CR-128646

STANFORD RSL TECHNICAL REPORT NO. 72-2

THE NATIONAL AERONAUTICAL AND SPACE ADMINISTRATION

RESEARCH CONTRACT NAS9-7313

"INFRARED SPECTROMETRY STUDIES"

FINAL REPORT -- PHASE V

"NEW FORMAT PRESENTATION FOR INFRARED SPECTRAL EMITTANCE DATA"

PERIOD: SEPTEMBER 1, 1971 to SEPTEMBER 30, 1972

(NASA-CR-128646) NEW FORMAT PRESENTATION FOR INFRARED R.J.P. Lyon, et al (Stanford Univ.) 30 Sep. 1972 157 p CSCL 14B

N73-12730

Unclas
G3/23 48431

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SEPTEMBER 30, 1972

REMOTE SENSING LABORATORY
SCHOOL OF EARTH SCIENCES

STANFORD UNIVERSITY • STANFORD, CALIFORNIA

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Period: September 1, 1971 to September 30, 1972

The report covers the last thirteen month period of the contract, under Modifications 6S, 7S and 8C.

The research was supported also by equipment provided by a Facilities Contract from NASA/Ames Research Center NAS2-3402(F). These supports are gratefully acknowledged.

Spectral data (airborne and field-generated) resulting from these studies are also reproduced in the Appendix of this Report.

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Research Geophysicist

R. J. P. Lyon
Principal Investigator

September 30, 1972

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70-6 "The Multiband Approach to Geologic Mapping from Orbiting Satellites: Is it Redundant or Vital?" (by R.J.P. Lyon), now published in Remote Sensing of Environment, 1, (4), 237-244

70-7 "Airborne Geological Mapping Using Infrared Emission Spectra" (by R.J.P. Lyon and J. Patterson), now published in Proc. of the 6th Symposium on Remote Sensing of Environment, 1, 527-552.

70-8 "Psuedo-Radar: Very High Contrast Aerial Photography at Low Sun Angles" (by R.J.P. Lyon, Jose Mercado and Robert Campbell, Jr.), now published in Photogrammetric Engineering, 36, (12), 1257-1261

70-9 "Remote Sensing in Exploration for Mineral Deposits" (by R.J.P. Lyon and Keenan Lee), now published in Economic Geology, 65, 785-800

70-10 "Phenomena and Properties of Geologic Materials Affecting Microwaves - A Review" (by D. Oberste-Lehn)

70-11 "1969/70 Stanford Spectral Data Management System" (by Michael Heathman)

71-1 "Operational Calibration of an Airborne Infrared Spectrometer Over Geologically-Significant Terrains", (by R.J.P. Lyon and A.A. Marshall) now published in IEEE Transactions on Geoscience Electronics, Vol. GE-9, (3), July 1971, 131-138

*Out of Print

September 1, 1972

71-2* 1970/71 Stanford Spectral Data Management Programs" (by A. A. Marshall) Final Report (A) -- Phase IV (Software - Computer Programming).

71-3 "Stanford Digital Data System." Final Report (B) -- Phase IV.

71-4 "Comparison of Airborne Infrared Spectral Emittance and Radar Scatterometer Data from Pisgah Crater Lava Flows," (Abstr.) Paper presented at 7th Int. Symp. on Rem. Sens. of Environ., Ann Arbor, Michigan, May 17, 1971.

71-5 "Infrared Spectral Emittance in Geological Mapping: Airborne Spectrometer Data from Pisgah Crater, California." Paper now published in Science, 175, 983-986, March 1972.

71-6 "Spectral Data from Flights 1 and 3, Mission 108." Final Report (C) -- Phase IV (IR Spectral Emittance Data - Airborne).

72-1 "Exploration Application of Remote Sensing Technology (Image Forming Systems)", Mining Congress Journal, June 1972, pp. 20-26.

72-2 "New Format Presentation for Infrared Spectral Emittance Data." Final Report, Phase V (IR Spectrometry Studies).

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I. INTRODUCTION

Under the general title of "Supporting Research and Technology Effort in Identification of Geological Materials by Remote Infrared Spectroscopy" the Remote Sensing Laboratory of School of Earth Sciences, Stanford University, has been carrying out infrared (IR) radiance measurements from geological materials since 1967. These have involved laboratory and field spectroscopic measurements both on the ground and airborne. The net result of this work is a proven, feasible system for airborne use[1] over terrains with minimal vegetation. The perturbing effect of a long atmospheric path is still being evaluated and this may be a great barrier to successful spacecraft usage, although this in no way detracts from its highly successful operation from altitudes of several thousand feet.

Recently parallel studies at University of Michigan by Vincent and Thompson[2], based directly upon results of this work, but operating with image-forming airborne scanners, have shown that the spectral emittance concepts can be utilized in emittance-ratio imagery which broadly depicts the silicate composition of the terrain. This is a much more attractive technique than using spectral curves as the imaging mode of data presentation is much more meaningful to geological users. In addition the possibilities of analog processing the multichannel-imaged data are most attractive both in ease of data handling and cost. Considerable savings of time and funds can be made providing the requisite spectral resolution can be retained. A trade off exists between signal-to-noise (S/N) ratio and the spectral bandpass of each channel and channels which are too wide sacrifice spectral discrimination for high S/N ratios.

1. Lyon, R.J.P. (1972) "Infrared Spectral Emittance in Geological Mapping: Airborne Spectrometer Data from Pisgah Crater, California"., Science, 175, 983-986

2. Vincent, R.K., and Thompson, F.J. (1972) "Rock-type Discrimination from Ratioed Infrared Scanner Images of Pisgah Crater, California", Science, 175, 986-988.

II. OBJECTIVES

Stanford University proposed three main objectives in the concluding phase of this study effort,

A. Calculation of Emittance Ratios (Task 2.2)

A first task involving the new concept of "emittance-ratio images". These are important because they directly correlate with the surface composition of the terrain in an imaged form. They are obtained from the analog signals of a multichannel scanner which has several channels in the thermal infrared region. Such data could be readily obtained from the channels No. 17-21 of the MSDS scanner being prepared for the C-130 at MSC. By "banding together" the data in our higher-resolution airborne spectra, we have attempted to predict the response of the scanner over these terrains.

B. Comparison of IR Spectral Emittance Data with K-Band Scatterometer Data (Task 2.3)

The second task followed initial research efforts in comparing the airborne scatterometer data over Pisgah Crater, with the infrared spectra. Both methods produce "spectral curves" (backscatter versus look-angle, and emittance spectra) but represent very different skin depths for the information content in their data.

The abstract (included in the appendix) is from a paper presented at the Seventh International Symposium in Remote Sensing of Environment. This paper reported the use of a color-bar generation system (Digicol-I^2S) to generate a given color for each input IR spectrum. Prior to this stage of the analysis, the BMD07M stepwise discrimination program was used to identify the 3 wavelengths for best "separation" of the materials. These 3 emittance values were quantized within 16-level steps, and used to pre-set the 16-level matricies for the red, blue and green color guns of a color TV monitor.

The unit could handle 16 such matricies at once as vertical color bars across the TV tube. The eye then could rapidly identify similarities and contrasts in the data sets. Due to the familiar problems (color plate costs, etc.) in color reproduction the paper was not prepared in a final form for that Symposium volume. These techniques are a very interesting way to compare spectral (line-trace) data, and comparisons can be made with the IR and the X-band scatterometer data (5th Symposium volume by the University of Kansas group). Contrasts of skin depth such as appear with the windblown-sands covering the basalt flows, may be noted.

C. Standard Infrared Spectral File (Task 2.4)

The third task was to take all our spectra from both the ground and the airborne collection and prepare them in a standard format file. This is important for their use by any second party (who does not have our familiarity with their collection methods), and thus our accumulated expertise can now be passed on. These spectra have been collected from geologically-selected targets and 75-100 sets have been compiled.

Where possible spectra represent rocks in their natural field location. In some sites (Sonora Pass) this was no longer possible and specimen rocks have been collected from sites.

III. RESULTS

A. TASK 2.2 CALCULATION OF EMITTANCE-RATIOS

1. Existing Spectral Data (MX108) - "Science" Article

Over 4300 spectra were collected on magnetic tape from the 4 flight lines over Site 2 (Pisgah) on MX108. A total of 514 of these have been segregated into geologically-significant (and differing) categories and analyzed. Rather than repeat a description that is already in print, we have included the Science article verbatim.

Infrared Spectral Emittance in Geological Mapping: Airborne Spectrometer Data from Pisgah Crater, California

Abstract. *Measurements of spectral emittance in the infrared region from 6.8 to 13.3 micrometers were made with an airborne spectrometer at a rate of six spectra per second, on flights 650 meters above the olivine basalt flows at Pisgah Crater in the southern Californian desert. The spectra show chemical and mineralogical differences that can be related to differences in the terrain below the aircraft.*

At a recent symposium (*1, 2*), two presentations were made of the techniques of independently performed geological mapping from the air, over the same terrain. This report emphasizes the nonimaging technique involving spectral measurements in the infrared from 6.8 to 13.3 μm taken while flying at 650 m (2000 feet) above the olivine basalt flows and alluvium and dry lake beds (Lavic Lake) at Pisgah Crater, near Barstow, California. The instrumentation (*3*), includes a boresight camera by which one can relocate the ground track of the (7 mrad, 0.4°) circular field of view of the spectrometer (*4*).

A total of 514 of the 4300 spectra were collected (*4*) in four flight lines of total length 28 km (*5*). They were separated into 31 geological groupings, located as black and white bands on the large-scale photographs (Fig. 1) taken at the same time along the flight line *F–F′* (*6*).

The raw radiance spectra from the rock and soil surfaces were ratioed by an average "water body" spectrum (average of 50 spectra) obtained by flying at the same altitude over a nearby lake (*7*). The emittance spectra were then inverted (*8*) and normalized for statistical studies, by setting their means at 0.0 and their standard deviation (S.D.) at 1.0. By this transform all the spectra have the same amplitude range, which permits more precise comparison of their information content. Care should be taken in using these normalized spectra, as they are no longer numerically the same as absolute emittance (used for calculating temperatures from radiance levels).

These selected spectra are then analyzed in two formats. In the first, emittance values for 10 to 50 spectra [mean

Reprinted from
3 March 1972, Volume 175, pp. 983-986
SCIENCE

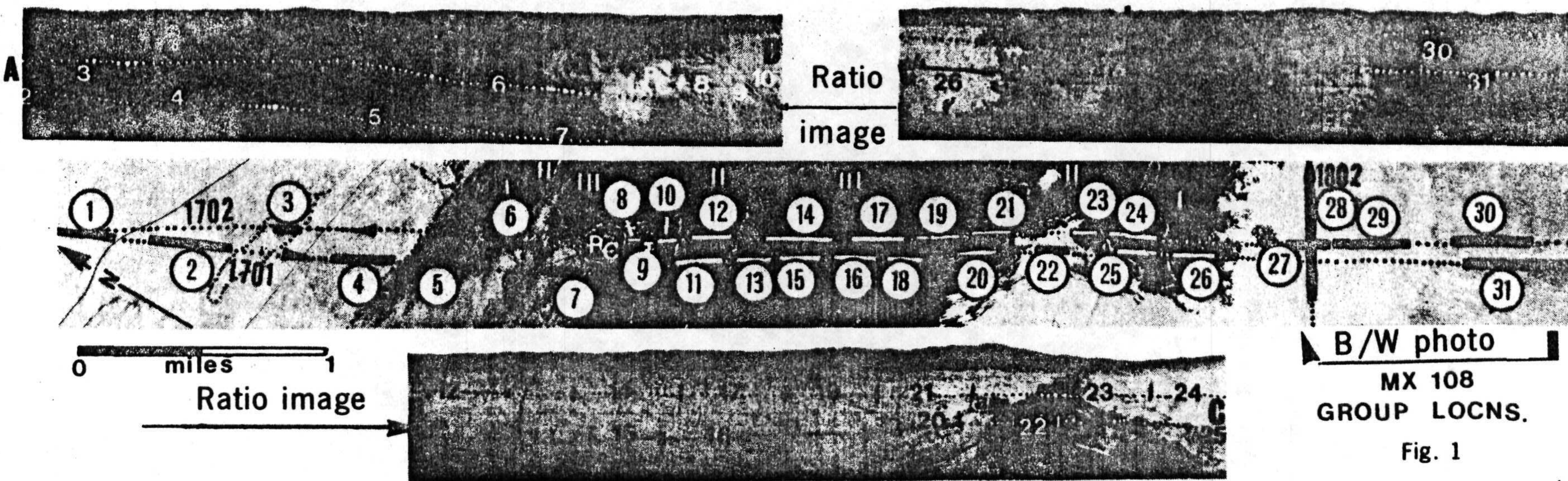

Fig. 1

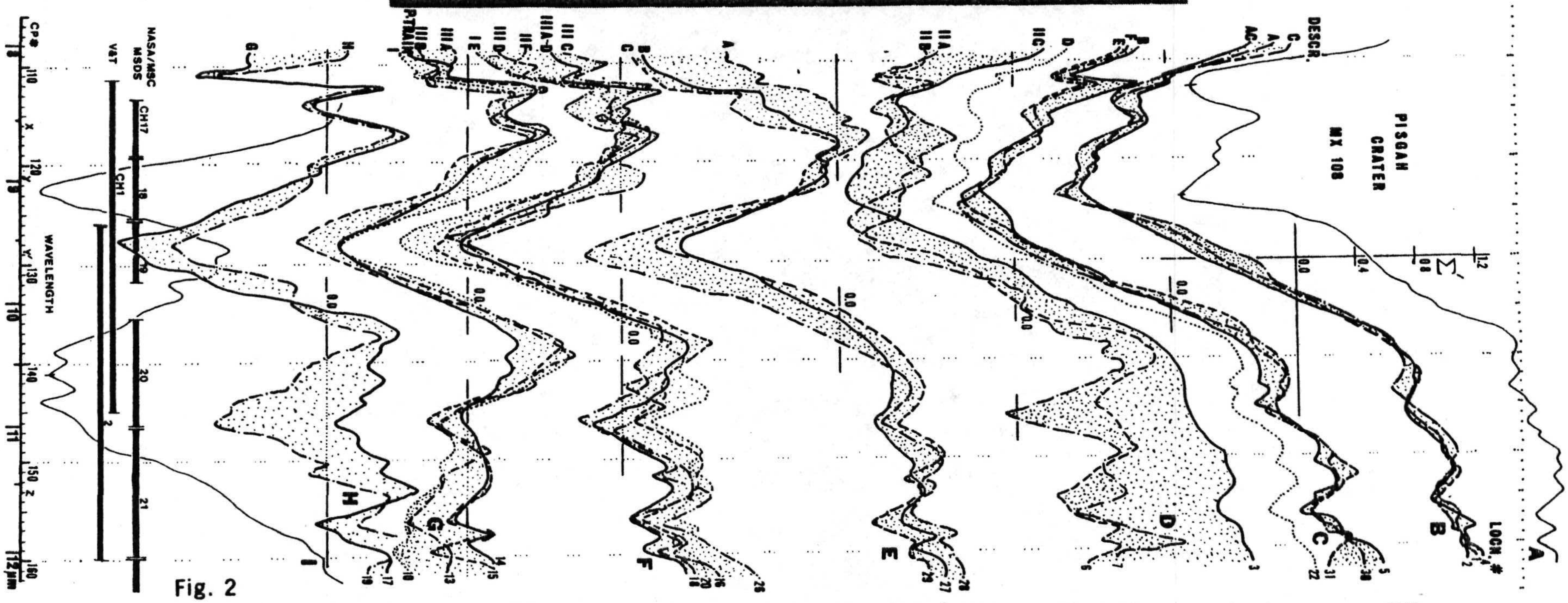

Fig. 2

Fig. 1. Photograph of Pisgah Crater (*PC*), center, and three image strips (*10*); 1 mile = 1.6 km. Fig. 2. Mean spectral emittance curves (*11*).

and ± 1 S.D.; (9)] are plotted as a function of wavelength. In the second, the standard deviations for 10 to 50 spectra are plotted in the same way. The standard deviation plot provides a rapid estimate of the variability of the data. It generally has one of two shapes, low and flat if there is little variability in radiance, or higher and bulging if there is considerable variability. An interesting standard deviation plot for the dry lake sediments of Lavic Lake (locality 28) shows a third type, with a pronounced upward bulge only where the reststrahlen effect (*1–3, 10*) indicated a chemical and mineralogical variation in an otherwise constant lake-floor terrain, which is clearly of geological significance.

The means of the spectral groups (or "mean spectra") may be compared by visual inspection, for example, by direct overlay of tracings (Fig. 2), or group populations may be studied by discriminant analysis (*11*). Several subgroups have been selected on the basis of more subtle features (such as weathering and surface chemical variability). In Fig. 2, B to H, the mean spectra of all the subgroups are plotted as single curves to show their similarities within a geological class. Thus, each spectrum represents the average of many individual spectra sequentially observed over the distance indicated by the bars on *F–F′* in Fig. 1.

The geology of the Recent lavas, rocks, and soils has been described (*12, 13*). The spectra can be correlated with geology and meaningful, systematic variations appear in the flight data. The spectra of the "younger" alluvium (Fig. 2B) and "older" alluvium (Fig. 2C) groups are similar, with a single, strong sloping minimum at 9.1 to 9.2 μm. Detailed examination shows that the pattern in Fig. 2B is displaced to shorter wavelengths and that the shoulder at 9.5 μm is absent, which indicates a higher quartz (sand) content in the younger materials (*12*). Comparable similarities are shown by the three olivine basalt flow types (Fig. 2, F to H), all of which show a single, sharp minimum at 9.45 to 9.55 μm. The differences between the basalt spectral types were emphasized by separating the subgroups that showed a weak minimum at 10.97 μm (Fig. 2, F and G) from those that had a pronounced feature there (Fig. 2H). A further separation was made by means of the broad pattern around 11.5 to 12.0 μm (in Fig. 2, F is flatter there than G). Comparable spectra of (polished) granodiorite (Fig. 2A) and gabbro (Fig. 2I) specimens have been included to show the closer similarity of the basalt to the gabbo spectrum (*14*).

The most interesting group (Fig. 2D) represents spectra from areas (3, 6, and 7 in Fig. 1) where blown sand now rests (patchily) in depths greater than the optical depth for these silicates. Thus, where cover is complete the spectrum of sand (here equivalent to the younger alluvium, Fig. 2B) should appear; where it is not complete the basalt spectrum should be evident. Within the group in Fig. 2D, the spectral mean IIC (locality 3) shows the younger alluvium pattern, while IIA (locality 7) is most like the basalt spectra (type 2, Fig. 2F), which establishes the ability of the airborne system to discern variations in rock composition. This variability is also clear on the *A–B* section of the ratio-imagery in Fig. 1 (*10*).

The spectra of dry lake sediments (Fig. 2E) from Lavic Lake present an enigma. Although creamy white in color, these fine-grained clays (*12*) consistently yield spectra (*15*) similar to those of the type-2 basalt flows (see Fig. 2B and localities 27, 28, and 29 in Fig. 1). This was true in 1965 in ground measurements along the same line. The new airborne data now support the earlier (still unexplained) findings. Similar support is gained from the ratio-imagery of the same area observed by Vincent and Thomson (*10*). Therefore, three pieces of evidence point to the similarity of the clay spectra to those of the nearby olivine basalt.

In summary, (i) infrared emittance spectra taken from the air over geologically selected areas across the Pisgah Crater lava flows show similarities within (and contrasts between) the areas. The spectral differences can be used to separate the flows. (ii) Within the lava flows themselves spectral types can be defined that (at the moment) are not clearly related to the mapped flow stages (flows I, II, and III); that is, the spectra are subtly depicting some other parameter than that used to differentiate the three flows in the field and on aerial photographs. (iii) Windblown sand on basalt shows spectra of sand, but where sand patchily covers the flow in one resolution cell the spectra of both the sand and the basalt appear in a composite pattern. (iv) The spectra of the dry lake sediments of argillic silts superficially resemble those of the basalt flows, but group variability in chemical and mineralogical composition is shown by the shapes of the standard deviation plots. (v) Each of these spectral similarities and differences may also be observed in the imagery prepared by ratioing concurrent radiance levels in two adjacent wavelength channels 2.5 μm wide (*10*). This is significant, as imagery is more practical to use than spectral curves. What cannot be explained yet is that this occurred with overlapping band-pass filters of such width (8.1 to 10.9 μm and 9.4 to 12.0 μm). These bands (Fig. 2) must represent the integration of all the spectral information within their bounds and express it as an average value, rather than show all the finer points of spectral differences evident on the curves. A more precise separation of rock types can be effected by using nonoverlapping or narrower bands, or both, even with the lowered signal-to-noise ratio incurred by the lessened energy throughput. Such a multichannel system as that being built for the National Aeronautics and Space Administration's aircraft program (*16*) can become a geological mapping tool.

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References and Notes

1. R. K. Vincent and F. J. Thomson, in *Proceedings of the International Symposium on Remote Sensing of the Environment, 7th* (Univ. of Michigan Press, Ann Arbor, 1971), pp. 247–252.
2. R. J. P. Lyon, *ibid.*, p. 1449.
3. ——, *Econ. Geol.* **60**, 715 (1965); —— and J. Patterson, *Proceedings of the International Symposium on Remote Sensing of the Environment, 6th* (Univ. of Michigan Press, Ann Arbor, 1970), p. 527; *Proceedings of the International Symposium on Remote Sensing of the Environment, 4th* (Univ. of Michigan Press, Ann Arbor, 1966), p. 213.
4. Spectra are taken at a rate of six per second, while the aircraft moves 15 m. The field of view of the spectrometer is small (7 mrad or 7 m/km altitude); at an altitude of 700 m the spectra are from patches 15 m long by 5 m wide. The spectrometer uses a circular variable filter as the dispersive element, with spectral resolution $\lambda/\Delta\lambda = 100$.
5. Flights were made on National Aeronautics and Space Administration Mission 108, 8 October 1968, over Pisgah Crater, California, about 61 km (35 miles) southeast of Barstow, San Bernardino County.
6. Self-organizing ("clustering") programs were extensively used with the older, noisy (earlier than mission MX-108) data but were not useful. The stepwise discriminant program BMDO7M (University of California at Los Angeles biomedical series) was the most suitable, both for early grouping into "training" groups and in the subsequent processing of other "unknown" spectral data.
7. In processing, the spectral emittance of water is used and blackbody radiance at the lake temperature (from the onboard radiometer, $\Delta\lambda$ is 10.375 to 12.1 μm), is modified by these values, until a "water body" spectrum is obtained. [See R. J. P. Lyon and A.

Marshall, *Inst. Electr. Electron. Eng. Trans.* GE-9, 131 (1971)]. The bands (6.8 to 7.9 μm) and (12.0 to 13.3 μm) are then "clipped off" as they contain information from atmospheric constituents and not geological (silicate) materials (*3*).

8. Both units chop the incoming radiance against an internal blackbody, set at 60°C (spectrometer) and 50° or 60°C (radiometer). The output voltages increase with lower target temperatures. Nonblackbody radiators have lower brightness temperatures (emittance at any wavelength is not equal to 1.0) at wavelengths of chemical interest (reststrahlen bands); thus, raw spectra have maxima of output voltage in these bands. Inverting the emittance data corrects this problem (*7*).

9. It is assumed that the distribution of the emittance values about their mean follows a normal distribution curve. See R. Hoffer, in *Laboratory for Agricultural Research (LARS) Bulletin 844* (Purdue Univ. Studies, West Lafayette, Indiana, 1968), chap. 3, pp. 68–71.

10. R. K. Vincent and F. J. Thomson, *Science* 175, 986 (1972).

11. In Fig. 2, the group number is the left-hand symbol and the locality number is the right-hand number. The groups are (*B*) younger alluvium, (*C*) older alluvium, (*D*) sand over basalt, (*E*) dry lake sediments, (*F*) olivine basalt flow of spectral type 2, (*G*) olivine basalt flow of spectral type 1, (*H*) olivine basalt flow of spectral type 3. In addition, there are (*A*) rock standard granodiorite and (*I*) rock standard gabbro. The discriminant program operates in a stepwise manner to find the most powerful discriminant in *X*-dimensional space, where *X* is the number of spectral emittance values as sequentially selected by the program (*3*).

12. S. J. Garawicki is quoted [in L. F. Dellwig, *Modern Geology* (Gordon & Breach, New York, 1969), p. 63; see also pp. 72–73] as follows, "playa surface (dry lake sediments) is a hard dense compact argillic crust consisting of approximately 79% clay, 20% granular components, 0.2% accessory minerals and a trace of saline minerals."

13. J. D. Friedman [*U.S. Geol. Surv. Tech. Lett. NASA-20* (1966), p. 4] gives the composition of the basalt flows at Pisgah Crater: (flow II) total feldspar 15.4 percent and total ferromagnesian 9.4 percent; (flow III) total feldspar 38.8 percent and total ferromagnesian 5.1 percent. Flow III is more spathic than flow II, at least at the two points sampled near the crater. Herein lies one of the major problems in relating regionally variable (airborne) composition data to those of classical geological studies, which are usually from selected points.

14. See note 3 in (*7*). Standard rock I: gabbro, contains plagioclase (60 percent anorthite molecule content), augite, and a little biotite; standard rock A, granodiorite, contains biotite, quartz, epidote, and plagioclase with orthoclase.

15. The marked drop-off near 8 μm (in Fig. 2E) or the correspondingly high maxima at 8.8 μm may be due to the Christiansen effect in these fine-grained materials. This, however, does not fit for the lavas (Fig. 2, F and G).

16. The 24-channel scanner [E. M. Zaitzeff, C. L. Korb, C. L. Wilson, *Inst. Electr. Electron. Eng. Trans.* GE-9, 114 (1971)] has six channels selected within the thermal band, as CH 16 (6.0 to 7.0 μm), CH 17 (8.3 to 8.8 μm), CH 18 (8.8 to 9.3 μm), CH 19 (9.3 to 9.8 μm), CH 20 (10.1 to 11.0 μm), CH 21 (11.0 to 12.0 μm), and CH 22 (12.0 to 13.0 μm). The data in (*1*) would represent the combination of channels 17 to 20, ratioed with the combined channels 19 to 21. My spectral data (Fig. 2) indicate that the Pisgah geology would be more clearly defined by using channels 17, 18, and 19 (either singly or combined), ratioed to channel 20. Channel 21 would still show some effect of chemical compositions (particularly in femic rocks).

17. This research was supported in its entirety by NASA contract NAS9-7313 with NASA/MSC, Houston. This financial support is gratefully acknowledged. This is Technical Report No. 71-5, Remote Sensing Laboratory, Stanford University.

21 September 1971, revised 22 November 1971

2. State of Art at End of 1971 Contract

The state of processing represented by the above article has been materially advanced during this new period, but the details will be covered in the next section.

Again, the material is best covered by reproducing a published paper by Lyon and Marshall, 1971, in IEEE Transactions on Geoscience Electronics.

Operational Calibration of an Airborne Infrared Spectrometer Over Geologically Significant Terrains

R. J. P. LYON AND A. A. MARSHALL

Abstract—A three-instrument infrared spectral emittance experiment, comprising a rapid-scan spectrometer (6.7–13.3 μm), radiometer (10.375–12.1 μm), and boresight camera, has been flight tested over selected geological terrain in central and southern California and Nevada. Pre- and post-flight calibrations of the infrared spectrometer were performed both by using polished samples of "standard" rocks (quartz diorite and gabbro) as well as the more familiar blackbody radiance standards. From these latter spectra the instrument transfer function ($A_{T\lambda}$) was derived. In-flight calibrations of wavelength were achieved by the rapid insertion and removal of a polystyrene film in the optical train of the spectrometer, as polystyrene is a material whose transmission spectrum is constant and well known. By flying over a body of water ($\epsilon_{6.7-13.3\mu m}=0.98$) and recording the radiance spectrum of that target one can determine the transmission spectrum of the atmospheric path between the aircraft and the water (at least to a first approximation) as both the spectral emittance of lake water and the optical transfer functions of the instrument are known or can be calculated. So far, flights have been made only at low altitudes (2000 ft above the lake), with the lake surface at 2000 ft (near Pisgah Crater, S. Calif.) or 6000 ft (Mono Lake, E. Calif.) above sea level. The lake should be in the area to be studied geologically. If the flight altitudes over the study areas are consistent with those over the lake, then the effect of the airpath can be evaluated relative to the spectral information from the geological targets.

Introduction

To ACCURATELY deduce the surface temperature of terrain from its infrared brightness temperature, the surface emittance as well as the background radiant emittance must be known. Generally when such measurements are made around 8–14 μm a simplifying assumption is used that $\epsilon_{8-14\mu m}\equiv 1.00$, i.e., the target is a blackbody. Sometimes a *graybody* emittance of 0.9 or similar factor is assumed to ease the conscience of the researcher involved. One method of arriving at the emittance integrated across a given passband is to measure the spectral emittance and then integrate for an averaged value. This experiment describes equipment and analytical techniques by which this may be achieved.

A geologically significant more sophisticated experiment which relies upon the nonblackbody behavior of silicate rock materials typically making up planetary terrain, is to use the *spectral* emittance in this band to derive the chemical composition of the terrain being overflown [1]–[3]. Subsequently, one can integrate the spectral data to obtain a suitable wide-band value. The background information on this method is detailed in several references, and the method has been reduced to practice both in the field and in airborne measurements [3].

In the airborne mode, infrared radiance spectra (with a resolution $\lambda/\Delta\lambda=100$) were taken six times a second over the bandpass 6.7 to 13.3 μm. With every second spectrum a 35-mm boresight photograph was taken to locate the precise ground-track of the sensor system after the data flight. Table I lists the equipment characteristics.

Also included as the third instrument in the infrared "pallet" was an infrared radiometer, a relatively broad-band sensor (10.375 to 12.1 μm), which has its bandpass centered in a region of high atmospheric transmittance. This band exhibits consistently high terrain emittance and does not show the spectral departures from a blackbody on which the geological experiment is based [3]. The radiometer served as a monitor to ensure that there were no marked temperature changes over the target which might be mistaken for spectral emittance changes. Within a given spectrum, temperature changes of less than 1°C were allowed—if higher than that level the spectrum was rejected.

Calibration Concepts

The operational calibration was of three main types, pre-flight, inflight, and post-flight; the pre- and post-flight sets being performed immediately prior to take-off and after landing.[1] The aircraft engines usually were not running and the internal systems were connected to ground power (sometimes the auxiliary power unit (APU) was used). There could be differences between the two ground power sources (and with the aircraft engine sources themselves) but the most significant "noise" problem at this stage is the degree of mechanical vibration generated by the APU, and the engines which induces microphonic signals into the infrared detectors.

The in-flight calibrations are more simple, being restricted to a wavelength check performed by inserting

Manuscript received February 26, 1971; revised March 24, 1971. This work was supported by NASA, under Contract NAS9-7313.

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[1] Cryogenic hold-times were in excess of eight hours; thus long flights could be made and post-flight calibrations obtained without refilling the cryogenic supplies.

TABLE I
INFRARED PALLET

Airborne Rapid Scan Spectrometer	
Scan wavelength	6.76–13.30 μm with 100 elements per spectrum. The CVF[a] wheel has 2 similar spectral octaves—one from 0° to 180°, and one from 180° to 360°
Scan period	0.150 s (6 spectra/s)
Field of view	0.4 degree square (7 mrad)
Detector	Hg-doped germanium, time constant less than 1 μs, cooled by liquid helium
Essential output signals (four)	a) spectral radiance output (analog) b) wavelength ramp (analog, not presently used) c) wavelength (peripheral-edge coding) pulses, every 2°, or 90 per spectrum, 180 per rotation of the CVF (See Table II) d) a spike pulse, (at 0°) was used to fire the boresight camera (used for location purposes)
Accuracy required	10-bit, i.e., better than 0.1 percent
Infrared Radiometer	
Filter bandpass; sampling frequency	10.375 to 12.1 μm approximately 60 temperature measurements per second, i.e., ten to every spectrum (or 1 every 9 spectral elements)
Field of view	0.4 degree, circular (7 mrad)
Detector	Hg-doped germanium, time constant less than 1 μs, liquid helium cooled
Essential output signals (one)	radiance signal sampled 60 times/s (analog)
Accuracy required	10 bit, i.e., better than 0.1 percent
Boresight Camera	
Type	35-mm framing camera, with film-recorded clock and frame counter, electrically pulsed by output command from spectrometer (at approximate rate 3 s)
Field of view	approximately 5° to yield telescopic view of the target. Camera pulse originates 5 ms before the no. 1 *data* pulse, i.e., just past the 0° position

[a] CVF: circular variable filter, a circular dispersive element.

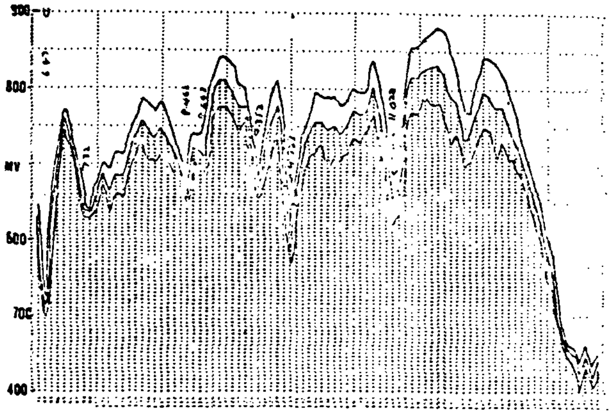

Fig. 1. Average and $\pm\sigma$ of $N=5$ polystyrene transmission spectra airborne over Pisgah target. $N=5$. Times from 17:13:14.442–17:13:16.000 GMT (local time PST = GMT − 8 h). Handwritten figures refer to the precisely known absorption lines for polystyrene.

TABLE II
COUNTER POINT (CP) VERSUS WAVELENGTH[a]

CP	λ (μm)	CP	λ (μm)	CP	λ (μm)
91	6.760	121	8.965	151	11.380
92	6.825	122	9.045	152	11.445
93	6.890	123	9.135	153	11.525
94	6.960	124	9.205	154	11.600
95	7.035	125	9.270	155	11.680
96	7.085	126	9.370	156	11.750
97	7.160	127	9.455	157	11.835
98	7.225	128	9.530	158	11.895
99	7.290	129	9.615	159	11.970
100	7.365	130	9.690	160	12.040
101	7.445	131	9.775	161	12.120
102	7.510	132	9.865	162	12.190
103	7.585	133	9.960	163	12.260
104	7.660	134	10.010	164	12.330
105	7.750	135	10.100	165	12.405
106	7.810	136	10.170	166	12.470
107	7.880	137	10.255	167	12.540
108	7.955	138	10.340	168	12.605
109	8.025	139	10.420	169	12.670
110	8.105	140	10.490	170	12.745
111	8.185	141	10.580	171	12.815
112	8.265	142	10.660	172	12.895
113	8.325	143	10.740	173	12.955
114	8.410	144	10.810	174	13.020
115	8.485	145	10.900	175	13.085
116	8.565	146	10.970	176	13.150
117	8.640	147	11.070	177	13.220
118	8.720	148	11.150	178	13.285
119	8.800	149	11.220		
120	8.885	150	11.305		

[a] Original data sheet for points 0–90 and 91–180 for the 1968–1970 ARSS CVF wheel, provided by NASA/MSC by letter TF2/LE 120-68, March 25, 1968. To make the data covered by both halves of the wheel more equal 1 CP is dropped from the leading data set for each side. Thus MSC CP 92 becomes Stanford CP 91, 179 becomes 178, etc. Operational verification of these values may be made by the spectrum of polystyrene in Fig. 1.

a polystyrene film into the spectrometer optical train. The known spectral transmission of polystyrene provides a characteristic signal readily observed on the data tapes. It was also used as a signal for "line-start" and "line-stop" in the later data analysis steps. Fig. 1 shows a group ($N=5$) of airborne polystyrene spectra. From this, Table II was verified.

A more fundamental type of in-flight calibration was performed by flying the infrared system over a body of water. Water has a well-known spectral emittance varying only slightly from a graybody value of 0.98 [6] over this bandpass. Thus a radiometric check between spectrometer and radiometer may be made in the data analysis steps and brightness temperatures compared. As will be seen later, the AIRPATH spectral transmittance between the water and the aircraft may be defined by this aspect of the flight program.

PRE- AND POST-FLIGHT CALIBRATIONS

In addition to the above, there were normal engineering-type calibrations of tape recorder channels, etc., of the type usually performed in all high quality data gathering operations [4]. The calibrations described here refer to *geological and meteorological calibrations* which are designed to recover *known* spectral characteristics from the data tapes as an overall check of the system. In detail these are the following.

1) Observation of an external blackbody source lying on the runway beneath the stationary aircraft. This blackbody was temperature controlled at 40°C (313°K), and is called 40°C BB-EXT.[2]

2) Sequential observation of a pair of "standardized" rock specimens (rock A, and rock B), lying on the runway beneath the stationary aircraft. Those were heated in an oven to approximately 40°C (313°K). The specimens were 20 by 20 cm across and 2.5 cm thick, thus having considerable thermal inertia.[3] Rock A was a dark gray to medium gray gabbro, and rock B was a light silver-gray granodiorite, two chemically, and mineralogically, distinct igneous rocks. The front surfaces of these "standards" were highly polished to decrease scattering effects from their front surface making it a more precise spectral emissivity standard.

In order to obtain high contrast in the spectral signature data, i.e., a large signal differential for small spectral emissivity variations, the background radiation *reflected* by the sample into the instrument must be small compared to the emitted radiation. This criterion was achieved by positioning the highly polished sample sufficiently below the aircraft and angled appropriately to ensure that "cold" sky was the effective background.[4] Since all pre- and post-flight calibration measurements were performed under moderately low humidity and cloudless conditions, the sky radiation (between 8 μm and 13.5 μm) was infinitesimal compared to that of the 40°C rock specimen and was neglected from further consideration. Identical procedures were followed during pre- and post-flight calibrations.

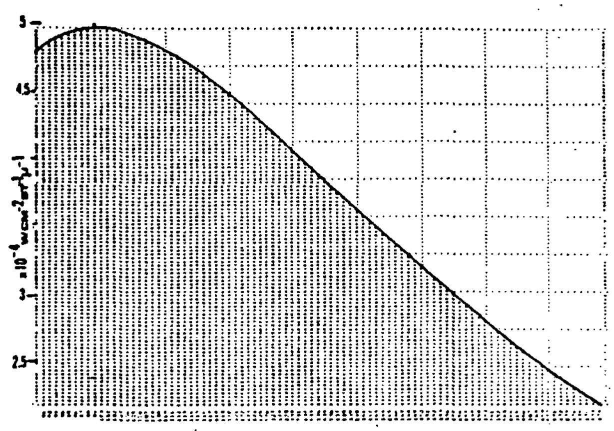

Fig. 2. *Calculated* radiance difference (W·cm^{-2} sr^{-1} μm^{-1}) for a blackbody exterior target at 40°C (313°K) and an internal blackbody reference at 60°C (333°K). Wavelength counter points appear as the abscissa, from 91 to 178 (from 6.8 to 13.3 μm), and are common to all graphs.

Transfer Function ($A\tau_\lambda$) Calculation

The optical spectral transfer function (τ_λ) for the spectrometer may be derived jointly with the system gain A as a product form, which we simply call the spectral "transfer function" ($A\tau_\lambda$). The data processing steps outlined in what follows agree closely with those published for the Purdue (LARS) procedures originally performed for field calibration of Block-Michelson interferometer spectra [5].

Calculate for each wavelength step the radiance spectrum (Planck Law) for the 60°C internal blackbody reference (BB-INT). Calculate the radiance spectrum for the temperature controlled external blackbody (BB-EXT). Derive the radiance difference spectrum (TRUE).

Fig. 2 shows this calculated difference

$$N\lambda_{\text{TRUE}} = N\lambda_{\text{BB-INT}} - N\lambda_{\text{BB-EXT}} \qquad (1)$$

where $N\lambda$ = radiance at wavelength λ (μm).

This difference $N\lambda_{\text{TRUE}}$ can be related to the actual signal observed from the spectrometer (proportional to the difference between the two blackbodies, but modified by the spectral transfer function). Figs. 3 and 4 show the actual signal (OBSERVED) from an external blackbody at 40°C (313°K); an average of 22 spectra with $\pm 1\sigma$ limits indicated. The standard deviation levels are a measure of the "noise" riding on the signal. From these data (Figs. 3 and 4) the spectral transfer function ($A\tau_\lambda$) was calculated (Fig. 5)

$$\text{SPECTRAN}\,(A\tau_\lambda) = \frac{\text{OBSERVED}}{\text{TRUE}}. \qquad (2)$$

[2] Extended Source Blackbody, Barnes Engineering, Inc., temperature controlled to ±0.5°C.

[3] The rocks were selected by a geologist from tombstone material (because of the overall high polish readily available across large slab areas). Thin sections were made and the correct rock type defined by optical means. The slabs were cut into two, and one half of each retained by Stanford University Infrared Lab. to calibrate our other spectrometer and data recording systems. Rock A: Gabbro, contains plagioclase (An_{60}), augite, and little biotite, Rock B: Granodiorite, contains biotite, quartz, epidote, and plagioclase, with orthoclase.

[4] The spectrometer measures $W_{\lambda(\text{eff})}$. Assume a target which entirely fills the instrument field of view.

$$W_{\lambda(\text{eff})} = W_{\lambda a}(1-\tau_{\lambda a}) + \tau_{\lambda a}[\Sigma_{t\lambda} W_{t\lambda} + H_{\lambda B}(1-\Sigma_{t\lambda})]$$

where

- $W_{\lambda(\text{eff})}$ effective radiant emittance seen by the radiometer at wavelength λ;
- $W_{\lambda a}$ radiant emittance of the air at wavelength λ;
- $\tau_{\lambda a}$ atmospheric transmission at λ;
- $\Sigma_{t\lambda}$ target emissivity at λ;
- $W_{t\lambda}$ radiant emittance of the target at λ;
- $H_{\lambda B}$ irradiance from the background (sky, terrain, room walls, or ceiling, etc.) incident on the target at wavelength λ.

Note the following:

1) $W_{\lambda a}$, $\tau_{\lambda a}$, $\Sigma_{t\lambda}$, $W_{t\lambda}$, and $H_{\lambda B}$ are integrated over the spectral bandpass of the instrument. The difference between the integrated values and monochromatic values at wavelength λ depends on the spectral bandwidths of the atmospheric absorption/emission bands, the bandwidth of the spectral features on the target, and similar considerations for the background relative to the instantaneous spectral bandwidth of the instrument. In the 7-14-μm region these differences are generally small for $\Delta\lambda/\lambda < 0.02$.

2) $H_{\lambda B}$ depends upon $\tau_{\lambda a}$, $W_{\lambda a}$, sky conditions, terrain temperature, the target angular aspect, and instrument view angle relative to the zenith. If $W_{\lambda t} = H_{\lambda B}$ no spectral signature of the target is discernible. $H_{\lambda B}$ can be better controlled or minimized with a polished (specular) sample.

3) $\tau_{\lambda a}$ has practical limits between zero and one and has both fine and coarse spectral features.

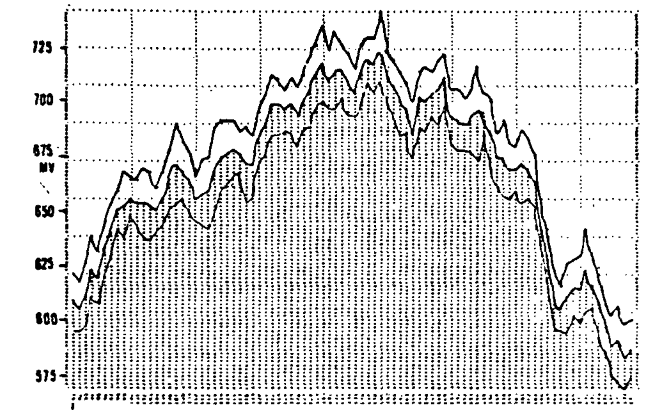

Fig. 3. *Observed* radiance difference (millivolts) for the same 40°C target and 60°C reference. $N=22$ spectra for the average calculation, $\pm 1\sigma$ limits shown, $\bar{X}=668$ mV. Noise (mean sigma, $\bar{\sigma}$) $=13.5$ mV. *Pre-flight* data, mission 108, day 1, times from 15:17:53.647–15:18:00.759 GMT.

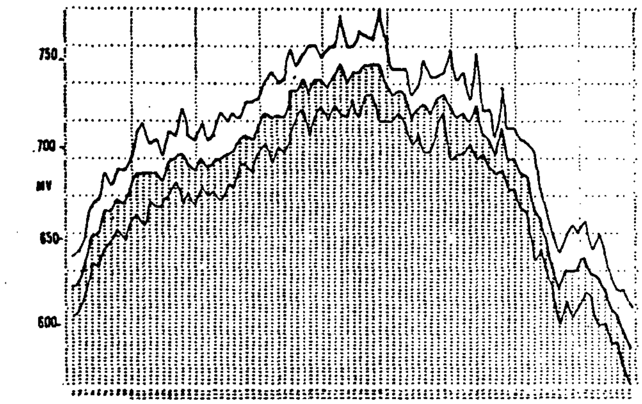

Fig. 4. Comparable *post*-flight data after return. $N=25$, $\bar{\sigma}=19.1$ mV, $\bar{X}=692$ mV (i.e., temperatures were *not* exactly at 40°C). Times from 21:21:23.167–21:21:30.766 GMT.

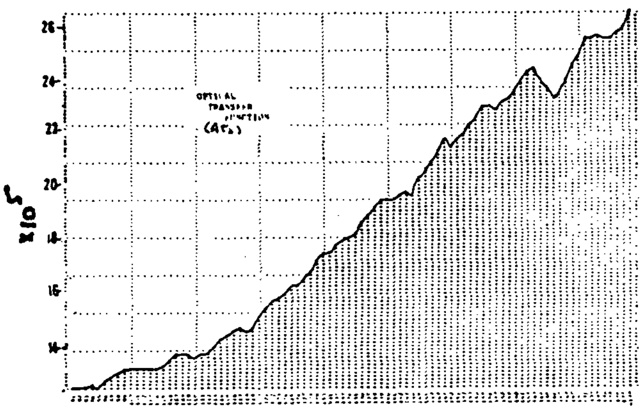

Fig. 5. Optical transfer function ($A\tau_\lambda$), from pre-flight 40°C BB-EXT data. Ratio calculated from Figs. 2 and 3.

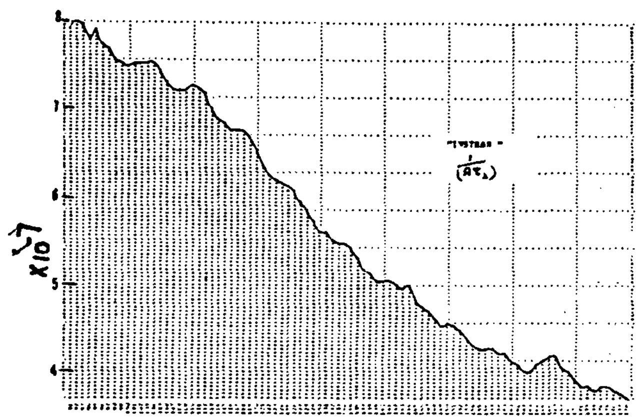

Fig. 6. INSTRAN, or inverse of optical transfer function ($=1/A\tau_\lambda$).

The inverse of the transfer function $1/A\tau_\lambda$ or INSTRAN was more useful in the calculations and this function was stored for data processing (Fig. 6). The principal straight-line component of the gradient is related to the wavelength sensitivity of the Ge:Hg detector, the system gain (A), and the optical transmittance (τ_λ). Higher frequencies in the function are caused by the variations in τ_λ exhibited by the CVF. Additional small effects of microphonic noise and interference may account for some of the observed high frequency variations.

AIRPATH Calculation

When airborne spectra are collected while flying over a water body (Figs. 7 and 8) a mean spectrum can be calculated which closely resembles the blackbody difference spectrum, OBSERVED (Fig. 3). Absolute levels (in volts) are higher, as most water bodies are cooler than the 40°C external blackbody used in the pre-flight ground calibrations. Standard deviation levels of 17–20 mV rms (Table III) again represent noise levels but are *not* significantly higher than on the ground, a marked change from earlier flights with this system which showed large microphonic noise. (Missions 56, 78, flown in 1967 and 1968.)[5]

The atmospheric transmittance was determined over the two lakes observed in this flight (Palmdale Lake, 96 mi west, and Shallow Lake, 25 mi north of the Pisgah lava field test site, which is at latitude 34.7°N, longitude 116.4°W). They are a considerable distance apart, and somewhat distant from the test site, but it is difficult to find water bodies in the southern Californian deserts! One is forced, therefore, to rely upon the assumption that the airmass over the test site is the same as that over the lakes. In most areas where water bodies are more common and hence closer to the site this is a quite reasonable assumption. Here one may argue otherwise, but no simple operational alternative exists.

AIRPATH is calculated from the airborne data over the lake by the following steps.

1) Calculate the mean and $\pm 1\sigma$ spectra for the (LAKE) airborne data. Calculate lake brightness tem-

[5] Operational rms voltage measurements ("noise") were made on the IR spectrometer output (with the CVF wheel stopped), as follows. MX 108, flight 1. Pre-flight—on ground 20 mV. 1915 GMT—over water 25 mV. MX 108, flight 3. Over Mono Lake, 1641 GMT 24 mV. Over Mono Lake, 1940 GMT 24 mV.

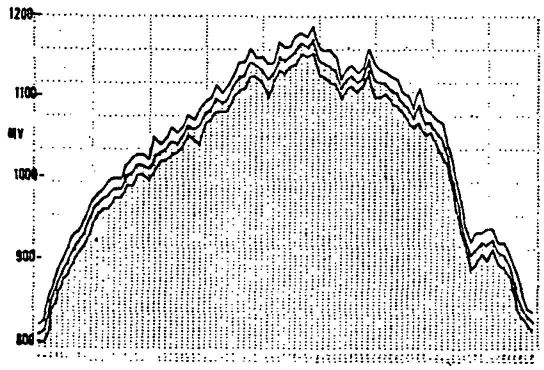

Fig. 7. Observed radiance spectrum from Palmdale Lake, $N=30$, $\sigma=14.7$ mV, $\bar{X}=1010$ mV. Brightness temperature of the lake is expressed as $T_L=30$°C, calculated from $\bar{X}$. Mean spectrum radiance, $\pm 1\sigma$ limits shown. Times from 17:12:38.495–17:12:52.400 GMT, mission 108, flight 1. Dewpoint−6°C; air temperature 23°C; RH 14 percent; radiometer $T_L(R)=30.5$°C.

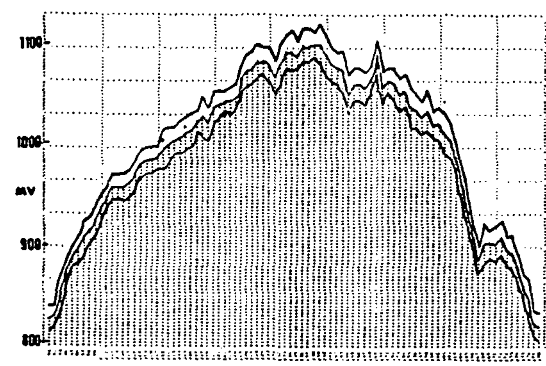

Fig. 8. Observed radiance spectrum from Shallow Lake, $N=26$, $\sigma=17.7$ mV, $\bar{X}=1000$ mV. Brightness temperature of lake $T_L=30$°C. Times from 19:16:20.898–19:16:28.470 GMT, mission 108, flight 1. Dewpoint−6°C; air temperature 27°C; RH 10 percent; radiometer $T_L(R)=33$°C.

TABLE III

Tabulated Reduced Data

Stanford/MSC Mission-108, Flight 1 (Pisgah, Site 2), Oct. 8, 1969						
GMT Time		N	Signal Mean (mV)	Std. Deviation[a] (mV)	Rel. Error[b]	Temperature by Spectrometer
	Pre-Flight					
1518	40°C BB-EXT	22	669	13	0.0043	40°C[c]
1516	rock A	30	569	15	0.0048	43
1517	rock B	30	595	15(20)[f]	0.0046	42
	In-Flight					
1712	Palmdale lake	30	1010	15	0.0027	30°C
1915	Shallow lake	30	1000	18(25)[f]	0.0033	30
	Post-Flight					
2121	40°C BB-EXT	25	693	19	0.0055	39°C
2120	rock A	36	512	22	0.0072	45
2120	rock B	28	568	24	0.0080	43
Stanford/MSC Mission-108, Flight 3 (Mono, Site 3), Oct 10, 1969						
GMT Time		N	Signal Mean (mV)	Std. Deviation (mV)	Rel. Error	Temperature by Spectrometer
	Pre-flight					
1423	40°C BB-EXT	30	664	16	0.0042	40°C[c]
1422	rock A	30	569	15	0.0048	43
1424	rock B	30	593	15	0.0046	42
	In-Flight					
1642	Mono Lake run 401	30	987	19(24)[f]	0.0034	30°C[d]
1943	Mono Lake run 402	30	1080	17(24)[f]	0.0029	27[e]

[a] Standard Deviation (σ) is defined as

$$\sigma = \sqrt{\frac{(X-\bar{X})^2}{N-1}}.$$

[b] Relative error is defined as

$$E = \frac{\sigma}{\bar{X}\cdot\sqrt{N}}.$$

[c] By definition, and used as a calibration point for temperature.
[d] West side.
[e] East side.
[f] Actual measured rms values in parentheses. See footnote 5.

perature (T_L), using the radiometer data, i.e., with broader bandpass. This unit was also recalibrated during the pre-flight period [4].

2) Correct the mean lake spectrum for the known spectral emittance for water (ϵ_λ) [6].

3) Divide the correct (observed) lake spectrum by the product of a calculated blackbody radiance spectrum for that temperature (T_L) and SPECTRAN ($A\tau_\lambda$). This modifies the blackbody radiance as though it had been observed through the instrument. If the lake had been at 40°C one could use the observed spectrum from the external 40°C blackbody. Generally, however, the lake temperatures are much lower (27–30°C), and hence their radiance must be calculated.

$$\text{AIRPATH} = \frac{\text{expected radiance}}{\text{actual radiance}} = \frac{\text{LAKE calculated}}{\text{LAKE observed}}$$

then

$$\text{AIRPATH} = \frac{(N_{BB\lambda}, \text{ at } T°_L) \times A\tau_\lambda \times \epsilon_\lambda}{\text{LAKE}_\lambda}. \quad (3)$$

AIRPATH is an absorbance-like ratio which ranges from 0.84 to 0.96 with 10 to 12 sharp maxima. These are

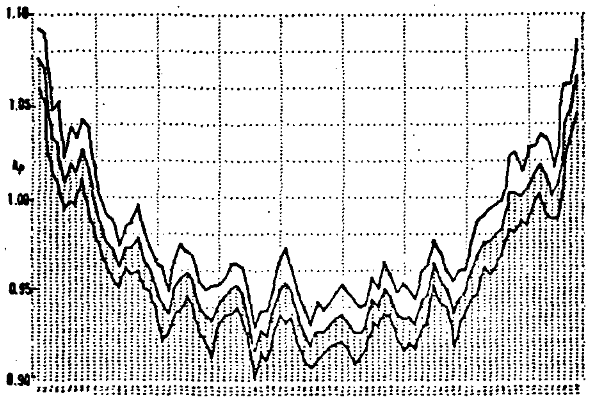

Fig. 9. AIRPATH, or atmospheric absorption ratio spectrum, from Palmdale Lake spectra, after removal of the optical transfer function. Mean airpath $(\bar{A}p)=0.96$, $\bar{\sigma}_{Ap}=0.014$

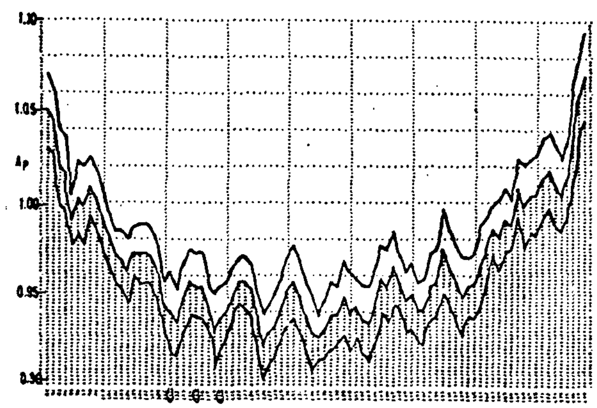

Fig. 10. AIRPATH, from Shallow Lake. Mean airpath $(\bar{A}p)=0.96$, $\bar{\sigma}_{Ap}=0.017$.

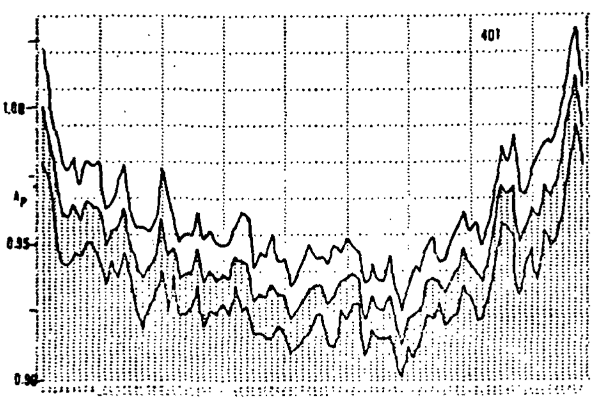

Fig. 11. AIRPATH, from Mono Lake 401 (site 3), flight 3, mean airpath $(\bar{A}p)=0.962$, $\bar{\sigma}_{Ap}=0.018$, $N=30$, $T_L=30°C$, times from 16:42:08.098–16:42:22.972 GMT. Dewpoint −15°C; air temperature +11°C; RH 15 percent.

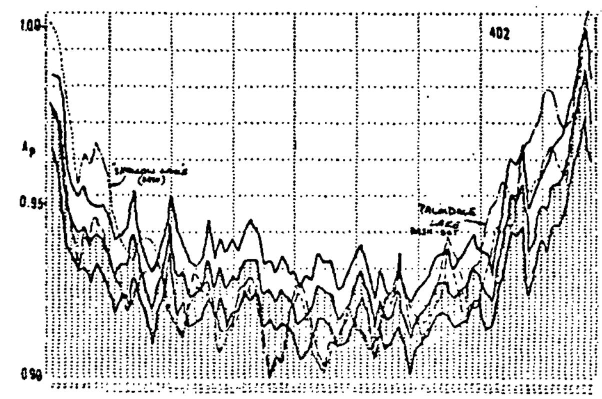

Fig. 12. AIRPATH, from Mono Lake 402 (site 3), flight 3, mean airpath $(\bar{A}p)=0.950$, $\bar{\sigma}_{Ap}=0.015$, $N=30$, $T_L=27°C$, times from 19:43:55.112–19:44:14.813 GMT, first 30 spectra used. Dewpoint −19°C; air temperature 10°C; RH 12 percent.

generally in the positions of the atmospheric absorption/emission bands, but may be more exactly caused by the high frequency components in the pre-flight calibration spectra which were ratioed to the lake spectra (Figs. 9–12). As might be expected, for a 2000-ft path in a low[6] humidity (desert) area, these absorptions are not strong between 7.5 and 13 μm. It is significant that both lakes surveyed this day showed very similar patterns with maxima at the same data points. On a subsequent flight (day 3) over Mono Lake several hundred miles to the north, both patterns for AIRPATH were again similar (Figs. 11 and 12), but differences exist between the flight 1 and flight 3 pairs.

Rock Standards—Operational Format

The pre-flight spectra from the two polished rock standards are shown in Figs. 13 and 14 with the mean and 1σ limits plotted. Immediate inspection reveals that they have different shapes as expected; rock A having two maxima at longer wavelengths than the more pronounced single peak for rock B.

At first glance the curves appear to be the inverse of what one would expect from emittance data. A moment's reflection, however, will show that if ϵ_λ is lower at a given point it will appear to have a lower (*colder*) brightness temperature. As we are using a hot internal reference blackbody (60°C) these regions will show a greater radiance difference, and hence a higher millivolt level, for low ϵ_λ regions. In effect, the raw plots are reflectance not emittance spectra.

For rapid checking of the data either this form of presentation or its exact inverse (FLIPPED) will suffice. For most operational use we do not go through the calculations for absolute emittance detailed below, but merely "flip" the data sets. All airborne spectra of the terrain are presented in this inverted form for subsequent statistical processing [7].

Rock Standards—Absolute Emittance

The absolute emittance from rocks A and B may be calculated by the following steps.

1) Prepare a mean and $\pm 1\sigma$ average rock A spectrum from the pre- and/or post-flight data (usually $N=30$). Determine the average brightness temperature from these spectral levels, e.g., $\bar{X}=593$ mV. Therefore, target brightness temperature was $T_A=42°C$.

2) Using the spectral transfer function $(A\tau_\lambda)$, transform the mean spectrum, wavelength interval by wave-

[6] Dewpoint −6°C, aircraft air temperature +23°C.

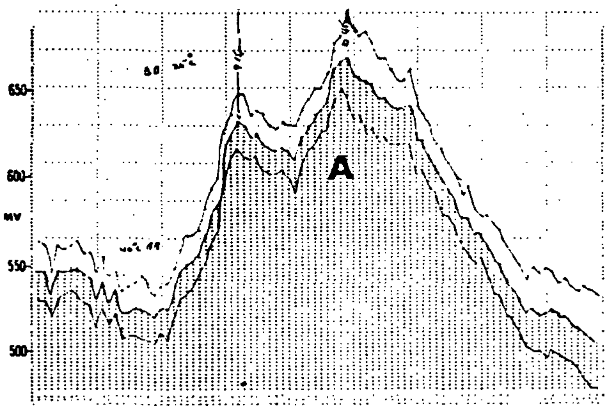

Fig. 13. Rock A mean spectrum for the gabbro slab at $T=43°C$, $N=56$, from raw (i.e., unsmoothed) *pre-flight* data, flight 1. Times are from 15:16:42.190–15:17:00.963 GMT. Peaks are seen at 122 (626 mV) and 139 (660 mV) data points. Radiance levels at data point 108 would approximate that from a 40°C blackbody target, at 139 would be that of a 25°C blackbody. This is indicative of the changing spectral emittance.

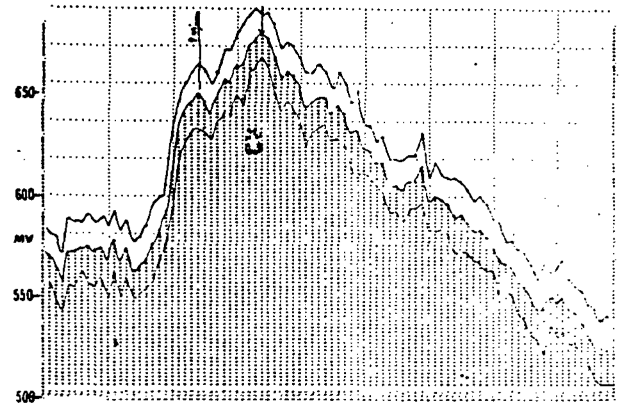

Fig. 14. Rock B mean spectrum for the granodiorite slab at $T=42°C$, $N=43$, from raw *pre-flight* data, flight 1. Times are from 15:17:10.651–15:17:23.674 GMT. Peaks are now at 114 (643 mV) and 124 (673 mV), much shorter wavelengths than for rock A.

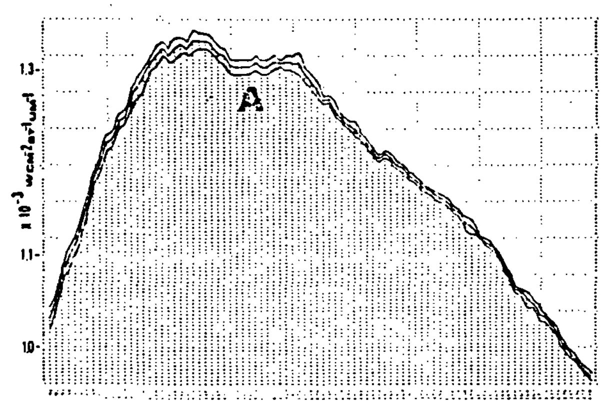

Fig. 15. Radiance mean spectrum ($\pm 1\sigma$) for rock A, pre-flight data, flight 1, for the above times (Fig. 13): Ordinate is now in $W \cdot cm^{-2}\ sr^{-1}\ \mu m^{-1}$, after conversion from millivolts using optical transfer function $(A\tau_\lambda)$. $T_A=43°C$, spectrometer.

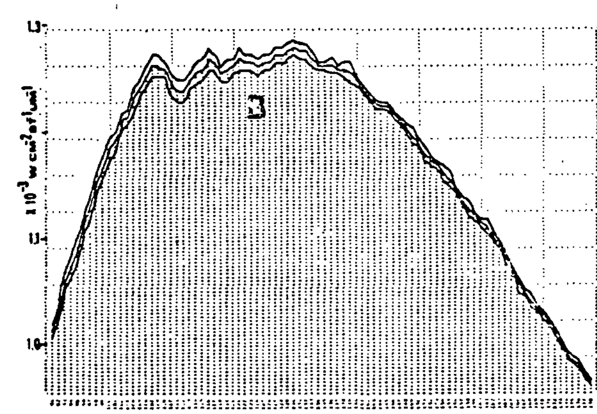

Fig. 16. Radiance mean spectrum ($\pm 1\sigma$) for rock B, pre-flight data, flight 1, for the above times (Fig. 14). Ordinate is now in $W \cdot cm^{-2}\ sr^{-1}\ \mu m^{-1}$. $T_B=42°C$, spectrometer.

length interval, into a radiance spectrum, i.e., transform millivolts to $W \cdot cm^{-2}\ sr^{-1}\ \mu m^{-1}$. In a similar manner one can transform the standard deviation spectra as well. This is plotted in Figs. 15 and 16 for rock A and B as *radiance* spectra.

3) Using the observed target brightness temperature (as above, of 42°C) calculate from the Planck Law, again one wavelength interval at a time, the expected radiance for the target, assuming now that it is a blackbody.

4) Divide the "observed" radiance spectrum by the calculated blackbody radiance spectrum to generate an emittance spectrum, Figs. 17 and 18. By the initial assumption of $\overline{T} \propto$ average brightness temperature this yields emittance values above 1.0. These then can be normalized to unity and the average "absolute" emittance recalculated.

Two items should be noted here. Inspection of Figs. 15 and 16 reveals the very small departures from blackbody behavior on which this geological experiment is based. Figs. 17 and 18 are therefore magnifications of the ϵ_λ ratios, and in this light the $\pm 1\sigma$ variations in the airborne data are strikingly small. As geologists rather than physicists we are not as concerned with the absolute levels in our data as with the homogeneity of the spectral data and its variability from one rock type to another. The strictly geological problems with this experiment are many and real, and added refinements in computational technique are premature at this stage.

Conclusions

1) Optical transfer functions for a spectrometer have been calculated from operational field-type measurements.

2) Standardized rock slabs with known spectral emittance below 1.0 have been used in the pre- and post-flight calibrational steps in a routine manner. From these data one may ascertain if the spectrometer and data system are functioning correctly, i.e., that a known spectrum can be recovered from the taped data record.

3) In-flight calibrations of wavelength can be readily obtained by inserting polystyrene into the optical train.

4) Atmospheric "absorption spectra" can be obtained in the airborne mode by flying over lakes within

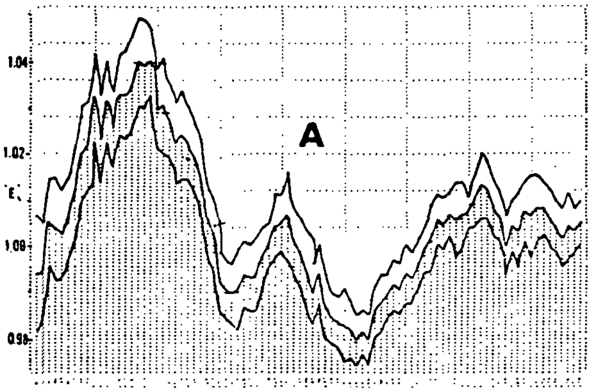

Fig. 17. Calculated "emittance" ratio for rock A target relative to a blackbody at the same *average* brightness temperature. Mean and $\pm 1\sigma$ limits shown. Average emittance = 1.00 by assumption, $\epsilon_{max} = 1.04$ (108), $\epsilon_{min} = 0.98$ (144). When normalized so that the $\epsilon_{max} = 1.00$, then $\epsilon_{min} = 0.94$.

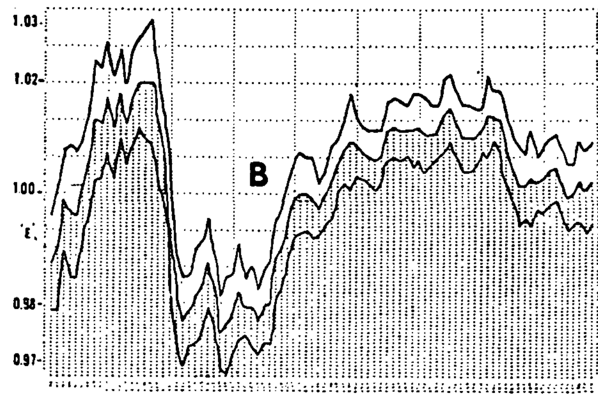

Fig. 18. Calculated "emittance" ratio for rock B. Mean and $\pm 1\sigma$ limits shown. Average emittance = 1.00 by assumption, $\epsilon_{max} = 1.02$ (106), $\epsilon_{min} = 0.97$ (118). When normalized so that $\epsilon_{max} = 1.00$, then $\epsilon_{min} = 0.95$.

or nearby the geological test site. These spectra have many of the characteristics of true atmospheric spectra of a short airpath (around 2000 ft) in a low humidity area. Additional work is necessary to confirm this interpretation or to support the possibility that they are artifacts of the ratioing of airborne data (which appear somewhat smoothed) to those of ground-based data which are more spiked.

5) In-flight spectral data over geological targets are being analyzed, and will be reported elsewhere [7]. Considerable careful study needs to be made, both of the airborne data as well as spectral emittance variabilities within a single rock type in the field. This should be tackled by ground-based mobile instrumentation as well as airborne to define the inhomogeneity of the basic target and separate this effect from artifacts of airborne measurements. Only then can we assess the "noise" uncertainties we presently perceive.

Acknowledgment

Without the careful attention to the many details of calibration, before and after the flights and during the airborne data-gathering, shown by the flight crews of NASA 927 P3A aircraft and especially during mission 108, these data could not have been given meaningful analysis. We would like to specifically mention O. Smistad, Manager, and J. Mitchell, Mission Manager, respectively, Aircraft Project Office, MSC. The infrared pallet operator H. Coppedge was most closely concerned with the calibration and data collection and his consistent attention to the experiment, specifically in the pre- and post-flight periods, is gratefully acknowledged. The contributions of J. Cobb, pilot of the P3A aircraft, and of T. Barnett, MSC Cognizant Scientist for this experiment, are greatly appreciated. A. Marshall developed the computer programs for the computations and the plotting aspects. D. Fain critically reviewed the manuscript and made several important remarks which have been incorporated into this text.

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[2] R. J. P. Lyon and J. Patterson, "Infrared spectral signatures—A field geological tool," *Proc. 4th Symp. Remote Sensing of Environment* (University of Michigan, Ann Arbor), Apr. 1966, p. 215-230.

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[5] *Remote Multispectral Sensing in Agriculture*, Res. Bull. 844, ch. III—"Measurement (field spectroscopy)," Sept., 1968, Lab. Agricultural Remote Sensing (LARS), Purdue University, Lafayette, Ind., p. 68-71.

[6] E. D. McAlister, unpublished data, 1951-1952, now reproduced as Figure 5-89 in *Handbook of Military Infrared Technology*, W. L. Wolfe, Ed., Supt. of Pub. Documents, U. S. Govt. Printing Office, 1965, pp. 1-905.

[7] R. J. P. Lyon, "Comparison of airborne infrared spectral emittance and radar scatterometer data from Pisgah Crater lava flows," to be presented at the 7th Symp. on Remote Sensing of Environment, Ann Arbor, Mich., May 17-21, 1971.

Reprinted from IEEE TRANSACTIONS ON *GEOSCIENCE ELECTRONICS*
Volume GE-9, Number 3, July, 1971
pp. 131-138

3. Generation of Emittance Spectra - 1972 Procedures

(a) Airborne Spectra

The basic data obtained from the digital tapes is a set of voltages digitized at a corresponding set of wavelengths provided by NASA in previous calibration work. These voltages must then be converted with the aid of several calibration and normalization procedures into a form which resembles true emittance spectra.

The voltage generated by the spectrometer, as a function of the spectral radiance incident on the spectrometer (N_{sp}), is dependent upon the temperature and thus the emitted spectral radiance of the internal reference blackbody $N_{bb}(T_{int})$ and the instrument transfer function At.

$$V = At\ (N_{bb}(T_{int}) - N_{sp})^{*} \qquad (1)$$

In general N_{sp} is made up of two contributions

(a) The radiance emitted by the surface as it is attenuated by the atmosphere ($N_{sur}\ \tau$) and

(b) The emittance of the atmosphere ($(1-\tau)\ N_{bb}(T_{sky})$ assuming uniform composition and temperature distribution over the observing path length). Thus the output volts given by

$$V = At\ (N_{bb}(T_{int}) - (1-\tau)\ N_{bb}(T_{air}) - \tau N_{sur}) \qquad (2)$$

To use the above equation three pieces of information are required to solve for N_{sur} in terms of the output voltage. However, in studies involving relatively short paths (less than or equal to 2000 feet) and involving warm rocks (approximately 40°C) we have

$$N_{sur} > N_{bb}(T_{atm}) \text{ and } (1-\tau) << \tau$$

Thus we can simplify Equation 2 to give

$$V = At\ (N_{bb}(T_{int}) - \tau\ N_{sur}) \qquad (3)$$

In the ground based calibration work at very short path lengths At and τ_g were determined by the observation of two blackbodies, one at 40°C and the other at ambient temperature. Equation 3 could then be solved for the two functions At and τg.

---

*All quantities mentioned are functions of wavelength.

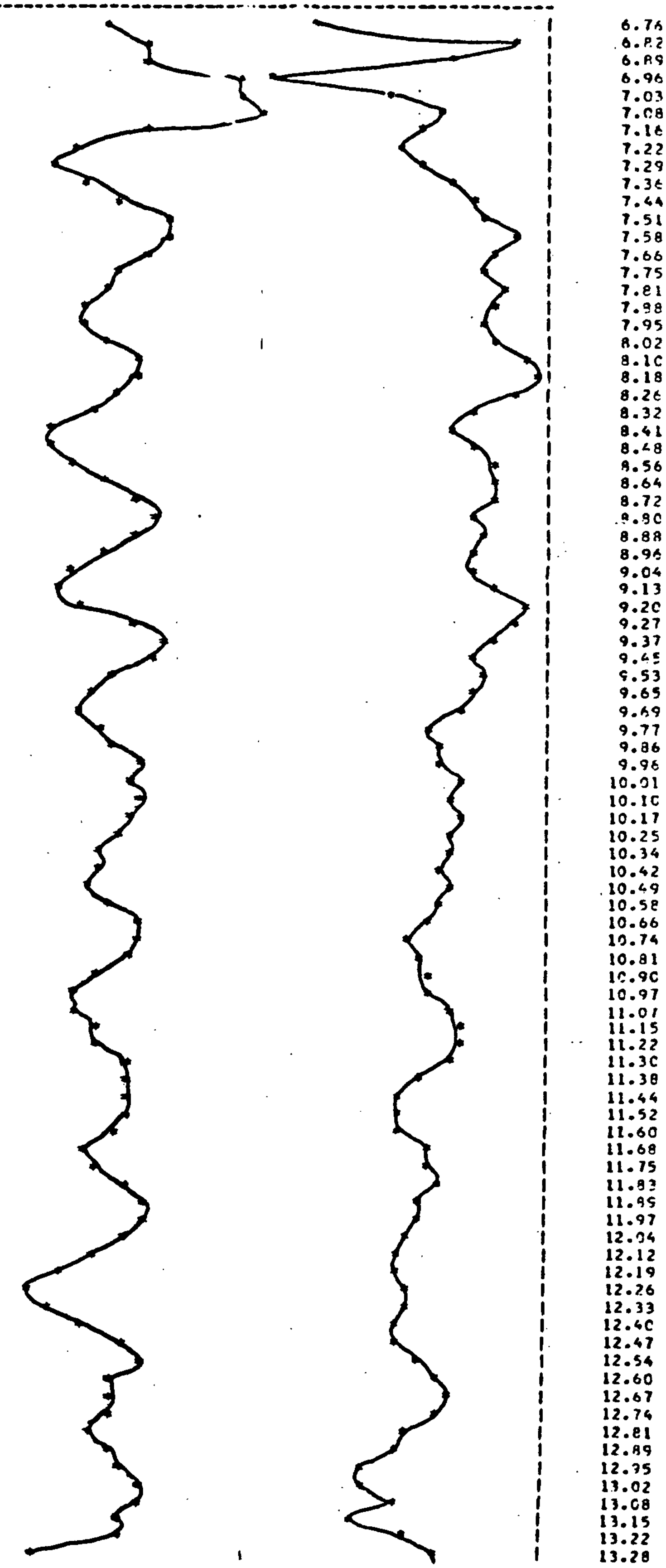
Of the two 40° blackbody measurements made on the day of the measurements over Pisgah Crater, it was found that the pre-flight 40° blackbody spectrum had a large amount of periodic noise (approximately 60 HZ) superimposed on the blackbody curve (see Fig. A1). Until this was realized flight spectra calculated using this measurement as a calibration were found to be seriously perturbed, the effect of which was masked in the normalization process used at the time. Thus in all successive calculations the post-flight 40° blackbody data were used in the instrument transfer function calibrations.

With the knowledge of At it was then possible to calculate the spectral radiance reaching the spectrometer during the flights over Pisgah Crater and during the calibration flight over Shallow Lake. The spectrum of spectral radiances recorded off Shallow Lake were then examined and a radiant temperature computed for each of the wavelengths at which measurements were taken. The wavelength at which a maximum blackbody temperature (T_{max}) was found was then selected and the temperature of the Lake was then taken to be this radiant temperature. This is equivalent to assuming that at one of the wavelengths measured the atmosphere had a transmission equal to 1.0. The atmospheric transmission at all other wavelengths was then computed assuming that the radiant energy leaving the lake's surface at this wavelength was that of a blackbody of temperature T_{max}.

These atmospheric transmissions were then used to compute the surface spectral radiance over Pisgah Crater. The wavelength dependence of this radiance was then examined and the wavelength within each recorded spectrum showing the maximum radiant temperature was again selected. The resulting radiant temperature was then assumed to be the rock temperature and the emissivity of the rock at the various wavelengths was formed by taking the ratio of the calculated surface radiance to the blackbody radiance at this maximum temperature. The previously

Figure A1

Preflight blackbody emittance spectra. Here the preflight calibration spectra have been treated in the same way as the rock samples. The upper curve is the Preflight 40°C Blackbody, the lower the Preflight Ambient Blackbody. The hot blackbody shows definite periodic noise which makes it unsuitable for calibration purposes.



selected groups of spectra were then separated and overall emittance spectrum for each geologic unit was computed, as well as the standard deviations at each wavelength.

b. Ground Measured Spectra

All the ground based measurements of rock emission spectra have been made with an Exotech Model 10 Spectrometer. The design of this instrument is essentially the same as that of spectrometer in the infrared pallet except that the reference blackbody is at ambient temperature in contrast to the 60°C blackbody in the infrared pallet.

Calibration measurements to determine the instrument transfer function were made using a water heated blackbody source while wavelength calibration was obtained with polystyrene transmission spectra.

The rock samples were observed at ambient temperature outside the laboratory in order to simulate as closely as possible practical remote sensing conditions. As these samples were mostly freshly broken rock, their reflectance can be much greater than the rocks observed in the airborne mode. Thus the contribution of a reflected sky spectrum in the data can not be ignored if similar measurements are to be made with the object of determining mineral content.

The data reduction procedure used in this analysis is a simplified form of that discussed for the airborne spectra. Thus the negligible path length enables one to make the approximation $N_{sur} = N_{sp}$. In the rest of the calculation the method is identical.

4. Generation of System Responses Simulating MSDS Scanner Outputs

The voltage (E) produced by any selected filter-detector combination in the infrared scanner is dependent upon the spectral response of this system ($\phi(\lambda)$) and upon the energy incident upon the filter and is given by

$$E \propto \int_{\Delta\lambda} \phi(\lambda)\, N_{sp}(\lambda)\, d\lambda \qquad (4)$$

In this analysis the spectral responses of the MSC multi-spectral scanner (MSDS) and the University of Michigan Scanner (see Figure A2)

Figure A2(a)

Spectral Responses of the MSDS Scanner

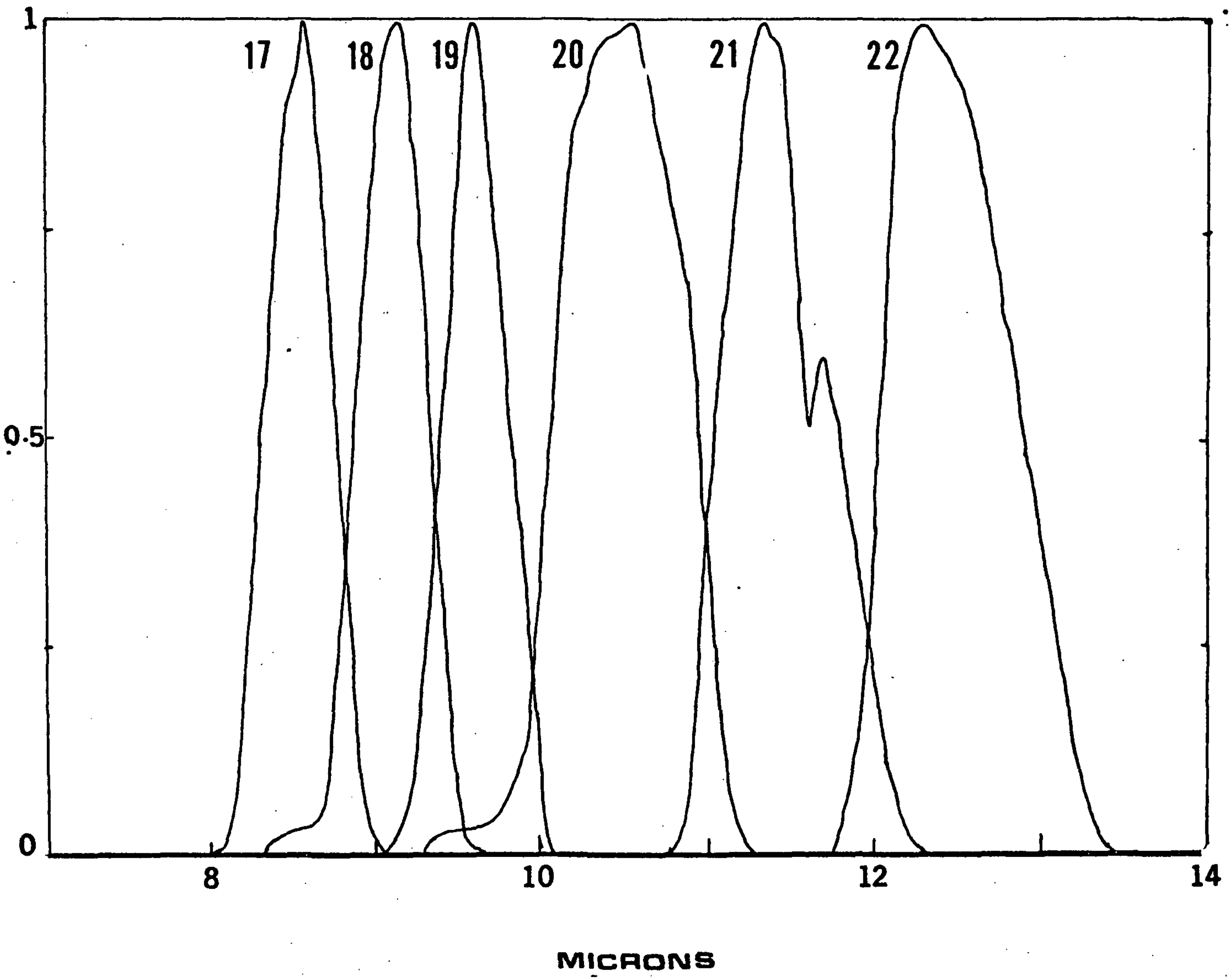
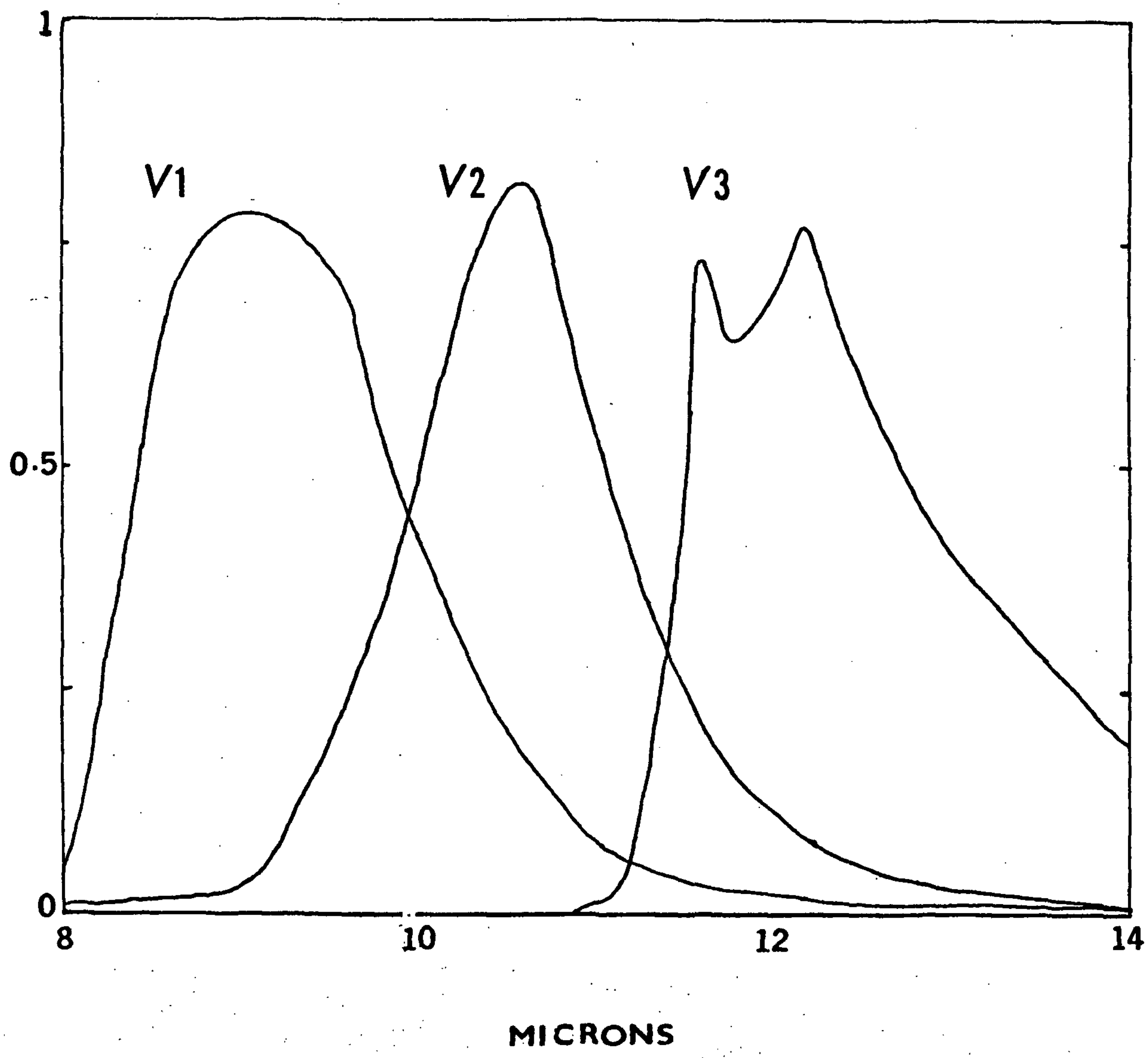


Figure A2(b)

Spectral Responses of the University of Michigan Scanner



were digitized at the same wavelengths at which the spectra over Pisgah Crater had been recorded, and the responses determined as if the MSDS were flying rather than the IR pallet in MX108. They were computed using Equation 5,

$$E = \Sigma \phi_i N_{sp} (\lambda_i) \qquad (5)$$

using the radiance calculated as that incident at the spectrometer in the flights over Pisgah Crater. These spectral responses contain brightness temperature information, that is, they vary with their true temperature and their emittance. They differ thus from the spectral emittance normally used which have been corrected for temperature effects.

