Analysis of vegetation covered waste deposits with the GER-II Scanner Data

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Abstract

In the course of the European Imaging Spectrometry Airborne Campaign 1989 (EISAC) several test sites over former waste deposits were flown in Southern Bavaria with the GER-II Scanner. The high spectral resolution of this sensor and the application of new quantitative data evaluation methods can yield valuable information regarding the interactions of the waste deposit and the surrounding environment. Presented here is the spectral analysis for one scene after atmospheric correction and the results of geochemical sampling over the waste site.

1. SITE DESCRIPTION

The examined waste tip in Southern Bavaria was opened in 1899 and served as a disposal site for communal and industrial waste. After the site was closed in 1949, the main part was used for agricultural purposes. At that time no protective measures were taken to prevent leakage of waste material into the surrounding environment. The site covers an area of about 1 km^2. A field survey during the EISAC-campaign (Lehmann *et al.* 1989) showed that the site only shows small topography and that the main part was equally dense covered with corn (rye) of the same height and maturity. This corn stand was further investigated (test site).

2. SPECTRAL ANALYSIS AND SCENE CLASSIFICATION

Though the test site looked apparently homogeneous, spectral differences were observed in the atmospherically corrected GER-Scanner data (Richter 1987, 1989). It was found that the reflectance values are increasing across the test site. Average spectra of all 63 channels with large relative differences between them were selected at four locations in the corn stand (Fig. 1). The selected spectra represent vegetation anomalies of different strength, i.e. strong anomaly, moderate anomaly, weak anomaly, no anomaly, on a relative scale. Based on the four selected corn spectra, a classification of the whole scene using 55 channels was made on a per pixel basis. Every pixel in the low-pass filtered scene was compared to each class-representative. If more than 90% of the pixels spectral points fell into the range of one standard deviation below and above the average classification spectrum, the corresponding class value was assigned, otherwise the pixel was rejected.

Fig. 2 shows the result of the classification, i.e. the spatial distribution of the anomaly classes as an overlay on a natural colour composite of the GER dataset. The colour of a classified pixel corresponds to the colour of the matched spectrum. Fig. 2 also contains two aerial photographs, taken in the years 1941 and 1943 which document the infill structures on the formerly open site. Comparison of the aerial photographs and the classification result shows a good correlation between the infill structures and the distribution of the "strong anomaly" pixels. The detection of infill structures after 40 years of agricultural use and the results of the field survey suggest, that the relative differences in the spectra are very likely to be related to the influence of a stress situation, caused by the buried waste.

3.GEOCHEMICAL ANALYSIS OF SOIL AND VEGETATION

This year samples of soil and vegetation were taken on the test site and analysed for heavy metal concentrations. It was found that heavy metal concentrations on the waste deposit

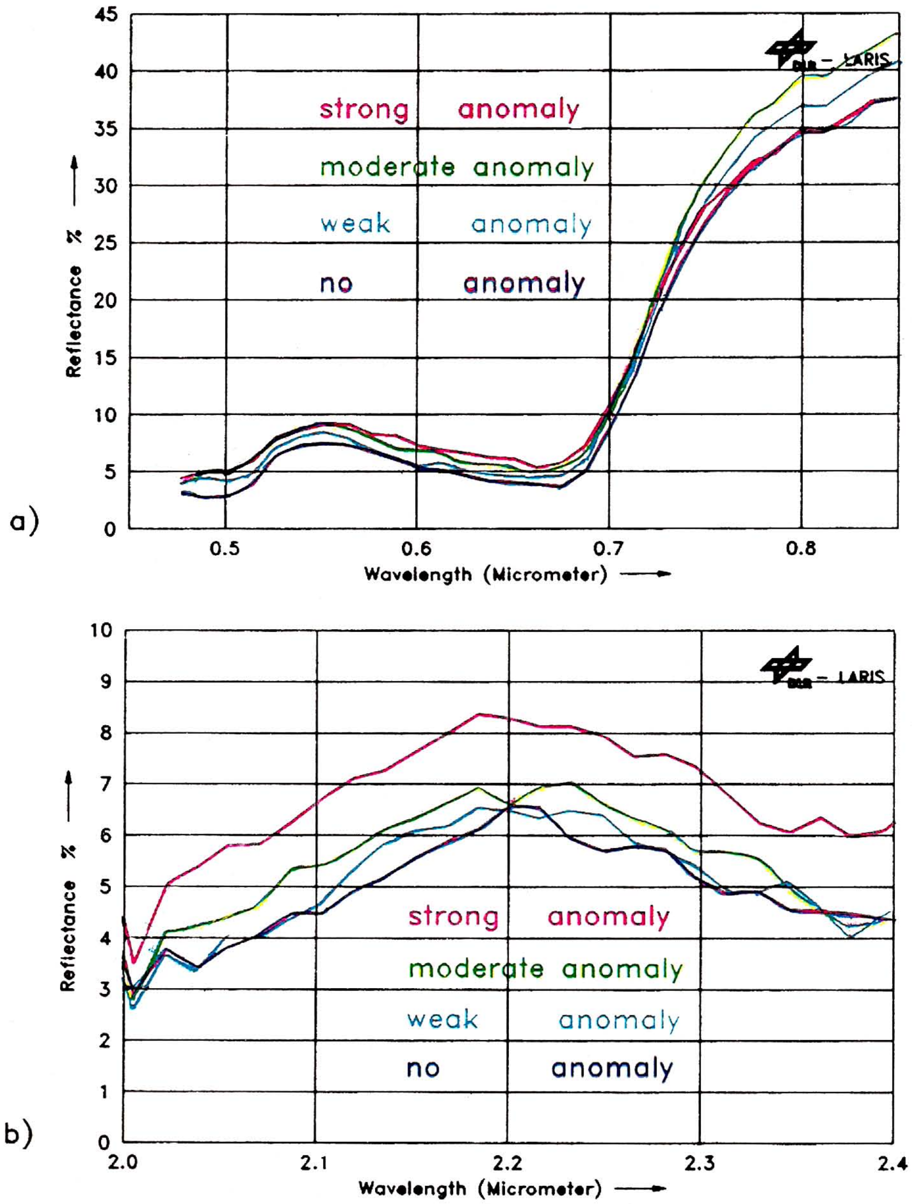


Fig. 1. Rye spectra from different locations on the waste deposit.
a) Visible to near infrared wavelength region
b) Short infrared wavelength region.

