



ICCP COMMISSION III

Self – heating of coal and coal wastes working group

71st ICCP Meeting, The Hague,
September 15-21, 2019

Convenors:

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The aim of the Self-heating Working Group:

- to gather examples of various forms of transformation of organic matter in coal wastes and coal of various rank.
- to establish a classification of transformed organic particles (oxidised and thermally altered) in coal wastes and in coals that will reflect the complex conditions in the waste dumps and in the thermally/oxidatively affected coal seams.

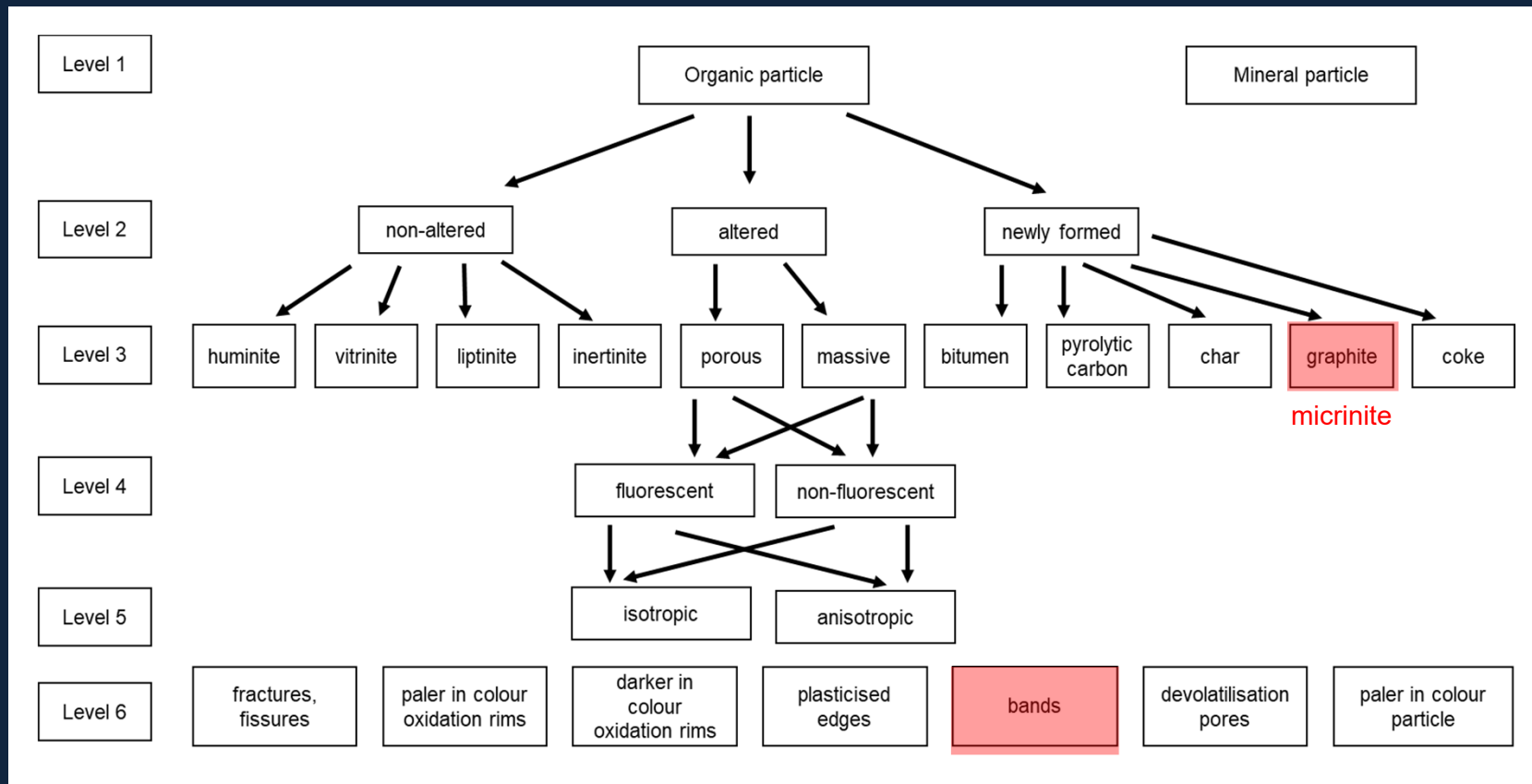
Past activity:

- The SHWG was established during the 62nd ICCP Meeting in Oviedo (2008) and information about it was published in the ICCP News Letter No. 45, 2008.
- Multiple Round Robin Exercises on coal waste were carried out in 2009, 2010, 2012, 2013, 2015, and 2016.
- In 2018 Round Robin Exercise on thermally/oxidatively affected coals in coal seams.
- In 2019 manuscript on the classification of coal waste subjected to self-heating and self-combustion processes submitted to IJCG for review and publication.

Objective of the 2018 SHWG Round Robin Exercise :

- to apply the established classification of oxidatively and thermally affected organic matter in coal wastes to oxidatively and thermally affected coaly matter in coal seams.
- to test the applicability of the established classification of oxidatively and thermally altered organic matter in coal wastes to self-heated coals in a ppt presentation.

