Palynofacies Working Group

2013 Exercise: Phytoclast Group

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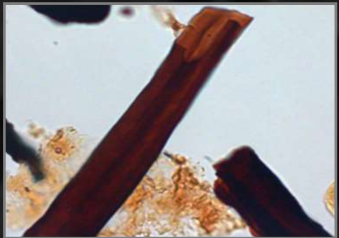
Exercise 1 (2012): Phytoclast Group

The main objective of this 1st Exercise was the characterization of the origin of the phytoclast* particles and the all aspects of the phytoclast assemblage, such as:

- **Identification of the individual particulate components;**
  - Translucent (brown) or opaque (black);
  - Biostructured or structured or "pseudoamorphous" / amorphous;



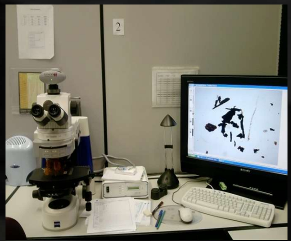


- **Assessment of their absolute and relative proportions;**
- **Particle sizes;**
- **Preservation states;**

* The phytoclast term was introduced by Bostick (1971) to describe all particles with size clay or fine-sand derived from higher plants or fungi and fluorescence depending on the origin of the tissues.

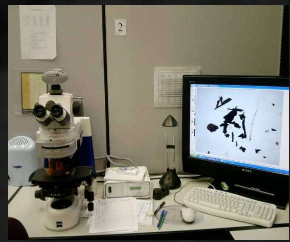
⌖ **See feasibility of an integration and correlation of the palynofacies information obtained in this WG with the classification of organic components from ICCP (maceral composition);**

TWL and FM



KC
Strewn
Slide

RWL and FM



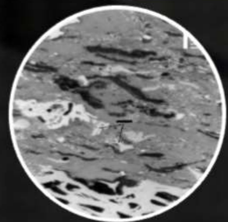
KC
Polish
Section

Opaque Phytoclasts
(TWL)

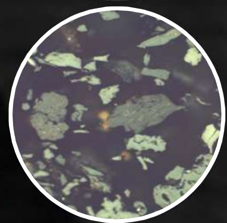
Non-opaque Phytoclasts
(TWL)

Opaque and non-opaque Phytoclasts
(TWL)

Inertinite (Fusinite)
(RWL)



Vitrinite
(RWL)



Inertinite and Vitrinite
(RWL)

Detailed classification system of the individual organic components from Phytoclast Group that was used in this 1st Exercise

GROUPS & SUBGROUPS					DESCRIPTION
PHYTOCLAST	Fragments of Tissues Derived from Higher Plants or Fungi	Opaque	**Equidimensional (Equant)** lenght: width ratio < 2		Black or opaque in colour even at grain boundary. Sharp outline; mostly no internal structure.
			Lath lenght: width ratio > 2		Black or opaque in colour even at grain boundary. Sharp outline; it may shows pits.
			Corroded		Black in colour. More diffuse outline; irregular.
		Non-Opaque (Translucent)		**Fungal Hyphae**	Fragments of hyphae. Brown in colour. Individual filaments of the mycelium of the vegetative phase of eumycote (higher) fungi.
			Undegraded Sharp outline (may be slightly irregular). May be splintered. or ***Degraded*** Irregular and diffuse outline or ***Pseudoamorphous/ "Amorphous"*** Diffuse outline, it may light brown, brown and dark brown in colour. Starting to show some features of AOM, but homogenous in apperance, not pyrite specked, no inclusions. It may exhibits fluorescence. or ***In decomposition (gelified) "Highly preserved"*** Irregular outline in transmitted white light, it exhibits coloration of fluorescence. The characteristics indicate a highly degree of chemistry preservation due to specific conditions.	**Non-biostructured**	No botanical structure. Translucent, generally brown in colour. Lath or equant in shape.
				Cuticle	Epidermal tissue of higher plants. Pale yellow-green, yellow, reddish-yellow in colour particle. Regular cell outlines; sheet-like, in some cases with visible stomata. It may occurs thick translucent phytoclasts that under fluorescence, present a yellow fluorescing cuticle overlaying ("coating") on these phytoclasts. This particular feature (cuticular layer fragments associated with innermost part of epiderms) could be indicating that the land plants fragments derived from leaves.
				Membrane	Pale yellow in colour; thin; sheet-like; irregular. They often fluorescent; highly translucent. Lack of diagnostic internal structure.
				Biostructured	Generally brown in colour; lath to equant in shape; clearly visible internal structure. Striate: shown thin (regular fibrous lineation). Striped: Irregular or unequal stripes (may be thicknings). Banded: Regular and equal parallel sided thickenings. Pitted: Bordered or scalariform pits.
		Sclereids			Generally opaque, but may be translucent (dark brown). Sclerenchymatic tissue cells, with thickened secondary wall and impregnated with lignin. Found in different parts of the plant (root, stem and leaf) with the sustentation function and mechanical resistance.

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

Participants...

These were the participants from the PWG 2013 Exercise

Participant	Affiliation	Country
Borrego, Angeles G.	INCAR-CSIC	Spain
Flores, Deolinda	University of Porto	Portugal
Gonçalves, Paula	University of Porto	Portugal
Hackley, Paul	U.S. Geological Survey	USA
Hámor-Vidó, Maria	Geological and Geophysical Institute of Hungary	Hungary
Holstein, Björn	RWE Dea / Wietze Laboratory	Germany
Kern, Marcio L.	Federal University of Rio de Janeiro	Brazil
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 Center	Brazil
Oskay, Riza Görkem	University of Patras	Greece
Rodrigues, Bruno	University of Algarve	Portugal
Shaaban, Aly	Alex Palynological Consultant	Egypt
Suarez-Ruiz, Isabel	INCAR-CSIC	Spain
Van De Wetering, Nikola	University of Queensland	Australia
Zivotič, Dragana	University of Belgrade	Serbia

Sample

One sample from continental system encompassing the subgroups from Phytoclast Group was used in this 1st Exercise (PWG1):

PWG 1: Rio Bonito Formation, Paraná Basin, Brazil (Permian Age)

- **Coaly Shale;**
- **Kerogen Type III;**
- **Total Organic Carbon (TOC), about 40wt.%;**
- **Sulfur Content: 8.7%;**
- **The vitrinite reflectance is between 0.45;**

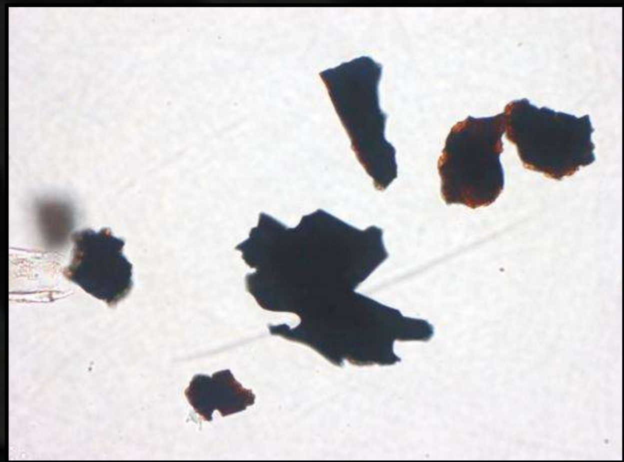
Obs. *Taking in account the amount of sample available and the number of participants, it was possible to prepare a KC strewn slides (TL) , a KC and WR polished sections (RL) to perform this exercise.*

Sample PWG1

In this sample it was possible to find:

Opaque Phytoclasts (OP): Black or opaque in color even at grain boundary;

- **Equant (Eq):** sharp outline; mostly no internal structure;
- **Lath Shape (LS):** sharp outline; it may shows pits;
- **Corroded (C):** more diffuse outline; irregular;



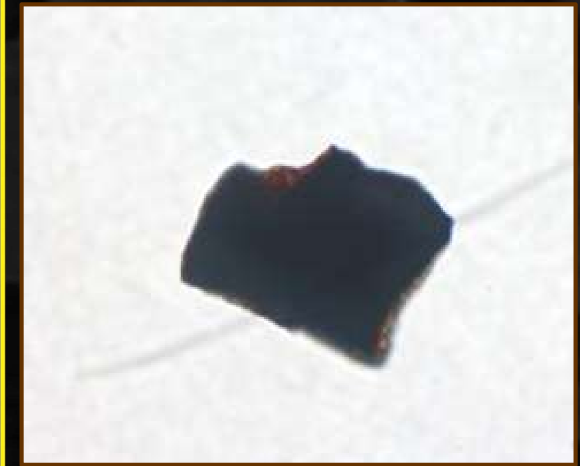
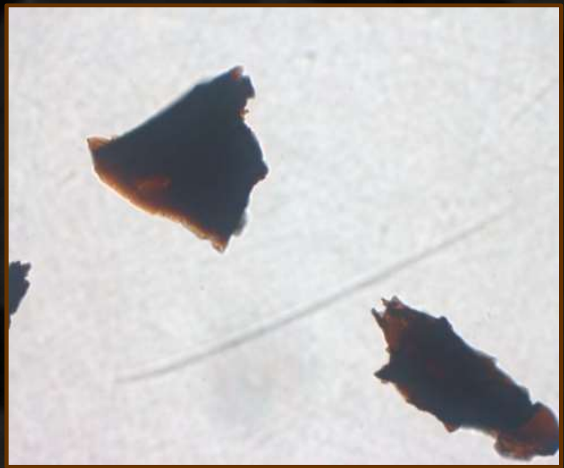
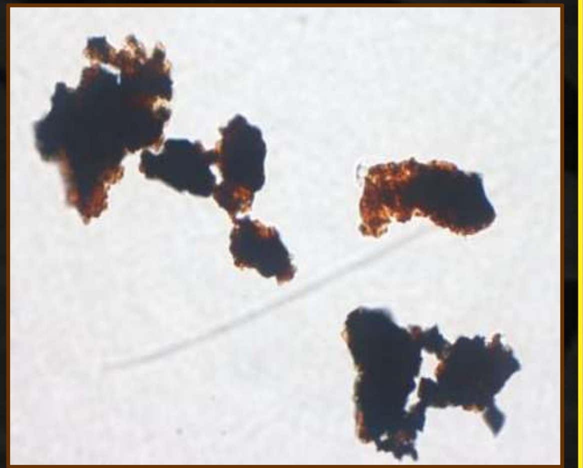
Sample PWG1

Non-Opaque Phytoclasts (NOP): Traslucent (pale yellow, orange, and brown in color), sometimes they can be black in color in mostly of particle due to the thickening of particle, but the color at grain boundary is brown;

Non-Biostructured (NONB): No botanical structure; generally brown in color, lath or equant (equidimensional) in shape;

Undegraded (NONB): sharp outline (may be slightly irregular), may be splintered;

Degraded (NONB-D): irregular and diffuse outline;

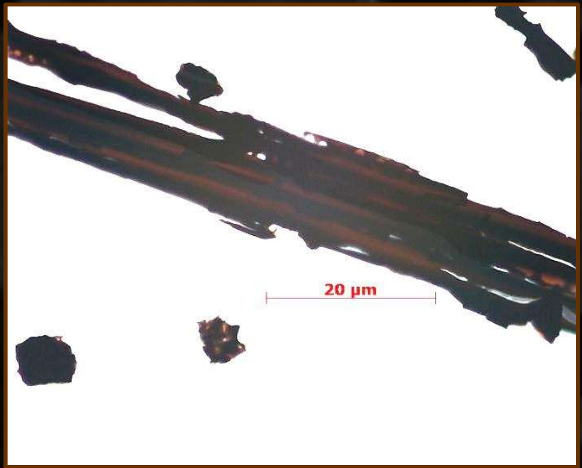




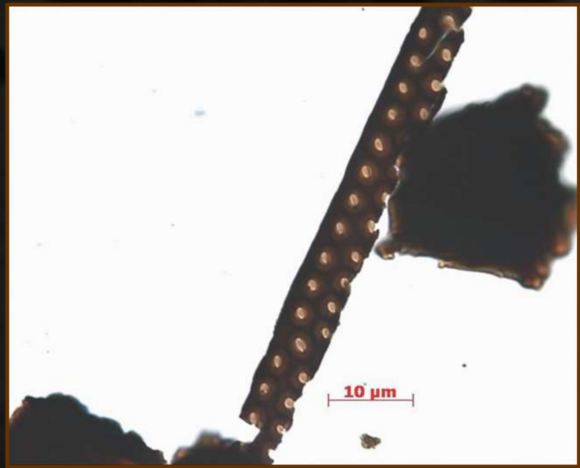
Sample PWG1

Non-Opaque Phytoclasts (NOP):

Biostructured (NOB): Generally brown in color; lath to equant in shape; clearly visible internal structure;

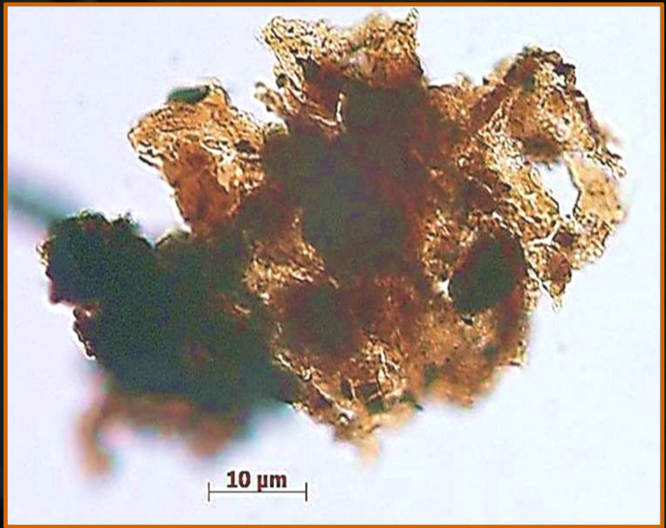
- **Striped (St):** irregular or unequal stripes (may be thickenings);
- **Banded (Bd):** regular and equal parallel sided thickenings;
- **Pitted (Pt):** bordered or scalariform pits;





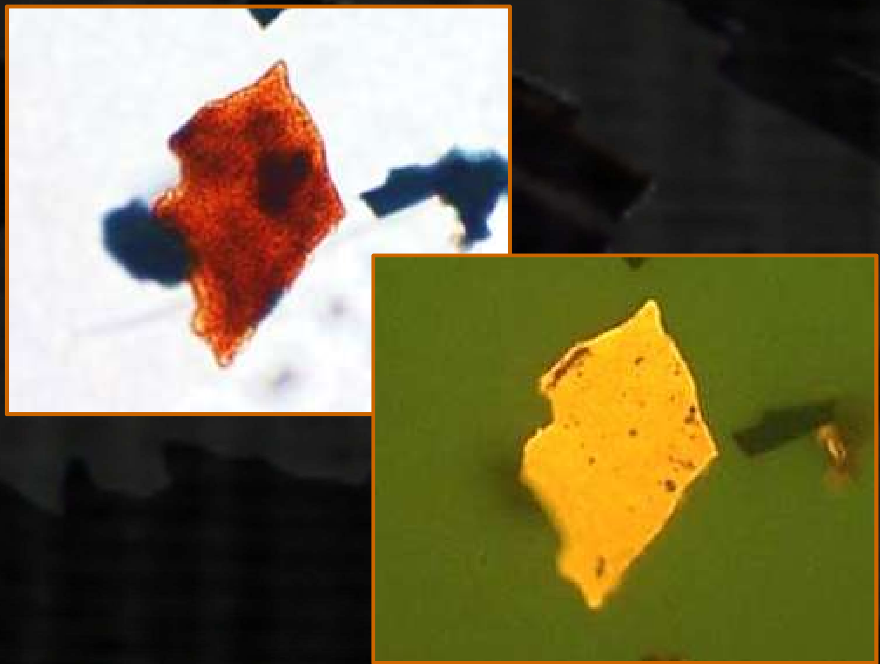
Sample PWG1

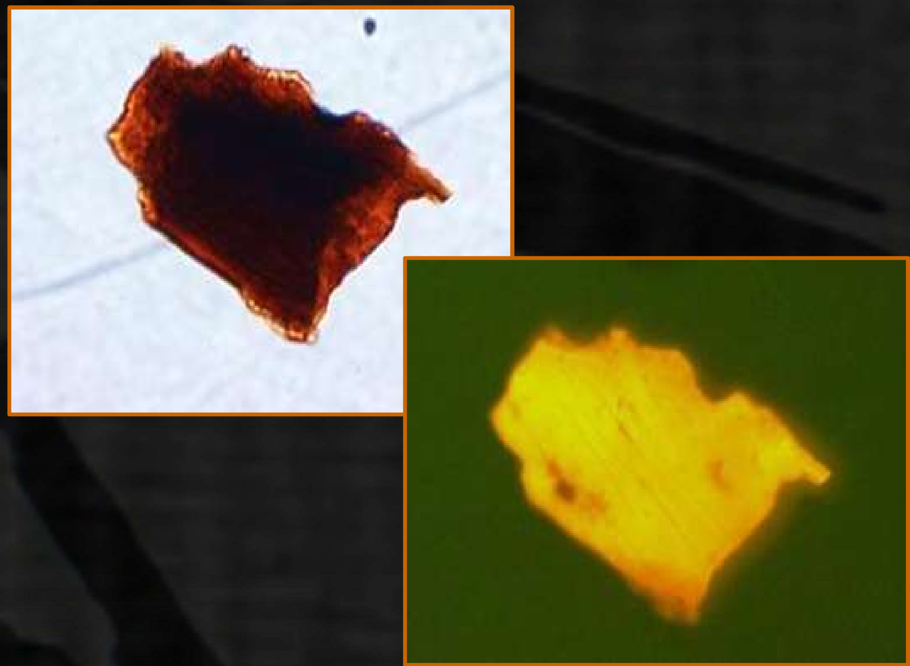
Cuticles (Cu): There is low amount of cuticles, but with low stage of preservation (degraded);



Sample PWG1

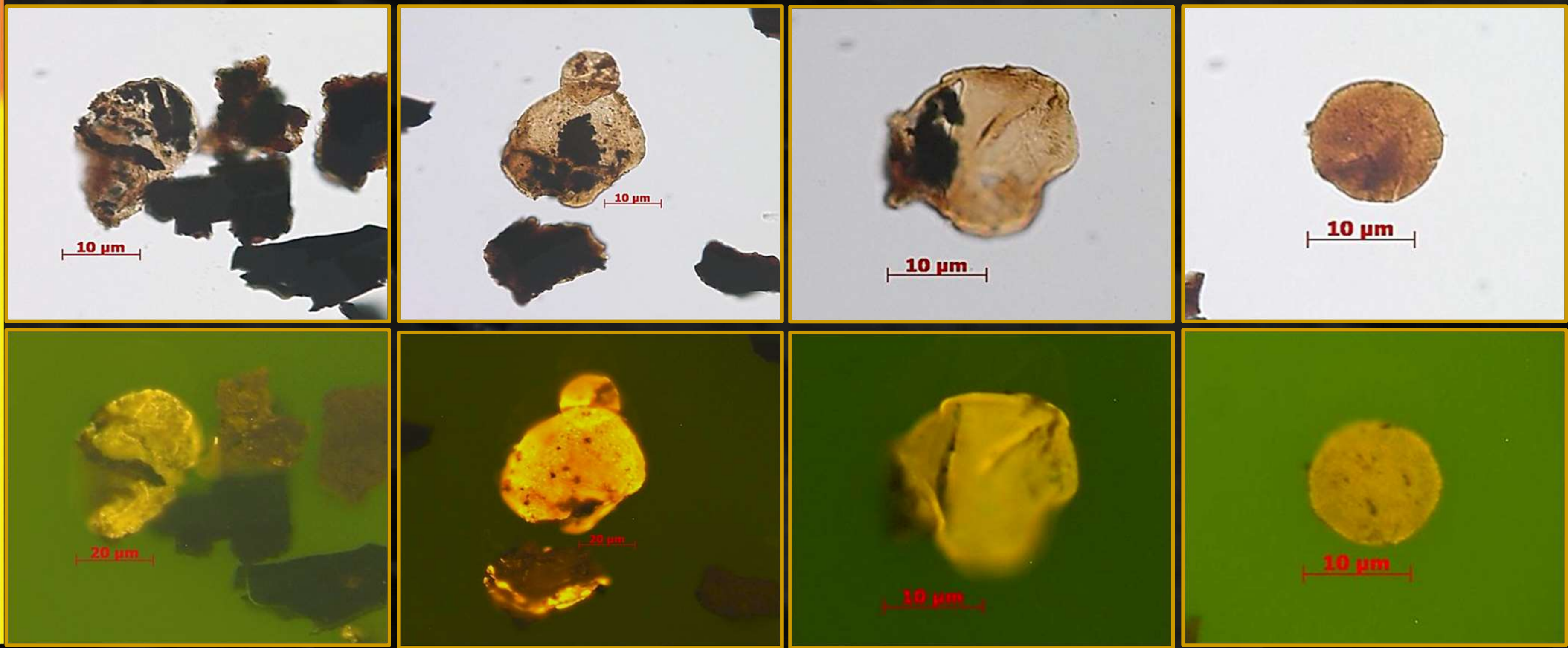
Resin (Re): Resins are natural products of higher plants which occur either as internal cell- or void-filling secretions, or as extracellular exudations on the plant (stem or leaf) surface. They are structureless particle (glassy shards), hyaline, homogeneous and strongly fluorescent, and they are classified within the Amorphous Group because they are inherently structureless. They can appear with low fluorescence owing to oxidative processes.





Sample PWG1

Sporomorphs: There is some amount of sporomorphs (spores and pollen grains) easily identifiable, but with low stage of preservation.



Phytoclasts	Opaque	Lath			
Phytoclasts	Opaque	Equant			
Phytoclasts	Opaque	Corroded			
Phytoclasts	Non-Opaque	Bioestructured	Striped	Degraded	
Phytoclasts	Non-Opaque	Bioestructured	Striped	Undegraded	
Phytoclasts	Non-Opaque	Bioestructured	Banded	Degraded	
Phytoclasts	Non-Opaque	Bioestructured	Banded	Undegraded	
Phytoclasts	Non-Opaque	Bioestructured	Pitted	Degraded	
Phytoclasts	Non-Opaque	Bioestructured	Pitted	Undegraded	
Phytoclasts	Non-Opaque	Non-Biostructured	Degraded		
Phytoclasts	Non-Opaque	Non-Biostructured	Undegraded		
Phytoclasts	Cuticle		Degraded		
Phytoclasts	Cuticle		Undegraded		
Phytoclasts	Resin				
Phytoclasts	Sporomorphs		Degraded		
Phytoclasts	Sporomorphs		Undegraded		

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

Counting Sheet
(TWL)

Counting sheet of organic matter (individual organic particle) for PWG1 Sample based on detailed classification system of the individual organic components from Phytoclast Group that was used in this 1st Exercise.

Maceral Group	Maceral Subgroup/Maceral	Number of Points	Total%
Vitrinite	Telovitrinite		
	Gelovitrinite		
	Detrovitrinite		
Liptinite	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 sample that was analyzed.

Counting Sheet
(RWL)

Counting sheet of Macerals * (RWL - Polished Section/WR and KC) for PWG1 Sample, based on the ICCP classification system, which was used in this 1st Exercise.

* ISO7404-3, 2009

Results

Data Representation

- **After obtaining of the absolute data through the counting methods of organic constituents, these absolute values were transformed to percentage values and they were put in form of graphs** (percentage data are used because they are easy to determine);

- **Palynofacies studies deal 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 are based on:**

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

    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 sum 100% in order to evaluate real correlations that may exist within the data;**

Data Representation

- **For data representation in this first exercise, we use subset percentages, rather than total particle percentages. In this case, it was better to express different phytoclasts as a percentage of the total phytoclasts, rather than as a percentage of the total particles** (e.g. opaque phytoclast percentage in relation to total phytoclasts rather than opaque phytoclast percentage in relation to the total kerogen; sporomorphs as a percentage of the total palynomorphs, rather than as a percentage of the total particles, etc)**;**

- **Such independent subset percentages can be cross-plotted against each other and the number of counts in each subset must be significant;**

- **For within-sample comparisons, percentages of one component are always correlated using the same sum** (i.e. that corresponds to 100%)**;**

- **The percentage data for each subset can then be compared with values from the other subset(s) in order to evaluate real correlations that may exist within the data;**

Data Representation

- **An effective way of graphically plotting percentage data is to use Ternary** (triangular) **Diagrams;**

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

- **To plot these diagrams, the percentage values of the three components must sum to 100% and each corner of the diagram corresponds to a sample with 100% of the component named at that corner;**

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

Palynofacies Absolute Data

Table: absolute values obtained through the counting of individual organic particles for PWG1 Sample based on detailed classification system of the individual organic components from OM (Kerogen) Groups that was used in this 1st Exercise.

Participants	Phytoclast %														Palynomorph %		AOM %	
	Opaque Phytoclast				Non-Opaque Phytoclast									Total	Sp	Total	Re	Total
	LS	Eq	C	Total	St	Bd	Pt	NOB	NONB	NONB-D	NONB	Cu	Total					
A	5.3	0.9	0.4	6.6	1.3	6.5	2.4	10.2	45.4	35.4	80.8	1.4	92.4	99.0	0.4	0.4	0.4	0.4
B	22.8	26.4	2.7	51.9	5.2	3.0	3.3	11.4	30.4	0.3	30.7	1.1	43.2	95.1	3.8	3.8	1.1	1.1
C	16.4	17.8	15.2	49.4	5.3	4.4	0.9	10.6	13.2	14.0	27.2	10.5	48.3	97.7	0.0	0.0	0.3	0.3
D	5.7	4.3	4.3	14.3	9.7	5.2	3.7	18.6	24.4	12.6	37.0	25.5	81.1	95.4	2.0	2.0	2.6	2.6
E	17.0	12.6	0.4	30.0	10.0	3.6	11.6	25.2	17.2	8.2	25.4	8.4	59.0	89.0	0.4	0.4	6.8	6.8
F	16.1	2.8	6.5	25.4	8.7	6.2	3.7	18.6	33.2	22.0	55.2	0.9	73.8	93.2	4.5	4.5	2.4	2.4
G	12.6	3.9	5.2	21.7	8.3	3.1	2.3	13.6	32.0	18.6	50.6	0.6	64.3	86.6	10.5	10.5	2.9	2.9
H	6.7	10.0	8.3	25.0	3.4	16.7	3.4	23.5	47.0	3.4	50.4	0.3	74.2	99.2	0.5	0.5	0.3	0.3
I	12.3	4.6	17.2	34.1	3.3	4.3	1.0	8.6	10.6	45.7	56.3	0.3	64.9	99.3	0.0	0.0	0.7	0.7
J	13.5	1.9	12.0	27.4	24.8	6.0	8.2	39.0	5.7	23.6	29.3	0.9	69.2	96.5	3.5	3.5	0.0	0.0
K	17.0	10.7	19.7	47.4	4.0	0.3	1.0	5.3	7.7	37.0	44.7	2.0	52.0	99.4	0.7	0.7	0.0	0.0
L	7.8	3.5	4.9	16.2	10.8	4.9	4.9	20.5	22.1	12.7	34.8	22.4	77.6	93.8	2.4	2.4	3.8	3.8
M	18.6	10.9	5.6	35.2	9.2	0.2	2.6	12.0	34.0	12.0	46.1	3.8	61.8	97.0	2.1	2.1	0.9	0.9
N	8.0	3.0	1.0	12.0	2.6	2.4	7.8	12.8	55.8	8.4	64.2	9.0	77.0	98.0	1.0	1.0	1.0	1.0
O	7.7	2.2	1.1	11.0	10.4	4.2	4.4	18.9	38.5	13.2	51.8	5.9	57.7	87.7	11.7	11.7	2.2	0.7
Average	12.5	7.7	7.0	27.2	7.8	4.7	4.1	16.6	27.8	17.8	45.6	6.2	66.4	95.1	2.9	2.9	1.7	1.6
δ	5.4	7.1	6.3	14.3	5.7	3.8	3.0	8.4	15.2	12.9	15.4	8.0	13.3	4.3	3.6	3.6	1.8	1.8

Maceral Absolute Data (WR)

Table: absolute values obtained through the counting of Macerals*ISO7404-3, 2009 (RWL - Polished Section/WR) for PWG1 Sample, based on the ICCP classification system that was used in this 1st Exercise. Some participants counted only the maceral groups categories.

Maceral - RWL - Polished Section (WR)																		
Participants	Vitrinite %				Inertinite %								Liptinite %					
	TV	GV	DV	Total	F	SF	Ma	Mi	Fu	Se	Id	Total	Sp	C	Re	Ld	Total
A	27.2	0.8	20.0	48.0	18.2	12.4	3.8	1.0	0.0	0.0	2.2	37.6	7.0	3.2	0.0	0.0	10.2
B	2.5	44.7	2.5	49.2	17.0	6.8	0.0	0.0	1.7	0.0	0.0	25.4	1.7	14.4	0.0	0.0	16.1
C	...	....	...	32.2	...	...	...	...	...	...	...	53.0	...	...	...	...	3.6
D	37.4	0.0	8.7	46.1	9.5	17.7	1.5	0.0	0.2	0.0	6.7	35.9	5.2	12.8	0.0	0.0	9.5
E	7.7	23.0	0.7	31.4	5.9	6.2	0.1	0.0	0.2	0.0	2.7	15.2	10.6	2.8	0.9	0.9	15.2
G	...	...	...	39.6	7.4	22.9	0.0	0.0	0.0	0.0	0.4	30.7	4.1	11.7	1.8	12.2	29.7
H	40.7	0.3	0.6	41.7	10.0	15.0	0.3	0.0	0.3	0.0	8.0	33.6	6.7	0.6	1.6	5.0	14.0
I	17.8	2.2	23.1	43.1	11.9	2.2	0.3	0.6	0.0	0.0	4.7	19.7	5.0	0.6	0.6	0.0	6.3
J	30.2	1.6	14.3	46.0	4.2	9.5	2.6	4.2	0.0	0.2	10.1	30.8	6.9	5.4	0.0	4.8	17.1
K	24.0	0.0	6.5	30.5	2.5	13.0	0.5	0.0	0.0	0.0	4.5	20.5	4.0	1.0	0.0	0.0	5.0
L	37.0	0.2	15.2	52.4	3.8	9.2	1.0	0.0	0.0	0.0	0.0	14.0	0.8	11.8	0.0	0.0	12.6
M	23.9	0.5	19.7	44.1	7.4	9.2	0.8	0.0	0.3	0.0	6.8	24.4	1.8	7.1	0.0	2.6	11.6
N	...	...	...	24.0	...	...	...	...	...	...	...	18.7	1.3	53.3	0.0	0.0	54.6
O	...	...	...	41.9	8.4	23.3	0.0	0.0	0.0	0.0	0.0	31.7	4.7	14.0	0.9	9.3	28.9
Average	24.8	7.3	11.1	40.7	8.8	12.3	0.9	0.5	0.2	0.0	3.8	27.9	4.6	10.7	0.4	2.7	16.7
δ	12.6	14.9	8.4	8.2	4.9	6.5	1.2	1.2	0.5	0.1	3.5	10.5	2.8	13.9	0.7	4.1	13.4

Maceral Absolute Data (KC)

Table: absolute values obtained through the counting of Macerals*ISO7404-3, 2009 (RWL - Polished Section/KC) for PWG1 Sample, based on the ICCP classification system that was used in this 1st Exercise. Some participants counted only the maceral groups categories.

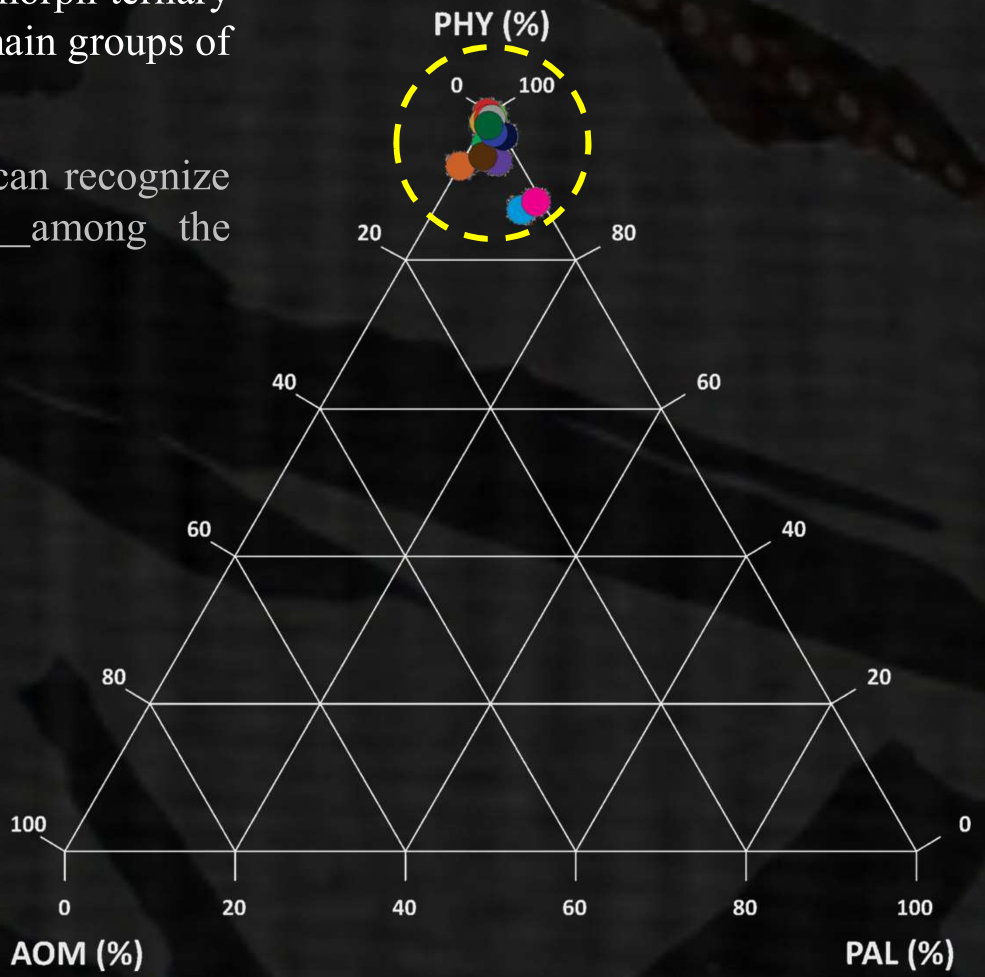
Maceral - RWL - Polished Section (KC)

Participants	Vitrinite %				Inertinite %								Liptinite %				
	TV	GV	DV	Total	F	SF	Ma	Mi	Fu	Se	Id	Total	Sp	C	Re	Ld	Total
A	24.8	0.2	10.2	35.2	38.8	7.6	0.8	0.0	0.0	0.0	2.0	49.2	4.6	7.8	0.0	0.0	12.4
B	3.0	26.0	0.0	28.9	44.0	7.7	0.0	0.0	0.0	0.0	0.0	51.9	5.0	11.5	0.4	0.0	16.6
C	...	...	...	30.1	35.2	25.9	0.0	0.0	0.0	0.0	0.0	61.1	...	...	...	...	5.4
D	48.0	0.0	3.7	51.7	16.8	13.6	1.3	0.0	0.0	0.0	6.0	37.8	0.3	8.9	0.5	0.8	10.1
E	28.0	19.9	2.0	49.9	13.4	7.4	3.3	0.2	0.6	0.0	7.6	32.4	3.7	2.8	2.2	0.9	9.6
G	...	...	...	47.7	15.6	13.9	0.0	0.0	0.0	0.0	0.0	29.6	6.0	14.5	2.0	0.3	22.7
H	45.3	0.3	0.3	46.0	11.7	16.7	0.3	0.0	0.3	0.0	11.7	37.3	6.7	0.0	1.7	6.7	15.0
I	37.9	9.1	7.4	54.4	18.1	11.7	0.3	0.3	2.3	0.0	5.5	38.2	4.2	1.3	0.6	0.0	6.1
J	25.9	0.4	19.1	45.4	20.8	10.2	1.4	0.8	0.0	0.0	6.1	39.3	3.0	2.6	0.0	1.0	6.5
K	46.3	0.0	6.3	52.7	2.7	38.3	0.3	0.0	0.0	0.0	0.0	41.3	0.0	2.0	0.3	0.0	2.3
L	45.0	0.2	9.6	57.8	21.7	9.3	1.4	0.0	0.0	0.0	1.4	33.8	0.0	8.2	0.0	0.0	8.2
M	31.8	1.2	7.5	40.5	27.2	8.1	0.6	0.6	0.0	0.6	12.7	49.8	0.0	8.1	0.0	0.0	8.1
N	...	...	...	54.0	...	...	...	...	...	...	...	33.0	1.4	9.6	0.0	0.0	11.0
O	...	...	...	48.9	15.4	6.0	0.0	0.0	0.0	0.0	0.0	21.4	5.0	15.0	1.6	6.0	27.5
Average	33.6	5.7	6.6	45.9	21.6	13.6	0.7	0.1	0.2	0.0	4.1	39.7	3.1	7.1	0.7	1.2	11.5
δ	14.0	9.6	5.7	9.1	11.7	9.1	0.9	0.3	0.6	0.2	4.6	10.3	2.4	5.0	0.8	2.3	6.9

Palynofacies: Organic Matter Assemblage Phytoclast-AOM-Palynomorph

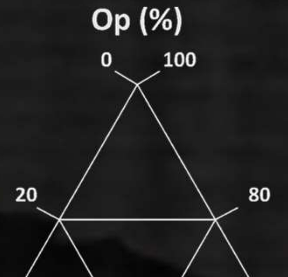
- The APP diagram (AOM-Phytoclast-Palynomorph ternary diagram) correlates the percentage of the 3 main groups of kerogen recognized in TWL microscopy;
- Through the results for all participants, we can recognize the absolute predominance of phytoclast among the kerogen groups;

Participant	Phyto	Palin	AOM
A	99.0	0.4	0.4
B	95.1	3.8	1.1
C	97.7	0.0	0.3
D	95.4	2.0	2.6
E	89.0	0.4	6.8
F	93.2	4.5	2.4
G	86.6	10.5	2.9
H	99.2	0.5	0.3
I	99.3	0.0	0.7
J	96.5	3.5	0.0
K	99.4	0.7	0.0
L	93.8	2.4	3.8
M	97.0	2.1	0.9
N	98.0	1.0	1.0
O	87.7	11.7	0.7
Average	95.1	2.9	1.6
δ	4.3	3.6	1.8

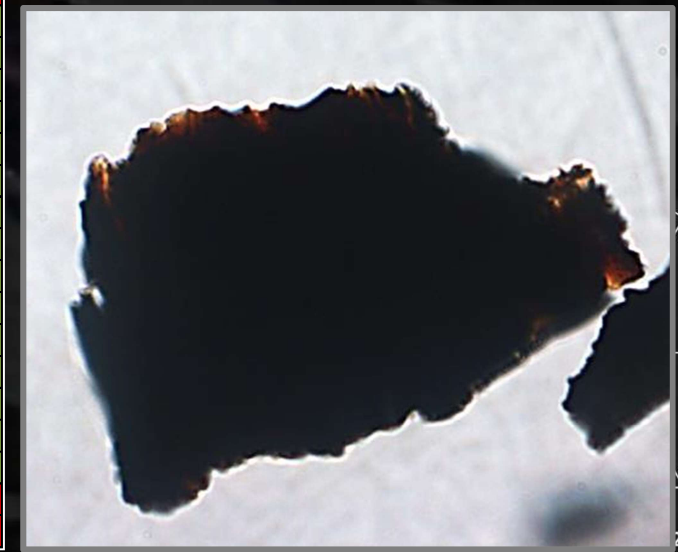


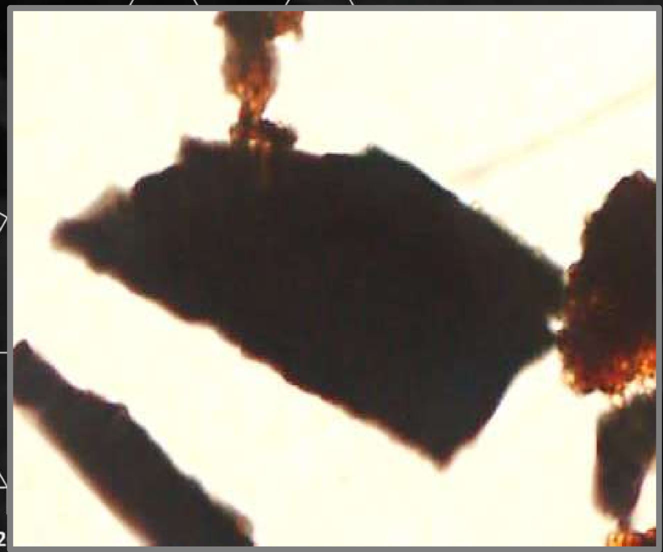
Palynofacies: Phytoclast Assemblage Op-NOB-NONB

- The diagram (Op-NOB-NONB) correlates the percentage of the 3 subgroups of components recognized in the total phytoclast population;
- We can notice a dispersion of the data in this diagram pointing out to the difficulty the participants had to differentiate the opaque and NONB particles, probably due to NONB particles thickening (sometimes these particles can be mostly black in color due to its thickening, but the color at grain boundary is brown). Even so, according to participants, it can be observed in this diagram a predominance of NONB particles;



Participants	Op	NOB	NONB
A	6.6	10.2	80.8
B	51.9	11.4	30.7
C	49.4	10.6	27.2
D	14.3	18.6	37.0
E	30.0	25.2	25.4
F	25.4	18.6	55.2
G	21.7	13.6	50.6
H	25.0	23.5	50.4
I	34.1	8.6	56.3
J	27.4	39.0	29.3
K	47.4	5.3	44.7
L	16.2	20.5	34.8
M	35.2	12.0	46.1
N	12.0	12.8	64.2
O	11.0	18.9	51.8
Average	27.2	16.6	45.6
δ	14.3	8.4	15.4

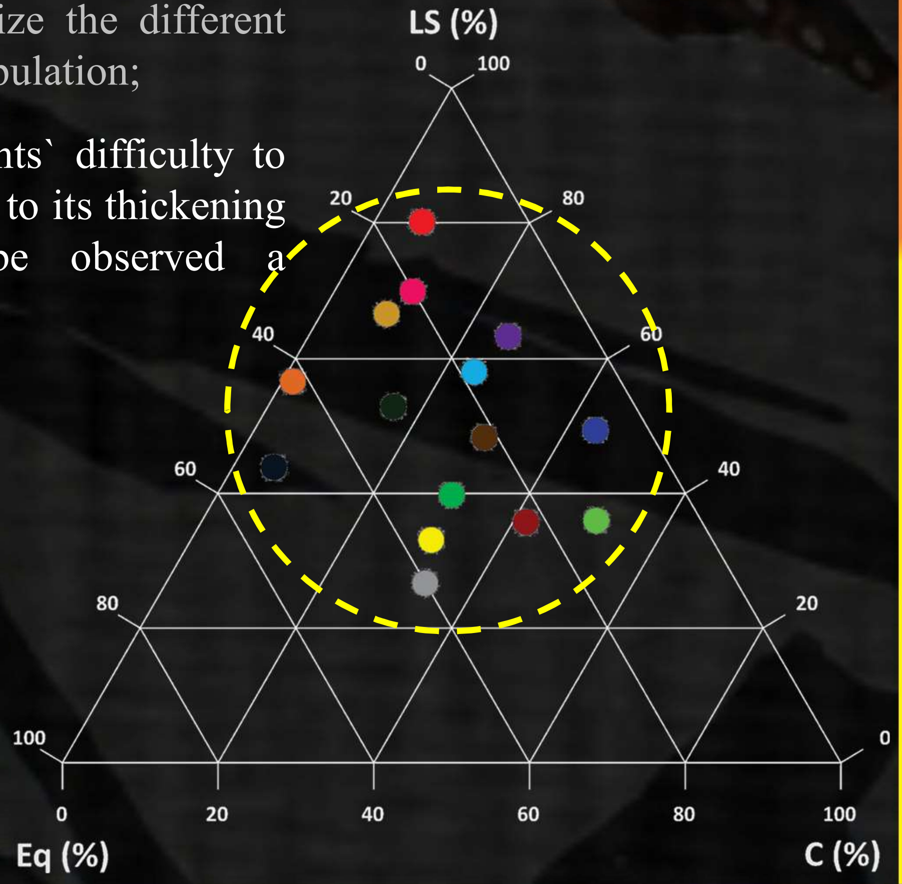




Palynofacies: opaque Phytoclast Assemblage LS-Eq-C

- The diagram (Ls-Eq-C) correlates the percentage of the 3 kinds of particles recognized in the Opaque Phytoclast population;
- We can perceive a dispersion of the data in this diagram pointing out to the difficulty participants had to recognize the different kinds of particles within the opaque phytoclast population;
- This feature is probably related to the participants` difficulty to differentiate the opaque and NONB particles, due to its thickening as previously noticed. However, it can be observed a predominance of LS particles;

