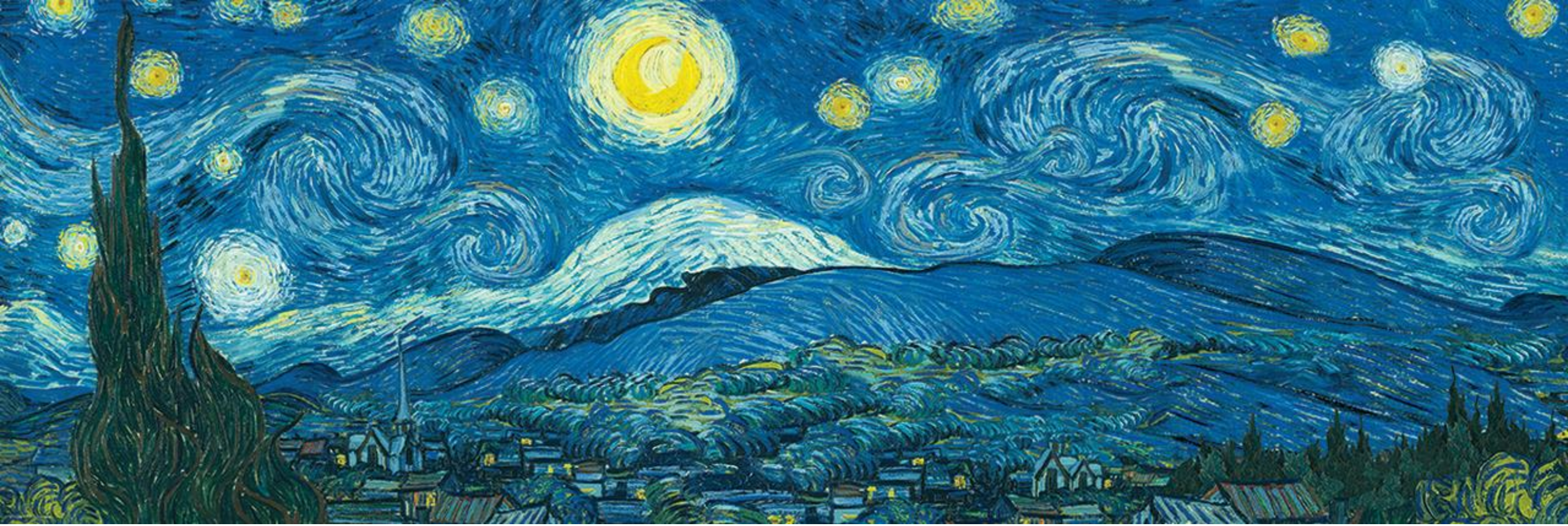


Biodiversity loss by the study of aberrant microfossils and their relative livings.

Amalia Spina, Roberto Rettori, Simonetta Cirilli, Nicola Mitillo, Andrea Sorci

Highlights:

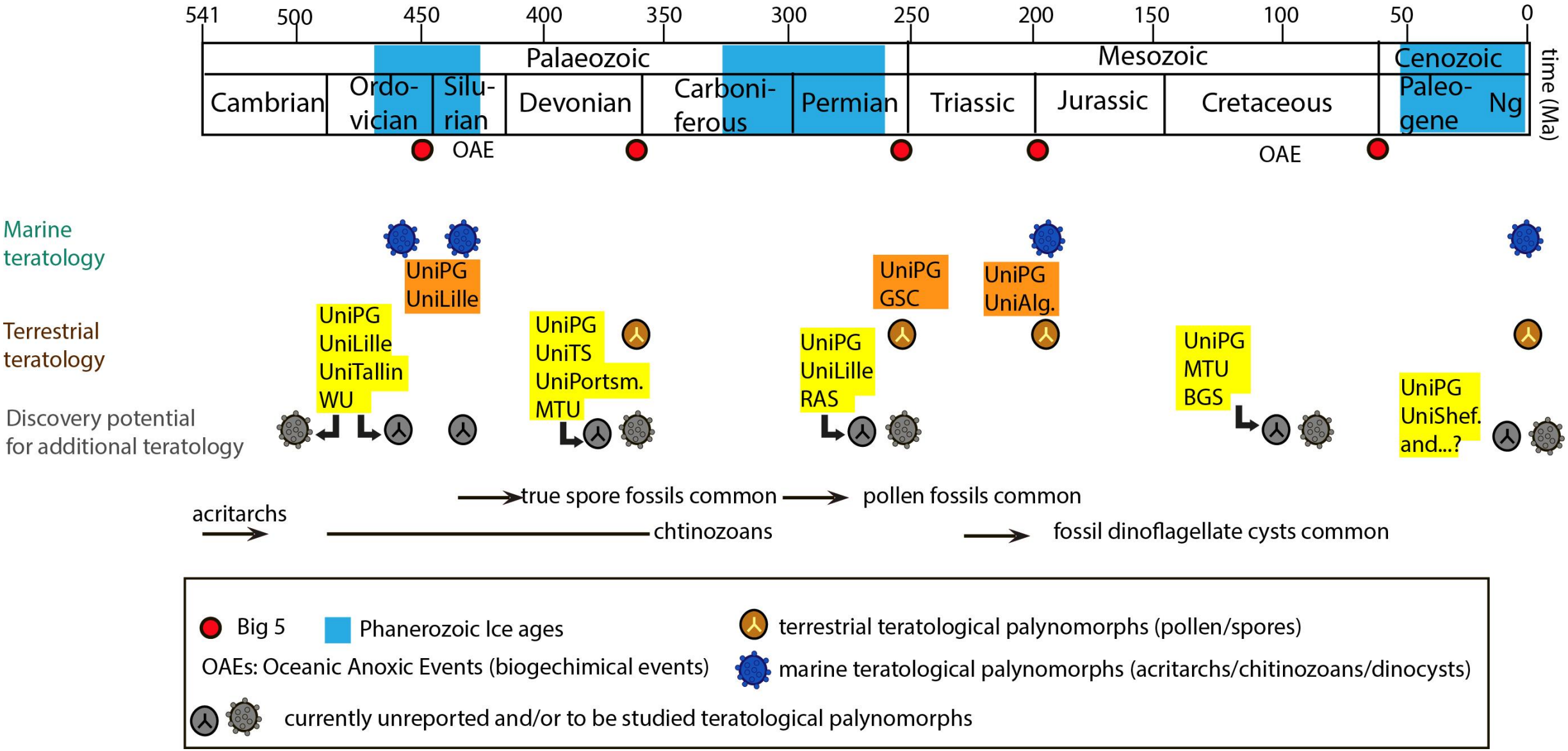
- Increase of teratological terrestrial and marine organic-walled microfossils associated with mass extinction events.
- Interaction with other research lines: biodiversity loss across the Earth history.
- Other: methods for the thermal maturity of organic matter.

- Increase of teratological terrestrial and marine organic-walled microfossils associated with mass extinction events.

Ambito/i del PTSR interessato/i

Ambito di ricerca nuovo: 1
TITOLO: Earth System and Global Changes
In particolare per le seguenti tematiche
- le cause e conseguenze delle variazioni climatiche nella storia del pianeta Terra e le maggiori estinzioni di massa;
- le relazioni tra i cambiamenti globali e lo sviluppo sostenibile;

Ambito di ricerca già attivato: 10
TITOLO: Geocronologia relativa e assoluta
In particolare per le seguenti tematiche
- studi di paleontologia sistematica.
- studi sull'evoluzione nel tempo degli esseri viventi attraverso indagini paleontologiche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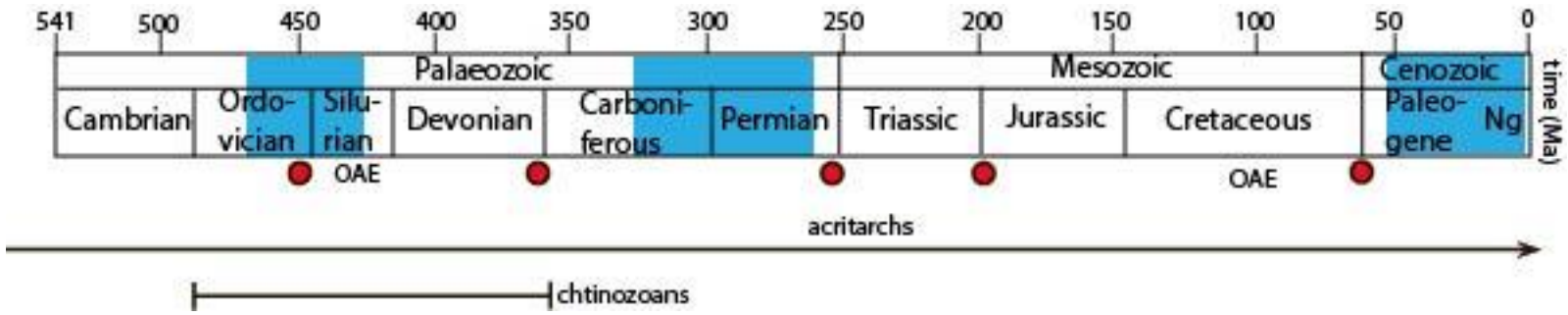
time (Ma)
Palaeozoic
Mesozoic
Cenozoic
Cambrian
Ordo-vician
Silu-rian
Devonian
Carboni-ferous
Permian
Triassic
Jurassic
Cretaceous
Paleo-gene
Ng
OAE
OAE
Marine teratology
Terrestrial teratology
Discovery potential for additional teratology
UniPG
UniLille
UniPG
UniLille
UniTallin
WU
UniPG
UniTS
UniPortsm.
MTU
UniPG
UniLille
RAS
UniPG
GSC
UniPG
UniAlg.
UniPG
MTU
BGS
UniPG
UniShef.
and...?
acritarchs
true spore fossils common
pollen fossils common
chtinozoans
fossil dinoflagellate cysts common
Big 5
Phanerozoic Ice ages
OAEs: Oceanic Anoxic Events (biogechimical events)
terrestrial teratological palynomorphs (pollen/spores)
marine teratological palynomorphs (acritarchs/chitinozoans/dinocysts)
currently unreported and/or to be studied teratological palynomorphs

Aberration in organic microfossils as a proxy for understanding the extinction events through time

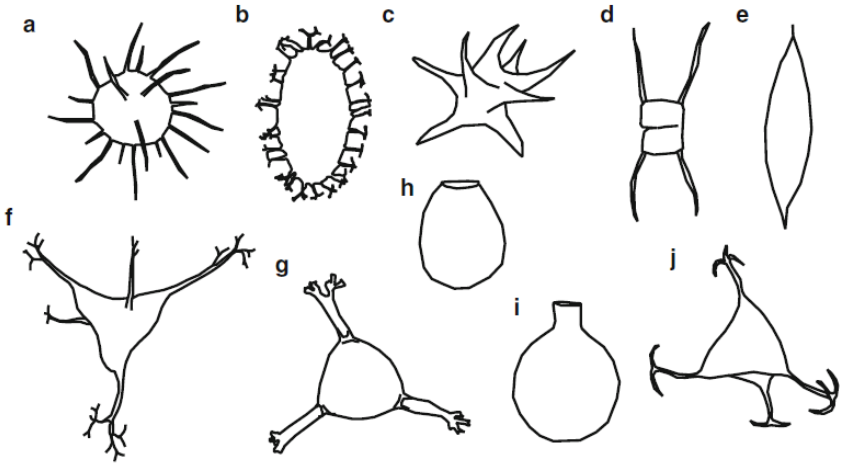
Objectives:

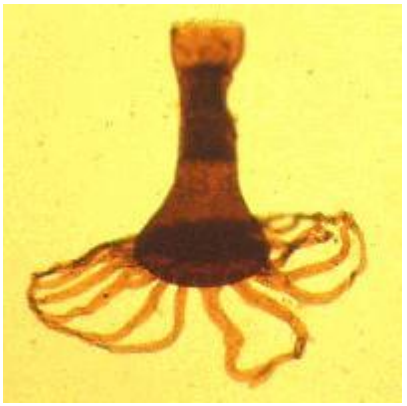
- To confirm the emerging temporal pattern of teratologies as harbingers of mass extinctions, across terrestrial and marine realms, across biological groups & kingdoms, and across geological time. Are palynomorphs the proverbial ‘canaries in the coal mine’, i.e. the first victims that announce catastrophic extinctions?
- To compare existing hypotheses for malformation for individual events and search for common denominators.
- To test and ground-truth our emerging hypotheses for the causes of malformations using experiments and modern analogue settings.
- To explore if causes for malformation actually scale up to the proximate mechanisms for mass extinctions.

Nomenclature:

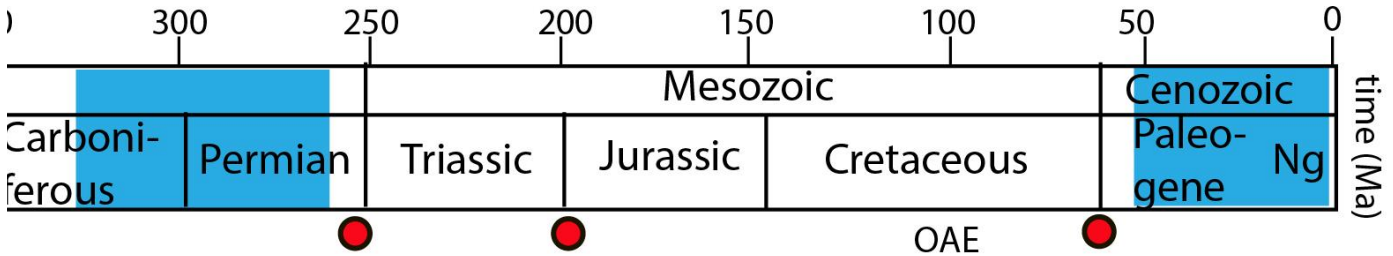


- Acritarchs: utilitarian category to classify all organic-walled microfossils of unknown biological affinity (Evitt, 1963). This definition clearly excludes a biological interpretation: the organisms that produced the acritarchs could be of diverse origins, marine and non-marine, planktonic and non-planktonic (Servais et al., 1997; Spina and Vecoli, 2009).
- Chitinozoans: extinct group of organic-walled microfossils of uncertain affinity. Knowledge about their biology and ecology is limited and has been gathered indirectly from associated fauna and facies. They are interpreted to be pelagic and marine. They have been assigned to various groups, from protozoans to dinoflagellates and fungi or eggs of soft-bodied metazoans that had a planktic mode of life (Paris and Verniers, 2005).





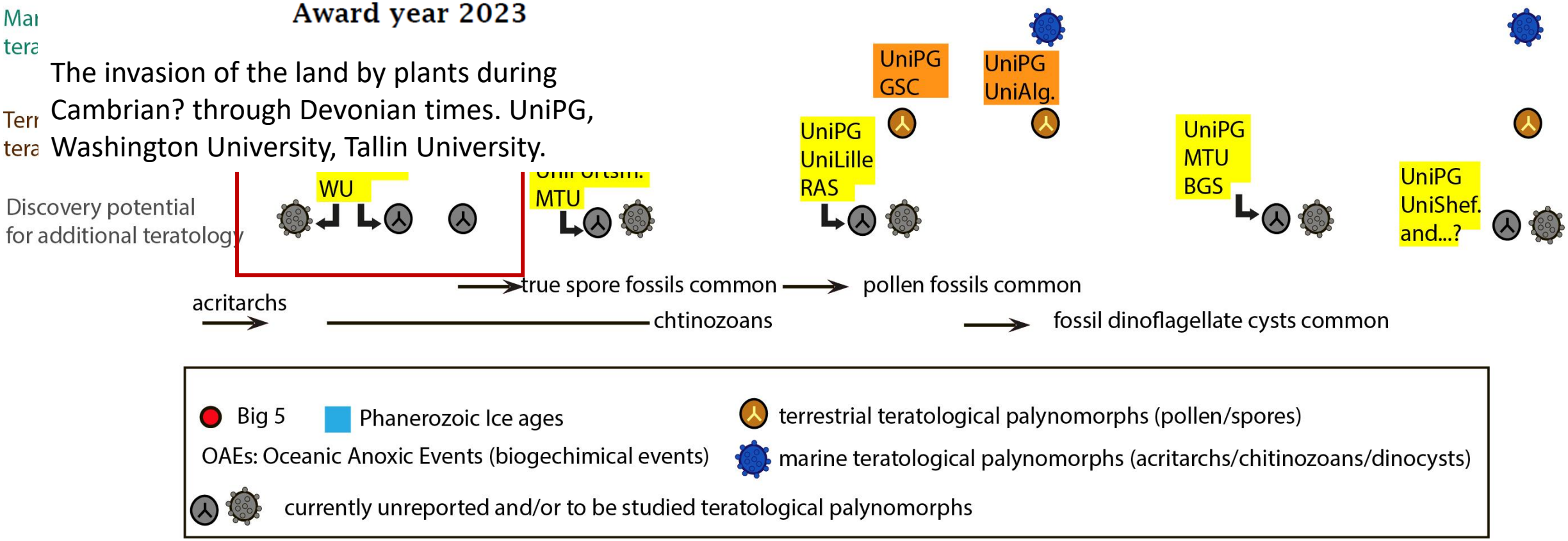
International Human Frontier Science Program Organization



HFSP Research Grants

Award year 2023

The invasion of the land by plants during Cambrian? through Devonian times. UniPG, Washington University, Tallin University.



International Human Frontier Science Program Organization

HFSP Research Grants

Award year 2023

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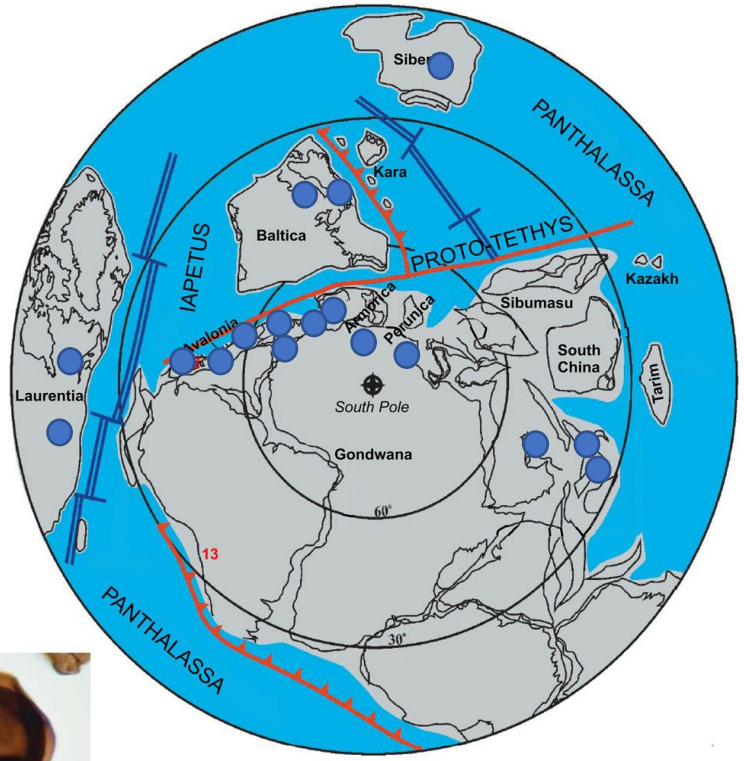
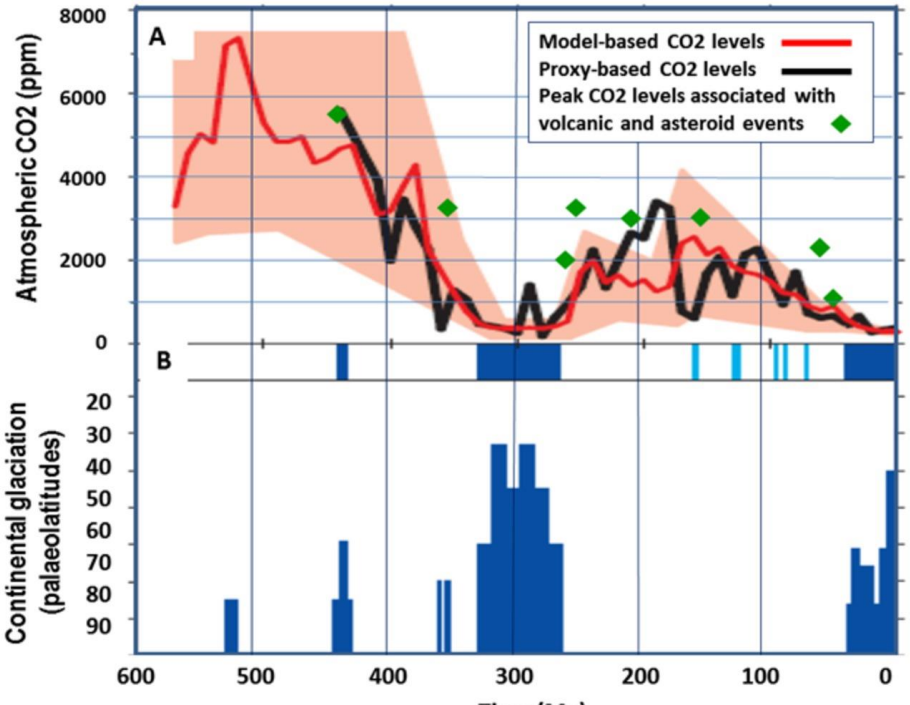
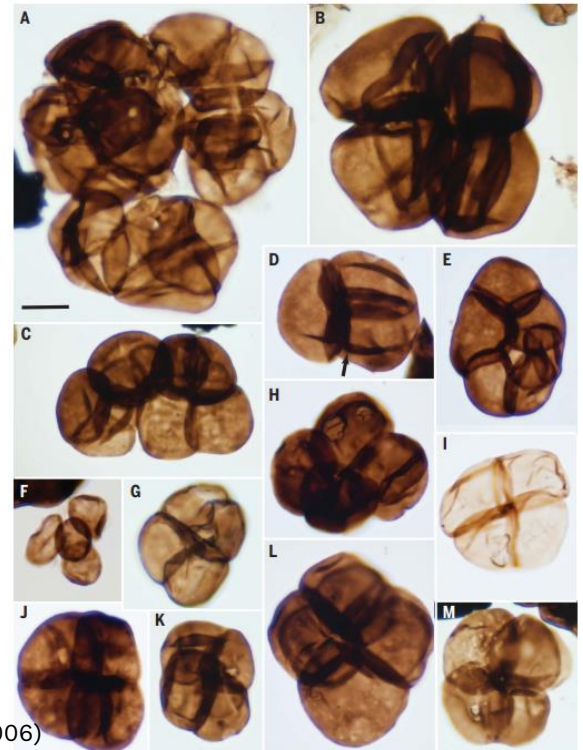


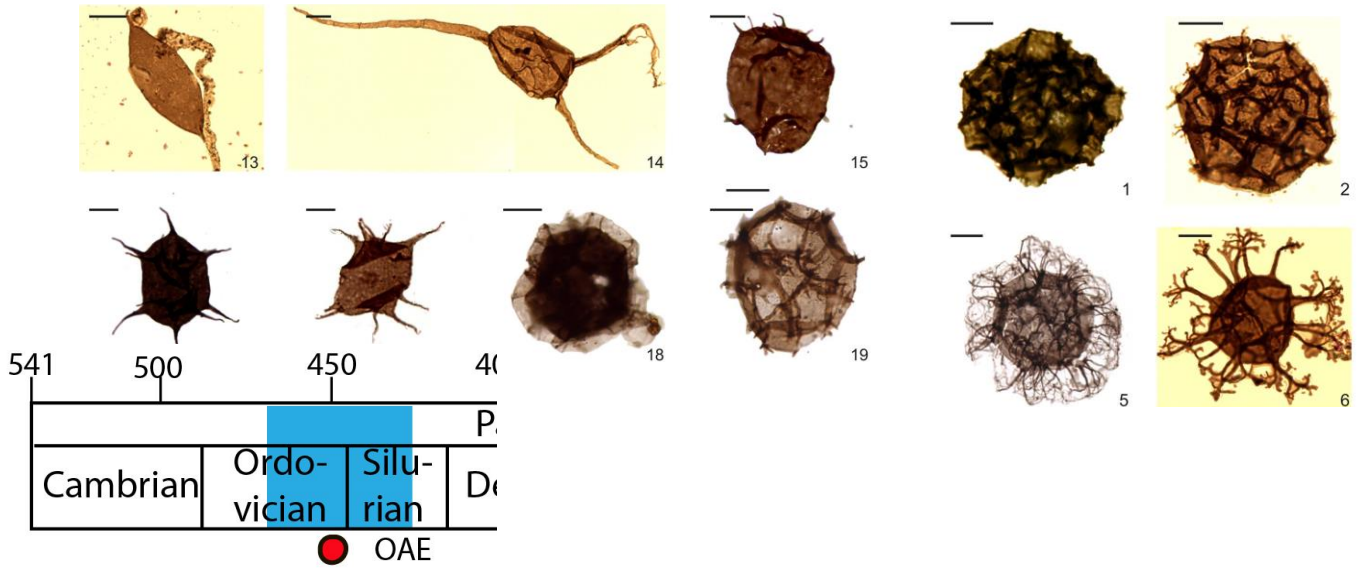
From Spina et al. (2021)



Data from Royer 2004 and 2006.

