Thermal Effect Evaluation of Basic Sill on Rhythmite of Taciba Formation (Permian), South of Brazil, Using RGB Measurements on Non-Opaque Phytoclasts*

Mateus Souza da Silva[1], Lucas Del Mouro[1], Lucas Debatin Vieira[1], Breno Leitao Waiche[1]

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[1]Federal University of Santa Catarina, Florianópolis, Santa Catarina, Brazil (mateussilva200@hotmail.com)

Abstract

The thermal effects on organic matter are the focus of many studies due its importance to the hydrocarbon industry. Through the years many methods to measure these effects such as; vitrinite reflectance (VR), Raman, Rock-eval pyrolysis, Termal Alteration Index (TAI) and Spore Color Index (SCI), have been developed and applied. However, these classical indices are often expensive, time consuming and require equipment not often available to many palynological studies. The current wide access to inexpensive digital color cameras has provided opportunities to develop new methods of thermal effect measurements, such as the Palynomorph Darkness Index (PDI). The PDI is based on grey scales produced by the combination of Red, Green and Blue (RGB) intensities. Despite the effectiveness of the PDI, the palynomorph content in some sequences are scarce, non-continuous or not easy to identify. It is common sense that the organic matter color responds to the temperature increase, then the PDI principle can be apply to other kerogens components e.g. non-opaque phytoclast (NOP). Here, we report on the evaluation of the thermal effect sill emplacement on rhythmites of the Taciba Formation (Lower Permian), south of Brazil, using RGB measurements on NOP. The outcrop, José Guelbcke, located in the city of Itaiópolis, Santa Catarina, Brazil, comprises a 5m sill above a 4.5m fossiliferous rhythmite (subdivided in 9 levels). A sample of each level has been analyzed using OLYMPUS IX83 equipped with the digital camera Olympus DP73 with 17 mpixel resolution. The luminosity was calibrated and pre-set. The kerogen compound, non-opaque phytoclast were chosen due their abundance. Fifteen NOP randomly chosen in each level have been measured. The values obtained were the mode of RGB intensities in all pixels on the selected NOP. The result was converted to a greyscale value and then applied in the PDI formula to obtain the NOP darkness index (NOPDI). Scale ranges from white to black are used. Three distinct groups have been observed in the sequence, from levels 0.5 to 2.0m the NOPDI vary

from 37.86% to 45.57%; from levels 2.5 to 4.0m the NOPDI range from 58.28% to 61.27%; and in the upper level (contact with the basic sill) was 70.39%. The NOPDI results allows us not only to assign that the thermal effectiveness of the sill penetrated only 2.5 m beneath the intrusion, but also that the first group of values represent the pre-intrusion conditions, as for example, background diagenesis.

References Cited

Goodhue, R., and G. Clayton, 2010, Palynomorph Darkness Index (PDI) e a new technique for assessing thermal maturity: Palynology, v. 34/2, p. 147-156.

C. Hartkopf-Fröder, P. Königshof, R. Littke, and J. Schwarzbauer, 2015, Optical thermal maturity parameters and organic geochemical alteration at low grade diagenesis to anchimetamorphism: A review: Int. J. Coal Geol., 10.1016/j.coal.2015.06.005

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Quadros, L.P., and J.H.G. Melo, 1987, Método prático de preparação palinológica em sedimentos prémesozóicos: Boletim de Geociências da Petrobrás, v. 1/2, p. 205-214.

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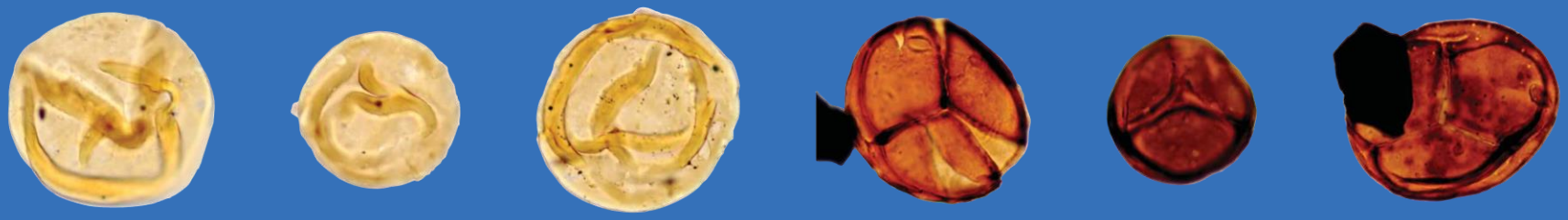
LABORATÓRIO DE GEOQUÍMICA-UFSC

Agenda

- Introduction;
- Problem;
- Methodology;
- Results & Discussions;
- Conclusions;
- Challenges.

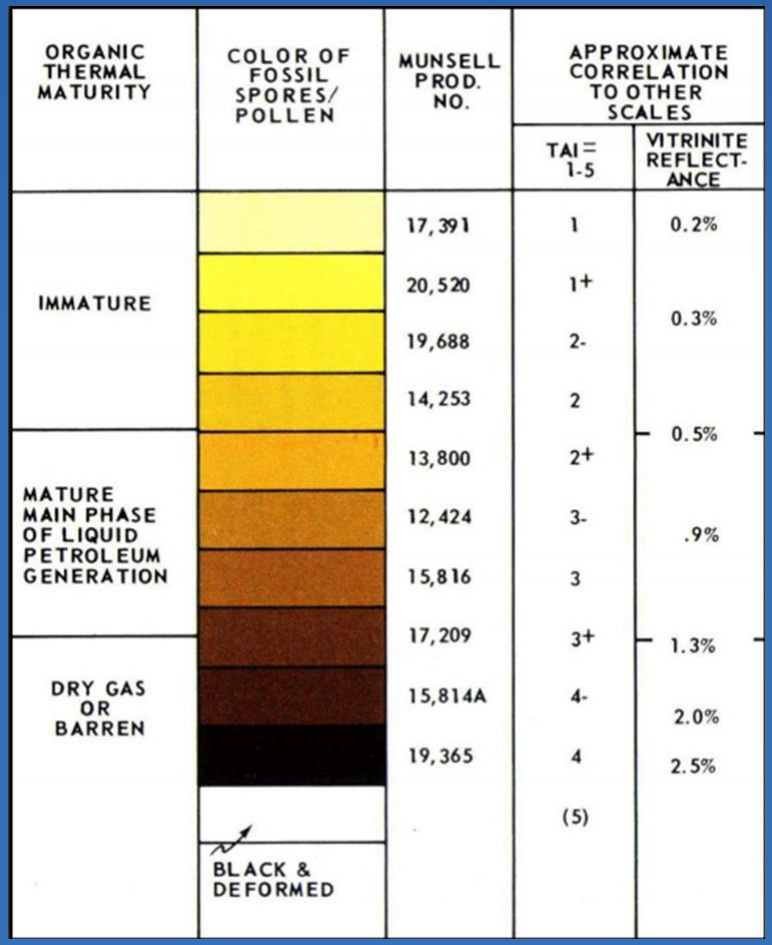
Introduction

The colour of organic matter has long been used in the oil industry to evalute potential hydrocarbon source rocks.



Modified from Goodhue and Clayton, 2010

Thermal Alteration Index (TAI) (Staplin, 1969)



- First of many schemes;
- Visual estimation;
- Original chart – 5 divisions;
- Later – 1+, 2+,…;

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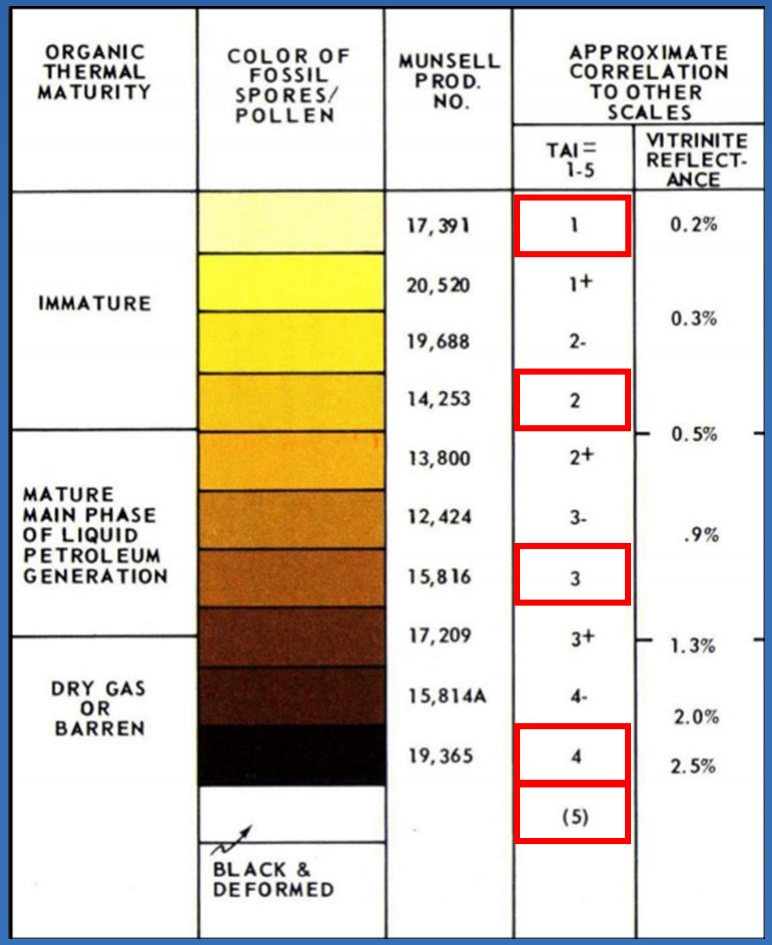

