APPENDICES

OF

DEVELOPMENT OF GEL PERMEATION CHROMATOGRAPHY, INFRARED, AND OTHER TESTS TO CHARACTERIZE ASPHALT CEMENTS AND CORRELATE WITH FIELD PERFORMANCE

VOLUME II

by

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METRIC (SI*) CONVERSION FACTORS

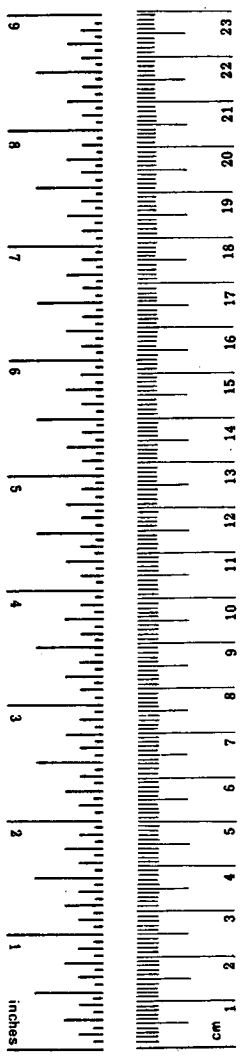
APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
LENGTH				
in	inches	2.54	millimetres	mm
ft	feet	0.3048	metres	m
yd	yards	0.914	metres	m
mi	miles	1.61	kilometres	km
AREA				
in²	square inches	645.2	millimetres squared	mm²
ft²	square feet	0.0929	metres squared	m²
yd²	square yards	0.836	metres squared	m²
mi²	square miles	2.59	kilometres squared	km²
ac	acres	0.395	hectares	ha
MASS (weight)				
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams	Mg
VOLUME				
fl oz	fluid ounces	29.57	millilitres	mL
gal	gallons	3.785	litres	L
ft³	cubic feet	0.0328	metres cubed	m³
yd³	cubic yards	0.0765	metres cubed	m³

NOTE: Volumes greater than 1000 L shall be shown in m³.

TEMPERATURE (exact)

°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

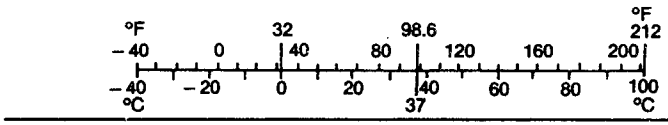


APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
LENGTH				
mm	millimetres	0.039	inches	in
m	metres	3.28	feet	ft
m	metres	1.09	yards	yd
km	kilometres	0.621	miles	mi
AREA				
mm²	millimetres squared	0.0016	square inches	in²
m²	metres squared	10.764	square feet	ft²
km²	kilometres squared	0.39	square miles	mi²
ha	hectores (10 000 m²)	2.53	acres	ac
MASS (weight)				
g	grams	0.0353	ounces	oz
kg	kilograms	2.205	pounds	lb
Mg	megagrams (1 000 kg)	1.103	short tons	T
VOLUME				
mL	millilitres	0.034	fluid ounces	fl oz
L	litres	0.264	gallons	gal
m³	metres cubed	35.315	cubic feet	ft³
m³	metres cubed	1.308	cubic yards	yd³

TEMPERATURE (exact)

°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



These factors conform to the requirement of FHWA Order 5190.1A.

* SI is the symbol for the International System of Measurements

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APPENDIX A

SECTION II

ANALYTICAL METHODS

Table A-1a

Percent LMS Versus Concentration Data for Study 287 Tank Asphalts

Name	Location	% LMS	Weight %
Cosden AC-10	Dickens	10.3	0.5
		10.6	1
		10.6	2
		10.9	3
		11.1	4
		11.2	5
		11.6	6
		11.9	7
	Dumas	8.1	0.5
		9.5	1
		10.9	2
		10.7	3
		10.8	4
		11.1	5
		11.3	6
		11.3	7
Cosden AC-20	Dickens	11.2	0.5
		11.0	1
		11.1	2
		11.5	3
		11.8	4
		12.1	5
		12.3	6
		12.4	7
	Dumas	10.5	0.5
		11.0	1
		11.1	2
		11.2	3
		11.5	4
		11.8	5
		12.0	6
		12.0	7

Table A-1a (Cont'd)

Percent LMS Versus Concentration Data for Study 287 Tank Asphalts

Name	Location	% LMS	Weight %
Cosden AC-20 (Cont'd)	Lufkin	10.7	1
		11.1	2
		11.3	3
		11.5	4
		12.0	5
		12.2	6
Diamond Shamrock AC-10	Dickens	39.8	1
		39.2	2
		39.3	3
		39.1	4
		38.9	5
		38.3	6
	Dumas	40.2	1
		39.9	2
		39.7	3
		39.4	4
		39.3	5
		36.6	6
Diamond Shamrock AC-20	Dickens	42.0	1
		41.6	2
		42.3	3
		41.6	4
		41.6	5
		41.4	6
	Dumas	40.2	1
		40.0	2
		39.7	3
		39.4	4
		39.3	5
		36.6	6

Table A-1a (Cont'd)

Percent LMS Versus Concentration Data for Study 287 Tank Asphalts

Name	Location	% LMS	Weight %
Diamond Shamrock AC-20 (Cont'd)	Lufkin	33.1	1
		33.1	2
		33.1	3
		33.2	4
		33.8	5
		34.1	6
Dorchester AC-10	Dumas	13.3	0.5
		14.1	1
		14.0	2
		15.0	3
		15.6	4
		16.2	5
		16.4	6
		15.6	7
Dorchester AC-20	Dickens	15.1	0.5
		15.6	1
		16.3	2
		16.9	3
		17.3	4
		18.2	5
		19.3	6
		19.3	7
	Lufkin	13.1	1
		14.1	2
		14.6	3
		15.2	4
		15.6	5
		15.9	6
		15.1	7

Table A-1a (Cont'd)

Percent LMS Versus Concentration Data for Study 287 Tank Asphalts

Name	Location	% LMS	Weight %
Exxon AC-10	Dumas	9.5	1
		9.8	2
		10.0	3
		10.3	4
		10.5	5
		10.6	
Exxon AC-20	Dickens	11.9	0.5
		11.9	1
		12.3	2
		12.7	3
		12.6	4
		13.2	5
		13.2	6
		13.2	7
	Lufkin	10.0	0.5
		10.5	1
		10.2	2
		10.4	3
		10.6	4
		10.8	5
		11.0	6
		11.2	7
MacMillan AC-10	Dumas	16.2	0.5
		14.9	1
		15.4	2
		15.9	3
		16.3	4
		16.7	5
		17.2	6
		16.2	7

Table A-1a (Cont'd)

Percent LMS Versus Concentration Data for Study 287 Tank Asphalts

Name	Location	% LMS	Weight %
MacMillan AC-20	Dickens	---	0.5
		19.8	1
		20.2	2
		21.0	3
		21.3	4
		22.0	5
		22.5	6
		22.5	7
MacMillan AC-20 (Cont'd)	Lufkin	23.4	1
		23.8	2
		24.1	3
		24.3	4
		25.0	5
		24.9	6
Texaco AC-20	Lufkin	13.9	1
		14.1	2
		14.7	3
		15.3	4
		15.4	5
		15.2	6

Table A-1b

Percent LMS Versus Concentration Data for Hot-Mix Study Tank Asphalts

Name	Process	% LMS	Weight %
1989 Ampet AC-20	Drum	14.0	1
		13.6	2
		14.4	3
		14.7	4
		14.8	5
		14.9	6
Coastal AC-20	Drum	14.2	0.5
		15.1	1
		14.6	2
		16.4	3
		17.5	4
		18.2	5
		18.2	6
		19.5	7
1989 Cosden AC-10	Drum	10.0	1
		10.0	2
		10.4	3
		8.9	4
		10.8	5
		10.7	6
1989 Cosden AC-20	Drum	23.5	1
		23.4	2
		23.6	3
		23.7	4
		24.1	5
		23.9	6
1987 Exxon AC-20	Batch	9.5	1
		9.6	2
		9.8	3
		10.0	4
		10.2	5
		10.2	6
		10.9	7

Table A-1b (Cont'd)

Percent LMS Versus Concentration Data for Hot-Mix Study Tank Asphalts

Name	Process	% LMS	Weight %
1987 Exxon AC-20	Drum	11.6	0.5
		12.2	1
		12.4	2
		12.9	3
		13.2	4
		13.7	5
		14.3	6
		14.6	7
1988 Exxon AC-20	Drum	10.4	1
		9.5	2
		9.8	3
		10.0	4
		10.5	5
		10.4	6
1989 Exxon AC-20	Drum	10.3	1
		10.6	2
		10.9	3
		11.3	4
		11.0	5
		11.1	6
Texas Gulf	Drum	14.3	1
		14.3	2
		14.9	3
		15.3	4
		15.7	5
		15.9	6

Table A-2

Percent LMS Versus Concentration Data for TFOT, ETFOT and Hot Mixes for the Hot-Mix Study Asphalts

Name	Process	Weight %	% LMS		
			5 hr TFOT	14.5 hr TFOT	Hot Mix
1989 Ampet AC-20	Drum	6	16.8	20.5	18.8
		5	16.8	20.1	18.5
		4	16.0	19.5	18.8
		3	15.7	19.0	18.2
		2	15.3	18.5	18.0
		1	14.8	18.0	18.2
Coastal AC-20	Drum	6	21.6	25.3	24.5
		5	21.7	24.9	24.4
		4	20.8	24.4	23.9
		3	20.5	23.3	24.6
		2	20.1	23.1	24.2
		1	19.8	22.5	23.6
1989 Cosden AC-10	Drum	6	13.6	16.9	18.8
		5	13.4	16.9	18.8
		4	13.1	16.6	18.5
		3	12.9	16.2	18.1
		2	12.6	15.8	18.0
		1	11.7	15.3	18.8
1989 Cosden AC-20	Drum	6	29.5	32.9	28.7
		5	29.4	32.2	28.1
		4	29.1	31.7	27.9
		3	28.9	32.0	27.6
		2	28.5	31.5	27.4
		1	27.8	31.1	26.9
1987 Exxon AC-20	Batch	6	12.0	14.5	15.5
		5	11.8	14.5	15.3
		4	11.4	14.4	15.0
		3	11.2	13.8	14.7
		2	10.5	13.7	14.4
		1	11.1	13.6	14.4

Table A-2 (Cont'd)

Percent LMS Versus Concentration Data for TFOT, ETFOT and Hot Mixes for the Hot-Mix Study Asphalts

Name	Process	Weight %	% LMS		
			5 hr TFOT	14.5 hr TFOT	Hot Mix
1987 Exxon AC-20	Drum	6	14.5	17.4	18.0
		5	14.4	17.1	17.5
		4	14.1	17.1	17.5
		3	13.8	16.8	17.4
		2	12.5	15.3	16.9
		1	13.4	16.1	17.4
1988 Exxon AC-20	Drum	6	12.9	13.8	15.5
		5	12.9	14.9	15.2
		4	12.2	15.0	15.2
		3	11.8	14.8	14.8
		2	11.5	14.4	14.6
		1	11.9	14.6	14.7
1989 Texaco AC-20	Drum	6	20.2	22.7	21.1
		5	20.0	22.7	20.9
		4	19.3	21.6	19.6
		3	18.3	20.4	18.6
		2	17.7	19.6	17.5
		1	17.2	19.4	16.2
Texas Gulf AC-20	Drum	6	17.8	20.4	18.7
		5	18.0	21.1	18.7
		4	17.4	20.5	17.0
		3	16.7	19.8	16.4
		2	16.2	19.4	15.9
		1	16.0	18.7	15.9

Table A-3a

Heithaus Results for Study 287 Tank Asphalts

Name	Location	Toluene (ml)	Asphalt (g)	Heptane (ml)
Cosden AC-10	Dickens	2.0	3.700	11.1
	6-21-82	2.0	3.785	10.9
		2.0	3.781	10.3
		4.0	3.948	15.9
		4.0	4.104	14.9
		4.0	4.134	15.0
		4.0	1.860	12.3
		4.0	2.128	12.5
		4.0	2.475	12.7
		14.0	1.593	34.4
		14.0	1.698	35.0
		14.0	2.182	33.8
	Dumas	2.0	4.379	14.1
	9-14-82	2.0	4.008	12.5
		2.0	4.398	13.5
		4.0	3.748	13.8
		4.0	4.399	18.5
		4.0	4.081	16.0
		4.0	1.916	13.0
		4.0	2.266	14.2
		4.0	1.972	12.8
		14.0	1.855	37.2
		14.0	2.404	35.6
		14.0	1.833	33.8
Cosden AC-20	Dickens	2.0	4.296	12.3
	6-21-82	2.0	3.698	11.1
		2.0	3.683	9.9
		4.0	3.609	14.0
		4.0	4.044	15.5
		4.0	3.787	15.5
		4.0	2.130	12.3
		4.0	2.132	14.6
		4.0	2.106	12.2
		14.0	1.611	32.2
		14.0	1.957	33.3
		14.0	2.294	33.9

Table A-3a (Cont'd)

Heithaus Results for Study 287 Tank Asphalts

Name	Location	Toluene (ml)	Asphalt (g)	Heptane (ml)
Cosden AC-20 (Cont'd)	Dumas 1982	2.0	3.731	11.3
		2.0	3.762	10.8
		2.0	3.720	11.0
		4.0	3.841	16.4
		4.0	3.838	16.2
		4.0	3.573	15.9
		4.0	2.142	13.4
		4.0	1.712	11.3
		4.0	1.792	12.9
		14.0	2.054	34.0
		14.0	1.769	35.4
		14.0	2.022	35.5
	Lufkin 8-10-83	2.0	3.829	12.4
		2.0	3.953	11.2
		2.0	3.754	10.7
		4.0	4.103	15.4
		4.0	3.874	14.8
		4.0	3.761	13.5
		4.0	1.627	11.8
		4.0	1.931	10.9
		4.0	1.937	12.3
		14.0	1.763	34.0
		14.0	1.725	33.0
		14.0	2.496	35.8
Dorchester AC-10	Dumas 9-13-82	2.1	3.853	15.2
		2.0	3.864	16.7
		2.0	3.607	12.8
		4.0	3.861	20.9
		4.0	3.574	16.7
		4.0	3.647	22.8
		4.0	2.204	19.3
		4.0	1.713	17.0
		4.0	2.221	14.0
		14.0	1.789	48.7
		14.0	2.071	49.9
		14.0	2.037	48.8

Table A-3a (Cont'd)

Heithaus Results for Study 287 Tank Asphalts

Name	Location	Toluene (ml)	Asphalt (g)	Heptane (ml)
Dorchester AC-20	Dickens	2.0	3.718	13.7
	6-21-82	2.0	3.903	17.7
		2.0	3.633	14.9
		4.0	3.611	21.5
		4.0	3.863	22.8
		4.0	3.538	17.8
		4.0	2.468	19.0
		4.0	2.116	17.8
		4.0	2.274	17.7
		14.0	1.949	47.0
		14.0	2.234	44.6
		14.0	2.058	47.0
	Lufkin	2.0	3.547	14.9
	7-21-83	2.0	3.675	14.4
		2.0	3.552	13.4
		4.0	3.722	19.8
		4.0	3.618	19.7
		4.0	3.543	17.8
		4.0	1.601	14.5
		4.0	1.774	13.9
		4.0	1.765	15.4
		14.0	2.141	43.4
		14.0	1.874	41.5
		14.0	1.639	41.2
Exxon AC-10	Dumas	2.0	3.765	15.3
	9-13-82	2.0	3.727	15.2
		2.0	3.985	15.1
		4.0	3.739	19.8
		4.0	4.082	20.6
		4.0	4.417	22.7
		4.0	1.778	18.4
		4.0	2.386	19.2
		4.0	2.479	19.0
		14.0	1.745	49.9
		14.0	2.110	50.0
		14.0	2.023	50.7

Table A-3a (Cont'd)

Heithaus Results for Study 287 Tank Asphalts

Name	Location	Toluene (ml)	Asphalt (g)	Heptane (ml)
Exxon AC-20	Dickens	2.0	3.912	14.5
	6-21-82	2.0	3.672	13.0
		2.0	4.093	12.3
		4.0	3.664	16.5
		4.0	3.568	18.0
		4.1	3.691	17.9
		4.0	1.959	14.0
		4.0	1.932	14.5
		4.0	1.970	13.6
		14.0	1.750	38.8
		14.0	2.070	40.0
		14.0	2.169	37.0
	Lufkin	2.0	3.697	17.9
	1983	2.0	3.909	16.6
		2.0	3.856	17.6
		4.0	3.713	24.0
		4.0	3.899	23.2
		4.0	4.010	22.4
		4.1	1.721	18.0
		4.0	1.879	18.6
		4.0	1.938	18.3
		14.0	1.923	52.5
		14.0	1.901	53.5
		14.0	1.513	51.8
MacMillan AC-10	Dumas	2.0	3.691	18.7
	9-13-82	2.0	3.918	20.2
		2.0	3.584	16.5
		4.0	3.675	14.4
		4.0	3.586	25.0
		4.0	1.869	20.4
		4.0	2.390	20.4
		4.0	1.928	20.4
		14.0	1.671	62.9
		14.0	1.746	62.9
		14.0	1.738	60.7

Table A-3a (Cont'd)

Heithaus Results for Study 287 Tank Asphalts

Name	Location	Toluene (ml)	Asphalt (g)	Heptane (ml)
MacMillan AC-20	Dickens	2.0	3.838	19.5
	6-21-82	2.0	3.917	16.3
		2.0	3.721	20.3
		4.0	3.769	24.3
		4.0	4.157	28.3
		4.0	3.917	27.0
		4.0	2.162	20.7
		4.0	1.952	20.0
		4.0	2.094	18.6
		14.0	2.150	56.6
		14.0	1.894	57.3
		14.0	1.965	57.9
	Lufkin	2.0	3.658	20.9
	8-11-83	2.0	4.448	19.2
		2.0	3.730	14.6
		4.0	3.637	23.9
		4.0	3.686	29.7
		4.0	3.709	29.8
		4.0	1.790	23.4
		4.0	1.631	22.5
		4.0	1.606	19.7
		14.0	1.716	73.5
		14.0	2.128	75.6
		14.0	1.609	69.8
Texaco AC-20	Lufkin	2.0	3.586	14.5
	1983	2.0	3.938	13.8
		2.0	3.604	15.3
		4.0	3.605	19.7
		4.0	3.554	19.9
		4.0	3.649	19.1
		4.0	2.001	15.0
		4.0	1.861	15.9
		4.0	1.657	13.9
		14.0	1.738	42.7
		14.0	1.744	42.9
		14.0	1.601	42.0

Table A-3b

Heithaus Results for Hot-Mix Study Tank Asphalts

Name	Process	Toluene (ml)	Asphalt (g)	Heptane (ml)
Ampet AC-20 1989	Drum	2.0	3.755	19.0
		2.0	3.691	18.8
		2.0	3.696	18.3
		4.0	3.664	27.1
		4.0	3.589	25.6
		4.0	3.520	25.2
		4.0	1.718	21.1
		4.0	1.610	20.1
		4.0	1.968	23.3
		14.0	1.651	64.7
		14.0	1.767	63.8
		14.0	1.669	66.1
Coastal AC-20 1987	Drum	2.0	3.900	12.3
		2.0	3.936	13.5
		2.0	3.711	12.4
		4.0	3.500	19.3
		4.0	3.806	16.8
		4.0	3.720	18.1
		4.0	1.762	11.9
		4.0	1.636	13.7
		4.0	1.560	13.4
		14.0	1.592	37.5
		14.0	1.586	37.4
		14.0	1.590	37.5
Cosden AC-10 1989	Drum	2.0	3.902	11.4
		2.0	4.495	13.1
		4.0	3.634	14.2
		4.0	3.892	15.9
		4.0	3.650	14.6
		4.0	1.644	11.9
		4.0	1.722	10.6
		4.0	1.598	12.2
		14.0	1.624	34.9
		14.0	1.743	33.7
		14.0	1.677	35.3

Table A-3b (Cont'd)

Heithaus Results for Hot-Mix Study Tank Asphalts

Name	Process	Toluene (ml)	Asphalt (g)	Heptane (ml)
Cosden AC-20 1989	Drum	2.0	3.577	23.0
		2.0	3.593	22.3
		2.0	3.735	24.4
		4.0	3.682	36.3
		4.0	3.554	29.6
		4.0	3.707	36.4
		4.0	1.527	27.8
		4.0	1.728	26.9
		4.0	1.609	23.8
		14.0	1.932	82.8
		14.0	1.578	83.4
		14.0	1.578	87.3
Exxon AC-20 1987	Batch	2.0	3.636	16.9
		2.0	4.054	17.5
		2.0	4.236	16.9
		4.0	3.638	24.3
		4.0	3.904	22.8
		4.0	3.763	24.7
		4.0	1.563	18.3
		4.0	1.933	17.8
		4.0	1.748	17.3
		14.0	1.653	60.2
		14.0	1.844	56.7
		14.0	1.624	56.0
Exxon AC-20 1987	Drum	2.0	3.870	16.4
		2.0	3.846	16.9
		2.0	3.721	17.2
		4.0	3.608	21.9
		4.0	3.639	21.4
		4.0	3.637	20.7
		4.0	1.610	15.8
		4.0	1.604	17.2
		4.0	1.748	16.5
		14.0	1.843	54.6
		14.0	1.634	53.7
		14.0	1.690	54.0

Table A-3b (Cont'd)

Heithaus Results for Hot-Mix Study Tank Asphalts

Name	Process	Toluene (ml)	Asphalt (g)	Heptane (ml)
Exxon AC-20 1988	Drum	2.0	4.161	18.0
		2.0	4.130	17.8
		2.0	3.742	16.8
		4.0	4.126	25.5
		4.0	4.057	23.0
		4.0	3.724	25.7
		4.0	2.487	21.0
		4.0	1.686	16.5
		4.0	1.866	18.7
		14.0	2.431	60.8
		14.0	1.847	58.9
		14.0	2.106	56.5
Exxon AC-20 1989	Drum	2.0	3.822	21.2
		2.0	3.829	17.7
		2.0	3.506	17.7
		4.0	3.533	27.1
		4.0	3.645	27.2
		4.0	3.739	23.8
		4.0	1.512	20.6
		4.0	1.644	18.2
		4.0	1.608	19.3
		14.0	1.648	67.8
		14.0	1.605	64.4
		14.0	1.708	63.3
Texaco AC-20 1989	Drum	2.0	4.199	14.8
		2.0	4.108	16.8
		2.0	3.782	16.4
		4.0	4.187	22.0
		4.0	4.368	22.7
		4.0	3.823	18.0
		4.0	2.438	15.8
		4.0	2.238	16.7
		4.0	1.754	15.8
		14.0	2.021	46.8
		14.0	2.060	45.3
		14.0	1.692	44.3

Table A-3b (Cont'd)

Heithaus Results for Hot-Mix Study Tank Asphalts

Name	Process	Toluene (ml)	Asphalt (g)	Heptane (ml)
Texas Gulf AC-20 1989	Drum	2.0	3.839	11.5
		2.0	3.574	9.9
		4.0	3.811	14.4
		4.0	3.635	12.2
		4.0	1.738	11.4
		4.0	1.714	9.8
		4.0	1.709	11.9
		14.0	1.638	34.0
		14.0	1.634	33.1
		14.0	1.633	31.7

Table A-4

Alternative Heithaus Results

Asphalt	Solvent/Titrant	Solvent (ml)	Asphalt (gm)	Titrant (ml)
Unknown	Toluene/Methanol	4.7	4.723	1.0
		2.3	2.292	0.5
		2	2	0.4
		4	2.02	0.4
	TCE/Methanol	2	4.006	0.35
		4	4.164	0.9
		4	2.245	1
		14	2.011	6.8
Cosden AC-20	Toluene/Ethanol	2	4.08	0.6
		4	4.147	1.1
		4	2.088	2
		14	2.193	8.9
	Toluene/Propanol	2	4.046	1.6
		4.7	4.706	3.2
		4	2.126	3.6
		14	2.072	14
	Toluene/Butanol	2	4.006	0.35
		4	4.164	0.9
		4	2.245	1
		14	2.011	6.8
	TCE/Ethanol	2	4.033	0.8
		2	4.092	0.8
		4	2.055	2.5
		4	2.111	2.5
		4	4.013	1.6
		4	4.198	1.7
		6	1.974	4.1
		8	0.1525	5.3
		10	0.1192	6.5
		14	0.0797	11.3
		14	2.131	9.1
		14.4	0.0994	10

Table A-4 (Cont'd)

Alternative Heithaus Results

Asphalt	Solvent/Titrant	Solvent (ml)	Asphalt (gm)	Titrant (ml)
Cosden AC-20 (Cont'd)	TCE/Propanol	2	3.9	1.9
		4	4.019	4.1
		4	2.128	4.2
		14	2.08	14.5
	TCE/Butanol	2	4.152	3.2
		4	4.173	5.4
		4	2.124	4.5
		14	2.047	18.9

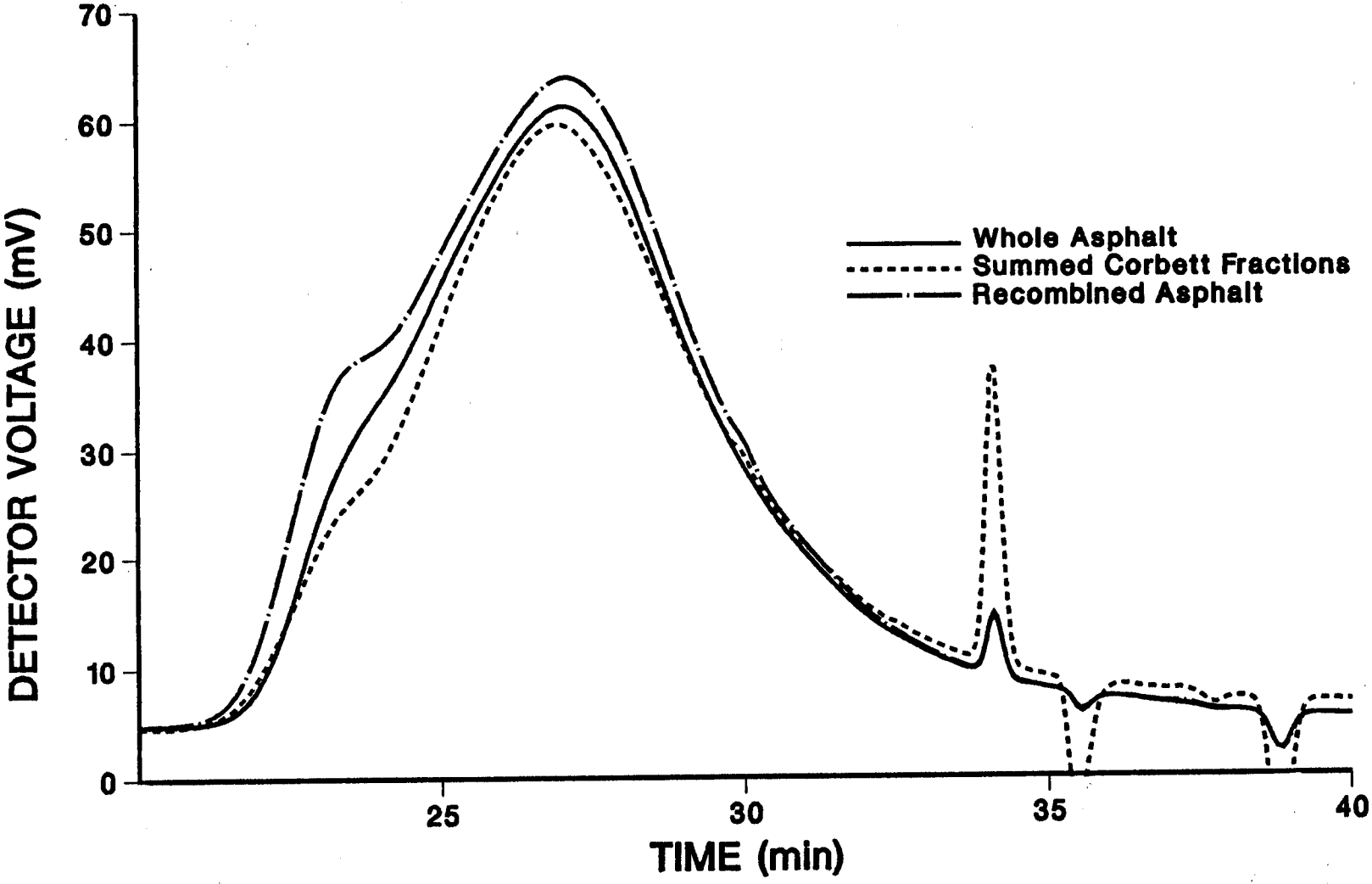

Figure A-1
Comparison of GPC Chromatograms for Whole Asphalt and Those Derived from Corbett Fractions (Upflow)-Ampet AC-10

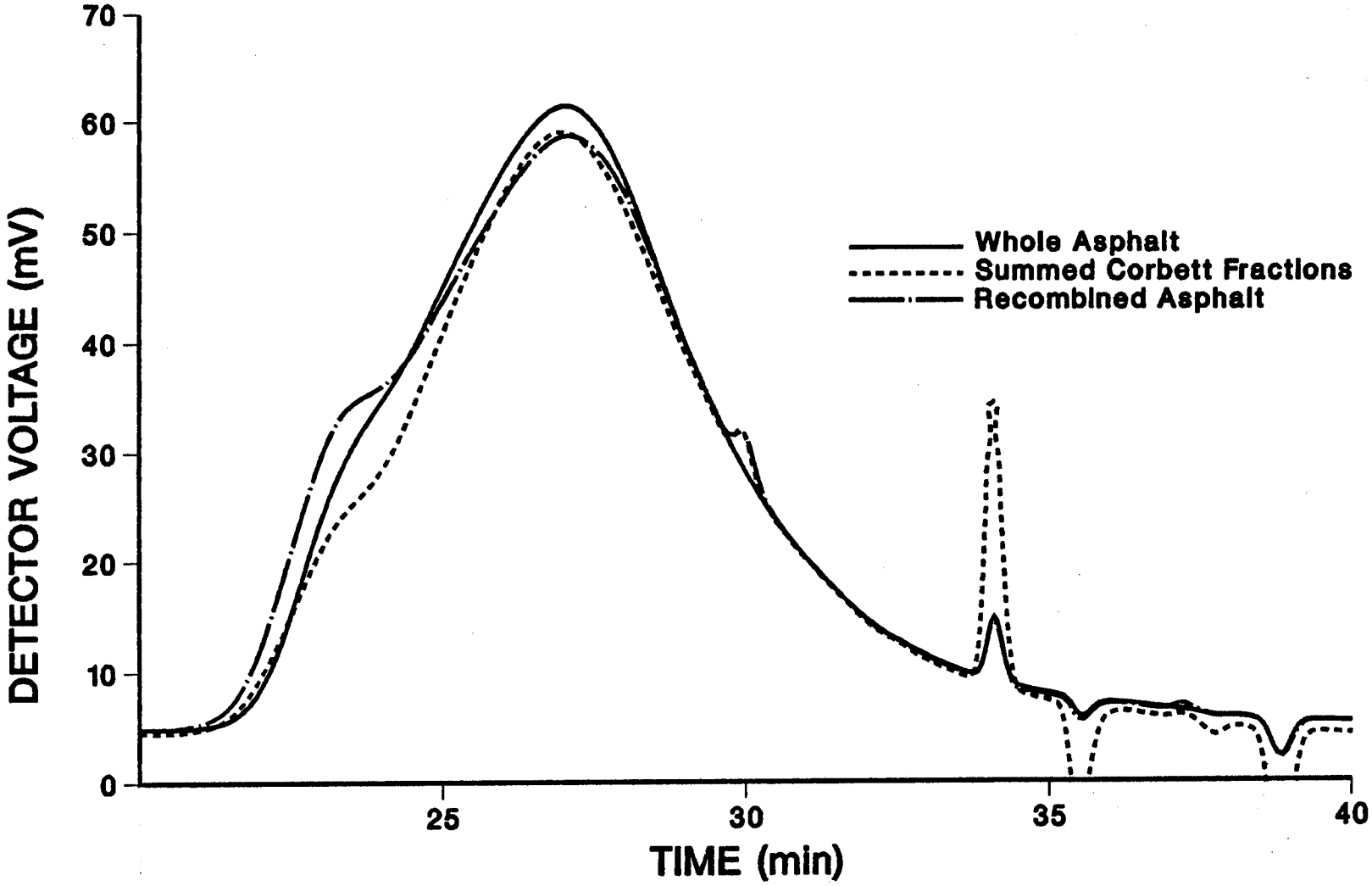

Figure A-2
Comparison of GPC Chromatograms for Whole Aspahlt and Those Derived from Corbett Fractions (Downflow)-Ampet AC-10

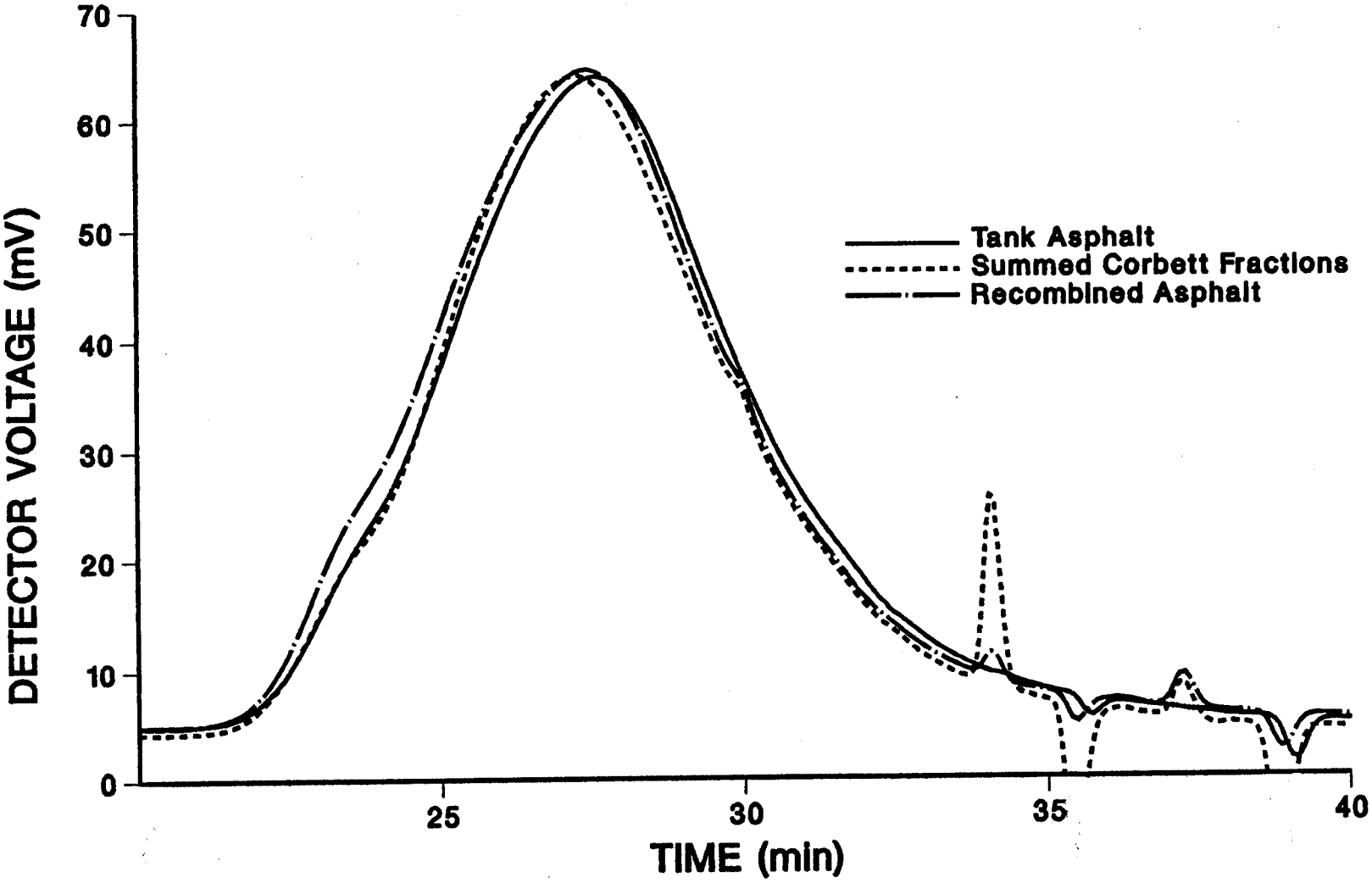

Figure A-3
Comparison of GPC Chromatograms for Whole Asphalt and Those Derived from Corbett Fractions (Upflow)-Exxon AC-20

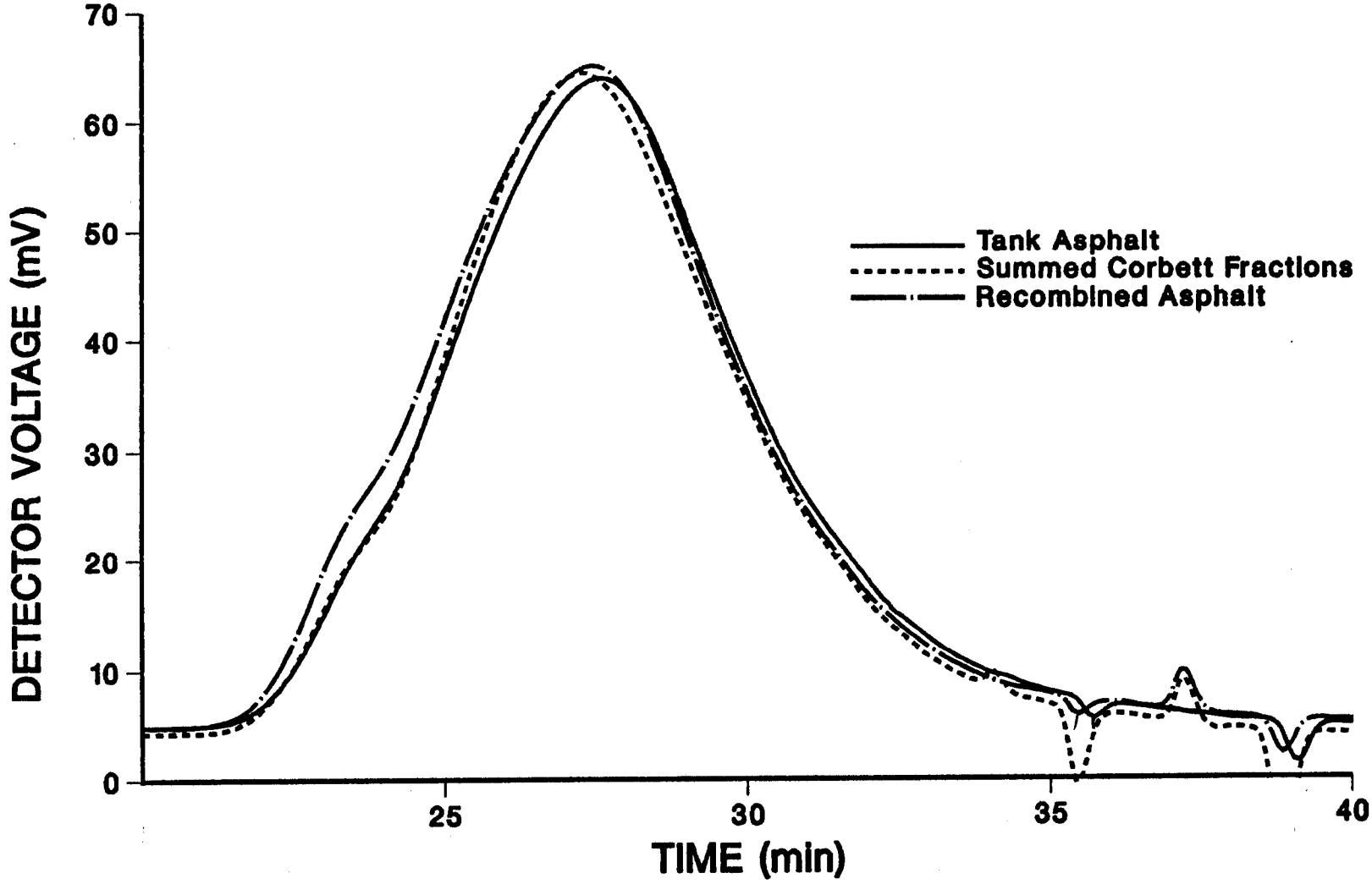

Figure A-4
Comparison of GPC Chromatograms for Whole Asphalt and Those Derived from Corbett Fractions (Downflow)-Exxon AC-20

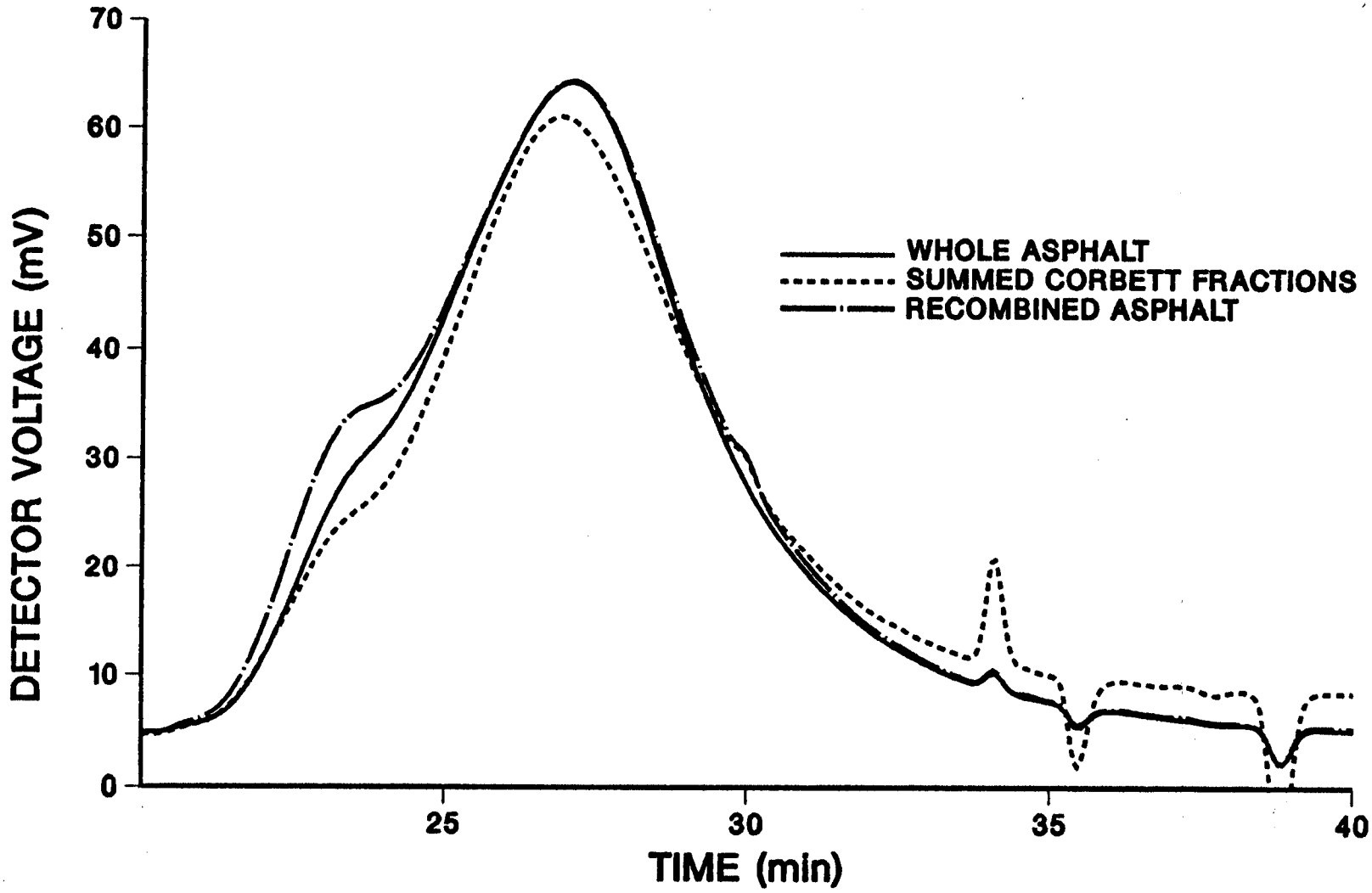

Figure A-5
Comparison of GPC Chromatograms for Whole Asphalt and Those Derived from Corbett Fractions (Upflow)-MacMillan AC-10

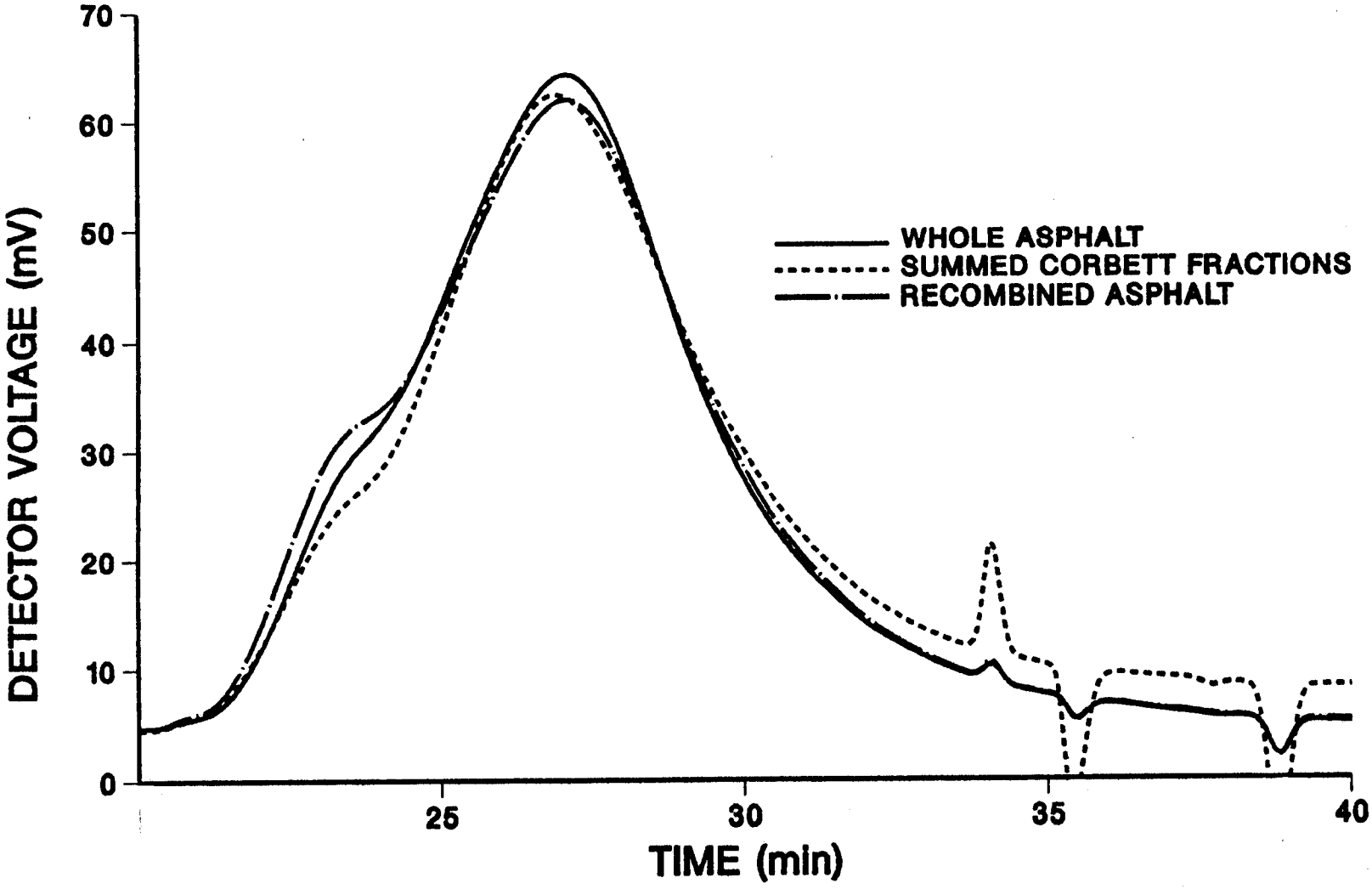

Figure A-6
Comparison of GPC Chromatograms for Whole Asphalt and Those Derived from Corbett Fractions (Downflow)-MacMillan AC-10

APPENDIX B

SECTION III

EXTRACTION AND RECOVERY OF ASPHALT FROM AGGREGATE

Table B-1

Data for Figure III-1-1
Removal of Solvent and Resulting Changes in Asphalt Viscosity.
The Tank and Oven-Aged Asphalts were Dissolved in Solvent
and Immediately Recovered with no Incubation Time
in the Solvent

	%TCE	Hardening Index (H.I.)
Tank	.145	.94
	.465	.925
	.638	.65
	.932	.55
	0	1.06
	.06	1.072
	0	1.054
	.301	.781
4 Hour Reflux	.340	1.26
	.193	1.069
	.978	1.17
	.975	.60
	.674	.72
	.159	1.15
RTFO	0	1.015
	0	.999
	0	1.053
	.02	.956
	.173	.778
	.02	.972

Table B-2

Data for Figure III-1-2
Hardening of Asphalt in Solvent at Room Temperature for Extended Periods of Time Prior to Hot Recovery. Also Shown is the Aging During a Cool Recovery Process with Short Incubation Time

	Time (hrs)	Hardening Index (H.I.)
Hot Recovered	7	1.215
	20	1.268
	49	1.342
	116	1.434
	1.5	1.142
	1.5	1.186
	1.5	1.096
Cool Recovered	1.5	1.110

Table B-3

Data for Figure III-1-4
Residual Solvent Concentrations Versus Abson Recovery Time at Three Temperatures for a Tank (AC-20) Asphalt

	Time (Min)	%TCE
325°F	5	1.8
	7.5	.89
	10	.33
	15	.03
	15	.015
	7	.6
	10	.22
	10	.17
	10	.12
	8	.39
	9	.32
	10	.16
	6.75	1.2
	8	.723
	10	.35
340°F	5	.84
	10	.19
	15	.06
380°F	5	.32
	7.5	.09
	10	0

Table B-4

Data for Figure III-1-5
Residual Solvent Concentrations Versus Abson Recovery Time at Three Temperatures for a 20,000 Poise Asphalt

	Time (Min)	%TCE
325°F	5	1.39
	8	.72
	10	.45
	15	.11
	20	0
340°F	4	1.85
	6	1.28
	8	.76
	10.5	.32
	15	.09
	28	0
380°F	4	1.43
	6	.46
	8	.13
	10	0

Table B-5

Data for Figure III-1-6
Residual Solvent Concentrations Versus Abson Recovery Time at Three Temperatures for a 200,000 Poise Asphalt

	Time (Min)	%TCE
325°F	5	1.62
	10	.69
	15	.23
	29	0
340°F	5	1.21
	10	.41
	15	.08
	30	0
380°F	5	1.04
	10	.10

Table B-6

Data for Figure III-1-10
Residual Solvent Concentrations Versus Roto-Vap Recovery Time at Three Temperatures for an AC-20 Asphalt

	Time (Min)	%TCE
280°F	1	1.55
	5	.72
	10	.203
	1.4	1.4
	5.75	.66
	10.25	.28
	20.2	0
280°F w/vac	15.0	0
	15	0
325°F	1.4	.86
	1.5	1.01
	5	.303
	5.9	.08
	10	.025
	10.2	.05
	19.2	0
350°F	0	.9
	1	.715
	5.2	.02
	6	.045
	10	0
	10.75	0

Table B-7

Data for Figure III-1-11
Residual Solvent Concentrations Versus Roto-Vap Recovery Time at Three Temperatures for a 20,000 Poise (Aged) Asphalt

	Time (Min)	%TCE
280°F	1	2.5
	5	1.89
	10	1.45
	15	1.03
280° w/vac	10	.327
	15	.263
325°F	1	1.02
	5	.436
	10	.114
	15	0
350°F	3	0

Table B-8
Data for III-1-12
Residual Solvent Concentration Versus Roto-Vap Recovery Time at Three Temperatures for a 200,000 Poise (Aged) Asphalt

	Time (Min)	%TCE
280°F	5	.344
	10	.362
	15	.179
	20	.045
280°F w/vac	5	1.560
	13	.597
	20	.213
325°F	5	.191
	10	0
350°F	5	0

Table B-9

Data for Figure III-1-13
Residual Solvent Concentration Versus Abson Recovery Time for Two Hot-Mix Extractions

	Time (Min)	%TCE
Diesel Fired	5	1.25
	8	.68
	10	.58
	15	.30
	12	.33
	30	.20
	30	.05
Gas Fired	5	1.35
	4.5	1.3
	7.5	.62
	7.5	.37
	9	.22
	11	.22
	15	.22
	15.5	0
	20	0

APPENDIX C

SECTION IV

CORRELATION OF ROAD AND HOT-MIX AGING WITH CHEMICAL PARAMETERS

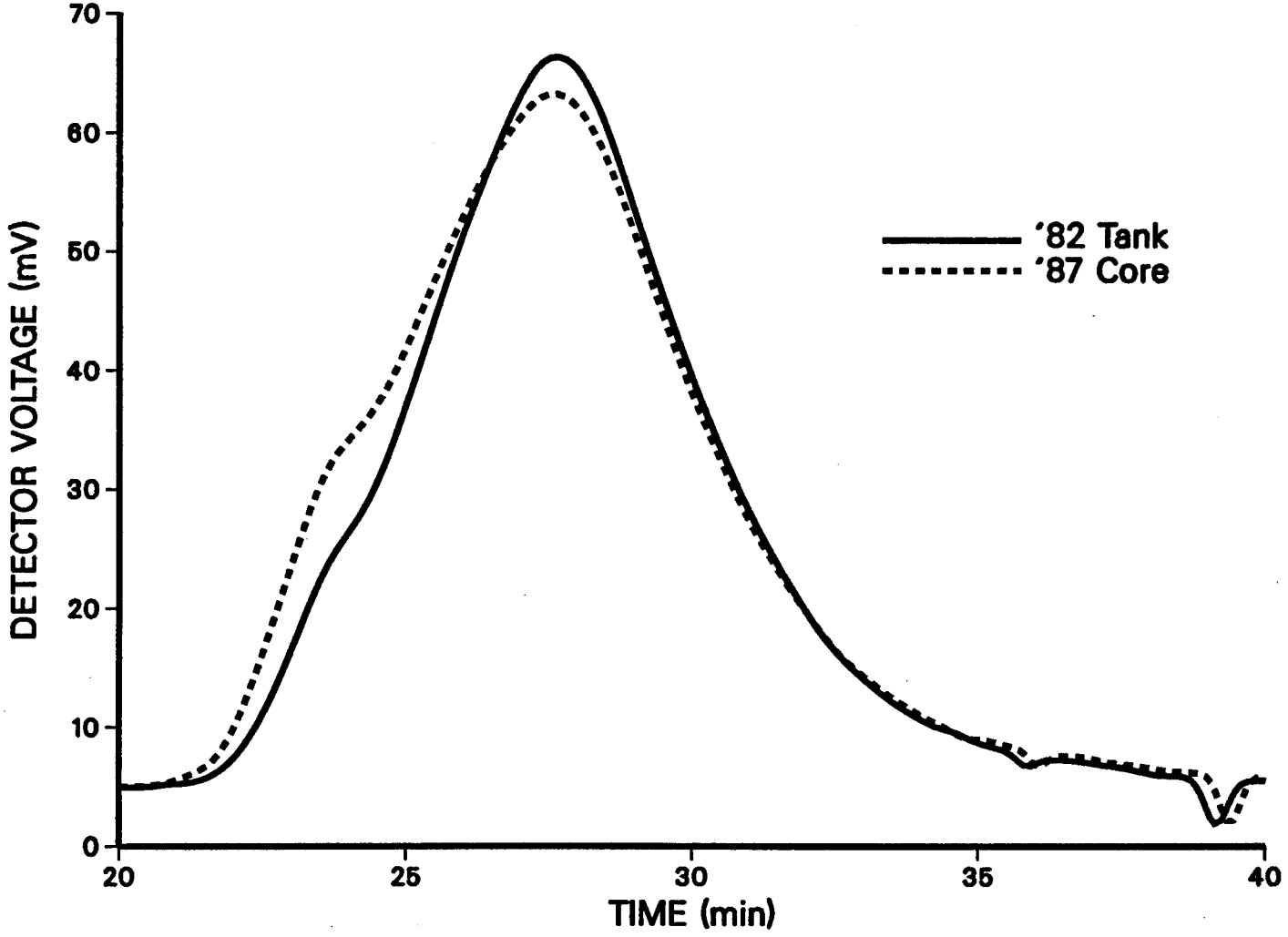

Figure C-1
Comparison of GPC Chromatograms for 1982 Tank Asphalt and 1987 Core-Lufkin Cosden AC-20

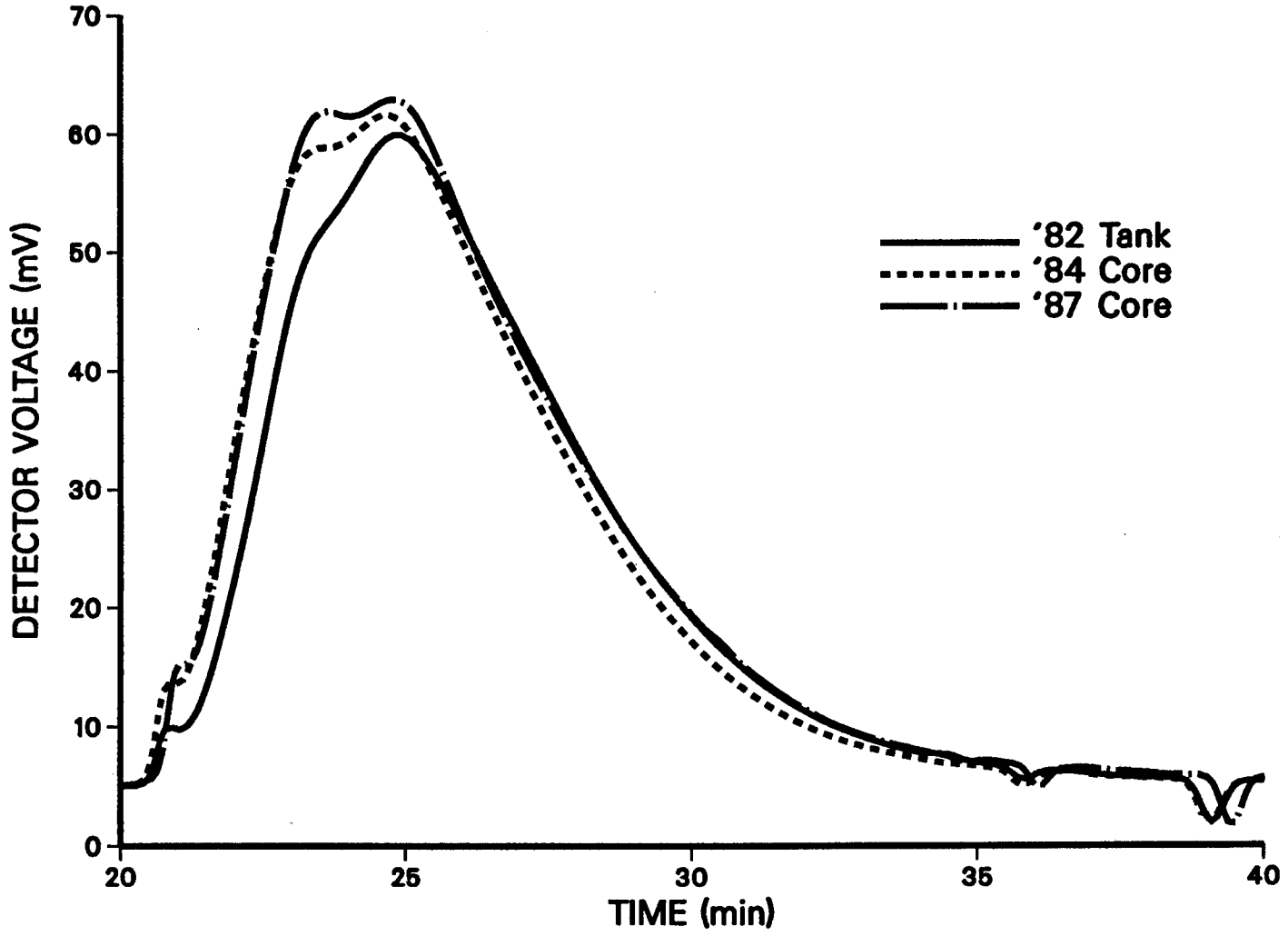

Figure C-2
Comparison of GPC Chromatograms for 1982 Tank Asphalt and 1984, 1987 Cores-Dumas Diamond Shamrock AC-20

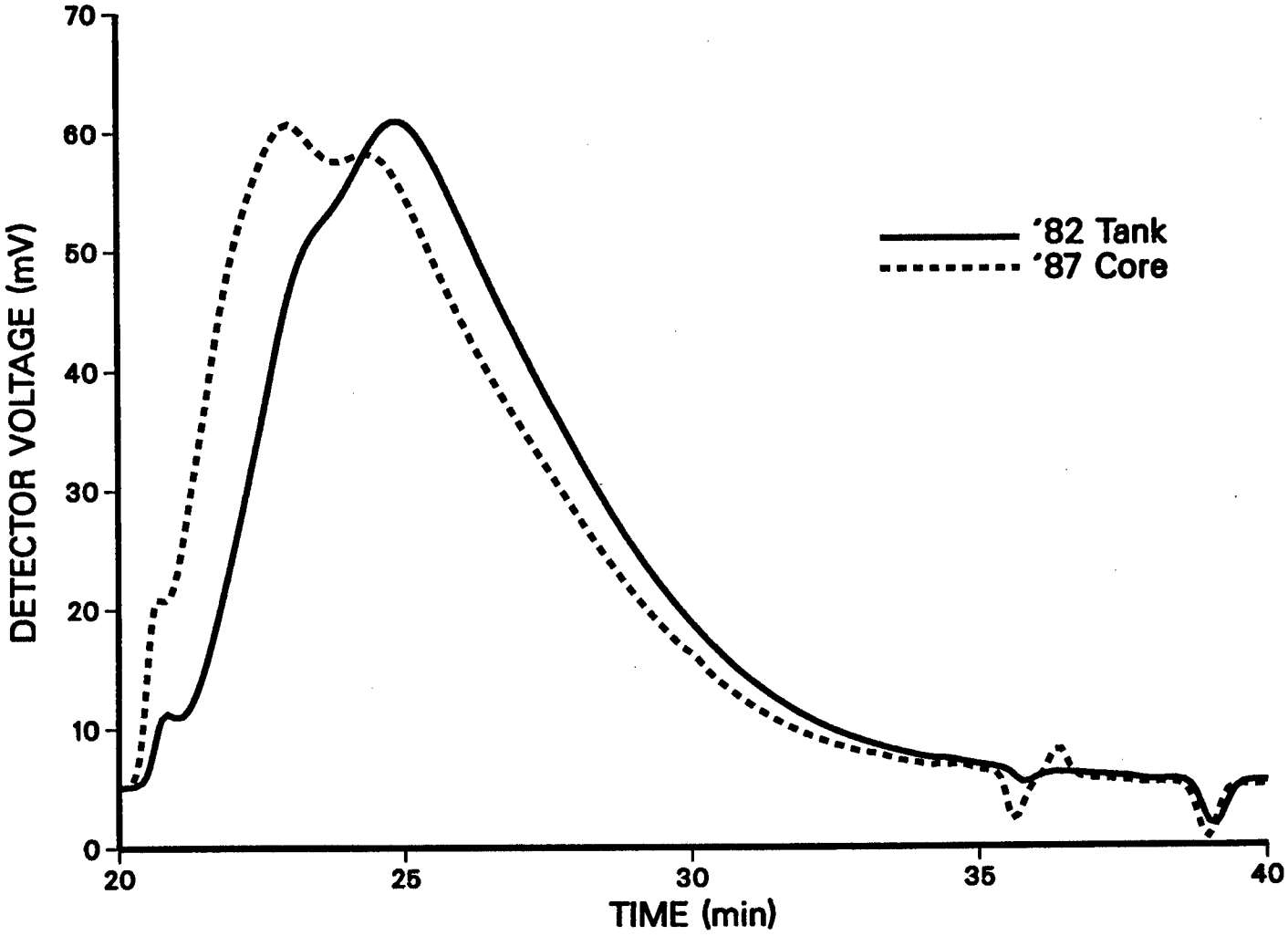

Figure C-3
Comparison of GPC Chromatograms for 1982 Tank Asphalt and
1987 Core- Dickens Diamond Shamrock AC-20

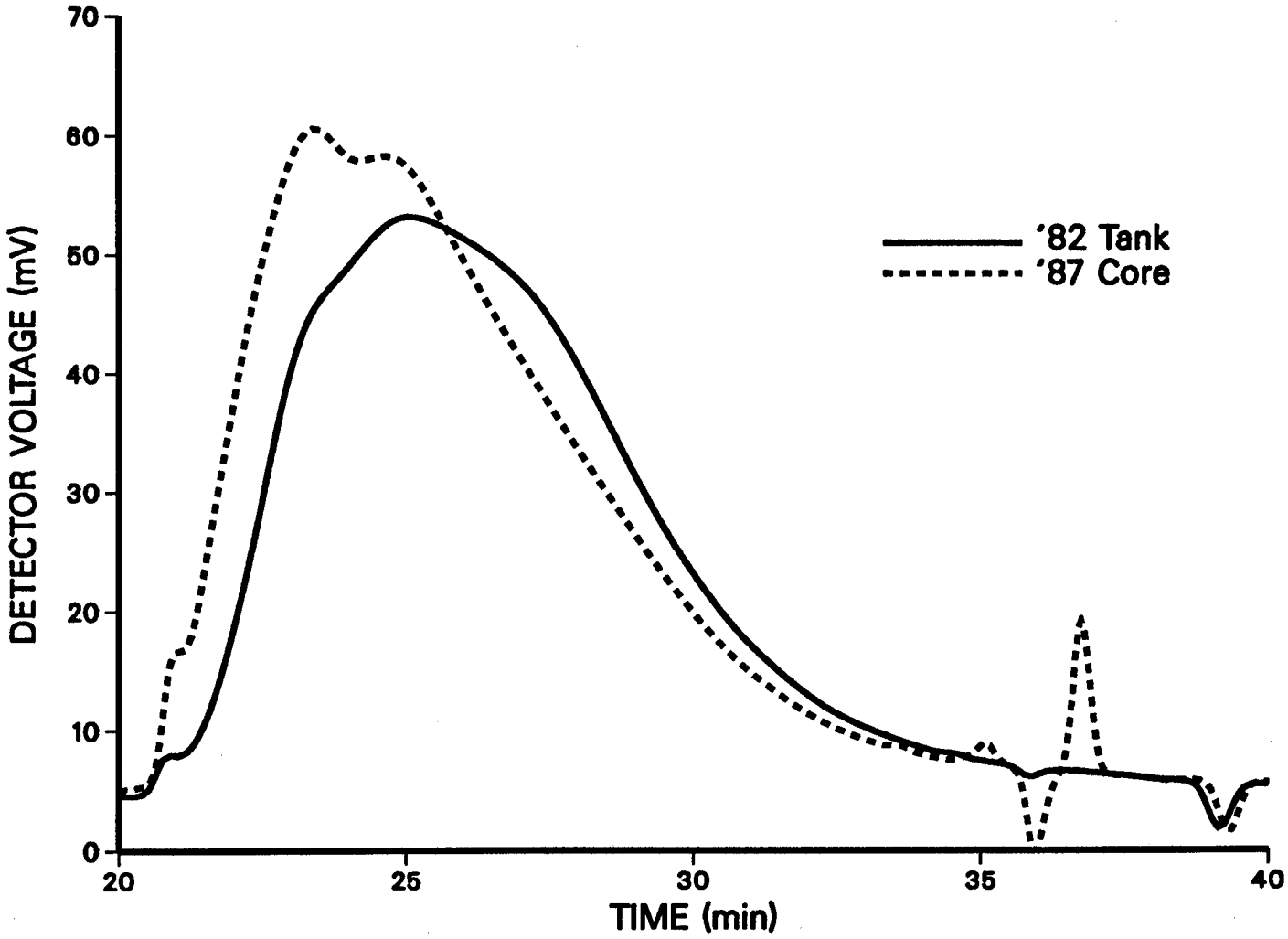

Figure C-4
Comparison of GPC Chromatograms for 1982 Tank Asphalt and 1987 Core-Lufkin Diamond Shamrock AC-20

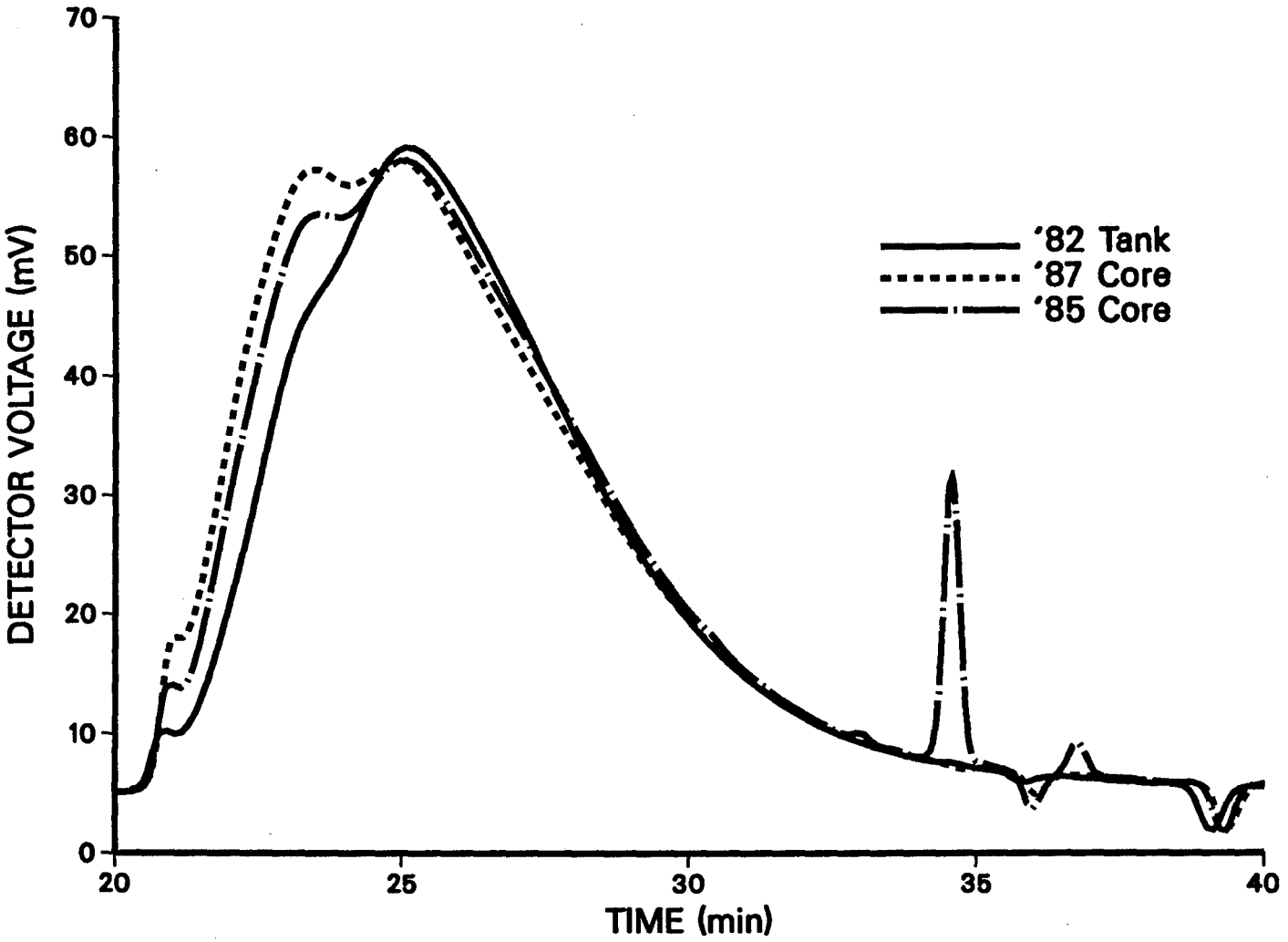

Figure C-5
Comparison of GPC Chromatograms for 1982 Tank Asphalt and 1985, 1987 Cores-Dickens Diamond Shamrock AC-10

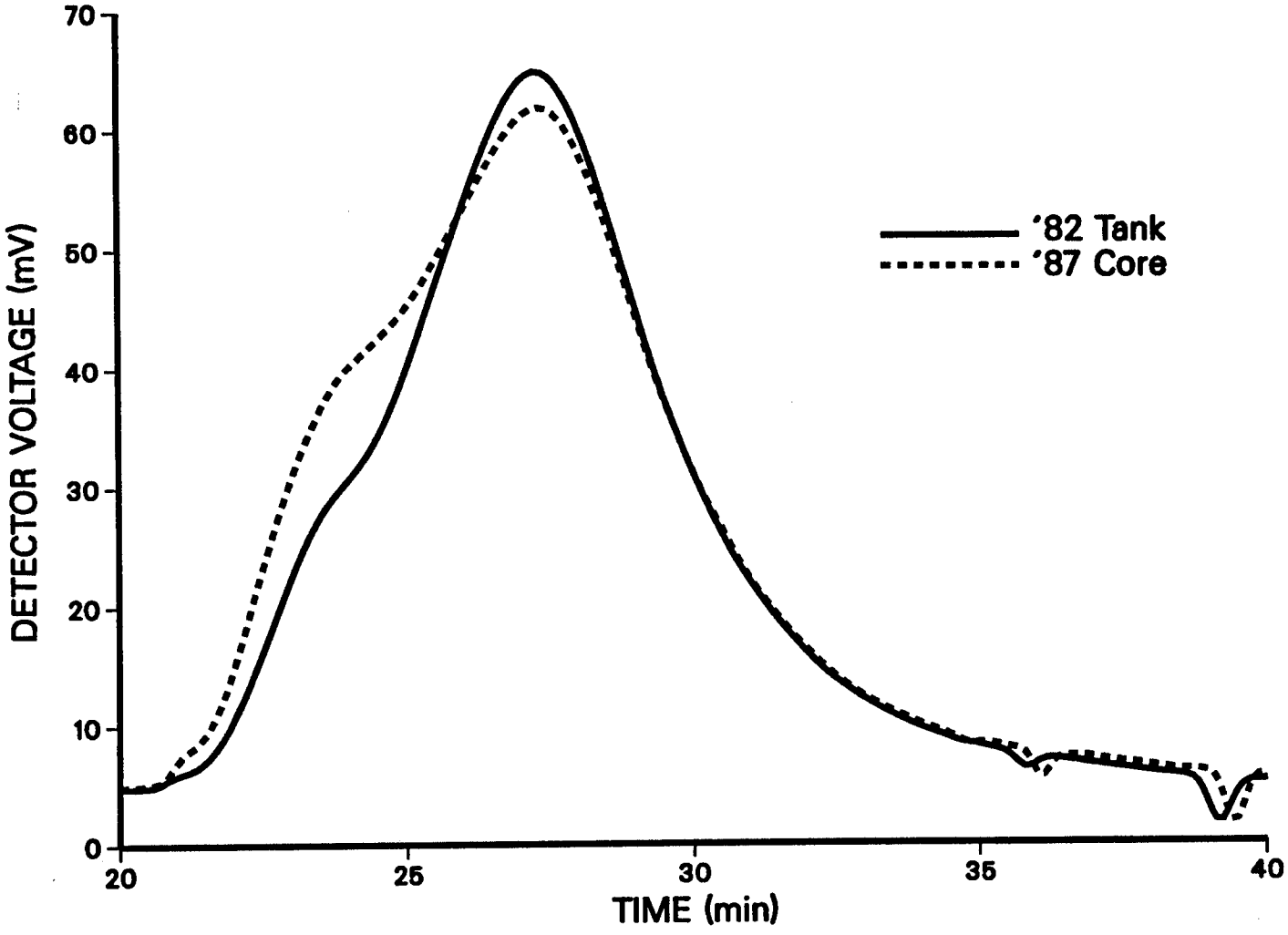

Figure C-6
Comparisons of GPC Chromatograms for 1982 Tank Asphalt and
1987 Core-Dumas MacMillan AC-10

