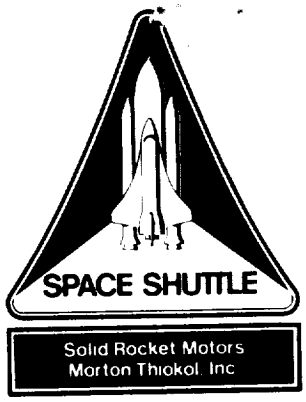

TWR- 50087

DEVELOPMENT OF INSPECTION TECHNIQUES FOR QUANTITATIVELY MEASURING SURFACE CONTAMINATION ON SRM HARDWARE

INTERIM REPORT

October 13, 1989

Prepared for:

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
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MARSHALL SPACE FLIGHT CENTER, ALABAMA 35812

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INTERIM REPORT

October 13, 1989

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PRELIMINARY

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DEVELOPMENT OF INSPECTION TECHNIQUES FOR QUANTITATIVELY MEASURING SURFACE CONTAMINATION ON SRM HARDWARE INTERIM REPORT

R. D. Law

1.0 INTRODUCTION

A contaminant is any material or substance which is potentially undesirable or which may adversely affect any part, component, or assembly. Contamination control of SRM hardware surfaces is a serious concern, for both Thiokol and NASA, with particular concern for contaminants which may adversely affect bonding surfaces. The purpose of this study is to develop laboratory analytical techniques which will make it possible to certify the cleanliness of any designated surface, with special focus on particulates (dust, dirt, lint, etc.), oils (hydrocarbons, silicones, plasticizers, etc.), and greases (HD-2, fluorocarbon grease, etc.). The hardware surfaces of concern will include D6AC steel, aluminum alloys, anodized aluminum alloys, glass/phenolic, carbon/phenolic, NBR/asbestos-silica, and EPDM rubber.

This interim report covers work performed in completion of Phases I and III, outlined in ETP-0491. Phases II, IV, and V of ETP-0491 will be completed in future work and will be reported in a final report (TWR-19555).

2.0 OBJECTIVES

A. To identify and select wiper cloth materials which are suitable for determination of non-volatile residues and particulates.
B. To determine the compatibility of selected cleaning solvents with selected wiper cloth materials and with hardware surfaces.
C. To determine the analytical efficiency of selected wiper/solvent combinations for removal of selected contaminants from each hardware surface.
D. To develop analytical methods for the isolation and identification of insoluble particulates and of soluble non-volatile residues.
E. Finalization of each of the foregoing into a complete inspection technique suitable for all SRM hardware.

3.0 EXPERIMENTAL METHOD

This study is being pursued in five phases, as follows:

3.1 Phase I, Wiper Cloth/Solvent Compatibility

The wiper cloth materials evaluated included polyester, nylon, polyurethane, polypropylene, cotton, cotton/polyester, and cotton/polypropylene. A list of commercially available wiper materials which were evaluated is given in Table I.

Solvents evaluated included 1,1,1-trichloroethane (methyl chloroform), 1,1,2-trichloro-1,2,2-trifluoroethane (Freon TF), and methyl ethyl ketone (MEK). Methyl chloroform and Freon TF were selected because of non-flammability, comparatively low toxicity, and widespread use in contamination control. MEK is included because of its widespread use in cleaning rubber surfaces and because chlorinated solvents frequently swell and/or degrade rubber. Although Freons are reportedly compatible with aluminum surfaces, it is possible that MEK will be needed here also. High purity clean room grade solvents were employed.

The compatibility of each wiper cloth with each solvent was determined by making repeated extractions followed by determination of the amount and nature of the material extracted.

3.2 Phase II, Hardware/Solvent Compatibility

Wiper cloth/solvent combinations which appear most acceptable from Phases I and III will be applied repeatedly by hand to clean experimental test panels of the following materials:

D6AC steel
Aluminum alloy
Phosphoric acid anodized aluminum alloy
Fiberglas-filled phenolic
Carbon fiber-filled phenolic
NBR/asbestos-silica
EPDM rubber

After air drying, the surface of the test panels will be examined microscopically for any evidence of corrosion or degradation. The wiper cloths will also be extracted and the amount and nature of any material extracted will be determined. This work has not been completed and is not reported herein.

3.3 Phase III, Cloth Extraction Study

Wiper cloth/solvent combinations which appear most acceptable will be employed to develop suitable cloth extraction techniques.

Wiper cloth samples were doped with known amounts of the following contaminants:

HD-2 grease
Hydraulic oil
Silicone oil
Dioctyl phthalate (DOP)
Fluorocarbon grease
Mineral oil
Vinyl tape adhesive
Teflon tape adhesive

Suitability of wiper/solvent combinations selected from Phase I was determined for each contaminant from a combination of Fourier transform infrared (FTIR) identifiability plus percent recovery.

3.4 Phase IV, Cleaning Efficiency Study

Clean test panels of the below-listed materials will be doped with known amounts of the below-listed contaminants:

Hardware Surface	Contaminant
D6AC steel	HD-2 grease
Aluminum alloy	Hydraulic fluid
Phosphoric acid anodized aluminum alloy	Silicone oil
Glass/phenolic	DOA
Carbon/phenolic	Fluorocarbon grease
NBR/asbestos-silica	Dust (soil)
EPDM/rubber	Mineral oil

Using the appropriate wiper cloth/solvent combinations selected during Phases I through III, repeated wiping operations will be conducted using fresh solvent and a fresh cloth each time. Using cloth extraction techniques developed in Phase III, the best wiping techniques and number of wipes needed for recovery of contaminant will be determined. This work has not been completed and is not reported herein.

3.5 Phase V Final Method Verification

Using test methods formulated during Phases I through IV, the final inspection technique will be verified by application in the field for each hardware surface. Parameters to be evaluated and optimized will include size of surface, number of surfaces, location of representative surfaces, number of wiping operations, and overall precision (repeatability) of the total technique. This work has not been completed and is not reported herein.

4.0 CONCLUSIONS (PHASES I AND III ONLY)

4.1 The wiper/solvent combinations of greatest potential interest for HD-2 grease were:

Miraclewipe/methyl chloroform
Fabwipe/methyl chloroform
Alphawipe/methyl chloroform
Polx 1200/methyl chloroform

4.2 The wiper/solvent combinations of greatest potential interest for a fluorocarbon grease such as Krytox 240AZ were:

Miraclewipe/Freon TF
Polx 1200/Freon TF or methyl chloroform
Fabwipe/Freon TF

4.3 The wiper/solvent combinations of greatest potential interest for hydraulic oil were:

Fabwipe/methyl chloroform or MEK
Alphawipe/ Freon TF
Q-Tips/Freon TF

4.4 The wiper/solvent combinations of greatest potential interest for silicone oil were:

Anticon/methyl chloroform or Freon TF or MEK
Miraclewipe/Freon TF or MEK
Fabwipe/methyl chloroform or MEK
Alphawipe/methyl chloroform or Freon TF or MEK
Polx 1200/methyl chloroform or Freon TF or MEK

4.5 The wiper/solvent combinations of greatest potential interest for mineral oil were:

Miraclewipe/methyl chloroform or Freon TF or MEK
Fabwipe/methyl chloroform or Freon TF or MEK
Alphawipe/Freon TF
Polx 1200/methyl chloroform
Q-Tips/methyl chloroform or Freon TF or MEK

4.6 All wiper/solvent systems were found to be suitable for DOP. Those chosen for further study may be any which are also of interest for other contaminants.

4.7 All wiper/solvent systems were found to be suitable for vinyl tape adhesive, except Q-Tips/methyl chloroform and Miraclewipe/Freon TF. Those chosen for further study may be any others which are also of interest for other contaminants.

4.8 All wiper/solvent systems were found to be suitable for Teflon tape adhesive, except Fabwipe/Freon TF. Those chosen for further study may be any others which are also of interest for other contaminants.

4.9 No one solvent was found to be suitable for all contaminants, e.g., only methyl chloroform was suitable for HD-2 grease, and only Freon TF was suitable for fluorocarbon grease. Since MEK may be the only solvent compatible with NBR and EPDM rubber (to be determined in the next phase of testing) all three solvents will be carried over for further study.

4.10 No one wiper material was ideal for all the contaminants tested, but Fabwipe (a cotton/polypropylene blend) came closest, it being of potential interest for use with all eight contaminants, but not always with the same solvent. Runners-up for most universal wiper were Miraclewipe (a nylon), Alphawipe (a polyester), and Polx 1200 (a polyester), all of potential interest for seven of the eight contaminants. Anticon 100 (a polyester) and Q-Tips (cotton) were unsuitable for half of the contaminants and will be considered for further study only as a back-up.

5.0 RECOMMENDATIONS

1. The remaining phases of ETP-0491 should be pursued using suitable combinations of methyl chloroform, Freon TF, and MEK with Fabwipe, Miraclewipe, Alphawipe, and Polx 1200, in which known contaminants are removed from test surfaces in a controlled laboratory situation, as outlined in ETP-0491.

2. The FTIR scans generated in the first phases of ETP-0491 will serve as a useful library of background spectra, and should be used as an aid in the interpretation of future wipe spectra.

6.0 DISCUSSION

All 13 of the wipers listed in Table I were subjected to repeated 1-hour Sohxlet extractions using each of the solvents of interest--TCE, Freon TF, and MEK. The solutions were filtered to isolate particulates, and the non-volatile residue (NVR) and total particulates were determined by drying and weighing. This was a preliminary screening operation to determine which wipers appeared to be most stable toward the solvents. The wipers selected for further study are given in Table II. Analytical data are summarized in Tables IV through XXIII. This completed Phase I of ETP-0491.

In the next step, samples of the six wipers chosen for further study (Alphawipe, Anticon 100, Fabwipe, Miraclewipe, Polx 1200, and Q-Tips) were first extracted for four hours using a Soxhlet extractor to remove most of the background NVR, and were then re-extracted a second time for four hours. Both the first and second extracts were subjected to FTIR analysis, thus providing background FTIR spectra for each wiper with each solvent. These background spectra are given in Figures 1 through 36. These background spectra illustrate the need to pre-wash any and all wipers prior to analytical use, and also indicate that background spectra from the wiper cloth itself can seriously impact FTIR identification of unknown surface contaminants.

Stock solutions of the eight contaminants of interest were next prepared, such that 1.00 cubic centimeter contained 10 milligrams of contaminant. Using pre-washed wipers (one 4-hour Soxhlet) in glass vials, 1.00 milliliter of each contaminant stock solution was added to individual 1-gram samples of cloth, yielding specimens with 10-milligram contaminant per gram of wiper. These samples were dried overnight in a hood to remove solvent and were then quantitatively transferred to the Soxhlet extractor, using a wash bottle to transfer any residual contaminant adhering to the glass vial. After 4-hour reflux with the solvent being used, and filtration to remove particulates, the NVR was isolated, weighed, and subjected to FTIR analysis. Results are summarized in Table III, and analytical data are given in Tables XXIV through XXXI. FTIR spectra of the original contaminants prior to contact with wiper cloth are given in Figures 37 through 44. FTIR spectra of the contaminant extracts are given in Figures 45 through 205.

Even though all wipers were pre-washed in hopes of eliminating FTIR background arising from the wiper cloth itself, some wiper background is evident in almost all of the spectra, and, in some cases, the wiper background obscures the FTIR scan sufficiently as to render identification almost impossible. The ease of FTIR identification for each extract was rated as either good (easy, for a novice), fair (some skill required), poor (impossible without considerable skill, experience, and access to background spectra), and very poor (almost impossible). As seen from the data in Tables XXIV through XXXI, the contaminants which pose the greatest

challenge are HD-2 grease, Krytox fluorocarbon grease, and hydraulic oil. For HD-2 grease, only methyl chloroform was a suitable solvent, whereas for Krytox, only Freon TF gave satisfactory results. The results for hydraulic oil (Table XXVI) were entirely unexpected, especially the low recovery. The effect of boiling followed by physical agitation was explored to a limited extent, as compared to Soxhlet extraction (repeated reflux). Results are seen in Table XXXII, and recoveries for hydraulic oil were even lower for boiling-shaking than for Soxhlet extraction. Some improvement in FTIR scans for HD-2 and Krytox was seen for boiling-shaking versus Soxhlet. These data illustrate the importance of verifying the suitability of test conditions for each contaminant. Once wiper/solvent choices are finalized for each contaminant/surface combination, extraction details may be optimized as outlined in ETP-0491.

TABLE I

CANDIDATE WIPER MATERIALS

Trade Name	Type	Manufacturer
Absorbond™	Polyester	Texwipe Company Upper Saddle River, New Jersey 07458
Alphawipe™	Polyester	Texwipe Company
Anticon 100™	Polyester	Thomas West Company P.O. Box 592 Belmont, California 94002
Clean-Pal™	Nylon	Clean Room Products, Incorporated 1800 Ocean Avenue Ronkonkoma, New York 11779
Crew-3330™	Polypropylene	Kimberly-Clark Corporation Roswell, Georgia 30076
Fabwipes™	Cotton/Polypropylene	Texwipe Company
Foamwipes™	Polyurethane	Texwipe Company
Miraclewipe™	Nylon	Texwipe Company
One-Ups™	Cotton/polyester	Berkshire Corporation Great Barrington, Massachusetts 01230
Polx 1200™	Polyester	Berkshire Corporation
Q-Tips	Cotton, glueless	Puritan Company Guilford, Maine 04443
Westwipe™	Polyester, sealed edge	Thomas West Company
Wonderwipe™	Nylon tricot	Clean Room Products, Incorporated

TABLE II

ETP-0491 WIPER CLOTH CANDIDATES
OVERALL SUMMARY OF WIPER EXTRACTION STUDIES

Trade Name	111-TCE	Freon TF	MEK
Fabwipes[1]	A	A	A
Miraclewipe[2]	A	A	A
Alphawipe[3]	A	A	A
Polx 1200[3]	A	A	A
Anticon 100[3]	B	B	B
Q-Tips, glueless[4]	B	B	B
Westwipes[3]	B	B	B
Absorbond[3]	C	C	C
Wonderwipe[2]	C	C	C
One-Ups[5]	C	C	C
Clean-Pal[2]	C	C	C
Foamwipes[6]	C	C	C
Crew-3330[7]	C	C	C

Codes: A. Carryover into final phases
B. Borderline. Retain for possible future study in case initial selections do not hold up.
C. Cancel from further consideration.

[1]Cotton/polypropylene
[2]Nylon
[3]Polyester
[4]Cotton
[5]Cotton/polyester
[6]Polyurethane
[7]Polypropylene

TABLE III

ETP-0491
EXTRACTION EFFICIENCY STUDY SUMMARY

1. **HD-2 Grease.**
   Adequate recovery for all systems except Freon/Anticon, Freon/Miraclewipe, Freon/Alphawipe, Freon/Polx 1200, and MEK/Q-Tips. Good FTIR only for methyl chloroform with Miraclewipe, Fabwipe, Alphawipe, and Polx 1200.

2. **Fluorocarbon Grease.**
   Suitable recovery only for Freon. Good FTIR only for Freon/Miraclewipe and Freon/Polx 1200.

3. **Hydraulic Oil.**
   Adequate recovery only for Freon/Alphawipe, Freon/Q-Tips, and Freon/Polx 1200. Fair recovery for methyl chloroform/Fabwipe and MEK/Q-Tips. No really good FTIRs. Fair FTIR for methyl chloroform/Fabwipe, Freon/Alphawipe, and Freon/Q-Tips.

4. **Silicone Oil.**
   Good recovery for all systems except methyl chloroform/Miraclewipe, Freon/Fabwipe, and Freon/Q-Tips. Good FTIR for all systems except Freon/Q-Tips.

5. **Mineral Oil.**
   Good recovery for all systems except MEK/Alphawipe. Good FTIR for all systems except methyl chloroform/Anticon, methyl chloroform/Alphawipe, Freon/Anticon, Freon/Polx 1200, MEK/Anticon, and MEK/Polx 1200.

6. **DOP.**
   Good recovery and FTIR for all systems.

7. **Vinyl Tape Adhesive.**
   Good recovery for all systems except methyl chloroform/Q-Tips and Freon/Miraclewipe. Good FTIR on all systems.

8. **Teflon Tape Adhesive.**
   Good recovery for all systems except Freon/Fabwipe. Good FTIR for all systems.

TABLE IV
NVR BLANK EXTRACTION WITH 111-TCE

Trade Name	Description	Total Extractables[1]	No. of Extractions for Acceptable Level[2]
Westwipe	Polyester, sealed edge	0.7	1 (0.1)[3]
Air Weave Bleeder Cloth	Polyester	1.3	1 (0.1)
Alphawipe	Polyester	1.3	1 (0.1)
Westwipe Anticon 100	Polyester (aka Polywipe)	1.4	1 (0.2)
Polx 1200	Polyester	1.6	1 (0.1)
Q-Tips, Glueless	Cotton	2.2	1 (0.2)
Miraclewipe	Nylon	1.5	2 (0.2)
Absorbond	Polyester	1.8	2 (0.2)
Wonderwipe	Nylon	8.3	1 (0.2)
One-Ups	Cotton/polyester	11.4	1 (0.6)
Fabwipe	Cotton/polypropylene	18.2	2 (0.4)
Foamwipe	Polyurethane	39.9	2 (0.5)
Clean-Pal	Nylon	31.9	3 (0.4)
Crew 33330	Polypropylene	35.9	2 (0.2)

[1]Total four-hour Soxhlet. Mg/gram of cloth.

[2]Consecutive one-hour Soxhlets on same sample.

[3]Level of residual extractables after indicated number of extractions, in mg/gram of cloth.

TABLE V
NVR BLANK EXTRACTION WITH FREON TF

Trade Name	Description	Total Extractables[1]	No. of Extractions for Acceptable Level[2]
Air Weave Bleeder Cloth	Polyester	0.8	1 (0.0)[3]
Alphawipe	Polyester	0.5	1 (0.1)
Westwipe	Polyester, sealed edge	0.6	1 (0.1)
Polx 1200	Polyester	0.8	1 (0.1)
Miraclewipe	Nylon	0.6	1 (0.1)
Absorbond	Polyester	0.7	2 (0.0)
Westwipe Anticon 100	Polyester	0.9	1 (0.3)
Q-Tips, Glueless	Cotton	1.9	1 (0.2)
One-Ups	Cotton/polyester	3.3	1 (0.4)
Wonderwipe	Nylon	3.8	1 (0.2)
Clean-Pal	Nylon	10.9	1 (0.3)
Fabwipe	Cotton/polypropylene	10.8	2 (0.5)
Foamwipe	Polyurethane	29.3	2 (0.6)
Crew 33330	Polypropylene	27.1	3 (0.5)

[1]Total four-hour Soxhlet; mg/gram of cloth.

[2]Consecutive one-hour Soxhlets on same sample.

[3]Level of residual extractables after indicated number of extractions, in mg/gram of cloth.

TABLE VI
NVR BLANK EXTRACTION WITH MEK

Trade Name	Description	Total Extractables[1]	No. of Extractions for Acceptable Level[2]
Air Weave Bleeder Cloth	Polyester	2.1	1 (0.2)[3]
Miraclewipe	Nylon	2.3	1 (0.3)
Westwipe	Polyester, sealed edge	2.6	1 (0.3)
Polx 1200	Polyester	2.9	1 (0.2)
Alphawipe	Polyester	2.6	1 (0.4)
Westwipe Anticon 100	Polyester	2.9	1 (0.4)
Wonderwipe	Nylon	8.8	1 (0.4)
Fabwipe	Cotton/polypropylene	9.1	1 (0.4)
Q-Tips, Glueless	Cotton	4.0	2 (0.5)
Absorbond	Polyester	7.3	2 (0.6)
One-Ups	Cotton/Polyester	13.2	2 (0.2)
Crew-3330	Polypropylene	16.0	3 (0.2)
Foamwipe	Polyurethane	49.9	3 (0.8)
Clean-Pal	Nylon	51.0	4 (0.7)

[1]Total four-hour Soxhlet; mg/gram of cloth.

[2]Consecutive one-hour Soxhlets on same sample.

[3]Level of residual extractables after indicated number of extractions, in mg/gram of cloth.

TABLE VII
PARTICULATES FROM BLANK EXTRACTION WITH 111-TCE

Trade Name	Description	Total Particulates[1]	No. of Extractions for Acceptable Level[2]
Polx 1200	Polyester	0.01	0 (.01)[3]
Westwipe Anticon 100	Polyester	0.05	0 (.03)
Miraclewipe	Nylon	0.04	1 (.04)
Alphawipe	Polyester	0.05	1 (0.00)
Air Weave Bleeder Cloth	Polyester	0.06	1 (0.00)
Q-Tips, Glueless	Cotton	0.08	1 (.04)
Westwipe	Polyester, sealed edge	0.09	1 (0.00)
Crew 3330	Polypropylene	0.14	1 (.03)
Wonderwipe	Nylon	0.25	1 (.01)
Fabwipe	Cotton/polypropylene	0.26	1 (0.00)
One-Ups	Cotton/polyester	0.28	1 (.02)
Clean-Pal	Nylon	0.34	1 (.06)
Absorbond	Polyester	0.40	2 (0.00)
Foamwipe	Polyurethane	0.42	2 (0.08)

[1]Total four-hour Soxhlet; mg/gram of cloth.

[2]Consecutive one-hour Soxhlets on same sample.

[3]Level of residual particulates after indicated number of extractions, in mg/gram of cloth.

TABLE VIII
PARTICULATES FROM BLANK EXTRACTION WITH FREON TF

Trade Name	Description	Total Particulates[1]	No. of Extractions for Acceptable Level[2]
Miraclewipe	Nylon	0.02	0 (.02)[3]
Polx 1200	Polyester	0.05	0 (.03)
Westwipe Anticon 100	Polyester	0.10	0 (.07)
Crew 33330	Polypropylene	0.11	1 (.05)
Alphawipe	Polyester	0.13	1 (.03)
Westwipe	Polyester, sealed edge	0.17	1 (.03)
Clean-Pal	Nylon	0.22	1 (0.00)
Air Weave Bleeder Cloth	Polyester	0.24	1 (.06)
Absorbond	Polyester	0.29	2 (0.00)
Fabwipe	Cotton/polypropylene	0.47	2 (.08)
Q-Tips, Glueless	Cotton	0.51	3 (0.00)
Foamwipe	Polyurethane	0.54	3 (.03)
Wonderwipe	Nylon	0.87	3 (.05)
One-Ups	Cotton/polyester	0.74	4 (.45)

[1] Total four-hour Soxhlet; mg/gram of cloth.

[2] Consecutive one-hour Soxhlets on same sample.

[3] Level of residual particulates after indicated number of extractions, in mg/gram of cloth.

TABLE IX
PARTICULATES FROM BLANK EXTRACTION WITH MEK

Trade Name	Description	Total Particulates[1]	No. of Extractions for Acceptable Level[2]
Polx 1200	Polyester	0.03	0 (.03)[3]
Westwipe	Polyester, sealed edge	0.03	0 (.03)
Westwipe Anticon 100	Polyester	0.04	0 (.02)
Air Weave Bleeder Cloth	Polyester	0.12	0 (.08)
Alphawipe	Polyester	0.03	0 (.03)
Foamwipe	Polyurethane	0.24	1 (0.00)
Wonderwipe	Nylon	0.44	1 (.01)
Clean-Pal	Nylon	0.53	1 (0.00)
Miraclewipe	Nylon	0.05	2 (0.00)
Absorbond	Polyester	0.41	2 (0.00)
Q-Tips, Glueless	Cotton	0.15	3 (0.00)
One-Ups	Cotton/polyester	0.41	4 (0.12)
Fabwipe	Cotton/polypropylene	3.01	4 (0.26)
Crew 33330	Polypropylene	6.81	4 (0.19)

[1]Total four-hour Soxhlet; mg/gram of cloth.

[2]Consecutive one-hour Soxhlets on same sample.

[3]Level of residual particulates after indicated number of extractions, in mg/gram of cloth.

TABLE X

ABSORBOND™ (POLYESTER)
CONSECUTIVE SOXHLET EXTRACTIONS ON THE SAME SAMPLE

	111-TCE		Freon TF		MEK	
	NVR	Particulates	NVR	Particulates	NVR	Particulates
First Hour	0.9	0.09	Nil	Nil	4.5	0.06
Second Hour	0.7	0.22	0.5	0.29	1.7	0.35
Third Hour	Nil	Nil	Nil	Nil	0.6	Nil
Fourth Hour	0.2	0.09	0.2	Nil	0.5	Nil
Total	1.8	0.40	0.7	0.29	7.3	0.41

Note: Results expressed as mg/gram of wiper.

TM: Texwipe Company
Upper Saddle River, New Jersey 07458

TABLE XI

AIR WEAVE BLEEDER CLOTH[TM] (POLYESTER)
CONSECUTIVE SOXHLET EXTRACTIONS ON THE SAME SAMPLE

	111-TCE		Freon TF		MEK	
	NVR	Particulates	NVR	Particulates	NVR	Particulates
First Hour	1.2	0.05	0.8	0.15	1.5	0.08
Second Hour	0.1	Nil	Nil	0.06	0.2	0.03
Third Hour	Nil	Nil	Nil	Nil	0.2	Nil
Fourth Hour	Nil	0.01	Nil	0.03	0.2	0.01
Total	1.3	0.06	0.8	0.24	2.1	0.12

Note: Results expressed as mg/gram of cloth.

TM: Richmond Corporation
Santa Fe Springs, California

TABLE XII

ALPHAWIPE™ (POLYESTER)
CONSECUTIVE SOXHLET EXTRACTIONS ON THE SAME SAMPLE

	111-TCE		Freon TF		MEK	
	NVR	Particulates	NVR	Particulates	NVR	Particulates
First Hour	1.2	0.04	0.3	0.04	1.9	Nil
Second Hour	0.1	Nil	0.1	Nil	0.4	Nil
Third Hour	Nil	Nil	0.1	0.03	0.2	0.03
Fourth Hour	Nil	0.01	0.1	0.06	0.1	Nil
Total	1.3	0.05	0.6	0.13	2.6	0.03

Note: Results expressed as mg/gram of wiper.

TM: Texwipe Company
Upper Saddle River, New Jersey 07458

TABLE XIII

CLEAN-PAL™ (NYLON)
CONSECUTIVE SOXHLET EXTRACTIONS ON THE SAME SAMPLE

	111-TCE		Freon TF		MEK	
	NVR	Particulates	NVR	Particulates	NVR	Particulates
First Hour	27.9	0.17	10.0	0.11	43.0	0.49
Second Hour	2.5	0.06	0.3	Nil	3.6	Nil
Third Hour	1.0	0.11	0.3	0.11	2.9	0.04
Fourth Hour	0.4	Nil	0.3	Nil	1.5	Nil
Total	31.8	0.34	10.9	0.22	51.0	0.53

Note: Results expressed as mg/gram of wiper.

TM: Clean Room Products, Incorporated
1800 Ocean Avenue
Ronkonkoma, New York 11779-9990

TABLE XIV

CREW™ (POLYPROPYLENE)
CONSECUTIVE SOXHLET EXTRACTIONS ON THE SAME SAMPLE

	111-TCE		Freon TF		MEK	
	NVR	Particulates	NVR	Particulates	NVR	Particulates
First Hour	33.5	0.09	20.9	0.06	14.7	5.92
Second Hour	1.9	0.03	5.2	0.05	0.4	0.51
Third Hour	0.3	0.03	0.5	Nil	0.7	0.19
Fourth Hour	0.2	Nil	0.5	Nil	0.2	0.19
Total	35.9	0.14	27.1	0.11	16.0	6.81

Note: Results expressed as mg/gram of wiper.

TM: Kimberly-Clark Corporation
Roswell, Georgia 30076

TABLE XV

FABWIPE™ (COTTON/POLYPROPYLENE)
CONSECUTIVE SOXHLET EXTRACTIONS ON THE SAME SAMPLE

	111-TCE		Freon TF		MEK	
	NVR	Particulates	NVR	Particulates	NVR	Particulates
First Hour	16.2	0.22	9.3	0.26	8.3	1.94
Second Hour	1.4	Nil	0.8	0.13	0.4	0.30
Third Hour	0.4	0.04	0.5	0.08	0.3	0.51
Fourth Hour	0.2	Nil	0.2	Nil	0.1	0.26
Total	18.2	0.26	10.8	0.47	9.1	3.02

Note: Results expressed as mg/gram of wiper.

TM: Texwipe Company
Upper Saddle River, New Jersey 07458

TABLE XVI

FOAMWIPE™ (POLYURETHANE)
CONSECUTIVE SOXHLET EXTRACTIONS ON THE SAME SAMPLE

	111-TCE		Freon TF		MEK	
	NVR	Particulates	NVR	Particulates	NVR	Particulates
First Hour	38.0	0.28	27.2	0.24	46.2	0.24
Second Hour	1.1	Nil	1.4	0.09	1.6	Nil
Third Hour	0.5	0.08	0.6	0.18	1.3	Nil
Fourth Hour	0.3	0.06	0.1	0.03	0.8	Nil
Total	39.9	0.42	29.3	0.54	49.9	0.24

Note: Results expressed as mg/gram of wiper.

TM: Texwipe Company
Upper Saddle River, New Jersey 07458

TABLE XVII

GLUELESS™ Q-TIPS (COTTON)
CONSECUTIVE SOXHLET EXTRACTIONS ON THE SAME SAMPLE

	111-TCE		Freon TF		MEK	
	NVR	Particulates	NVR	Particulates	NVR	Particulates
First Hour	1.7	0.04	1.6	Nil	2.5	Nil
Second Hour	0.1	Nil	Nil	Nil	0.5	Nil
Third Hour	0.3	0.04	0.1	0.51	0.5	0.15
Fourth Hour	0.1	Nil	0.2	Nil	0.5	Nil
Total	2.2	0.08	1.9	0.51	4.0	0.15

Note: Results expressed as mg/gram of Q-Tip ends.

TM: Puritan Company
Guilford, Maine 04443

TABLE XVIII

MIRACLEWIPE™ (NYLON)
CONSECUTIVE SOXHLET EXTRACTIONS ON THE SAME SAMPLE

	111-TCE		Freon TF		MEK	
	NVR	Particulates	NVR	Particulates	NVR	Particulates
First Hour	1.1	Nil	0.4	Nil	1.6	Nil
Second Hour	0.1	0.04	0.1	0.01	0.3	0.05
Third Hour	0.2	Nil	0.1	Nil	0.2	Nil
Fourth Hour	0.1	Nil	0.1	0.01	0.1	Nil
Total	1.5	0.04	0.7	0.02	2.2	0.05

Note: Results expressed as mg/gram of wiper.

TM: Texwipe Company
Upper Saddle River, New Jersey 07458

TABLE XIX

ONE/UPS™ (COTTON/POLYESTER)
CONSECUTIVE SOXHLET EXTRACTIONS ON THE SAME SAMPLE

	111-TCE		Freon TF		MEK	
	NVR	Particulates	NVR	Particulates	NVR	Particulates
First Hour	9.9	0.07	2.9	0.14	12.3	0.19
Second Hour	0.6	0.02	0.4	0.05	0.5	Nil
Third Hour	0.6	0.12	Nil	0.10	0.2	0.10
Fourth Hour	0.3	0.07	Nil	0.45	0.2	0.12
Total	11.4	0.28	3.3	0.74	13.2	0.41

Note: Results expressed as mg/gram of wiper.

TM: Berkshire Corporation
Great Barrington, Massachusetts 01230

TABLE XX

POLX1200[TM] (POLYESTER)
CONSECUTIVE SOXHLET EXTRACTIONS ON THE SAME SAMPLE

	111-TCE		Freon TF		MEK	
	NVR	Particulates	NVR	Particulates	NVR	Particulates
First Hour	1.3	0.01	0.4	0.03	2.2	Nil
Second Hour	0.1	Nil	0.1	0.02	0.2	0.03
Third Hour	0.1	Nil	0.1	Nil	0.3	Nil
Fourth Hour	0.1	Nil	0.2	Nil	0.2	Nil
Total	1.6	0.01	0.8	0.05	2.9	0.03

Note: Results expressed as mg/gam of wiper.

TM: Berkshire Corporation
Great Barrington, Massachusetts 01230

TABLE XXI

WESTWIPES™ (ANTICON 100) (POLYESTER)
CONSECUTIVE SOXHLET EXTRACTIONS ON THE SAME SAMPLE

	111-TCE		Freon TF		MEK	
	NVR	Particulates	NVR	Particulates	NVR	Particulates
First Hour	1.0	Nil	0.4	Nil	1.9	0.02
Second Hour	0.2	0.03	0.3	0.07	0.4	Nil
Third Hour	Nil	0.02	0.1	0.03	0.3	0.02
Fourth Hour	0.2	Nil	0.1	Nil	0.3	Nil
Total	1.4	0.05	0.9	0.10	2.9	0.04

Note: Results expressed as mg/gram of wiper.

TM: Thomas E. West Company
P.O. Box 592
Belmont, California 94002

TABLE XXII

WESTWIPES™ (SEALED EDGES) (POLYESTER)
CONSECUTIVE SOXHLET EXTRACTIONS ON THE SAME SAMPLE

	111-TCE		Freon TF		MEK	
	NVR	Particulates	NVR	Particulates	NVR	Particulates
First Hour	0.6	0.09	0.30	0.14	1.7	0.03
Second Hour	0.1	Nil	0.10	0.03	0.3	Nil
Third Hour	Nil	Nil	0.10	Nil	0.4	Nil
Fourth Hour	Nil	Nil	0.05	Nil	0.2	Nil
Total	0.7	0.09	0.60	0.17	2.6	0.03

Note: Results expressed as mg/gram of wiper.

TM: Thomas E. West Company
P.O. Box 592
Belmont, California 94002

TABLE XXIII

WONDER-WIPE™ (NYLON)
CONSECUTIVE SOXHLET EXTRACTIONS ON THE SAME SAMPLE

	111-TCE		Freon TF		MEK	
	NVR	Particulates	NVR	Particulates	NVR	Particulates
First Hour	8.0	0.22	3.4	0.47	8.0	0.54
Second Hour	0.2	0.01	0.2	0.20	0.4	0.01
Third Hour	0.1	0.01	0.2	0.15	0.2	Nil
Fourth Hour	0.0	0.01	0.0	0.05	0.2	0.44
Total	8.3	0.25	3.8	0.87	8.8	0.99

Note: Results expressed as mg/gram of wiper.

TM: Clean Room Products, Incorporated
1800 Ocean Avenue
Ronkonkoma, New York 11779-9990

TABLE XXIV

SOHXLET EXTRACTION[1] OF HD-2 GREASE FROM VARIOUS WIPER MATERIALS[2,3]

Wiper	111-TCE[4] % Recovery	111-TCE[4] FTIR ID	Freon TF % Recovery	Freon TF FTIR ID	MEK % Recovery	MEK FTIR ID
Anticon 100 Polyester	89.9	Fair	78.9	Poor	92.9	Very poor
Miraclewipe Nylon	105.9	Good	76.9	Very poor	98.9	Poor
Fabwipe Cotton/polypropylene	104.9	Good	90.9	Very poor	91.9	Poor
Alphawipe Polyester	89.9	Good	71.9	Poor	86.9	Very Poor
Q-Tips, Glueless Cotton	95.8	Poor	103.8	Very poor	72.0	Very poor
Polx 1200 Polyester	93.9	Good	70.9	Poor	87.0	Poor

[1]Four-hour reflux.

[2]Wiper material prewashed with solvent used in extraction.

[3]About 10 mg of HD-2 added per gram of wiper.

[4]Methyl chloroform.

TABLE XXV

SOHXLET EXTRACTION[1] OF KRYTOX FLUOROCARBON GREASE FROM VARIOUS WIPER MATERIALS[2,3]

Wiper	111-TCE[4] % Recovery	111-TCE[4] FTIR ID	Freon TF % Recovery	Freon TF FTIR ID	MEK % Recovery	MEK FTIR ID
Anticon 100 Polyester	64.8	Fair	94.2	Fair	20.8	Poor
Miraclewipe Nylon	69.5	Fair	104.8	Good	16.8	Poor
Fabwipe Cotton/polypropylene	37.9	Fair	104.8	Fair	18.8	Poor
Alphawipe Polyester	68.3	Poor	66.5	Fair	12.9	Fair
Q-Tips, Glueless Cotton	61.2	Poor	110.7	Fair	10.0	Poor
Polx 1200 Polyester	66.0	Good	104.8	Good	15.8	Fair

[1]Four-hour reflux.

[2]Wiper material prewashed with solvent used in extraction.

[3]About 10 mg of Krytox added per gram of wiper.

[4]Methyl chloroform.

TABLE XXVI

SOHXLET EXTRACTION[1] OF HYDRAULIC OIL FROM VARIOUS WIPER MATERIALS[2,3]

Wiper	111-TCE[4] % Recovery	111-TCE[4] FTIR ID	Freon TF % Recovery	Freon TF FTIR ID	MEK % Recovery	MEK FTIR ID
Anticon 100 Polyester	61.7	Very poor	31.9	Very poor	78.7	Very poor
Miraclewipe Nylon	42.6	Poor	46.8	Fair	48.9	Fair
Fabwipe Cotton/polypropylene	72.3	Fair	34.0	Fair	61.7	Fair
Alphawipe Polyester	31.9	Very poor	85.1	Poor	34.0	Fair
Q-Tips, Glueless Cotton	68.1	Fair	85.1	Fair	76.6	Poor
Polx 1200 Polyester	25.5	Very poor	87.2	Very poor	53.2	Poor

[1]Four-hour reflux.

[2]Wiper materials prewashed with solvent used in extraction.

[3]About 10 mg of hydraulic oil added per gram of wiper.

[4]Methyl chloroform.

TABLE XXVII

SOHXLET EXTRACTION[1] OF SILICONE OIL FROM VARIOUS WIPER MATERIALS[2,3]

Wiper	111-TCE[4] % Recovery	111-TCE[4] FTIR ID	Freon TF % Recovery	Freon TF FTIR ID	MEK % Recovery	MEK FTIR ID
Anticon 100 Polyester	104.5	Good	87.6	Good	106.5	Good
Miraclewipe Nylon	79.6	Good	102.5	Good	105.5	Good
Fabwipe Cotton/polypropylene	115.4	Good	47.8	Good	109.5	Good
Alphawipe Polyester	94.5	Good	113.4	Good	104.5	Good
Q-Tips, Glueless Cotton	107.4	Good	49.8	Fair	111.0	Good
Polx 1200 Polyester	103.5	Good	107.5	Good	95.5	Good

[1]Four-hour reflux.

[2]Wiper materials prewashed with solvent used in extraction.

[3]About 10 mg of silicone oil applied per gram of wiper.

[4]Methyl chloroform.

TABLE XXVIII

SOHXLET EXTRACTION[1] OF MINERAL OIL FROM VARIOUS WIPER MATERIALS[2,3]

Wiper	111-TCE[4] % Recovery	111-TCE[4] FTIR ID	Freon TF % Recovery	Freon TF FTIR ID	MEK % Recovery	MEK FTIR ID
Anticon 100 Polyester	103.5	Fair	84.6	Fair	105.5	Fair
Miraclewipe Nylon	96.5	Good	89.6	Good	106.5	Good
Fabwipe Cotton/polypropylene	111.4	Good	101.5	Good	97.5	Good
Alphawipe Polyester	86.6	Fair	89.6	Good	68.7	Good
Q-Tips, Glueless Cotton	97.4	Good	83.7	Good	111.6	Good
Polx 1200 Polyester	97.5	Good	113.4	Fair	102.5	Fair

[1]Four-hour reflux.

[2]Wiper materials prewashed with solvent used in extraction.

[3]About 10 mg of mineral oil applied per gram of wiper.

[4]Methyl chloroform.

TABLE XXIX

SOHXLET EXTRACTION[1] OF DOP FROM VARIOUS WIPER MATERIALS[2,3]

Wiper	111-TCE[4] % Recovery	111-TCE[4] FTIR ID	Freon TF % Recovery	Freon TF FTIR ID	MEK % Recovery	MEK FTIR ID
Anticon 100 Polyester	119.6	Good	106.7	Good	118.6	Good
Miraclewipe Nylon	103.6	Good	110.7	Good	108.6	Good
Fabwipe Cotton/polypropylene	118.6	Good	108.7	Good	106.7	Good
Alphawipe Polyester	113.6	Good	119.6	Good	96.7	Good
Q-Tips, Glueless Cotton	105.8	Good	119.7	Good	113.8	Good
Polx 1200 Polyester	118.6	Good	121.6	Good	106.9	Good

[1]Four-hour reflux.

[2]Wiper materials prewashed with solvent used in extraction.

[3]About 10 mg of DOP applied per gram of wiper.

[4]Methyl chloroform.

TABLE XXX

SOHXLET EXTRACTION[1] OF YELLOW VINYL TAPE ADHESIVE* FROM VARIOUS WIPER MATERIALS[2,3]

Wiper	111-TCE[4] % Recovery	FTIR ID	Freon TF % Recovery	FTIR ID	MEK % Recovery	FTIR ID
Anticon 100 Polyester	93.0	Good	80.3	Good	110.5	Good
Miraclewipe Nylon	101.9	Good	50.9	Good	107.7	Good
Fabwipe Cotton/polypropylene	118.5	Good	93.0	Good	107.7	Good
Alphawipe Polyester	111.6	Good	97.9	Good	105.8	Good
Q-Tips, Glueless Cotton	76.4	Good	90.2	Good	109.6	Good
Polx 1200 Polyester	105.8	Good	94.0	Good	109.7	Good

[1]Four-hour reflux.

[2]Wiper materials prewashed with solvent used in extraction.

[3]About 10 mg of vinyl tape extract applied per gram of wiper.

[4]Methyl chloroform.

*Permacel, New Brunswick, New Jersey 08903

TABLE XXXI

SOHXLET EXTRACTION[1] OF TEFLON TAPE ADHESIVE* FROM VARIOUS WIPER MATERIALS[2,3]

Wiper	111-TCE[4] % Recovery	111-TCE[4] FTIR ID	Freon TF % Recovery	Freon TF FTIR ID	MEK % Recovery	MEK FTIR ID
Anticon 100 Polyester	97.0	Good	105.9	Good	113.9	Good
Miraclewipe Nylon	111.9	Good	103.0	Good	105.0	Good
Fabwipe Cotton/polypropylene	117.7	Good	71.3	Good	113.8	Good
Alphawipe Polyester	108.7	Good	117.0	Good	105.0	Good
Q-Tips, Glueless Cotton	116.8	Good	112.9	Good	103.0	Good
Polx 1200 Polyester	101.0	Good	111.9	Good	105.9	Good

[1]Four-hour reflux.

[2]Wiper materials prewashed with solvent used in extraction.

[3]About 10 mg of Teflon tape extract applied per gram of wiper.

[4]Methyl chloroform.

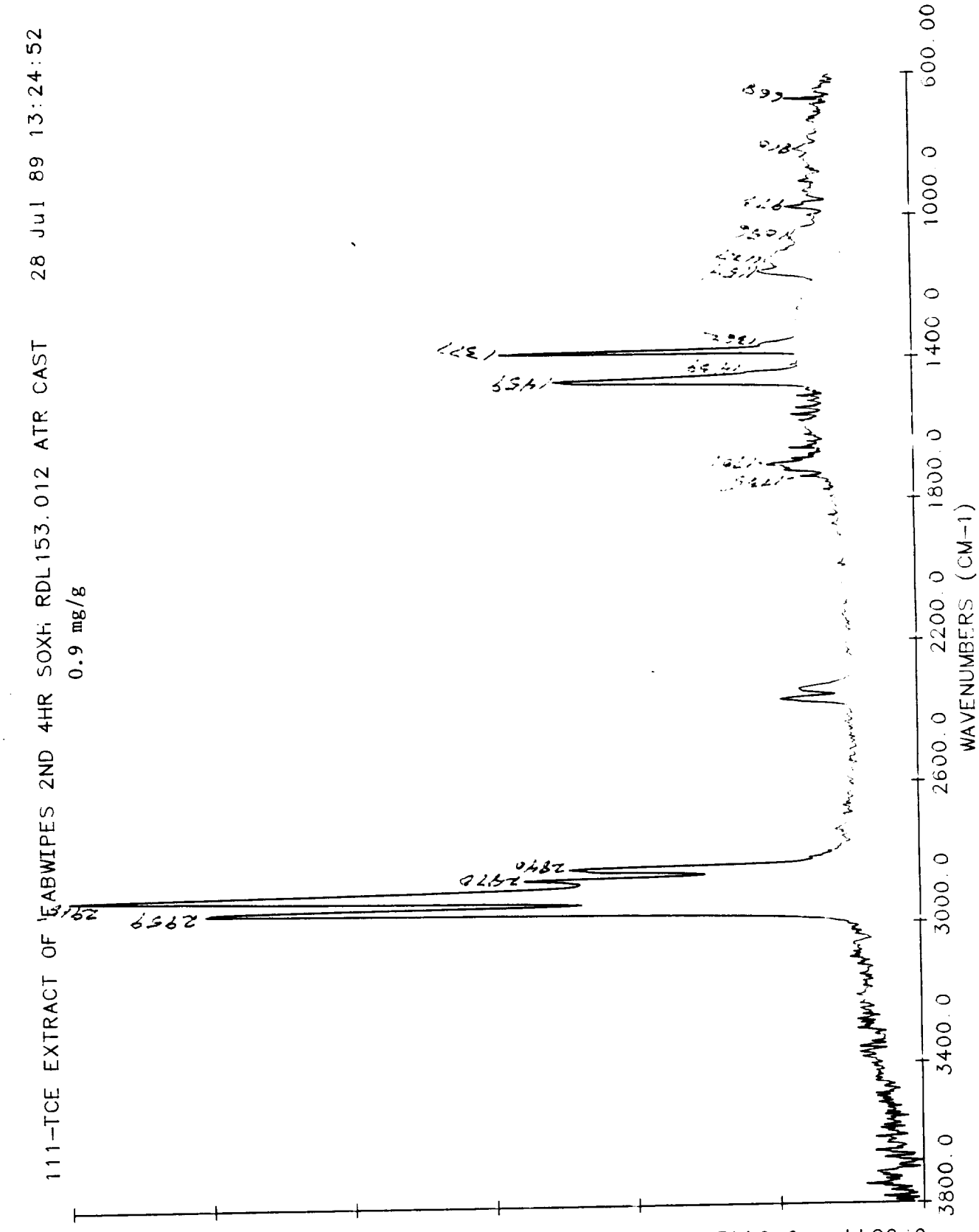
*"Fluoroglas"™, Dodge Company.

TABLE XXXII

COMPARISON OF SOXHLET EXTRACTION
VERSUS BOILING-SHAKING EXTRACTION

System	Soxhlet		Boiling-Shaking	
	% Recovery	FTIR ID	% Recovery	FTIR ID
HD-2/Anticon/TCE	89.9	Fair	100.9	Fair
HD-2/Anticon/Freon TF	78.9	Poor	77.9	Very poor
HD-2/Miraclewipe/Freon TF	76.9	Very poor	80.9	Poor
HD-2/Fabwipe/Freon TF	90.9	Very poor	85.9	Poor
HD-2/Miraclewipe/MEK	98.9	Poor	85.9	Good
HD-2/Fabwipe/MEK	91.9	Poor	104.9	Good
HD-2/Polx 1200/MEK	87.0	Poor	88.9	Good
Krytox/Miraclewipe/TCE	69.5	Fair	68.2	Good
Krytox/Polx 1200/TCE	66.0	Good	62.3	Good
Krytox/Anticon/Freon TF	94.2	Fair	87.0	Good
Krytox/Fabwipe/Freon TF	104.8	Fair	93.0	Good
Krytox/Alphawipe/Freon TF	66.5	Fair	88.0	Good
Hydraulic oil/Alphawipe/Freon TF	85.1	Poor	35.1	Very poor
Hydraulic oil/Q-Tips/Freon TF	85.1	Fair	26.2	Fair
Hydraulic oil/Anticon/MEK	78.7	Very poor	32.1	Poor
Hydraulic oil/Fabwipe/MEK	61.7	Fair	32.1	Fair
Hydraulic oil/Fabwipe/TCE	72.3	Fair	37.1	Fair
Hydraulic oil/Q-Tips/TCE	68.1	Fair	30.2	Poor

Figure 1.



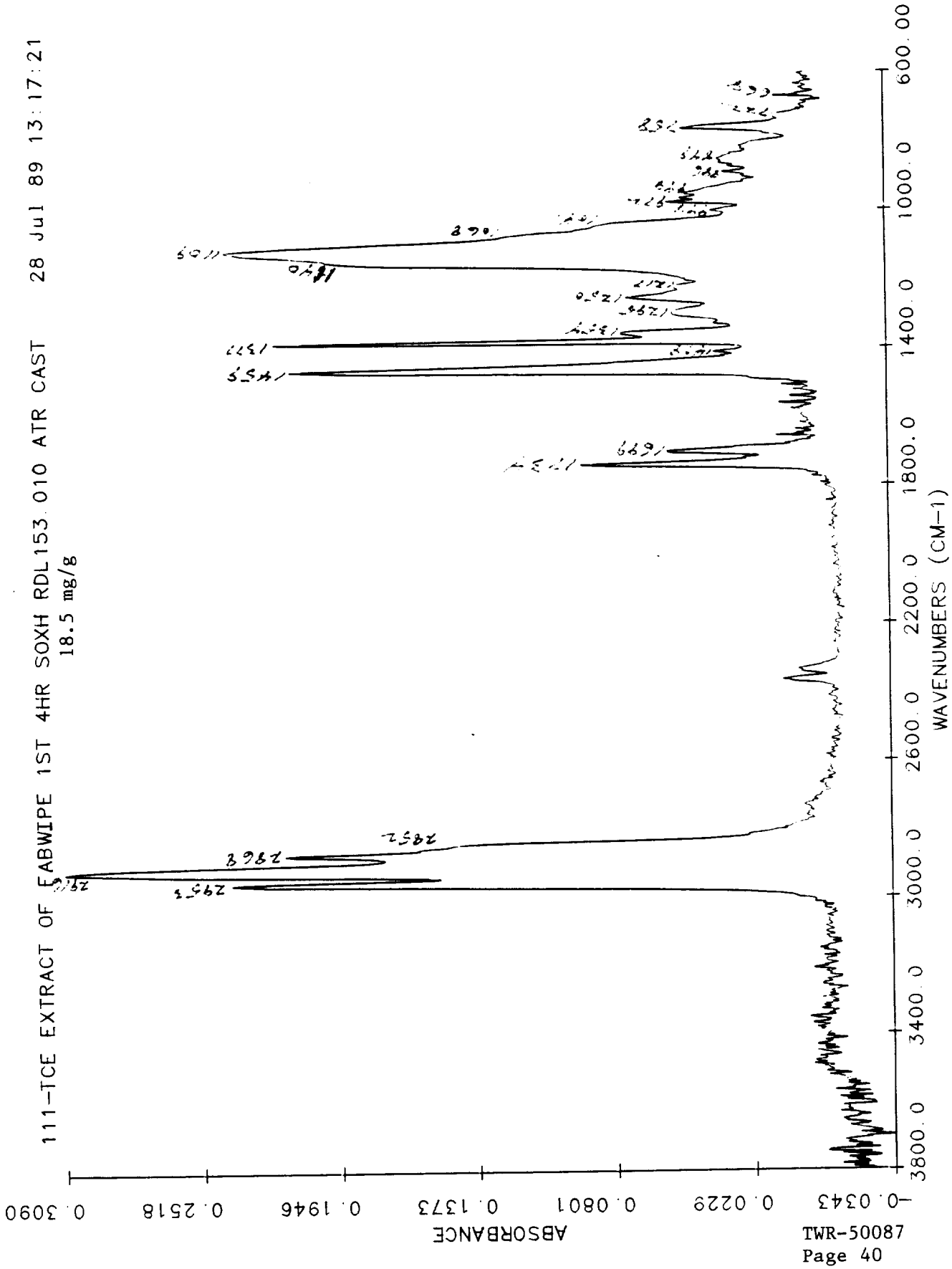
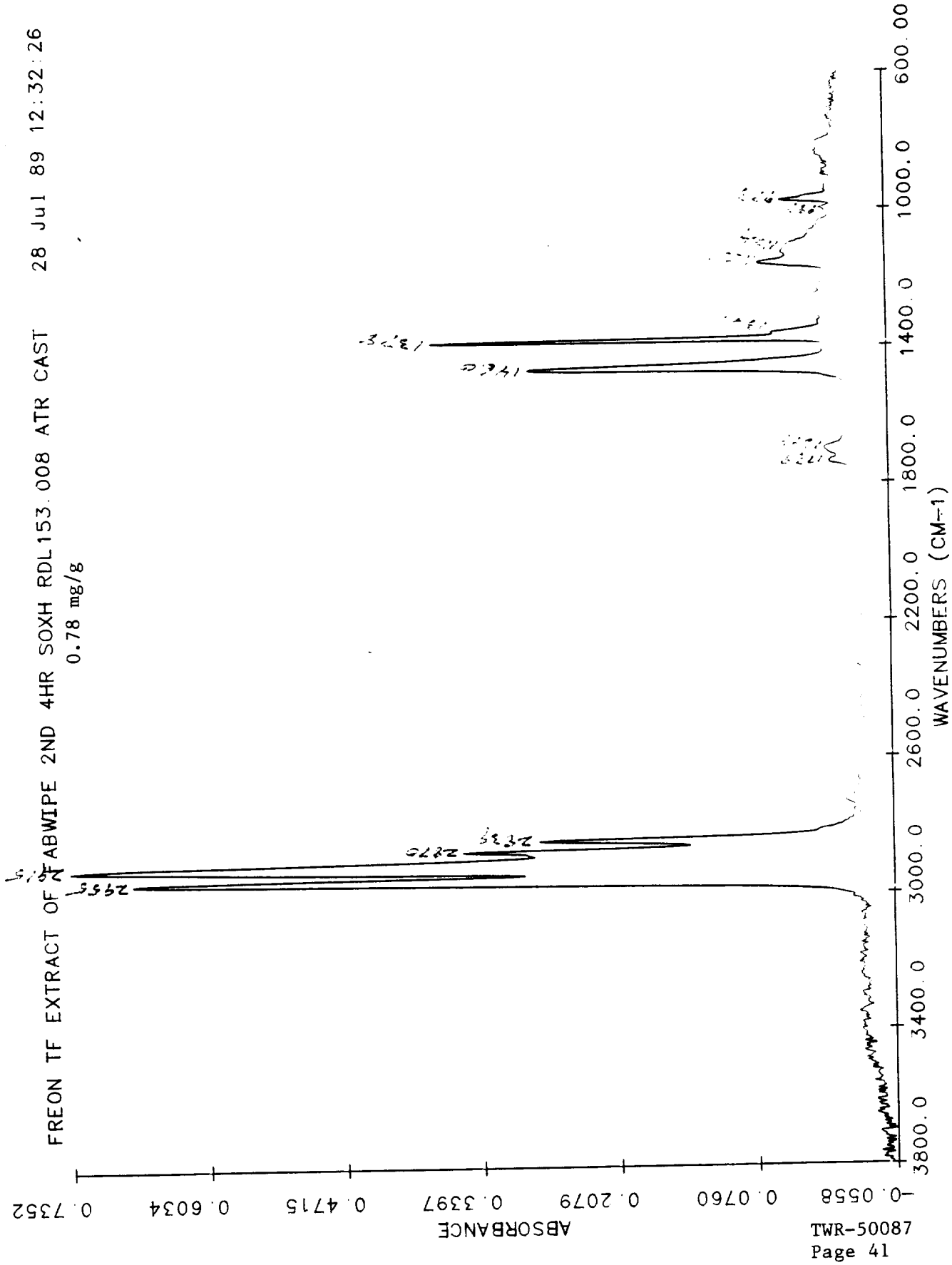


Figure 2.

Figure 3.



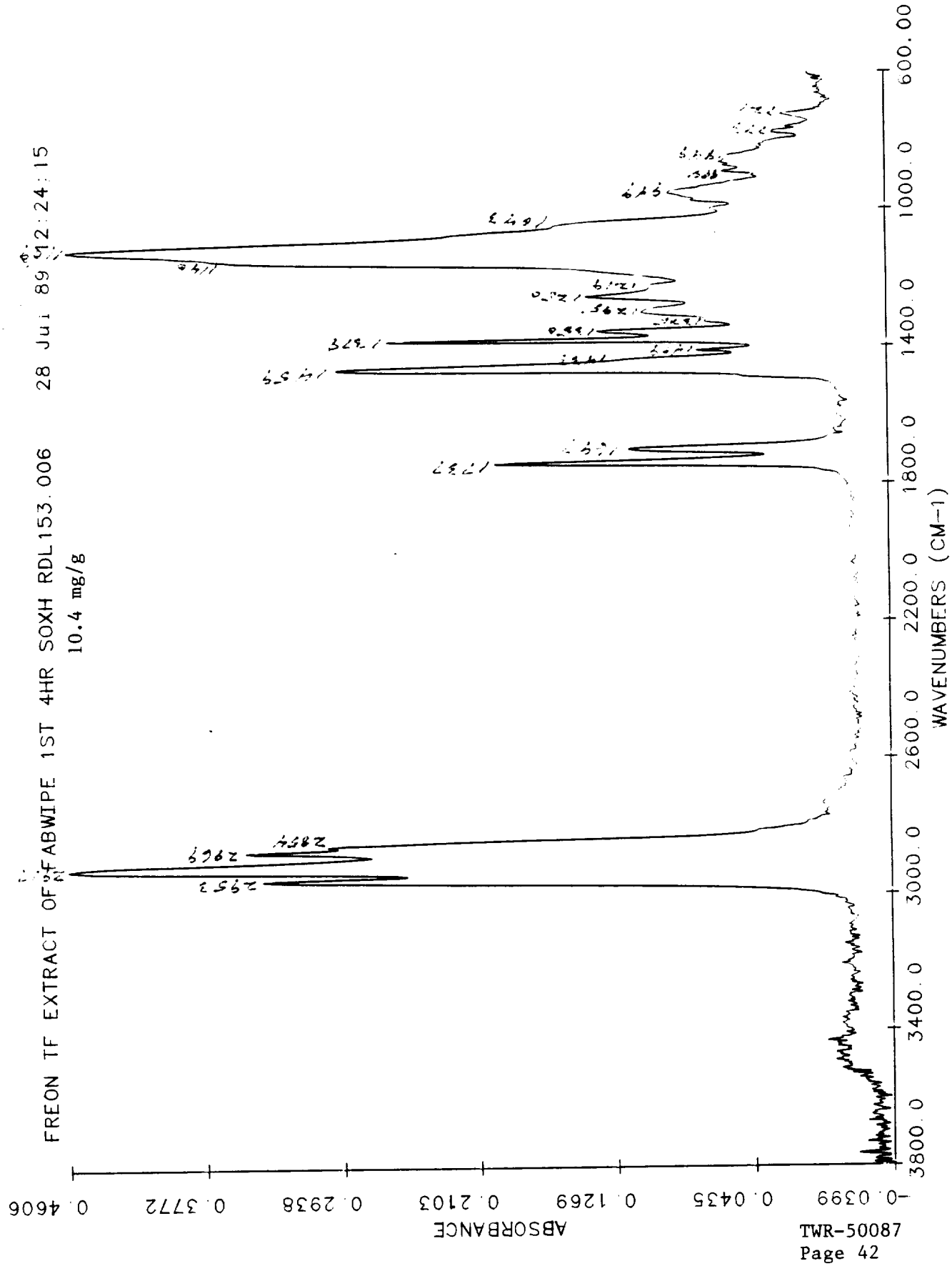


Figure 4.

Figure 5.

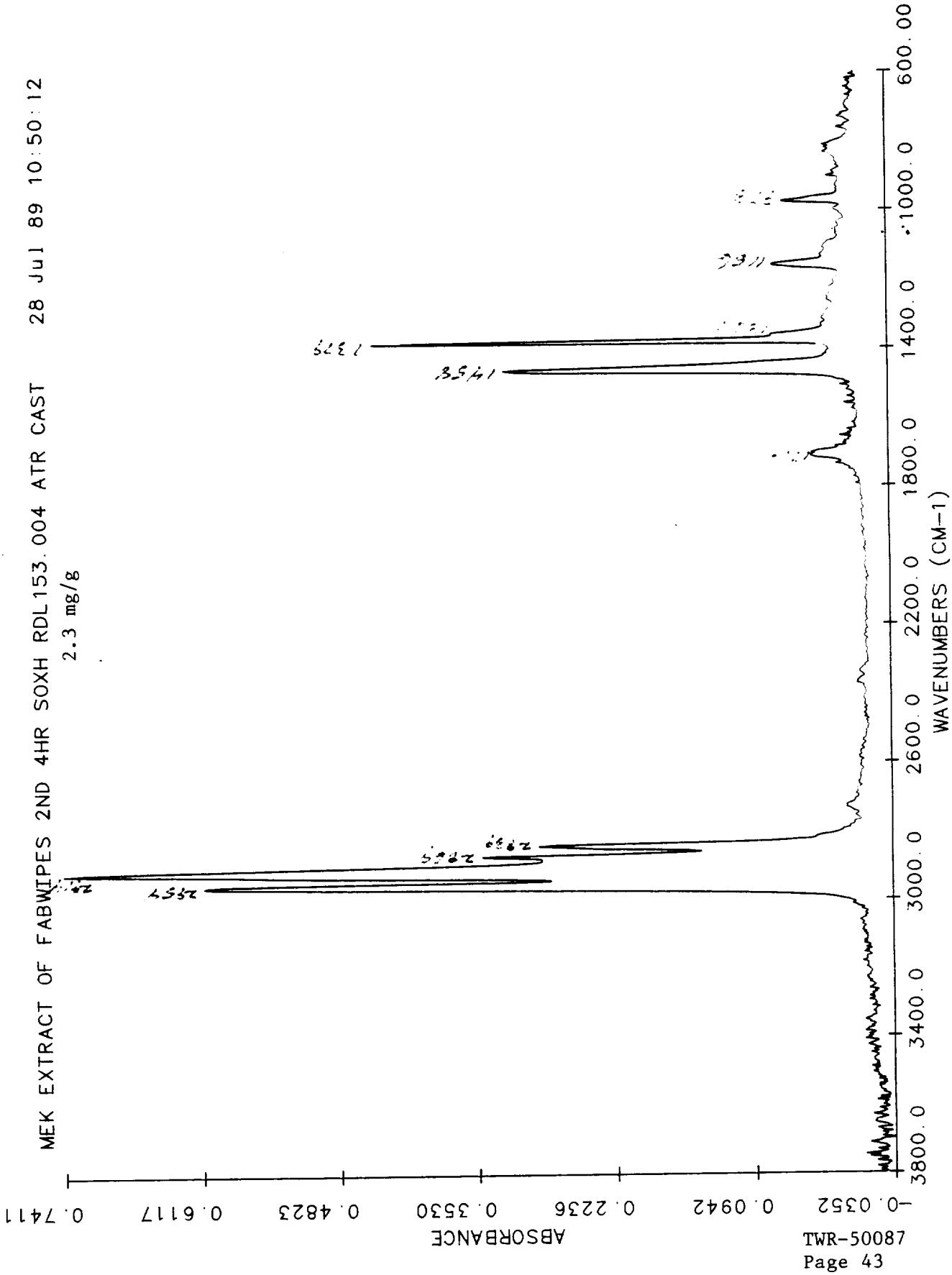

MEK EXTRACT OF FABWIPES 2ND 4HR SOXH RDL153.004 ATR CAST 28 Jul 89 10:50:12
2.3 mg/g
ABSORBANCE
0.0352
0.0942
0.2236
0.3530
0.4823
0.6117
0.7411
WAVENUMBERS (CM-1)
3800.0
3400.0
3000.0
2600.0
2200.0
1800.0
1400.0
1000.0
600.00

Figure 6.

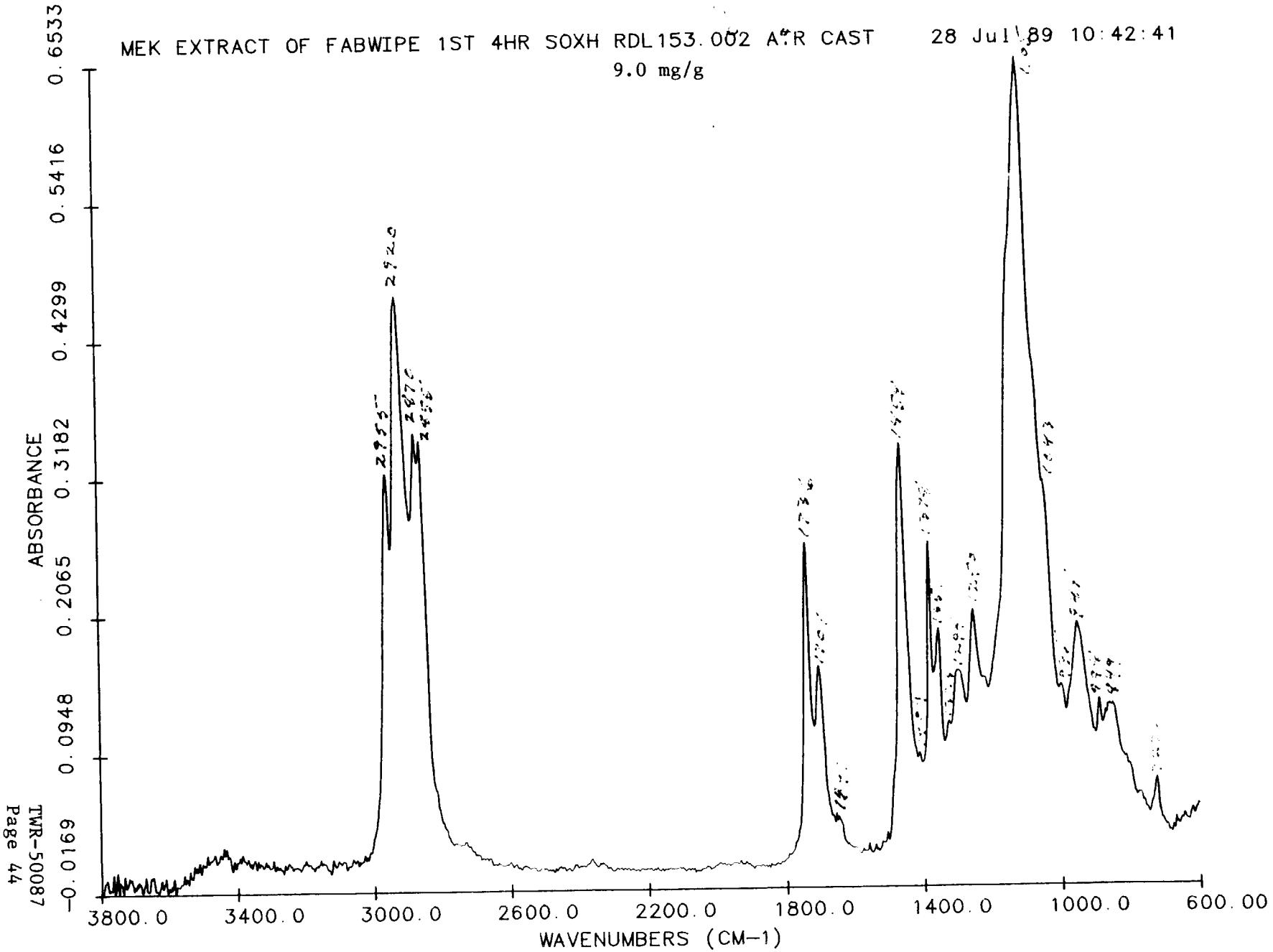

MEK EXTRACT OF FABWIPE 1ST 4HR SOXH RDL153.002 AIR CAST 28 Jul 89 10:42:41
9.0 mg/g
ABSORBANCE
0.6533
0.5416
0.4299
0.3182
0.2065
0.0948
-0.0169
3800.0
3400.0
3000.0
2600.0
2200.0
1800.0
1400.0
1000.0
600.00
WAVENUMBERS (CM-1)

Figure 7.

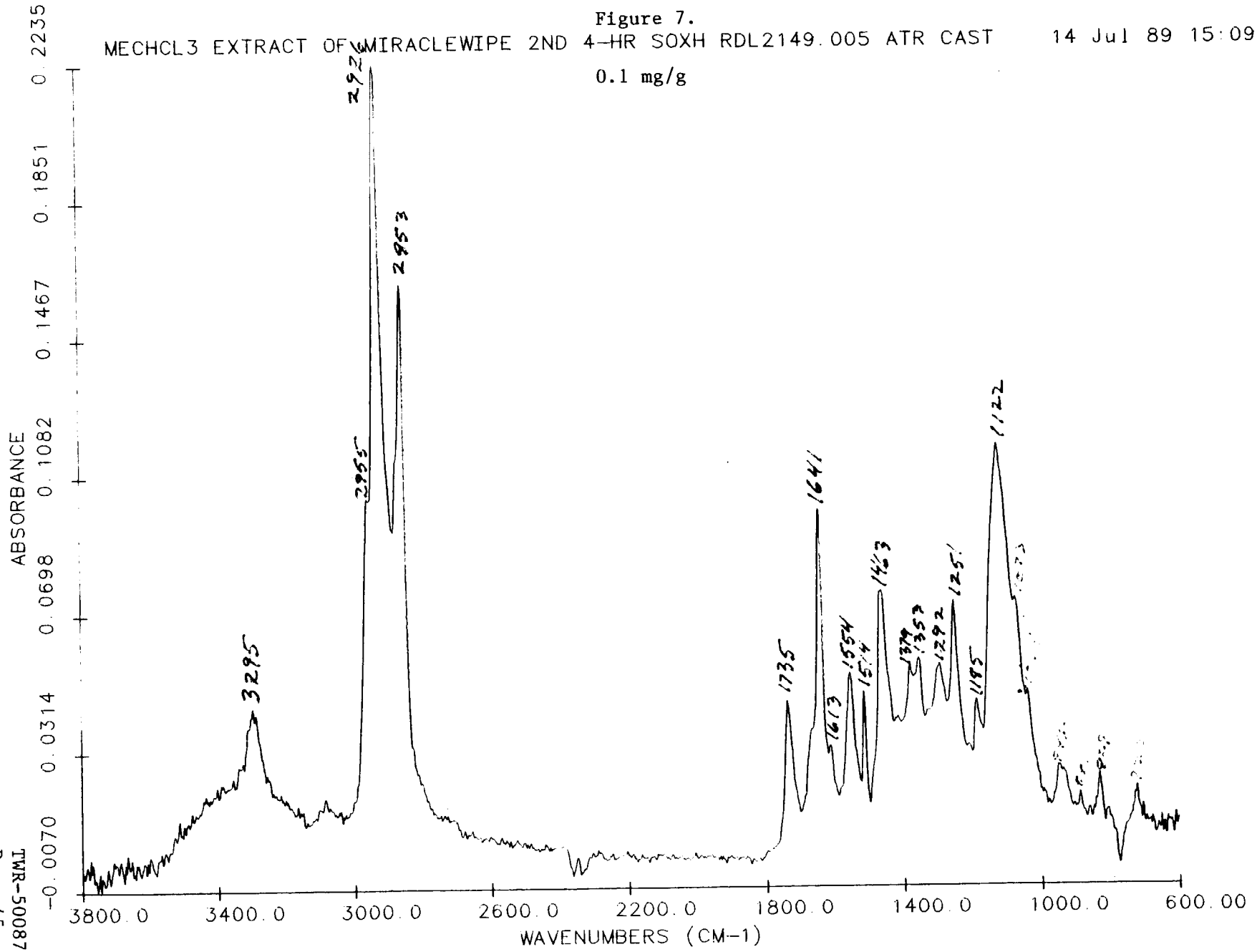

MECHCL3 EXTRACT OF MIRACLEWIPE 2ND 4-HR SOXH RDL2149.005 ATR CAST 14 Jul 89 15:09:30
0.1 mg/g
ABSORBANCE
0.2235
0.1851
0.1467
0.1082
0.0698
0.0314
-0.0070
2926
2955
2853
3295
1735
1641
1613
1554
1514
1463
1379
1353
1292
1251
1185
1122
3800.0
3400.0
3000.0
2600.0
2200.0
1800.0
1400.0
1000.0
600.00
WAVENUMBERS (CM-1)

Figure 8.

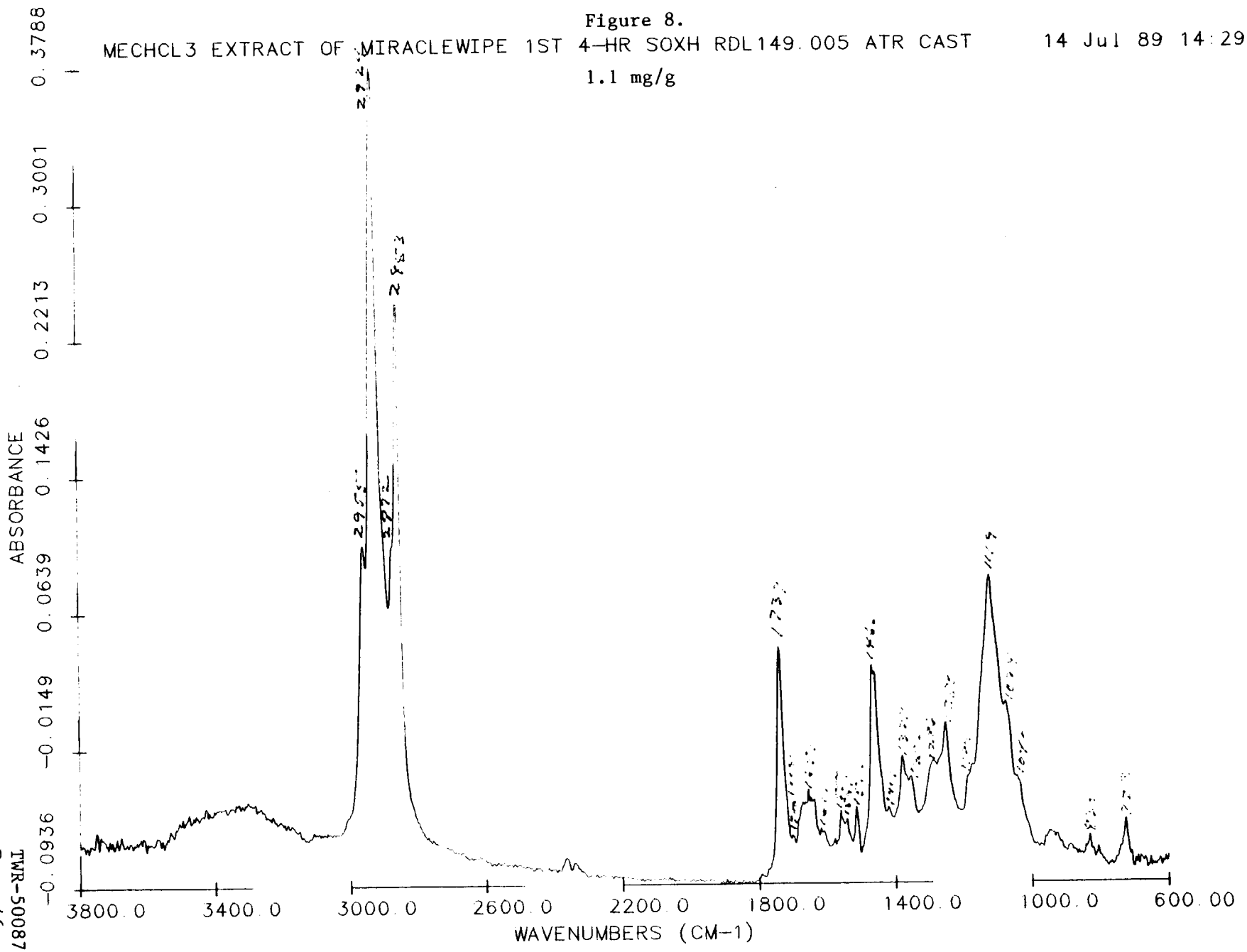

MECHCL3 EXTRACT OF MIRACLEWIPE 1ST 4-HR SOXH RDL149.005 ATR CAST
14 Jul 89 14:29:10
1.1 mg/g
ABSORBANCE
0.3788
0.3001
0.2213
0.1426
0.0639
-0.0149
-0.0936
3800.0
3400.0
3000.0
2600.0
2200.0
1800.0
1400.0
1000.0
600.00
WAVENUMBERS (CM-1)

Figure 9.

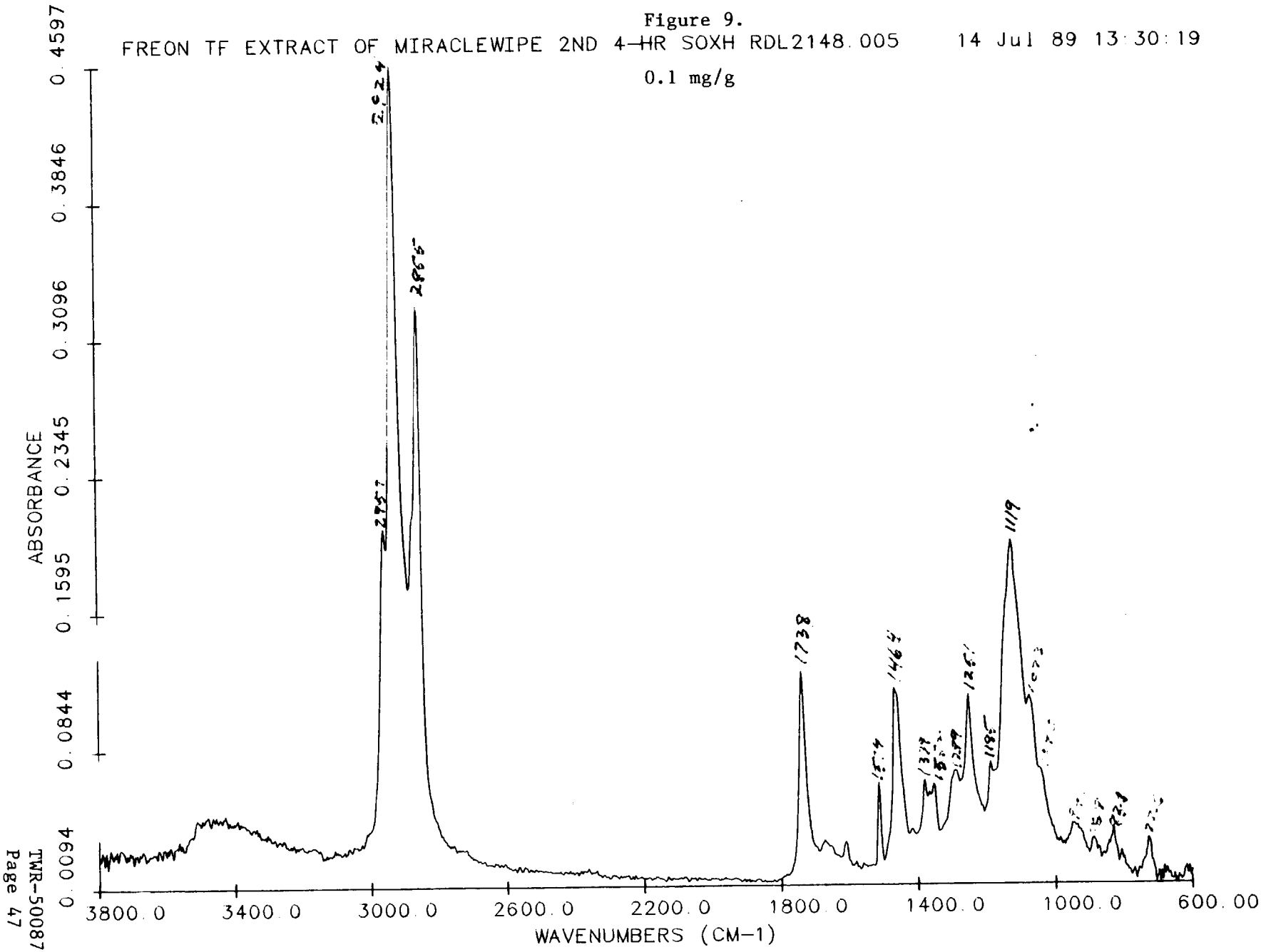

FREON TF EXTRACT OF MIRACLEWIPE 2ND 4-HR SOXH RDL2148.005 14 Jul 89 13:30:19
0.1 mg/g
ABSORBANCE
0.0094
0.0844
0.1595
0.2345
0.3096
0.3846
0.4597
2924
2857
1738
1464
1119
3800.0
3400.0
3000.0
2600.0
2200.0
1800.0
1400.0
1000.0
600.00
WAVENUMBERS (CM-1)

Figure 10.

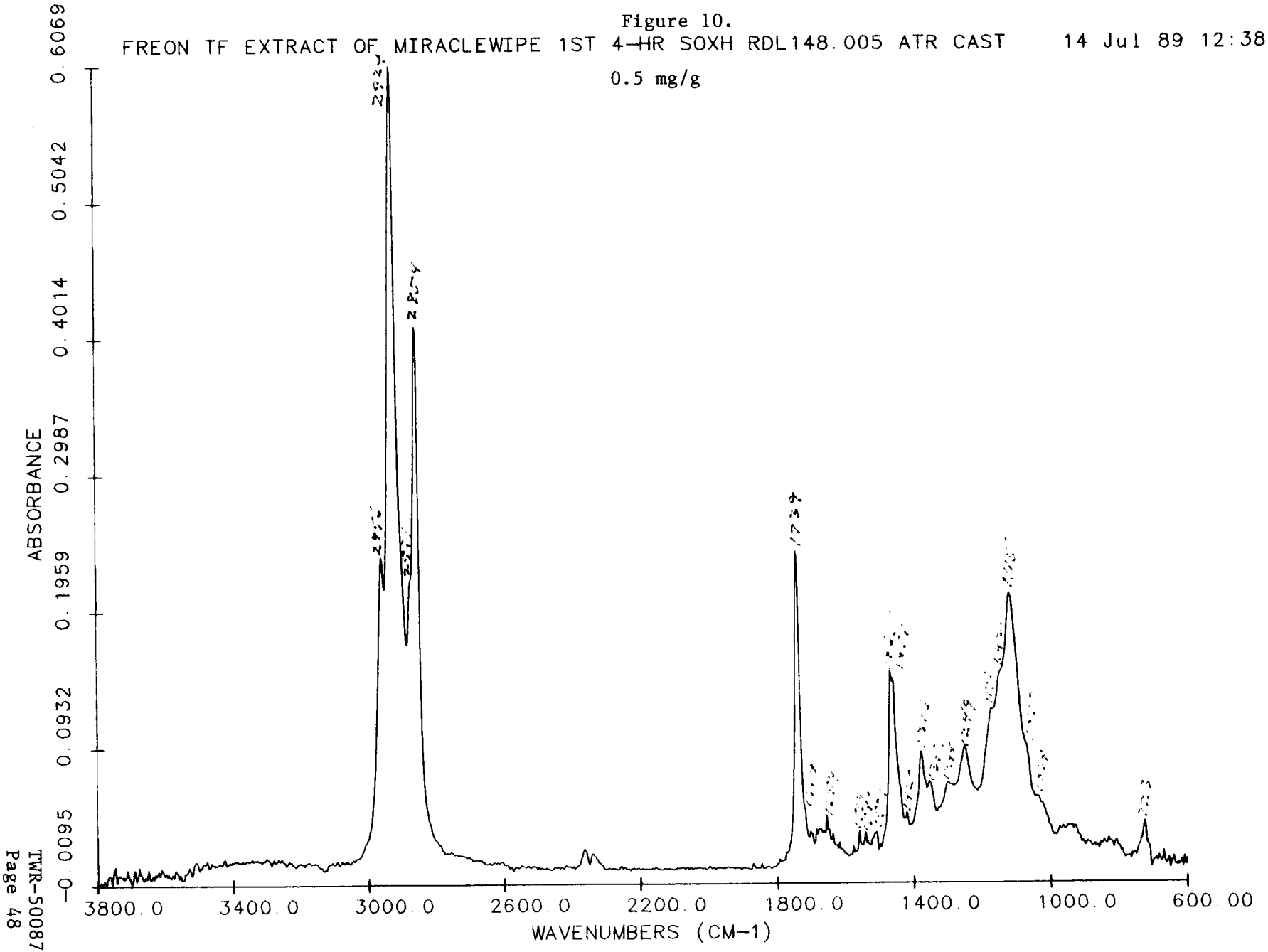

FREON TF EXTRACT OF MIRACLEWIPE 1ST 4-HR SOXH RDL148.005 ATR CAST 14 Jul 89 12:38:25
0.5 mg/g
ABSORBANCE
0.6069
0.5042
0.4014
0.2987
0.1959
0.0932
-0.0095
3800.0
3400.0
3000.0
2600.0
2200.0
1800.0
1400.0
1000.0
600.00
WAVENUMBERS (CM-1)

Figure 11.

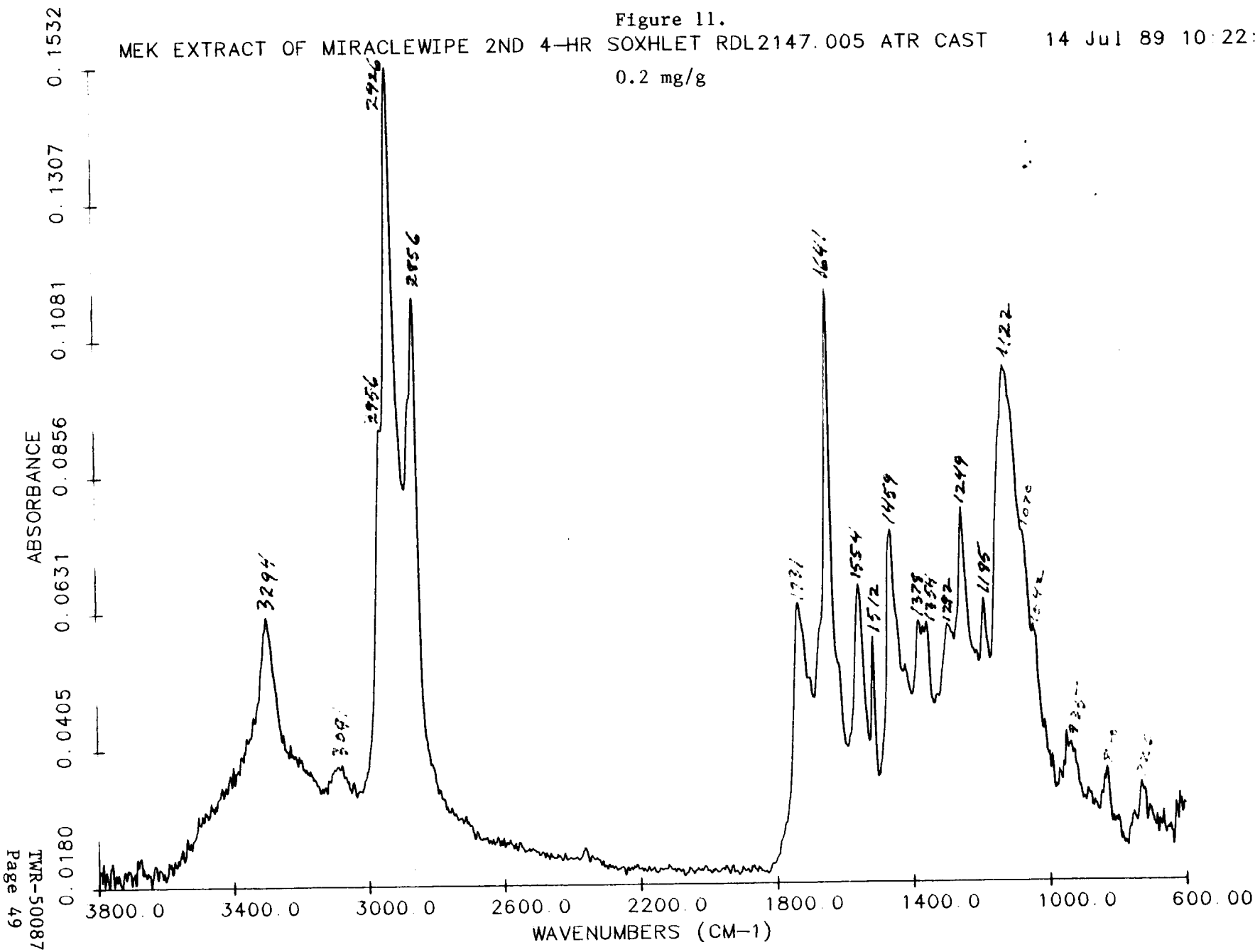
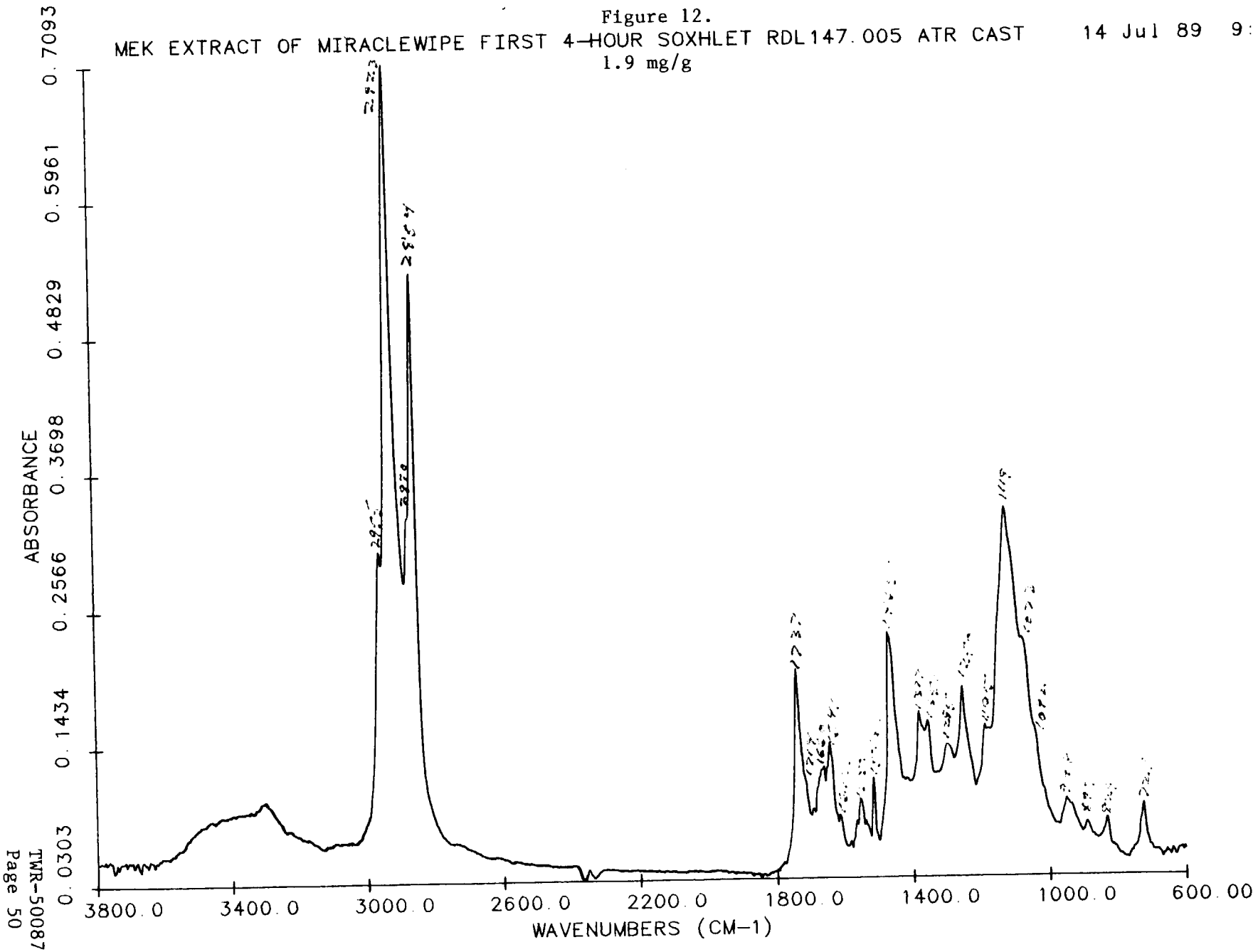

MEK EXTRACT OF MIRACLEWIPE 2ND 4-HR SOXHLET RDL2147.005 ATR CAST 14 Jul 89 10:22:27
0.2 mg/g
ABSORBANCE
0.1532
0.1307
0.1081
0.0856
0.0631
0.0405
0.0180
3800.0
3400.0
3000.0
2600.0
2200.0
1800.0
1400.0
1000.0
600.00
WAVENUMBERS (CM-1)
3294
2926
2856
1641
1554
1512
1459
1249
1122

Figure 12.


MEK EXTRACT OF MIRACLEWIPE FIRST 4-HOUR SOXHLET RDL147.005 ATR CAST 14 Jul 89 9:27:23
1.9 mg/g
ABSORBANCE
0.7093
0.5961
0.4829
0.3698
0.2566
0.1434
0.0303
3800.0
3400.0
3000.0
2600.0
2200.0
1800.0
1400.0
1000.0
600.00
WAVENUMBERS (CM-1)

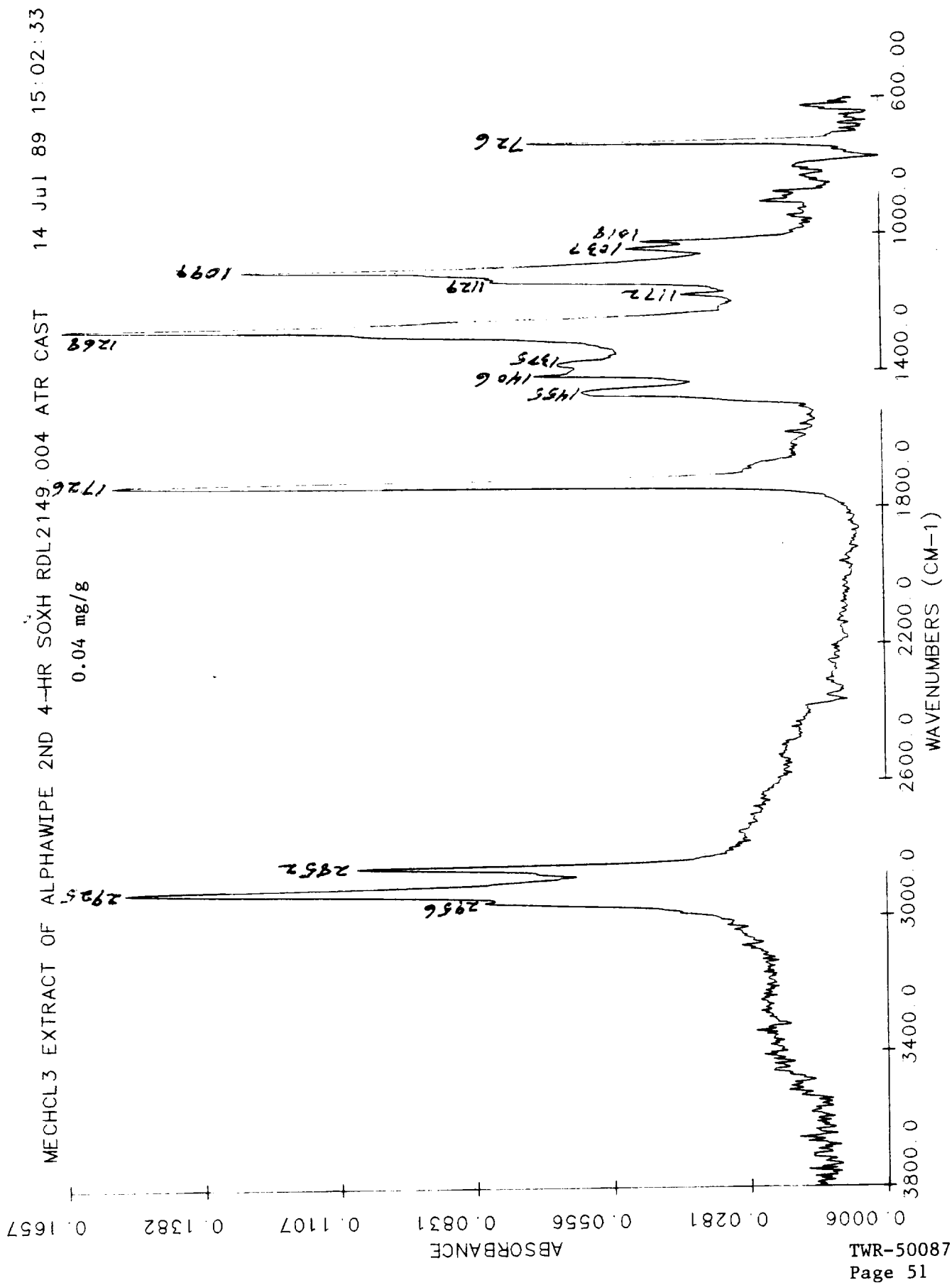


Figure 13.

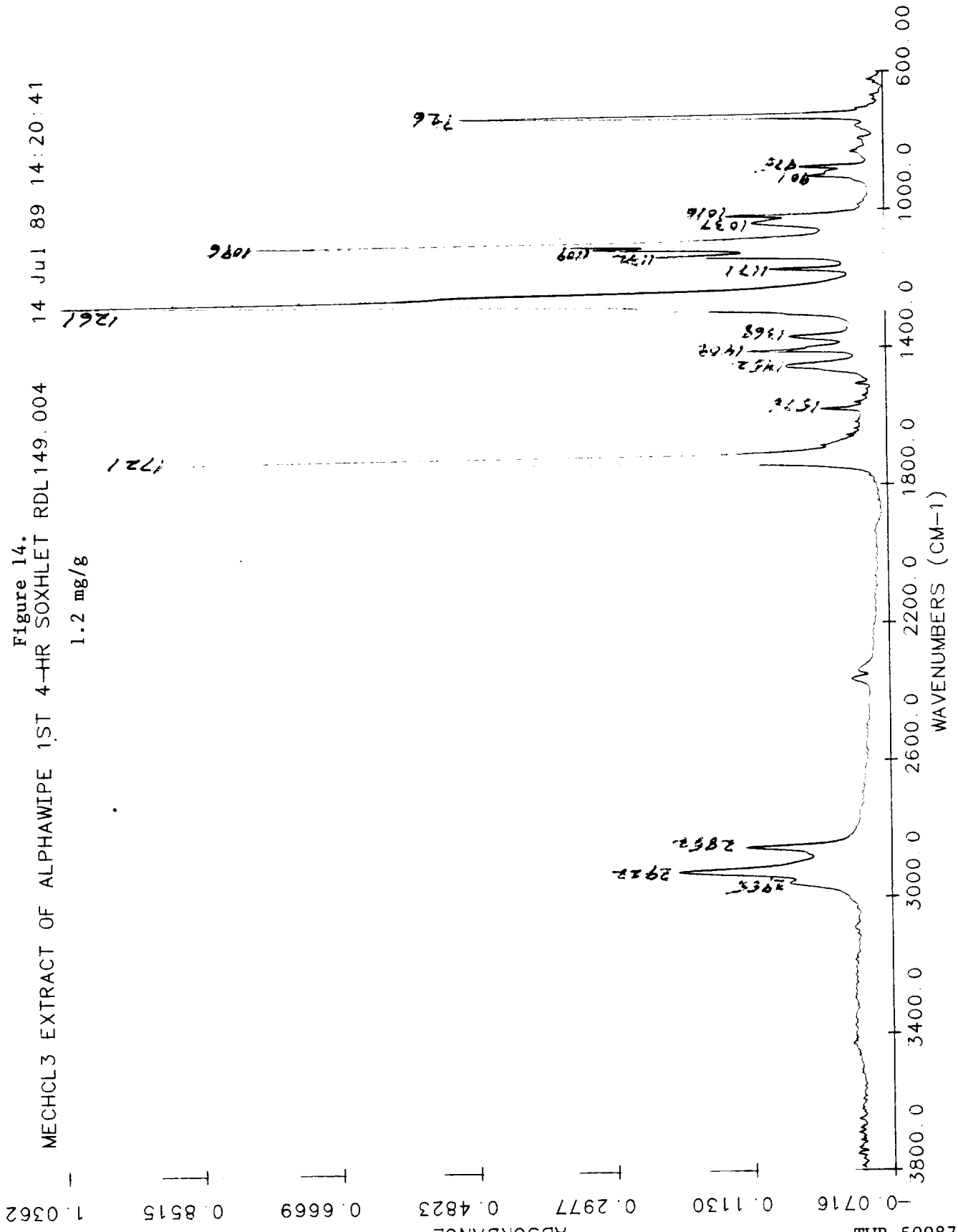


Figure 14.

Figure 15.