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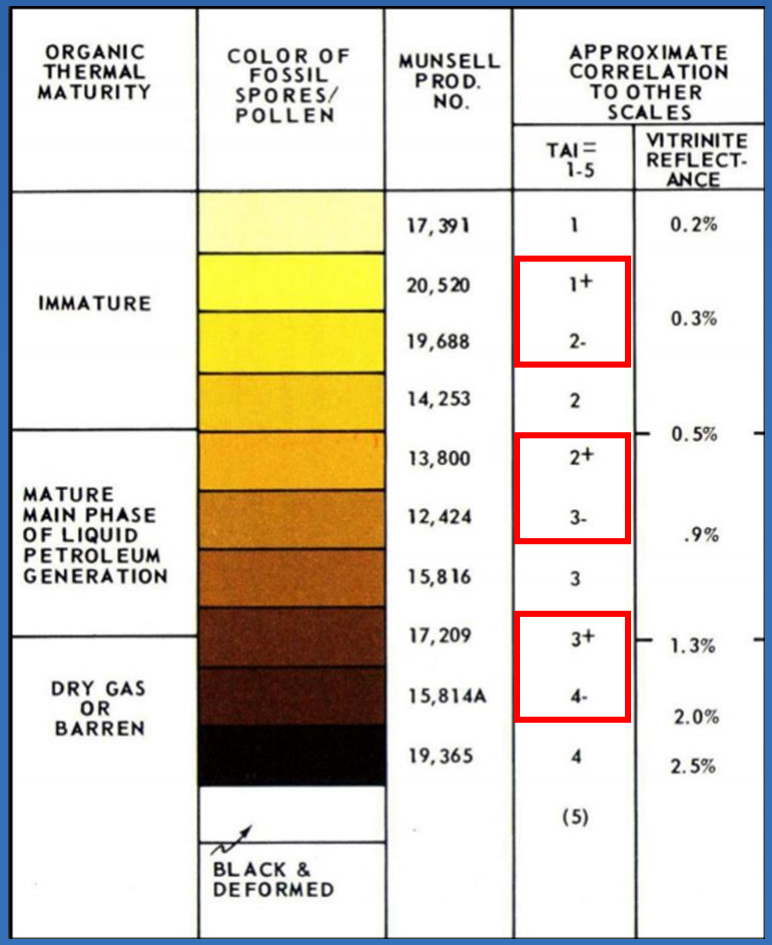

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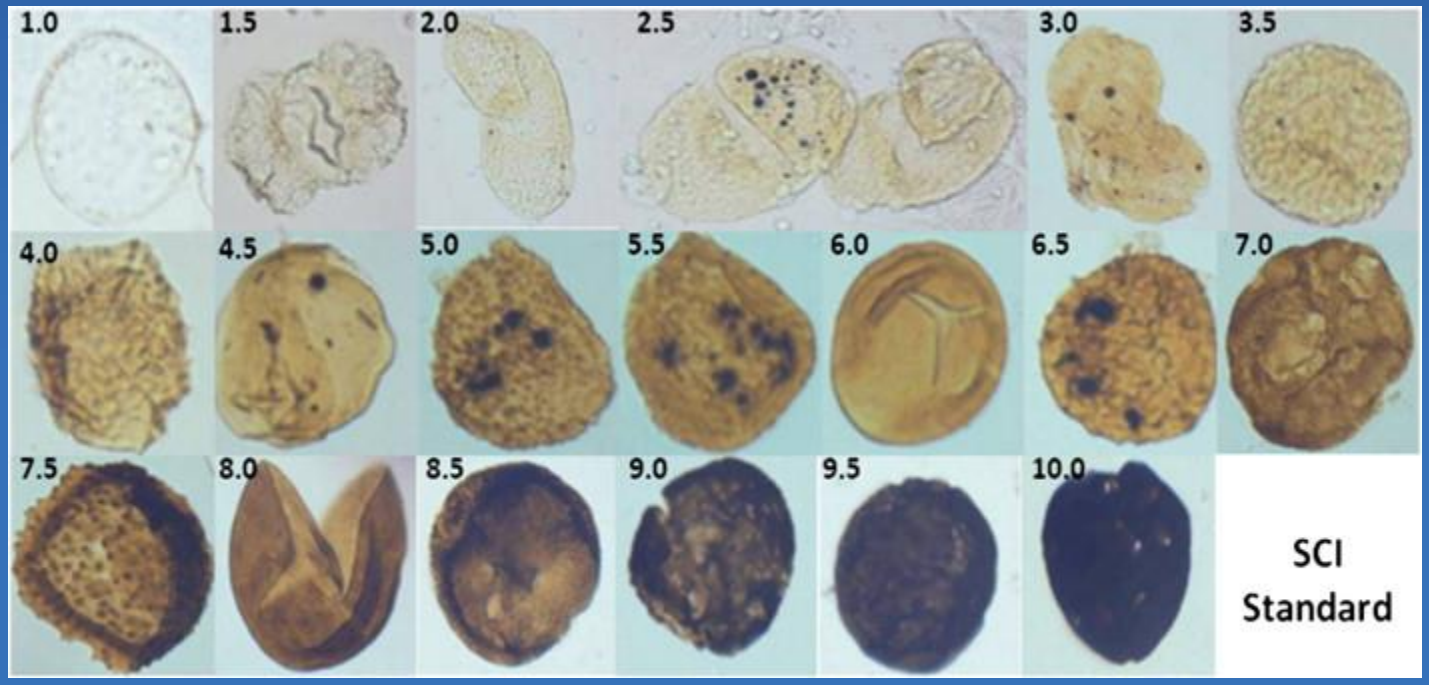
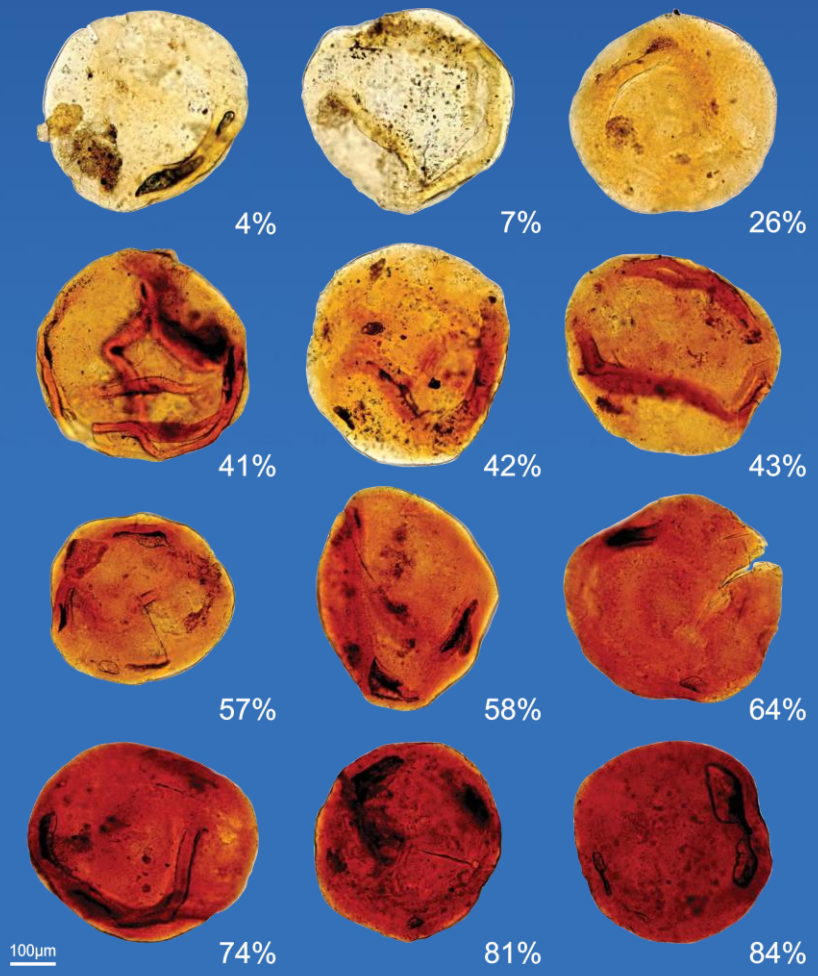
- Visual estimation;
- Original chart – 5 divisions;
- Later – 1+, 2+,…;

Spore Colour Index (SCI) (Fisher et al., 1981)



Fischer et al. (1981). (Photomicrographs were taken and approved by Fugro Robertson Ltd.)

Palynomorph Darkness Index (Goodhue and Clayton, 2010)



Modified from Goodhue and Clayton, 2010

- Grey scale produced by a combination of Red, Green and Blue intensities
- Single point is measured on a specific taxon
- Scale varies from 0% (white) to 100% (black)

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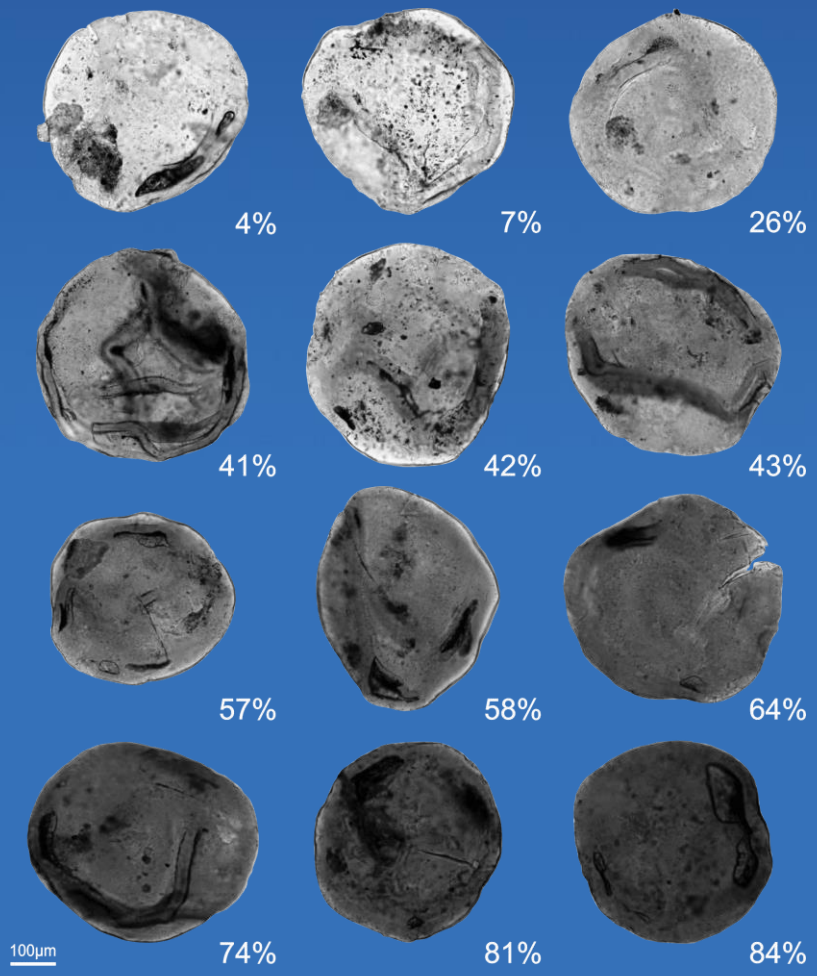

