Palynofacies Working Group

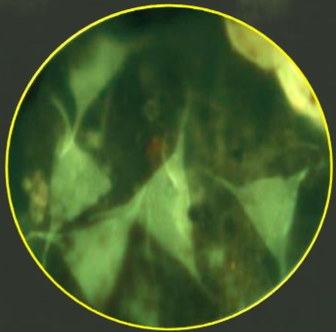
3rd (2015) Exercise: Palynomorph Group

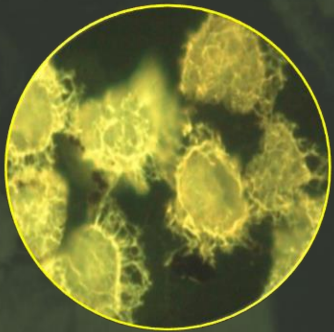
Convener: João Graciano Mendonça Filho

3rd Exercise (2015): Palynomorph Group

The main objective of this 3rd Exercise was the characterization of the origin of the marine palynomorph* particles, such as:

- Identification of the individual particulate components;

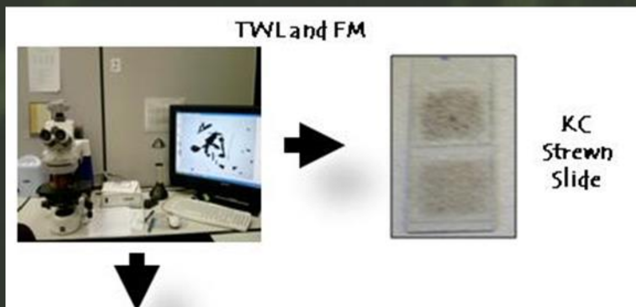


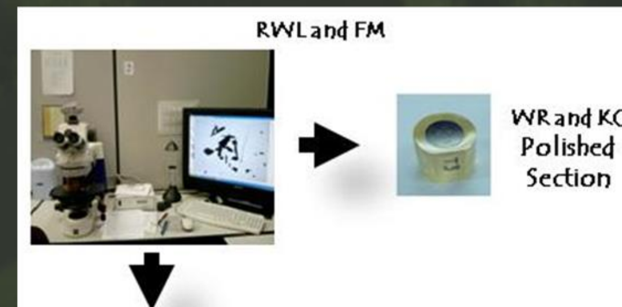


- Assessment of their absolute and relative proportions;
- Preservation states;

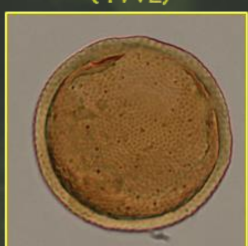
* Palynomorph Group: organic walled constituents that remain after maceration using HCl and HF acids

⌖ To see the feasibility of an integration and correlation between palynofacies characterization and ICCP classification of organic components (maceral composition);

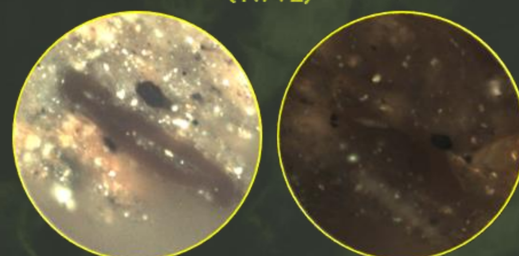




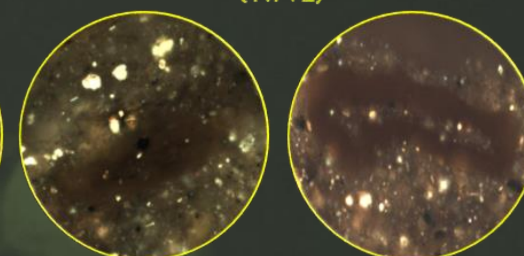
KC Strewn Slide
(TWL)



WR Polished Block
(RWL)



KC Polished Block
(RWL)



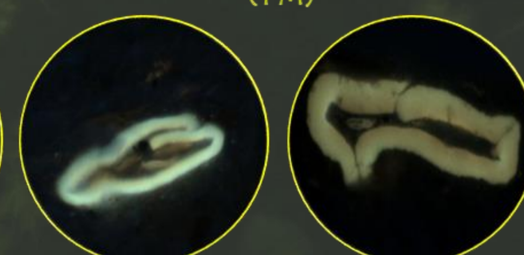
Tasmanite

KC Strewn Slide
(FM)

Telalginite

WR Polished Block
(FM)

KC Polished Block
(FM)



Detailed classification system of the individual organic components from Palynomorph Group that was used in this 3rd Exercise

GROUP	SUBGROUPS				DESCRIPTION
PALYNOMORPH	Sporomorph	Spores	Terrestrial Palynomorph produced by Pteridophyte, Briophyte and Fungi.		Triangular or circular form palynomorph, trilete mark ("Y") or monolete (scar). They can occur as massulae of the freshwater fern (Azolla), agglomerates and tetrad. "First spores" (Cambrian): Cryptospores (spore-like bodies) and Embryophyte Spores: Upper Ordovician-Recent.
PALYNOMORPH	Sporomorph	Pollen Grain	Terrestrial Palynomorph produced by Gymnosperms and Angiosperms		Palynomorph with varied ornamentation, most with circular or oval outline; could present opening or not. They can occur as agglomerates or tetrads. Devonian-Recent.
PALYNOMORPH	Freshwater Microplanckon	***Botryococcus***	Green Algae	Chlorophyta (Chlorococcales)	Irregular globular colonies; size 30 to 2000 µm, sometimes with several lobes (like miniature cauliflower); Ordovician-Recent.
PALYNOMORPH	Freshwater Microplanckon	***Pediastrum***	Green Algae	Chlorophyta (Chlorococcales)	Colonial green algae (coenobia). Rounded colonies with 30-200 µm diameter. In polygonal form the cells have a concentric arrangement; cells present two horns in the side external. Jurassic (?) - Recent.
PALYNOMORPH	Freshwater Microplanckon	***Scenedesmus***	Green Algae	Chlorophyta (Chlorococcales)	*Scenedesmus* genus of colonial (coenobia) green algae with 4, 8, or 16 cells arranged in a row and non-motile. Different forms of coenobia are found including linear, costulatoid, irregular, alternating, or dactylococcoid patterns.
PALYNOMORPH	Freshwater Microplanckon	Zignemataceae	Green Algae	Chlorophyta (Zignematales)	They are hydro-terrestrial, filamentous or unicellular, uniseriate (unbranched) green algae which produce acid-resistant spores. The filaments are septated and they present diversely shaped chloroplasts, such as stellate in Zygnema, helical in Spirogyra, and flat in Mougeotia. Only the filamentous algae spores are preserved. The majority of species have spores of constant form, only a very few are polymorphic. The forms are of four primary types (globose, obovoid, ellipsoid and quadrangular) of which a number of variation are known (Grenfell, 1995).
PALYNOMORPH	Freshwater Microplanckon	***Gloeocapsomorpha***	Green Algae (?) Blue-Green Algae (?)	Chlorophyta Cyanophyta	*Gloeocapsomorpha* is a colonial organism. In colonies the cell voids are completely ensheathed by thick, multilayered walls and do not open to the surface of the colonies. The outer layer of the cell walls of the colony is smooth. Ordovician *G. prisca* is considered occur in marine systems
PALYNOMORPH	Marine Microplankton	Dinoflagellate Cysts	Cell produced during the sexual phase of the dinoflagellate life cycle		The fossil record of dinocysts is almost entirely confined to forms that have a meroplanktonic life cycle. Major dinocyst morphotypes: Proximate, Cavate and Chorate. Triassic-Recent. According to their nutritional behavior they can be autotrophic, heterotrophic or mixotrophic.
PALYNOMORPH	Marine Microplankton	Prasinophyte	Fossilized structure produced by small quadri-flagellate motile phase.		Majority, like *Tasmanites*, are spherical; diameter 50 to 2000 µm. Modern species include freshwater. Precambrian-Recent.
PALYNOMORPH	Marine Microplankton	Acritarchs	Unicellular fossilized cysts with organic cell walls. They have no formal taxonomic status.		The acritarchs are a polyphyletic group of palynomorphs whose name means "of uncertain origin". Acritarcha (*akritos* = uncertain, mixed and *arche* = origin). Small dimension organism (5 a 150 µm). Simmetrically shaped withvaried ornamentation. They first appeared in the late Precambrian, attained their acme during the Ordovician-Devonian.
PALYNOMORPH	Zoomorph	Foraminiferal Test-Linings	They are tectinous linings derived from certain marine benthic foraminifera.		The linings are typically dark brown colour, although their outer chambers are often more thin-walled and translucent. Good indicator of marine conditions.
PALYNOMORPH	Zoomorph	Scolecodonts	Elements of the jaw of benthic polychaete annelid worms.		They are the part-calcified and scleroprotenaceous ("chitinous") mouth parts ("pharyngeal jaws") of benthic polychaete annelid worms. Ordovician - Recent.
PALYNOMORPH	Zoomorph	Chitinozoa	Vesicles in format of flasks or small hollow bottles (30 to 2000 µm). Uncertain affinity.		They constitute an extinct group of organic-walled microfossils found in Palaeozoic marine sediments. Early Ordovician - Late Devonian.
Others	Zooclasts (Graptolite, Crustacean eggs); *Spongiophyton;* Salviniaceae*;* Solid Bitumen.				

All participants received a guideline showing the classification details and explaining the counting procedures.

Tyson, 1995; Vincent, 1995; Mendonça Filho, 1999; Mendonça Filho *et al.*, 2011; 2012; 2014; 2015

Participants

Participant	Affiliation	Country
Ali, Shaaban M.	Stratochem Services	Egypt
Borrego, Angeles G.	INCAR-CSIC	Spain
Flores, Deolinda	University of Porto	Portugal
Furukawa, Gisele	Federal University of Rio de Janeiro	Brazil
Gomes, Sinda B.V.C.	Federal University of Rio de Janeiro	Brazil
Gonçalves, Paula A.	University of Porto	Portugal
Gorken, Riza	University of Patras	Greece
Hackley, Paul	U.S. Geological Survey	USA
Holstein, Björn	RWE Dea AG/Wietze Laboratory	Germany
Kus, Jolanta	Federal Institute for Geosciences and Natural Resources	Germany
Mendonça Filho, João G.	Federal University of Rio de Janeiro	Brazil
Mendonça, Joalice O.	Federal University of Rio de Janeiro	Brazil
Menezes, Taíssa R.	PETROBRAS R&D	Brazil
Oliveira, Antonio D.	Federal University of Rio de Janeiro	Brazil
Silva, Frederico S.	Federal University of Rio de Janeiro	Brazil
Suarez-Ruis, Isabel	INCAR-CSIC	Spain
Torres, Jaqueline S.	Federal University of Rio de Janeiro	Brazil
Zivotič, Dragana	University of Belgrade	Serbia

Sample

Two immature samples from marine system encompassing the subgroups from Palynomorph Group was used in this 3rd Exercise.

PWG3

Ponta Grossa Formation (Devonian), Paraná Basin, Brazil

- Kerogen Type II
- TOC = 0.50 wt.%
- $CaCO_3$: 9 wt.%
- S: 0.37 wt.%
- Immature sample

PWG4

Campos Formation (Pleistocene), Campos Basin, Brazil

- Kerogen Type II
- TOC = 0.56 wt.%
- $CaCO_3$: 22 wt.%
- S: 0.10 wt.%
- Immature sample

Obs. Taking in account the amount of sample available and the number of participants, it was possible to prepare a KC strewn slides (TL), KC and WR polished sections (RL) to perform this exercise.

PWG3

Counting Sheet: Palynofacies

Individual Organic Particles			Number of Particles	% of Particles
PHYTO	Opaque			
	Non-Opaque	Biostructured		
		Non-Biostructures		
		Cuticles/Membranes		
	Phytoclasts (Total)			
AM	AOM			
	Resin			
	Amorphous (Total)			
PALYN	Sporomorph	Spores		
		Pollen Grain		
	Marine OWM	Prasinophytes		
		Acritarchs		
	Fresh Water OWM	*Botryococcus*		
	Zoomorphs	Chitinozoa		
	Palynomorphs (Total)			
Zooclast Group (Total)				
Other	*Spongyophyton*, Zooclasts, etc.			

All participants received a counting sheet, according to organic particles (TWL) present in the PWG3 sample.

Counting Sheet (TWL)

Counting sheet of organic matter (individual organic particle) for PWG3 Sample based on detailed classification system of the individual organic components from Palynomorph Group that was used in this 3rd Exercise.

PWG3

Counting Sheet: Macerals

Maceral Group	Maceral Subgroup/Maceral		Number of Points	Total%
Vitrinite	Telovitrinite			
	Gelovitrinite			
	Detrovitrinite			
Liptinite	Alginite	Telalginite		
		Lamalginite		
	Sporinite			
	Cutinite			
	Resinite			
	Liptodetrinite			
Inertinite	Fusinite			
	Semifusinite			
	Macrinite			
	Micrinite			
	Funginite			
	Secretinite			
	Inertodetrinite			
Mineral	Clay			
	Carbonate			
	Quartz			
	Pyrite			

All participants received a counting sheet, according to organic particles (RWL) present in the samples that were analyzed.