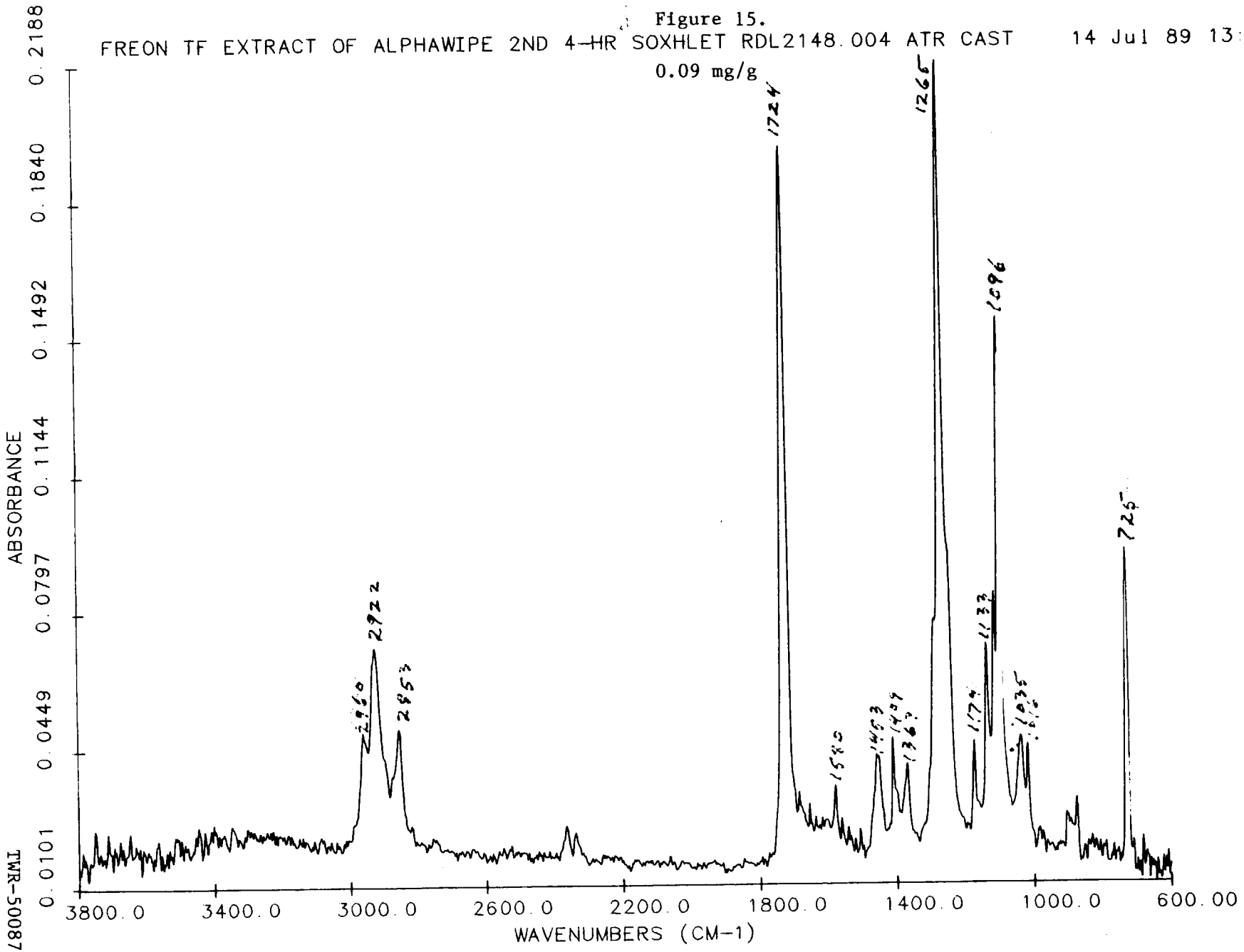
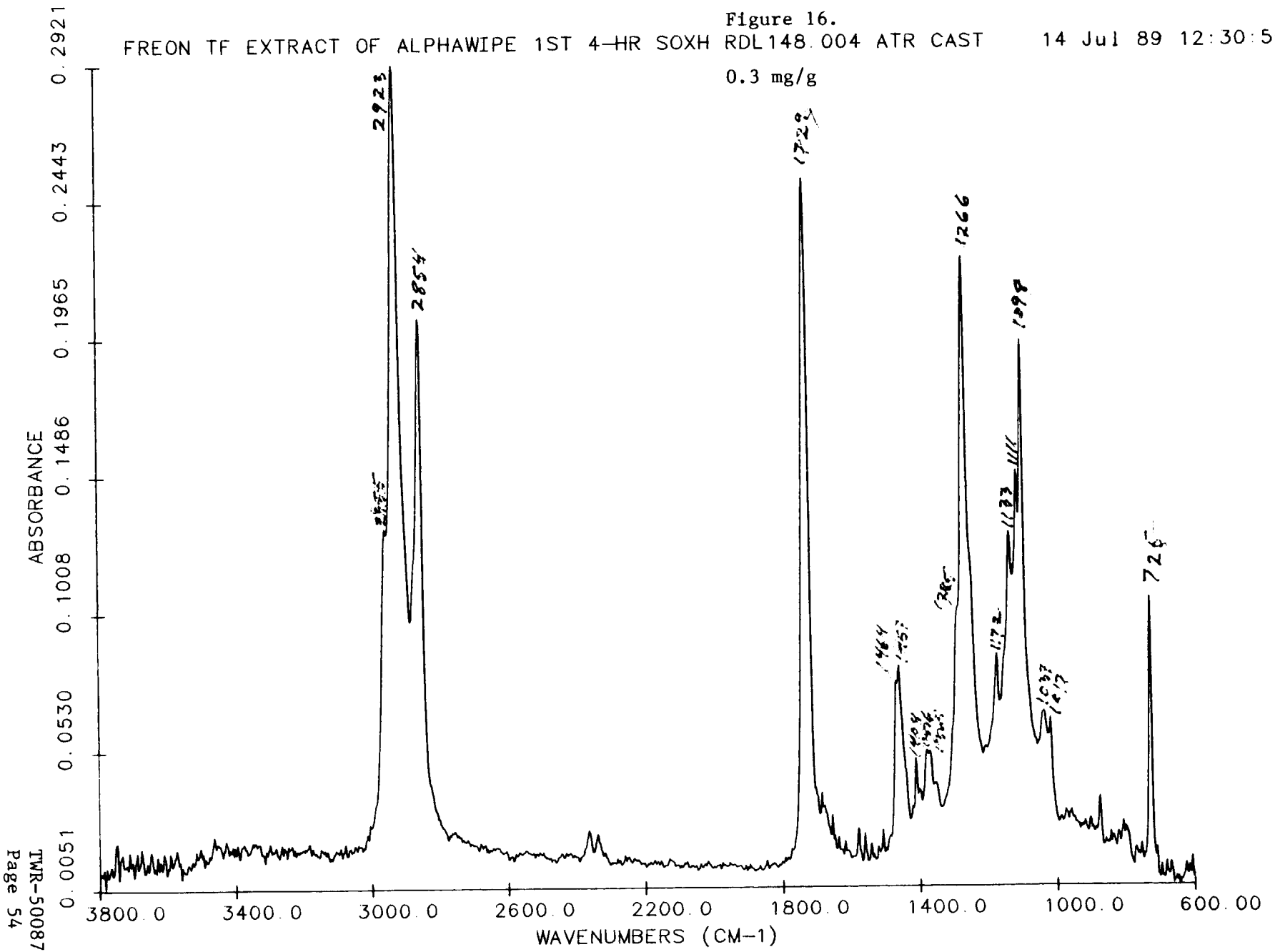

FREON TF EXTRACT OF ALPHAWIPE 2ND 4-HR SOXHLET RDL2148.004 ATR CAST 14 Jul 89 13:19:36
0.09 mg/g
ABSORBANCE
0.2188
0.1840
0.1492
0.1144
0.0797
0.0449
0.0101
3800.0
3400.0
3000.0
2600.0
2200.0
1800.0
1400.0
1000.0
600.00
WAVENUMBERS (CM-1)
2922
2853
1724
1580
1463
1265
1096
725

Figure 16.


FREON TF EXTRACT OF ALPHAWIPE 1ST 4-HR SOXH RDL148.004 ATR CAST 14 Jul 89 12:30:59
0.3 mg/g
2923
2854
1720
1266
1099
726
ABSORBANCE
0.0051
0.0530
0.1008
0.1486
0.1965
0.2443
0.2921
3800.0
3400.0
3000.0
2600.0
2200.0
1800.0
1400.0
1000.0
600.00
WAVENUMBERS (CM-1)

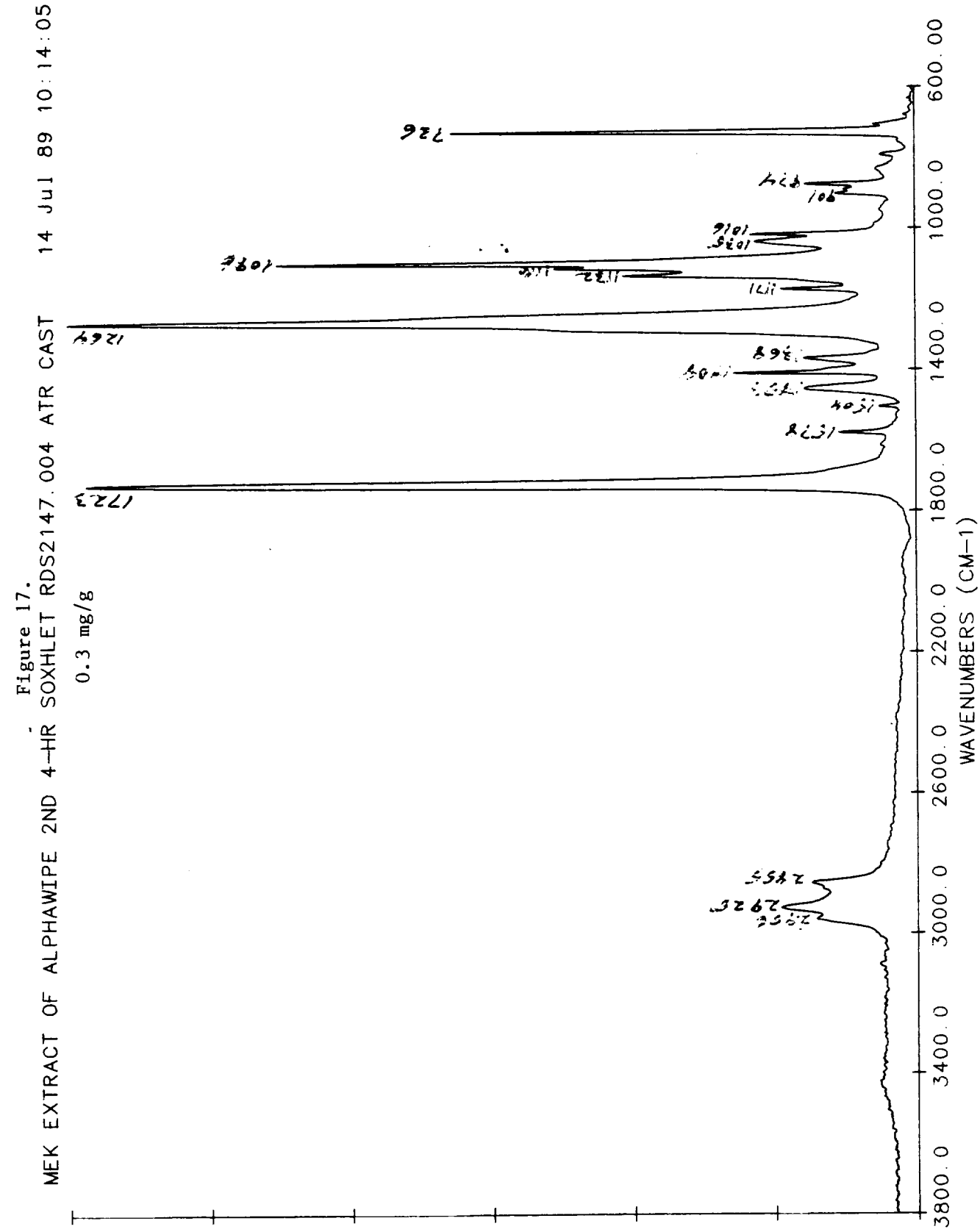
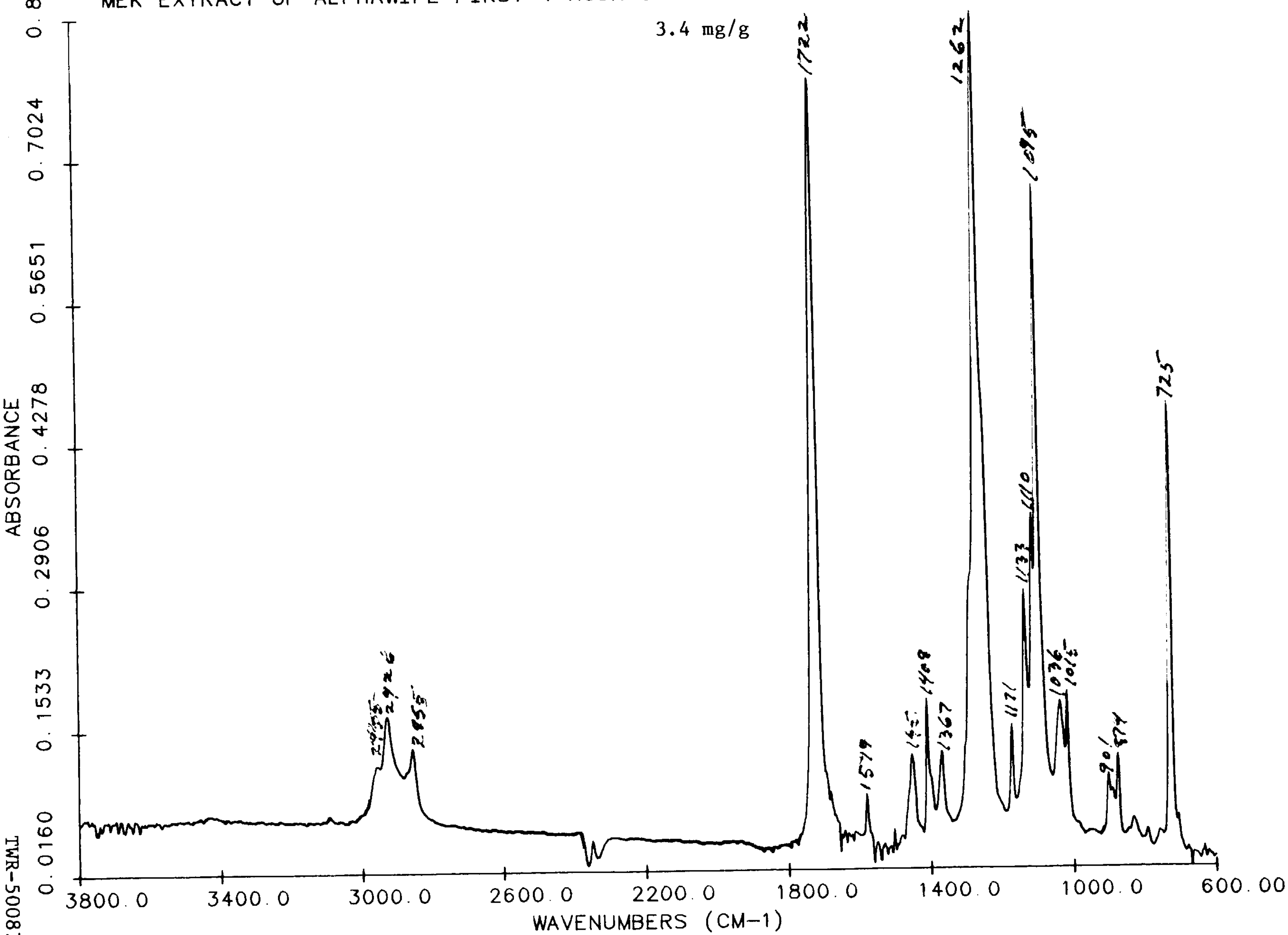

MEK EXTRACT OF ALPHAWIPE 2ND 4-HR SOXHLET RDS2147.004 ATR CAST 14 Jul 89 10:14:05
0.3 mg/g
ABSORBANCE
0.0216
0.1412
0.2609
0.3806
0.5002
0.6199
0.7395
WAVENUMBERS (CM-1)
3800.0
3400.0
3000.0
2600.0
2200.0
1800.0
1400.0
1000.0
600.00

Figure 17.

Figure 18.

MEK EXTRACT OF ALPHAWIPE FIRST 4-HOUR SOXHLET RDL147.004 ATR CAST   14 Jul 89   9:03:28

3.4 mg/g



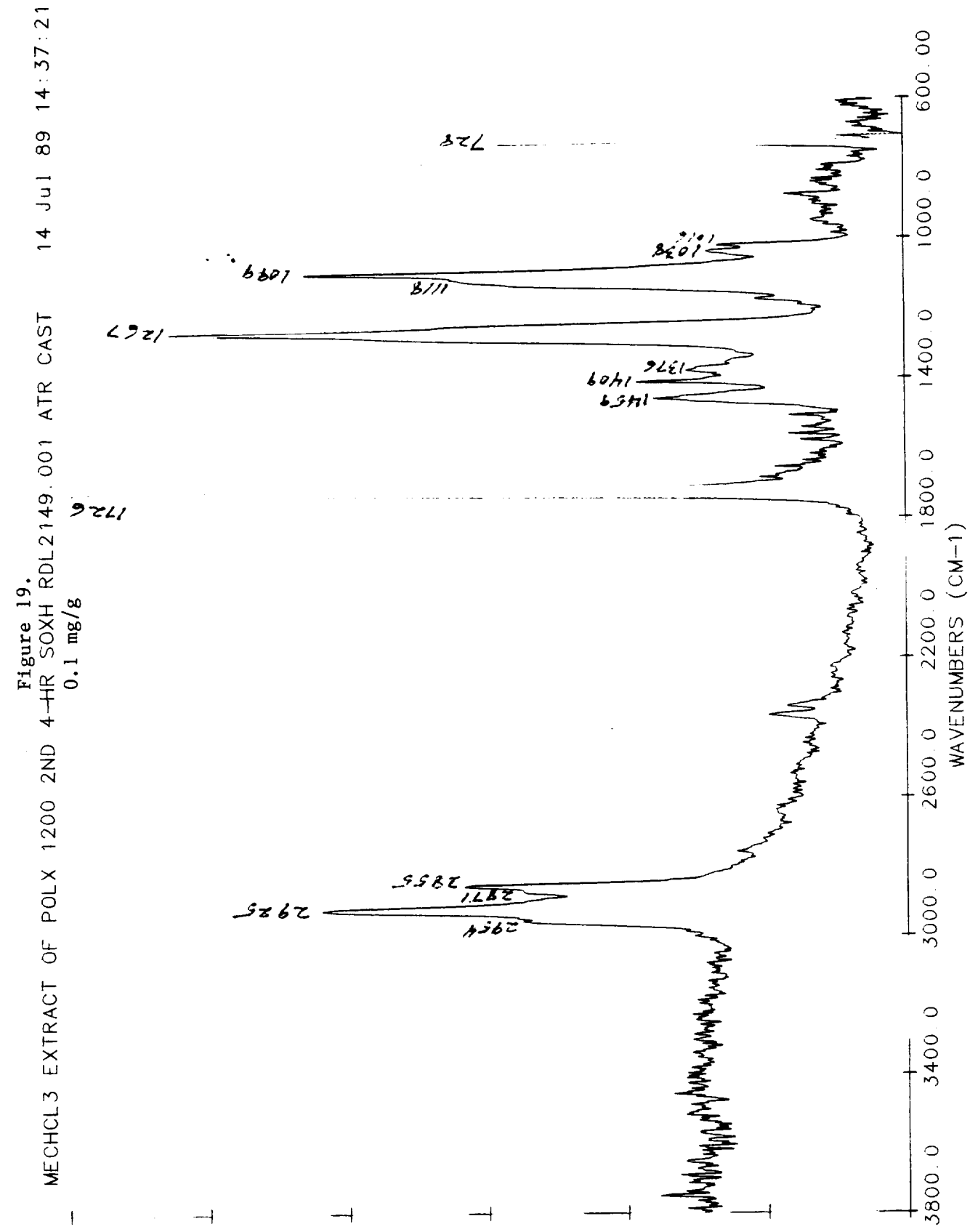
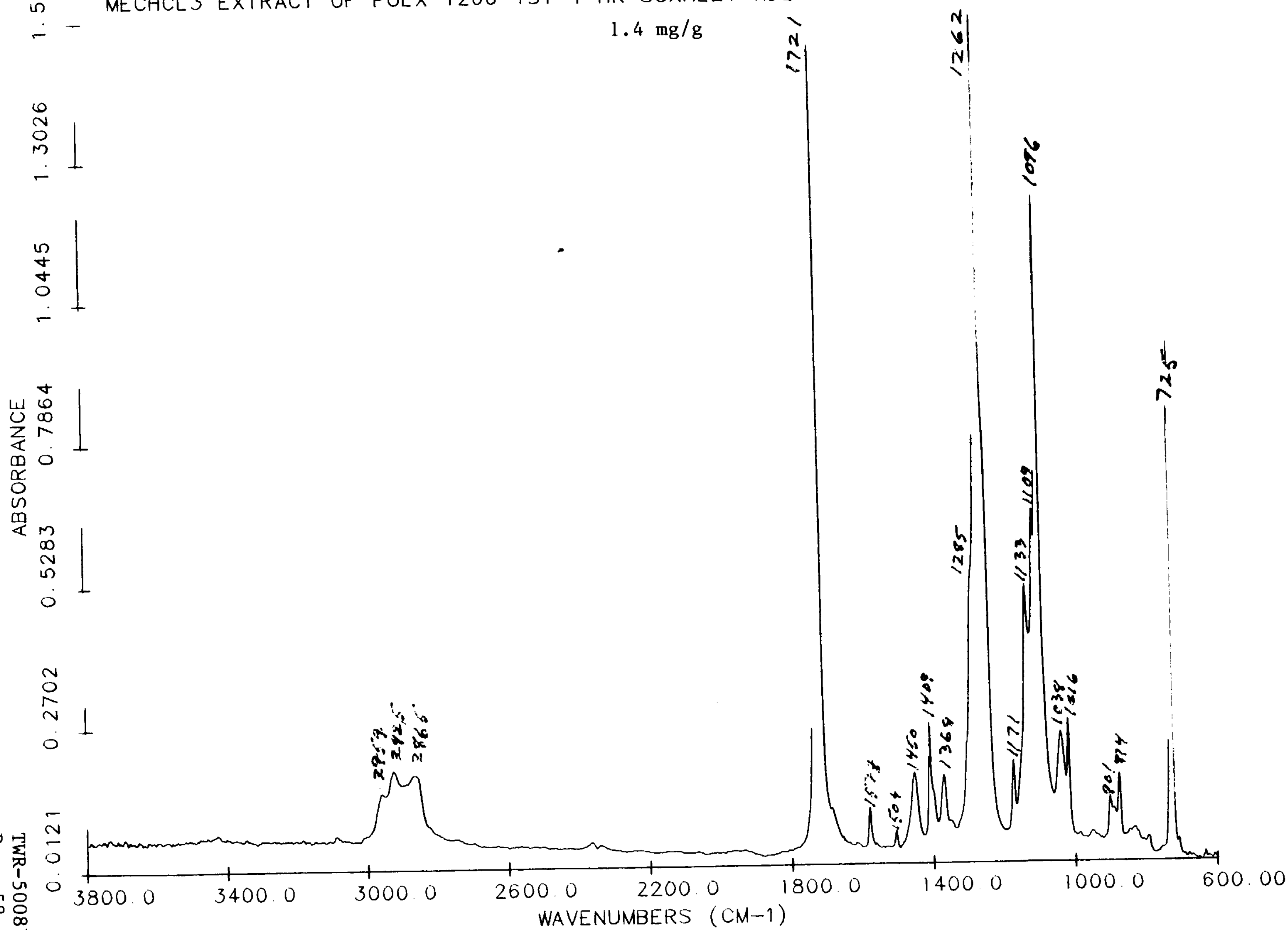


Figure 19.

Figure 20.
MECHCL3 EXTRACT OF POLX 1200 1ST 4-HR SOXHLET RDL149.001   14 Jul 89 13:37:35
1.4 mg/g



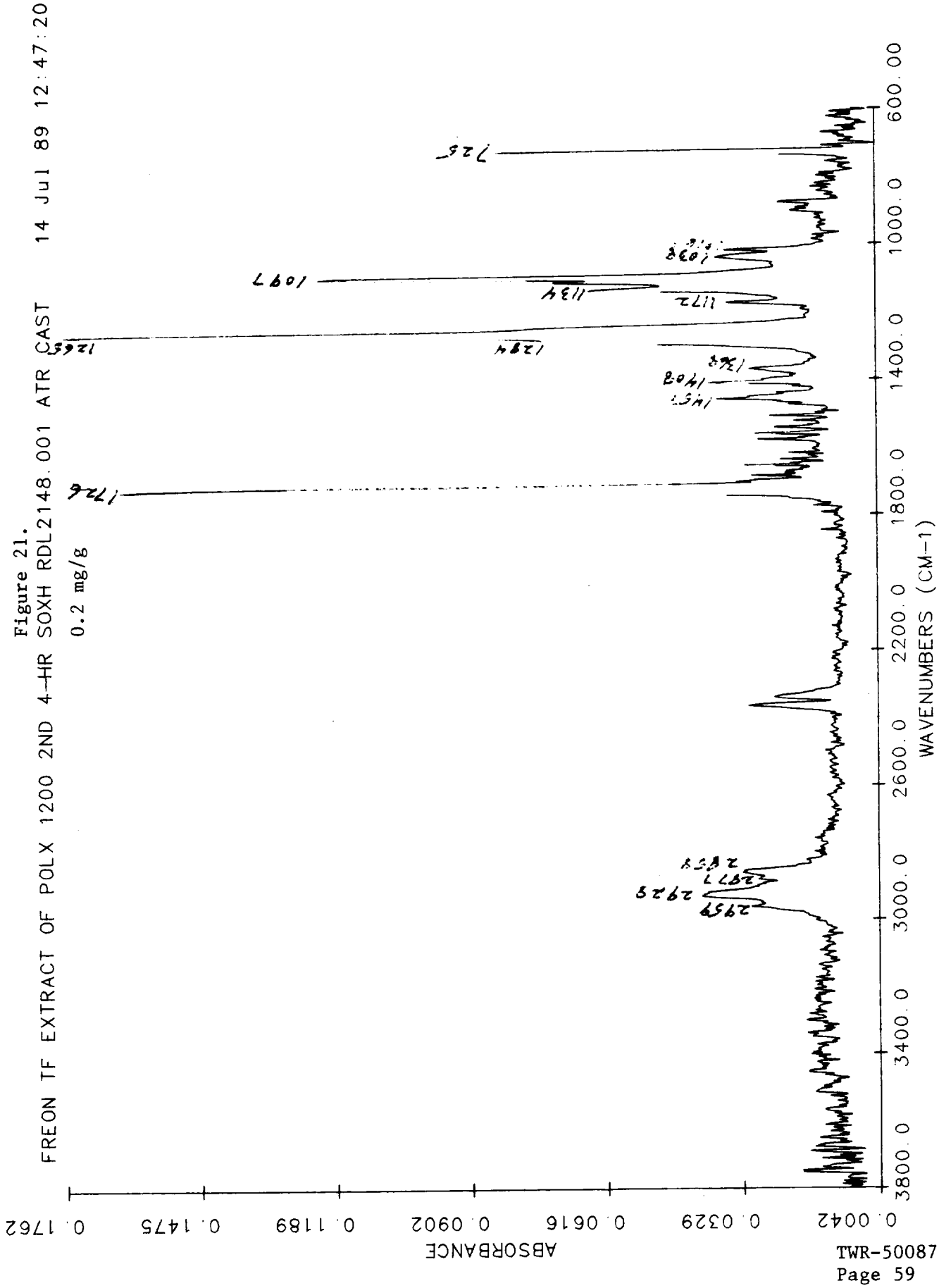


Figure 21.

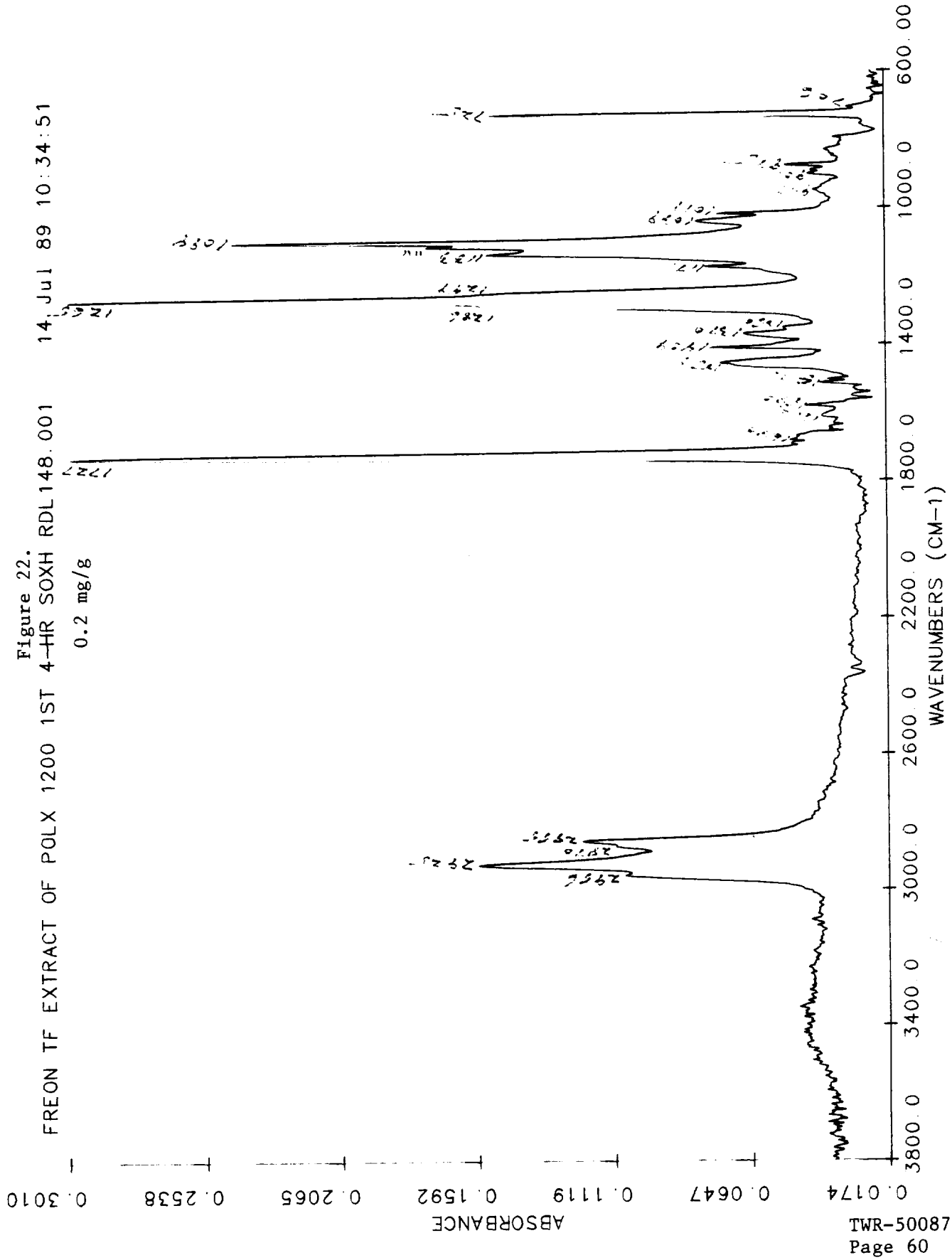
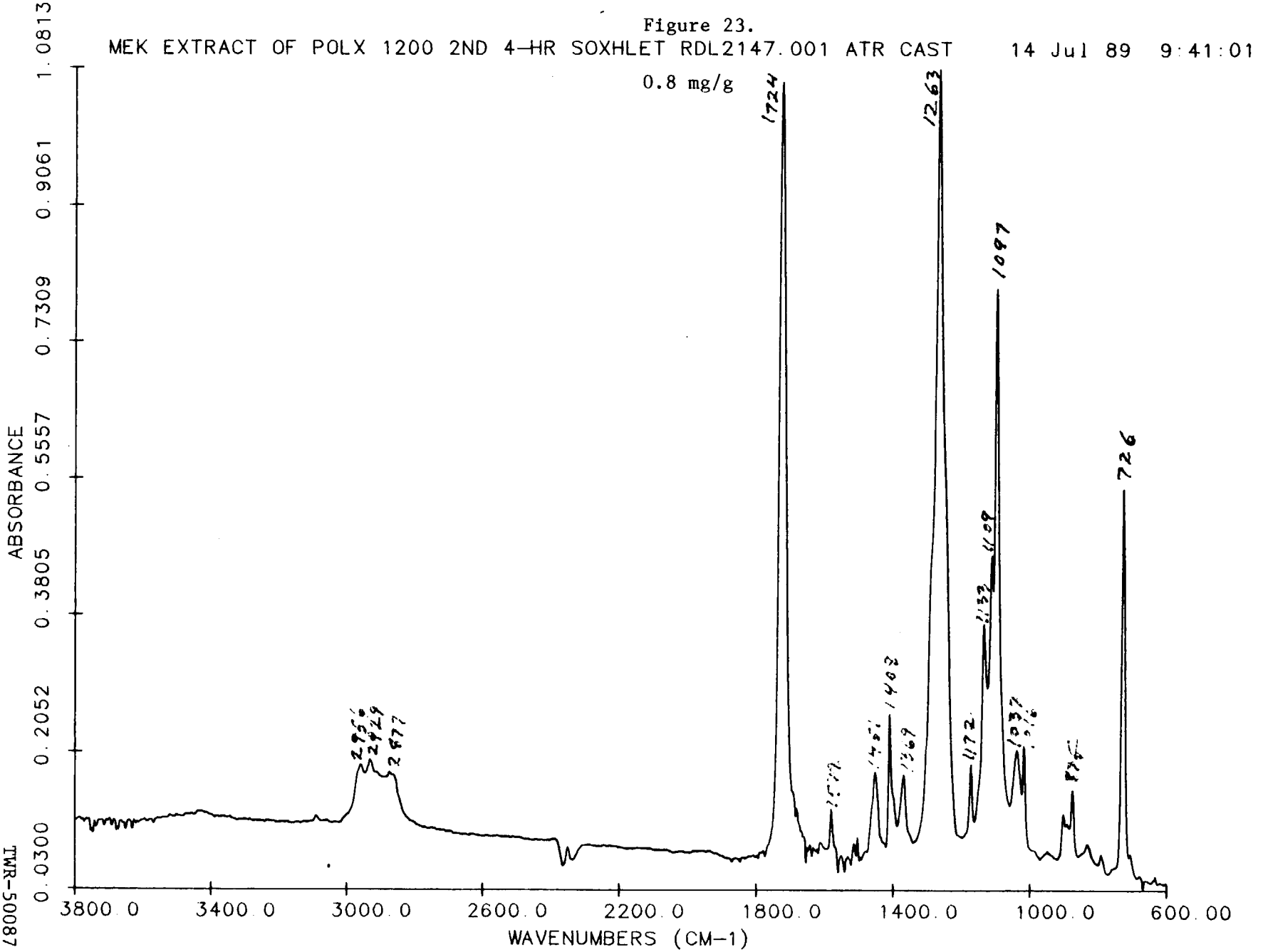


Figure 22.

Figure 23.


MEK EXTRACT OF POLX 1200 2ND 4-HR SOXHLET RDL2147.001 ATR CAST 14 Jul 89 9:41:01
0.8 mg/g
ABSORBANCE
0.0300
0.2052
0.3805
0.5557
0.7309
0.9061
1.0813
3800.0
3400.0
3000.0
2600.0
2200.0
1800.0
1400.0
1000.0
600.00
WAVENUMBERS (CM-1)
1724
1263
1097
726

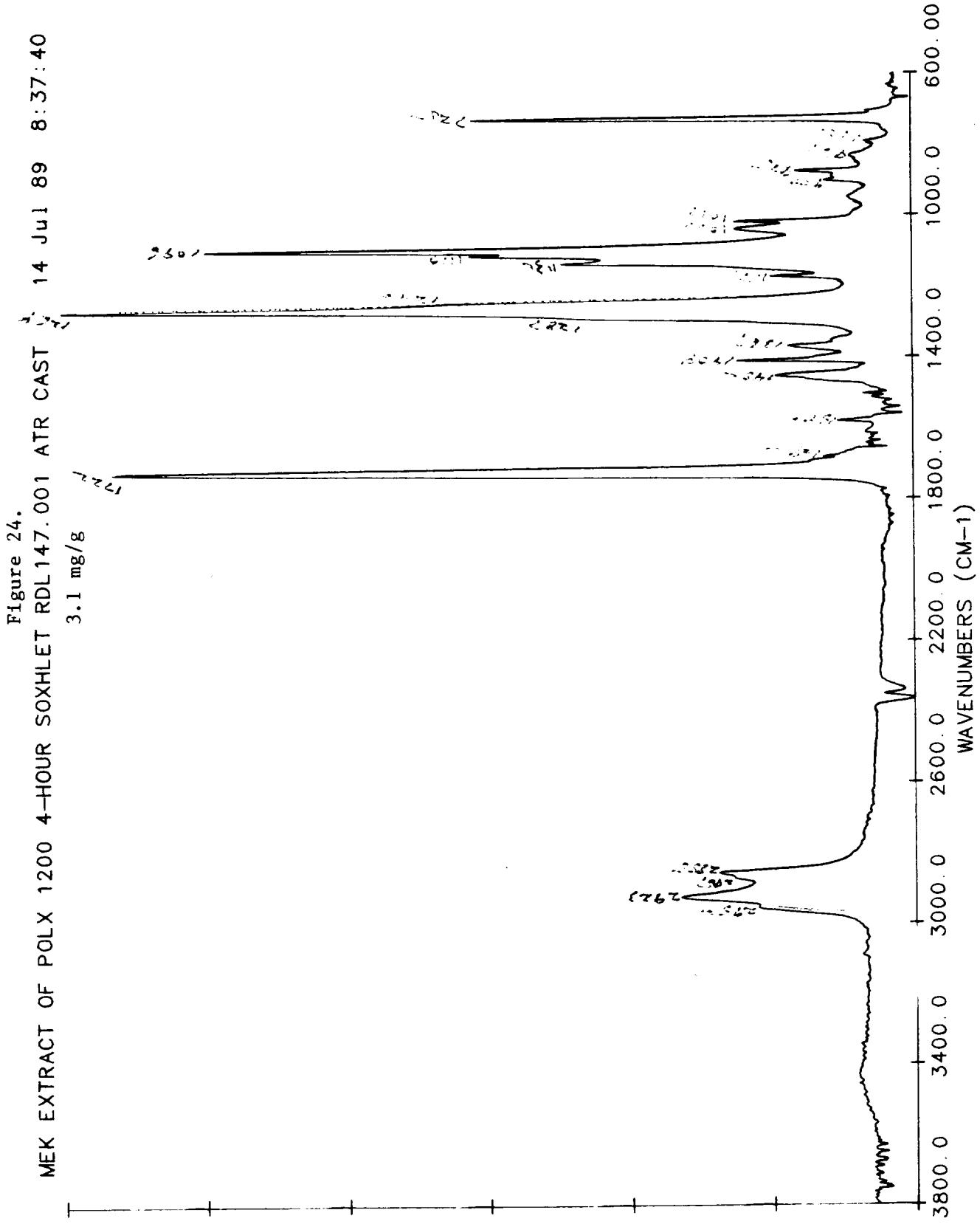


Figure 24.

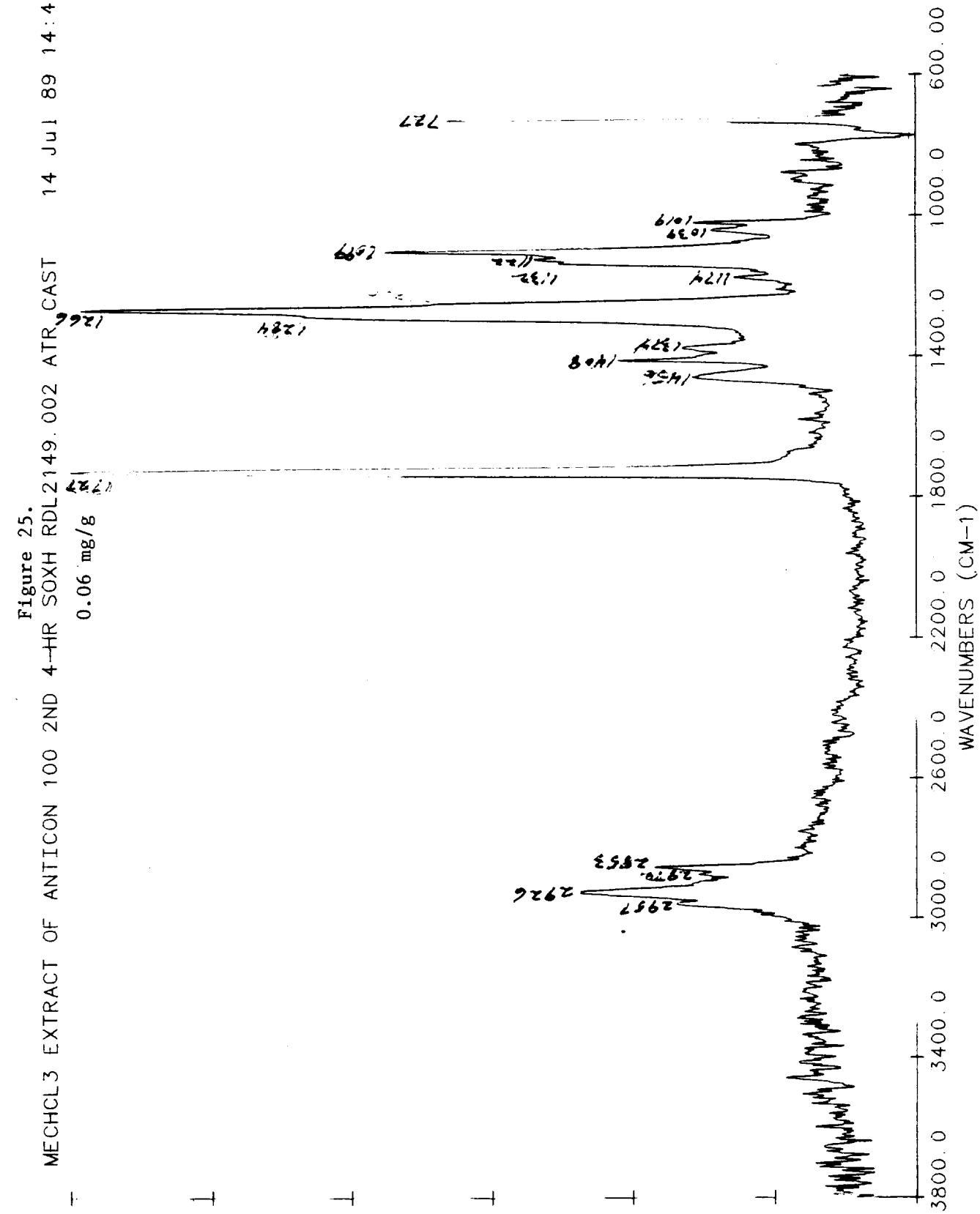


Figure 25.

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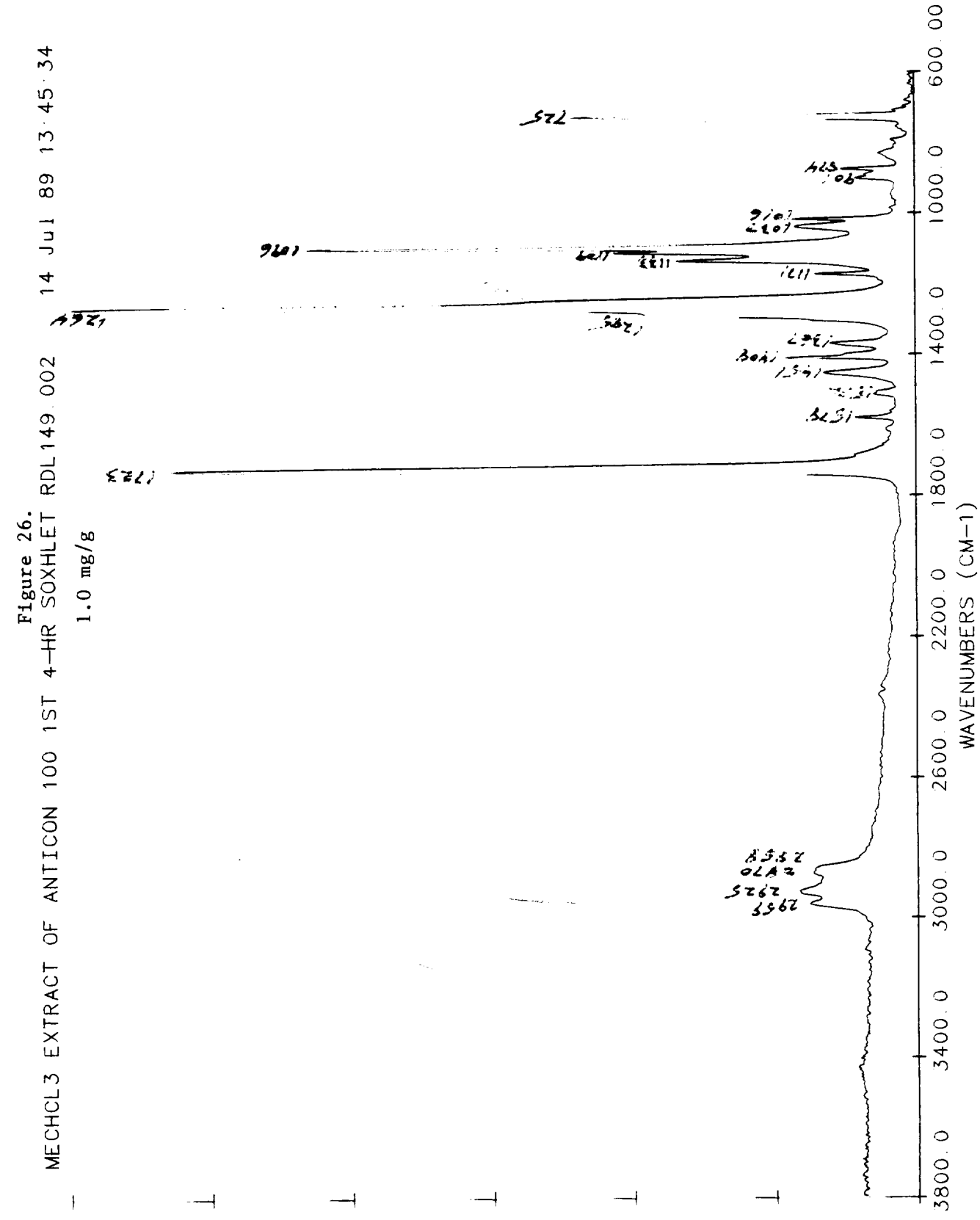
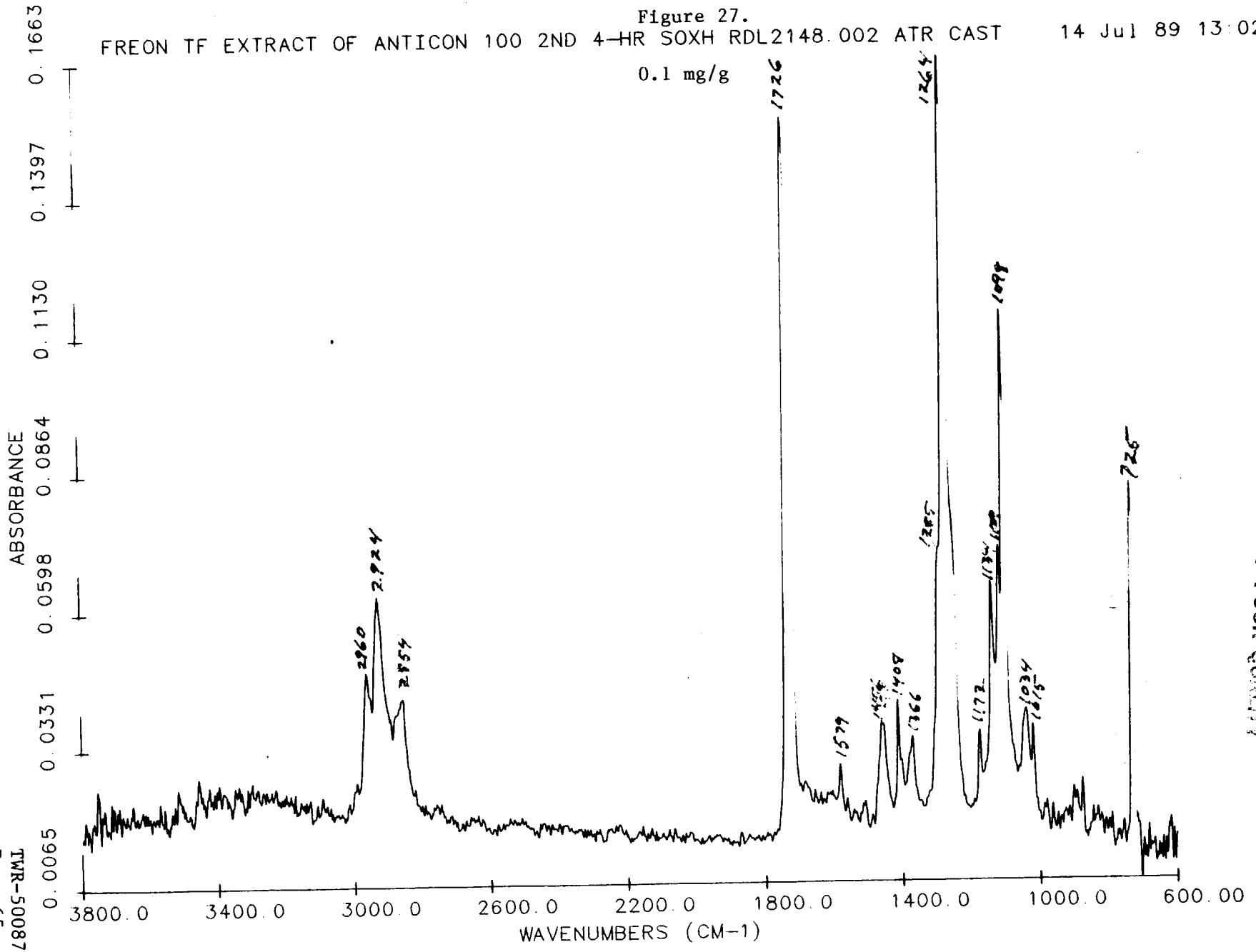


Figure 26.

Figure 27.



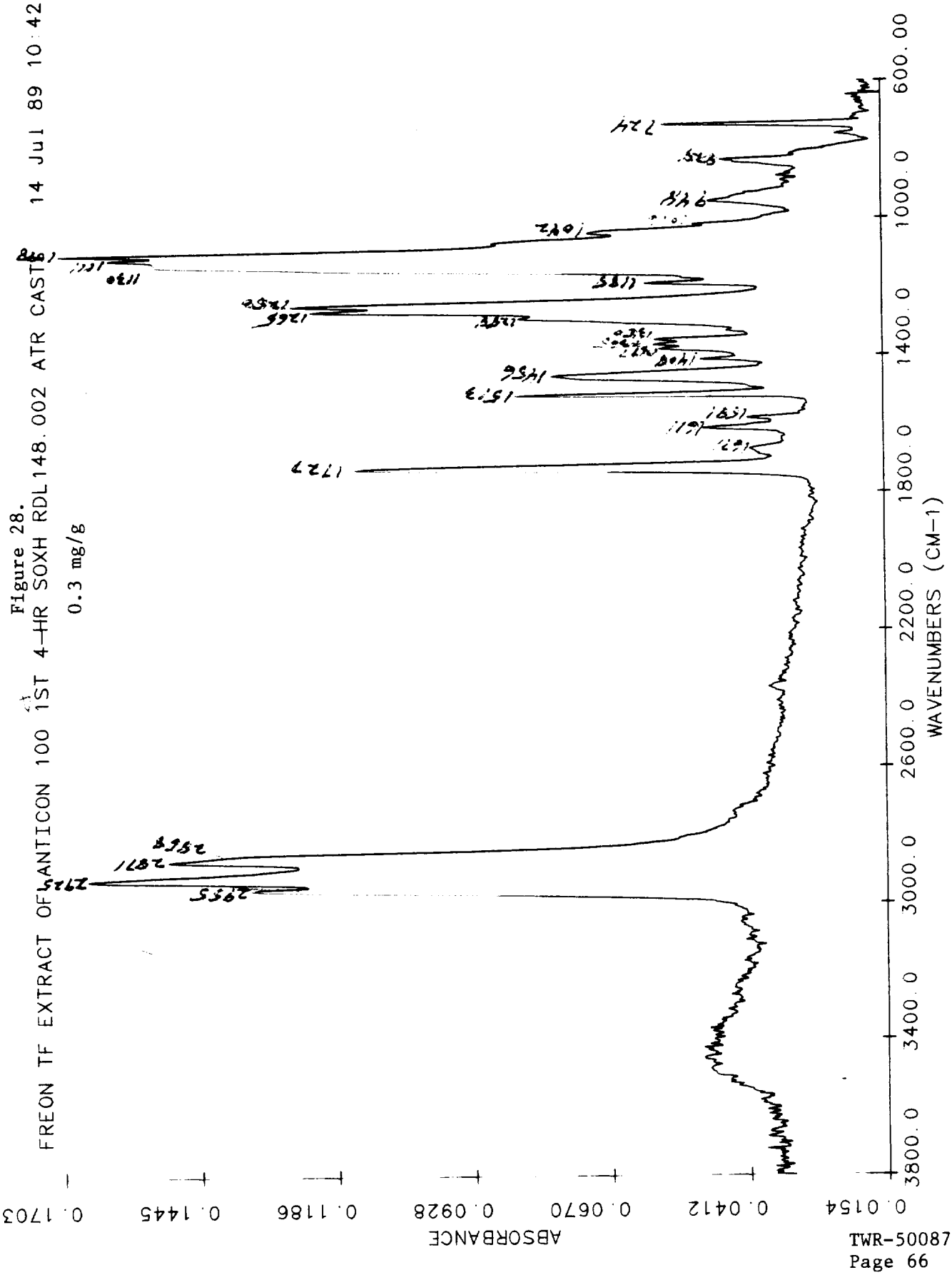


Figure 28.

Figure 29.

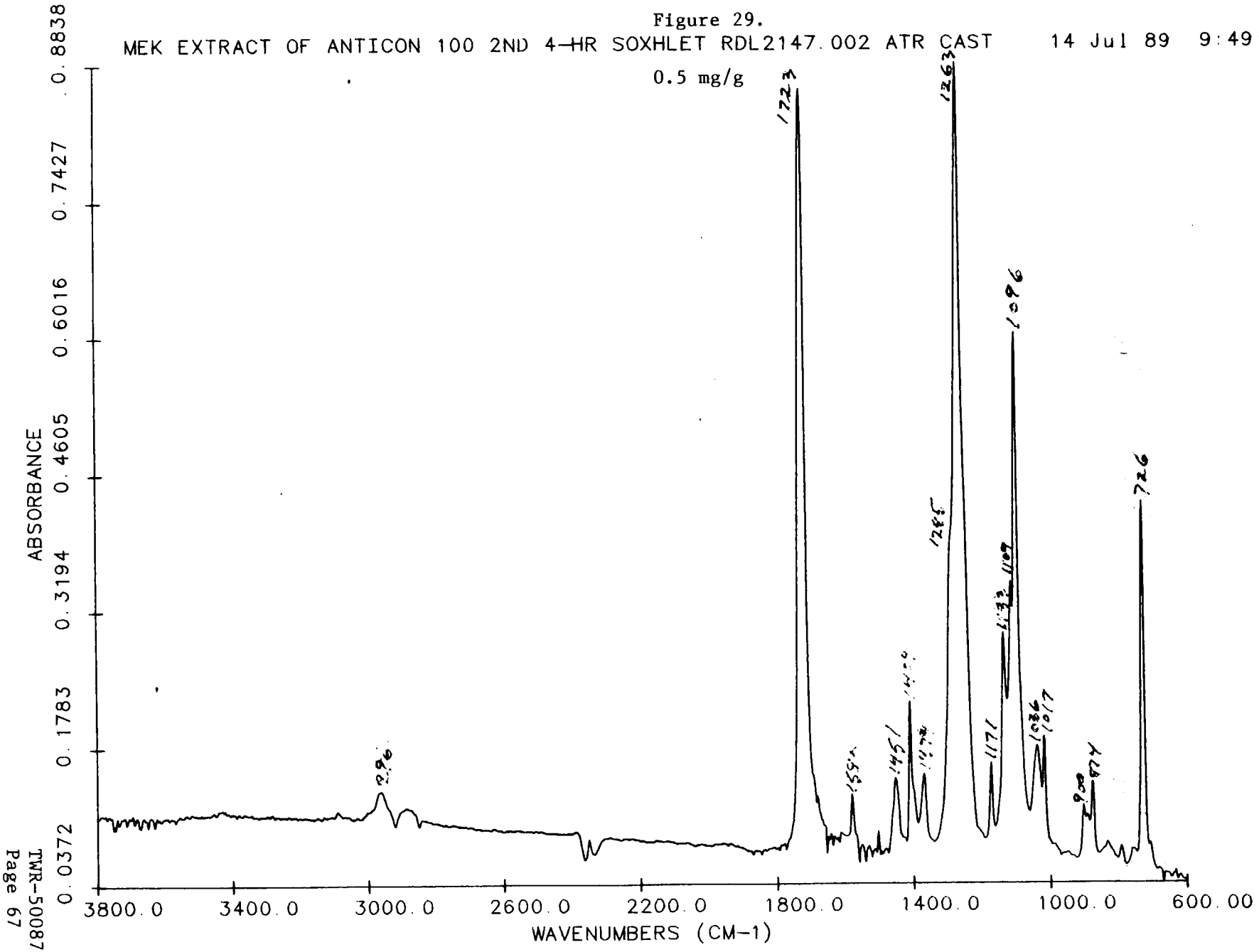


Figure 30.

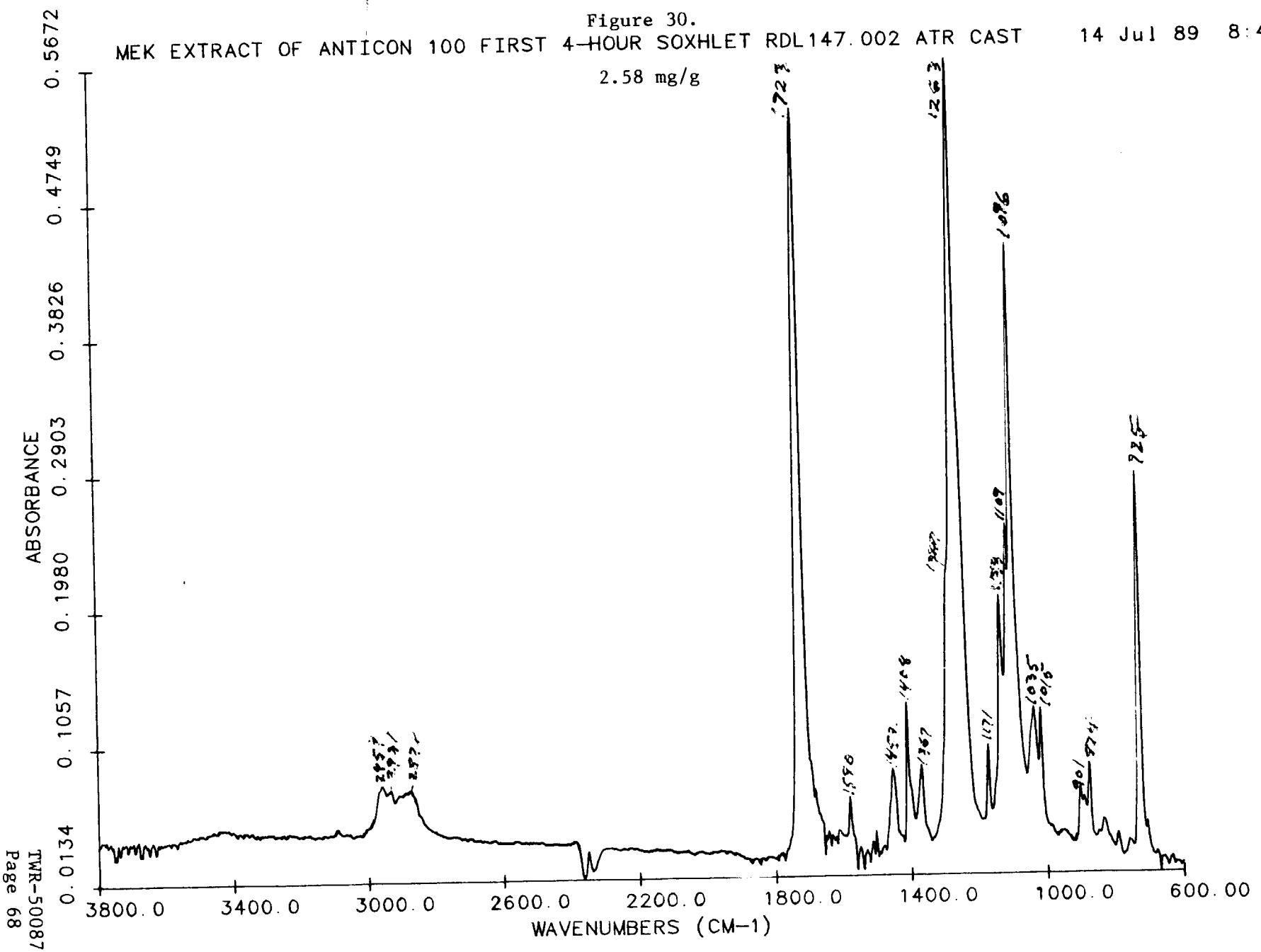
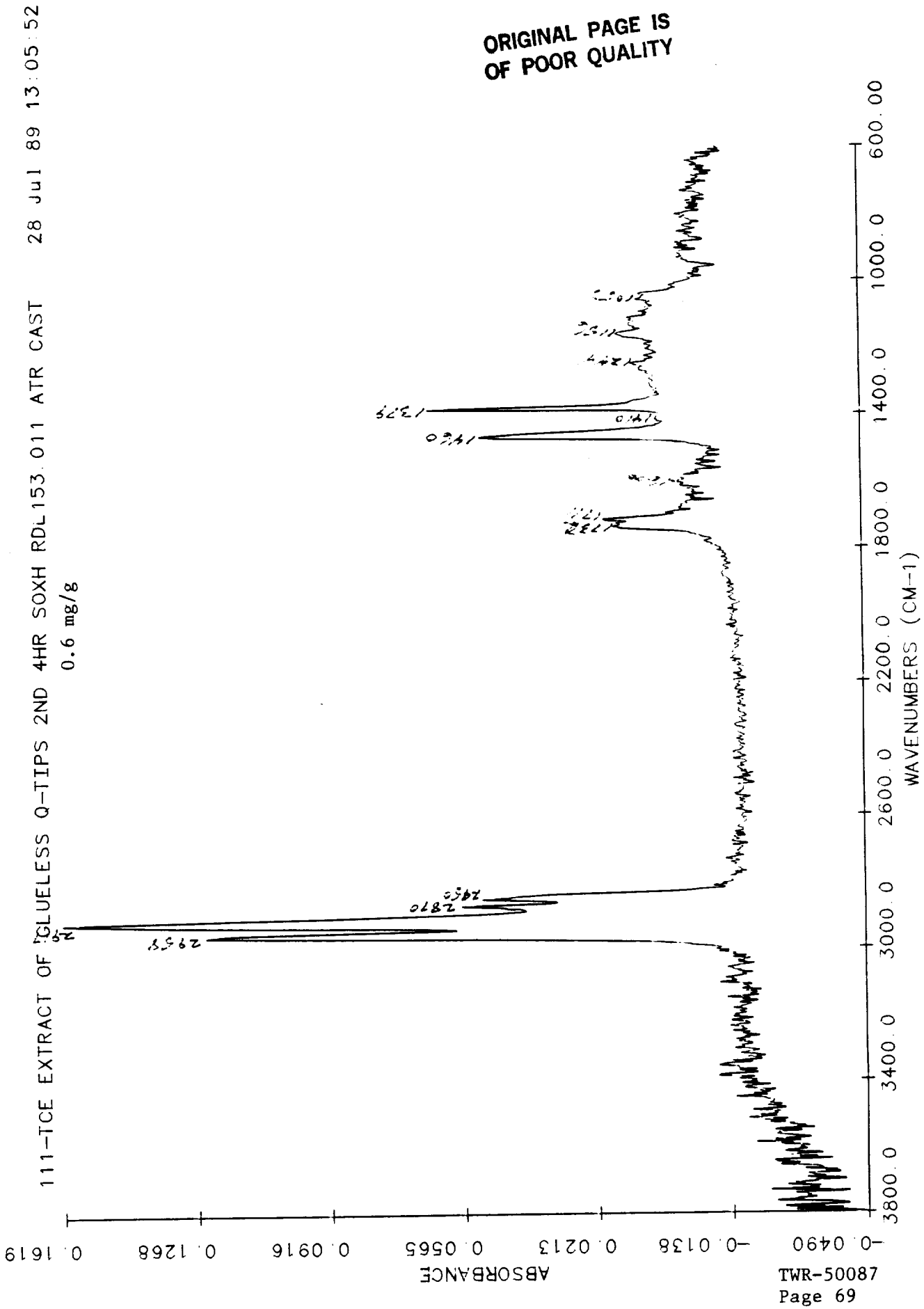


Figure 31.



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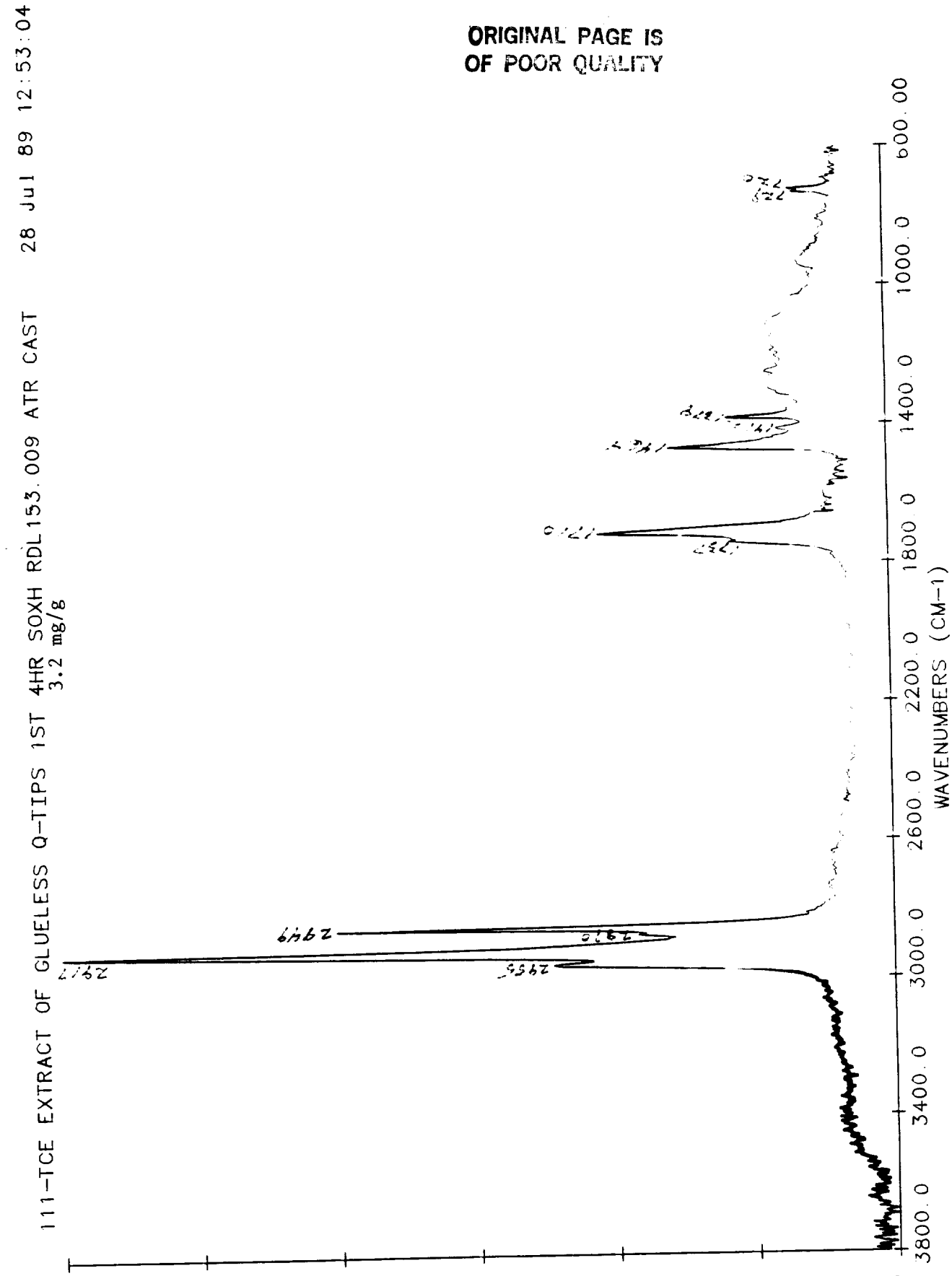
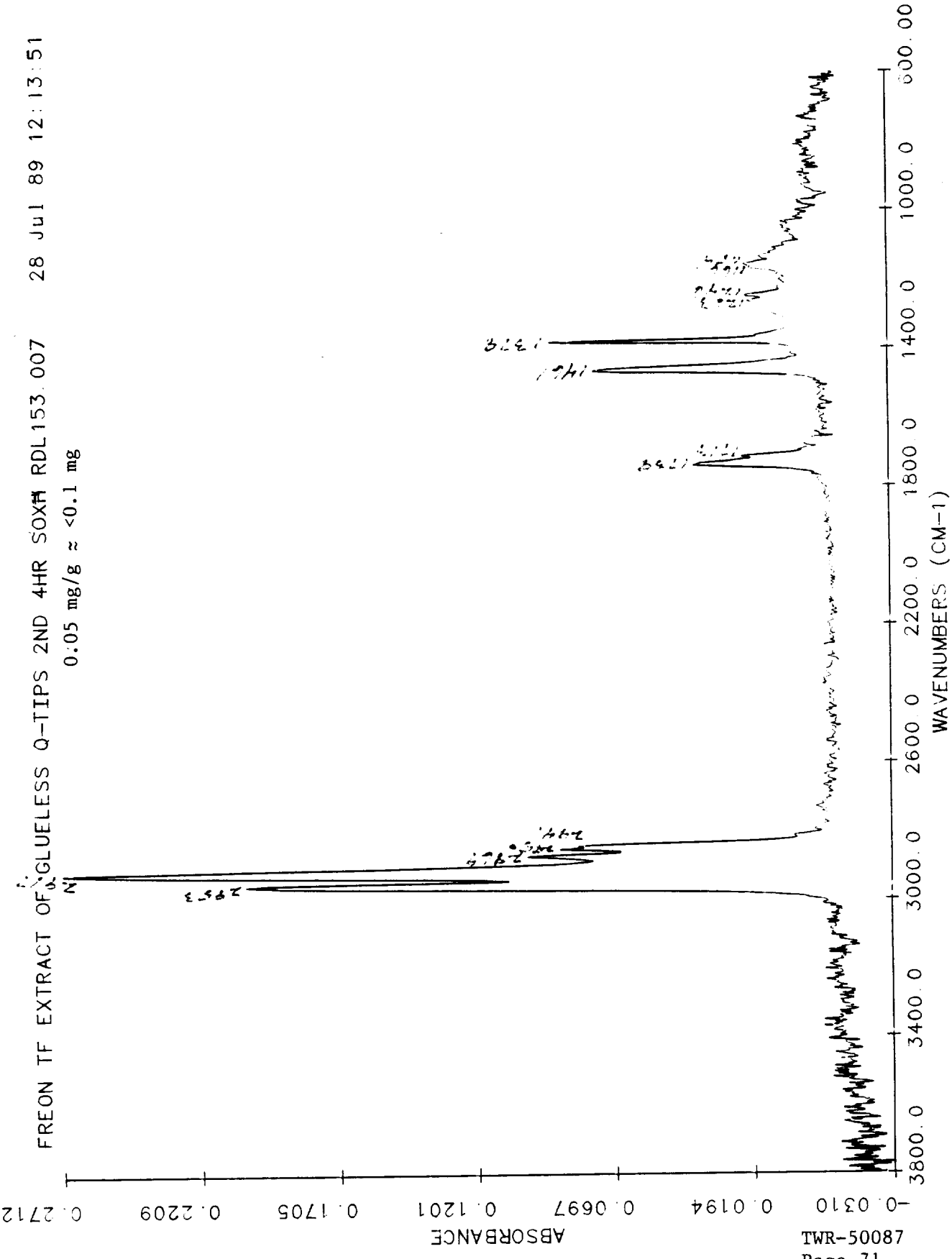


Figure 32.

Figure 33.



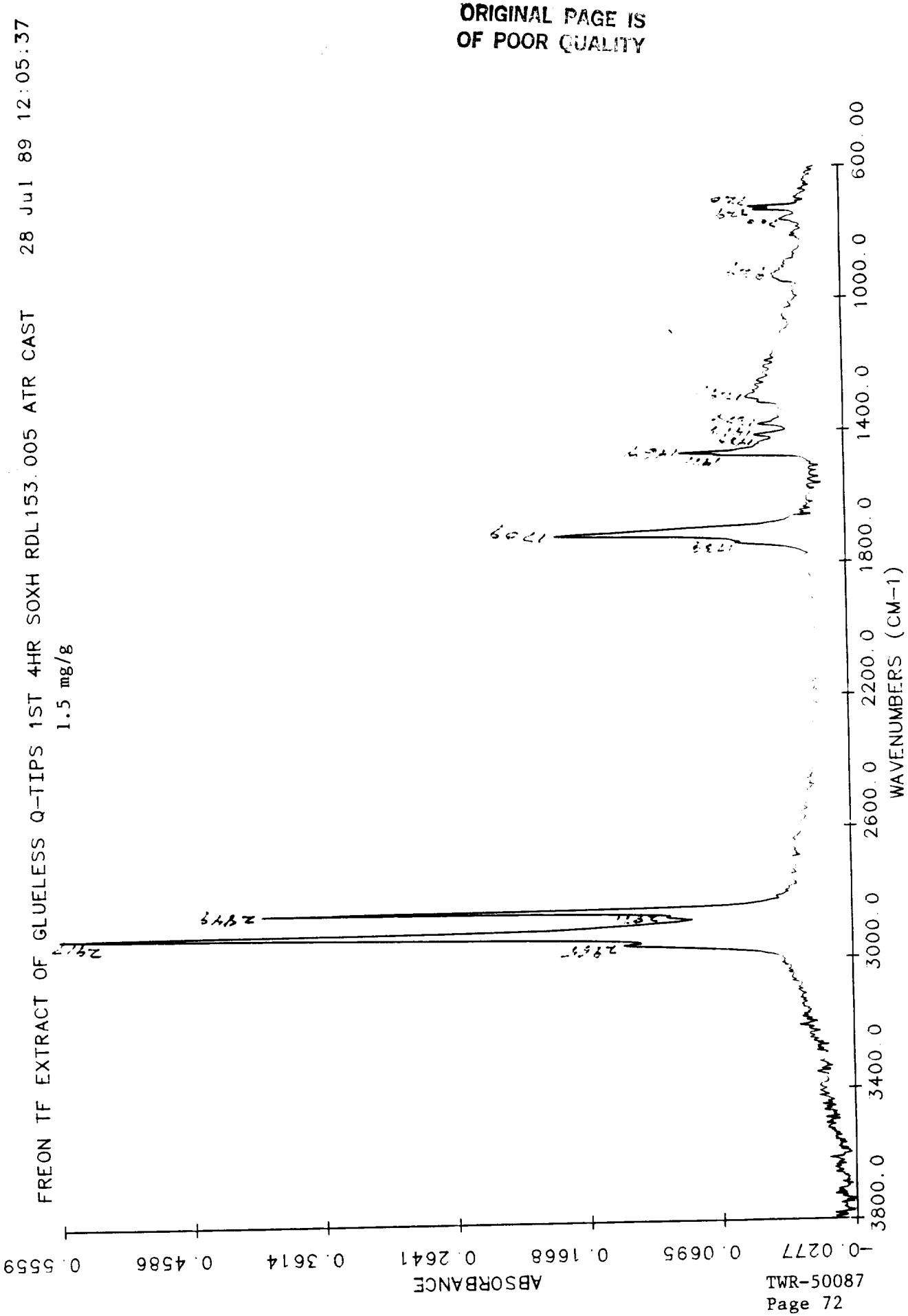


Figure 34.

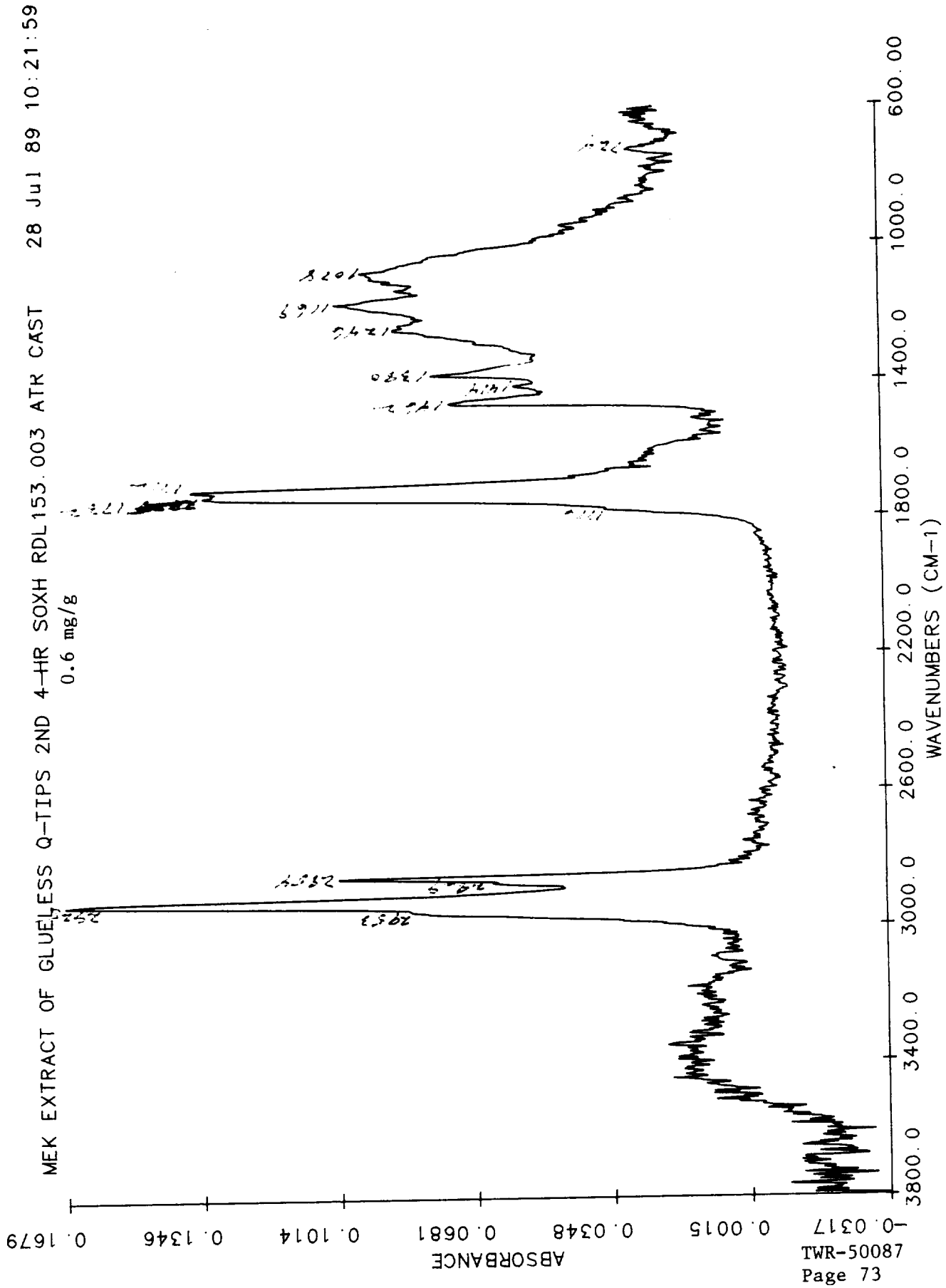
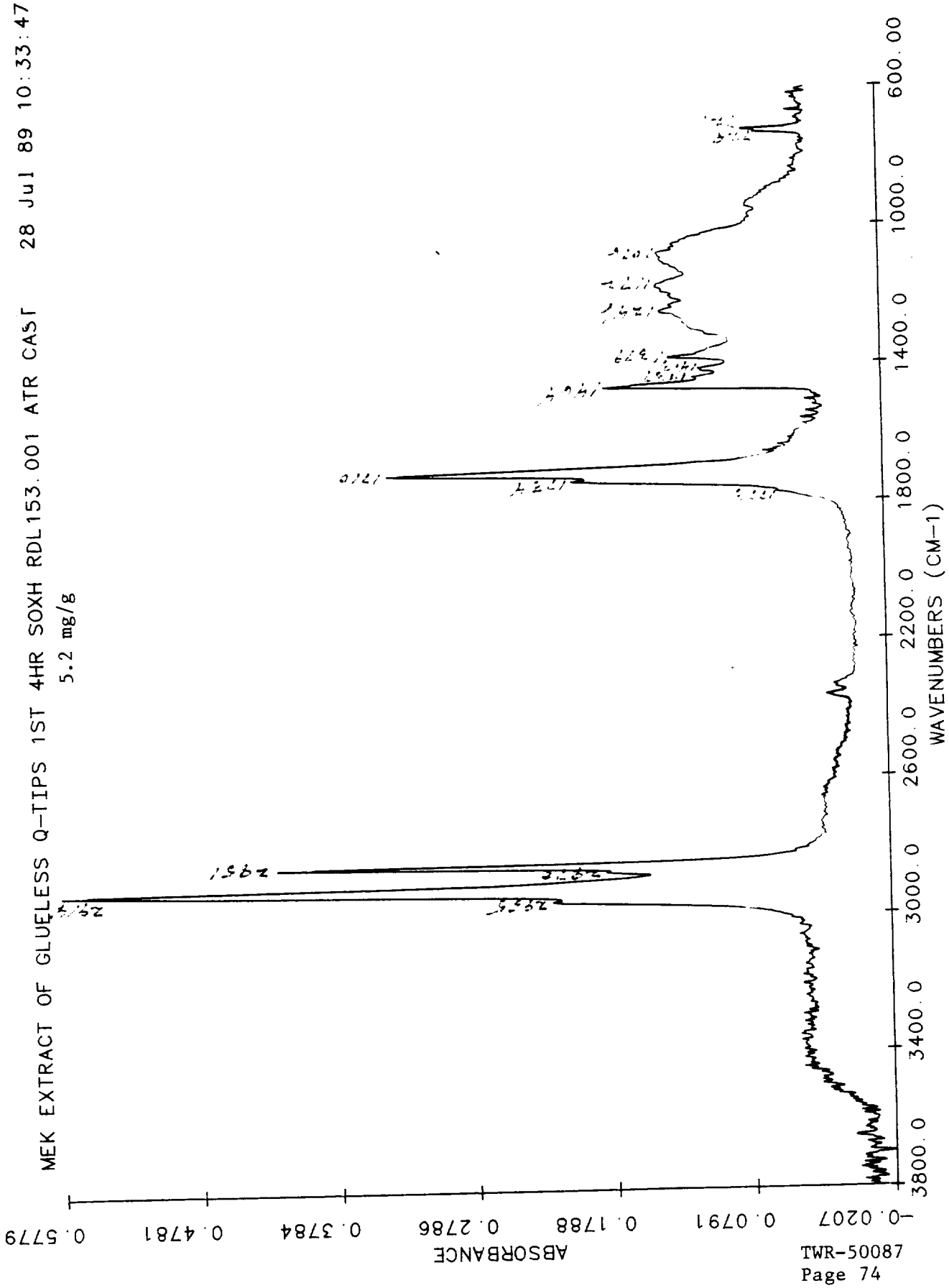


Figure 35.

Figure 36.



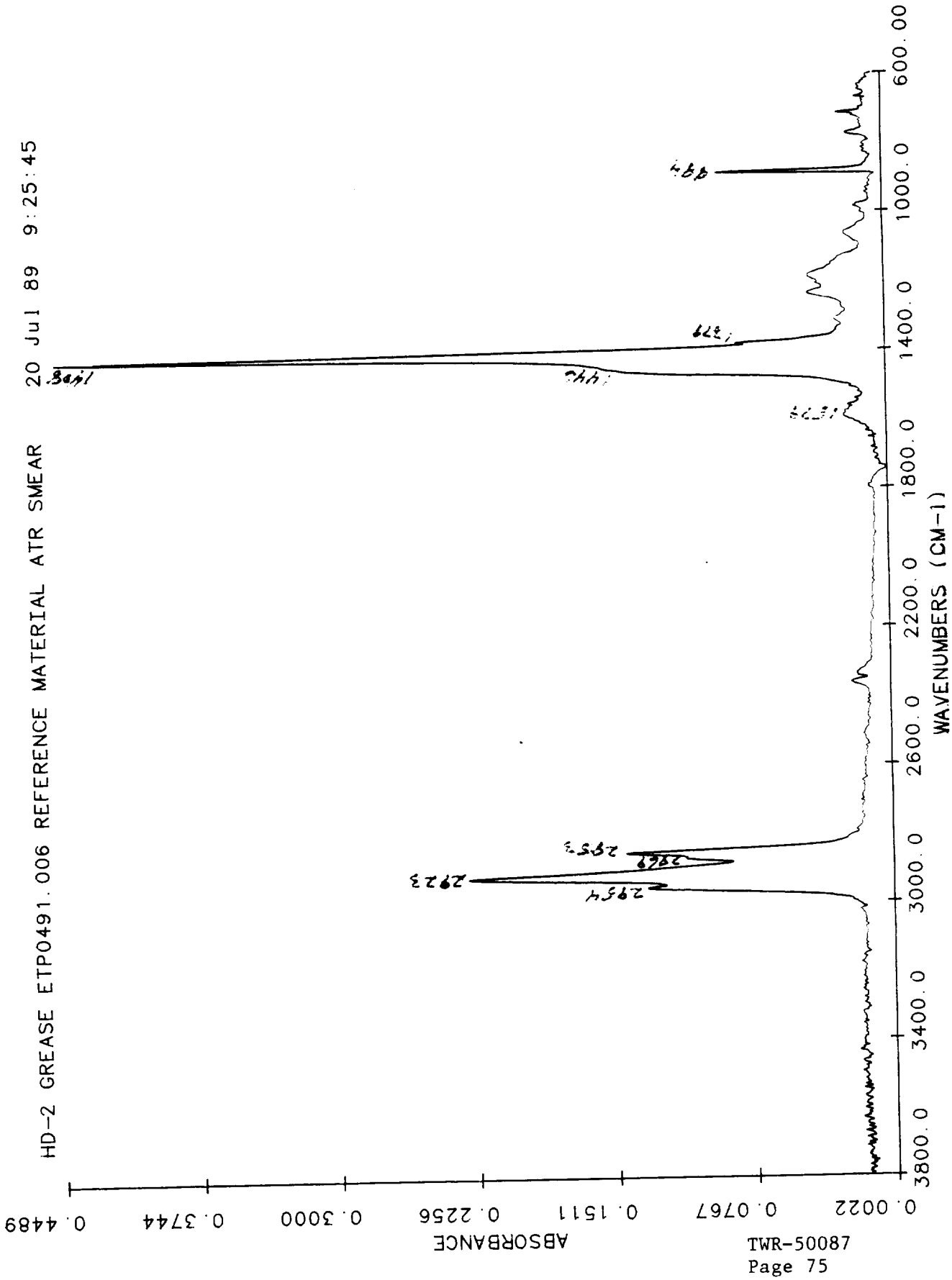


Figure 37.

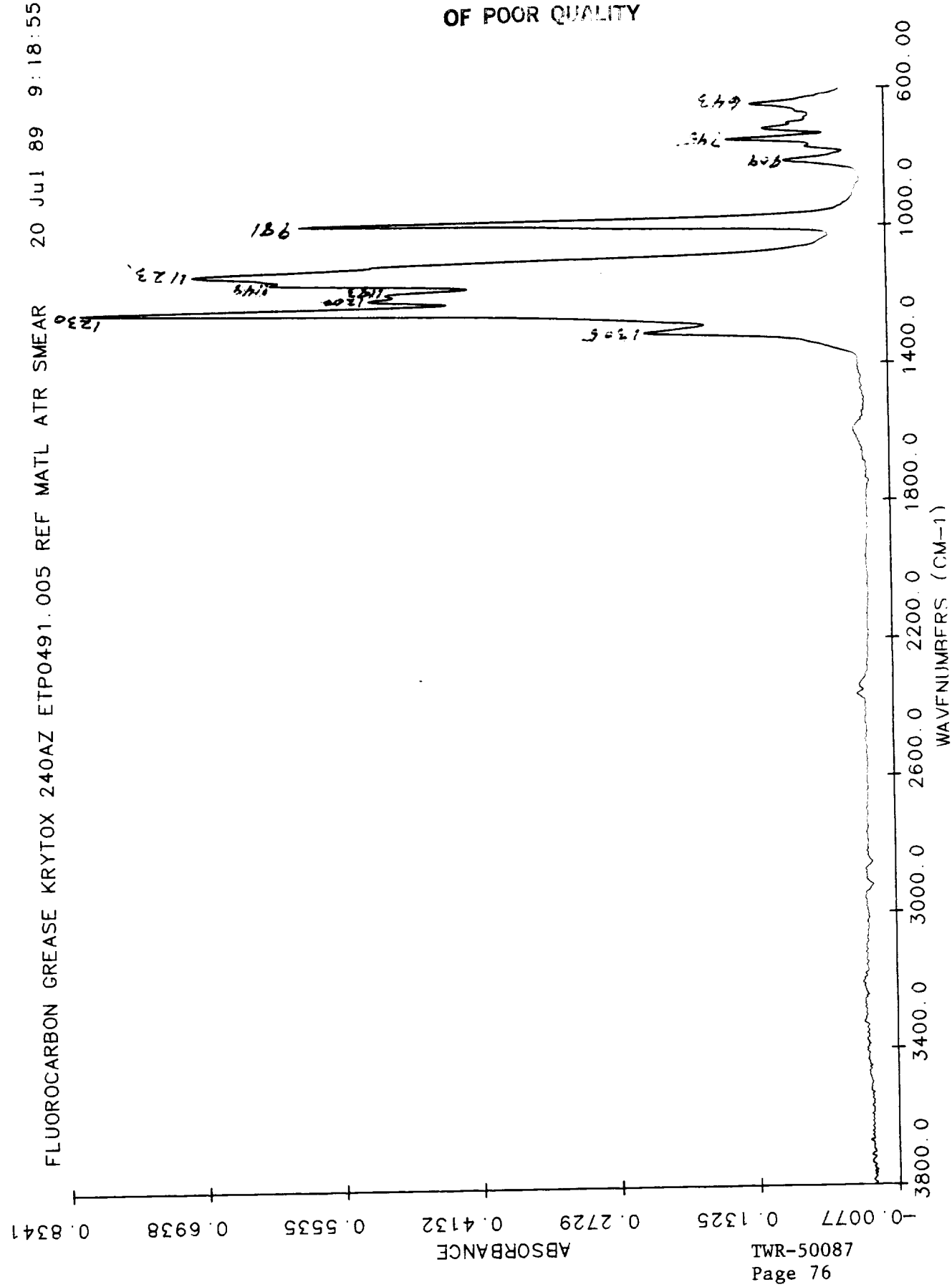


Figure 38.

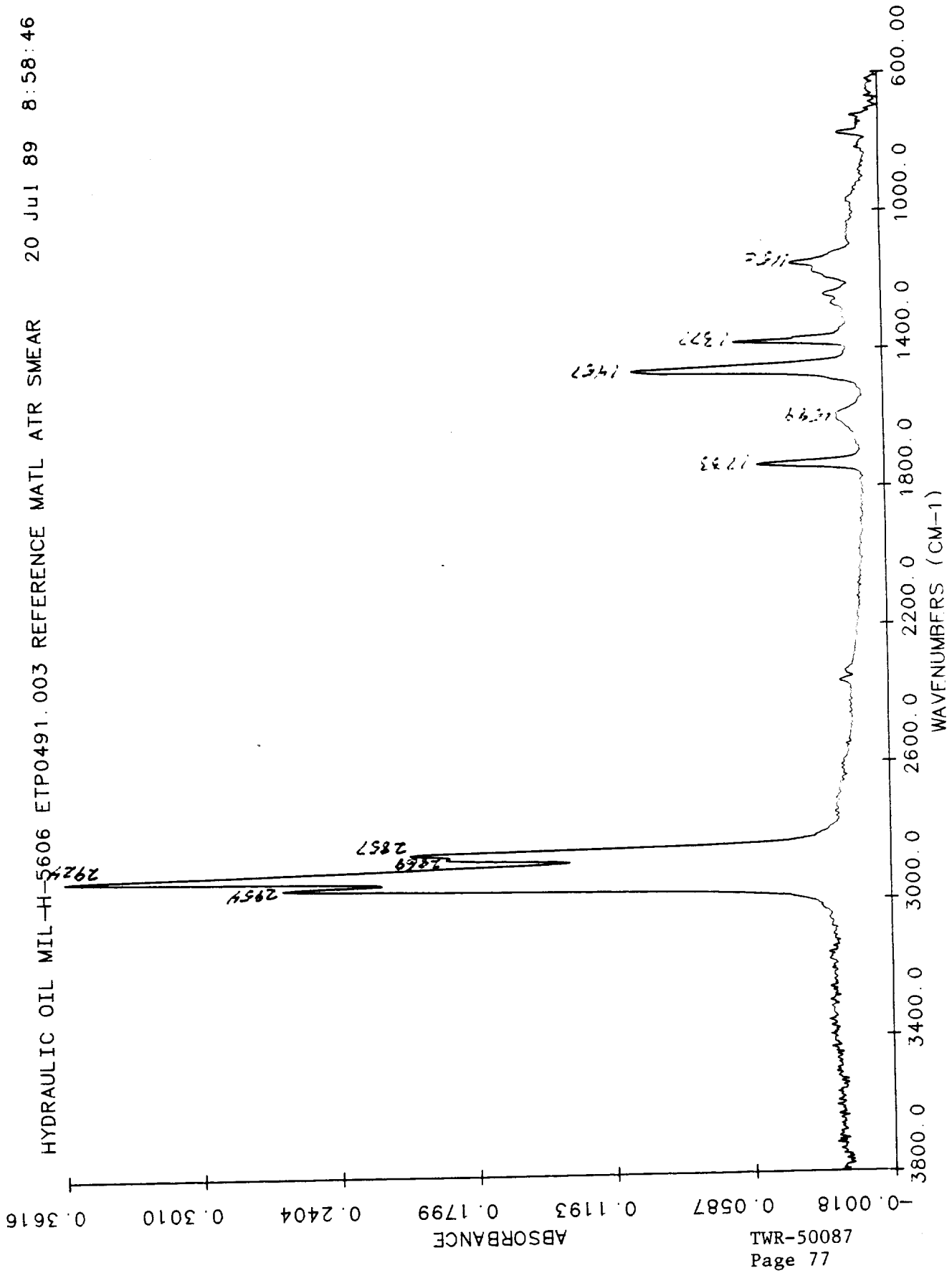


Figure 39.

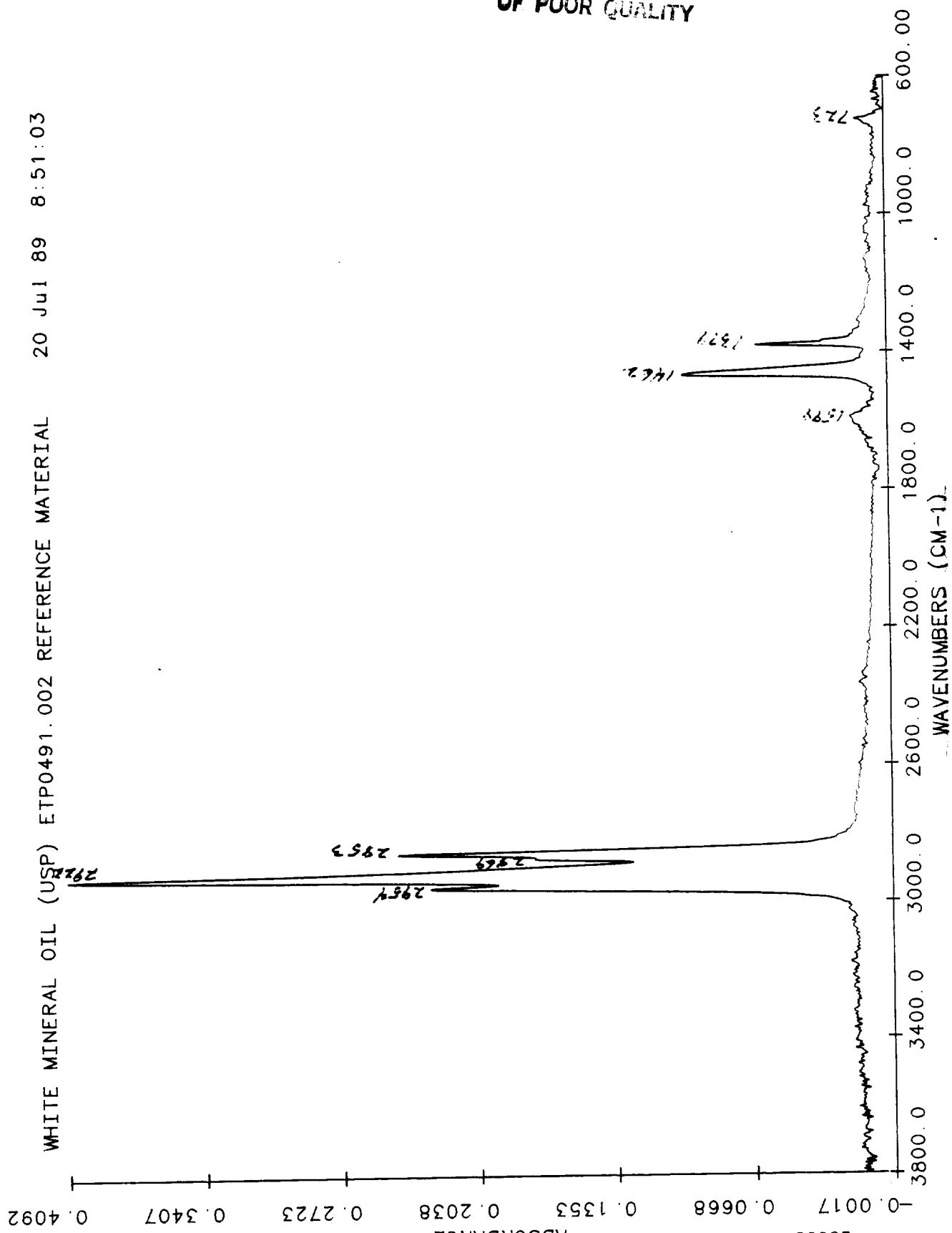


Figure 40.