The system responses and the various ratios which can be formed from them are given in the appendix.

5. BMDO7M Analysis of Data-MX108

The BMDO7M stepwise discriminant analysis program was used to test several types of data derived from the airborne radiance measurements of MX108. The following transforms were used as "variables",

1. 50 centermost wavelengths, in the spectral emittance curves.
2. System Responses (9), from the three channels used by Vincent and the 6 from the MSDS Scanner.
3. Ratios (18), from
   (a) Vincent's channels (3), and
   (b) MSDS channels (15)

(To reduce the calculations cross ratios between channels in (a) and (b) systems were not made. These, of course, can be theoretical ratios only.)

Table A1 shows these variables in detail.

Table A2 indicates the sequential success using the BMDO7M analysis on the two "end-member" terrain types - mixed terrains (dry lake sediments, alluvium and a lava) and "all lava" terrains. The success, by rock type, is listed in detail in Appendix Table D5.

Table A3 examines the sequence of variables chosen by the program, for analysis of each terrain, and by "method". The ranking in the initial or zero-step of BMDO7M is quoted, that is, the "redundant" data is still included. When BMDO7M selects its variable for the second and successive step this redundancy is minimized. It is unclear yet whether this is a desirable or undesirable concept.

Figures A3 - A5 show the discriminant plots from the BMDO7M analysis for the mixed terrain; A6 - A8 are for the all lava terrain.

TABLE A1

VARIABLES USED IN BMDO7M ANALYSIS

A. "50 Central Wavelengths"

#1 = 8.100 μm

#50 = 11.970 μm

B. System Responses

1 :	Vincent #1 (V1)	6 :	19
2 :	V2	7 :	20
3 :	V3	8 :	21
4 :	MSDS #17	9 :	22
5 :	18		

C. Ratios

1 :	V1/V2	10 :	18/20
2 :	V1/V3	11 :	18/21
3 :	V2/V3	12 :	18/22
4 :	MSDS 17/18	13 :	19/20
5 :	17/19	14 :	19/21
6 :	17/20	15 :	19/22
7 :	17/21	16 :	20/21
8 :	17/22	17 :	20/22
9 :	18/19	18 :	21/22

TABLE A2

PERCENTAGE CORRECTLY IDENTIFIED IN TRAINING SET (BMDO7M)

Mixed Terrain		All Lava Terrain	
Dry Lake Seds. A	(53)	Lava Phase I*	(35)
Alluvium A	(27)	Phase II	(62)
P-Train Lava III	(31)	Phase III	(65)
	111 spectra		162 spectra

	Mixed Terrain 1 Step	2 Step	3 Step	9 Step	All Lava Terrain 1 Step	2 Step	3 Step	9 Step
A. Normal Method (Spectral Emittance)								
1. 50 Central λ's	66	70	69**	89	45	49	53	59
B. Systems Responses								
1. Vincent's - 3	90	93	97	--	59	61	60**	--
2. MSDS - 6	90	95	99	--	46	60	63	--
C. Ratios of Channel Outputs								
1. Vincent's - 3	86	84**	--	--	41	51	--	--
2. MSDS - 15	58	77	--	--	45	46	--	--

*Phase I Lava = (IE + IK)

Phase II Lava = (IIA + IIB + IIC + IID + IIF)

Phase III Lava = (IIIA + III-TRAIN + IIIG + IIIH)

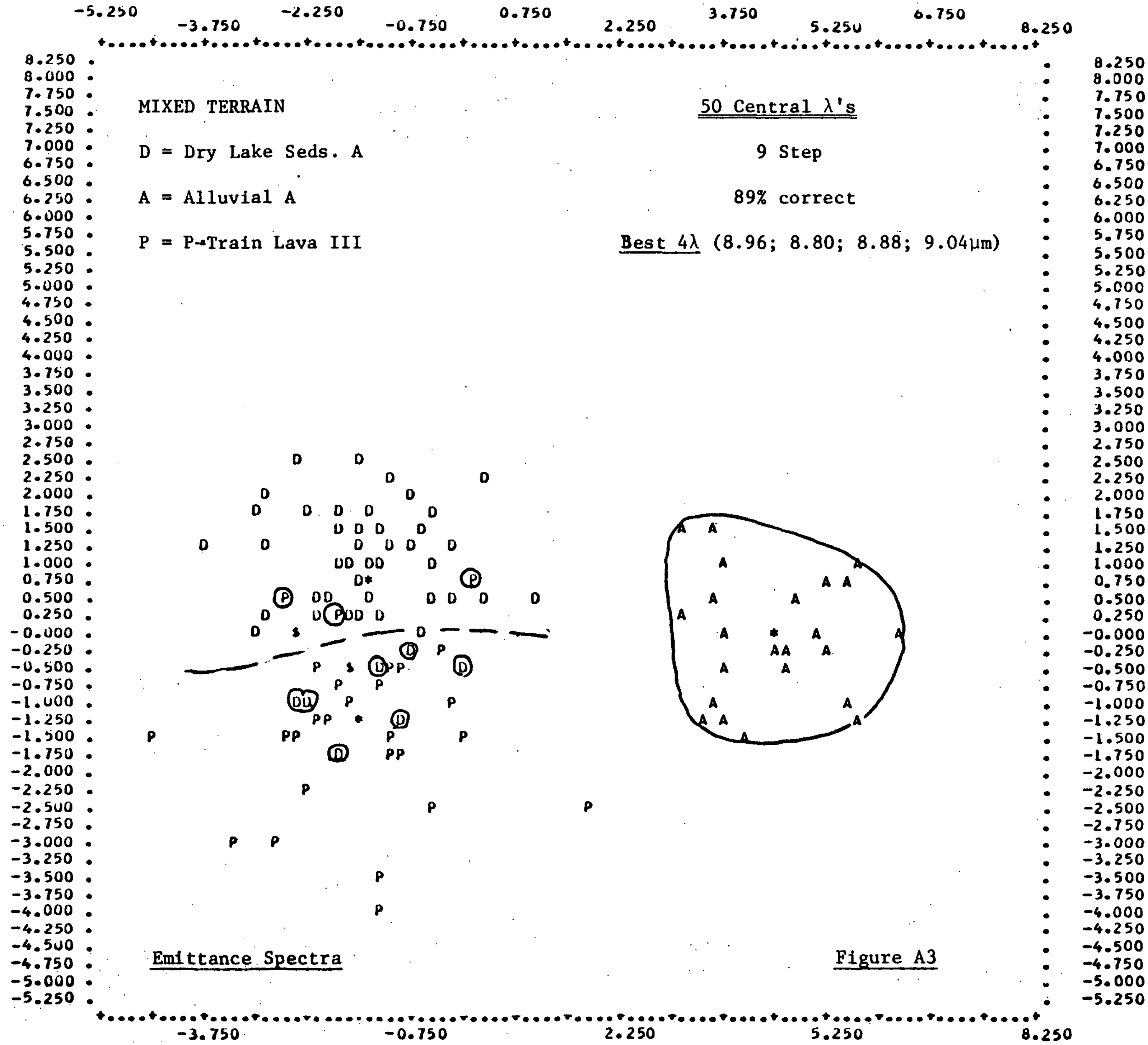
**Success can oscillate with increased stepping

TABLE A3

INITIAL RANKING OF FIRST FOUR VARIABLES CHOSEN

(Zero-Step of BMD07M)

	Mixed Terrain	All Lava Terrain
A. EMITTANCE SPECTRA	SEQUENCE	SEQUENCE
50 Central λ's	8.96; 8.80; 8.88; 9.04 μm	11.75; 11.83; 11.07; 10.97
B. SYSTEM RESPONSE		
Vincent's - 3	V1; V3; V2; --	(V1 = V2 = V3) --
MSDS - 6	18; 17; 22; 21	17; 20; (21 = 22)
C. RATIOS		
Vincent's - 3	V1/V2; V1/V3; V2/V3; --	(V1/V2 = V1/V3) V2/V3 --
MSDS - 15	18/19; 18/20; 18/21; 17/21	17/18; 17/22; 17/21; 17/19


MIXED TERRAIN
D = Dry Lake Seds. A
A = Alluvial A
P = P-Train Lava III
50 Central λ's
9 Step
89% correct
Best 4λ (8.96; 8.80; 8.88; 9.04μm)
Emittance Spectra
Figure A3

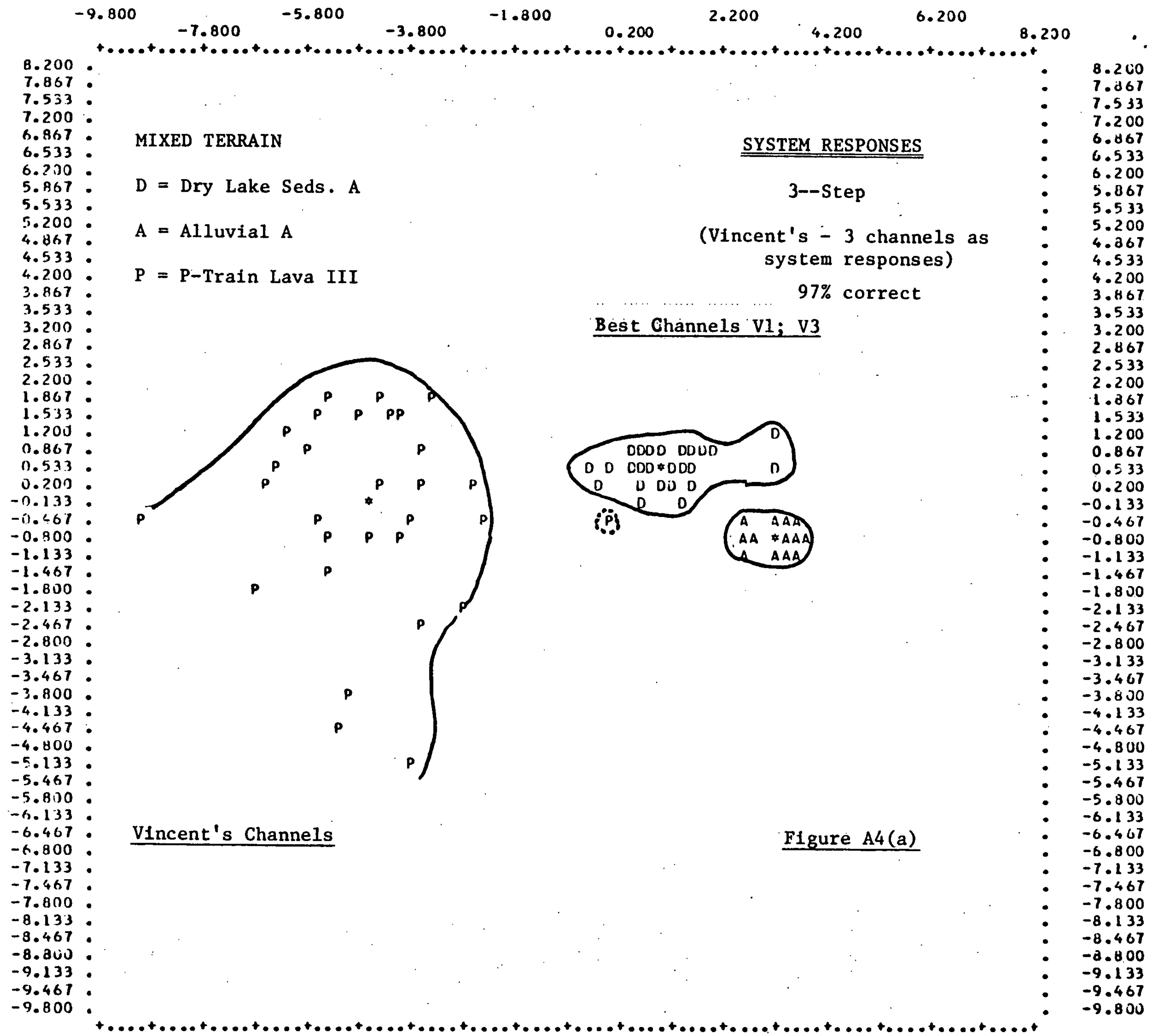

MIXED TERRAIN
D = Dry Lake Seds. A
A = Alluvial A
P = P-Train Lava III
SYSTEM RESPONSES
3--Step
(Vincent's - 3 channels as system responses)
97% correct
Best Channels V1; V3
Vincent's Channels

Figure A4(a)

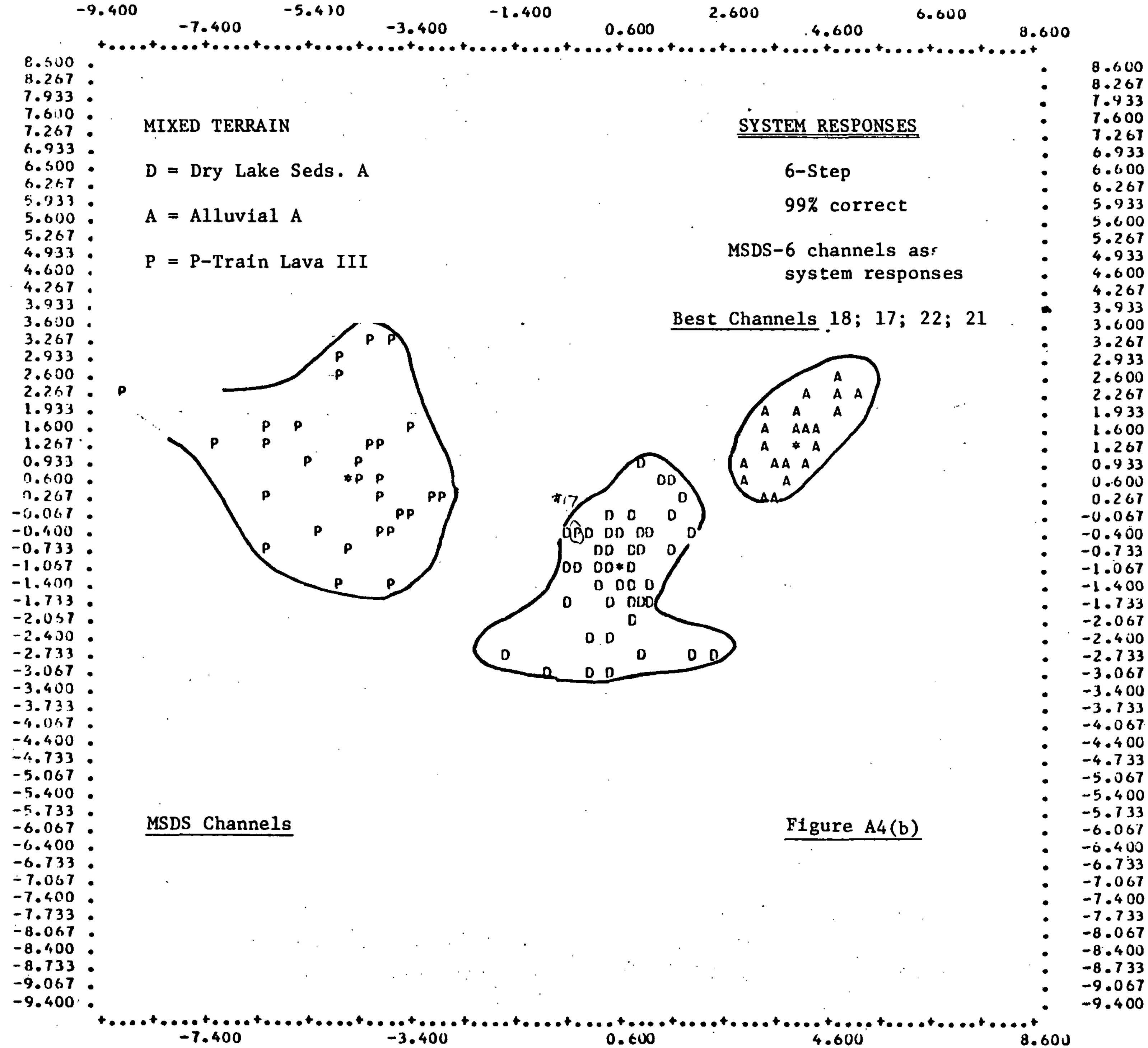

MIXED TERRAIN
D = Dry Lake Seds. A
A = Alluvial A
P = P-Train Lava III
SYSTEM RESPONSES
6-Step
99% correct
MSDS-6 channels as system responses
Best Channels 18; 17; 22; 21
MSDS Channels

Figure A4(b)

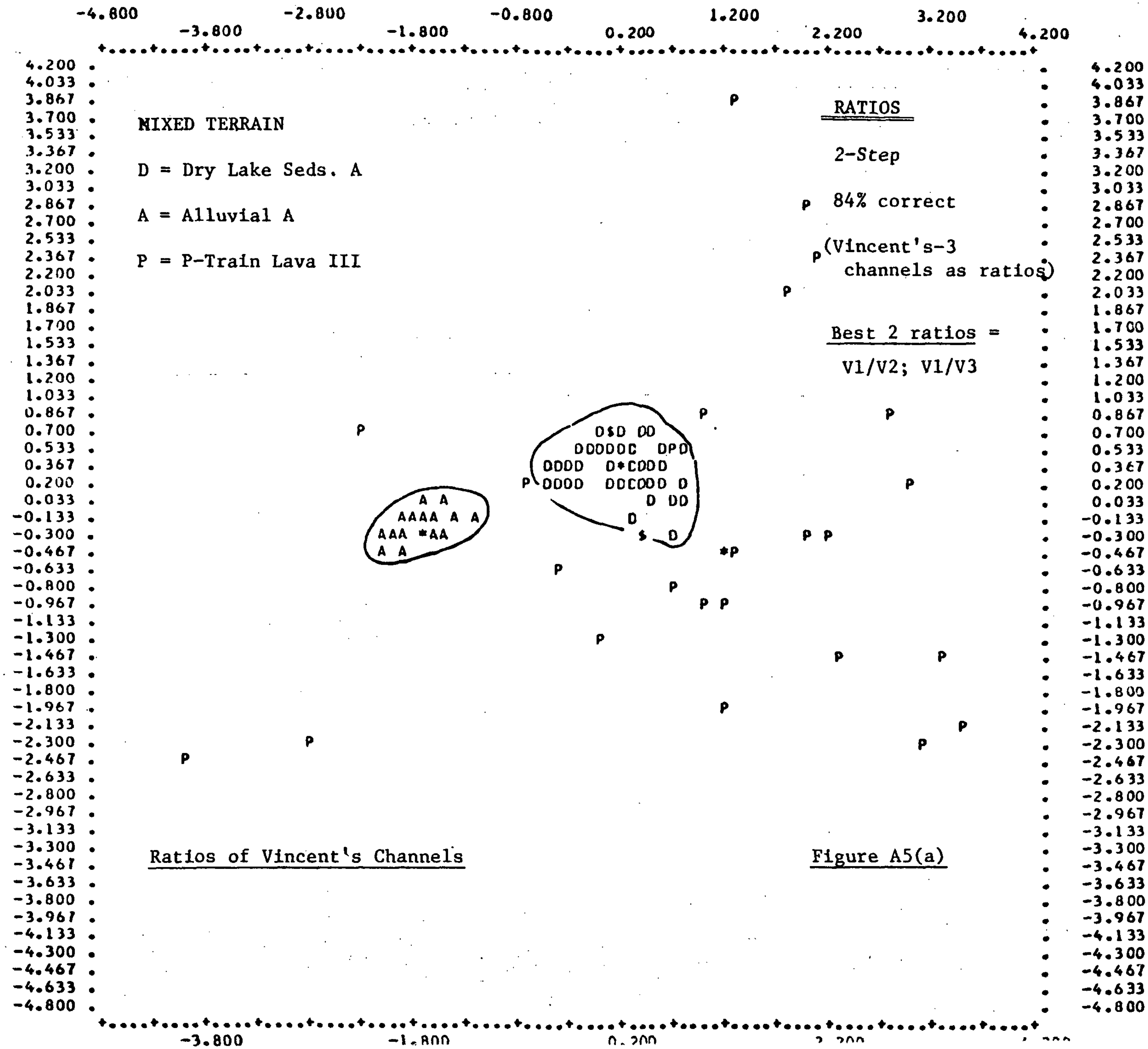

MIXED TERRAIN
D = Dry Lake Seds. A
A = Alluvial A
P = P-Train Lava III
RATIOS
2-Step
84% correct
(Vincent's-3 channels as ratios)
Best 2 ratios =
V1/V2; V1/V3
Ratios of Vincent's Channels

Figure A5(a)

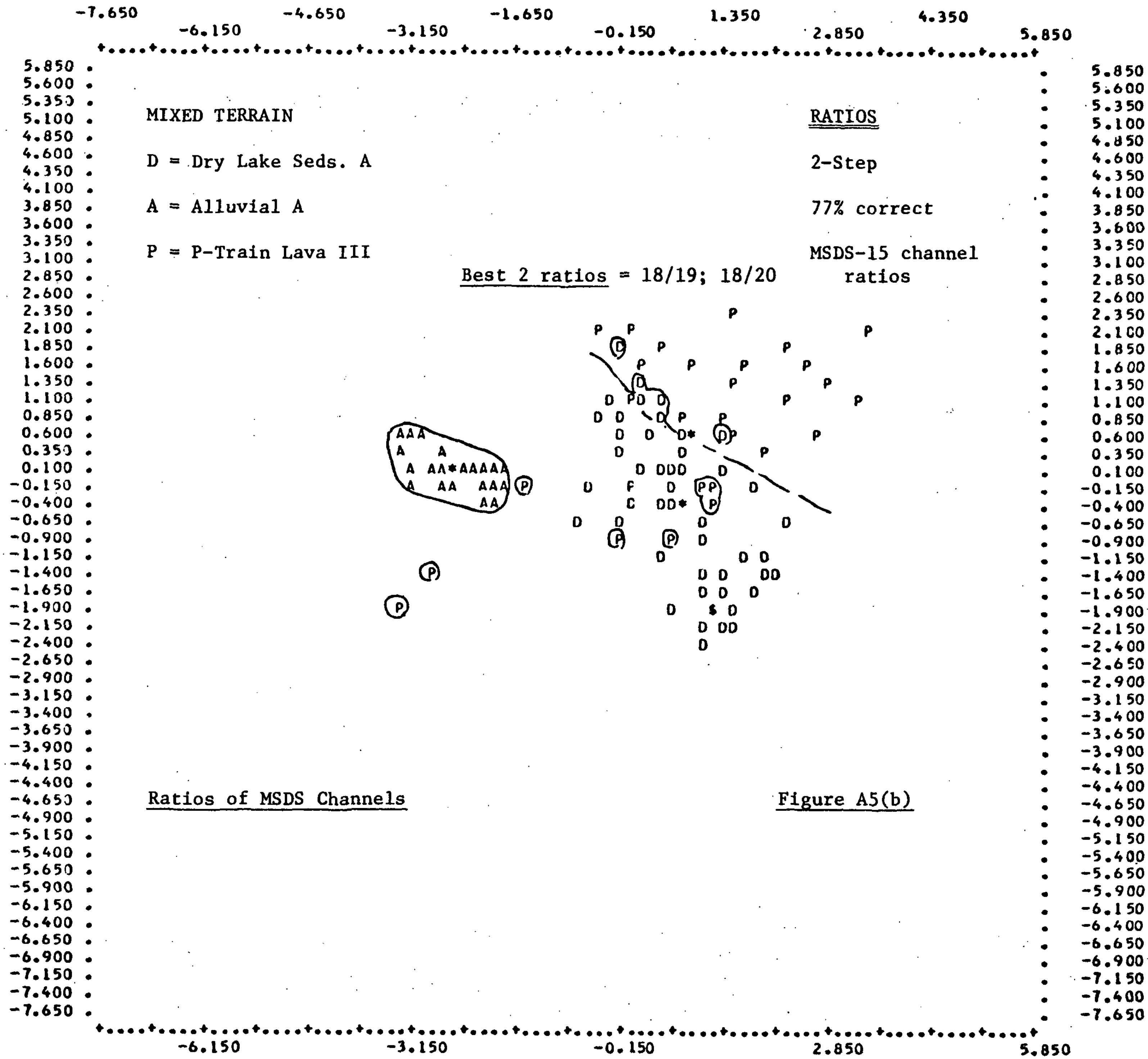

MIXED TERRAIN
D = Dry Lake Seds. A
A = Alluvial A
P = P-Train Lava III
RATIOS
2-Step
77% correct
MSDS-15 channel ratios
Best 2 ratios = 18/19; 18/20
Ratios of MSDS Channels

Figure A5(b)

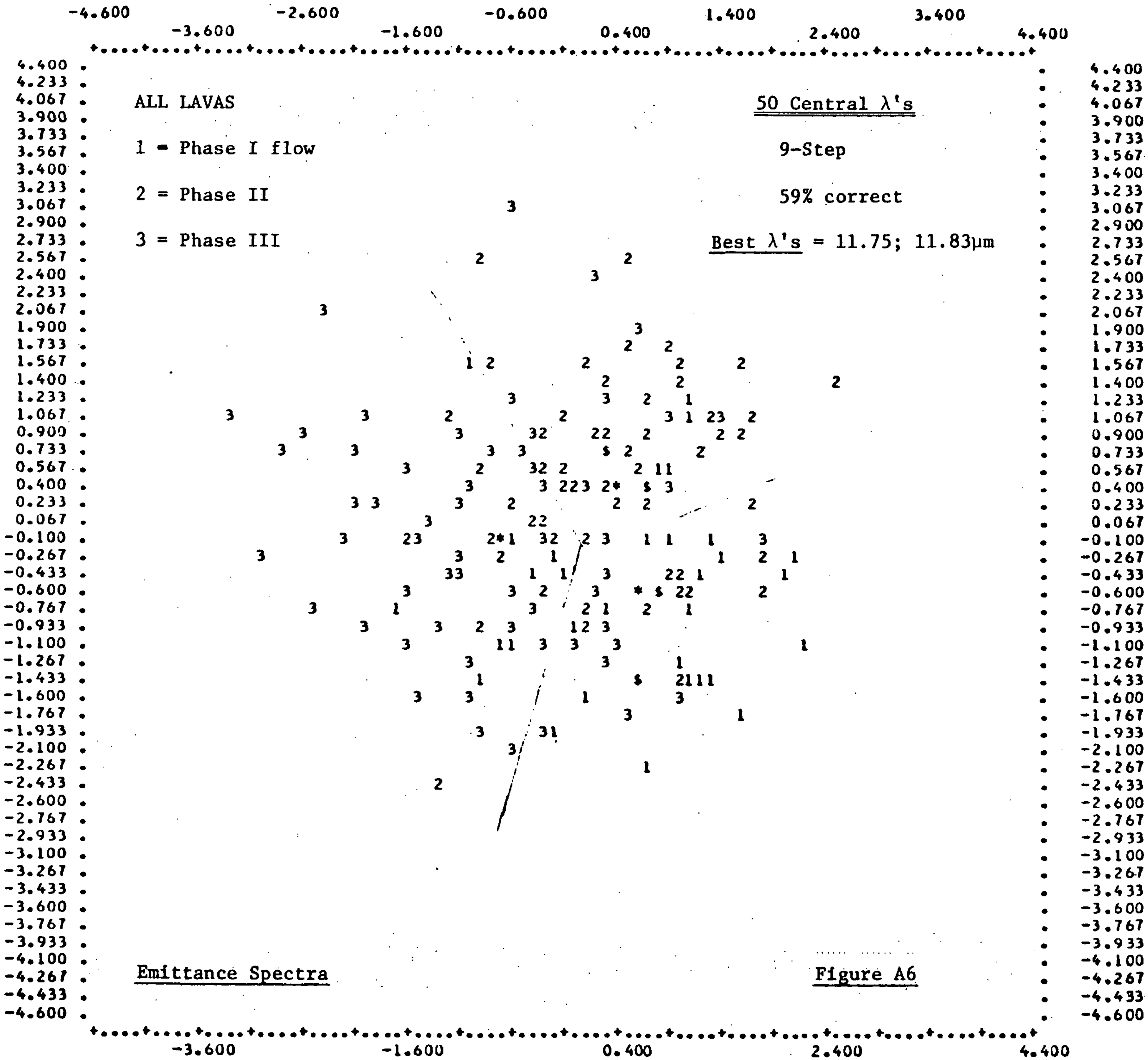

ALL LAVAS
1 = Phase I flow
2 = Phase II
3 = Phase III
50 Central λ's
9-Step
59% correct
Best λ's = 11.75; 11.83μm
Emittance Spectra

Figure A6

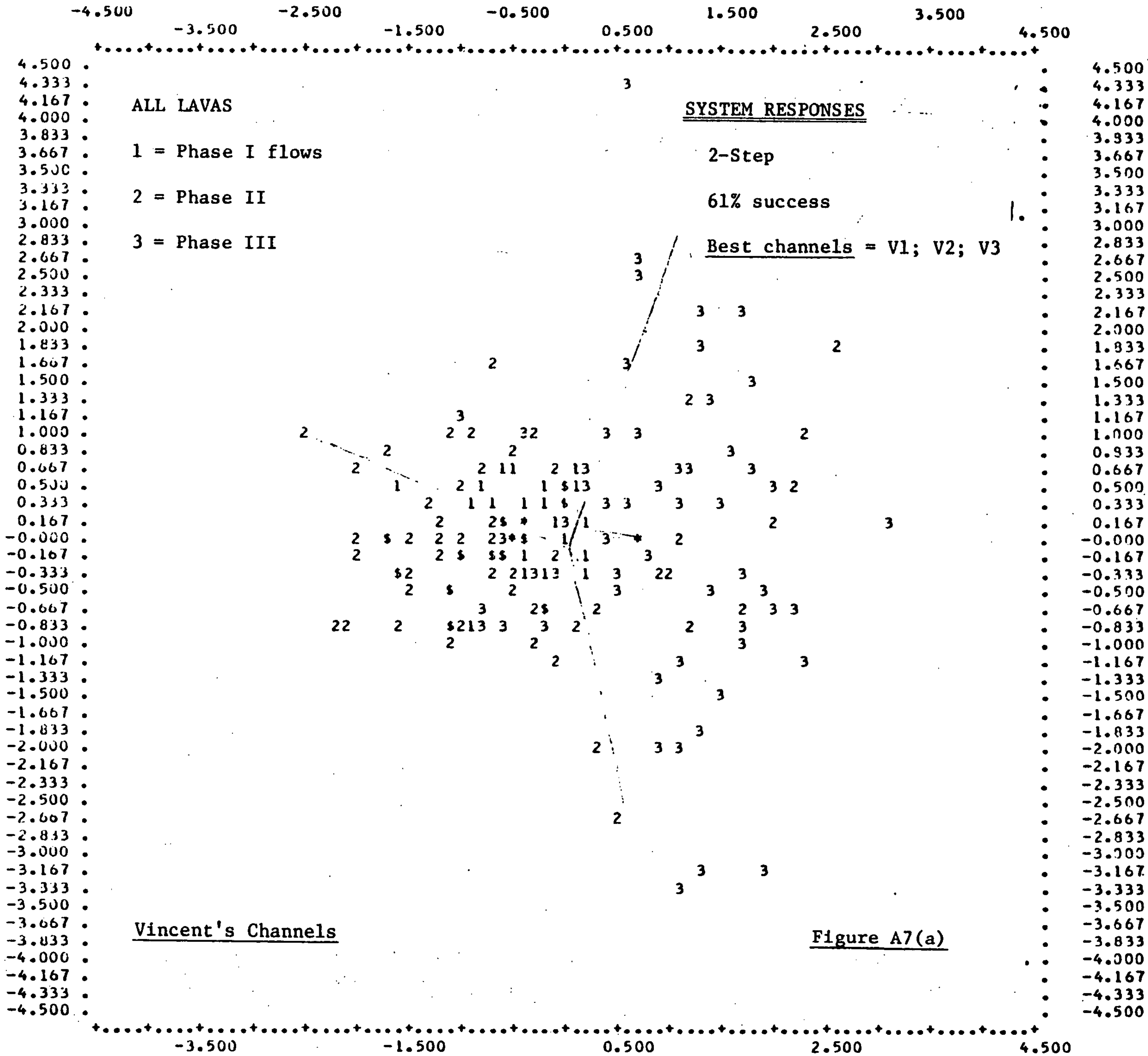
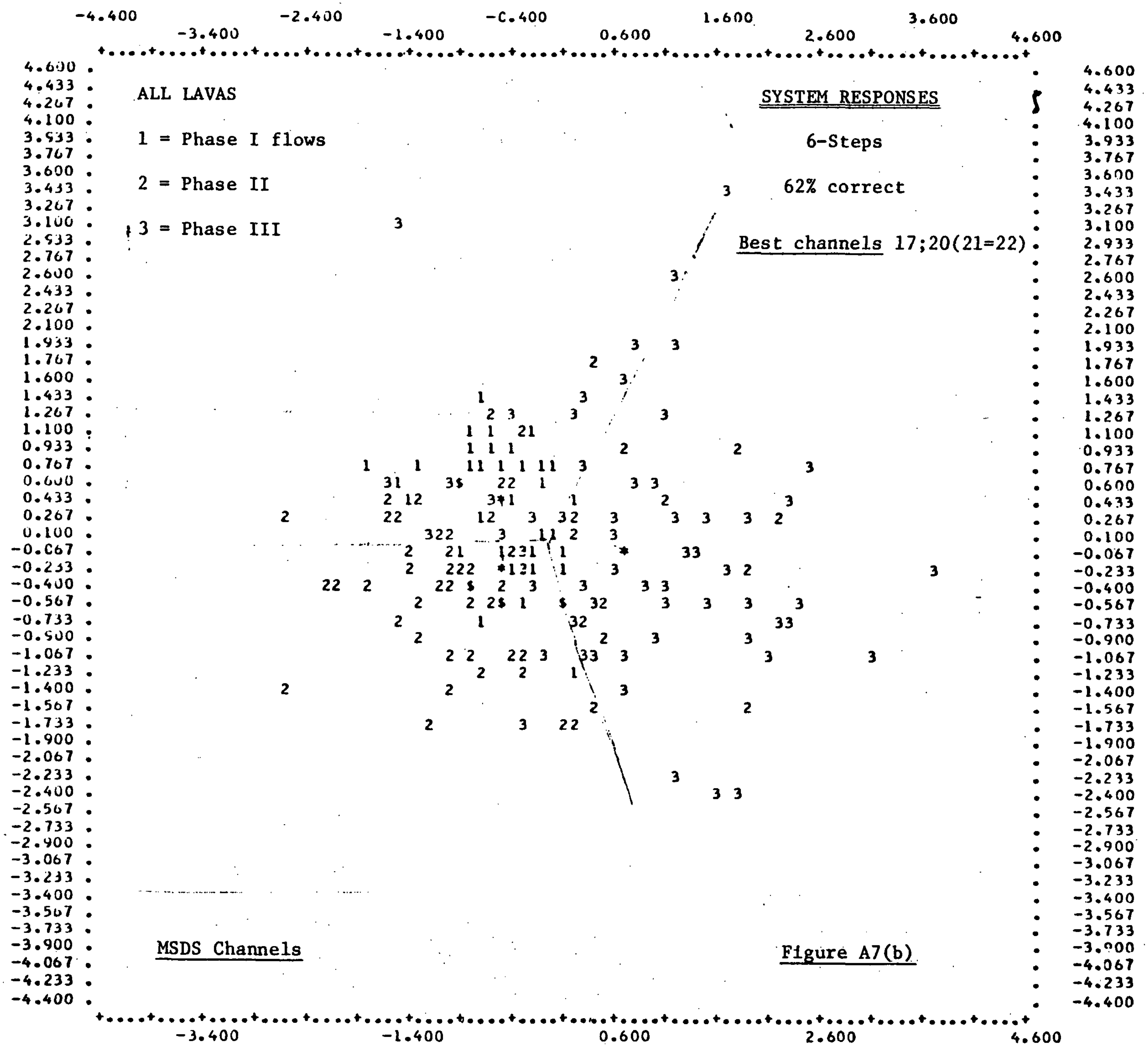
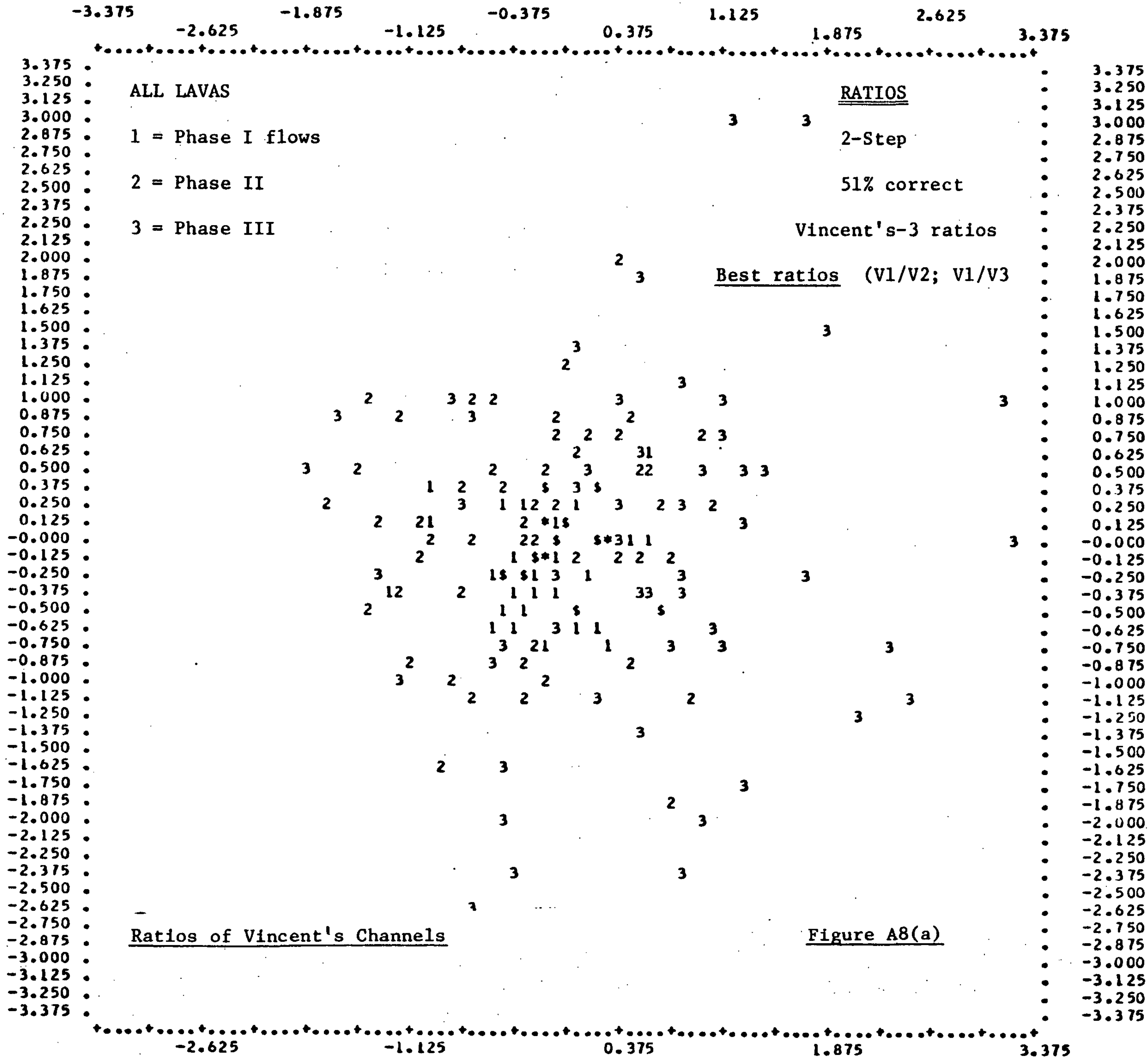

ALL LAVAS
1 = Phase I flows
2 = Phase II
3 = Phase III
SYSTEM RESPONSES
2-Step
61% success
Best channels = V1; V2; V3
Vincent's Channels

Figure A7(a)


ALL LAVAS
1 = Phase I flows
2 = Phase II
3 = Phase III
SYSTEM RESPONSES
6-Steps
62% correct
Best channels 17;20(21=22)
MSDS Channels
Figure A7(b)


ALL LAVAS
1 = Phase I flows
2 = Phase II
3 = Phase III
RATIOS
2-Step
51% correct
Vincent's-3 ratios
Best ratios (V1/V2; V1/V3
Ratios of Vincent's Channels
Figure A8(a)

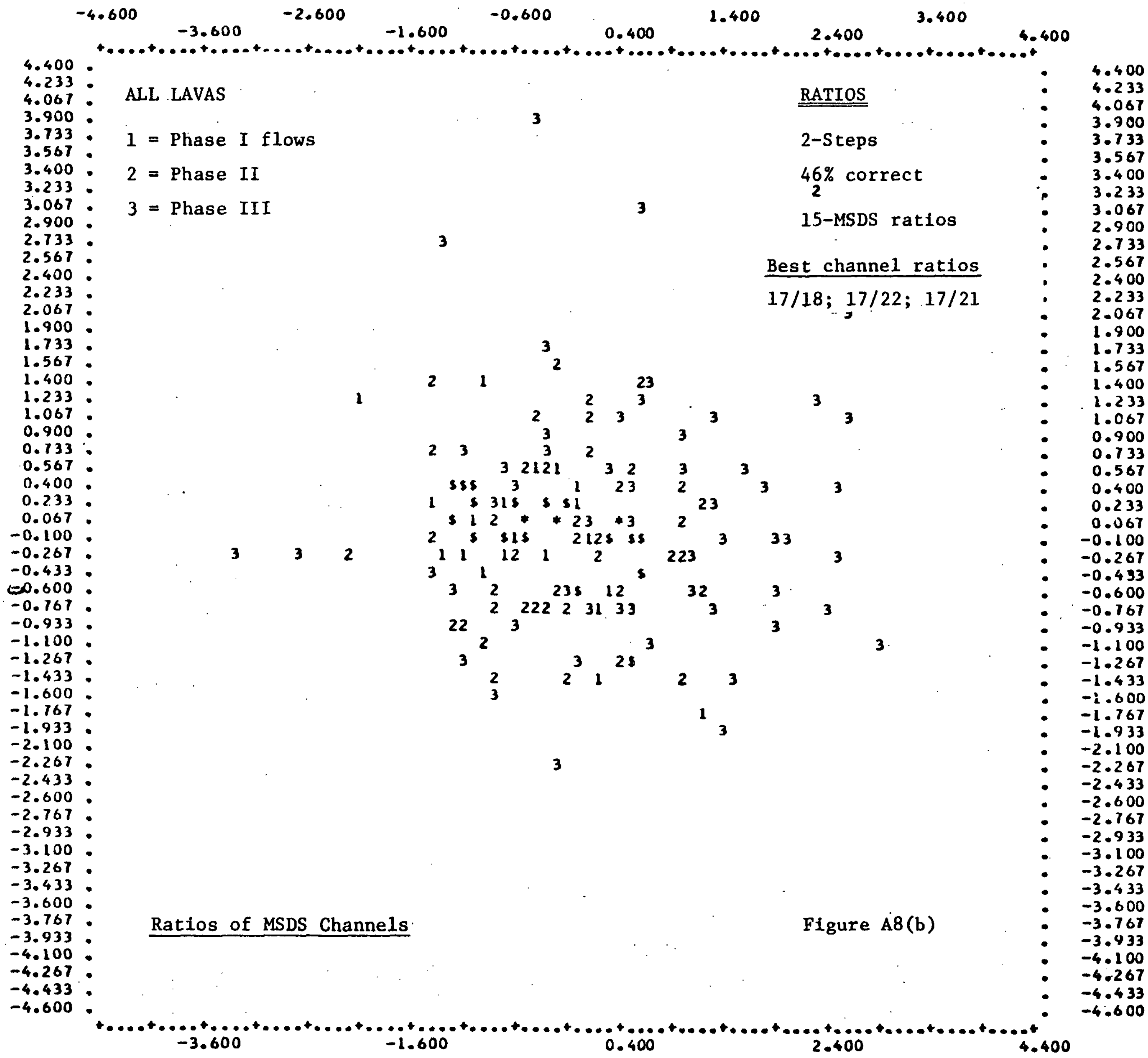

ALL LAVAS
1 = Phase I flows
2 = Phase II
3 = Phase III
RATIOS
2-Steps
46% correct
15-MSDS ratios
Best channel ratios
17/18; 17/22; 17/21
Ratios of MSDS Channels

Figure A8(b)

BMD07M

A. Summary - Effect of Temperature of the Target

1. Temperature effects have been removed in spectral emittance calculations, wherein each spectrum is directly ratioed to a blackbody at its "apparent temperature" (ε_{max} = 1.0 at one wavelength).

2. Temperature effects are also minimized in the ratio calculations, wherein system responses of pairs of filter channels are ratioed.

3. Original temperature effects still remain in the raw system response data.

4. Because of these facts, the second most powerful discriminant is the rock radiance level (system response data), which varies directly with the temperature of the target (alluvials and dry lake sediments are cooler than the black lavas).

B. Summary - Spectral Emittance Data Only

Using spectral emittance data (50 central wavelengths) temperature effects are minimal and chemical (raststrahlen) effects can dominate. Many of the closely-adjacent wavelengths are redundant (high correlation) coefficient in BMD, and hence not utilized, after the first step, by BMD07M.

a. Mixed Terrain: A high success (> 90%) is achieved only after several steps. (See Figure A9 and Table D5). Firstly Alluvium (A), and then Dry Lake Sediments (D) are correctly differentiated, but the P-Lavas take at least 4 steps to reach 75%.

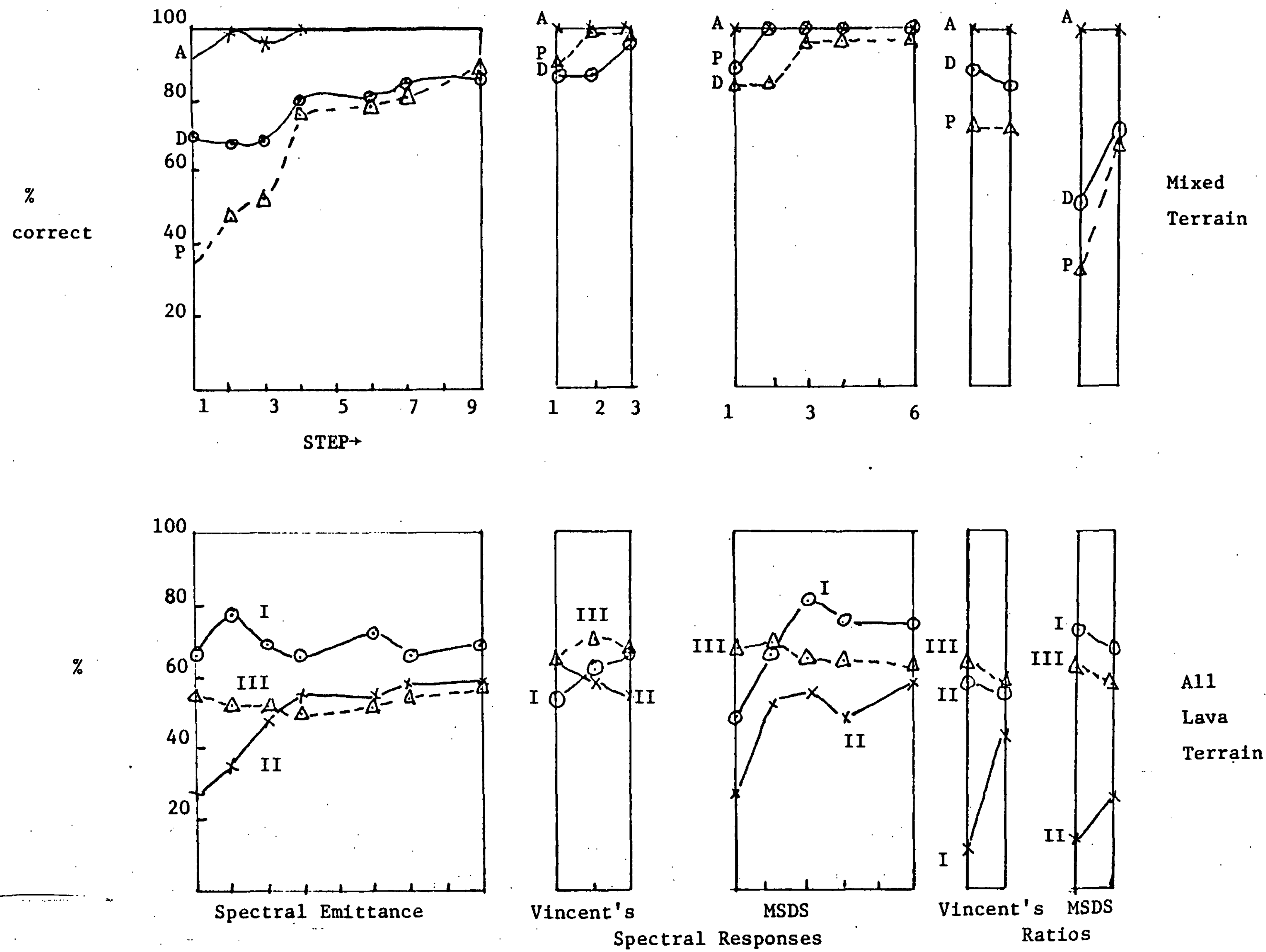
b. All Lavas: After the first steps Phase I (oldest) and Phase III (youngest) are classified at 50-60% level. Phase II reaches this level only after 4 steps.

C. Summary - System Response (Radiances) Only

a. Mixed Terrain: Responses from either Vincent's or MSDS channels reach 90% correct-levels after 2 steps, much more quickly than the spectral emittance, hence are more simply diagnostic.

b. All Lavas: Vincent's channel radiance levels are only 70-80% correct regardless of the number used. The MSDS system does better with Phase I and II

Figure A9. Discrimination Success as a function of numbers of steps in BMD07M.



lavas with increasing steps, but Phase III remains constant.

D. Summary - Ratios

a. Mixed Terrain: Vincent's ratios are correct at the 75-80% level at Step 1, but the MSDS system only reaches 77% after 2 steps.

b. All Lavas: No clear pattern emerges; if anything extra steps decrease the success achieved.

E. Conclusions

Table A4 acts as a summary of these results. From this it is reasonably clear that the chemical effect sought is always effective as a discriminant in the first step of the classification process, but the success level varies with the method (system response - best; then spectral emittance, closely followed by the ratios).

TABLE A4

INFORMATION USED IN DECISION SEQUENCE

(BMDO7M)

	MIXED TERRAIN	ALL LAVAS
Spectral Emittance	Chemical	? Temperature
System Response		
Vincent's	Chem. → Temp. → Chem.	Chem. – Chem. – Temp.
MSDS	Chem. → Temp. → Chem.	Chem. – Temp. – Chem.
Ratios		
Vincent's	Chem. → Temp.	Chem. → Temp.
MSDS	Temp. → Chem.	Chem. → Temp.

B. TASK 2.3 -

Comparison of IR Spectral Emittance Data with K-Band Scatterometer Data.

1. General Background

The presentation of non-imaged data to an audience of users, oriented towards imagery, has always been a problem. Numeric data and data representing the changing values of one variable measured against time (or distance) form an increasing proportion of that collected by aircraft and satellites. As we progress towards a more clear understanding of the processes involved in the interaction of electromagnetic radiation with the earth, and towards predictive modelling, the need for numeric data rather than spatially displayed imagery becomes more evident.

Attendant with the increase in numeric data is the problem of display, and the education of the audience to the manner in which significant changes are identified. One of the most difficult types of data to display are spectra. Yet these are capable of being gathered by an instrument like the infrared spectrometer at rates like six spectra per second.

The purpose of this part of our program was to illustrate how we have adapted a colorizing method (developed for radar back-scatter spectra) to our infrared spectra, and show the comparison between radar spectra and infrared spectra obtained along the same flight line, albeit at different times.

Both sets of data can be colorized in a comparable way as easy guides to visualizing their differing information contents. We have followed the lead of Moore et al. (1968)[1] wherein they displayed radar back-scattering spectra (σ vs. look angle) as colors generated in a 3-gun color TV tube.

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(1) Moore, R.K., Waite, W.P., Lundien, J.R., and Masenthius, H.W. (1968) "Radar Scatterometer Data Analysis Techniques". Proc. 5th Symp. Remote Sens. of Environ., Ann Arbor, Mich., 1967, — (U of Michigan Press, Ann Arbor).

2. University of Kansas Presentation of Scatterometer Spectra

Moore et al. (1968) found that these Scatterometer spectra (σ vs θ) (Fig. B1) could be rendered more meaningful to outside observers if a transform was performed involving subtraction of the curve from the group mean (Fig. B2). A further and far more successful presentation was made after a Principal Components analysis revealed that 90% of the spectral variability would be accounted for by using only 3- of the 8- data points in the curve. These 3 values were found to be the σ value at 5°, 30° and 60° look angles (measured from the vertical, nadir = 0°).

The values were converted numerically to equivalent voltages and used to produce colors in the color TV tube (Fig. B3).

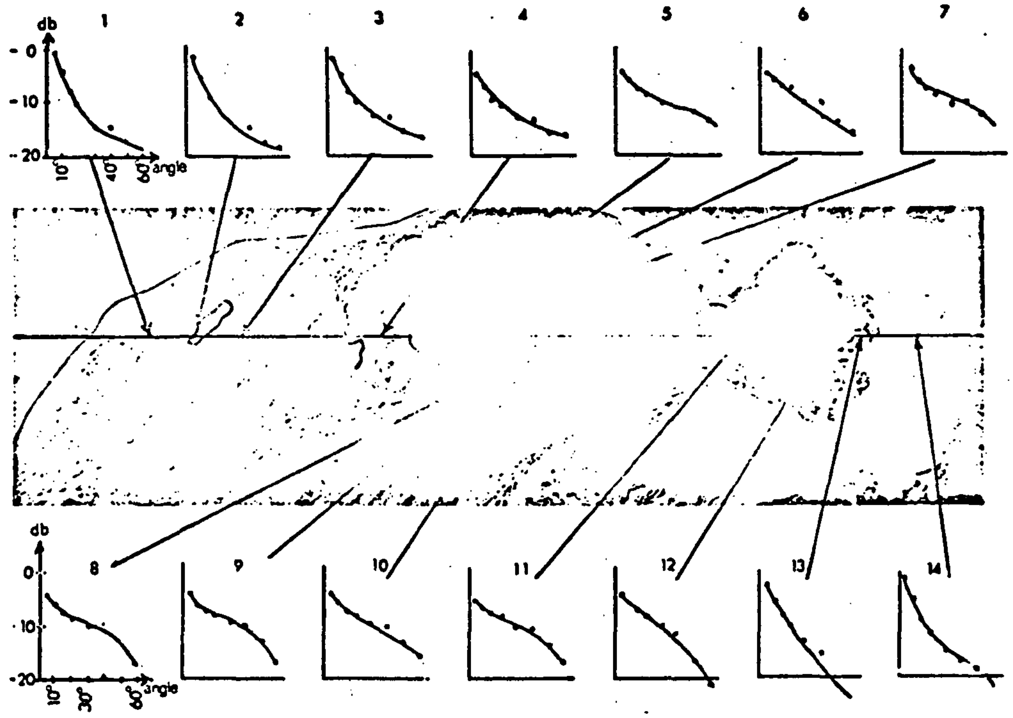
3. Stanford Technique for IR Spectra

a. Selection of 3-values using BMD07M

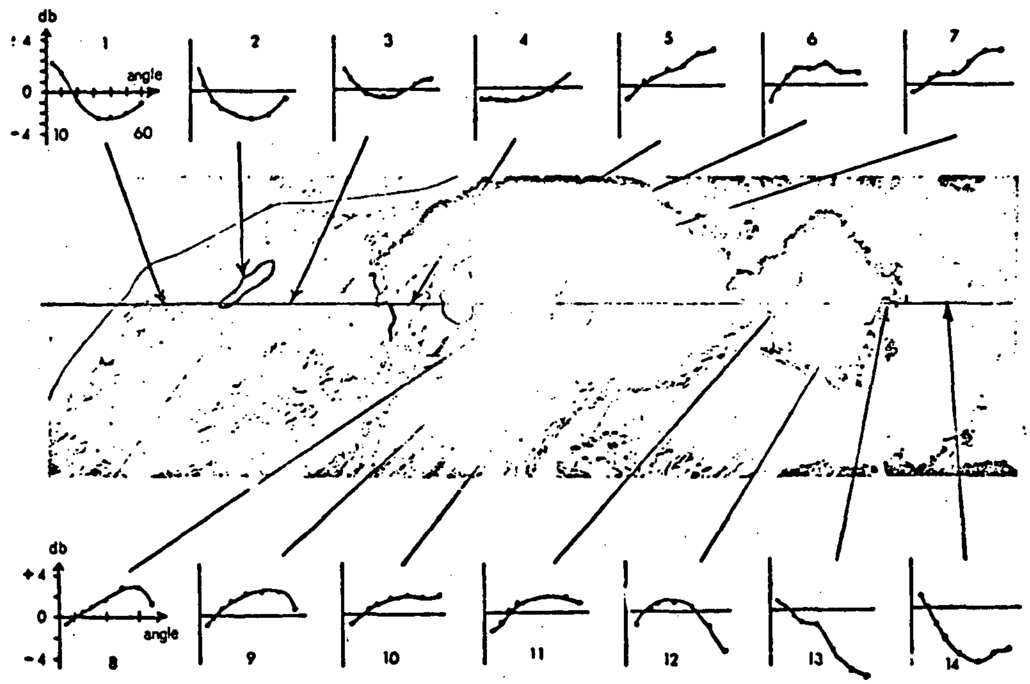
The Stanford IR Spectra are composed of a large number of digitized emittance values. Our analysis using the Stepwise Discriminant program BMD07M enabled the 1-, 2- and 3- most significant values to be identified from this contribution to the discrimination process. These key wavelengths (X,Y and Z) are those at which the several rock types of the Pisgah area can be best separated. The program also identifies other wavelengths, which are "almost-as-significant", but only selects the most-significant pair or triad in the first 3 steps. A high degree of redundancy exists in the data and actually one or other of several closely-adjacent points could have been chosen with almost equal effect.

b. I^2S Digital Image Processes (MCFV)

The processer unit in the International Imaging System (I^2S) MCFV equipment has three sets of matrix boards which enable each color band to be created by 16-levels each in the Red, Green and Blue color-guns in the nearby color TV tube.



B 1. Figure B 1. Average Return versus Angle Spectra



B 2. Figure B 2. Derivation of Spectra from Average

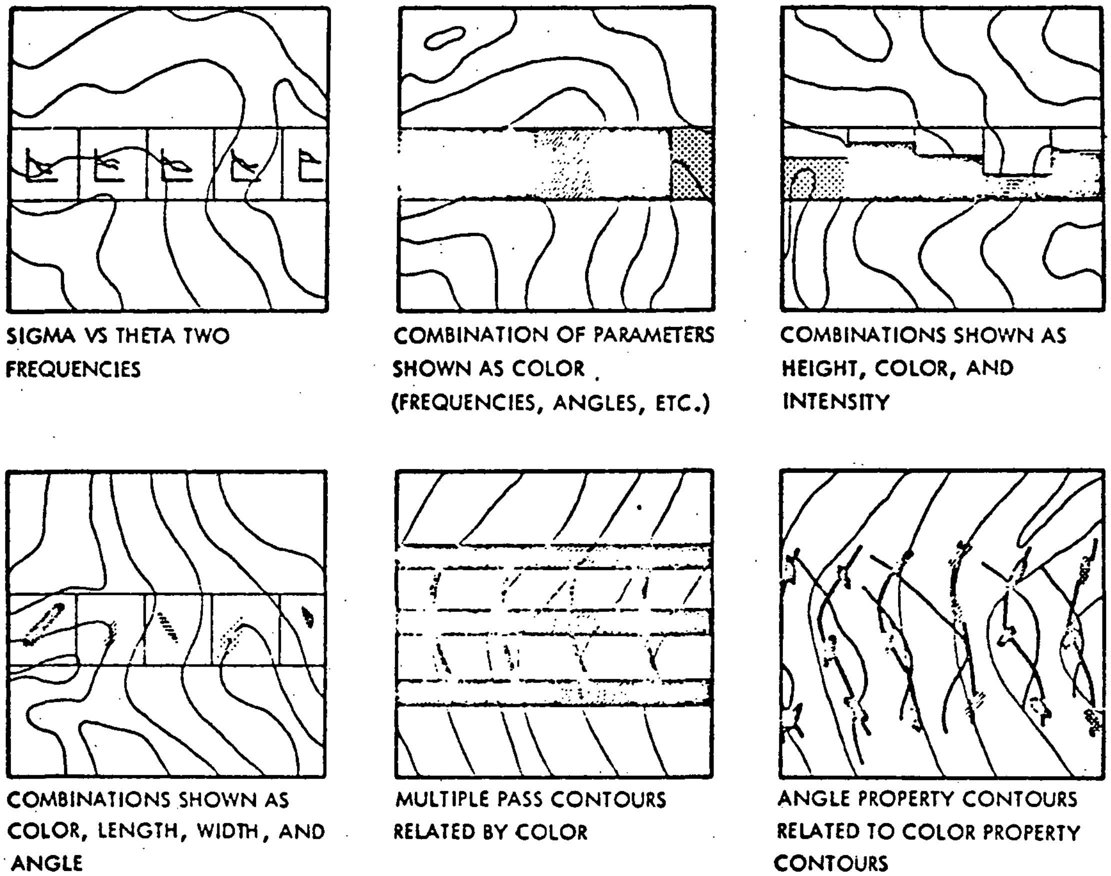


Figure B 3. Possible Modes of Presentation of Scatterometer Data.

Sixteen color bands can be created simultaneously, as parallel vertical bands in the tube. (This necessitates setting 16 trios of slides in the matrix board, each into one of 16 levels of intensity). (Fig. B4).

In this mode only the digital processing position of the unit is operated, and the front-end (TV camera and image processer) units turned off. Only the color display is activated and controlled by the digital settings on the matrix board panel. Some analog bias can be introduced to further saturate the colors, if desired.

Each value of the spectral curve at the 3 (X,Y,Z) wavelengths is obtained and reconverted into a 16-level(4 bit) number. In our examples the spectral curves have been normalized (mean, set to 0.0 and S.D. = 1.0) so the values of X, Y and Z ranged from -2.0 to +2.0 before the transform and from 0 to 16 afterwards. For each spectrum three new values of X*, Y* and Z* were calculated by this process.

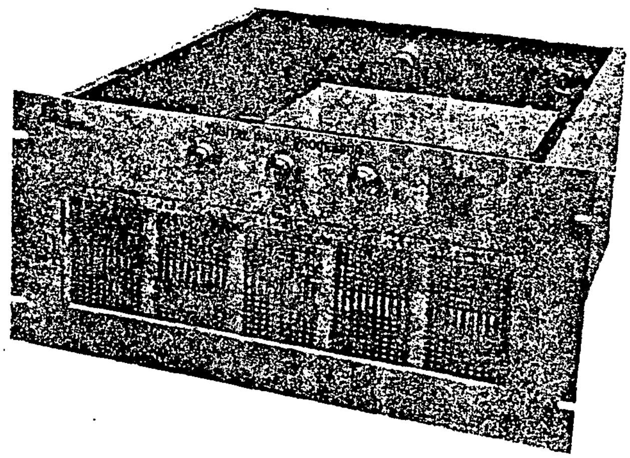
c. Operating Matrix Boards

Almost infinite flexibility exists in the manner of assigning the X*, Y* and Z* values to the red, green and blue color guns. After considerable experimentation the following assignments were found most useful.

TABLE B-1 ASSIGNMENTS

CVF Counter Pt.	Wavelength	Descriptor	Specific Color-Gun Activated	
166	8.565 μm	X	Blue	Slides 2, 3, 5 and 6
121	8.965	Y	Green	
153	11.525	Z	Red	
or 128	9.53	Y'	Red (special case used in Slide 9)	

Thus the silicic and felsic rocks with lower spectral emittance in 8-9.5 μm regions would show less blue and more red and green; while the femic basalts, with higher emittances at X and Y, would show more bluish, with less red.



MCFV DIGITAL IMAGE PROCESSOR

Fig. B4. Digital Processor: The very high speed (40MHz) Digital Processor accepts the outputs of the A/D Converter. A transformation is set up in a matrix, giving each individual level slice a specific combination of red, green and blue signal weighting. Thus, for each channel, the 16 levels are each assigned a red, green and blue value. The color assignment is made by a switch with a discrete number of settings. These settings are infinitely repeatable. The output of the color matrix is decoded to a 4-bit code and converted to an analog signal, where it is scaled to give an independent gain control for that color in that channel. The switch is the point where the matrix conversion is actually performed. Each of the one-of-sixteen decoders feeds three 16 by 16 matrix switches, one for each color. Since only one line is active at any time, the same output may be tied to a number of inputs, but the converse is not possible. Any level may be transformed in this manner to give any color, and, in fact, all levels in one channel may be transformed to the same color. The switch outputs are decoded and scaled as described above.

It should be noted that these assignments are completely arbitrary and any other observer could have created a differing (but parallel) set of false colors by choosing a different X-*, Y-*, and Z-*to-color gun associates.

Upon setting the red-green-blue values for each spectrum a vertical band of color tone appeared on the TV tube representing the relative intensities of these 3 spectral emittance values. Color photographs (slides) were taken of each set of 14-16 bands so programmed, and used for data recording. (Usually only 14 were used to a black (non-activated) border on each side).

Several sets of bands have been color printed and are shown as Figures B5-9. Unfortunately, even today color prints do not have the full brilliance and saturation of the slides or the original screen, but they give an idea of the color discrimination which can be produced by this method.

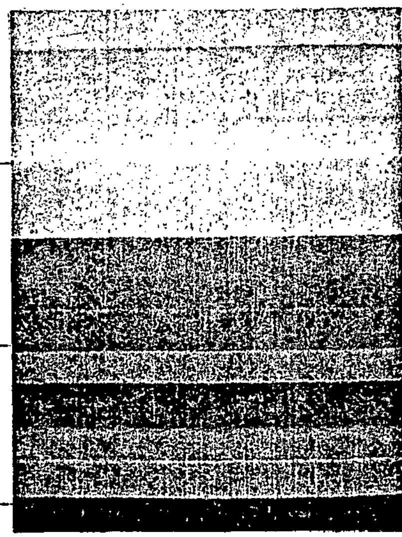
d. Application to Pisgah Crater, California flight data (MX108).

Fig. B10 shows the original color page from Moore et al. (1968) paper, on which have been placed the chips of the color prints prepared from the slides for set 5. This set of 14 spectra represents the most complete sampling of rock types possible during the flight line.

e. Scatterometer Ground Pattern or "Footprint"

The 2-cm, vertically-polarized scatterometer operating in the NASA aircraft on Mission 21 (MX21) has a fan-shaped beam 2.5° wide by 120° (fore and aft), pointing normal to the ground surface (Fig. B11). Discrete areas from which a spectrum of back-scatter (σ) values may be obtained as a function of look-angle (from +60° to -60°). The cross-track width is set by the 2° fan and is 140 feet at the 4000-4200 feet flight altitude used in Line 1, Run 3, Flight 5 of MX21. The long-track dimension is a function of the post-flight Doppler filtering of the returned signals, and was set to give a square cell at the

COLOR* PRINT OF SLIDE #2



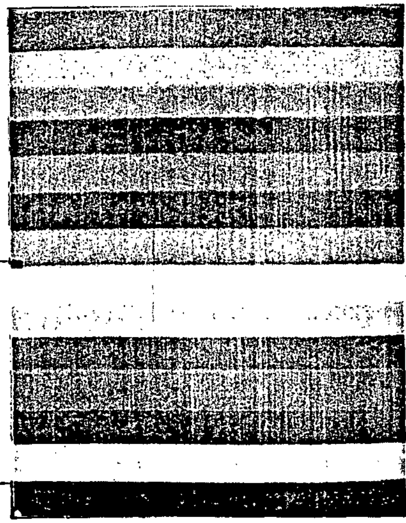
	Site #		DIGICOL MATRIX SETTINGS R (6.7x)		G (4.9x)		B (3.7x)	COLOR* ON ORIGINAL SLIDE #2
TYPE 1 SPECTRA	10tr	P TRAIN III	9	:	8	:	10	Light Blue
	10a	III – A	7	:	8	:	9	Turquoise Blue
	10b	III – B	10	:	8	:	10	Light Lavender
	8	P FLOW – I	8	:	9	:	10	Turquoise Blue
TYPE 2 SPECTRA	–	A – D	10	:	8	:	9	Grey Blue
	10c	III – C	10	:	8	:	9	Grey Blue
	10d	III – D	10	:	7	:	8	Peach Brown
	12	I – E	11	:	9	:	8	Yellow
	16f	II – F	11	:	7	:	9	Light Fuchsia
DRY LAKE SEDIMENTS	14a	A	11	:	8	:	9	Grey
	14b	B	11	:	8	:	8	Orange brown (ginger)
	14c	C	10	:	8	:	8	Pale Yellow
	–	A + B + C	11	:	8	:	9	Pink
ROCK B (Q. DIORITE)		B	12	:	3	:	4	Red

Counter Pt.		
153	R	11.525 μm
121	G	8.965
116	B	8.565

*Varies with printing processing used

Figure B 5.

COLOR* PRINT OF SLIDE #3



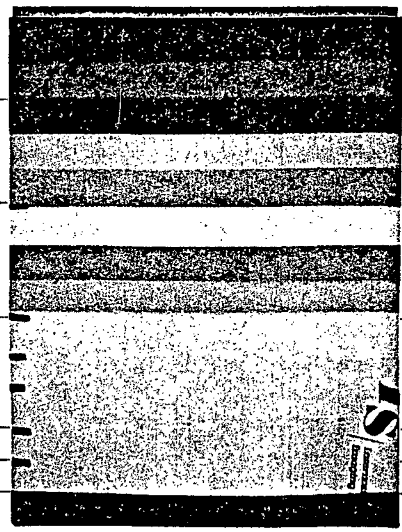
	Site #		DIGICOL MATRIX SETTINGS R (7.5x)	G (5x)	B (3.8x)	COLOR* ON ORIGINAL SLIDE #3
	-	II - A + D	10 :	8 :	9	Tan
	9a	II - A	9 :	7 :	10	Lavender
PHASE II	16b	II - B	10 :	8 :	9	Tan
	16c	II - C	11 :	7 :	8	Orange Red
("AA")	9d	II - D	11 :	10 :	9	Yellow
	16f	II - F	11 :	7 :	9	Orange Red
FLOWS	-	II - B + C	10 :	8 :	9	Tan
	10a	III A	7 :	8 :	9	Light Turquoise
PHASE III	10b	III B	10 :	8 :	10	Light Lavender
	10c	III C	10 :	8 :	9	Ginger
(PAHOEHOE)	10d	III D	10 :	7 :	8	Light Fuchsia
	-	III A - D	10 :	8 :	9	Ginger
FLOWS	-	III ALL	9 :	8 :	10	Pale Blue
ROCK B (Q. DIORITE)			12 :	3 :	4	Red

Counter Pt.	
153	R 11.525 µm
121	G 8.965
116	B 8.565

*Varies with printing processing used

Figure B 6.

COLOR* PRINT OF SLIDE #5

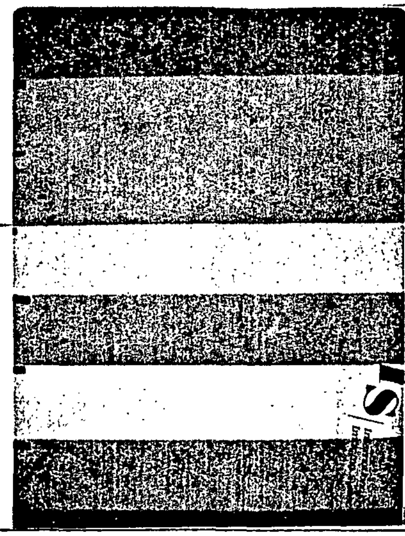


Site #				DIGICOL MATRIX SETTINGS R (4.0x)	G (5.4x)	B (2.4x)	COLOR* ON ORIGINAL SLIDE #5
Alluvium Younger		1a	A	12 :	3 :	4	Orange
Older		3b	B	12 :	3 :	4	Dark Pink
Sand over		2	C	13 :	2 :	4	Red
		4a	A	11 :	5 :	6	Grey Blue Green
Basalt		4b	B	10 :	6 :	5	Avocado Green
Lava Flows	I	6	I	8 :	9 :	10	Blue
	II	7	II	13 :	4 :	6	Fuchsia
	III	8	III	9 :	6 :	6	Moss Green
	II	9a+9d	A + D	10 :	8 :	9	Very Light Blue
Type 1	III	10tr	P-TRAIN	9 :	8 :	10	Light Blue
2	III	10a+b+c+d	A - D	10 :	8 :	9	Light Blue
	II	16b + 16c	B + C	10 :	8 :	9	Light Blue
Dry Lake Sed.		14	A + B + C	11 :	8 :	9	Very Light Blue
Alluvium Older		15	E	13 :	4 :	5	Brown

*Varies with printing processing used

Figure B 7.

COLOR* PRINT OF SLIDE #6



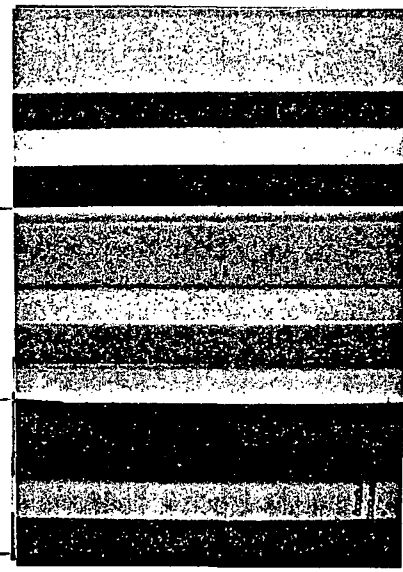
	Site #		DIGICOL MATRIX SETTINGS R (4.0x)	G (5.4x)	B (2.4x)	COLOR* ON ORIGINAL SLIDE #6
YOUNGER ALLUVIUM	3a	A	12 :	2 :	4	Fuchsia Pink
	1b	AC	12 :	3 :	4	Peach
	1a	C	12 :	3 :	4	Peach
OLDER ALLUVIUM	3b	B	12 :	3 :	5	Lavender
	15d	D	13 :	4 :	4	Yellow
	15e	E	13 :	4 :	5	Pale Green
	15f	F	13 :	4 :	4	Yellow

Counter Pt.		
153	R	11.525 µm
121	G	8.965
116	B	8.565

*Varies with printing processing used

Figure B 8.

COLOR* PRINT OF SLIDE #9



	Site #		DIGICOL MATRIX SETTINGS R (10x)	G (4.7x)	B (2.8x)	COLOR* ON ORIGINAL SLIDE #9
DRY LAKE SEDIMENTS	14a	A	1	8	9	Light Blue
	14b	B	2	8	8	Light Moss Green
	14c	C	4	8	8	Orange
	-	A + B + C	3	8	9	White
						Black
LAVA FLOWS (Type 2 Spectra)	-	III A - D	4	8	9	Pink-Peach
	10c	III - C	4	8	9	Pink-Peach
	10d	III - D	3	7	8	Pink-Tan
	12	I - E	4	9	8	Yellow
	16f	II - F	2	7	9	Blue
	10tr	P-TRAIN III	5	8	10	Red
	10a	III - A	5	8	9	Red
	10b	III - B	4	8	10	Pink
	8	P FLOW - I	5	9	10	Red

Counter Pt.**		
128	R	9.53 µm
121	G	8.965
116	B	8.565

*Varies with printing processing used

**NOTE: NEW COUNTER POINT USED FOR RED

Figure B 9.

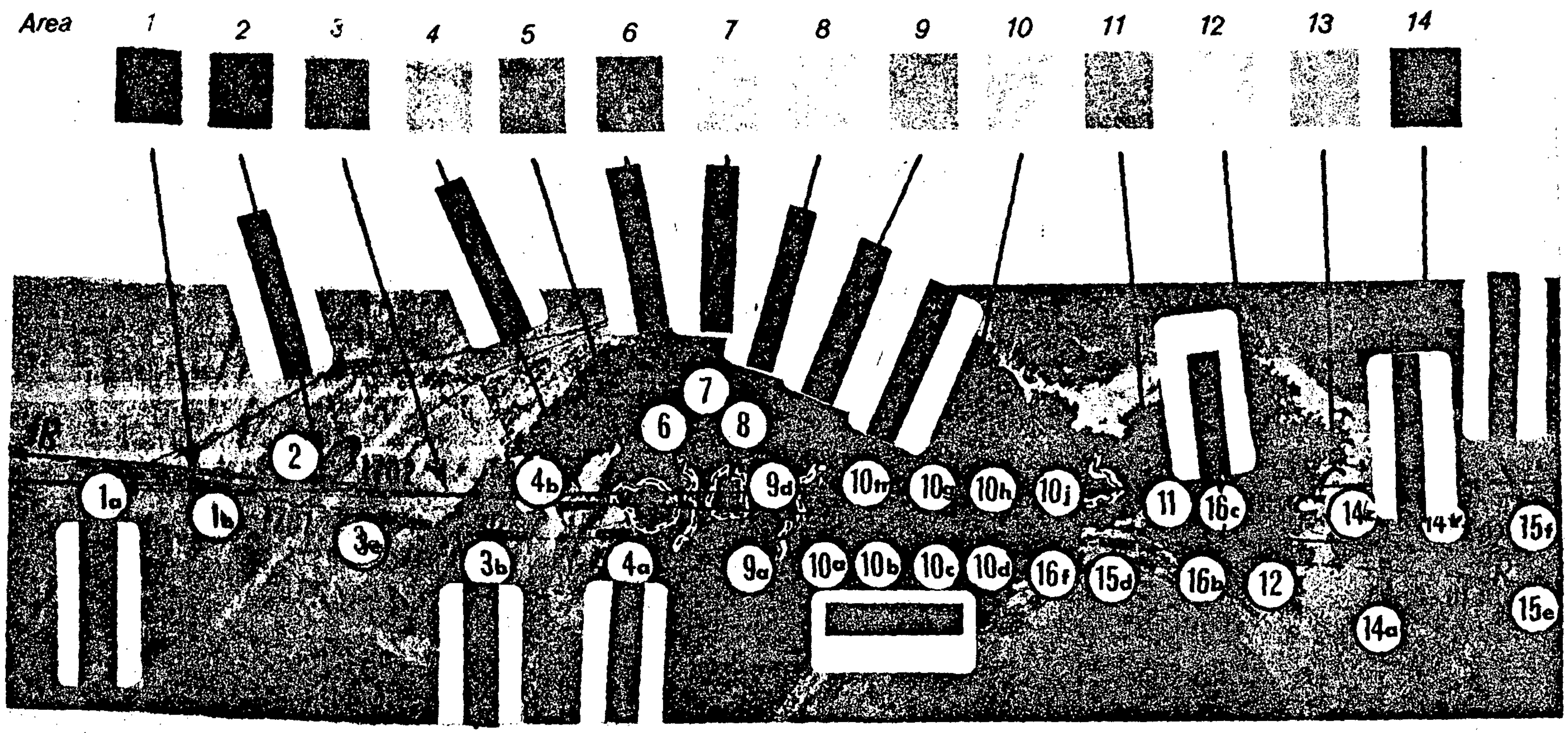


Figure B10. Original illustration from Moore et al (1968) overlaid with IR spectral emittance data. New color-chips show the response of colorizing the emittance curves.

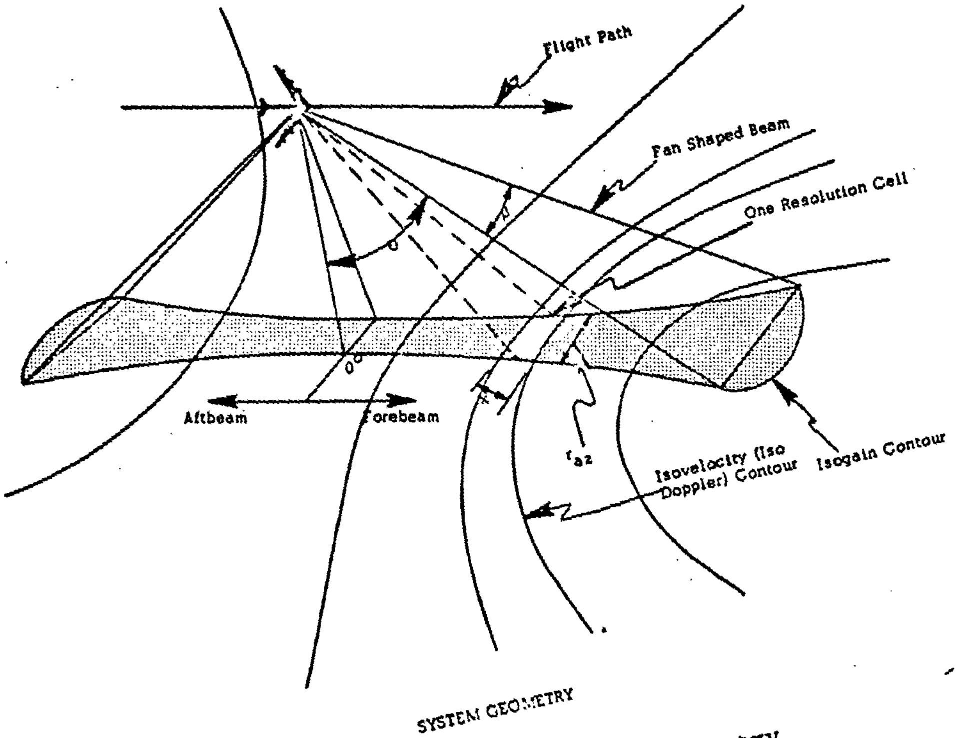


Figure B 11. Scatterometer System Geometry

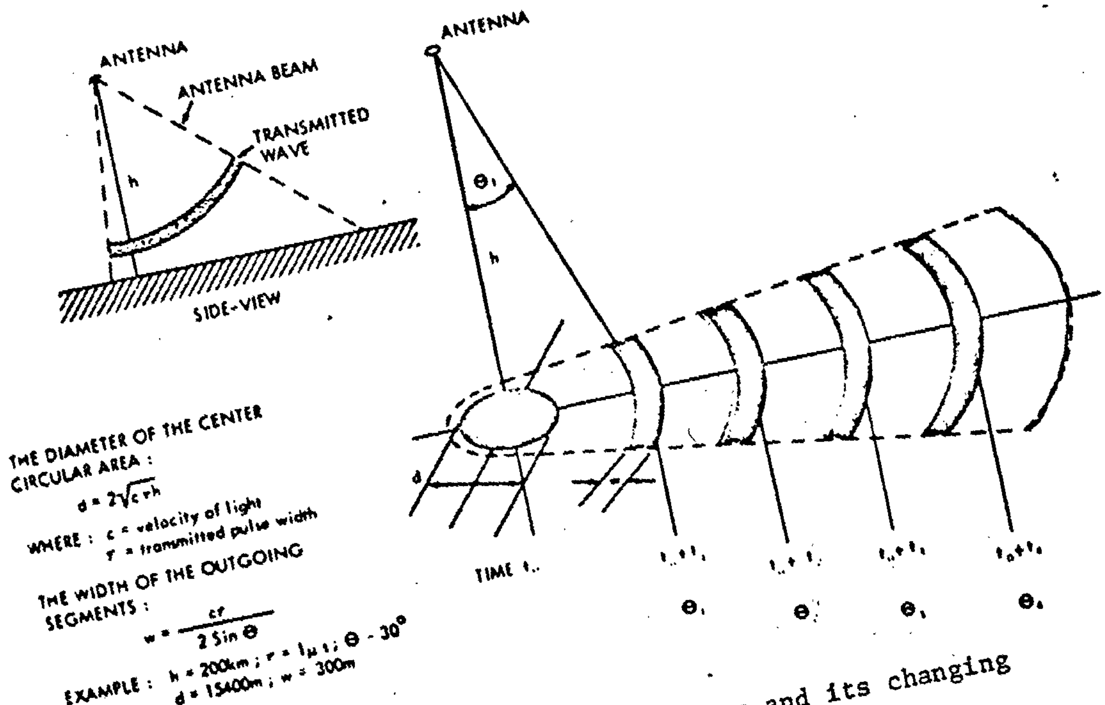


Figure B 12. Footprint of Scatterometer and its changing resolution cell.

+30° (forward view from the nadir). This increases the square cell (or "footprint") of the data block to 165 x 165 feet at the +30° viewing angle (Fig. B12).

The flight line across the lava flows and adjoining sedimentary and lake beds is shown in Fig. B10 (marked "Sc"). The line contained 135 of these footprints and was therefore further subdivided on a geological basis into the 14 units shown therein.

f. Infrared Spectrometer Ground Patterns

In a comparable manner the 6-12 μm spectrometer operating from the NASA aircraft on Mission 108 (MX108) collected data from a 0.4° (7mrad) circular field of view, swept forward by the motion of the aircraft down the two flight lines shown also on Fig. B10 (marked IR 1701 and 1702), almost exactly parallel to that of the scatterometer. In a desert environment like this little change in terrain would be expected between the MX flight of 1966 and that of the MX108 flight in 1968, except perhaps in the lake mud, which would change in texture each wet season.

The field of view or ground pattern thus at the 2000 feet flight altitude would be 15 feet wide. Each spectrum takes 150msec to collect, during which the aircraft has moved forward about 40 feet, or 40 x 15 feet of terrain for each spectrum. The group mean spectra tabulated in Table B-2 are shown in Figure B13.