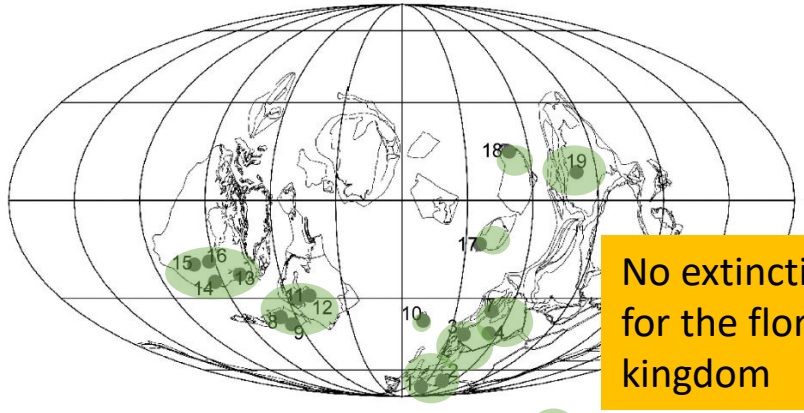


From Strother et al. (2006)



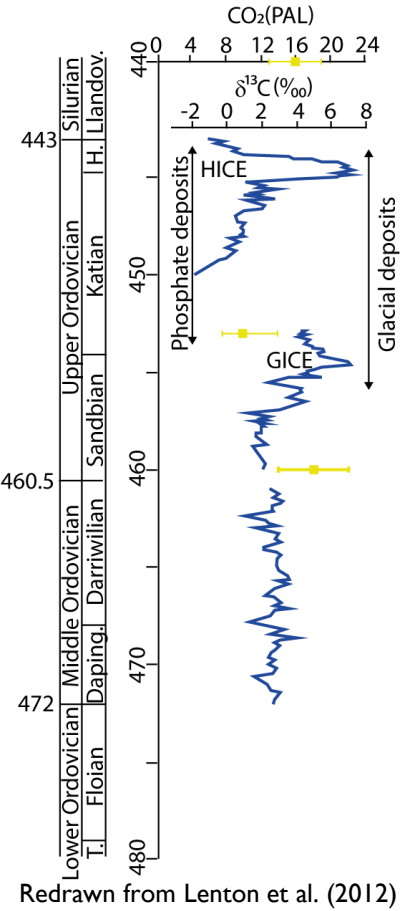
Late Ordovician (about 455-445 ma) mass extinction: glacial event

From Achab and Paris (2007); modified by Vecoli et al. (2011)

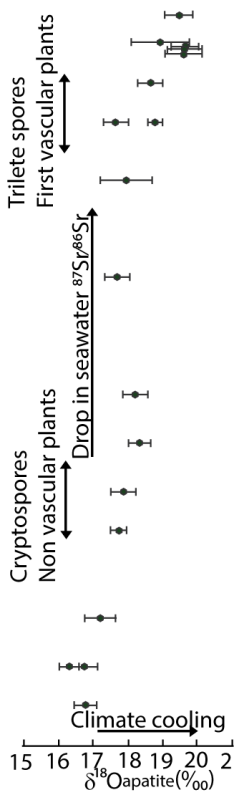


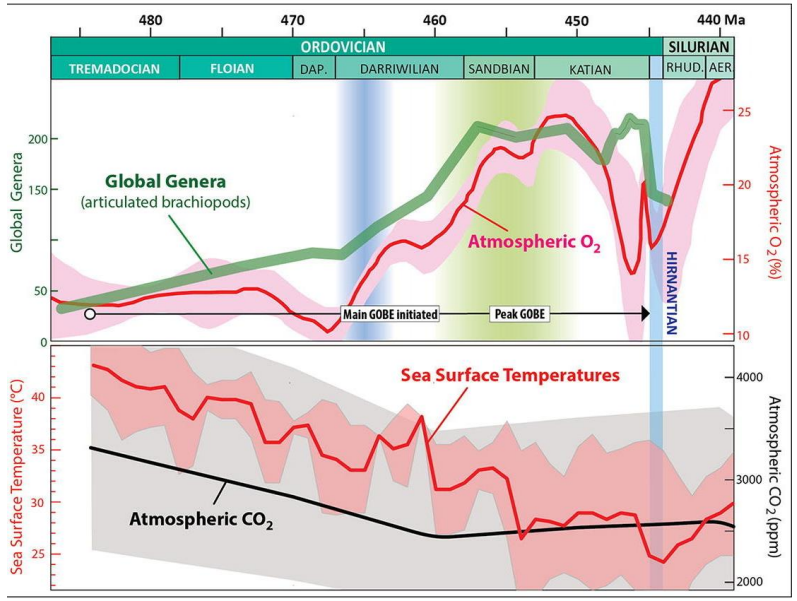
No extinction for the floral kingdom

Modified from Spina (2015) Flora

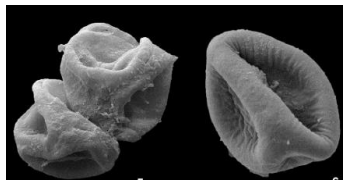


Redrawn from Lenton et al. (2012)





From Cocks and Torsvik (2021)

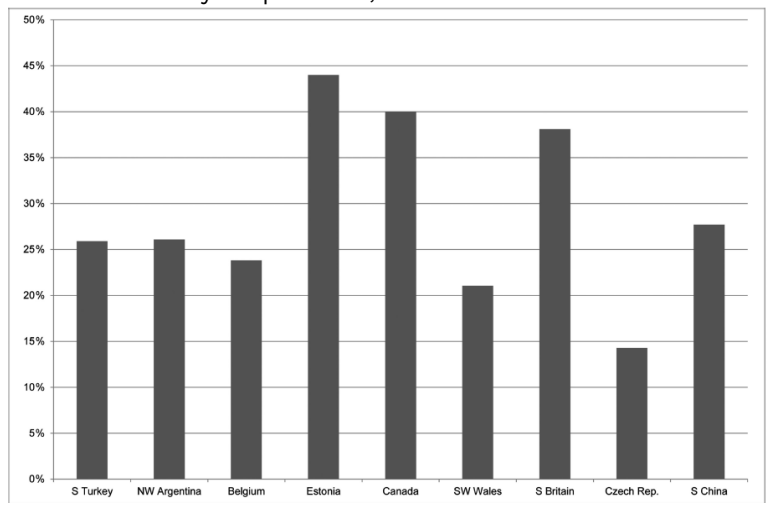


International Human Frontier Science Program Organization

Application guidelines for HFSP Research Grants Award year 2023

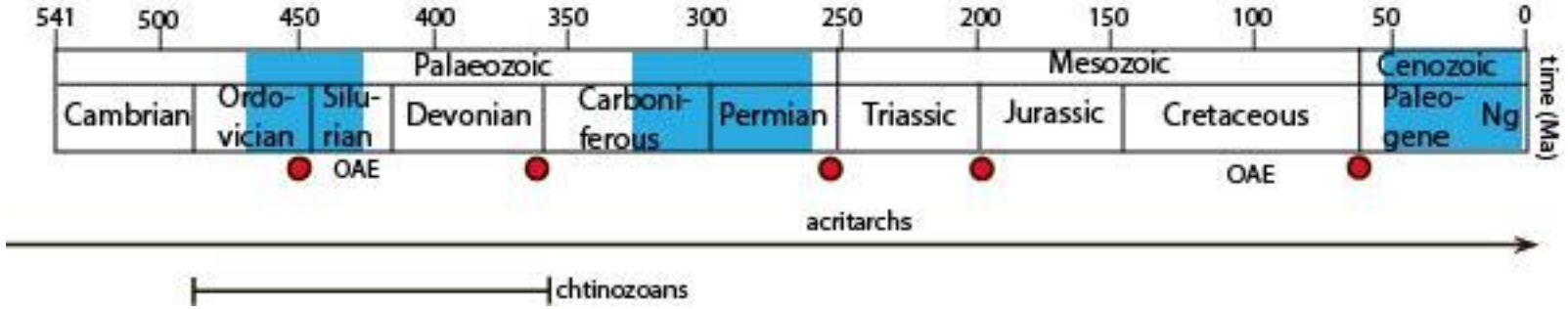
The invasion of the land by plants during Cambrian? through Devonian times. UniPG, Washington University, Tallin University.

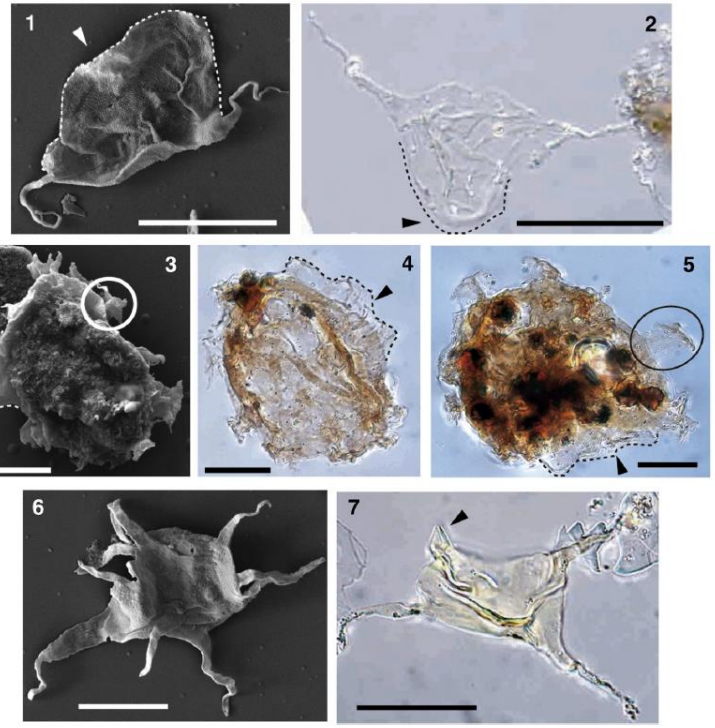
Modified by Harper et al., 2019



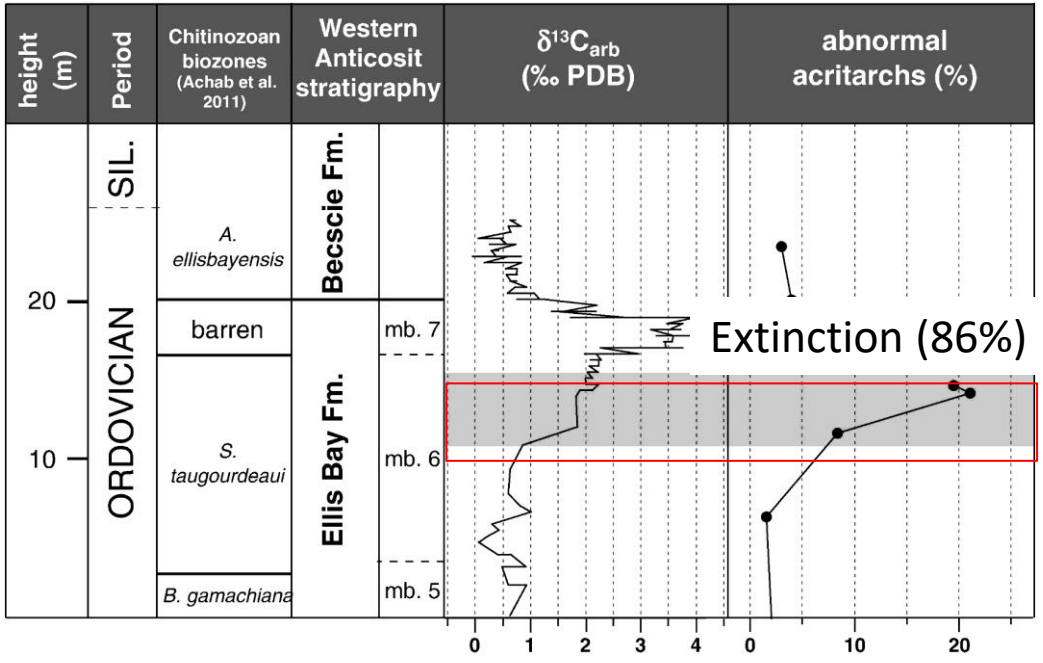
Similarity index among cryptospore assemblages (percentage of shared species on total species; from Spina, 2015)

Late Ordovician teratological events

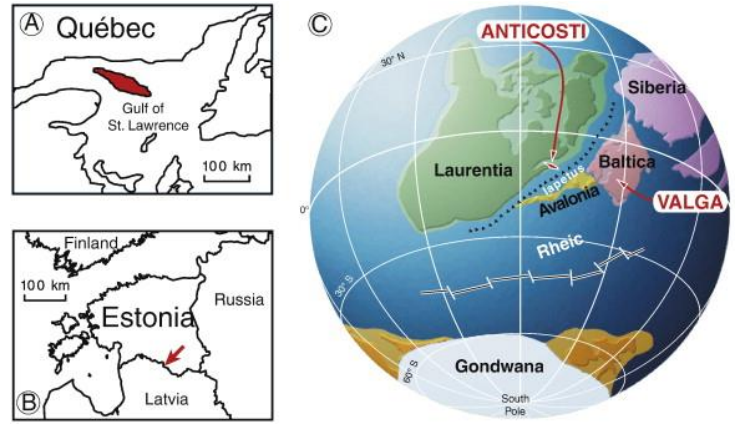


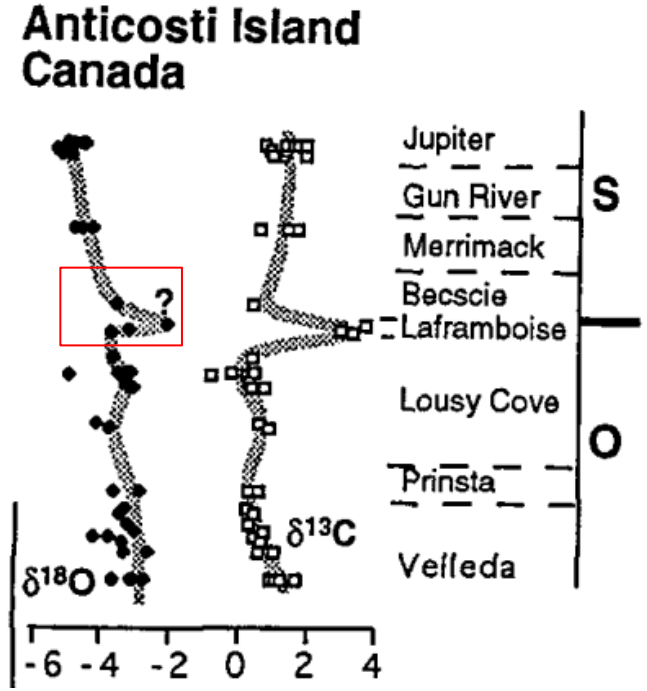


From Delabroye et al. (2011); Vecoli et al. (2011); Spina, 2015)



From Delabroye et al. (2011); Vecoli et al. (2011)

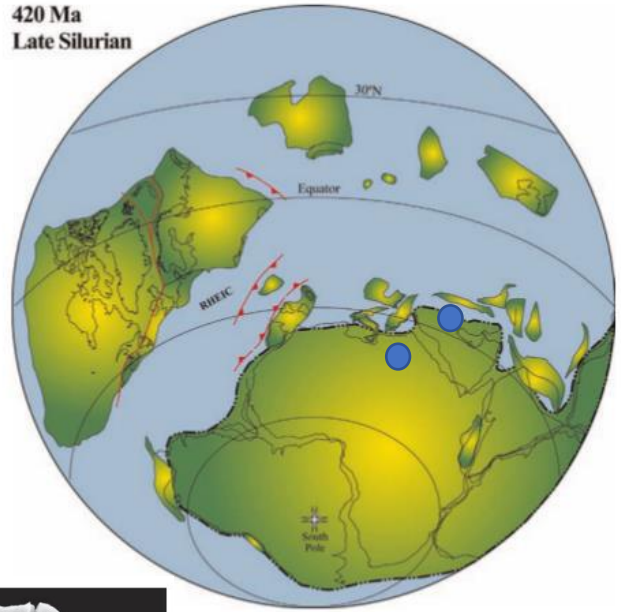




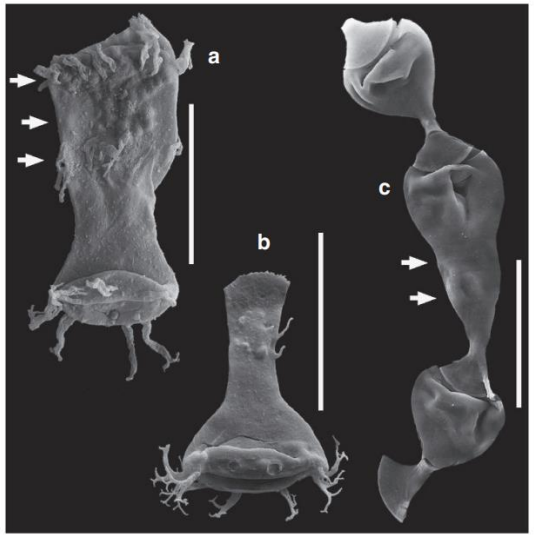
From Brenchley et al. (1994)

Ordovician and Silurian teratological events

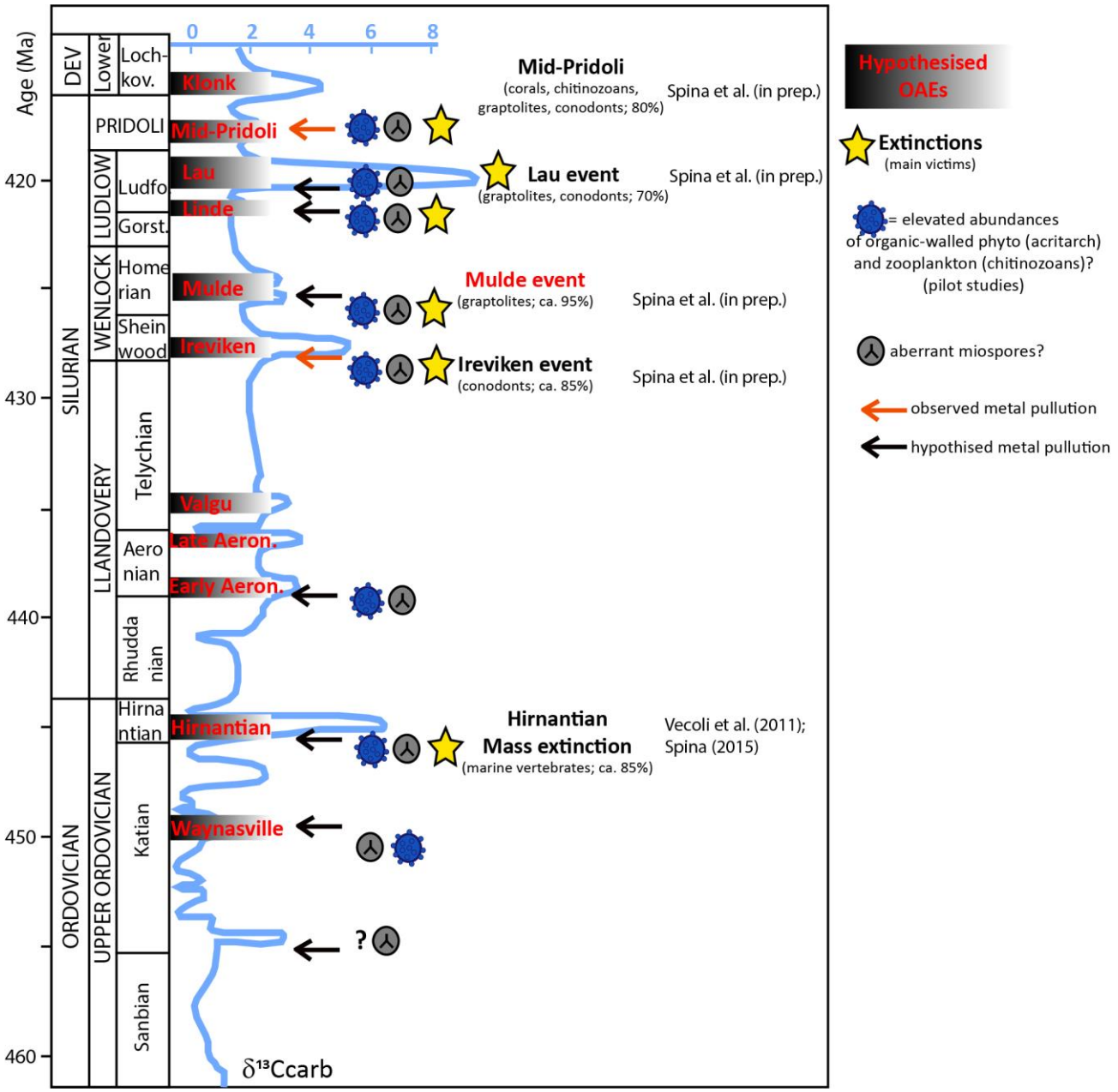
This research

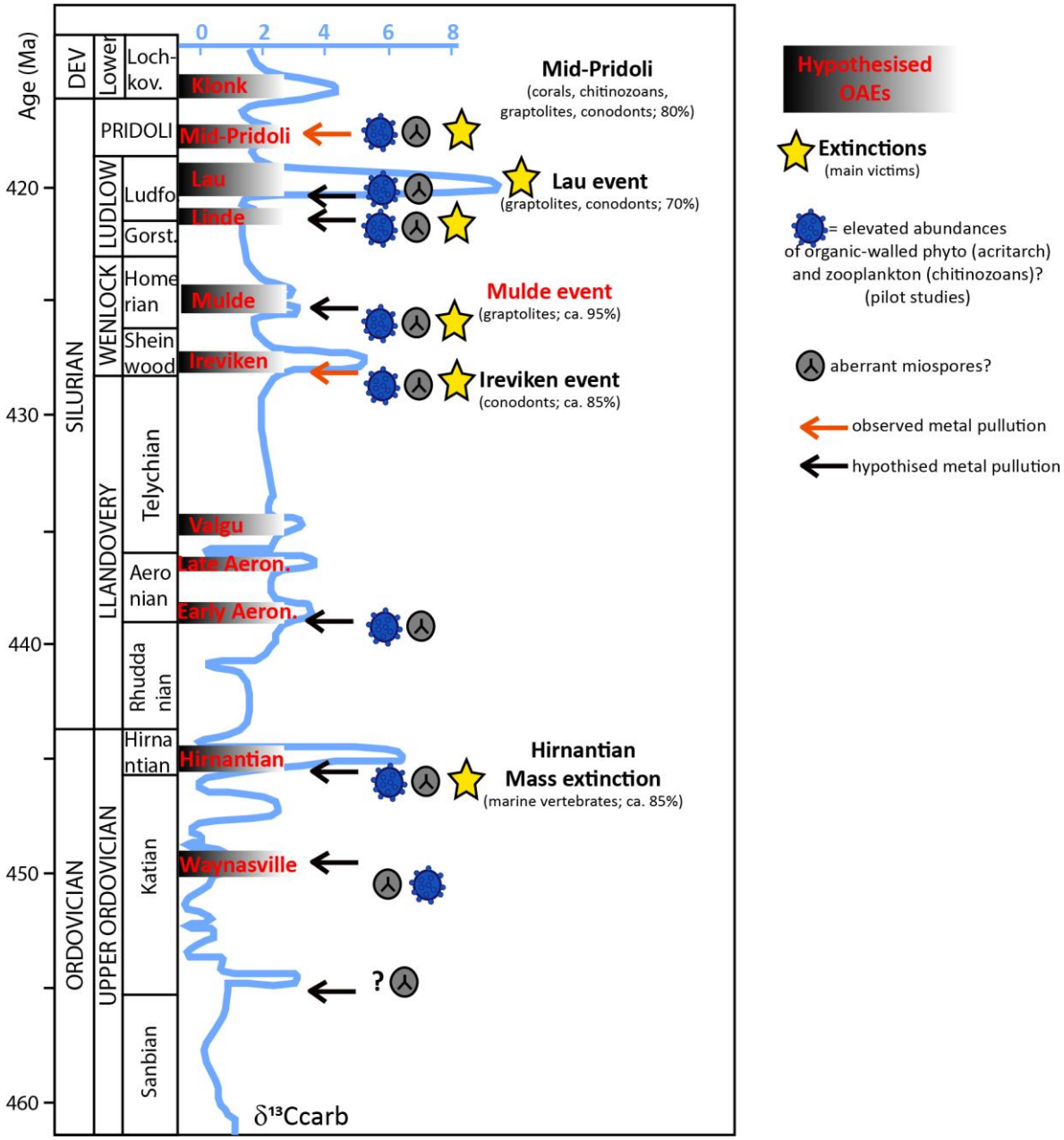


(Palaeogeographic map from Cocks and Torsvick, 2002)