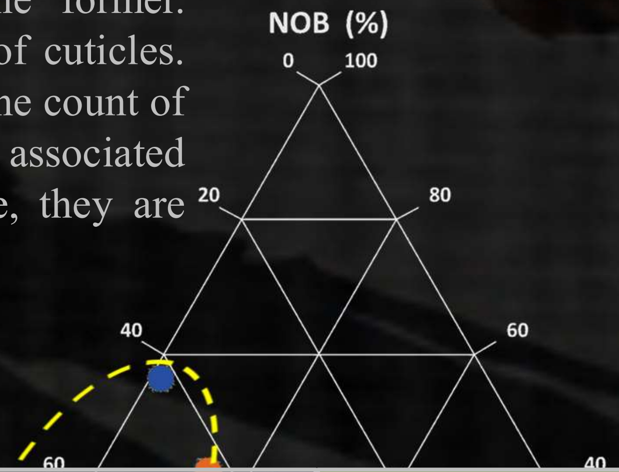
Participants	Opaque Phytoclast			
	LS	Eq	C	Total
A	5.3	0.9	0.4	6.6
B	22.8	26.4	2.7	51.9
C	16.4	17.8	15.2	49.4
D	5.7	4.3	4.3	14.3
E	17.0	12.6	0.4	30.0
F	16.1	2.8	6.5	25.4
G	12.6	3.9	5.2	21.7
H	6.7	10.0	8.3	25.0
I	12.3	4.6	17.2	34.1
J	13.5	1.9	12.0	27.4
K	17.0	10.7	19.7	47.4
L	7.8	3.5	4.9	16.2
M	18.6	10.9	5.6	35.2
N	8.0	3.0	1.0	12.0
O	7.7	2.2	1.1	11.0
Average	12.5	7.7	7.0	27.2
δ	5.4	7.1	6.3	14.3

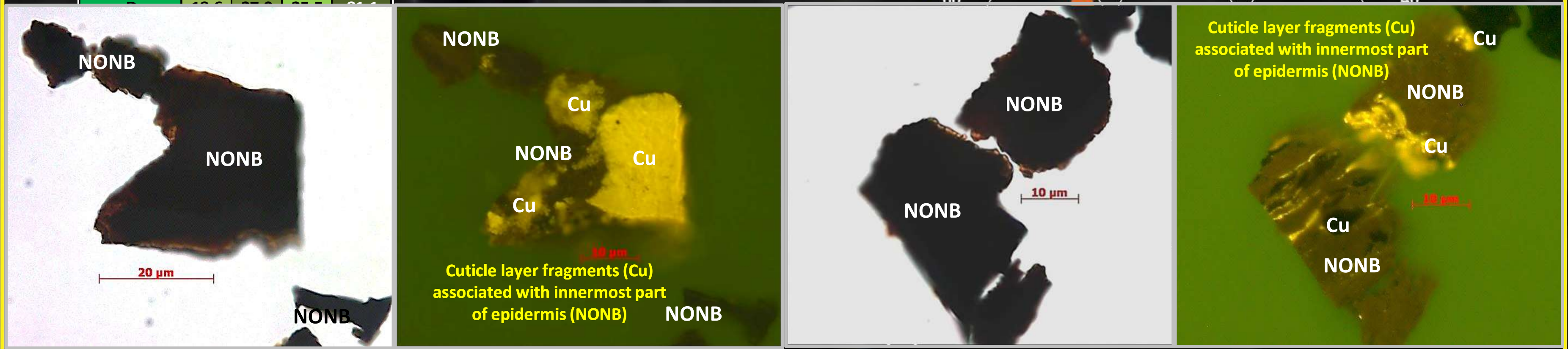


Palynofacies: Non-Opaque Phytoclasts Assemblage NOB-NONB-Cu

- The diagram (NOB-NONB-Cu) correlates the percentage of the 3 kinds of particles recognized in the total brown (non-opaque) phytoclast population;
- The majority of participants agreed with the amount of NONB and NOB phytoclasts, with absolute predominance of the former. However, some participants overestimated the amount of cuticles. This feature may have been caused by the use of FM in the count of these particles (in this sample the majority of cuticles is associated with the innermost part of epidermis and, in this case, they are classified as NONB phytoclast in TWL);

Participants	NOP			
	NOB	NONB	Cu	Total
A	10.2	80.8	1.4	92.4
B	11.4	30.7	1.1	43.2
C	10.6	27.2	10.5	48.3

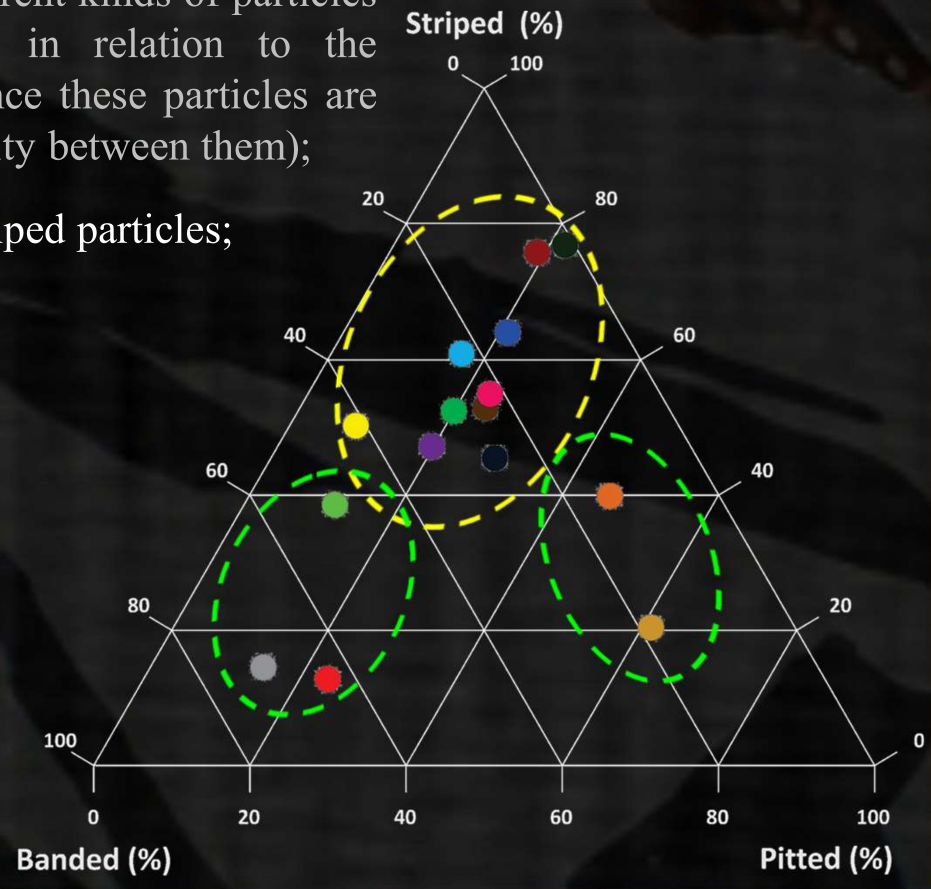




Palynofacies: NOB Phytoclasts Assemblage St-Bd-Pt

- The diagram (St-Bd-Pt) correlates the percentage of the 3 kinds of particles recognized in the total brown (non-opaque) biostructured woody phytoclast population;
- We can perceive a dispersion of the data in this diagram pointing out the participants' difficulty to recognize the different kinds of particles within NOB Phytoclast population, mainly in relation to the differentiation between Bd and Pt particles (once these particles are generally linked), and Bd and St (for the similarity between them);
- However, we can observe a predominance of striped particles;

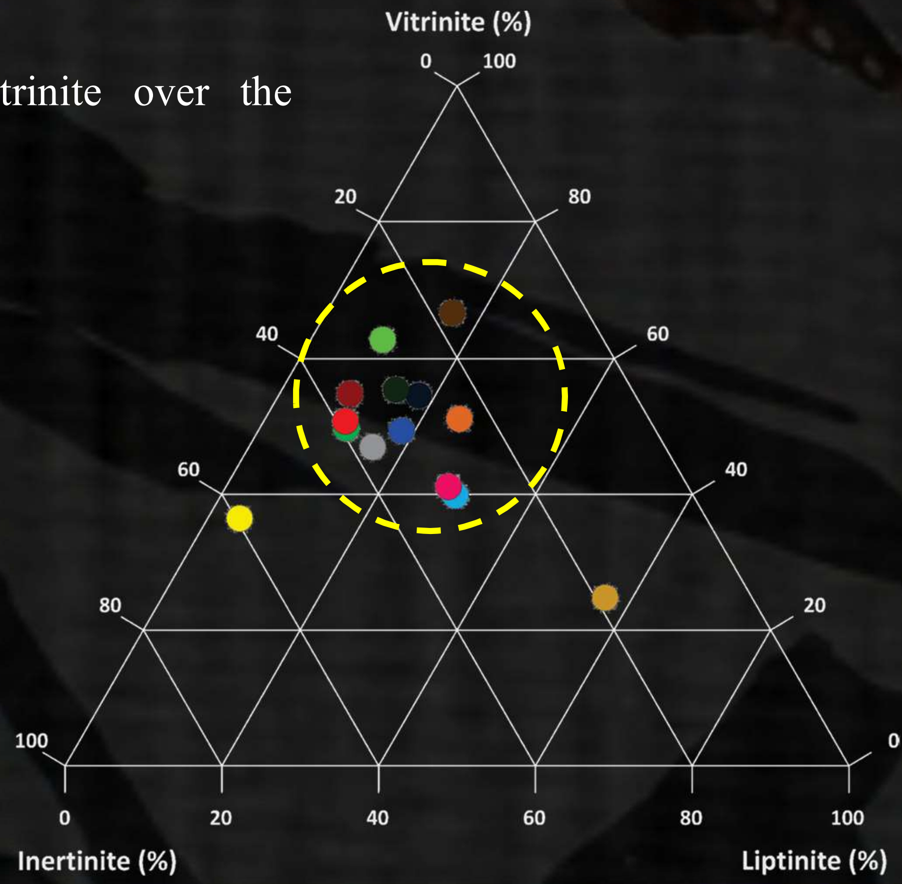
Participants	NOB			
	St	Bd	Pt	Total
A	1.3	6.5	2.4	10.2
B	5.2	3.0	3.3	11.4
C	5.3	4.4	0.9	10.6
D	9.7	5.2	3.7	18.6
E	10.0	3.6	11.6	25.2
F	8.7	6.2	3.7	18.6
G	8.3	3.1	2.3	13.6
H	3.4	16.7	3.4	23.5
I	3.3	4.3	1.0	8.6
J	24.8	6.0	8.2	39.0
K	4.0	0.3	1.0	5.3
L	10.8	4.9	4.9	20.5
M	9.2	0.2	2.6	12.0
N	2.6	2.4	7.8	12.8
O	10.4	4.2	4.4	18.9
Average	7.8	4.7	4.1	16.6
δ	5.7	3.8	3.0	8.4



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;
- The majority of participants agreed with the distribution of the Macerals Groups from polished section of WR;
- We can recognize the predominance of Vitrinite over the Inertinite and Liptinite groups;

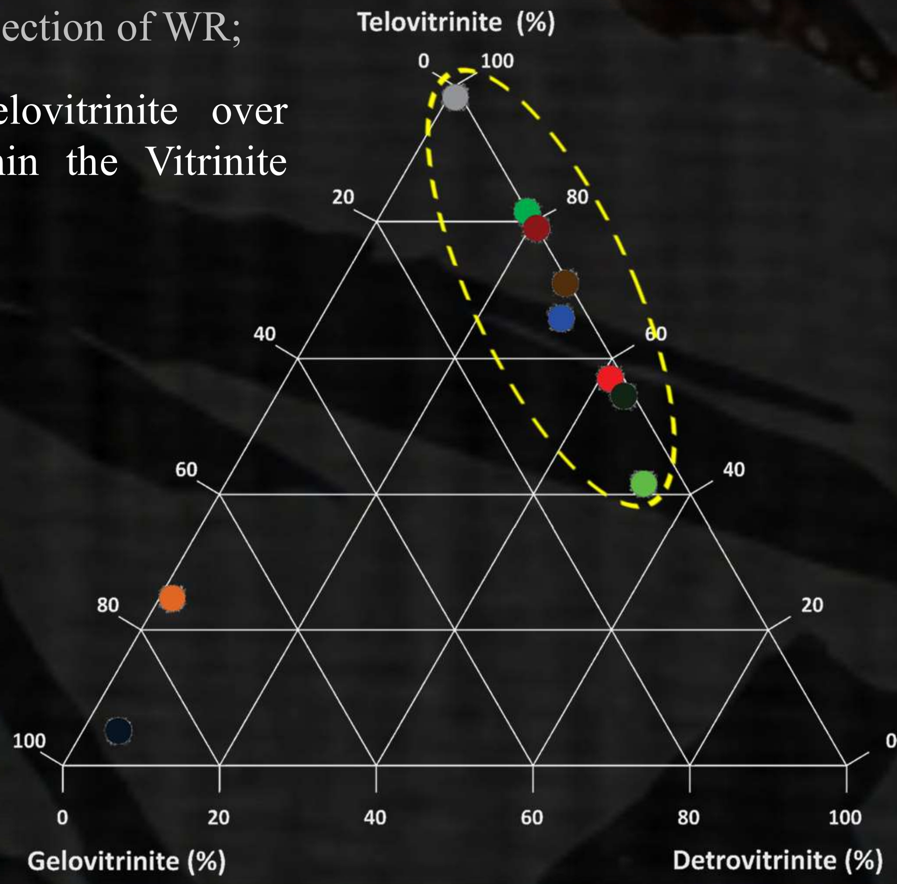
Participants	Maceral Groups		
	Vit	In	Lip
A	48.0	37.6	10.2
B	49.2	25.4	16.1
C	32.2	53.0	3.6
D	46.1	35.9	9.5
E	31.4	15.2	15.2
G	39.6	30.7	29.7
H	41.7	33.6	14.0
I	43.1	19.7	6.3
J	46.0	30.8	17.1
K	30.5	20.5	5.0
L	52.4	14.0	12.6
M	44.1	24.4	11.6
N	24.0	18.7	54.6
O	41.9	31.7	28.9
Average	40.7	27.9	16.7
δ	8.2	10.5	13.4



Vitrinite Maceral Assemblage (WR)
Telovitrinite-Gelovitrinite-Detrovitrinite

- The diagram (TV-GV-DV) correlates the percentage of 3 macerals within the Vitrinite Group using RWL on polished section of WR;
- The majority of participants agreed with the distribution of the macerals within the Vitrinite Group on polished section of WR;
- We can recognize the predominance of Telovitrinite over Gelovitrinite and Detrovitrinite macerals within the Vitrinite Group;

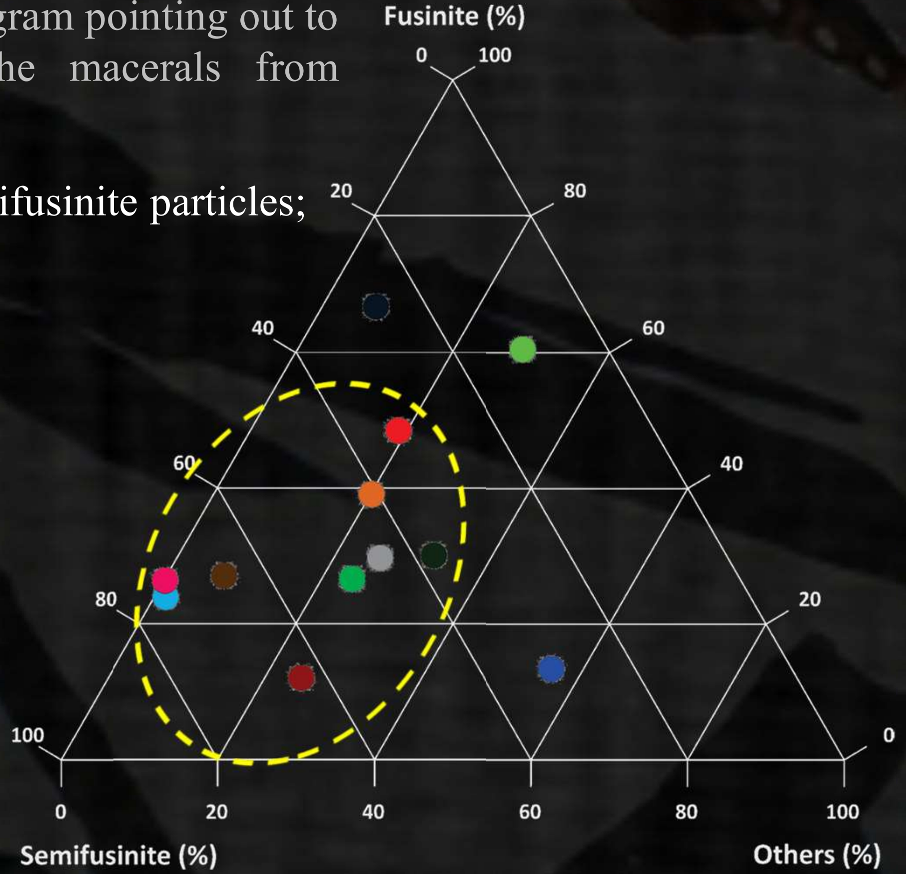
Participants	Vitrinite %			
	TV	GV	DV	Total
A	27.2	0.8	20.0	48.0
B	2.5	44.7	2.5	49.2
D	37.4	0.0	8.7	46.1
E	7.7	23.0	0.7	31.4
H	40.7	0.3	0.6	41.7
I	17.8	2.2	23.1	43.1
J	30.2	1.6	14.3	46.0
K	24.0	0.0	6.5	30.5
L	37.0	0.2	15.2	52.4
M	23.9	0.5	19.7	44.1
Average	24.8	7.3	11.1	43.2
δ	12.6	14.9	8.4	7.2



Inertinite Maceral Assemblage (WR)
Fusinite-Semifusinite-Others (Ma+Mi+Se+Fu+Id)

- The diagram (F-SF-Others, where "others" is the sum of Macrinite, Micrinite, Funginite, Secretinite and Inertodetrinite) correlates to the percentage of macerals within the Inertinite Group using RWL on polished section of WR;
- We can notice a dispersion of the data in this diagram pointing out to the participants' difficulty to differentiate the macerals from Inertinite Group on polished section of WR;
- However, we can observe a predominance of semifusinite particles;

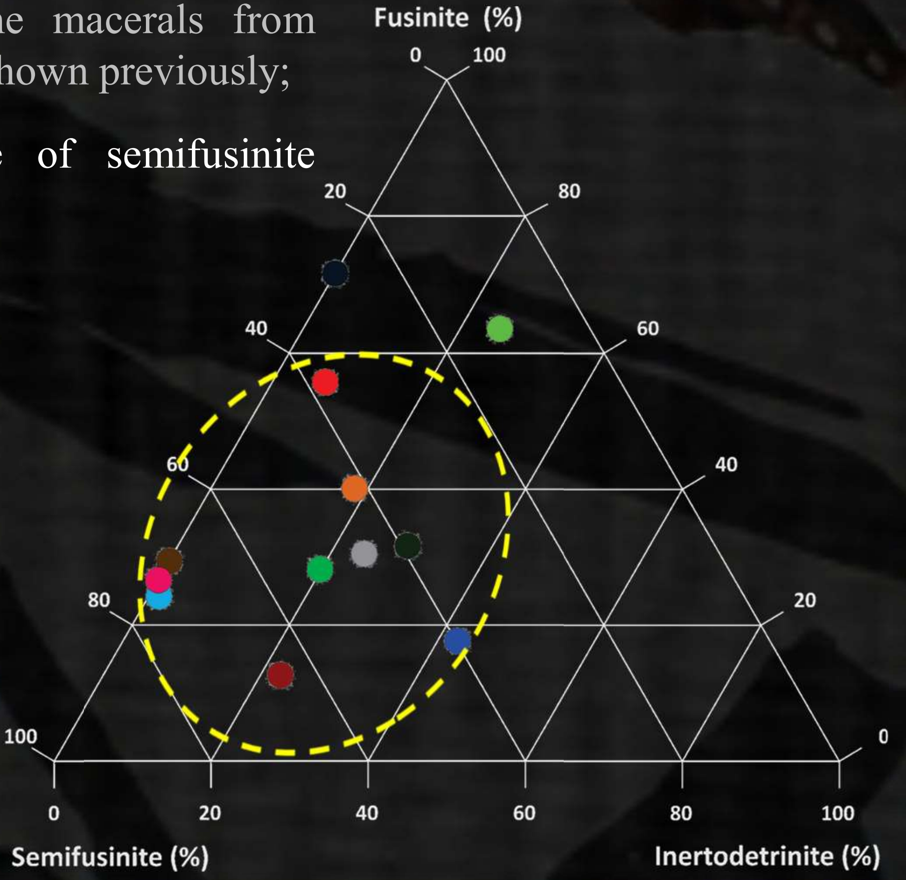
Participants	Inertinite %							
	F	SF	Ma	Mi	Fu	Se	Id	Total
A	18.2	12.4	3.8	1.0	0.0	0.0	2.2	37.6
B	17.0	6.8	0.0	0.0	1.7	0.0	0.0	25.4
D	9.5	17.7	1.5	0.0	0.2	0.0	6.7	35.9
E	5.9	6.2	0.1	0.0	0.2	0.0	2.7	15.2
G	7.4	22.9	0.0	0.0	0.0	0.0	0.4	30.7
H	10.0	15.0	0.3	0.0	0.3	0.0	8.0	33.6
I	11.9	2.2	0.3	0.6	0.0	0.0	4.7	19.7
J	4.2	9.5	2.6	4.2	0.0	0.2	10.1	30.8
K	2.5	13.0	0.5	0.0	0.0	0.0	4.5	20.5
L	3.8	9.2	1.0	0.0	0.0	0.0	0.0	14.0
M	7.4	9.2	0.8	0.0	0.3	0.0	6.8	24.4
O	8.4	23.3	0.0	0.0	0.0	0.0	0.0	31.7
Average	8.8	12.3	0.9	0.5	0.2	0.0	3.8	26.6
δ	4.9	6.5	1.2	1.2	0.5	0.1	3.5	8.0



Inertinite Maceral Assemblage (WR)
Fusinite-Semifusinite-Inertodetrinite

- The diagram (F-SF-Id) correlates to the percentage of 3 main macerals within the Inertinite Group using RWL on polished section of WR;
- We can notice a dispersion of the data in this diagram pointing out the participants' difficulty to differentiate the macerals from Inertinite Group on polished section of WR, as shown previously;
- However, we can observe a predominance of semifusinite particles;

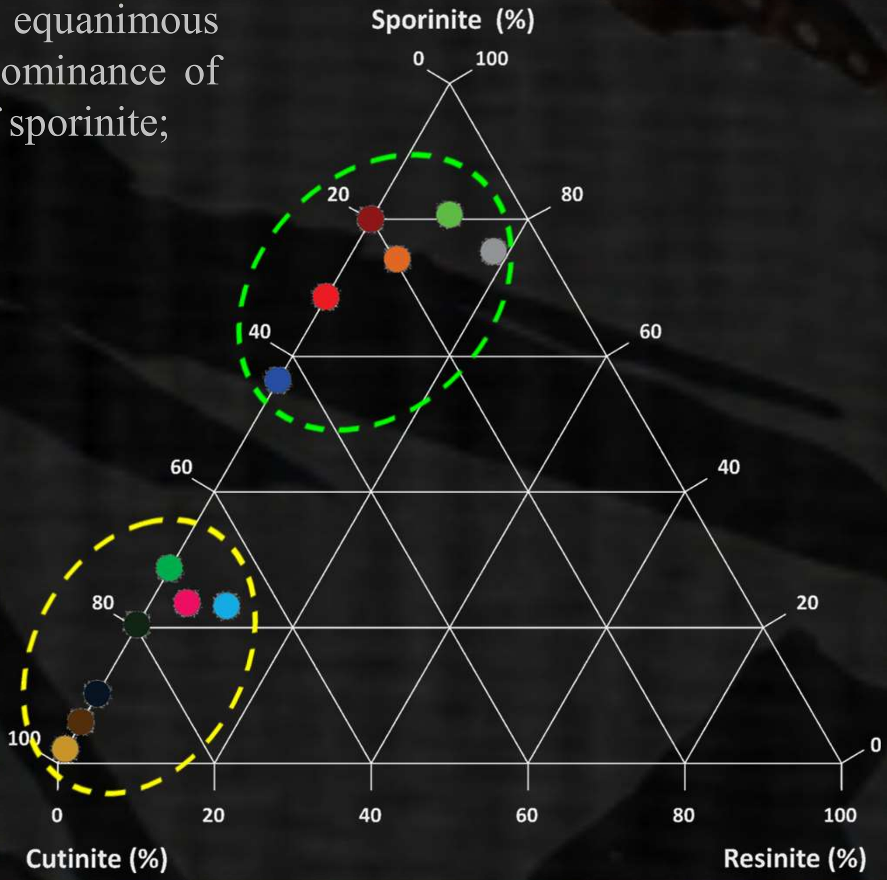
Participants	Inertinite %							
	F	SF	Ma	Mi	Fu	Se	Id	Total
A	18.2	12.4	3.8	1.0	0.0	0.0	2.2	37.6
B	17.0	6.8	0.0	0.0	1.7	0.0	0.0	25.4
D	9.5	17.7	1.5	0.0	0.2	0.0	6.7	35.9
E	5.9	6.2	0.1	0.0	0.2	0.0	2.7	15.2
G	7.4	22.9	0.0	0.0	0.0	0.0	0.4	30.7
H	10.0	15.0	0.3	0.0	0.3	0.0	8.0	33.6
I	11.9	2.2	0.3	0.6	0.0	0.0	4.7	19.7
J	4.2	9.5	2.6	4.2	0.0	0.2	10.1	30.8
K	2.5	13.0	0.5	0.0	0.0	0.0	4.5	20.5
L	3.8	9.2	1.0	0.0	0.0	0.0	0.0	14.0
M	7.4	9.2	0.8	0.0	0.3	0.0	6.8	24.4
O	8.4	23.3	0.0	0.0	0.0	0.0	0.0	31.7
Average	8.8	12.3	0.9	0.5	0.2	0.0	3.8	26.6
δ	4.9	6.5	1.2	1.2	0.5	0.1	3.5	8.0



Liptinite Maceral Assemblage (WR)
Sporinite-Cutinite-Resinite

- The diagram (Sp-C-Re) correlates to the percentage of 3 macerals within the Liptinite Group using RWL and FM on polished section of WR;
- We can observe the distribution of the macerals (S, C and R) from Liptinite Group in WR divided into 2 equanimous distinct groups. One of them based on the predominance of cutinite and the other one on the predominance of sporinite;

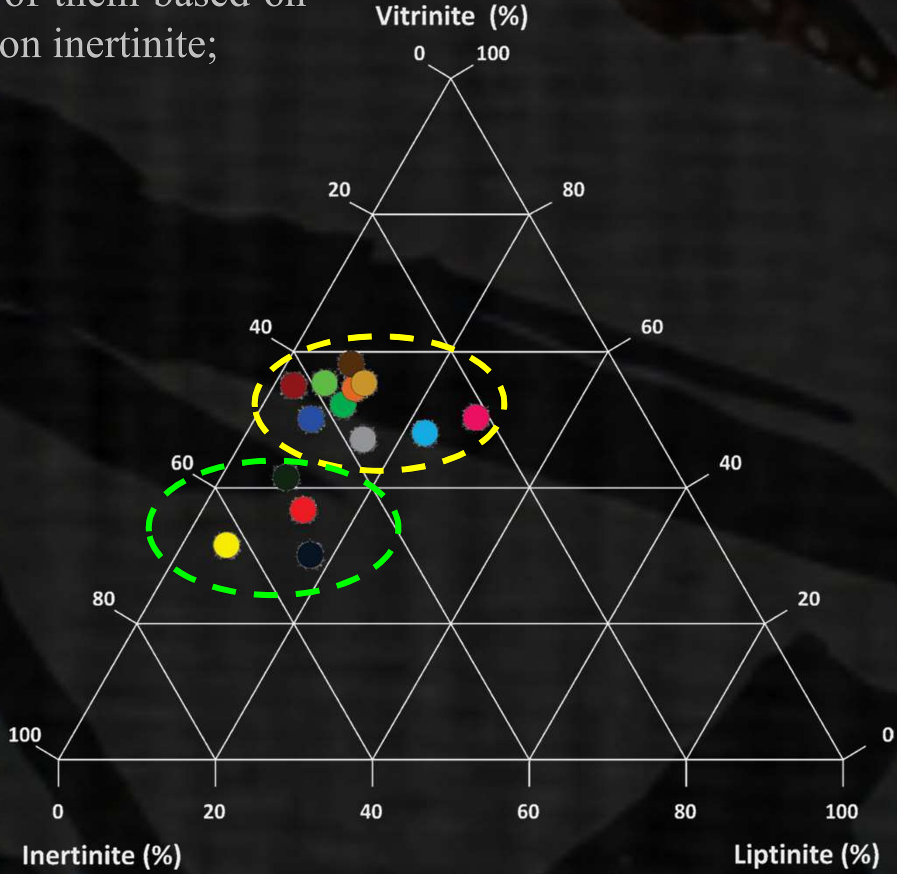
Participants	Liptinite %				
	Sp	C	Re	Ld	Total
A	7.0	3.2	0.0	0.0	10.2
B	1.7	14.4	0.0	0.0	16.1
D	5.2	12.8	0.0	0.0	9.5
E	10.6	2.8	0.9	0.9	15.2
G	4.1	11.7	1.8	12.2	29.7
H	6.7	0.6	1.6	5.0	14.0
I	5.0	0.6	0.6	0.0	6.3
J	6.9	5.4	0.0	4.8	17.1
K	4.0	1.0	0.0	0.0	5.0
L	0.8	11.8	0.0	0.0	12.6
M	1.8	7.1	0.0	2.6	11.6
N	1.3	53.3	0.0	0.0	54.6
O	4.7	14.0	0.9	9.3	28.9
Average	4.6	10.7	0.4	2.7	17.7
δ	2.8	13.9	0.7	4.1	13.3



Maceral Groups (KC)
Vitrinite-Inertinite-Liptinite

- The diagram (Vit-In-Lip) correlates to the percentage of the 3 groups of maceral recognized in the total organic matter assemblage using RWL and FM on polished section of KC;
- We can recognize a division into 2 groups. One of them based on light predominance of vitrinite and the other one on inertinite;

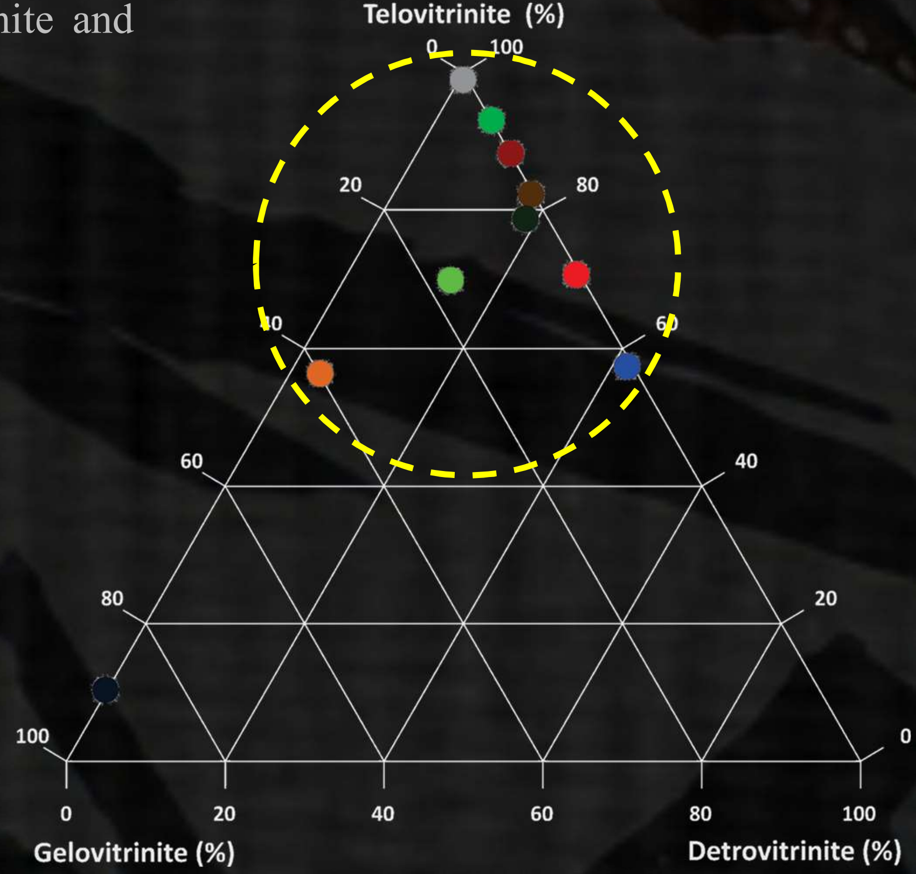
Participants	Maceral Group		
	Vit	In	Lip
A	35.2	49.2	12.4
B	28.9	51.9	16.6
C	30.1	61.1	5.4
D	51.7	37.8	10.1
E	49.9	32.4	9.6
G	47.7	29.6	22.7
H	46.0	37.3	15.0
I	54.4	38.2	6.1
J	46.0	30.8	17.1
K	52.7	41.3	2.3
L	57.8	33.8	8.2
M	40.5	49.8	8.1
N	54.0	33.0	11.0
O	48.9	21.4	27.5
Average	46.0	39.1	12.3
δ	9.1	10.6	6.9



Vitrinite Maceral Assemblage (KC)
Telovitrinite-Gelovitrinite-Detrovitrinite

- The diagram (TV-GV-DV) correlates to the percentage of 3 macerals within the Vitrinite Group using RWL on polished section of KC;
- The majority of participants agreed with the absolute predominance of Telovitrinite over Gelovitrinite and Detrovitrinite;

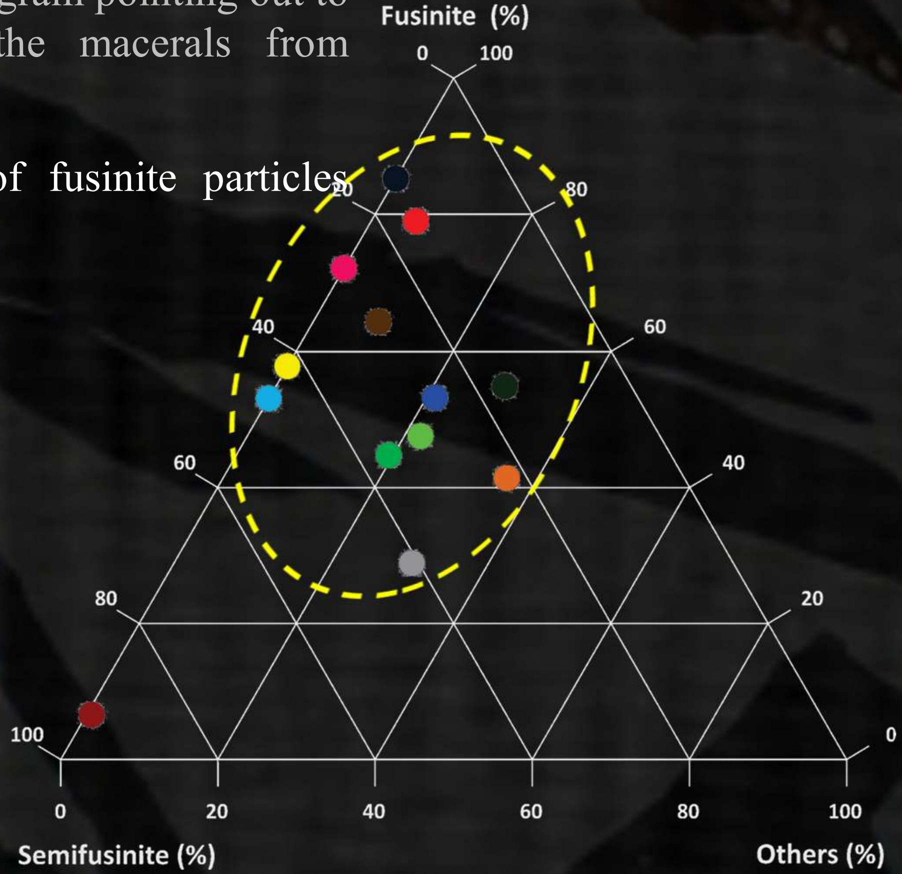
Participants	Vitrinite %			
	TV	GV	DV	Total
A	24.8	0.2	10.2	35.2
B	3.0	26.0	0.0	28.9
D	48.0	0.0	3.7	51.7
E	28.0	19.9	2.0	49.9
H	45.3	0.3	0.3	46.0
I	37.9	9.1	7.4	54.4
J	30.2	1.6	14.3	46.0
K	46.3	0.0	6.3	52.7
L	45.0	0.2	9.6	57.8
M	31.8	1.2	7.5	40.5
Average	34.0	5.8	6.1	46.3
δ	13.8	9.5	4.6	9.1



Inertinite Maceral Assemblage (KC)
Fusinite-Semifusinite-Others (Ma+Mi+Se+Fu+Id)

- The diagram (F-SF-Others, where "others" is the sum of Macrinite, Micrinite, Funginite, Secretinite and Inertodetrinite) correlates to the percentage of macerals within the Inertinite Group using RWL on polished section of KC;
- We can notice a dispersion of the data in this diagram pointing out to the participants' difficulty to differentiate the macerals from Inertinite Group on polished section of KC;
- However, we can observe a predominance of fusinite particles among the macerals;

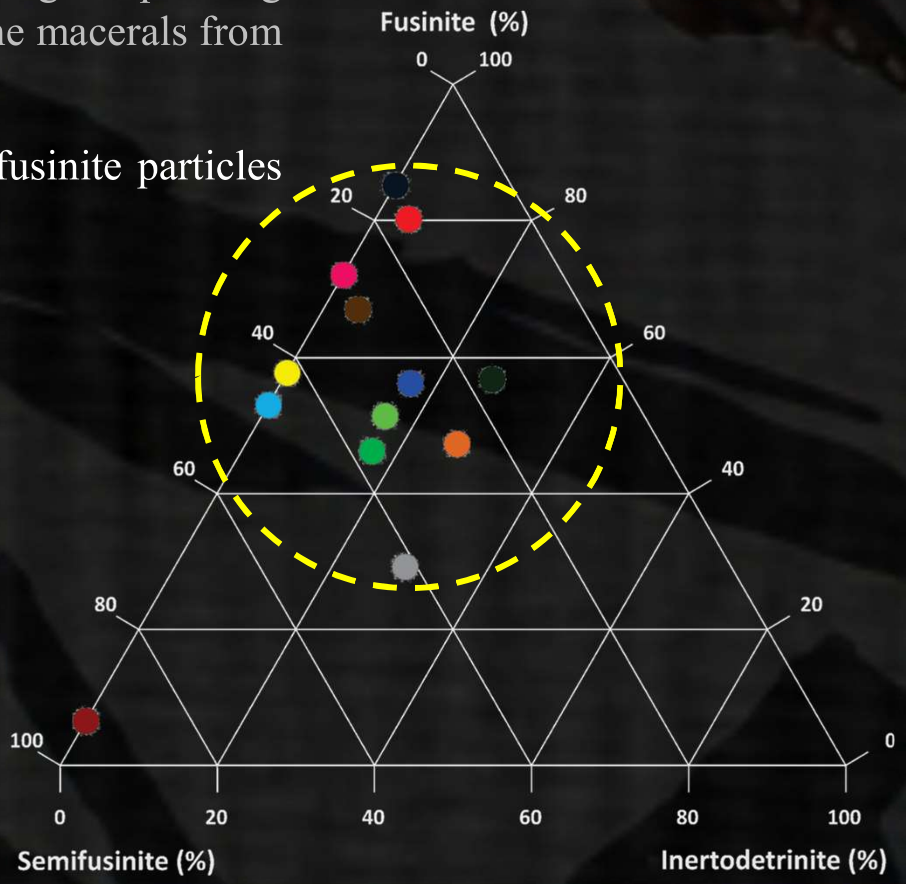
Participants	Inertinite %							
	F	SF	Ma	Mi	Fu	Se	Id	Total
A	38.8	7.6	0.8	0.0	0.0	0.0	2.0	49.2
B	44.0	7.7	0.0	0.0	0.0	0.0	0.0	51.9
C	35.2	25.9	0.0	0.0	0.0	0.0	0.0	61.1
D	16.8	13.6	1.3	0.0	0.0	0.0	6.0	37.8
E	13.4	7.4	3.3	0.2	0.6	0.0	7.6	32.4
G	15.6	13.9	0.0	0.0	0.0	0.0	0.0	29.6
H	11.7	16.7	0.3	0.0	0.3	0.0	11.7	37.3
I	18.1	11.7	0.3	0.3	2.3	0.0	5.5	38.2
J	4.2	9.5	2.6	4.2	0.0	0.2	10.1	30.8
K	2.7	38.3	0.3	0.0	0.0	0.0	0.0	41.3
L	21.7	9.3	1.4	0.0	0.0	0.0	1.4	33.8
M	27.2	8.1	0.6	0.6	0.0	0.6	12.7	49.8
O	15.4	6.0	0.0	0.0	0.0	0.0	0.0	21.4
Average	20.4	13.5	0.8	0.4	0.2	0.1	4.4	39.6
δ	12.7	9.2	1.1	1.1	0.6	0.2	4.8	10.9



Inertinite Maceral Assemblage (KC)
Fusinite-Semifusinite-Inertodetrinite

- The diagram (F-SF-Id) correlates to the percentage of 3 main macerals within the Inertinite Group using RWL on polished section of KC;
- We can notice a dispersion of the data in this diagram pointing out the participants' difficulty to differentiate the macerals from Inertinite Group on polished section of KC;
- However, we can observe a predominance of fusinite particles among the macerals;

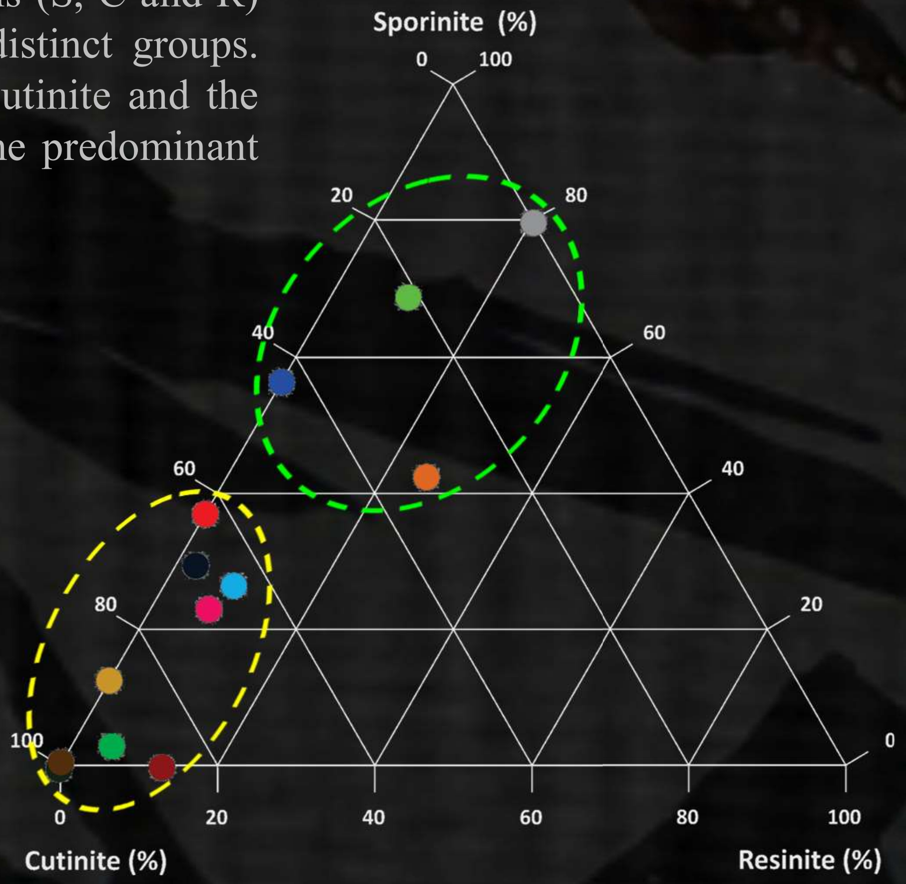
Participants	Inertinite %							
	F	SF	Ma	Mi	Fu	Se	Id	Total
A	38.8	7.6	0.8	0.0	0.0	0.0	2.0	49.2
B	44.0	7.7	0.0	0.0	0.0	0.0	0.0	51.9
C	35.2	25.9	0.0	0.0	0.0	0.0	0.0	61.1
D	16.8	13.6	1.3	0.0	0.0	0.0	6.0	37.8
E	13.4	7.4	3.3	0.2	0.6	0.0	7.6	32.4
G	15.6	13.9	0.0	0.0	0.0	0.0	0.0	29.6
H	11.7	16.7	0.3	0.0	0.3	0.0	11.7	37.3
I	18.1	11.7	0.3	0.3	2.3	0.0	5.5	38.2
J	4.2	9.5	2.6	4.2	0.0	0.2	10.1	30.8
K	2.7	38.3	0.3	0.0	0.0	0.0	0.0	41.3
L	21.7	9.3	1.4	0.0	0.0	0.0	1.4	33.8
M	27.2	8.1	0.6	0.6	0.0	0.6	12.7	49.8
O	15.4	6.0	0.0	0.0	0.0	0.0	0.0	21.4
Average	20.4	13.5	0.8	0.4	0.2	0.1	4.4	39.6
δ	12.7	9.2	1.1	1.1	0.6	0.2	4.8	10.9