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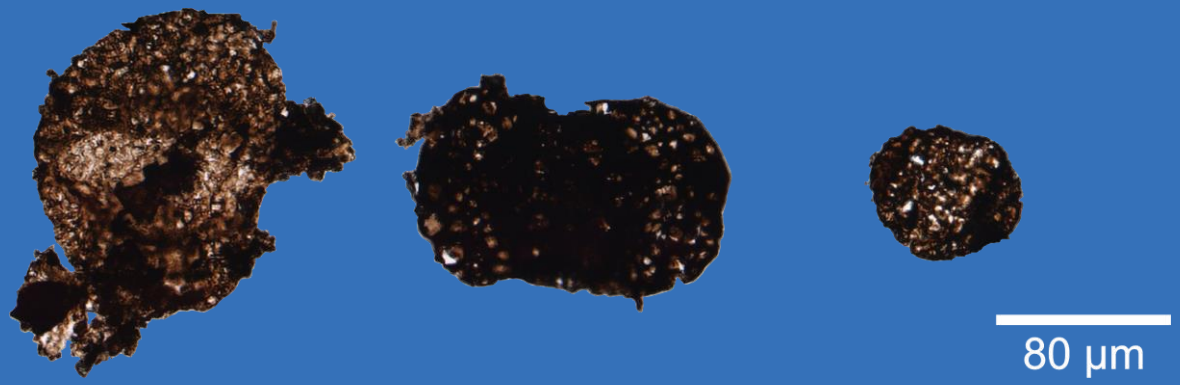
- Grey scale produced by a combination of Red, Green and Blue intensities
- Single point is measured on a specific taxon
- Scale varies from 0% (white) to 100% (black)

Problems and Objective

- Palynomorph content:
  - Scarce;
  - Non-continuos
  - Poorly preserved, due taphonomic conditions

- Use of the non-opaque phytoclasts darkness index for thermal effect evaluation



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Methodology

1

Field Work

2

Sample Preparation

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Image Acquisition

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Digital assessment of RGB

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Data Interpretation

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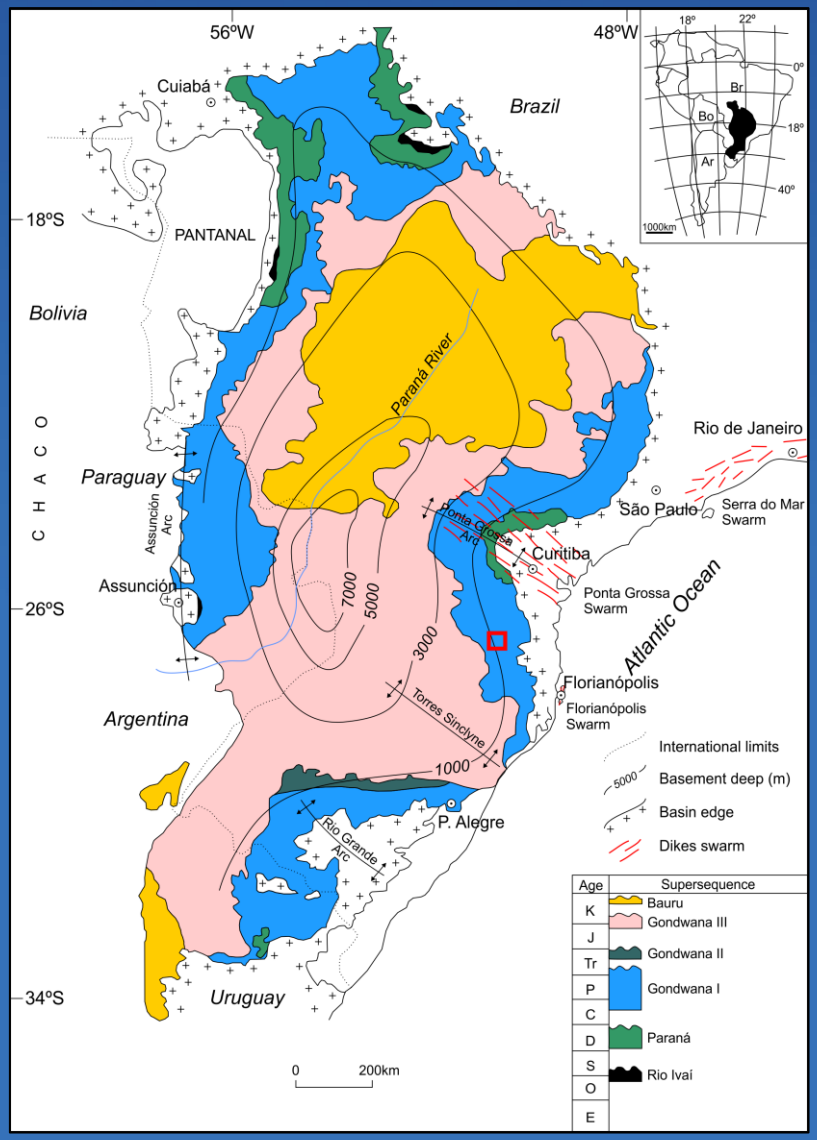
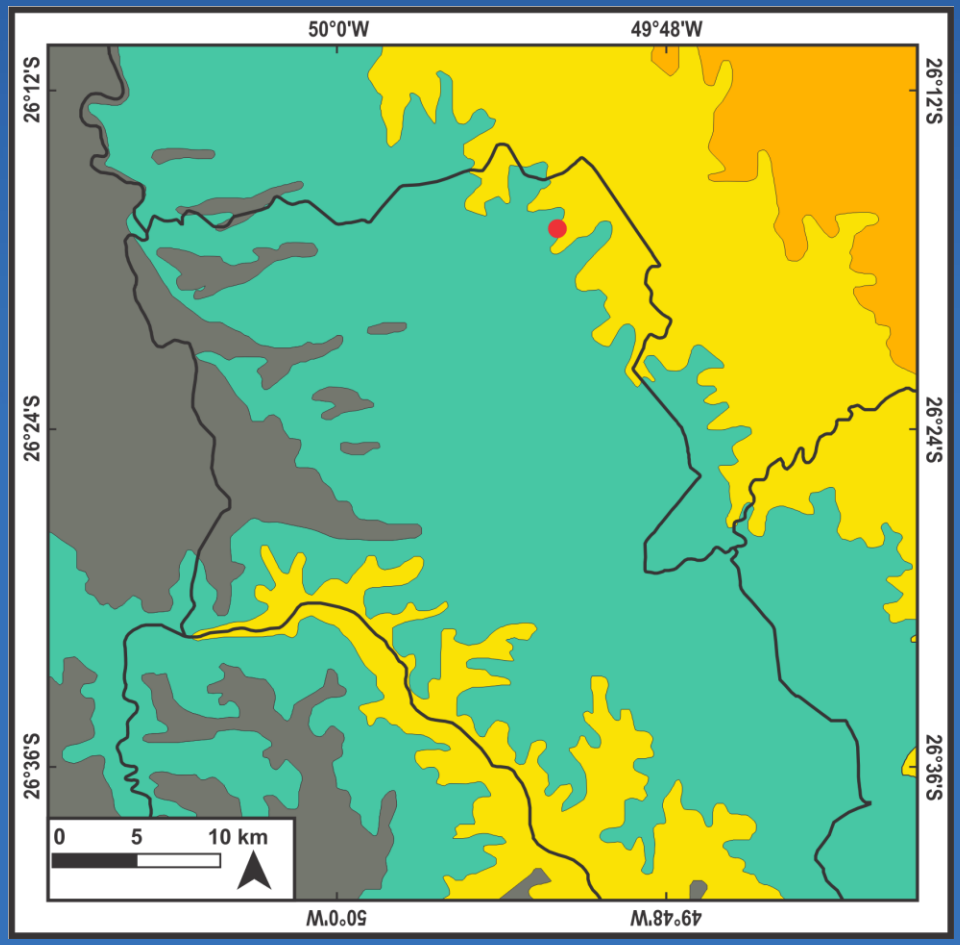
Paraná Basin



Modified from Milani, 2004

- Intracratonic volcano-sedimentary basin
- 75% of its areal distribution occurs in Brazil
- Geologic record from Paleozoic to Mesozoic

José Gulbeck Outcrop



Symbols

- José Gulbcke Outcrop
- City limits

Lithologies

- Paraná Basin
- Rio Bonito Fm.
- Taciba Fm.
- Campo Mourão Fm.