Again the spectra were segregated on a geological basis into the groups shown by the 31 wider black bars along the two flight lines (Fig. B10). The numbering has been modified so that the circled numbers are now directly relatable to those used in the scatterometer analysis.

Generally 15-30 spectra, covering 15 feet width x 600-1200 feet length, were used in each group. In a similar pattern to the scatterometer path, the IR path often crossed changing lithologies before this optimal number of spectra

TABLE B2

DESCRIPTIONS OF SPECTRAL GROUPS - ON FLIGHT 1

MX108-1-PISGAH

LOC *	NAME	NO. OF SPECTRA	GMT START	GMT STOP	GROUP NUMBER
1a.	Alluvium C	25	18:49:44078	18:49:51360	1
1b.	Alluvium AC	30	18:50:22915	18:50:31410	2
2.	Sand over Basalt II-C	11	19: 9:23685	19: 9:26719	3
3a.	Alluvium A	26	18:49:58035	18:50:05923	4
3b.	Alluvium B	30	18:50:35050	18:50:43864	5
4b.	Sand over Basalt I-B	21	19: 8:37569	19: 8:43636	6
4a.	Sand over Basalt I-A	9	18:50:52041	18:50:54468	7
6.	Pisgah Flow III	6	19: 8:27252	19: 8:28784	8
7.	Pisgah Flow II	4	19: 8:25750	19: 8:26647	9
8.	Pisgah Flow I	15	19: 8:20896	19: 8:25143	10
9a.	Lava Flow II-A	13	18:51:04785	18:51:13887	11
9d.	Lava Flow II-D	9	19: 8:12083	19: 8:16649	12
10a.	Pisgah Lava III-A	8	18:51:16921	18:51:22383	13
10tr.	P-Train Lava (not included)	31	19: 7:57521	19: 8:06623	14
10b.	Pisgah Lava III-B	8	18:51:23596	18:51:28452	15
10c.	Pisgah Lava III-C	18	18:51:29058	18:51:34231	16
10g.	Lava III-G	10	19: 7:48418	19: 7:55701	17
10d.	Pisgah Lava III-D	12	18:51:34837	18:51:38161	18
10h.	Lava III-H	8	19: 7:40241	19: 7:46309	19
16f.	Pisgah Lava II-F	20	18:51:47263	18:51:53332	20
10j.	Lava III-J	16	19: 7:31746	19: 7:39317	21
15d.	Alluvium D	21	18:51:58186	18:52:04254	22
11.	Lava I-K	16	19: 7:15652	19: 7:20506	23
16c.	Lava II-C	10	19: 7::08371	19: 7:14439	24
16b.	Lava Flow II-B	10	18:52:12461	18:52:16998	25
12.	Pisgah Lava I-E	19	18:52:19136	18:52:25204	26
14b.	Dry Lake Sediments B	23	19: 6:44098	19: 6:50774	27
14a.	Dry Lake Sediments A	53	18:57:38314	18:57:54090	28
14c.	Dry Lake Sediments C	25	19: 6:34390	19: 6:41671	29
15f.	Alluvium F	42	19: 6:14078	19: 6:26501	30
15e.	Alluvium E	27	18:52:59793	18:53:07681	31

*Locations on Fig. B 14

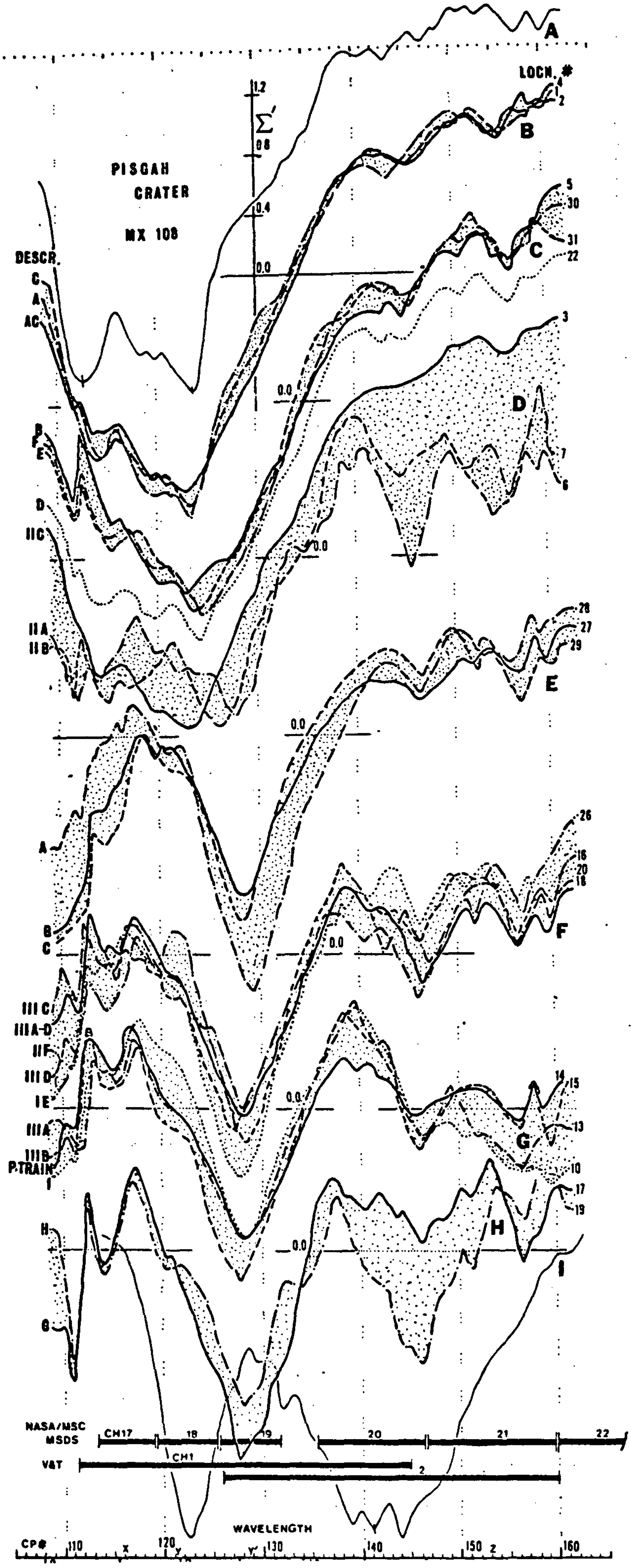


Fig. B13. Nine sets of normalized group mean spectral emittance curves, all with the same horizontal scale (wavelength from 8.0 to 12.0μm). The vertical scale in all sets is constant, but the sets have been displaced vertically for ease in viewing. Normalized spectral emittance is plotted as the ordinate, with the mean = 0.0 as the central line on each spectrum. Spectral shapes thus may be directly compared.

accumulated (especially near the crater). The group then contains less spectra (N, varying from 4-15) with correspondingly higher relative error in the estimation of the group mean spectrum.

TABLE B-3 DIMENSIONS OF SPECTRA ON GROUND

	MX21 (4/5/66)	MX108 (10/8/68)
	Scatterometer	IR Spectrometer
F.O.V :	2° wide	0.4° circular
Flight Alt. Terrain :	4000-4200 ft.one flight line (103)	2000-2500 ft. two lines (1701, 1702)
Ground patch width :	165' (+30° view)	15' (vertical)
Ground patch length :	165'	40'
# of Spectra :	168 Spectra/14 groups	600 Spectra/31 groups

4. Results

a. The method of colorizing appears to emphasize differences in the spectral curves quite clearly.

b. It is simple to achieve providing one has access to the specific units (I^2S - MCVF or the University of Kansas equivalent).

c. It is not clear however if the method can be developed (without a further research period) to give suitably diagnostic colors of a unique tone for each setting without additional 3 color-saturation from the analog processer. Above each color slide print we have indicated the analog settings for the red-blue-green guns as for example in Slide 9 (R[10x]; G[4.7x]; B[2.8x]). It will be noted that those vary from slide to slide and throw a non-linear bias into our comparisons.

d. The 14 color pattern shown in Fig. B10 and tabulated (Table B-4) do show the same relationship between the scatterometer color sequence and the IR color sequence, indicating a close general correlation between the two methods.

TABLE B-4

COLORIZED SPECTRA IN SEQUENCE DOWN FLIGHT LINE

NORTH	SCATTEROMETER	IR (#5 Slide)	
1	Brown	1a	Orange
2	Dark Tan	2	Red
3	Light Tan	3b	Dark Pink (15 = Brown)
4	Grey Tan	4a	Grey Blue Green
		4b	Avocado Green
5	Light Blue	-	*
6	Blue	6	Blue
7	Grey	7	Fuschia
8	Light Grey Blue	8	Moss Green
9	Blue Grey	9a+d	Very Light Blue
10	Grey Blue	10tr	Light Blue
		10a+b +c+d	Light Blue
11	Blue	-	*
12	Light Grey	-	*
13	Light Grey Tan	-	*
14	Dark Tan	14	Very Light Blue
15	- *	15	Brown
SOUTH			

*Not represented

TABLE B-5 SUMMARY

	COLORS PRODUCED	
	SCATTEROMETER	INFRARED
A. SIMILARITIES		
1. Sands and Alluvials (#1-3, 14, 15)	Browns and Tan	Red, Orange and Brown
2. Basalt Flows (#5-12)	Blue, Grey-Blue and Grey	Blue, Light Green and Light Blues
B. DISSIMILARITIES		
1. Sands over Basalt	Grey Tan	Grey-Blue-Green
(#4a, 4b)		Avocado Green
(#2)	Dark Tan	Red
2. Lake Beds (#14)	Dark Tan	Very Light Blue
3. Specific Lava Flows		
(#7)	Grey	Fuchsia

e. The dissimilarities are indicative of the effect of surface roughness (scatterometer) and the shallow "skin depth" or penetration shown by the IR data. The windblown sands (Site 2 and Sites 4a and 4b) are cases in point, showing more of the character of sands to both the IR and scatterometer. With the various lava flows and cinders of the Pisgah Crater area the scatterometer generally agrees with the IR (blues and greys). Some lava flows (#7) are different in the IR data, being more like alluvials.

The most clear dissimilarity is in the dry lake sediments which the scatterometer sees more as alluvials (light grey tan and dark tan) while the IR data closely agree with the basalt composition. (This has been further substantiated by the work of Vincent and Thompson using emittance-ratio imagery).

5. Conclusion

The method is a valid and dramatic technique for displaying spectral data. It needs further study if one wishes to make unique colors from digital input alone.

C. Standard Infrared Spectral File

1. MX108 Airborne Spectra

The following spectra were analyzed as described in Section A3(a). The spectra are plotted between 8 and 12 microms as it was felt that this is the only region where atmospheric effects could be reliably eliminated. The scale is such that each step is 0.001 of an emittance unit. The heavy curve is the average "effective emissivity" for the group in question. The other curve is the standard deviation of this main curve. The table at the top gives the number of spectra in the group, the location and time of measurement and the average temperature with its standard deviation as calculated from the spectral data.

It should be noted that full scale on the graph is not equal to 1 but that the effective emittance and the standard deviations are plotted from 1 and 0 respectively.

F

TABLE C1

DESCRIPTIONS OF SPECTRAL GROUPS - ON FLIGHT 1 LINE AIRBORNE SPECTRA

LOC	NAME	NO. OF SPECTRA	GMT START	GMT STOP
	MX108-1-PISGAH			
1.	Alluvium C	25	18:49:44078	18:49:51360
2.	Alluvium AC	30	18:50:22915	18:50:31410
3.	Sand over Basalt II-C	11	19: 9:23685	19: 9:26719
4.	Alluvium A	26	18:49:58035	18:50:05923
5.	Alluvium B	30	18:50:35050	18:50:43864
6.	Sand over Basalt I-B	21	19: 8:37569	19: 8:43636
7.	Sand over Basalt I-A	9	18:50:52041	18:50:54468
8.	Pisgah Flow III	6	19: 8:27252	19: 8:28784
9.	Pisgah Flow II	4	19: 8:25750	19: 8:26647
10.	Pisgah Flow I	15	19: 8:20896	19: 8:25143
11.	Lava Flow II-A	13	18:51:04785	18:51:13887
12.	Lava Flow II-D	9	19: 8:12083	19: 8:16649
13.	Pisgah Lava III-A	8	18:51:16921	18:51:22383
14.	P-Train Lava (not included)	31	19: 7:57521	19: 8:06623
15.	Pisgah Lava III-B	8	18:51:23596	18:51:28452
16.	Pisgah Lava III-C	18	18:51:29058	18:51:34231
17.	Lava III-G	10	19: 7:48418	19: 7:55701
18.	Pisgah Lava III-D	12	18:51:34837	18:51:38161
19.	Lava III-H	8	19: 7:40241	19: 7:46309
20.	Pisgah Lava II-F	20	18:51:47263	18:51:53332
21.	Lava III-J	16	19: 7:31746	19: 7:39317
22.	Alluvium D	21	18:51:58186	18:52:04254
23.	Lava I-K	16	19: 7:15652	19: 7:20506
24.	Lava II-C	10	19: 7:08371	19: 7:14439
25.	Lava Flow II-B	10	18:52 12461	18:52:16998
26.	Pisgah Lava I-E	19	18:52:19136	18:52:25204
27.	Dry Lake Sediments B	23	19: 6:44098	19: 6:50774
28.	Dry Lake Sediments A	53	18:57:38314	18:57:54090
29.	Dry Lake Sediments C	25	19: 6:34390	19: 6:41671
30.	Alluvium F	42	19: 6:14078	19: 6:26501
31.	Alluvium E	27	18:52:59793	18:53:07681
44.	Pisgah Cinders I	4	18:50:55076	18:50:56000
45.	Pisgah Cinders II	5	18:50:56607	18:50:57821
46.	Pisgah Cinders III	9	18:50:58427	18:50:00855
54.	Pisgah Lava III (A-D)	53	18:51:21169	18:51:36948
	MX108-1-SUNSHINE			
40.	Sunshine Lava A	22	18:57:11905	18:57:18290
41.	Sunshine Lava B	25	18:57:04017	18:57:11297
42.	Sunshine Cinders C	17	18:56:54626	18:56:59480
43.	Sunshine Cinders D	20	18:56:47633	18:56:53412
	VARIOUS			
53.	Palmdale Lake	44	17:12:38496	17:12:52143

AVERAGED DATA
NUMBER OF SPECTRA 25
FOR GROUP 1 1P 49 51360 60011101 02000000 MX109-1 ALLUVIUM C

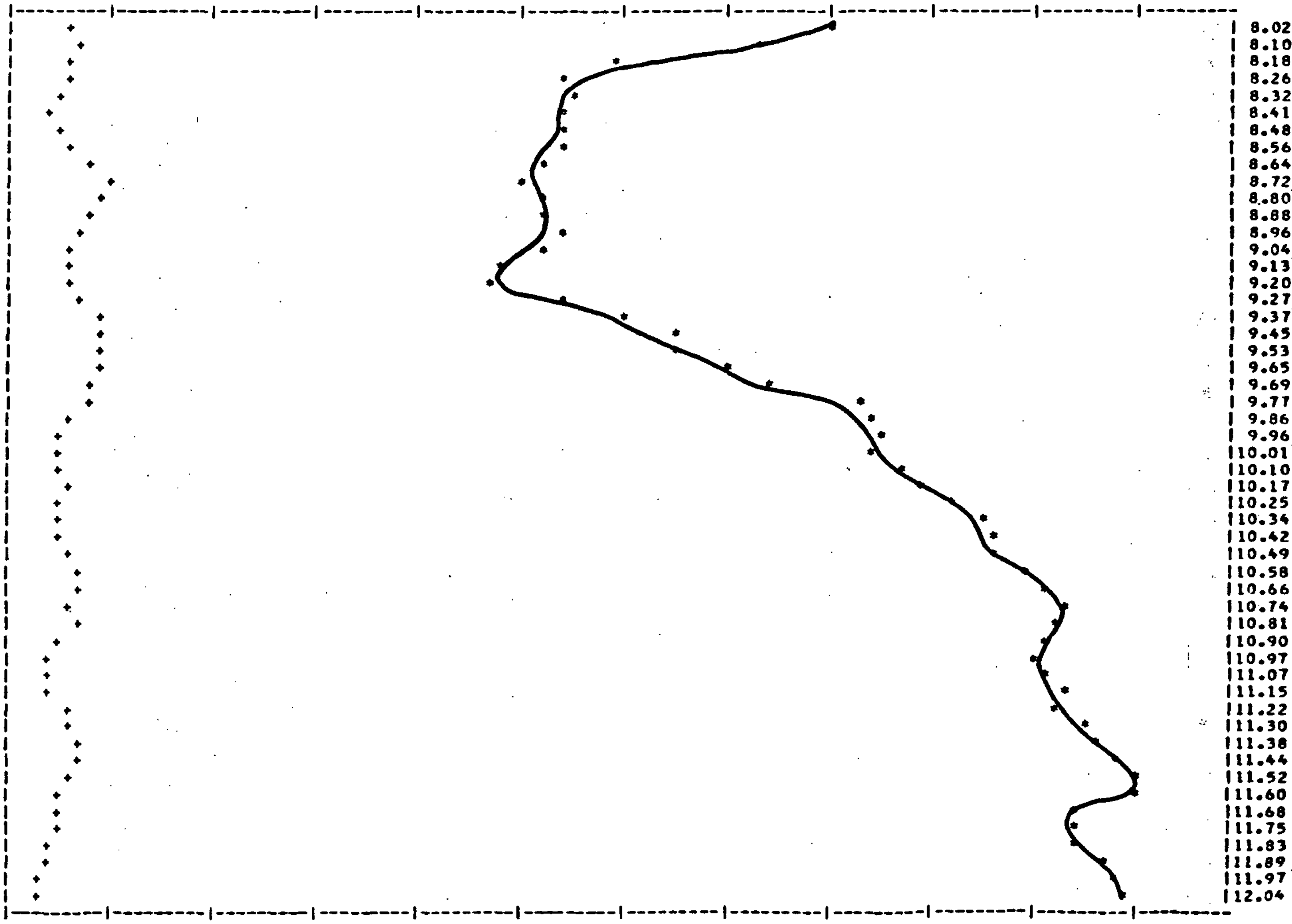
AVERAGE TEMPERATURE= 38.462 STD.DEV.= 0.301

WAVELENGTH,AVERAGE EMIT.

7.750 0.941	7.810 0.943	7.880 0.935	7.950 0.967	8.020 0.961	8.100 0.955	8.180 0.941	8.260 0.936
8.320 0.937	8.410 0.935	8.480 0.935	8.560 0.936	8.640 0.934	8.720 0.932	8.800 0.933	8.880 0.934
8.960 0.936	9.040 0.933	9.130 0.929	9.200 0.928	9.270 0.935	9.370 0.941	9.450 0.946	9.530 0.946
9.650 0.951	9.690 0.959	9.770 0.964	9.860 0.965	9.960 0.967	10.010 0.965	10.100 0.969	10.170 0.971
10.250 0.974	10.340 0.976	10.420 0.976	10.490 0.977	10.580 0.980	10.660 0.982	10.740 0.984	10.810 0.983
10.900 0.983	10.970 0.982	11.070 0.983	11.150 0.984	11.220 0.984	11.300 0.986	11.380 0.988	11.440 0.989
11.520 0.991	11.600 0.991	11.680 0.986	11.750 0.985	11.830 0.986	11.890 0.988	11.970 0.990	12.040 0.991
12.120 0.992	12.190 0.993	12.260 0.987	12.330 0.985				

WAVELENGTH,STD.DEV.

7.750 0.014	7.810 0.013	7.880 0.013	7.950 0.011	8.020 0.008	8.100 0.008	8.180 0.007	8.260 0.008
8.320 0.006	8.410 0.006	8.480 0.007	8.560 0.008	8.640 0.009	8.720 0.011	8.800 0.011	8.880 0.010
8.960 0.009	9.040 0.008	9.130 0.007	9.200 0.007	9.270 0.009	9.370 0.010	9.450 0.011	9.530 0.011
9.650 0.010	9.690 0.010	9.770 0.009	9.860 0.008	9.960 0.007	10.010 0.007	10.100 0.007	10.170 0.008
10.250 0.006	10.340 0.007	10.420 0.006	10.490 0.008	10.580 0.009	10.660 0.008	10.740 0.008	10.810 0.008
10.900 0.006	10.970 0.006	11.070 0.005	11.150 0.005	11.220 0.007	11.300 0.008	11.380 0.009	11.440 0.009
11.520 0.007	11.600 0.007	11.680 0.007	11.750 0.006	11.830 0.006	11.890 0.006	11.970 0.005	12.040 0.005
12.120 0.007	12.190 0.007	12.260 0.008	12.330 0.009				



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[illegible] OF SPECTRA [illegible]
[illegible]: 2 18 50 1410 PC011101 02000000 MX108-1 ALLUVIUM AC

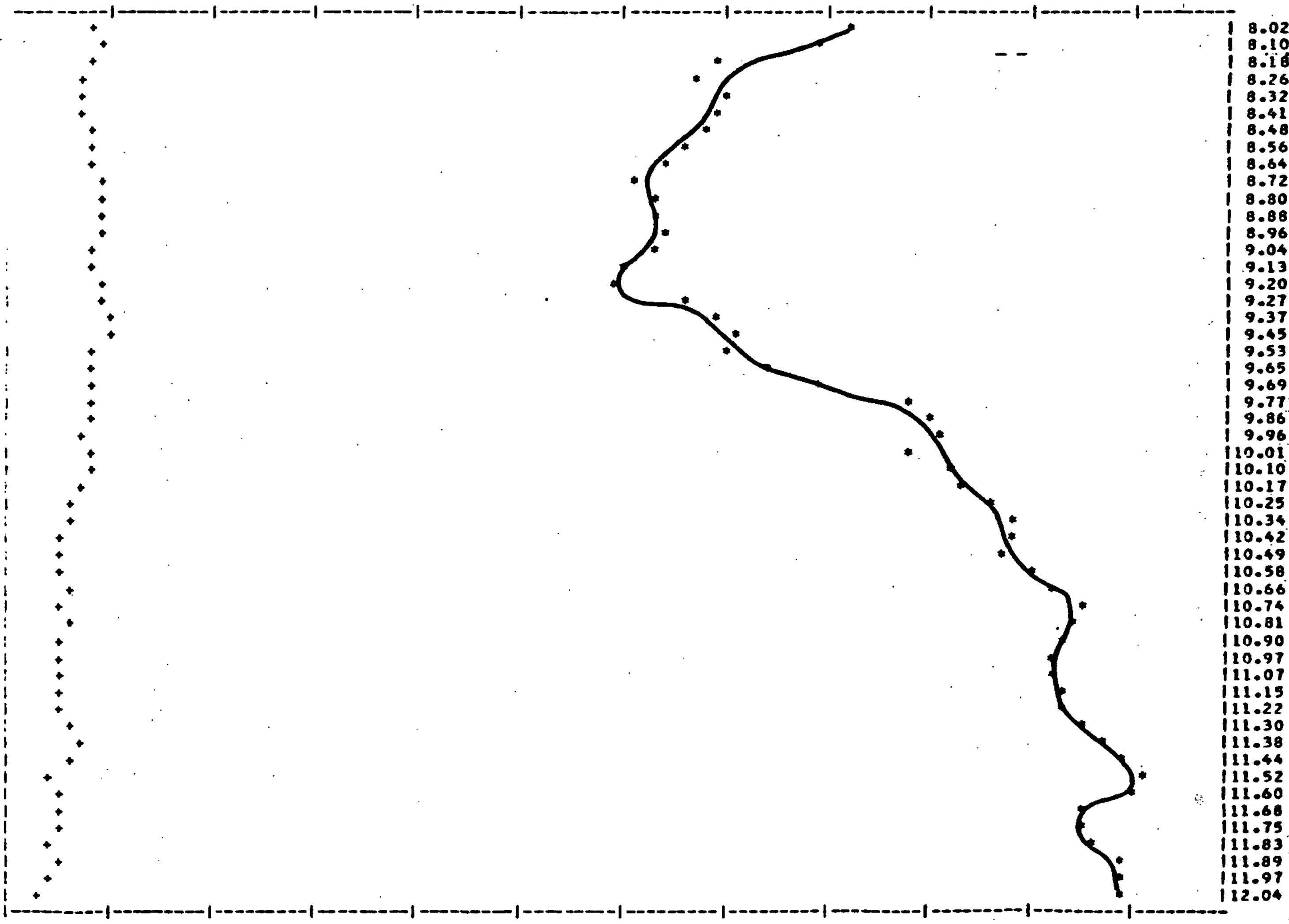
AVERAGE TEMPERATURE= 37.507 STD.DEV.= 0.414

AVE LENGTH,AVERAGE REFL.

7.750 0.933	7.810 0.939	7.880 0.930	7.950 C.968	8.020 0.964	8.100 0.960	8.180 0.950	8.260 0.949
8.320 0.951	8.410 0.951	8.480 0.949	8.560 C.947	8.640 0.946	8.720 0.943	8.800 0.945	8.880 0.945
8.960 0.946	9.040 0.944	9.130 0.942	9.200 C.941	9.270 0.947	9.370 0.950	9.450 0.953	9.530 0.951
9.650 0.956	9.690 0.961	9.770 0.970	9.860 C.971	9.960 0.972	10.010 0.969	10.100 0.973	10.170 0.975
10.250 0.977	10.340 0.979	10.420 0.980	10.490 C.979	10.580 0.982	10.660 0.984	10.740 0.986	10.810 0.985
10.900 0.984	10.970 0.983	11.070 0.984	11.150 C.985	11.220 0.984	11.300 0.987	11.380 0.989	11.440 0.990
11.520 0.992	11.600 0.992	11.680 0.986	11.750 C.986	11.830 0.987	11.890 C.990	11.970 0.991	12.040 0.991
12.120 0.992	12.190 0.993	12.260 0.985	12.330 C.985				

AVE LENGTH,STD.DEV.

7.750 0.015	7.810 0.016	7.880 0.017	7.950 C.012	8.020 0.010	8.100 0.011	8.180 0.010	8.260 0.009
8.320 0.009	8.410 0.009	8.480 0.010	8.560 C.010	8.640 0.010	8.720 0.010	8.800 0.011	8.880 0.011
8.960 0.010	9.040 0.010	9.130 0.010	9.2CC C.010	9.270 0.011	9.370 0.012	9.450 0.011	9.530 0.010
9.650 0.010	9.690 0.010	9.770 0.010	9.860 0.009	9.960 0.008	10.010 0.009	10.100 0.009	10.170 0.008
10.250 0.008	10.340 0.007	10.420 0.006	10.49C C.006	10.580 0.006	10.660 0.007	10.740 0.007	10.810 0.007
10.900 0.006	10.970 0.006	11.070 0.007	11.150 C.007	11.220 0.007	11.300 0.008	11.380 0.008	11.440 0.008
11.520 0.006	11.600 0.006	11.680 0.006	11.750 C.006	11.830 0.006	11.890 0.006	11.970 0.006	12.040 0.005
12.120 0.006	12.190 0.006	12.260 0.009	12.33C C.C07				



AVERAGED DATA
NUMBER OF SPECTRA 11
FILE GROUP 3 15 9 26719 6C011102 02000000 MX108-1 SAND BASALT 2C

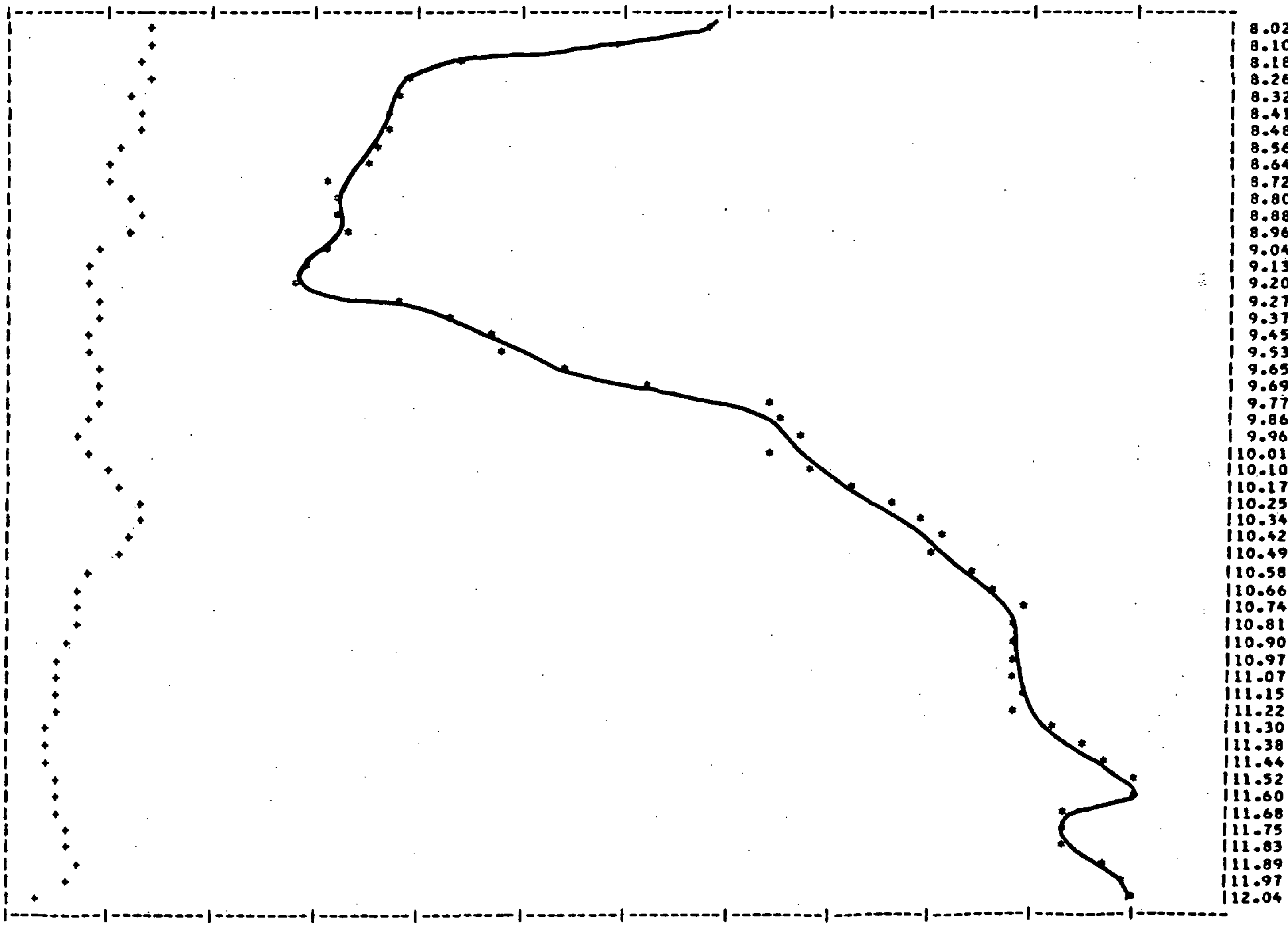
AVERAGE TEMPERATURE= 40.870 STD.DEV.= 0.682

WAVELENGTH,AVERAGE EMIT.

7.750 0.929	7.810 0.928	7.880 0.921	7.950 0.959	8.020 0.949	8.100 0.941	8.180 0.925	8.260 0.920
8.320 0.920	8.410 0.918	8.480 0.918	8.560 0.918	8.640 0.916	8.720 0.912	8.800 0.913	8.880 0.913
8.960 0.914	9.040 0.912	9.130 0.910	9.200 0.910	9.270 0.919	9.370 0.925	9.450 0.929	9.530 0.929
9.650 0.935	9.690 0.943	9.770 0.955	9.860 0.957	9.960 0.958	10.010 0.955	10.100 0.959	10.170 0.963
10.250 0.968	10.340 0.971	10.420 0.972	10.490 0.971	10.580 0.975	10.660 0.978	10.740 0.980	10.810 0.979
10.900 0.979	10.970 0.977	11.070 0.979	11.150 0.980	11.220 0.979	11.300 0.984	11.380 0.987	11.440 0.989
11.520 0.992	11.600 0.991	11.680 0.985	11.750 0.984	11.830 0.965	11.890 0.989	11.970 0.990	12.040 0.991
12.120 0.994	12.190 0.995	12.260 0.986	12.330 0.982				

WAVELENGTH,STD.DEV.

7.750 0.013	7.810 0.016	7.880 0.014	7.950 0.019	8.020 0.015	8.100 0.016	8.180 0.015	8.260 0.015
8.320 0.013	8.410 0.014	8.480 0.015	8.560 0.013	8.640 0.012	8.720 0.012	8.800 0.013	8.880 0.014
8.960 0.013	9.040 0.011	9.130 0.010	9.200 0.010	9.270 0.010	9.370 0.010	9.450 0.009	9.530 0.010
9.650 0.010	9.690 0.011	9.770 0.011	9.860 0.009	9.960 0.009	10.010 0.010	10.100 0.012	10.170 0.013
10.250 0.014	10.340 0.014	10.420 0.014	10.490 0.012	10.580 0.009	10.660 0.008	10.740 0.008	10.810 0.009
10.900 0.008	10.970 0.006	11.070 0.006	11.150 0.006	11.220 0.006	11.300 0.006	11.380 0.005	11.440 0.006
11.520 0.006	11.600 0.006	11.680 0.006	11.750 0.007	11.830 0.007	11.890 0.008	11.970 0.007	12.040 0.005
12.120 0.007	12.190 0.005	12.260 0.008	12.330 0.011				



AVERAGED DATA
NUMBER OF SPECTRA 27
FOR GROUP 4 18 50 5923 6C011101 02000000 MX108-1 ALLUVIUM A

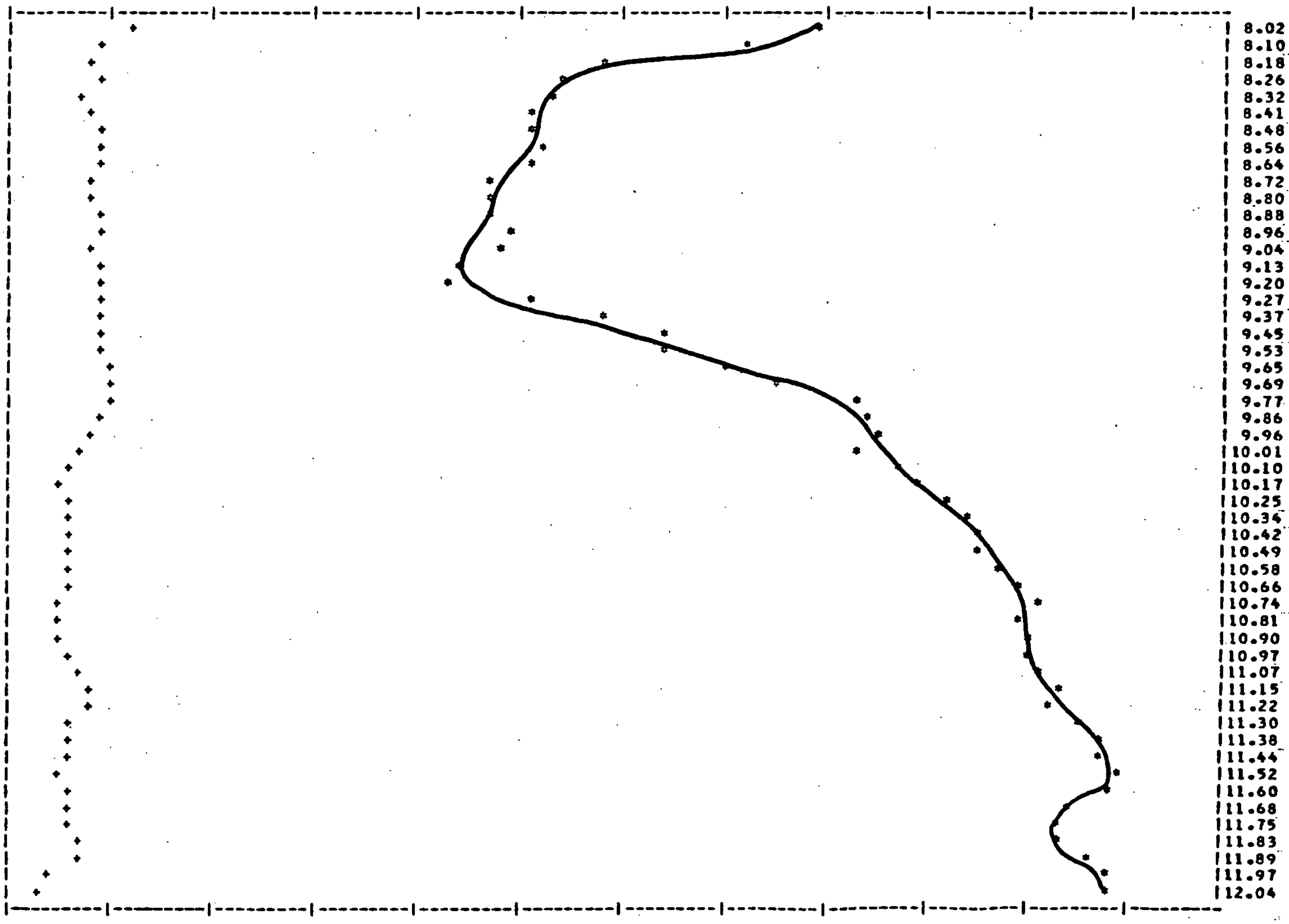
AVERAGE TEMPERATURE= 37.972 STD.DEV.= 0.528

WAVELENGTH,AVERAGE EMIT.

7.750	0.944	7.810	0.947	7.880	0.936	7.950	C.970	8.020	0.960	8.100	0.953	8.180	0.939	8.260	0.935
8.320	0.934	8.410	0.932	8.480	0.933	8.56C	C.934	8.640	0.933	8.720	0.929	8.800	0.928	8.880	0.929
8.950	0.931	9.040	0.930	9.130	0.926	9.200	0.925	9.270	0.932	9.370	0.940	9.450	0.945	9.530	0.946
9.650	0.951	9.690	0.956	9.770	0.965	9.860	C.966	9.960	0.966	10.010	0.965	10.100	0.969	10.170	0.970
10.250	0.974	10.340	0.976	10.420	0.976	10.490	0.976	10.560	0.978	10.660	0.981	10.740	0.982	10.810	0.981
10.900	0.981	10.970	0.981	11.070	0.983	11.150	0.985	11.220	0.984	11.300	0.987	11.380	0.989	11.440	0.989
11.520	0.991	11.600	C.990	11.680	0.985	11.75C	C.985	11.830	0.985	11.890	0.938	11.970	0.989	12.040	0.989
12.120	0.990	12.190	0.992	12.260	0.985	12.330	0.984								

WAVELENGTH,STD.DEV.

7.750	0.018	7.810	0.018	7.880	0.019	7.95C	C.015	8.020	0.013	8.100	0.011	8.180	0.009	8.260	0.010
8.320	0.009	8.410	0.010	8.480	0.011	8.56C	C.010	8.640	0.010	8.720	0.010	8.800	0.010	8.880	0.011
8.950	0.010	9.040	0.C10	9.130	0.011	9.2C0	0.011	9.270	0.011	9.370	0.011	9.450	0.011	9.530	0.011
9.650	0.011	9.690	0.012	9.770	0.011	9.86C	C.011	9.960	0.010	10.010	0.008	10.100	0.007	10.170	0.C07
10.250	0.007	10.340	0.CC8	10.420	0.007	10.490	0.007	10.580	0.007	10.660	0.007	10.740	0.007	10.810	0.007
10.900	0.007	10.970	0.CC7	11.070	0.008	11.15C	C.009	11.220	0.009	11.300	0.008	11.380	0.008	11.440	0.007
11.520	0.007	11.600	0.007	11.680	0.007	11.750	C.C08	11.830	0.009	11.890	0.008	11.970	0.006	12.040	0.005
12.120	0.C09	12.190	0.CC8	12.260	0.007	12.330	0.C09								



AVERAGED DATA
NUMBER OF SPECTRA 30
FOR GROUP 5 18 50 43864 6C011101 02000900 MX108-1 ALLUVIUM B

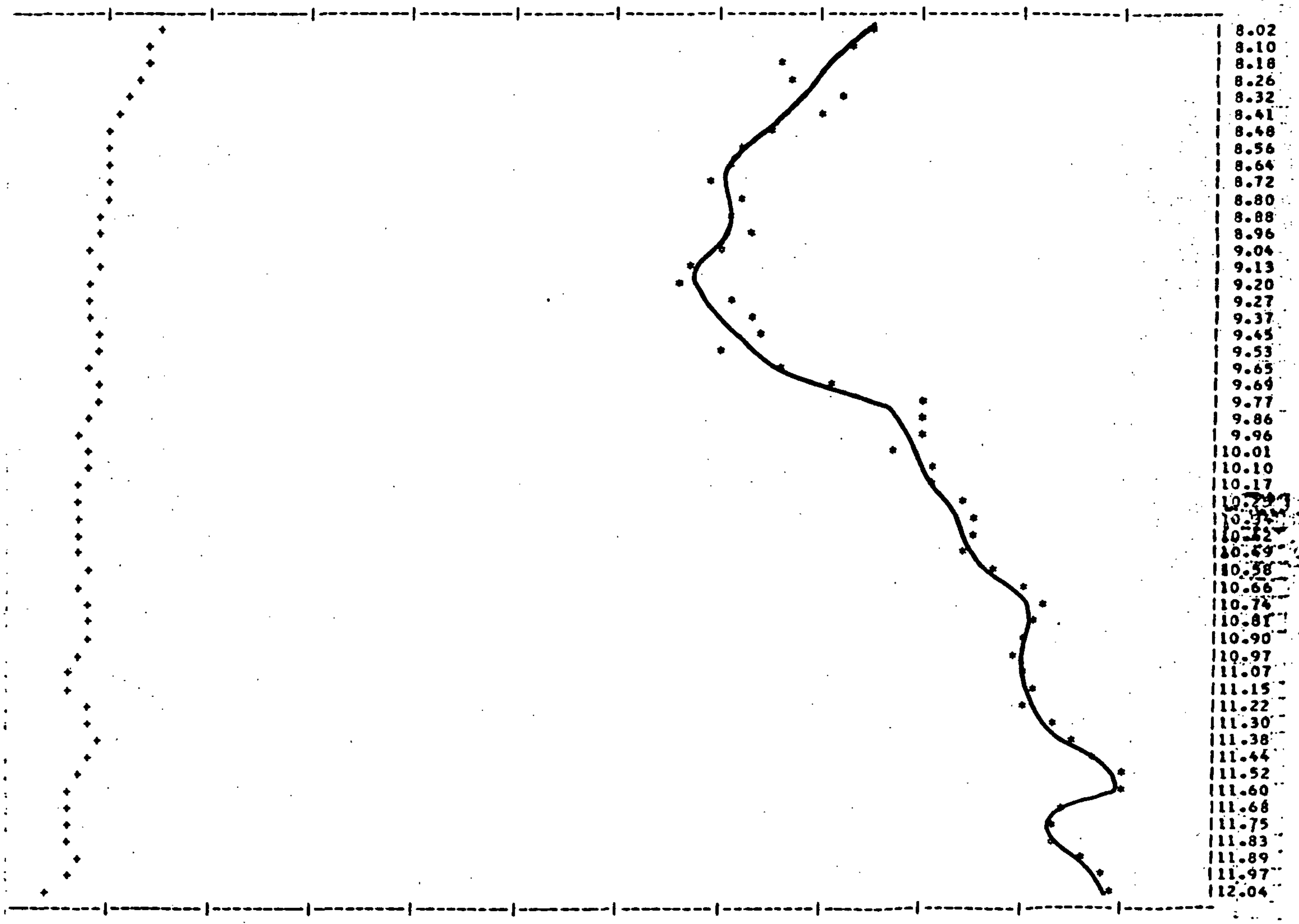
AVERAGE TEMPERATURE= 40.446 STD.DEV.= 0.741

WAVELENGTH,AVERAGE EMIT.

7.750 0.930	7.810 0.932	7.880 0.926	7.950 C.967	8.020 0.966	8.100 0.965	8.180 0.958	8.260 0.959
8.320 0.964	8.410 0.961	8.480 0.956	8.560 C.954	8.640 0.952	8.720 0.951	8.800 0.953	8.880 0.952
8.960 0.954	9.040 0.952	9.130 0.949	9.200 0.948	9.270 0.952	9.370 0.954	9.450 0.955	9.530 0.951
9.650 0.957	9.690 0.962	9.770 0.972	9.860 C.972	9.960 0.972	10.010 0.969	10.100 0.972	10.170 0.973
10.250 0.975	10.340 0.976	10.420 0.977	10.490 0.975	10.580 0.979	10.660 0.981	10.740 0.983	10.810 0.982
10.900 0.981	10.970 0.991	11.070 0.982	11.150 C.982	11.220 0.981	11.300 0.985	11.380 0.987	11.440 0.989
11.520 C.992	11.600 0.992	11.680 0.986	11.750 C.985	11.830 0.984	11.890 0.988	11.970 0.989	12.040 0.990
12.120 C.991	12.190 0.993	12.260 0.983	12.330 C.984				

WAVELENGTH,STD.DEV.

7.750 0.017	7.810 0.C17	7.880 0.019	7.950 C.019	8.020 0.016	8.100 0.015	8.180 0.015	8.260 0.015
8.320 C.013	8.410 0.C13	8.480 0.012	8.560 C.012	8.640 0.011	8.720 0.011	8.800 0.011	8.880 0.011
8.960 0.010	9.040 0.010	9.130 0.010	9.2CC C.010	9.270 0.010	9.370 0.010	9.450 0.010	9.530 0.010
9.650 0.010	9.690 0.C10	9.770 0.010	9.860 0.010	9.960 0.009	10.010 0.009	10.100 0.009	10.170 0.009
10.250 0.009	10.340 0.C06	10.420 0.009	10.45C C.C08	10.580 0.009	10.660 0.008	10.740 0.009	10.810 0.010
10.900 0.009	10.970 0.008	11.070 0.008	11.150 C.008	11.220 0.009	11.300 0.010	11.380 0.010	11.440 0.009
11.520 C.008	11.600 0.C07	11.680 0.007	11.750 0.007	11.830 0.008	11.890 0.009	11.970 0.008	12.040 0.006
12.120 0.008	12.190 0.CC8	12.260 0.007	12.33C C.C08				



AVERAGED DATA
NUMBER OF SPECTRA 21
FLD GROUP 6 19 8 43636 EC011102 02000000 MX108-1 SAND BASALT

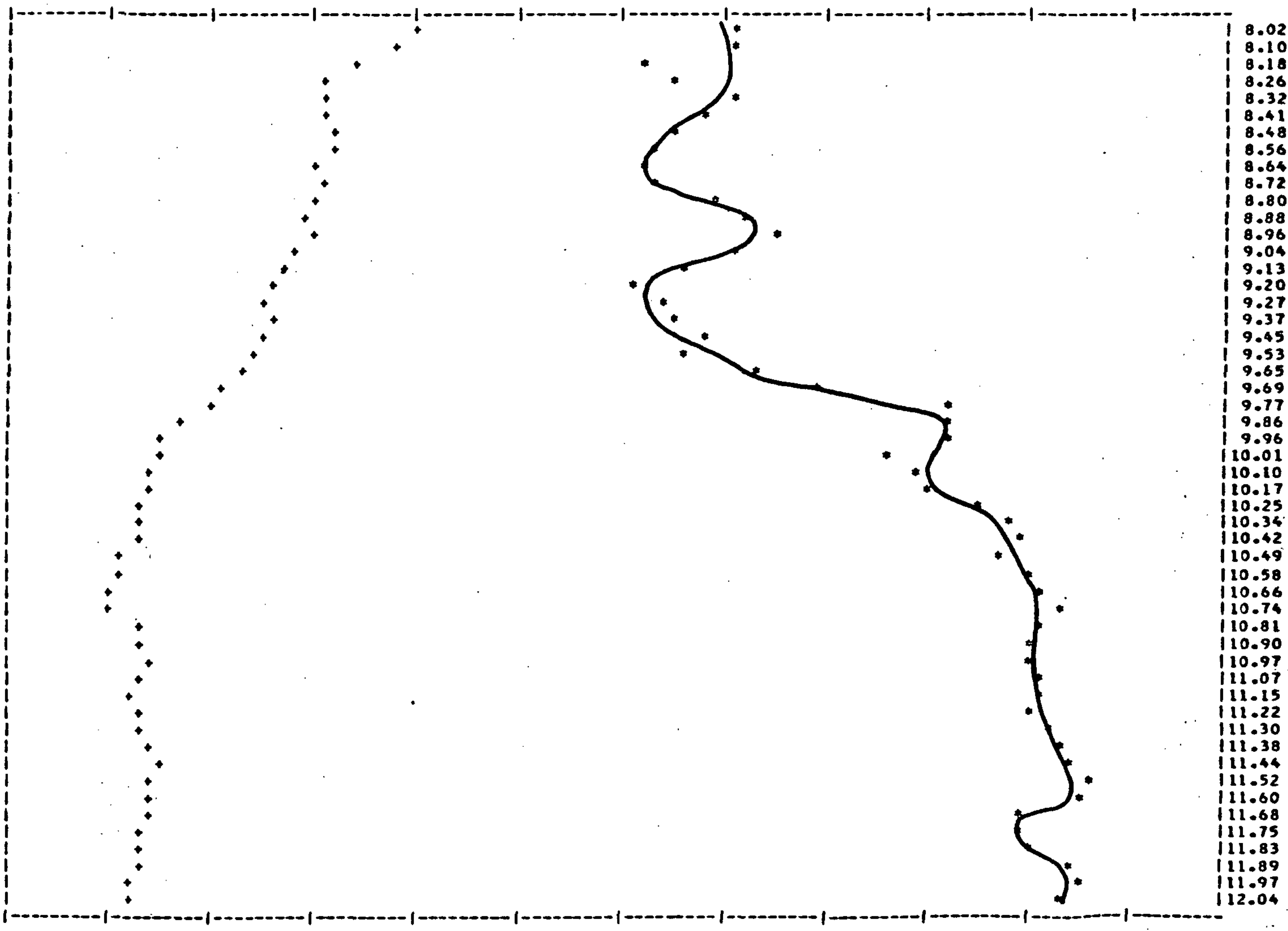
AVERAGE TEMPERATURE= 43.950 STD.DEV.= 1.969

WAVELENGTH,AVERAGE EMIT.

7.750 0.910	7.810 0.912	7.880 0.903	7.950 0.955	8.020 0.953	8.100 0.952	8.180 0.943	8.260 0.946
8.320 0.952	8.410 0.950	8.480 0.946	8.560 0.944	8.640 0.943	8.720 0.945	8.800 0.951	8.880 0.953
8.960 0.957	9.040 0.953	9.130 0.947	9.200 0.942	9.270 0.946	9.370 0.947	9.450 0.949	9.530 0.947
9.650 0.955	9.690 0.961	9.770 0.973	9.860 0.974	9.960 0.974	10.010 0.969	10.100 0.970	10.170 0.971
10.250 0.976	10.340 0.979	10.420 0.981	10.490 0.978	10.580 0.981	10.660 0.982	10.740 0.984	10.810 0.982
10.900 0.982	10.970 0.981	11.070 0.982	11.150 0.982	11.220 0.981	11.300 0.983	11.380 0.985	11.440 0.985
11.520 0.987	11.600 0.987	11.680 0.981	11.750 0.981	11.830 0.982	11.890 0.986	11.970 0.986	12.040 0.985
12.120 0.985	12.190 0.987	12.260 0.977	12.330 0.978				

WAVELENGTH,STD.DEV.

7.750 0.038	7.810 0.035	7.880 0.038	7.950 0.041	8.020 0.041	8.100 0.039	8.180 0.035	8.260 0.033
8.320 0.033	8.410 0.033	8.480 0.033	8.560 0.033	8.640 0.032	8.720 0.032	8.800 0.032	8.880 0.031
8.960 0.031	9.040 0.029	9.130 0.028	9.200 0.028	9.270 0.027	9.370 0.028	9.450 0.027	9.530 0.025
9.650 0.025	9.690 0.023	9.770 0.021	9.860 0.019	9.960 0.017	10.010 0.016	10.100 0.016	10.170 0.016
10.250 0.015	10.340 0.014	10.420 0.014	10.490 0.013	10.580 0.012	10.660 0.012	10.740 0.011	10.810 0.014
10.900 0.015	10.970 0.015	11.070 0.015	11.150 0.014	11.220 0.015	11.300 0.014	11.380 0.015	11.440 0.017
11.520 0.016	11.600 0.016	11.680 0.015	11.750 0.014	11.830 0.015	11.890 0.015	11.970 0.014	12.040 0.014
12.120 0.013	12.190 0.013	12.260 0.011	12.330 0.014				



NUMBER OF SPECTRA - 9
FOR GROUP 7 18 50 54468 6C011101 0.000000 MX108-1 SAND OVER BASALT

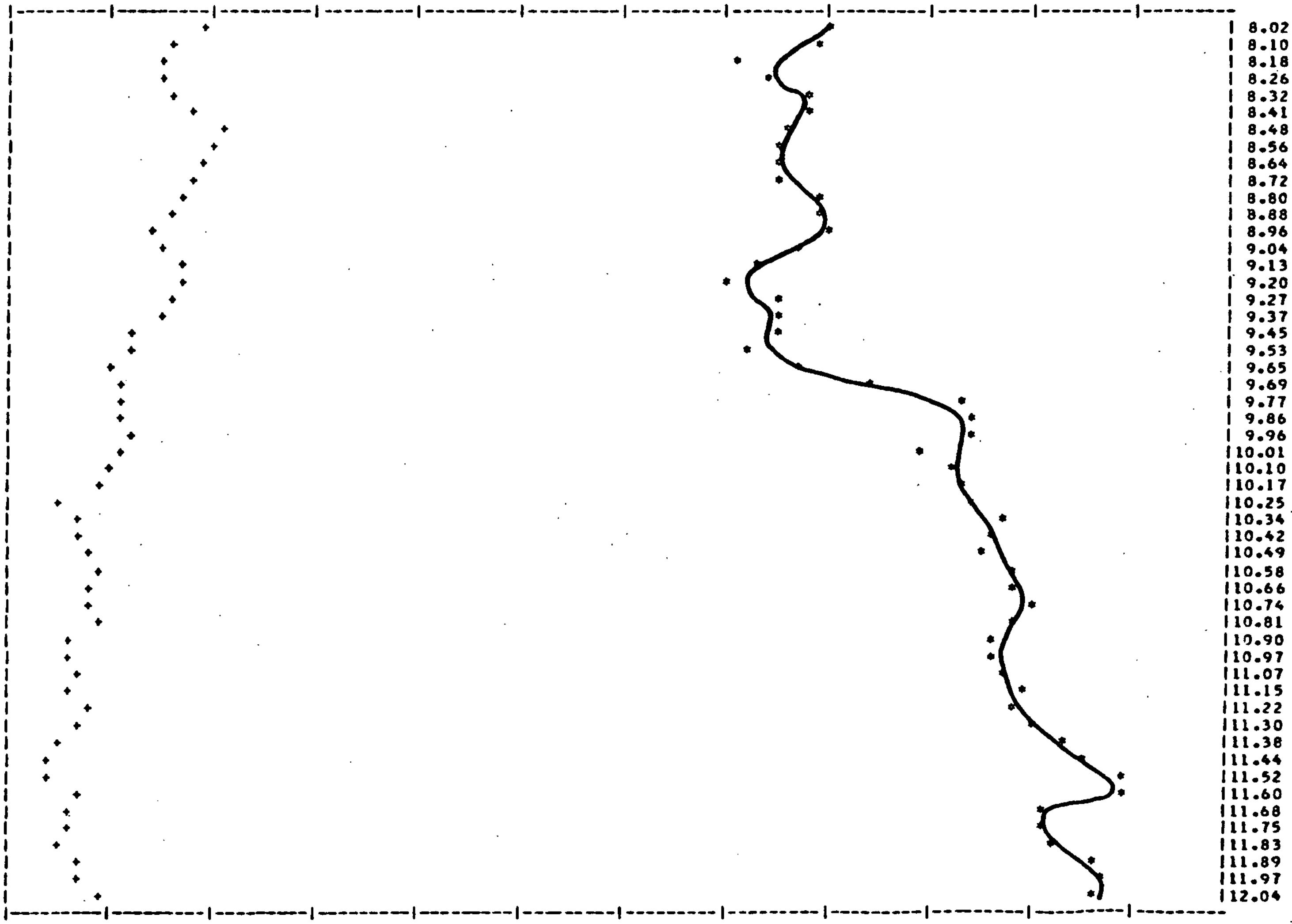
AVERAGE TEMPERATURE= 40.713 STD.DEV.= 1.655

WAVELENGTH,AVERAGE EMIT.

7.750 0.924	7.810 0.931	7.880 0.919	7.950 0.965	8.020 0.961	8.100 0.961	8.180 0.953	8.260 0.955
8.320 0.960	8.410 0.959	8.480 0.957	8.560 0.956	8.640 0.957	8.720 0.956	8.800 0.960	8.880 0.961
8.960 0.961	9.040 0.958	9.130 0.954	9.200 0.952	9.270 0.956	9.370 0.956	9.450 0.956	9.530 0.953
9.650 0.958	9.690 0.965	9.770 0.975	9.860 0.976	9.960 0.976	10.010 0.971	10.100 0.974	10.170 0.974
10.250 0.976	10.340 0.978	10.420 0.977	10.490 0.976	10.580 0.979	10.660 0.980	10.740 0.982	10.810 0.979
10.900 0.977	10.970 0.975	11.070 0.978	11.150 0.961	11.220 0.980	11.300 0.982	11.380 0.984	11.440 0.986
11.520 0.990	11.600 0.990	11.680 0.983	11.750 0.983	11.830 0.984	11.890 0.987	11.970 0.988	12.040 0.987
12.120 0.986	12.190 0.990	12.260 0.986	12.330 0.984				

WAVELENGTH,STD.DEV.

7.750 0.026	7.810 0.028	7.880 0.031	7.950 0.023	8.020 0.020	8.100 0.017	8.180 0.016	8.260 0.016
8.320 0.017	8.410 0.020	8.480 0.023	8.560 0.022	8.640 0.021	8.720 0.020	8.800 0.018	8.880 0.017
8.960 0.016	9.040 0.017	9.130 0.019	9.200 0.018	9.270 0.018	9.370 0.016	9.450 0.014	9.530 0.013
9.650 0.012	9.690 0.012	9.770 0.013	9.860 0.013	9.960 0.014	10.010 0.013	10.100 0.012	10.170 0.010
10.250 0.007	10.340 0.008	10.420 0.009	10.490 0.009	10.580 0.010	10.660 0.010	10.740 0.009	10.810 0.010
10.900 0.008	10.970 0.007	11.070 0.008	11.150 0.008	11.220 0.010	11.300 0.008	11.380 0.007	11.440 0.005
11.520 0.006	11.600 0.008	11.680 0.007	11.750 0.007	11.830 0.006	11.890 0.008	11.970 0.009	12.040 0.010
12.120 0.010	12.190 0.015	12.260 0.009	12.330 0.009				



AVERAGED DATA
NUMBER OF SPECTRA 6
FOR GROUP 8 19 8 28784 6C011102 02000000 MX10B-1 PISGAH FLOW 3

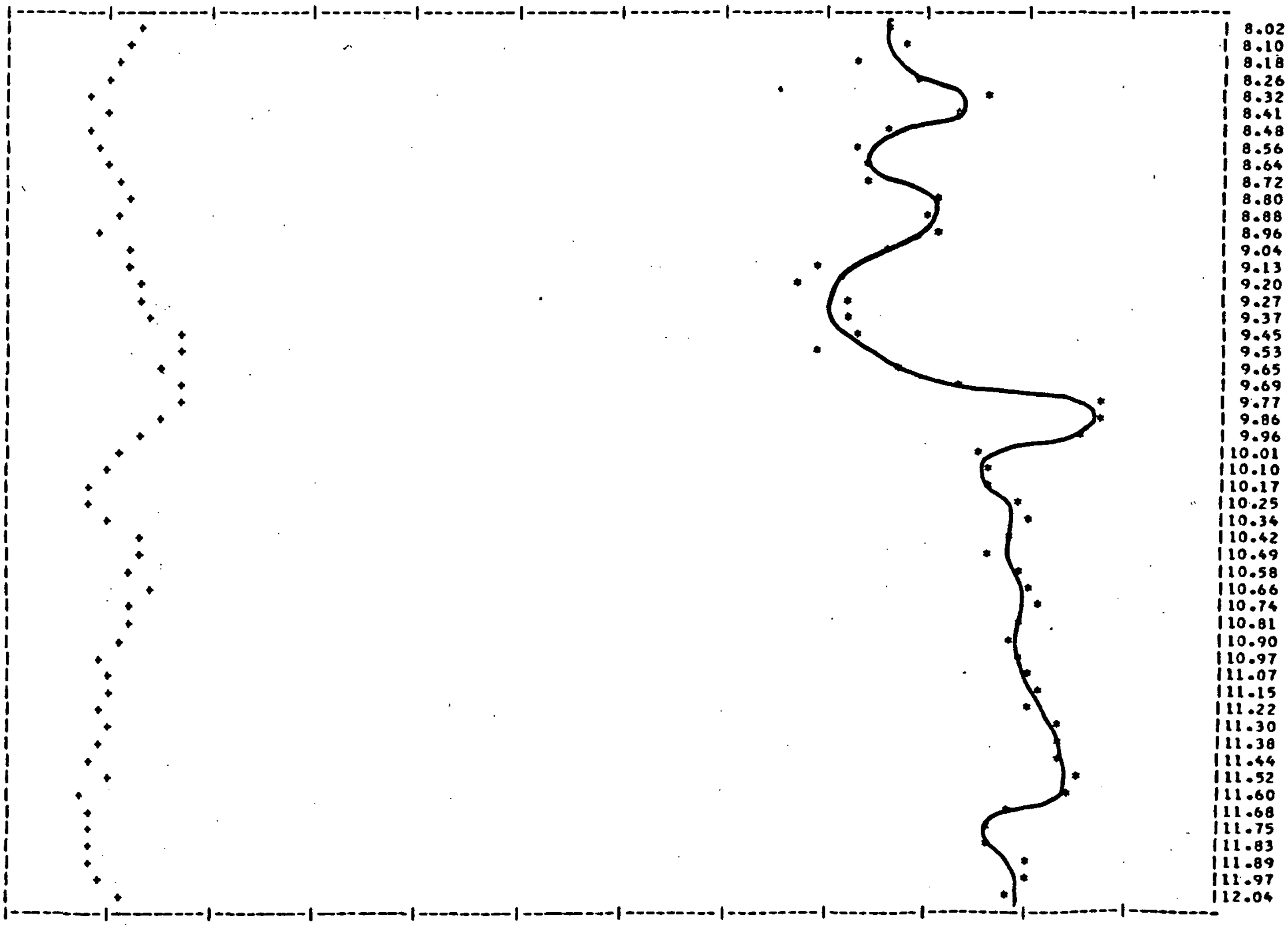
AVERAGE TEMPERATURE= 46.015 STD.DEV.= 5.038

WAVELENGTH,AVERAGE EMIT.

7.750 0.914	7.810 0.921	7.880 0.909	7.950 0.967	8.020 0.967	8.100 0.969	8.180 0.965	8.260 0.970
8.320 0.978	8.410 0.974	8.480 0.967	8.560 0.965	8.640 0.965	8.720 0.965	8.800 0.972	8.880 0.971
8.960 0.972	9.040 0.967	9.130 0.961	9.200 0.959	9.270 0.963	9.370 0.963	9.450 0.965	9.530 0.960
9.650 0.968	9.690 0.975	9.770 0.988	9.860 0.989	9.960 0.987	10.010 0.977	10.100 0.978	10.170 0.977
10.250 0.981	10.340 0.981	10.420 0.980	10.490 0.977	10.580 0.980	10.660 0.982	10.740 0.983	10.810 0.981
10.900 0.980	10.970 0.980	11.070 0.981	11.150 0.982	11.220 0.981	11.300 0.984	11.380 0.985	11.440 0.985
11.520 0.986	11.600 0.985	11.680 0.979	11.750 0.978	11.830 0.978	11.890 0.982	11.970 0.982	12.040 0.979
12.120 0.977	12.190 0.980	12.260 0.972	12.330 0.973				

WAVELENGTH,STD.DEV.

7.750 0.019	7.810 0.025	7.880 0.023	7.950 0.019	8.020 0.014	8.100 0.013	8.180 0.012	8.260 0.012
8.320 0.010	8.410 0.011	8.480 0.010	8.560 0.011	8.640 0.012	8.720 0.012	8.800 0.013	8.880 0.012
8.960 0.011	9.040 0.014	9.130 0.014	9.200 0.014	9.270 0.015	9.370 0.015	9.450 0.018	9.530 0.018
9.650 0.016	9.690 0.018	9.770 0.018	9.860 0.016	9.960 0.015	10.010 0.013	10.100 0.012	10.170 0.010
10.250 0.010	10.340 0.011	10.420 0.014	10.490 0.015	10.580 0.014	10.660 0.015	10.740 0.014	10.810 0.013
10.900 0.013	10.970 0.011	11.070 0.012	11.150 0.011	11.220 0.010	11.300 0.011	11.380 0.011	11.440 0.010
11.520 0.011	11.600 0.009	11.680 0.010	11.750 0.009	11.830 0.010	11.890 0.009	11.970 0.010	12.040 0.012
12.120 0.017	12.190 0.013	12.260 0.010	12.330 0.020				



AVERAGED DATA
NUMBER OF SPECTRA 4
FOR GROUP 9 19 8 26647 6C011132 02000000 MX108-1 PISGAH FLOW 2

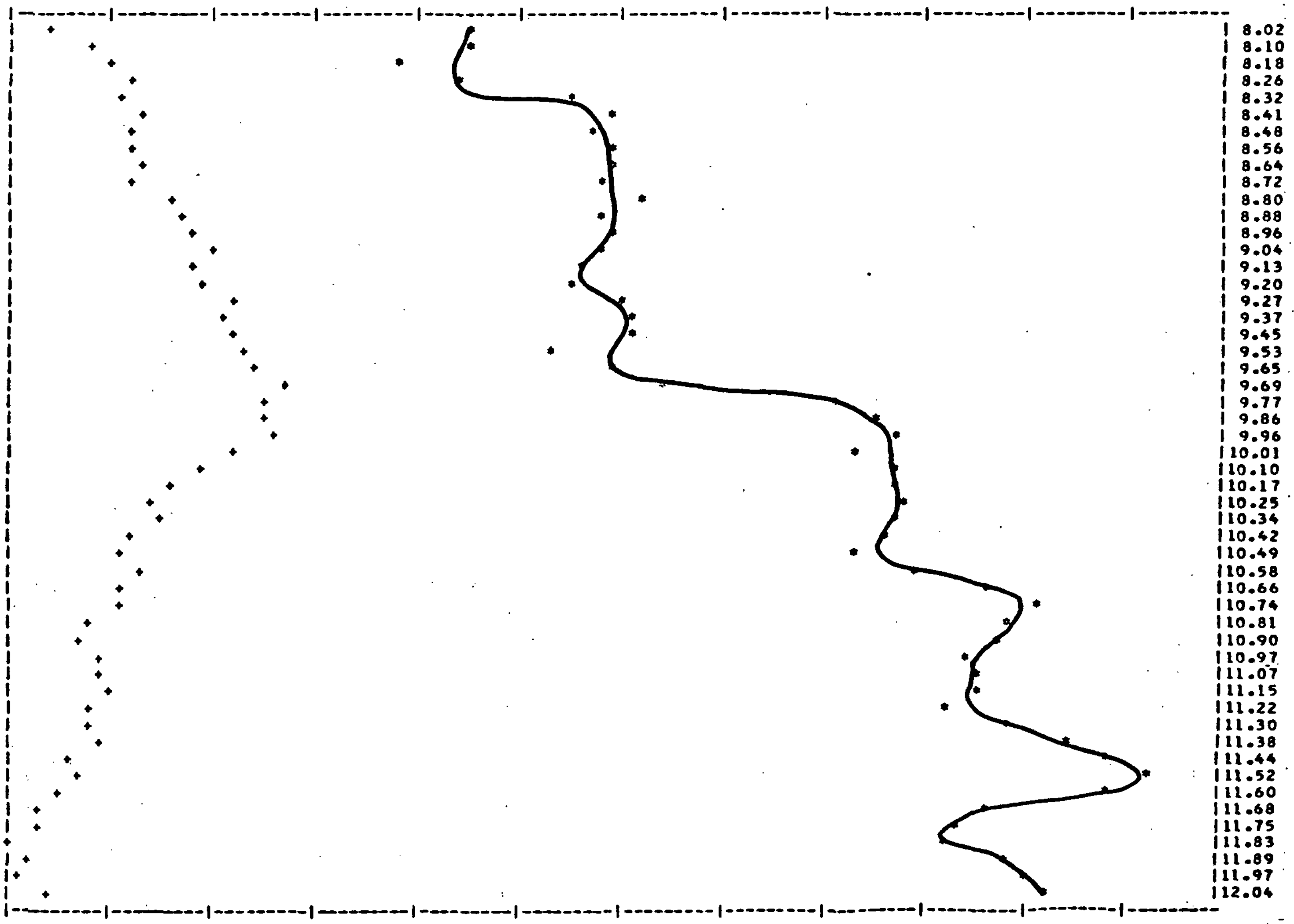
AVERAGE TEMPERATURE= 48.633 STD.DEV.= 1.240

WAVELENGTH,AVERAGE EMIT.

7.750	0.869	7.810	0.875	7.880	0.870	7.950	0.930	8.020	0.926	8.100	0.926	8.180	0.919	8.260	0.925
8.320	0.936	8.410	0.941	8.480	0.939	8.560	0.941	8.640	0.941	8.720	0.940	8.800	0.943	8.880	0.940
8.960	0.941	9.040	0.939	9.130	0.938	9.200	0.936	9.270	0.942	9.370	0.943	9.450	0.942	9.530	0.935
9.650	0.940	9.690	0.946	9.770	0.962	9.860	0.966	9.960	0.968	10.010	0.964	10.100	0.968	10.170	0.968
10.250	0.970	10.340	0.968	10.420	0.967	10.490	0.964	10.580	0.970	10.660	0.977	10.740	0.987	10.810	0.980
10.900	0.978	10.970	0.976	11.070	0.977	11.150	0.976	11.220	0.973	11.300	0.979	11.380	0.985	11.440	0.989
11.520	0.993	11.600	0.989	11.680	0.978	11.750	0.974	11.830	0.973	11.890	0.979	11.970	0.982	12.040	0.983
12.120	0.987	12.190	0.989	12.260	0.975	12.330	0.973								

WAVELENGTH,STD.DEV.

7.750	0.005	7.810	0.015	7.880	0.010	7.950	0.005	8.020	0.005	8.100	0.009	8.180	0.011	8.260	0.013
8.320	0.012	8.410	0.015	8.480	0.014	8.560	0.013	8.640	0.015	8.720	0.014	8.800	0.017	8.880	0.018
8.960	0.019	9.040	0.021	9.130	0.020	9.200	0.021	9.270	0.024	9.370	0.023	9.450	0.024	9.530	0.024
9.650	0.026	9.690	0.028	9.770	0.027	9.860	0.027	9.960	0.027	10.010	0.023	10.100	0.021	10.170	0.018
10.250	0.016	10.340	0.016	10.420	0.014	10.490	0.013	10.580	0.014	10.660	0.013	10.740	0.013	10.810	0.009
10.900	0.009	10.970	0.010	11.070	0.010	11.150	0.011	11.220	0.009	11.300	0.010	11.380	0.010	11.440	0.008
11.520	0.008	11.600	0.006	11.680	0.005	11.750	0.005	11.830	0.001	11.890	0.004	11.970	0.003	12.040	0.006
12.120	0.013	12.190	0.009	12.260	0.012	12.330	0.017								



AVERAGED DATA
NUMBER OF SPECTRA 15
FOR GROUP 10 19 6 25145 6 011172 02000000 EXTOR-1 PISGAH FLOW 1

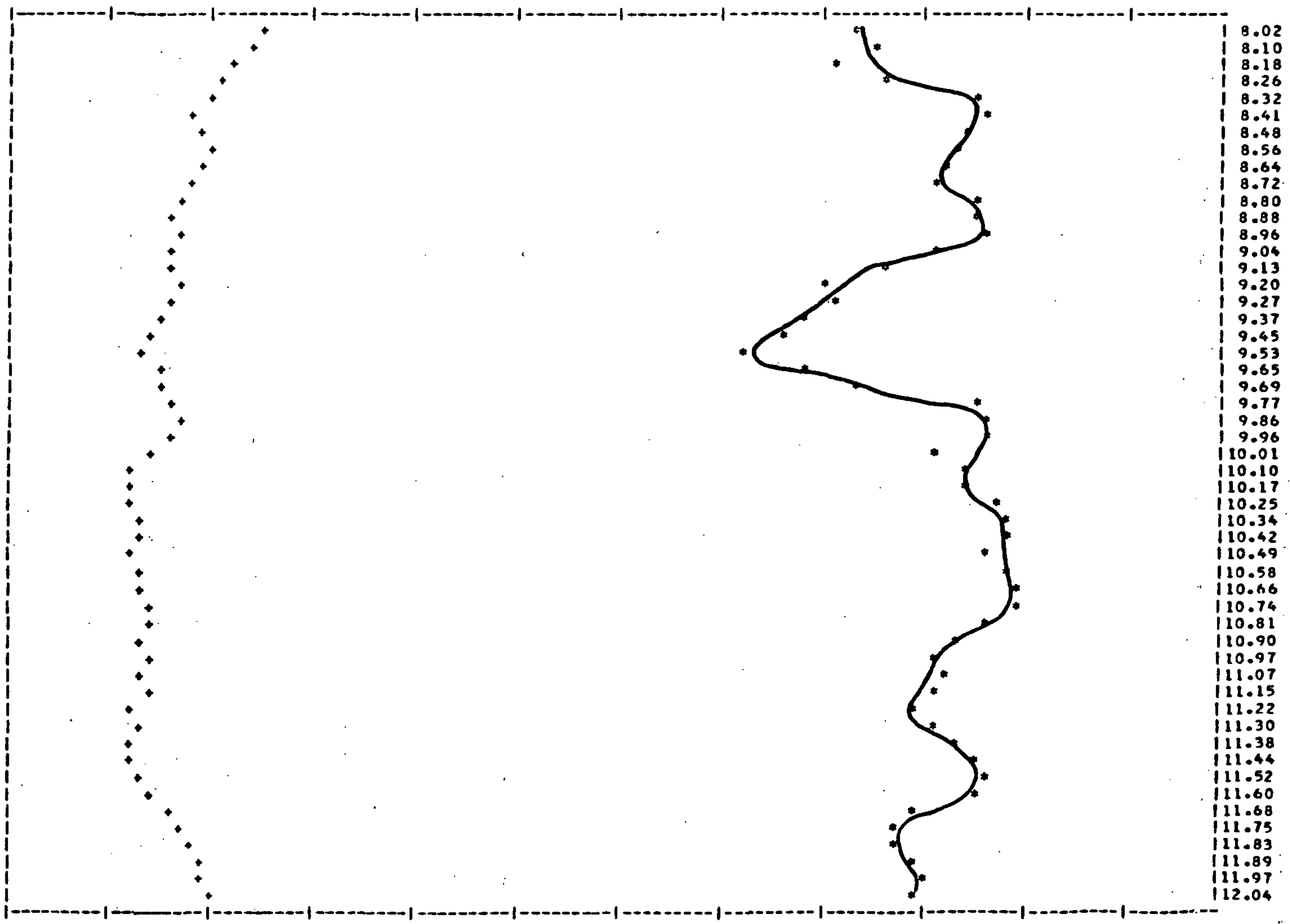
AVERAGE TEMPERATURE= 41.051   STD.DEV.= 2.160

WAVELENGTH,AVERAGE EMIT.

7.750 0.920	7.810 0.925	7.880 0.918	7.950 0.965	8.020 0.965	8.100 0.967	8.180 0.962	8.260 0.968
8.320 0.976	8.410 0.977	8.480 0.976	8.560 0.974	8.640 0.973	8.720 0.972	8.800 0.976	8.880 0.976
8.960 0.977	9.040 0.972	9.130 0.967	9.200 0.961	9.270 0.962	9.370 0.959	9.450 0.958	9.530 0.954
9.650 0.959	9.690 0.964	9.770 0.976	9.860 0.977	9.960 0.978	10.010 0.973	10.100 0.975	10.170 0.976
10.250 0.979	10.340 0.979	10.420 0.980	10.490 0.977	10.580 0.979	10.660 0.980	10.740 0.980	10.810 0.977
10.900 0.974	10.970 0.973	11.070 0.973	11.150 0.973	11.220 0.971	11.300 0.973	11.380 0.975	11.440 0.976
11.520 0.977	11.600 0.977	11.680 0.970	11.750 0.969	11.830 0.968	11.890 0.970	11.970 0.971	12.040 0.971
12.120 0.971	12.190 0.970	12.260 0.964	12.330 0.965				

WAVELENGTH,STD.DEV.

7.750 0.025	7.810 0.026	7.880 0.025	7.950 0.027	8.020 0.026	8.100 0.025	8.180 0.024	8.260 0.023
8.320 0.022	8.410 0.020	8.480 0.020	8.560 0.021	8.640 0.021	8.720 0.019	8.800 0.019	8.880 0.017
8.960 0.018	9.040 0.013	9.130 0.018	9.200 0.018	9.270 0.017	9.370 0.017	9.450 0.016	9.530 0.014
9.650 0.016	9.690 0.016	9.770 0.018	9.860 0.019	9.960 0.017	10.010 0.015	10.100 0.013	10.170 0.013
10.250 0.014	10.340 0.015	10.420 0.014	10.490 0.014	10.580 0.015	10.660 0.015	10.740 0.015	10.810 0.015
10.900 0.015	10.970 0.015	11.070 0.015	11.150 0.015	11.220 0.014	11.300 0.014	11.380 0.014	11.440 0.013
11.520 0.015	11.600 0.016	11.680 0.017	11.750 0.019	11.830 0.019	11.890 0.020	11.970 0.020	12.040 0.022
12.120 0.025	12.190 0.026	12.260 0.026	12.330 0.028				



... DATA
... OF SPECTRA 11
... GROUP 11 18 81 13067 60011101 02000000 MX103-1 LAVA FLOW 2A

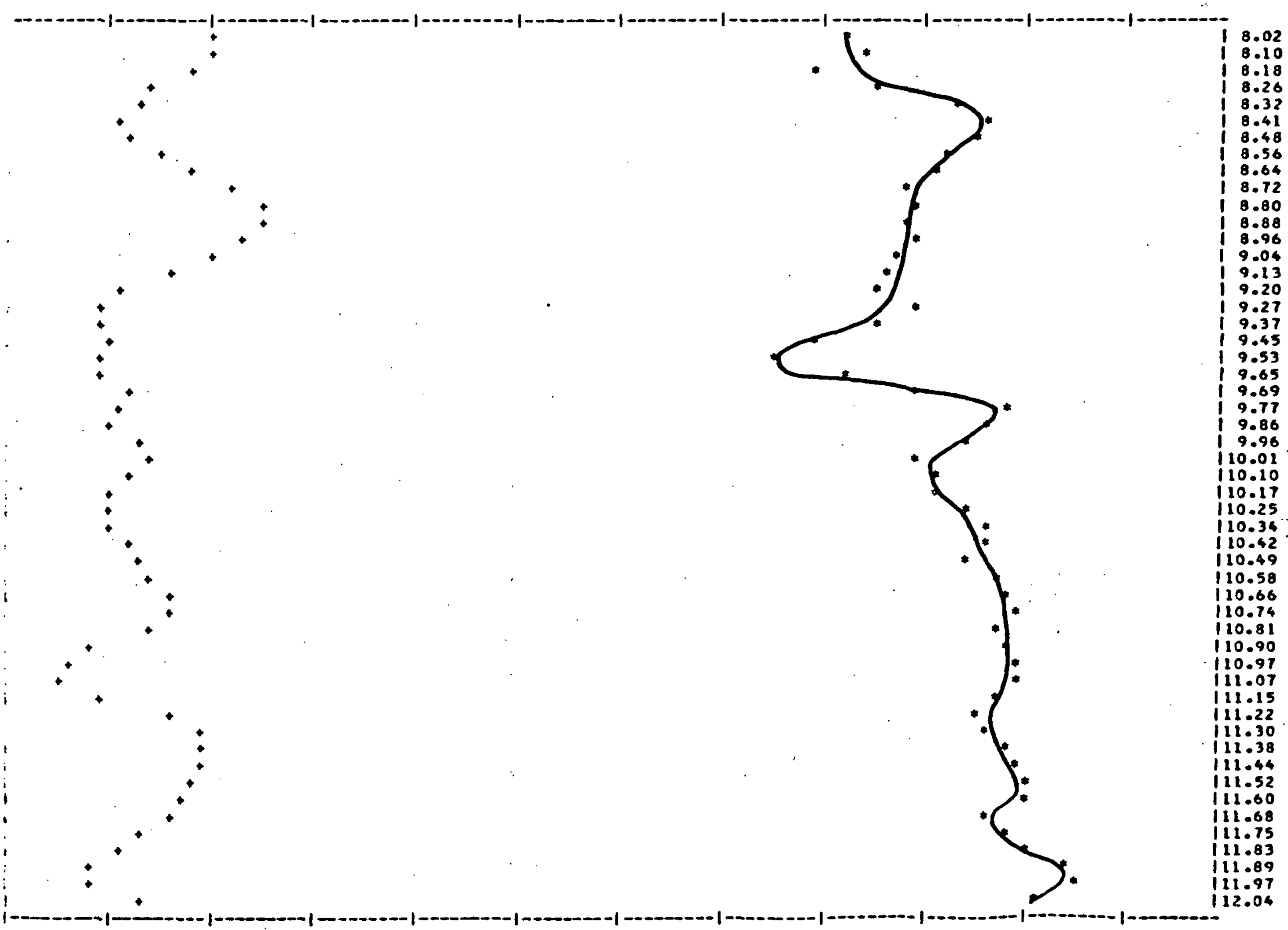
...L TEMPERATURE= 37.806 STD.DEV.= 2.411

WAVELENGTH,AVERAGE EMIT.

7.750 0.929	7.810 0.934	7.880 0.924	7.950 0.967	8.020 0.964	8.100 0.965	8.180 0.960	8.260 0.966
8.320 0.975	8.410 0.977	8.480 0.976	8.560 0.974	8.640 0.972	8.720 0.969	8.800 0.970	8.880 0.970
8.960 0.970	9.040 0.968	9.130 0.967	9.200 0.966	9.270 0.970	9.370 0.967	9.450 0.960	9.530 0.956
9.650 0.964	9.690 0.971	9.770 0.980	9.860 0.977	9.960 0.975	10.010 0.971	10.100 0.972	10.170 0.973
10.250 0.976	10.340 0.977	10.420 0.977	10.490 0.975	10.580 0.978	10.660 0.979	10.740 0.980	10.810 0.979
10.900 0.979	10.970 0.980	11.070 0.981	11.150 0.979	11.220 0.976	11.300 0.977	11.380 0.980	11.440 0.980
11.520 0.981	11.600 0.981	11.680 0.976	11.750 0.980	11.830 0.982	11.890 0.985	11.970 0.986	12.040 0.983
12.120 0.979	12.190 0.977	12.260 0.974	12.330 0.973				

WAVELENGTH,STD.DEV.

7.750 0.018	7.810 0.025	7.880 0.018	7.950 0.022	8.020 0.021	8.100 0.022	8.180 0.019	8.260 0.015
8.320 0.014	8.410 0.013	8.480 0.014	8.560 0.017	8.640 0.019	8.720 0.023	8.800 0.026	8.880 0.026
8.960 0.025	9.040 0.022	9.130 0.018	9.200 0.013	9.270 0.011	9.370 0.010	9.450 0.011	9.530 0.010
9.650 0.011	9.690 0.014	9.770 0.013	9.860 0.011	9.960 0.015	10.010 0.016	10.100 0.013	10.170 0.012
10.250 0.011	10.340 0.011	10.420 0.013	10.490 0.015	10.590 0.016	10.660 0.017	10.740 0.018	10.810 0.015
10.900 0.009	10.970 0.009	11.070 0.007	11.150 0.010	11.220 0.017	11.300 0.021	11.380 0.020	11.440 0.021
11.520 0.020	11.600 0.019	11.680 0.018	11.750 0.015	11.830 0.012	11.890 0.010	11.970 0.010	12.040 0.014
12.120 0.028	12.190 0.029	12.260 0.027	12.330 0.028				



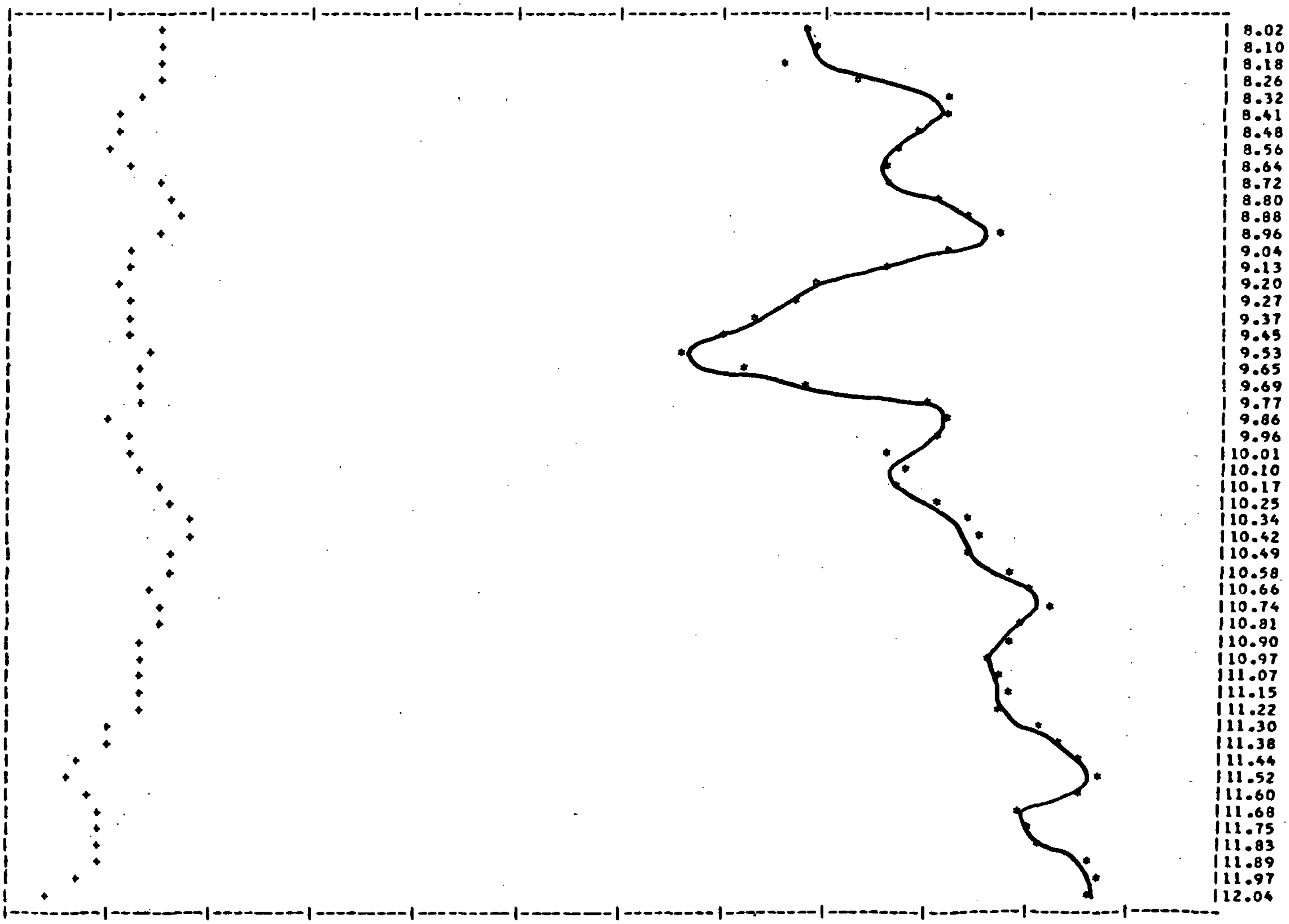
AVERAGED DATA
NUMBER OF SPECTRA 9
FOR GROUP 12 15 8 16649 6C311102 02000000 PX103-1 LAVA FLOW 2D

AVERAGE TEMPERATURE= 42.725 STD.DEV.= 1.507
WAVELENGTH,AVERAGE EMIT.