Liptinite Maceral Assemblage (KC)
Sporinite-Cutinite-Resinite

- The diagram (Sp-C-Re) correlates to the percentage of 3 macerals within the Liptinite Group using RWL and FM on polished section of KC;
- We can observe the distribution of the macerals (S, C and R) from Liptinite Group in KC divided into 2 distinct groups. One of them based on the predominance of cutinite and the other one on sporinite. However, cutinite is the predominant maceral for the majority of participants in KC;

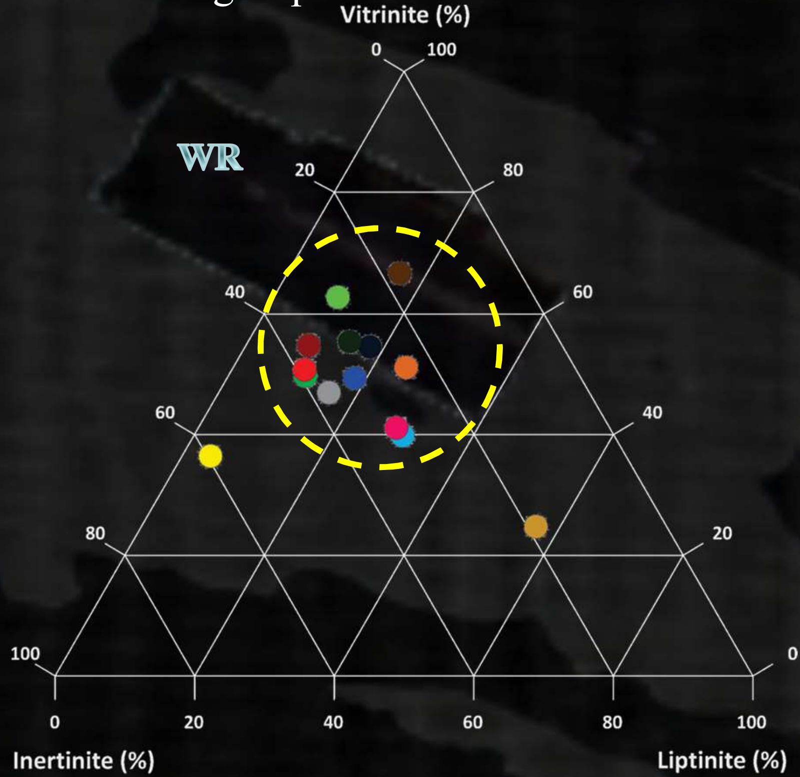
Participants	Liptinite %				
	Sp	C	Re	Ld	Total
A	4.6	7.8	0.0	0.0	12.4
B	5.0	11.5	0.4	0.0	16.6
D	0.3	8.9	0.5	0.8	10.1
E	3.7	2.8	2.2	0.9	9.6
G	6.0	14.5	2.0	0.3	22.7
H	6.7	0.0	1.7	6.7	15.0
I	4.2	1.3	0.6	0.0	6.1
J	6.9	5.4	0.0	4.8	17.1
K	0.0	2.0	0.3	0.0	2.3
L	0.0	8.2	0.0	0.0	8.2
M	0.0	8.1	0.0	0.0	8.1
N	1.4	9.6	0.0	0.0	11.0
O	5.0	15.0	1.6	6.0	27.5
Average	3.4	7.3	0.7	1.5	12.8
δ	2.7	4.8	0.8	2.5	6.9

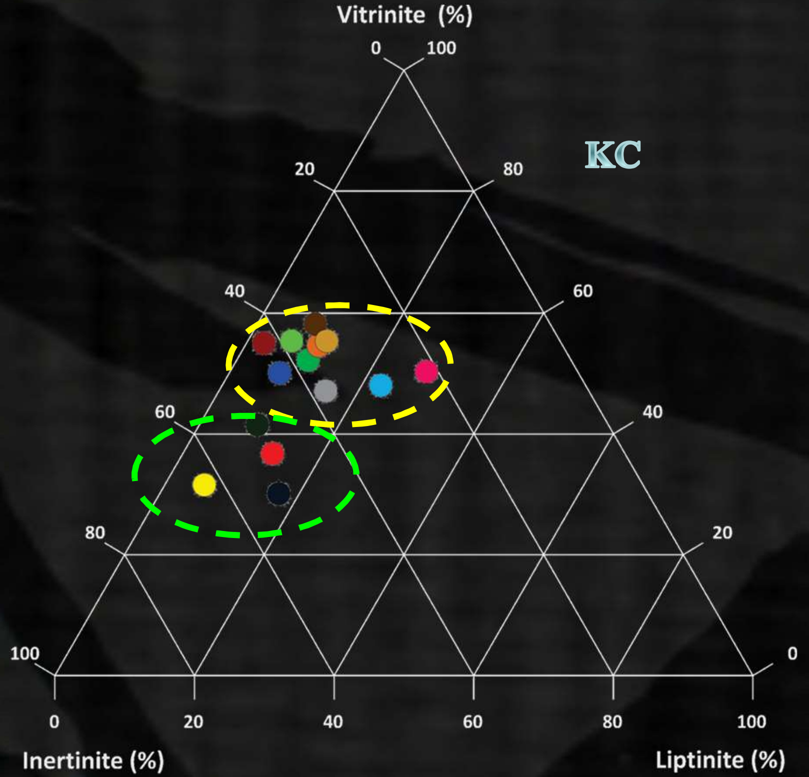


Comparisons of the results between WR and KC polished section examination

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

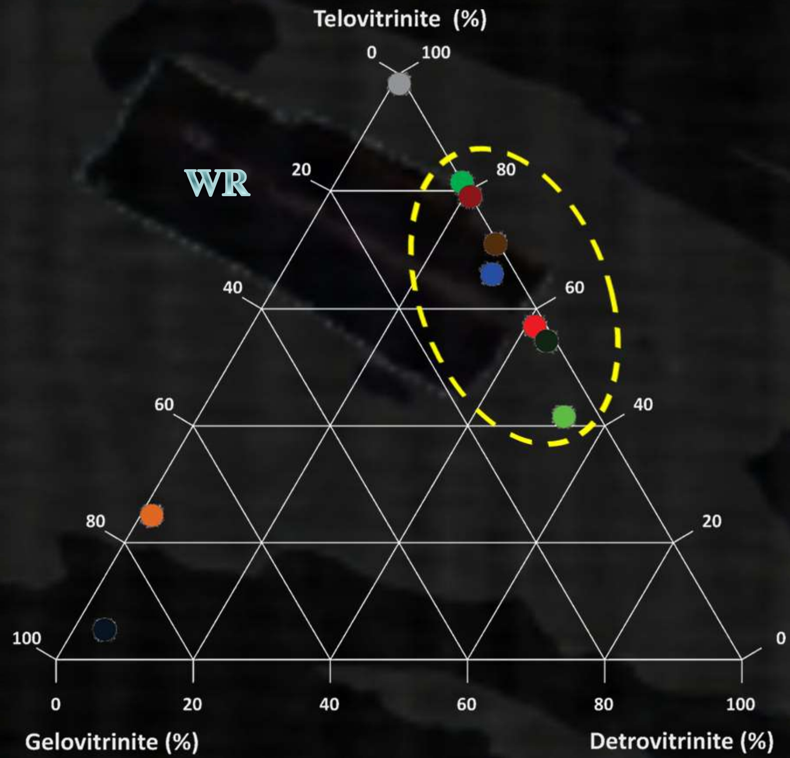
- Comparing the results obtained using RWL on polished section in both, WR and KC, the contribution of Inertinite Group seems to be higher in KC than WR, at least for some participants. This feature can be a result of a higher concentration of inertinite particles in the isolated organic matter (KC) through the preparation process or the participants' difficulty to differentiate the macerals on polished section of KC. However, in both, WR and KC polished section, vitrinite is the predominant group.

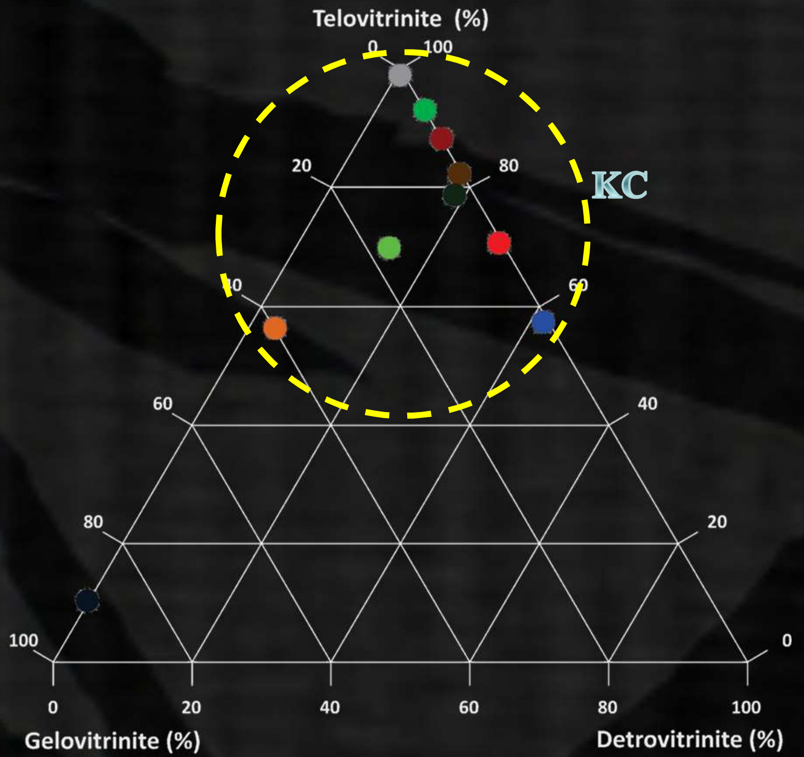




Vitrinite Maceral Assemblage (WR and KC)
Telovitrinite-Gelovitrinite-Detrovitrinite

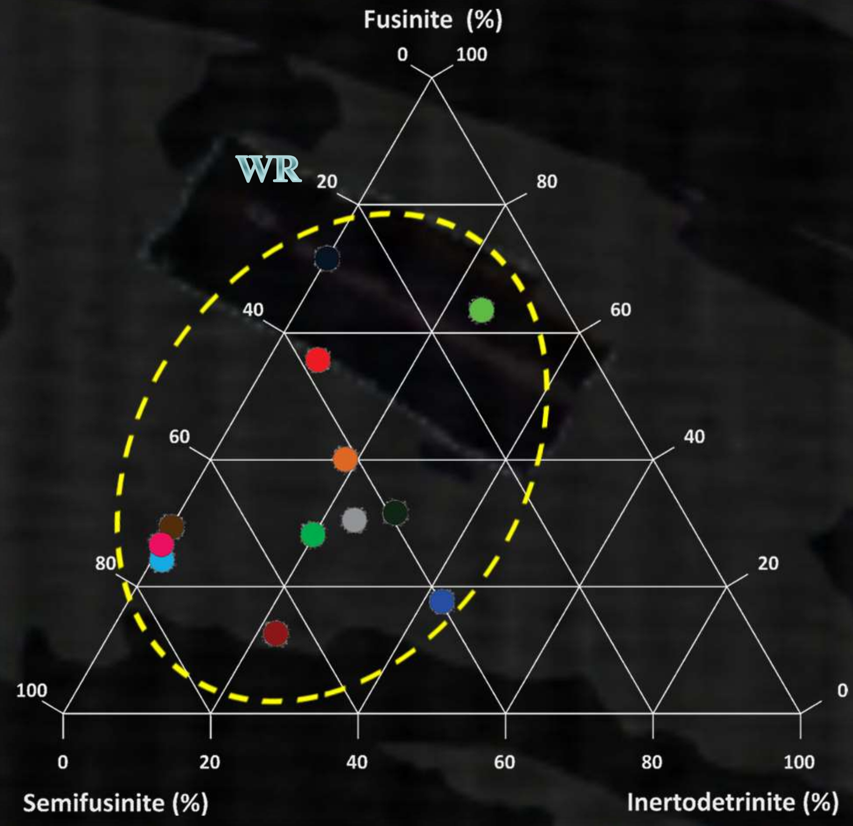
- Comparing the results obtained using RWL on polished section in both, WR and KC, the majority of participants agreed with the prenominance of Telovitrinite. This feature is more evident in the KC than WR examination. It may be that this is a result of the higher difficulty to differentiate the macerals within the Vitrinite Group in KC than WR or the opposite also can be used for explanation, i.e., in KC is easier to classify the vitrinite particles than WR. Regardless the explanation, the majority of participants preferred to classify the particles from this group as Telovitrinite in KC polished section.

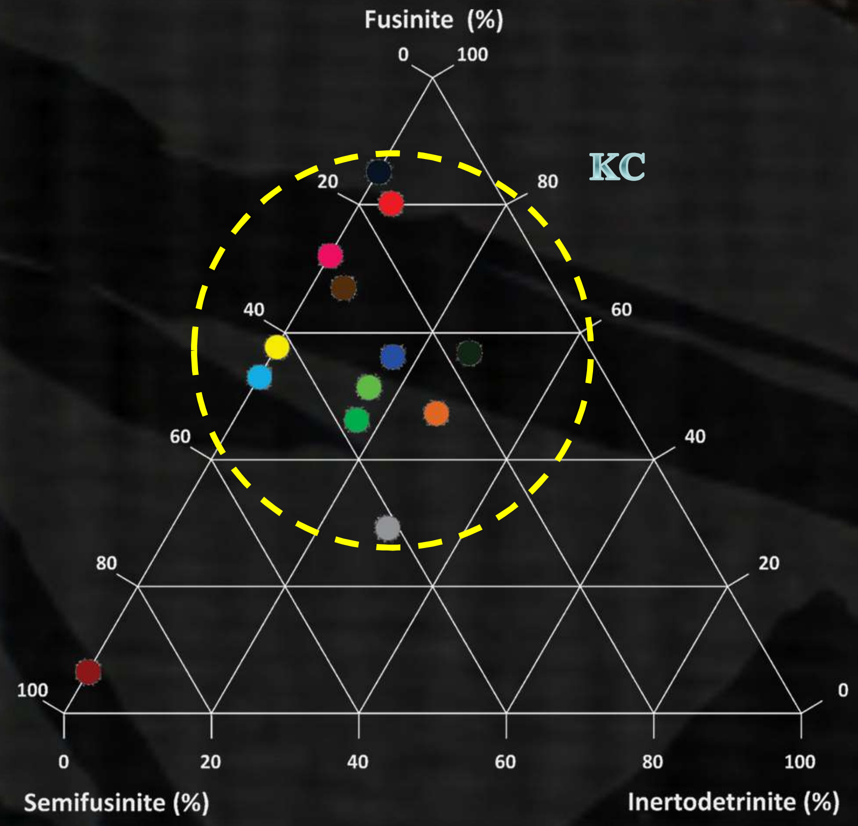




Inertinite Maceral Assemblage (WR and KC)
Fusinite-Semifusinite-Inertodetrinite

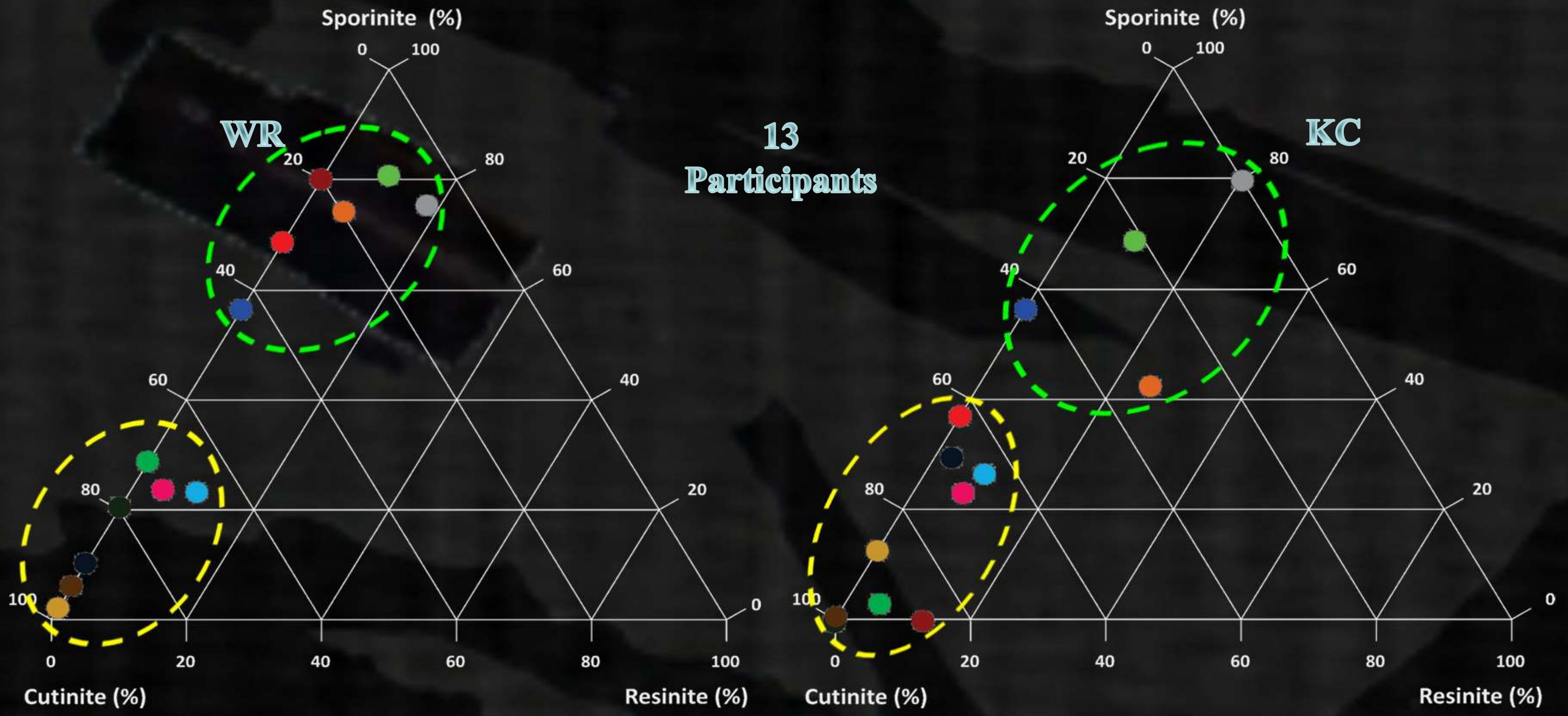
- Comparing the results obtained using RWL on polished section in both, WR and KC, the contribution of fusinite within the Inertinite Group is higher in the KC than WR polished section for the majority of participants. This feature can be a result of a higher concentration of fusinite particles in the isolated organic matter (KC) through the preparation process or the participants' difficulty to differentiate the macerals from Inertinite Group on polished section of KC;





Liptinite Maceral Assemblage (WR and KC)
Sporinite-Cutinite-Resinite

- Comparing the results obtained using RWL on polished section we can observe the distribution of the macerals from Liptinite Group in both, WR and KC, is divided into 2 distinct groups. One of them based on the predominance of cutinite and the other one on sporinite. Although, cutinite is the predominant maceral for the majority of participants in WR, as well as in KC. However, this feature is more evident in the KC than WR examination. It may be that this is the result of a higher difficulty to differentiate between cutinite and sporinite in the WR than in the KC polished section;



Correlation among the particles in TWL, RWL and FM

Photomicrographies
Sample PWG1

All participants received a guideline showing the classification details, photomicrophies of the components in TWL and RWL (WR and KC), and explaining how to present the results.

Palynofacies Slides : KC

- Transmitted White Light (TWL)
- Fluorescence Mode (FM)

Polished Section: WR and KC

- Reflected White Light (RWL)
- Fluorescence Mode (FM)

Photomicrographies
Sample PWG1 – TWL and FM
Palynofacies Slides (PS) – Kerogen Concentrate

Legend:

OP: Opaque Phytoclasts
- **Eq:** Equant;
- **LS:** Lath Shape;
- **C:** Corroded;

NOP: Non-Opaque Phytoclasts
- **NONB: Non-Biostructured**
  - **NONB: Undegraded;**
  - **NONB-D: Degraded;**
- **NOB: Non-Opaque Biostructured**
  - **NOB-St: Striped;**
  - **NOB-Bd: Banded;**
  - **NOB-Pt : Pitted;**

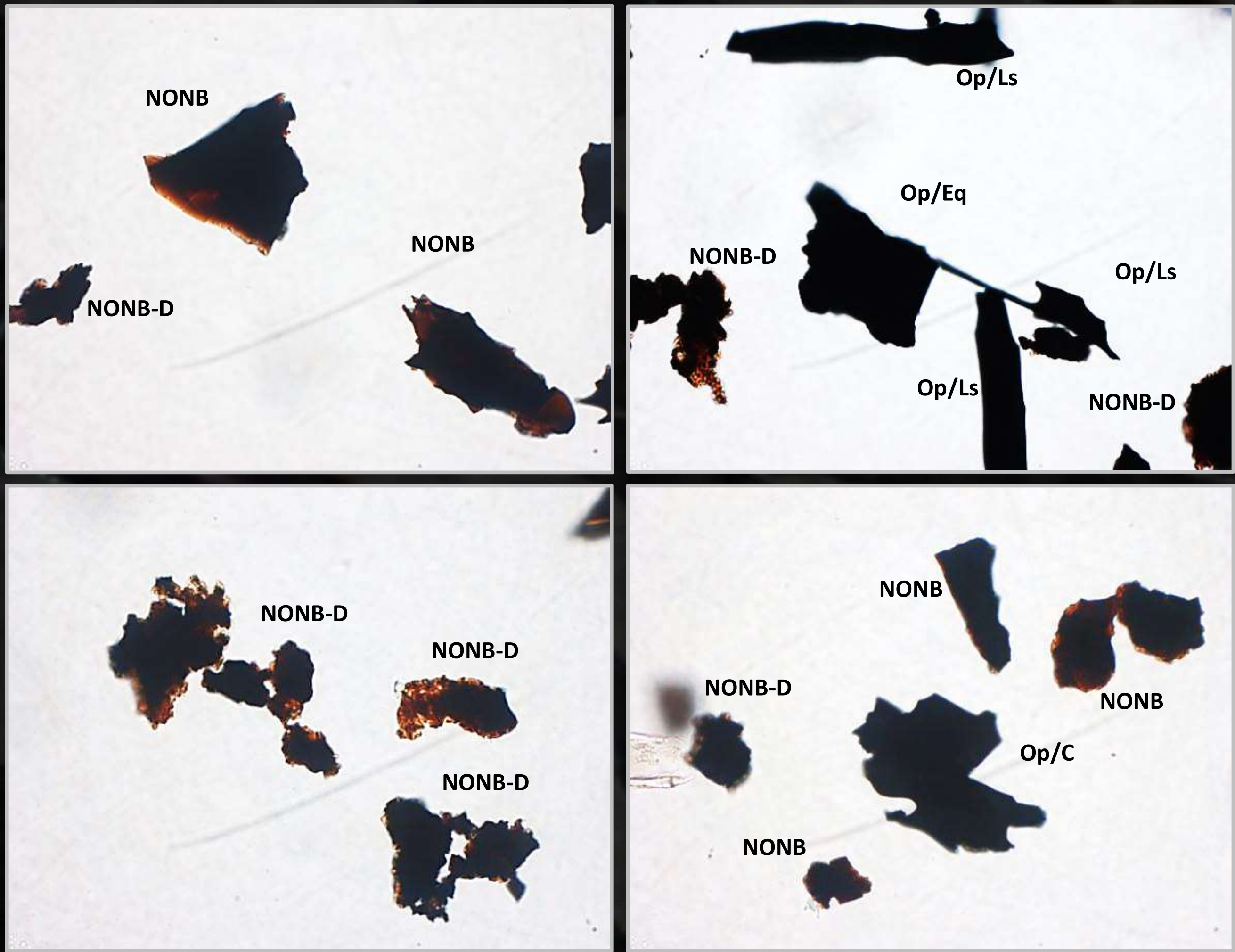
Cu: Cuticle

Re: Resin

Sp: Sporomorph

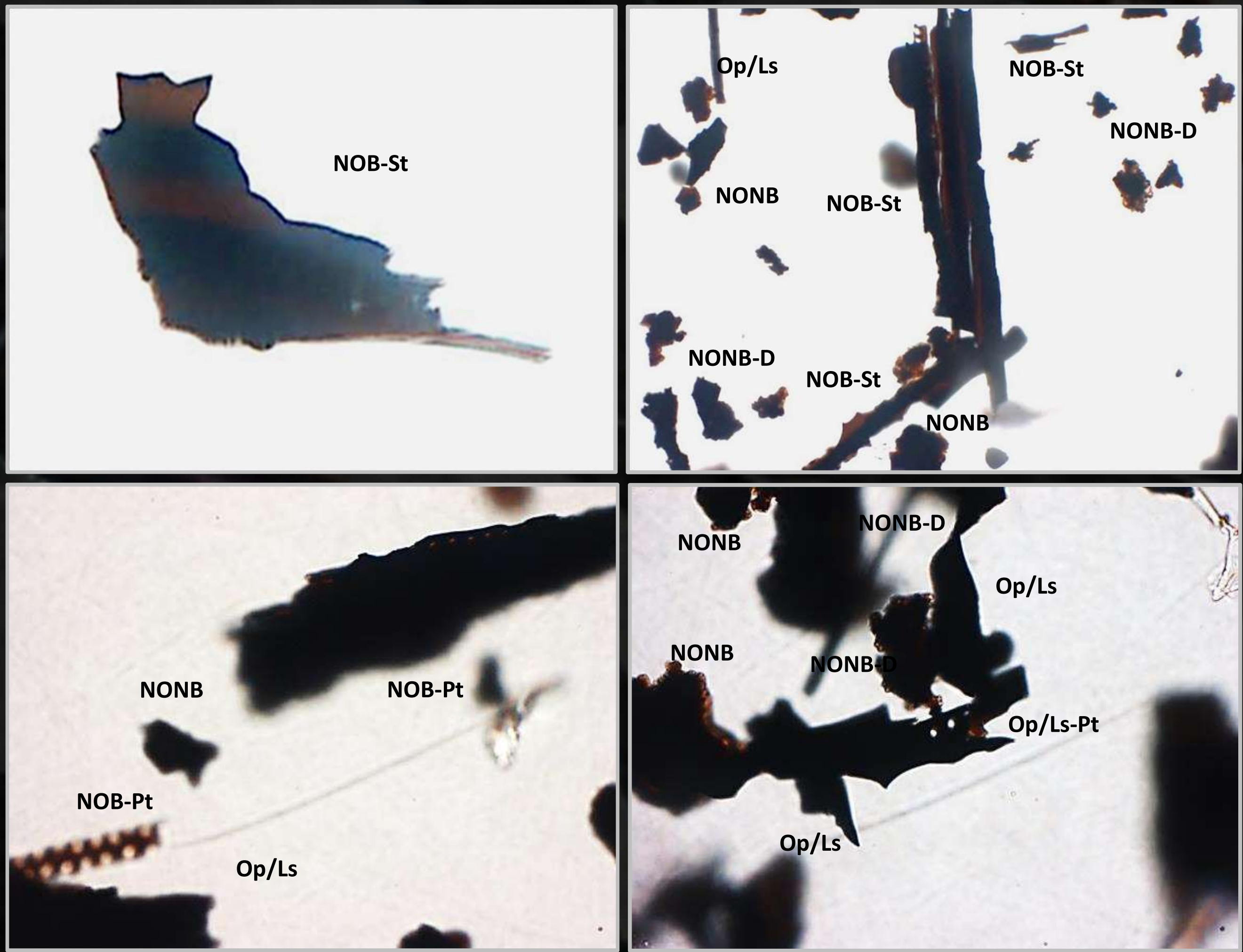
Sample PWG1 - Palynofacies Slides (PS)

- Palynofacies assemblage showing particles from phytoclast population (TWL);



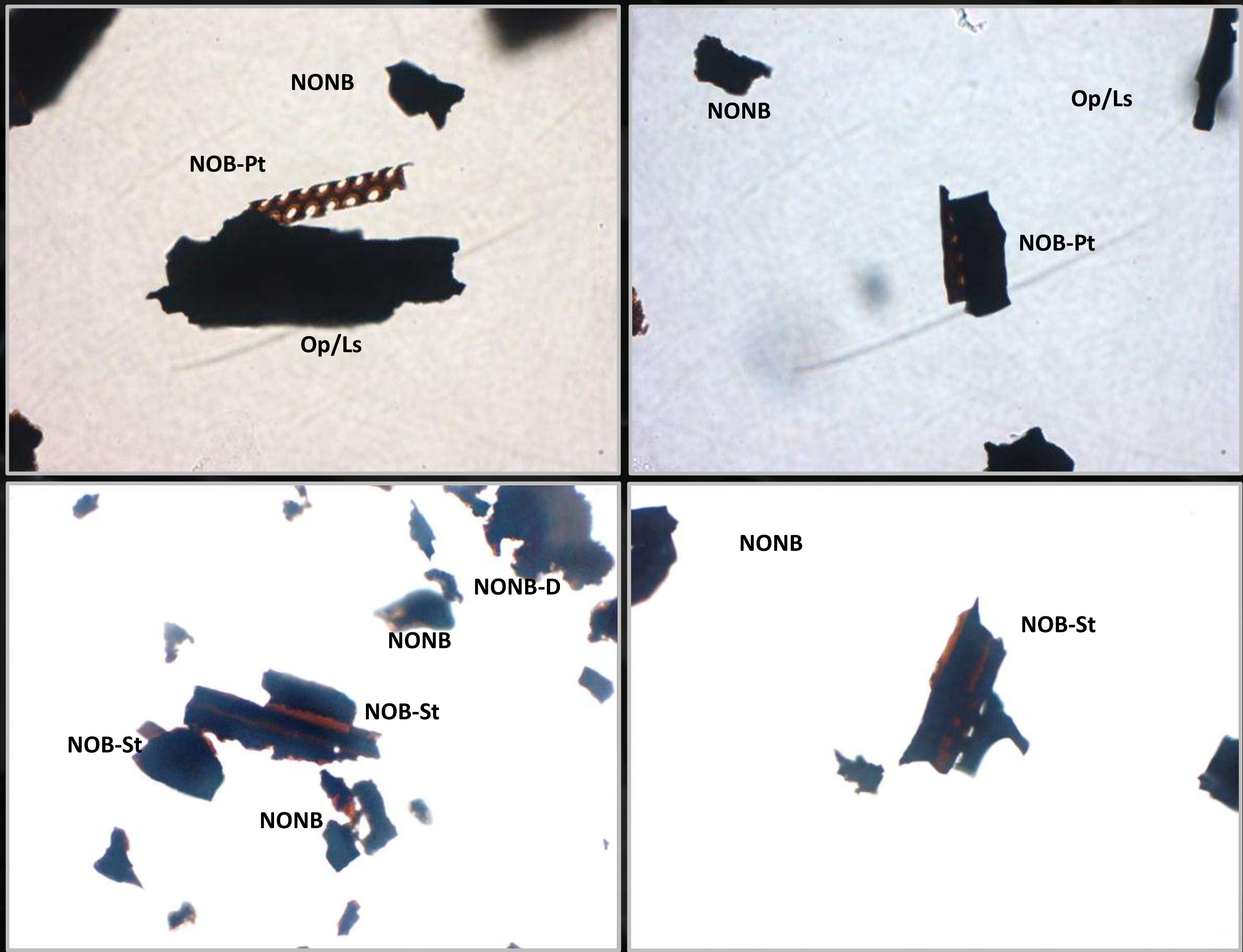
Sample PWG1 - Palynofacies Slides (PS)

- Palynofacies assemblage showing particles from phytoclast population (TWL);



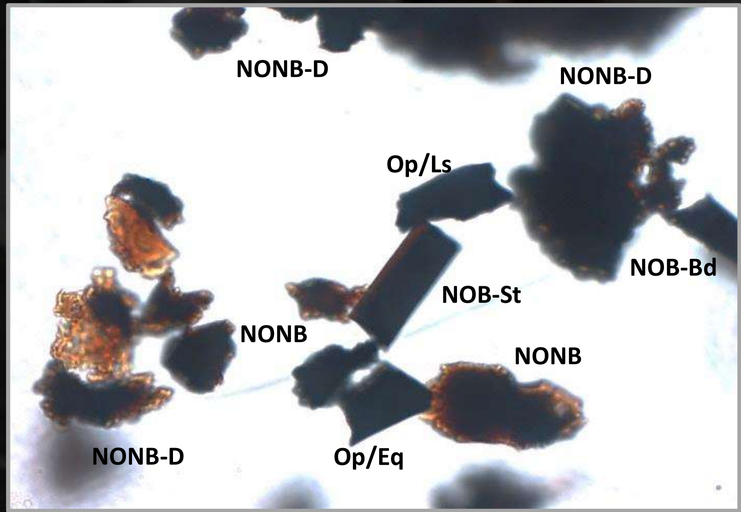
Sample PWG1 - Palynofacies Slides (PS)

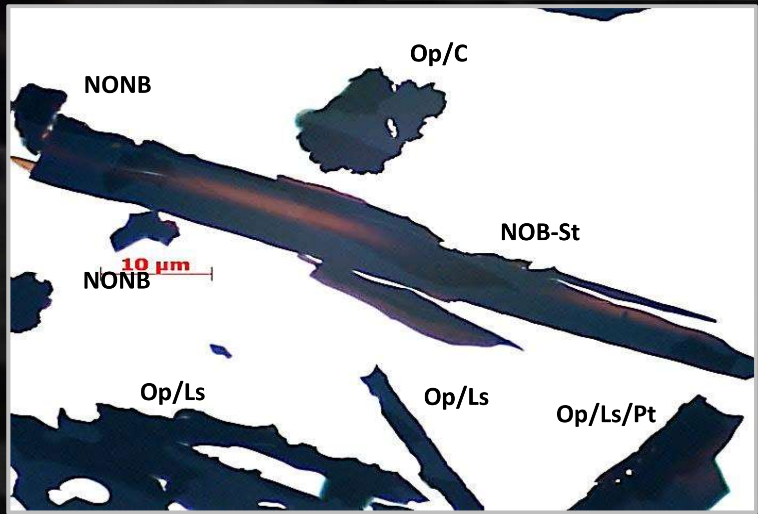
- Palynofacies assemblage showing particles from phytoclast population (TWL);



Sample PWG1 - Palynofacies Slides (PS)

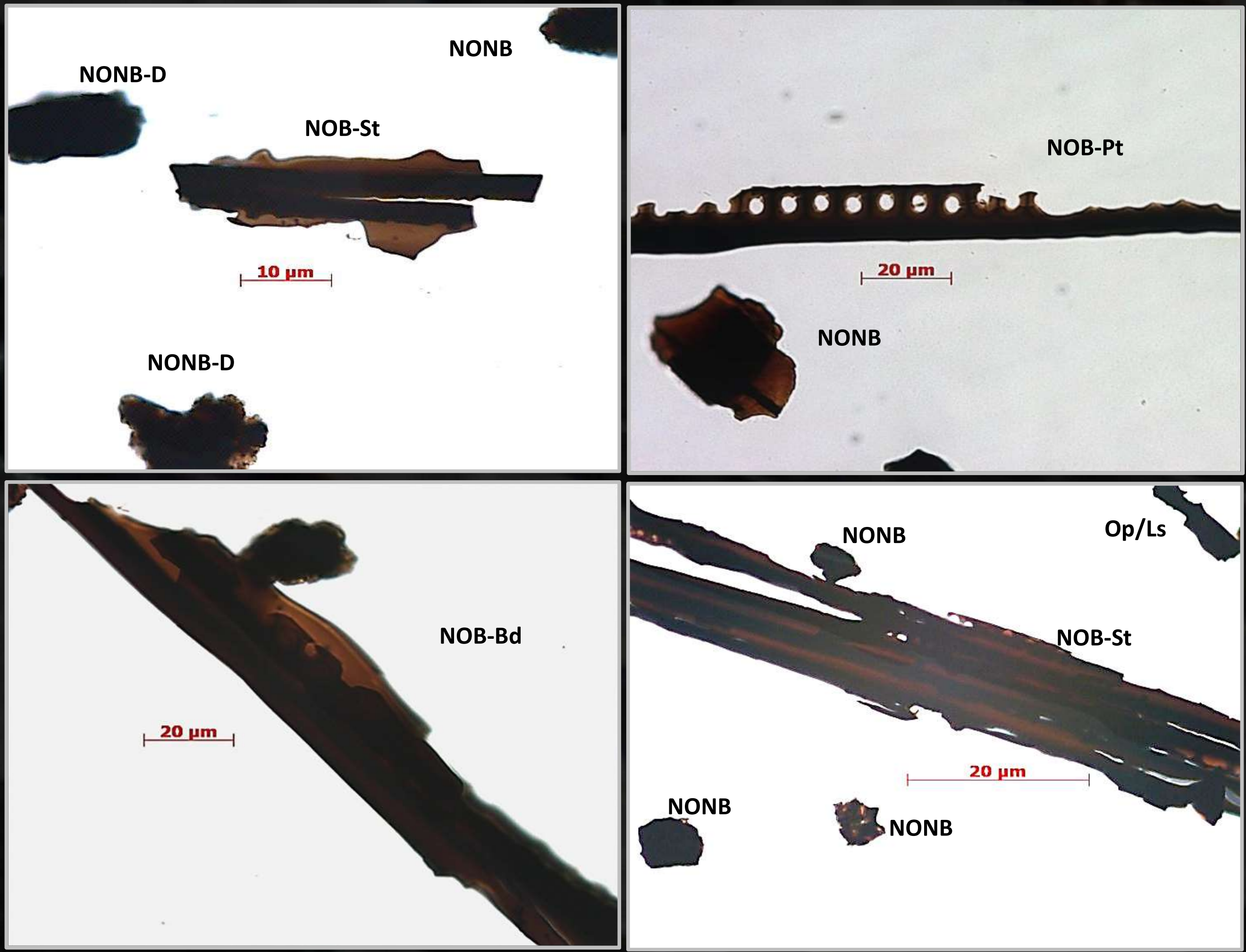
- Palynofacies assemblage showing particles from phytoclast population (TWL);





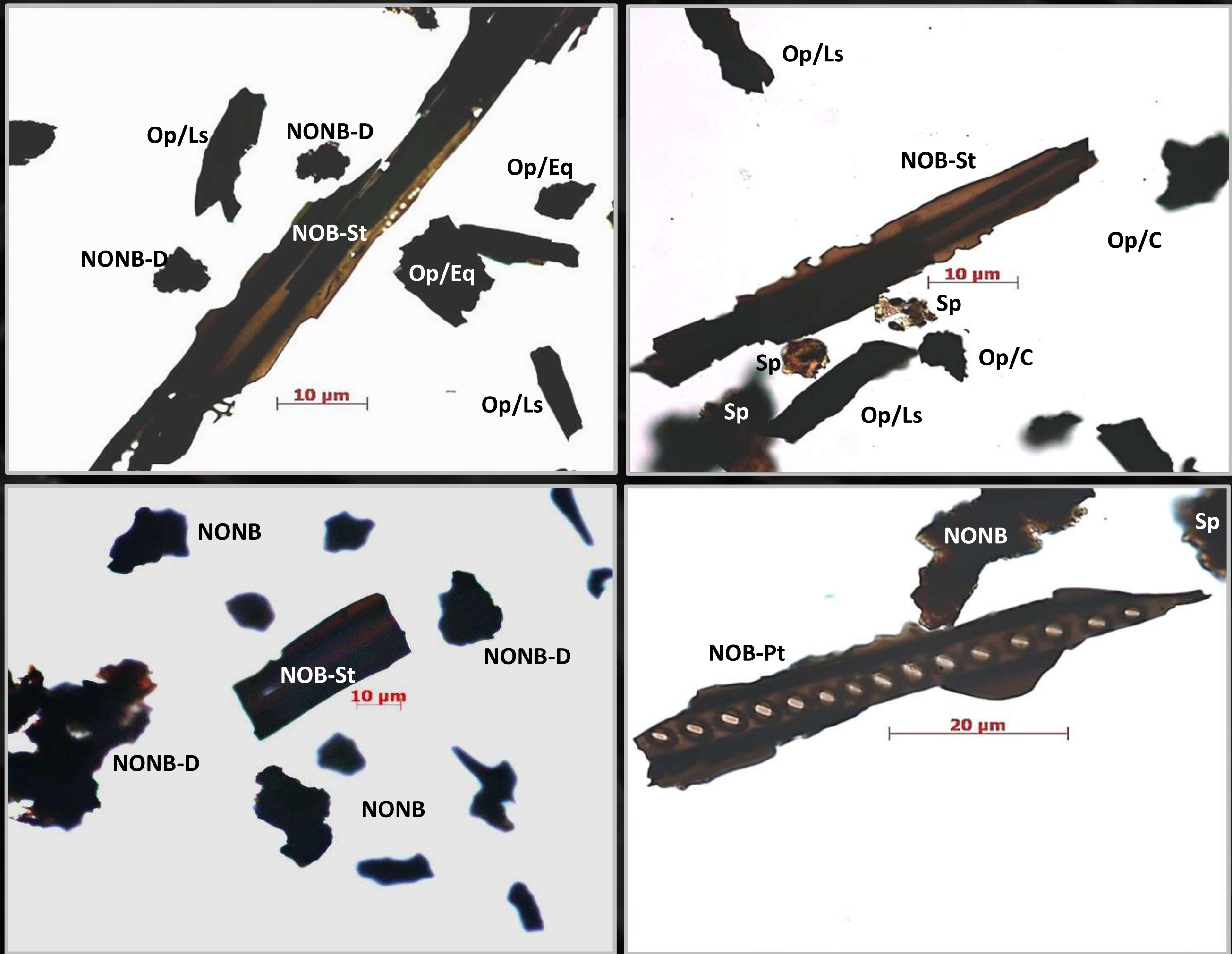
Sample PWG1 - Palynofacies Slides (PS)

- Palynofacies assemblage showing particles from phytoclast population (TWL);



