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Presented Paper

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TITLE: "DOES COLOR CHANGE WITH TYPE OF ROCK? AN APPLICATION OF MULTISPECTRAL ANALYSIS TO THE DISCRIMINATION OF ROCK TYPES IN S.E. SPAIN".

ABSTRACT: A methodology for the automatic analysis of spectral reflectance curves, in order to check its utility in the discrimination of different types of land cover, is exposed. This metodology allows to test the possibility of correct classification of objects by spectral criterions alone. Its main utility is in the selection of the best film-filter combination to obtain aerial photographs that will allow an easier and more accurate analysis of the study area.

The methodology exposed was applied to 4630 relative spectral refllectance curves, corresponding to 10 different rock types that were gathered and field classified at 22 different areas in S.E. Spain (Cape of Palos). The results were encouraging: Most of the rock types, like limestones and black shales, appeared as highly distinguishable groups.

1. INTRODUCTION

In this paper, a methodology for the automatic analysis of spectral reflectance curves, in order to check its utility in the discrimination of different types of rocks, is exposed. The methology exposed is applicable to any broad set of spectral reflectance data, and allows to test the possibility of correct classification of data by spectral criterions alone. Its main utility is in the selection of the best film-filter combination to obtain aerial photographs that will allow an easier and more accurate analysis of the study area.

2. THE DATA

The Instituto Geográfico Nacional of Spain operates a Tele-Spectro Radiometer Spectral Data Model 31. This unit has been installed on a van so as to ensure a high mobility. Spectral Data Model 31 Tele-Spectro Radiometer outputs the relative reflectance of the target respect to that of a white plate (ideal Lambertian surface) in 52 intervals between 400 and 1075 nanometers. Ancillary data are also outputted in 9 intervals. Usually, five measurements are made of each target, against two reference measurements.

A campaign to collect spectral reflectance data of rocks over a 200 square kilometers zone in South-East Spain (Cape of Palos area) was conducted from Dec. 1977 to May 1978 with this TeleSpectro Radiometer. About 4630 relative spectral reflectance curves, corresponding to 10 rock types, were gathered and field-classified at 22 different areas.

The curves were rearranged according to rock types and area, as follows:

- Cipolines	(1 area)	(306 samples)
- Blue Limestone	(3 ")	(631 ")
- Dolomite	(4 ")	(638 ")
- " beige	(2 ")	(402 ")
- " black	(2 ")	(385 ")
- Shales	(2 ")	(281 ")
- " black	(1 ")	(485 ")
- Filites	(4 ")	(579 ")

- Andesite (2 area)(863 samples)
- Basalt (1 ")(10 ")

3. DATA PROCESSING

An exhaustive statistical analysis of the data was performed:

First of all, the reference measurements made to check the white reference plate aganist itself were rejected, together with anomalously high measurements.

The mean relative spectral reflectance of each rock type and area was computed and plotted, so as the mean ± 1 and ± 2 standard deviations and upper and lower bounds curves.

Histograms of values for several selected wavelenghts were also plotted.

These curves were checked against the others from different areas, but same rock type, to observe their differences, and against those of different rock types.

A Multivariate Analysis of Variance (MANOVA) test was performed, with the result that the means of the various groups were different, with a confidence of 95%.

Since the aim of this work was to verify that spectral signatures of rocks may serve by themselves to classify different types of rocks, and data in 52 channels, or spectral intervals, are very expensive to deal with, the correlation-matrix of the data was computed, showing a high correlation between channels.

This evidence suggested to perform a principal components transformation of the data, so as to reduce the high dimensionality as well as to make sure that the transformed data will be uncorrelated, ensuring thus a good performance of the unsupervised classification algorithm to be used later. The principal components analysis over the variance-covariance matrix showed that the first component explained about 80% of the variance in the data, the second 10.2% and the third 5.15%, acounting the first five components for 99% of the information. The first component was highly related to the brightness or overall energy reflected by each target, being an almost linear eigenvector.

The second, third, fourth and five gave different balances between the visible and near-infrared regions.

In all of then the 525-600 nm region shows neatly differenced, thus having a high importance.

The data transformed to its first five principal components were used as input of a program for non-hierarchical cluster analysis. The aim of this phase was to test if the spectral signatures will be automatically grouped into the natural geological types of the samples, without any external help, so as eliminate outliers and erroneous measurements.

4. RESULTS

The results were encouraging: most rock types, like limestones and black shales, appeared as highly distinguishable groups. Others, like basalts and andesites, were intermixed, maybe because of the small number of basalt samples and its lack of purity.

Afterwards, each relative spectral reflectance measurement was reduced to two data, the first related to the reflectance in the 525-600 nm. region, and the second to the 750-850 nm. one. These transformed data were also used as input of the non-hierarchical clustering program, being the results, excepting bad data and outliers, comparable to the obtained using the complete measurements. So, we determined the form of the ideal filter that will transform the spectral reflectance in such a way that the resulting value will correspond to a single rock type, and hence will allow the classification in terms of tone only, in the area and for the rock types under study. The final aim is to simulate the ideal filter with a combination of optical filters and photographic film, test this filter flying over the study area, and verify it the resulting aerial photographs are similar, by its tone alone, to existing rock-type maps of the area.

5. REFERENCES

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