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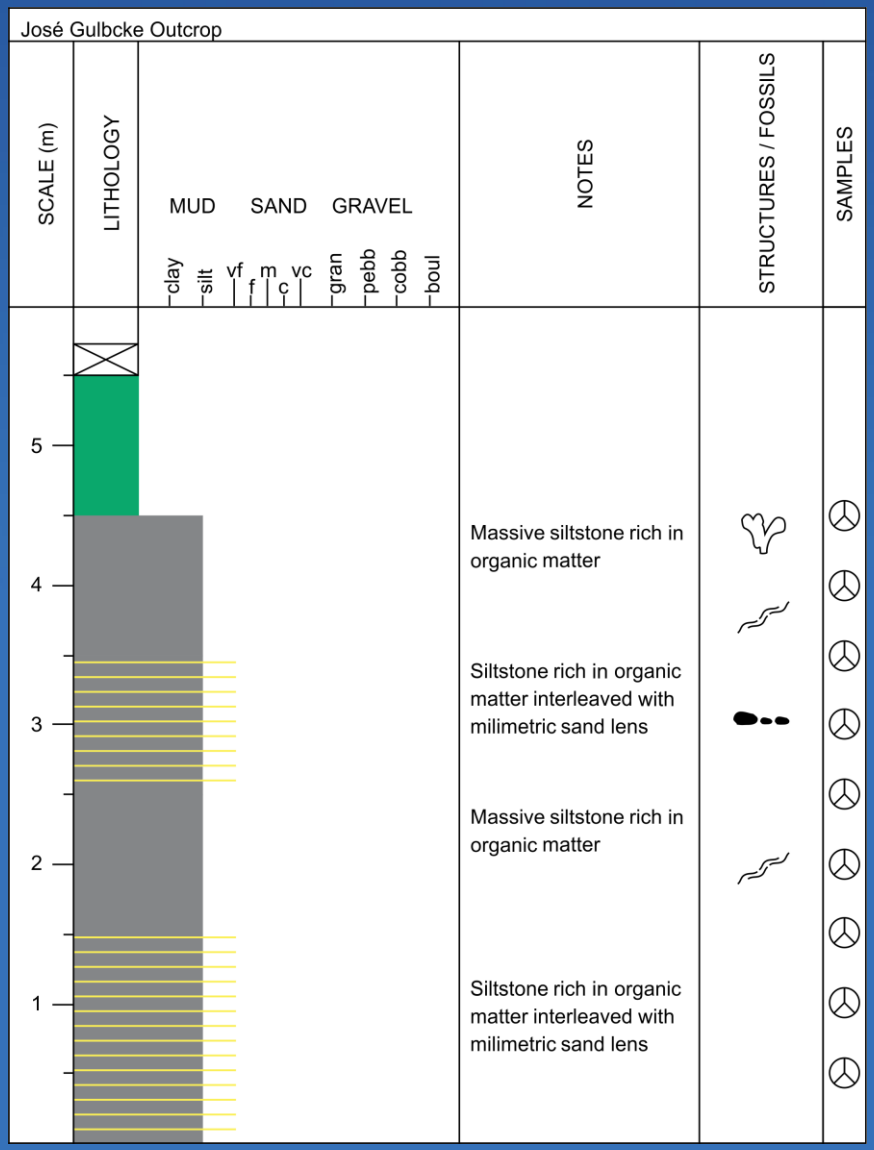
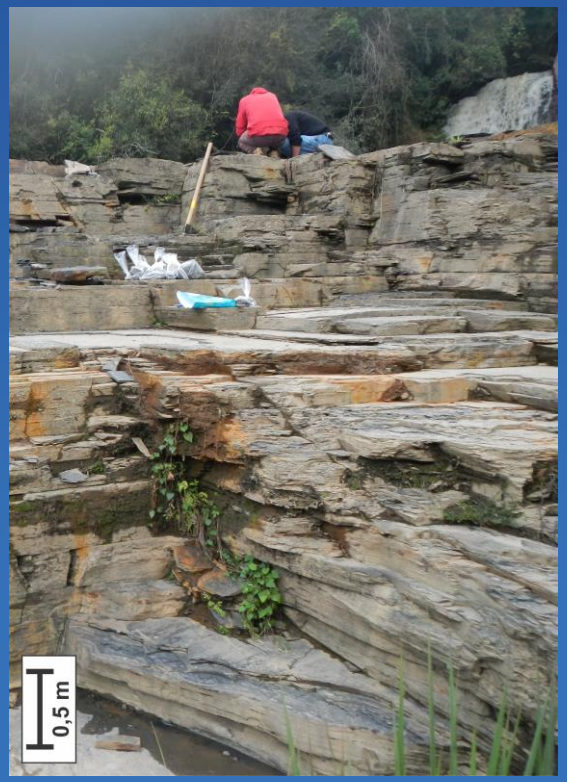
José Gulbcke Outcrop





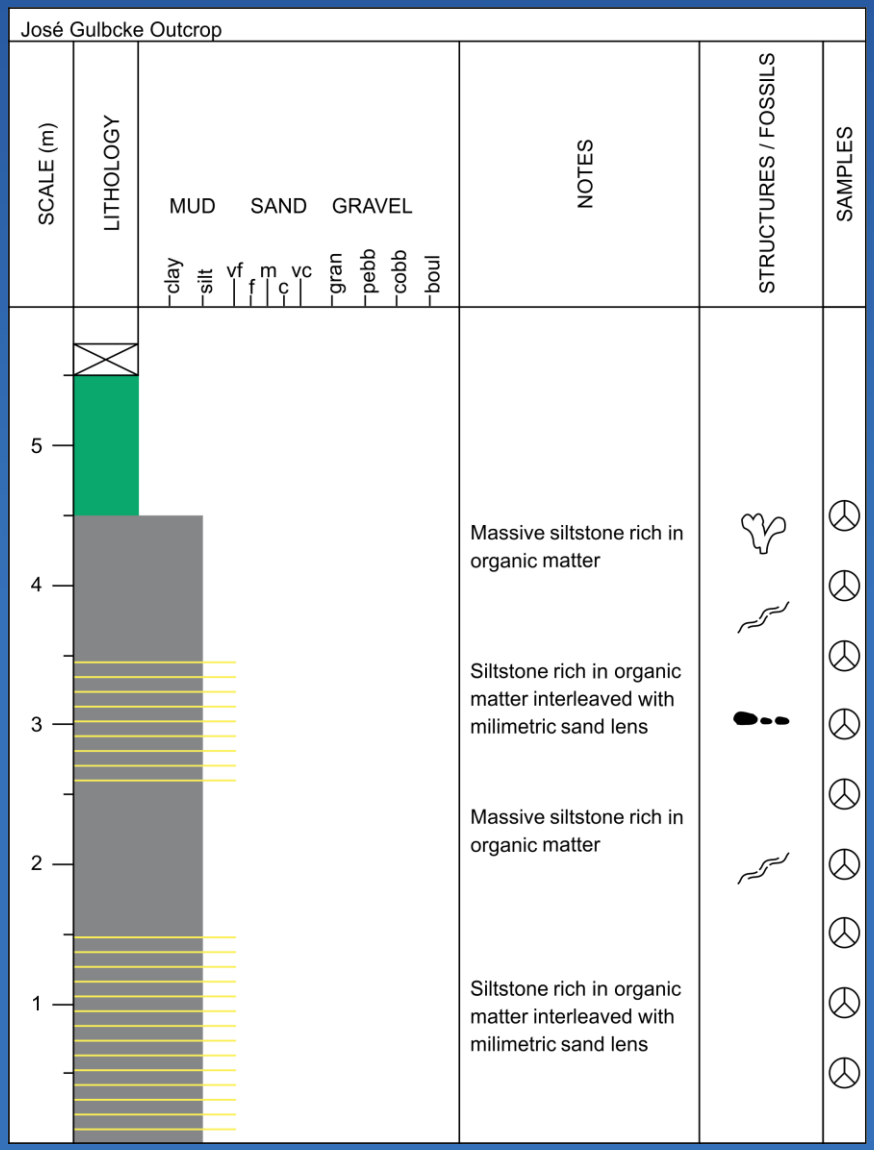
Lithologies

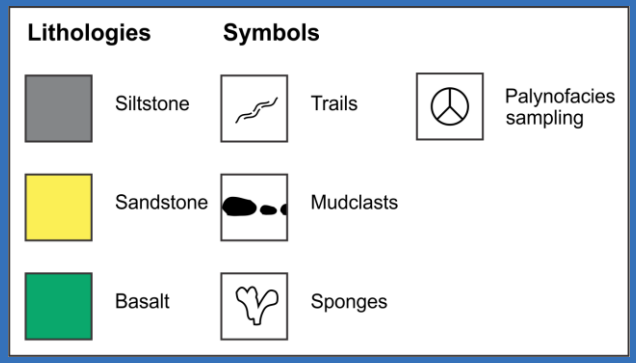
- Siltstone
- Sandstone
- Basalt

Symbols

- Trails
- Mudclasts
- Sponges
- Palynofacies sampling

José Gulbcke Outcrop





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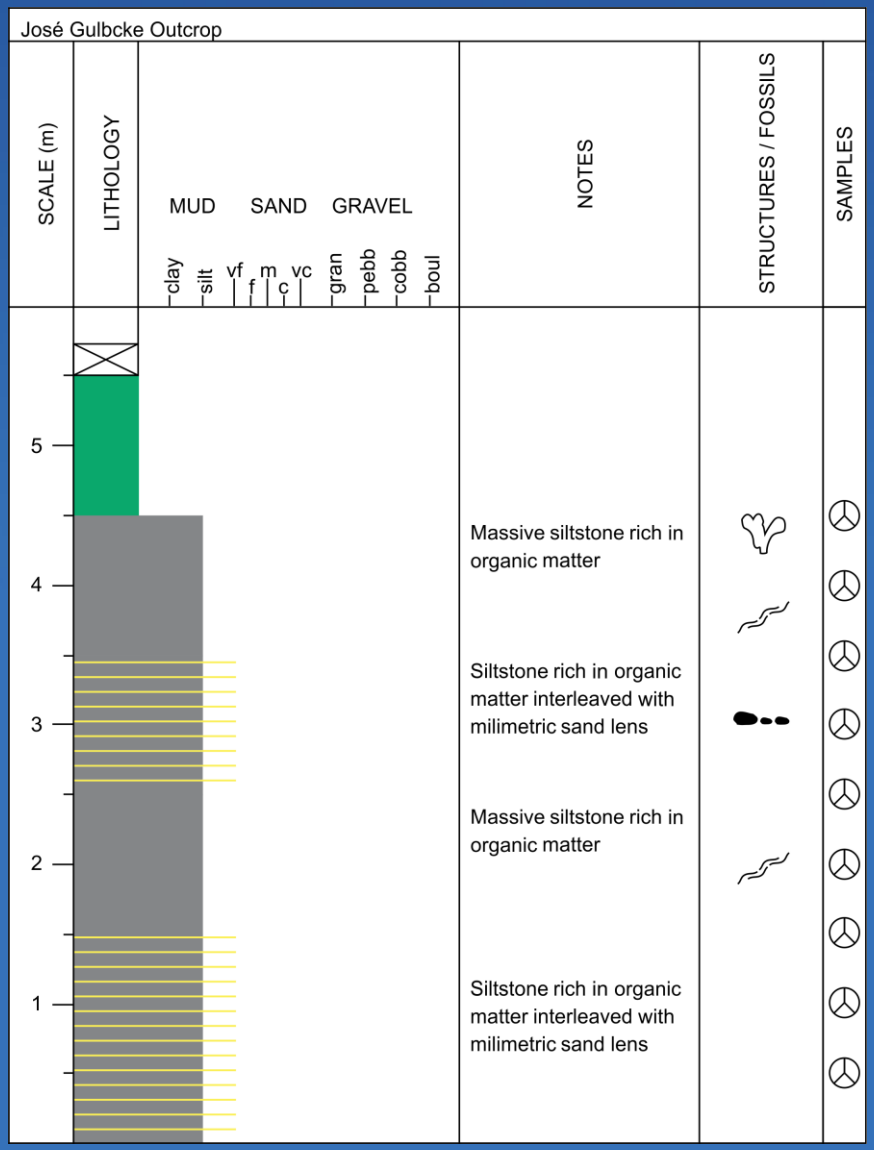

