EISAC'89: Evaluation of GER Airborne Scanner Data in the Almaden Testsite (Spain)

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Abstract

In the framework of the European Imaging Spectroscopy Airborne Campaign (EISAC) 1989 the Almaden testsite (Central Spain) was flown with the GER Scanner, the FLI (Fluorescence Line Imager) and the Metric Camera. A parallel field survey comprised field spectroscopy measurements, soil sampling and vegetation inventory. The airborne data acquired with the GER Scanner, a high spectral resolution airborne imaging spectrometer (0.47 - 2.45 µm), have been analysed for soil/vegetation studies. First results of spectral classification analysis for the differentiation of soil surface with variable mineral content are demonstrated.

1. INTRODUCTION

During the EISAC Campaign carried out in May/June 1989 six European countries were flown with the GER Scanner, the FLI and the Metric Camera on water and land testsites for oceanographic, hydrologic, vegetation and soil spectral studies. The Almaden testsite was selected for the spectral analysis of soil and vegetation in a Mediterranean environment, taking into account the soil spectral characteristics dependent on the geological situation. For studies of both soil and vegetation spectral characteristics GER airborne scanner data are most promising, especially when ground spectral information obtained during a simultaneous field survey is available.

2. GER SCANNER

The GER Scanner (Geophysical Environmental Research Corp.) is an airborne imaging instrument containing three spectrometers covering the VNIR/SWIR wavelength region in 63 spectral bands (see Table 1). With an IFOV of 3.3 mrad and a flight altitude of 3000 m the pixel size was 10 x 10 m^2 (Lehmann *et al*. 1989).

3. THE ALMADEN TESTSITE

The testsite is located in the Central Iberian Zone of Spain. It has an extension of approx. 10 x 15 km^2 covering the central part of a NW- SE trending anticline consisting of precambrian sedimentary rocks and partly outcropping granitic intrusives. Contact metamorphic influence of the granitic cupolas is displayed in the contact zone of the surrouding sedimentary boundary (see Fig. 1).

The topography in the investigation area is moderate with a smoothly undulated morphology and maximum altitude differences of 160 m. The region is characterised by typical Mediterranean vegetation forming an irregular pattern of

TABLE 1
SPECTRAL RANGE AND RESOLUTION OF GER IMAGING SPECTROMETERS

	wavelength range	spectral resolution	number of channels
1. spectrometer	0.47 - 0.84 µm	12.3 nm	31
2. spectrometer	1.44 - 1.84 µm	120 nm	4
3. spectrometer	2.00 - 2.45 µm	16.2 nm	28