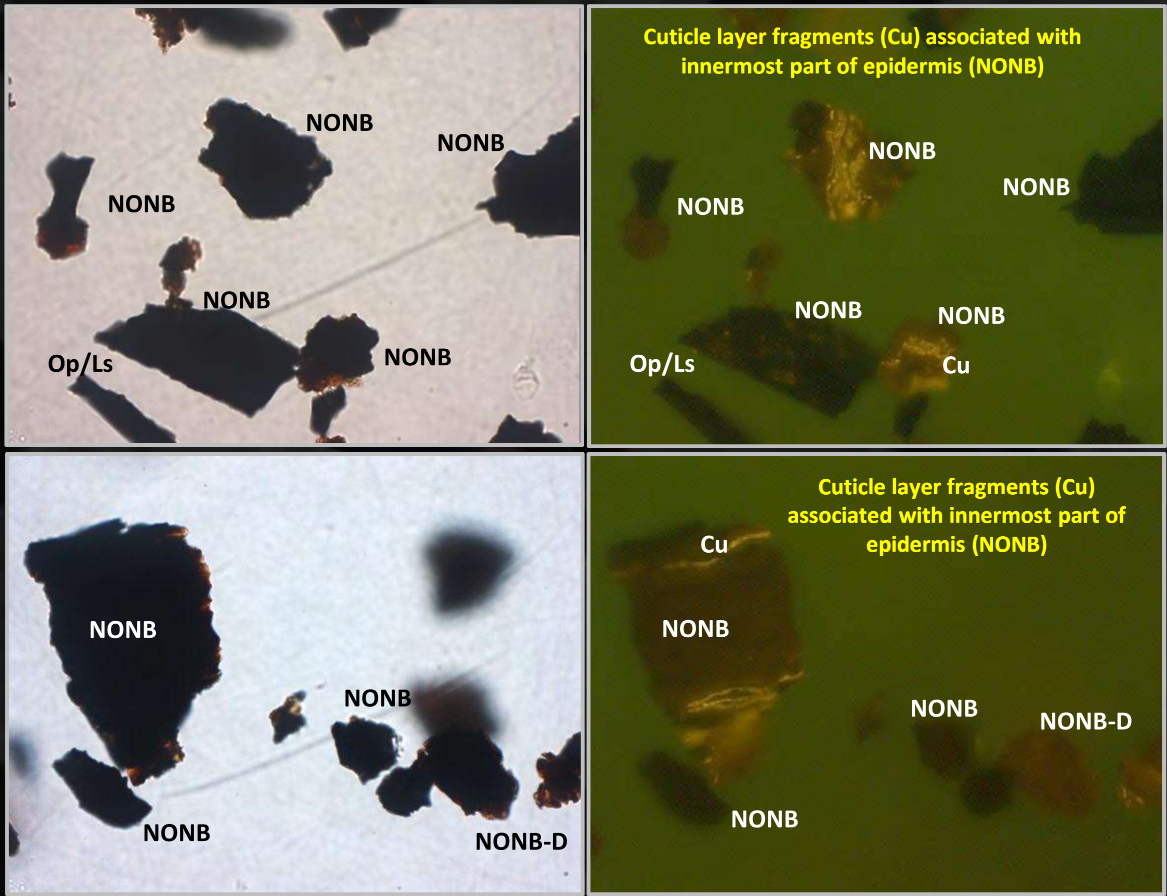
Sample PWG1 - Palynofacies Slides (PS)

- Palynofacies assemblage showing particles from phytoclast population (TWL);



Sample PWG1 - Palynofacies Slides (PS)

- Palynofacies assemblage showing particles from phytoclast population (TWL and FM);

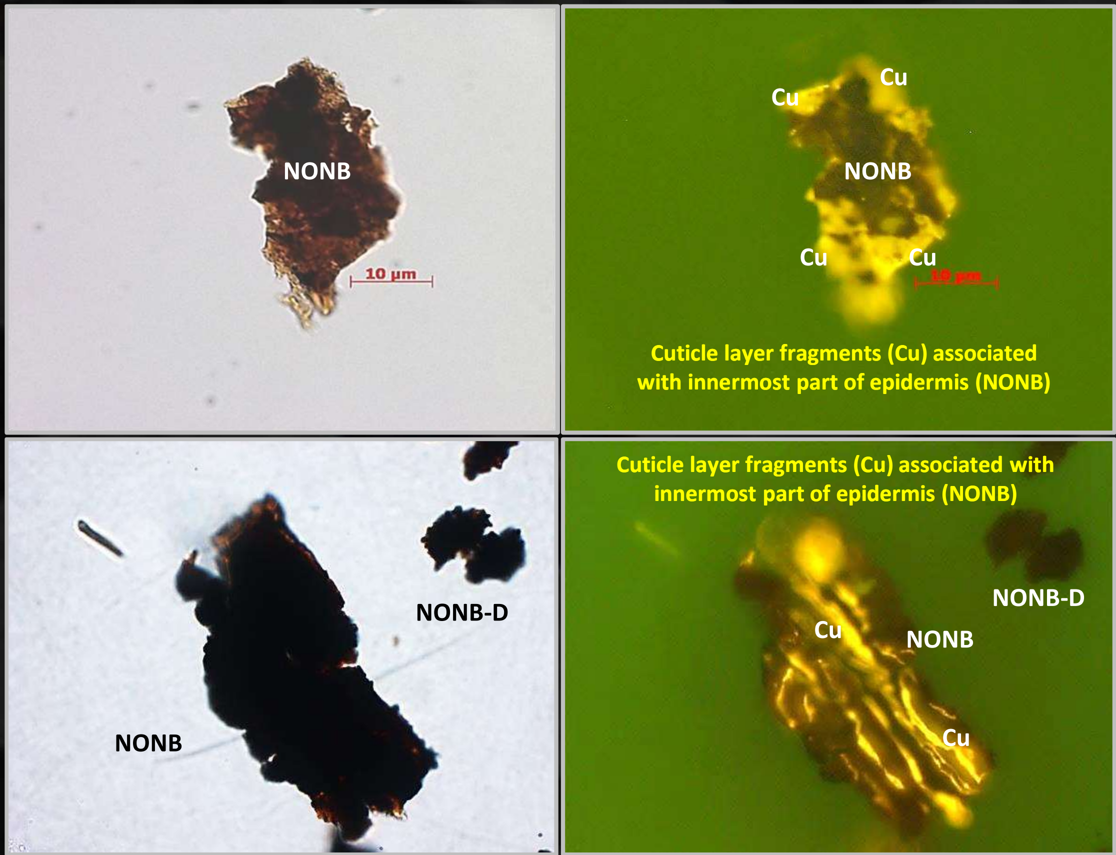


☼ The cuticle layer tends to detach as thin strips and sheets. Cuticle phytoclasts consist of thin, transparent sheets;

☼ When the cuticles also preserve more than one layer of tissues (more than the part of the wall of the outer surface of the cells or more than the outermost part of cuticular tissue), they can be confused with others types of phytoclasts (NONB), we named these particles as cuticle layer fragments associated with innermost part of epidermis;

Sample PWG1 - Palynofacies Slides (PS)

- Palynofacies assemblage showing particles from phytoclast population (TWL and FM);



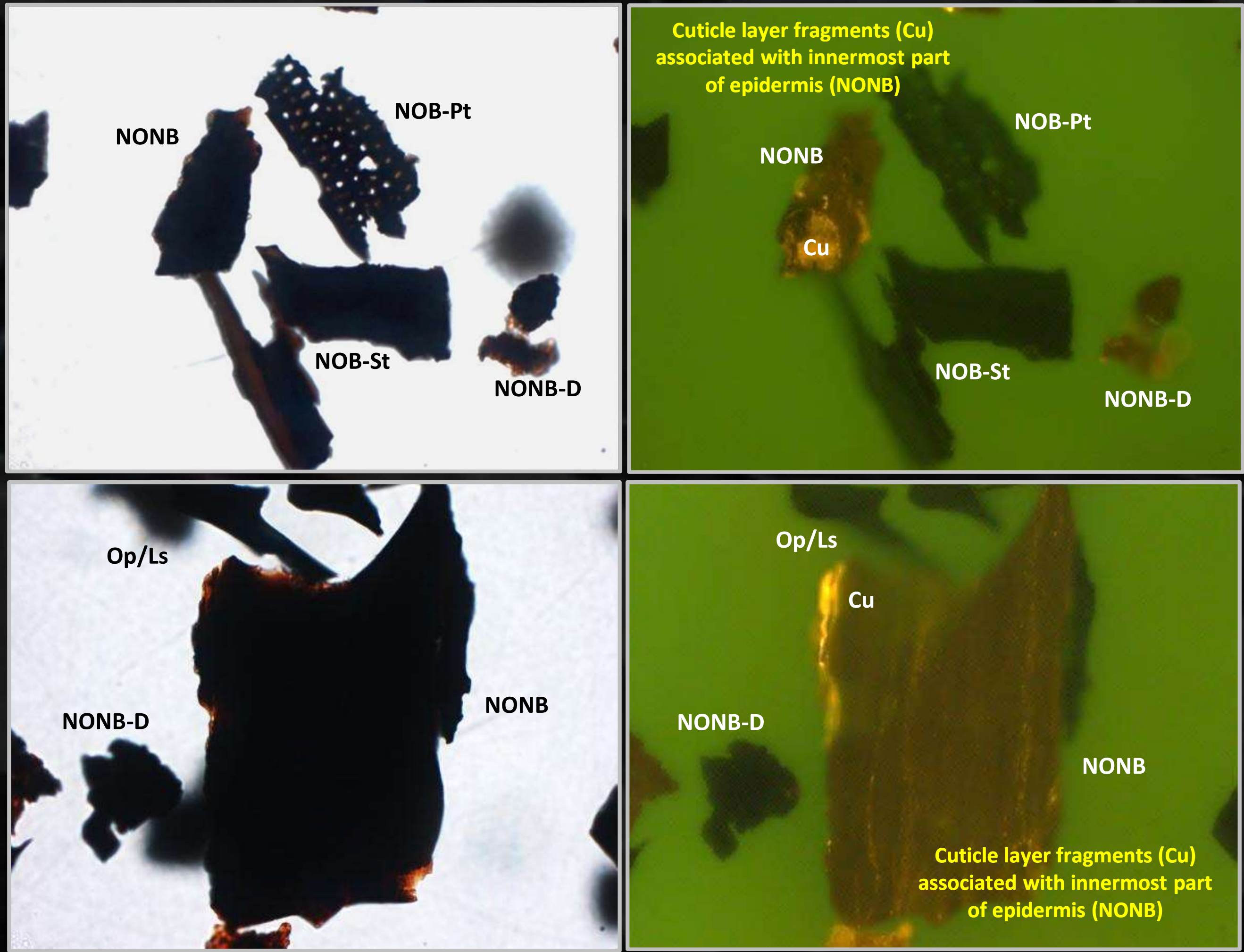
☼ This particular feature could be indicating that the land plants fragments derived from leaves;

☼ During degradation, the cellulosic tissues in the middle of the leaf degrade most rapidly (either completely destroyed or partly converted to "phyllovitrinite" when preserved);

☼ In the cuticle layer fragments associated with innermost part of epidermis: the cellulosic tissues in the middle of the leaf are preserved and they are converted to "phyllovitrinite";

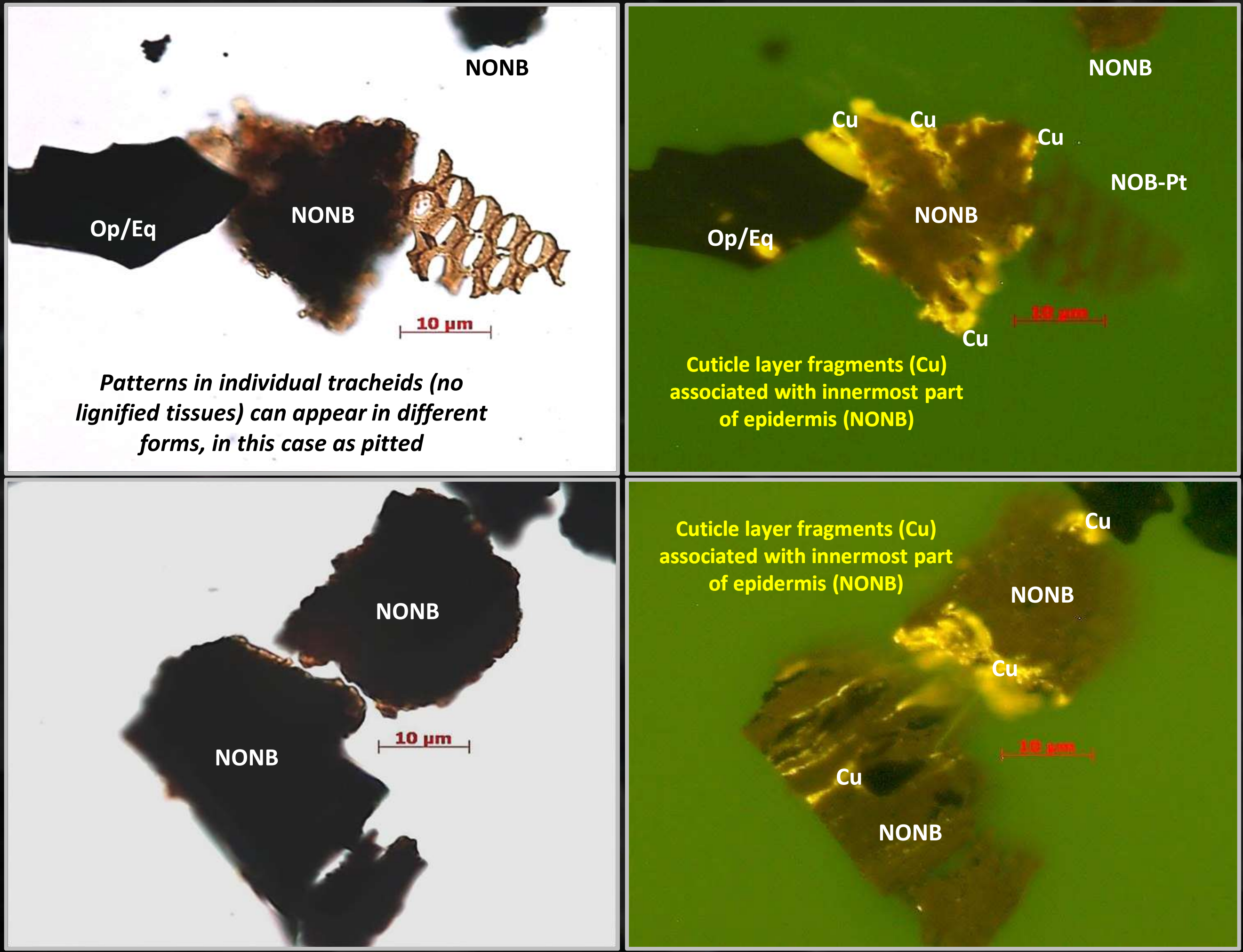
Sample PWG1 - Palynofacies Slides (PS)

- Palynofacies assemblage showing particles from phytoclast population (TWL and FM);



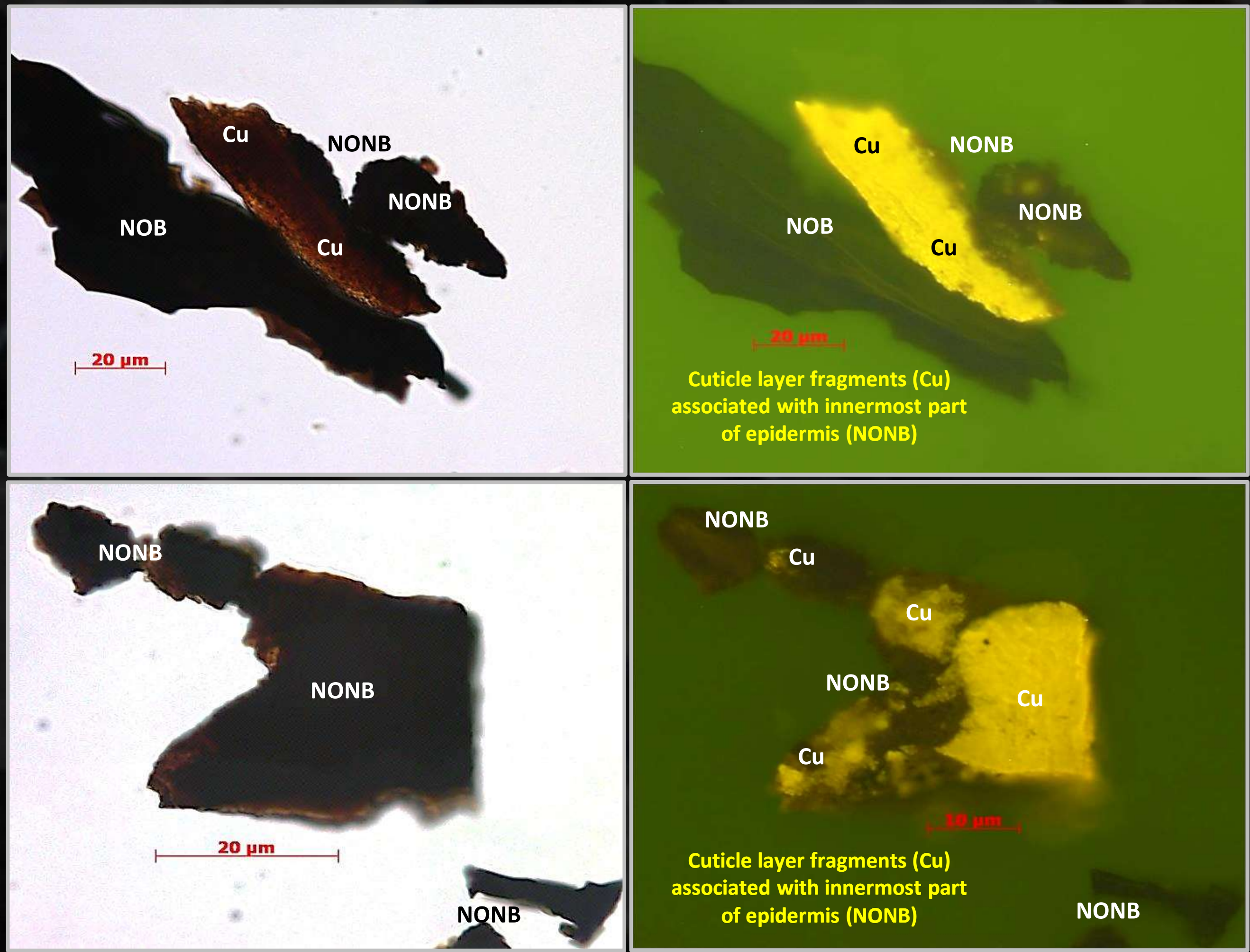
Sample PWG1 - Palynofacies Slides (PS)

- Palynofacies assemblage showing particles from phytoclast population (TWL and FM);



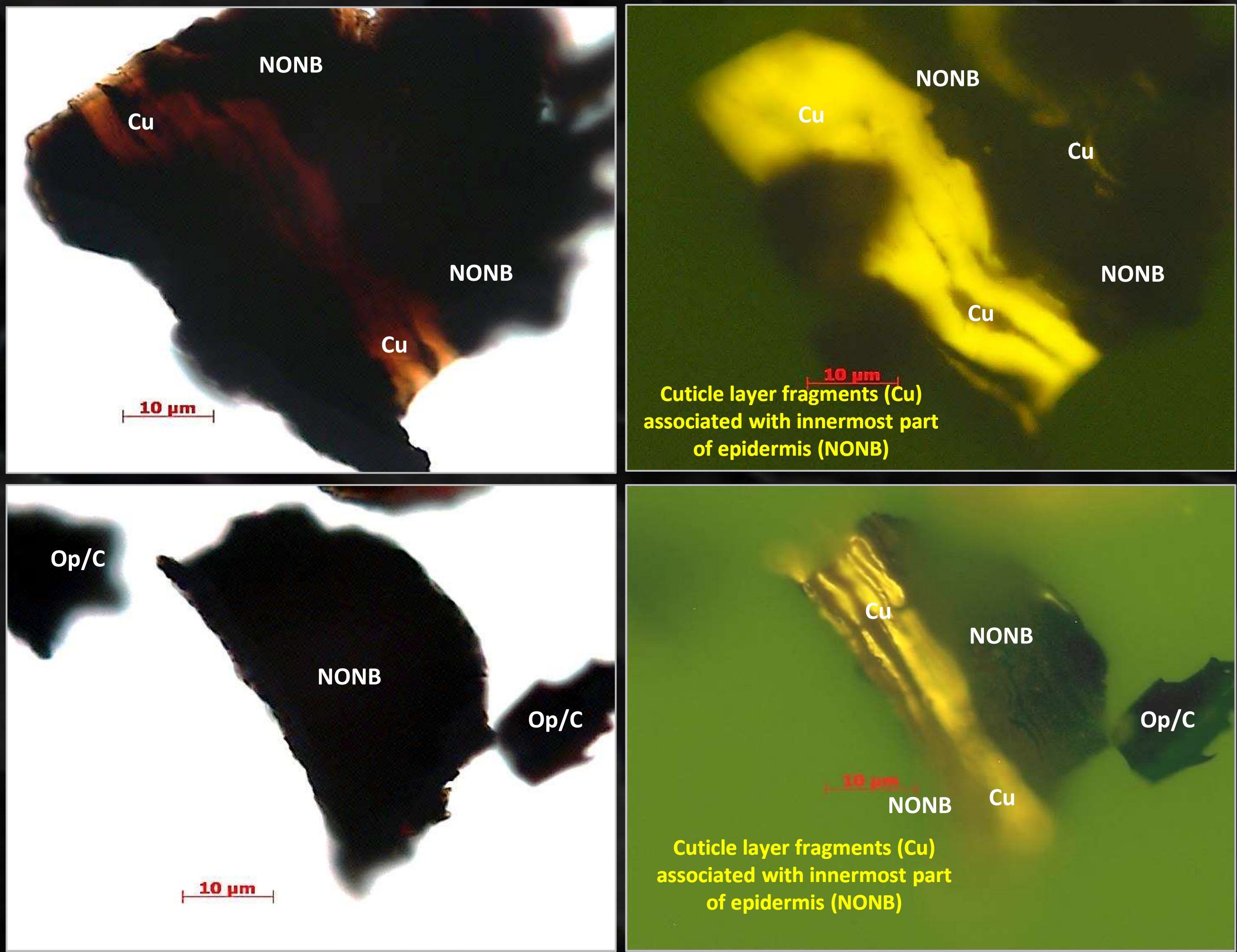
Sample PWG1 - Palynofacies Slides (PS)

- Palynofacies assemblage showing particles from phytoclast population (TWL and FM);



Sample PWG1 - Palynofacies Slides (PS)

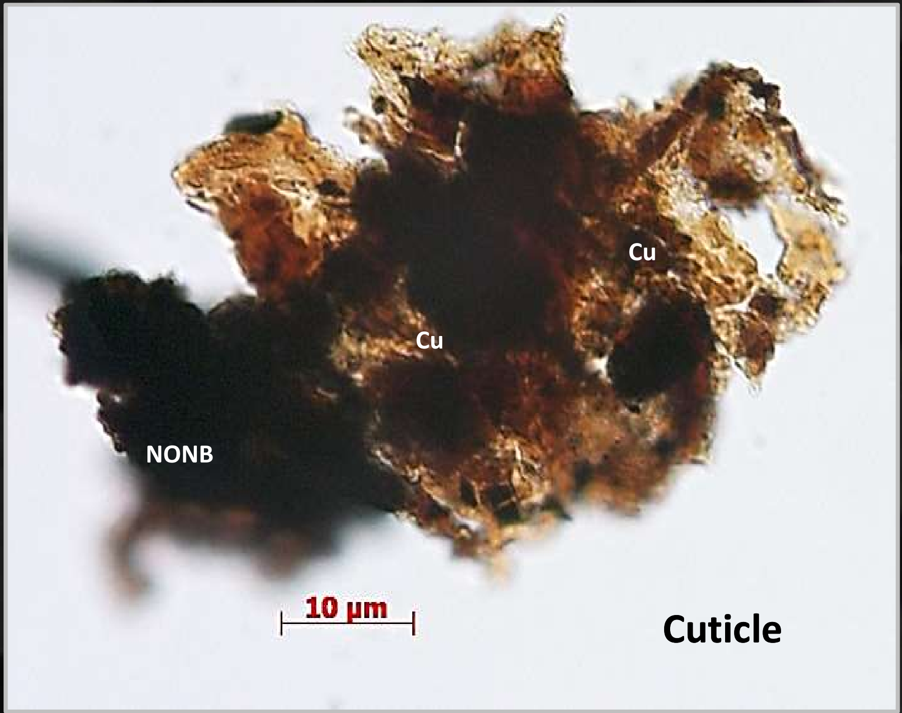
- Palynofacies assemblage showing particles from phytoclast population (TWL and FM);

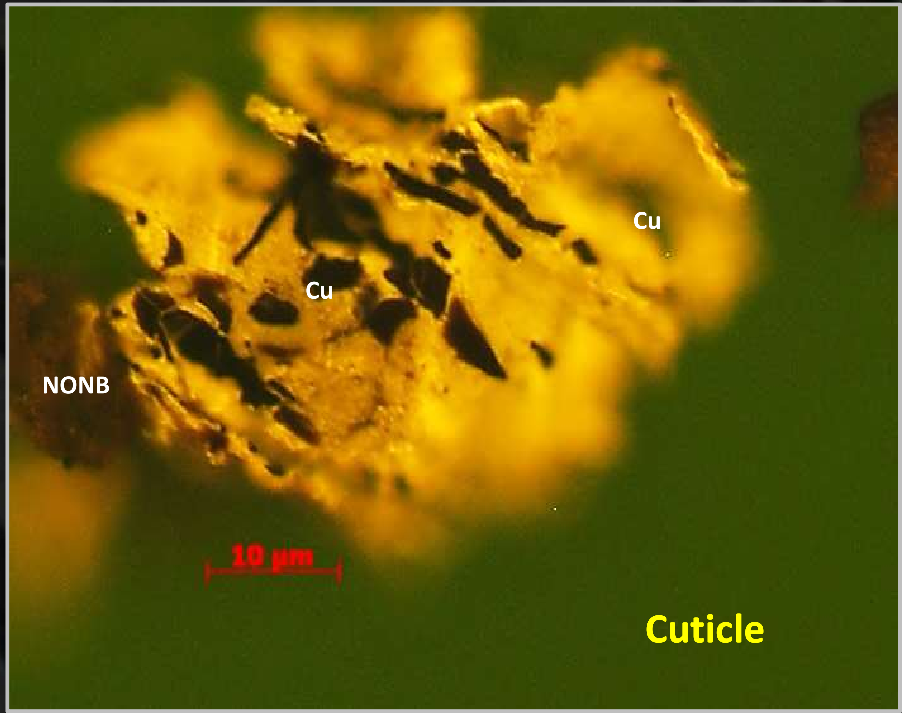


Sample PWG1 - Palynofacies Slides (PS)

- Palynofacies assemblage showing particles from phytoclast population (TWL and FM);

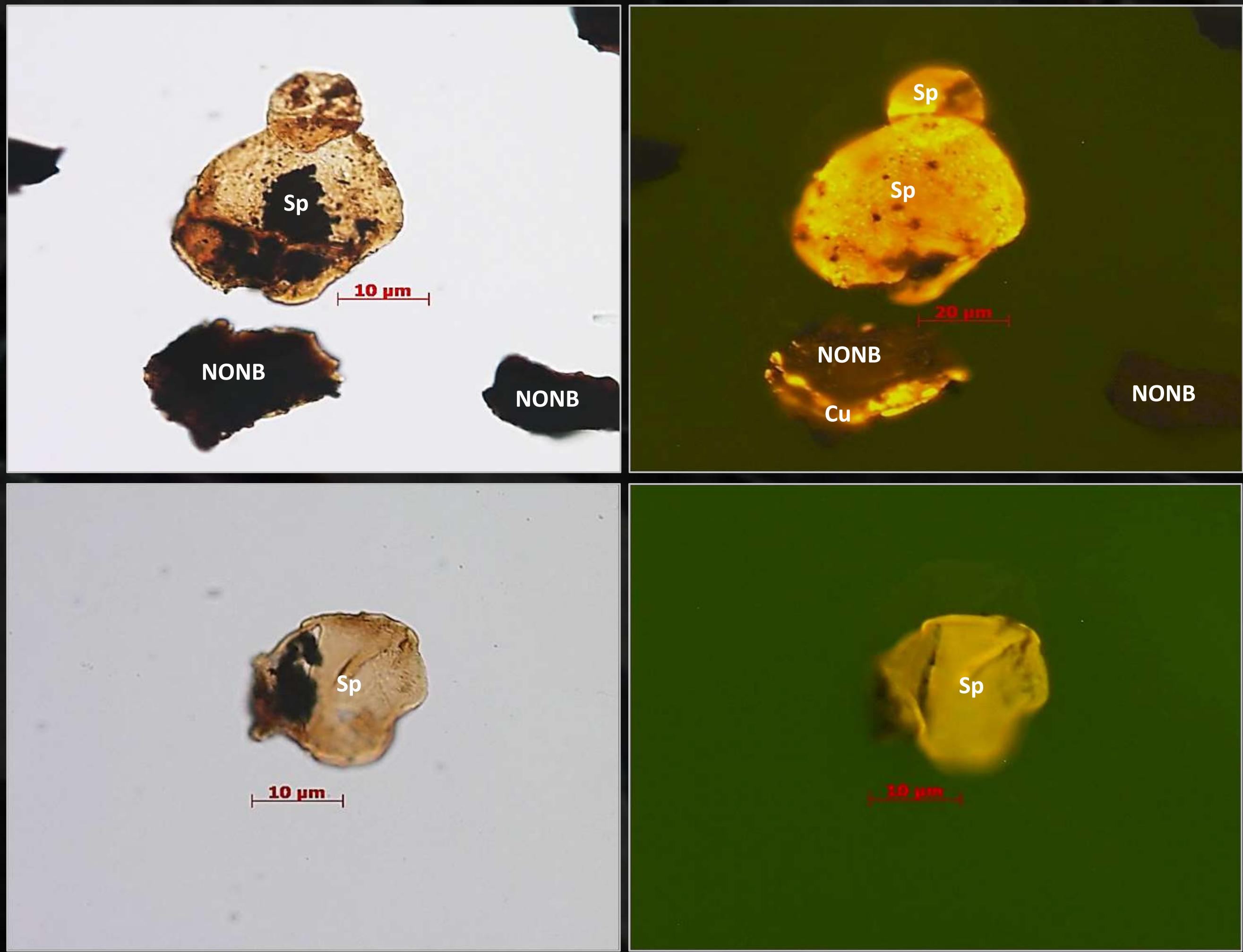
The cuticle layer detached as transparent sheets:





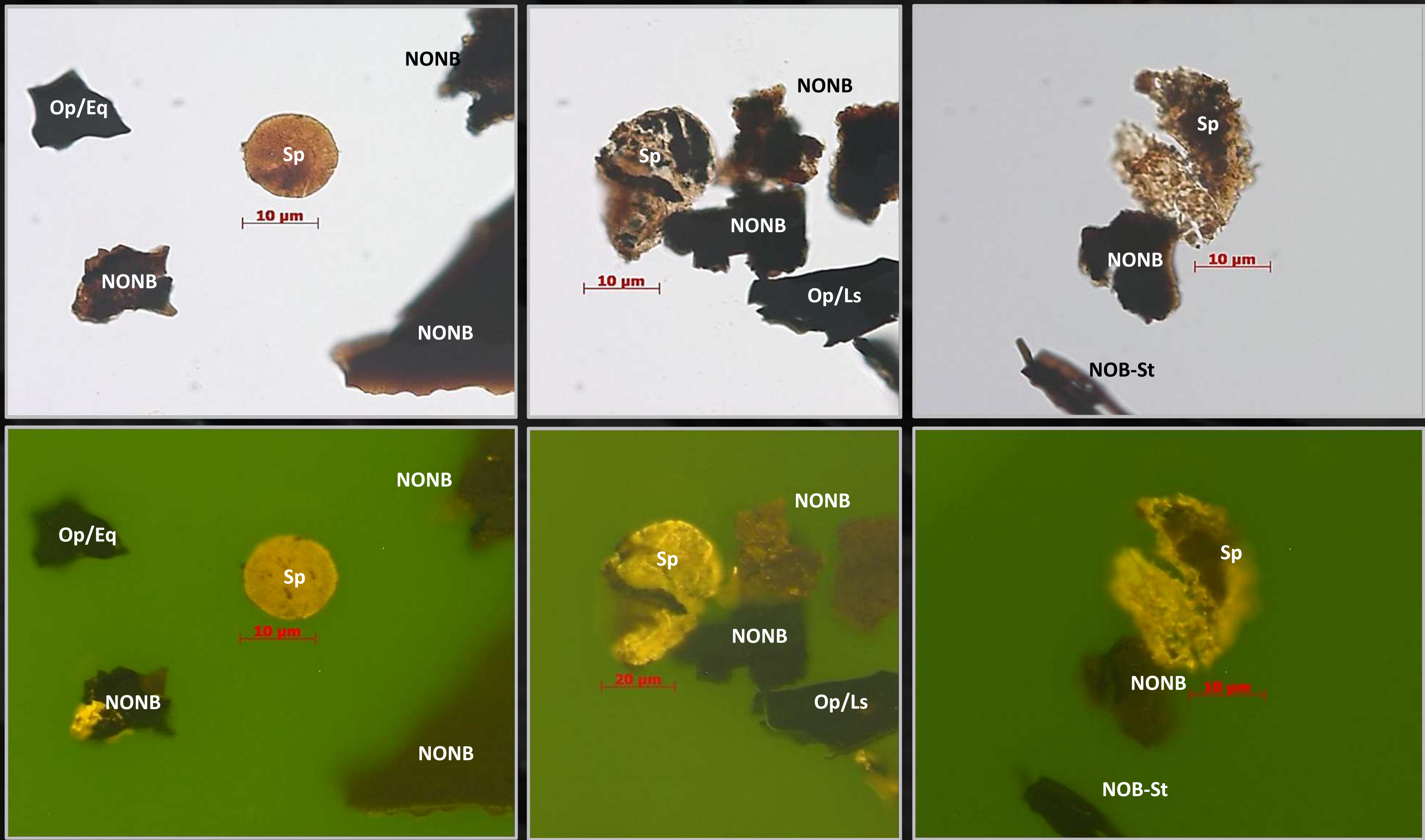
Sample PWG1 - Palynofacies Slides (PS)

- Palynofacies assemblage showing particles from palynomorph population (TWL and FM);



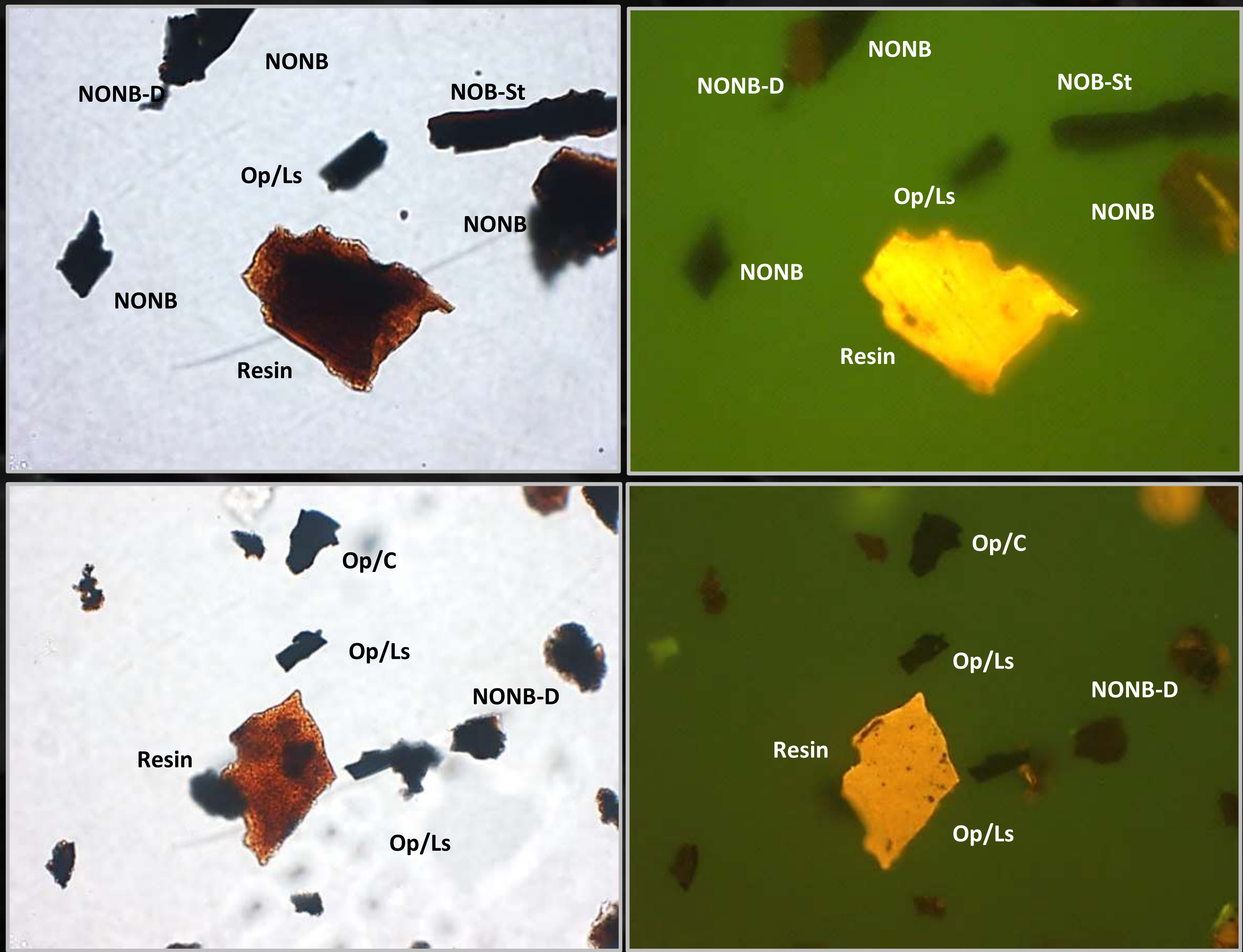
Sample PWG1 - Palynofacies Slides (PS)

- Palynofacies assemblage showing particles from palynomorph population (TWL and FM);



Sample PWG1 - Palynofacies Slides (PS)

- Palynofacies assemblage showing particles from AOM population (TWL and FM);



Photomicrographies
Sample PWG1 – RWL and FM
Polished Section – Whole Rock (WR)

Legend:

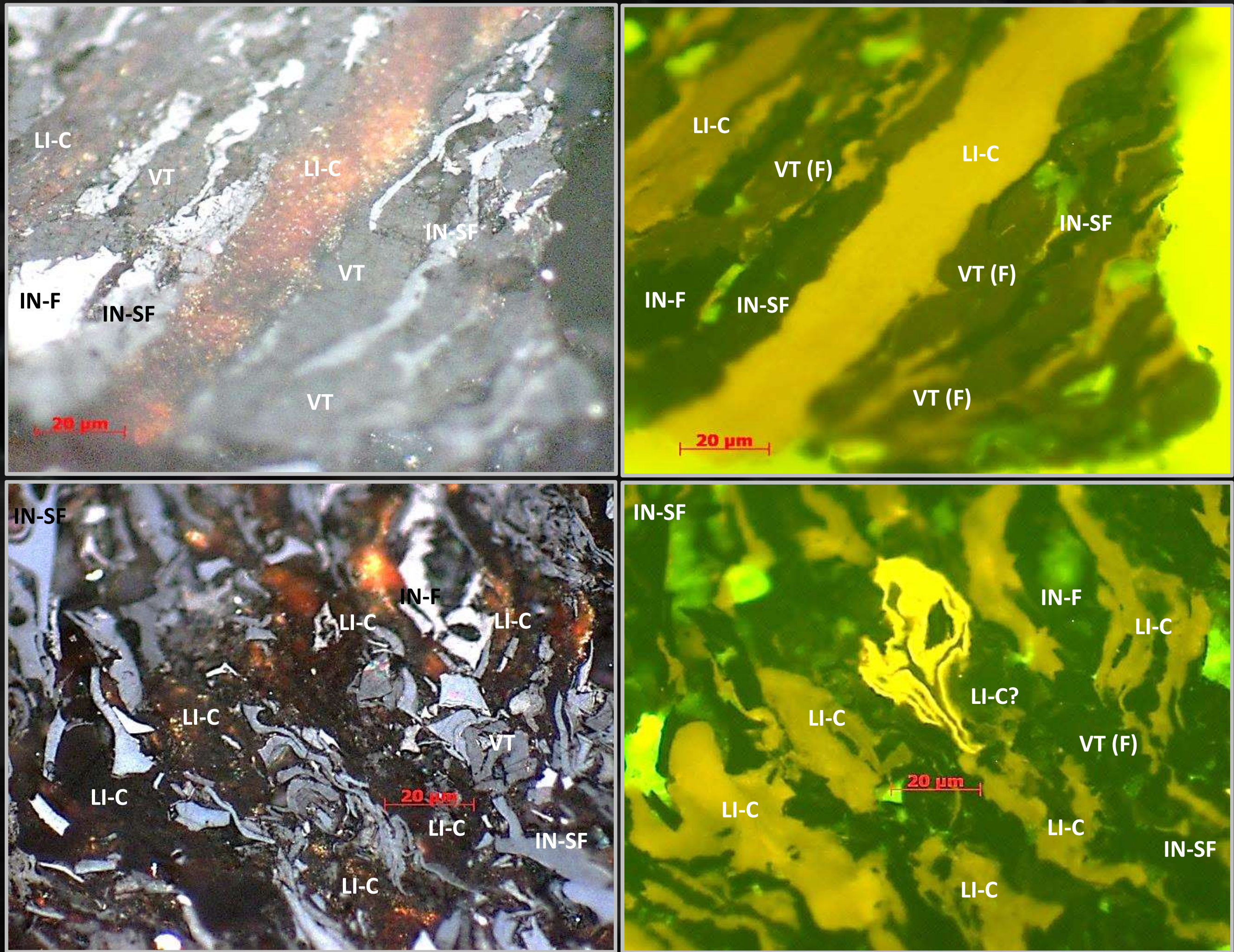
VT: Vitrinite
- **VT (F):** Vitrinite Fluorescent;

IN: Inertinite
- **IN-F:** Fusinite;
- **IN-SF:** Semifusinite;

LI: Liptinite
- **LI-S:** Sporinite;
- **LI-C:** Cutinite;
- **LI-R:** Resinite;

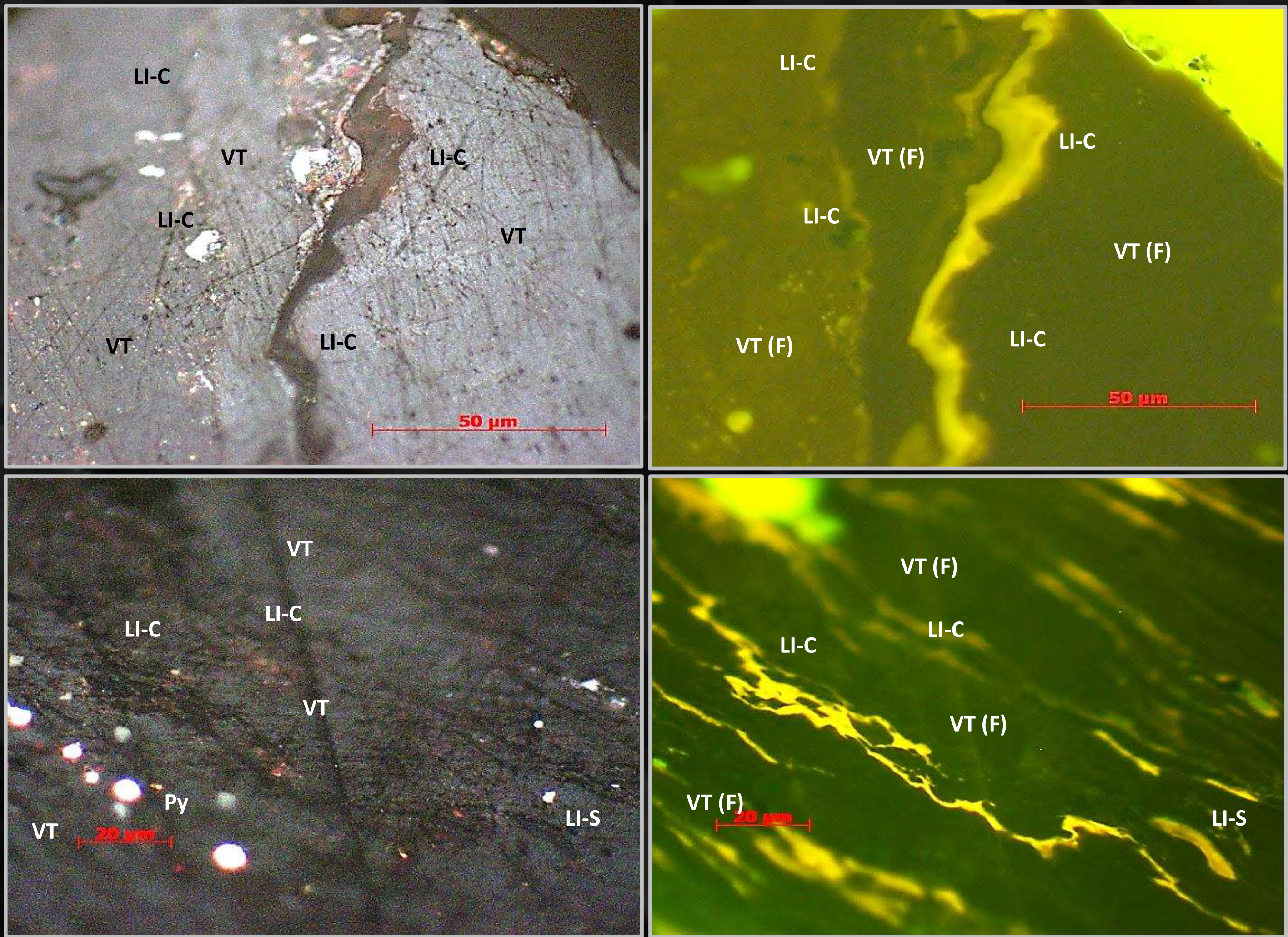
Sample PWG1 – Polished Section (WR)

