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ΠΕΡΙΦΕΡΕΙΑ ΚΡΗΤΗΣ
ΔΙΗΜΕΡΙΔΑ
«ΕΡΕΥΝΑ ΚΑΙ ΕΚΜΕΤΑΛΛΕΥΣΗ ΥΔΡΟΓΟΝΑΝΘΡΑΚΩΝ ΣΤΗΝ ΕΛΛΑΔΑ»

Μητρικά πετρώματα πετρελαίου και εκτεταμένες σπογγοαποικίες στην Κρήτη

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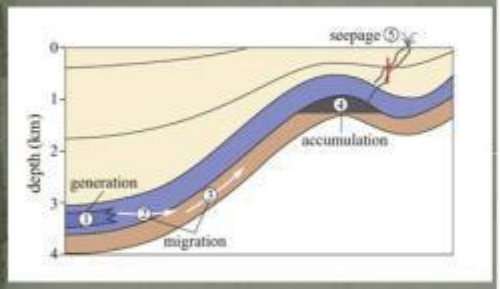
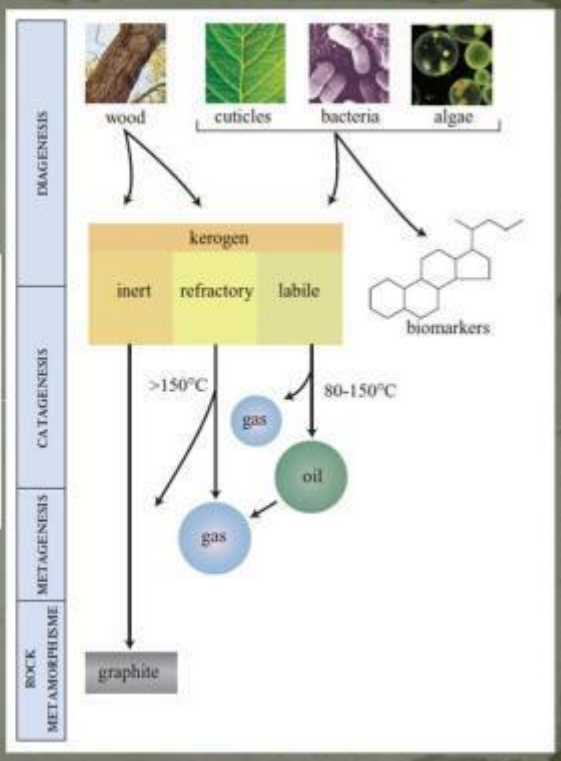
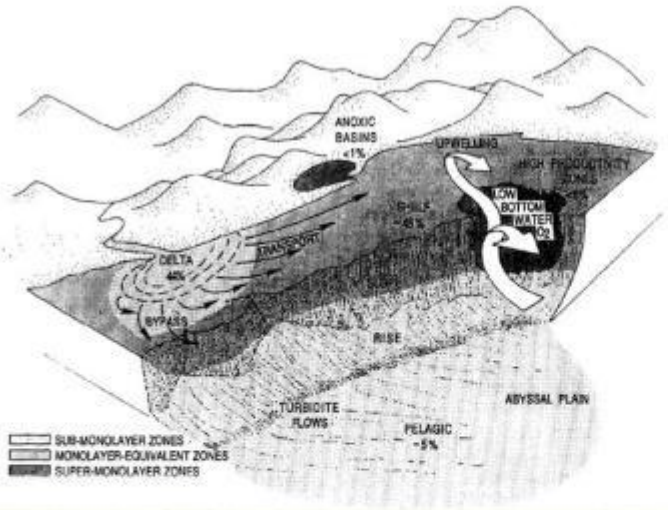
Γεωλόγος
Καθηγητής
Τμήμα Μηχανικών Ορυκτών Πόρων
Πολυτεχνείο Κρήτης





ENCYCLOPAEDIA OF HYDROCARBONS, 2005



Major reservoirs of inorganic and organic carbon

Reservoir type	Amount [a]	Reference
Sedimentary rocks		
Inorganic		
Carbonates	60,000	Berner (1989)
Organic		
Kerogen, coal, etc.	15,000	Berner (1989)
Active (surficial) pools		
Inorganic		
Marine DIC	38	Olson et al. (1985)
Soil carbonate	1.1	Olson et al. (1985)
Atmospheric CO_2	0.66	Olson et al. (1985)
Organic		
Soil humus [b]	1.6	Olson et al. (1985)
Land plant tissue [b]	0.95	Olson et al. (1985)
Seawater DOC	0.60	Williams and Druffel (1987)
Surface marine sediments	0.15	Emerson and Hedges (1988)

[a] Unit = 10^{15} g C
[b] Values corrected to levels before anthropogenic effects.

Idealized diagram depicting current estimates of the percentage of total organic matter burial occurring within various marine sediment types. *J.I. Hedges, R.G. Keil/Marine Chemistry 49 (1995) 81-115*

Oceanic productivity	**50 X 10^{15} grC yr^{-1}**
sediment burial rates	**0.16 X 10^{15} grC yr^{-1}**
Organic preservation in the marine environment	**<0.5%**
Shelf	**~45%**
Delta	**44%**
High productivity zones	**<6%**
Pelagic	**~5%**
Anoxic Basins	**1%**

J.I. Hedges, R.G. Keil/Marine Chemistry 49 (1995) 81-115

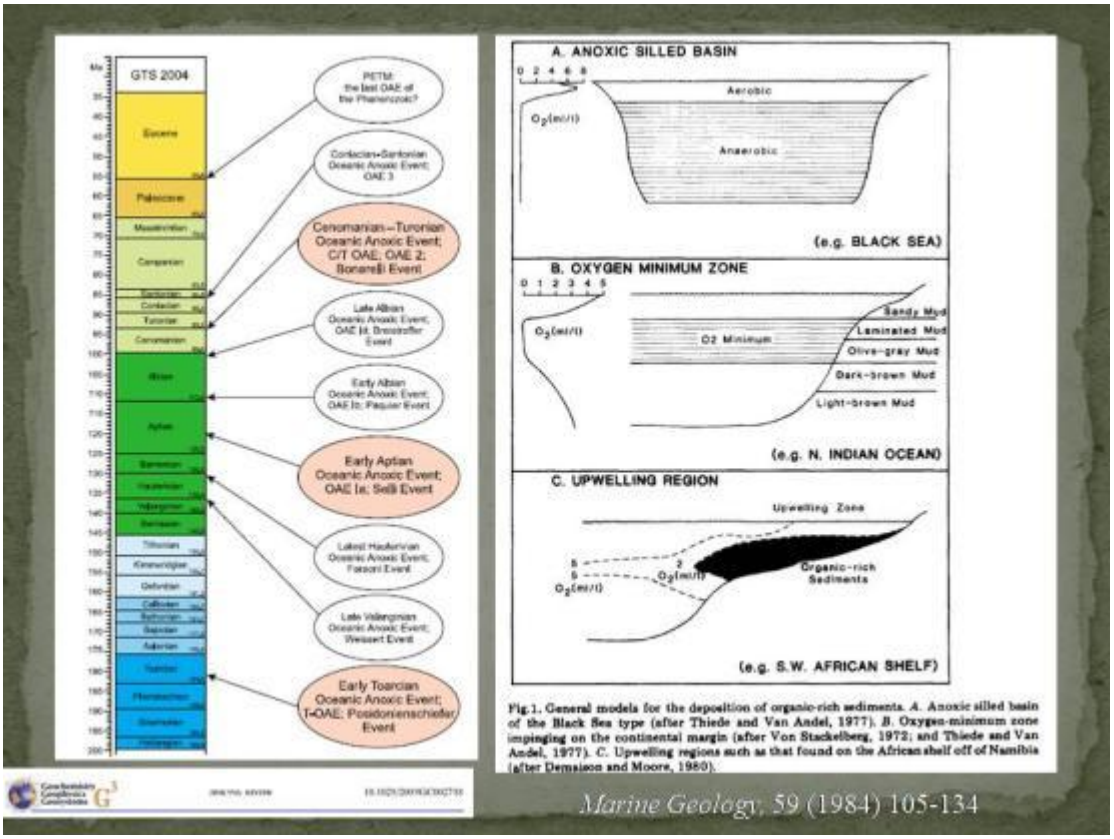
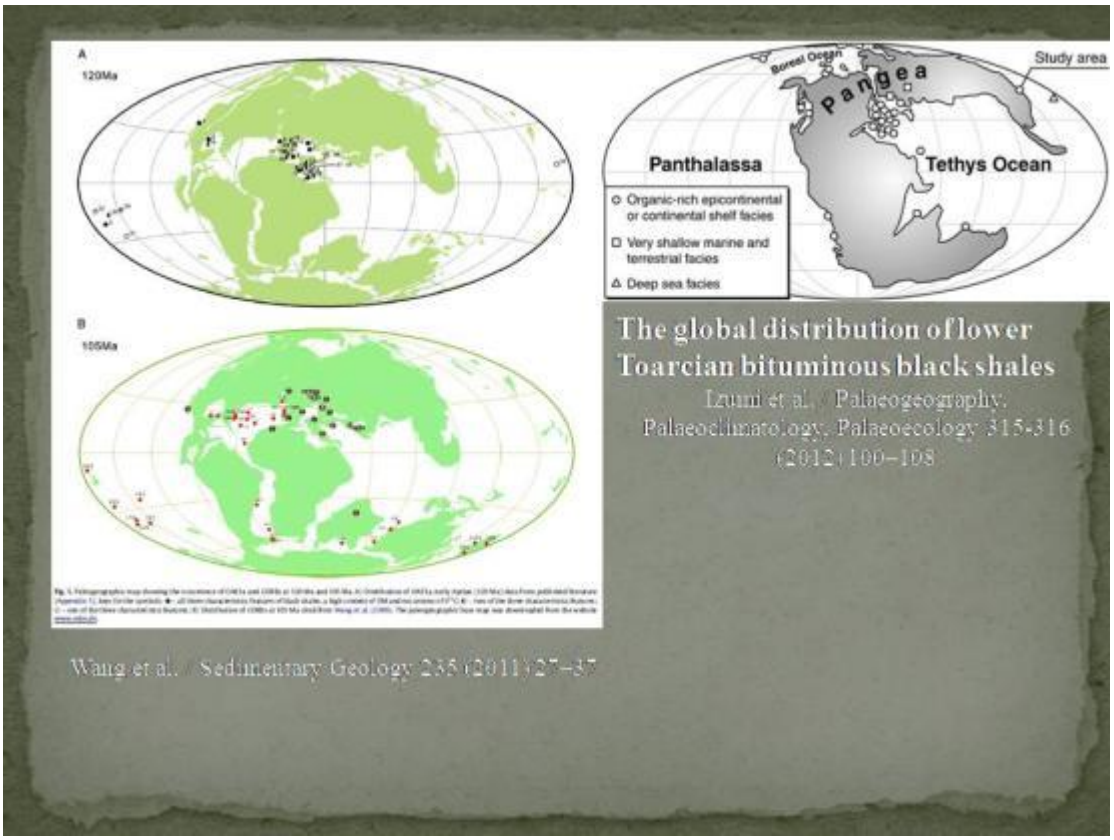


Fig. 1. General models for the deposition of organic-rich sediments. *A*. Anoxic silled basin of the Black Sea type (after Thiede and Van Andel, 1977). *B*. Oxygen-minimum zone impinging on the continental margin (after Von Stackelberg, 1972; and Thiede and Van Andel, 1977). *C*. Upwelling regions such as that found on the African shelf off of Namibia (after Demaison and Moore, 1980).