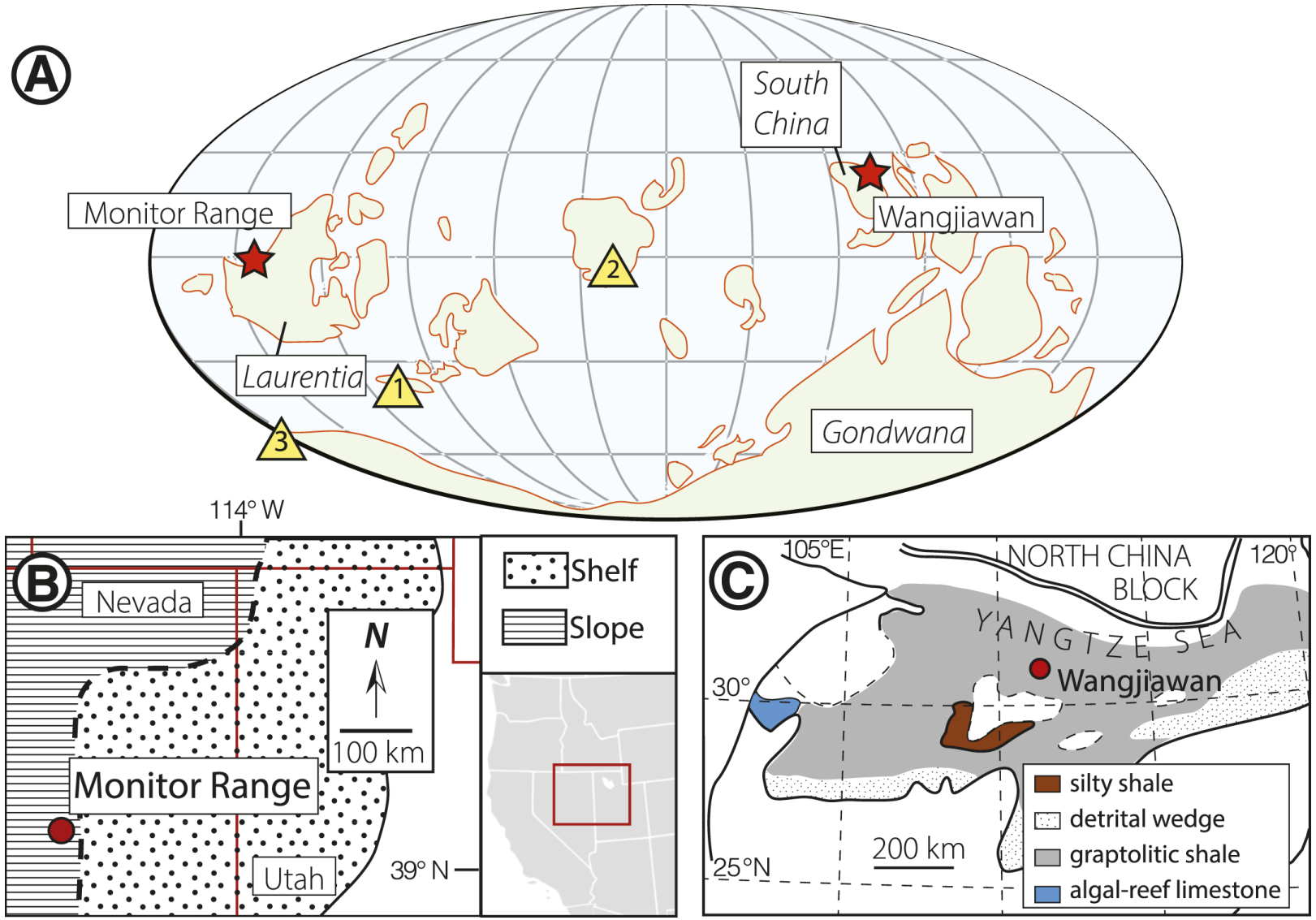
(Vandenbroucke et al., 2015)



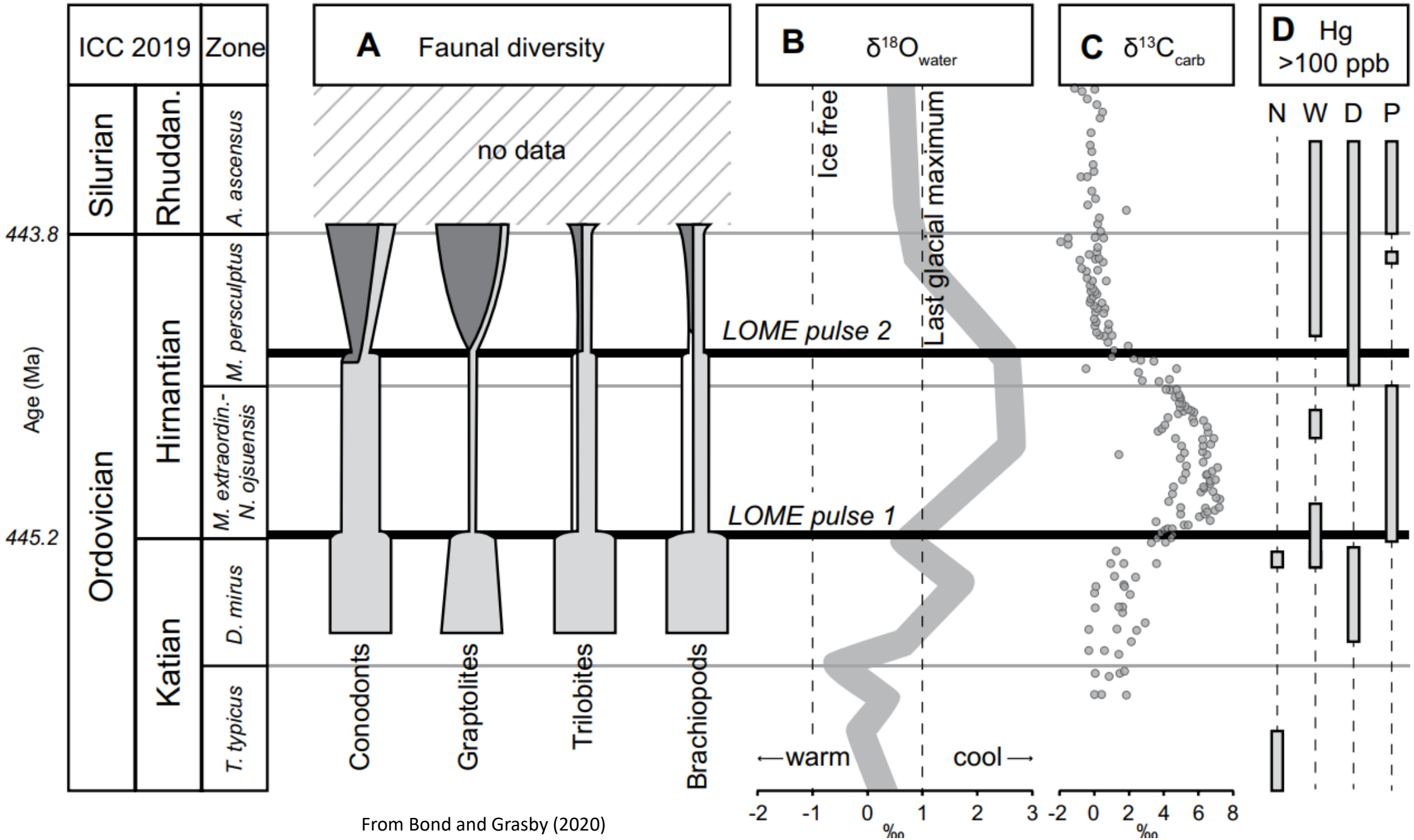


Possible causes for the Ordovician and Silurian teratological events:

- Volcanism
- Upwelling of anoxic/dysoxic waters
- Heavy metal pollution

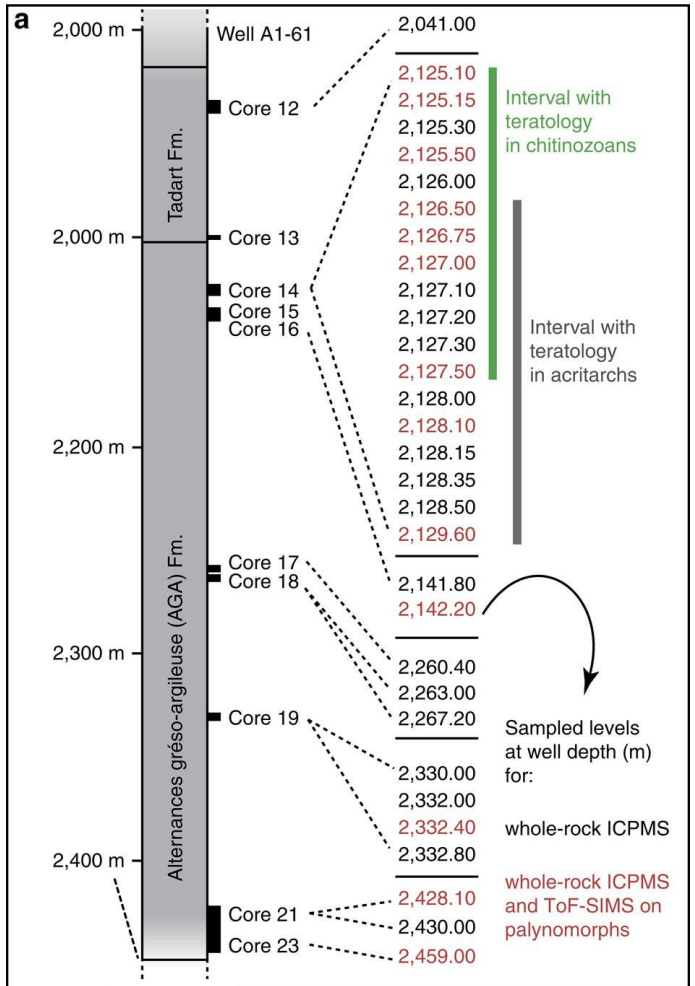


Late Ordovician paleogeography and study locations. A: Paleogeographic reconstruction at 446 Ma, modified from Kilian et al. (2016). Stars mark locations of stratigraphic sections at the Monitor Range (western Laurentia; Nevada, USA) and Wangjiawan (south China). Triangles mark the locations of Late Ordovician mafic provinces: 1—Cape St. Mary's sills, Newfoundland; 2—Suordakh, Siberia; 3—Sierra del Tigre, Argentina. B: Location map for the Monitor Range (after Jones et al., 2016). C: Location map for Wangjiawan (after Gorjan et al., 2012).

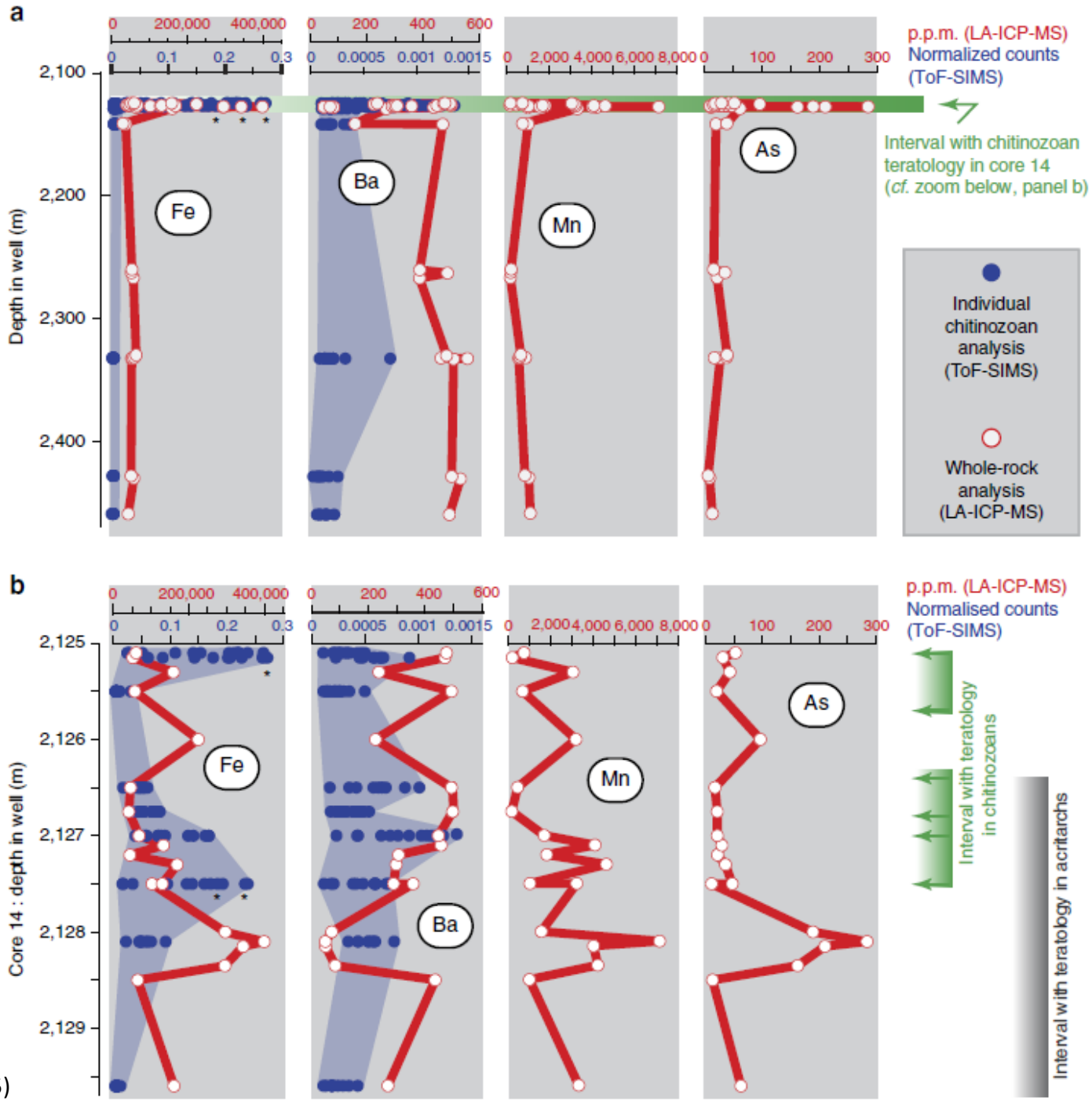


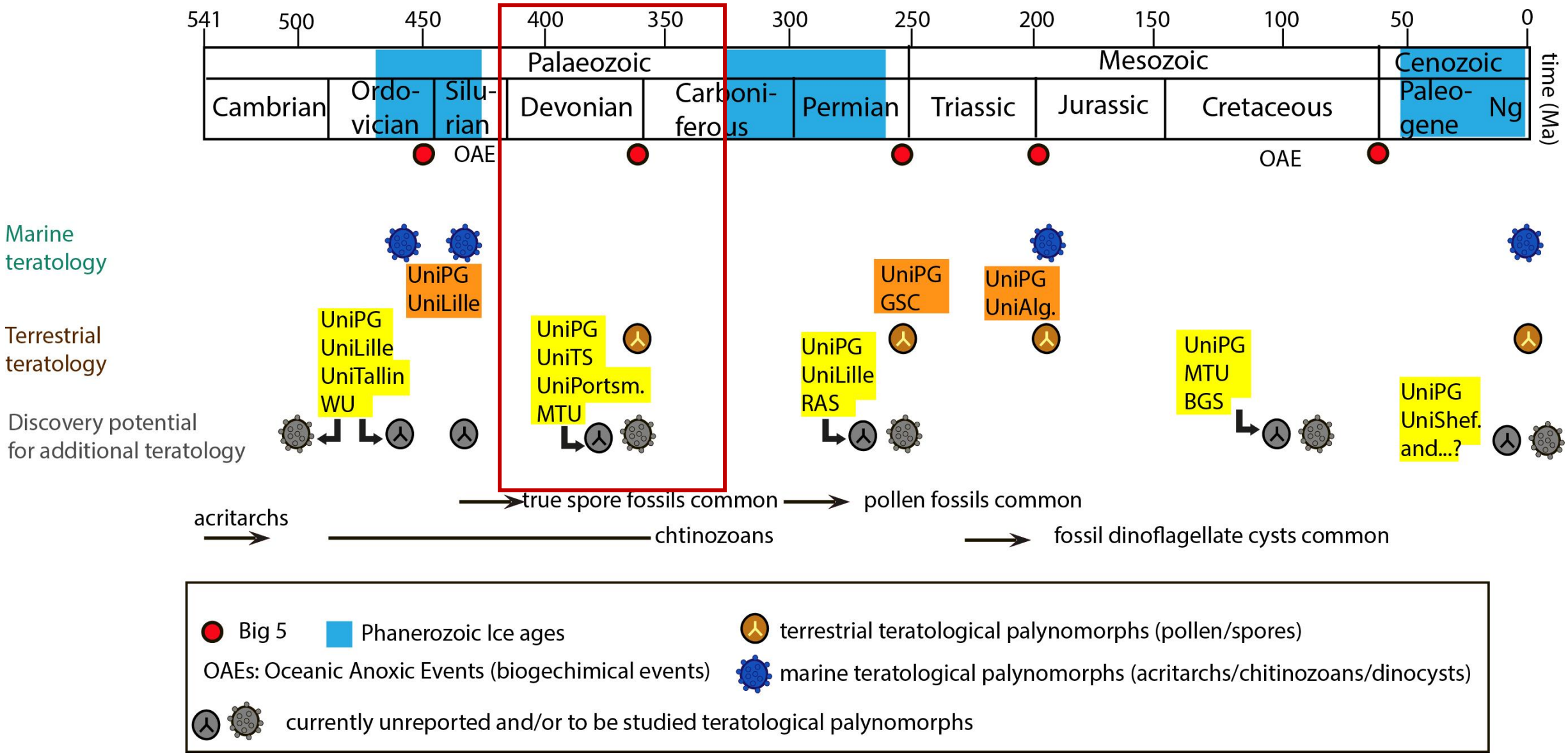
From Bond and Grasby (2020)

Silurian OAEs



From Vanderboucke et al. 2015)

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time (Ma)
Palaeozoic
Mesozoic
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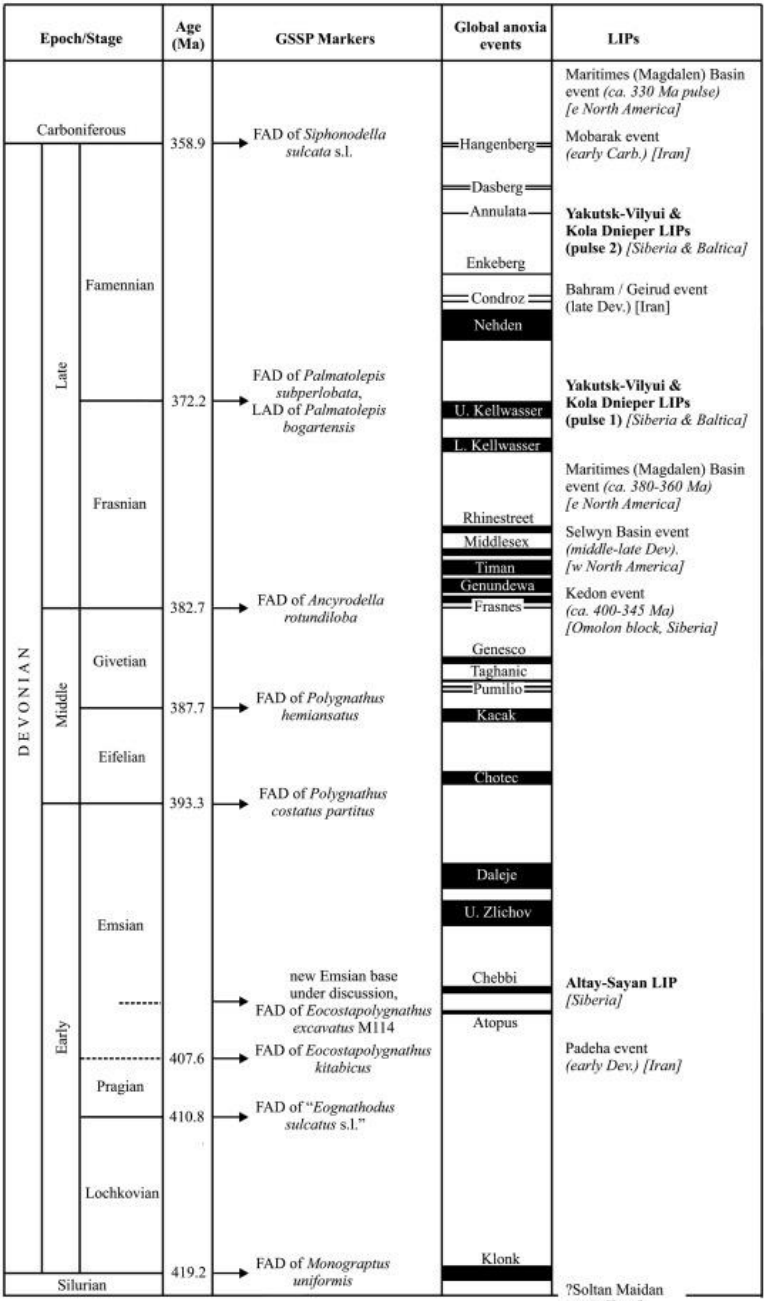
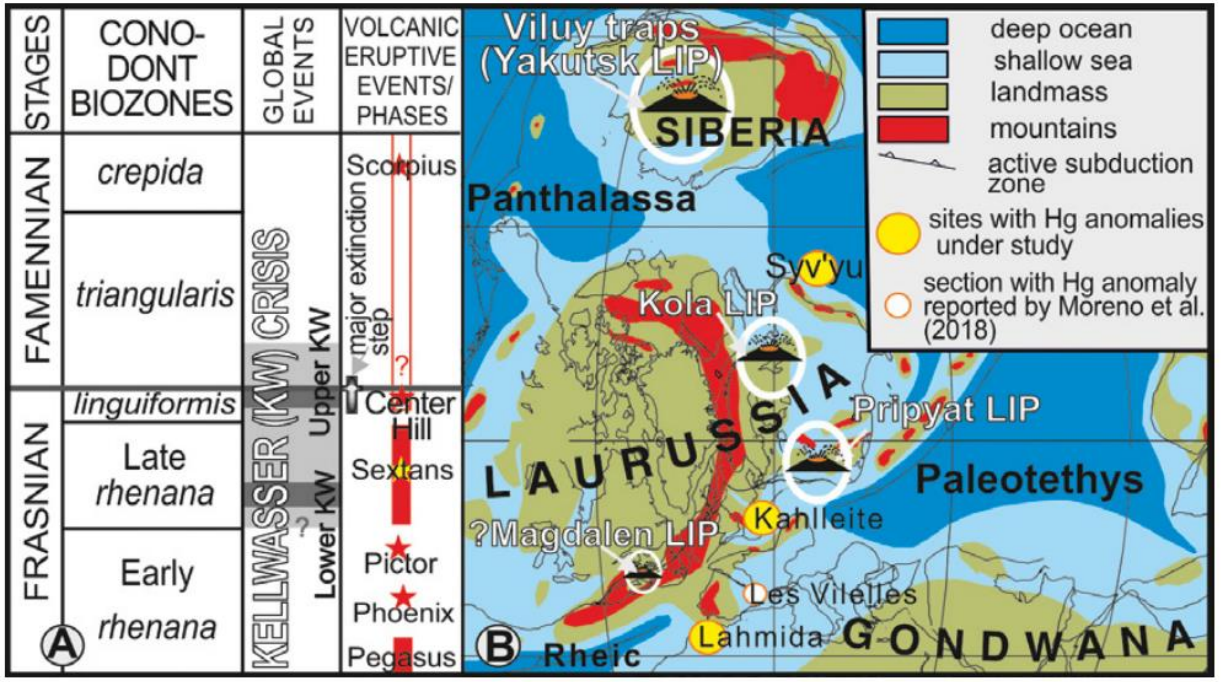
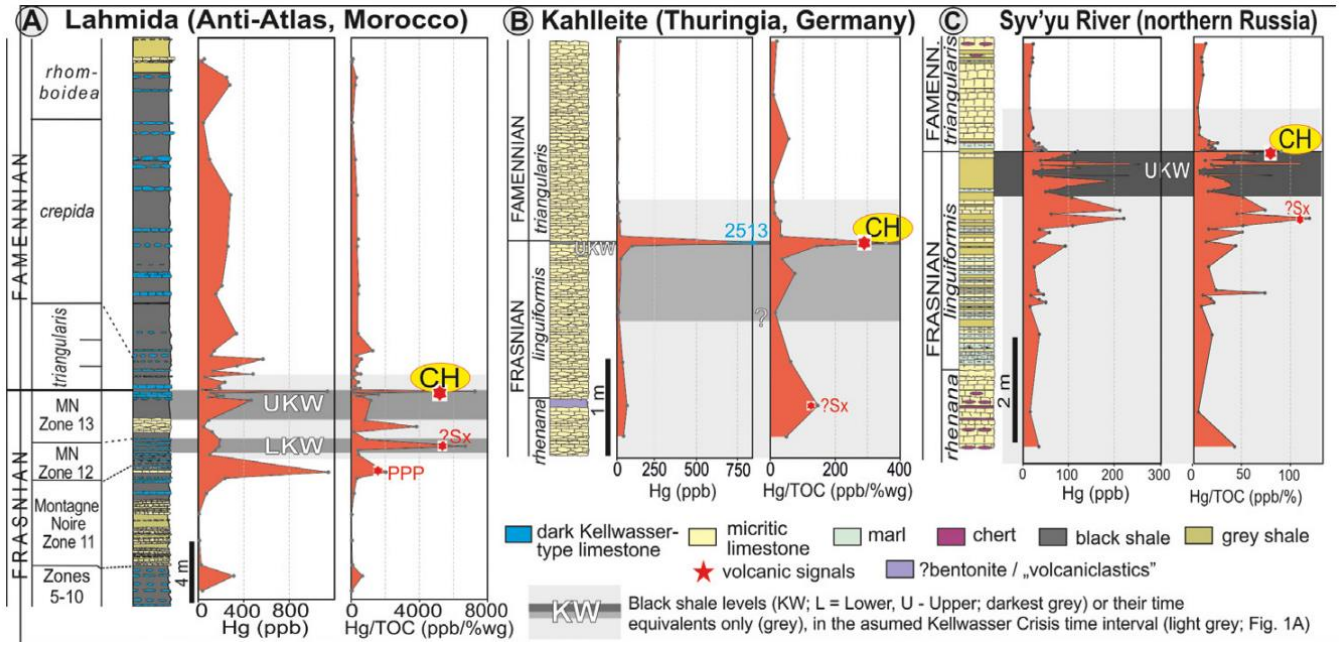


