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APPENDICES

Table A1 Characterization of Catalysts

Catalyst	Composition of Catalyst (%wt)														
	F	Na	Mg	Al	Si	P	S	Cl	K	Ca	Ti	Fe	Co	Ni	Sn
Fe 10-5-2 / MS(4A-DG)	1.8	10.8	2.0	20.7	29.9	0.3	0.2	18.7	0.2	0.9	0.1	10.2	-	-	4.3
Co 10-5-2 / MS(4A-DG)	1.9	11.4	2.0	21.4	32.0	0.3	0.2	15.0	0.2	1.0	0.1	0.8	10.6	-	5.2
Ni 10-5-2 / MS(4A-DG)	1.8	11.3	2.0	20.8	30.9	0.3	0.2	14.8	0.2	0.9	0.1	0.8	-	10.4	5.4
Ni 10-5-1 / MS(4A-DG)	0.9	11.3	2.1	21.5	31.6	0.4	0.2	15.2	0.2	0.9	0.1	0.8	-	9.9	4.9
Ni 10-2.5-2 / MS(4A-DG)	2.2	11.2	2.2	22.0	33.1	0.4	0.2	13.4	0.2	1.0	0.1	0.8	-	10.7	2.5
Ni 5-5-2 / MS(4A-DG)	2.2	12.7	2.3	23.6	35.0	0.4	0.2	10.0	0.2	1.0	0.1	0.8	-	5.7	5.6
Ni 10-5-2 / MS(3A-EPG)	2.0	7.0	1.8	20.3	29.0	0.6	0.2	14.9	7.8	0.4	0.1	0.7	-	10.0	5.2
Ni 10-5-2 / MS(13xPG)	2.1	11.3	2.0	20.5	34.9	0.6	0.2	14.6	0.2	0.8	0.1	0.7	-	9.3	4.8

Table B1 Composition of oil product from hydrocracking on molecular sieve (4A-DG type) catalyst as functions of catalyst type and element composition

Peak No.	MW.	No. of Carbon	Retention time (min)					
			Fe10-5-2	Co10-5-2	Ni10-5-2	Ni10-5-1	Ni10-2.5-2	Ni5-5-2
1	86	C ₆	1.10	-	1.14	1.09	1.08	1.04
2	100	C ₇	1.52	1.52	1.53	1.51	1.51	1.46
3	114	C ₈	2.45	2.45	2.46	2.44	2.43	2.39
4	128	C ₉	4.68	4.67	4.67	4.67	4.67	4.62
5	142	C ₁₀	8.63	8.60	8.59	8.62	8.60	8.57
6	156	C ₁₁	12.34	12.30	12.29	12.33	12.32	12.30
7	170	C ₁₂	14.92	14.91	14.89	14.92	14.91	14.90
8	184	C ₁₃	17.24	17.22	17.19	17.24	17.22	17.21
9	198	C ₁₄	20.04	20.03	19.98	20.03	20.02	20.00
10	212	C ₁₅	22.68	22.66	22.62	22.67	22.66	22.64
11	226	C ₁₆	25.15	25.13	25.09	25.14	25.12	25.11
12	240	C ₁₇	27.45	27.43	27.40	27.44	27.43	27.42
13	254	C ₁₈	29.62	29.60	29.57	29.61	29.60	29.59
14	268	C ₁₉	31.66	31.64	31.62	31.65	31.65	31.64
15	282	C ₂₀	33.60	33.58	33.56	33.59	33.59	33.58
16	296	C ₂₁	35.44	35.40	35.41	35.43	35.43	35.43
17	310	C ₂₂	37.19	37.17	37.18	37.18	37.19	37.19
18	324	C ₂₃	38.88	38.86	38.87	38.87	38.88	38.88
19	338	C ₂₄	40.50	40.47	40.48	40.49	40.49	40.50
20	352	C ₂₅	42.05	42.02	42.03	42.04	42.04	42.05
21	366	C ₂₆	43.53	43.52	43.53	-	43.54	43.54
22	380	C ₂₇	-	-	44.96	-	-	44.98

Table B2 The molecular weight distributions of oil product from hydrocracking on molecular sieve (4A-DG type) catalyst as functions of catalyst type and element composition

Peak No.	MW.	No. of Carbon	%Peak area					
			Fe10-5-2	Co10-5-2	Ni10-5-2	Ni10-5-1	Ni10-2.5-2	Ni5-5-2
3	114	C ₈	11	5	7	5	4	10
4	128	C ₉	10	6	8	6	7	9
5	142	C ₁₀	8	8	8	7	8	8
6	156	C ₁₁	9	9	8	9	8	8
7	170	C ₁₂	10	9	9	9	9	8
8	184	C ₁₃	9	9	9	9	9	8
9	198	C ₁₄	8	9	8	9	9	8
10	212	C ₁₅	8	9	8	9	9	8
11	226	C ₁₆	7	9	8	9	8	7
12	240	C ₁₇	6	9	8	9	8	7
13	254	C ₁₈	5	7	7	8	8	7
14	268	C ₁₉	5	6	6	6	7	6
15	282	C ₂₀	4	5	6	5	6	6

Table B3 Composition of oil product from hydrocracking over Ni(10%)-Sn(5%)-F(2%) on molecular sieve (4A-DG type) catalyst as a function of reaction time

Peak No.	MW.	No. of Carbon	Retention time (min)		
			30 min	2 hr.	4 hr.
1	86	C ₆	1.13	1.12	1.14
2	100	C ₇	1.54	1.53	1.53
3	114	C ₈	2.46	2.45	2.46
4	128	C ₉	4.69	4.68	4.67
5	142	C ₁₀	8.61	8.61	8.59
6	156	C ₁₁	12.32	12.32	12.29
7	170	C ₁₂	14.91	14.91	14.89
8	184	C ₁₃	17.22	17.22	17.19
9	198	C ₁₄	20.01	20.02	19.98
10	212	C ₁₅	22.65	22.66	22.62
11	226	C ₁₆	25.12	25.12	25.09
12	240	C ₁₇	27.43	27.43	27.40
13	254	C ₁₈	29.60	29.60	29.57
14	268	C ₁₉	31.65	31.065	31.62
15	282	C ₂₀	33.59	33.59	33.56
16	296	C ₂₁	35.44	35.44	35.41
17	310	C ₂₂	37.21	37.20	37.18
18	324	C ₂₃	38.89	38.89	38.87
19	338	C ₂₄	40.50	40.50	40.48
20	352	C ₂₅	42.06	42.06	42.03
21	366	C ₂₆	43.55	43.55	43.53
22	380	C ₂₇	-	44.99	44.96

Table B4 The molecular weight distributions of oil product from hydrocracking over Ni(10%)-Sn(5%)-F(2%) on molecular sieve (4A-DG type) catalyst as a function of reaction time

Peak No.	MW.	No. of Carbon	%Peak area		
			30 min	2 hr.	4 hr.
3	114	C ₈	5	5	7
4	128	C ₉	8	7	8
5	142	C ₁₀	7	8	8
6	156	C ₁₁	8	9	8
7	170	C ₁₂	8	9	9
8	184	C ₁₃	9	9	9
9	198	C ₁₄	9	9	8
10	212	C ₁₅	9	9	8
11	226	C ₁₆	8	8	8
12	240	C ₁₇	8	8	8
13	254	C ₁₈	8	7	7
14	268	C ₁₉	7	6	6
15	282	C ₂₀	6	6	6

Table B5 Composition of oil product from hydrocracking over Ni(10%)-Sn(5%)-F(2%) on molecular sieve (4A-DG type) catalyst as a function of reaction temperature

Peak No.	MW.	No. of Carbon	Retention time (min)		
			350 °C	370 °C	390 °C
1	86	C ₆	1.13	1.13	1.14
2	100	C ₇	1.53	1.54	1.53
3	114	C ₈	2.44	2.64	2.46
4	128	C ₉	4.64	4.69	4.67
5	142	C ₁₀	8.55	8.61	8.59
6	156	C ₁₁	12.27	12.31	12.29
7	170	C ₁₂	14.86	14.90	14.89
8	184	C ₁₃	17.16	17.21	17.19
9	198	C ₁₄	19.94	20.00	19.98
10	212	C ₁₅	22.58	22.64	22.62
11	226	C ₁₆	25.04	25.10	25.09
12	240	C ₁₇	27.35	27.41	27.40
13	254	C ₁₈	29.52	29.58	29.57
14	268	C ₁₉	31.56	31.63	31.62
15	282	C ₂₀	33.50	33.57	33.56
16	296	C ₂₁	35.35	35.42	35.41
17	310	C ₂₂	37.12	37.18	37.18
18	324	C ₂₃	38.80	38.87	38.87
19	338	C ₂₄	40.43	40.49	40.48
20	352	C ₂₅	-	42.05	42.03
21	366	C ₂₆	-	43.54	43.53
22	380	C ₂₇	-	-	44.96

Table B6 The molecular weight distributions of oil product from hydrocracking over Ni(10%)-Sn(5%)-F(2%) on molecular sieve (4A-DG type) catalyst as a function of reaction temperature

Peak No.	MW.	No. of Carbon	%Peak area		
			350 °C	370 °C	390 °C
3	114	C ₈	5	5	7
4	128	C ₉	8	8	8
5	142	C ₁₀	8	8	8
6	156	C ₁₁	10	10	8
7	170	C ₁₂	10	10	9
8	184	C ₁₃	9	9	9
9	198	C ₁₄	9	9	8
10	212	C ₁₅	9	8	8
11	226	C ₁₆	8	8	8
12	240	C ₁₇	7	7	8
13	254	C ₁₈	7	7	7
14	268	C ₁₉	5	6	6
15	282	C ₂₀	5	5	6

Table B7 Composition of oil product from hydrocracking over Ni(10%)-Sn(5%)-F(2%) on molecular sieve (4A-DG type) catalyst as a function of hydrogen pressure

Peak No.	MW.	No. of Carbon	Retention time (min)		
			400 psig	500 psig	600 psig
1	86	C ₆	1.13	1.10	1.14
2	100	C ₇	1.52	1.52	1.53
3	114	C ₈	2.43	2.43	2.46
4	128	C ₉	4.64	4.63	4.67
5	142	C ₁₀	8.54	8.54	8.59
6	156	C ₁₁	12.26	12.26	12.29
7	170	C ₁₂	14.85	14.86	14.89
8	184	C ₁₃	17.15	17.16	17.19
9	198	C ₁₄	19.93	19.94	19.98
10	212	C ₁₅	22.57	22.58	22.62
11	226	C ₁₆	25.03	25.05	25.09
12	240	C ₁₇	27.34	27.36	27.40
13	254	C ₁₈	29.51	29.53	29.57
14	268	C ₁₉	31.55	31.57	31.62
15	282	C ₂₀	33.50	33.52	33.56
16	296	C ₂₁	35.34	35.37	35.41
17	310	C ₂₂	37.11	37.13	37.18
18	324	C ₂₃	38.80	38.82	38.87
19	338	C ₂₄	40.42	40.43	40.48
20	352	C ₂₅	41.97	41.99	42.03
21	366	C ₂₆	43.47	43.49	43.53
22	380	C ₂₇	-	44.92	44.96

Table B8 The molecular weight distributions of oil product from hydrocracking over Ni(10%)-Sn(5%)-F(2%) on molecular sieve (4A-DG type) catalyst as a function of hydrogen pressure

Peak No.	MW.	No. of Carbon	%Peak area		
			400 psig	500 psig	600 psig
3	114	C ₈	9	6	7
4	128	C ₉	10	8	8
5	142	C ₁₀	9	9	8
6	156	C ₁₁	9	9	8
7	170	C ₁₂	9	9	9
8	184	C ₁₃	9	9	9
9	198	C ₁₄	8	8	8
10	212	C ₁₅	8	8	8
11	226	C ₁₆	7	8	8
12	240	C ₁₇	6	7	8
13	254	C ₁₈	6	7	7
14	268	C ₁₉	5	6	6
15	282	C ₂₀	5	6	6

Table B9 Composition of oil product from hydrocracking over Ni(10%)-Sn(5%)-F(2%) on molecular sieve (4A-DG type) catalyst as a function of catalyst concentration

Peak No.	MW.	No. of Carbon	Retention time (min)		
			20%wt	30%wt	40%wt
1	86	C ₆	1.10	1.10	1.10
2	100	C ₇	1.52	1.52	1.52
3	114	C ₈	2.43	2.43	2.43
4	128	C ₉	4.62	4.63	4.64
5	142	C ₁₀	8.52	8.53	8.54
6	156	C ₁₁	12.24	12.25	12.26
7	170	C ₁₂	14.84	14.85	14.86
8	184	C ₁₃	17.13	17.14	17.16
9	198	C ₁₄	19.91	19.92	19.94
10	212	C ₁₅	22.56	22.57	22.58
11	226	C ₁₆	25.02	25.03	25.05
12	240	C ₁₇	27.33	27.34	27.36
13	254	C ₁₈	29.50	29.51	29.53
14	268	C ₁₉	31.54	31.56	31.57
15	282	C ₂₀	33.48	33.50	33.52
16	296	C ₂₁	35.33	35.34	35.37
17	310	C ₂₂	37.10	37.11	37.13
18	324	C ₂₃	38.78	38.79	38.82
19	338	C ₂₄	40.41	40.41	40.43
20	352	C ₂₅	41.96	-	41.99
21	366	C ₂₆	-	-	43.49
22	380	C ₂₇	-	-	44.92

Table B10 The molecular weight distributions of oil product from hydrocracking over Ni(10%)-Sn(5%)-F(2%) on molecular sieve (4A-DG type) catalyst as a function catalyst concentration

Peak No.	MW.	No. of Carbon	%Peak area		
			20%wt	30%wt	40%wt
3	114	C ₈	7	5	6
4	128	C ₉	8	7	8
5	142	C ₁₀	9	7	9
6	156	C ₁₁	9	8	9
7	170	C ₁₂	9	8	9
8	184	C ₁₃	9	8	9
9	198	C ₁₄	8	9	8
10	212	C ₁₅	8	9	8
11	226	C ₁₆	8	9	8
12	240	C ₁₇	7	9	7
13	254	C ₁₈	7	8	7
14	268	C ₁₉	6	7	6
15	282	C ₂₀	5	6	6