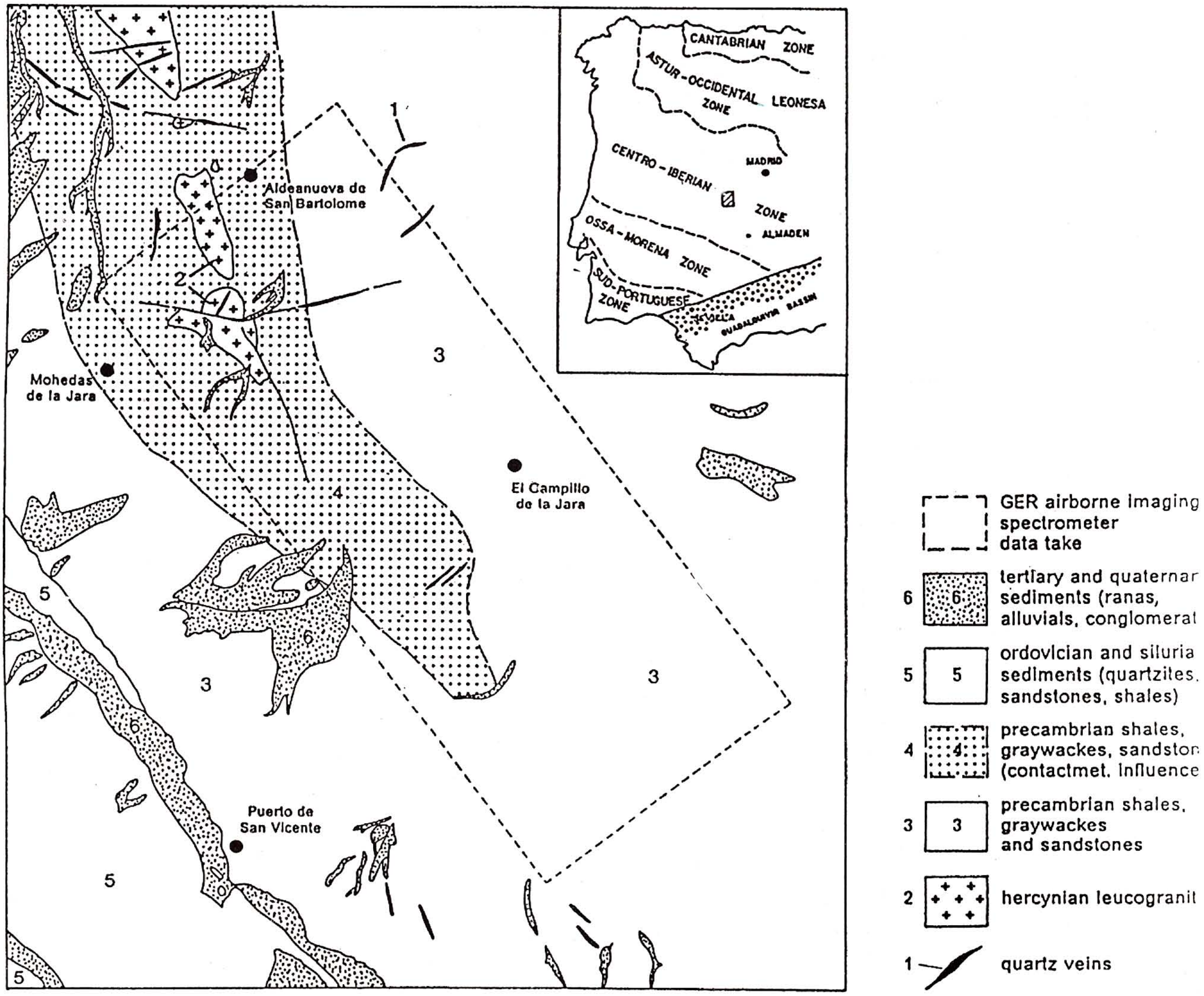

Fig. 1. Geological sketch map of the Almaden testsite (from geological map sheet No.15-27 (682), 1:50 000). Scale approx. 1 : 128 000.

cultivated (oat, olive tree plantations) and uncultivated areas. Due to cultivation cycles of several years large areas are fallow land, grassland and pasture, while areas of more expressed morphology with partly outcropping rocks and thin soil layers are not cultivated; those areas are mostly covered by garigue, macchie, and/or oak trees.

Soil spectral analyses have already been carried out in the framework of the Raw Materials Programme funded by the European Communities for mineral exploration purposes (Werner and Lehmann 1990a). The aim was to delineate suboutcropping granitic cupolas (with possible mineralisations in their roof zones) coming near the topographic surface according to their contactmetamorphic influence on the sedimentary formations.

The observed variations in mineral composition in those altered areas are spectrally displayed by increasing relative reflectance intensity in the shortwave infrared wavelength range and strong 2.2 μm and 2.35 μm absorption depths.

4. FIELD SURVEY

During a three days ground survey spectral field measurements have been carried out at 22 locations in the testsite. Three GER IRIS spectroradiometers covering the 0.4 - 2.5 μm spectral range were used for field spectroscopy measurements of bare soil and vegetation covered targets over outcropping granites, contactmetamorphic influenced and non influenced precambrian series. The

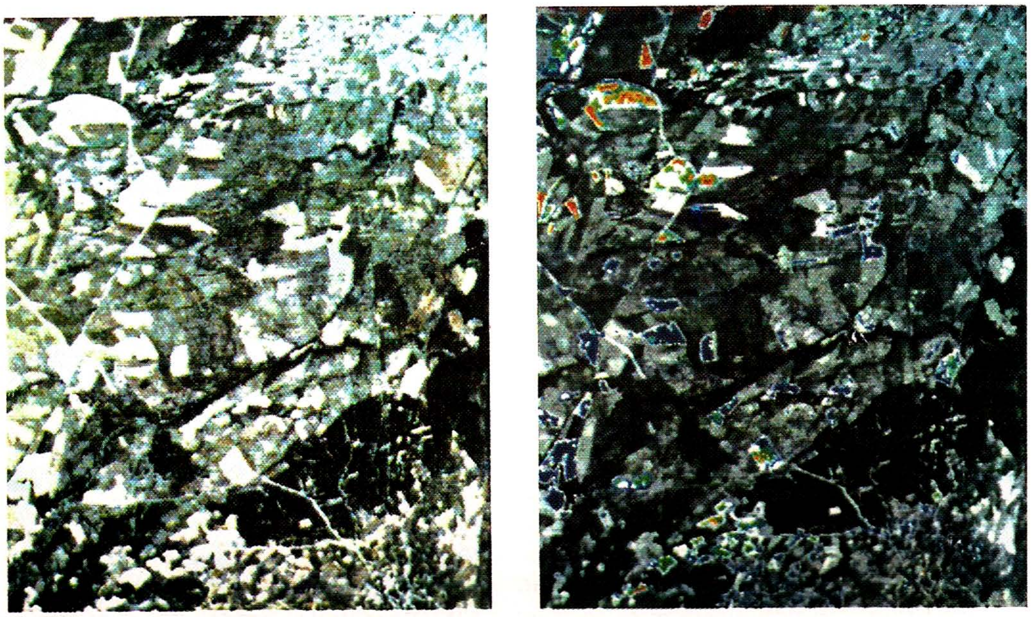

Fig. 2. GER airborne scanner data of the Almaden testsite
a = RGB natural colour composite (GER bands 15,7,2), b = GER band 15 and classified soil targets (red, green, blue). Scale approx. 1: 110 000.

vegetation analysis included an estimation of the percentual vegetation coverage discriminating between green and dry vegetation, indication of the average plant height and determination of vegetation types and landuse (Werner and Lehmann 1990b).

