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OVERVIEW OF AUSTRIAN AIRBORNE IMAGING SPECTROMETER (AIS) PROGRAMME AND FIRST RESULTS

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ABSTRACT

AIS data collected from eight test areas in Austria during the summer of 1986 are currently being evaluated for their usefulness in forest damage assessment, geobotany, alpine vegetation mapping, and land-use classification. Difficulties encountered in installing the SPAM spectral analysis software for use on our image display system and the necessity to adapt existing in-house programs for this task have impeded and delayed the analysis of the AIS data. Spectral reflectance curves obtained from a geobotanical test site show a marked increase in reflectance across most of the measured spectrum for metal-stressed spruce trees compared with non-stressed spruce trees.

INTRODUCTION

The deployment of the NASA C-130 research aircraft to Europe during the spring and summer of 1986 gave Austria the opportunity to acquire high spatial and spectral resolution data from several test areas in the eastern Alps for use in vegetation mapping and stress detection and urban and rural land-use classification. During a one week period in July, C-130 overflights of Austria collected airborne imaging spectrometer (AIS), Thematic Mapper Simulator (NS001), and Thermal Infrared Multispectral Scanner (TIMS) data from eight test sites situated in the Austrian provinces of Styria, Carinthia, and Upper Austria. Unsettled weather, cloud build up in the mountains, and heavy haze - common conditions at this time of the year in the Alps - necessitated overflights well before the preferred mid-day time period to minimise their effects on the data collection. The earlier than planned flights did, however, result in an increase in the amount of shadow in the data.

TEST SITE DESCRIPTIONS

All test sites flown as part of the Austrian AIS programme have as their principal objective the mapping of vegetation as to type, species, or condition. Five of the eight test sites are concerned with forest damage associated with air pollutants emitted by chemical, refining, pulp, and coal-burning plants or tree stress related to the presence of heavy metals in the underlying soil. The remaining three test sites pertain to alpine vegetation and soil mapping and land-use classification of an urban-rural setting. FIGURE 1 shows the location of the test sites and TABLE 1 gives a brief description of their main vegetation cover or land type and the nature of their research work.

SENSOR SYSTEM CHARACTERISTICS

TABLE 2 lists the pertinent information on the AIS-2, NS001, and TIMS sensor systems. AIS-2 differs principally from AIS-1 in comprising a 64 by 64 detector element array (thereby doubling the swath width obtainable with AIS-1), a

TABLE 1 DESCRIPTION OF AUSTRIAN AIS TEST SITES

Test Site	Location	Description	Study Purpose
Burghausen	Upper Austria	Spruce (pine-larch-beech) forest	Assessment of tree damage related to chemical plant emissions.
Ranshofen	Upper Austria	Spruce (pine-larch-beech) forest	Assessment of tree damage related to aluminium plant emissions (fluorine)
Frohnleiten	Styria	Spruce (pine-fir-beech) and spruce-broad-leaved (fir) forests	Geobotany - heavy metal (Cu-Pb-Zn) stress
Koralpe	Carinthia	Spruce (pine-fir-larch-beech) forest	Assessment of tree damage related to pulp mill and coal-burning power plant emissions (SO2)
Klagenfurt	Carinthia	City-urban-rural setting	Land use classification
Hochobir	Carinthia	Spruce-Larch (fir-beech) forest	Geobotany - heavy metal (Pb-Zn) stress
Hochtor	Carinthia	High alpine terrain	Alpine vegetation and soil mapping
Gross-glockner	Carinthia	High alpine terrain	Alpine vegetation and soil mapping