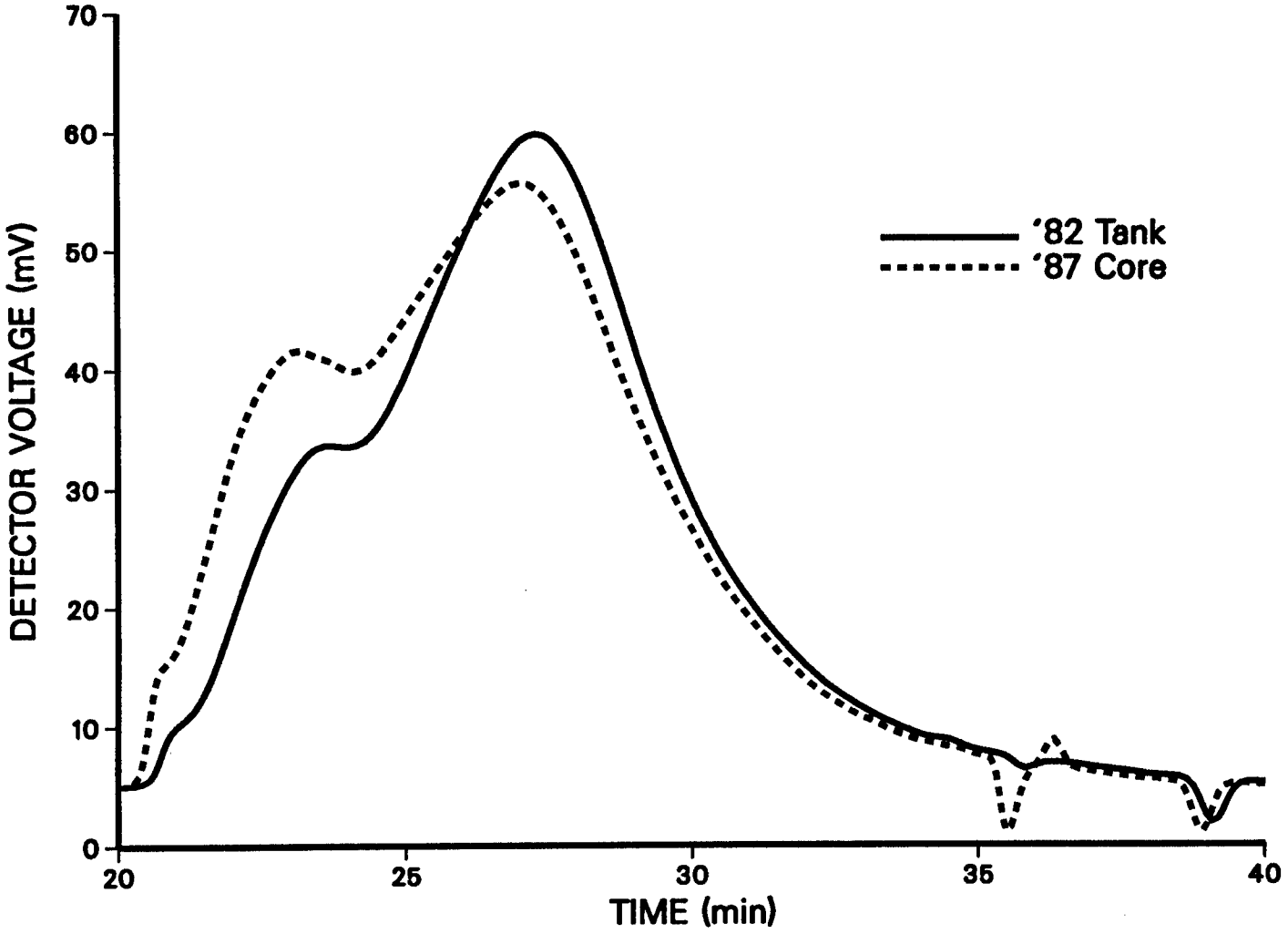

Figure C-7
Comparisons of GPC Chromatograms for 1982 Tank Asphalt and 1987 Core-Dickens MacMillan AC-20

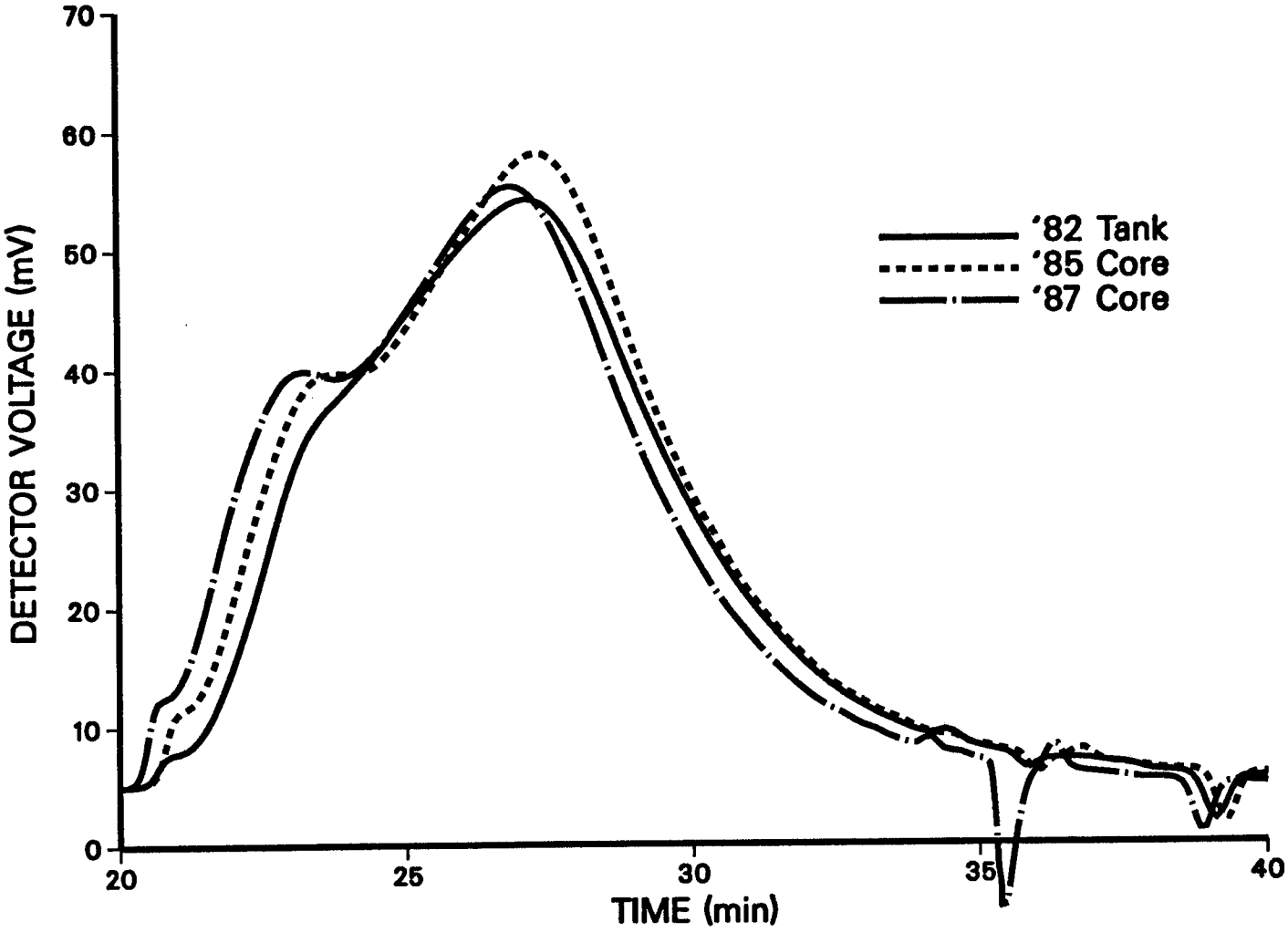

Figure C-8
Comparisons of GPC Chromatograms for 1982 Tank Asphalt and
1985,1987 Cores-Lufkin MacMillan AC-20

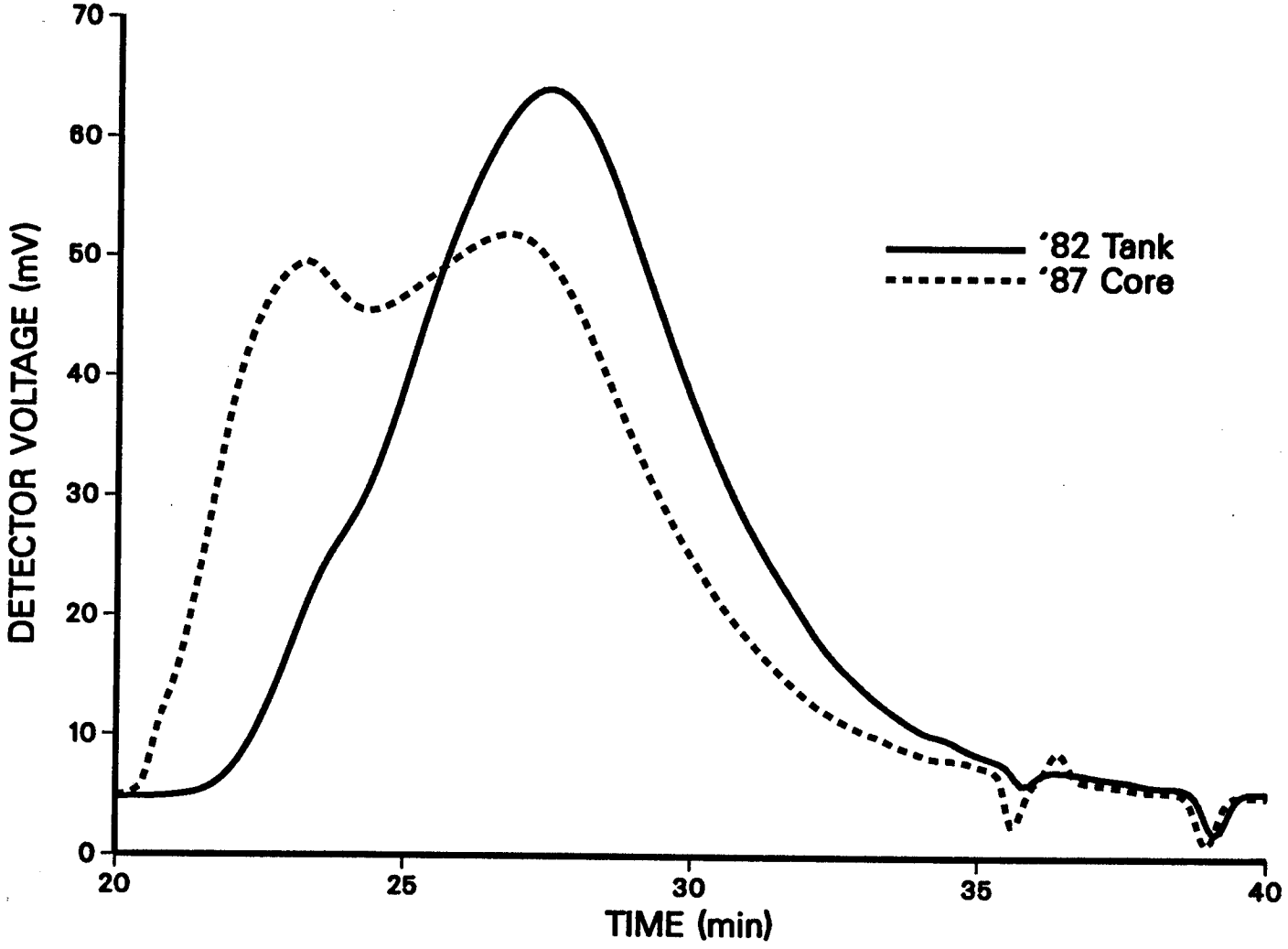

Figure C-9
Comparisons of GPC Chromatograms for 1982 Tank Asphalt and 1987 Core-Dickens Exxon AC-20

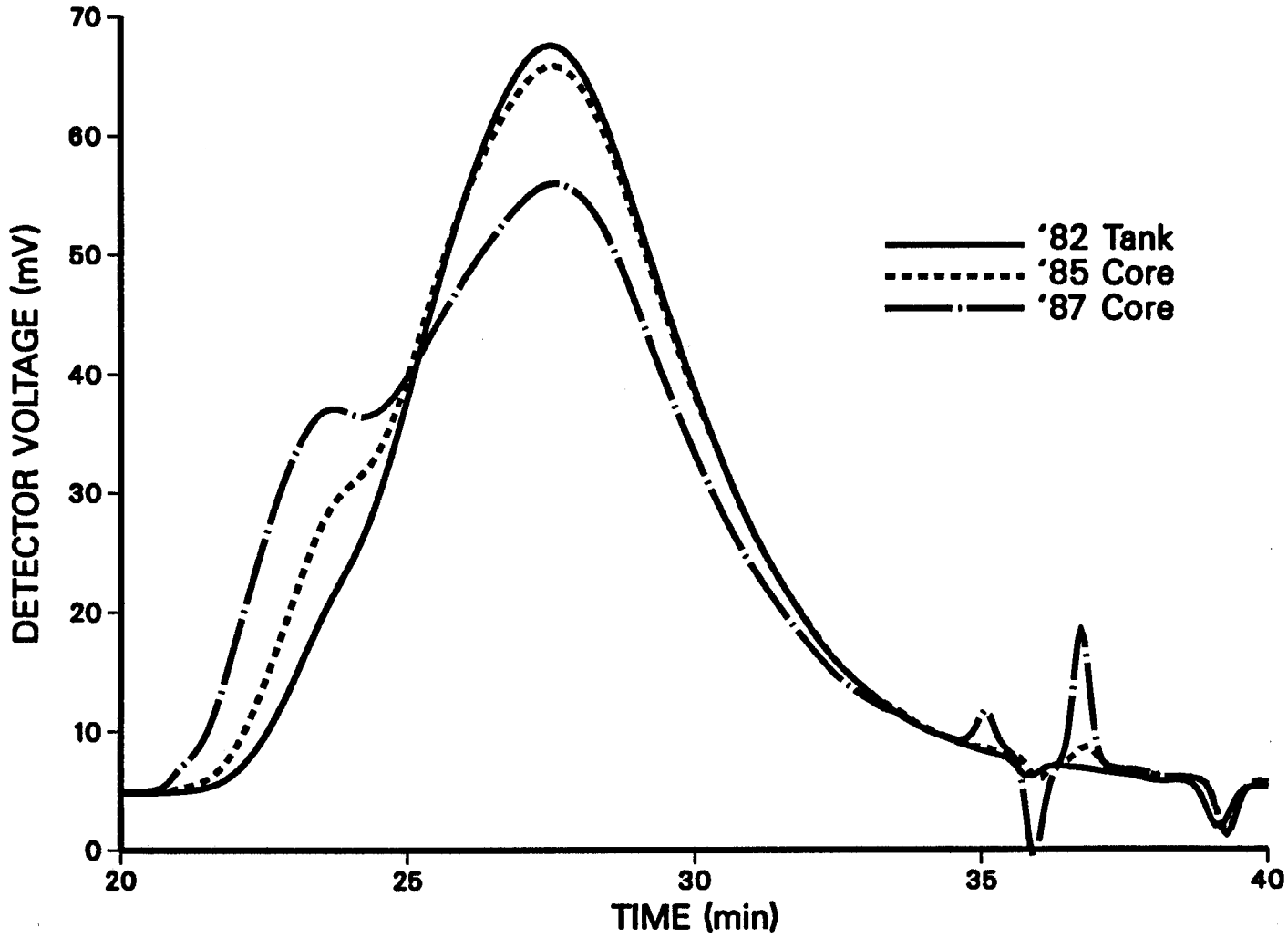

Figure C-10
Comparisons of GPC Chromatograms for 1982 Tank Asphalt and
1985, 1987 Cores-Lufkin Exxon AC-20

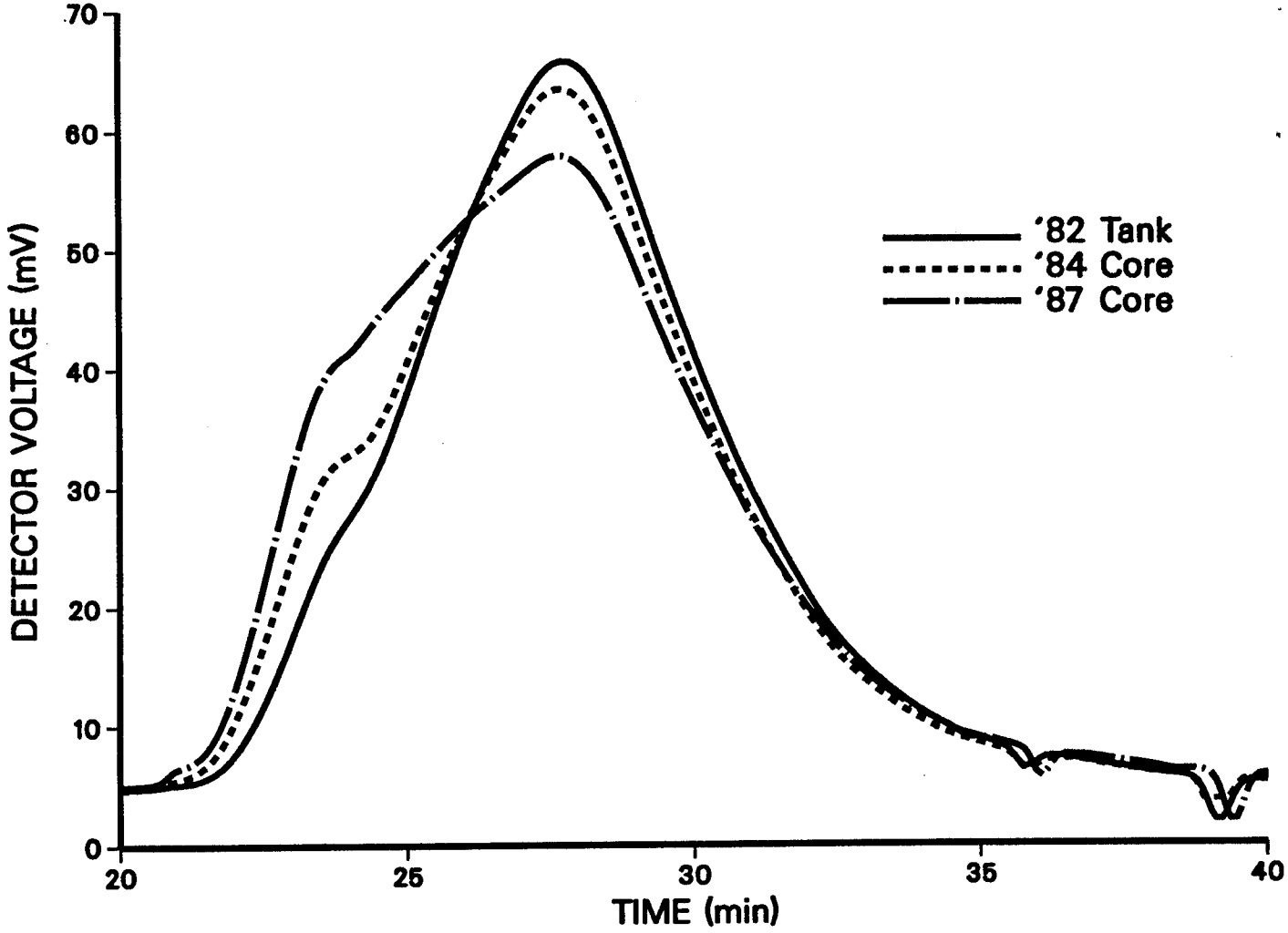

Figure C-11
Comparisons of GPC Chromatograms for 1982 Tank Asphalt
and 1984, 1987 Cores-Dumas Cosden AC-20

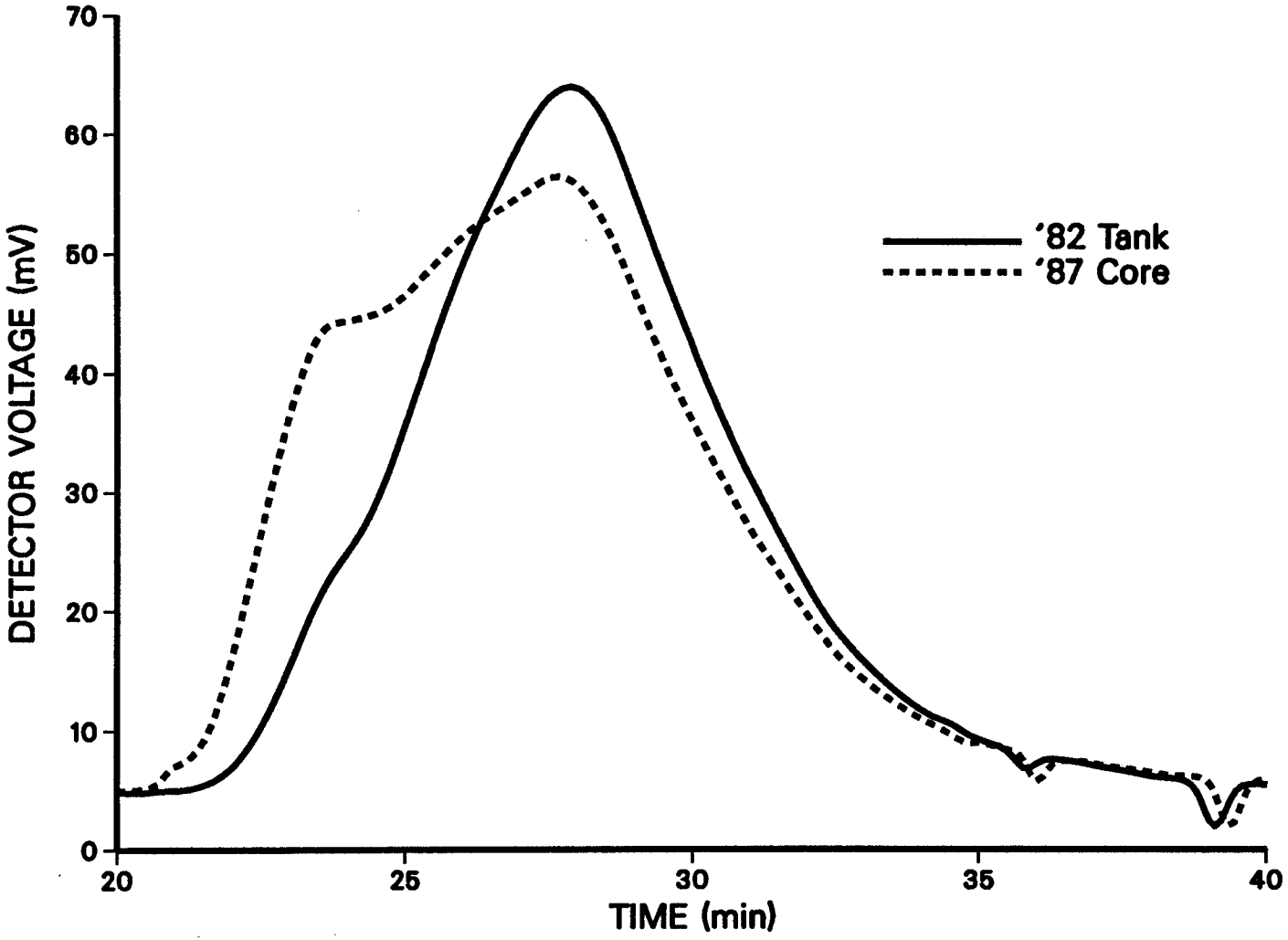

Figure C-12
Comparisons of GPC Chromatograms for 1982 Tank Asphalt and 1987 Core-Dickens Cosden AC-10

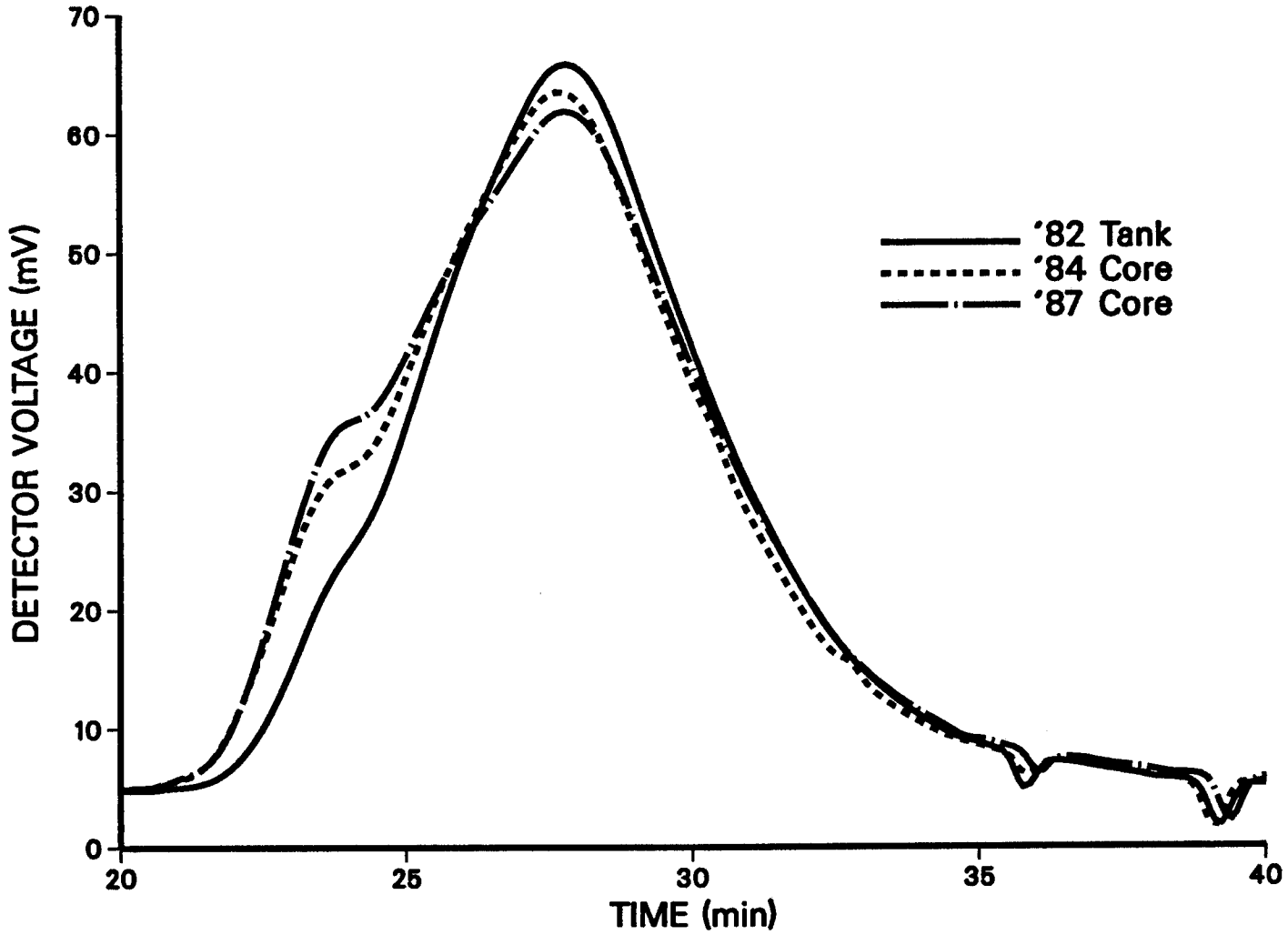

Figure C-13
Comparisons of GPC Chromatograms for 1982 Tank Asphalt and 1984, 1987 Cores-Dumas Cosden AC-10

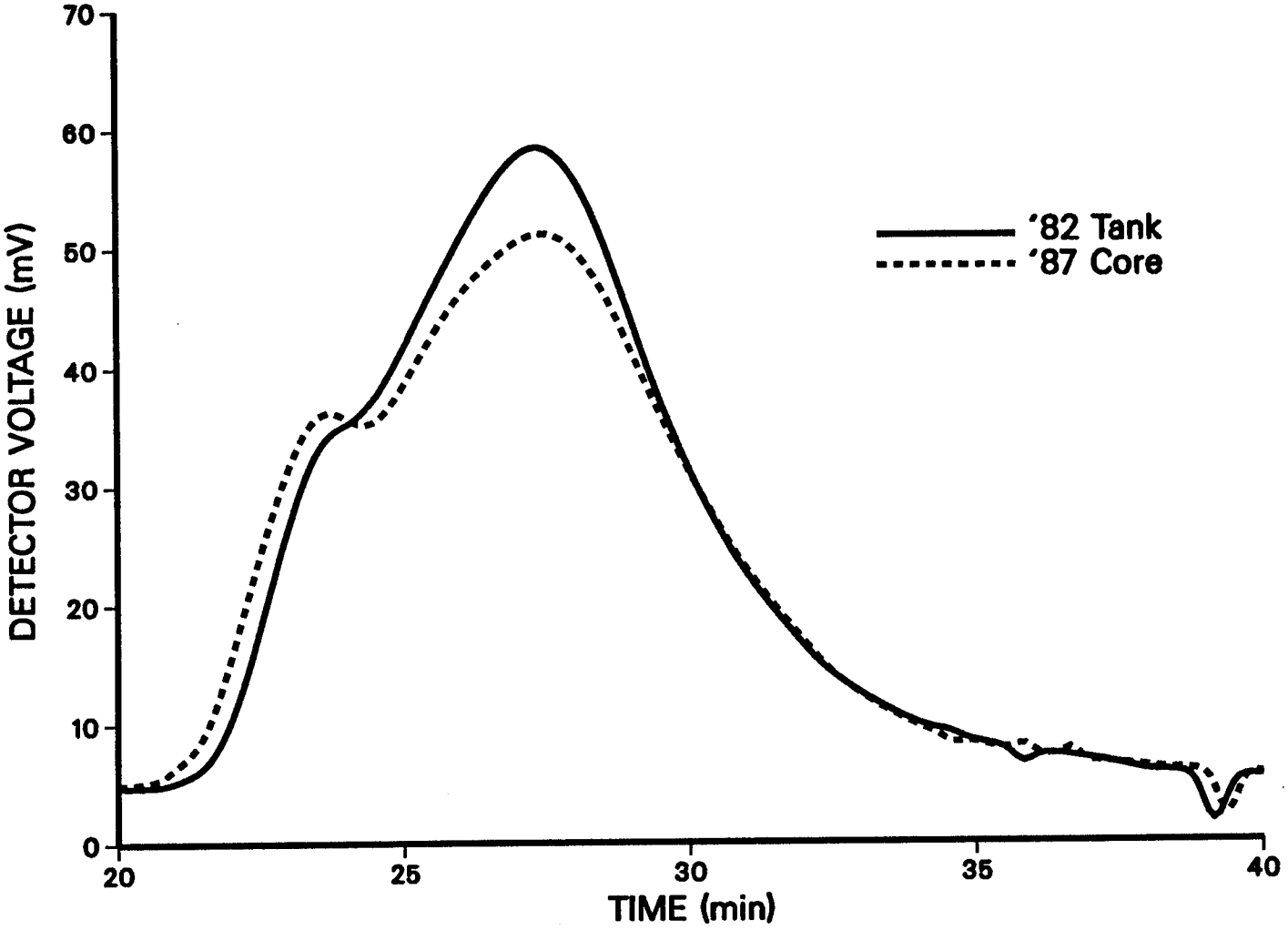

Figure C-14
Comparisons of GPC Chromatograms for 1982 Tank Asphalt and 1987 Cores-Dickens Ampet AC-20

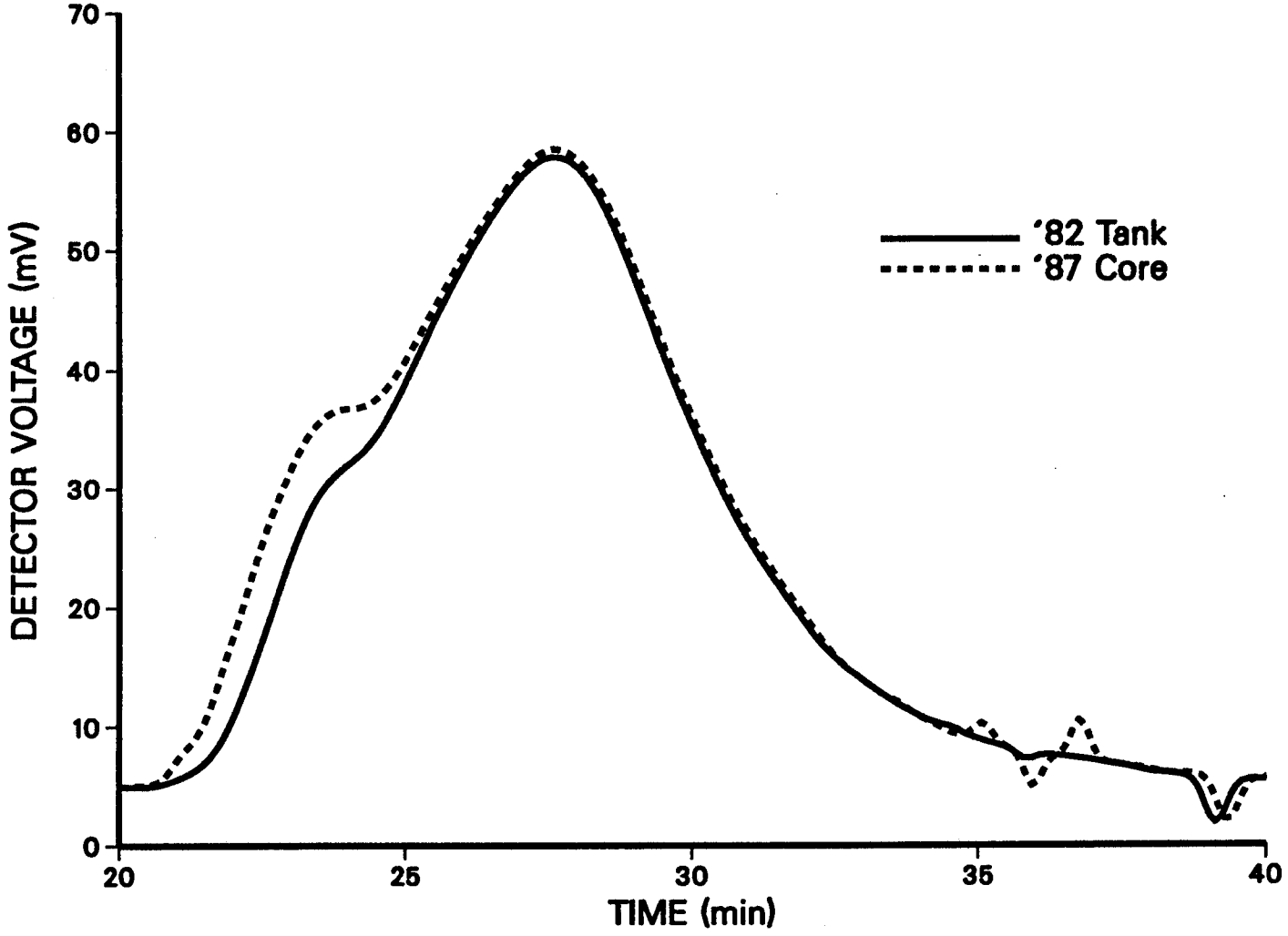

Figure C-15
Comparisons of GPC Chromatograms for 1982 Tank Asphalt and
1987 Core-Lufkin Ampet AC-10

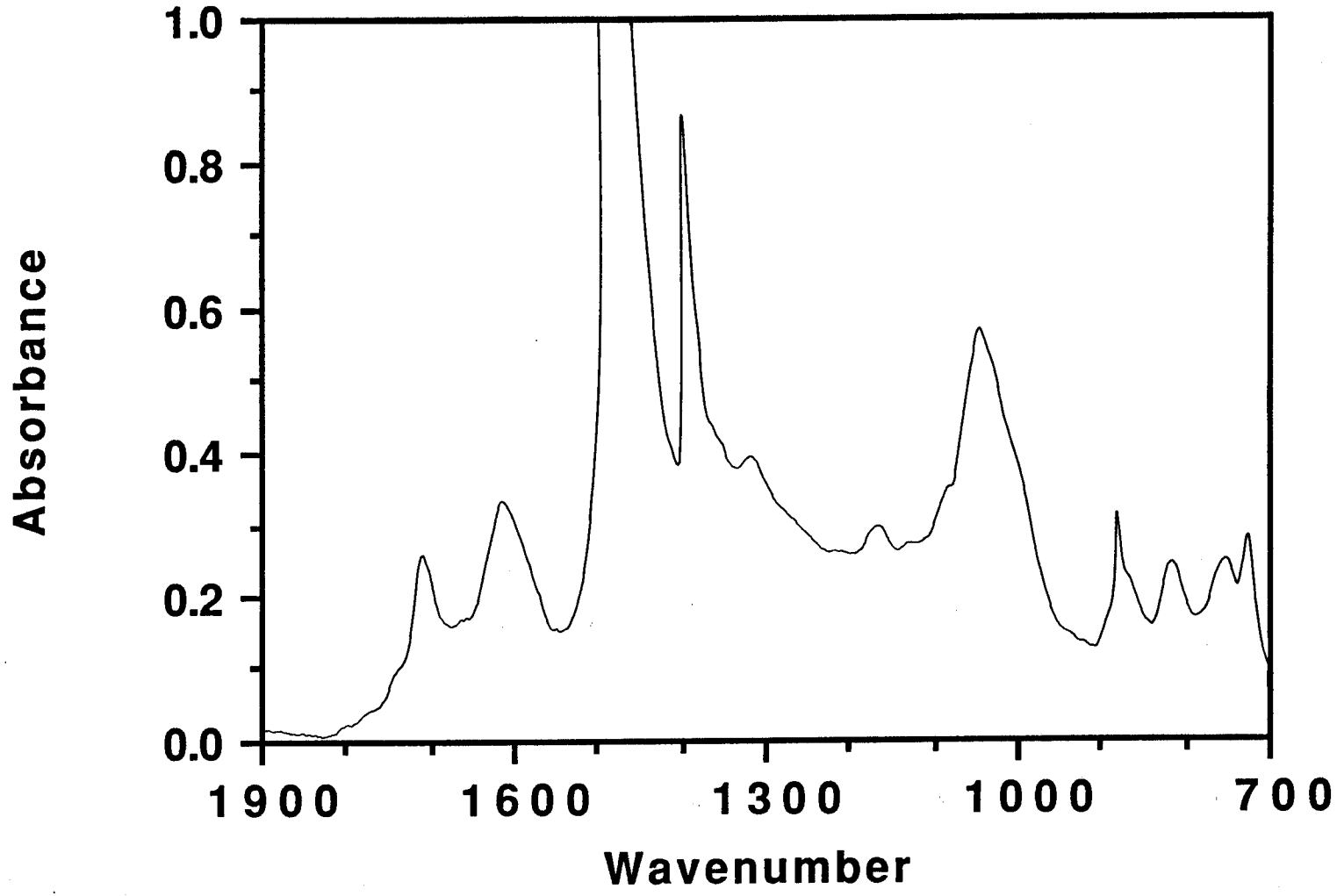

Figure C-16
FT-IR Spectra (KBr Method)-1987 Dumas MacMillan AC-10

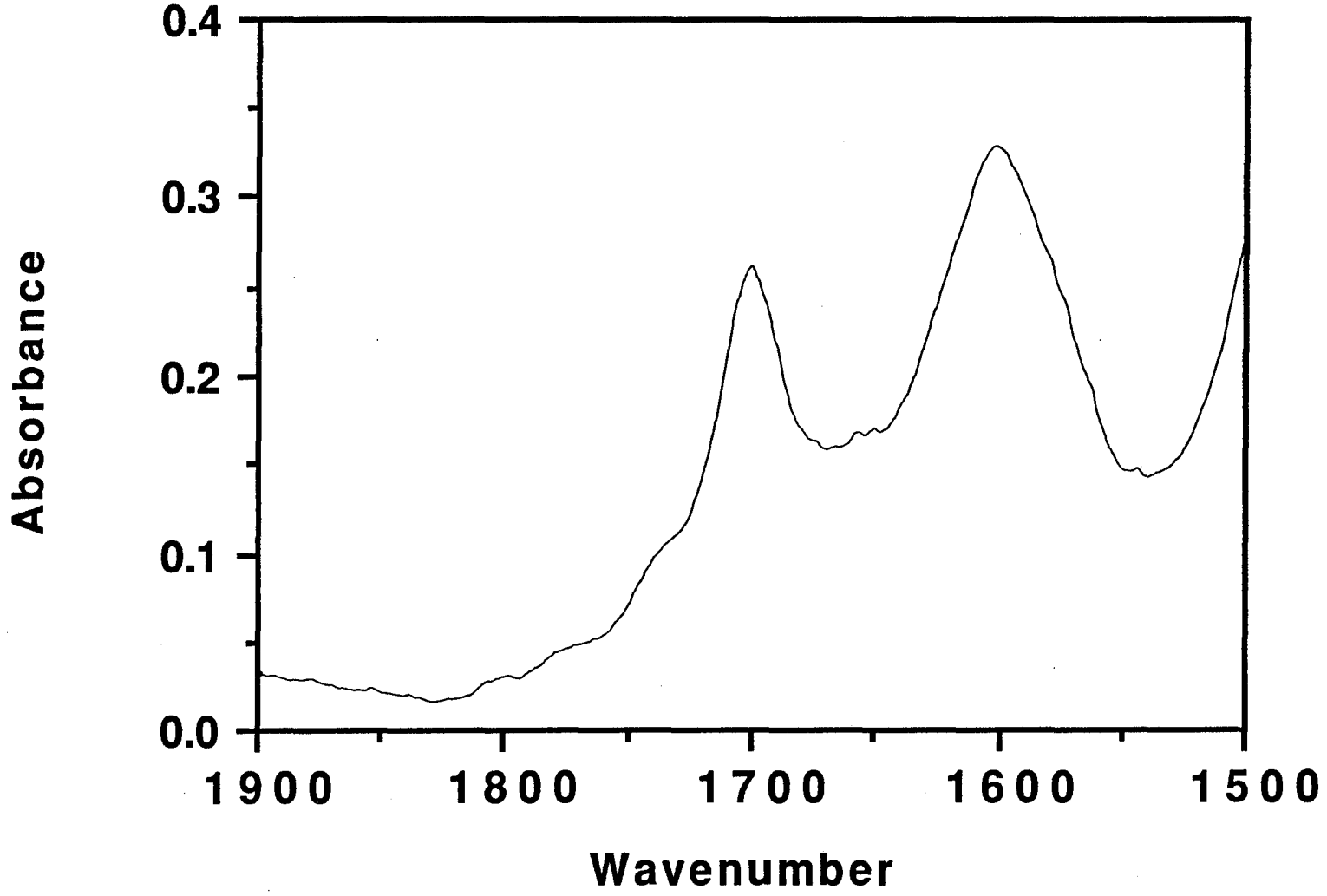

Figure C-17
FT-IR Spectra (KBr Method) Carbonyl Region-1987 Dumas
MacMillan AC-10

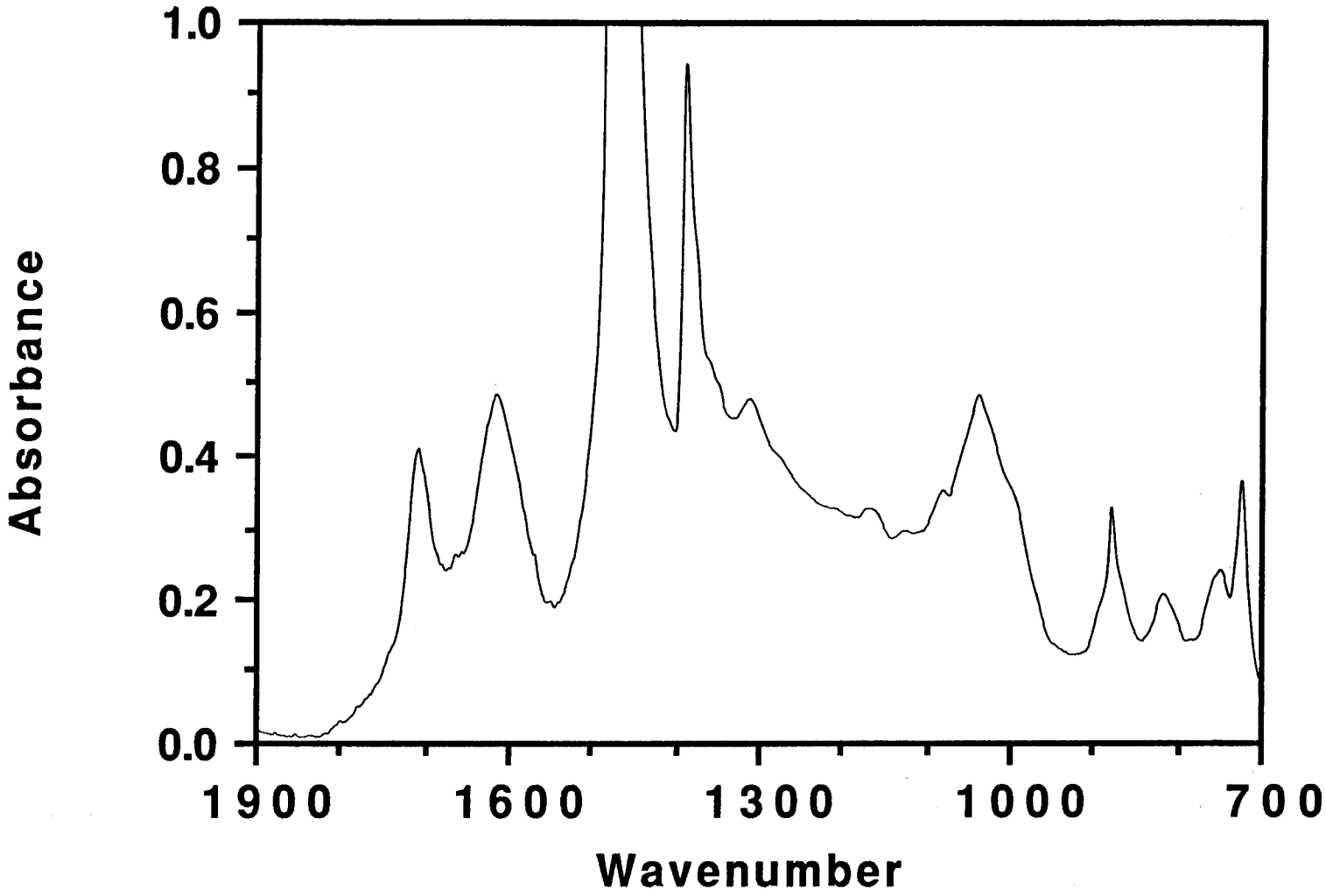

Figure C-18
FT-IR Spectra (KBr Method)-1987 Dumas Diamond Shamrock AC-20

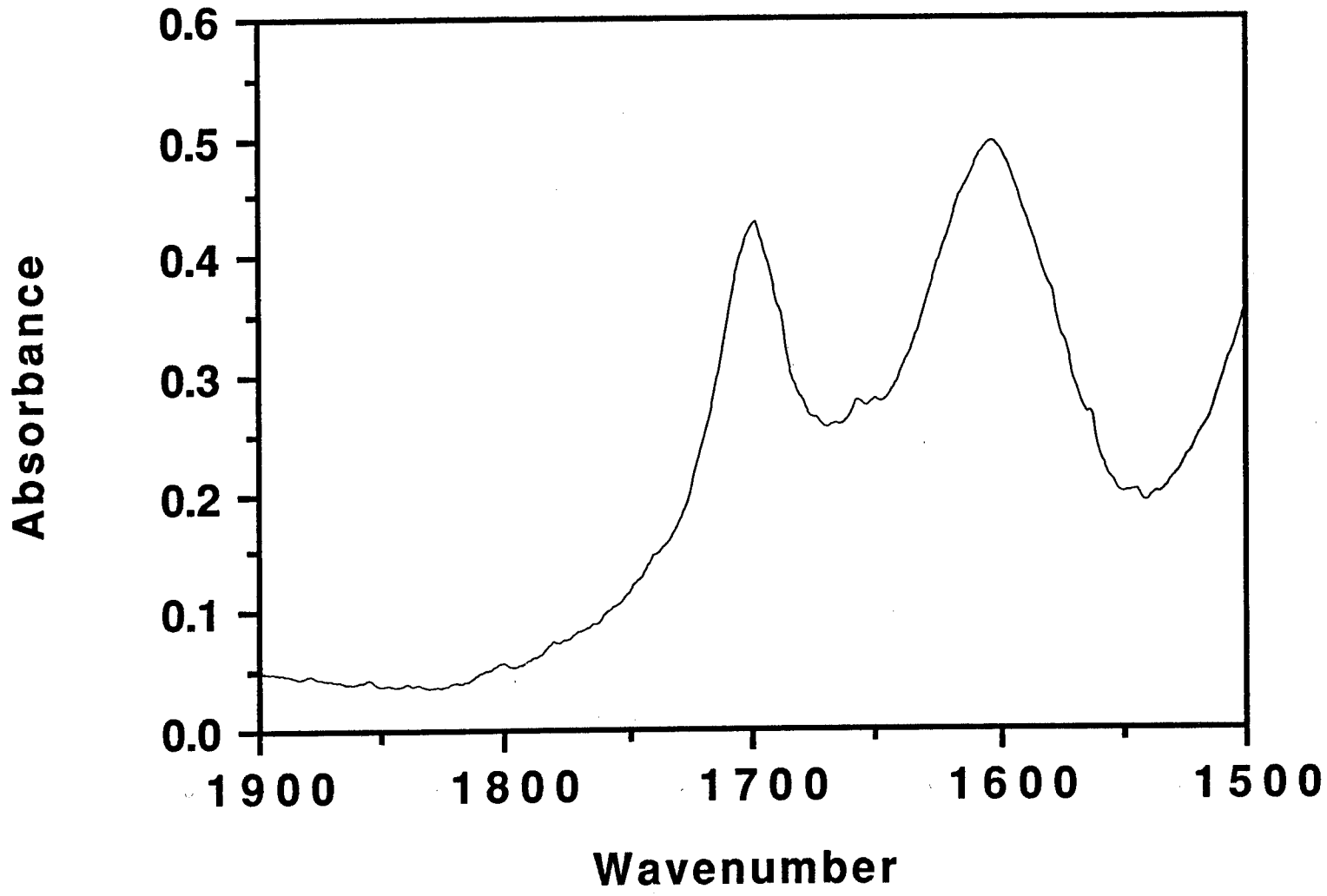

Figure C-19
FT-IR Spectra (KBr Method) Carbonyl Region-1987 Dumas Diamond
Shamrock AC-20

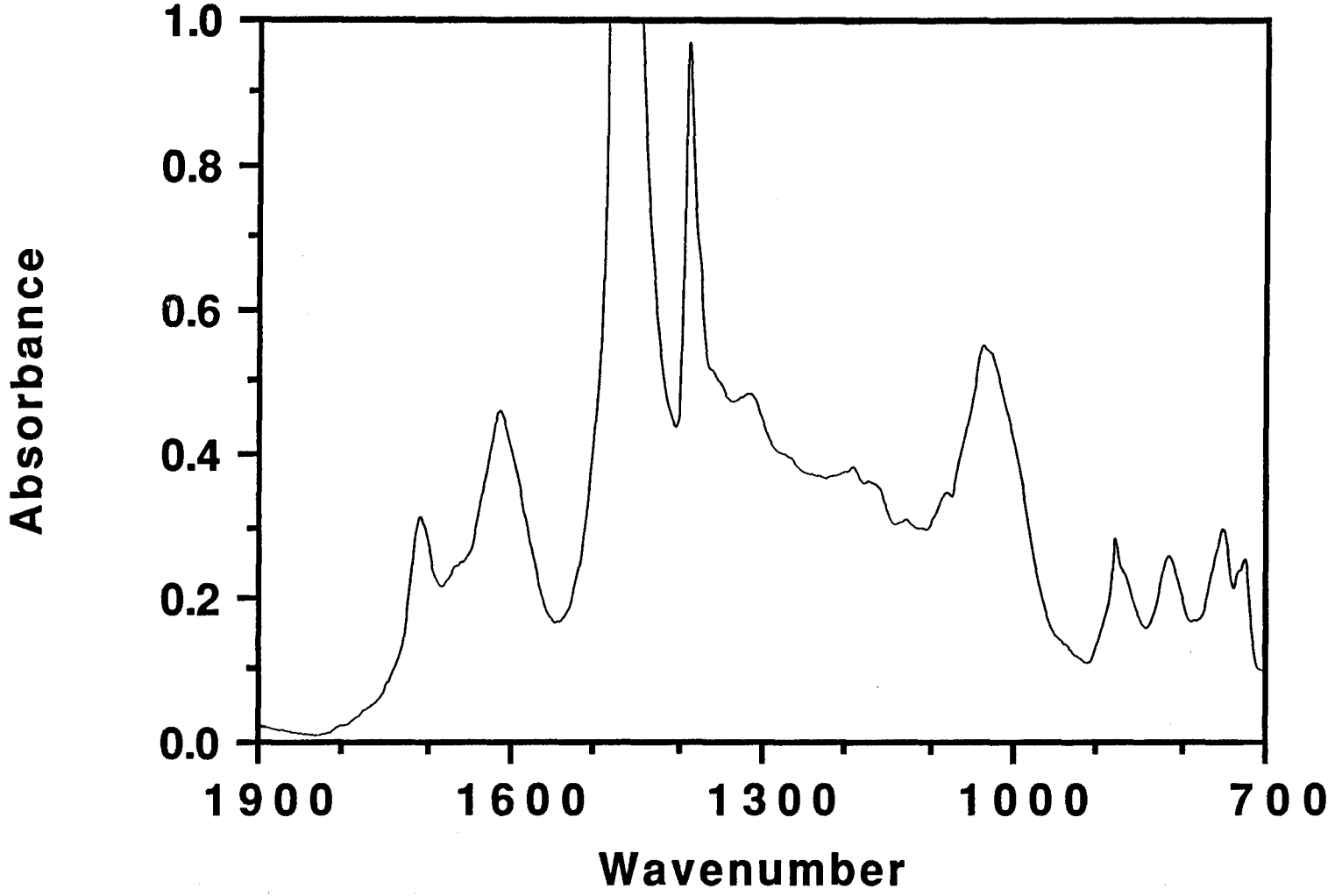

Figure C-20
FT-IR Spectra (KBr Method)-1987 Dumas Cosden AC-10

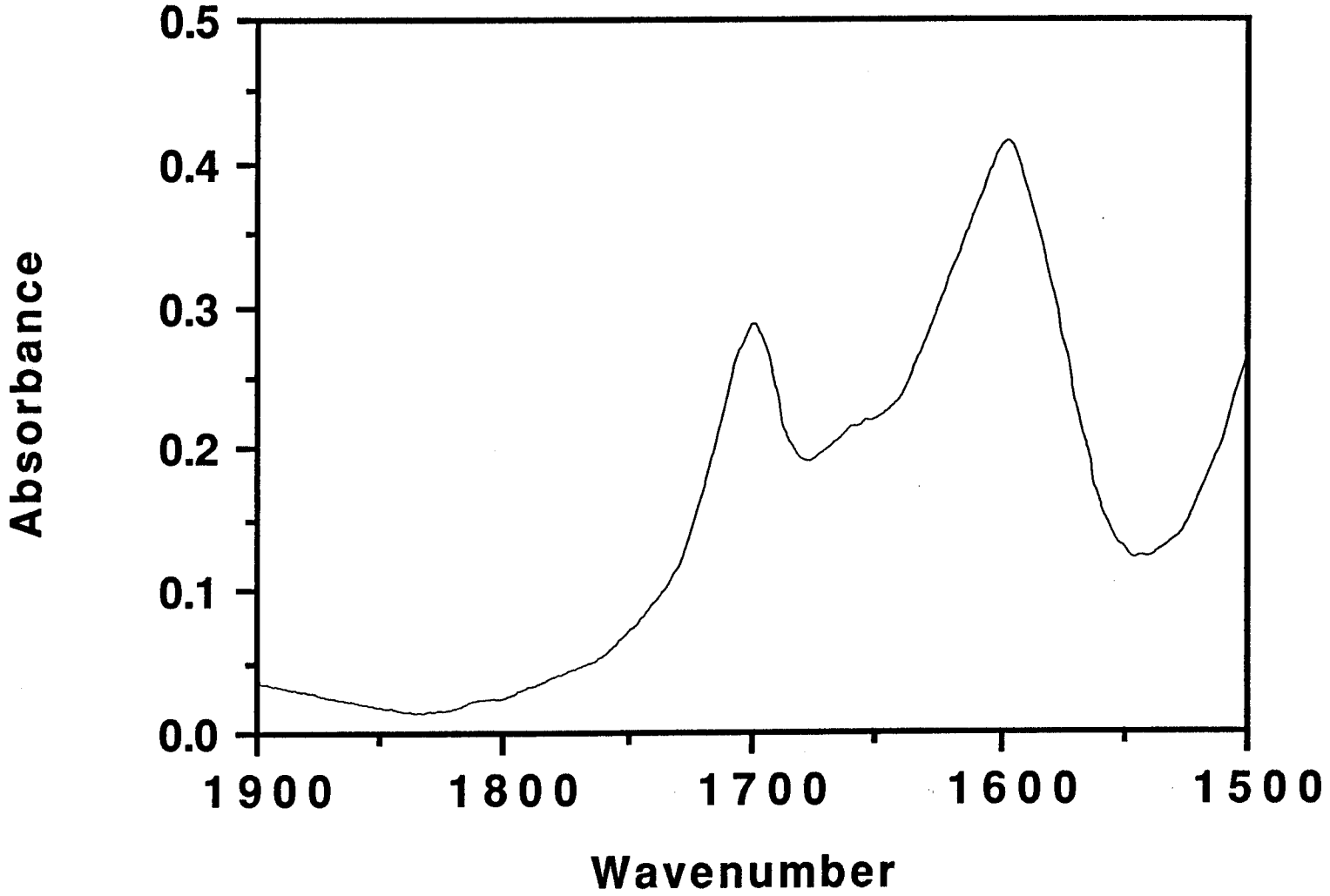

Figure C-21
FT-IR Spectra (KBr Method) Carbonyl Region-1987 Dumas
Cosden AC-10

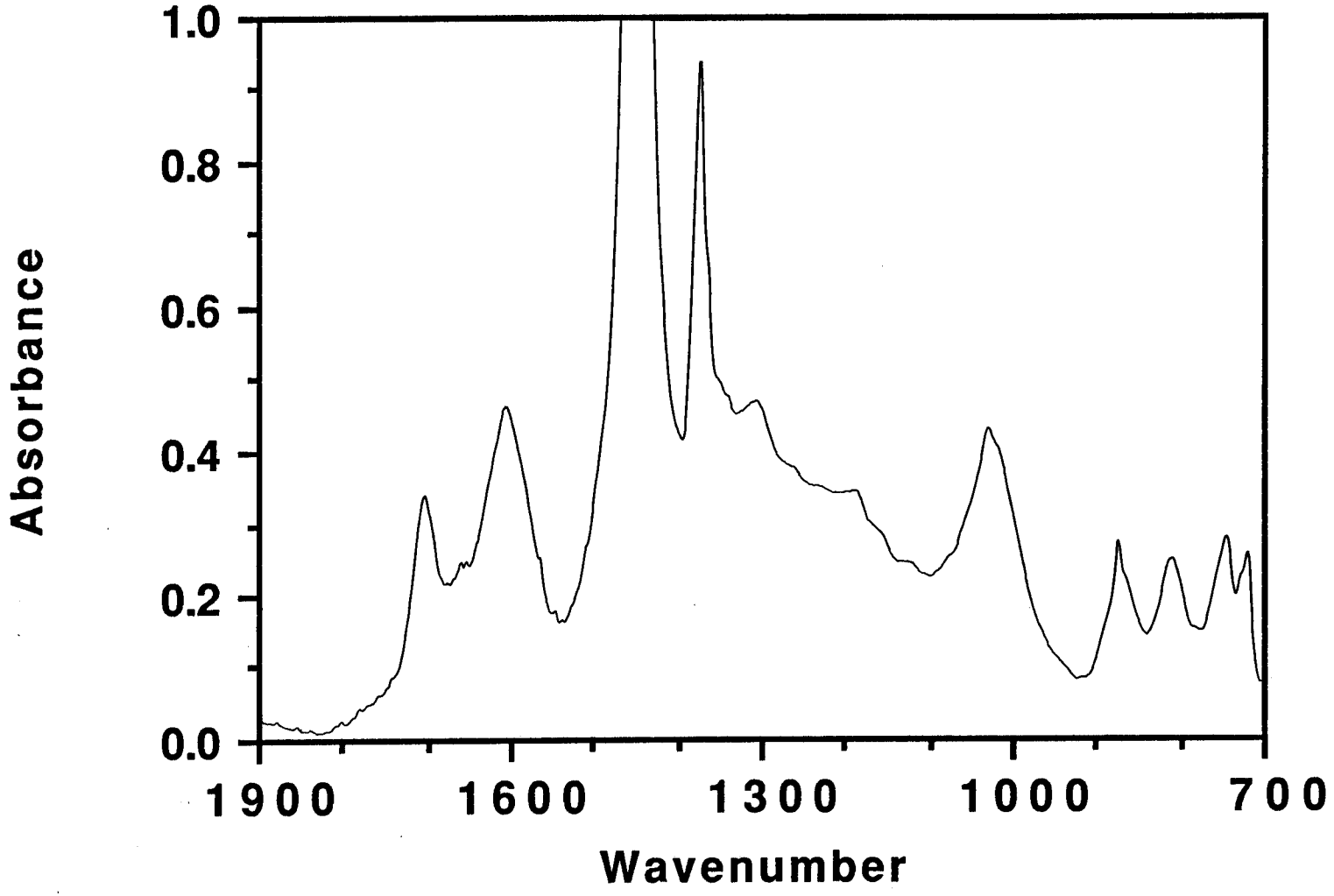

Figure C-22
FT-IR Spectra (KBr Method)-1987 Dumas Cosden AC-20

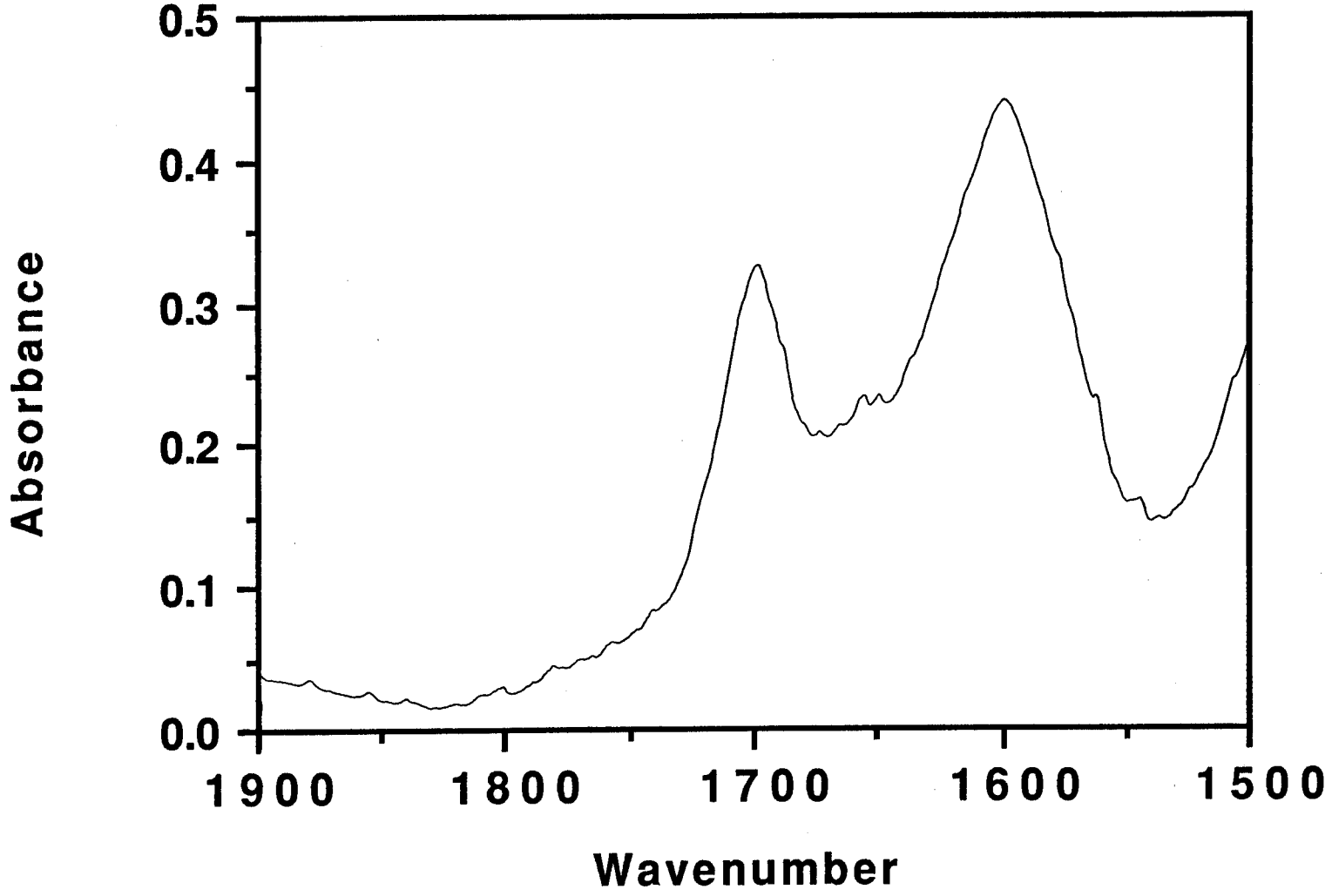

Figure C-23
FT-IR Spectra (KBr Method) Carbonyl Region-1987 Dumas
Cosden AC-20

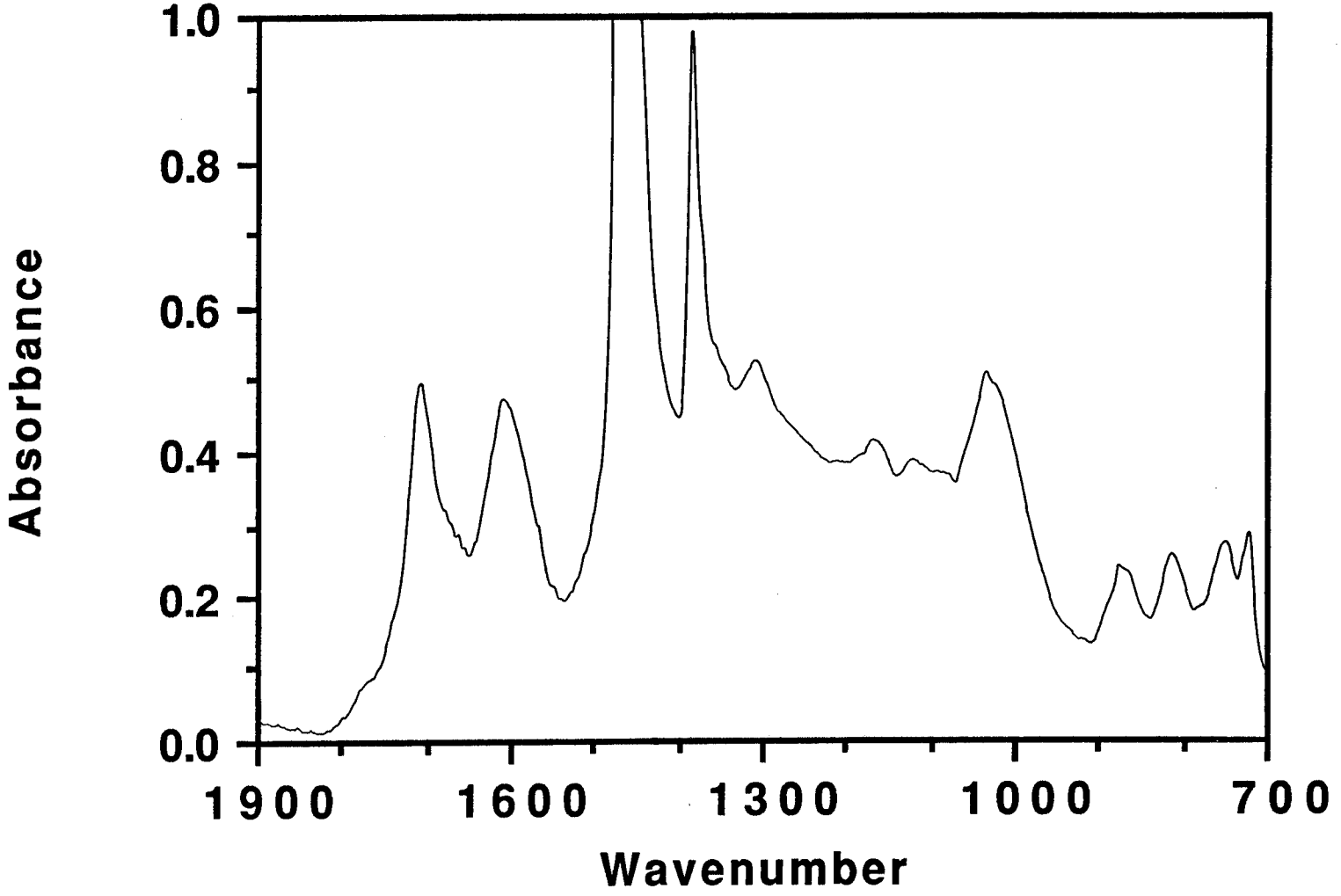

Figure C-24
FT-IR Spectra (KBr Method)-1987 Dickens MacMillan AC-20

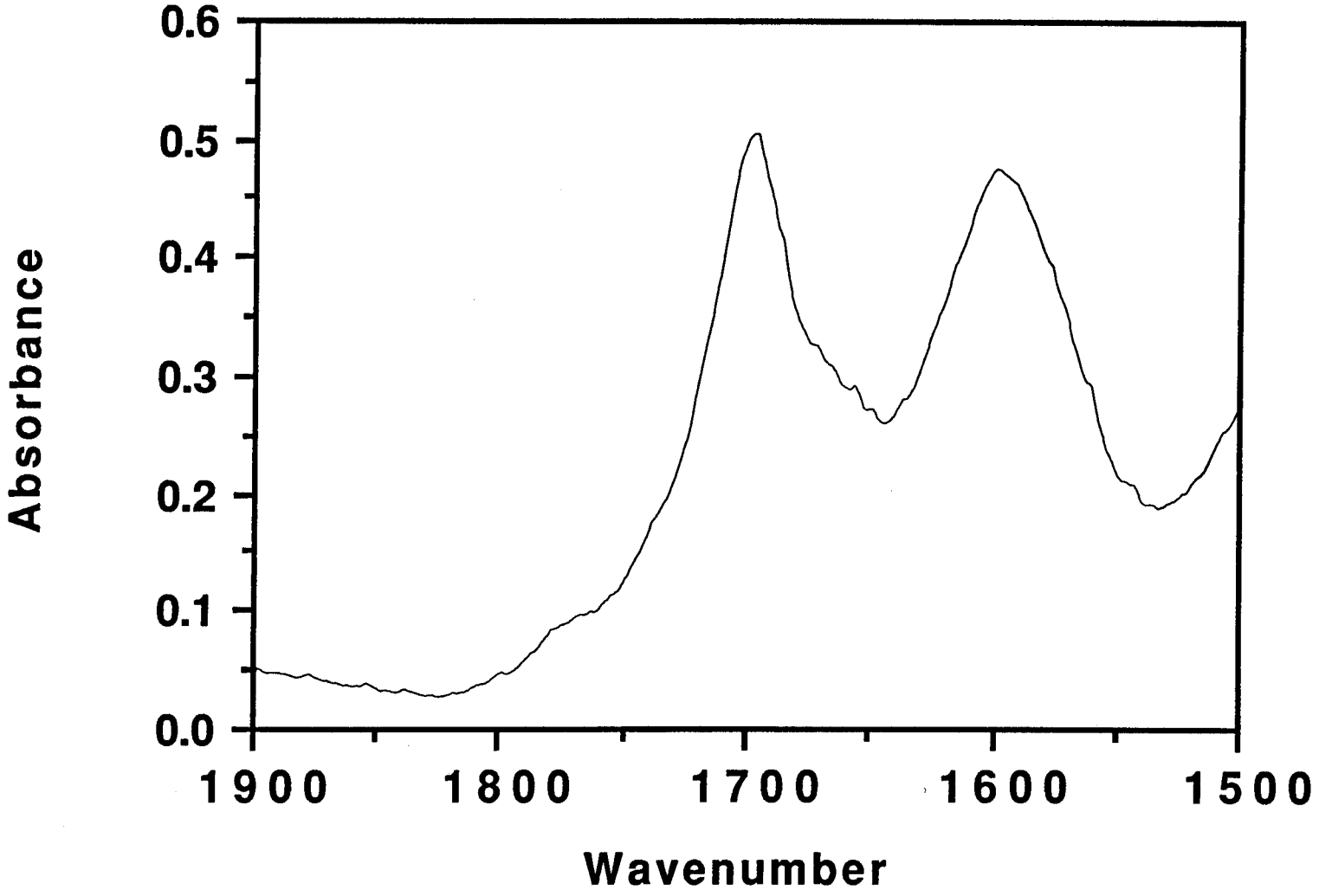

Figure C-25
FT-IR Spectra (KBr Method) Carbonyl Region-1987 Dickens
MacMillan AC-20

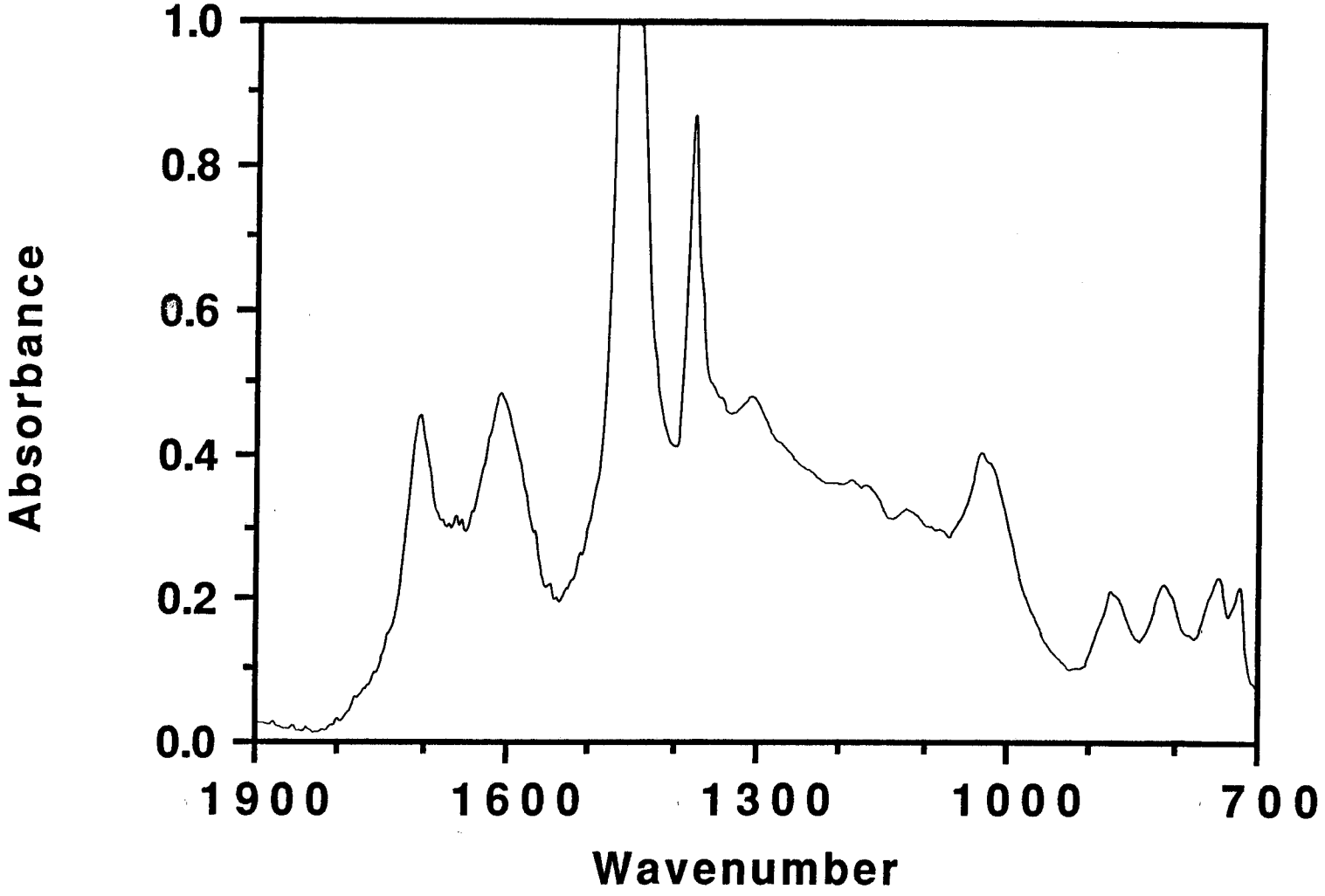

Figure C-26
FT-IR Spectra (KBr Method)-1987 Dickens Ampet AC-20 (Dorchester)