7.750 0.914	7.810 0.921	7.880 0.912	7.950 0.958	8.020 0.959	8.100 0.961	8.180 0.957	8.260 0.964
8.320 0.974	8.410 0.974	8.480 0.971	8.560 0.968	8.640 0.967	8.720 0.967	8.800 0.973	8.880 0.975
8.960 0.978	9.040 0.974	9.130 0.967	9.200 0.960	9.270 0.959	9.370 0.955	9.450 0.952	9.530 0.947
9.650 0.954	9.690 0.960	9.770 0.972	9.860 0.973	9.960 0.973	10.010 0.968	10.100 0.970	10.170 0.969
10.250 0.973	10.340 0.975	10.420 0.977	10.450 0.976	10.580 0.979	10.660 0.981	10.740 0.984	10.810 0.981
10.900 0.979	10.970 0.977	11.070 0.978	11.150 0.979	11.220 0.978	11.300 0.982	11.380 0.985	11.440 0.986
11.520 0.966	11.600 0.987	11.680 0.981	11.750 0.981	11.830 0.983	11.890 0.938	11.970 0.988	12.040 0.987
12.120 0.986	12.190 0.988	12.260 0.970	12.330 0.978				

WAVELENGTH,STD.DEV.

7.750 0.016	7.810 0.019	7.880 0.013	7.950 0.018	8.020 0.016	8.100 0.017	8.180 0.016	8.260 0.016
8.320 0.015	8.410 0.012	8.480 0.012	8.560 0.012	8.640 0.013	8.720 0.016	8.800 0.018	8.880 0.019
8.960 0.016	9.040 0.014	9.130 0.014	9.200 0.012	9.270 0.014	9.370 0.013	9.450 0.013	9.530 0.016
9.650 0.014	9.690 0.014	9.770 0.014	9.860 0.012	9.960 0.014	10.010 0.013	10.100 0.014	10.170 0.017
10.250 0.017	10.340 0.019	10.420 0.019	10.450 0.018	10.580 0.017	10.660 0.016	10.740 0.017	10.810 0.016
10.900 0.015	10.970 0.015	11.070 0.014	11.150 0.014	11.220 0.014	11.300 0.012	11.380 0.011	11.440 0.009
11.520 0.008	11.600 0.009	11.680 0.011	11.750 0.010	11.830 0.011	11.890 0.010	11.970 0.009	12.040 0.006
12.120 0.006	12.190 0.008	12.260 0.008	12.330 0.012				



AVERAGED DATA
NUMBER OF SPECTRA
FOR GROUP 13 18 51 21487 0C311191 02300000 RX108-1 PLAVA A

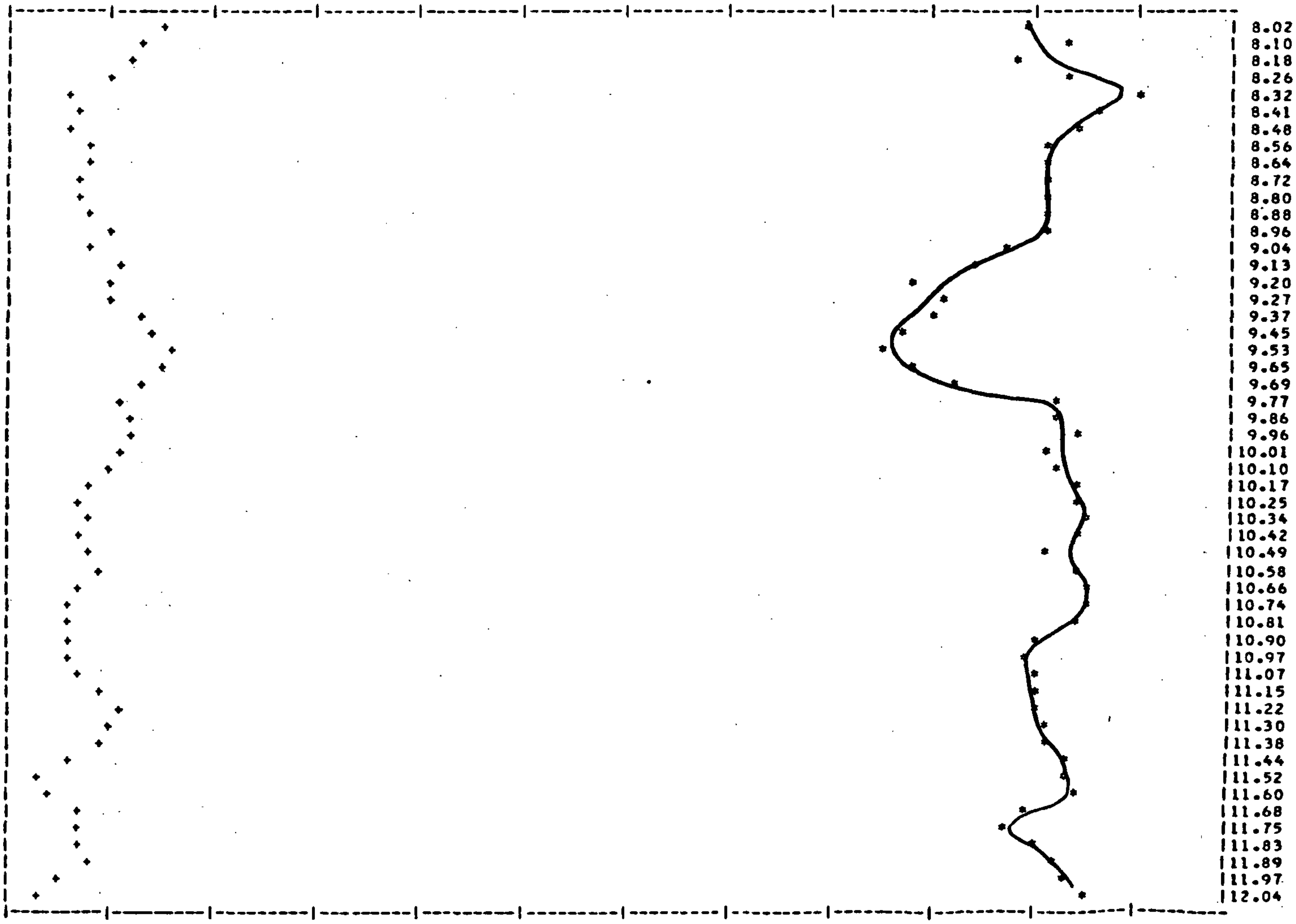
AVERAGE TEMPERATURE= 36.438 STD.DEV.= 1.366

WAVELENGTH,AVERAGE EMIT.

7.750	0.942	7.810	0.956	7.880	0.940	7.950	0.979	8.020	0.981	8.100	0.984	8.180	0.979	8.260	0.985
8.320	0.991	8.410	0.988	8.480	0.985	8.560	0.983	8.640	0.983	8.720	0.983	8.800	0.982	8.880	0.982
8.960	0.983	9.040	0.979	9.130	0.975	9.200	0.970	9.270	0.972	9.370	0.971	9.450	0.969	9.530	0.966
9.650	0.969	9.690	0.973	9.770	0.983	9.860	0.984	9.960	0.986	10.010	0.983	10.100	0.983	10.170	0.985
10.250	0.986	10.340	0.987	10.420	0.986	10.490	0.983	10.580	0.986	10.660	0.987	10.740	0.987	10.810	0.986
10.900	0.981	10.970	0.981	11.070	0.982	11.150	0.982	11.220	0.982	11.300	0.982	11.380	0.983	11.440	0.985
11.520	0.985	11.600	0.985	11.680	0.980	11.750	0.979	11.830	0.982	11.890	0.983	11.970	0.985	12.040	0.987
12.120	0.991	12.190	0.987	12.260	0.980	12.330	0.986								

WAVELENGTH,STD.DEV.

7.750	0.022	7.810	0.024	7.880	0.024	7.950	0.018	8.020	0.017	8.100	0.014	8.180	0.014	8.260	0.012
8.320	0.038	8.410	0.006	8.480	0.008	8.560	0.009	8.640	0.009	8.720	0.009	8.800	0.008	8.880	0.010
8.960	0.011	9.040	0.010	9.130	0.012	9.200	0.011	9.270	0.012	9.370	0.015	9.450	0.015	9.530	0.017
9.650	0.016	9.690	0.014	9.770	0.013	9.860	0.013	9.960	0.013	10.010	0.013	10.100	0.012	10.170	0.010
10.250	0.009	10.340	0.009	10.420	0.009	10.490	0.010	10.580	0.010	10.660	0.008	10.740	0.008	10.810	0.007
10.900	0.008	10.970	0.008	11.070	0.008	11.150	0.010	11.220	0.012	11.300	0.012	11.380	0.011	11.440	0.007
11.520	0.004	11.600	0.006	11.680	0.008	11.750	0.009	11.830	0.008	11.890	0.009	11.970	0.006	12.040	0.005
12.120	0.004	12.190	0.008	12.260	0.009	12.330	0.008								



AVERAGED DATA
NUMBER OF SPECTRA 31
FOR GROUP 14 19 5 6624 6C011102 02000000 MX105-1 P TRAIN LAVA

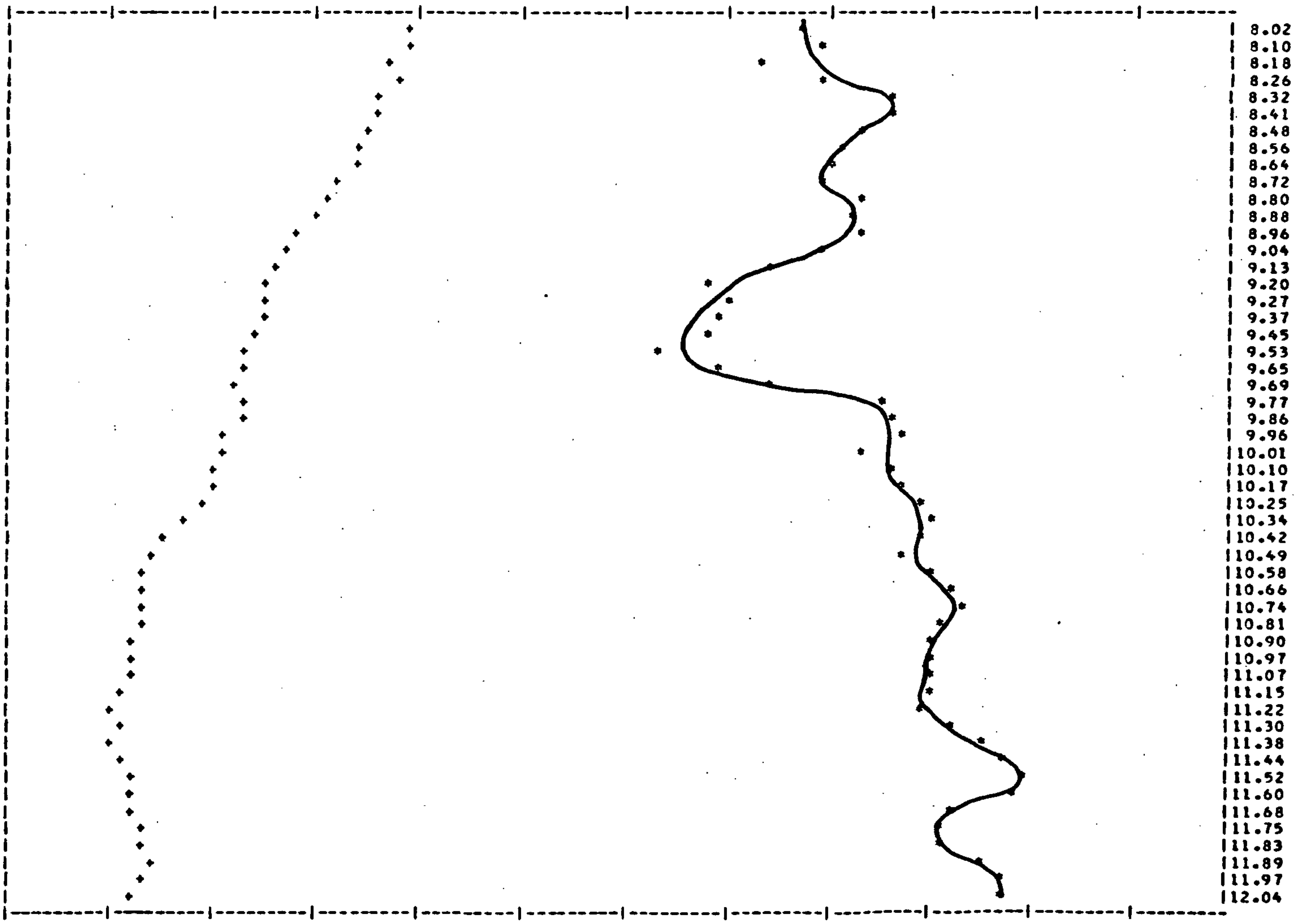
AVERAGE TEMPERATURE= 42.864 STD.DEV.= 1.670

WAVELENGTH,AVERAGE EMIT.

7.750 0.912	7.810 0.916	7.880 0.908	7.950 0.960	8.020 0.959	8.100 0.960	8.180 0.955	8.260 0.960
8.320 0.968	8.410 0.967	8.480 0.965	8.560 0.963	8.640 0.962	8.720 0.960	8.800 0.964	8.880 0.963
8.960 0.965	9.040 0.960	9.130 0.955	9.200 0.950	9.270 0.951	9.370 0.950	9.450 0.950	9.530 0.945
9.650 0.951	9.690 0.956	9.770 0.967	9.860 0.968	9.960 0.968	10.010 0.964	10.100 0.968	10.170 0.968
10.250 0.971	10.340 0.971	10.420 0.971	10.490 0.968	10.580 0.971	10.660 0.974	10.740 0.975	10.810 0.973
10.930 0.972	10.970 0.971	11.070 0.971	11.150 0.972	11.220 0.971	11.300 0.974	11.380 0.977	11.440 0.978
11.520 0.981	11.600 0.980	11.680 0.973	11.750 0.972	11.830 0.973	11.890 0.977	11.970 0.979	12.040 0.979
12.120 0.980	12.190 0.981	12.260 0.974	12.330 0.974				

WAVELENGTH,STD.DEV.

7.750 0.032	7.810 0.037	7.880 0.033	7.950 0.044	8.020 0.040	8.100 0.040	8.180 0.039	8.260 0.039
8.320 0.038	8.410 0.037	8.480 0.037	8.560 0.036	8.640 0.035	8.720 0.033	8.800 0.033	8.880 0.032
8.960 0.030	9.040 0.028	9.130 0.027	9.200 0.027	9.270 0.027	9.370 0.026	9.450 0.026	9.530 0.025
9.650 0.024	9.690 0.024	9.770 0.024	9.860 0.024	9.960 0.023	10.010 0.022	10.100 0.022	10.170 0.021
10.250 0.020	10.340 0.019	10.420 0.017	10.490 0.015	10.580 0.014	10.660 0.014	10.740 0.014	10.810 0.014
10.900 0.014	10.970 0.013	11.070 0.013	11.150 0.013	11.220 0.012	11.300 0.012	11.380 0.012	11.440 0.013
11.520 0.013	11.600 0.013	11.680 0.013	11.750 0.014	11.830 0.015	11.890 0.015	11.970 0.015	12.040 0.014
12.120 0.013	12.190 0.017	12.260 0.016	12.330 0.016				



AVERAGED DATA
NUMBER OF SPECTRA 8
FFF GROUP 15 18 51 28162 6001I101 02000000 MXIC9-1 PLAVA P

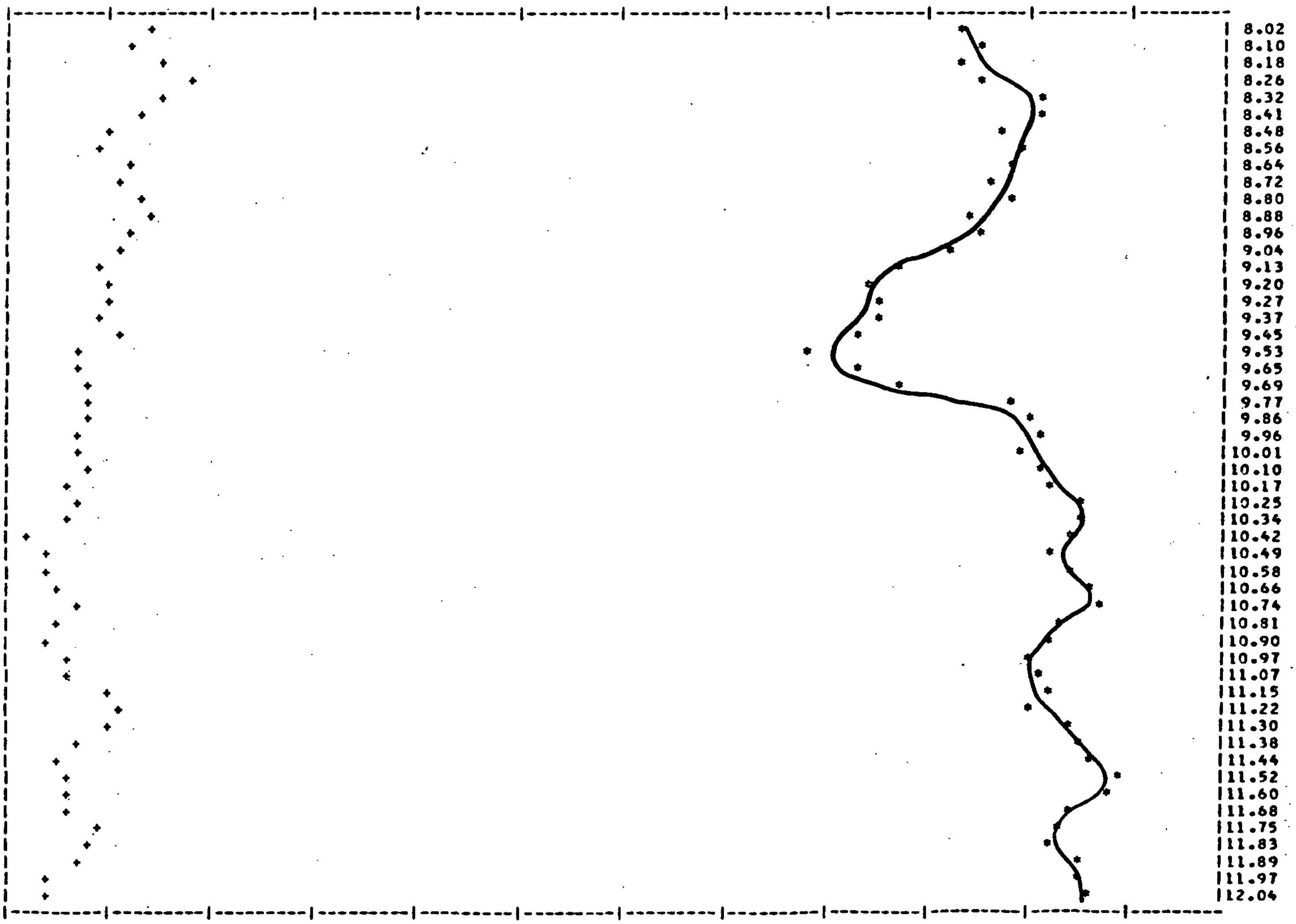
AVERAGE TEMPERATURE= 33.372 STD.DEV.= 0.831

WAVELENGTH,AVERAGE EMIT.

7.750 0.937	7.810 0.939	7.880 0.937	7.950 0.972	8.020 0.974	8.100 0.976	8.180 0.975	8.260 0.977
8.320 0.982	8.410 0.992	8.480 0.979	8.560 0.981	8.640 0.979	8.720 0.978	8.800 0.979	8.880 0.976
8.960 0.977	9.040 0.973	9.130 0.968	9.200 0.965	9.270 0.966	9.370 0.966	9.450 0.965	9.530 0.960
9.650 0.965	9.690 0.969	9.770 0.979	9.860 0.962	9.960 0.983	10.010 0.981	10.100 0.983	10.170 0.983
10.250 0.987	10.340 0.986	10.420 0.985	10.490 0.983	10.580 0.985	10.660 0.988	10.740 0.986	10.810 0.985
10.900 0.984	10.970 0.982	11.070 0.983	11.150 0.983	11.220 0.982	11.300 0.985	11.380 0.987	11.440 0.988
11.520 0.991	11.600 0.989	11.680 0.985	11.750 0.985	11.830 0.984	11.890 0.986	11.970 0.987	12.040 0.988
12.120 0.988	12.190 0.992	12.260 0.979	12.330 0.981				

WAVELENGTH,STD.DEV.

7.750 0.022	7.810 0.017	7.880 0.023	7.950 0.018	8.020 0.016	8.100 0.013	8.180 0.017	8.260 0.019
8.320 0.016	8.410 0.014	8.480 0.012	8.560 0.011	8.640 0.013	8.720 0.013	8.800 0.015	8.880 0.015
8.960 0.014	9.040 0.012	9.130 0.010	9.200 0.011	9.270 0.011	9.370 0.011	9.450 0.012	9.530 0.009
9.650 0.009	9.690 0.010	9.770 0.009	9.860 0.009	9.960 0.008	10.010 0.008	10.100 0.009	10.170 0.008
10.250 0.008	10.340 0.007	10.420 0.004	10.490 0.005	10.580 0.006	10.660 0.007	10.740 0.009	10.810 0.007
10.900 0.006	10.970 0.007	11.070 0.008	11.150 0.011	11.220 0.012	11.300 0.011	11.380 0.009	11.440 0.007
11.520 0.007	11.600 0.007	11.680 0.008	11.750 0.010	11.830 0.009	11.890 0.009	11.970 0.006	12.040 0.005
12.120 0.007	12.190 0.008	12.260 0.011	12.330 0.011				



AVERAGED DATA
NUMBER OF SPECTRA 10
FOR GROUP 16 16 51 34231 40011101 02000009 MXICP-1 PLAVA C

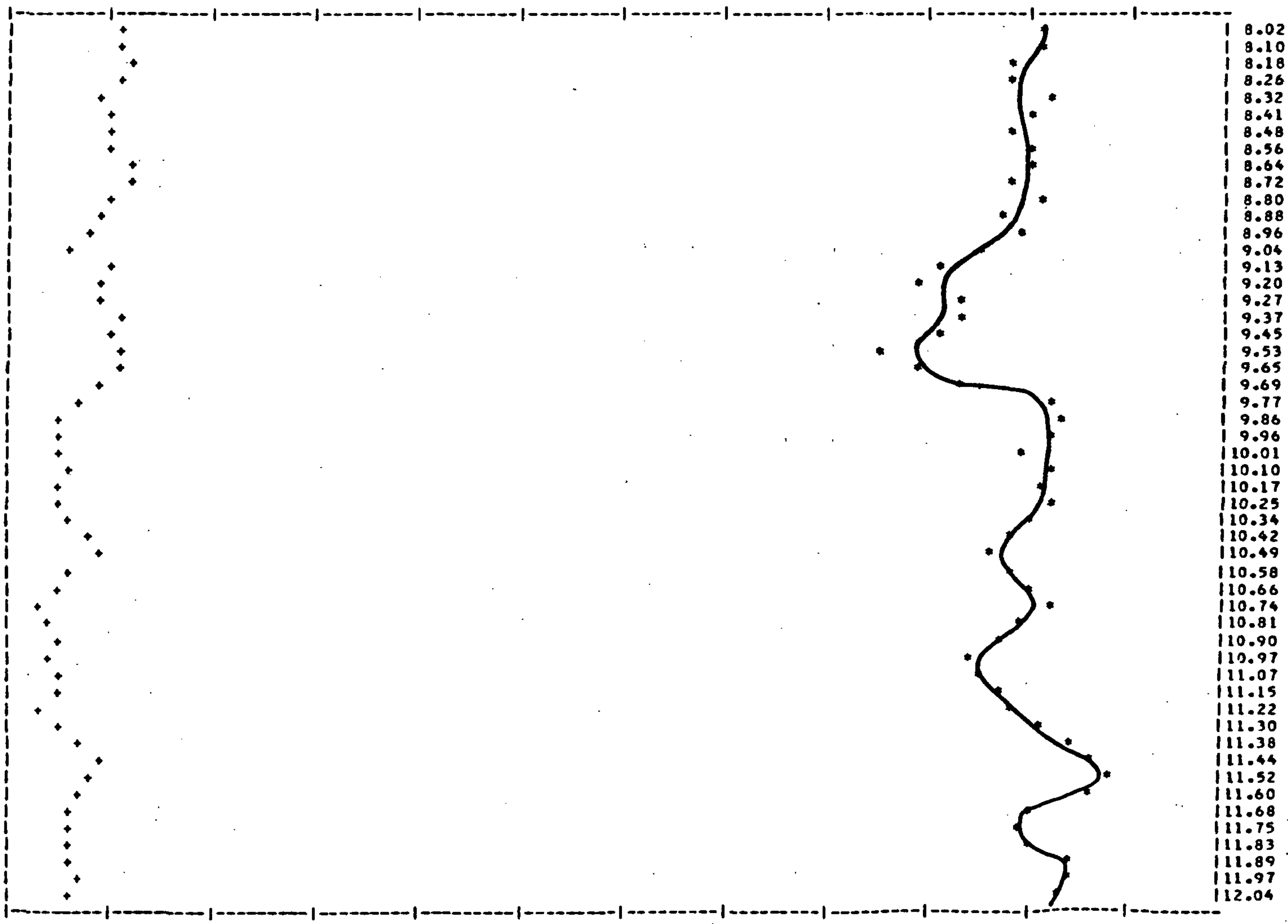
AVERAGE TEMPERATURE= 16.385 STD.DEV.= 0.835

WAVELENGTH,AVERAGE EMIT.

7.750 0.942	7.810 0.947	7.880 0.946	7.950 0.979	8.020 0.982	8.100 0.983	8.180 0.979	8.260 0.980
8.320 0.984	8.410 0.981	8.480 0.979	8.560 0.981	8.640 0.982	8.720 0.980	8.800 0.983	8.880 0.979
8.960 0.981	9.040 0.976	9.130 0.972	9.200 0.971	9.270 0.975	9.370 0.975	9.450 0.973	9.530 0.966
9.650 0.971	9.690 0.975	9.770 0.984	9.860 0.984	9.960 0.983	10.010 0.981	10.100 0.983	10.170 0.982
10.250 0.983	10.340 0.981	10.420 0.979	10.490 0.977	10.580 0.979	10.660 0.982	10.740 0.983	10.810 0.981
10.900 0.979	10.970 0.976	11.070 0.977	11.150 0.979	11.220 0.979	11.300 0.983	11.380 0.986	11.440 0.987
11.520 0.989	11.600 0.987	11.680 0.981	11.750 0.981	11.830 0.982	11.890 0.985	11.970 0.986	12.040 0.985
12.120 0.984	12.190 0.985	12.260 0.979	12.330 0.981				

WAVELENGTH,STD.DEV.

7.750 0.007	7.810 0.014	7.880 0.016	7.950 0.015	8.020 0.013	8.100 0.012	8.180 0.014	8.260 0.012
8.320 0.010	8.410 0.011	8.480 0.011	8.560 0.012	8.640 0.013	8.720 0.014	8.800 0.012	8.880 0.011
8.960 0.009	9.040 0.008	9.130 0.011	9.200 0.011	9.270 0.011	9.370 0.012	9.450 0.011	9.530 0.012
9.650 0.012	9.690 0.010	9.770 0.009	9.860 0.007	9.960 0.006	10.010 0.007	10.100 0.007	10.170 0.006
10.250 0.007	10.340 0.007	10.420 0.009	10.490 0.010	10.580 0.007	10.660 0.006	10.740 0.005	10.810 0.005
10.900 0.006	10.970 0.006	11.070 0.007	11.150 0.006	11.220 0.005	11.300 0.007	11.380 0.008	11.440 0.010
11.520 0.010	11.600 0.009	11.680 0.007	11.750 0.007	11.830 0.008	11.890 0.008	11.970 0.009	12.040 0.007
12.120 0.011	12.190 0.007	12.260 0.012	12.330 0.011				



AVERAGED DATA
NUMBER OF SPECTRA 10
FOR GROUP 17 15 7 55701 6011192 02000000 MX100-1 LAVA 3G

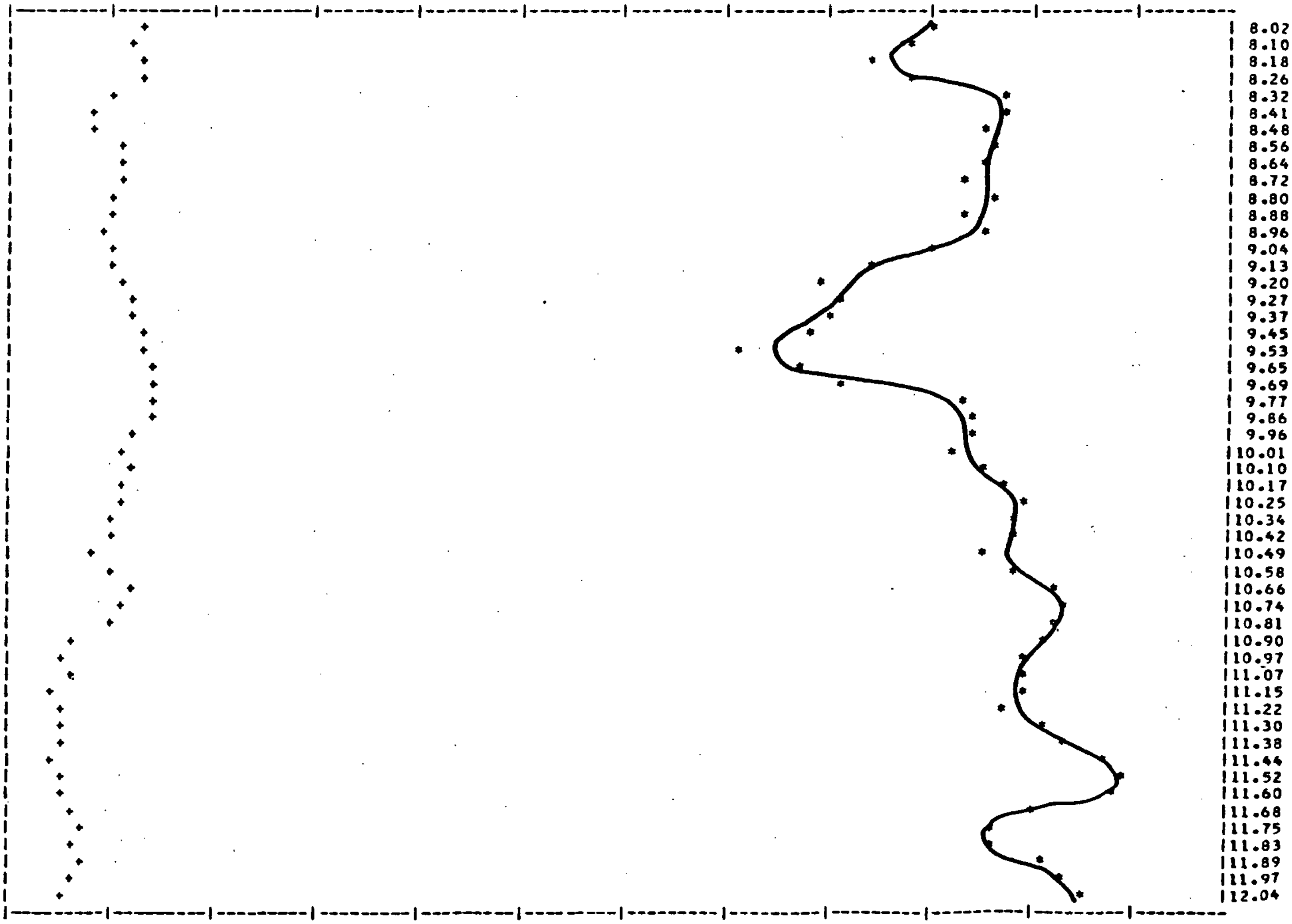
AVERAGE TEMPERATURE = 42.344 STD.DEV.= 0.947

WAVELENGTH,AVERAGE EMIT.

7.750 0.922	7.810 0.924	7.880 0.927	7.950 0.971	8.020 0.971	8.100 0.970	8.180 0.966	8.260 0.969
8.320 0.978	8.410 0.976	8.480 0.976	8.560 0.977	8.640 0.976	8.720 0.974	8.800 0.978	8.880 0.975
8.960 0.977	9.040 0.971	9.130 0.965	9.200 0.961	9.270 0.962	9.370 0.962	9.450 0.959	9.530 0.953
9.650 0.959	9.690 0.963	9.770 0.974	9.860 0.975	9.960 0.975	10.010 0.974	10.100 0.977	10.170 0.978
10.250 0.981	10.340 0.973	10.420 0.979	10.490 0.976	10.580 0.979	10.660 0.984	10.740 0.985	10.810 0.984
10.900 0.982	10.970 0.983	11.070 0.981	11.150 0.980	11.220 0.978	11.300 0.982	11.380 0.984	11.440 0.988
11.520 0.991	11.600 0.990	11.680 0.991	11.750 0.976	11.830 0.977	11.890 0.982	11.970 0.984	12.040 0.987
12.120 0.990	12.190 0.990	12.260 0.979	12.330 0.983				

WAVELENGTH,STD.DEV.

7.750 0.015	7.810 0.015	7.880 0.015	7.950 0.018	8.020 0.015	8.100 0.014	8.180 0.014	8.260 0.014
8.320 0.012	8.410 0.010	8.480 0.010	8.560 0.013	8.640 0.013	8.720 0.013	8.800 0.012	8.880 0.011
8.960 0.011	9.040 0.011	9.130 0.011	9.200 0.012	9.270 0.013	9.370 0.014	9.450 0.014	9.530 0.014
9.650 0.015	9.690 0.015	9.770 0.016	9.860 0.016	9.960 0.014	10.010 0.012	10.100 0.013	10.170 0.013
10.250 0.012	10.340 0.011	10.420 0.011	10.490 0.010	10.580 0.011	10.660 0.013	10.740 0.013	10.810 0.011
10.900 0.007	10.970 0.007	11.070 0.008	11.150 0.006	11.220 0.007	11.300 0.006	11.380 0.006	11.440 0.006
11.520 0.007	11.600 0.007	11.680 0.007	11.750 0.008	11.830 0.008	11.890 0.008	11.970 0.008	12.040 0.006
12.120 0.007	12.190 0.007	12.260 0.007	12.330 0.007				



AVERAGED DATA
NUMBER OF SPECTRA 8
FOR GROUP 18 18 51 30161 60311101 02000000 MX1CB-1 FLAVA D

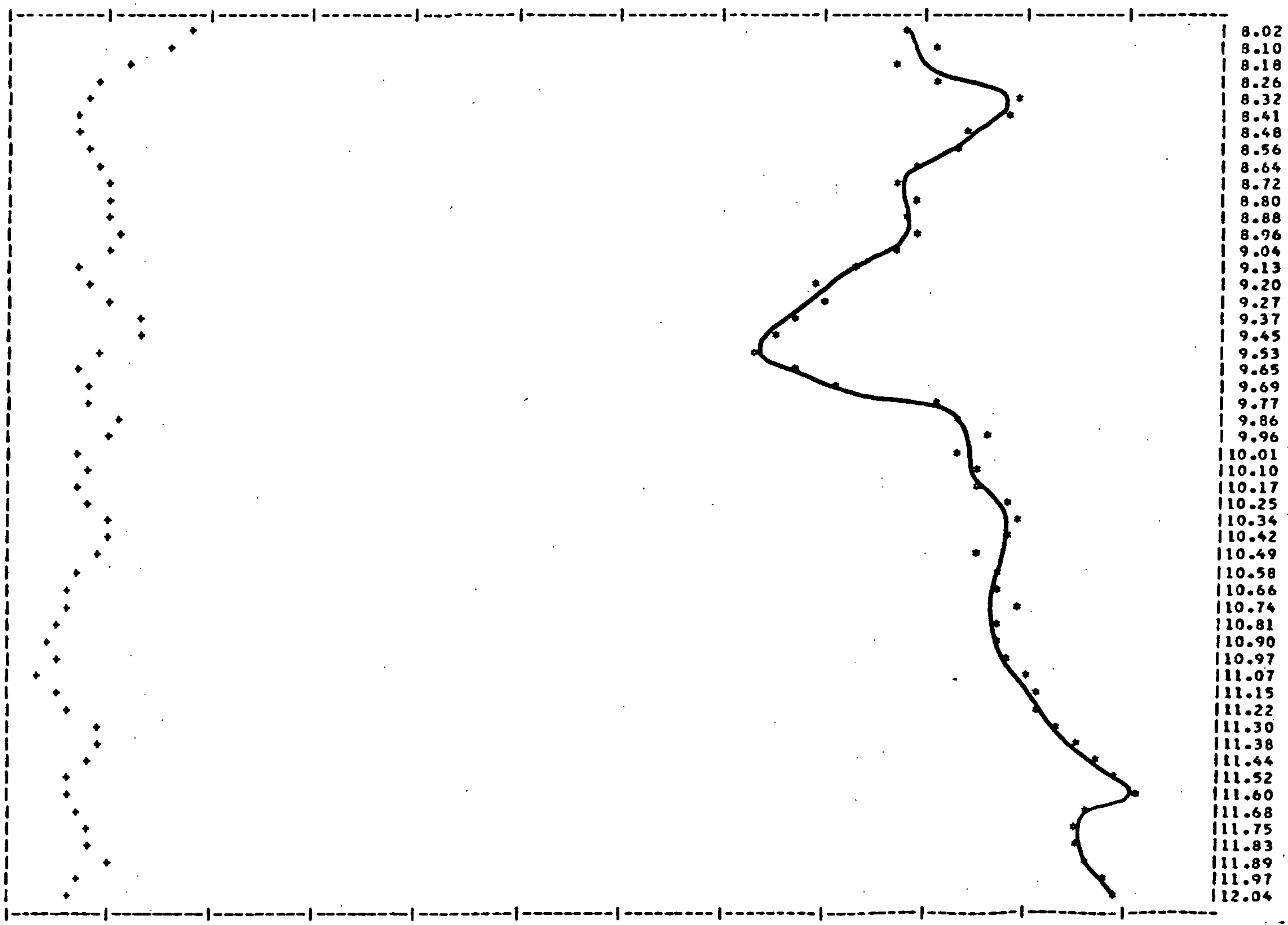
AVERAGE TEMPERATURE= 30.366 STD.DEV.= 1.097

WAVELENGTH,AVERAGE EMIT.

7.750 0.934	7.810 0.947	7.880 0.935	7.950 0.971	8.020 0.969	8.100 0.972	8.180 0.968	8.260 0.973
8.320 0.980	8.410 0.979	8.480 0.976	8.560 0.974	8.640 0.971	8.720 0.969	8.800 0.970	8.880 0.969
8.960 0.970	9.040 0.969	9.130 0.965	9.200 0.961	9.270 0.962	9.370 0.958	9.450 0.957	9.530 0.954
9.650 0.958	9.690 0.963	9.770 0.972	9.860 0.975	9.960 0.978	10.010 0.975	10.100 0.976	10.170 0.977
10.250 0.979	10.340 0.981	10.420 0.980	10.490 0.976	10.580 0.979	10.660 0.979	10.740 0.980	10.810 0.979
10.900 0.978	10.970 0.979	11.070 0.982	11.150 0.982	11.220 0.983	11.300 0.984	11.380 0.986	11.440 0.988
11.520 0.991	11.600 0.992	11.680 0.986	11.750 0.986	11.830 0.987	11.890 0.988	11.970 0.989	12.040 0.990
12.120 0.993	12.190 0.989	12.260 0.987	12.330 0.987				

WAVELENGTH,STD.DEV.

7.750 0.016	7.810 0.021	7.880 0.028	7.950 0.017	8.020 0.019	8.100 0.017	8.180 0.014	8.260 0.010
8.320 0.009	8.410 0.009	8.480 0.009	8.560 0.010	8.640 0.010	8.720 0.011	8.800 0.011	8.880 0.012
8.960 0.013	9.040 0.012	9.130 0.008	9.200 0.010	9.270 0.012	9.370 0.014	9.450 0.014	9.530 0.011
9.650 0.008	9.690 0.010	9.770 0.010	9.860 0.012	9.960 0.011	10.010 0.009	10.100 0.009	10.170 0.009
10.250 0.010	10.340 0.012	10.420 0.011	10.490 0.011	10.560 0.009	10.660 0.007	10.740 0.008	10.810 0.007
10.900 0.005	10.970 0.006	11.070 0.005	11.150 0.007	11.220 0.008	11.300 0.010	11.380 0.011	11.440 0.010
11.520 0.007	11.600 0.007	11.680 0.008	11.750 0.009	11.830 0.010	11.890 0.011	11.970 0.009	12.040 0.007
12.120 0.008	12.190 0.006	12.260 0.006	12.330 0.008				



AVERAGED DATA
NUMBER OF SPECTRA 6
FOR GROUP 19 19 7 46309 6C011102 02000000 MX106-1 LAVA VH

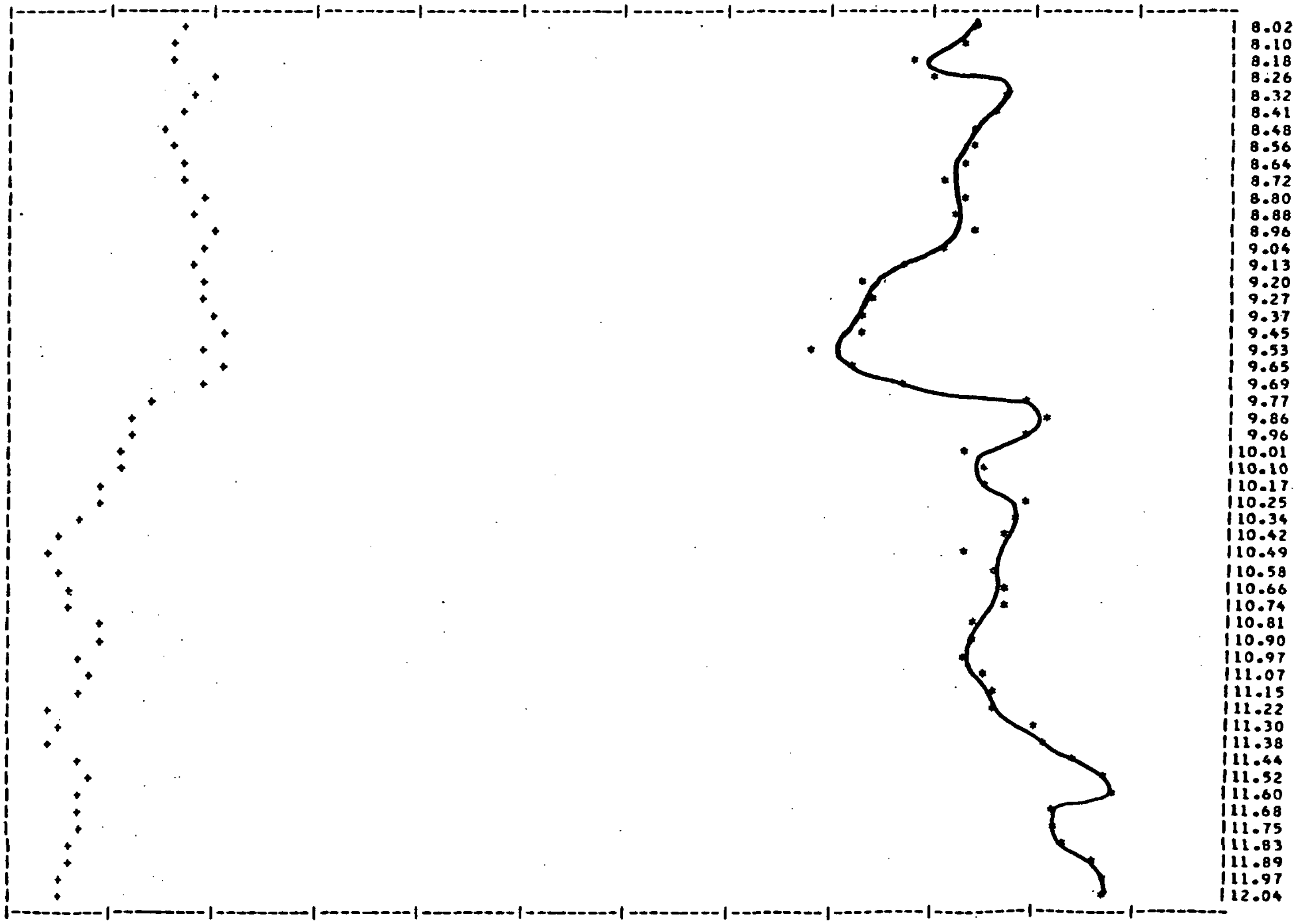
AVERAGE TEMPERATURE- 39.673 STD.DEV.- 1.371

WAVELENGTH,AVERAGE EMIT.

7.750	0.936	7.810	0.937	7.880	0.936	7.950	0.971	8.020	0.975	8.100	0.974	8.180	0.969	8.260	0.971
8.320	0.978	8.410	0.977	8.480	0.976	8.560	0.976	8.640	0.975	8.720	0.972	8.800	0.975	8.880	0.974
8.960	0.975	9.040	0.973	9.130	0.968	9.200	0.964	9.270	0.966	9.370	0.965	9.450	0.965	9.530	0.959
9.650	0.964	9.690	0.969	9.770	0.980	9.860	0.987	9.960	0.980	10.010	0.974	10.100	0.976	10.170	0.977
10.250	0.980	10.340	0.980	10.420	0.976	10.490	0.975	10.580	0.977	10.660	0.978	10.740	0.978	10.810	0.975
10.900	0.975	10.970	0.974	11.070	0.977	11.150	0.976	11.220	0.977	11.300	0.981	11.380	0.982	11.440	0.985
11.520	0.989	11.600	0.989	11.680	0.984	11.750	0.983	11.830	0.984	11.890	0.988	11.970	0.989	12.040	0.988
12.120	0.992	12.190	0.989	12.260	0.984	12.330	0.984								

WAVELENGTH,STD.DEV.

7.750	0.023	7.810	0.014	7.880	0.013	7.950	0.024	8.020	0.018	8.100	0.018	8.180	0.018	8.260	0.021
8.320	0.020	8.410	0.018	8.480	0.016	8.560	0.018	8.640	0.019	8.720	0.019	8.800	0.021	8.880	0.020
8.960	0.021	9.040	0.020	9.130	0.020	9.200	0.021	9.270	0.020	9.370	0.021	9.450	0.022	9.530	0.021
9.650	0.022	9.690	0.020	9.770	0.015	9.860	0.014	9.960	0.013	10.010	0.013	10.100	0.013	10.170	0.011
10.250	0.010	10.340	0.009	10.420	0.006	10.490	0.005	10.580	0.006	10.660	0.008	10.740	0.007	10.810	0.010
10.900	0.011	10.970	0.008	11.070	0.009	11.150	0.009	11.220	0.005	11.300	0.006	11.380	0.006	11.440	0.008
11.520	0.009	11.600	0.009	11.680	0.009	11.750	0.009	11.830	0.008	11.890	0.008	11.970	0.006	12.040	0.007
12.120	0.008	12.190	0.010	12.260	0.009	12.330	0.012								



[illegible] ATA
[illegible] SPECTRA [illegible]
[illegible] 20 18 51 [illegible] 0.000000 MXIO8-1 FLAVA F

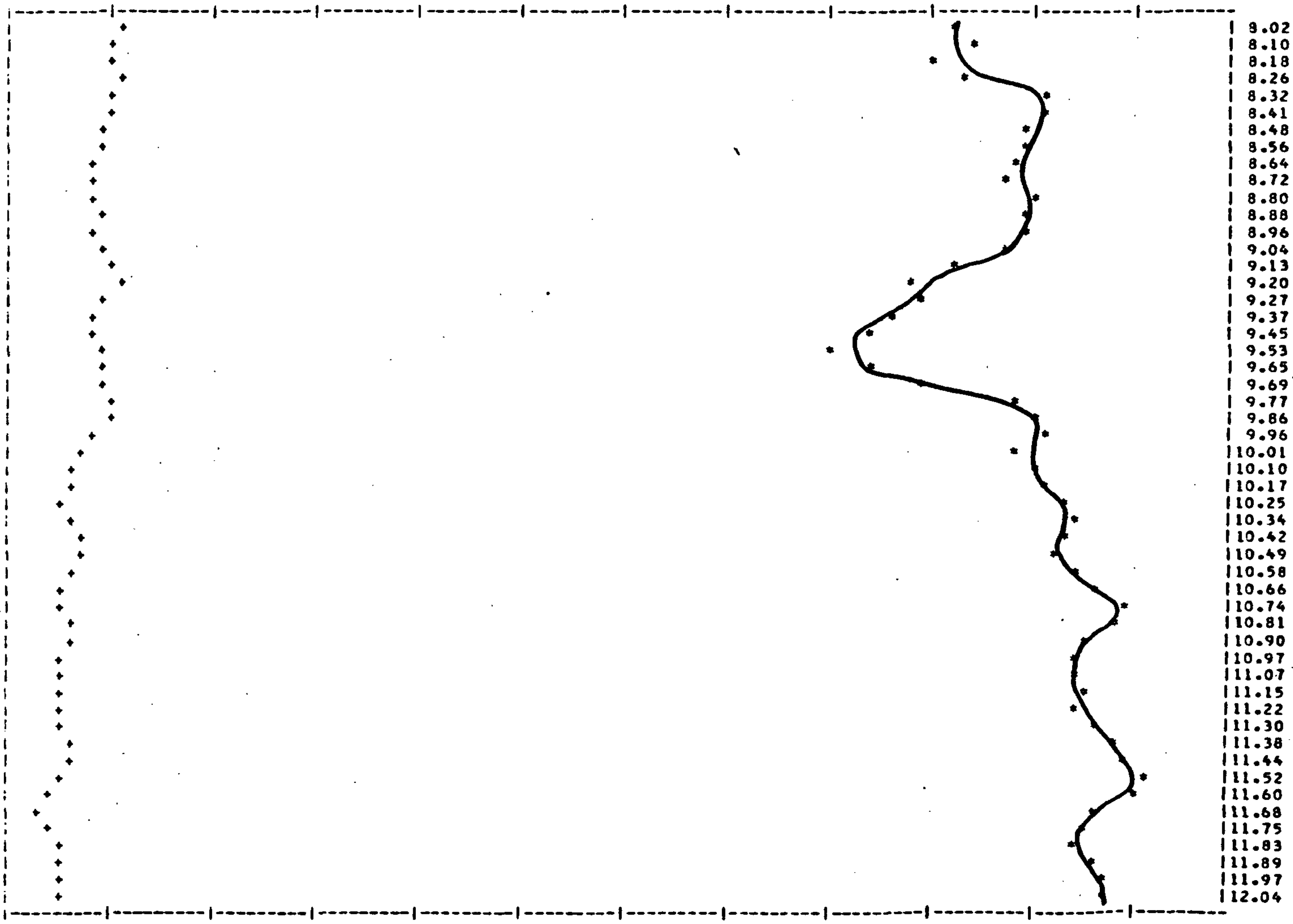
AVE [illegible] TEMPERATURE= 33.331 STD.DEV.= 0.866

*AVELENGTH,AVERAGE [illegible]

7.750 0.936	7.810 0.943	7.880 0.937	7.950 0.972	8.020 0.974	8.100 0.976	8.180 0.971	8.260 0.975
8.320 0.982	8.410 0.962	8.480 0.981	8.560 0.980	8.640 0.979	8.720 0.978	8.800 0.982	8.880 0.980
8.960 0.981	9.040 0.973	9.130 0.974	9.200 0.970	9.270 0.970	9.370 0.967	9.450 0.966	9.530 0.962
9.650 0.965	9.690 0.971	9.770 0.979	9.870 0.981	9.960 0.983	10.010 0.980	10.100 0.982	10.170 0.982
10.250 0.984	10.340 0.986	10.420 0.985	10.490 0.983	10.580 0.986	10.660 0.988	10.740 0.991	10.810 0.989
10.900 0.987	10.970 0.986	11.070 0.986	11.150 0.987	11.220 0.986	11.300 0.988	11.380 0.989	11.440 0.990
11.520 0.992	11.600 0.992	11.680 0.987	11.750 0.986	11.830 0.986	11.890 0.988	11.970 0.989	12.040 0.988
12.120 0.989	12.190 0.990	12.260 0.984	12.330 0.986				

*AVELENGTH,STD.DEV.

7.750 0.020	7.810 0.021	7.380 0.020	7.950 0.016	8.020 0.013	8.100 0.011	8.180 0.011	8.260 0.012
8.320 0.012	8.410 0.011	8.480 0.011	8.560 0.010	8.640 0.009	8.720 0.009	8.800 0.010	8.880 0.010
8.960 0.010	9.040 0.011	9.130 0.012	9.200 0.012	9.270 0.010	9.370 0.010	9.450 0.010	9.530 0.010
9.650 0.010	9.690 0.011	9.770 0.012	9.860 0.011	9.960 0.009	10.010 0.008	10.100 0.008	10.170 0.007
10.250 0.007	10.340 0.007	10.420 0.008	10.490 0.008	10.580 0.007	10.660 0.007	10.740 0.006	10.810 0.007
10.900 0.007	10.970 0.007	11.070 0.006	11.150 0.007	11.220 0.007	11.300 0.007	11.380 0.007	11.440 0.007
11.520 0.007	11.600 0.005	11.680 0.004	11.750 0.006	11.830 0.006	11.890 0.007	11.970 0.007	12.040 0.007
12.120 0.008	12.190 0.008	12.260 0.009	12.330 0.007				



AVERAGED DATA
NUMBER OF SPECTRA 16
PER GROUP 21 19 7 39317 LC011102 02000000 MX108-1 LAVA 3J

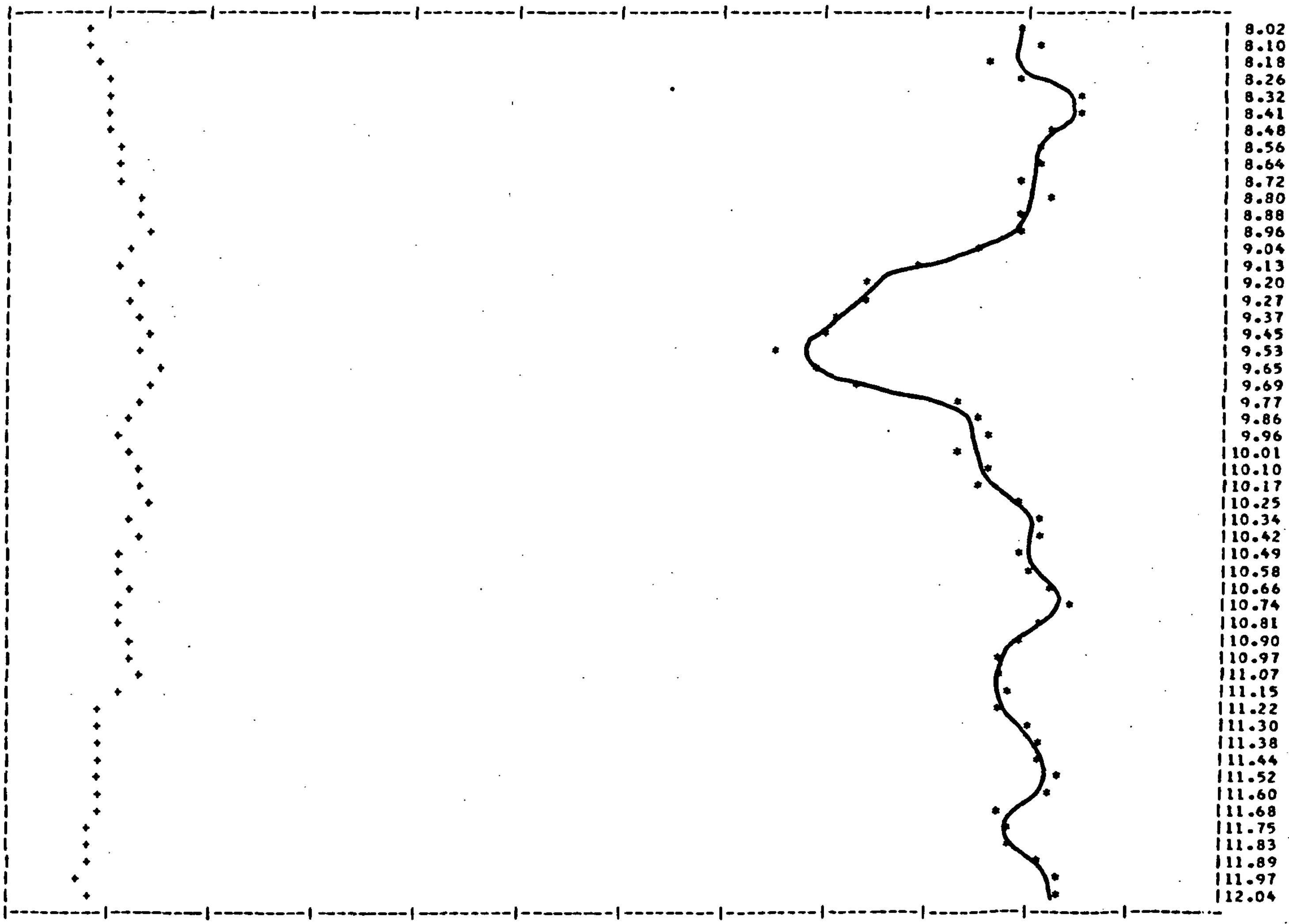
AVERAGE TEMPERATURE= 39.600 STD.DEV.= 0.831

WAVELENGTH,AVERAGE EMIT.

7.750	0.934	7.810	0.939	7.880	0.932	7.950	0.979	8.020	0.980	8.100	0.983	8.180	0.978	8.260	0.981
8.320	0.986	8.410	0.986	8.480	0.964	8.560	0.983	8.640	0.983	8.720	0.980	8.800	0.983	8.880	0.981
8.960	0.980	9.040	0.977	9.130	0.971	9.200	0.965	9.270	0.966	9.370	0.963	9.450	0.961	9.530	0.956
9.650	0.961	9.690	0.965	9.770	0.974	9.860	0.977	9.940	0.977	10.010	0.975	10.100	0.977	10.170	0.976
10.250	0.980	10.340	0.982	10.420	0.982	10.490	0.981	10.580	0.982	10.660	0.983	10.740	0.985	10.810	0.982
10.900	0.981	10.970	0.979	11.070	0.979	11.150	0.980	11.220	0.979	11.300	0.981	11.380	0.982	11.440	0.982
11.520	0.985	11.600	0.984	11.680	0.979	11.750	0.979	11.830	0.980	11.890	0.982	11.970	0.984	12.040	0.984
12.120	0.987	12.190	0.986	12.260	0.981	12.330	0.981								

WAVELENGTH,STD.DEV.

7.750	0.018	7.810	0.012	7.880	0.014	7.950	0.014	8.020	0.010	8.100	0.009	8.180	0.011	8.260	0.011
8.320	0.011	8.410	0.012	8.480	0.012	8.560	0.012	8.640	0.012	8.720	0.013	8.800	0.014	8.880	0.014
8.960	0.015	9.040	0.014	9.130	0.013	9.200	0.015	9.270	0.014	9.370	0.015	9.450	0.015	9.530	0.015
9.650	0.017	9.690	0.015	9.770	0.014	9.860	0.013	9.960	0.012	10.010	0.013	10.100	0.014	10.170	0.015
10.250	0.016	10.340	0.014	10.420	0.014	10.490	0.013	10.580	0.013	10.660	0.014	10.740	0.013	10.810	0.013
10.900	0.014	10.970	0.013	11.070	0.014	11.150	0.012	11.220	0.011	11.300	0.010	11.380	0.010	11.440	0.011
11.520	0.010	11.600	0.010	11.680	0.010	11.750	0.009	11.830	0.010	11.890	0.009	11.970	0.009	12.040	0.010
12.120	0.012	12.190	0.009	12.260	0.011	12.330	0.011								



NUMBER OF SPECTRA 21
FOR GROUP 22 16 52 4254 GEOIIICL 02000000 PXICR-1 ALLUVIUM 0

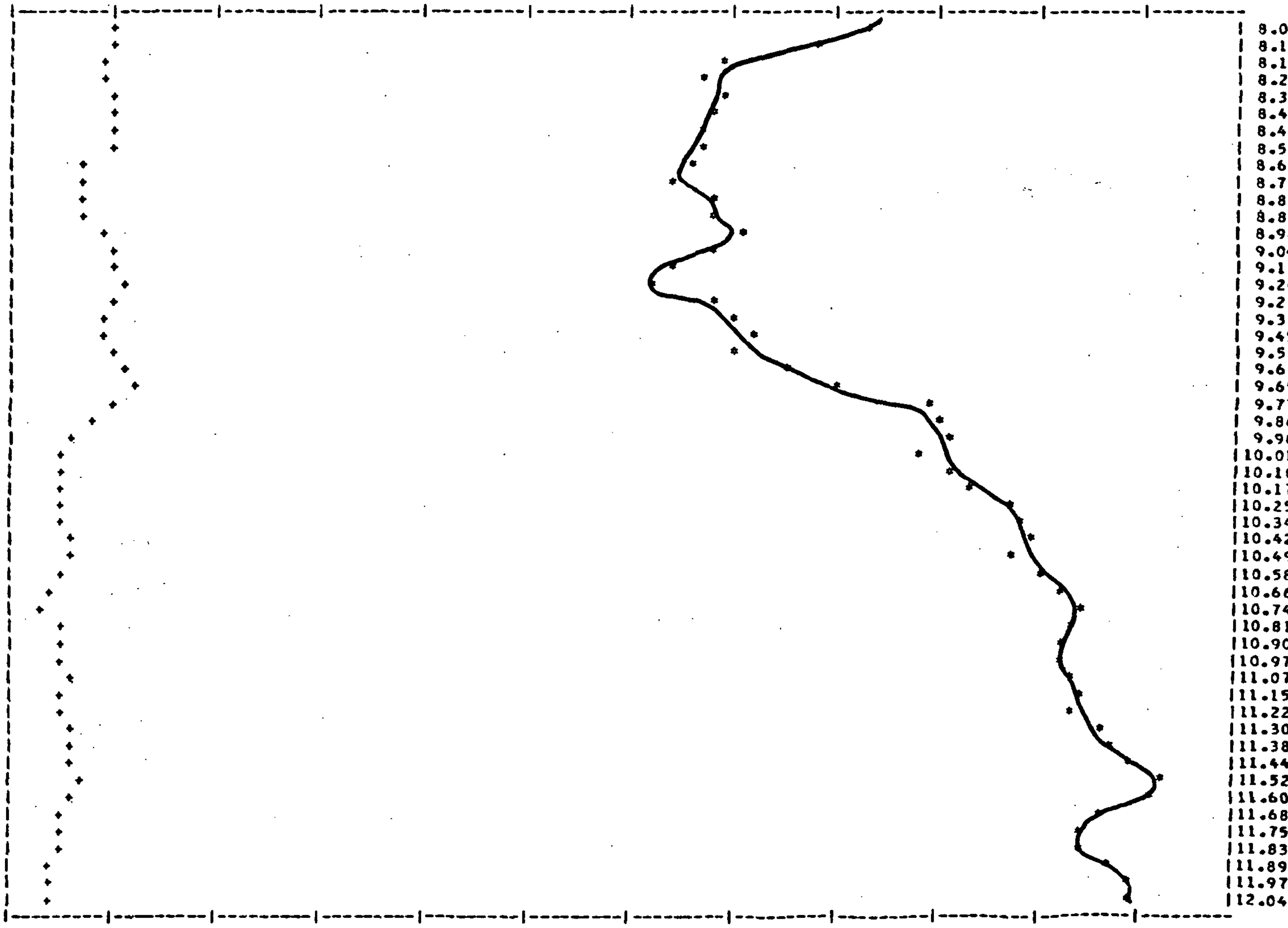
AVERAGE TEMPERATURE = 38.841 STD.DEV.= 0.470

WAVELENGTH,AVERAGE EMIT.

7.750 0.940	7.810 0.939	7.880 0.934	7.950 0.970	8.020 0.964	8.100 0.959	8.180 0.950	8.260 0.949
8.320 0.951	8.410 0.950	8.480 0.949	8.560 0.949	8.640 0.948	8.720 0.946	8.800 0.949	8.880 0.950
8.960 0.952	9.040 0.950	9.130 0.946	9.200 0.943	9.270 0.949	9.370 0.952	9.450 0.954	9.530 0.952
9.650 0.957	9.690 0.961	9.770 0.971	9.860 0.972	9.960 0.972	10.010 0.970	10.100 0.973	10.170 0.975
10.250 0.978	10.340 0.980	10.420 0.980	10.490 0.979	10.580 0.982	10.660 0.984	10.740 0.985	10.810 0.984
10.900 0.984	10.970 0.983	11.070 0.985	11.150 0.985	11.220 0.984	11.300 0.987	11.380 0.989	11.440 0.990
11.520 0.993	11.600 0.993	11.680 0.987	11.750 0.986	11.830 0.986	11.890 0.989	11.970 0.990	12.040 0.990
12.120 0.991	12.190 0.991	12.260 0.987	12.330 0.987				

WAVELENGTH,STD.DEV.

7.750 0.016	7.810 0.018	7.380 0.017	7.950 0.012	8.020 0.011	8.100 0.012	8.180 0.011	8.260 0.011
8.320 0.012	8.410 0.012	8.480 0.012	8.560 0.011	8.640 0.009	8.720 0.008	8.800 0.008	8.880 0.009
8.960 0.011	9.040 0.012	9.130 0.012	9.200 0.012	9.270 0.011	9.370 0.011	9.450 0.011	9.530 0.011
9.650 0.012	9.690 0.013	9.770 0.012	9.860 0.010	9.960 0.008	10.010 0.007	10.100 0.007	10.170 0.007
10.250 0.007	10.340 0.007	10.420 0.008	10.450 0.006	10.580 0.007	10.660 0.006	10.740 0.005	10.810 0.006
10.900 0.007	10.970 0.007	11.070 0.007	11.150 0.007	11.220 0.007	11.300 0.008	11.380 0.007	11.440 0.008
11.520 0.008	11.600 0.007	11.680 0.006	11.750 0.006	11.830 0.006	11.890 0.006	11.970 0.006	12.040 0.006
12.120 0.008	12.190 0.007	12.260 0.007	12.330 0.009				



AVERAGED DATA
NUMBER OF SPECTRA 16
FOR GROUP 23-19 7 2 [illegible] 66011162 02000000 MX10F-1 LAVA IK

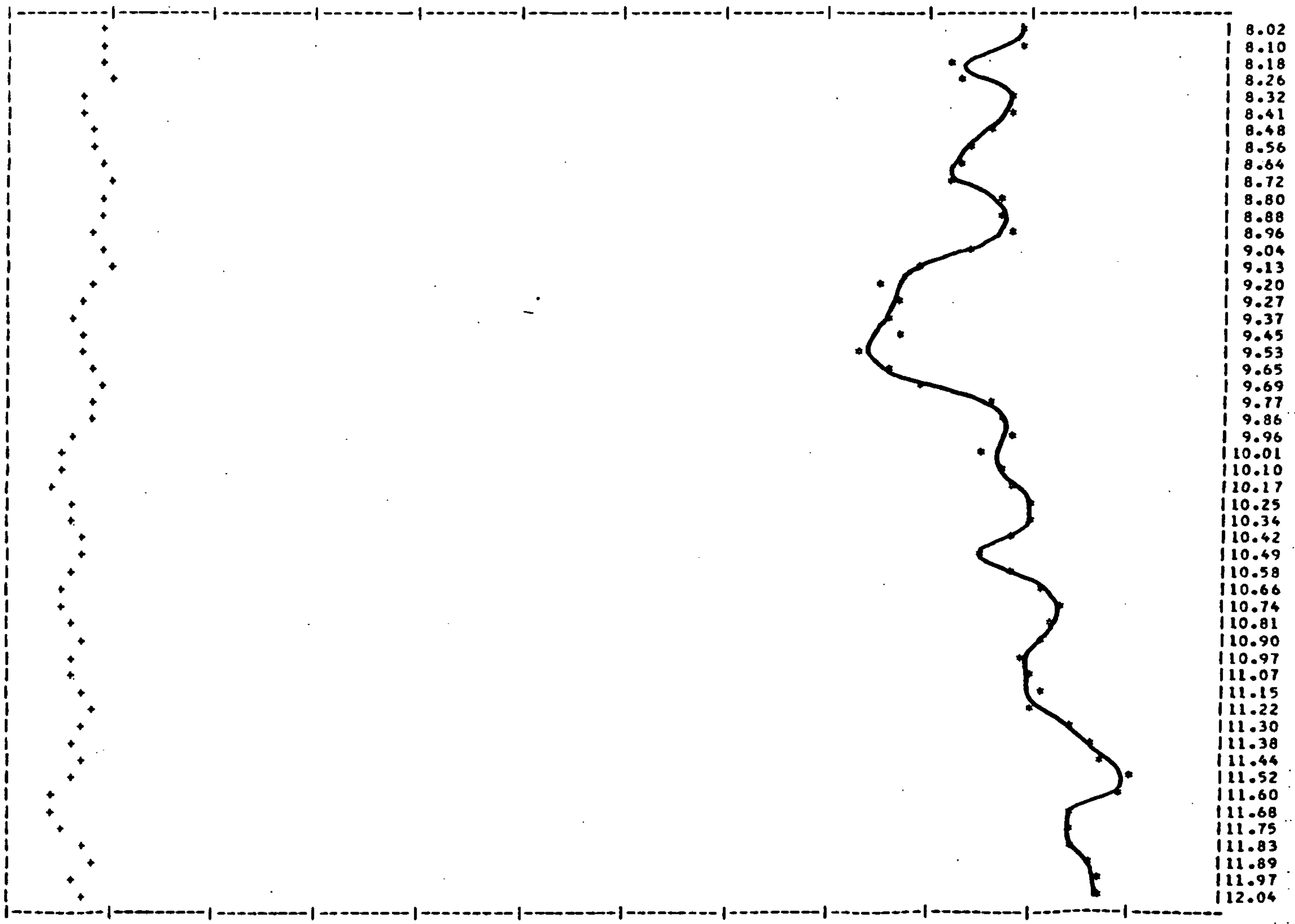
AVERAGE TEMPERATURE= [illegible] STD.DEV.= 0.696

WAVELENGTH,AVERAGE EMIT.

7.750 0.943	7.810 0.944	7.880 0.936	7.950 0.962	8.020 0.981	8.100 0.981	8.180 0.973	8.260 0.975
8.320 0.979	8.410 0.979	8.480 0.978	8.560 0.976	8.640 0.974	8.720 0.974	8.800 0.978	8.880 0.978
8.960 0.979	9.040 0.975	9.130 0.971	9.200 0.967	9.270 0.969	9.370 0.968	9.450 0.968	9.530 0.964
9.650 0.968	9.690 0.971	9.770 0.978	9.860 0.978	9.960 0.979	10.010 0.977	10.100 0.979	10.170 0.979
10.250 0.981	10.340 0.981	10.420 0.980	10.490 0.977	10.580 0.979	10.660 0.982	10.740 0.984	10.810 0.984
10.900 0.983	10.970 0.981	11.070 0.982	11.150 0.983	11.220 0.982	11.300 0.985	11.380 0.988	11.440 0.989
11.520 0.991	11.600 0.990	11.680 0.985	11.750 0.985	11.830 0.985	11.890 0.987	11.970 0.988	12.040 0.988
12.120 0.990	12.190 0.991	12.260 0.986	12.330 0.985				

WAVELENGTH,STD.DEV.

7.750 0.014	7.810 0.015	7.880 0.011	7.950 0.013	8.020 0.011	8.100 0.010	8.180 0.010	8.260 0.011
8.320 0.009	8.410 0.008	8.480 0.009	8.560 0.010	8.640 0.010	8.720 0.011	8.800 0.011	8.880 0.010
8.960 0.010	9.040 0.011	9.130 0.011	9.200 0.010	9.270 0.009	9.370 0.007	9.450 0.008	9.530 0.009
9.650 0.010	9.690 0.010	9.770 0.010	9.860 0.009	9.960 0.002	10.010 0.006	10.100 0.006	10.170 0.006
10.250 0.008	10.340 0.008	10.420 0.008	10.490 0.009	10.580 0.007	10.660 0.007	10.740 0.007	10.810 0.008
10.900 0.008	10.970 0.007	11.070 0.008	11.150 0.009	11.220 0.009	11.300 0.009	11.380 0.008	11.440 0.008
11.520 0.007	11.600 0.005	11.680 0.006	11.750 0.007	11.830 0.008	11.890 0.010	11.970 0.008	12.040 0.008
12.120 0.009	12.190 0.007	12.260 0.008	12.330 0.007				



AVERAGED DATA
NUMBER OF SPECTRA 10
FOR GROUP 24 19 7 14439 6C011102 02000000 MX108-1 LAVA FLOW 2C

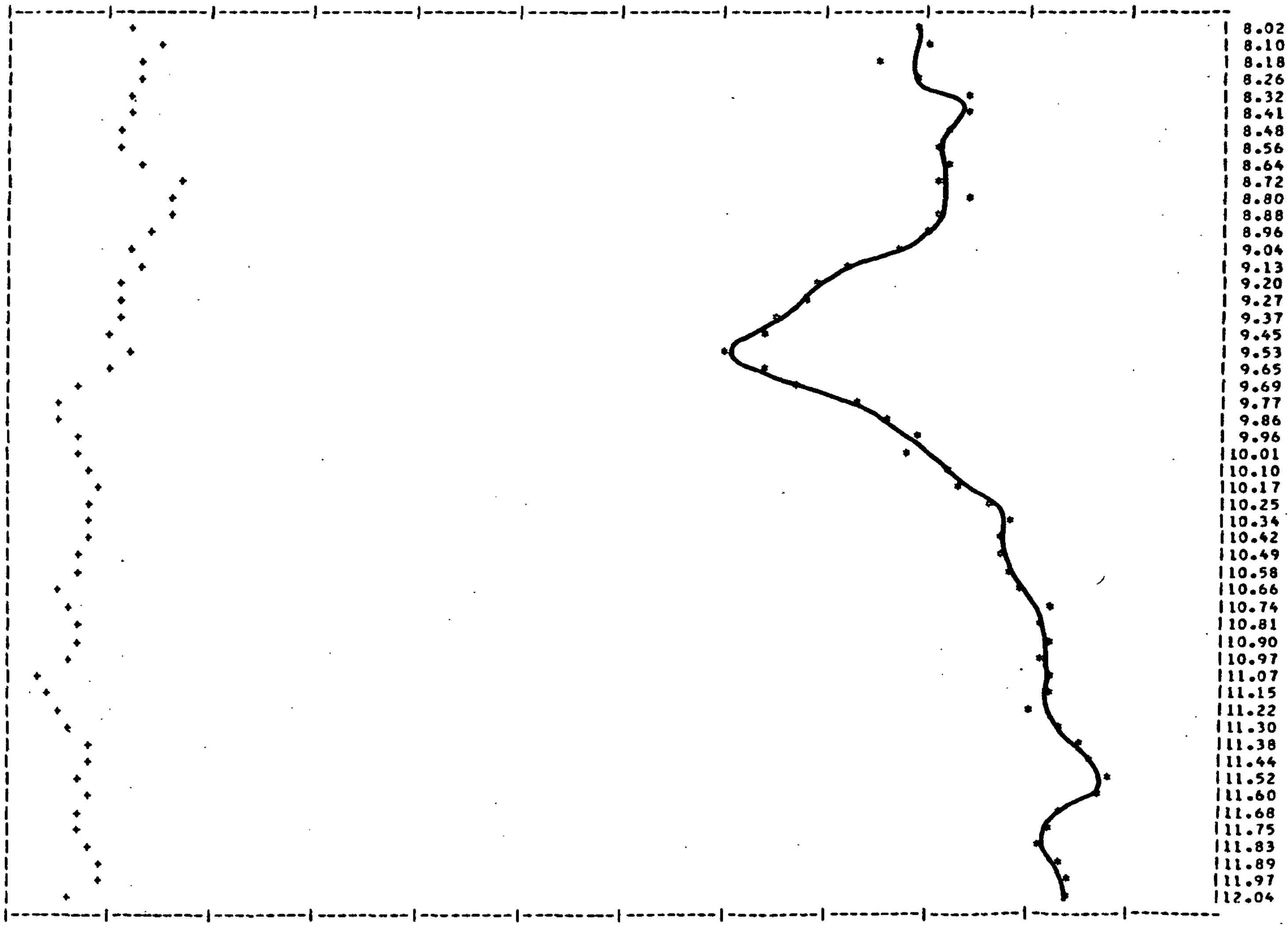
AVERAGE TEMPERATURE= 36.372 STD.DEV.= 0.919

WAVELENGTH,AVERAGE EMIT.

7.750 0.938	7.810 0.937	7.880 0.934	7.950 0.973	8.020 0.971	8.100 0.971	8.180 0.967	8.260 0.971
8.320 0.975	8.410 0.975	8.480 0.973	8.560 0.973	8.640 0.973	8.720 0.973	8.800 0.975	8.880 0.973
8.960 0.972	9.040 0.969	9.130 0.964	9.200 0.960	9.270 0.960	9.370 0.956	9.450 0.956	9.530 0.952
9.650 0.955	9.690 0.959	9.770 0.964	9.860 0.967	9.960 0.970	10.010 0.969	10.100 0.974	10.170 0.975
10.250 0.977	10.340 0.979	10.420 0.979	10.490 0.978	10.580 0.980	10.660 0.981	10.740 0.983	10.810 0.983
10.900 0.983	10.970 0.982	11.070 0.983	11.150 0.984	11.220 0.981	11.300 0.984	11.380 0.986	11.440 0.987
11.520 0.990	11.600 0.987	11.680 0.984	11.750 0.983	11.830 0.982	11.890 0.984	11.970 0.985	12.040 0.986
12.120 0.986	12.190 0.992	12.260 0.983	12.330 0.984				

WAVELENGTH,STD.DEV.

7.750 0.013	7.810 0.014	7.880 0.017	7.950 0.014	8.020 0.014	8.100 0.017	8.180 0.015	8.260 0.015
8.320 0.014	8.410 0.013	8.480 0.012	8.560 0.012	8.640 0.014	8.720 0.018	8.800 0.017	8.880 0.017
8.960 0.016	9.040 0.013	9.130 0.014	9.200 0.012	9.270 0.012	9.370 0.012	9.450 0.011	9.530 0.013
9.650 0.012	9.690 0.009	9.770 0.007	9.860 0.006	9.960 0.009	10.010 0.009	10.100 0.010	10.170 0.011
10.250 0.009	10.340 0.009	10.420 0.009	10.490 0.006	10.580 0.009	10.660 0.007	10.740 0.008	10.810 0.009
10.900 0.008	10.970 0.008	11.070 0.005	11.150 0.006	11.220 0.007	11.300 0.008	11.380 0.010	11.440 0.009
11.520 0.009	11.600 0.010	11.680 0.008	11.750 0.009	11.830 0.010	11.890 0.011	11.970 0.011	12.040 0.008
12.120 0.009	12.190 0.009	12.260 0.012	12.330 0.007				



AVERAGED DATA
NUMBER OF SPECTRA 10
FOR GROUP 25 16 52 16 ... 2000000 MX106-1 LAVA FLOW 28

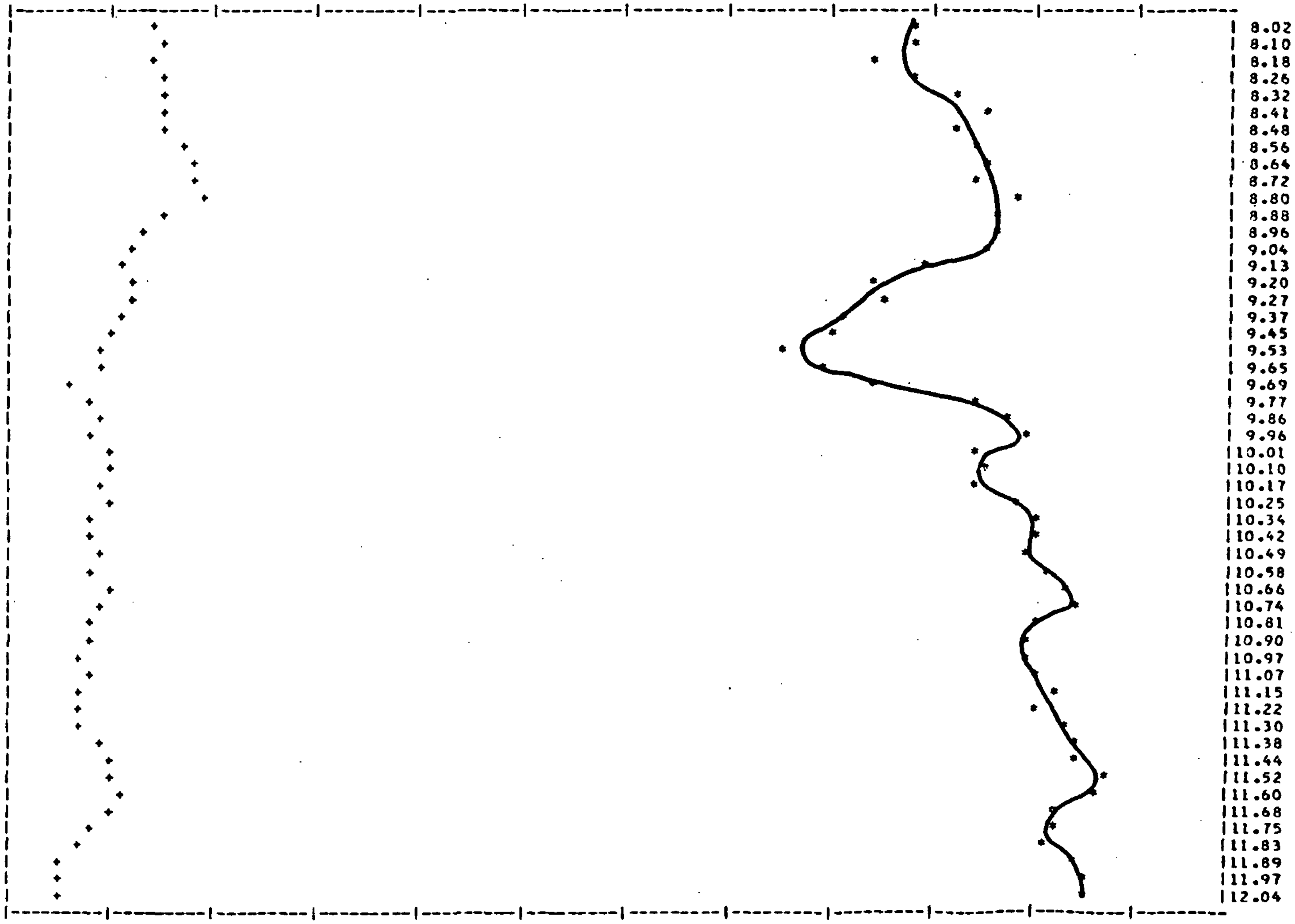
AVERAGE TEMPERATURE= 39.431 STD.DEV.= 1.306

WAVELENGTH,AVERAGE EMIT.

7.750	0.932	7.810	0.931	7.880	0.927	7.950	0.971	8.020	0.969	8.100	0.970	8.180	0.966	8.260	0.969
8.320	0.974	8.410	0.977	8.480	0.974	8.560	0.975	8.640	0.977	8.720	0.975	8.800	0.979	8.880	0.978
8.960	0.977	9.040	0.976	9.130	0.970	9.200	0.966	9.270	0.967	9.370	0.963	9.450	0.962	9.530	0.956
9.650	0.960	9.690	0.966	9.770	0.975	9.860	0.979	9.960	0.969	10.010	0.976	10.100	0.977	10.170	0.975
10.250	0.979	10.340	0.982	10.420	0.982	10.450	0.980	10.580	0.982	10.660	0.985	10.740	0.985	10.810	0.981
10.900	0.980	10.970	0.960	11.070	0.982	11.150	0.983	11.220	0.981	11.300	0.985	11.380	0.985	11.440	0.985
11.520	0.968	11.600	0.988	11.680	0.983	11.750	0.983	11.830	0.982	11.890	0.986	11.970	0.987	12.040	0.986
12.120	0.985	12.190	0.989	12.260	0.981	12.330	0.983								

WAVELENGTH,STD.DEV.