Classification of thermally and oxidatively affected coaly matter in self-heated coal:



Aim of the 2018 SHWG Round Robin Exercise :

- Determine the form of coaly matter in the rectangle in accordance to the established classification and mark the answer in the attached Excel file (2018 Round Robin Exercise SHWG.xls).
- Background mean VRr – 0.94% with SD 0.04%.
- $0.90 \leq \text{VRr} \leq 0.98$ were considered to be oxidatively and thermally altered.
- 12 Participants

Participants of the 2018 SHWG

Round Robin Exercise :

- **Ali İhsan Karayiğit** – Hacettepe University, Department of Geological Engineering, 06800 Ankara, Turkey
- **Claudio Avila** – University of Nottingham, School of Chemical and Environmental Engineering, Nottingham (NG7 2JT), United Kingdom
- **Deolinda Flores** – University of Porto, Department of Geosciences, Environment and Spatial Planning, Rua do Campo Alegre, 687, 4169-007 Porto, Portugal
- **Georgeta Predeanu** – University Politehnica of Bucharest (UPB) ,Faculty of Applied Chemistry and Materials Science, PolizuSt.1–7, 011061Bucharest, Romania
- **Ivana Sýkorová** – Academy of Sciences of the Czech Republic, Institute of Rocks Structure and Mechanics, V Holešovičkách 94/41, Praha 18209, Czech Republic
- **Joana Ribeiro** – Universidade do Porto, Departamento de Geociências, Ambiente e Ordenamento do Território, Rua do Campo Alegre, 687, 4169-007 Porto, Portugal
- **Kimon Christanis** – University of Patras, Department of Geology, Postal Code 265 04 Rio Patra, Greece
- **Nikki Wagner** – University of Johannesburg, Department of Geology, Johannesburg, South Africa
- **Sławka Pusz** – Polish Academy of Sciences, Centre of Polymer and Carbon Materials, M. Curie-Skłodowskiej 34, PL-41819 Zabrze, Poland
- **Stavros Kalaitzidis** – University of Patras, Department of Geology, Postal Code 265 04 Rio Patras, Greece
- **Walter Pickel** – 4/38-3302 Darling Street, Balmain, NSW 2041, Australia
- **Zeynep Buckun** – Dokuz Eylul University, Department of Geology Engineering, Izmir, Turkey

Photo 1.0 Vitrinite reflectance: 0.96% VRr; NA% VRmax

Reflectance values below 0.90% VRr and above 0.98 VRr are considered to be oxidatively and thermally altered.

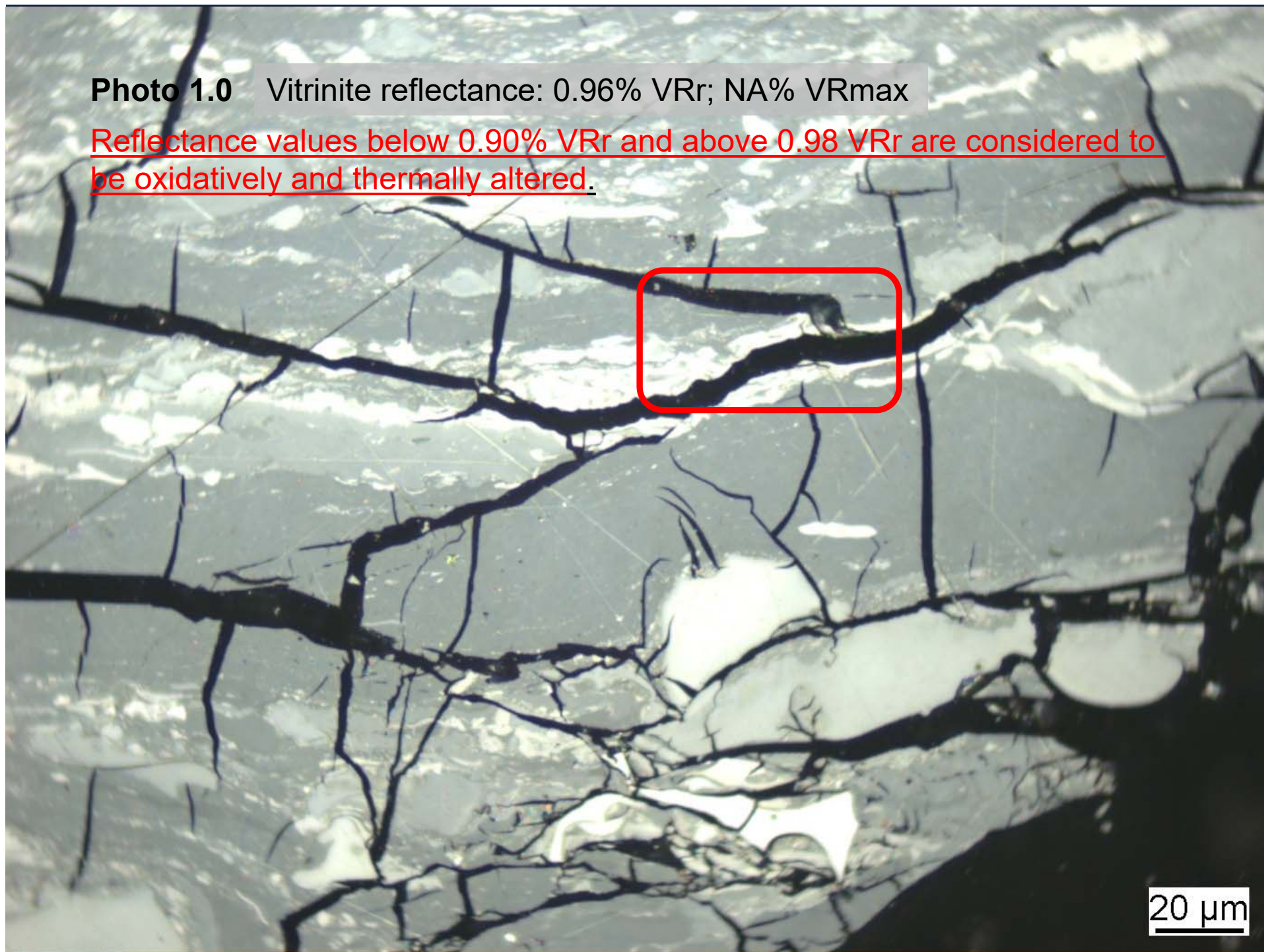
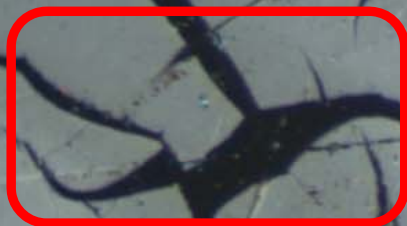