٥ Maceral Groups in RWL and FM on WR polished section
(association among vitrinite, fusinite, semifusinite and cutinite)



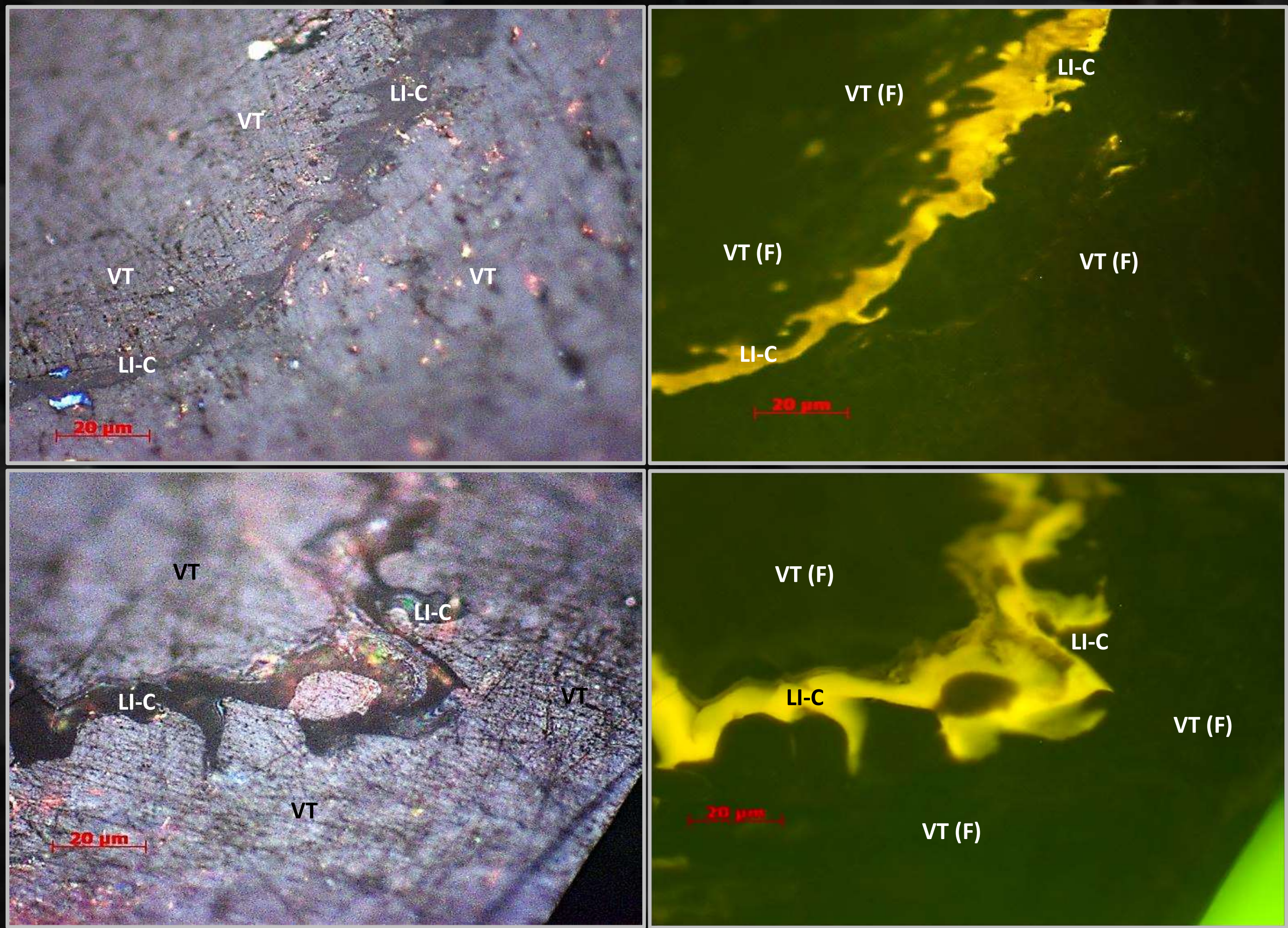
Sample PWG1 – Polished Section (WR)

- Maceral Groups in RWL and FM on WR polished section
  (association between vitrinite and cutinite/sporinite)



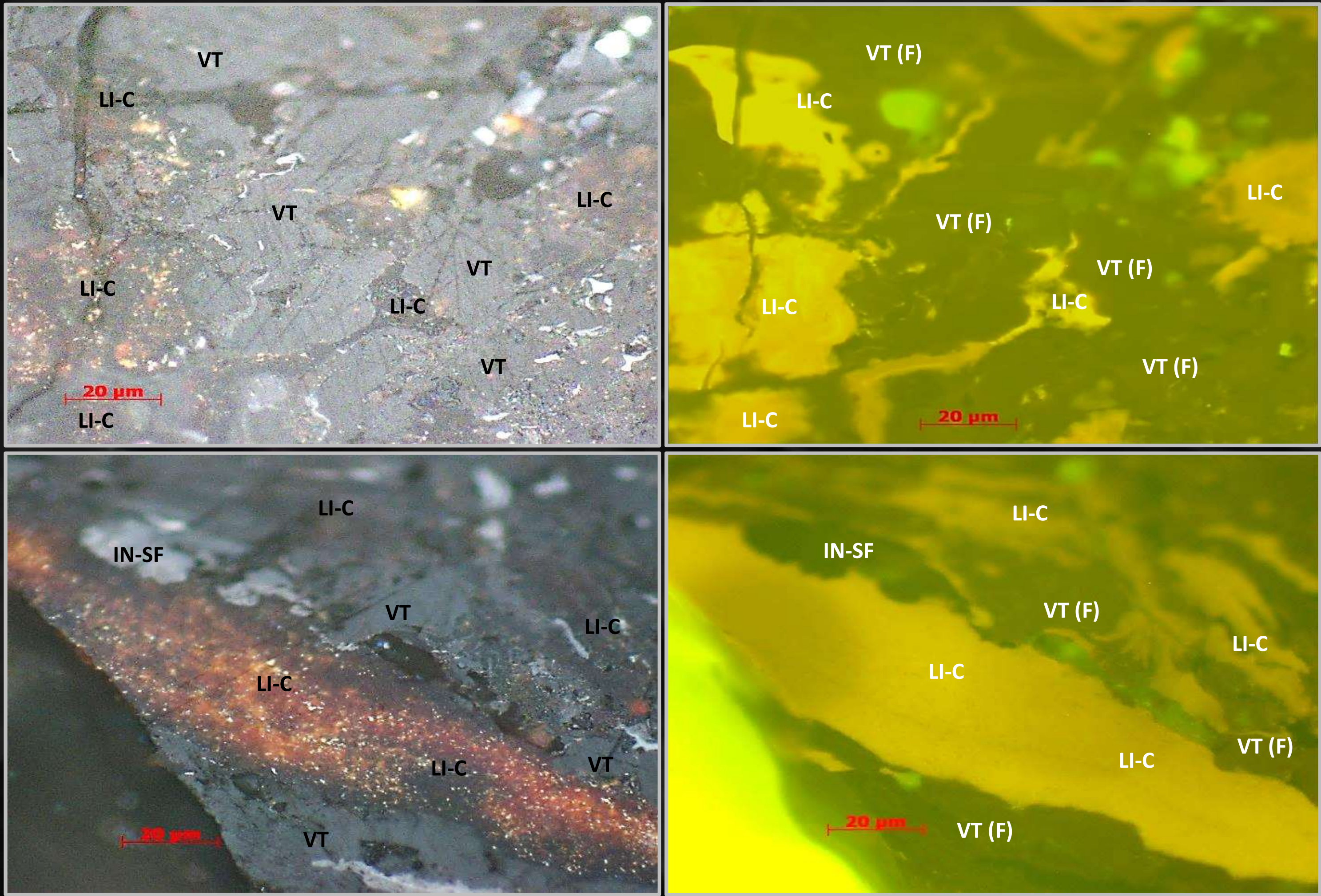
Sample PWG1 – Polished Section (WR)

- Maceral Groups in RWL and FM on WR polished section
(association between vitrinite and cutinite)



Sample PWG1 – Polished Section (WR)

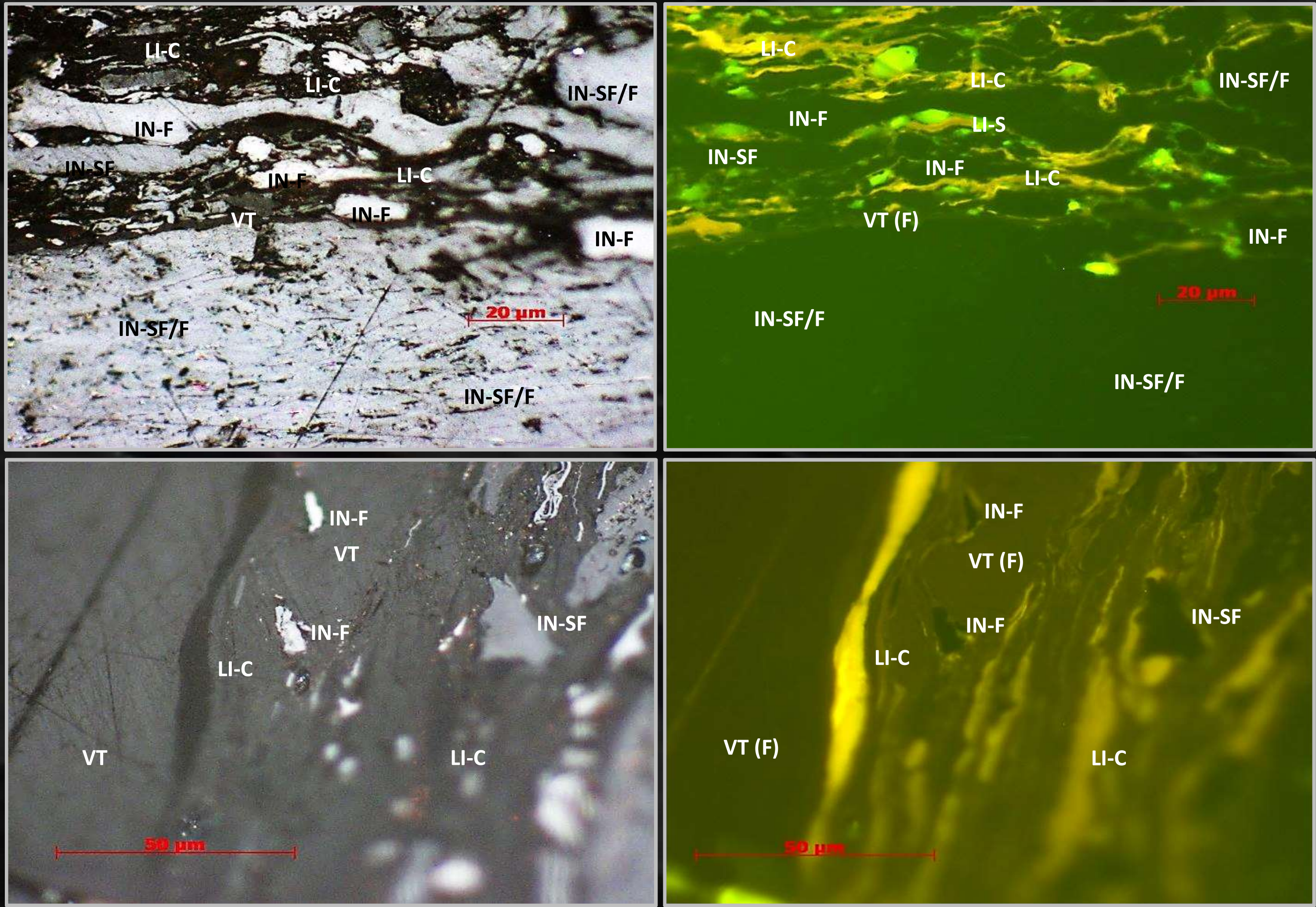
- Maceral Groups in RWL and FM on WR polished section
  (association among vitrinite, fusinite, semifusinite and cutinite)



Sample PWG1 – Polished Section (WR)

- Maceral Groups in RWL and FM on WR polished section

(association among vitrinite, fusinite, semifusinite and cutinite)



Photomicrographies
Sample PWG1 – RWL and FM
Polished Section – Kerogen Concentrate (KC)

Legend:

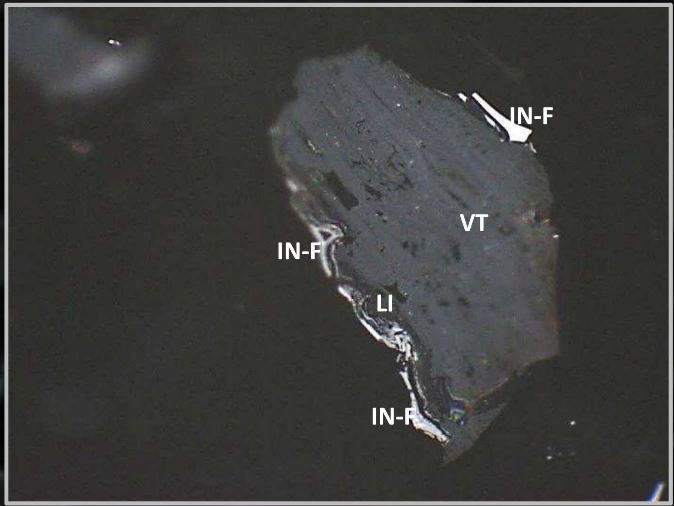
VT: Vitrinite
- **VT (F):** Vitrinite Fluorescent;

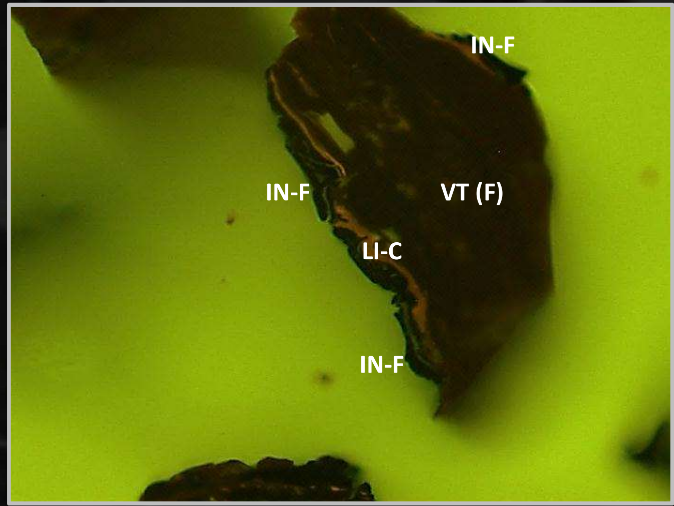
IN: Inertinite
- **IN-F:** Fusinite;
- **IN-SF:** Semifusinite;

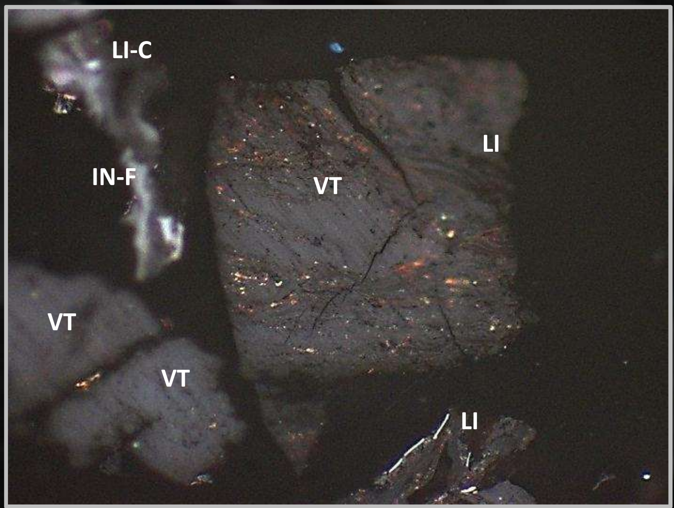
LI: Liptinite
- **LI-S:** Sporinite;
- **LI-C:** Cutinite;
- **LI-R:** Resinite;

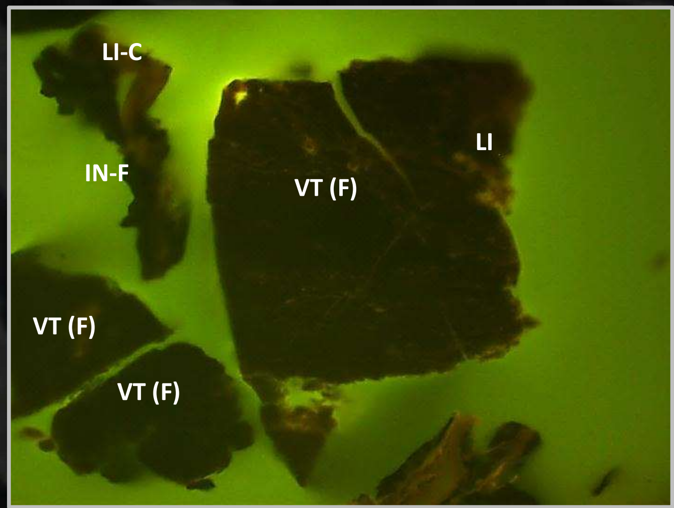
Sample PWG1 – Polished Section (KC)

- Maceral Groups in RWL and FM on KC polished section (association among vitrinite, fusinite, semifusinite and cutinite)



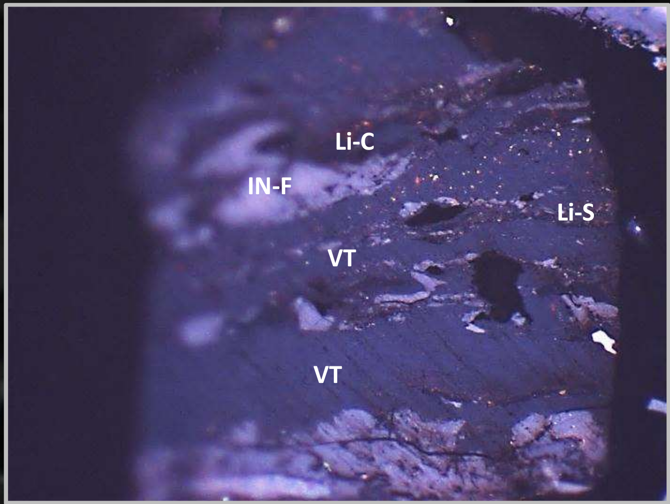


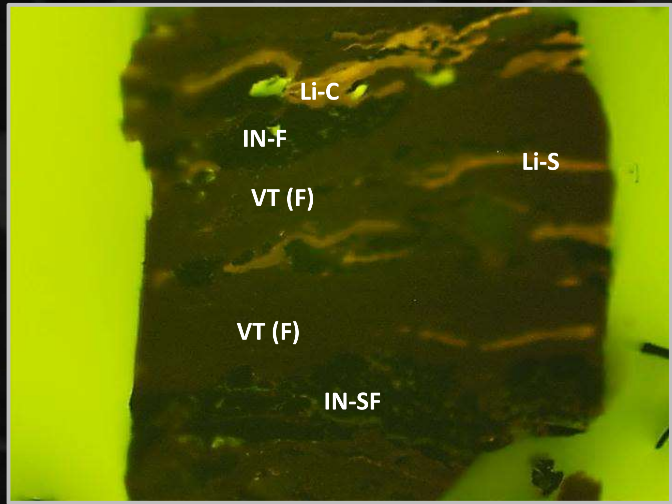


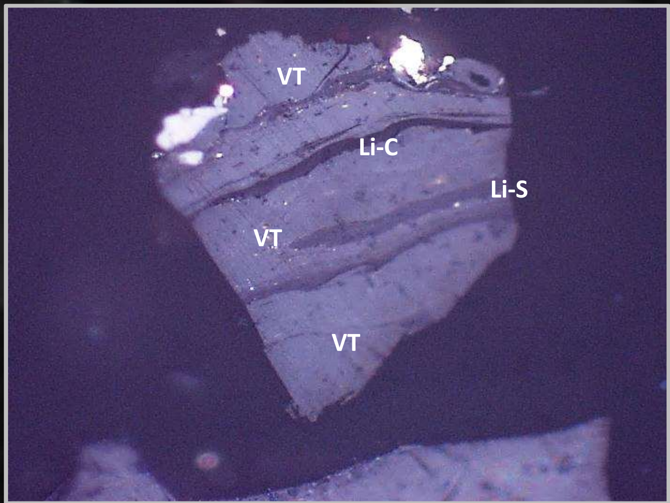


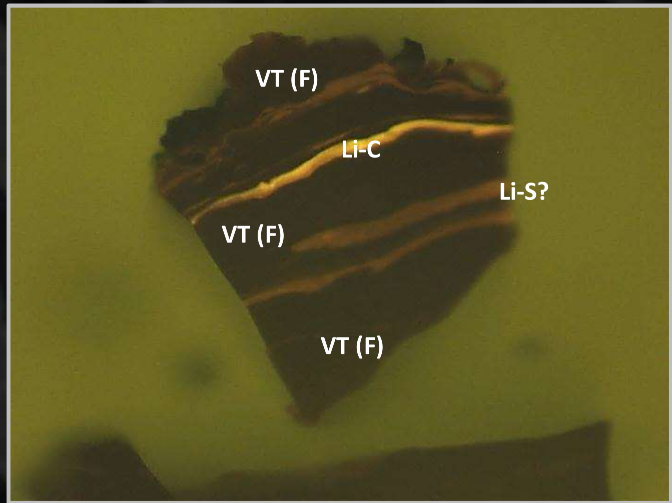
Sample PWG1 – Polished Section (KC)

- Maceral Groups in RWL and FM on KC polished section
(association among vitrinite, fusinite, semifusinite and cutinite)



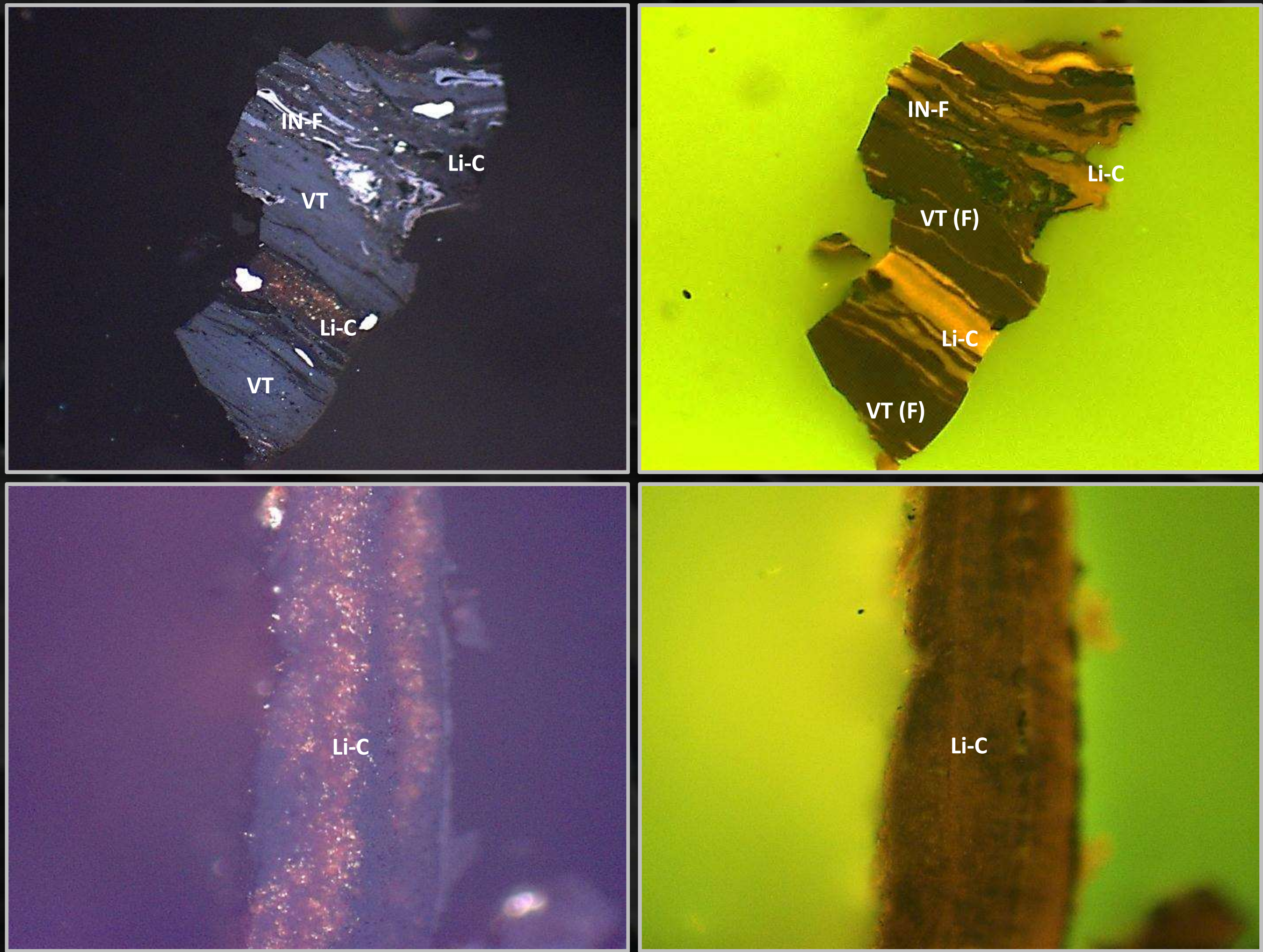






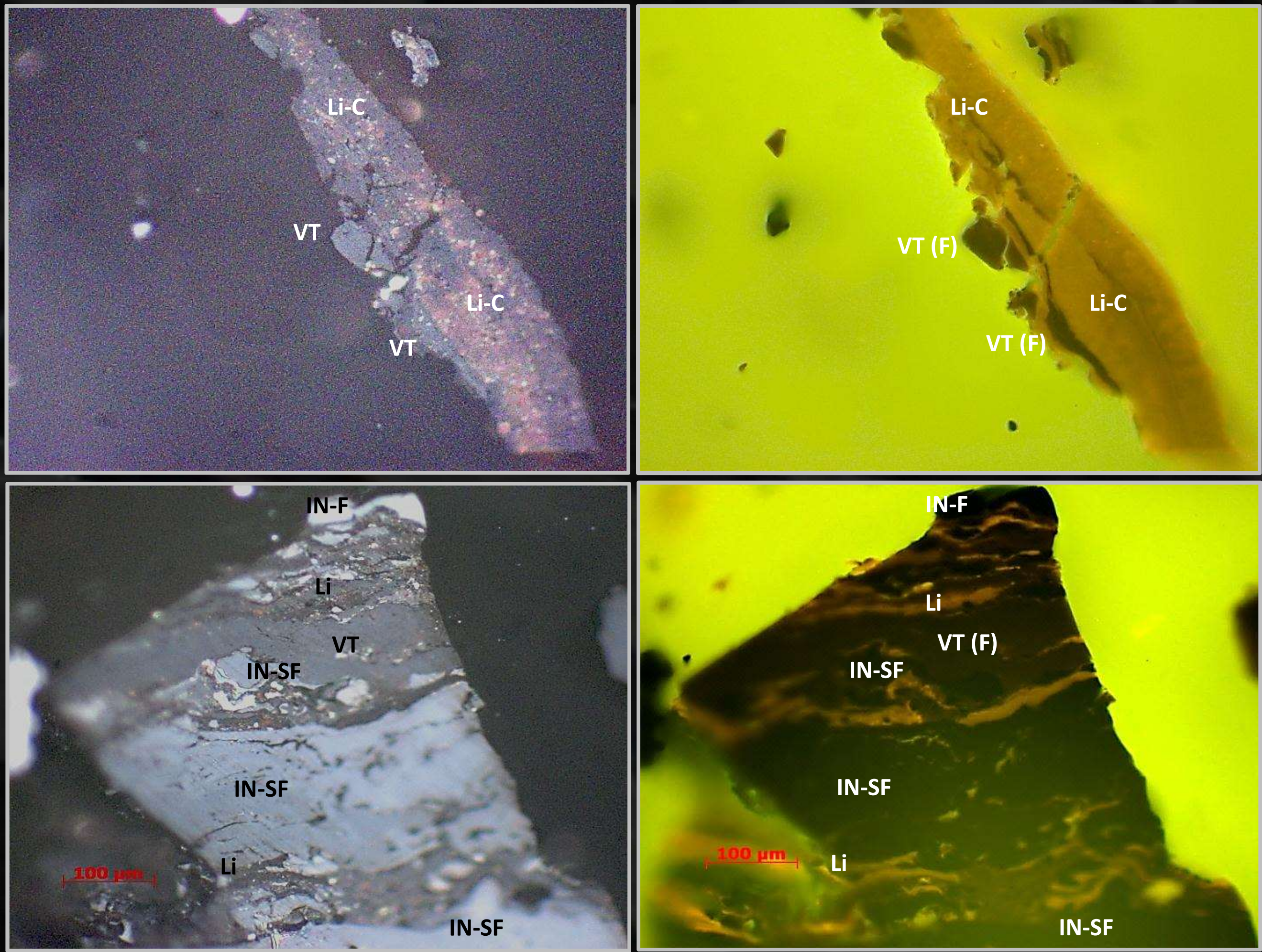
Sample PWG1 – Polished Section (KC)

- Maceral Groups in RWL and FM on KC polished section
(association among vitrinite, fusinite, semifusinite and cutinite)



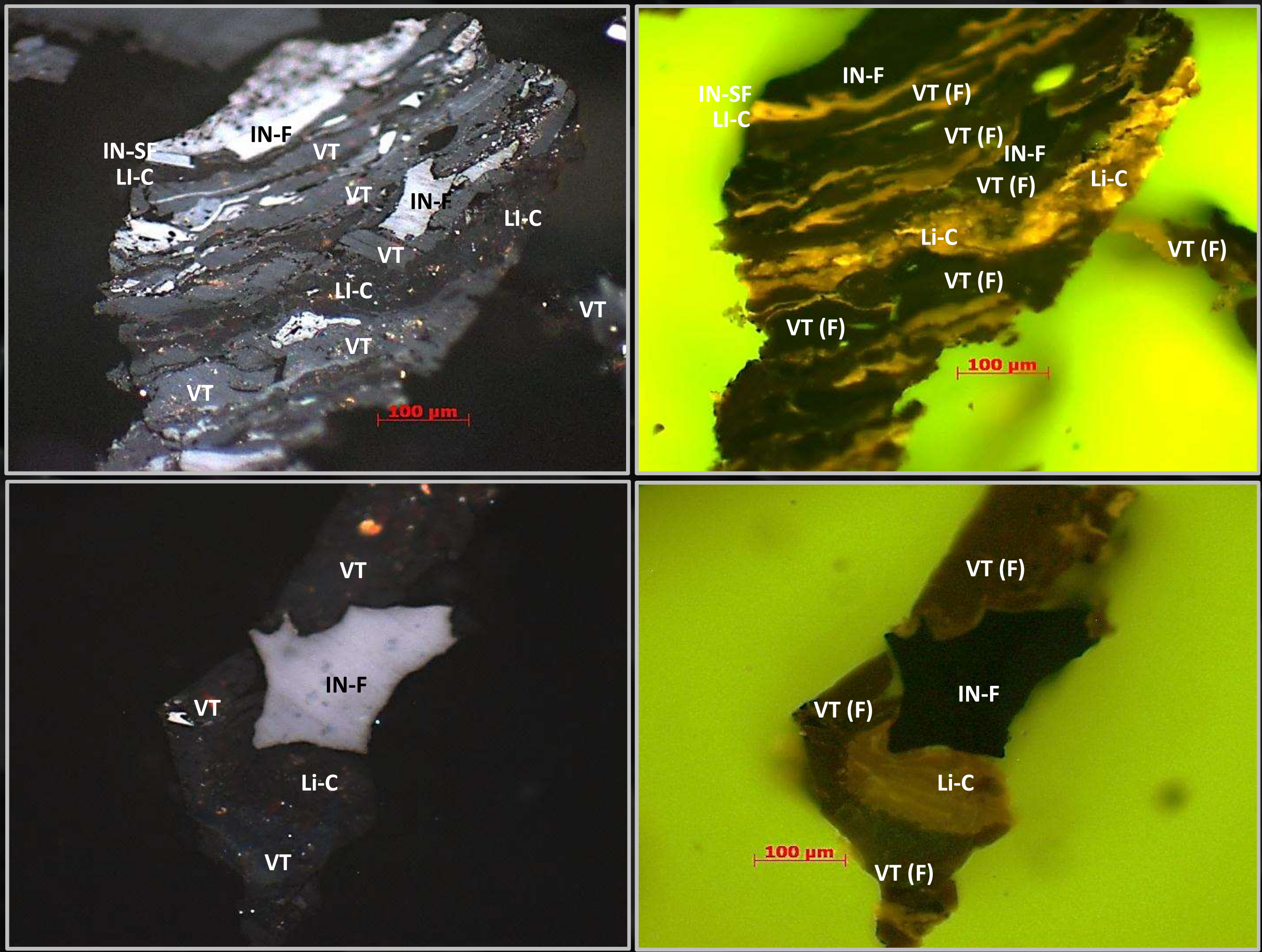
Sample PWG1 – Polished Section (KC)

- Maceral Groups in RWL and FM on KC polished section
  (association among vitrinite, fusinite, semifusinite and cutinite)



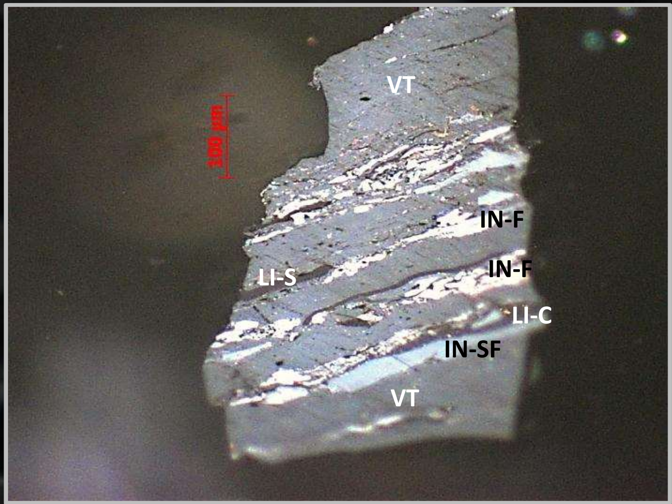
Sample PWG1 – Polished Section (KC)

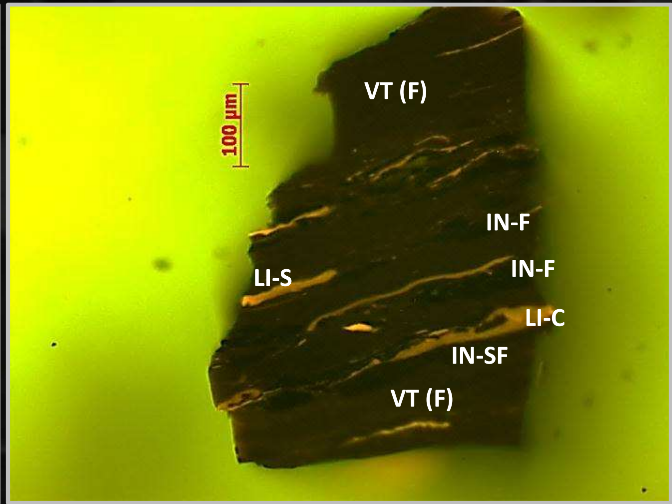
- Maceral Groups in RWL and FM on KC polished section
(association among vitrinite, fusinite, semifusinite and cutinite)

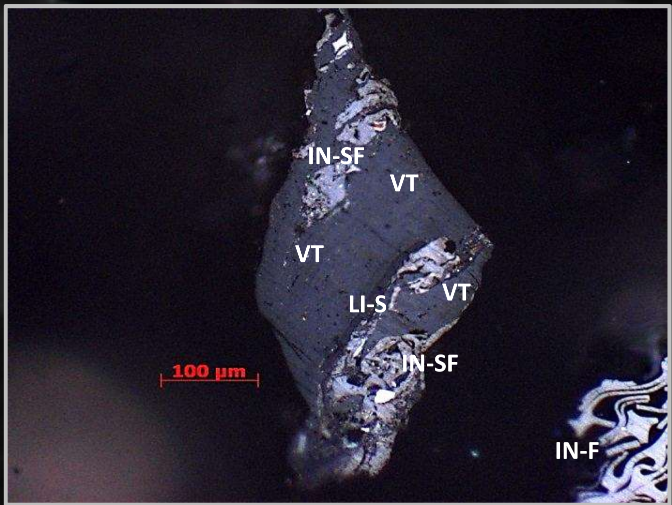


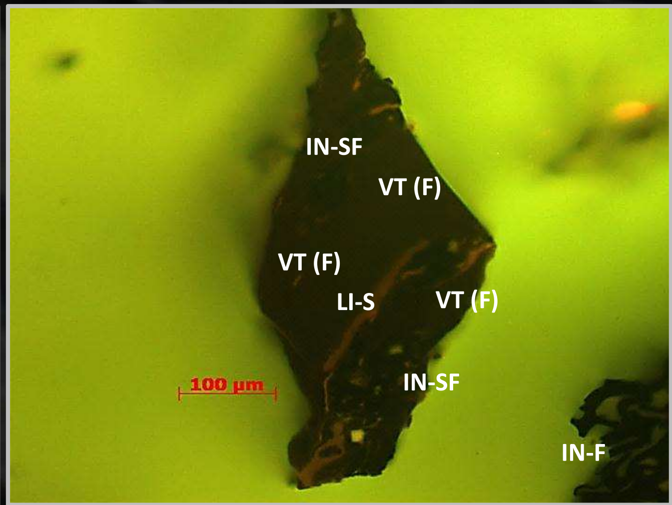
Sample PWG1 – Polished Section (KC)

- Maceral Groups in RWL and FM on KC polished section
(association among vitrinite, fusinite, semifusinite and cutinite)









Sample PWG1 – Polished Section (KC)

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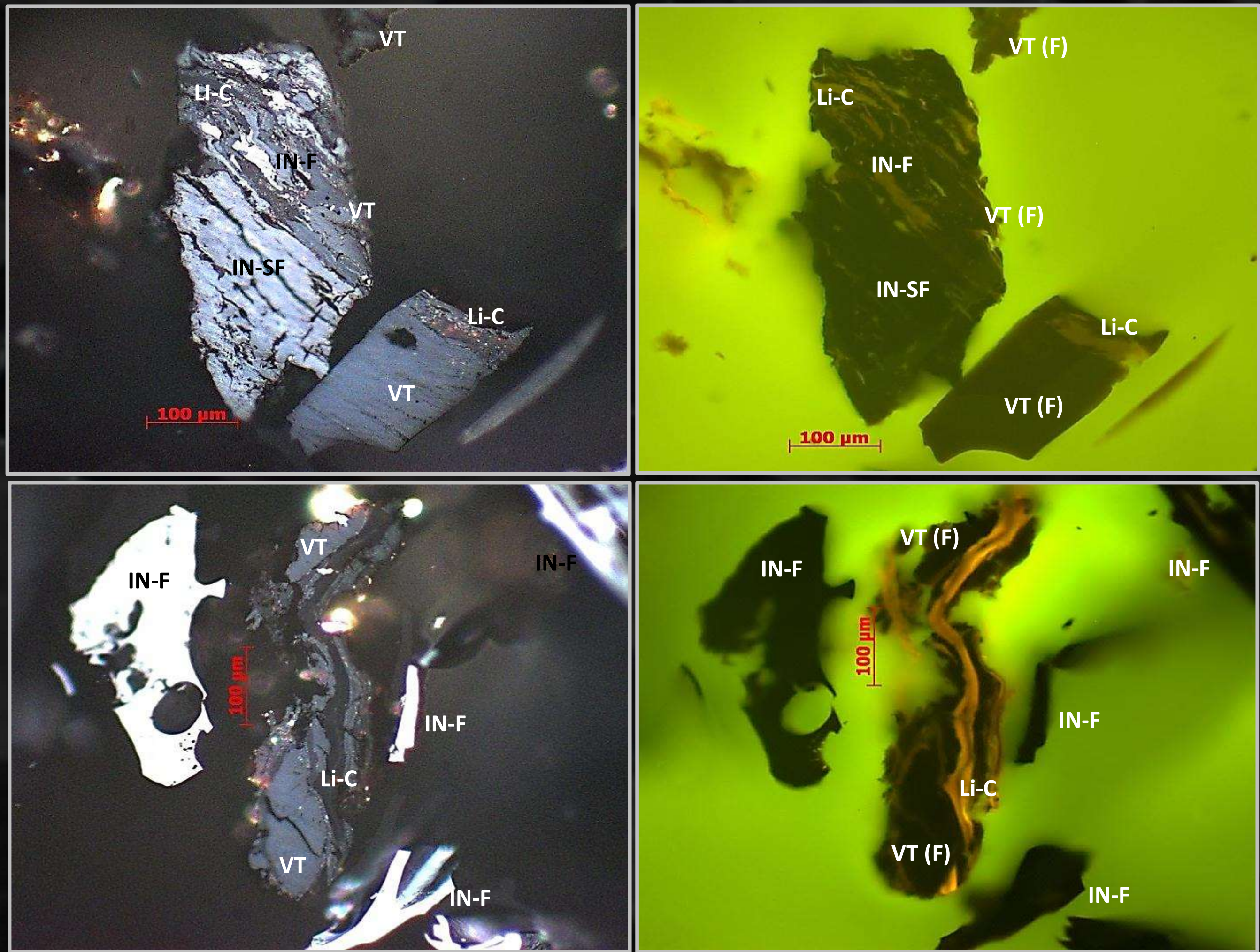
(association among vitrinite, fusinite, semifusinite and cutinite)



Sample PWG1 – Polished Section (KC)

