

Reflectance spectroscopy applied to the lithological characterization of Permo-Carboniferous siltstones and organic shales found in the Paraná Basin, Brazil

Laís V. Souza¹, Marcelo Kehl de Souza^{1*}, Maurício Roberto Veronez^{1,2}, Francisco Tognoli^{1,2}, Luiz Paulo Luna de Oliveira^{1,3} & Luiz Gonzaga Jr.^{1,3}

¹ Advanced Visualization Laboratory (VizLab), Vale do Rio dos Sinos University (UNISINOS), São Leopoldo, Brazil, veronez@unisin.br

² Graduate Program in Geology, UNISINOS, São Leopoldo, Brazil

³ Graduate Program in Applied Computing, UNISINOS, São Leopoldo, Brazil

Key words: Reflectance spectroscopy, PCA, Paraná Basin, sedimentary rocks, organic matter.

This paper shows the application of reflectance spectroscopy in the characterization of siltstones and organic shales in different lithostratigraphic units (e.g. formation, group). Naked eye observation and characterization can be difficult when describing and comparing these rocks in distinct units, since sedimentary rocks of fine granulometry present very similar physical properties. Other factors could also aggravate its identification in field, especially in tropical regions that present a more humid climate, such as the degree of weathering of the outcrop or the contact between two formations. The spectral analysis of these lithologies is not yet widely studied, since the presence of organic matter makes the reflectance patterns in the spectral curve much lower and with no characterizing absorption features. Thus, a methodology that facilitates the recognition and classification of fine granulometry rocks represents progress in the field of sedimentary petrology, which currently makes use of microscopic, geochemical and geophysical techniques. The reflectance spectroscopy technique provides a quantitative measure of the spectral reflectance of materials that is obtained by the ratio between radiance and irradiance. By using the spectral signature, it is possible to identify the main characteristics of the absorption features of the minerals found and thus recognize constituent elements and/or classify such rocks. The objectives of this research are: 1) to search for patterns that characterize each sample/lithostratigraphic unit using its spectral behaviour, also identifying the main absorption features of the fine granulometry rocks that present organic matter in their composition; 2) to test the possibility of distinguishing and grouping together each formation by its spectral behaviour using a classifier. To do so, 45 samples of lithostratigraphic units were selected, representing part of the permo-carboniferous succession of the Paraná Basin - Brazil, such as the Rio do Sul, Palermo, and Irati Formations. All samples were ground to a size smaller than the silt fraction (0.062 mm) and the ground sample measurements were made with a SPECTRAL EVOLUTION field spectroradiometer, type SR-3500, which records the spectral pattern in the wavelength interval from 350 to 2500 nm. Initial results show that the samples of each formation present distinct spectral responses, even when they present very similar physical characteristics (Fig. 1). Spectral data obtained through Principal Component Analysis (PCA) show that the samples are classified into three distinct groups (Fig. 2). This technique has shown to be effective for lithological differentiation, as the spectral reflectance is directly related to the chemical properties of the rocks, which are distinct for each formation and too subtle to be perceived by naked eye analysis.

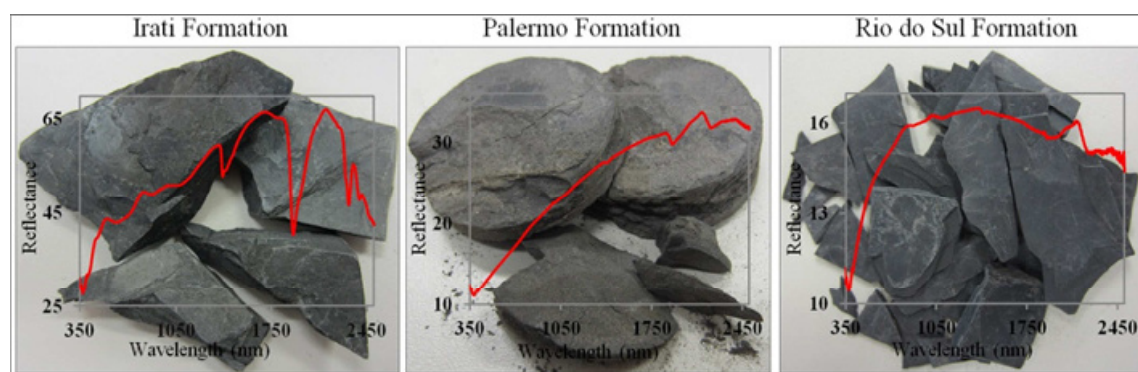


Figure 1: Average spectral curves of siltstones and shales organic of the formations studied.

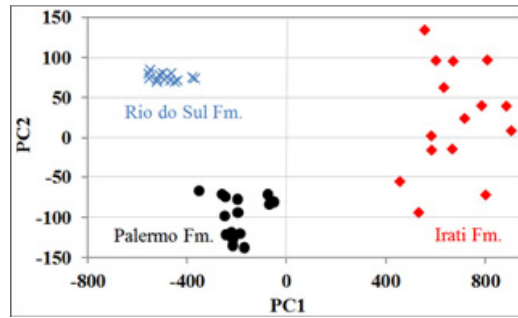


Figure 2: *PC1 versus PC2. It is possible to note the data clustering of each formation, mainly in PC1 values.*

Acknowledgements: This project was financially supported by the projects Modelagem Digital de Afloramentos utilizando GPU (MCT/FINEP - Pré-Sal Cooperativos ICT - Empresas 03/2010 - Contract 01.23.4567.89) and FINEP-PROINFRA (Contract: 01.13.0302.00). MKS thanks PROSUP/CAPES for the financial support of the PhD scholarship. MRV thanks the Brazilian Council for Scientific and Technological Development (CNPq) for the research grant (Process 309399/2014-9).