Photo 13.0 Vitrinite reflectance: 0.92% VRr; NA% VRmax

Reflectance values below 0.90% VRr and above 0.98 VRr are considered to be oxidatively and thermally altered.



20 μm

Photo 23.0 Vitrinite reflectance: 0.93% VRr; 1.05% VRmax

Reflectance values below 0.90% VRr and above 0.98 VRr are considered to be oxidatively and thermally altered.

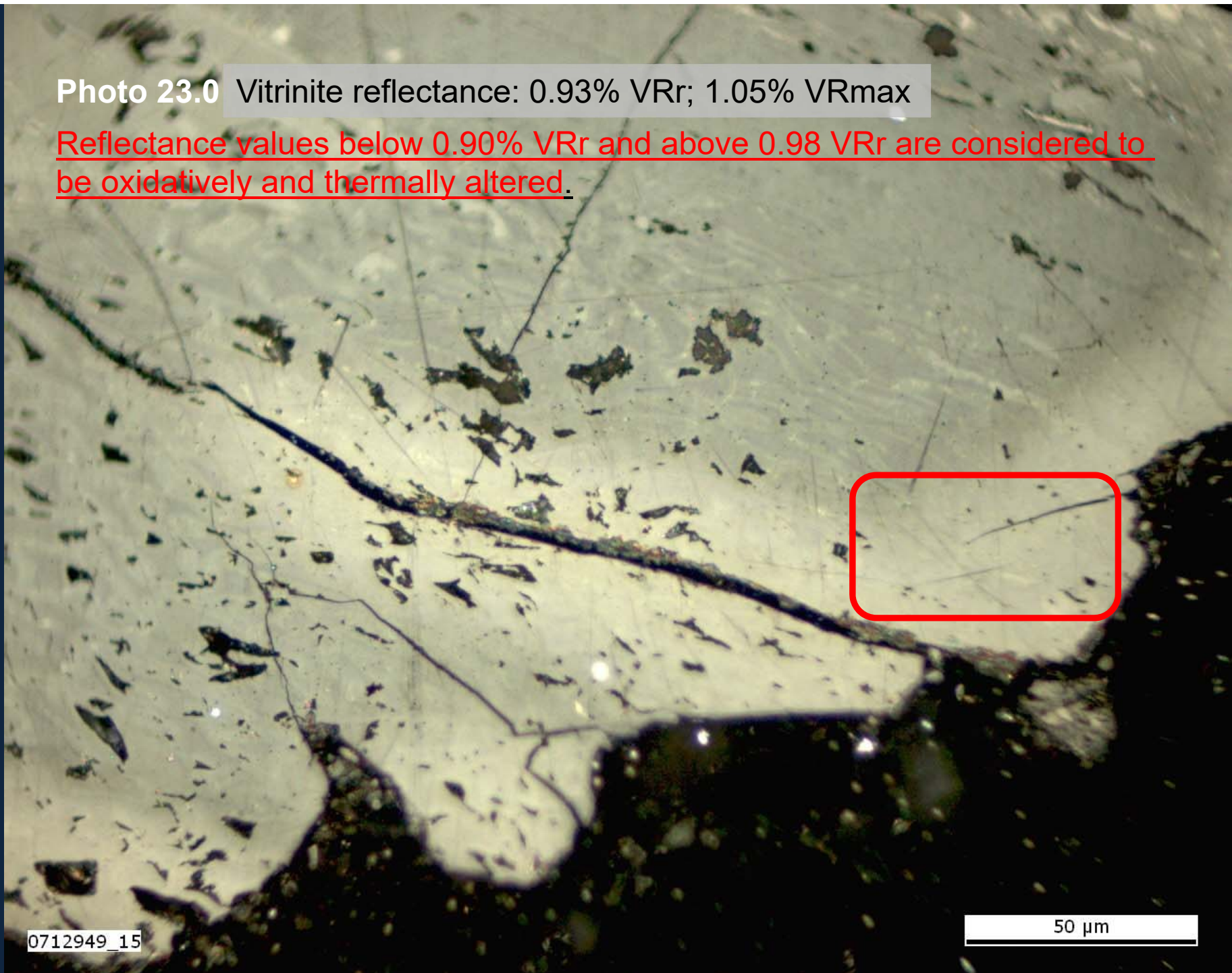
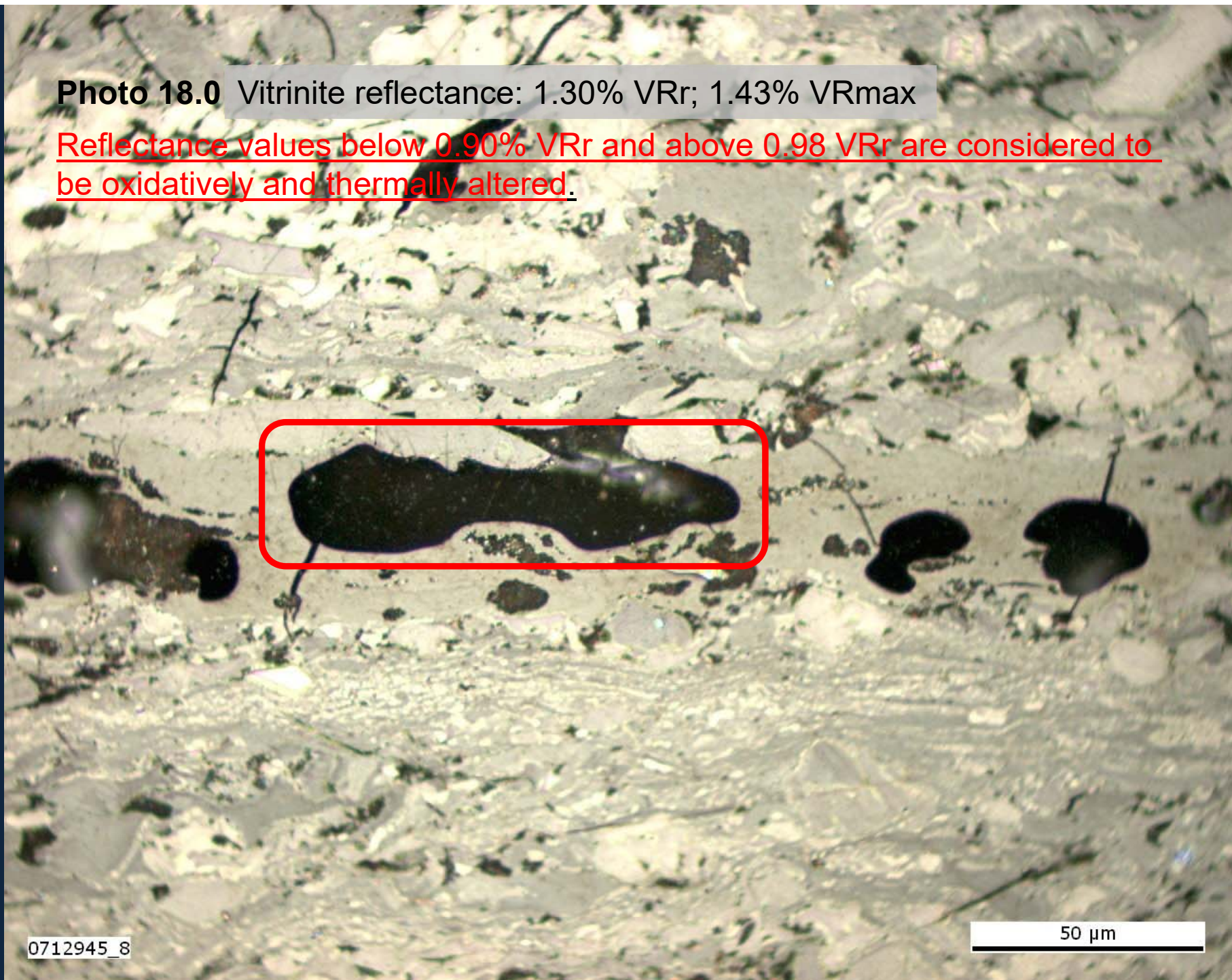


Photo 18.0 Vitrinite reflectance: 1.30% VRr; 1.43% VRmax

Reflectance values below 0.90% VRr and above 0.98 VRr are considered to be oxidatively and thermally altered.