Table B11 Composition of oil product from hydrocracking over Ni(10%)-Sn(5%)-F(2%) catalyst as a function of molecular sieve support type

Peak No.	MW.	No. of Carbon	Retention time (min)		
			4A-DG	3A-EPG	13xPG
1	86	C ₆	1.10	1.10	1.10
2	100	C ₇	1.52	1.52	1.52
3	114	C ₈	2.43	2.43	2.43
4	128	C ₉	4.63	4.62	4.62
5	142	C ₁₀	8.54	8.53	8.52
6	156	C ₁₁	12.26	12.25	12.24
7	170	C ₁₂	14.86	14.85	14.84
8	184	C ₁₃	17.16	17.15	17.12
9	198	C ₁₄	19.94	19.93	19.91
10	212	C ₁₅	22.58	22.58	22.55
11	226	C ₁₆	25.05	25.05	25.01
12	240	C ₁₇	27.36	27.35	27.32
13	254	C ₁₈	29.53	29.52	29.49
14	268	C ₁₉	31.57	31.57	31.53
15	282	C ₂₀	33.52	33.52	33.48
16	296	C ₂₁	35.37	35.37	35.32
17	310	C ₂₂	37.13	37.13	37.09
18	324	C ₂₃	38.82	38.82	38.78
19	338	C ₂₄	40.43	40.43	40.40
20	352	C ₂₅	41.99	41.99	-
21	366	C ₂₆	43.49	43.48	-
22	380	C ₂₇	44.92	44.91	-

Table B12 The molecular weight distributions of oil product from hydrocracking over Ni(10%)-Sn(5%)-F(2%) catalyst as a function of molecular sieve support type

Peak No.	MW.	No. of Carbon	%Peak area		
			4A-DG	3A-EPG	13xPG
3	114	C ₈	6	5	6
4	128	C ₉	8	6	8
5	142	C ₁₀	9	7	8
6	156	C ₁₁	9	8	9
7	170	C ₁₂	9	8	9
8	184	C ₁₃	9	8	9
9	198	C ₁₄	8	9	9
10	212	C ₁₅	8	9	9
11	226	C ₁₆	8	9	9
12	240	C ₁₇	7	8	7
13	254	C ₁₈	7	8	6
14	268	C ₁₉	6	8	6
15	282	C ₂₀	5	7	5

Table B13 Composition of oil product from hydrocracking over reused Ni(10%)-Sn(5%)-F(2%) on molecular sieve (4A-DG type) catalyst

Peak No.	MW.	No. of Carbon	Retention time (min)		
			Ni10-5-2/(4A-DG)	Reused #1	Reused #2
1	86	C ₆	1.10	1.11	1.09
2	100	C ₇	1.52	1.53	1.51
3	114	C ₈	2.43	2.45	2.43
4	128	C ₉	4.63	4.67	2.65
5	142	C ₁₀	8.54	8.58	8.55
6	156	C ₁₁	12.26	12.29	12.27
7	170	C ₁₂	14.86	14.88	14.88
8	184	C ₁₃	17.16	17.18	17.18
9	198	C ₁₄	19.94	19.97	19.96
10	212	C ₁₅	22.58	22.61	22.60
11	226	C ₁₆	25.05	25.08	25.08
12	240	C ₁₇	27.36	27.39	27.39
13	254	C ₁₈	29.53	29.55	29.55
14	268	C ₁₉	31.57	31.60	31.60
15	282	C ₂₀	33.52	33.54	33.55
16	296	C ₂₁	35.37	35.39	35.40
17	310	C ₂₂	37.13	37.16	37.17
18	324	C ₂₃	38.82	38.84	38.85
19	338	C ₂₄	40.43	40.46	40.47
20	352	C ₂₅	41.99	42.01	42.03
21	366	C ₂₆	43.49	-	-
22	380	C ₂₇	44.92	-	-

Table B14 The molecular weight distributions of oil product from hydrocracking over reused Ni(10%)-Sn(5%)-F(2%) on molecular sieve (4A-DG type) catalyst

Peak No.	MW.	No. of Carbon	%Peak area		
			Ni10-5-2/(4A-DG)	Reused #1	Reused #2
3	114	C ₈	6	4	5
4	128	C ₉	8	8	7
5	142	C ₁₀	9	7	8
6	156	C ₁₁	9	9	9
7	170	C ₁₂	9	9	10
8	184	C ₁₃	9	9	9
9	198	C ₁₄	8	9	9
10	212	C ₁₅	8	8	8
11	226	C ₁₆	8	8	8
12	240	C ₁₇	7	8	8
13	254	C ₁₈	7	8	7
14	268	C ₁₉	6	7	6
15	282	C ₂₀	6	6	6

Table B15 Composition of oil product from hydrocracking over reused Ni(10%)-Sn(5%)-F(2%) on molecular sieve (3A-EPG type) catalyst

Peak No.	MW.	No. of Carbon	Retention time (min)	
			Ni10-5-2/(3A-EPG)	Reused #1
1	86	C ₆	1.10	1.11
2	100	C ₇	1.52	1.53
3	114	C ₈	2.43	2.45
4	128	C ₉	4.62	4.66
5	142	C ₁₀	8.53	8.57
6	156	C ₁₁	12.25	12.28
7	170	C ₁₂	14.85	14.88
8	184	C ₁₃	17.15	17.18
9	198	C ₁₄	19.93	19.96
10	212	C ₁₅	22.58	22.61
11	226	C ₁₆	25.05	25.08
12	240	C ₁₇	27.35	27.39
13	254	C ₁₈	29.52	29.56
14	268	C ₁₉	31.57	31.60
15	282	C ₂₀	33.52	33.54
16	296	C ₂₁	35.37	35.39
17	310	C ₂₂	37.13	37.16
18	324	C ₂₃	38.82	38.84
19	338	C ₂₄	40.43	40.47
20	352	C ₂₅	41.99	42.02
21	366	C ₂₆	43.48	43.52
22	380	C ₂₇	44.91	-

Table B16 The molecular weight distributions of oil product from hydrocracking over reused Ni(10%)-Sn(5%)-F(2%) on molecular sieve (3A-EPG type) catalyst

Peak No.	MW.	No. of Carbon	%Peak area	
			Ni10-5-2/(3A-EPG)	Reused #1
3	114	C ₈	5	6
4	128	C ₉	6	7
5	142	C ₁₀	7	7
6	156	C ₁₁	8	8
7	170	C ₁₂	8	8
8	184	C ₁₃	8	9
9	198	C ₁₄	9	9
10	212	C ₁₅	9	9
11	226	C ₁₆	9	8
12	240	C ₁₇	8	8
13	254	C ₁₈	8	8
14	268	C ₁₉	8	7
15	282	C ₂₀	7	6

Table B17 Composition of oil product from hydrocracking over reused Ni(10%)-Sn(5%)-F(2%) on molecular sieve (13xPG type) catalyst

Peak No.	MW.	No. of Carbon	Retention time (min)	
			Ni10-5-2/(13xPG)	Reused #1
1	86	C ₆	1.10	1.11
2	100	C ₇	1.52	1.53
3	114	C ₈	2.43	2.45
4	128	C ₉	4.62	4.67
5	142	C ₁₀	8.52	8.57
6	156	C ₁₁	12.24	12.28
7	170	C ₁₂	14.84	14.87
8	184	C ₁₃	17.12	17.17
9	198	C ₁₄	19.90	19.95
10	212	C ₁₅	22.55	22.59
11	226	C ₁₆	25.01	25.06
12	240	C ₁₇	27.32	27.37
13	254	C ₁₈	29.49	29.53
14	268	C ₁₉	31.53	31.58
15	282	C ₂₀	33.48	33.52
16	296	C ₂₁	35.32	35.37
17	310	C ₂₂	37.09	37.14
18	324	C ₂₃	38.78	38.83
19	338	C ₂₄	40.40	40.45
20	352	C ₂₅	-	42.01
21	366	C ₂₆	-	43.51
22	380	C ₂₇	-	-

Table B18 The molecular weight distributions of oil product from hydrocracking over reused Ni(10%)-Sn(5%)-F(2%) on molecular sieve (13xPG type) catalyst

Peak No.	MW.	No. of Carbon	%Peak area	
			Ni10-5-2/(13xPG)	Reused #1
3	114	C ₈	6	9
4	128	C ₉	8	9
5	142	C ₁₀	8	10
6	156	C ₁₁	9	10
7	170	C ₁₂	9	10
8	184	C ₁₃	9	8
9	198	C ₁₄	9	8
10	212	C ₁₅	9	8
11	226	C ₁₆	9	7
12	240	C ₁₇	7	6
13	254	C ₁₈	6	6
14	268	C ₁₉	6	5
15	282	C ₂₀	5	4

Table B19 Composition of oil product from reproducibility of hydrocracking over Ni(10%)-Sn(5%)-F(2%) on molecular sieve (4A-DG type) catalyst

Peak No.	MW.	No. of Carbon	Retention time (min)	
			Ni10-5-2/(4A-DG)	reproduced #1
1	86	C ₆	1.10	1.11
2	100	C ₇	1.52	1.54
3	114	C ₈	2.43	2.45
4	128	C ₉	4.63	4.65
5	142	C ₁₀	8.54	8.55
6	156	C ₁₁	12.26	12.27
7	170	C ₁₂	14.86	17.87
8	184	C ₁₃	17.16	17.18
9	198	C ₁₄	19.94	19.95
10	212	C ₁₅	22.58	22.59
11	226	C ₁₆	25.05	25.07
12	240	C ₁₇	27.36	27.38
13	254	C ₁₈	29.53	29.56
14	268	C ₁₉	31.57	31.59
15	282	C ₂₀	33.52	33.55
16	296	C ₂₁	35.37	35.39
17	310	C ₂₂	37.13	37.16
18	324	C ₂₃	38.82	38.86
19	338	C ₂₄	40.43	40.47
20	352	C ₂₅	41.99	42.03
21	366	C ₂₆	43.49	43.53
22	380	C ₂₇	44.92	44.96

Table B20 The molecular weight distributions of oil product from reproducibility of hydrocracking over Ni(10%)-Sn(5%)-F(2%) on molecular sieve (4A-DG type) catalyst

Peak No.	MW.	No. of Carbon	%Peak area	
			Ni10-5-2/(4A-DG)	reproduced #1
3	114	C ₈	6	6
4	128	C ₉	8	7
5	142	C ₁₀	9	8
6	156	C ₁₁	9	8
7	170	C ₁₂	9	9
8	184	C ₁₃	9	9
9	198	C ₁₄	8	9
10	212	C ₁₅	8	8
11	226	C ₁₆	8	8
12	240	C ₁₇	7	7
13	254	C ₁₈	7	7
14	268	C ₁₉	6	7
15	282	C ₂₀	6	7

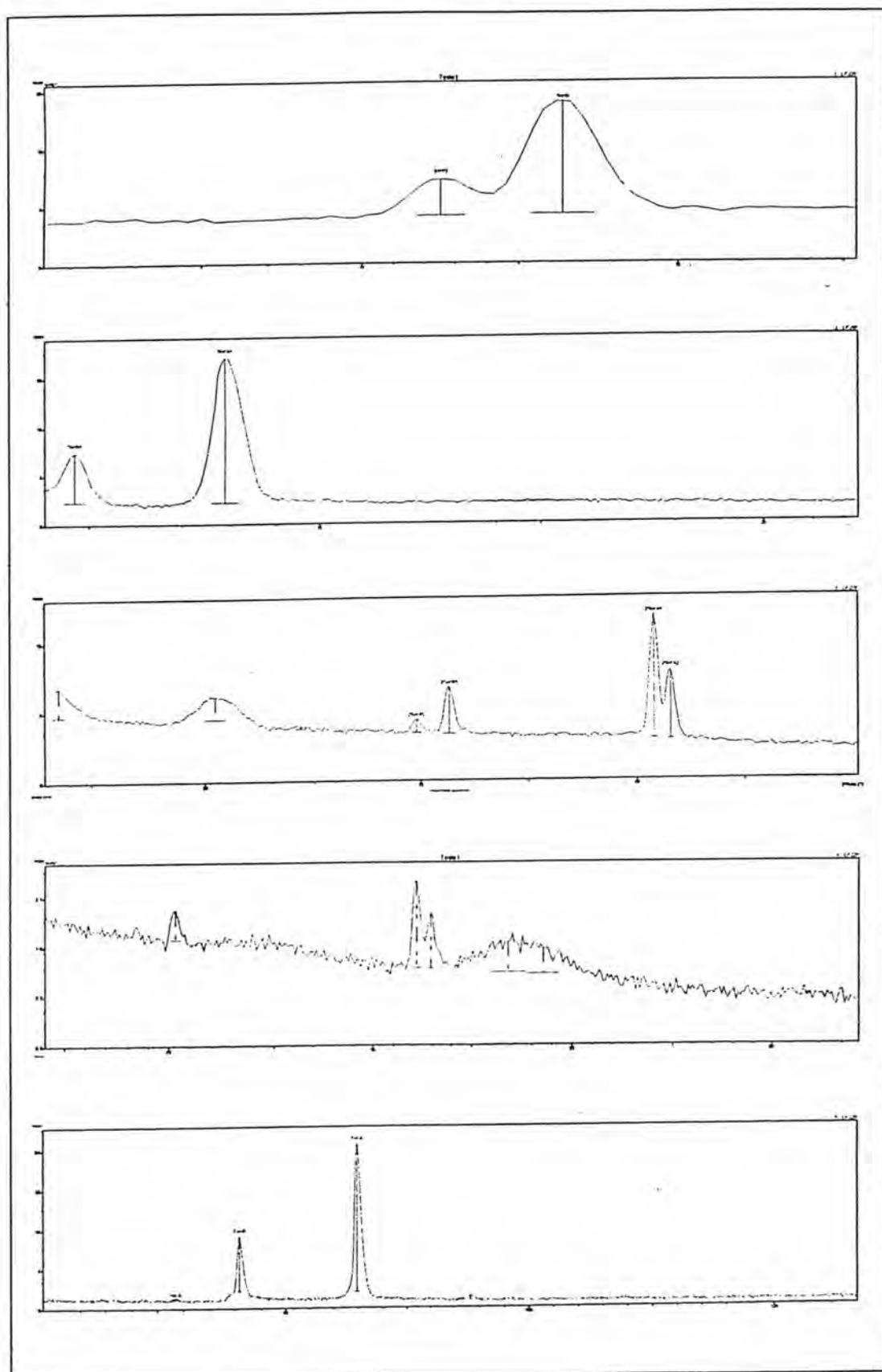


Figure A1 Plots of X-ray fluorescence data of Fe(10%)-Sn(5%)-F(2%) on molecular sieve (4A-DG type) catalyst