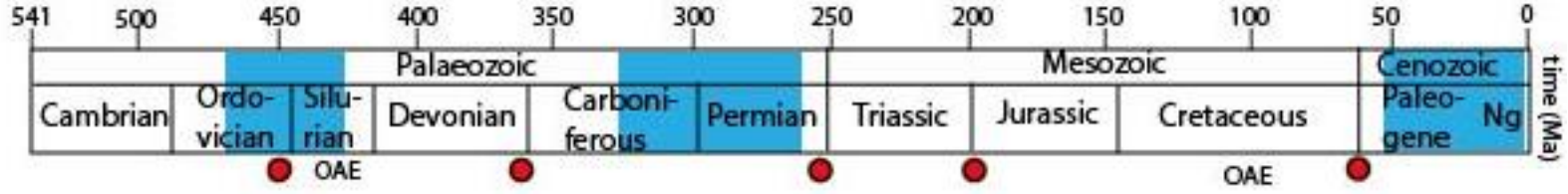
From Bond and Grasby (2020)

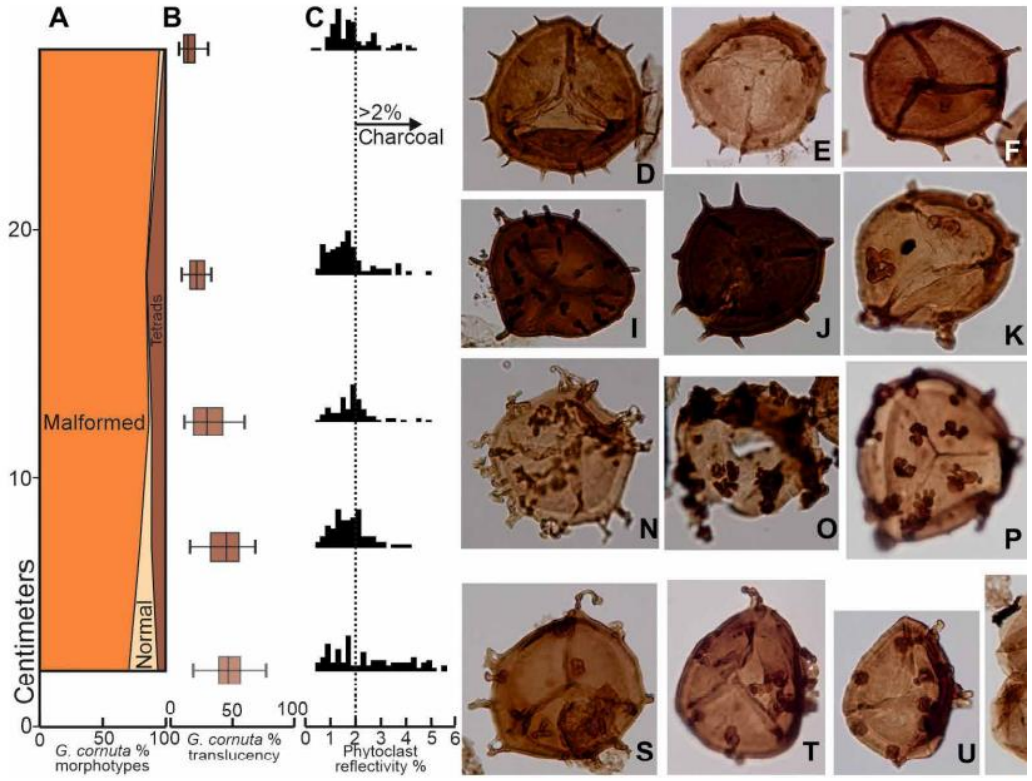


From Racki et al. (2018)

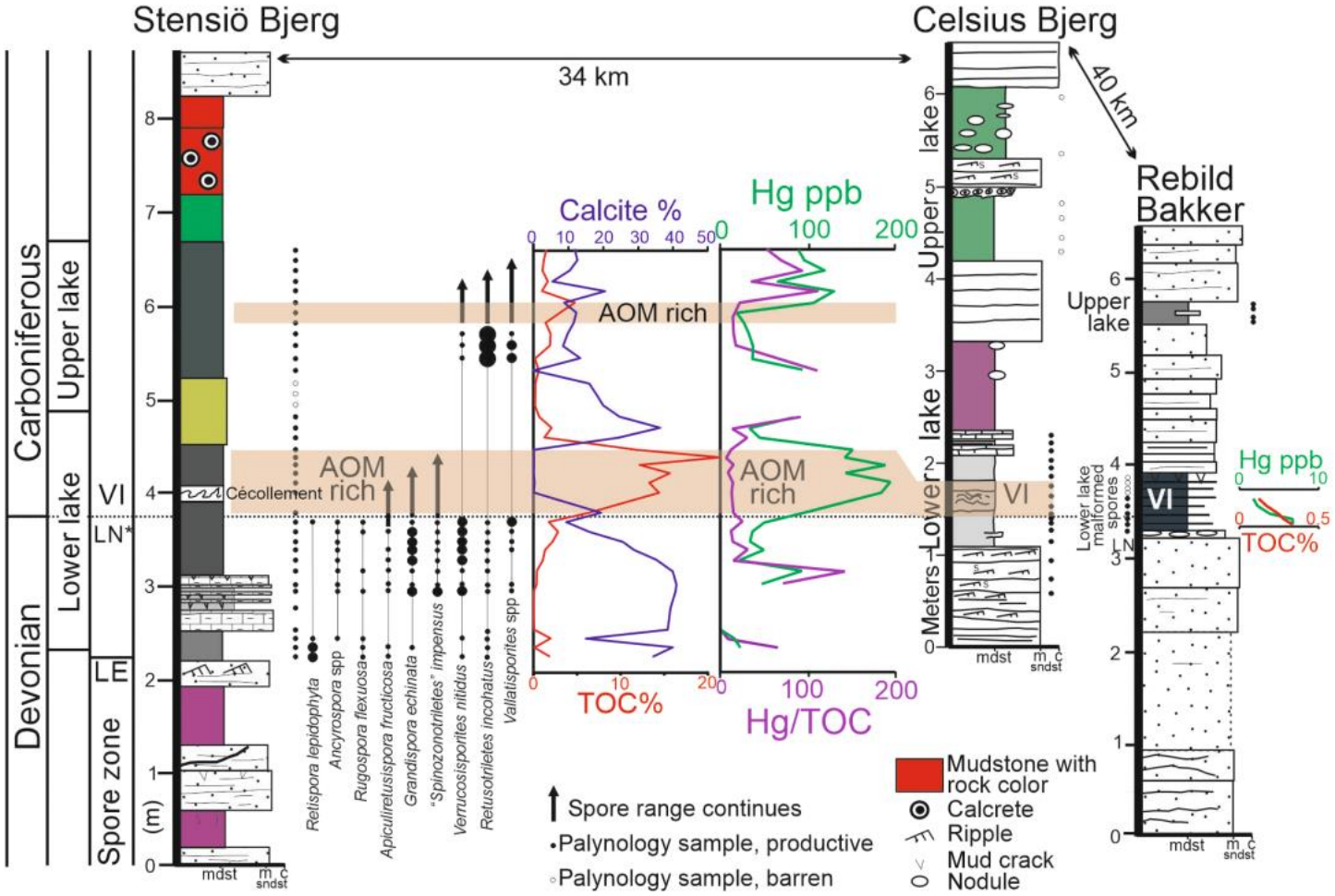


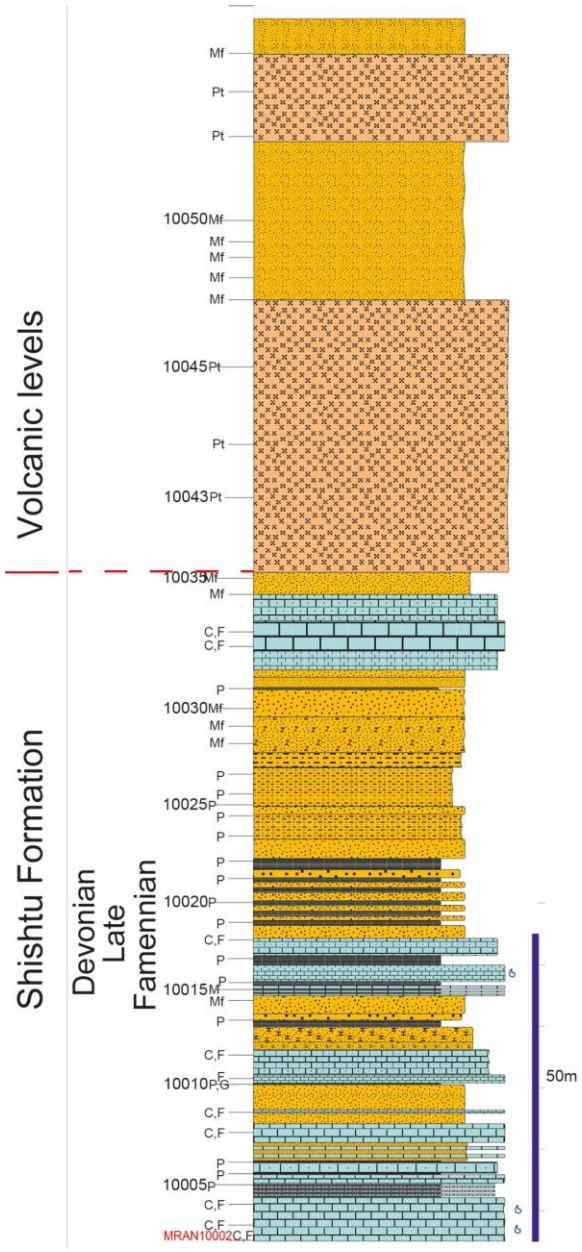
Devonian-Carboniferous and teratological events





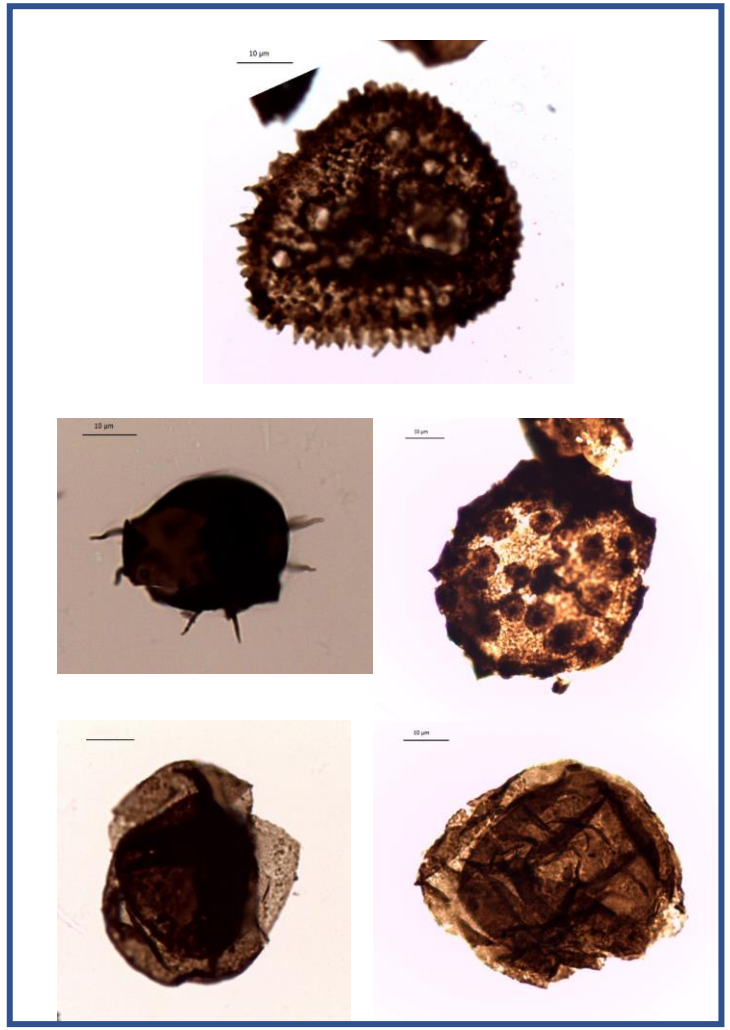
From Marshall et al. (2020)

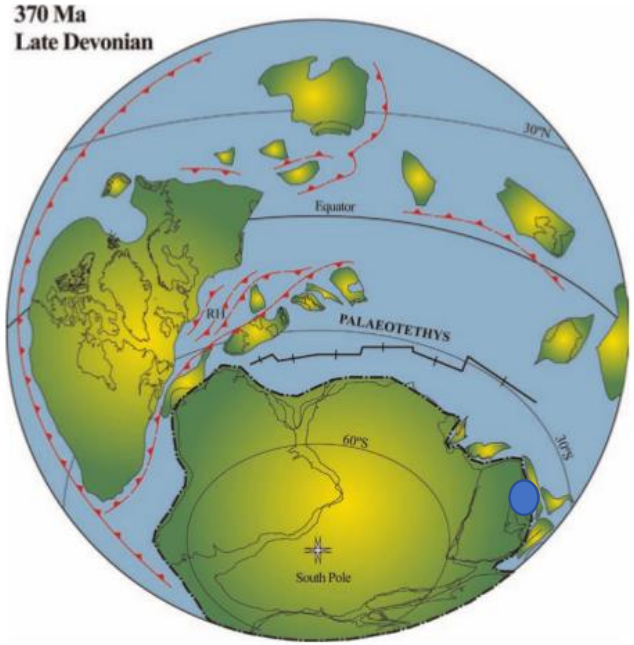




LE Spore Zone

Spores with abnormal morphologies





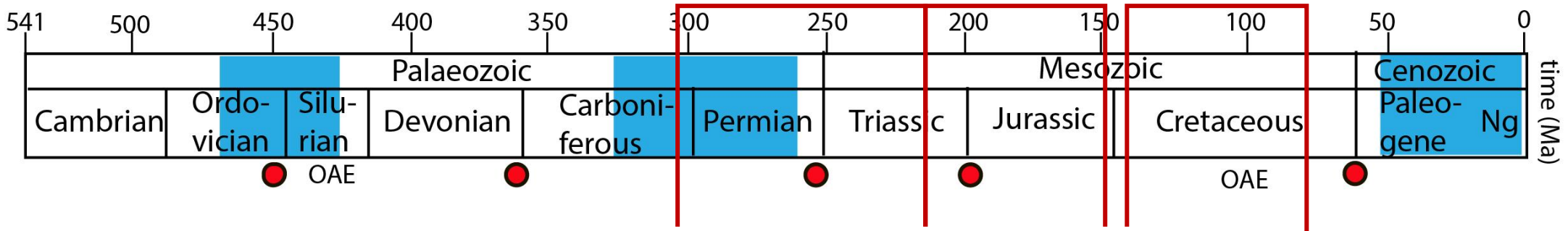
Service Contract

Subject

Paleontology and Biozonation of Paleozoic Sediments of Central Iran and Zagros Basins

PI: Roberto Rettori (UniPG)

Research in progress



Marine teratology

Terrestrial teratology

Discovery potential for additional teratology

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UniLille

UniPG
UniLille
UniTallin
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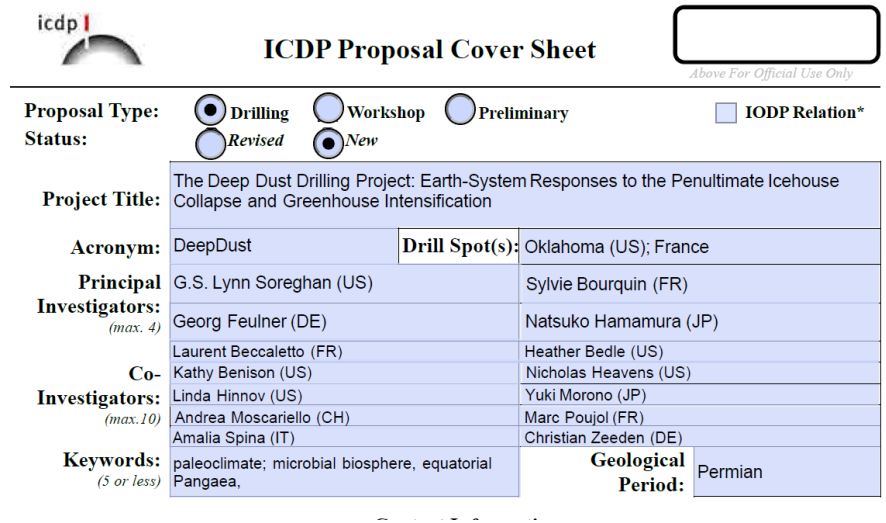


ICDP Proposal Cover Sheet

Above For Official Use Only

Proposal Type: Drilling Workshop Preliminary IODP Relation*

Status: Revised New

Project Title:	The Deep Dust Drilling Project: Earth-System Responses to the Penultimate Icehouse Collapse and Greenhouse Intensification		
Acronym:	DeepDust	Drill Spot(s):	Oklahoma (US); France
Principal Investigators: (max. 4)	G.S. Lynn Soreghan (US)		Sylvie Bourquin (FR)
	Georg Feulner (DE)		Natsuko Hamamura (JP)
Co-Investigators: (max.10)	Laurent Beccaletto (FR)		Heather Bedle (US)
	Kathy Benison (US)		Nicholas Heavens (US)
	Linda Hinnov (US)		Yuki Morono (JP)
	Andrea Moscariello (CH)		Marc Poujol (FR)
	Amalia Spina (IT)		Christian Zeeden (DE)
Keywords: (5 or less)	paleoclimate; microbial biosphere, equatorial Pangaea,	Geological Period:	Permian

UniPG
MTU
BGS

UniPG
UniShef.
and...?

jellate cysts common

Big 5

Phanerozoic Ice ages

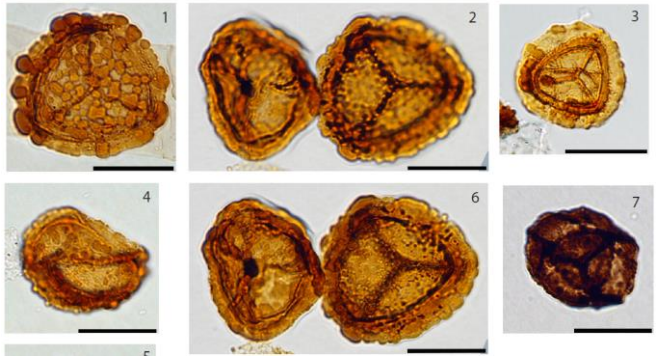
OAEs: Oceanic Anoxic Events (biogechimical events)

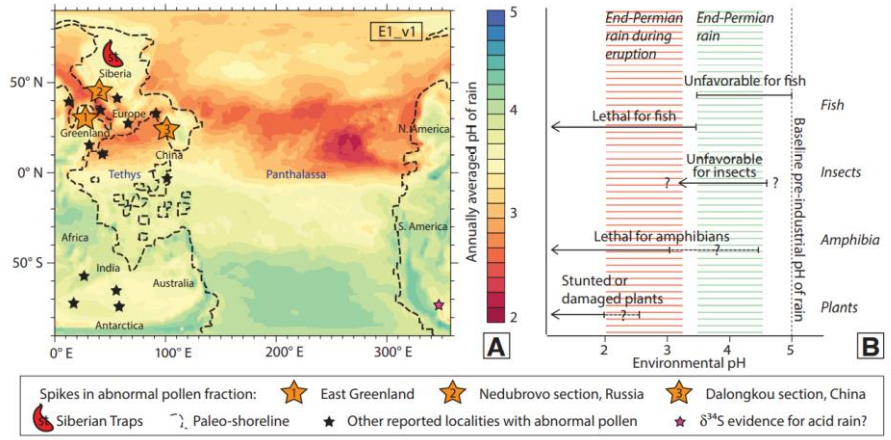
terrestrial teratological palynomorphs (pollen/spores)

marine teratological palynomorphs (acritarchs/chitinozoans/dinocysts)

currently unreported and/or to be studied teratological palynomorphs

Late Permian and teratological events-UV-B driven teratology during the crisis: FTIR spectroscopy and ultrastructure analysis, and other

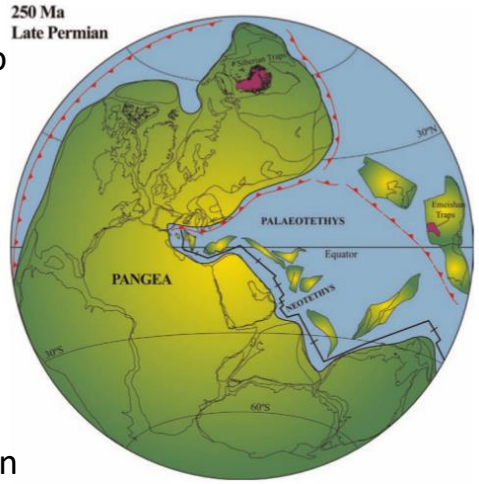




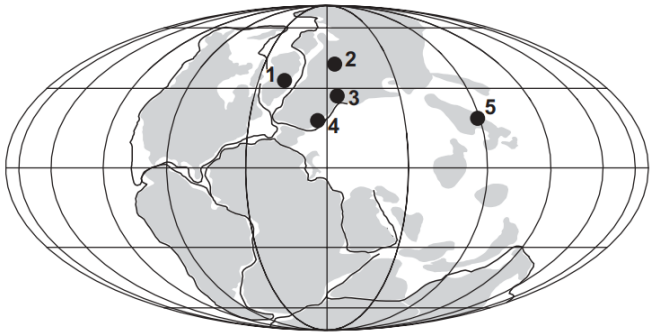
From Black et al. (2020)

- a 100–200 kyr main eruptive phase had the potential to produce high latitude stratospheric O3 depletion due to largereleases of HCl - organohalogen release from heating of organic-rich rocks was insufficient to extensively damage the ozone layer. However, including the possibility that dispersed organic matter provided a precursor for organohalogen synthesis results in massive CH3Cl production that could lead to substantial O3 depletion when released over 100 kyr.