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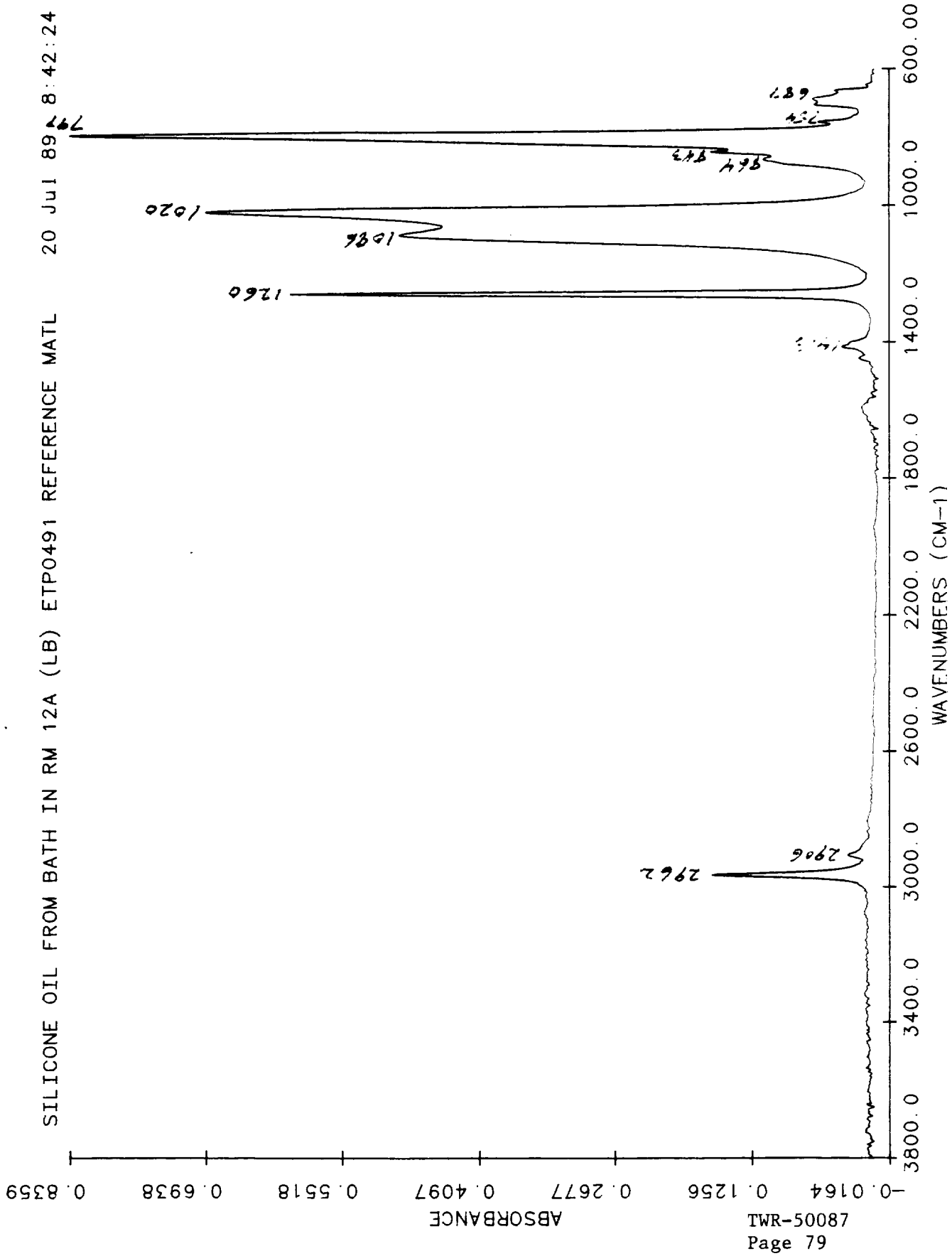

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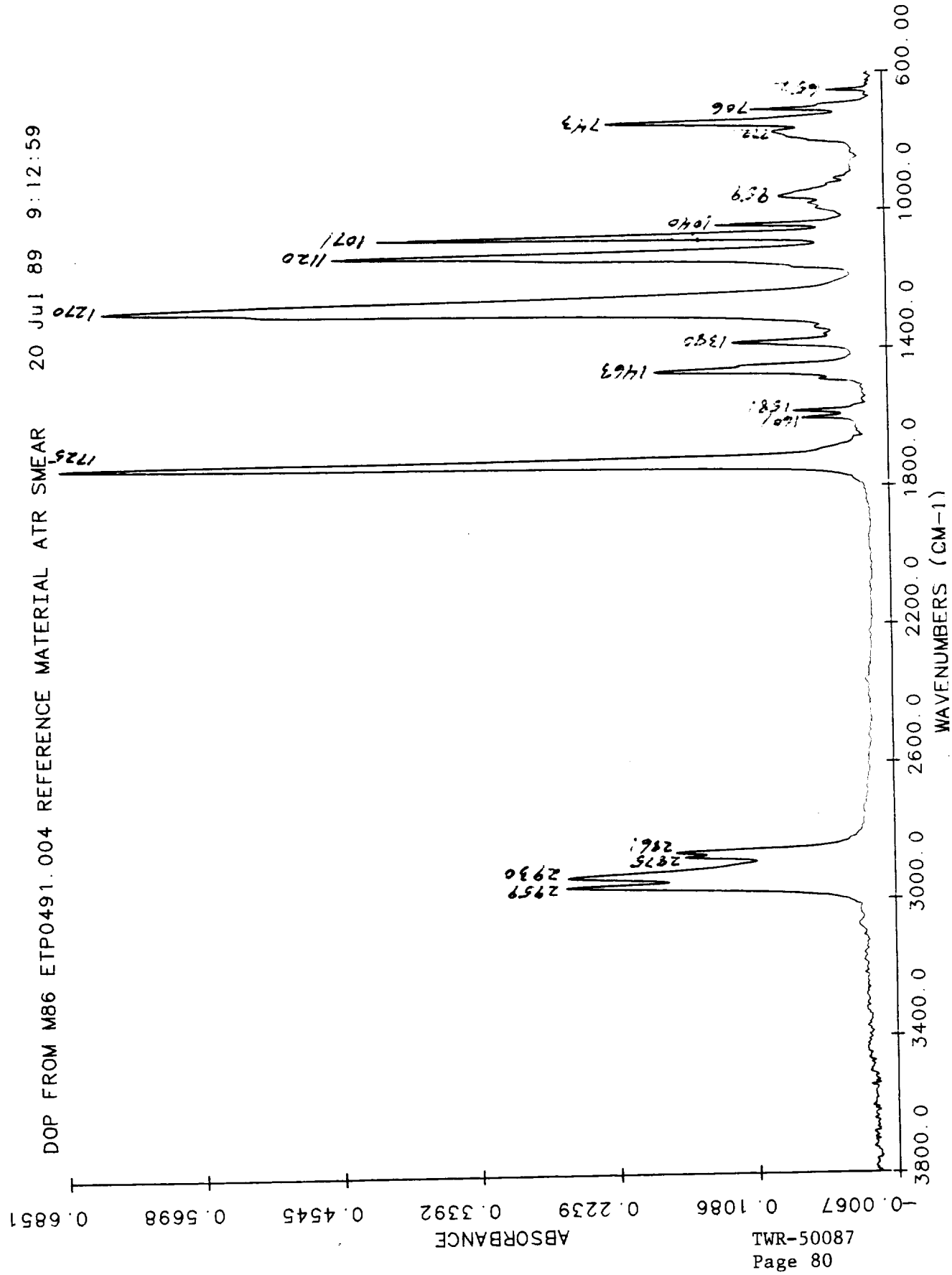


Figure 42.

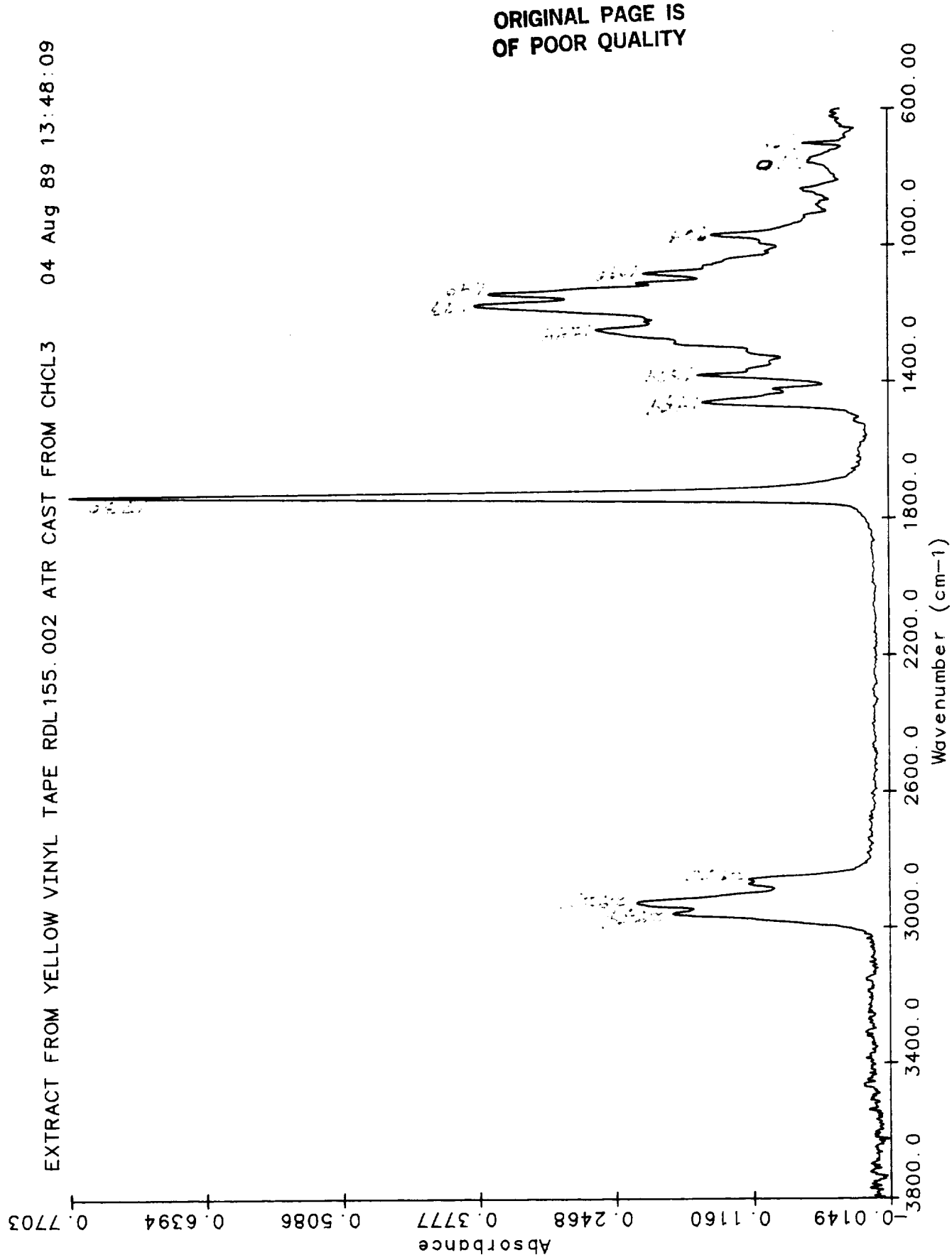


Figure 43.

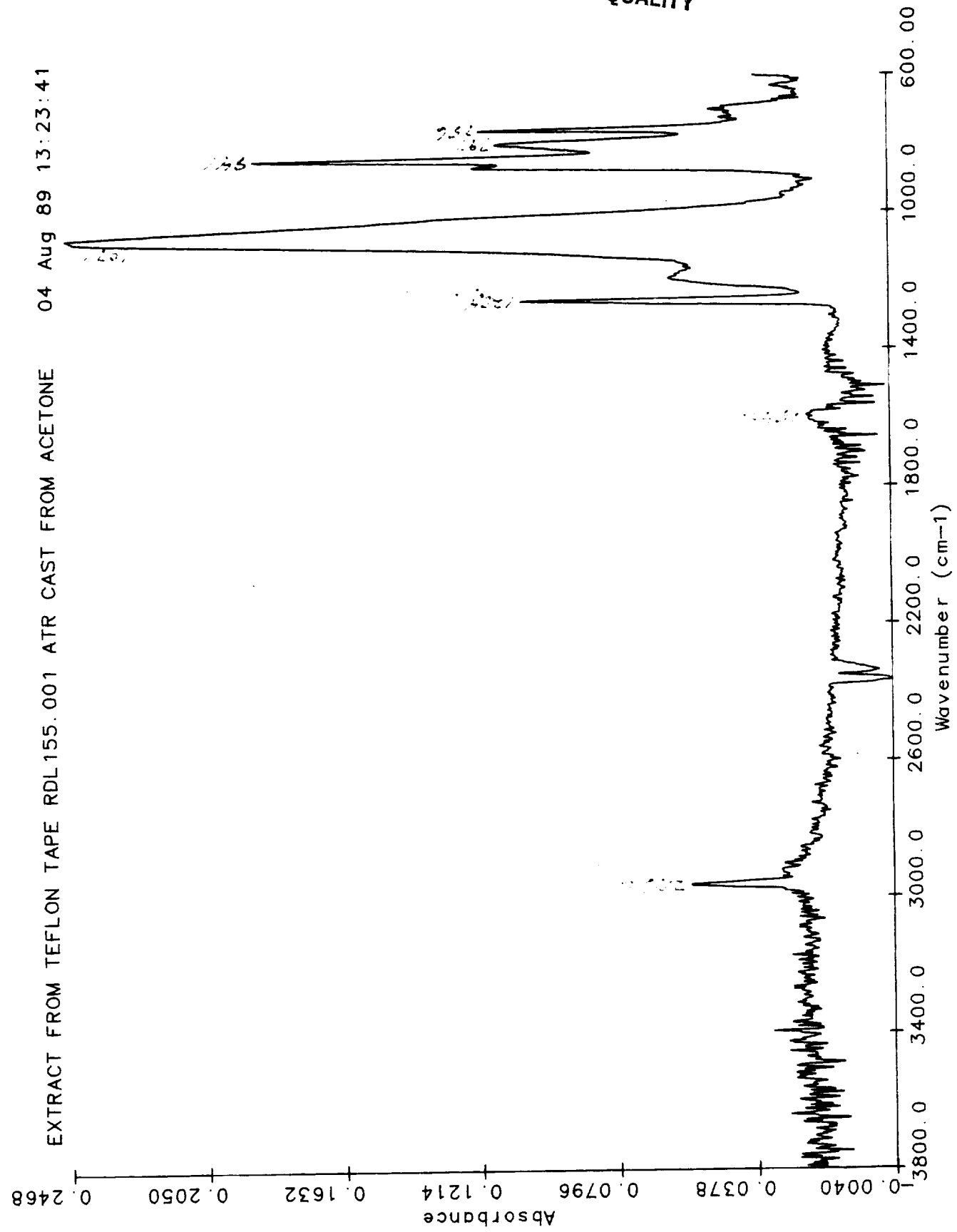


Figure 44.

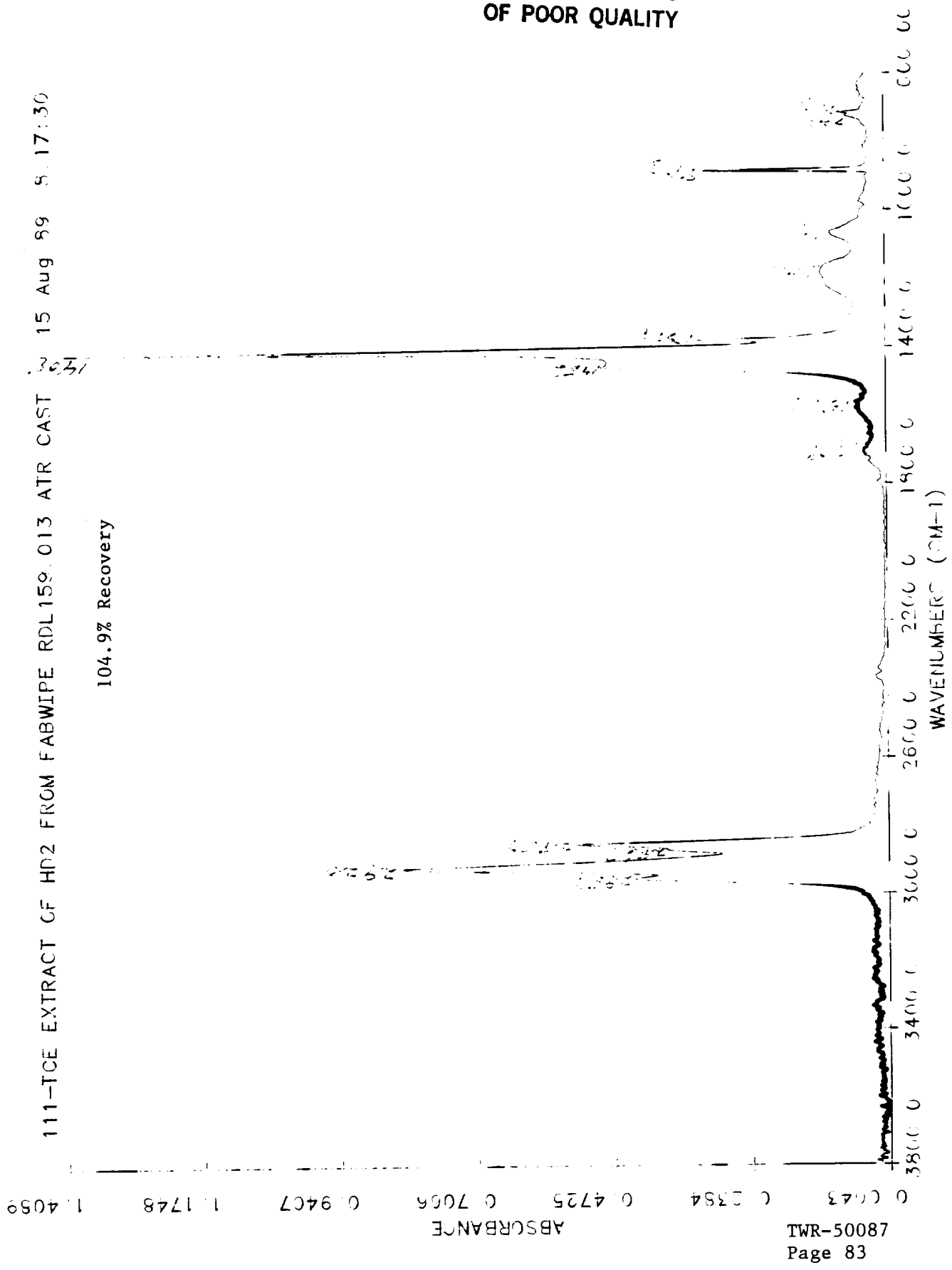


Figure 45.

Figure 46.

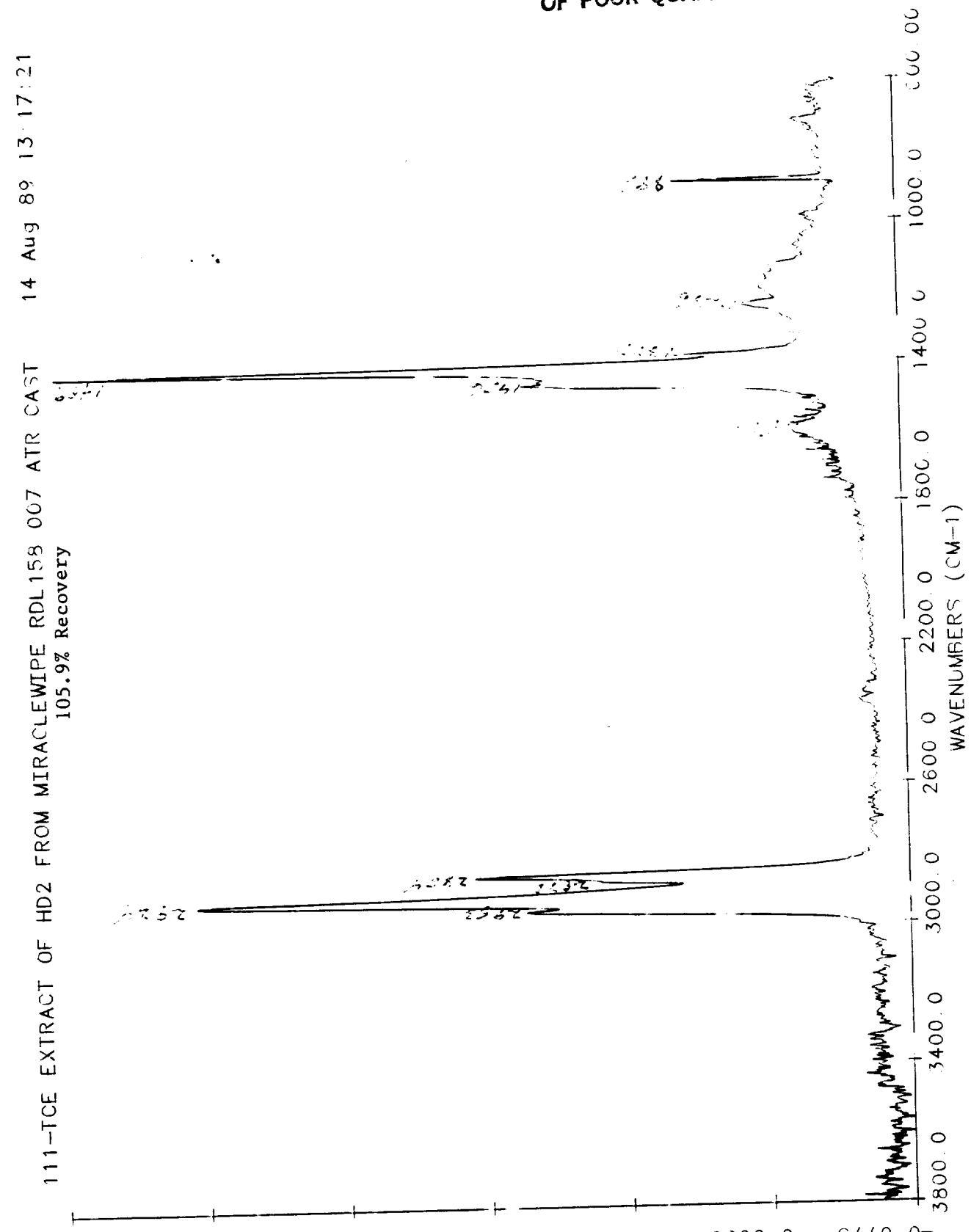
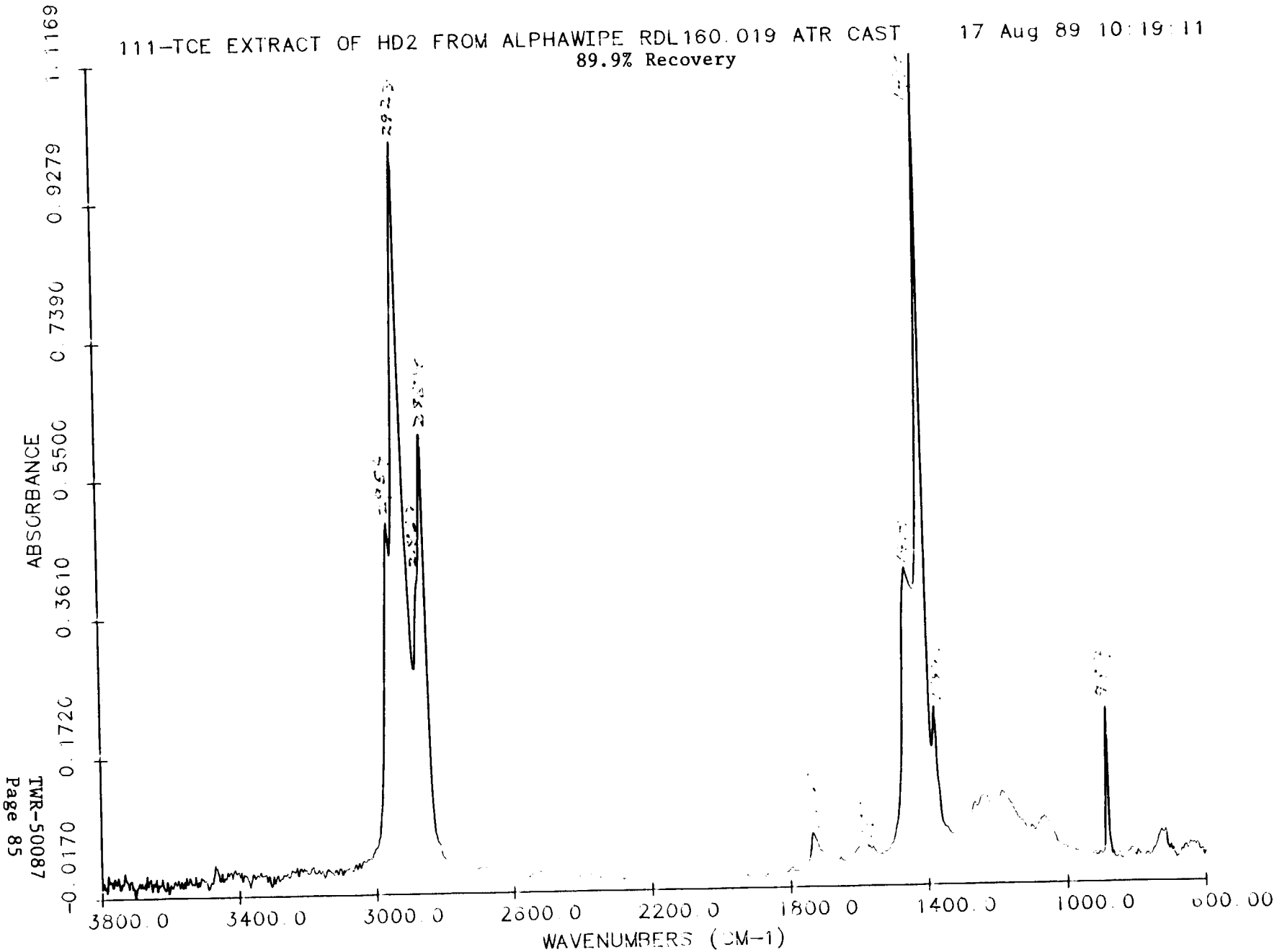


Figure 47.



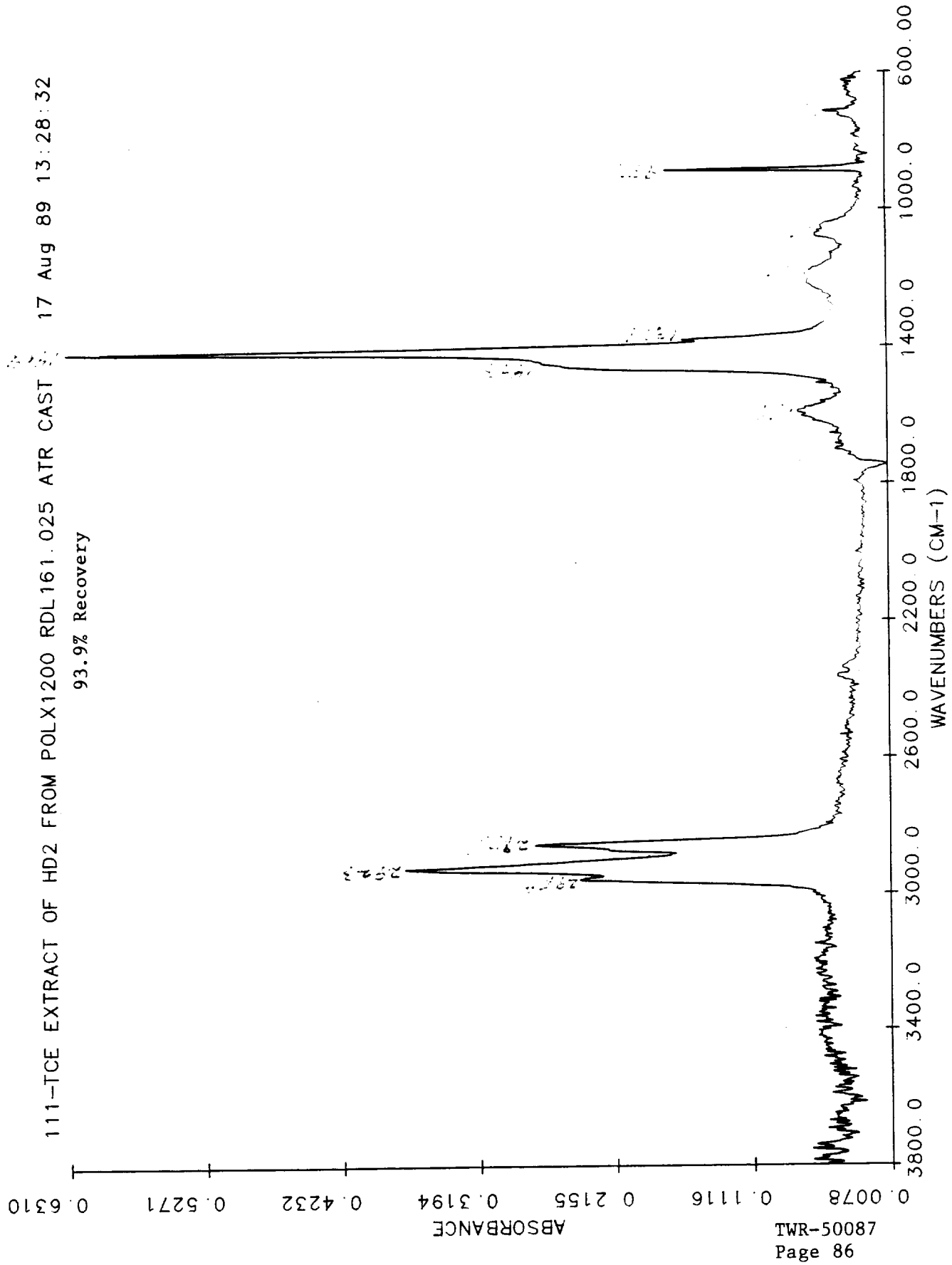


Figure 48.

Figure 49.

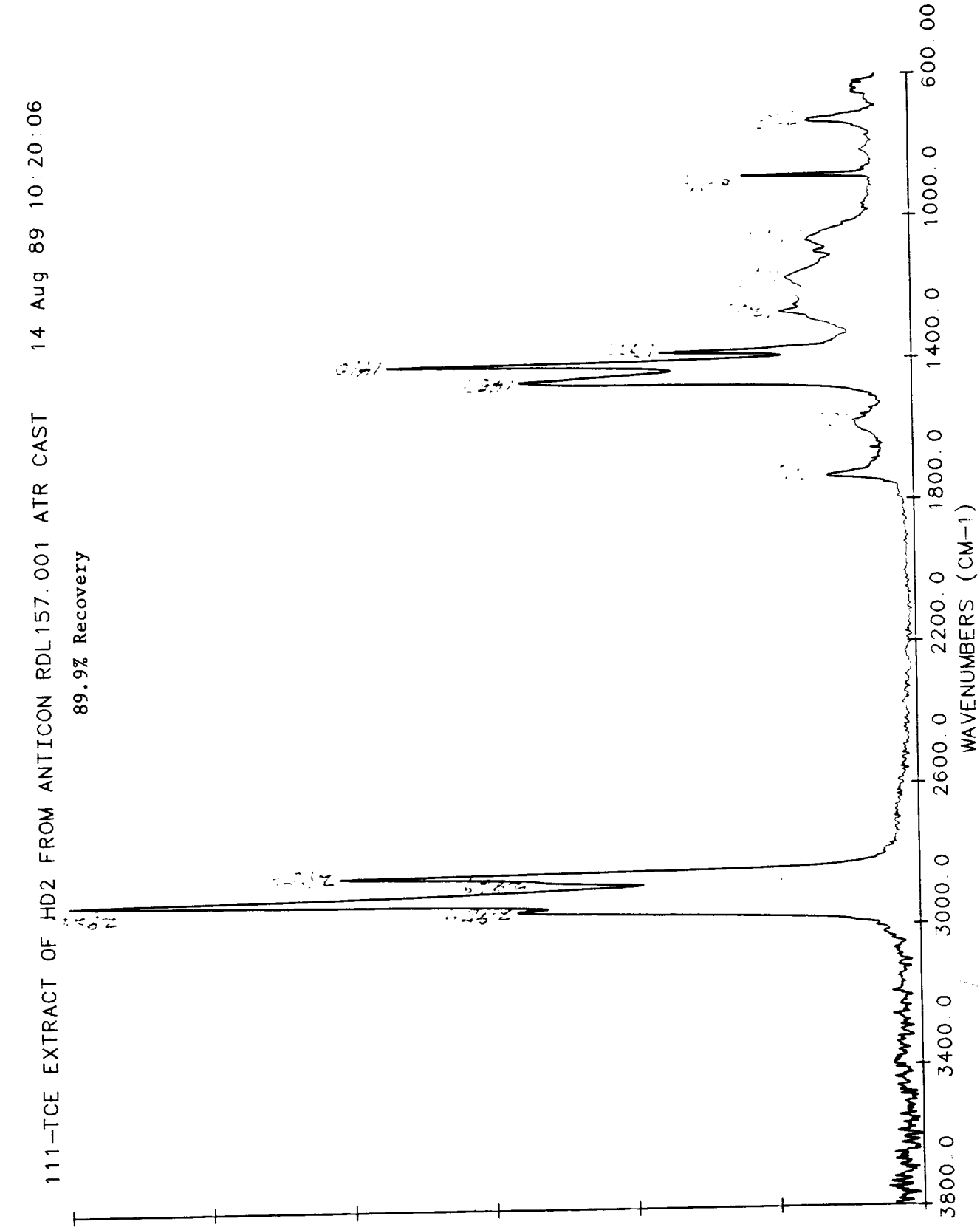
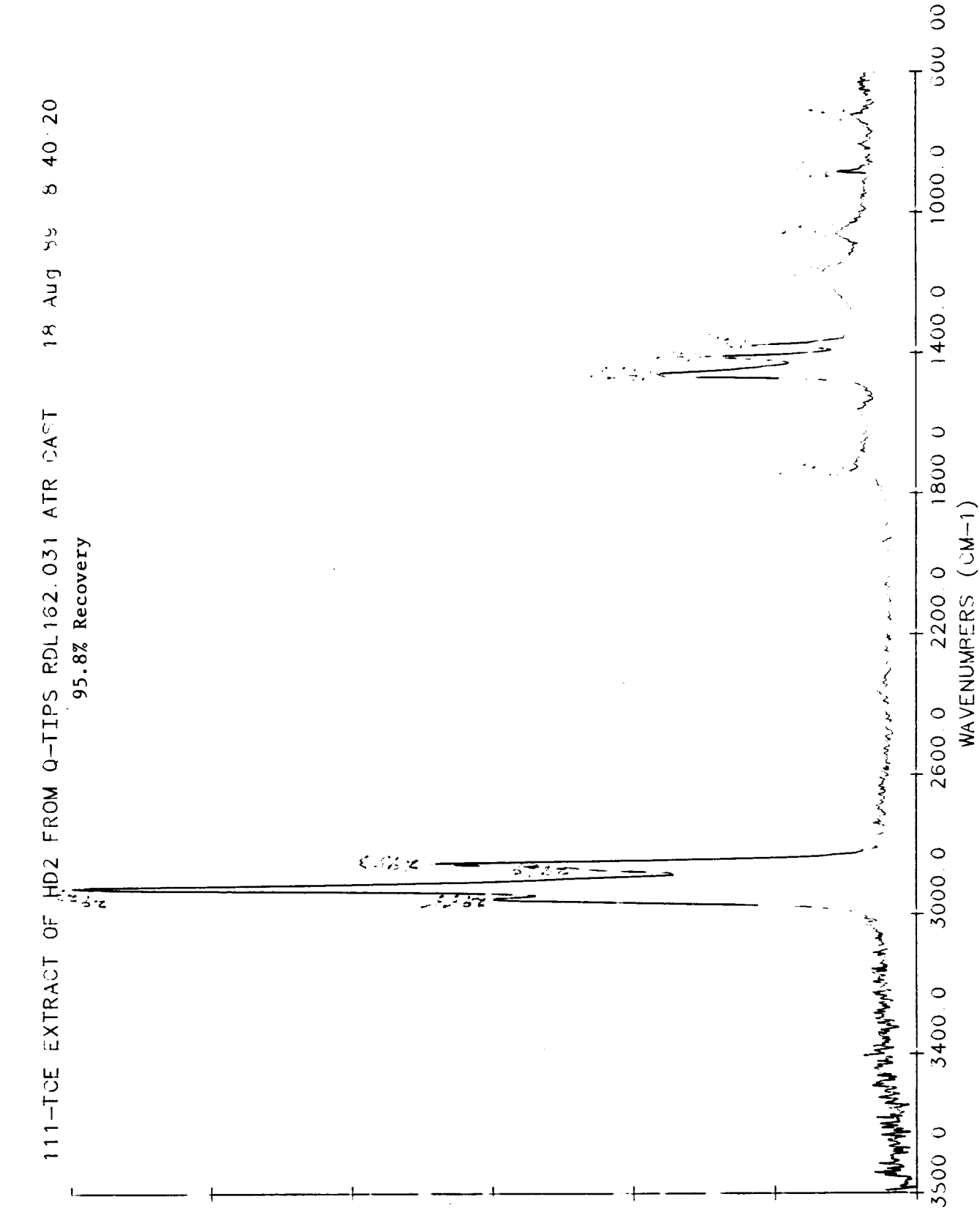


Figure 50.



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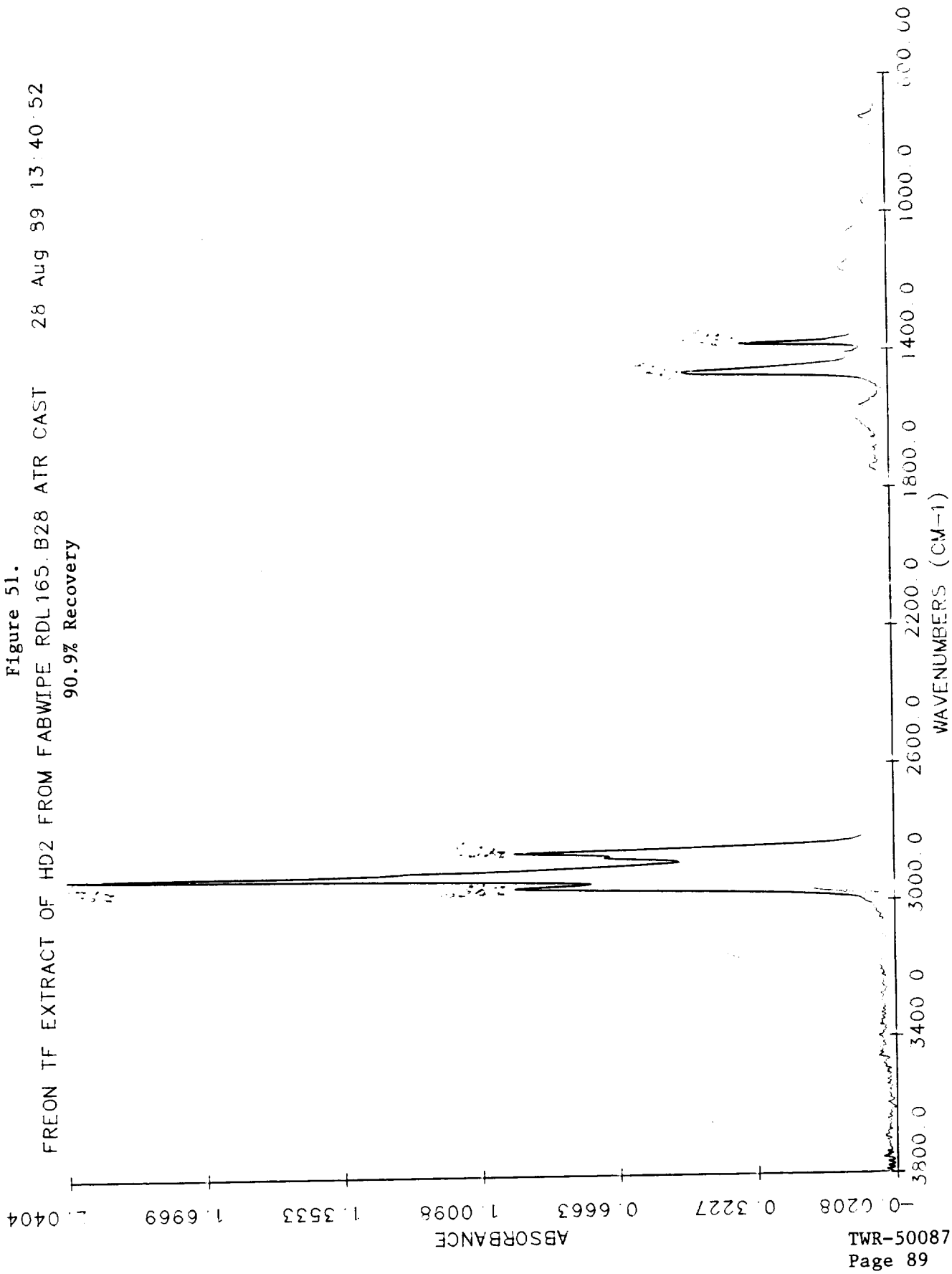


Figure 51.

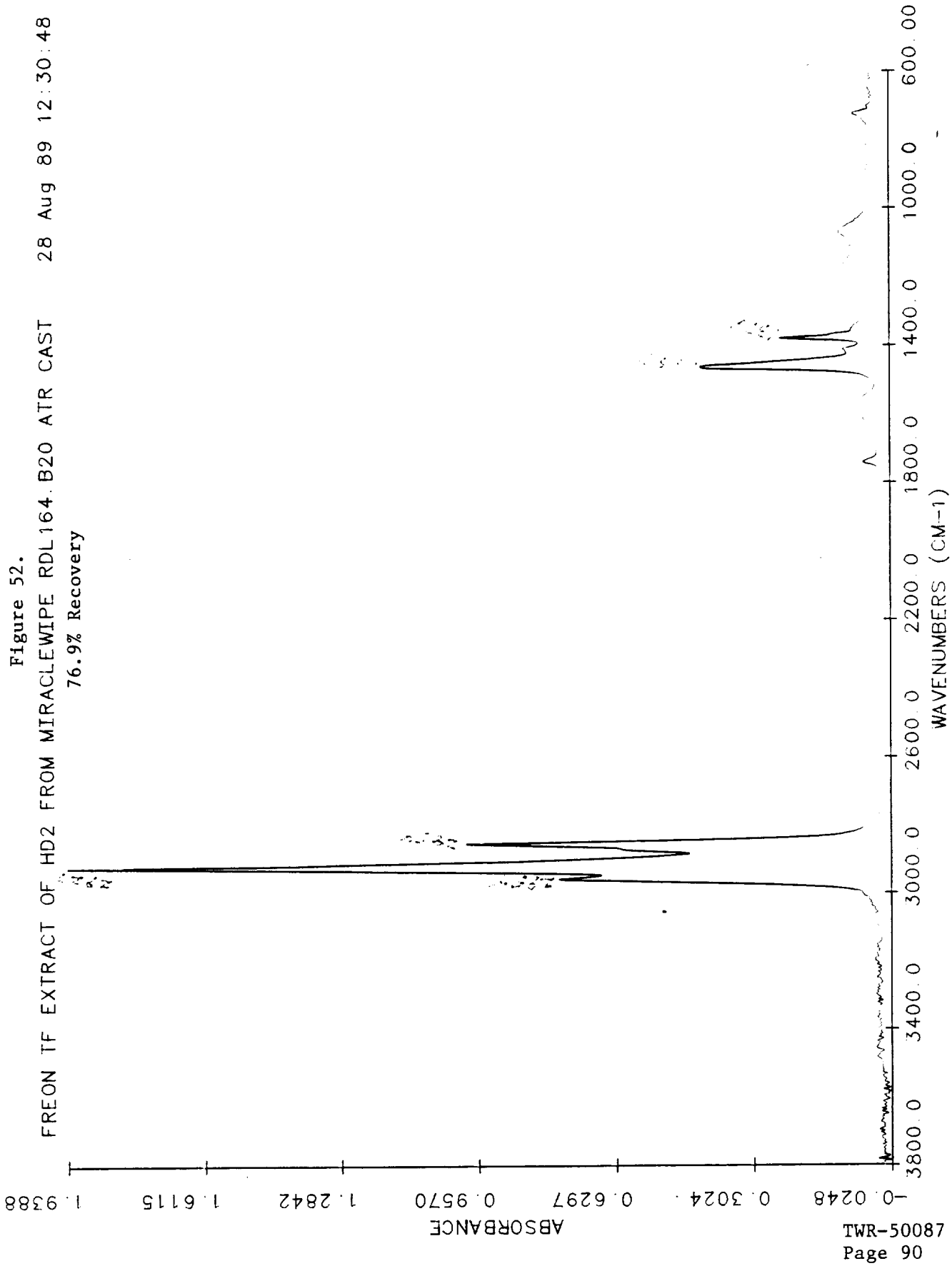


Figure 52.
76.9% Recovery

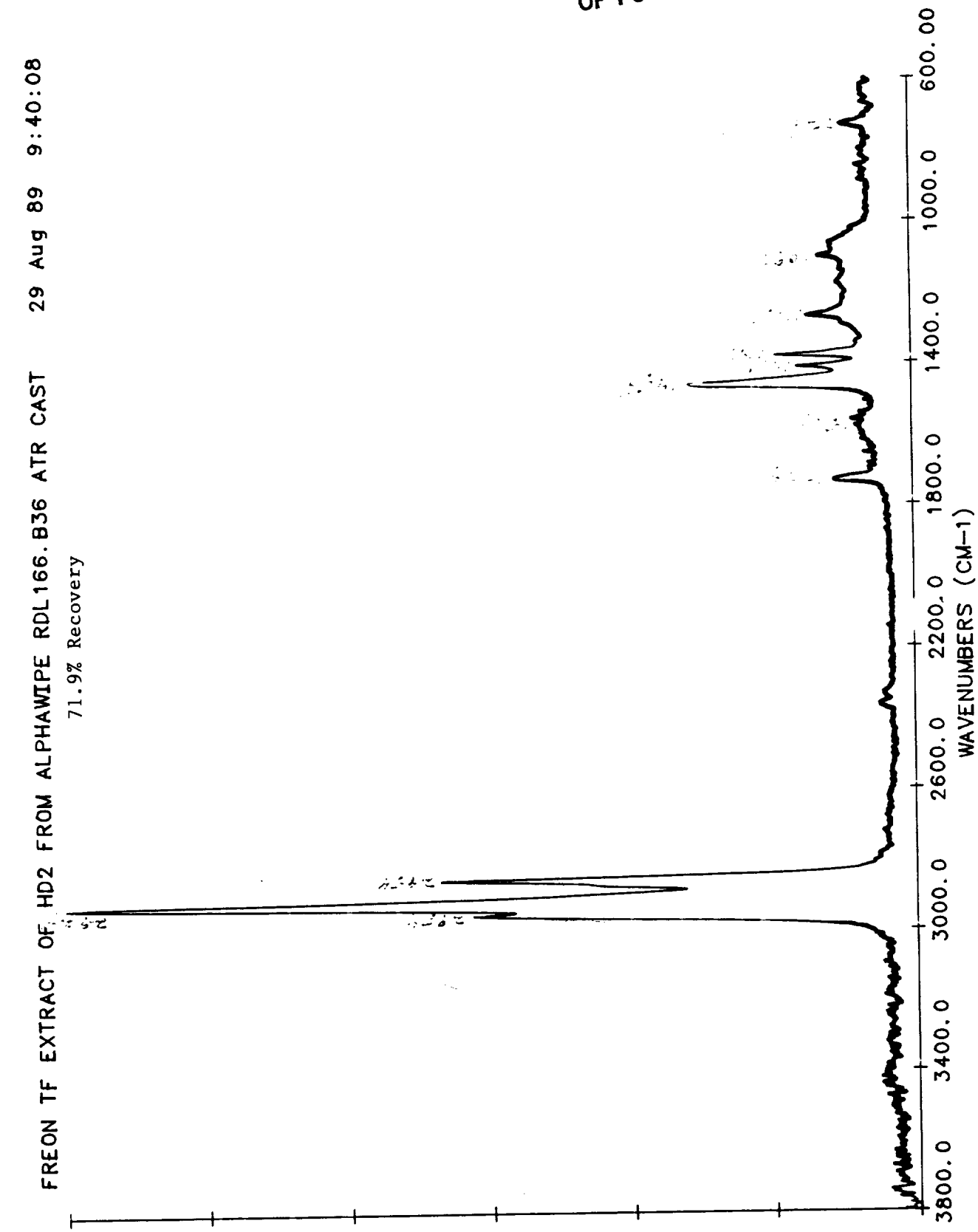


Figure 53.

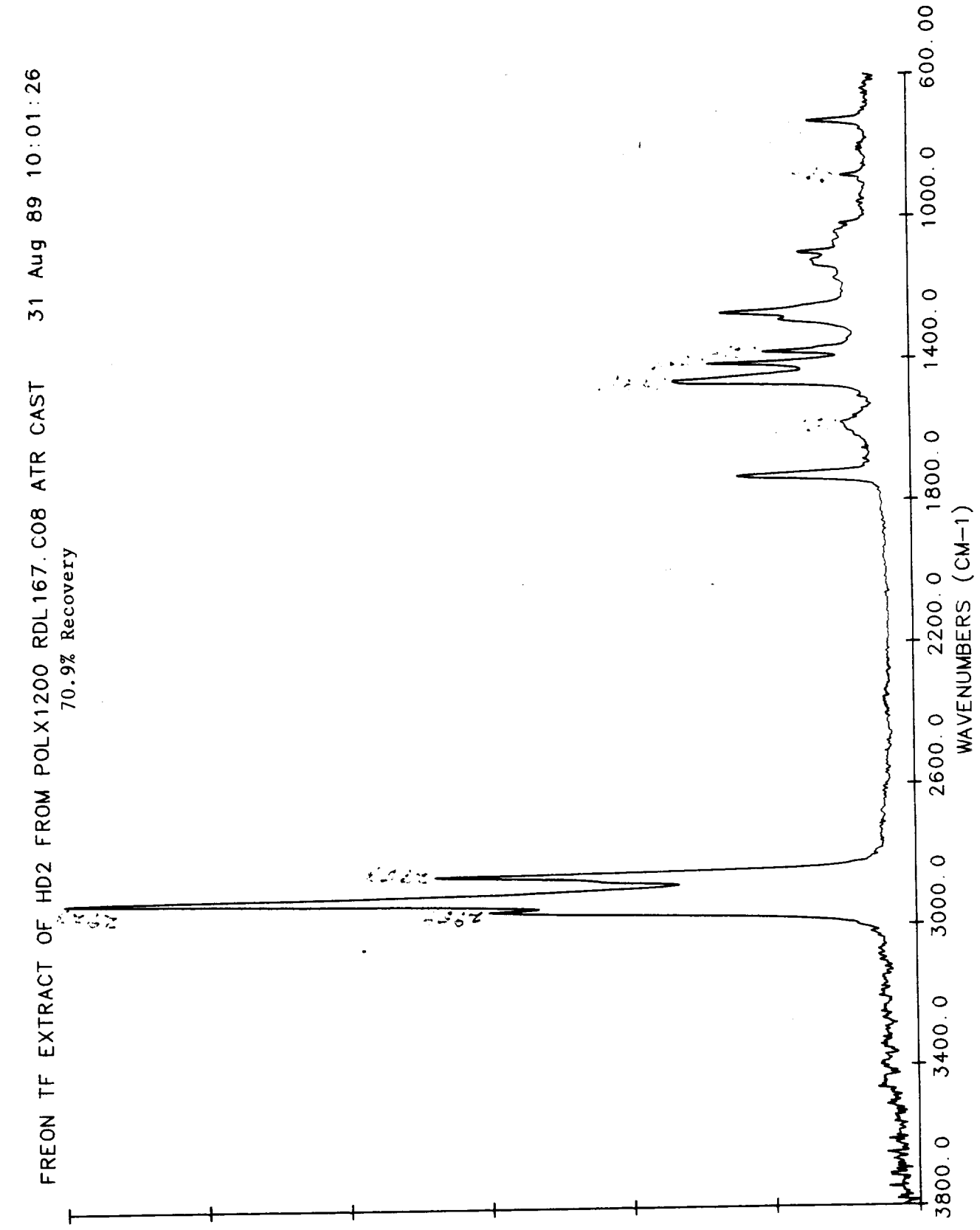


Figure 54.

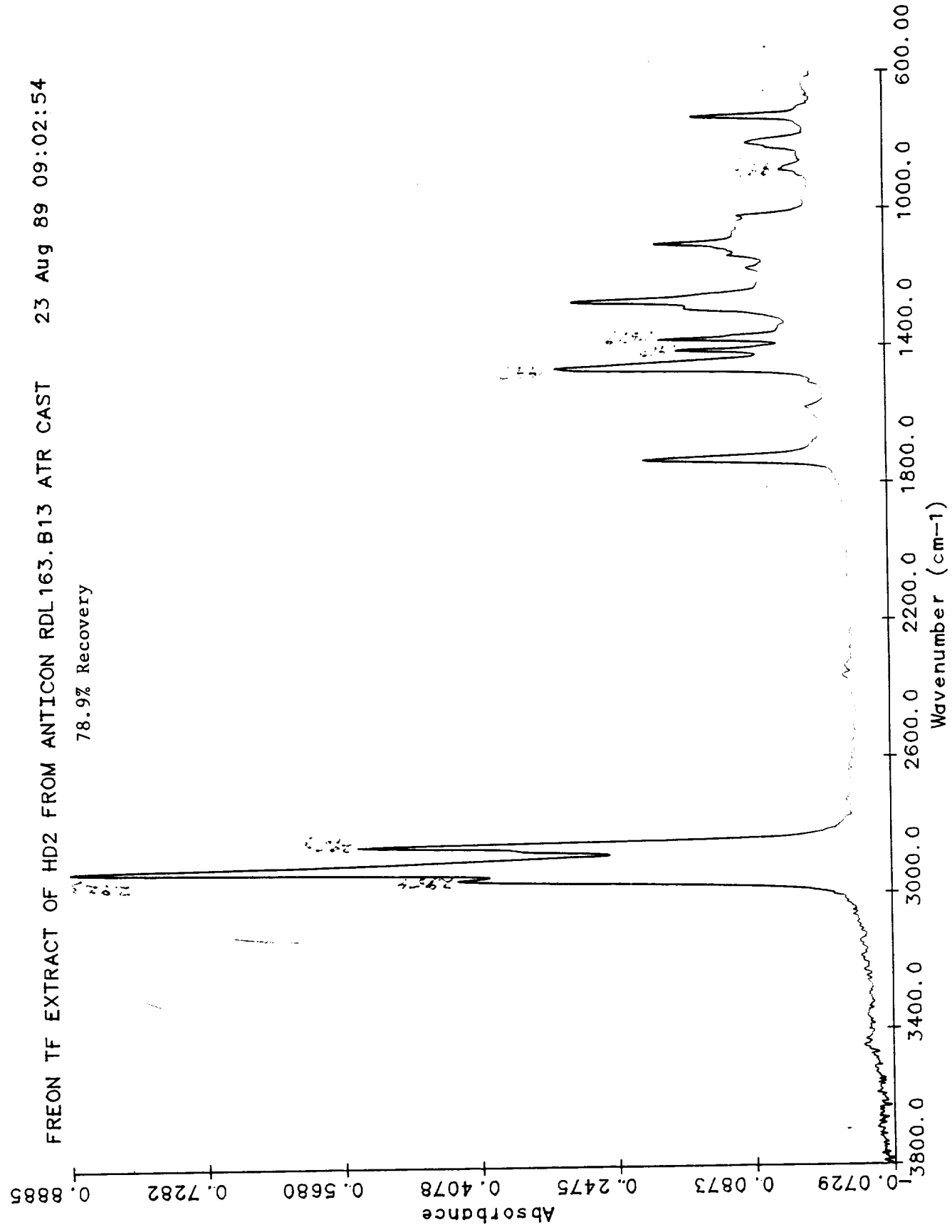


Figure 55.

Figure 56.

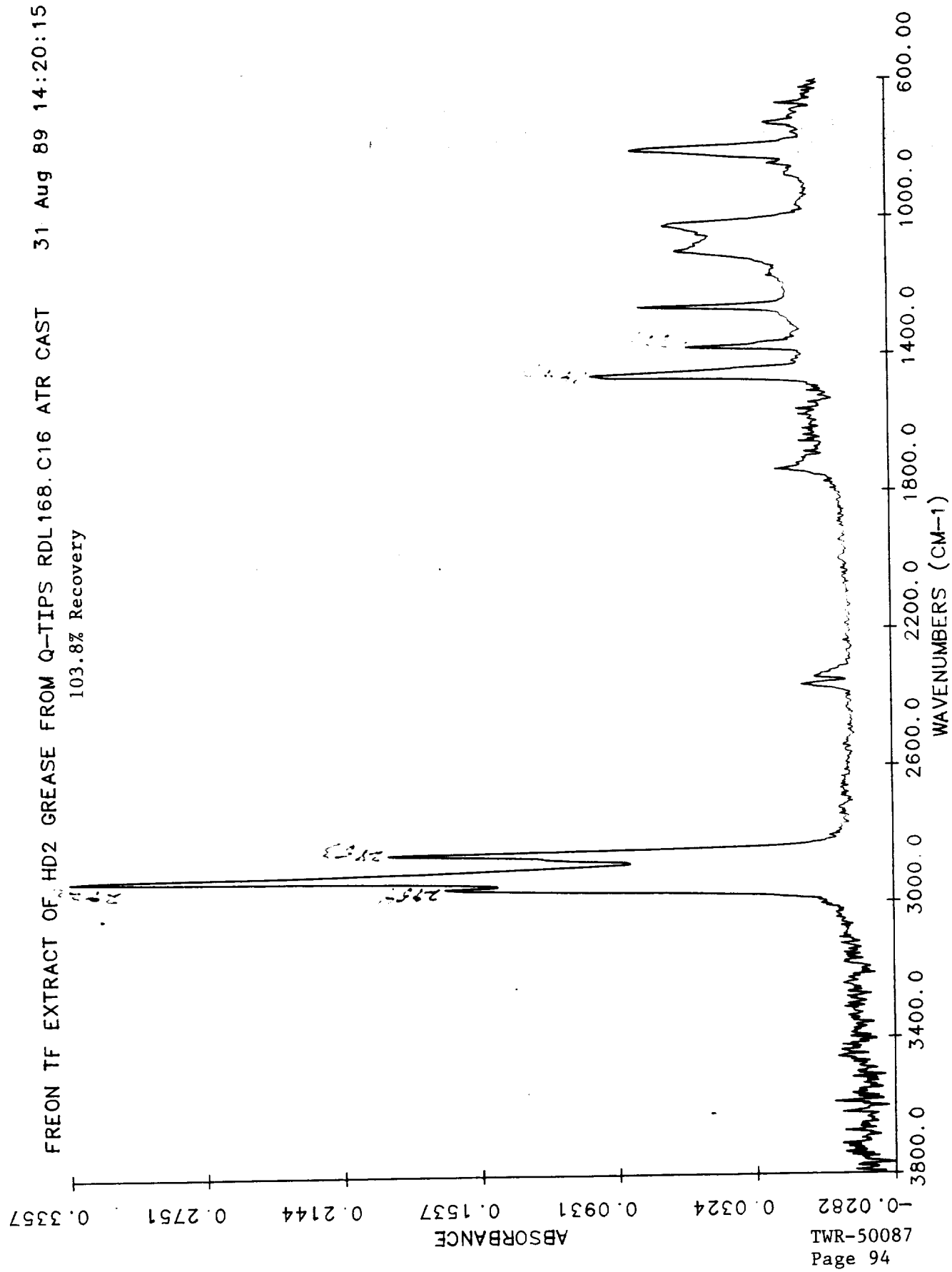


Figure 57.

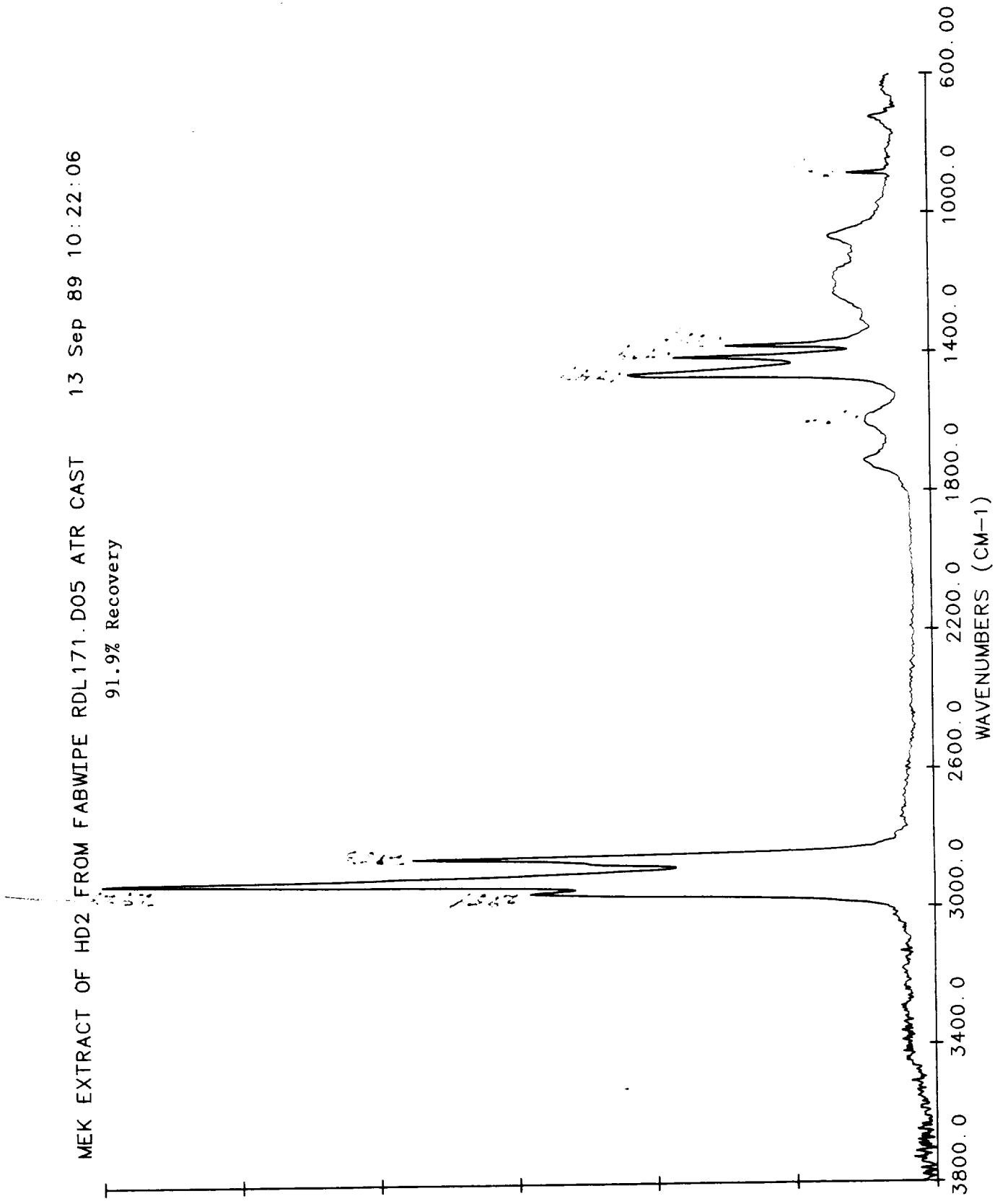
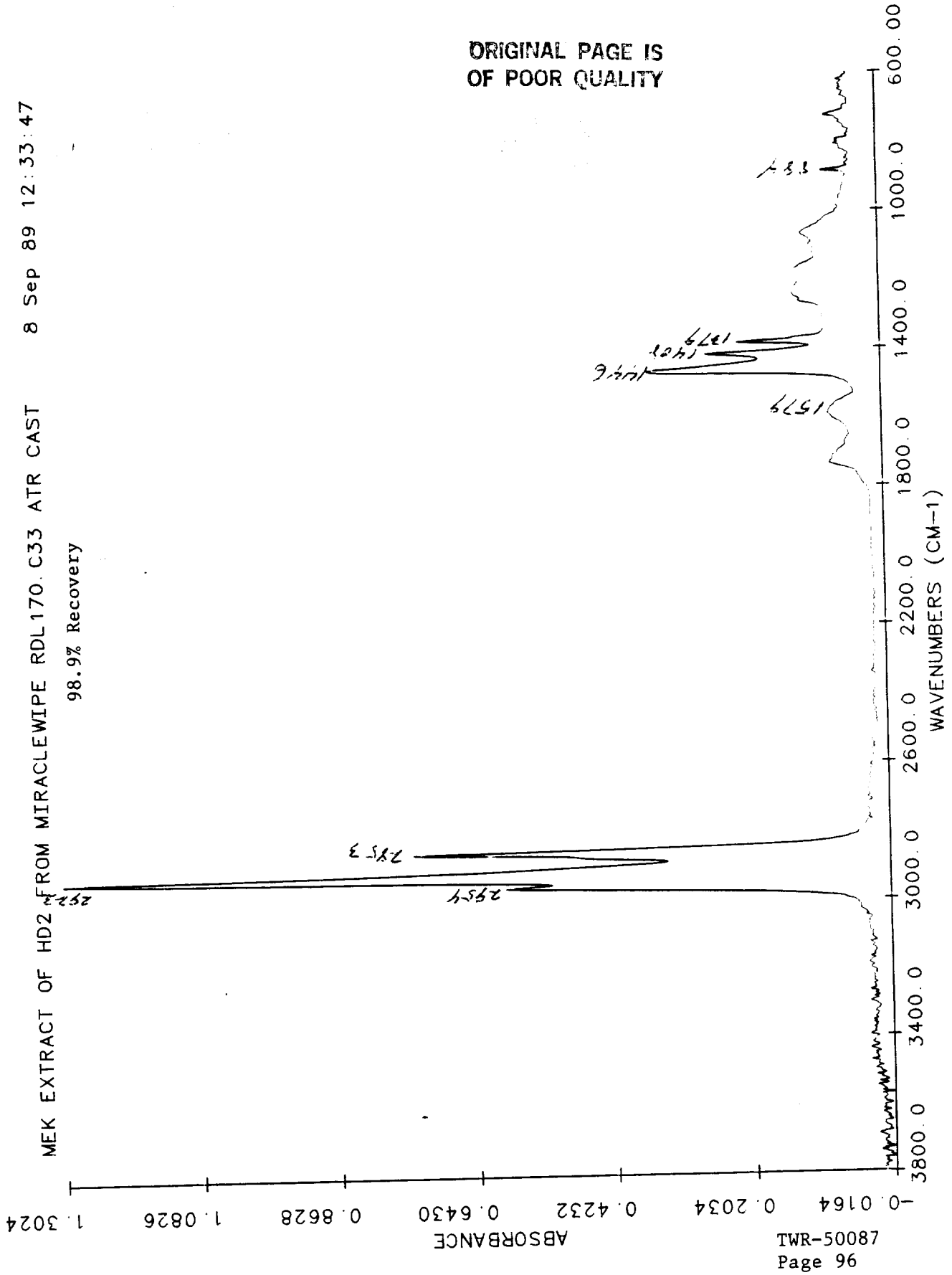


Figure 58.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MEK EXTRACT OF HD2 FROM MIRACLEWIPE RDL170.C33 ATR CAST 8 Sep 89 12:33:47
98.9% Recovery
ABSORBANCE
-0.0164
0.2034
0.4232
0.6430
0.8628
1.0826
1.3024
WAVENUMBERS (CM-1)
3800.0
3400.0
3000.0
2600.0
2200.0
1800.0
1400.0
1000.0
600.00

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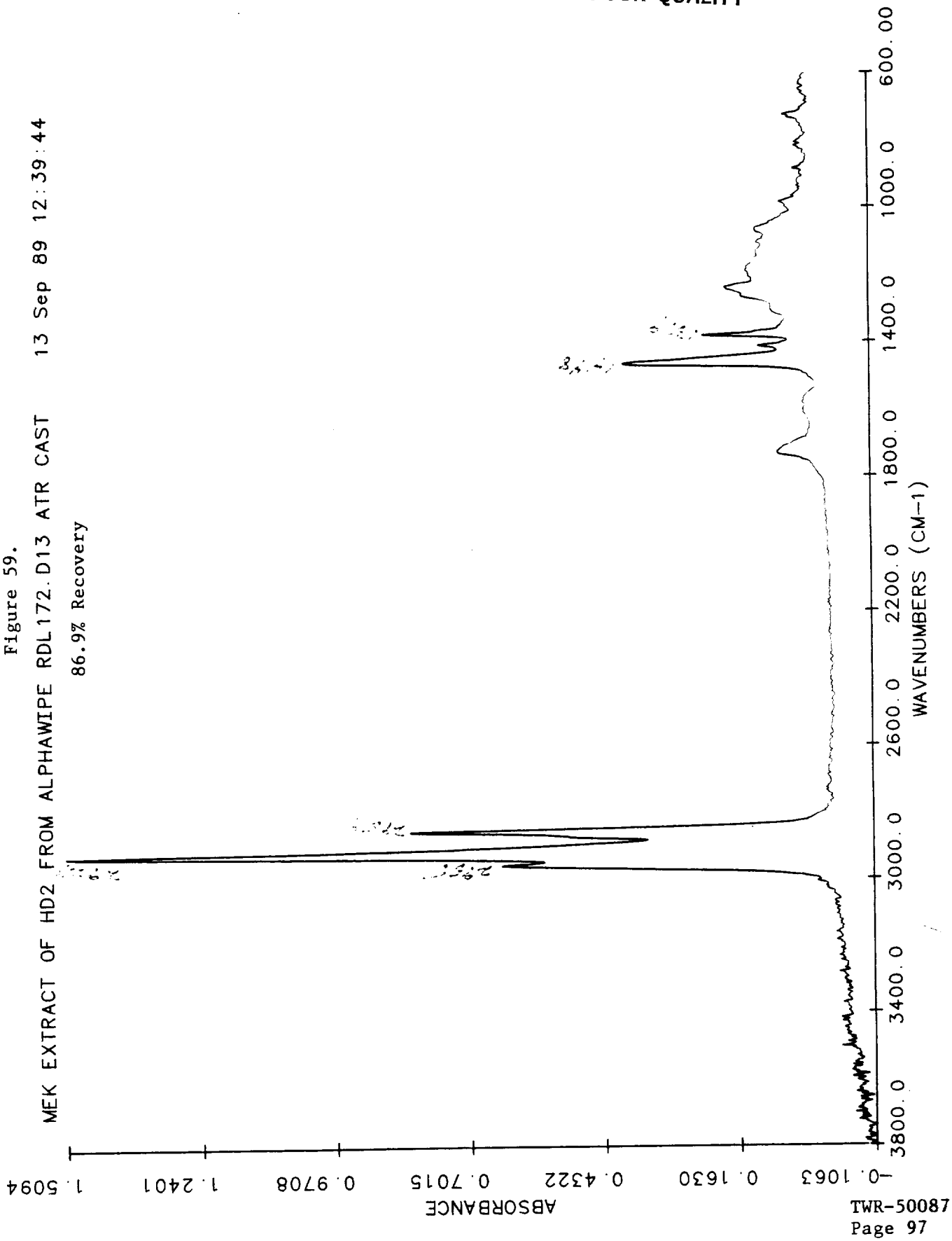
Figure 59.



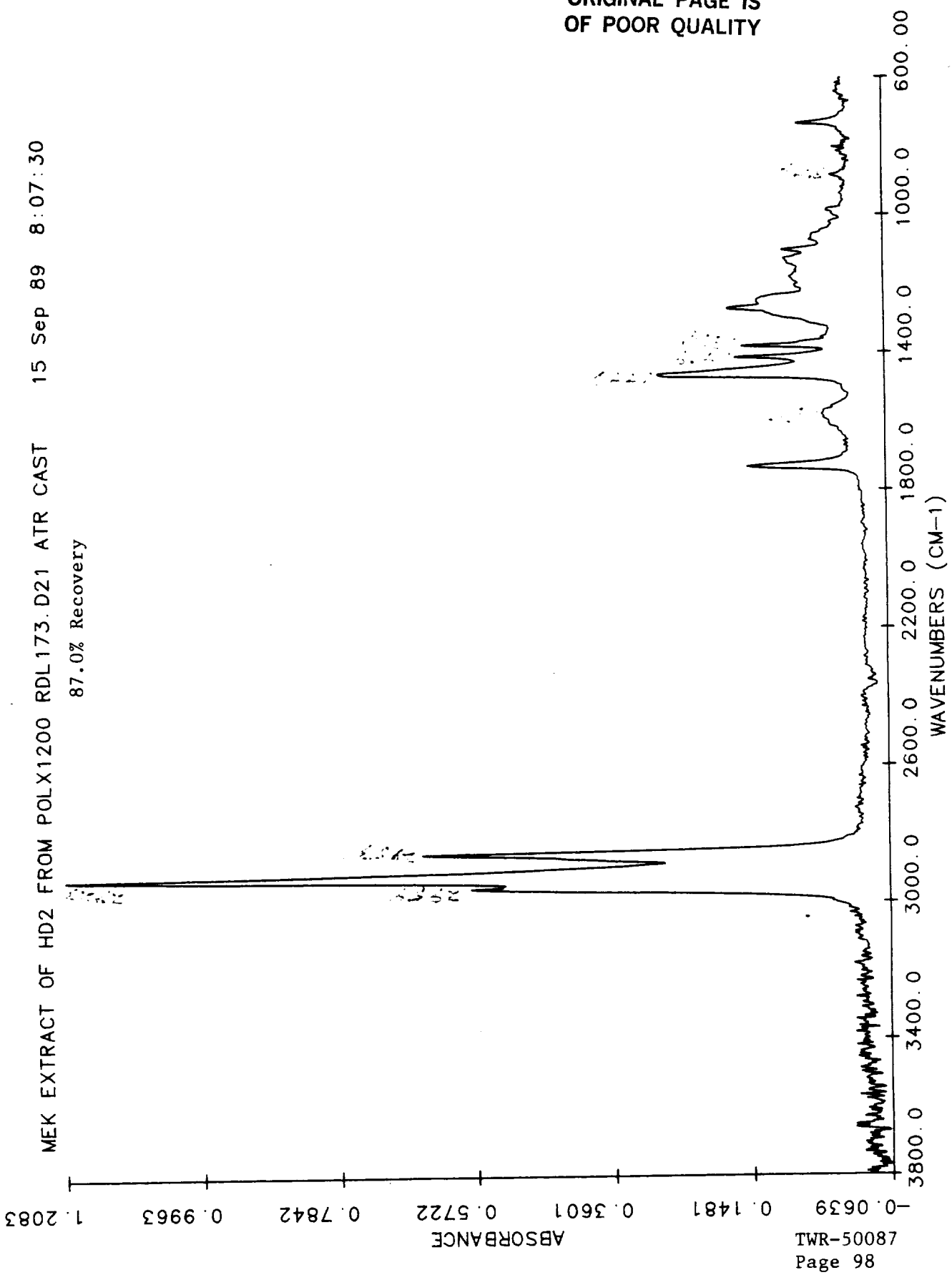


Figure 60.

Figure 61.

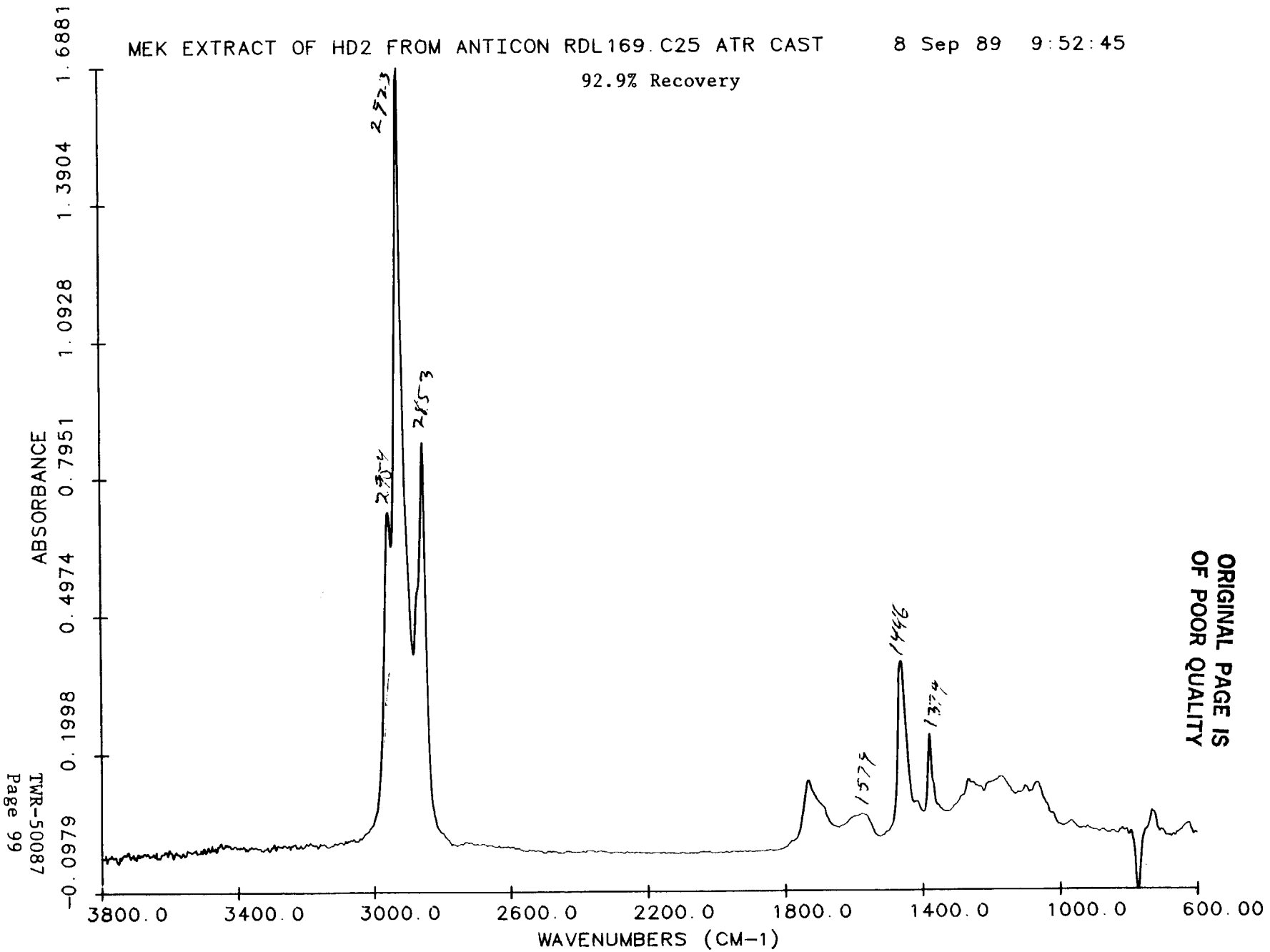

MEK EXTRACT OF HD2 FROM ANTICON RDL169.C25 ATR CAST 8 Sep 89 9:52:45
92.9% Recovery
ABSORBANCE
1.6881
1.3904
1.0928
0.7951
0.4974
0.1998
-0.0979
3800.0
3400.0
3000.0
2600.0
2200.0
1800.0
1400.0
1000.0
600.00
WAVENUMBERS (CM-1)
2923
2853
2357
1577
1464
1378
TWR-50087
Page 99
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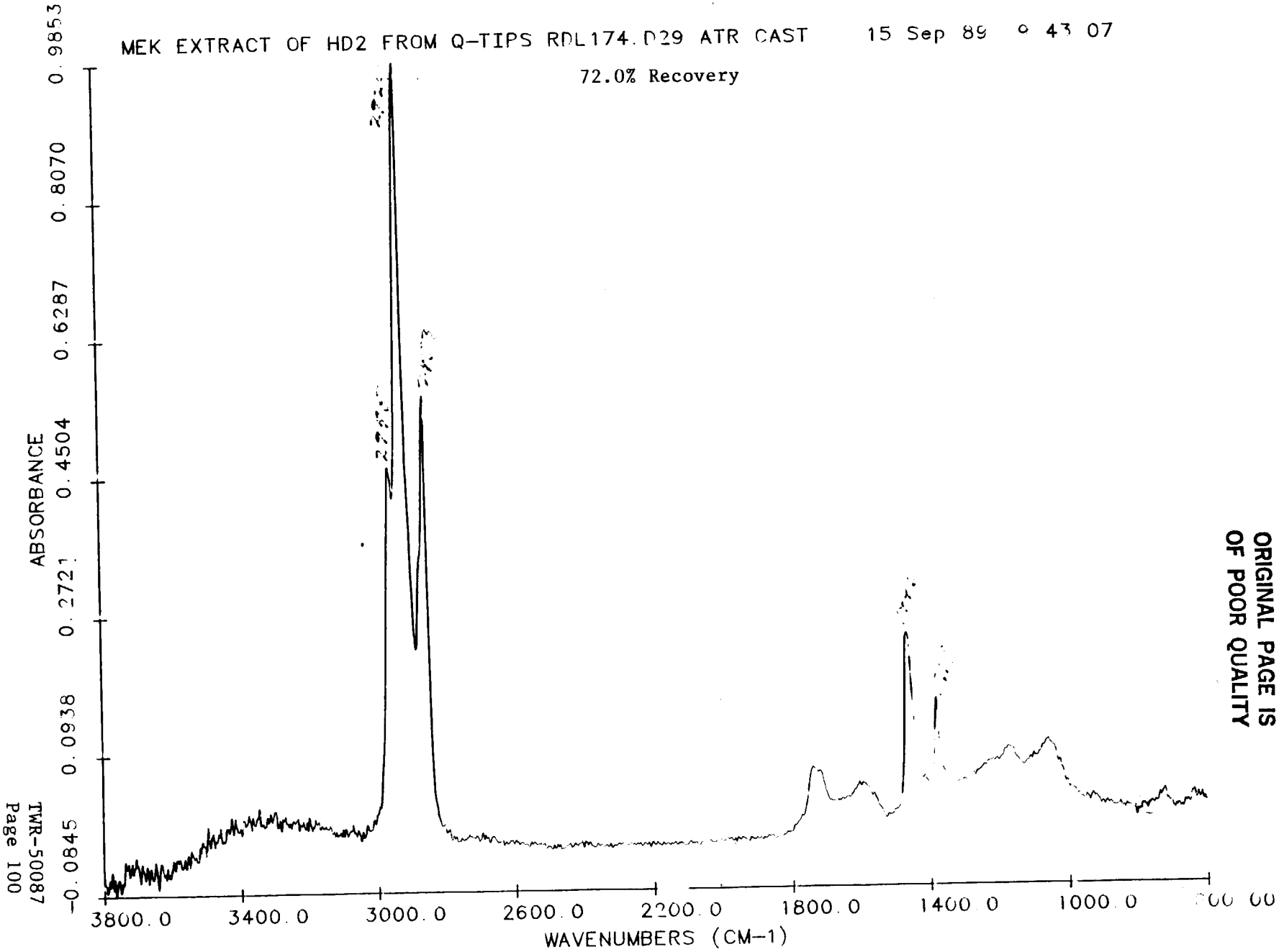
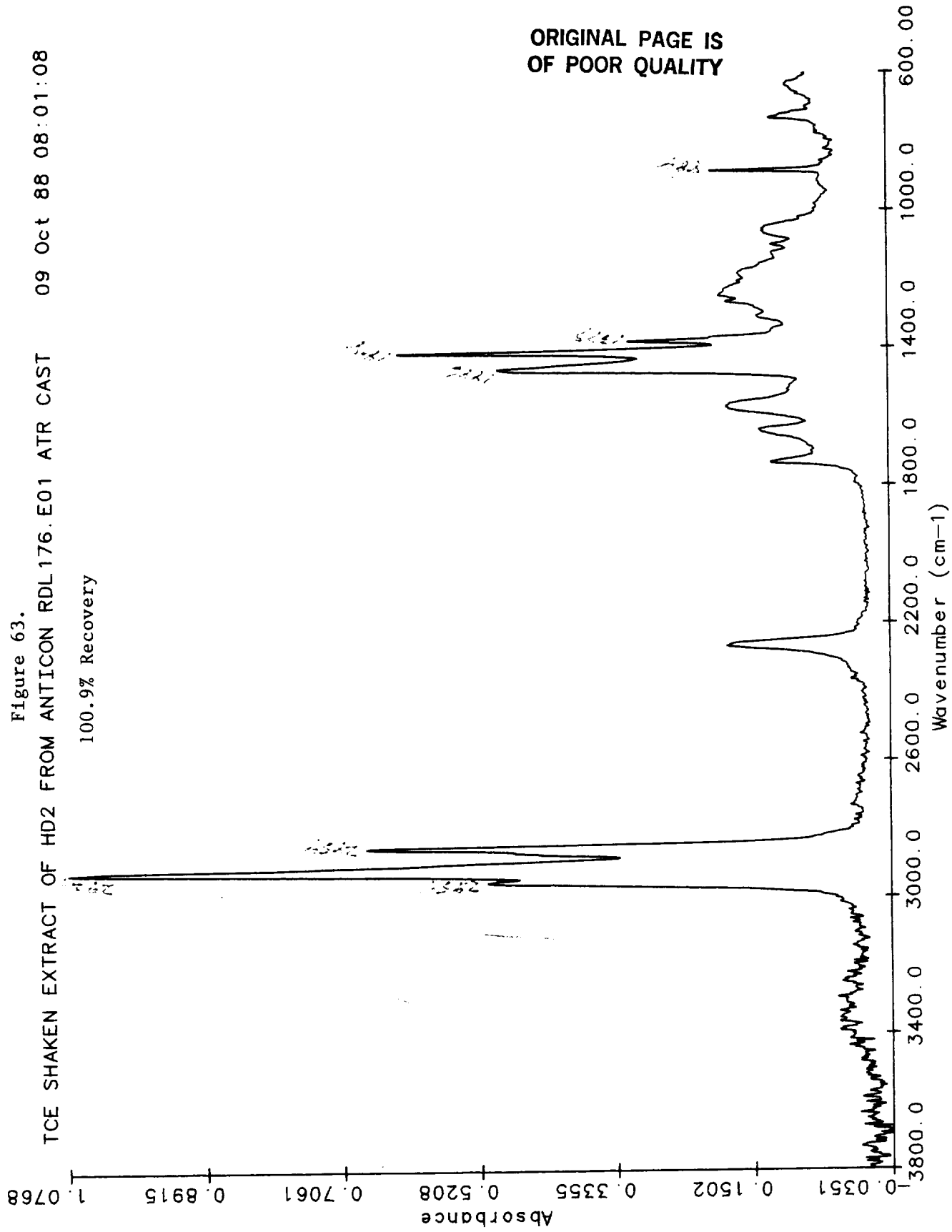
Figure 62.




ORIGINAL PAGE IS
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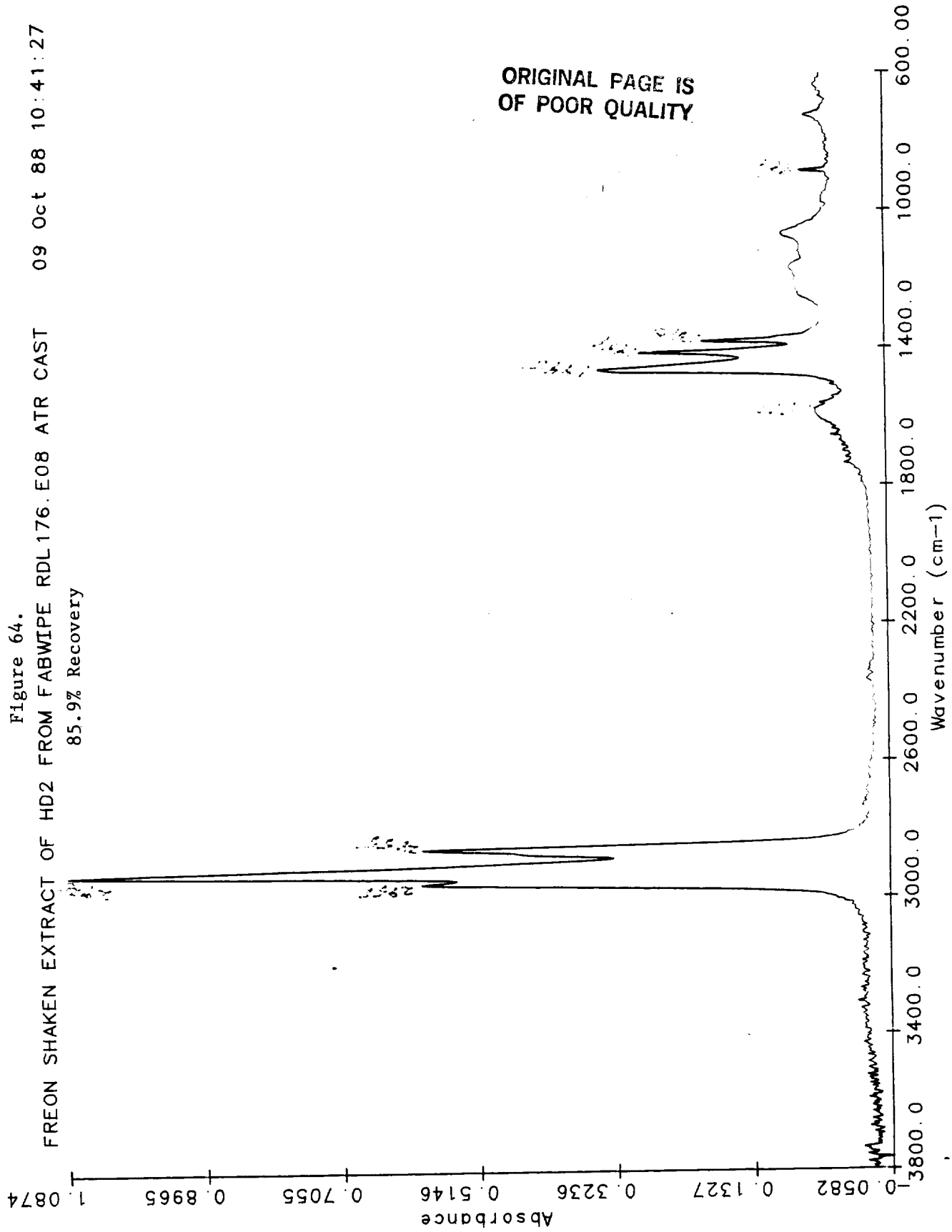
TCE SHAKEN EXTRACT OF HD2 FROM ANTICON RDL176.E01 ATR CAST 09 Oct 88 08:01:08
100.9% Recovery
Absorbance
1.0768
0.8915
0.7061
0.5208
0.3355
0.1502
0.0351
Wavenumber (cm-1)
3800.0
3400.0
3000.0
2600.0
2200.0
1800.0
1400.0
1000.0
600.00

Figure 63.


FREON SHAKEN EXTRACT OF HD2 FROM FABWIPE RDL176.E08 ATR CAST 09 Oct 88 10:41:27
85.9% Recovery
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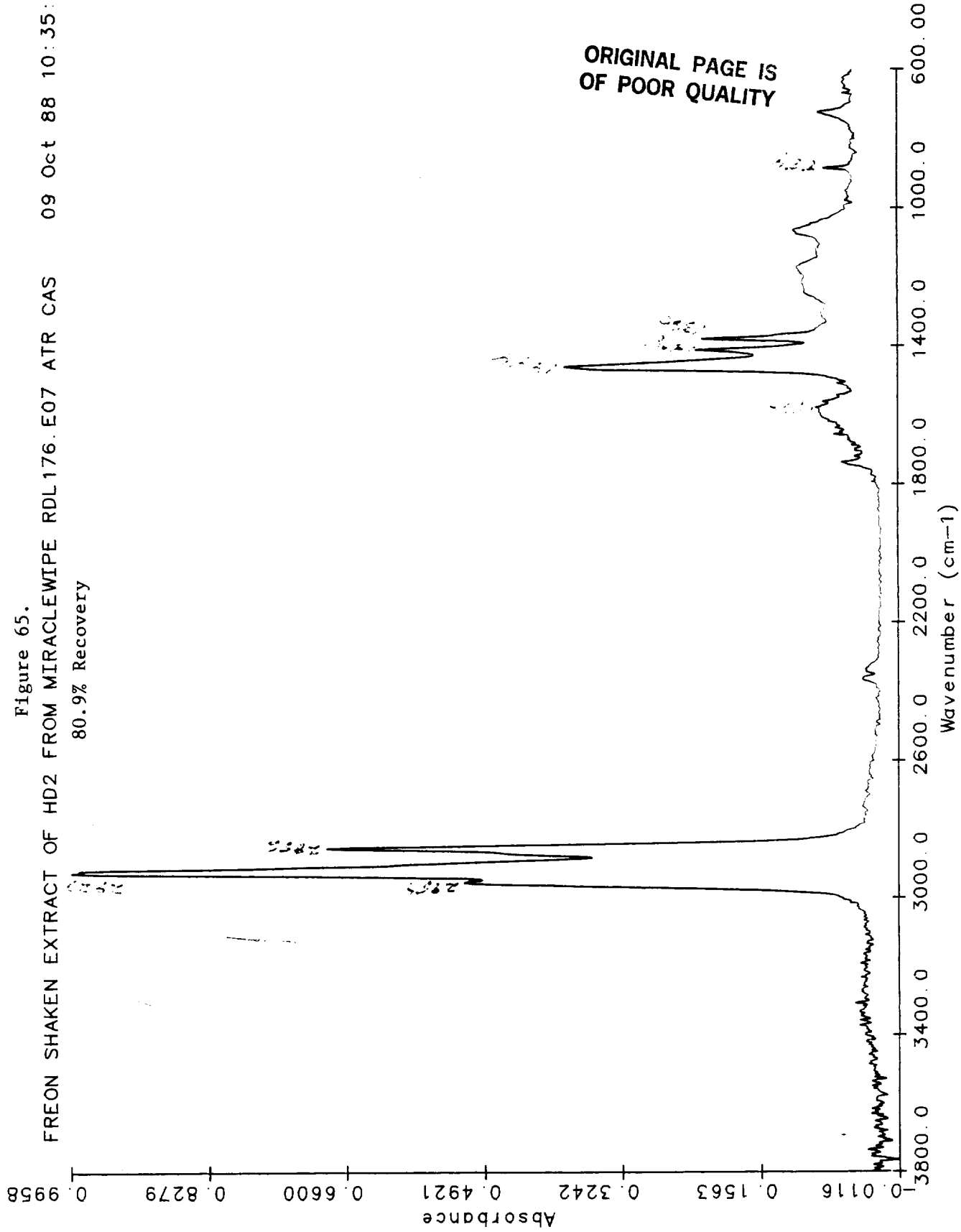
Absorbance
0.0582
0.1327
0.3236
0.5146
0.7055
0.8965
1.0874
Wavenumber (cm-1)
3800.0
3400.0
3000.0
2600.0
2200.0
1800.0
1400.0
1000.0
600.00

Figure 64.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FREON SHAKEN EXTRACT OF HD2 FROM MIRACLEWIPE RDL176.E07 ATR CAS 09 Oct 88 10:35:17
80.9% Recovery
Absorbance
0.0116
0.1563
0.3242
0.4921
0.6600
0.8279
0.9958
Wavenumber (cm-1)
3800.0
3400.0
3000.0
2600.0
2200.0
1800.0
1400.0
1000.0
600.00

Figure 65.

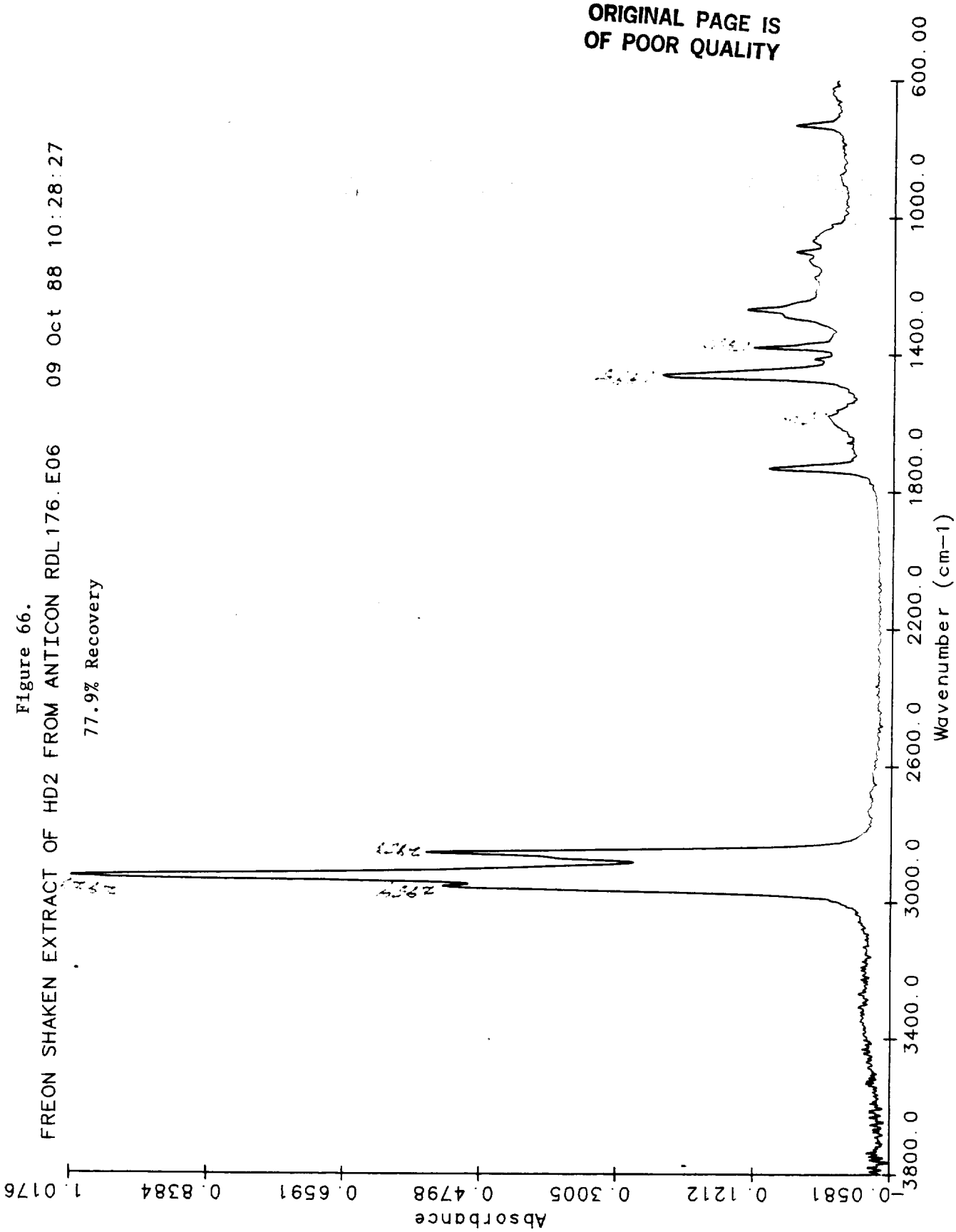
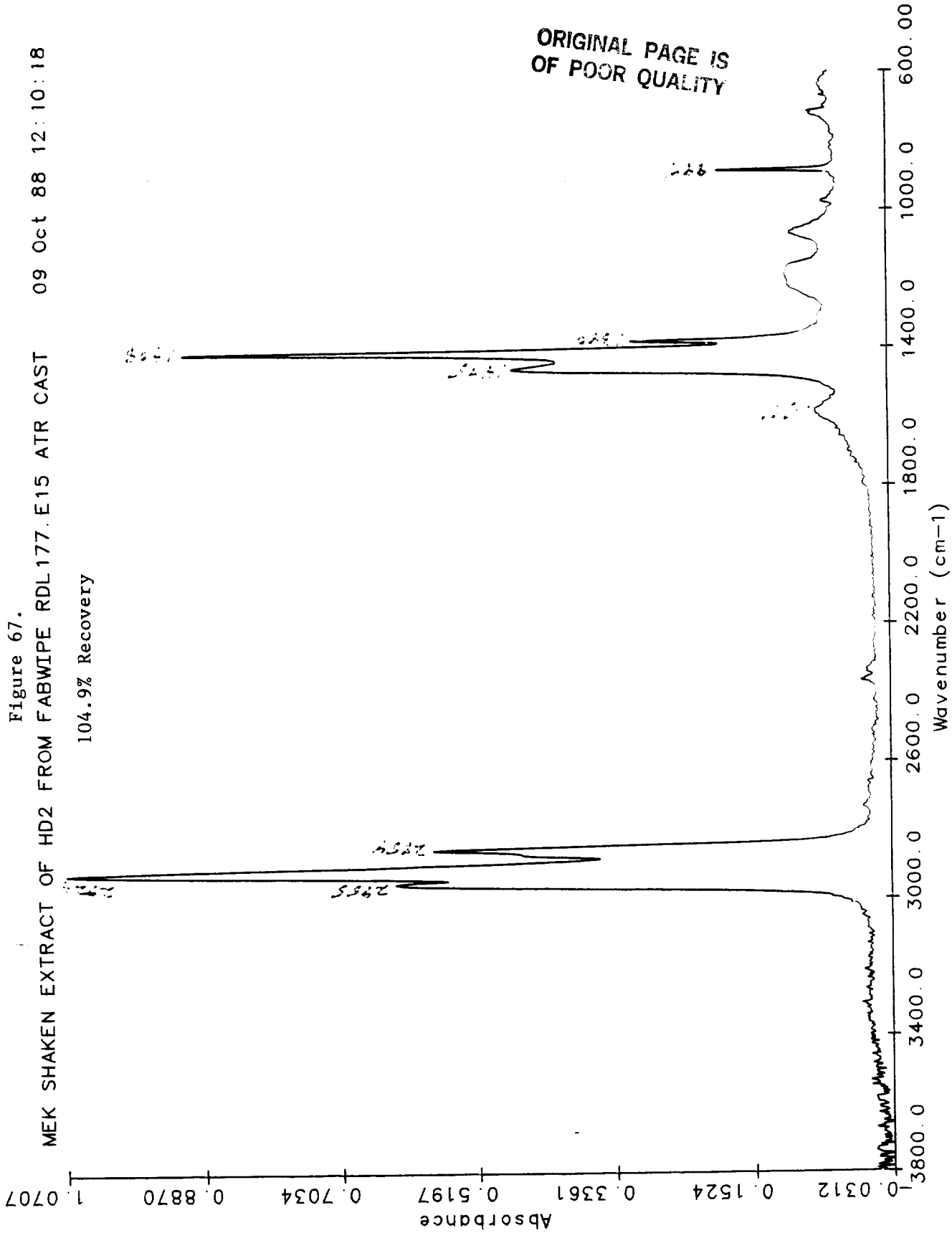


Figure 66.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MEK SHAKEN EXTRACT OF HD2 FROM FABWIPE RDL177.E15 ATR CAST 09 Oct 88 12:10:18
104.9% Recovery
Absorbance
0.0312
0.1524
0.3361
0.5197
0.7034
0.8870
1.0707
Wavenumber (cm-1)
3800.0
3400.0
3000.0
2600.0
2200.0
1800.0
1400.0
1000.0
600.00

Figure 67.