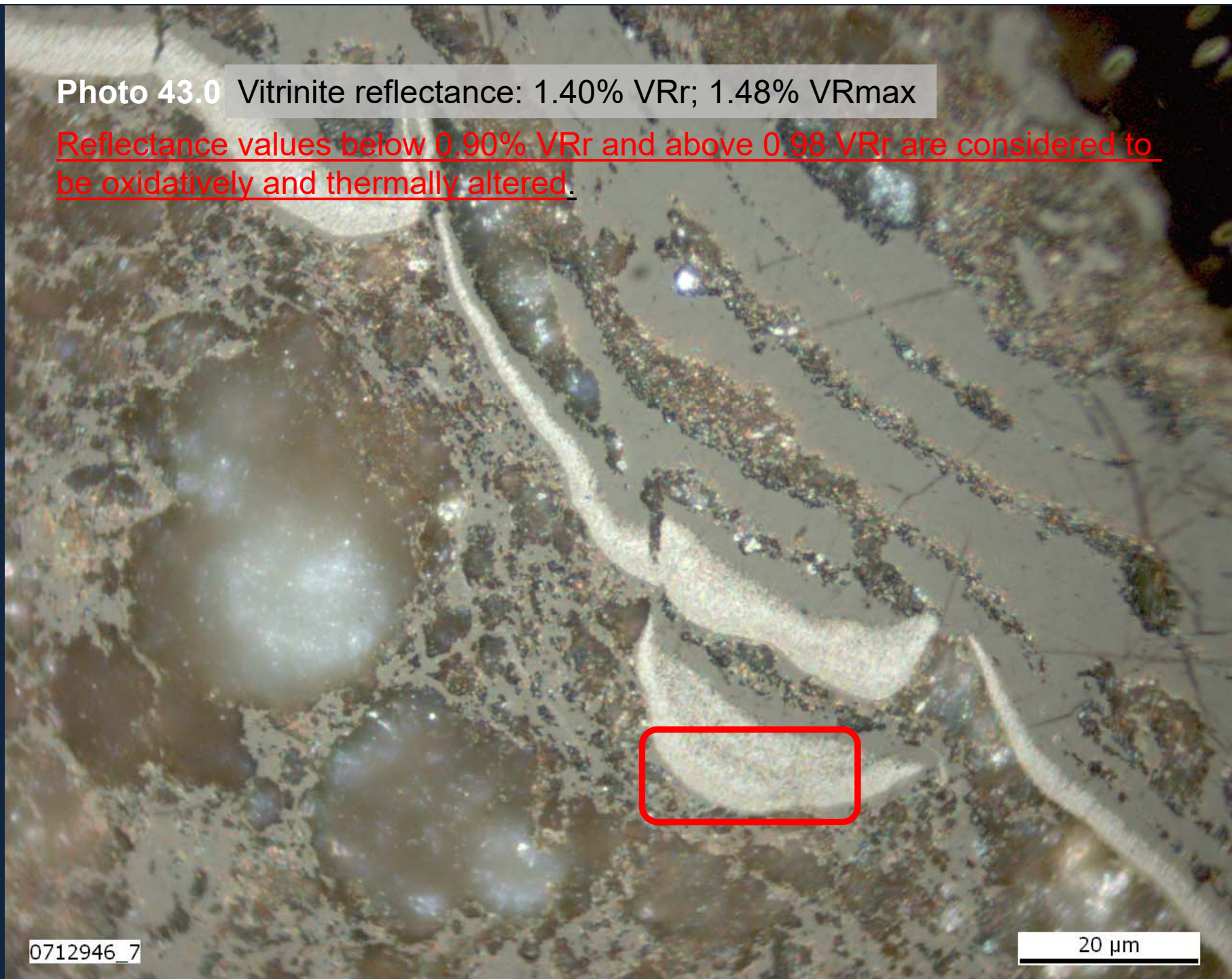


0712945_8

50 μm

Photo 43.0 Vitrinite reflectance: 1.40% VRr; 1.48% VRmax

Reflectance values below 0.90% VRr and above 0.98 VRr are considered to be oxidatively and thermally altered.