Marine Geology, 59 (1984) 105-134



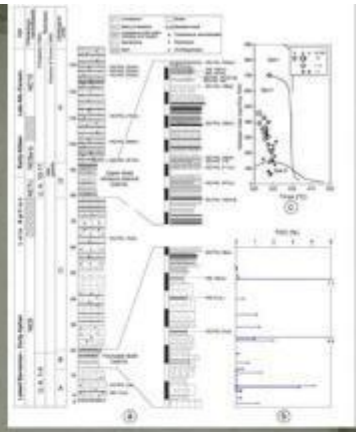
The global distribution of lower Toarcian bituminous black shales

Izumi et al. / Palaeogeography, Palaeoclimatology, Palaeoecology 315-316 (2012) 100–108

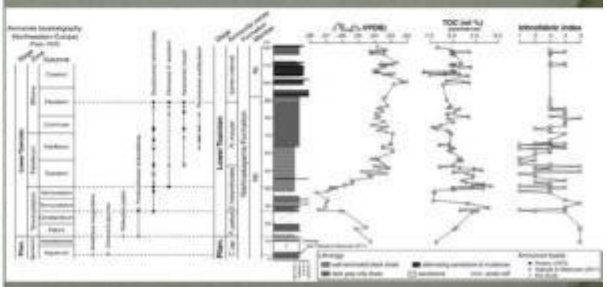
Wang et al. / Sedimentary Geology 235 (2011) 27–37

Wang et al. / Sedimentary Geology 235 (2011) 27–37

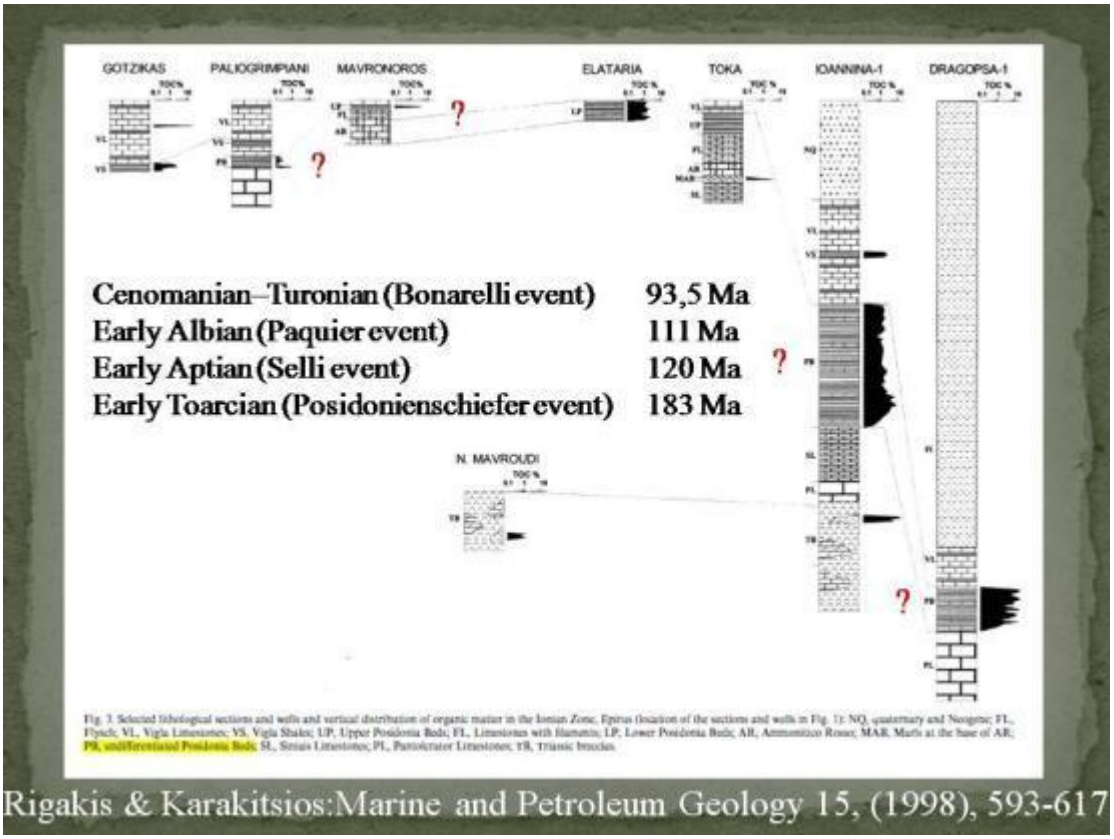
Cretaceous Research, 28, (2007) 597-612



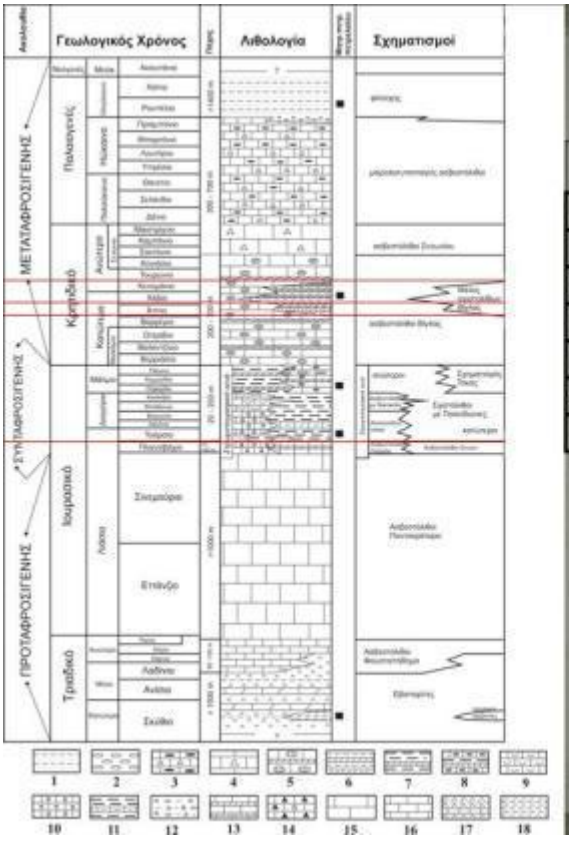
Revue de Micropaléontologie 50 (2007) 225–237



Izumi et al. / Palaeogeography, Palaeoclimatology, Palaeoecology 315-316 (2012) 100–108



Rigakis & Karakitsios:Marine and Petroleum Geology 15, (1998), 593-617



	1,1	1,1	0,9	1,3	1,7
	1,7	1,5	1,2	1,3	1,3
	1,2	1,4	0,7	2,4	0,9
	1,0	1,6	0,9	1,9	1,0
	1,1	0,8	0,8	1,2	0,7
	1,2	0,9	1,3	0,9	0,6
	1,2	1,2	1,0	1,5	1,0

Μέσος όρος πορώδους (%) ανά σχηματισμό στην περιοχή της Ηπείρου, από Μπακόπουλο 2006, Δ.Δ. ΕΚΠΑ

Τροποποιημένο από Karakitsios& Rigakis 2007, JPG, 30, 197-218

Στον χώρο των Εξωτερικών Ελληνίδων εμφανίζεται από το Μέσο Τριαδικό αλλά κυρίως μετά το Ιουρασικό, μια συζυγία πετρωμάτων πυριτικής σύστασης στις Ζώνες Πίνδου, Ιόνιος, Παξών καθώς και στα μεταμορφωμένα πετρώματα των Πλακωδών Ασβεστολίθων (Πελοπόννησος, Κρήτη, Κάσος, Κάρπαθος, Ρόδος).

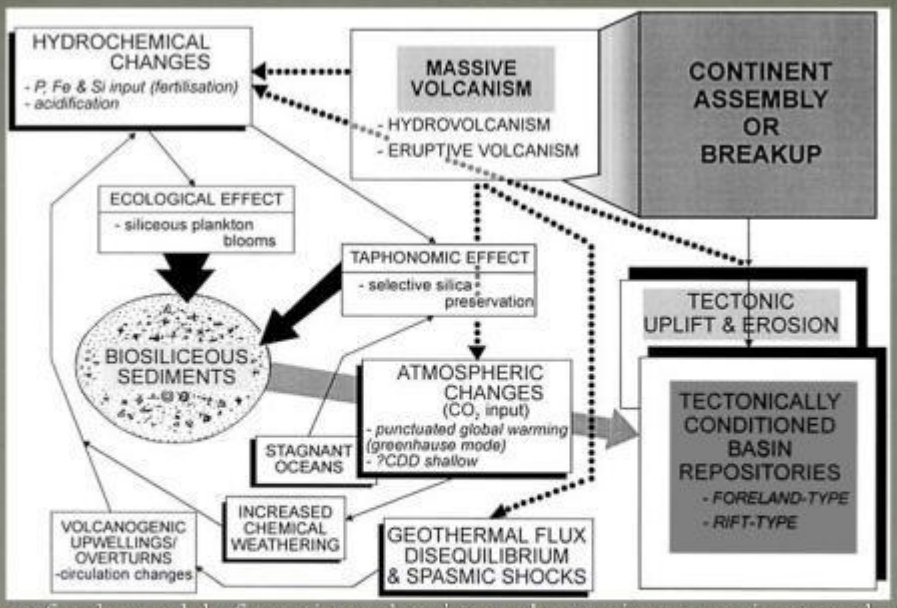
Ορισμοί - Ερμηνείες

- Πυριτόλιθοι - κερατόλιθοι

  Ανόργανης (διαγενετικής) προέλευσης

  ή

- "Ραδιολαρίτες"

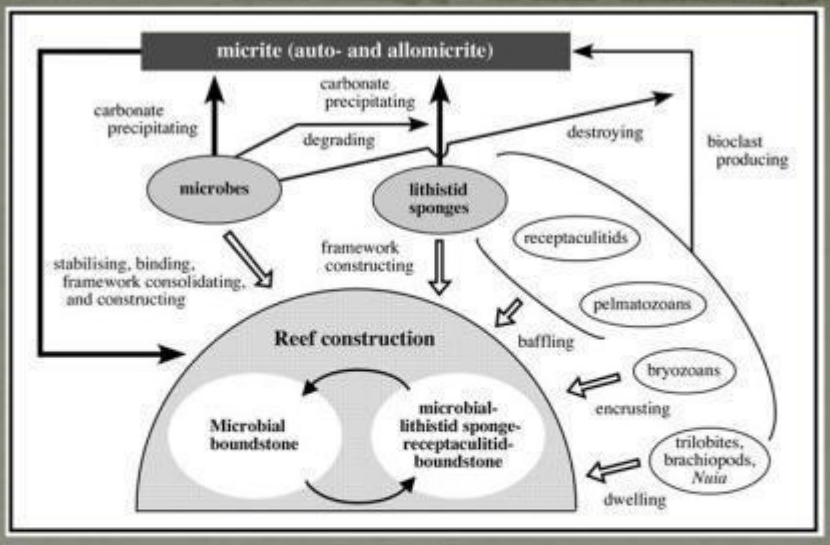


Flow chart for the model of massive volcanism and tectonics as a main control of biosiliceous sedimentation

G. Racki, F. Cordey, Earth-Science Rewiews 52 (2000) 83–120

Ύφαλοι πυριτιοσπόγγων έχουν εμφανιστεί διαδοχικά στην εξελικτική παρεία του πλανήτη. Στο Ανώτερο όμως Ιουρασικό σχημάτισαν μια υφαλογόνο αλυσίδα που επεκτάθηκε πάνω από 7.000 χιλ. Ο σημερινός ύφαλος που υπάρχει (Great Barrier Reef) στην Αυστραλία είναι σχετικά μικρός σε σχέση με αυτόν του Ανωτέρου Ιουρασικού. Το σύστημα αυτό των υφάλων αποτέλεσε την μεγαλύτερη βιοτική δομή που δημιουργήθηκε ποτέ πάνω στην Γη.

