THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION RESEARCH GRANT

NGR-05-020-237

"FUNDAMENTAL STUDIES RELATING PARTICLE SIZE EFFECTS TO INFRARED SPECTRA"

FINAL REPORT

1 June 1967 - 31 May 1968

21 June 1968

REMOTE SENSING LABORATORY
SCHOOL OF EARTH SCIENCES

STANFORD UNIVERSITY • STANFORD, CALIFORNIA

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ILLUSTRATIONS

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I. INTRODUCTION

This report is the final report on NASA Grant No. NGR 05-020-237. The level of effort on this grant has been approximately,

Professional	7 man months
Graduate assistant	6 man months
Secretarial	1.5 man months

During the first six months of this grant, the main effort was directed at upgrading our equipment and data handling system, in order to detect the subtle spectral differences that were anticipated from our earlier work. The last few months were spent gathering data in and interpreting the results.

This data handling system has been used recently in other field studies with the SG-4 spectrometer. Over 700 rock and soil spectra collected in a one six-hour recording period and successfully reduced in the computer. Group mean and standard deviation spectra can be reduced within an hour or two of recording.

II. BACKGROUND

In the early stages of the grant it was clear from the literature that the spectra of powdered samples would not be easy to collect with any accuracy, since the spectral departures became very subtle when the powder size becomes comparable with the wavelength of the emitted radiation. Nevertheless, a number of samples, of differing powder sizes and compositions were examined with the SG-4 spectrometer, in order to estimate the severity of the problem.

The results from this early experiment were disappointing in that the spectra were dominated by noise. Whether this noise arose from the instrumentation or the digitizing process is not clear, but it was clear that considerable effort was necessary to improve the equipment sensitivity. This was done, and the first of the "enhanced" spectra was published in the semi-annual report. Shortly after that, the automated data system was completed, allowing us to take groups of spectra and process their means and standard deviations.

III. INFRARED SPECTRA OF POWDERED ROCKS

The experimental procedure for taking the spectra of the powdered rock samples was as close to normal field procedure as possible. The powders were shaken into a tray to form a loosely packed layer about 1/8" thick. The sample tray was then oriented so that the powder surface was approximately normal to the incident solar radiation, and the spectrometer optical axis moved to be almost colinear. (Exact alignment would have cast the shadow of the spectrometer onto the sample). A short period of time was used to allow the powder to heat up to an approximately equilibrium condition, and a number of spectra were recorded. In most cases, ten to fifteen spectra were taken, each with a spectral period of eight seconds. The spectrometer used was the Stanford version of the Perkin-Elmer SG-4, which chops the sample radiation against a cold reference. As discussed in an earlier report, (ref. 1) the temperature of this reference was found to have a profound enhancing effect on the ability of the spectrometer to record small emissivity differences. In all the work reported here, the reference was held at 273°K (by using an ice-water bath).

The powders examined were

a) Quartz monzonite (June Lake, Calif., sample #312)

b) Basalt (Pisgah Crater (Lavic Lake end), Calif., sample # PC-LL-12 and PC-LL-15)

c) Pumice rock (Mono Craters, Calif., sample #4094)

d) Residue from a hypervelocity impact on a Mono Crater pumice. (Sample # MS 498)

Of these four, only the vesicular basalt Pisgah samples did not produce usable spectra. The spectral departure even for this particular rock in the solid form is not as pronounced as for the others and for powdered materials was not visible above the noise level. The data for this set of powders are not included in this report.

The data for the June Lake quartz monzonite shows very clearly the effects of particle size on spectral departure. Fig. 1 shows the spectrum for some powders which were ground and dry sieved, without washing. The largest size (833-147μ) still shows the characteristic depressions in emissivity at about 8.5 and 9.0μ, although the two minima are no longer resolvable. Once the powder size has been reduced below 147μ, the minima are almost completely filled in, and the powder behaves as a greybody.

In contrast to this however is the behavior of water-sieved samples, in which the fine powder normally adhering to the coarser grains has been removed. The spectra of the washed powders in the size fractions 43μ-147μ mesh and <43μ are shown in figure 2. The spectral features can be seen clearly, although once again, the resolution when compared with the solid sample is worse.

The conclusion to be drawn from these figures is that the dominating feature in the unwashed powders is the fine dust adhering to

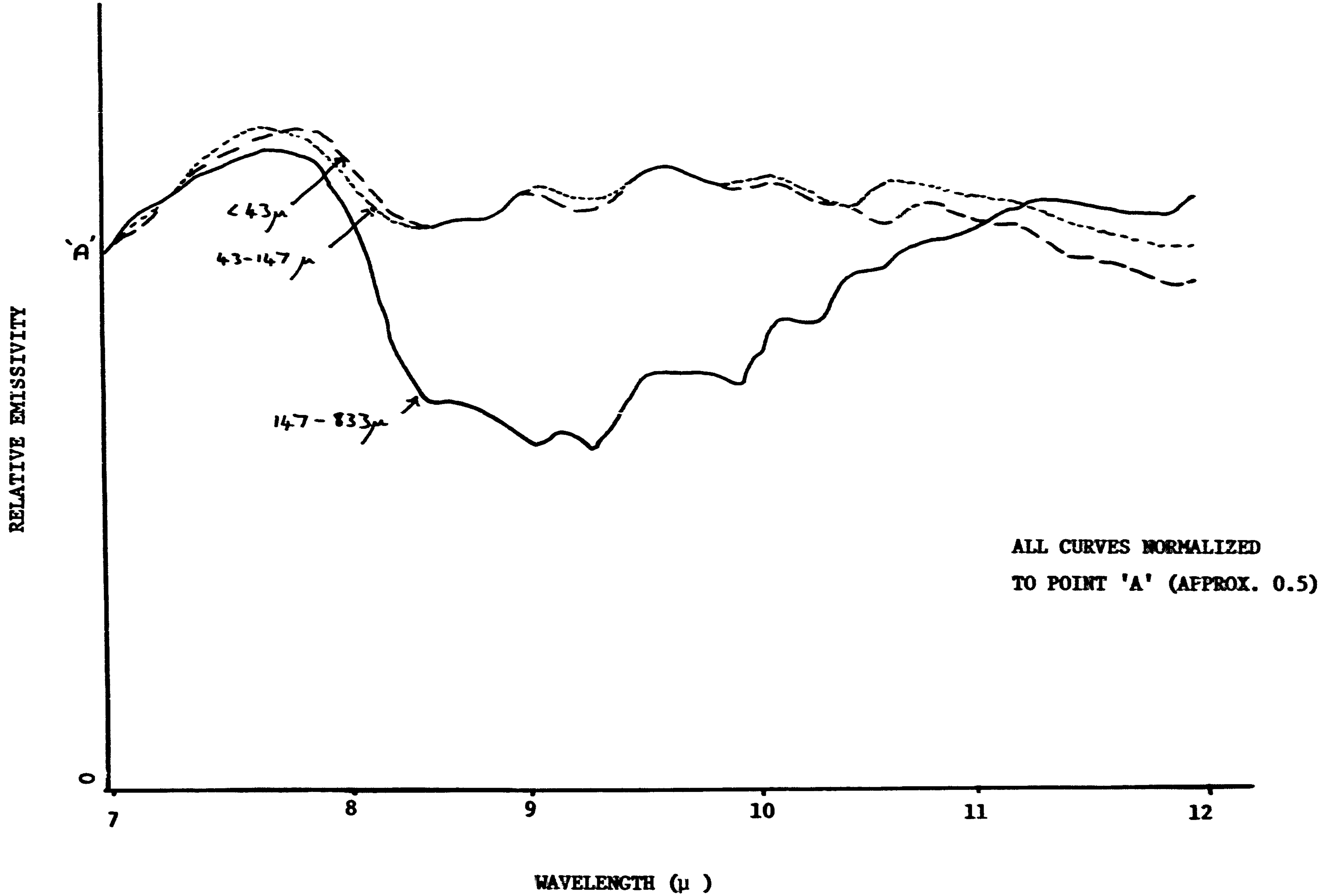

Fig. 1 Spectra of Quartz Monzonite (dry sieved)

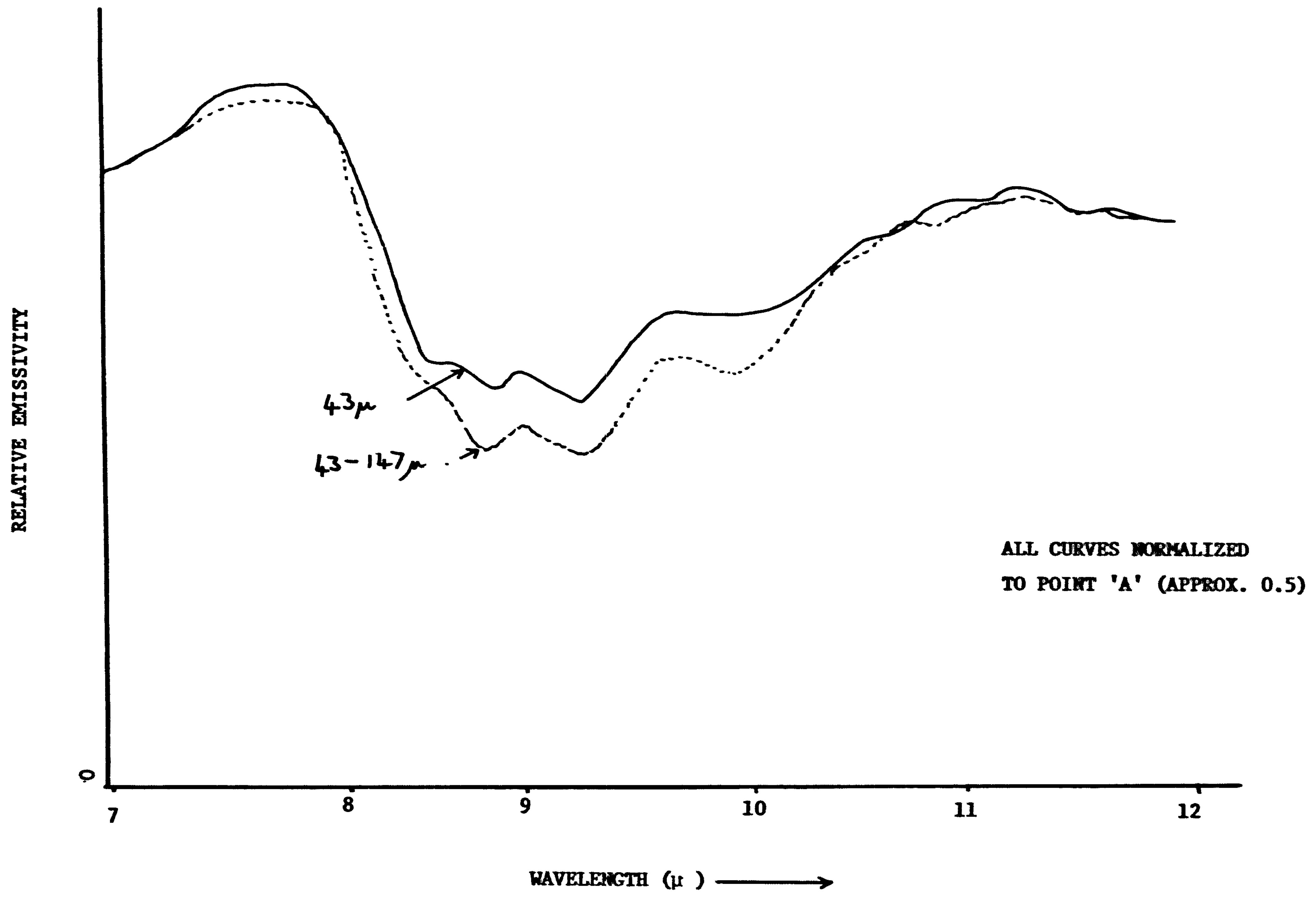

Fig. 2 Spectra of Quartz Monzonite (elutriated)

the particles. This powder apparently does not show any spectral features at all, and effectively obscures any such features from the underlying course particles. It should be noted that there is no shift in the wavelength of the emissivity minima as the particle size changes, only in the depth of the features.

Three sets of powders were available for Mono Crater's pumice. The first set were mechanically ground in a conventional mill and separated into two sets of size fractions both by dry sieving and by water-elutriation. A third set was obtained by kind permission of Donald Gault of NASA/Ames Research Center. This powder was generated the hyper-velocity impact (25,000 ft./sec.) of a polyethylene pellet into a block of the pumice. The crater from which the powders were taken is shown in figure 3. The powders from the impact were not washed with the exception of the 10 to 43μ size. It can be seen that in both cases the powder retains some spectral identity down to the 40-80μ size fraction. (Figures 4, 5). There is even a suggestion of the spectral features present in the 10-43μ size. There is no conspicuous difference between the spectra of the impacted pumice and the normally ground pumice. From the spectra of the two washed-powder sizes it is easily seen that the spectral features are much stronger, emphasing again the important role of the fine dust in surface emission. There is one disagreement with this general conclusion. The 10 to 43μ size fraction in the impacted powders does not show the same "color" as the larger particles, suggesting that it is a dry sieved sample. It has proved impossible to pin down the preparation procedure for this fraction, but its small size (smaller than standard screen sizes) strongly suggests that it was elutriated.