Counting Sheet (RWL)

Counting sheet of Macerals * (RWL – Polished Section/WR and KC) for PWG3 Sample, based on the ICCP classification system, which was used in this 3rd Exercise.

* ISO7404-3, 2009

PWG4

Counting Sheet: Palynofacies

Individual Organic Particles			Number of Particles	% of Particles
PHYTO	Opaque			
	Non-Opaque	Biostructured		
		Non-Biostructures		
		Cuticles/Membranes		
	Phytoclasts (Total)			
AM	AOM			
	Resin			
	Amorphous (Total)			
PALYN	Sporomorph	Spores		
		Pollen Grain		
	Marine OWM	Dinocysts		
	Fresh Water OWM	*Botryococcus*		
		Pedistrum		
	Zoomorphs	Foraminiferal test-linings		
	Palynomorphs (Total)			
Zooclast Group (Total)				
Other	*Spongyophyton*, Zooclasts, etc.			

All participants received a counting sheet, according to organic particles (TWL) present in the PWG4 sample.

Counting Sheet (TWL)

Counting sheet of organic matter (individual organic particle) for PWG4 Sample based on detailed classification system of the individual organic components from Palynomorph Group that was used in this 3rd Exercise.

PWG4

Counting Sheet: Macerals

Maceral Group	Maceral Subgroup/Maceral		Number of Points	Total%
Vitrinite	Telovitrinite			
	Gelovitrinite			
	Detrovitrinite			
Liptinite	Alginite	Telalginite		
		Lamalginite		
	Sporinite			
	Cutinite			
	Resinite			
	Liptodetrinite			
Inertinite	Fusinite			
	Semifusinite			
	Macrinite			
	Micrinite			
	Funginite			
	Secretinite			
	Inertodetrinite			
Mineral	Clay			
	Carbonate			
	Quartz			
	Pyrite			

All participants received a counting sheet, according to organic particles (RWL) present in the samples that were analyzed.

Counting Sheet
(RWL)

Counting sheet of Macerals * (RWL – Polished Section/WR and KC) for PWG4 Sample, based on the ICCP classification system, which was used in this 3rd Exercise.

* ISO7404-3, 2009

Results

Kerogen Counting

- For obtaining palynofacies data in this 3rd exercise, organic particles were assigned according to the classification system and the counting data were obtained making a series of non-overlapping traverses across the strewn slide, and recording only those particles located directly under the cross-wires (very center of the field of view), omitting any remaining particles;

- This counting was made through the covering of the strewn slides with three transverse lines using the vertical and horizontal lines from the cross graduated reticule (scale), using ocular with 10X and objective 20X magnification;

Transverse lines on strewn slides

Organic particles that pass directly under the cross-wires

Data Representation

- After obtaining of the data through the counting procedures of organic constituents, these counting values were transformed to percentage values and they were put in form of graphs;

- This exercise dealt primarily with the characterization of the kerogen assemblage in terms of the relative contributions of its constituents (generally percentages based on relative numeric particle frequencies) and they were based on:

  1. **Percentage frequency** (the frequency of any component related to that of the total population of particles);

  2. **Relative frequency ratios** (the numeric frequency of any component related to that of any other component, not the total particle population);

- For the data closure all results summed 100% in order to evaluate real correlations that may exist within the data;

Data Representation

- For representation and correlation of data in this 3rd exercise, it was used Ternary (triangular) Diagrams;

- The main advantage of ternary diagrams is that the data are plotted with a spatial separation that is useful for grouping samples into empirically defined associations or assemblages;

- These procedures for data representation were used for both TWL (Palynofacies Counting) and RWL (Maceral Counting/WR and KC) only as a correlation factor and to highlight different aspects of OM assemblages;

PWG3

Palynofaces Data

Table: values obtained through the counting of individual organic particles for PWG3 Sample based on detailed classification system of the individual organic components from OM (Kerogen) Groups that was used in this 3rd Exercise.

TWL-Palynofacies Slides/KC- Ratios & Representation data														
Participant	Phytoclast %					Palynomorph %						Amorphous %		
	Opaque Phytoclast	Non-Opaque Phytocalst			Total									
		Non-Op	Cut	Mem		Sp	Acri	Prasi	Botry	Zoo	Total	AOM	Re	Total
A	0.00	0.00	0.32	0.32	0.64	4.50	63.67	22.51	0.00	0.00	90.68	8.68	0.00	8.68
B	0.00	0.97	0.00	5.48	6.45	9.68	41.94	35.48	0.00	0.00	87.10	6.45	0.00	6.45
C	5.33	4.00	1.33	4.67	15.33	5.33	26.67	35.67	1.00	0.00	68.67	16.00	2.67	18.67
D	1.67	1.33	1.33	0.00	4.33	6.67	25.00	47.67	0.00	0.00	79.33	16.33	0.00	16.33
E	0.00	0.00	0.00	0.00	0.00	0.00	78.23	12.93	0.00	0.00	91.17	8.83	0.00	8.83
F	0.98	0.33	0.00	0.98	2.30	2.62	60.66	29.51	0.00	0.00	92.79	4.92	0.00	4.92
G	0.00	4.90	3.17	1.15	9.22	10.09	53.31	23.05	1.15	0.00	87.61	3.17	0.29	3.46
H	0.00	1.66	2.99	1.99	6.64	16.28	37.21	32.89	0.00	0.00	86.38	6.98	0.00	6.98
I	0.96	1.44	1.44	0.00	3.85	2.88	48.32	41.11	0.24	0.00	92.55	3.61	0.00	3.61
J	1.10	0.55	0.82	0.00	2.47	6.58	59.45	26.85	0.00	0.00	92.88	4.66	0.00	4.66
K	2.82	0.28	0.00	0.00	3.10	3.10	65.35	26.20	0.00	0.00	94.65	2.25	0.00	2.25
L	4.01	0.40	0.20	0.00	4.61	6.01	29.06	60.12	0.00	0.00	95.19	0.20	0.00	0.20
M	1.40	2.55	0.29	0.00	4.24	31.26	36.76	23.53	0.29	0.00	91.84	3.92	0.00	3.92
N	0.00	2.56	0.28	5.11	7.95	23.86	24.72	40.34	0.57	0.00	89.49	2.56	0.00	2.56
O	4.00	0.00	8.33	0.00	12.33	2.00	12.33	62.00	0.00	0.00	76.33	11.33	0.00	11.33
P	9.84	6.23	0.00	3.61	19.67	11.14	45.98	19.28	0.98	0.00	72.13	1.97	0.98	2.95
Average	2.01	1.70	1.28	1.46	6.45	8.88	44.16	33.50	0.26	0.00	86.80	6.37	0.25	6.61
SD	2.69	1.89	2.14	2.06	5.40	8.45	18.25	14.15	0.42	0.00	8.23	4.80	0.69	5.13

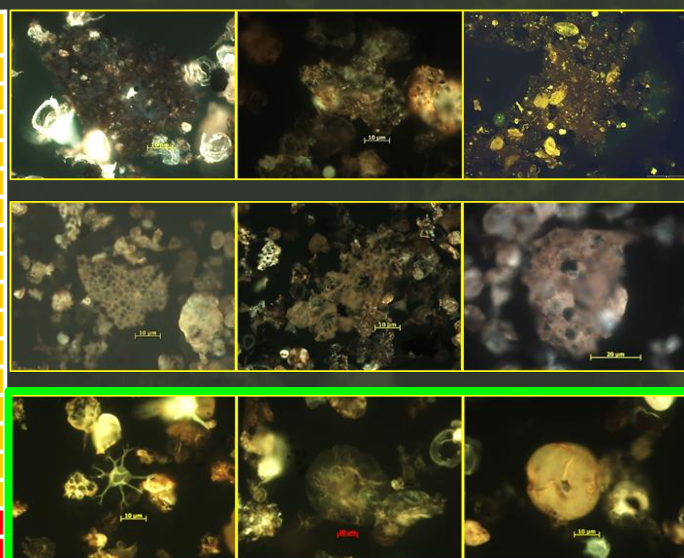
Most of participants counted organic matter only in TWL and FM.

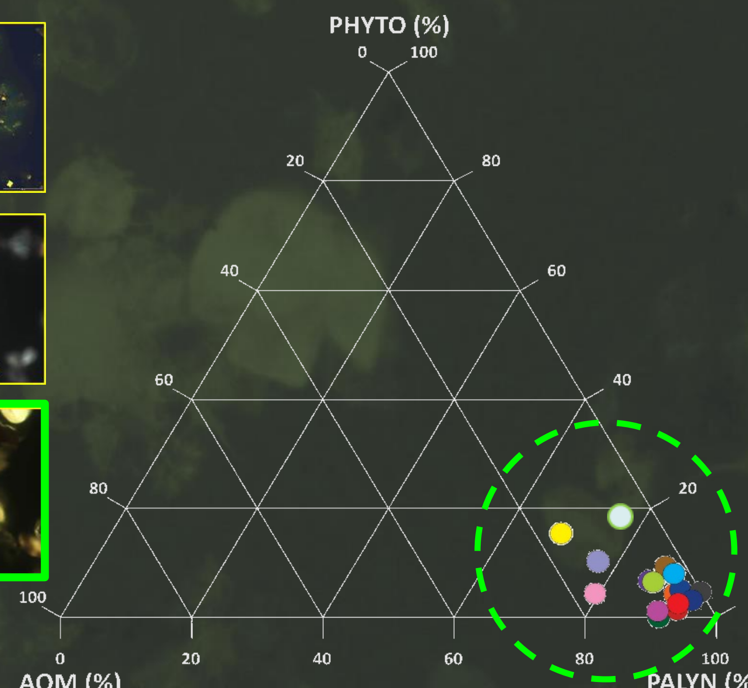
PWG3

Palynofacies: Organic Matter Assemblage Phytoclast-AOM-Palynomorph

- The APP diagram (AOM-Phytoclast-Palynomorph ternary diagram) correlates the percentage of the 3 main groups of kerogen recognized in TWL microscopy and FM;
- Through the results from all participants, we can observe the significant predominance of palynomorphs among the kerogen groups;

Participant	Phyto	Palyn	AOM
A	0.64	90.68	8.68
B	6.45	87.10	6.45
C	15.33	68.67	16.00
D	4.33	79.33	16.33
E	0.00	91.17	8.83
F	2.30	92.79	4.92
G	9.22	87.61	3.17
H	6.64	86.38	6.98
I	3.85	92.55	3.61
J	2.47	92.88	4.66
K	3.10	94.65	2.25
L	4.61	95.19	0.20
M	4.24	91.84	3.92
N	7.95	89.49	2.56
O	12.33	76.33	11.33
P	19.67	77.38	2.95
Average	6.45	86.80	6.61
SD	5.40	8.23	5.13





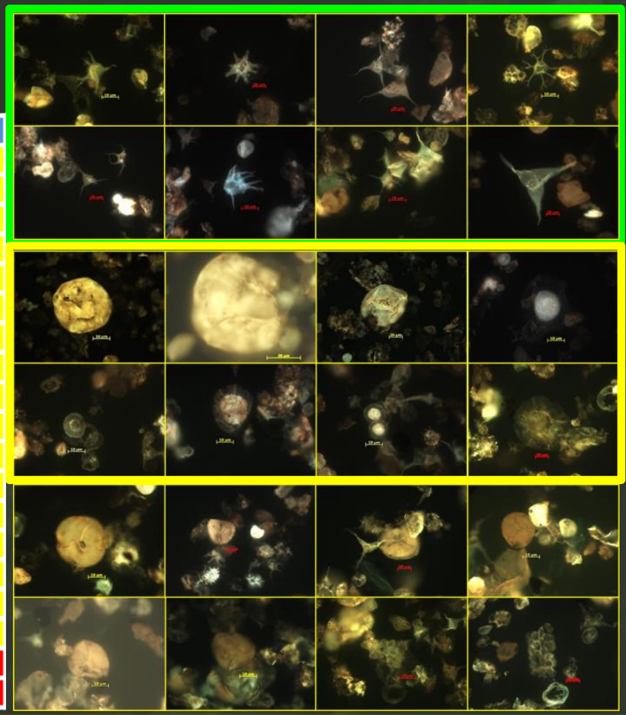
PWG3

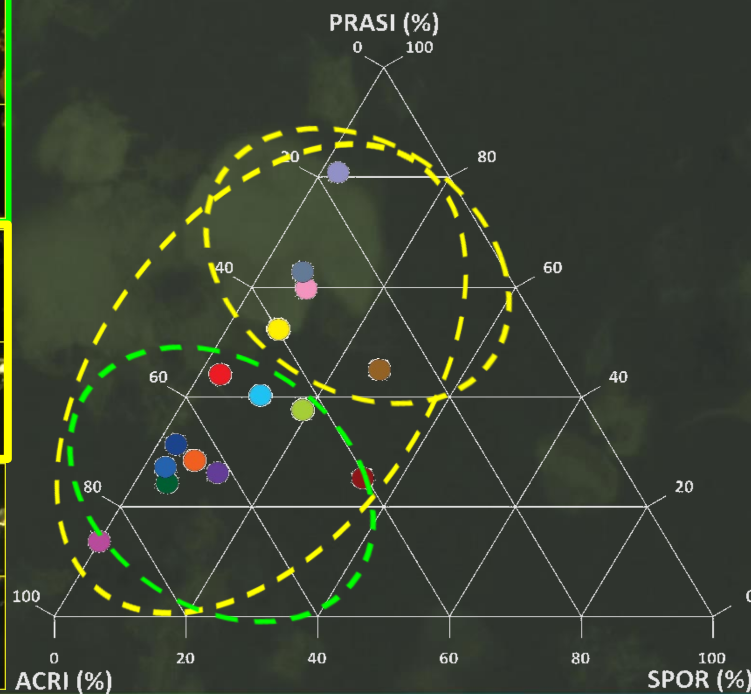
Palynofacies: Palinomorph Assemblage Acritarch-Prasinophyte-Sporomorph