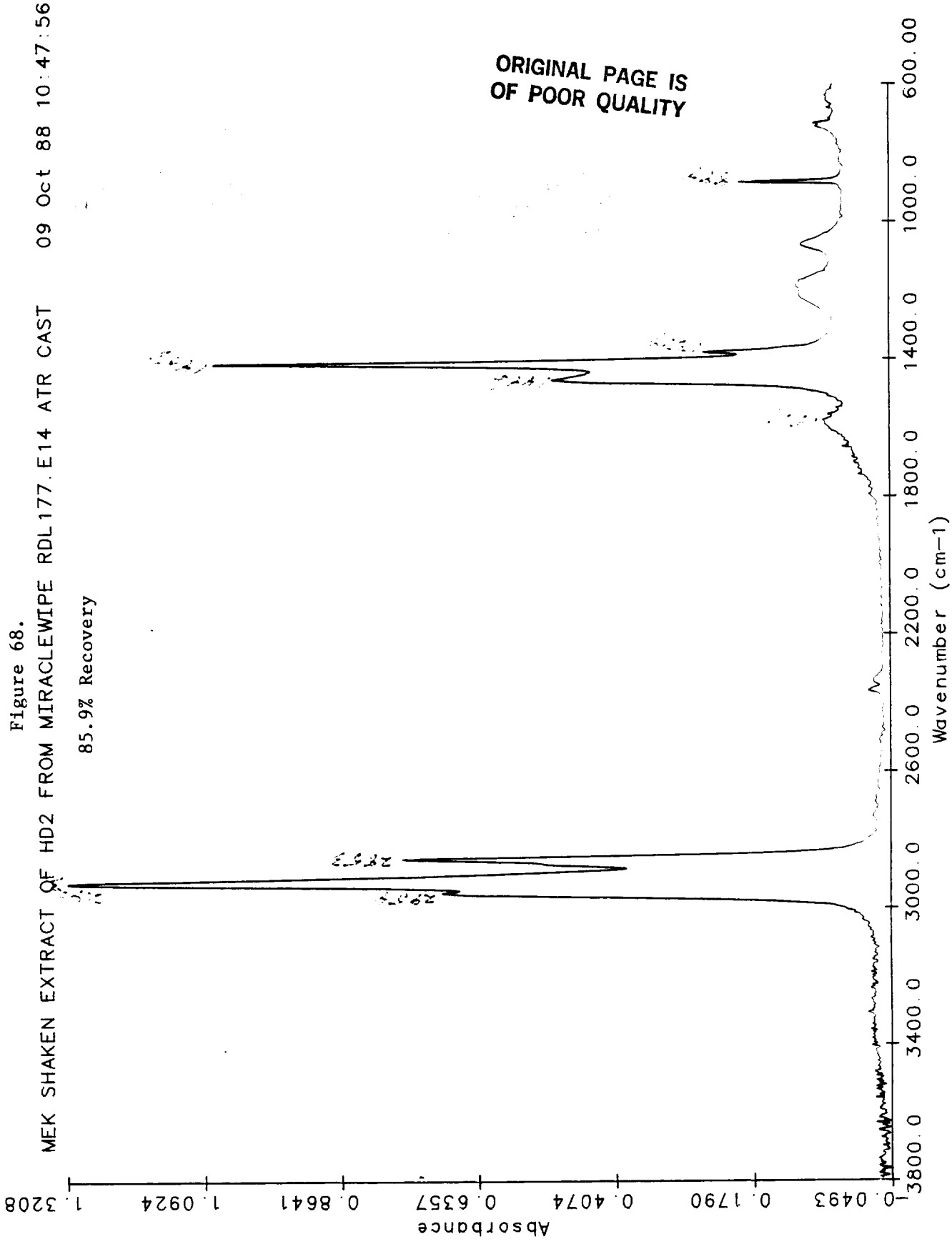
ORIGINAL PAGE IS
OF POOR QUALITY
MEK SHAKEN EXTRACT OF HD2 FROM MIRACLEWIPE RDL177.E14 ATR CAST 09 Oct 88 10:47:56
85.9% Recovery
Absorbance
0.0493
0.1790
0.4074
0.6357
0.8641
1.0924
1.3208
Wavenumber (cm-1)
3800.0
3400.0
3000.0
2600.0
2200.0
1800.0
1400.0
1000.0
600.00

Figure 68.

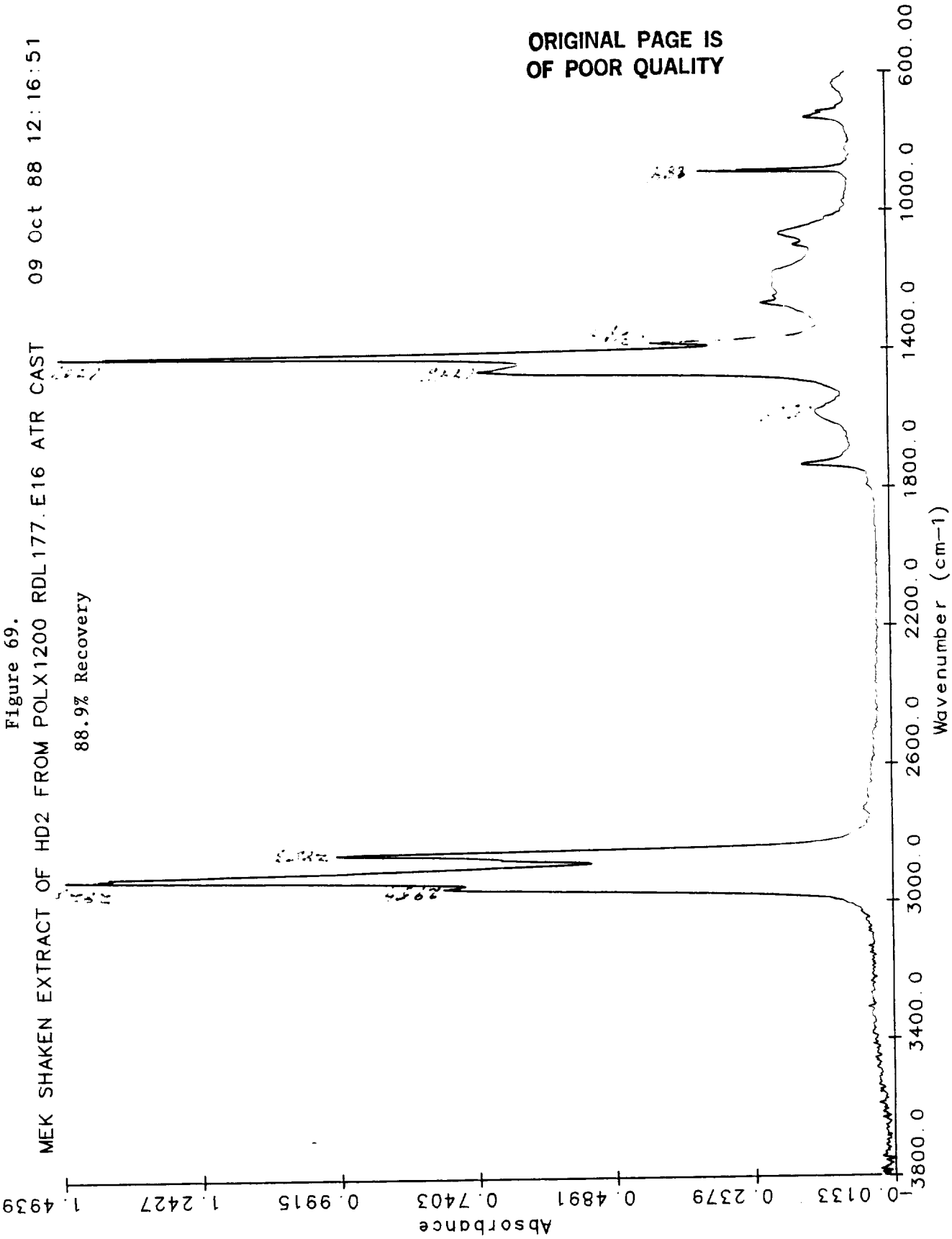

Figure 69.

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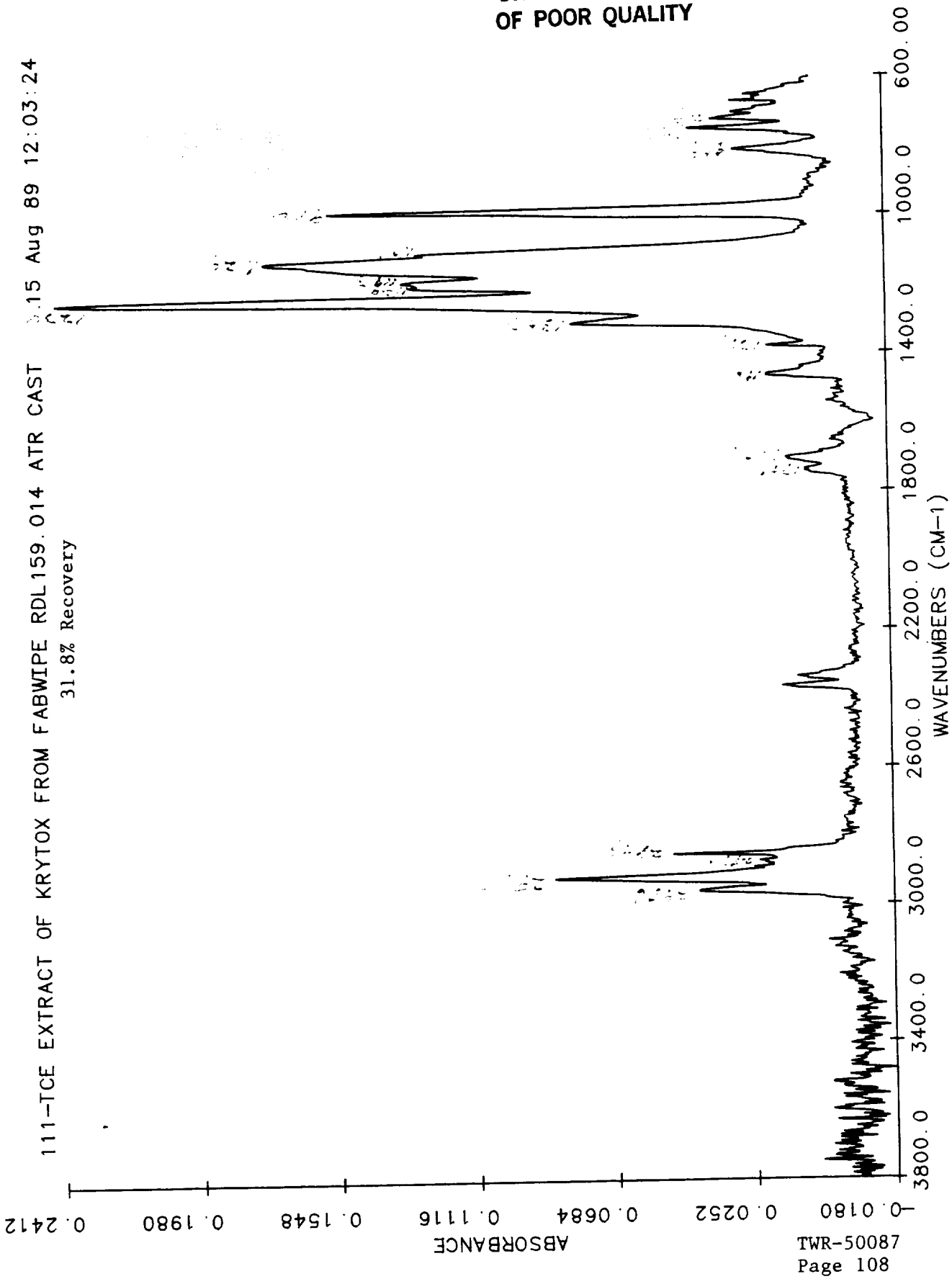


Figure 70.

Figure 71.

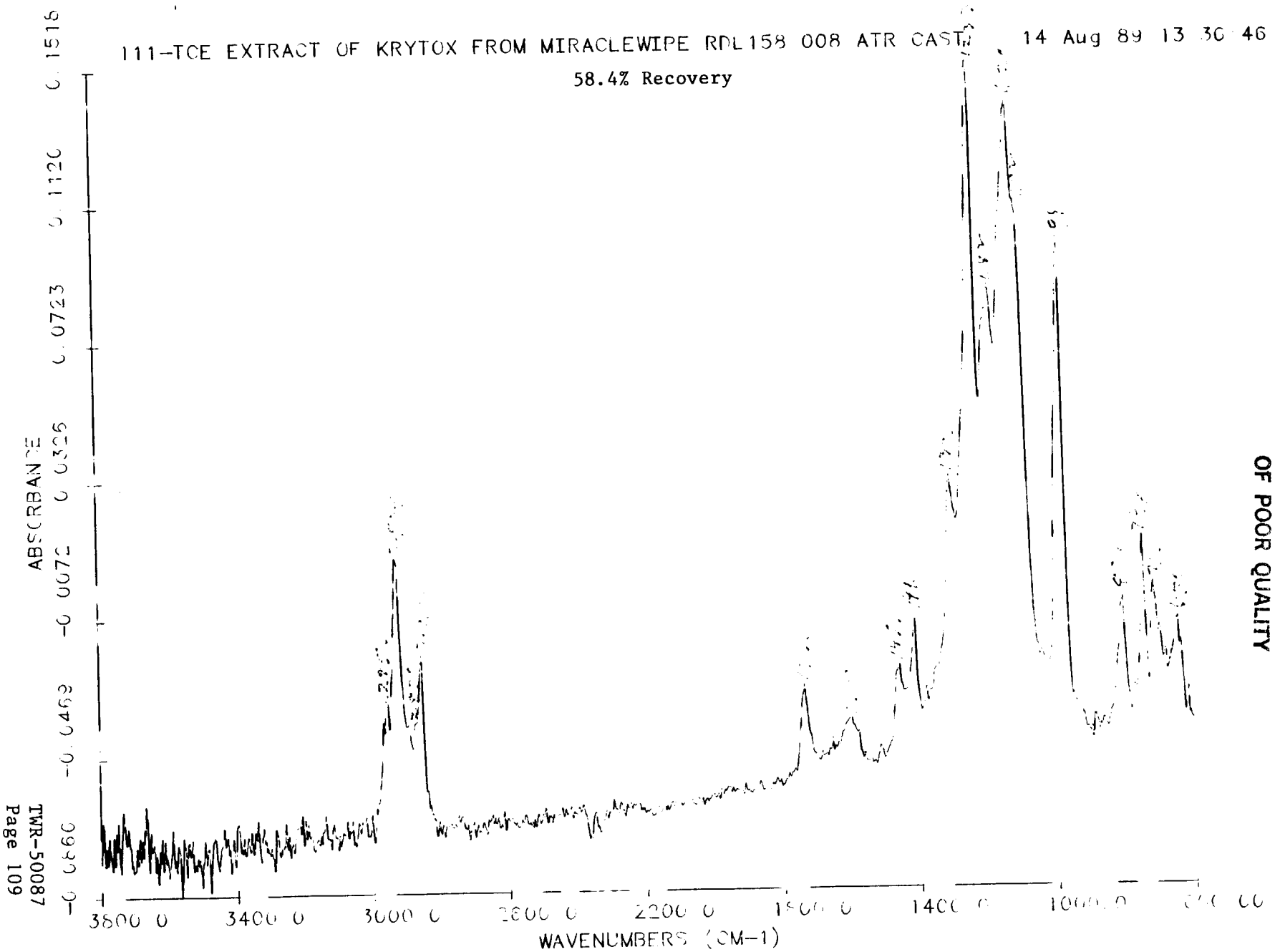
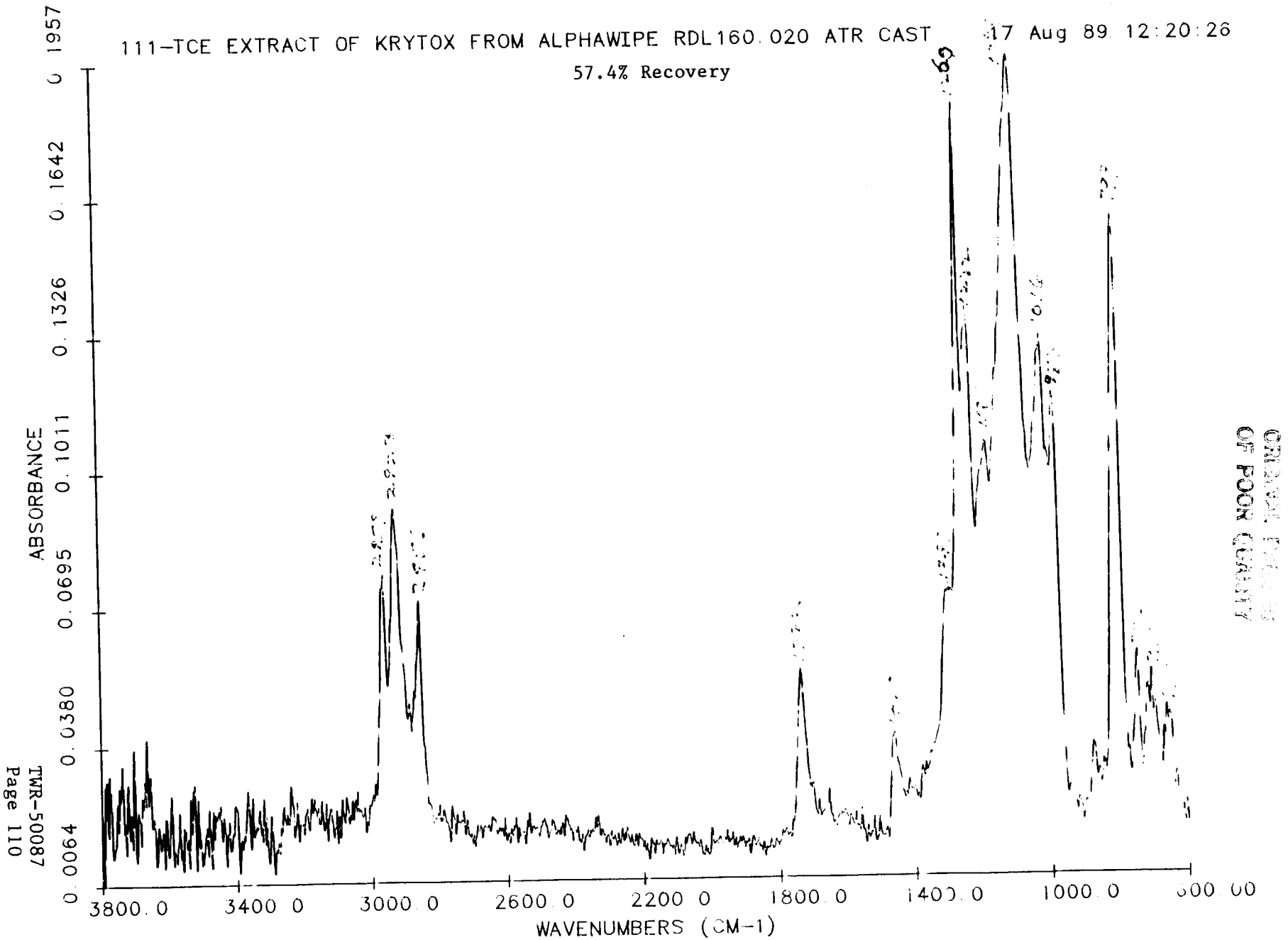


Figure 72.


111-TCE EXTRACT OF KRYTOX FROM ALPHAWIPE RDL160.020 ATR CAST
17 Aug 89 12:20:26
57.4% Recovery
ABSORBANCE
0.1957
0.1642
0.1326
0.1011
0.0695
0.0380
0.0064
3800.0
3400.0
3000.0
2600.0
2200.0
1800.0
1400.0
1000.0
WAVENUMBERS (CM-1)
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ORIGINAL PAGE IS
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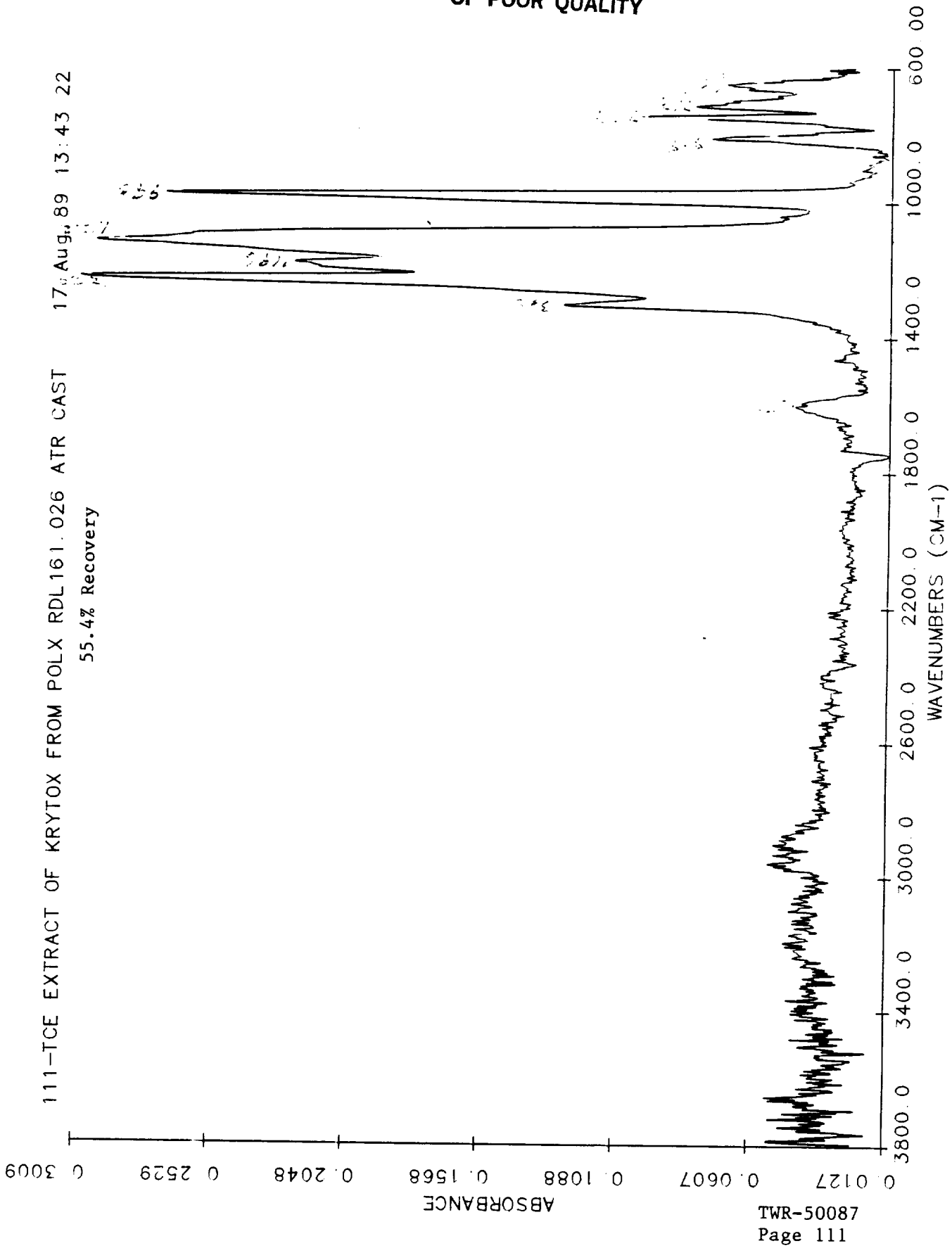

Figure 73.

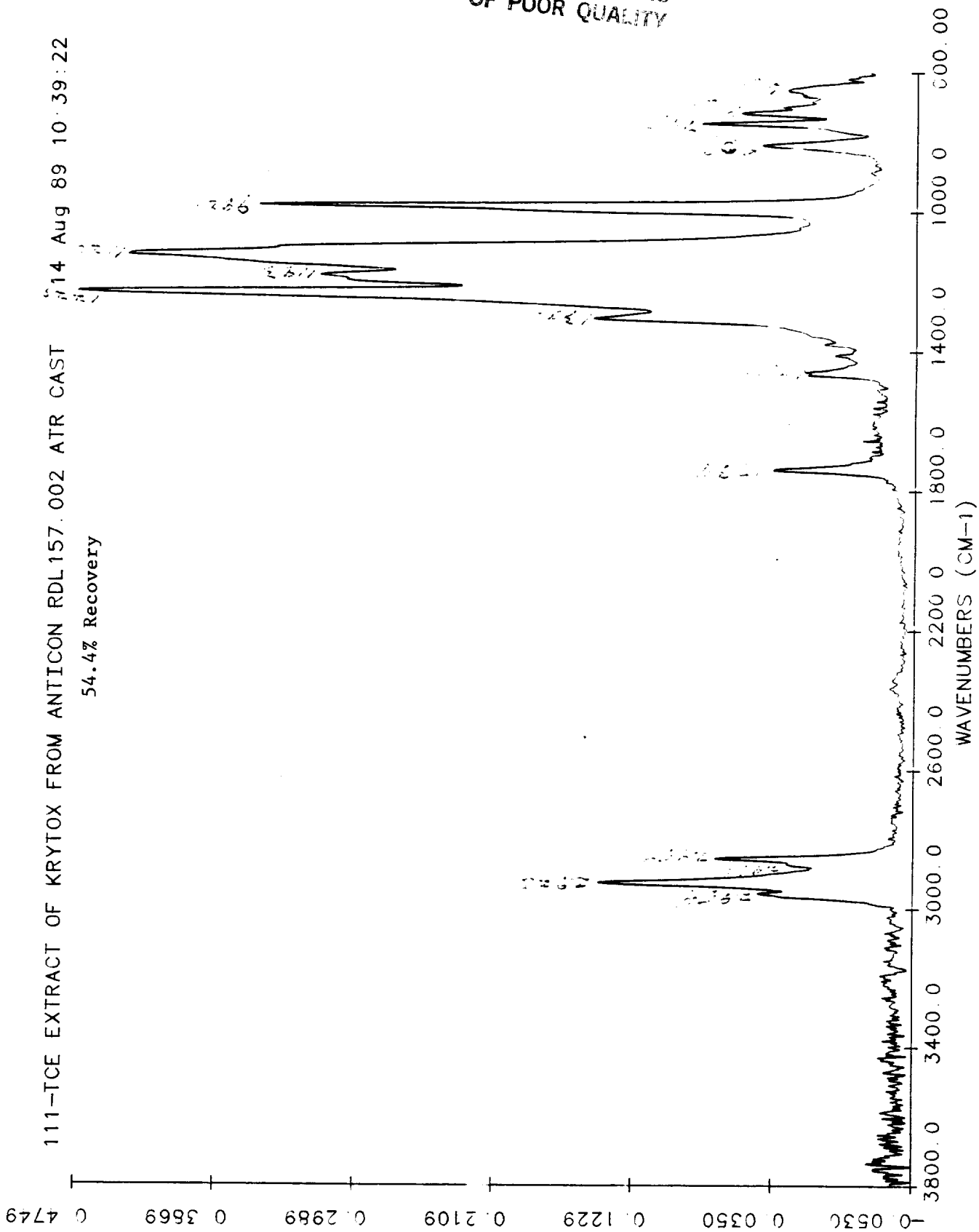

Figure 74.

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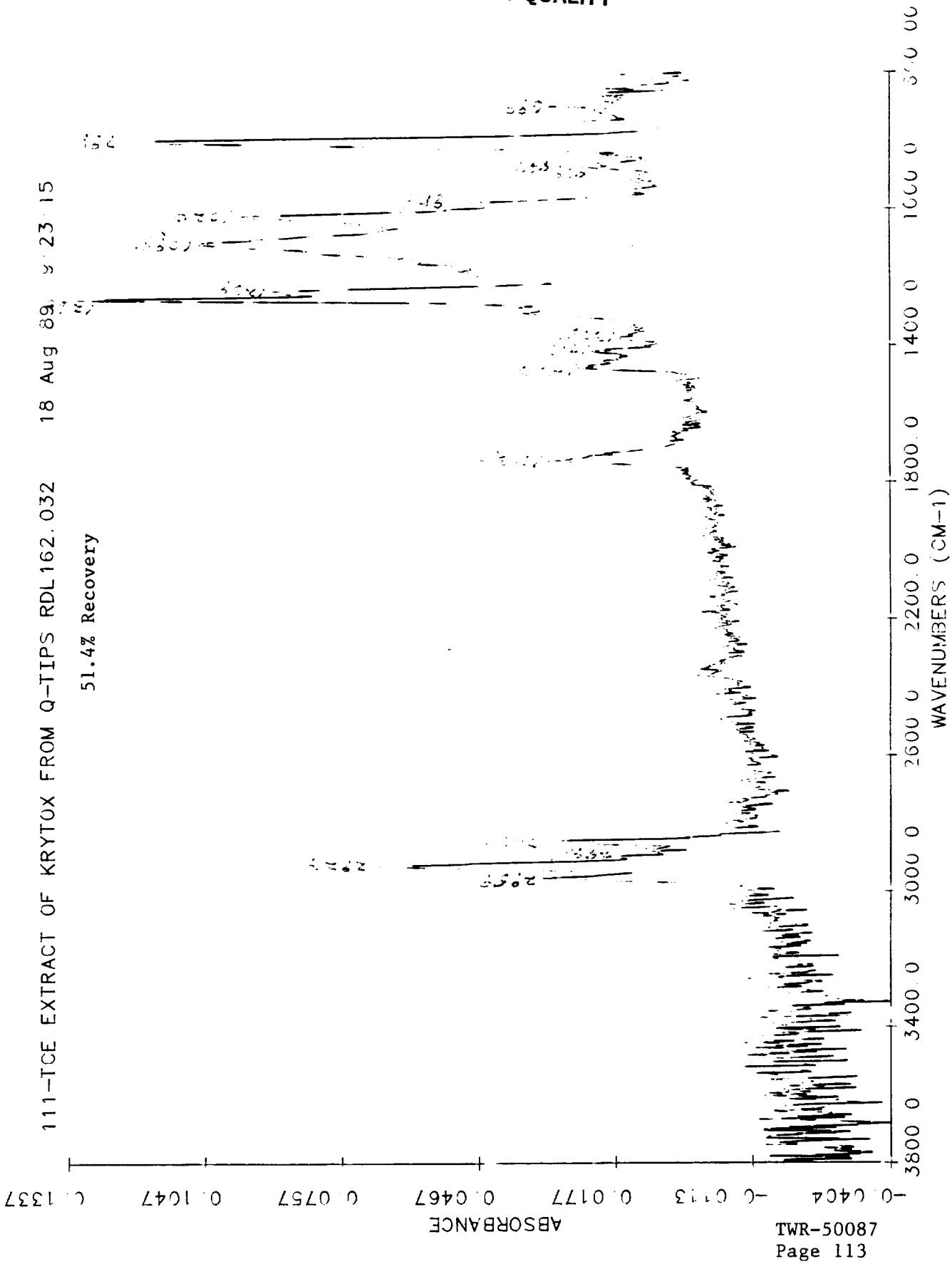

Figure 75.

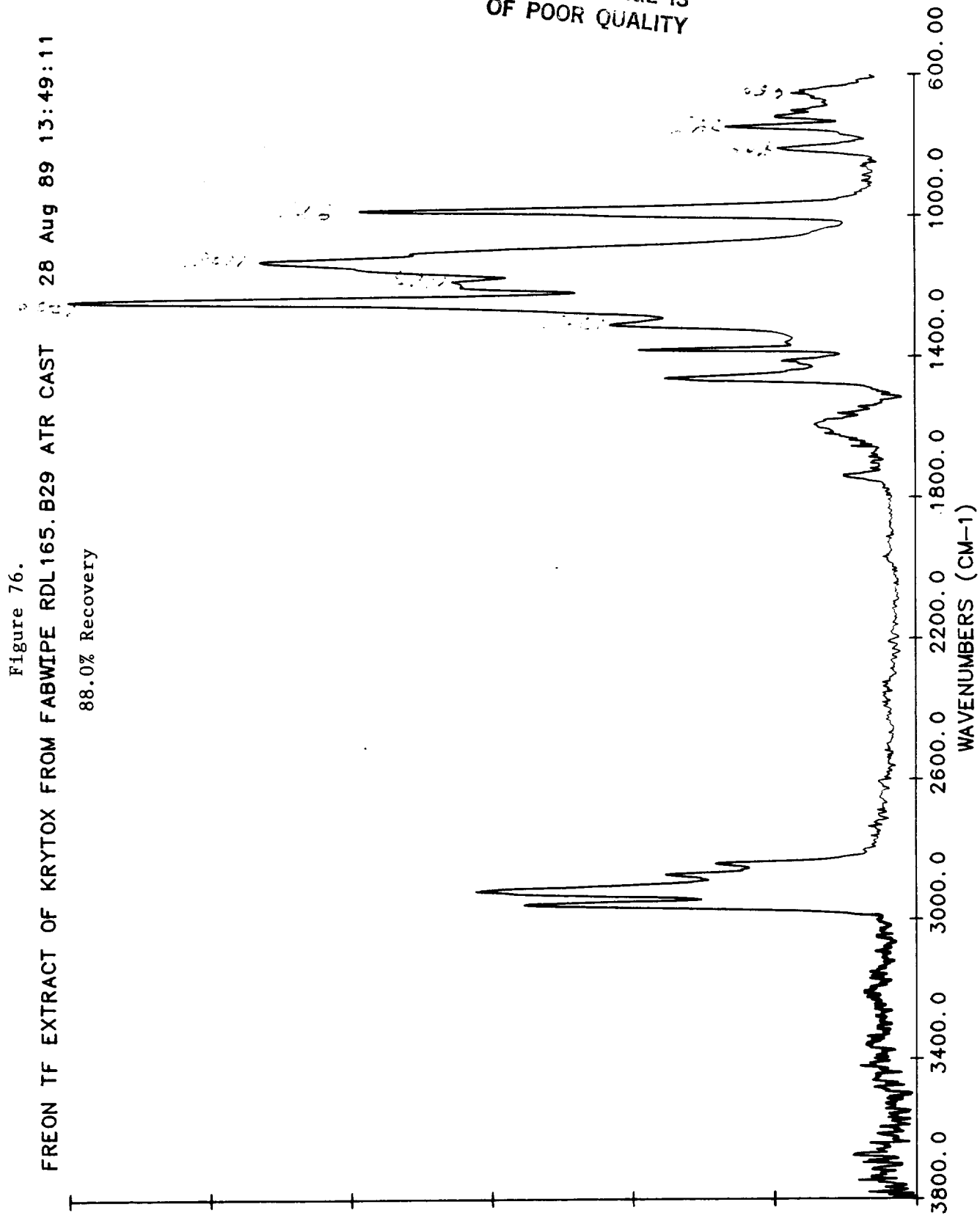

Figure 76.

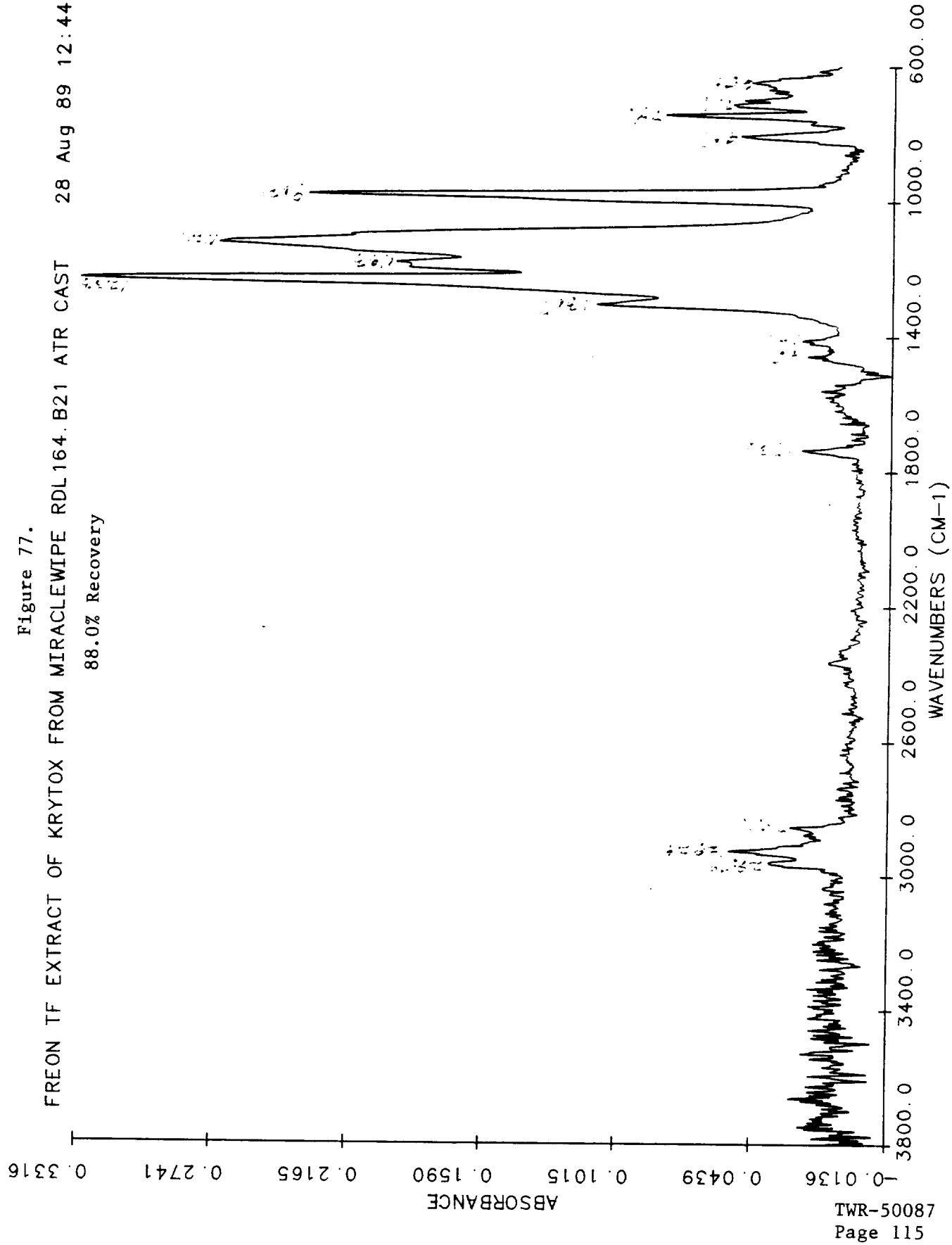

Figure 77.

Figure 78.

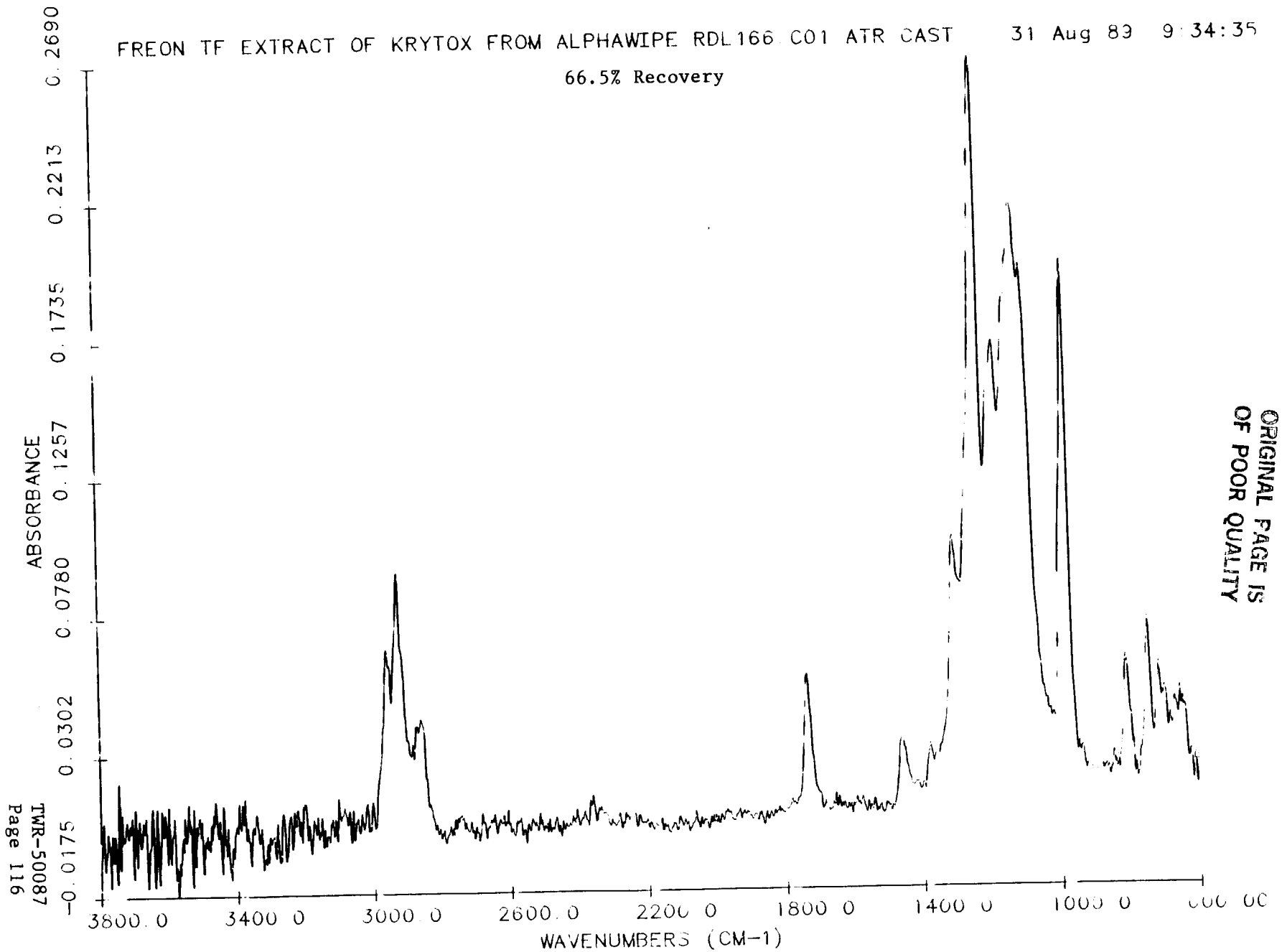
FREON TF EXTRACT OF KRYTOX FROM ALPHAWIPE RDL166 C01 ATR CAST 31 Aug 89 9:34:35
66.5% Recovery
ABSORBANCE
0.2690
0.2213
0.1735
0.1257
0.0780
0.0302
-0.0175
3800.0
3400.0
3000.0
2600.0
2200.0
1800.0
1400.0
1000.0
WAVENUMBERS (CM-1)
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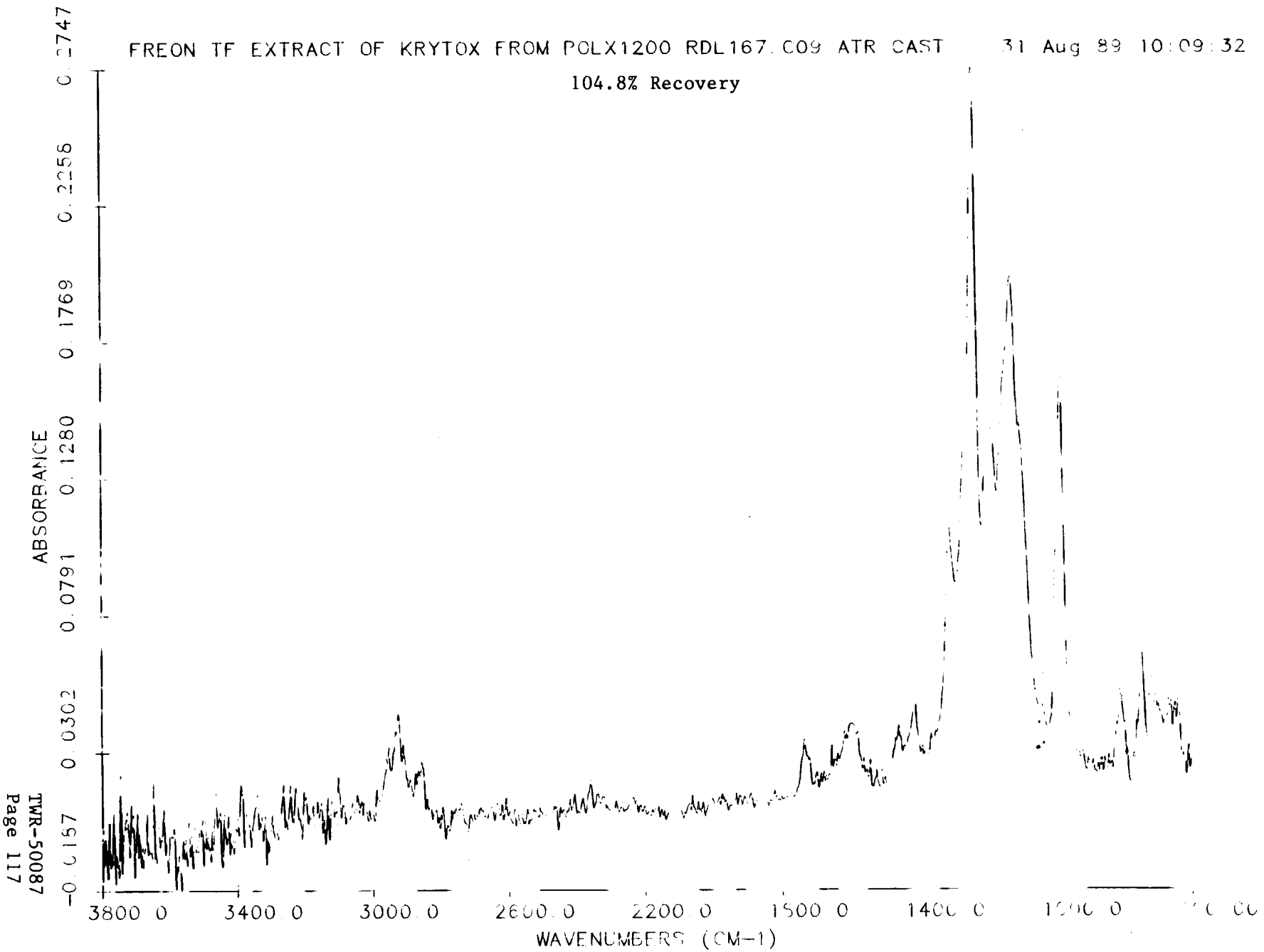
Figure 79.



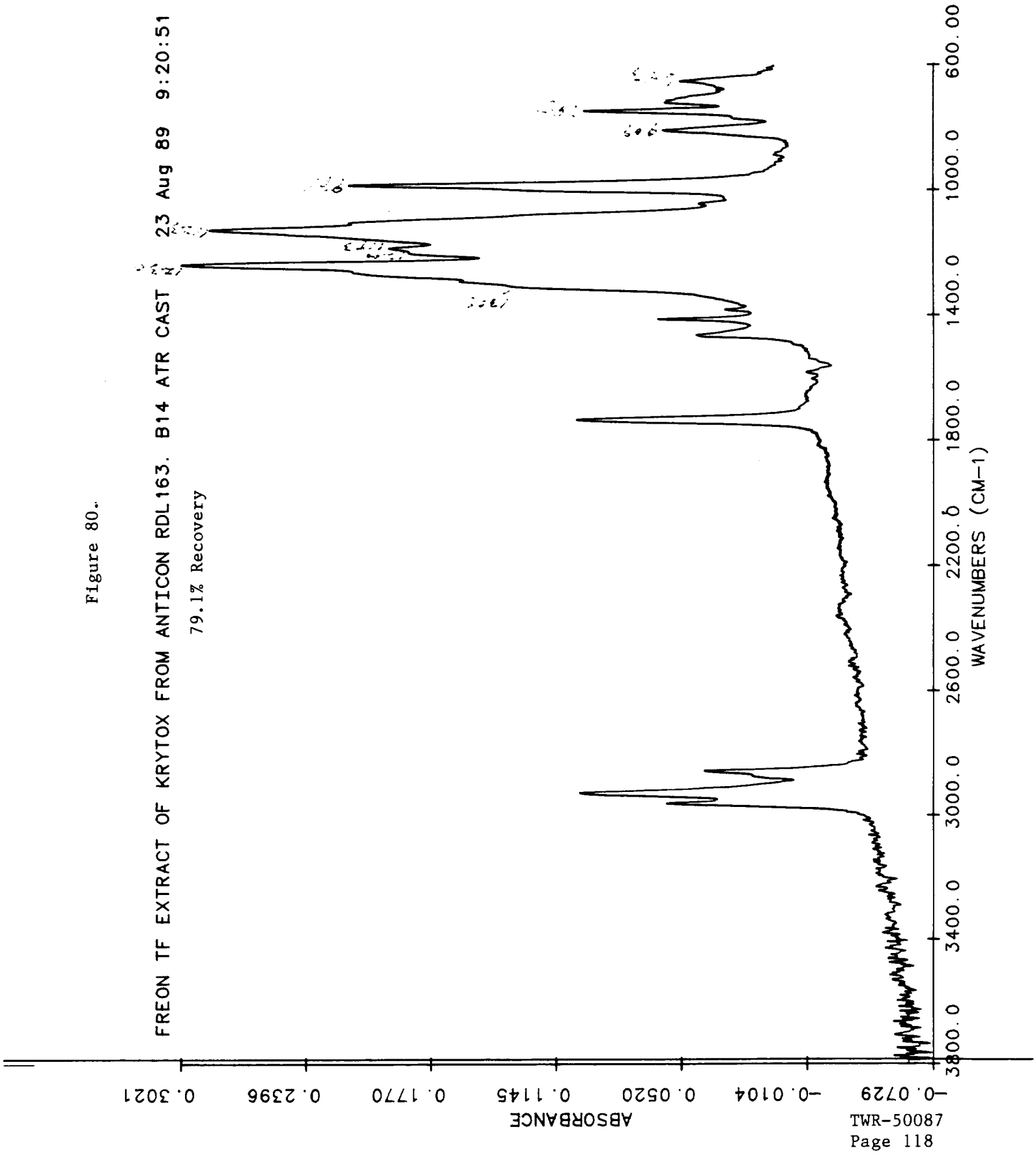


Figure 80.

Figure 81.

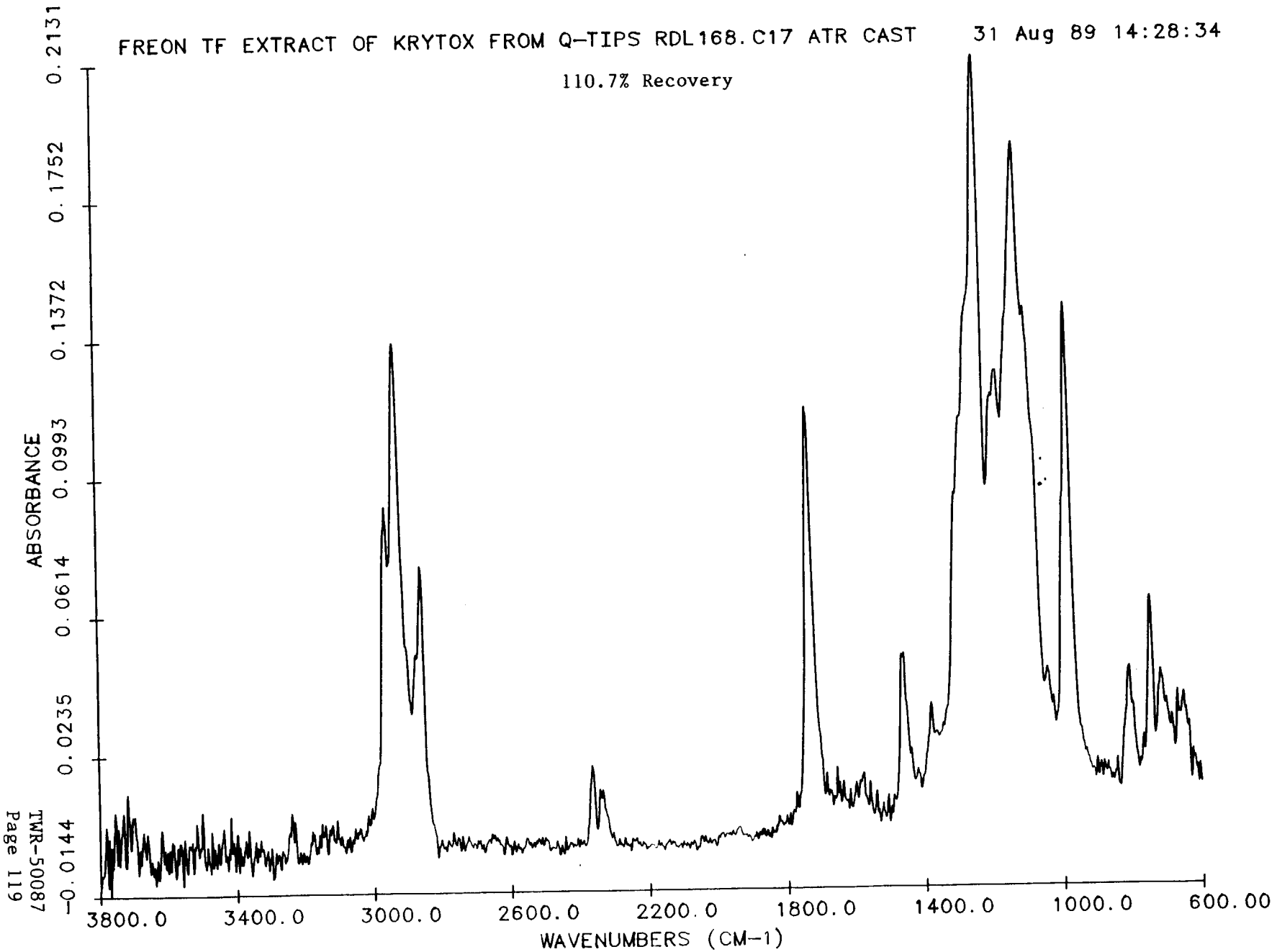

FREON TF EXTRACT OF KRYTOX FROM Q-TIPS RDL168.C17 ATR CAST
31 Aug 89 14:28:34
110.7% Recovery
ABSORBANCE
0.2131
0.1752
0.1372
0.0993
0.0614
0.0235
-0.0144
3800.0
3400.0
3000.0
2600.0
2200.0
1800.0
1400.0
1000.0
600.00
WAVENUMBERS (CM-1)

Figure 82.

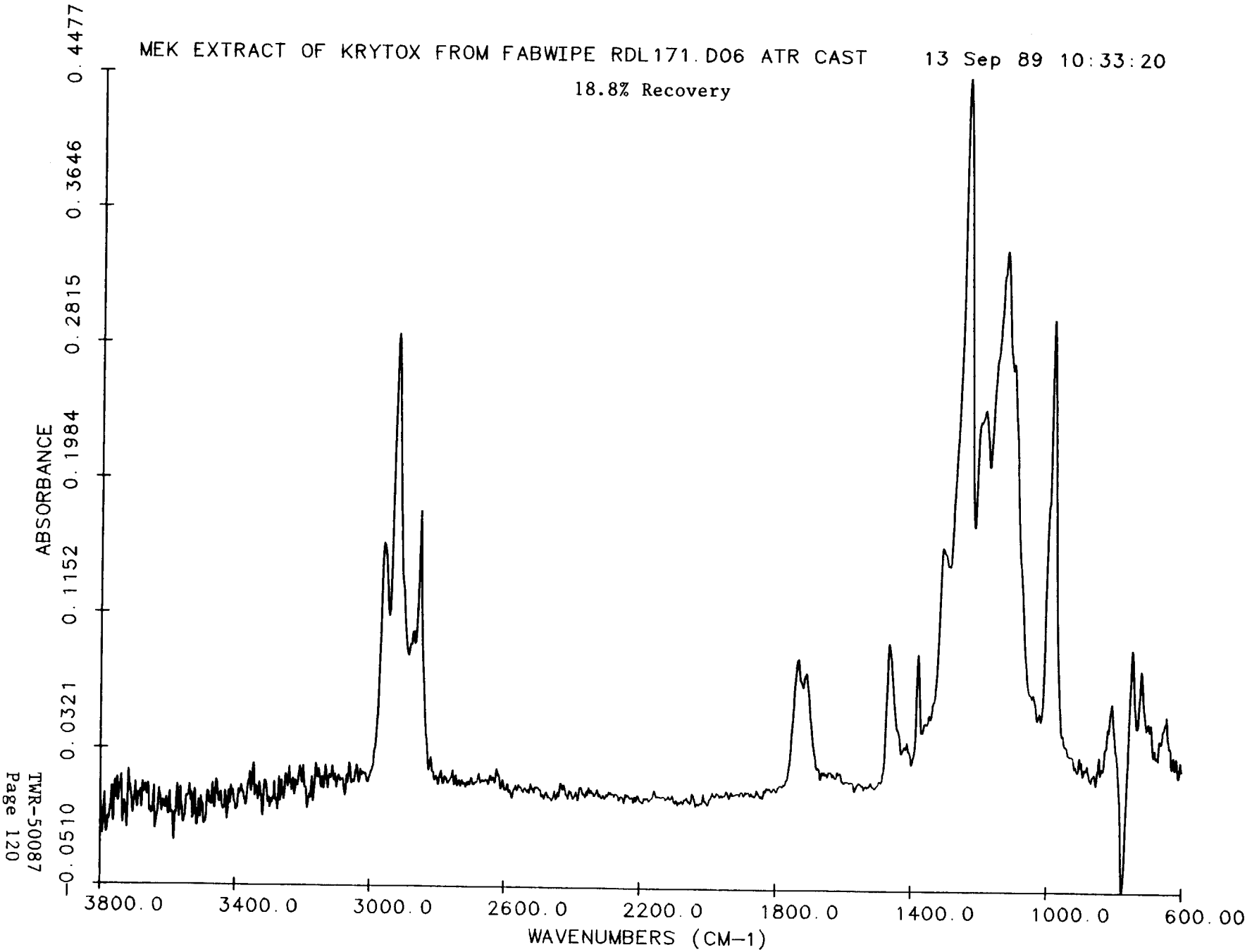

MEK EXTRACT OF KRYTOX FROM FABWIPE RDL171.D06 ATR CAST
13 Sep 89 10:33:20
18.8% Recovery
ABSORBANCE
0.4477
0.3646
0.2815
0.1984
0.1152
0.0321
-0.0510
3800.0
3400.0
3000.0
2600.0
2200.0
1800.0
1400.0
1000.0
600.00
WAVENUMBERS (CM-1)

Figure 83.

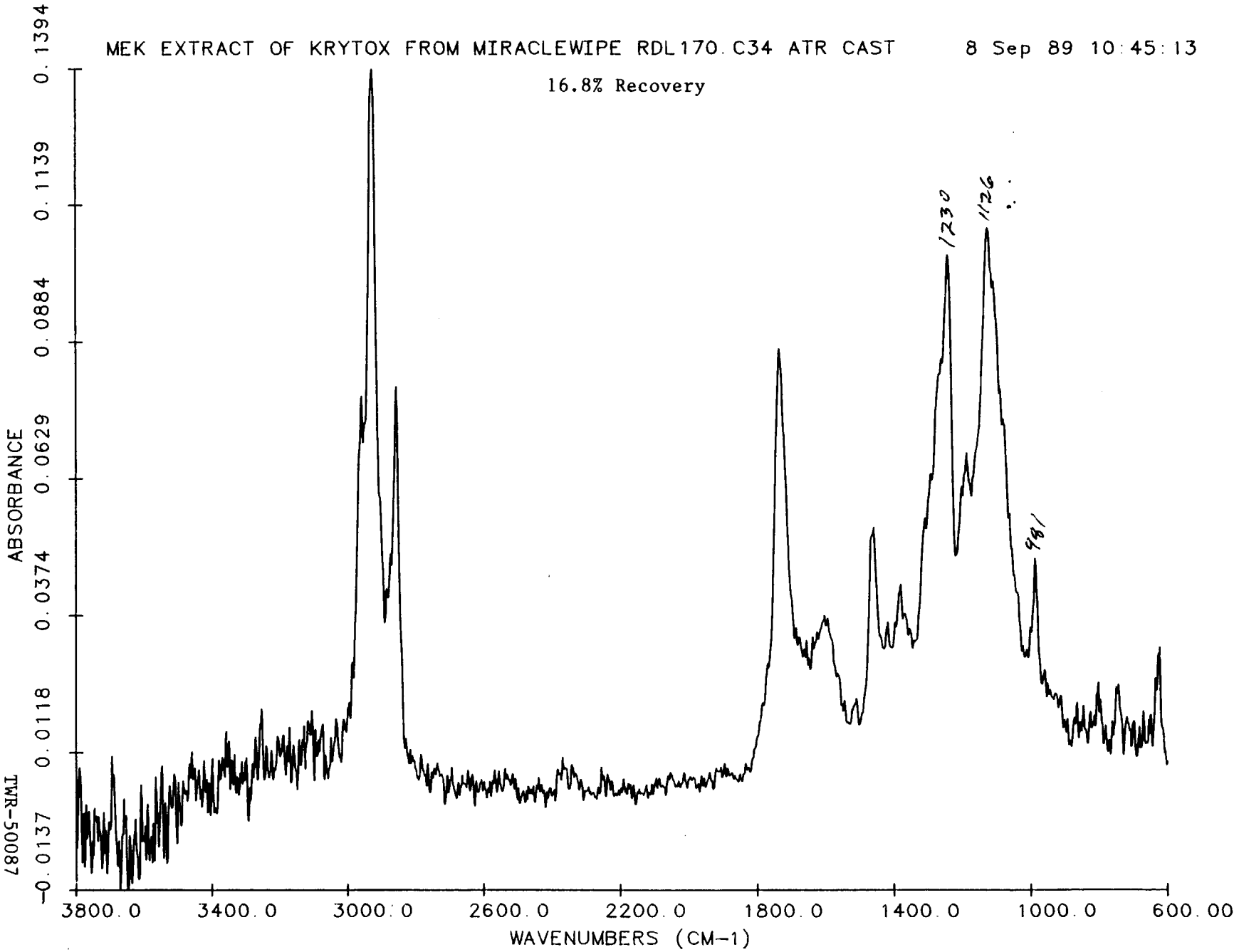

MEK EXTRACT OF KRYTOX FROM MIRACLEWIPE RDL170.C34 ATR CAST
8 Sep 89 10:45:13
16.8% Recovery
ABSORBANCE
0.1394
0.1139
0.0884
0.0629
0.0374
0.0118
-0.0137
3800.0
3400.0
3000.0
2600.0
2200.0
1800.0
1400.0
1000.0
600.00
WAVENUMBERS (CM-1)
1230
1126
981

Figure 84.

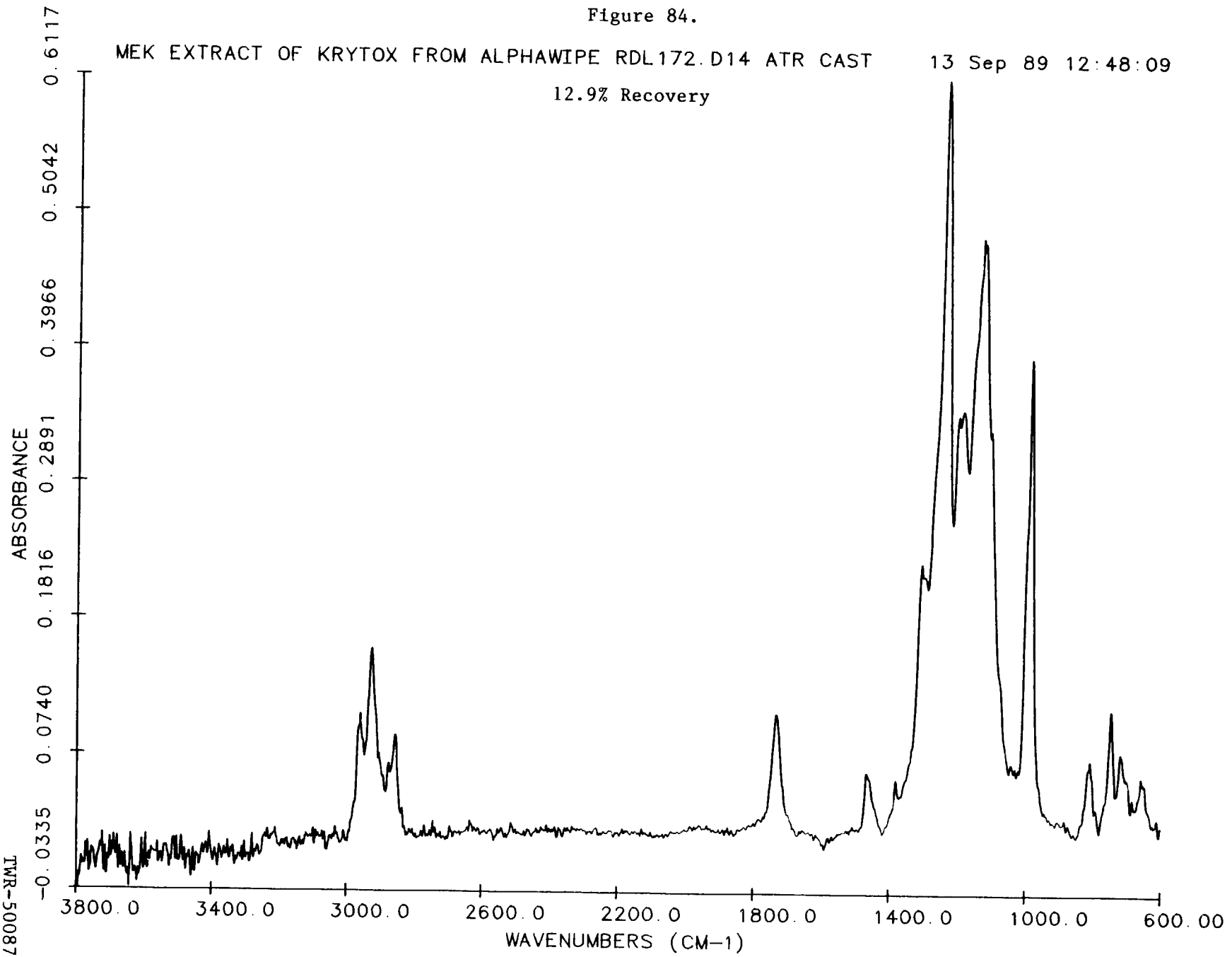

MEK EXTRACT OF KRYTOX FROM ALPHAWIPE RDL172.D14 ATR CAST
13 Sep 89 12:48:09
12.9% Recovery
ABSORBANCE
0.6117
0.5042
0.3966
0.2891
0.1816
0.0740
-0.0335
3800.0
3400.0
3000.0
2600.0
2200.0
1800.0
1400.0
1000.0
600.00
WAVENUMBERS (CM-1)

Figure 85.

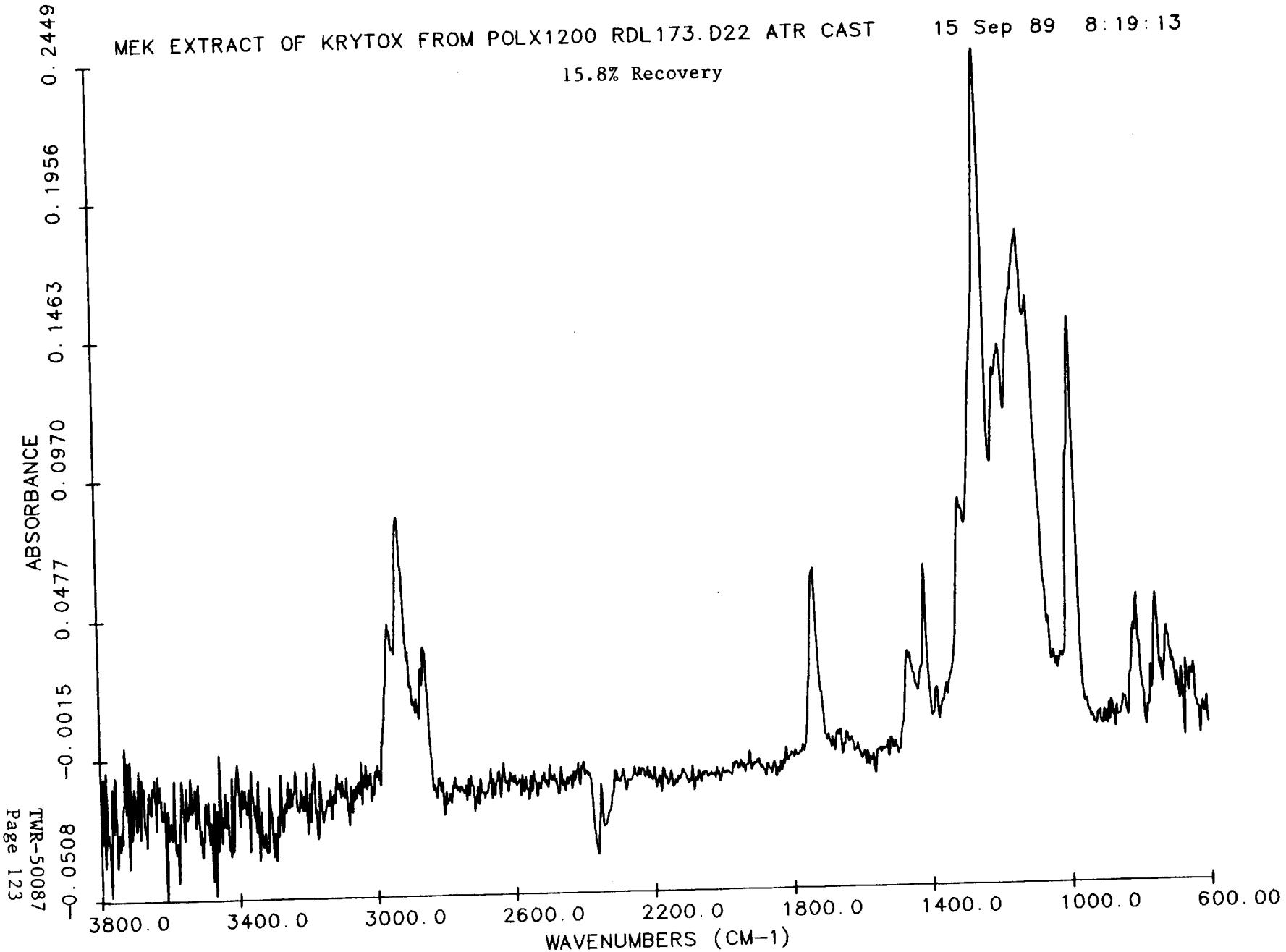

MEK EXTRACT OF KRYTOX FROM POLX1200 RDL173.D22 ATR CAST
15 Sep 89 8:19:13
15.8% Recovery
ABSORBANCE
0.2449
0.1956
0.1463
0.0970
0.0477
-0.0015
-0.0508
3800.0
3400.0
3000.0
2600.0
2200.0
1800.0
1400.0
1000.0
600.00
WAVENUMBERS (CM-1)

Figure 86.

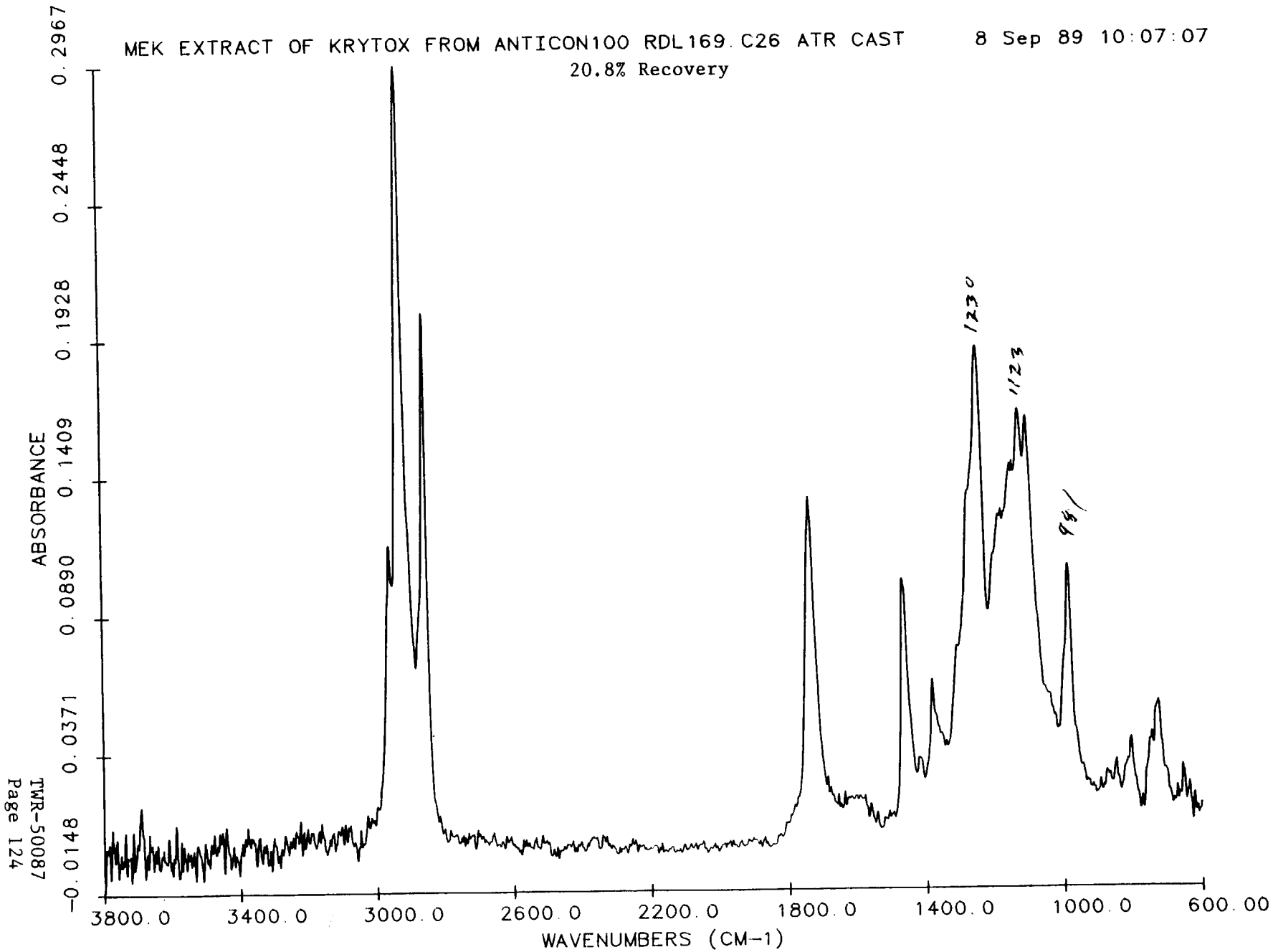
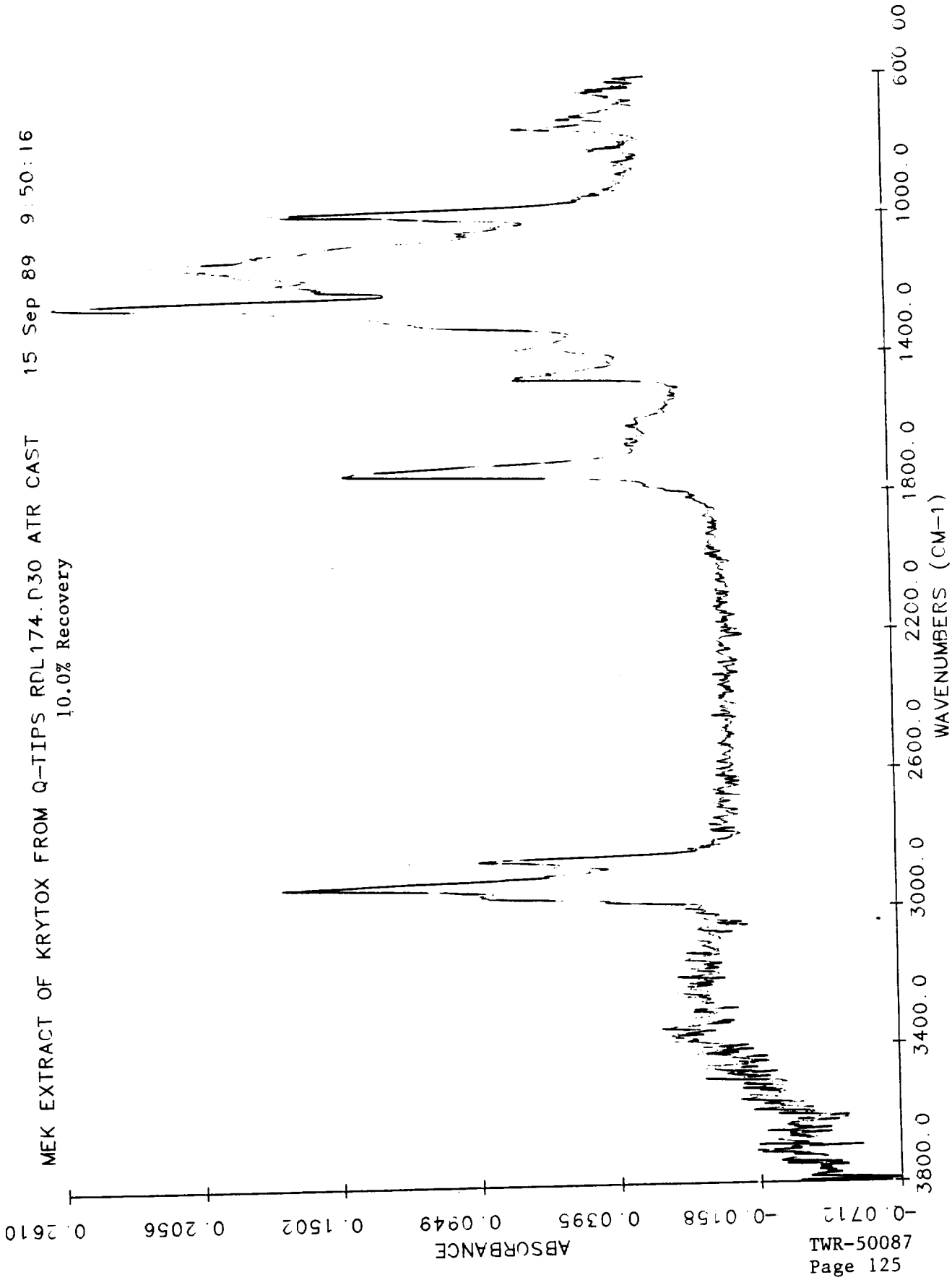

MEK EXTRACT OF KRYTOX FROM ANTICON100 RDL169.C26 ATR CAST
8 Sep 89 10:07:07
20.8% Recovery
ABSORBANCE
0.2967
0.2448
0.1928
0.1409
0.0890
0.0371
-0.0148
3800.0
3400.0
3000.0
2600.0
2200.0
1800.0
1400.0
1000.0
600.00
WAVENUMBERS (CM-1)
1230
1123
968

Figure 87.



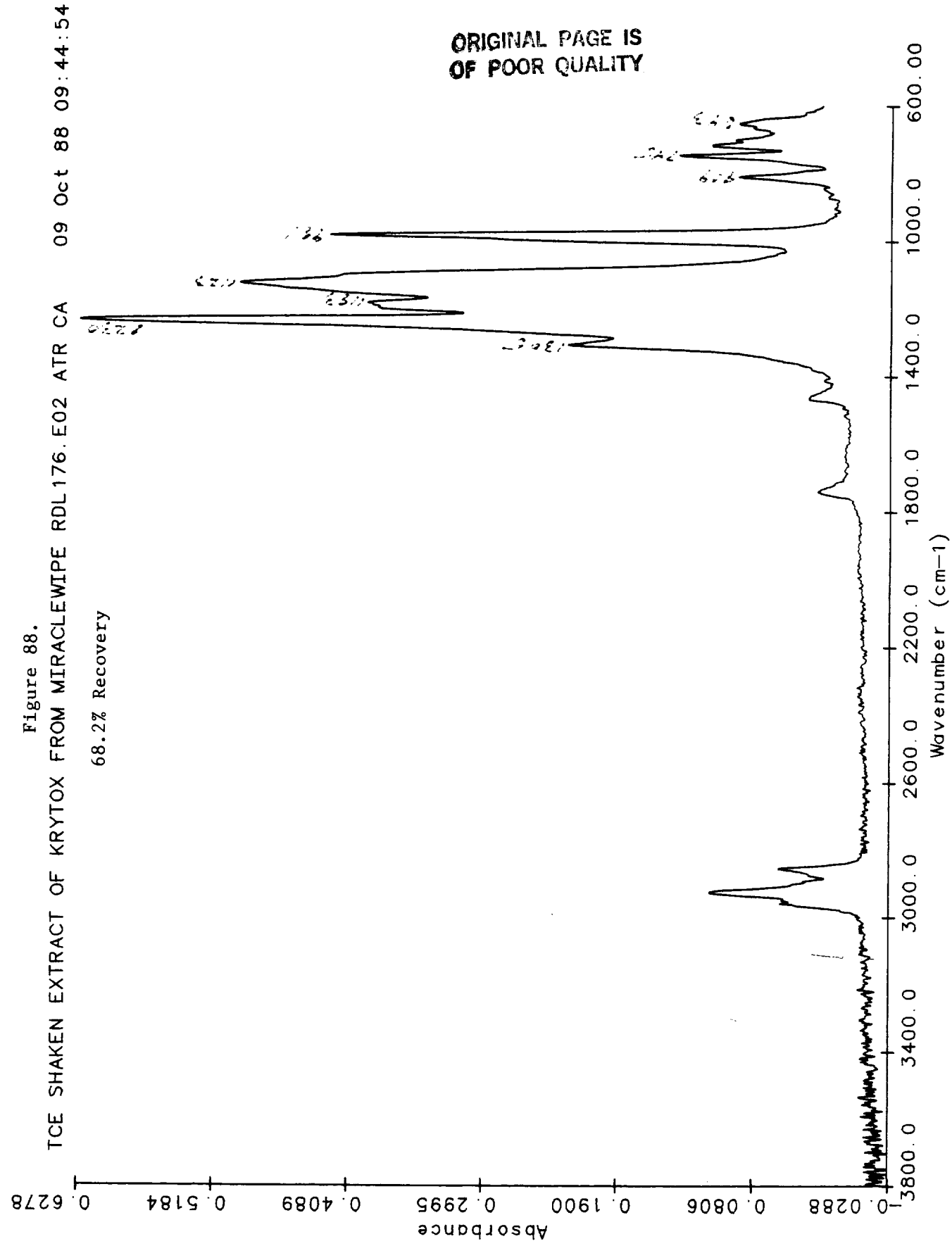


Figure 88.

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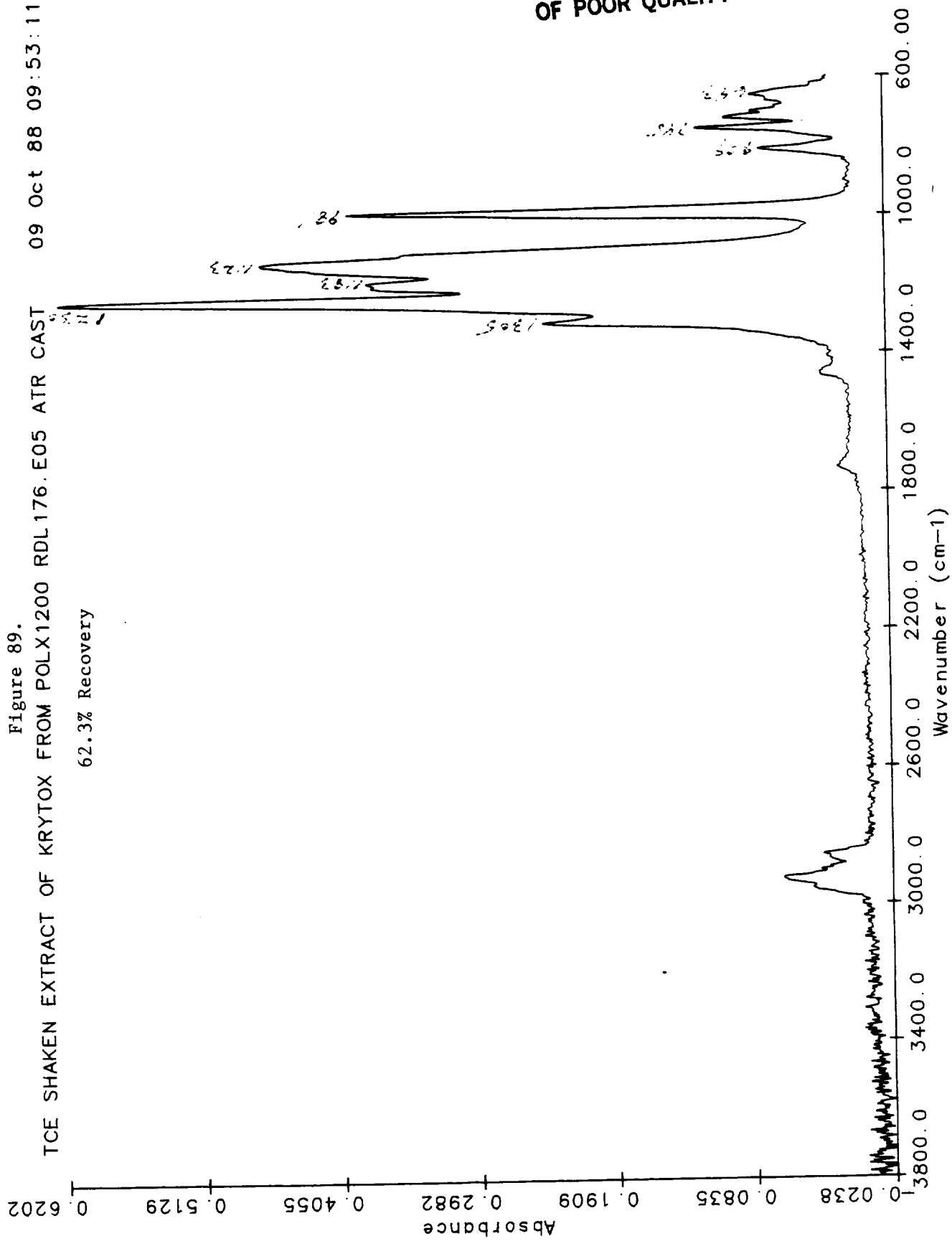

Figure 89.
62.3% Recovery

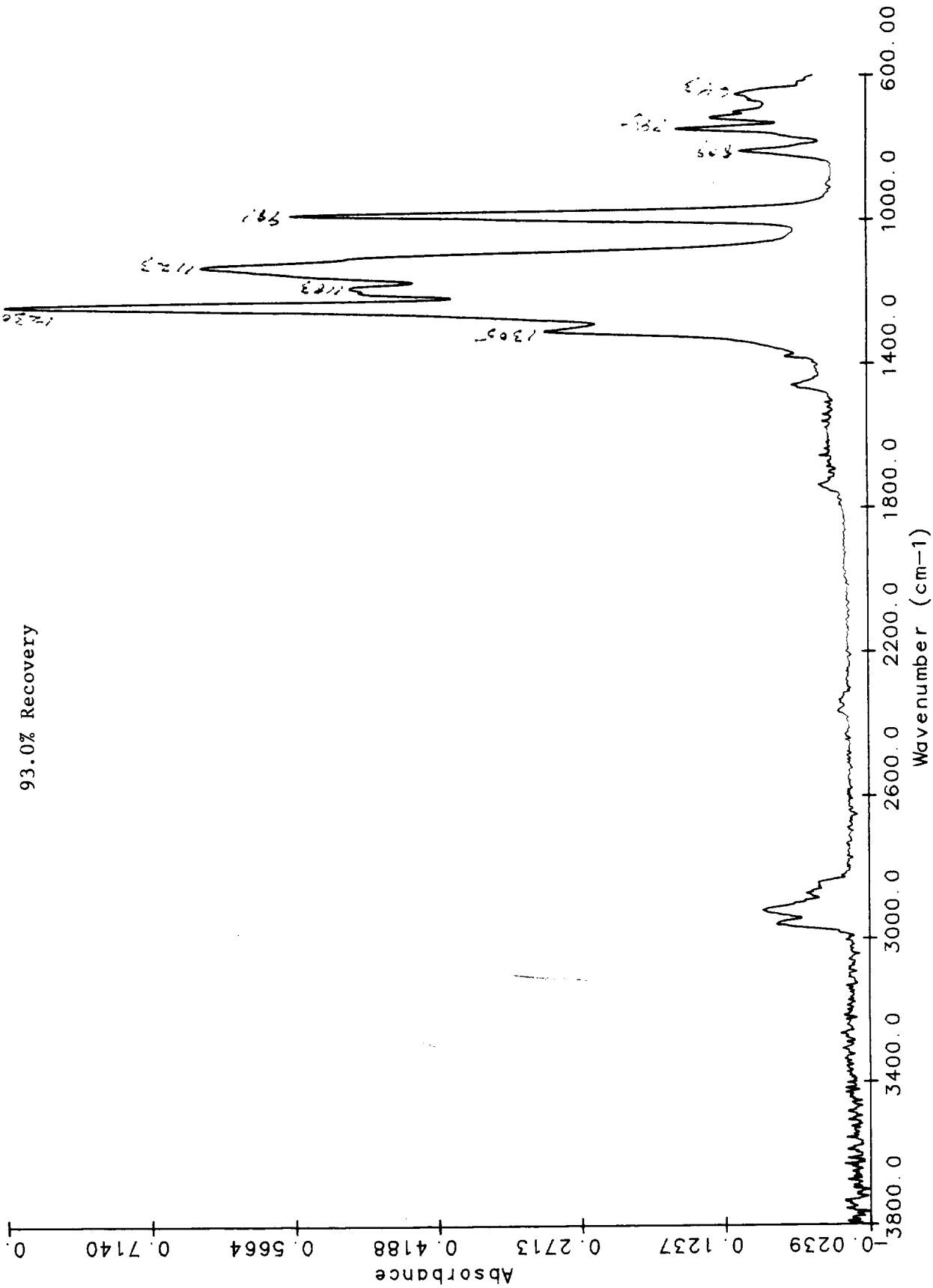

Figure 90.

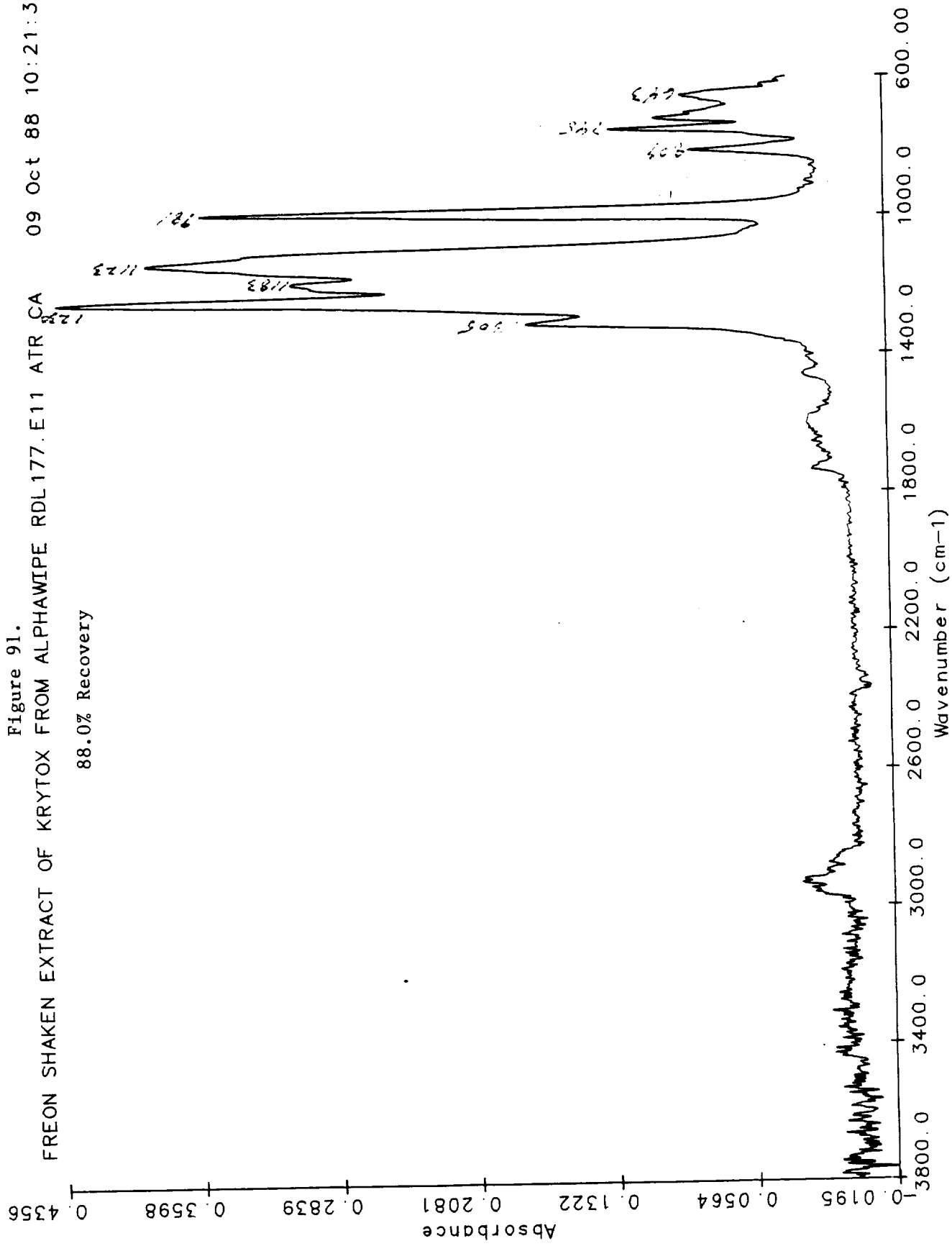

Figure 91.

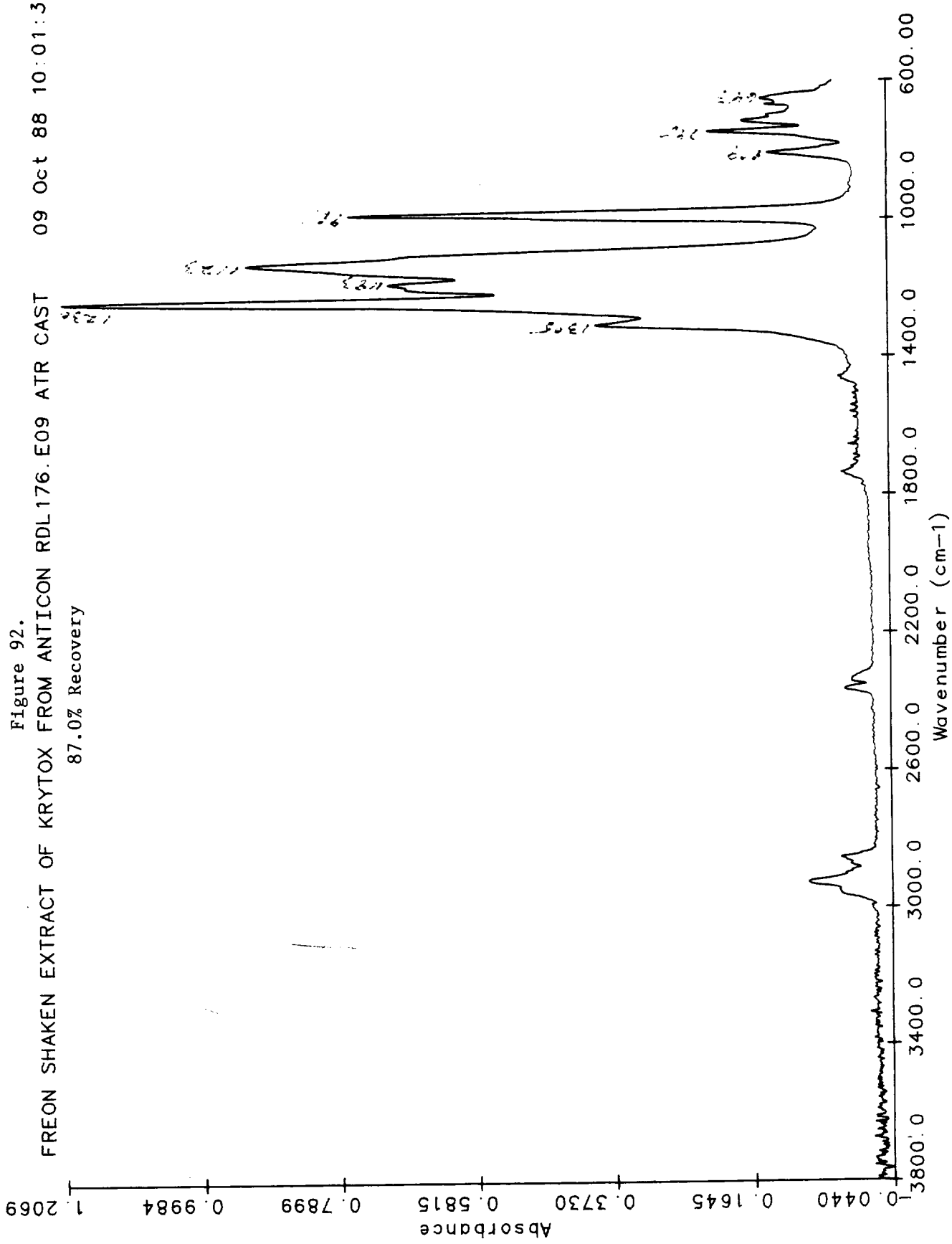

Figure 92.

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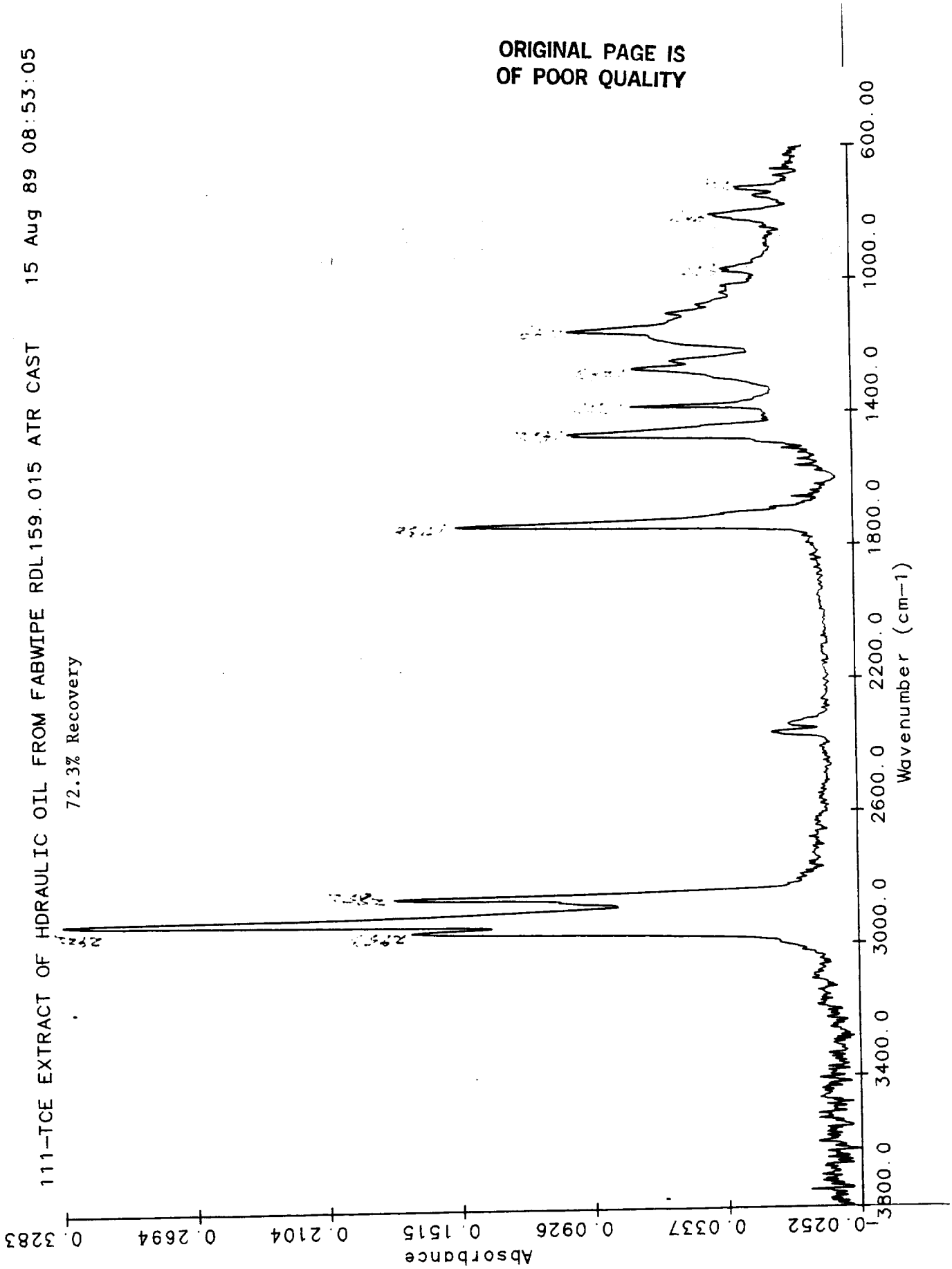
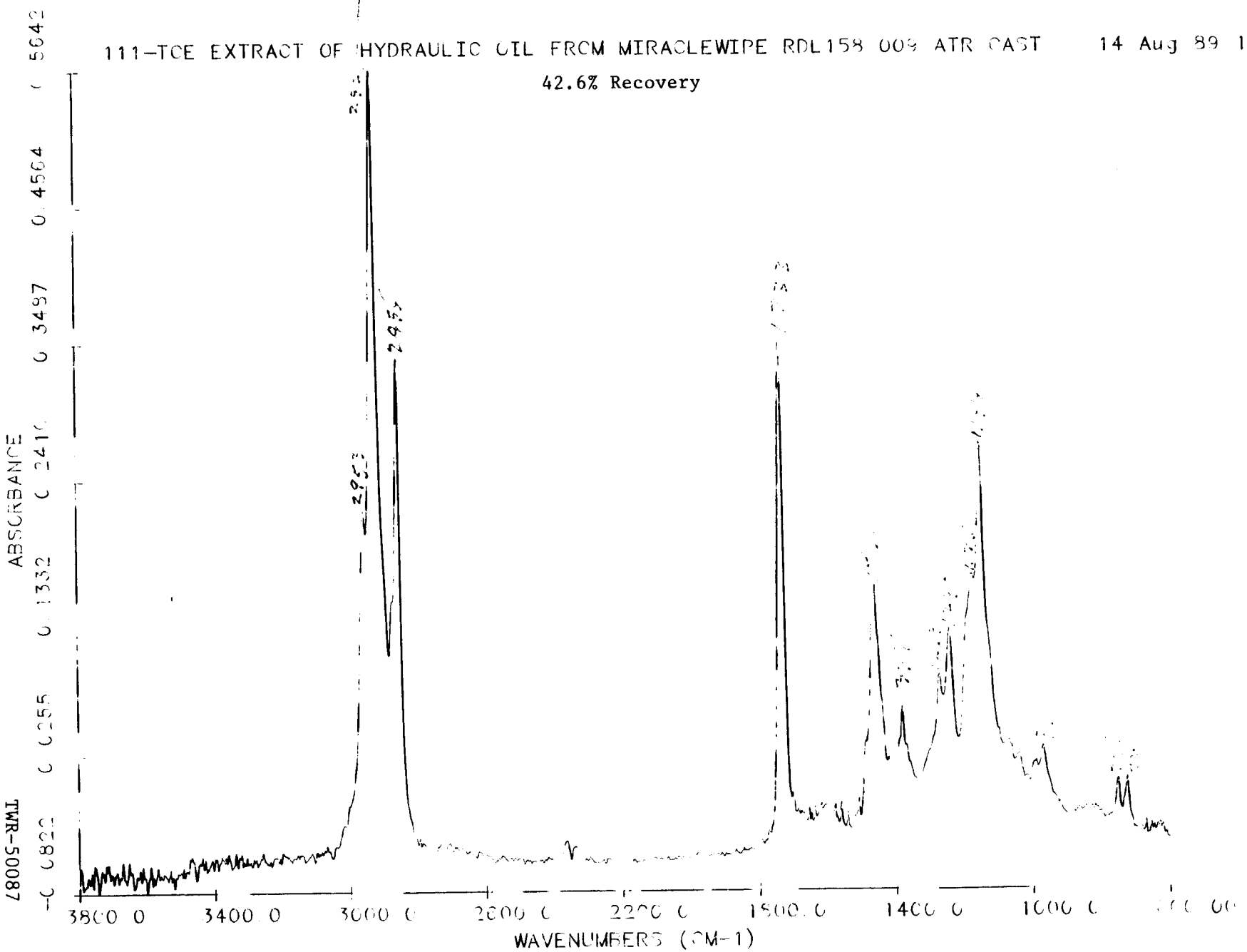


Figure 93.