Paleogeographic situation during Late Jurassic. (Map used and modified after Blakey 2002



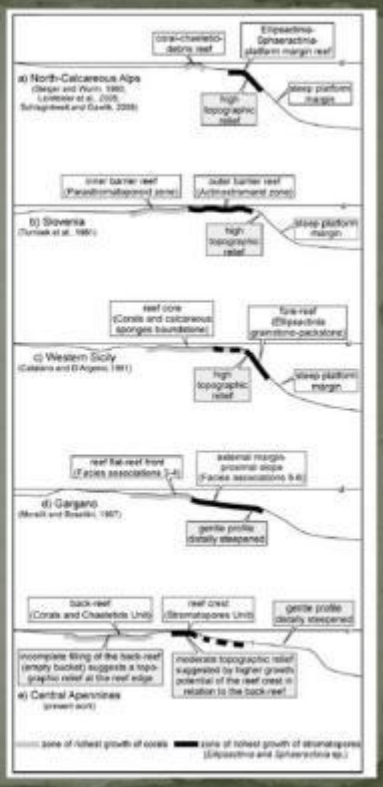
Schematic model showing those elements that combined to construct the Lower Ordovician reefs, made up of microbial boundstones and microbial-lithistid spongereceptaculitid boundstones. Micrites are a significant component of the reefs and are produced variously by microbes as well as skeletal organisms (lithistid sponges in particular).

N. Adachi et al. / Sedimentary Geology 220 (2009) 1–11

"The Late Jurassic records is one of the largest reefal expansions of the Phanerozoic, with a greater diffusion and differentiation in the Tethys realm"

Comparison of main morphological features and distribution of main biota along the depositional profiles of available examples from Intra-Tethys reef types

..zonation model for Upper Jurassic Intra-Tethys reef complexes. Rusciadelli et al. Sedimentary Geology 233 (2011) 69–87



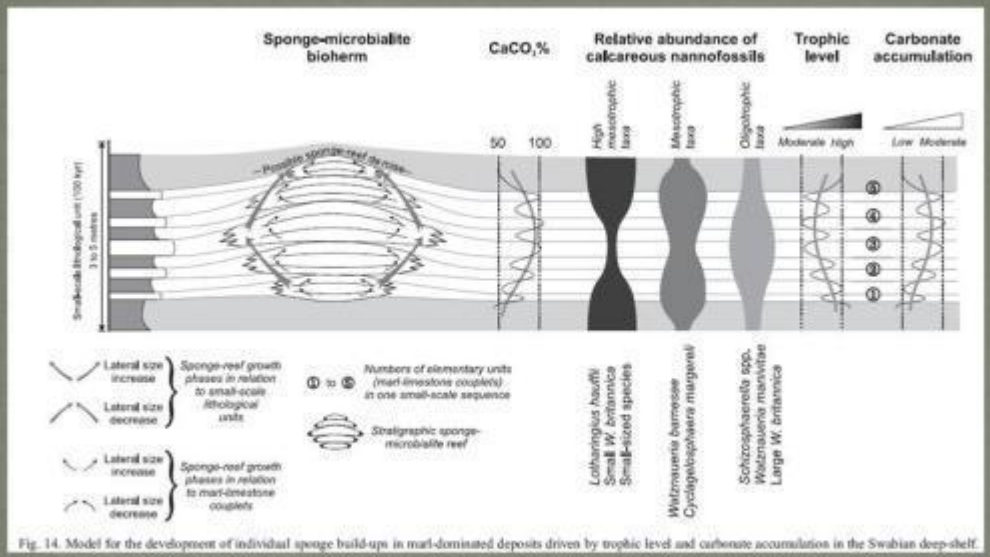
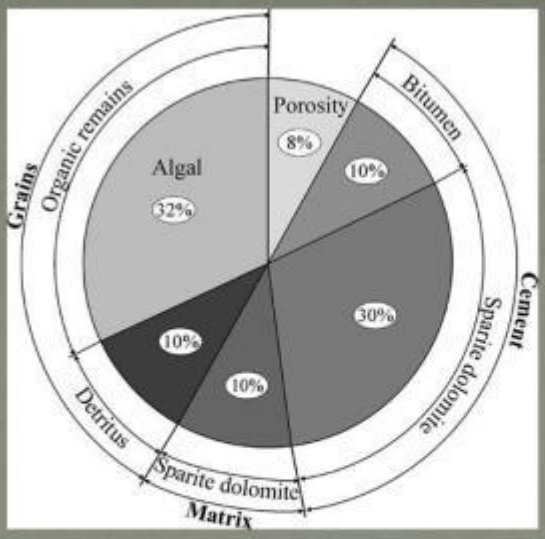


Fig. 14. Model for the development of individual sponge build-ups in marl-dominated deposits driven by trophic level and carbonate accumulation in the Swabian deep-shelf.

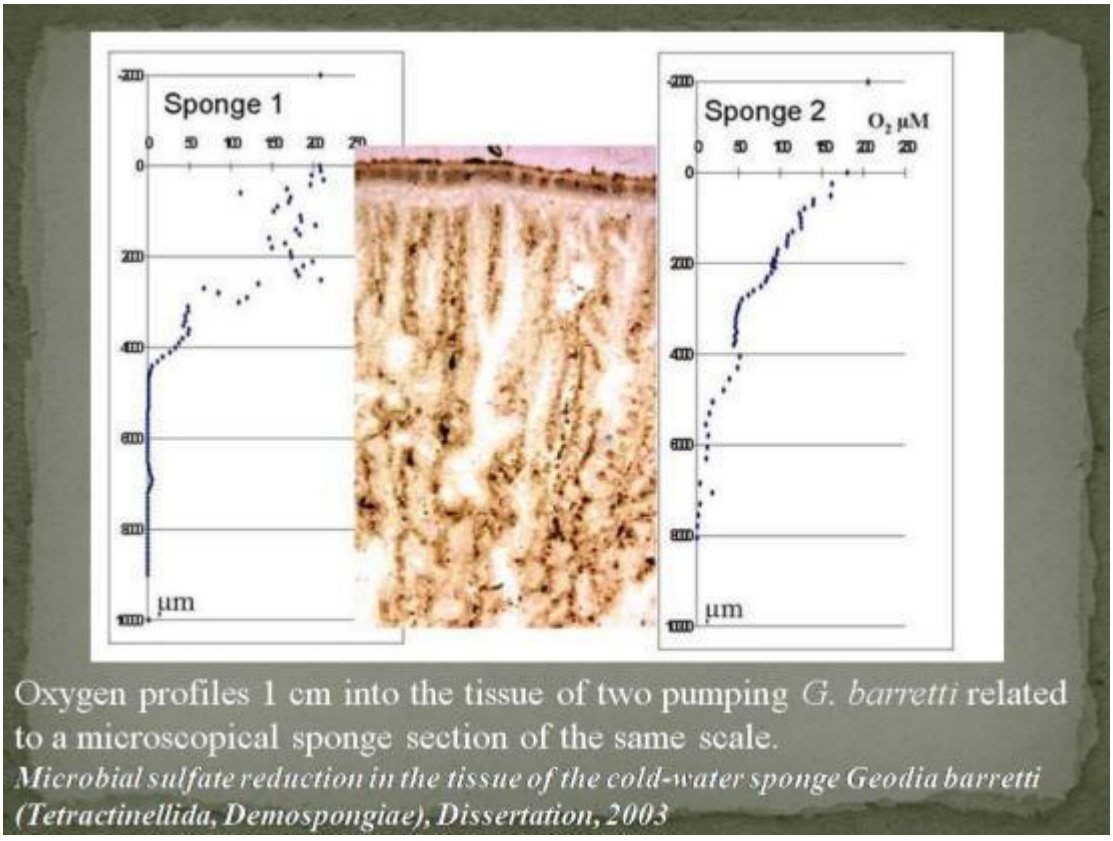
Olivier et al. / Palaeogeography, Palaeoclimatology, Palaeoecology 212 (2004) 233–263

- "The sediment within the sponge bioherms is characterized by a high levels of organic carbon. The large amount of organic carbon **(more than 3 weight percent)** found in the reef sediments is similar to that found at modern deltas on the west coast of Canada (Bornhold, 1978). Reducing conditions, which are usually observed in the recovered cores and grab samples in the shallow subsurface in reef sediments, are probably explained by this high organic carbon content. These dys- or anoxic conditions are responsible for the paucity and low diversity of endobenthic organisms" (**Recent Hexactinellid Sponge Reefs on the Continental Shelf of British Columbia, Canada,** http://www.porifera.org/a/a11.htm)

The link between black cherts and high biological activity is nearly systematic from the Precambrian to the Recent (van Kranendonk, 2001)

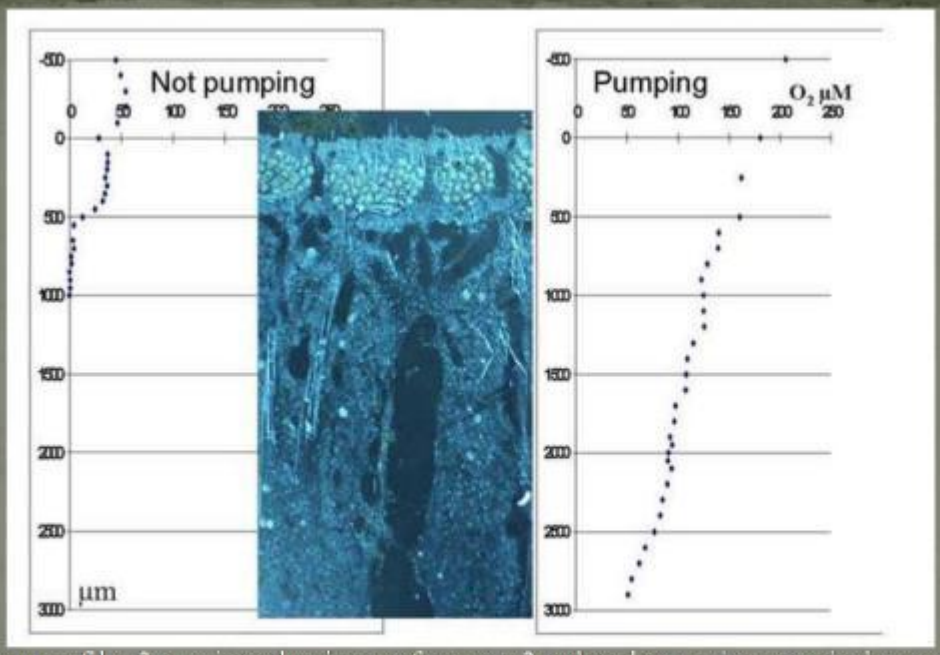


Organogenic build-up
(Organic remain: algae, stromatoporoids, crinoids, gastropods, protozoans)
A lithofacies model for the Upper Devonian Pamyatno-Sasovskoye **reef (oilfield)** (Volgagradskoe Povolzhye, Russia)
S.V. Deliya, N.V. Danshina / Palaeoworld 19 (2010) 278–283



Oxygen profiles 1 cm into the tissue of two pumping *G. barretti* related to a microscopical sponge section of the same scale.