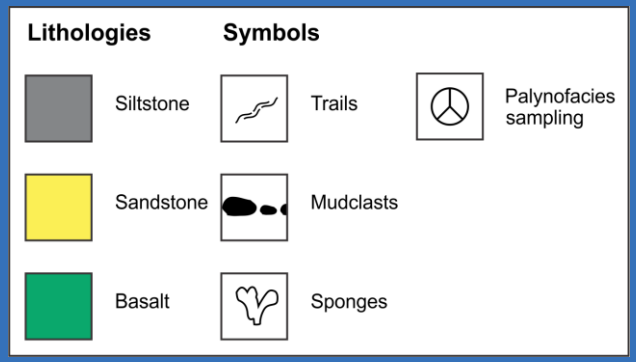

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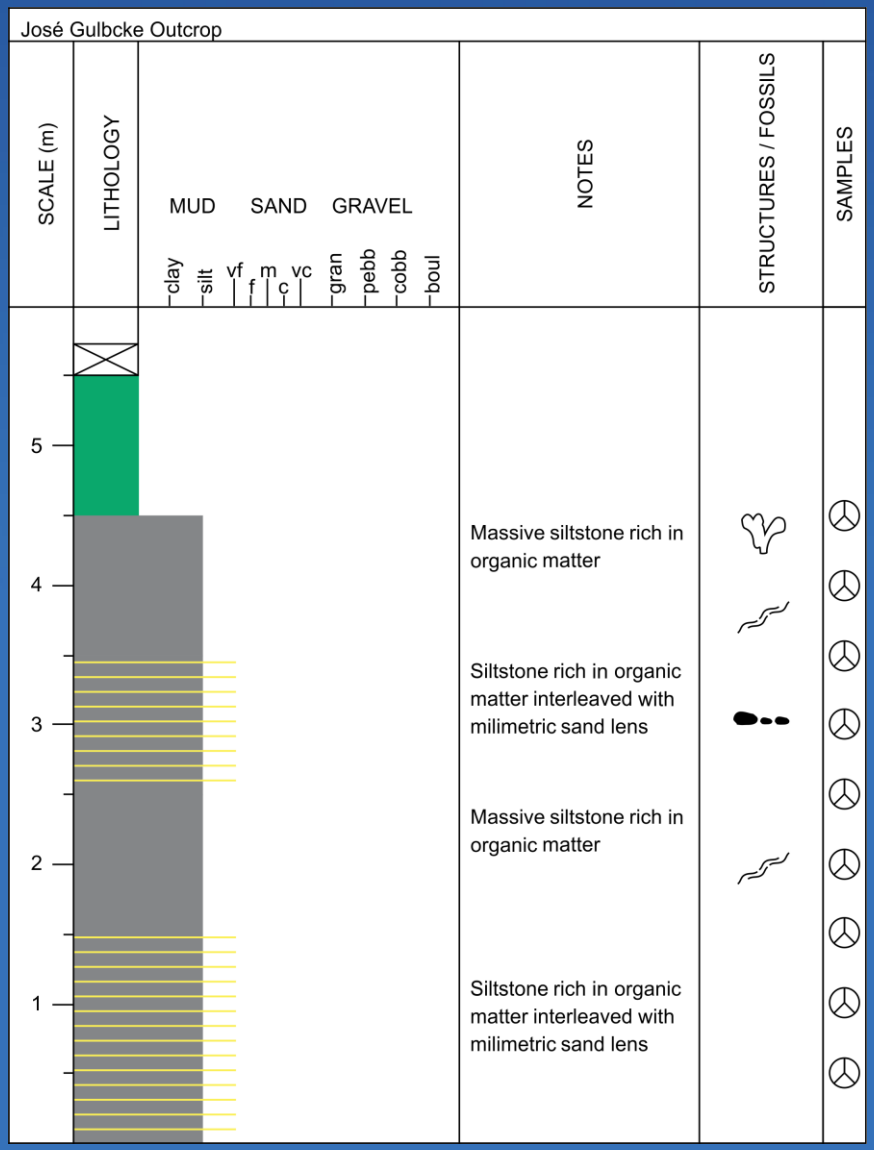

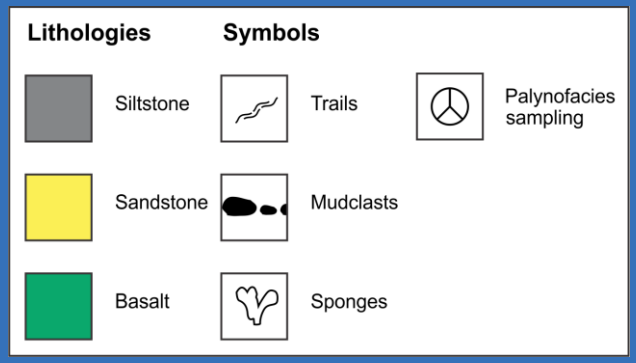

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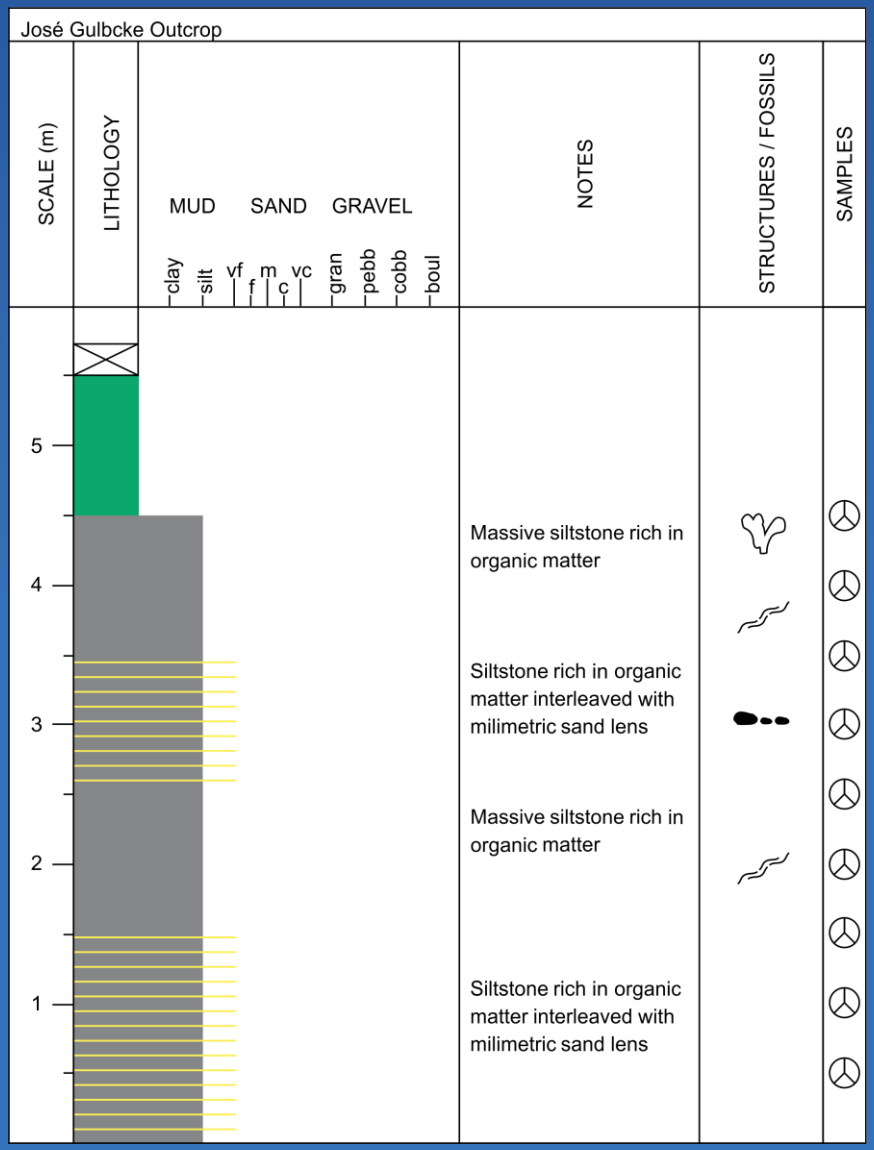