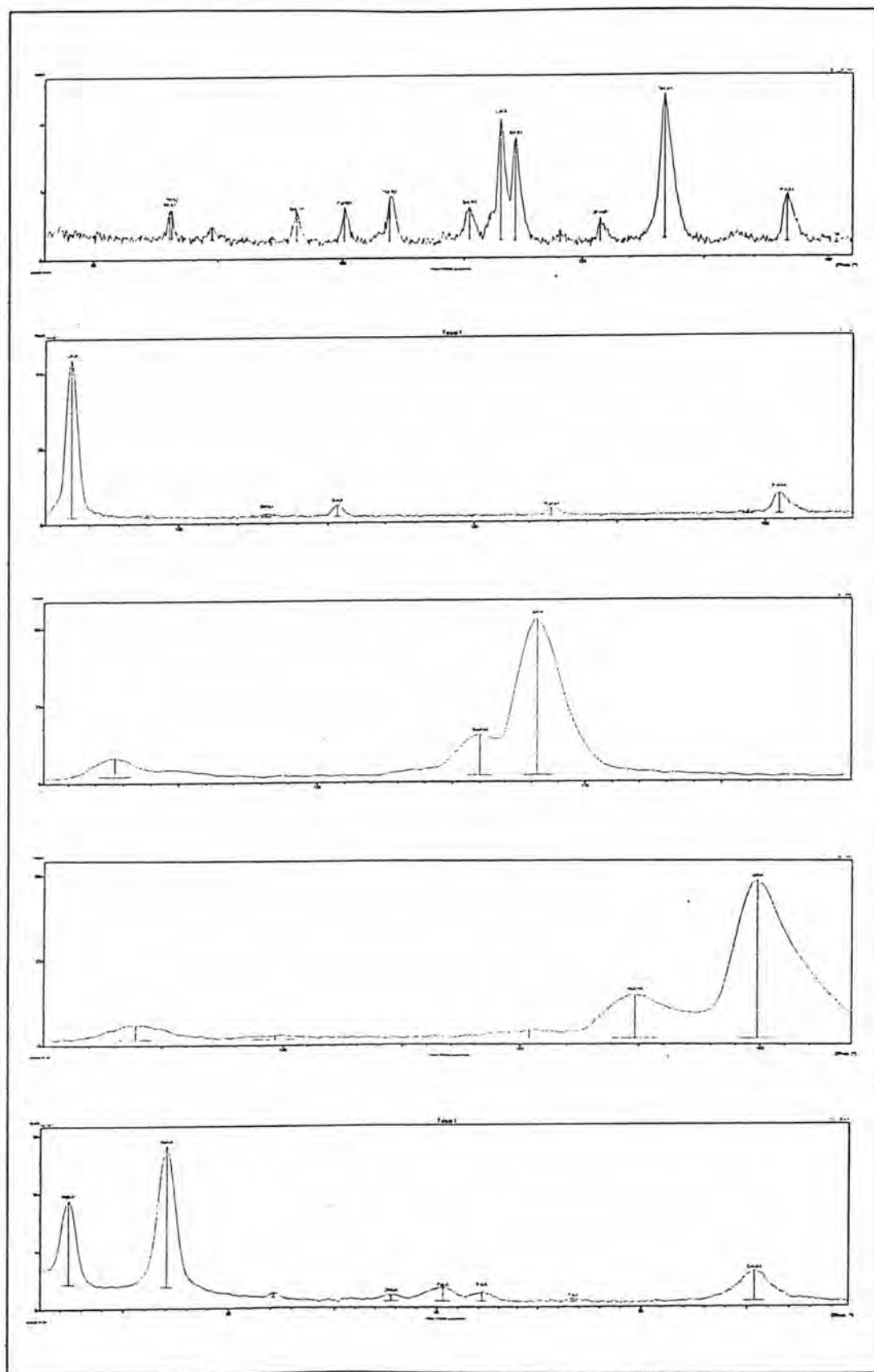


Figure A1 Plots of X-ray fluorescence data of Fe(10%)-Sn(5%)-F(2%) on molecular sieve (4A-DG type) catalyst (continued)

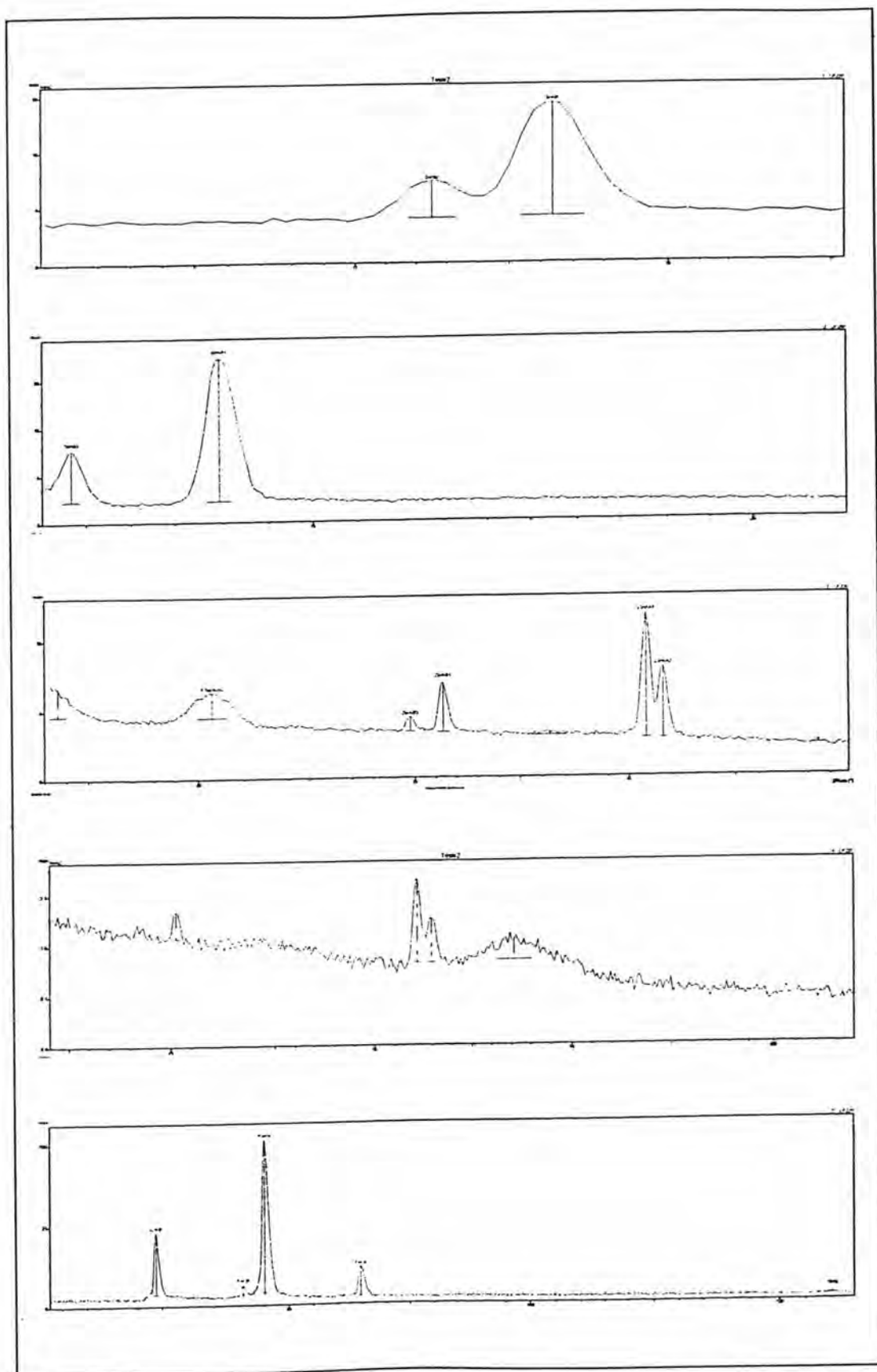


Figure A2 Plots of X-ray fluorescence data of Co(10%)-Sn(5%)-F(2%) on molecular sieve (4A-DG type) catalyst

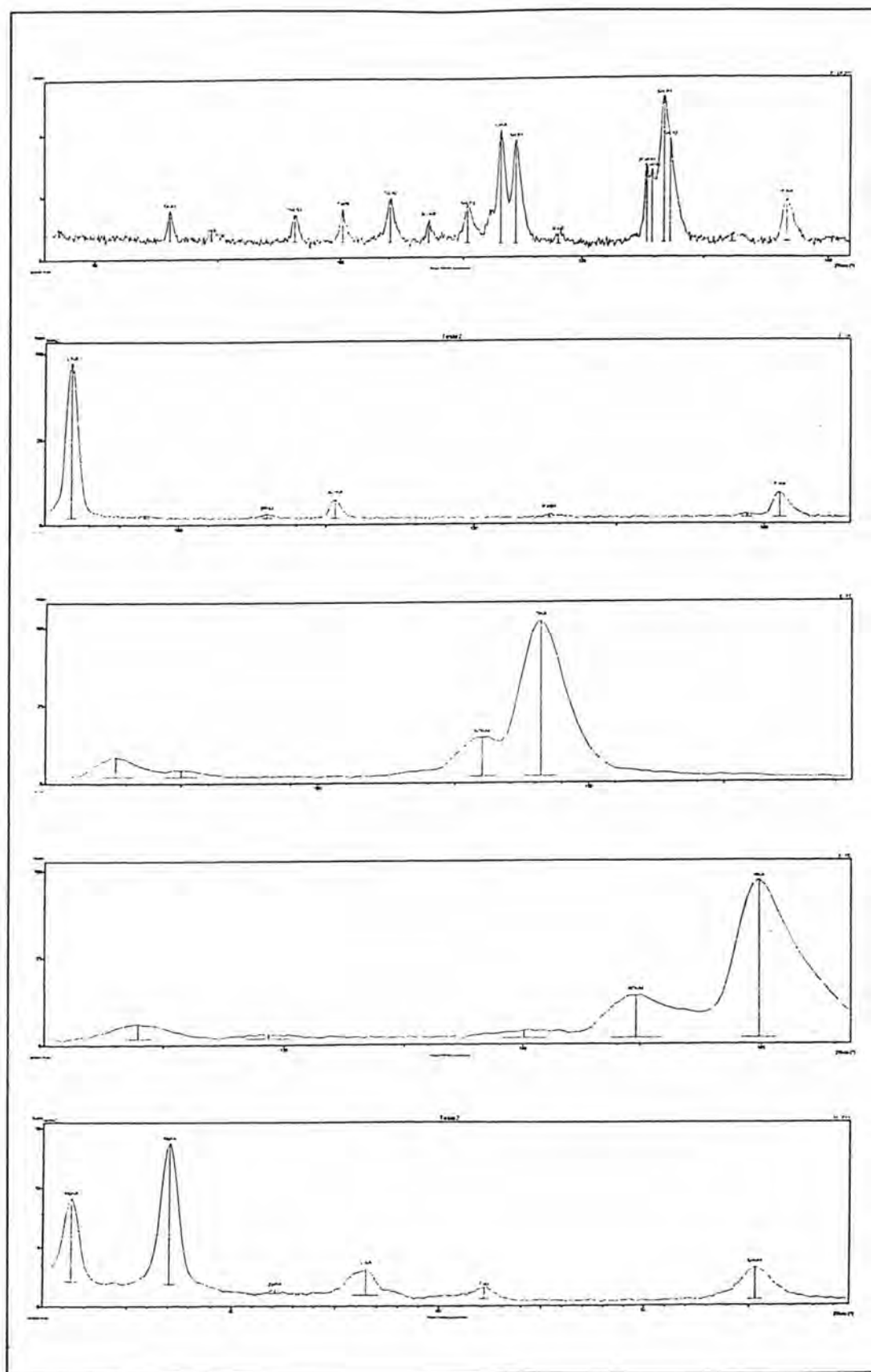


Figure A2 Plots of X-ray fluorescence data of Co(10%)-Sn(5%)-F(2%) on molecular sieve (4A-DG type) catalyst (continued)