Microbial sulfate reduction in the tissue of the cold-water sponge Geodia barretti (Tetractinellida, Demospongiae), Dissertation, 2003

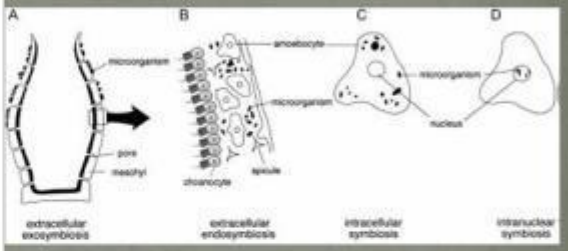


Oxygen profiles 3 mm into the tissue of sponge 2. related to a microscopical sponge section of the same scale.

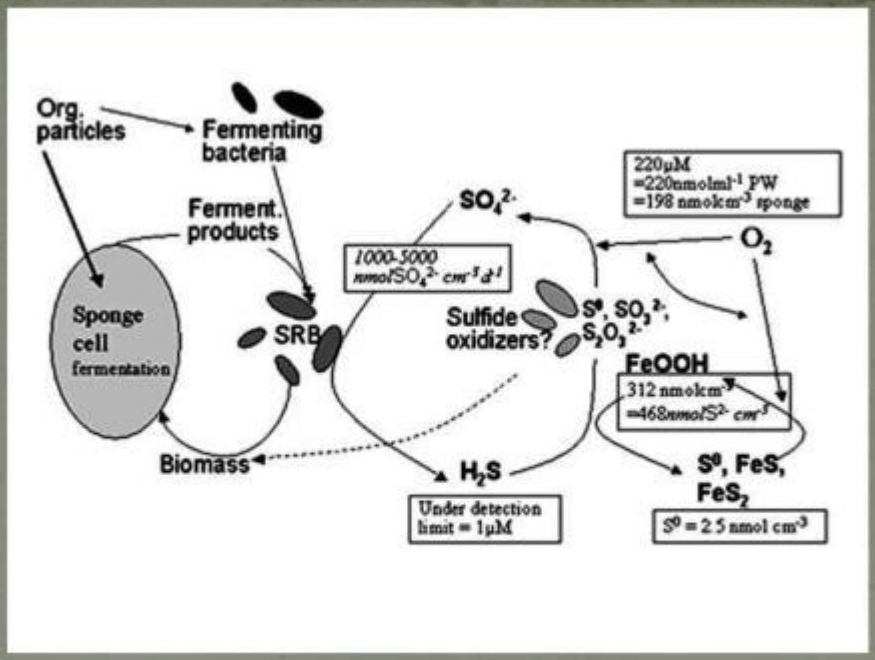
Microbial sulfate reduction in the tissue of the cold-water sponge Geodia barretti (Tetractinellida, Demospongiae), **Hoffmann F.,** *Dissertation,* Göttingen, *2003*

Table 2. Sponges and their symbiotic microorganisms producing natural products

Sponge	Symbiotic microorganism*
Acicultina orientalis	Filamentous bacteria
Antarctic sponge	B. *Pseudomonas aeruginosa*
Aplysina sp.	B. *Arthrobacter* sp.
Aplysina sp.	B. *Bacillus* sp.
Aplysina sp.	B. *Micrococcus* sp.
Aplysina sp.	B. *Pseudoalteromonas* sp.
Aplysina sp.	B. *Vibrio* sp.
Cenarchaeum symbiosum	Archeon
Dysidea herbacea	Cyanobacterium
Dysidea herbacea	C. *Oscillatoria spongeliae*
Dysidea sp.	B. *Vibrio* sp.
Halichondria okadai	B. *Aeromonas* sp.
Halichondria okadai	D. *Prorocentrum lima*
Halichondria panicea	B. *Antarcticum vesiculatum*
Halichondria panicea	B. *Pseudomonas mosilla*
Halichondria panicea	B. *Rhodobacter* sp.
Halichondria panicea	B. *Psychroserpens burtonensis*
Homophymia sp.	B. *Pseudomonas* sp.
Hyattella sp.	B. *Vibrio* sp.
Rhopaloeides odorabile	B. *β-Proteobacteria*
Rhopaloeides odorabile	B. *γ-Proteobacteria*
Rhopaloeides odorabile	A. *Actinobacteria* sp.
Rhopaloeides odorabile	B. *Cytophaga* sp.
Rhopaloeides odorabile	Green sulfur bacteria
Sigmadocia symbiotica	R. *Ceratodictyon spongiosum*
Suberea creba	B. *Pseudomonas* sp.
Suberea creba	B. *Pseudomonas* sp.
Tedania ignis	B. *Micrococcus* sp.
Theonella swinhoei	B. *δ-Proteobacteria*
Theonella swinhoei	C. *Aphanocapsa feldmanni*
Theonella swinhoei	Filamentous bacteria
Theonella swinhoei	Unicellular bacteria
Unidentified sponge	A. *Streptomyces* sp.
Verongia sp.	B. *Aeromonas* sp.
Verongia sp.	B. *Pseudomonas* sp.
Xestospongia sp.	B. *Micrococcus luteus*



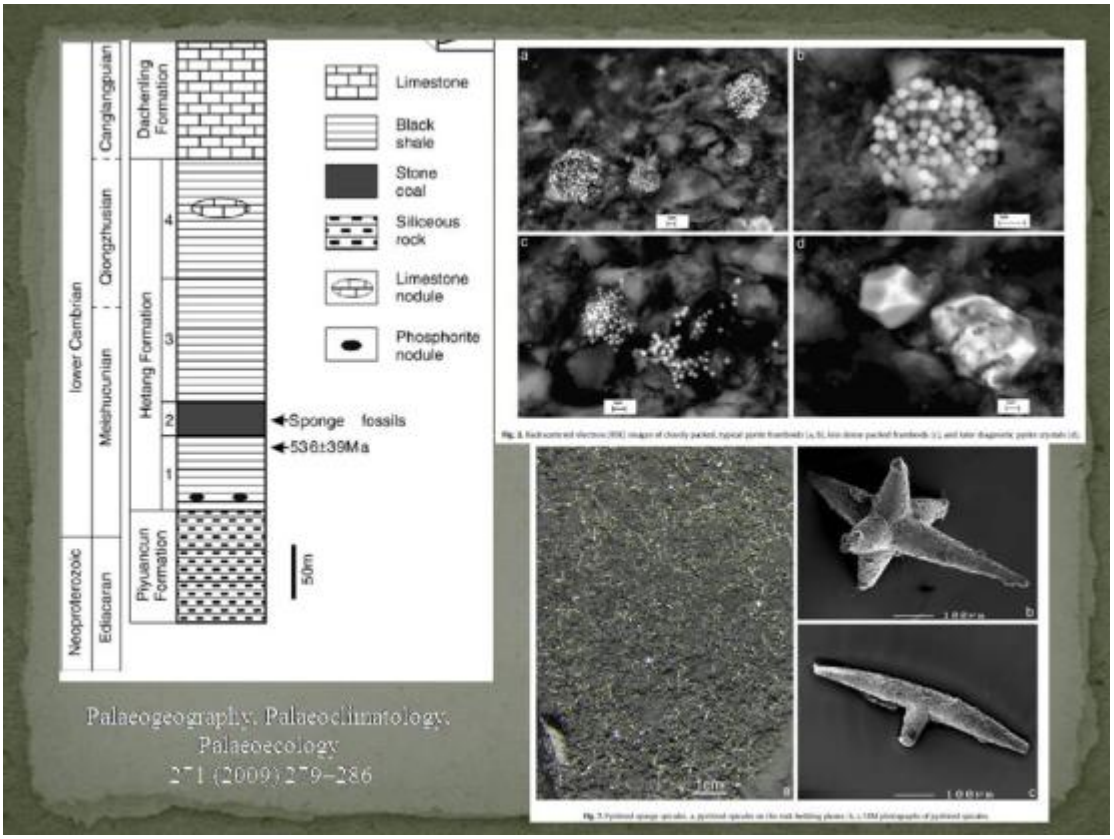
Schematic diagram of symbiotic relationships between sponges and microorganisms. A. extracellular exosymbiosis; B. extracellular endosymbiosis; C. intracellular symbiosis; and D. intranuclear symbiosis. Microbial Symbiosis in Marine Sponges. Lee *et al.* J. Microbiol., Vol. 39. No. 4. 254-264.

