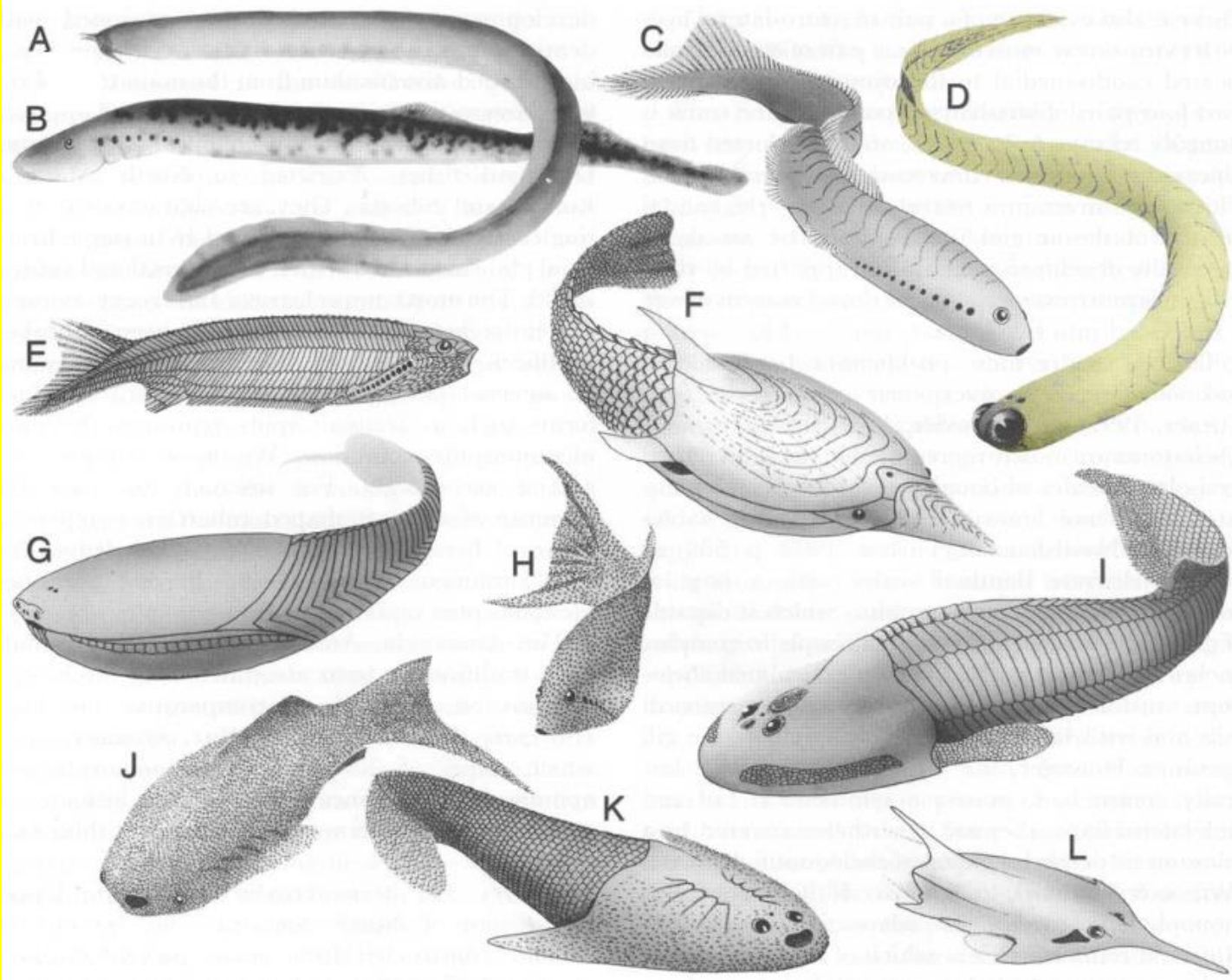
- Agnati (senza mandibole)
- Gnatostomi (dotati di una mandibola mobile)

possiamo subito escludere la loro appartenenza agli Gnatostomi in quanto i denti dei Conodonti “lavoravano” lateralmente invece che verticalmente.

I Conodonti erano quindi degli “Agnati”

il gruppo parafiletico che comprende i pesci primitivi senza mandibola.

VERTEBRATI PRIMITIVI



C
H
O
R
D
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T
A

UROCHORDATA (Ascidie)
(TUNICATA)
CEPHALOCHORDATA (Anfiosso)

AGNATHA
(pesci senza
mandibole)

MYXINOIDEA
(Missine)
PETROMYZONTOIDEA
(Lamprede)

CONODONTA



"OSTRACODERMATA"
(Anaspida, Heterostraci,
ecc.)

VERTEBRATA
(CRANIATA)

PESCI con
mandibole

Condroitti
(squali)

Osteitti

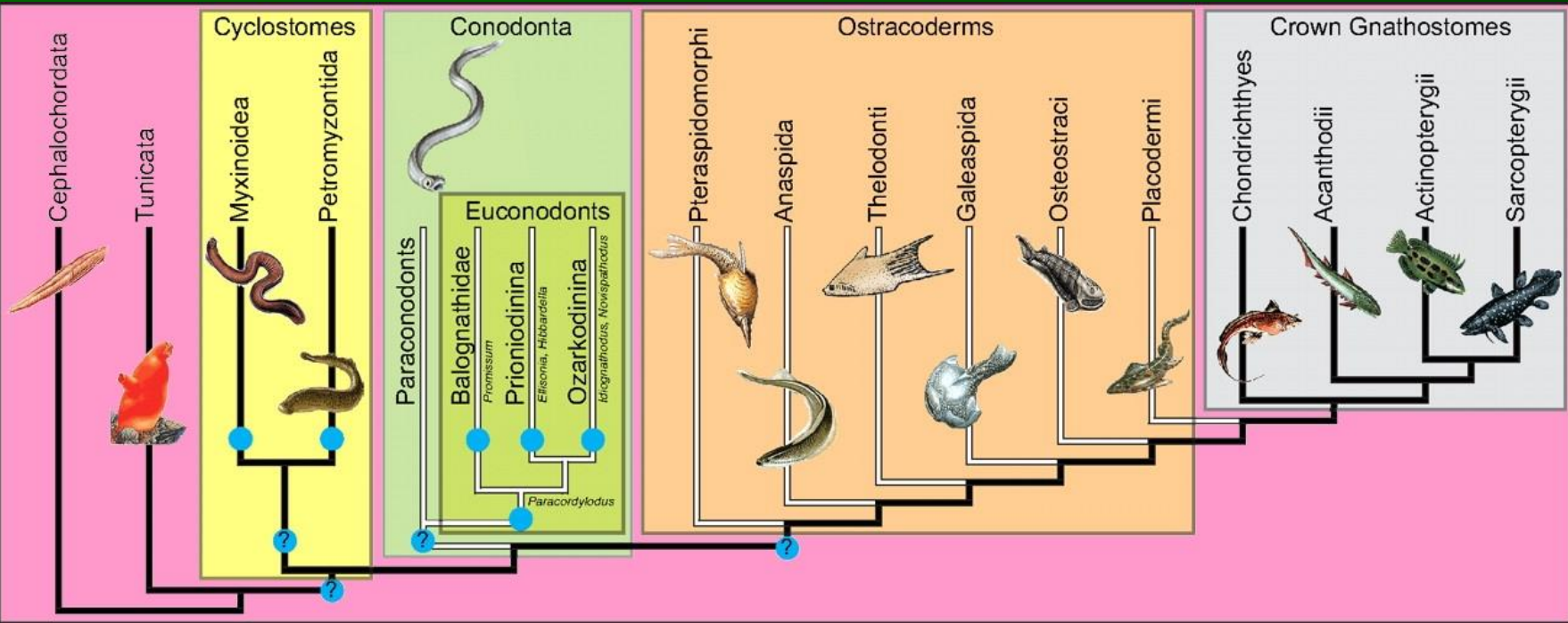
GNATHOSTOMATA
(con mandibola mobile)