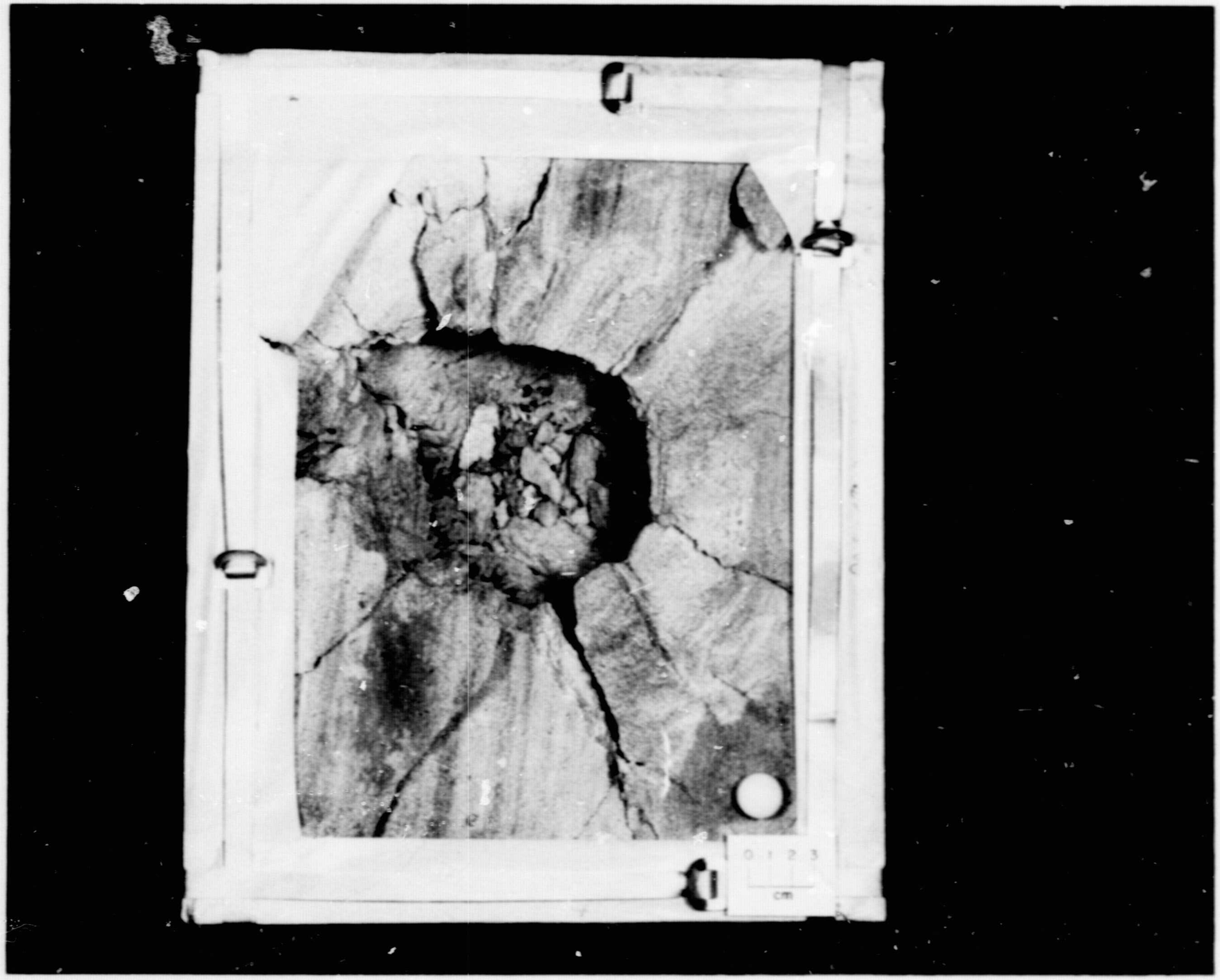

Fig. 3 Hypervelocity Impact Crater in Mono Pumice

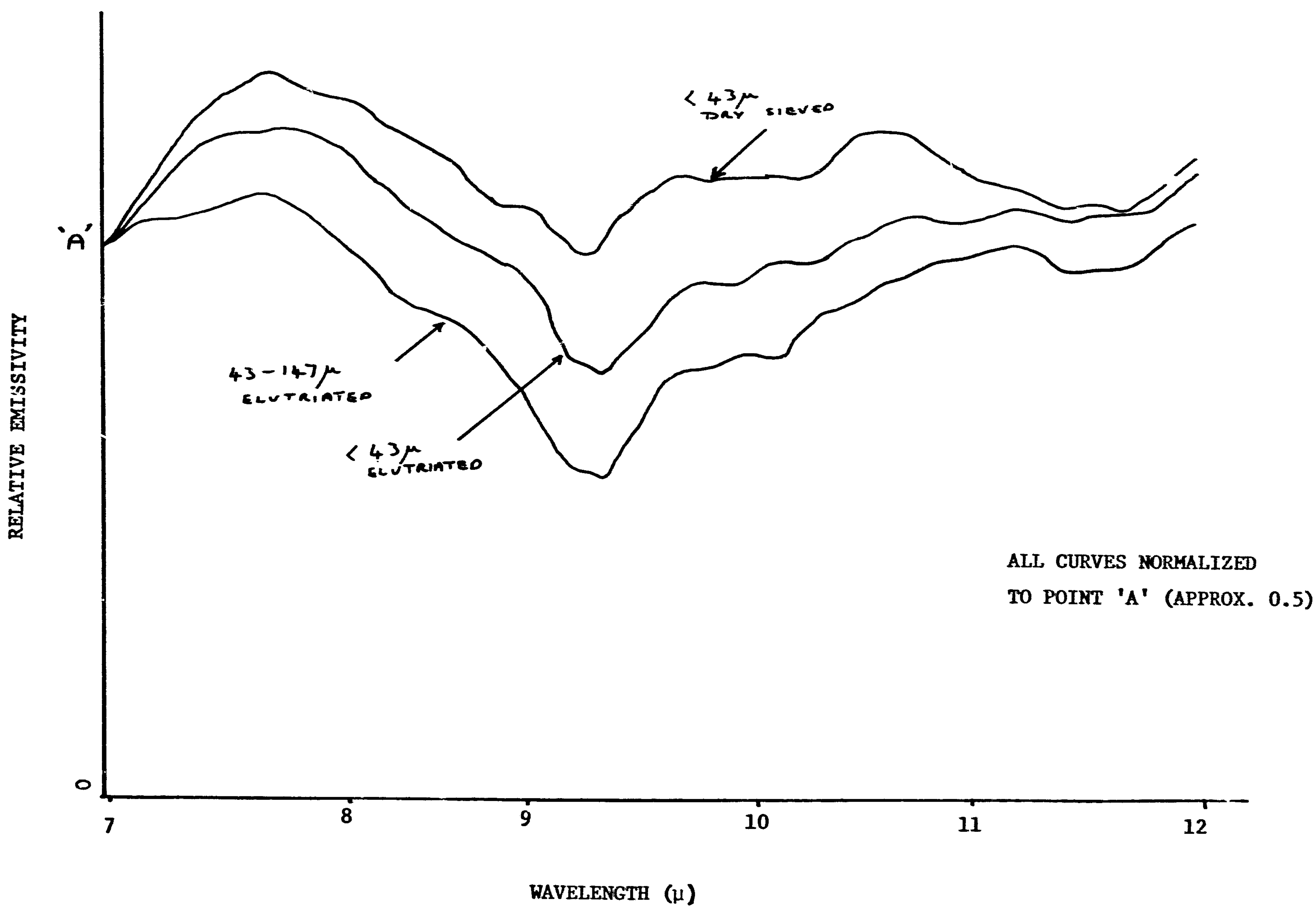

Fig. 4 Spectra of Pumice Powder

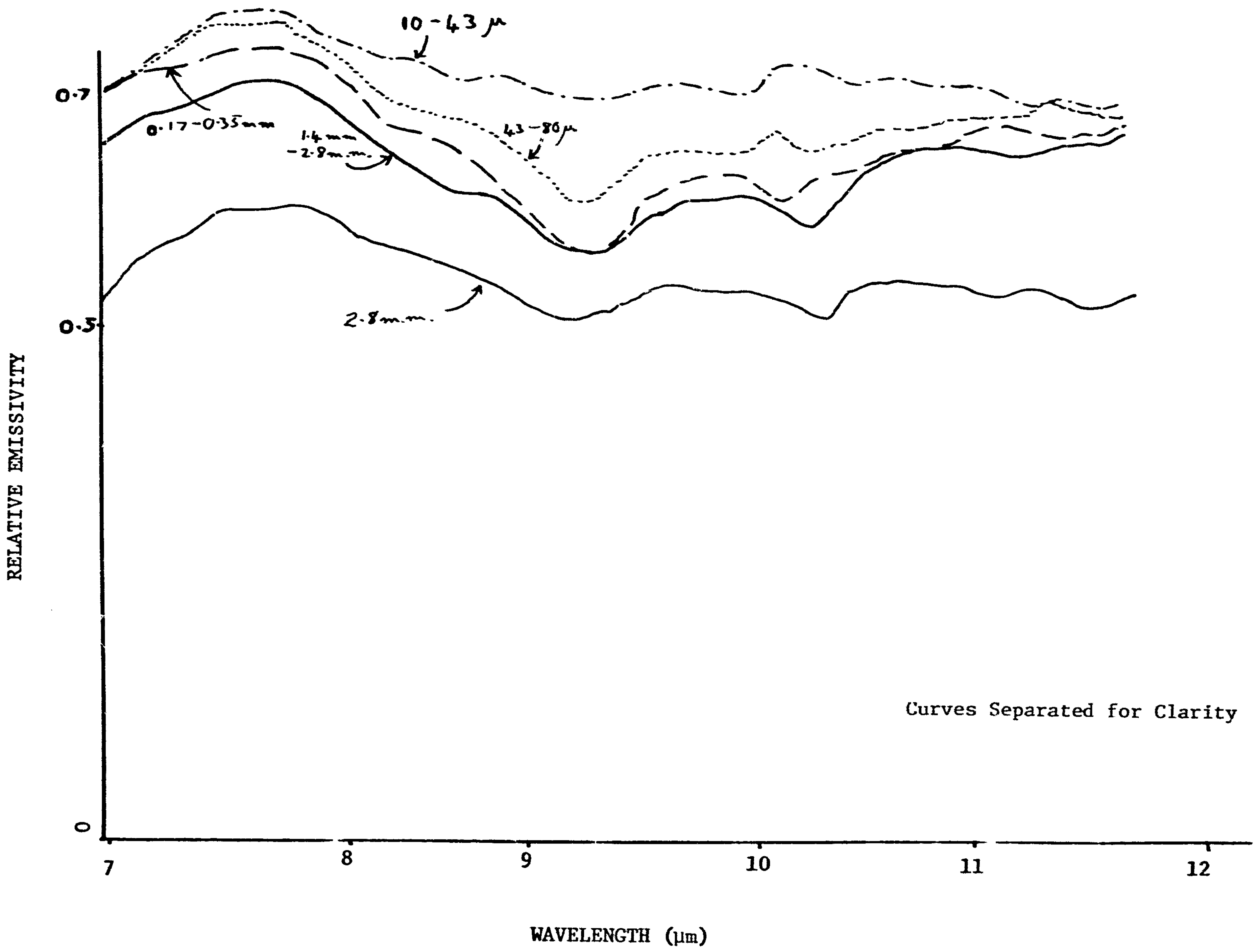

Fig: 5 Spectra of Pumice Powder (Dry Sieved)

The findings from this limited study are in general in agreement with those of Lyon (ref. 2) and are:

1) The positions of emissivity minima are not affected by the powder size.

2) The depth of the minima diminishes as the powder size decreases; ie. the sample behaves more and more like a greybody.

3) Fine dust, such as normally occurs during the grinding process, dominates the spectral emission (in the 7-14μ range) of powdered samples. Any work on such samples should therefore be performed on samples that have been washed.

4) Using washed powder samples, the spectral features can still be seen at least to a particle size of 40μ. (= four wavelengths of emitted radiation).

Significantly, we do <u>not</u> see any additional (new) spectral features appearing as the powder size is reduced, as reported by Hovis and Callahan (ref. 3). We therefore cannot agree that the particle size needs to be known before identification by spectral emission analysis can be made.

IV. GONIOMETRIC FUNCTIONS

The emission spectrum of a given surface is dependent on a number of factors such as roughness, composition, degree of crystal orientation (alignment), and possibly, the angle of view of the spectrometer. The effects of composition have been reported extensively by Lyon (ref. 2) and Hovis (ref. 4). The spectral deterioration due to increased surface roughness can be estimated by working with carefully-sized powders, as reported here. The goniometric function does not appear to have been reported extensively, at least in these longer wavelengths of infrared.

In order to investigate this last effect therefore, the goniometric functions of several rocks were examined.

In this experiment, the variations in the average emissivity and in the degree of spectral "color," (departures from mean value) were the unknown parameters to be investigated. The experimental procedure was to set up a target-rock normal to the sun illumination, and then to take spectra with the rock progressively tilted further from the normal. If, as was anticipated, the target's reflectivity increased (ie. apparent emissivity decreased), as the spectrometer's angle of view approached grazing incidence, then the resulting data should show an increasing contribution from the reflected background. The background used could be considered as a blackbody at ambient temperature, and so the spectra should approach that of blackbody as the incidence angle decreases. The behavior observed however was exactly the opposite.

In interpreting the data we have not considered the effects of reflected sunlight since its contribution in the 7-14μ range is negligible compared with that from the target. (Ref. 5). The sun angle therefore is only important in its effect on the target temperature.

In all three rocks examined, the maximum value of emissivity showed some slight decrease as the incidence angle decreased, but the minima decreased quite markedly, with the result that the spectral "color" was enhanced. The data extend from 10° to 90° angle of view, (ie. from almost grazing incidence to the spectrometer axis being normal to the rock surface). It was not possible to approach grazing incidence closer than 10° because of foreshortening effect on the sample, and the consequent difficulty in filling the field of view of the spectrometer.

Figure 6 shows the depth of the spectral minima for a rough surfaced slab of limestone, as a function of viewing angle. (Each point on this and subsequent figures was obtained by averaging 10-15 consecutive spectra).

The two granite faces (fig.s 7 and 8) show a less pronounced effect than the limestone, but in general the result is still the same, that the spectral contrast increases as the incidence angle decreases.

There is not enough data here to draw a generalised conclusion, but if these results <u>are</u> typical of all rock surfaces, then there are obvious implications to be drawn for telescopic spectrometry. If one is looking for a spectral signature in the 7-14μ region of a given target area, then an almost horizontal incidence angle of 10° or so would seem to offer the highest chance of success.

V. CVF SPECTROMETER

The construction of this circularly variable filter (CVF) spectrometer*, which was partially supported by NGR 05-020-237, was completed this year, and the digital data system can also be used with the SG-4. Figure 9 shows the spectrometer with the case partly removed. The telescope is a 4", f/2.5 Cassegrain, and the detector is presently a

*Construction supported by NASA grant NGR 05-115-020 64%
NASA contract NAS9-7313 18%
NASA grant NGR 05-020-237 18%