- The diagram (Ac-Pr-Sp) correlates the percentage of the 3 main subgroups of components recognized in the total palynomorph population;

- We can notice a dispersion of the data in this diagram pointing out to difficulty to differentiate the 3 main subgroups from Palynomorph Group. However, we can also observe the distribution of the components from Palynomorph Group divided into 2 distinct sets. One of them based on the predominance of Acritarchs and the other one on the predominance of Prasinophytes. Even so, the most of participants recorded a predominance of Acritarchs;

Participant	Palynomorph %			
	Sp	Acri	Prasi	Botry
A	4.50	63.67	22.51	0.00
B	9.68	41.94	35.48	0.00
C	5.33	26.67	35.67	1.00
D	6.67	25.00	47.67	0.00
E	0.00	78.23	12.93	0.00
F	2.62	60.66	29.51	0.00
G	10.09	53.31	23.05	1.15
H	16.28	37.21	32.89	0.00
I	2.88	48.32	41.11	0.24
J	6.58	59.45	26.85	0.00
K	3.10	65.35	26.20	0.00
L	6.01	29.06	60.12	0.00
M	31.26	36.76	23.53	0.29
N	23.86	24.72	40.34	0.57
O	2.00	12.33	62.00	0.00
P	11.14	45.98	19.28	0.98
Average	8.88	44.16	33.50	0.26
SD	8.45	18.25	14.15	0.42





PWG3

Maceral Data (WR and KC)

Tables: values obtained through the counting of Macerals*ISO7404-3, 2009 (RWL/FM – Polished Section/WR and KC) for PWG3 Sample, based on the ICCP classification system that was used in this 3rd Exercise.

Only 4 participants counted maceral groups categories.

Maceral - RWL - Polished Section (WR)			
Participant	Vitrinite %	Inertinite %	Liptinite %
C	13.00	75.40	11.60
N	0.00	100.00	0.00
D	1.12	95.88	3.00
P	11.61	0.00	88.39
Average	6.43	67.82	25.75
SD	6.82	46.48	42.05

Maceral - RWL - Polished Section (KC)			
Participant	Vitrinite %	Inertinite %	Liptinite %
C	15.00	5.40	79.60
N	25.00	25.00	50.00
D	12.22	2.69	85.09
P	13.13	2.02	84.85
Average	16.34	8.78	74.89
SD	5.89	10.91	16.78

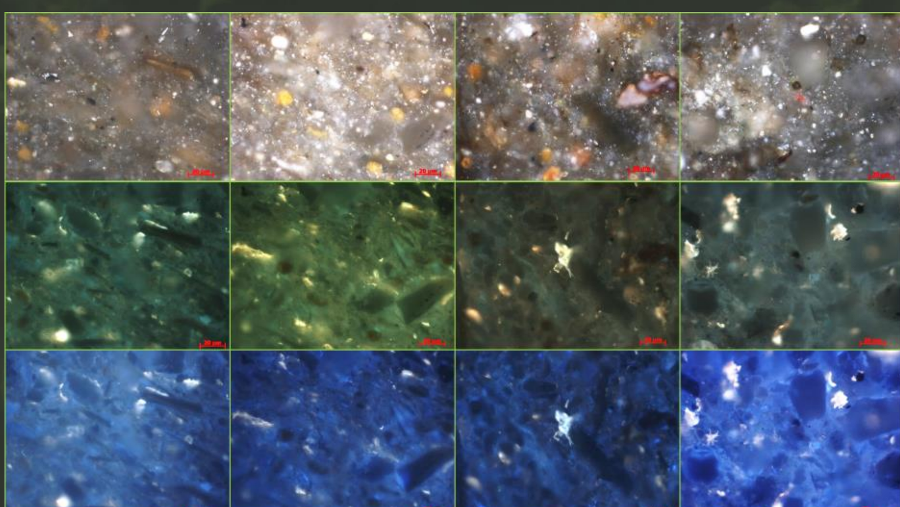
PWG3

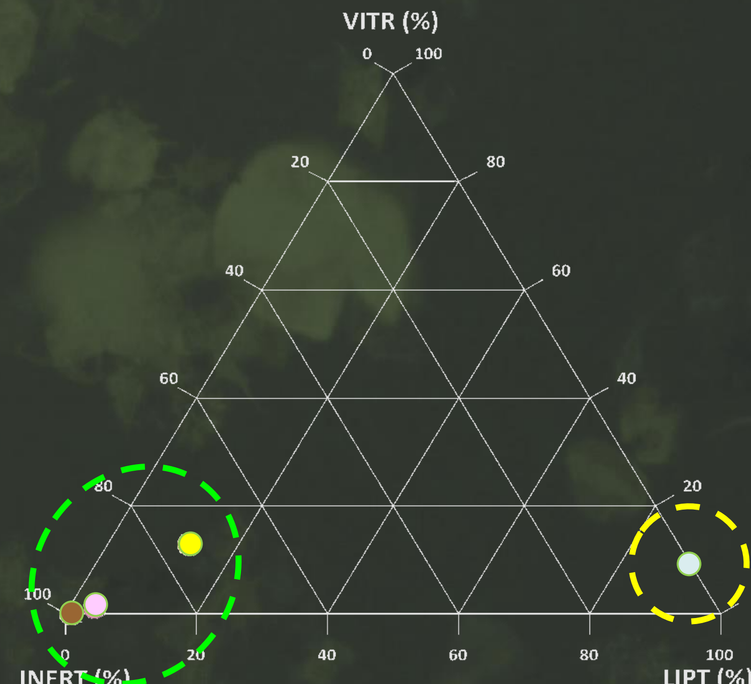
Maceral Groups (WR)
Vitrinite-Inertinite-Liptinite

- The diagram (Vit-In-Lip) correlates the percentage of the 3 groups of maceral recognized in the maceral association using RWL and FM on polished section of WR;
- Three participants recognized the predominance of Inertinite over the Vitrinite and Liptinite groups and one participant pointed out the remarkable predominance of Liptinite;

Maceral - RWL - Polished Section (WR)			
Participant	Vitrinite %	Inertinite %	Liptinite %
C	13.00	75.40	11.60
N	0.00	100.00	0.00
D	1.12	95.88	3.00
P	11.61	0.00	88.39
Average	6.43	67.82	25.75
SD	6.82	46.48	42.05

* Results were based on performance of 4 participants.
* Only organic matter (mineral matter content was excluded).





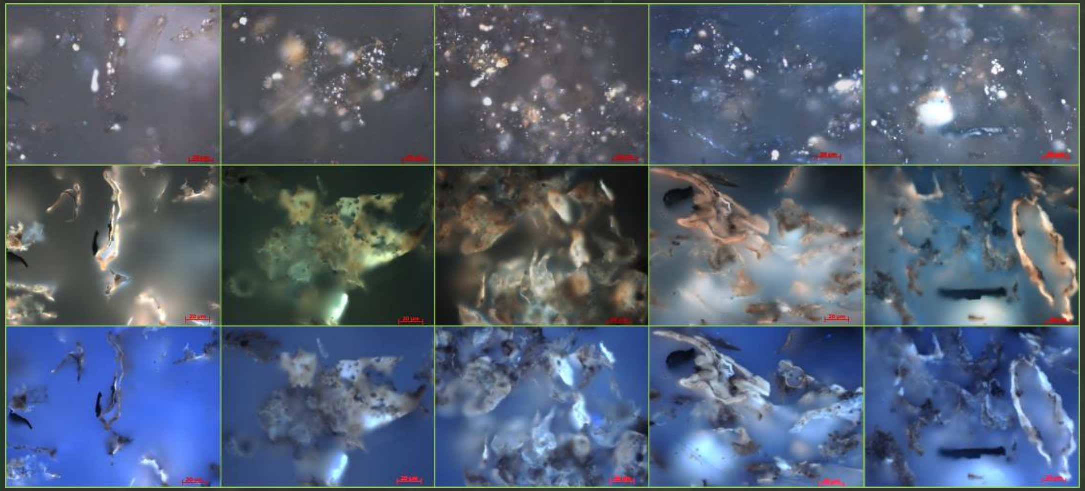
PWG3

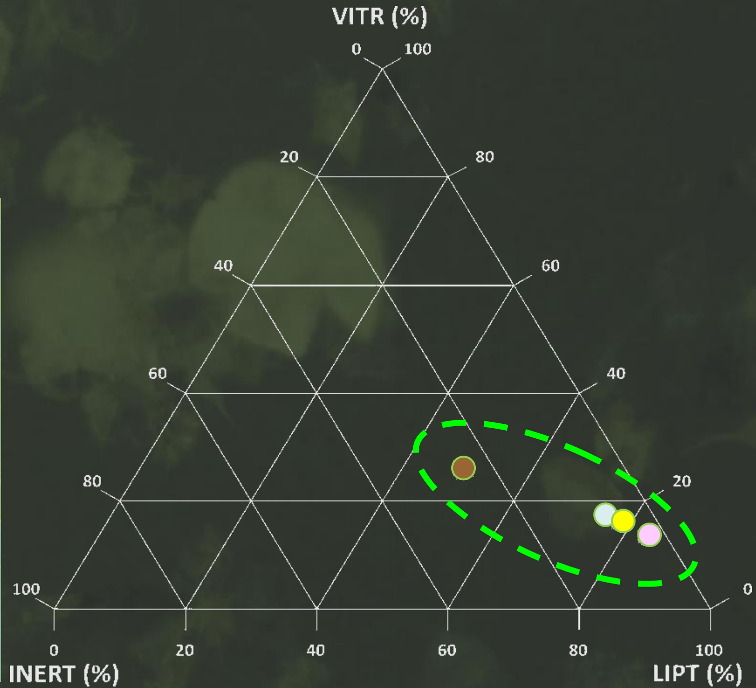
Maceral Groups (KC)
Vitrinite-Inertinite-Liptinite

- The diagram (Vit-In-Lip) correlates the percentage of the 3 groups of maceral recognized in the total organic matter assemblage using RWL and FM on polished section of KC;
- Participants agreed with the predominance of Liptinite over the Vitrinite and Inertinite groups;

Maceral - RWL - Polished Section (KC)			
Participant	Vitrinite %	Inertinite %	Liptinite %
C	15.00	5.40	79.60
N	25.00	25.00	50.00
D	12.22	2.69	85.09
P	13.13	2.02	84.85
Average	16.34	8.78	74.89
SD	5.89	10.91	16.78

* Results were based on performance of 4 participants.





PWG4

Palynofaces Data

Table: values obtained through the counting of individual organic particles for PWG4 Sample based on detailed classification system of the individual organic components from OM (Kerogen) Groups that was used in this 3rd Exercise.