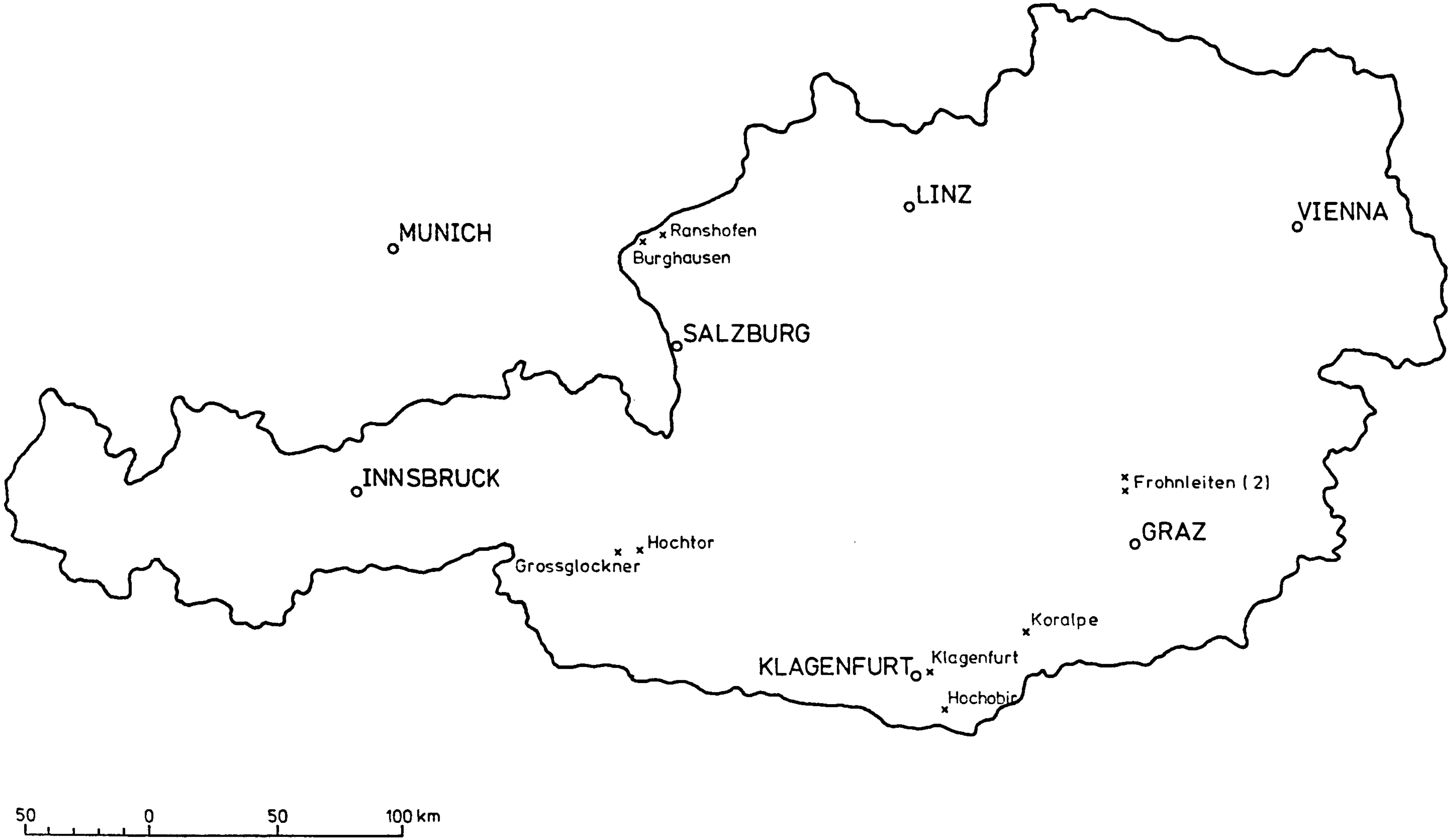

FIGURE 1. AUSTRIAN AIS TEST SITES

TABLE 2 Airborne Imaging Sepctrometer (AIS), Thematic Mapper Simulator (NS001), and Thermal Infrared Multispectral Scanner (TIMS) Sensor Characteristics

Sensor	Bands	Bandwidths (microns)	Comments
AIS-2	128 (contiguous)	Interval: 10.5 m Range: 0.78 - 2.53 Tree mode: 0.78 - 2.14 Rock mode: 1.19 - 2.53	64 x 64 detector element array swath: 512 m* pixel size: 8 m*
NS001	8 (discrete)	0.46 - 0.52 0.53 - 0.60 0.63 - 0.70 0.77 - 0.91 1.13 - 1.35 1.57 - 1.71 2.10 - 2.38 10.90 - 12.30	FOV: 5 km* IFOV: 10 m*
TIMS	6 (contiguous)	8.2 - 8.6 8.6 - 9.0 9.0 - 9.4 9.4 - 10.2 10.2 - 11.2 11.2 - 12.2	FOV: 4.6 km* IFOV: 10.0 m*