TETRAPODA

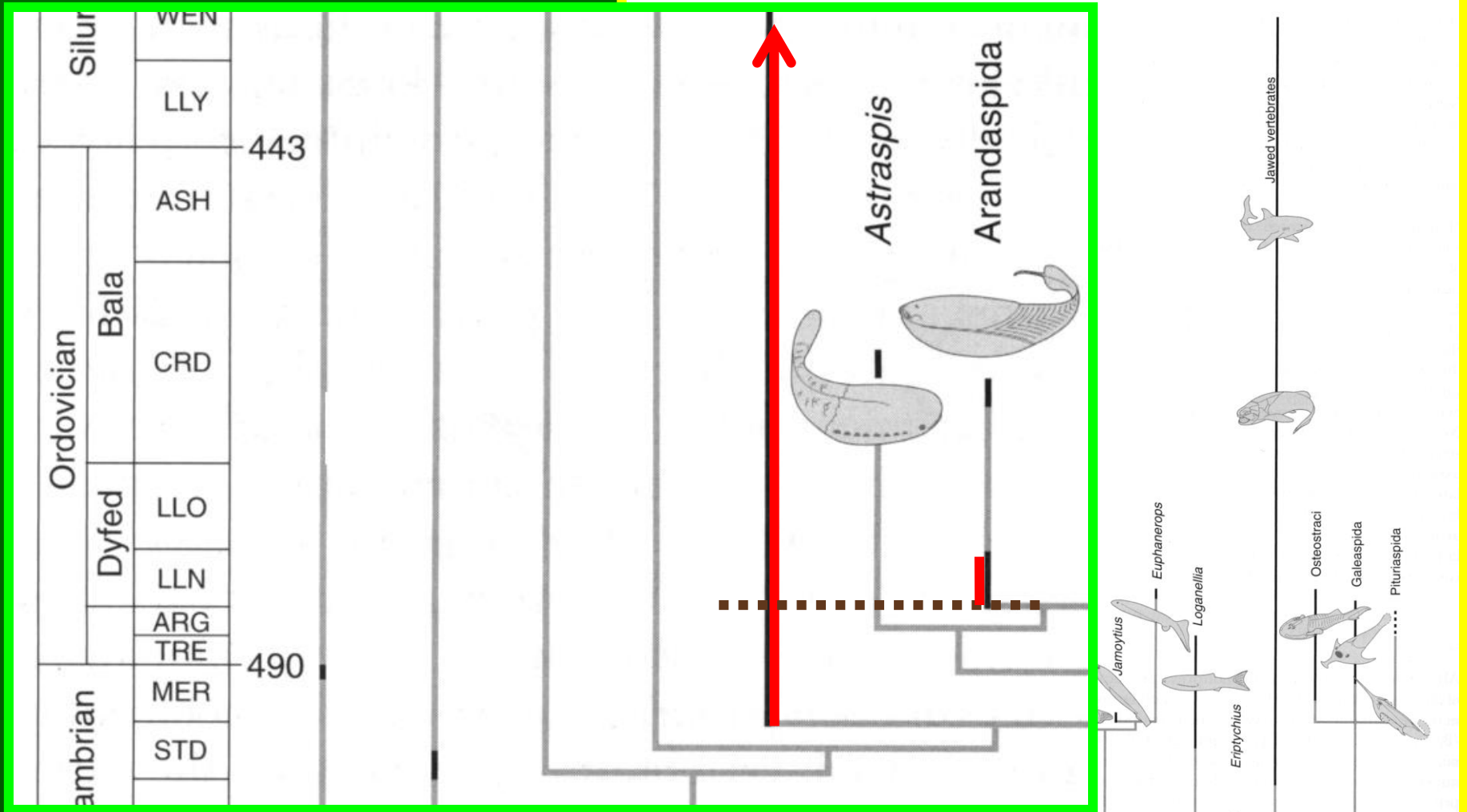
Rettili
Anfibi

Mammiferi
Uccelli

Conodonti



Conodonti

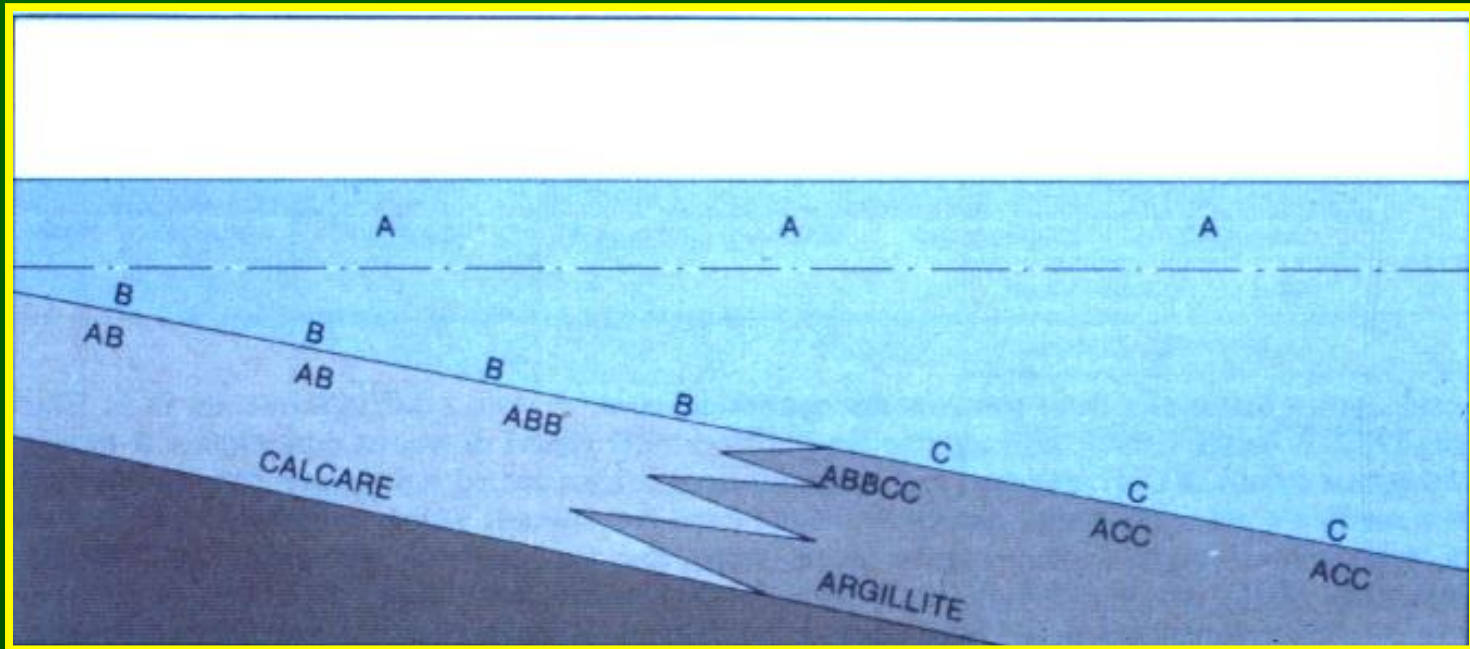


I più antichi Conodonti sono più vecchi di almeno 30 milioni di anni dei primi Agnati certi;

Ricostruzione filogenetica dei Cordati (linee grigie) e distribuzione stratigrafica dei principali gruppi (tratto nero).