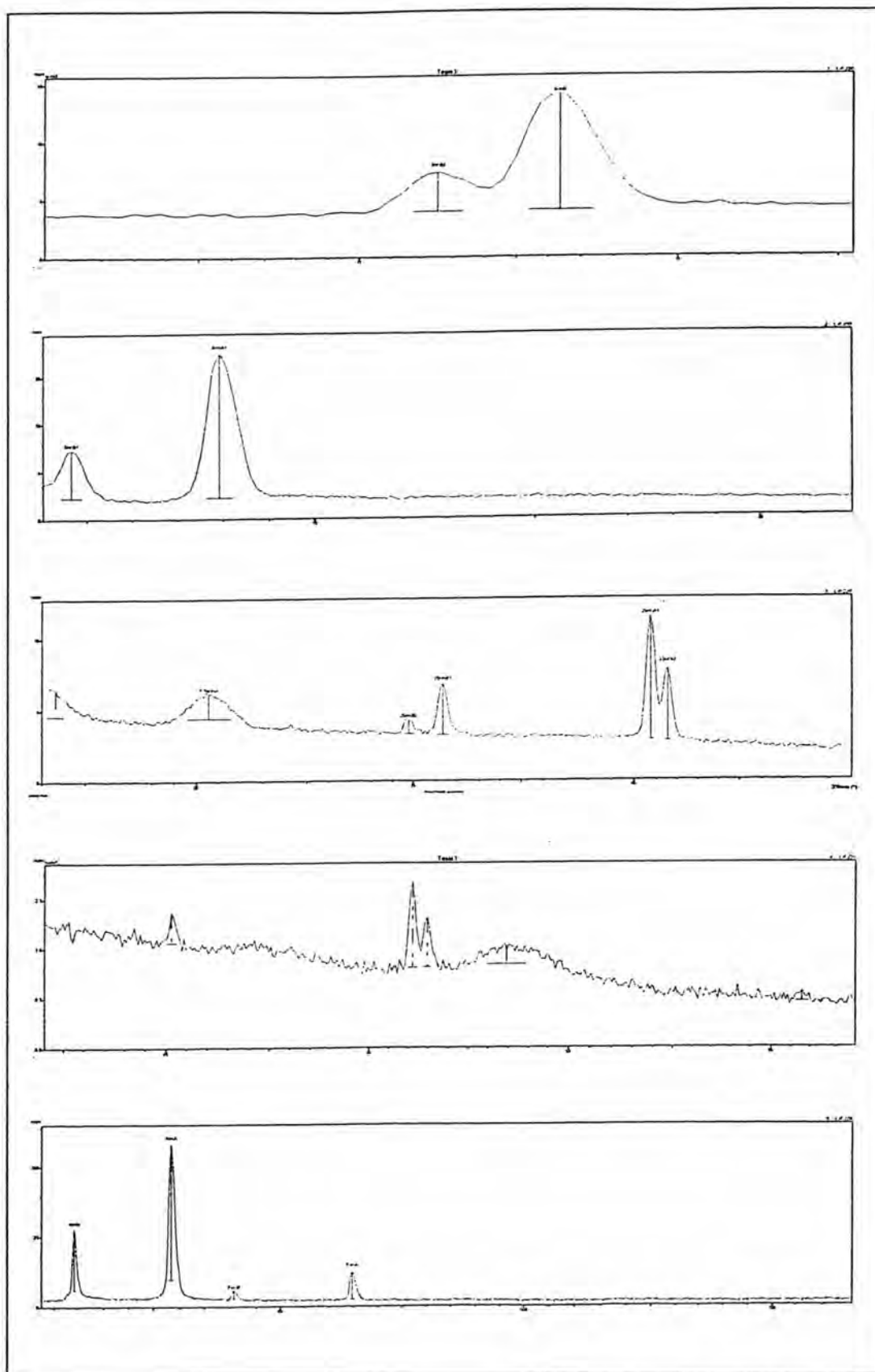


Figure A3 Plots of X-ray fluorescence data of Ni(10%)-Sn(5%)-F(2%) on molecular sieve (4A-DG type) catalyst

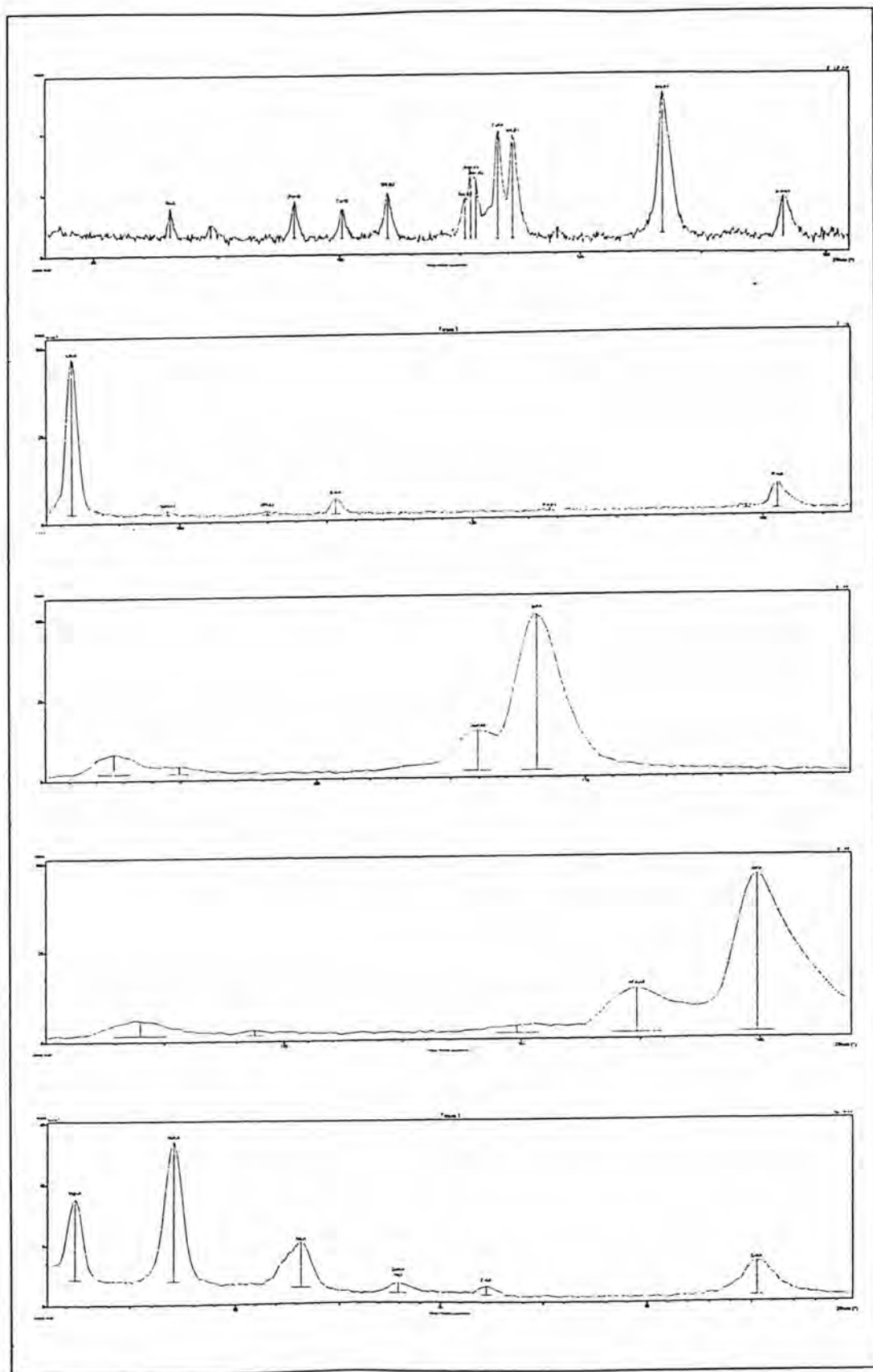


Figure A3 Plots of X-ray fluorescence data of Ni(10%)-Sn(5%)-F(2%) on molecular sieve (4A-DG type) catalyst (continued)

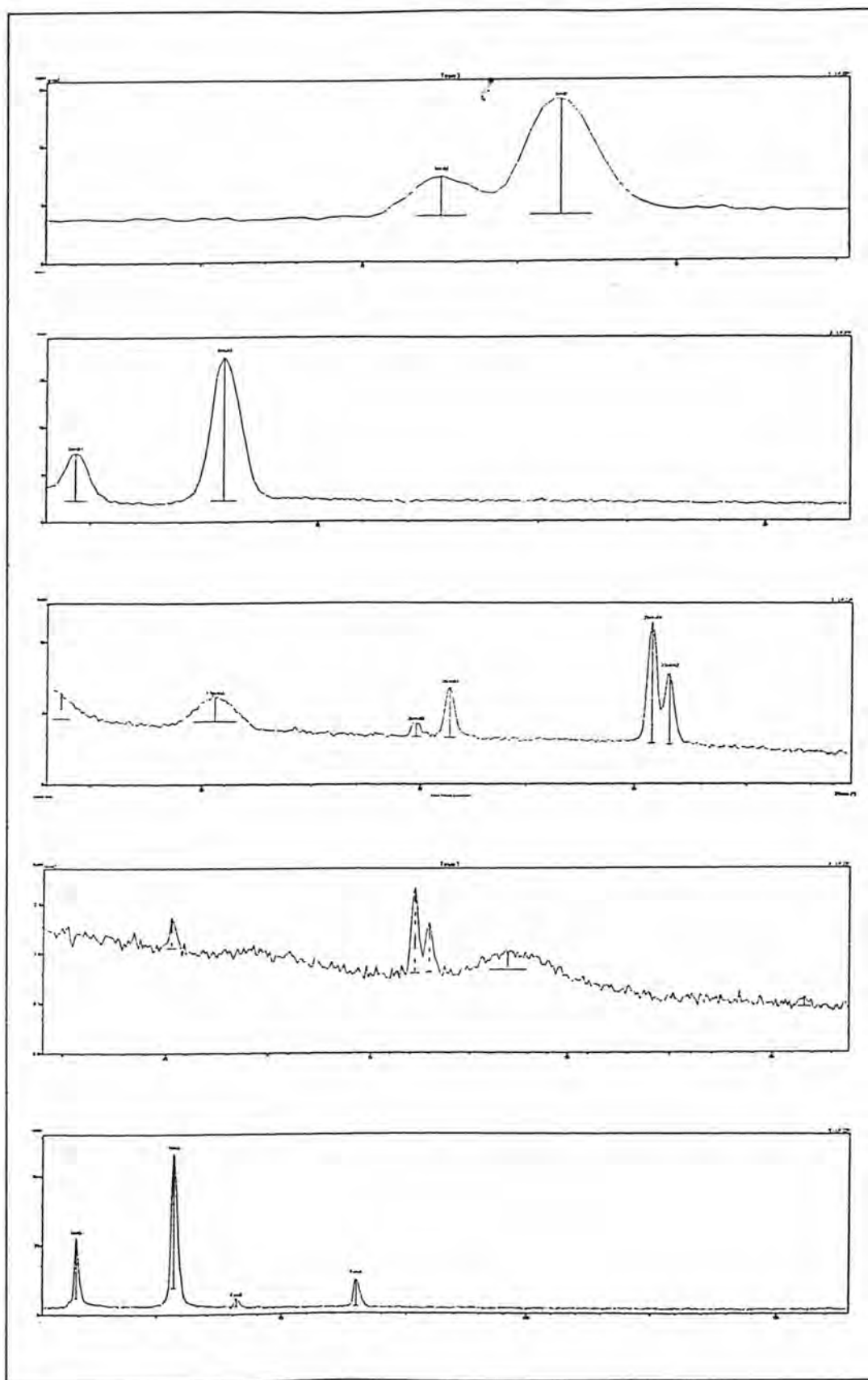


Figure A4 Plots of X-ray fluorescence data of Ni(10%)-Sn(5%)-F(1%) on molecular sieve (4A-DG type) catalyst

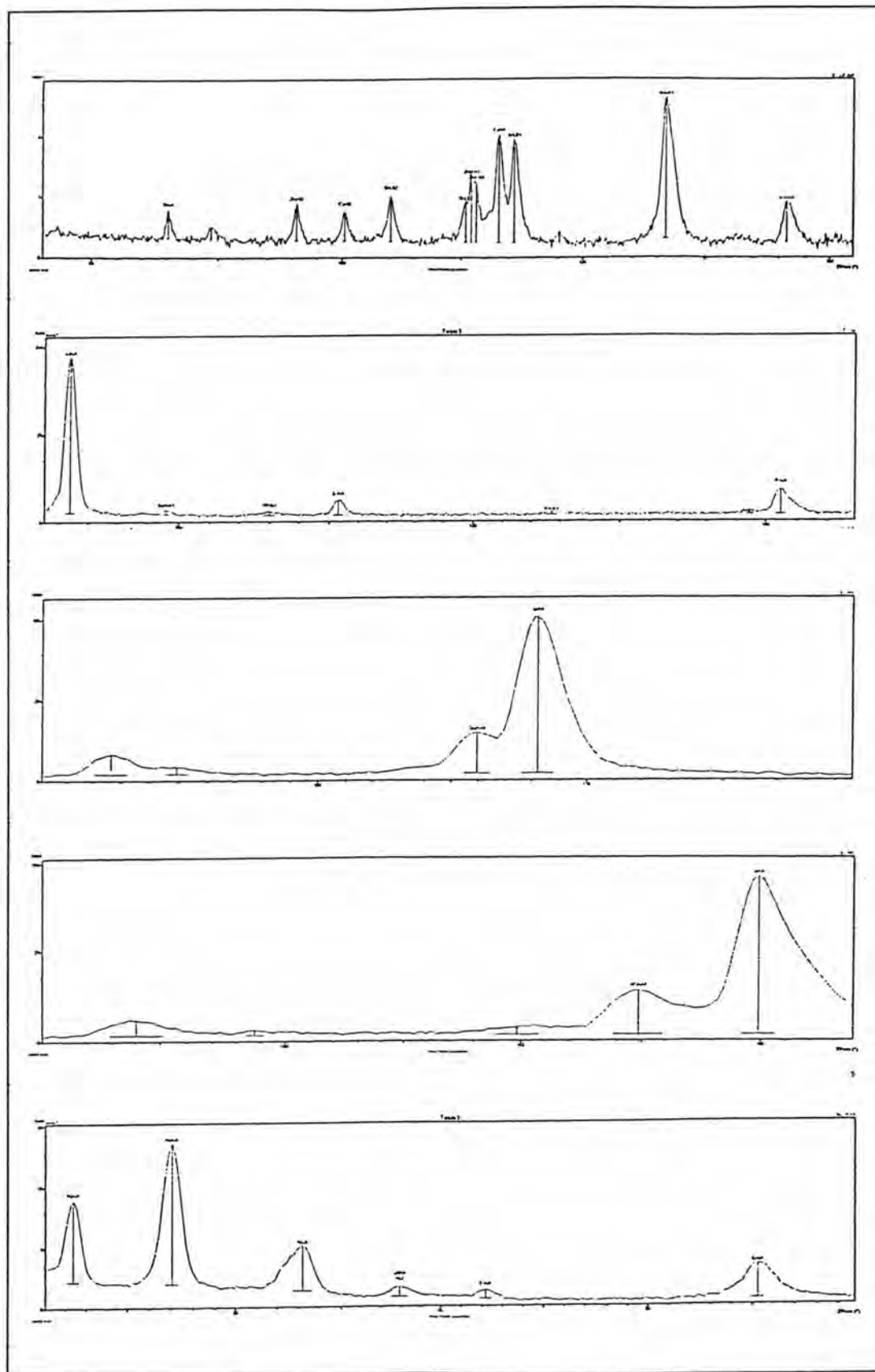


Figure A4 Plots of X-ray fluorescence data of Ni(10%)-Sn(5%)-F(1%) on molecular sieve (4A-DG type) catalyst (continued)