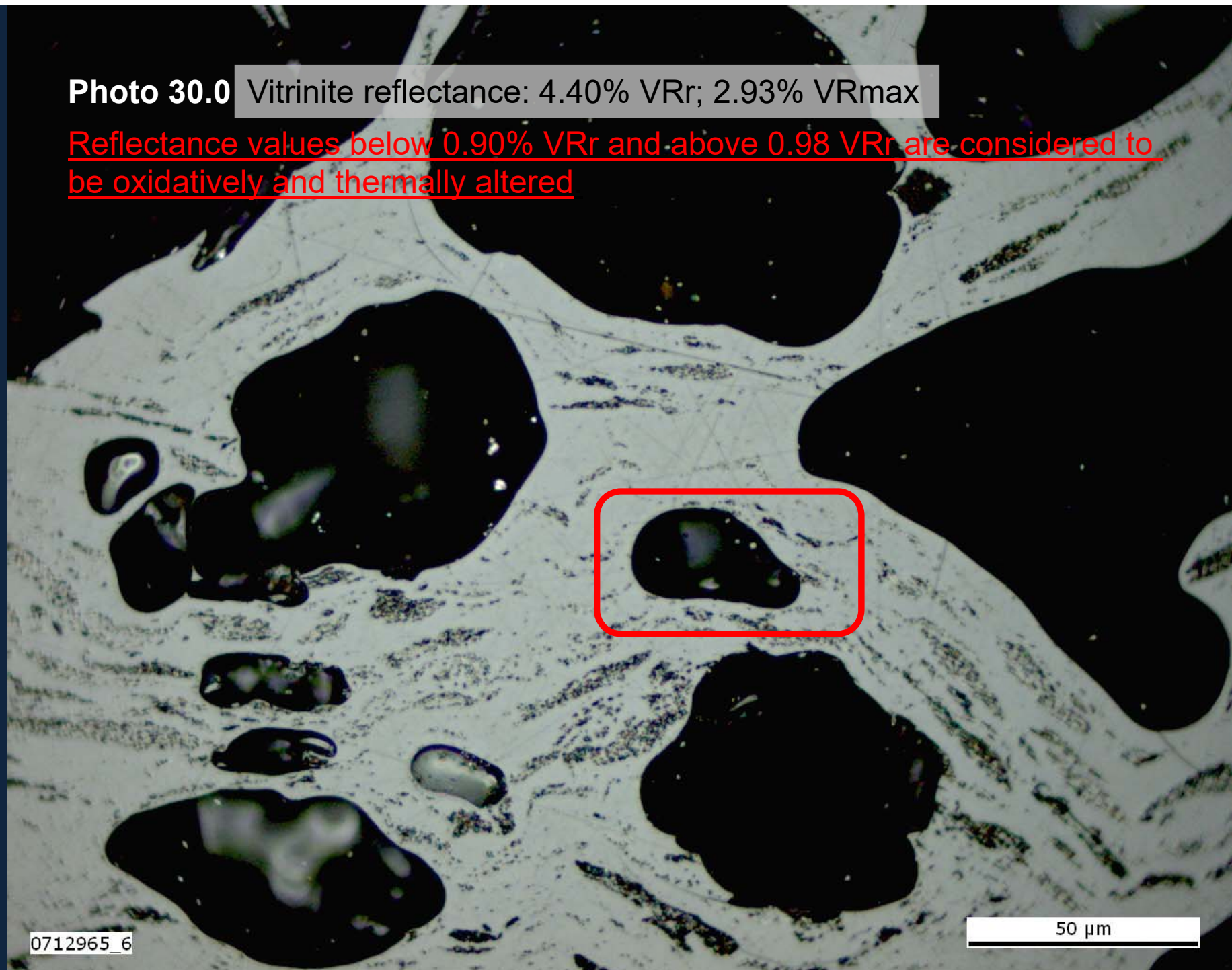


0712946_7

20 μm

Photo 30.0 Vitrinite reflectance: 4.40% VRr; 2.93% VRmax

Reflectance values below 0.90% VRr and above 0.98 VRr are considered to be oxidatively and thermally altered

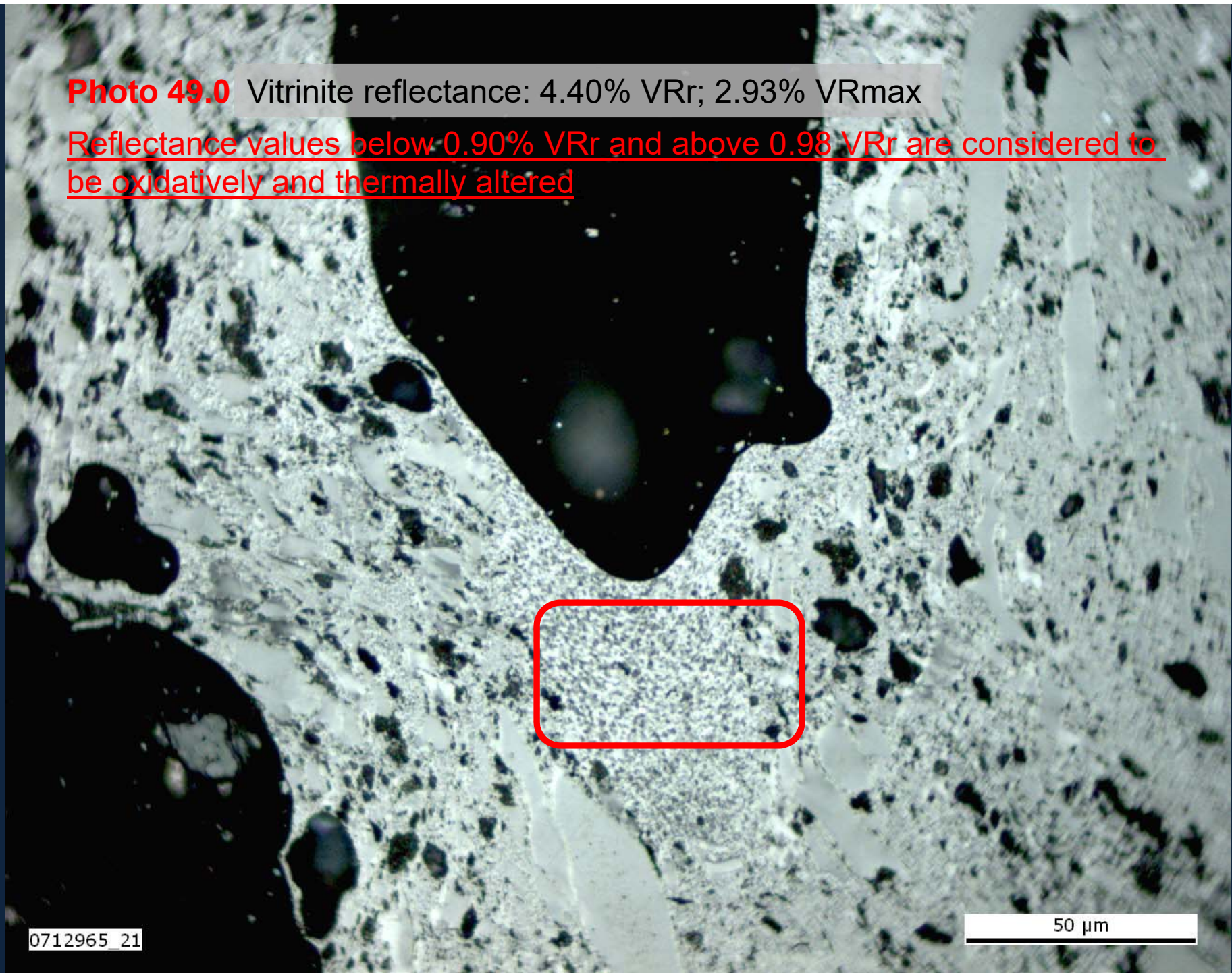


0712965_6

50 μm

Photo 49.0 Vitrinite reflectance: 4.40% VRr; 2.93% VRmax

Reflectance values below 0.90% VRr and above 0.98 VRr are considered to be oxidatively and thermally altered