From Beerling et al. (2007)



From Cocks and Torsvik (2002)



From Spina et al. (2015)

Review of Palaeobotany and Palynology 218 (2015) 3–14
Contents lists available at ScienceDirect
Review of Palaeobotany and Palynology
journal homepage: www.elsevier.com/locate/revpalbo

Palynology of the Permian and Triassic of the Tesero and Bulla sections (Western Dolomites, Italy) and consideration about the enigmatic species *Reduviasporonites chalastus*

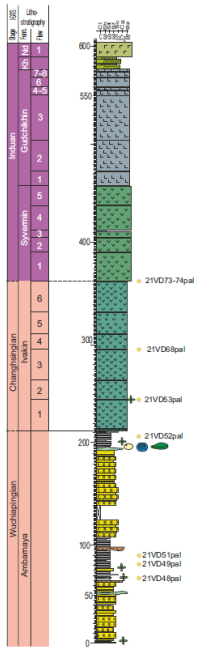
Amalia Spina [a,*], Simonetta Cirilli [a], John Utting [b], Jan Jansonius [1]

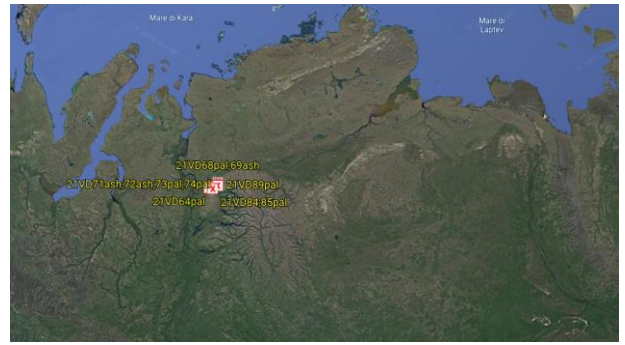
Available online at ScienceDirect www.sciencedirect.com
Elsevier Masson France EM|consulte www.em-consulte.com/en
Research paper

First record of Permo-Triassic palynomorphs of the N'Condédzi sub-basin, Moatize-Minjova Coal Basin, Karoo Supergroup, Mozambique

Francesca Galasso [a,b,1], Zélia Pereira [c,*], Paulo Fernandes [b], Amalia Spina [a], João Marques [d]

Present research

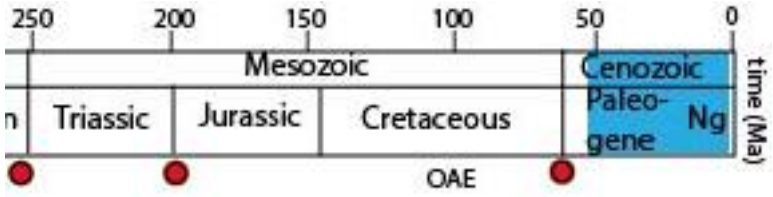


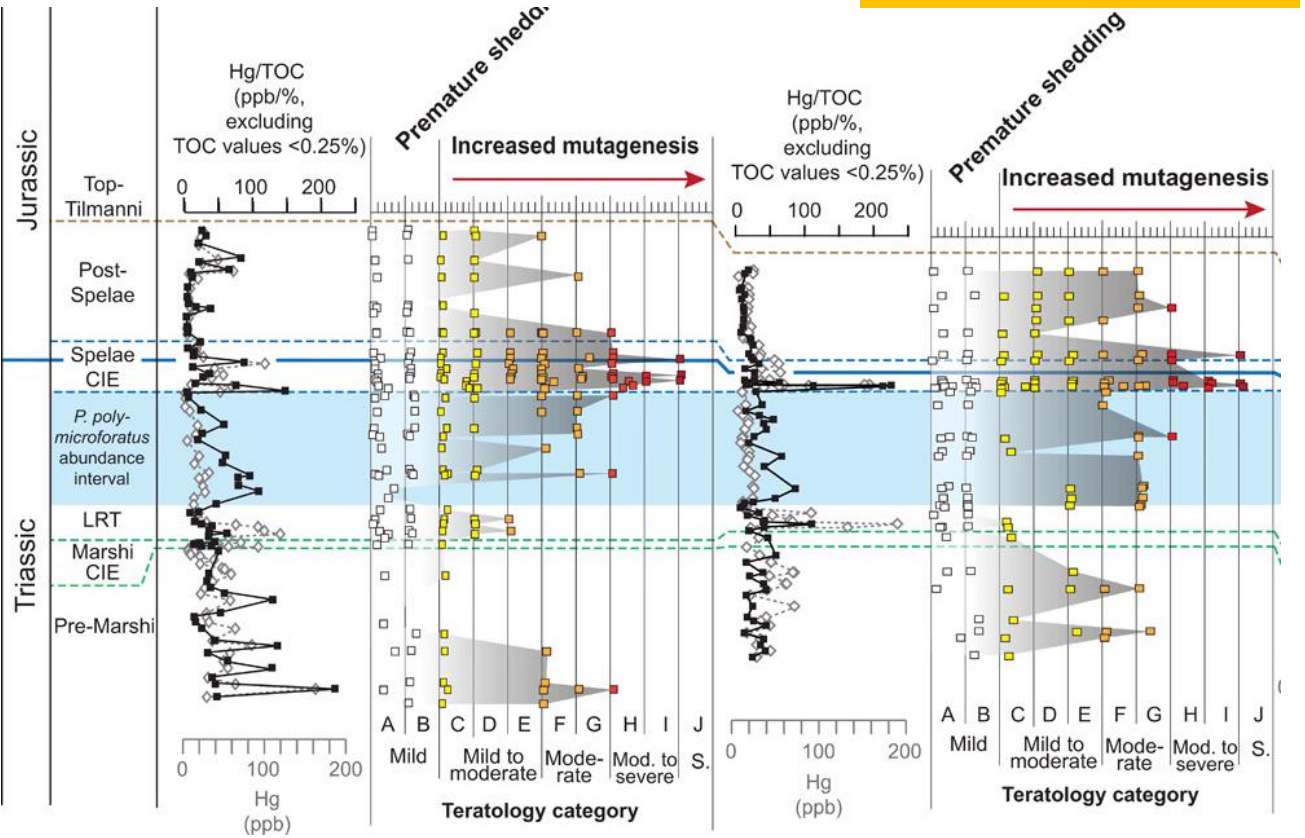


From Spina et al. (in prep.)

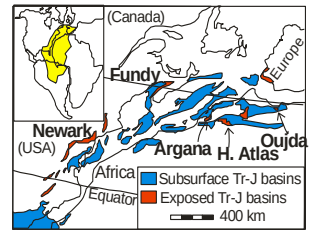
Volcanic mercury and mutagenesis in land plants during the end-Triassic mass extinction

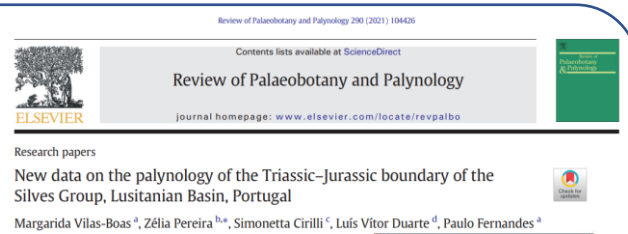
2019- 2021:
Progetto PRIN-2017:
Biotic Resilience to Global Change.
PI: Simonetta Cirilli





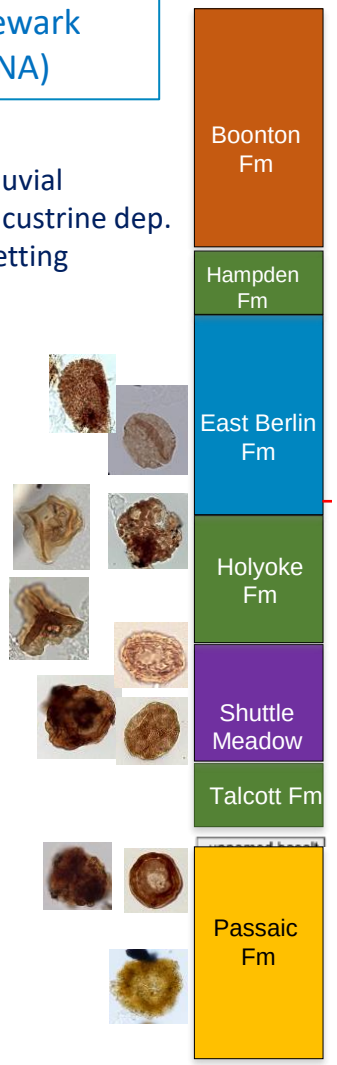
Lindström et al. (2019)





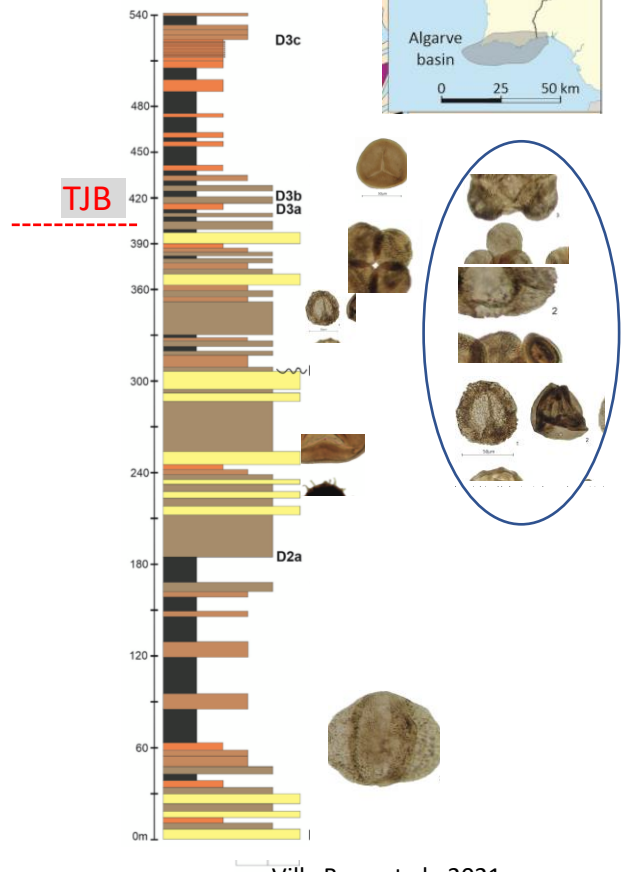
Newark (ENA)

Fluvial lacustrine dep. setting



Cirilli et al. (in prep)

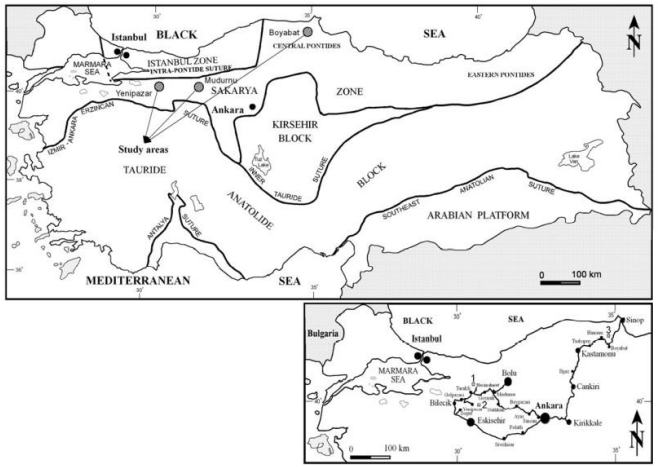
Silves Group, Lusitanian Basin, Portugal



Villa Boas et al., 2021

Cretaceous OAEs and teratological events

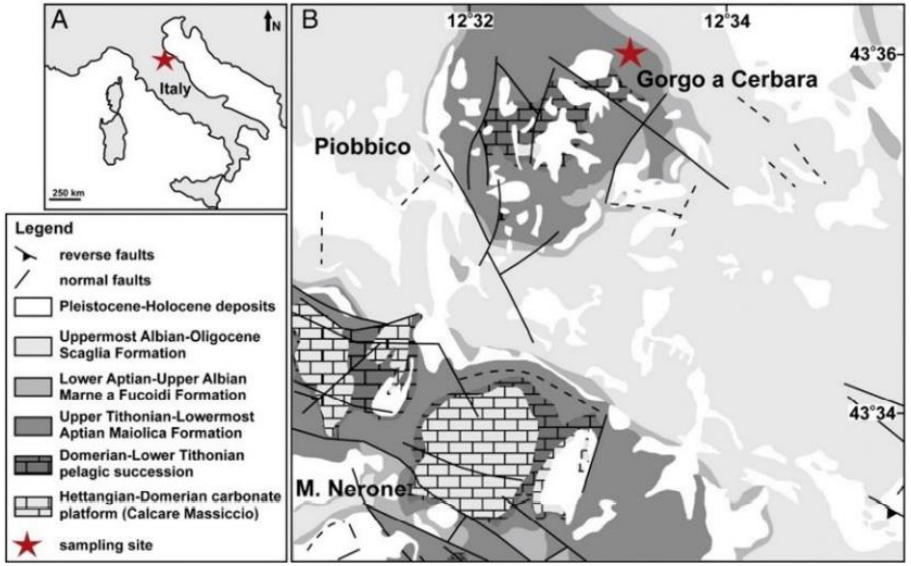
Turkey

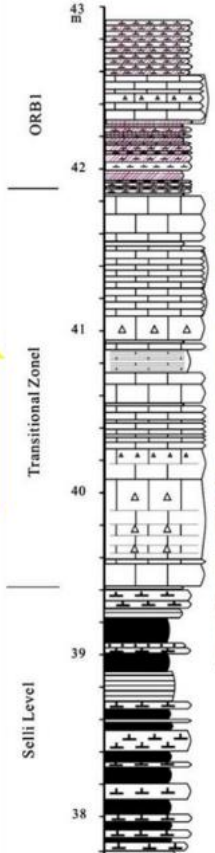


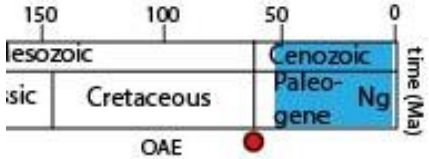
With I. Yilmaiz (MTU) and
E. Capezzuoli (UniFI)

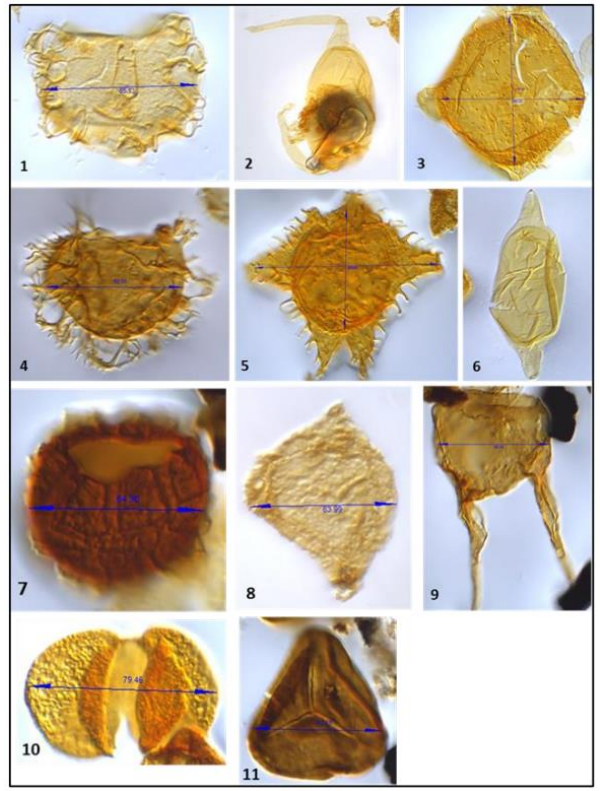
Umbria-Marche Apennine

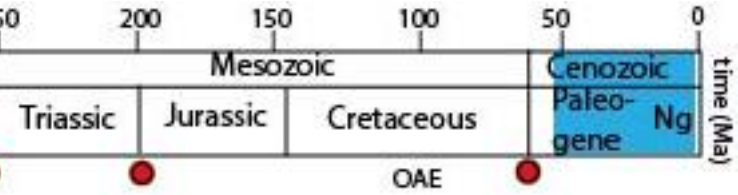
TotalEnergies











Proximal research: Chemical analyses of teratological organic-walled microfossil

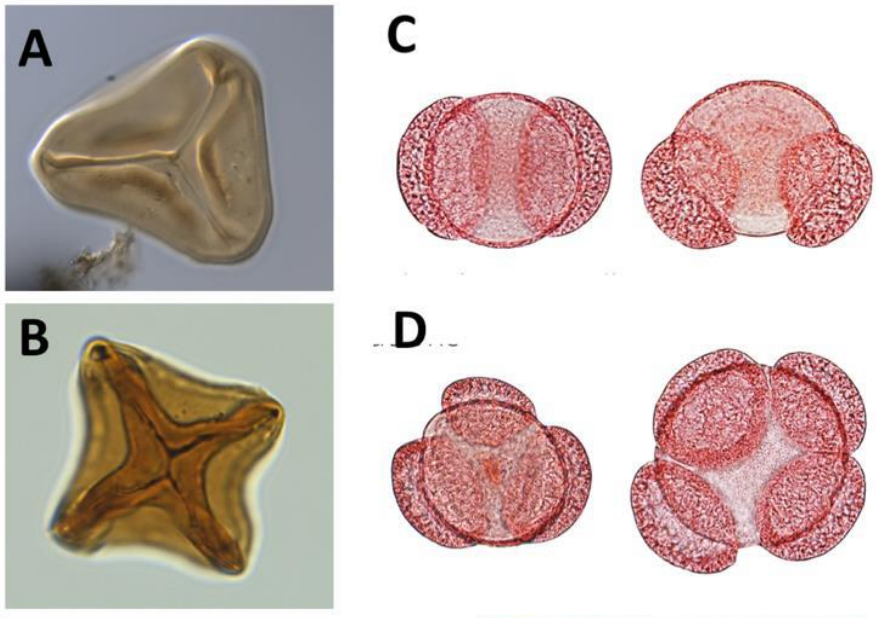
- their formation and their geochemistry may be used as markers and as a series of independent proxies for monitoring the paleo-environmental conditions during the biological crises;

- Fully characterization of the chemistry of teratological and non-teratological individuals using non-destructive (FTIR and Raman) techniques.

- LA-ICPMS: trace-element geochemistry on shared specimens using Laser Ablation Inductively Coupled Plasma Mass Spectrometry: different degrees of metal toxicity (Hg, Ni, Cd, Pb)

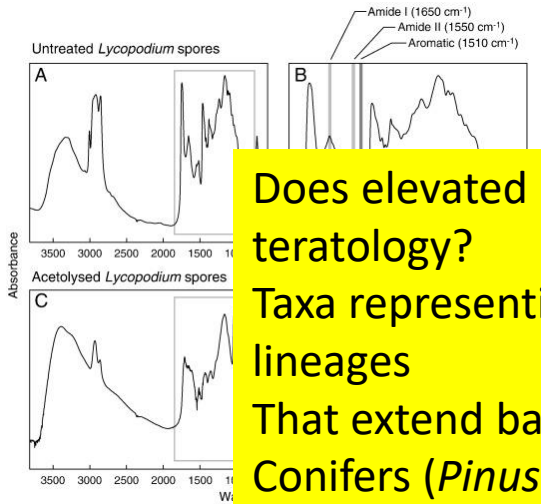
- FTIR and Raman: Samples will be imaged for infrared and Raman spectroscopy analysis to determine/test for changes in UV-B flux through time and relationships between teratologies and UV-B.

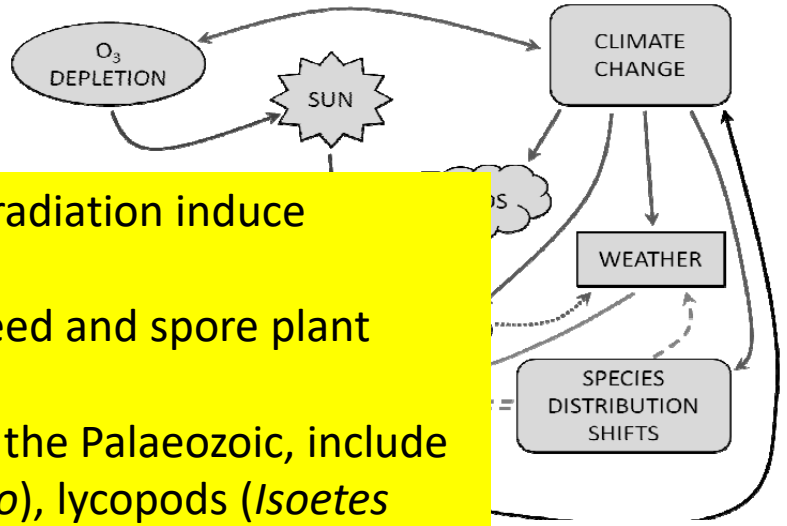
- Laser scanning Confocal microscopy and Optical confocal microscopy: ultrastructure analysis



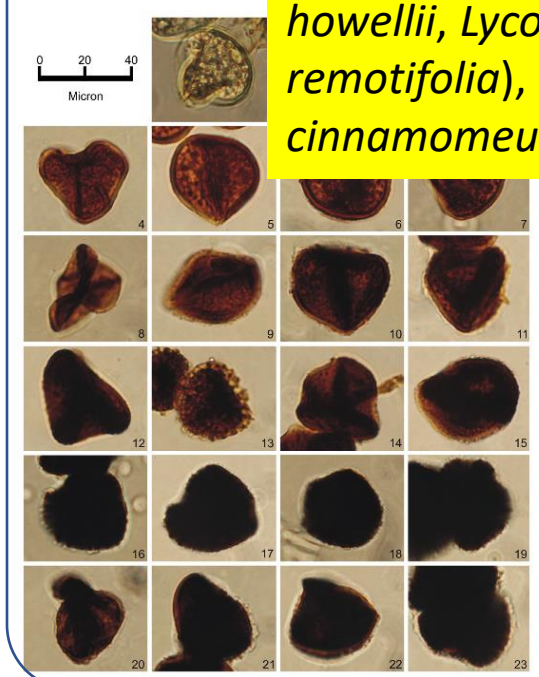
How did the ozone layer depletion contribute to the mass extinction events?