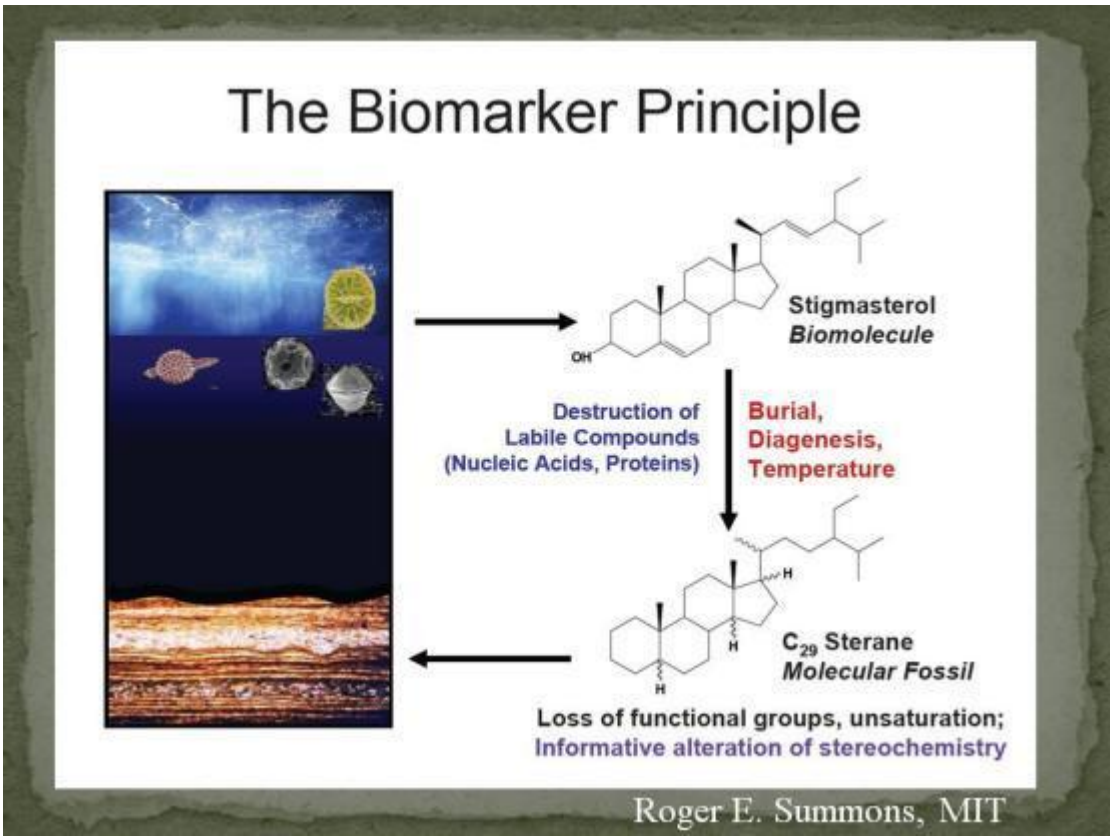


Biological-chemical and sponge-bacteria interactions in the tissue of *G. barretti*.
***Microbial sulfate reduction in the tissue of the cold-water sponge Geodia barretti (Tetractinellida, Demospongiae)*, Hoffmann F., *Dissertation*,** Göttingen, 2003

How the sponge stays slim, *Nature | doi:10.1038/news.2009.1088*
One species' rapid cell shedding explains its huge carbon-catching capacity.

De Goeij, J. M. *et al.*, ***Cell kinetics of the marine sponge Halisarca caerulea reveal rapid cell turnover and shedding.*** *J. Exp. Biol.* **212,** 3892-3900 (2009)


lower Cambrian
Neoproterozoic
Ediacaran
Meishucunian
Qiongzhusian
Canglangpuian
Dachenling Formation
Hetang Formation
Piyuancun Formation
Limestone
Black shale
Stone coal
Siliceous rock
Limestone nodule
Phosphorite nodule
Sponge fossils
536±39Ma
50m
Palaeogeography, Palaeoclimatology, Palaeoecology
271 (2009) 279–286


The Biomarker Principle
Stigmasterol
Biomolecule
OH
Destruction of
Labile Compounds
(Nucleic Acids, Proteins)
Burial,
Diagenesis,
Temperature
H
H
H
C29 Sterane
Molecular Fossil
Loss of functional groups, unsaturation;
Informative alteration of stereochemistry
Roger E. Summons, MIT

- **Petroleums and bitumens from Early Proterozoic (1800 Ma) to Miocene (15 Ma) age marine strata contain 24-isopropylcholestanes,** a novel group of C$_{30}$ steroids. The abundance of these compounds, relative to 24-n-propylcholestanes, varies with source rock age. Late Proterozoic (Vendian) and Early Cambrian oils and/or bitumens from Siberia, the Urals, Oman, Australia, and India have a high ratio of 24-isopropylcholestanes to 24-n-propylcholestanes (>1), while younger and older samples have a lower ratio (<0.4). **Temporal changes in this parameter may reflect the relative abundance of certain Porifera (sponges) and certain marine algae through time**. Geochemical indicators such as this, which can constrain the source rock age of a migrated oil, are useful in source rock identification during petroleum exploration.

Paleoenvironmental implications of novel C$_{30}$ steranes in Precambrian to Cenozoic age petroleum and bitumen, McCaffrey et al., *Geochimica et Cosmochimica Acta, 1994, Vol. 58, pp. 529-532*

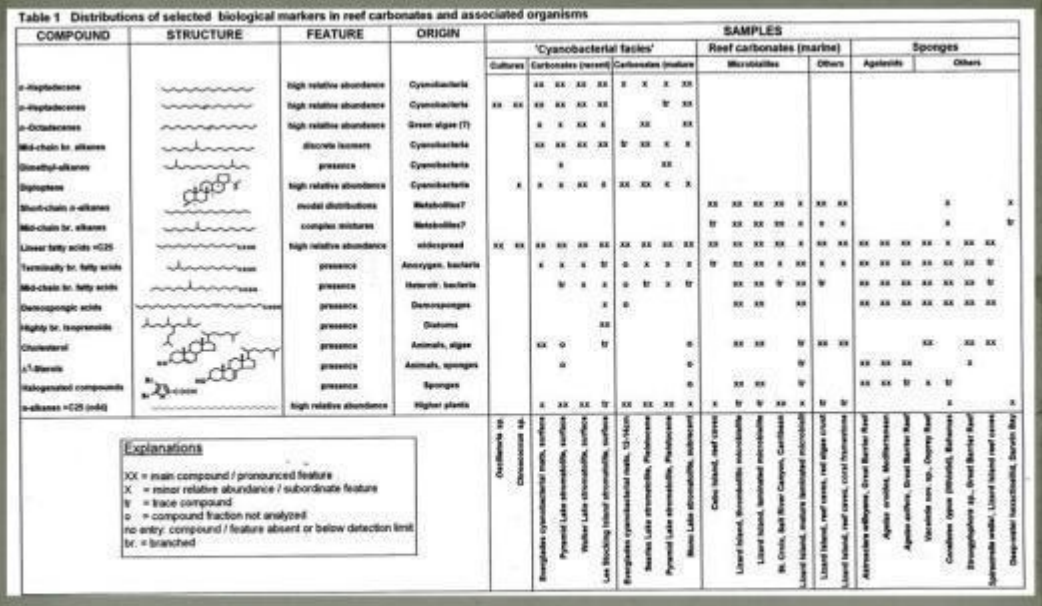


Table 1 Distributions of selected biological markers in reef carbonates and associated organisms

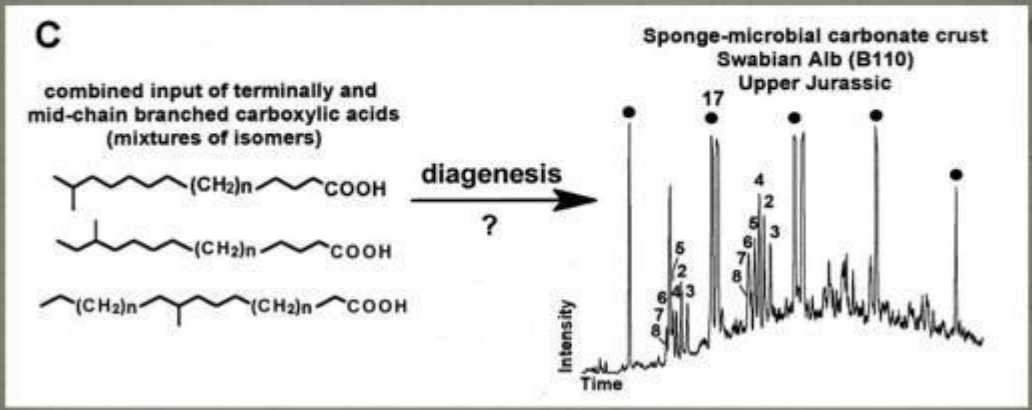
COMPOUND	STRUCTURE	FEATURE	ORIGIN	SAMPLES
				'Cyanobacterial facies'
				Cultures
				Carbonates (recent)
				Carbonates (mature)
				Reef carbonates (marine)
				Microbialites
				Others
				Sponges
				Agelasids
				Others
n-Heptadecene		high relative abundance	Cyanobacteria	
n-Heptadecenes		high relative abundance	Cyanobacteria	
n-Octadecenes		high relative abundance	Green algae (?)	
Mid-chain br. alkenes		discrete isomers	Cyanobacteria	
Dimethyl-alkanes		presence	Cyanobacteria	
Diplopterene		high relative abundance	Cyanobacteria	
Short-chain n-alkanes		modal distributions	Metabolites?	
Mid-chain br. alkanes		complex mixtures	Metabolites?	
Linear fatty acids <C25		high relative abundance	widespread	
Terminally br. fatty acids		presence	Anoxygen. bacteria	
Mid-chain br. fatty acids		presence	Heterotr. bacteria	
Demospongic acids		presence	Demosponges	
Highly br. isoprenoids		presence	Diatoms	
Cholesterol		presence	Animals, algae	
Δ7-Sterols		presence	Animals, sponges	
Halogenated compounds		presence	Sponges	
n-alkanes >C25 (mid)		high relative abundance	Higher plants	

Explanations

XX = main compound / pronounced feature
X = minor relative abundance / subordinate feature
tr = trace compound
o = compound fraction not analyzed
no entry: compound / feature absent or below detection limit
br. = branched

Thiel et al., (1996): Biogeochemistry of Modern Porifera and Microbialites from Lizard Island (Great Barrier Reef, Australia) and Fossil Analoges. In: Reitner et al., **Globale und regionale Steuerungsfaktoren biogener Sedimentation.** Gött.Arb.Geol.Paläont.SB2, 129-132; Göttingen.

"The found mid-chain branched carboxylic acids represent potential biological precursors for series of mid-chain branched alkanes present in ancient sediments and oils"



Mid-chain branched alkanoic acids from "living fossil" demosponges: a link to ancient sedimentary lipids? Thiel et al. Organic Geochemistry 30 (1999) 1-14.