Figure 94.



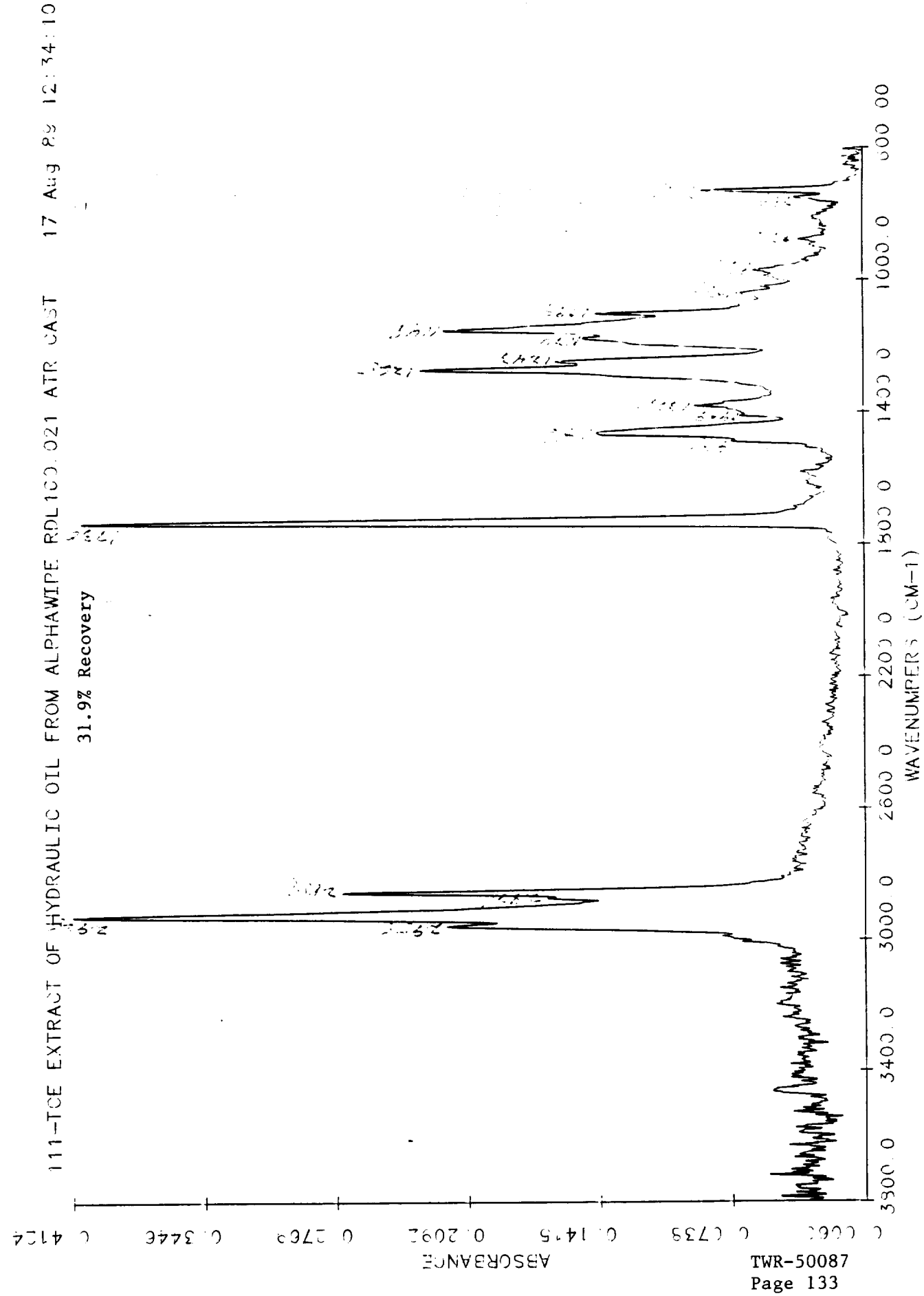
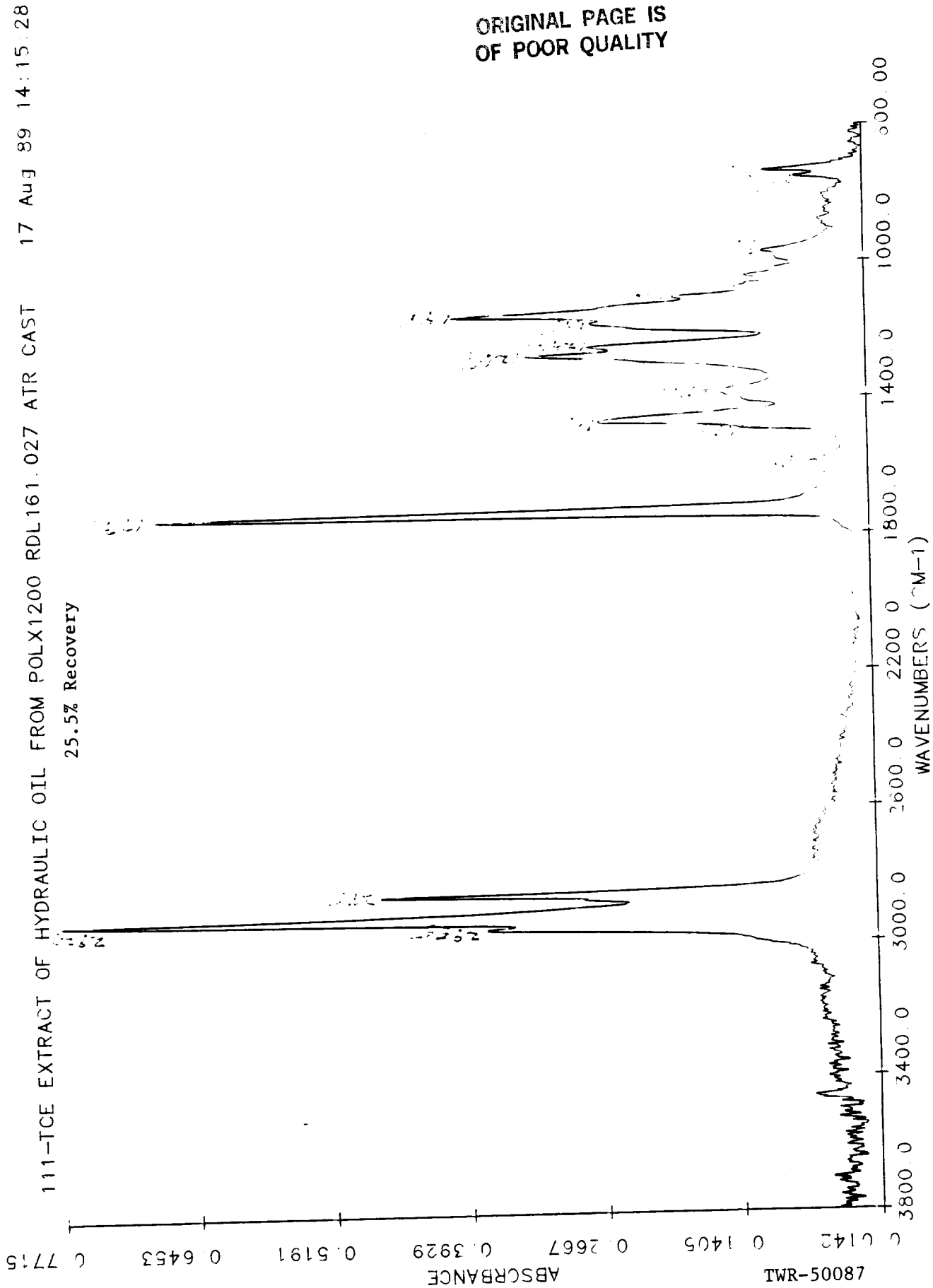


Figure 95.

Figure 96.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OF POOR QUALITY
111-TCE EXTRACT OF HYDRAULIC OIL FROM POLX1200 RDL161.027 ATR CAST 17 Aug 89 14:15:28
25.5% Recovery
ABSORBANCE
0.7715
0.6453
0.5191
0.3929
0.2667
0.1405
0.0142
WAVENUMBERS (CM-1)
3800.0
3400.0
3000.0
2600.0
2200.0
1800.0
1400.0
1000.0
600.00

Figure 97.

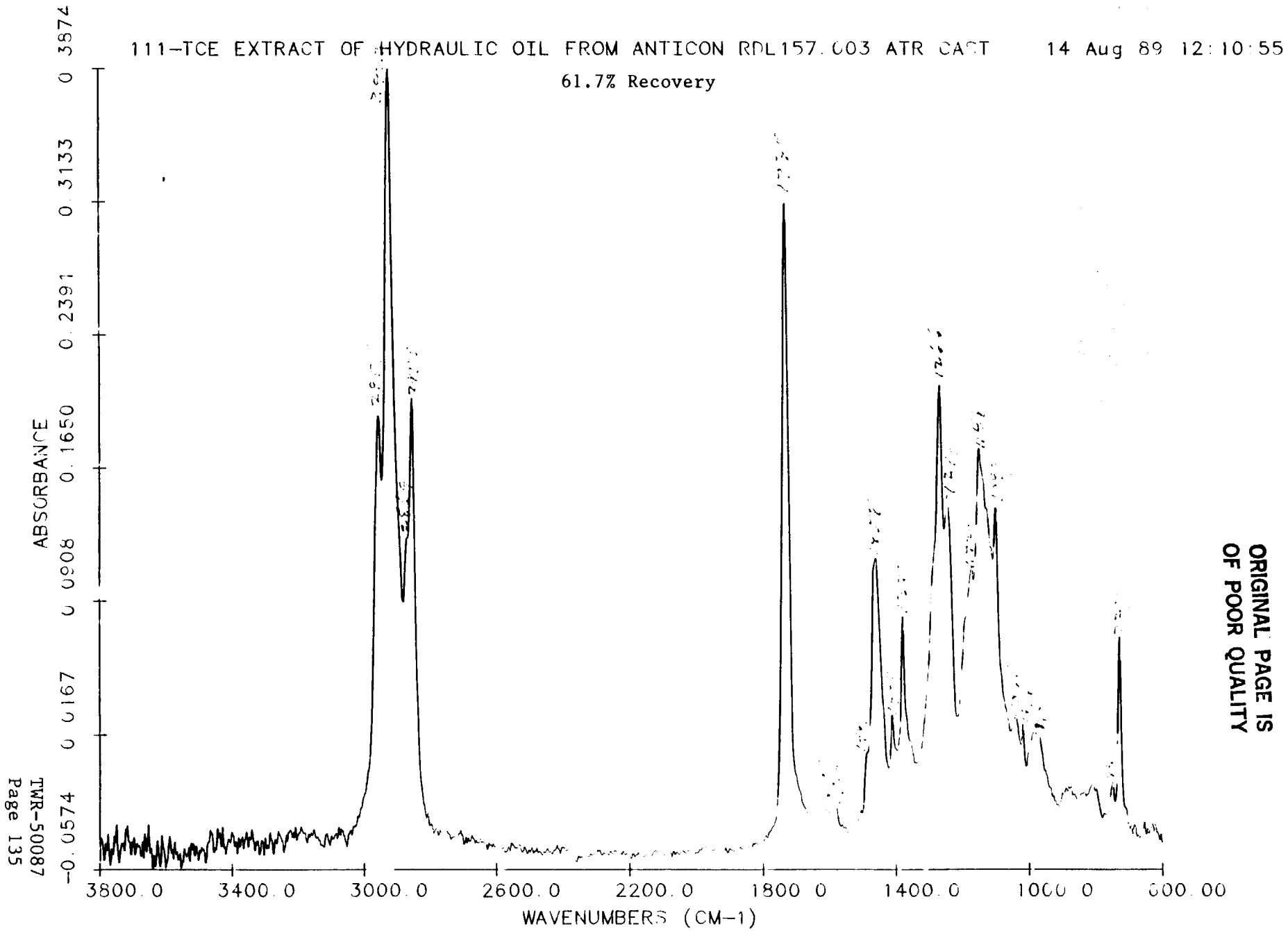
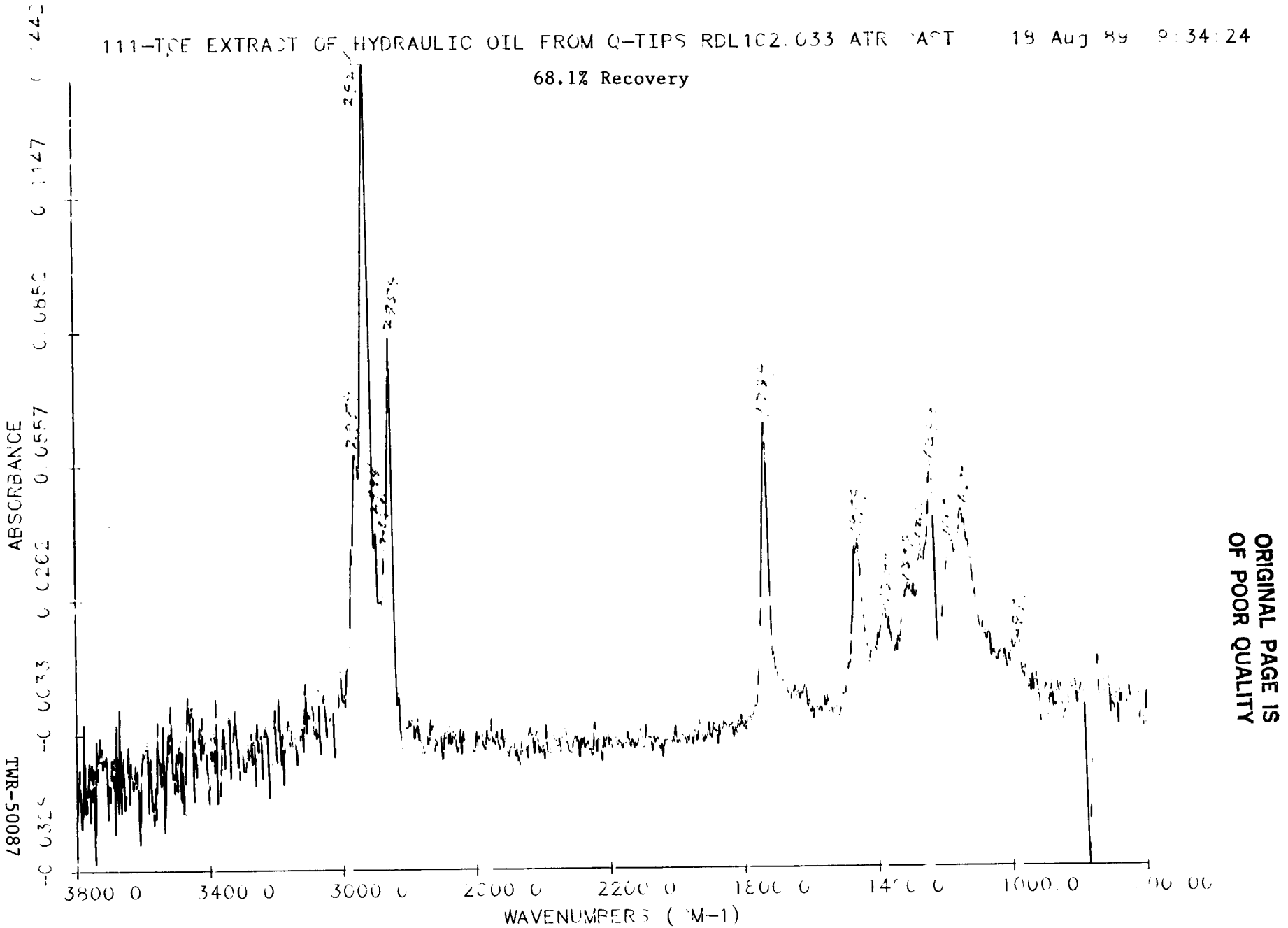


Figure 98.



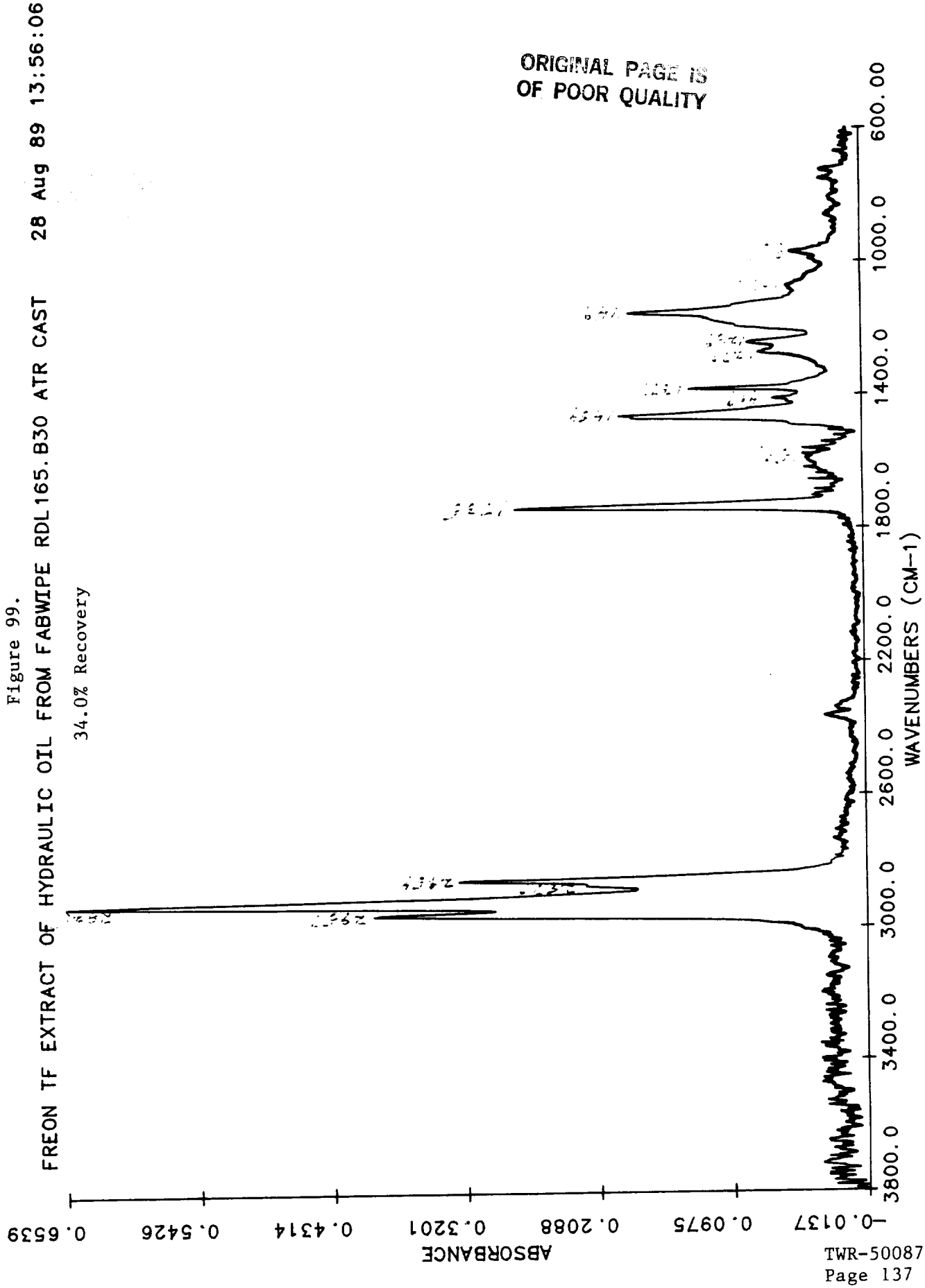


Figure 99.

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Figure 100.

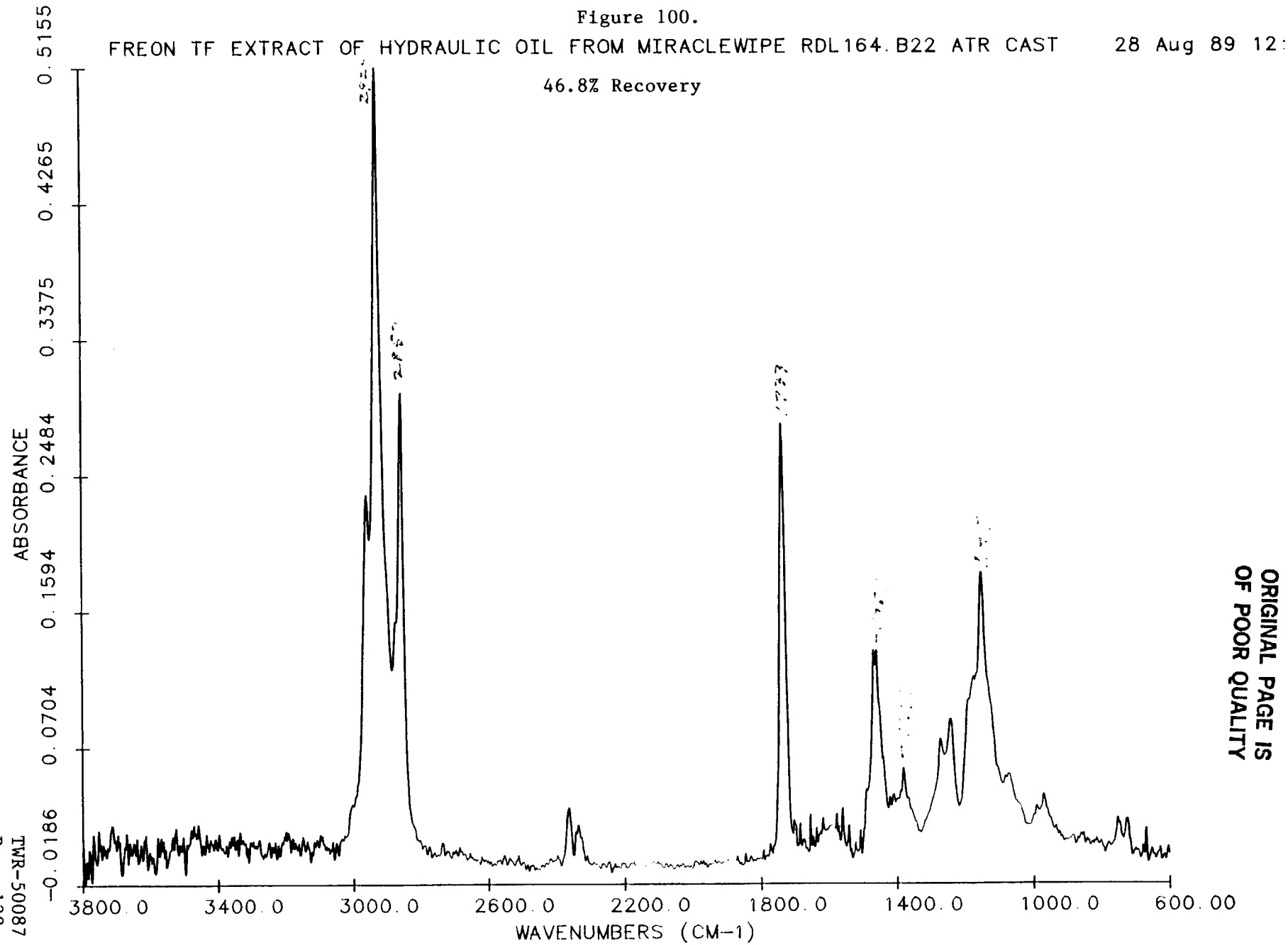

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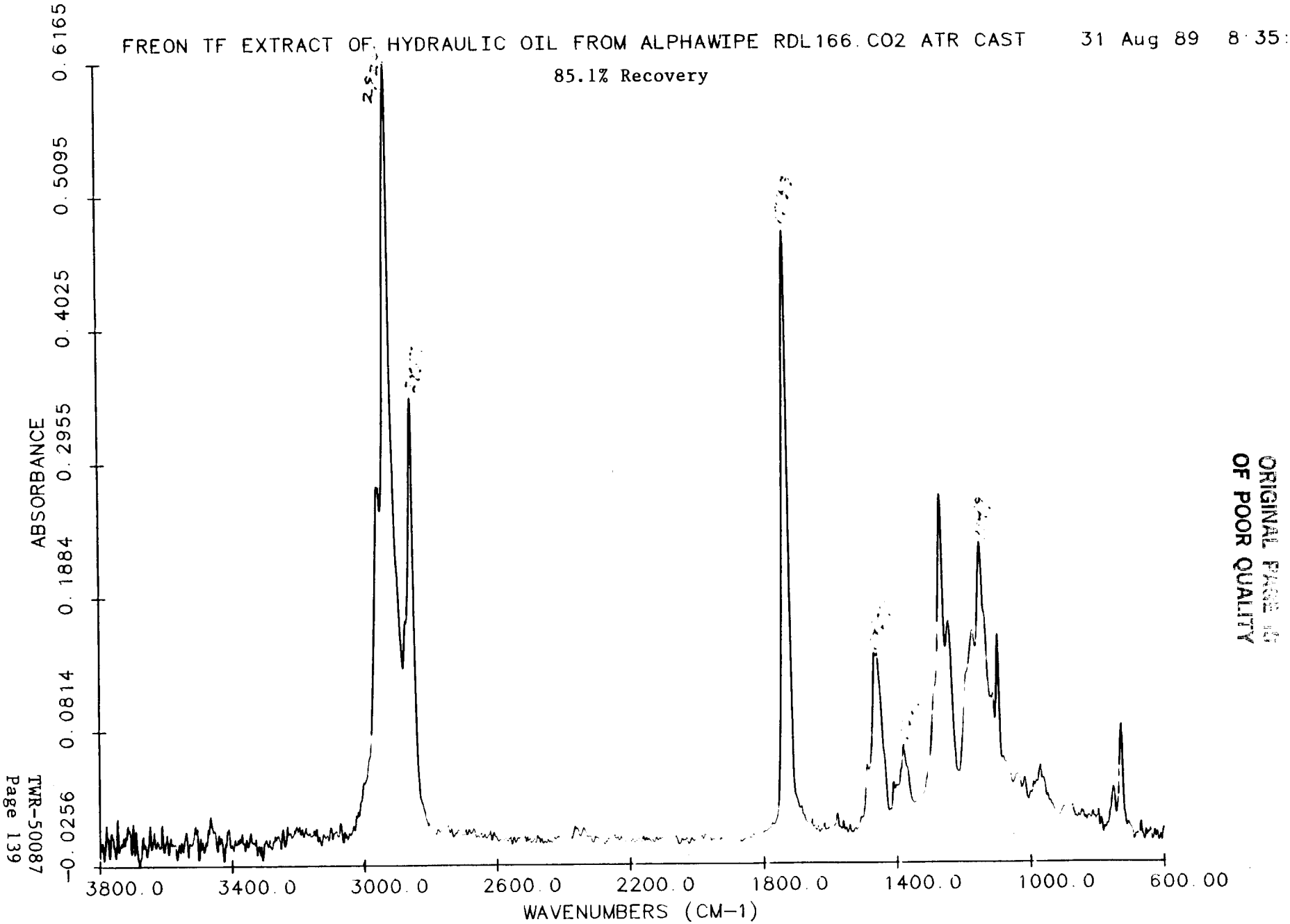
Figure 101.



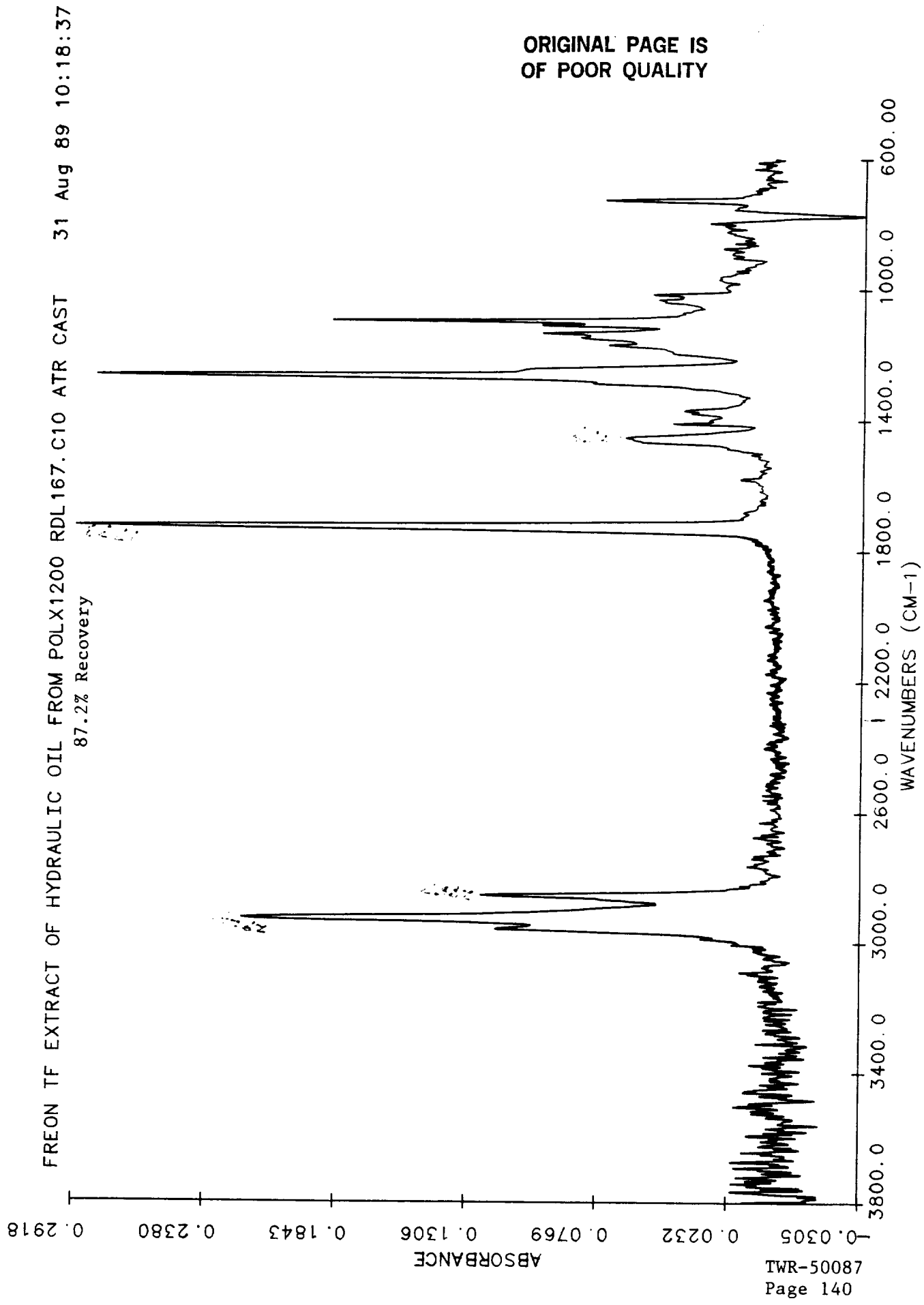

ORIGINAL PAGE IS
OF POOR QUALITY
FREON TF EXTRACT OF HYDRAULIC OIL FROM POLX1200 RDL167.C10 ATR CAST 31 Aug 89 10:18:37
87.2% Recovery
ABSORBANCE
-0.0305
0.0232
0.0769
0.1306
0.1843
0.2380
0.2918
WAVENUMBERS (CM-1)
3800.0
3400.0
3000.0
2600.0
2200.0
1800.0
1400.0
1000.0
600.00

Figure 102.

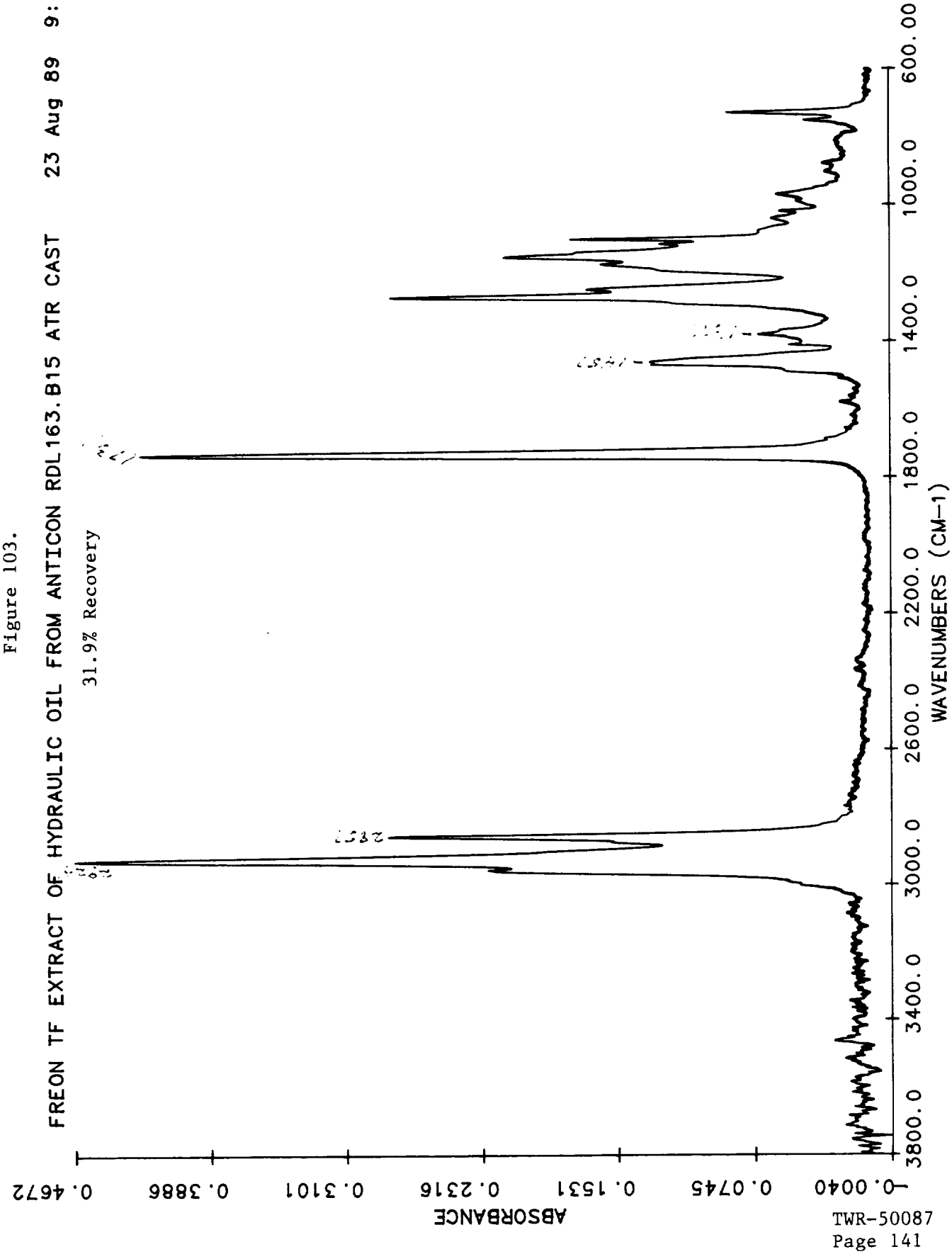


Figure 103.

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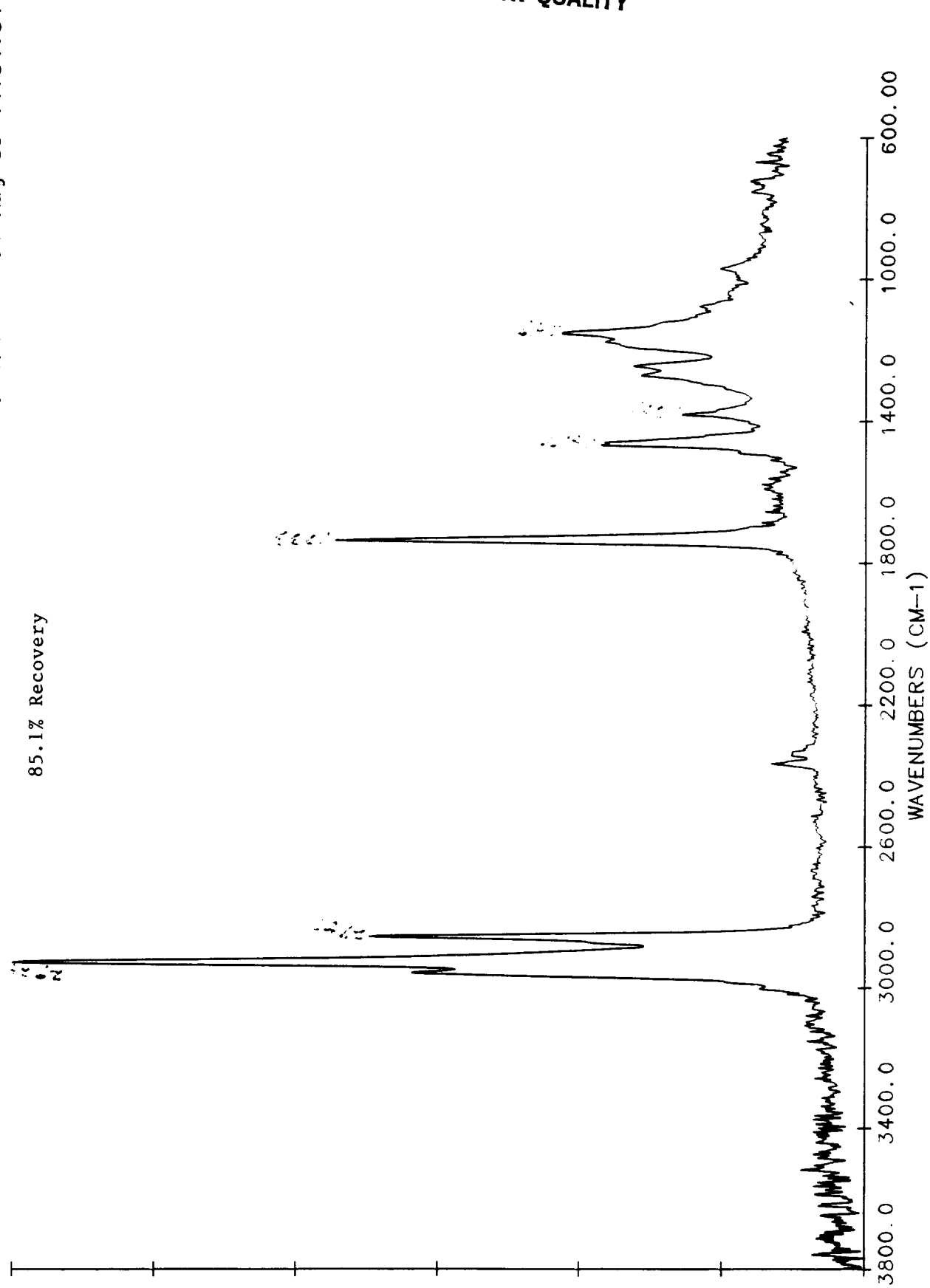


Figure 104.

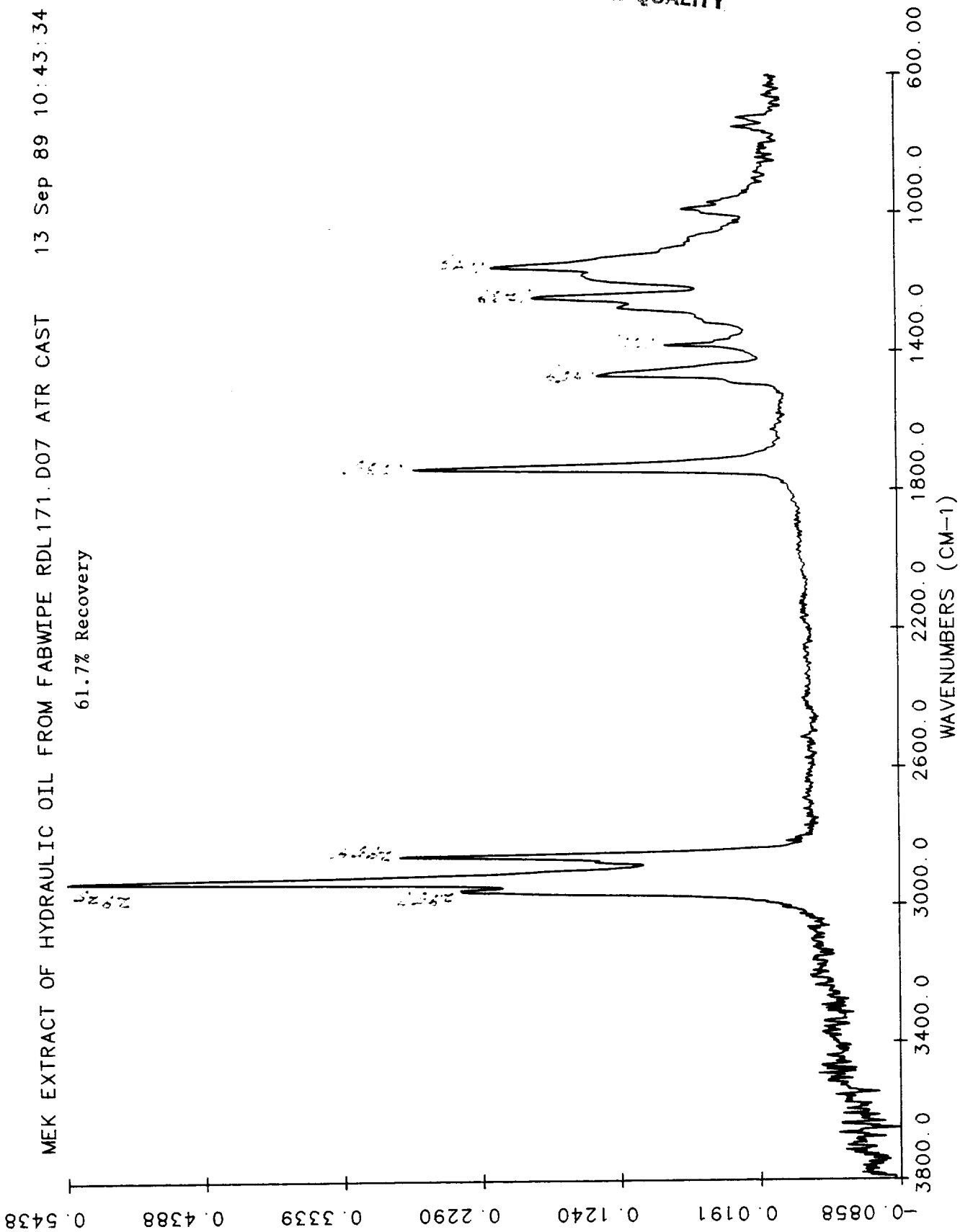


Figure 105.

Figure 106.

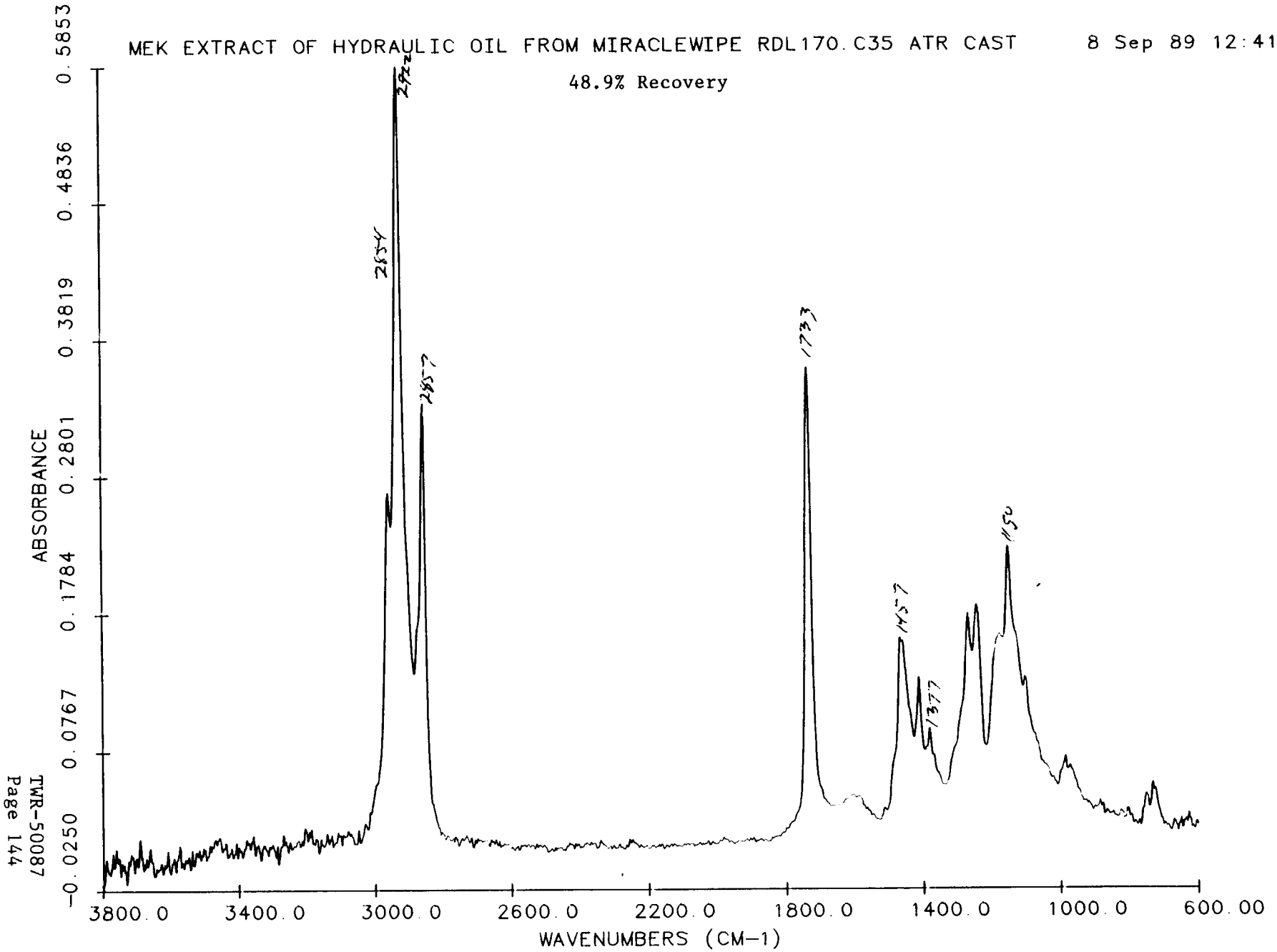
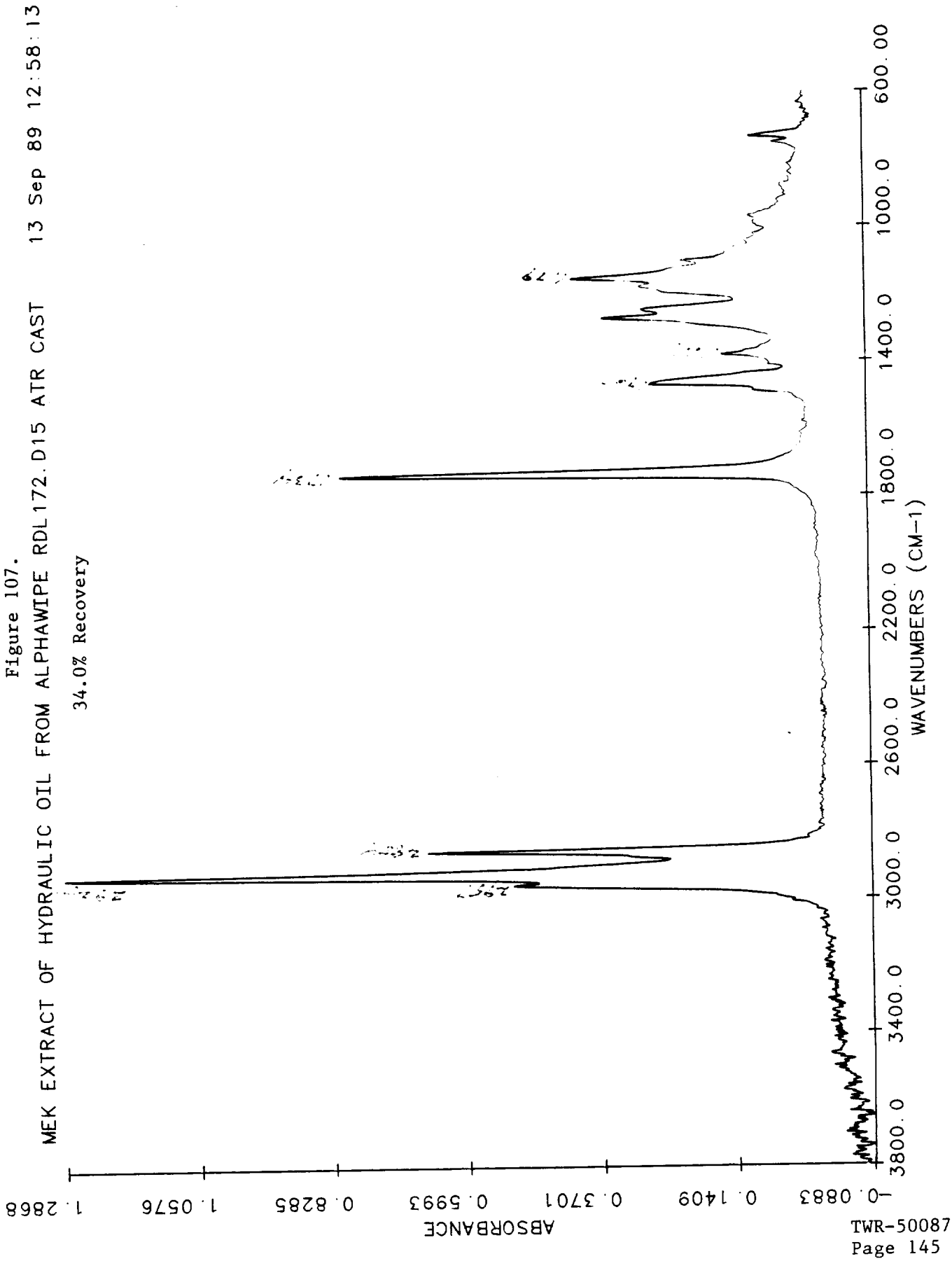

MEK EXTRACT OF HYDRAULIC OIL FROM MIRACLEWIPE RDL170.C35 ATR CAST
8 Sep 89 12:41:03
48.9% Recovery
2922
2854
2857
1733
1457
1377
1150
ABSORBANCE
0.5853
0.4836
0.3819
0.2801
0.1784
0.0767
-0.0250
3800.0
3400.0
3000.0
2600.0
2200.0
1800.0
1400.0
1000.0
600.00
WAVENUMBERS (CM-1)

Figure 107.



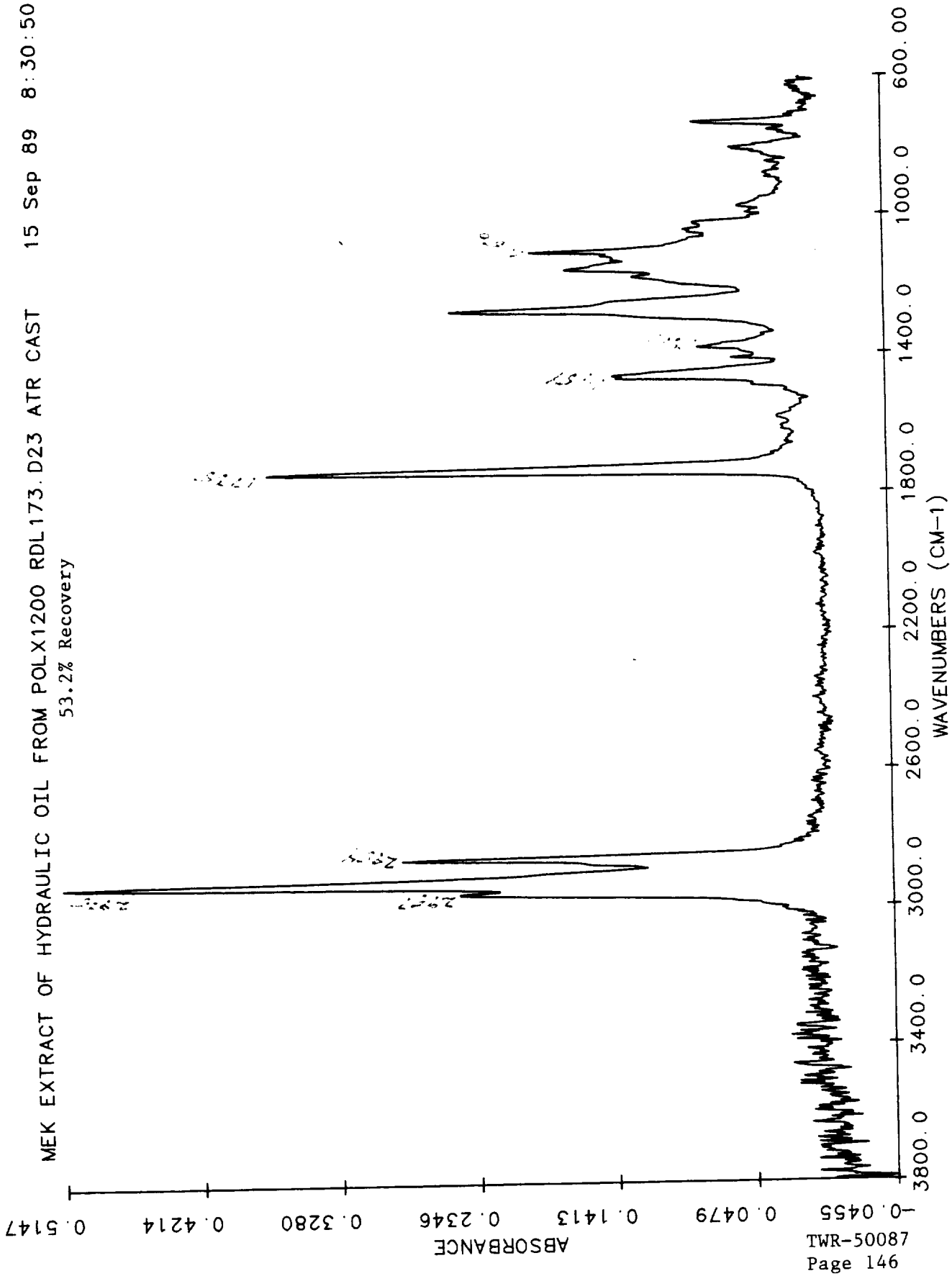


Figure 108.

Figure 109.

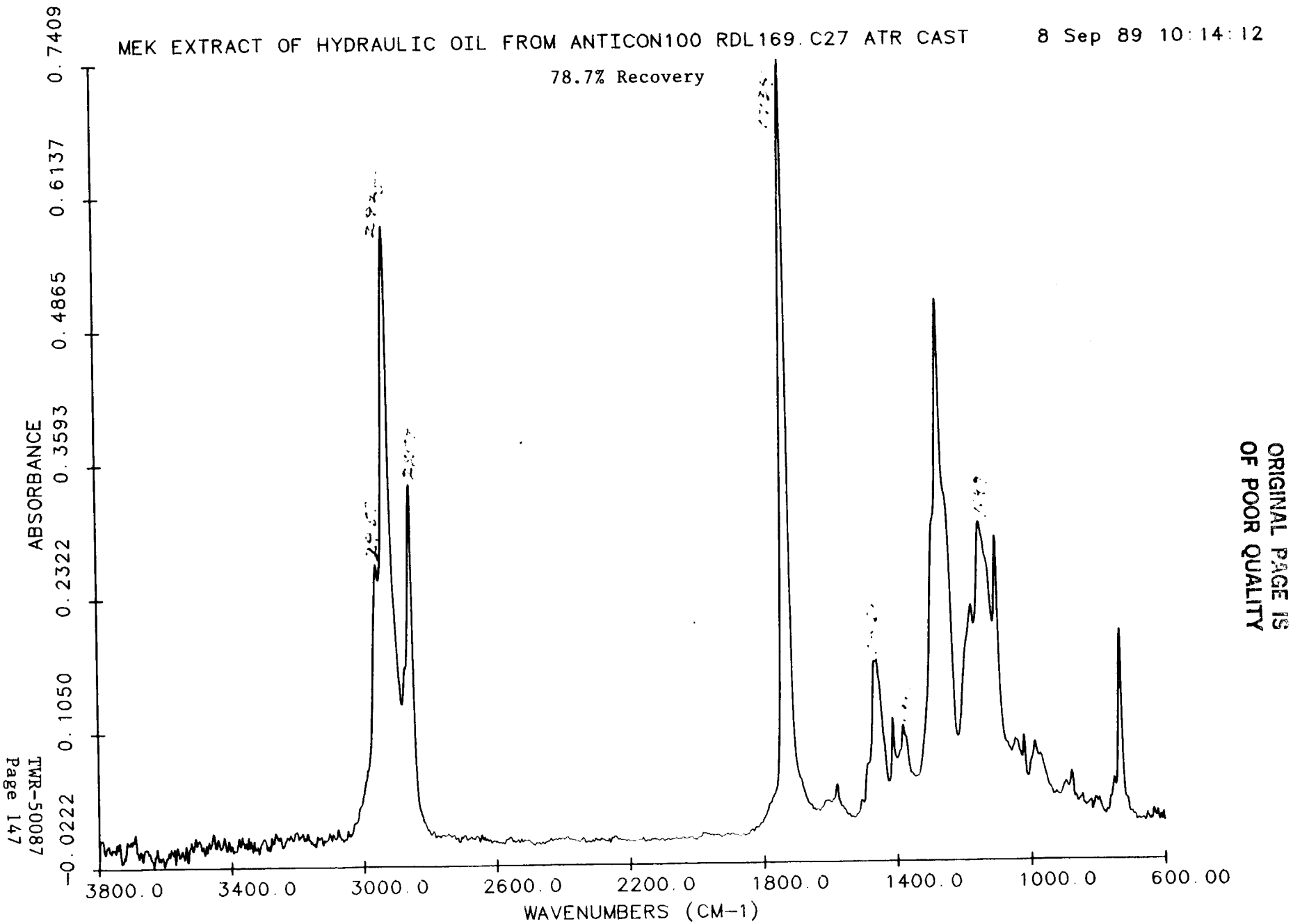
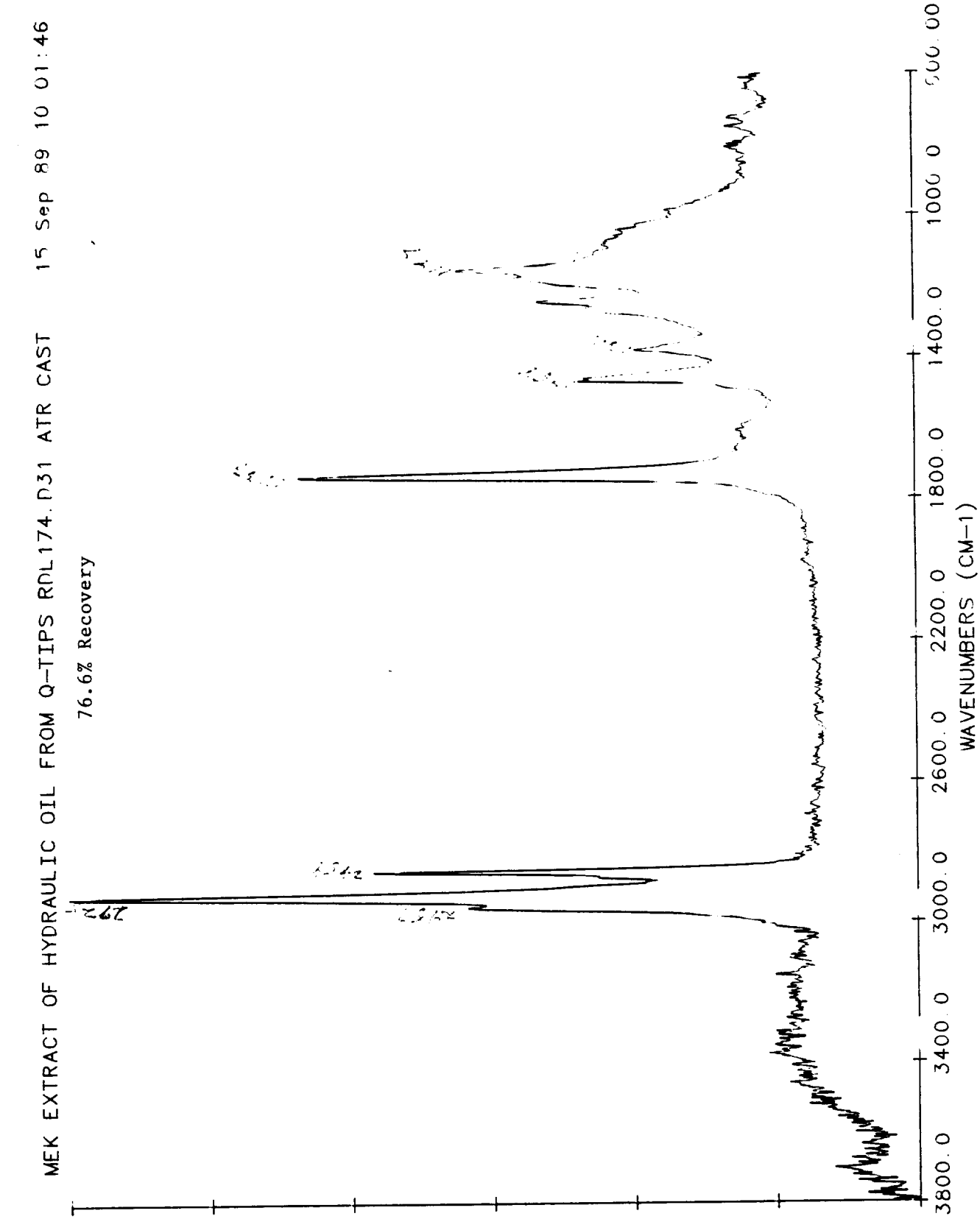


Figure 110.



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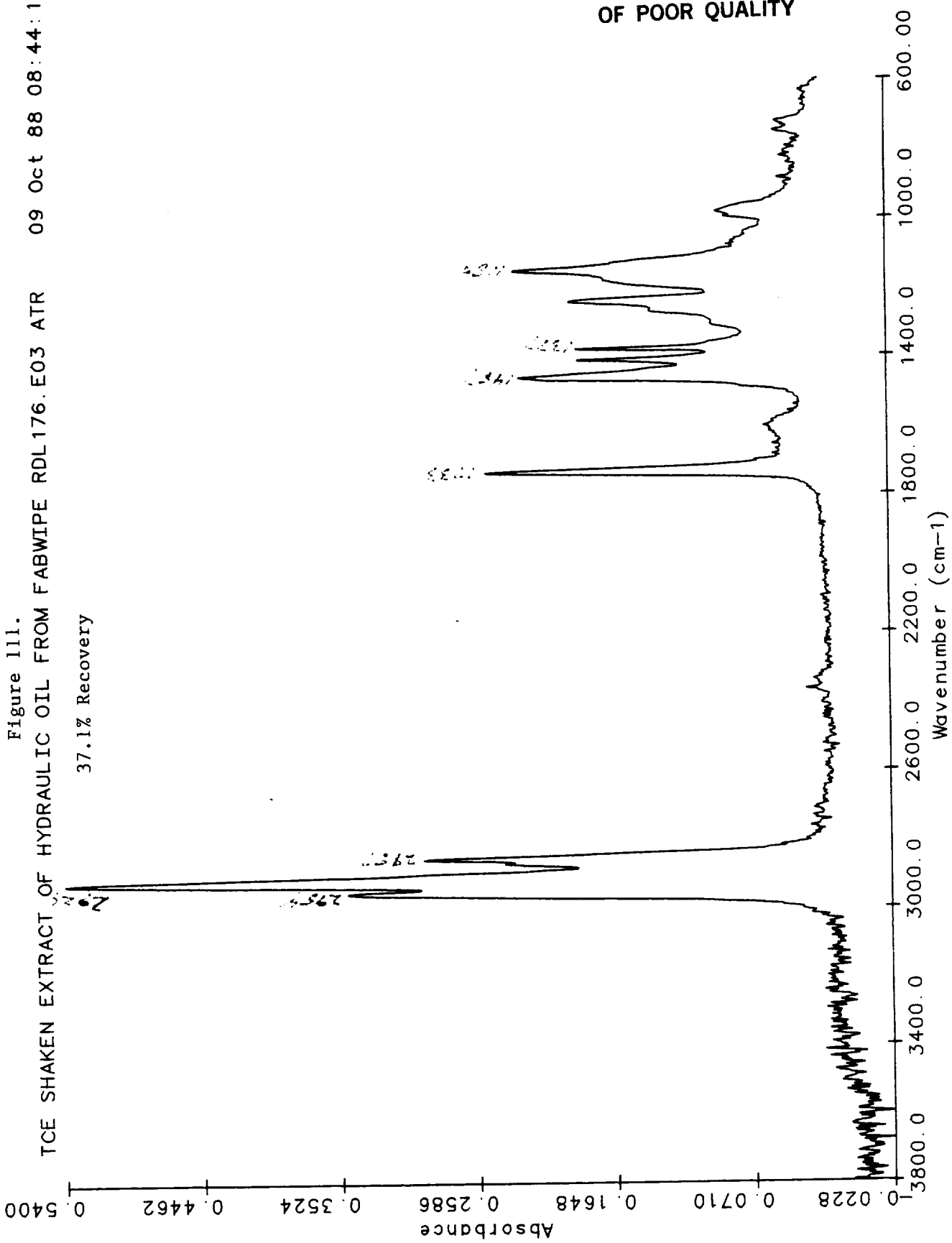

Figure 111.

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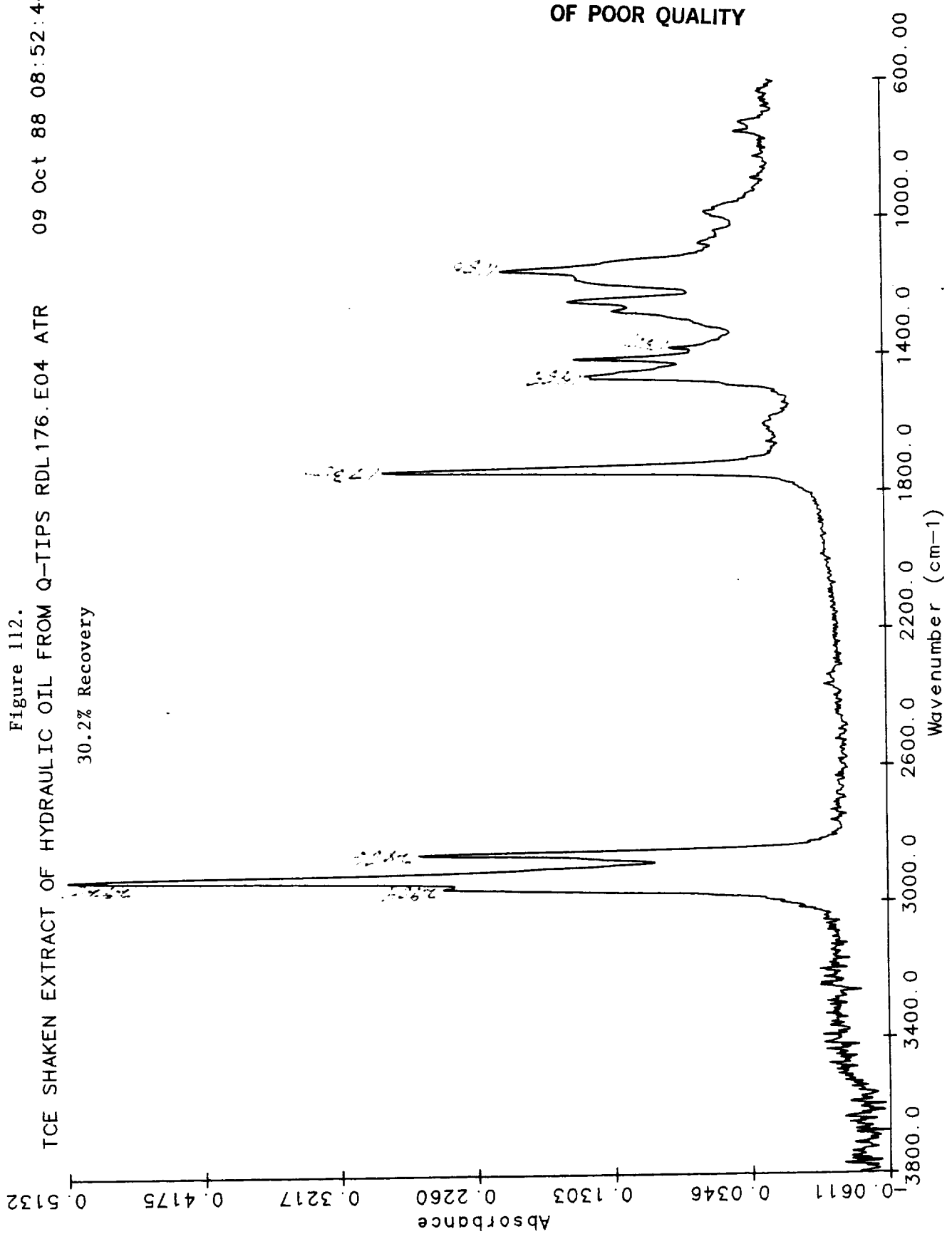

Figure 112.

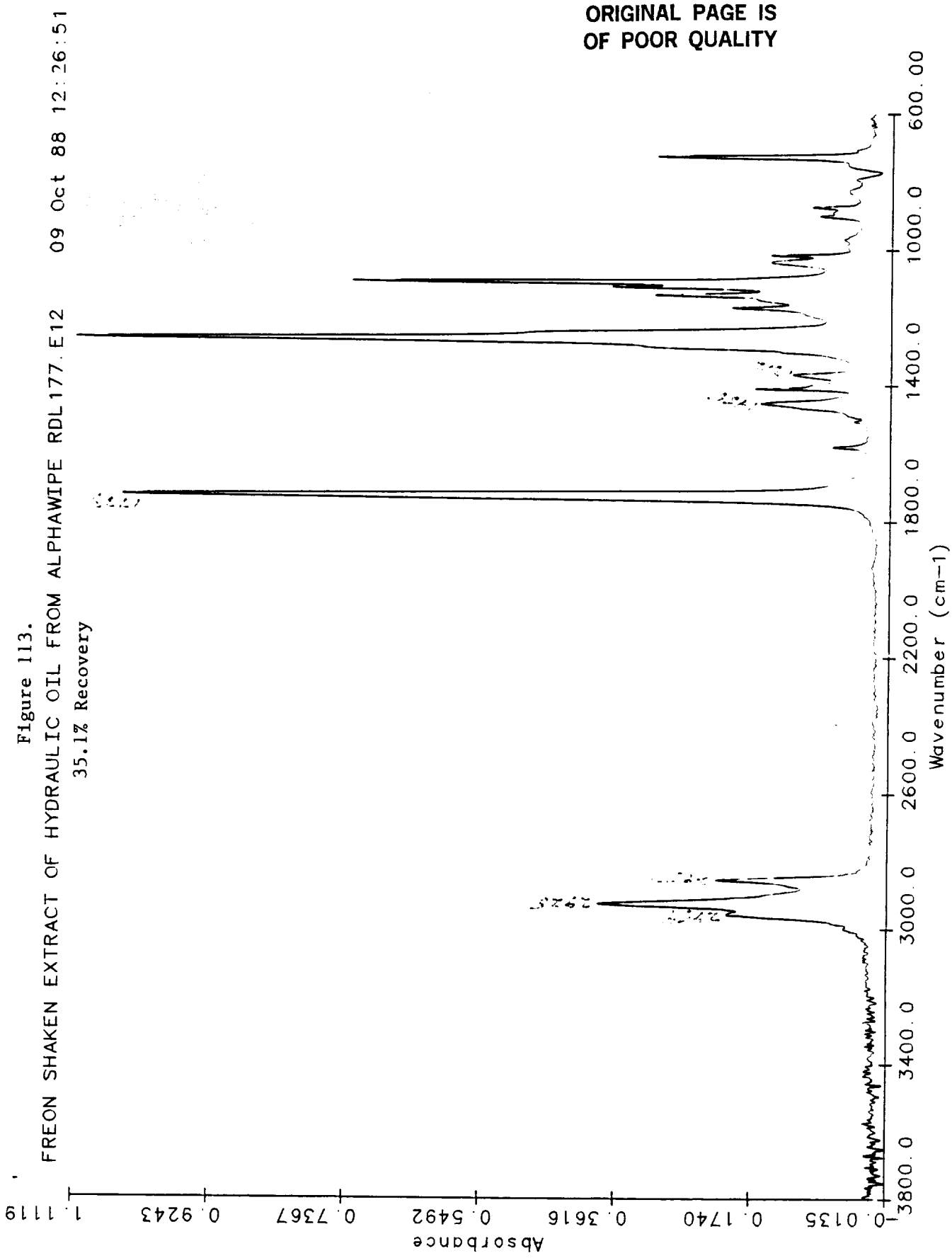

Figure 113.

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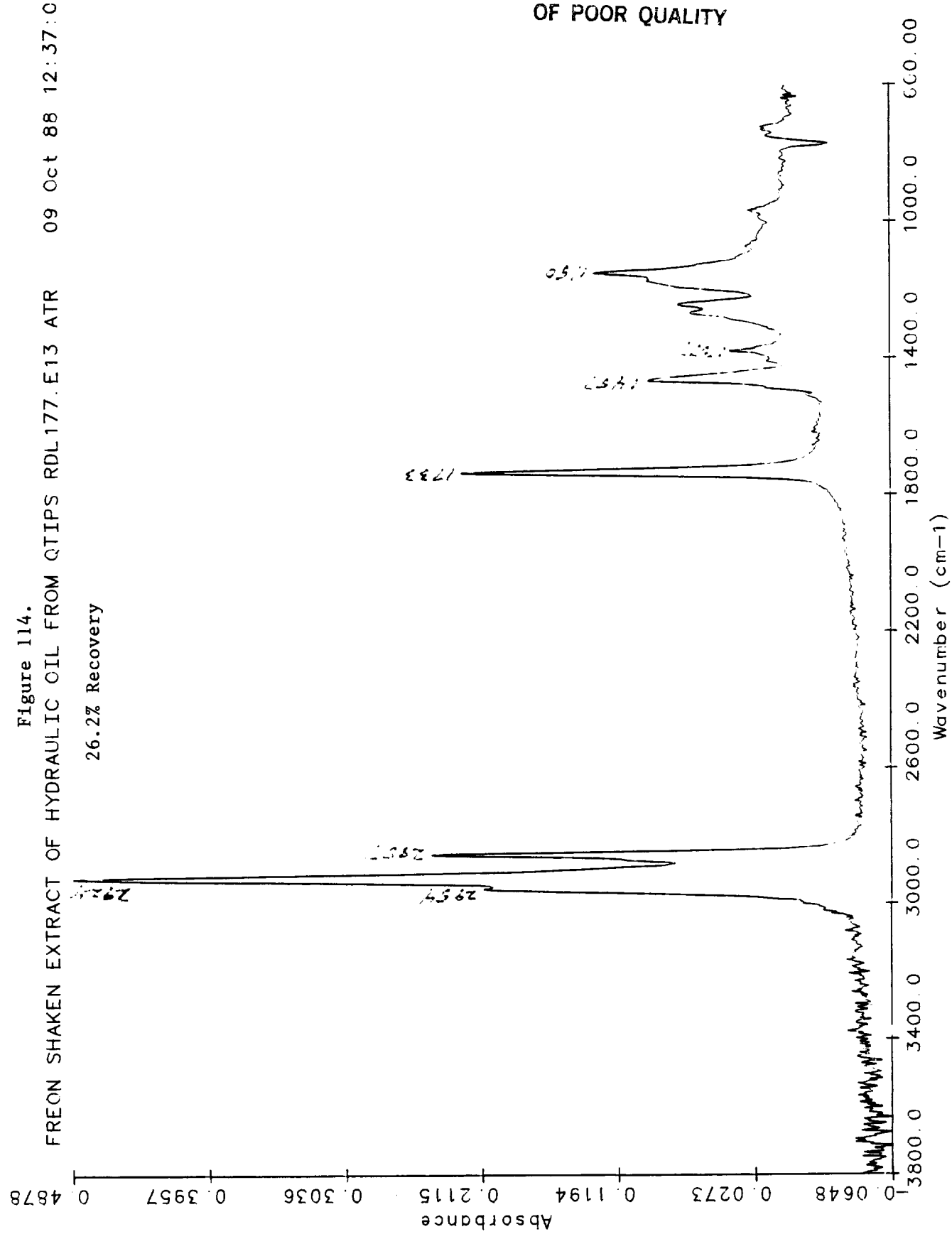

Figure 114.

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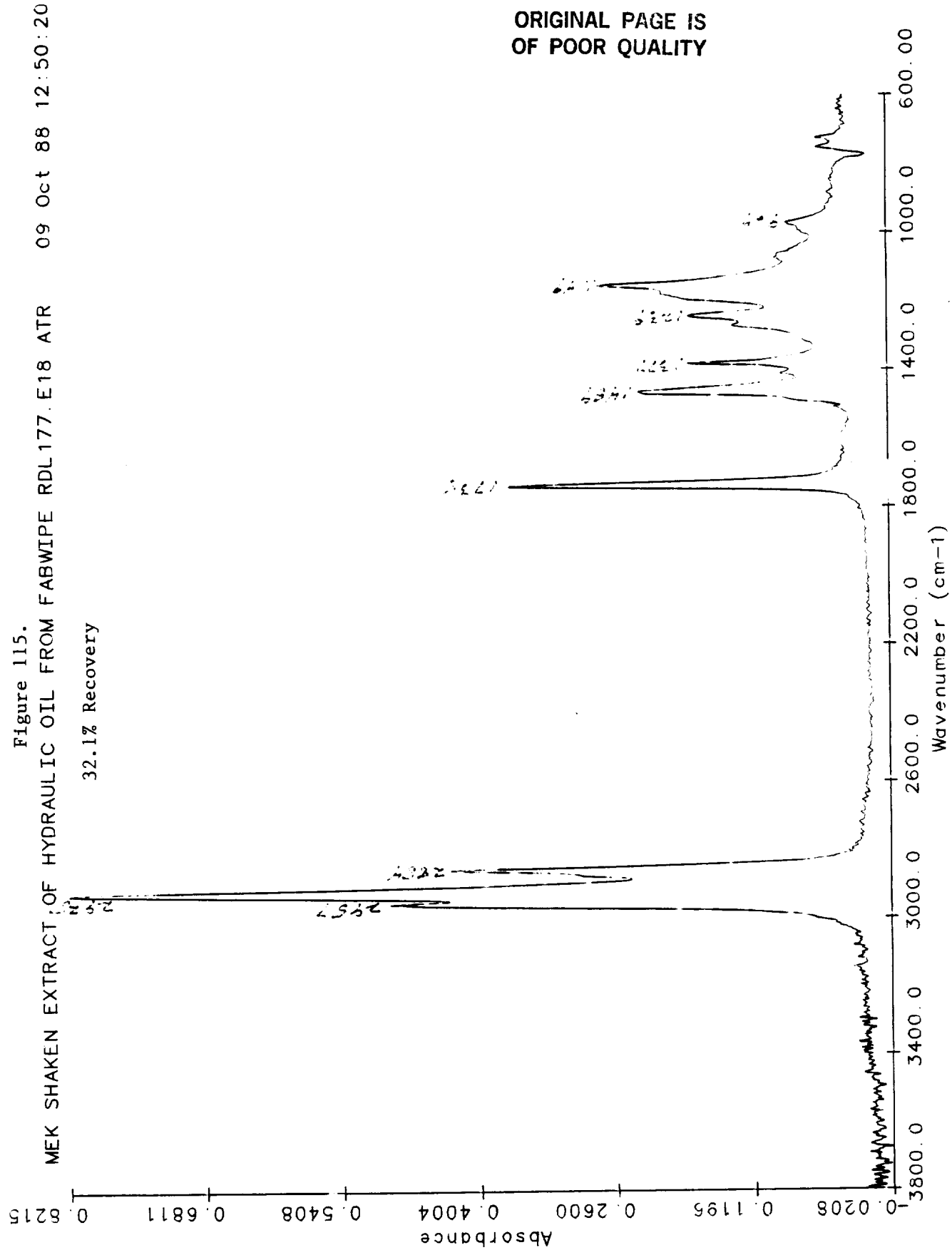


Figure 115.

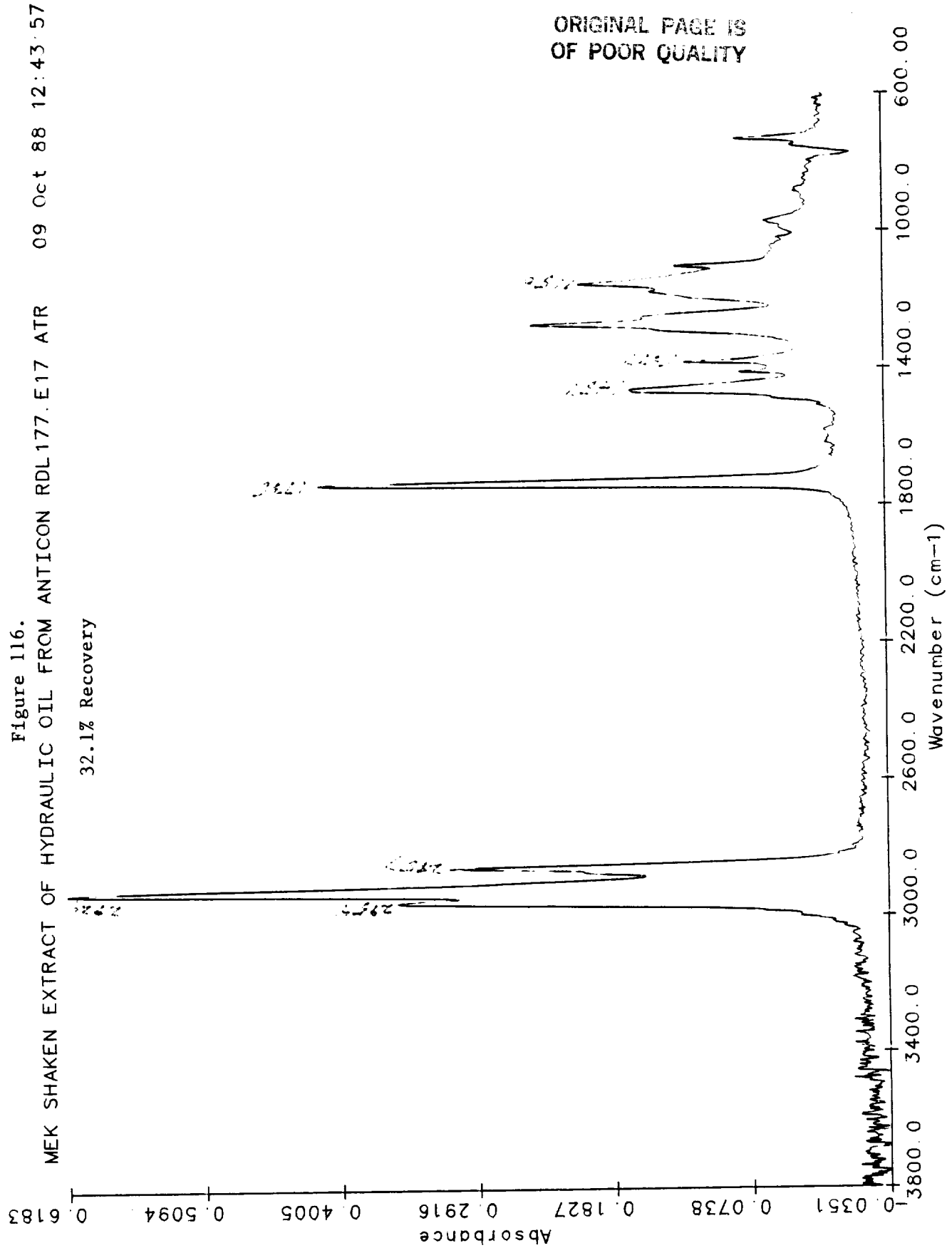


Figure 116.

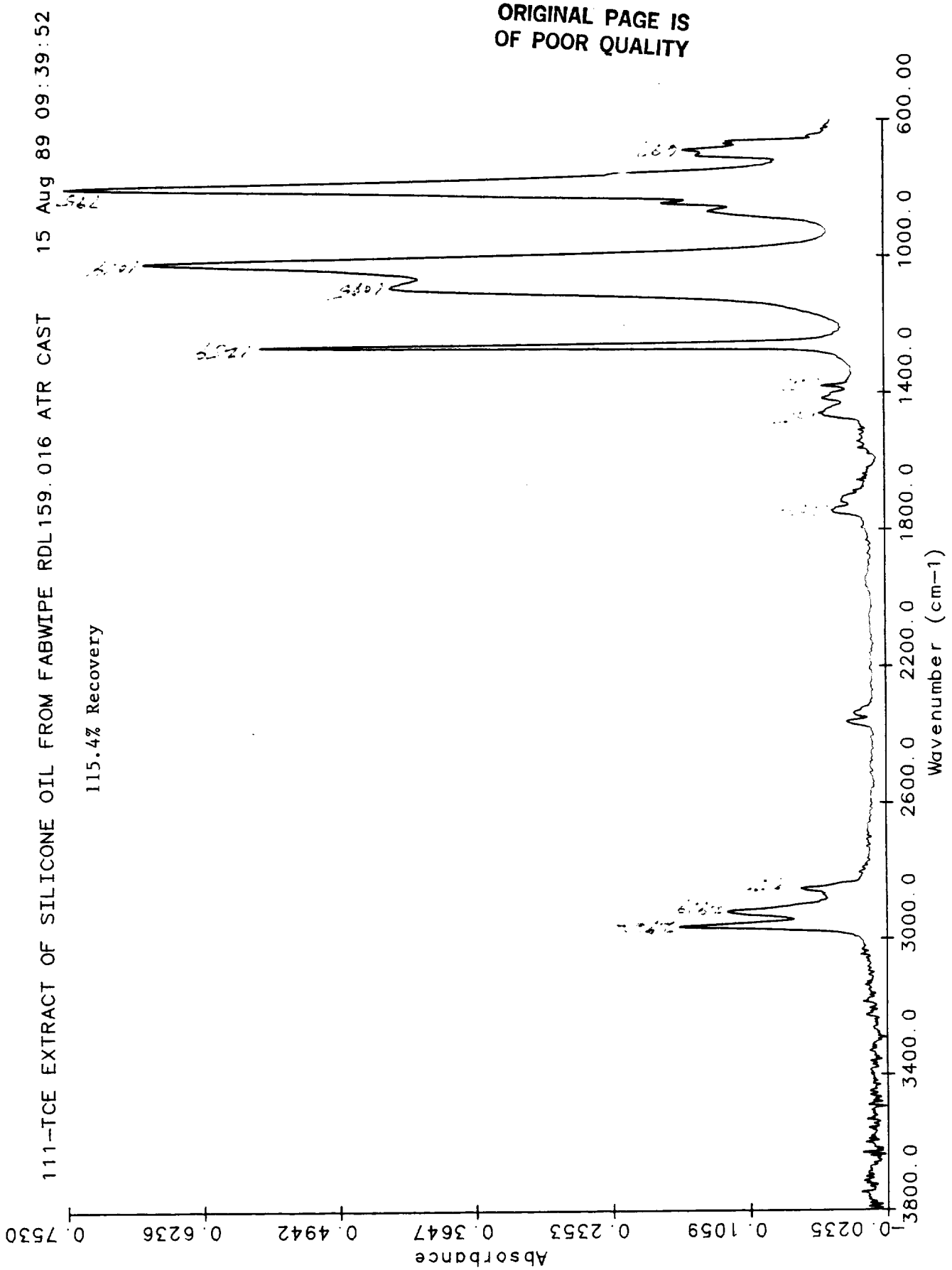
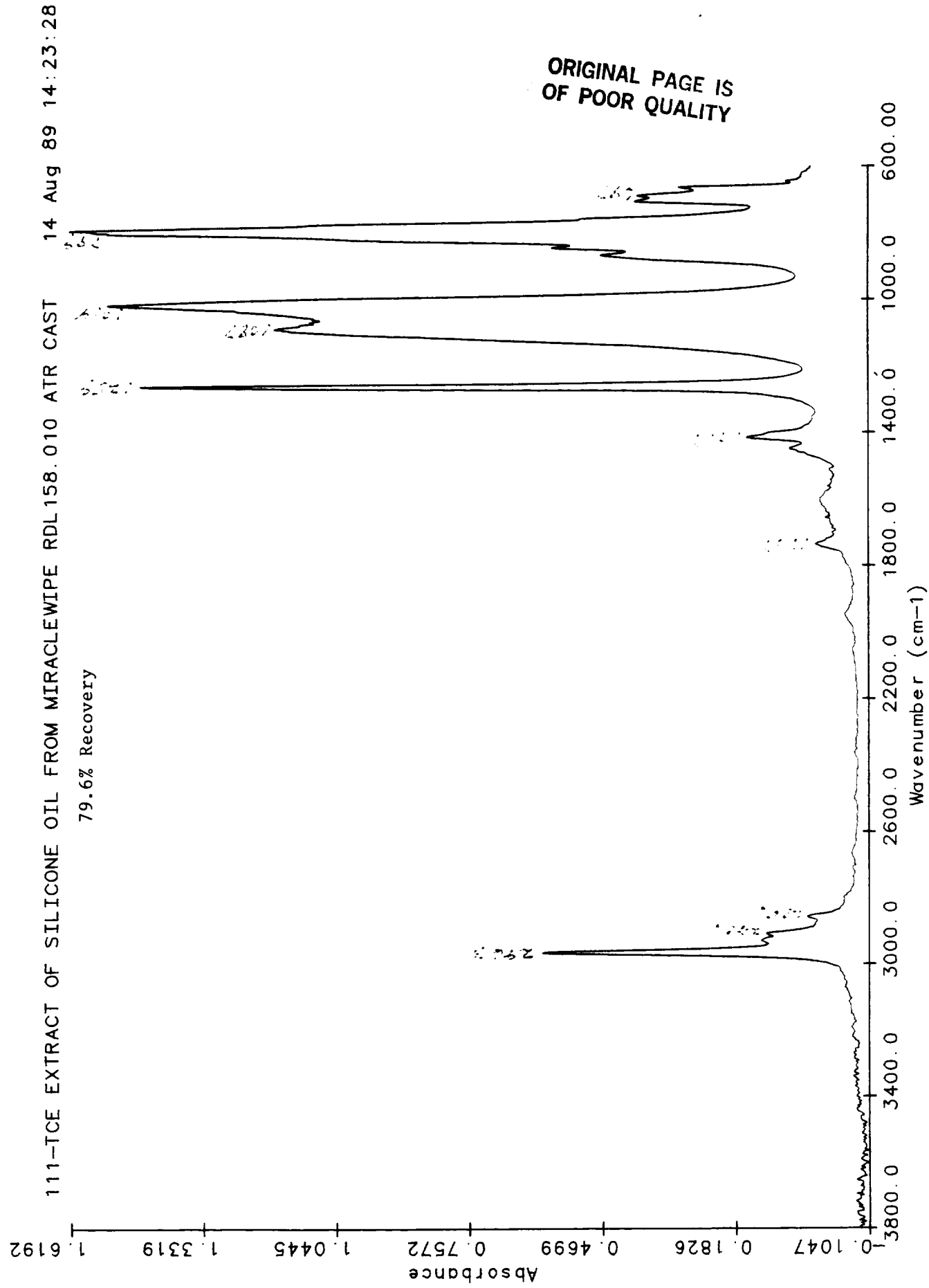


Figure 117.

Figure 118.


111-TCE EXTRACT OF SILICONE OIL FROM MIRACLEWIPE RDL158.010 ATR CAST 14 Aug 89 14:23:28
79.6% Recovery
ORIGINAL PAGE IS
OF POOR QUALITY
Absorbance
1.6192
1.3319
1.0445
0.7572
0.4699
0.1826
0.1047
Wavenumber (cm-1)
3800.0
3400.0
3000.0
2600.0
2200.0
1800.0
1400.0
1000.0
600.00

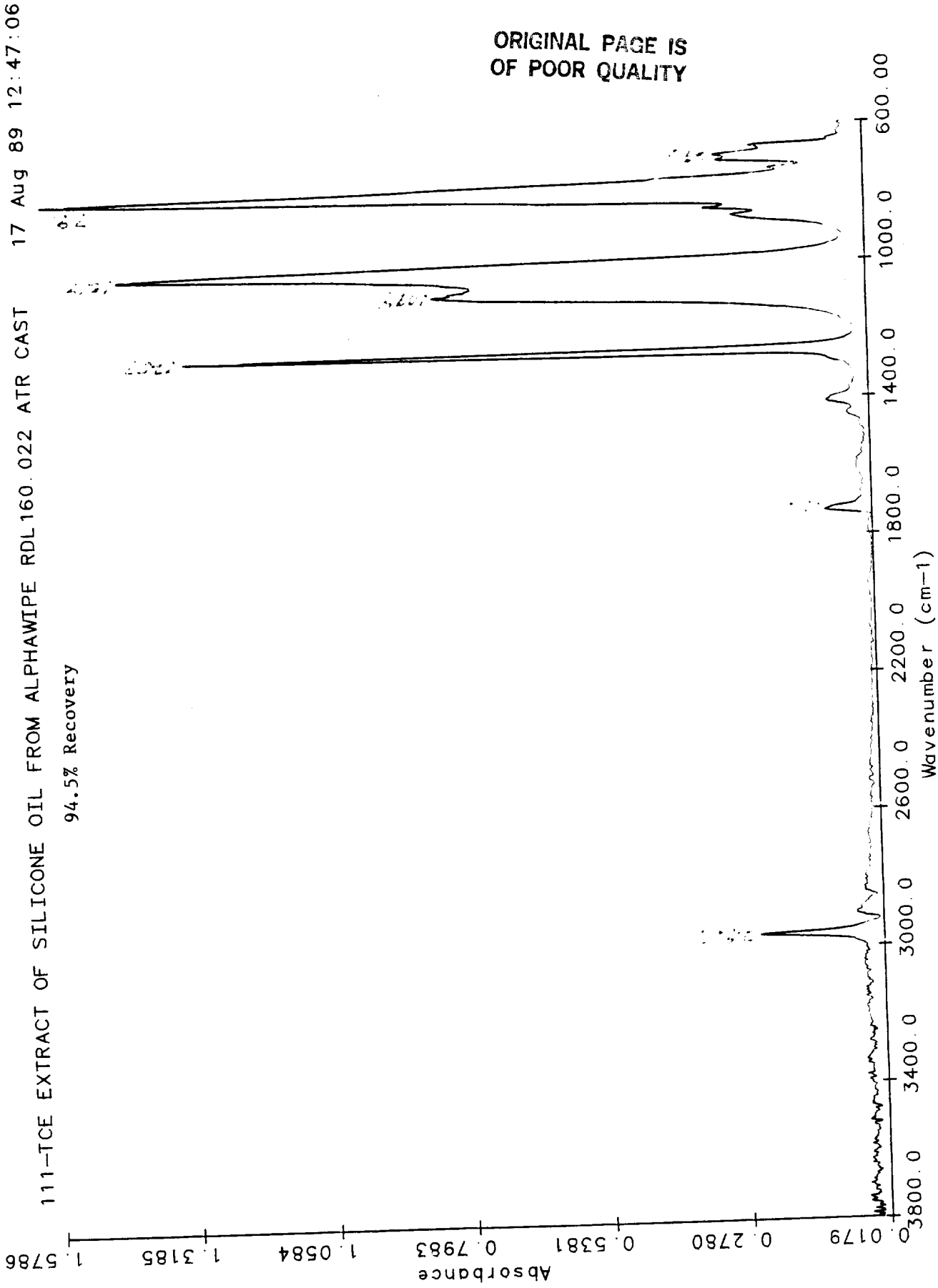


Figure 119.

Figure 120.

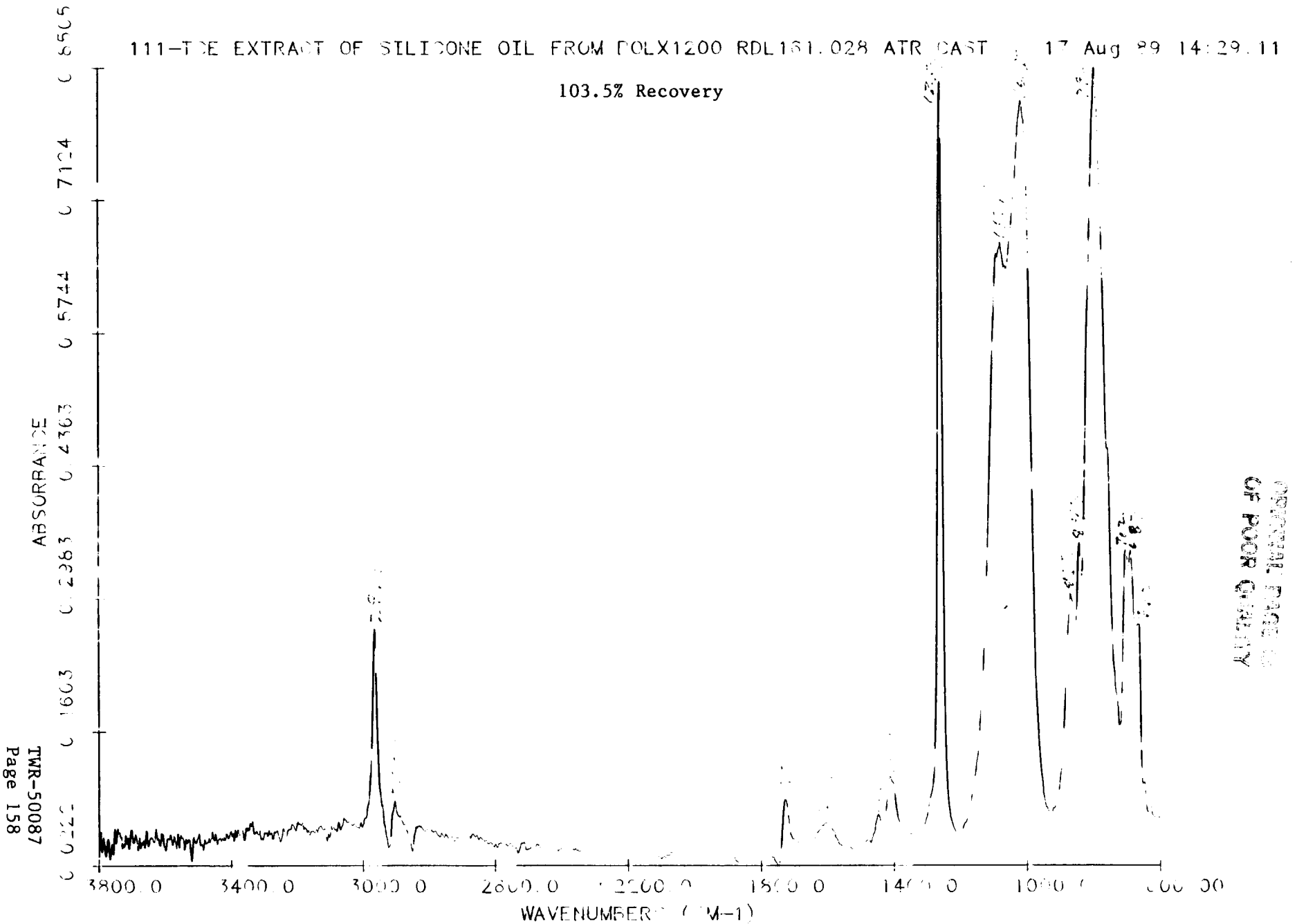


Figure 121.