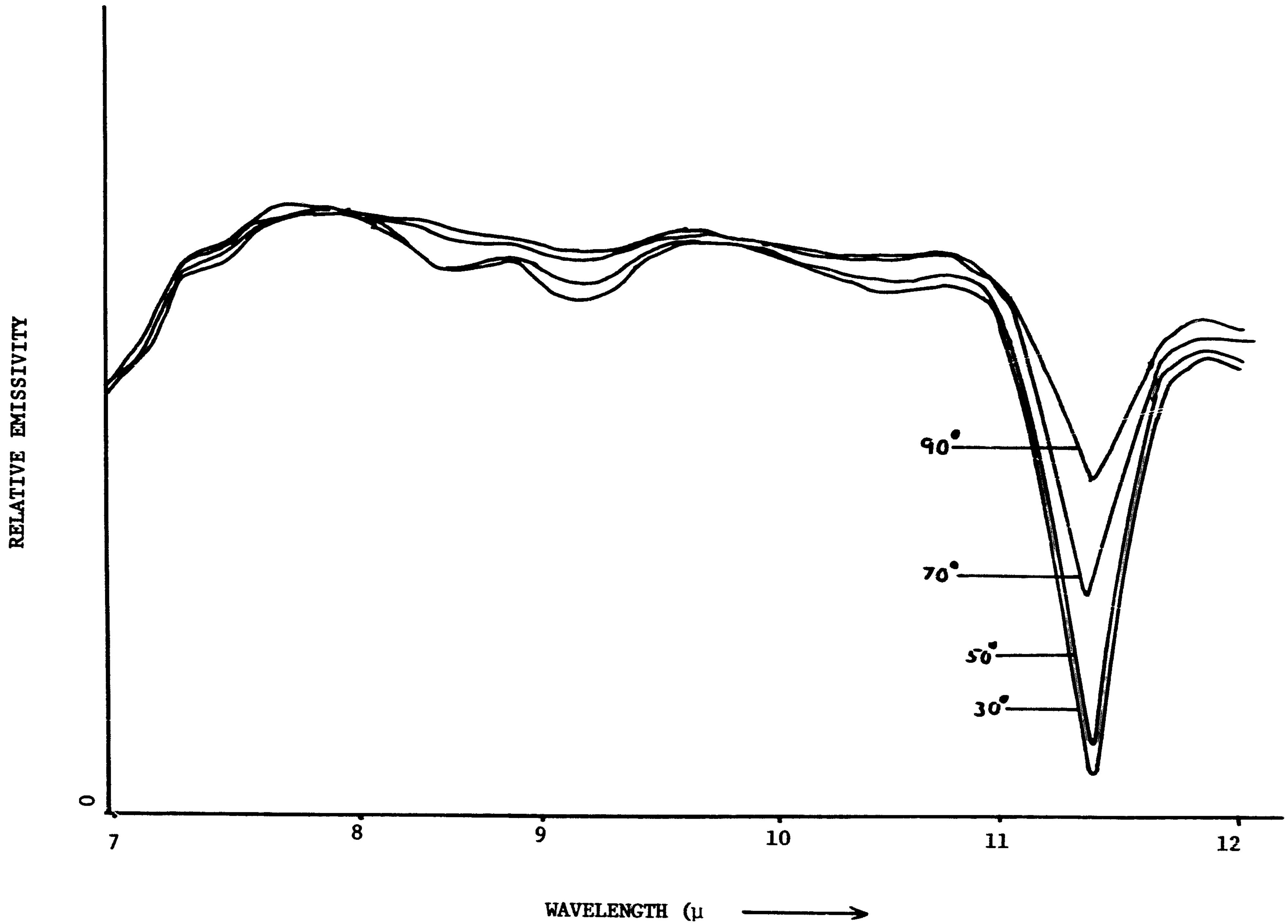

Fig. 6 Spectra of Limestone Slab at Different Angles of Incidence

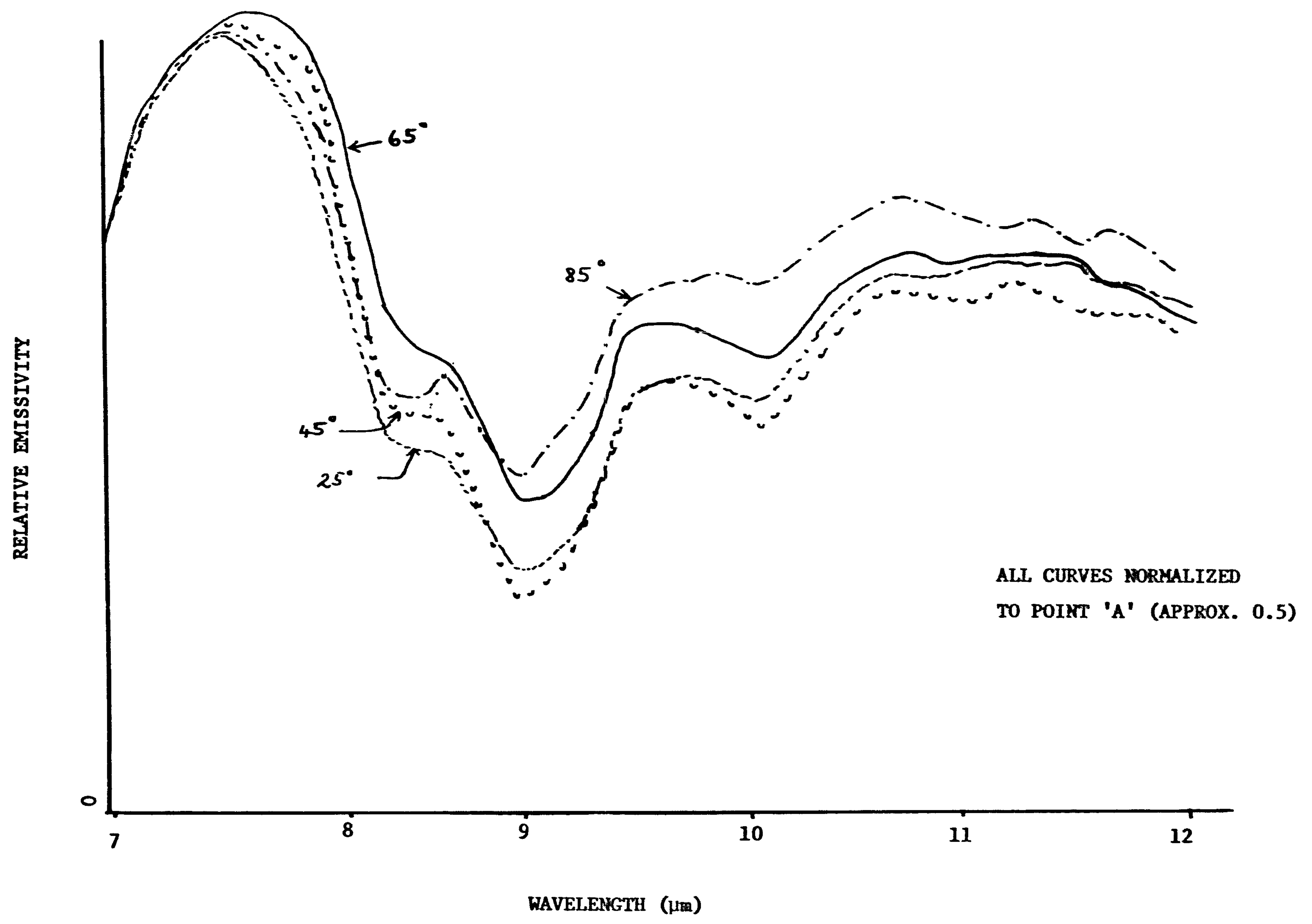

Fig. 7 Spectra of Rough Sawn Granite Slab (from 8" drill core) at Different Angles of Incidence Side II

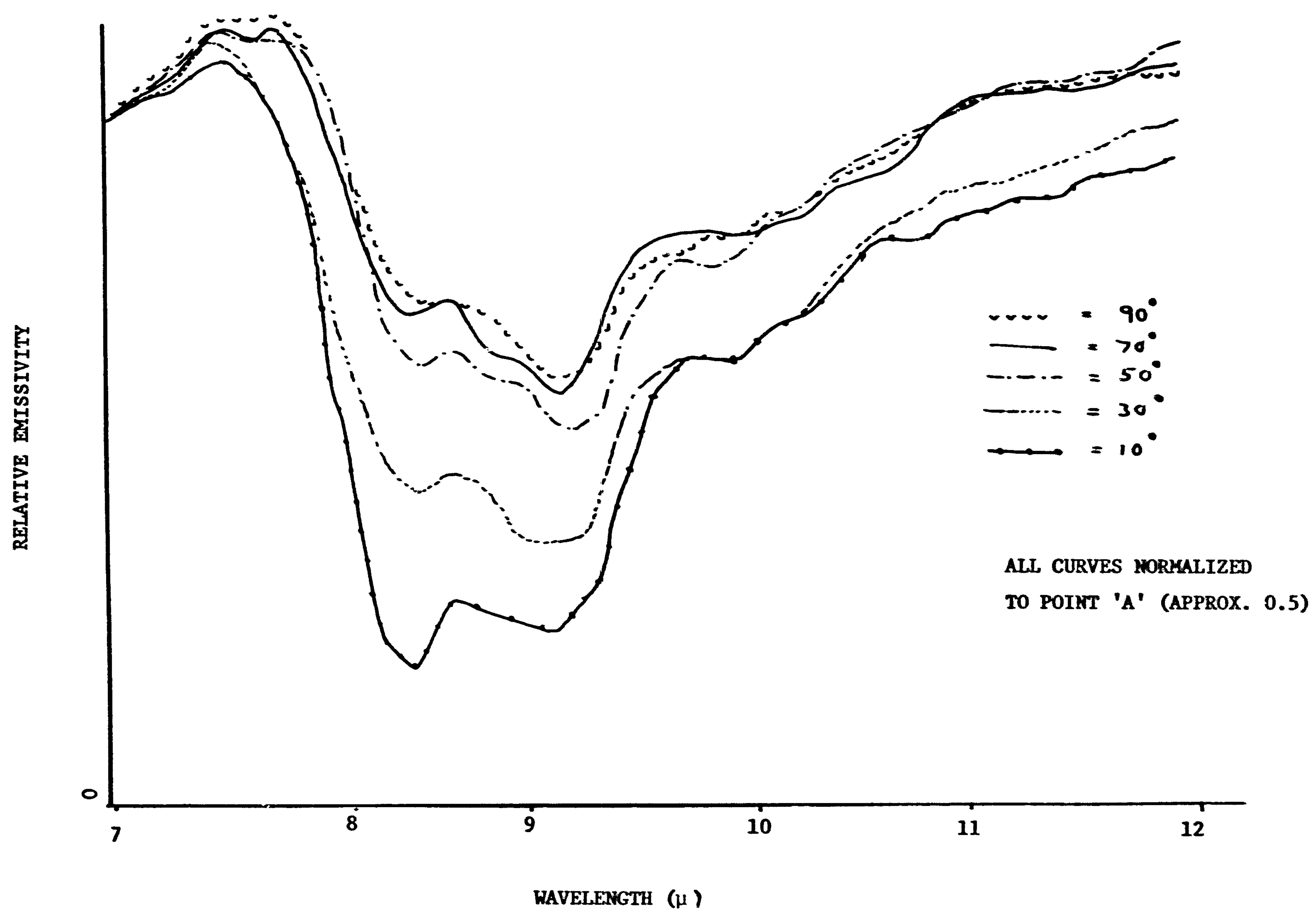

Fig. 8 Spectra of Rough Sawn Granite Slab (from 8" drill core) Side I

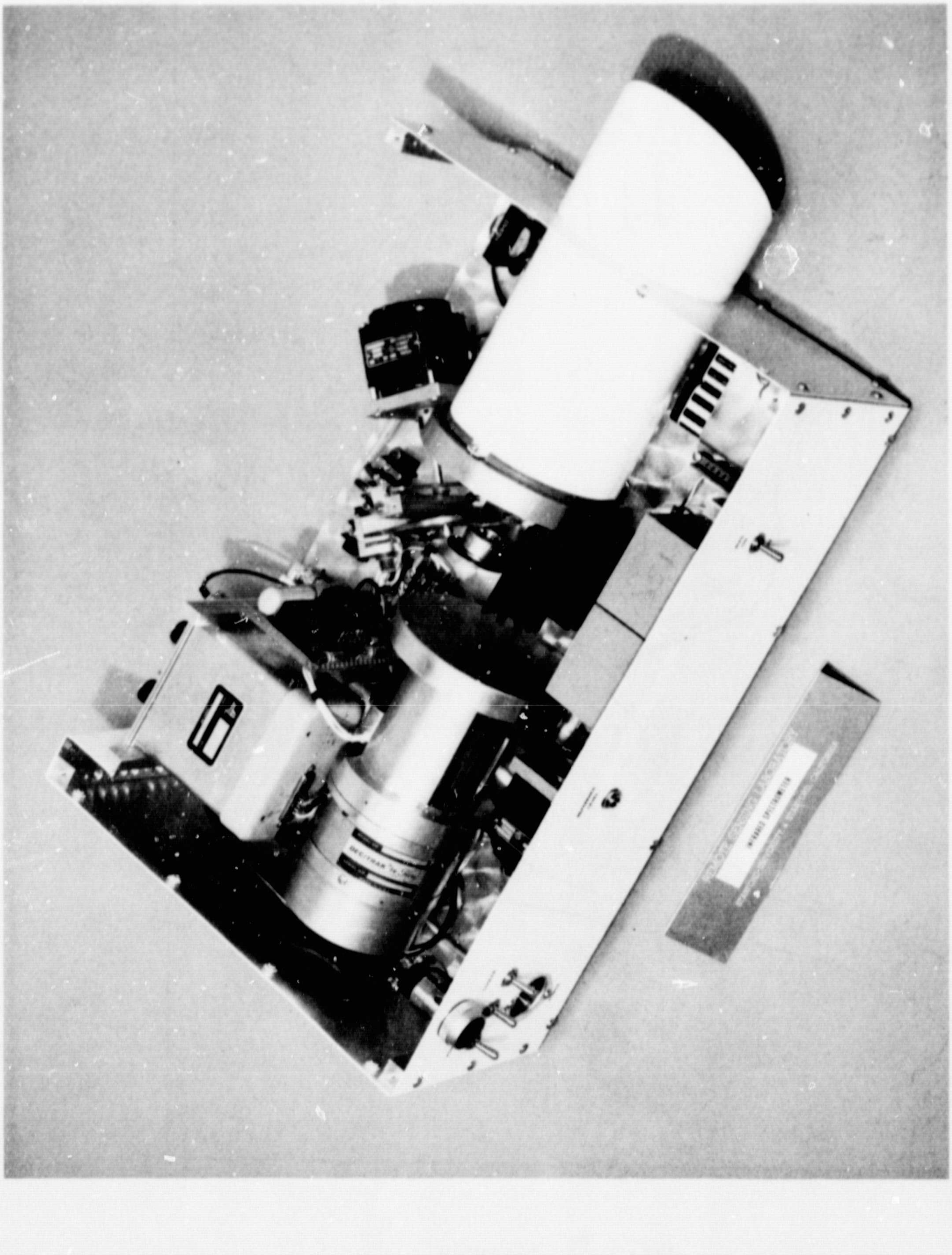

Fig. 9 Stanford CVF Infrared Spectrometer

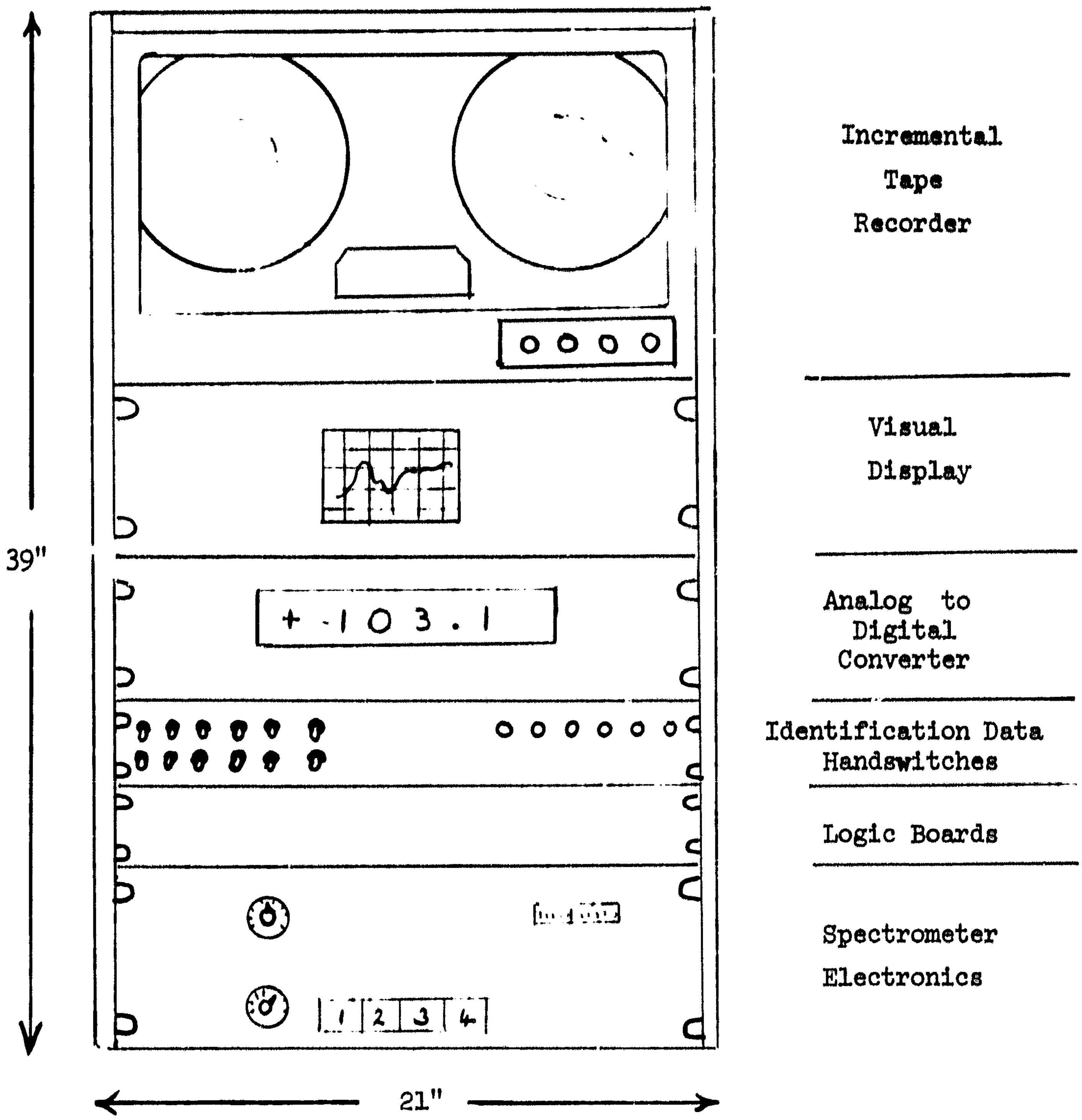

Fig. 10 Diagram of Spectrometer And Data System

Servo-Corp. thermistor on loan from W. Hovis (NASA/GSFC). This detector has served to check out the spectrometer alignment and initial performance, but its relay system and low sensitivity are unsuited to the acquisition of rapid short-period spectra. It is planned to replace the thermistor with a faster, cooled detector and the appropriate relay optics. The estimated improvement in performance is a factor of 100 or so. Further improvement can be achieved by using an extra, electronically filtered, pre-amplifying stage, at which time the spectrometer should be capable of a spectral period of 1 sec. (it is presently 60 sec.). Its resolution will then be limited only by the filter wheel (1.0-1.5%).

The instrument design was discussed in some detail in the semi-annual report (ref. 1), and will not be reiterated.

The data system design too was outlined in the earlier report, and construction has since been completed. It has since been used to process up to 700 spectra per day at a considerable time and cost saving over the previous analog system.

A diagram of the rebuilt field data system (truck mounted) is given in figure 10. The information that can be entered on the hand-switch panel is presently

Target temperature
Blackbody temperature
Target number
Spectrum number
Blackbody indicator.

This information is formatted in front of each spectrum and available to be processed by the computer, (see figure 11). The blackbody "indicator" causes the computer to initiate an extra routine whereby the blackbody spectra are stored, averaged, and then used to obtain emissivity ratios.

The detailed design of the data system will be published shortly. In the interim, however, an outline of logic was reported in the semi-annual report (ref. 1).

VI. AUTOMATIC GONIOMETER

Very little effort was expended on this instrument during the contractual period. As a result it was not completed, and the studies planned using the goniometer were replaced by the spectral goniometric work reported here.

VII. TRAVEL

No travel funds were expended during the last six months. Previous travel amounted to $ .50.

VIII. CAPITAL EQUIPMENT

No capital equipment was purchased on this grant. Some funds were used for expendible supplies however, particularly during the construction phase of the data recording system.

FISCAL DETAILS

ESTIMATED ALLOCATION OF EFFORT

DECEMBER 1, 1967 - June 30, 1968

TASK	PROFESSIONAL	SUB-PROFESSIONAL	SECRETARIAL	TOTAL (Man months)
Report Writing Papers etc.	0.5	0.25	0.5	1.25
Meetings and Travel	-	0.35	-	0.35
Field Operations	-	-	-	0.25
Lab. Studies	1.00	1.00	-	2.00
Data Reduction Lab. Spectra	1.00	-	-	1.00
Equipment-building Maintenance and Repair	1.00	0.5	0.2	1.7
General	0.25	-	-	0.25
Vacation	0.1	-	-	0.1
6 month total	3.85	2.1	0.7	6.65
Total over contractual period	7.15	5.86	1.38	14.39

REFERENCE

1) "Fundamental Studies Relating Particle Size Effects to Infrared Spectra," Semi-annual Report on NASA Grant NGR-05-020-237, Jan. 15, 1967.