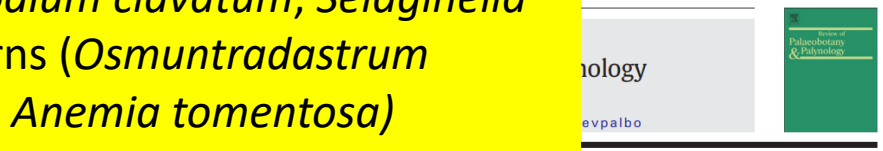
Infrared spectroscopy





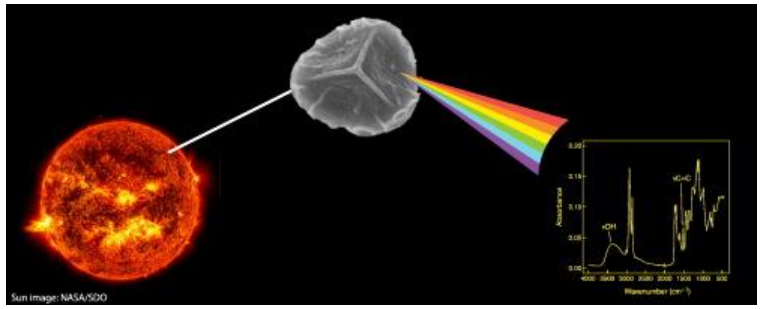
Does elevated UVB radiation induce teratology?
Taxa representing seed and spore plant lineages
That extend back to the Palaeozoic, include Conifers (*Pinus mugo*), lycopods (*Isoetes howellii*, *Lycopodium clavatum*, *Selaginella remotifolia*), ferns (*Osmuntradastrum cinnamomeum*, *Anemia tomentosa*)





Shedding light on sporopollenin chemistry, with reference to UV reconstructions

Phillip E. Jardine [a,*], Feargus A.J. Abernethy [b], Barry H. Lomax [c], William D. Gosling [a,d], Wesley T. Fraser [a,e]

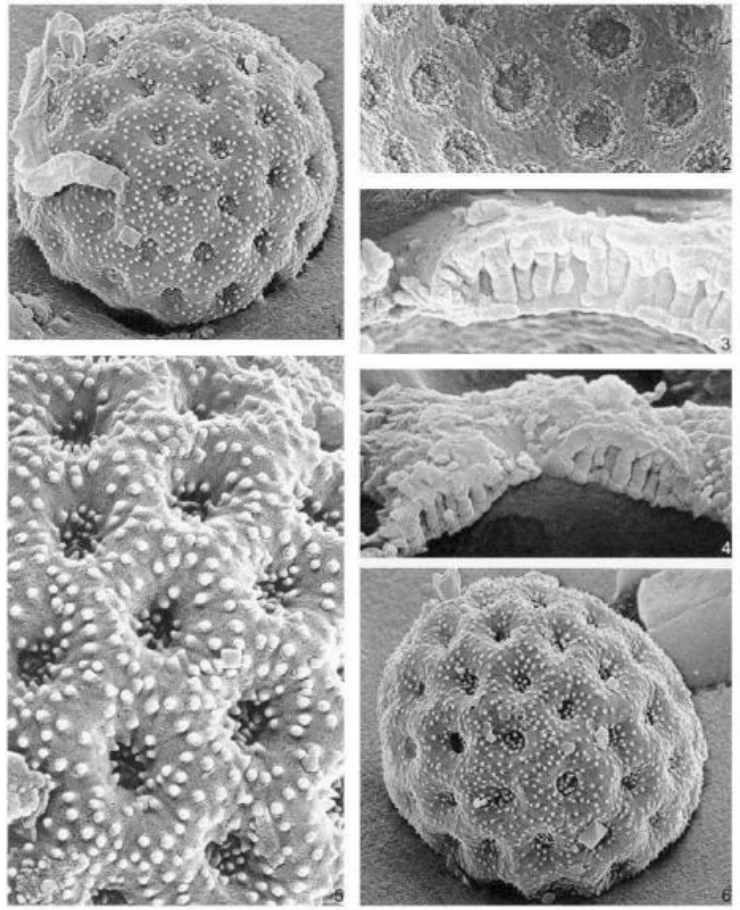


Morphological ultrastructure analyses

Fl. Medit. 24: 247-272
doi: 10.7320/FlMedit24.247
Version of Record published online on 30 December 2014

P. Angelini, E. Bricchi, D. Gigante, S. Poponessi, A. Spina & R. Venanzoni

Pollen morphology of some species of *Amaranthaceae* s. lat. common in Italy



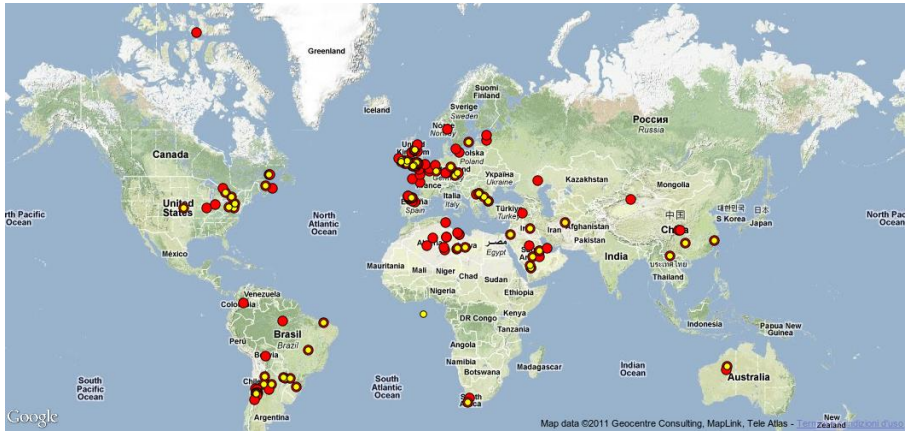
Highlights:

- Increase of teratological terrestrial and marine organic-walled microfossils associated with mass extinction events.
- Interaction with other research lines: biodiversity loss across the Earth history.
- Other: methods for the thermal maturity of organic matter.

Ambito di ricerca già attivato: 12
TITOLO: ***Geoinformatica***
· georeferenziazione di mappe paleogeografiche in ambiente GIS e compilazione del database GIS correlato di dati paleontologici;

Palynological database: Palaeozoic biodiversity curve of miospores

Localities plotted



PostgreSQL Database: bibliography

Nessun limit

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6	6	Velatitetras rugosa	3
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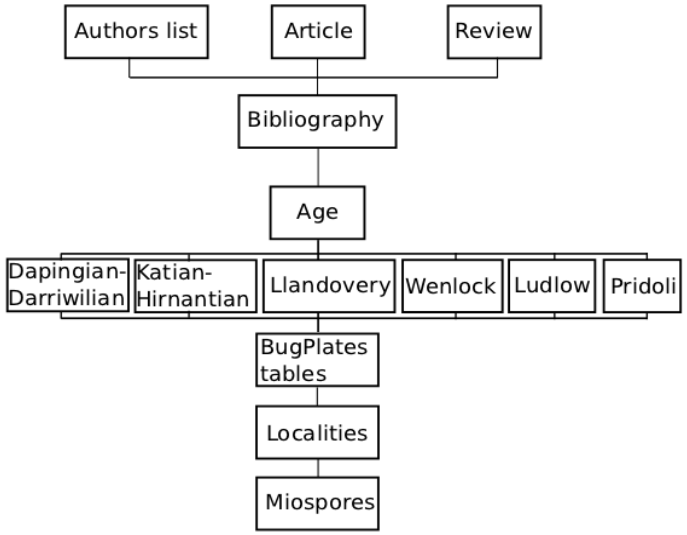
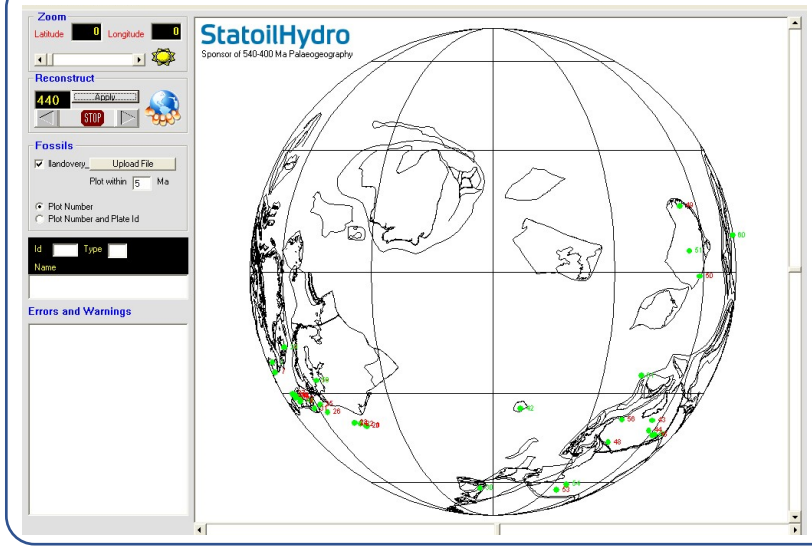
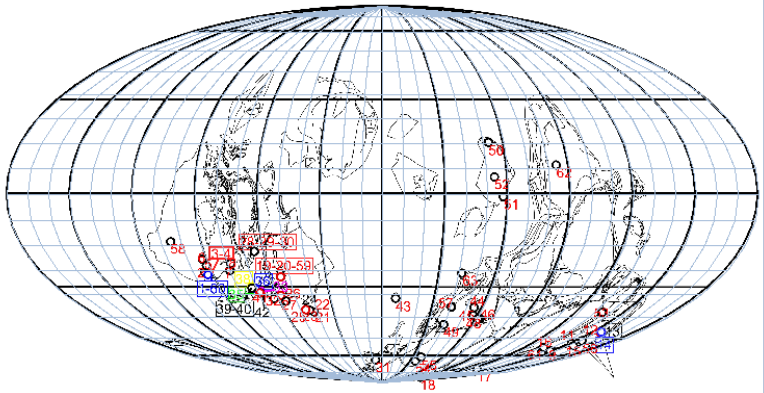
Organization







PalaeoCO₂ reconstruction from fossil leaves

Received: 15 September 2019 | Revised: 16 January 2020 | Accepted: 20 February 2020
DOI: 10.1002/gj.3807

SPECIAL ISSUE ARTICLE

WILEY

Quantitative critique of leaf-based paleo-CO_2 proxies: Consequences for their reliability and applicability

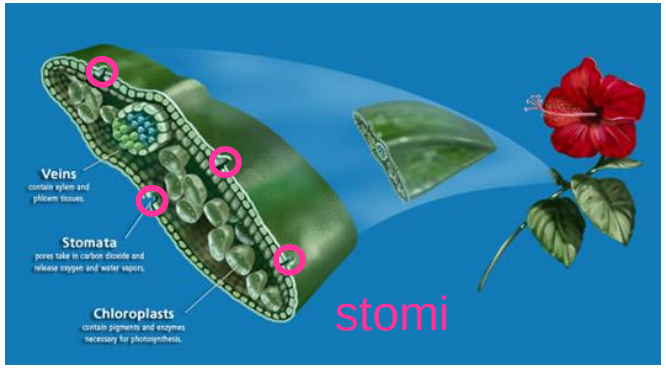
Wilfried Konrad[1,2] | Dana L. Royer[3] | Peter J. Franks[4] | Anita Roth-Nebelsick[5]

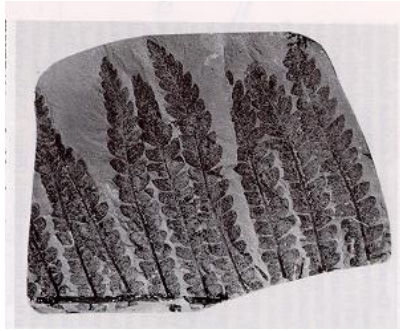
[1]Department of Geosciences, University of Tübingen, Tübingen, Germany
[2]Institute of Botany, Technical University of Dresden, Dresden, Germany
[3]Department of Earth and Environmental Sciences, Wesleyan University, Middletown, Connecticut
[4]Faculty of Agriculture and Environment, The University of Sydney, Sydney, New South Wales, Australia
[5]State Museum of Natural History Stuttgart, Stuttgart, Germany

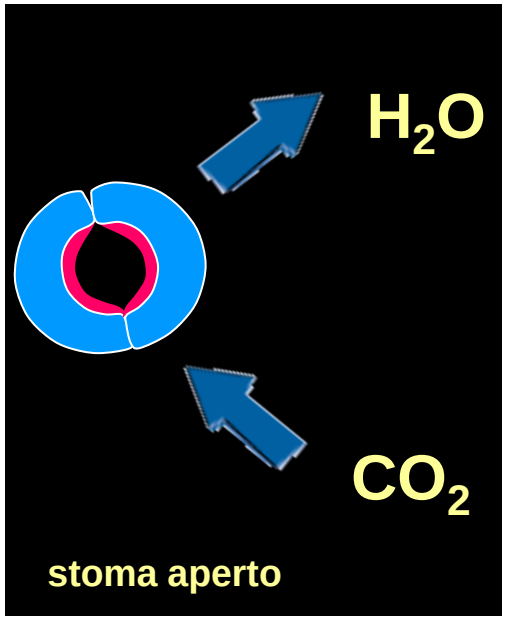
Correspondence

A variety of proxies have been developed to reconstruct paleo-CO_2 from fossil leaves. These proxies rely on some combination of stomatal morphology, leaf $\delta^{13}C$, and leaf gas exchange. A common conceptual framework for evaluating these proxies is lacking, which has hampered efforts for inter-comparison. Here we develop such a framework, based on the underlying physics and biochemistry. From this conceptual framework, we find that the more extensively parameterised proxies, such as the optimisation model, are likely to be the most robust. The simpler proxies, such as the stomatal ratio model, tend to under-predict CO_2, especially in warm (>15°C) and moist (>50% humidity) environments. This identification of a structural under-prediction may help to explain the common observation that the simpler proxies

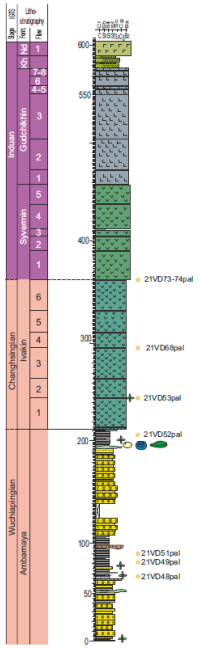
DENSITA' DEGLI STOMI E ANIDRIDE CARBONICA

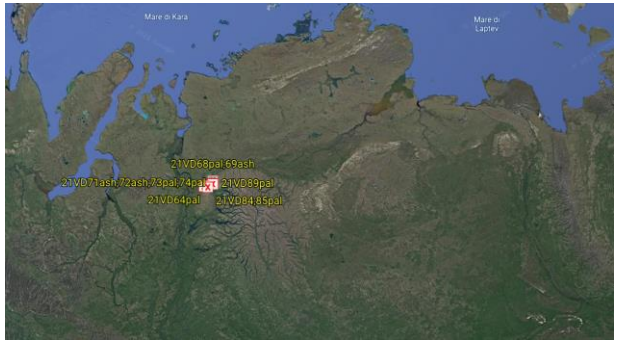


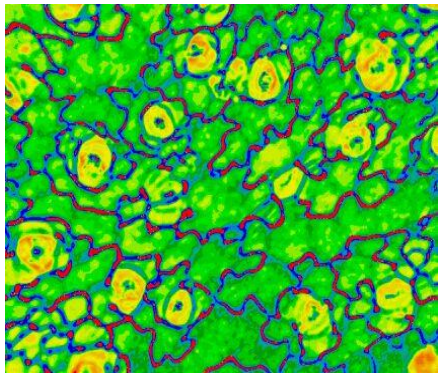


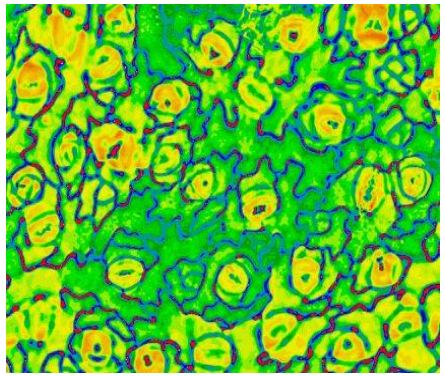


Siberian traps: leaf remains



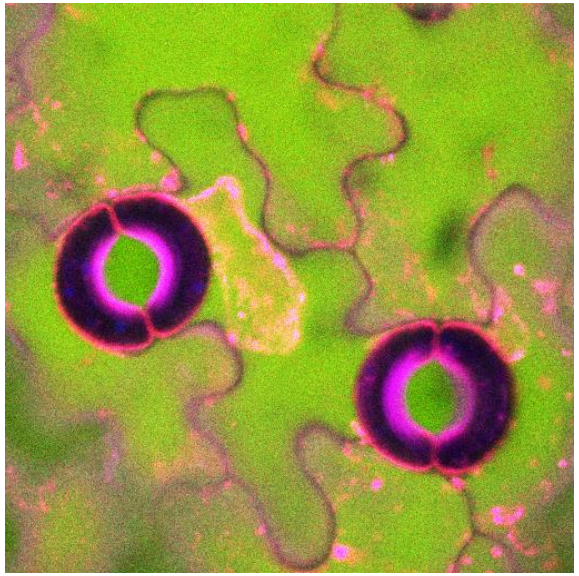






aumento densità degli stomi

diminuzione CO_2



Highlights:

- Increase of teratological terrestrial and marine organic-walled microfossils associated with mass extinction events.
- Interaction with other research lines: biodiversity loss across the Earth history.
- Other: methods for the thermal maturity of organic matter.

Palynomorph Darkness Index

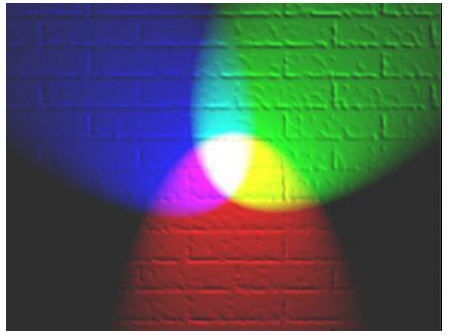
The computation of PDI is based on the following steps:

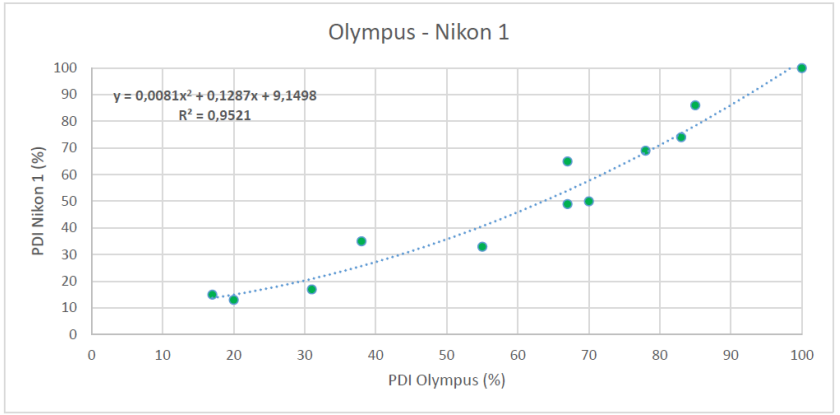
- Selection of palynomorph taxa to investigate
- White background balance
- White background and palynomorph RGB measurements
- Ya computation

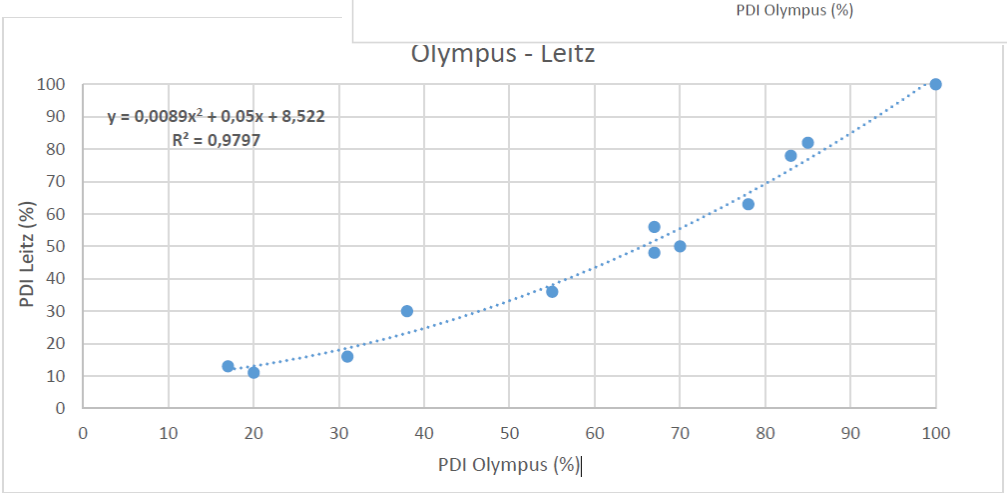
Ya= (0.299R * 255/Rb) + (0.587G * 255/Gb) + (0.114B * 255/Bb)

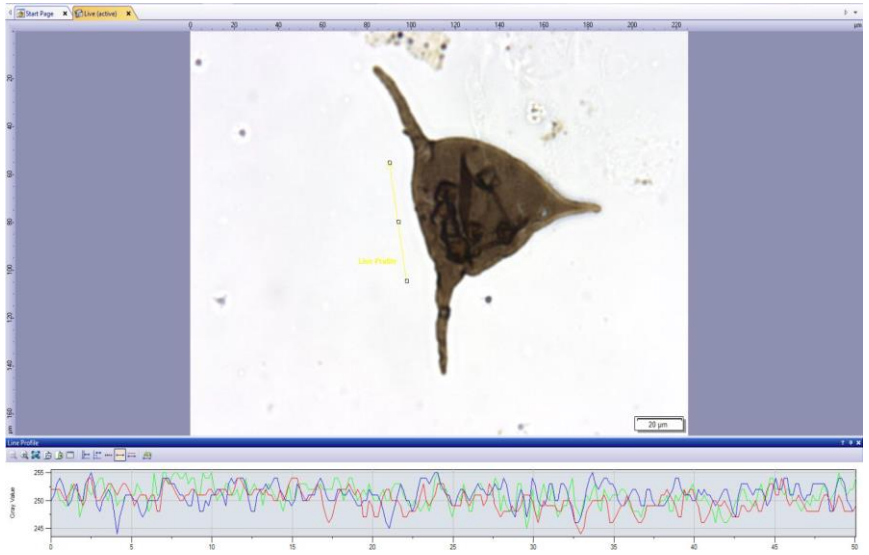
- PDI computation:

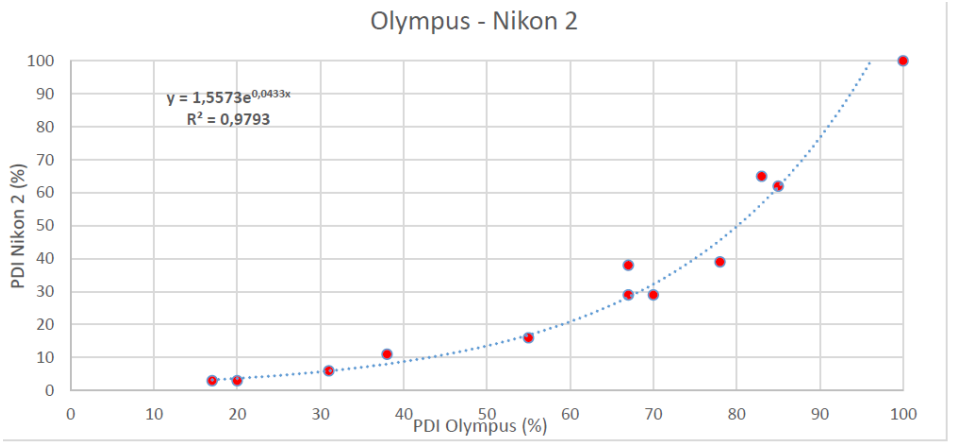
PDI (%) = 100 – (100Ya/255)