0712965 21

50 μm

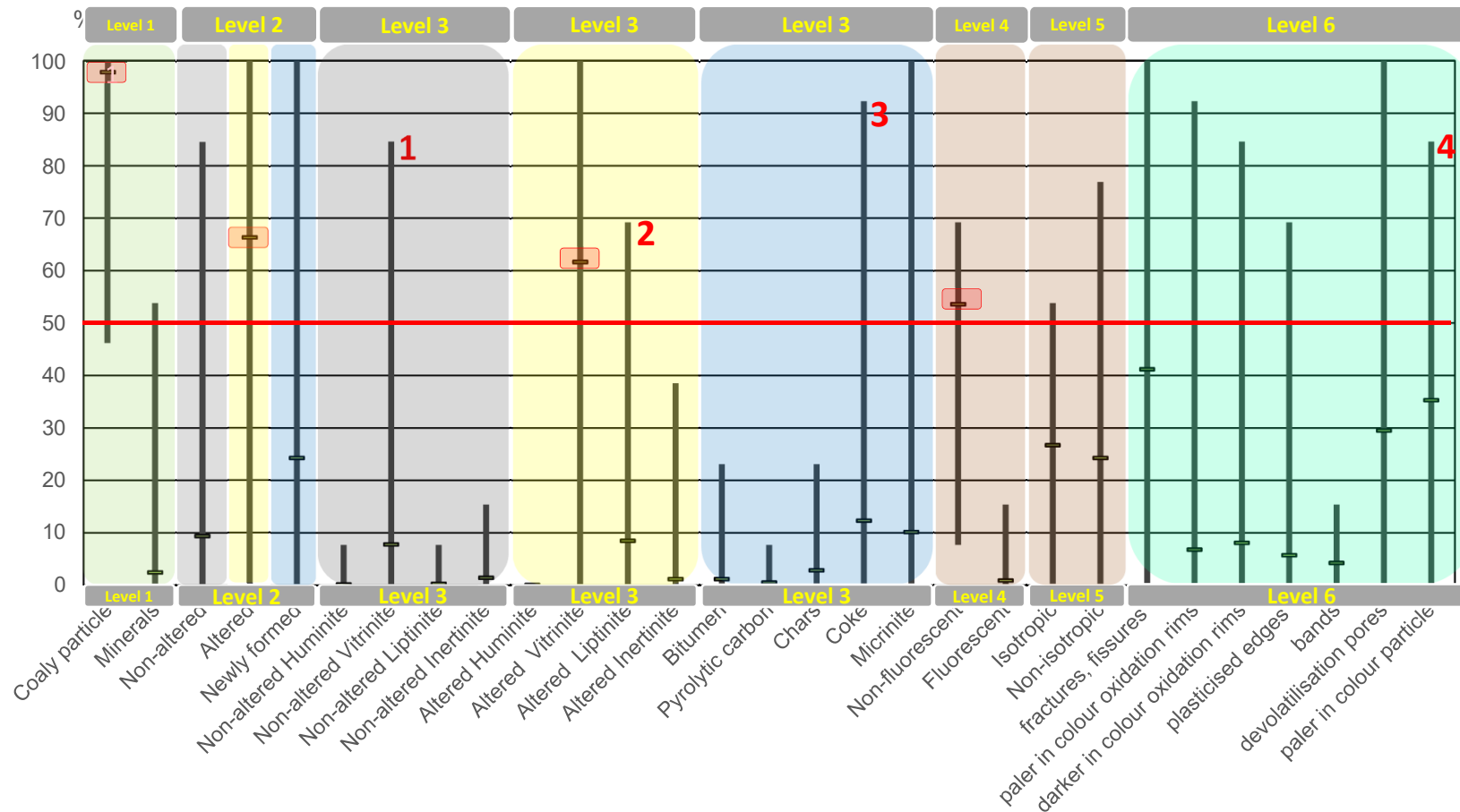
Responses to the 2018 SHWG

Round Robin Exercise :

- For altered particles in the level 3 the excell sheet contains 'H/V/L/I' and not the elements 'Massive Porous'
- For level 6 the word file without the form 'Band'
- For level 6 the excell file with the form 'Band' and without the form 'micrinite'
- Comments related to individual forms.
- Inconsistency between the VRr and Vrmax values:

Vitrinite reflectance: 4.40% VRr; 2.93% VRmax

Results of the 2018 SHWG Round Robin Exercise



- A highly differentiated picture

Results to the 2018 SHWG Round Robin Exercise

1. Level 3 – Non-altered vitrinite

For particles with background VRr (%), within the SD and showing for e.g., rims, fractures, is the status 'altered' or 'not altered' ?