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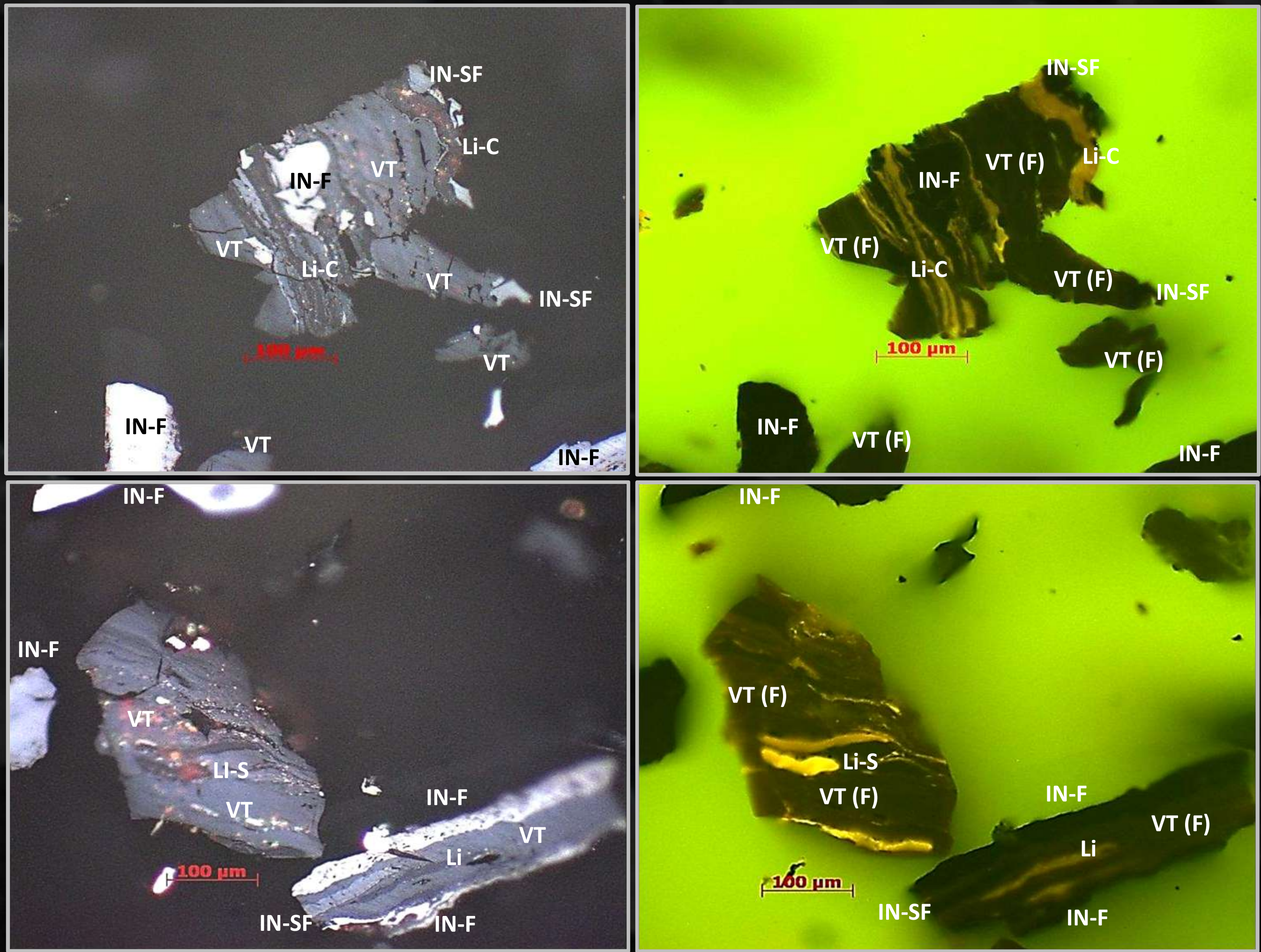

Sample PWG1 – Polished Section (KC)

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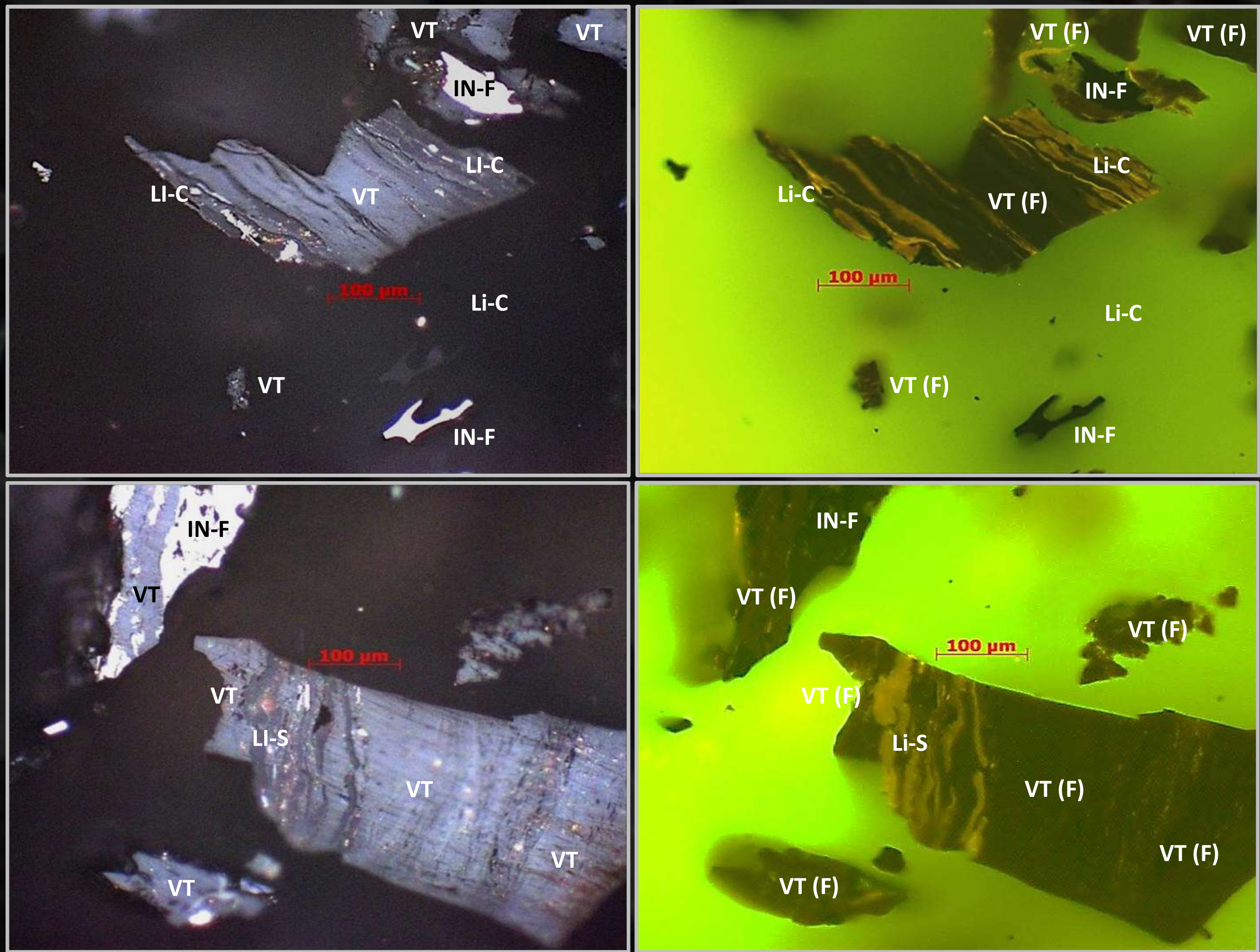
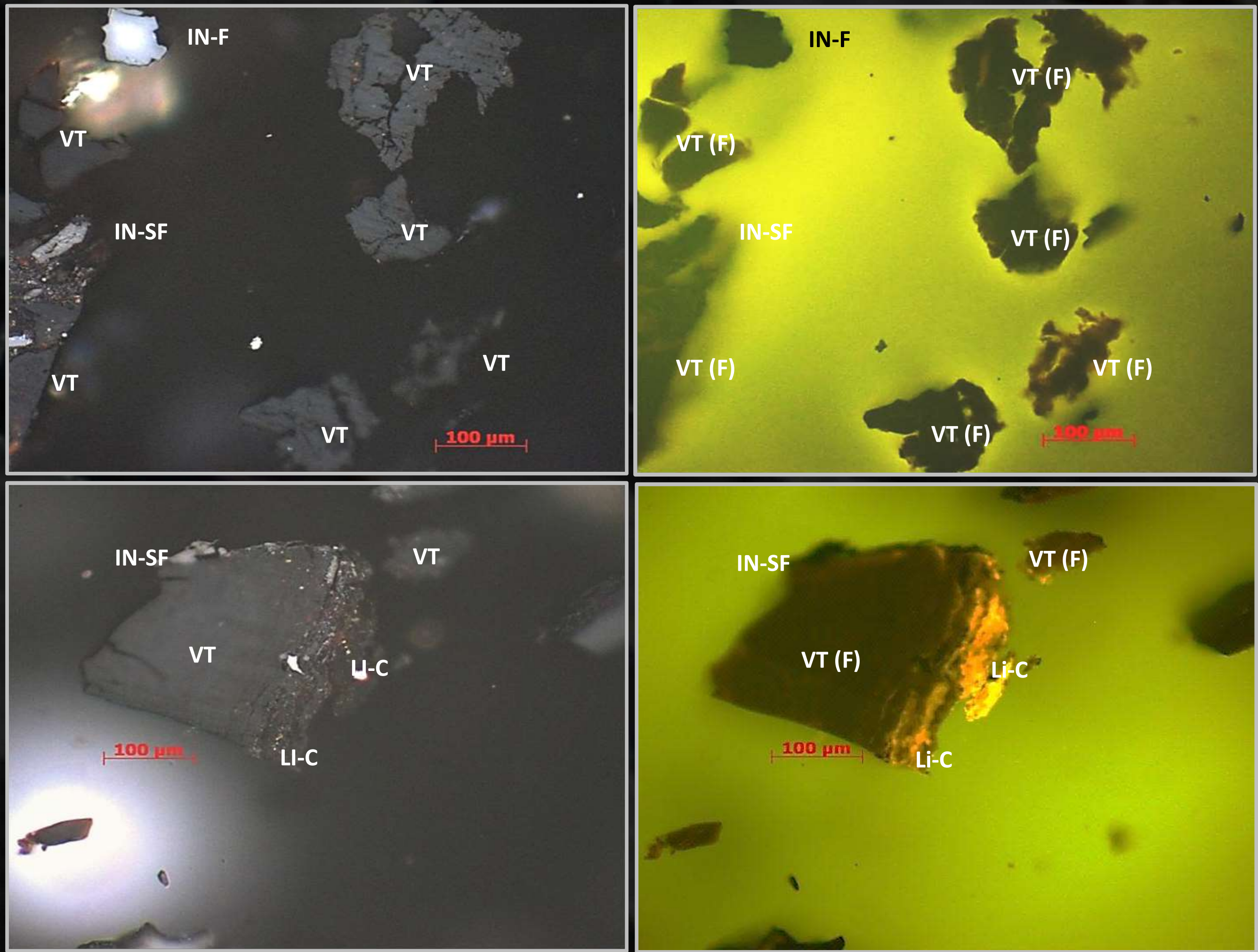


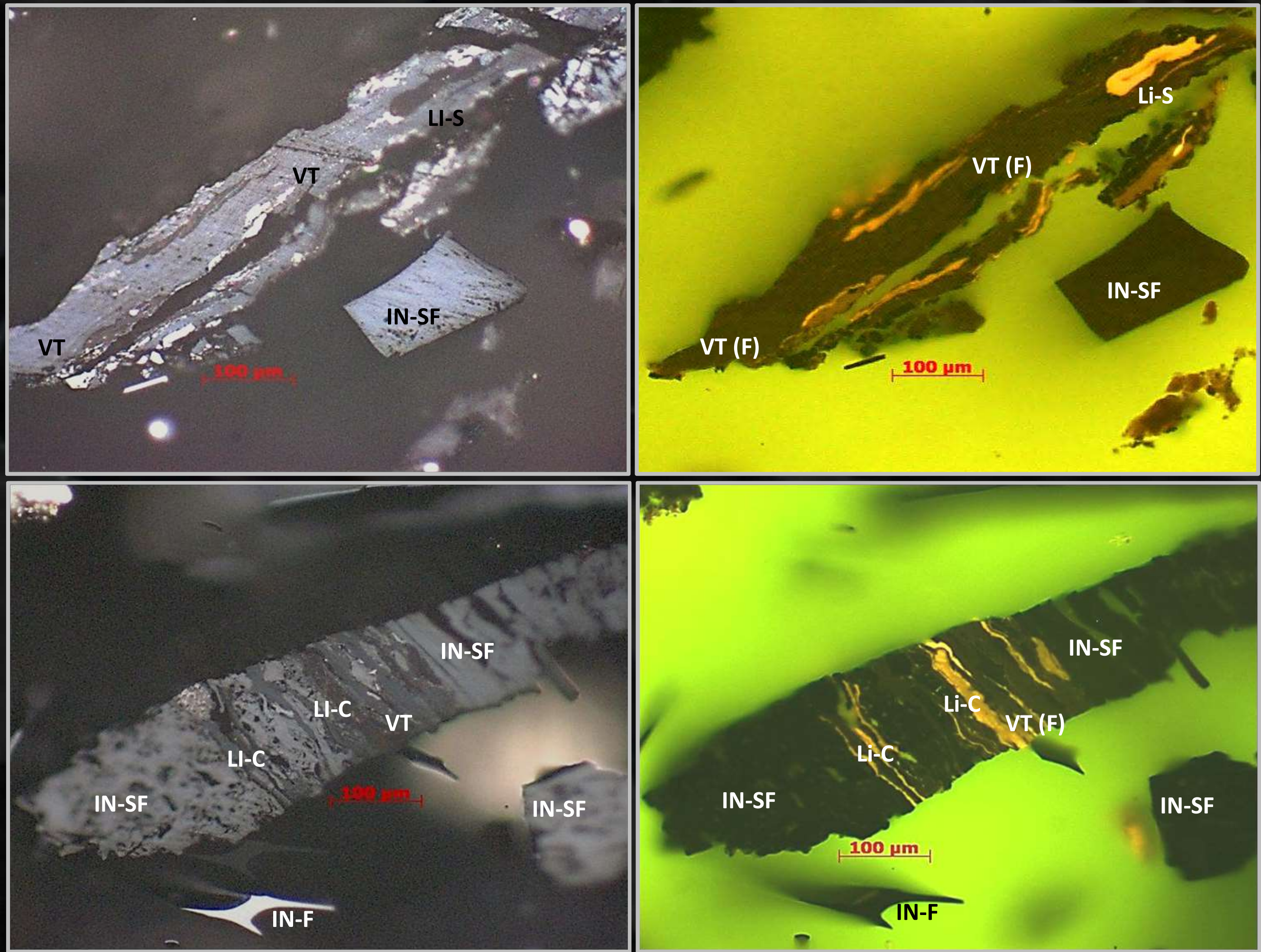
Sample PWG1 – Polished Section (KC)

- Maceral Groups in RWL and FM on KC polished section (association among vitrinite, fusinite, semifusinite and cutinite)



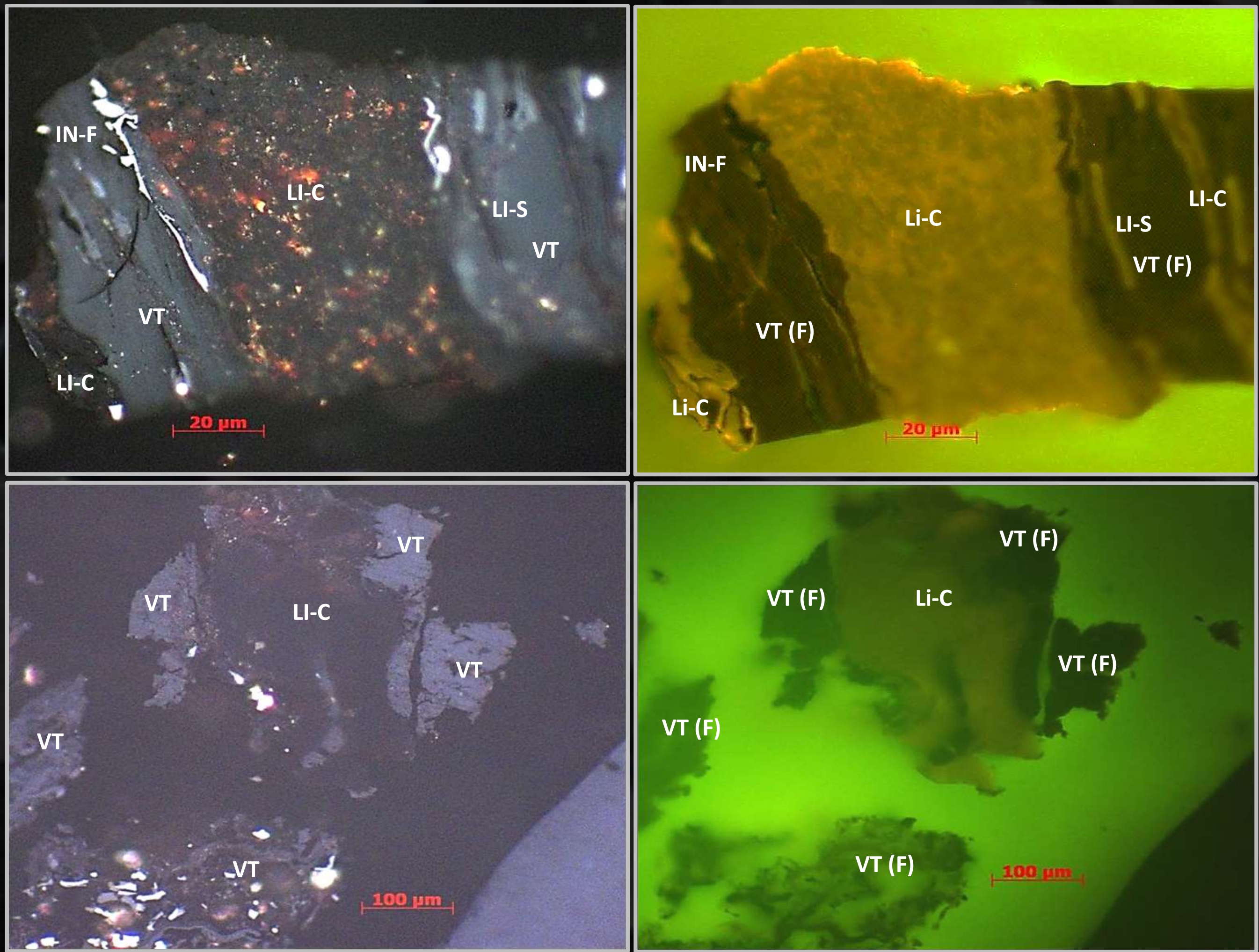
Sample PWG1 – Polished Section (KC)

- Maceral Groups in RWL and FM on KC polished section
(association among vitrinite, fusinite, semifusinite and cutinite)



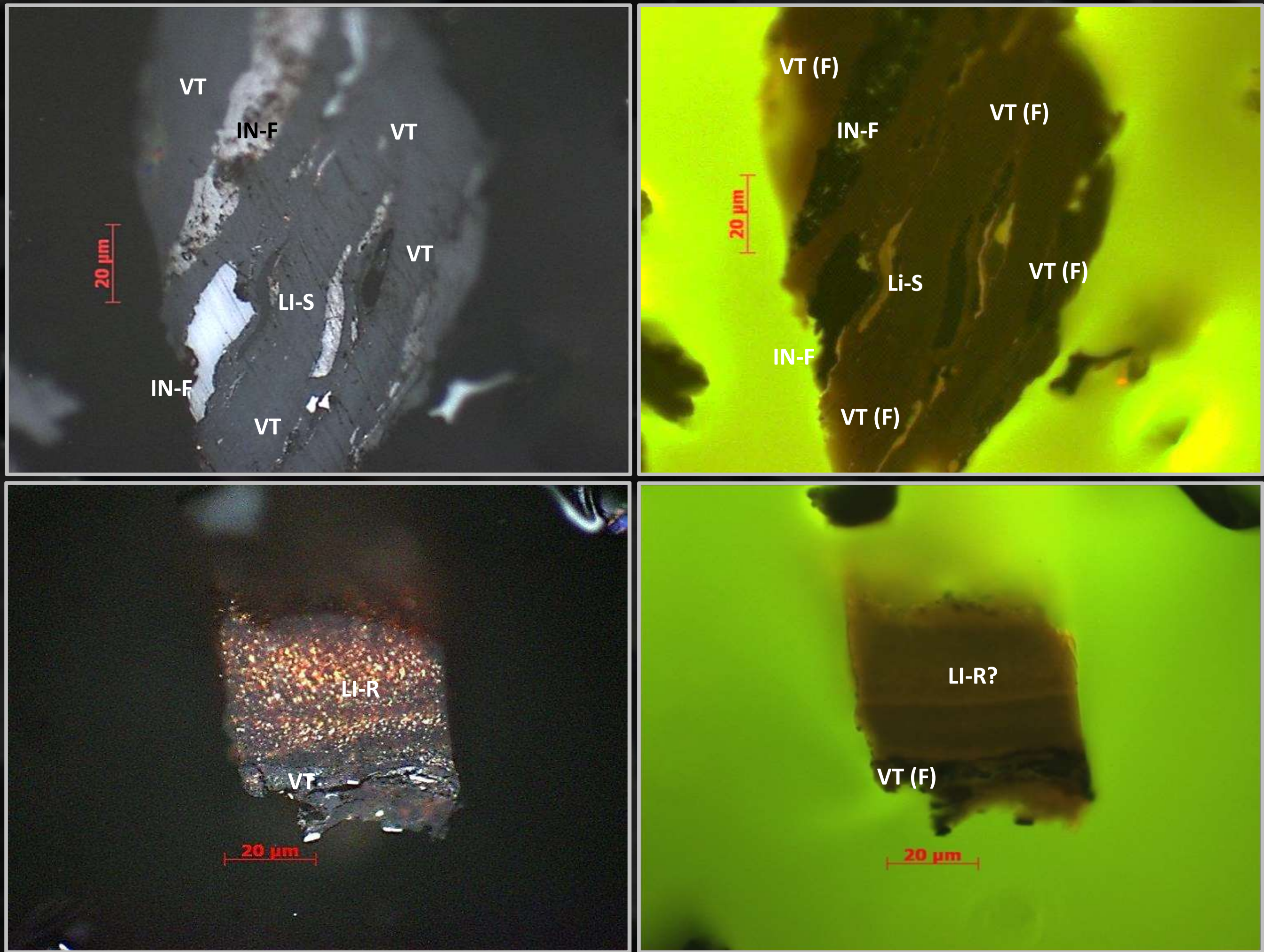
Sample PWG1 – Polished Section (KC)

- Maceral Groups in RWL and FM on KC polished section
(association among vitrinite, fusinite, semifusinite and cutinite)



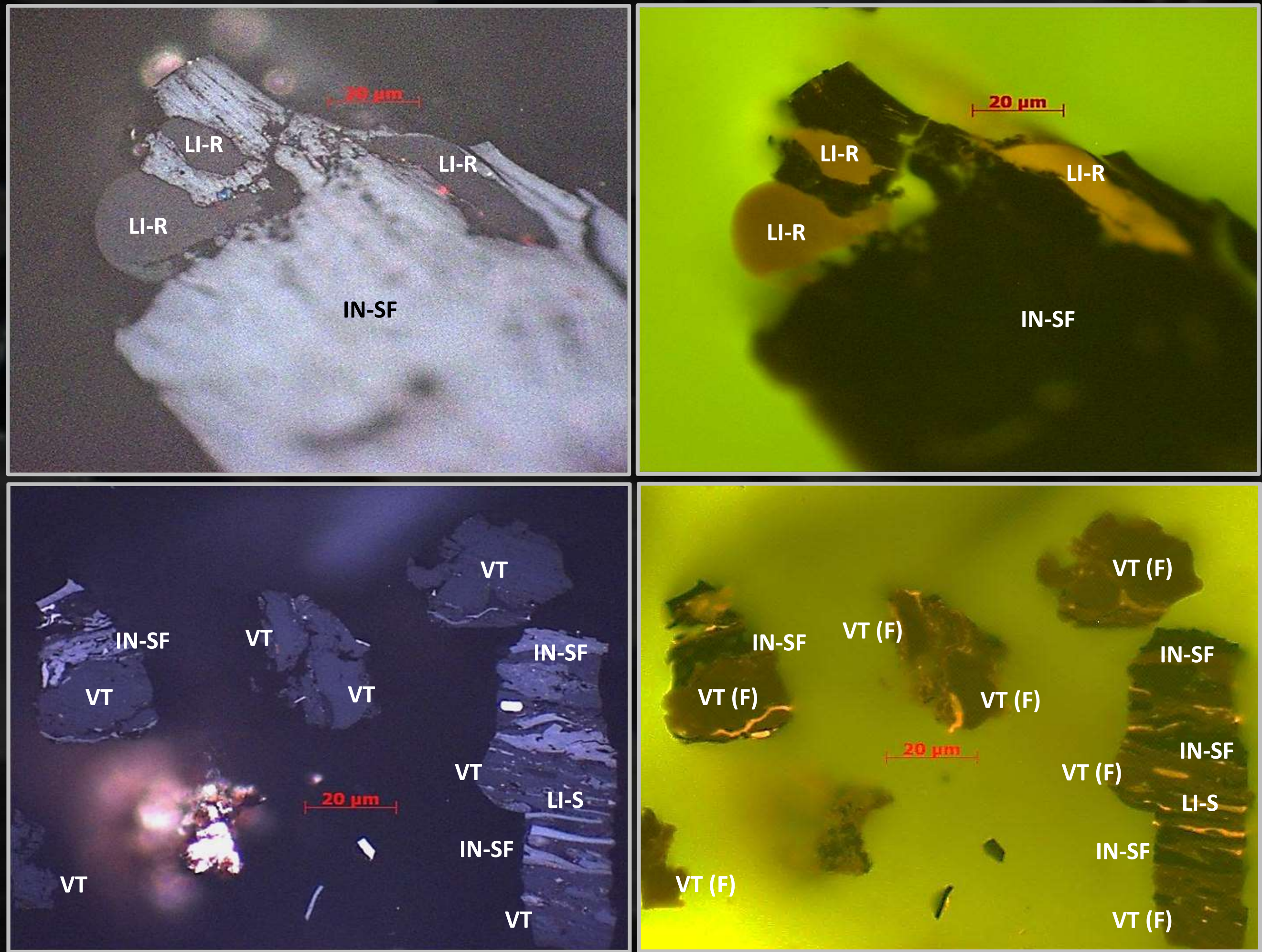
Sample PWG1 – Polished Section (KC)

- Maceral Groups in RWL and FM on KC polished section (association among vitrinite, fusinite, semifusinite, cutinite and resinite)



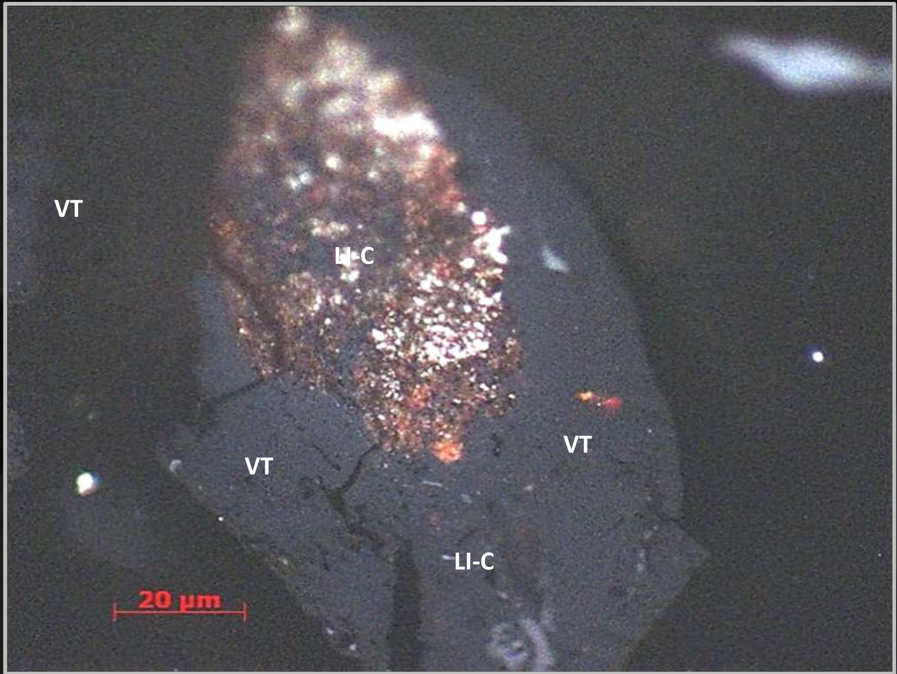
Sample PWG1 – Polished Section (KC)

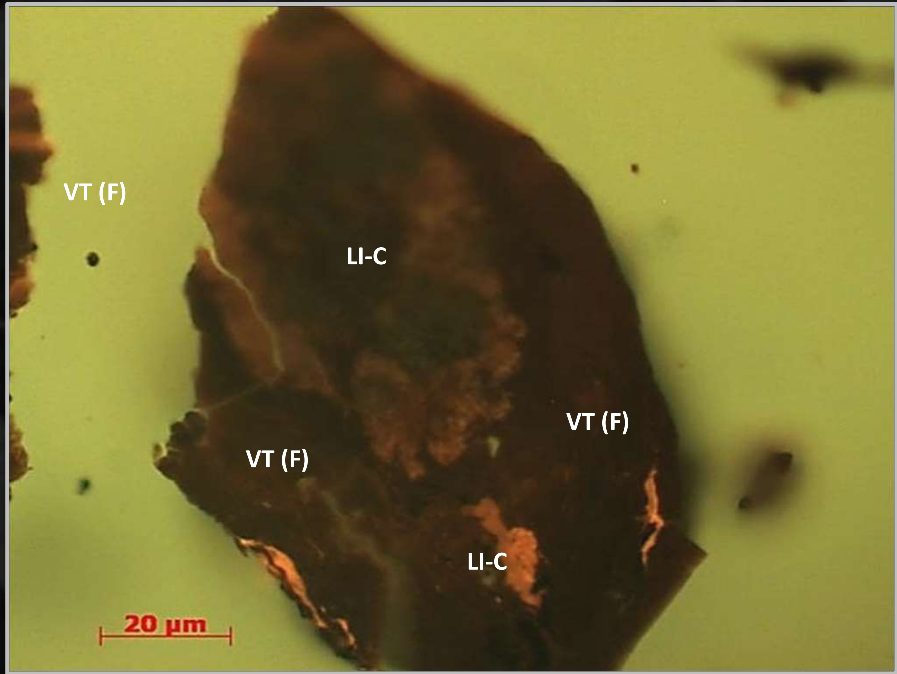
- Maceral Groups in RWL and FM on KC polished section (association among vitrinite, fusinite, semifusinite, cutinite and resinite)



Sample PWG1 – Polished Section (KC)

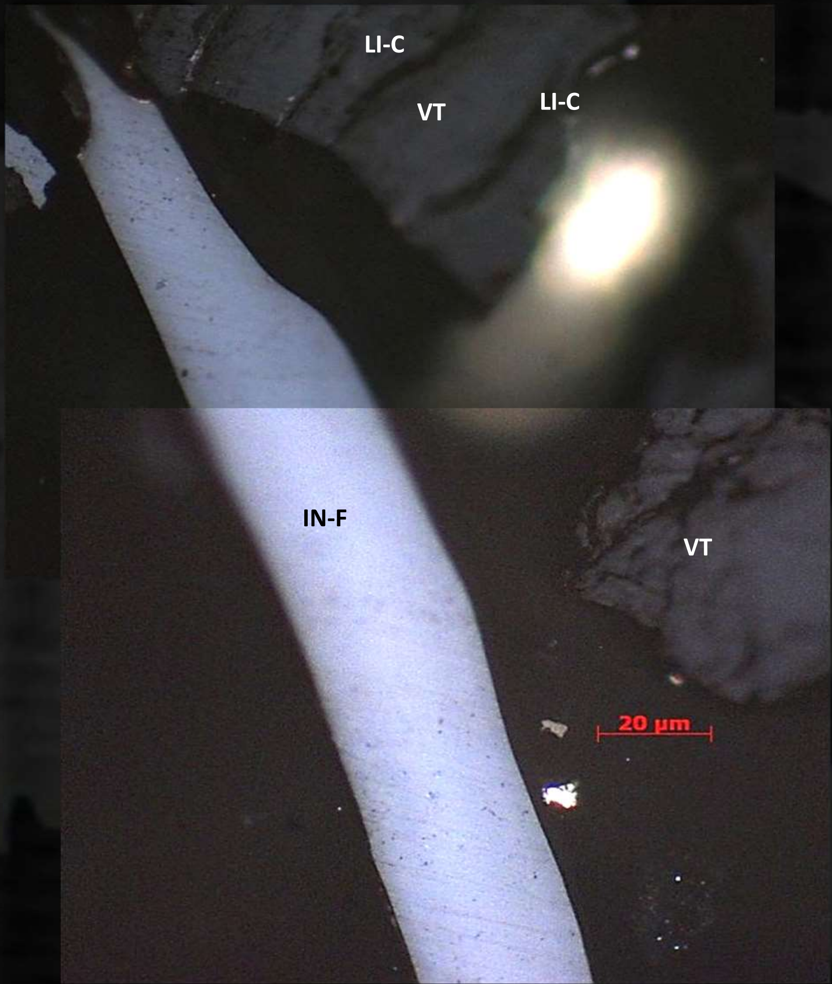
- Maceral Groups in RWL and FM on KC polished section
  (association among vitrinite and cutinite)

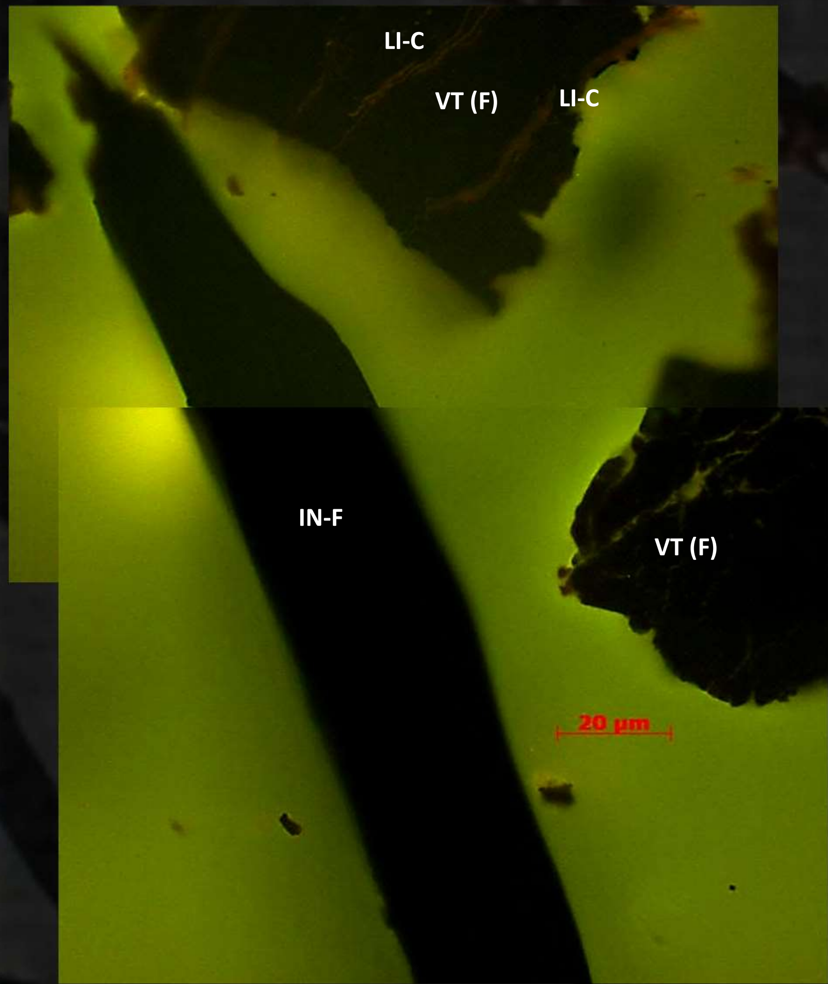




Sample PWG1 – Polished Section (KC)

- Maceral Groups in RWL and FM on KC polished section
(association among vitrinite, fusinite, semifusinite, cutinite and resinite)

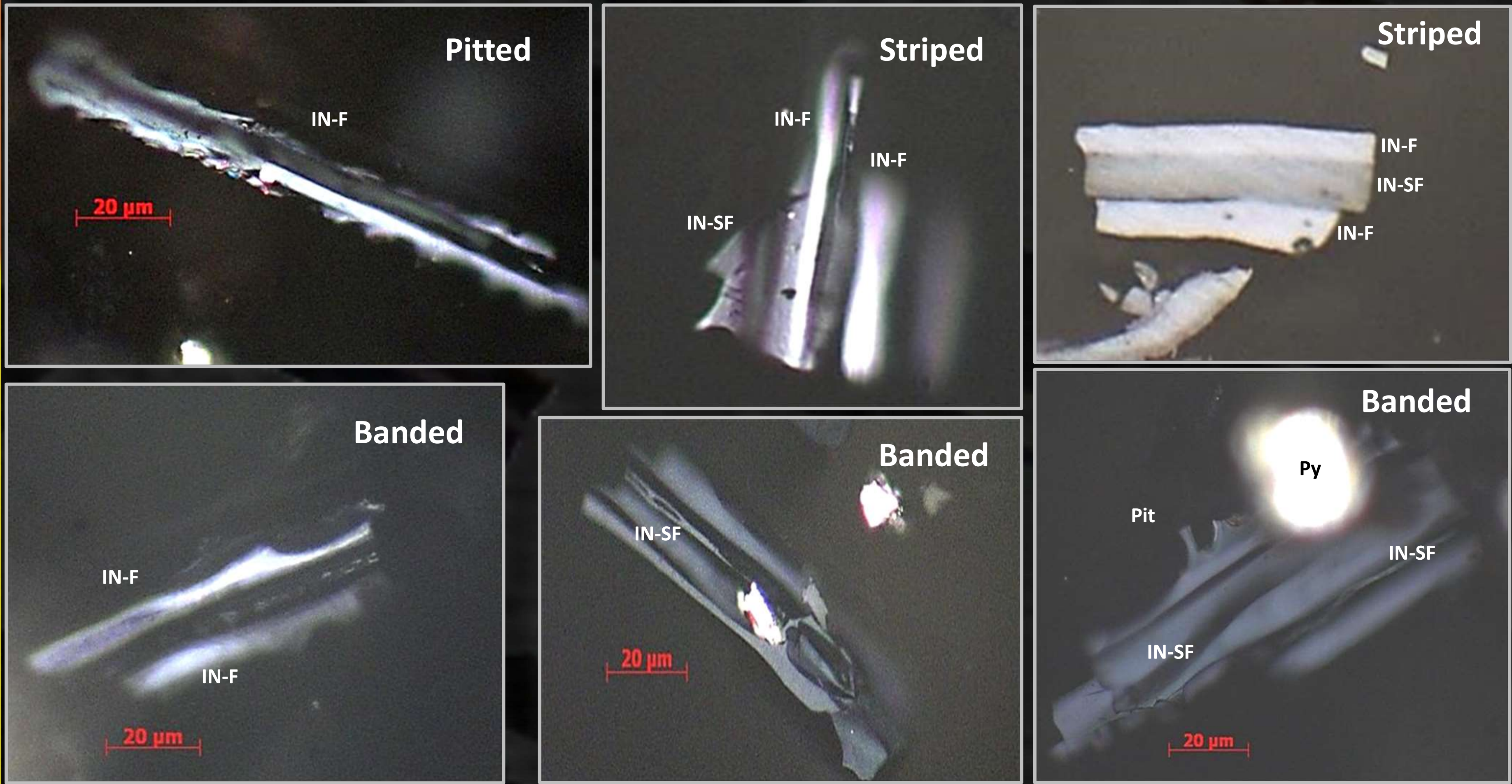




Sample PWG1 – Polished Section (KC)

- Isolated particles of NOB Phytoclasts were hand-picked* from the total organic residue and prepared as KC polished section and analyzed in RWL microscopy;

* *Hand-picking method of separation from LAFO-UFRJ*



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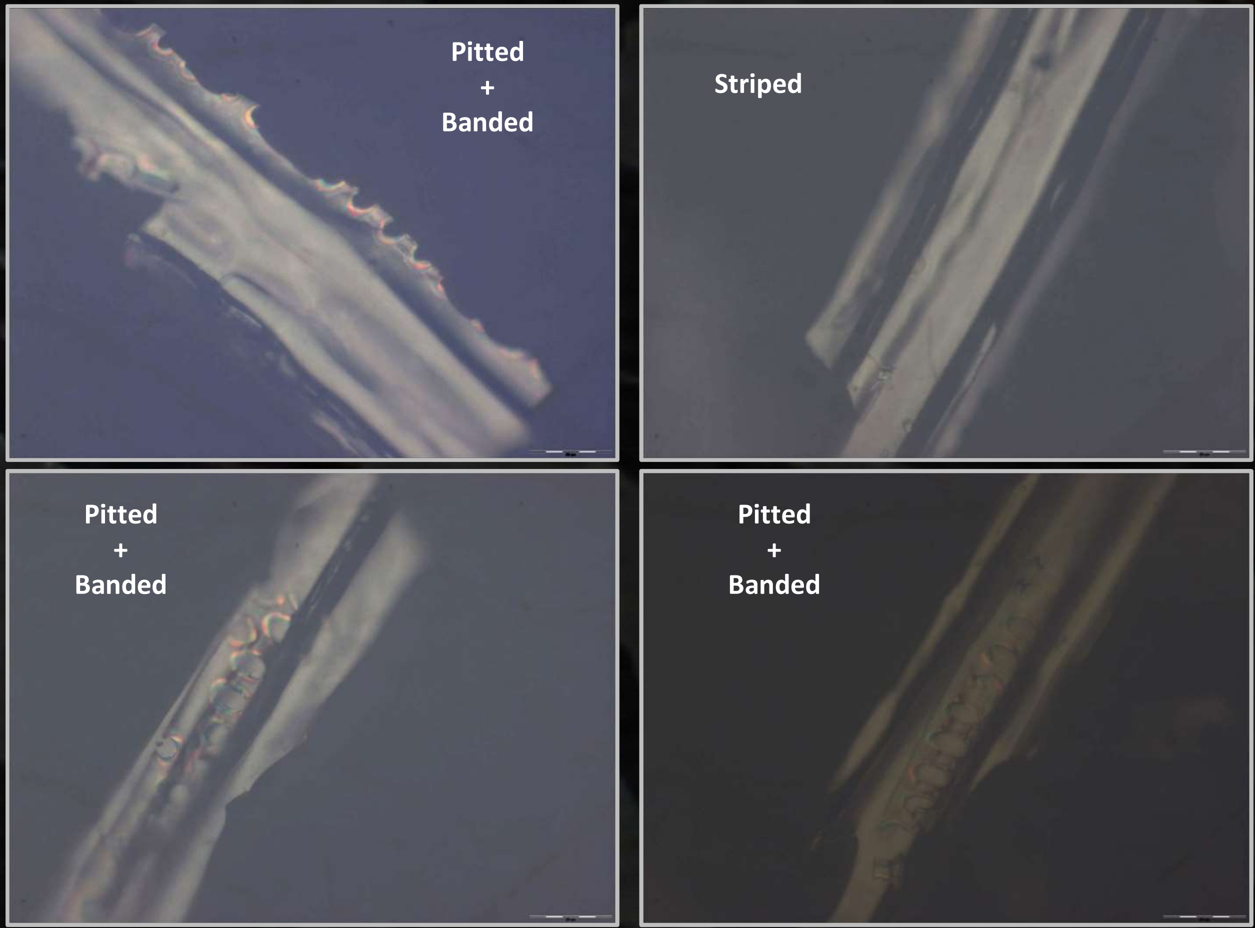


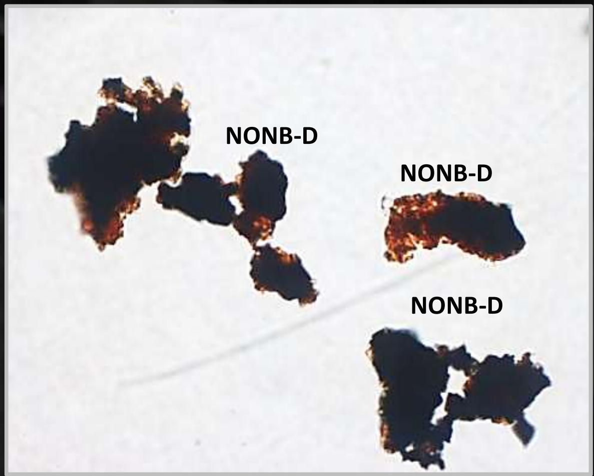
Correlation between TL and RL

Phytoclasts *versus* Vitrinite

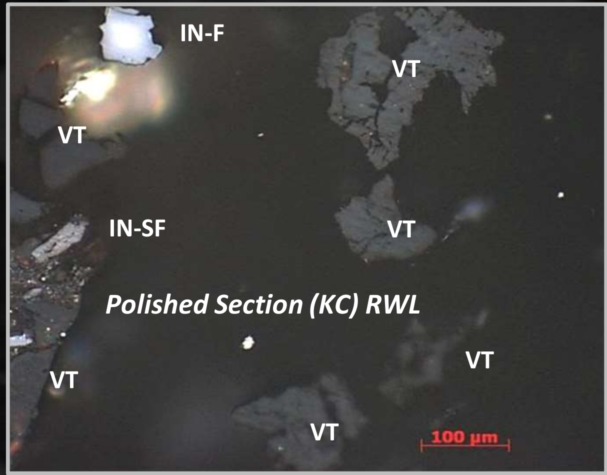
Correlation between TL and RL

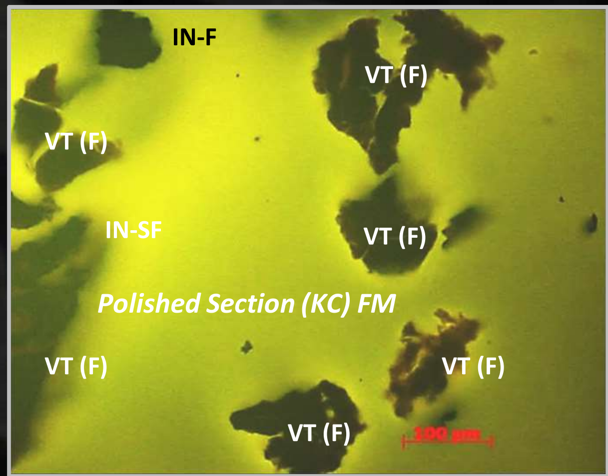
Non-opaque Non-Biostructured Phytoclasts *versus* Vitrinite