5. GER AIRBORNE DATA EVALUATION

GER airborne scanner data have been obtained from the central part of the investigation area with outcropping granites, precabrian sediments and the contactmetamorphic influenced contact zone (see Fig. 1). The area is mostly covered by various transition stages of grassland/pasture and macchie/garigue vegetation.

The GER preprocessed airborne data were first corrected for atmospheric and adjacency effects. These calculations allowed a conversion into relative reflectance values (Lehmann *et al.* 1989) which are comparable to ground measurement data. Due to atmospheric inhomogenities during the flight in the Almaden testsite, however, an additional correction had to be applied: relative reflectance spectra obtained on ground truth targets during the field campaign were selected and compared to reflectance spectra retrieved from GER image data of the corresponding locations. Based on the resulting spectral differences between ground and image data, correction factors have been calculated for each GER image band. They were used for the calculation of a calibrated GER image.

6. RESULTS

First analyses of GER airborne scanner data were concentrated on the spectral characteristics of bare soil targets/ploughed arable land. Based on GER airborne spectra a classification analysis has been carried out, taking into account the spectral response of all 63 GER scanner bands (Lehmann *et al.* 1990).

Fig. 2a shows an RGB natural colour composite of the GER image using band 15 at 650 nm (red), band 7 at 551 nm (green) and band 2 at 489 nm (blue) center wavelengths. Bare soil targets are characterised by high intensities, GER band 15 (650 nm) was used in Fig. 2b with the classified bare soil targets marked by red, green and blue colours. Soil targets with high intensities in the SWIR and strong 2.2 µm absorption bands are displayed by red colours. Those areas are mainly occuring over outcropping granites. Soil targets with medium intensity in the SWIR and less pronounced 2.2 µm absorption features are displayed by green colours and are located close to the outcropping granites and in contactmetamorphic influenced areas, while the spectra of blue coloured targets are characterised by low SWIR intensities and very weak absorption bands.