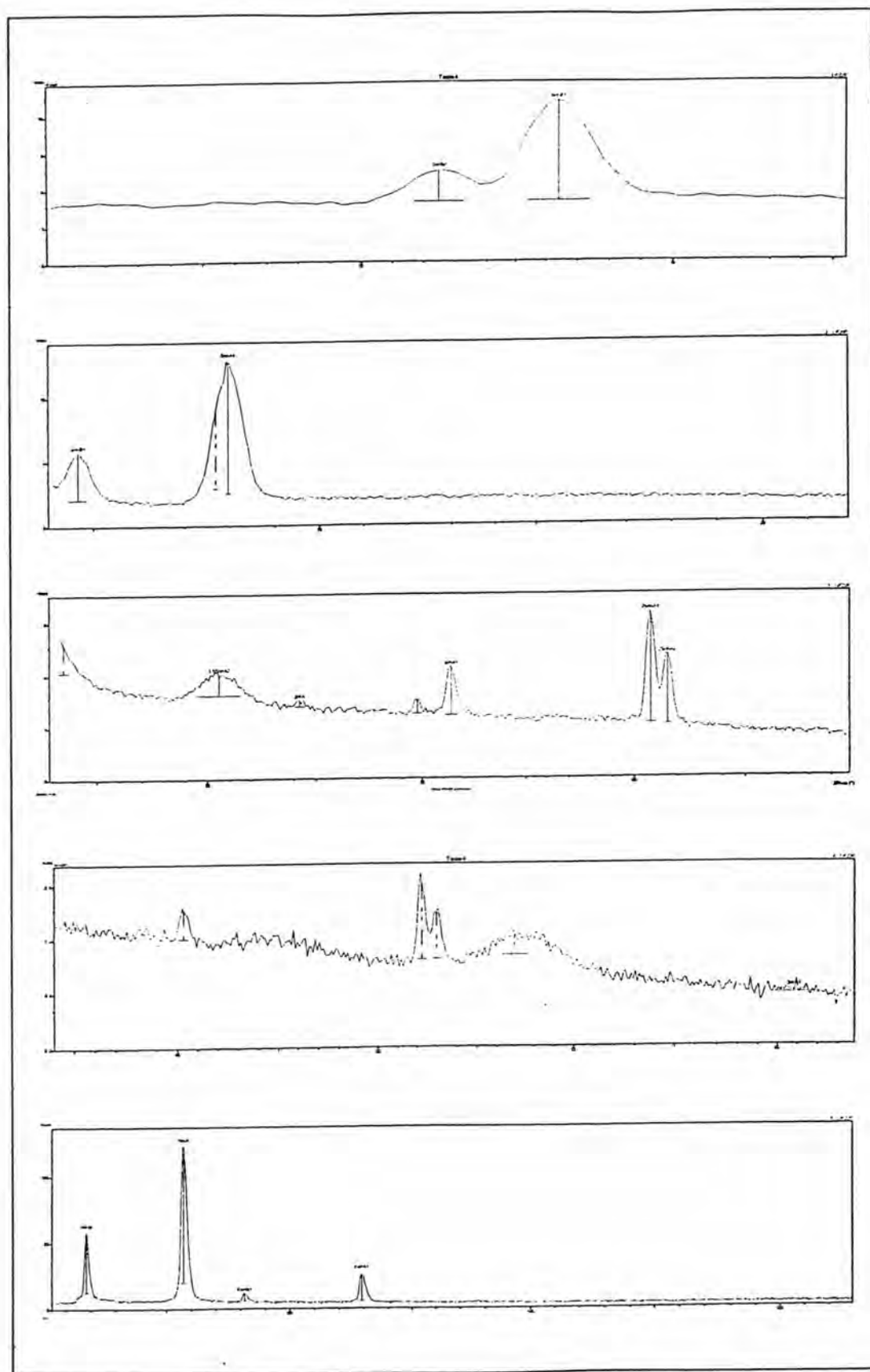


Figure A5 Plots of X-ray fluorescence data of Ni(10%)-Sn(2.5%)-F(2%) on molecular sieve (4A-DG type) catalyst

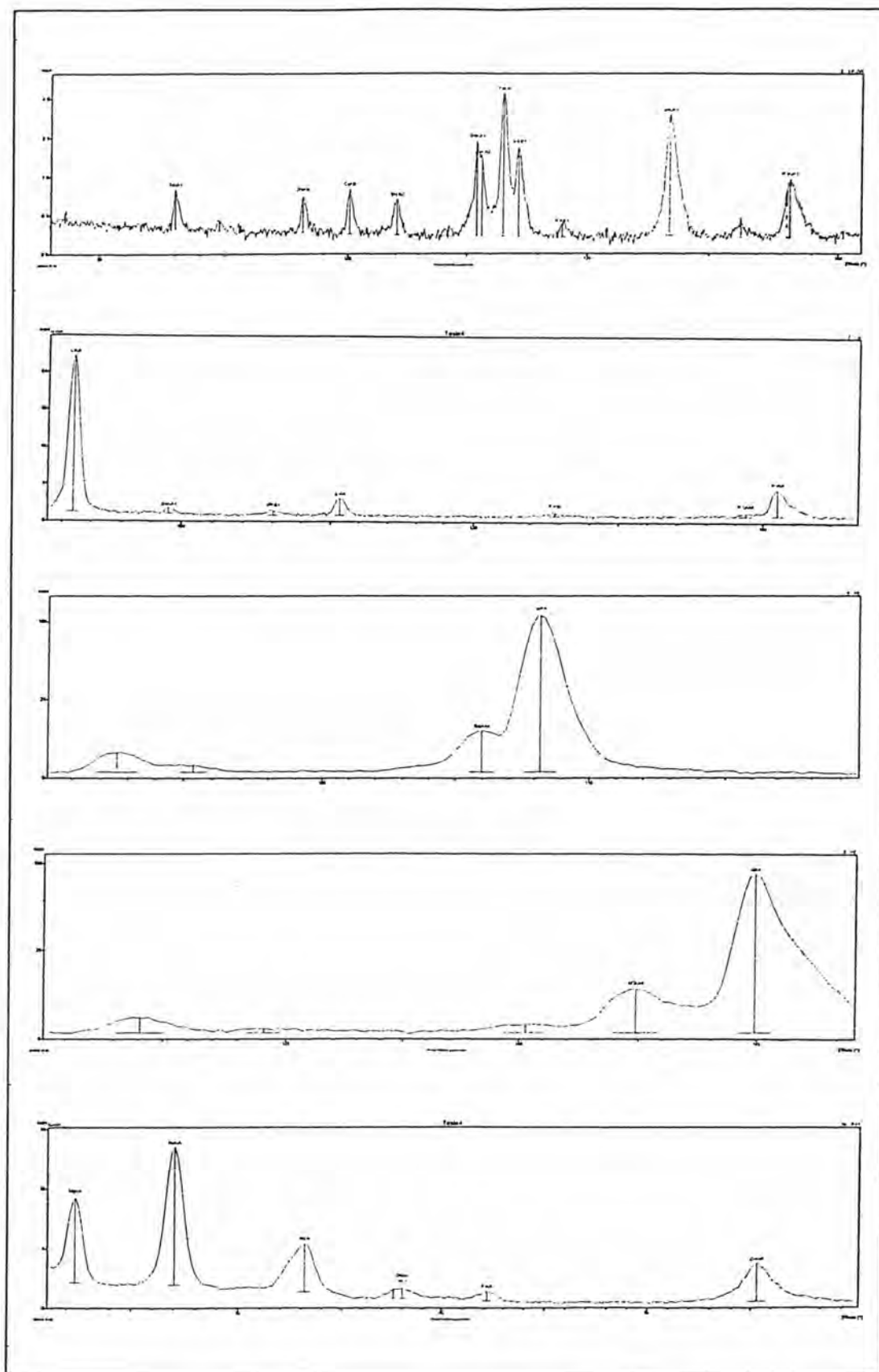


Figure A5 Plots of X-ray fluorescence data of Ni(10%)-Sn(2.5%)-F(2%) on molecular sieve (4A-DG type) catalyst (continued)

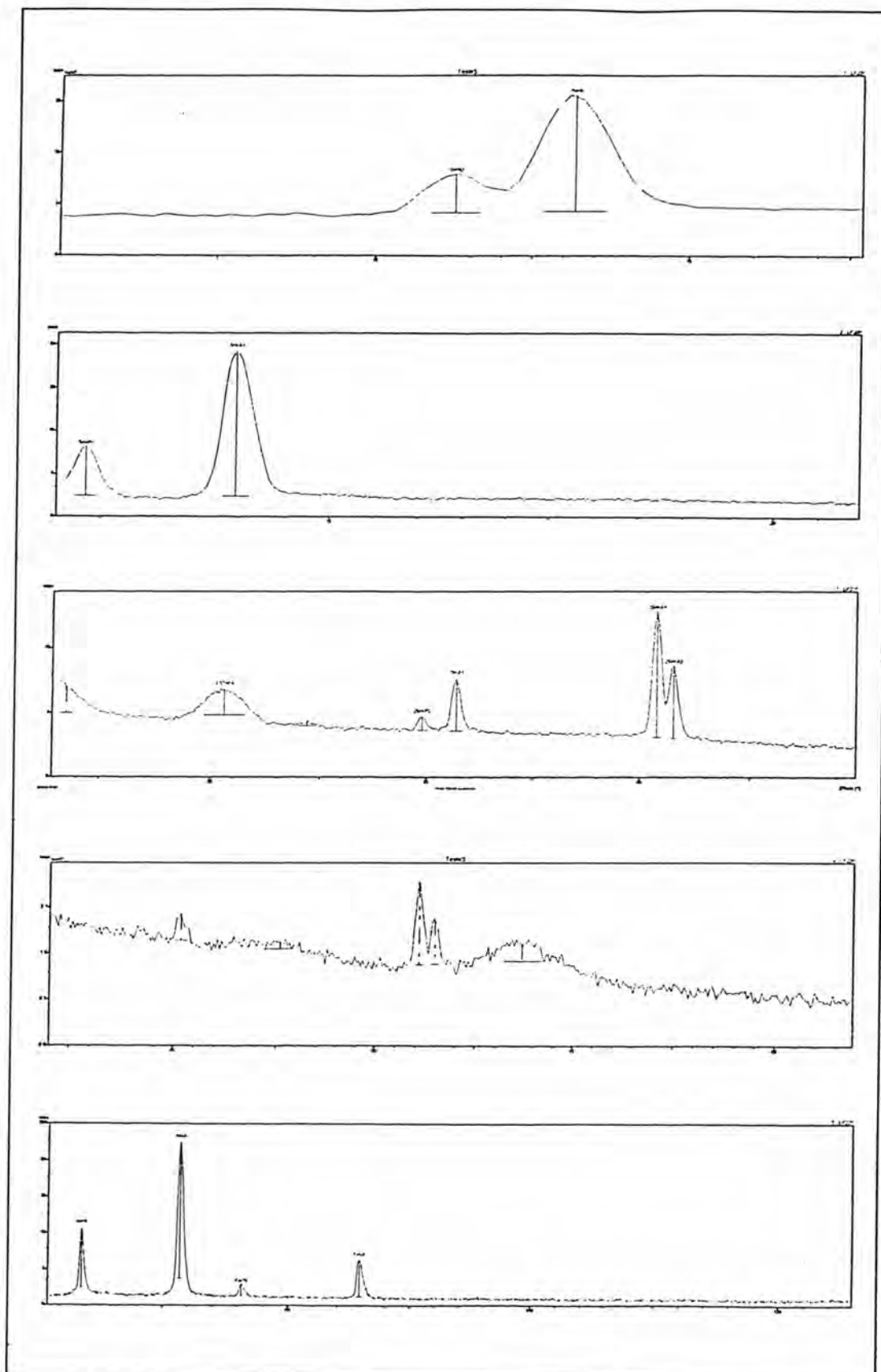


Figure A6 Plots of X-ray fluorescence data of Ni(5%)-Sn(5%)-F(2%) on molecular sieve (4A-DG type) catalyst