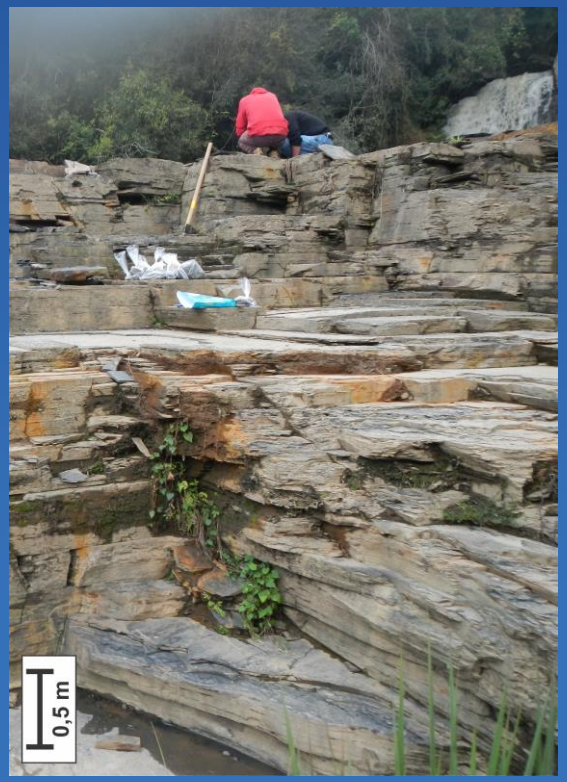

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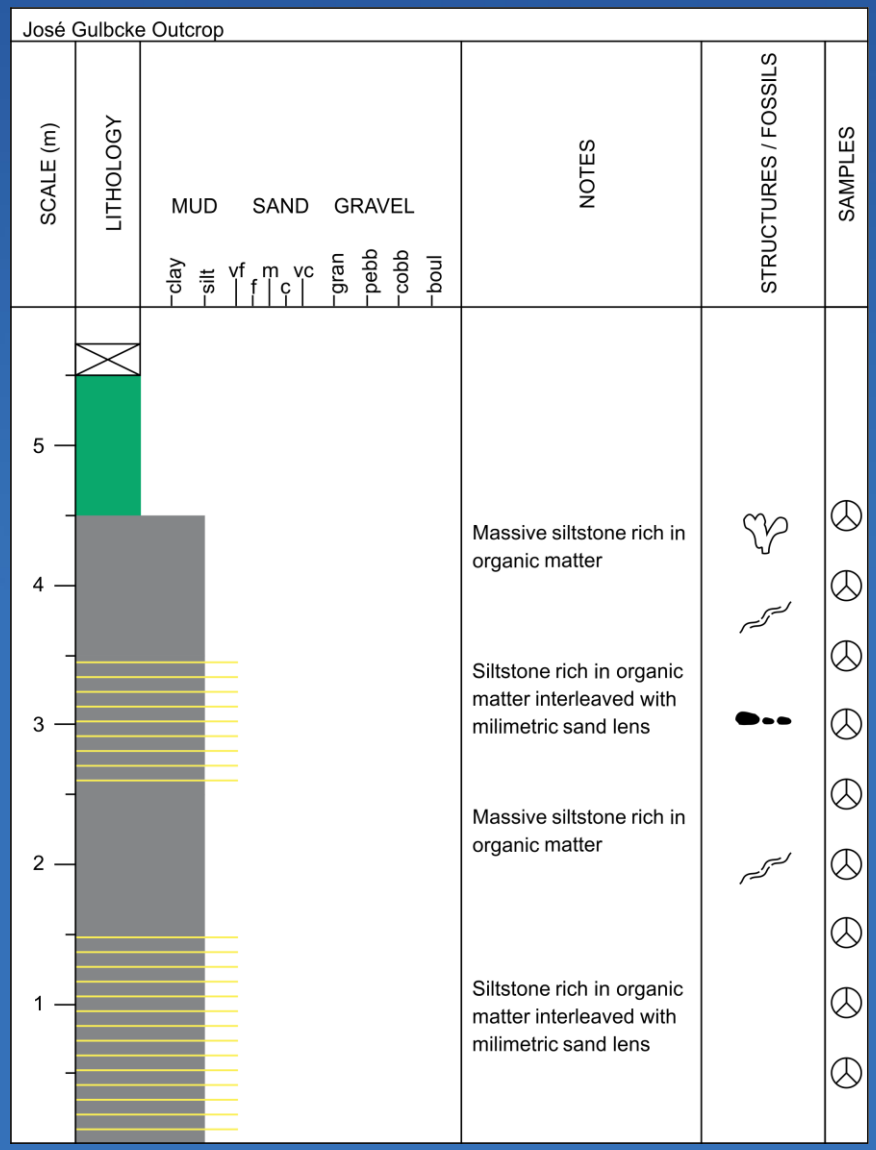

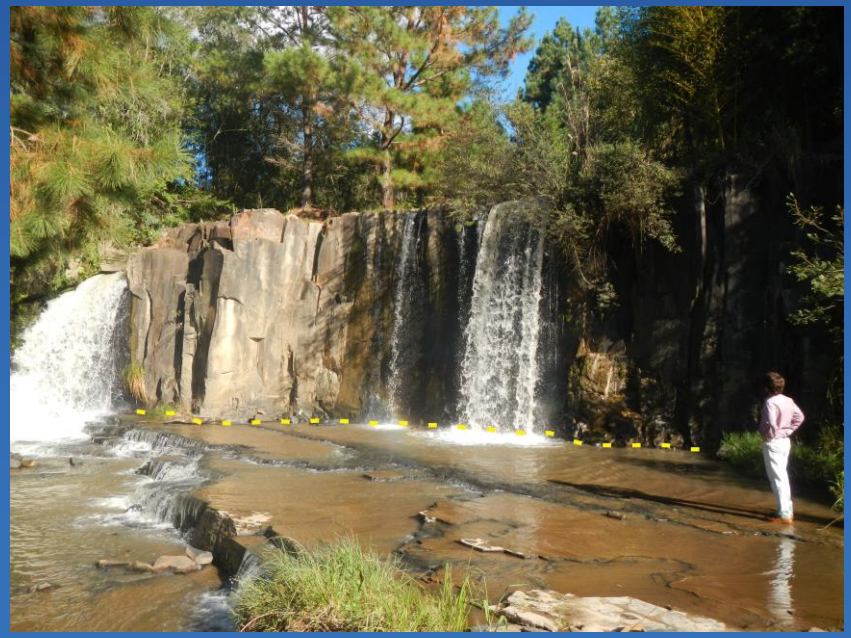

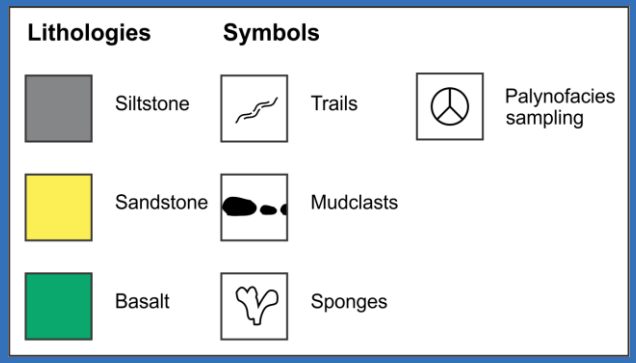

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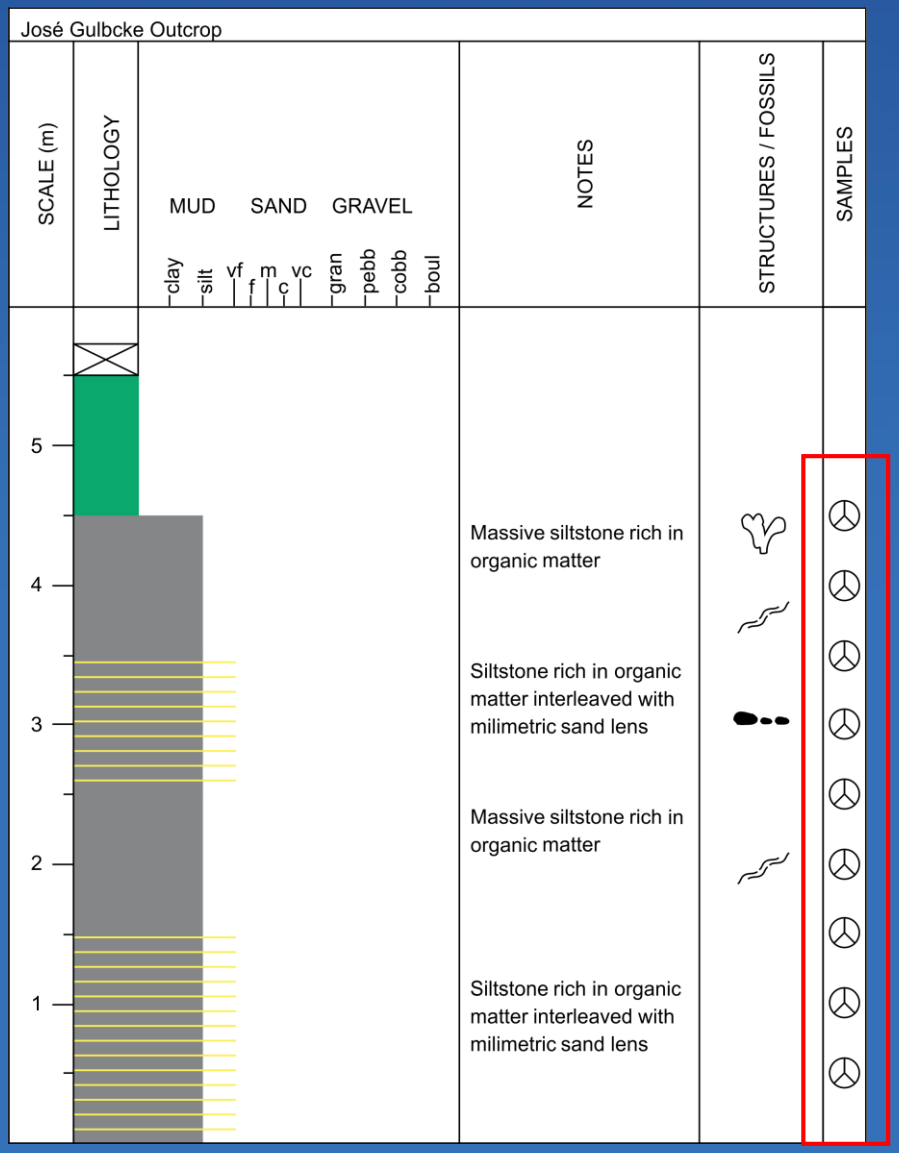