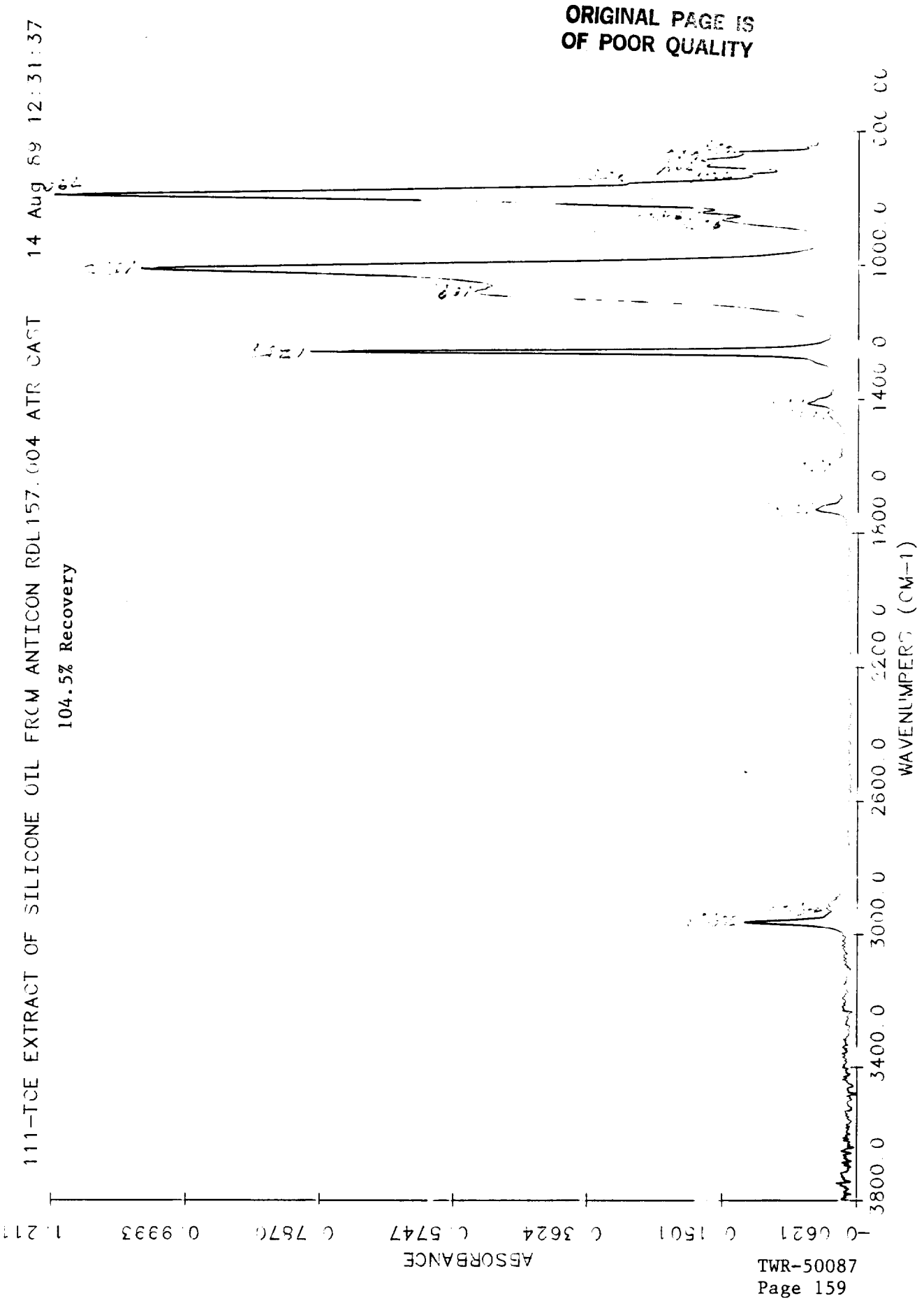


Figure 122.

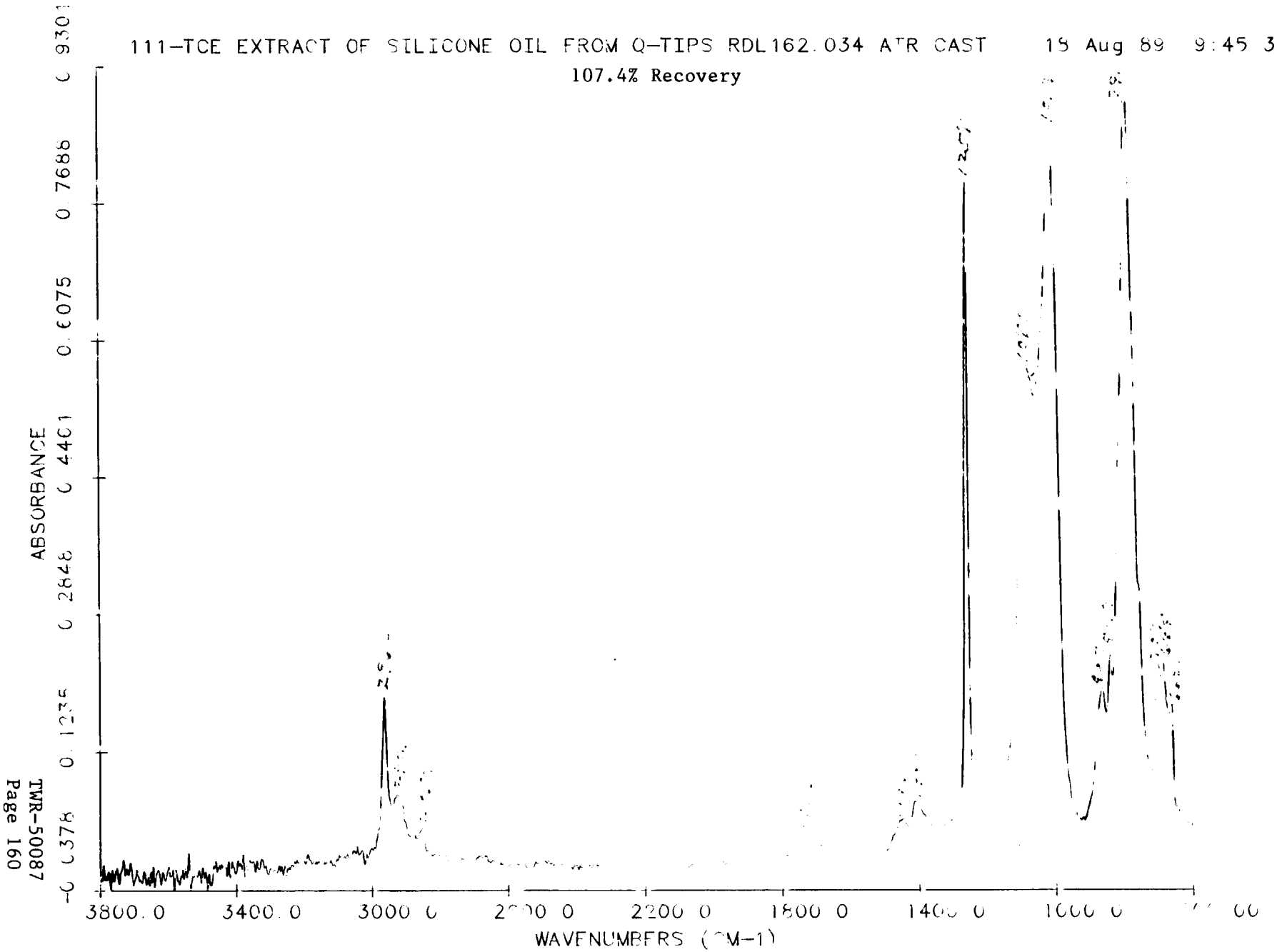


Figure 123.

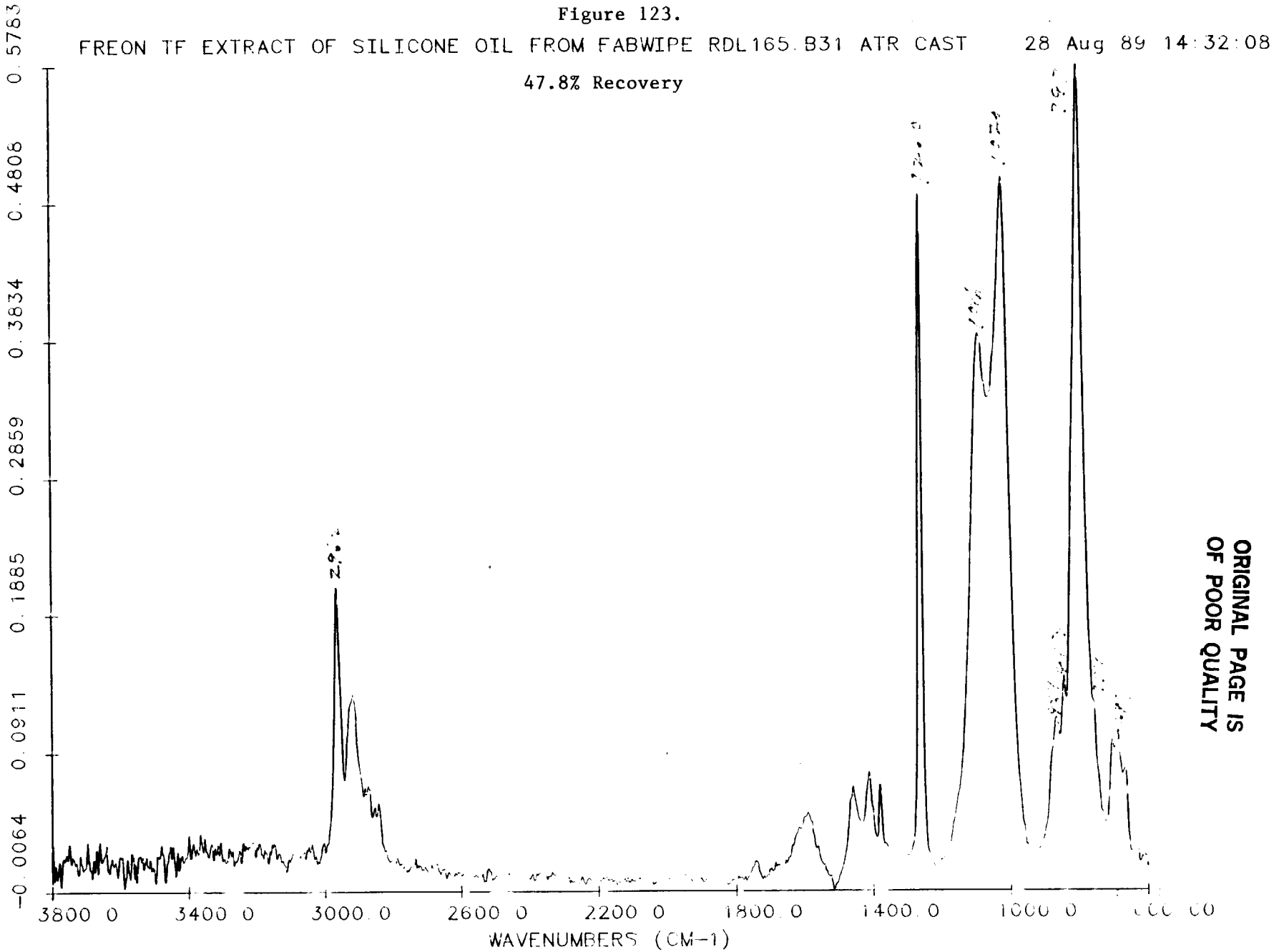
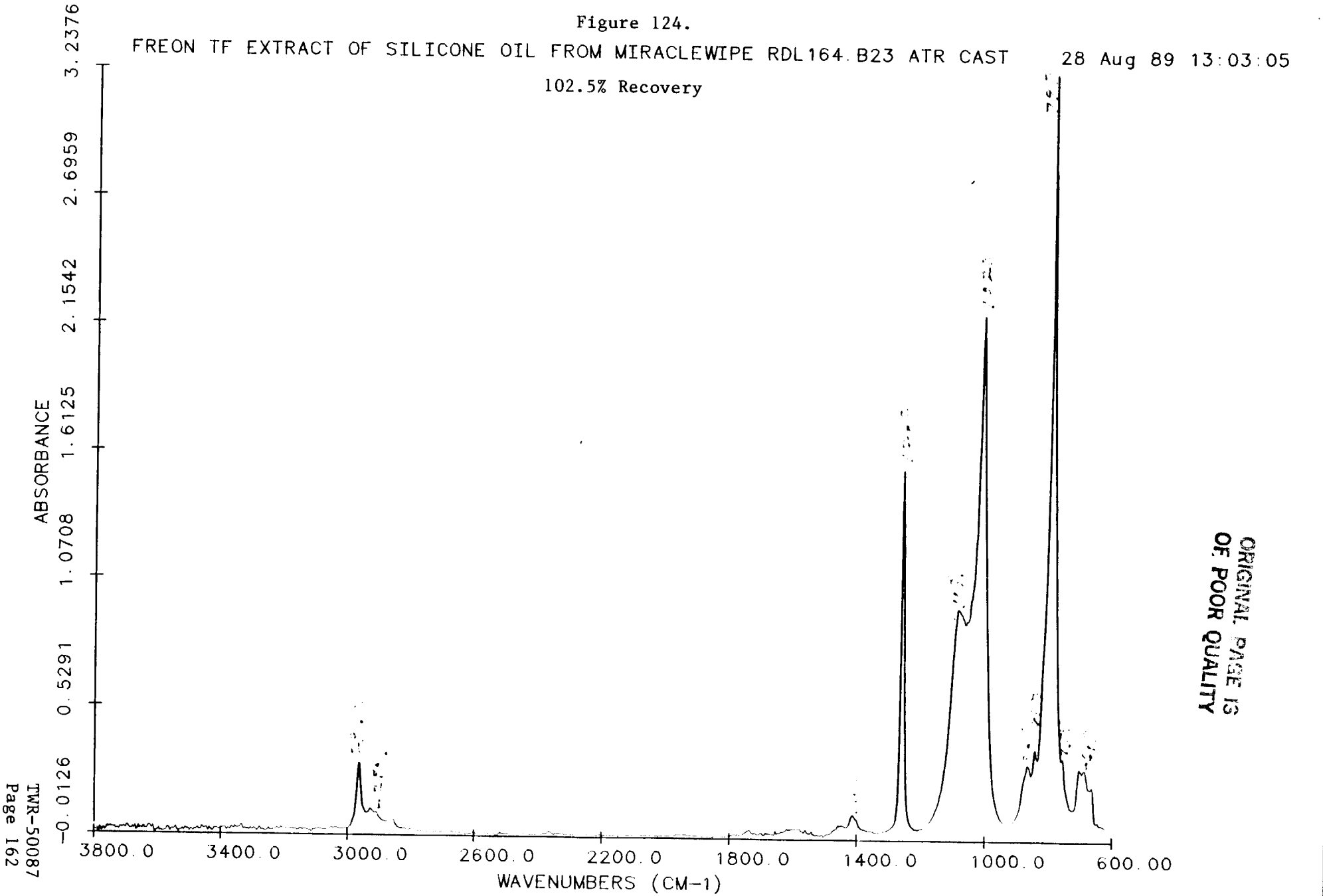


Figure 124.



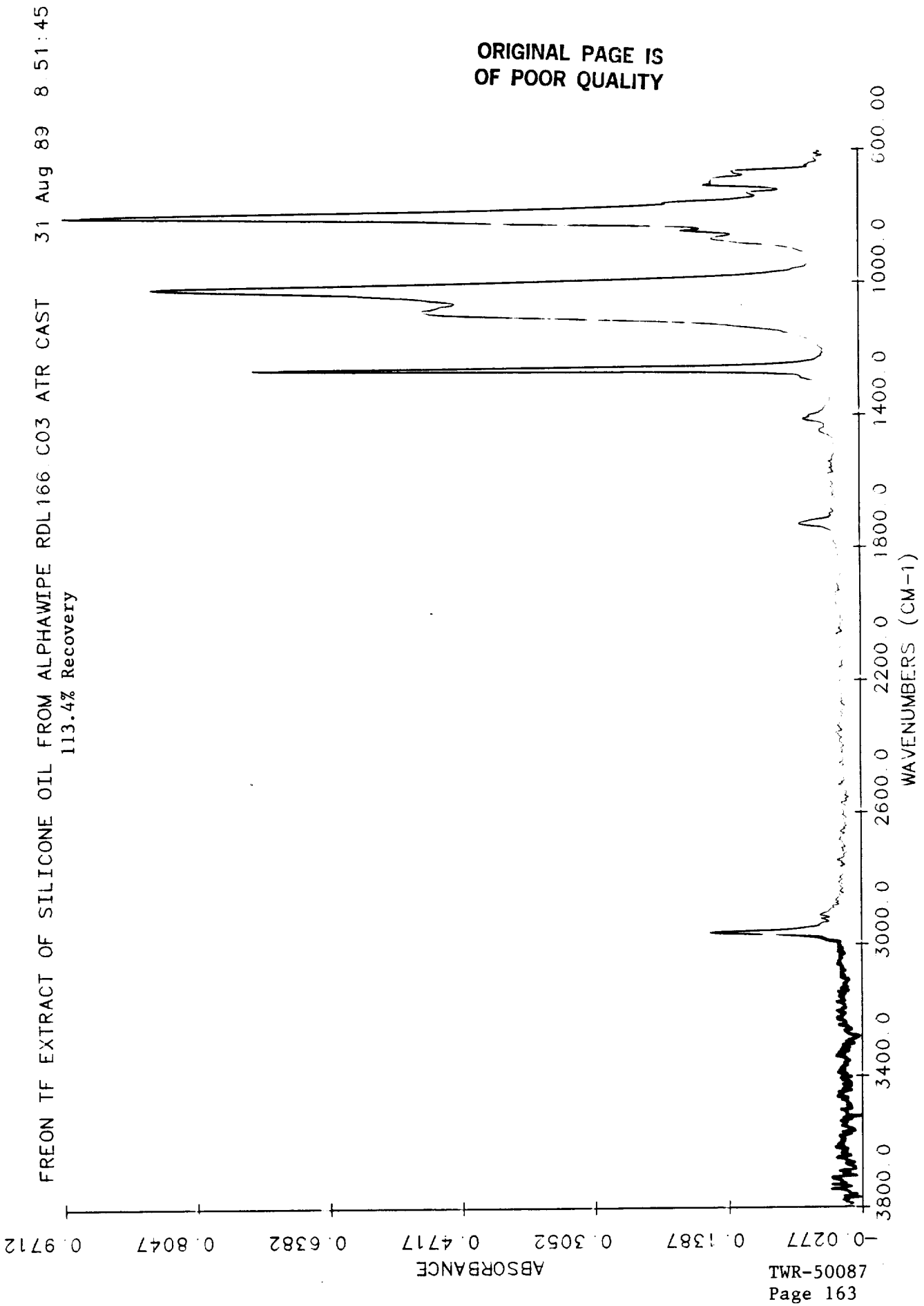
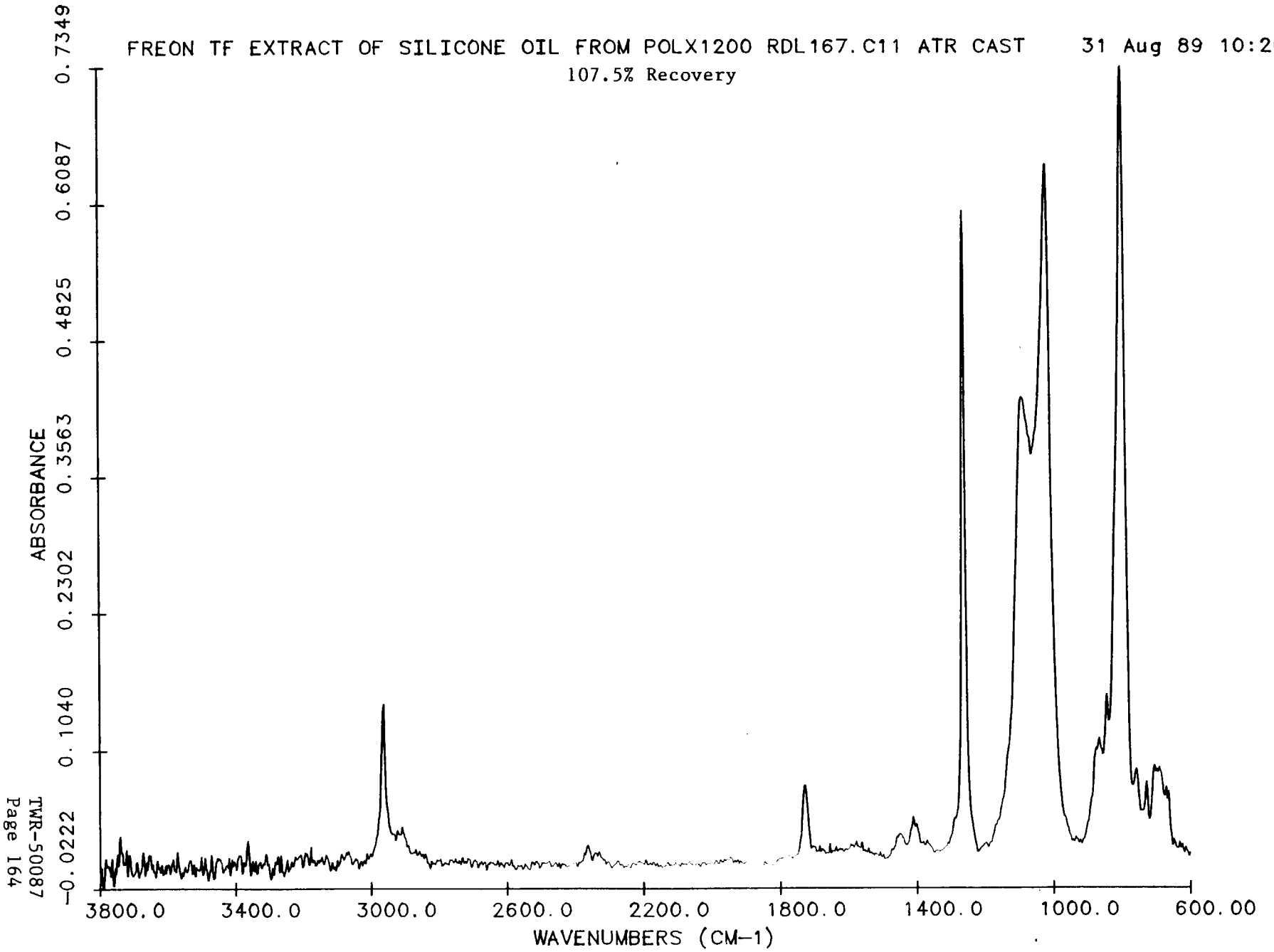


Figure 125.

Figure 126.


FREON TF EXTRACT OF SILICONE OIL FROM POLX1200 RDL167.C11 ATR CAST 31 Aug 89 10:26:15
107.5% Recovery
ABSORBANCE
0.7349
0.6087
0.4825
0.3563
0.2302
0.1040
-0.0222
3800.0
3400.0
3000.0
2600.0
2200.0
1800.0
1400.0
1000.0
600.00
WAVENUMBERS (CM-1)

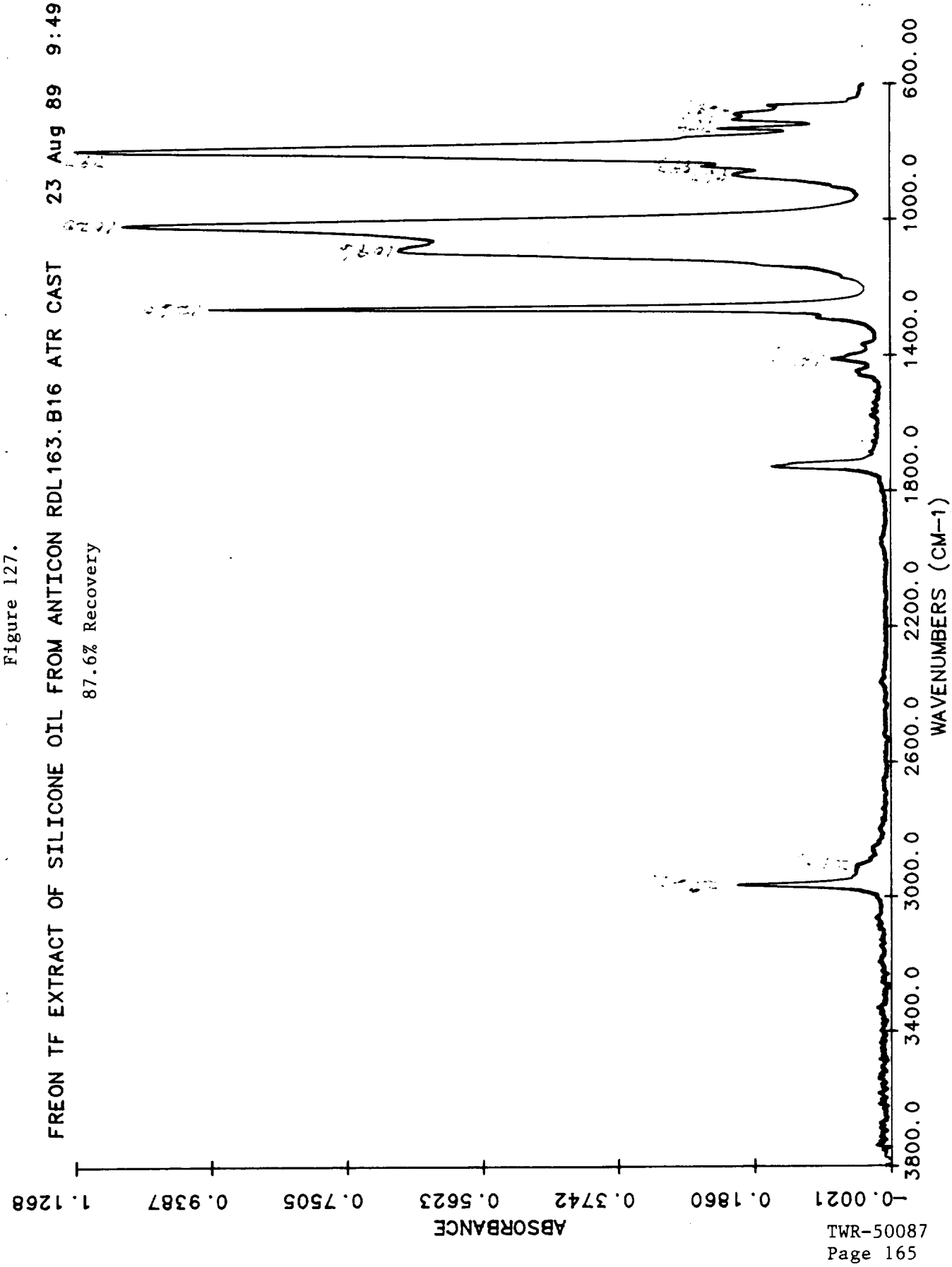


Figure 127.

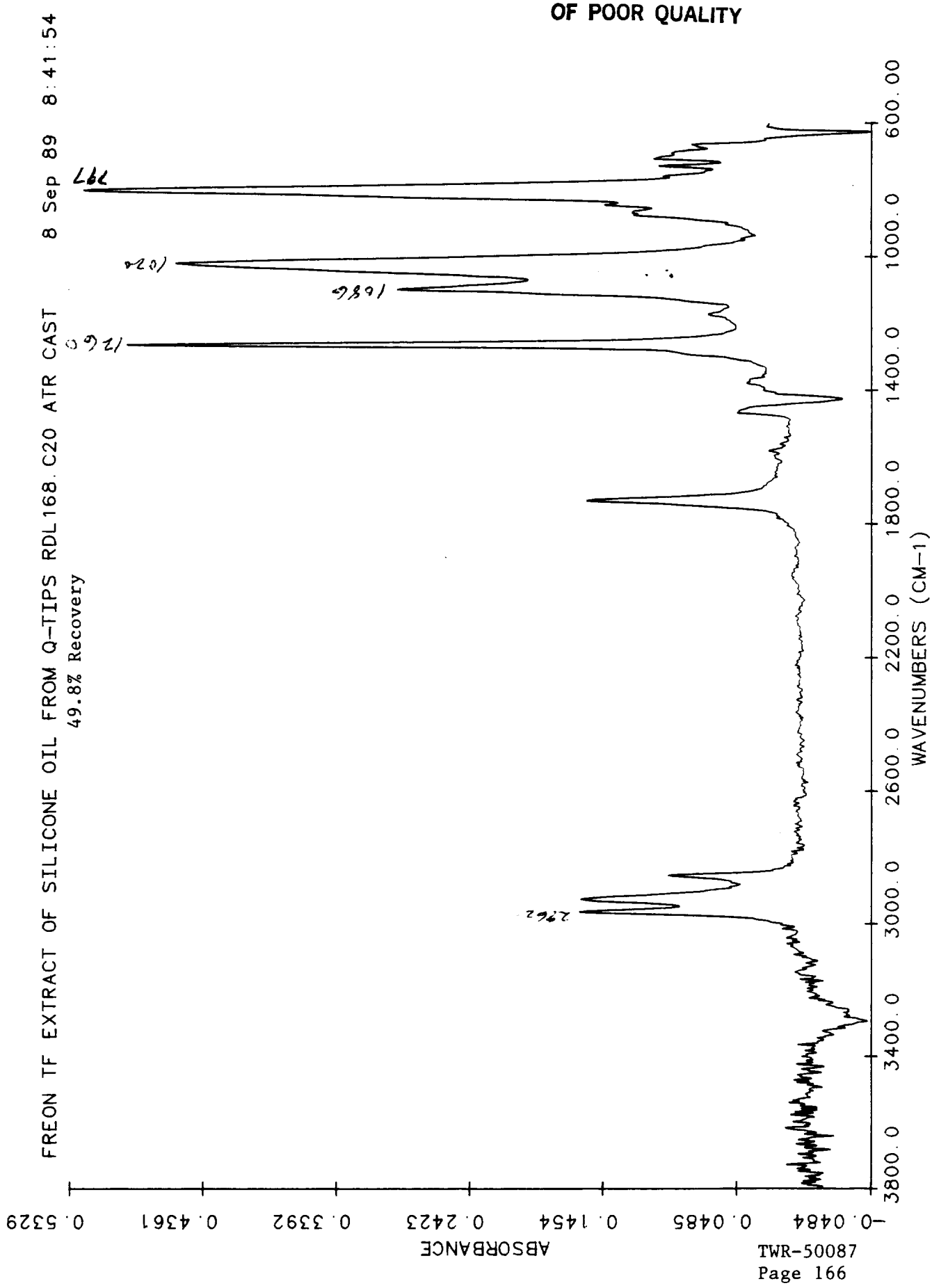


Figure 128.

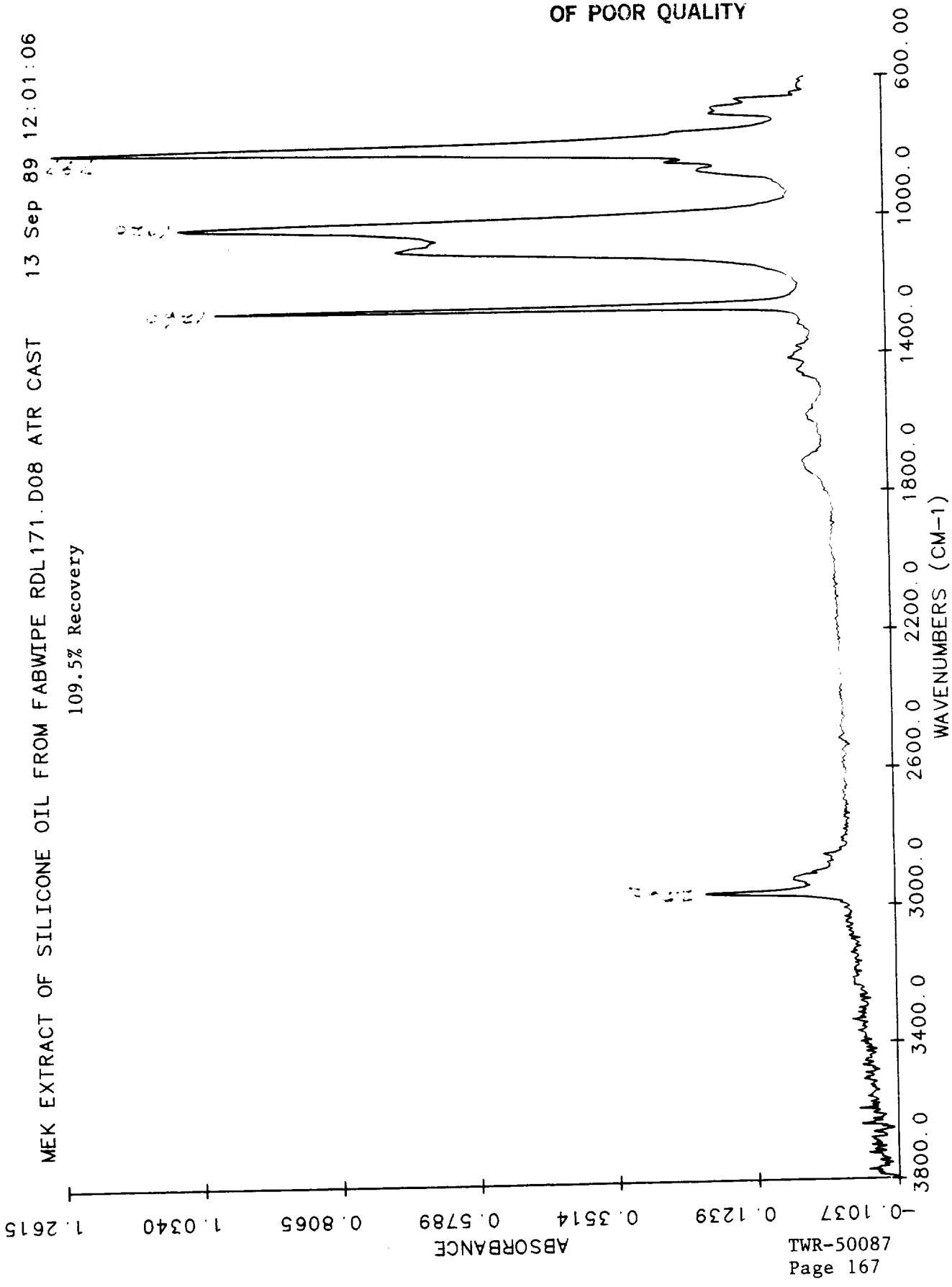


Figure 129.

Figure 130.

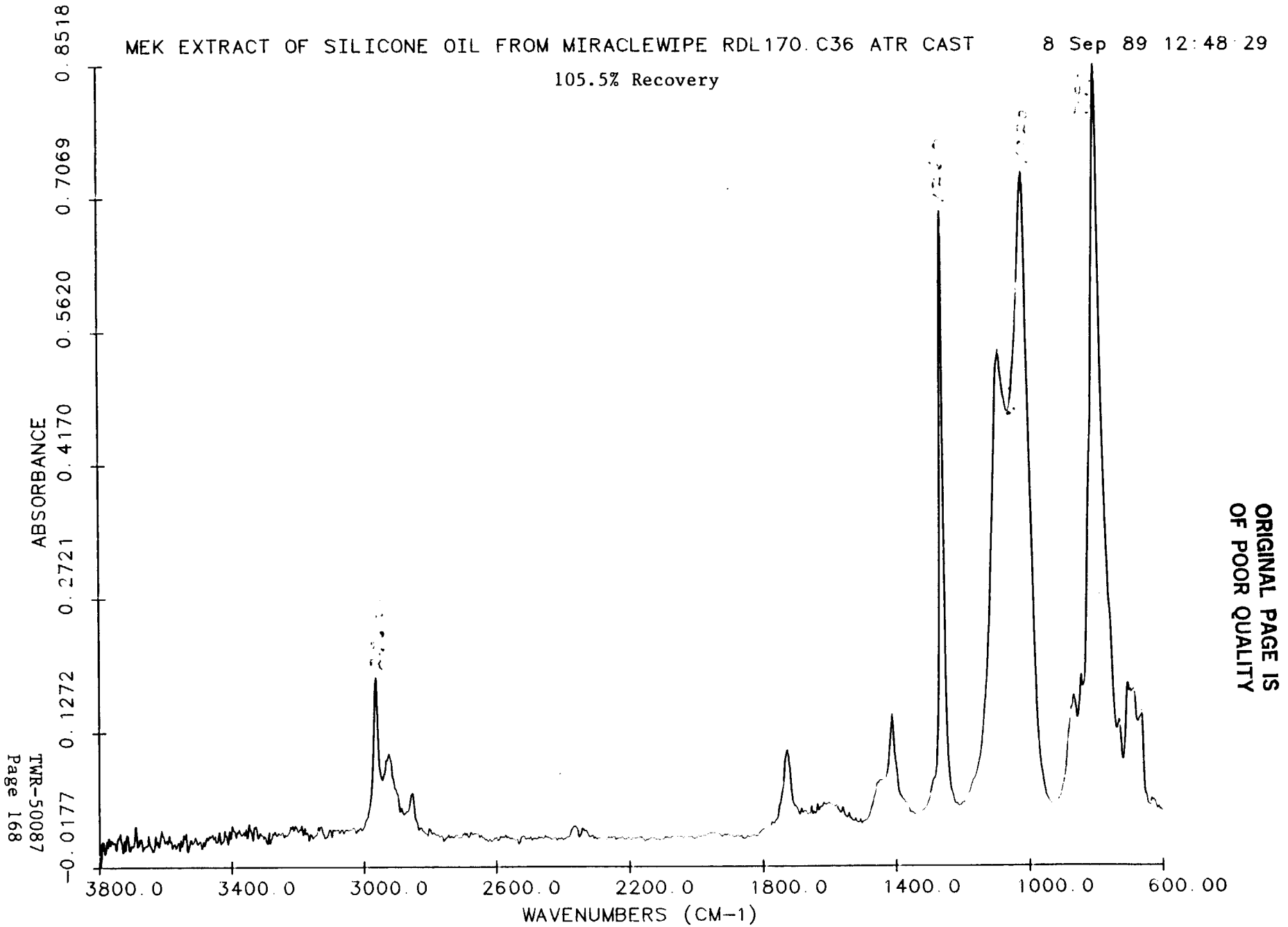
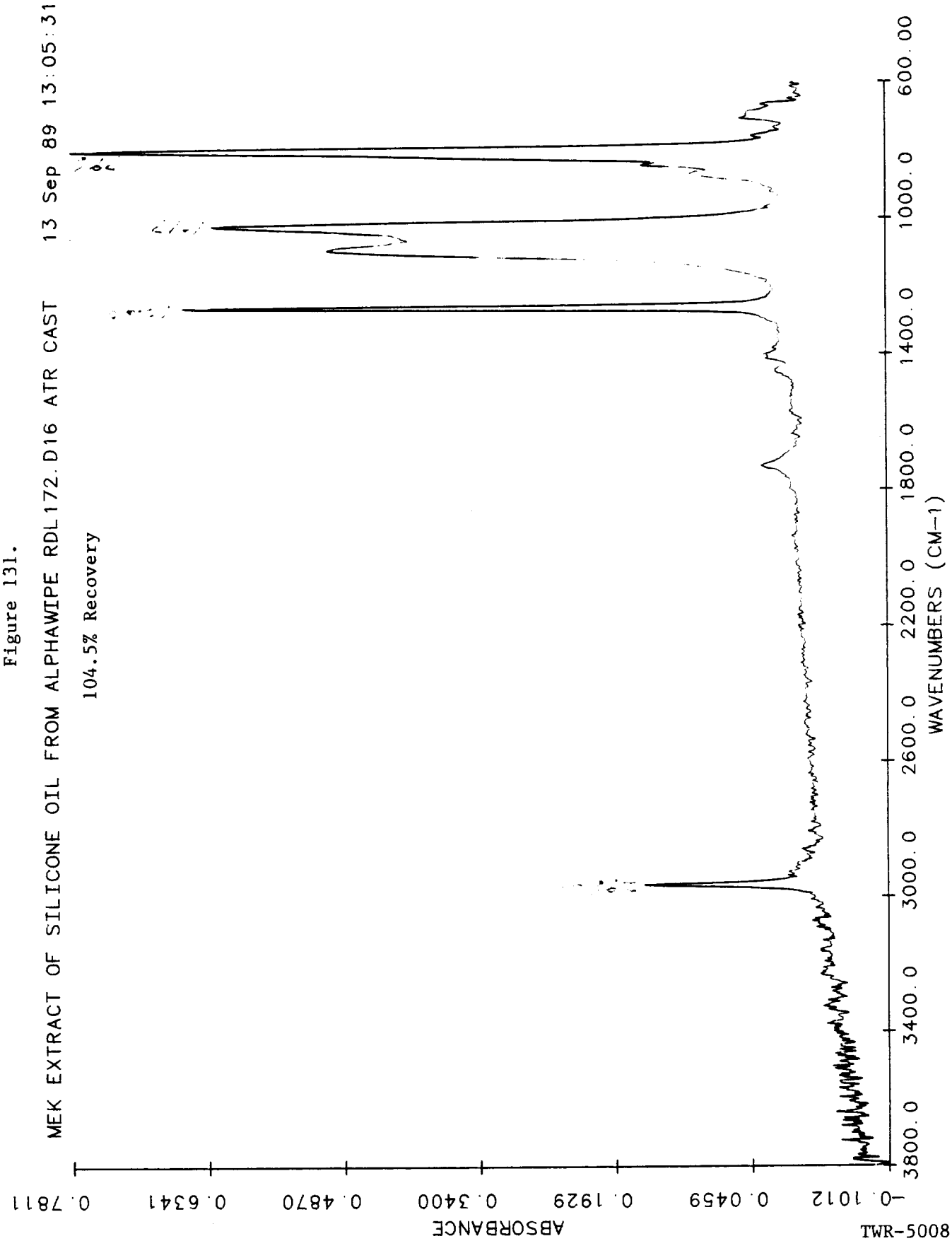


Figure 131.



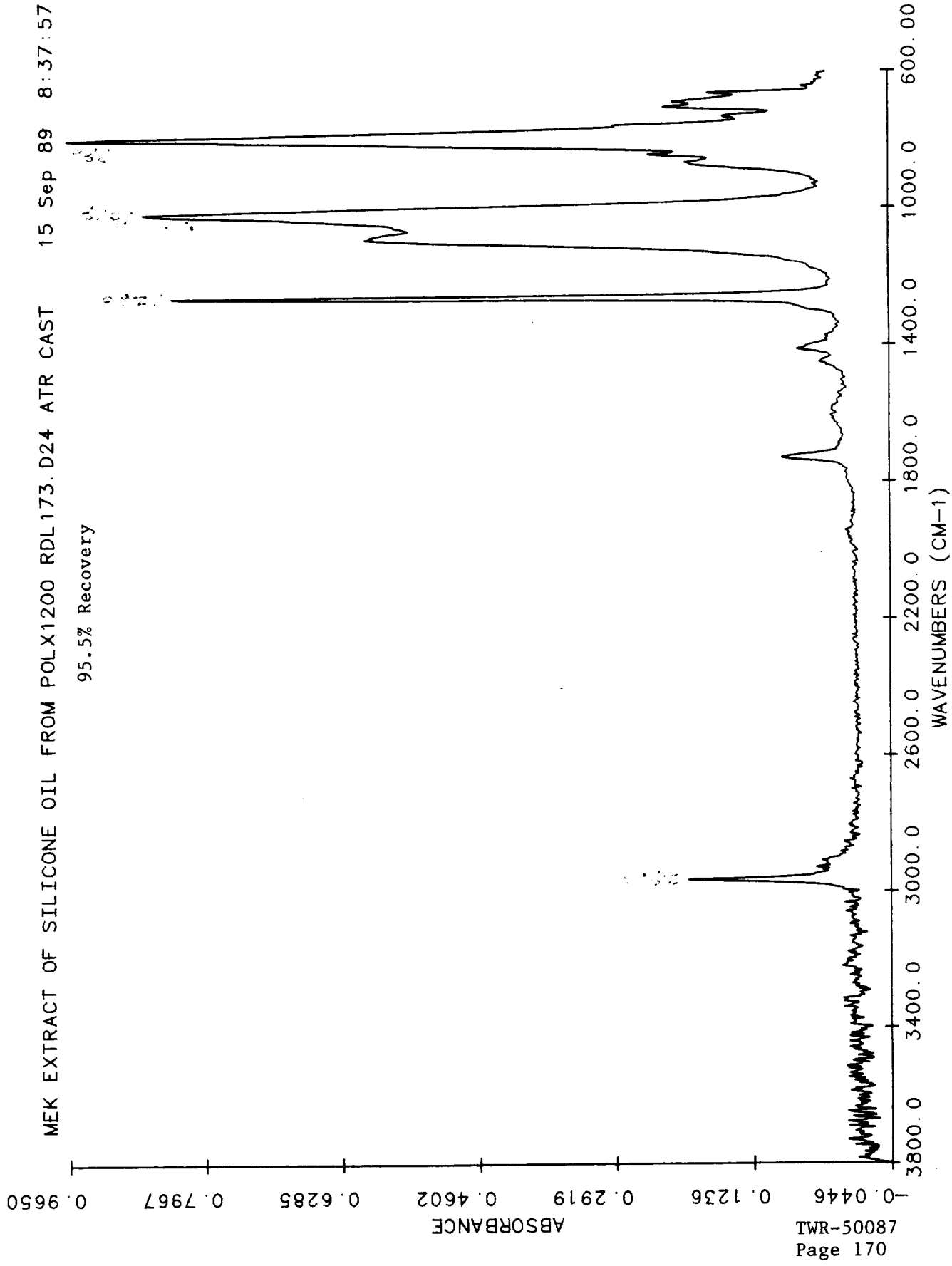


Figure 132.

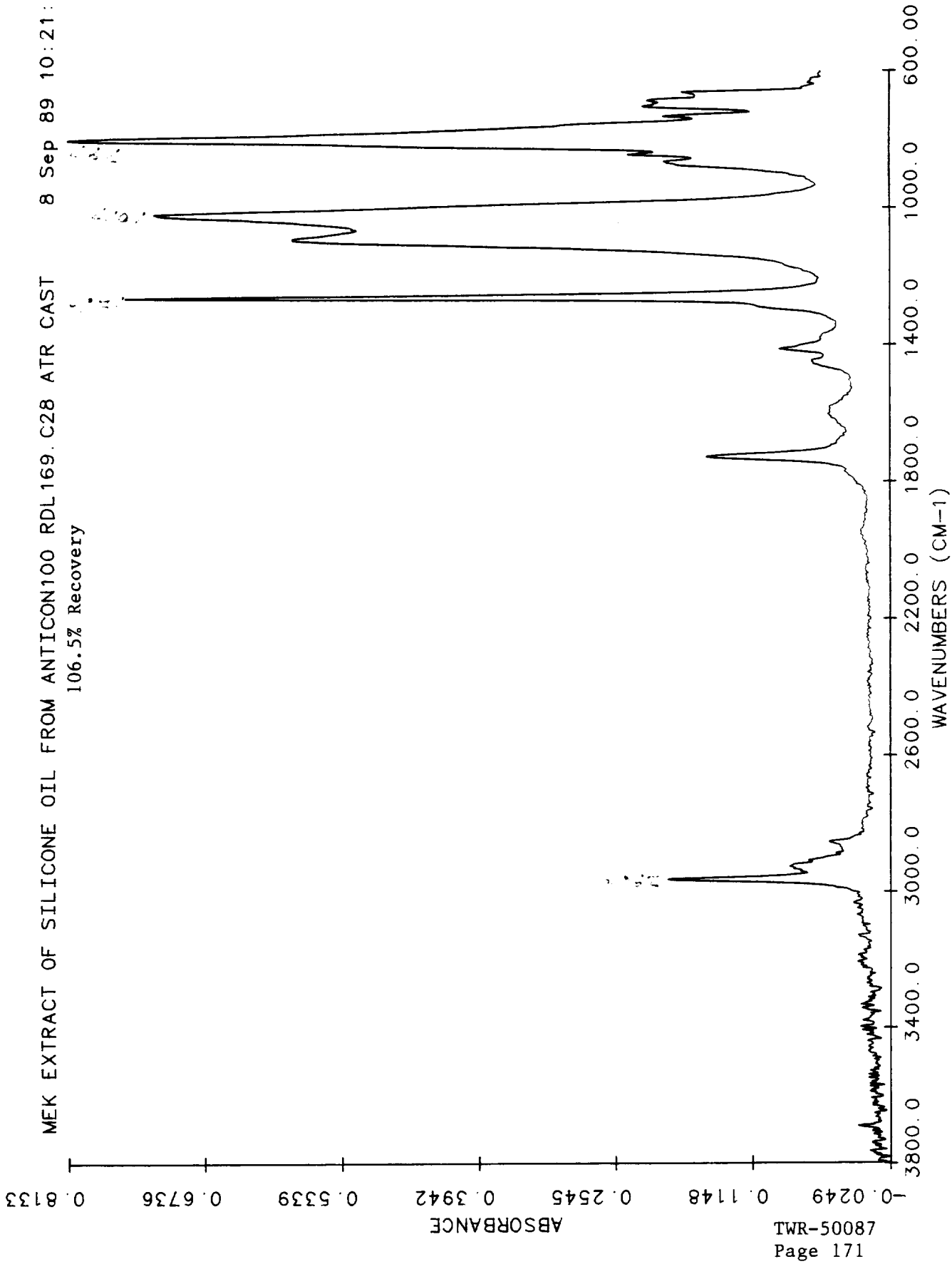


Figure 133.

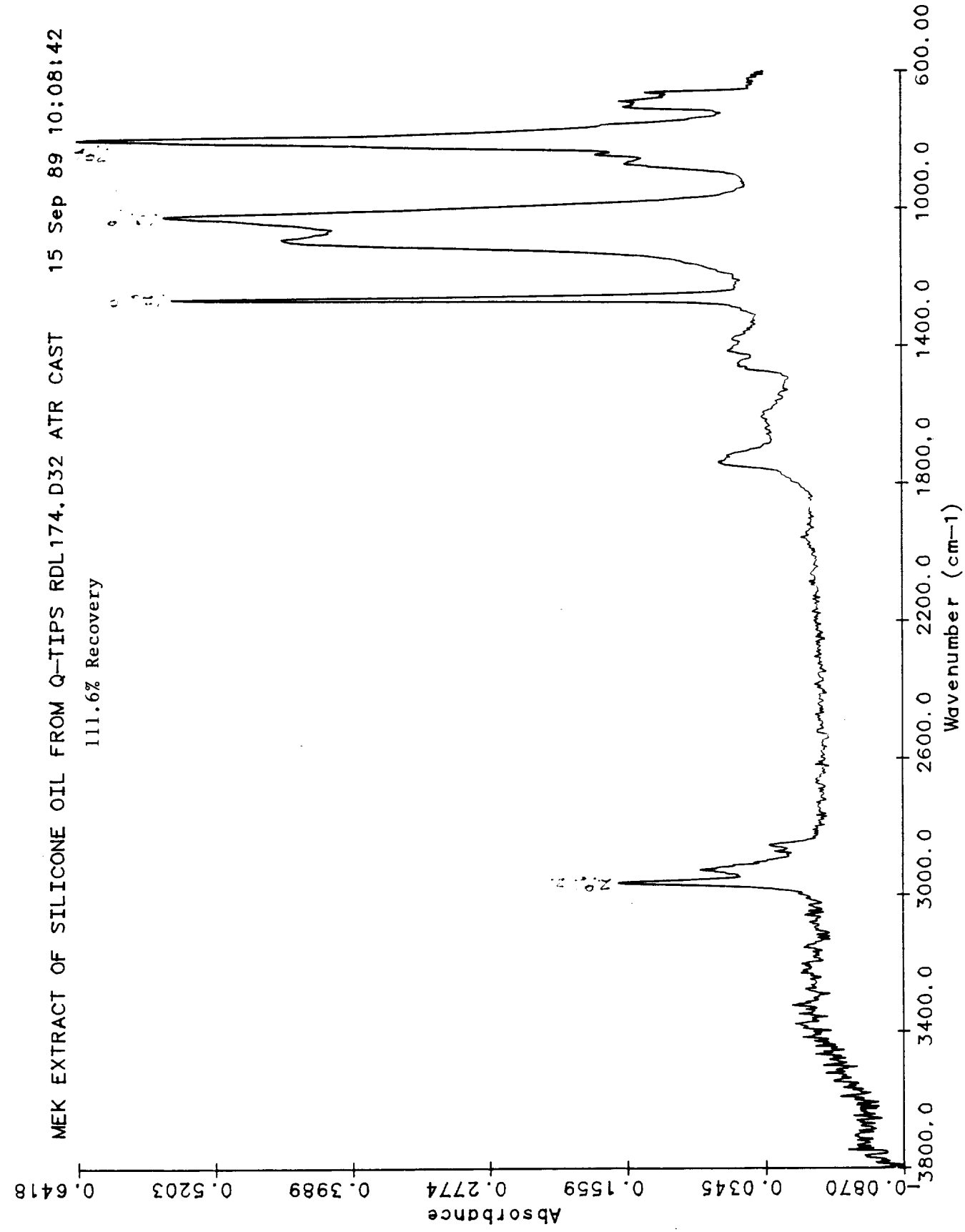


Figure 134.

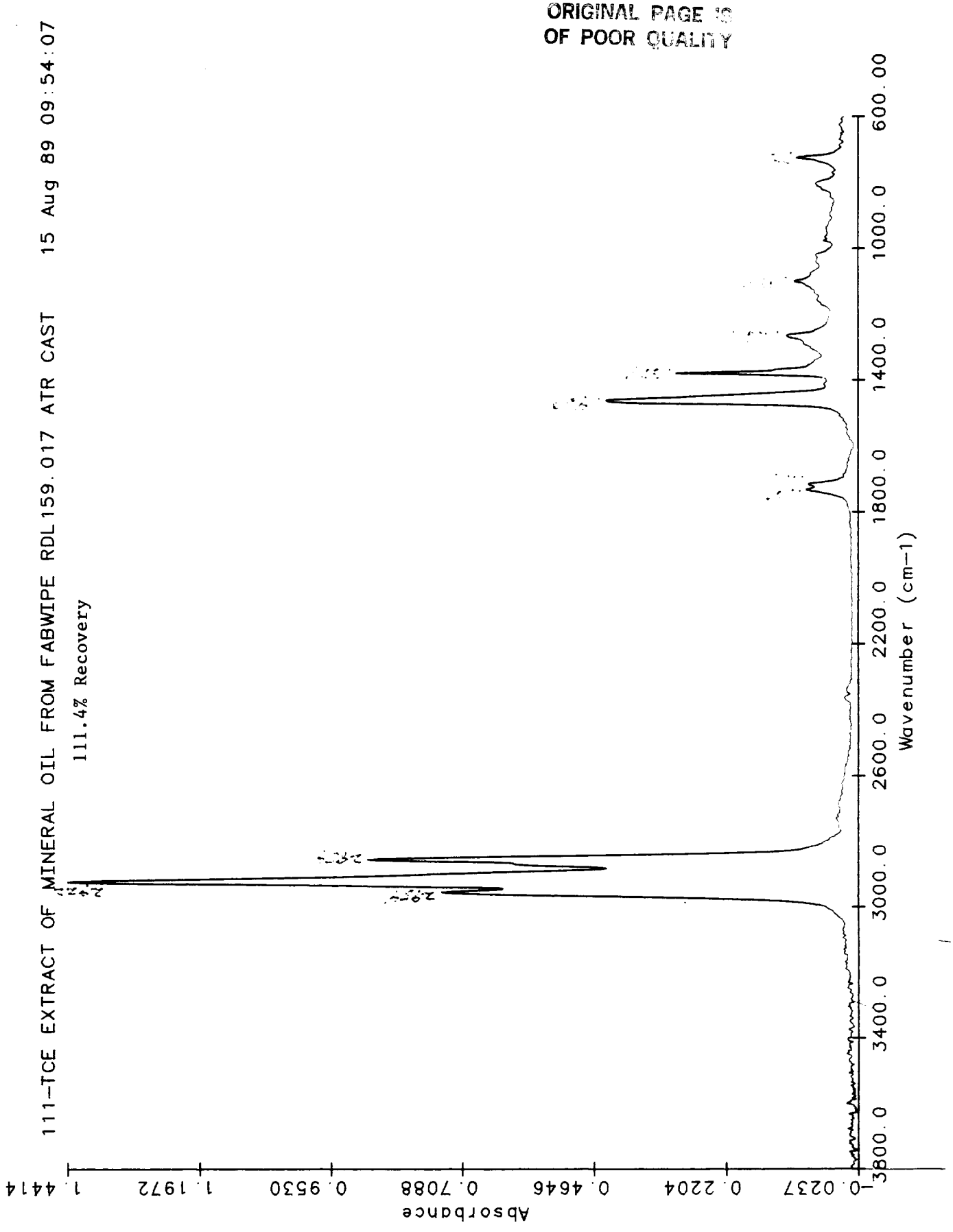


Figure 135.

Figure 136.

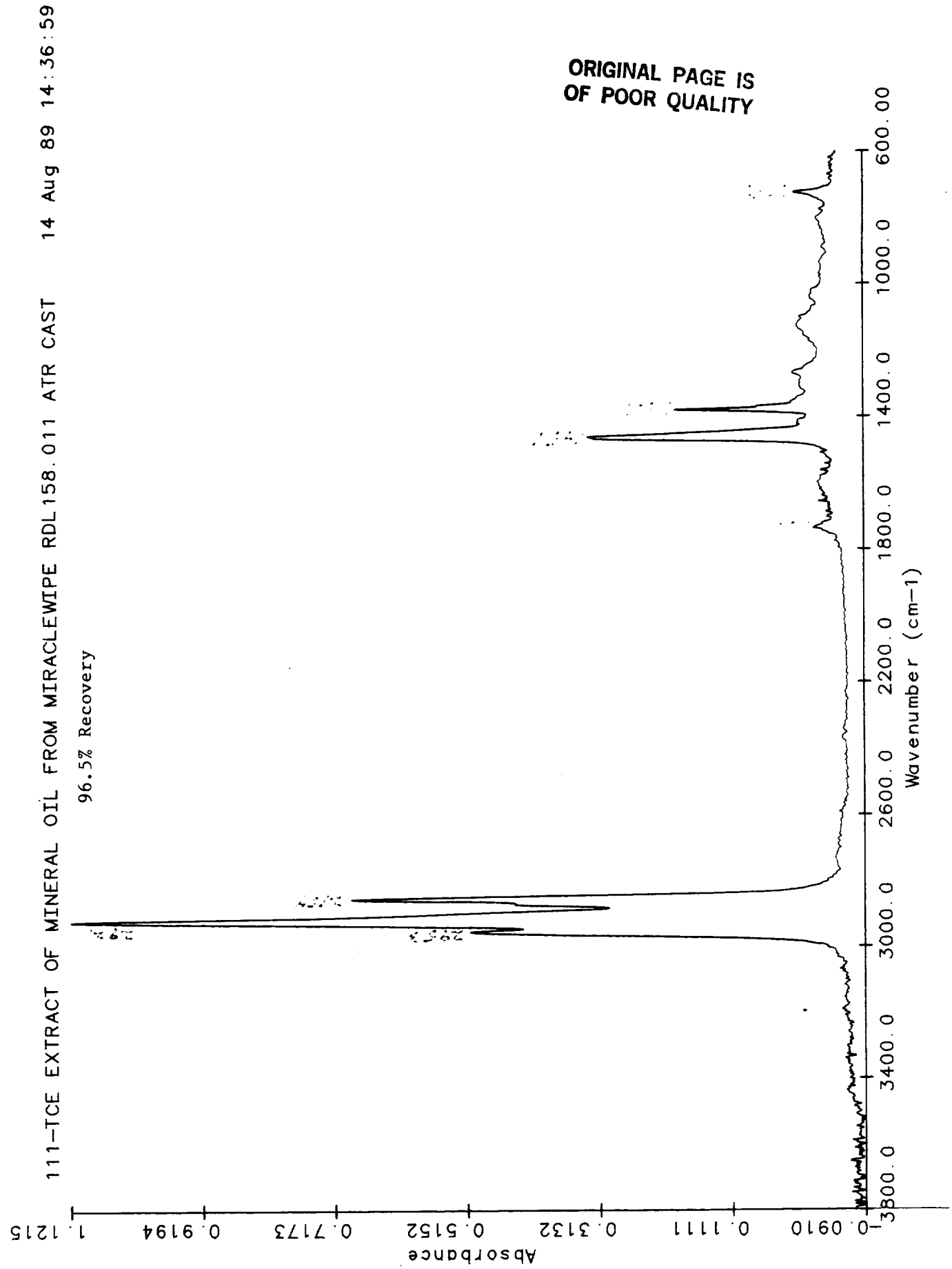

111-TCE EXTRACT OF MINERAL OIL FROM MIRACLEWIPE RDL158.011 ATR CAST 14 Aug 89 14:36:59
96.5% Recovery
ORIGINAL PAGE IS
OF POOR QUALITY
Absorbance
1.1215
0.9194
0.7173
0.5152
0.3132
0.1111
0.0910
Wavenumber (cm-1)
600.00
1000.0
1400.0
1800.0
2200.0
2600.0
3000.0
3400.0
3800.0

Figure 137.

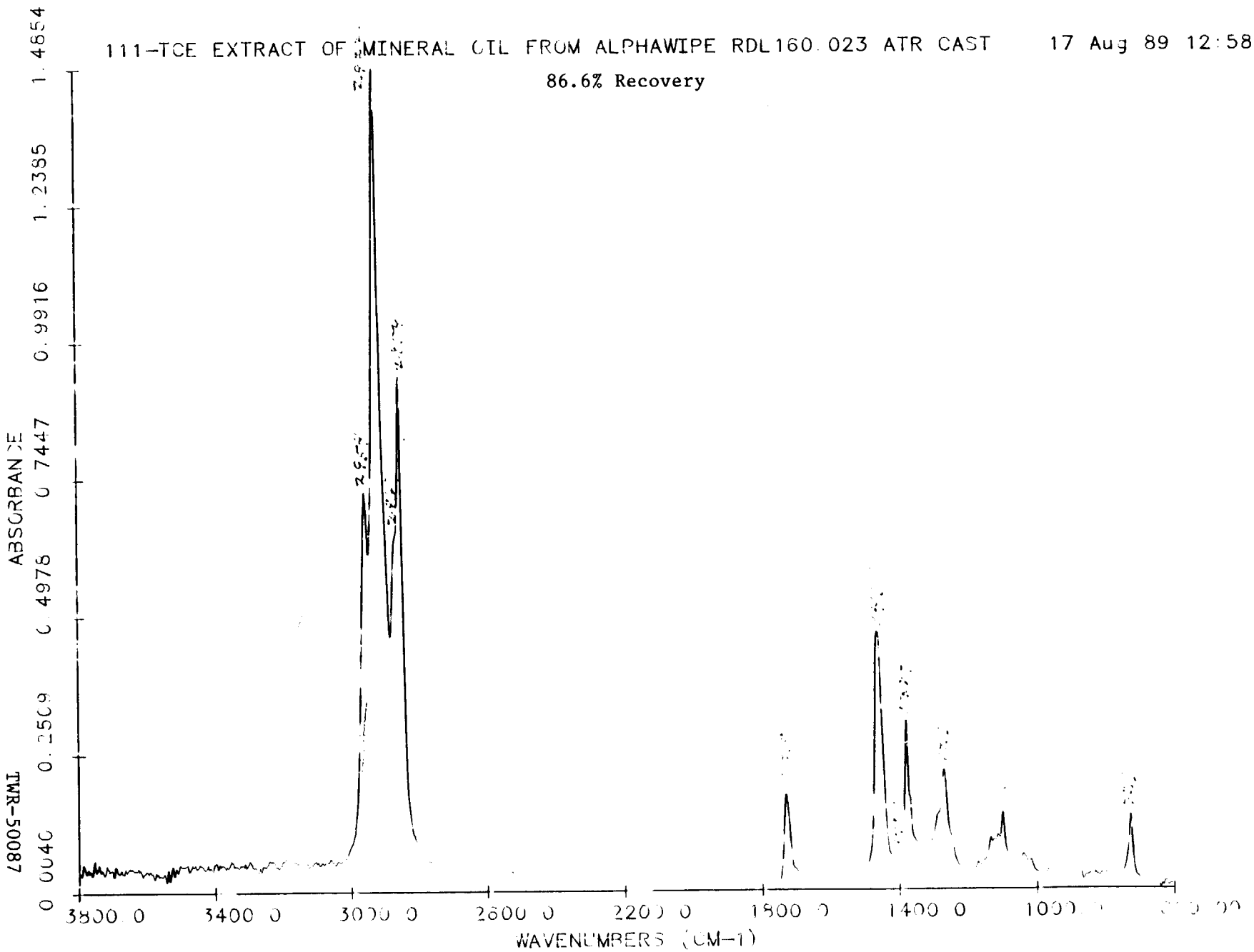


Figure 138.

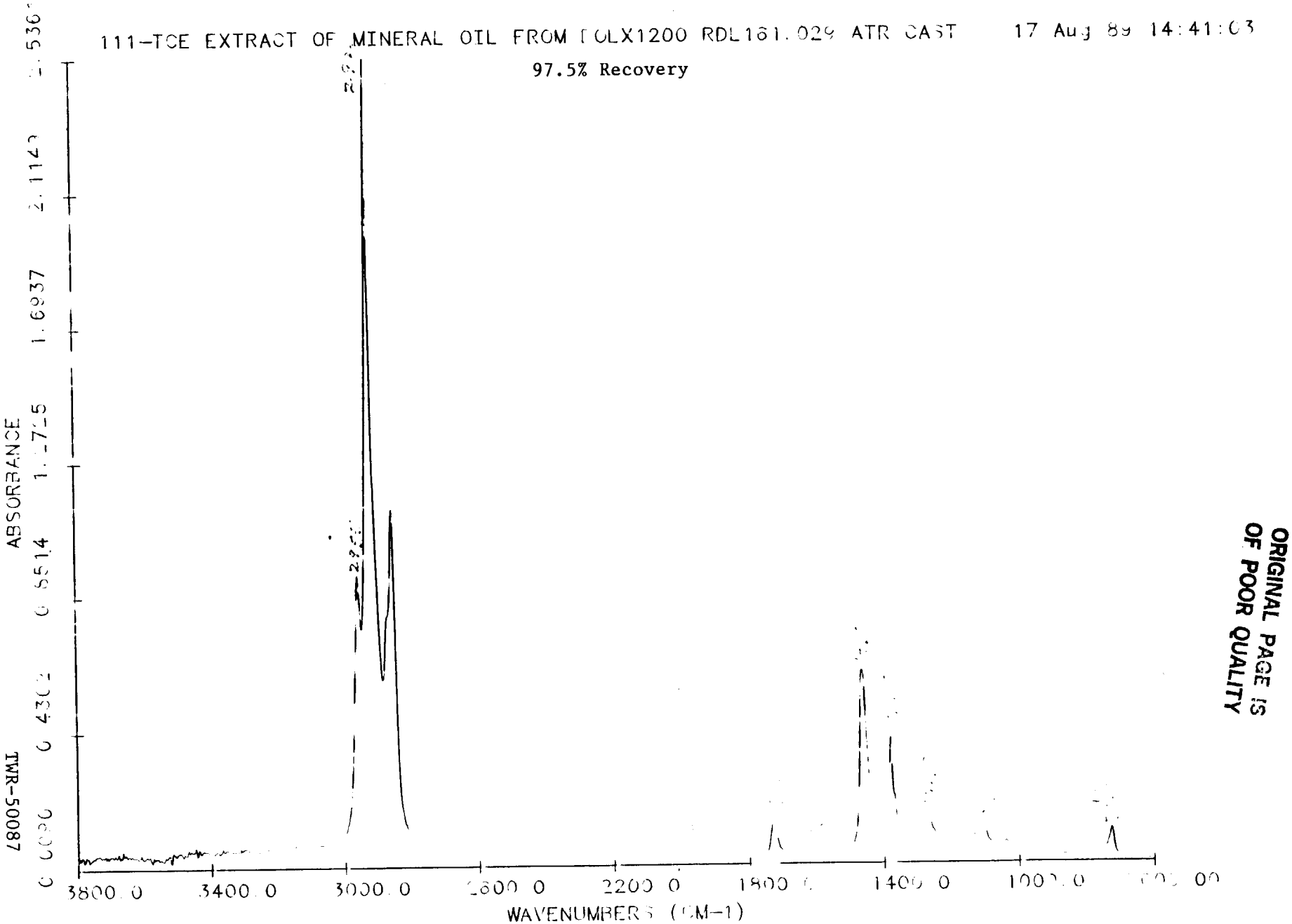
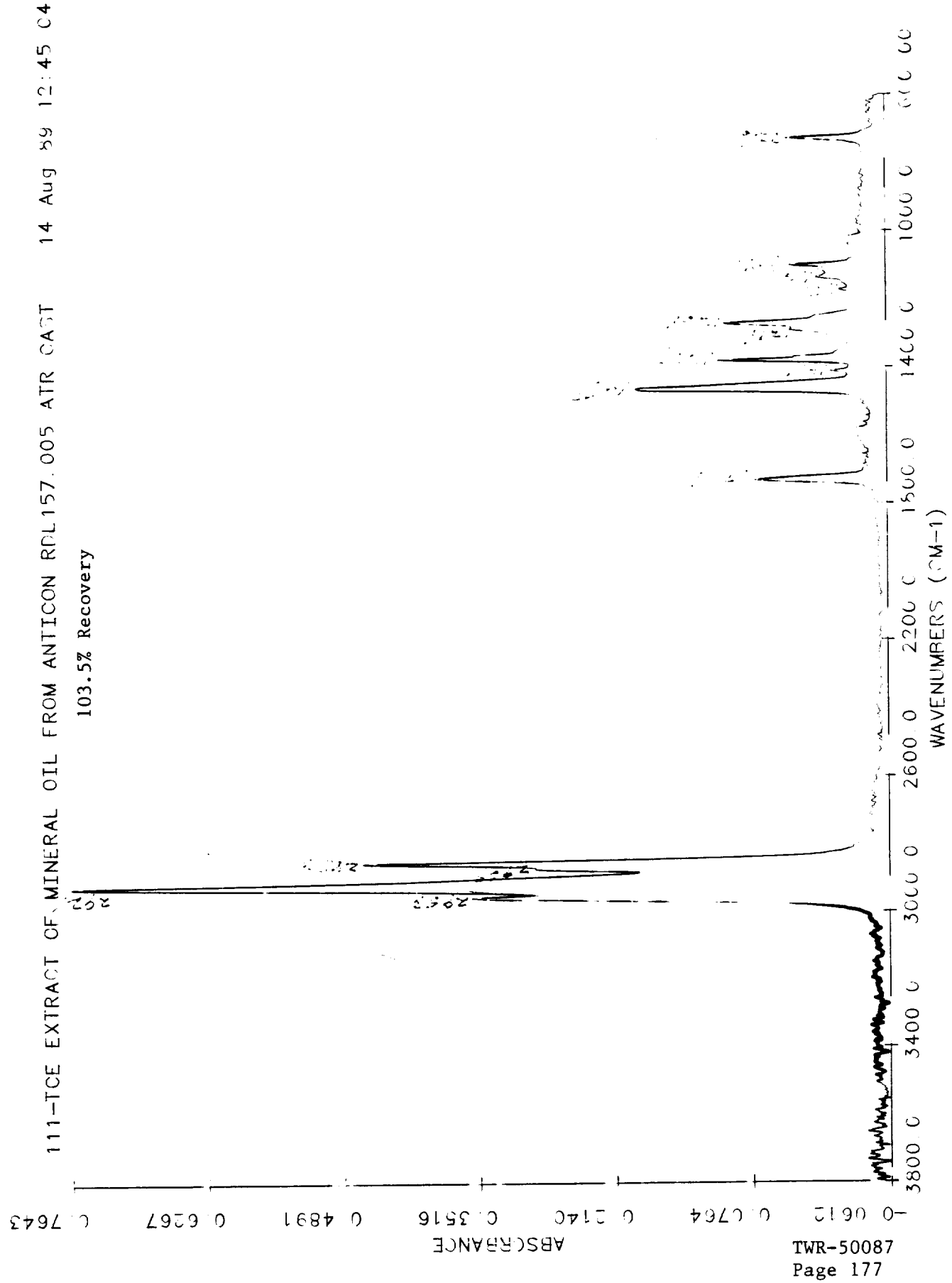


Figure 139.



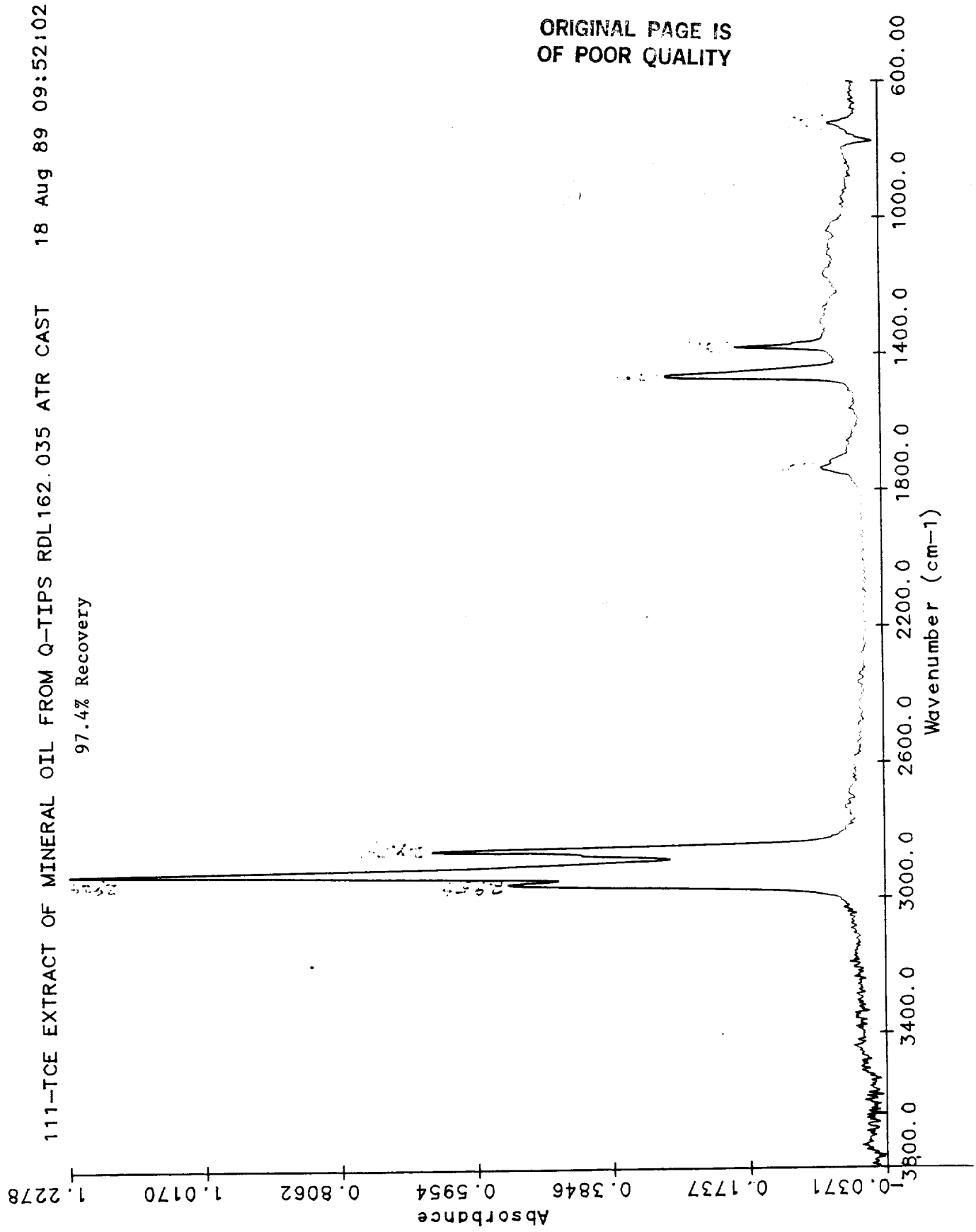


Figure 140.

Figure 141.

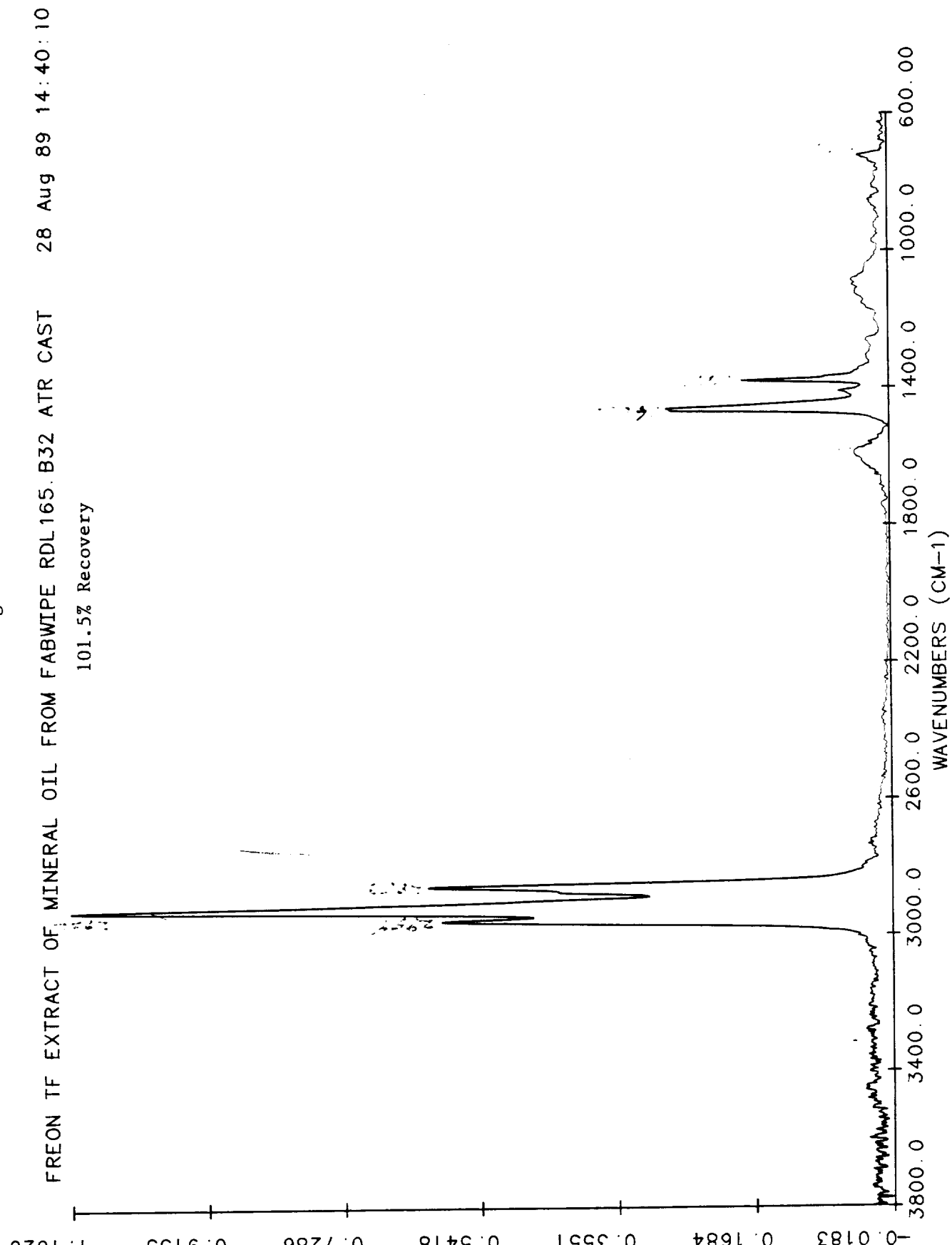


Figure 142.

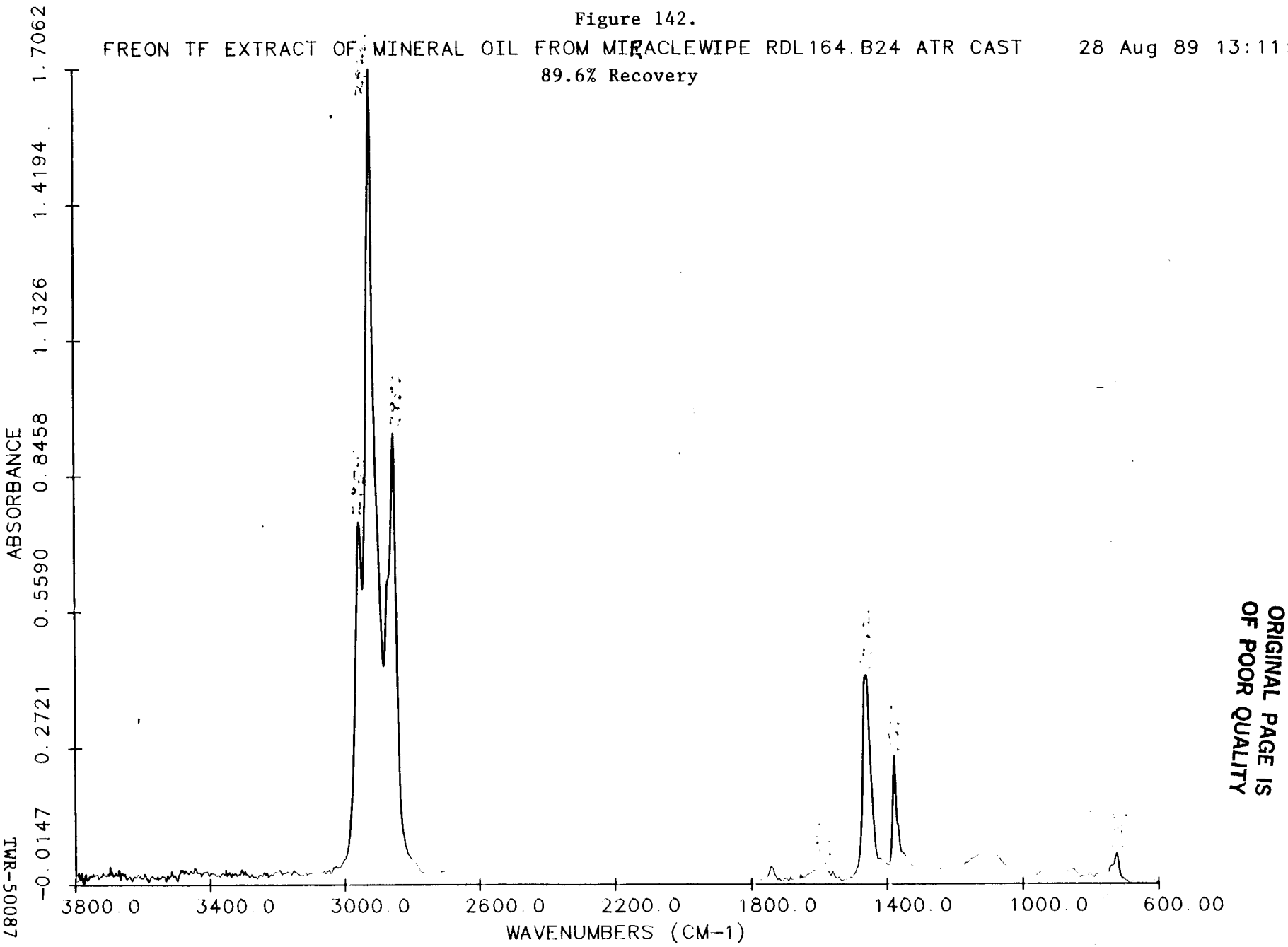


Figure 143.

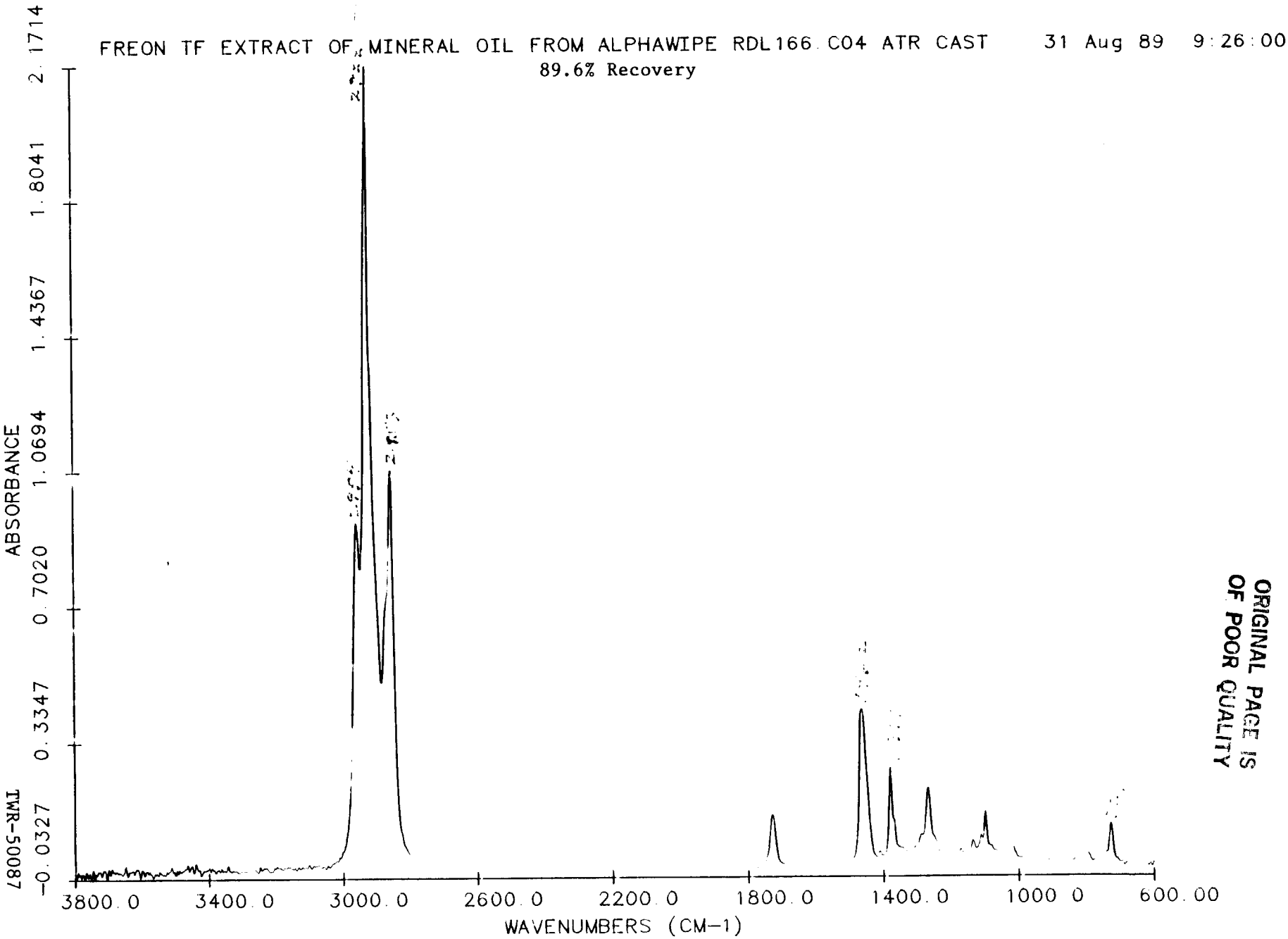


Figure 144.

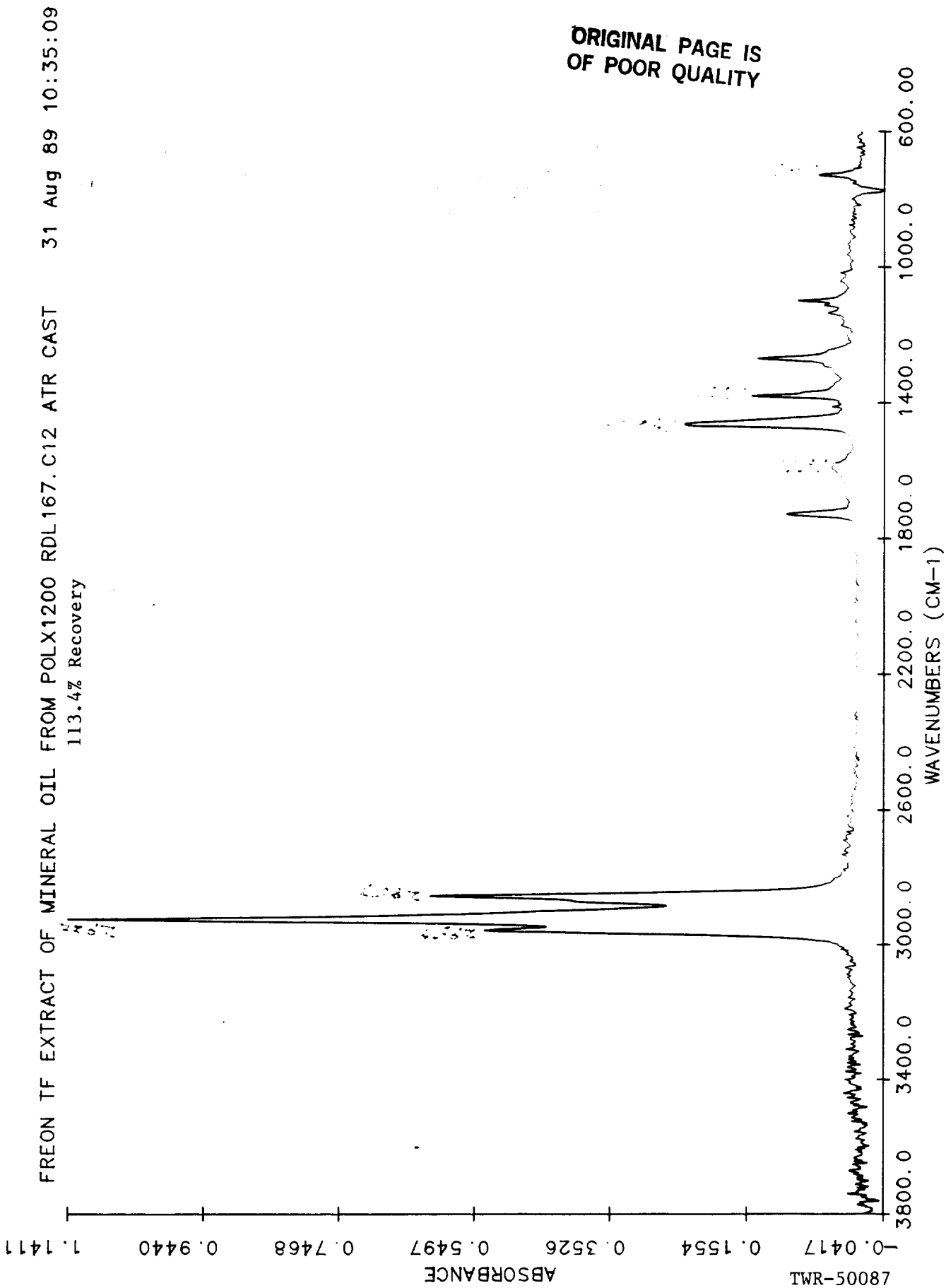


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Figure 145.

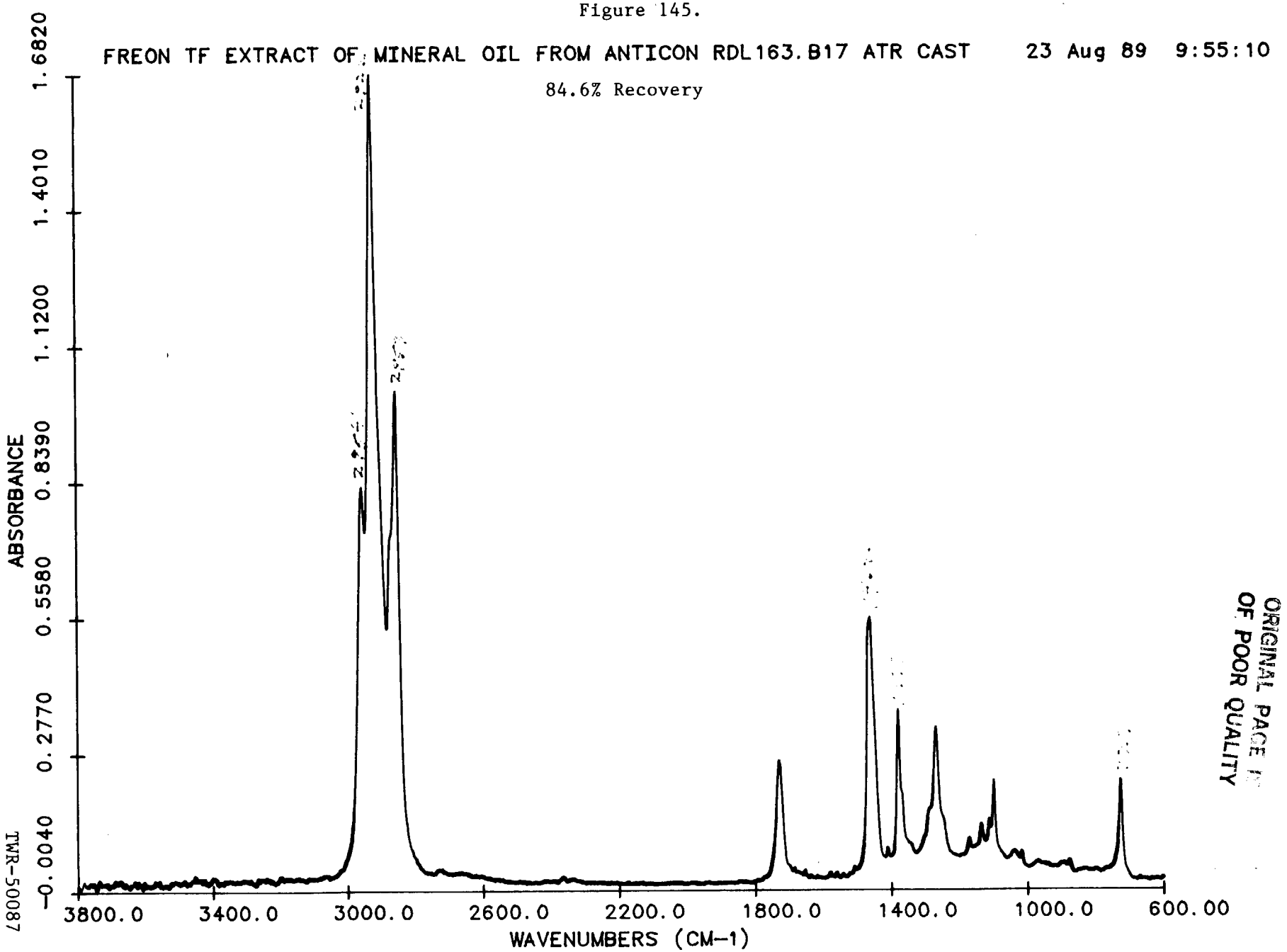


Figure 146.

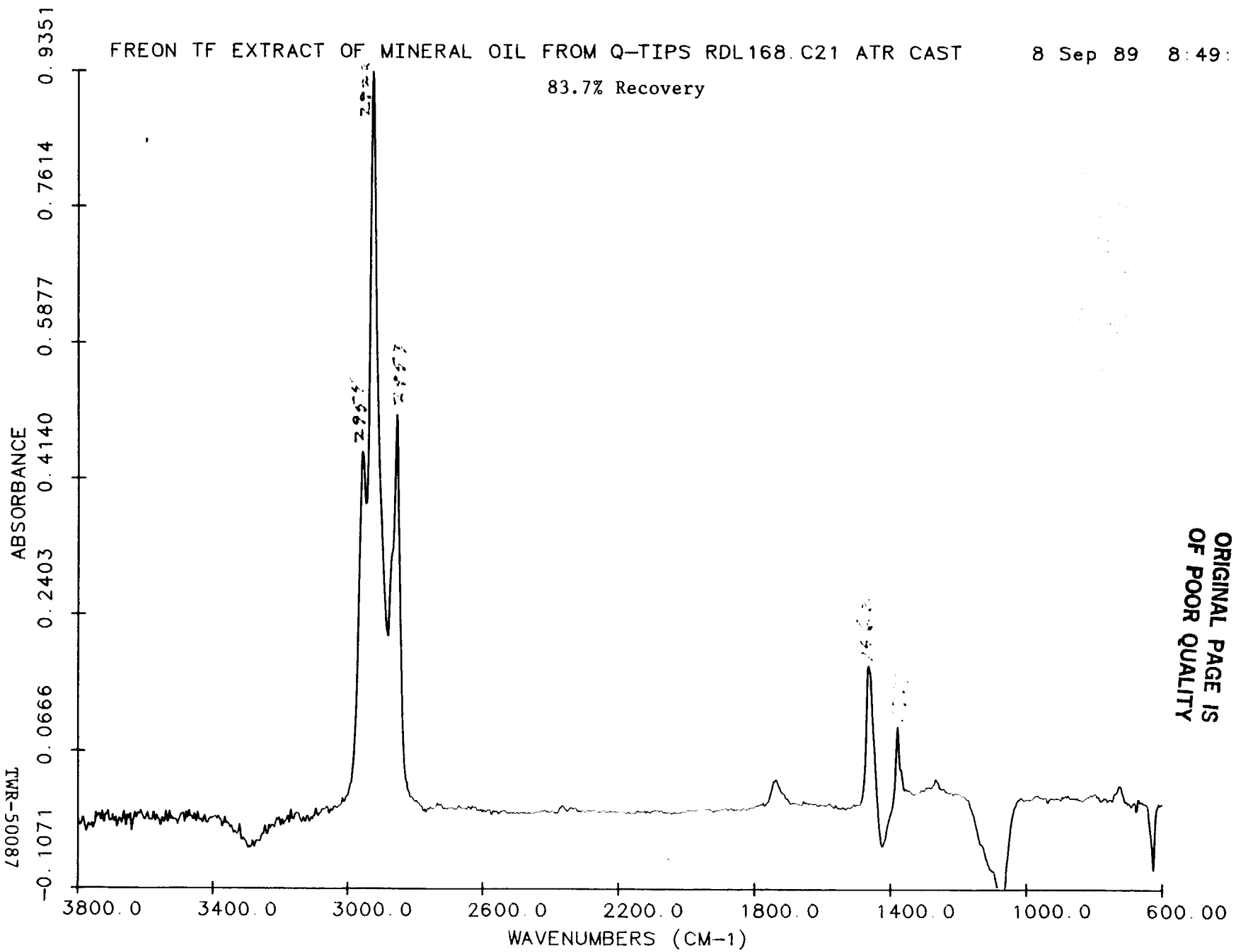
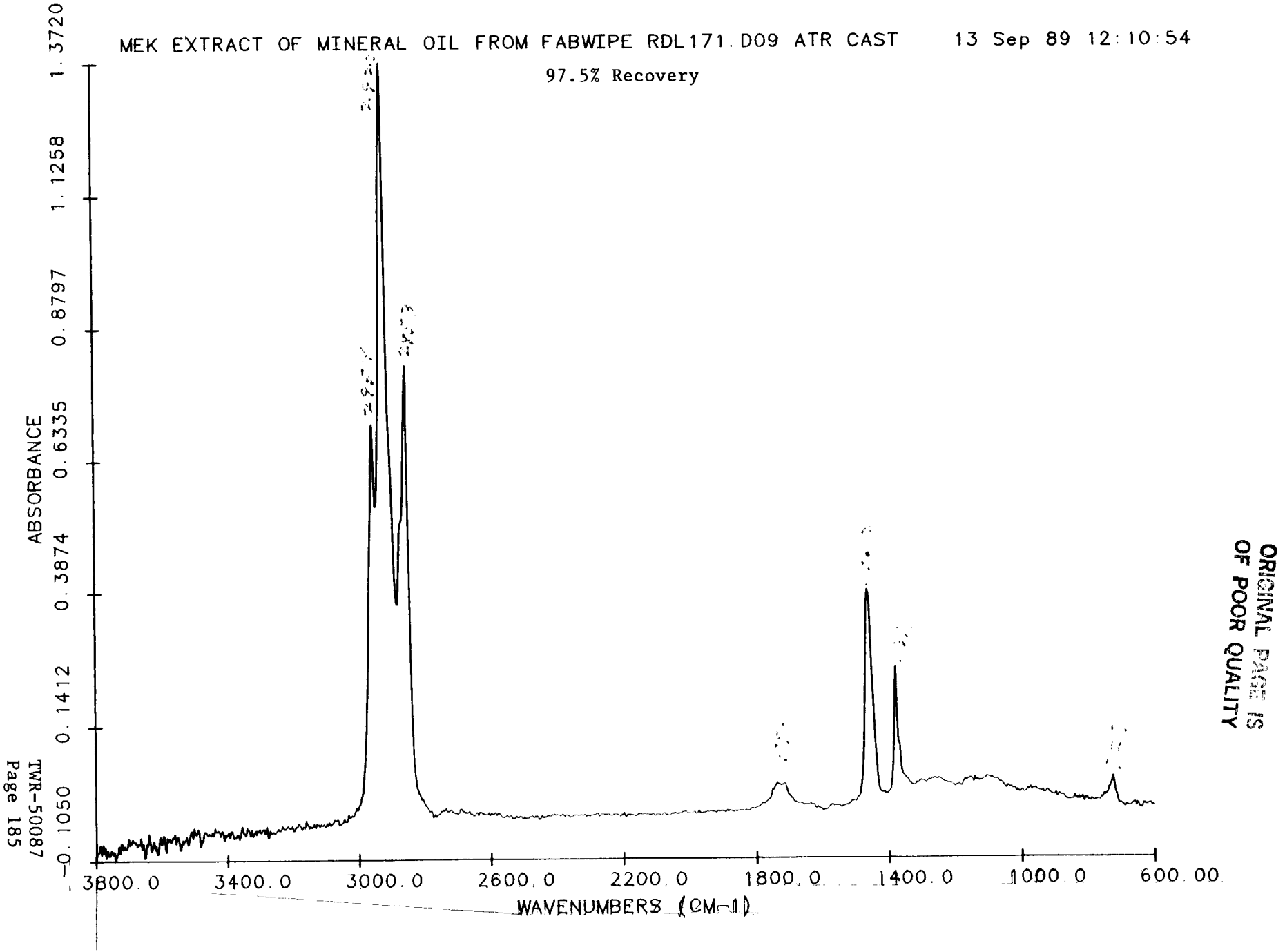


Figure 147.