7.750	0.011	7.510	0.013	7.880	0.013	7.950	0.017	8.020	0.015	8.100	0.016	8.180	0.016	8.260	0.016
8.320	0.017	8.410	0.017	8.480	0.017	8.560	0.018	8.640	0.020	8.720	0.020	8.800	0.021	8.880	0.017
8.960	0.015	9.040	0.013	9.130	0.012	9.200	0.014	9.270	0.013	9.370	0.013	9.450	0.012	9.530	0.010
9.650	0.010	9.690	0.005	9.770	0.009	9.860	0.011	9.960	0.010	10.010	0.011	10.100	0.011	10.170	0.010
10.250	0.012	10.340	0.009	10.420	0.009	10.450	0.010	10.580	0.010	10.660	0.011	10.740	0.010	10.810	0.010
10.900	0.009	10.970	0.009	11.070	0.009	11.150	0.009	11.220	0.009	11.300	0.008	11.380	0.010	11.440	0.011
11.520	0.012	11.600	0.012	11.680	0.011	11.750	0.010	11.830	0.008	11.890	0.007	11.970	0.007	12.040	0.007
12.120	0.006	12.190	0.006	12.260	0.004	12.330	0.008								



AVERAGED DATA
NUMBER OF SPECTRA 17
[illegible] 26 18 52 24086 [illegible] PX108-1 PLAVA F

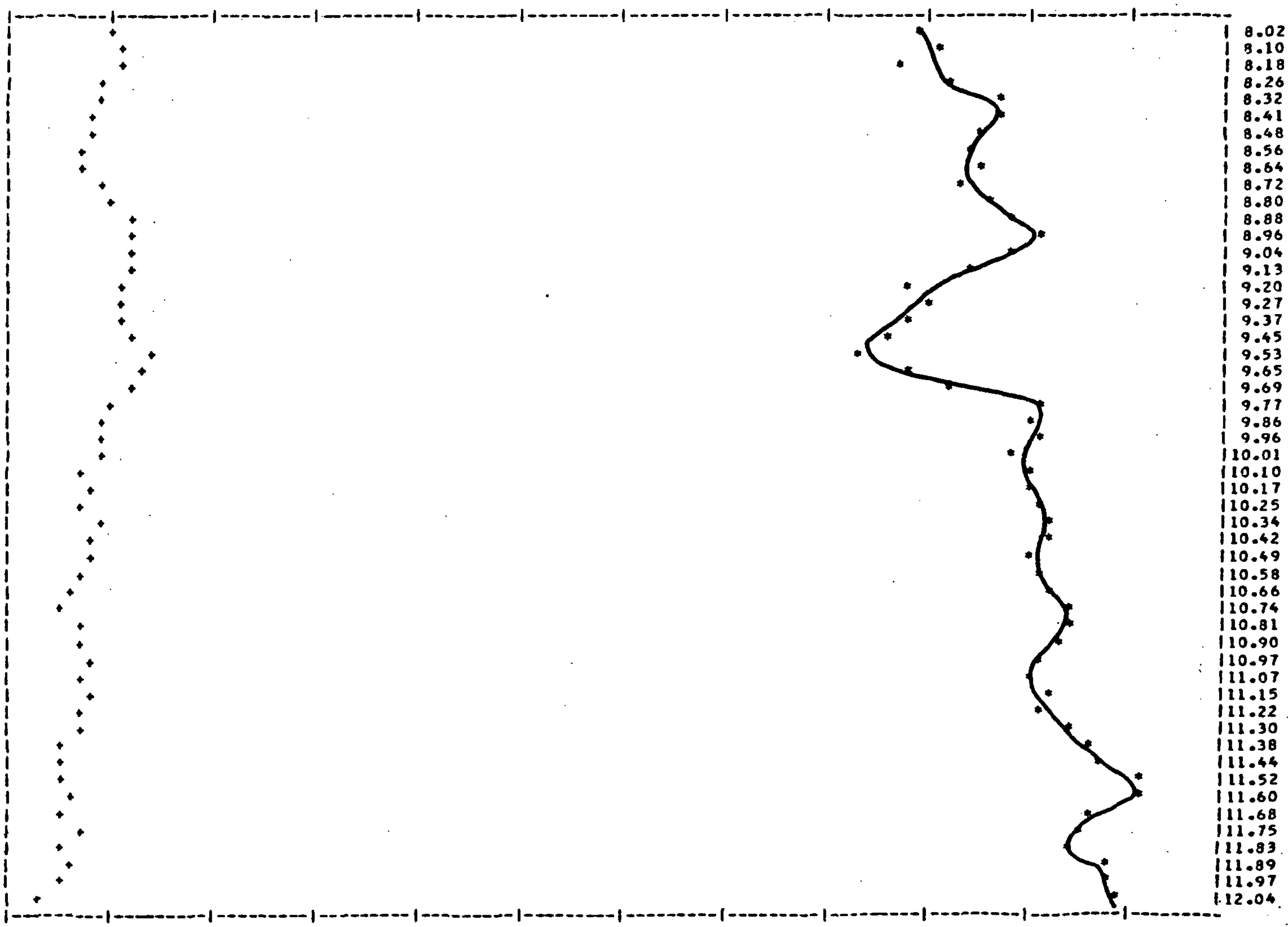
AVERAGE TEMPERATURE= 39.142 STD.DEV.= 0.747

WAVELENGTH,AVERAGE EMIT.

7.750	0.931	7.810	0.960	7.880	0.931	7.950	0.972	8.020	0.971	8.100	0.972	8.180	0.968	8.260	0.973
8.320	0.978	8.410	0.976	8.480	0.977	8.560	0.975	8.640	0.976	8.720	0.975	8.800	0.978	8.880	0.980
8.960	0.982	9.040	0.980	9.130	0.975	9.200	0.970	9.270	0.971	9.370	0.969	9.450	0.968	9.530	0.965
9.650	0.970	9.690	0.974	9.770	0.982	9.860	0.982	9.960	0.982	10.010	0.979	10.100	0.981	10.170	0.981
10.250	0.982	10.340	0.983	10.420	0.983	10.490	0.981	10.580	0.982	10.660	0.984	10.740	0.986	10.810	0.986
10.900	0.985	10.970	0.983	11.070	0.982	11.150	0.983	11.220	0.982	11.300	0.986	11.380	0.987	11.440	0.989
11.520	0.992	11.600	0.992	11.680	0.987	11.750	0.986	11.830	0.986	11.890	0.989	11.970	0.990	12.040	0.990
12.120	0.989	12.190	0.994	12.260	0.985	12.330	0.986								

WAVELENGTH,STD.DEV.

7.750	0.017	7.810	0.017	7.980	0.014	7.950	0.016	8.020	0.012	8.100	0.012	8.180	0.012	8.260	0.011
8.320	0.010	8.410	0.009	8.460	0.010	8.560	0.009	8.640	0.009	8.720	0.010	8.800	0.011	8.880	0.014
8.960	0.013	9.040	0.015	9.130	0.013	9.200	0.012	9.270	0.012	9.370	0.012	9.450	0.013	9.530	0.016
9.650	0.014	9.690	0.013	9.770	0.012	9.860	0.011	9.960	0.011	10.010	0.010	10.100	0.009	10.170	0.010
10.250	0.008	10.340	0.010	10.420	0.009	10.490	0.009	10.580	0.008	10.660	0.007	10.740	0.007	10.810	0.009
10.900	0.009	10.970	0.009	11.070	0.008	11.150	0.010	11.220	0.009	11.300	0.009	11.380	0.007	11.440	0.006
11.520	0.006	11.600	0.007	11.680	0.006	11.750	0.008	11.830	0.007	11.890	0.008	11.970	0.006	12.040	0.005
12.120	0.008	12.190	0.007	12.260	0.010	12.330	0.005								



AVERAGED DATA.
NUMBER OF SPECTRA 21.
FOR GROUP 27 19 6 50774 6C011102 C2000000 MX138-1 DRY LAKE SEDS B

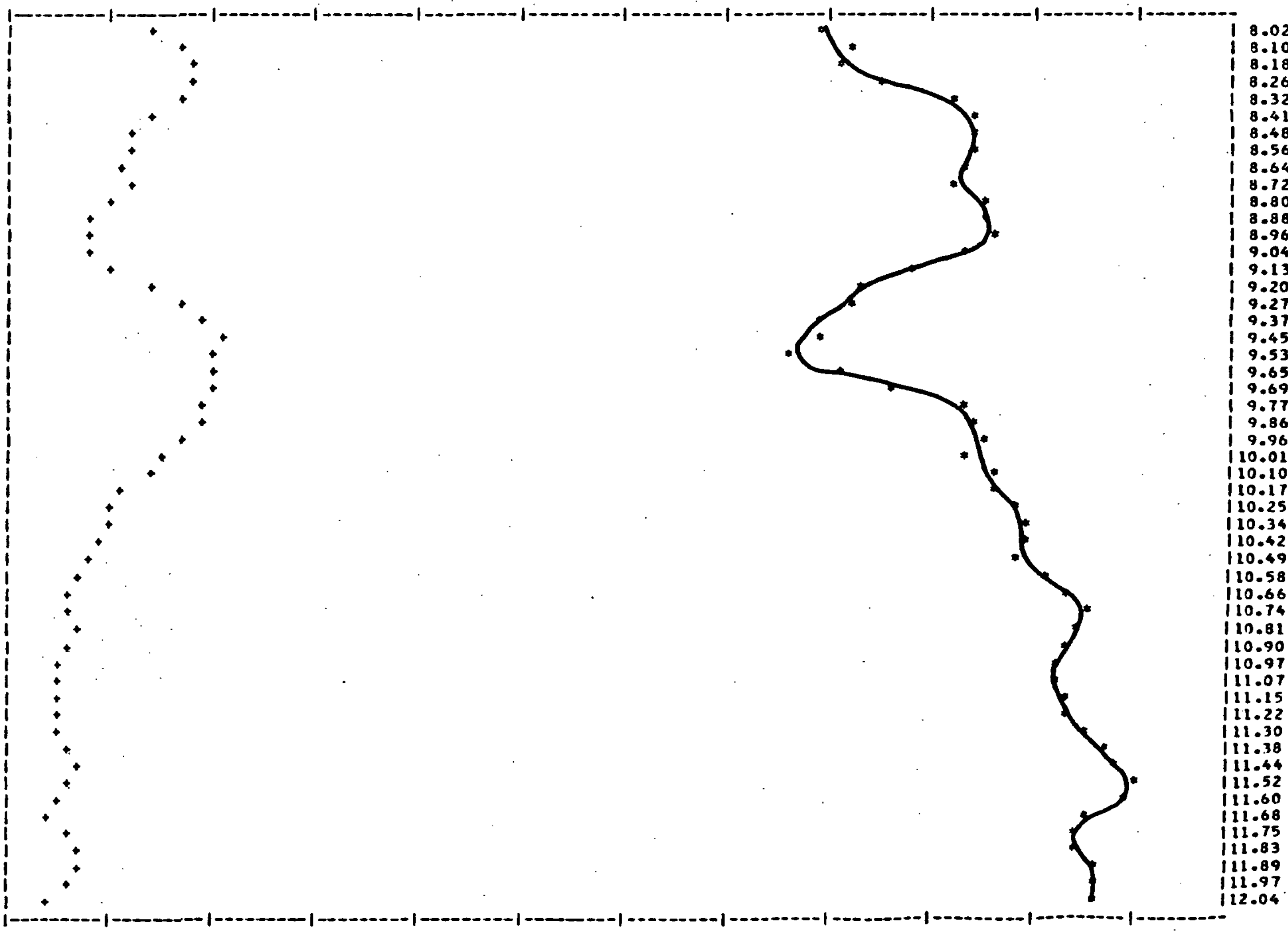
AVERAGE TEMPERATURE= 37.432 STD.DEV.= 0.498

WAVELENGTH,AVERAGE EMIT.

7.750 0.931	7.810 0.936	7.880 0.931	7.950 0.957	8.020 0.960	8.100 0.963	8.180 0.962	8.260 0.966
8.320 0.973	8.410 0.975	8.480 0.975	8.560 0.975	8.640 0.975	8.720 0.973	8.800 0.977	8.880 0.976
8.960 0.977	9.040 0.974	9.130 0.969	9.200 0.964	9.270 0.964	9.370 0.961	9.450 0.960	9.530 0.958
9.650 0.962	9.690 0.967	9.770 0.975	9.860 0.976	9.960 0.977	10.010 0.975	10.100 0.977	10.170 0.978
10.250 0.979	10.340 0.980	10.420 0.981	10.490 0.980	10.580 0.983	10.660 0.985	10.740 0.986	10.810 0.985
10.900 0.985	10.970 0.983	11.070 0.983	11.150 0.984	11.220 0.984	11.300 0.987	11.380 0.988	11.440 0.989
11.520 0.991	11.600 0.990	11.680 0.986	11.750 0.985	11.830 0.985	11.890 0.987	11.970 0.988	12.040 0.988
12.120 0.989	12.190 0.990	12.260 0.985	12.330 0.985				

WAVELENGTH,STD.DEV.

7.750 0.012	7.810 0.013	7.880 0.013	7.950 0.014	8.020 0.015	8.100 0.018	8.180 0.019	8.260 0.020
8.320 0.018	8.410 0.015	8.480 0.014	8.560 0.014	8.640 0.013	8.720 0.013	8.800 0.011	8.880 0.010
8.960 0.009	9.040 0.009	9.130 0.011	9.200 0.015	9.270 0.019	9.370 0.021	9.450 0.022	9.530 0.021
9.650 0.022	9.690 0.021	9.770 0.020	9.860 0.020	9.960 0.018	10.010 0.016	10.100 0.015	10.170 0.013
10.250 0.012	10.340 0.012	10.420 0.011	10.490 0.010	10.580 0.008	10.660 0.007	10.740 0.008	10.810 0.009
10.900 0.008	10.970 0.007	11.070 0.007	11.150 0.007	11.220 0.006	11.300 0.006	11.380 0.008	11.440 0.008
11.520 0.007	11.600 0.006	11.680 0.006	11.750 0.007	11.830 0.008	11.890 0.008	11.970 0.007	12.040 0.006
12.120 0.008	12.190 0.005	12.260 0.009	12.330 0.010				



AVERAGED DATA
NUMBER OF SPECTRA [illegible]
FOR GROUP 28 18 57 54370 6C011201 07000000 MX108-1 DRY LAKE SEDS A

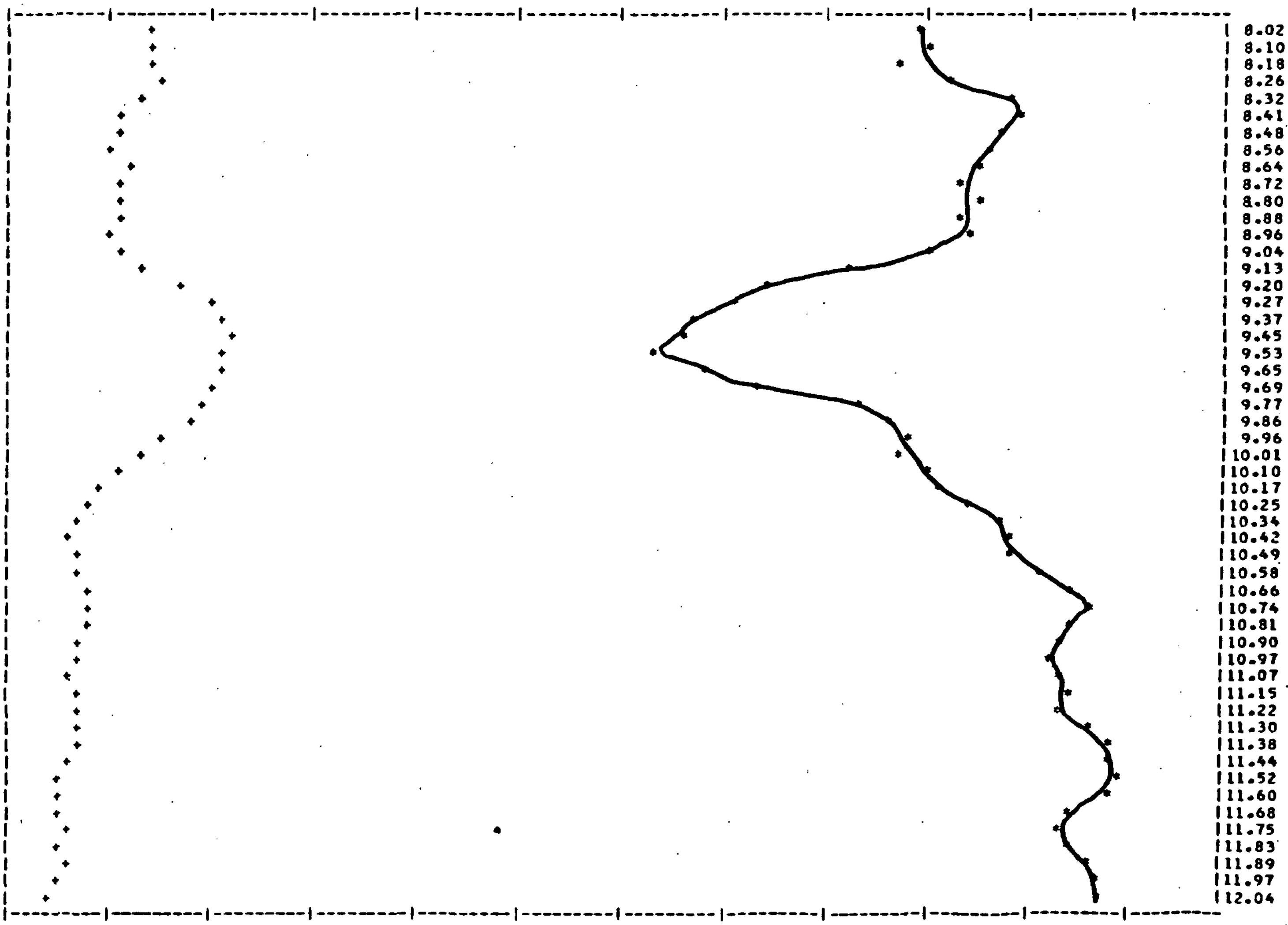
AVERAGE TEMPERATURE= [illegible] STD.DEV.= 0.540

WAVELENGTH,AVERAGE EMITT.

7.750	0.935	7.810	0.938	7.880	0.933	7.950	0.970	8.020	0.970	8.100	0.972	8.180	0.969	8.260	0.973
8.320	0.980	8.410	0.980	8.480	0.979	8.560	0.978	8.640	0.976	8.720	0.974	8.800	0.976	8.880	0.975
8.960	0.975	9.040	0.971	9.130	0.963	9.200	0.956	9.270	0.953	9.370	0.949	9.450	0.947	9.530	0.944
9.650	0.950	9.690	0.955	9.770	0.964	9.860	0.967	9.960	0.969	10.010	0.968	10.100	0.972	10.170	0.973
10.250	0.976	10.340	0.973	10.420	0.980	10.490	0.980	10.580	0.983	10.660	0.986	10.740	0.988	10.810	0.986
10.930	0.985	10.970	0.983	11.070	0.984	11.150	0.986	11.220	0.985	11.300	0.988	11.380	0.989	11.440	0.989
11.520	0.991	11.600	0.990	11.680	0.986	11.750	0.985	11.830	0.985	11.890	0.988	11.970	0.989	12.040	0.989
12.120	0.989	12.190	0.991	12.260	0.983	12.330	0.984								

WAVELENGTH,STD.DEV.

7.750	0.018	7.810	0.016	7.880	0.015	7.950	0.019	8.020	0.016	8.100	0.016	8.180	0.016	8.260	0.017
8.320	0.014	8.410	0.012	8.480	0.012	8.560	0.012	8.640	0.014	8.720	0.013	8.800	0.012	8.880	0.012
8.960	0.012	9.040	0.013	9.130	0.015	9.200	0.018	9.270	0.021	9.370	0.023	9.450	0.023	9.530	0.022
9.650	0.022	9.690	0.022	9.770	0.021	9.860	0.019	9.960	0.017	10.010	0.015	10.100	0.012	10.170	0.010
10.250	0.009	10.340	0.008	10.420	0.008	10.490	0.008	10.580	0.009	10.660	0.009	10.740	0.009	10.810	0.009
10.900	0.008	10.970	0.008	11.070	0.006	11.150	0.009	11.220	0.009	11.300	0.009	11.380	0.009	11.440	0.007
11.520	0.007	11.600	0.007	11.680	0.006	11.750	0.007	11.830	0.007	11.890	0.007	11.970	0.007	12.040	0.006
12.120	0.009	12.190	0.008	12.260	0.009	12.330	0.008								



AVERAGED DATA
NUMBER OF SPECTRA 25
FOR GROUP 29 19 6 41671 6C011102 C2000000 MXICE-1 DRY LAKE SEDS C

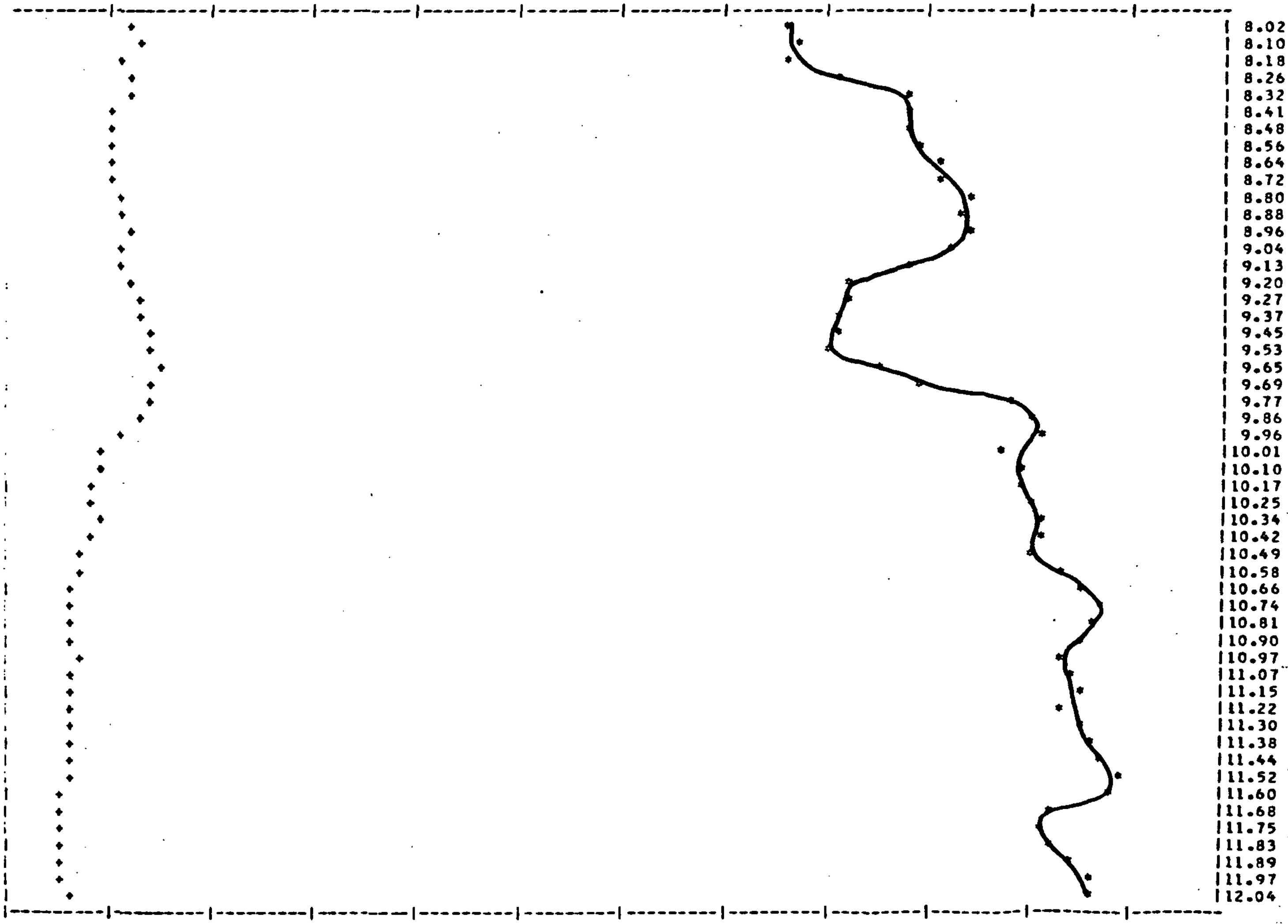
AVERAGE TEMPERATURE= 36.282 STD.DEV.= 0.905

WAVELENGTH,AVERAGE EMIT.

7.750	0.926	7.810	0.929	7.880	0.926	7.950	0.957	8.020	0.957	8.100	0.959	8.180	0.957	8.260	0.962
8.320	0.969	8.410	0.970	8.480	0.969	8.560	0.971	8.640	0.972	8.720	0.972	8.800	0.975	8.880	0.975
8.960	0.976	9.040	0.976	9.130	0.969	9.200	0.964	9.270	0.964	9.370	0.962	9.450	0.963	9.530	0.961
9.650	0.966	9.690	0.971	9.770	0.980	9.860	0.982	9.960	0.982	10.010	0.978	10.100	0.980	10.170	0.980
10.250	0.982	10.340	0.983	10.420	0.983	10.490	0.981	10.580	0.984	10.660	0.986	10.740	0.988	10.810	0.987
10.900	0.986	10.970	0.985	11.070	0.985	11.150	0.986	11.220	0.985	11.300	0.987	11.380	0.987	11.440	0.988
11.520	0.990	11.600	0.989	11.680	0.984	11.750	0.983	11.830	0.983	11.890	0.986	11.970	0.988	12.040	0.988
12.120	0.989	12.190	0.988	12.260	0.984	12.330	0.963								

WAVELENGTH,STD.DEV.

7.750	0.015	7.810	0.017	7.880	0.014	7.950	0.015	8.020	0.014	8.100	0.014	8.180	0.013	8.260	0.013
8.320	0.013	8.410	0.012	8.480	0.011	8.560	0.011	8.640	0.011	8.720	0.011	8.800	0.012	8.880	0.013
8.960	0.014	9.040	0.013	9.130	0.013	9.200	0.014	9.270	0.015	9.370	0.015	9.450	0.016	9.530	0.015
9.650	0.016	9.690	0.016	9.770	0.015	9.860	0.015	9.960	0.013	10.010	0.011	10.100	0.010	10.170	0.010
10.250	0.010	10.340	0.011	10.420	0.010	10.490	0.009	10.580	0.009	10.660	0.007	10.740	0.008	10.810	0.007
10.900	0.008	10.970	0.008	11.070	0.007	11.150	0.008	11.220	0.007	11.300	0.007	11.380	0.008	11.440	0.007
11.520	0.007	11.600	0.006	11.680	0.006	11.750	0.007	11.830	0.006	11.890	0.007	11.970	0.006	12.040	0.008
12.120	0.010	12.190	0.009	12.260	0.008	12.330	0.011								



AVE FIELD DATA
NUMBER OF SPECTRA 42
FOE GROUP 30 19 6 26511 6C011102 0/000000 MXICF-1 ALLUVIUM F

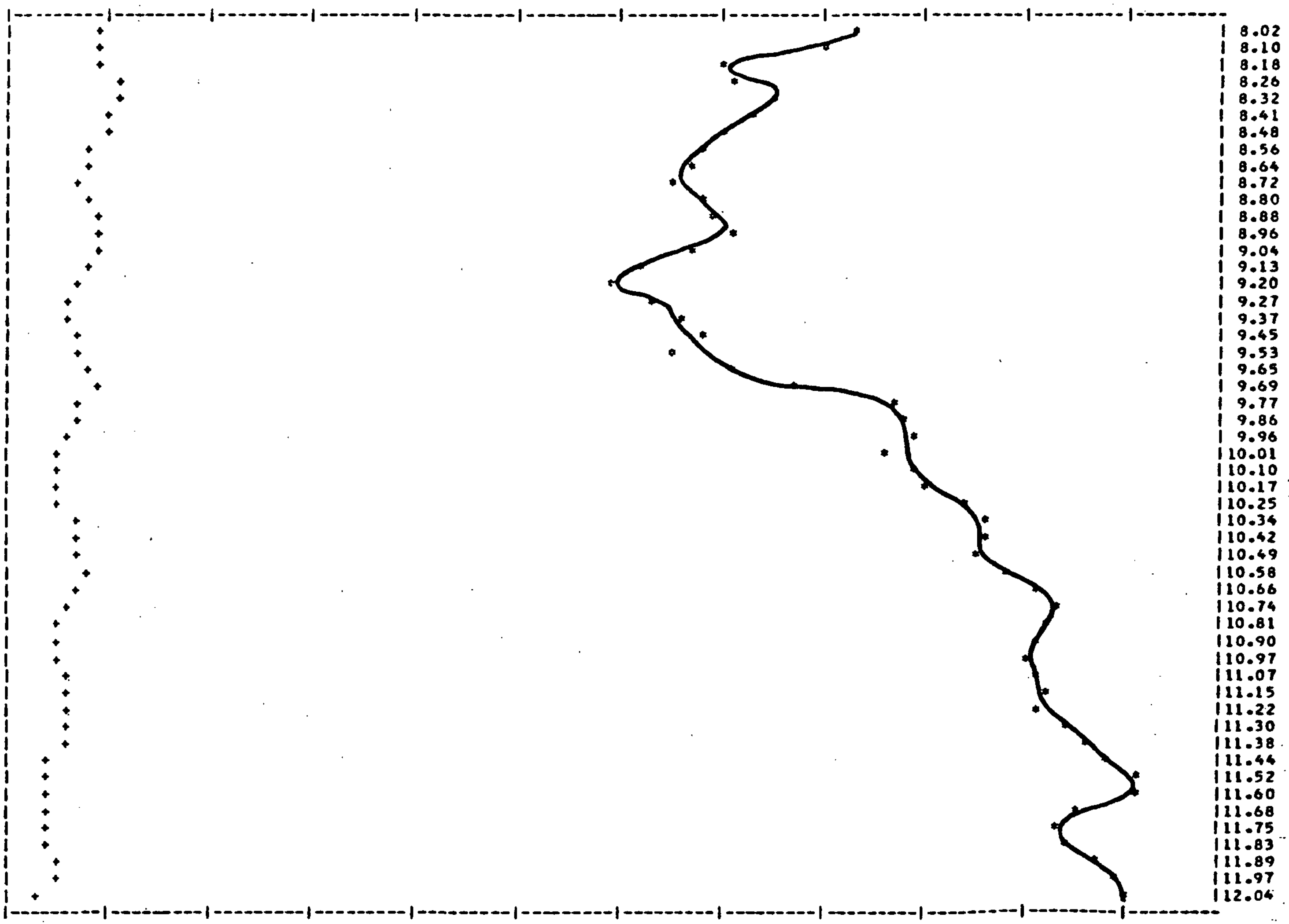
AVERAGE TEMPERATURE= 41.176 STD.DEV.= 0.372

WAVELENGTH,AVERAGE EMIT.

7.750 0.921	7.810 0.923	7.880 0.916	7.950 0.968	8.020 0.965	8.100 0.962	8.180 0.951	8.260 0.952
8.320 0.957	8.410 0.954	8.480 0.951	8.560 0.949	8.640 0.948	8.720 0.947	8.800 0.950	8.880 0.950
8.960 0.952	9.040 0.949	9.130 0.944	9.200 0.940	9.270 0.945	9.370 0.947	9.450 0.949	9.530 0.947
9.650 0.953	9.690 0.958	9.770 0.969	9.860 0.970	9.960 0.971	10.010 0.968	10.100 0.971	10.170 0.972
10.250 0.975	10.340 0.977	10.420 0.978	10.490 0.976	10.580 0.980	10.660 0.982	10.740 0.985	10.810 0.984
10.900 0.982	10.970 0.982	11.070 0.982	11.150 0.983	11.220 0.983	11.300 0.986	11.380 0.988	11.440 0.990
11.520 0.993	11.600 0.993	11.680 0.987	11.750 0.985	11.830 0.985	11.890 0.989	11.970 0.991	12.040 0.992
12.120 0.993	12.190 0.994	12.260 0.984	12.330 0.986				

WAVELENGTH,STD.DEV.

7.750 0.015	7.810 0.014	7.880 0.013	7.950 0.014	8.020 0.010	8.100 0.010	8.180 0.010	8.260 0.012
8.320 0.012	8.410 0.012	8.480 0.011	8.560 0.010	8.640 0.009	8.720 0.009	8.800 0.009	8.880 0.010
8.960 0.010	9.040 0.011	9.130 0.010	9.200 0.009	9.270 0.008	9.370 0.007	9.450 0.008	9.530 0.009
9.650 0.009	9.690 0.010	9.770 0.009	9.860 0.008	9.960 0.008	10.010 0.006	10.100 0.006	10.170 0.007
10.250 0.007	10.340 0.008	10.420 0.009	10.490 0.009	10.580 0.009	10.660 0.009	10.740 0.008	10.810 0.007
10.900 0.006	10.970 0.006	11.070 0.007	11.150 0.006	11.220 0.008	11.300 0.007	11.380 0.007	11.440 0.006
11.520 0.006	11.600 0.006	11.680 0.005	11.750 0.005	11.830 0.006	11.890 0.007	11.970 0.006	12.040 0.005
12.120 0.007	12.190 0.006	12.260 0.008	12.330 0.009				



AVERAGED DATA
NUMBER OF SPECTRA 27
FOR GROUP 31 [illegible] MX108-1 ALLUVIUM F

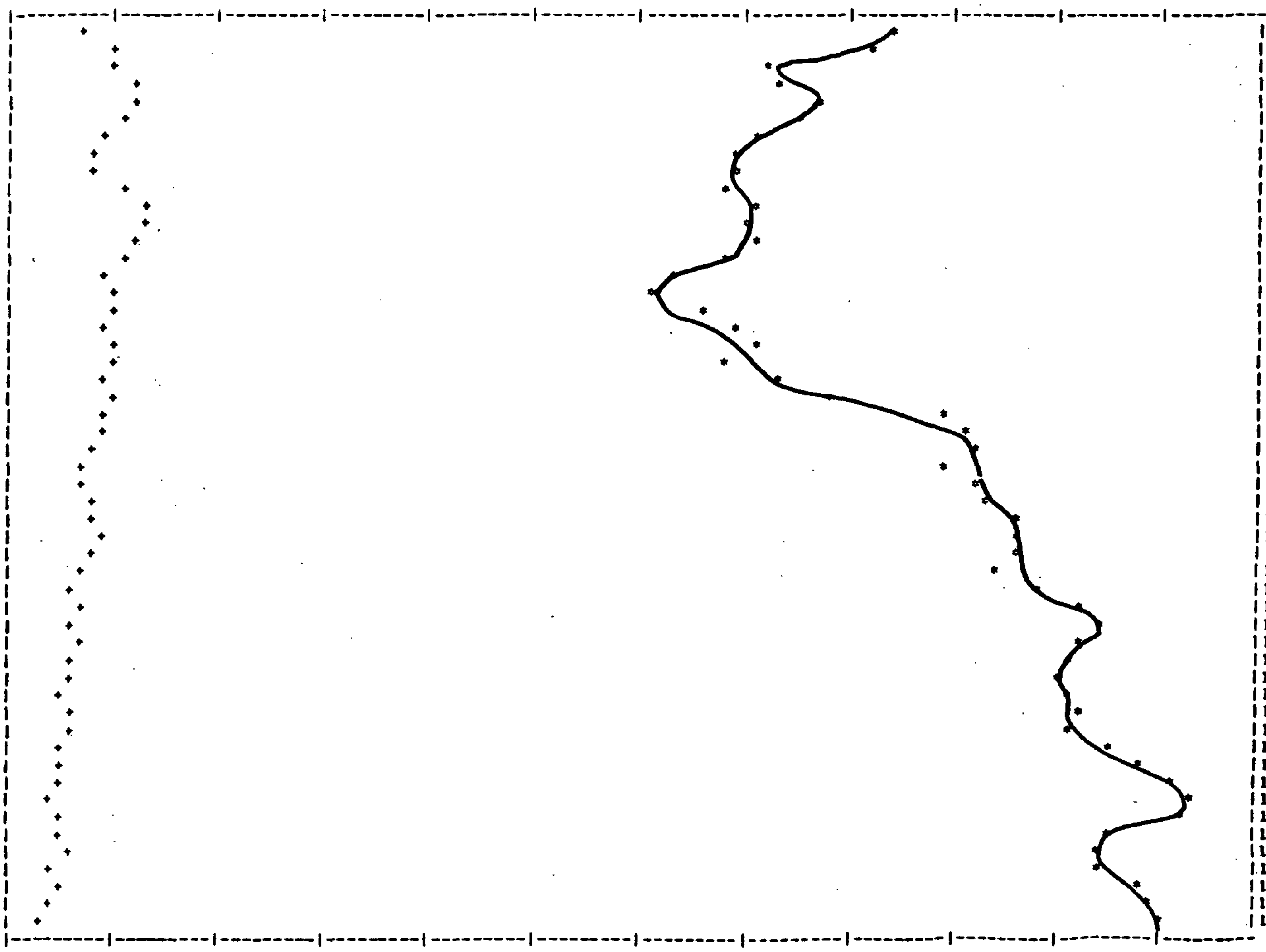
AVERAGE TEMPERATURE= 41.096 STD.DEV.= 0.494

WAVELENGTH,AVERAGE EMIT.

7.750 0.922	7.810 0.926	7.880 0.918	7.950 0.968	8.020 0.966	8.100 0.963	8.180 0.953	8.260 0.954
8.320 0.950	8.410 0.956	8.480 0.952	8.560 0.951	8.640 0.950	8.720 0.950	8.800 0.953	8.880 0.952
8.960 0.953	9.040 0.949	9.130 0.945	9.200 0.942	9.270 0.947	9.370 0.950	9.450 0.952	9.530 0.949
9.650 0.955	9.690 0.959	9.770 0.970	9.860 0.972	9.960 0.974	10.010 0.971	10.100 0.974	10.170 0.974
10.250 0.977	10.340 0.978	10.420 0.977	10.490 0.976	10.580 0.979	10.660 0.983	10.740 0.985	10.810 0.984
10.900 0.983	10.970 0.982	11.070 0.983	11.150 0.984	11.220 0.983	11.300 0.987	11.380 0.989	11.440 0.992
11.520 0.995	11.600 0.993	11.680 0.987	11.750 0.985	11.830 0.985	11.890 0.989	11.970 0.990	12.040 0.991
12.120 0.992	12.190 0.993	12.260 0.983	12.330 0.985				

WAVELENGTH,STD.DEV.

7.750 0.014	7.810 0.015	7.860 0.010	7.950 0.012	8.070 0.009	8.100 0.011	8.180 0.011	8.260 0.013
8.320 0.013	8.410 0.012	8.480 0.011	8.560 0.009	8.640 0.010	8.720 0.012	8.800 0.014	8.880 0.015
8.960 0.014	9.040 0.013	9.130 0.011	9.200 0.011	9.270 0.011	9.370 0.011	9.450 0.012	9.530 0.012
9.650 0.010	9.690 0.011	9.770 0.010	9.860 0.010	9.960 0.010	10.010 0.008	10.100 0.009	10.170 0.009
10.250 0.009	10.340 0.010	10.420 0.009	10.490 0.009	10.580 0.008	10.660 0.008	10.740 0.008	10.810 0.008
10.900 0.007	10.970 0.007	11.070 0.007	11.150 0.006	11.220 0.007	11.300 0.007	11.380 0.006	11.440 0.006
11.520 0.006	11.600 0.007	11.680 0.006	11.750 0.007	11.830 0.006	11.890 0.007	11.970 0.005	12.040 0.005
12.120 0.007	12.190 0.007	12.260 0.003	12.330 0.007				



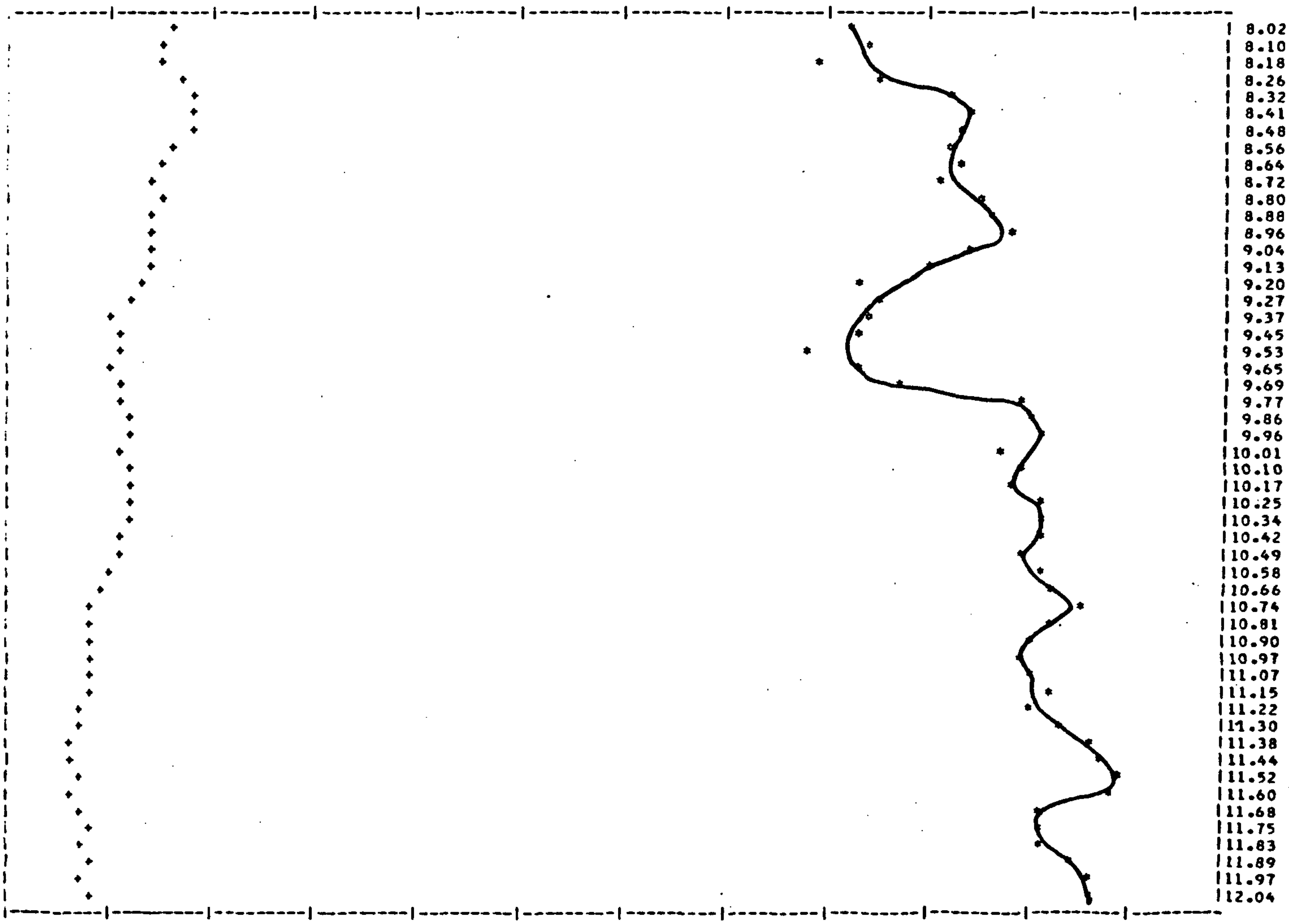
[illegible] DATA
[illegible] SPECTRA 22
[illegible]OUP 40 18 57 18290 66011201 02000090 MX108-1 SUNSHINE LAVA A

AVERAGE TEMPERATURE= 42.003 STD.DEV.= 1.453
WAVELENGTH,AVERAGE EMIT.

7.750 0.917	7.810 0.921	7.880 0.910	7.950 0.963	8.020 0.963	8.100 0.966	8.180 0.961	8.260 0.966
8.320 0.974	8.410 0.975	8.480 0.974	8.560 0.973	8.640 0.974	8.720 0.973	8.800 0.977	8.880 0.977
8.960 0.979	9.040 0.976	9.130 0.971	9.200 0.965	9.270 0.967	9.370 0.965	9.450 0.965	9.530 0.960
9.650 0.964	9.690 0.969	9.770 0.980	9.860 0.982	9.960 0.983	10.010 0.978	10.100 0.981	10.170 0.980
10.250 0.982	10.340 0.983	10.420 0.982	10.490 0.980	10.560 0.983	10.660 0.984	10.740 0.986	10.810 0.983
10.900 0.982	10.970 0.981	11.070 0.981	11.150 0.963	11.220 0.982	11.300 0.985	11.380 0.988	11.440 0.988
11.520 0.991	11.600 0.990	11.680 0.983	11.750 0.982	11.830 0.982	11.890 0.986	11.970 0.988	12.040 0.988
12.120 0.968	12.190 0.989	12.260 0.982	12.330 0.983				

WAVELENGTH,STD.DEV.

7.750 0.020	7.810 0.023	7.880 0.019	7.950 0.023	8.020 0.017	8.100 0.017	8.180 0.016	8.260 0.019
8.320 0.019	8.410 0.019	8.480 0.019	8.560 0.018	8.640 0.017	8.720 0.016	8.800 0.017	8.880 0.016
8.960 0.015	9.040 0.015	9.130 0.016	9.200 0.015	9.270 0.014	9.370 0.012	9.450 0.012	9.530 0.012
9.650 0.012	9.690 0.012	9.770 0.012	9.860 0.013	9.960 0.013	10.010 0.012	10.100 0.013	10.170 0.013
10.250 0.014	10.340 0.013	10.420 0.012	10.490 0.012	10.580 0.012	10.660 0.010	10.740 0.010	10.810 0.010
10.900 0.010	10.970 0.010	11.070 0.010	11.150 0.009	11.220 0.009	11.300 0.008	11.380 0.007	11.440 0.008
11.520 0.009	11.600 0.008	11.680 0.009	11.750 0.009	11.830 0.009	11.890 0.009	11.970 0.009	12.040 0.009
12.120 0.010	12.190 0.012	12.260 0.010	12.330 0.012				



AVERAGED DATA
NUMBER OF SPECTRA 25
FCP GROUP 41 18 57 11297 66011201 02000000 MX10F-1 SUNSHINE LAVA B

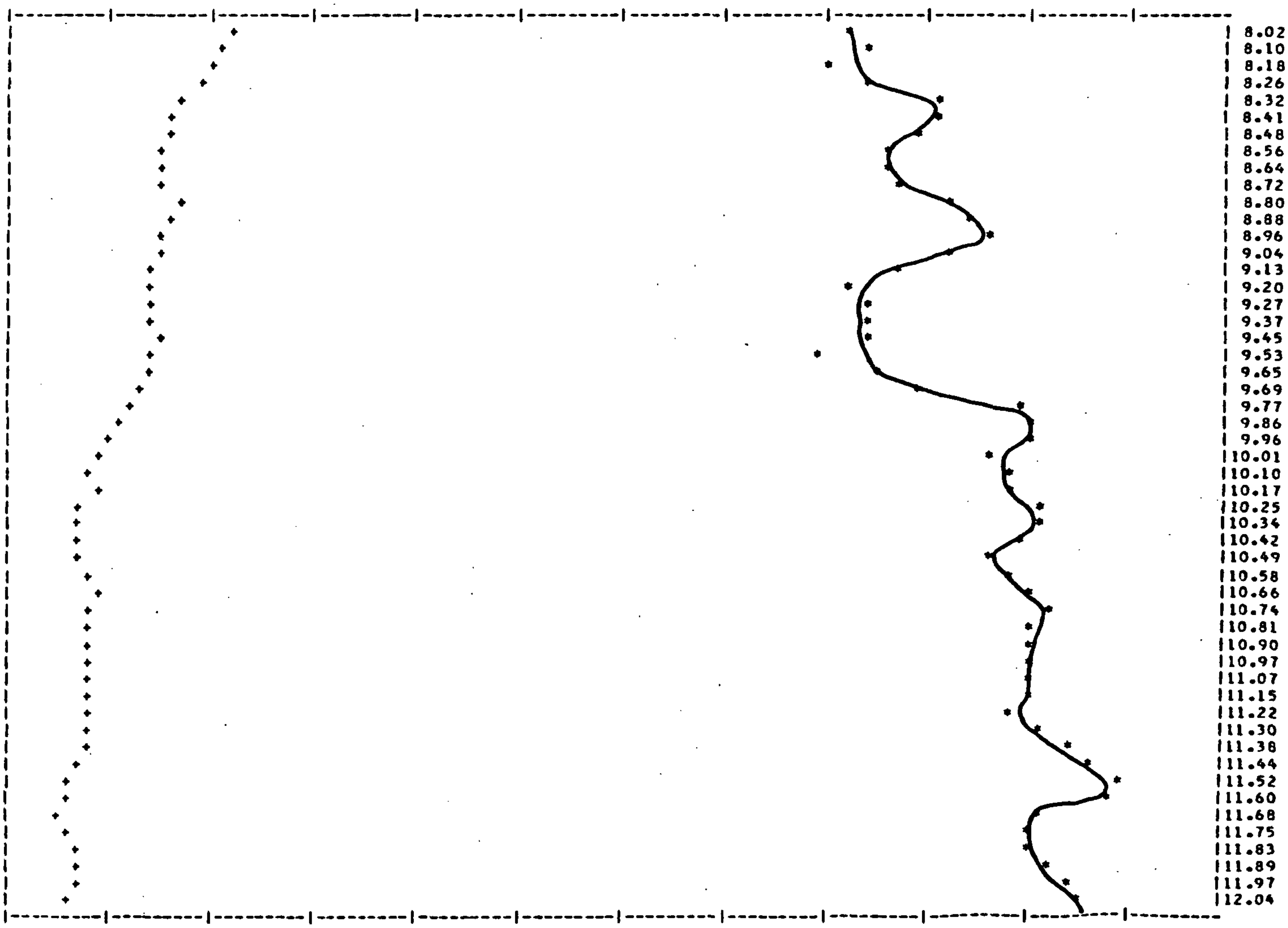
AVERAGE TEMPERATURE= 41.841 STD.DEV.= 1.547

WAVELENGTH,AVERAGE EMIT.

7.750 0.922	7.810 0.927	7.880 0.917	7.950 0.964	8.020 0.963	8.100 0.966	8.180 0.961	8.260 0.966
8.320 0.973	8.410 0.972	8.480 0.970	8.560 0.968	8.640 0.968	8.720 0.968	8.800 0.974	8.880 0.975
8.960 0.977	9.040 0.973	9.130 0.966	9.200 0.963	9.270 0.966	9.370 0.965	9.450 0.965	9.530 0.961
9.650 0.966	9.690 0.970	9.770 0.981	9.860 0.981	9.960 0.982	10.010 0.978	10.100 0.980	10.170 0.980
10.250 0.982	10.340 0.983	10.420 0.981	10.490 0.976	10.580 0.980	10.660 0.982	10.740 0.984	10.810 0.982
10.900 0.981	10.970 0.981	11.070 0.981	11.150 0.981	11.220 0.979	11.300 0.983	11.380 0.985	11.440 0.987
11.520 0.990	11.600 0.990	11.680 0.983	11.750 0.982	11.830 0.981	11.890 0.984	11.970 0.985	12.040 0.986
12.120 0.986	12.190 0.989	12.260 0.980	12.330 0.982				

WAVELENGTH,STD.DEV.

7.750 0.025	7.810 0.021	7.880 0.023	7.950 0.025	8.020 0.024	8.100 0.022	8.180 0.021	8.260 0.021
8.320 0.019	8.410 0.018	8.480 0.017	8.560 0.016	8.640 0.017	8.720 0.017	8.800 0.018	8.880 0.018
8.960 0.017	9.040 0.016	9.130 0.016	9.200 0.016	9.270 0.016	9.370 0.016	9.450 0.016	9.530 0.016
9.650 0.015	9.690 0.014	9.770 0.014	9.860 0.012	9.960 0.011	10.010 0.011	10.100 0.010	10.170 0.011
10.250 0.009	10.340 0.006	10.420 0.008	10.490 0.009	10.580 0.010	10.660 0.011	10.740 0.010	10.810 0.010
10.900 0.010	10.970 0.010	11.070 0.009	11.150 0.009	11.220 0.010	11.300 0.009	11.380 0.010	11.440 0.009
11.520 0.007	11.600 0.007	11.680 0.007	11.750 0.008	11.830 0.009	11.890 0.008	11.970 0.009	12.040 0.008
12.120 0.009	12.190 0.009	12.260 0.010	12.330 0.010				



AVERAGED DATA
NUMBER OF SPECTRA 17
FOR GROUP 42 18 56 5945C 66011201 02000036 MX108-1 SUNSHINE CINDERS C

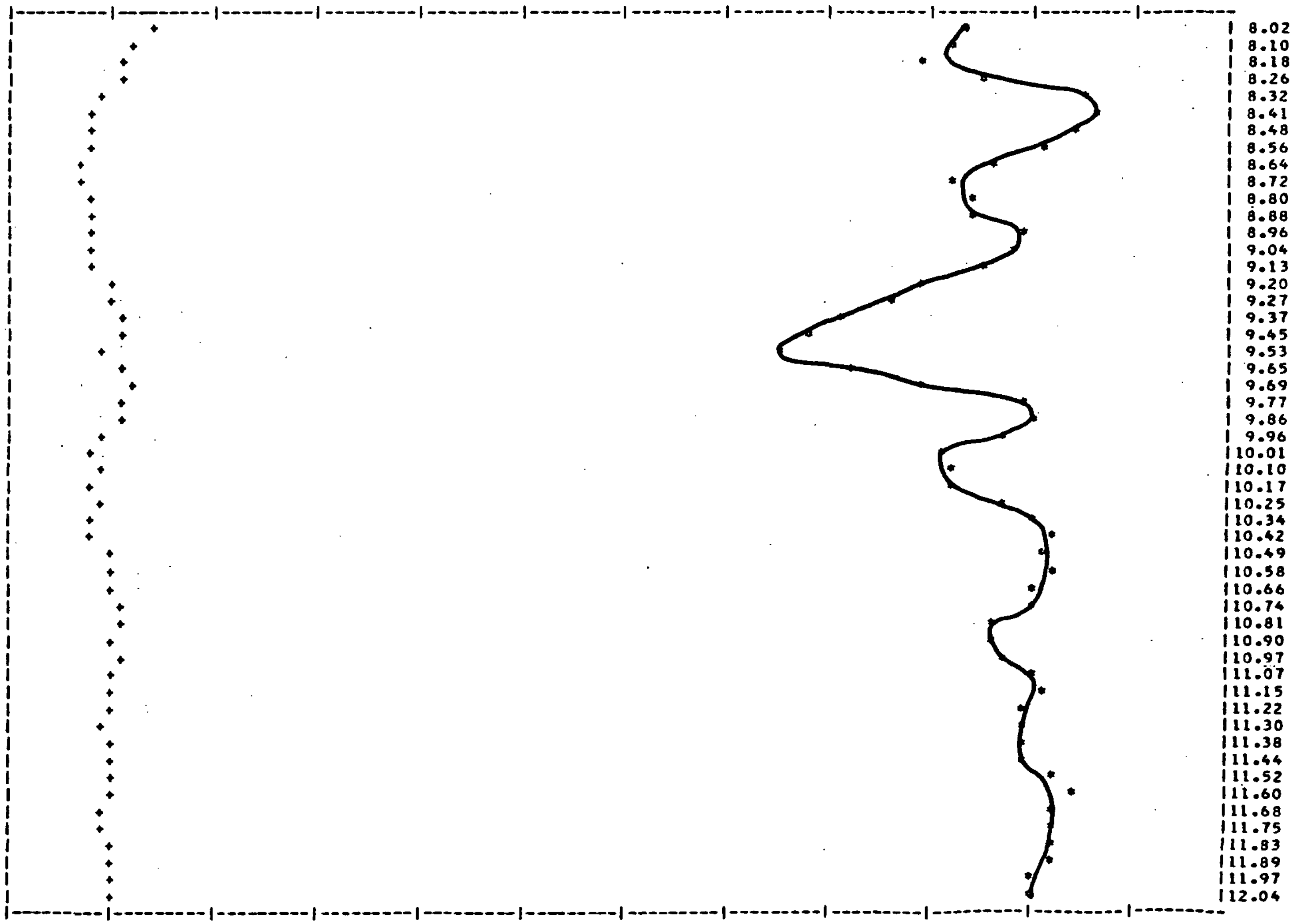
AVERAGE TEMPERATURE= 39.457 STD.DEV.= 1.587

WAVELENGTH,AVERAGE EMIT.

7.750 0.942	7.810 [illegible]	7.880 0.965	7.950 0.977	8.020 0.975	8.100 0.974	8.180 0.971	8.260 0.976
8.320 0.986	8.410 0.986	8.480 0.986	8.560 0.982	8.640 0.978	8.720 0.974	8.800 0.976	8.880 0.976
8.960 0.980	9.040 [illegible]	9.130 0.976	9.200 0.971	9.270 0.968	9.370 0.962	9.450 0.959	9.530 0.956
9.650 0.964	9.690 0.970	9.770 0.931	9.860 0.982	9.960 0.979	10.010 0.972	10.100 0.973	10.170 0.973
10.250 0.978	10.340 0.982	10.420 0.983	10.490 0.982	10.580 0.983	10.660 0.982	10.740 0.981	10.810 0.978
10.900 0.977	10.970 0.973	11.070 0.981	11.150 0.982	11.220 0.981	11.300 0.981	11.380 0.981	11.440 0.981
11.520 0.984	11.600 0.986	11.680 0.984	11.750 0.984	11.830 0.984	11.890 0.984	11.970 0.982	12.040 0.981
12.120 0.983	12.190 0.986	12.260 0.980	12.330 0.987				

WAVELENGTH,STD.DEV.

7.750 0.016	7.810 0.020	7.880 0.017	7.950 0.016	8.020 0.016	8.100 0.014	8.180 0.013	8.260 0.013
8.320 0.011	8.410 0.010	8.480 0.010	8.560 0.009	8.640 0.009	8.720 0.009	8.800 0.009	8.880 0.009
8.960 0.010	9.040 0.009	9.130 0.010	9.200 0.012	9.270 0.012	9.370 0.012	9.450 0.012	9.530 0.011
9.650 0.012	9.690 0.013	9.770 0.012	9.860 0.012	9.960 0.010	10.010 0.009	10.100 0.010	10.170 0.010
10.250 0.010	10.340 0.010	10.420 0.010	10.490 0.011	10.580 0.012	10.660 0.012	10.740 0.012	10.810 0.012
10.900 0.012	10.970 0.012	11.070 0.012	11.150 0.011	11.220 0.011	11.300 0.010	11.380 0.011	11.440 0.012
11.520 0.011	11.600 0.011	11.630 0.011	11.750 0.011	11.830 0.011	11.890 0.011	11.970 0.011	12.040 0.011
12.120 0.012	12.190 0.012	12.260 0.012	12.330 0.014				



AVE... DATA
NUMBER OF SPECTRA ...
FIR GROUP 43 10 56 53412 4C011201 02000000 MX108-1 SUNSHINE CINDERS D

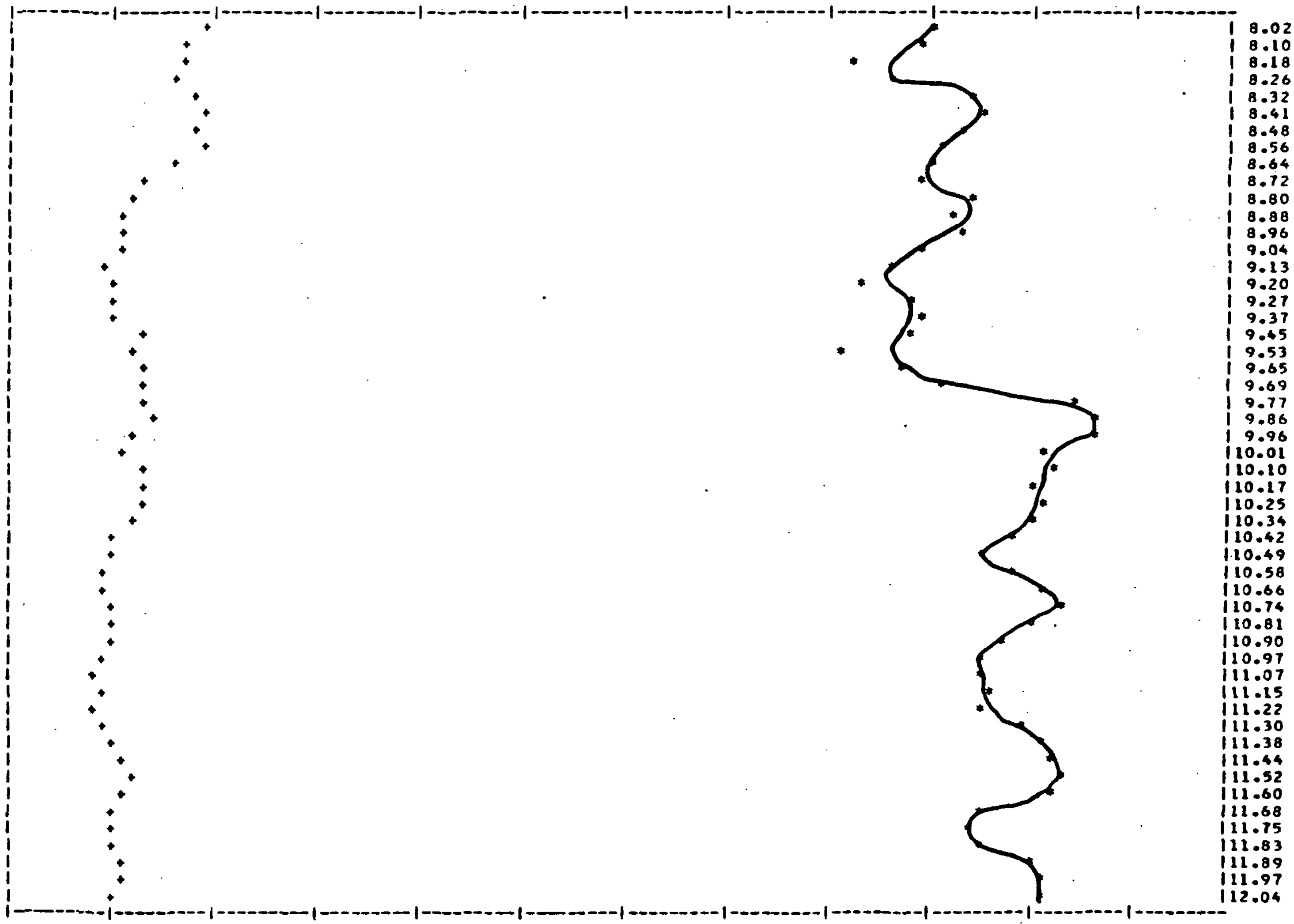
AVERAGE TEMPERATURE= 44.119 STD.DEV.= 1.986

*AVELENGTH,AVERAGE EMIT.

7.750 0.926	7.810 0.932	7.880 0.925	7.950 0.975	8.020 0.972	8.100 0.970	8.180 0.964	8.260 0.967
8.320 0.976	8.410 0.977	8.480 0.974	8.560 0.973	8.640 0.972	8.720 0.971	8.800 0.975	8.880 0.974
8.960 0.975	9.040 0.970	9.130 0.967	9.200 0.965	9.270 0.969	9.370 0.970	9.450 0.970	9.530 0.963
9.650 0.968	9.690 0.972	9.770 0.985	9.860 0.987	9.960 0.968	10.010 0.992	10.100 0.983	10.170 0.982
10.250 0.983	10.340 0.981	10.420 0.980	10.450 0.976	10.580 0.980	10.660 0.982	10.740 0.984	10.810 0.981
10.900 0.979	10.970 0.976	11.070 0.977	11.150 0.977	11.220 0.977	11.300 0.980	11.380 0.982	11.440 0.983
11.520 0.985	11.600 0.983	11.680 0.977	11.750 0.976	11.830 0.977	11.890 0.981	11.970 0.982	12.040 0.983
12.120 0.983	12.190 0.984	12.260 0.974	12.330 0.978				

*AVELENGTH,STD.DEV.

7.750 0.024	7.810 0.022	7.880 0.024	7.950 0.024	8.020 0.021	8.100 0.018	8.180 0.018	8.260 0.018
8.320 0.019	8.410 0.020	8.480 0.020	8.560 0.020	8.640 0.017	8.720 0.014	8.800 0.014	8.880 0.012
8.960 0.013	9.040 0.012	9.130 0.011	9.200 0.011	9.270 0.011	9.370 0.012	9.450 0.014	9.530 0.014
9.650 0.014	9.690 0.015	9.770 0.015	9.860 0.015	9.960 0.014	10.010 0.012	10.100 0.014	10.170 0.014
10.250 0.015	10.340 0.014	10.420 0.012	10.450 0.011	10.580 0.011	10.660 0.011	10.740 0.012	10.810 0.012
10.900 0.011	10.970 0.010	11.070 0.009	11.150 0.010	11.220 0.010	11.300 0.011	11.380 0.011	11.440 0.012
11.520 0.013	11.600 0.012	11.680 0.011	11.750 0.011	11.830 0.011	11.890 0.013	11.970 0.012	12.040 0.012
12.120 0.011	12.190 0.016	12.260 0.014	12.330 0.013				



AVERAGED DATA
NUMBER OF SPECTRA 4
FOR GROUP 44 18 50 56000 6C011101 02000000 MX108-1 PISGAH CINDERS 1

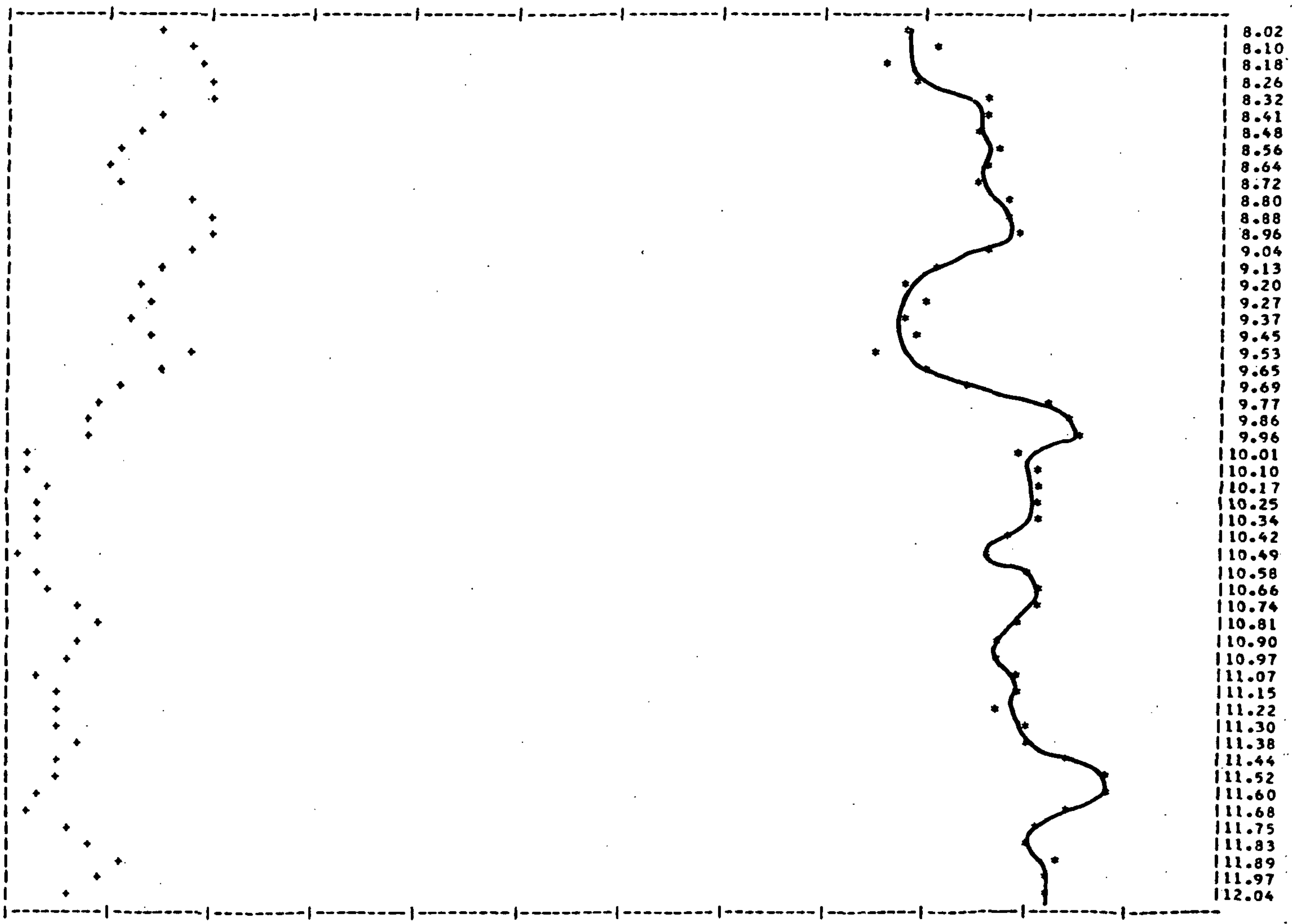
AVERAGE TEMPERATURE= 39.866 STD.DEV.= 1.010

WAVELENGTH,AVERAGE EMIT.

7.750 0.927	7.810 0.941	7.880 0.929	7.950 0.970	8.020 0.969	8.100 0.973	8.180 0.968	8.260 0.971
8.320 0.977	8.410 0.978	8.480 0.977	8.570 0.979	8.640 0.977	8.720 0.976	8.800 0.980	8.880 0.979
8.960 0.981	9.040 0.977	9.130 0.972	9.200 0.970	9.270 0.972	9.370 0.970	9.450 0.970	9.530 0.967
9.650 0.971	9.690 0.976	9.770 0.983	9.860 0.986	9.960 0.986	10.010 0.981	10.100 0.983	10.170 0.983
10.250 0.983	10.340 0.982	10.420 0.979	10.490 0.977	10.580 0.981	10.660 0.983	10.740 0.983	10.810 0.981
10.900 0.978	10.970 0.979	11.070 0.981	11.150 0.981	11.220 0.979	11.300 0.982	11.380 0.982	11.440 0.985
11.520 0.989	11.600 0.990	11.680 0.985	11.750 0.983	11.830 0.982	11.890 0.985	11.970 0.984	12.040 0.984
12.120 0.984	12.190 0.990	12.260 0.980	12.320 0.978				

WAVELENGTH,STD.DEV.

7.750 0.024	7.810 0.023	7.880 0.008	7.950 0.019	8.020 0.016	8.100 0.020	8.180 0.021	8.260 0.021
8.320 0.022	8.410 0.017	8.480 0.014	8.560 0.012	8.640 0.012	8.720 0.012	8.800 0.019	8.880 0.022
8.960 0.022	9.040 0.019	9.130 0.016	9.200 0.014	9.270 0.015	9.370 0.014	9.450 0.016	9.530 0.019
9.650 0.017	9.690 0.013	9.770 0.011	9.860 0.009	9.960 0.009	10.010 0.003	10.100 0.004	10.170 0.006
10.250 0.005	10.340 0.004	10.420 0.005	10.490 0.003	10.580 0.004	10.660 0.005	10.740 0.009	10.810 0.010
10.900 0.009	10.970 0.007	11.070 0.004	11.150 0.007	11.220 0.007	11.300 0.007	11.380 0.009	11.440 0.007
11.520 0.007	11.600 0.005	11.680 0.003	11.750 0.007	11.830 0.010	11.890 0.012	11.970 0.010	12.040 0.007
12.120 0.007	12.190 0.010	12.260 0.013	12.330 0.007				



AVERAGED DATA
NUMBER OF SPECTRA 5
FOR GROUP 45 18 59 57621 6C011101 02000000 MX10P-1 PISGAH CINDERS 2

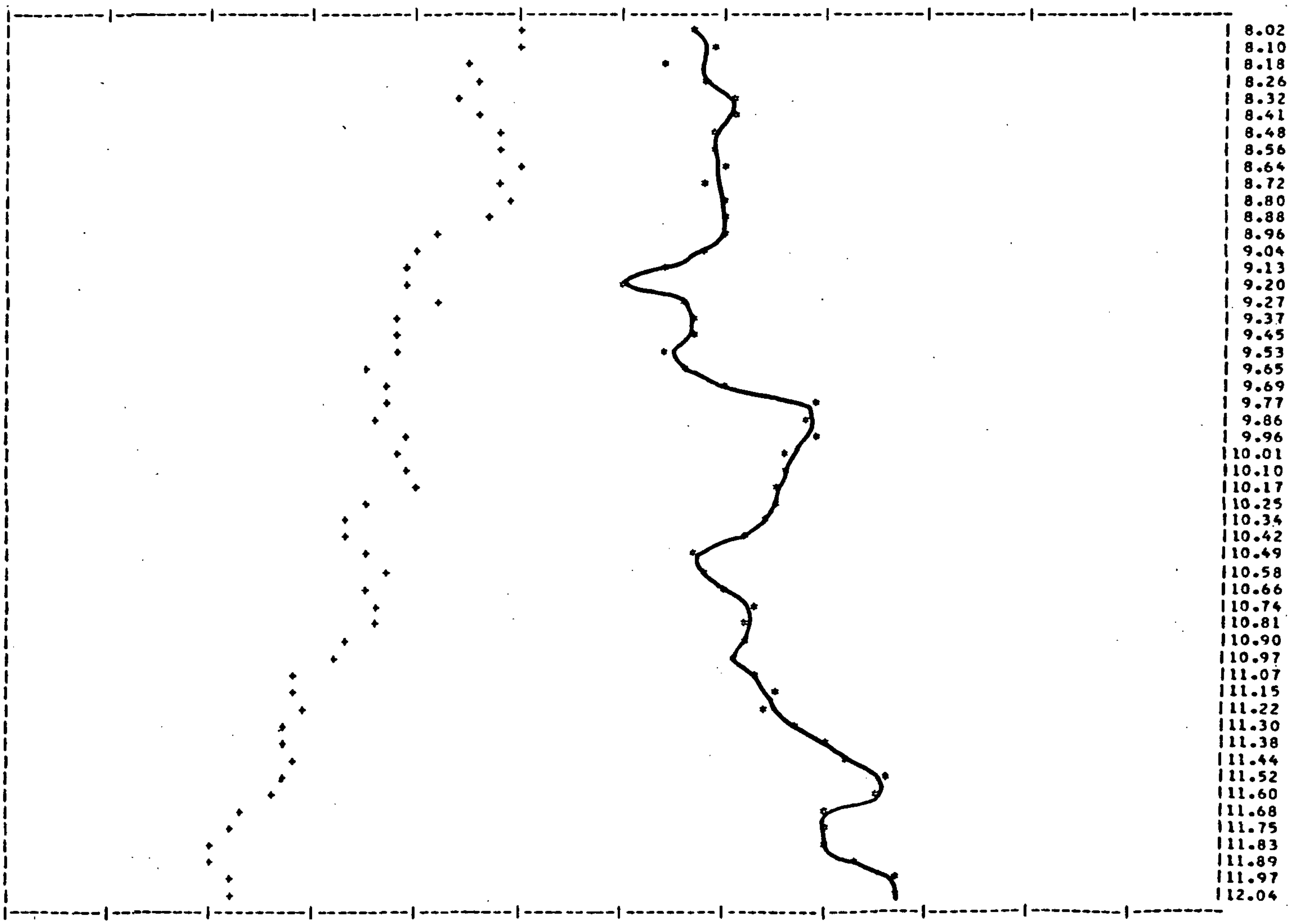
AVERAGE TEMPERATURE= 40.622 STD.DEV.= 2.676

WAVELENGTH,AVERAGE EMIT.

7.750	0.909	7.810	0.919	7.880	0.910	7.950	0.950	8.020	0.949	8.100	0.959	8.180	0.946	8.260	0.949
8.320	0.952	8.410	0.952	8.480	0.951	8.560	0.950	8.640	0.951	8.720	0.950	8.800	0.952	8.880	0.952
8.960	0.952	9.040	0.959	9.130	0.945	9.200	0.942	9.270	0.948	9.370	0.949	9.450	0.948	9.530	0.946
9.650	0.948	9.690	0.952	9.770	0.961	9.860	0.959	9.960	0.961	10.010	0.957	10.100	0.957	10.170	0.957
10.250	0.956	10.340	0.956	10.420	0.953	10.490	0.948	10.580	0.949	10.660	0.951	10.740	0.955	10.810	0.954
10.900	0.953	10.970	0.953	11.070	0.955	11.150	0.957	11.220	0.956	11.300	0.958	11.380	0.961	11.440	0.963
11.520	0.967	11.600	0.967	11.680	0.962	11.750	0.961	11.830	0.961	11.890	0.965	11.970	0.968	12.040	0.969
12.120	0.969	12.190	0.971	12.260	0.966	12.330	0.965								

WAVELENGTH,STD.DEV.

7.750	0.041	7.810	0.042	7.880	0.041	7.950	0.056	8.020	0.051	8.100	0.051	8.180	0.047	8.260	0.047
8.320	0.046	8.410	0.047	8.480	0.049	8.560	0.050	8.640	0.051	8.720	0.049	8.800	0.050	8.880	0.049
8.960	0.044	9.040	0.041	9.130	0.041	9.200	0.041	9.270	0.044	9.370	0.040	9.450	0.040	9.530	0.039
9.650	0.036	9.690	0.038	9.770	0.039	9.860	0.037	9.960	0.040	10.010	0.039	10.100	0.041	10.170	0.041
10.250	0.036	10.340	0.035	10.420	0.035	10.490	0.037	10.580	0.039	10.660	0.037	10.740	0.038	10.810	0.038
10.900	0.034	10.970	0.033	11.070	0.030	11.150	0.030	11.220	0.031	11.300	0.028	11.380	0.029	11.440	0.029
11.520	0.028	11.600	0.027	11.630	0.024	11.750	0.023	11.830	0.021	11.890	0.022	11.970	0.023	12.040	0.023
12.120	0.024	12.190	0.027	12.260	0.024	12.330	0.016								



AVERAGED DATA
NUMBER OF SPECTRA 9
FOR GROUP 46 18 51 255 6C011101 02000000 MX108-1 PISGAH CINDERS 3

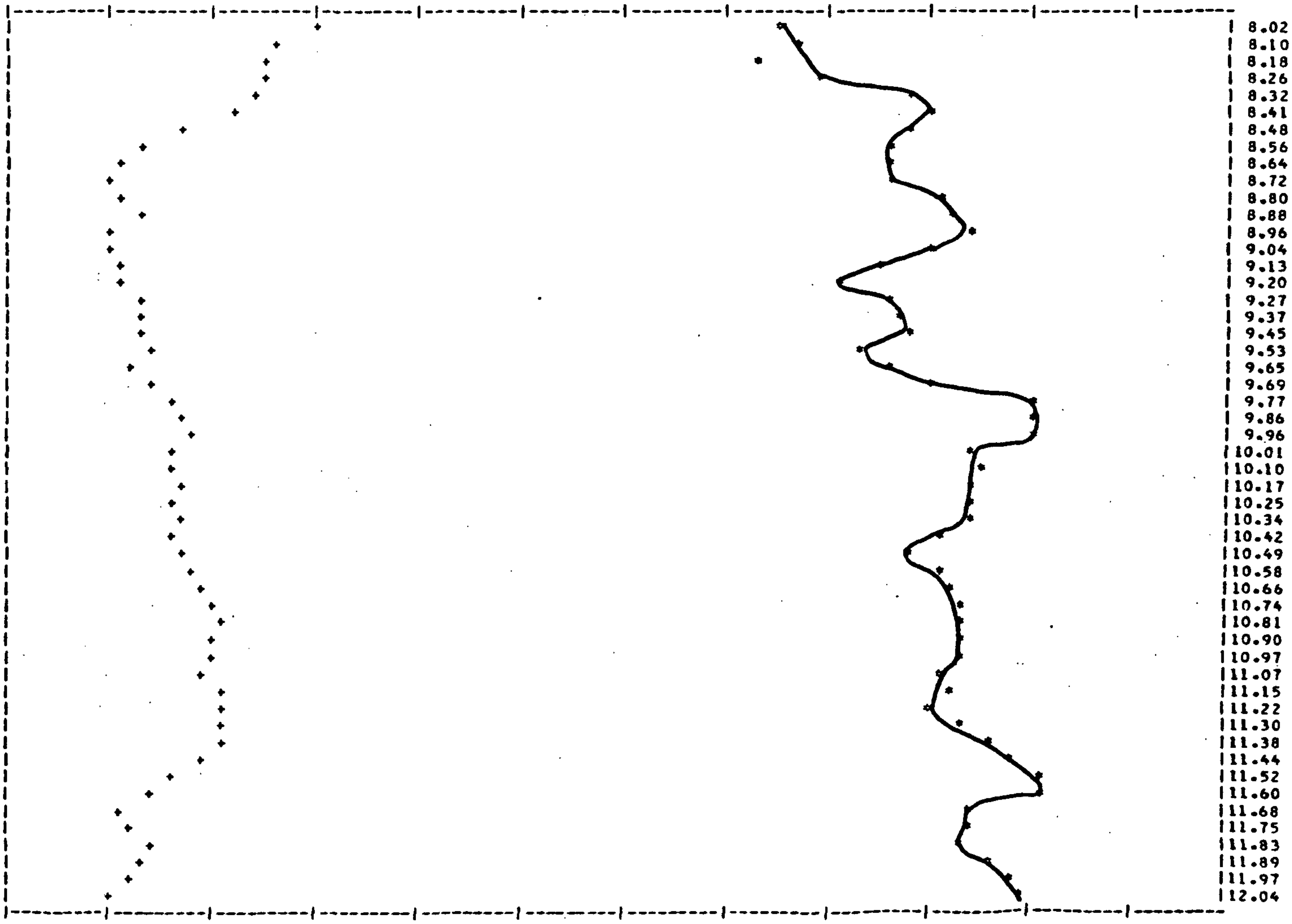
AVERAGE TEMPERATURE= 41.783 STD.DEV.= 2.709

WAVELENGTH,AVERAGE EMIT.

7.750 0.918	7.810 0.923	7.880 0.915	7.950 0.958	8.020 0.957	8.100 0.958	8.180 0.954	8.260 0.961
8.320 0.969	8.410 0.971	8.480 0.969	8.560 0.968	8.640 0.967	8.720 0.967	8.800 0.972	8.880 0.973
8.960 0.976	9.040 0.972	9.130 0.967	9.200 0.963	9.270 0.968	9.370 0.969	9.450 0.970	9.530 0.965
9.650 0.968	9.690 0.971	9.770 0.981	9.860 0.982	9.960 0.982	10.010 0.976	10.100 0.976	10.170 0.975
10.250 0.976	10.340 0.975	10.420 0.973	10.490 0.970	10.580 0.972	10.660 0.973	10.740 0.975	10.810 0.974
10.900 0.975	10.970 0.974	11.070 0.973	11.150 0.973	11.220 0.971	11.300 0.975	11.380 0.978	11.440 0.979
11.520 0.982	11.600 0.982	11.680 0.975	11.750 0.975	11.830 0.974	11.890 0.977	11.970 0.979	12.040 0.981
12.120 0.981	12.190 0.980	12.260 0.977	12.330 0.977				

WAVELENGTH,STD.DEV.

7.750 0.038	7.810 0.034	7.880 0.032	7.950 0.034	8.020 0.031	8.100 0.027	8.180 0.027	8.260 0.027
8.320 0.025	8.410 0.023	8.480 0.019	8.560 0.014	8.640 0.013	8.720 0.011	8.800 0.012	8.880 0.015
8.960 0.012	9.040 0.011	9.130 0.012	9.200 0.013	9.270 0.015	9.370 0.014	9.450 0.014	9.530 0.015
9.650 0.014	9.690 0.016	9.770 0.017	9.860 0.016	9.960 0.019	10.010 0.017	10.100 0.018	10.170 0.018
10.250 0.018	10.340 0.017	10.420 0.016	10.490 0.019	10.580 0.020	10.660 0.020	10.740 0.022	10.810 0.022
10.900 0.021	10.970 0.022	11.070 0.020	11.150 0.022	11.220 0.023	11.300 0.022	11.380 0.023	11.440 0.020
11.520 0.017	11.600 0.015	11.680 0.012	11.750 0.014	11.830 0.015	11.890 0.014	11.970 0.014	12.040 0.012
12.120 0.015	12.190 0.011	12.260 0.011	12.330 0.014				



AVERAGED DATA
NUMBER OF SPECTRA 44
FCF GROUP 53 17 12 52141 66011301 02600000 MX102-1 PALMDALE LAKE

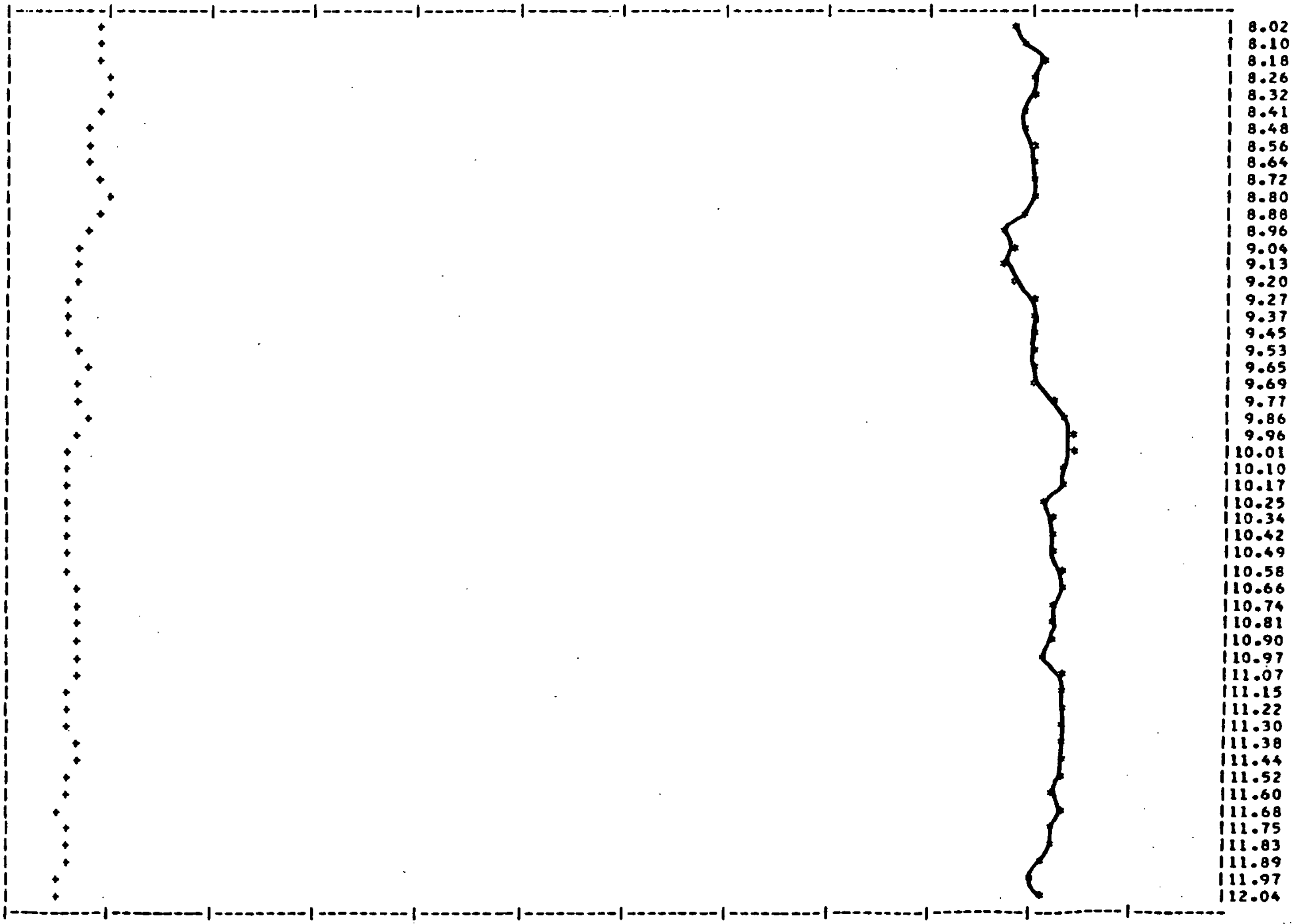
AVERAGE TEMPERATURE= 29.474 STD.DEV.= 0.312

WAVELENGTH,AVERAGE EMIT.