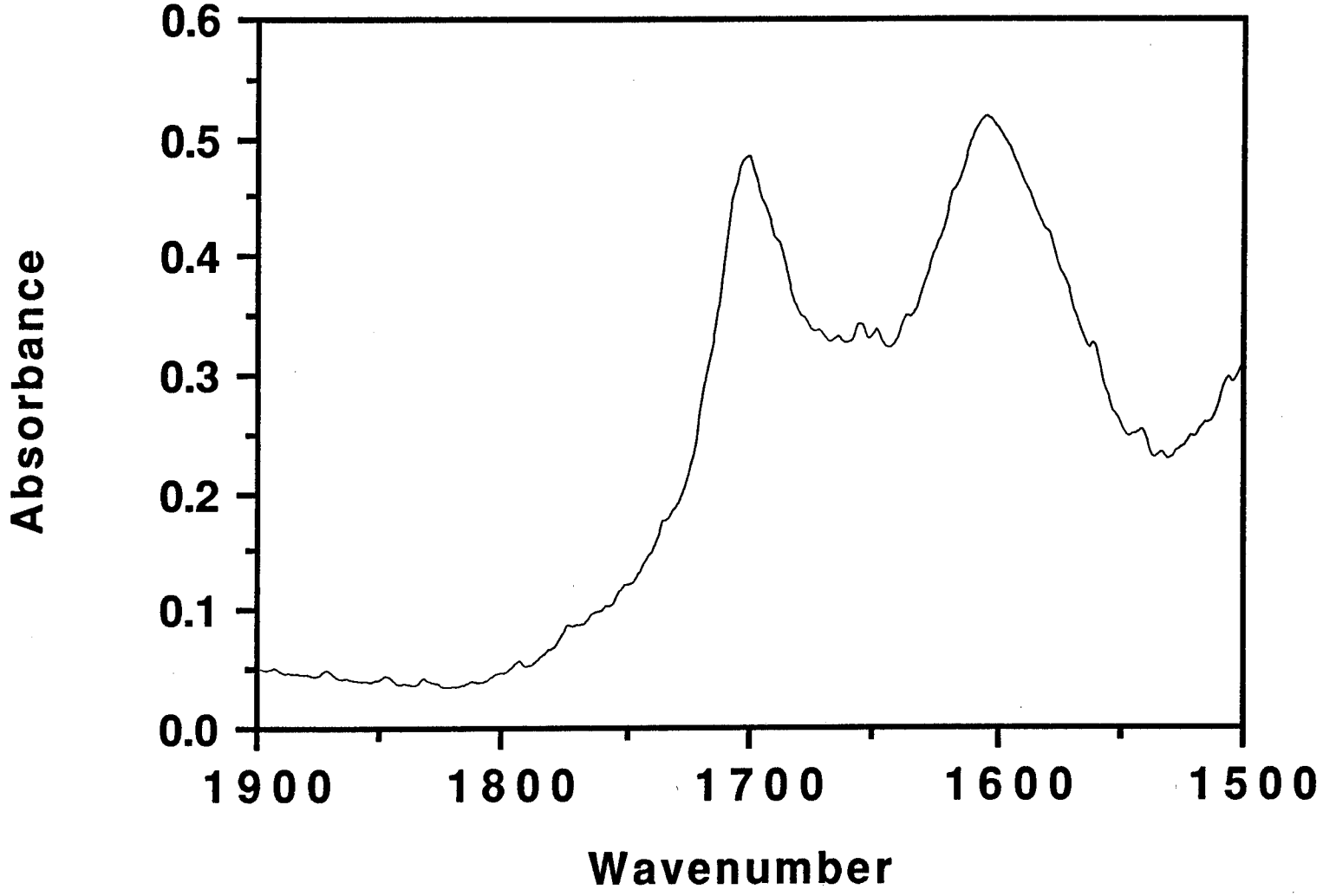

Figure C-27
FT-IR Spectra (KBr Method) Carbonyl Region-1987 Dickens
Ampet AC-20 (Dorchester)

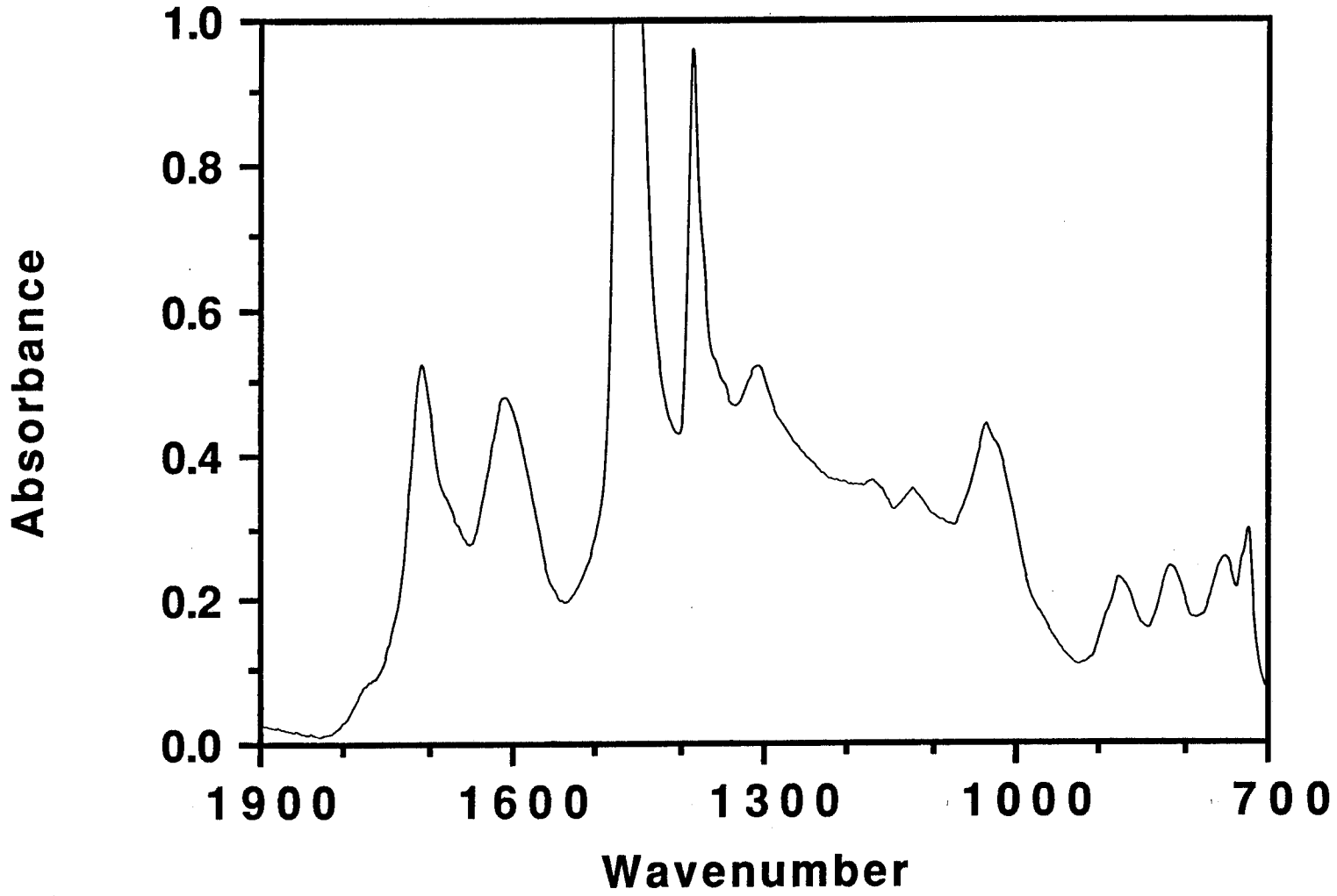

Figure C-28
FT-IR Spectra (KBr Method)-1987 Dickens Exxon AC-20

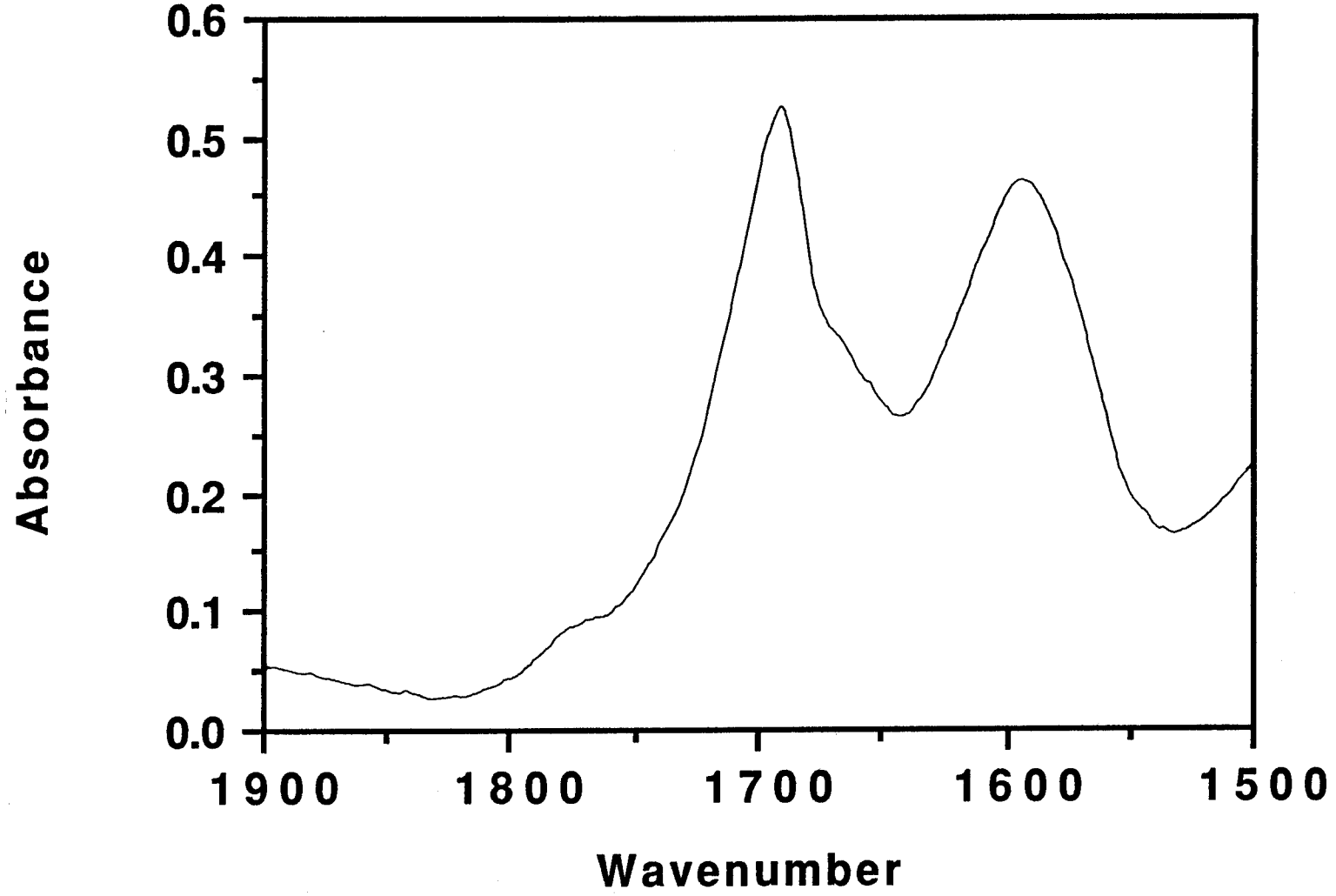

Figure C-29
FT-IR Spectra (KBr Method) Carbonyl Region-1987 Dickens
Exxon AC-20

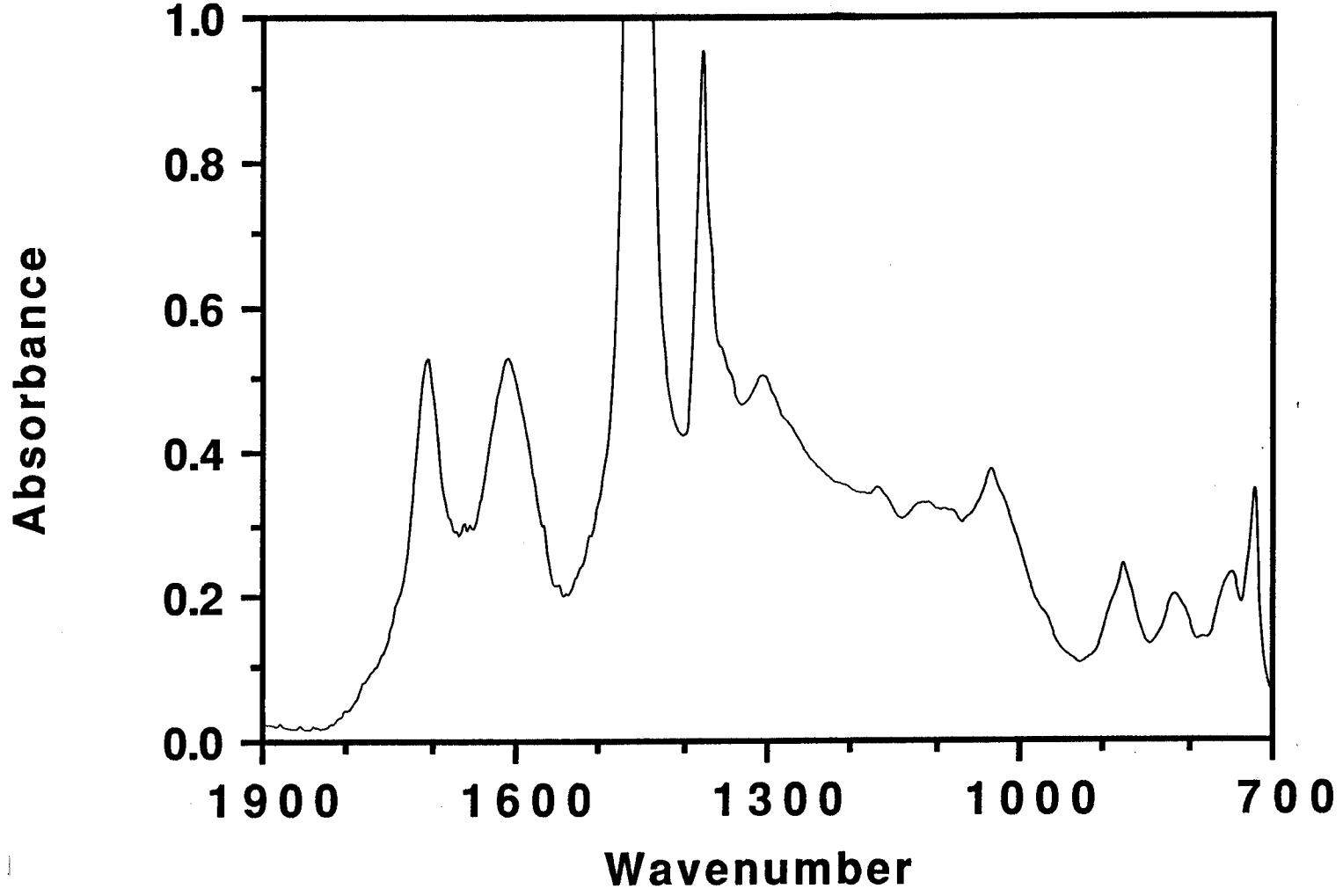

Figure C-30
FT-IR Spectra (KBr Method)-1987 Dickens Diamond Shamrock AC-20

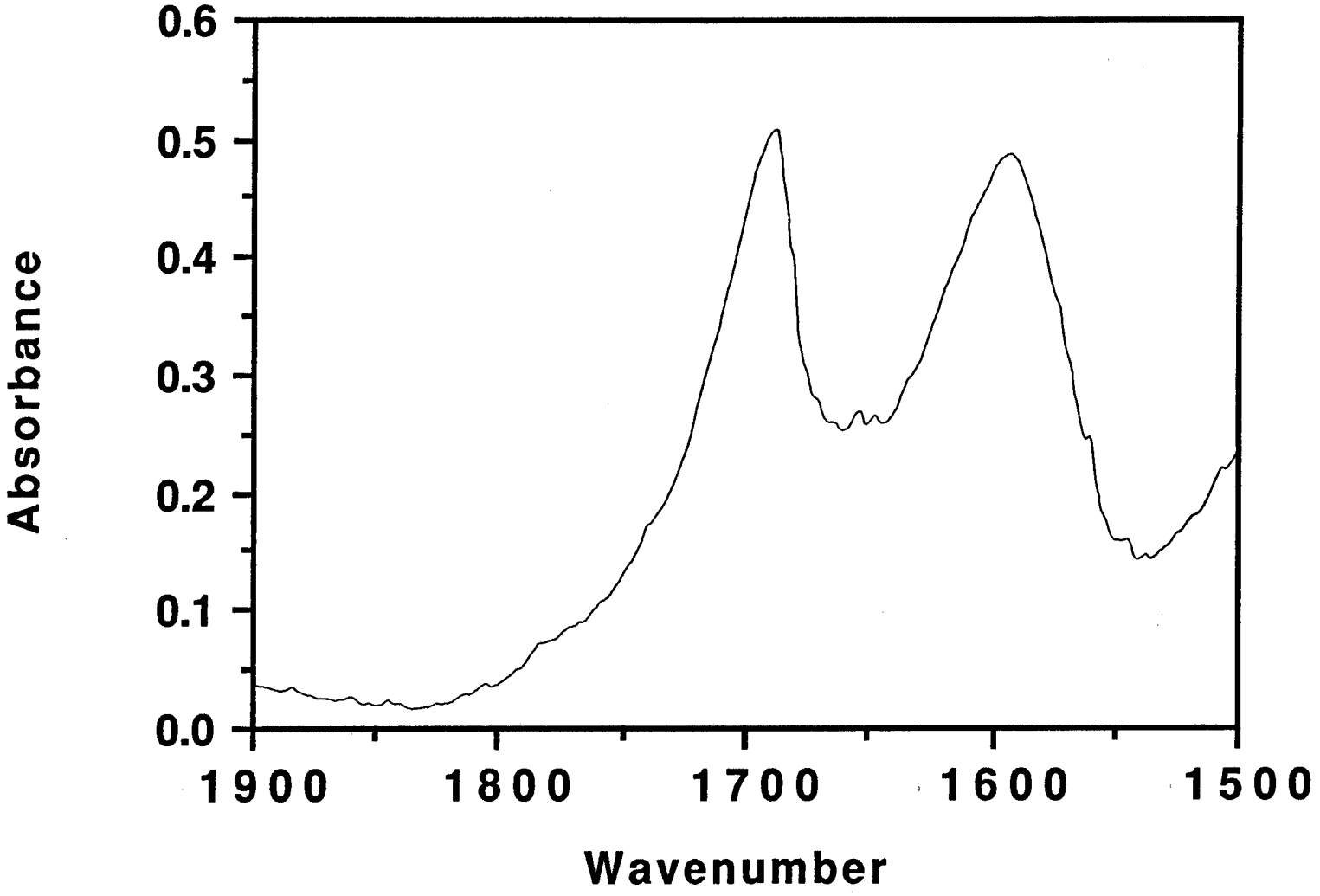

Figure C-31
FT-IR Spectra (KBr Method) Carbonyl Region- 1987 Dickens
Diamond Shamrock AC-20

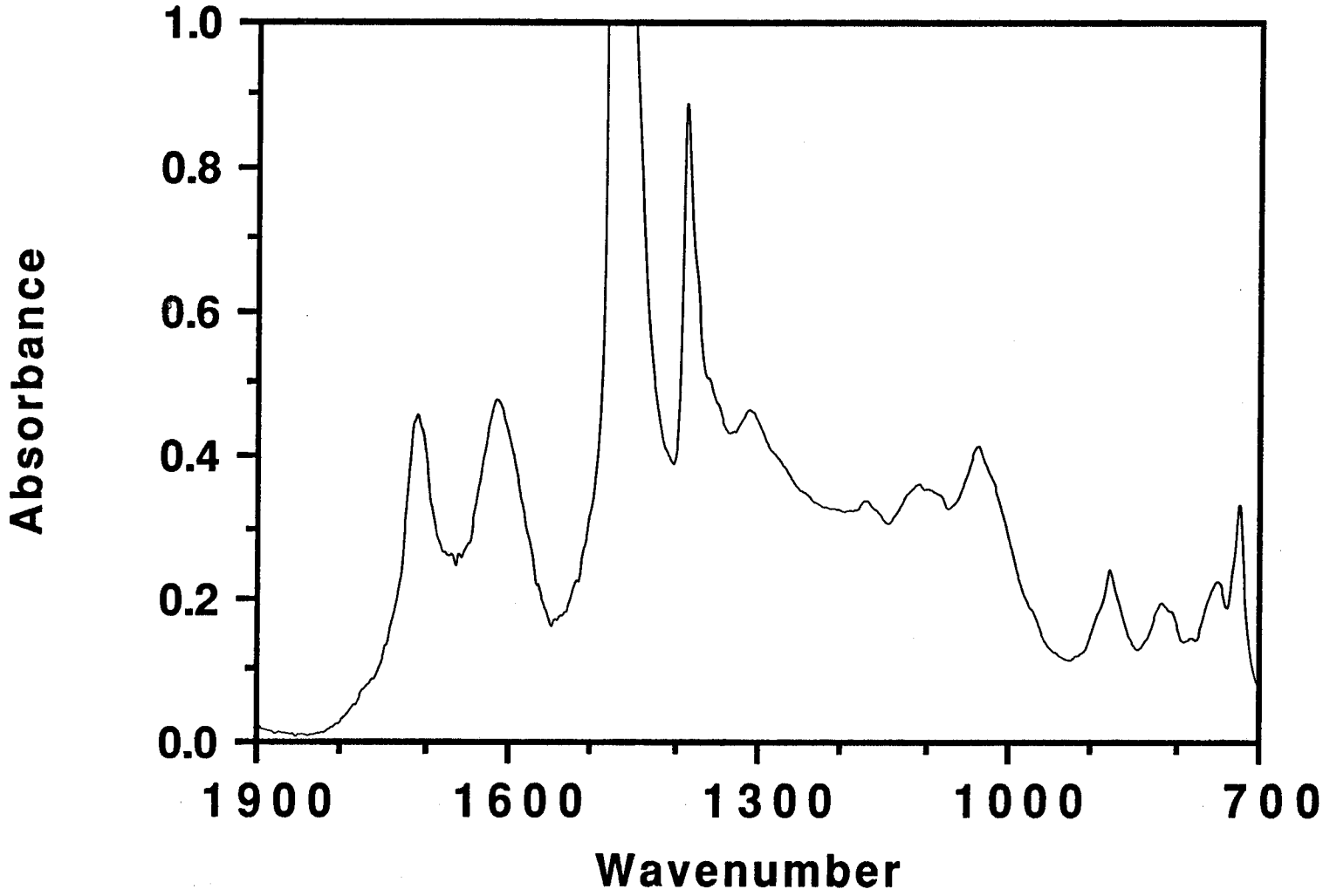

Figure C-32
FT-IR Spectra (KBr Method)-1987 Dickens Diamond Shamrock AC-10

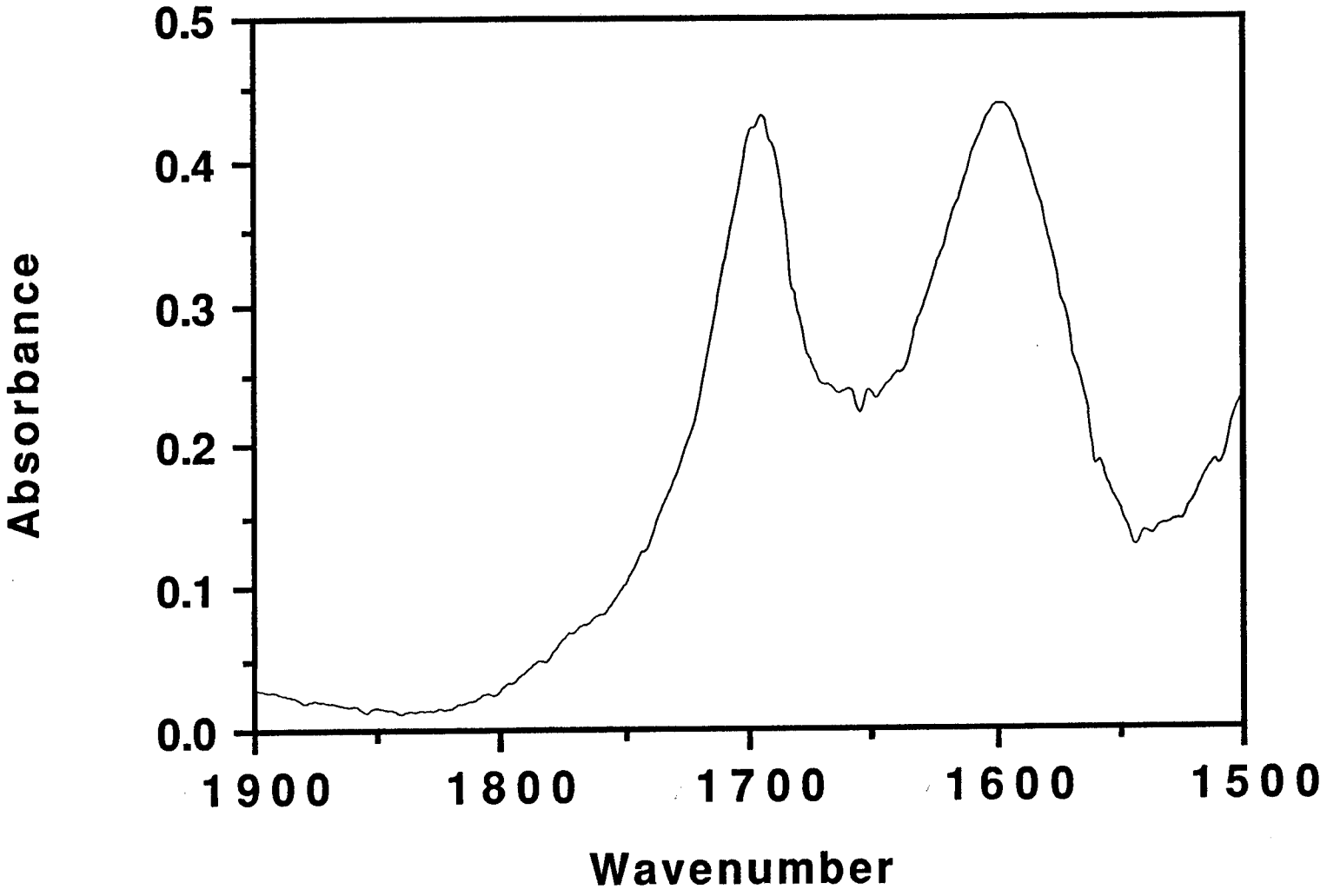

Figure C-33
FT-IR Spectra (KBr Method) Carbonyl Region-1987 Diamond Shamrock AC-10

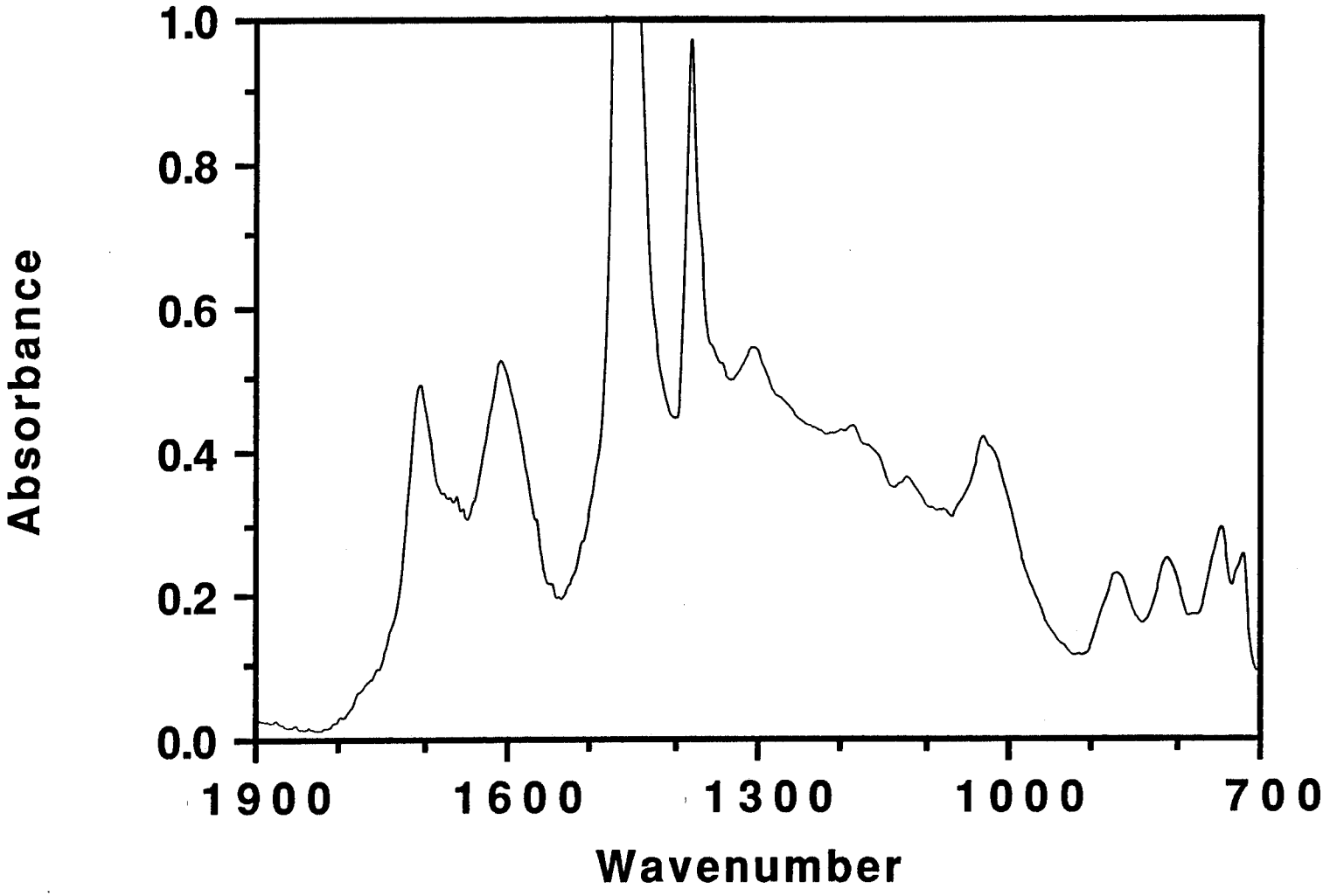

Figure C-34
FT-IR Spectra (KBr Method)-1987 Dickens Cosden AC-20

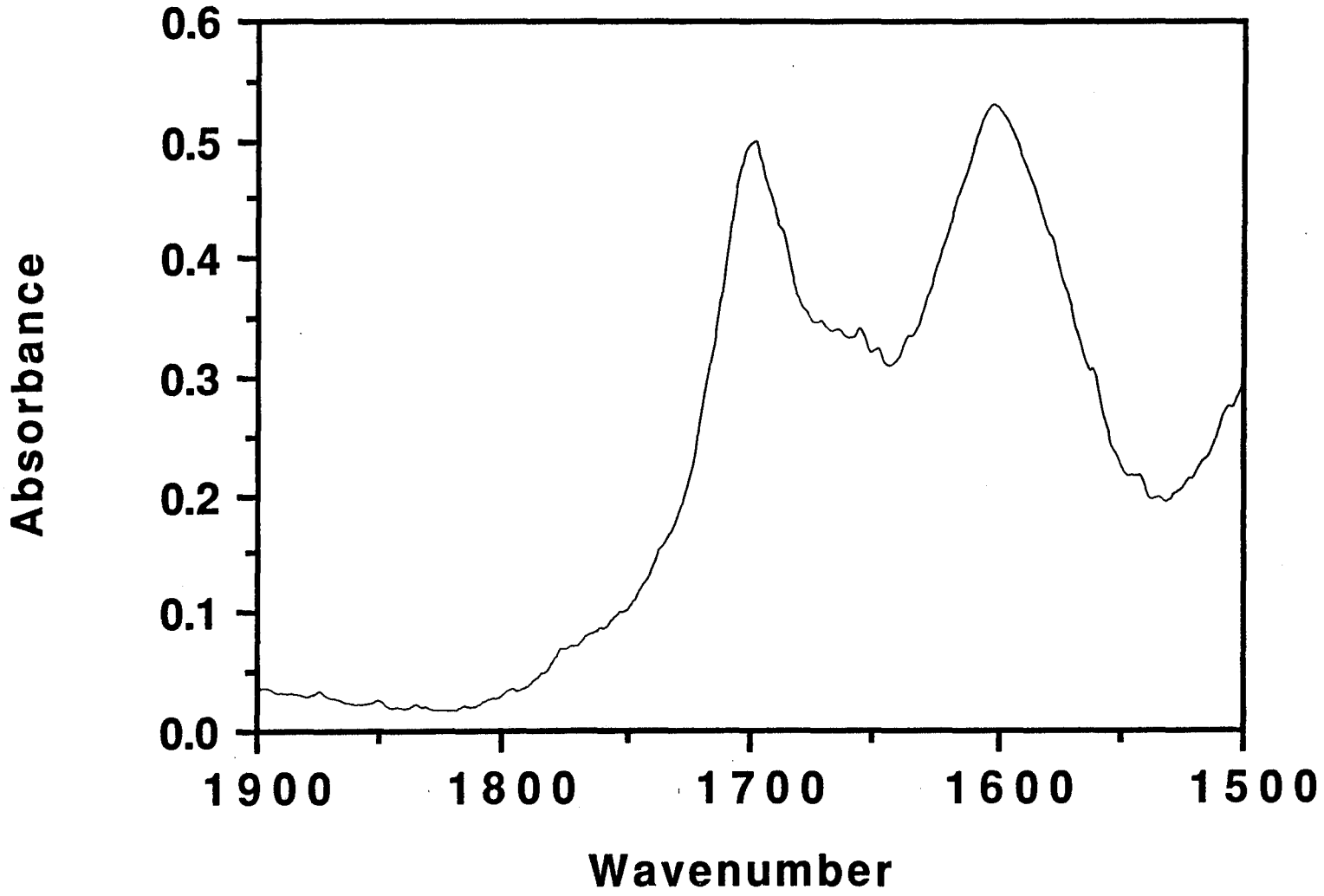

Figure C-35
FT-IR Spectra (KBr Method) Carbonyl Region-1987 Dickens
Cosden AC-20

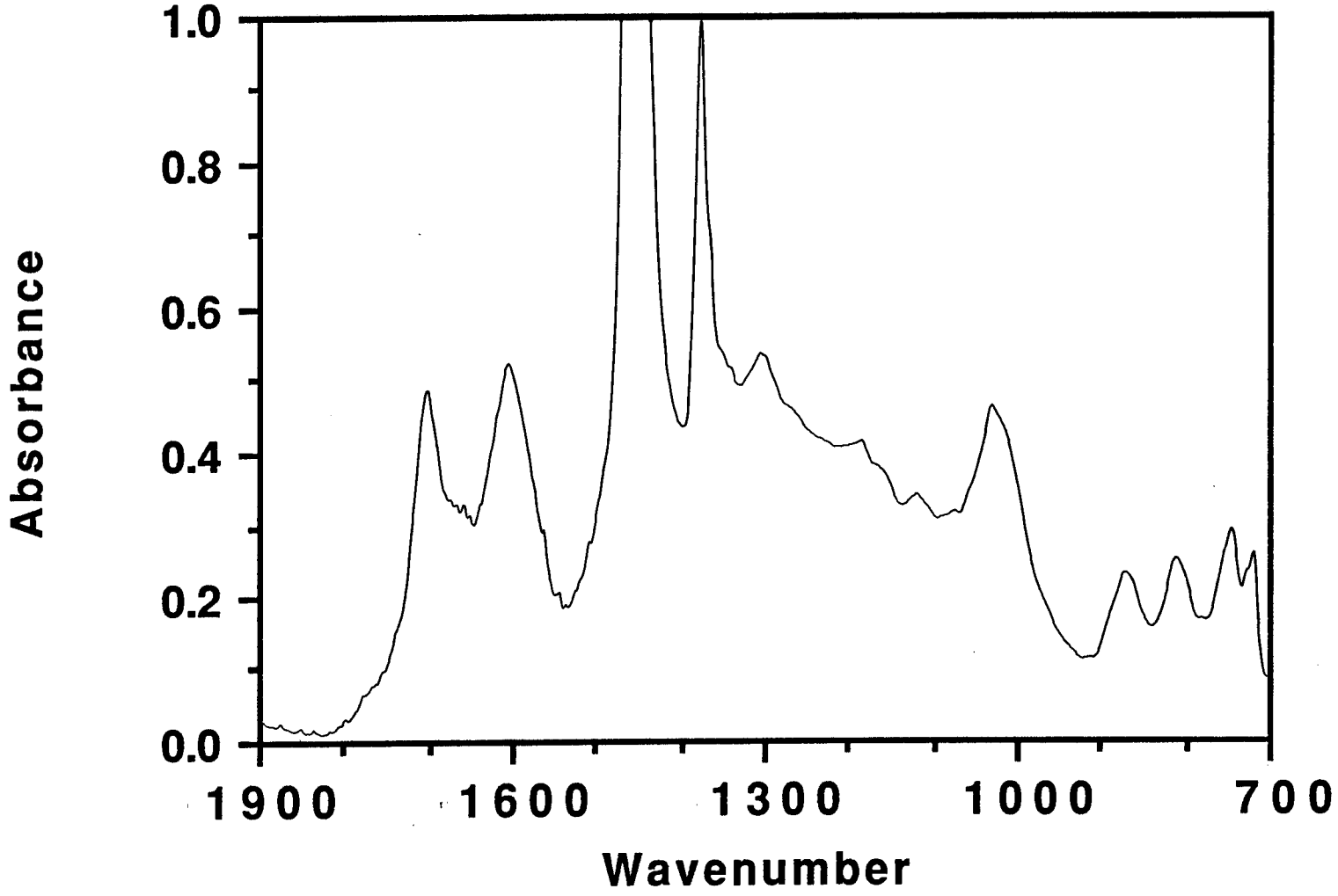

Figure C-36
FT-IR Spectra (KBr Method)-1987 Dickens Cosden AC-10

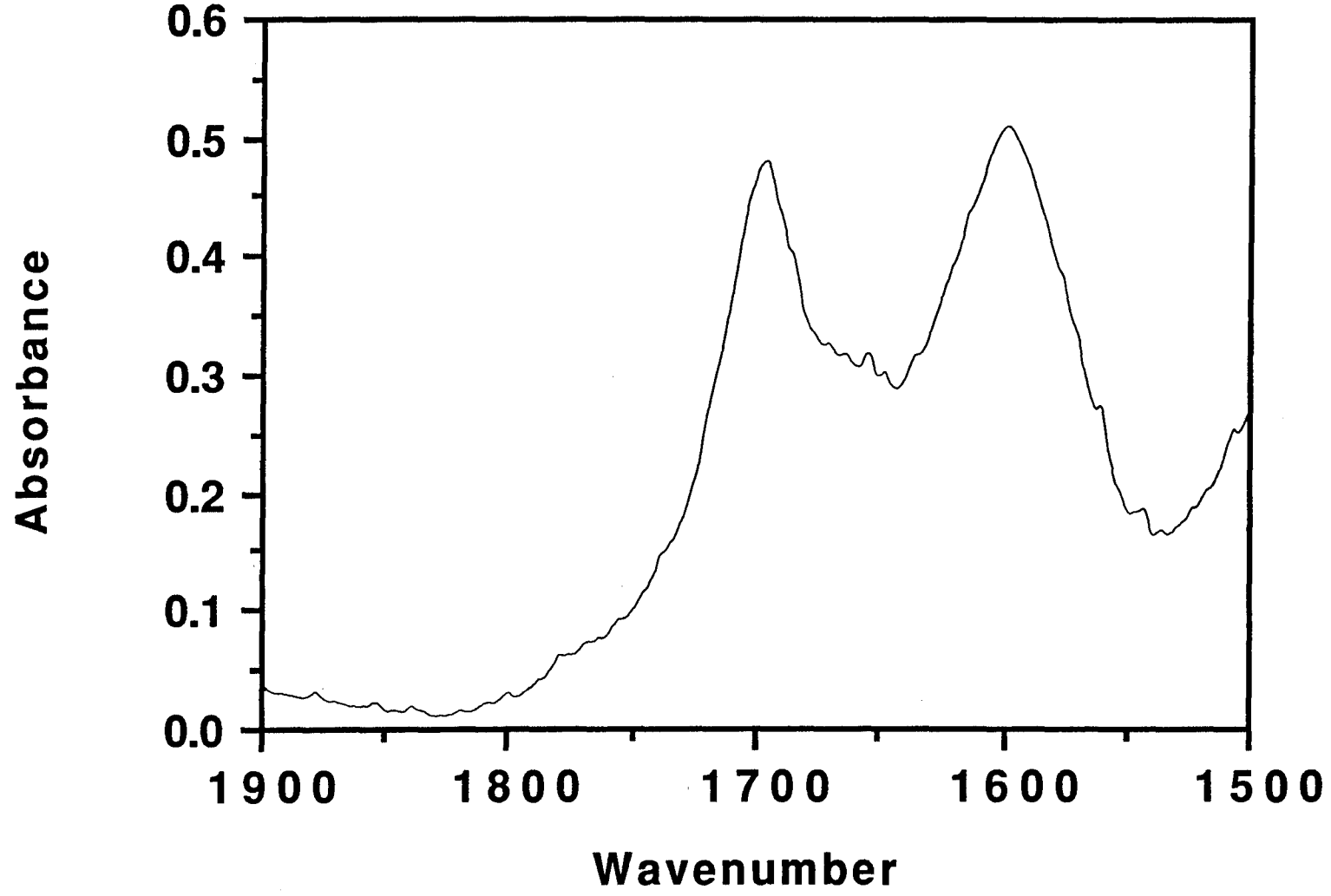

Figure C-37
FT-IR Spectra (KBr Method) Carbonyl Region-1987 Dickens
Cosden AC-10

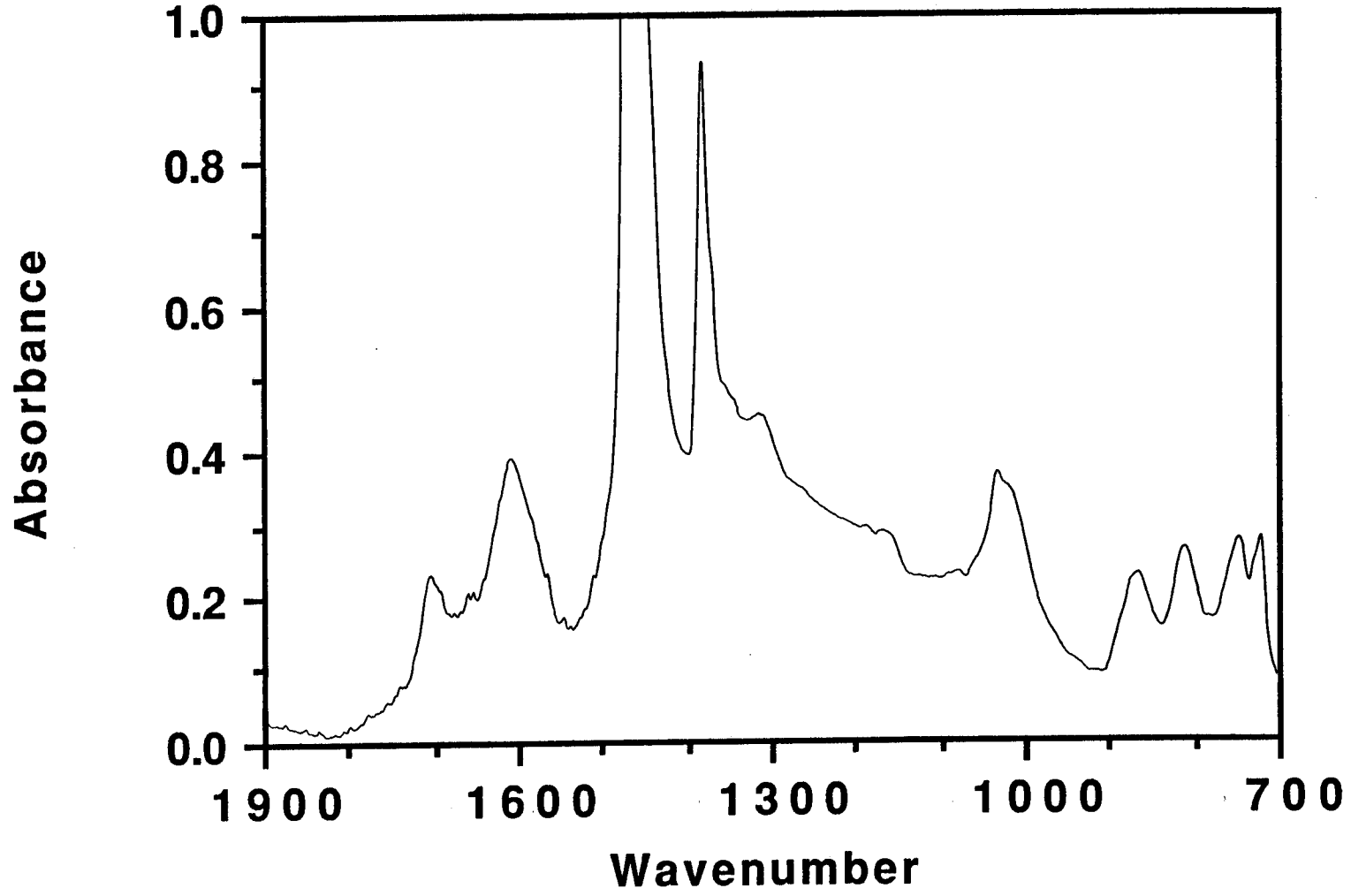

Figure C-38
FT-IR Spectra (KBr Method)-1987 Lufkin Ampet AC-20

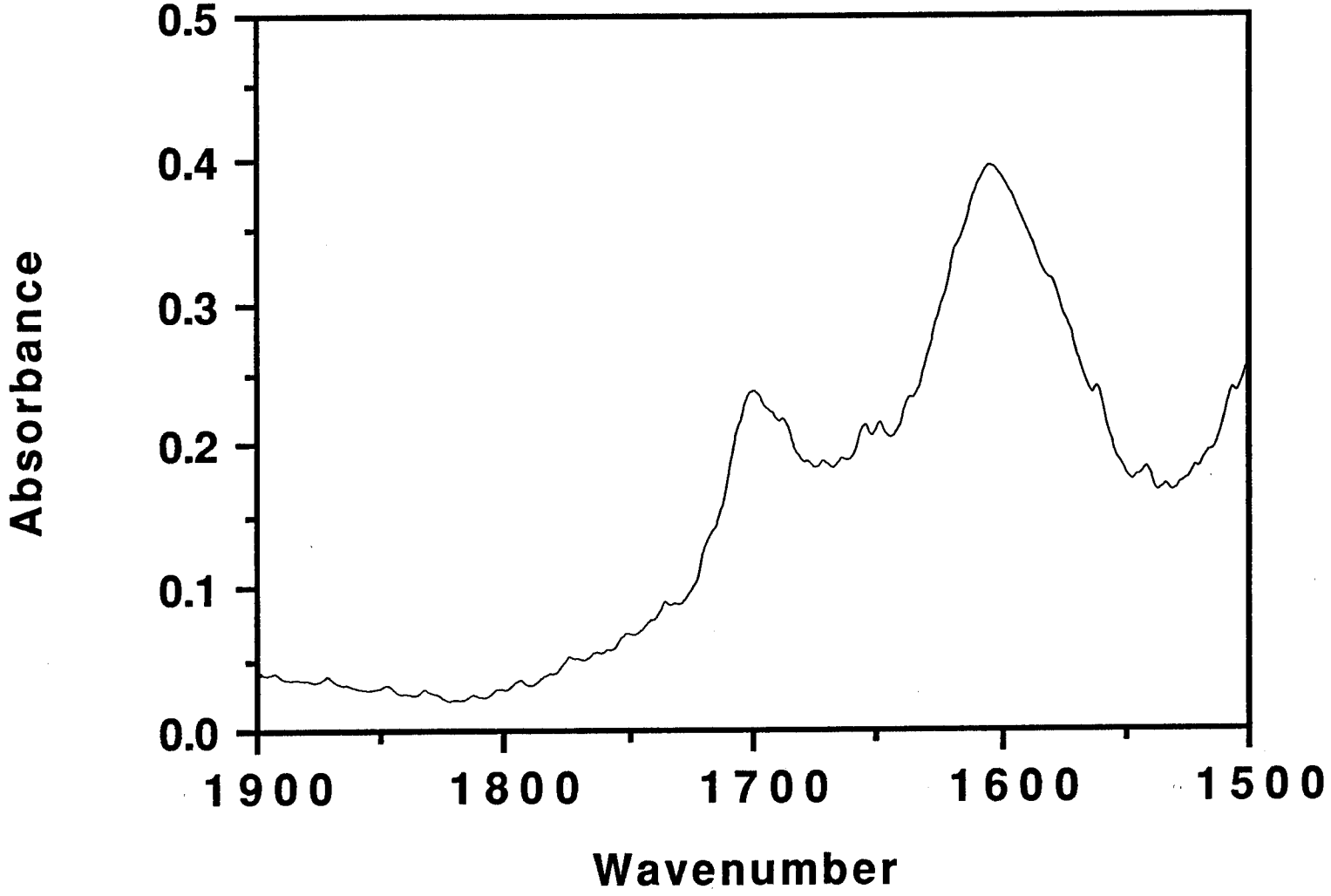

Figure C-39
FT-IR Spectra (KBr Method) Carbonyl Region-1987 Lufkin
Ampet AC-20 (Dorchester)

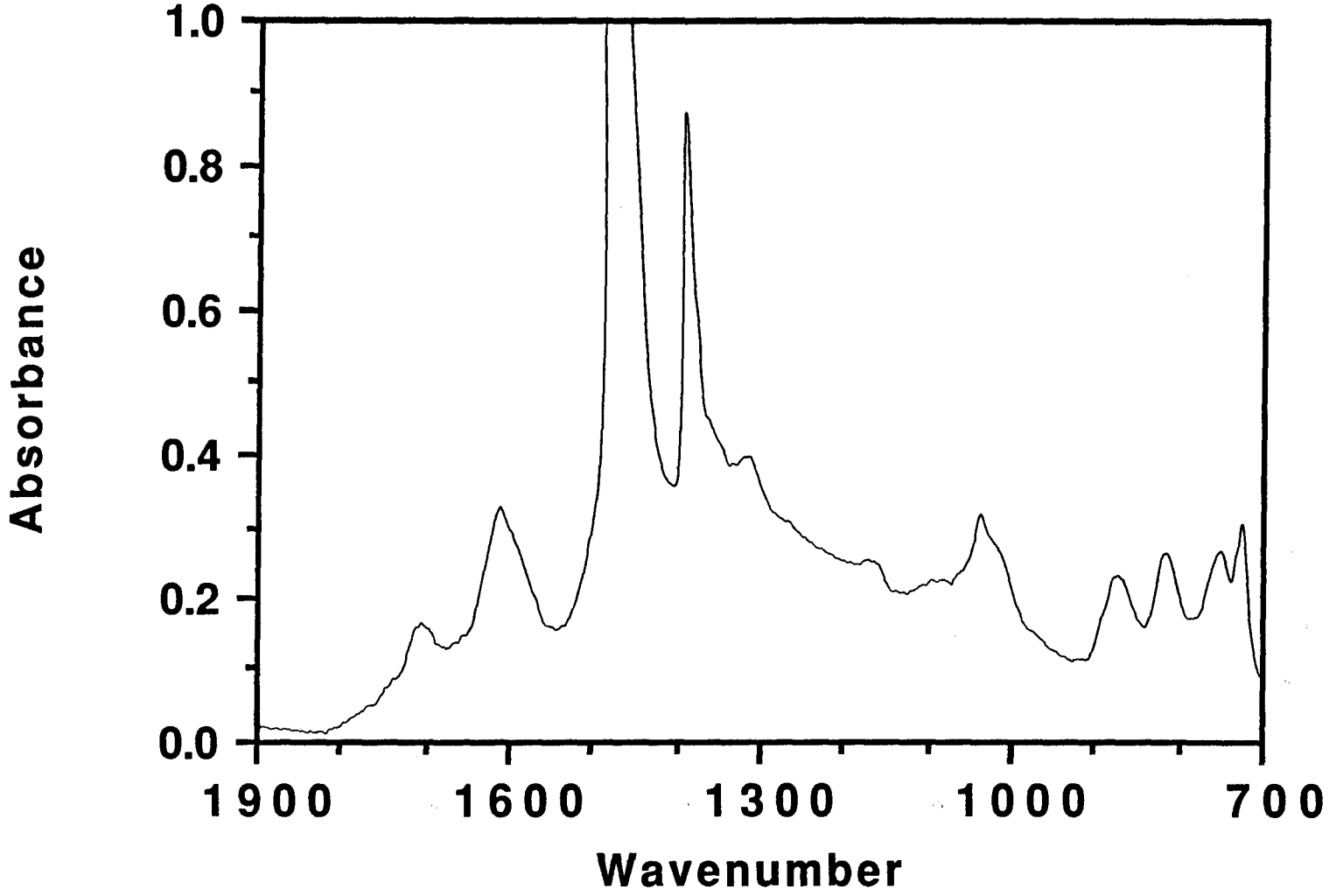

Figure C-40
FT-IR Spectra (KBr Method)-1987 Lufkin MacMillan AC-20

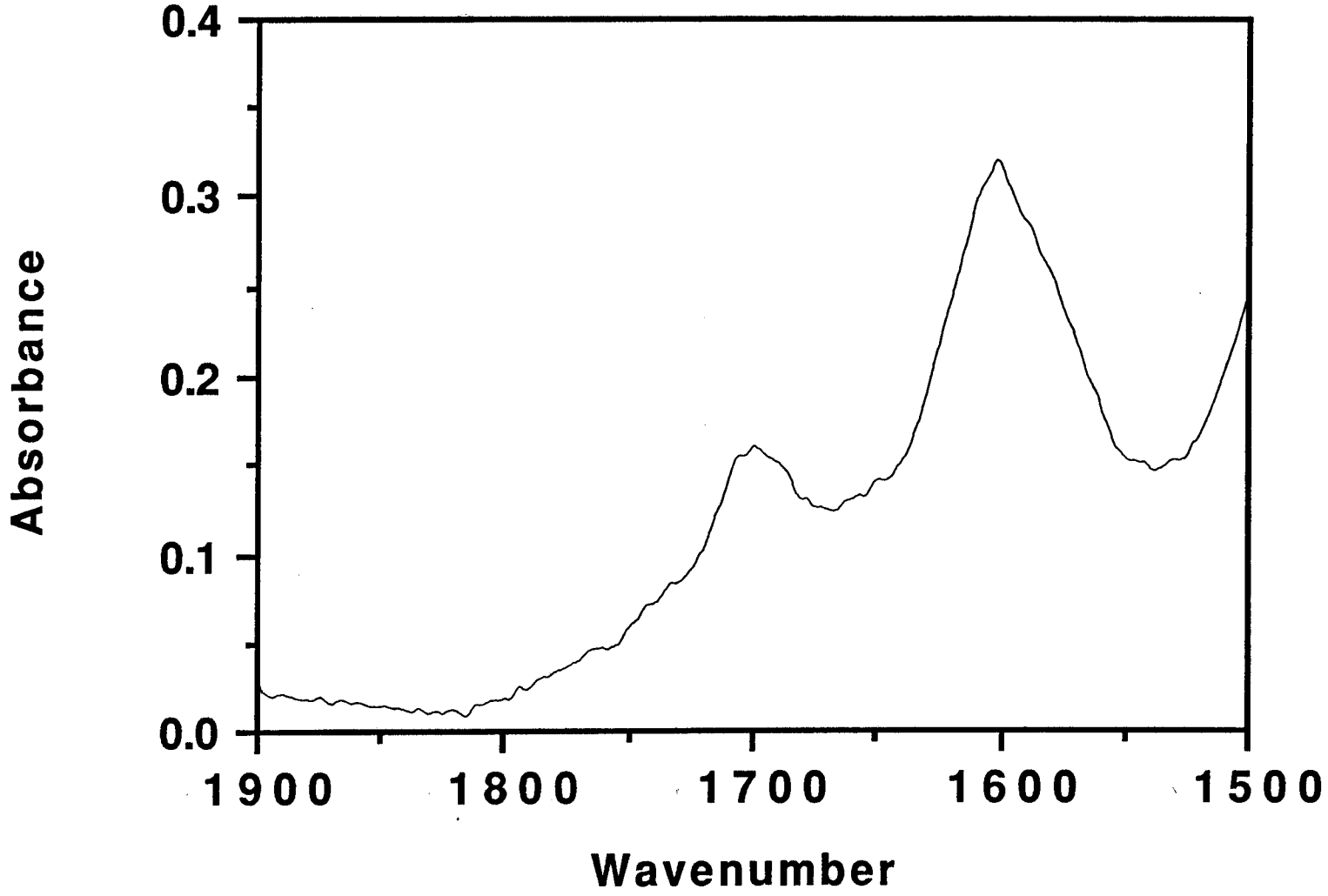

Figure C-41
FT-IR Spectra (KBr Method) Carbonyl Region-1987 Lufkin
MacMillan AC-20

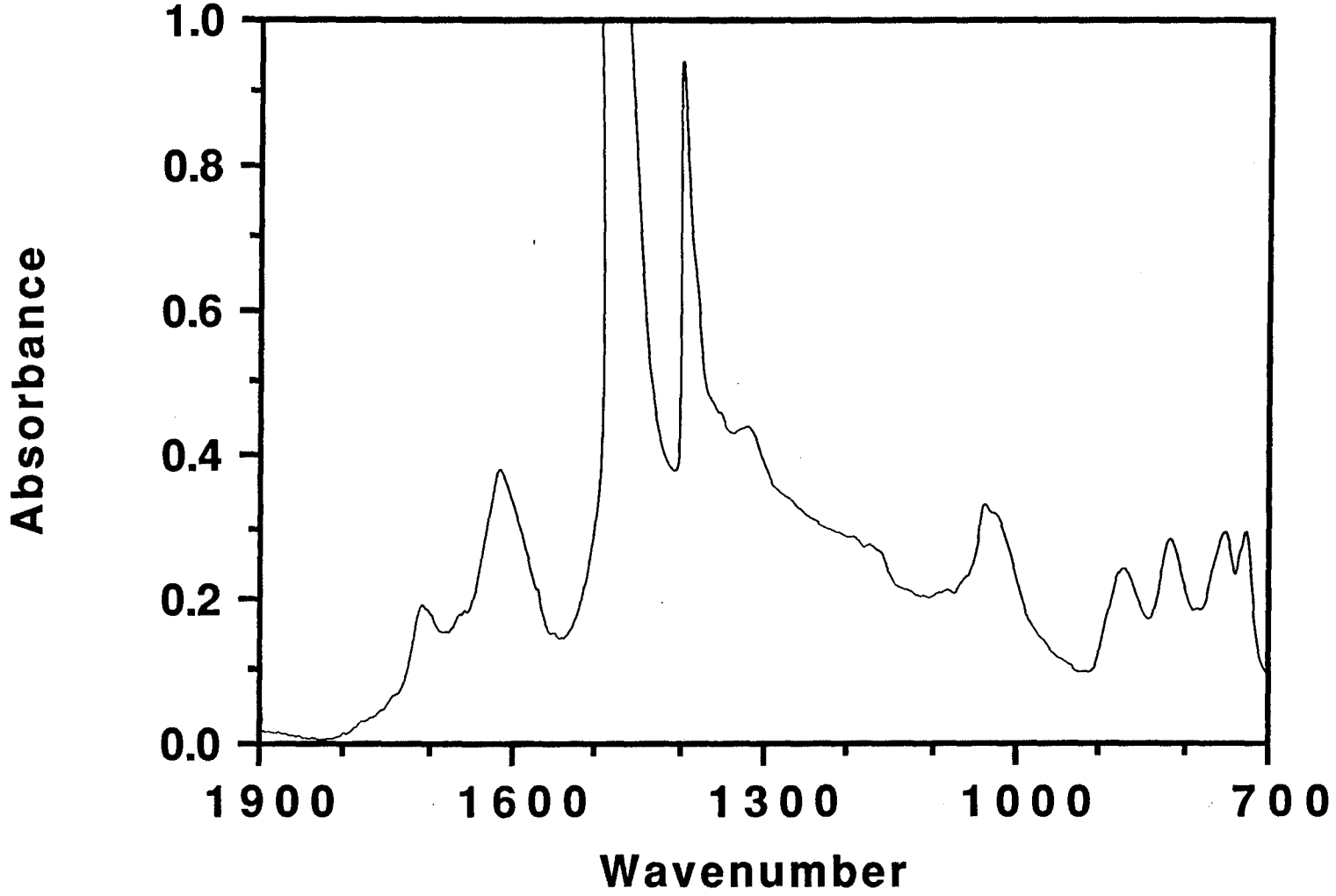

Figure C-42
FT-IR Spectra (KBr Method)-1987 Lufkin Cosden AC-20

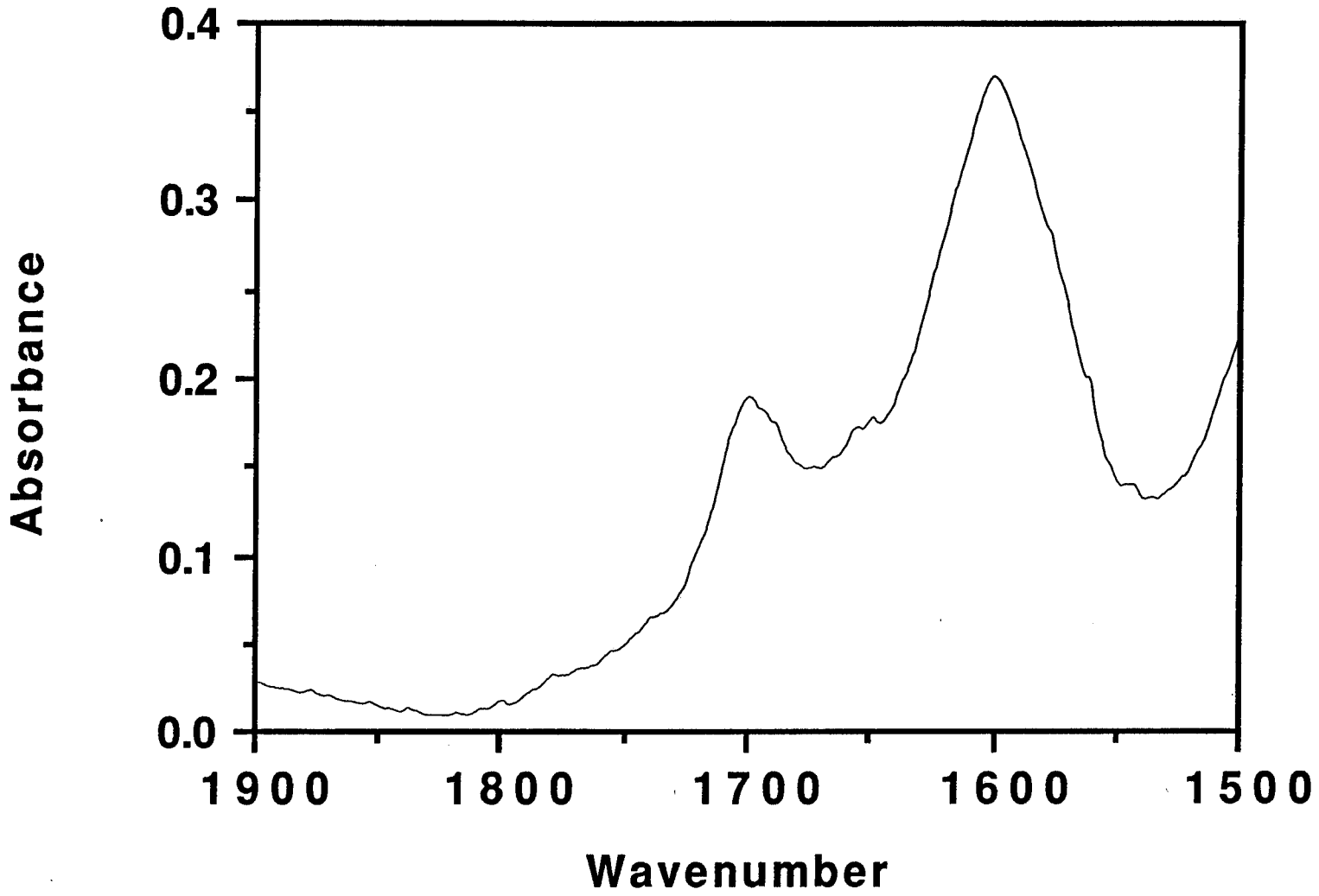

Figure C-43
FT-IR Spectra (KBr Method) Carbonyl Region-1987 Lufkin
Cosden AC-20

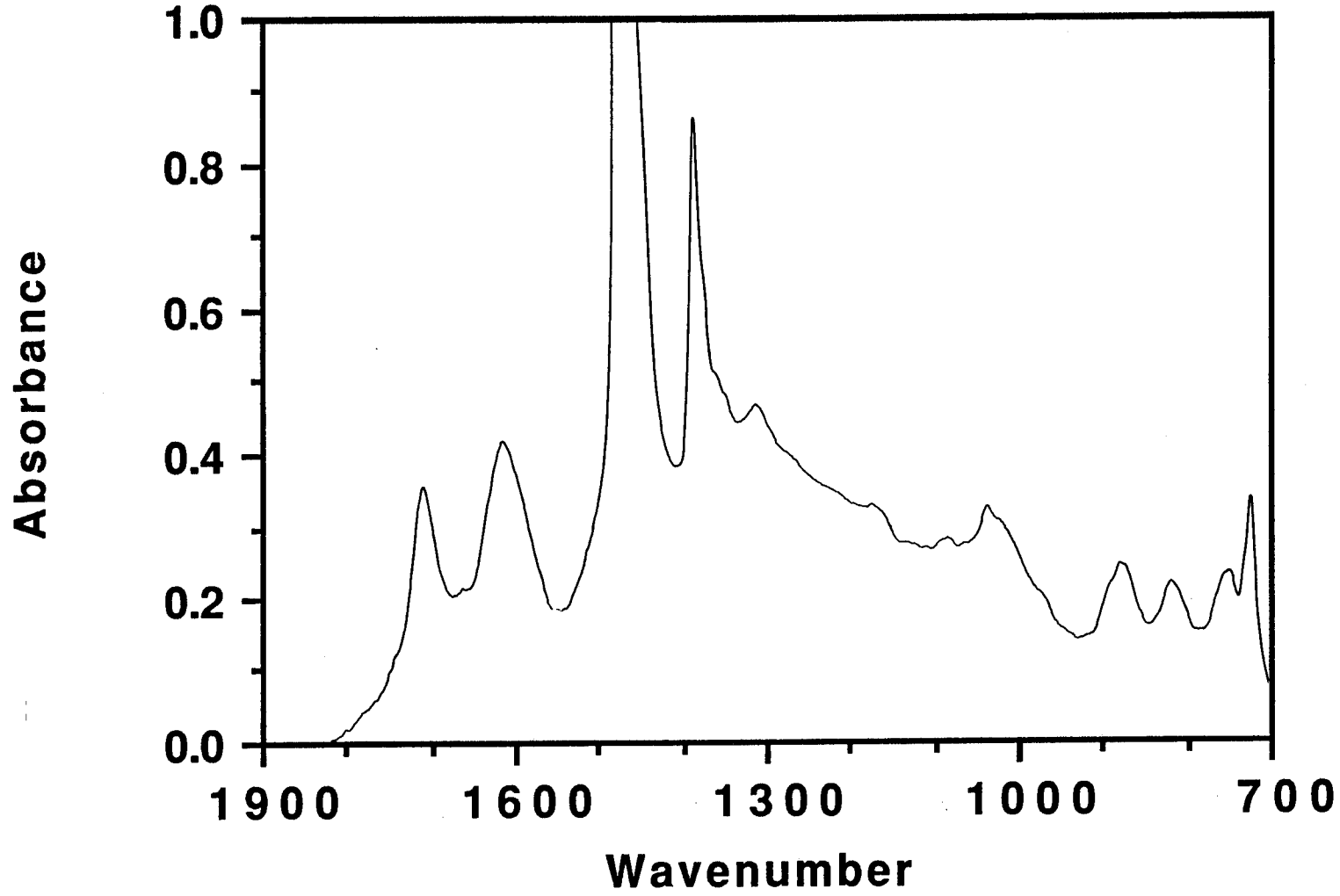

Figure C-44
FT-IR Spectra (KBr Method)-1987 Lufkin Diamond Shamrock AC-20

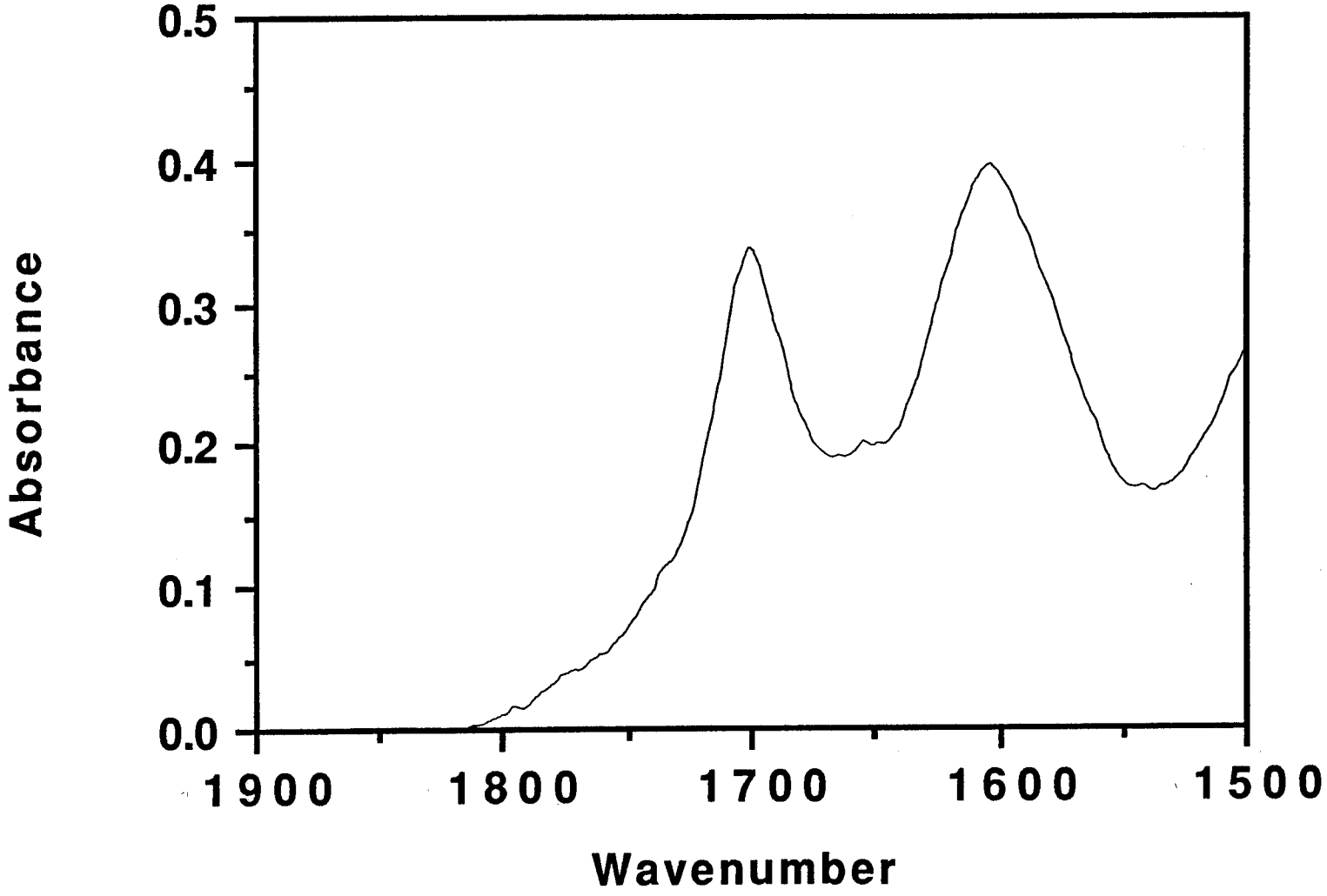

Figure C-45
FT-IR Spectra (KBr Method) Carbonyl Region-1987 Lufkin
Diamond Shamrock AC-20