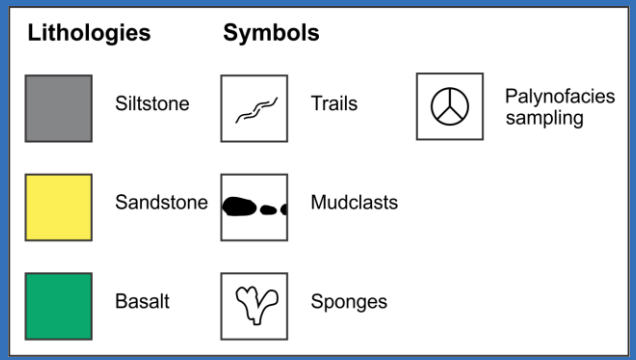

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Sample Preparation

- The samples were prepared at the Marleni Marquez Toigo Palynology Laboratory (UFRGS)
- Practical method of palynological preparation for pre-Mesozoic sediments (Quadros & Melo, 1987)
- Oxidation process was excluded to avoid changing on organic matter color

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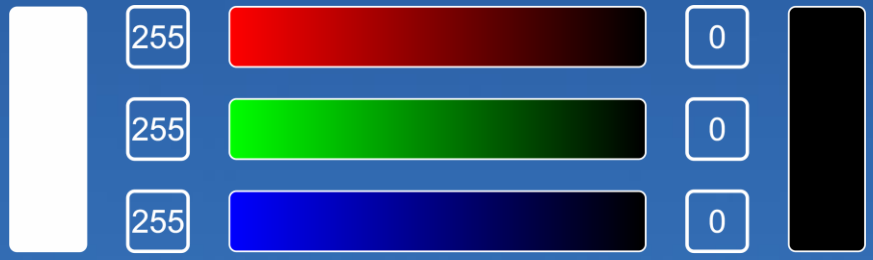
Image Aquisition – RGB System



$$Y_a = (0.299R * 255/R_b) + (0.587G * 255/G_b) + (0.114B * 255/B_b)$$

$$PDI(\%) = 100\text{-}(100Y_a/255)$$

Adapted from Goodhue and Clayton, 2010

- The RGB system is based on the integration of Red, Green and Blue intensities
- Gray scale conversion adapted from JPEG and NTSC sytems
- Conversion to a intuitive scale
- Scale varies from 0% (white) to 100% (black)

Image Aquisition

- Background RGB values:
  - close to (255, 255, 255)
- Olympus IX83 Inverted Microscope equipped with a digital camera and the Software Oympus CellSens Dimension 1.15
- Obtained background:
  - 245, 247, 249
- Fifteen NOP randomly chosen in each level have been measured

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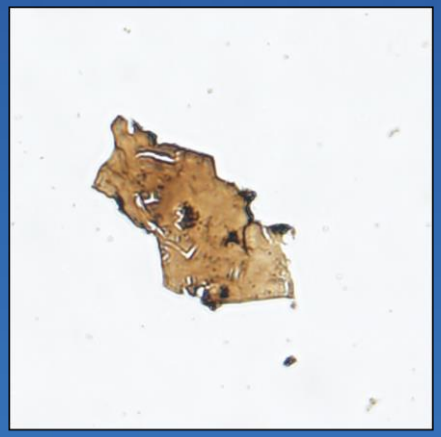
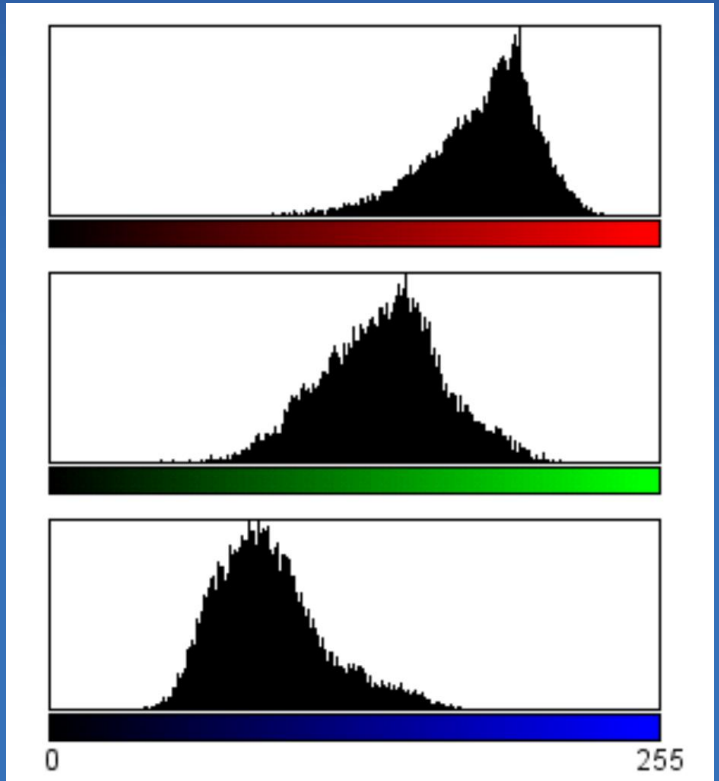
Digital Assessment of RGB



- Free Software for Image Analisys
  - ImageJ
- Define a Region of Interest (ROI)
- Cut the perforations and imperfections

Digital Assessment of RGB



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Data Interpretation

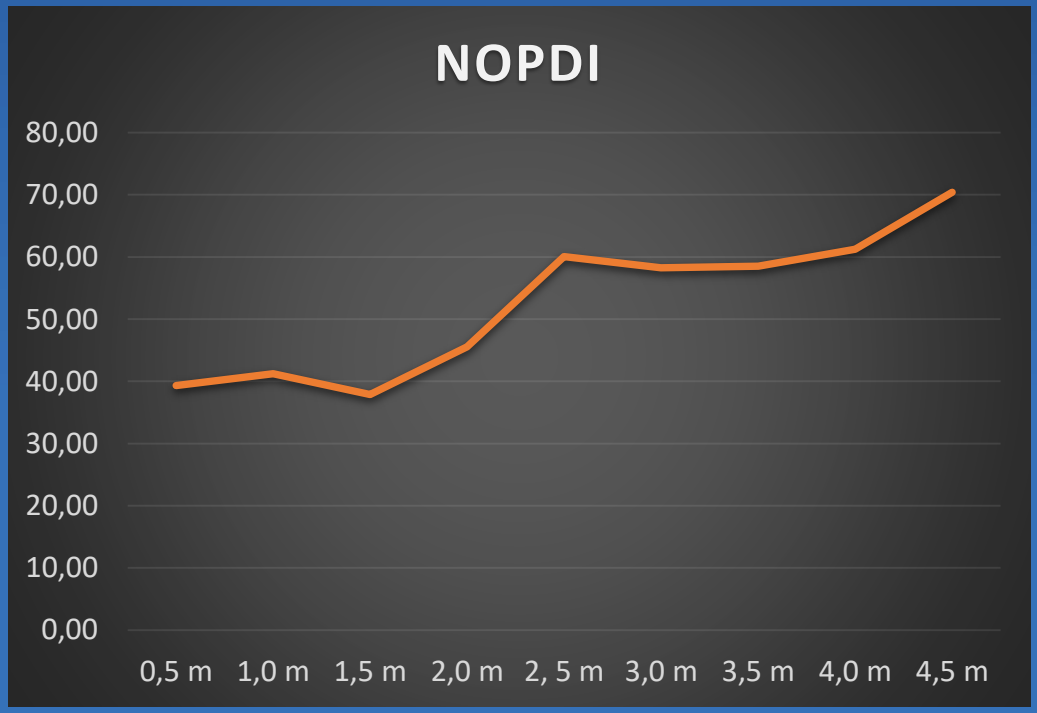
Results & Discussions

Contact

Base

Level	NOPDI	St. Dev
4,5 m	70,39	8,93
4,0 m	61,27	14,23
3,5 m	58,50	14,01
3,0 m	58,28	14,01
2, 5 m	60,04	12,04
2,0 m	45,57	15,81
1,5 m	37,86	11,48
1,0 m	41,23	14,40
0,5 m	39,34	12,07