7.750 0.978	7.810 0.979	7.880 0.983	7.950 0.976	8.020 0.980	8.100 0.981	8.180 0.982	8.260 0.982
8.320 0.982	8.410 0.981	8.480 0.980	8.560 0.981	8.640 0.982	8.720 0.982	8.800 0.982	8.880 0.981
8.960 0.979	9.040 0.979	9.130 0.979	9.200 0.980	9.270 0.982	9.370 0.981	9.450 0.982	9.530 0.982
9.650 0.981	9.690 0.982	9.770 0.983	9.860 0.984	9.960 0.985	10.010 0.985	10.100 0.985	10.170 0.985
10.250 0.983	10.340 0.983	10.420 0.983	10.490 0.984	10.580 0.984	10.660 0.984	10.740 0.983	10.810 0.983
10.900 0.983	10.970 0.982	11.070 0.984	11.150 0.984	11.220 0.984	11.300 0.985	11.380 0.985	11.440 0.984
11.520 0.985	11.600 0.984	11.680 0.984	11.750 0.984	11.830 0.984	11.890 0.982	11.970 0.982	12.040 0.982
12.120 0.983	12.190 0.983	12.260 0.981	12.330 0.982				

WAVELENGTH,STD.DEV.

7.750 0.013	7.810 0.014	7.880 0.012	7.950 0.012	8.020 0.010	8.100 0.011	8.180 0.010	8.260 0.012
8.320 0.011	8.410 0.010	8.480 0.010	8.560 0.010	8.640 0.010	8.720 0.011	8.800 0.011	8.880 0.011
8.960 0.010	9.040 0.009	9.130 0.009	9.200 0.009	9.270 0.007	9.370 0.009	9.450 0.008	9.530 0.008
9.650 0.009	9.690 0.009	9.770 0.009	9.860 0.009	9.960 0.008	10.010 0.008	10.100 0.008	10.170 0.008
10.250 0.006	10.340 0.007	10.420 0.007	10.490 0.007	10.580 0.008	10.660 0.008	10.740 0.008	10.810 0.009
10.900 0.009	10.970 0.008	11.070 0.008	11.150 0.007	11.220 0.008	11.300 0.008	11.380 0.009	11.440 0.008
11.520 0.008	11.600 0.008	11.680 0.007	11.750 0.007	11.830 0.007	11.890 0.008	11.970 0.007	12.040 0.006
12.120 0.008	12.190 0.010	12.260 0.007	12.330 0.009				



AVERAGED DATA
NUMBER OF SPECTRA 53
FILE GROUP 54 18 51 36548 6CC111C1 00000000 MXICE-1 PLAVA ABCD

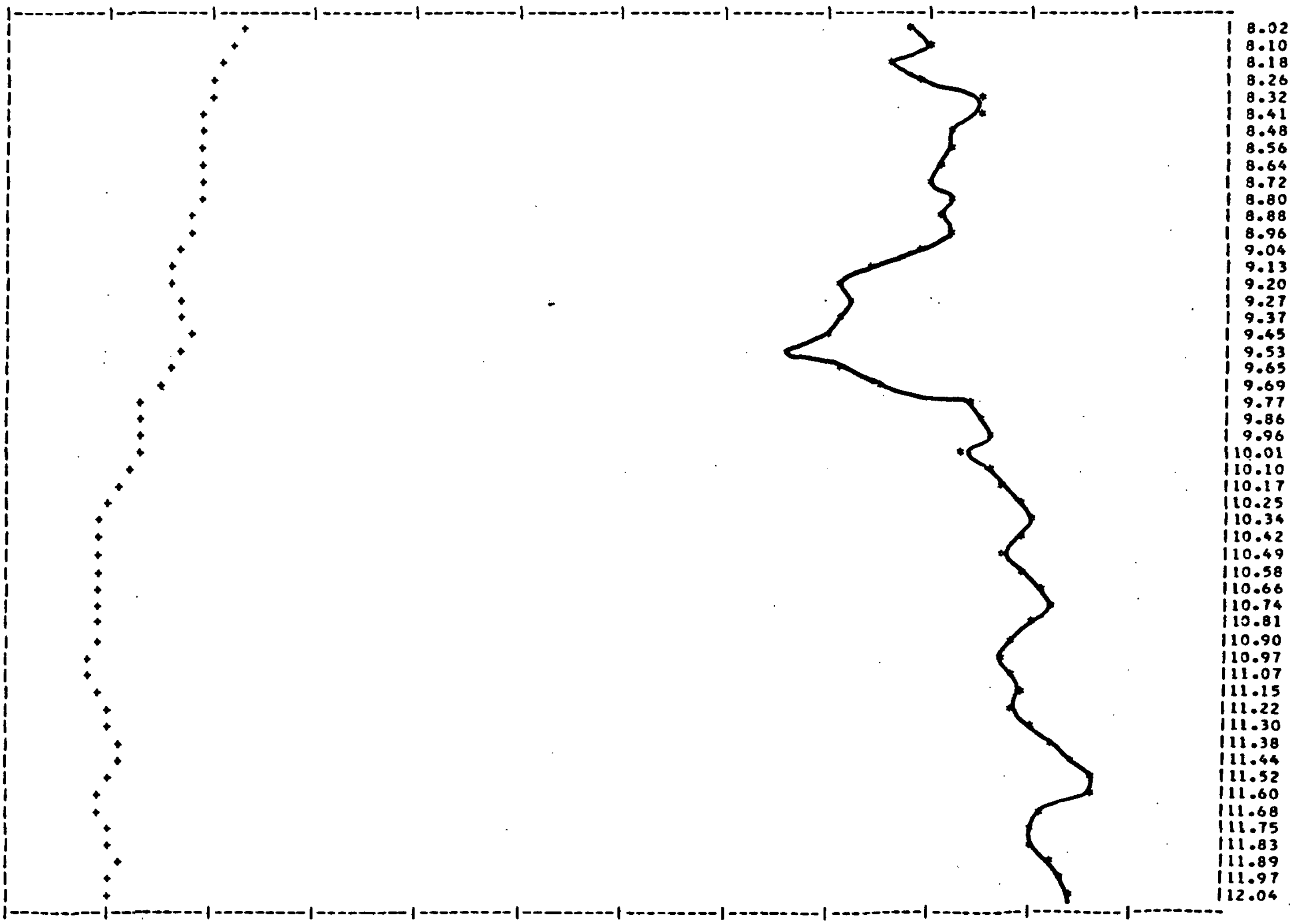
AVERAGE TEMPERATURE= 36.692 STD.DEV.= 1.037

WAVELENGTH,AVERAGE EMIT.

7.750	0.934	7.810	0.935	7.880	0.933	7.950	0.969	8.020	0.970	8.100	0.971	8.180	0.968	8.260	0.971
8.320	0.977	8.410	0.976	8.480	0.974	8.560	0.974	8.640	0.973	8.720	0.971	8.800	0.974	8.880	0.972
8.960	0.974	9.040	0.970	9.130	0.966	9.200	0.967	9.270	0.964	9.370	0.962	9.450	0.961	9.530	0.957
9.650	0.962	9.690	0.966	9.770	0.975	9.860	0.976	9.960	0.977	10.010	0.975	10.100	0.978	10.170	0.978
10.250	0.981	10.340	0.981	10.420	0.980	10.490	0.978	10.580	0.980	10.660	0.982	10.740	0.983	10.810	0.981
10.900	0.979	10.970	0.978	11.070	0.979	11.150	0.980	11.220	0.979	11.300	0.982	11.380	0.984	11.440	0.985
11.520	0.988	11.600	0.987	11.680	0.982	11.750	0.981	11.830	0.981	11.890	0.983	11.970	0.985	12.040	0.985
12.120	0.986	12.190	0.987	12.260	0.980	12.330	0.981								

WAVELENGTH,STD.DEV.

7.750	0.023	7.810	0.025	7.880	0.024	7.950	0.027	8.020	0.025	8.100	0.024	8.180	0.022	8.260	0.022
8.320	0.021	8.410	0.020	8.480	0.020	8.560	0.020	8.640	0.020	8.720	0.020	8.800	0.020	8.880	0.020
8.960	0.019	9.040	0.018	9.130	0.018	9.200	0.018	9.270	0.018	9.370	0.018	9.450	0.019	9.530	0.018
9.650	0.017	9.690	0.016	9.770	0.015	9.860	0.015	9.960	0.015	10.010	0.014	10.100	0.013	10.170	0.012
10.250	0.011	10.340	0.010	10.420	0.010	10.490	0.010	10.580	0.010	10.660	0.010	10.740	0.010	10.810	0.011
10.900	0.010	10.970	0.010	11.070	0.010	11.150	0.010	11.220	0.011	11.300	0.012	11.380	0.012	11.440	0.012
11.520	0.012	11.600	0.011	11.680	0.011	11.750	0.011	11.830	0.012	11.890	0.012	11.970	0.012	12.040	0.011
12.120	0.013	12.190	0.011	12.260	0.012	12.330	0.012								



C2. Ground Spectra - Short Path Length

These spectra were analyzed as described in Section A3(b). The basic format is the same as for the airborne spectra; however the spectra have been digitized at regular wavelength intervals (0.05μ) providing more points. The standard deviations have not been included as the extremely low noise level provided by the ground based equipment in comparison with airborne spectra over a fluctuating terrain would not give a meaningful comparison.

The following table contains a brief mineralogical description of the rocks studied. Not all the rocks described are included in the spectra due to experimental difficulties at the time of measurement. The spectra can be correlated with the table through the time indicated at the top of each spectrum.

TABLE C2

DESCRIPTION OF SAMPLES USED FOR GROUND SPECTRA (Site #27)

Run	Sample	Time	Mineralogy of the 1 1/2" x 1 1/2" Sample Area	Surface
1.	----- Cinko Lake Granodiorite	10:40	The surface is coated approximately 75% by fine grained, black tourmaline crystals. The remaining lighter area is largely quartz 20% and feldspar 5%.	Rough
2.	----- Cinko Lake Granodiorite	10:45	The sample area is approximately 30% quartz — 30% biotite, 20% feldspar mostly plagioclase, 15% hornblende 5% accessory minerals. The texture is medium grained equigranular-granodiorite.	Polished
3.	----- Cinko Lake Granodiorite	10:50	The 1/2" xenolith in a matrix of Cinko Lake granodiorite is composed of fine grained biotite 80% and hornblende 20%.	Sawed
4.	----- Cinko Lake Granodiorite	11:00	The sample is approximately the same composition as that seen in Run #2 at 10:45.	Sawed
5.	----- Cinko Lake Granodiorite	11:05	The surface is coated approximately 50% by fine grained, dark tourmaline crystals. The lighter material is approximately 25% quartz and 25% feldspar.	Rough
6.	----- Fremont Lake Granodiorite	11:10	The sample area is medium grained, equigranular, and is composed of 60% feldspar, mostly plagioclase, 15% quartz, 10% biotite, 10% hornblende, and 5% accessory minerals.	Rough
7.	NASA #302 Cascade Creek Granite	11:15	The sample area is medium grained hypodiomorphic, and is composed of 50% quartz, 30% orthoclase, 10% biotite, 2% hornblende, some plagioclase and accessory minerals.	Rough
8.	NASA #162 Dorothy Lake Alaskite-Granite	11:25	The sample is a fine grained texture composed of 60% feldspar, 30% quartz, 2% biotite and accessory minerals.	Sawed
9.	NASA #162 Dorothy Lake Alaskite-Granite	11:30	The sample is approximately the same as Run #8 at 11:25.	Rough
10.	NASA #308 Millcreek Porphyritic Quartz Monzonite	11:35	The sample has porphyritic phenocryst of orthoclase in a coarse grained matrix of 30% orthoclase, 20% plagioclase, 30% quartz, 10% biotite, 5% hornblende and 5% accessory minerals.	Rough

TABLE C2 (cont'd)

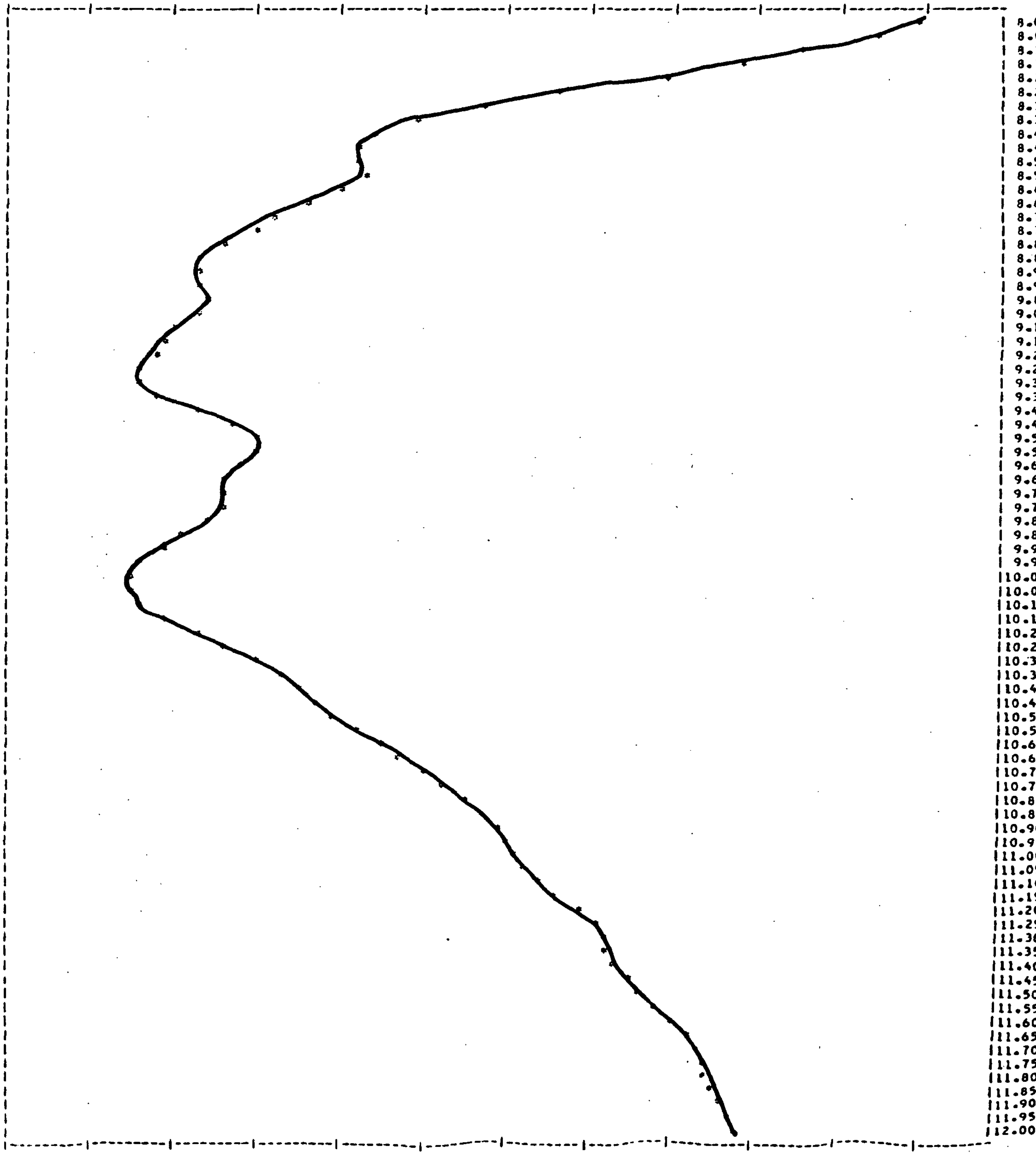
Run	Sample Time	Mineralogy of the 1 1/2" x 1 1/2" Sample Area	Surface
11.	NASA #308 11:40 Millcreek Porphyritic Quartz Monzonite	The xenolith is composed of approximately 50% biotite and 50% quartz in a very fine grained equigranular matrix.	Rough
12.	NASA #316 11:45 Patterson Grade Granodiorite	The sample area is medium grained, equigranular and composed of 60% feldspar mostly plagioclase, 15% quartz, 15% hornblende and biotite and 10% accessory minerals.	Rough
13.	NASA #383 11:50 Cathedral Peak Porphyritic Quartz Monzonite	The sample has orthoclase (?) phenocryst in a coarse grained matrix of feldspar approximately 30% orthoclase and 30% plagioclase, 30% quartz, 5% biotite and 5% accessory minerals. The surface area was moderately weathered.	Rough
14.	NASA #383 11:55	Same as above, except fresh rathered than weathered.	Rough
15.	NASA #331 12:05 Topaz Lake	1 1/2" microcline phenocryst in a matrix of Run #17, Sample #331 at 12:20.	Rough
16.	NASA #331 12:15 Topaz Lake	1 1/2" microcline phenocryst in a matrix of the below sample - NASA #331.	Rough
17.	NASA #331 12:20 Topaz Lake Porphyritic Quartz Monzonite (General pass)	The sample has microcline phenocryst in a matrix of coarse grained subhedral crystals composed of 35% microcline, 30% plagioclase, 25% quartz, 4% biotite, 6% accessory minerals.	Rough
18-19-20	Calibration		
21.	NASA #621 14:50 Brown Bear Pass Basalt	Weathered surface of basalt, some hematite staining.	Rough
22.	NASA #621 15:00 Brown Bear Pass Basalt	Fresh surface is composed of 70% plagioclase feldspar, 15% augite, 5% orthoclase, 5% pyroxene and 5% magnetite weathering to hematite.	Rough
23.	Q #8 15:05 Crow Springs Porphyritic Quartz Monzonite	The sample has porphyritic phenocrysts of plagioclase 30%, and interstitial quartz 25%, orthoclase 30% and hornblende 10% and 5% accessory minerals.	Rough
24.	Q #18 15:15 Crow Springs Quartz Monzonite Porphyry	Sample has medium grained matrix, phenocrysts mostly well-formed plagioclase 35% up to 5mm. in in length, quartz 25%, orthoclase 30%, biotite 50%, some hornblende, and the rest accessory minerals (Dark Phase).	Sawed

TABLE C2 (cont'd)

Run	Sample	Time	Mineralogy of the 1 1/2" x 1 1/2" Sample Area	Surface
25.	Q #18	15:25	Same as above Q #18 - 15:15 except it has a rough surface.	Rough
26.	Q #50 Crow Springs	15:30	Sample area strongly welded, ash flow tuff, completely devitrified, axiolitic texture, composition 60% glass and ash devitrified to cristobalite and K-feldspar. 15% subhedral quartz, 10% sanidine with trace of biotite and magnetite.	Rough
27.	Q #71 Crow Springs	15:35	Fine grained (hypocrystalline) with microlite matrix. Approximately 50% of area mostly plagioclase, larger plagioclase, subhedral to euhedral (21%), augite 8%, glass 17%.	Rough
28.	Q #71	15:40	Same as above except deeply weathered, magnetite is forming ironstain.	Rough
29.	Q #1 Crow Springs	15:45	Strongly welded quartz latite. Composition - 30% plagioclase, 10% quartz, 10% biotite, in a matrix of 50% devitrified glass.	Rough
30.	Q #61 Crow Springs	15:50	Non-welded lithic tuff. Composition - 50% volcanic dust, 14% subhedral sanidine, 12% quartz, 2% biotite, 10% pumice fragments.	Rough
31.	Q #77 Crow Springs	16:05	Weathered vitrophere, strongly welded, squashed fiamine filled with glass fragments.	Rough
32.	Q #77	16:10	Non-weathered side of the above sample.	Rough
33.	Q #63 Crow Springs	16:15	Welded quartz latite - 20% plagioclase, 15% sanidine, 10% quartz, 5% biotite, some hornblende - 10% fiamine. The matrix is composed of 40% devitrified shards. The sample is weathered.	Rough
34.	Q #63 Crow Springs	16:20	Approximately the same as above except the sample is fresh rather than weathered.	Rough
35.	Q #56 Crow Springs	16:25	Strongly altered obsidian or welded tuff - strongly devitrified 40% glass, 25% cristobalite, 20% sericite (?), 10% feldspar, 5% quartz.	Rough
36.	Q #58 Crow Springs	16:35	Strongly welded crystal tuff. 15% sanidine, 10% quartz, 10% fiamine. The matrix is composed of 60% glass shards which have been devitrified.	Rough
37.	Q #58	16:40	Same as above except for sawed surface.	Sawed
38.	Q #70 Crow Springs	16:45	Strongly welded ash flow tuff - 5% plagioclase, 5% sanidine, 2% quartz, 20% lithic fragments, 68% severely welded glass shards - reddish brown, devitrified to cristobalite and K-feldspar - a weathered sample.	Rough

1045
YI-----.50 CALIB. DIST.=-2.89 VOLTS PER INCH= 0.1038 OHMS= 448.50
INITIAL EFF. TEMPERATURE= 31.27 TARGET TEMPERATURE= 35.50
WAVELENGTH OF EMIT. MAX.= 7.84
TARGET TEMPERATURE (SPECTROMETER) = 36.28
EMITTANCES AT SPECIFIC WAVELENGTHS

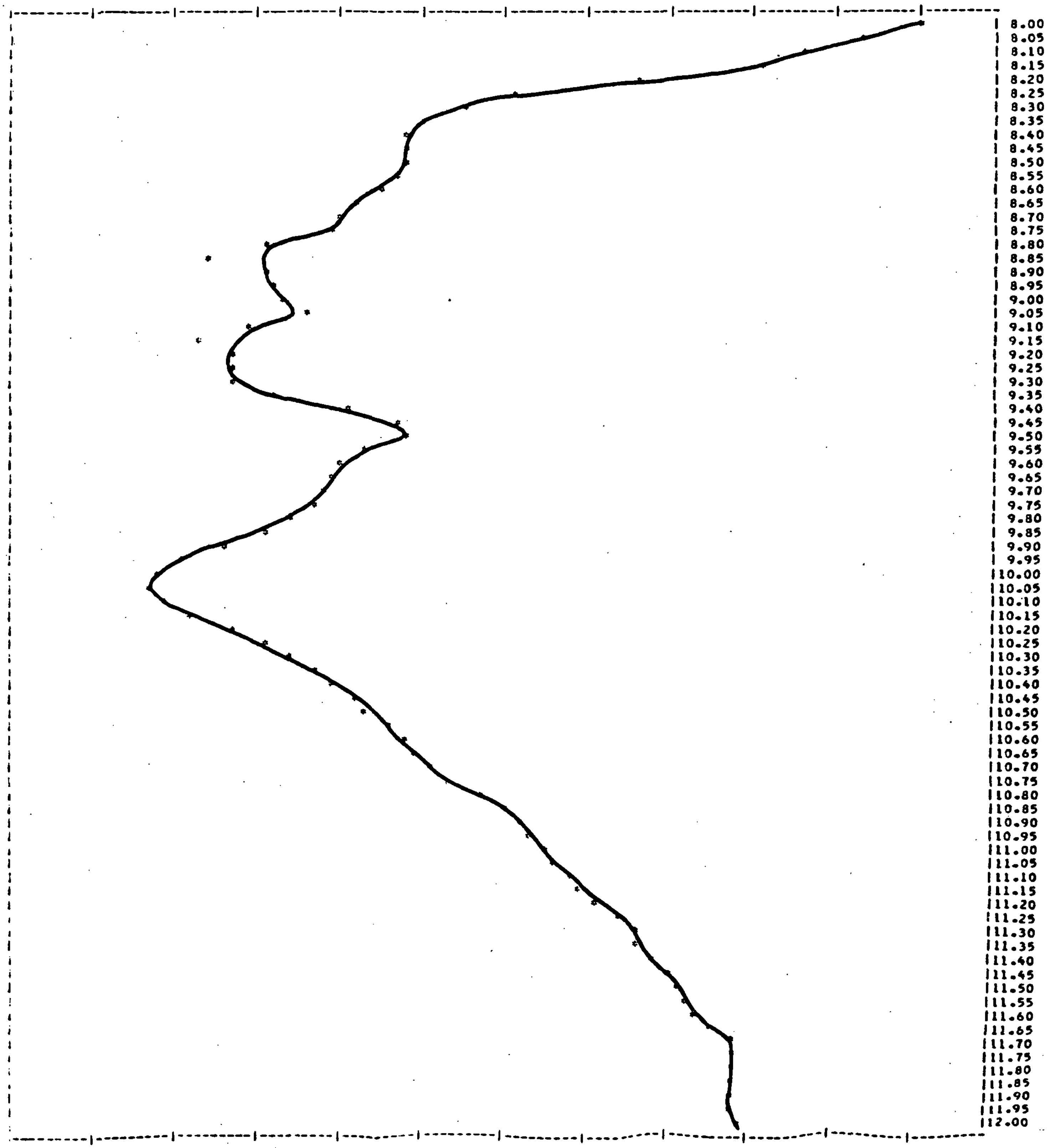
8.000 0.991	8.050 0.985	8.100 0.977	8.150 0.969	8.200 0.961	8.250 0.947	8.300 0.939	8.350 0.931
8.400 0.926	8.450 0.923	8.500 0.924	8.550 0.924	8.600 0.922	8.650 0.918	8.700 0.914	8.750 0.911
8.800 0.906	8.850 0.905	8.900 0.905	8.950 0.904	9.000 0.905	9.050 0.905	9.100 0.902	9.150 0.901
9.200 0.895	9.250 0.897	9.300 0.897	9.350 0.900	9.400 0.904	9.450 0.908	9.500 0.911	9.550 0.912
9.600 0.910	9.650 0.908	9.700 0.908	9.750 0.907	9.800 0.905	9.850 0.903	9.900 0.900	9.950 0.898
10.000 0.896	10.050 0.896	10.100 0.898	10.150 0.900	10.200 0.904	10.250 0.908	10.300 0.911	10.350 0.915
10.400 0.916	10.450 0.918	10.500 0.921	10.550 0.924	10.600 0.926	10.650 0.929	10.700 0.931	10.750 0.934
10.800 0.936	10.850 0.938	10.900 0.940	10.950 0.942	11.000 0.943	11.050 0.944	11.100 0.946	11.150 0.948
11.200 0.951	11.250 0.952	11.300 0.953	11.350 0.954	11.400 0.955	11.450 0.956	11.500 0.958	11.550 0.960
11.600 0.961	11.650 0.964	11.700 0.965	11.750 0.965	11.800 0.966	11.850 0.966	11.900 0.967	11.950 0.968
12.000 0.970							



1050

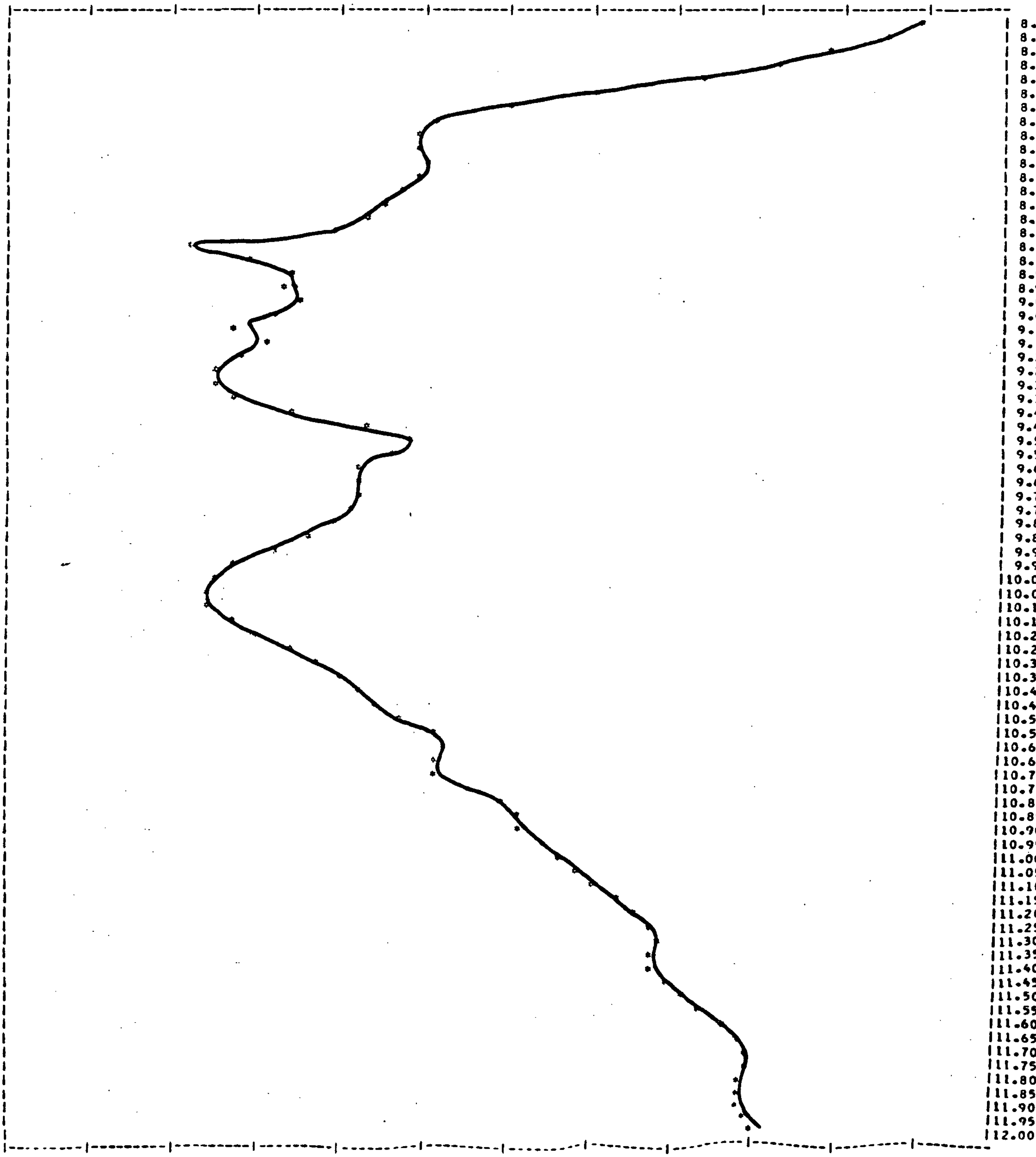
[illegible] CALIB. DIST.=-3.71 VOLTS PER INCH= 0.CLC09 OHMS= 448.50
[illegible] REF. TEMPERATURE= 31.27 TARGET TEMPERATURE= 30.50
[illegible] OF EMIT. MAX.= 7.57
[illegible] TEMPERATURE (SPECTROMETER) = 28.01
[illegible] AT SPECIFIC WAVELENGTHS

[illegible] 0.991	8.050 [illegible]	8.100 0.976	8.150 0.972	8.200 0.958	8.250 0.942	8.300 0.936	8.350 0.932
[illegible] 0.730	8.450 0.930	8.500 0.930	8.550 0.929	8.600 0.926	8.650 0.924	8.700 0.922	8.750 0.920
[illegible] 0.912	8.850 0.906	8.900 0.913	8.950 0.914	9.000 0.915	9.050 0.917	9.100 0.911	9.150 0.905
[illegible] 0.909	9.250 0.908	9.300 0.908	9.350 0.914	9.400 0.922	9.450 0.929	9.500 0.930	9.550 0.925
[illegible] 0.921	9.650 0.920	9.700 0.920	9.750 0.918	9.800 0.916	9.850 0.913	9.900 0.907	9.950 0.902
10.000 0.930	10.050 0.899	10.100 0.900	10.150 0.904	10.200 0.909	10.250 0.913	10.300 0.916	10.350 0.918
10.400 0.920	10.450 0.923	10.500 0.924	10.550 0.927	10.600 0.929	10.650 0.931	10.700 0.932	10.750 0.935
10.800 0.939	10.850 0.942	10.900 0.943	10.950 0.944	11.000 0.946	11.050 0.947	11.100 0.949	11.150 0.951
11.200 0.953	11.250 0.955	11.300 0.957	11.350 0.958	11.400 0.959	11.450 0.961	11.500 0.962	11.550 0.963
11.600 0.964	11.650 0.967	11.700 0.969	11.750 0.970	11.800 0.969	11.850 0.970	11.900 0.970	11.950 0.970
12.000 0.970							



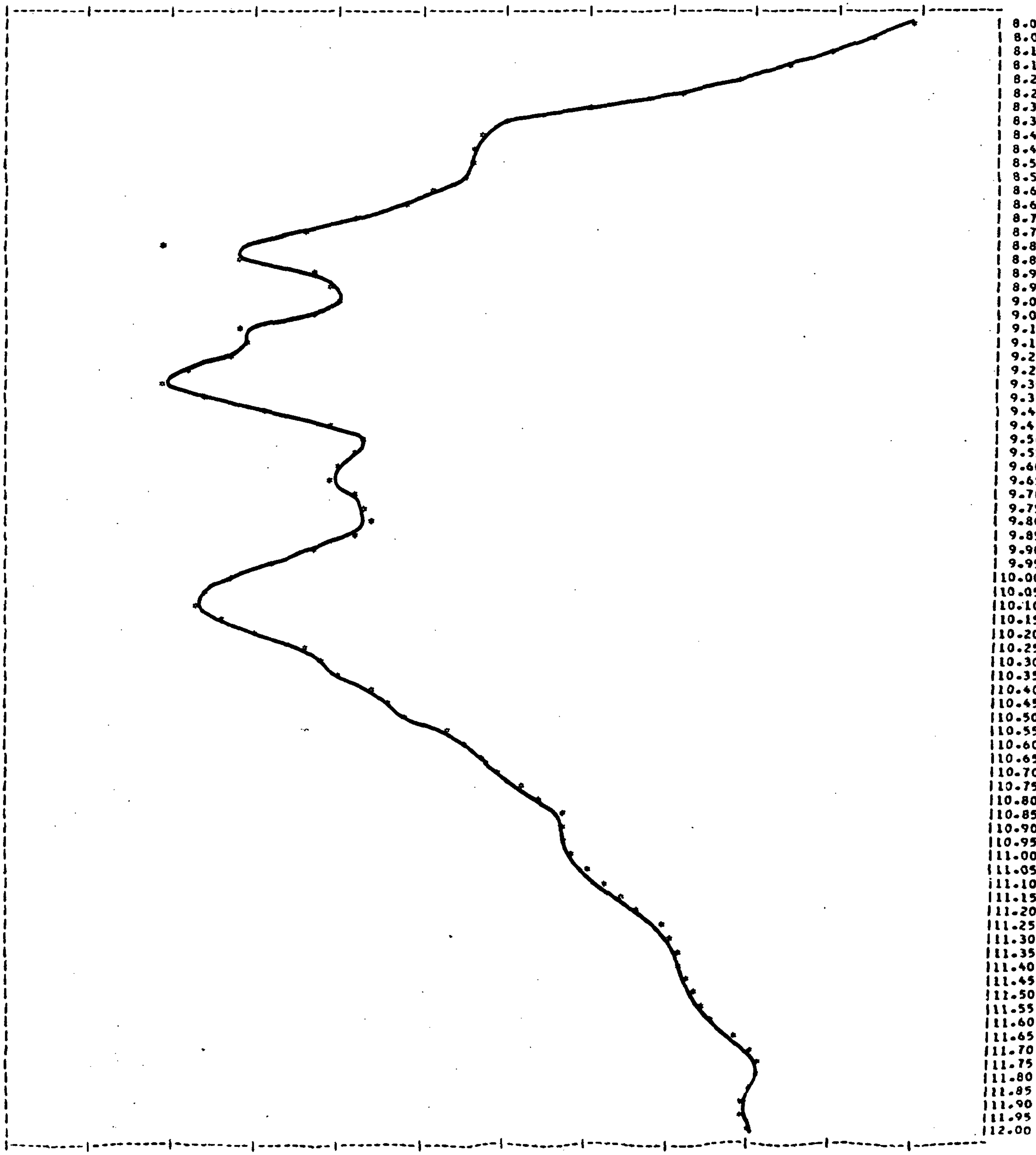
1100
YO=-0.500 SCALING DIST.=-3.17 VOLTS PER INCH= 0.056 OHMS= 448.50
INITIAL REF. TEMPERATURE= 31.27 TARGET TEMPERATURE= 23.00
WAVELENGTH OF EMIT. MAX.= 7.68
TARGET TEMPERATURE (SPECTROMETER) = 27.76
EMITTANCES AT SPECIFIC WAVELENGTHS

8.000	0.991	8.050	0.986	8.100	0.980	8.150	0.973	8.200	0.964	8.250	0.951	8.300	0.941	8.350	0.933
8.400	0.930	8.450	0.931	8.500	0.932	8.550	0.931	8.600	0.929	8.650	0.927	8.700	0.924	8.750	0.921
8.800	0.903	8.850	0.911	8.900	0.915	8.950	0.915	9.000	0.917	9.050	0.913	9.100	0.909	9.150	0.913
9.200	0.909	9.250	0.907	9.300	0.907	9.350	0.909	9.400	0.916	9.450	0.925	9.500	0.930	9.550	0.927
9.600	0.923	9.650	0.923	9.700	0.923	9.750	0.925	9.800	0.920	9.850	0.917	9.900	0.913	9.950	0.909
10.000	0.906	10.050	0.905	10.100	0.906	10.150	0.907	10.200	0.912	10.250	0.916	10.300	0.919	10.350	0.921
10.400	0.924	10.450	0.926	10.500	0.929	10.550	0.932	10.600	0.933	10.650	0.933	10.700	0.933	10.750	0.936
10.800	0.940	10.850	0.942	10.900	0.943	10.950	0.945	11.000	0.948	11.050	0.949	11.100	0.952	11.150	0.954
11.200	0.956	11.250	0.958	11.300	0.959	11.350	0.959	11.400	0.959	11.450	0.960	11.500	0.962	11.550	0.965
11.600	0.968	11.650	0.970	11.700	0.971	11.750	0.970	11.800	0.970	11.850	0.970	11.900	0.970	11.950	0.970
12.000	0.971														



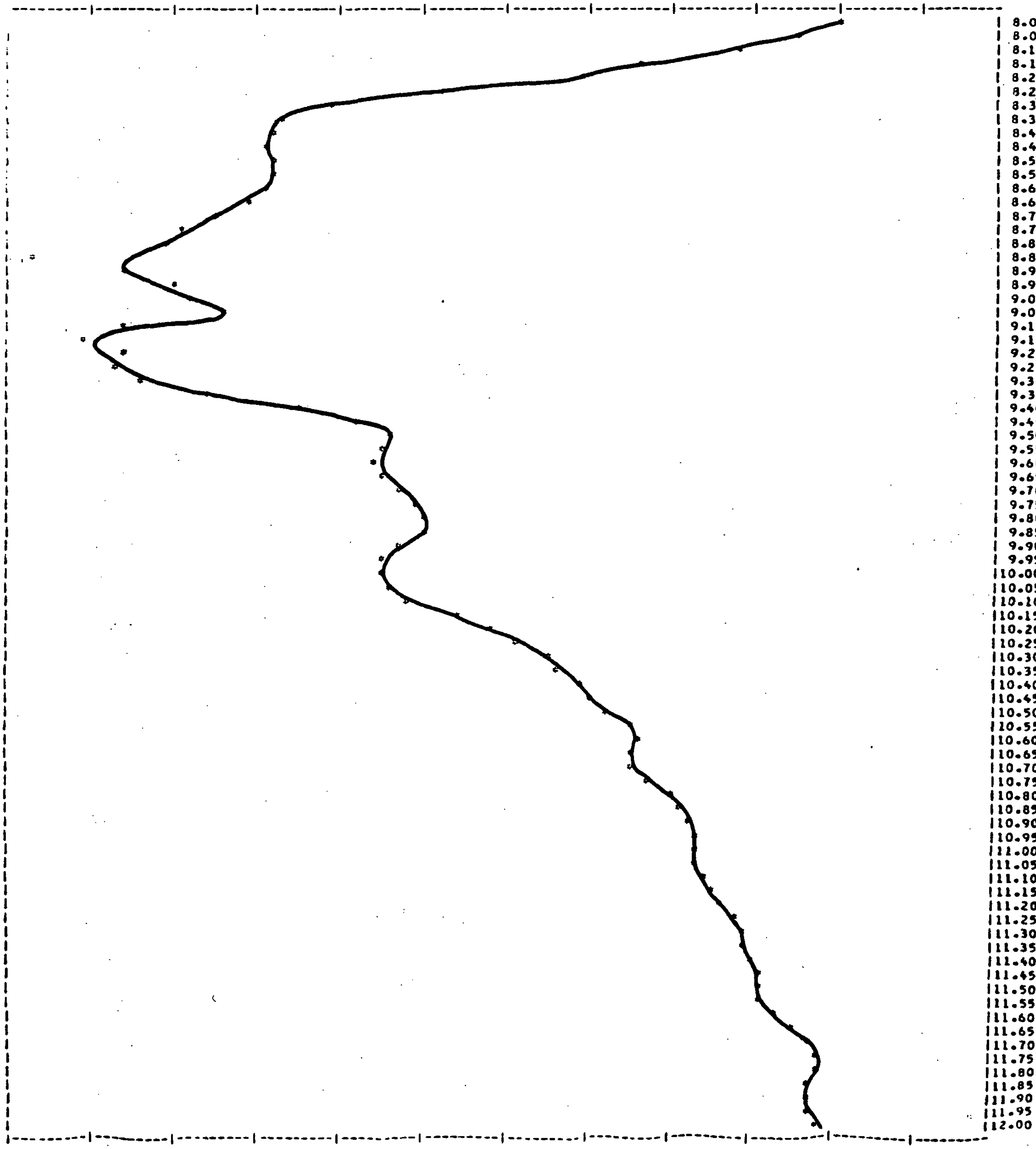
1105
YC= [illegible] CALIB. DIST.=-3.50 VOLTS PER INCH= 0.0857 CPMS= 449.10
INTERNAL REF. TEMPERATURE= 31.65 TARGET TEMPERATURE= 29.00
WAVELENGTH OF EMIT. MAX.= 7.71
TARGET TEMPERATURE (SPECTROMETER) = 27.51
EMITTANCES AT SPECIFIC WAVELENGTHS

8.000	0.990	8.050	0.986	8.100	0.980	8.150	0.976	8.200	0.970	8.250	0.962	8.300	0.951	8.350	0.941
8.400	0.938	8.450	0.938	8.500	0.938	8.550	0.936	8.600	0.933	8.650	0.929	8.700	0.924	8.750	0.917
8.800	0.931	8.850	0.909	8.900	0.919	8.550	0.920	9.000	0.922	9.050	0.918	9.100	0.909	9.150	0.910
9.200	0.909	9.250	0.914	9.300	0.901	9.350	0.905	9.400	0.913	9.450	0.921	9.500	0.924	9.550	0.923
9.600	0.921	9.650	0.920	9.700	0.923	9.750	0.925	9.800	0.925	9.850	0.924	9.900	0.919	9.950	0.914
10.000	0.909	10.050	0.906	10.100	0.905	10.150	0.906	10.200	0.911	10.250	0.917	10.300	0.920	10.350	0.922
10.400	0.925	10.450	0.927	10.500	0.930	10.550	0.934	10.600	0.937	10.650	0.938	10.700	0.941	10.750	0.944
10.800	0.945	10.850	0.948	10.900	0.949	10.950	0.949	11.000	0.950	11.050	0.951	11.100	0.954	11.150	0.956
11.200	0.958	11.250	0.960	11.300	0.962	11.350	0.962	11.400	0.962	11.450	0.963	11.500	0.964	11.550	0.966
11.600	0.967	11.650	0.969	11.700	0.972	11.750	0.973	11.800	0.973	11.850	0.971	11.900	0.971	11.950	0.971
12.000	0.971														



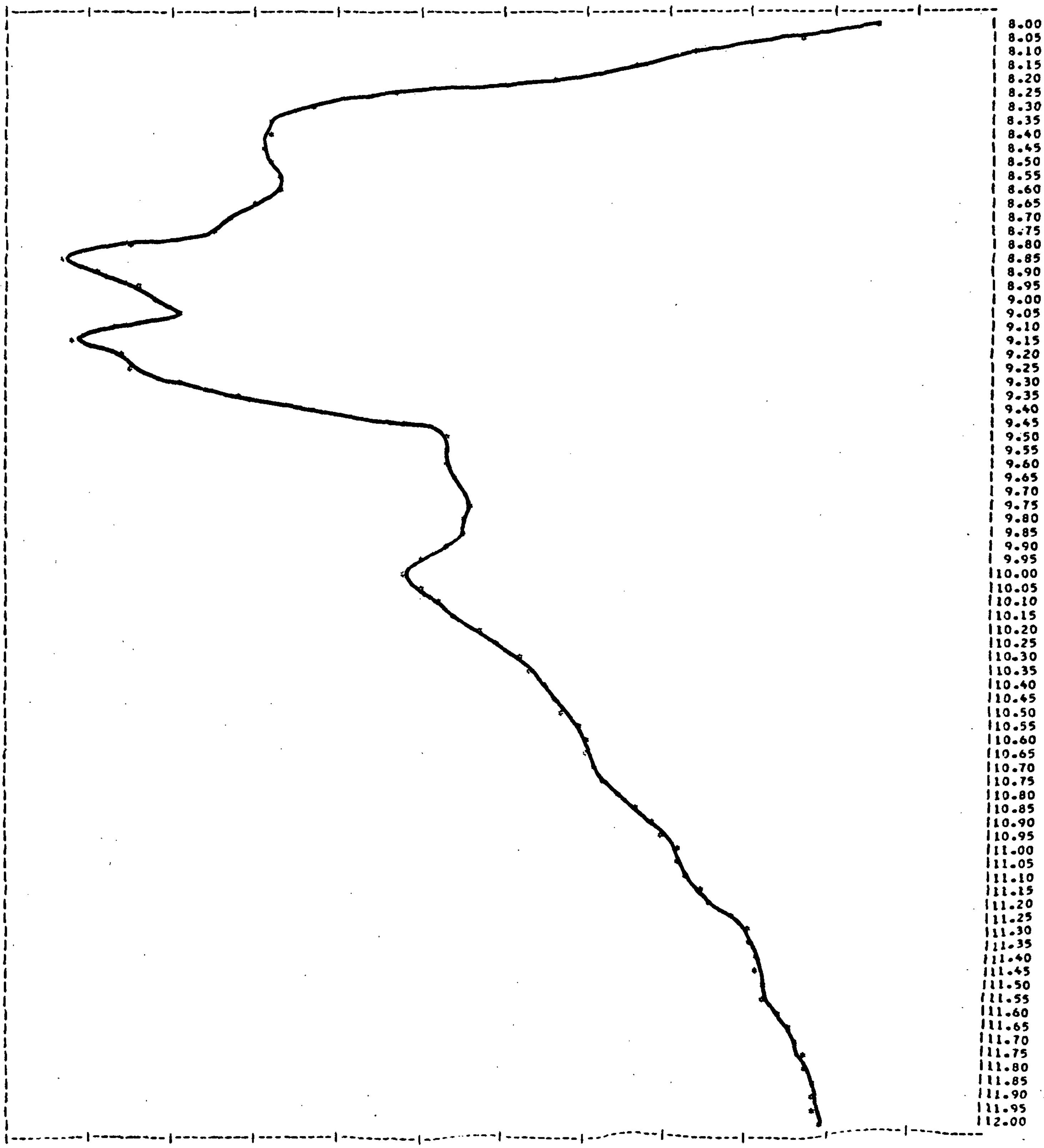
1110
[illegible] CALIB. [illegible]=-4.11 VOLTS PER INCH= 0.0730 PHASE= 449.50
[illegible] REF. TEMPERATURE= 31.91 TARGET TEMPERATURE= 29.50
WAVELENGTH OF EMIT. MAX.= 7.68
TARGET TEMPERATURE (SPECTROMETER) = 28.52
EMITTANCES AT SPECIFIC WAVELENGTHS

8.000 0.982	8.050 0.976	8.100 0.969	8.150 0.957	8.200 0.950	8.250 0.933	8.300 0.921	8.350 0.915
8.400 0.913	8.450 0.913	8.500 0.913	8.550 0.914	8.600 0.913	8.650 0.919	8.700 0.906	8.750 0.903
8.800 0.900	8.850 0.884	8.900 0.896	8.950 0.902	9.000 0.904	9.050 0.907	9.100 0.896	9.150 0.890
9.200 0.895	9.250 0.895	9.300 0.898	9.350 0.906	9.400 0.917	9.450 0.923	9.500 0.927	9.550 0.926
9.600 0.926	9.650 0.927	9.700 0.929	9.750 0.930	9.800 0.931	9.850 0.931	9.900 0.929	9.950 0.926
10.000 0.927	10.050 0.928	10.100 0.930	10.150 0.935	10.200 0.939	10.250 0.943	10.300 0.946	10.350 0.948
10.400 0.950	10.450 0.951	10.500 0.953	10.550 0.956	10.600 0.957	10.650 0.957	10.700 0.957	10.750 0.958
10.800 0.961	10.850 0.963	10.900 0.963	10.950 0.964	11.000 0.965	11.050 0.965	11.100 0.966	11.150 0.967
11.200 0.968	11.250 0.970	11.300 0.971	11.350 0.971	11.400 0.971	11.450 0.972	11.500 0.972	11.550 0.973
11.600 0.974	11.650 0.976	11.700 0.978	11.750 0.979	11.800 0.979	11.850 0.979	11.900 0.979	11.950 0.979
12.000 0.980							



1115
YC= -0.500 CALIB. DIST.= -3.45 VOLTS PER INCH= 0.0759 GAMS= 450.00
INTERNAL REF. TEMPERATURE= 32.23 TARGET TEMPERATURE= 30.50
WAVELENGTH OF EMIT. MAX.= 7.73
TARGET TEMPERATURE (SPECTROMETER) = 26.65
EMITTANCES AT SPECIFIC WAVELENGTHS

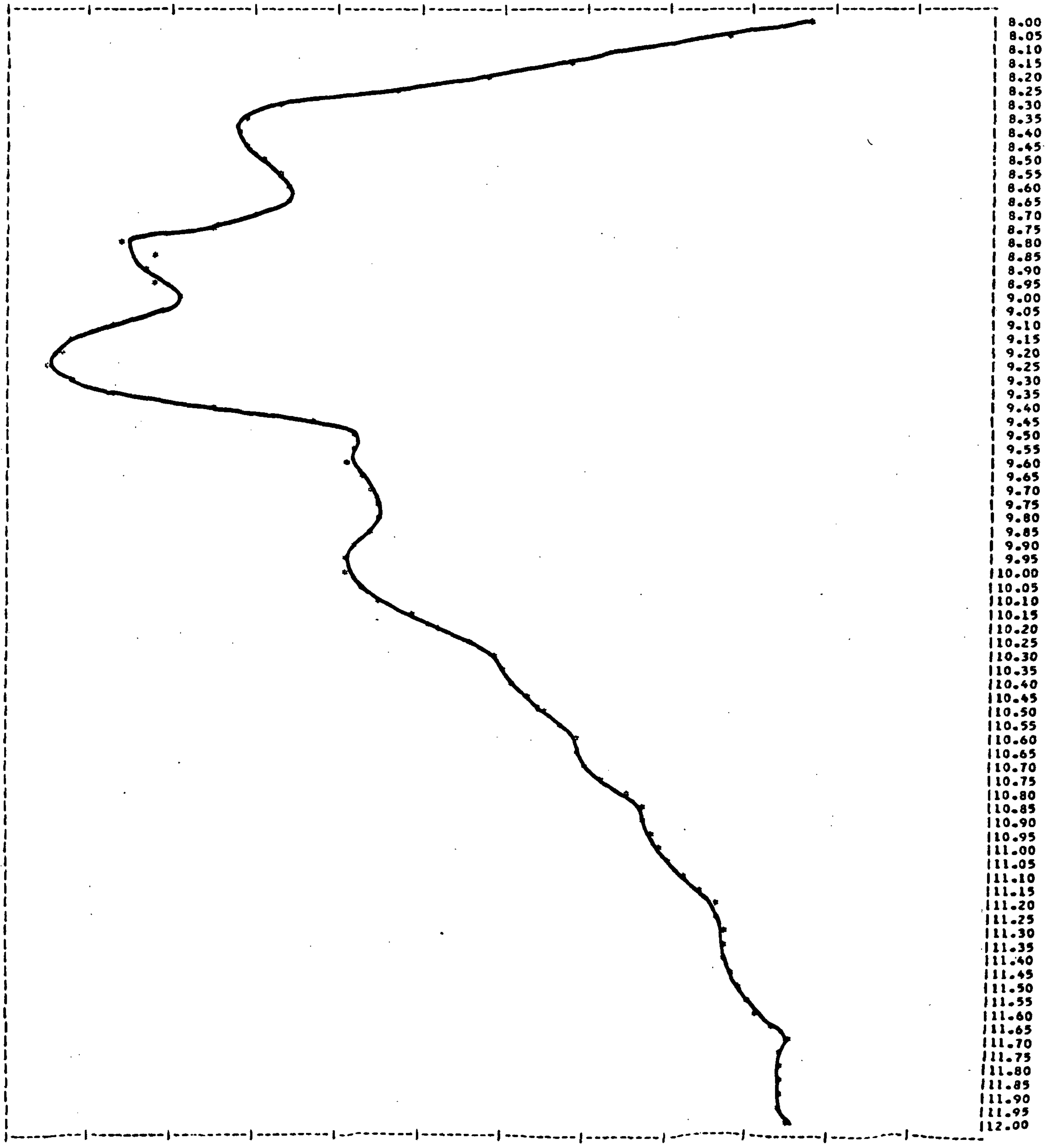
8.000 0.987	8.050 0.976	8.100 0.965	8.150 0.956	8.200 0.947	8.250 0.929	8.300 0.918	8.350 0.914
8.400 0.913	8.450 0.912	8.500 0.914	8.550 0.915	8.600 0.914	8.650 0.912	8.700 0.908	8.750 0.906
8.800 0.897	8.850 0.869	8.900 0.893	8.950 0.898	9.000 0.930	9.050 0.903	9.100 0.895	9.150 0.890
9.200 0.896	9.250 0.897	9.300 0.902	9.350 0.910	9.400 0.919	9.450 0.930	9.500 0.934	9.550 0.935
9.600 0.934	9.650 0.936	9.700 0.937	9.750 0.938	9.800 0.937	9.850 0.937	9.900 0.934	9.950 0.931
10.000 0.930	10.050 0.932	10.100 0.934	10.150 0.936	10.200 0.938	10.250 0.941	10.300 0.943	10.350 0.944
10.400 0.947	10.450 0.948	10.500 0.948	10.550 0.950	10.600 0.952	10.650 0.952	10.700 0.952	10.750 0.954
10.800 0.956	10.850 0.958	10.900 0.960	10.950 0.961	11.000 0.962	11.050 0.963	11.100 0.964	11.150 0.965
11.200 0.967	11.250 0.969	11.300 0.971	11.350 0.971	11.400 0.972	11.450 0.973	11.500 0.973	11.550 0.974
11.600 0.975	11.650 0.976	11.700 0.978	11.750 0.978	11.800 0.978	11.850 0.979	11.900 0.979	11.950 0.980
12.000 0.981							



1135

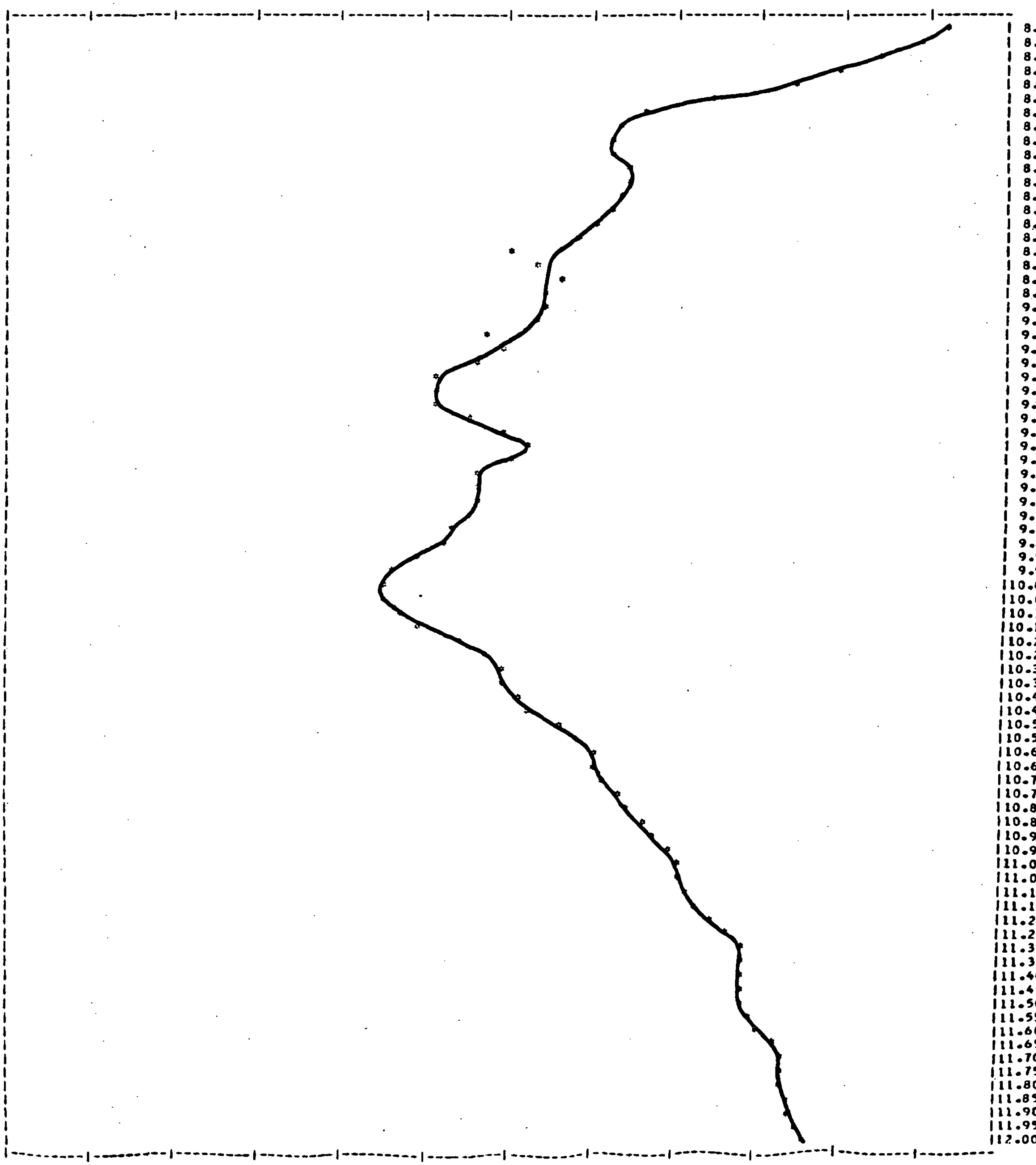
YC=[illegible] CALIB. DIST.=-4.83 VOLTS PER INCH= 0.0221 [illegible]= 450.50
INTERNAL REF. TEMPERATURE= 32.56 TARGET TEMPERATURE= 33.00
WAVELENGTH OF EMIT. MAX.= 7.75
TARGET TEMPERATURE (SPECTROMETER) = 31.68
EMITTANCES AT SPECIFIC WAVELENGTHS

8.000 0.979	8.050 0.969	8.100 0.953	8.150 0.947	8.200 0.940	8.250 0.929	8.300 0.914	8.350 0.910
8.400 0.910	8.450 0.911	8.500 0.913	8.550 0.915	8.600 0.916	8.650 0.915	8.700 0.912	6.750 0.907
8.800 0.895	8.850 0.899	8.900 0.899	8.950 0.900	9.000 0.902	9.050 0.901	9.100 0.894	9.150 0.889
9.200 0.885	9.250 0.887	9.300 0.870	9.350 0.894	9.400 0.907	9.450 0.918	9.500 0.924	9.550 0.923
9.600 0.923	9.650 0.924	9.700 0.926	9.750 0.926	9.800 0.926	9.850 0.925	9.900 0.924	9.950 0.922
10.000 0.922	10.050 0.925	10.100 0.927	10.150 0.930	10.200 0.934	10.250 0.938	10.300 0.940	10.350 0.941
10.400 0.945	10.450 0.945	10.500 0.946	10.550 0.949	10.600 0.950	10.650 0.950	10.700 0.951	10.750 0.954
10.800 0.957	10.850 0.958	10.900 0.959	10.950 0.960	11.000 0.960	11.050 0.962	11.100 0.964	11.150 0.966
11.200 0.967	11.250 0.968	11.300 0.968	11.350 0.968	11.400 0.969	11.450 0.969	11.500 0.970	11.550 0.971
11.600 0.972	11.650 0.975	11.700 0.976	11.750 0.976	11.800 0.976	11.850 0.975	11.900 0.975	11.950 0.975
12.000 0.976							



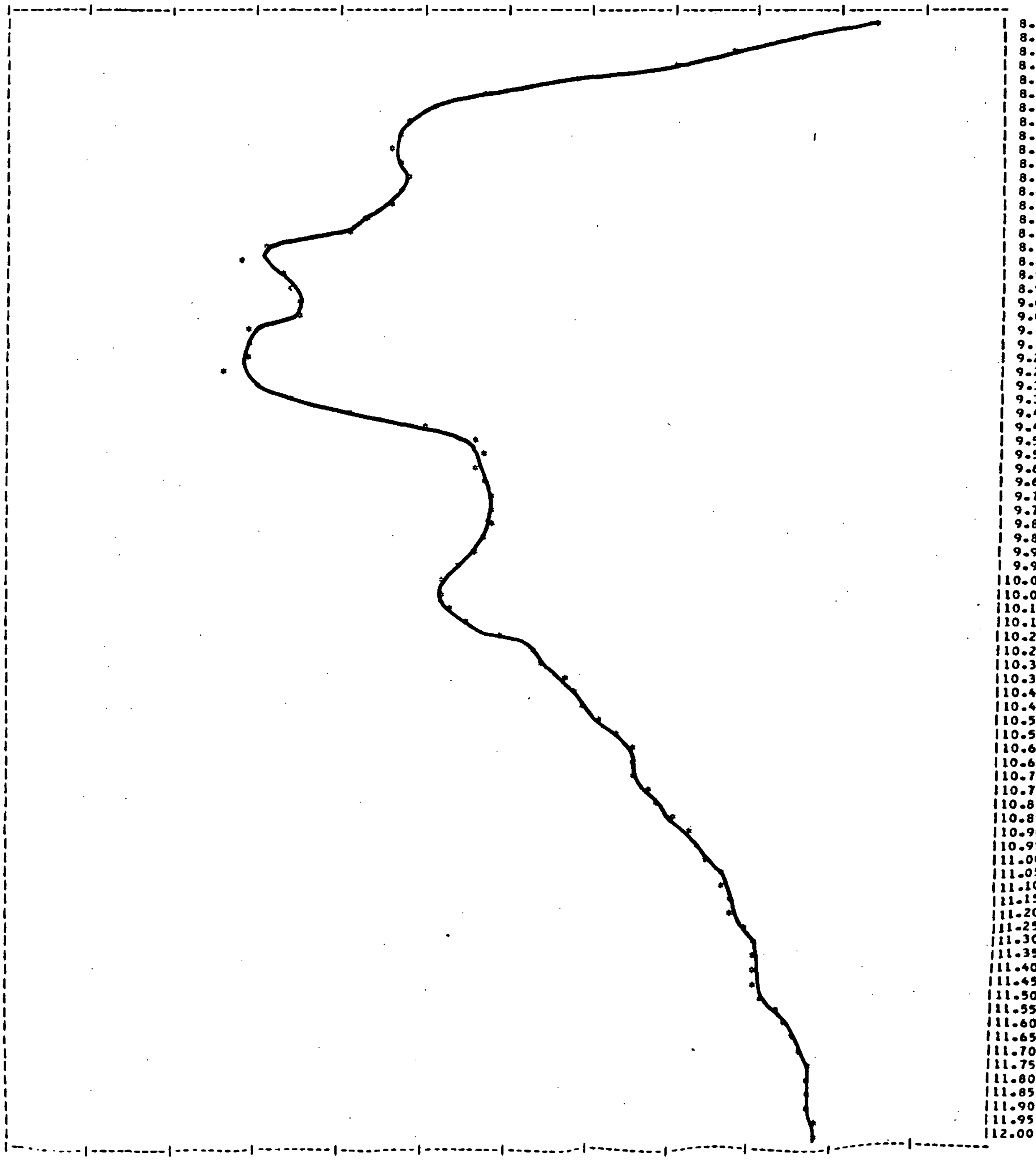
1140
YO=   CALIB. DIST.==5.93   VOLTS PER INCH= 0.0506   CORS= 456.50
WATER AT REF. TEMPERATURE= 32.56   TARGET TEMPERATURE= 31.00
WAVELENGTH OF EMIT. MAX.= 7.73
TARGET TEMPERATURE (SPECTROMETER) = 31.10
EMITTANCES AT SPECIFIC WAVELENGTHS

8.000	0.994	8.050	0.990	8.100	0.985	8.150	0.981	8.200	0.976	8.250	0.965	8.300	0.957	8.350	0.954
8.400	0.953	8.450	0.954	8.500	0.955	8.550	0.956	8.600	0.955	8.650	0.954	8.700	0.952	8.750	0.949
8.800	0.942	8.850	0.945	8.900	0.947	8.950	0.945	9.000	0.945	9.050	0.945	9.100	0.939	9.150	0.941
9.200	0.937	9.250	0.933	9.300	0.932	9.350	0.933	9.400	0.937	9.450	0.941	9.500	0.944	9.550	0.941
9.600	0.938	9.650	0.937	9.700	0.937	9.750	0.936	9.800	0.934	9.850	0.933	9.900	0.931	9.950	0.928
10.000	0.927	10.050	0.927	10.100	0.926	10.150	0.931	10.200	0.935	10.250	0.938	10.300	0.941	10.350	0.941
10.400	0.942	10.450	0.944	10.500	0.947	10.550	0.949	10.600	0.951	10.650	0.952	10.700	0.953	10.750	0.954
10.800	0.956	10.850	0.957	10.900	0.959	10.950	0.960	11.000	0.961	11.050	0.962	11.100	0.962	11.150	0.963
11.200	0.966	11.250	0.967	11.300	0.959	11.350	0.967	11.400	0.969	11.450	0.970	11.500	0.970	11.550	0.970
11.600	0.972	11.650	0.973	11.700	0.974	11.750	0.975	11.800	0.975	11.850	0.975	11.900	0.976	11.950	0.976
12.000	0.977														



1145
YC=-0.350 CALIB. DIST.=-4.80 VOLTS PER INCH= 0.0025 OHMS= 450.50
INTERNAL REF. TEMPERATURE= 32.56 TARGET TEMPERATURE= 32.00
WAVELENGTH OF EMIT. MAX.= 7.73
TARGET TEMPERATURE (SPECTROMETER) = 31.04
EMITTANCES AT SPECIFIC WAVELENGTHS

8.000 0.986	8.050 0.977	8.100 0.969	8.150 0.962	8.200 0.950	8.250 0.939	8.300 0.932	8.350 0.929
8.400 0.928	8.450 0.926	8.500 0.929	8.550 0.930	8.600 0.929	8.650 0.927	8.700 0.924	8.750 0.922
8.800 0.912	8.850 0.909	8.900 0.914	8.950 0.916	9.000 0.916	9.050 0.917	9.100 0.910	9.150 0.910
9.200 0.910	9.250 0.907	9.300 0.911	9.350 0.916	9.400 0.922	9.450 0.932	9.500 0.938	9.550 0.938
9.600 0.933	9.650 0.936	9.700 0.940	9.750 0.940	9.800 0.940	9.850 0.939	9.900 0.937	9.950 0.935
10.000 0.934	10.050 0.933	10.100 0.935	10.150 0.937	10.200 0.941	10.250 0.944	10.300 0.946	10.350 0.948
10.400 0.950	10.450 0.951	10.500 0.953	10.550 0.954	10.600 0.956	10.650 0.956	10.700 0.957	10.750 0.958
10.800 0.960	10.850 0.961	10.900 0.963	10.950 0.964	11.000 0.966	11.050 0.967	11.100 0.968	11.150 0.968
11.200 0.969	11.250 0.970	11.300 0.971	11.350 0.971	11.400 0.971	11.450 0.972	11.500 0.973	11.550 0.974
11.600 0.975	11.650 0.976	11.700 0.976	11.750 0.976	11.800 0.978	11.850 0.978	11.900 0.979	11.950 0.979
12.000 0.980							



1150

... .500 CALIB. DIST.=-3.84 VOLTS PER INCH= 0.0781 OHMS= 450.50

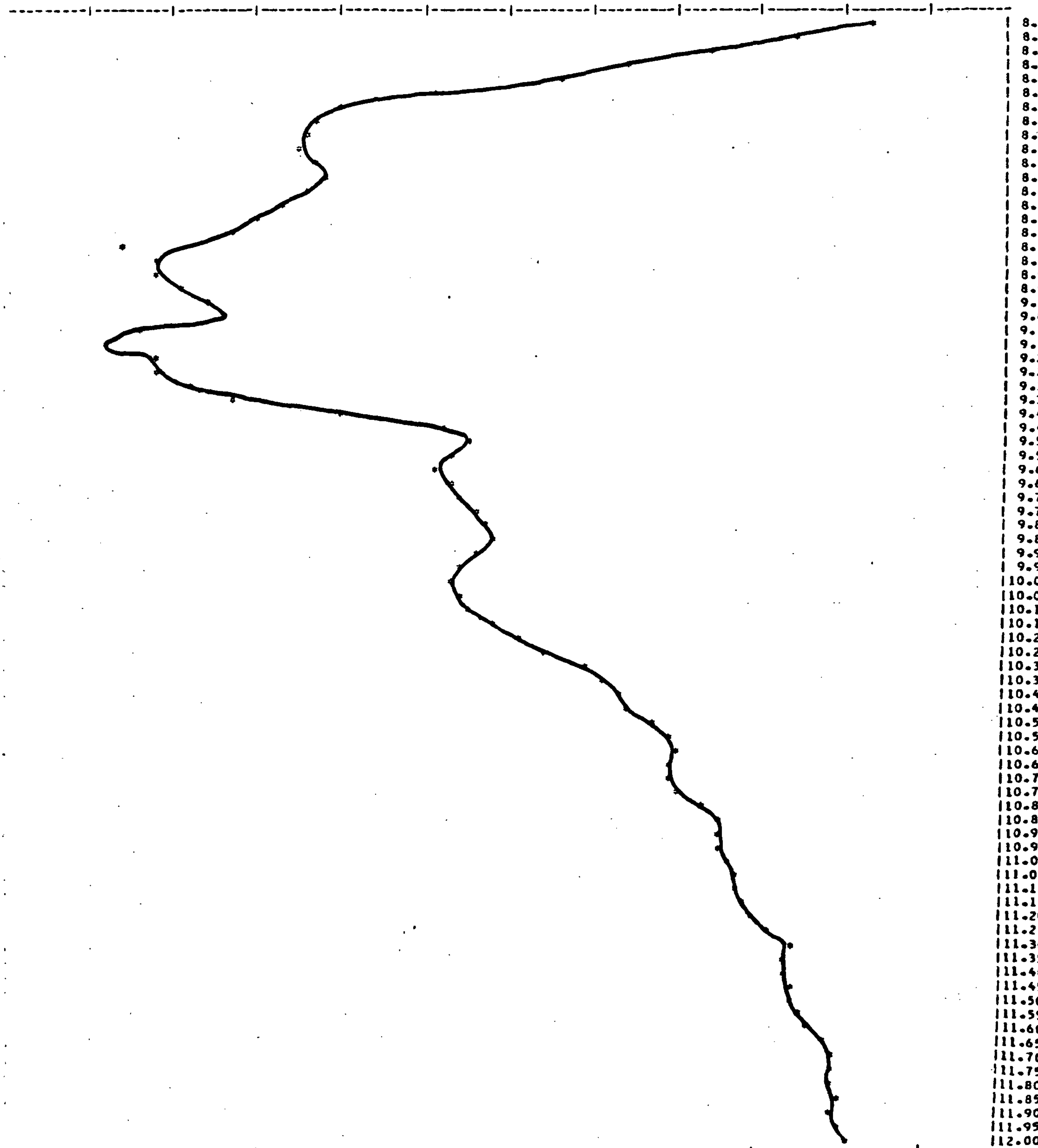
INTERNAL REF. TEMPERATURE= 32.90 TARGET TEMPERATURE= 29.00

WAV LENGTH OF EMIT. MAX.= 7.68

TARGET TEMPERATURE (SPECTROMETER) = 26.90

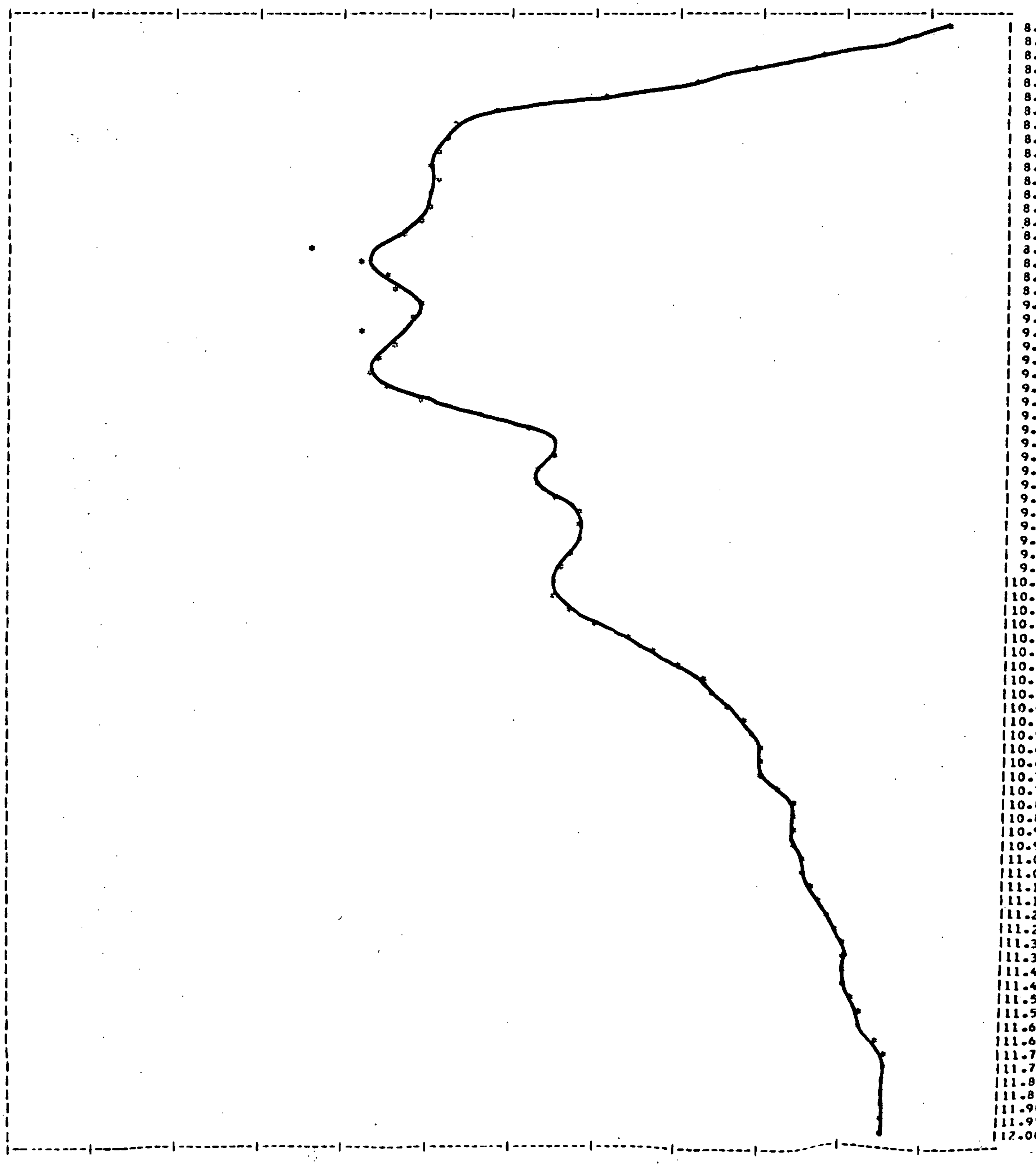
EMITTANCES AT SPECIFIC WAVELENGTHS

8.000 0.985	8.050 0.976	8.100 0.965	8.150 0.956	8.200 0.947	8.250 0.933	8.300 0.921	8.350 0.918
8.400 0.917	8.450 0.917	8.500 0.918	8.550 0.919	8.600 0.918	8.650 0.915	8.700 0.912	8.750 0.908
8.800 0.896	8.850 0.899	8.900 0.903	8.950 0.905	9.000 0.905	9.050 0.907	9.100 0.897	9.150 0.894
9.200 0.899	9.250 0.895	9.300 0.905	9.350 0.909	9.400 0.922	9.450 0.933	9.500 0.937	9.550 0.935
9.600 0.933	9.650 0.934	9.700 0.936	9.750 0.938	9.800 0.938	9.850 0.939	9.900 0.938	9.950 0.935
10.000 0.935	10.050 0.936	10.100 0.937	10.150 0.939	10.200 0.942	10.250 0.946	10.300 0.950	10.350 0.953
10.400 0.955	10.450 0.956	10.500 0.958	10.550 0.960	10.600 0.961	10.650 0.960	10.700 0.960	10.750 0.962
10.800 0.964	10.850 0.966	10.900 0.967	10.950 0.966	11.000 0.967	11.050 0.968	11.100 0.969	11.150 0.969
11.200 0.971	11.250 0.973	11.300 0.975	11.350 0.974	11.400 0.974	11.450 0.975	11.500 0.975	11.550 0.976
11.600 0.978	11.650 0.979	11.700 0.981	11.750 0.980	11.800 0.980	11.850 0.981	11.900 0.981	11.750 0.982
12.000 0.983							



1155
YE = .250 CALIB. DIST.=-3.77 VOLTS PER INCH= 0.0792 OHMS= 450.50
INTERNAL REF. TEMPERATURE= 32.56 TARGET TEMPERATURE= 33.00
WAVELENGTH OF EMIT. MAX.= 7.71
TARGET TEMPERATURE (SPECTROMETER) = 29.04
EMITTANCES AT SPECIFIC WAVELENGTHS

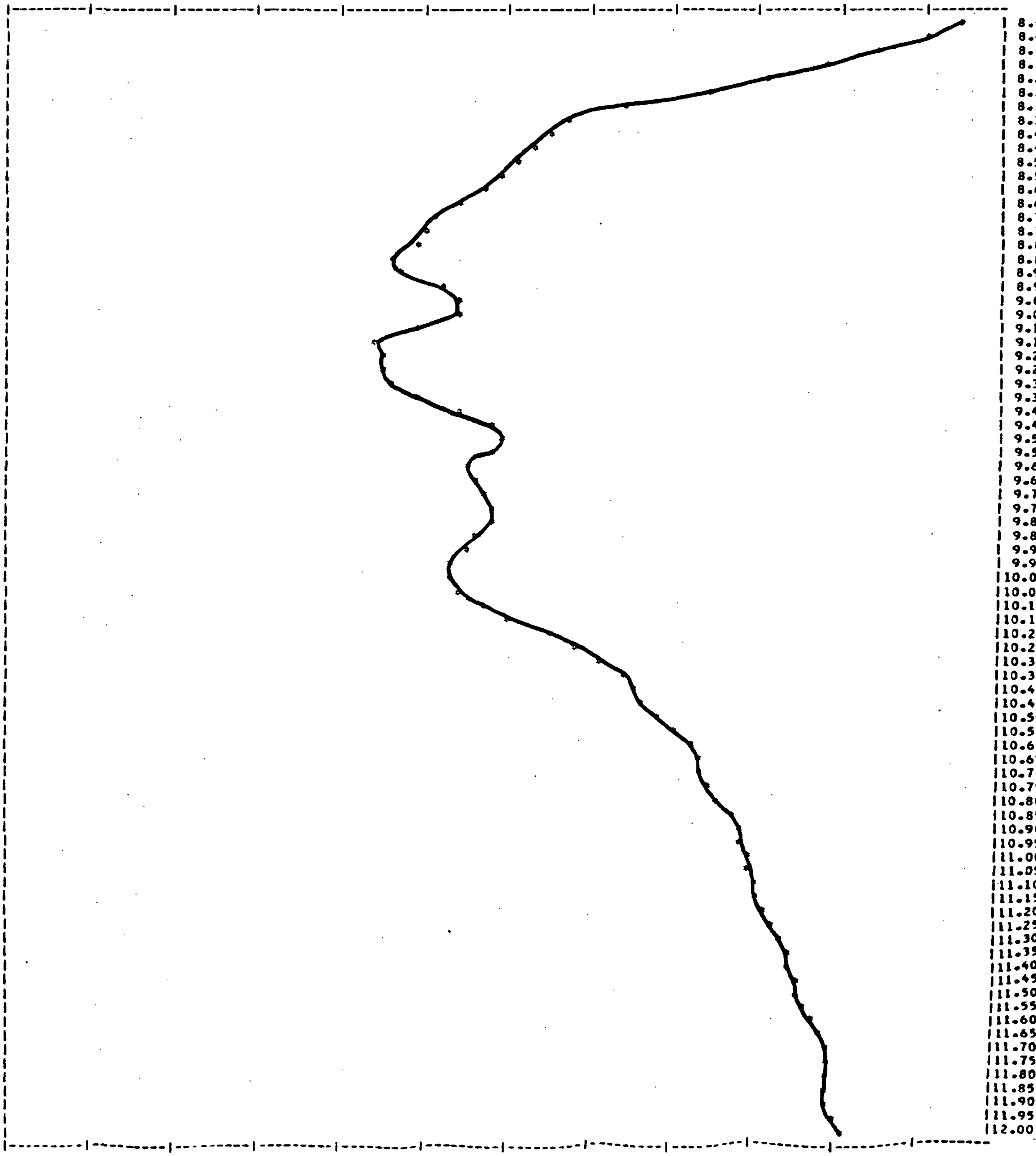
8.000 0.993	8.050 0.987	8.100 0.975	8.150 0.970	8.200 0.964	8.250 0.953	8.300 0.940	8.350 0.935
8.400 0.933	8.450 0.932	8.500 0.932	8.550 0.932	8.600 0.932	8.650 0.932	8.700 0.931	8.750 0.928
8.800 0.916	8.850 0.924	8.900 0.925	8.950 0.926	9.000 0.930	9.050 0.930	9.100 0.924	9.150 0.927
9.200 0.926	9.250 0.924	9.300 0.926	9.350 0.931	9.400 0.938	9.450 0.944	9.500 0.947	9.550 0.946
9.600 0.944	9.650 0.944	9.700 0.946	9.750 0.94[illegible]	9.800 0.950	9.850 0.950	9.900 0.949	9.950 0.947
10.000 0.947	10.050 0.947	10.100 0.949	10.150 0.952	10.200 0.956	10.250 0.958	10.300 0.962	10.350 0.964
10.400 0.966	10.450 0.967	10.500 0.970	10.550 0.971	10.600 0.971	10.650 0.971	10.700 0.971	10.750 0.973
10.800 0.975	10.850 0.976	10.900 0.976	10.950 0.976	11.000 0.977	11.050 0.977	11.100 0.977	11.150 0.978
11.200 0.979	11.250 0.981	11.300 0.982	11.350 0.981	11.400 0.981	11.450 0.982	11.500 0.983	11.550 0.983
11.600 0.984	11.650 0.985	11.700 0.986	11.750 0.987	11.800 0.987	11.850 0.986	11.900 0.986	11.950 0.986
12.000 0.986							



1205

YC=-0.100 CALIB. DIST.=-5.94 VOLTS PER INCH= 0.0505 OHMS= 450.50
INTEGRAL VOL. TEMPERATURE= 32.56 TARGET TEMPERATURE= 0.00
WAVELENGTH OF EMIT. MAX.= 7.77
TARGET TEMPERATURE (SPECTROMETER) = 31.95
EMITTANCES AT SPECIFIC WAVELENGTHS

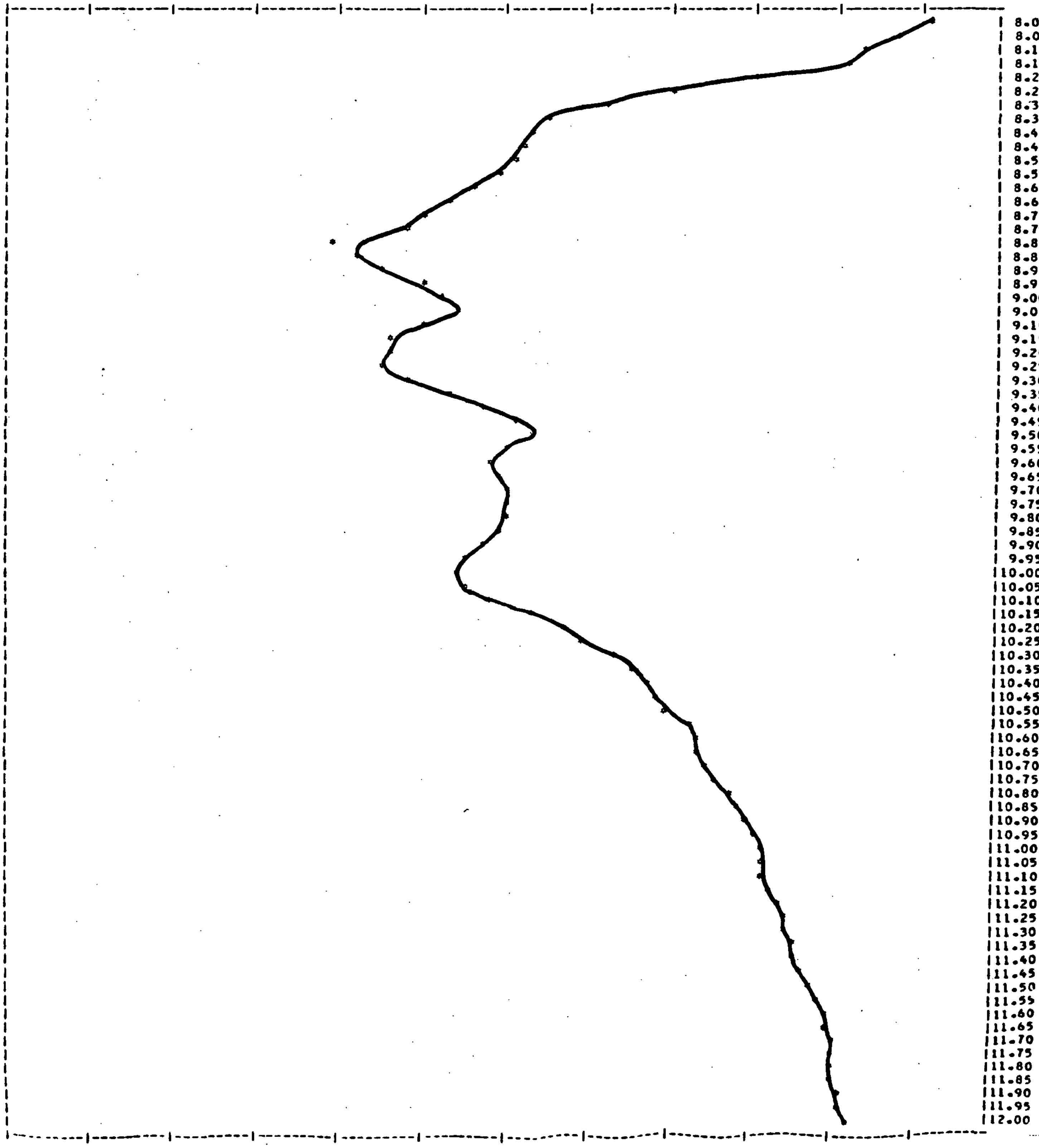
8.000	0.996	8.050	0.992	8.100	0.985	8.150	0.980	8.200	0.973	8.250	0.966	8.300	0.956	8.350	0.948
8.400	0.946	8.450	0.945	8.500	0.943	8.550	0.941	8.600	0.938	8.650	0.936	8.700	0.933	8.750	0.932
8.800	0.930	8.850	0.928	8.900	0.929	8.950	0.933	9.000	0.935	9.050	0.936	9.100	0.931	9.150	0.926
9.200	0.926	9.250	0.927	9.300	0.928	9.350	0.930	9.400	0.935	9.450	0.939	9.500	0.941	9.550	0.939
9.600	0.937	9.650	0.937	9.700	0.939	9.750	0.939	9.800	0.939	9.850	0.936	9.900	0.936	9.950	0.935
10.000	0.935	10.050	0.936	10.100	0.936	10.150	0.942	10.200	0.947	10.250	0.950	10.300	0.953	10.350	0.955
10.400	0.956	10.450	0.957	10.500	0.959	10.550	0.962	10.600	0.963	10.650	0.964	10.700	0.965	10.750	0.965
10.800	0.967	10.850	0.968	10.900	0.969	10.950	0.970	11.000	0.970	11.050	0.971	11.100	0.971	11.150	0.972
11.200	0.973	11.250	0.973	11.300	0.974	11.350	0.975	11.400	0.976	11.450	0.976	11.500	0.977	11.550	0.978
11.600	0.979	11.650	0.980	11.700	0.980	11.750	0.981	11.800	0.981	11.850	0.981	11.900	0.981	11.950	0.981
12.000	0.982														