TWL-Palynofacies Slides/KC- Ratios & Representation data

Participant	Phytoclast %					Palynomorph %								Amorphous %		
	Opaque Phytoclast	Non-Opaque Phytocalst			Total											
		Non-Op	Cut	Mem		Spore	P. Grain	Sp	Din	Prasin	*Botry*	*Pedia*	Total	AOM	Re	Total
A	0.00	0.00	2.33	1.00	3.33	1.66	2.33	3.99	8.97	0.00	0.00	0.00	12.96	83.72	0.00	83.72
B	0.00	1.68	0.56	2.51	4.75	2.23	0.84	3.07	10.61	0.00	1.40	0.00	15.08	80.17	0.56	80.73
C	0.00	6.95	2.32	2.98	12.25	2.65	1.99	4.64	15.56	1.32	2.98	1.66	26.16	61.59	5.30	66.89
D	1.00	0.67	1.33	1.00	4.00	0.00	0.00	0.00	11.67	0.00	0.00	0.00	11.67	84.33	0.67	85.00
E	0.00	0.31	0.00	0.00	0.31	0.31	0.93	1.23	6.48	0.00	0.00	0.00	7.72	91.98	0.00	91.98
F	0.00	1.65	0.82	3.02	5.49	1.37	2.47	3.85	11.54	0.00	0.82	0.00	16.21	78.30	0.27	78.57
G	0.00	4.10	1.26	1.58	6.94	0.95	0.95	1.89	12.62	0.32	0.00	1.58	16.40	76.66	1.26	77.92
H	0.00	2.25	1.69	0.84	4.78	0.28	1.69	1.97	10.96	0.00	0.28	0.00	13.20	82.02	0.56	82.58
I	1.08	1.08	0.27	0.54	2.96	1.34	0.00	1.34	5.65	0.00	0.54	0.27	7.80	89.25	0.27	89.52
J	0.00	0.00	1.28	1.92	3.19	0.32	0.32	0.64	20.77	0.00	0.00	0.00	21.41	75.40	0.00	75.40
K	0.00	0.59	1.47	0.59	2.64	0.00	0.59	0.59	12.32	0.00	0.00	0.00	12.90	84.46	0.00	84.46
L	0.00	0.80	1.20	0.00	2.00	0.00	4.21	4.21	19.04	0.00	0.00	4.01	27.25	70.74	0.20	70.94
M	0.92	3.22	4.15	5.76	14.05	0.00	0.00	7.10	21.20	0.00	1.20	0.00	29.50	56.45	0.00	56.45
N	0.93	1.49	5.40	12.29	20.11	0.19	1.12	1.12	16.01	0.00	0.00	0.00	17.13	62.76	0.00	62.76
O	2.00	0.33	0.67	0.00	3.00	0.00	0.00	1.67	14.33	0.00	0.00	0.00	16.00	81.00	0.00	81.00
P	1.43	1.15	0.57	2.00	5.14	1.14	0.29	1.43	3.71	0.29	0.29	0.00	5.71	87.71	0.86	88.57
Average	0.46	1.64	1.58	2.25	5.93	0.78	1.11	2.42	12.59	0.12	0.47	0.47	16.07	77.91	0.62	78.53
SD	0.66	1.81	1.42	3.07	5.20	0.87	1.17	1.89	5.11	0.34	0.81	1.09	6.98	10.29	1.30	9.91

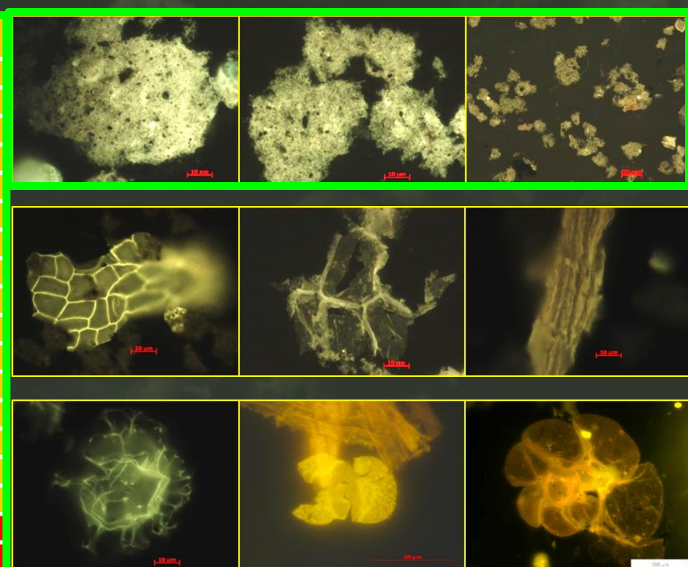
Most of participants counted organic matter only in TWL and FM.

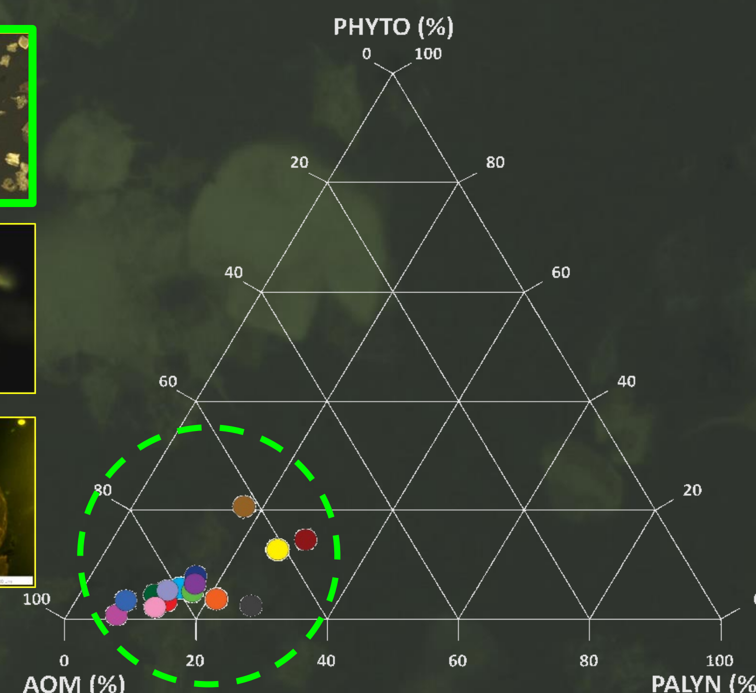
PWG4

Palynofacies: Organic Matter Assemblage
Phytoclast-AOM-Palynomorph

- The APP diagram (AOM-Phytoclast-Palynomorph ternary diagram) correlates the percentage of the 3 main groups of kerogen recognized in TWL microscopy;
- Through the results from all participants, we can observe the predominance of AOM among the kerogen groups;

Participant	Phyto	Palyn	AOM
A	3.33	12.96	83.72
B	4.75	15.08	80.17
C	12.25	26.16	61.59
D	4.00	11.67	84.33
E	0.31	7.72	91.98
F	5.49	16.21	78.30
G	6.94	16.40	76.66
H	4.78	13.20	82.02
I	2.96	7.80	89.25
J	3.19	21.41	75.40
K	2.64	12.90	84.46
L	2.00	27.25	70.74
M	14.05	29.50	56.45
N	20.11	17.13	62.76
O	3.00	16.00	81.00
P	5.14	5.71	87.71
Average	5.93	16.07	77.91
SD	5.20	6.98	10.29



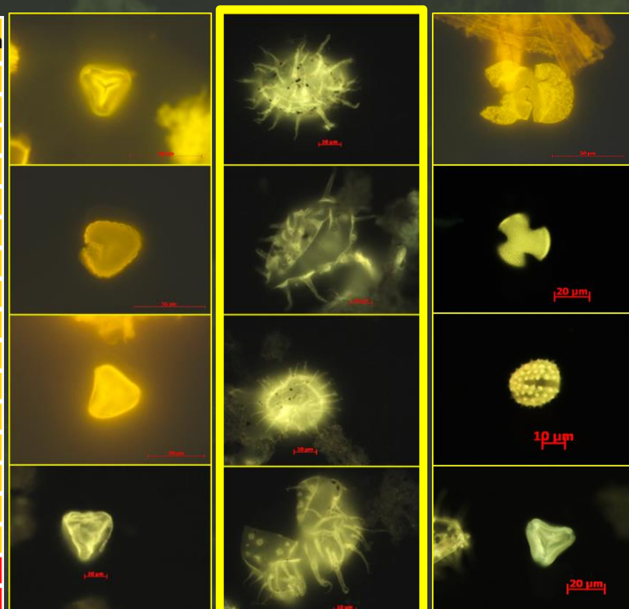


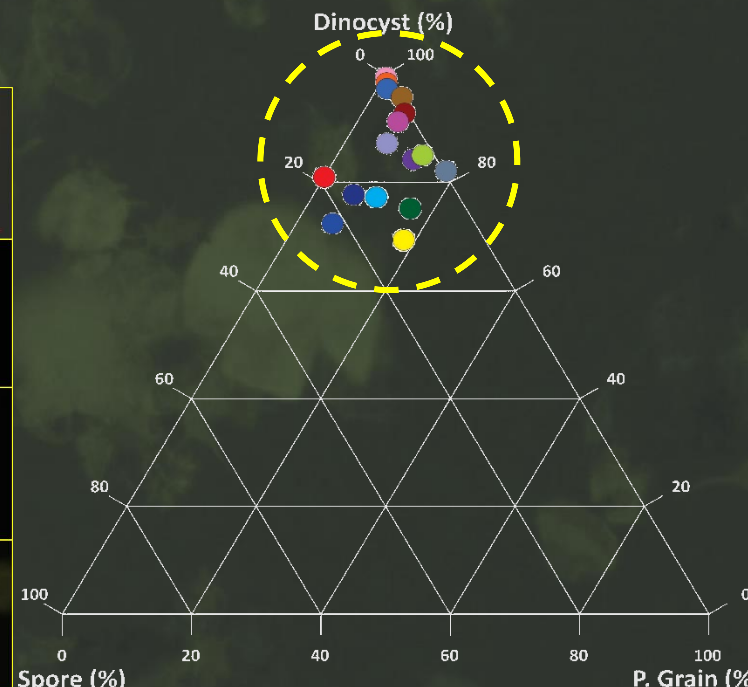
PWG4

Palynofacies: Palinomorph Assemblage
Spore-Dinocyst-Pollen Grain

- The diagram (Spo-Din-PG) correlates the percentage of the 3 main organic components recognized in the total palynomorph population;
- Through the results from all participants, we can identify the absolute predominance of dinocysts among the palynomorphs;

Participant	Dinocyst	Spore	Pollen Grain
A	8.97	1.66	2.33
B	10.61	2.23	0.84
C	15.56	2.65	1.99
D	11.67	0.00	0.00
E	6.48	0.31	0.93
F	11.54	1.37	2.47
G	12.62	0.95	0.95
H	10.96	0.28	1.69
I	5.65	1.34	0.00
J	20.77	0.32	0.32
K	12.32	0.00	0.59
L	19.04	0.00	4.21
M	21.20	0.00	0.00
N	16.01	0.19	1.12
O	14.33	0.00	0.00
P	3.71	1.14	0.29
Average	12.59	0.78	1.11
SD	5.11	0.87	1.17



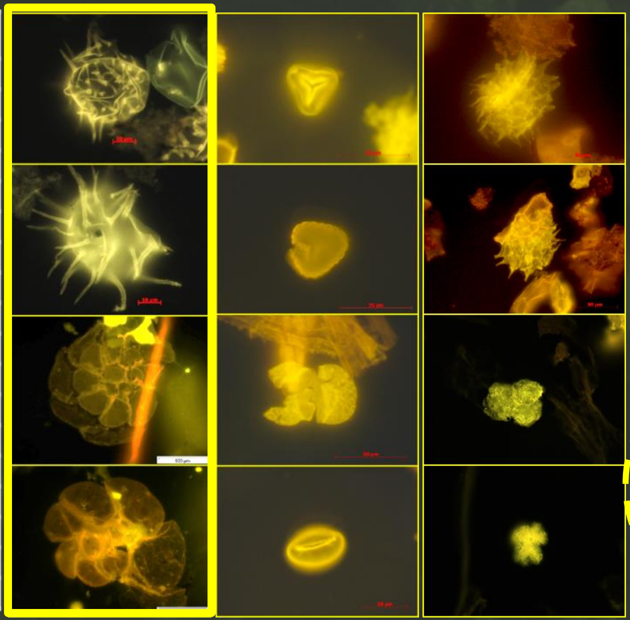


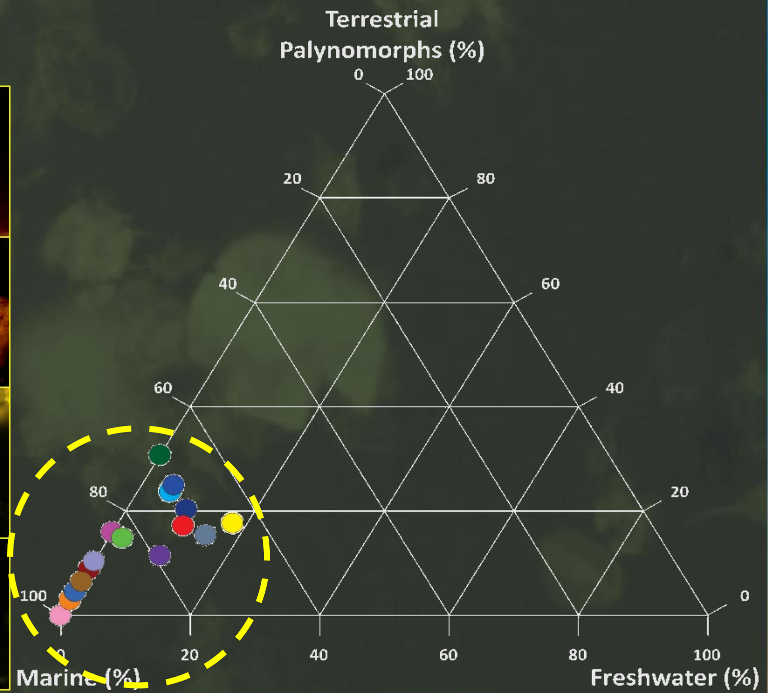
PWG4

Palynofacies: Palinomorph Assemblage Marine-Terrestrial-Freshwater

- The diagram Mr-Tr-Fw correlates the origin of organic components recognized in the total palynomorph population;
- Through the results from all participants, we can recognize the absolute predominance of marine-derived components among the palynomorphs;

Participant	Marine	Terrestrial	Freshwater
A	8.97	3.99	0.00
B	10.61	3.07	1.40
C	16.89	4.64	4.64
D	11.67	0.00	0.00
E	6.48	1.23	0.00
F	11.54	3.85	0.82
G	12.93	1.89	1.58
H	10.96	1.97	0.28
I	5.65	1.34	0.81
J	20.77	0.64	0.00
K	12.32	0.59	0.00
L	19.04	4.21	4.01
M	21.20	7.10	1.20
N	16.01	1.12	0.00
O	14.33	1.67	0.00
P	4.00	1.43	0.29
Average	12.71	2.45	0.94
SD	5.14	1.89	1.43





PWG4

Maceral Data (WR and KC)

Tables: values obtained through the counting of Macerals*ISO7404-3, 2009 (RWL – Polished Section/WR and KC) for PWG4 Sample, based on the ICCP classification system that was used in this 3rd Exercise.