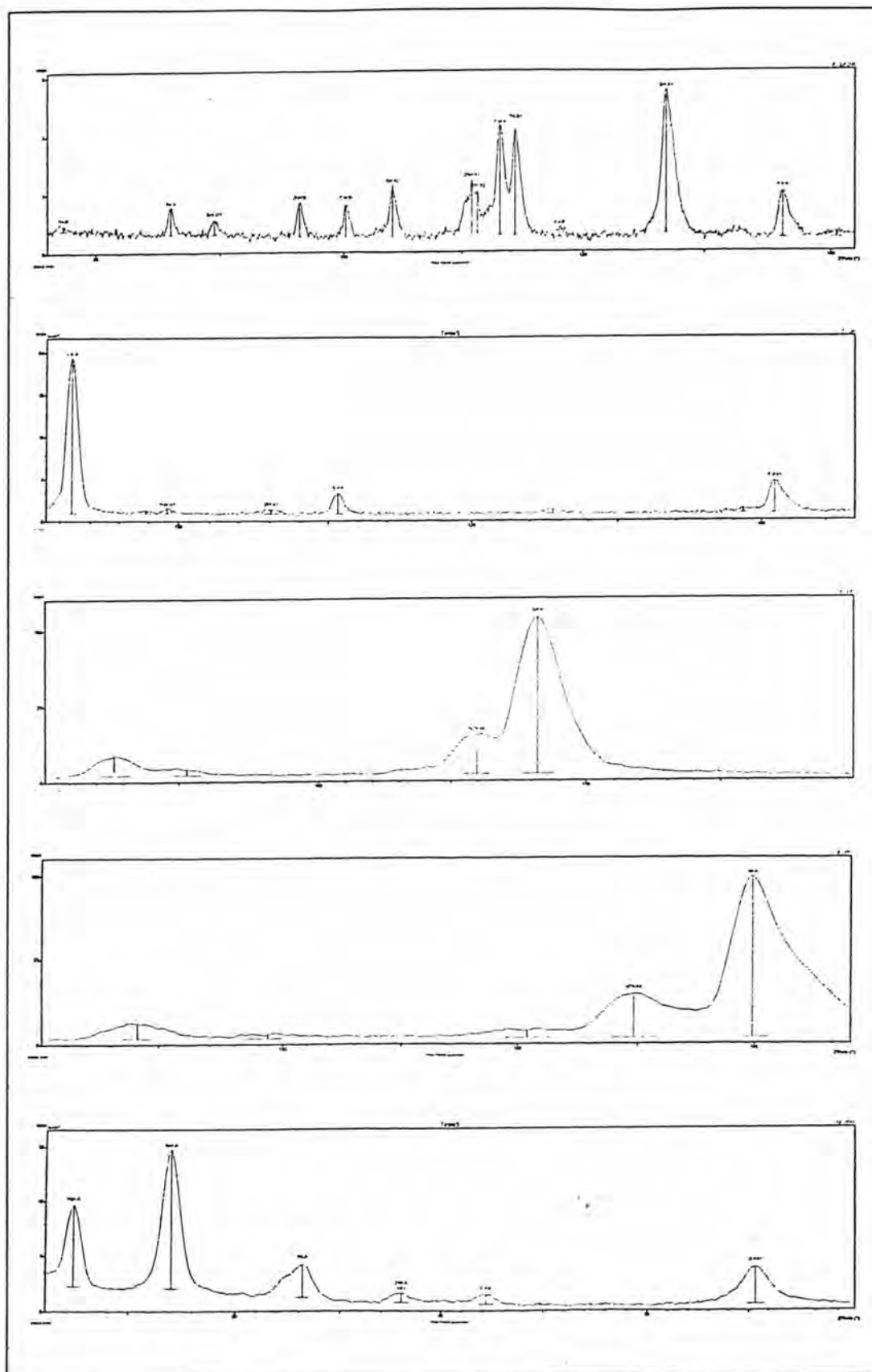


Figure A6 Plots of X-ray fluorescence data of Ni(5%)-Sn(5%)-F(2%) on molecular sieve (4A-DG type) catalyst (continued)

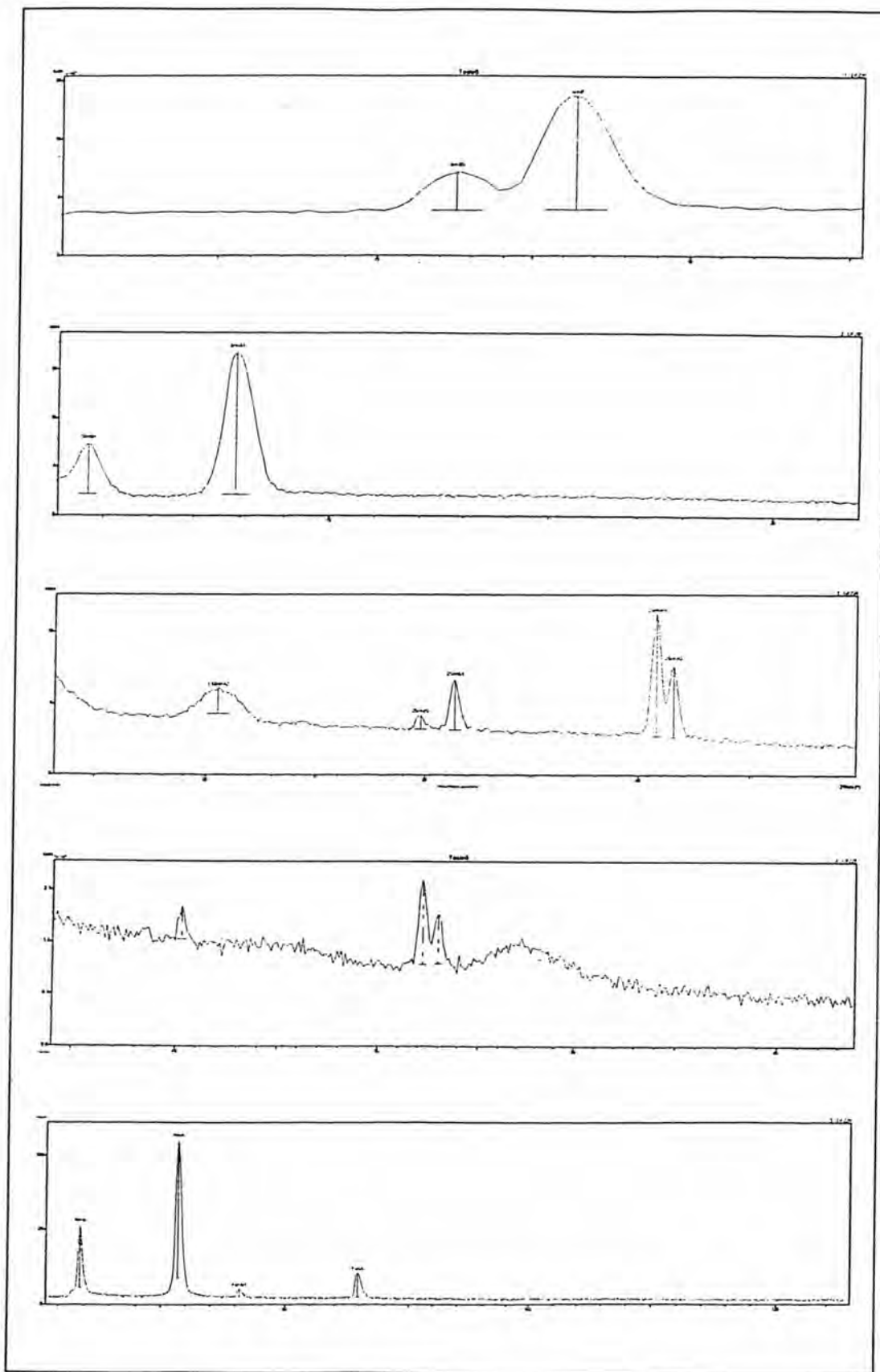


Figure A7 Plots of X-ray fluorescence data of Ni(10%)-Sn(5%)-F(2%) on molecular sieve (3A-EPG type) catalyst

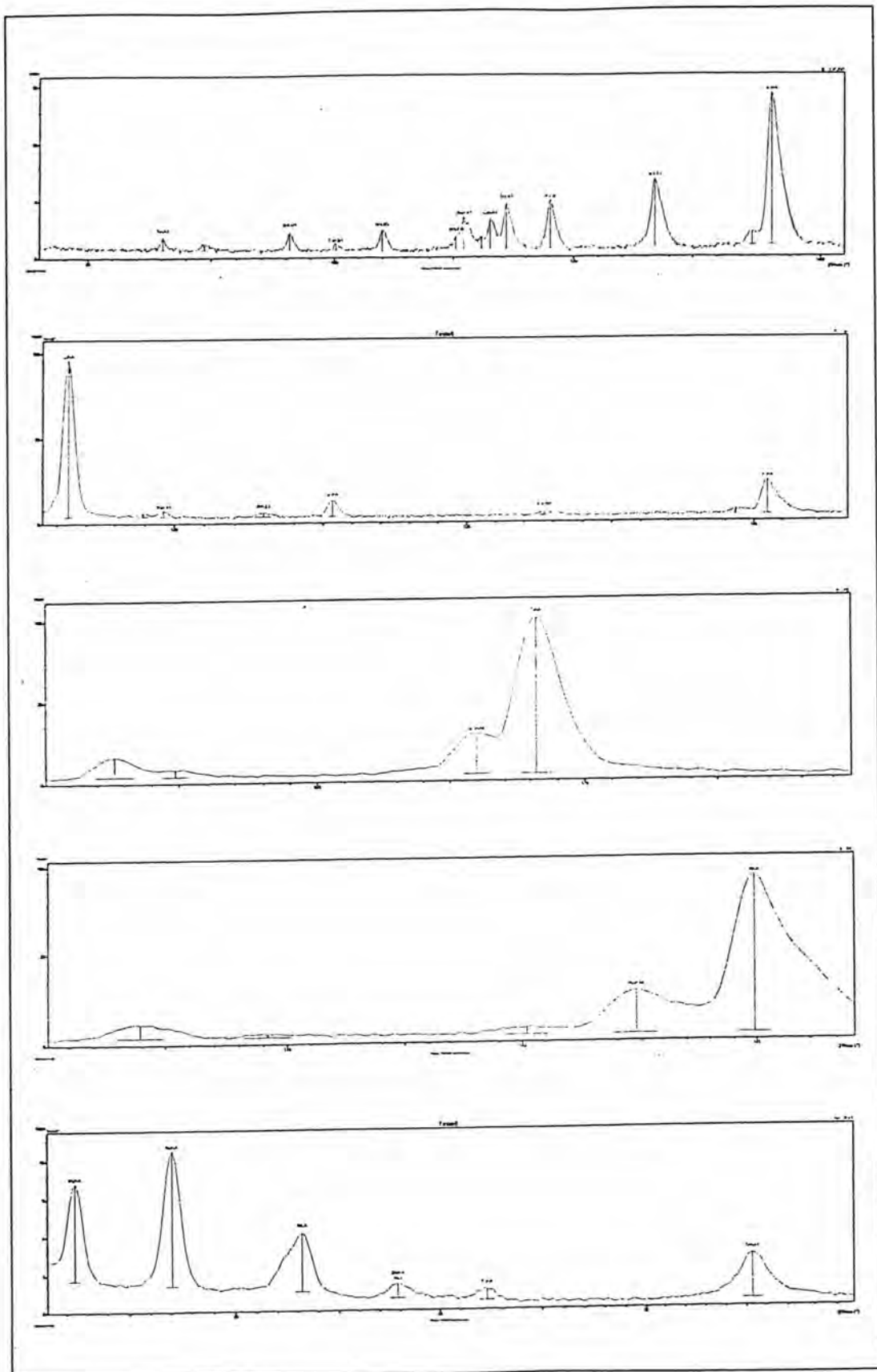


Figure A7 Plots of X-ray fluorescence data of Ni(10%)-Sn(5%)-F(2%) on molecular sieve (3A-EPG type) catalyst (continued)

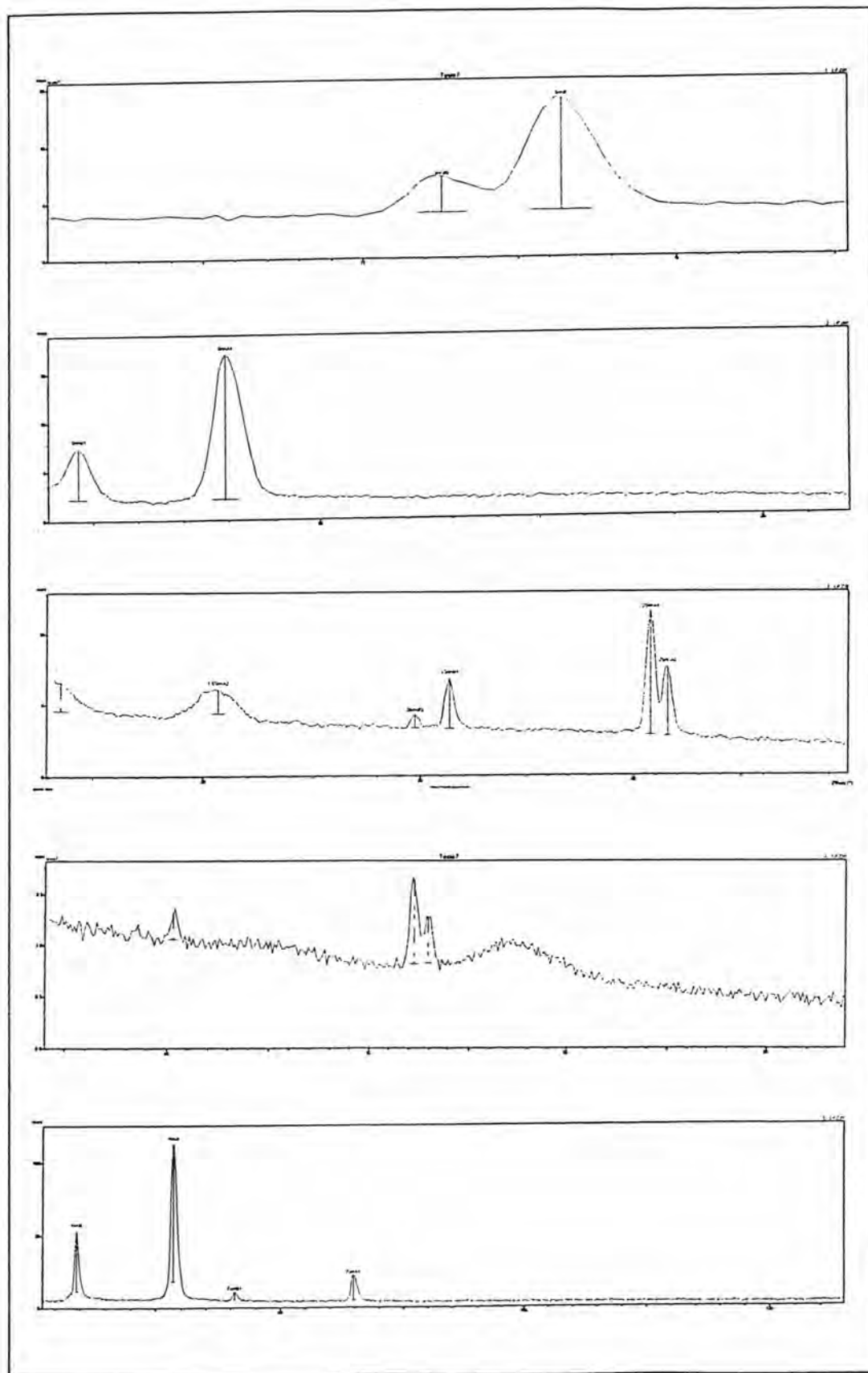


Figure A8 Plots of X-ray fluorescence data of Ni(10%)-Sn(5%)-F(2%) on molecular sieve (13xPG type) catalyst