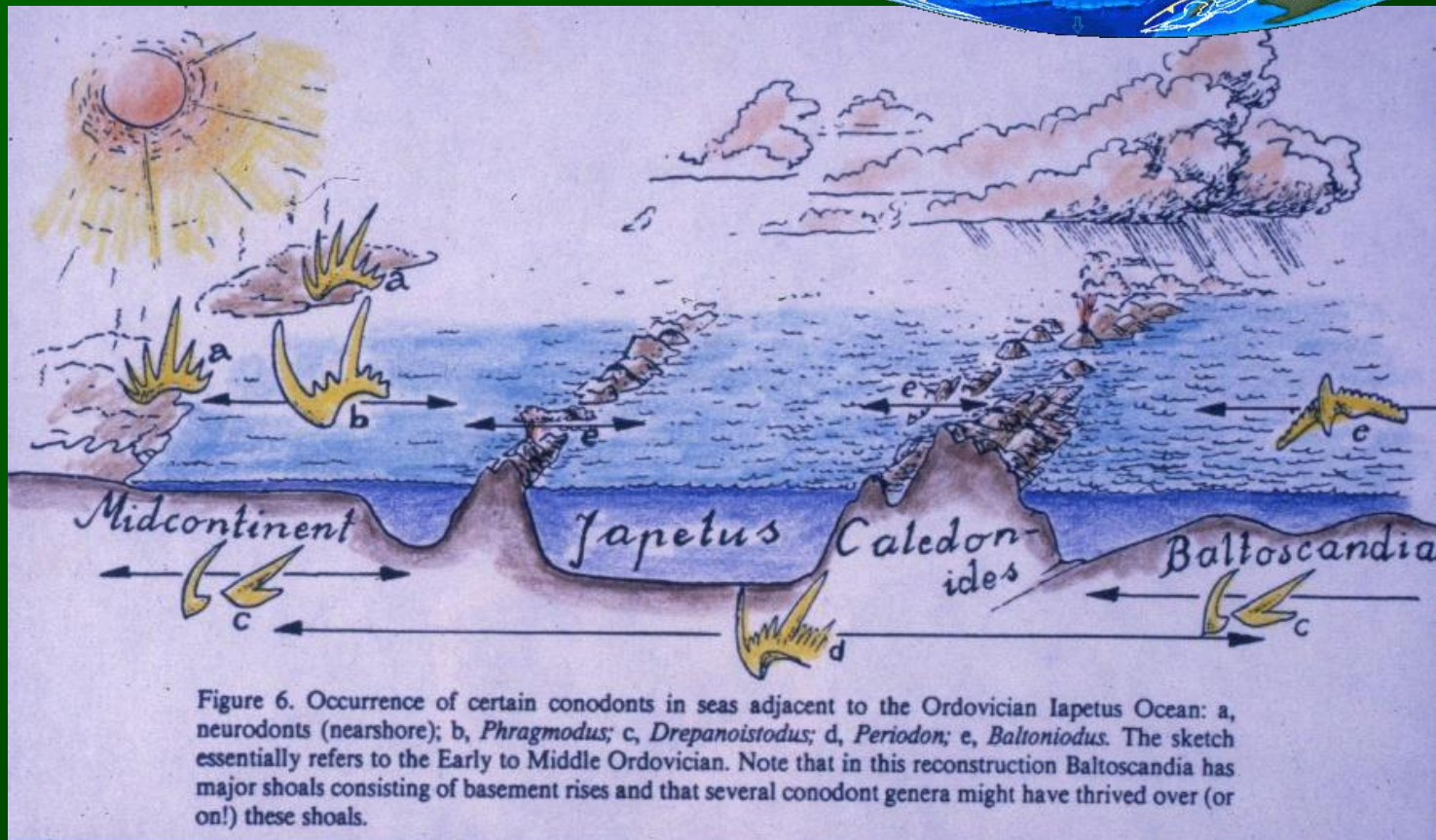
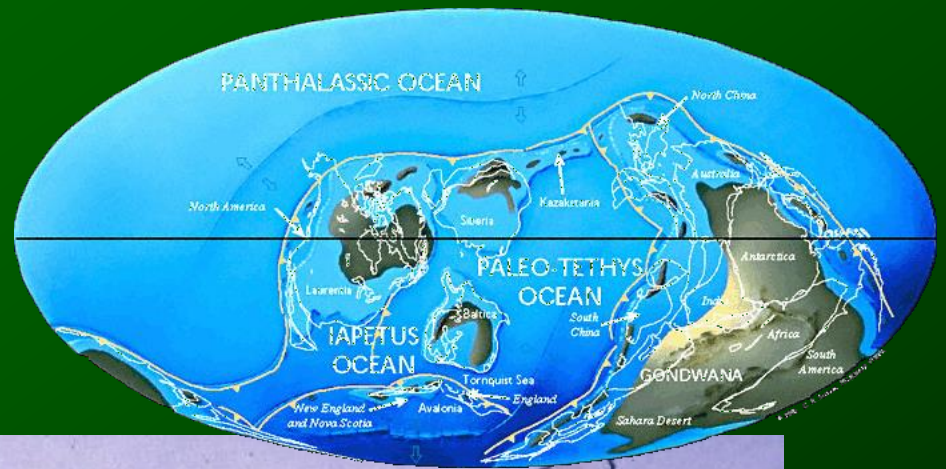
Modo di vita