Only 4 participants counted maceral groups categories.

Maceral - RWL - Polished Section (WR)			
Participant	Vitrinite %	Inertinite %	Liptinite %
C	49.60	21.00	29.40
N	0.00	0.00	100.00
D	0.00	1.75	98.25
P	12.28	0.00	87.72
Average	15.47	5.69	78.84
SD	23.48	10.24	33.40

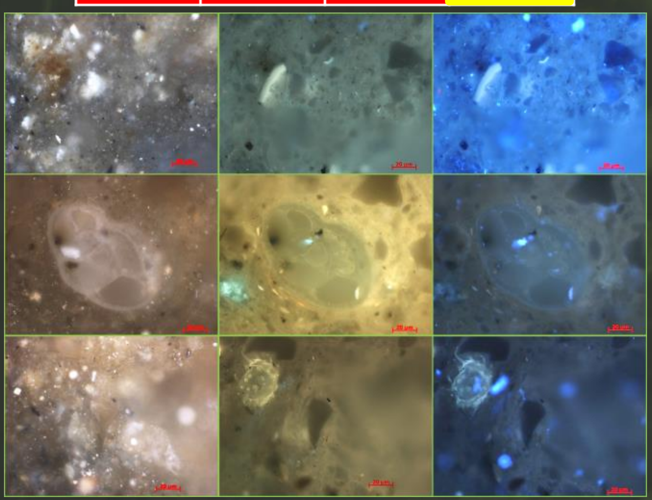
Maceral - RWL - Polished Section (KC)			
Participant	Vitrinite %	Inertinite %	Liptinite %
C	8.40	4.80	86.80
N	7.69	23.08	69.23
D	8.19	10.71	81.09
P	11.56	0.00	88.44
Average	8.96	9.65	81.39
SD	1.76	9.97	8.70

PWG4

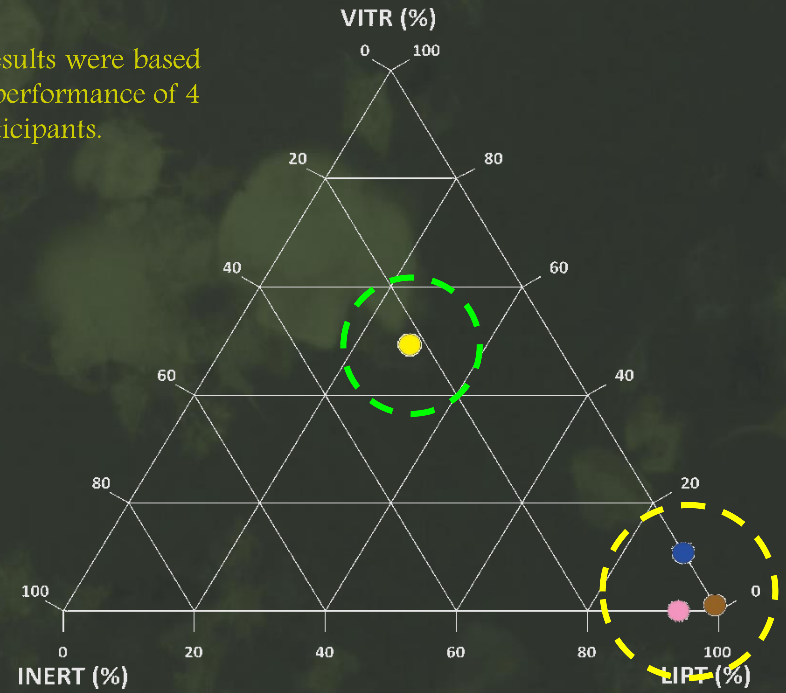
Maceral Groups (WR) Vitrinite-Inertinite-Liptinite

- The diagram (Vit-In-Lip) correlates the percentage of the 3 groups of maceral recognized in the total organic matter assemblage using RWL and FM on polished section of WR;
- Three participants recognized a remarkable predominance of Liptinite over the Vitrinite and Inertinite groups and one participant pointed out a more balanced distribution among the groups;

Maceral - RWL - Polished Section (WR)			
Participant	Vitrinite %	Inertinite %	Liptinite %
C	49.60	21.00	29.40
N	0.00	0.00	100.00
D	0.00	1.75	98.25
P	12.28	0.00	87.72
Average	15.47	5.69	78.84
SD	23.48	10.24	33.40



* Results were based on performance of 4 participants.

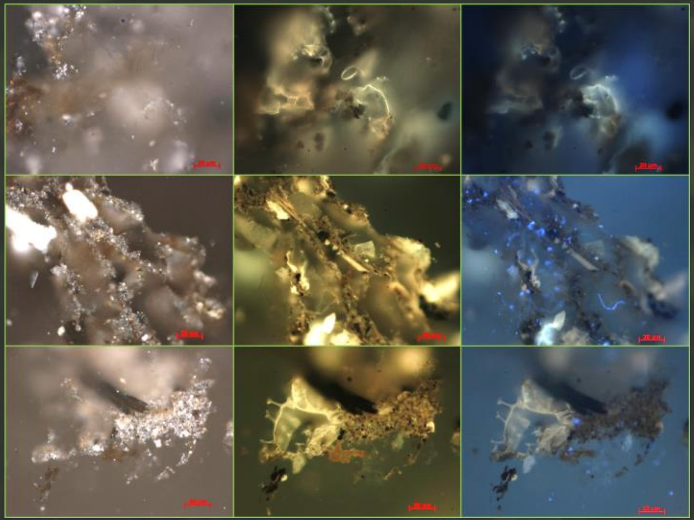


PWG4

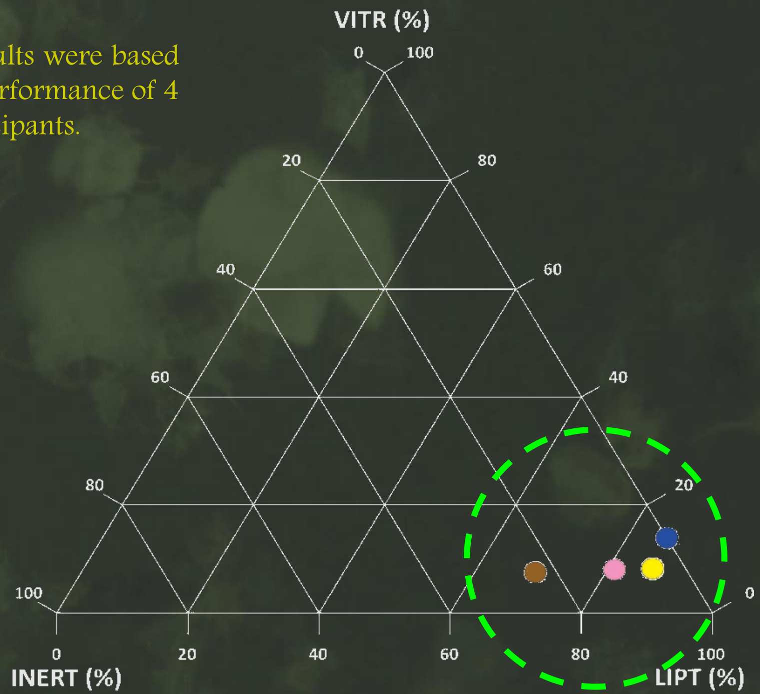
Maceral Groups (KC)
Vitrinite-Inertinite-Liptinite

- The diagram (Vit-In-Lip) correlates the percentage of the 3 groups of maceral recognized in the total organic matter assemblage using RWL and FM on polished section of KC;
- Participants agreed with the distribution of the Macerals Groups from polished section of KC, recognizing the predominance of Liptinite over the Vitrinite and Inertinite groups;

Maceral - RWL - Polished Section (KC)			
Participant	Vitrinite %	Inertinite %	Liptinite %
C	8.40	4.80	86.80
N	7.69	23.08	69.23
D	8.19	10.71	81.09
P	11.56	0.00	88.44
Average	8.96	9.65	81.39
SD	1.76	9.97	8.70



* Results were based on performance of 4 participants.



Comparisons of the results between WR and KC polished section examination

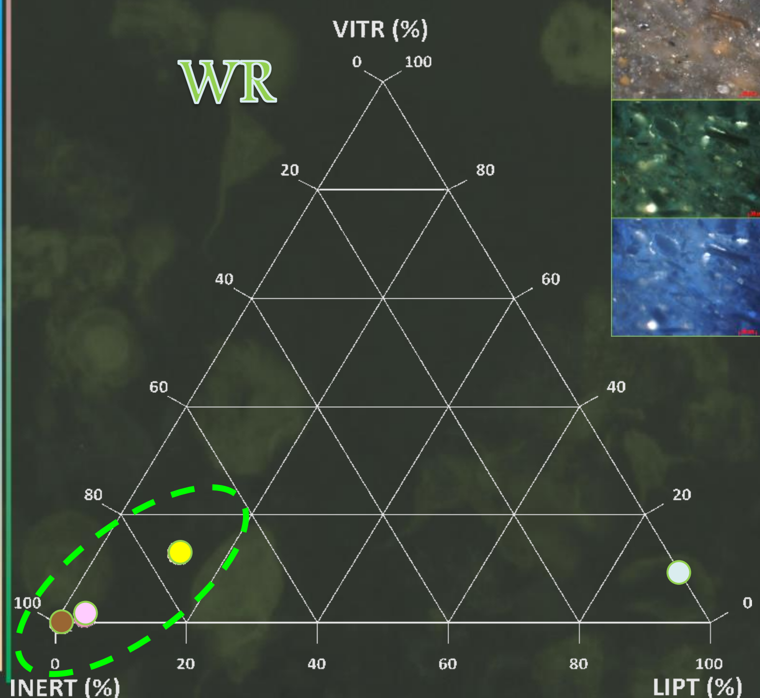
PWG3

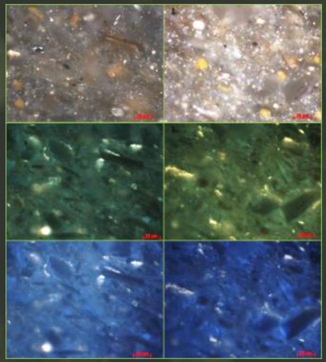
Maceral Groups (WR and KC) Vitrinite–Inertinite–Liptinite

- Comparing the results obtained using RWL on polished section in both, WR and KC, most of participants reported the higher contribution of Inertinite Group in WR. However, in KC polished section, all participants agreed on the predominance of the Liptinite Group.

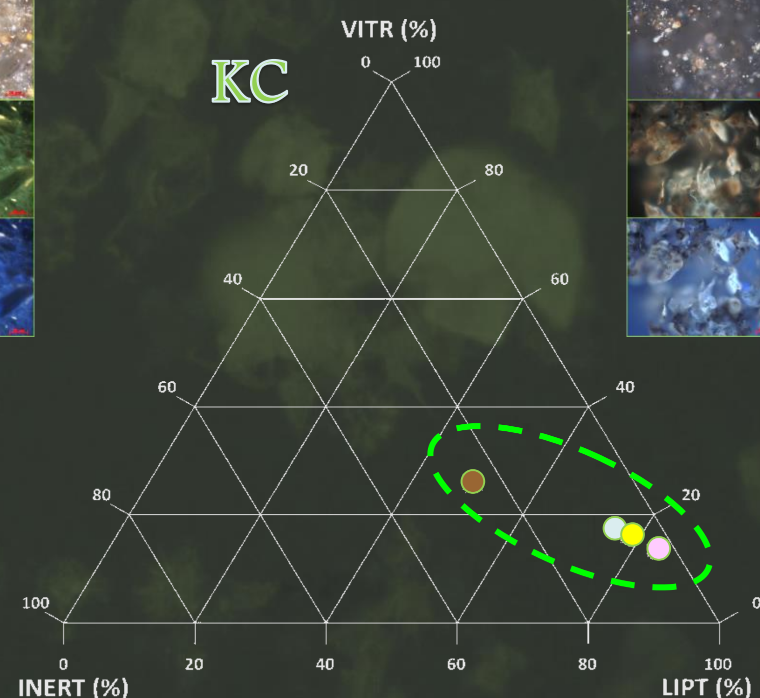
- Results were based on performance of only 4 participants.