- ❖ According to the exercise guidelines, the status was considered to be non-altered.
- ❖ However, one might change the status to altered as VRr (%) is not sensitive to the thermal alteration sourced by the coal fire – pale and dark oxidation rims.
- ❖ Also, one might change the status to altered as VRr (%) is sensitive to the oxidative alteration sourced by the coal fire – pale and dark oxidation rims with lower or higher VRr (%).

Therefore: it is suggested for the 2019 SHWG Round Robin Exercise to characterise the coals as altered due to coal fire based on Level 6 options, independently of VRr (%).

Photo 1.0 Vitrinite reflectance: 0.96% VRr; NA% VRmax

Reflectance values below 0.90% VRr and above 0.98 VRr are considered to be oxidatively and thermally altered.

- Non-altered – 4 Participants
- Altered – 8 Participants

20 μm

Results to the 2018 SHWG Round Robin Exercise

2. Level 3 – Altered liptinite

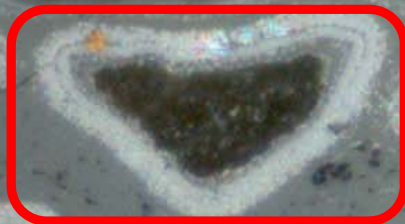
2a. For sporinite, cutinite, exudatinite, etc. altered to micrinite is the status altered or newly formed?

- ❖ According to the exercise guidelines, the status was considered to be newly formed.

Therefore: it is suggested for the 2019 SHWG Round Robin Exercise to characterise micrinite, having the form of former liptinite macerals as newly formed.

Photo 44.0 Vitrinite reflectance: 1.40% VRr; 1.48% VRmax

Reflectance values below 0.90% VRr and above 0.98 VRr are considered to be oxidatively and thermally altered



- Newly formed – 13 Participants
- Altered liptinite – 4 Participants

Results to the 2018 SHWG Round Robin Exercise

3. Level 3 – Coke

For micrinite and coke: there is a high potential for misinterpretation

- ❖ According to the exercise guidelines, micrinite will maintain the former shape (outline) of former unaltered liptinite macerals. It occurs as fine grained material characterised by a high reflectance.
- ❖ coal heated in the absence of air, vesiculated and harden into coke. For further reference on similar textures and structures in metallurgical coke see Suárez-Ruiz and Crelling (2008), on natural coke Kwiecińska and Petersen (2004).

Therefore: it is suggested for the 2019 SHWG Round Robin Exercise to modify the description of coke and provide more graphical examples of both forms.

Photo 29.0 Vitrinite reflectance: 1.13% VRr; 1.20% VRmax

Reflectance values below 0.90% VRr and above 0.98 VRr are considered to be oxidatively and thermally altered.

- Newly formed coke – 3 Participants
- Newly formed micrinite – 5 Participants



Results to the 2018 SHWG Round Robin Exercise

4. Level 6 – Paler in colour particle

For the option „paler in colour particle“ what is the reference state? The colour of the background unaltered vitrinite or the vitrinite in the vicinity of the examining rectangle?

- ❖ According to the exercise guidelines, paler in colour particles are vitrinite grains of higher reflectance compared with the background value.
- ❖ Also paler in colour particle does not refer to the paler in colour oxidation rim.

Therefore: it is suggested for the 2019 SHWG Round Robin Exercise to:

1. Insert a box on each microphotograph with the actual background colour of vitrinite for an unequivocal comparison.
2. Paler in colour particle can also refer to the paler in colour oxidation rim at vitrinite.

Photo 17.0 Vitrinite reflectance: 1.01% VRr; NA% VRmax

Reflectance values below 0.90% VRr and above 0.98 VRr are considered to be oxidatively and thermally altered.



- Paler in colour particle – only 3 Participants

20 μm

Results to the 2018 SHWG Round Robin Exercise

General Considerations for Convenors:

- ❖ Select only one maceral to be identified.
- ❖ Clear images (not diffused).
- ❖ Polarised and florescence images are required.
- ❖ Apply the term reflectance to values measured in coke (not vitrinite reflectance!)
- ❖ Chared particles whitout a characteristic shape of chars – provide some additional information.
- ❖ The identification relates only to the square. The size of the square is equal for all slides.
- ❖ Description of plasticised edges and bands require more explanaiton.
- ❖ Characterisation of inherent and thermal cracks: perpendicular to bedding, with and without bifurcations, extending through bands of inertinite, etc...
- ❖ Cracks were not filled. In Pict. 16. it is mineral matter.
- ❖ Do we need to consider Level 4 and Level 5 also for the newly formed particles?

Results to the 2018 SHWG Round Robin Exercise

2019 Round Robin Exercise:

- ❖ Microphotographs without/with polarised light, and under blue light fluorescence.
- ❖ Clear images (not diffused).
- ❖ Selection of one maceral only under the rectangle.
- ❖ Avoidance of mineral matter.
- ❖ Correct VRr and V_{rmax} values.
- ❖ Descriptions on chars/plasticised edges and bands as well as inherent and thermal cracks.
- ❖ Coals of the same background VRr (%)

Results to the 2018 SHWG Round Robin Exercise

2018 Round Robin Exercise:

- ❖ The Conveners would like to express their warm thanks for participation, time taken and submission of valuable comments and remarks !!!