Animali esclusivamente marini



nectobentonico

Provincialismi



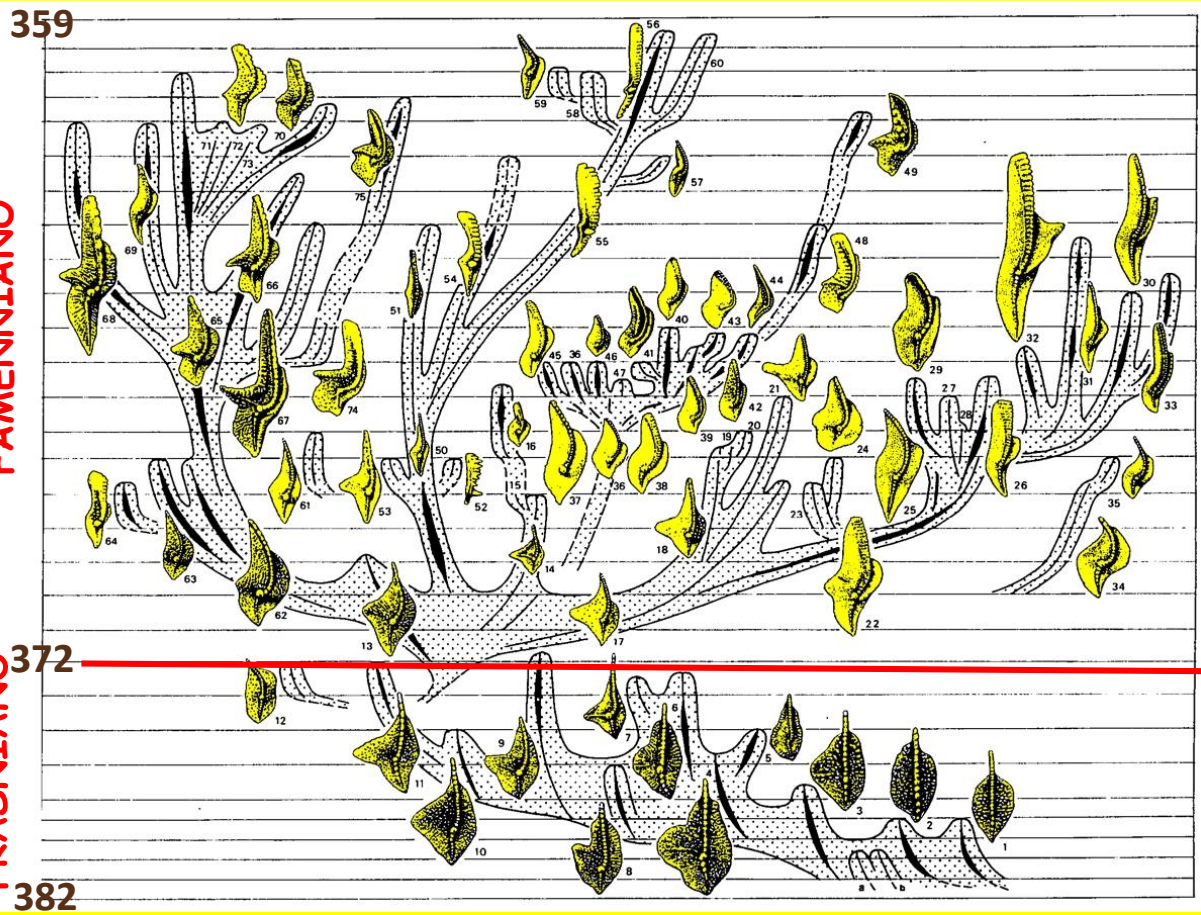
APPLICAZIONI

NELLE SCIENZE DELLA TERRA

- BIOSTRATIGRAFIA
- PALEOECOLOGIA
- GEOLOGIA REGIONALE
- RICERCHE PETROLIFERE

BIOSTRATIGRAFIA

DEVONIANO SUPERIORE
FAMENNIANO
FRASNIANO



Genere *Palmatolepis*

FAMENNIAN CONODONT ZONATION

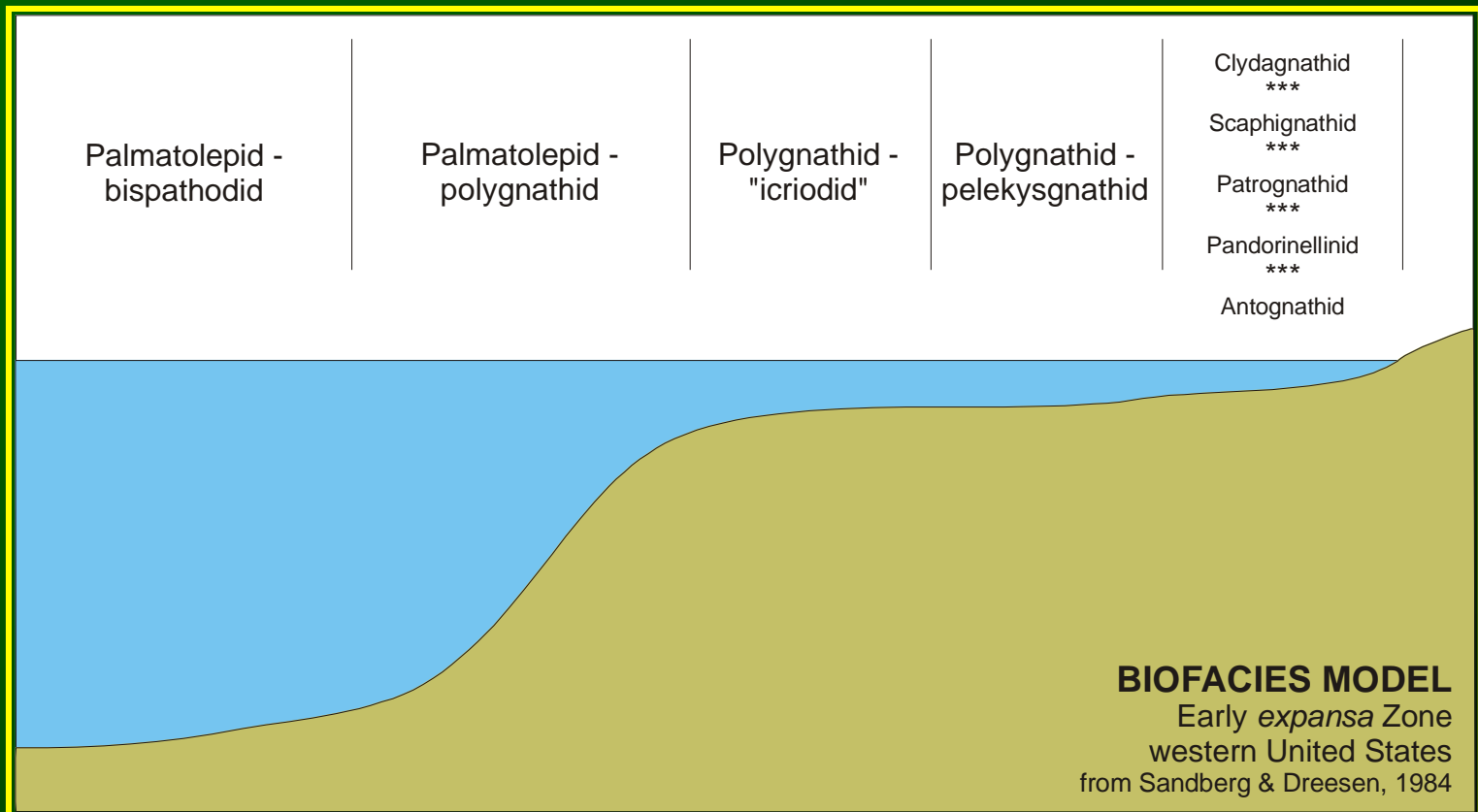
- Protognathodus kockeli*
- Bispathodus ultimus*
- Bispathodus costatus*
- Bispathodus ac. aculeatus*
- Palmatolepis gr. expansa*
- Palmatolepis gr. manca*
- Polygnathus styriacus*
- Pseudopolygnathus granulatus*
- Palmatolepis r. trachytera*
- Scaphignathus v. velifer*
- Palmatolepis m. utahensis*
- Palmatolepis m. marginifera*
- Palmatolepis gr. gracilis*
- Palmatolepis rhomboidea*
- Palmatolepis gl. pectinata*
- Palmatolepis gl. prima*
- Palmatolepis termini*
- Palmatolepis crepida*
- Palmatolepis m. minuta*
- Palmatolepis del. platys*
- Palmatolepis triangularis*
- Palmatolepis subperlobata*