2) Lyon, R.J.P., "Evaluation of Infrared Spectrophotometry for Compositional Analysis of Lunar and Planetary Soils (Part II)", NASA Contractor Report, NASA-CR-100, November, 1964.

3) Hovis, W.A. Jr., and Callahan, W.R., "infrared Reflectance Spectra of Igneous Rocks, Tuffs, and Red Sandstone from 0.5 to 22 Microns", JOSA, Vol. 56 No.5, 1966.

4) Hovis, W.A. Jr., "Optimum Wavelength Intervals for Surface Temperature Radiometry", Applied Optics, Vol. 5, No. 5, May, 1966.

5) Jameson, McFee, et. al., "Infrared Physics and Engineering", (Chapter 4) McGraw-Hill Book Company, 1963.

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APPENDIX A

A. CONVERSION FACTORS FOR MEASUREMENT OF TRUE EMISSIVITY

In the semi-annual report (ref. 1), an approximate formula was developed for correcting our measured emissivity values to true emissivity. The two quantities are different for two reasons,

a) All spectrometers chop against a reference which contributes to the radiance output signal.

b) Our blackbody spectra taken in the field are usually at a slightly different temperature to the targets, hence ratioing the two does not give true emissivity.

In an attempt to bring the calculated values closer to the true values, the following formulation was developed.

Let $R_{BT_{1\lambda}}$ be the radiance received by the spectrometer from a blackbody at temperature T_1

Let $R_{S\lambda}$ be the radiance received by the spectrometer from a sample at temperature T_2

Let R_{Ref_λ} be the radiance from the reference body at temperature T_3

The measured emissivity ratio (Σ_m) at a given wavelength λ will be

$$\Sigma_{m\lambda} = \frac{R_{S_\lambda} - R_{Ref_\lambda}}{R_{BT_\lambda} - R_{Ref_\lambda}}$$

If the temperature of the blackbody and the target are the same ($T_1 = T_2$), then this formulation can be reduced to

$$\frac{R_{Ref\,\lambda}}{R_{BT_{2\lambda}}}(1 - \Sigma_m) + \Sigma_m - \frac{R_S}{R_{BT_{2\lambda}}} = \Sigma_{T\lambda}$$

where $\Sigma_{T\lambda}$ is the true emissivity of the target.

If T_1 and T_2 are not equal then $\Sigma_{T\lambda}$ will calculate out to be $\frac{R_{S\lambda}}{R_{BT_1}}$ which is incorrect. The ratio $\frac{R_{BT_1\lambda}}{R_{BT_2\lambda}}$ must therefore be included, (for each wavelength) to remove the error.

i.e. $$\Sigma_{T_\lambda} = \left[\frac{R_{Ref_\lambda}}{R_{BT_{1_\lambda}}}(1 - \Sigma_m) + \Sigma_m\right]\frac{R_{BT_{1\lambda}}}{R_{BT_{2\lambda}}}$$

i.e. $$\Sigma_{T_\lambda} = \left[\frac{R_{Ref_\lambda}}{R_{BT_{2\lambda}}}(1 - \Sigma_m) + \frac{R_{BT_{1\lambda}}}{R_{BT_{2\lambda}}}\Sigma_m\right]$$

From Planck's radiation law, we have that the energy between wavelengths λ and $(\lambda + d\lambda)$ is given by

$$W = \frac{2\pi c^2 h}{\lambda^5}\exp\left(\frac{ch}{\lambda KT} - 1\right)^{-1} d\lambda$$

(Where the fundamental constants c, h, K have their usual meaning).

W is the spectral radiant emittance of the blackbody.

Assuming the field blackbody and the spectrometer reference to be true blackbodies, we have for a given wavelength (λ)

$$\Sigma_{T(\lambda)} = \left\{ \left[\frac{\exp \frac{ch}{\lambda K T_3} - 1}{\exp \frac{ch}{\lambda K T_2} - 1} \right]^{-1} (1 - \Sigma_m) + \left[\frac{\exp \frac{ch}{\lambda K T_1} - 1}{\exp \frac{ch}{\lambda K T_2} - 1} \right]^{-1} \right\} \Sigma_m$$

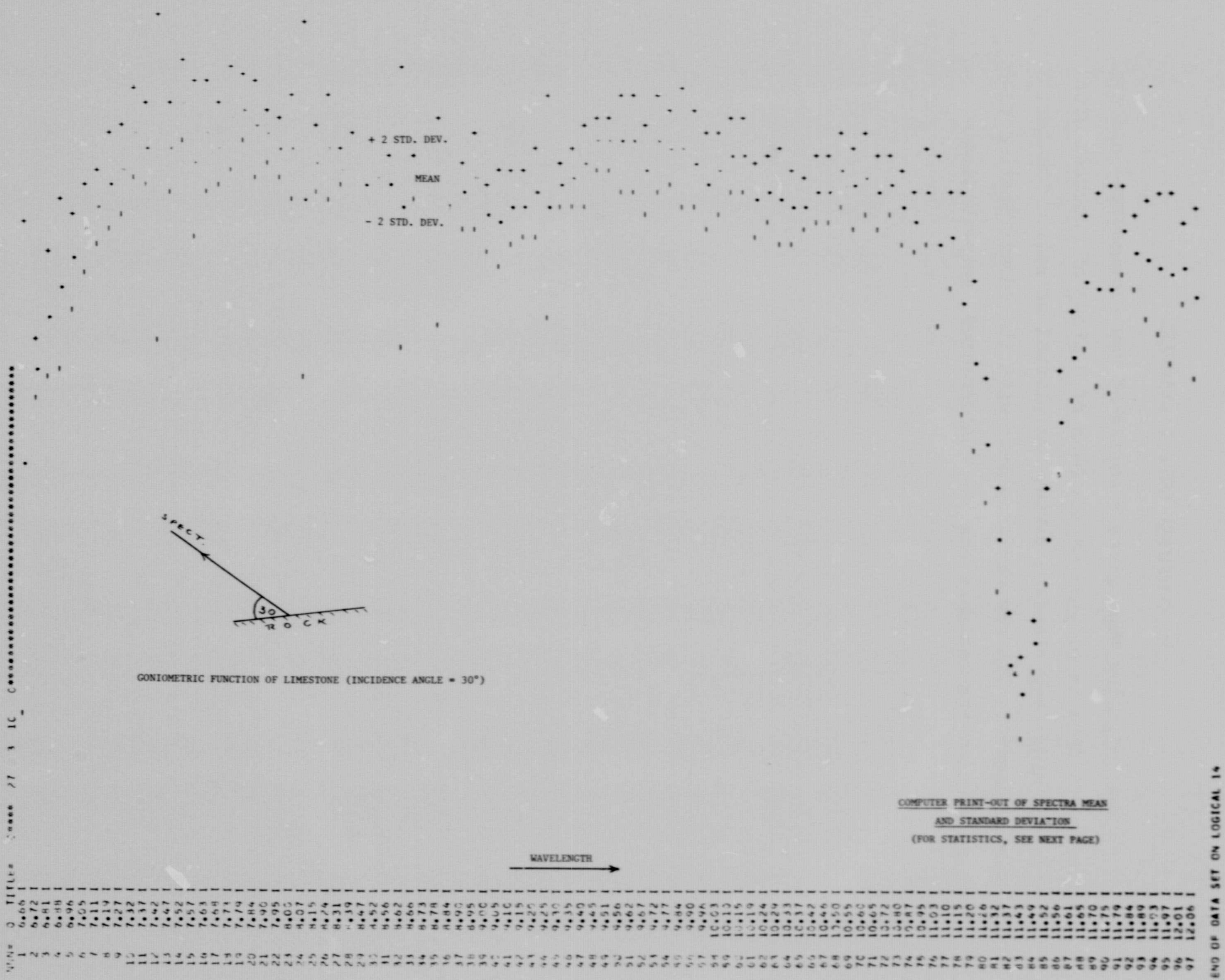
ie.

$$\Sigma_{T(\lambda)} = \left\{ \left[\frac{\exp \frac{ch}{\lambda K T_2} - 1}{\exp \frac{ch}{\lambda K T_3} - 1} \right] (1 - \Sigma_m) + \left[\frac{\exp \frac{ch}{\lambda K T_2} - 1}{\exp \frac{ch}{\lambda K T_1} - 1} \right] \right\} \Sigma_m$$

APPENDIX B

B. COMPUTER OUTP"T EXAMPLES

The following page gives examples of raw (unsmoothed) spectral data. The data is plotted as the mean of a group of spectra, with plus and minus two standard deviations plotted as well. The last example shown is the raw radiance data with its identification data. Printed below the radiance are the (uncorrected) emissivities.



GONIOMETRIC FUNCTION OF LIMESTONE (INCIDENCE ANGLE = 30°)

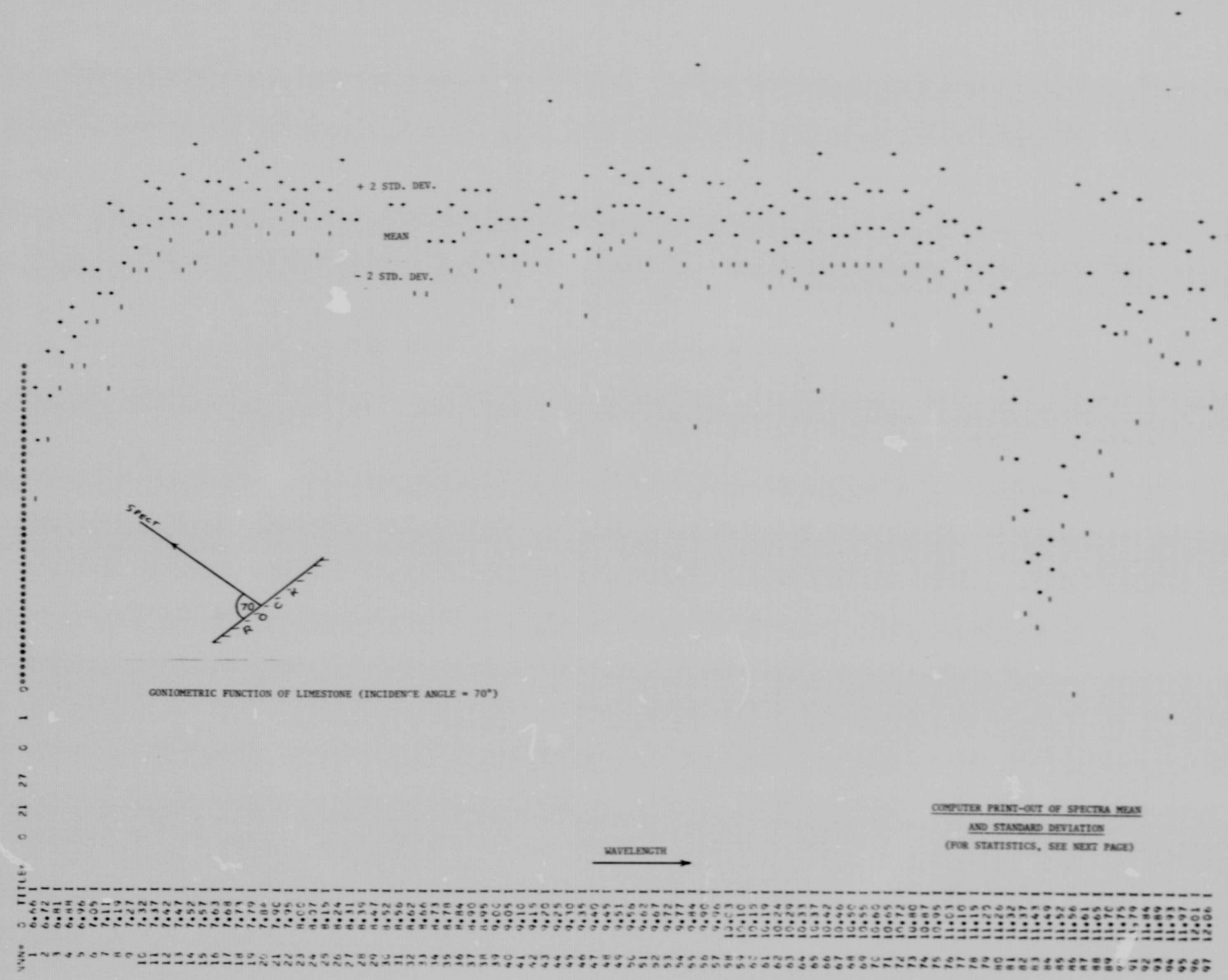
COMPUTER PRINT-OUT OF SPECTRA MEAN AND STANDARD DEVIATION

(FOR STATISTICS, SEE NEXT PAGE)