* 4000 m flying height above ground level.

set of blocking filters that reduces the problem of wavelength contamination caused by second order light, and the use of all 12 bits of the recorded data to increase the dynamic range of the detectors. The need to change the foreoptics of AIS-2 to accommodate the doubling of the sensor field of view (FOV) did result in a degradation of the instantaneous field of view (IFOV) and, more importantly, an approximate 1.8 reduction in the effective versus the nominal spatial resolution of the pixels.

DATA ACQUISITION

All sensor systems appeared to function normally during the data acquisition flights, except for jamming problems related to the Nikon 35 mm camera. AIS, NS001, and TIMS data and colour and colour-infrared photography were collected over each test site, with AIS data obtained in both the tree and rock modes for the Burghausen, Ranshofen, Frohnleiten, and Hochobir test sites, but only in the tree mode for the Koralpe and Klagenfurt sites and in the rock mode for the Hochtor and Grossglockner sites.

TABLE 3 AIS Test Site Data Acquisition Information

Test Site	Flight Date	Flight Time (Solar Time)	Atmospheric Conditions	AIS-2 Scan Modes	Nominal Pixel Spatial Resolution (metres)	
					Ground	Effective
Burghausen	16.07	12.00-12.15	Hazy	Tree Rock	6	11
Ranshofen	16.07	12.15-12.30	Hazy	Tree Rock	6	11
Frohnleiten	17.07	8.45-9.45	Hazy	Tree Rock	6/10	11/18
Koralpe	17.07	10.00	Wispy Clouds	Tree	10	18
Klagenfurt	17.07	10.30	Hazy	Tree	11	20
Hochtor	21.07	8.30	Clear-Cloudy	Rock	10.5	19
Hochobir	21.07	9.00-9.30	Heavy Clouds	Tree Rock	10-11	18-20
Grossglockner	21.07	10.00	Clear-Cloudy	Rock	10	18

Flying heights above the test sites resulted in nominal ground pixel sizes of between 6 and 11 metres, although the effective spatial resolution of the pixels is between 11 and 20 metres, due to the degradation of the optics.

Where possible, highways or water bodies are contained within each flight line to permit calibration of the response of each detector, using the flat-field correction method.

Data from the first priority test sites (Burghausen, Ranshofen, and Frohnleiten) are cloud free (although with considerable haze), while data from the remaining test sites vary from being hazy to heavily contaminated by clouds. The occurrence of storms and late morning cloud build up in the Alps during the time of the Austria overflights necessitated data acquisition times much earlier than the preferred mid-day period, thereby increasing the shadow component in the data - especially in the mountainous regions.

TABLE 3 summarises the principal data acquisition information from the eight test sites.

DATA ANALYSIS

Only a limited amount of analysis has been performed on the AIS data from the Austrian test sites, and this has been mainly confined to examining the quality of the data on our display system and obtaining spectral reflectance curves from some of the test sites, using raw, uncorrected data. We have not been able to install the SPAM spectral analysis software to operate on our system, because of software-display interface incompatibility. This means that either an extensive amount of program rewriting has to be done or existing in-house image processing programs need to be modified to operate on AIS data. Both approaches are a time consuming and costly affair, and a decision is still pending on the third option of purchasing an image processing system that is compatible with the TAE/VICAR2 (which SPAM is one component) software. The third option is presently the favoured approach, with select in-house image processing and analysis programs being modified to handle AIS data as an interim measure until a new image processing system is available.

Modification of some of our in-house image processing programs has allowed us to produce spectral reflectance curves from a number of the test sites and to do a preliminary visual analysis of the data. FIGURES 2 and 3 show the spectral plots from one of the Frohnleiten geobotanical test sites, where an almost pure Norway spruce forest is growing in soils containing high concentrations of copper, lead, and zinc. The spectral curves represent 2 by 2 pixel areas from stressed and non-stressed parts of the forest, and clearly show an increase in reflectance across most of the measured spectrum for the stressed compared with the non-stressed trees. This is in agreement with the expected response of stressed vegetation in the inter-water absorption region between approximately 1500 nm and 1800 nm, but is less in agreement for the near-infrared plateau region between 800 nm and 1350 nm. Similar results are obtained using 3 by 3 and 5 by 5 pixel windows. Differences in curve shape and slope can also be seen between the two spectra, but as only raw, noisy data have been used so far in the analysis, no attempt has been made to analyse these features, other than to note their presence for a closer examination when corrected data are available.