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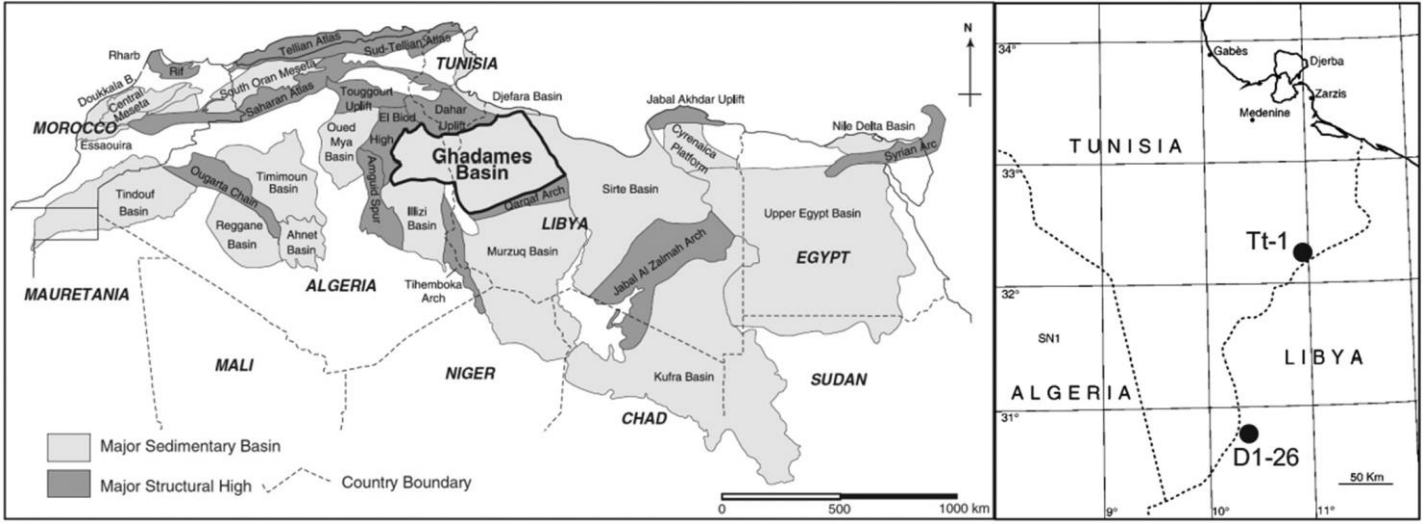

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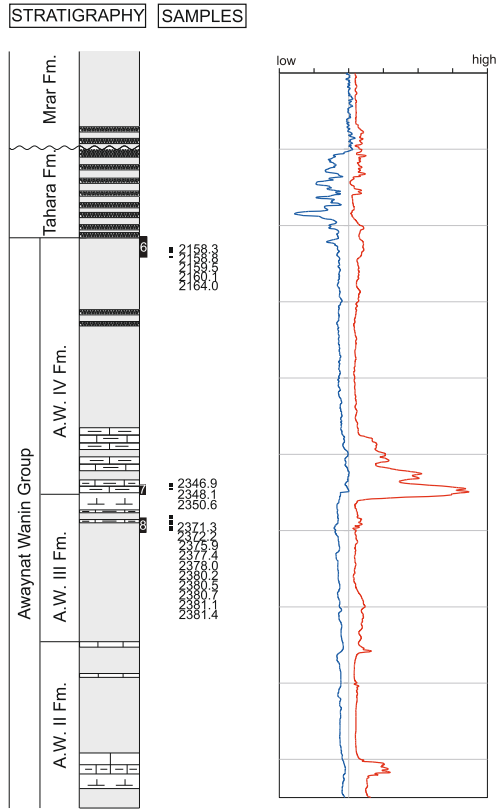
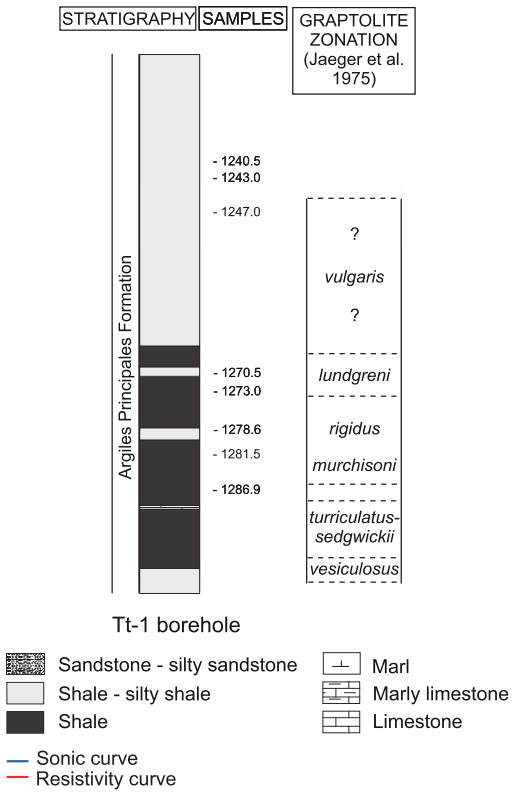
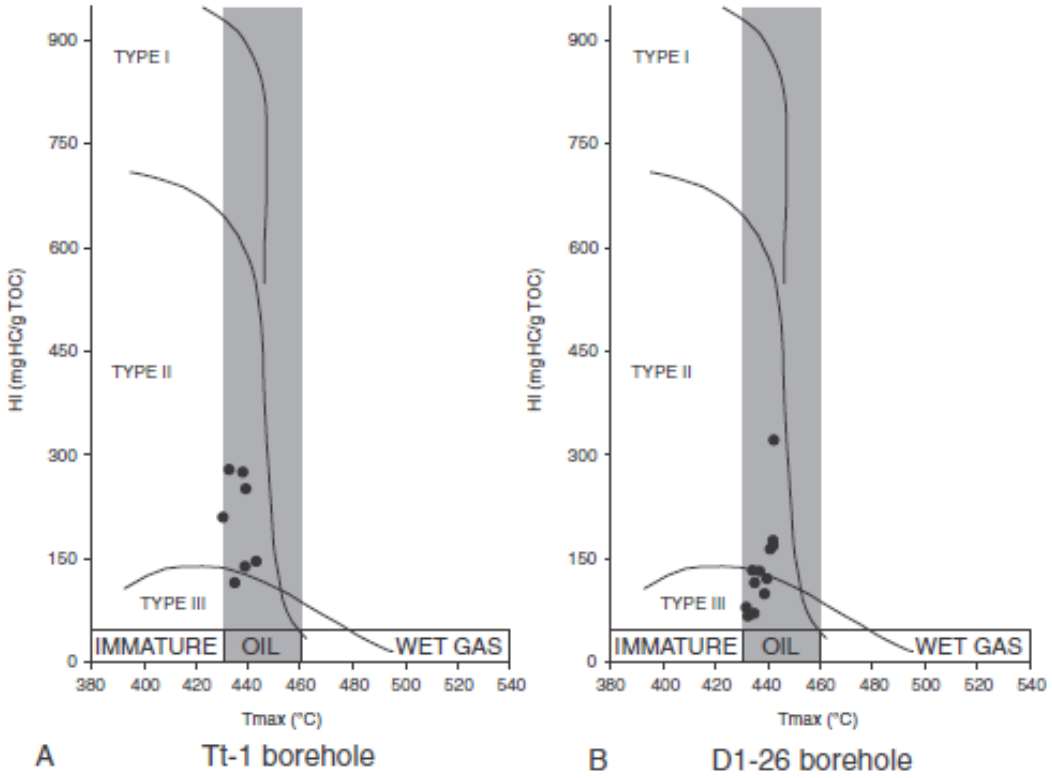
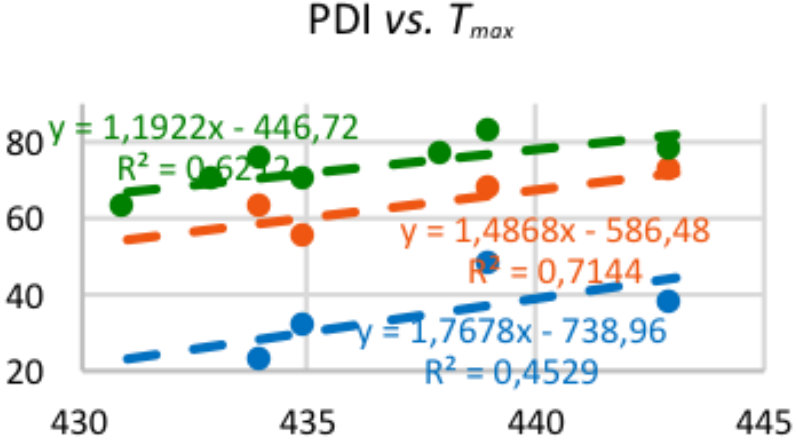
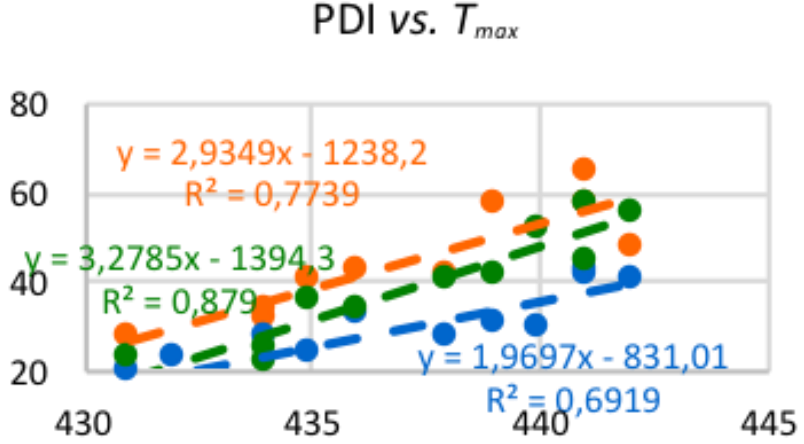




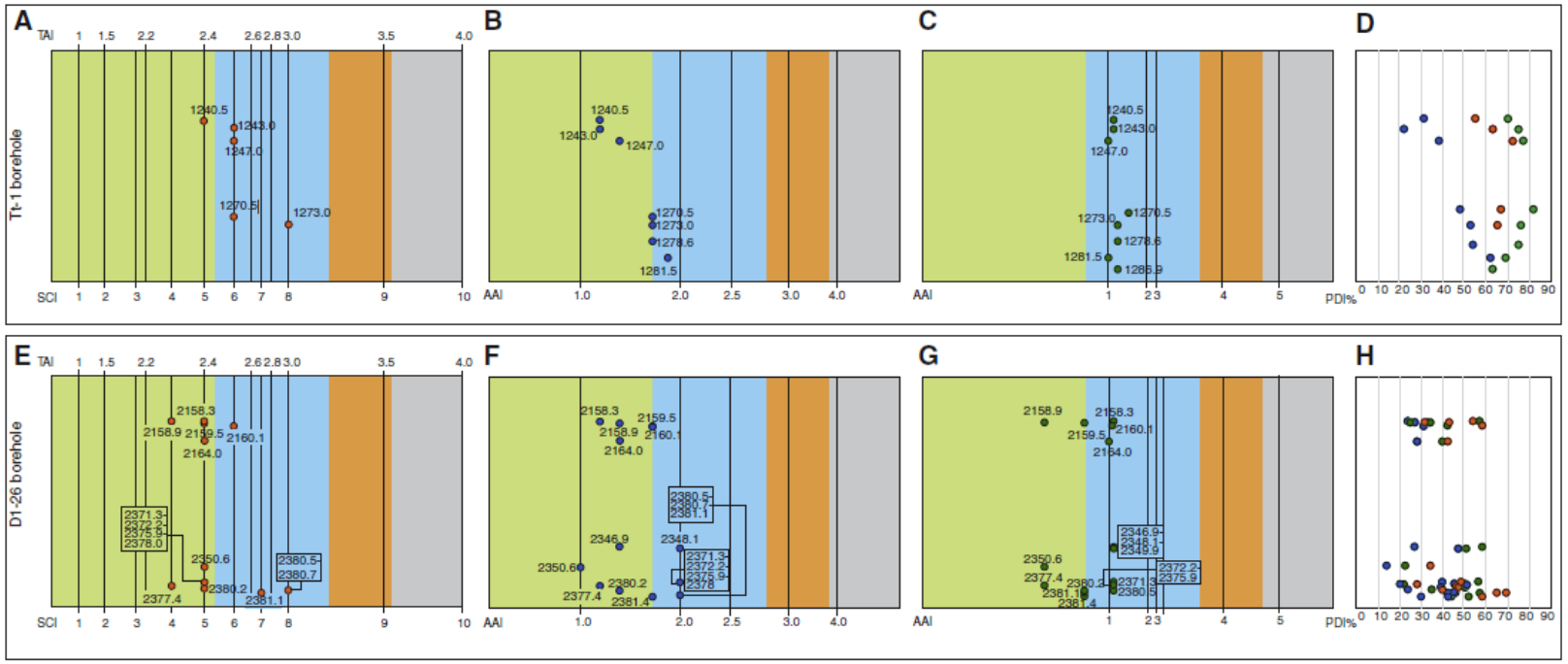


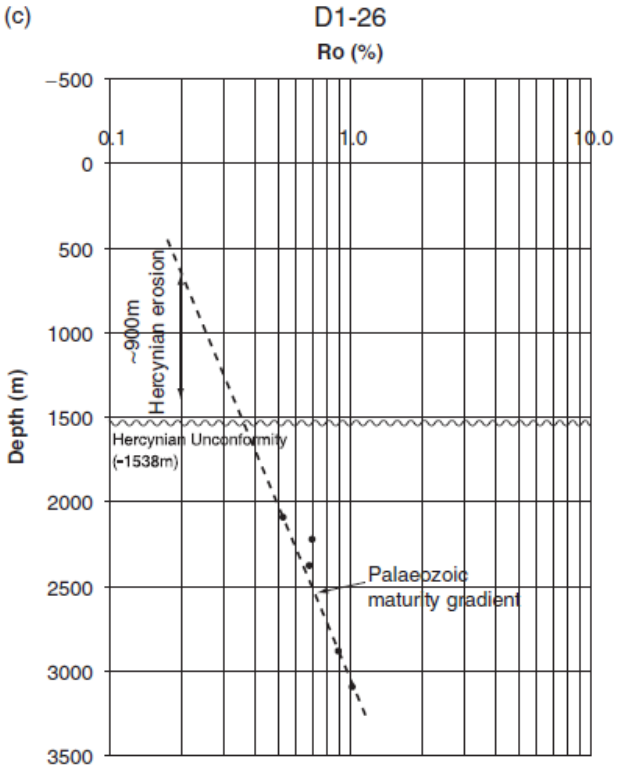


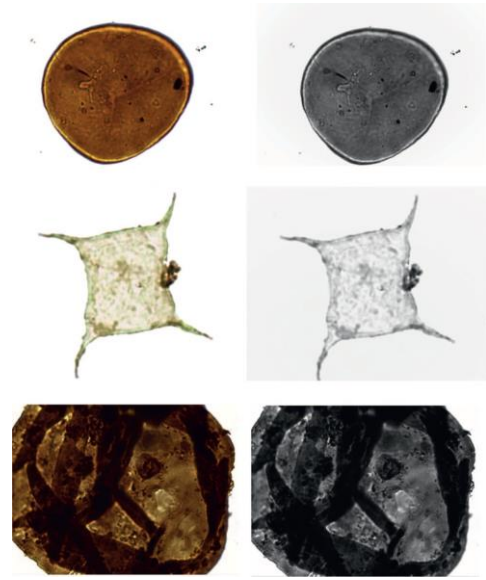
Tt-1 borehole



D1-26 borehole







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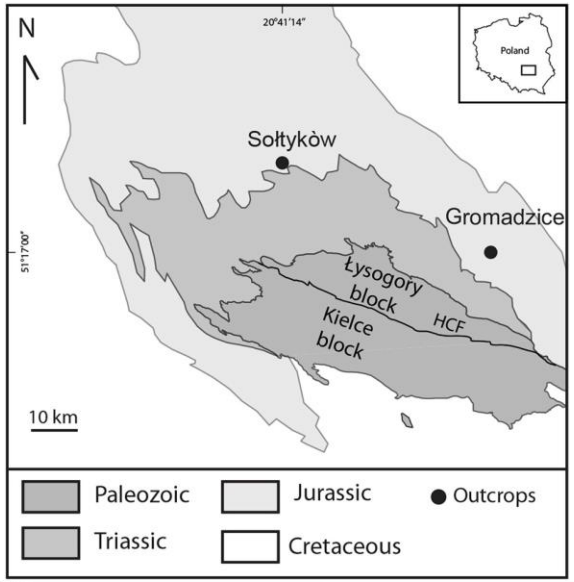