1215

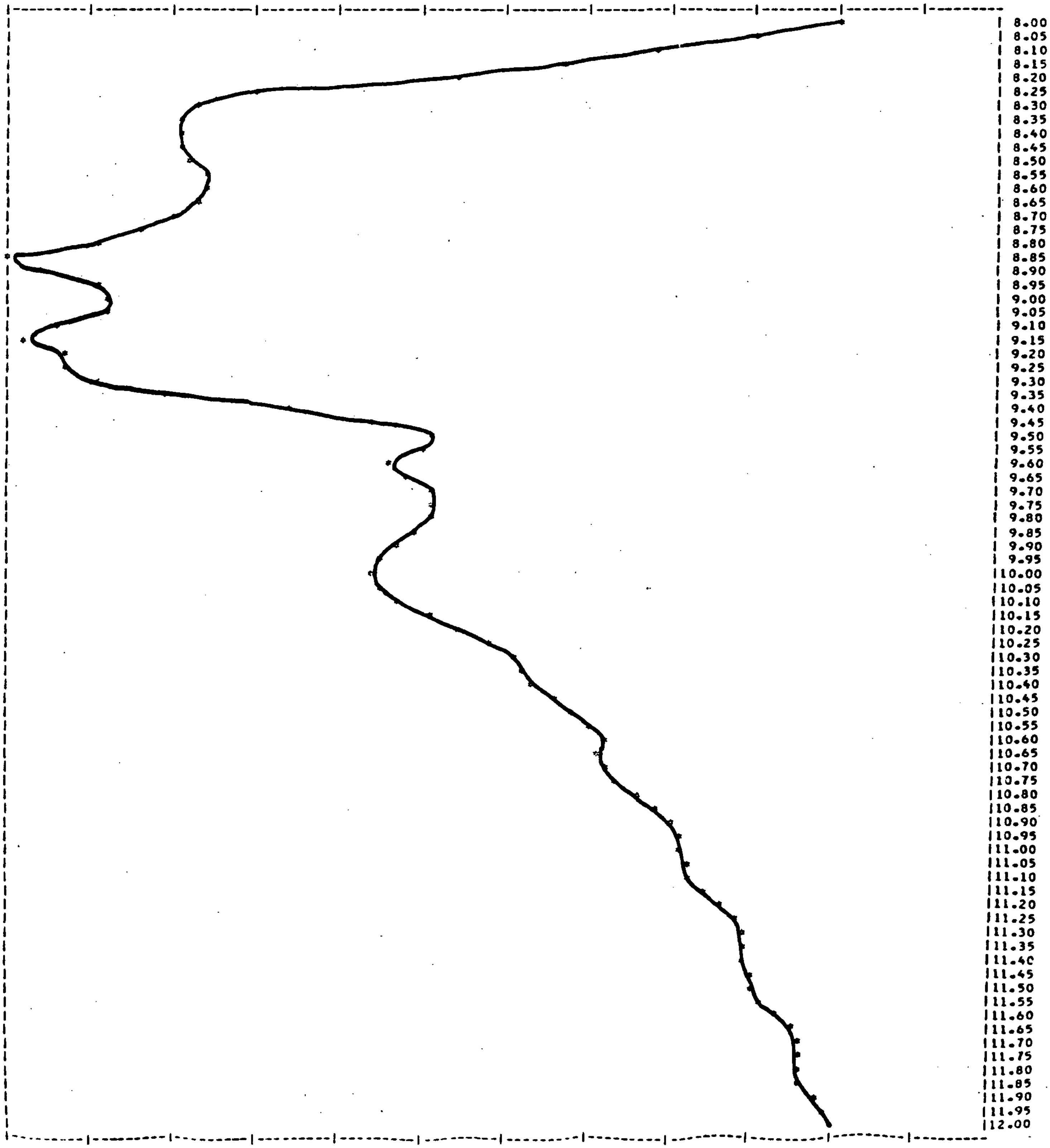
YC = 7.300 CALIB. DIST.=-5.92 VOLTS PER INCH= 0.0507 OHMS= 451.50
INTERNAL REF. TEMPERATURE= 33.20 TARGET TEMPERATURE= 32.00
WAVELENGTH OF EMIT. MAX.= 7.73
TARGET TEMPERATURE (SPECTROMETER) = 31.67
EMITTANCES AT SPECIFIC WAVELENGTHS

8.000	0.992	8.050	0.989	8.100	0.985	8.150	0.982	8.200	0.972	8.250	0.962	8.300	0.954	8.350	0.947
8.400	0.945	8.450	0.944	8.500	0.943	8.550	0.940	8.600	0.938	8.650	0.935	8.700	0.931	8.750	0.930
8.800	0.920	8.850	0.924	8.900	0.927	8.950	0.932	9.000	0.933	9.050	0.935	9.100	0.931	9.150	0.927
9.200	0.927	9.250	0.927	9.300	0.929	9.350	0.934	9.400	0.938	9.450	0.942	9.500	0.945	9.550	0.942
9.600	0.939	9.650	0.940	9.700	0.941	9.750	0.942	9.800	0.941	9.850	0.940	9.900	0.938	9.950	0.936
10.000	0.935	10.050	0.937	10.100	0.940	10.150	0.945	10.200	0.948	10.250	0.951	10.300	0.954	10.350	0.956
10.400	0.959	10.450	0.960	10.500	0.961	10.550	0.963	10.600	0.964	10.650	0.965	10.700	0.965	10.750	0.967
10.800	0.968	10.850	0.970	10.900	0.970	10.950	0.971	11.000	0.972	11.050	0.972	11.100	0.973	11.150	0.974
11.200	0.974	11.250	0.975	11.300	0.976	11.350	0.976	11.400	0.977	11.450	0.978	11.500	0.978	11.550	0.979
11.600	0.980	11.650	0.981	11.700	0.981	11.750	0.981	11.800	0.982	11.850	0.982	11.900	0.982	11.950	0.983
12.000	0.983														



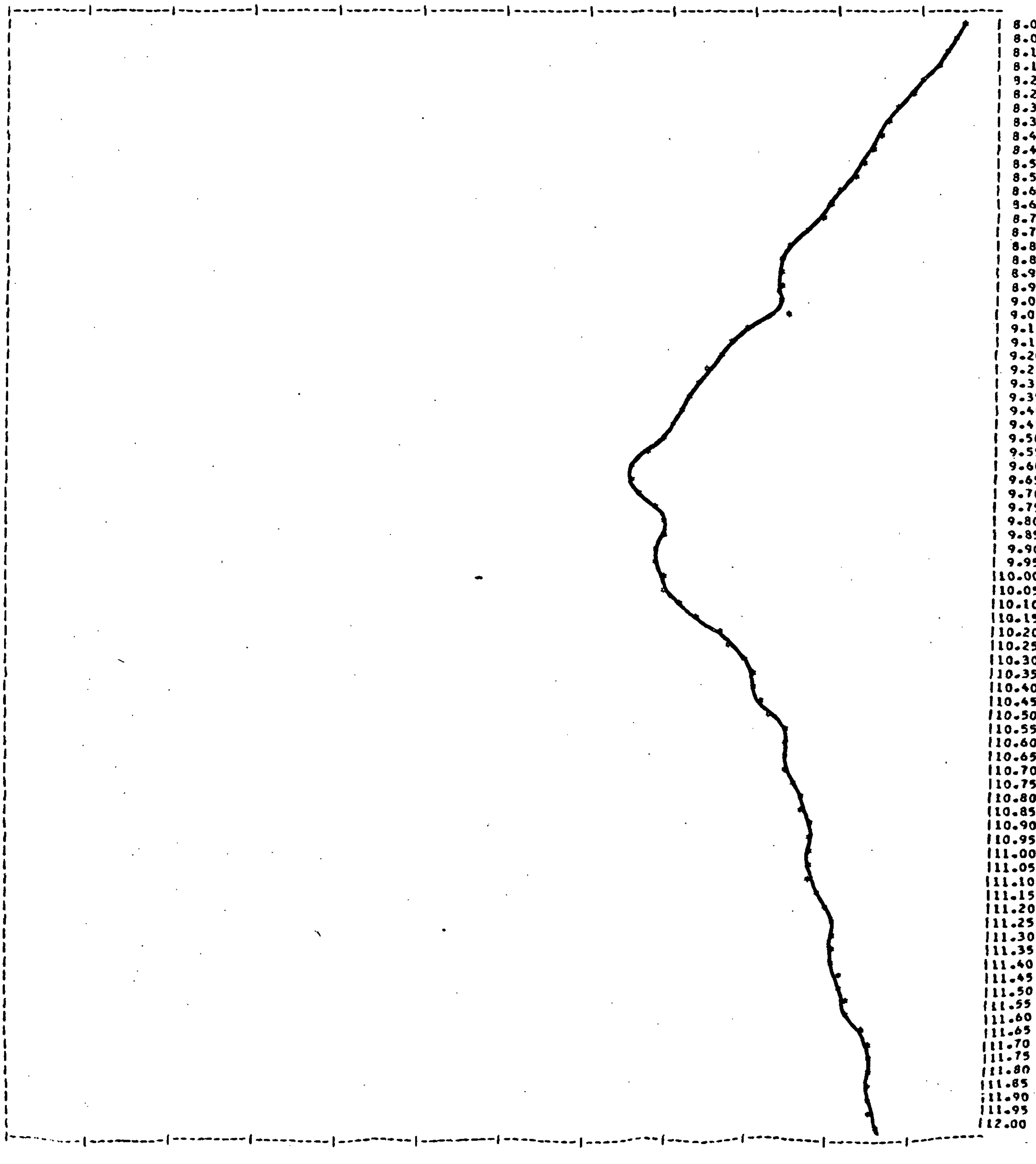
1220
[illegible] CALIB. ST.T.=-4.29 VOLTS PER INCH= 0.0099 [illegible]= 451.70
INTERNAL REF. TEMPERATURE= 33.31 TARGET TEMPERATURE= 0.00
WAVELENGTH OF EMIT. MAX.= 7.71
TARGET TEMPERATURE (SPECTROMETER) = 31.54
EMITTANCES AT SPECIFIC WAVELENGTHS

8.000 0.981	8.050 0.977	8.100 0.959	8.150 0.949	8.200 0.935	8.250 0.911	8.300 0.905	8.350 0.903
8.400 0.902	8.450 0.902	8.500 0.904	8.550 0.905	8.600 0.905	8.650 0.904	8.700 0.901	8.750 0.898
8.800 0.892	8.850 [illegible]	8.900 0.866	8.950 0.893	9.000 0.874	9.050 0.893	9.100 0.897	9.150 0.884
9.200 0.868	9.250 0.885	9.300 0.895	9.350 0.901	9.400 0.916	9.450 0.926	9.500 0.933	9.550 0.931
9.600 0.928	9.650 0.929	9.700 0.932	9.750 0.933	9.800 0.932	9.850 0.931	9.900 0.929	9.950 0.927
10.000 0.926	10.050 0.926	10.100 0.929	10.150 0.932	10.200 0.936	10.250 0.939	10.300 0.943	10.350 0.944
10.400 0.944	10.450 0.947	10.500 0.949	10.550 0.952	10.600 0.953	10.650 0.953	10.700 0.953	10.750 0.955
10.800 0.957	10.850 0.960	10.900 0.961	10.950 0.962	11.000 0.963	11.050 0.963	11.100 0.964	11.150 0.966
11.200 0.968	11.250 0.969	11.300 0.970	11.350 0.970	11.400 0.971	11.450 0.971	11.500 0.972	11.550 0.973
11.600 0.974	11.650 0.976	11.700 0.978	11.750 0.978	11.600 0.978	11.650 0.978	11.900 0.979	11.950 0.980
12.000 0.981							



1953
Y[illegible] CALIB. DIST. [illegible] VOLTS PER INCH= 0.0467 CONS= 453.50
[illegible] TEMPERATURE= 34.45 TARGET TEMPERATURE= 35.50
WAVELENGTH OF EMIT. MAX.= 7.71
TARGET TEMPERATURE (SPECTROMETER) = 33.97
EMITTANCES AT SPECIFIC WAVELENGTHS

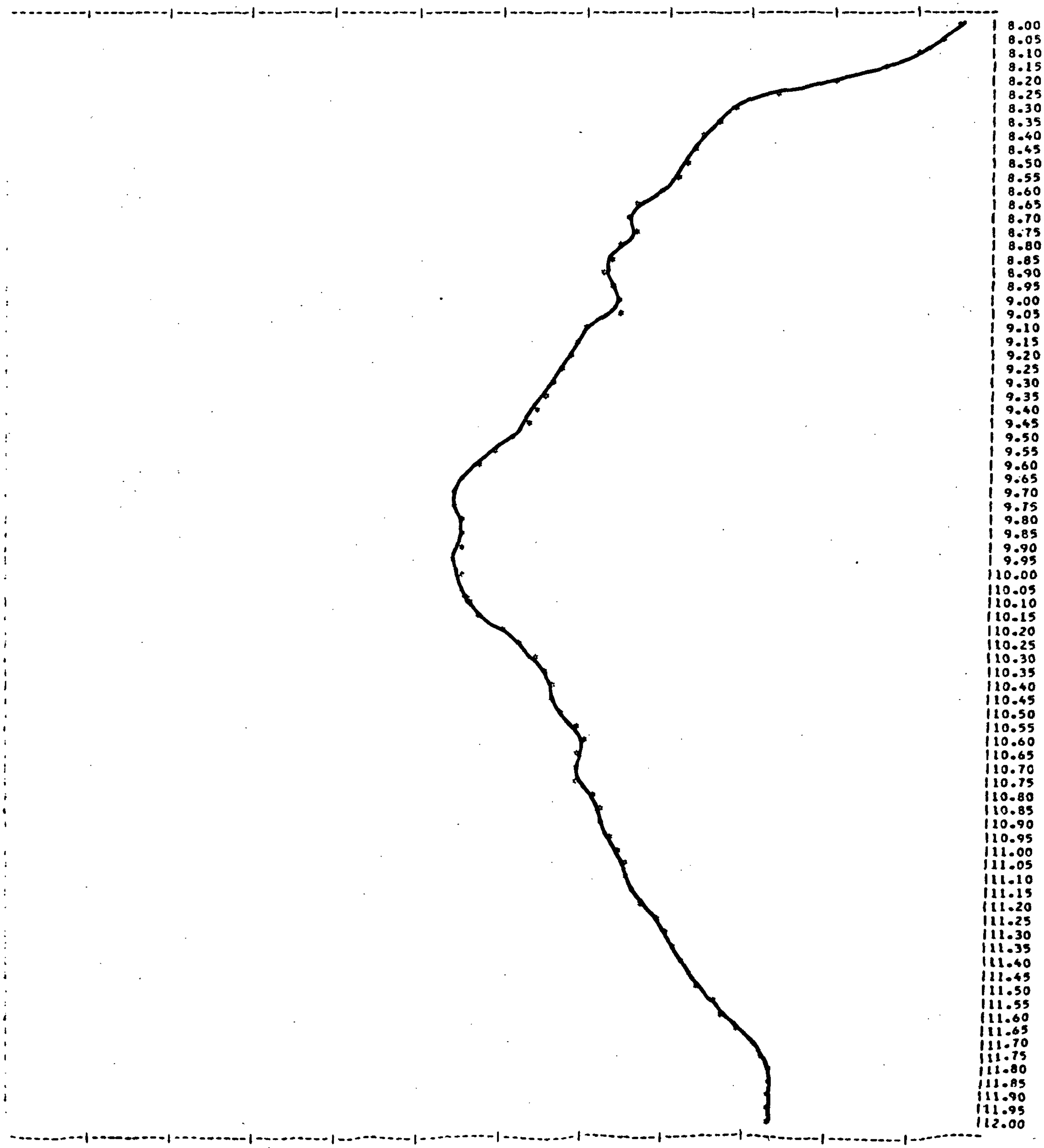
8.000 0.997	8.050 [illegible]	8.100 0.994	8.150 0.993	8.200 0.992	8.250 0.991	8.300 0.989	8.350 0.988
8.400 0.987	8.450 0.986	8.500 0.985	8.550 0.983	8.600 0.982	8.650 0.981	8.700 0.979	8.750 0.978
8.800 0.975	8.850 0.975	8.900 0.974	8.950 0.974	9.000 0.974	9.050 0.975	9.100 0.971	9.150 0.968
9.200 0.966	9.250 0.966	9.300 0.965	9.350 0.963	9.400 0.962	9.450 0.961	9.500 0.960	9.550 0.958
9.600 0.957	9.650 0.957	9.700 0.958	9.750 0.959	9.800 0.960	9.850 0.960	9.900 0.960	9.950 0.960
10.000 0.960	10.050 0.961	10.100 0.962	10.150 0.965	10.200 0.967	10.250 0.969	10.300 0.970	10.350 0.971
10.400 0.972	10.450 0.972	10.500 0.974	10.550 0.975	10.600 0.976	10.650 0.976	10.700 0.976	10.750 0.977
10.800 0.977	10.850 0.978	10.900 0.978	10.950 0.978	11.000 0.978	11.050 0.978	11.100 0.979	11.150 0.979
11.200 0.981	11.250 0.981	11.300 0.982	11.350 0.982	11.400 0.982	11.450 0.982	11.500 0.982	11.550 0.983
11.600 0.984	11.650 0.985	11.700 0.986	11.750 0.986	11.800 0.986	11.850 0.986	11.900 0.986	11.950 0.987
12.000 0.988							



[illegible]DATA

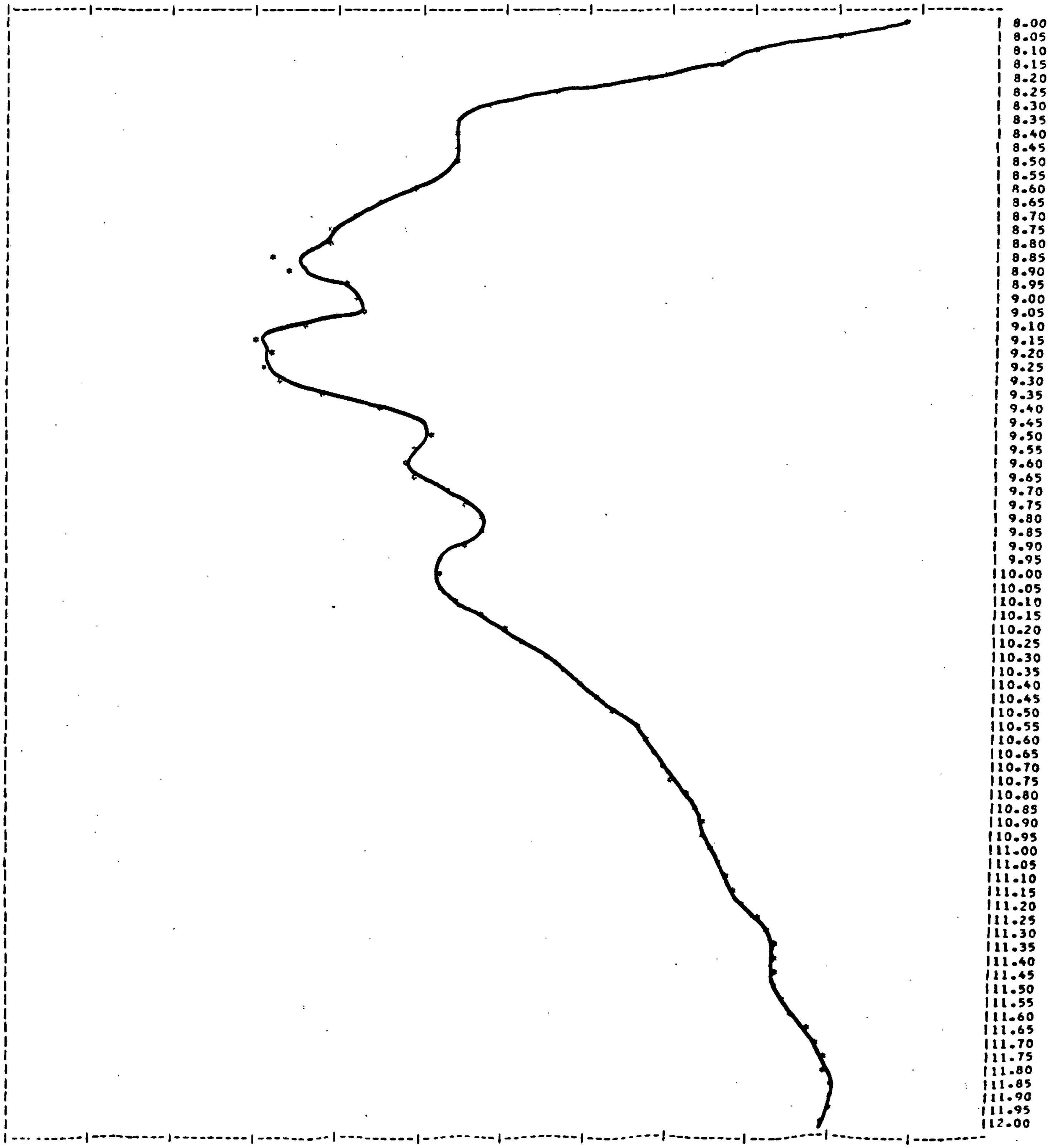
1500.
[illegible] CALIB. [illegible] VOLTS PER INCH= 0.0425 OHMS= 453.00
[illegible] REF. TEMPERATURE= 34.0[illegible] TARGET TEMPERATURE= 35.50
[illegible] EMIT. MAX.= [illegible]
[illegible] TEMPERATURE (SPECTROMETER) = 34.71
[illegible] AT SPECIFIC WAVELENGTHS

[illegible] 0.990	[illegible] 0.994	[illegible]	8.150 0.986	8.200 0.981	8.250 0.975	8.300 0.970	8.350 0.968
[illegible] 0.960	[illegible] 0.964	[illegible] 0.964	8.550 0.965	8.600 0.960	8.650 0.958	8.700 0.957	8.750 0.957
[illegible] 0.956	[illegible] 0.954	[illegible]	8.950 0.954	9.000 0.955	9.050 0.956	9.100 0.952	9.150 0.950
[illegible] 0.949	9.250 0.948	9.300 0.948	9.350 0.947	9.400 0.946	9.450 0.945	9.500 0.943	9.550 0.941
[illegible] 0.938	9.650 0.936	9.700 0.936	9.750 0.936	9.800 0.936	9.850 0.937	9.900 0.936	9.950 0.936
[illegible] 0.936	10.050 0.937	10.100 0.937	10.150 0.939	10.200 0.941	10.250 0.944	10.300 0.946	10.350 0.947
[illegible] 0.947	10.450 0.947	10.500 0.949	10.550 0.951	10.600 0.951	10.650 0.950	10.700 0.950	10.750 0.951
[illegible] 0.952	10.850 0.953	10.900 0.954	10.950 0.955	11.000 0.956	11.050 0.956	11.100 0.957	11.150 0.958
11.200 0.959	11.250 0.960	11.300 0.961	11.350 0.962	11.400 0.963	11.450 0.964	11.500 0.966	11.550 0.968
11.600 0.969	11.650 0.971	11.700 0.973	11.750 0.974	11.800 0.974	11.850 0.974	11.900 0.974	11.950 0.974
12.000 0.975							



1565
YL- .500 CALIB. DIST.=-5.00 VOLTS PER INCH= 0.3[illegible] OHMS= 454.00
BLK. BAT REF. TEMPERATURE= 34.67 TARGET TEMPERATURE= 34.50
WAVELENGTH OF EMIT. MAX.= 7.71
TARGET TEMPERATURE (SPECTROMETER) = 33.45
EMITTANCES AT SPECIFIC WAVELENGTHS

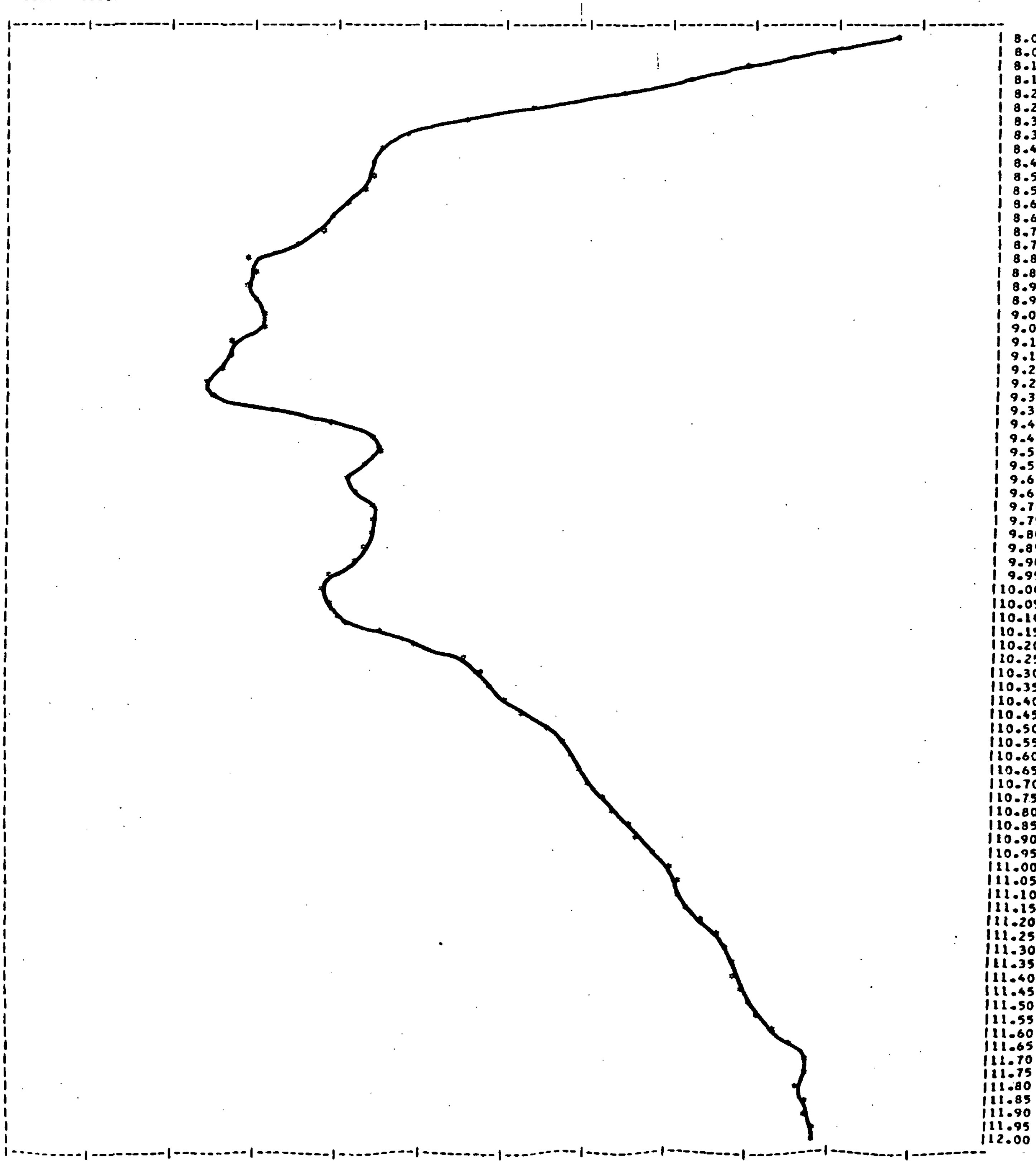
8.000 0.989	8.050 0.981	8.100 0.971	8.150 0.967	8.200 0.958	8.250 0.948	8.300 0.939	8.350 0.936
8.400 0.936	8.450 0.935	8.500 0.935	8.550 0.933	8.600 0.931	8.650 0.927	8.700 0.923	8.750 0.921
8.800 0.921	8.850 0.913	8.900 0.916	8.950 0.922	9.000 0.924	9.050 0.925	9.100 0.918	9.150 0.911
9.200 0.914	9.250 0.912	9.300 0.914	9.350 0.919	9.400 0.927	9.450 0.931	9.500 0.933	9.550 0.931
9.600 0.929	9.650 0.930	9.700 0.934	9.750 0.937	9.800 0.938	9.850 0.938	9.900 0.936	9.950 0.934
10.000 0.933	10.050 0.934	10.100 0.935	10.150 0.938	10.200 0.942	10.250 0.944	10.300 0.946	10.350 0.948
10.400 0.950	10.450 0.952	10.500 0.955	10.550 0.958	10.600 0.959	10.650 0.959	10.700 0.960	10.750 0.962
10.800 0.963	10.850 0.964	10.900 0.965	10.950 0.966	11.000 0.967	11.050 0.967	11.100 0.968	11.150 0.969
11.200 0.971	11.250 0.972	11.300 0.973	11.350 0.974	11.400 0.974	11.450 0.975	11.500 0.975	11.550 0.976
11.600 0.977	11.650 0.978	11.700 0.980	11.750 0.980	11.800 0.981	11.850 0.981	11.900 0.981	11.950 0.981
12.000 0.981							



1515

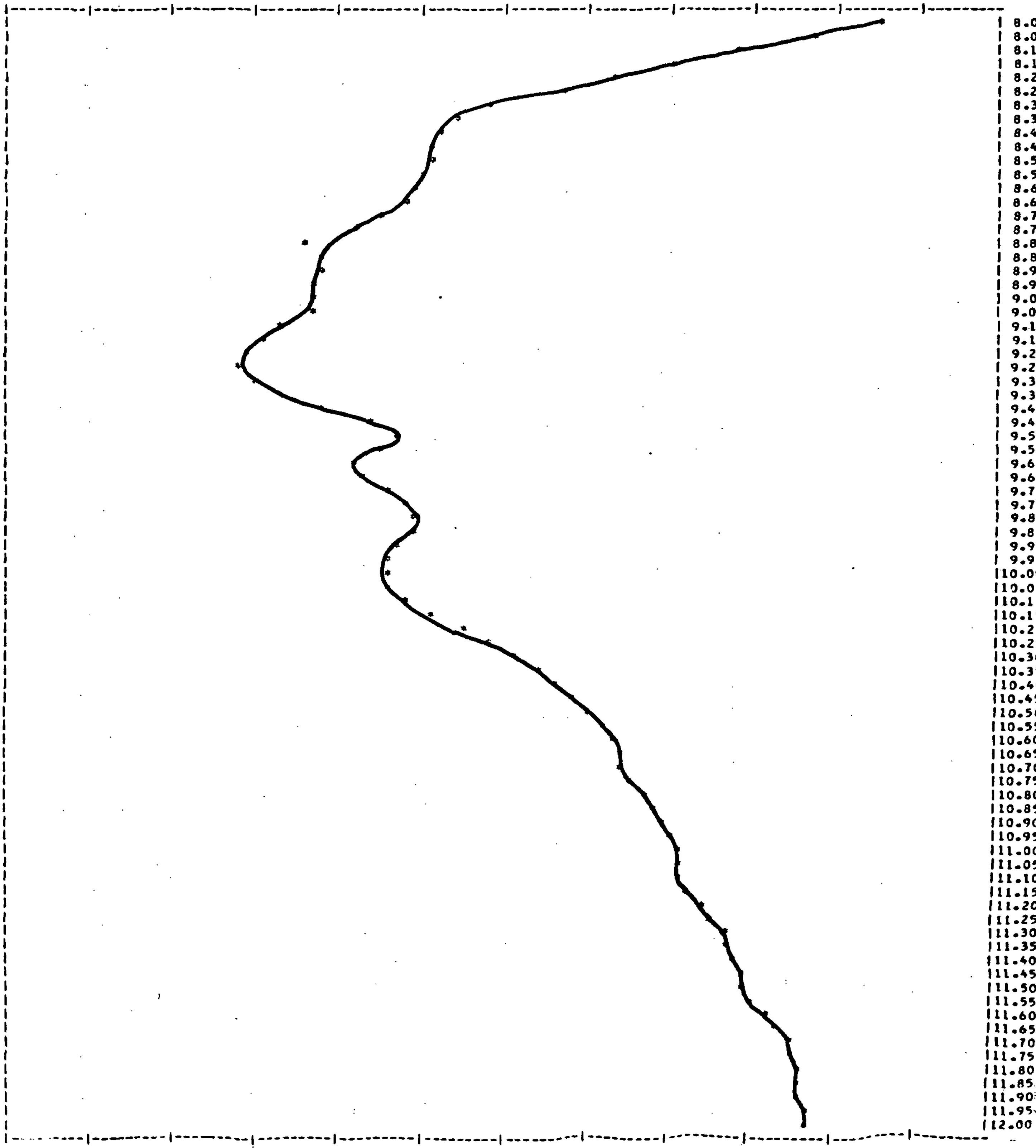
[illegible] CALIB. DIST.=-5.03 VOLTS PER INCH= 0.0596 OHMS= 454.30
INTERNAL REF. TEMPERATURE= 35.01 TARGET TEMPERATURE= 34.50
WAVELENGTH OF EMIT. MAX.= 7.77
TARGET TEMPERATURE (SPECTROMETER) = 36.35
EMITTANCES AT SPECIFIC WAVELENGTHS

8.000	0.989	8.050	0.980	8.100	0.970	8.150	0.964	8.200	0.956	8.250	0.945	8.300	0.936	8.350	0.929
8.400	0.927	8.450	0.926	8.500	0.925	8.550	0.924	8.600	0.923	8.650	0.921	8.700	0.919	8.750	0.917
8.800	0.911	8.850	0.911	8.900	0.910	8.950	0.912	9.000	0.912	9.050	0.912	9.100	0.909	9.150	0.909
9.200	0.907	9.250	0.906	9.300	0.907	9.350	0.913	9.400	0.920	9.450	0.926	9.500	0.926	9.550	0.924
9.600	0.925	9.650	0.924	9.700	0.925	9.750	0.925	9.800	0.925	9.850	0.925	9.900	0.923	9.950	0.921
10.000	0.920	10.050	0.920	10.100	0.922	10.150	0.926	10.200	0.930	10.250	0.936	10.300	0.938	10.350	0.940
10.400	0.941	10.450	0.944	10.500	0.946	10.550	0.946	10.600	0.949	10.650	0.950	10.700	0.952	10.750	0.953
10.800	0.955	10.850	0.956	10.900	0.958	10.950	0.959	11.000	0.961	11.050	0.962	11.100	0.963	11.150	0.964
11.200	0.966	11.250	0.967	11.300	0.968	11.350	0.969	11.400	0.970	11.450	0.971	11.500	0.972	11.550	0.973
11.600	0.975	11.650	0.977	11.700	0.978	11.750	0.976	11.800	0.978	11.850	0.978	11.900	0.979	11.950	0.979
12.000	0.980														



1525
[illegible] CALIB. DIST.=-5.01 VOLTS PER INCH= 0.1999 OHMS= 454.00
INTERNAL REF. TEMPERATURE= 34.[illegible] TARGET TEMPERATURE= 26.00
WAVELENGTH OF EMIT. MAX.= 7.62
TARGET TEMPERATURE (SPECTROMETER) = 35.96
EMITTANCES AT SPECIFIC WAVELENGTHS

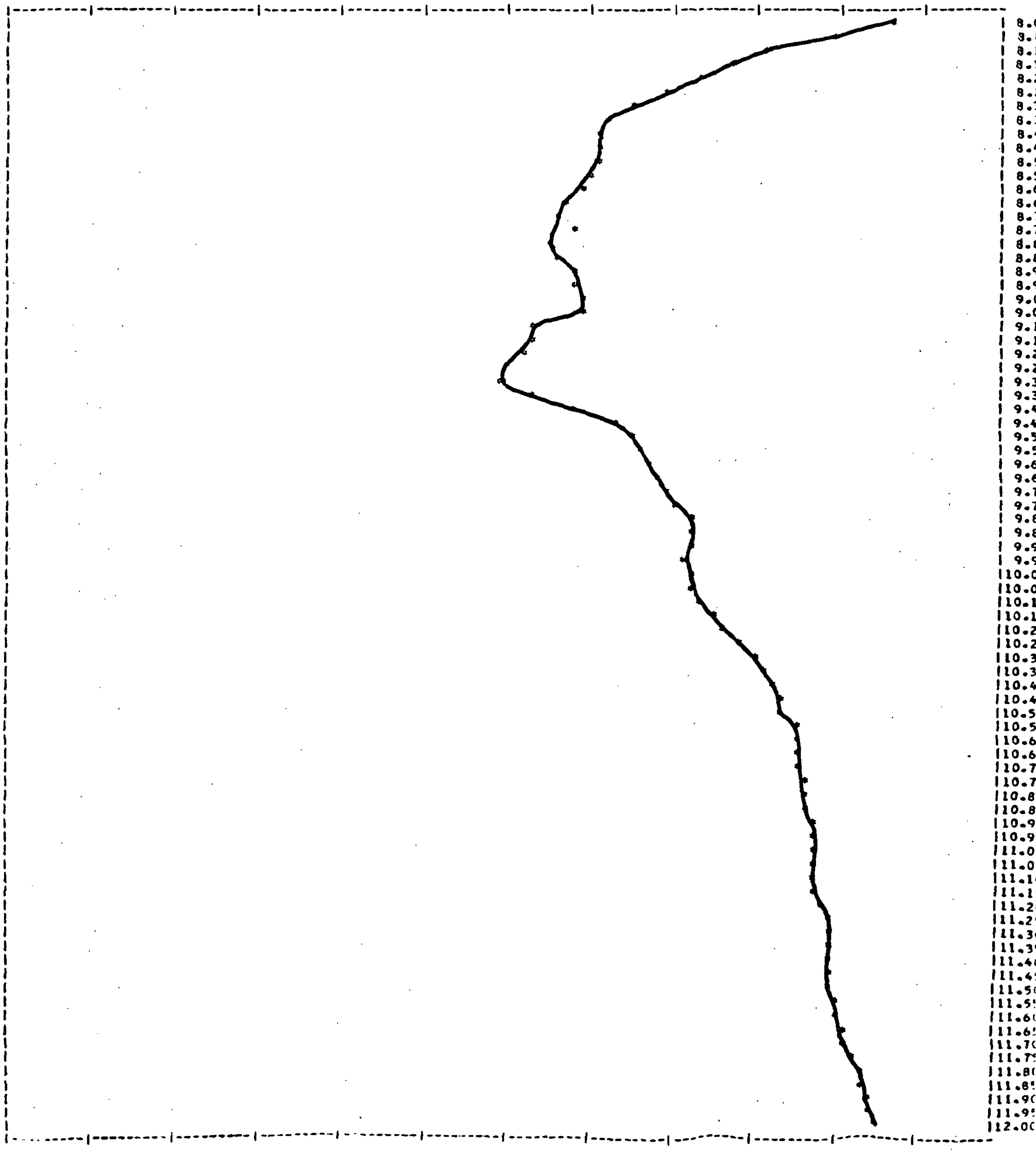
8.000	0.987	8.050	0.979	8.100	0.970	8.150	0.962	8.200	0.955	8.250	0.948	8.300	0.940	8.350	0.935
8.400	0.933	8.450	0.933	8.500	0.932	8.550	0.932	8.600	0.931	8.650	0.929	8.700	0.927	8.750	0.923
8.800	0.918	8.850	0.919	8.900	0.920	8.950	0.916	9.000	0.919	9.050	0.919	9.100	0.914	9.150	0.913
9.200	0.910	9.250	0.905	9.300	0.911	9.350	0.914	9.400	0.920	9.450	0.926	9.500	0.928	9.550	0.927
9.600	0.924	9.650	0.925	9.700	0.927	9.750	0.927	9.800	0.930	9.850	0.933	9.900	0.929	9.950	0.928
10.000	0.926	10.050	0.928	10.100	0.930	10.150	0.932	10.200	0.936	10.250	0.939	10.300	0.942	10.350	0.945
10.400	0.946	10.450	0.949	10.500	0.951	10.550	0.954	10.600	0.955	10.650	0.955	10.700	0.956	10.750	0.957
10.800	0.958	10.850	0.960	10.900	0.961	10.950	0.962	11.000	0.962	11.050	0.962	11.100	0.963	11.150	0.964
11.200	0.965	11.250	0.967	11.300	0.968	11.350	0.967	11.400	0.969	11.450	0.970	11.500	0.971	11.550	0.972
11.600	0.973	11.650	0.975	11.700	0.976	11.750	0.977	11.800	0.977	11.850	0.977	11.900	0.977	11.950	0.978
12.000	0.979														



1530

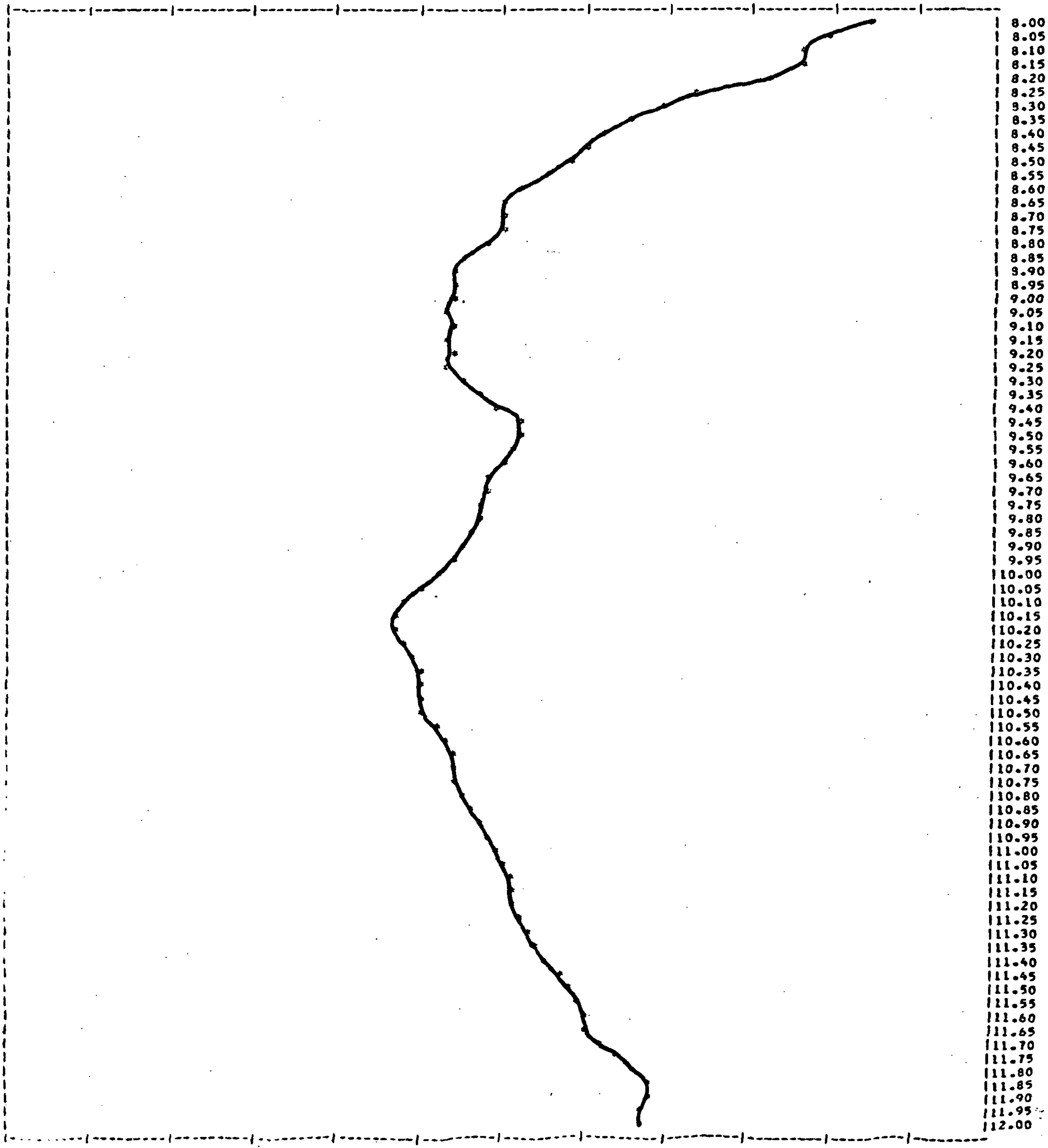
TC [illegible] CALIB. [illegible] -5.00 VOLTS PER INCH- 0.0200 [illegible]= 494.00
INTERNAL REF. TEMPERATURE= 34.82 TARGET TEMPERATURE= 35.50
WAVELENGTH OF EMIT. MAX.= 7.71
TARGET TEMPERATURE (SPECTROMETER) = 33.96
EMITTANCES AT SPECIFIC WAVELENGTHS

8.000	0.987	8.050	0.980	8.100	0.973	8.150	0.968	8.200	0.965	8.250	0.961	8.300	0.957	8.350	0.954
8.400	0.953	8.450	0.952	8.500	0.952	8.550	0.951	8.600	0.950	8.650	0.948	8.700	0.947	8.750	0.949
8.800	0.947	8.850	0.947	8.900	0.944	8.950	0.949	9.000	0.950	9.050	0.950	9.100	0.945	9.150	0.945
9.200	0.944	9.250	0.941	9.300	0.941	9.350	0.945	9.400	0.950	9.450	0.955	9.500	0.957	9.550	0.957
9.600	0.958	9.650	0.959	9.700	0.963	9.750	0.962	9.800	0.963	9.850	0.964	9.900	0.963	9.950	0.963
10.000	0.963	10.050	0.964	10.100	0.965	10.150	0.966	10.200	0.968	10.250	0.970	10.300	0.971	10.350	0.973
10.400	0.974	10.450	0.974	10.500	0.975	10.550	0.976	10.600	0.976	10.650	0.977	10.700	0.977	10.750	0.977
10.800	0.978	10.850	0.978	10.900	0.978	10.950	0.978	11.000	0.978	11.050	0.978	11.100	0.979	11.150	0.979
11.200	0.979	11.250	0.980	11.300	0.981	11.350	0.980	11.400	0.980	11.450	0.981	11.500	0.981	11.550	0.981
11.600	0.982	11.650	0.982	11.700	0.983	11.750	0.984	11.800	0.984	11.850	0.985	11.900	0.985	11.950	0.986
12.000	0.986														



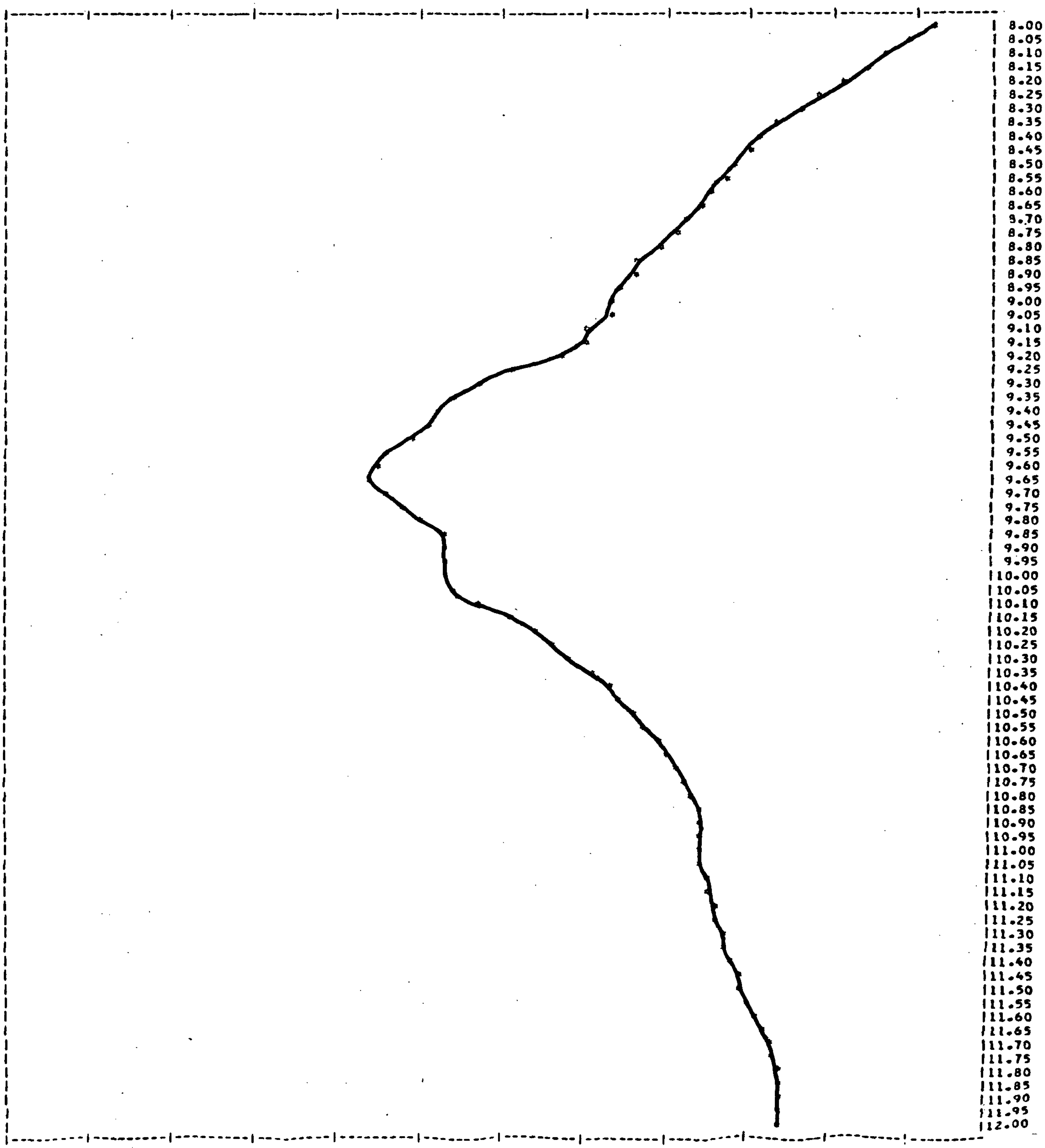
1535
YC=... CALIB. DIST.=-6.15 VOLTS PER INCH= 0.0448 OHMS= 454.00
INTERNAL REF. TEMPERATURE= 34.82 TARGET TEMPERATURE= 37.50
WAVELENGTH OF EMIT. MAX.= 7.64
TARGET TEMPERATURE (SPECTROMETER) = 35.56
EMITTANCES AT SPECIFIC WAVELENGTHS

8.000 0.985	8.050 0.981	8.100 0.978	8.150 0.977	8.200 0.974	8.250 0.964	8.300 0.961	8.350 0.956
8.400 0.953	8.450 0.951	8.500 0.947	8.550 0.946	8.600 0.943	8.650 0.941	8.700 0.941	8.750 0.942
8.800 0.939	8.850 0.936	8.900 0.935	8.950 0.935	9.000 0.936	9.050 0.935	9.100 0.935	9.150 0.935
9.200 0.935	9.250 0.935	9.300 0.937	9.350 0.939	9.400 0.941	9.450 0.943	9.500 0.944	9.550 0.943
9.600 0.942	9.650 0.940	9.700 0.939	9.750 0.939	9.800 0.938	9.850 0.938	9.900 0.937	9.950 0.935
10.000 0.934	10.050 0.932	10.100 0.929	10.150 0.928	10.200 0.928	10.250 0.930	10.300 0.930	10.350 0.932
10.400 0.932	10.450 0.931	10.500 0.931	10.550 0.933	10.600 0.935	10.650 0.936	10.700 0.936	10.750 0.936
10.800 0.937	10.850 0.937	10.900 0.939	10.950 0.939	11.000 0.941	11.950 0.942	11.100 0.942	11.150 0.942
11.200 0.942	11.250 0.943	11.300 0.945	11.350 0.946	11.400 0.947	11.450 0.948	11.500 0.950	11.550 0.951
11.600 0.951	11.650 0.952	11.700 0.953	11.750 0.955	11.800 0.957	11.850 0.959	11.900 0.959	11.950 0.959
12.000 0.956							



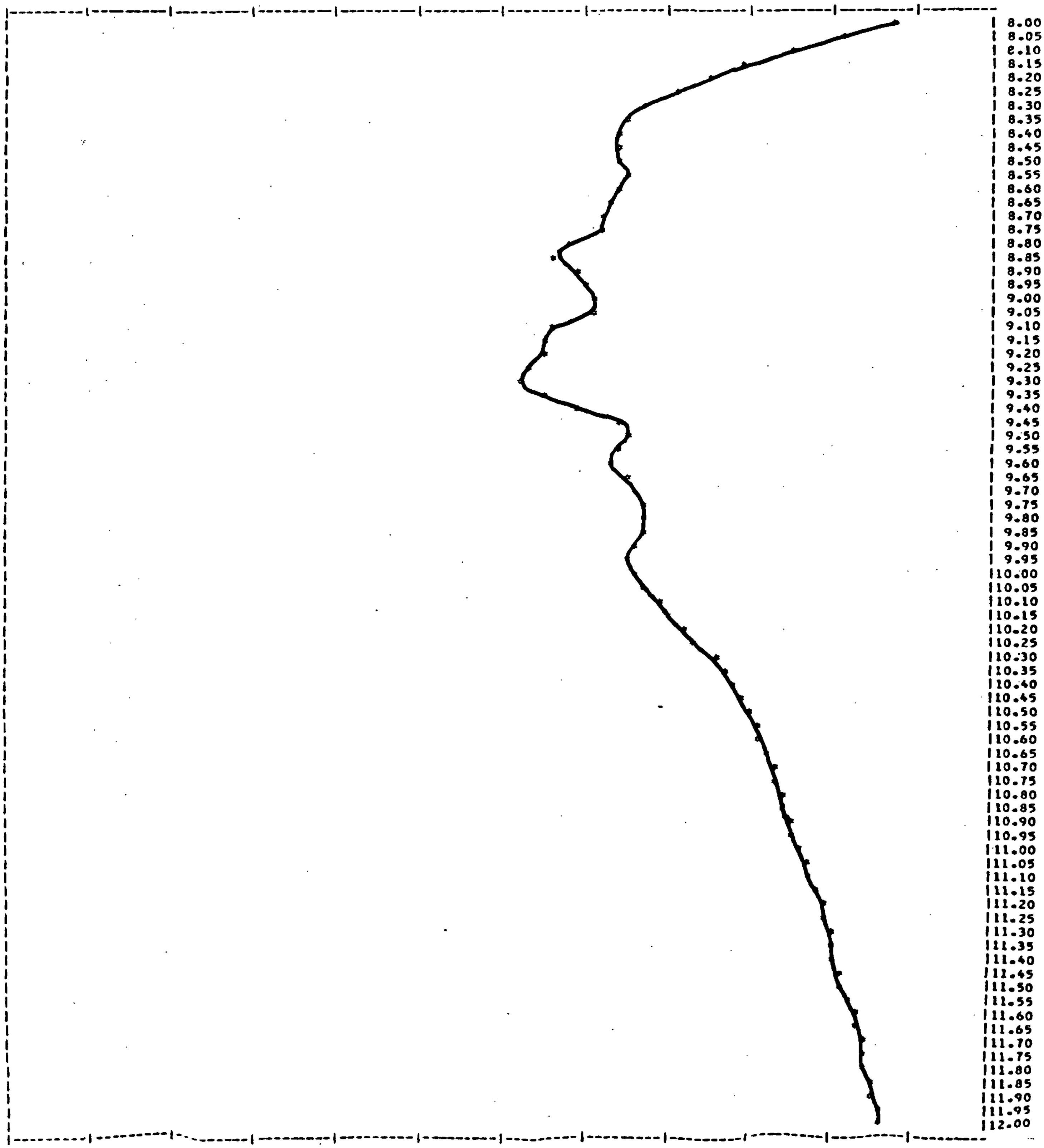
1540
[illegible] CALIB. [illegible] VOLTS PER INCH= 0.0460 [illegible] 456.00
[illegible] TEMPERATURE= 34.82 TARGET TEMPERATURE= 37.00
WAVELENGTH OF EMIT. MAX.= 7.62
TARGET TEMPERATURE (SPECTROMETER) = 35.45
EMITTANCES AT SPECIFIC WAVELENGTHS

8.000	0.993	8.050	0.991	8.100	0.988	8.150	0.985	8.200	0.982	8.250	0.980	8.300	0.977	8.350	0.975
8.400	0.973	8.450	0.971	8.500	0.969	8.550	0.968	8.600	0.967	8.650	0.965	8.700	0.964.	8.750	0.962
8.800	0.961	8.850	0.958	8.900	0.957	8.950	0.956	9.000	0.955	9.050	0.955	9.100	0.952	9.150	0.951
9.200	0.948	9.250	0.942	9.300	0.938	9.350	0.936	9.400	0.934	9.450	0.932	9.500	0.930	9.550	0.928
9.600	0.926	9.650	0.925	9.700	0.927	9.750	0.929	9.800	0.932	9.850	0.934	9.900	0.934	9.950	0.934
10.000	0.935	10.050	0.936	10.100	0.939	10.150	0.943	10.200	0.945	10.250	0.947	10.300	0.949	10.350	0.952
10.400	0.954	10.450	0.956	10.500	0.957	10.550	0.959	10.600	0.960	10.650	0.961	10.700	0.962	10.750	0.963
10.800	0.964	10.850	0.965	10.900	0.966	10.950	0.965	11.000	0.965	11.050	0.966	11.100	0.966	11.150	0.967
11.200	0.967	11.250	0.968	11.300	0.968	11.350	0.969	11.400	0.969	11.450	0.970	11.500	0.971	11.550	0.972
11.600	0.972	11.650	0.973	11.700	0.974	11.750	0.975	11.800	0.975	11.850	0.975	11.900	0.975	11.950	0.976
12.000	0.976														



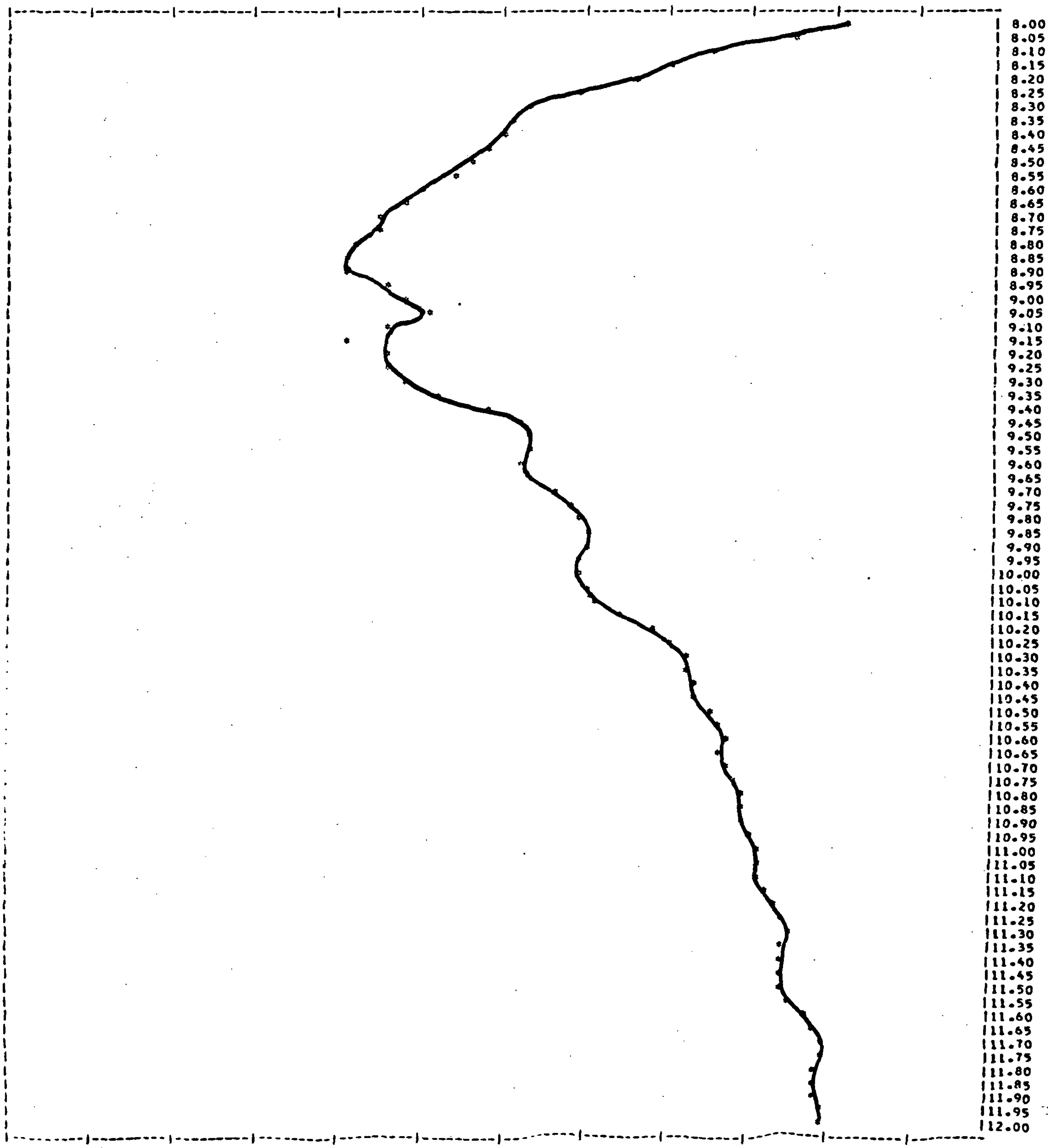
1545
YC[illegible] CALIB. DIST.=-6.16 VOLTS PER INCH- 0.C4E7 OHMS= 454.20
INTERNAL REF. TEMPERATURE= 34.94 TARGET TEMPERATURE= 35.00
WAVELENGTH OF EMIT. MAX.= 7.60
TARGET TEMPERATURE (SPECTROMETER) = 34.34
EMITTANCES AT SPECIFIC WAVELENGTHS

8.000 0.983	8.050 0.983	8.100 0.976	8.150 0.971	8.200 0.967	8.250 0.962	8.300 0.959	8.350 0.957
8.400 0.955	8.450 0.955	8.500 0.956	8.550 0.956	8.600 0.956	8.650 0.955	8.700 0.953	8.750 0.953
8.800 0.950	8.850 0.948	8.900 0.950	8.950 0.952	9.000 0.952	9.050 0.953	9.100 0.948	9.150 0.947
9.200 0.946	9.250 0.944	9.300 0.943	9.350 0.946	9.400 0.951	9.450 0.955	9.500 0.956	9.550 0.956
9.600 0.955	9.650 0.956	9.700 0.957	9.750 0.958	9.800 0.958	9.850 0.958	9.900 0.957	9.950 0.957
10.000 0.956	10.050 0.959	10.100 0.960	10.150 0.962	10.200 0.964	10.250 0.965	10.300 0.967	10.350 0.969
10.400 0.970	10.450 0.973	10.500 0.971	10.550 0.972	10.600 0.973	10.650 0.974	10.700 0.974	10.750 0.975
10.800 0.975	10.850 0.976	10.900 0.976	10.950 0.977	11.000 0.977	11.050 0.978	11.100 0.979	11.150 0.980
11.200 0.980	11.250 0.981	11.300 0.981	11.350 0.981	11.400 0.982	11.450 0.982	11.500 0.983	11.550 0.984
11.600 0.984	11.650 0.985	11.700 0.985	11.750 0.986	11.800 0.986	11.850 0.986	11.900 0.987	11.950 0.987
12.000 0.988							



[illegible] 1550
[illegible] CALIB. DIST. [illegible] VOLTS PER INCH= [illegible] [illegible]= 453.60
[illegible] TEMPERATURE [illegible] TARGET TEMPERATURE= 35.50
[illegible] MAX.= 7.71
[illegible] TEMPERATURE (SPECTROMETER) = 32.51
[illegible] AT SPECIFIC WAVELENGTHS

[illegible]	0.965	8.050	0.976	8.100	0.966	8.150	0.962	8.200	0.958	8.250	0.950	8.300	0.945	8.350	0.942
[illegible]	0.941	8.450	0.940	8.500	0.933	8.550	0.935	8.600	0.932	8.650	0.929	8.700	0.927	8.750	0.926
[illegible]	0.924	8.850	0.923	8.900	0.922	8.950	0.927	9.000	0.929	9.050	0.932	9.100	0.928	9.150	0.922
[illegible]	0.927	9.250	0.927	9.300	0.929	9.350	0.933	9.400	0.940	9.450	0.944	9.500	0.945	9.550	0.944
[illegible]	0.943	9.650	0.944	9.700	0.947	9.750	0.949	9.800	0.951	9.850	0.952	9.900	0.952	9.950	0.951
[illegible]	0.951	10.050	0.951	10.100	0.953	10.150	0.956	10.200	0.959	10.250	0.967	10.300	0.963	10.350	0.964
[illegible]	0.954	10.450	0.965	10.500	0.956	10.550	0.961	10.600	0.968	10.650	0.968	10.700	0.968	10.750	0.969
[illegible]	0.970	10.850	0.971	10.900	0.971	10.950	0.971	11.000	0.972	11.050	0.973	11.100	0.973	11.150	0.974
[illegible]	0.975	11.250	0.976	11.300	0.976	11.350	0.976	11.400	0.976	11.450	0.976	11.500	0.976	11.550	0.977
[illegible]	0.979	11.650	0.980	11.700	0.981	11.750	0.980	11.800	0.980	11.850	0.979	11.900	0.980	11.950	0.980
[illegible]	0.981														



$DATA

1605

[illegible] CALIB. DIST.=5.00 VOLTS PER INCH= 0.0000 OHMS= 454.20

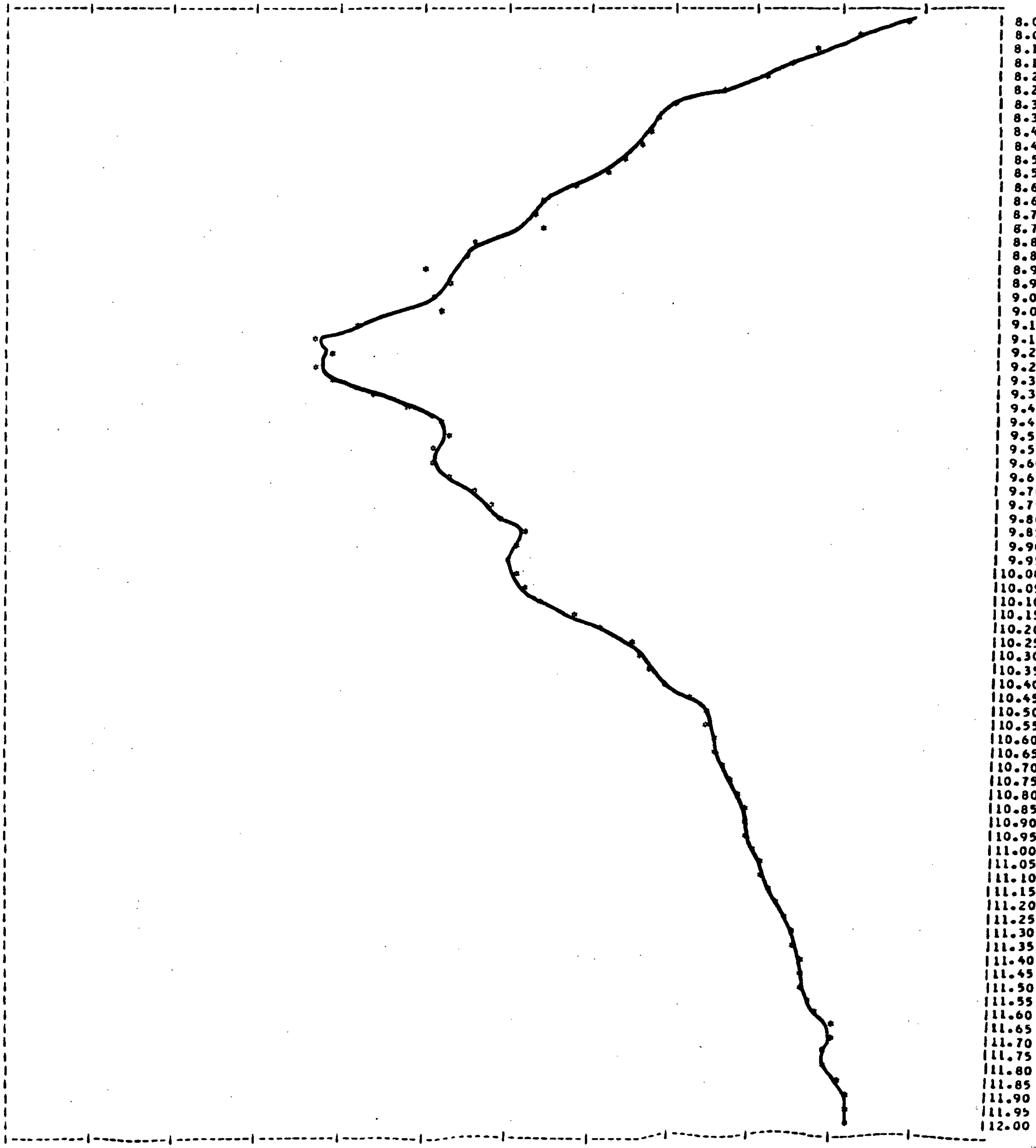
[illegible] REF. TEMPERATURE= 34.[illegible] [illegible] TEMPERATURE= 34.00

WAVELENGTH OF EMIT. MAX.= 7.71

[illegible] TEMPERATURE (SPECTROMETER) = [illegible]

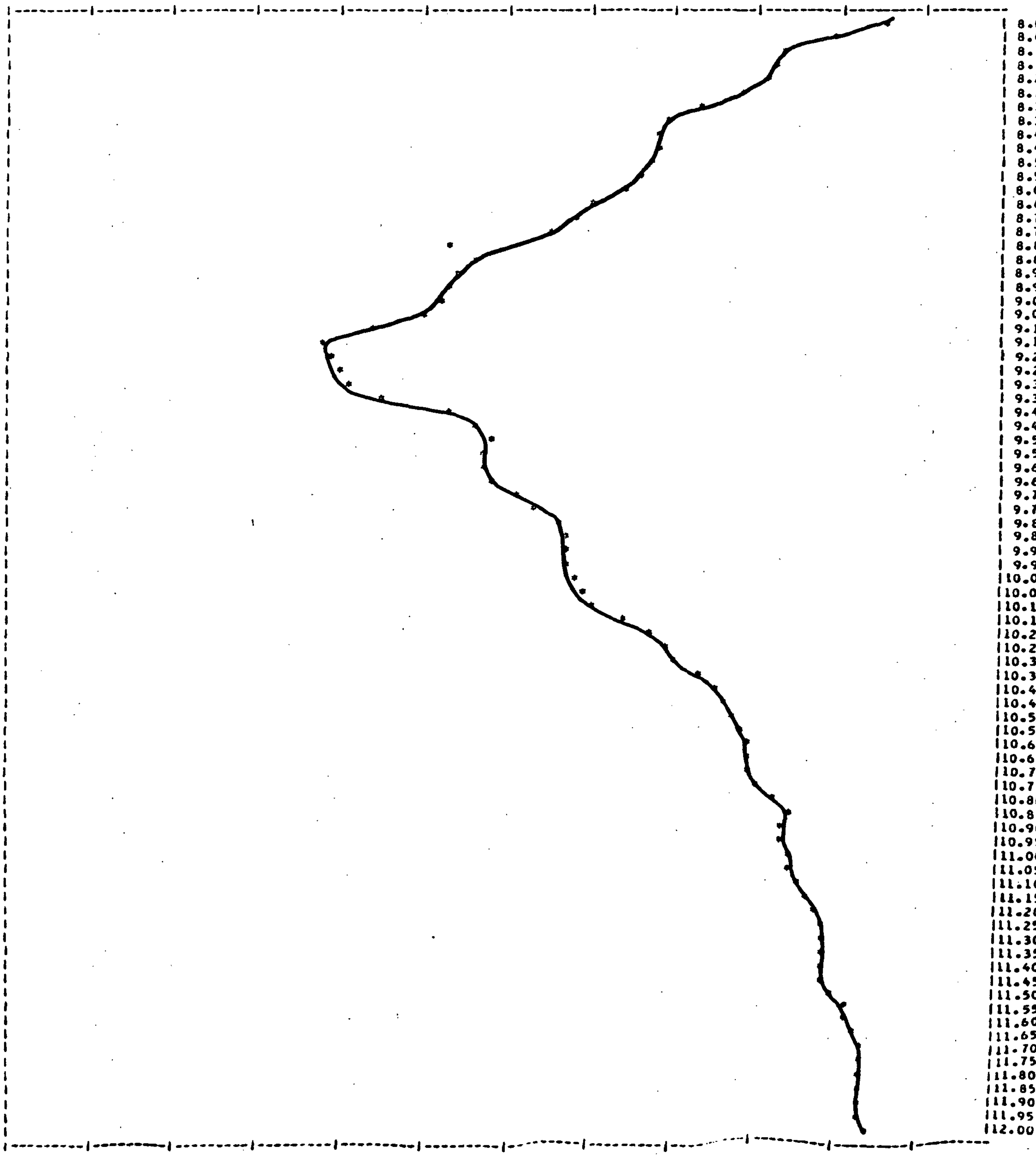
EMITTANCES AT SPECIFIC WAVELENGTHS

8.000 0.989	8.050 0.984	8.100 0.978	8.150 0.975	8.200 0.972	8.250 0.968	8.300 0.961	8.350 0.960
8.400 0.959	8.450 0.956	8.500 0.956	8.550 0.953	8.600 0.949	8.650 0.946	8.700 0.944	8.750 0.945
8.800 0.936	8.850 0.937	8.900 0.932	8.950 0.934	9.000 0.932	9.050 0.934	9.100 0.924	9.150 0.918
9.200 0.920	9.250 0.918	9.300 0.921	9.350 0.925	9.400 0.930	9.450 0.934	9.500 0.934	9.550 0.933
9.600 0.933	9.650 0.935	9.700 0.937	9.750 0.939	9.800 0.941	9.850 0.943	9.900 0.943	9.950 0.942
10.000 0.942	10.050 0.944	10.100 0.946	10.150 0.949	10.200 0.953	10.250 0.956	10.300 0.957	10.350 0.958
10.400 0.961	10.450 0.964	10.500 0.965	10.550 0.966	10.600 0.966	10.650 0.967	10.700 0.968	10.750 0.968
10.800 0.970	10.850 0.971	10.900 0.971	10.950 0.971	11.000 0.972	11.050 0.972	11.100 0.972	11.150 0.973
11.200 0.975	11.250 0.975	11.300 0.976	11.350 0.977	11.400 0.977	11.450 0.977	11.500 0.977	11.550 0.978
11.600 0.980	11.650 0.981	11.700 0.981	11.750 0.981	11.800 0.981	11.850 0.982	11.900 0.983	11.950 0.983
12.000 0.984							



1619
[illegible] CALIB. DIST. [illegible] VOLTS PER INCH= 0.055[illegible] OHMS= 454.29
[illegible] REF. TEMPERATURE= 34.34 TARGET TEMPERATURE= 34.00
WAVELENGTH OF EMIT. MAX.= [illegible]
TARGET TEMPERATURE (SPECTROMETER) = 33.00
EMITTANCES AT SPECIFIC WAVELENGTHS

8.000	[illegible]	8.050	0.980	8.100	0.975	8.150	0.973	8.200	0.972	8.250	0.970	8.300	0.964	8.350	0.961
8.400	0.960	8.450	[illegible]	8.500	0.959	8.550	0.958	8.600	0.955	8.650	0.951	8.700	0.949	8.750	0.947
8.800	0.934	8.850	0.937	8.900	0.936	8.950	0.935	9.000	0.934	9.050	0.932	9.100	0.926	9.150	0.920
9.200	0.920	9.250	0.921	9.300	0.925	9.350	0.927	9.400	0.934	9.450	0.930	9.500	0.940	9.550	0.939
9.600	0.938	9.650	0.940	9.700	0.943	9.750	0.945	9.800	0.947	9.850	0.949	9.900	0.949	9.950	0.949
10.000	0.950	10.050	0.951	10.100	0.952	10.150	0.955	10.200	0.958	10.250	0.960	10.300	0.962	10.350	0.964
10.400	0.966	10.450	0.967	10.500	0.968	10.550	0.969	10.600	0.970	10.650	0.970	10.700	0.971	10.750	0.972
10.800	0.974	10.850	0.975	10.900	0.975	10.950	0.975	11.000	0.976	11.050	0.976	11.100	0.976	11.150	0.977
11.200	0.978	11.250	0.979	11.300	0.980	11.350	0.979	11.400	0.979	11.450	0.980	11.500	0.981	11.550	0.982
11.600	0.983	11.650	0.984	11.700	0.985	11.750	0.985	11.800	0.985	11.850	0.984	11.900	0.985	11.950	0.985
12.000	0.985														



1615

[illegible]=-[illegible].300 CALIB. DIST.=-6.15 VOLTS PER INCH= 0.0488 OHMS= 454.20

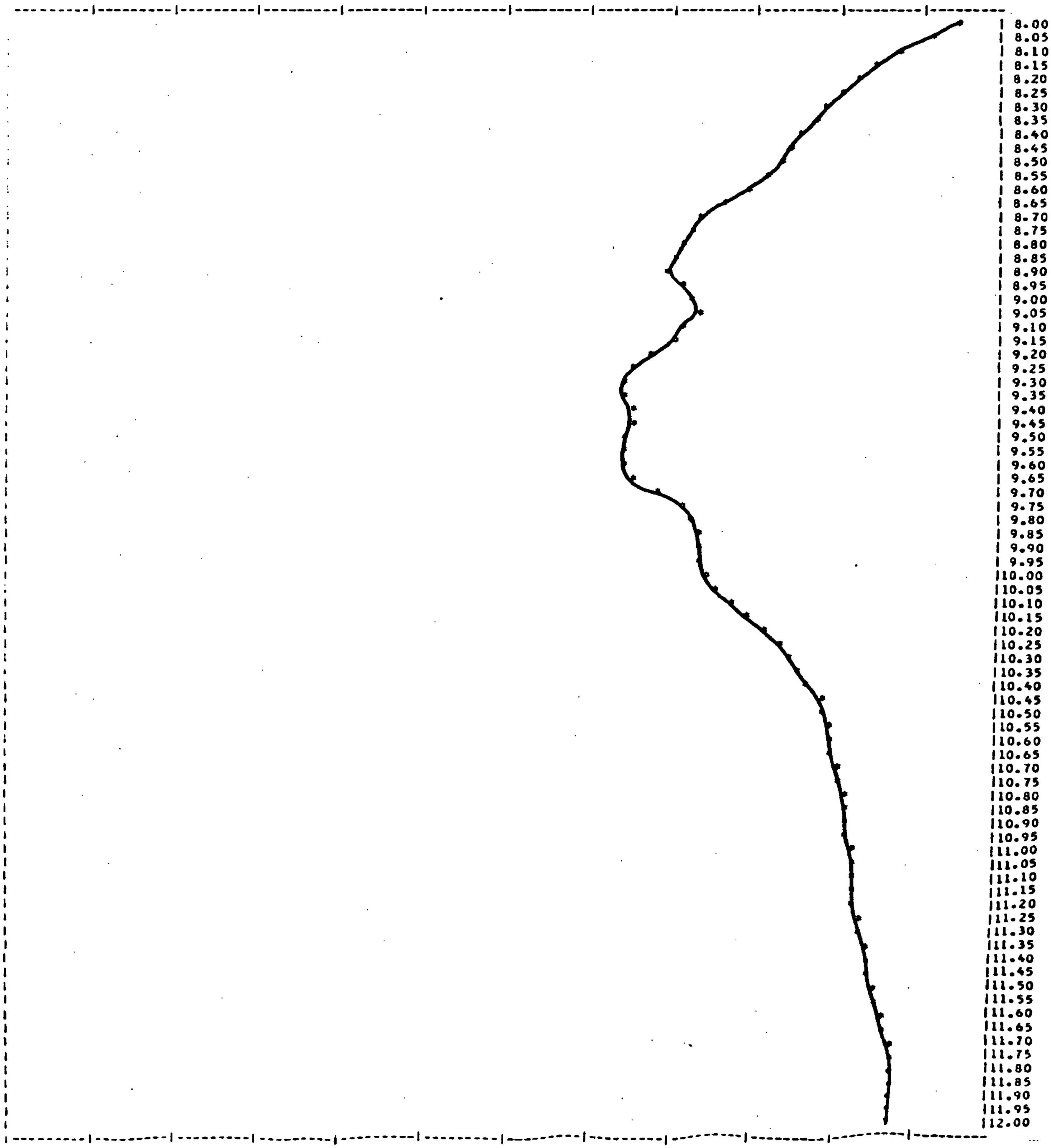
[illegible]NAL REF. TEMPERATURE= 34.94 TARGET TEMPERATURE= 35.00

[illegible]LENGTH OF EMIT. MAX.= 7.7[illegible]

[illegible]T TEMPERATURE (SPECTROMETER) = [illegible].57

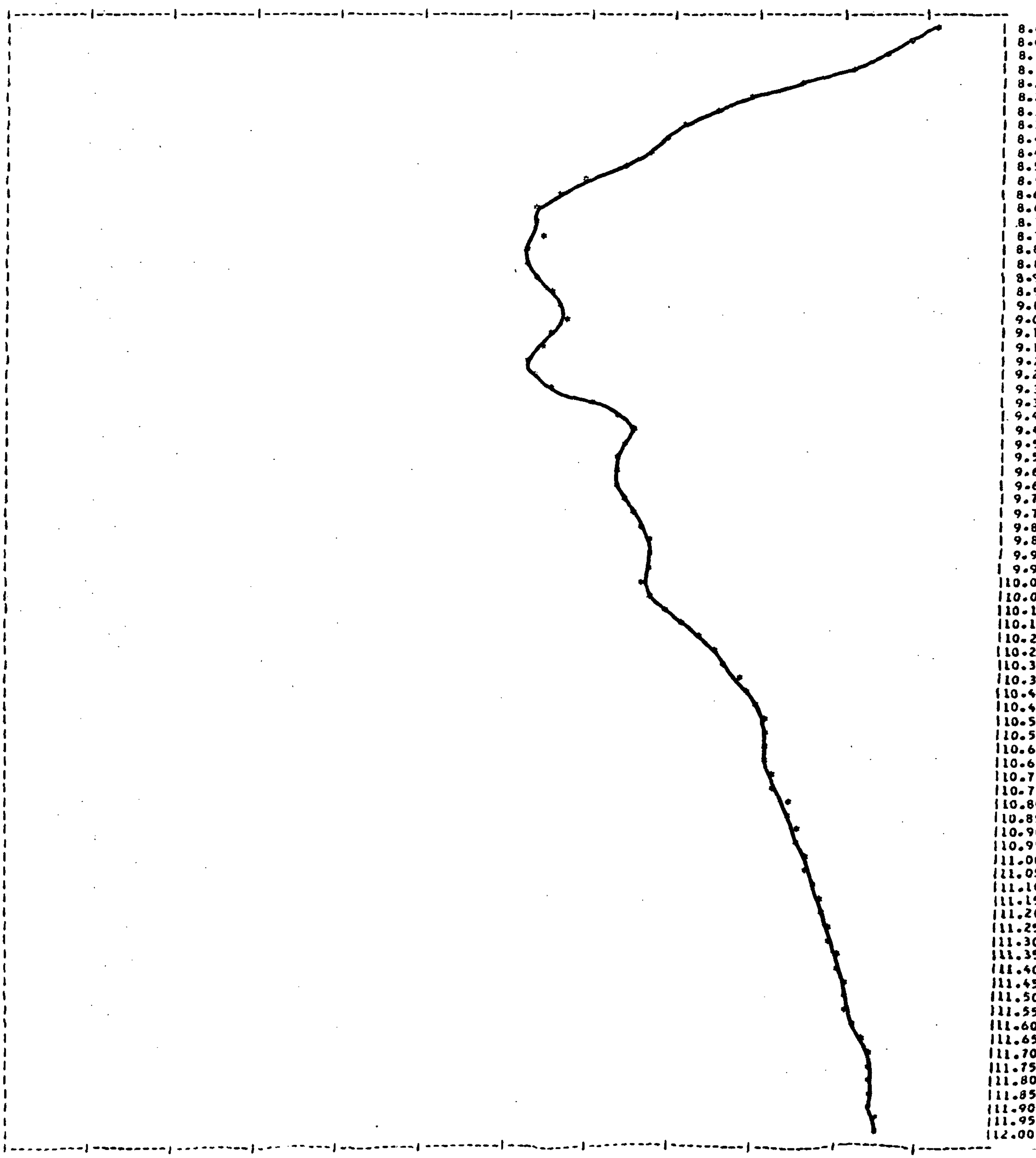
[illegible]ITTANCES AT SPECIFIC WAVELENGTHS