ACKNOWLEDGMENTS

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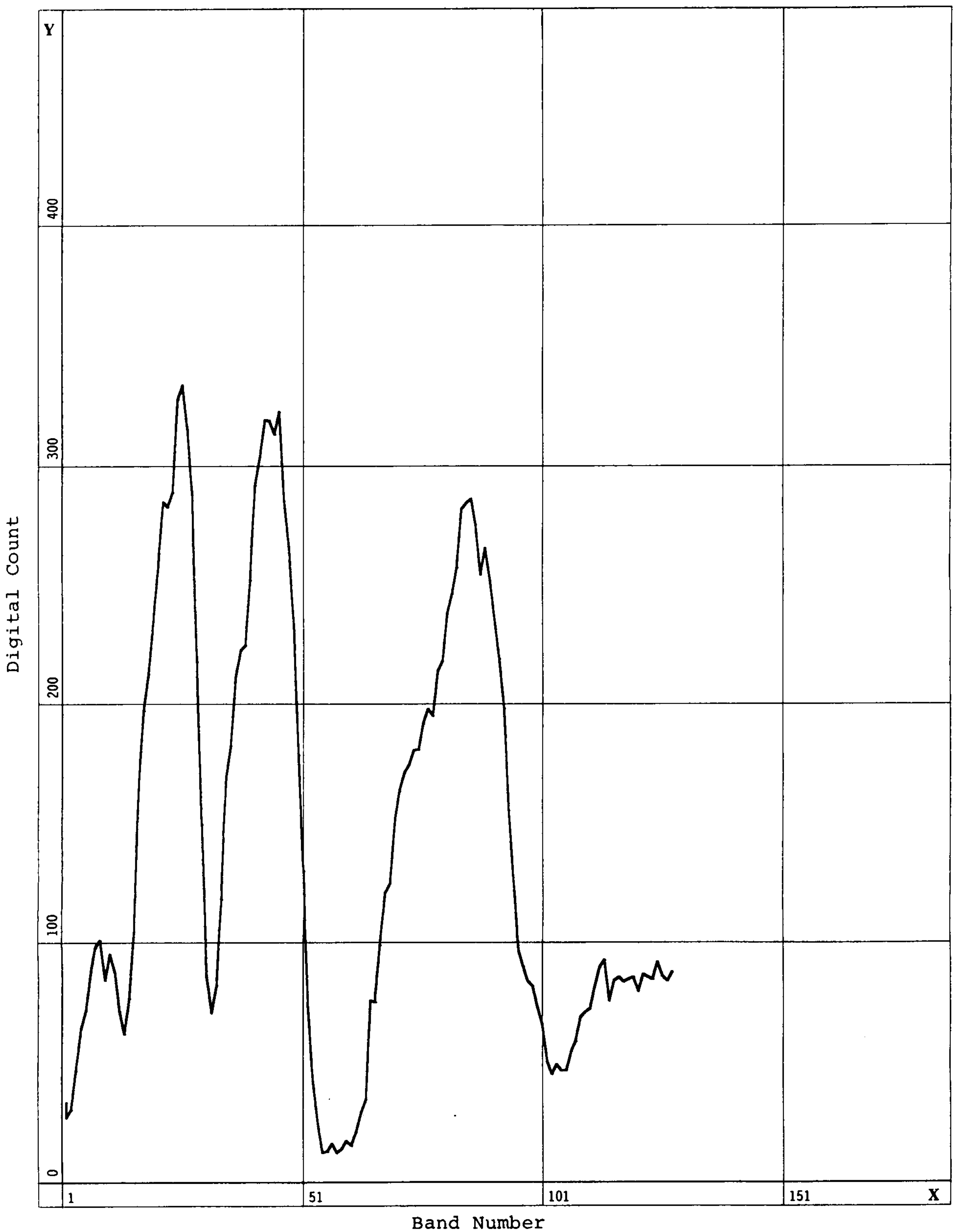