END OF DATA SET ON LOGICAL 14

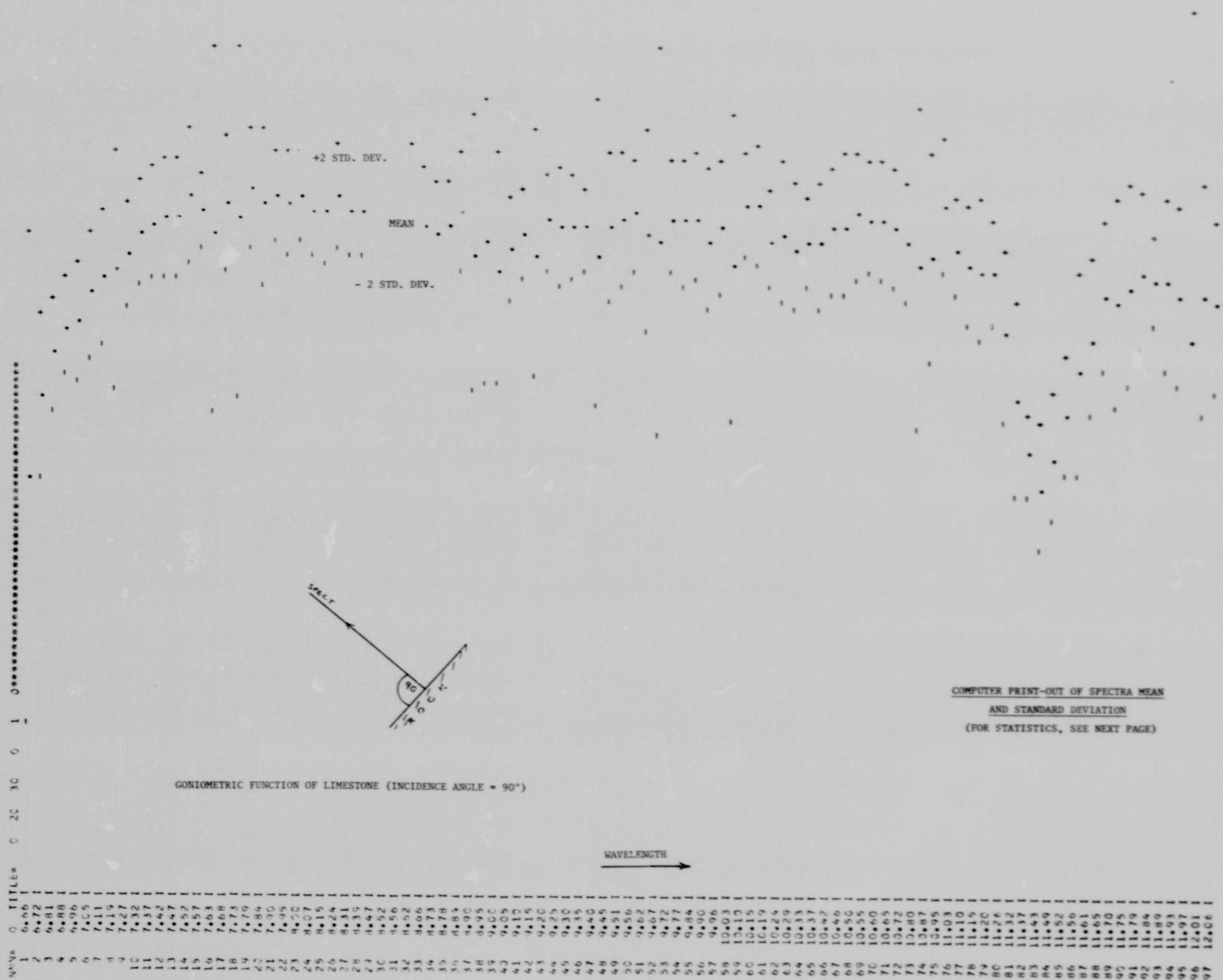
I	N	MEAN	VARIANCE	STD. DEV.	STD.ERR.	+2 STD.DEV.	-2 STD.DEV.
1	10	0.1692003	0.0023232	0.0481999	0.0152422	0.2656001	0.0728005
2	10	0.2090168	0.0000395	0.0062851	0.0019875	0.2215869	0.1964466
3	10	0.2290456	0.0001529	0.0123667	0.0039107	0.2537790	0.2043121
4	10	0.2413092	0.0002859	0.0169081	0.0053468	0.2751254	0.2074931
5	10	0.2513790	0.0000941	0.0097029	0.0030683	0.2707847	0.2319733
6	10	0.2632020	0.0000820	0.0090536	0.0028630	0.2813092	0.2450947
7	10	0.2720722	0.0000492	0.0070175	0.0022191	0.2861072	0.2580371
8	10	0.2826439	0.0000848	0.0092093	0.0029122	0.3010625	0.2642252
9	10	0.2864959	0.0000745	0.0086289	0.0027287	0.3037537	0.2692380
10	10	0.3014897	0.0000858	0.0092616	0.0029288	0.3200129	0.2829665
11	10	0.2963154	0.0000671	0.0081887	0.0025895	0.3126929	0.2799383
12	10	0.2855662	0.0010351	0.0321724	0.0101738	0.3499110	0.2212214
13	10	0.2965730	0.0000835	0.0091362	0.0028891	0.3148454	0.2783006
14	10	0.3138040	0.0000637	0.0079831	0.0025245	0.3297701	0.2978379
15	10	0.2915256	0.0002448	0.0156454	0.0049475	0.3228164	0.2602348
16	10	0.3004461	0.0001216	0.0110253	0.0034865	0.3224967	0.2783954
17	10	0.2966928	0.0000652	0.0080766	0.0025540	0.3128460	0.2805396
18	10	0.3065083	0.0001050	0.0102461	0.0032401	0.3270004	0.2860162
19	10	0.3116144	0.0000492	0.0070137	0.0022179	0.3256418	0.2975870
20	10	0.3035007	0.0000793	0.0089043	0.0028158	0.3213091	0.2856921
21	10	0.3007918	0.0000222	0.0047126	0.0014903	0.3102170	0.2913666
22	10	0.2968767	0.0000334	0.0057764	0.0018267	0.3084294	0.2853239
23	10	0.2963534	0.0001009	0.0100425	0.0031757	0.3164383	0.2762684
24	10	0.2752020	0.0012373	0.0351753	0.0111234	0.3455526	0.2048513
25	10	0.2911916	0.0000469	0.0068512	0.0021665	0.3048940	0.2774892
26	10	0.2951767	0.0001017	0.0100824	0.0031883	0.3153416	0.2750118
27	10	0.2883053	0.0000108	0.0032918	0.0010410	0.2948889	0.2817216
28	10	0.2831684	0.0000921	0.0095972	0.0030349	0.3023629	0.2639739
29	10	0.2818155	0.0000444	0.0066606	0.0021063	0.29[illegible]1367	0.2684943
30	10	0.2846849	0.0000816	0.0090358	0.0028574	0.3027565	0.2666132
31	10	0.2827570	0.0000342	0.0058502	0.0018500	0.2944574	0.2710566
32	10	0.2730882	0.0007813	0.0279522	0.0088393	0.3289926	0.2171836
33	10	0.2848234	0.0000231	0.0048028	0.0015188	0.2944290	0.2752178
34	10	0.2803440	0.0000625	0.0079088	0.0025010	0.2961616	0.2645264
35	10	0.2667711	0.0004275	0.0206758	0.0065383	0.3081228	0.2254193
36	10	0.2856200	0.0000428	0.0065387	0.0020677	0.2986973	0.2725426
37	10	0.2776084	0.0000432	0.0065714	0.0020781	0.2907512	0.2644655
38	10	0.2830466	0.0000826	0.0090862	0.0028733	0.3012189	0.2648742
39	10	0.2686501	0.0000483	0.0069522	0.0021985	0.2825544	0.2547456
40	10	0.2676203	0.0000850	0.0092210	0.0029159	0.2860622	0.2491784
41	10	0.2725226	0.0000597	0.0077235	0.0024424	0.2879696	0.2570755
42	10	0.2735541	0.0000387	0.0062234	0.0019680	0.2860009	0.2611072
43	10	0.2788142	0.0000759	0.0087094	0.0027541	0.2962329	0.2613955
44	10	0.2725887	0.0005046	0.0224640	0.0071037	0.3175167	0.2276607
45	10	0.2826192	0.0000189	0.0043516	0.0013761	0.2913224	0.2739159
46	10	0.2844701	0.0000375	0.0061235	0.0019364	0.2967171	0.2722231
47	10	0.2888080	0.0000631	0.0079426	0.0025117	0.3046933	0.2729228
48	10	0.2976234	0.0000306	0.0055345	0.0017502	0.3086924	0.2865543
49	10	0.2976277	0.0000317	0.0056258	0.0017790	0.3088793	0.2863760
50	10	0.2984276	0.0000914	0.0095608	0.0030234	0.3175492	0.2793059
51	10	0.2979500	0.0000835	0.0091391	0.0028901	0.3162282	0.2796717
52	10	0.2881247	0.0000725	0.0085163	0.0026931	0.3051572	0.2710922
53	10	0.2983318	0.0000921	0.0095944	0.0030340	0.3175207	0.2791429
54	10	0.2967359	0.0000539	0.0073389	0.0023207	0.3114136	0.2820582
55	10	0.2954019	0.0001363	0.0116729	0.0036913	0.3187477	0.2720562
56	10	0.2905385	0.0000876	0.0093505	0.0029597	0.3092576	0.2718195
57	10	0.2825998	0.0000821	0.0090625	0.0028658	0.3007248	0.2644747
58	10	0.2858073	0.0000735	0.0085728	0.0027110	0.3029528	0.2686617
59	10	0.2935960	0.0000558	0.0074729	0.0023631	0.3085417	0.2786503
60	10	0.2925628	0.0000511	0.0071463	0.0022599	0.3068554	0.2782702
61	10	0.2766384	0.0000534	0.0073096	0.0023115	0.2912575	0.2620193
62	10	0.2794479	0.0000492	0.0070137	0.0022179	0.2934753	0.2654206
63	10	0.2768652	0.0000857	0.0092587	0.0029279	0.2953826	0.2583477
64	10	0.2728989	0.0000584	0.0076432	0.0024170	0.2881853	0.2576125
65	10	0.2739994	0.0000267	0.0051634	0.0016328	0.2843263	0.2636725
66	10	0.2787262	0.0000430	0.0065551	0.0020729	0.2918363	0.2656162
67	10	0.2793724	0.0000450	0.0067088	0.0021215	0.2927899	0.2659549
68	10	0.2871415	0.0000624	0.0079020	0.0024988	0.3029455	0.2713374
69	10	0.2800323	0.0000743	0.0086196	0.0027258	0.2972715	0.2627931
70	10	0.2846453	0.0000622	0.0078850	0.0024935	0.3004153	0.2688752
71	10	0.2795734	0.0000522	0.0072264	0.0022858	0.2940302	0.2651167
72	10	0.2813686	0.0000357	0.0059772	0.0018902	0.2933230	0.2694142
73	10	0.2715704	0.0000542	0.0073644	0.0023288	0.2862992	0.2568417
74	10	0.2668670	0.0000329	0.0057344	0.0018134	0.2783359	0.2553981
75	10	0.2777942	0.0000870	0.0093280	0.0029498	0.2964501	0.2591383
76	10	0.2591597	0.0002888	0.0169931	0.0053737	0.2931460	0.2251735
77	10	0.2595861	0.0000953	0.0097607	0.0030866	0.2791076	0.2400646
78	10	0.2350752	0.0004593	0.0214319	0.0067773	0.2779390	0.1922114
79	10	0.2110863	0.0002797	0.0167244	0.0052887	0.2445350	0.1776375
80	10	0.1801867	0.0001561	0.0124926	0.0039505	0.2051719	0.1552016
81	10	0.1411054	0.0001144	0.0106953	0.0033822	0.1624960	0.1197148
82	10	0.0915720	0.0001103	0.0105043	0.0033217	0.1125805	0.0705635
83	10	0.0790831	0.0000624	0.0078973	0.0024974	0.0948778	0.0632885
84	10	0.0993835	0.0000282	0.0053148	0.0016807	0.1100131	0.0887539
85	10	0.1424484	0.0000911	0.0095433	0.0030179	0.1615350	0.1233618
86	10	0.[illegible]875874	0.0001073	0.0103593	0.0032759	0.2083060	0.1668688
87	10	0.2133819	0.0000724	0.0085088	0.0026907	0.2303995	0.1963643
88	10	0.2441270	0.0001715	0.0130949	0.0041410	0.2703168	0.2179371
89	10	0.2403337	0.0003505	0.0187211	0.0059201	0.2777760	0.2028915
90	10	0.2403800	0.0004344	0.0208428	0.0065911	0.2820656	0.1986945
91	10	0.2625897	0.0000762	0.0087309	0.0027609	0.2800514	0.2451279
92	10	0.2558456	0.0000566	0.0075265	0.0023801	0.2708986	0.2407926
93	10	0.2516801	0.0001411	0.0118801	0.0037569	0.2754403	0.2279199
94	10	0.2496224	0.0001915	0.0138370	0.0043756	0.2772964	0.2219484
95	10	0.2456911	0.0002698	0.0164258	0.0051943	0.2785426	0.2128396
96	10	0.2507440	0.0000613	0.0078270	0.0024751	0.2663980	0.2350901
97	10	0.2380030	0.0002809	0.0167588	0.0052996	0.2715206	0.2044853

GONIOMETRIC FUNCTION OF LIMESTONE (INCIDENCE ANGLE = 30°)


+ 2 STD. DEV.
MEAN
- 2 STD. DEV.
SPECT
70°
ROCK
GONIOMETRIC FUNCTION OF LIMESTONE (INCIDENCE ANGLE = 70°)
WAVELENGTH
COMPUTER PRINT-OUT OF SPECTRA MEAN
AND STANDARD DEVIATION
(FOR STATISTICS, SEE NEXT PAGE)

I	N	MEAN	VARIANCE	STD. DEV.	STD.ERR.	+2 STD.DEV.	-2 STD.DEV.
1	11	0.2298356	0.0001972	0.0140424	0.0042339	0.2579204	0.2017507
2	11	0.2541602	0.0001252	0.0111904	0.0033740	0.2765408	0.2317795
3	11	0.2751712	0.0000813	0.0090185	0.0027192	0.2932081	0.2571341
4	11	0.2843445	0.0000586	0.0076570	0.0023087	0.2996584	0.2690305
5	11	0.2922697	0.0001395	0.0118122	0.0035615	0.3158942	0.2686452
6	11	0.3056570	0.0000399	0.0063194	0.0019054	0.3182958	0.2930182
7	11	0.3048732	0.0005479	0.0234079	0.0070577	0.3516889	0.2580574
8	11	0.3225359	0.0001379	0.0117432	0.0035407	0.3460224	0.2990494
9	11	0.3290311	0.0000396	0.0062936	0.0018976	0.3416184	0.3164438
10	11	0.3406194	0.0001277	0.0113012	0.0034074	0.3632217	0.3180170
11	11	0.3425308	0.0000774	0.0087965	0.0026522	0.3601238	0.3249379
12	11	0.3434209	0.0000215	0.0046381	0.0013984	0.3526970	0.3341447
13	11	0.3435113	0.0001480	0.0121670	0.0036685	0.3678453	0.3191772
14	11	0.3517923	0.0002302	0.0151735	0.0045750	0.3821394	0.3214452
15	11	0.3494610	0.0000375	0.0061235	0.0018463	0.3617079	0.3372141
16	11	0.3487557	0.0000455	0.0067426	0.0020330	0.3622404	0.3352702
17	11	0.3496898	0.0000295	0.0054343	0.0016385	0.3605583	0.3388212
18	11	0.3614014	0.0000444	0.0066617	0.0020086	0.3747248	0.3480780
19	11	0.3598668	0.0000962	0.0098072	0.0029570	0.3794811	0.3402525
20	11	0.3532187	0.0000604	0.0077729	0.0023436	0.3687645	0.3376729
21	11	0.3524495	0.0000253	0.0050304	0.0015167	0.3625103	0.3423887
22	11	0.3487086	0.0000375	0.0061235	0.0018463	0.3609555	0.3364617
23	11	0.3507357	0.0000166	0.0040786	0.0012297	0.3588929	0.3425784
24	11	0.3441857	0.0000791	0.0088914	0.0026809	0.3619685	0.3264028
25	11	0.3469664	0.0000337	0.0058055	0.0017504	0.3585774	0.3353555
26	11	0.3453262	0.0001979	0.0140672	0.0042414	0.3734607	0.3171917
27	11	0.3429995	0.0001548	0.0124401	0.0037508	0.3678796	0.3181193
28	11	0.3350106	0.0001578	0.0125614	0.0037874	0.3601335	0.3098877
29	11	0.3369441	0.0001750	0.0132275	0.0039882	0.3633991	0.3104891
30	11	0.3368775	0.0000537	0.0073279	0.0022095	0.3515334	0.3222216
31	11	0.3369715	0.0000499	0.0070605	0.0021288	0.3510926	0.3228504
32	11	0.3359337	0.0002247	0.0149903	0.0045197	0.3659143	0.3059531
33	11	0.3329348	0.0001639	0.0128028	0.0038602	0.3585405	0.3073291
34	11	0.3332761	0.0000616	0.0078492	0.0023666	0.3489744	0.3175777
35	11	0.3336814	0.0000710	0.0084284	0.0025413	0.3505382	0.3168246
36	11	0.3484741	0.0000373	0.0061057	0.0018409	0.3606856	0.3362626
37	11	0.3395947	0.0001080	0.0103920	0.0031333	0.3603786	0.3188107
38	11	0.3414837	0.0000695	0.0083379	0.0025140	0.3581595	0.3248079
39	11	0.3270066	0.0000647	0.0080435	0.0024252	0.3430936	0.3109195
40	11	0.3243885	0.0001124	0.0106036	0.0031971	0.3455957	0.3031813
41	11	0.3337256	0.0000317	0.0056302	0.0016976	0.3449859	0.3224652
42	11	0.3367772	0.0000489	0.0069911	0.0021079	0.3507594	0.3227949
43	11	0.3277375	0.0014514	0.0380976	0.0114869	0.4039327	0.2515423
44	11	0.3332165	0.0001147	0.0107078	0.0032285	0.3546322	0.3118008
45	11	0.3391843	0.0000581	0.0076215	0.0022980	0.3544273	0.3239412
46	11	0.3307196	0.0002927	0.0171073	0.0051580	0.3649341	0.2965051
47	11	0.3376164	0.0000357	0.0059711	0.0018004	0.3495587	0.3256742
48	11	0.3497981	0.0001173	0.0108311	0.0032657	0.3714603	0.3281358
49	11	0.3505309	0.0000763	0.0087346	0.0026336	0.3680001	0.3330616
50	11	0.3500987	0.0000506	0.0071102	0.0021438	0.3643191	0.3358781
51	11	0.3467313	0.0001612	0.0126966	0.0038282	0.3721245	0.3213381
52	11	0.3489228	0.0000604	0.0077694	0.0023426	0.3644615	0.3333840
53	11	0.3450907	0.0000598	0.0077309	0.0023310	0.3605525	0.3296288
54	11	0.3441601	0.0001462	0.0120933	0.0036463	0.3683467	0.3199734
55	11	0.3309962	0.0021495	0.0463628	0.0139789	0.4237217	0.2382707
56	11	0.3371999	0.0001775	0.0133214	0.0040165	0.3638426	0.3105571
57	11	0.3423747	0.0000946	0.0097267	0.0029327	0.3618281	0.3229212
58	11	0.3382460	0.0000617	0.0078526	0.0023677	0.3539512	0.3225407
59	11	0.3475236	0.0001874	0.0136905	0.0041278	0.3749045	0.3201426
60	11	0.3482751	0.0000577	0.0075930	0.0022894	0.3634611	0.3330890
61	11	0.3308361	0.0000920	0.0095893	0.0028913	0.3500146	0.3116576
62	11	0.3311642	0.0000564	0.0075069	0.0022634	0.3461779	0.3161504
63	11	0.3358601	0.0001189	0.0109059	0.0032882	0.3576719	0.3140483
64	11	0.3341374	0.0001266	0.0112531	0.0033929	0.3566436	0.3116311
65	11	0.3188437	0.0009259	0.0304282	0.0091745	0.3797001	0.2579872
66	11	0.3383217	0.0000609	0.0078042	0.0023530	0.3539300	0.3227133
67	11	0.3380967	0.0000804	0.0089643	0.0027028	0.3560252	0.3201681
68	11	0.3418109	0.0001038	0.0101866	0.0030714	0.3621840	0.3214377
69	11	0.3404387	0.0000903	0.0095013	0.0028647	0.3594412	0.3214361
70	11	0.3391110	0.0000824	0.0090754	0.0027363	0.3572618	0.3209602
71	11	0.3354554	0.0004496	0.0212033	0.0063930	0.3778621	0.2930487
72	11	0.3397074	0.0001077	0.0103763	0.0031286	0.3604600	0.3189548
73	11	0.3339789	0.0000490	0.0070027	0.0021114	0.3479844	0.3199734
74	11	0.3328888	0.0000767	0.0087563	0.0026401	0.3504015	0.3153762
75	11	0.3439770	0.0001524	0.0123439	0.0037218	0.3686647	0.3192893
76	11	0.3255431	0.0001030	0.0101493	0.0030601	0.3458416	0.3052446
77	11	0.3223479	0.0000485	0.0069639	0.0020997	0.3362758	0.3084199
78	11	0.3189549	0.0000977	0.0098842	0.0029802	0.3387233	0.2991865
79	11	0.3062392	0.0000520	0.0072124	0.0021746	0.3206639	0.2918144
80	11	0.2662795	0.0004798	0.0219047	0.0066045	0.3100890	0.2224702
81	11	0.2244216	0.0002186	0.0147835	0.0044574	0.2539886	0.1948546
82	11	0.1721820	0.0001664	0.0128980	0.0038889	0.1979779	0.1463860
83	11	0.1562907	0.0000738	0.0085916	0.0025905	0.1734738	0.1391076
84	11	0.1689010	0.0000548	0.0074024	0.0022319	0.1837057	0.1540961
85	11	0.2047440	0.0000552	0.0074314	0.0022407	0.2196068	0.1898811
86	11	0.2342747	0.0041890	0.0647224	0.0195145	0.3637194	0.1048300
87	11	0.2533033	0.0010710	0.0327259	0.0098672	0.3187552	0.1878515
88	11	0.2917750	0.0009887	0.0314441	0.0094808	0.3546632	0.2288868
89	11	0.2878037	0.0012224	0.0349634	0.0105419	0.3577304	0.2178770
90	11	0.3025533	0.0000642	0.0080098	0.0024150	0.3185728	0.2865338
91	11	0.3003429	0.0007849	0.0280168	0.0084474	0.3563763	0.2443093
92	11	0.3072139	0.0001506	0.0122712	0.0036999	0.3317564	0.2826714
93	11	0.3056002	0.0002064	0.0143683	0.0043322	0.3343368	0.2768635
94	11	0.2719216	0.0080374	0.0896513	0.0270309	0.4512241	0.0926190
95	11	0.3085530	0.0000956	0.0097767	0.0029478	0.3281064	0.2889995
96	11	0.3085445	0.0003098	0.0176022	0.0053072	0.3437487	0.2733401
97	11	0.2936897	0.0004883	0.0220968	0.0066624	0.3378834	0.2494960