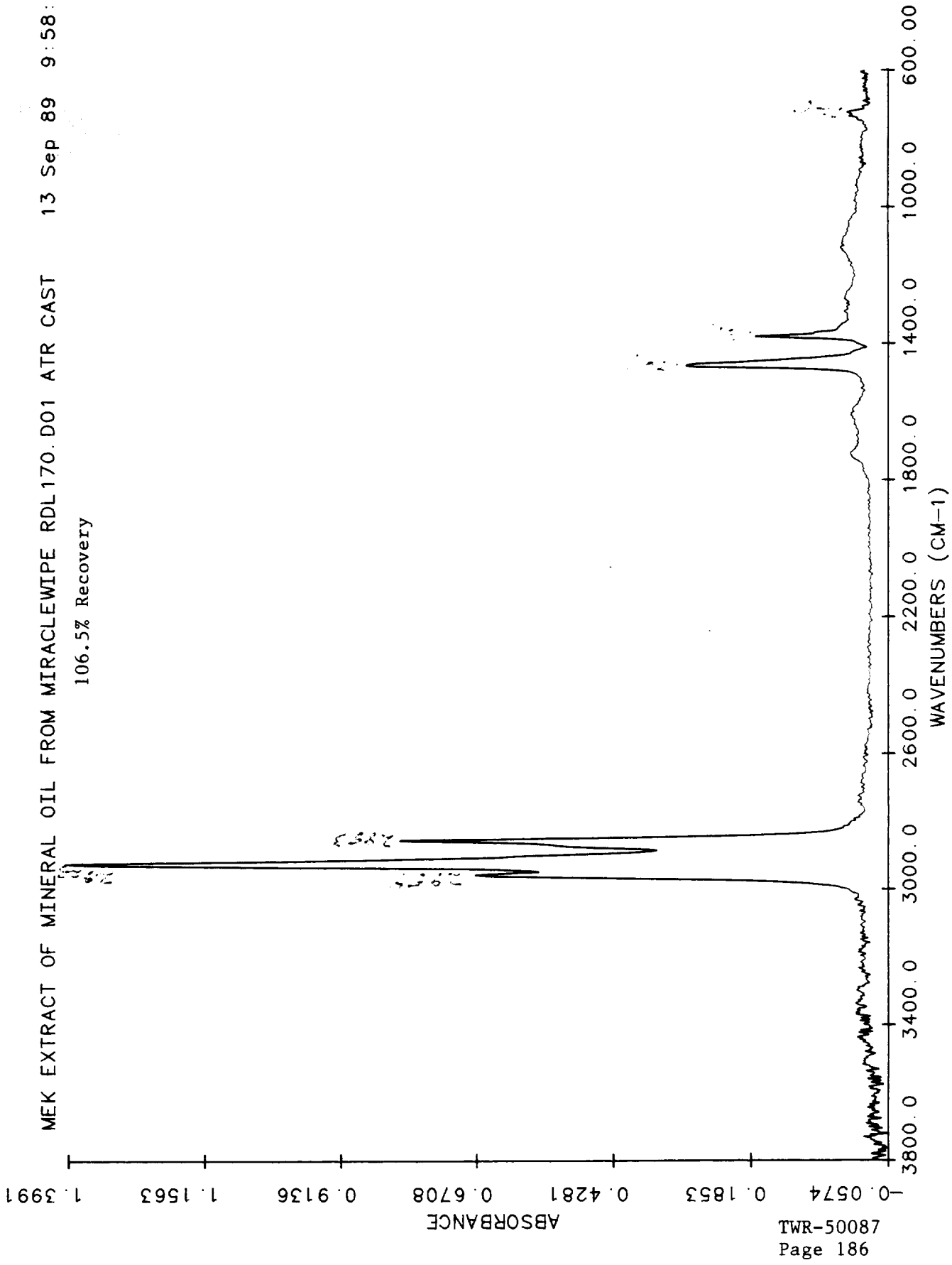


Figure 148.

Figure 149.

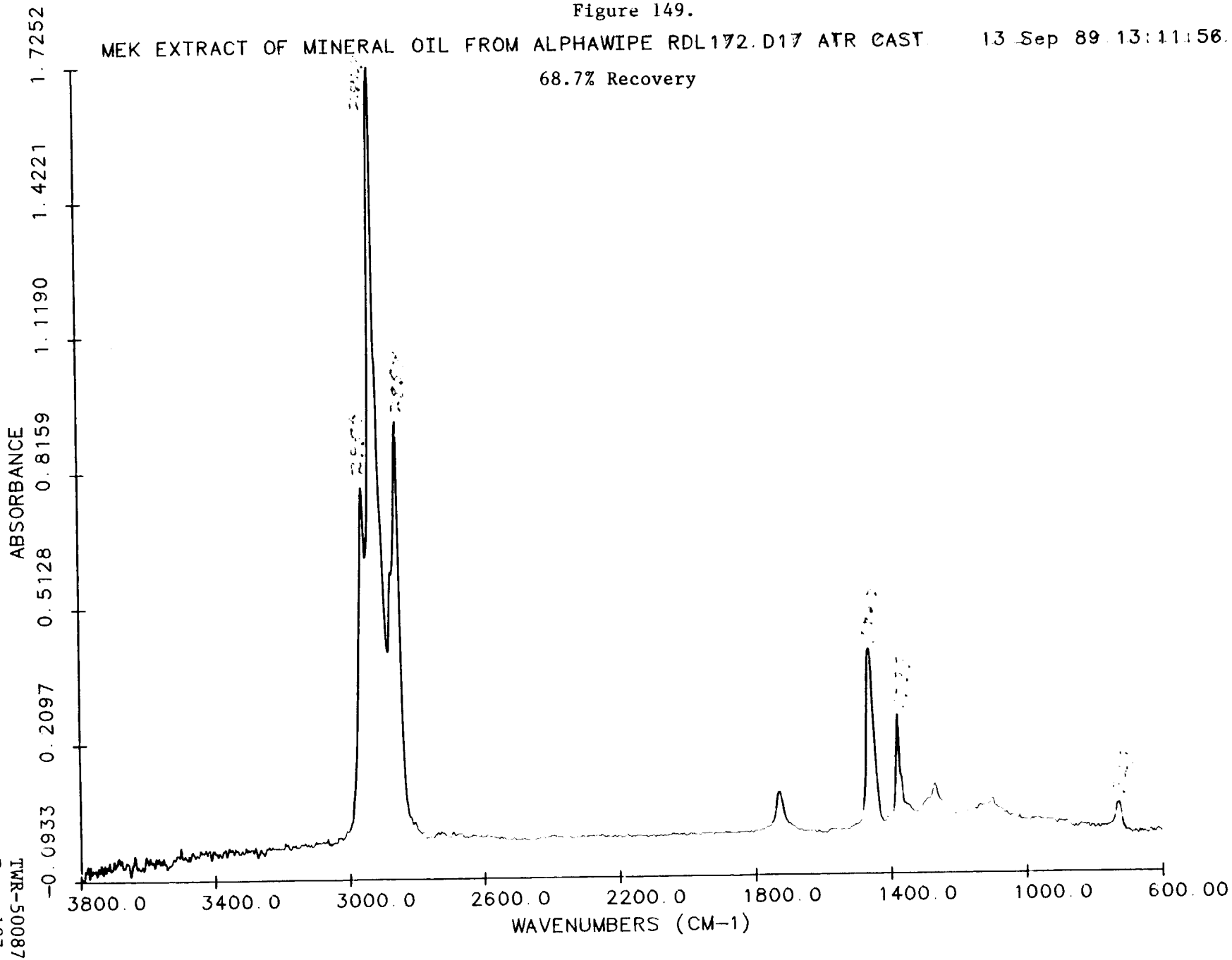
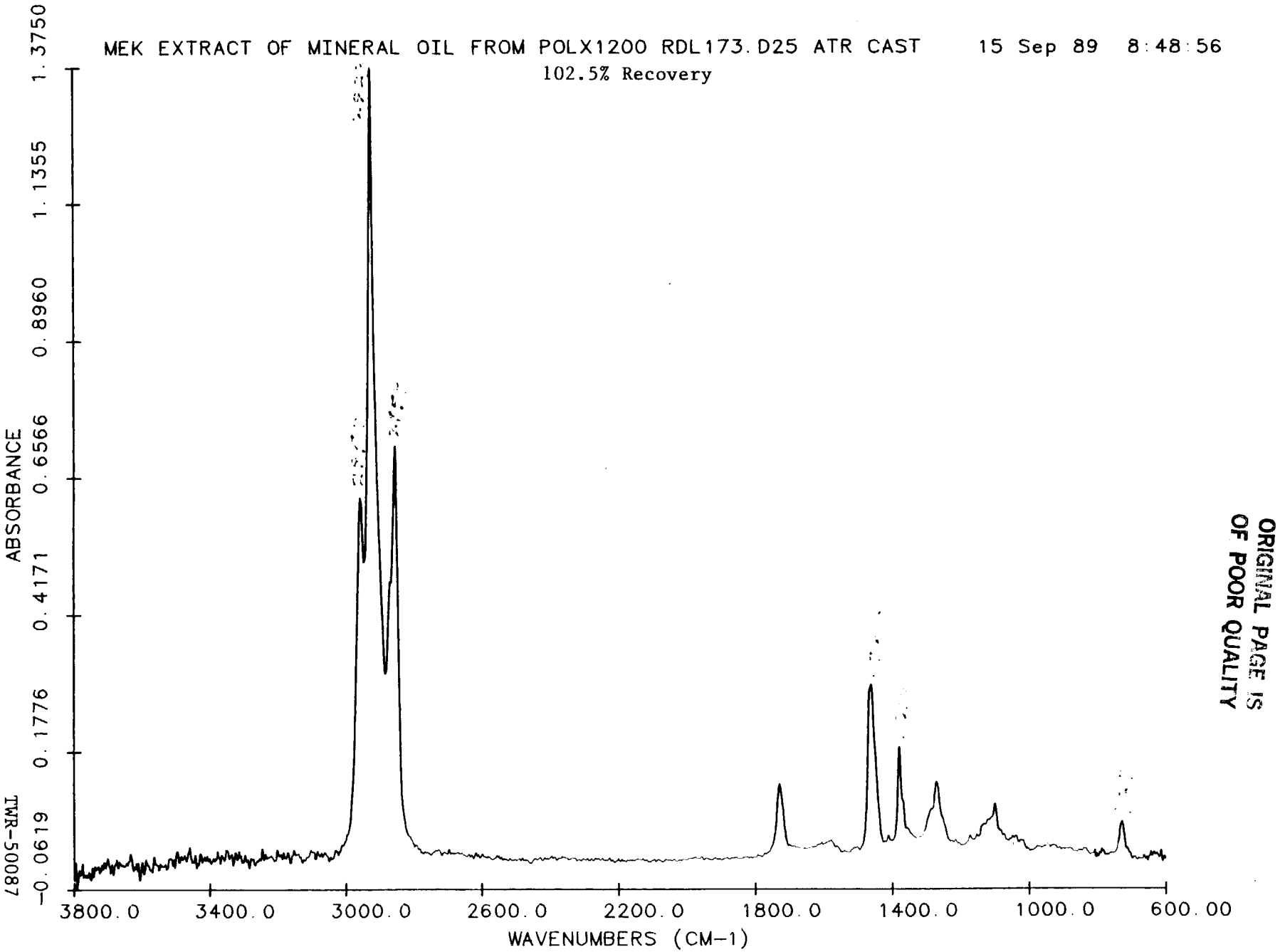


Figure 150.



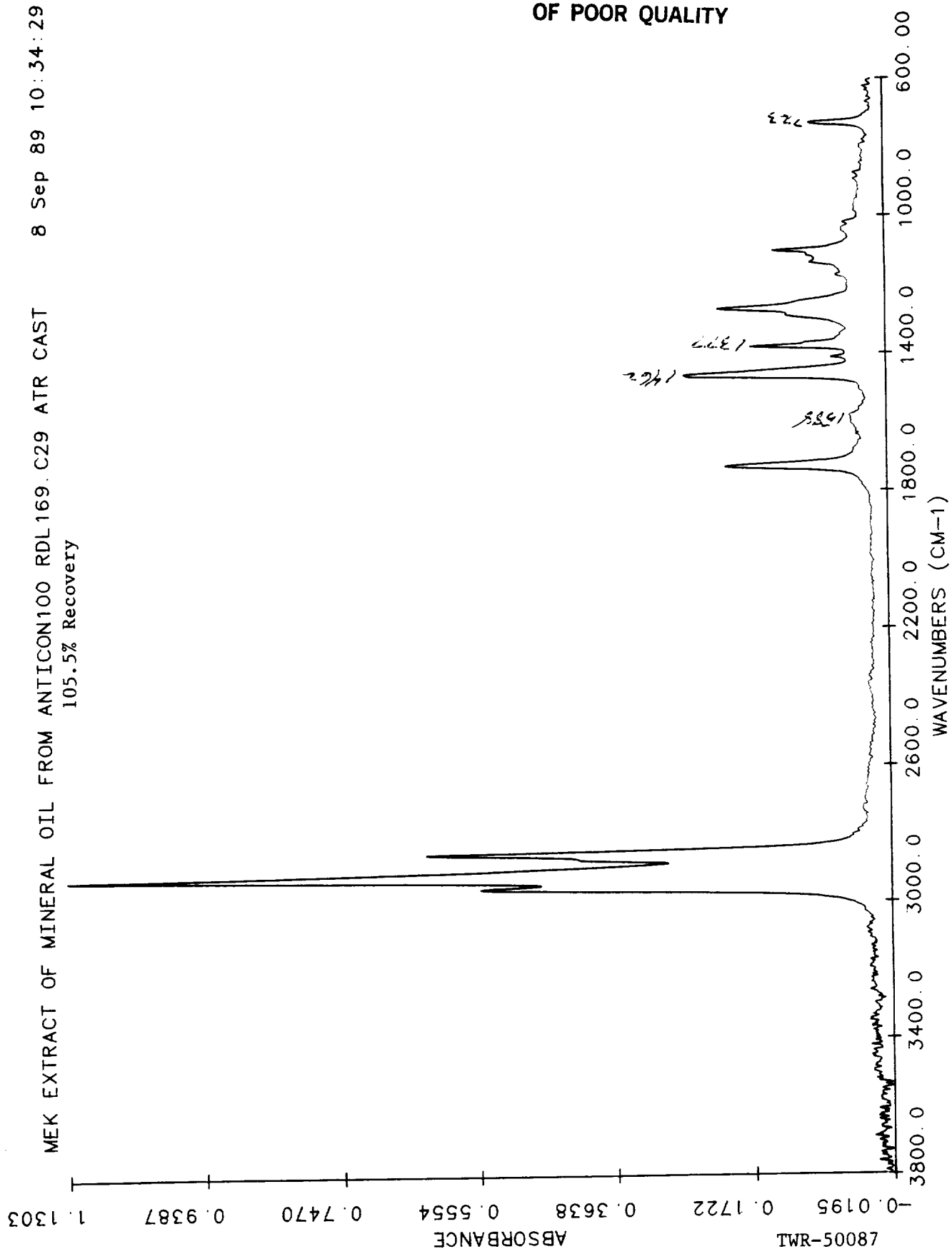
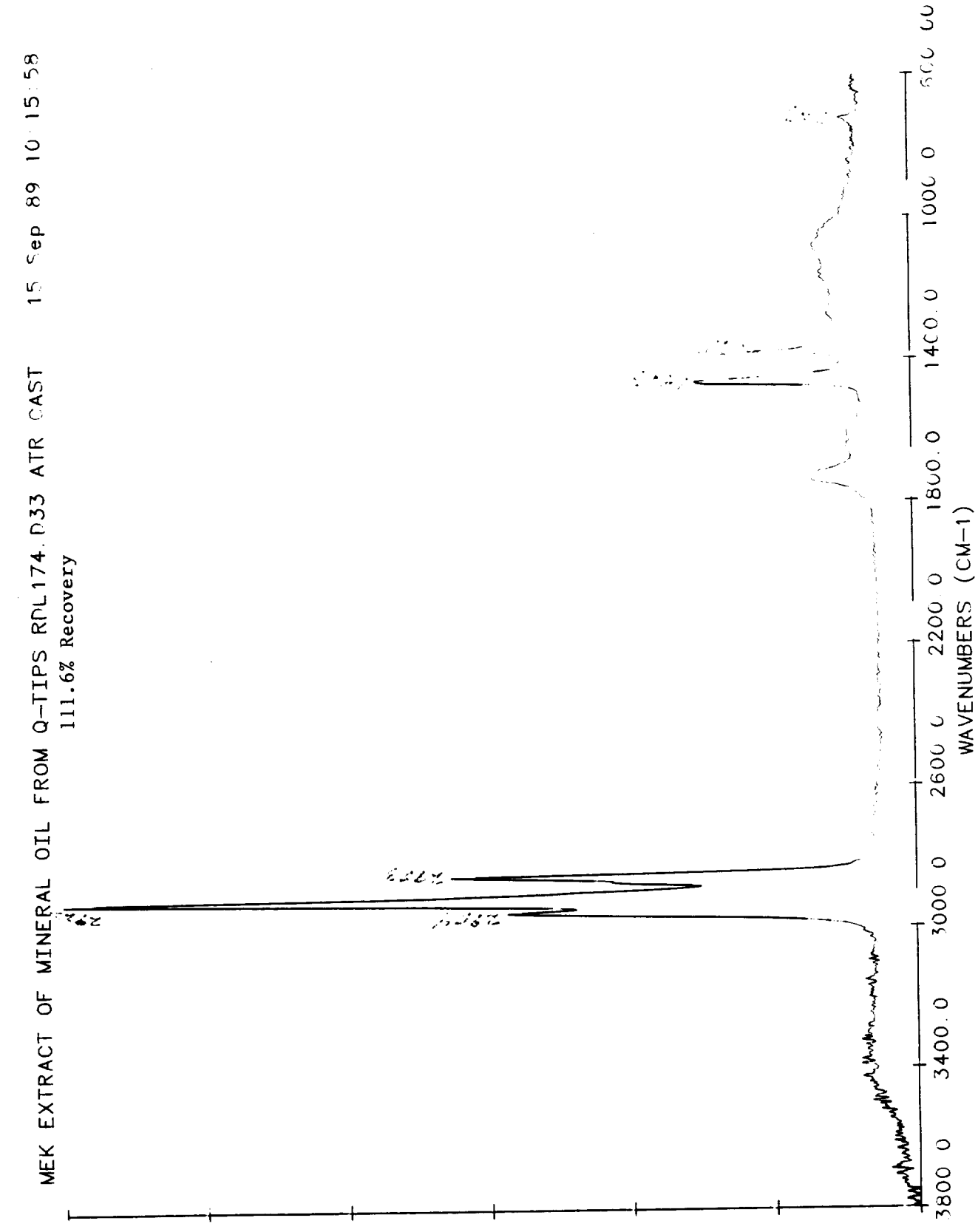


Figure 151.

Figure 152.



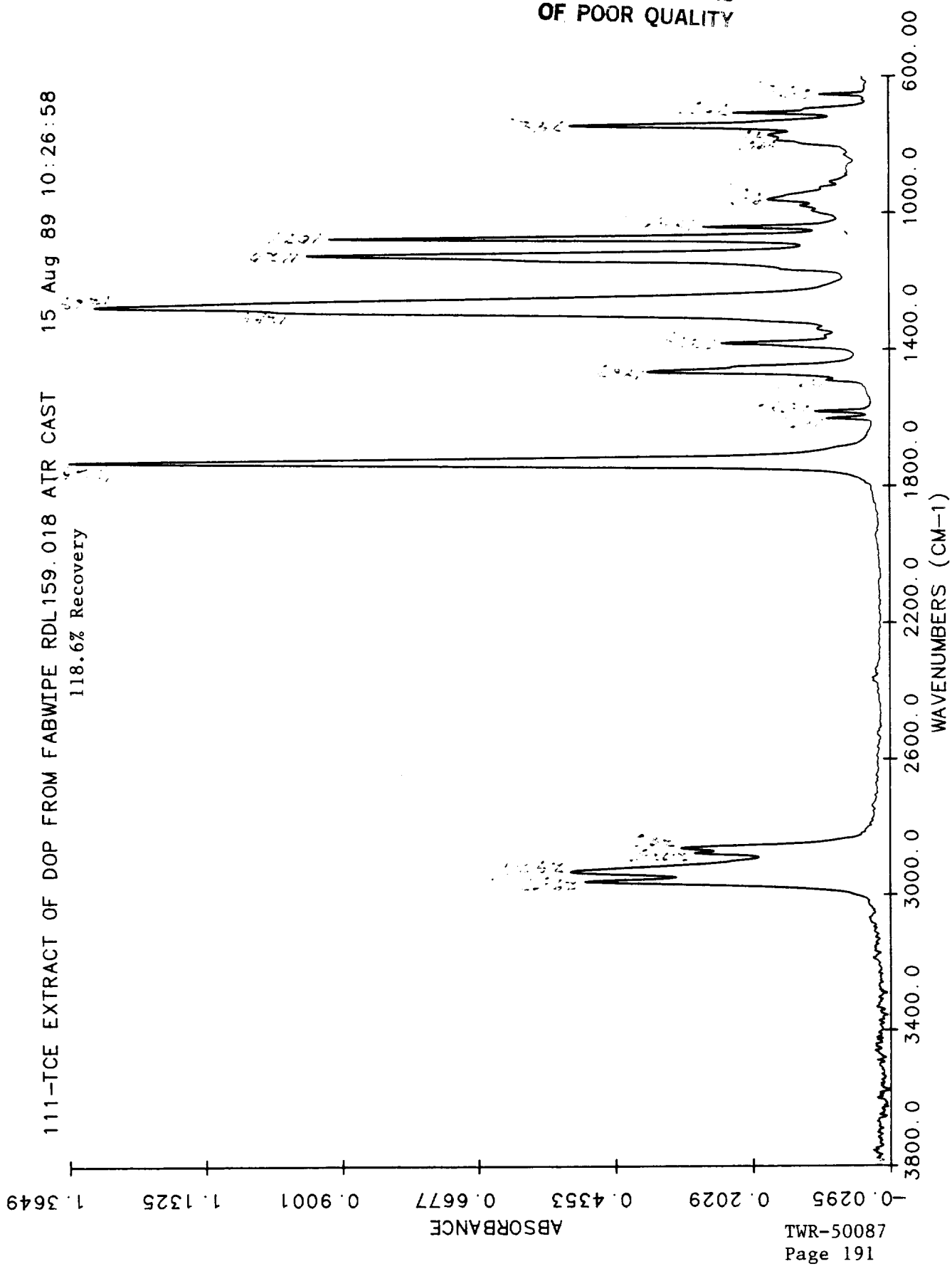


Figure 153.

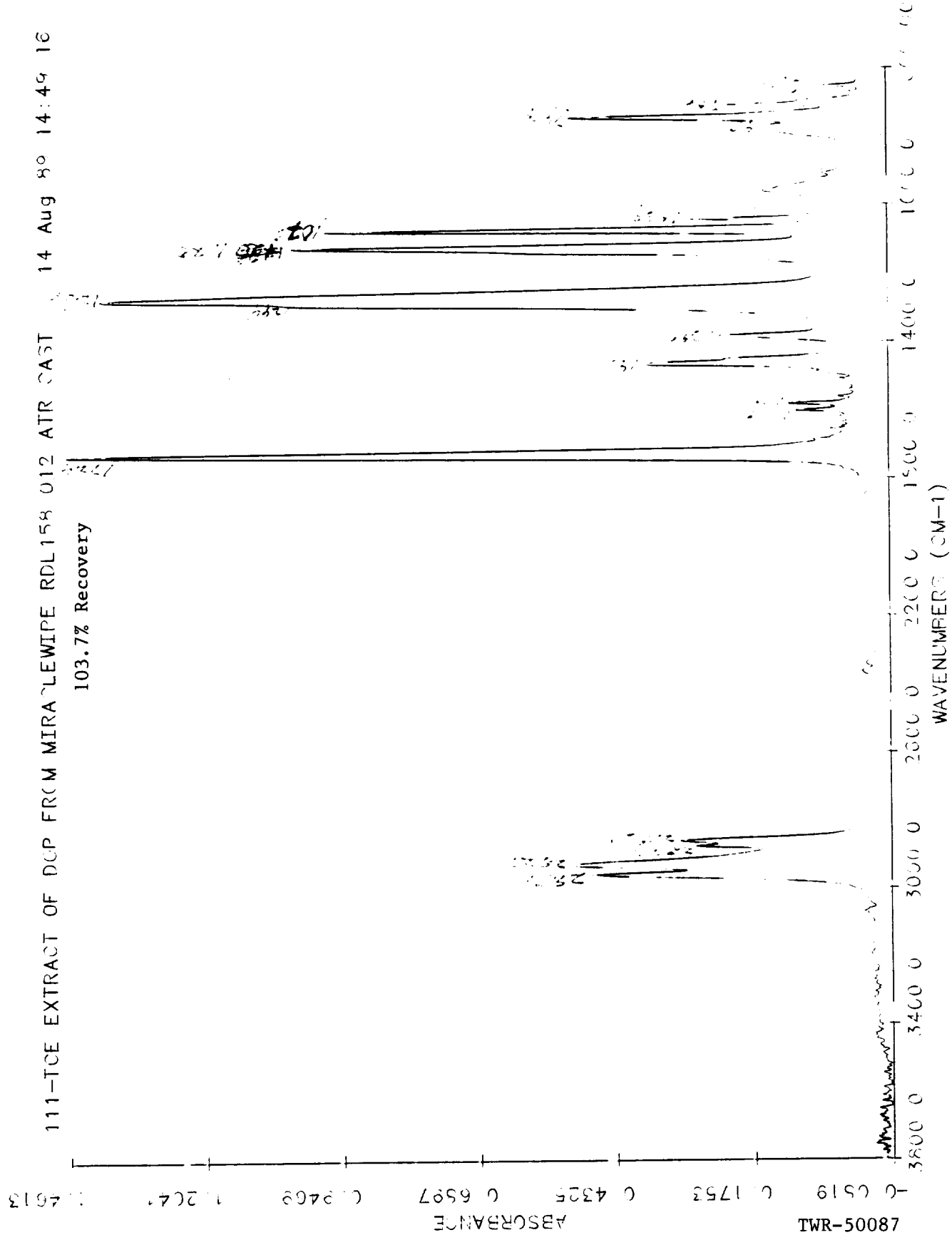


Figure 154.

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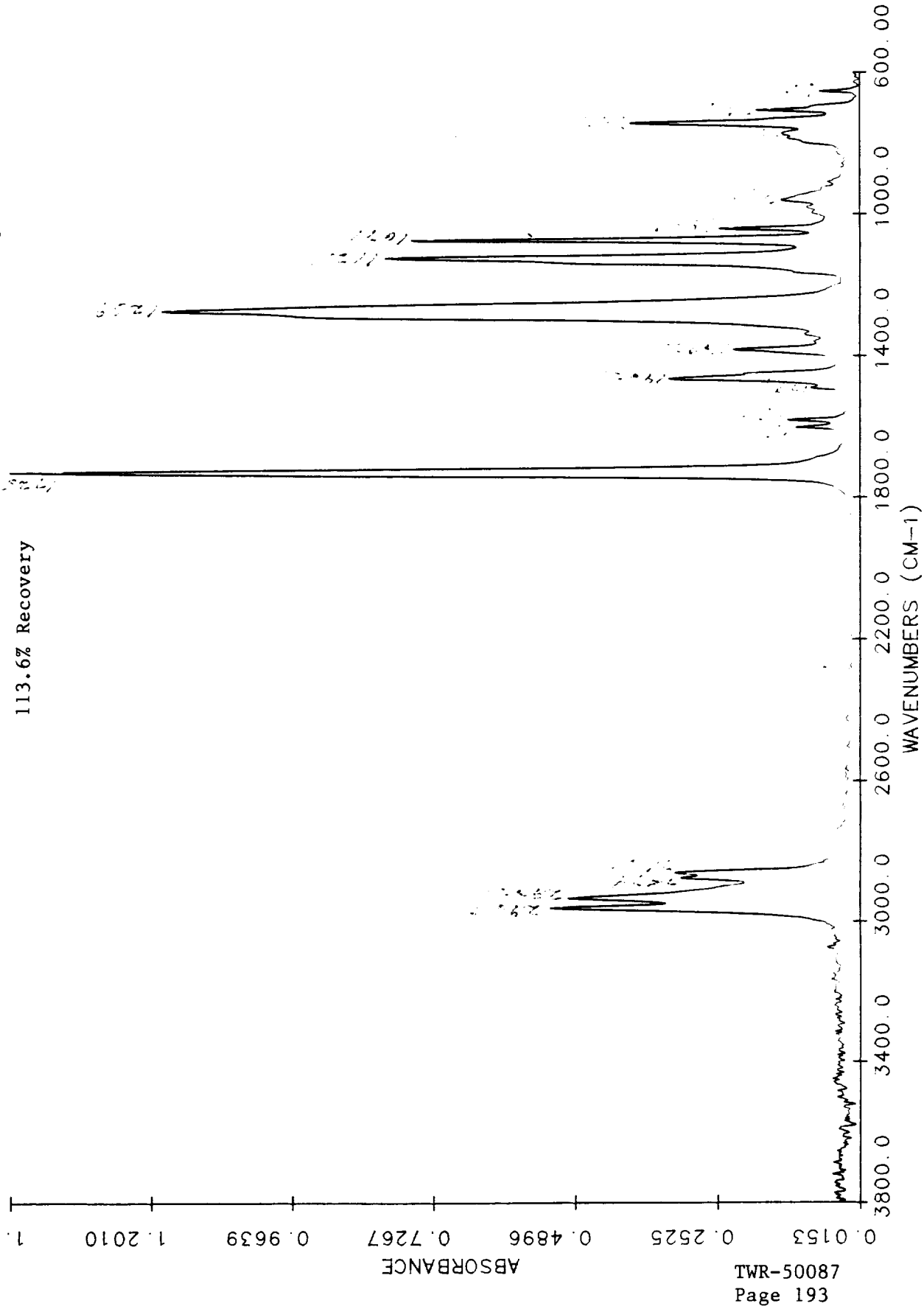

Figure 155.

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OF POOR QUALITY

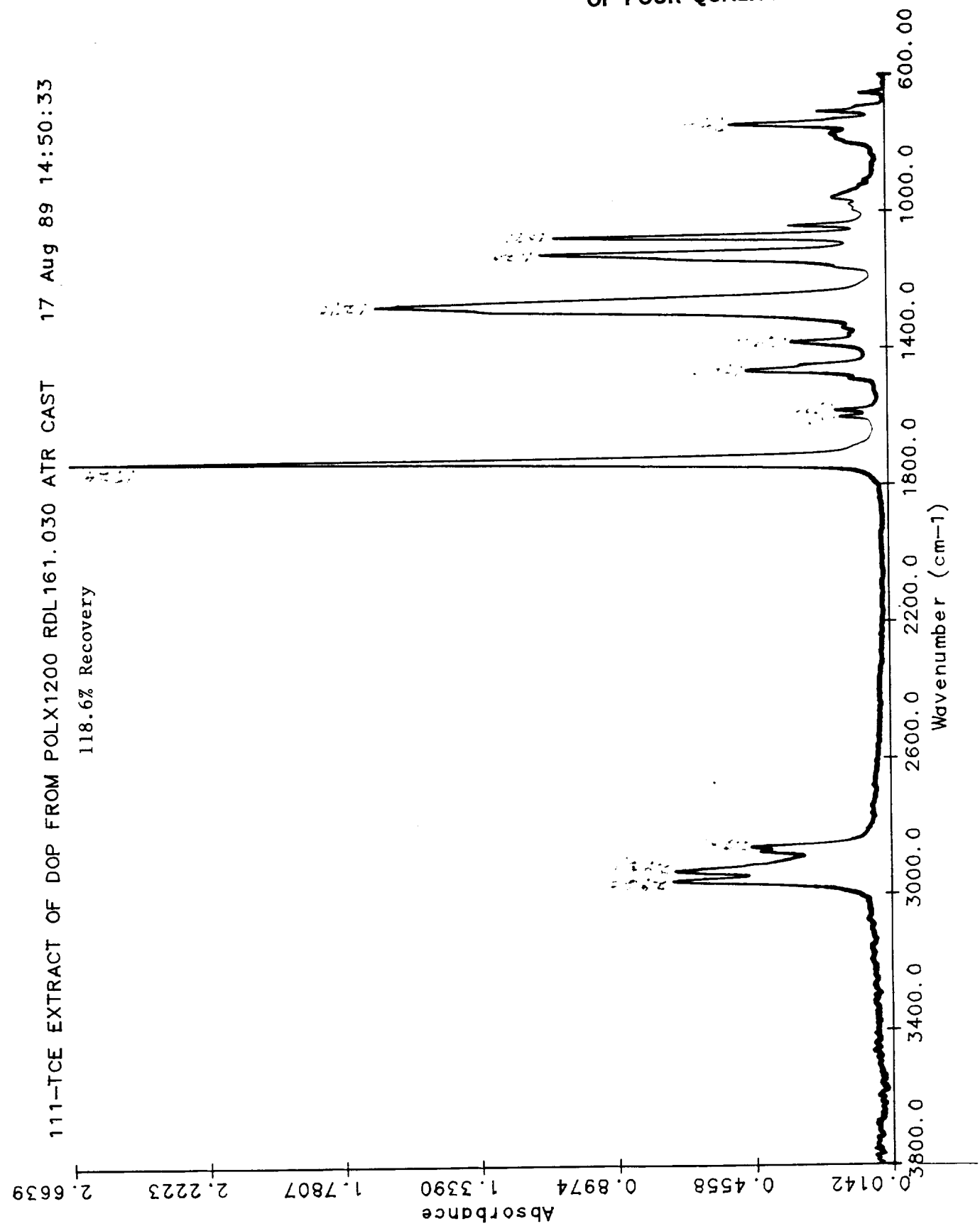


Figure 156.

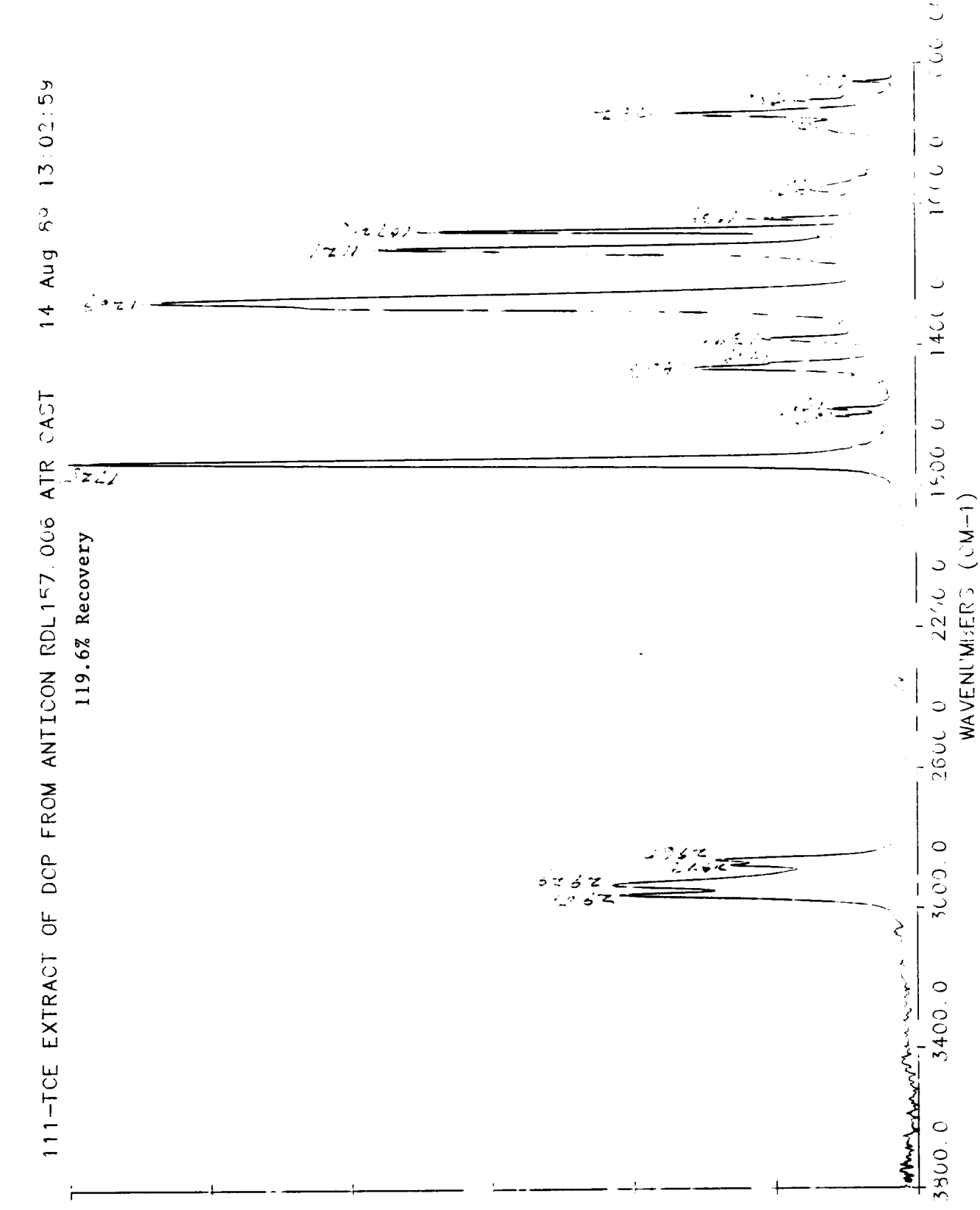


Figure 157.

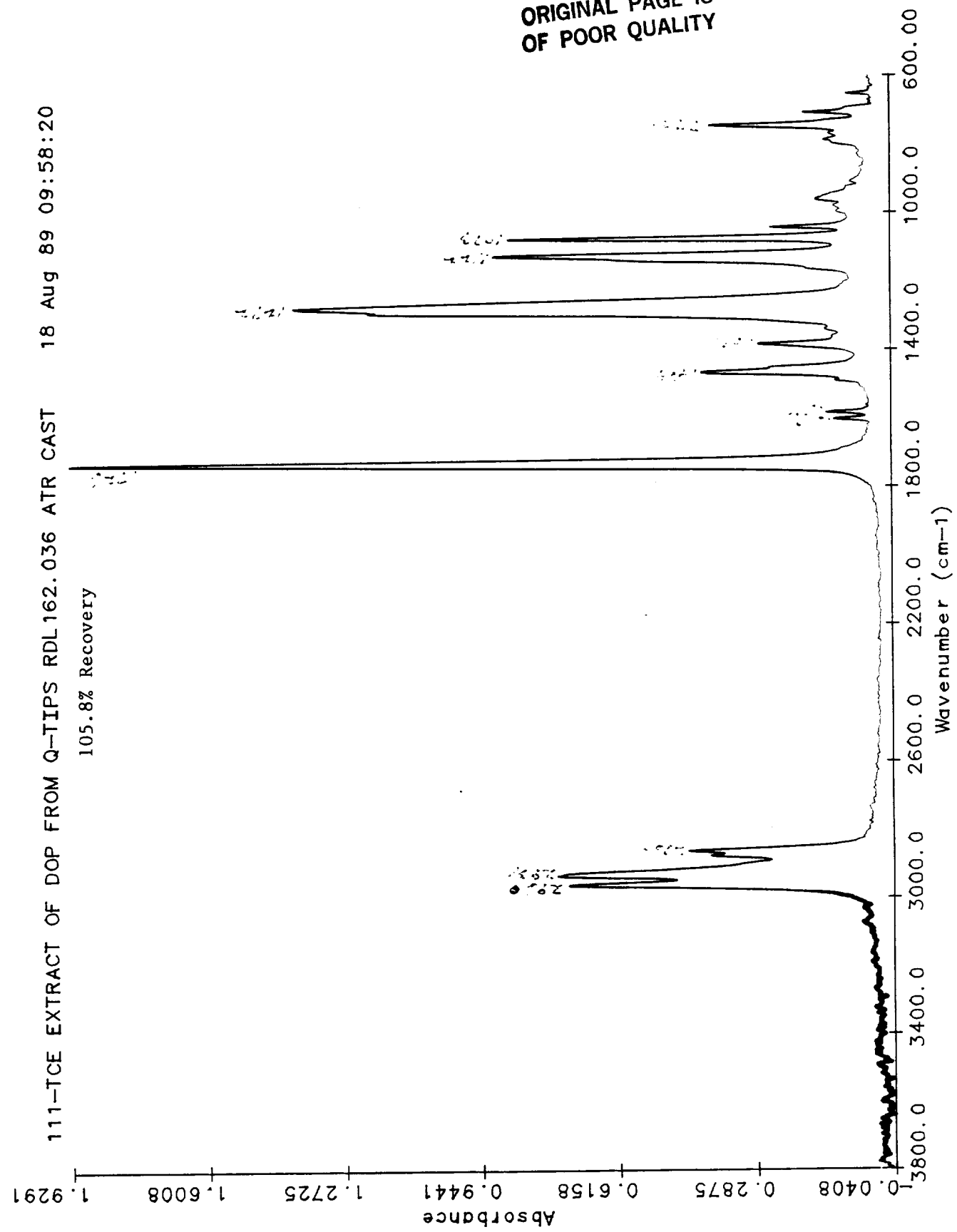
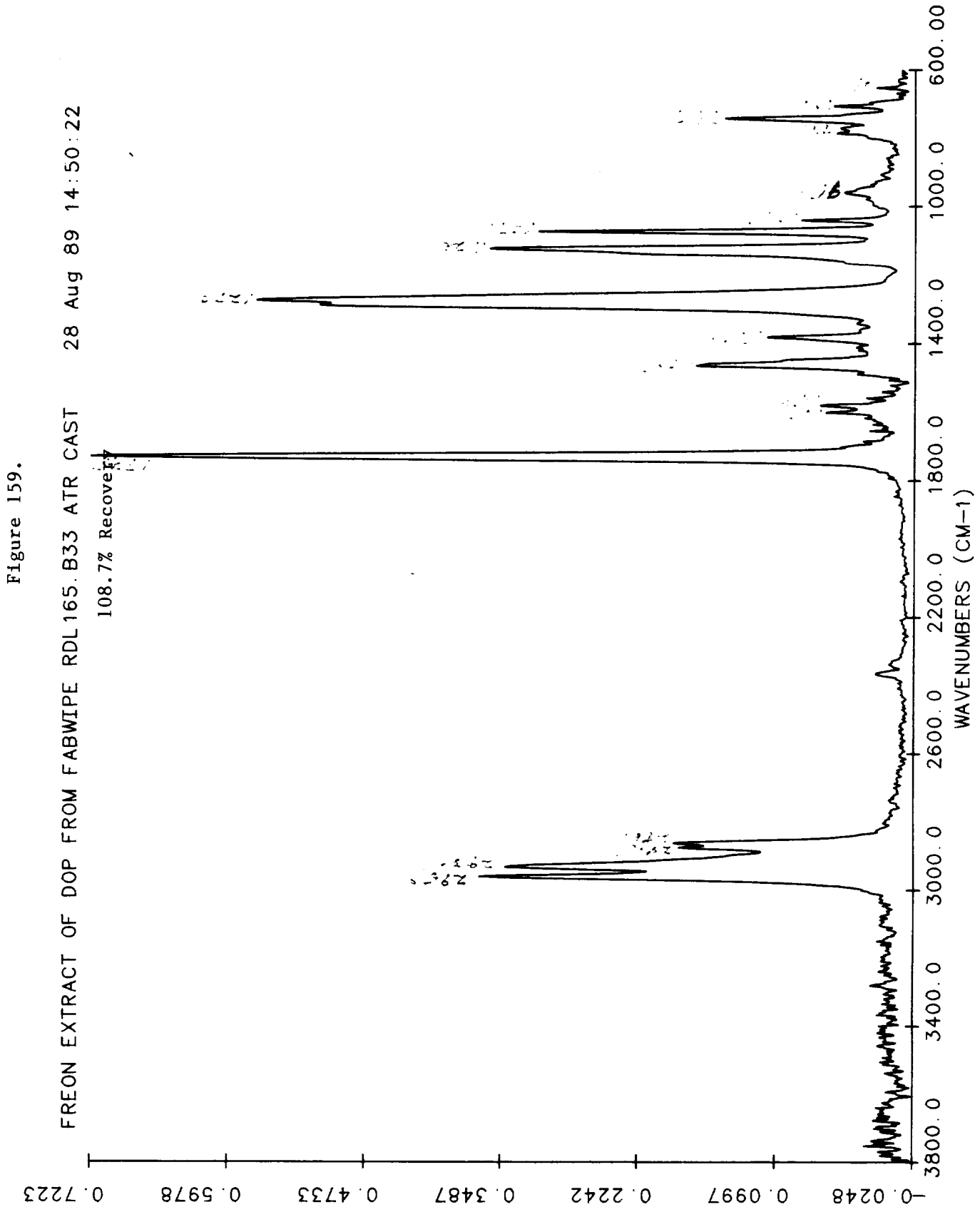


Figure 158.

Figure 159.



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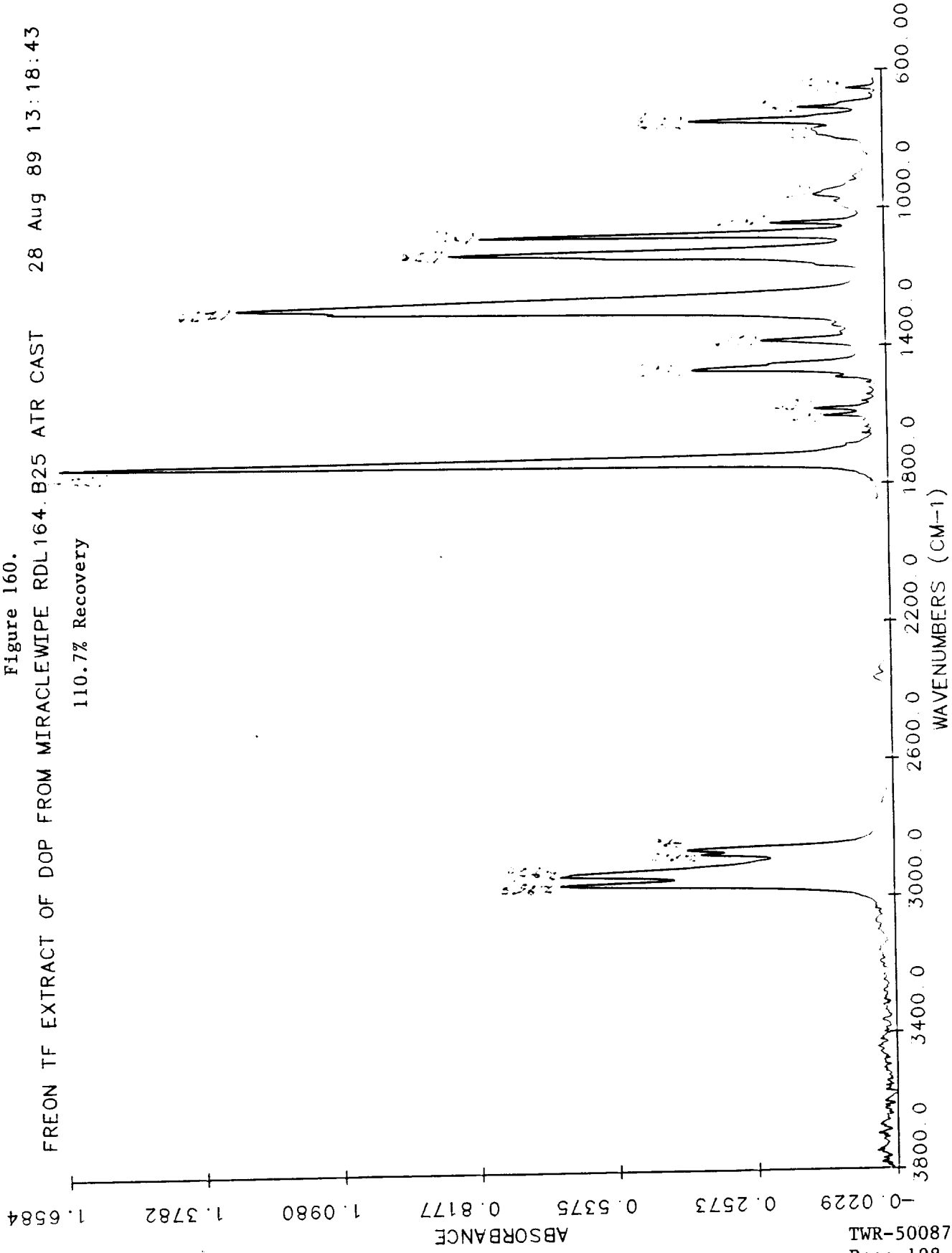
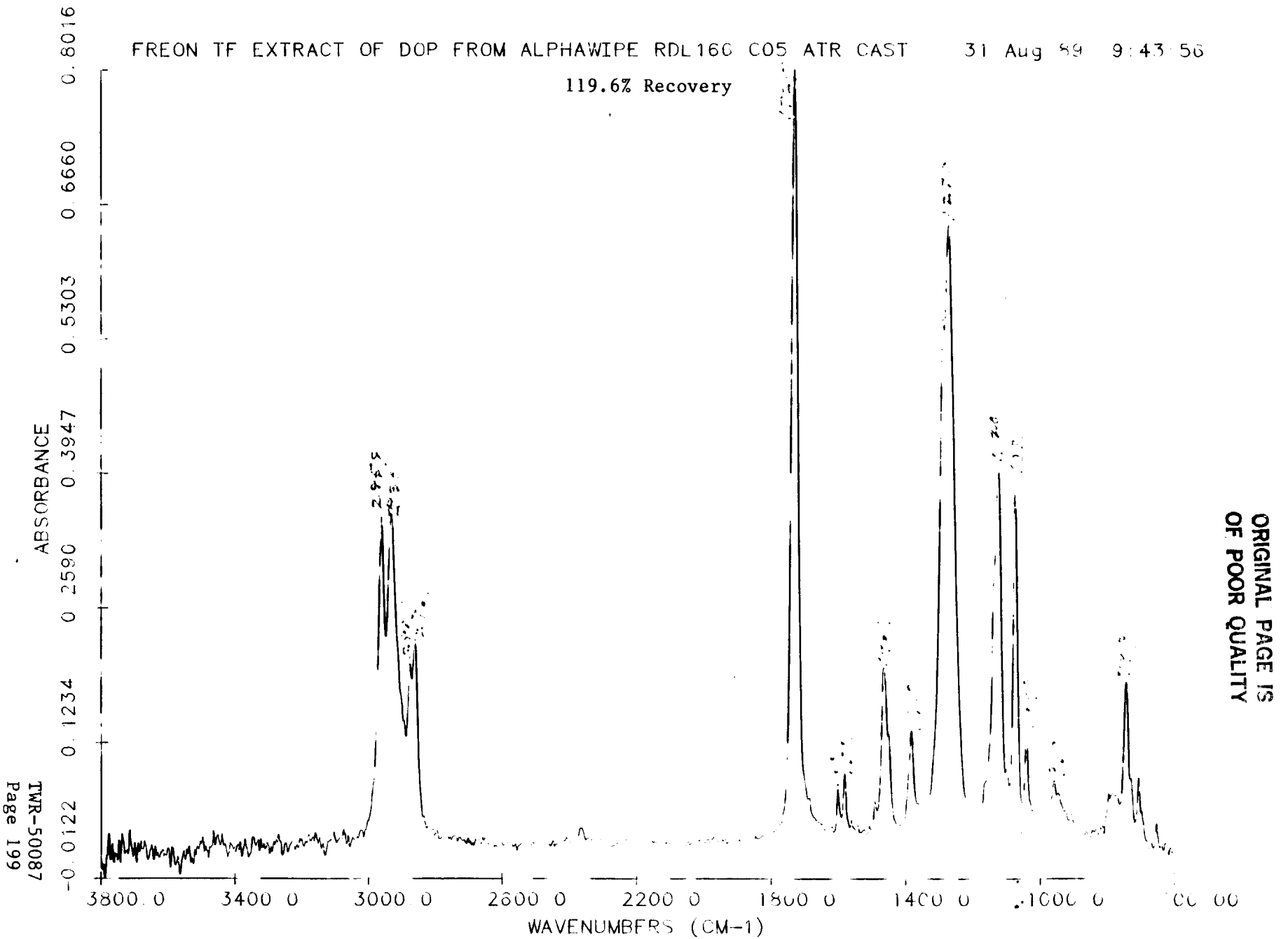


Figure 160.

Figure 161.



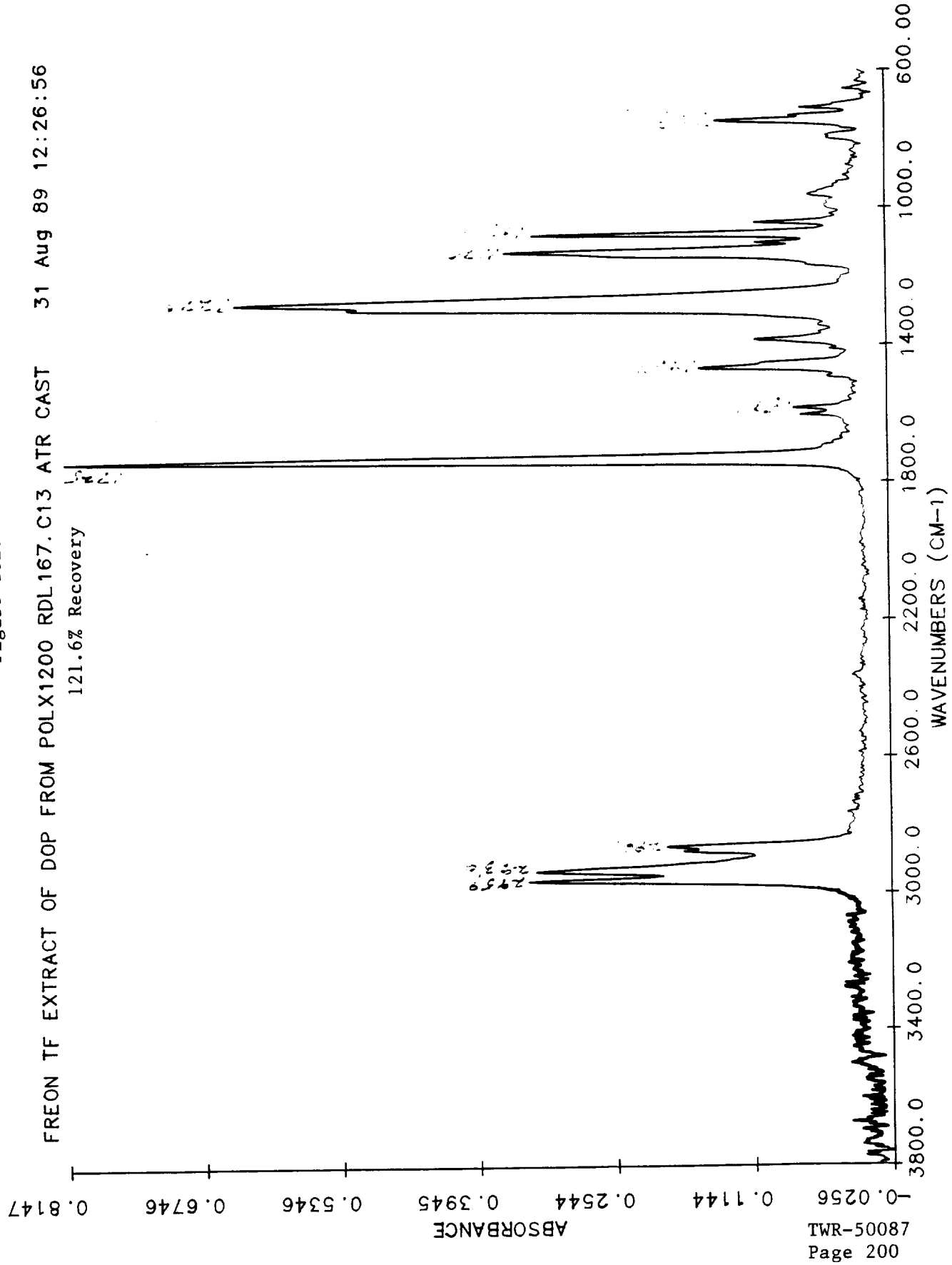


Figure 162.

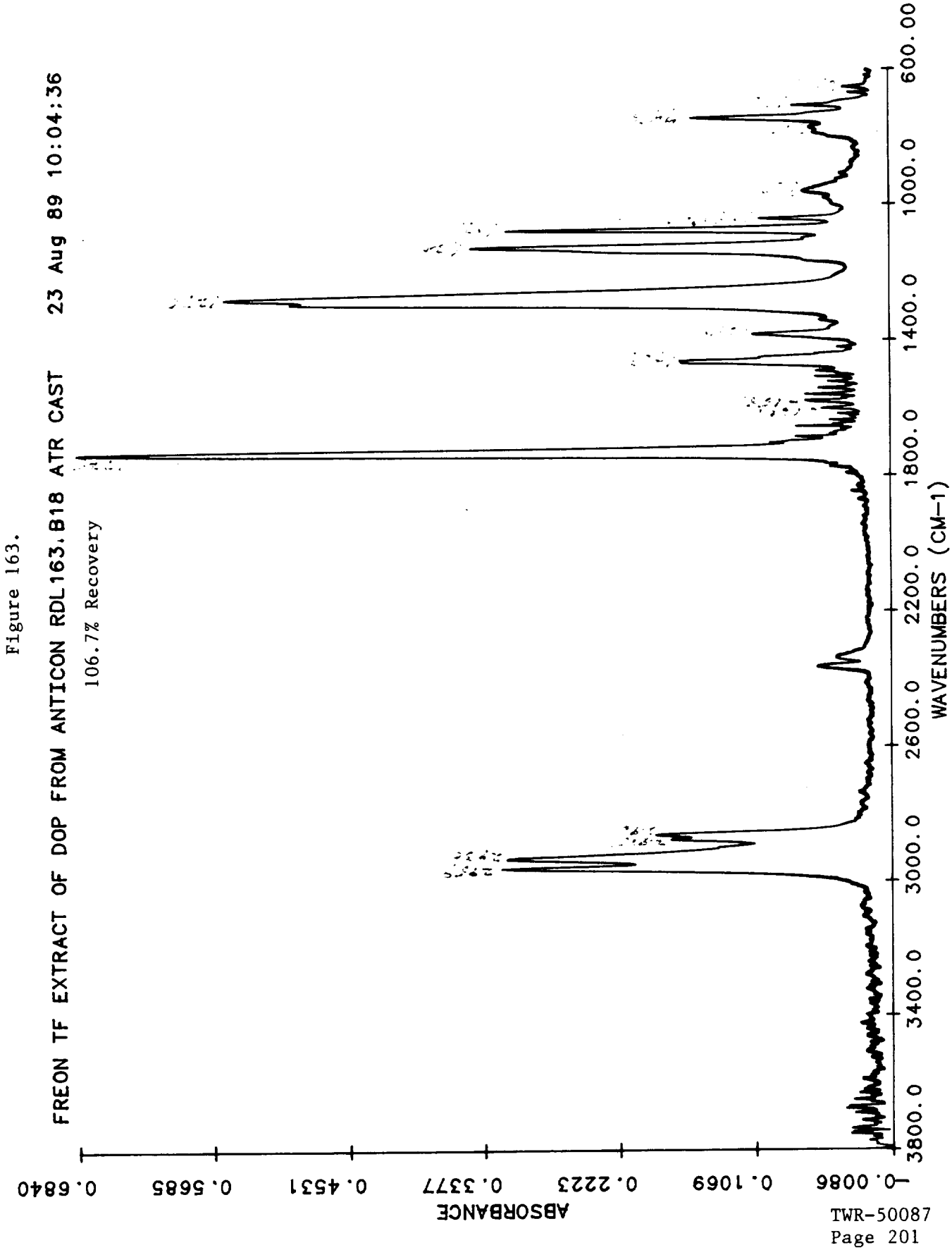


Figure 163.

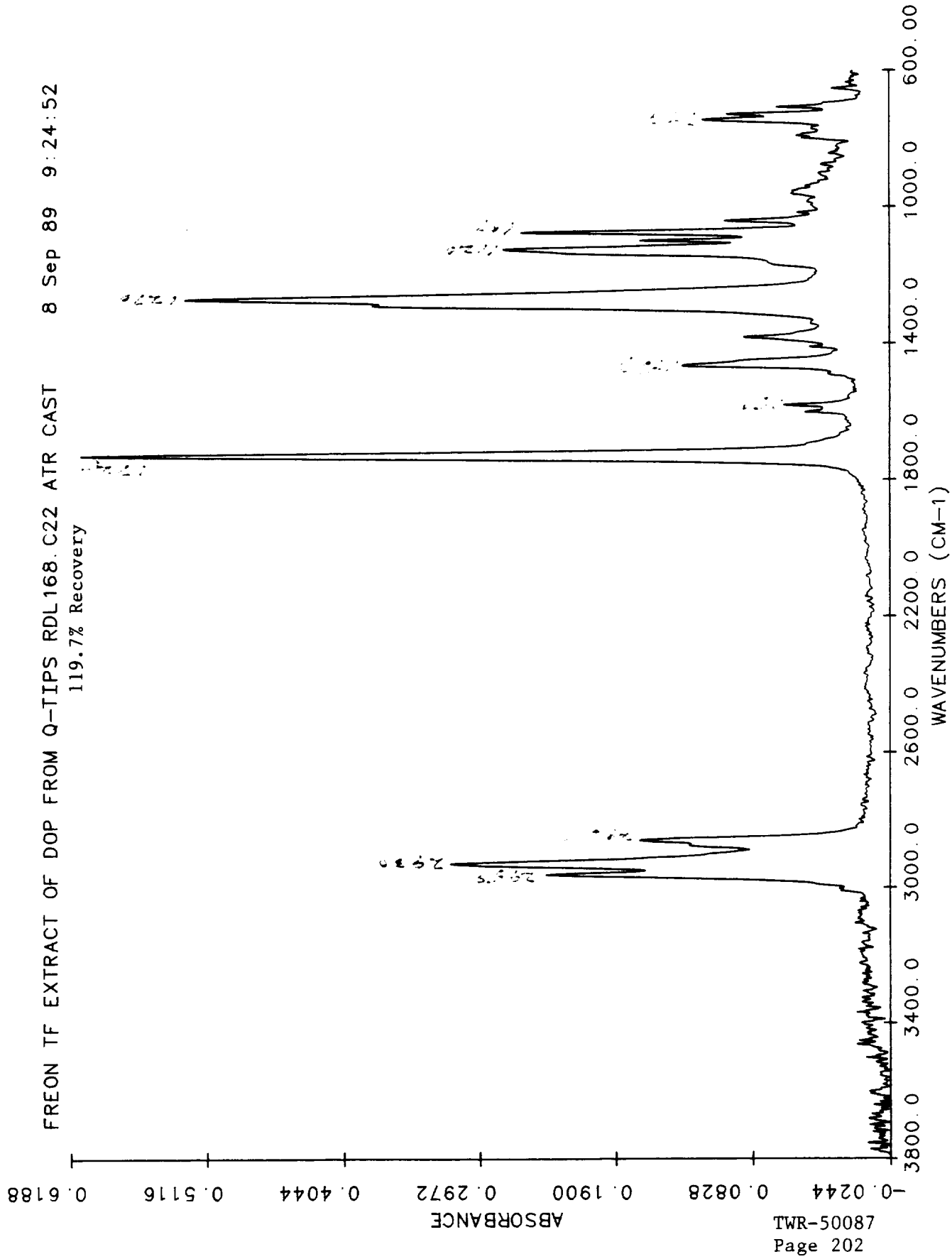
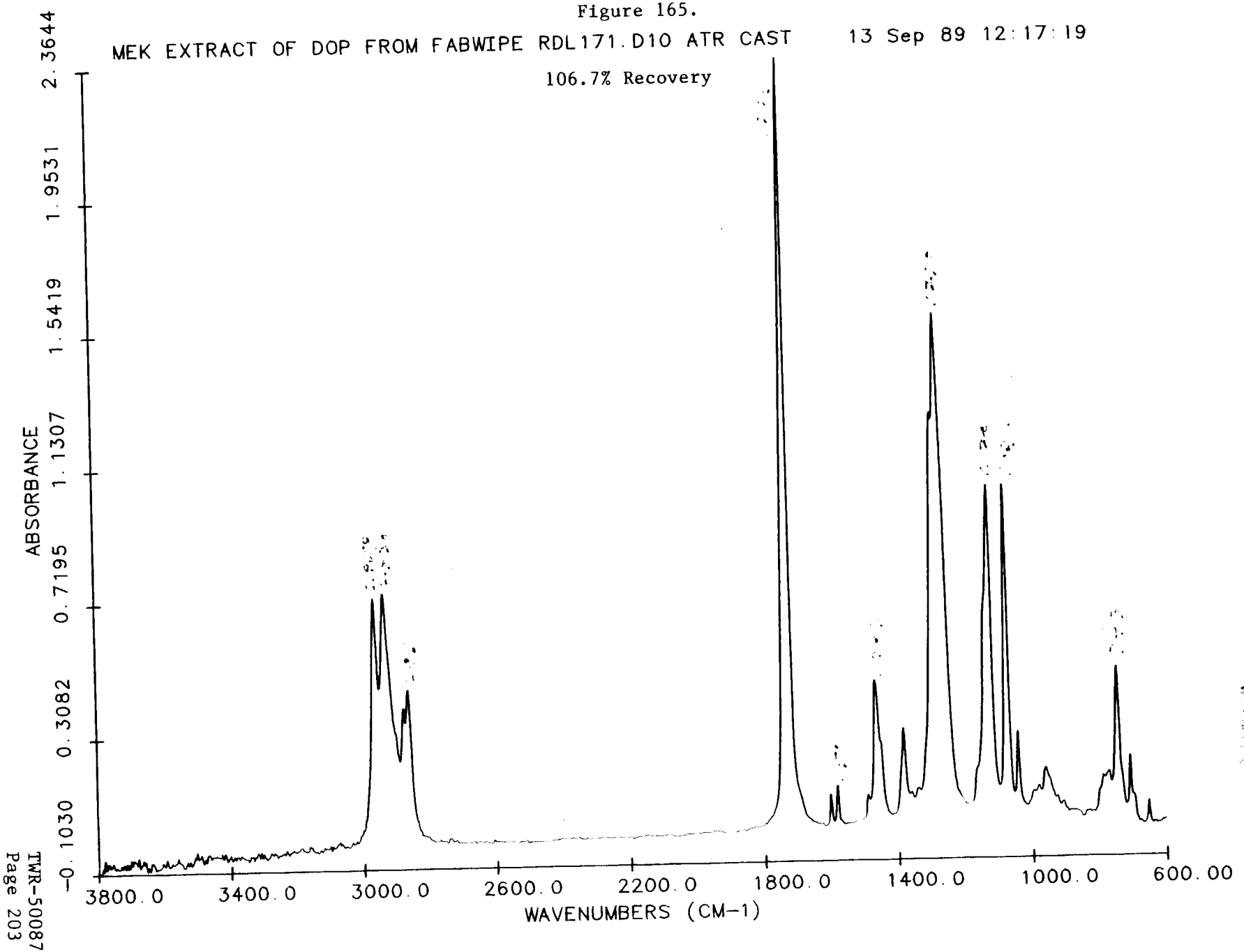


Figure 164.

Figure 165.


MEK EXTRACT OF DOP FROM FABWIPE RDL171.D10 ATR CAST
13 Sep 89 12:17:19
106.7% Recovery
ABSORBANCE
2.3644
1.9531
1.5419
1.1307
0.7195
0.3082
-0.1030
3800.0
3400.0
3000.0
2600.0
2200.0
1800.0
1400.0
1000.0
600.00
WAVENUMBERS (CM-1)

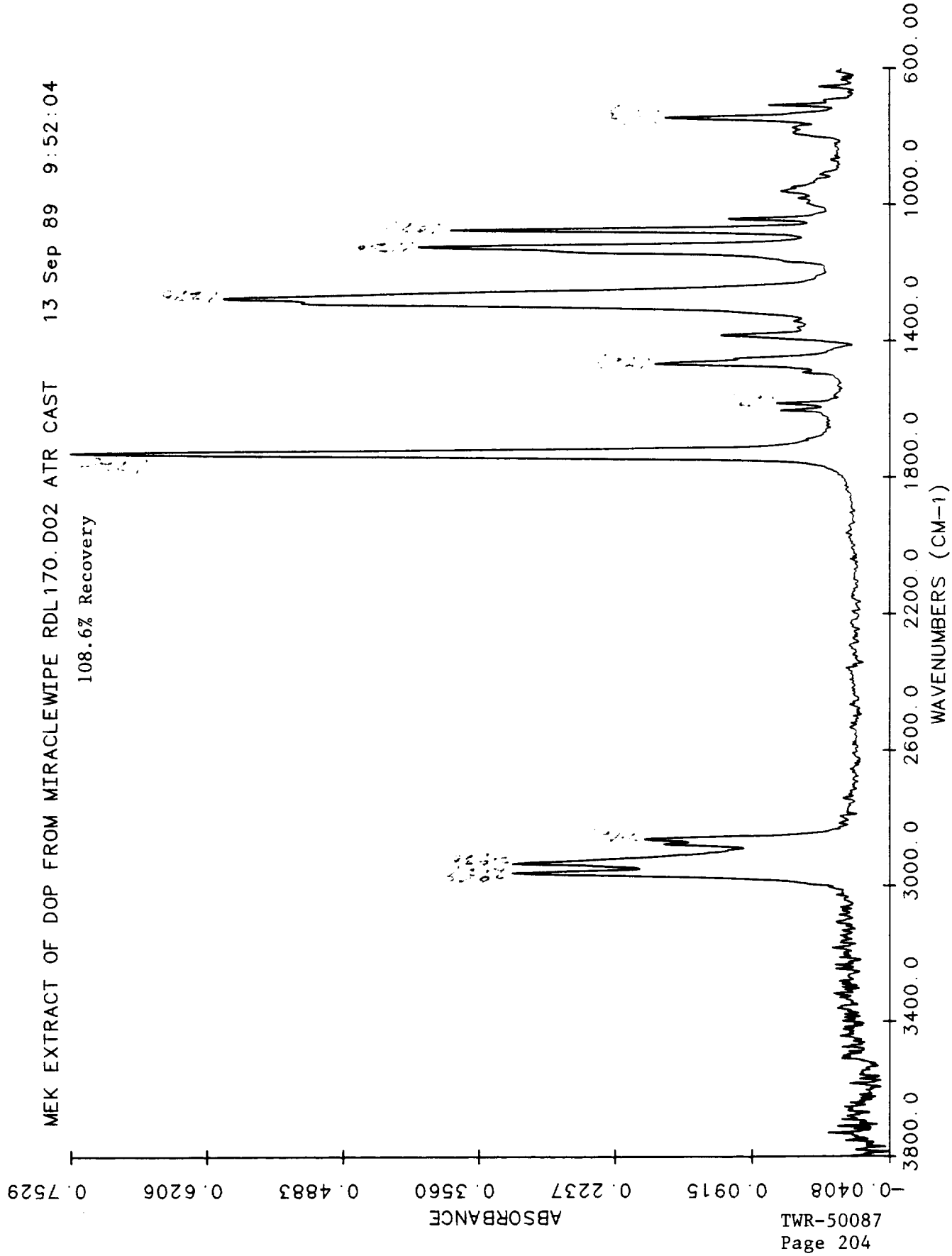


Figure 166.

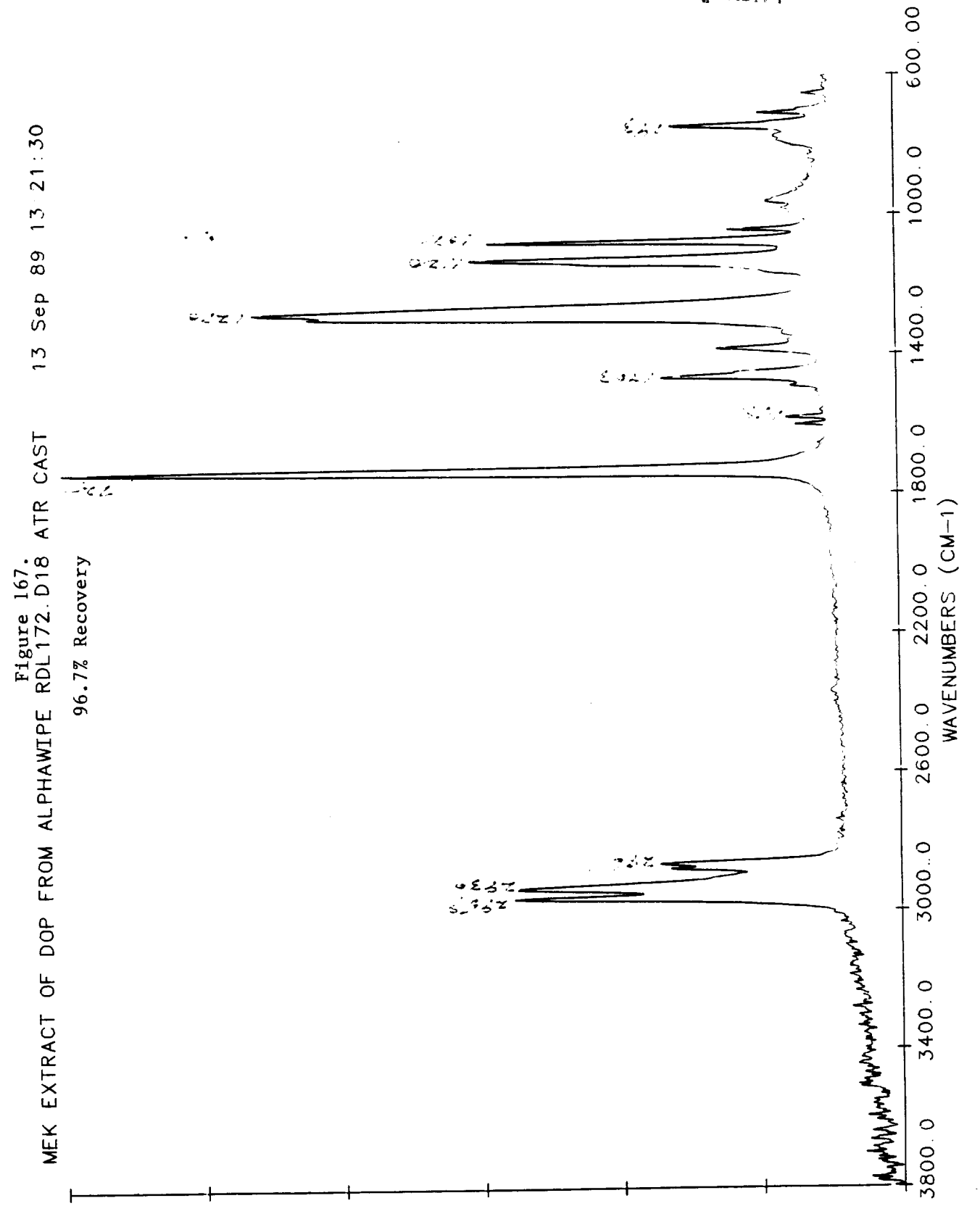


Figure 167.

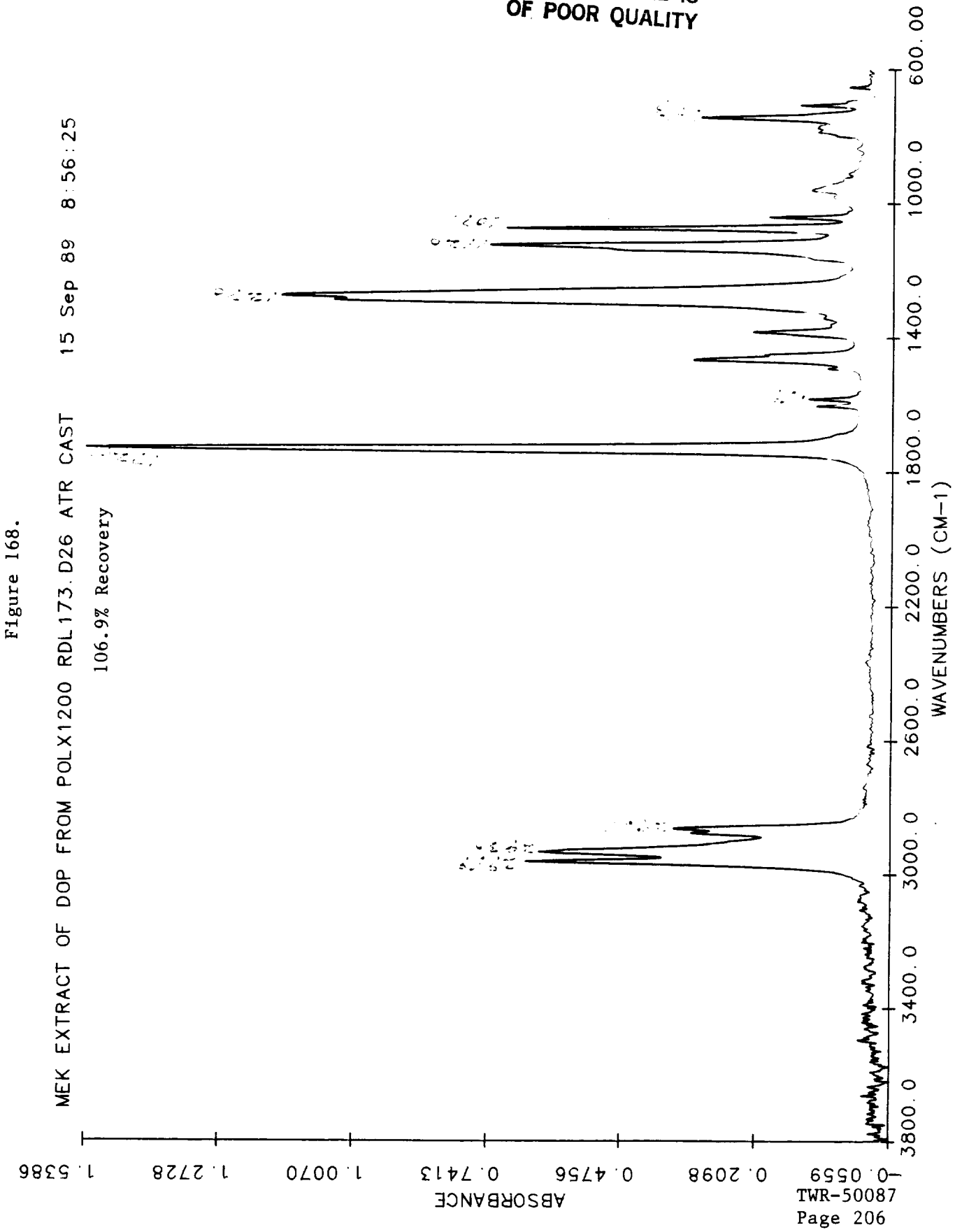
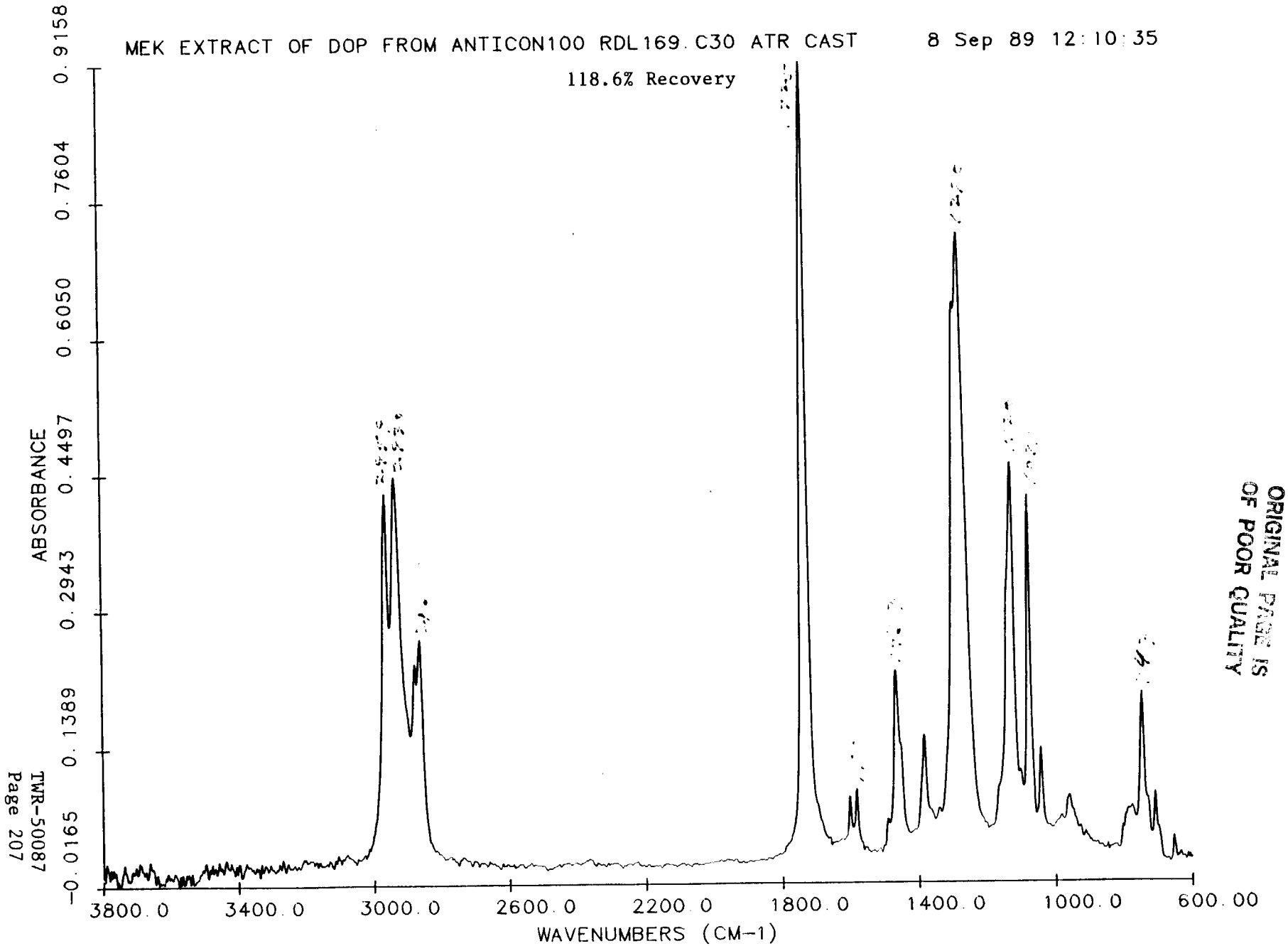


Figure 168.

Figure 169.



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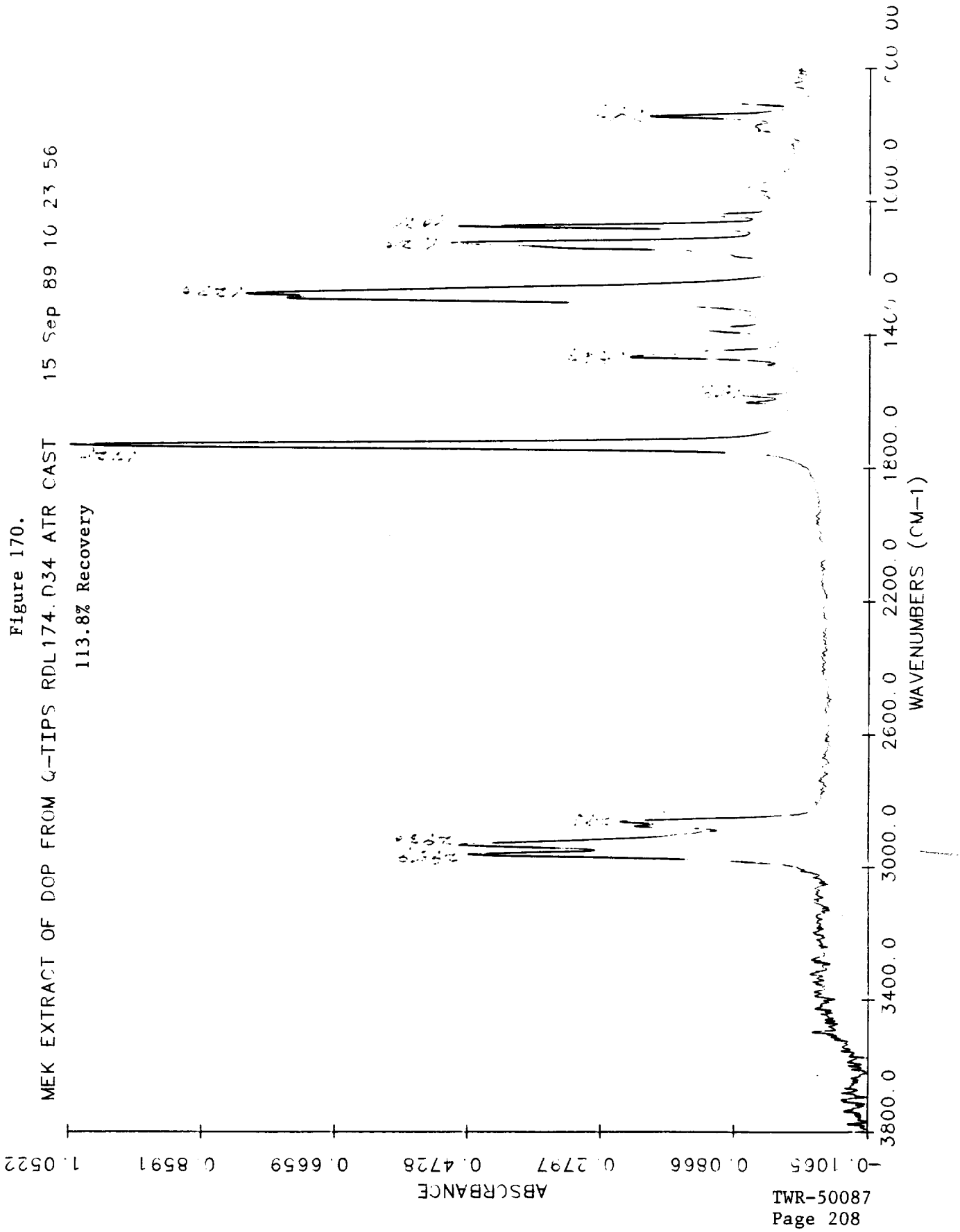
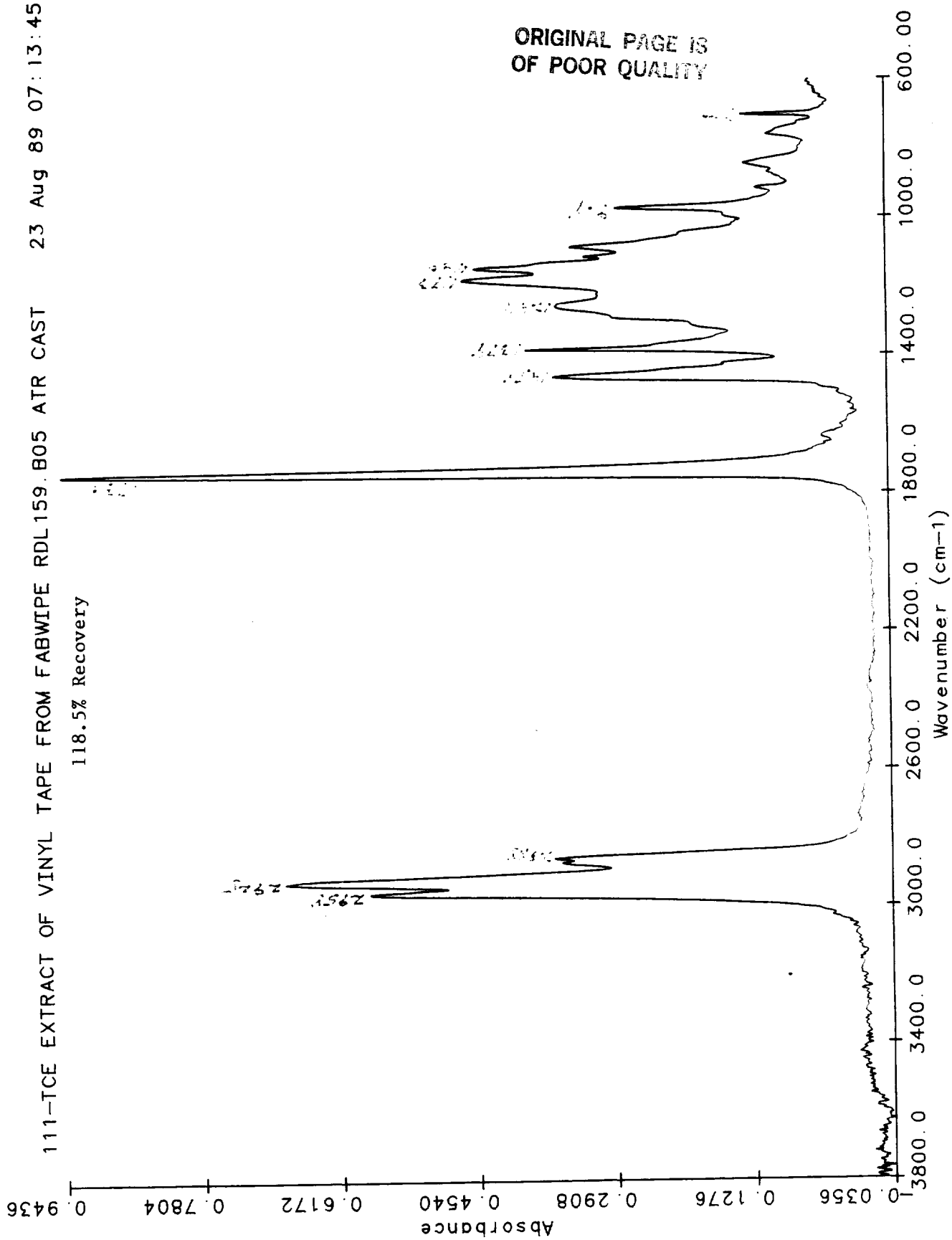


Figure 170.

Figure 171.


111-TCE EXTRACT OF VINYL TAPE FROM FABWIPE RDL159.B05 ATR CAST 23 Aug 89 07:13:45
118.5% Recovery
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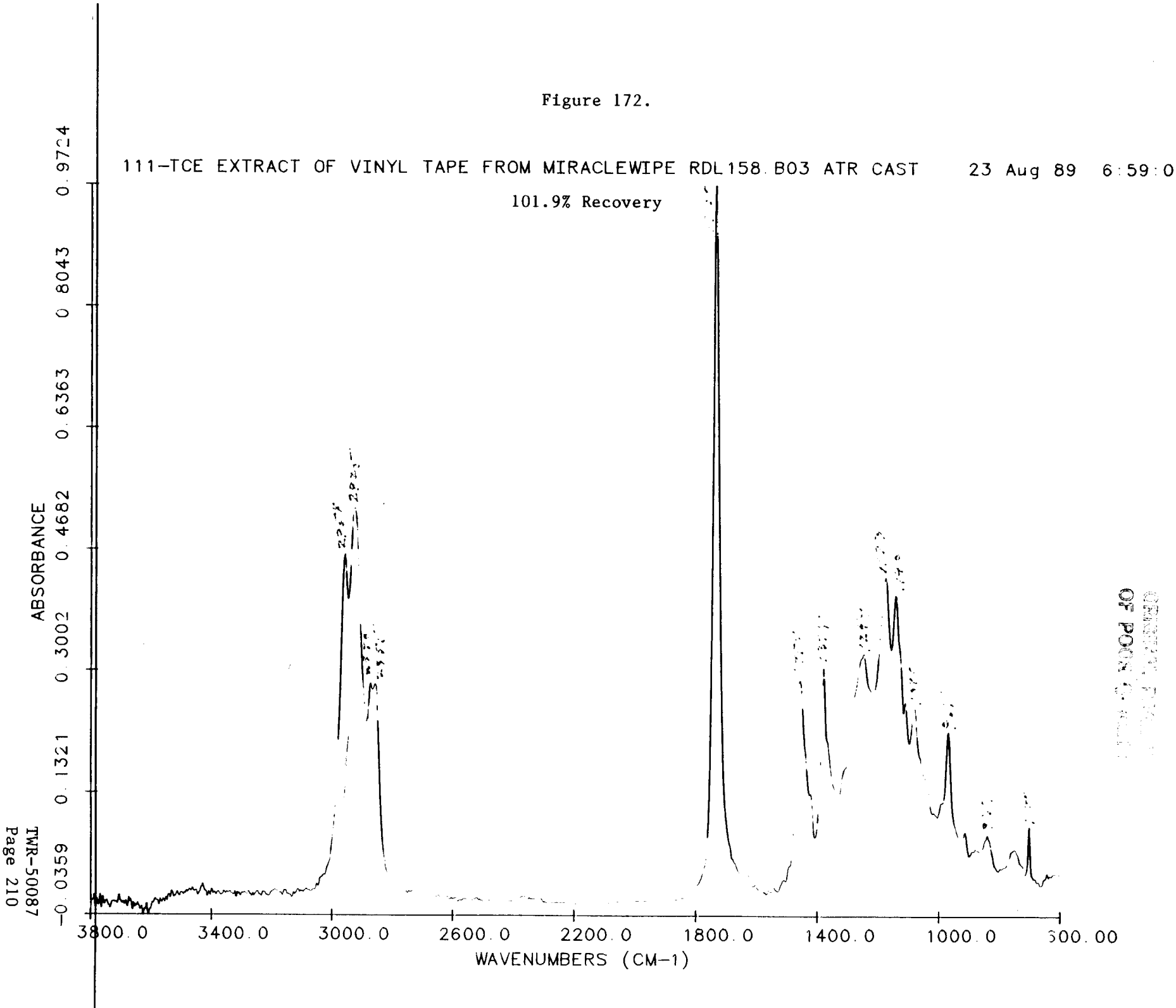
Absorbance
0.0356
0.1276
0.2908
0.4540
0.6172
0.7804
0.9436
Wavenumber (cm-1)
3800.0
3400.0
3000.0
2600.0
2200.0
1800.0
1400.0
1000.0
600.00

Figure 172.


111-TCE EXTRACT OF VINYL TAPE FROM MIRACLEWIPE RDL158.B03 ATR CAST 23 Aug 89 6:59:04
101.9% Recovery
ABSORBANCE
0.9724
0.8043
0.6363
0.4682
0.3002
0.1321
-0.0359
3800.0
3400.0
3000.0
2600.0
2200.0
1800.0
1400.0
1000.0
300.00
WAVENUMBERS (CM-1)

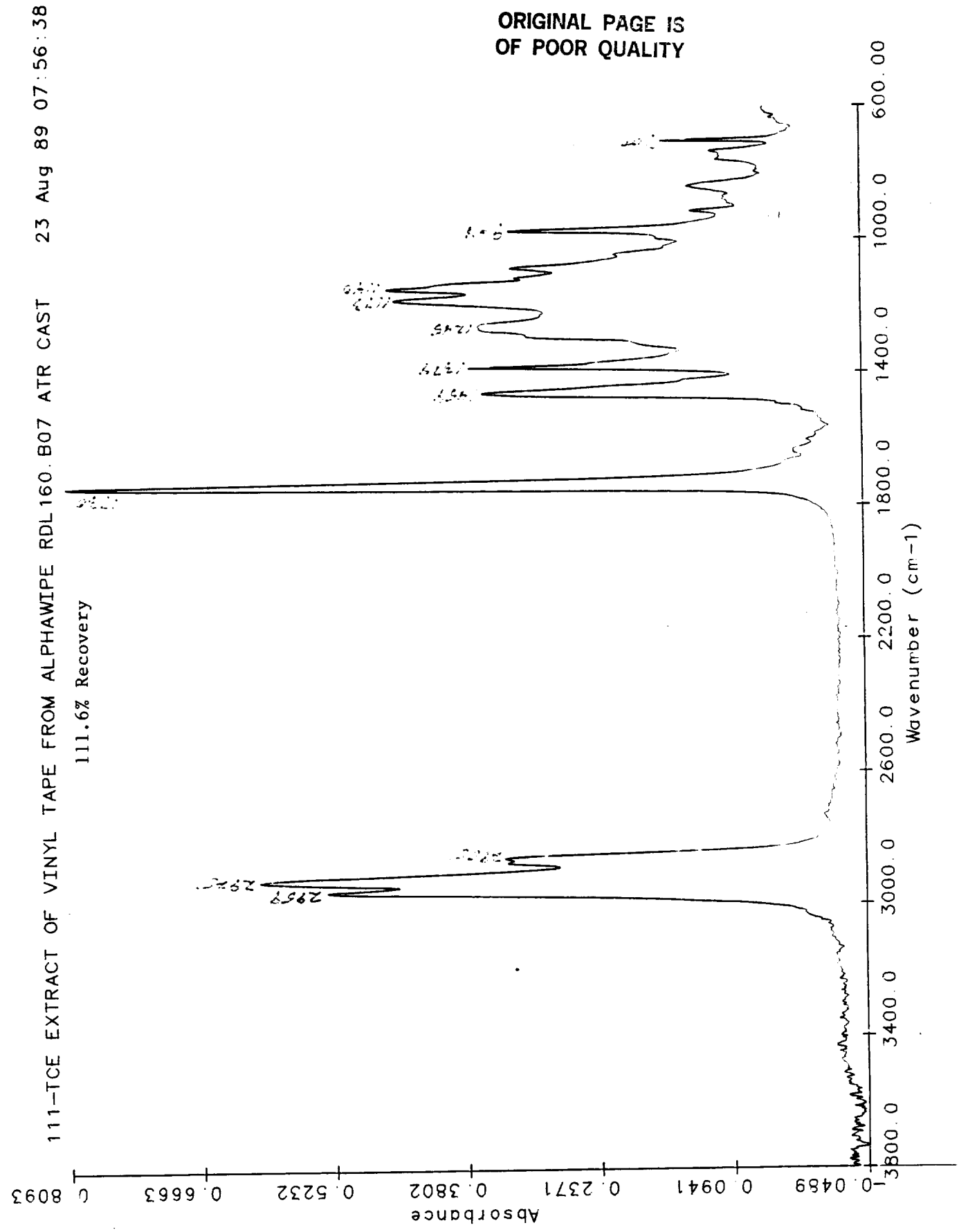
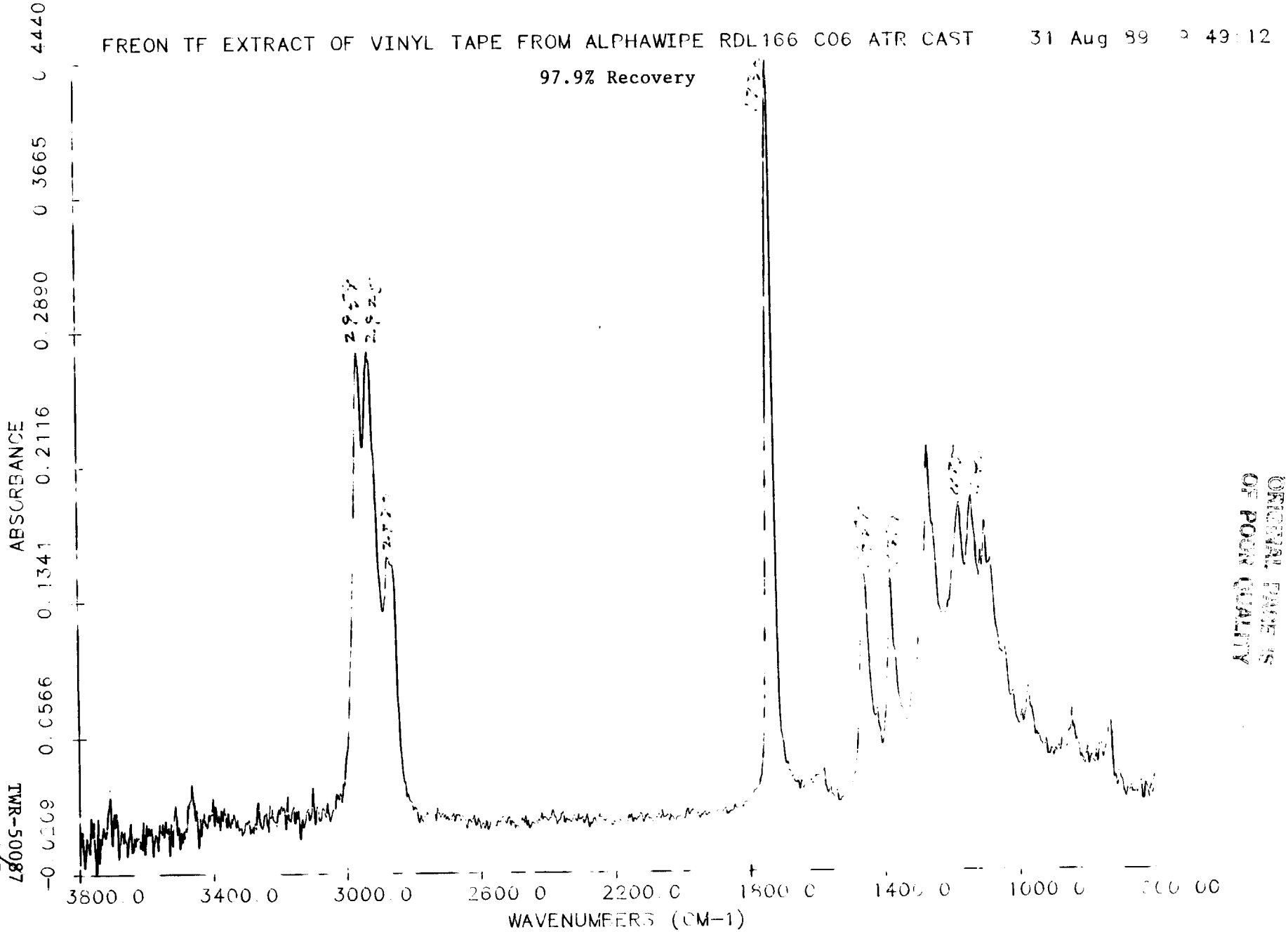


Figure 173.