FIGURE 2. Non-Stressed Spruce Forest (Frohnleiten Test Site)

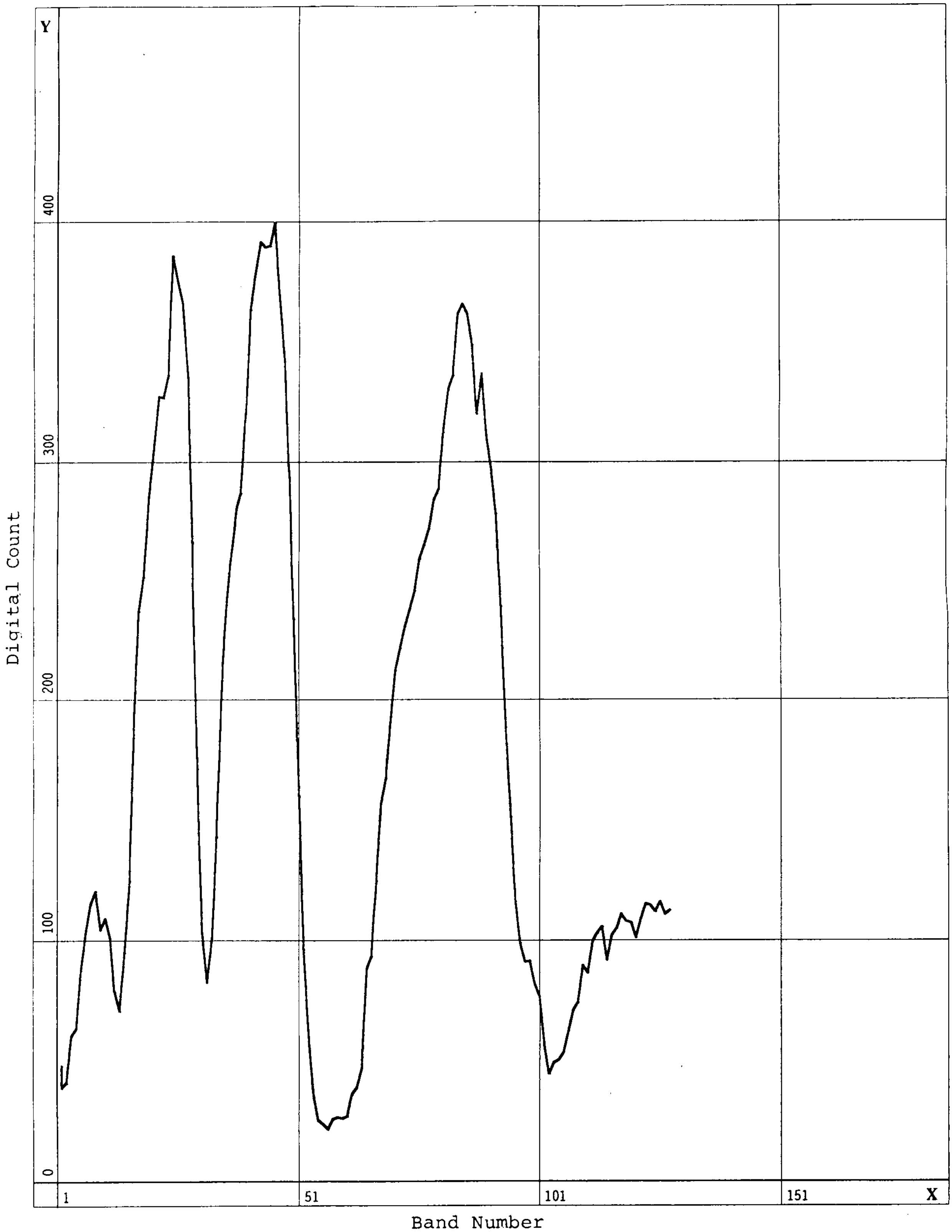

FIGURE 3. Stressed Spruce Forest (Frohnleiten Test Site)