GONIOMETRIC FUNCTION OF LIMESTONE (INCIDENCE ANGLE = 70°)



GONIOMETRIC FUNCTION OF LIMESTONE (INCIDENCE ANGLE = 90°)

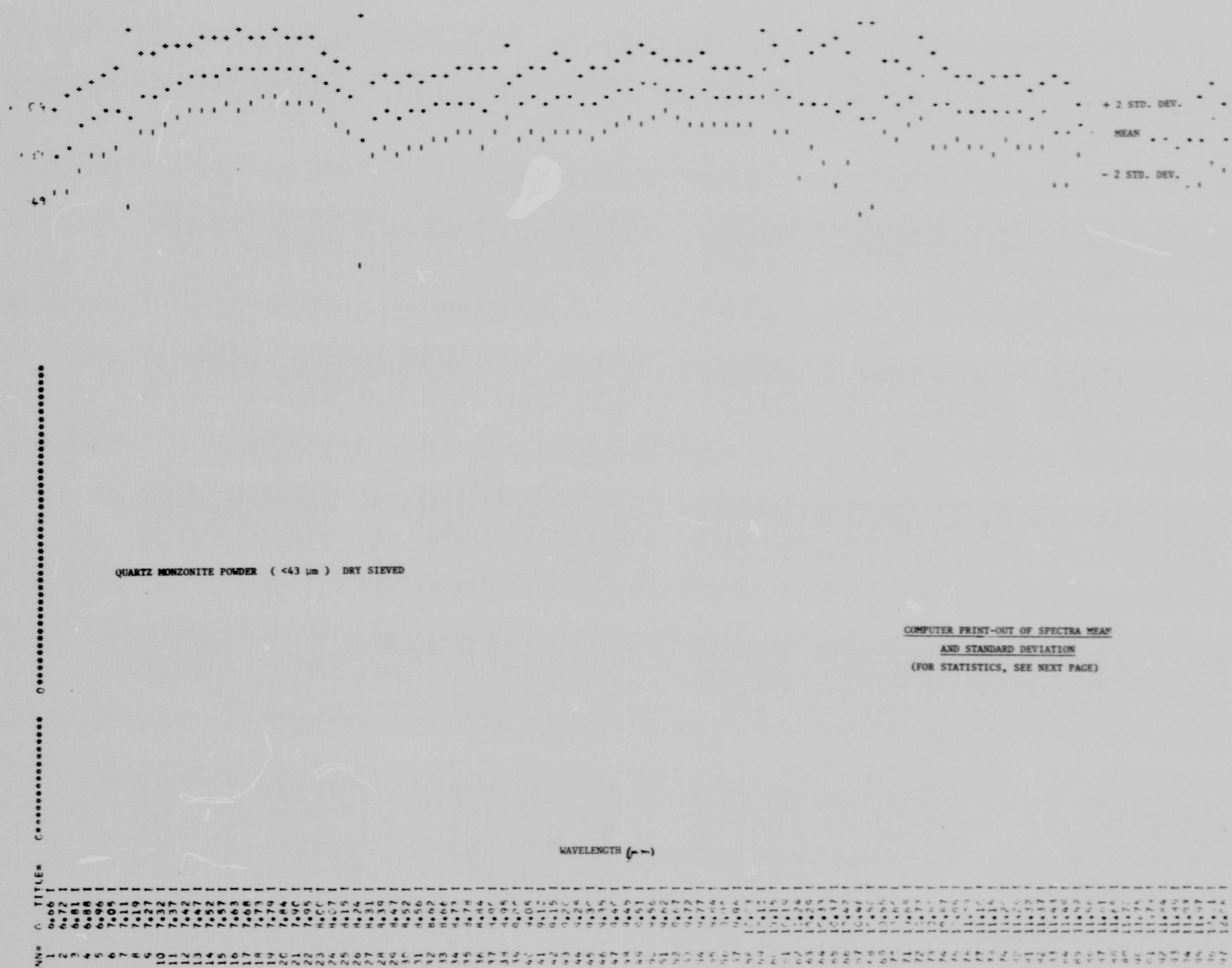
COMPUTER PRINT-OUT OF SPECTRA MEAN

AND STANDARD DEVIATION

(FOR STATISTICS, SEE NEXT PAGE)

I	N	MEAN	VARIANCE	STD. DEV.	STD.ERR.	+2 STD.DEV.	-2 STD.DEV.
1	12	0.2103555	0.0038085	0.0617128	0.0178150	0.3337811	0.0869300
2	12	0.2523952	0.0003943	0.0198561	0.0057320	0.2921074	0.2126830
3	12	0.2737433	0.0002140	0.0146274	0.0042226	0.3029981	0.2444885
4	12	0.2870218	0.0001381	0.0117526	0.0033927	0.3105270	0.2635165
5	12	0.2900846	0.0002092	0.0144640	0.0041754	0.3190126	0.2611566
6	12	0.3036647	0.0002370	0.0153936	0.0044437	0.3344519	0.2728775
7	12	0.3126878	0.0002596	0.0161133	0.0046515	0.3449143	0.2804612
8	12	0.3171035	0.0008922	0.0298702	0.0086228	0.3768440	0.2573630
9	12	0.3240384	0.0001789	0.0133747	0.0038610	0.3507878	0.2972889
10	12	0.3354614	0.0001782	0.0133482	0.0038533	0.3621576	0.3087651
11	12	0.3401107	0.0002123	0.0145694	0.0042058	0.3692494	0.3109719
12	12	0.3419189	0.0002088	0.0144508	0.0041716	0.3708205	0.3130174
13	12	0.3418330	0.0002150	0.0146628	0.0042328	0.3711587	0.3125073
14	12	0.3531108	0.0002607	0.0161455	0.0046608	0.3854017	0.3208199
15	12	0.3460455	0.0000944	0.0097139	0.0028041	0.3654732	0.3266178
16	12	0.3358954	0.0021300	0.0461524	0.0133231	0.4282002	0.2435905
17	12	0.3485899	0.0002814	0.0167761	0.0048428	0.3821421	0.3150376
18	12	0.3407121	0.0018776	0.0433315	0.0125087	0.4273751	0.2540491
19	12	0.3566761	0.0002307	0.0151899	0.0043850	0.3870560	0.3262962
20	12	0.3479179	0.0003606	0.0189897	0.0054818	0.3858972	0.3099385
21	12	0.3521010	0.0001223	0.0110580	0.0031922	0.3742169	0.3299850
22	12	0.3508252	0.0001707	0.0130668	0.0037721	0.3769588	0.3246915
23	12	0.3545349	0.0001336	0.0115581	0.0033365	0.3776510	0.3314187
24	12	0.3464222	0.0001438	0.0119896	0.0034611	0.3704014	0.3224429
25	12	0.3464795	0.0001812	0.0134623	0.0038862	0.3734041	0.3195550
26	12	0.3526971	0.0001827	0.0135170	0.0039020	0.3797310	0.3256632
27	12	0.3476052	0.0001283	0.0113265	0.0032697	0.3702582	0.3249522
28	12	0.3466700	0.0001383	0.0117596	0.0033947	0.3701891	0.3231508
29	12	0.3425655	0.0002078	0.0144167	0.0041617	0.3713989	0.3137321
30	12	0.3395631	0.0003176	0.0178200	0.0051442	0.3752032	0.3039231
31	12	0.3376712	0.0002949	0.0171720	0.0049571	0.3720152	0.3033270
32	12	0.3416710	0.0003632	0.0190572	0.0055013	0.3797854	0.3035567
33	12	0.3368371	0.0002652	0.0162853	0.0047012	0.3694077	0.3042665
34	12	0.3357697	0.0001552	0.0124568	0.0035960	0.3606831	0.3108561
35	12	0.3377699	0.0001514	0.0123045	0.0035520	0.3623788	0.3131608
36	12	0.3457310	0.0002148	0.0146554	0.0042306	0.3750418	0.3164202
37	12	0.3240811	0.0012089	0.0347694	0.0100371	0.3936198	0.2545423
38	12	0.3302947	0.0012442	0.0352725	0.0101823	0.4008397	0.2597496
39	12	0.3175151	0.0008224	0.0286776	0.0082785	0.3748703	0.2601599
40	12	0.3262959	0.0001659	0.0128794	0.0037180	0.3520547	0.3005370
41	12	0.3344595	0.0001292	0.0113650	0.0032808	0.3571899	0.3117295
42	12	0.3254136	0.0009670	0.0310971	0.0089770	0.3876078	0.2632194
43	12	0.3412412	0.0001374	0.0117200	0.0033833	0.3646812	0.3178012
44	12	0.3395302	0.0002117	0.0145487	0.0041999	0.3686277	0.3104327
45	12	0.3374205	0.0001748	0.0132206	0.0038165	0.3638617	0.3109791
46	12	0.3369136	0.0001190	0.0109087	0.0031491	0.3587311	0.3150961
47	12	0.3248235	0.0014247	0.0377456	0.0108962	0.4003151	0.2493327
48	12	0.3398098	0.0003497	0.0186997	0.0053982	0.3772092	0.3024102
49	12	0.3426095	0.0002893	0.0170074	0.0049096	0.3766242	0.3085946
50	12	0.3445013	0.0002059	0.0143483	0.0041420	0.3731979	0.3158046
51	12	0.3366290	0.0005957	0.0244061	0.0070454	0.3854412	0.2878168
52	12	0.3308197	0.0023345	0.0483167	0.0139478	0.4274530	0.2341864
53	12	0.3428400	0.0001949	0.0139623	0.0040306	0.3707647	0.3149153
54	12	0.3405602	0.0002478	0.0157411	0.0045441	0.3720423	0.3090780
55	12	0.3427225	0.0002540	0.0159360	0.0046003	0.3745944	0.3108505
56	12	0.3326430	0.0002901	0.0170331	0.0049170	0.3667092	0.2985769
57	12	0.3380816	0.0002953	0.0171848	0.0049608	0.3724511	0.3037121
58	12	0.3190647	0.0014967	0.0386878	0.0111682	0.3964401	0.2416892
59	12	0.3496426	0.0001916	0.0138425	0.0039960	0.3773275	0.3219576
60	12	0.3505226	0.0002337	0.0152885	0.0044134	0.3810997	0.3199455
61	12	0.3325012	0.0001505	0.0122667	0.0035411	0.3570346	0.3079677
62	12	0.3357500	0.0003238	0.0179955	0.0051948	0.3717409	0.2997590
63	12	0.3290792	0.0002279	0.0150979	0.0043584	0.3592751	0.2988833
64	12	0.3326464	0.0001252	0.0111881	0.0032297	0.3550227	0.3102701
65	12	0.3293405	0.0002641	0.0162517	0.0046915	0.3618439	0.2968371
66	12	0.3371926	0.0002597	0.0161167	0.0046525	0.3694259	0.3049592
67	12	0.3394383	0.0003171	0.0178078	0.0051407	0.3750538	0.3038227
68	12	0.3450323	0.0002563	0.0160095	0.0046216	0.3770514	0.3130133
69	12	0.3434047	0.0001997	0.0141315	0.0040794	0.3716677	0.3151416
70	12	0.3428155	0.0002260	0.0150345	0.0043401	0.3728845	0.3127465
71	12	0.3381757	0.0002074	0.0144015	0.0041574	0.3669787	0.3093725
72	12	0.3314571	0.0002436	0.0156086	0.0045058	0.3626744	0.3002399
73	12	0.3183697	0.0015685	0.0396041	0.0114327	0.3975778	0.2391616
74	12	0.3239015	0.0007107	0.0266584	0.0076956	0.3772182	0.2705846
75	12	0.3505688	0.0002706	0.0164489	0.0047484	0.3834665	0.3176711
76	12	0.3280614	0.0001498	0.0122399	0.0035334	0.3525413	0.3035815
77	12	0.3186392	0.0002178	0.0147576	0.0042601	0.3481542	0.2891240
78	12	0.3174554	0.0003006	0.0173367	0.0050047	0.3521288	0.2827820
79	12	0.3153535	0.0001604	0.0126634	0.0036556	0.3406802	0.2900267
80	12	0.2852726	0.0004808	0.0219261	0.0063295	0.3291249	0.2414203
81	12	0.2523760	0.0006234	0.0249672	0.0072074	0.3023123	0.2024436
82	12	0.2260859	0.0001046	0.0102264	0.0029521	0.2465387	0.2056330
83	12	0.2084527	0.0002411	0.0155264	0.0044821	0.2395054	0.1773999
84	12	0.2241290	0.0002632	0.0162220	0.0046829	0.2565730	0.1916848
85	12	0.2444115	0.0002330	0.0152643	0.0044064	0.2749400	0.2138829
86	12	0.2660051	0.0006713	0.0259090	0.0074793	0.3178231	0.2141870
87	12	0.2839940	0.0003914	0.0197844	0.0057113	0.3235629	0.2444251
88	12	0.3047621	0.0003773	0.0194235	0.0056071	0.3436091	0.2659151
89	12	0.3016237	0.0006803	0.0260824	0.0075293	0.3537885	0.2494588
90	12	0.3100010	0.0006365	0.0252284	0.0072828	0.3604578	0.2595441
91	12	0.3169680	0.0003733	0.0193220	0.0055778	0.3556119	0.2783241
92	12	0.3123963	0.0001259	0.0112198	0.0032389	0.3348360	0.2899566
93	12	0.3106401	0.0004659	0.0215846	0.0062309	0.3538092	0.2674709
94	12	0.3049538	0.0005393	0.0232223	0.0067037	0.3513983	0.2585093
95	12	0.2828403	0.0068949	0.0830354	0.0239703	0.4489111	0.1167694
96	12	0.3037595	0.0008534	0.0292137	0.0084333	0.3621868	0.2453321
97	12	0.2997289	0.0004656	0.0215770	0.0062287	0.3428828	0.2565749