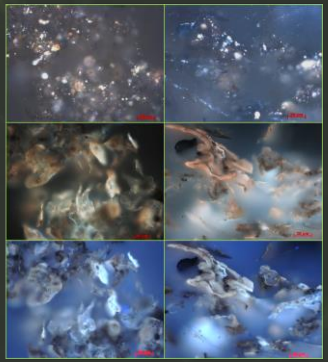
WR





KC





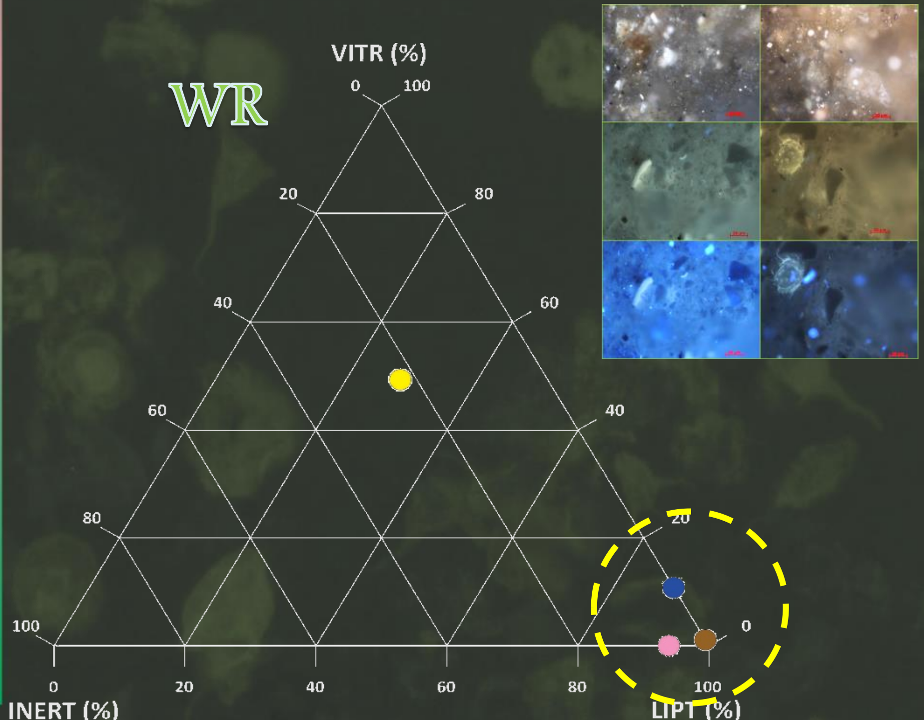
PWG4

Maceral Groups (WR and KC)
Vitrinite–Inertinite–Liptinite

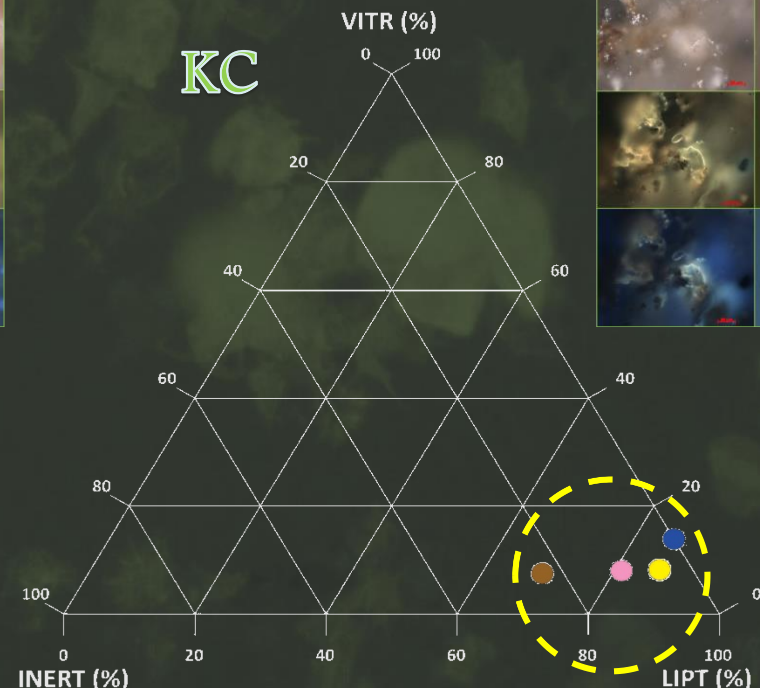
- Comparing the results obtained using RWL on WR and KC polished section, most of participants reported the higher contribution of Liptinite Group in both.

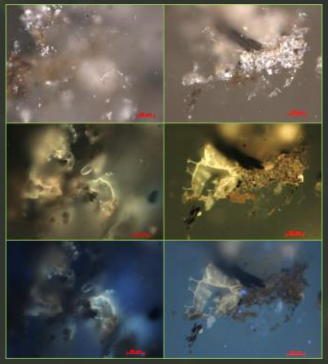
- Results are based on performance of only 4 participants.

WR



KC





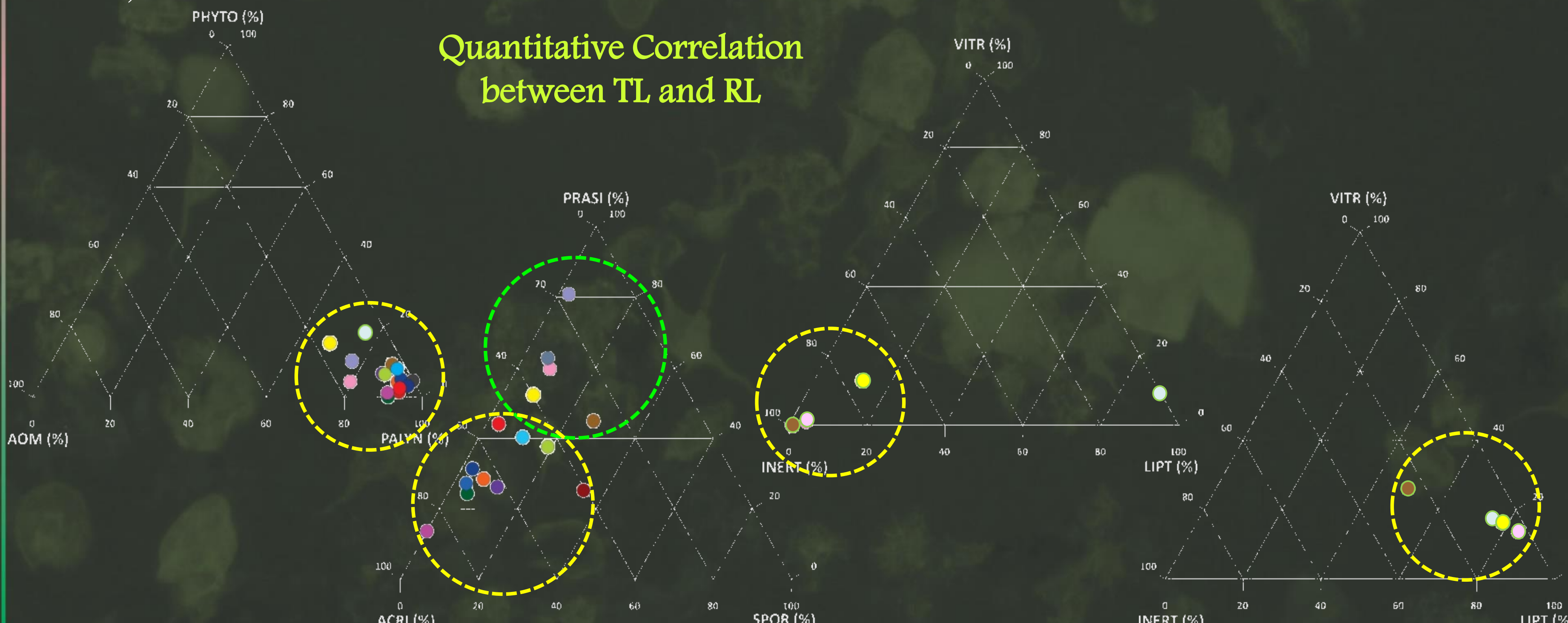
Correlation among the particles in TWL, RWL and FM

PWG3

Correlation between TL and RL

- The APP diagram showed the absolute predominance of palynomorphs among the kerogen groups;
- The Ac-Pr-Sp diagram suggested two distinct sets for the distribution of the components from Palynomorph Group. However, most of participants recorded a predominance of Acritarchs;
- The Vit-In-Lip diagram shows the predominance of Inertinite Group in WR and Liptinite Group in KC;

Quantitative Correlation between TL and RL

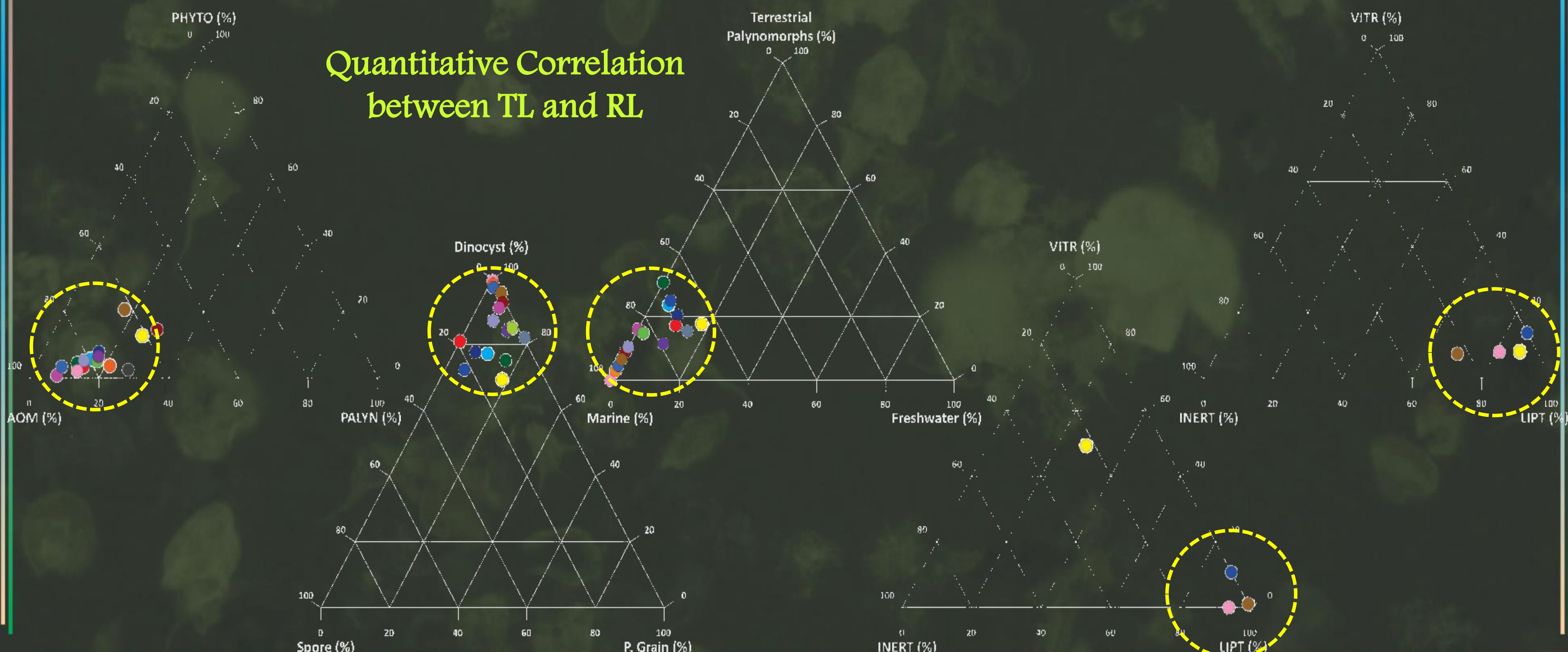


PWG4

Correlation between TL and RL

- The APP diagram showed the absolute predominance of AOM among the kerogen groups;
- The Spo-Din-PG and Mr-Tr-FW diagrams showed the predominance of Dinocysts and Marine Components, respectively;
- The Vit-In-Lip diagram showed the predominance of Liptinite Group in both, WR and KC

Quantitative Correlation between TL and RL

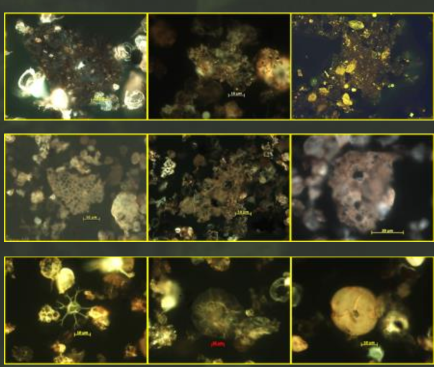


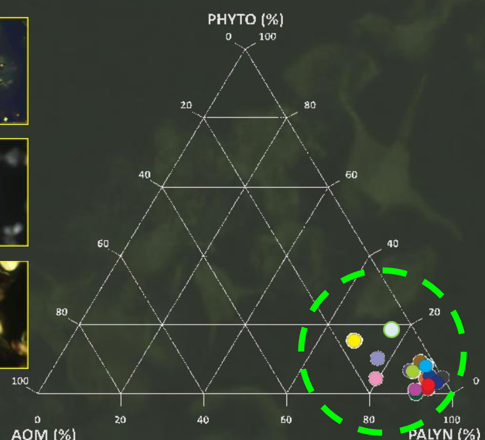
Concluding Remarks

Based on the results obtained by the participants, it was possible to conclude:

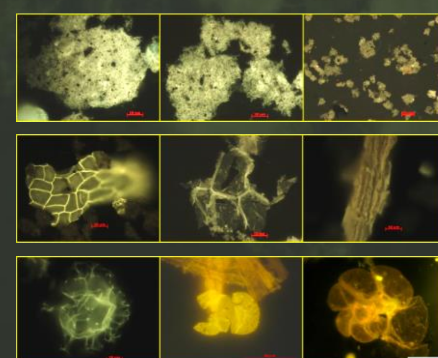
- There was an excellent agreement among participants for both samples (PWG3 and PWG4) regarding the recognition of the different Kerogen Groups (Phytoclast, Amorphous, and Palynomorph);