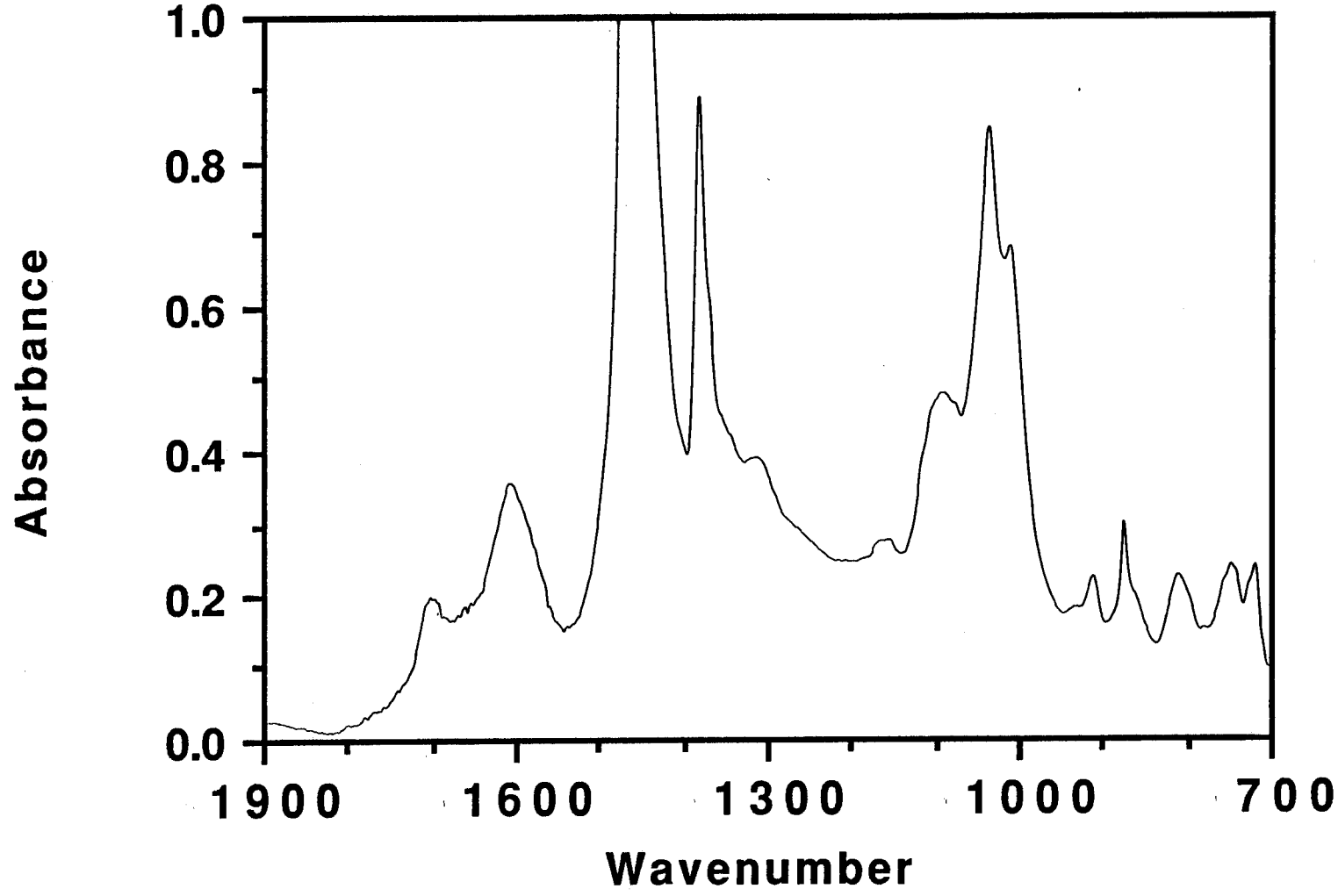

Figure C-46
FT-IR Spectra (KBr Method)-1987 Lufkin Texaco AC-20

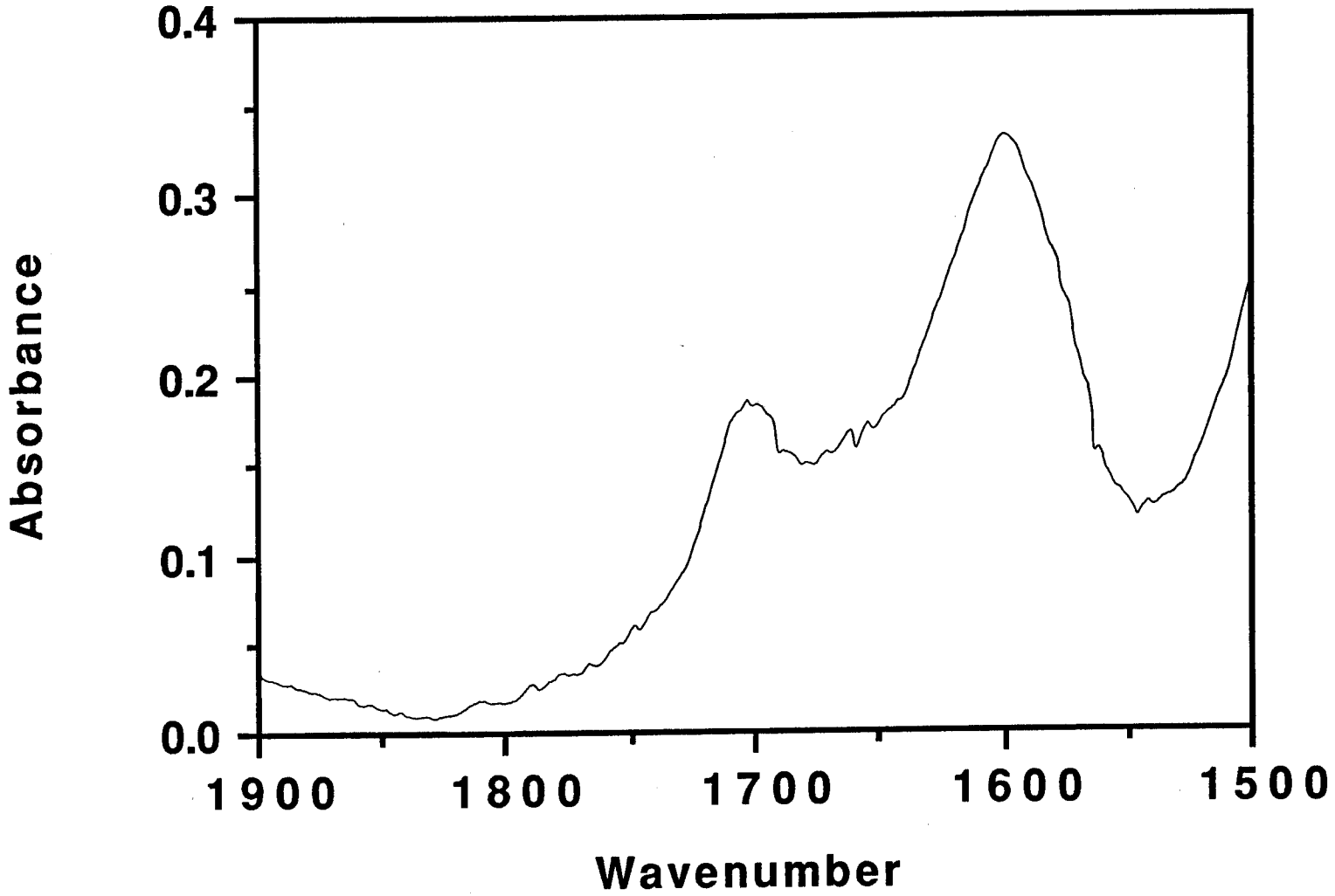

Figure C-47
FT-IR Spectra (KBr Method) Carbonyl Region-1987 Lufkin
Texaco AC-20

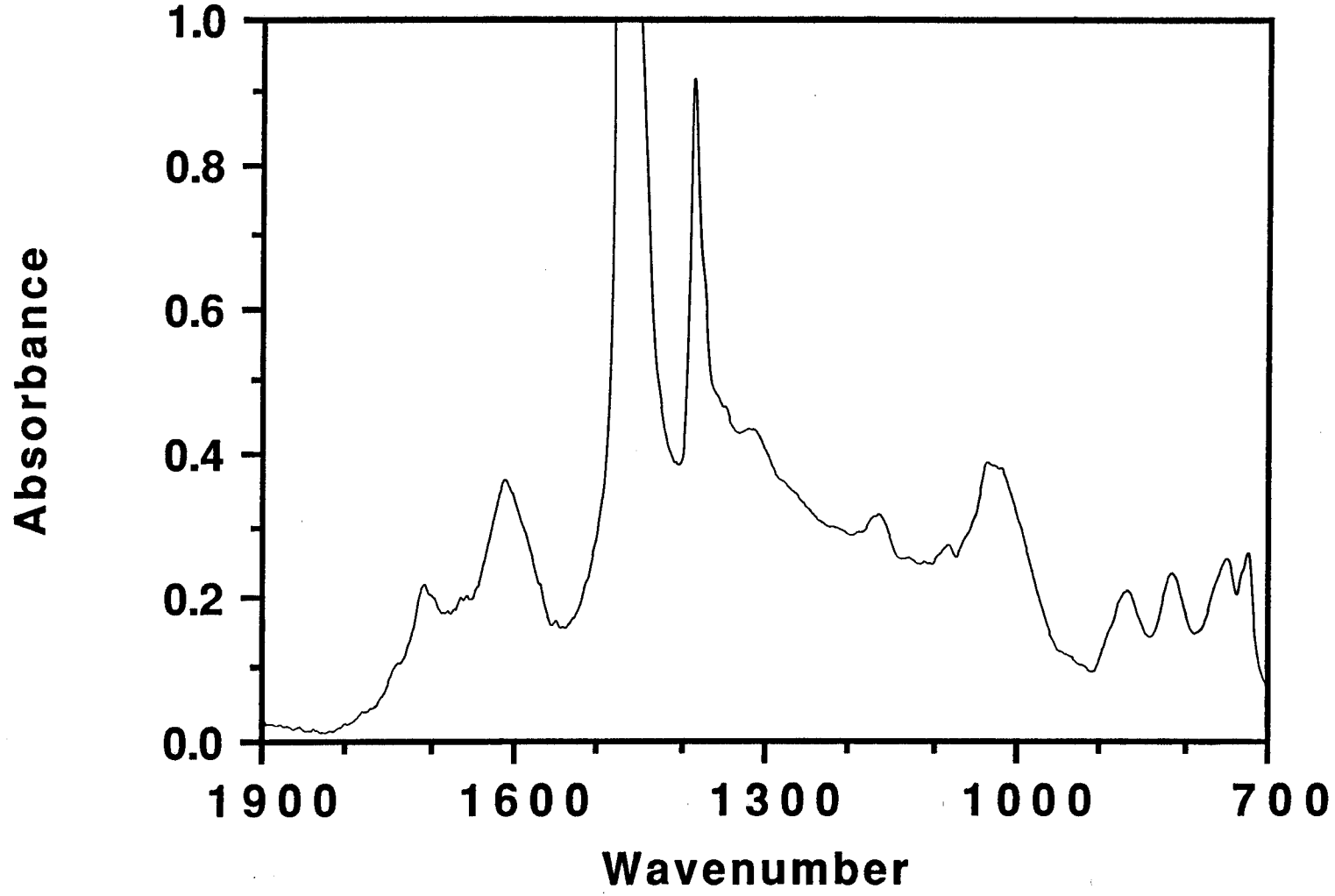

Figure C-48
FT-IR Spectra (KBr Method)-1987 Lufkin Exxon AC-20

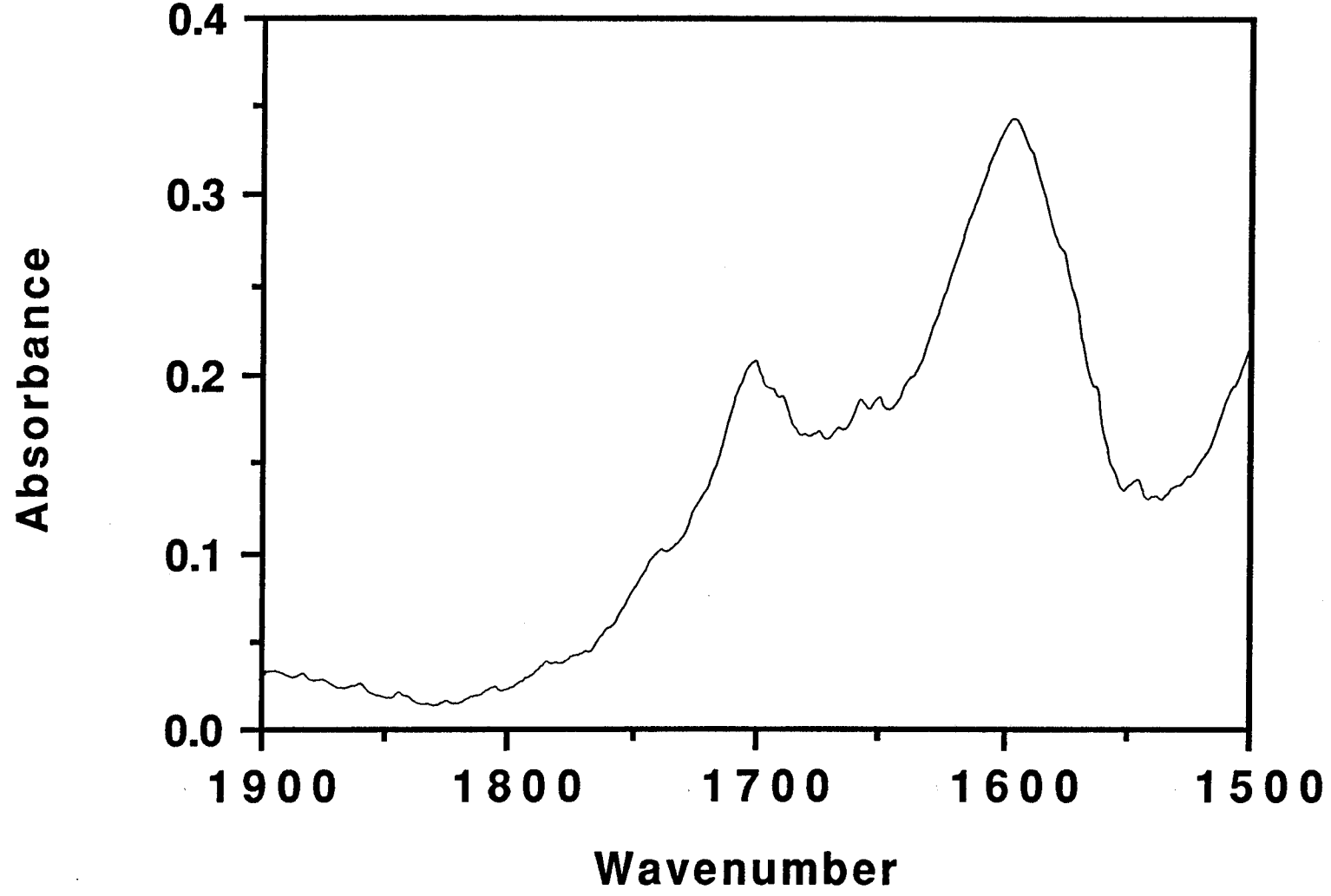

Figure C-49
FT-IR Spectra (KBr Method) Carbonyl Region-1987 Exxon AC-20

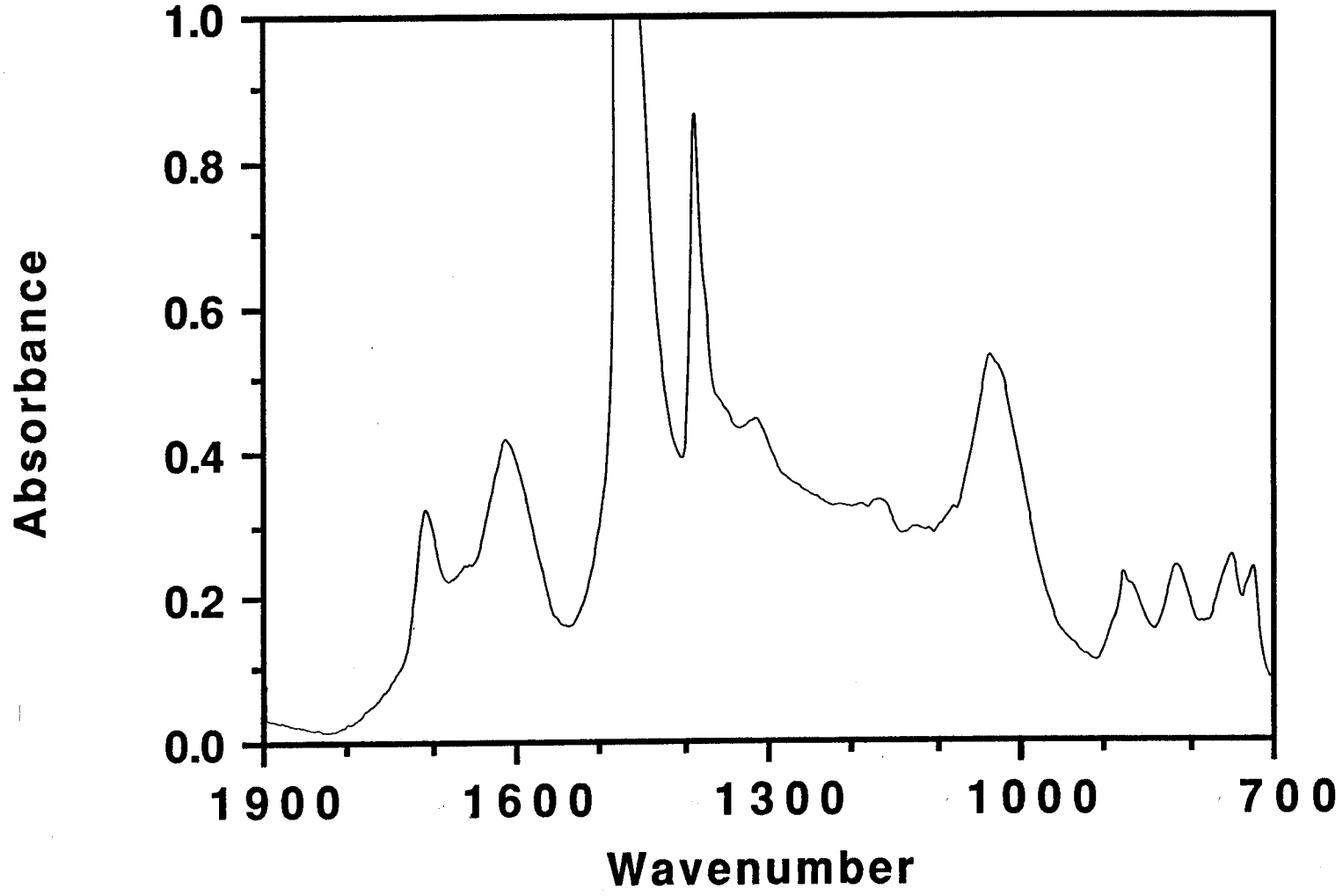

Figure C-50
FT-IR Spectra (KBr Method)-1987 South Texas U.S. 77 mp 16

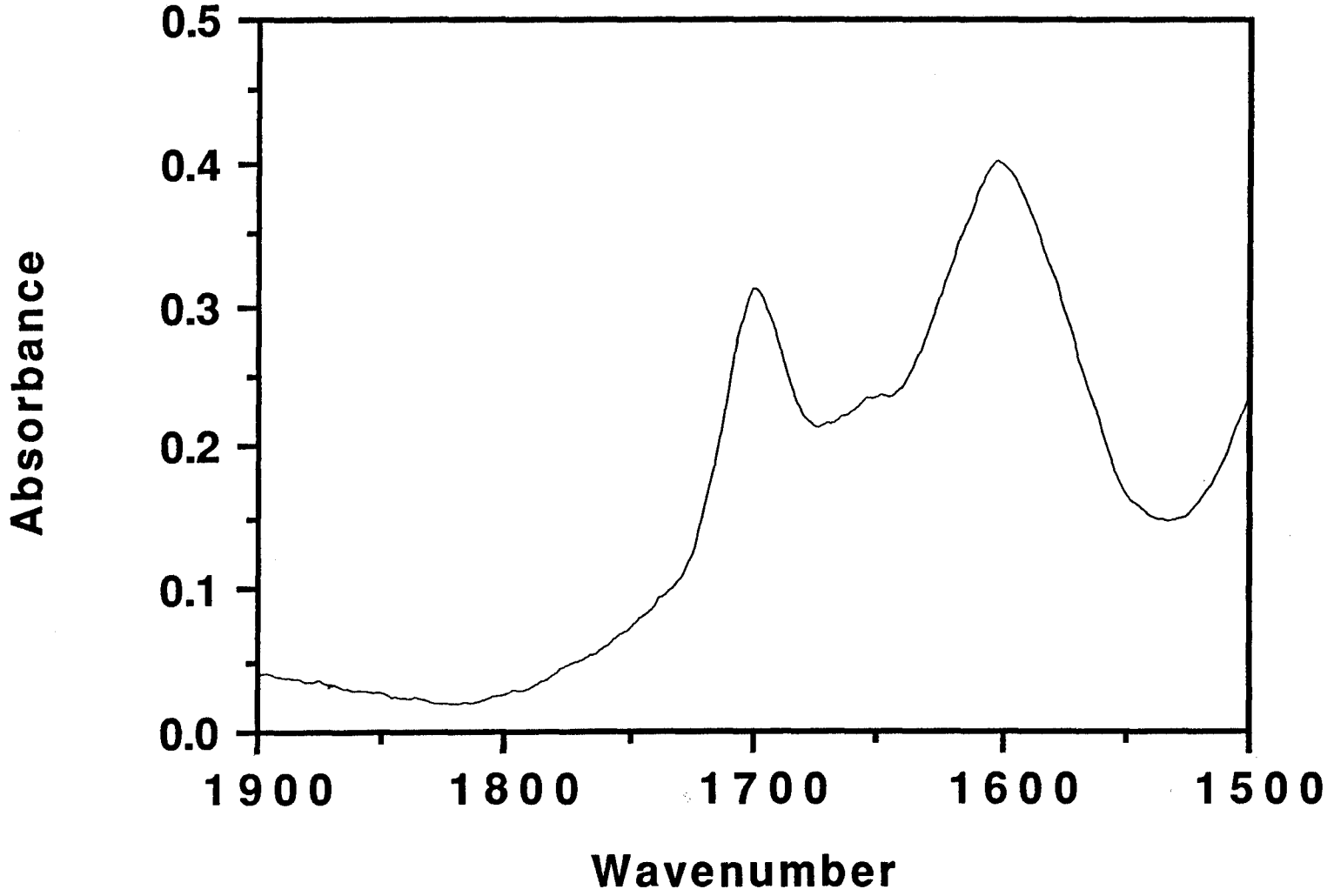

Figure C-51
FT-IR Spectra (KBr Method) Carbonyl Region-1987 South Texas
U.S. 77 mp 16

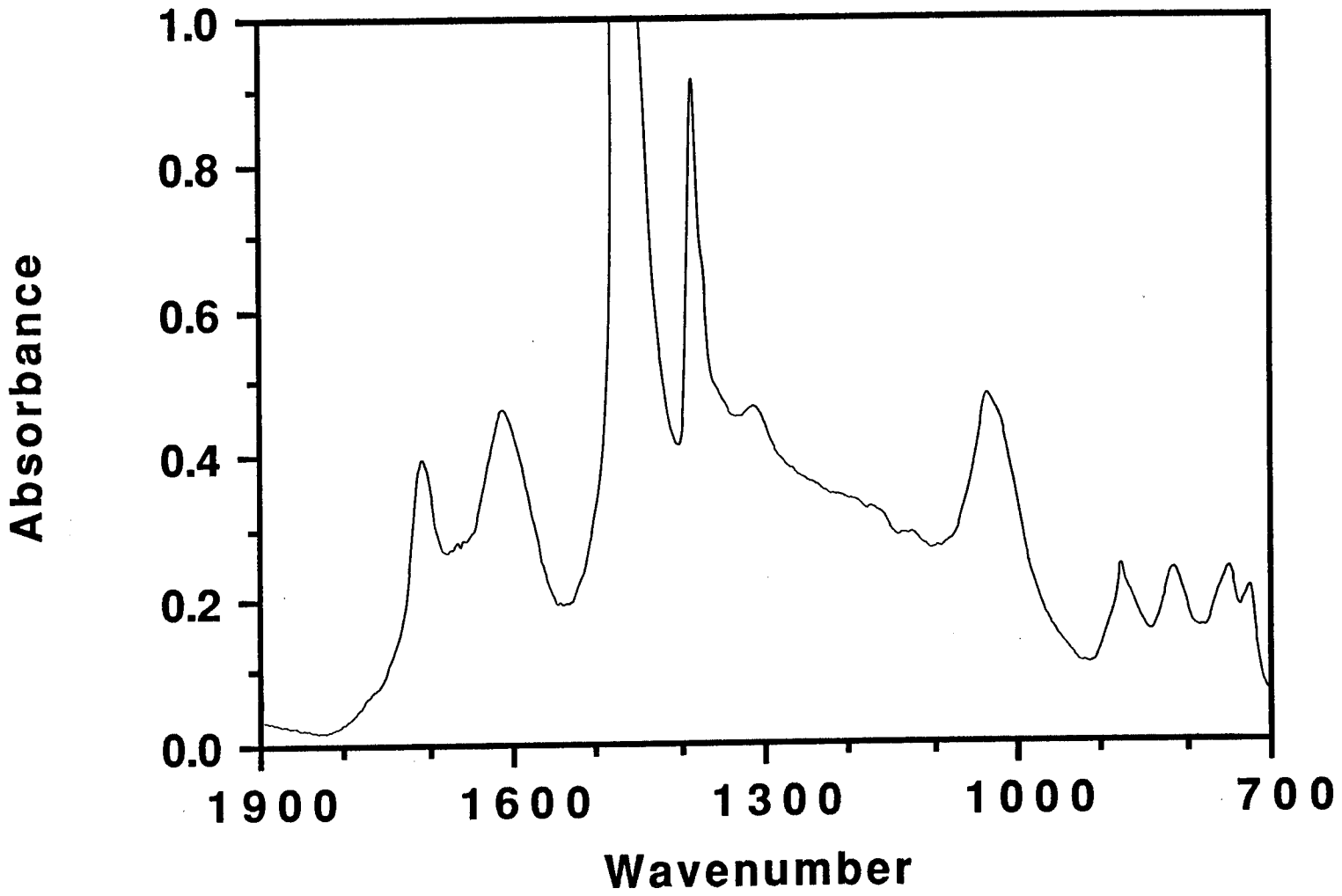

Figure C-52
FT-IR Spectra (KBr Method)-1987 South Texas FM 2925 mp 12

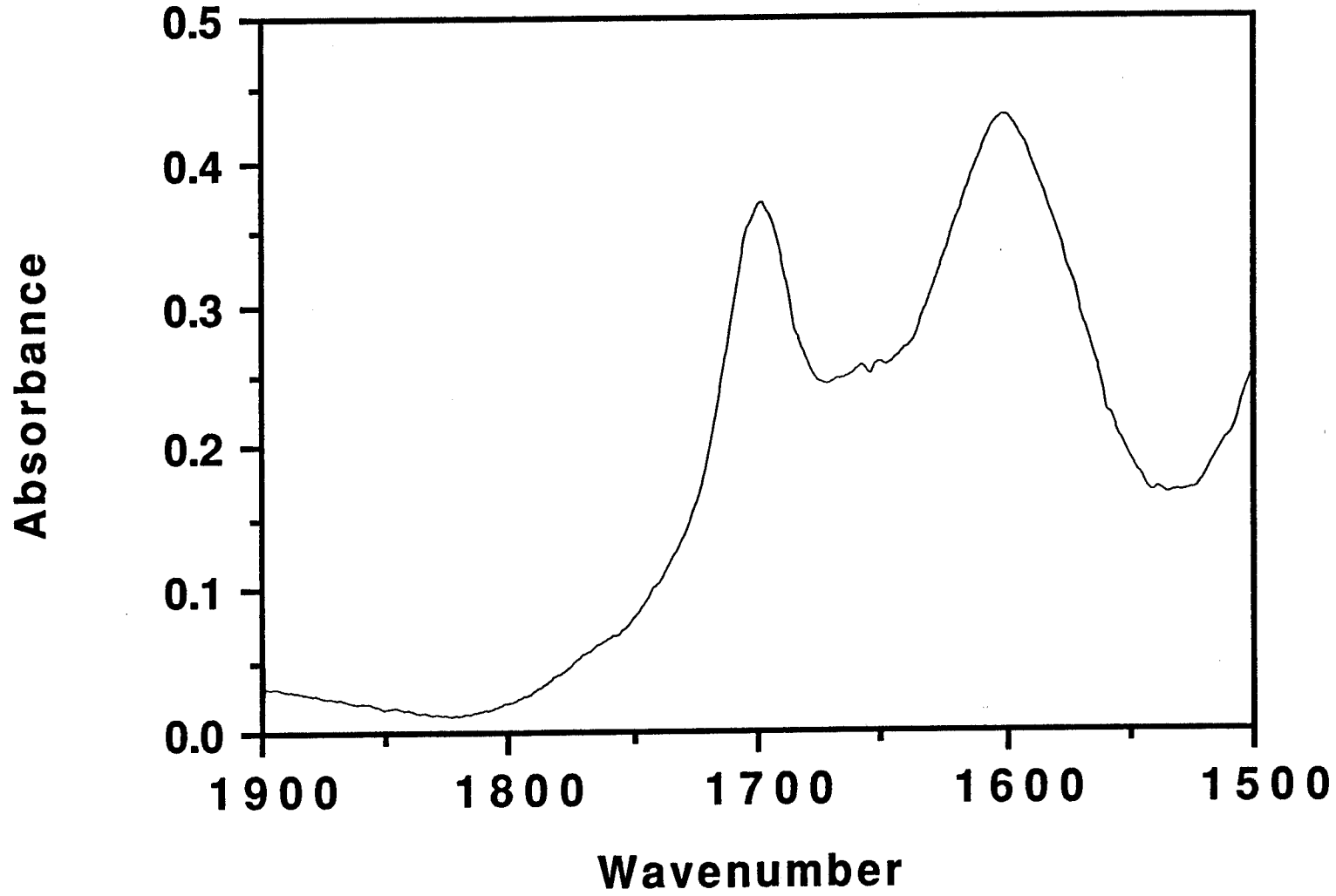

Figure C-53
FT-IR Spectra (KBr Method) Carbonyl Region-1987 South Texas FM 2925 mp 12

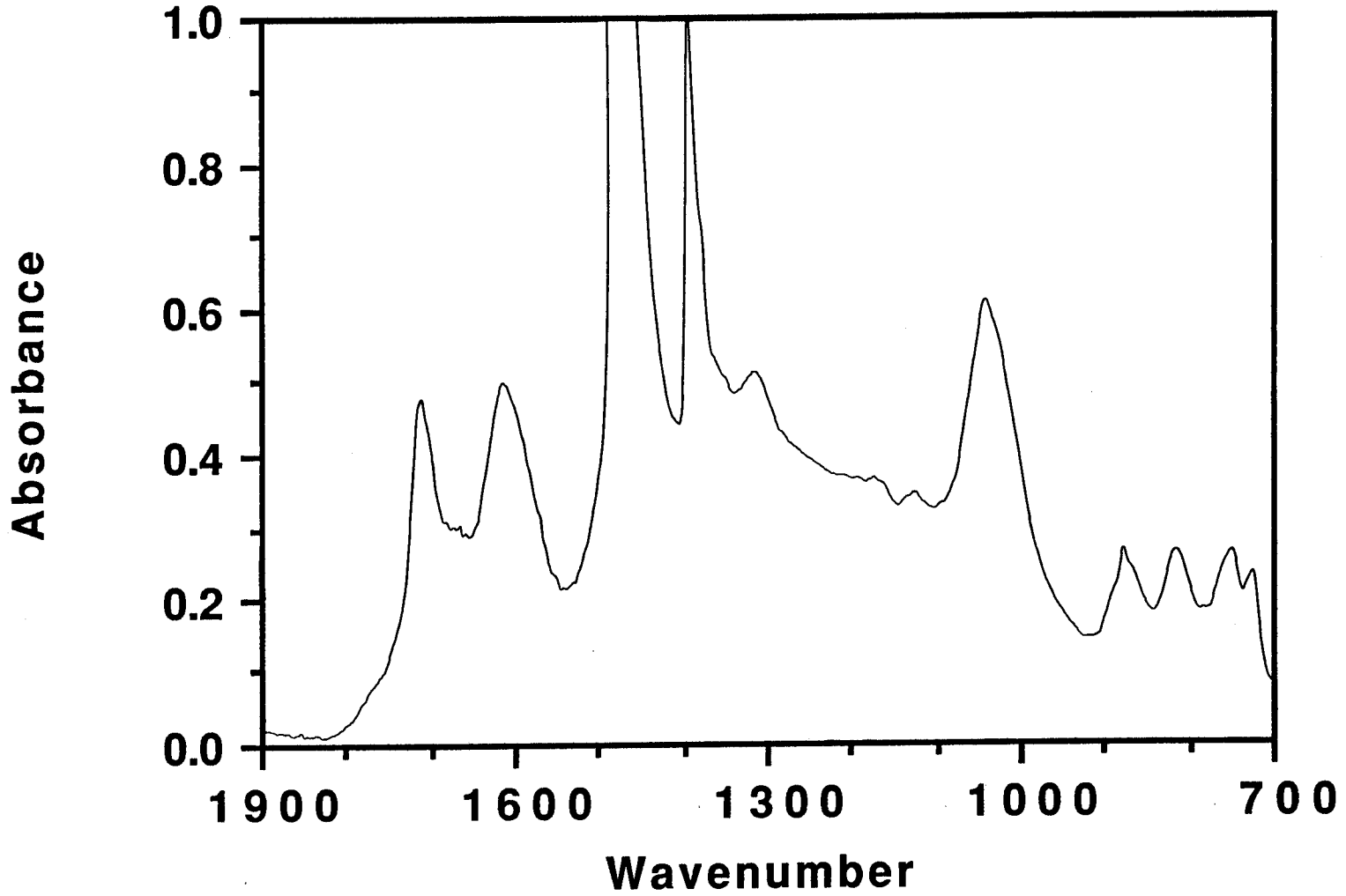

Figure C-54
FT-IR Spectra (KBr Method)-1987 South Texas SH 186 mp 25

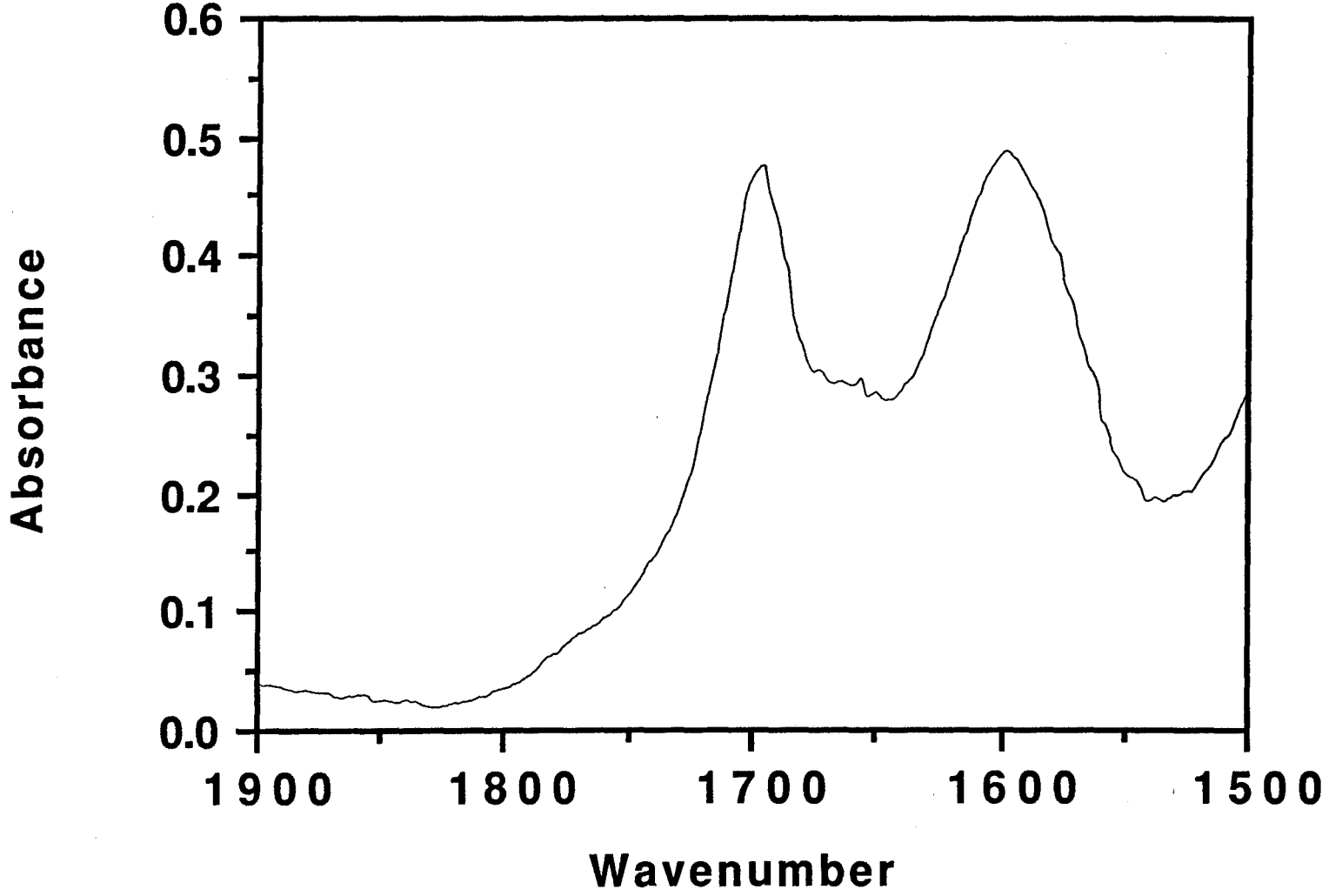

Figure C-55
FT-IR Spectra (KBr Method) Carbonyl Region-1987 South Texas
SH 186 mp 25

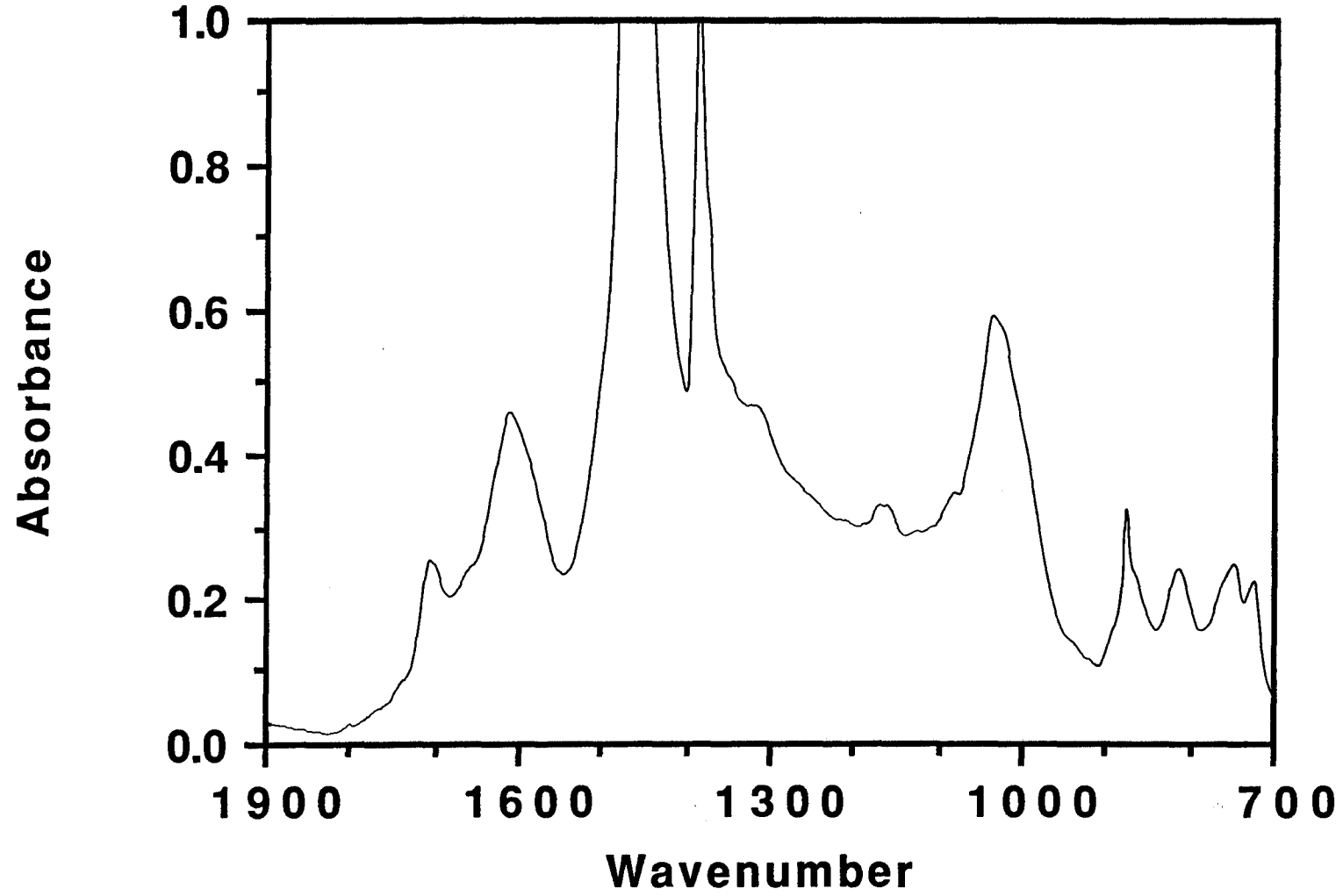

Figure C-56
FT-IR Spectra (KBr Method)-1987 South Texas U.S. 77 mp 27

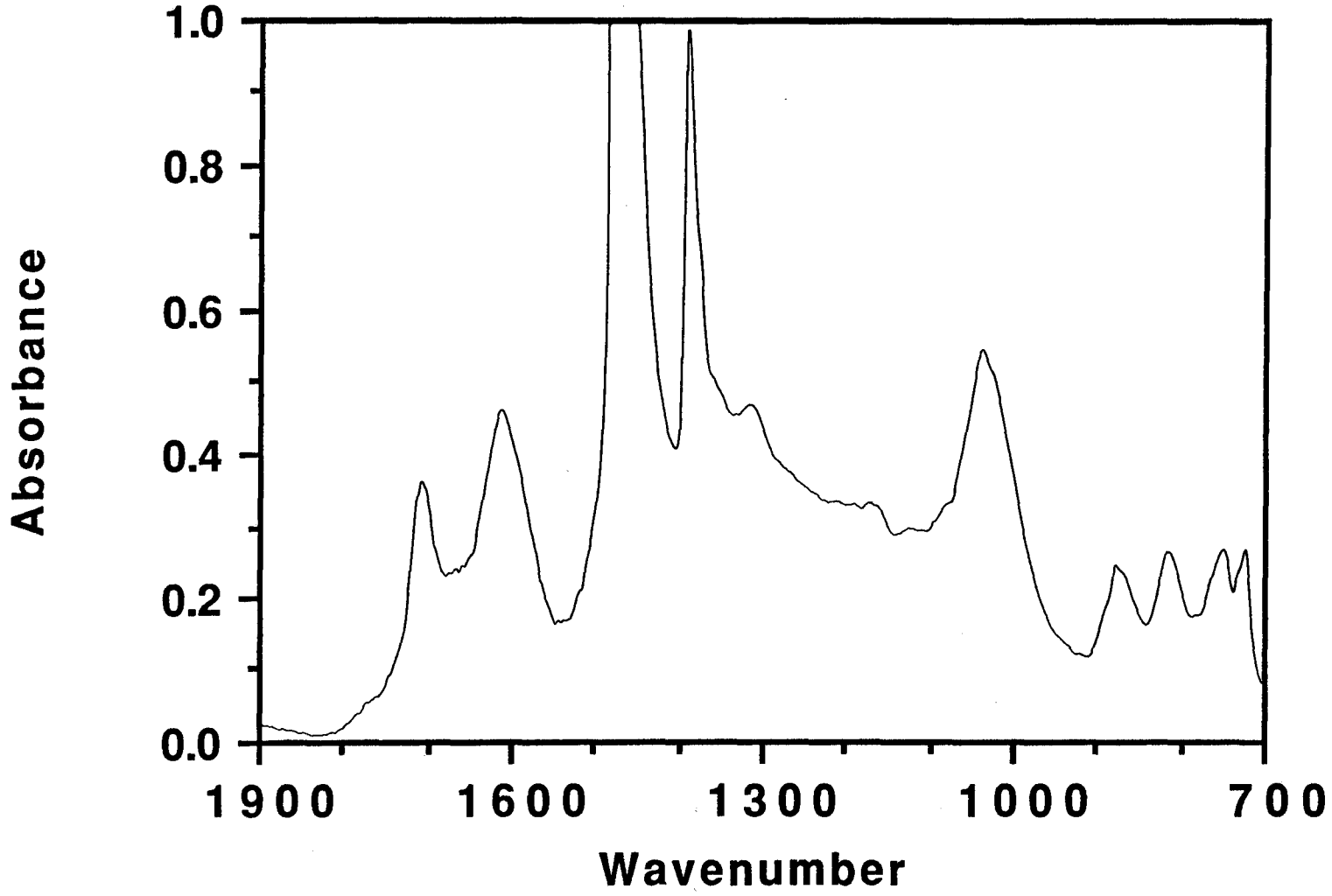

Figure C-57
FT-IR Spectra (KBr Method) Carbonyl Region-1987 South Texas
U.S. 77 mp 27

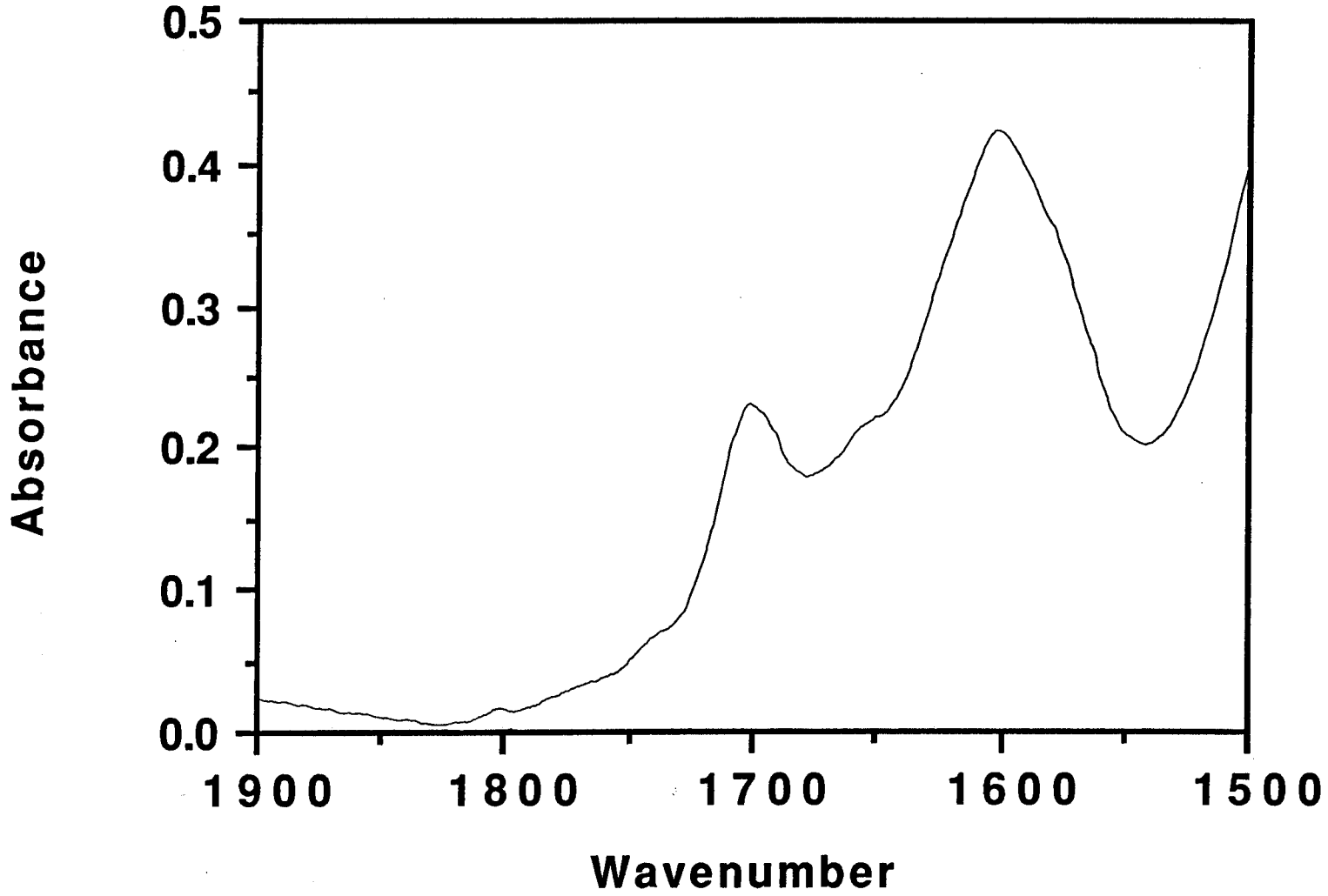

Figure C-58
FT-IR Spectra (KBr Method) 1987 South Texas U.S. 281 mp 37

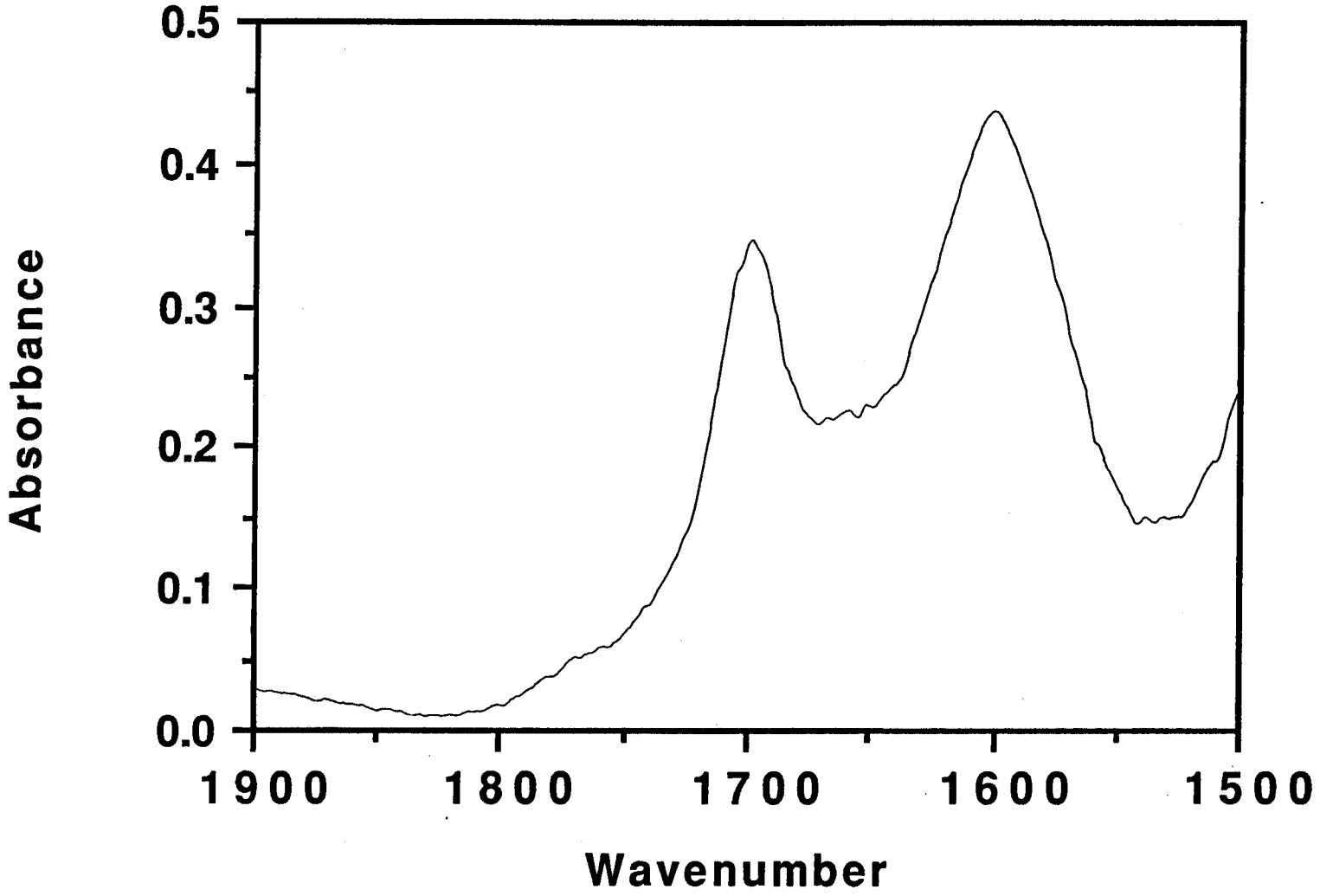

Figure C-59
FT-IR Spectra (KBr Method) Carbonyl Region-1987 South Texas
U.S. 281 mp 37

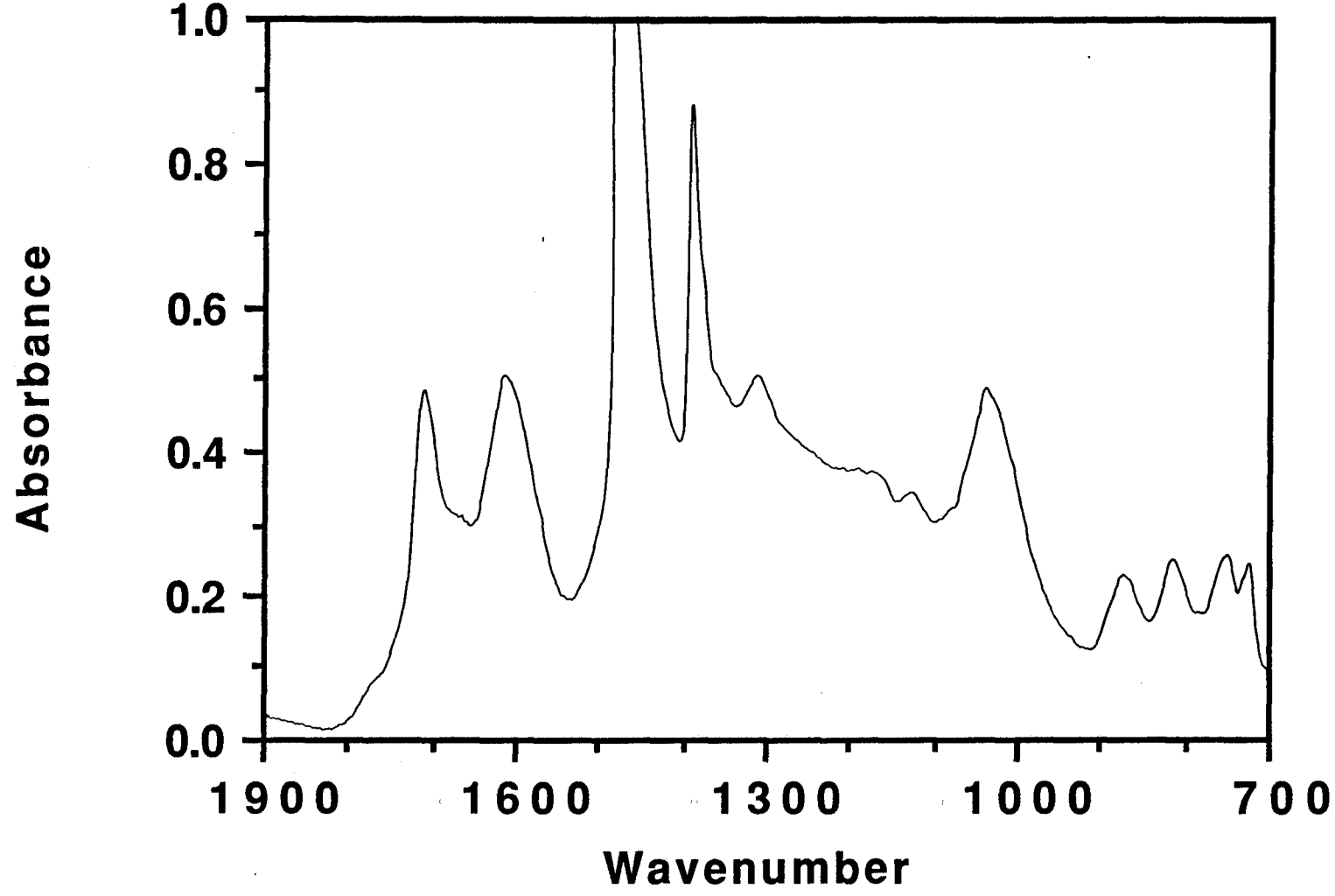

Figure C-60
FT-IR Spectra (KBr Method)-1987 South Texas SH 186 mp 36

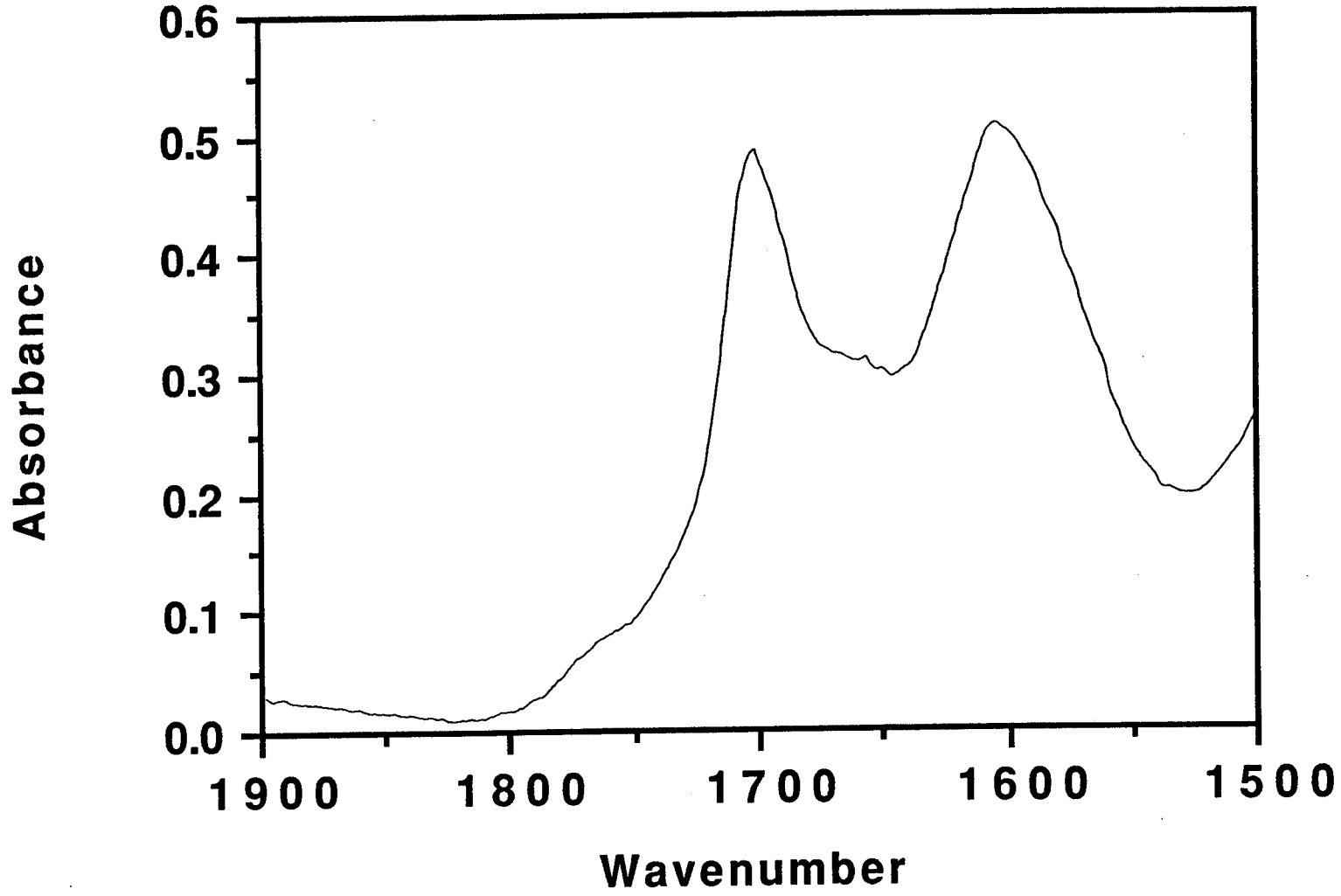

Figure C-61
FT-IR Spectra (KBr Method) Carbonyl Region-1987 South
Texas SH 186 mp 36

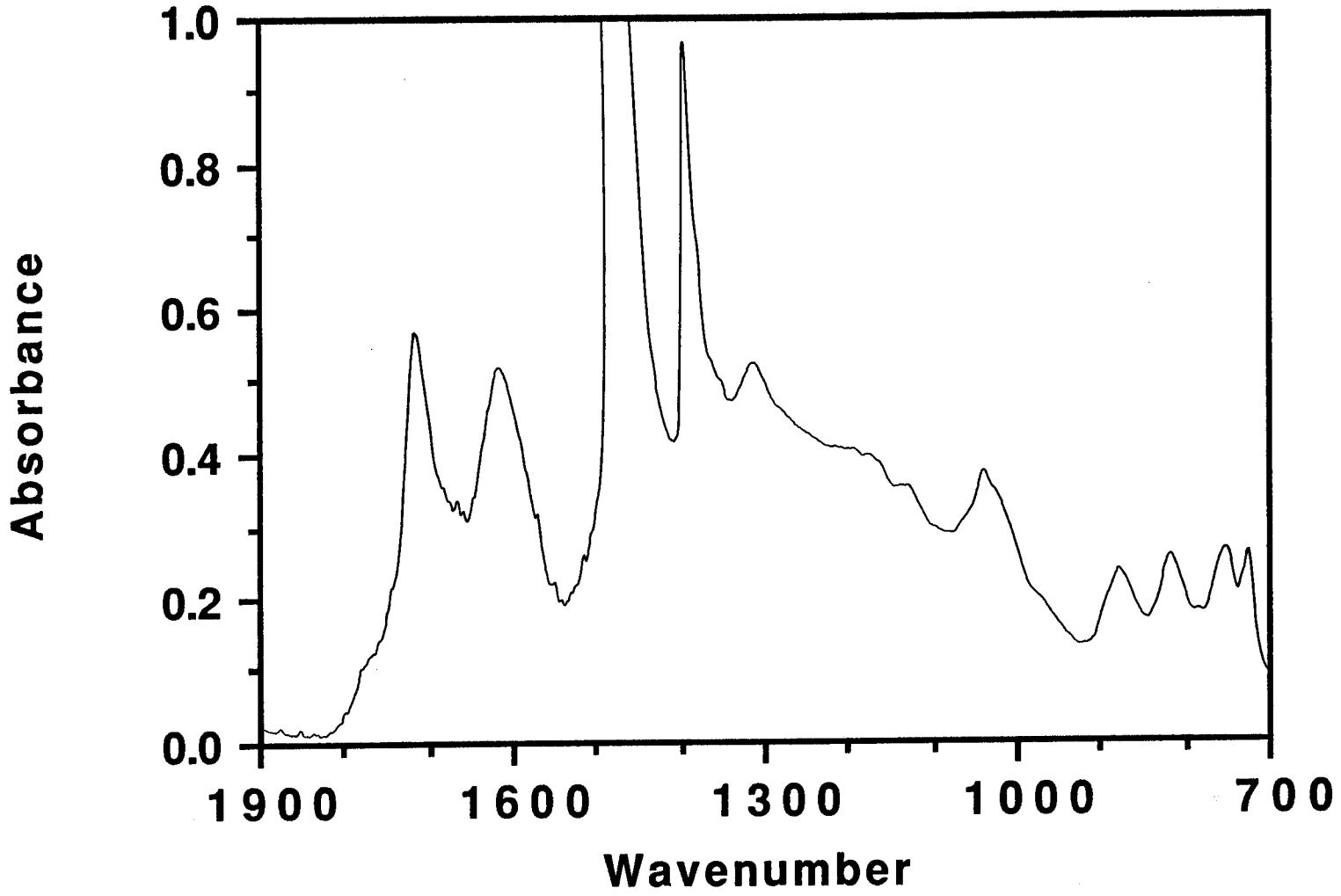

Figure C-62
FT-IR Spectra (KBr Method)-1987 South Texas FM 1017 mp 7

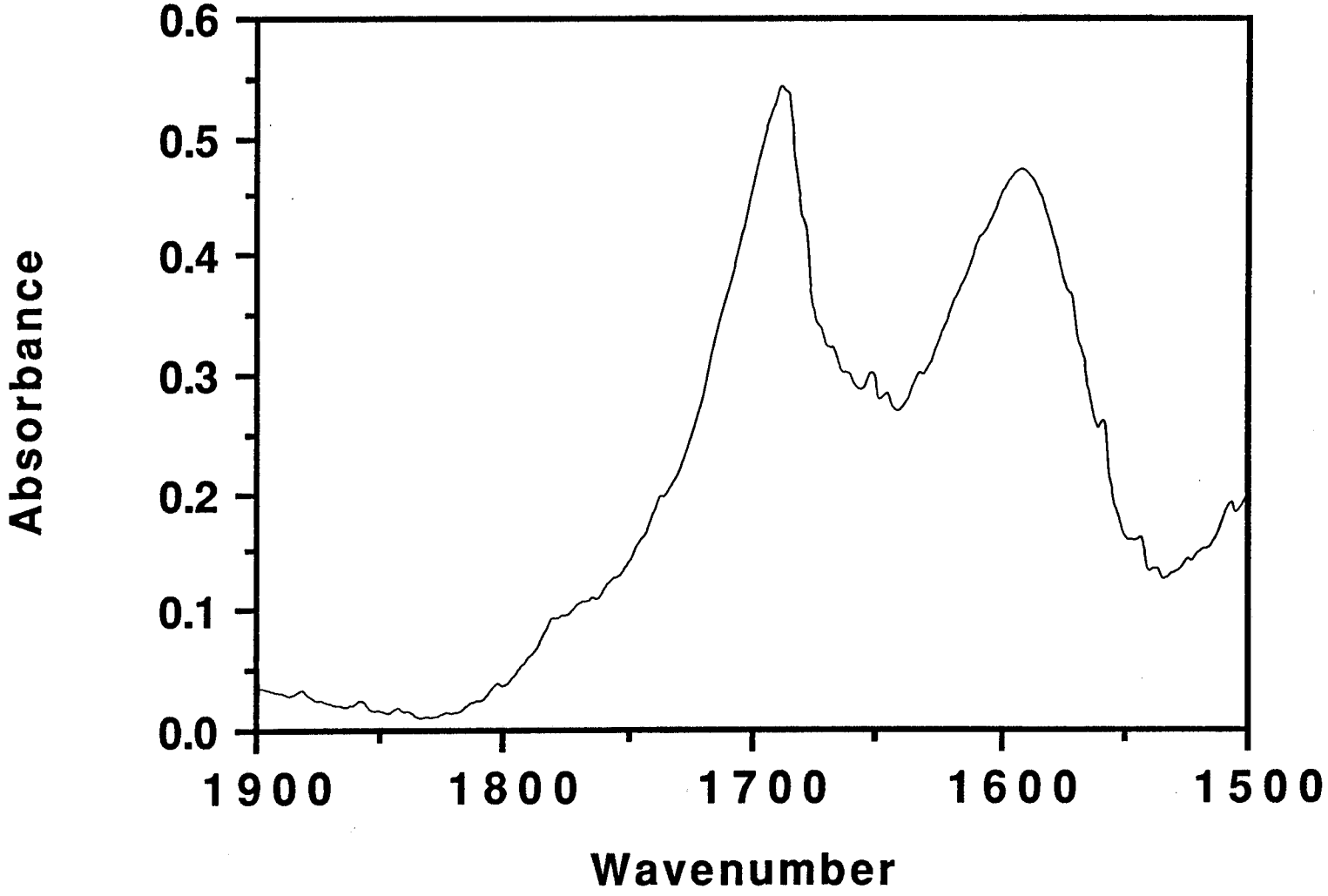

Figure C-63
FT-IR Spectra (KBr Method) Carbonyl Region-1987 South
Texas FM 1017 mp 7

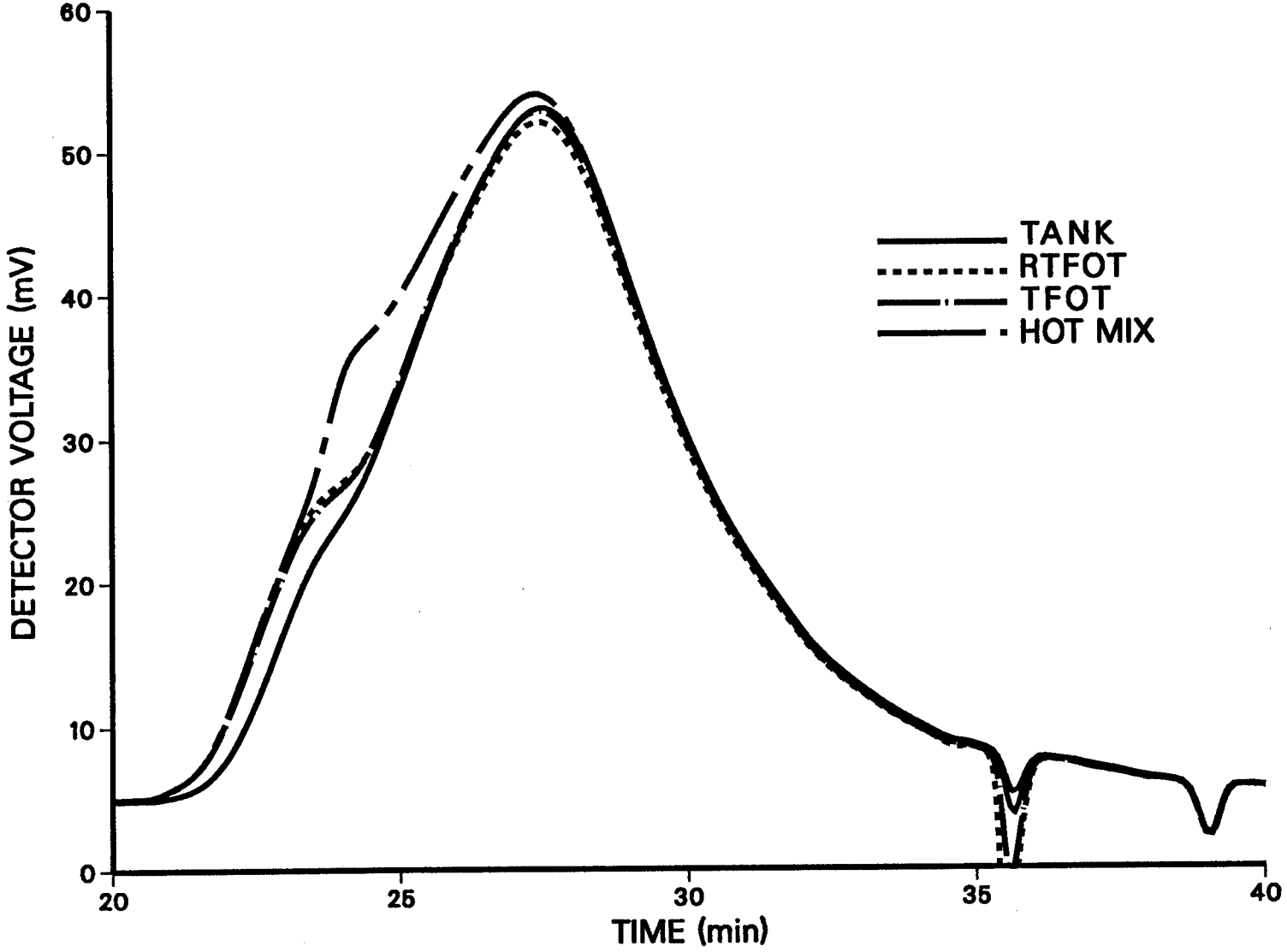

Figure C-64
GPC Chromatograms of Tank, RTFOT, TFOT and Hot-Mix
1989 Texas Gulf AC-20

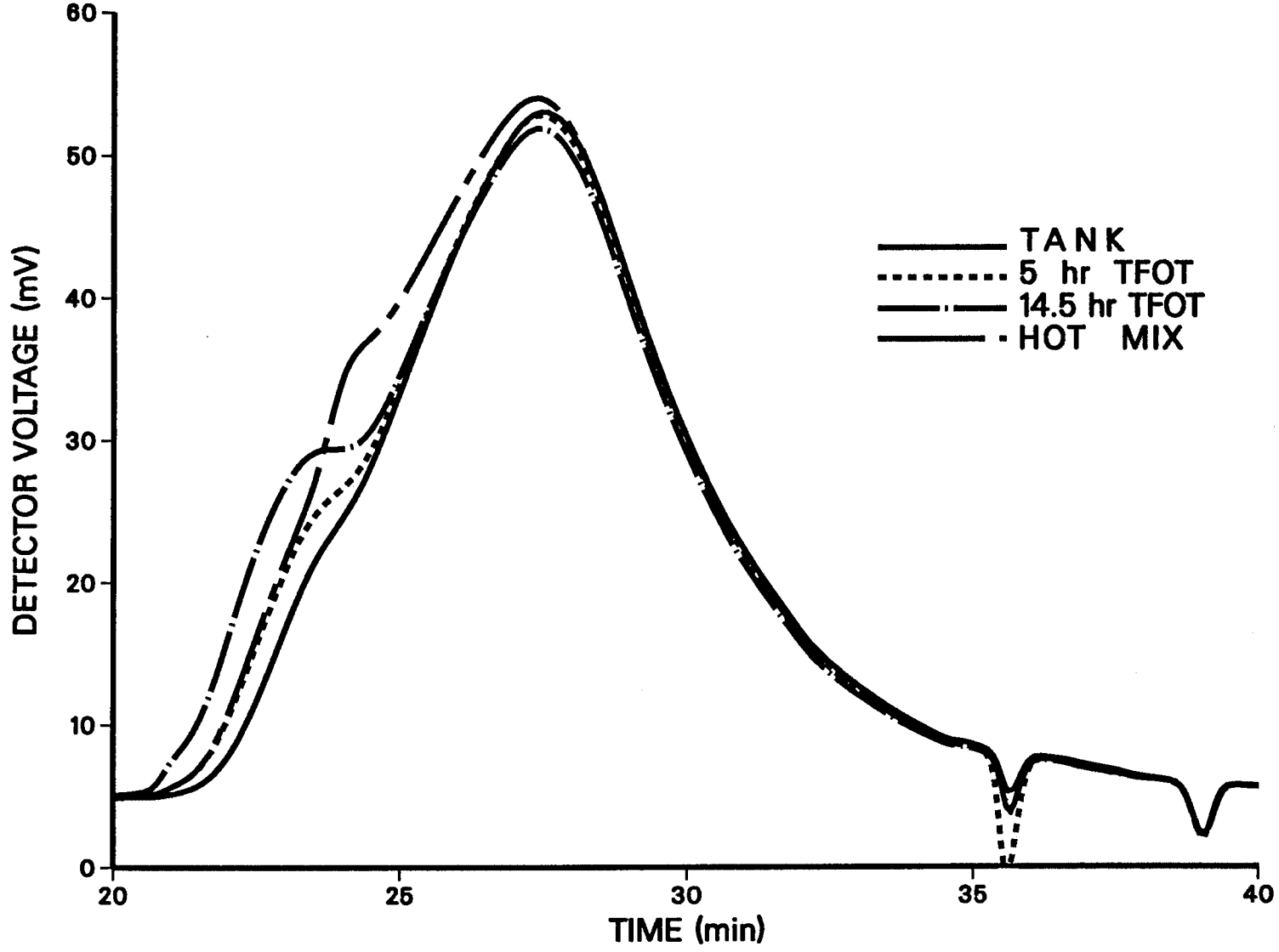

Figure C-65
GPC Chromatograms of Tank, 5 hr TFOT, 14.5 hr TFOT and Hot Mix
1989 Texas Gulf AC-20

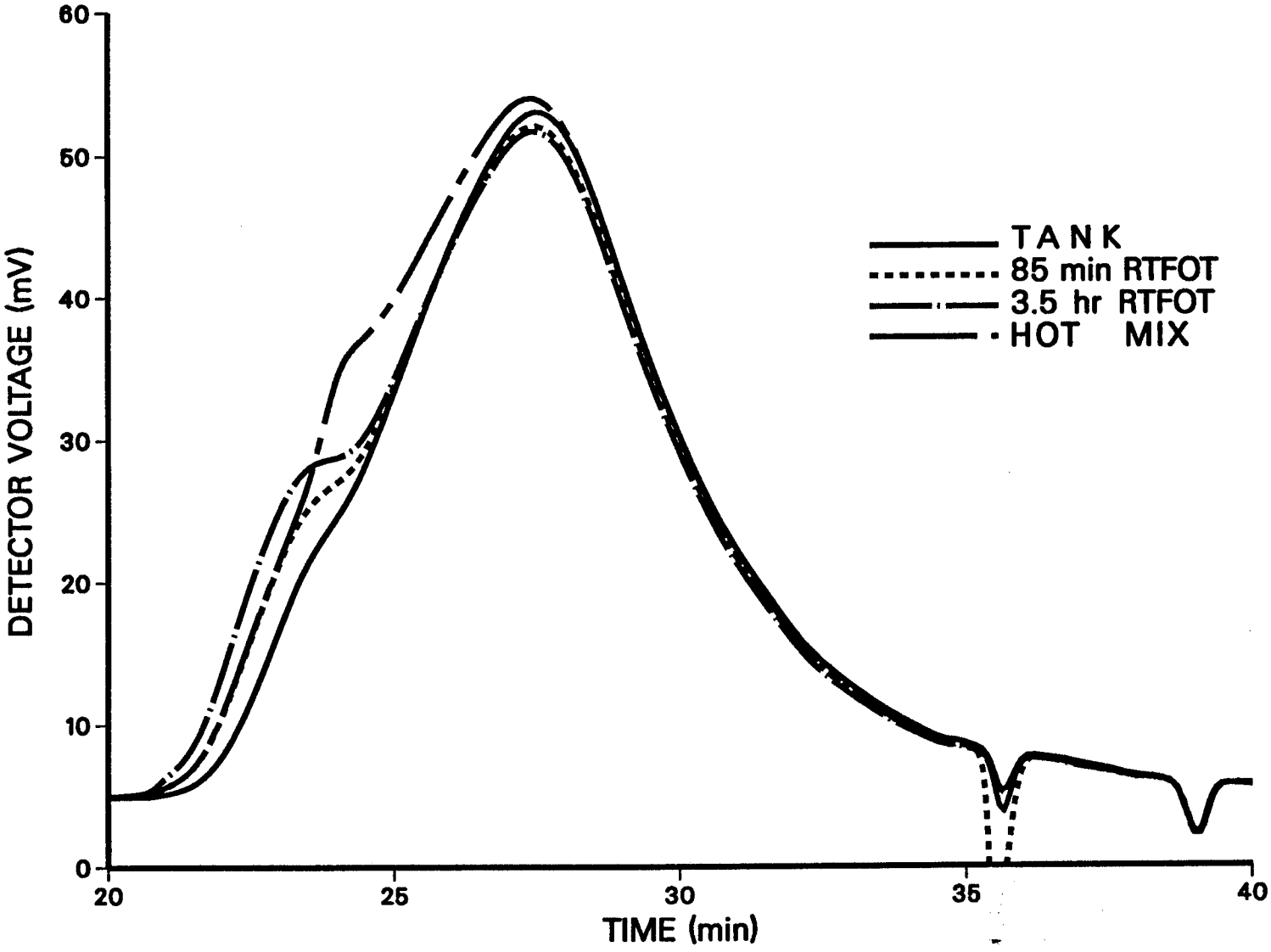

Figure C-66
GPC Chromatograms of Tank, 85 min RTFOT, 3.5 hr RTFOT and Hot Mix-1989 Texas Gulf AC-20