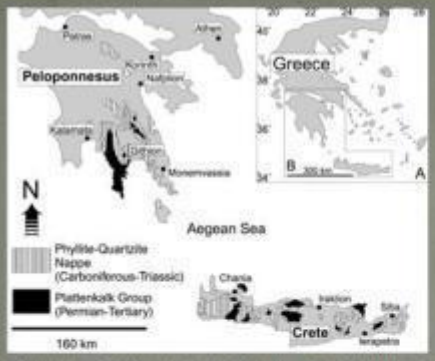
nature Vol 457|5 February 2009|doi:10.1038/nature07673

LETTERS

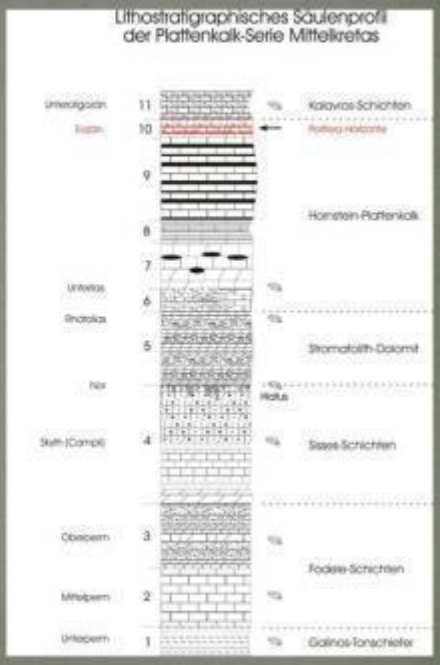
Fossil steroids record the appearance of Demospongiae during the Cryogenian period

Gordon D. Love[1,2], Emmanuelle Grosjean[3], Charlotte Stalvies[4], David A. Fike[5], John P. Grotzinger[5], Alexander S. Bradley[2], Amy E. Kelly[2], Maya Bhatia[2], William Meredith[6], Colin E. Snape[6], Samuel A. Bowring[2], Daniel J. Condon[2]† & Roger E. Summons[3]

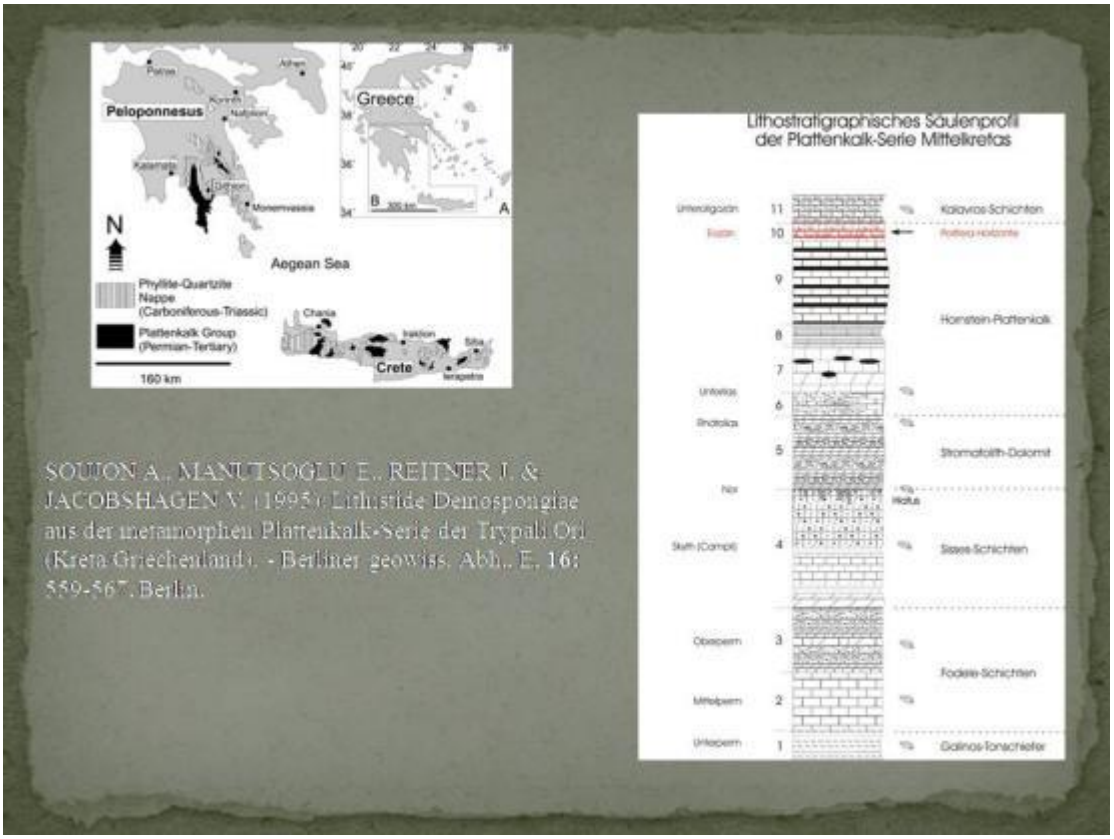
"…C30 steranes comprised 2.7% of total C27–C30 extractable steranes in Huqf samples and 63% of the summed C30 compounds were 24-isopropylcholestanes, suggesting ***that demosponges must have made a significant contribution to preserved sedimentary organic matter***…"

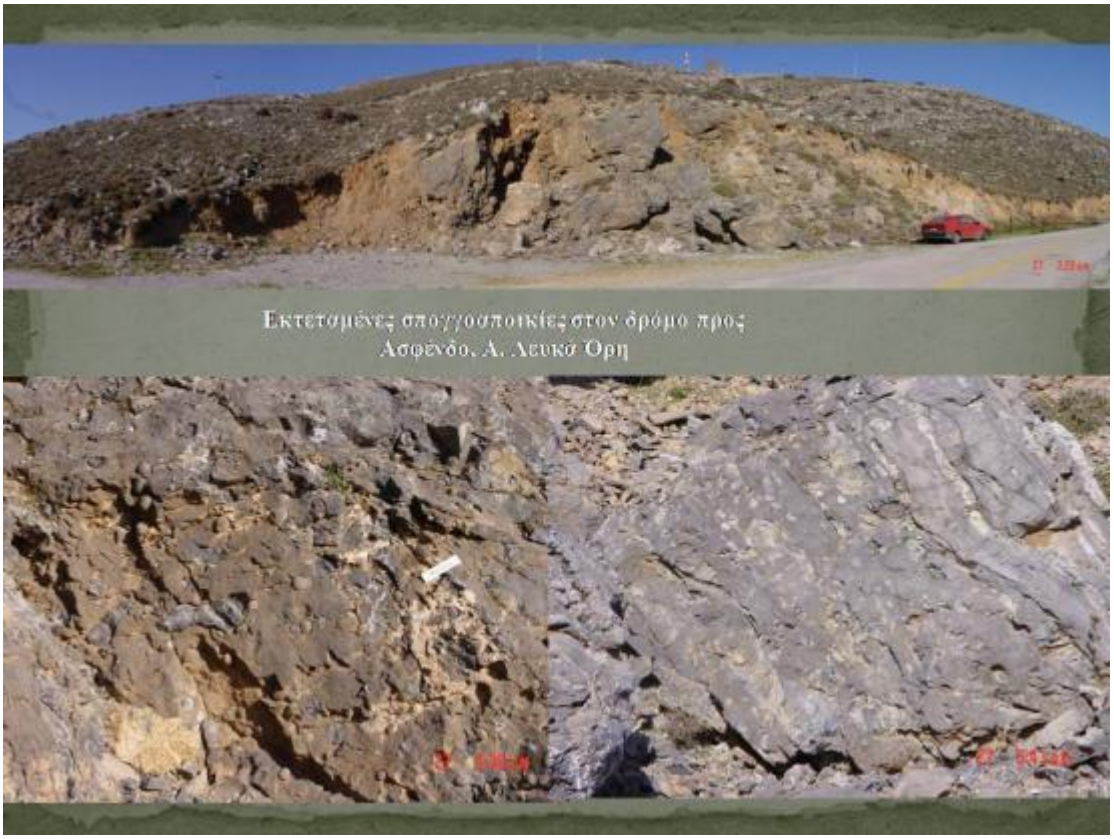


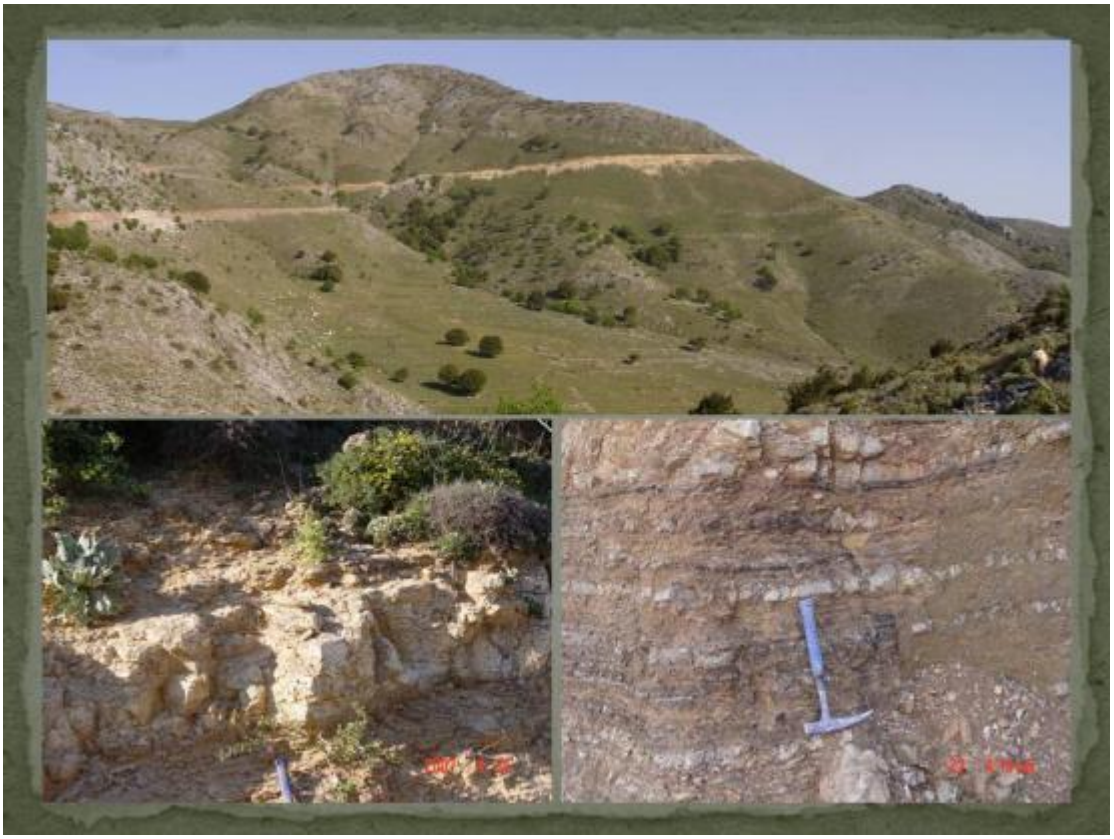
MANUTSOGLU E., SOUION A., REITNER J. & DORNSIEPEN U.F. (1995): Relikte lithistider Demospongiae aus der metamophen Plattenkalk-Serie der Insel Kreta (Griechenland) und ihre palaeobathymetrische Bedeutung. - N. Jb. Geol. Palaeont. Mh., **1995/4**: 235-247.



Εκτεταμένες σπηλαιοποιήσεις στην ΝΔΑ ΨΗΛΟΡΕΙΤΗΣ


Peloponnesus
Greece
Aegean Sea
Phyllite-Quartzite Nappe (Carboniferous-Triassic)
Plattenkalk Group (Permian-Tertiary)
160 km
Crete
Lithostratigraphisches Säulenprofil der Plattenkalk-Serie Mittelkretas
Kalavros-Schichten
Hornstein-Plattenkalk
Stromatolith-Dolomit
Sisses-Schichten
Fodele-Schichten
Gallinos-Tonschiefer
SOUTON A., MANUTSOGLU E., REITNER J. & JACOBSHAGEN V. (1995): Lithistide Demospongiae aus der metamorphen Plattenkalk-Serie der Trypali Ori (Kreta, Griechenland). - Berliner geowiss. Abh., E, 16: 559-567, Berlin.