CRONOSTRATIGRAFIA



CONODONTI **AMMONOIDI**
GRAPTOLITI **FORAMINIFERI**
TRILOBITI

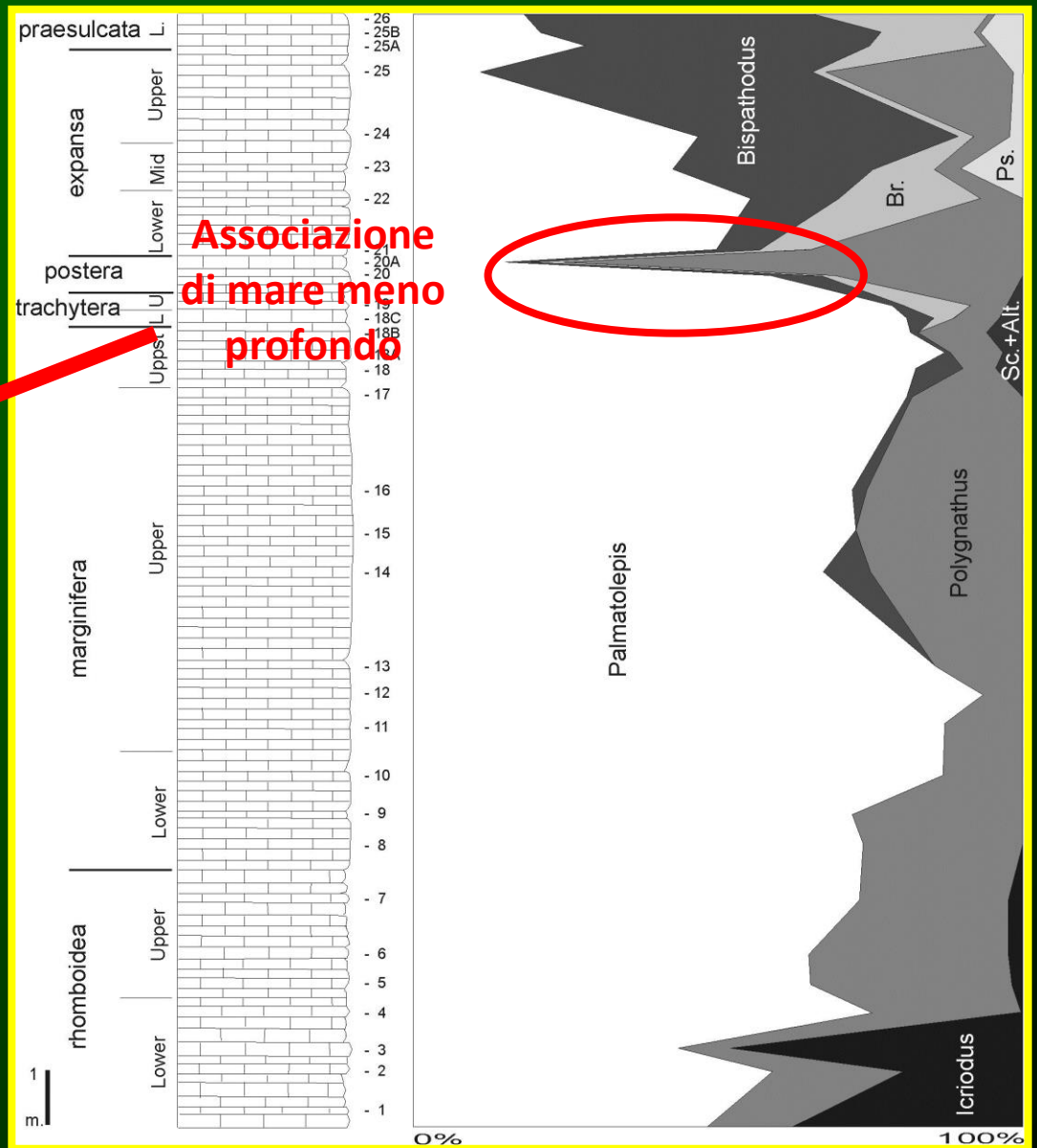
Ricostruzioni paleoambientali



Ricostruzioni paleoambientali

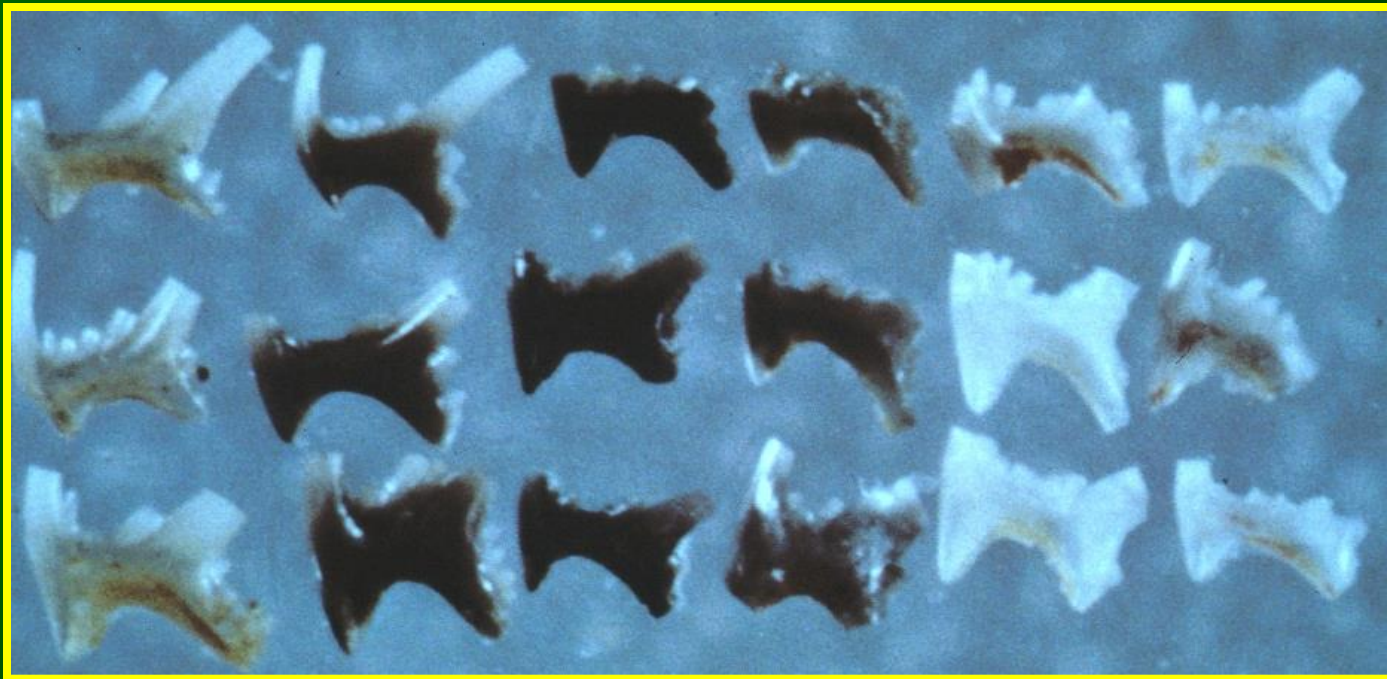
Sezione Corona Mizziu I
Devoniano Sup. – Sardegna

Abbassamento
del livello del
mare





Conodonti



Temperatura

L'alterazione di colore nei conodonti dipende dal TEMPO e dalla TEMPERATURA

La variazione di colore è dovuta ad alterazione di materia organica presente in tracce nei singoli conodonti


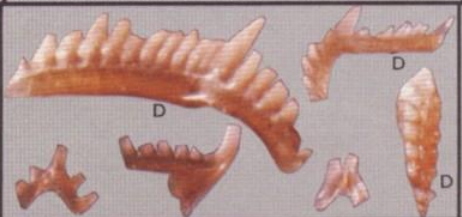










L'alterazione di colore è PROGRESSIVA, CUMULATIVA e IRREVERSIBILE


La pressione non accelera né ritarda il processo di alterazione di colore

Possono essere distinti otto livelli di alterazione di colore.