GONIOMETRIC FUNCTION OF LIMESTONE (INCIDENCE ANGLE = 90°)

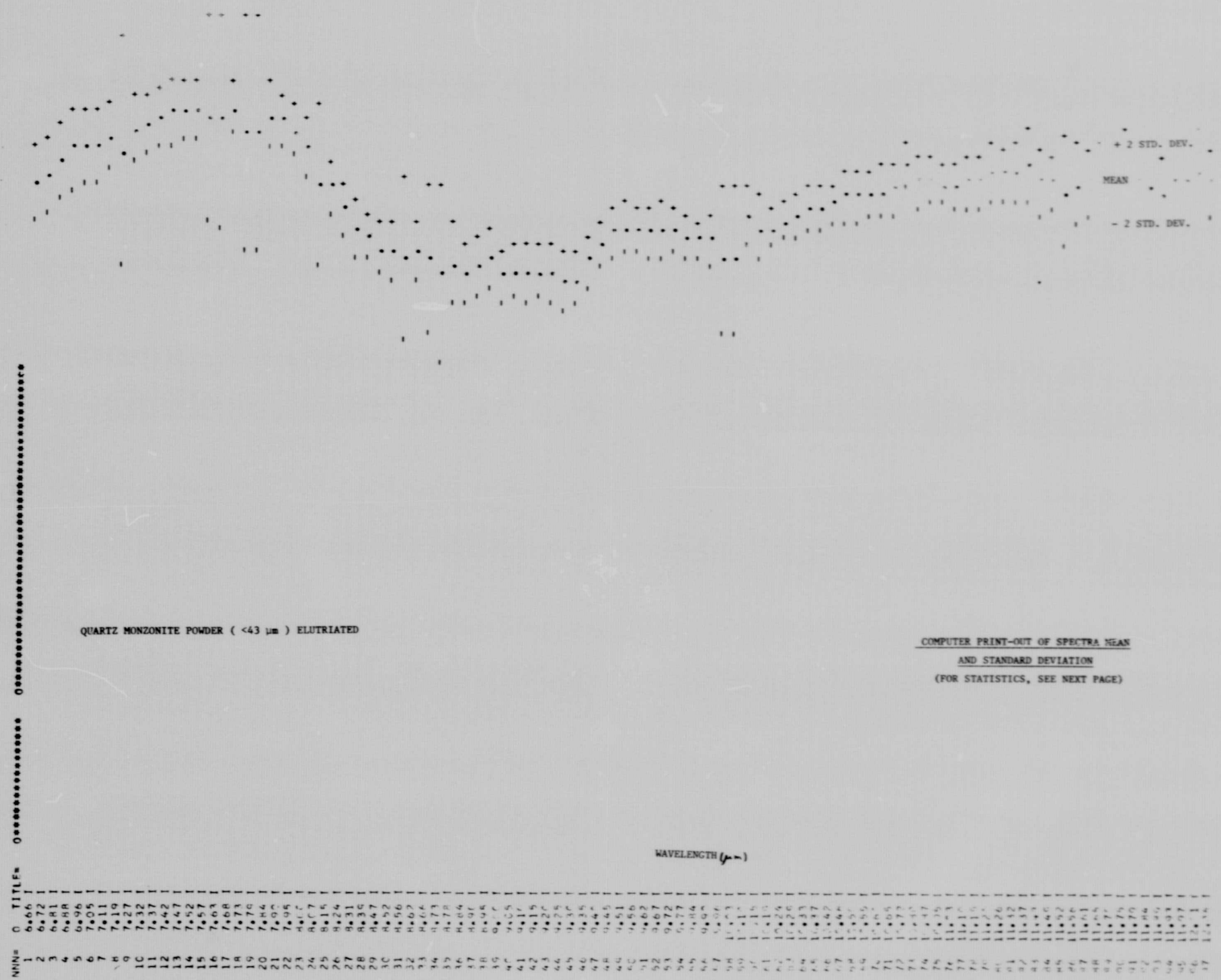


QUARTZ MONZONITE POWDER (<43 μm) DRY SIEVED

COMPUTER PRINT-OUT OF SPECTRA MEAN
AND STANDARD DEVIATION
(FOR STATISTICS, SEE NEXT PAGE)

I	N	MEAN	VARIANCE	STD. DEV.	STD.ERR.	+2 STD.DEV.	-2 STD.DEV.
1	11	0.5190228	0.0001886	0.0137320	0.0041403	0.5464868	0.4915588
2	11	0.5244063	0.0002682	0.0163774	0.0049380	0.5571612	0.4916514
3	11	0.5360067	0.0002134	0.0146095	0.0044049	0.5652258	0.5067877
4	11	0.5415952	0.0001503	0.0122602	0.0036966	0.5661155	0.5170748
5	11	0.5458344	0.0002266	0.0150516	0.0045382	0.5759377	0.5157311
6	11	0.5500059	0.0001776	0.0133255	0.0040178	0.5766568	0.5233550
7	11	0.5428393	0.0009190	0.0303149	0.0091403	0.6034692	0.4822094
8	11	0.5599734	0.0001943	0.0139396	0.0042029	0.5878525	0.5320943
9	11	0.5593834	0.0001953	0.0139745	0.0042135	0.5873324	0.5314344
10	11	0.5635887	0.0002012	0.0141842	0.0042767	0.5919572	0.5352202
11	11	0.5676625	0.0001518	0.0123197	0.0037145	0.5923018	0.5430230
12	11	0.5715165	0.0001269	0.0112652	0.0033966	0.5940467	0.5489861
13	11	0.5735144	0.0001811	0.0134590	0.0040580	0.6004323	0.5465964
14	11	0.5731572	0.0001582	0.0125787	0.0037926	0.5983145	0.5479998
15	11	0.5763329	0.0001474	0.0121403	0.0036604	0.6006134	0.5520524
16	11	0.5768170	0.0001[illegible]58	0.0132582	0.0039975	0.6033334	0.5503007
17	11	0.5775046	0.0001484	0.0121804	0.0036725	0.6018653	0.5531438
18	11	0.5788358	0.0001289	0.0113514	0.0034226	0.6015386	0.5561330
19	11	0.5807643	0.0001362	0.0116692	0.0035184	0.6041026	0.5574259
20	11	0.5780148	0.0001258	0.0112170	0.0033820	0.6004487	0.5555809
21	11	0.5772630	0.0001214	0.0110171	0.0033218	0.5992972	0.5552288
22	11	0.5745940	0.0001256	0.0112170	0.0033820	0.5970279	0.5521601
23	11	0.5696821	0.0001026	0.0101306	0.0030545	0.5899432	0.5494210
24	11	0.5622842	0.0001377	0.0117340	0.0035379	0.5857521	0.5388162
25	11	0.5561303	0.0001401	0.0118352	0.0035684	0.5798006	0.5324600
26	11	0.5284713	0.0019801	0.0444979	0.0134166	0.6174672	0.4394754
27	11	0.5443860	0.0001624	0.0127435	0.0038423	0.5698729	0.5188991
28	11	0.5495303	0.0001644	0.0128219	0.0038659	0.5751740	0.5238856
29	11	0.5441201	0.0001597	0.0126388	0.0038108	0.5693978	0.5188424
30	11	0.5476621	0.0001448	0.0120327	0.0036280	0.5717274	0.5235967
31	11	0.5474524	0.0001400	0.0118306	0.0035671	0.5711136	0.5237913
32	11	0.5512902	0.0001141	0.0106800	0.0032201	0.5726501	0.5299302
33	11	0.5507337	0.0001182	0.0108711	0.0032777	0.5724758	0.5289916
34	11	0.5546055	0.0001352	0.0116296	0.0035065	0.5778648	0.5313463
35	11	0.5541916	0.0001367	0.0116924	0.0035254	0.5775763	0.5308068
36	11	0.5502368	0.0001755	0.0132480	0.0039944	0.5767327	0.5237408
37	11	0.5575820	0.0001409	0.0118717	0.0035795	0.5813255	0.5338385
38	11	0.5698397	0.0001728	0.0131453	0.0039635	0.5961303	0.5435491
39	11	0.5514106	0.0001311	0.0114488	0.0034520	0.5743082	0.5285128
40	11	0.5565972	0.0001364	0.0116808	0.0035219	0.5799587	0.5332357
41	11	0.5527819	0.0001458	0.0120754	0.0036409	0.5769326	0.5286311
42	11	0.5602287	0.0001867	0.0136628	0.0041195	0.5875545	0.5329034
43	11	0.5586716	0.0001889	0.0137458	0.0041445	0.5861632	0.5311800
44	11	0.5520209	0.0001054	0.0102687	0.0030961	0.5725583	0.5314835
45	11	0.5527632	0.0001502	0.0122558	0.0036953	0.5772747	0.5282516
46	11	0.5558674	0.0001604	0.0126667	0.0038191	0.5812008	0.5305340
47	11	0.5614573	0.0001401	0.0118352	0.0035684	0.5851277	0.5377870
48	11	0.5658854	0.0001365	0.0116854	0.0035233	0.5892562	0.5425146
49	11	0.5666087	0.0001820	0.0134891	0.0040671	0.5935869	0.5396304
50	11	0.5663987	0.0001403	0.0118443	0.0035712	0.5900874	0.5427101
51	11	0.5650188	0.0000807	0.0089854	0.0027092	0.5829895	0.5470480
52	11	0.5630225	0.0001051	0.0102528	0.0030914	0.5835282	0.5425168
53	11	0.5601537	0.0001191	0.0109133	0.0032905	0.5819803	0.5383270
54	11	0.5613601	0.0001684	0.0129752	0.0039122	0.5873104	0.5354096
55	11	0.5585324	0.0001063	0.0103082	0.0031080	0.5791488	0.5379160
56	11	0.5585000	0.0001099	0.0104828	0.0031607	0.5794656	0.5375344
57	11	0.5565173	0.0001126	0.0106112	0.0031994	0.5777398	0.5352948
58	11	0.5562688	0.0000988	0.0099416	0.0029975	0.5761519	0.5363855
59	11	0.5799588	0.0001431	0.0119627	0.0036069	0.6038841	0.5560334
60	11	0.5637234	0.0002152	0.0146688	0.0044228	0.5930609	0.5343858
61	11	0.5569791	0.0001747	0.0132173	0.0039852	0.5834135	0.5305445
62	11	0.5528359	0.0006393	0.0252841	0.0076234	0.6034041	0.5022676
63	11	0.5556935	0.0003144	0.0177325	0.0053466	0.5911585	0.5202284
64	11	0.5527601	0.0004070	0.0201740	0.0060827	0.5931082	0.5124121
65	11	0.5488682	0.0006973	0.0264068	0.0079620	0.6016818	0.4960546
66	11	0.5527021	0.0003725	0.0192996	0.0058190	0.5913013	0.5141028
67	11	0.5432242	0.0011846	0.0344182	0.0103775	0.6120606	0.4743877
68	11	0.5439105	0.0010580	0.0325275	0.0098074	0.6089655	0.4788555
69	11	0.5585737	0.0001836	0.0135513	0.0040859	0.5856762	0.5314712
70	11	0.5541207	0.0002029	0.0142452	0.0042951	0.5826111	0.5256302
71	11	0.5571071	0.0001089	0.0104336	0.0031458	0.5779743	0.5362399
72	11	0.5721150	0.0001925	0.0138733	0.0041830	0.5998616	0.5443683
73	11	0.5546274	0.0002910	0.0170581	0.0051432	0.5887436	0.5205112
74	11	0.5506729	0.0002079	0.0144191	0.0043475	0.5795112	0.5218346
75	11	0.5490872	0.0001370	0.0117063	0.0035296	0.5724996	0.5256746
76	11	0.5485045	0.0001509	0.0122823	0.0037032	0.5730690	0.5239400
77	11	0.5474463	0.0001368	0.0116947	0.0035261	0.5708356	0.5240569
78	11	0.5469083	0.0002040	0.0142832	0.0043066	0.5754752	0.5183423
79	11	0.5488931	0.0001280	0.0113155	0.0034119	0.5715241	0.5262620
80	11	0.5487243	0.0001567	0.0125182	0.0037744	0.5737607	0.5236878
81	11	0.5446105	0.0001006	0.0100284	0.0030237	0.5646673	0.5245536
82	11	0.5461649	0.0001529	0.0123658	0.0037284	0.5708965	0.5214333
83	11	0.5342476	0.0003955	0.0198875	0.0059962	0.5740222	0.4944730
84	11	0.5334938	0.0003117	0.0176544	0.0053230	0.5688026	0.4981850
85	11	0.5353993	0.0001026	0.0101279	0.0030537	0.5556550	0.5151435
86	11	0.5338349	0.0001117	0.0105678	0.0031863	0.5549704	0.5126993
87	11	0.5300086	0.0001296	0.0113848	0.0034326	0.5527781	0.5072390
88	11	0.5320757	0.0001396	0.0118145	0.0035622	0.5557048	0.5084466
89	11	0.5317732	0.0001268	0.0112628	0.0033958	0.5542987	0.5092477
90	11	0.5329684	0.0001045	0.0102211	0.0030818	0.5534105	0.5125262
91	11	0.5290641	0.0001611	0.0126923	0.0038269	0.5544487	0.5036794
92	11	0.5274781	0.0001884	0.0137241	0.0041380	0.5549263	0.5000299
93	11	0.5241317	0.0001293	0.0113729	0.0034290	0.5468774	0.5013859
94	11	0.5284204	0.0002526	0.0158939	0.0047922	0.5602082	0.4966326
95	11	0.5274716	0.0002142	0.0146355	0.0044128	0.5567626	0.4982006
96	11	0.5410520	0.0001905	0.0138028	0.0041617	0.5686576	0.5134463
97	11	0.5282597	0.0001326	0.0115173	0.0034726	0.5512942	0.5052251

QUARTZ MONZONITE POWDER (<43µm) DRY SIEVED



QUARTZ MONZONITE POWDER (<43 μm) ELUTRIATED

COMPUTER PRINT-OUT OF SPECTRA MEAN
AND STANDARD DEVIATION
(FOR STATISTICS, SEE NEXT PAGE)