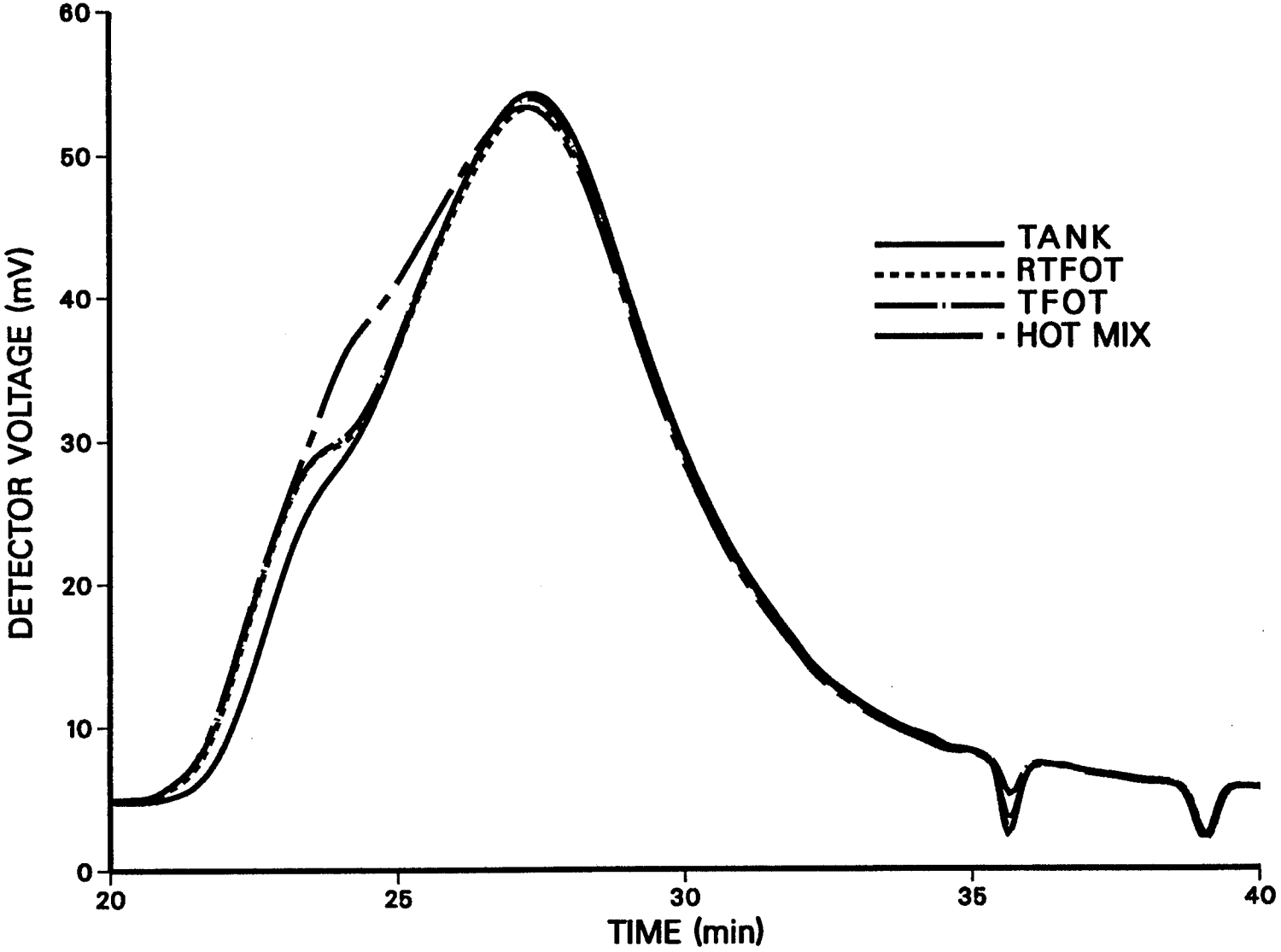

Figure C-67
GPC Chromatograms of Tank, RTFOT, TFOT and Hot Mix
1989 Texaco AC-20

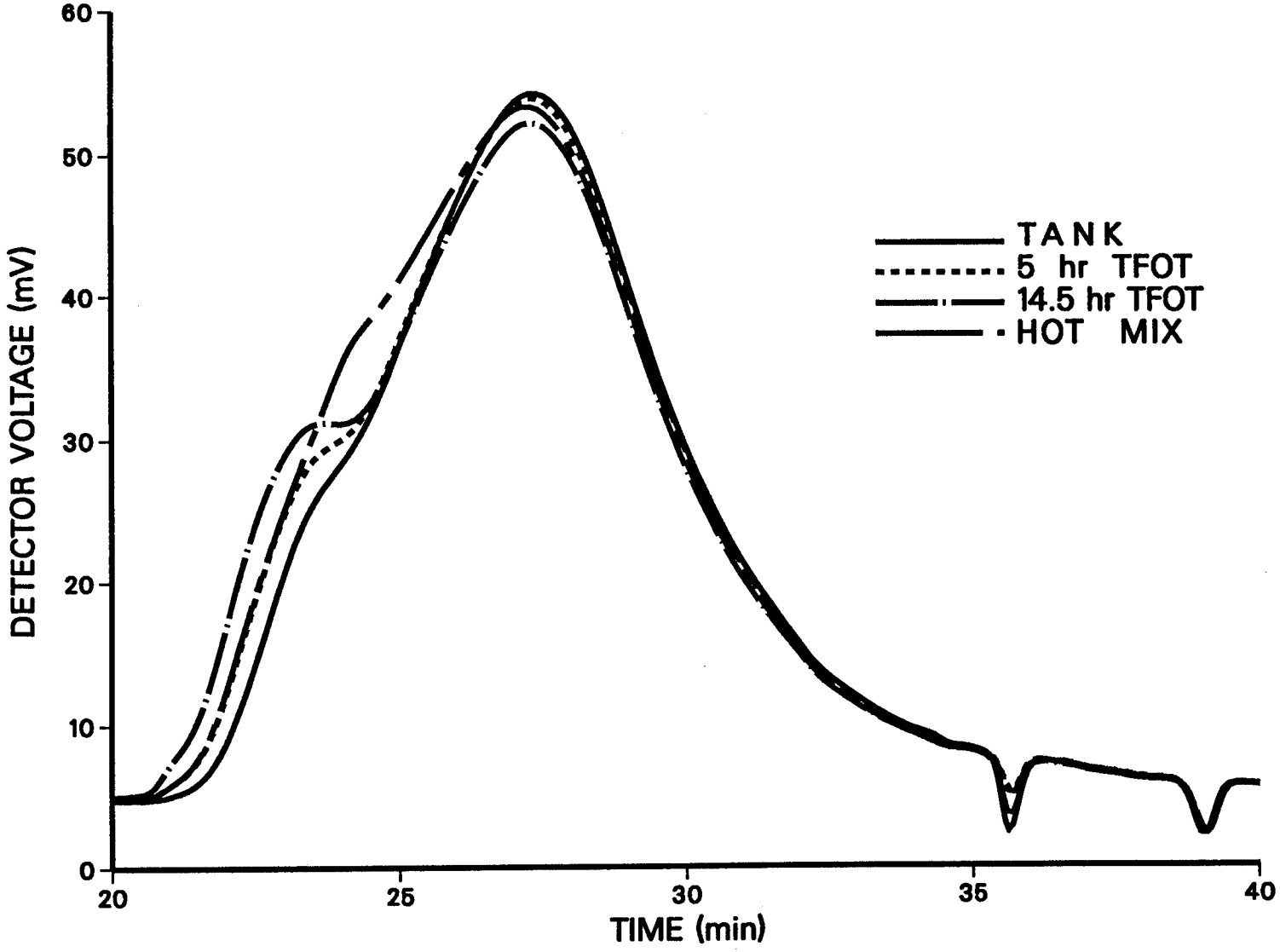

Figure C-68
GPC Chromatograms of Tank, 5 hr TFOT, 14.5 hr TFOT and Hot Mix
1989 Texaco AC-20

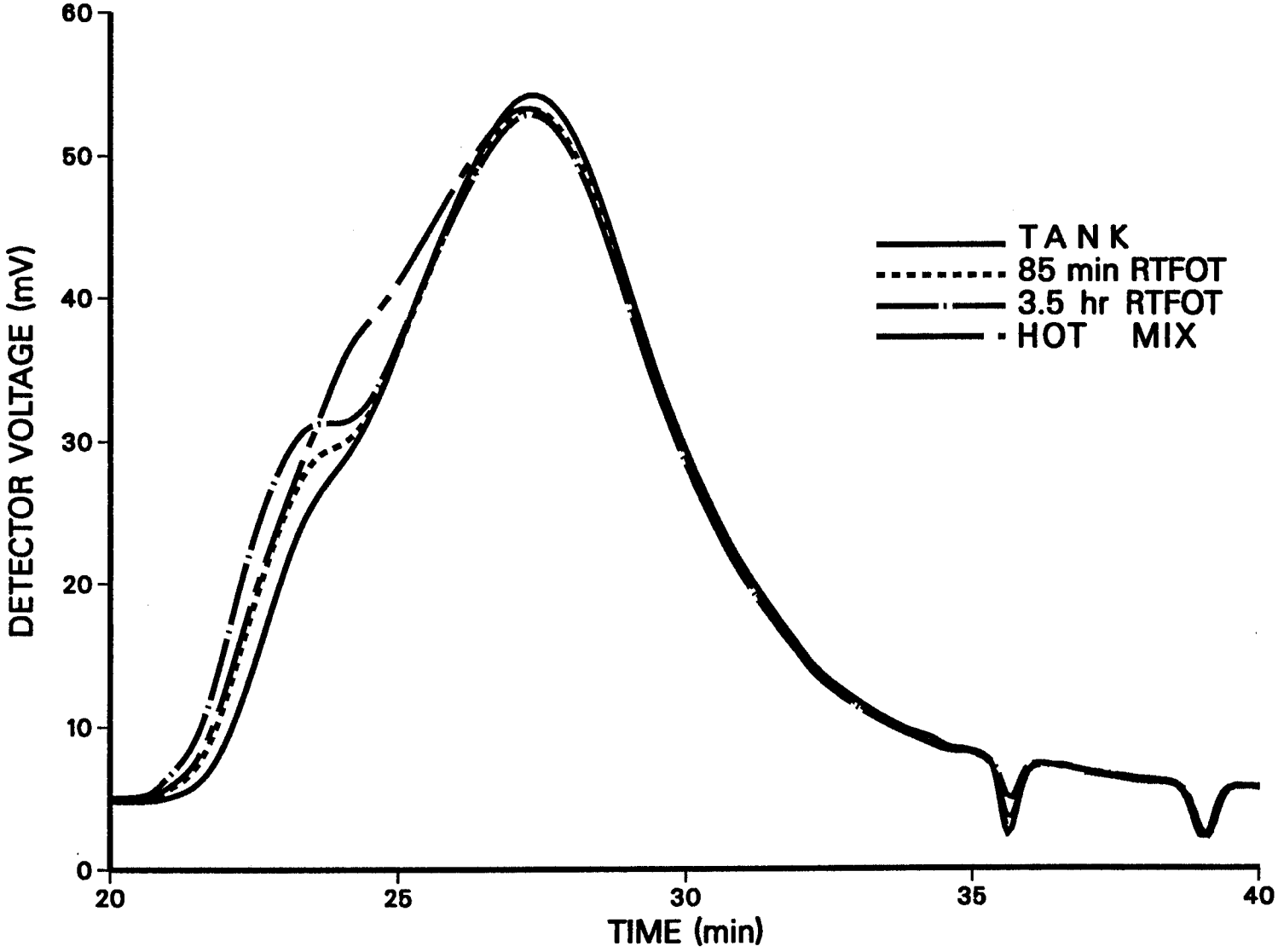

Figure C-69
GPC Chromatograms of Tank, 85 min RTFOT, 3.5 hr RTFOT and Hot Mix-1989 Texaco AC-20

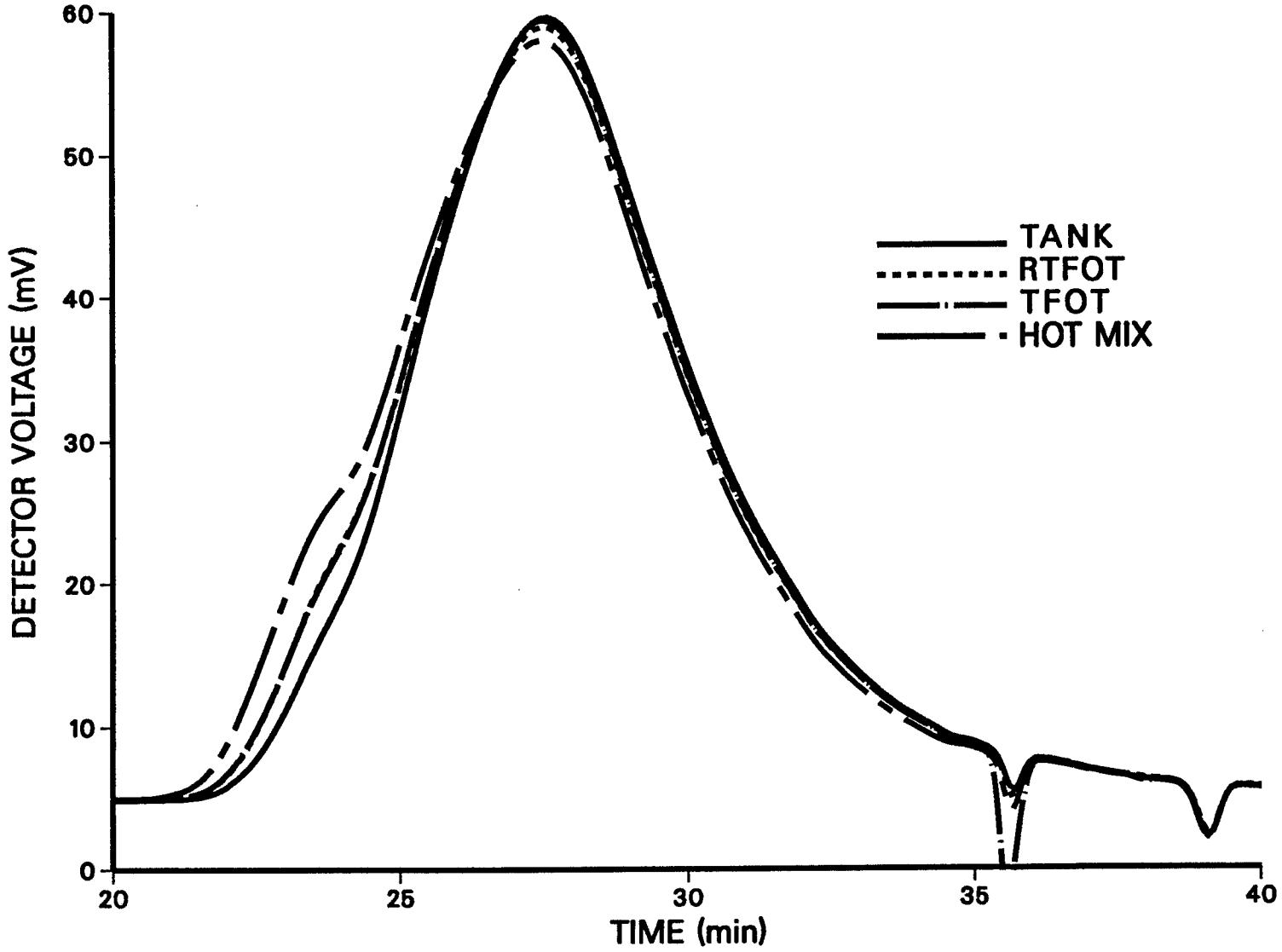

Figure C-70
GPC Chromatograms of Tank, RTFOT, TFOT and Hot Mix
1988 Exxon AC-20

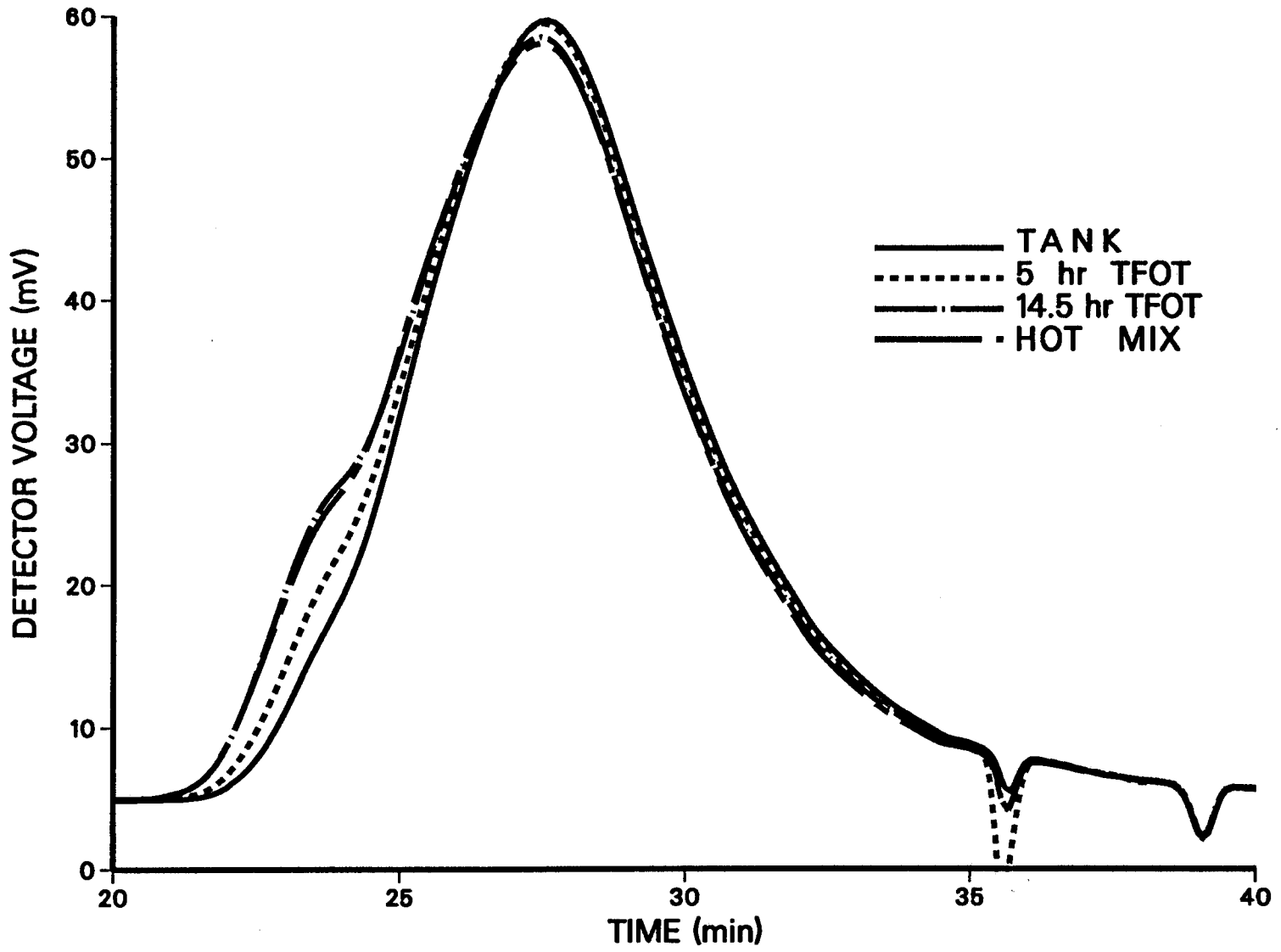

Figure C-71
GPC Chromatograms of Tank, 5 hr TFOT, 14.5 TFOT and Hot Mix
1988 Exxon AC-20

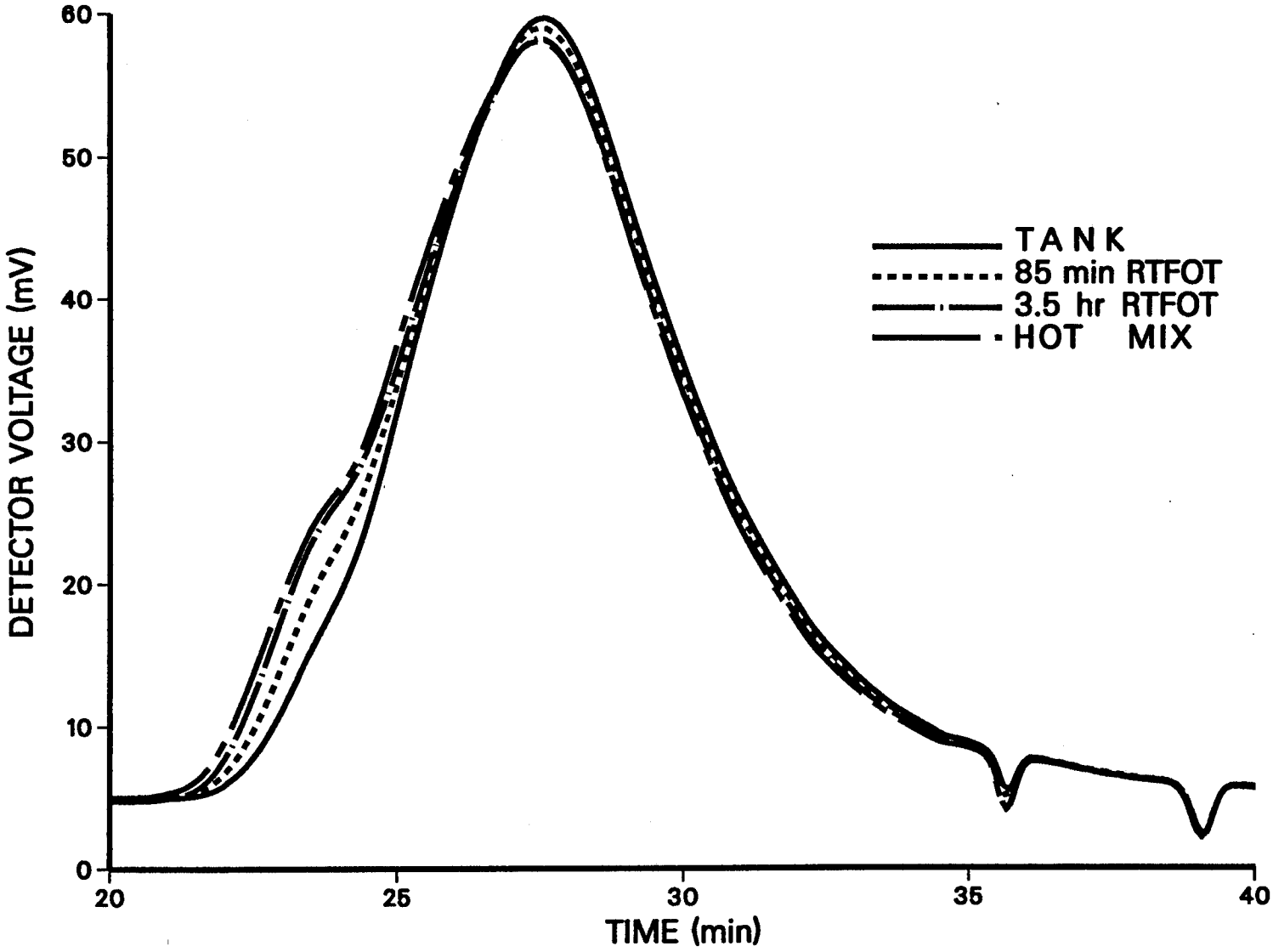

Figure C-72
GPC Chromatograms of Tank, 85 min RTFOT, 3.5 hr RTFOT and Hot Mix-1988 Exxon AC-20

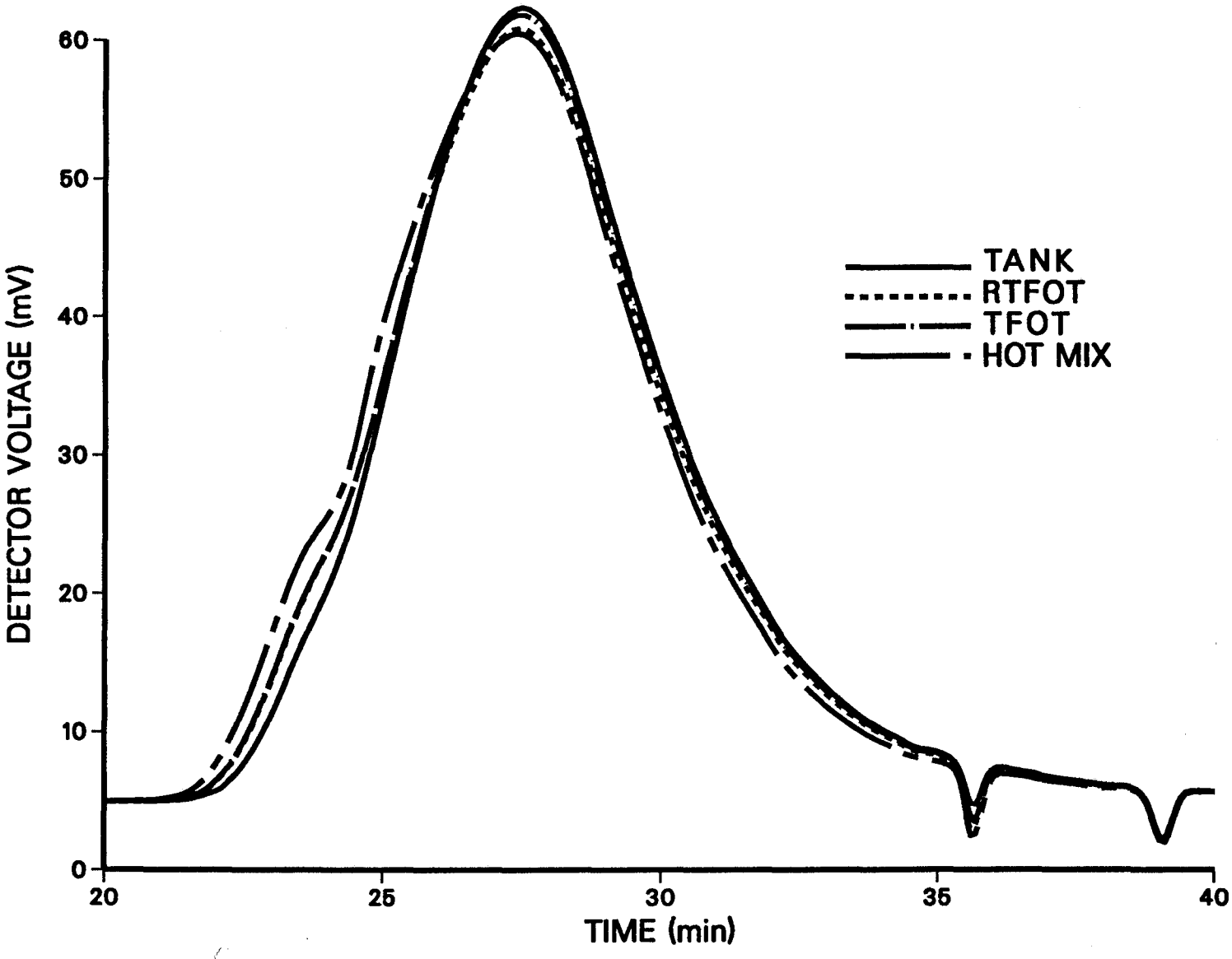

Figure C-73
GPC Chromatograms of Tank, RTFOT, TFOT and Hot Mix
1987 Exxon AC-20 (Batch)

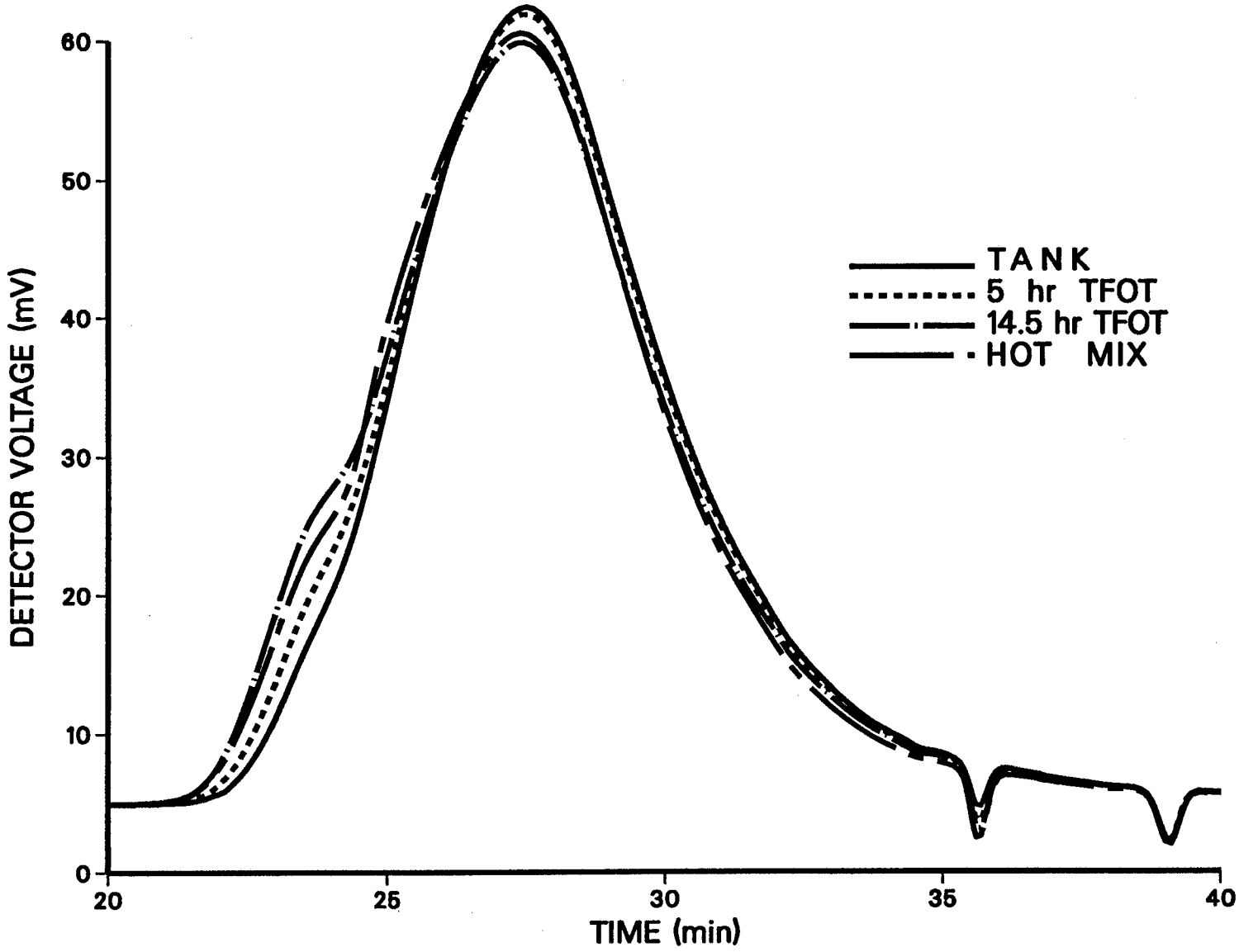

Figure C-74
GPC Chromatograms of Tank, 5 hr TFOT, 14.5 TFOT and Hot Mix
1987 Exxon AC-20 (Batch)

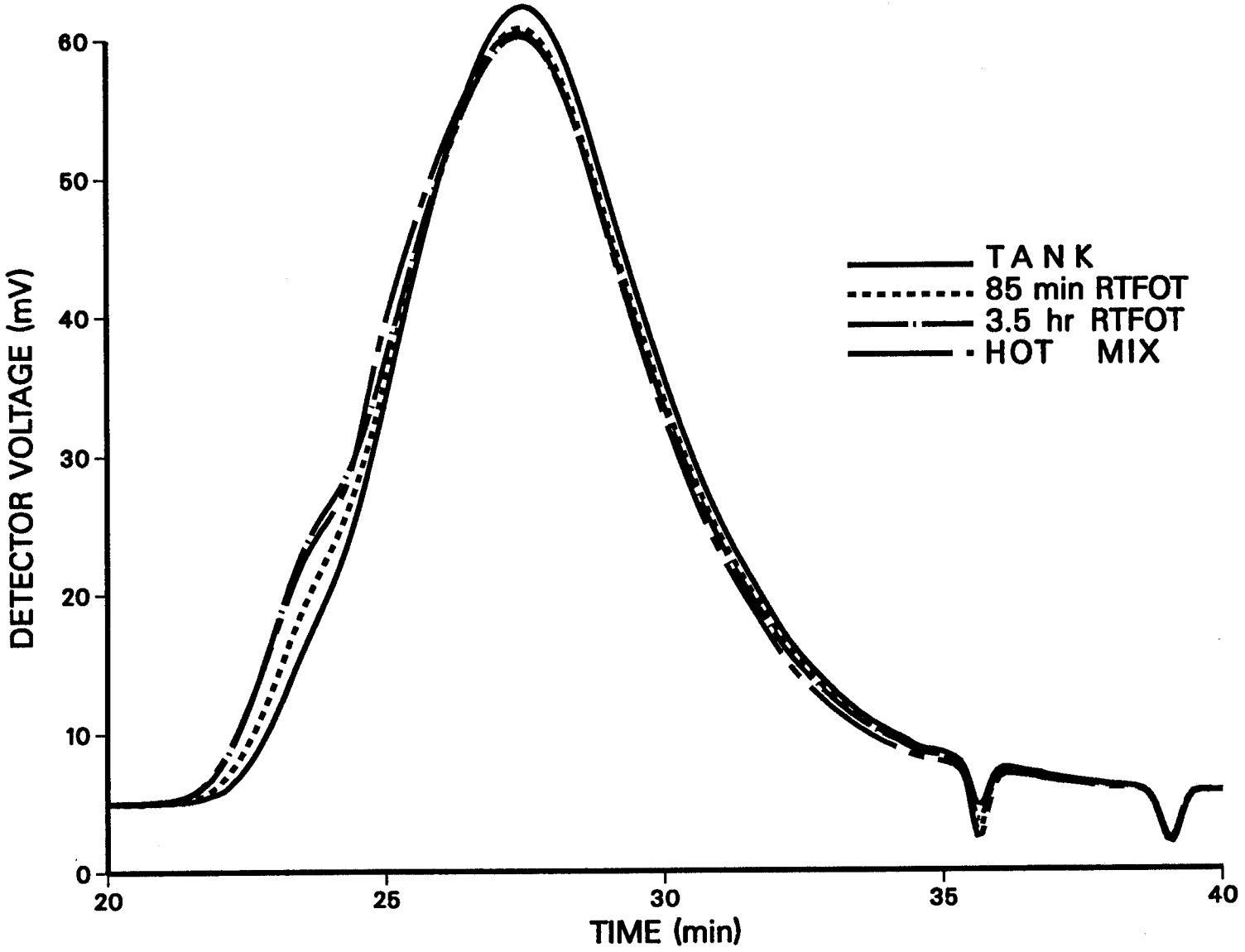

Figure C-75
GPC Chromatograms of Tank, 85 min RTFOT, 3.5 hr RTFOT and Hot Mix
1987 Exxon AC-20 (Batch)

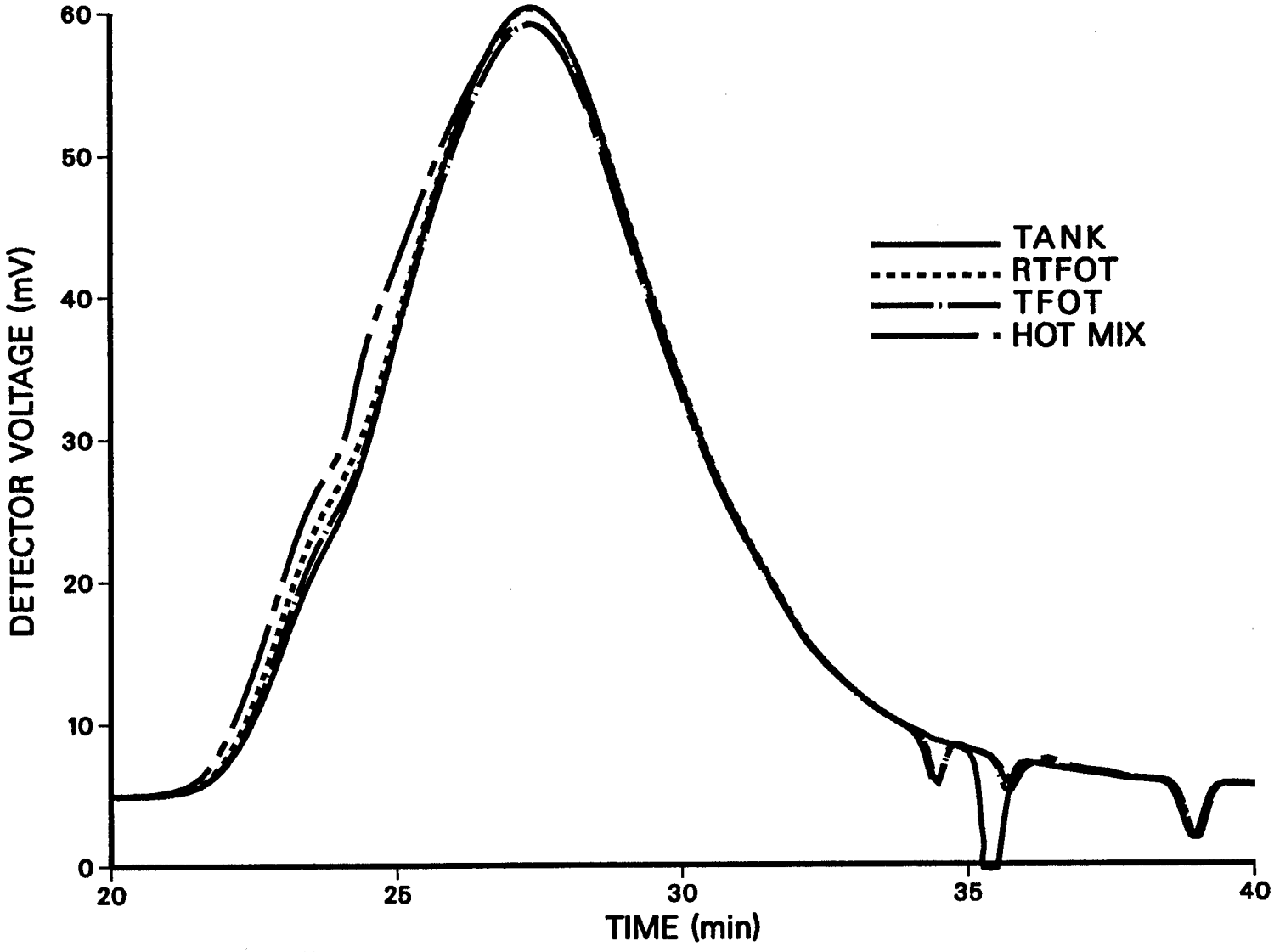

Figure C-76
GPC Chromatograms of Tank, RTFOT, TFOT and Hot Mix
1987 Exxon AC-20

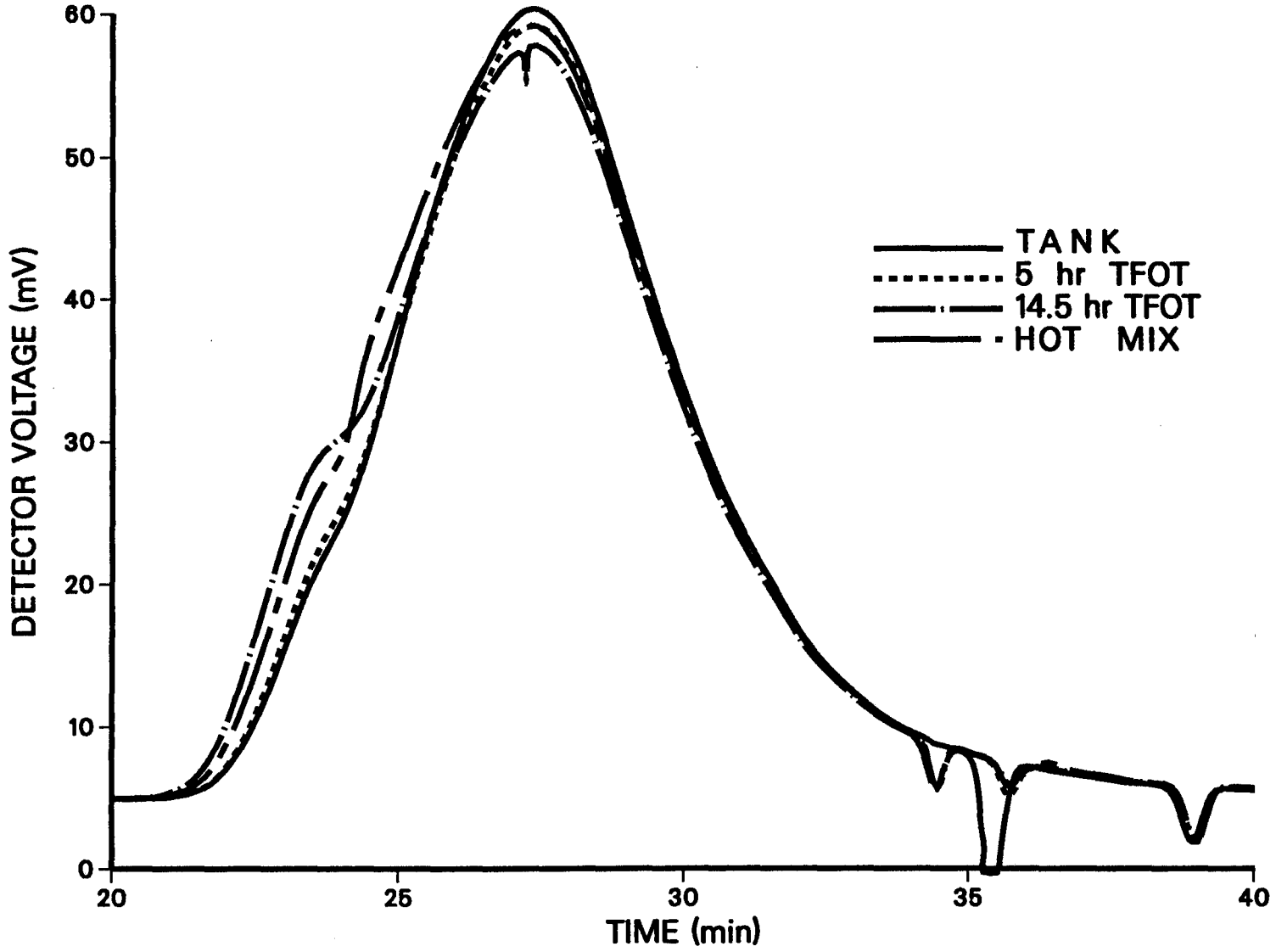

Figure C-77
GPC Chromatograms of Tank, 5 hr TFOT, 14.5 hr TFOT and Hot Mix
1987 Exxon AC-20

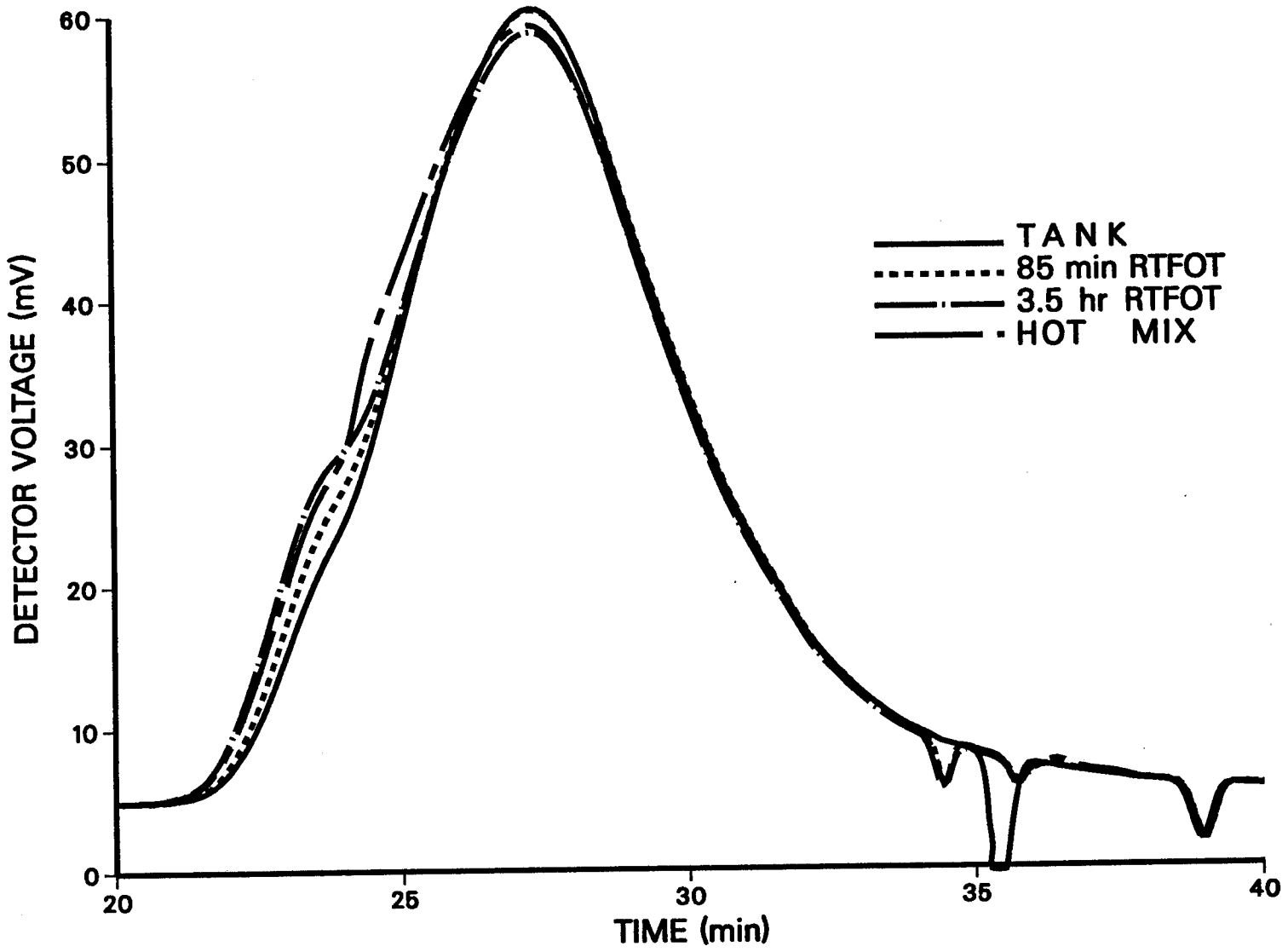

Figure C-78
GPC Chromatograms of Tank, 85 min RTFOT, 3.5 hr RTFOT and Hot Mix
1987 Exxon AC-20

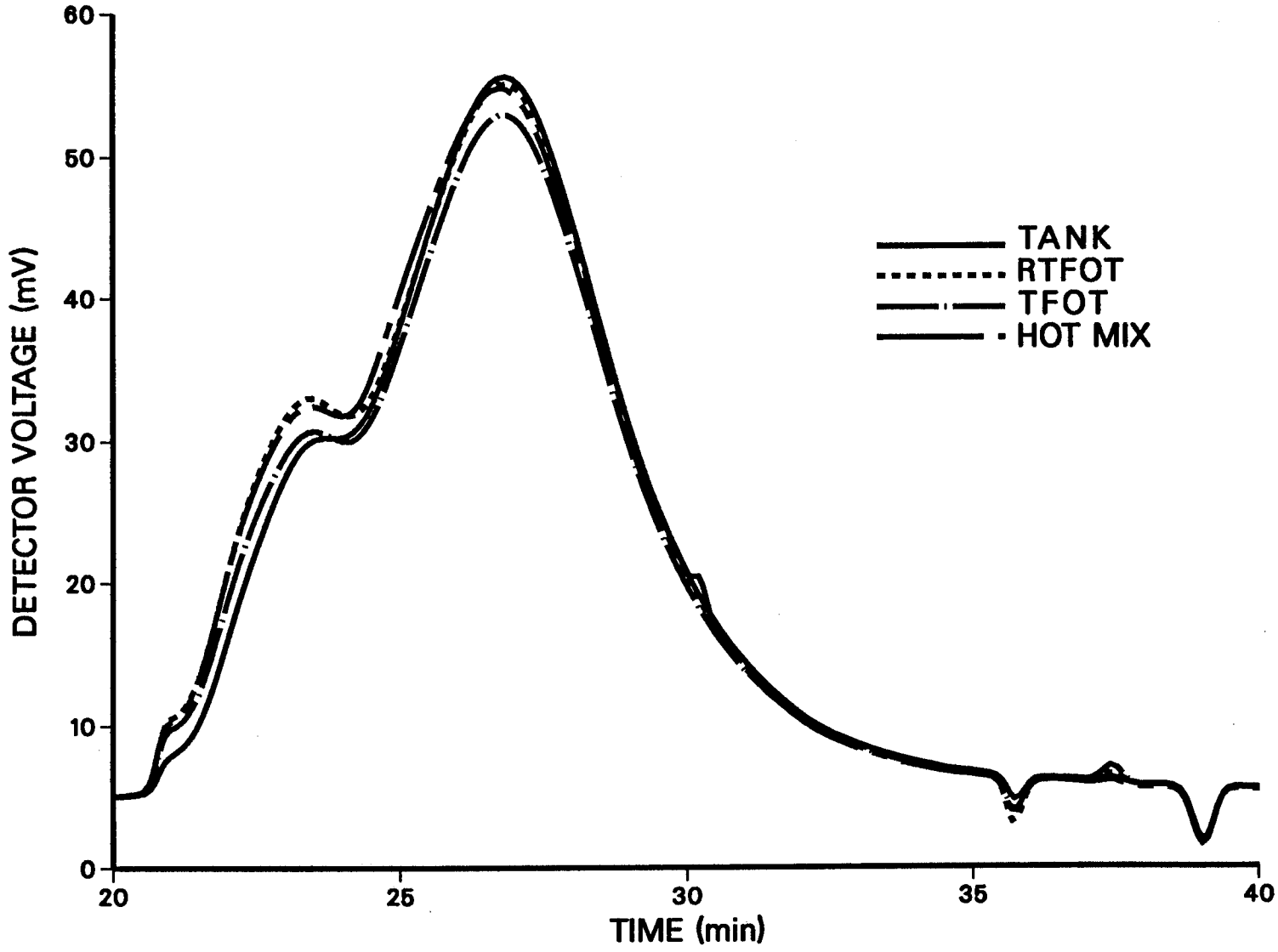

Figure C-79
GPC Chromatograms of Tank, RTFOT,TFOT and Hot Mix
1989 Cosden AC-20

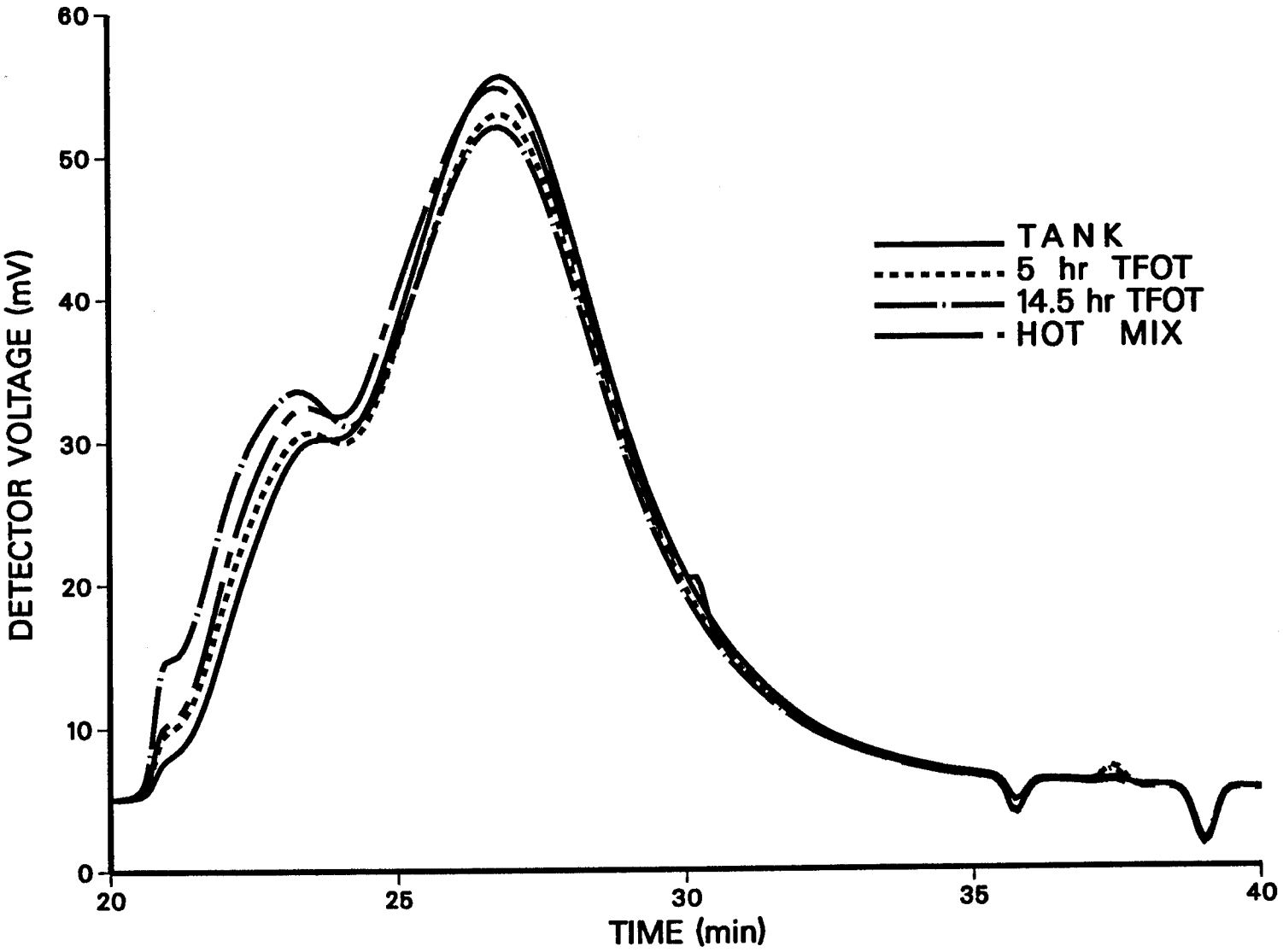

Figure C-80
GPC Chromatograms of Tank, 5 hr TFOT, 14.5 TFOT and Hot Mix
1989 Cosden AC-20

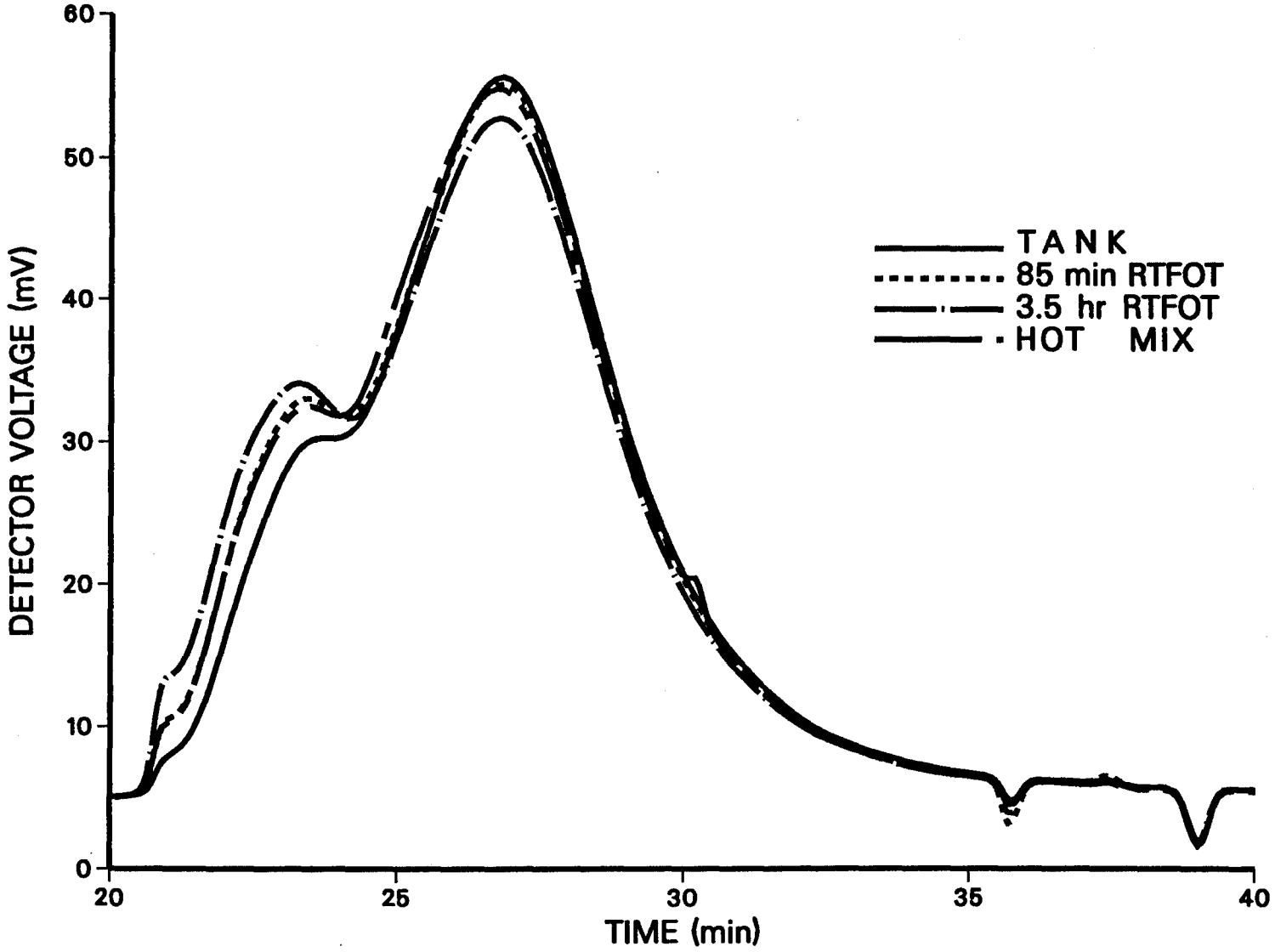

Figure C-81
GPC Chromatograms of Tank, 85 min RTFOT, 3.5 hr RTFOT and Hot Mix-1989 Cosden AC-20

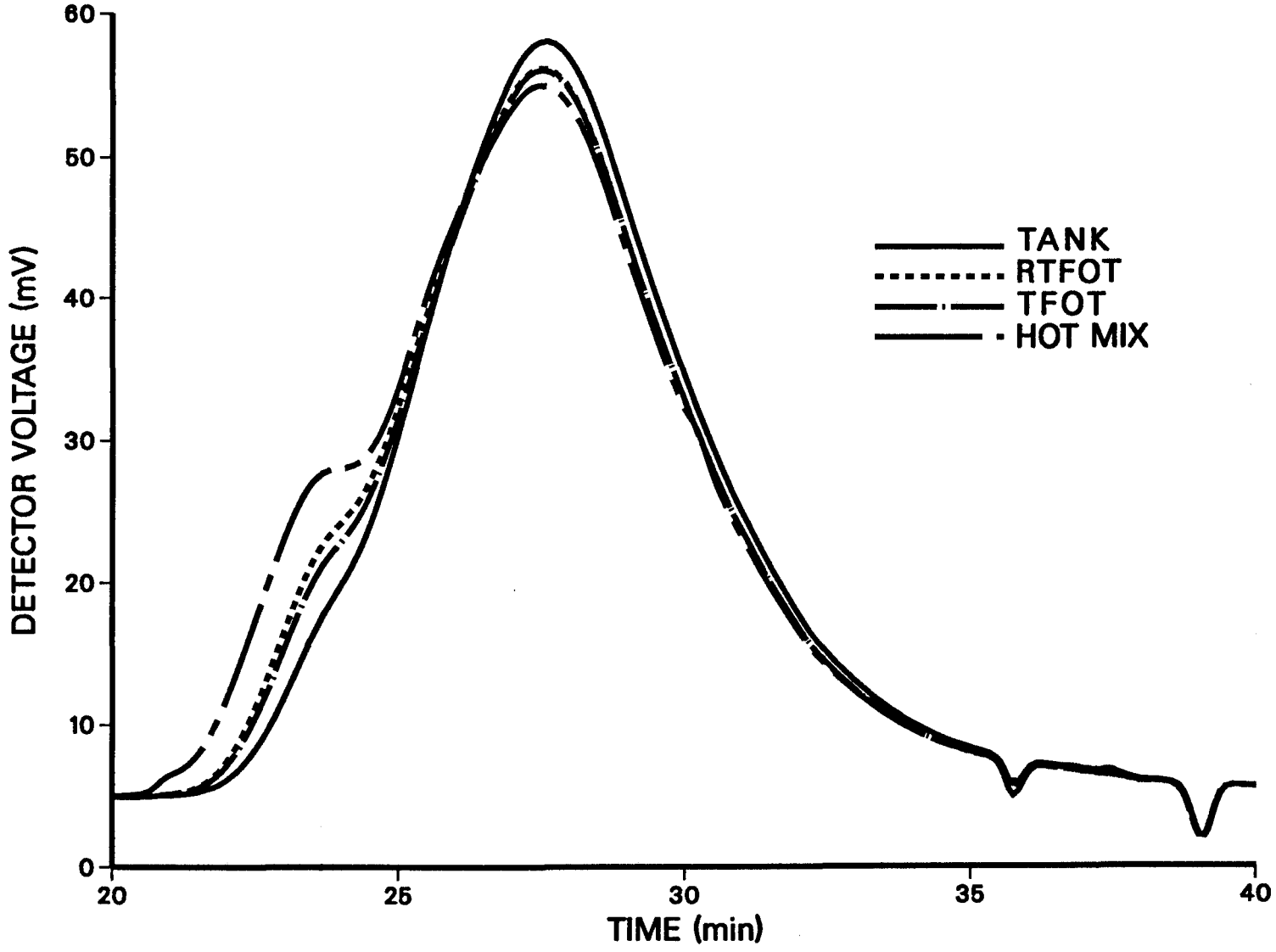

Figure C-82
GPC Chromatograms of Tank, RTFOT, TFOT and Hot Mix
1989 Cosden AC-10

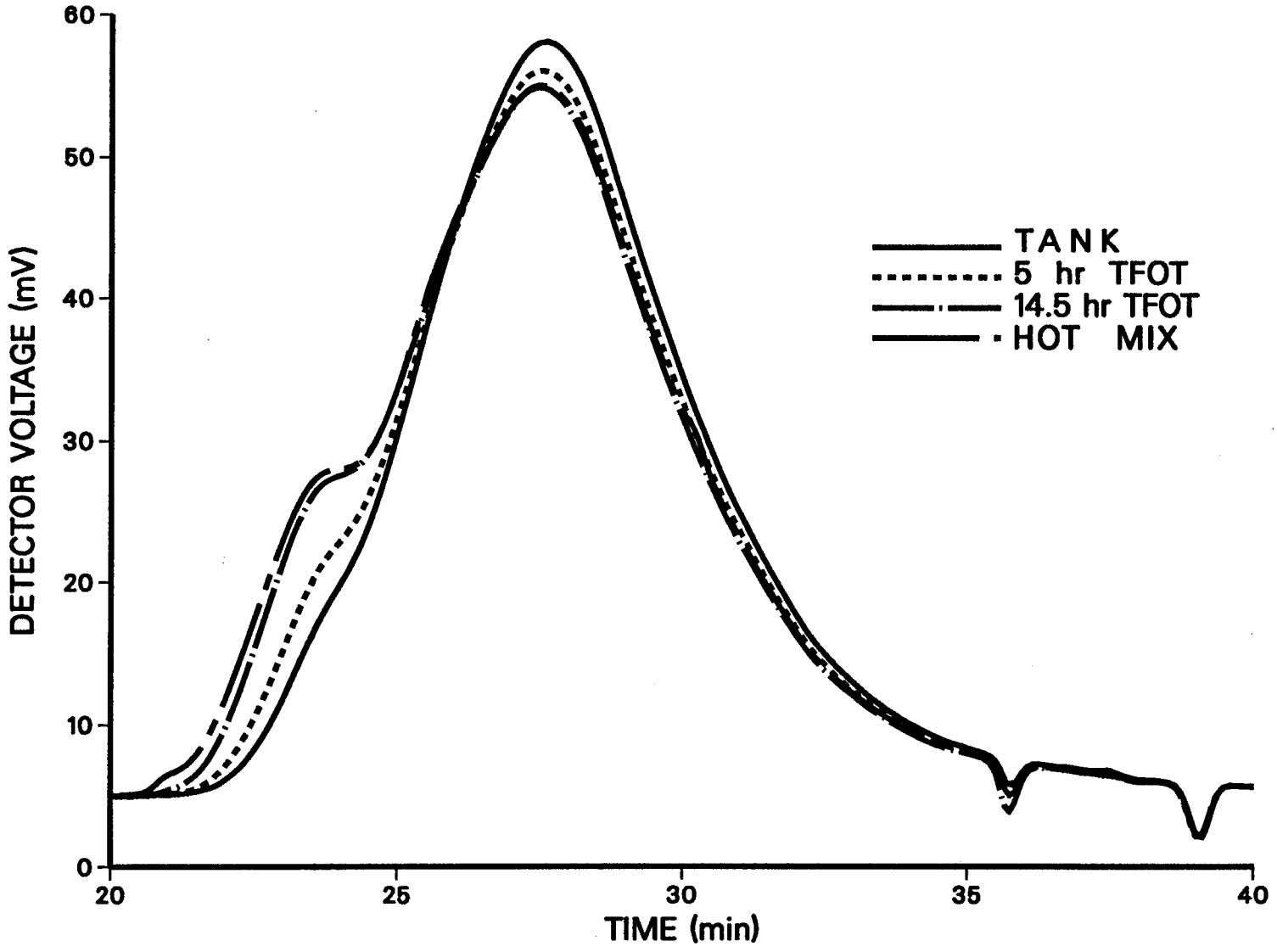

Figure C-83
GPC Chromatograms of Tank, 5 hr TFOT, 14.5 TFOT and Hot Mix
1989 Cosden AC-10

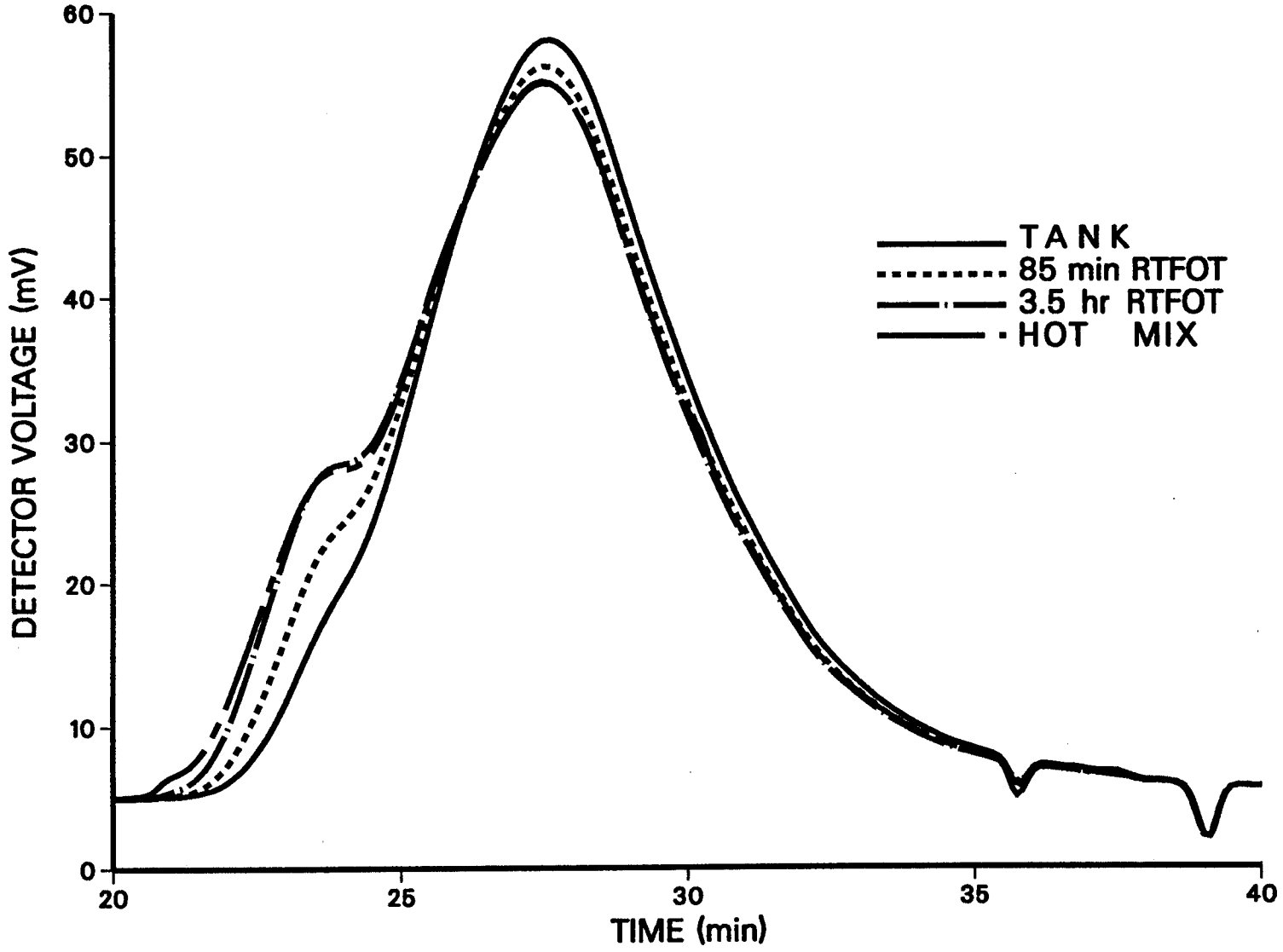

Figure C-84
GPC Chromatograms of Tank, 85 min RTFOT, 3.5 hr RTFOT and Hot Mix-1989 Cosden AC-10

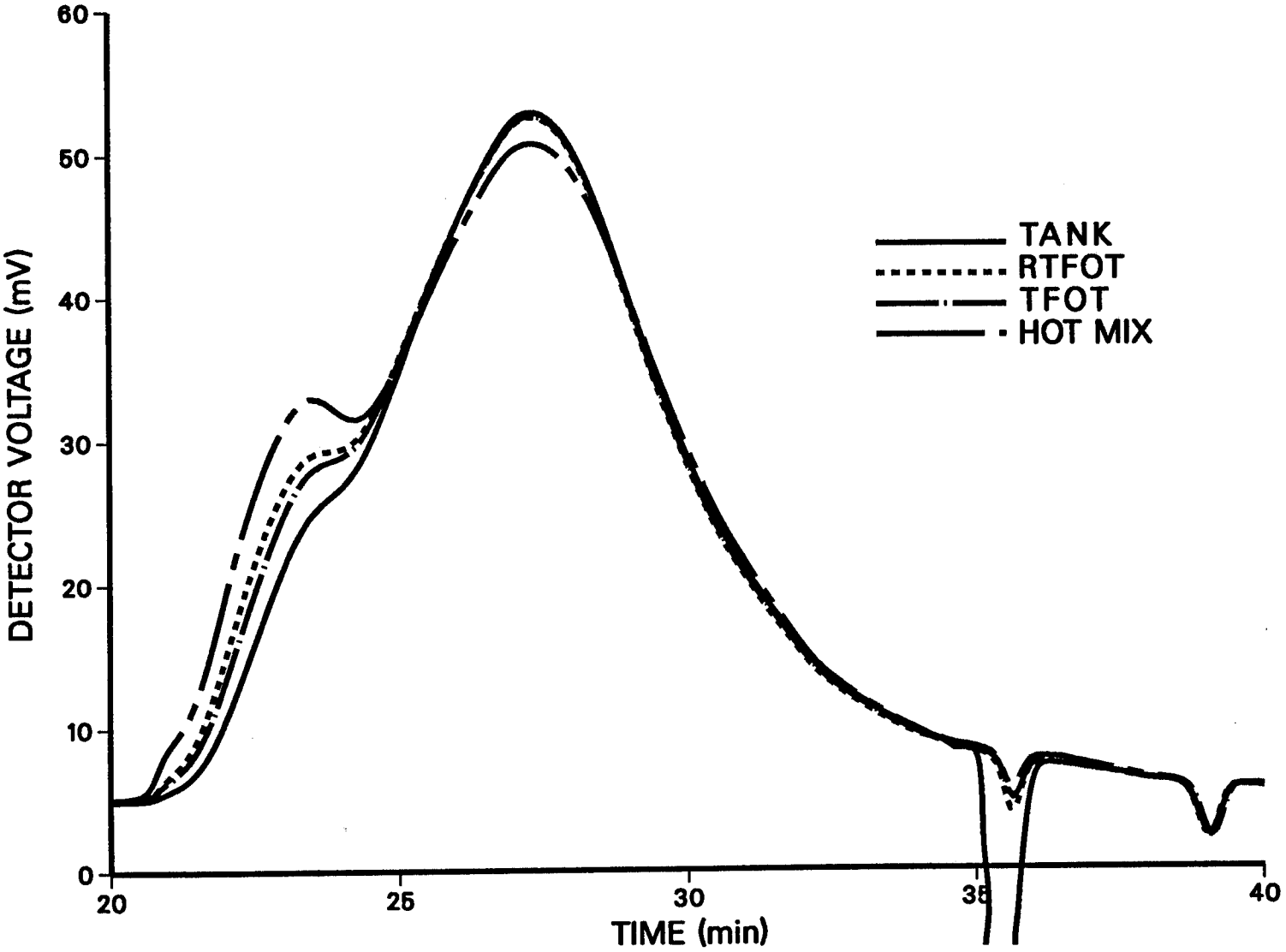

Figure C-85
GPC Chromatograms of Tank RTFOT, TFOT and Hot Mix
1987 Coastal AC-20

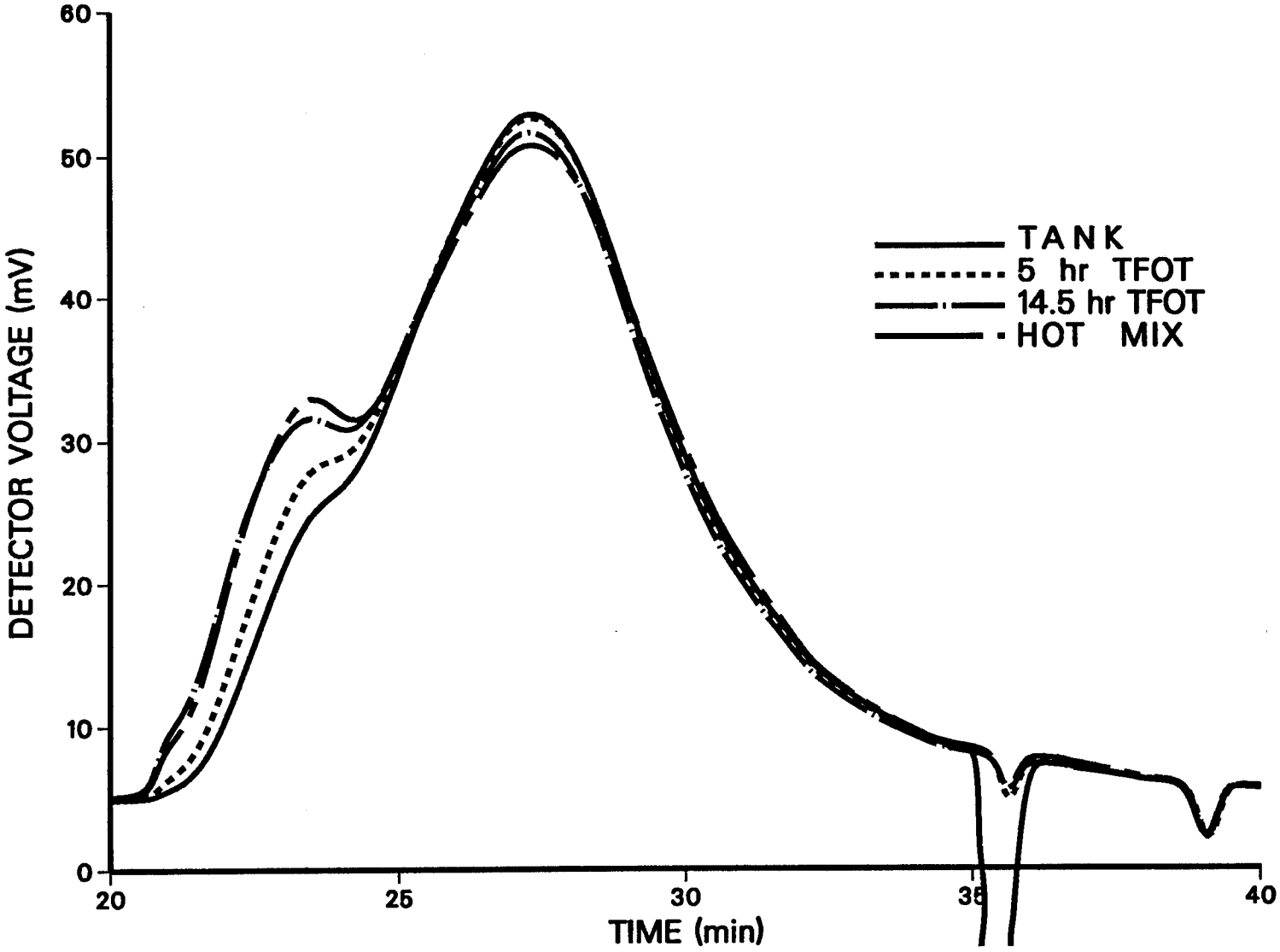

Figure C-86
GPC Chromatograms of Tank, 5 hr TFOT, 14.5 TFOT and Hot Mix
1987 Coastal AC-20