Εκτεταμένες σπογγοσποικίες στον δρόμο προς Ασφενδο, Α. Λευκά Ορη

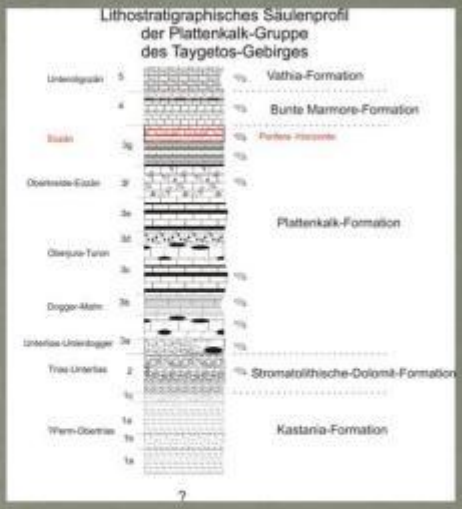



Περιοχή Ασφένδου - Καλικράτη

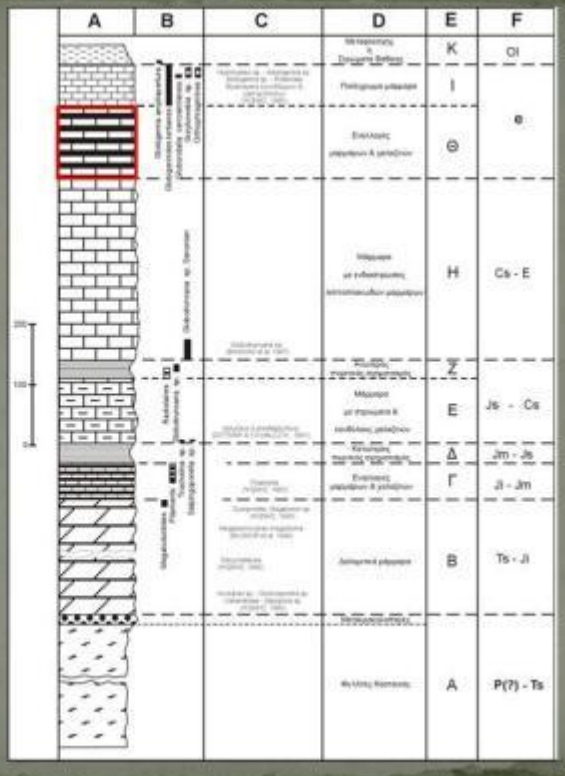
Διαφορετικές μορφές σπογγοσποικιών εντός του Ενθικού Δρυμού Λευκών Ορέων

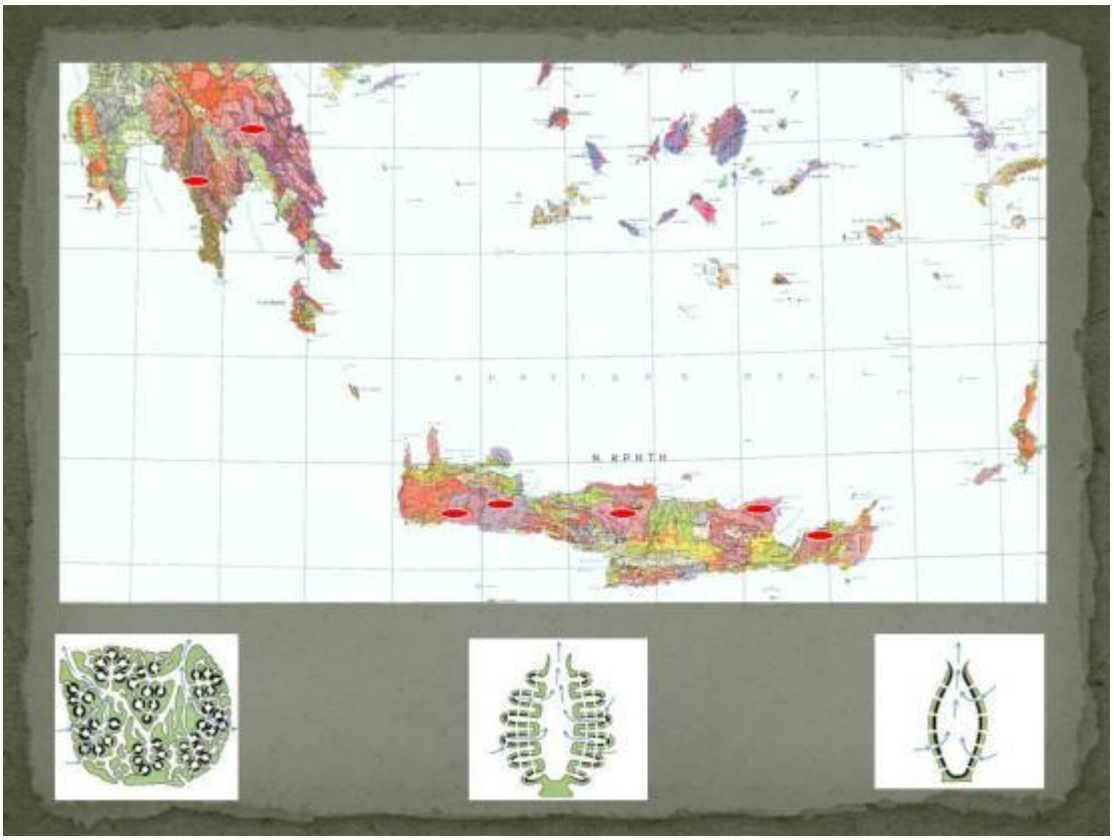


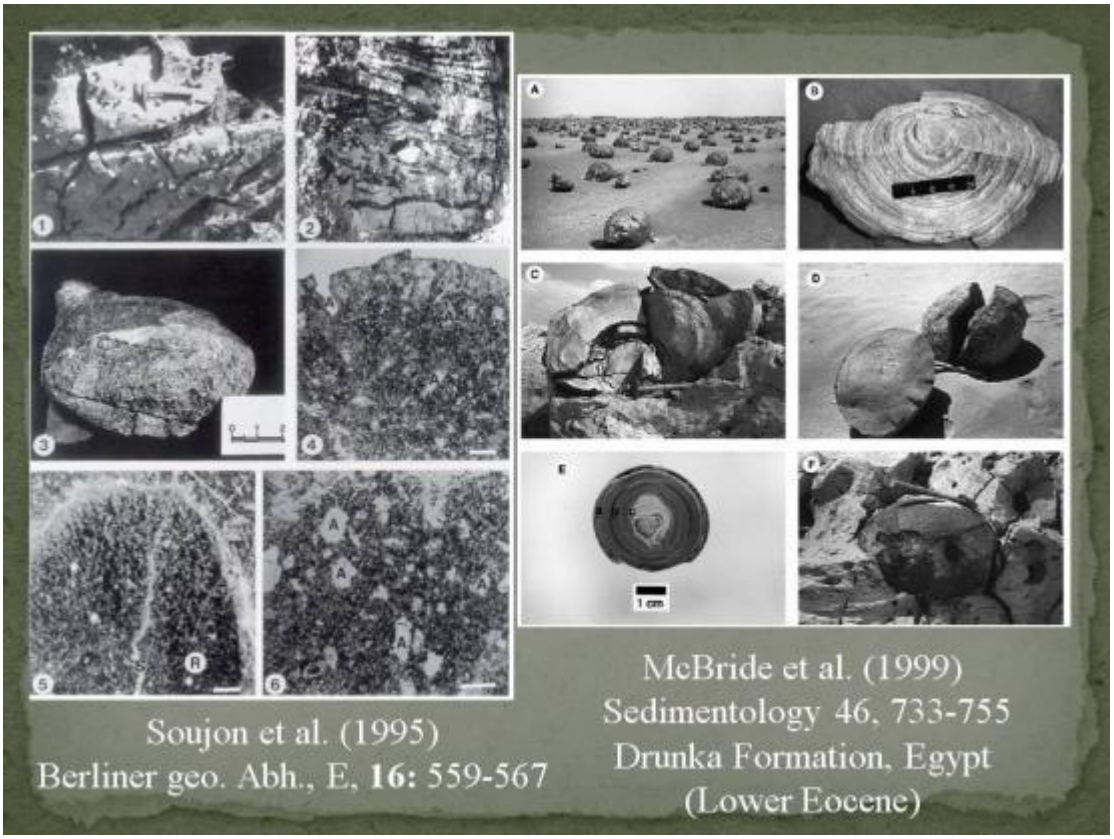

MANUTSOGLU E., REITNER J., MARIOLAKOS D., BELLAS S.M. & MARIOLAKOS I. (1998): Erster Nachwers von Relikten lithistrider Demospongiae aus der Plattenkalk-Gruppe des Taygetos Gebirges, Peloponnes Griechenland. - Z. dt. geol. Ges., **149**: 91-103, Stuttgart.



Μαριολάκος Δ., Σκούρτσος Ε. & Μανούτσογλου Ε. (2012): Υπολειμματικές σπογγώδοικιες εντός των μεταμορφωμένων πετρωμάτων της Ομάδας των Πλακωδών Ασβεστολίθων του Πάρνωνα - **Extended Abstract.** Επιστημονική Συνεδρία της Ελληνικής Γεωλογικής Εταιρίας, 6 Φεβρουαρίου 2012, Τεύχος Περιλήψεων, σελ. 18-20, Αθήνα.