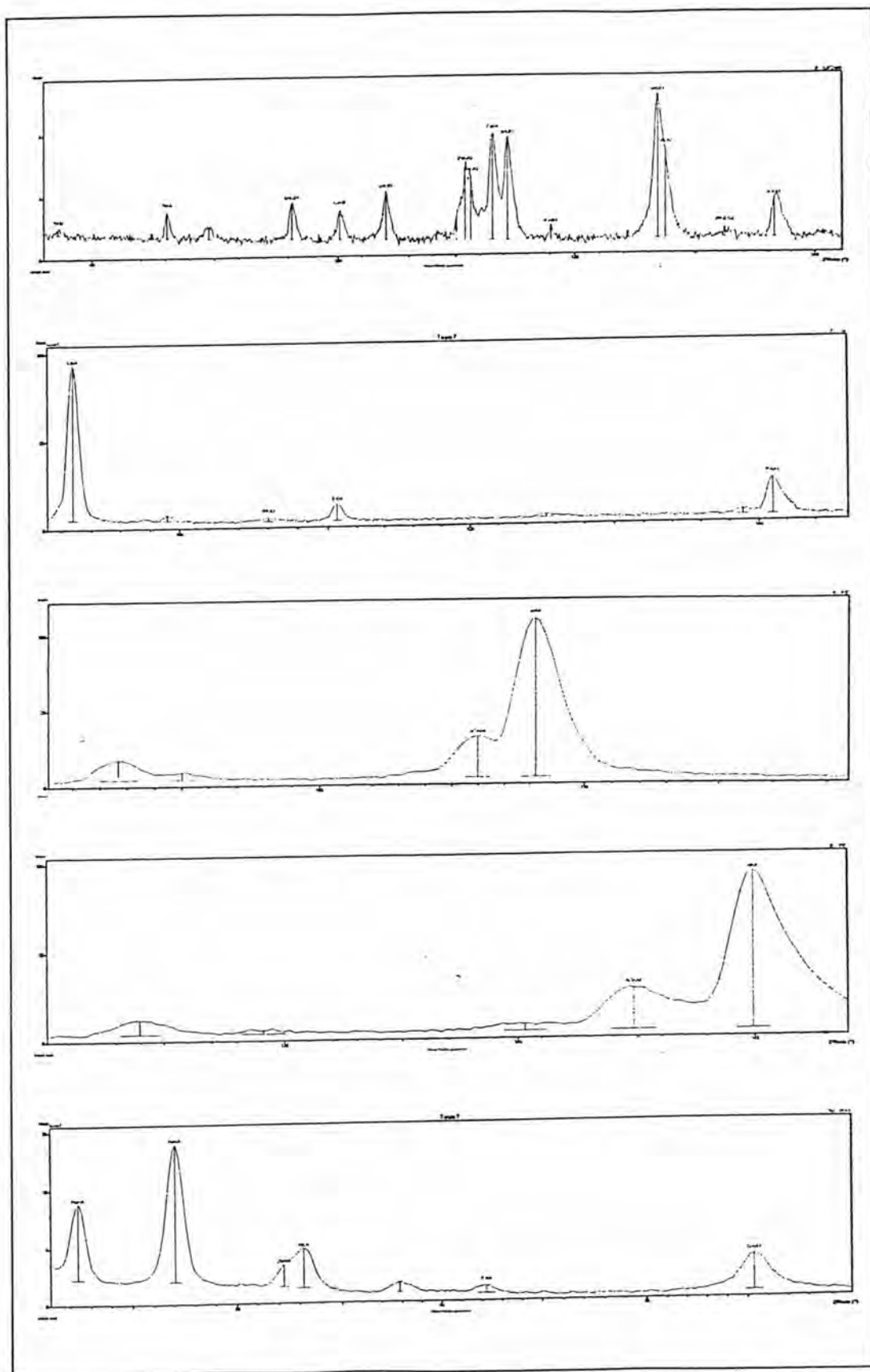


Figure A8 Plots of X-ray fluorescence data of Ni(10%)-Sn(5%)-F(2%) on molecular sieve (13xPG type) catalyst (continued)

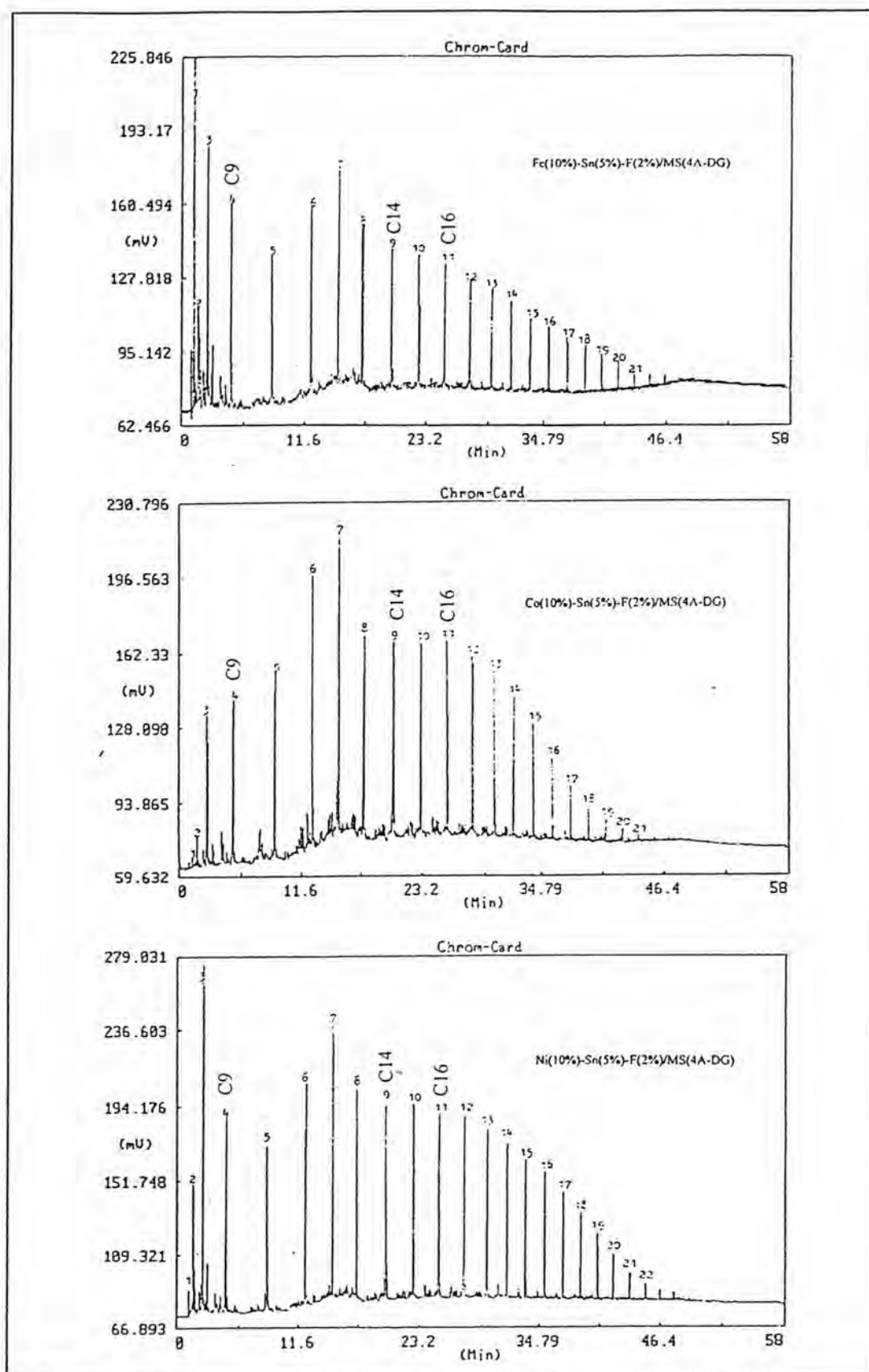


Figure B1 GC chromatograms of oil product from hydrocracking on molecular sieve (4A-DG type) catalyst as functions of catalyst type and element composition

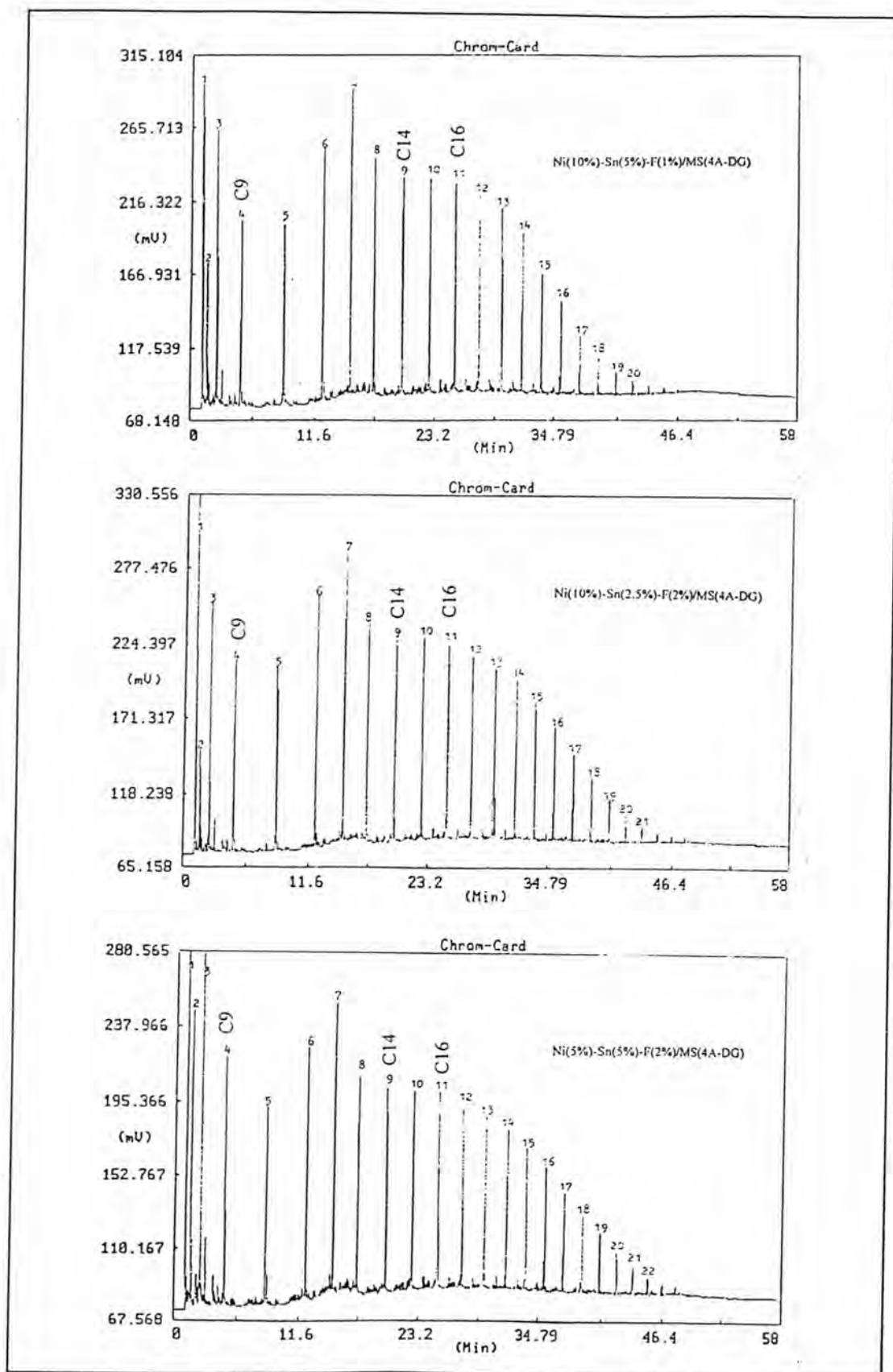


Figure B2 GC chromatograms of oil product from hydrocracking on molecular sieve (4A-DG type) catalyst as functions of catalyst type and element composition (continued)