- Mean of the modes obtained from each level



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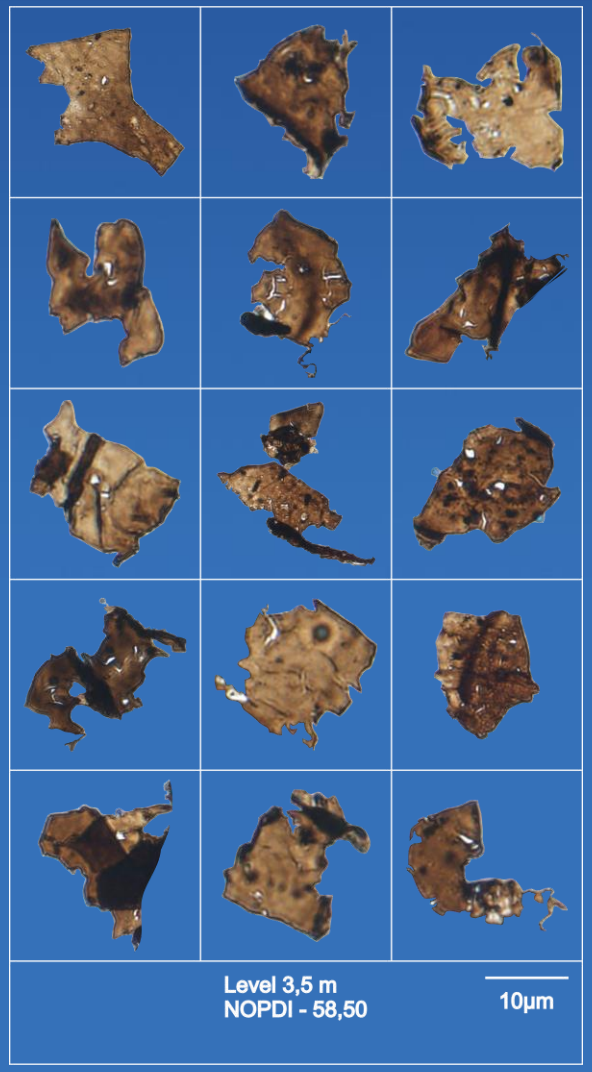
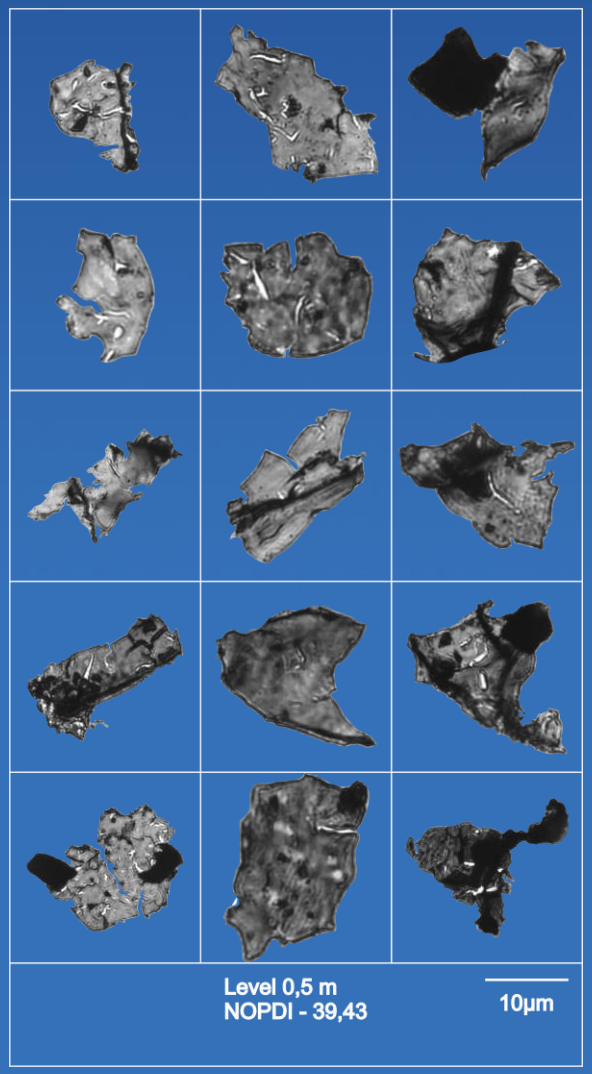
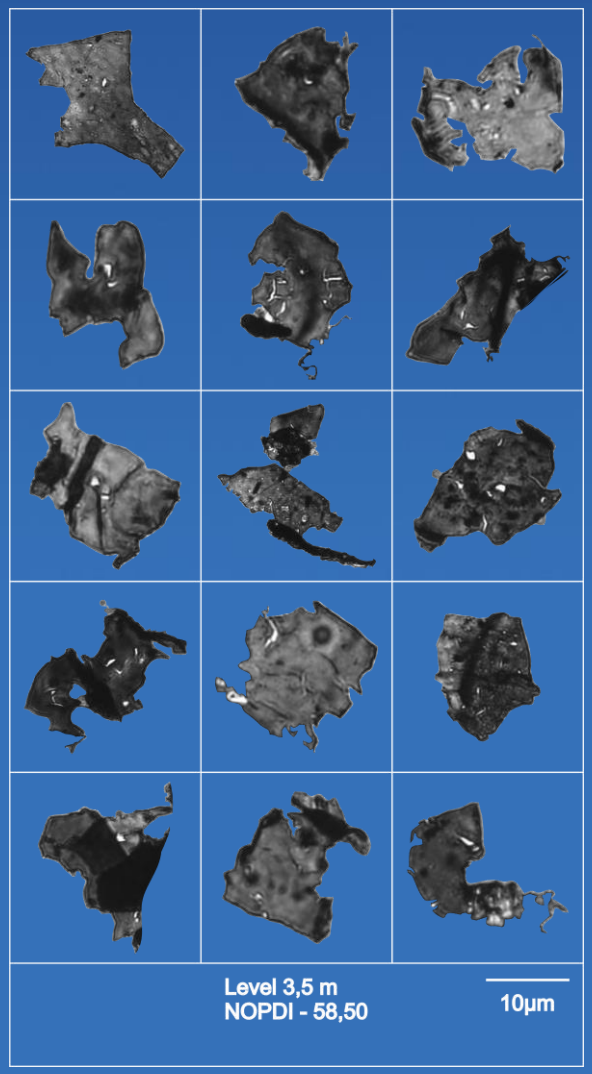
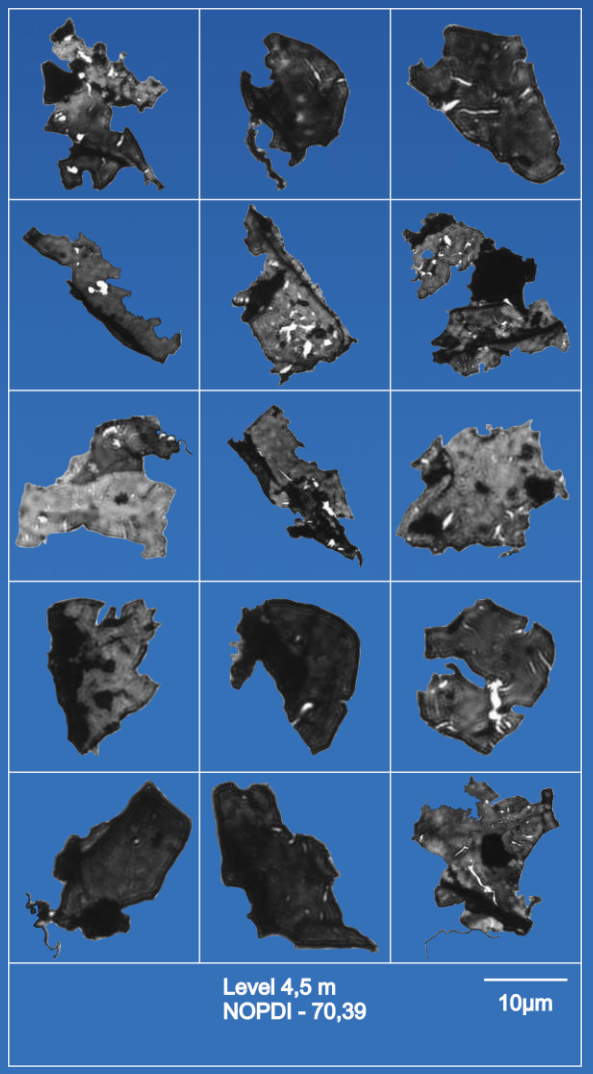


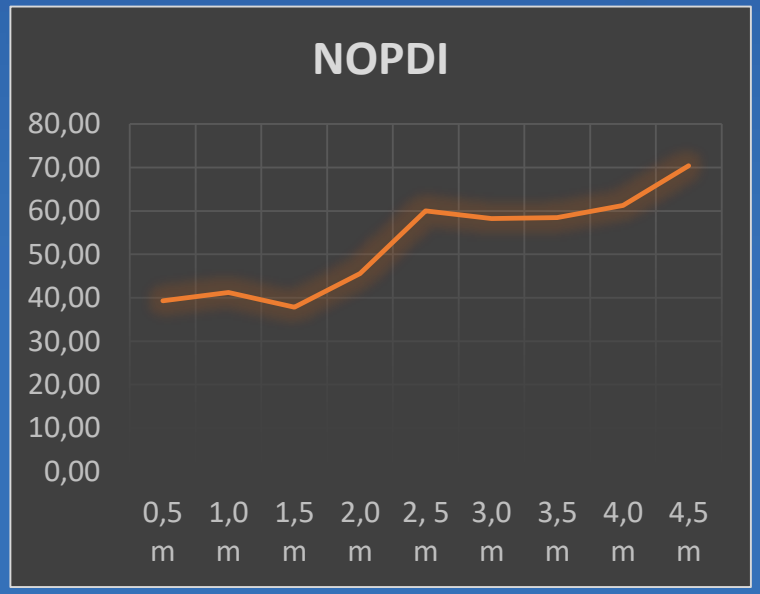

Level 0,5 m
NOPDI - 39,43
10µm


Level 3,5 m
NOPDI - 58,50
10µm

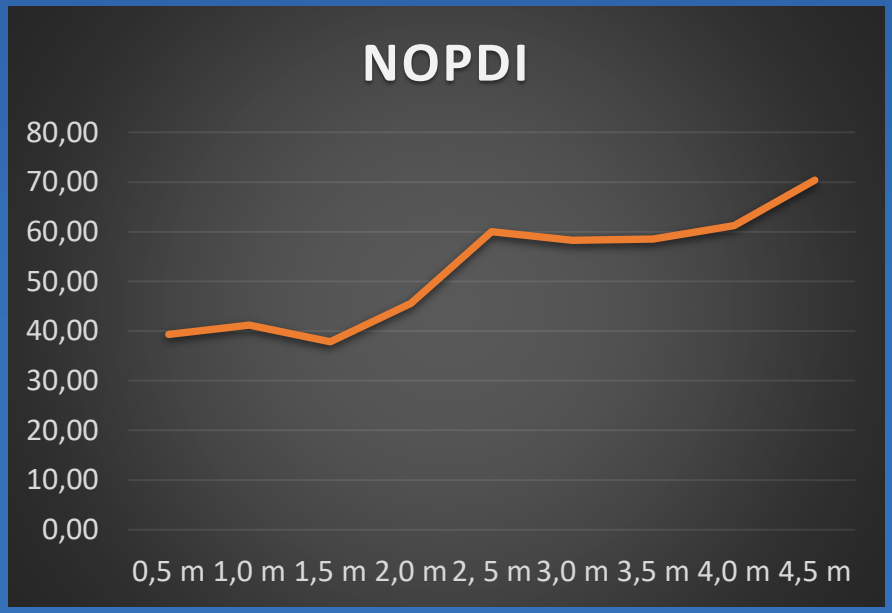

Level 4,5 m
NOPDI - 70,39
10µm

Conclusions

The Non–Opaque Phytoclast Darkness Index results allows us not only to assign that thermal effectivennes of the sill penetrated only 2.5 meters beneath the intrusion, but also that the first group of values represent the pre-intrusion conditions, as for example, background diagenisis.



Challenges



- Improve statistical approach to verify the plateau behavior
- Correlate with Vitrinite Reflectance and other thermal parameters
- Use of scanned slides to speed up the digital assessment of RGB values

References

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