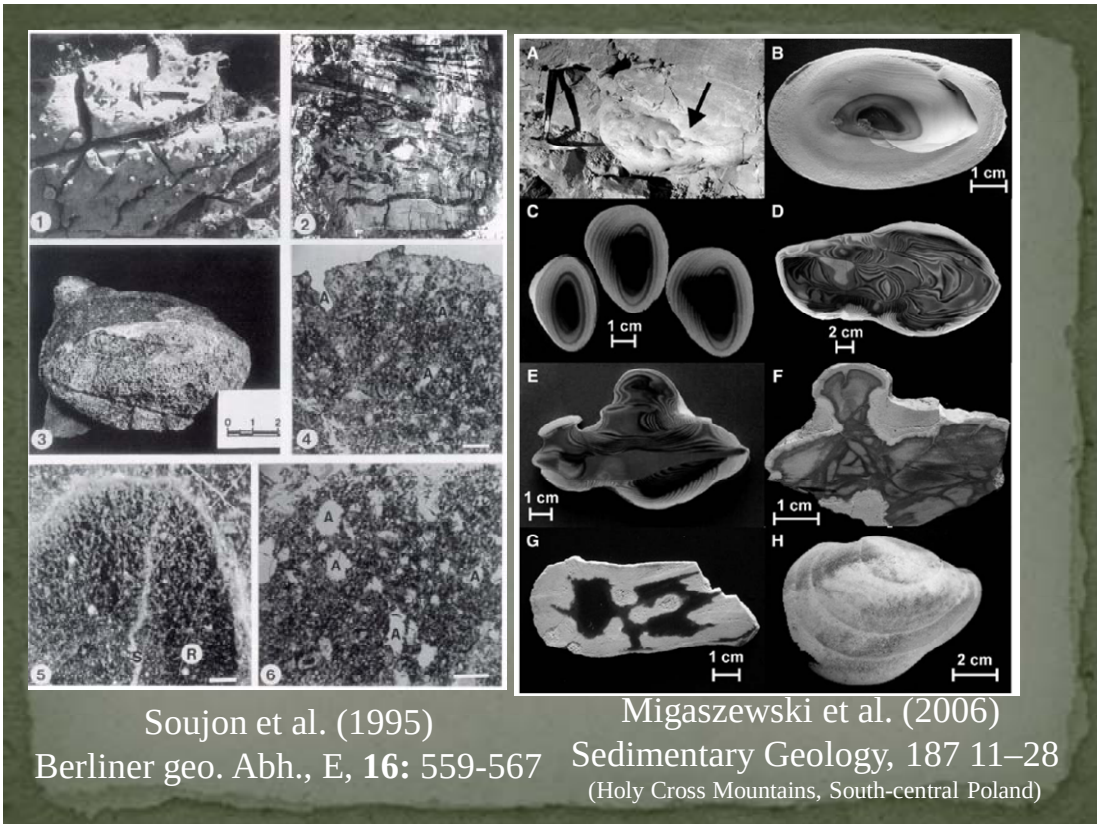



Κ. ΚΡΗΤΗ



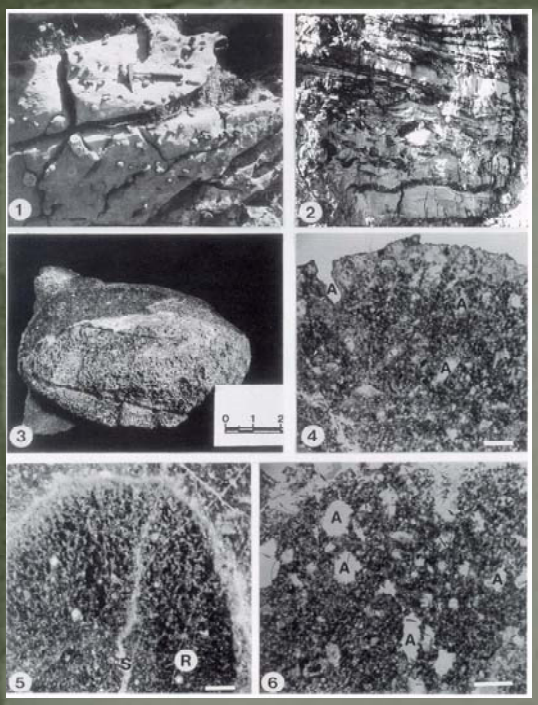
Soujon et al. (1995)
Berliner geo. Abh., E, **16:** 559-567

McBride et al. (1999)
Sedimentology 46, 733-755
Drunka Formation, Egypt
(Lower Eocene)

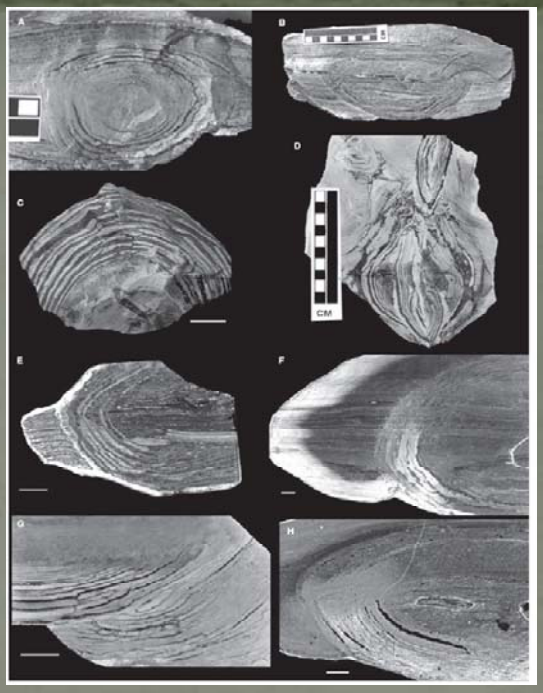


Soujon et al. (1995)
Berliner geo. Abh., E, **16:** 559-567

Migaszewski et al. (2006)
Sedimentary Geology, 187 11–28
(Holy Cross Mountains, South-central Poland)



Soujon et al. (1995)
Berliner geo. Abh., E, **16:** 559-567



R. J. Behl (2010), Sedimentology,
doi: 10.1111/j.1365-3091.2010.01165.x
Monterey Formation of California
Miocene

Source rock analysis by pyrolysis gas chromatography on siliceous and argillaceous rocks from Ajigasawa of Aomori area, Japan

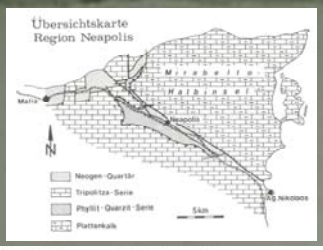
Sample No.	Lithology	Formation	T_{max} (°C)	TOC (%)	S_1 (‰)	S_2 (‰)	S_3 (‰)	S_2/S_3	ρg (g/cm^3)	Φ (%)	k_a (md)
I-5A	Diatomite	Maido	400	0.55	0.78	1.27	0.47	2.7	2.32	64.6	3.9
I-3B	Diatomite	Maido ?	384	1.35	0.62	1.95	0.09	21.7	2.29	61.9	1.6
G-65.5	Diatomite	Maido	393	0.88	0.34	0.90	0.06	15.0	2.39	51.8	0.0
D-10	Diatomite	Akaishi	386	0.89	0.40	0.95	0.06	15.8	2.38	49.4	0.0
G-38C	Sil. shale	Akaishi	409	0.94	0.30	1.72	0.00	–	2.52	30.2	0.0
G-34	Sil. shale	Akaishi	417	1.17	0.55	3.86	0.19	20.3	2.47	26.7	0.0
G-20	Sil. shale	Akaishi	416	0.99	0.23	2.37	0.00	–	2.56	24.7	0.0
G-18B	Sil. shale	Akaishi	421	1.43	0.63	4.86	0.22	22.1	2.50	25.5	0.0
G-9D	Sil. shale	Ohdoji	420	2.76	0.79	16.31	0.73	22.3	2.48	26.4	0.0
G-2B	Sil. shale	Ohdoji	408	2.23	1.81	16.74	0.50	33.5	2.50	25.0	0.0
K-17.5	Sil. shale	Ohdoji	–	1.71	1.05	4.54	0.07	64.9	2.27	36.9	0.0
M-22	Sil. shale	Ohdoji?	406	0.42	0.21	0.51	0.18	2.8	2.51	28.3	75
G-15	Chert	Akaishi	416	0.86	0.56	1.86	0.04	46.5	2.49	19.2	0.7
K-25B	Chert	Ohdoji	–	1.72	1.52	7.30	1.94	3.8	2.19	21.9	0.1
K-19B	Chert	Ohdoji	–	1.88	0.97	5.87	1.40	4.2	2.21	27.3	0.0
G-9L	Chert	Ohdoji	417	2.30	0.81	13.05	0.81	16.1	2.52	29.1	0.5
G-41B	Siltstone	Akaishi	407	0.60	0.27	0.76	0.33	2.3	2.31	29.0	0.0
M-37B	Claystone	Akaishi ?	390	0.97	0.50	1.14	0.14	8.1	2.24	39.4	0.6
K-10	Mudstone	Ohdoji	–	0.44	0.33	0.60	0.88	0.7	2.40	29.1	0.0
K-8	Siltstone	Ohdoji	437	0.48	0.44	0.90	0.24	3.7	2.55	40.6	–
M-3	Mudstone	Tanosawa ?	404	0.75	0.27	0.46	0.21	2.2	2.53	27.2	–

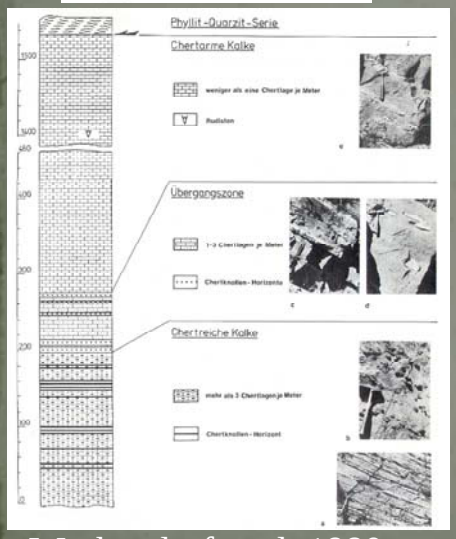
Journal of Petroleurn Science and Engineering, 7 (1992) 247-262

Sample no.	Cherts (the Shangsi Section, Guangyuan Area)				
	159-1	156-1	155-2	154-3	154-1
TOC	2.72	2.43	2.19	1.35	7.49
Ti	256.79	294.96	289.76	227.45	840.53
Al	7188.72	8706.06	8586.23	7279.89	21,895.24
T Fe	3604.13	8741.59	6000.05	6231.89	18,632.49
Mn	72.96	46.21	68.04	143.21	55.9
P	523.03	149.94	489.23	313.13	830.82
Mg	2460.92	3043.66	8552.09	5392.54	2462.22
Ca	159,854.56	69,111.87	103,152.81	245,783.47	9318.47
K	1322.6	1231.32	1565.28	1958.11	4354.16
Cd	12.36	11.42	11.65	0.38	19.18
V	323.64	741.55	331.38	95.73	466.1
Cr	79.25	154.13	88.49	12.04	120.99
Co	3	7.09	4.43	1.44	4.25
Ni	36.92	90.47	47.61	11.1	83.6
Cu	48.52	31.26	43.27	5.22	39.4
Zn	36.23	54.31	36.88	10.71	60.24
Rb	9.54	11.17	11.32	2.91	10.07
Sr	1284.77	739.4	2045.77	541	896.15
Y	4.7	7.23	8.3	2.09	14.69
Zr	13.87	23.34	27.65	8.04	18.12
Mo	22.77	213.61	32.32	23.69	73.16
Pb	2.09	3.73	3.33	1.23	2.75
Th	0.83	1.23	1.31	0.54	1.1
Ba	39.72	45.4	42.34	7.71	92.41
Ga	1.66	1.98	1.89	0.57	1.74
U	10.39	21.02	15.77	3.27	23.74

Elements in ppm; TOC in %.

Chen et al. (2012) Journal of Geochemical Exploration, 112, 35-53





Wachendorf et al, 1980

(Soujon, Jacobshagen & Manutsoglu, 1998)

Σας ευχαριστώ πολύ για την προσοχή σας