Figure 179.



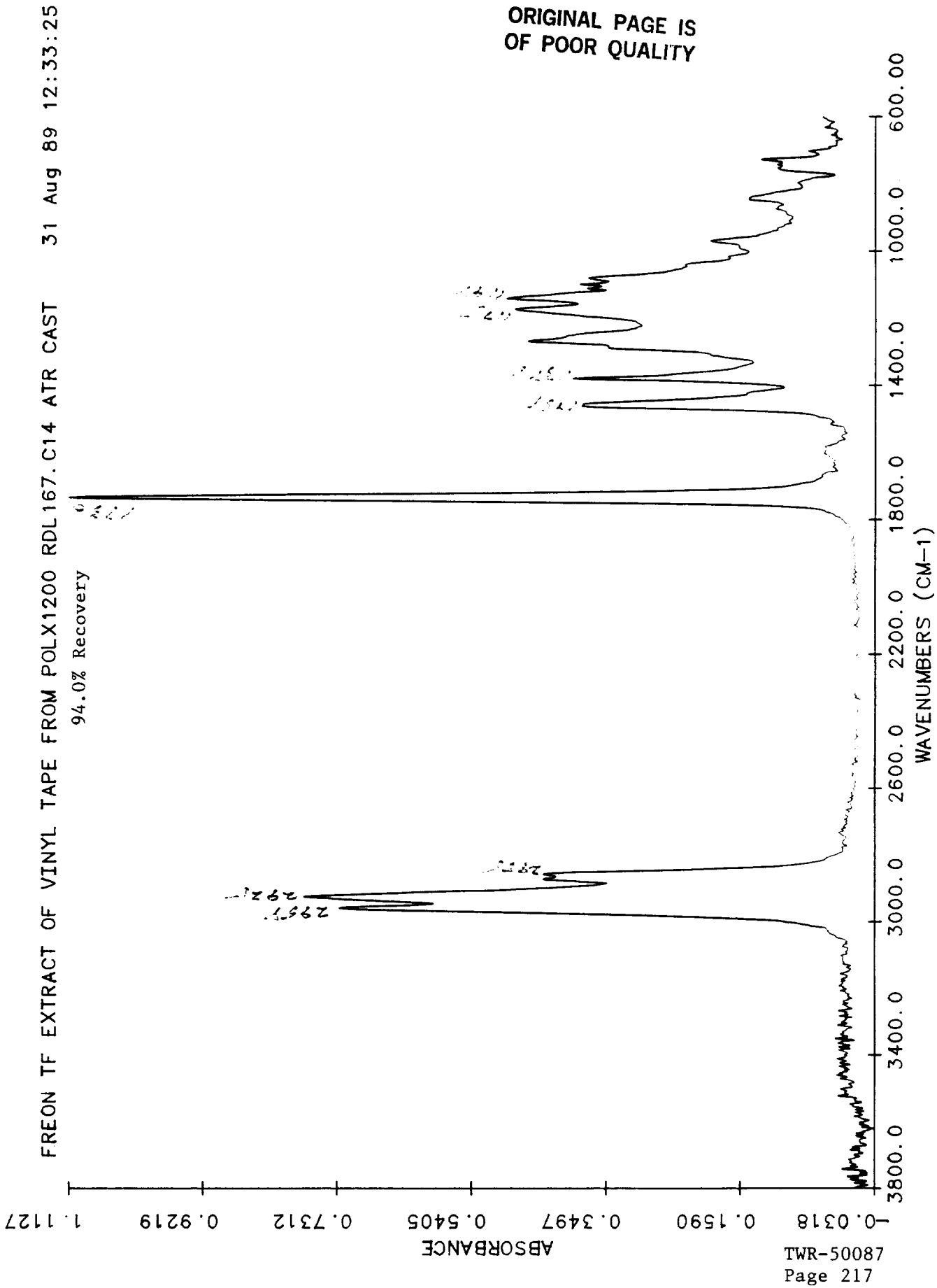
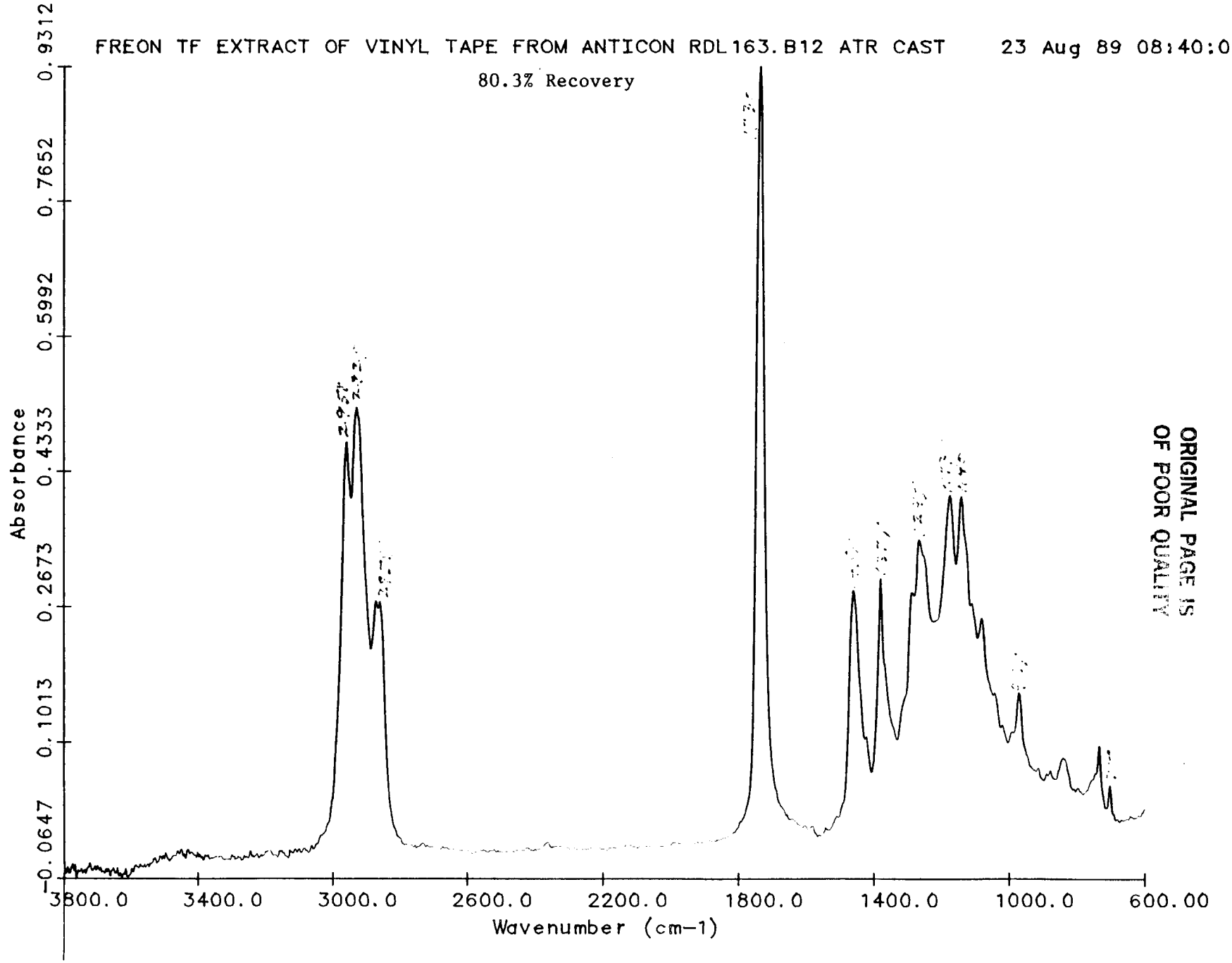


Figure 180.

Figure 181.



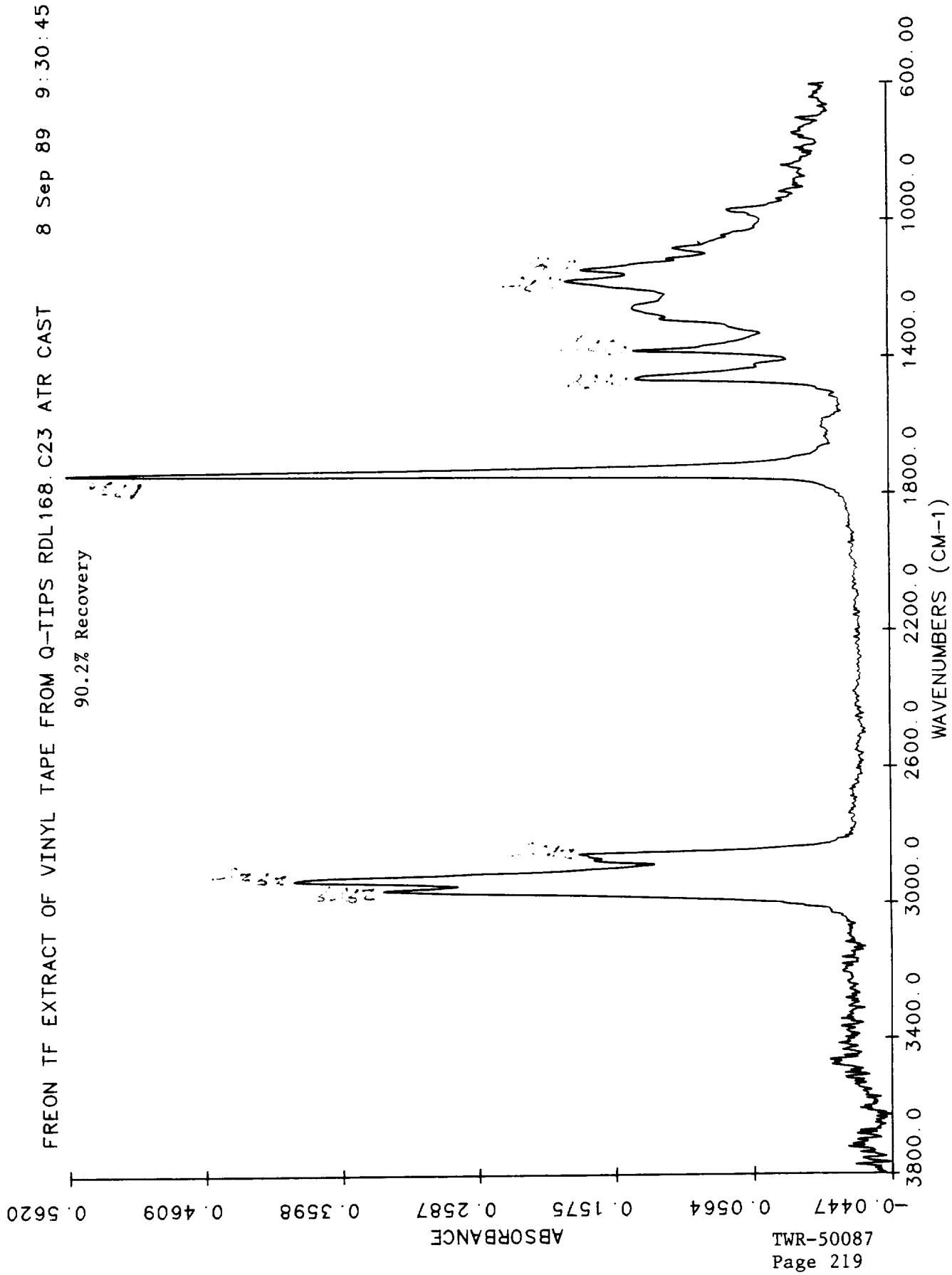


Figure 182.

Figure 183.

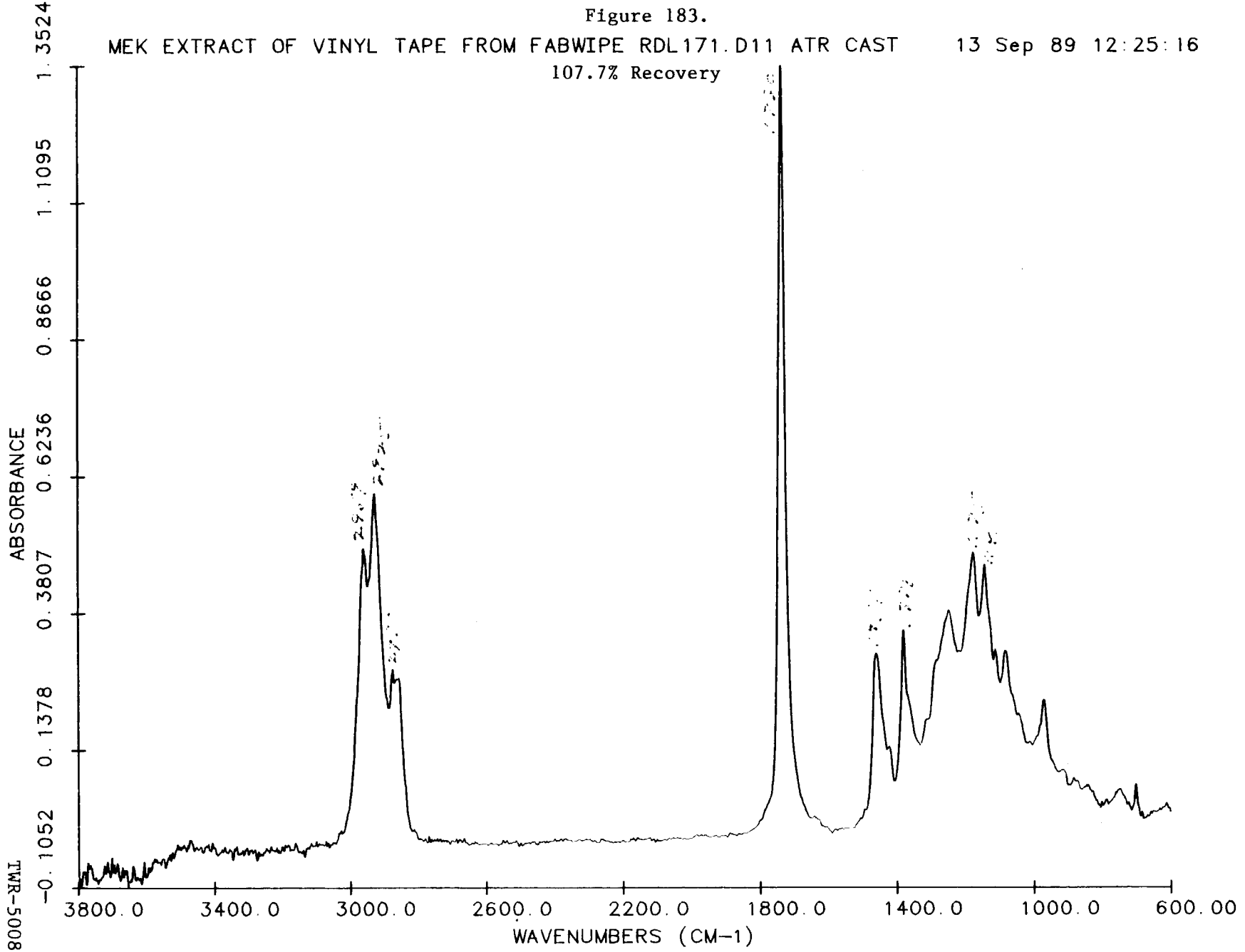
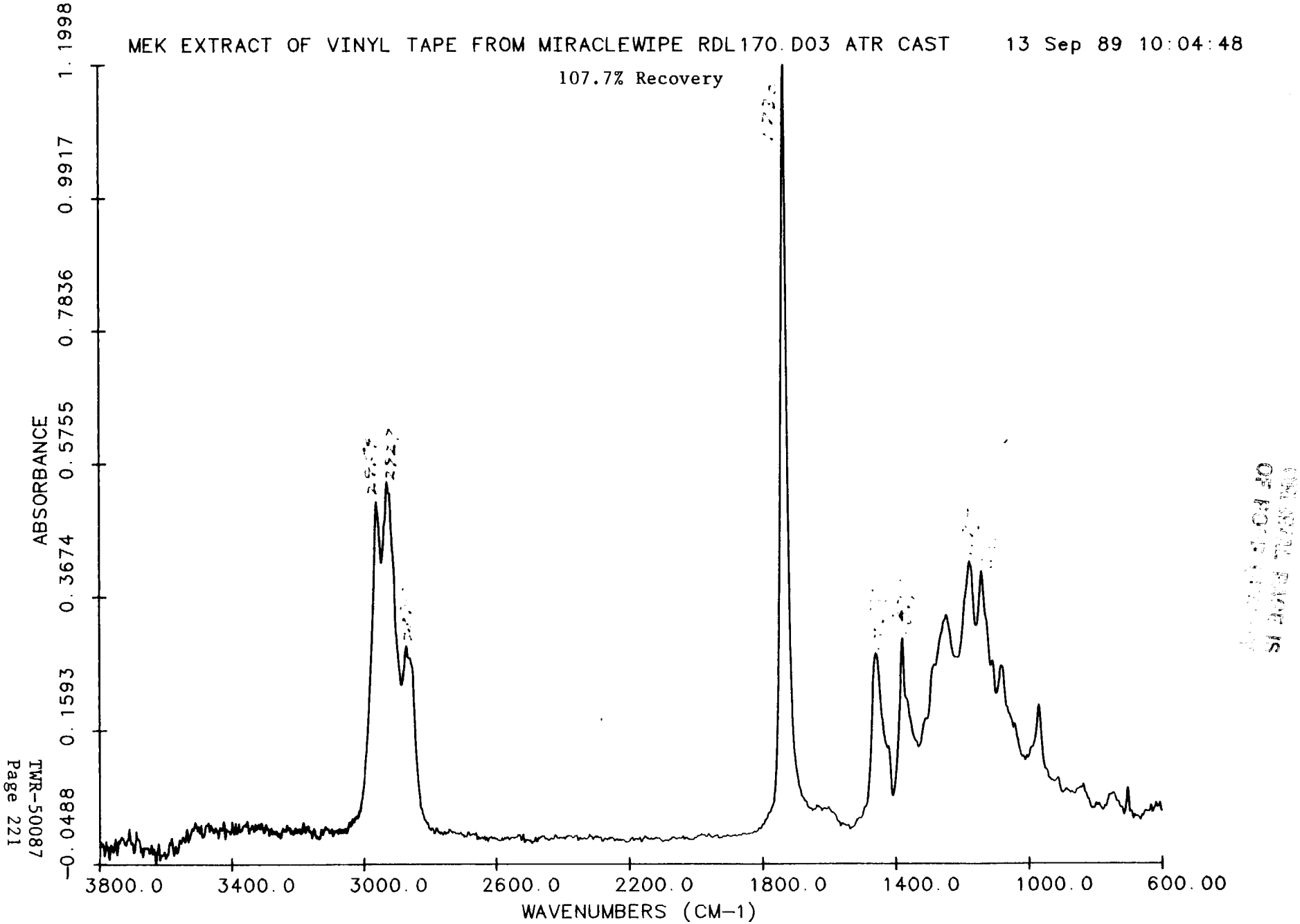


Figure 184.


MEK EXTRACT OF VINYL TAPE FROM MIRACLEWIPE RDL170.D03 ATR CAST 13 Sep 89 10:04:48
107.7% Recovery
ABSORBANCE
1.1998
0.9917
0.7836
0.5755
0.3674
0.1593
-0.0488
3800.0
3400.0
3000.0
2600.0
2200.0
1800.0
1400.0
1000.0
600.00
WAVENUMBERS (CM-1)

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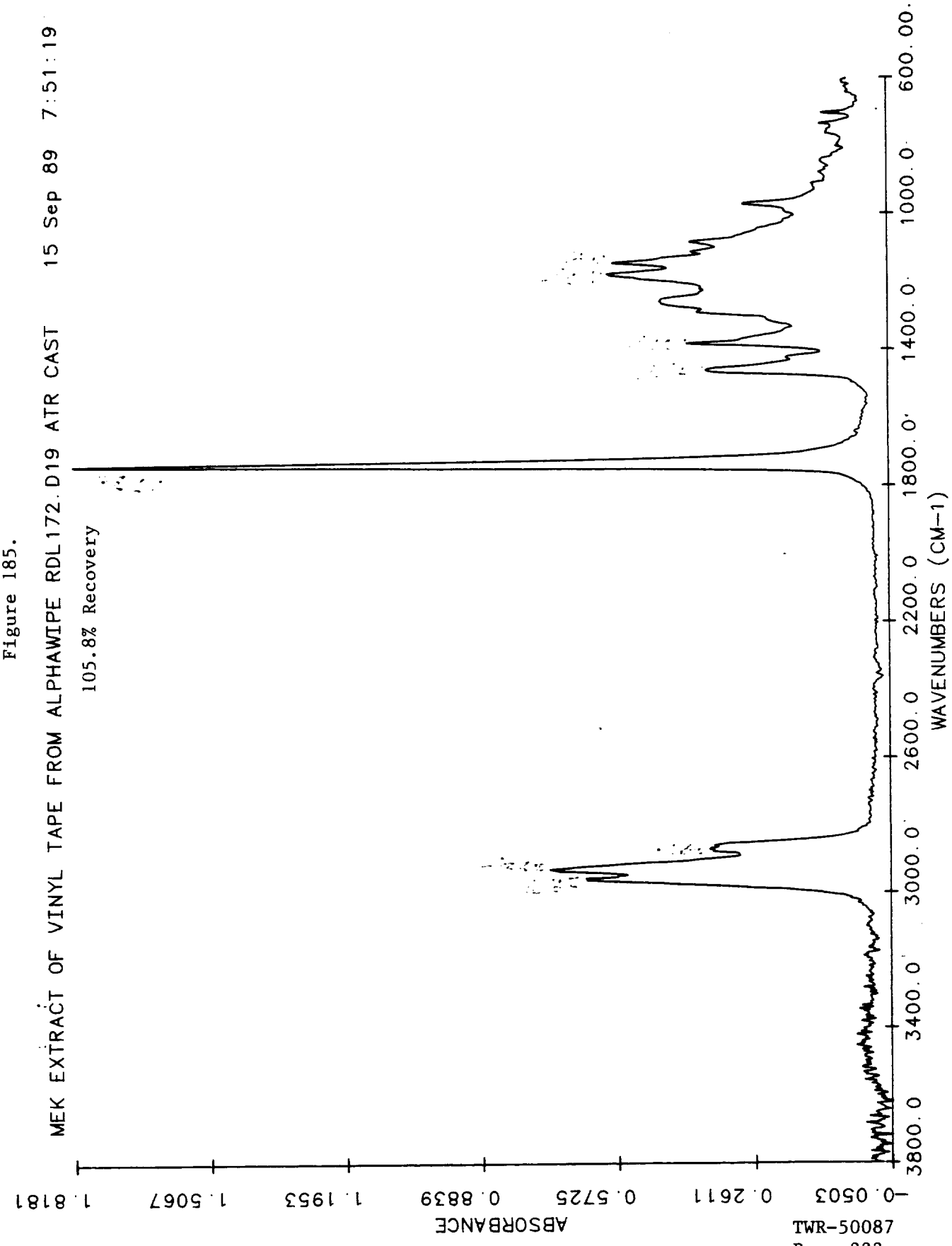

Figure 185.

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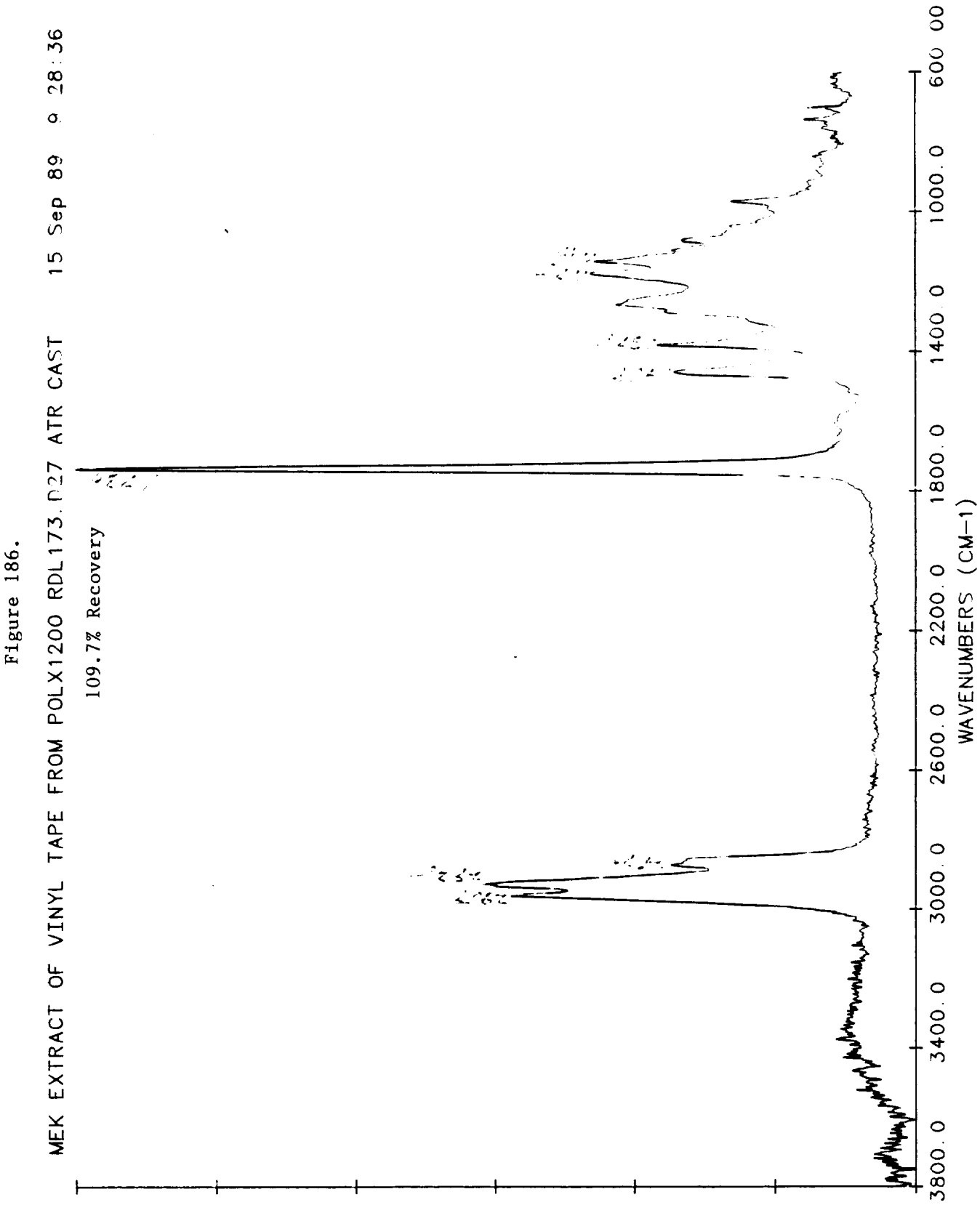
Figure 186.



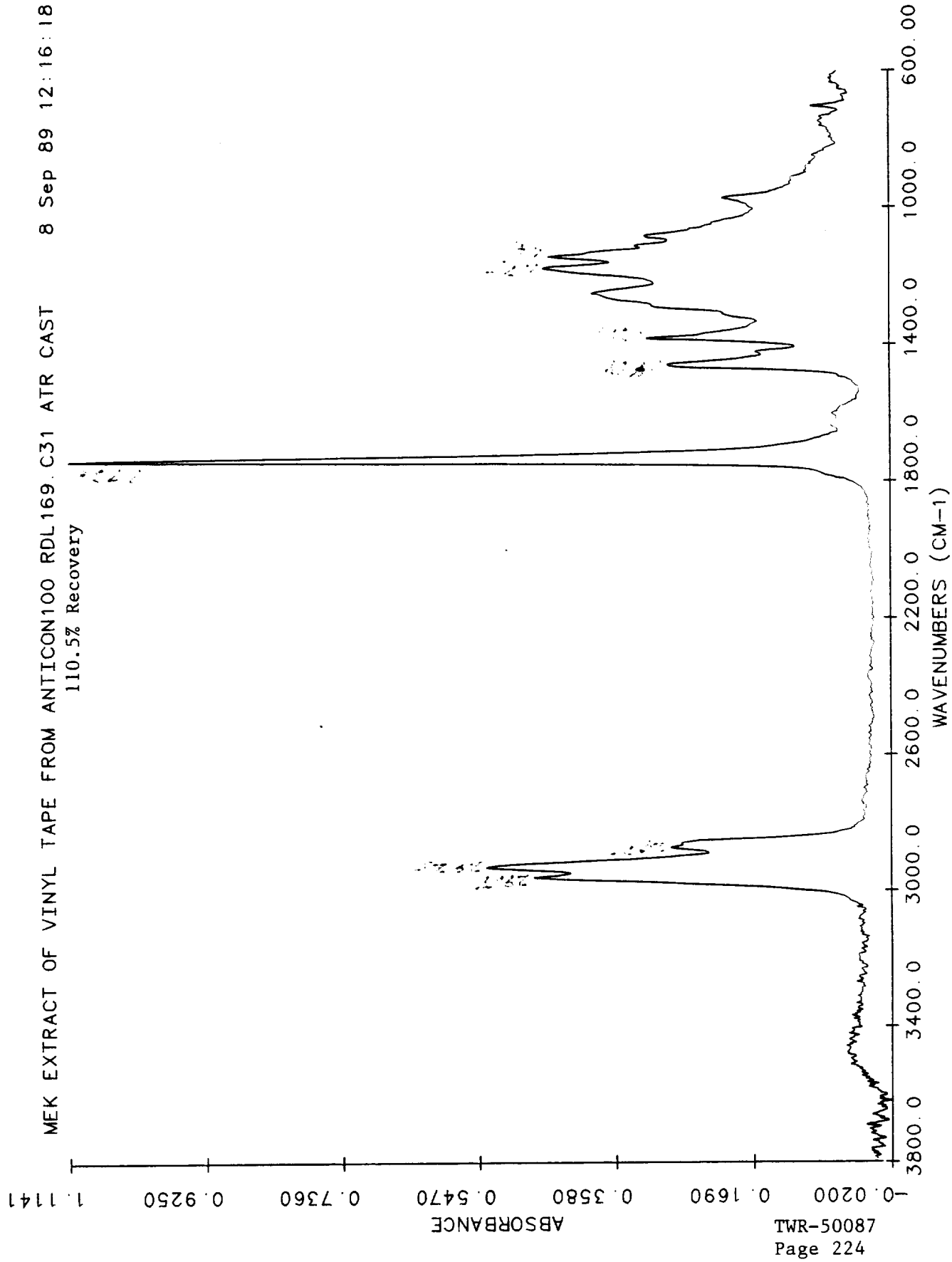


Figure 187.

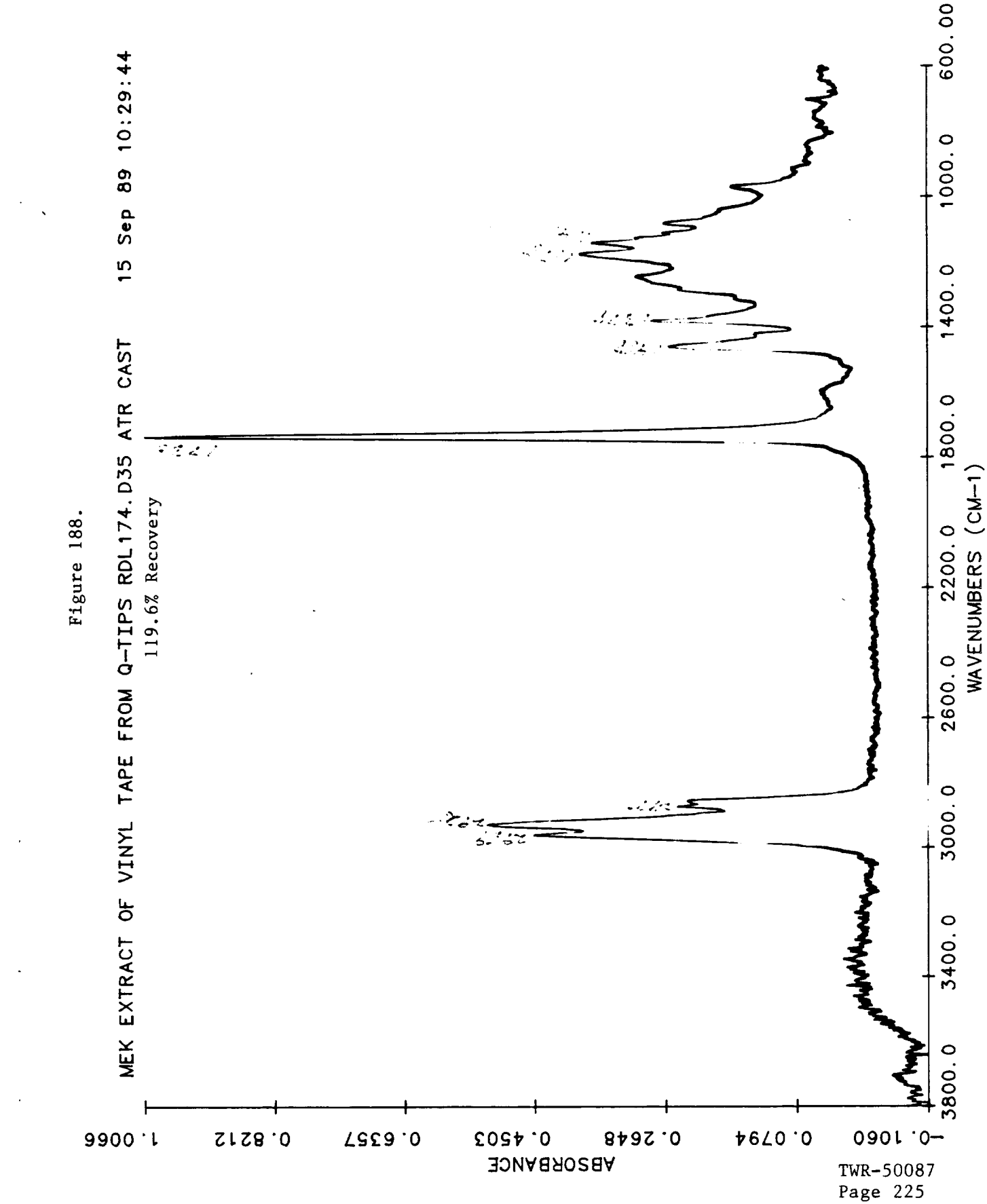


Figure 188.

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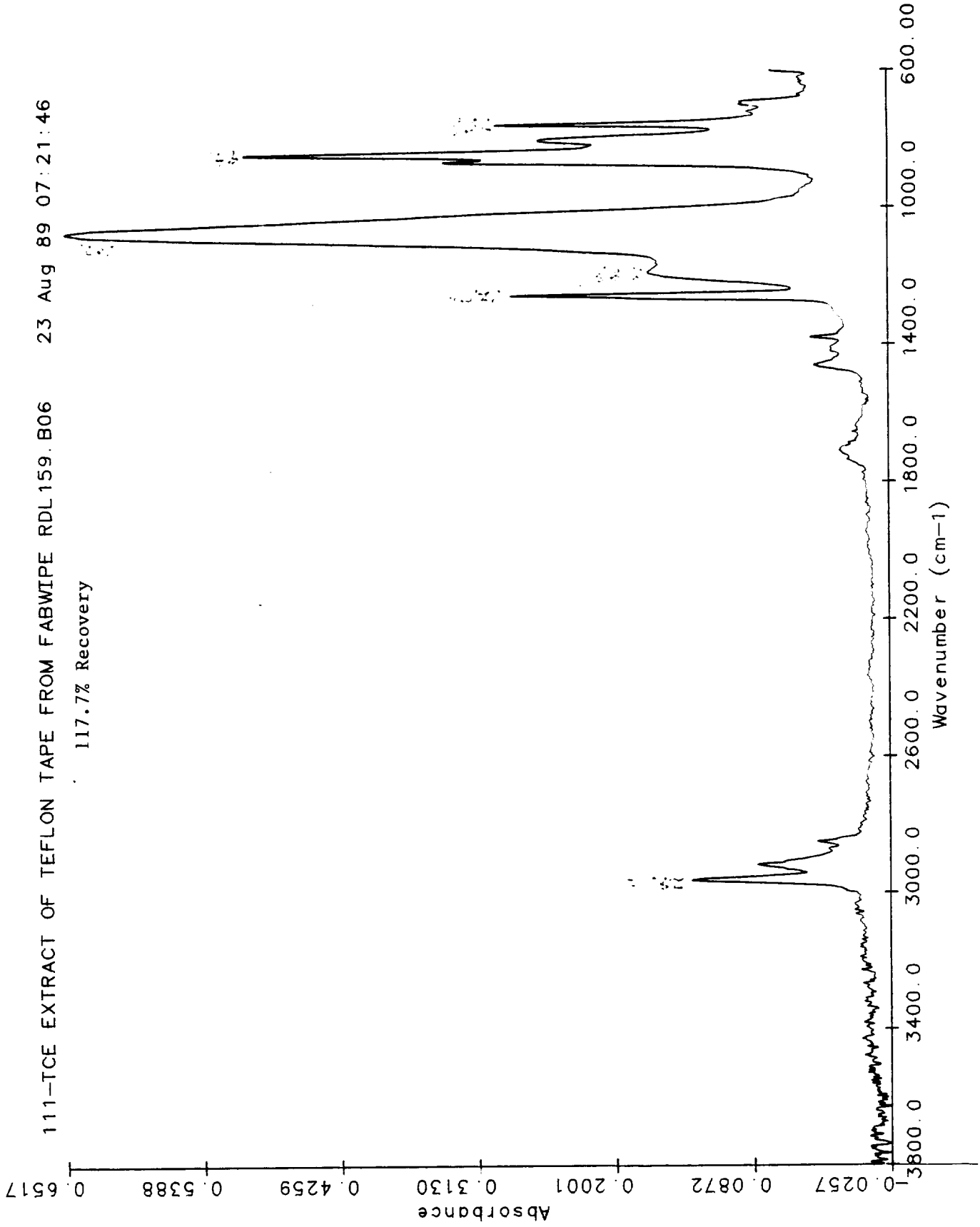
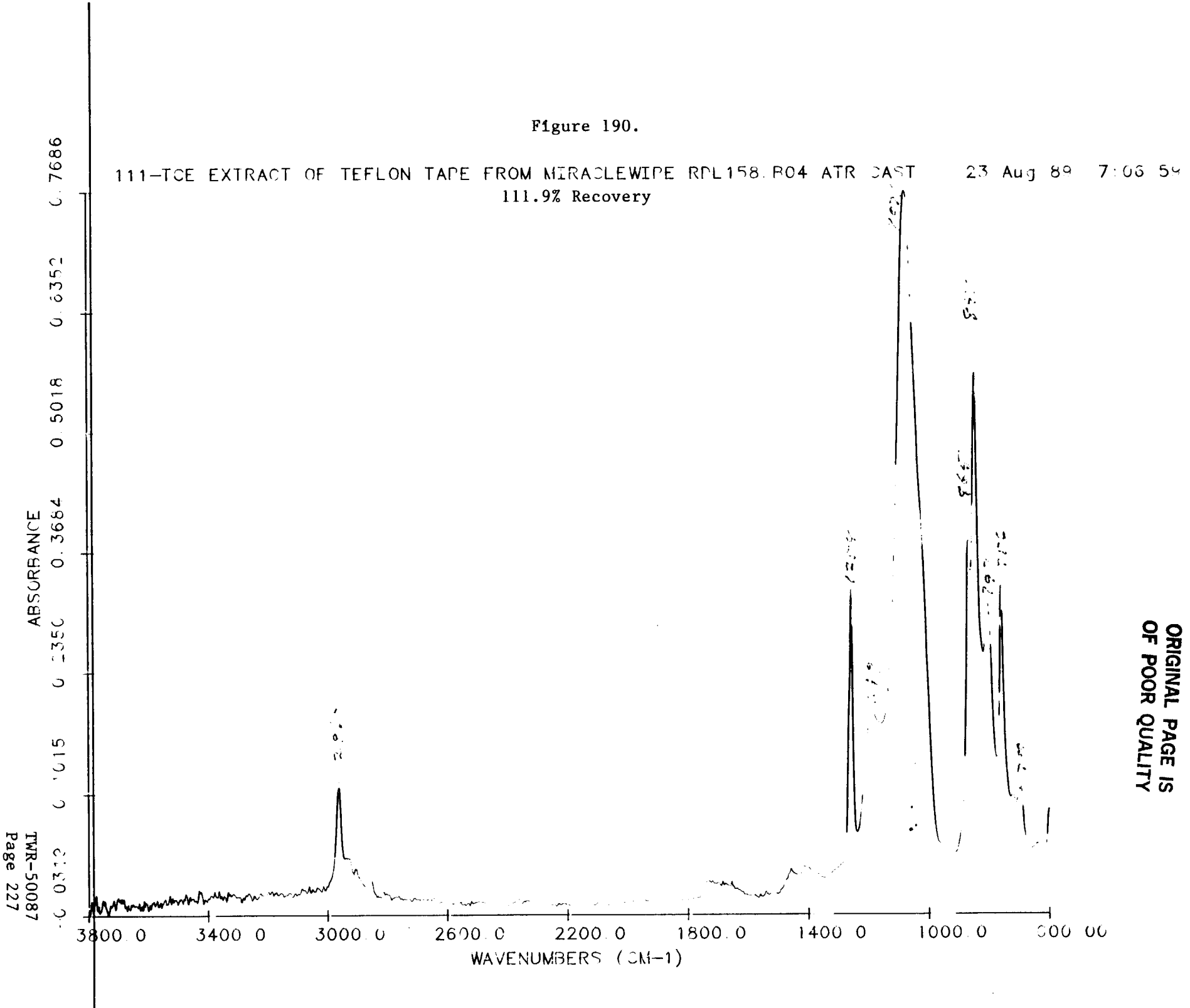
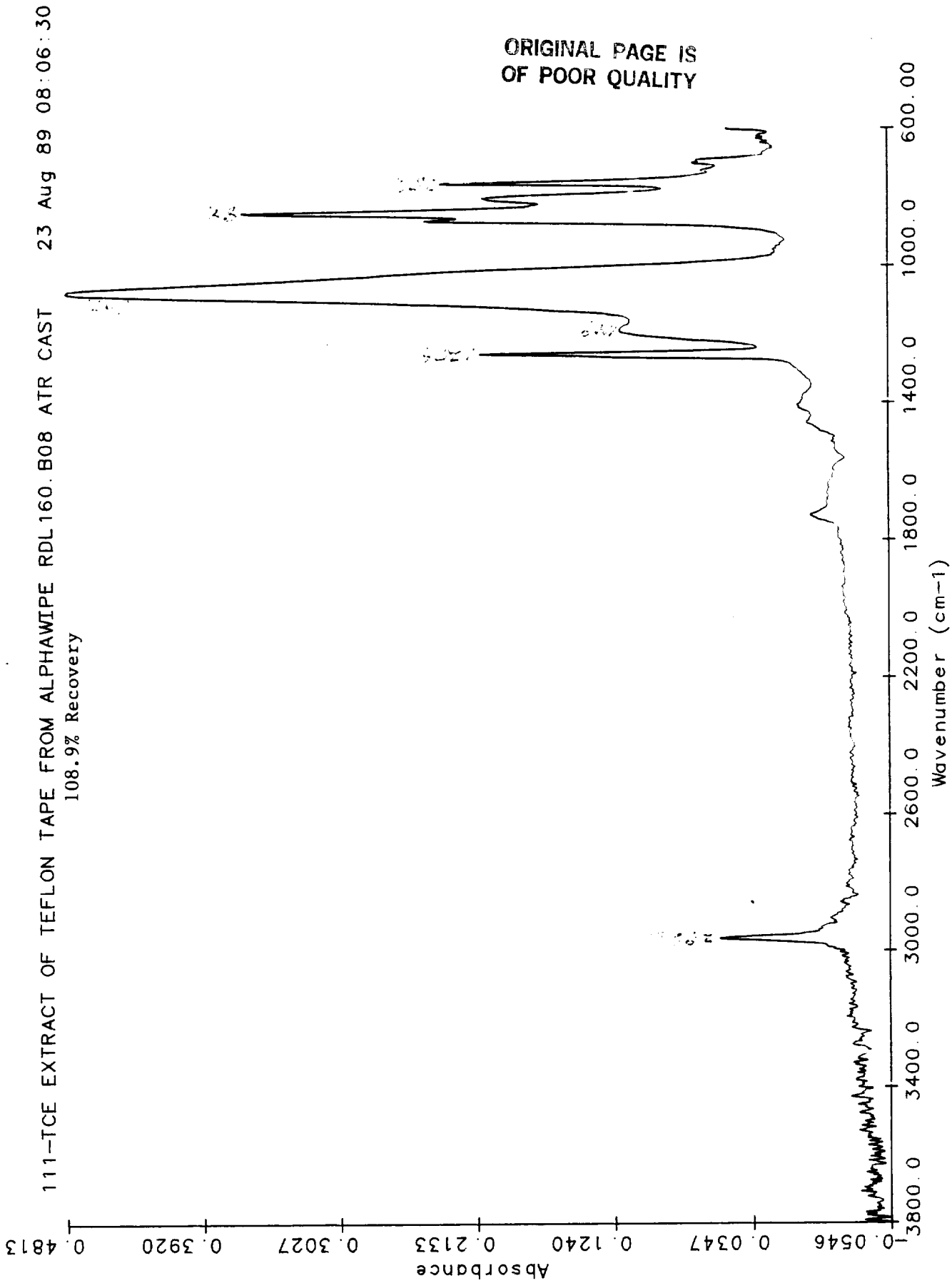


Figure 189.

Figure 190.





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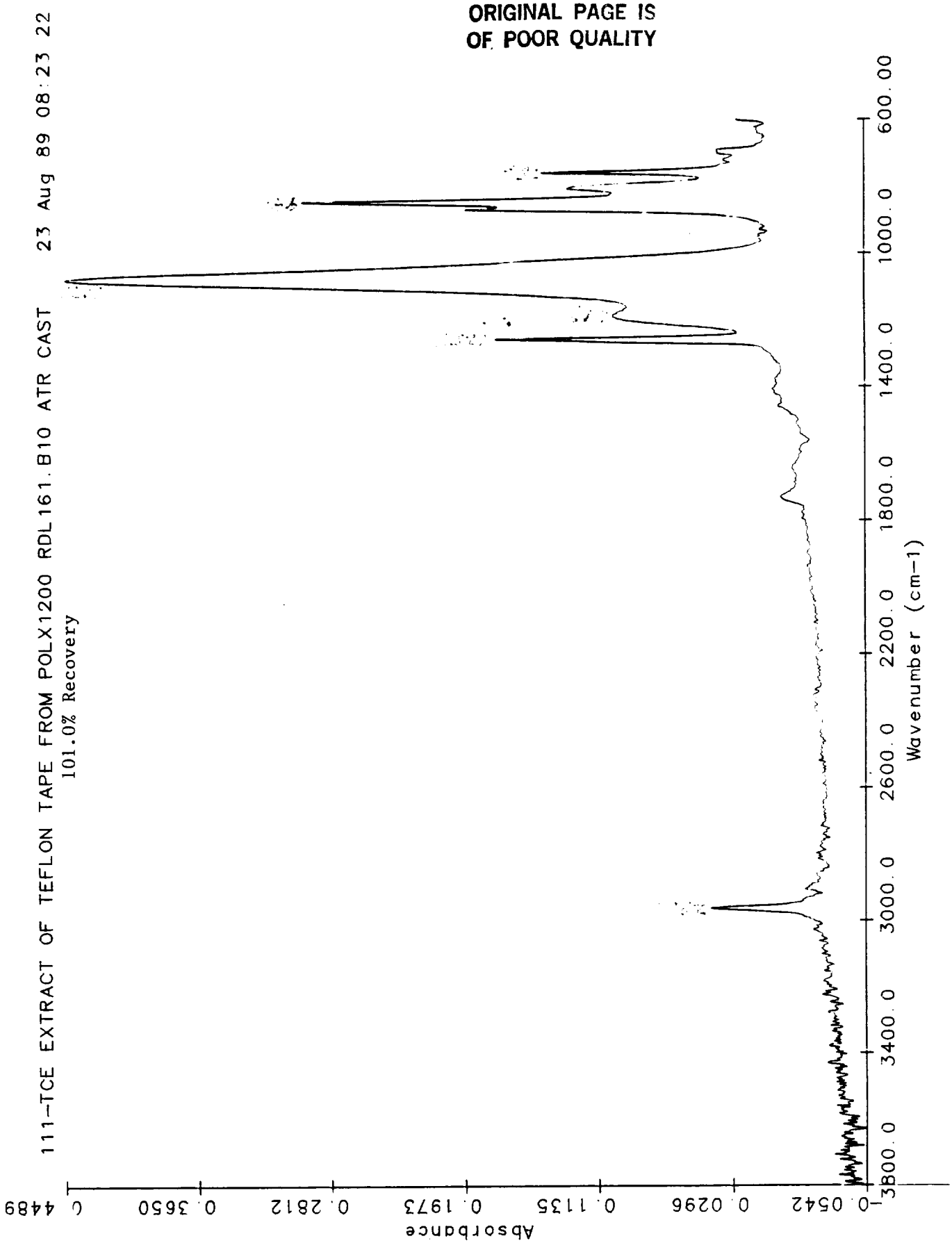
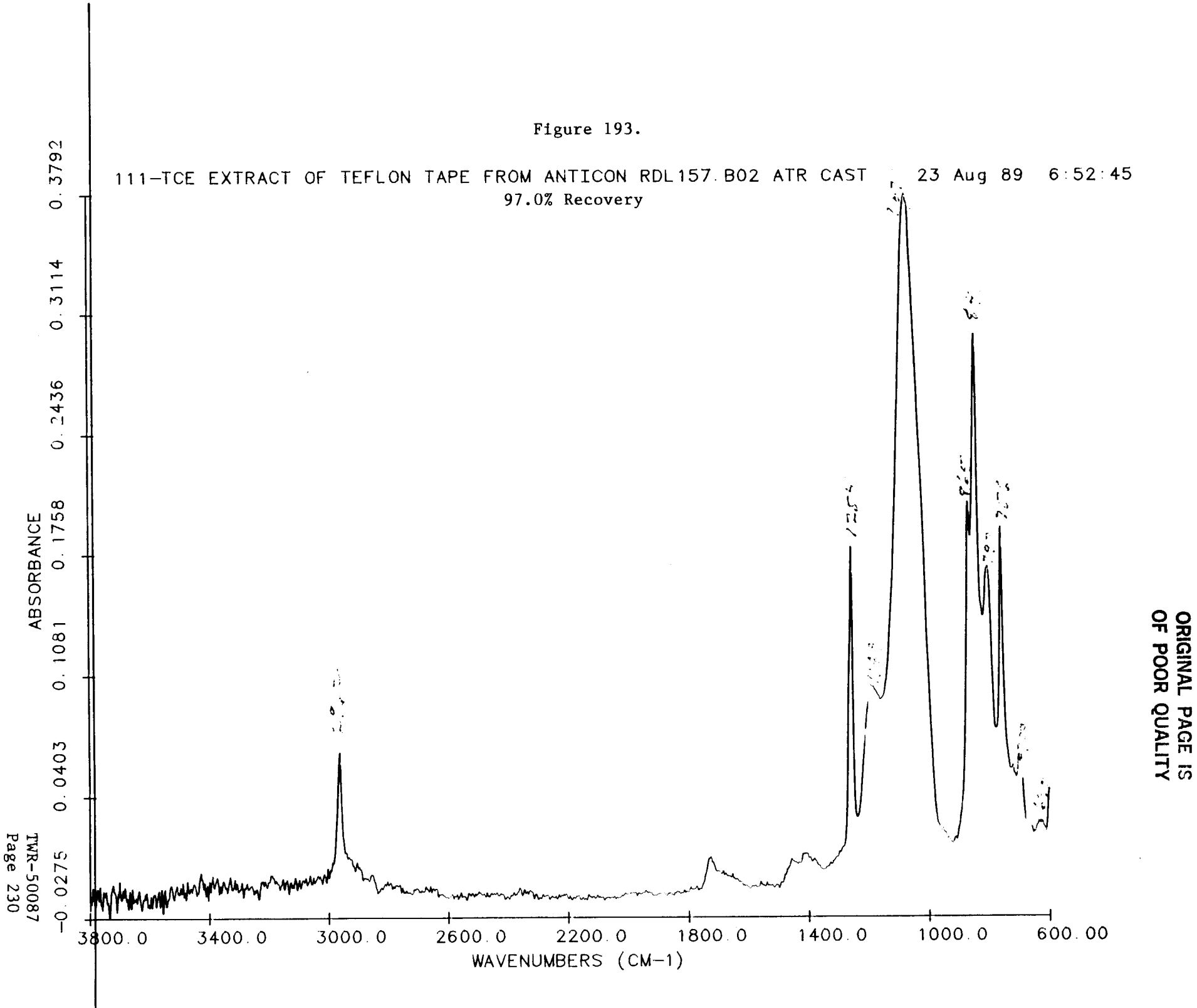


Figure 192.

Figure 193.



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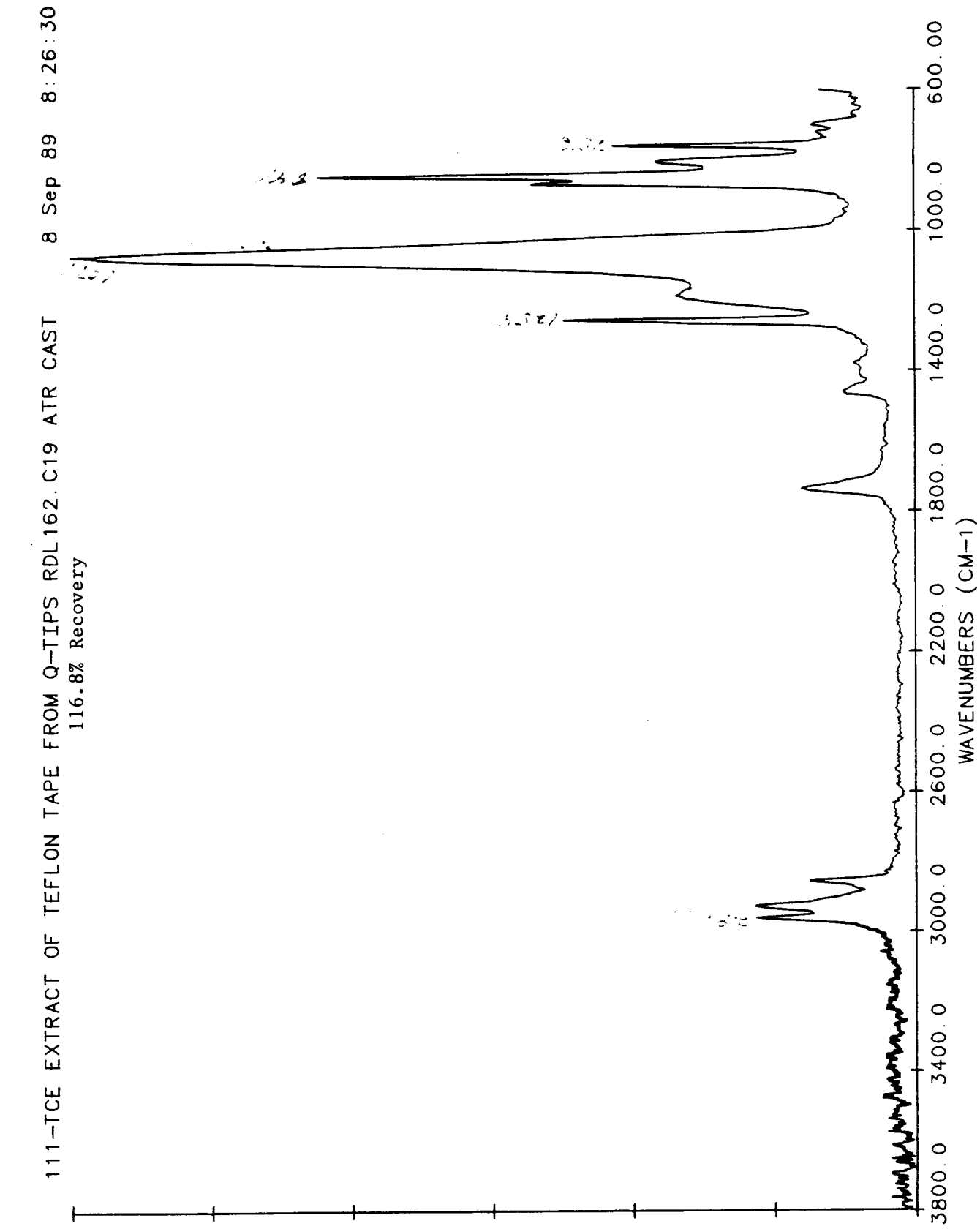
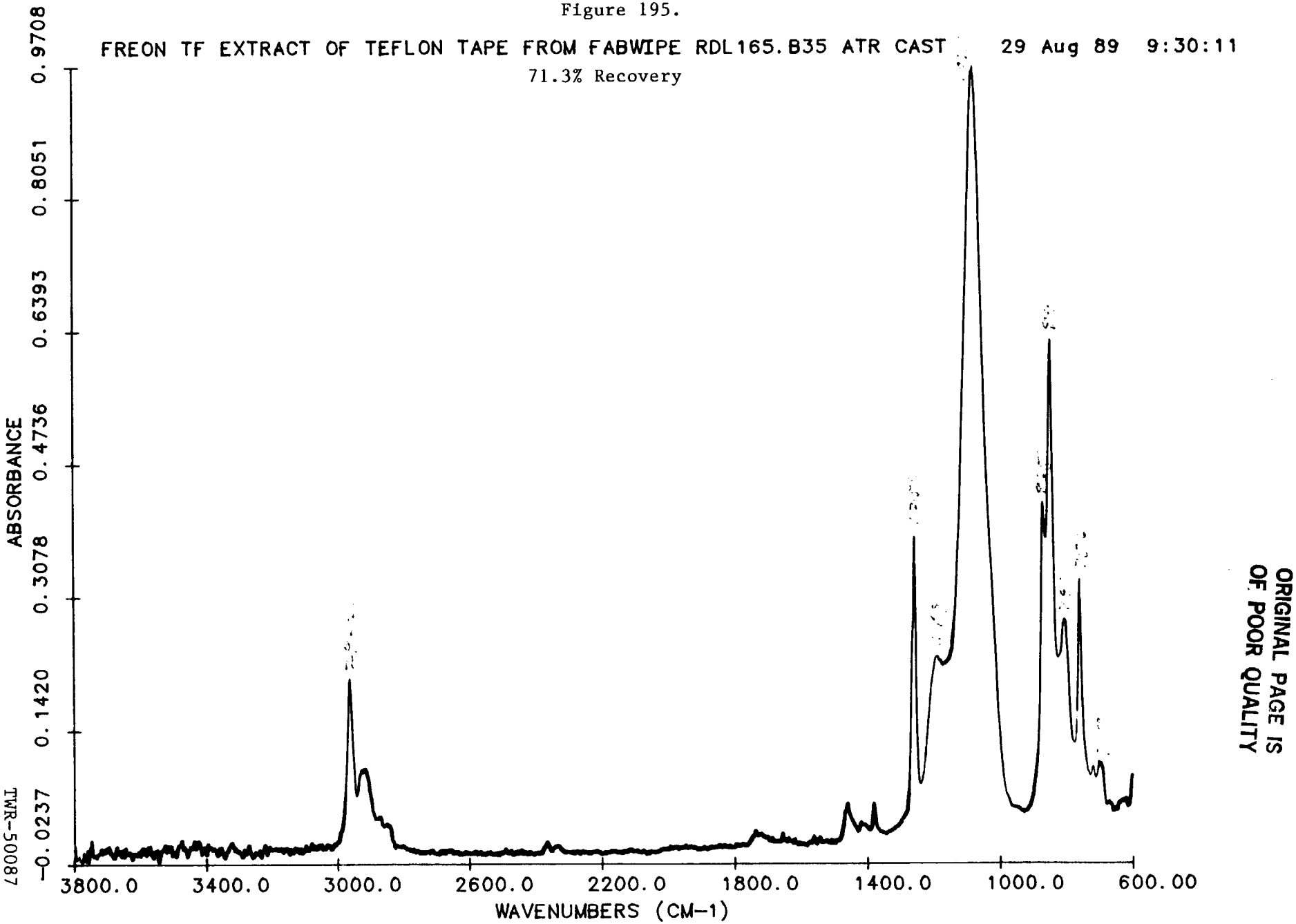


Figure 194.

Figure 195.



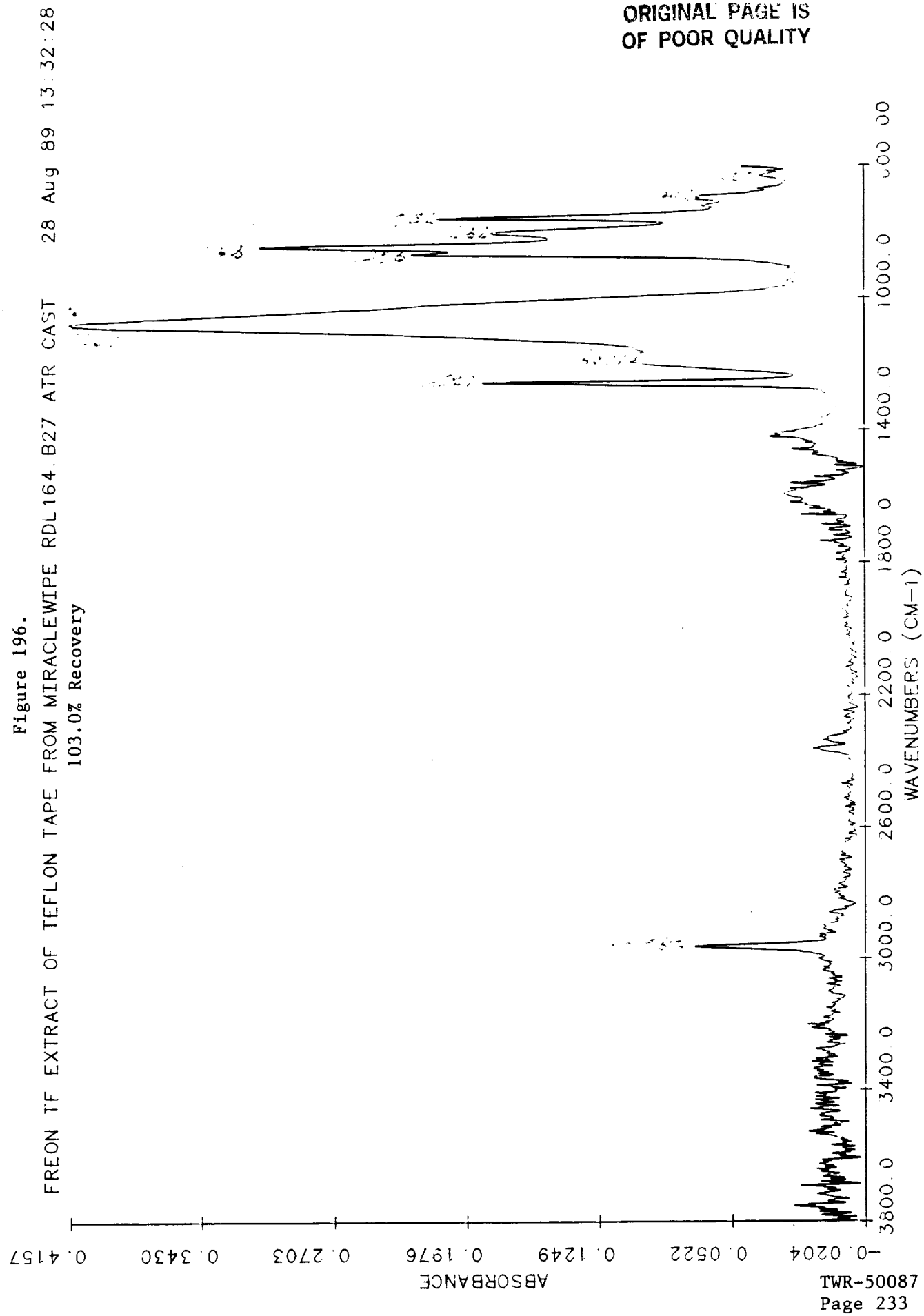
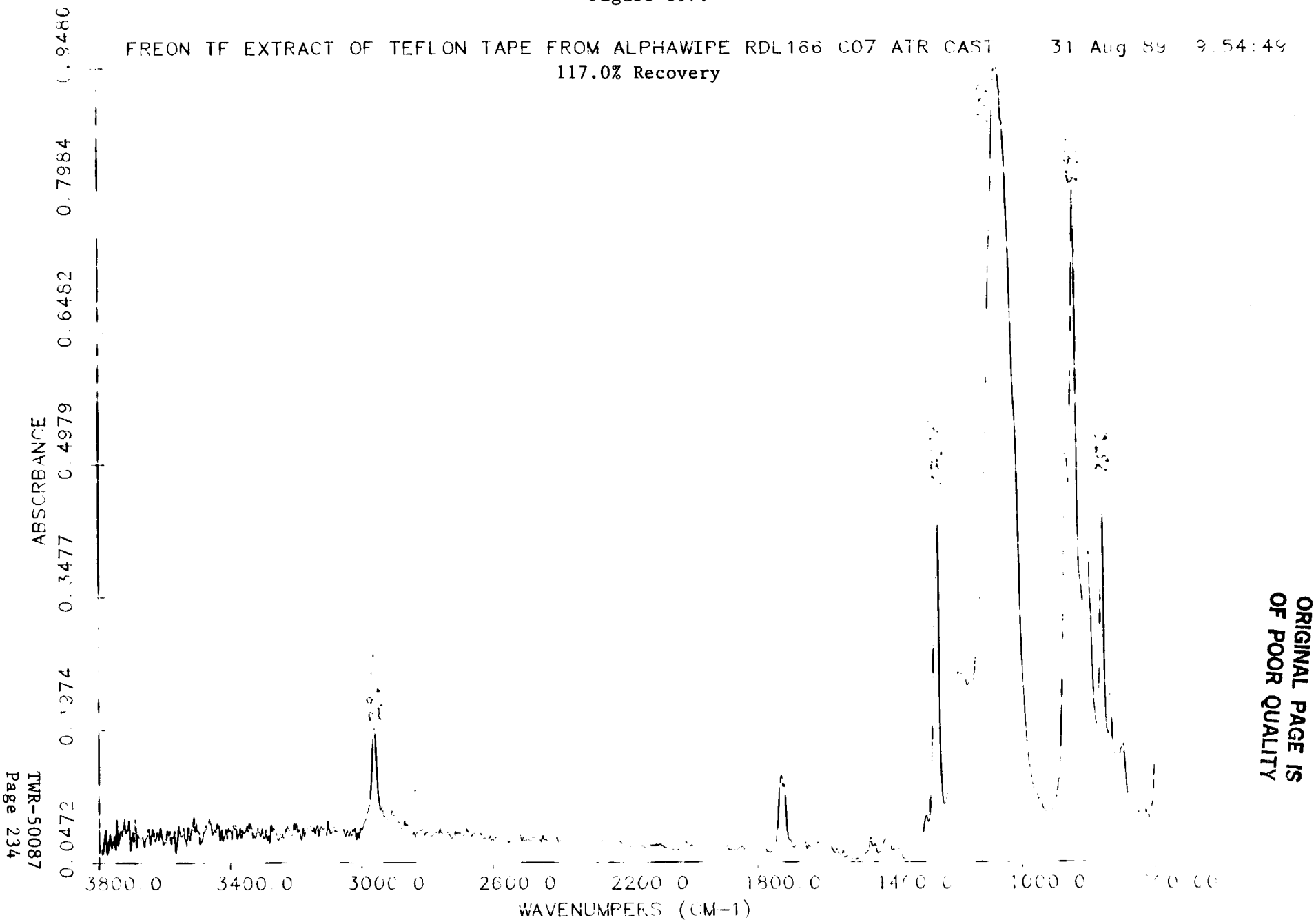


Figure 196.
103.0% Recovery

Figure 197.



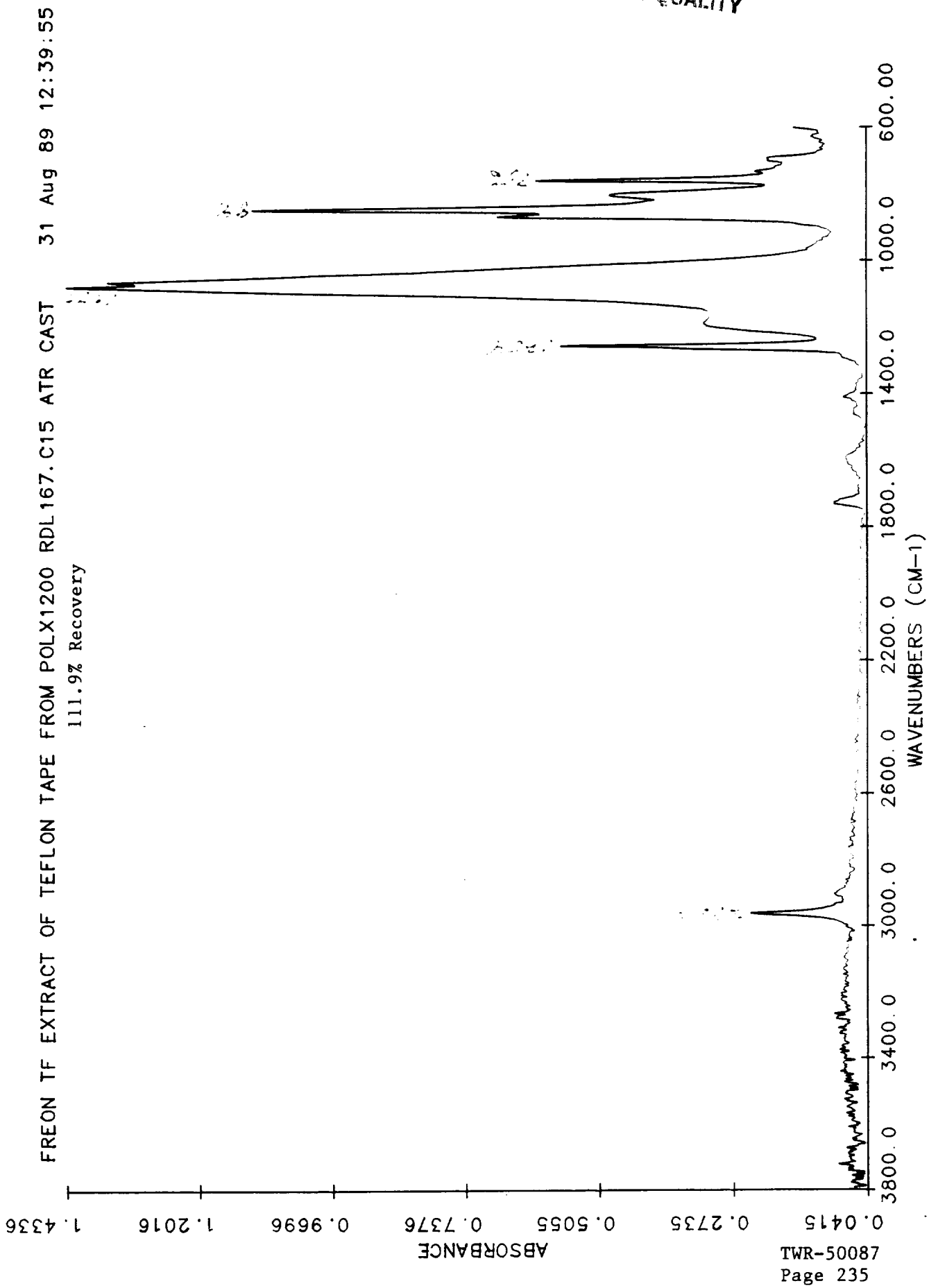


Figure 198.

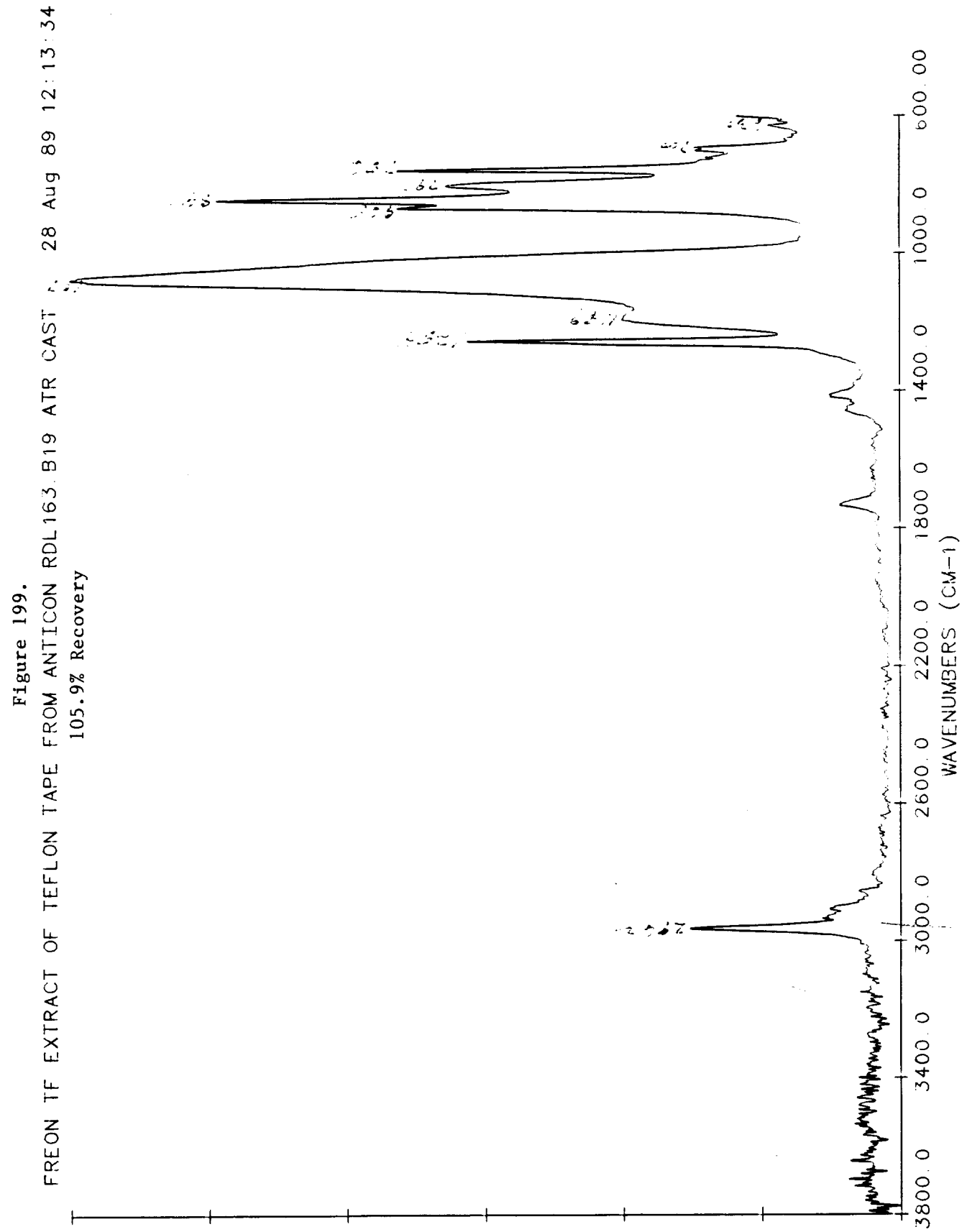


Figure 199.
105.9% Recovery

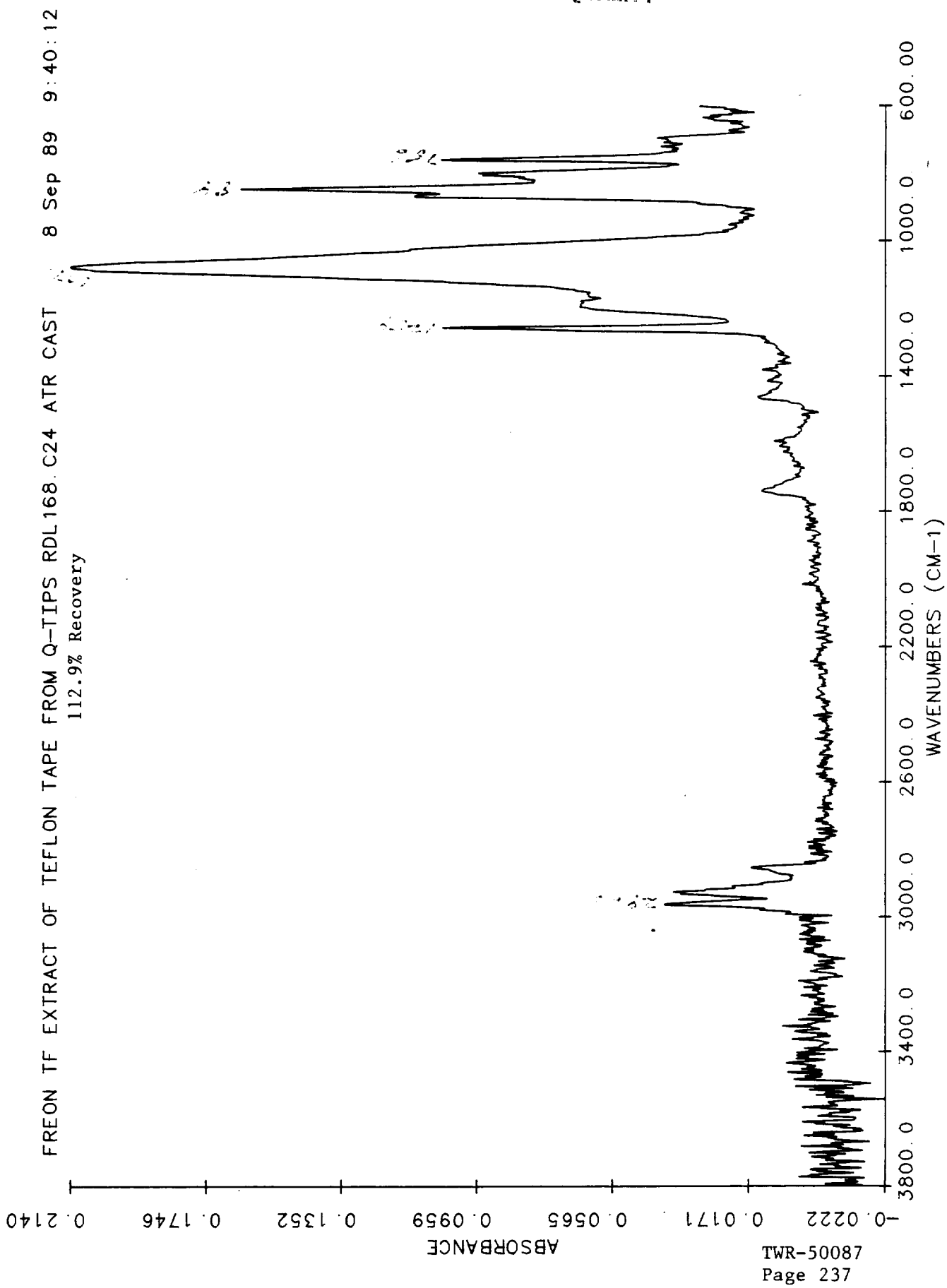


Figure 200.

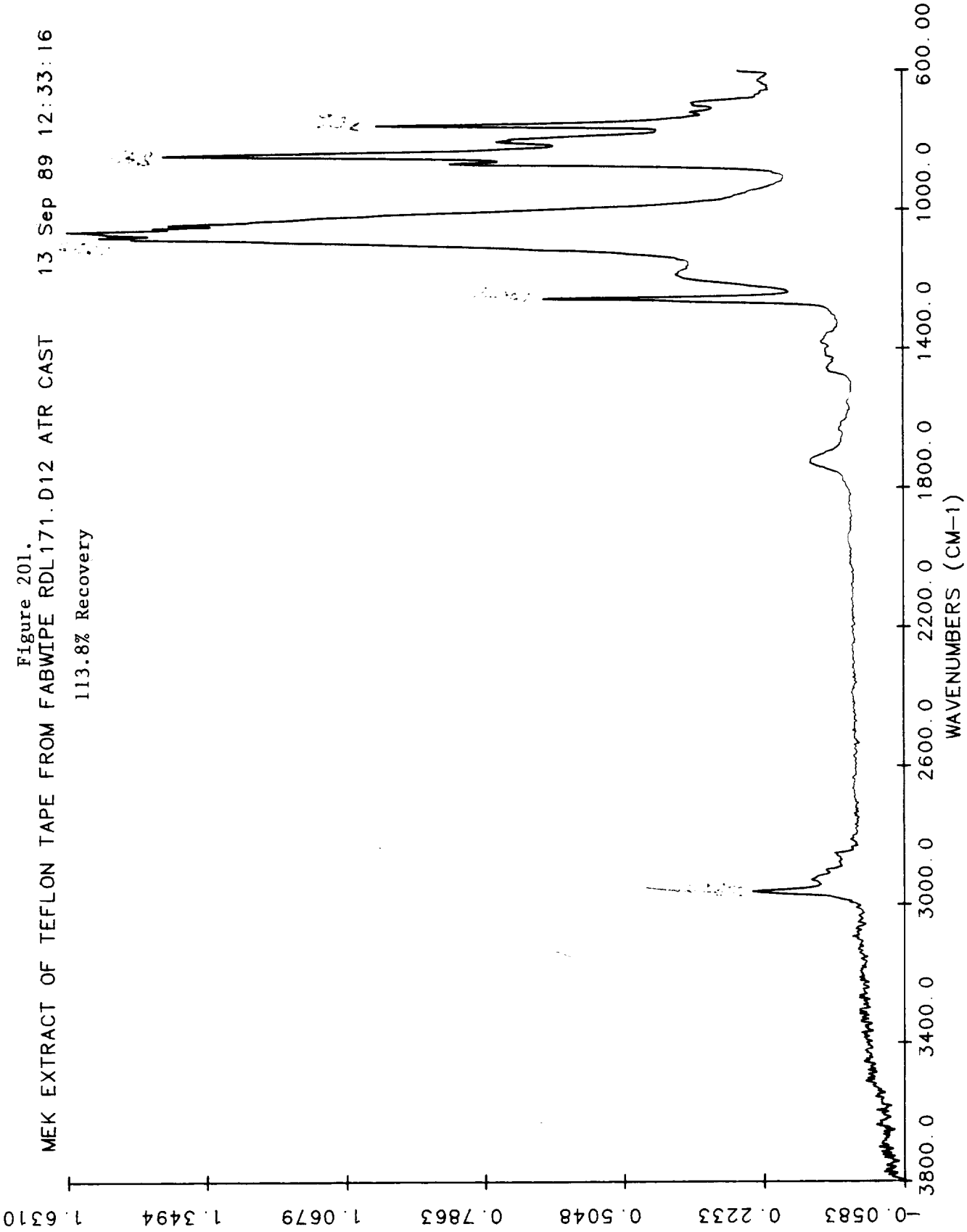
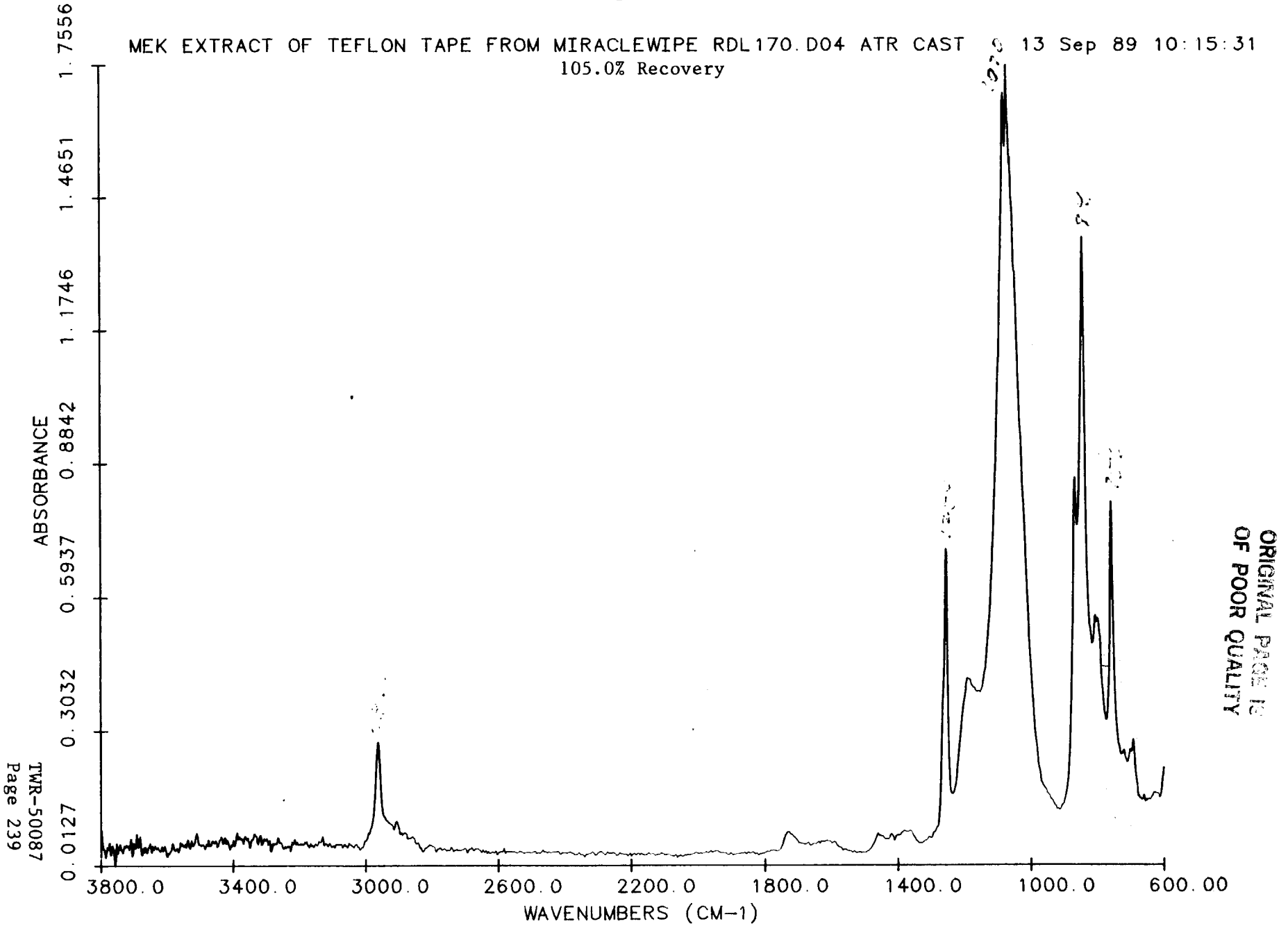


Figure 201.

Figure 202.



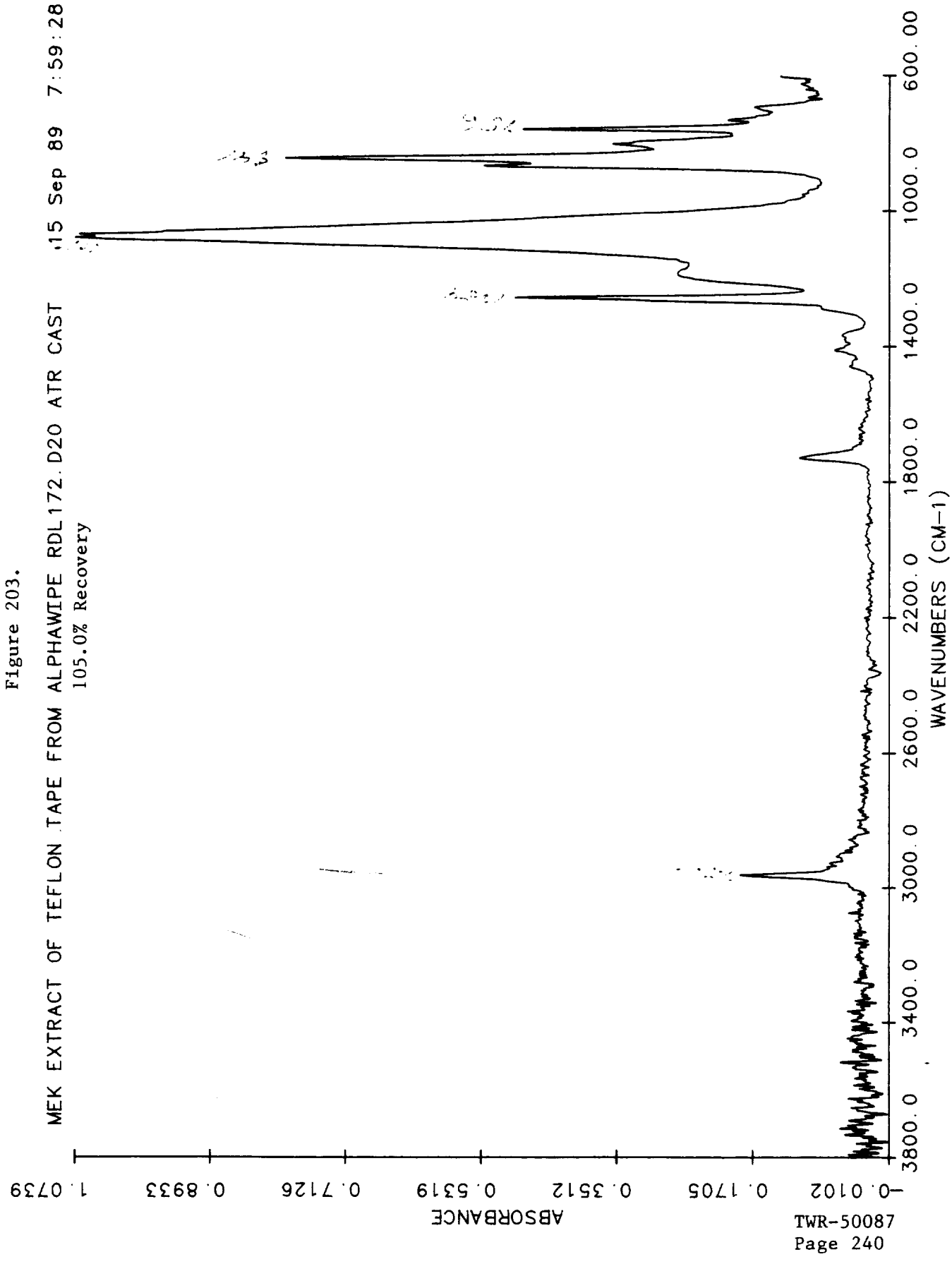


Figure 203.

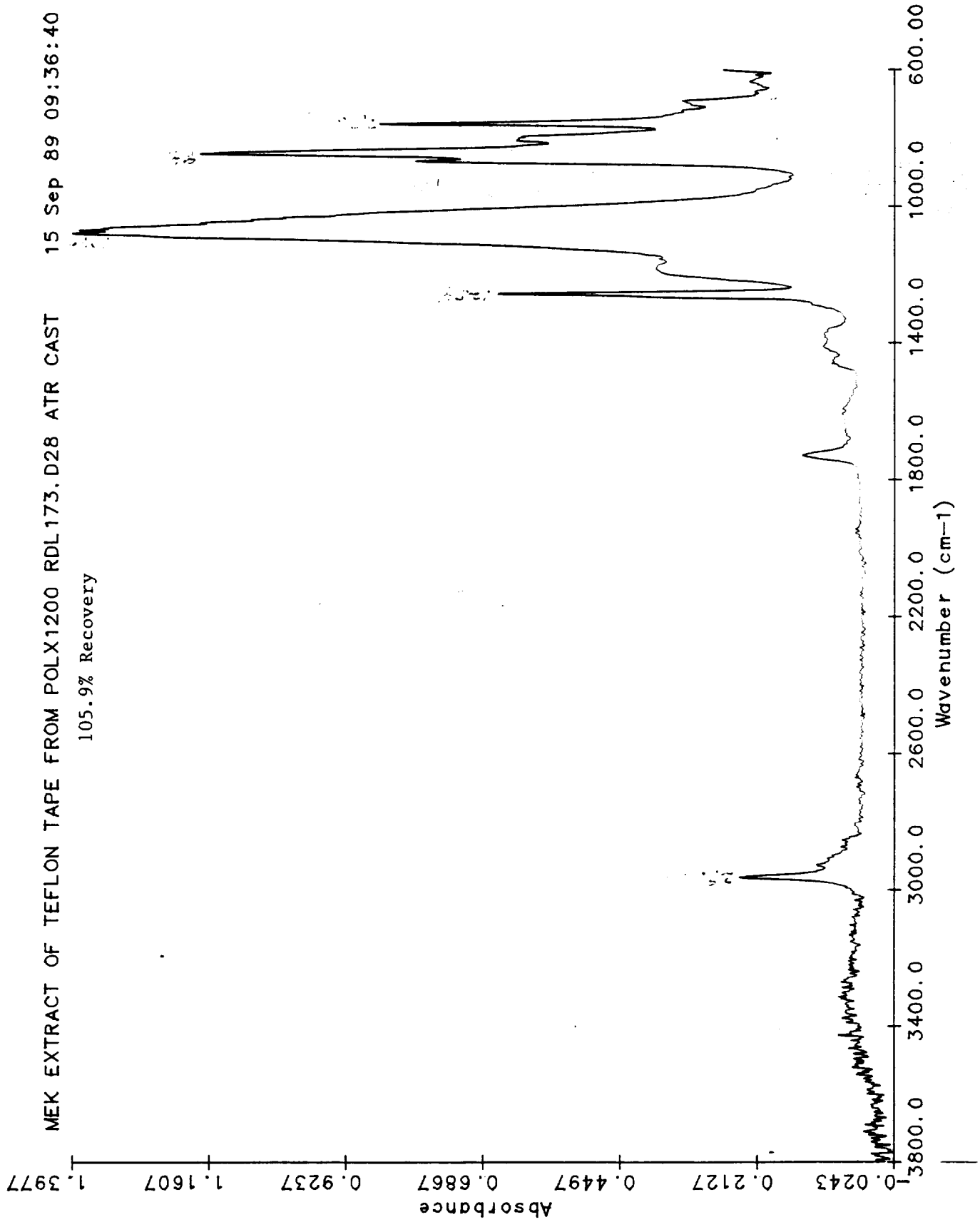


Figure 204.

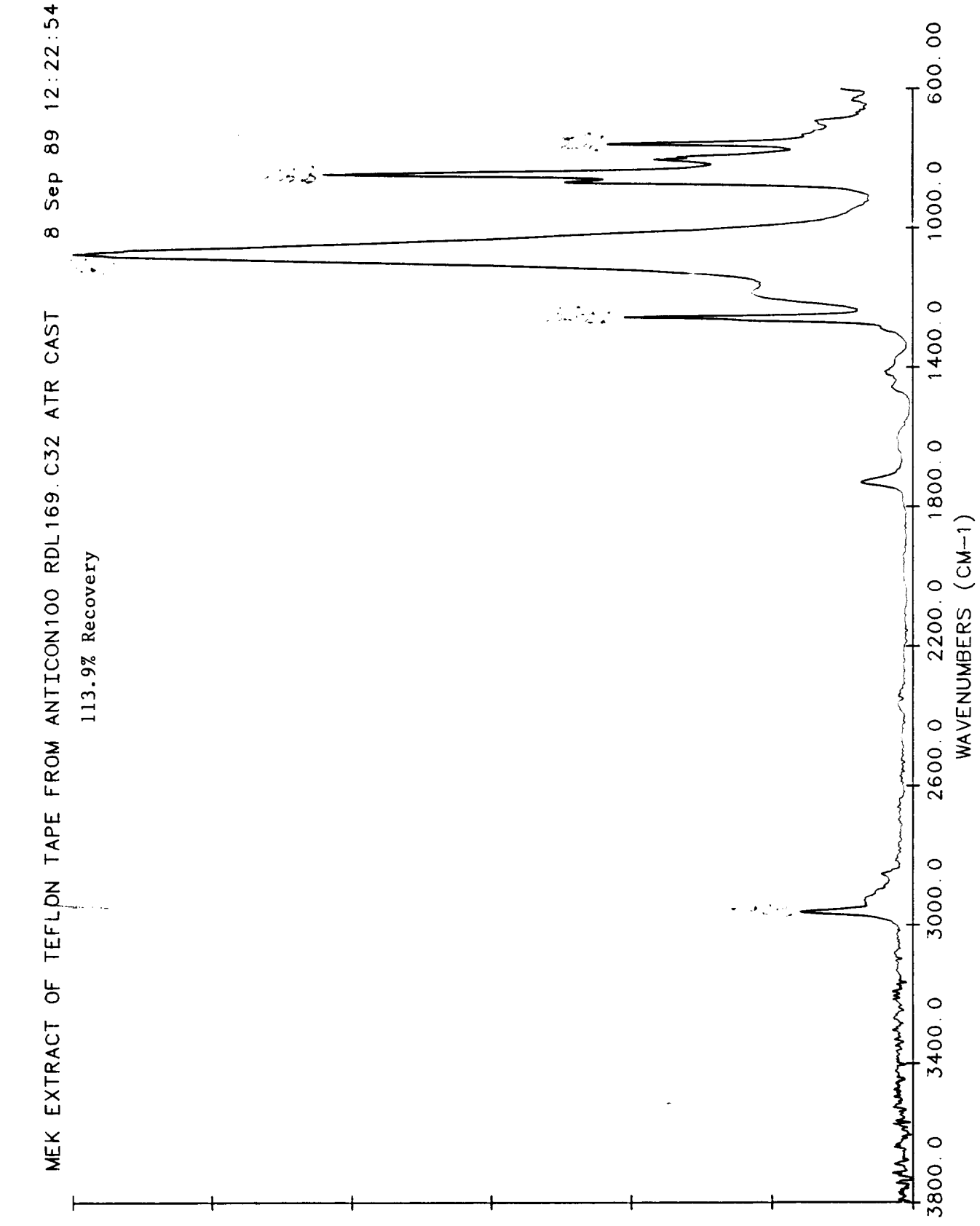


Figure 205.

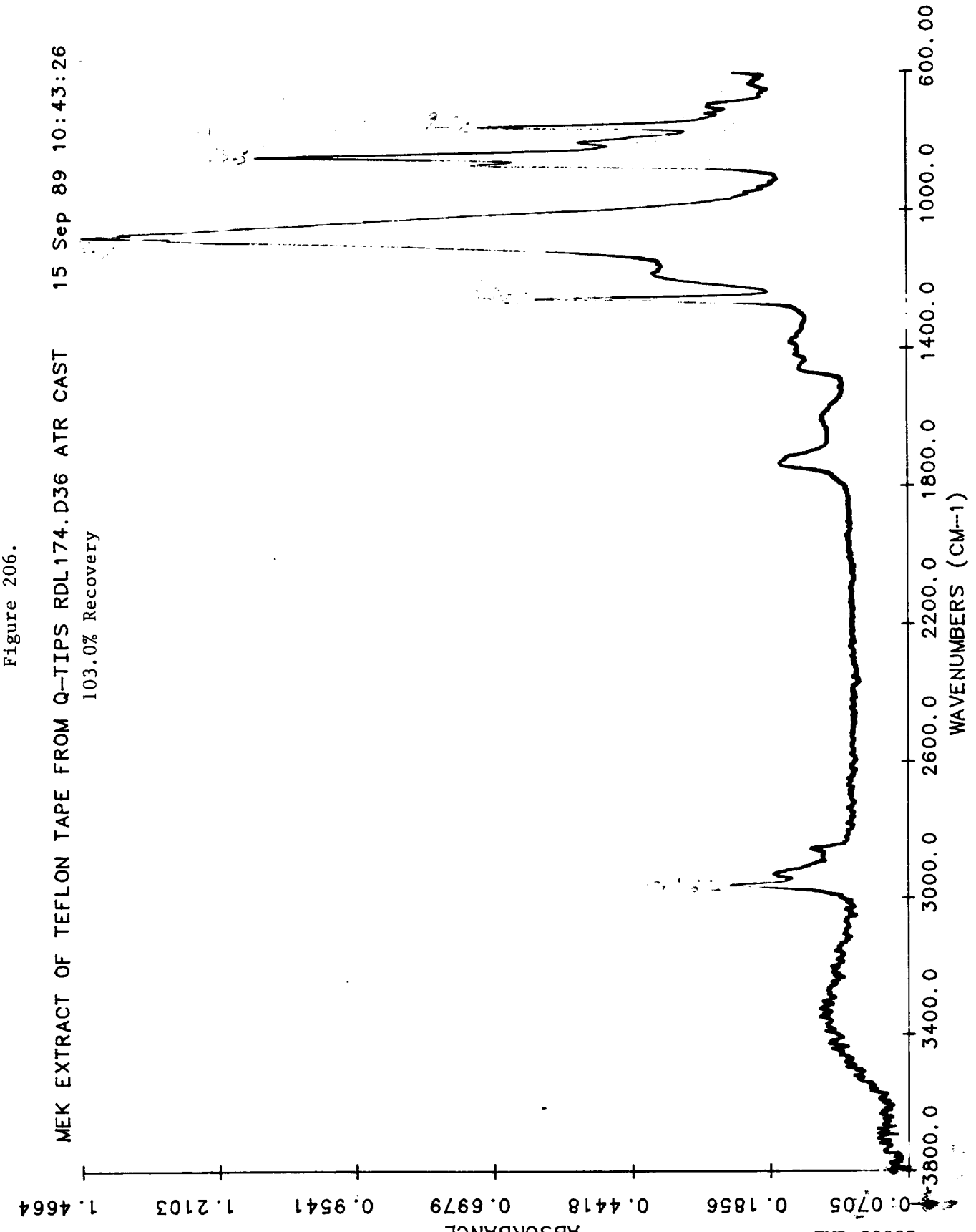


Figure 206.