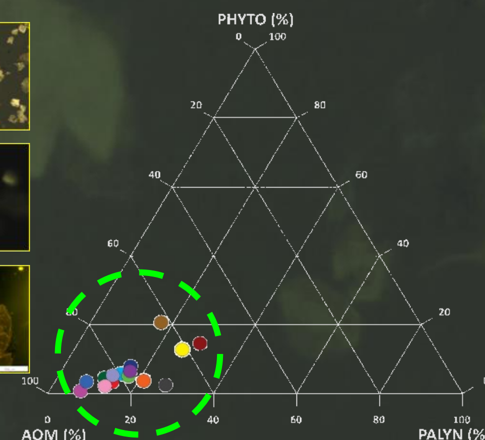
PWG3





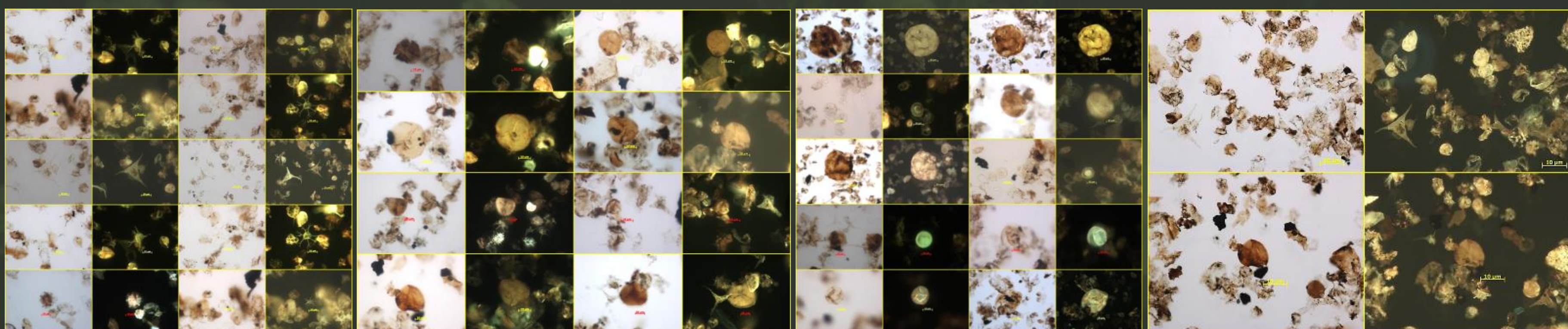
PWG4





Concluding Remarks

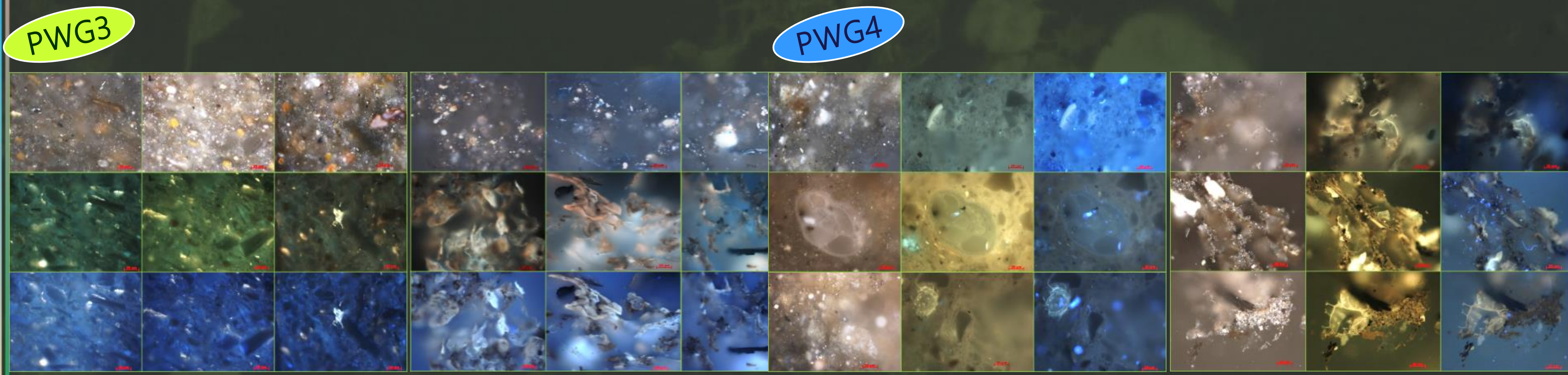
- However, the difficulty to differentiate components from Palynomorph Group in strewn slide occurred only with the PWG3 sample. This sample contains predominantly both, acritarchs and prasinophytes, besides the acessory presence of sporomorphs. As the palynofacies assemblage is very diversified and rich in specimens in this sample, the individual particulate components can be somewhat complex to distinguish one from the other;



Concluding Remarks

- Now, relating organic matter characterization in polished sections (maceral counting) both, WR and KC samples, it would be necessary to make some considerations based on the results of this exercise, as well as on the information provided by the participants:

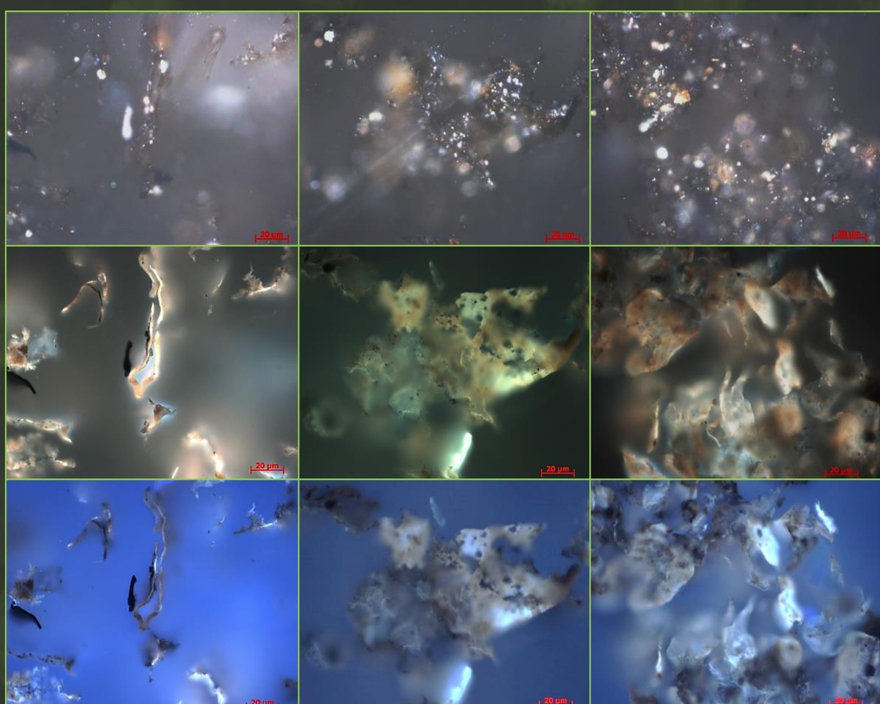
    - Both samples (PWG3 and PWG4) present a low content of organic matter (±0.5wt.% TOC), and mineral matter is the main component in these samples, making difficult the recognition of any organic particle in WR;



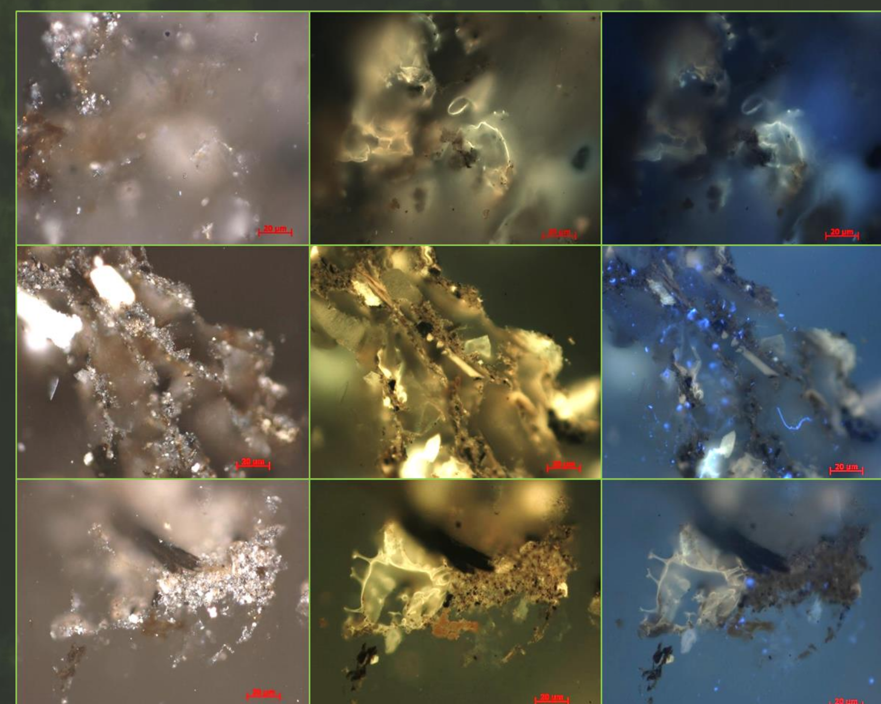
Concluding Remarks

- Even in KC samples, the effect of both, low content of organic matter and high degree of particle fragmentation, influences in the accuracy of identification of organic component and counting procedures;

PWG3

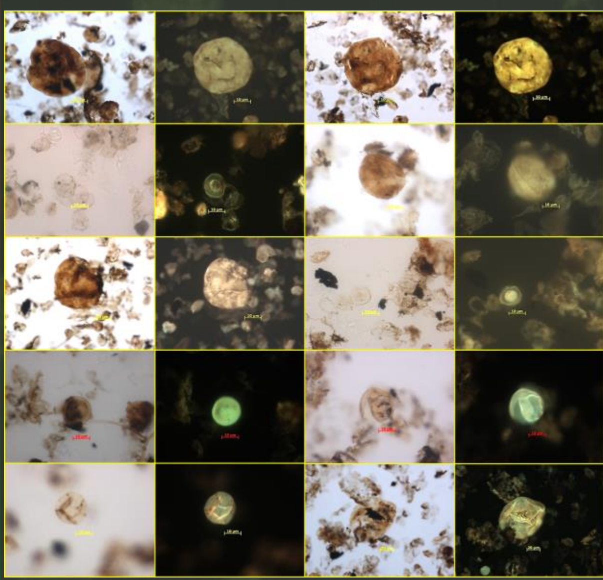


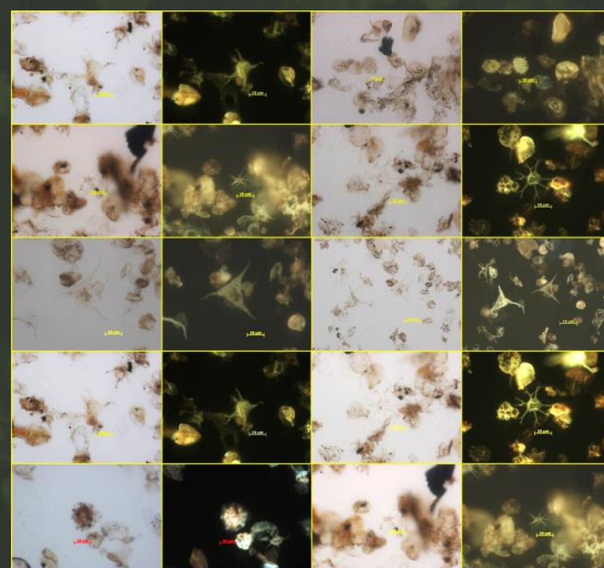
PWG4

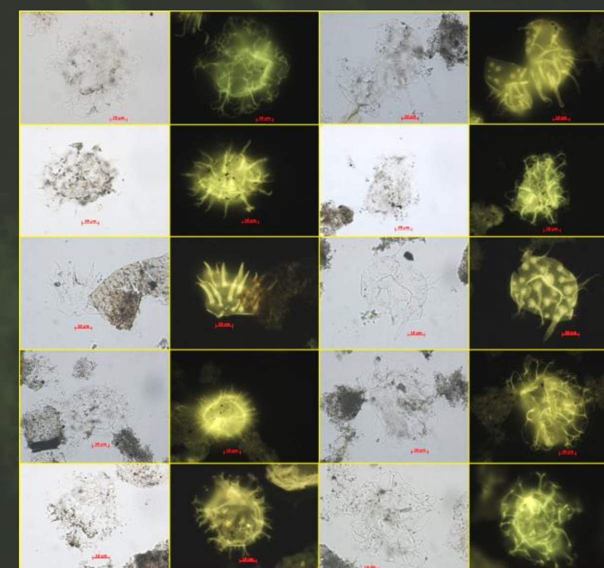


Concluding Remarks

- Most of palynomorphs recognized in strewn slides, such as some prasinophyte genera, acritarchs, and dinocysts are identified as lamalginite in polished sections;