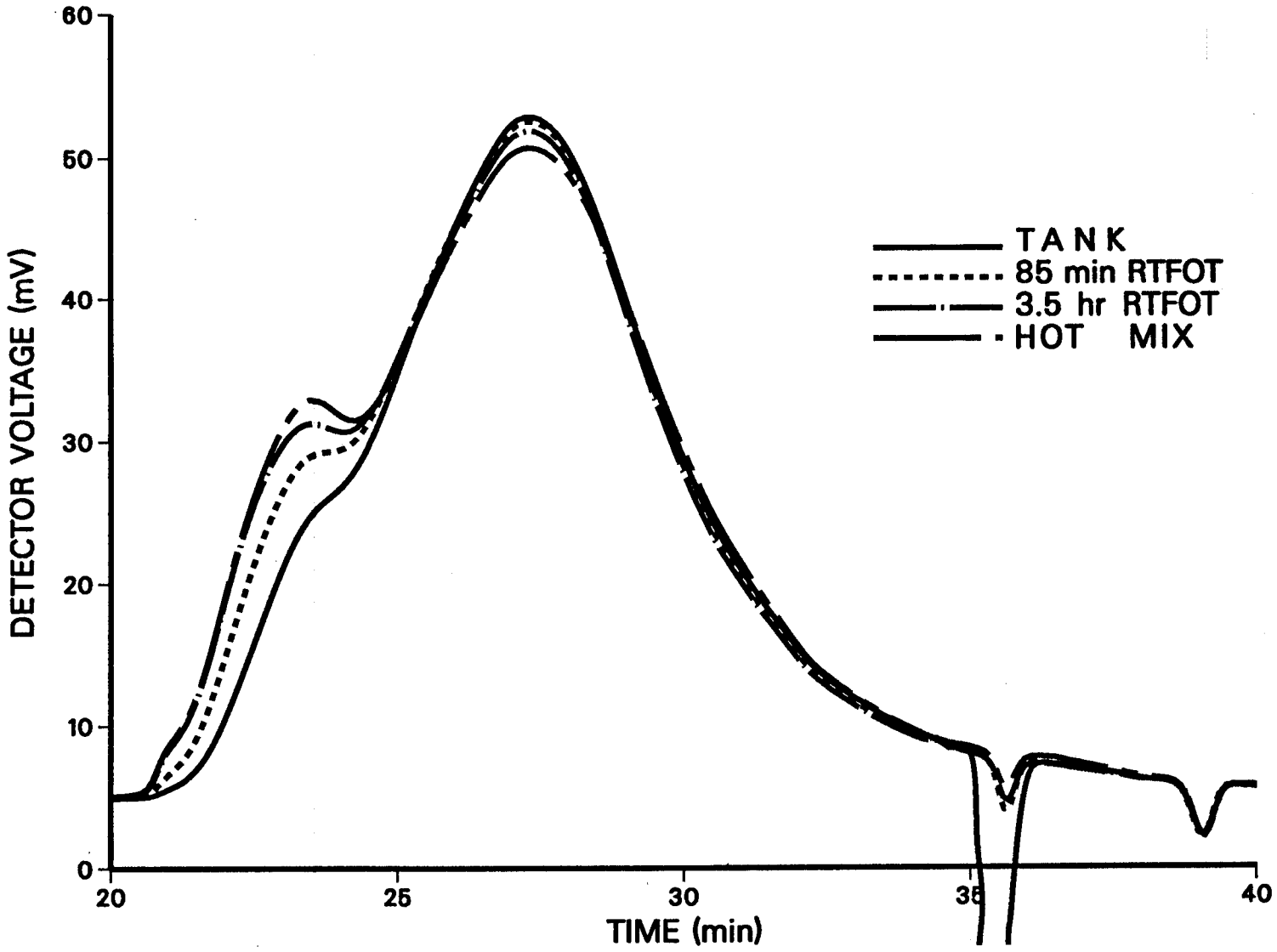

Figure C-87
GPC Chromatograms of Tank, 85 min RTFOT, 3.5 hr RTFOT and Hot Mix-1987 Coastal AC-20

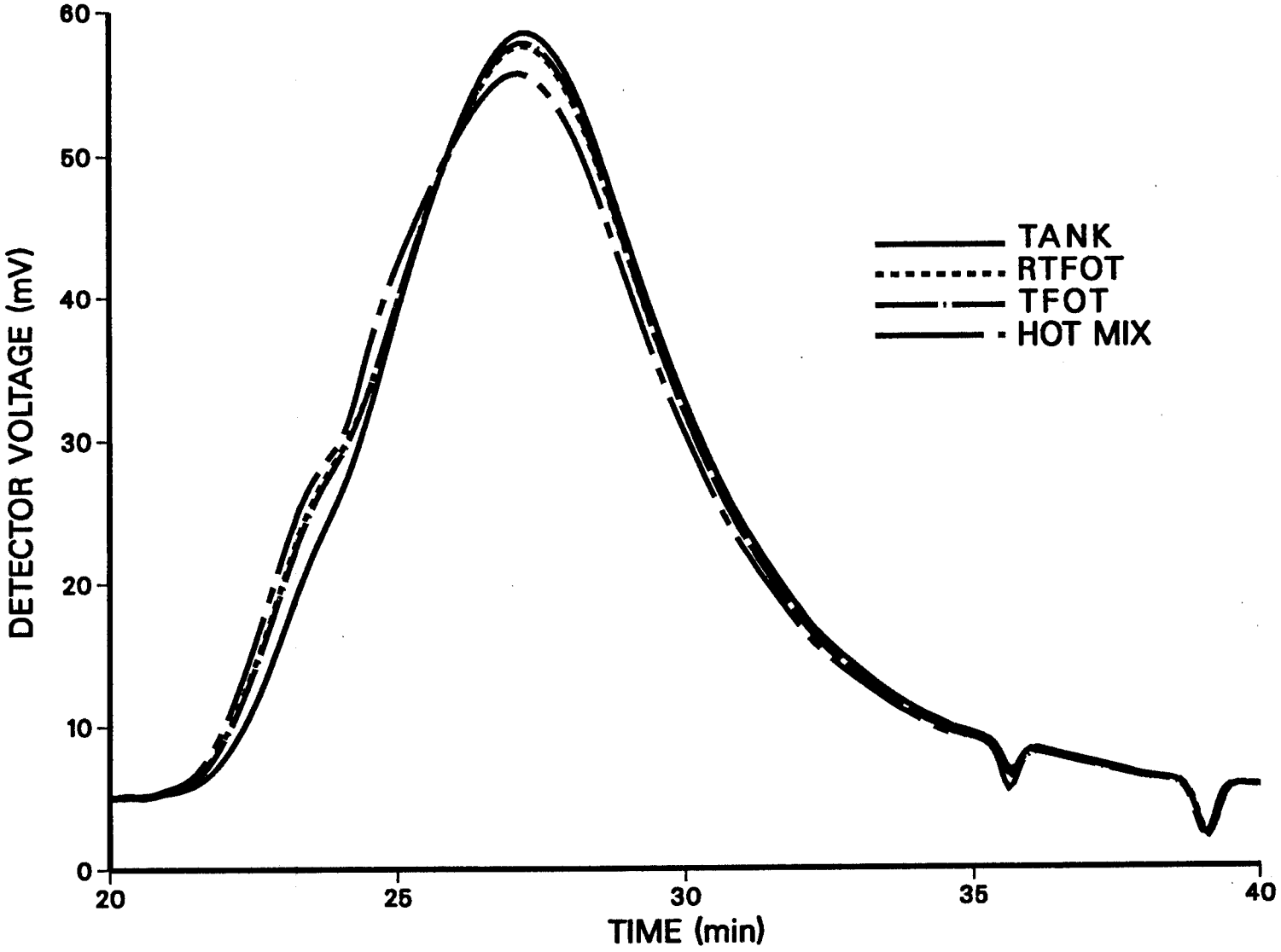

Figure C-88
GPC Chromatograms of Tank, RTFOT, TFOT, and Hot Mix
1989 Ampet AC-20 (Batch)

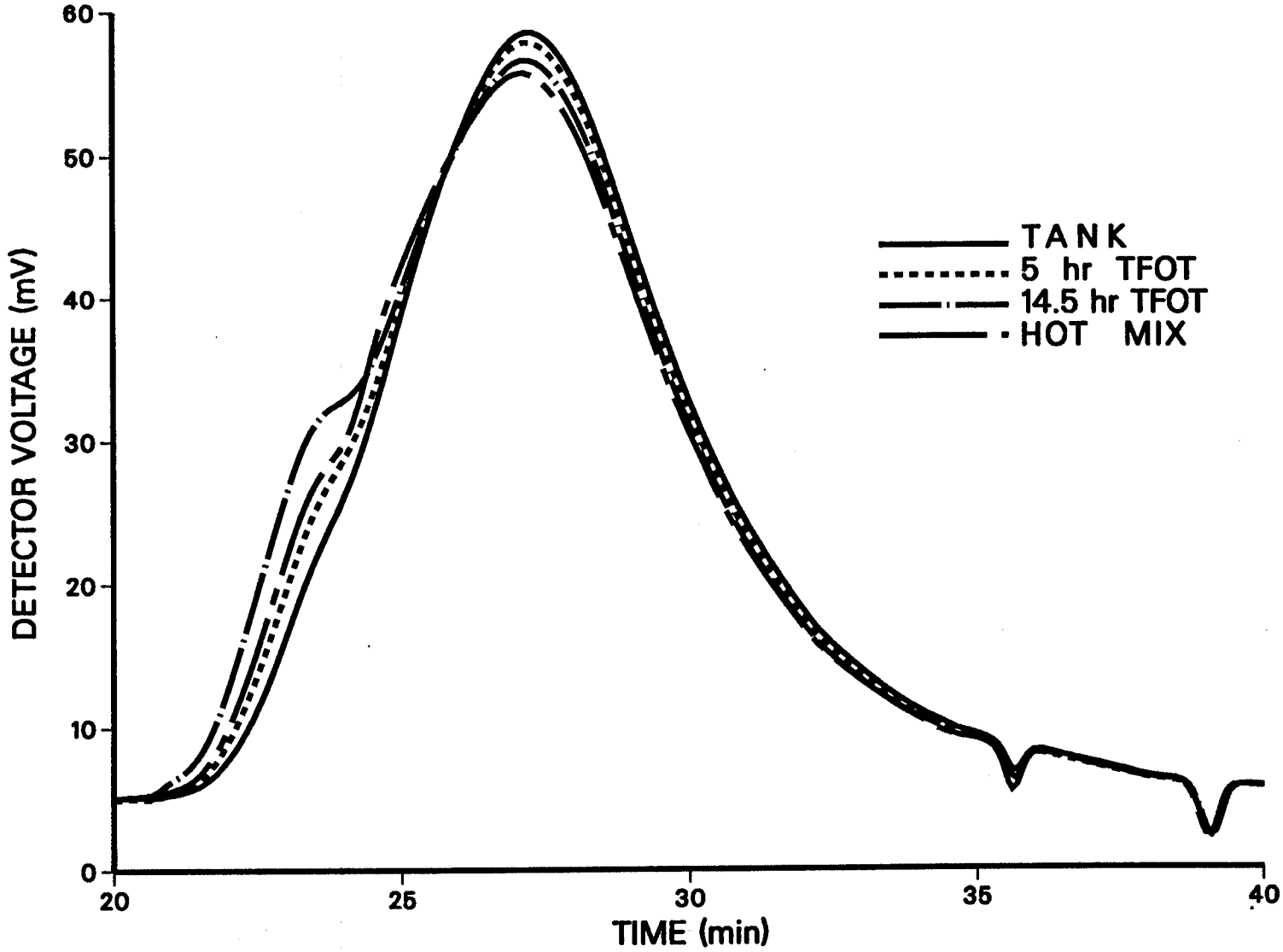

Figure C-89
GPC Chromatograms of Tank, 5 hr TFOT, 14.5 hr TFOT and Hot Mix
1989 Ampet AC-20 (Batch)

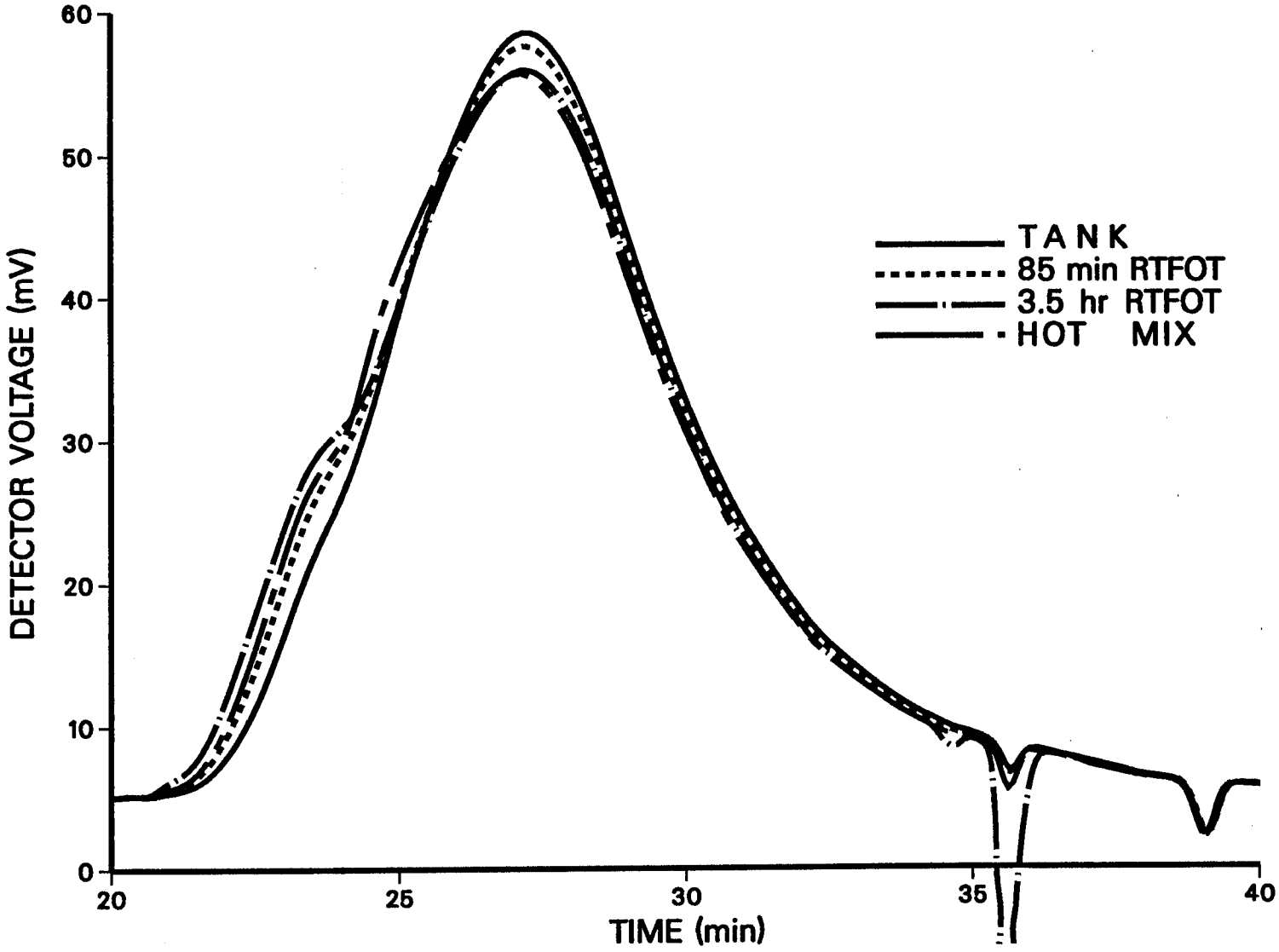

Figure C-90
GPC Chromatograms of Tank, 85 min RTFOT, 3.5 hr RTFOT and Hot Mix-1989 Ampet AC-20 (Batch)

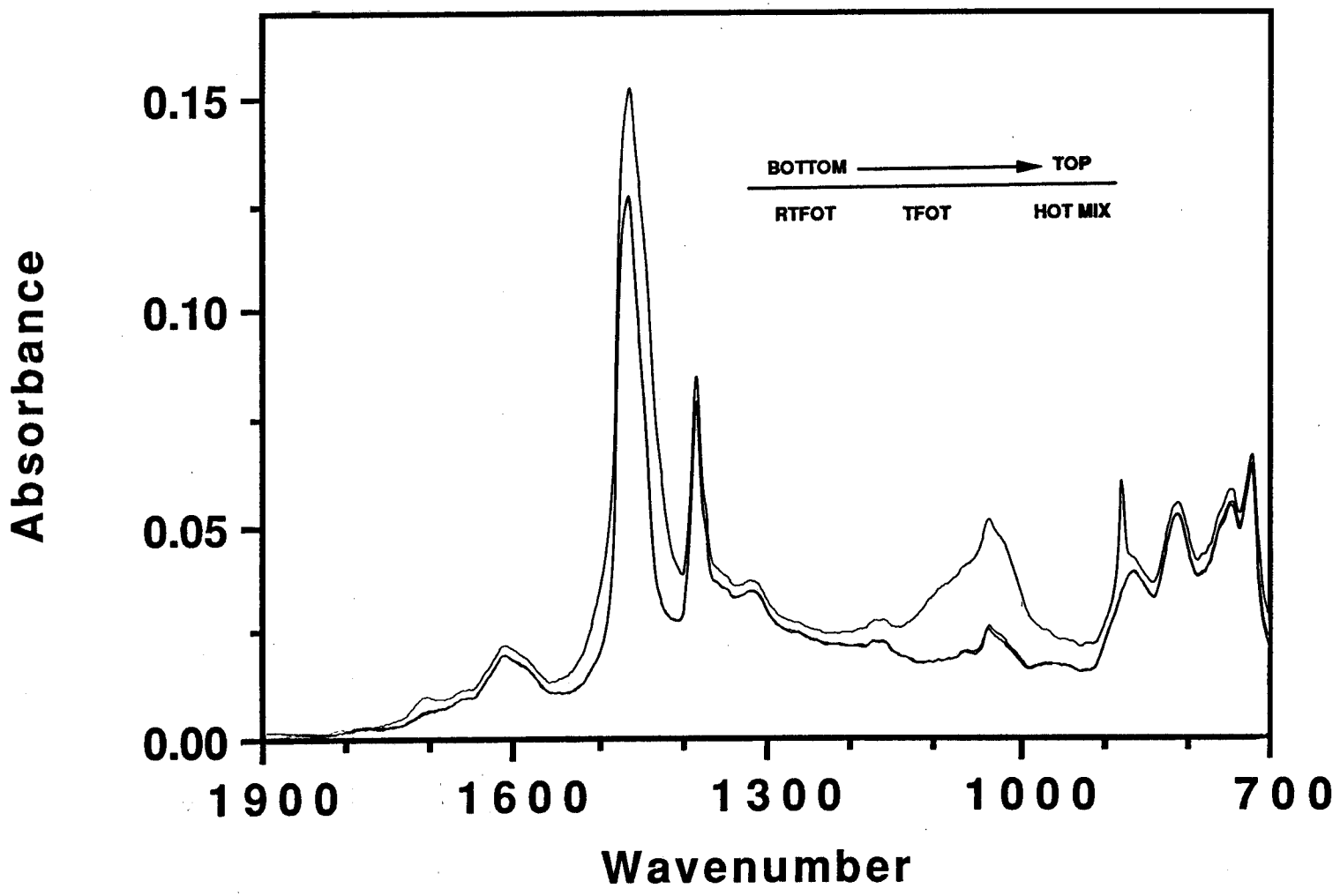

Figure C-91
Comparison of FT-IR Spectra (ATR Method) for RTFOT, TFOT and Hot Mix-1989 Ampet AC-20

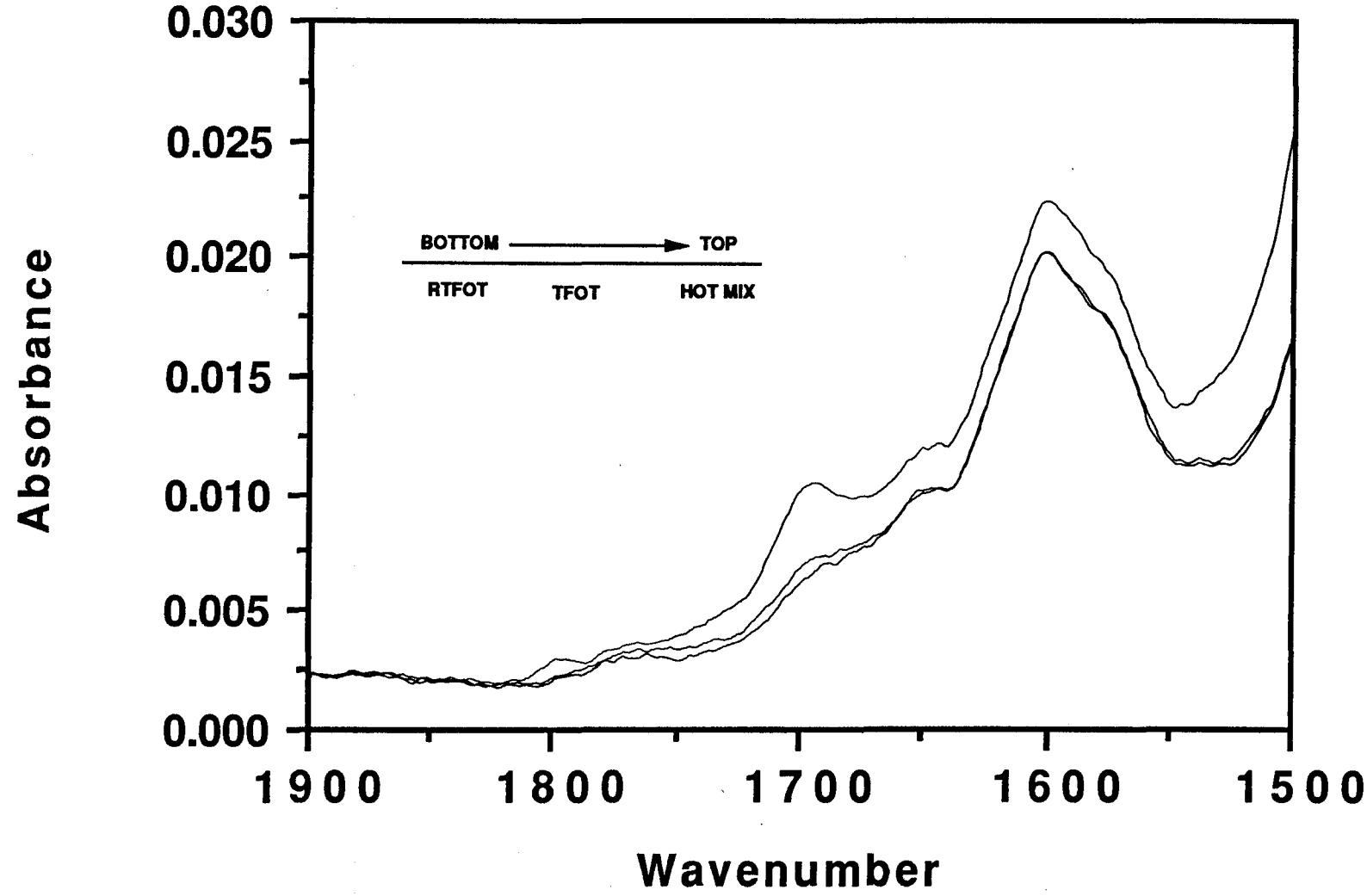

Figure C-92
Comparison of Carbonyl Region of FT-IR Spectra (ATR Method) for
RTFOT, TFOT and Hot Mix-1989 Ampet AC-20

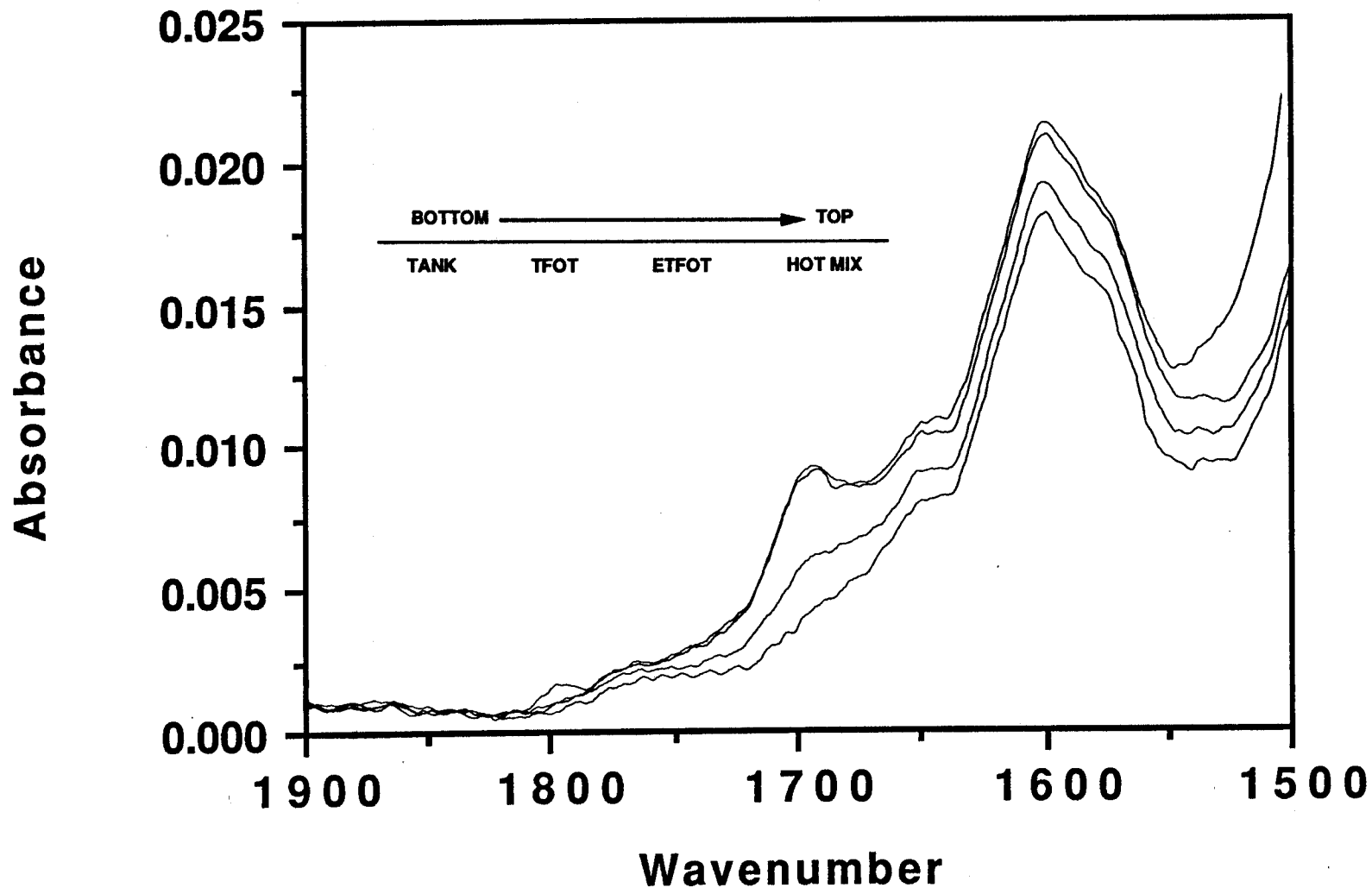

Figure C-93
Comparison of Carbonyl Region of FT-IR Spectra (ATR Method) for
Tank, TFOT, ETFOT and Hot Mix-1989 Ampet AC-20 (Batch)

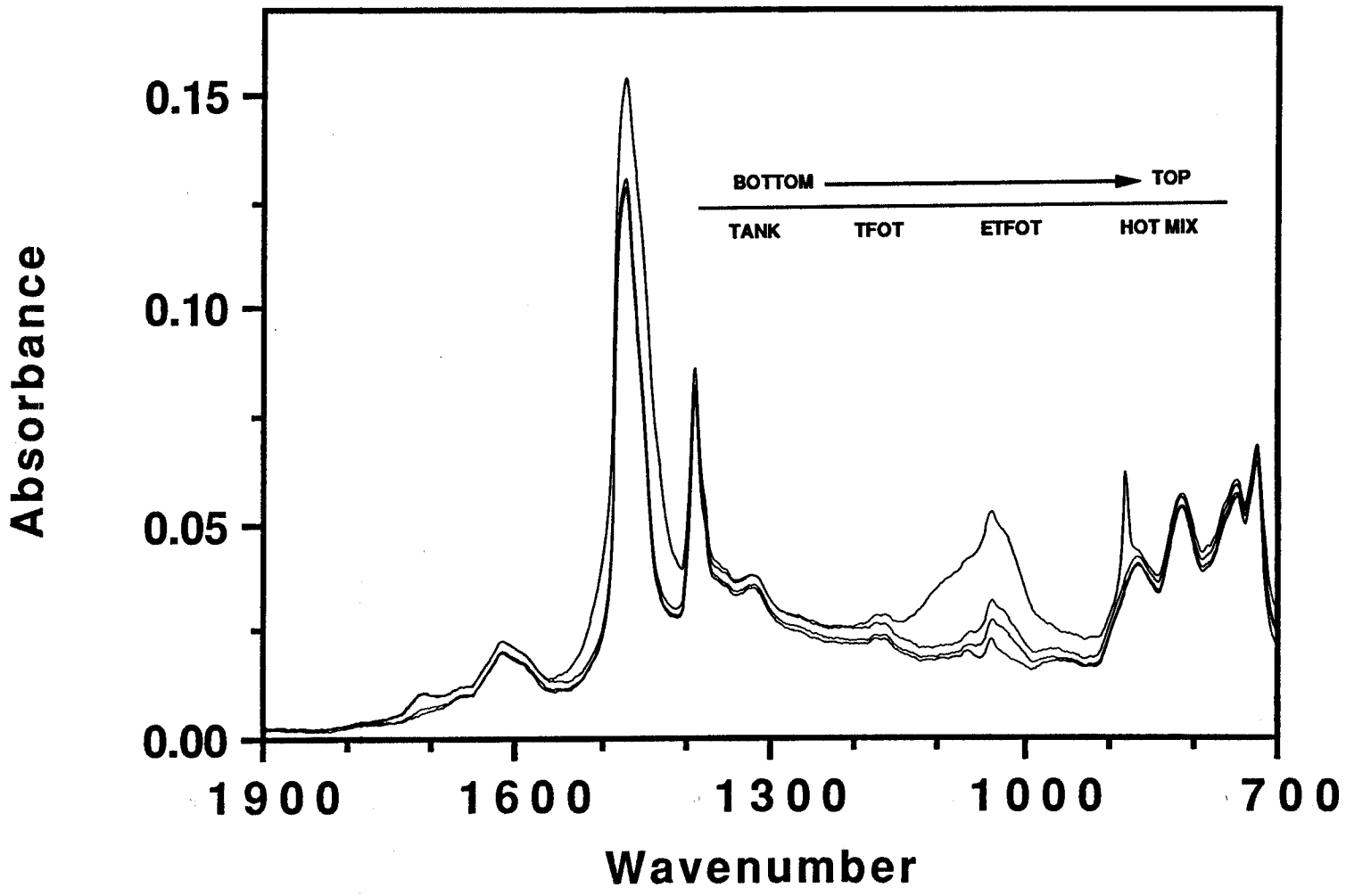

Figure C-94
Comparison of FT-IR Spectra (ATR Method) for Tank, TFOT, ETFOT
and Hot Mix-1989 Ampet AC-20

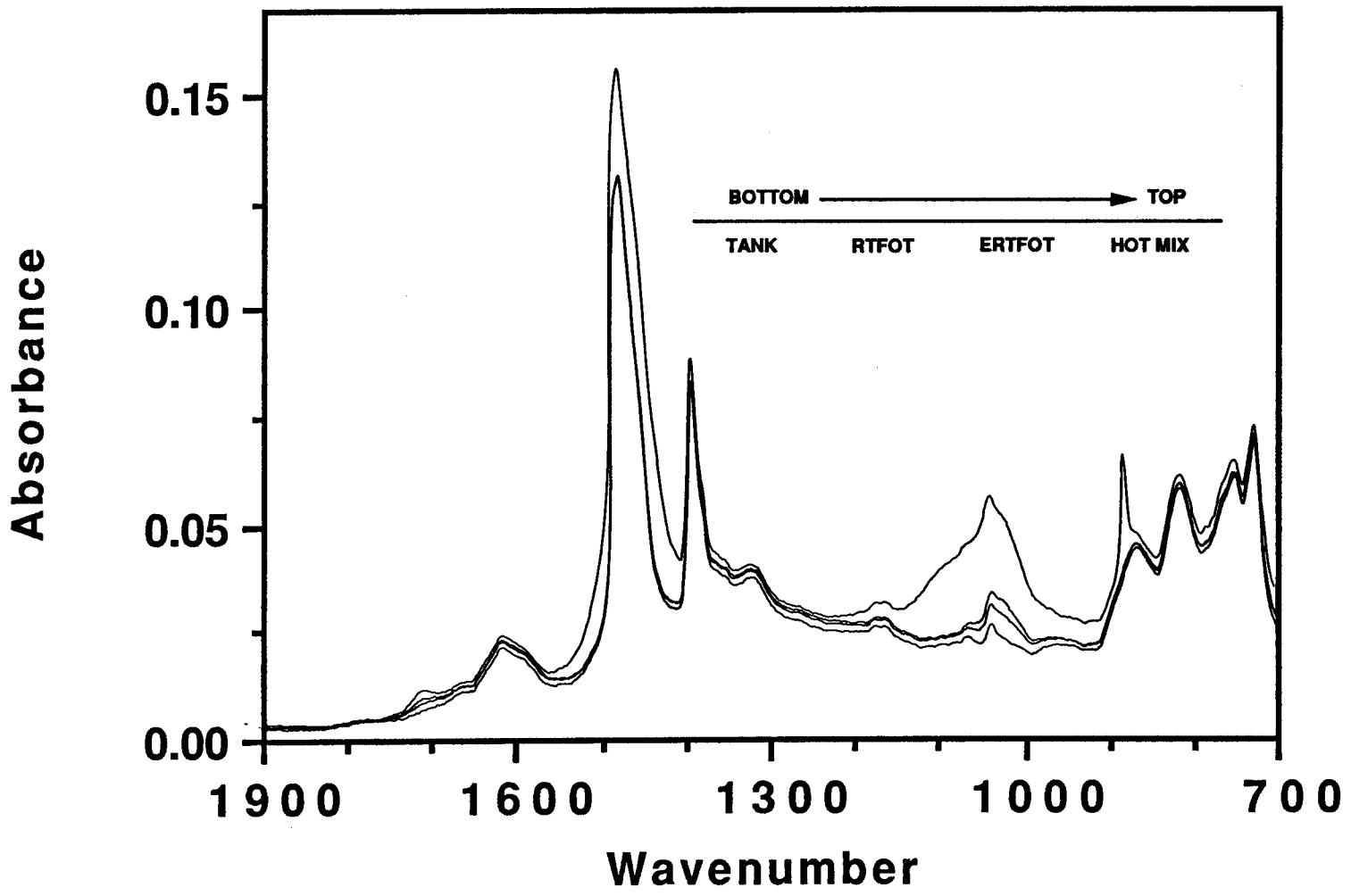

Figure C-95
Comparison of FT-IR Spectra (ATR Method) for Tank, RTFOT, ERTFOT and Hot Mix-1989 Ampet AC-20 (Batch)

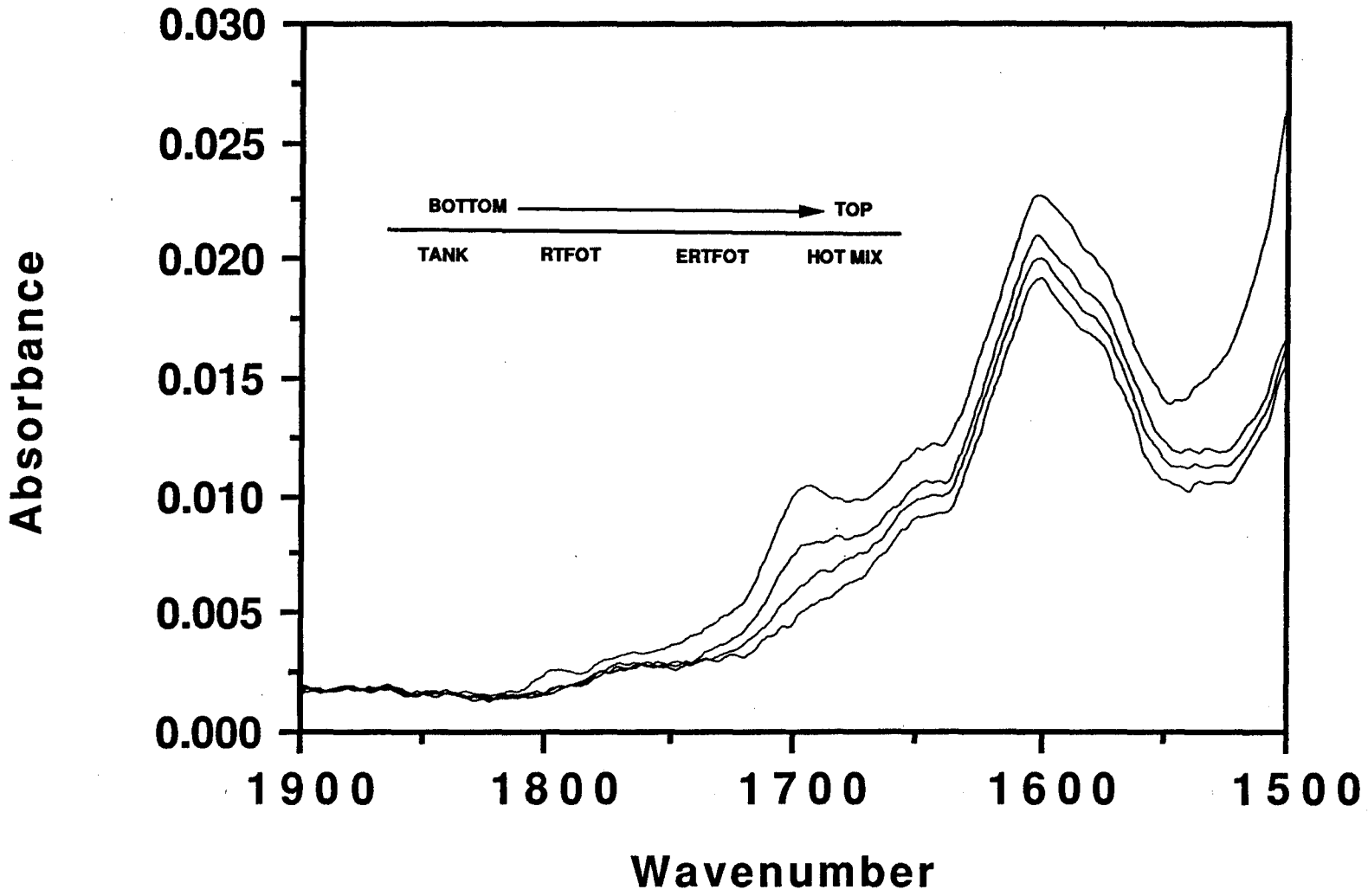

Figure C-96
Comparison of FT-IR Spectra (ATR Method) of Carbonyl Region for Tank, RTFOT, ERTFOT and Hot Mix-1989 Ampet AC-20 (Batch)

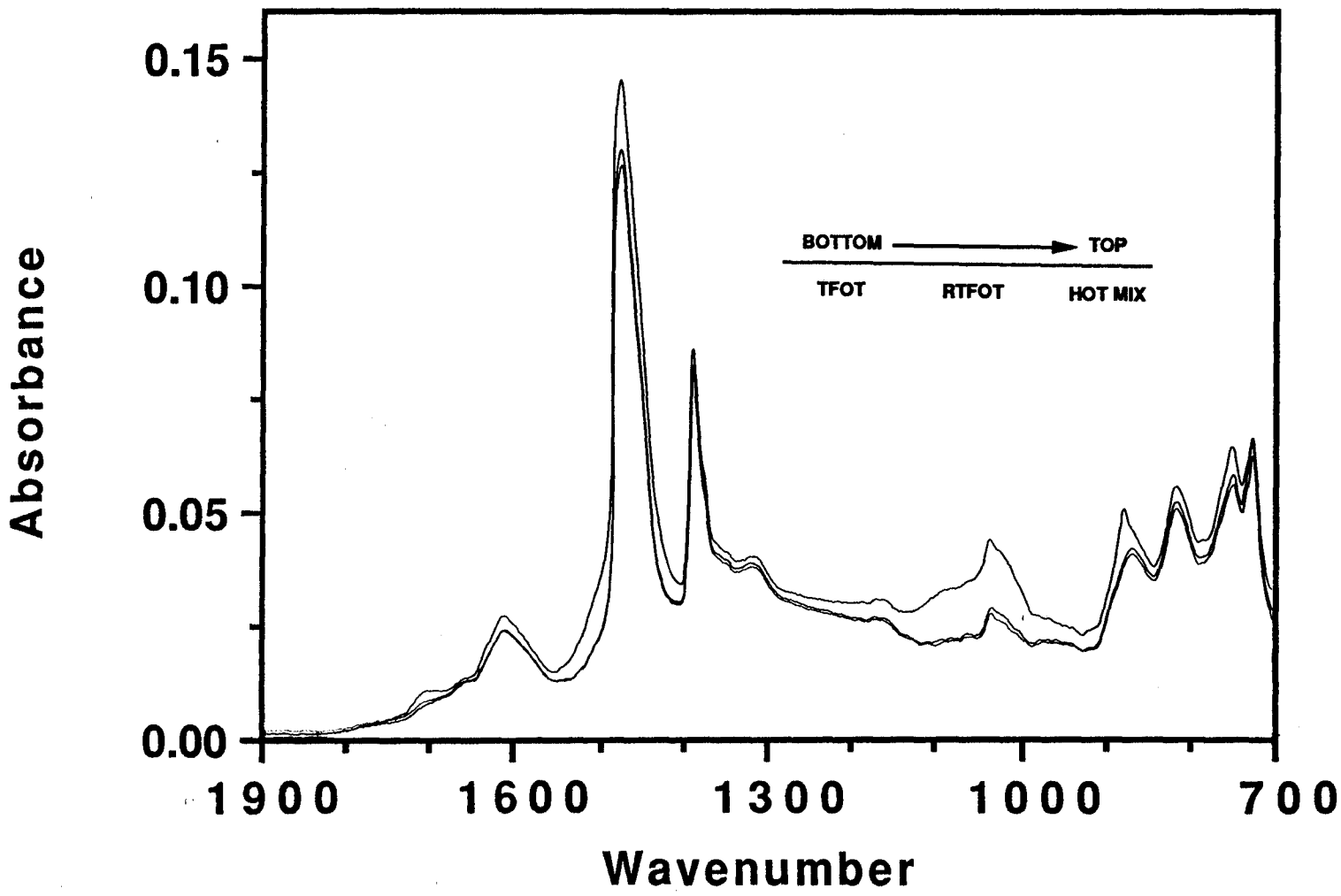

Figure C-97
Comparison of FT-IR Spectra (ATR Method) for TFOT, RTFOT and Hot Mix-1987 Coastal AC-20

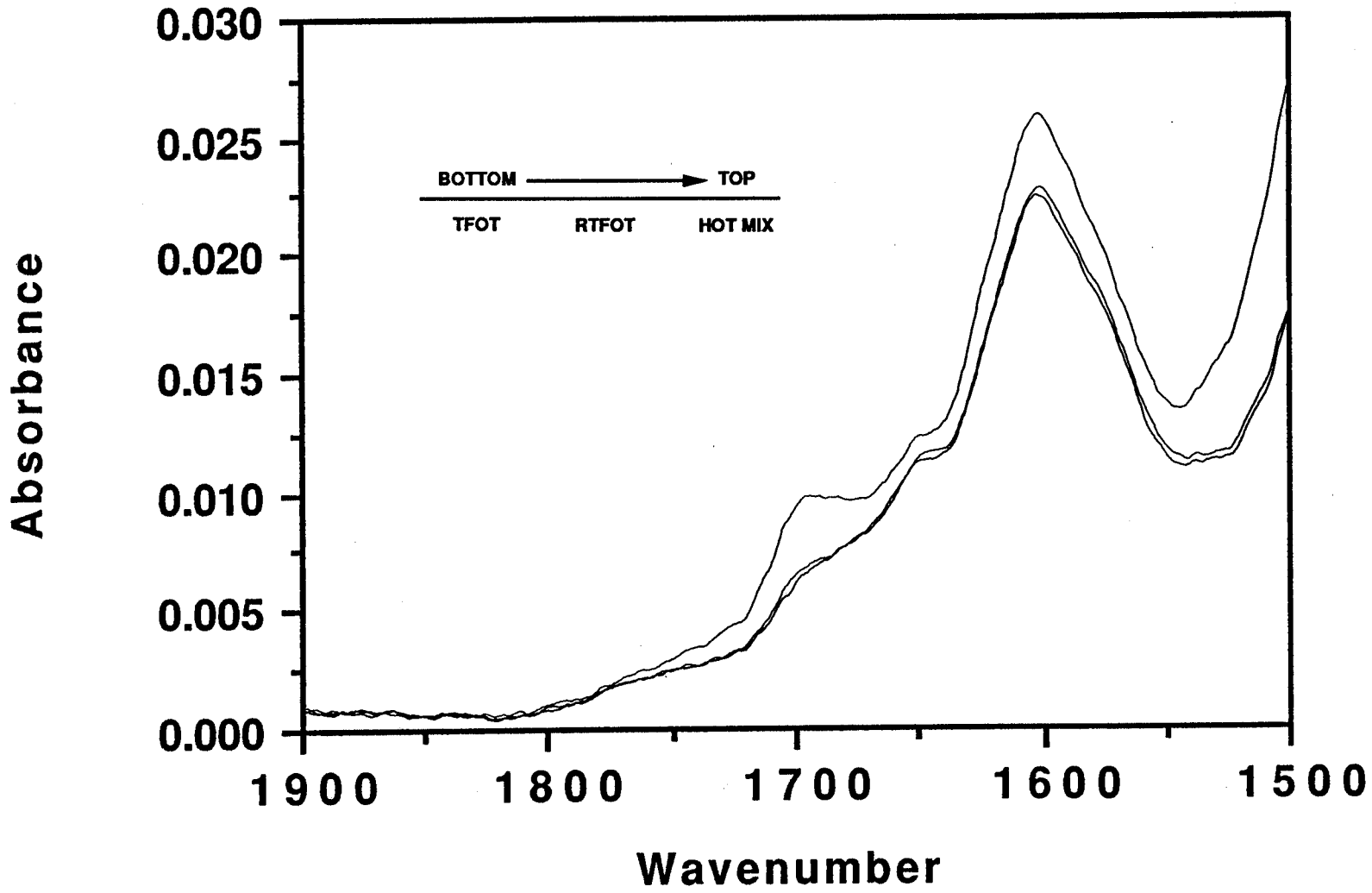

Figure C-98
Comparison of Carbonyl Region of FT-IR Spectra (ATR Method) for
TFOT, RTFOT and Hot Mix-1987 Coastal AC-20

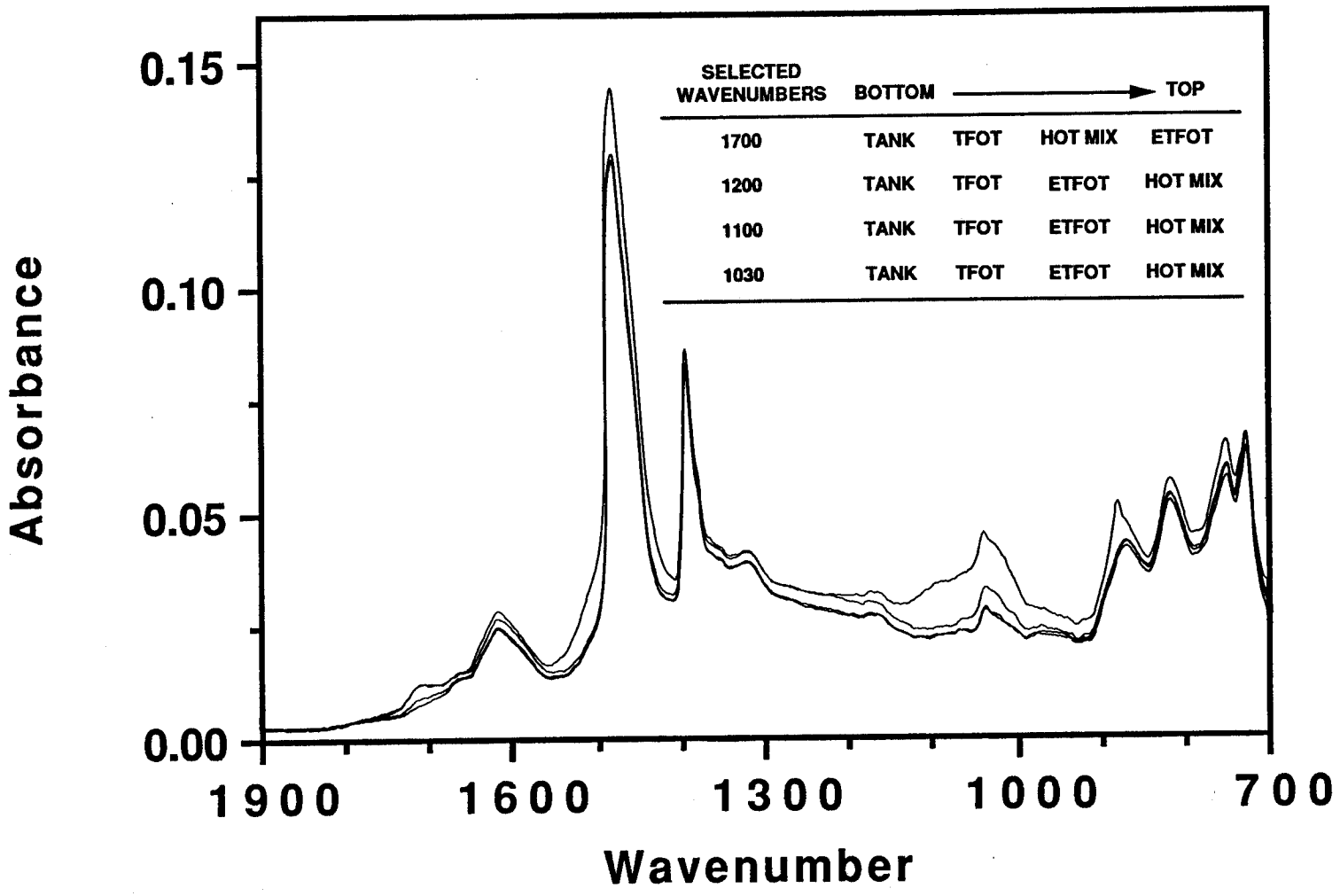

Figure C-99
Comparison of FT-IR Spectra (ATR Method) for Tank, TFOT, ETFOT and Hot Mix-1987 Coastal AC-20

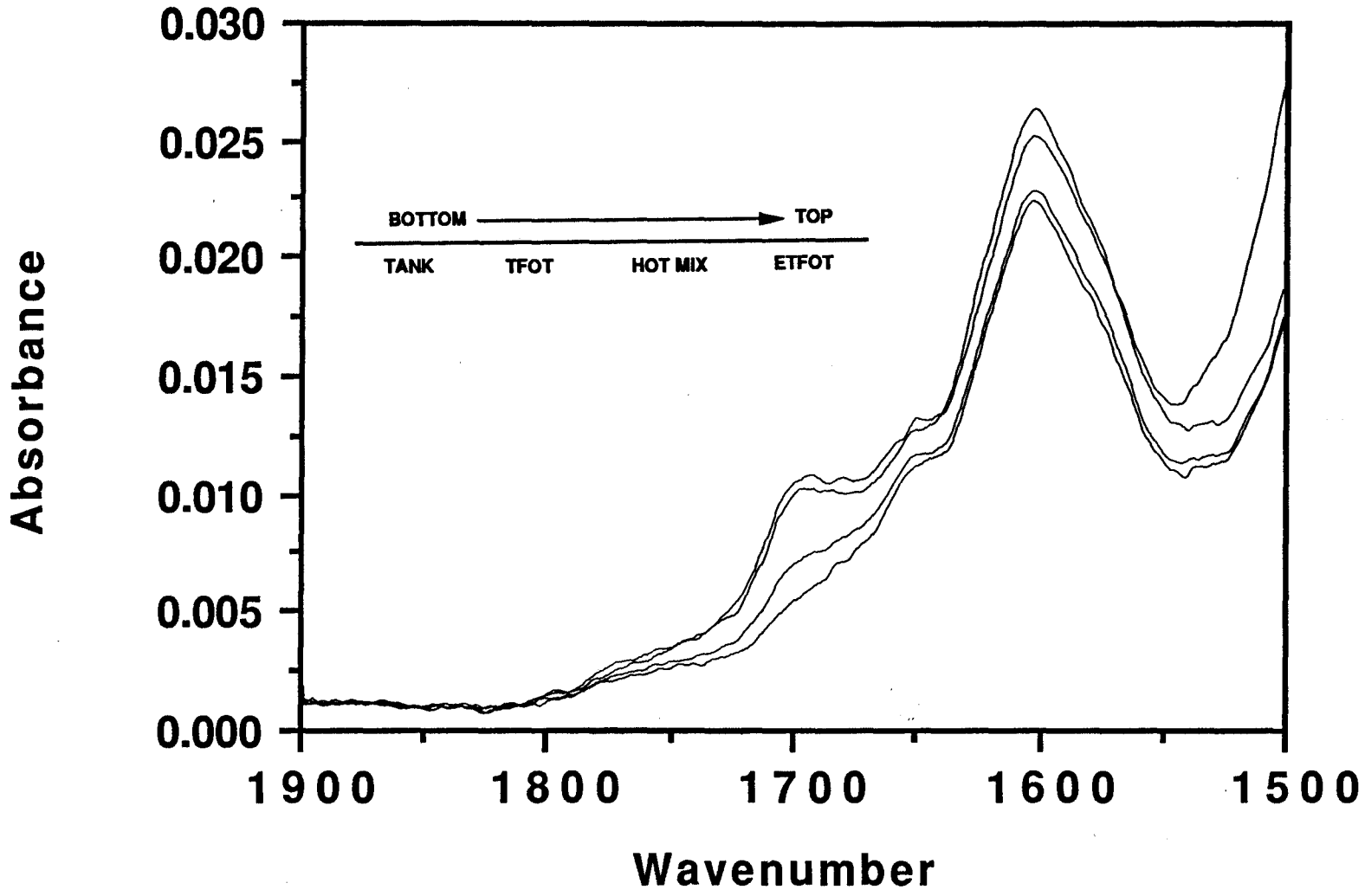

Figure C-100
Comparison of Carbonyl Region of FT-IR Spectra (ATR Method) for
Tank, TFOT, ETFOT and Hot Mix-1987 Coastal AC-20

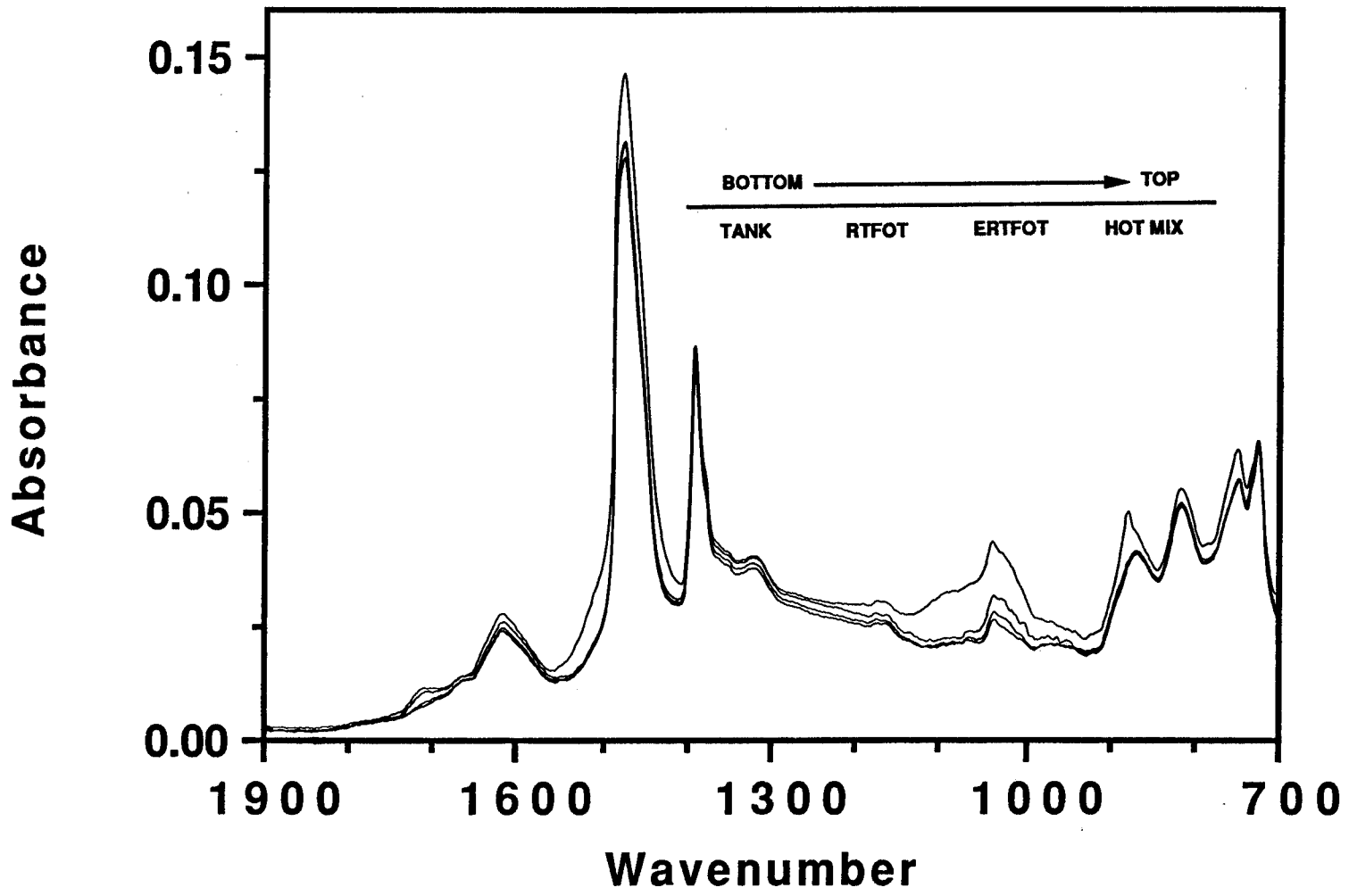

Figure C-101
Comparison of FT-IR Spectra (ATR Method) for Tank, RTFOT, ERTFOT, and Hot Mix-1987 Coastal AC-20

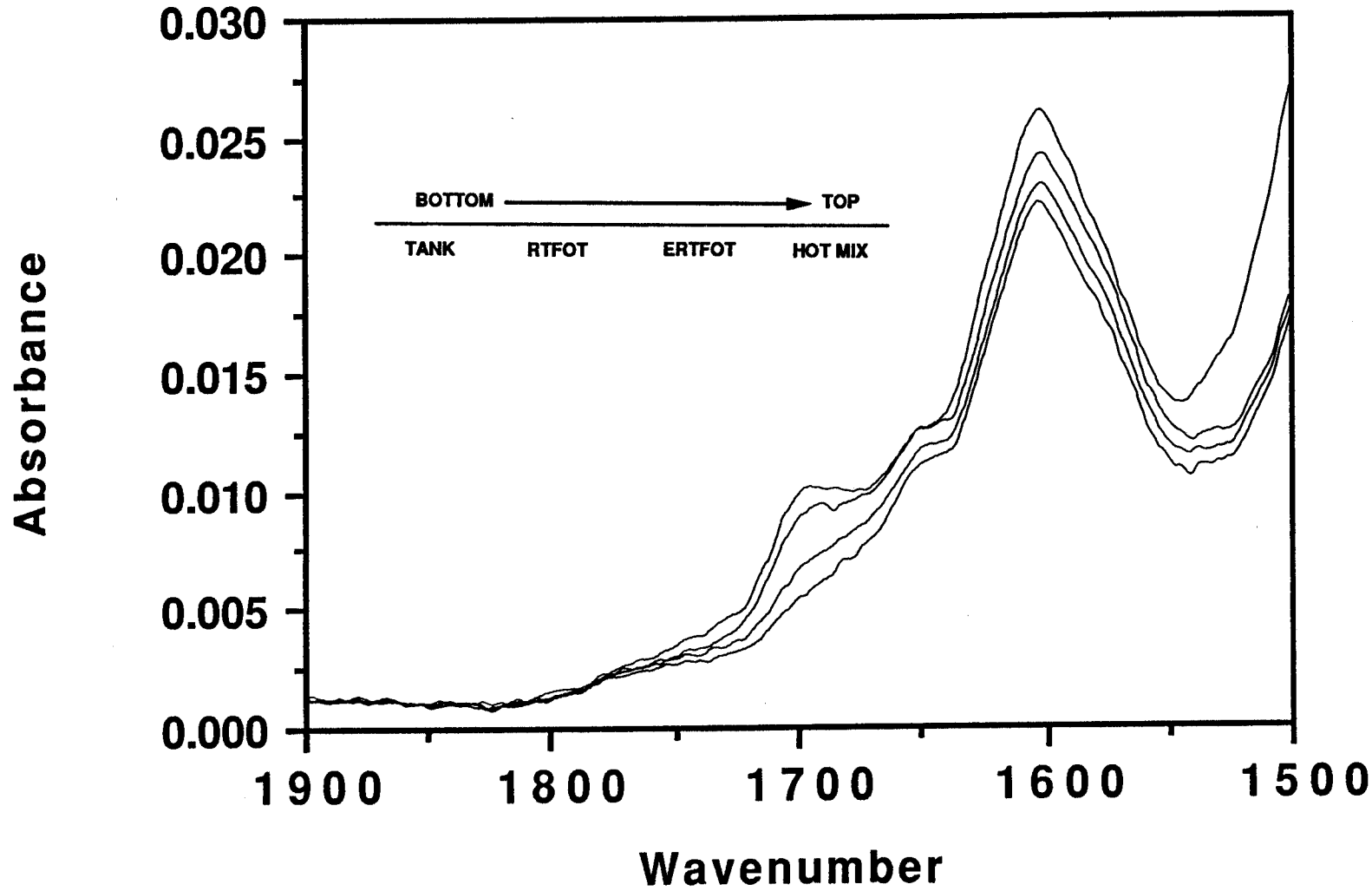

Figure C-102
Comparison of FT-IR Spectra (ATR Method) of Carbonyl Region
for Tank, RTFOT, ERTFOT and Hot Mix-1987 Coastal AC-20

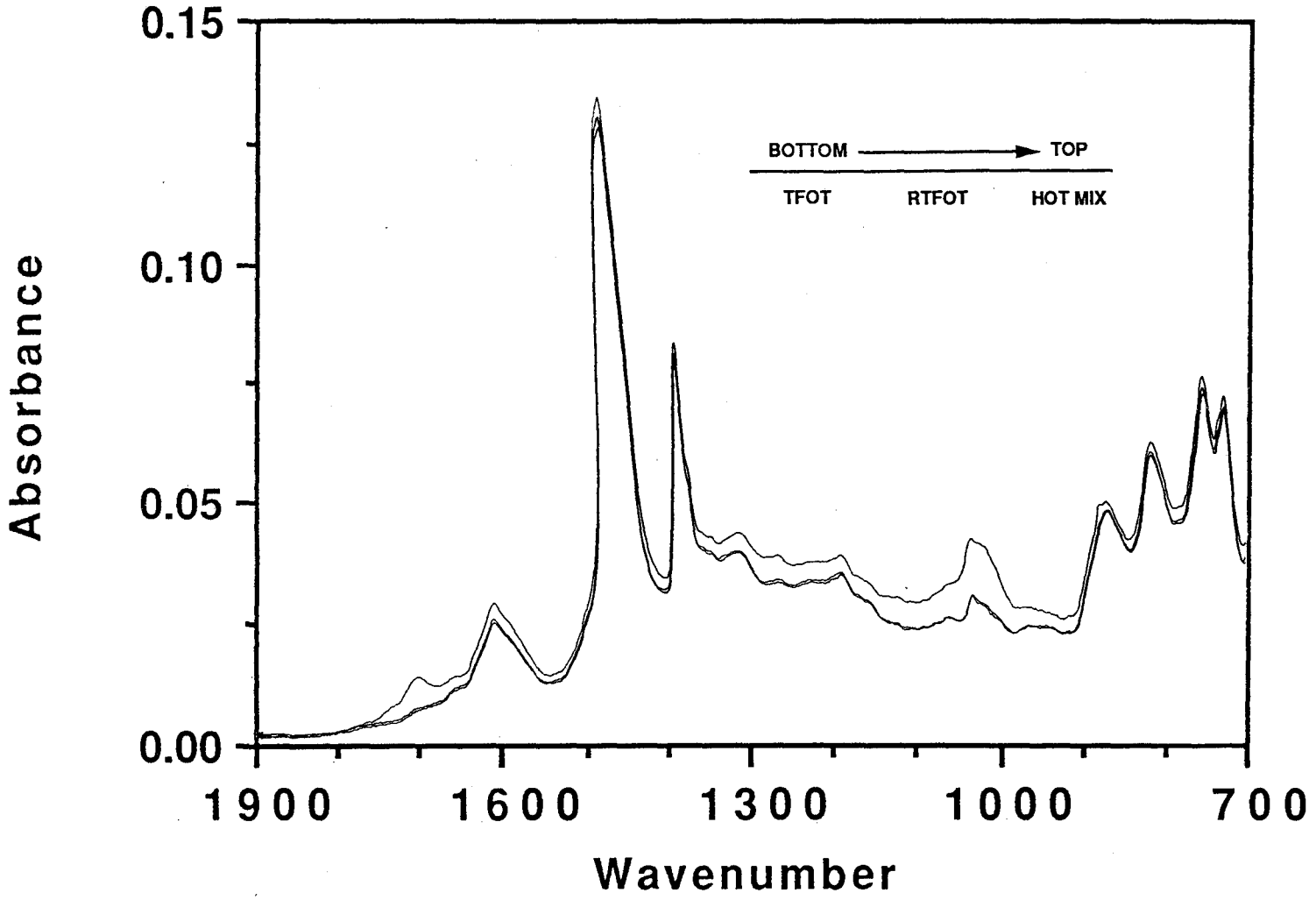

Figure C-103
Comparison of FT-IR Spectra (ATR Method) for TFOT, RTFOT and Hot Mix-1989 Cosden AC-10

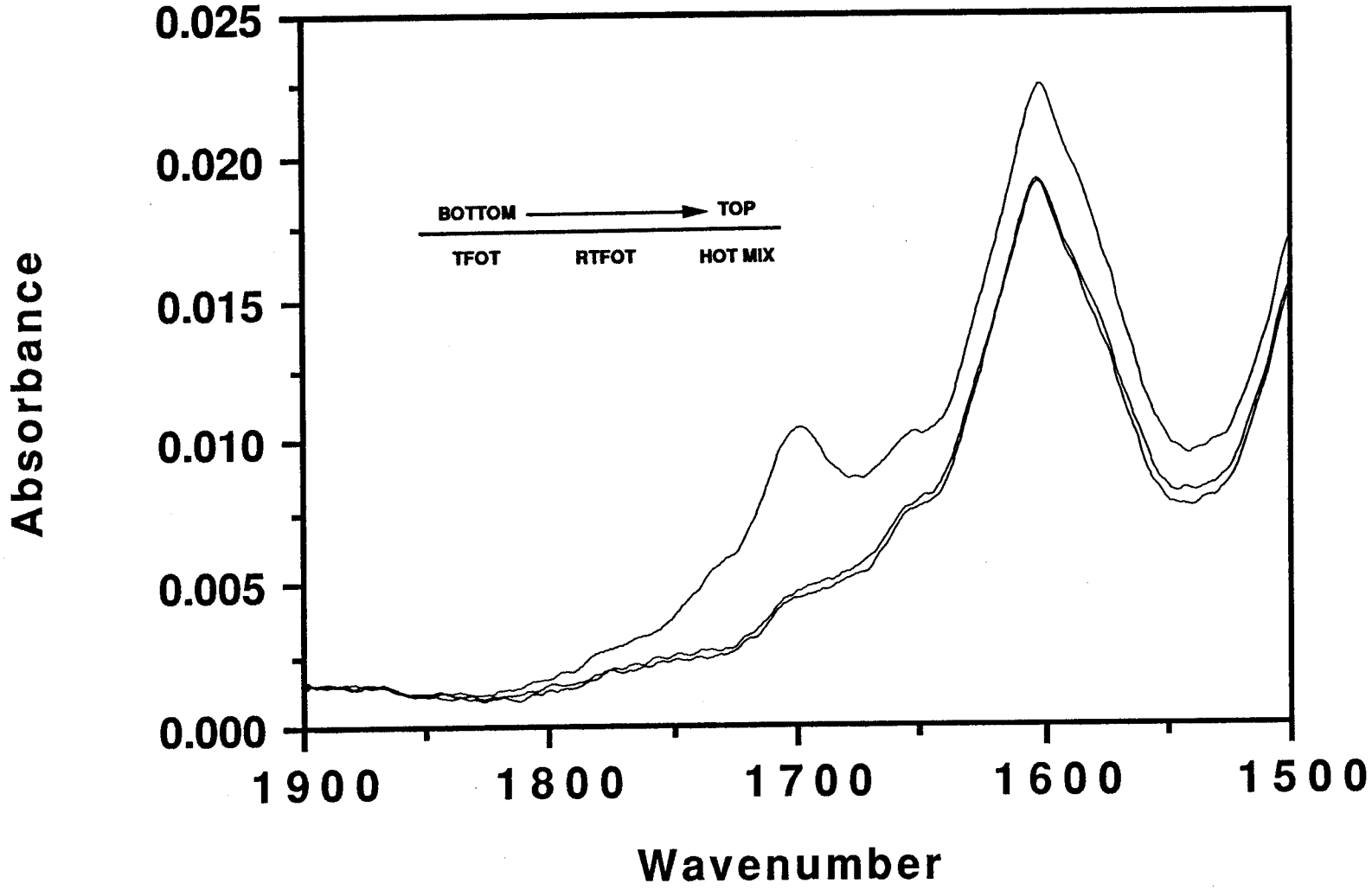

Figure C-104
Comparison of Carbonyl Region of FT-IR Spectra (ATR Method) for
TFOT, RTFOT and Hot Mix-1989 Cosden AC-10

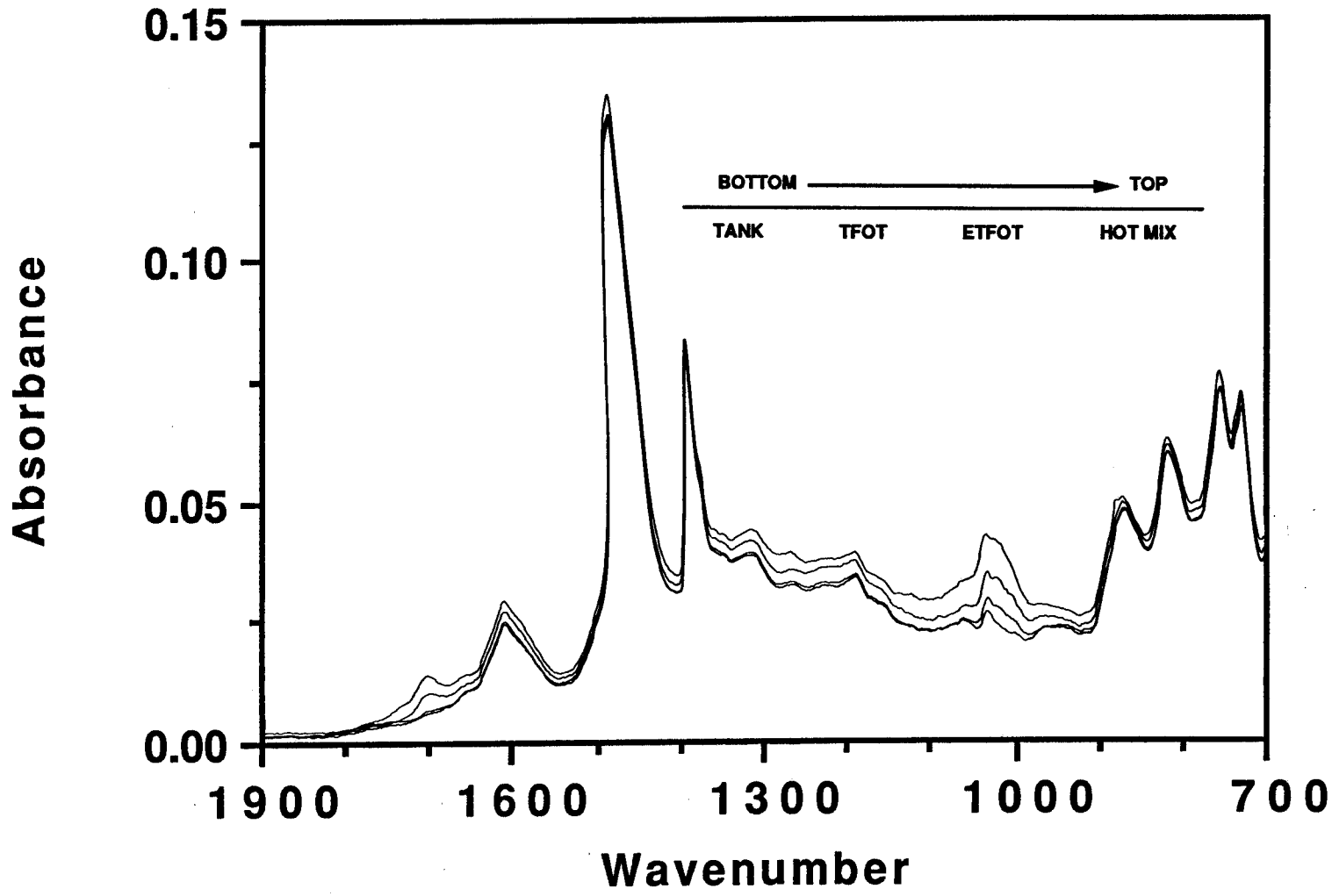

Figure C-105
Comparison of FT-IR Spectra (ATR Method) for Tank, TFOT, ETFOT
and Hot Mix-1989 Cosden AC-10