8.000	0.995	8.050	0.993	8.100	0.989	8.150	0.986	8.200	0.984	8.250	0.982	8.300	0.980	8.350	0.978
8.400	0.977	8.450	0.975	8.500	0.974	8.550	0.973	8.600	0.971	8.650	0.967	8.700	0.965	8.750	0.964
8.800	0.962	8.850	0.962	8.900	0.961	8.950	0.963	9.000	0.964	9.050	0.964	9.100	0.963	9.150	0.961
9.200	0.959	9.250	0.956	9.300	0.956	9.350	0.956	9.400	0.956	9.450	0.956	9.500	0.956	9.550	0.955
9.600	0.955	9.650	0.957	9.700	0.960	9.750	0.962	9.800	0.964	9.850	0.964	9.900	0.965	9.950	0.965
10.000	0.966	10.050	0.967	10.100	0.968	10.150	0.971	10.200	0.973	10.250	0.974	10.300	0.975	10.350	0.976
10.400	0.978	10.450	0.979	10.500	0.980	10.550	0.980	10.600	0.981	10.650	0.981	10.700	0.981	10.750	0.982
10.800	0.982	10.850	0.982	10.900	0.983	10.950	0.983	11.000	0.983	11.050	0.984	11.100	0.983	11.150	0.984
11.200	0.984	11.250	0.984	11.300	0.985	11.350	0.985	11.400	0.986	11.450	0.986	11.500	0.986	11.550	0.986
11.600	0.987	11.650	0.988	11.700	0.988	11.750	0.988	11.800	0.988	11.850	0.988	11.900	0.988	11.950	0.989
12.000	0.989														



1670
[illegible] CALIB. [illegible] VOLTS PER [illegible] OHMS= 454.30
[illegible] REF. TEMPERATURE= 34.02   TARGET TEMPERATURE= 35.00
WAVELENGTH OF EMIT. MAX.= 7.7.
TARGET TEMPERATURE (SPECTROMETER) = 34.50
EMITTANCES AT SPECIFIC WAVELENGTHS

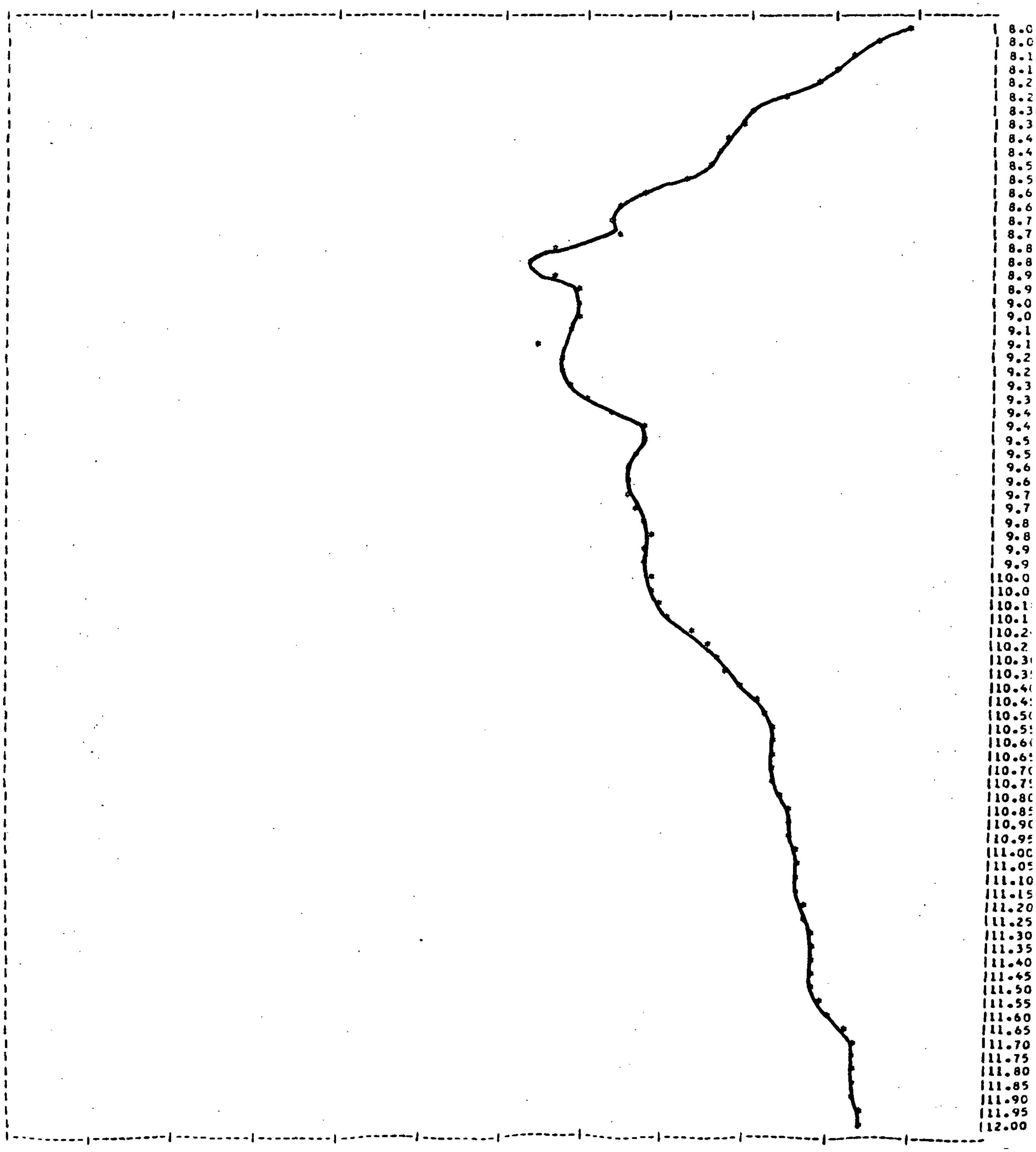
8.000 0.992	8.050 0.990	8.100 0.987	8.150 0.984	8.200 0.977	8.250 0.970	8.300 0.966	8.350 0.962
8.400 0.960	8.450 0.958	8.500 0.955	8.550 0.951	8.600 0.948	8.650 0.945	8.700 0.945	8.750 0.945
8.800 0.944	8.850 0.943	8.900 0.945	8.950 0.946	9.000 0.947	9.050 0.949	9.100 0.946	9.150 0.945
9.200 0.943	9.250 0.944	9.300 0.947	9.350 0.951	9.400 0.954	9.450 0.956	9.500 0.955	9.550 0.955
9.600 0.954	9.650 0.954	9.700 0.956	9.750 0.957	9.800 0.958	9.850 0.959	9.900 0.959	9.950 0.958
10.000 0.958	10.050 0.958	10.100 0.960	10.150 0.963	10.200 0.965	10.250 0.966	10.300 0.967	10.350 0.970
10.400 0.971	10.450 0.972	10.500 0.972	10.550 0.973	10.600 0.973	10.650 0.973	10.700 0.973	10.750 0.974
10.800 0.975	10.850 0.976	10.900 0.976	10.950 0.977	11.000 0.977	11.050 0.978	11.100 0.976	11.150 0.979
11.200 0.980	11.250 0.980	11.300 0.981	11.350 0.981	11.400 0.982	11.450 0.982	11.500 0.982	11.550 0.983
11.600 0.983	11.650 0.984	11.700 0.985	11.750 0.986	11.800 0.986	11.850 0.986	11.900 0.986	11.950 0.986
12.000 0.987							



1625

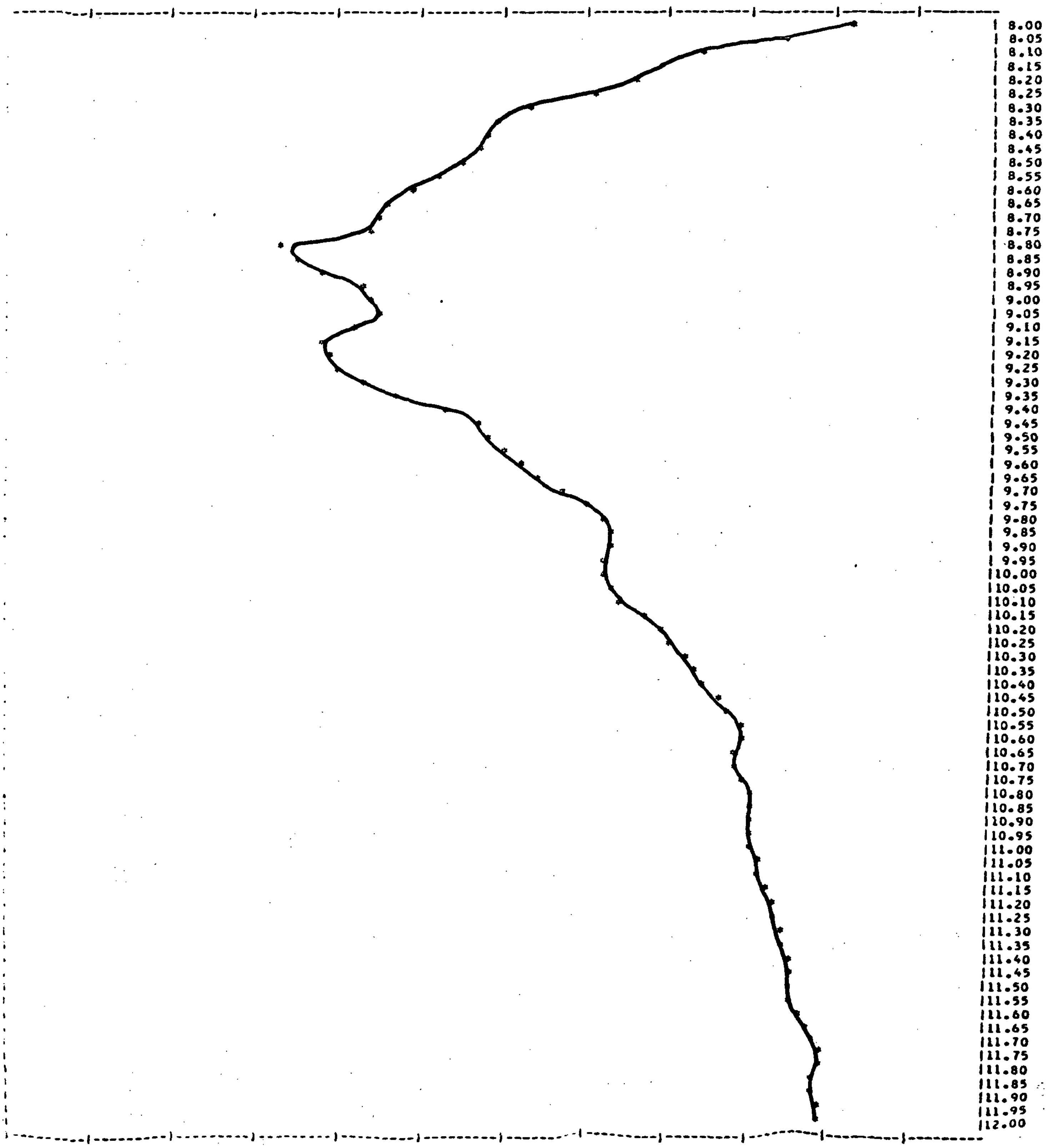
?? -??.??) CALIB. ???.? -0.17 VOLTS PER INCH= 0.0436 OHMS= 454.00
INTERNAL REF. TEMPERATURE= 34.02 TARGET TEMPERATURE= 33.50
WAVELENGTH OF FAIL. 4.?.? 7.71
TARGET TEMPERATURE (SPECTROMETER) = 32.53
EMITTANCES AT SPECIFIC WAVELENGTHS

8.000 0.990	8.050 0.987	8.100 0.984	8.150 0.982	8.200 0.980	8.250 0.975	8.300 0.972	8.350 0.970
8.400 0.969	8.450 0.966	8.500 0.966	8.550 0.963	8.600 0.958	8.650 0.956	8.700 0.955	8.750 0.956
8.800 0.948	8.850 0.945	8.900 0.947	8.950 0.951	9.000 0.951	9.050 0.951	9.100 0.949	9.150 0.946
9.200 0.948	9.250 0.946	9.300 0.950	9.350 0.952	9.400 0.954	9.450 0.956	9.500 0.958	9.550 0.957
9.600 0.957	9.650 0.956	9.700 0.957	9.750 0.957	9.800 0.959	9.850 0.959	9.900 0.959	9.950 0.958
10.000 0.959	10.050 0.960	10.100 0.960	10.150 0.962	10.200 0.964	10.250 0.967	10.300 0.968	10.350 0.968
10.400 0.971	10.450 0.972	10.500 0.973	10.550 0.974	10.600 0.974	10.650 0.974	10.700 0.974	10.750 0.975
10.800 0.976	10.850 0.977	10.900 0.977	10.950 0.977	11.000 0.977	11.050 0.977	11.100 0.977	11.150 0.978
11.200 0.978	11.250 0.979	11.300 0.979	11.350 0.979	11.400 0.979	11.450 0.979	11.500 0.980	11.550 0.980
11.600 0.982	11.650 0.983	11.700 0.984	11.750 0.984	11.800 0.984	11.850 0.984	11.900 0.985	11.950 0.985
12.000 0.986							



1635.
[illegible] CALIB. DIST.=-5.01 VOLTS PER INCH= 0.0599 OHMS= 453.80
[illegible] TEMPERATURE= [illegible] TARGET TEMPERATURE= [illegible]
[illegible] CHIL. MAX.= 7.60
[illegible] TEMPERATURE (SPECTROMETER) = [illegible]
EMITTANCES AT SPECIFIC WAVELENGTHS

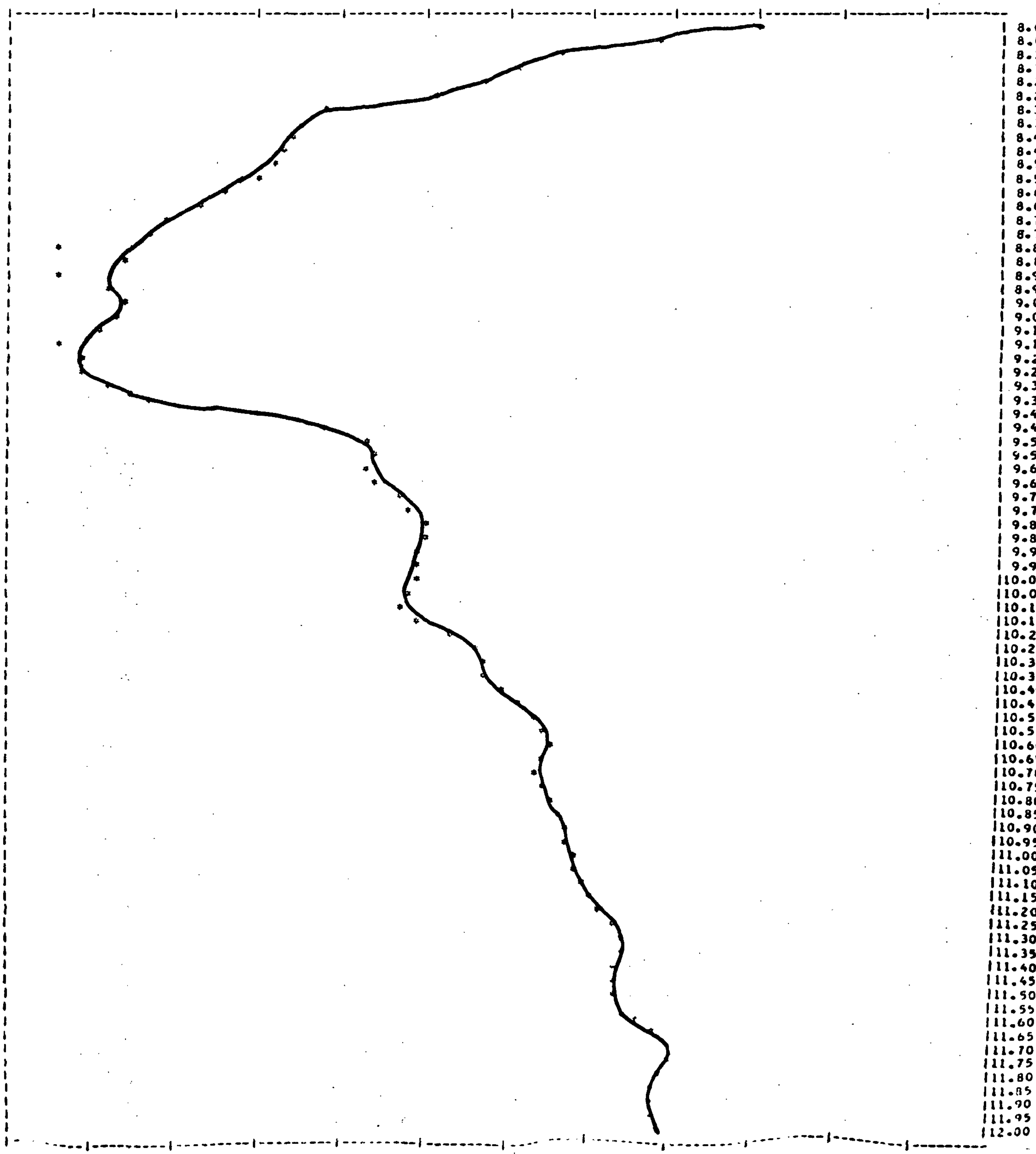
8.000 0.984	8.050 0.975	8.100 0.965	8.150 0.961	8.200 0.957	8.250 0.952	8.300 0.945	8.350 0.941
8.400 0.939	8.450 0.936	8.500 0.936	8.550 0.934	8.600 0.930	8.650 0.927	8.700 0.926	8.750 0.926
8.800 0.915	8.850 0.917	8.900 0.917	8.950 0.924	9.000 0.926	9.050 0.926	9.100 0.924	9.150 0.920
9.200 0.921	9.250 0.921	9.300 0.924	9.350 0.929	9.400 0.934	9.450 0.938	9.500 0.940	9.550 0.942
9.600 0.943	9.650 0.946	9.700 0.948	9.750 0.951	9.800 0.953	9.850 0.955	9.900 0.954	9.950 0.953
10.000 0.954	10.050 0.955	10.100 0.956	10.150 0.958	10.200 0.960	10.250 0.962	10.300 0.964	10.350 0.965
10.400 0.966	10.450 0.967	10.500 0.969	10.550 0.970	10.600 0.971	10.650 0.970	10.700 0.969	10.750 0.970
10.800 0.971	10.850 0.971	10.900 0.971	10.950 0.971	11.000 0.972	11.050 0.972	11.100 0.973	11.150 0.974
11.200 0.974	11.250 0.975	11.300 0.975	11.350 0.975	11.400 0.976	11.450 0.976	11.500 0.976	11.550 0.977
11.600 0.977	11.650 0.979	11.700 0.980	11.750 0.980	11.800 0.980	11.850 0.980	11.900 0.980	11.950 0.980
12.000 0.981							



1640

[illegible] CALIB. [illegible] = -5.47 POINTS PER INCH = 0.0005 OHMS= 453.80
INITIAL REF. TEMPERATURE= 34.57 TARGET TEMPERATURE= 33.00
WAVELENGTH OF EMIT. MAX.= 7.65
TARGET TEMPERATURE (SPECTROMETER) = 31.29
EMITTANCES AT SPECIFIC WAVELENGTHS

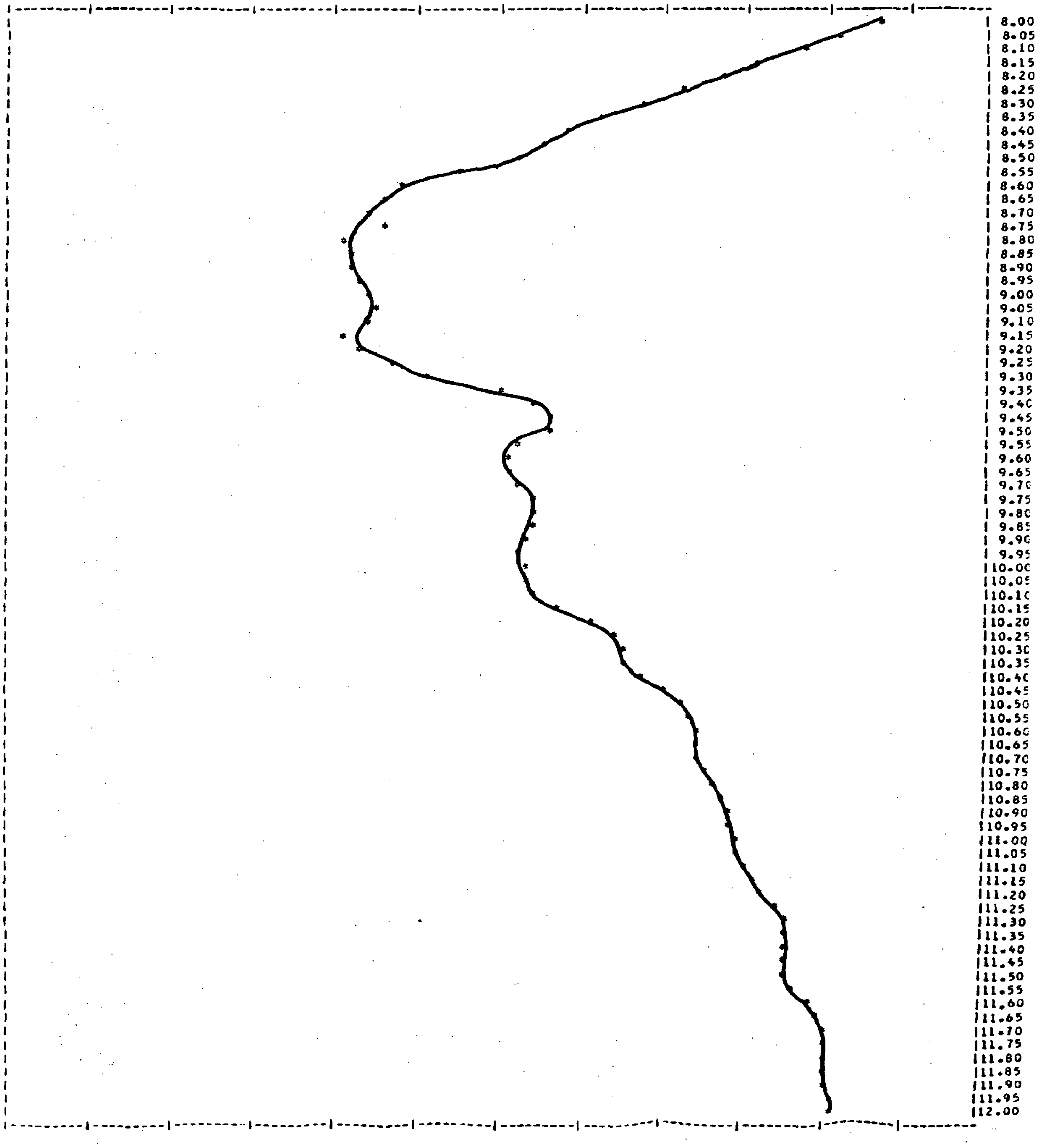
8.000 0.971	8.050 0.960	8.100 0.947	8.150 0.942	8.200 0.938	8.250 0.933	8.300 0.920	8.350 0.917
8.400 0.915	8.450 0.915	8.500 0.913	8.550 0.911	8.600 0.908	8.650 0.904	8.700 0.900	8.750 0.898
8.800 0.887	8.850 0.896	8.900 0.887	8.950 0.893	9.000 0.895	9.050 0.894	9.100 0.892	9.150 0.887
9.200 0.891	9.250 0.890	9.300 0.893	9.350 0.898	9.400 0.911	9.450 0.919	9.500 0.925	9.550 0.926
9.600 0.925	9.650 0.926	9.700 0.928	9.750 0.930	9.800 0.931	9.850 0.932	9.900 0.930	9.950 0.930
10.000 0.930	10.050 0.929	10.100 0.929	10.150 0.931	10.200 0.935	10.250 0.937	10.300 0.936	10.350 0.939
10.400 0.941	10.450 0.943	10.500 0.944	10.550 0.946	10.600 0.946	10.650 0.945	10.700 0.944	10.750 0.945
10.800 0.947	10.850 0.948	10.900 0.948	10.950 0.948	11.000 0.949	11.050 0.950	11.100 0.950	11.150 0.951
11.200 0.952	11.250 0.954	11.300 0.956	11.350 0.956	11.400 0.955	11.450 0.954	11.500 0.954	11.550 0.956
11.600 0.958	11.650 0.960	11.700 0.962	11.750 0.962	11.800 0.960	11.850 0.960	11.900 0.960	11.950 0.960
12.000 0.961							



1645

YC=-0.300 CALIB. DIST.=-5.03 VOLTS PER INCH= 0.0596 OHMS= 453.20
INTERNAL REF. TEMPERATURE= 34.30 TARGET TEMPERATURE= 33.50
WAVELENGTH OF EMIT. MAX.= 7.71
TARGET TEMPERATURE (SPECTROMETER) = 32.77
EMITTANCES AT SPECIFIC WAVELENGTHS

8.000	0.987	8.050	0.983	8.100	0.978	8.150	0.973	8.200	0.968	8.250	0.964	8.300	0.959	8.350	0.954
8.400	0.949	8.450	0.946	8.500	0.943	8.550	0.937	8.600	0.929	8.650	0.927	8.700	0.926	8.750	0.927
8.800	0.922	8.850	0.923	8.900	0.924	8.950	0.925	9.000	0.926	9.050	0.927	9.100	0.925	9.150	0.923
9.200	0.924	9.250	0.926	9.300	0.933	9.350	0.941	9.400	0.946	9.450	0.948	9.500	0.948	9.550	0.944
9.600	0.943	9.650	0.943	9.700	0.944	9.750	0.945	9.800	0.946	9.850	0.946	9.900	0.944	9.950	0.944
10.000	0.944	10.050	0.945	10.100	0.946	10.150	0.949	10.200	0.953	10.250	0.955	10.300	0.956	10.350	0.957
10.400	0.959	10.450	0.962	10.500	0.963	10.550	0.965	10.600	0.966	10.650	0.965	10.700	0.965	10.750	0.966
10.800	0.967	10.850	0.969	10.900	0.970	10.950	0.970	11.000	0.971	11.050	0.971	11.100	0.971	11.150	0.972
11.200	0.973	11.250	0.975	11.300	0.977	11.350	0.977	11.400	0.976	11.450	0.976	11.500	0.976	11.550	0.977
11.600	0.979	11.650	0.980	11.700	0.981	11.750	0.981	11.800	0.982	11.850	0.982	11.900	0.982	11.950	0.982
12.000	0.983														



D APPENDIX

APPENDIX TABLE D1

FILTER TRANSMISSION FUNCTIONS

Wavelength	Channels #17	#18	#19	#20	#21	V1	V2	V3
8.02	--	--	--	--	--	.06	.01	--
8.10	.02	--	--	--	--	.11	.01	--
8.18	.18	--	--	--	--	.18	.01	--
8.26	.41	--	--	--	--	.35	.02	--
8.32	.57	--	--	--	--	.43	.02	--
8.41	.78	--	--	--	--	.49	.02	--
8.48	.90	--	--	--	--	.53	.02	--
8.56	.99	.03	--	--	--	.62	.02	--
8.64	.90	.03	--	--	--	.69	.02	--
8.72	.65	.12	--	--	--	.72	.02	--
8.80	.37	.36	--	--	--	.76	.02	--
8.88	.15	.57	--	--	--	.77	.02	--
8.96	.05	.75	--	--	--	.78	.02	--
9.04	.01	.95	.01	--	--	.78	.02	--
9.13	--	.99	.02	--	--	.78	.03	--
9.20	--	.91	.05	--	--	.77	.03	--
9.27	--	.73	.17	.02	--	.77	.04	--
9.37	--	.42	.42	.03	--	.76	.07	--
9.45	--	.14	.68	.03	--	.74	.12	--
9.53	--	.03	.96	.04	--	.72	.15	--
9.65	--	--	.92	.04	--	.68	.20	--
9.69	--	--	.83	.05	--	.61	.26	--
9.77	--	--	.64	.06	--	.56	.32	--
9.86	--	--	.42	.11	--	.49	.40	--
9.96	--	--	.22	.22	--	.43	.47	--

APPENDIX TABLE D1 (cont'd)

FILTER TRANSMISSION FUNCTIONS

Wavelength	Channels #17	#18	#19	#20	#21	V1	V2	V3
10.01	--	--	.10	.41	--	.40	.52	--
10.10	--	--	--	.62	--	.37	.58	--
10.17	--	--	--	.83	--	.33	.64	--
10.25	--	--	--	.91	--	.30	.69	--
10.34	--	--	--	.97	--	.26	.75	--
10.42	--	--	--	.98	--	.23	.81	--
10.49	--	--	--	.98	--	.20	.82	--
10.58	--	--	--	.99	--	.17	.82	--
10.66	--	--	--	.92	--	.16	.79	--
10.74	--	--	--	.83	--	.13	.74	--
10.81	--	--	--	.74	.02	.11	.68	--
10.90	--	--	--	.66	.08	.09	.61	--
10.97	--	--	--	.45	.29	.07	.54	.01
11.07	--	--	--	.18	.59	.06	.48	.20
11.15	--	--	--	.05	.76	.05	.42	.30
11.22	--	--	--	--	.91	.04	.38	.60
11.30	--	--	--	--	.98	.04	.34	.14
11.38	--	--	--	--	.97	.04	.31	.24
11.44	--	--	--	--	.92	.04	.27	.38
11.52	--	--	--	--	.73	.03	.24	.60
11.60	--	--	--	--	.51	.03	.21	.74
11.68	--	--	--	--	.59	.03	.19	.68
11.75	--	--	--	--	.53	.03	.17	.65
11.83	--	--	--	--	.43	.02	.16	.64
11.89	--	--	--	--	.38	.02	.13	.65

APPENDIX TABLE D 1 (cont'd)

FILTER TRANSMISSION FUNCTIONS

Wavelength	Channels #17	#18	#19	#20	#21	V1	V2	V3
11.97	--	--	--	--	.26	.02	.12	.68
12.04	--	--	--	--	.15	.02	.11	.70
12.12	--	--	--	--	.07	--	--	.75
12.19	--	--	--	--	.15	--	--	.77
12.26	--	--	--	--	--	--	--	.74
12.33	--	--	--	--	--	--	--	.68
12.40	--	--	--	--	--	--	--	.65
12.47	--	--	--	--	--	--	--	.61
12.54	--	--	--	--	--	--	--	.57
12.60	--	--	--	--	--	--	--	.55
12.67	--	--	--	--	--	--	--	.50
12.74	--	--	--	--	--	--	--	.48
12.81	--	--	--	--	--	--	--	.44
12.89	--	--	--	--	--	--	--	.42
12.95	--	--	--	--	--	--	--	.40
13.02	--	--	--	--	--	--	--	.39
13.08	--	--	--	--	--	--	--	.37
13.15	--	--	--	--	--	--	--	.36
13.22	--	--	--	--	--	--	--	.35
13.28	--	--	--	--	--	--	--	.34

APPENDIX TABLE D2

This table contains the calculated System responses* for the MSDS and University of Michigan Scanners

	Channel 17	18	19	20	21	22	V1	V2	V3
GROUP 1									
AVERAGES	19.58	16.28	14.84	6.43	6.60	6.05	12.35	9.76	11.59
STD.DEVS.	0.09	0.07	0.06	0.03	0.04	0.04	0.06	0.04	0.06
% ERROR	0.44	0.41	0.39	0.47	0.64	0.74	0.50	0.39	0.55
GROUP 2									
AVERAGES	20.09	16.56	15.04	6.64	6.80	6.19	12.57	9.90	11.75
STD.DEVS.	0.11	0.07	0.06	0.05	0.05	0.04	0.06	0.05	0.06
% ERROR	0.55	0.45	0.42	0.68	0.68	0.73	0.50	0.46	0.52
GROUP 3									
AVERAGES	20.00	16.73	15.28	6.57	6.71	6.18	12.70	10.05	11.94
STD.DEVS.	0.11	0.11	0.09	0.06	0.04	0.06	0.09	0.07	0.07
% ERROR	0.57	0.65	0.59	0.86	0.56	0.91	0.72	0.73	0.60
GROUP 4									
AVERAGES	19.38	16.14	14.73	6.36	6.52	6.00	12.25	9.69	11.50
STD.DEVS.	0.08	0.06	0.07	0.04	0.04	0.03	0.06	0.04	0.07
% ERROR	0.41	0.39	0.46	0.62	0.57	0.57	0.48	0.46	0.57
GROUP 5									
AVERAGES	20.49	16.76	15.22	6.81	6.95	6.29	12.71	10.01	11.89
STD.DEVS.	0.22	0.17	0.13	0.09	0.08	0.07	0.14	0.09	0.10
% ERROR	1.09	1.03	0.83	1.33	1.09	1.07	1.12	0.93	0.87
GROUP 6									
AVERAGES	21.63	17.66	15.84	7.18	7.35	6.63	13.41	10.47	12.36
STD.DEVS.	0.48	0.38	0.37	0.21	0.18	0.15	0.29	0.27	0.29
% ERROR	2.24	2.15	2.34	2.87	2.49	2.19	2.13	2.58	2.33
GROUP 7									
AVERAGES	20.62	16.81	15.21	6.84	7.01	6.33	12.76	10.01	11.88
STD.DEVS.	0.34	0.38	0.39	0.10	0.11	0.11	0.30	0.25	0.31
% ERROR	1.66	2.27	2.54	1.50	1.51	1.73	2.34	2.47	2.64
GROUP 8									
AVERAGES	22.22	17.90	15.96	7.45	7.57	6.80	13.59	10.56	12.46
STD.DEVS.	1.63	1.20	0.77	0.54	0.57	0.52	0.94	0.60	0.57
% ERROR	7.31	6.73	4.82	7.25	7.54	7.60	6.91	5.69	4.54
GROUP 9									
AVERAGES	23.20	18.81	16.60	7.74	7.89	7.11	14.28	11.10	12.90
STD.DEVS.	0.80	0.48	0.34	0.27	0.32	0.25	0.35	0.26	0.25
% ERROR	3.44	2.56	2.05	3.43	4.08	3.52	2.46	2.35	1.97
GROUP 10									
AVERAGES	21.21	17.10	15.22	7.11	7.24	6.46	12.99	10.08	11.87
STD.DEVS.	0.79	0.57	0.46	0.27	0.28	0.26	0.44	0.29	0.38
% ERROR	3.71	3.33	3.05	3.86	3.89	4.09	3.42	2.93	3.23
GROUP 11									
AVERAGES	20.40	16.52	14.92	6.82	6.97	6.23	12.53	9.83	11.64
STD.DEVS.	0.54	0.39	0.20	0.18	0.18	0.21	0.30	0.18	0.15
% ERROR	2.65	2.35	1.35	2.62	2.60	3.30	2.37	1.85	1.33
GROUP 12									
AVERAGES	21.36	17.25	15.56	7.16	7.32	6.49	13.08	10.26	12.14
STD.DEVS.	0.35	0.22	0.29	0.15	0.13	0.10	0.16	0.16	0.24
% ERROR	1.63	1.25	1.87	2.11	1.81	1.47	1.23	1.58	1.99

* Watts cm^{-2} $ster^{-1}$ $X10^3$

APPENDIX TABLE D 2 (cont'd)

	17	18	19	20	21	22	V1	V2	V3
GROUP 13									
AVERAGES	20.29	16.40	14.79	6.78	6.92	6.20	12.45	9.72	11.57
STD.DEVS.	0.42	0.30	0.26	0.17	0.16	0.11	0.22	0.18	0.20
% ERROR	2.07	1.80	1.73	2.44	2.30	1.81	1.78	1.87	1.77
GROUP 14									
AVERAGES	21.29	17.19	15.52	7.15	7.26	6.48	13.05	10.21	12.13
STD.DEVS.	0.62	0.43	0.29	0.26	0.22	0.21	0.36	0.22	0.23
% ERROR	2.92	2.53	1.84	3.68	3.06	3.19	2.75	2.15	1.86
GROUP 15									
AVERAGES	20.48	16.59	14.96	6.86	6.98	6.24	12.60	9.84	11.69
STD.DEVS.	0.23	0.18	0.20	0.10	0.10	0.06	0.14	0.12	0.18
% ERROR	1.13	1.11	1.31	1.41	1.37	1.04	1.14	1.21	1.51
GROUP 16									
AVERAGES	20.22	16.32	14.80	6.76	6.89	6.19	12.37	9.71	11.58
STD.DEVS.	0.30	0.23	0.16	0.12	0.10	0.11	0.19	0.13	0.12
% ERROR	1.50	1.44	1.06	1.72	1.50	1.72	1.50	1.32	1.00
GROUP 17									
AVERAGES	21.33	17.23	15.50	7.16	7.28	6.49	13.08	10.22	12.11
STD.DEVS.	0.37	0.28	0.16	0.13	0.14	0.13	0.24	0.12	0.11
% ERROR	1.75	1.61	1.02	1.79	1.94	2.04	1.81	1.18	0.89
GROUP 18									
AVERAGES	20.12	16.38	14.87	6.72	6.86	6.14	12.42	9.77	11.63
STD.DEVS.	0.36	0.23	0.13	0.12	0.14	0.12	0.20	0.10	0.11
% ERROR	1.80	1.41	0.88	1.82	2.06	1.89	1.58	0.98	0.93
GROUP 19									
AVERAGES	20.60	16.65	15.08	6.90	7.03	6.28	12.63	9.91	11.79
STD.DEVS.	0.39	0.26	0.22	0.13	0.15	0.14	0.20	0.15	0.17
% ERROR	1.89	1.59	1.49	1.90	2.12	2.15	1.61	1.51	1.47
GROUP 20									
AVERAGES	20.06	16.31	14.77	6.69	6.84	6.12	12.37	9.71	11.55
STD.DEVS.	0.26	0.20	0.15	0.10	0.09	0.08	0.16	0.10	0.12
% ERROR	1.28	1.23	1.00	1.45	1.34	1.35	1.31	1.07	1.00
GROUP 21									
AVERAGES	20.54	16.59	15.00	6.90	7.01	6.24	12.60	9.85	11.73
STD.DEVS.	0.29	0.25	0.17	0.10	0.10	0.11	0.20	0.14	0.14
% ERROR	1.43	1.50	1.15	1.50	1.49	1.76	1.58	1.39	1.17
GROUP 22									
AVERAGES	19.92	16.41	14.92	6.57	6.75	6.13	12.45	9.82	11.66
STD.DEVS.	0.11	0.07	0.07	0.05	0.05	0.05	0.05	0.05	0.06
% ERROR	0.54	0.44	0.47	0.74	0.75	0.84	0.40	0.53	0.54
GROUP 23									
AVERAGES	20.32	16.47	14.95	6.78	6.94	6.21	12.48	9.81	11.70
STD.DEVS.	0.26	0.19	0.16	0.08	0.10	0.09	0.15	0.12	0.11
% ERROR	1.28	1.18	1.05	1.13	1.50	1.53	1.20	1.22	0.98
GROUP 24									
AVERAGES	19.50	15.91	14.54	6.51	6.65	5.94	12.07	9.52	11.38
STD.DEVS.	0.30	0.21	0.14	0.13	0.12	0.09	0.18	0.09	0.12
% ERROR	1.52	1.29	0.95	1.96	1.73	1.47	1.46	0.96	1.04

APPENDIX TABLE D 2 (cont'd)

	17	18	19	20	21	22	V1	V2	V3
GROUP 13									
AVERAGES	20.29	16.40	14.79	6.78	6.92	6.20	12.45	9.72	11.57
STD.DEVS.	0.42	0.30	0.26	0.17	0.16	0.11	0.22	0.18	0.20
% ERROR	2.07	1.80	1.73	2.44	2.30	1.81	1.78	1.87	1.77
GROUP 14									
AVERAGES	21.29	17.19	15.52	7.15	7.26	6.48	13.05	10.21	12.13
STD.DEVS.	0.62	0.43	0.29	0.26	0.22	0.21	0.36	0.22	0.23
% ERROR	2.92	2.53	1.84	3.68	3.06	3.19	2.75	2.15	1.86
GROUP 15									
AVERAGES	20.48	16.59	14.96	6.86	6.98	6.24	12.60	9.84	11.69
STD.DEVS.	0.23	0.18	0.20	0.10	0.10	0.06	0.14	0.12	0.18
% ERROR	1.13	1.11	1.31	1.41	1.37	1.04	1.14	1.21	1.51
GROUP 16									
AVERAGES	20.22	16.32	14.80	6.76	6.89	6.19	12.37	9.71	11.58
STD.DEVS.	0.30	0.23	0.16	0.12	0.10	0.11	0.19	0.13	0.12
% ERROR	1.50	1.44	1.06	1.72	1.50	1.72	1.50	1.32	1.00
GROUP 17									
AVERAGES	21.33	17.23	15.50	7.16	7.28	6.49	13.08	10.22	12.11
STD.DEVS.	0.37	0.28	0.16	0.13	0.14	0.13	0.24	0.12	0.11
% ERROR	1.75	1.61	1.02	1.79	1.94	2.04	1.81	1.18	0.89
GROUP 18									
AVERAGES	20.12	16.38	14.87	6.72	6.86	6.14	12.42	9.77	11.63
STD.DEVS.	0.36	0.23	0.13	0.12	0.14	0.12	0.20	0.10	0.11
% ERROR	1.80	1.41	0.88	1.82	2.06	1.89	1.58	0.98	0.93
GROUP 19									
AVERAGES	20.60	16.65	15.08	6.90	7.03	6.28	12.63	9.91	11.79
STD.DEVS.	0.39	0.26	0.22	0.13	0.15	0.14	0.20	0.15	0.17
% ERROR	1.89	1.59	1.49	1.90	2.12	2.15	1.61	1.51	1.47
GROUP 20									
AVERAGES	20.06	16.31	14.77	6.69	6.84	6.12	12.37	9.71	11.55
STD.DEVS.	0.26	0.20	0.15	0.10	0.09	0.08	0.16	0.10	0.12
% ERROR	1.28	1.23	1.00	1.45	1.34	1.35	1.31	1.07	1.00
GROUP 21									
AVERAGES	20.54	16.59	15.00	6.90	7.01	6.24	12.60	9.85	11.73
STD.DEVS.	0.29	0.25	0.17	0.10	0.10	0.11	0.20	0.14	0.14
% ERROR	1.43	1.50	1.15	1.50	1.49	1.76	1.58	1.39	1.17
GROUP 22									
AVERAGES	19.92	16.41	14.92	6.57	6.75	6.13	12.45	9.82	11.66
STD.DEVS.	0.11	0.07	0.07	0.05	0.05	0.05	0.05	0.05	0.06
% ERROR	0.54	0.44	0.47	0.74	0.75	0.84	0.40	0.53	0.54
GROUP 23									
AVERAGES	20.32	16.47	14.95	6.78	6.94	6.21	12.48	9.81	11.70
STD.DEVS.	0.26	0.19	0.16	0.08	0.10	0.09	0.15	0.12	0.11
% ERROR	1.28	1.18	1.05	1.13	1.50	1.53	1.20	1.22	0.98
GROUP 24									
AVERAGES	19.50	15.91	14.54	6.51	6.65	5.94	12.07	9.52	11.38
STD.DEVS.	0.30	0.21	0.14	0.13	0.12	0.09	0.18	0.09	0.12
% ERROR	1.52	1.29	0.95	1.96	1.73	1.47	1.46	0.96	1.04

APPENDIX TABLE D 2 (cont'd)

	17	18	19	20	21	22	V1	V2	V3
GROUP 13									
AVERAGES	20.29	16.40	14.79	6.78	6.92	6.20	12.45	9.72	11.57
STD.DEVS.	0.42	0.30	0.26	0.17	0.16	0.11	0.22	0.18	0.20
% ERROR	2.07	1.80	1.73	2.44	2.30	1.81	1.78	1.87	1.77
GROUP 14									
AVERAGES	21.29	17.19	15.52	7.15	7.26	6.48	13.05	10.21	12.13
STD.DEVS.	0.62	0.43	0.29	0.26	0.22	0.21	0.36	0.22	0.23
% ERROR	2.92	2.53	1.84	3.68	3.06	3.19	2.75	2.15	1.86
GROUP 15									
AVERAGES	20.48	16.59	14.96	6.86	6.98	6.24	12.60	9.84	11.69
STD.DEVS.	0.23	0.18	0.20	0.10	0.10	0.06	0.14	0.12	0.18
% ERROR	1.13	1.11	1.31	1.41	1.37	1.04	1.14	1.21	1.51
GROUP 16									
AVERAGES	20.22	16.32	14.80	6.76	6.89	6.19	12.37	9.71	11.58
STD.DEVS.	0.30	0.23	0.16	0.12	0.10	0.11	0.19	0.13	0.12
% ERROR	1.50	1.44	1.06	1.72	1.50	1.72	1.50	1.32	1.00
GROUP 17									
AVERAGES	21.33	17.23	15.50	7.16	7.28	6.49	13.08	10.22	12.11
STD.DEVS.	0.37	0.28	0.16	0.13	0.14	0.13	0.24	0.12	0.11
% ERROR	1.75	1.61	1.02	1.79	1.94	2.04	1.81	1.18	0.89
GROUP 18									
AVERAGES	20.12	16.38	14.87	6.72	6.86	6.14	12.42	9.77	11.63
STD.DEVS.	0.36	0.23	0.13	0.12	0.14	0.12	0.20	0.10	0.11
% ERROR	1.80	1.41	0.88	1.82	2.06	1.89	1.58	0.98	0.93
GROUP 19									
AVERAGES	20.60	16.65	15.08	6.90	7.03	6.28	12.63	9.91	11.79
STD.DEVS.	0.39	0.26	0.22	0.13	0.15	0.14	0.20	0.15	0.17
% ERROR	1.89	1.59	1.49	1.90	2.12	2.15	1.61	1.51	1.47
GROUP 20									
AVERAGES	20.06	16.31	14.77	6.69	6.84	6.12	12.37	9.71	11.55
STD.DEVS.	0.26	0.20	0.15	0.10	0.09	0.08	0.16	0.10	0.12
% ERROR	1.28	1.23	1.00	1.45	1.34	1.35	1.31	1.07	1.00
GROUP 21									
AVERAGES	20.54	16.59	15.00	6.90	7.01	6.24	12.60	9.85	11.73
STD.DEVS.	0.29	0.25	0.17	0.10	0.10	0.11	0.20	0.14	0.14
% ERROR	1.43	1.50	1.15	1.50	1.49	1.76	1.58	1.39	1.17
GROUP 22									
AVERAGES	19.92	16.41	14.92	6.57	6.75	6.13	12.45	9.82	11.66
STD.DEVS.	0.11	0.07	0.07	0.05	0.05	0.05	0.05	0.05	0.06
% ERROR	0.54	0.44	0.47	0.74	0.75	0.84	0.40	0.53	0.54
GROUP 23									
AVERAGES	20.32	16.47	14.95	6.78	6.94	6.21	12.48	9.81	11.70
STD.DEVS.	0.26	0.19	0.16	0.08	0.10	0.09	0.15	0.12	0.11
% ERROR	1.28	1.18	1.05	1.13	1.50	1.53	1.20	1.22	0.98
GROUP 24									
AVERAGES	19.50	15.91	14.54	6.51	6.65	5.94	12.07	9.52	11.38
STD.DEVS.	0.30	0.21	0.14	0.13	0.12	0.09	0.18	0.09	0.12
% ERROR	1.52	1.29	0.95	1.96	1.73	1.47	1.46	0.96	1.04

APPENDIX TABLE D2 (cont'd)

	17	18	19	20	21	22	V1	V2	V3
GROUP 25									
AVERAGES	20.38	16.53	14.96	6.81	6.96	6.20	12.54	9.83	11.70
STD.DEVS.	0.48	0.35	0.22	0.17	0.18	0.14	0.29	0.19	0.17
% ERROR	2.37	2.14	1.48	2.51	2.66	2.25	2.29	1.96	1.43
GROUP 26									
AVERAGES	20.41	16.55	15.01	6.80	6.97	6.24	12.55	9.85	11.74
STD.DEVS.	0.22	0.15	0.13	0.09	0.09	0.06	0.13	0.08	0.12
% ERROR	1.06	0.92	0.87	1.37	1.25	0.98	1.01	0.83	0.98
GROUP 27									
AVERAGES	19.76	16.11	14.67	6.58	6.74	6.03	12.21	9.63	11.48
STD.DEVS.	0.19	0.15	0.09	0.09	0.08	0.13	0.12	0.06	0.07
% ERROR	0.98	0.91	0.58	1.36	1.13	2.12	0.96	0.67	0.59
GROUP 28									
AVERAGES	19.95	16.28	14.82	6.70	6.80	6.04	12.35	9.74	11.59
STD.DEVS.	0.22	0.14	0.10	0.07	0.10	0.14	0.11	0.06	0.09
% ERROR	1.12	0.86	0.69	1.00	1.41	2.31	0.86	0.67	0.74
GROUP 29									
AVERAGES	20.04	16.34	14.80	6.65	6.83	6.14	12.40	9.73	11.57
STD.DEVS.	0.22	0.19	0.18	0.08	0.08	0.09	0.15	0.10	0.16
% ERROR	1.08	1.13	1.22	1.27	1.18	1.41	1.24	1.07	1.39
GROUP 30									
AVERAGES	20.64	16.94	15.36	6.86	7.00	6.33	12.85	10.12	12.00
STD.DEVS.	0.08	0.06	0.05	0.05	0.04	0.04	0.06	0.05	0.06
% ERROR	0.37	0.35	0.35	0.66	0.57	0.66	0.46	0.50	0.48
GROUP 31									
AVERAGES	20.65	16.93	15.34	6.86	7.00	6.33	12.84	10.11	11.98
STD.DEVS.	0.13	0.09	0.09	0.05	0.06	0.04	0.08	0.06	0.08
% ERROR	0.62	0.52	0.58	0.79	0.81	0.67	0.62	0.63	0.65
GROUP 40									
AVERAGES	21.33	17.23	15.48	7.13	7.29	6.51	13.07	10.21	12.09
STD.DEVS.	0.43	0.32	0.31	0.16	0.16	0.12	0.25	0.20	0.25
% ERROR	2.02	1.87	1.98	2.24	2.15	1.88	1.93	2.00	2.05
GROUP 41									
AVERAGES	21.22	17.17	15.46	7.08	7.25	6.49	13.03	10.18	12.08
STD.DEVS.	0.48	0.33	0.29	0.19	0.17	0.13	0.26	0.19	0.23
% ERROR	2.24	1.94	1.87	2.70	2.38	2.06	1.98	1.88	1.90
GROUP 42									
AVERAGES	20.49	16.57	14.99	6.87	7.01	6.25	12.57	9.85	11.73
STD.DEVS.	0.51	0.40	0.34	0.19	0.17	0.16	0.30	0.24	0.26
% ERROR	2.50	2.41	2.29	2.73	2.48	2.57	2.42	2.43	2.25
GROUP 43									
AVERAGES	22.06	17.70	15.82	7.40	7.53	6.74	13.44	10.43	12.36
STD.DEVS.	0.66	0.53	0.40	0.24	0.22	0.21	0.42	0.28	0.31
% ERROR	2.99	2.99	2.53	3.24	2.89	3.13	3.15	2.67	2.49
GROUP 44									
AVERAGES	20.84	16.77	15.06	6.96	7.13	6.39	12.72	9.93	11.76
STD.DEVS.	0.33	0.27	0.20	0.11	0.08	0.14	0.20	0.16	0.14
% ERROR	1.56	1.61	1.33	1.59	1.18	2.14	1.56	1.64	1.17

APPENDIX TABLE D2 (cont'd)

	17	18	19	20	21	22	V1	V2	V3
GROUP 45									
AVERAGES	20.51	16.53	15.12	6.83	7.01	6.29	12.51	9.87	11.86
STD.DEVS.	0.58	0.39	0.46	0.30	0.23	0.17	0.32	0.25	0.38
% ERROR	2.83	2.38	3.03	4.39	3.31	2.71	2.56	2.50	3.25
GROUP 46									
AVERAGES	21.38	17.21	15.52	7.12	7.31	6.56	13.05	10.18	12.14
STD.DEVS.	0.64	0.45	0.39	0.31	0.23	0.16	0.35	0.28	0.32
% ERROR	3.00	2.63	2.52	4.35	3.09	2.47	2.69	2.77	2.61
GROUP 50									
AVERAGES	21.28	17.19	15.18	7.09	7.10	6.68	13.03	9.99	11.81
STD.DEVS.	0.08	0.14	0.22	0.03	0.03	0.05	0.09	0.14	0.20
% ERROR	0.38	0.79	1.47	0.39	0.48	0.75	0.72	1.37	1.69
GROUP 51									
AVERAGES	21.66	17.41	15.39	7.21	7.35	6.77	13.21	10.17	11.95
STD.DEVS.	0.22	0.18	0.59	0.10	0.08	0.03	0.16	0.07	0.64
% ERROR	1.01	1.01	3.86	1.37	1.06	0.42	1.23	0.70	5.38
GROUP 52									
AVERAGES	21.48	17.49	15.75	7.06	7.24	6.78	13.28	10.24	12.32
STD.DEVS.	0.02	0.01	0.02	0.03	0.02	0.03	0.03	0.04	0.04
% ERROR	0.10	0.06	0.12	0.44	0.32	0.49	0.24	0.40	0.31
GROUP 53									
AVERAGES	17.50	14.38	13.19	5.75	5.96	5.41	10.89	8.62	10.33
STD.DEVS.	0.05	0.03	0.02	0.03	0.03	0.03	0.04	0.04	0.05
% ERROR	0.30	0.23	0.15	0.51	0.52	0.52	0.39	0.46	0.49
GROUP 54									
AVERAGES	20.22	16.44	14.89	6.75	6.89	6.18	12.47	9.78	11.64
STD.DEVS.	0.37	0.28	0.22	0.14	0.14	0.12	0.22	0.16	0.17
% ERROR	1.84	1.68	1.49	2.03	2.06	2.00	1.76	1.69	1.50

APPENDIX TABLE D 3

This table contains the ratios which can be formed from the system responses of the University of Michigan System

GROUP 1			
AVERAGES	1.2031	1.3196	1.0968
STD.DEVS.	0.0044	0.0058	0.0042
% ERROR	0.36	0.44	0.38
GROUP 2			
AVERAGES	1.2131	1.3355	1.1010
STD.DEVS.	0.0041	0.0075	0.0046
% ERROR	0.34	0.56	0.42
GROUP 3			
AVERAGES	1.1954	1.3085	1.0946
STD.DEVS.	0.0036	0.0078	0.0055
% ERROR	0.30	0.60	0.50
GROUP 4			
AVERAGES	1.2005	1.3158	1.0959
STD.DEVS.	0.0041	0.0062	0.0037
% ERROR	0.34	0.47	0.34
GROUP 5			
AVERAGES	1.2221	1.3459	1.1012
STD.DEVS.	0.0054	0.0093	0.0058
% ERROR	0.44	0.69	0.52
GROUP 6			
AVERAGES	1.2249	1.3658	1.1149
STD.DEVS.	0.0206	0.0336	0.0132
% ERROR	1.68	2.46	1.19
GROUP 7			
AVERAGES	1.2262	1.3556	1.1055
STD.DEVS.	0.0098	0.0174	0.0086
% ERROR	0.80	1.29	0.78
GROUP 8			
AVERAGES	1.2406	1.3907	1.1209
STD.DEVS.	0.0122	0.0419	0.0248
% ERROR	0.99	3.01	2.21
GROUP 9			
AVERAGES	1.2334	1.3971	1.1326
STD.DEVS.	0.0109	0.0234	0.0106
% ERROR	0.88	1.67	0.93
GROUP 10			
AVERAGES	1.2403	1.3933	1.1233
STD.DEVS.	0.0171	0.0419	0.0280
% ERROR	1.38	3.00	2.49
GROUP 11			
AVERAGES	1.2344	1.3671	1.1074
STD.DEVS.	0.0065	0.0270	0.0182
% ERROR	0.52	1.97	1.65
GROUP 12			
AVERAGES	1.2382	1.3733	1.1091
STD.DEVS.	0.0103	0.0126	0.0113
% ERROR	0.84	0.92	1.02
GROUP 13			
AVERAGES	1.2369	1.3716	1.1088
STD.DEVS.	0.0046	0.0109	0.0068
% ERROR	0.37	0.80	0.61
GROUP 14			
AVERAGES	1.2384	1.3724	1.1081
STD.DEVS.	0.0237	0.0452	0.0239
% ERROR	1.91	3.29	2.15
GROUP 15			
AVERAGES	1.2340	1.3687	1.1092
STD.DEVS.	0.0068	0.0100	0.0046
% ERROR	0.55	0.73	0.42
GROUP 16			
AVERAGES	1.2384	1.3656	1.1027
STD.DEVS.	0.0072	0.0133	0.0083
% ERROR	0.58	0.98	0.75
GROUP 17			
AVERAGES	1.2381	1.3759	1.1113
STD.DEVS.	0.0096	0.0154	0.0127
% ERROR	0.78	1.12	1.15
GROUP 18			
AVERAGES	1.2284	1.3524	1.1009
STD.DEVS.	0.0085	0.0170	0.0112
% ERROR	0.69	1.25	1.02
GROUP 19			
AVERAGES	1.2371	1.3660	1.1041
STD.DEVS.	0.0116	0.0231	0.0108
% ERROR	0.93	1.69	0.98
GROUP 20			
AVERAGES	1.2296	1.3577	1.1041
STD.DEVS.	0.0064	0.0115	0.0072
% ERROR	0.52	0.85	0.66
GROUP 21			
AVERAGES	1.2377	1.3693	1.1064
STD.DEVS.	0.0069	0.0149	0.0115
% ERROR	0.56	1.09	1.04
GROUP 22			
AVERAGES	1.2136	1.3346	1.0996
STD.DEVS.	0.0042	0.0080	0.0043
% ERROR	0.35	0.60	0.39
GROUP 23			
AVERAGES	1.2341	1.3591	1.1013
STD.DEVS.	0.0056	0.0085	0.0040
% ERROR	0.46	0.62	0.37
GROUP 24			
AVERAGES	1.2252	1.3411	1.0945
STD.DEVS.	0.0100	0.0144	0.0085
% ERROR	0.81	1.07	0.78
GROUP 25			
AVERAGES	1.2331	1.3618	1.1042
STD.DEVS.	0.0103	0.0199	0.0099
% ERROR	0.84	1.46	0.89
GROUP 26			
AVERAGES	1.2333	1.3596	1.1024
STD.DEVS.	0.0041	0.0107	0.0067
% ERROR	0.33	0.79	0.61
GROUP 27			
AVERAGES	1.2265	1.3466	1.0979
STD.DEVS.	0.0053	0.0129	0.0087
% ERROR	0.43	0.96	0.79
GROUP 28			
AVERAGES	1.2256	1.3461	1.0983
STD.DEVS.	0.0057	0.0148	0.0084
% ERROR	0.47	1.10	0.76
GROUP 29			
AVERAGES	1.2261	1.3541	1.1043
STD.DEVS.	0.0056	0.0119	0.0075
% ERROR	0.46	0.88	0.68
GROUP 30			
AVERAGES	1.2189	1.3440	1.1026
STD.DEVS.	0.0045	0.0061	0.0040
% ERROR	0.37	0.46	0.36
GROUP 31			
AVERAGES	1.2199	1.3459	1.1032
STD.DEVS.	0.0055	0.0108	0.0056
% ERROR	0.45	0.80	0.51
GROUP 40			
AVERAGES	1.2382	1.3776	1.1126
STD.DEVS.	0.0077	0.0188	0.0101
% ERROR	0.62	1.36	0.91
GROUP 41			
AVERAGES	1.2361	1.3731	1.1108
STD.DEVS.	0.0108	0.0202	0.0086
% ERROR	0.87	1.47	0.78
GROUP 42			
AVERAGES	1.2368	1.3668	1.1051
STD.DEVS.	0.0092	0.0178	0.0090
% ERROR	0.75	1.30	0.82
GROUP 43			
AVERAGES	1.2460	1.3941	1.1188
STD.DEVS.	0.0100	0.0214	0.0142
% ERROR	0.81	1.53	1.27
GROUP 44			
AVERAGES	1.2425	1.3833	1.1133
STD.DEVS.	0.0026	0.0147	0.0101
% ERROR	0.21	1.06	0.90
GROUP 45			
AVERAGES	1.2409	1.3582	1.0942
STD.DEVS.	0.0311	0.0697	0.0380
% ERROR	2.51	5.13	3.48
GROUP 46			
AVERAGES	1.2422	1.3774	1.1089
STD.DEVS.	0.0206	0.0186	0.0067
% ERROR	1.66	1.35	0.60
GROUP 53			
AVERAGES	1.2171	1.3272	[illegible]
STD.DEVS.	[illegible]	[illegible]	[illegible]
% ERROR	[illegible]	[illegible]	[illegible]
GROUP 54			
AVERAGES	[illegible]	1.3578	[illegible]
STD.DEVS.	[illegible]	[illegible]	[illegible]
% ERROR	[illegible]	1.77	[illegible]

APPENDIX TABLE D4

This table contains the ratios which can be formed with the system responses of the MSDS System as given in Table

	17/18	17/19	17/20	17/21	17/22	18/19	18/20	18/21	18/22	19/20	19/21	19/22	20/21	20/22	21/22
GROUP 1															
AVERAGES	0.9744	1.0632	0.5208	0.6590	0.5549	1.0911	0.5345	0.6764	0.5695	0.4899	0.6199	0.5219	1.2654	1.0654	0.8419
STD.DEVS.	0.0072	0.0113	0.0030	0.0041	0.0027	0.0078	0.0035	0.0039	0.0039	0.0037	0.0043	0.0054	0.0046	0.0060	0.0046
% ERROR	0.74	1.06	0.58	0.63	0.48	0.72	0.65	0.58	0.69	0.75	0.69	1.04	0.37	0.56	0.54
GROUP 2															
AVERAGES	0.9770	1.0735	0.5284	0.6705	0.5651	1.0988	0.5408	0.6863	0.5784	0.4922	0.6246	0.5264	1.2690	1.0695	0.8428
STD.DEVS.	0.0067	0.0092	0.0023	0.0051	0.0041	0.0073	0.0031	0.0043	0.0041	0.0031	0.0042	0.0048	0.0057	0.0054	0.0038
% ERROR	0.69	0.86	0.43	0.76	0.72	0.66	0.58	0.63	0.72	0.64	0.67	0.91	0.45	0.50	0.45
GROUP 3															
AVERAGES	0.9799	1.0642	0.5177	0.6540	0.5506	1.0860	0.5283	0.6674	0.5620	0.4865	0.6145	0.5175	1.2632	1.0637	0.8420
STD.DEVS.	0.0089	0.0128	0.0039	0.0071	0.0062	0.0082	0.0039	0.0038	0.0042	0.0037	0.0041	0.0044	0.0083	0.0076	0.0044
% ERROR	0.91	1.20	0.75	1.09	1.12	0.75	0.74	0.58	0.74	0.77	0.67	0.86	0.66	0.71	0.52
GROUP 4															
AVERAGES	0.9756	1.0596	0.5193	0.6561	0.5528	1.0861	0.5323	0.6725	0.5667	0.4901	0.6192	0.5217	1.2633	1.0645	0.8426
STD.DEVS.	0.0072	0.0094	0.0024	0.0046	0.0033	0.0076	0.0036	0.0038	0.0040	0.0035	0.0034	0.0047	0.0065	0.0048	0.0048
% ERROR	0.73	0.89	0.46	0.69	0.60	0.70	0.68	0.57	0.70	0.71	0.56	0.91	0.52	0.45	0.56
GROUP 5															
AVERAGES	0.9793	1.0826	0.5356	0.6799	0.5725	1.1055	0.5470	0.6943	0.5846	0.4948	0.6280	0.5288	1.2693	1.0687	0.8420
STD.DEVS.	0.0078	0.0092	0.0043	0.0074	0.0063	0.0064	0.0034	0.0049	0.0047	0.0033	0.0043	0.0046	0.0068	0.0072	0.0040
% ERROR	0.80	0.85	0.81	1.09	1.10	0.57	0.62	0.71	0.80	0.67	0.69	0.87	0.54	0.67	0.48
GROUP 6															
AVERAGES	0.9766	1.0919	0.5354	0.6857	0.5812	1.1078	0.5482	0.7021	0.5951	0.4948	0.6337	0.5372	1.2805	1.0855	0.8477
STD.DEVS.	0.0114	0.0198	0.0148	0.0237	0.0194	0.0096	0.0122	0.0204	0.0177	0.0079	0.0145	0.0134	0.0119	0.0160	0.0108
% ERROR	1.17	1.83	2.76	3.45	3.34	0.86	2.22	2.91	2.97	1.58	2.31	2.49	0.93	1.47	1.28
GROUP 7															
AVERAGES	0.9749	1.0811	0.5362	0.6831	0.5757	1.1089	0.5500	0.7007	0.5906	0.4960	0.6319	0.5325	1.2739	1.0736	0.8428
STD.DEVS.	0.0078	0.0122	0.0072	0.0112	0.0090	0.0067	0.0065	0.0108	0.0098	0.0046	0.0072	0.0076	0.0081	0.0091	0.0056
% ERROR	0.80	1.13	1.34	1.64	1.56	0.60	1.18	1.54	1.66	0.93	1.14	1.42	0.64	0.85	0.66
GROUP 8															
AVERAGES	0.9846	1.0962	0.5480	0.7050	0.5976	1.1133	0.5566	0.7161	0.6070	0.5000	0.6433	0.5453	1.2864	1.0903	0.8475
STD.DEVS.	0.0085	0.0104	0.0033	0.0138	0.0193	0.0045	0.0076	0.0181	0.0221	0.0075	0.0173	0.0209	0.0182	0.0301	0.0128
% ERROR	0.86	0.95	0.60	1.95	3.23	0.40	1.36	2.53	3.64	1.51	2.69	3.83	1.41	2.76	1.51
GROUP 9															
AVERAGES	0.9807	1.0882	0.5416	0.6967	0.5998	1.1096	0.5523	0.7104	0.6117	0.4977	0.6403	0.5513	1.2864	1.1075	0.8610
STD.DEVS.	0.0090	0.0126	0.0056	0.0080	0.0111	0.0094	0.0091	0.0124	0.0165	0.0062	0.0083	0.0140	0.0014	0.0145	0.0111
% ERROR	0.91	1.16	1.04	1.15	1.85	0.85	1.64	1.75	2.70	1.25	1.30	2.53	0.11	1.31	1.29
GROUP 10															
AVERAGES	0.9822	1.1023	0.5476	0.7062	0.5996	1.1223	0.5575	0.7190	0.6106	0.4968	0.6407	0.5441	1.2896	1.0952	0.8491
STD.DEVS.	0.0156	0.0237	0.0139	0.0203	0.0214	0.0115	0.0108	0.0183	0.0226	0.0073	0.0151	0.0208	0.0188	0.0353	0.0171
% ERROR	1.58	2.15	2.54	2.87	3.56	1.02	1.94	2.54	3.70	1.46	2.36	3.82	1.46	3.22	2.02
GROUP 11															
AVERAGES	0.9781	1.0940	0.5440	0.6931	0.5853	1.1185	0.5562	0.7086	0.5984	0.4974	0.6337	0.5352	1.2740	1.0758	0.8444
STD.DEVS.	0.0073	0.0158	0.0044	0.0075	0.0138	0.0143	0.0049	0.0080	0.0148	0.0069	0.0115	0.0180	0.0099	0.0237	0.0133
% ERROR	0.75	1.44	0.82	1.08	2.36	1.28	0.88	1.13	2.48	1.40	1.81	3.37	0.78	2.21	1.58
GROUP 12															
AVERAGES	0.9779	1.1038	0.5473	0.6976	0.5900	1.1286	0.5596	0.7134	0.6033	0.4958	0.6320	0.5345	1.2748	1.0782	0.8457
STD.DEVS.	0.0058	0.0090	0.0077	0.0076	0.0064	0.0057	0.0078	0.0087	0.0082	0.0052	0.0058	0.0064	0.0107	0.0153	0.0082
% ERROR	0.59	0.91	1.40	1.09	1.00	0.50	1.39	1.22	1.36	1.06	0.92	1.20	0.84	1.42	0.97

APPENDIX TABLE D4 (cont'd)

	17/18	17/19	17/20	17/21	17/22	18/19	18/20	18/21	18/22	19/20	19/21	19/22	20/21	20/22	21/22
GROUP 13															
AVERAGES	0.9798	1.0932	0.5447	0.6976	0.5862	1.1158	0.5560	0.7121	0.5983	0.4983	0.6382	0.5362	1.2808	1.0761	0.8402
STD.DEVS.	0.0086	0.0129	0.0042	0.0077	0.0064	0.0086	0.0042	0.0063	0.0056	0.0034	0.0063	0.0057	0.0091	0.0083	0.0044
% ERROR	0.87	1.18	0.76	1.10	1.09	0.77	0.75	0.88	0.93	0.67	0.99	1.06	0.71	0.77	0.53
GROUP 14															
AVERAGES	0.9847	1.1034	0.5483	0.7010	0.5897	1.1204	0.5567	0.7118	0.5988	0.4969	0.6353	0.5345	1.2783	1.0756	0.8413
STD.DEVS.	0.0151	0.0289	0.0188	0.0291	0.0251	0.0151	0.0134	0.0239	0.0221	0.0080	0.0184	0.0189	0.0220	0.0285	0.0125
% ERROR	1.54	2.62	3.44	4.16	4.25	1.35	2.41	3.34	3.69	1.62	2.89	3.54	1.72	2.65	1.48
GROUP 15															
AVERAGES	0.9830	1.0989	0.5443	0.6970	0.5866	1.1179	0.5537	0.7090	0.5966	0.4953	0.6342	0.5338	1.2805	1.0776	0.8416
STD.DEVS.	0.0090	0.0115	0.0063	0.0101	0.0086	0.0061	0.0045	0.0056	0.0050	0.0030	0.0044	0.0048	0.0065	0.0068	0.0041
% ERROR	0.92	1.05	1.16	1.46	1.47	0.55	0.81	0.79	0.84	0.60	0.69	0.90	0.51	0.63	0.49
GROUP 16															
AVERAGES	0.9798	1.0917	0.5461	0.6958	0.5836	1.1141	0.5574	0.7101	0.5956	0.5003	0.6374	0.5347	1.2739	1.0686	0.8388
STD.DEVS.	0.0082	0.0152	0.0047	0.0095	0.0067	0.0101	0.0059	0.0091	0.0065	0.0050	0.0063	0.0076	0.0086	0.0110	0.0075
% ERROR	0.83	1.39	0.87	1.37	1.15	0.91	1.06	1.28	1.09	0.99	0.99	1.43	0.67	1.03	0.90
GROUP 17															
AVERAGES	0.9833	1.1032	0.5475	0.7004	0.5914	1.1219	0.5568	0.7124	0.6015	0.4953	0.6350	0.5361	1.2794	1.0803	0.8443
STD.DEVS.	0.0097	0.0161	0.0066	0.0079	0.0079	0.0072	0.0076	0.0085	0.0084	0.0073	0.0090	0.0085	0.0138	0.0164	0.0053
% ERROR	0.98	1.46	1.20	1.13	1.34	0.64	1.36	1.20	1.40	1.47	1.42	1.59	1.08	1.51	0.63
GROUP 18															
AVERAGES	0.9807	1.0957	0.5412	0.6882	0.5782	1.1173	0.5519	0.7018	0.5896	0.4940	0.6281	0.5277	1.2715	1.0683	0.8402
STD.DEVS.	0.0039	0.0069	0.0051	0.0085	0.0074	0.0057	0.0063	0.0098	0.0095	0.0053	0.0068	0.0066	0.0138	0.0140	0.0052
% ERROR	0.40	0.63	0.94	1.23	1.28	0.51	1.14	1.39	1.44	1.06	1.08	1.26	1.09	1.31	0.61
GROUP 19															
AVERAGES	0.9824	1.0996	0.5465	0.6968	0.5855	1.1182	0.5563	0.7093	0.5961	0.4975	0.6343	0.5331	1.2749	1.0714	0.8404
STD.DEVS.	0.0113	0.0115	0.0066	0.0110	0.0100	0.0052	0.0078	0.0132	0.0127	0.0063	0.0120	0.0118	0.0107	0.0132	0.0045
% ERROR	1.15	1.05	1.21	1.58	1.70	0.46	1.41	1.86	2.14	1.26	1.89	2.21	0.84	1.24	0.54
GROUP 20															
AVERAGES	0.9773	1.0926	0.5406	0.6885	0.5790	1.1179	0.5531	0.7045	0.5925	0.4948	0.6302	0.5300	1.2737	1.0712	0.8410
STD.DEVS.	0.0087	0.0108	0.0051	0.0076	0.0063	0.0083	0.0046	0.0066	0.0066	0.0033	0.0050	0.0063	0.0068	0.0097	0.0052
% ERROR	0.89	0.99	0.94	1.10	1.10	0.74	0.84	0.94	1.11	0.66	0.80	1.18	0.54	0.91	0.62
GROUP 21															
AVERAGES	0.9842	1.1060	0.5480	0.7004	0.5883	1.1238	0.5568	0.7117	0.5977	0.4955	0.6333	0.5319	1.2781	1.0735	0.8399
STD.DEVS.	0.0097	0.0167	0.0075	0.0101	0.0080	0.0082	0.0042	0.0068	0.0082	0.0032	0.0064	0.0080	0.0107	0.0147	0.0083
% ERROR	0.99	1.51	1.37	1.44	1.36	0.73	0.75	0.96	1.37	0.65	1.01	1.50	0.84	1.37	0.99
GROUP 22															
AVERAGES	0.9739	1.0721	0.5279	0.6694	0.5638	1.1008	0.5420	0.6874	0.5790	0.4924	0.6244	0.5260	1.2681	1.0681	0.8423
STD.DEVS.	0.0084	0.0112	0.0034	0.0057	0.0045	0.0072	0.0038	0.0046	0.0054	0.0039	0.0044	0.0056	0.0050	0.0053	0.0047
% ERROR	0.86	1.04	0.64	0.85	0.81	0.65	0.70	0.67	0.93	0.79	0.71	1.07	0.39	0.50	0.55
GROUP 23															
AVERAGES	0.9772	1.0912	0.5430	0.6909	0.5796	1.1167	0.5557	0.7069	0.5932	0.4976	0.6330	0.5312	1.2722	1.0675	0.8391
STD.DEVS.	0.0094	0.0119	0.0042	0.0064	0.0053	0.0065	0.0048	0.0047	0.0066	0.0044	0.0036	0.0061	0.0076	0.0064	0.0060
% ERROR	0.96	1.09	0.78	0.92	0.92	0.58	0.86	0.67	1.11	0.88	0.57	1.15	0.60	0.59	0.72
GROUP 24															
AVERAGES	0.9786	1.0960	0.5391	0.6832	0.5716	1.1200	0.5509	0.6982	0.5842	0.4919	0.6234	0.5216	1.2674	1.0604	0.8367
STD.DEVS.	0.0077	0.0149	0.0082	0.0100	0.0093	0.0107	0.0084	0.0085	0.0085	0.0047	0.0051	0.0052	0.0120	0.0102	0.0030
% ERROR	0.78	1.36	1.52	1.47	1.62	0.96	1.52	1.22	1.45	0.95	0.82	1.00	0.95	0.96	0.36

APPENDIX TABLE D4 (cont'd)

	17/18	17/19	17/20	17/21	17/22	18/19	18/20	19/21	18/22	19/20	19/21	19/22	20/21	20/22	21/22
GROUP 25															
AVERAGES	0.9782	1.0985	0.5433	0.6930	0.5820	1.1230	0.5555	0.7084	0.5950	0.4946	0.6308	0.5298	1.2753	1.0711	0.8399
STD.DEVS.	0.0073	0.0112	0.0070	0.0154	0.0095	0.0091	0.0056	0.0137	0.0092	0.0033	0.0097	0.0068	0.0145	0.0120	0.0081
% ERROR	0.74	1.02	1.28	2.22	1.63	0.81	1.01	1.93	1.55	0.66	1.54	1.29	1.13	1.12	0.97
GROUP 26															
AVERAGES	0.9746	1.0888	0.5416	0.6899	0.5789	1.1172	0.5558	0.7079	0.5940	0.4975	0.6337	0.5317	1.2737	1.0688	0.8391
STD.DEVS.	0.0085	0.0123	0.0034	0.0055	0.0043	0.0078	0.0035	0.0065	0.0059	0.0038	0.0057	0.0059	0.0081	0.0080	0.0033
% ERROR	0.87	1.13	0.62	0.80	0.73	0.69	C.63	0.91	0.99	0.76	0.89	1.11	0.64	0.75	0.39
GROUP 27															
AVERAGES	0.9758	1.0917	0.5388	0.6833	0.5733	1.1185	0.5522	0.7003	0.5877	0.4938	0.6262	0.5255	1.2681	1.0642	0.8392
STD.DEVS.	0.0177	0.0335	0.0086	0.0090	0.0074	0.0159	0.0043	0.0081	0.0073	0.0077	0.0131	0.0115	0.0103	0.0097	0.0056
% ERROR	1.81	3.07	1.59	1.32	1.29	1.43	0.78	1.16	1.24	1.57	2.10	2.19	0.81	0.91	0.67
GROUP 28															
AVERAGES	0.9858	1.1103	0.5428	0.6879	0.5784	1.1261	0.5506	0.6979	0.5869	0.4891	0.6199	0.5213	1.2675	1.0658	0.8409
STD.DEVS.	0.0165	0.0300	0.0059	0.0073	0.0057	0.0146	0.0053	0.0089	0.0089	0.0088	0.0133	0.0125	0.0097	0.0092	0.0049
% ERROR	1.67	2.70	1.08	1.05	0.99	1.30	C.96	1.27	1.51	1.79	2.15	2.39	0.76	0.86	0.59
GROUP 29															
AVERAGES	0.9729	1.0837	0.5363	0.6831	0.5748	1.1139	0.5513	0.7022	0.5909	0.4950	0.6305	0.5305	1.2738	1.0718	0.8414
STD.DEVS.	0.0116	0.0181	0.0056	0.0066	0.0060	0.0088	0.0054	0.0060	0.0083	0.0050	0.0074	0.0082	0.0100	0.0095	0.0073
% ERROR	1.20	1.67	1.04	0.97	1.04	0.79	0.98	0.85	1.40	1.00	1.17	1.54	0.79	0.88	0.87
GROUP 30															
AVERAGES	0.9801	1.0833	0.5338	0.6778	0.5717	1.1053	0.5446	0.6915	0.5833	0.4927	0.6257	0.5277	1.2698	1.0710	0.8434
STD.DEVS.	0.0080	0.0112	0.0037	0.0055	0.0038	0.0064	0.0035	0.0041	0.0048	0.0038	0.0043	0.0050	0.0061	0.0055	0.0055
% ERROR	0.81	1.04	0.69	0.81	0.66	0.58	0.64	0.59	0.83	0.77	0.68	0.94	0.48	0.51	0.65
GROUP 31															
AVERAGES	0.9906	1.0835	0.5344	0.6789	0.5728	1.1049	0.5450	0.6923	0.5841	0.4933	0.6266	0.5287	1.2703	1.0718	0.8437
STD.DEVS.	0.0074	0.0093	0.0031	0.0065	0.0051	0.0072	0.0041	0.0072	0.0061	0.0036	0.0049	0.0048	0.0081	0.0065	0.0041
% ERROR	0.76	0.86	0.58	0.95	0.90	0.65	C.75	1.04	1.05	0.72	0.78	0.92	0.64	0.61	0.49
GROUP 40															
AVERAGES	0.9783	1.0561	0.5457	0.6983	0.5899	1.1204	0.5578	0.7138	0.6029	0.4978	0.6371	0.5381	1.2797	1.0810	0.8447
STD.DEVS.	0.0063	0.0099	0.0055	0.0111	0.0098	0.0077	0.0048	0.0095	0.0085	0.0034	0.0081	0.0077	0.0128	0.0117	0.0040
% ERROR	0.64	0.91	1.01	1.60	1.67	0.68	0.86	1.33	1.40	0.68	1.28	1.44	1.00	1.08	0.47
GROUP 41															
AVERAGES	0.9762	1.0907	0.5432	0.6951	0.5861	1.1173	0.5564	0.7121	0.6004	0.4980	0.6373	0.5374	1.2796	1.0789	0.8431
STD.DEVS.	0.0086	0.0147	0.0083	0.0131	0.0121	0.0088	0.0065	0.0110	0.0112	0.0046	0.0076	0.0090	0.0077	0.0106	0.0064
% ERROR	0.88	1.34	1.53	1.88	2.06	0.79	1.16	1.55	1.87	0.93	1.19	1.67	0.60	0.98	0.75
GROUP 42															
AVERAGES	0.9799	1.0993	0.5463	0.6972	0.5855	1.1218	0.5575	0.7116	0.5975	0.4970	0.6343	0.5327	1.2763	1.0717	0.8397
STD.DEVS.	0.0077	0.0120	0.0065	0.0087	0.0096	0.0068	0.0064	0.0093	0.0100	0.0049	0.0077	0.0086	0.0082	0.0113	0.0069
% ERROR	0.79	1.09	1.19	1.24	1.64	0.61	1.14	1.31	1.67	0.99	1.21	1.62	0.64	1.05	0.82
GROUP 43															
AVERAGES	0.9831	1.0980	0.5509	0.7094	0.5989	1.1168	0.5603	0.7216	0.6092	0.5017	0.6462	0.5456	1.2879	1.0876	0.8443
STD.DEVS.	0.0127	0.0228	0.0111	0.0134	0.0119	0.0113	0.0066	0.0102	0.0103	0.0040	0.0103	0.0110	0.0163	0.0185	0.0059
% ERROR	1.29	2.07	2.01	1.88	1.99	1.01	1.18	1.42	1.69	0.80	1.60	2.02	1.26	1.70	0.70
GROUP 44															
AVERAGES	0.9761	1.0891	0.5471	0.7008	0.5916	1.1160	0.5605	0.7180	0.6060	0.5022	0.6434	0.5431	1.2811	1.0816	0.8441
STD.DEVS.	0.0051	0.0077	0.0022	0.0078	0.0093	0.0106	0.0023	0.0057	0.0066	0.0029	0.0062	0.0093	0.0092	0.0139	0.0069
% ERROR	0.52	0.70	0.40	1.11	1.57	0.95	0.40	0.79	1.08	0.58	0.97	1.71	0.72	1.29	0.81

APPENDIX TABLE D4 (cont'd)

	17/18	17/19	17/20	17/21	17/22	18/19	18/20	18/21	18/22	19/20	19/21	19/22	20/21	20/22	21/22
GROUP 45															
AVERAGES	0.9742	1.0855	0.5465	0.6930	0.5771	1.1140	0.5608	0.7110	0.5922	0.5033	0.6381	0.5314	1.2676	1.0557	0.8325
STD.DEVS.	0.0177	0.0396	0.0267	0.0405	0.0403	0.0211	0.0177	0.0311	0.0358	0.0066	0.0174	0.0267	0.0217	0.0457	0.0240
% ERROR	1.81	3.65	4.88	5.84	6.98	1.89	3.16	4.37	6.04	1.31	2.73	5.02	1.71	4.33	2.89
GROUP 46															
AVERAGES	0.9740	1.0843	0.5456	0.6991	0.5862	1.1136	0.5600	0.7175	0.6017	0.5029	0.6443	0.5403	1.2812	1.0745	0.8387
STD.DEVS.	0.0165	0.0282	0.0193	0.0252	0.0172	0.0118	0.0115	0.0145	0.0092	0.0067	0.0085	0.0063	0.0086	0.0090	0.0083
% ERROR	1.69	2.60	3.54	3.60	2.94	1.06	2.06	2.02	1.53	1.34	1.32	1.16	0.67	0.84	0.99
GROUP 53															
AVERAGES	0.9645	1.0620	0.5274	[illegible]	0.5552	[illegible]	[illegible]	[illegible]	0.5767	[illegible]	0.6273	0.5233	[illegible]	1.0547	0.8343
STD.DEVS.	0.0274	0.0102	0.0025	0.0053	0.0023	[illegible]	[illegible]	0.0037	0.0042	0.0030	0.0031	0.0043	0.0074	0.0032	0.0054
% ERROR	0.77	0.93	0.40	0.70	0.50	0.72	0.70	[illegible]	0.73	0.73	0.49	0.81	0.58	0.30	0.64
GROUP 54															
AVERAGES	0.9702	1.0026	0.5411	[illegible]	0.5705	1.1158	[illegible]	[illegible]	0.5010	0.4953	0.6313	0.5305	1.2745	1.0712	0.8402
STD.DEVS.	0.0096	0.0144	0.0095	0.0153	0.0131	[illegible]	[illegible]	0.0136	[illegible]	0.0050	0.0124	0.0104	0.0111	0.0142	0.0078
% ERROR	0.90	1.32	1.75	2.22	2.25	0.71	[illegible]	[illegible]	0.76	1.19	1.65	1.97	0.87	1.33	0.32

COMPARISON OF AIRBORNE INFRARED SPECTRAL EMITTANCE AND RADAR SCATTEROMETER DATA FROM PISGAH CRATER LAVA FLOWS

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SUMMARY

The olivine basalt lava fields of Pisgah Crater, 35 miles ESE of Barstow, California, are one of the very few areas which have been studied by more than one sensor. In fact, a big problem in evaluating various remote sensing systems is that so rarely have they been viewing the same targets, let alone from the same attitude and look angles.

In NASA/MSC Mission 108 the infrared spectrometer/radiometer instrumentation was flown twice down the same three-mile long flight line, as was used for the 2 cm-band radar scatterometer in Mission 21, and reported at the Fifth Symposium on Remote Sensing of Environment. These two, non-imaging systems measure different parameters - spectral emittance for the infrared, and goniometric radar backscatter for the scatterometer. In addition, cross-track width of the "ground patch" (or footprint) of the IR units is 7 milliradians and the radar is 44 milliradians. Despite these obvious differences, data from both units can be used to arrive at similar classifications for the geological materials at this site - lava flows of three types, lava cinders of Pisgah Crater, dry sediments of Lavic Lake, and several types of Older and Younger alluviums in the desert outwash fans surrounding the crater and flows.

APPENDIX TABLE D5

SEQUENTIAL SUCCESS BY ROCK TYPE FOR EACH METHOD USING BMDO7M

A. MIXED TERRAIN (D, A, P)

1. Spectral Emittance (50 central λ's)

	D	A	P
Step 1	70	93	35
2	68	100	48
3	68	96	52
4	81	100	77
6	81	100	78
7	84	100	81
9	85	100	87

2. System Response

a. Vincent's - 3

	D	A	P
Step 1	87	100	87
2	87	100	97
3	96	100	97

b. MSDS - 6

	D	A	P
Step 1	89	100	84
2	100	100	84
3	100	100	97
4	100	100	97
6	100	100	97

3. Ratios

a. Vincent's - 3

	D	A	P
Step 1	87	100	71
2	83	100	71

b. MSDS - 15

	D	A	P
Step 1	51	100	32
2	72	100	68

B. ALL LAVAS (I, II, III)

1. Spectral Emittance (50 central λ's)

	I	II	III
Step 1	66	27	54
2	78	35	51
3	69	48	51
4	66	55	49
6	72	55	52
7	66	57	55
9	69	58	57

2. System Response

a. Vincent's - 3

	I	II	III
Step 1	52	61	63
2	61	57	69
3	65	55	66

b. MSDS - 6

	I	II	III
Step 1	48	26	67
2	65	52	69
3	81	55	66
4	75	47	65
6	74	59	63

3. Ratios

a. Vincent's - 3

	I	II	III
Step 1	58	11	63
2	56	44	57

b. MSDS - 15

	I	II	III
Step 1	22	15	62
2	68	26	58