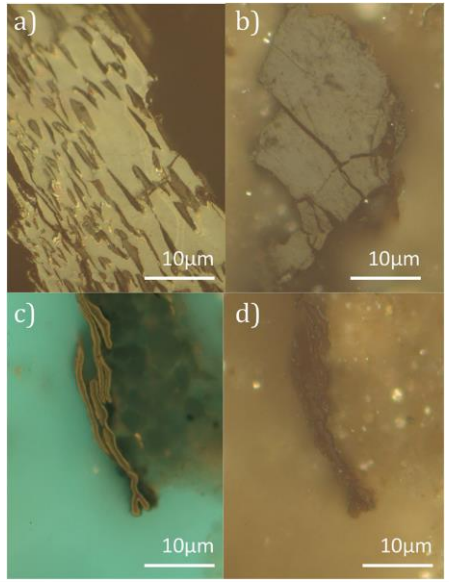

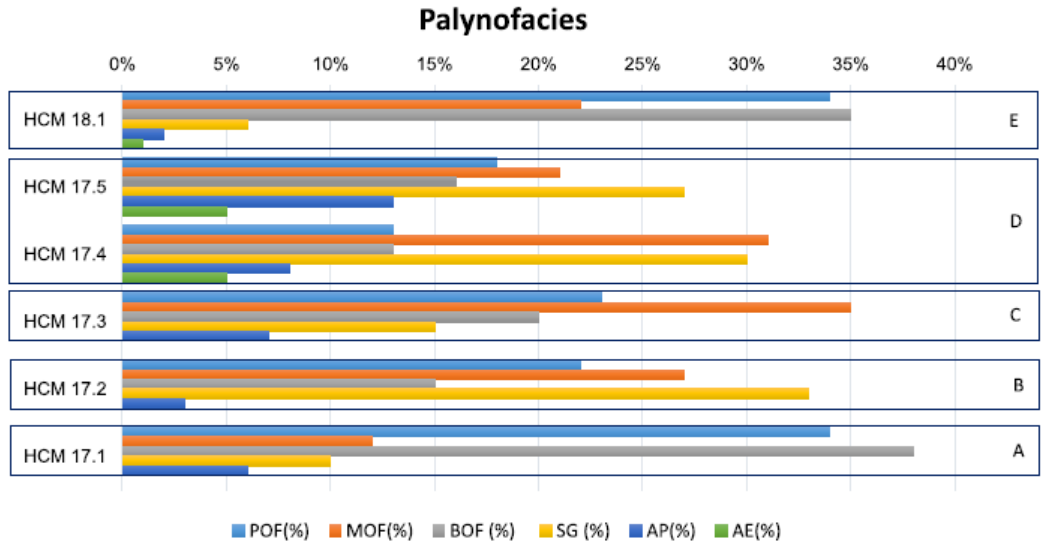

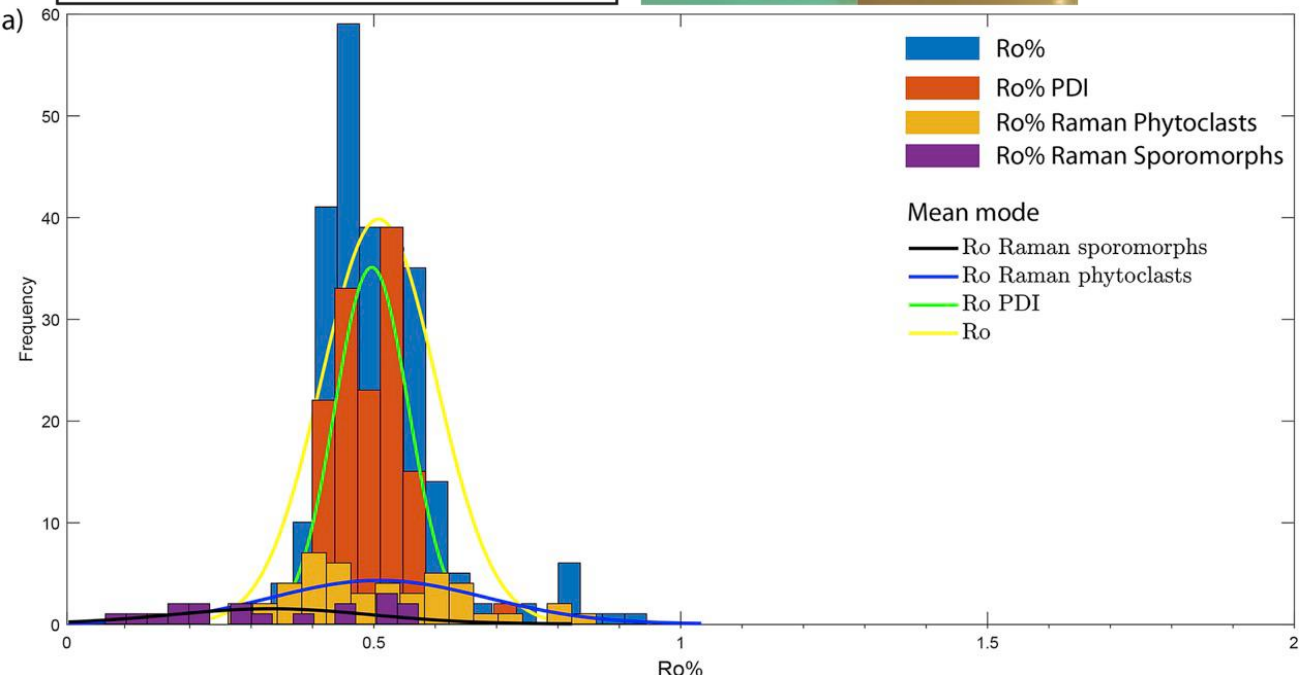

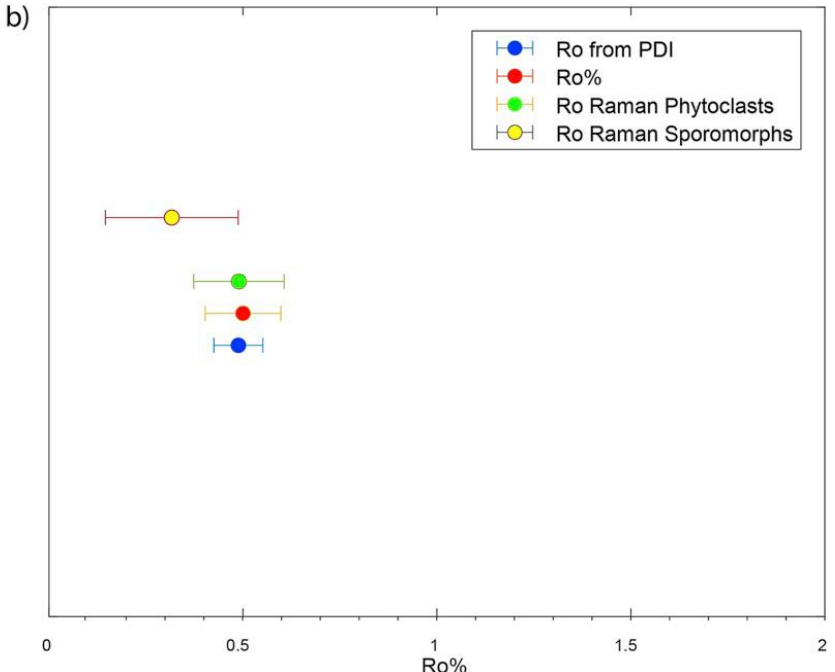

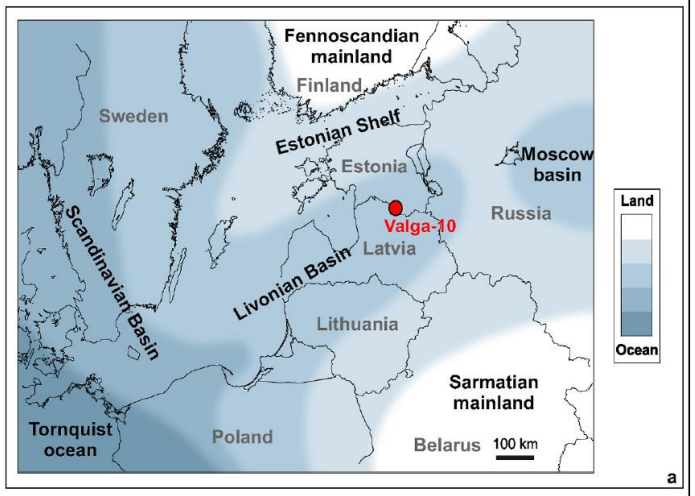

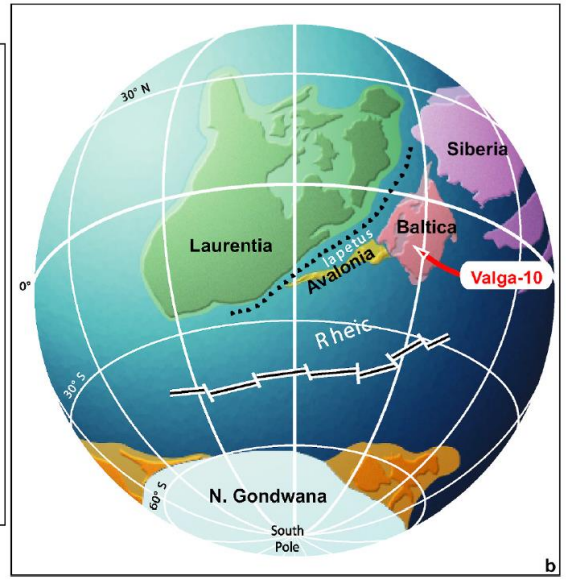

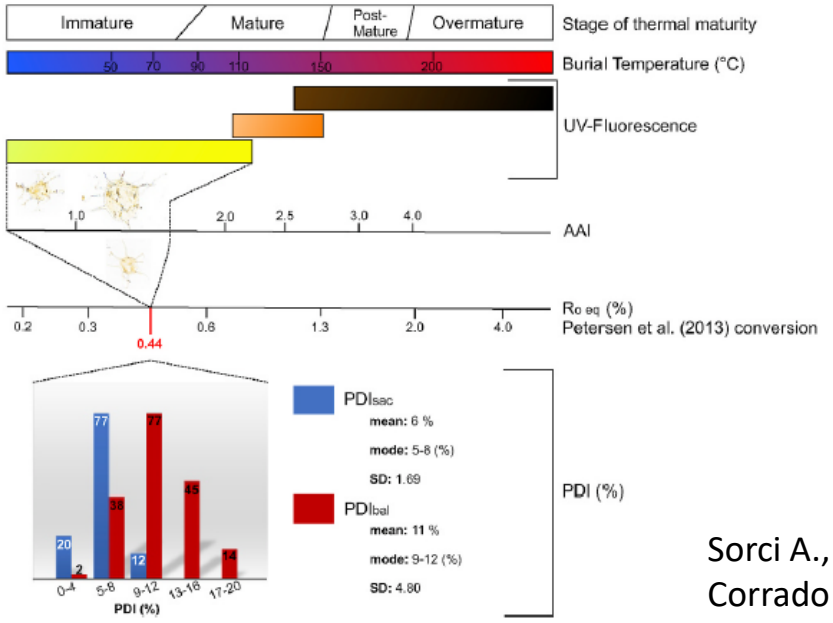

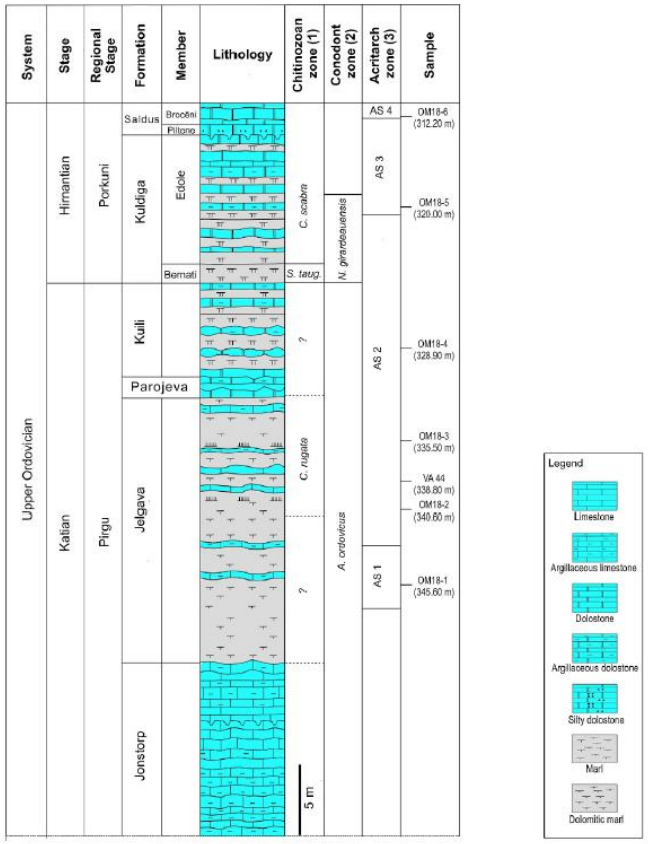

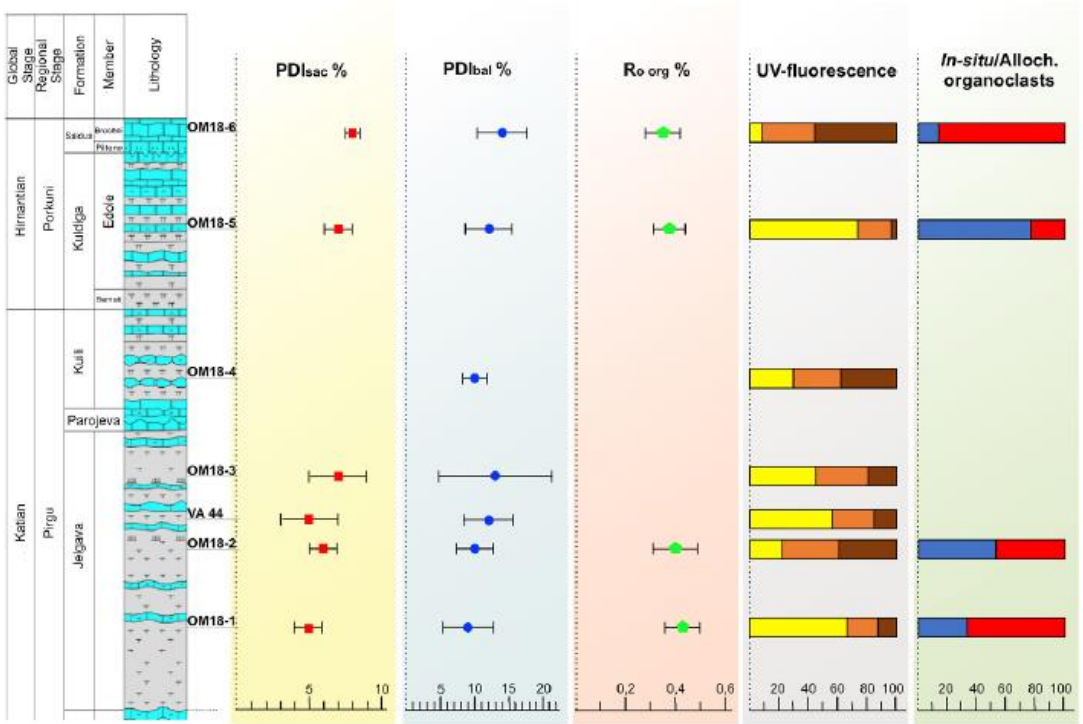

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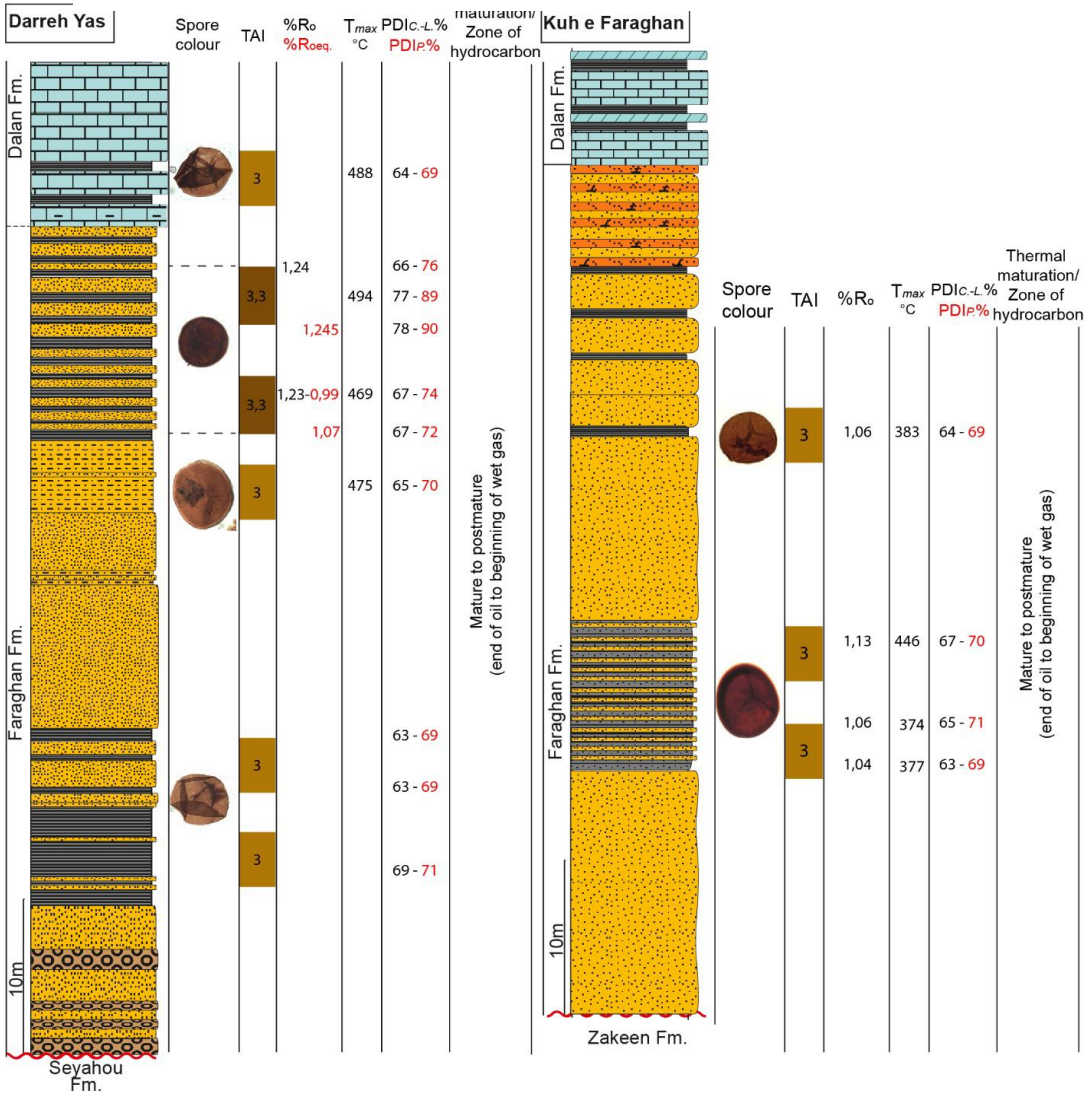
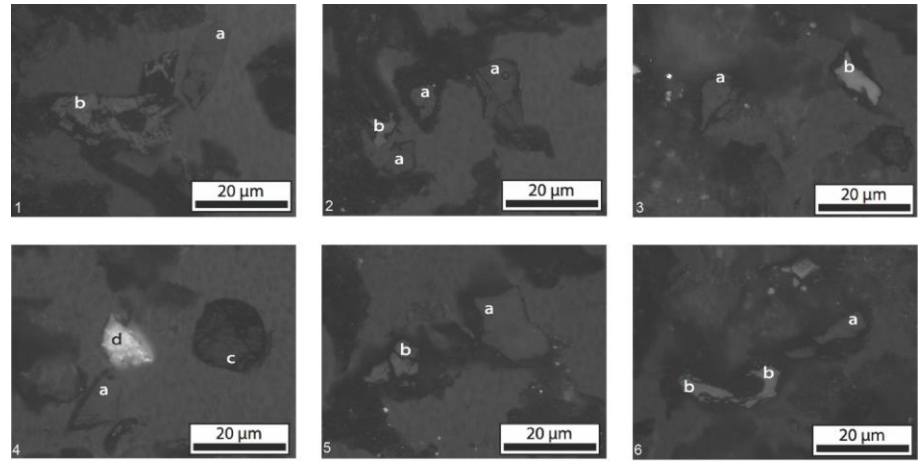
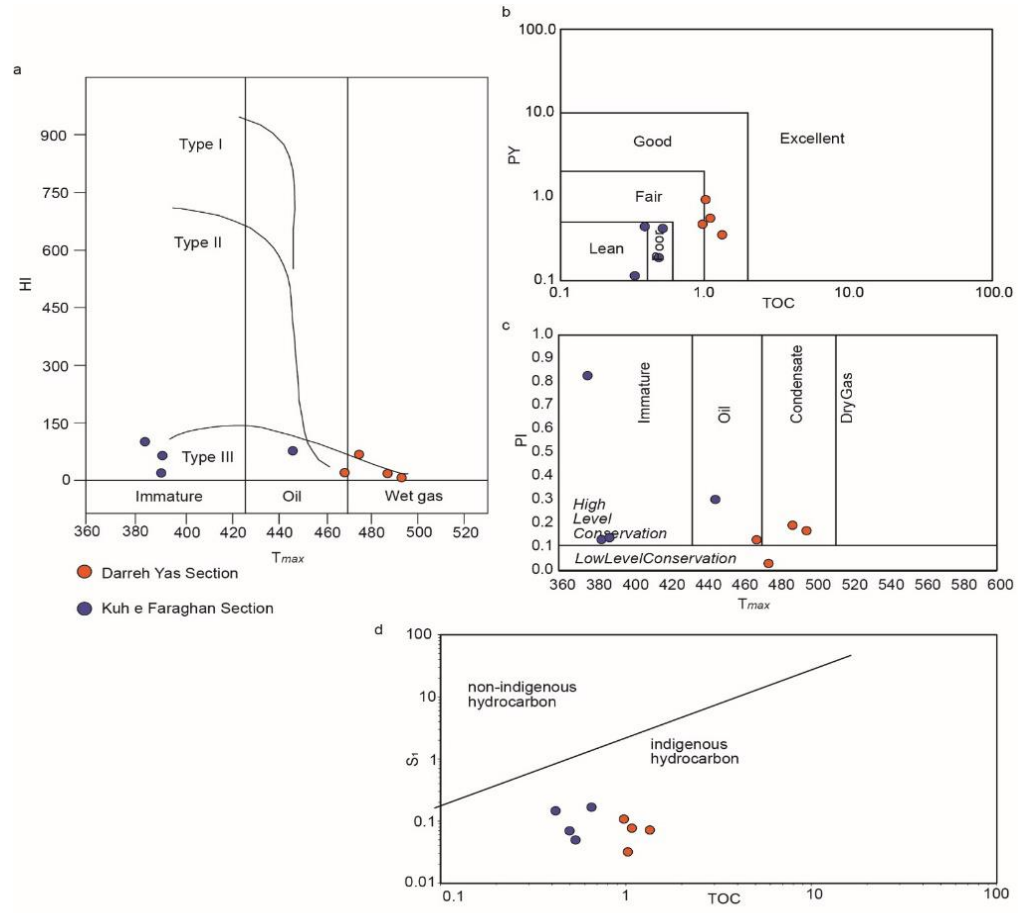
Article

Assessing Thermal Maturity through a Multi-Proxy Approach: A Case Study from the Permian Faraghan Formation (Zagros Basin, Southwest Iran)

Amalia Spina [1,*], Simonetta Cirilli [1], Andrea Sorci [1], Andrea Schito [2], Geoff Clayton [3], Sveva Corrado [4], Paulo Fernandes [5], Francesca Galasso [6], Giovanni Montesi [1], Zelia Pereira [7], Mehrab Rashidi [8] and Roberto Rettori [1]







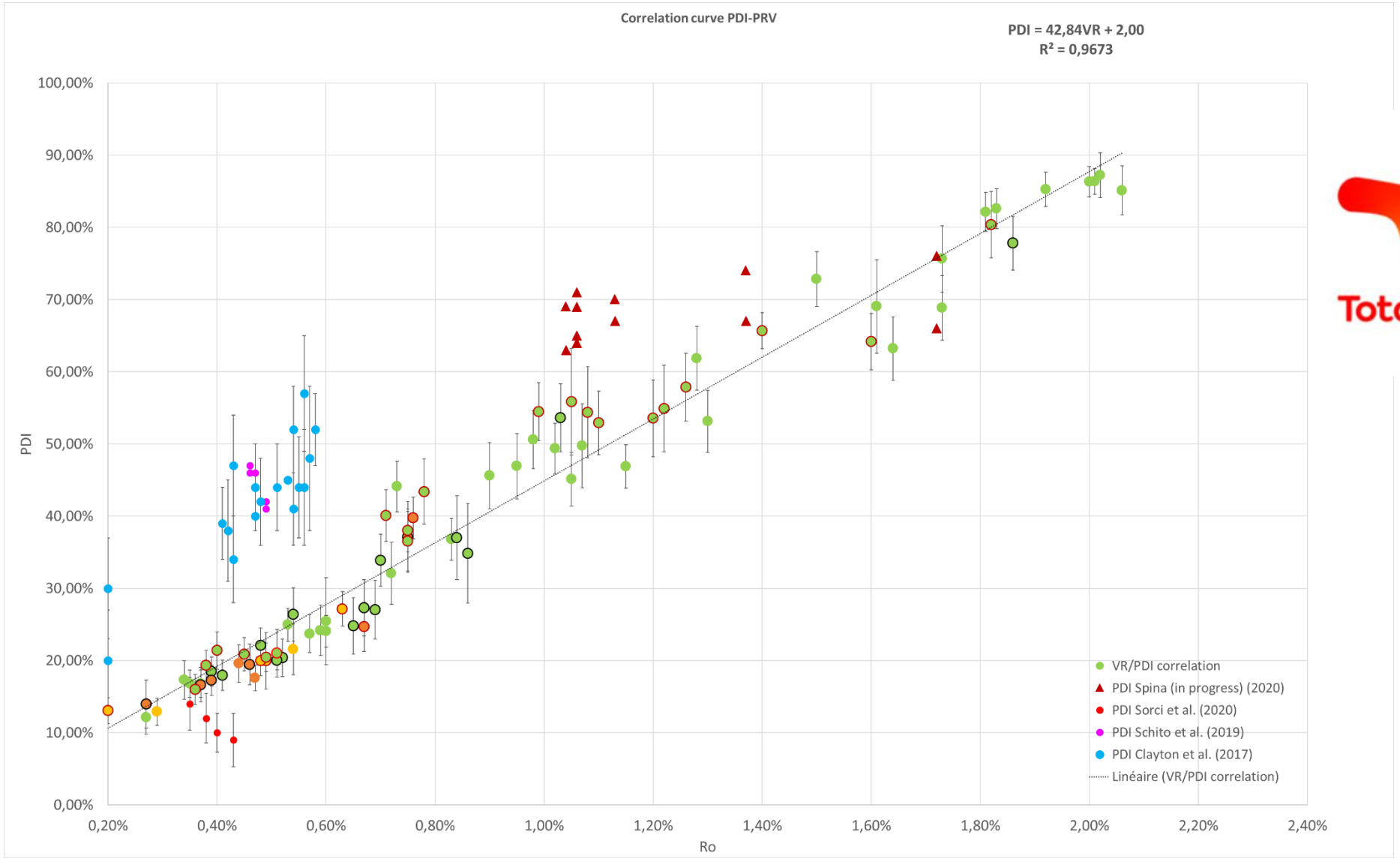
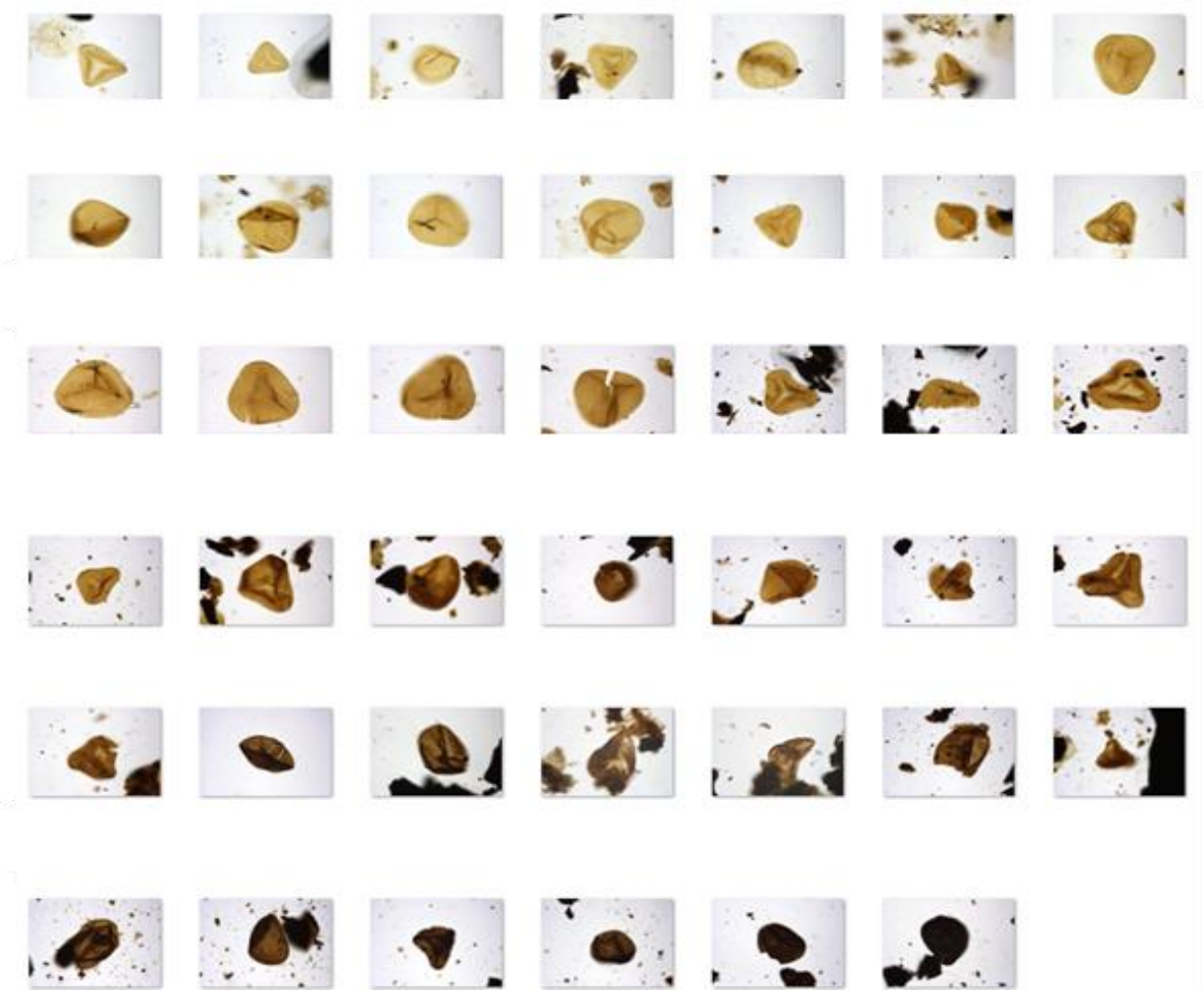


Figure 24: *PDI/VR correlation final curve with bibliography data.*



Attraverso questo progetto:

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- Uno stage di sei mesi Per tesi di laurea

TotalEnergies

Progetto inter e transdisciplinare @ UniPG

Dipartimento di Fisica e Geologia:

- Analisi palinologiche (palinomorfi malformati e non): microscopio ottico e SEM
- Realizzazione di mappe paleofitogeografiche georeferenziate
- Elaborazione di curve di biodiversità vegetale
- Analisi densità stomi

Dipartimento di Chimica, Biologia e Biotecnologie:

- Analisi spettroscopiche (FTIR e RAMAN)
- TOC e Hg
- PAHs

Dipartimento di Filosofia, Scienze Sociali, Umane e della Formazione:
azioni efficaci di divulgazione, di educazione e sensibilizzazione che sviluppino una maggior attenzione alle tematiche legate ai valori e alle preoccupazioni biosferiche (ecopsicologia), di impatto sulla comunità scientifica e sulla società

Dipartimento di Dipartimento di Scienze Agrarie, Alimentari e Ambientali:

- In-vitro germination
- Morphological and ultrastructural analysis
- Transriptome sequencing

Roberto Rettori

Simonetta Cirilli

Andrea Sorci

Nicola Mitillo

Grazie per l’attenzione