are substantially higher compared to a reference field near the site, as well for soil as for vegetation samples. Fig. 3 shows the concentrations of metals Lead, Copper and Zinc in soil samples taken along a profile in the "high anomaly" area (P1 to P12), on various other locations on the site and two samples taken from a reference field (P16 and P17) outside the infill area. This data supports the suggestion, that the material present is responsible for the differences in the observed spectral signatures. Physiological plant material analyses are planned for the next growing season, which should yield more information regarding the presence and influence of stress effects.

4. SUMMARY

Regarding the number of old, unprotected waste deposits (e.g. in Germany about 50,000), and the environmental threats related to many of these sites, new methods have to be found to reduce the costly and time consuming ground surveys. Using high resolution Imaging Spectro-

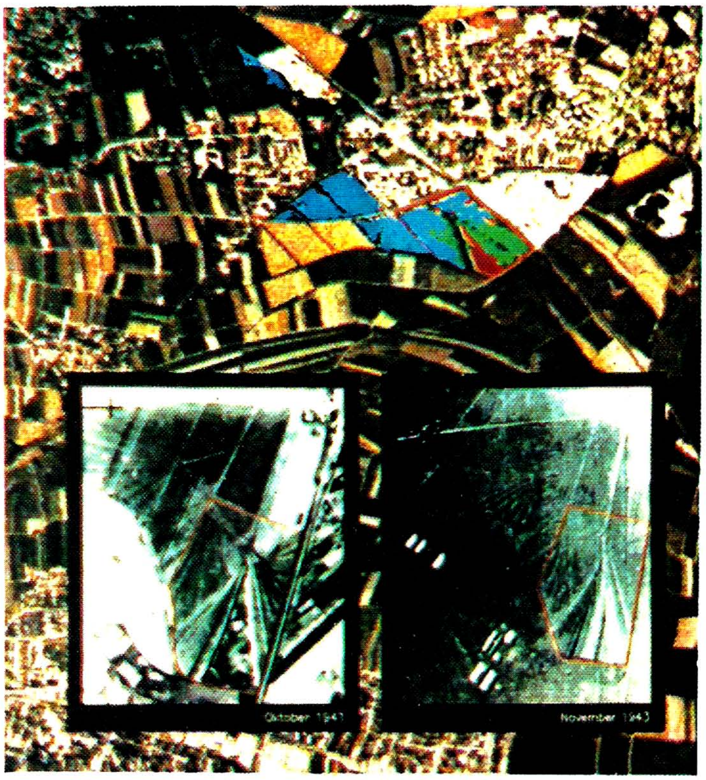
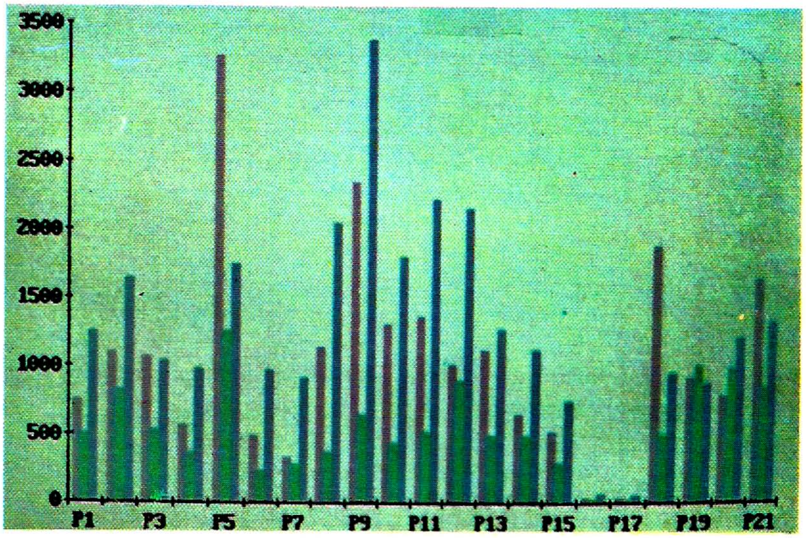


Fig. 2. Scene classification based on the selected rye spectra.
The classification is overlaid on a natural RGB colour composite of the atmospherically corrected GER data, where Red = GER channel 15 (center wavelength 650 mm), Green = channel 7 (551 nm) and Blue = channel 2 (489 nm). The same area on the ground is outlined in red in the RGB and the aerial photographs, which document the process of former infill on the site (British Crown Copyright, RAF photograph).



Metal contents in ppm
Sampling points

Fig. 3. Concentrations of heavy metals in soil samples. Red: Lead, Green: Copper, Blue: Zinc
Samples P16 and P17 are taken from a reference field near the waste deposit and show considerably smaller heavy metal concentrations.
Allowed maximum concentrations in soils are as follows: Zinc: 300 ppm, Lead and Copper: 100 ppm.

meter data, the vegetation cover on and around these sites is analysed for stress signatures which are possibly related to the waste deposit. This remote sensing method could be employed as a fast, nondestructive way of delineating spectrally anomalous areas as an input for specific ground surveys.

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