C.A.I

(Color Alteration Index)

COLOR ALTERATION INDEX	EXPERIMENTALLY PRODUCED COLOR ALTERATION	COLOR ALTERATION IN FIELD COLLECTIONS	TEMPERATURE RANGE, °C	FIXED CARBON RANGE
1			<50°-80°	<60%
1½			50°-90°	55% to 70%
2			60°-140°	
3			110°-200°	70% to 80%
4			190°-300°	80% to 95%
5			+300°	+95%



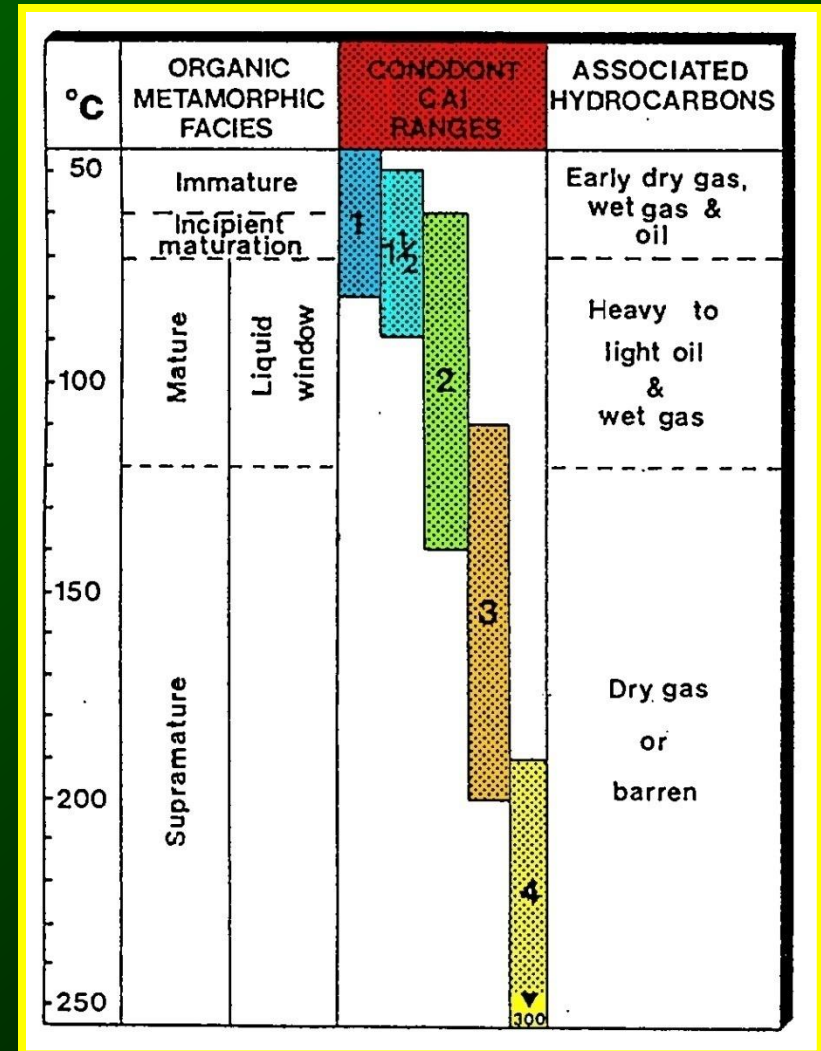
COLOR ALTERATION INDEX (CAI)	EXPERIMENTALLY INDUCED COLOR ALTERATION	NATURAL COLOR ALTERATION FROM FIELD COLLECTIONS	TEMPERATURE RANGE, °C	MUNSELL ROCK COLOR
5			300° - 480°	BLACK (N1)
6			360° - 550°	MEDIUM DARK GRAY TO MEDIUM GRAY (N4-N5)
6½			440° - 610°	MEDIUM LIGHT GRAY TO LIGHT GRAY (N6-N7)
7			490° - 720°	VERY LIGHT GRAY TO WHITE (N8-N9)
8			> 600°	COLORLESS OR CRYSTAL CLEAR

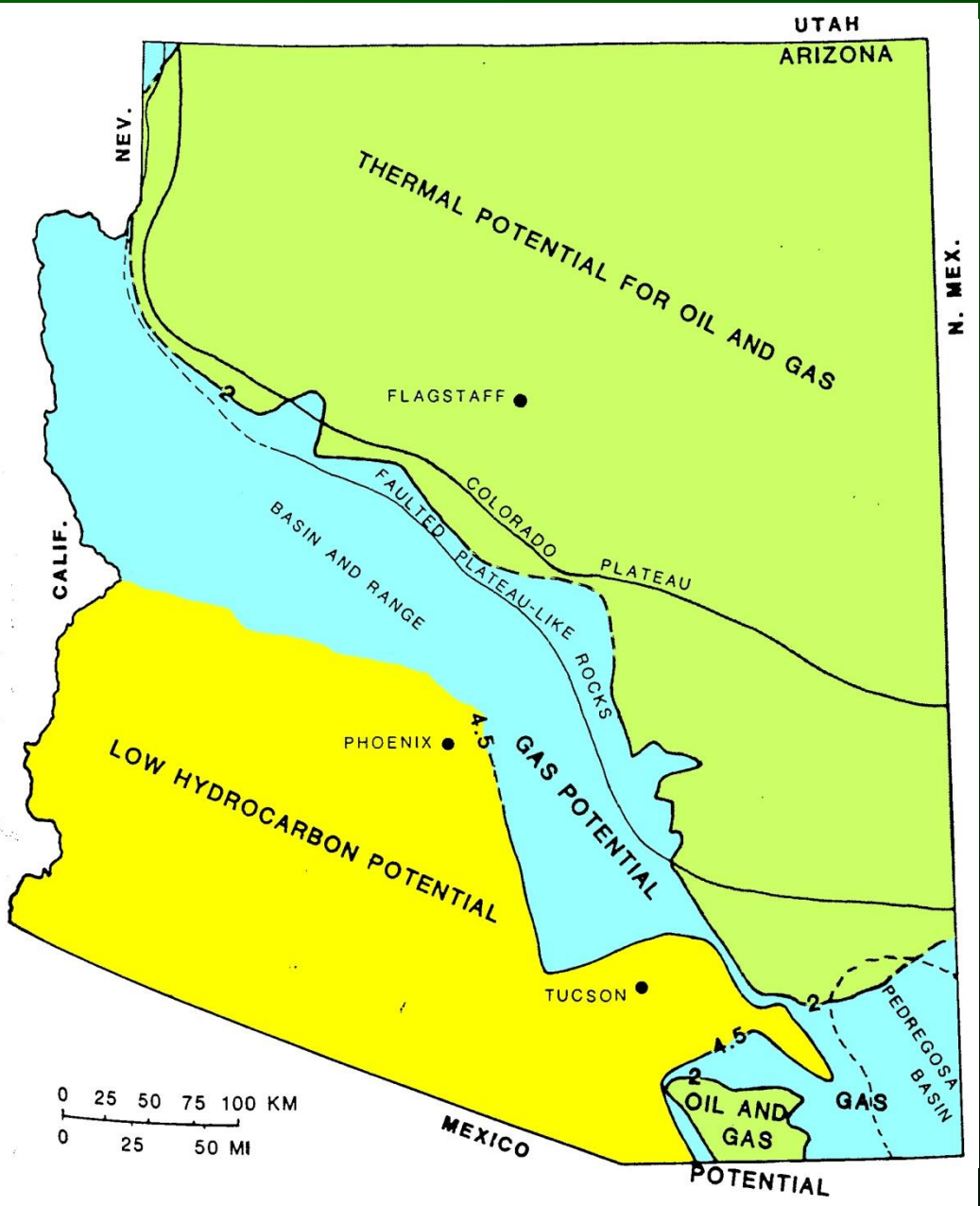
APPLICAZIONI

Conoscere la storia termica di un bacino sedimentario, fornendo informazioni sulle aree e sugli intervalli stratigrafici che potrebbero contenere idrocarburi.

