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High-Resolution Spectroscopy for Detecting Stratigraphic Surfaces and Stacking Patterns in Sedimentary Basins

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Abstract: In this research was evaluated the potential of using scores derived from spectral data to detect surfaces and stacking patterns in the sedimentary record, and propose a new method for analyzing spectral data. Spectral field surveys with wavelengths ranging between 2.0-2.5 μm were acquired from three well-exposed outcrops in the Neuquén Basin, Argentina. The sedimentary succession surveyed in this area presents a continuous exposure up to 600 meters thick and comprises both pure and hybrid siliciclastic, carbonate and evaporitic rocks. Reflectance data obtained from this area were processed by multivariate analysis, which demonstrates that almost all of the data variance is represented by the first principal component. Inflections of the scores' derivatives can be used to identify stratigraphic surfaces and as an indicator of stacking patterns. Overall, these results demonstrate that fast, inexpensive and non-destructive spectral data are useful tools in the fields of sedimentology and stratigraphy, which have the potential to eventually support more complex and detailed hyperspectral stratigraphy research.

Keywords: Reflectance Spectroscopy; Stratigraphic Surfaces; Stacking Patterns; Multivariate Analysis; Mixed Carbonate-Siliciclastic

1. Introduction

For decades, spectroscopy has been used to identify and quantify materials (Clark, 1999; Hunt, 1977; Kruse, 2012). Recent technological advancements have provided rapid progress in scientific research, increasing both the quality and quantity of publications based on spectral data. Different research areas, such as geology, astronomy, chemistry, and planetary science use spectroscopic measurements to detect characteristics related to specific chemical bonds, which improve the determination of their abundance and physical state according to their absorption features (Clark, 1999). Spectroscopy studies have been performed in the field of soils (Galvão et al., 1995; Leone and Sommer, 2000), in mineral identification (Baissa et al., 2011; Clark, 1995; Clark et al., 2003; Clark and Roush, 1984; Clénet et al., 2011; Denk et al., 2015; Gomez et al., 2008; Jarrard and Berg, 2006; Smith et al., 1985; Swayze et al., 2014; Zaini et al., 2012), for identification of clays (Murphy et al., 2015; Senna, 2003), for identification of faults and fractures (Bellian et al., 2007), and in analyses of sedimentary rocks (Dadon et al., 2011; Dennison et al., 2004; van der Meer, 2006; Villa et al., 2011).