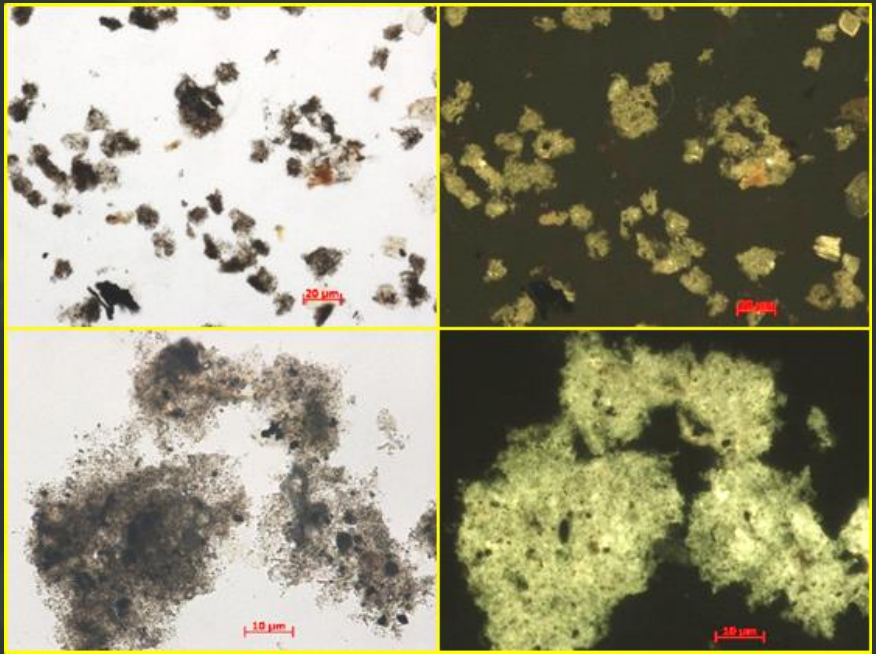


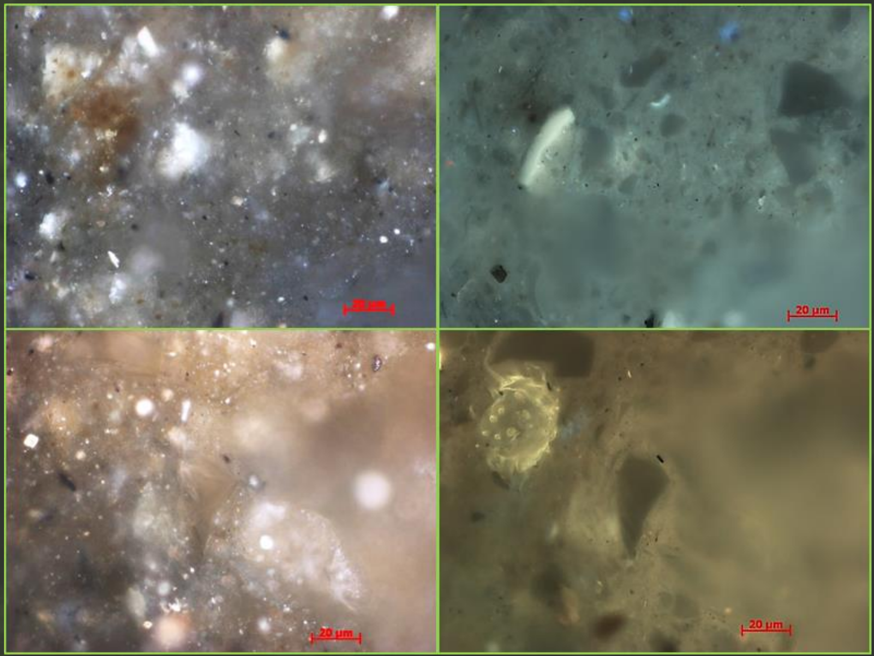




Concluding Remarks

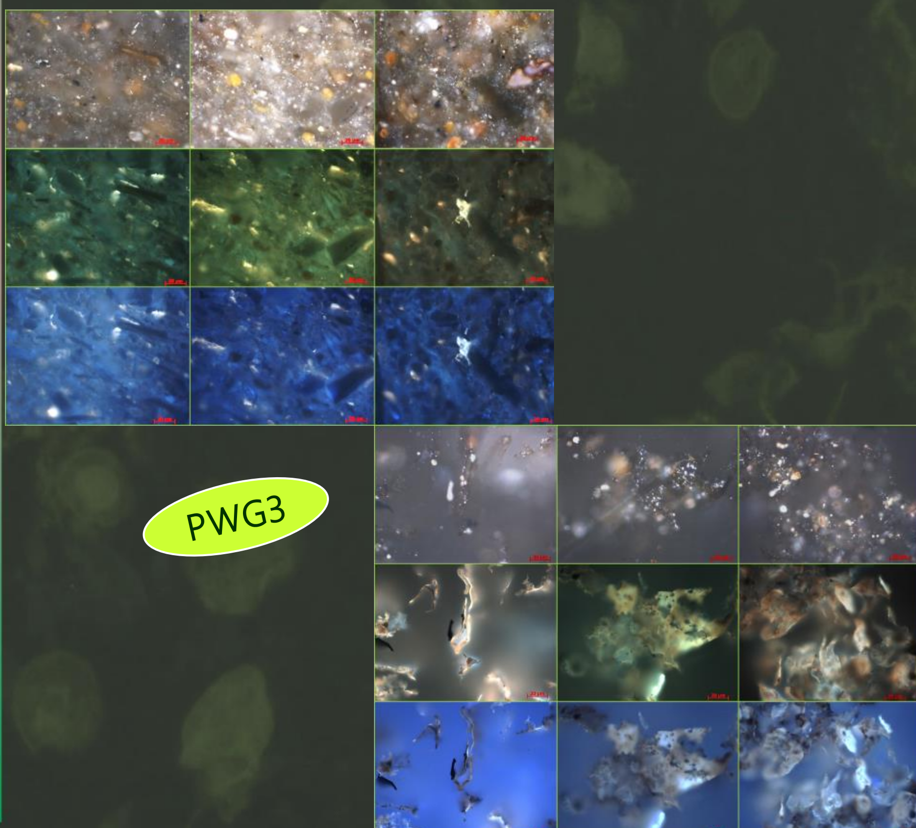
- The high relative abundance of AOM decribed in PWG4 sample when observed in strewn slides can not be properly characterized in WR polished section.

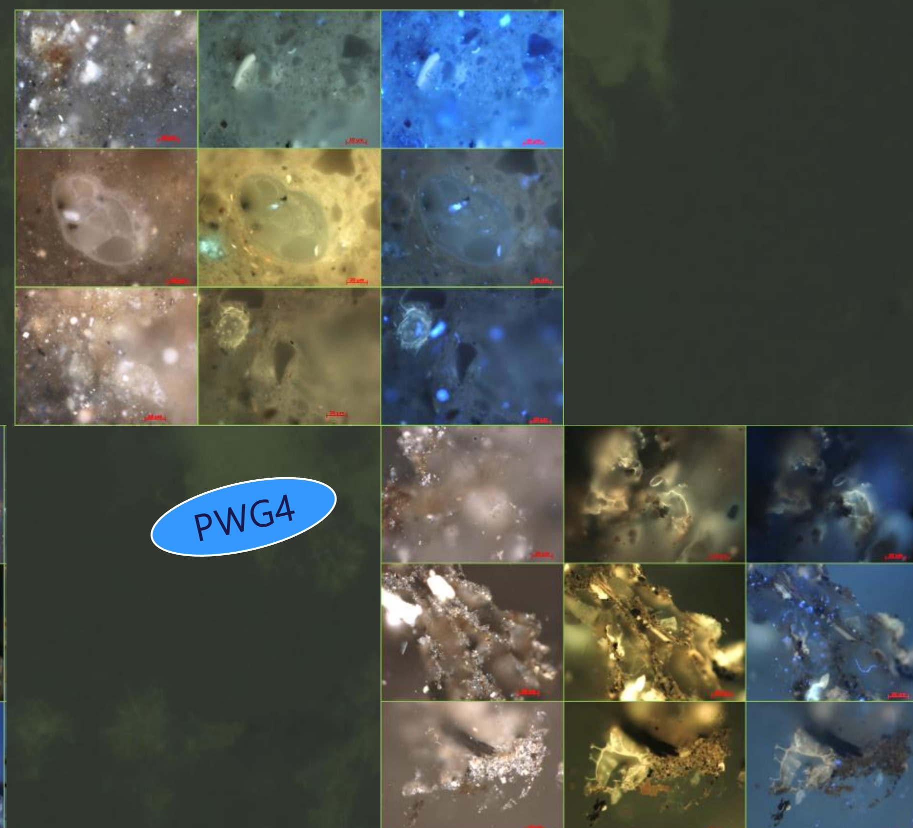




Concluding Remarks

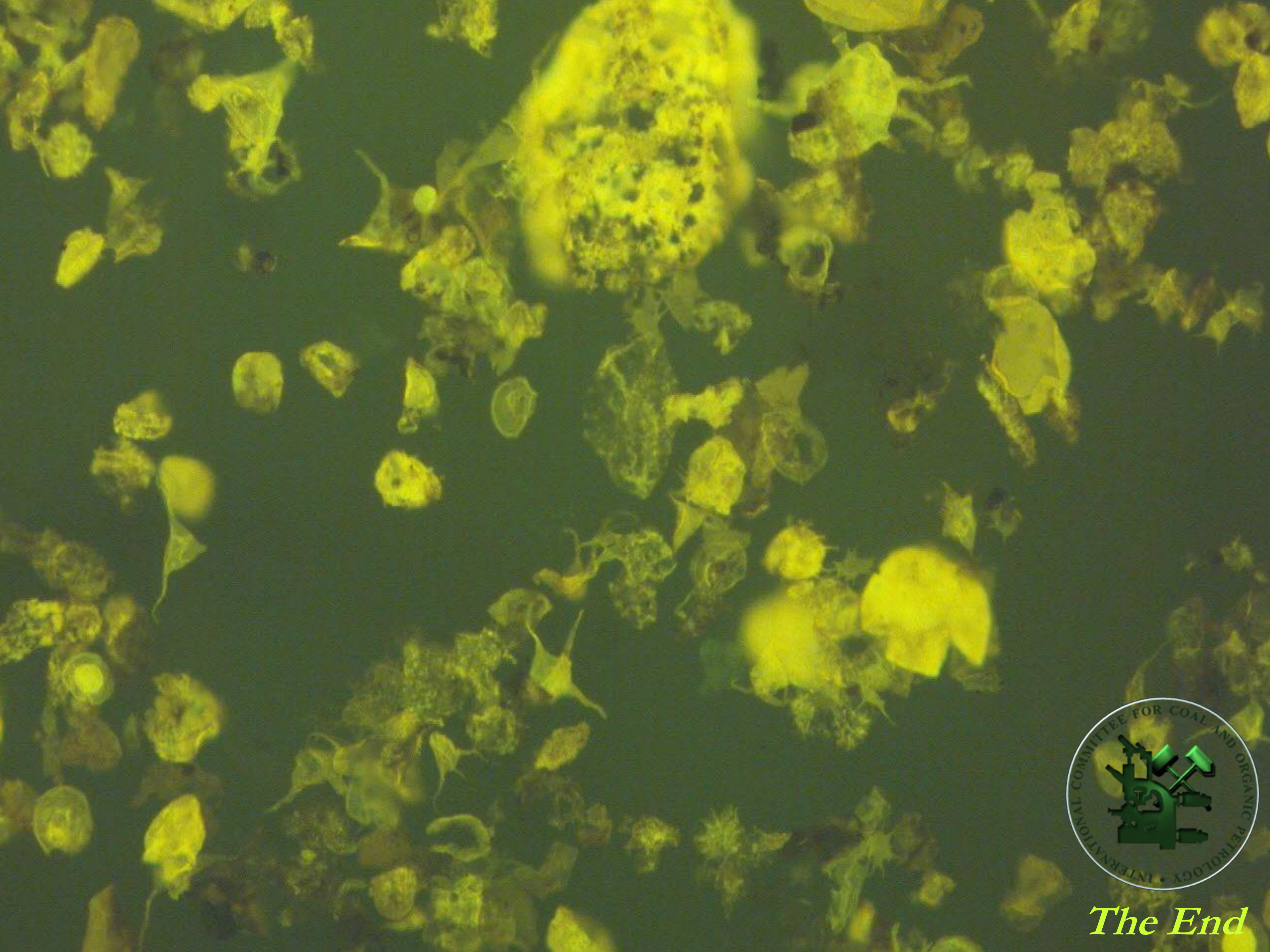
- Therefore, the maceral's characterization and counting procedures in both, WR and KC polished sections must be avoided for DOM in samples containing a low amount of organic matter.





Acknowledgements

- LAFO-UFRJ for providing the samples and organic geochemistry analysis;
- It is gratefully acknowledged the effort of Thiago Barbosa (LAFO-UFRJ) for sample preparation;
- A special thanks to Joalice O. Mendonça (LAFO-UFRJ) for all her efforts to complete this WG;
- To all the Participants;


INTERNATIONAL COMMITTEE FOR COAL AND ORGANIC PETROLOGY
The End