Identificare intrusioni localizzate, e quindi contribuire all'individuazione di depositi minerali.

Identificare effetti tettonici locali, che hanno provocato flussi di calore (grandi sovrascorrimenti o rifting).

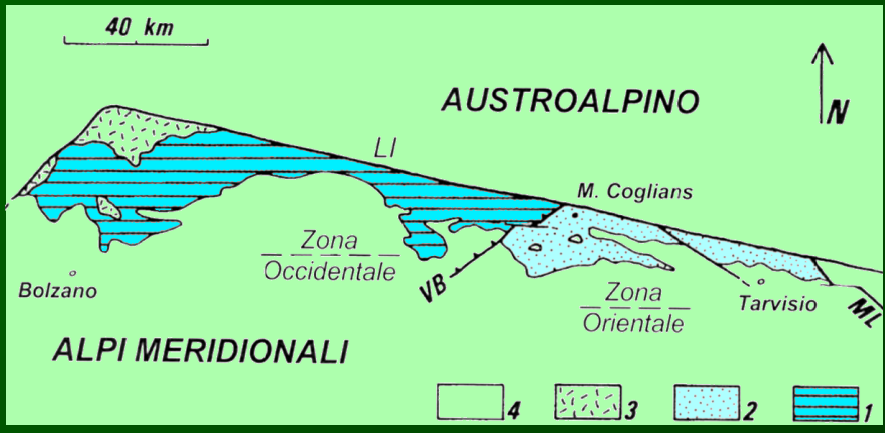
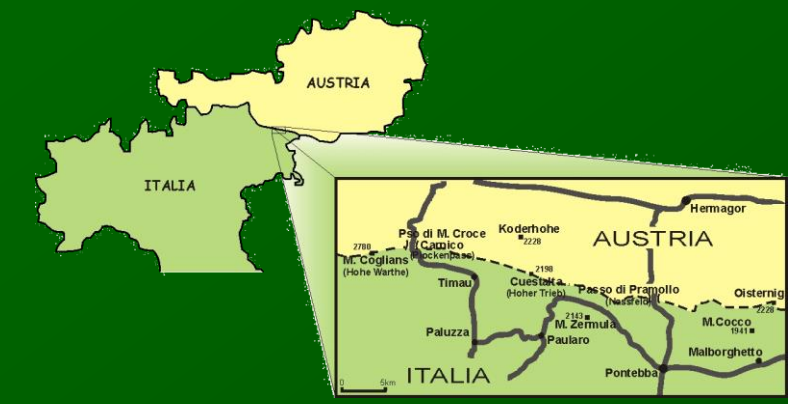




ARIZONA

Wardlaw & Harris, 1984

Conodonti



TRIASSIC	L	Norian	DP	
		Carnian	R DU VD DC SC WG	
	M	Ladinian	S BU	
		Anisian	BR SR	
		Olenekian	W	
	PERMIAN	L	Changhsing	B VG
			Wuchiapingian	
		M	Capitanian	
			Wordian	
			Roadian	
F		Kungurian		
		Artinskian		
		Sakmarian		
		Asselian	T R	
CARBONIFEROUS	Pennsylvanian	Gzhelian	P	
		Kasim.		
		Moscov.		
	Mississippian	Bashkir.	D HW	
		Serpuk.		
	Devonian	Visean		
		Tournaisian	PR R3	
		Famennian		
		Frasnian		
		Givetian	PG C F	
SILURIAN	Eifelian			
	Emsian			
	Pragian	CU B		
	Lochkovian	RK		
	Llandovery	O G		
ORD.	L	Ashg.		
		Caradoc	U	

DP = Dolomite Principale: Massive and stromatolitic dolostones and lime dolostones, tidal-flat environments, Late Triassic (Norian).

R = Raiblf Fm.: Red siltstones and shales followed by laminated gypsum and calcareous dolostones and by cataclastic vuggy dolostones, marls and polychrome shales, tidal-flat to shallow marine environments, Late Triassic (late Carnian).

DU = Dürrenstein Fm.: Red sandstones and shales interbedded with limestones and marls passing into dolomitic limestones and marls, basinal environments, Late Triassic (Carnian).

VD = Val Degano Fm.: Dark bioturbites and marls with rare layers of green lutiteous arenites, siliceous mudstones and coals passing into bituminous laminated micrites, marls and terrigenous turbidites, lagoon and deep lagoon environments, Late Triassic (early Carnian).

DC = Cassian Dolomite: Grey dolomitic limestones, poorly bedded limestones and calcareous breccias, Backreef, reef and fore reef environments, Middle-Late Triassic (latest Ladinian-early Carnian).

SC = San Cassiano Fm.: Coarse, black bioturbitic turbidites (packstone and wackestone) interbedded with grey to black marls, basinal environments, Middle-Late Triassic (latest Ladinian-early Carnian).

WG = Wengen Fm.: Dark turbiditic sandstones and shaly marls with marly limestones and micrites, basinal environments, Middle-Late Triassic (late Ladinian-early Carnian).

BU = Buchenstein Fm.: Limestones, cherty limestones, siliceous shales and, locally, pyroclastic breccias and tuffs (petra verde), turbiditic sandstones and shales (Zoppè Sandstone), calcarenites (packstone/wackestone) interbedded with marly layers and, locally, volcanics (Acquatona Fm.), basinal environments, Middle Triassic (Ladinian).

S = Schiär (or Schiären) Dolomite: Massive white reefal dolostones and dolomitic limestones, Middle Triassic (latest Anisian-early Carnian).

BR = Brales Group: Conglomerates with subordinate sandstones and shales overlain by basinal marly limestones passing into turbiditic sandstones and marly pelites, eight formations: Piz de Pareis Fm. (base), Valgogo and Rindlhorn Conglomerates, Marzica Limestone, Doni Fm., M. Bivara Fm., Anzola Fm., Aupa Turbidites, Middle Triassic (Anisian-Early-Late Ladinian-Fansian).

SR = Serla Dolomite (Lower and Upper units): Stromatolitic and vuggy dolomites overlain by massive dolomites and dolomitic limestones, shallow marine environments, Middle Triassic (Anisian-Palaeonian).

W = Werfen Fm.: Light grey marly limestones with thin dark grey pelitic interbeds, passing up-section to red siltstones and shales interbedded with bioturbitic layers, oolitic levels present, shallow marine environments, Latest Permian-Early Triassic (late Changhsingian-Olenekian).

B = Bellerophon Fm.: Grey to dark grey limestones and dolomitic limestones interbedded with laminated sabkha gypsum, shallow marine environments, Late Permian (Changhsingian).

VG = Val Gardena Sandstone: Red sandstones and shales with calciche and thin dolomitic layers and, at the base, calcareous breccias and conglomerates (Tarvisio Breccias) and reddish polymictic rudites (Sesto Conglomerate), nearshore (non-marine and marine) environments, Late Permian.

Paraconformity or low-angle unconformity

T = Troglkofel Group: Upper part of Pontebba Supergroup, light grey and pink limestones and massive dolomites, shallow marine, Early Permian (Sakmarian-Artinskian).

R = Rattendorfer Group: Middle part of Pontebba Supergroup, massively bedded calcarenites and oolitic micrites of the Lower and Upper Pseudoschwagerina Fms separated by grey and red shales with sandstones and quartz-conglomerates of the Val Döls Fm., shallow marine environments, Late Carboniferous-Early Permian (Gzhelian-Sakmarian).