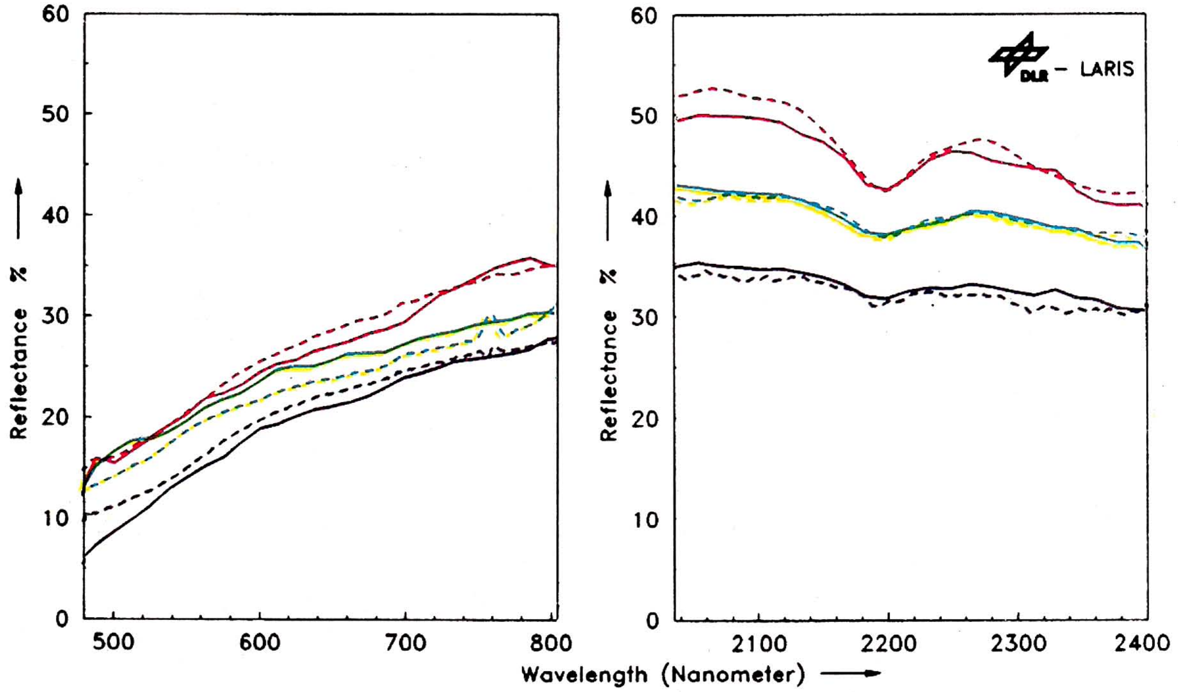

Fig. 3. Relative reflectance spectra from GER airborne scanner data (solid lines) and field spectra measured with the IRIS Mark IV spectroradiometer (dotted lines) at the corresponding ground locations.

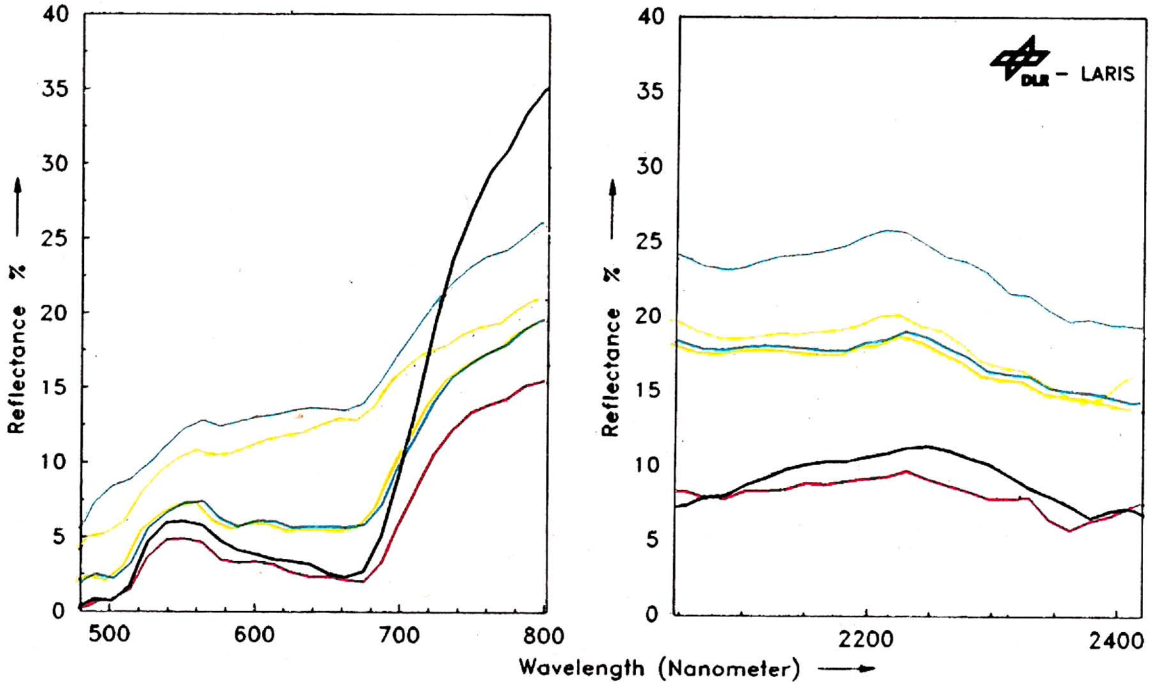

Fig. 4. Reflectance spectra calculated from GER airborne data representing various vegetation cover types
blue = grassland, yellow = ripe oat, green = lavendula stoechas/cistus ladanifer garigue, black = dump vegetation, red = cistus ladanifer macchie.

Soil spectra calculated from GER airborne scanner data and ground spectra measured with the IRIS Mark IV spectroradiometer during the field survey at the corresponding targets are presented in Fig. 3. The colours in the diagram correspond to the classified soil targets in Fig. 2. In contrast to an insignificant spectral variation in the VIS/NIR (see also Fig. 2a) the soil spectra are well differentiated in the SWIR wavelength region.

GER airborne scanner spectra from various Almaden vegetation cover types are shown in Fig. 4. Due to an inhomogeneous vegetation distribution within the testsite, however, spectral variations of equivalent vegetation types dependent on different soil types could not be noticed yet.

7. CONCLUSIONS

GER airborne scanner data is regarded to be very useful for soil/vegetation studies. Soil surfaces with even small mineralogical variation could be differentiated according to their spectral characteristics in the SWIR wavelength range. GER airborne scanner spectra of different vegetation types display noticeable variations in the VNIR and/or SWIR. Statistical spectral analyses are limited due to the small size of fields, the irregular pattern of cultivated and uncultivated areas and missing bare soil targets in some regions of the Almaden testsite. The relationship between geology and vegetation cover has to be examined in detail by further spectral analysis.

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