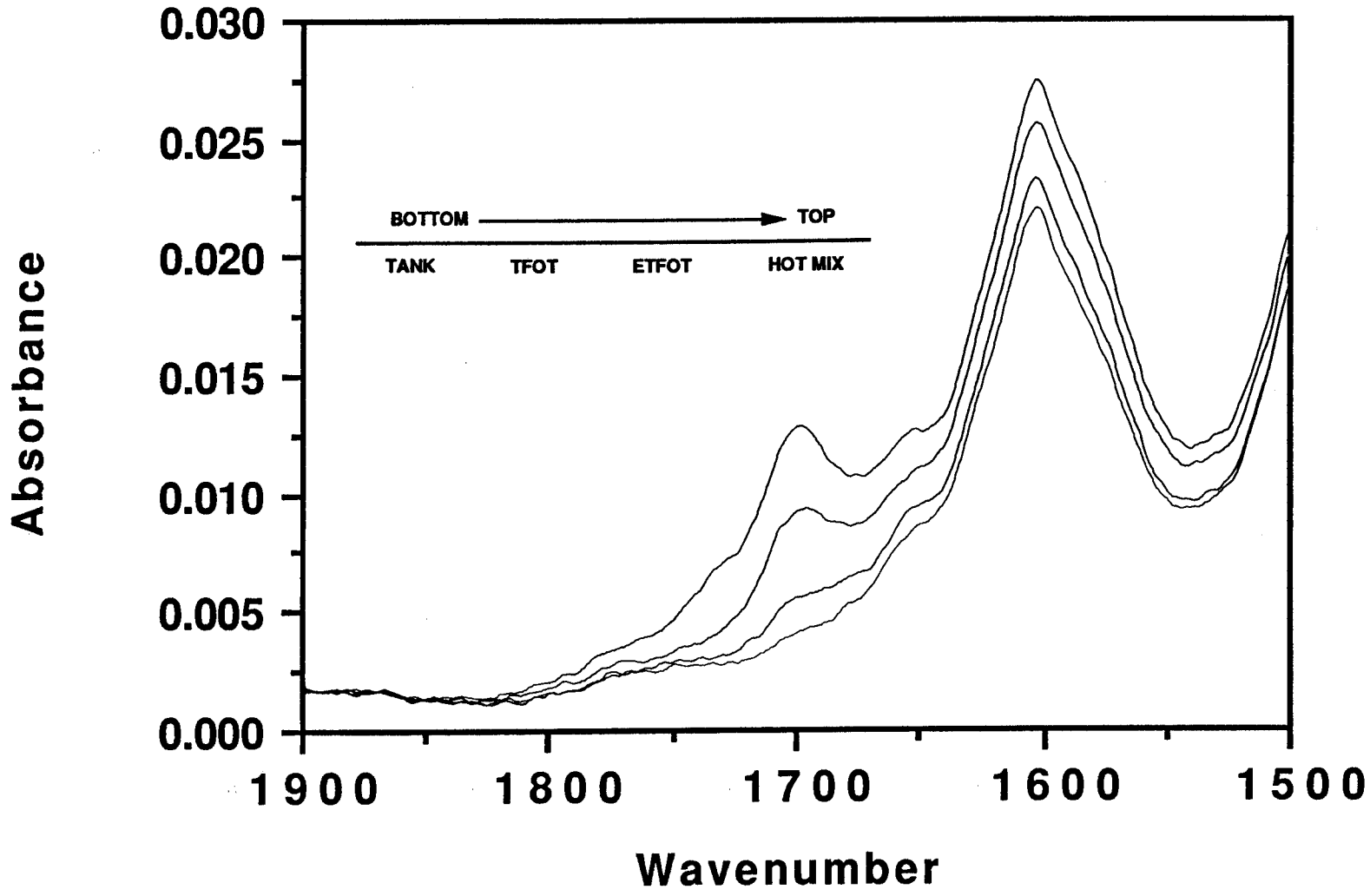

Figure C-106
Comparison of Carbonyl Region of FT-IR Spectra (ATR Method) for
Tank, TFOT, ETFOT and Hot Mix- 1989 Cosden AC-10

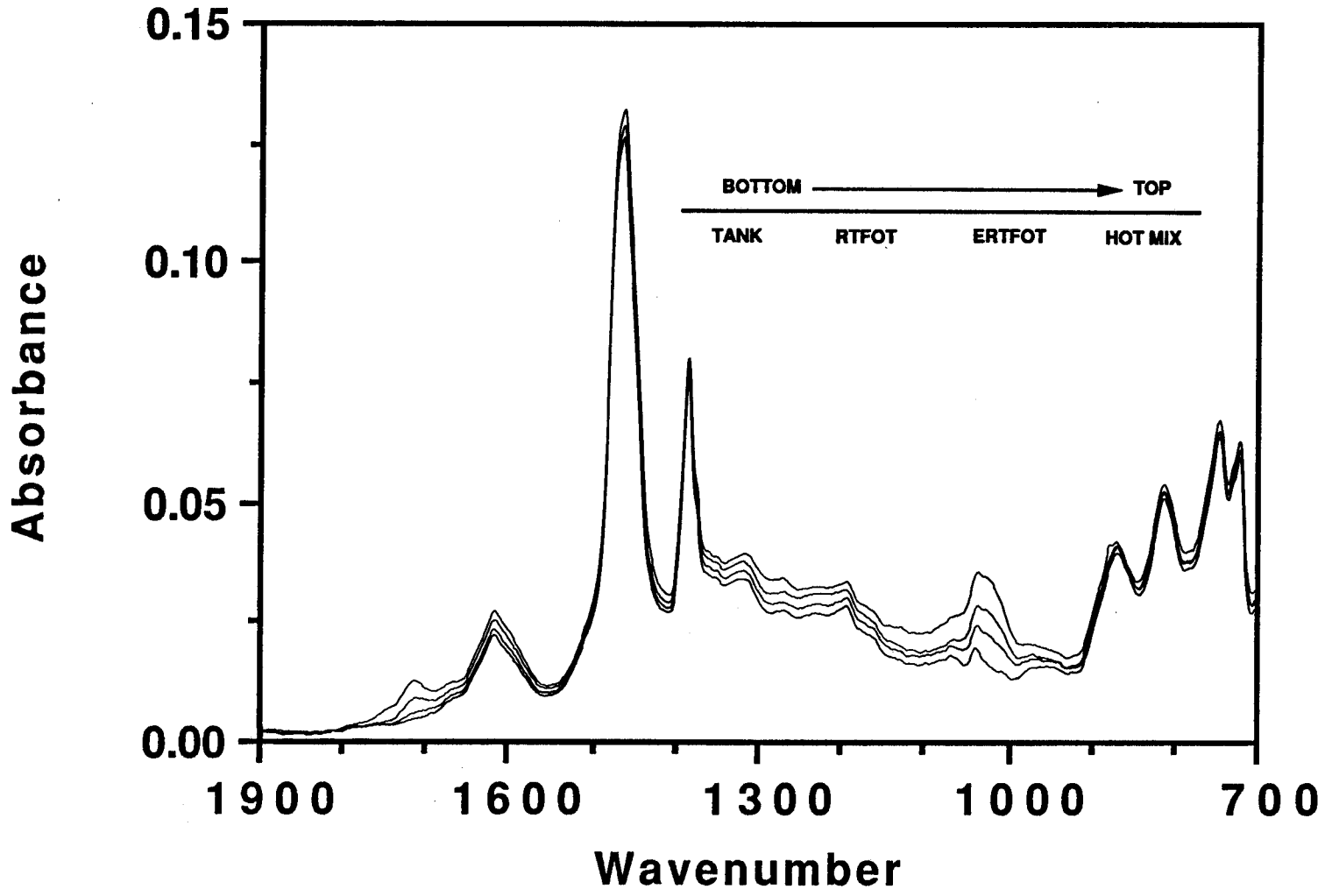

Figure C-107
Comparison of FT-IR Spectra (ATR Method) for Tank, RTFOT, ERTFOT and Hot Mix-1989 Cosden AC-10

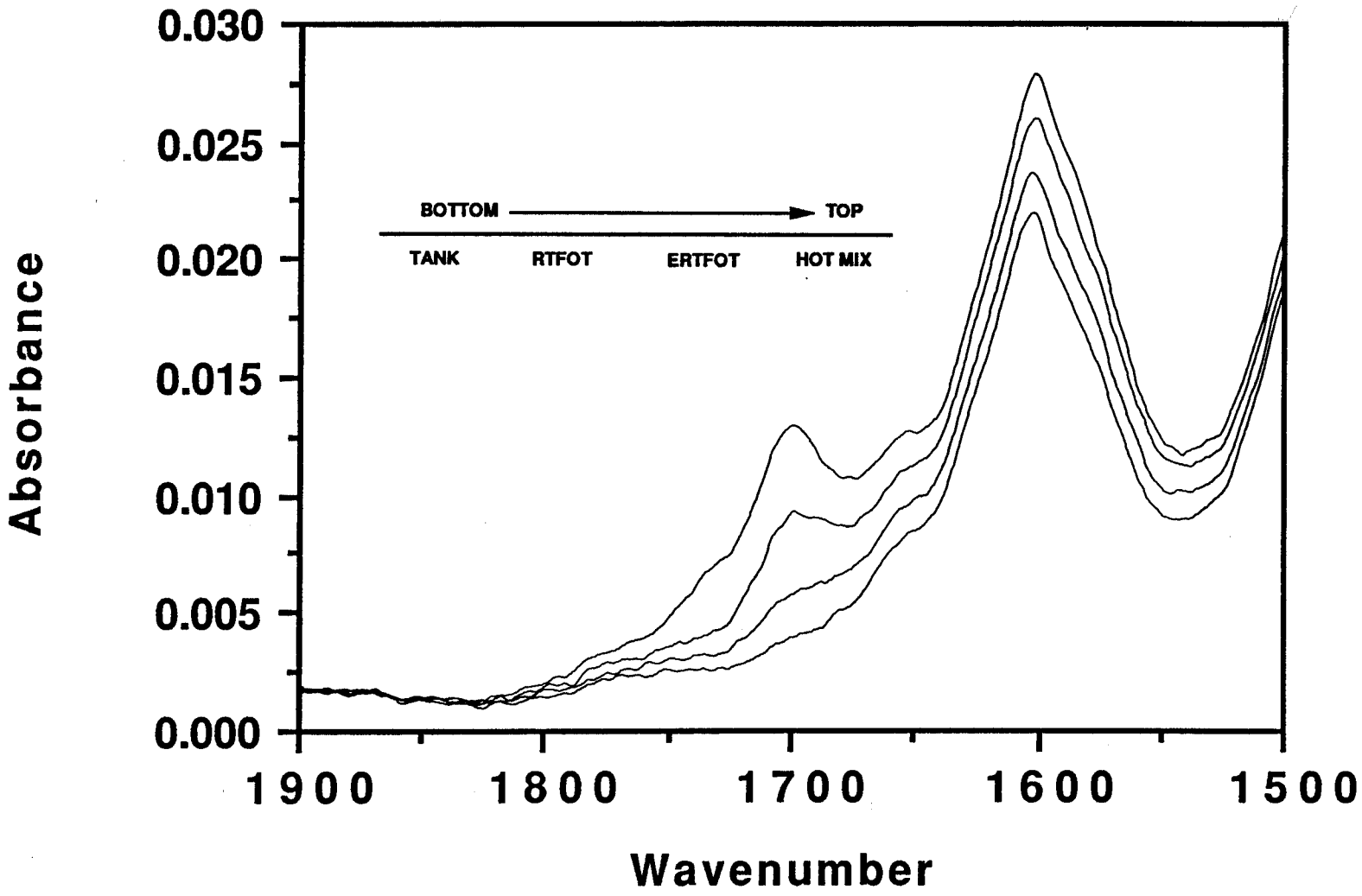

Figure C-108
Comparison of FT-IR Spectra (ATR Method) of Carbonyl Region
for Tank, RTFOT, ERTFOT and Hot Mix-1989 Cosden AC-10

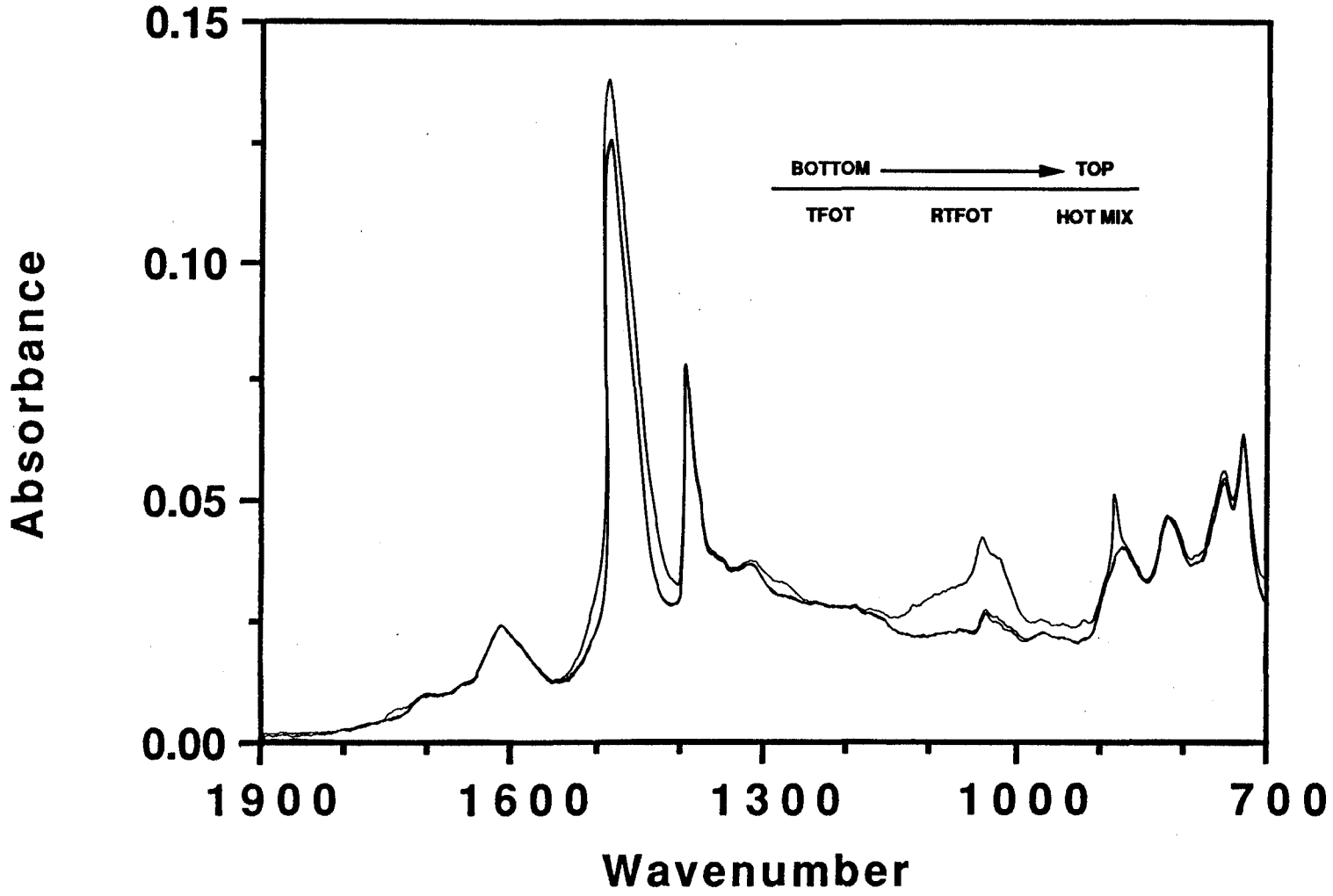

Figure C-109
Comparison of FT-IR Spectra (ATR Method) for TFOT, RTFOT and Hot Mix-1989 Cosden AC-20

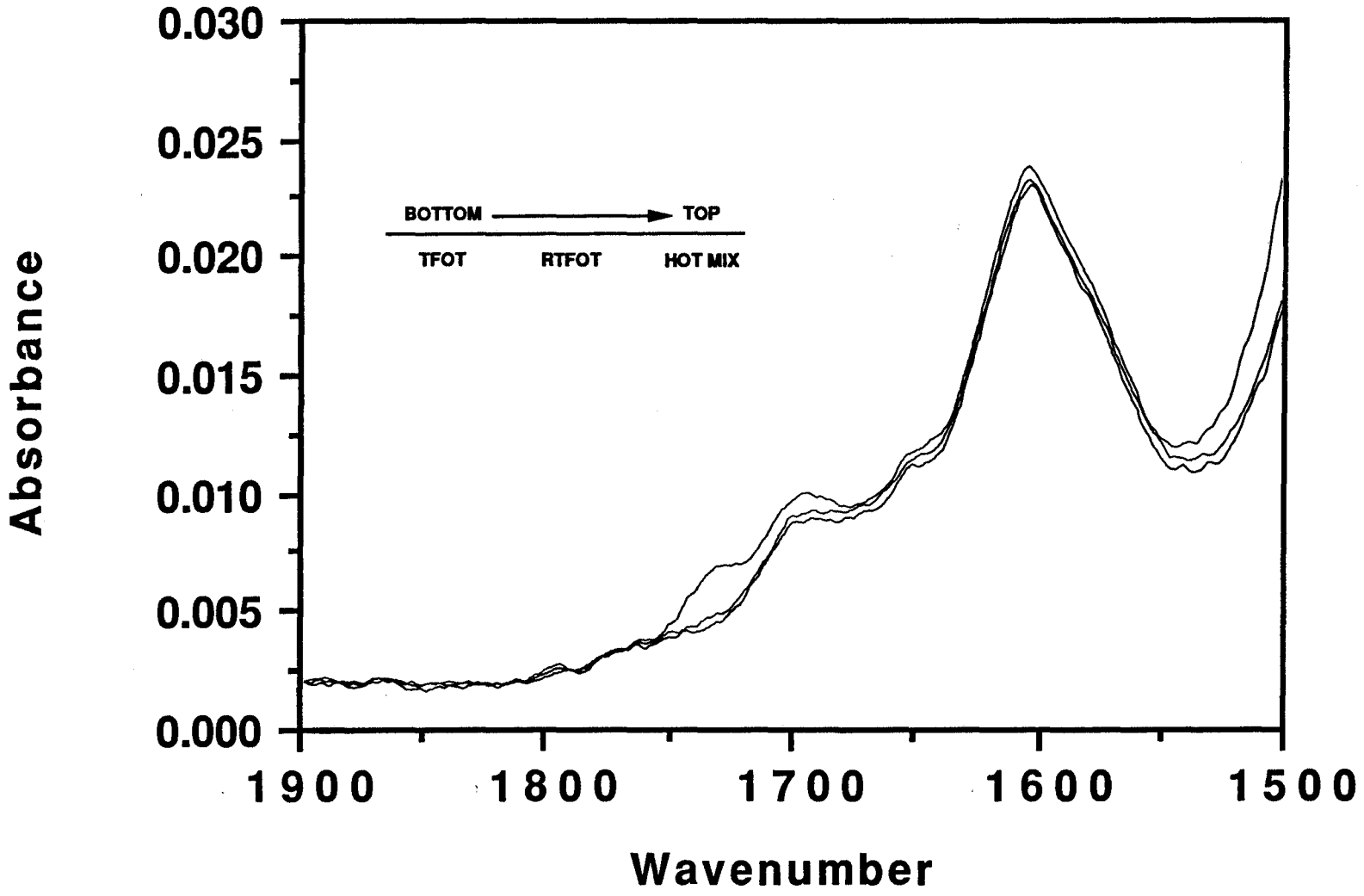

Figure C-110
Comparison of Carbonyl Region of FT-IR Spectra (ATR Method) for
TFOT, RTFOT and Hot Mix-1989 Cosden AC-20

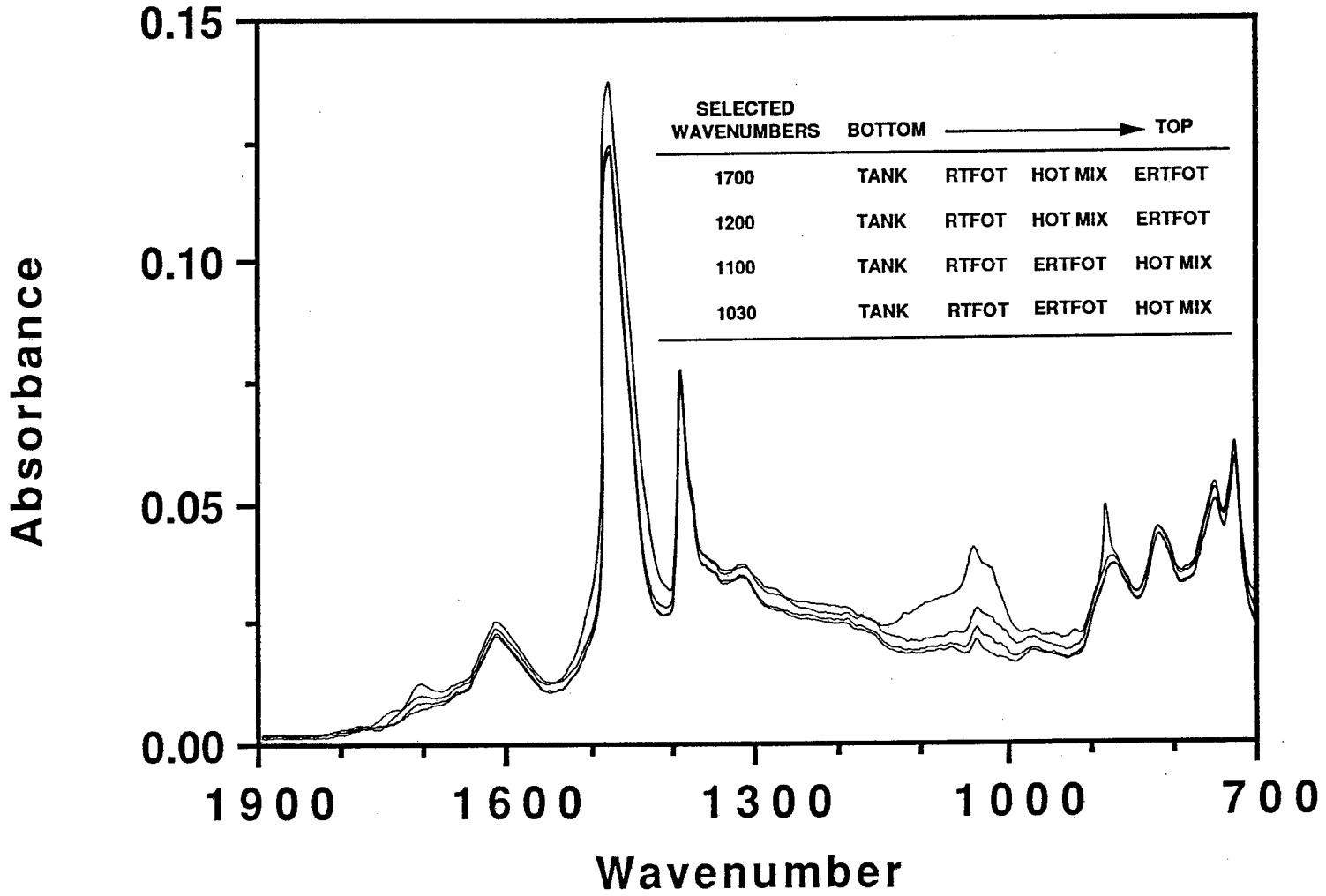

Figure C-111
Comparison of FT-IR Spectra (ATR Method) for Tank, RTFOT, Hot Mix and ERTFOT-1989 Cosden AC-20

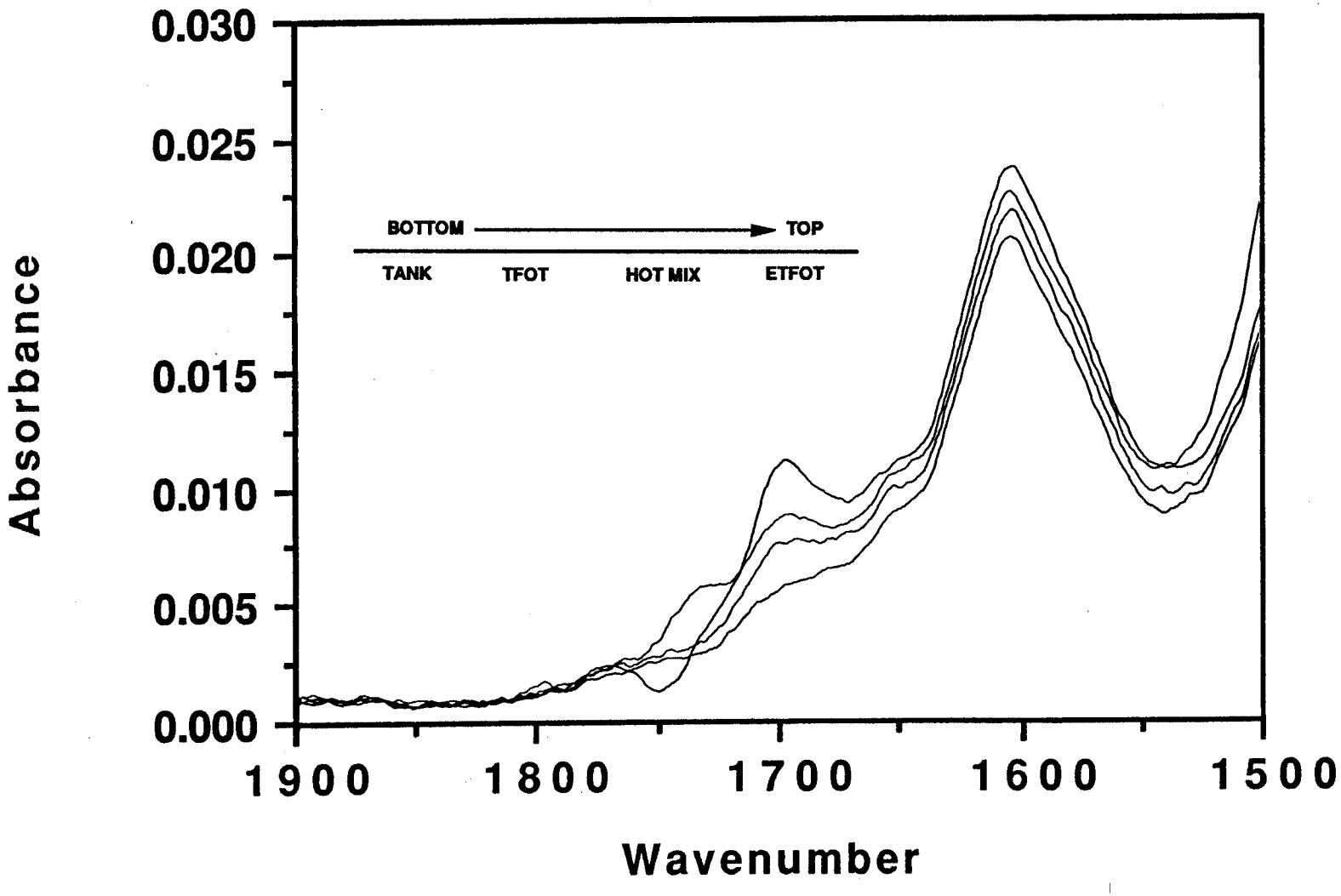

Figure C-112
Comparison of Carbonyl Region of FT-IR Spectra (ATR Method) for
Tank, TFOT and Hot Mix-1989 Cosden AC-20

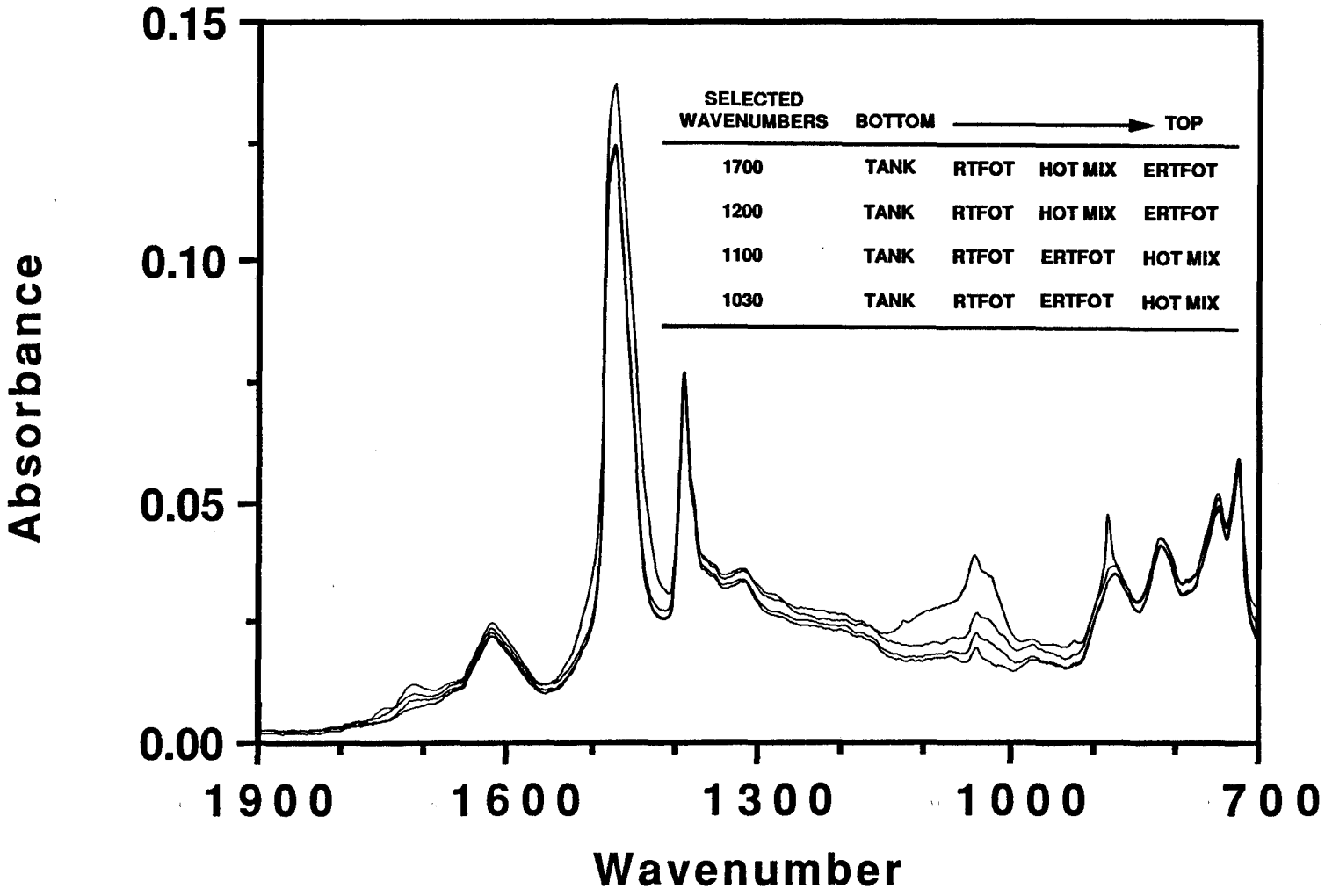

Figure C-113
Comparison of FT-IR Spectra (ATR Method) for Tank, RTFOT, ERTFOT and Hot Mix-1989 Cosden AC-20

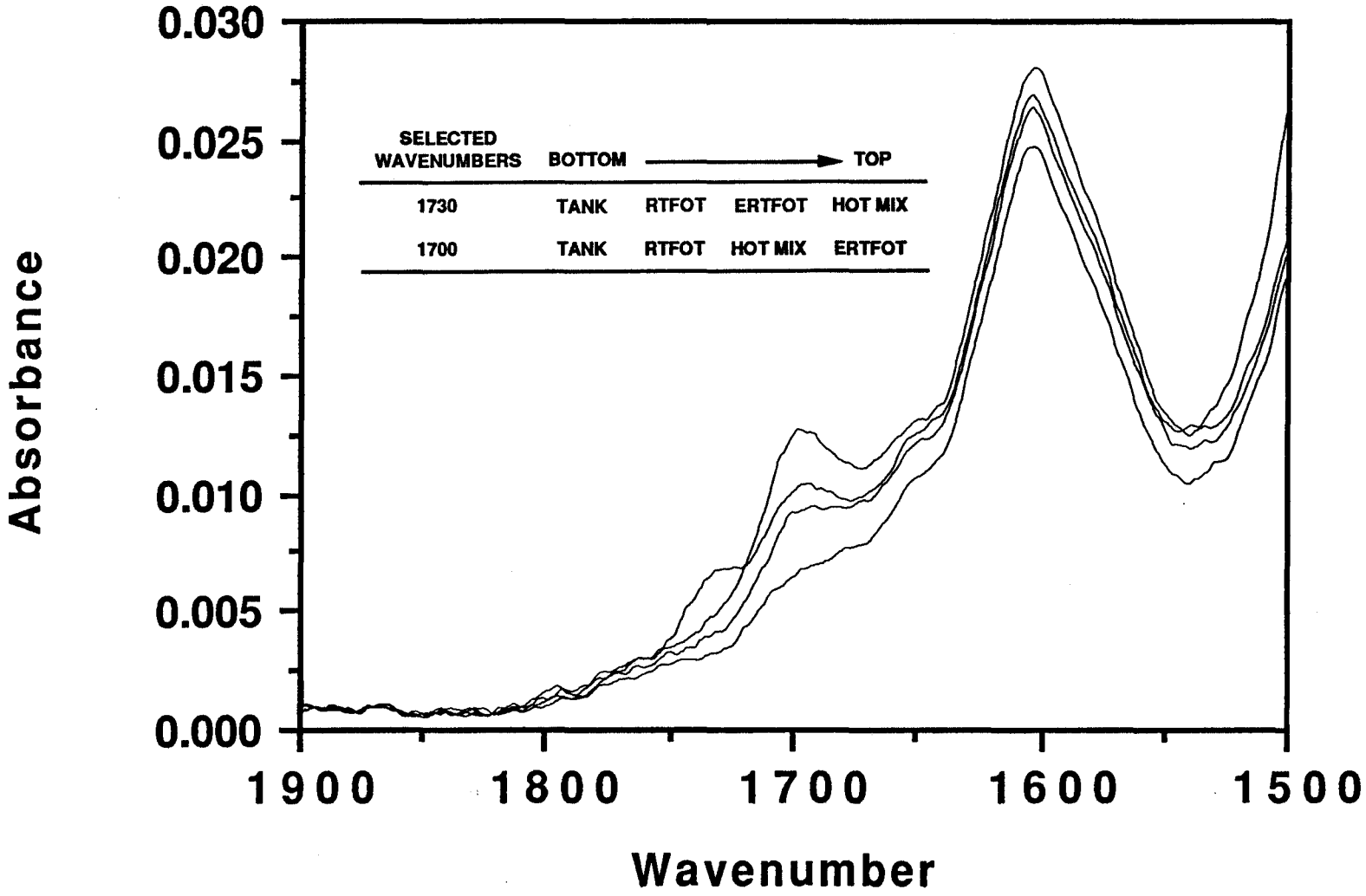

Figure C-114
Comparison of FT-IR Spectra (ATR Method) of Carbonyl Region of
Tank, RTFOT, ERTFOT and Hot Mix-1989 Cosden AC-20

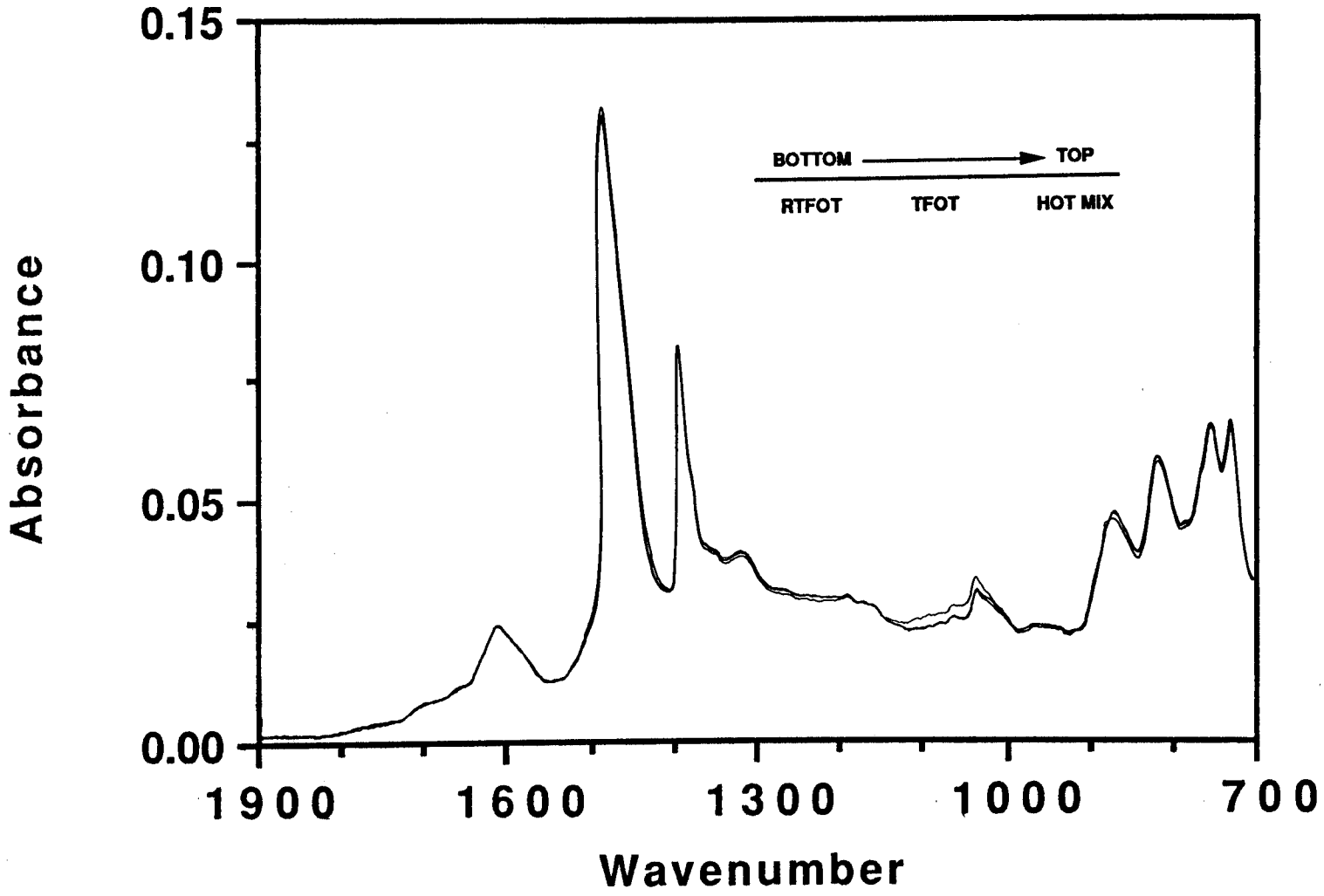

Figure C-115
Comparison of FT-IR Spectra (ATR Method) for RTFOT, TFOT and
Hot Mix-1987 Exxon AC-20 (Drum)

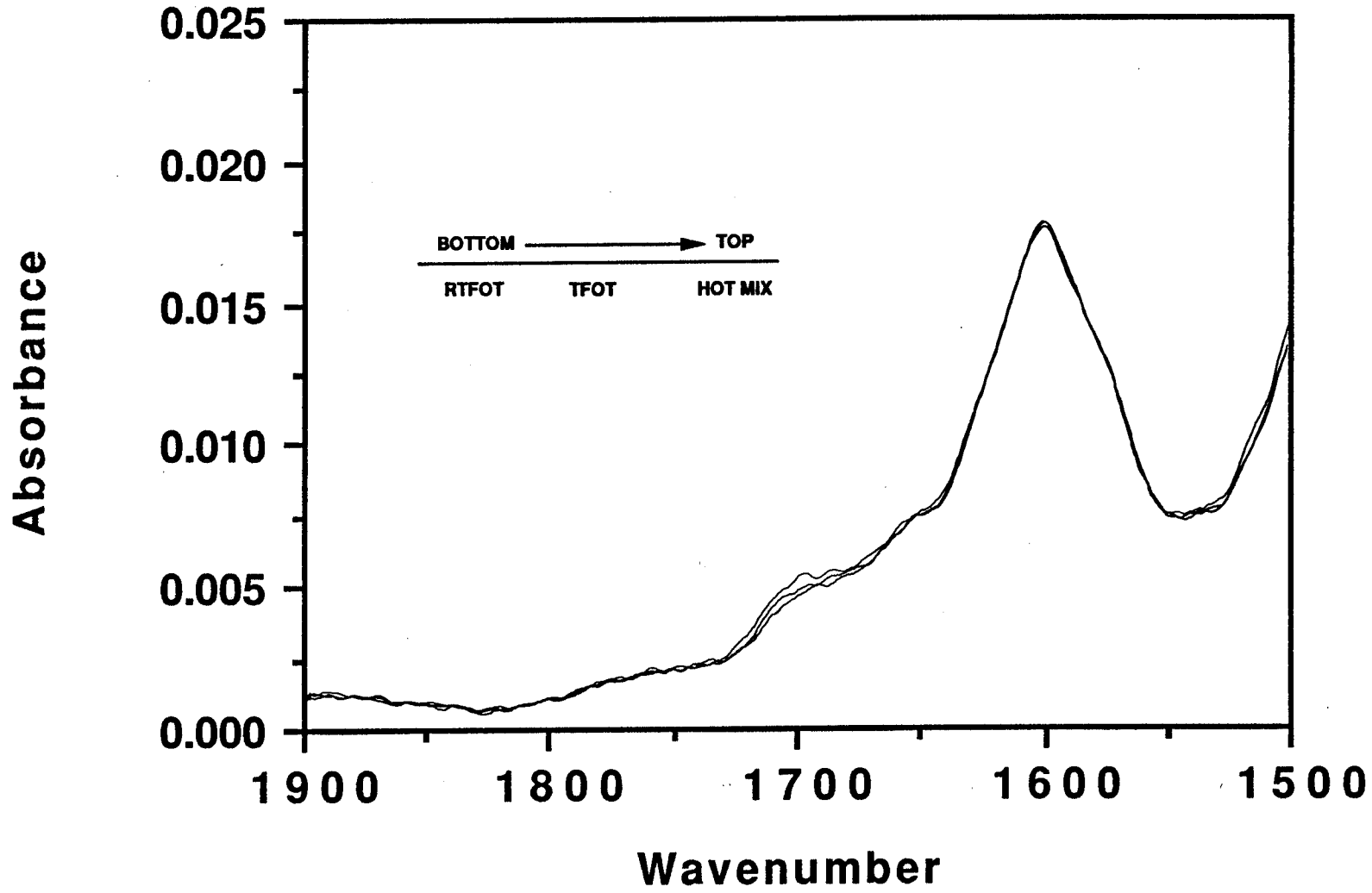

Figure C-116
Comparison of Carbonyl Region of FT-IR Spectra (ATR Method) of
RTFOT, TFOT and Hot Mix- 1987 Exxon AC-20 (Drum)

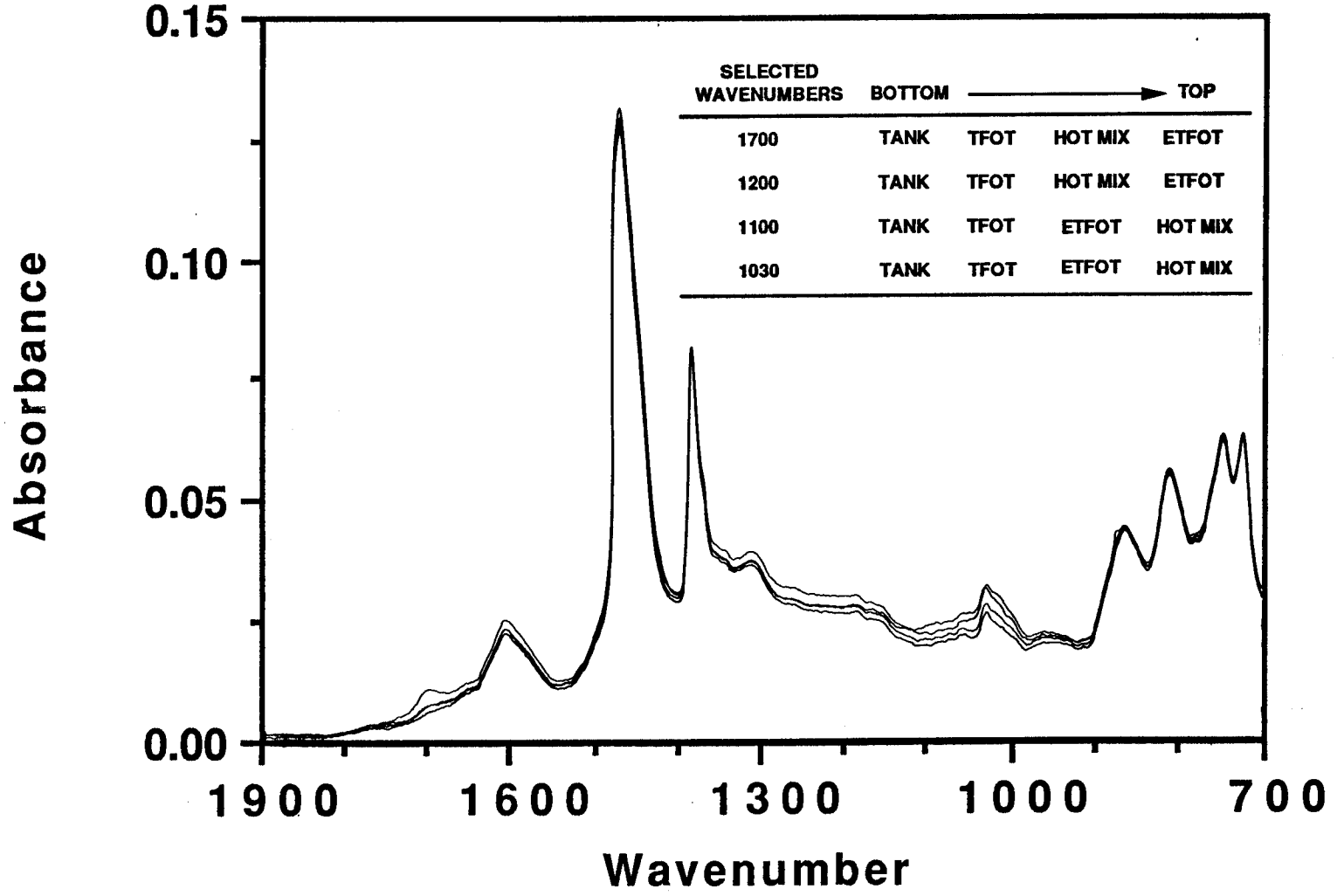

Figure C-117
Comparison of FT-IR Spectra (ATR Method) for Tank, TFOT, ETFOT
and Hot Mix-1987 Exxon AC-20 (Drum)

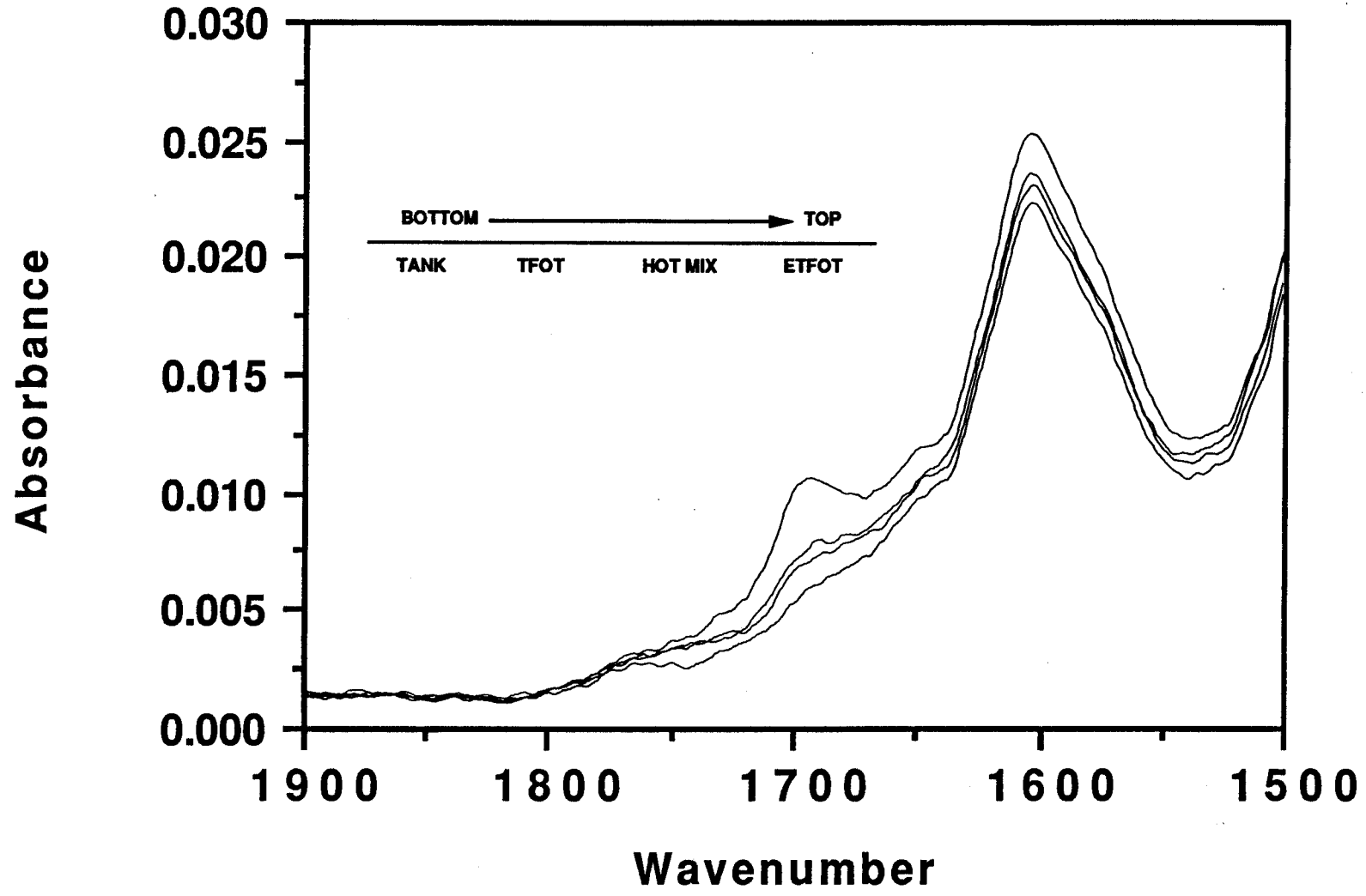

Figure C-118
Comparison of Carbonyl Region of FT-IR Spectra (ATR Method)
for Tank, TFOT, ETFOT and Hot Mix-1987 Exxon AC-20 (Drum)

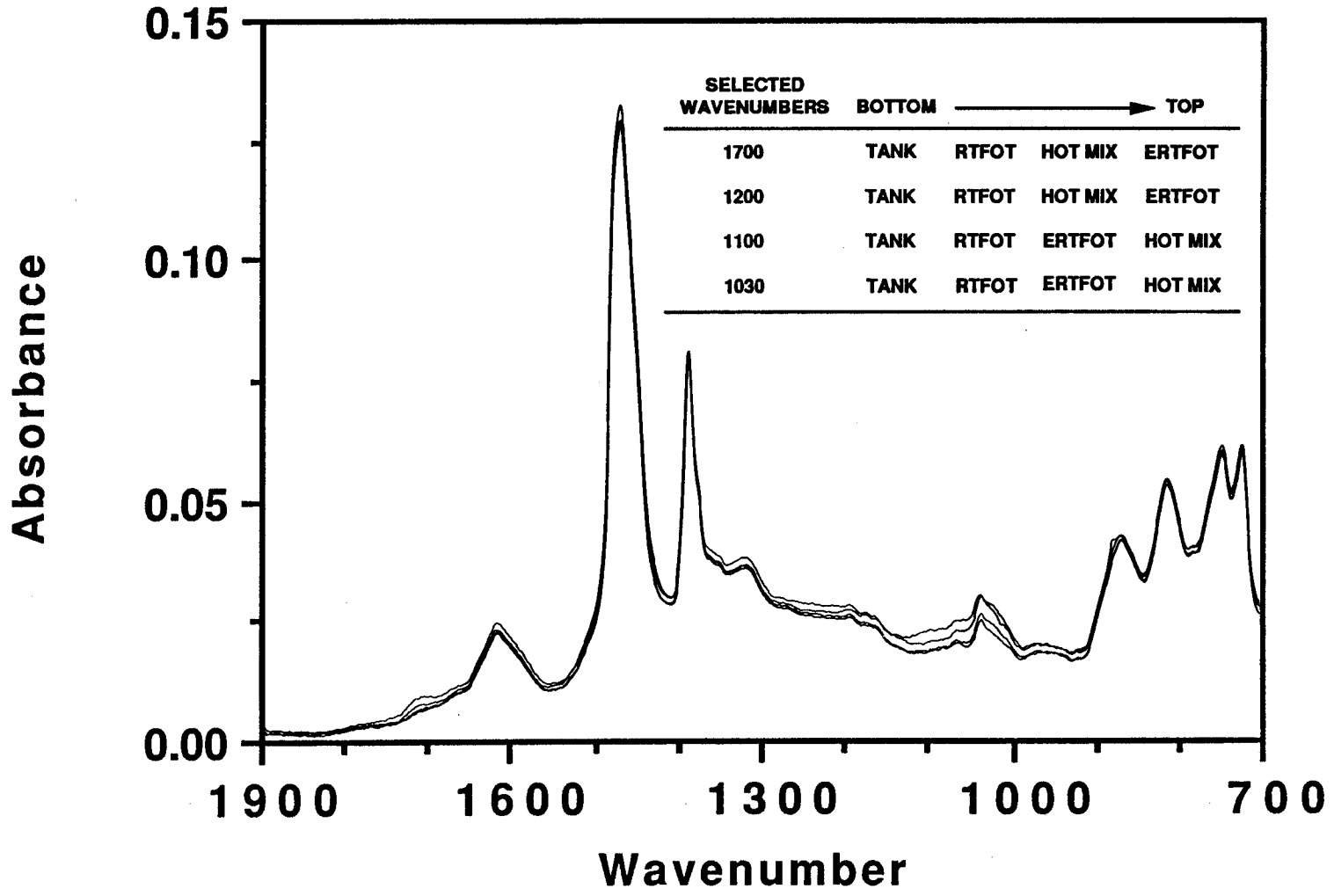

Figure C-119
Comparison of FT-IR Spectra (ATR Method) for Tank, RTFOT, ERTFOT and Hot Mix-1987 Exxon AC-20 (Drum)

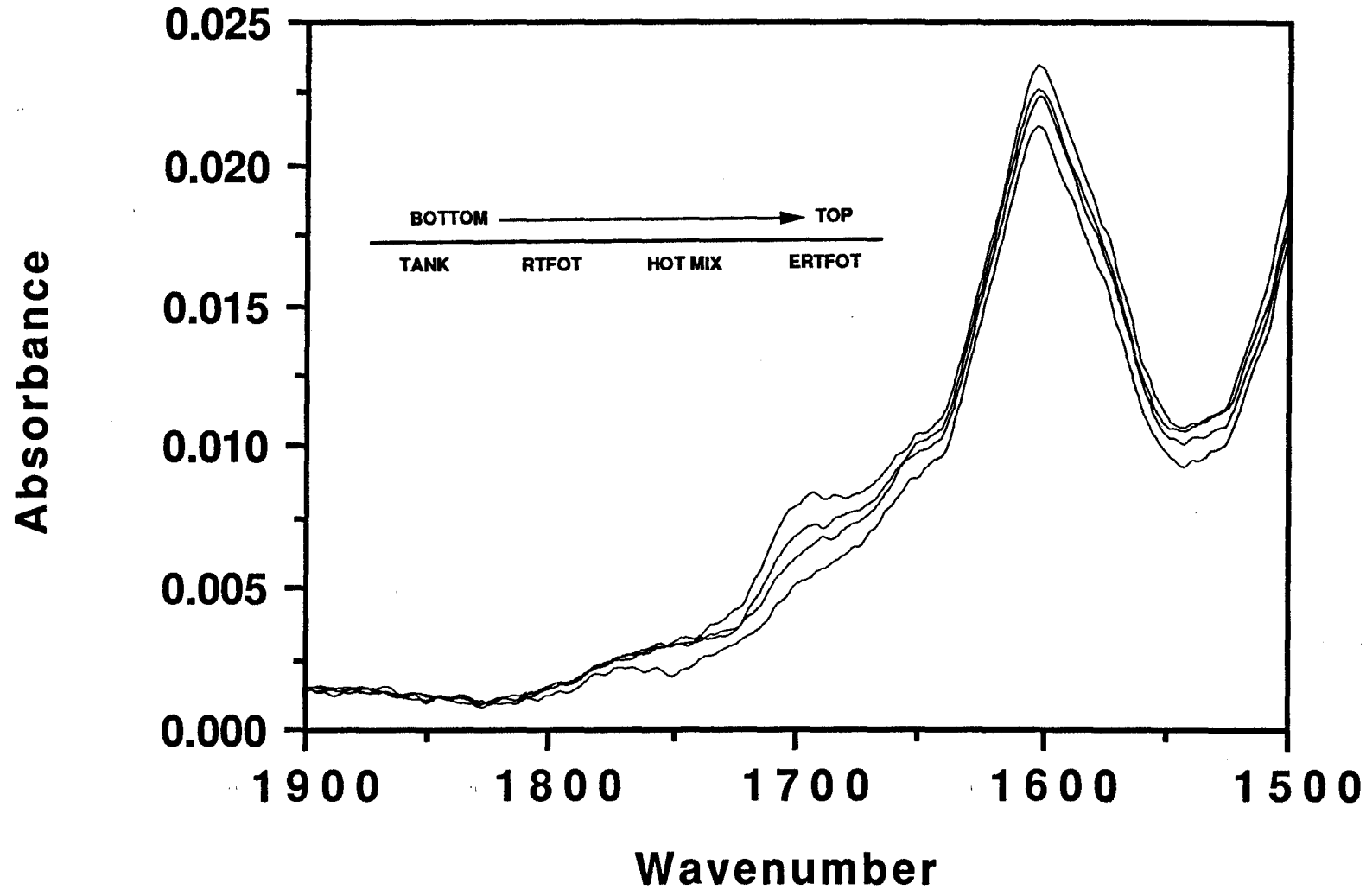

Figure C-120
Comparison of FT-IR Spectra (ATR Method) of Carbonyl Region for Tank, RTFOT, Hot Mix and ERTFOT-1987 Exxon AC-20 (Drum)

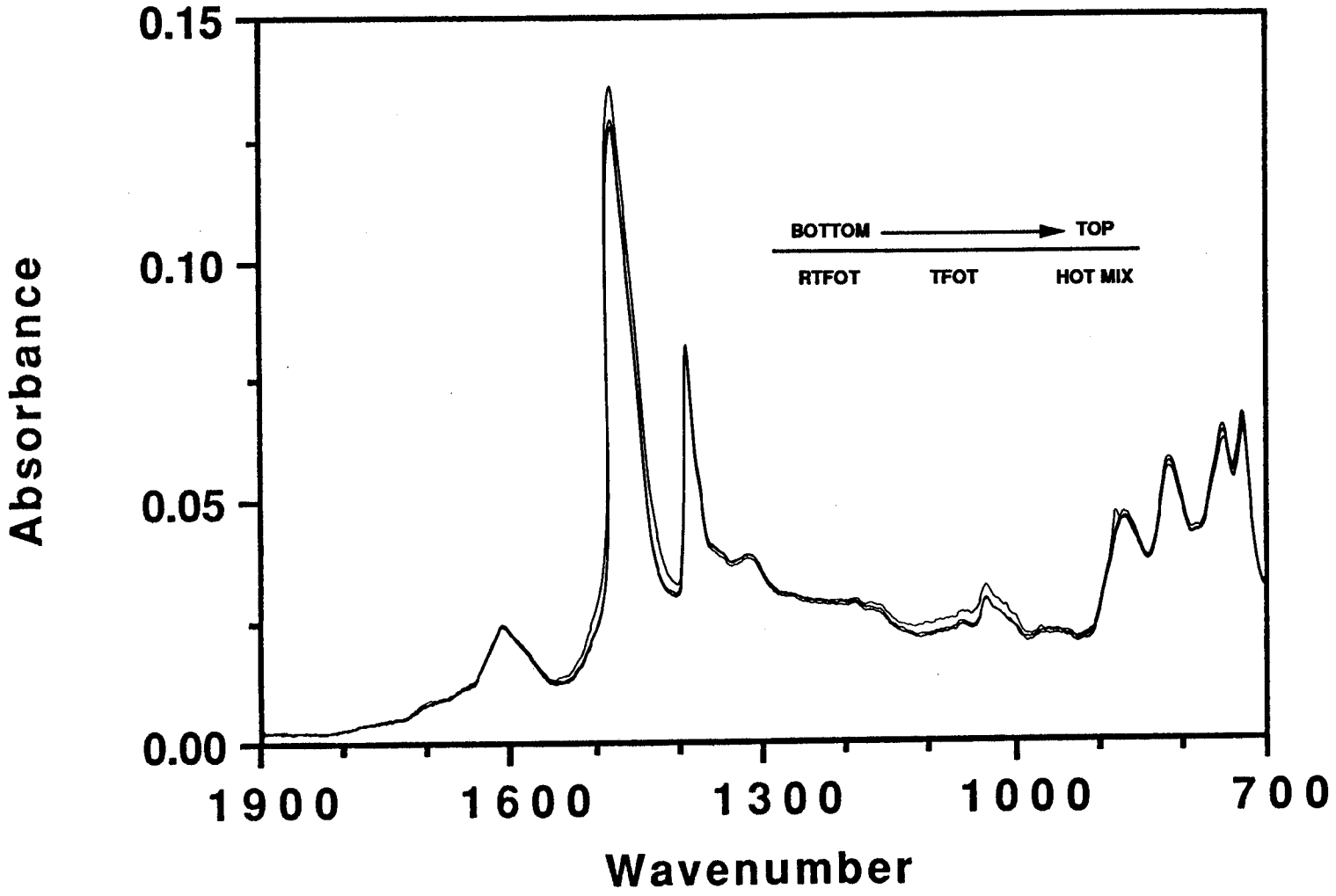

Figure C-121
Comparison of FT-IR Spectra (ATR Method) for RTFOT, TFOT and Hot Mix-1987 Exxon AC-20 (Batch)

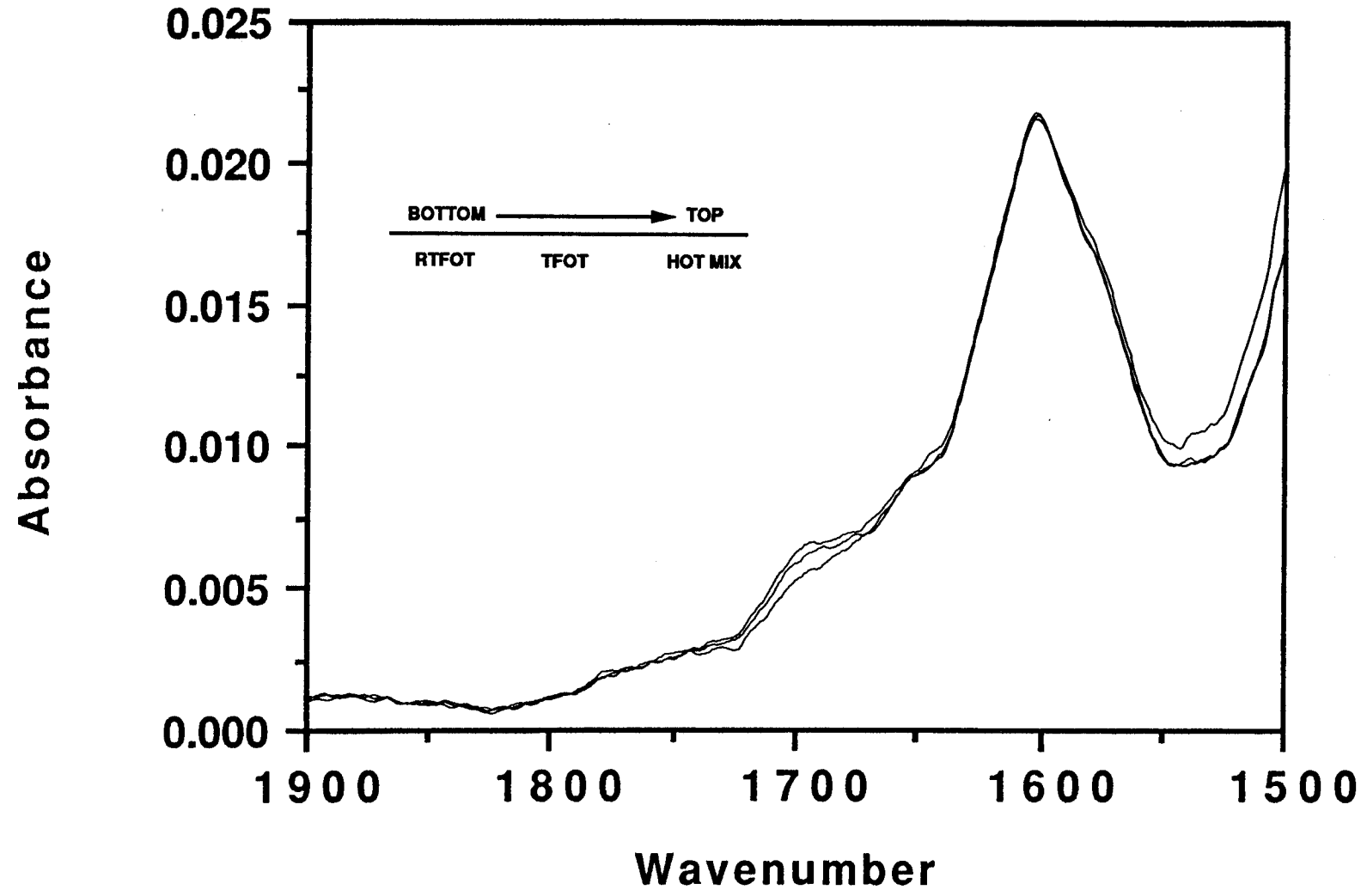

Figure C-122
Comparison of Carbonyl Region of FT-IR Spectra (ATR Method)
for RTFOT, TFOT and Hot Mix-1987 Exxon AC-20 (Batch)

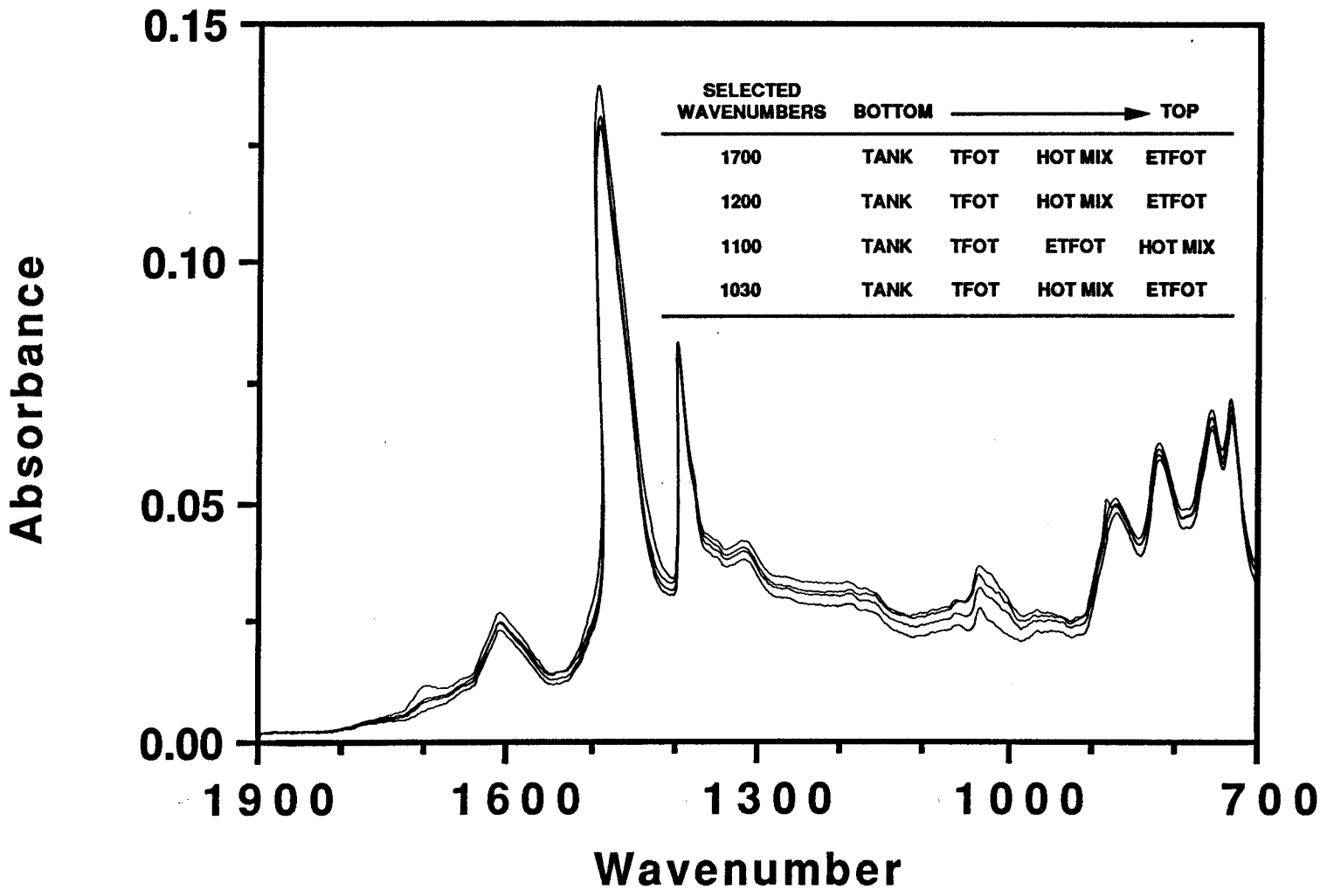

Figure C-123
Comparison of FT-IR Spectra (ATR Method) for Tank, TFOT, ETFOT and Hot Mix-1987 Exxon AC-20 (Batch)

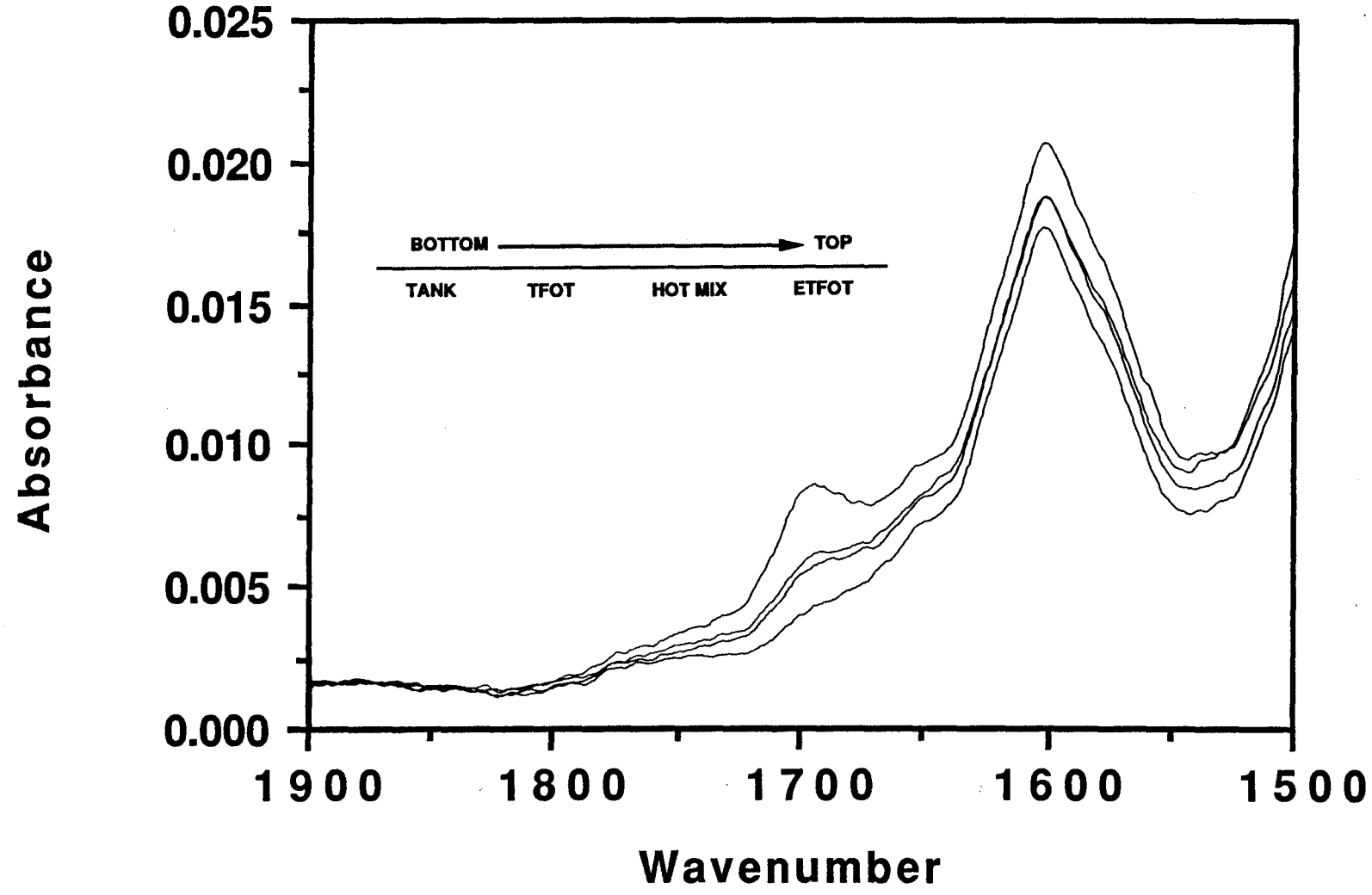

Figure C-124
Comparison of Carbonyl Region of FT-IR Spectra (ATR Method) for
Tank, TFOT, Hot Mix and ETFOT-1987 Exxon AC-20 (Batch)