- The correlation between NONB phytoclasts and vitrinite seems to be positive;



Palynofacies Slides (KC)
TWL





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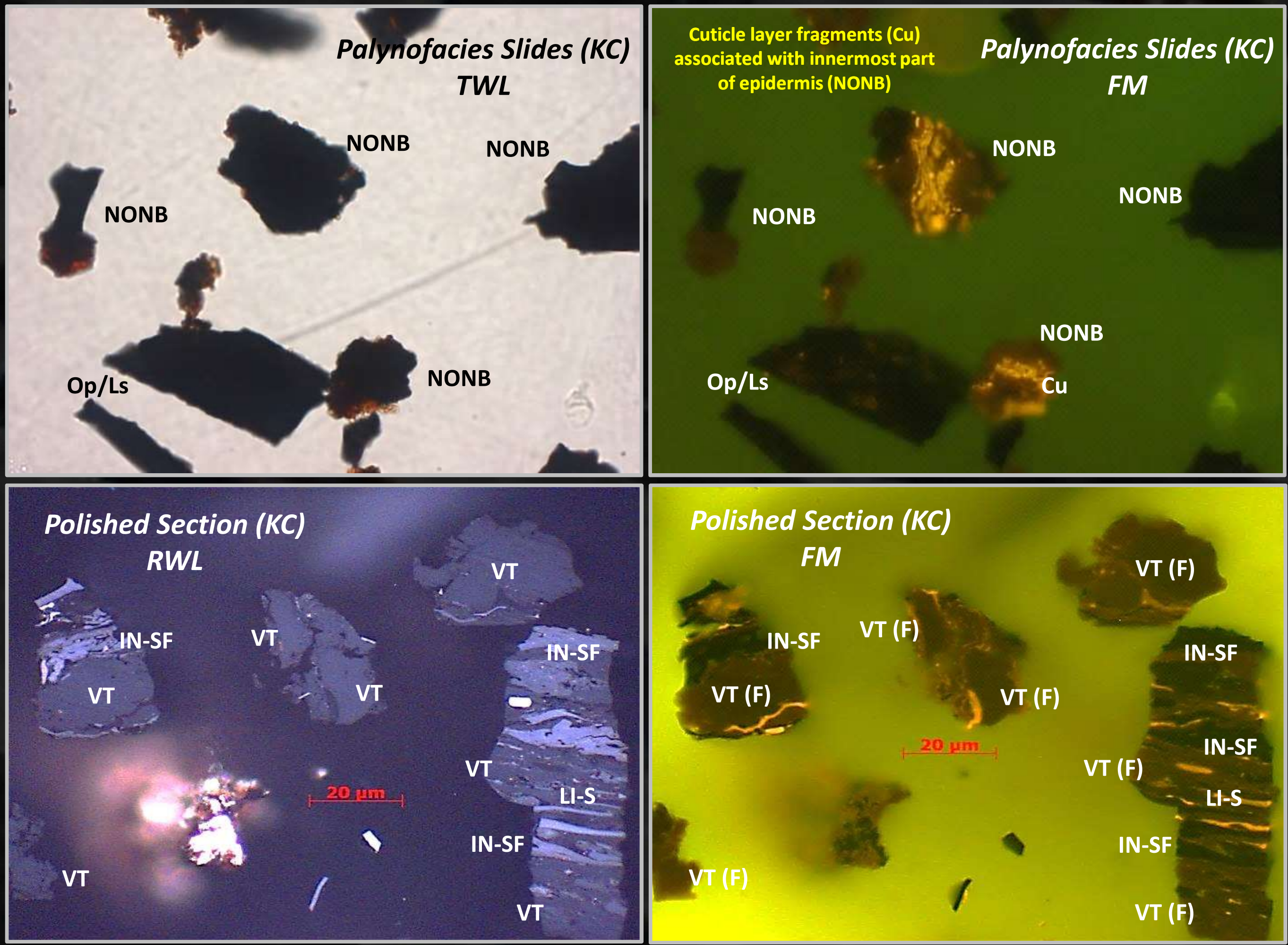

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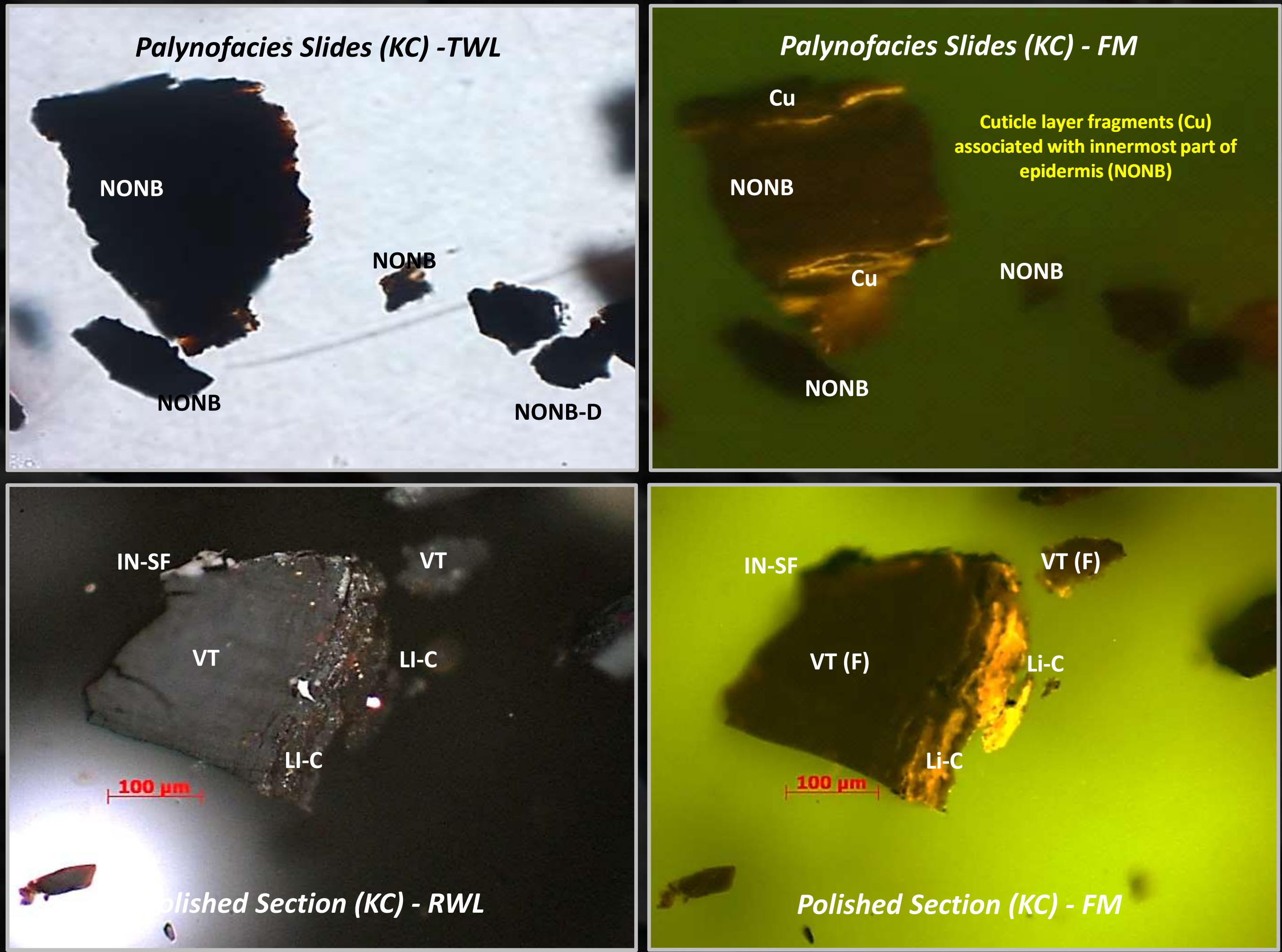

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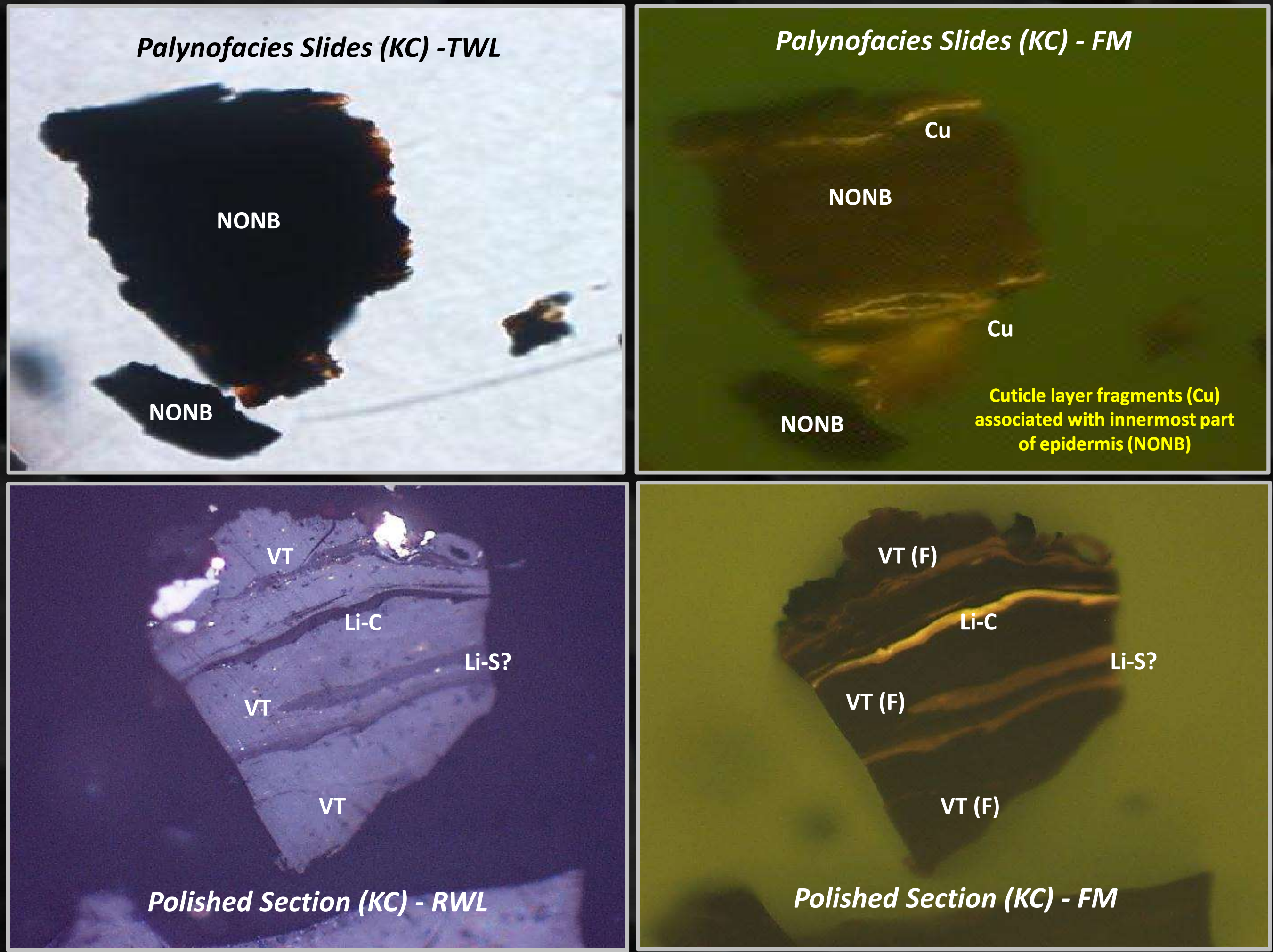

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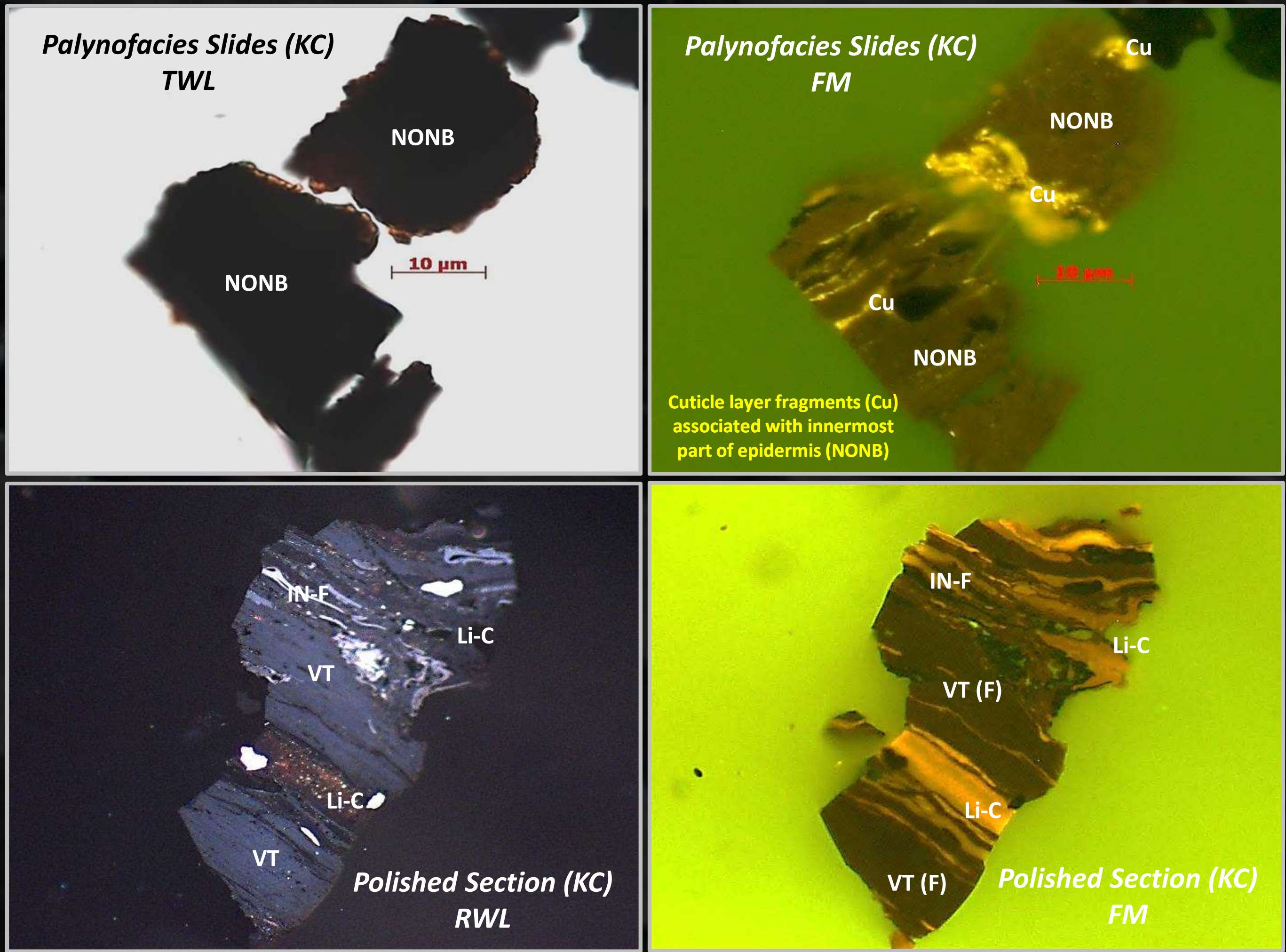

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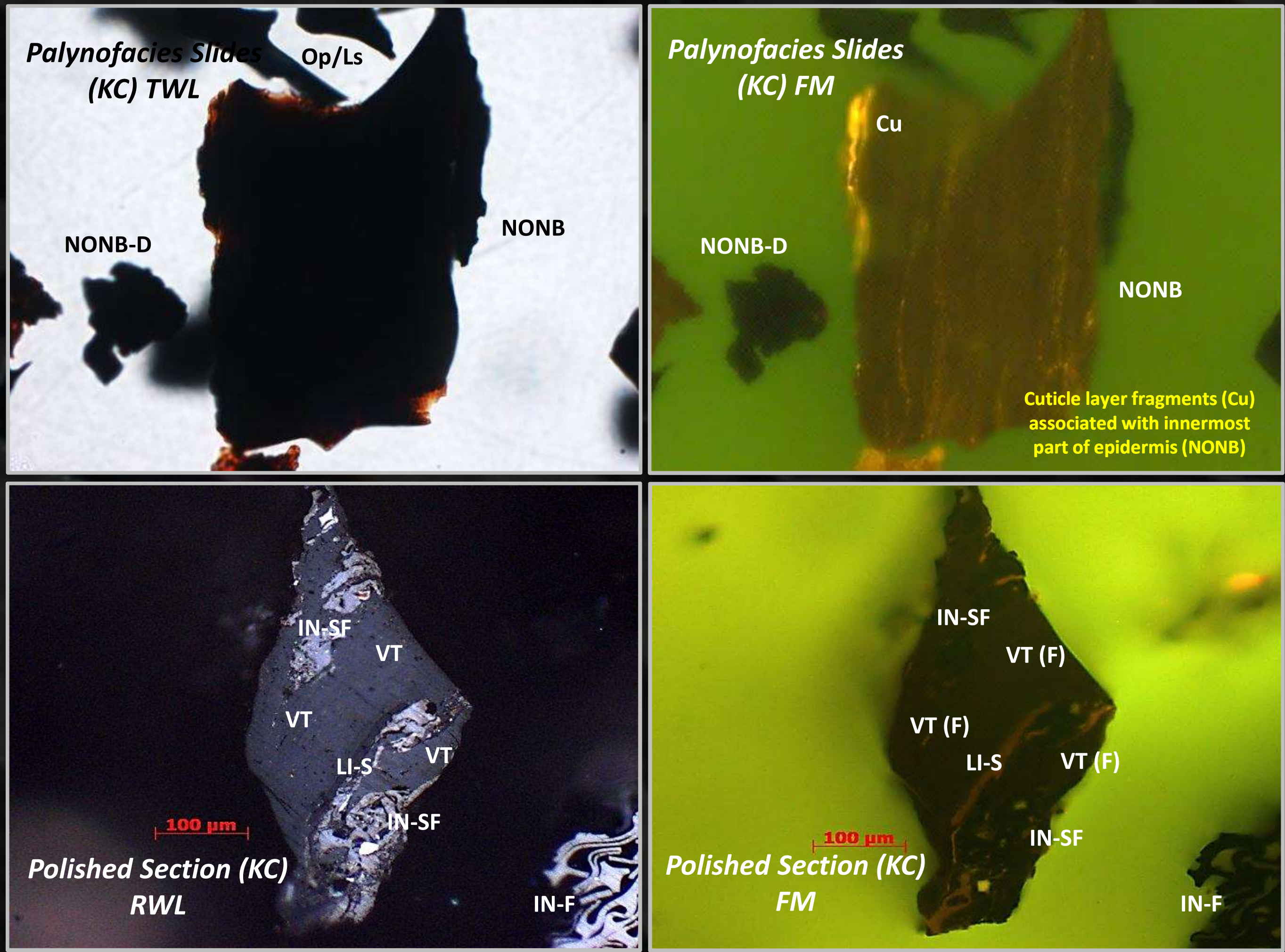

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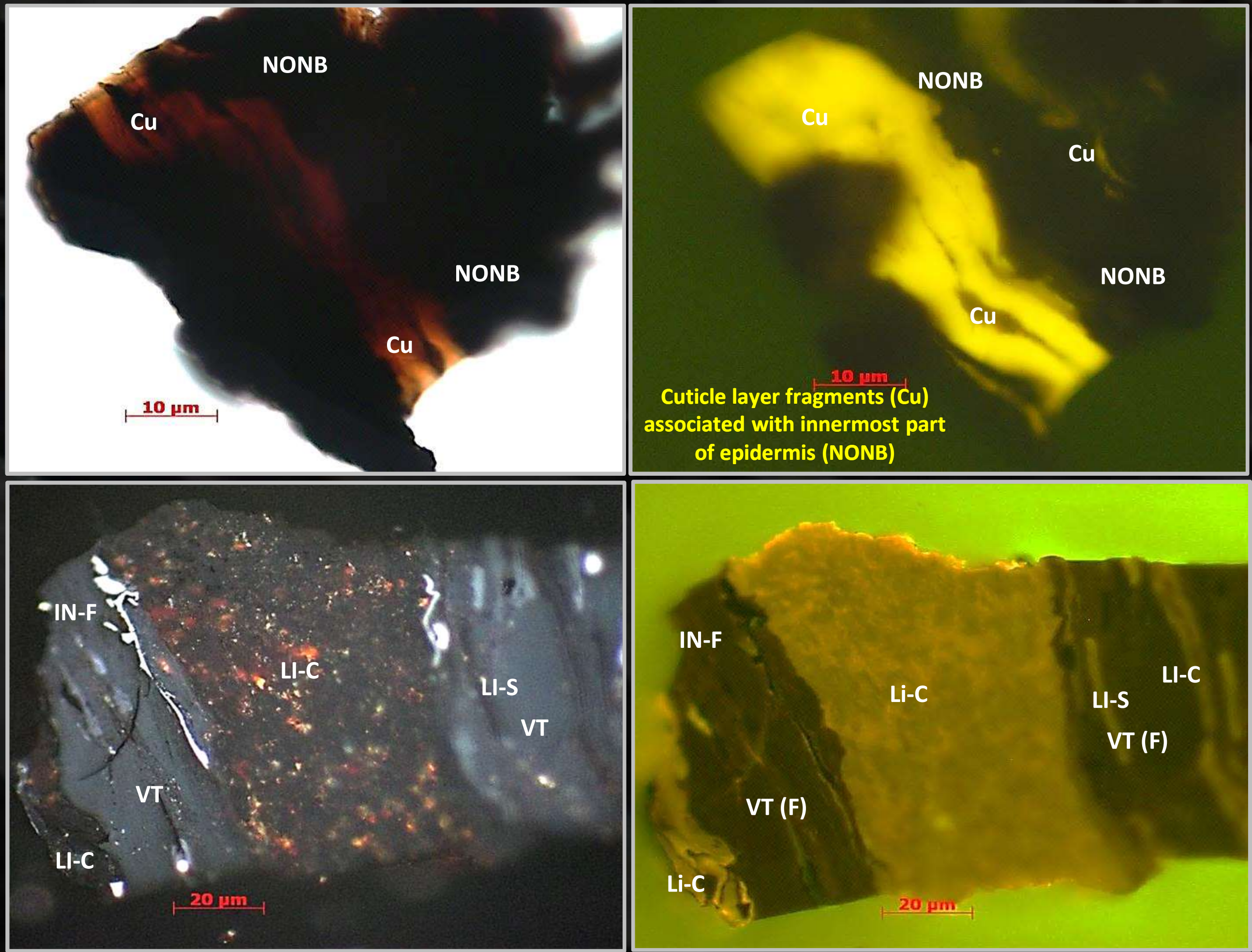


Quantitative Correlation between TL and RL

Non-opaque Non-Biostructured Phytoclasts *versus* Vitrinite

Correlation between TL and RL

Non-opaque Non-Biostructured Phytoclasts *versus* Vitrinite

- To put and compare the quantitative results from the different groups or components in tables and graphs, all values have been normalized to 100%, each one in relation to its own respective group;
- Within-sample comparisons, percentages of one component also are always correlated using the same sum (i.e. that corresponds to 100%);
- These procedures for data representation were used for both, TWL (Palynofacies Counting) and RWL (Maceral Counting/WR and KC), as a correlation factor and to highlight different aspects of the organic matter assemblage;

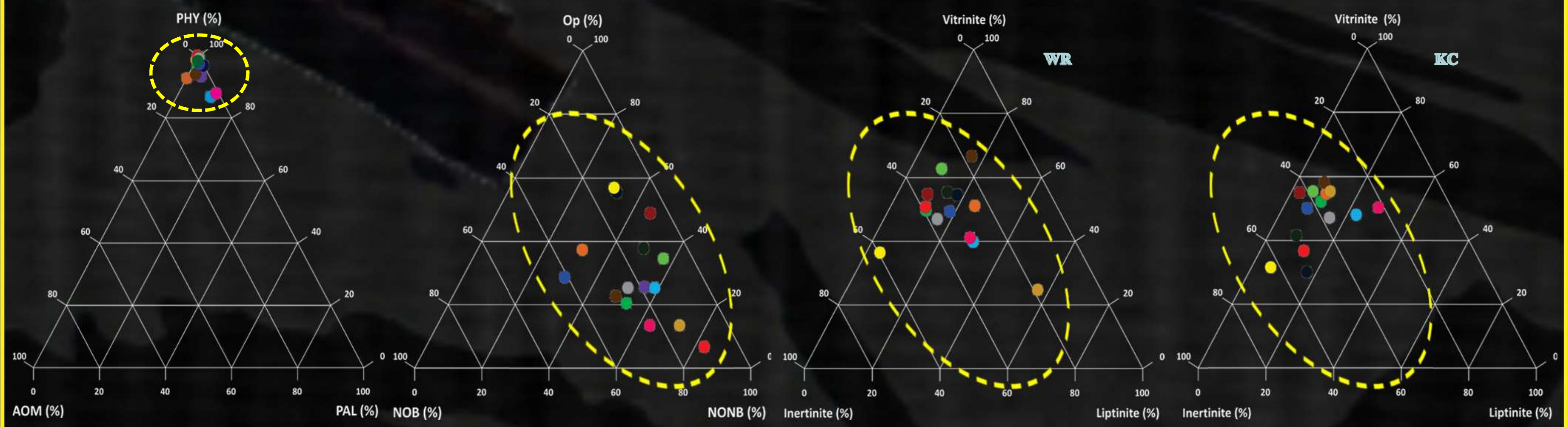
Participant	TWL (PS) NONB	RWL (WR) Vit WR	RWL (KC) Vit KC
A	82.8	57.7	42.3
B	32.7	62.9	37.1
C	31.2	51.7	48.3
D	52.9	47.1	52.9
E	31.5	38.6	61.4
G	58.9	45.4	54.6
H	51.0	47.5	52.5
I	56.9	44.2	55.8
J	30.6	50.4	49.6
K	45.9	36.7	63.3
L	48.7	47.6	52.4
M	49.4	52.1	47.9
N	72.1	30.8	69.2
O	63.3	46.1	53.9
Average	50.6	47.1	52.9
δ	15.9	8.2	8.2

- The table shows the quantitative values (normalized to 100%) for NONB Phytoclasts (TWL) and Vitrinite Group (RWL - WR and KC);
- Based on the correlation of these values, we can recognize a positive correlation between NONB Phytoclast and the Vitrinite Group quantitatives, as previously shown on pictures;

Correlation between TL and RL

Non-opaque Non-Biostructured Phytoclasts *versus* Vitrinite

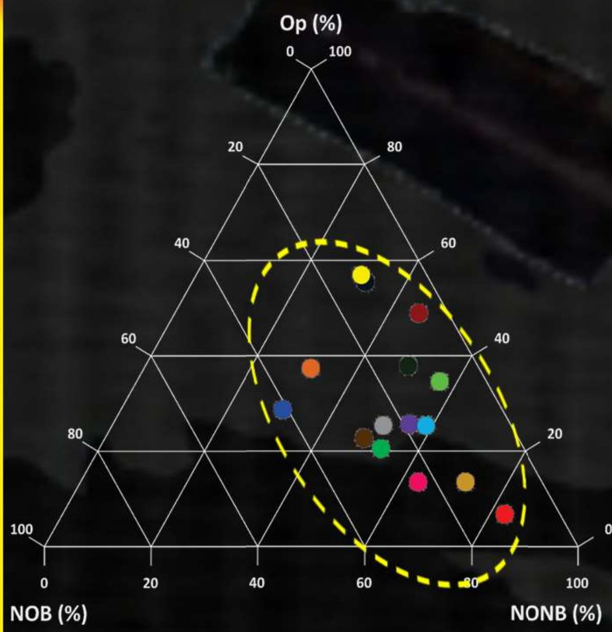
- The APP diagram shows the absolute predominance of phytoclast among the kerogen groups;
- The Op-NOB-NONB diagram shows a predominance of NONB particles;
- The Vit-In-Lip diagram shows the predominance of Vitrinite Group (WR and KC);
- Thus, based on this distribution we can recognize a positive correlation between NONB Phytoclasts and the Vitrinite Group;

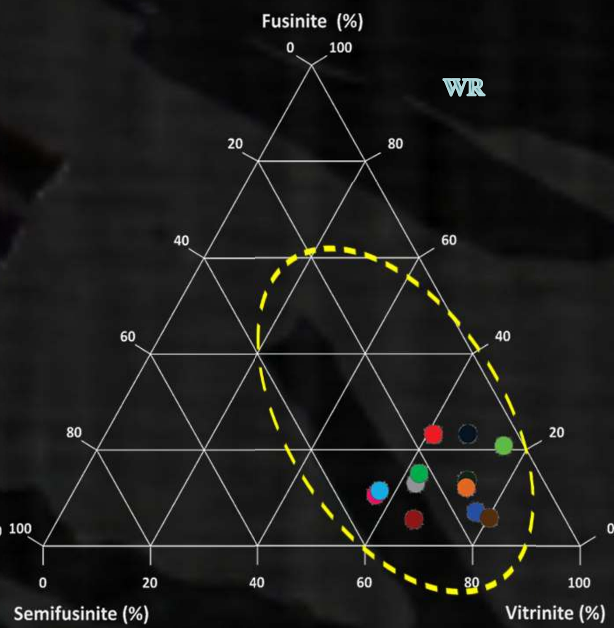


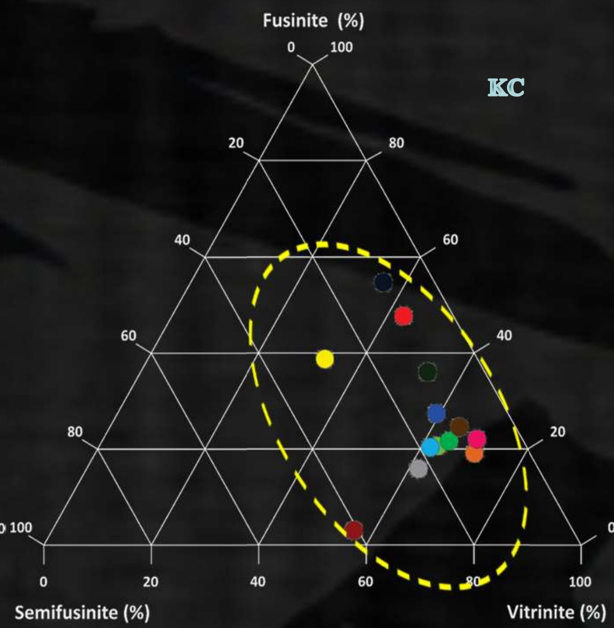
Correlation between TL and RL

Non-opaque Non-Biostructured Phytoclasts *versus* Vitrinite

- The Op-NOB-NONB diagram shows a predominance of NONB particles;
- The Vit-F-SF diagram (WR and KC), normalized to 100%, shows the predominance of Vitrinite Group at the same proportion that the Op-NOB-NONB diagram shows the predominance of NONB particles, mainly in KC polished section;
- Based on correlation of these diagrams, we can also recognize a positive correlation between NONB Phytoclasts and the Vitrinite Group, as previously shown;





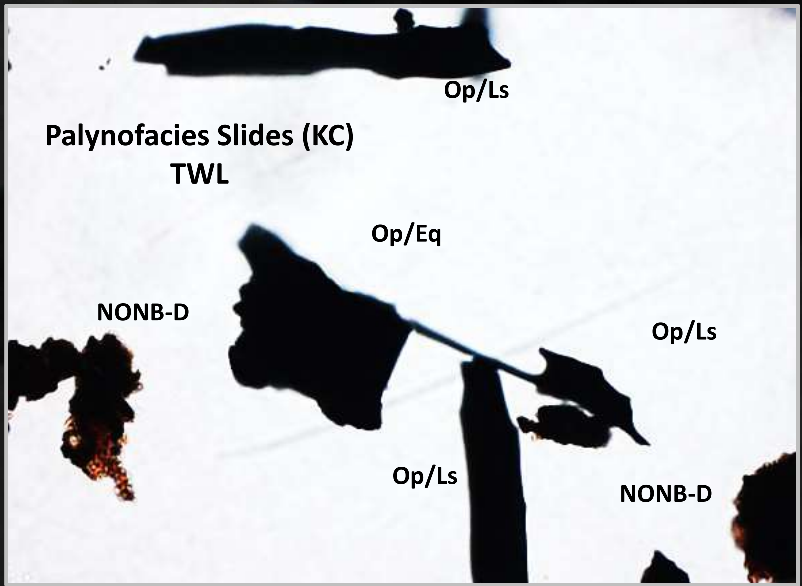


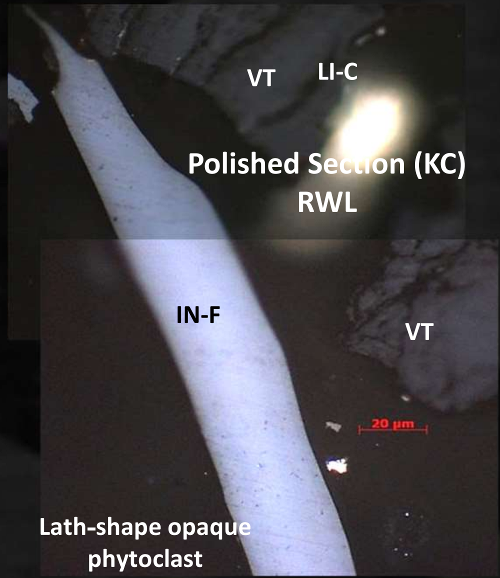
Correlation between TL and RL

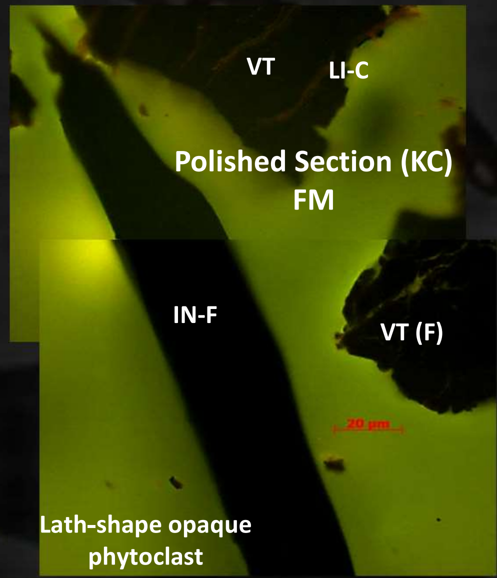
Phytoclasts *versus* Inertinite

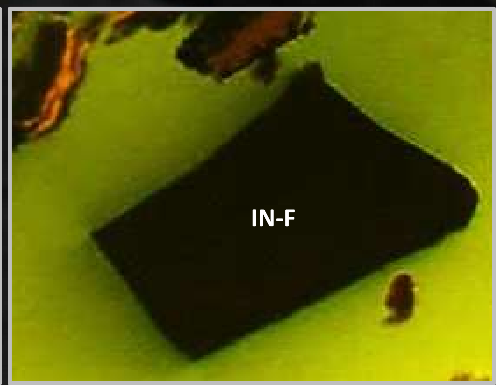
Correlation between TL and RL
Opaque Phytoclasts *versus* Fusinite

- The correlation between opaque phytoclast and inertinite (fusinite) seems to be evident;





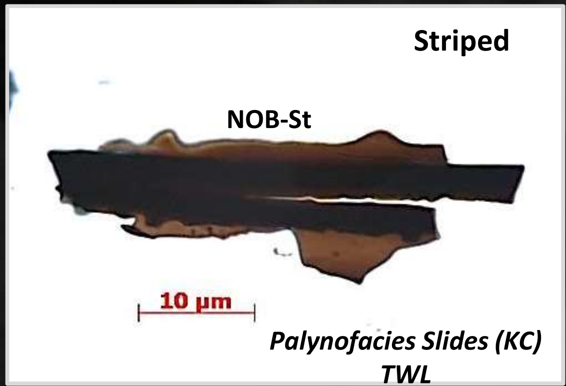


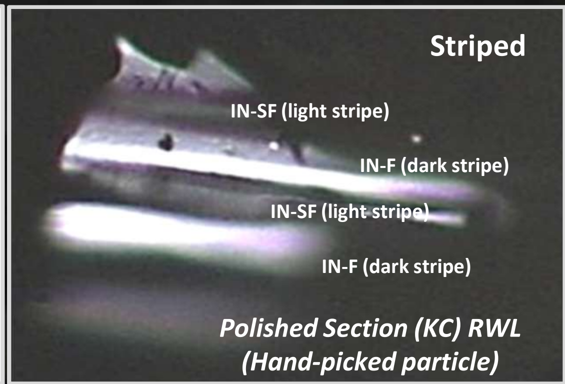


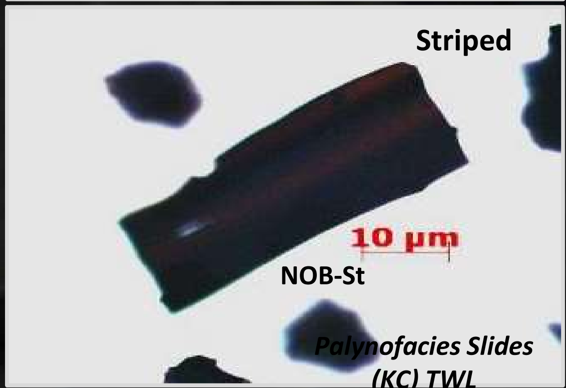
Correlation between TL and RL

Non-Opaque Biostructured Phytoclasts *versus* Fusinite/Semifusinite

- NOB Phytoclasts (Striped) show irregular or unequal stripes (may be thickenings) and they are non-tracheids tissues (poorly lignified) and seem to have a positive correlation with inertinite (SF/F);
- The interchange of the light and dark stripes (TL) seems to correlate the one of semifusinite (light stripes) and fusinite (dark stripes) in RL;
- Besides, it seems to have a positive correlation between the amount of lignin present in the component and maceral type;
- Components, from phytoclast group, presenting higher content of lignin seem to have a positive correlation with fusinite and, on the other hand, components presenting lower content of lignin seem to have better correlation with semifusinite;



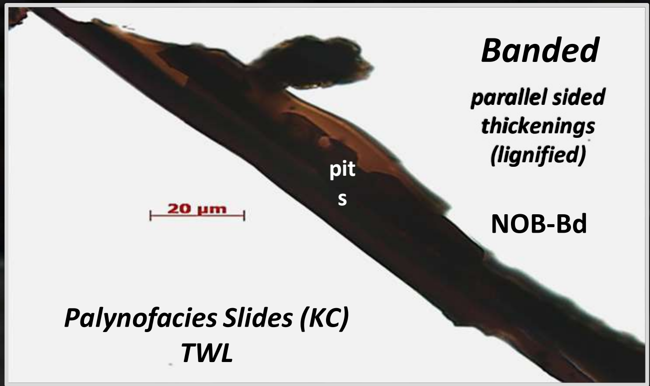


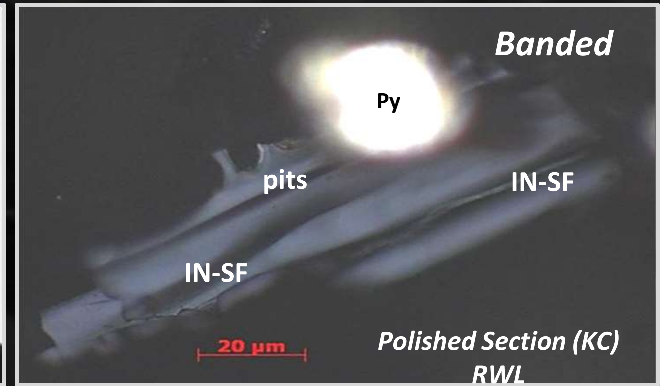


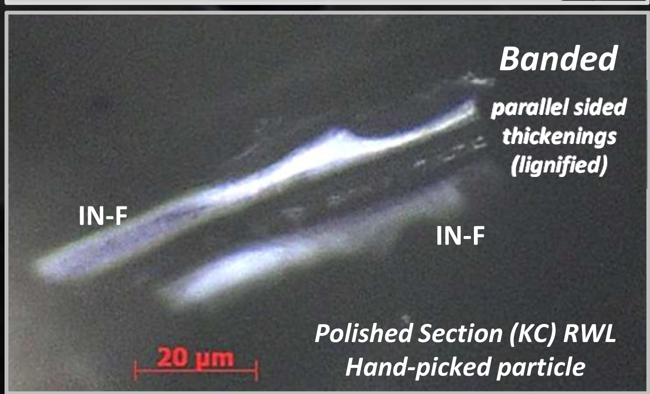
Correlation between TL and RL

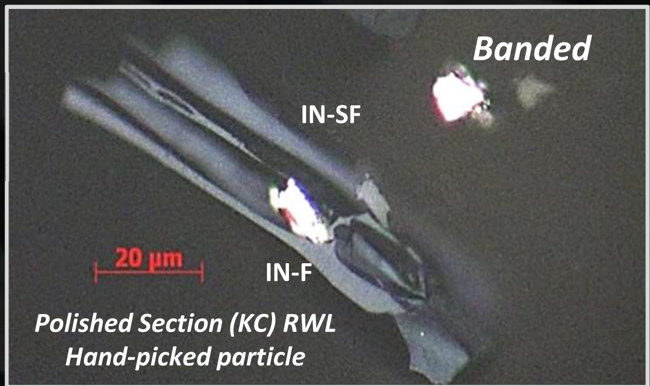
Non-Opaque Biostructured Phytoclasts *versus* Semifusinite

- NOB Phytoclasts (Banded) show regular and equal parallel sided (fusiform) thickenings and they are tracheids tissues (lignified) and seem to have a positive correlation with inertinite (SF/F);
- Besides, it seems to be a + correlation between the amount of lignin present in the component and maceral type. Components presenting higher lignin content seem to have a + correlation with F and those presenting lower lignin content seem to have better correlation with SF;





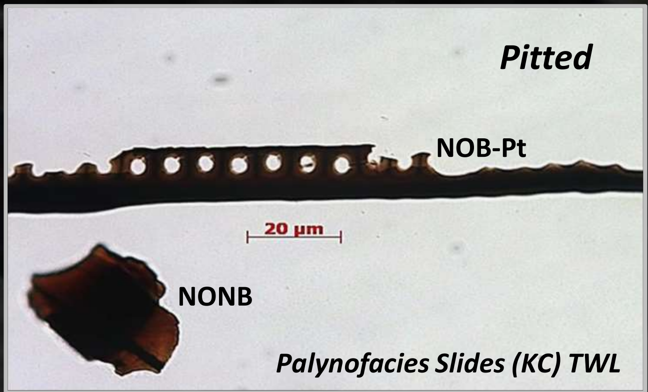




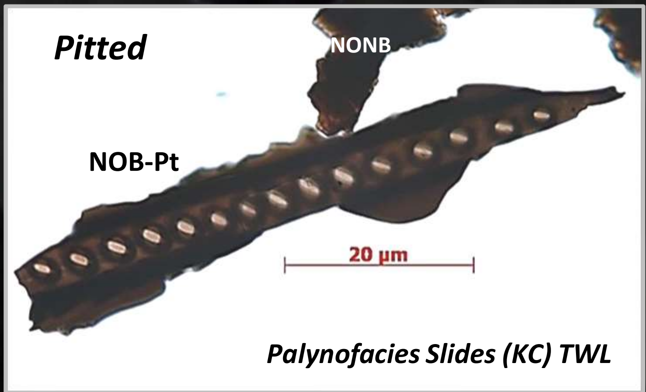
Correlation between TL and RL

Non-Opaque Biostructured Phytoclasts *versus* Fusinite

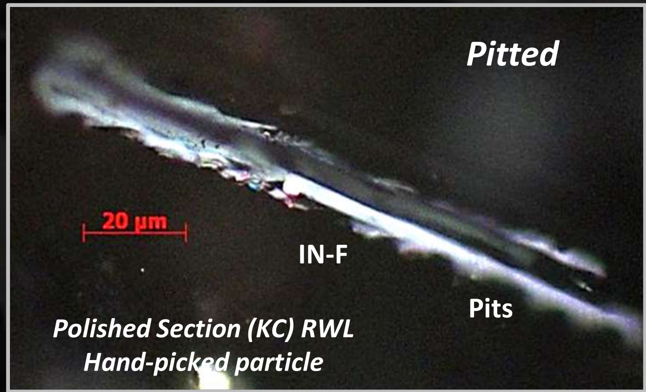
- NOB Phytoclasts (Pitted) show bordered or scalariform pits and they are tracheids tissues (highly lignified) and seem to have a positive correlation with inertinite (Fusinite);
- Besides, it seems to be a + correlation between the amount of lignin present in the component and maceral type. Components presenting higher lignin content seem to have a + correlation with F and those presenting lower lignin content seem to have better correlation with SF;