P = Pramsoio Group: Lower part of Pontebba Supergroup, quartz-sandstones and quartz-conglomerates with interbedded shales with oolitic and foraminiferal limestone levels, five formations: Moléris Fm., Pizella Fm., Corona Fm., Aseniga Fm., and Carrizola Fm., basinal and nearshore environments. At the very base immature conglomerates and bititic arenites (Bombass Fm.), Late Carboniferous (late Moscovian-Asselian).

Angular unconformity

D = Dimen Fm.: Deep sea volcanoclastic turbidites and alkali-olivine basaltic volcanics: grey feldspar sandstones, grey to greenish, red and green shales, hyaloclastites, diabases, pillow lavas and explosive volcanic breccias, Late Carboniferous (Bashkirian).

HW = Hochwipfel Fm.: Siliclastic turbidites: dark grey quartz-sandstones and shales, calcareous oolites, bioturbites and micritic rudites in the lower part, locally low grade metamorphic facies, deep-sea fan environments, Carboniferous (?middle Visean-Bashkirian).

RC = Rio Chienetta Radiolite: Basinal black radiolarian cherts interbedded with brown pelites, rare calcareous layers, Early Devonian-Early Carboniferous (Pragian-Frasnian).

B = Bänderkalk: Low-grade metamorphic facies of Silurian-early Visean calcareous succession (equates with Orthoceras Limestone through to Pramsoio Limestone).

PR = Pramsoio Limestone: Light grey, pink to light brown bioturbites (mudstones, wackestones and packstones) interbedded with rare mm-cm calcarenitic and calcilitic layers, shelf to basin environments, Late Devonian-Early Carboniferous (Frasnian-early Visean).

CU = Cuestella Limestone: Reddish nodular bioturbites (wackestones and packstones) rich in tentaculites, sometimes with interbedded grey calcarenites, micritic dark-red to greyish marly layers, inner shelf environments, Early-Middle Devonian (Lochkovian-Givetian).

PG = Piz Grande Calcarenite: Grey calcarenites and calcilitic (packstones and grainstones) interbedded with micrites and rudstones, distal transitional facies, Early-Late Devonian (Pragian-Frasnian).

F = Freikofel Rudstone: Grey calcinulites and calcarenites (packstones and grainstones) interbedded with rare mudstones, brachiopod coquinas in the upper part (Collina Fm.), proximal transitional facies, Early-Late Devonian (?Pragian-Famennian).

C = Coglians Limestone: Massive, light grey fossiliferous limestones—with predominance of stromatopora (including Amphiporidae) and corals—and bioclastic limestones, backreef, reef and fore reef environments, Early-Late Devonian (?Lochkovian-Frasnian).

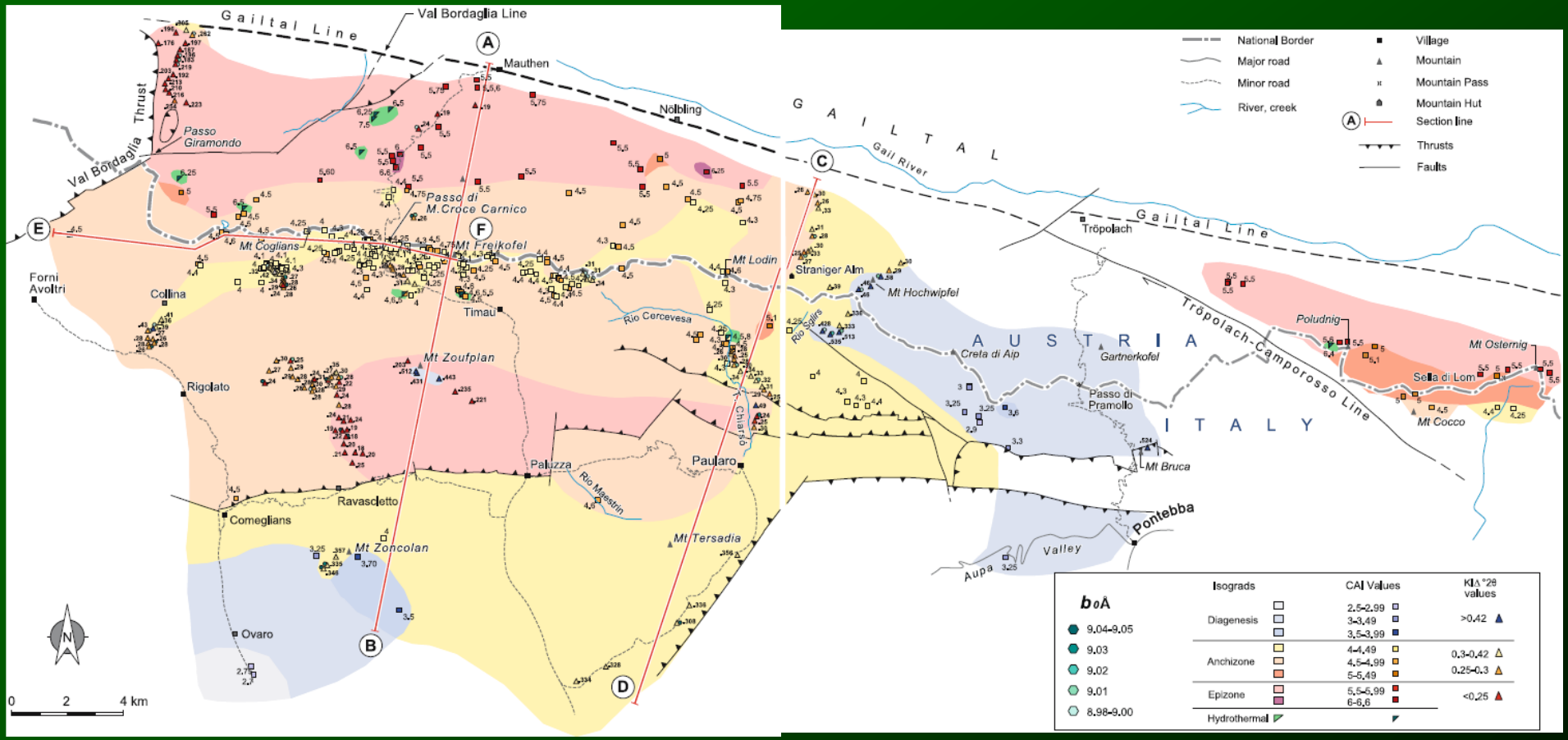
RK = Raichkofel Limestone: Dark grey to black calcilitic, calcarenites and micrites, partly dolomitized, shelf-face to offshore environments, Early Devonian (Lochkovian).

G = Graptolite Shales: Dark grey to black shales rich in graptolites, interbedded with micritic limestones and rare radiolites, outer shelf to basin environments, locally low grade metamorphic facies, Silurian-Early Devonian (Llandovery-Lochkovian).

O = Orthoceras Limestone: Reddish, foraminiferal, nodular micritic limestones (with orthoconic cephalopods) and calcareous marls, offshore environments, Silurian (Llandovery-Frasnian).

U = Uqua Fm.: Quartz siltstones and sandstones interbedded, in the upper part, with nodular bioclastic limestones, coastal to offshore environments, Late Ordovician (Caradoc-Ashg.).

Conodonti



Brime et al., 2007



Conodonts / Conodontes
Microfossils / Microfossiles
Palaeozoic Era / Ère paléozoïque

CANADA

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