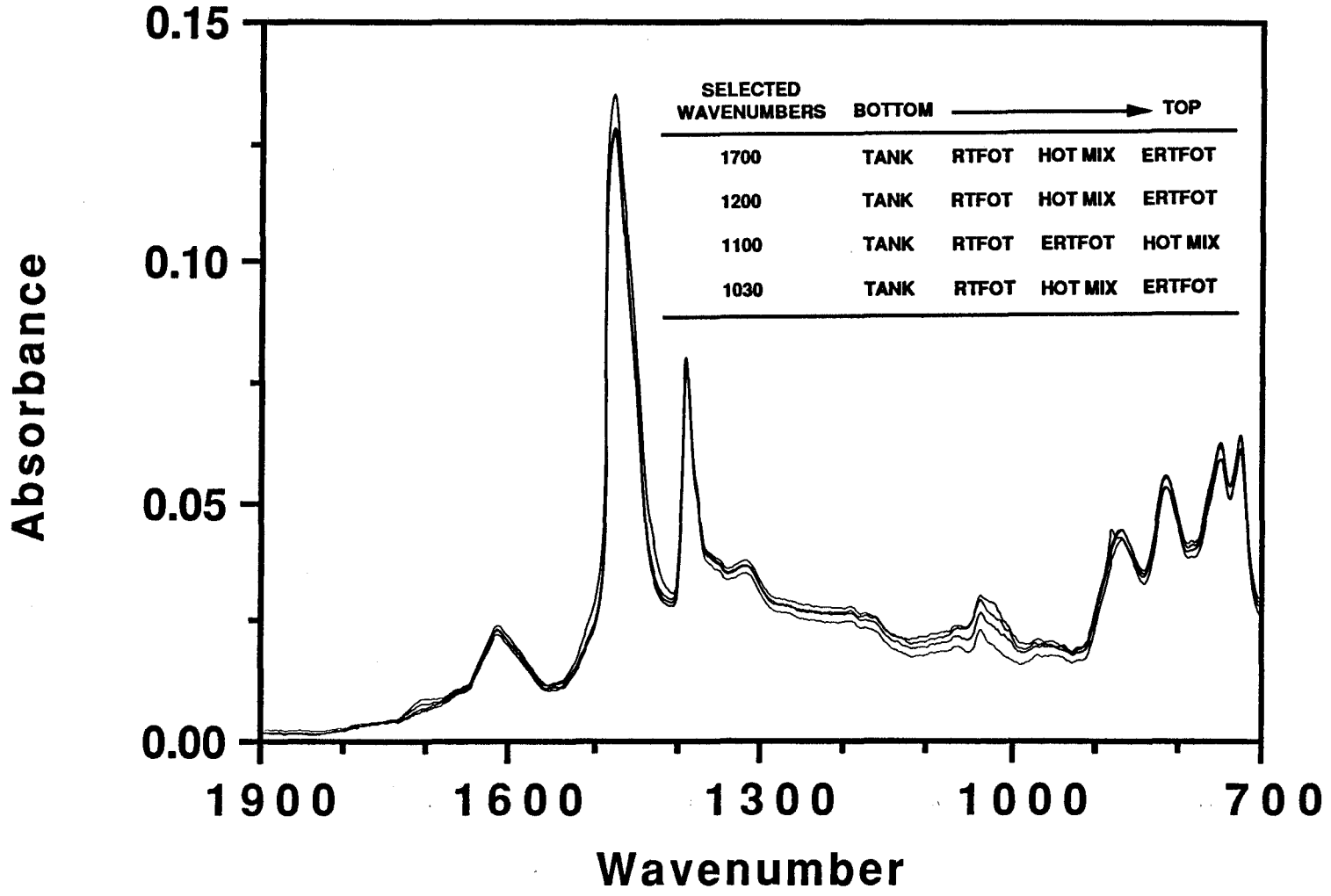

Figure C-125
Comparison of FT-IR Spectra (ATR Method) for Tank, RTFOT, ERTFOT and Hot Mix-1987 Exxon AC-20 (Batch)

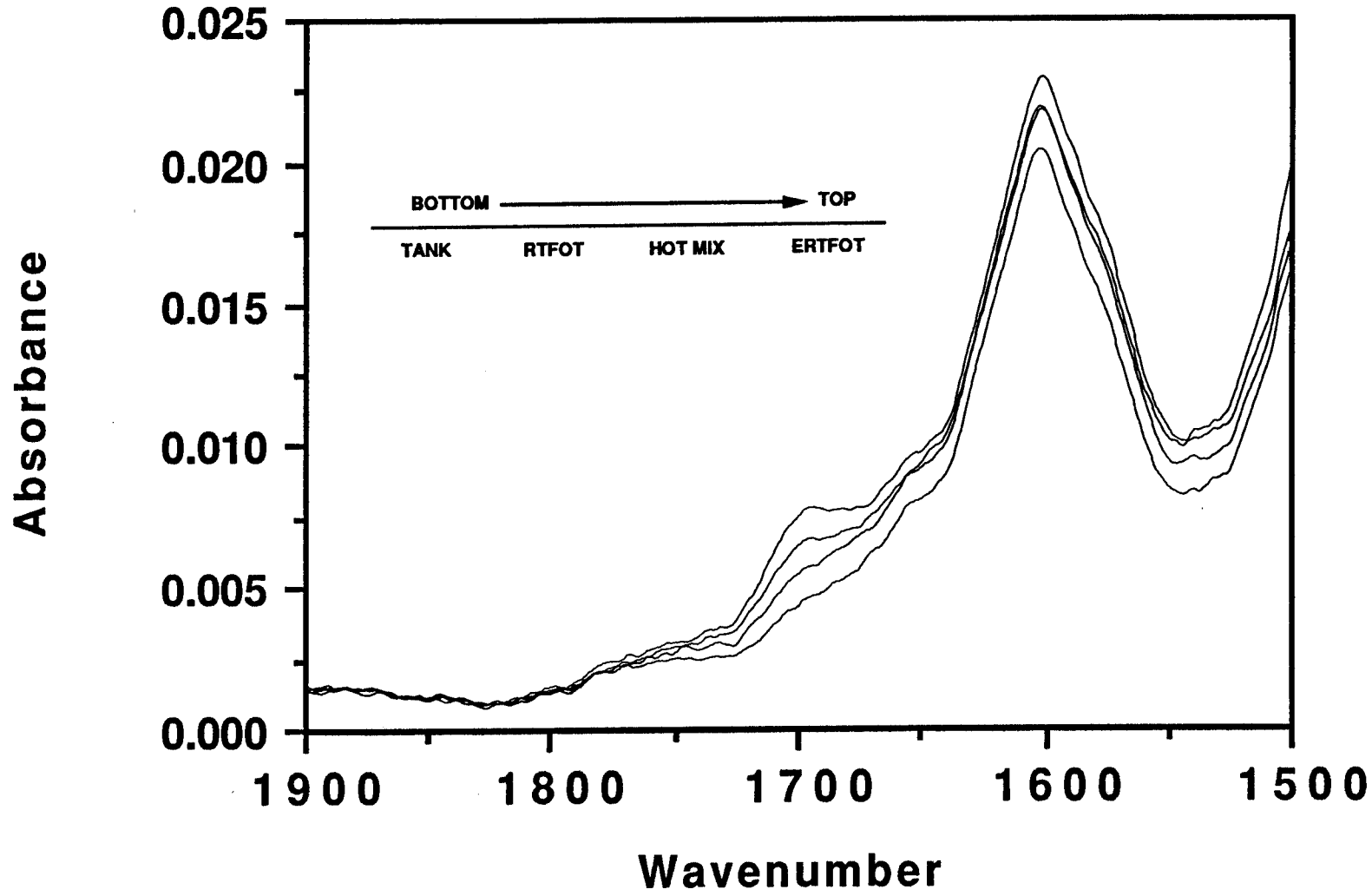

Figure C-126
Comparison of FT-IR Spectra (ATR Method) of Carbonyl Region for Tank, RTFOT, Hot Mix and ERTFOT-1987 Exxon AC-20 (Batch)

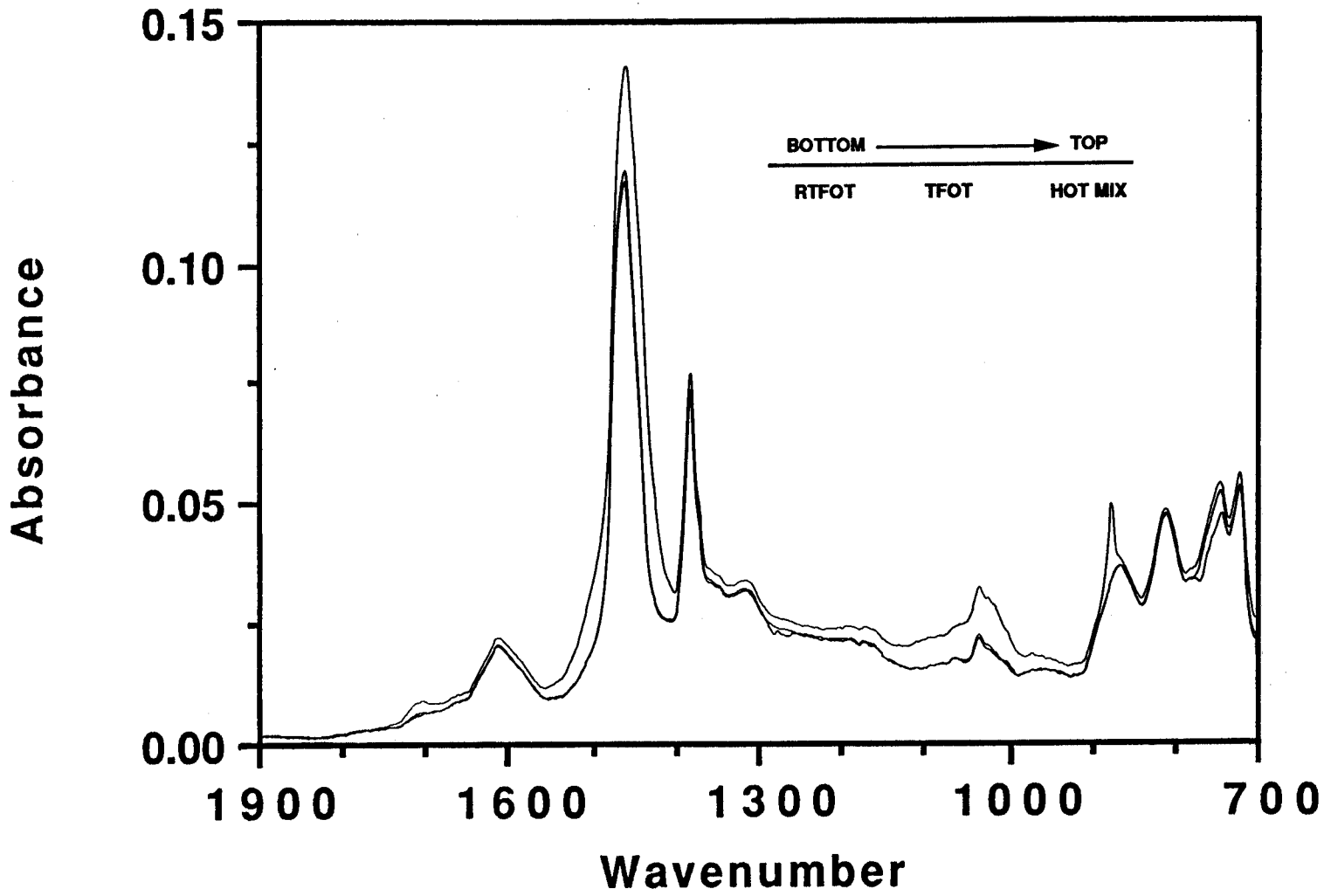

Figure C-127
Comparison of FT-IR Spectra (ATR Method) for RTFOT, TFOT and Hot Mix-1988 Exxon AC-20

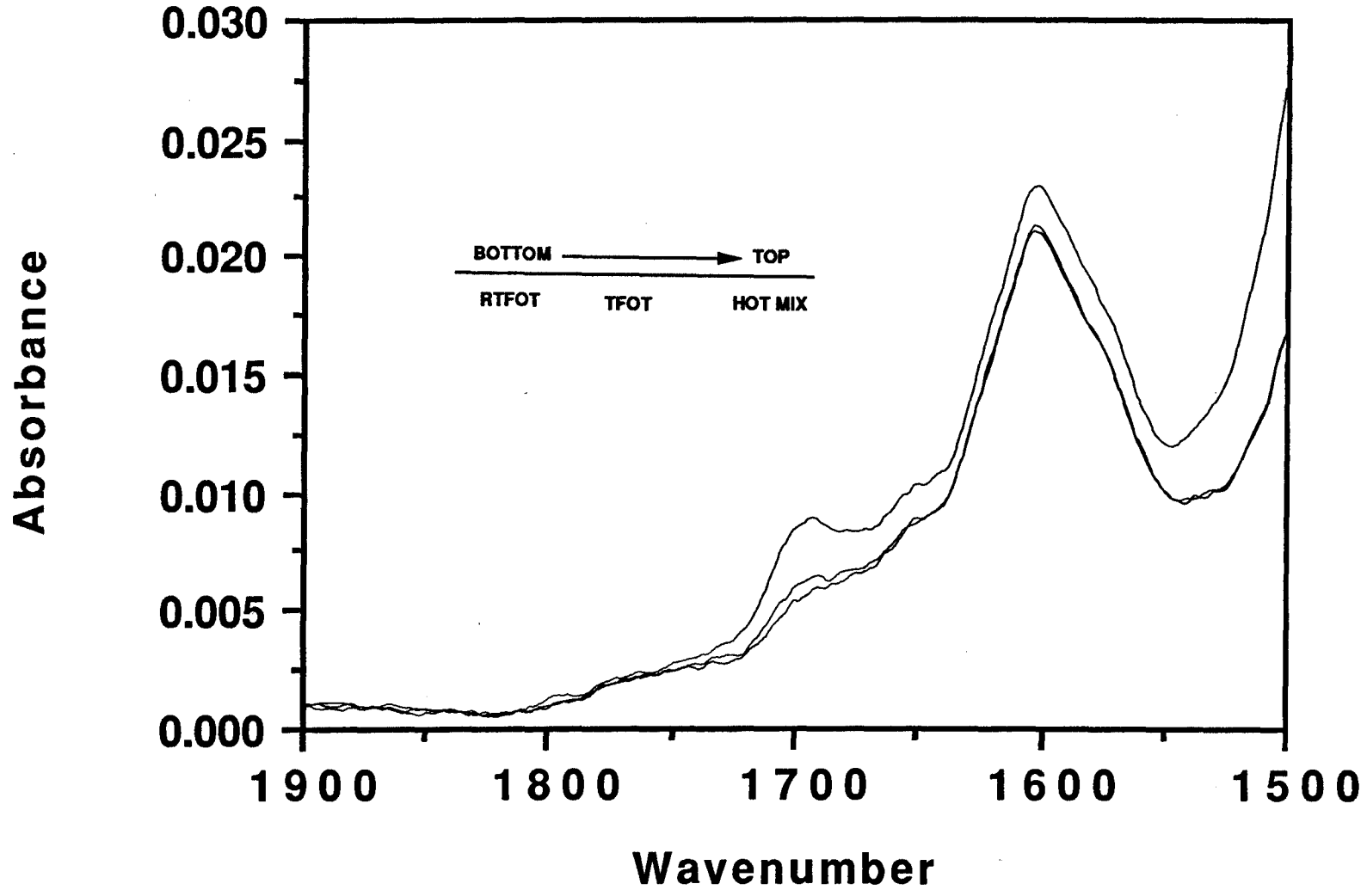

Figure C-128
Comparison of Carbonyl Region of FT-IR Spectra (ATR Method) for
RTFOT, TFOT and Hot Mix-1988 Exxon AC-20

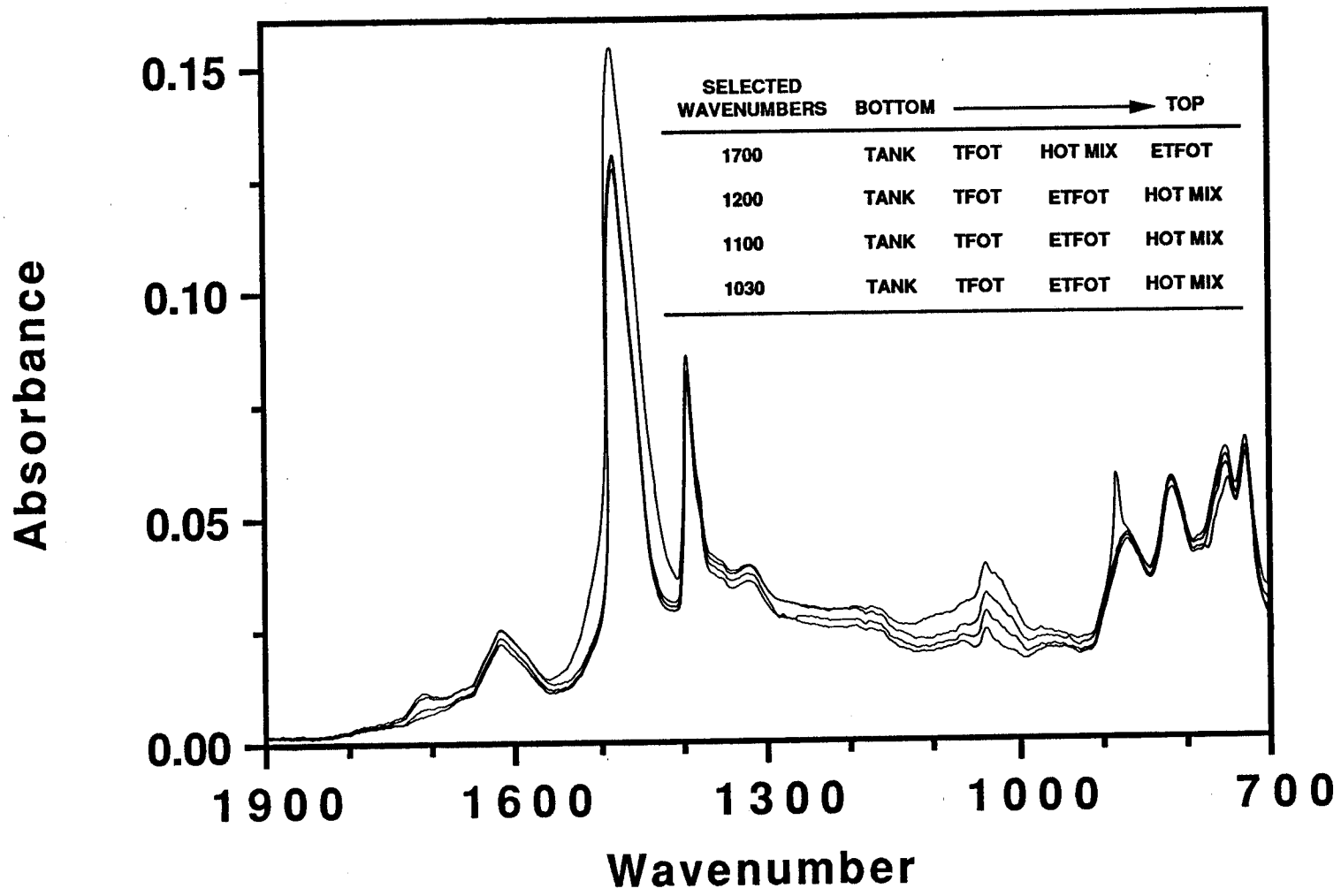

Figure C-129
Comparison of FT-IR Spectra (ATR Method) for Tank, TFOT, ETFOT and Hot Mix-1988 Exxon AC-20

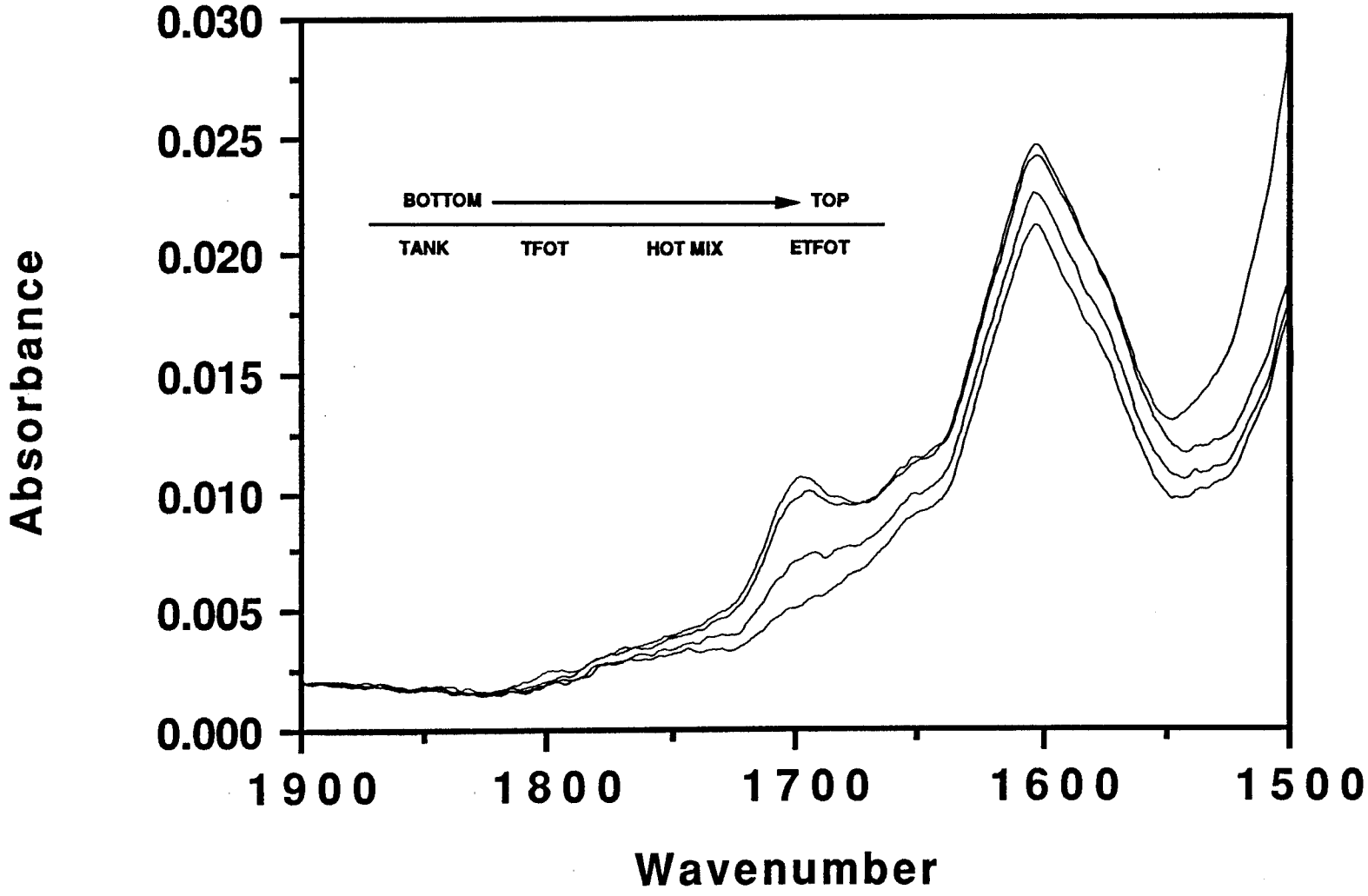

Figure C-130
Comparison of Carbonyl Region of FT-IR Spectra (ATR Method) for
Tank, TFOT, Hot Mix and ETFOT-1988 Exxon AC-20

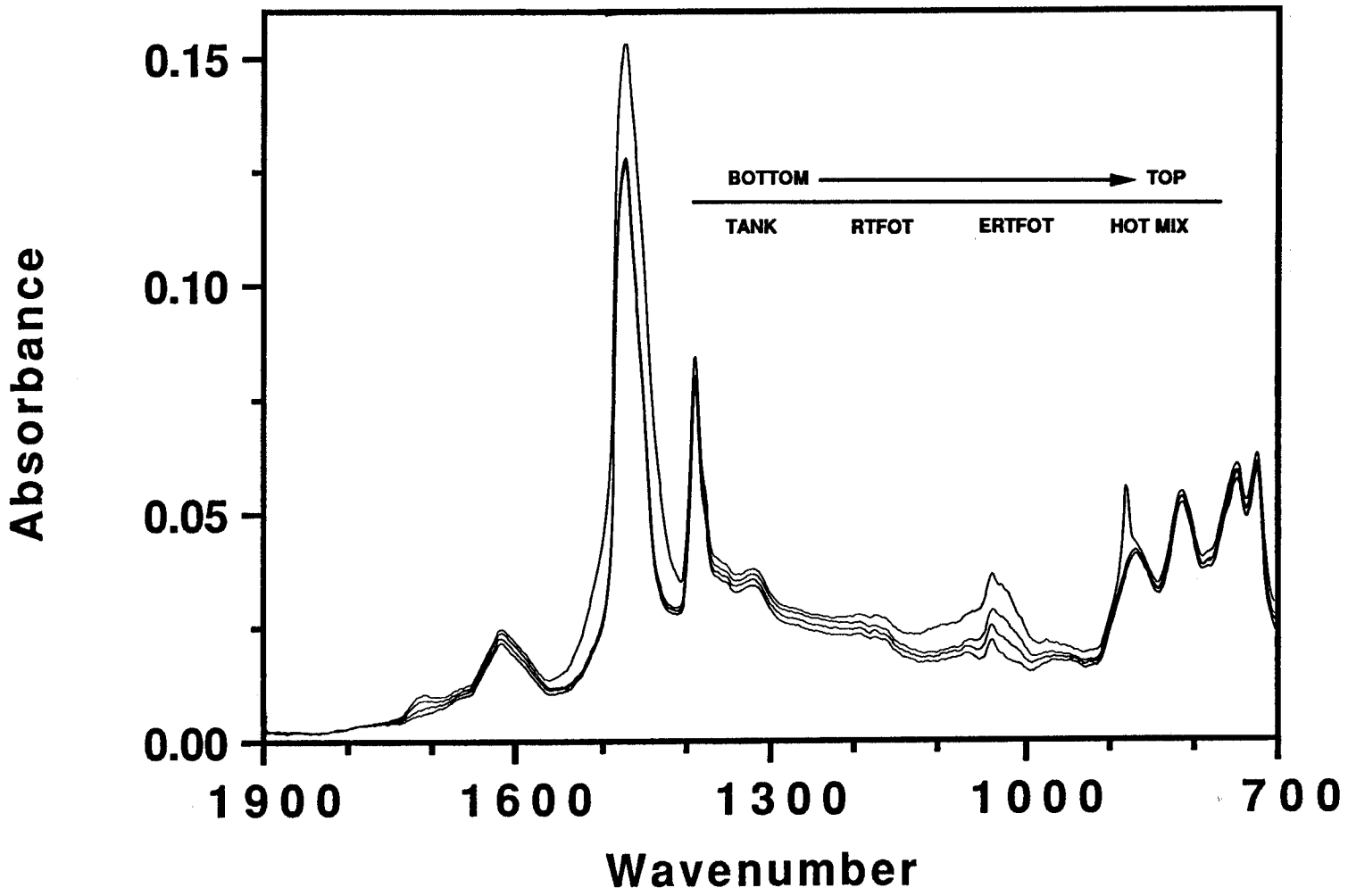

Figure C-131
Comparison of FT-IR Spectra (ATR Method) for Tank, RTFOT, ERTFOT and Hot Mix-1988 Exxon AC-20

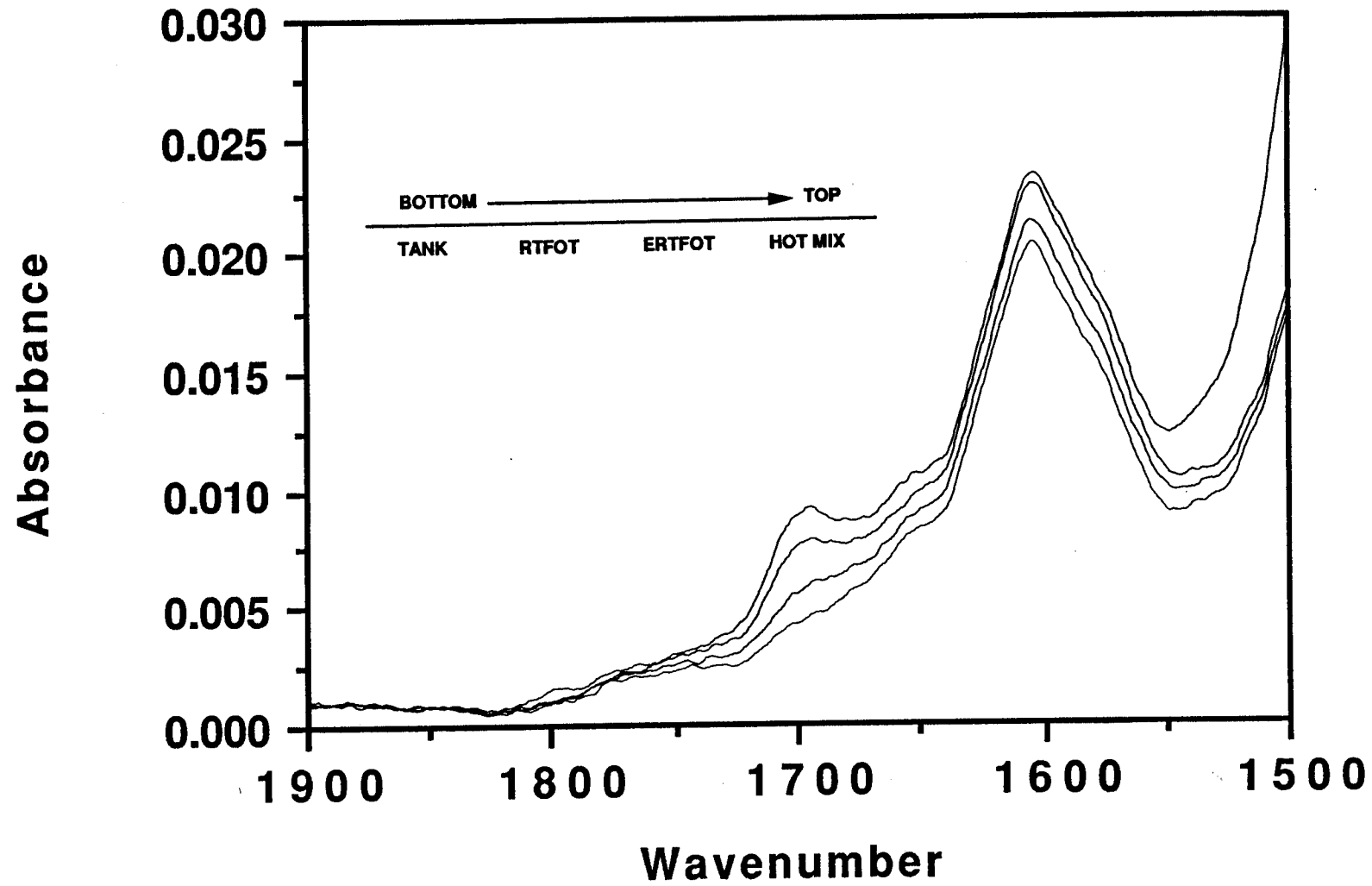

Figure C-132
Comparison of FT-IR Spectra (ATR Method) of Carbonyl Region
for Tank, RTFOT, ETFOT and Hot Mix-1988 Exxon AC-20

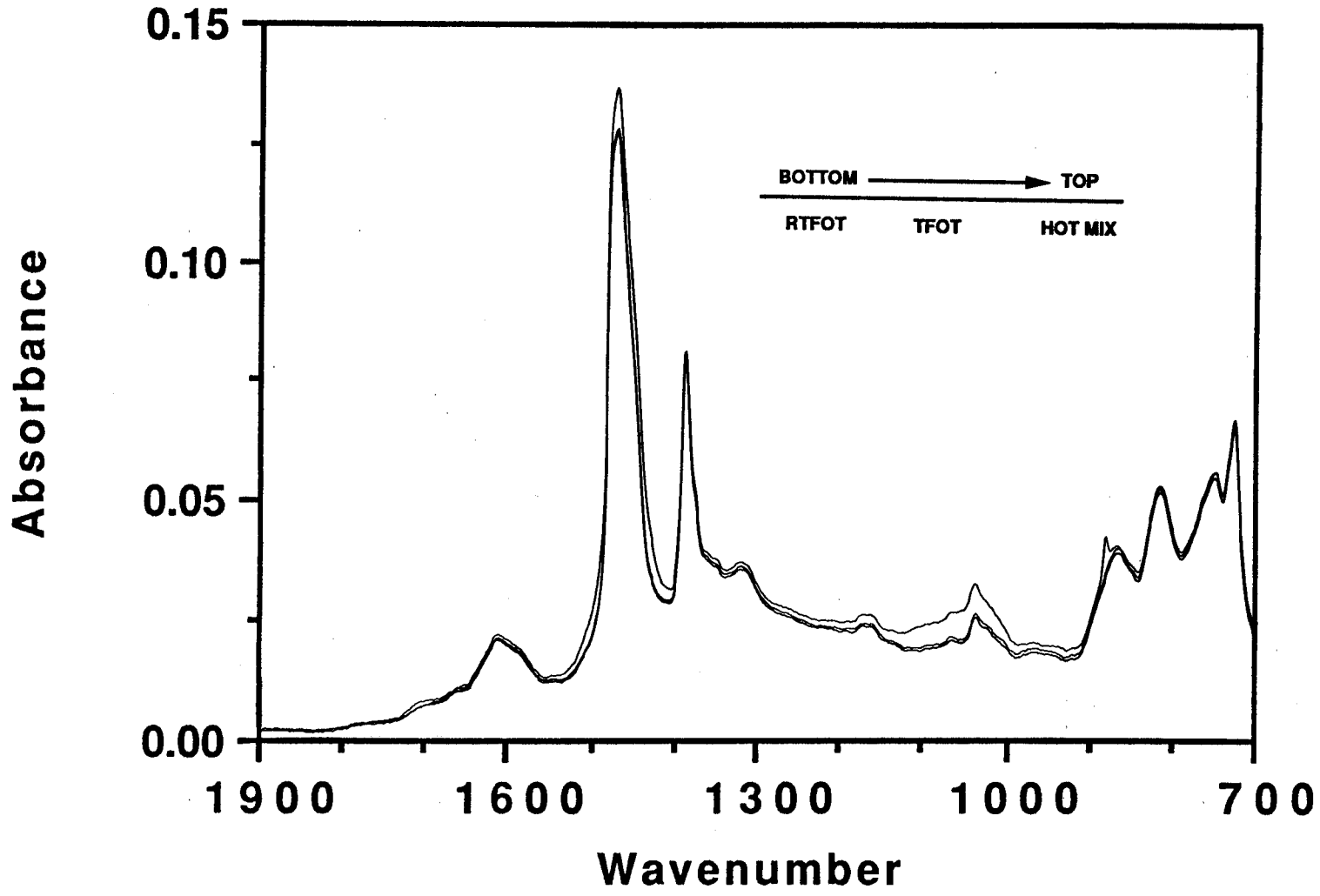

Figure C-133
Comparison of Carbonyl Region of FT-IR Spectra (ATR Method) for
RTFOT, TFOT and Hot Mix-1989 Texaco AC-20

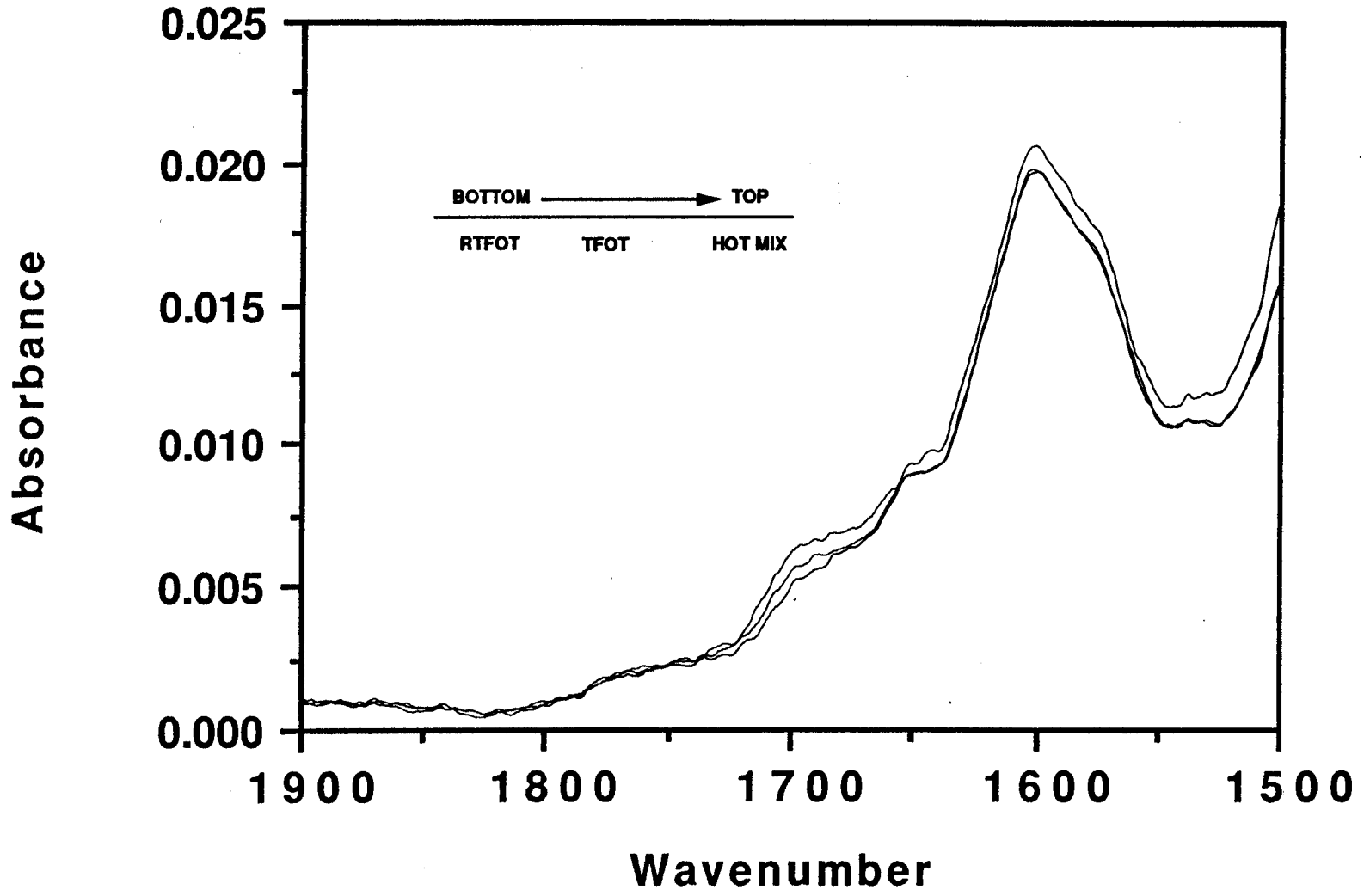

Figure C-134
Comparison of Carbonyl Region of FT-IR Spectra (ATR Method)
for RTFOT, TFOT and Hot Mix- 1989 Texaco AC-20

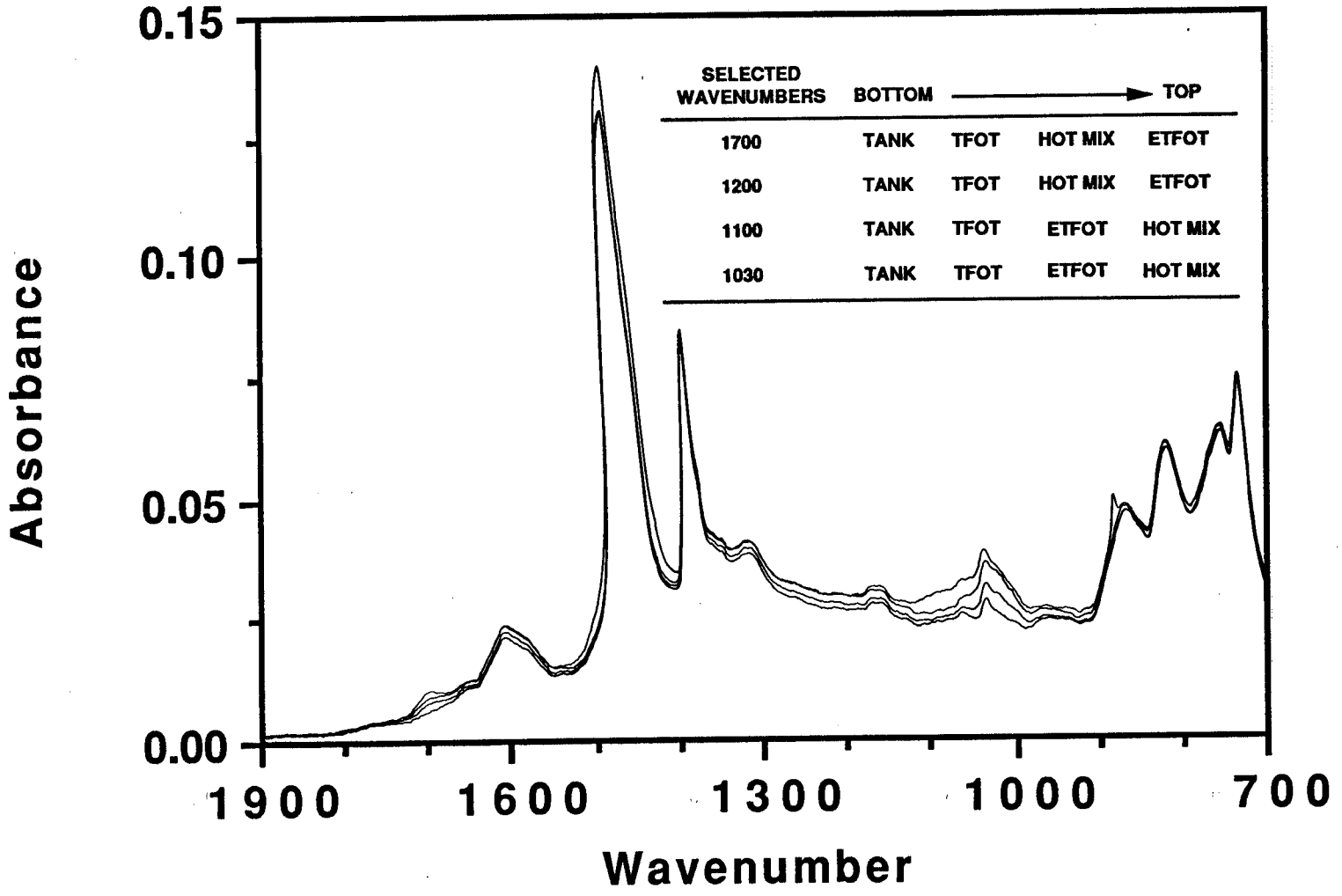

Figure C-135
Comparison of FT-IR Spectra (ATR Method) for Tank, ETFOT, TFOT
and Hot Mix-1989 Texaco AC-20

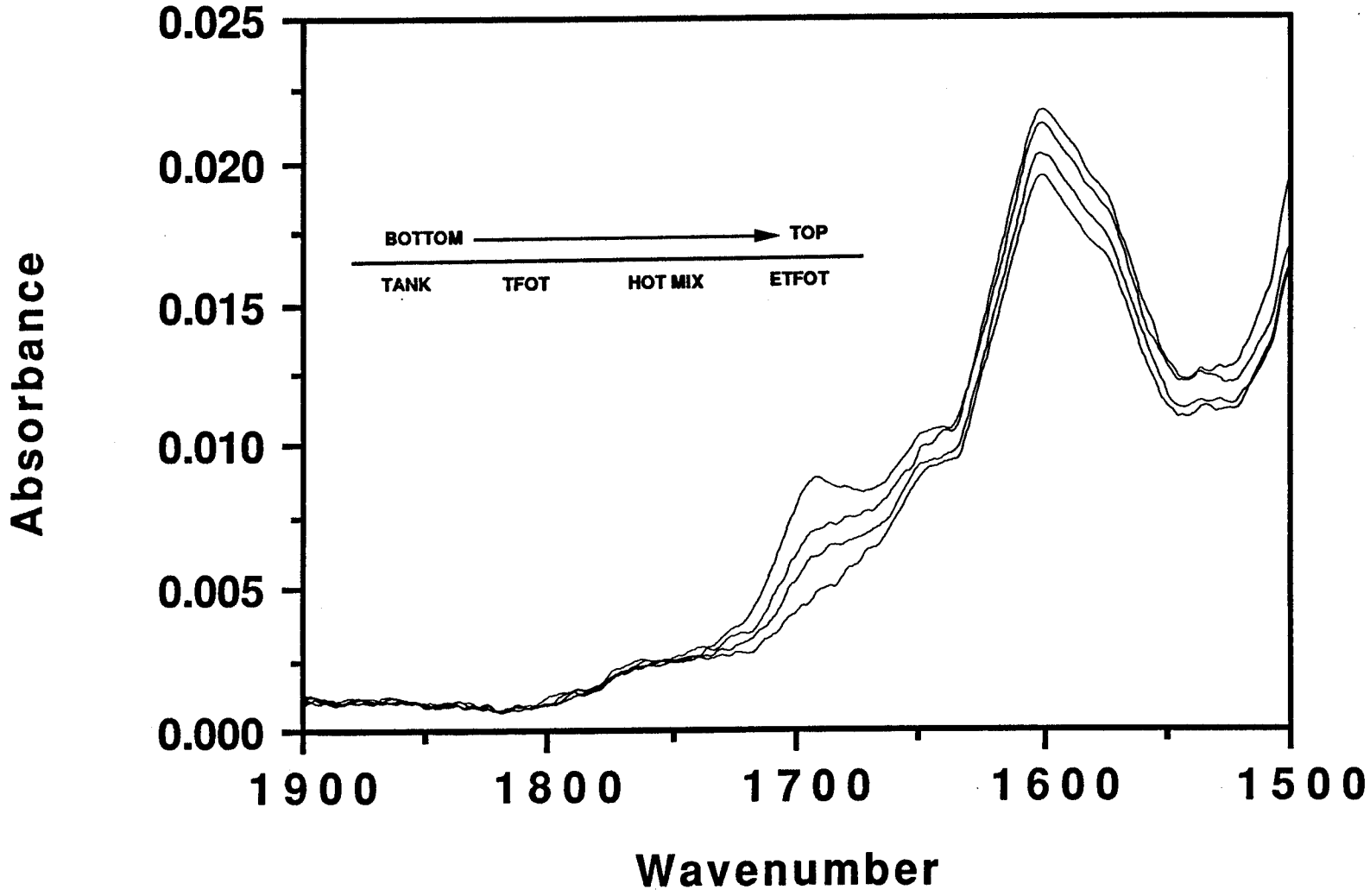

Figure C-136
Comparison of Carbonyl Region of FT-IR Spectra (ATR Method)
for Tank, TFOT, ETFOT and Hot Mix-1989 Texaco AC-20

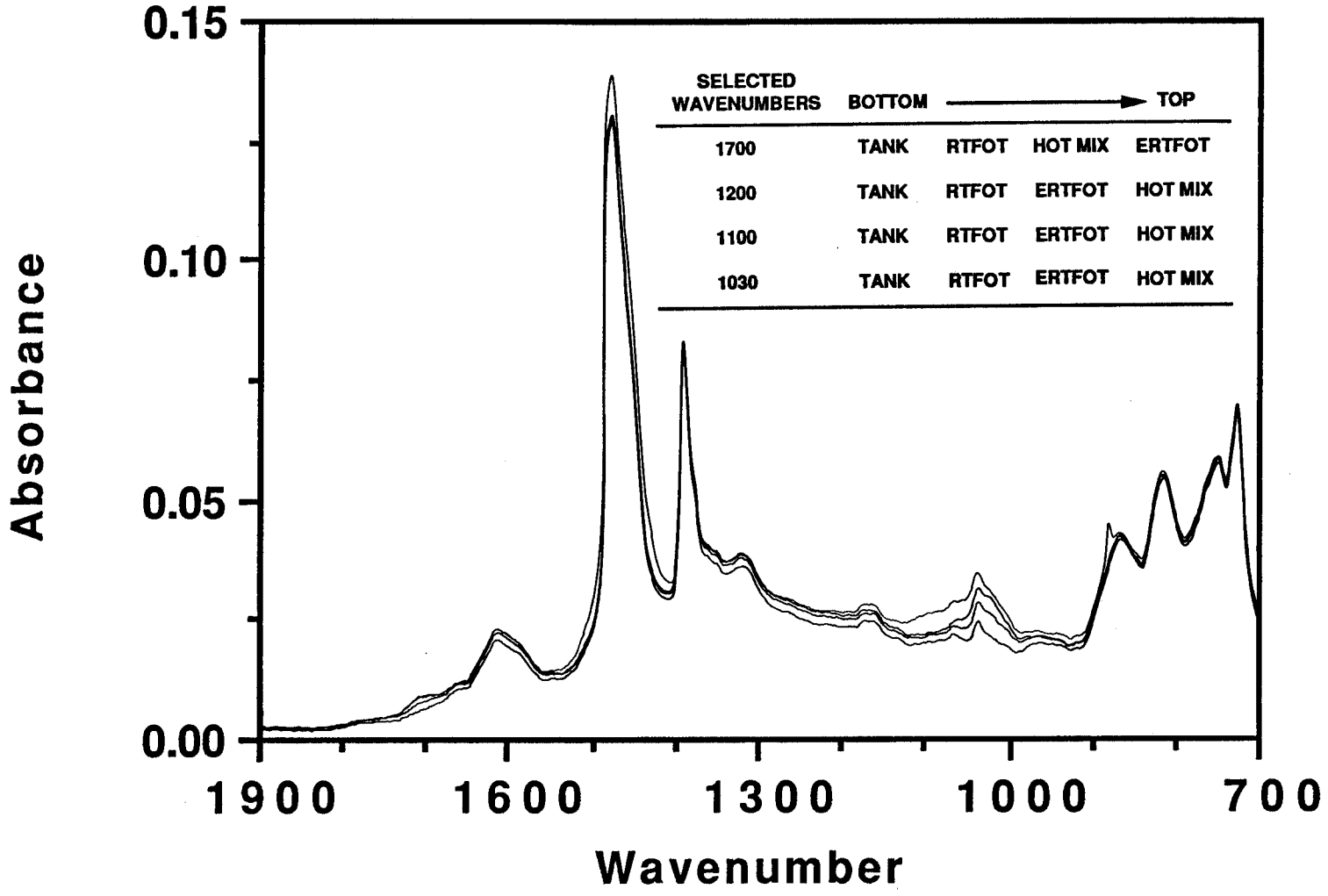

Figure C-137
Comparison of FT-IR Spectra (ATR Method) for Tank, RTFOT, ERTFOT and Hot Mix-1989 Texaco AC-20

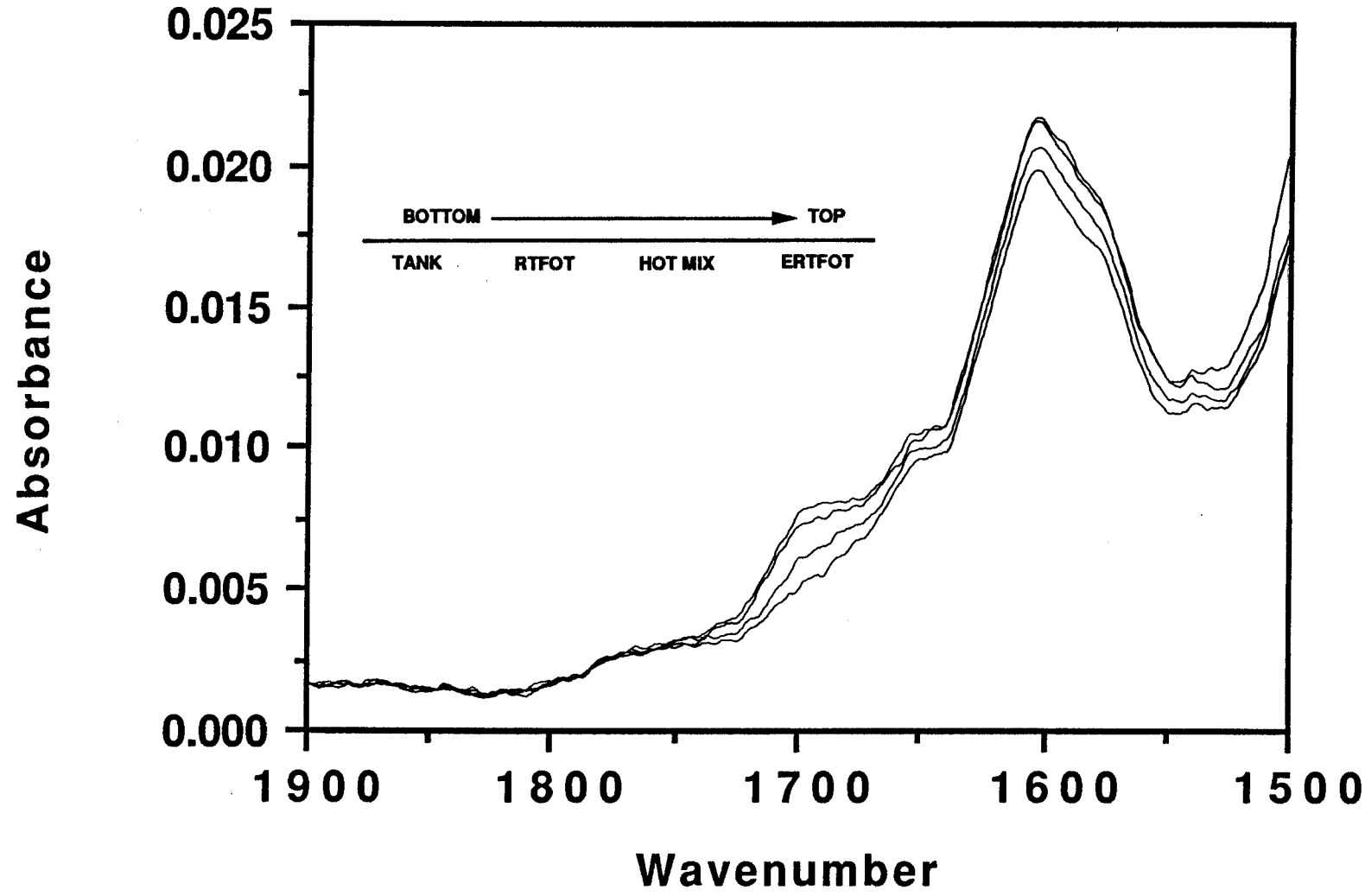

Figure C-138
Comparison of FT-IR Spectra (ATR Method) of Carbonyl Region for Tank, RTFOT, Hot Mix and ERTFOT-1989 Texaco AC-20

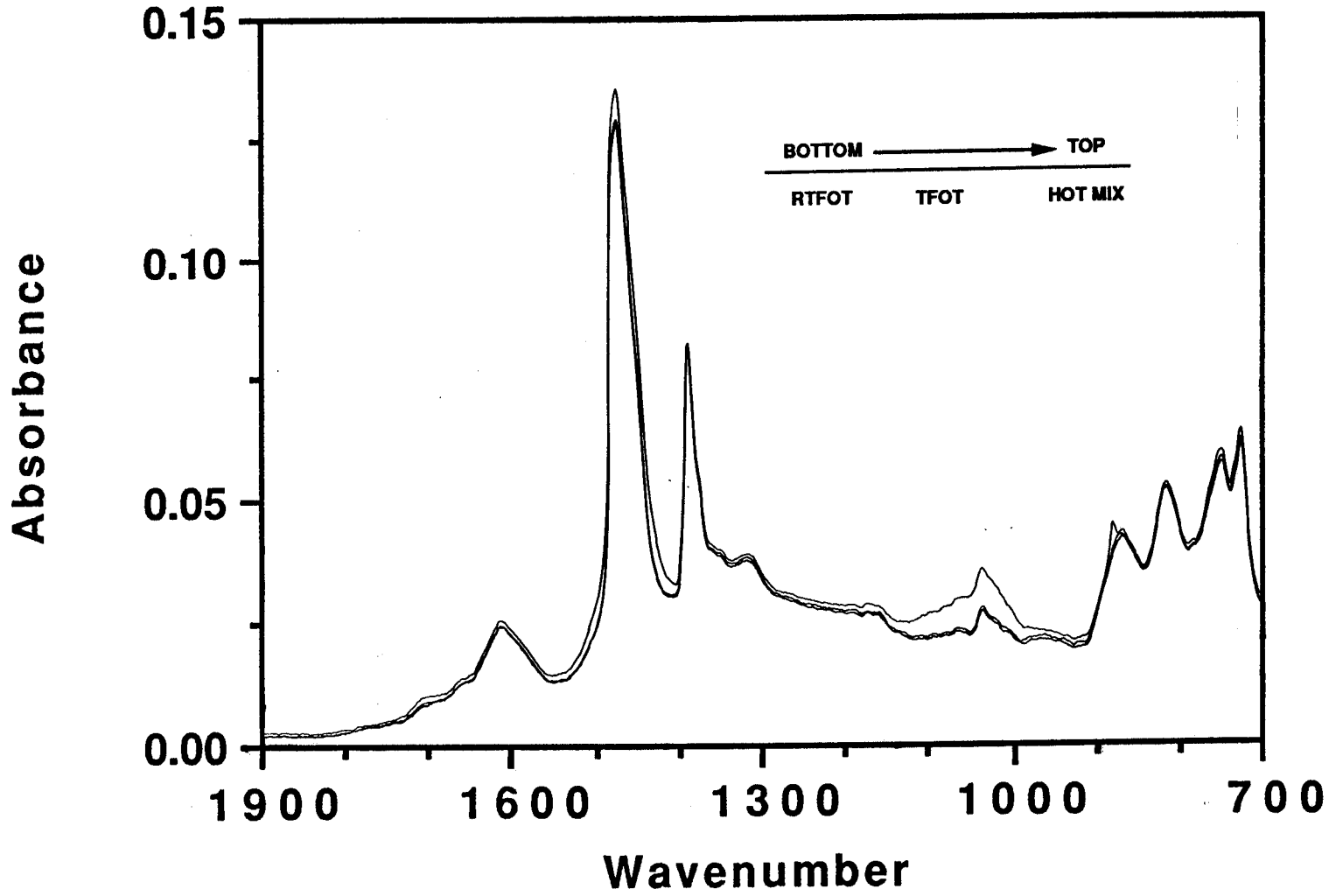

Figure C-139
Comparison of FT-IR Spectra (ATR Method) for RTFOT, TFOT and Hot Mix-1989 Texas Gulf AC-20

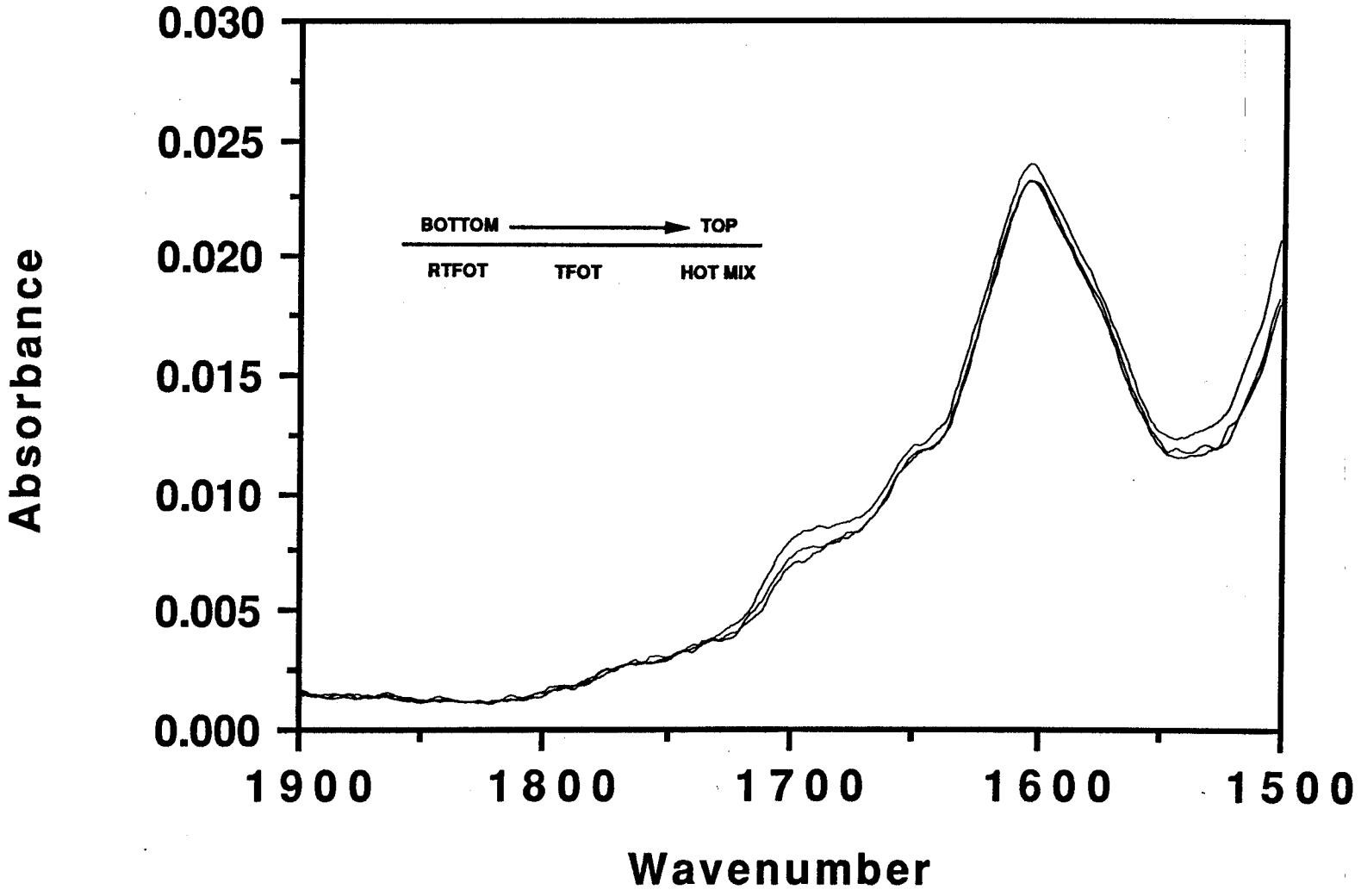

Figure C-140
Comparison of Carbonyl Region of FT-IR Spectra (ATR Method) for
RTFOT, TFOT, and Hot Mix-1989 Texas Gulf AC-20

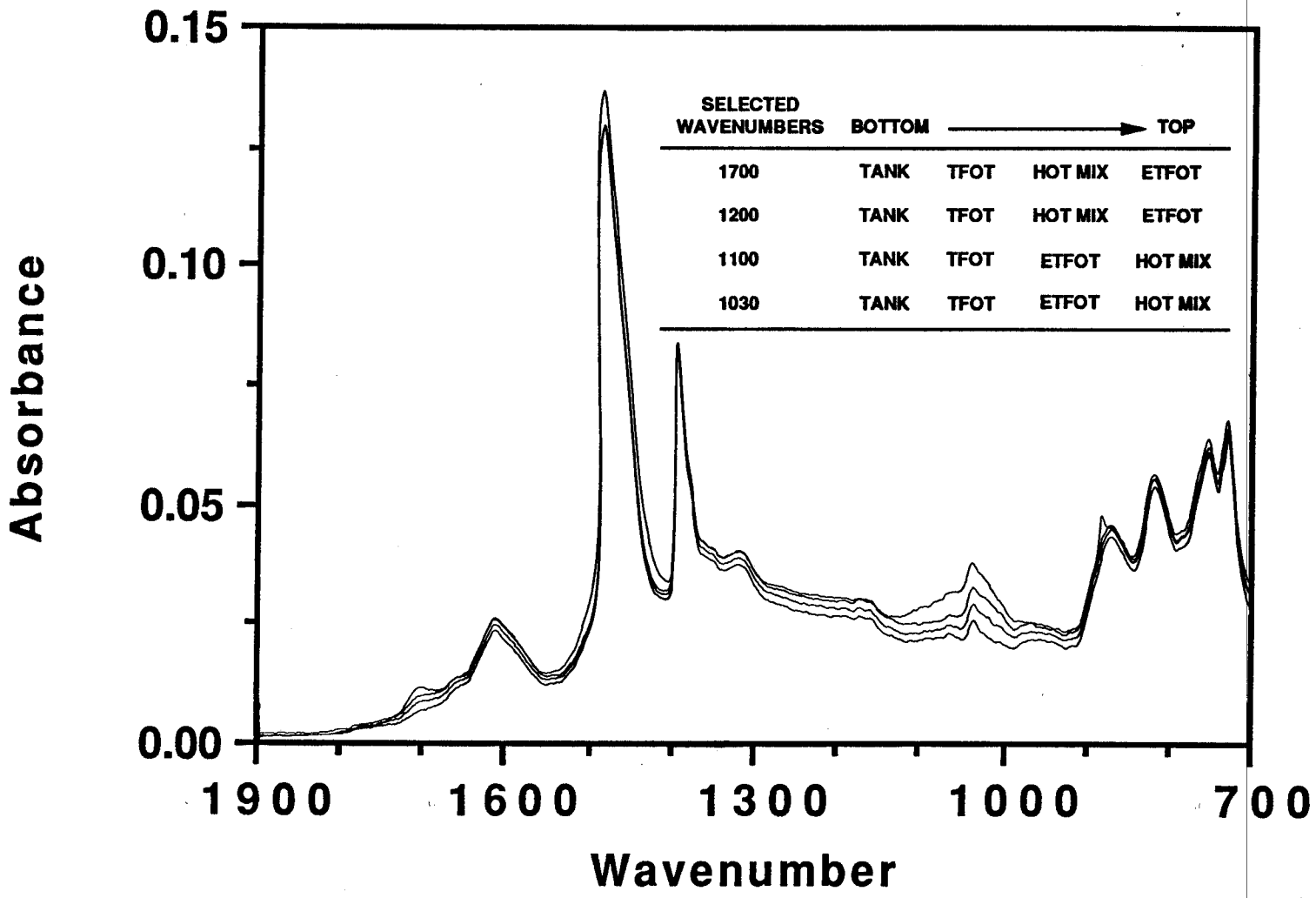

Figure C-141
Comparison of FT-IR Spectra (ATR Method) for Tank, TFOT, ETFOT and Hot Mix-1989 Texas Gulf AC-20

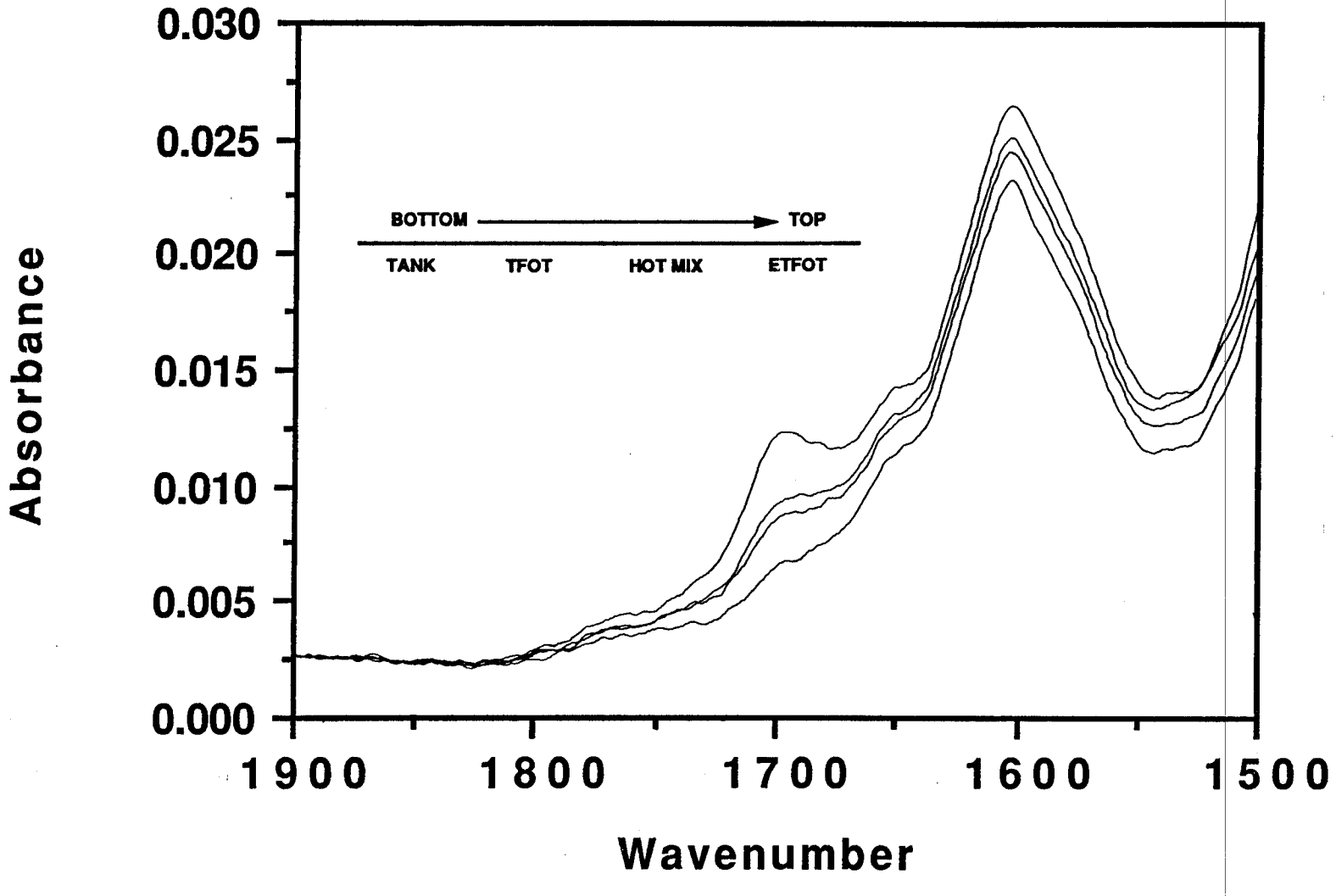

Figure C-142
Comparison of Carbonyl Region of FT-IR Spectra (ATR Method) for Tank, TFOT, Hot Mix and ETFOT-1989 Texas Gulf AC-20

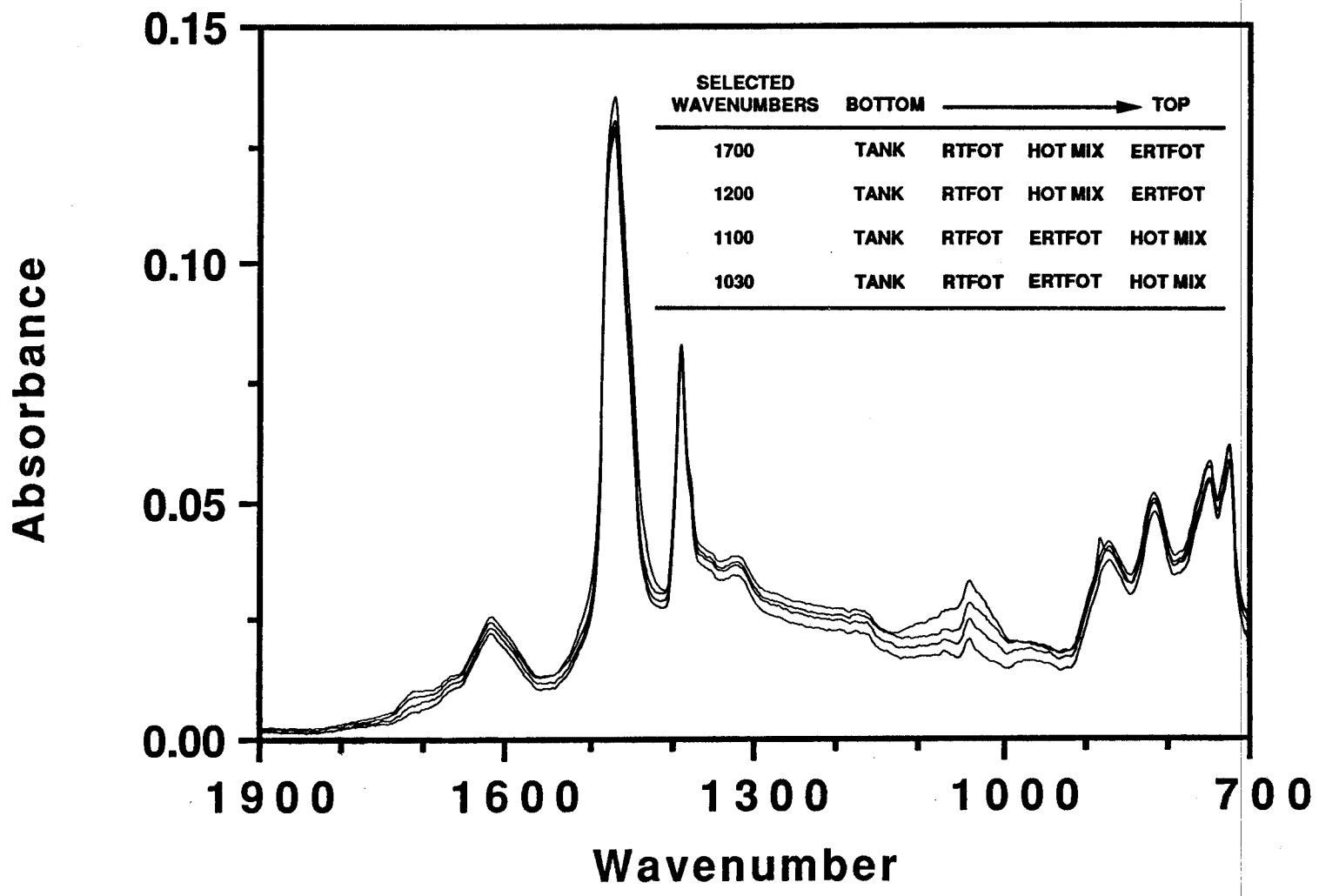

Figure C-143
Comparison of FT-IR Spectra (ATR Method)for Tank, RTFOT,ERTFOT
and Hot Mix-1989 Texas Gulf AC-20

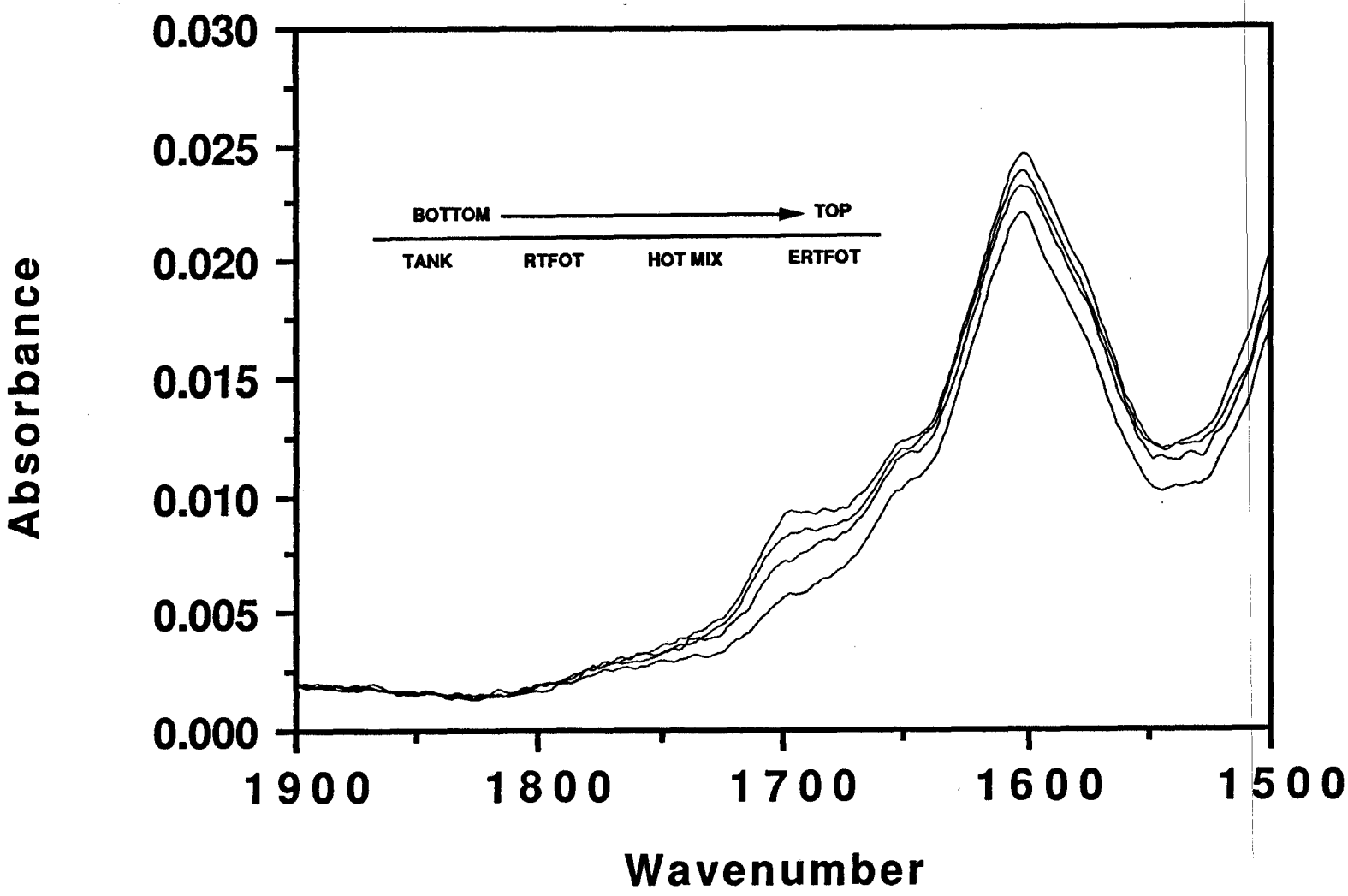

Figure C-144
Comparison of FT-IR Spectra (ATR Method) of Carbonyl Region for Tank, RTFOT, ERTFOT and Hot Mix-1989 Texas Gulf AC-20