I	N	MEAN	VARIANCE	STD. DEV.	STD.ERR.	+2 STD.DEV.	-2 STD.DEV.
1	14	0.5195339	0.0001723	0.0131261	0.0035081	0.5457861	0.4932815
2	14	0.5231794	0.0001745	0.0132081	0.0035300	0.5495955	0.4967631
3	14	0.5347450	0.0001699	0.0130352	0.0034838	0.5608154	0.5086747
4	14	0.5425937	0.0001980	0.0140724	0.0037610	0.5707385	0.5144489
5	14	0.5445638	0.0001604	0.0126648	0.0033848	0.5698932	0.5192342
6	14	0.5466253	0.0001801	0.0134201	0.0035867	0.5734655	0.5197850
7	14	0.5510792	0.0001440	0.0119983	0.0032067	0.5750756	0.5270826
8	14	0.5413545	0.0016803	0.0409913	0.0109554	0.6233370	0.4593719
9	14	0.5569776	0.0001507	0.0122764	0.0032810	0.5815304	0.5324247
10	14	0.5608087	0.0001429	0.0119520	0.0031943	0.5847127	0.5369046
11	14	0.5638807	0.0001212	0.0110096	0.0029424	0.5858998	0.5418616
12	14	0.5689481	0.0001292	0.0113658	0.0030376	0.5916796	0.5462166
13	14	0.5705462	0.0001300	0.0114022	0.0030474	0.5933506	0.5477418
14	14	0.5711847	0.0001115	0.0105579	0.0028217	0.5923005	0.5500689
15	14	0.5644320	0.0013747	0.0370764	0.0099091	0.6385848	0.4902793
16	14	0.5642468	0.0015815	0.0397680	0.0106284	0.6437827	0.4847109
17	14	0.5733965	0.0000716	0.0084628	0.0022618	0.5903221	0.5564709
18	14	0.5564291	0.0017937	0.0423527	0.0113192	0.6411344	0.4717238
19	14	0.5565635	0.0018465	0.0429715	0.0114846	0.6425064	0.4706206
20	14	0.5685942	0.0001160	0.0107707	0.0028786	0.5901355	0.5470527
21	14	0.5641171	0.0000948	0.0097370	0.0026023	0.5835911	0.5446430
22	14	0.5575449	0.0000978	0.0098893	0.0026430	0.5773235	0.5377662
23	14	0.5455828	0.0001182	0.0108704	0.0029052	0.5673236	0.5238419
24	14	0.5163361	0.0008392	0.0289685	0.0077422	0.5742730	0.4583991
25	14	0.5159962	0.0000979	0.0098949	0.0026445	0.5357860	0.4962063
26	14	0.5006197	0.0000903	0.0095040	0.0025401	0.5196277	0.4816116
27	14	0.4861140	0.0001010	0.0100503	0.0026861	0.5062146	0.4660134
28	14	0.4813610	0.0000710	0.0084268	0.0022521	0.4982145	0.4645074
29	14	0.4720063	0.0000795	0.0089182	0.0023835	0.4898427	0.4541699
30	14	0.4706403	0.0001107	0.0105238	0.0028125	0.4916879	0.4495927
31	14	0.4634101	0.0008371	0.0289322	0.0077324	0.5212744	0.4055457
32	14	0.4700830	0.0000965	0.0098247	0.0026258	0.4897324	0.4504335
33	14	0.4621857	0.0007342	0.0270968	0.0072419	0.5163793	0.4079921
34	14	0.4533468	0.0010183	0.0319105	0.0085284	0.5171677	0.3895259
35	14	0.4608394	0.0001905	0.0138024	0.0036888	0.4884441	0.4332346
36	14	0.4555503	0.0001168	0.0108092	0.0028889	0.4771686	0.4339319
37	14	0.4576686	0.0001324	0.0115061	0.0030751	0.4806808	0.4346564
38	14	0.4662189	0.0001120	0.0105841	0.0028287	0.4873871	0.4450508
39	14	0.4507968	0.0001133	0.0106440	0.0028447	0.4720849	0.4295087
40	14	0.4552153	0.0000843	0.0091842	0.0024545	0.4735836	0.4368470
41	14	0.4520971	0.0001268	0.0112606	0.0030095	0.4746183	0.4295760
42	14	0.4555063	0.0000945	0.0097200	0.0025978	0.4749462	0.4360664
43	14	0.4515114	0.0001066	0.0103247	0.0027594	0.4721607	0.4308620
44	14	0.4476119	0.0001350	0.0116210	0.0031058	0.4708538	0.4243699
45	14	0.4506440	0.0000848	0.0092083	0.0024610	0.4690605	0.4322275
46	14	0.4619610	0.0000865	0.0092980	0.0024850	0.4805569	0.4433650
47	14	0.4753339	0.0000748	0.0086504	0.0023119	0.4926347	0.4580330
48	14	0.4829746	0.0000743	0.0086183	0.0023034	0.5002112	0.4657379
49	14	0.4869764	0.0000756	0.0086951	0.0023239	0.5043666	0.4695863
50	14	0.4866425	0.0000763	0.0087363	0.0023349	0.5041152	0.4691697
51	14	0.4850258	0.0000849	0.0092143	0.0024626	0.5034543	0.4665972
52	14	0.4851348	0.0000948	0.0097342	0.0026015	0.5046031	0.4656664
53	14	0.4841017	0.0000655	0.0080917	0.0021626	0.5002850	0.4679182
54	14	0.4808610	0.0000557	0.0074656	0.0019953	0.4957921	0.4659299
55	14	0.4775096	0.0000599	0.0077422	0.0020692	0.4929938	0.4620252
56	14	0.4776081	0.0000715	0.0084530	0.0022592	0.4945140	0.4607021
57	14	0.4653345	0.0007281	0.0269832	0.0072115	0.5193008	0.4113681
58	14	0.4633589	0.0007531	0.0274418	0.0073341	0.5182425	0.4084752
59	14	0.4947439	0.0001197	0.0109415	0.0029242	0.5166269	0.4728609
60	14	0.4861105	0.0001401	0.0118357	0.0031632	0.5097819	0.4624391
61	14	0.4874026	0.0000551	0.0074209	0.0019833	0.5022445	0.4725607
62	14	0.4933083	0.0000473	0.0068751	0.0018374	0.5070584	0.4795582
63	14	0.4974077	0.0000763	0.0087332	0.0023340	0.5148740	0.4799413
64	14	0.5011801	0.0000496	0.0070460	0.0018831	0.5152721	0.4870880
65	14	0.5027045	0.0000580	0.0076160	0.0020355	0.5179366	0.4874725
66	14	0.5046037	0.0000582	0.0076305	0.0020393	0.5198647	0.4893426
67	14	0.5101863	0.0001008	0.0100393	0.0026831	0.5302648	0.4901077
68	14	0.5107517	0.0000772	0.0087837	0.0023475	0.5283192	0.4931842
69	14	0.5122980	0.0000632	0.0079503	0.0021248	0.5281985	0.4963974
70	14	0.5132109	0.0000825	0.0090842	0.0024279	0.5313793	0.4950424
71	14	0.5156107	0.0000913	0.0095534	0.0025533	0.5347175	0.4965039
72	14	0.5313709	0.0000660	0.0081224	0.0021708	0.5476158	0.5151260
73	14	0.5210558	0.0000751	0.0086664	0.0023162	0.5383886	0.5037230
74	14	0.5210505	0.0000644	0.0080265	0.0021452	0.5371034	0.5049975
75	14	0.5203416	0.0000535	0.0073120	0.0019542	0.5349656	0.5057176
76	14	0.5181739	0.0000665	0.0081530	0.0021790	0.5344799	0.5018678
77	14	0.5214587	0.0000902	0.0094953	0.0025377	0.5404493	0.5024680
78	14	0.5218199	0.0000917	0.0095881	0.0025625	0.5409961	0.5026436
79	14	0.5277769	0.0001028	0.0101408	0.0027102	0.5480584	0.5074953
80	14	0.5278649	0.0000832	0.0091237	0.0024384	0.5461124	0.5096175
81	14	0.5276327	0.0001321	0.0114941	0.0030719	0.5506209	0.5046445
82	14	0.5333970	0.0001949	0.0139599	0.0037309	0.5613167	0.5054773
83	14	0.5221026	0.0001484	0.0121814	0.0032556	0.5464653	0.4977399
84	14	0.5224426	0.0000830	0.0091085	0.0024344	0.5406597	0.5042256
85	14	0.5129657	0.0004014	0.0200344	0.0053544	0.5530345	0.4728969
86	14	0.5202824	0.0002133	0.0146051	0.0039034	0.5494925	0.4910722
87	14	0.5196383	0.0001420	0.0119173	0.0031850	0.5434732	0.4958043
88	14	0.5203068	0.0002338	0.0152910	0.0040869	0.5508905	0.4897230
89	14	0.5181409	0.0001648	0.0128384	0.0034312	0.5438176	0.4924641
90	14	0.5225378	0.0003776	0.0194328	0.0051936	0.5614033	0.4836721
91	14	0.5209734	0.0001675	0.0129414	0.0034587	0.5468562	0.4950905
92	14	0.5182807	0.0001447	0.0120305	0.0032153	0.5423417	0.4942197
93	14	0.5146030	0.0001673	0.0129329	0.0034565	0.5404688	0.4887372
94	14	0.5211191	0.0002070	0.0143874	0.0038452	0.5498940	0.4923442
95	14	0.5216204	0.0001483	0.0121791	0.0032550	0.5459785	0.4972622
96	14	0.5284244	0.0002612	0.0161612	0.0043193	0.5607467	0.4961021
97	14	0.5205051	0.0001461	0.0120856	0.0032300	0.5446762	0.4963340

QUARTZ MONZONITE POWDER (<43 μm) ELUTRIATED

246.0	250.0	251.0	244.0	208.0	235.0	224.0	217.0	214.0	212.0
200.0	203.0	204.0	200.0	198.0	190.0	186.0	152.0	163.0	164.0
173.0	157.0	182.0	188.0	196.0	193.0	192.0	201.0	205.0	207.0
210.0	210.0	210.0	210.0	208.0	204.0	193.0	163.0	175.0	170.0
167.0	163.0	146.0	140.0	152.0	161.0	160.0	165.0	168.0	162.0
157.0	150.0	150.0	146.0	140.0	135.0	132.0	121.0	117.0	113.0
131.0	96.0	81.0	85.0	91.0	91.0	103.0	100.0	100.0	100.0
98.0	71.0	90.0	90.0	90.0	82.0	81.0			

EMMITTANCE RATIO

0.31483	0.33870	0.36023	0.37556	0.37823	0.37253	0.40673	0.40879	0.39177	0.40459
0.41822	0.42629	0.42903	0.42028	0.42751	0.42522	0.43215	0.42483	0.43000	0.43384
0.43239	0.42931	0.43266	0.42239	0.36771	0.42915	0.41589	0.41125	0.41339	0.41390
0.41254	0.41525	0.45692	0.40805	0.40926	0.40056	0.40400	0.34472	0.37878	0.38887
0.40383	0.35472	0.39525	0.39769	0.41321	0.39816	0.40586	0.42894	0.42204	0.40920
0.41091	0.40374	0.40457	0.40719	0.40918	0.46811	0.40315	0.34691	0.38643	0.38713
0.39251	0.38921	0.35512	0.34745	0.37556	0.39786	0.40810	0.41907	0.41413	0.41292
0.46276	0.39151	0.40636	0.40258	0.40054	0.39543	0.39348	0.36608	0.36163	0.35401
0.32310	0.31102	0.26639	0.30336	0.32057	0.32710	0.36812	0.37764	0.37258	0.38373
0.38879	0.28108	0.36735	0.36556	0.37584	0.35284	0.36000			

TAPE NUMBER= 99
SAMPLE ID NUMBER= 0
SPECTRUM GROUP NUMBER= 5
BLACK BODY TEMP= 57
REFERENCE TEMP= 0
SPECTRUM NUMBER= 5
ID ERROR NUMBER= 0

60.0	76.0	106.0	121.0	127.0	140.0	146.0	154.0	150.0	174.0
161.0	203.0	212.0	223.0	232.0	230.0	230.0	220.0	230.0	236.0
240.0	247.0	250.0	247.0	233.0	230.0	223.0	215.0	213.0	210.0
200.0	200.0	203.0	166.0	194.0	192.0	155.0	171.0	168.0	161.0
167.0	170.0	184.0	163.0	190.0	196.0	202.0	200.0	202.0	207.0
211.0	213.0	204.0	208.0	200.0	174.0	193.0	184.0	181.0	150.0
166.0	108.0	160.0	161.0	158.0	160.0	166.0	160.0	160.0	146.0
140.0	151.0	150.0	143.0	136.0	134.0	130.0	124.0	118.0	110.0
100.0	93.0	81.0	82.0	85.0	98.0	100.0	105.0	71.0	100.0
90.0	93.0	94.0	90.0	90.0	70.0	82.0			

EMMITTANCE RATIO

0.32498	0.32176	0.38185	0.38511	0.38123	0.39511	0.39588	0.39346	0.36729	0.40692
0.40480	0.42629	0.42108	0.42601	0.43123	0.42156	0.42295	0.40636	0.42630	0.42661
0.42184	0.42416	0.43094	0.42758	0.41190	0.42002	0.41404	0.40746	0.41146	0.41000
0.41254	0.40911	0.45468	0.33868	0.40099	0.40478	0.33666	0.38782	0.39040	0.38176
0.38982	0.38410	0.39960	0.34680	0.40056	0.40435	0.42700	0.42680	0.41587	0.40920
0.41286	0.40951	0.39301	0.40331	0.39344	0.39927	0.40315	0.39160	0.39968	0.34158
0.39016	0.25788	0.38917	0.39957	0.39038	0.39539	0.42340	0.40637	0.39441	0.37213
0.41266	0.39412	0.40636	0.39430	0.38909	0.39250	0.38752	0.37515	0.36472	0.34461
0.31990	0.29158	0.26639	0.29265	0.29944	0.35227	0.35740	0.39653	0.26453	0.38373
0.35705	0.35629	0.38367	0.36556	0.37584	0.30120	0.36444			

TAPE NUMBER= 99
SAMPLE ID NUMBER= 0
SPECTRUM GROUP NUMBER= 5
BLACK BODY TEMP= 57
REFERENCE TEMP= 0
SPECTRUM NUMBER= 6

ID ERROR NUMBER= 0

63.0	75.0	105.0	113.0	120.0	134.0	143.0	150.0	150.0	177.0
147.0	202.0	210.0	221.0	232.0	230.0	225.0	228.0	236.0	237.0
204.0	241.0	240.0	244.0	230.0	227.0	224.0	210.0	211.0	208.0
203.0	201.0	203.0	200.0	191.0	186.0	181.0	150.0	165.0	160.0
170.0	172.0	185.0	185.0	177.0	190.0	190.0	169.0	202.0	201.0
205.0	213.0	210.0	212.0	209.0	204.0	194.0	180.0	175.0	172.0
160.0	166.0	150.0	160.0	148.0	150.0	160.0	167.0	164.0	[illegible]
159.0	154.0	144.0	146.0	140.0	134.0	130.0	120.0	117.0	113.0
105.0	91.0	80.0	85.0	90.0	94.0	90.0	101.0	103.0	78.0
44.0	94.0	92.0	95.0	90.0	86.0	80.0			

EMMITTANCE RATIO

0.31991	0.31753	0.37824	0.35964	0.36022	0.37818	0.37961	0.38324	0.36729	0.41394
0.41822	0.42419	0.41711	0.42219	0.43123	0.42156	0.41376	0.42113	0.43742	0.42842
0.35857	0.41385	0.41370	0.42239	0.40660	0.41454	0.41589	0.39798	0.40760	0.40609
0.41873	0.41116	0.45468	0.40805	0.39479	0.39213	0.39314	0.34019	0.38343	0.37939
0.39683	0.38861	0.40177	0.39134	0.37316	0.39197	0.40164	0.36065	0.41587	0.39734
0.40112	0.40374	0.40457	0.41107	0.41115	0.46811	0.40524	0.38309	0.38643	0.39168
0.37606	0.39637	0.36485	0.39709	0.36567	0.37068	0.40810	0.42415	0.40427	0.36704
0.40866	0.40195	0.39013	0.40258	0.40054	0.39250	0.38752	0.36305	0.36163	0.35401
0.33589	0.29482	0.26310	0.30336	0.31705	0.33789	0.32166	0.38142	0.36376	0.29931
0.33325	0.37213	0.37551	0.38587	0.37584	0.37005	0.35556			

TAPE NUMBER= 99
SAMPLE ID NUMBER= 0
SPECTRUM GROUP NUMBER= 5
BLACK BODY TEMP= 57
REFERENCE TEMP= 0
SPECTRUM NUMBER= 7
ID ERROR NUMBER= 0

40.0	81.0	100.0	113.0	120.0	140.0	140.0	152.0	168.0	180.0
188.0	201.0	211.0	221.0	220.0	236.0	234.0	233.0	230.0	235.0
240.0	246.0	246.0	241.0	242.0	233.0	225.0	210.0	210.0	211.0
203.0	206.0	204.0	205.0	201.0	180.0	164.0	173.0	162.0	167.0
166.0	175.0	182.0	164.0	195.0	199.0	160.0	160.0	205.0	200.0
212.0	211.0	206.0	207.0	200.0	202.0	193.0	192.0	157.0	174.0
166.0	162.0	105.0	160.0	147.0	161.0	164.0	160.0	166.0	164.0
145.0	156.0	152.0	146.0	130.0	137.0	134.0	127.0	124.0	116.0
108.0	96.0	83.0	86.0	81.0	95.0	105.0	97.0	101.0	103.0
133.0	96.0	93.0	91.0	90.0	81.0	82.0			

EMMITTANCE RATIO

0.23311	0.34293	0.36023	0.35964	0.36022	0.39511	0.37961	0.38835	0.41135	0.42096
0.42046	0.42209	0.41910	0.42219	0.40892	0.43255	0.43031	0.43037	0.42630	0.42480
0.42184	0.42244	0.42404	0.41720	0.42781	0.42549	0.41775	0.39798	0.40567	0.41195
0.41873	0.42138	0.45692	0.41825	0.41546	0.37948	0.35621	0.39235	0.37645	0.39599
0.38749	0.39539	0.39525	0.34692	0.41110	0.41054	0.33822	0.34144	0.42204	0.39536
0.41482	0.40567	0.39687	0.40137	0.39344	0.46352	0.40315	0.40863	0.34668	0.39624
0.39016	0.38682	0.25539	0.39709	0.36320	0.39786	0.41830	0.40637	0.40920	0.41801
0.42739	0.40717	0.41178	0.40258	0.37193	0.40129	0.39945	0.38423	0.38327	0.36341
0.34549	0.31102	0.27297	0.30692	0.28535	0.34148	0.37527	0.36632	0.37631	0.39524
0.40862	0.38005	0.37959	0.36962	0.37584	0.34854	0.36444			

TAPE NUMBER= 99