Palynofacies Slides (KC) TWL



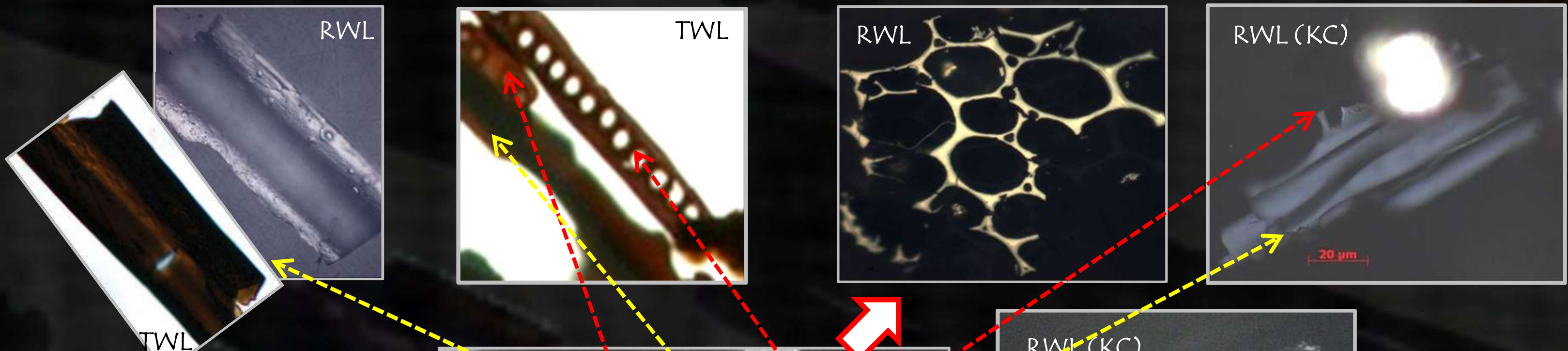
Palynofacies Slides (KC) TWL



Polished Section (KC) RWL
Hand-picked particle

Pitted/Banded Phytoclasts: wood tracheids

- The tracheid is a non-living element of xylem formed from a single cell that serves to conduct water and to provide mechanical support;
- Tracheids are elongated, thick, lignified, and pitted walls and they are characteristic of vascular plants other than flowering plants;



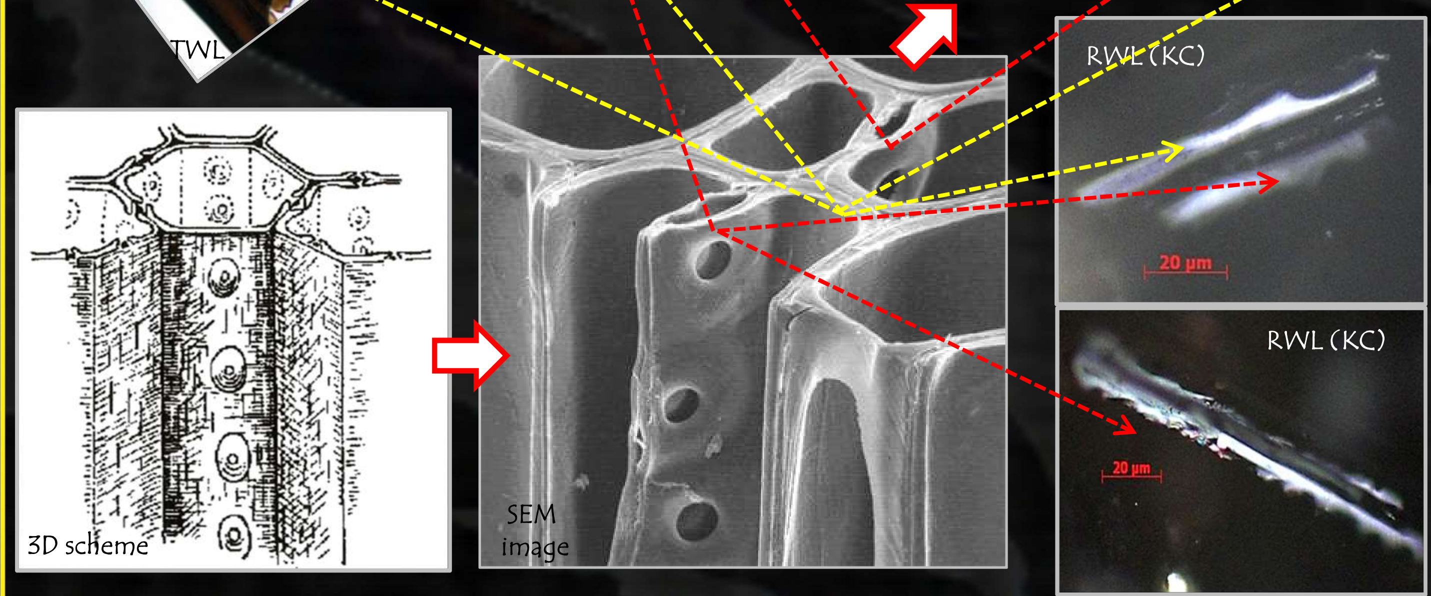


Figure: a detail of the pitted and banded components, side by side in the bordered walls of a soft wood tracheid (as a hollow fiber) and the tracheids in several sections (including in 3D scheme, SEM image and basal viewing);
They are generally together and associated to each other;

Quantitative Correlation between TL and RL

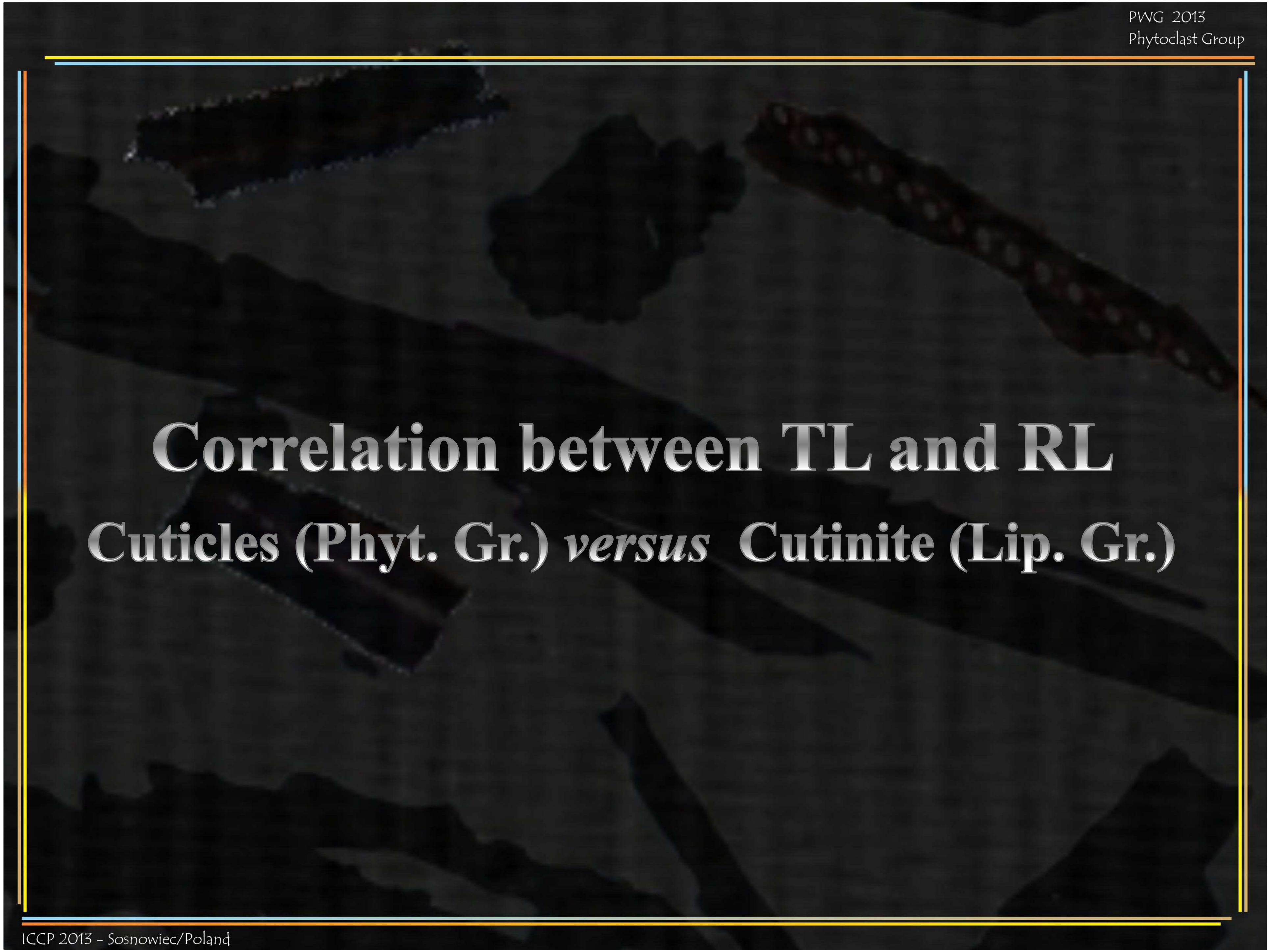
Phytoclasts *versus* Inertinite

Correlation between TL and RL

Phytoclasts *versus* Inertinite

- The table shows the quantitative values (normalized to 100%) for Opaque and NOB Phytoclasts (TWL) and Inertinite Group (RWL - WR and KC);
- Based on the correlation of these values, it seems to have a positive correlation between the total of Opaque and NOB Phytoclasts and the Inertinite Group, as previously shown;

Participant	TWL (PS) Opaque	TWL (PS) NOB	Total	RWL (WR) In (WR)	RWL (KC) In (KC)
A	6.8	10.5	17.2	43.3	56.7
B	55.2	12.1	67.3	32.9	67.1
C	56.7	12.2	68.8	46.5	53.5
D	20.5	26.6	47.1	48.7	51.3
E	37.2	31.3	68.5	31.9	68.1
G	25.2	15.9	41.1	50.9	49.1
H	25.3	23.8	49.0	47.4	52.6
I	34.4	8.7	43.1	34.0	66.0
J	28.6	40.8	69.4	43.9	56.1
K	48.7	5.4	54.1	33.2	66.8
L	22.6	28.7	51.3	29.3	70.7
M	37.7	12.9	50.6	32.9	67.1
N	13.5	14.4	27.9	36.2	63.8
O	13.5	23.2	36.7	59.7	40.3
Average	30.4	19.0	49.4	40.8	59.2
δ	15.4	10.2	15.9	9.1	9.1



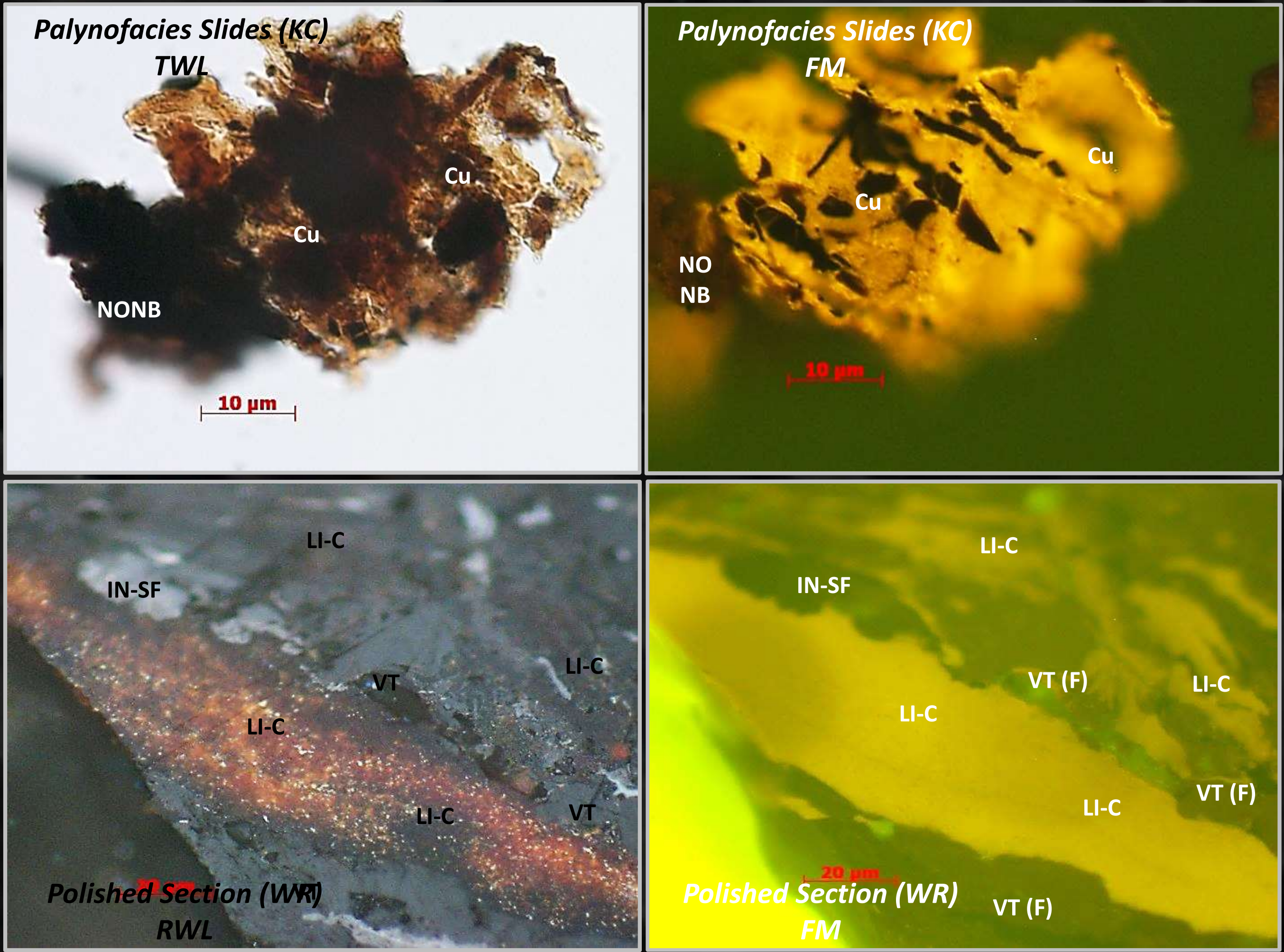
Correlation between TL and RL

Cuticles (Phyt. Gr.) *versus* Cutinite (Lip. Gr.)

Correlation between TL and RL

Cuticles *versus* Cutinite

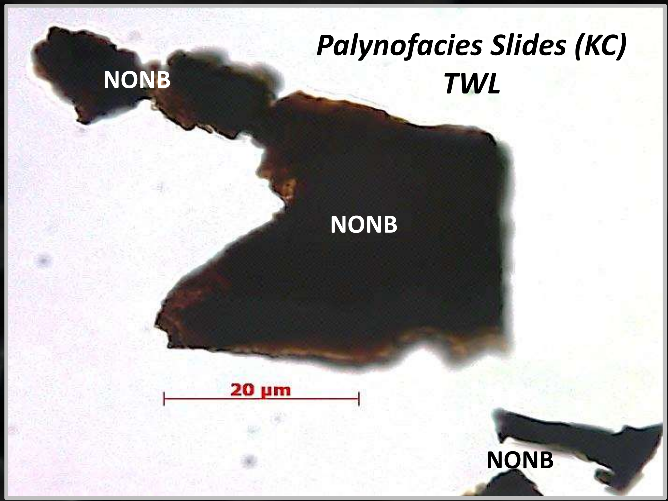
- The correlation between cuticles and cutinite is evident;

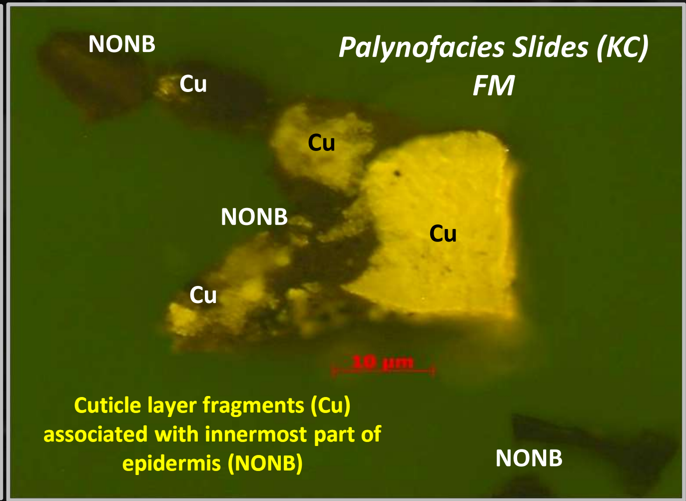


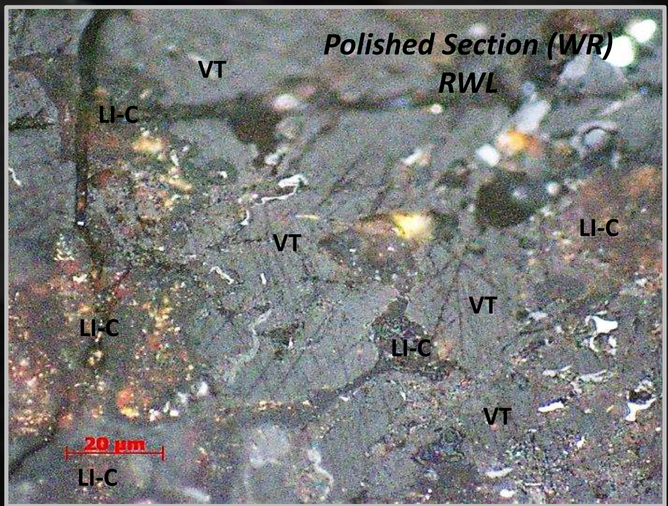
Correlation between TL and RL

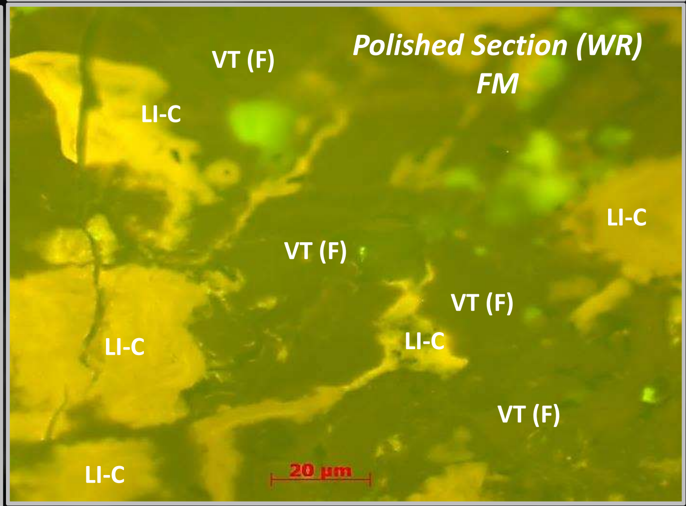
Cuticles *versus* Cutinite

- The correlation between cuticles and cutinite is evident;





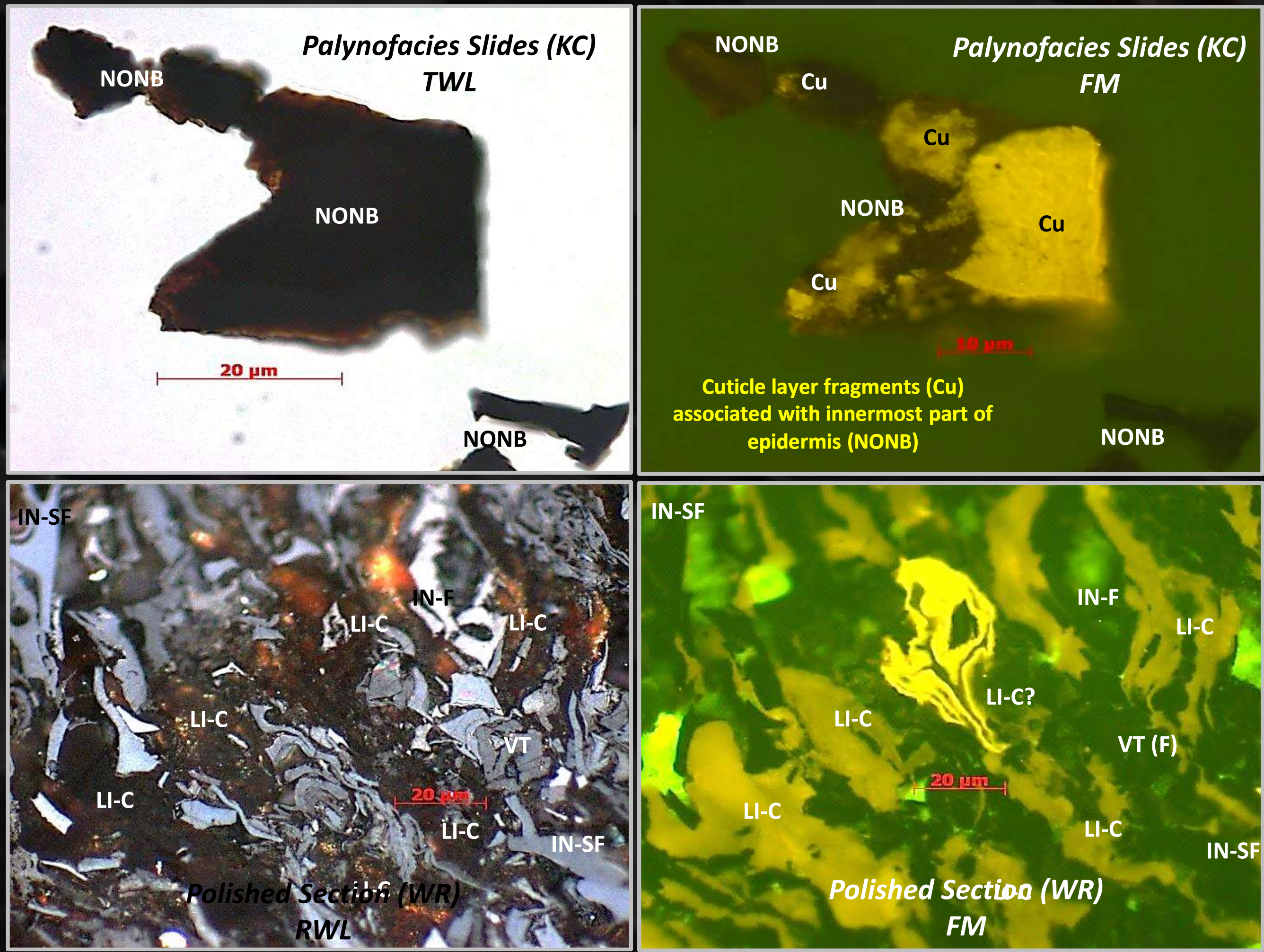




Correlation between TL and RL

Cuticles *versus* Cutinite

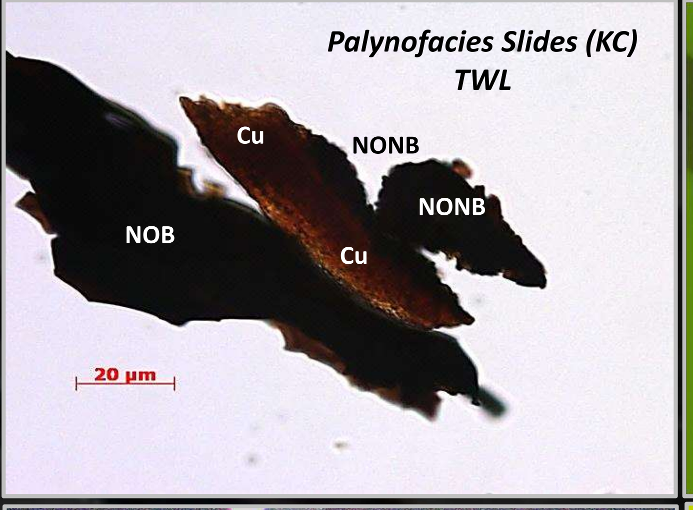
- The correlation between cuticles and cutinite is evident;

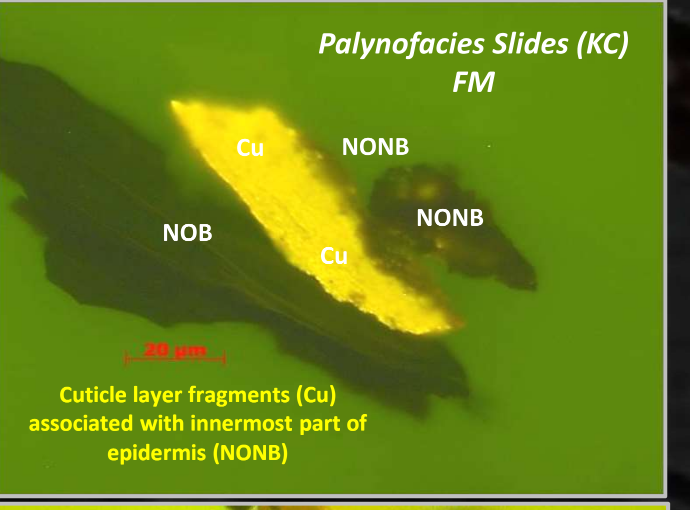


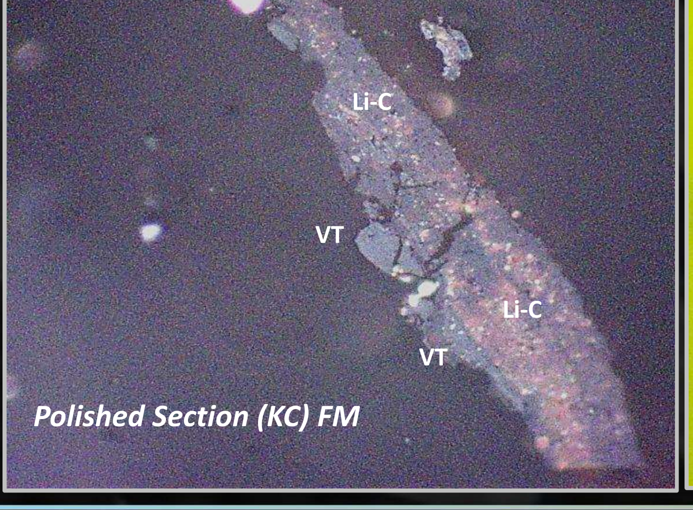
Correlation between TL and RL

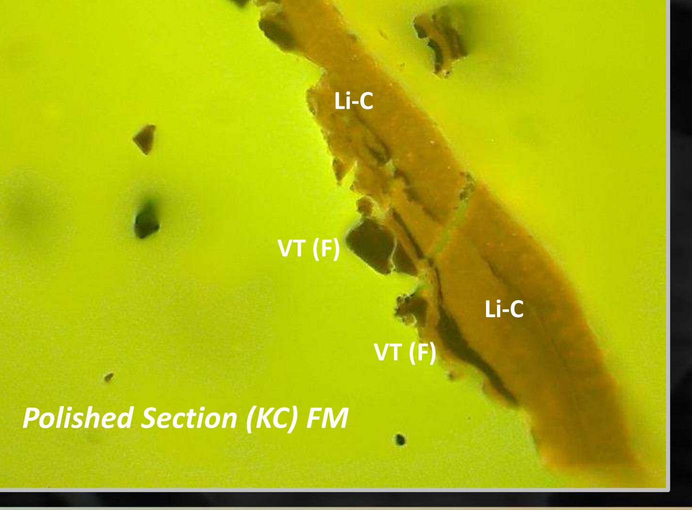
Cuticles *versus* Cutinite

- The correlation between cuticles and cutinite is evident;









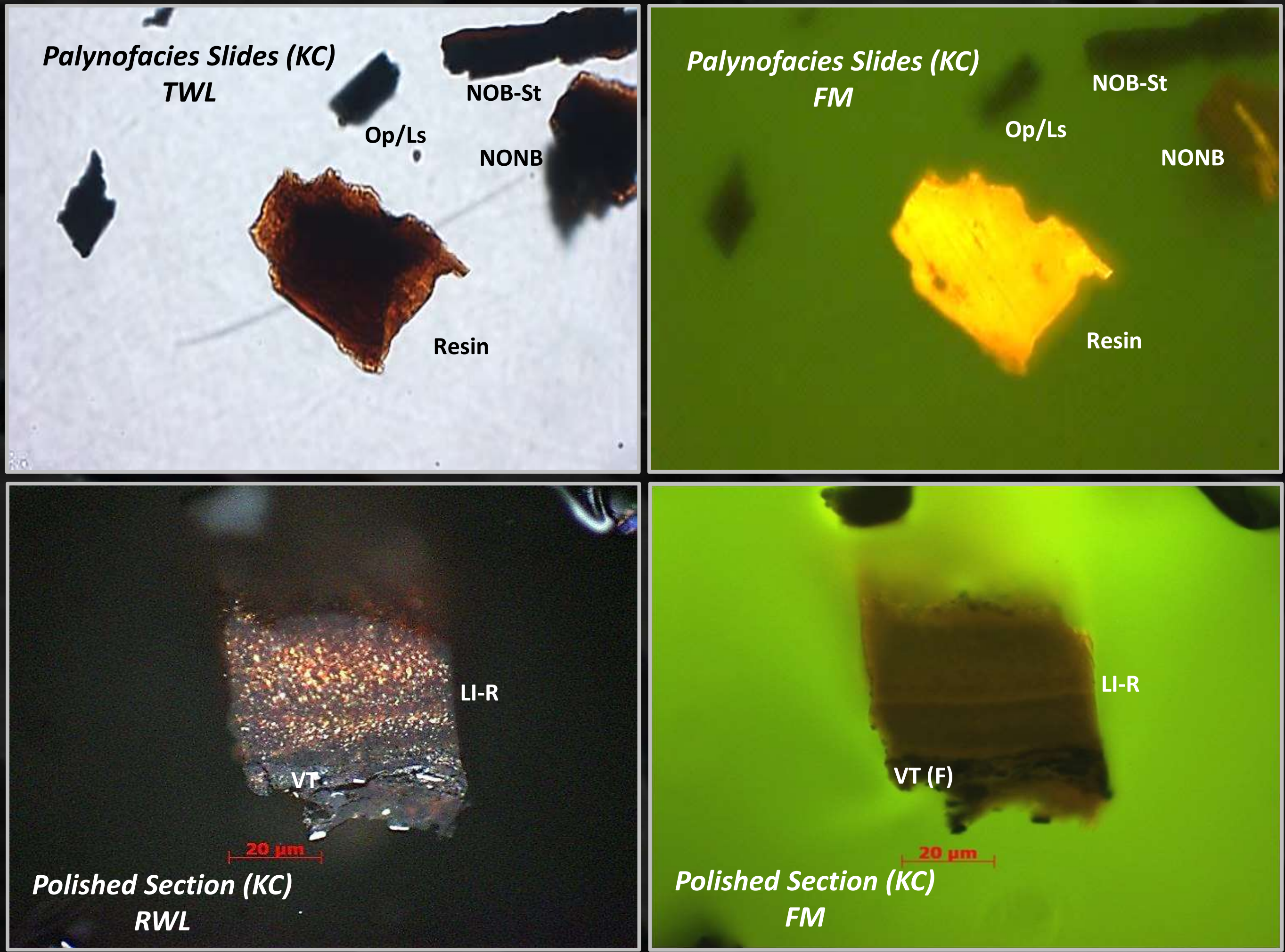
Correlation between TL and RL

Resin (AOM) *versus* Resinite (Lip. Group)

Correlation between TL and RL

Resin (AOM)*versus* Resinite

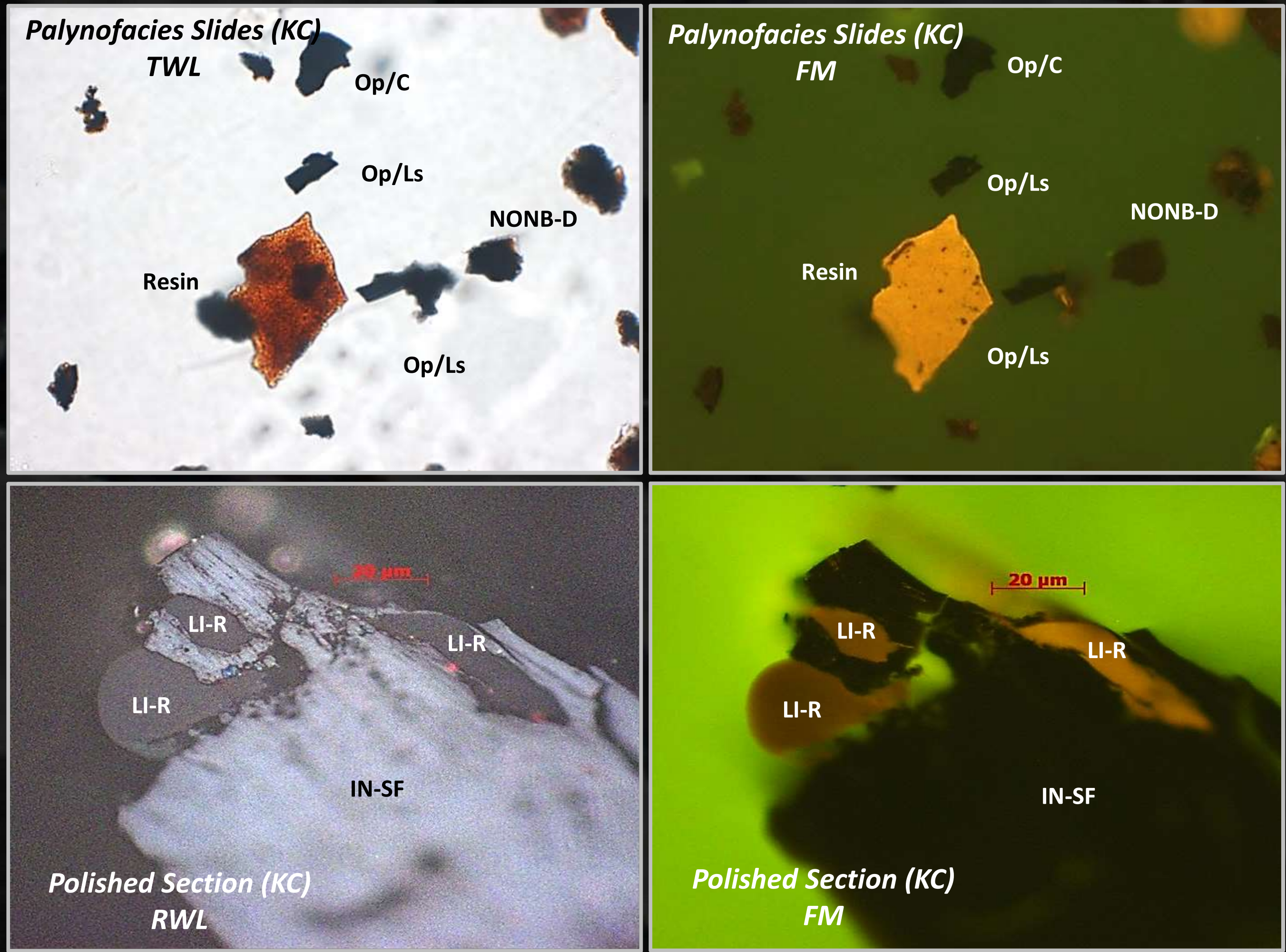
- The correlation between resin and resinite is evident;



Correlation between TL and RL

Resin (AOM) *versus* Resinite

- The correlation between resin and resinite is evident;



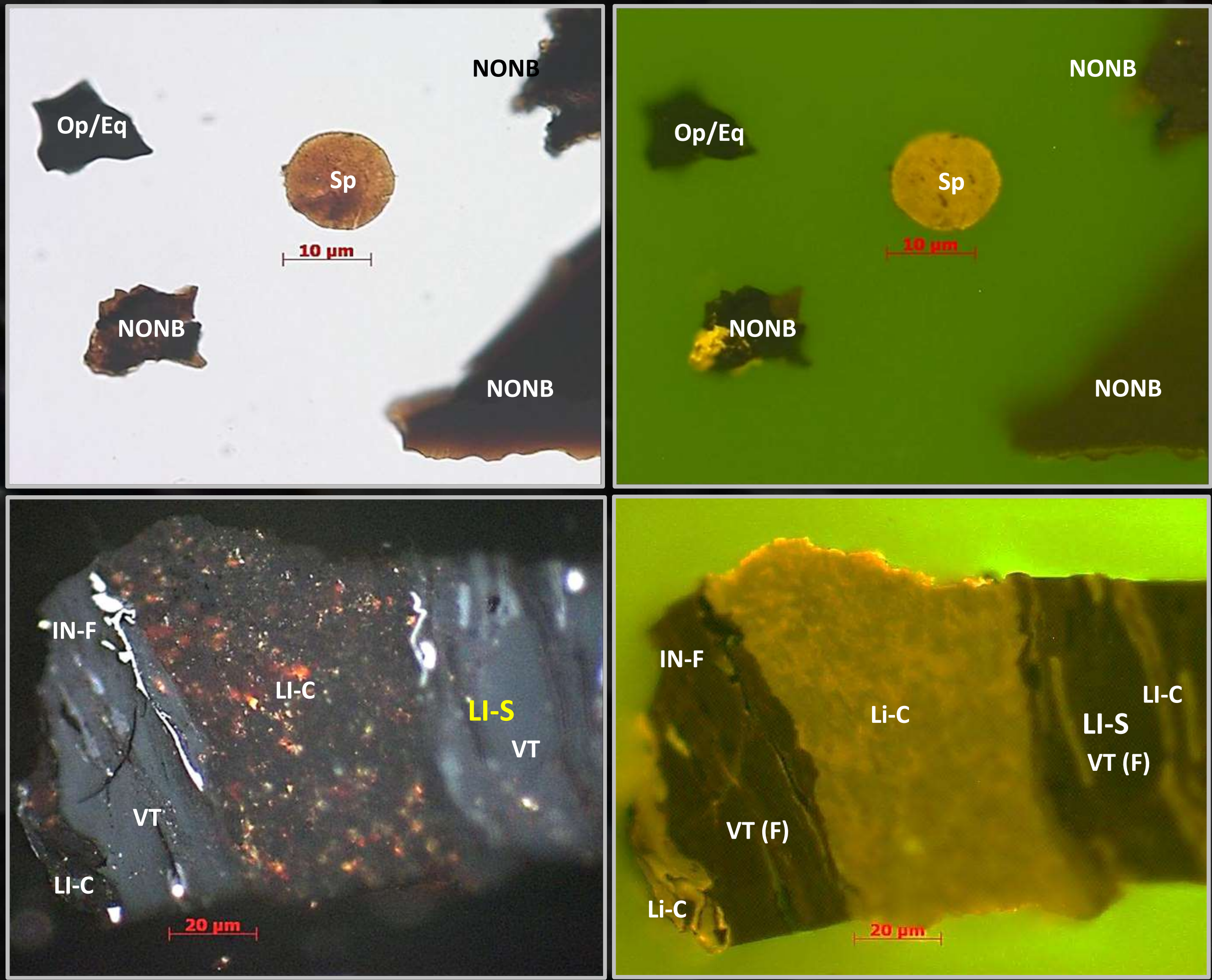
Correlation between TL and RL

Sporomorph *versus* Sporinite (Lip. Group)

Correlation between TL and RL

Resin (AOM) *versus* Resinite

- The correlation between sporomorph and sporinite is evident;



Concluding Remarks

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

- **The difficulty the participants had to differentiate some particles in TWL was due to the thickenings (Op versus NONB) and structure (NOB subgroup) of the components;**

- **The massive presence of cuticle layer fragments (Cu) associated with the innermost part of epidermis (NONB) in this sample caused an overestimation of Cuticles, in which in TWL must be classified as NONB phytoclast;**

- **All participants recognized the absolute predominance of phytoclasts among the kerogen groups, pointing out the predominance of NONB particles among the subgroups;**

Concluding Remarks

- On the same way, it was recognized the predominance of Vitrinite over Inertinite and Liptinite groups and of Telovitrinite over Gelovitrinite and Detrovitrinite macerals within the Vitrinite Group;

- Comparing the results obtained using RWL in both, WR and KC, the contribution of Inertinite Group was higher in KC than WR, at least for some participants. This feature can be a result of a higher concentration of inertinite particles in the isolated organic matter (KC) through the preparation process or the participants' difficulty to differentiate the macerals on polished section of KC;

- Now, in relation to macerals within the Inertinite Group, fusinite content was higher in the KC than WR, for the majority of participants. This feature can be a result of a higher concentration of fusinite particles in the isolated organic matter (KC) also through the preparation process or the participants' difficulty to differentiate the macerals from Inertinite Group on polished section of KC;

Concluding Remarks

- **Comparing the results obtained using RWL on polished section was observed the distribution of macerals from the Liptinite Group (WR and KC), was divided into 2 distinct groups. One of them based on the predominance of cutinite and the other one on sporinite. Although, cutinite was the predominant maceral for the majority of participants in WR, as well as in KC. It may be that this was the result of a higher difficulty to differentiate between cutinite and sporinite in the WR than in the KC polished sections;**

- **Based on the correlation of the quantitative values for NONB Phytoclasts (TWL) and Vitrinite Group (RWL - WR and KC) was recognized a positive correlation between NONB Phytoclast and the Vitrinite Group quantitatives, as shown on pictures;**

Concluding Remarks

- Now, in the correlation between phytoclasts population and inertinite macerals:
  - It was evident the positive correlation between opaque phytoclasts and fusinite/semifusinite macerals;
  - It was suggested a positive correlation between the amount of lignin present in the component and maceral type;
  - Components from phytoclast group presenting higher content of lignin seem to have a positive correlation with fusinite and, on the other hand, components presenting lower content of lignin seem to have better correlation with semifusinite;
- Based on the correlation of the quantitative values for Opaque and NOB Phytoclasts (TWL) and Inertinite Group (RWL - WR and KC) was recognized a positive correlation between the overall total of Opaque and NOB Phytoclasts and the Inertinite Group quantitatives, as shown on pictures;

Proposal for 2014 Exercise

- **Based on these results and as the Phytoclast is one of the most diversified group from Kerogen and the most difficult to correlate between TWL and RWL, it is strongly suggested to continue its examination in the next exercise.**
- **Thus, the main objective of the 2nd Exercise continues to be the characterization of the origin of the phytoclast * particles and all the aspects of its assemblage, such as:**
  - **Identification of the individual particulate components;**
  - **Assessment of their absolute and relative proportions;**
  - **Particle sizes;**
  - **Preservation states;**
- **See feasibility of an integration and correlation of the palynofacies information obtained in this WG with the classification of organic components from ICCP (maceral composition);**

* The phytoclast term was introduced by Bostick (1971) to describe all particles with size clay or fine-sand derived from higher plants or fungi and fluorescence depending on the origin of the tissues.

Acknowledgements

- The sample from Rio Bonito Formation was provided by LAFO-UFRJ;
- LAFO-UFRJ for providing the organic geochemistry analysis;
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- Taíssa R. Menezes (PETROBRAS) for deliberations and data interpretation;
- Special thanks to Joalice Mendonça (LAFO-UFRJ) for all the efforts to complete this WG;
- All the Participants;

Thank you for your attention!

The End