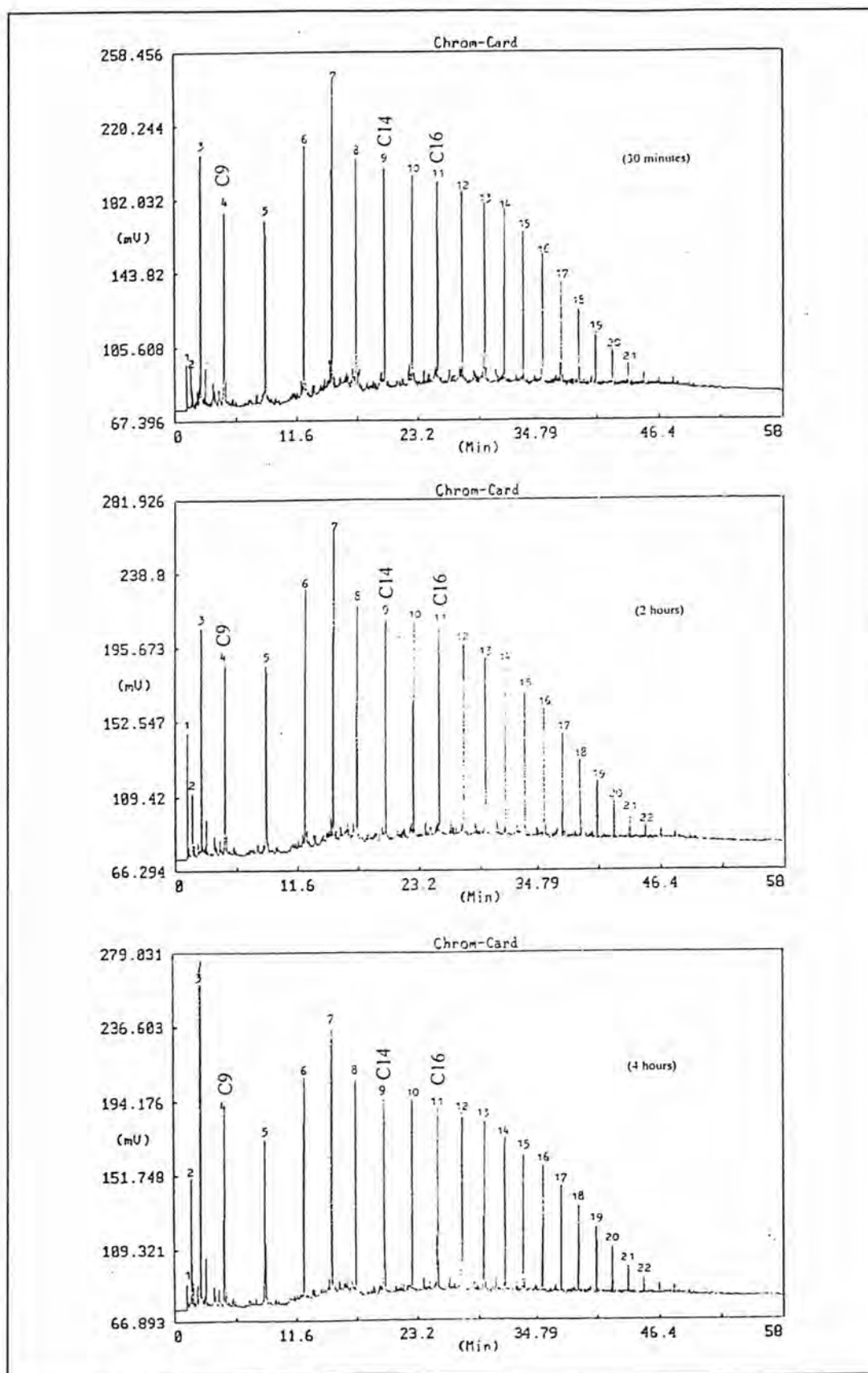


Figure B3 GC chromatograms of oil product from hydrocracking over Ni(10%)-Sn(5%)-F(2%) on molecular sieve (4A-DG type) catalyst as a function of reaction time

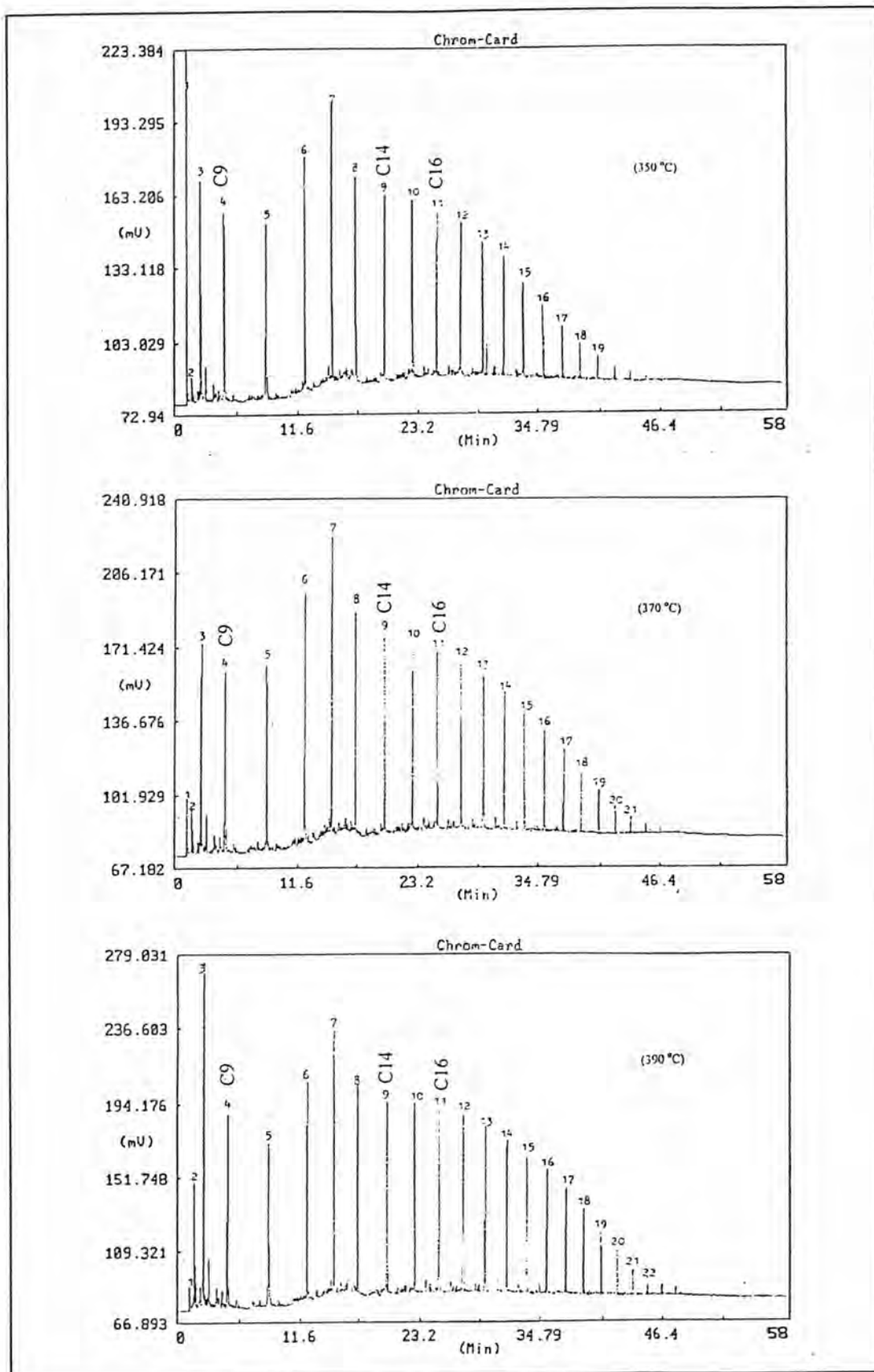


Figure B4 GC chromatograms of oil product from hydrocracking over Ni(10%)-Sn(5%)-F(2%) on molecular sieve (4A-DG type) catalyst as a function of reaction temperature

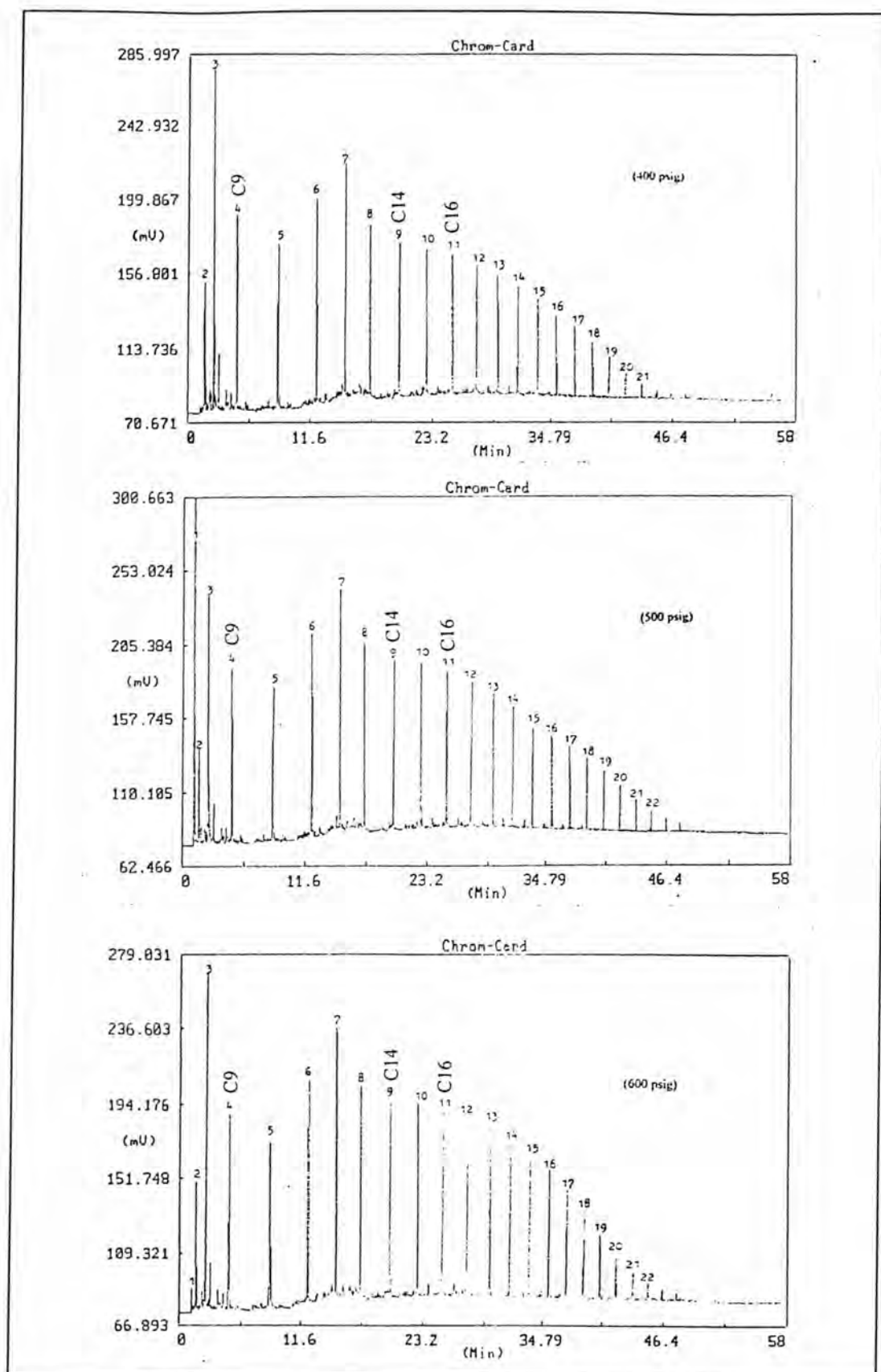


Figure B5 GC chromatograms of oil product from hydrocracking over Ni(10%)-Sn(5%)-F(2%) on molecular sieve (4A-DG type) catalyst as a function of hydrogen pressure

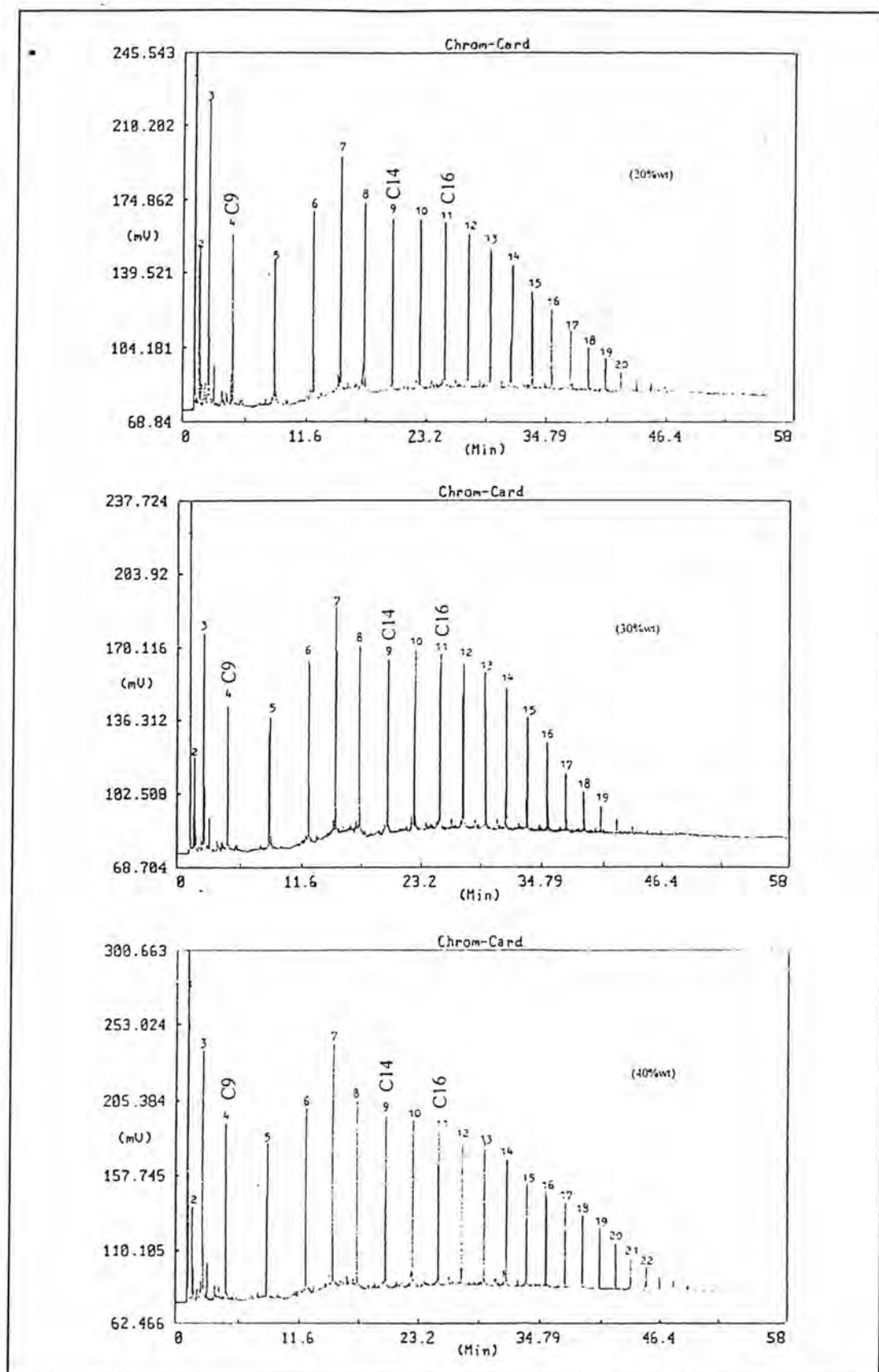


Figure B6 GC chromatograms of oil product from hydrocracking over Ni(10%)-Sn(5%)-F(2%) on molecular sieve (4A-DG type) catalyst as a function of catalyst concentration

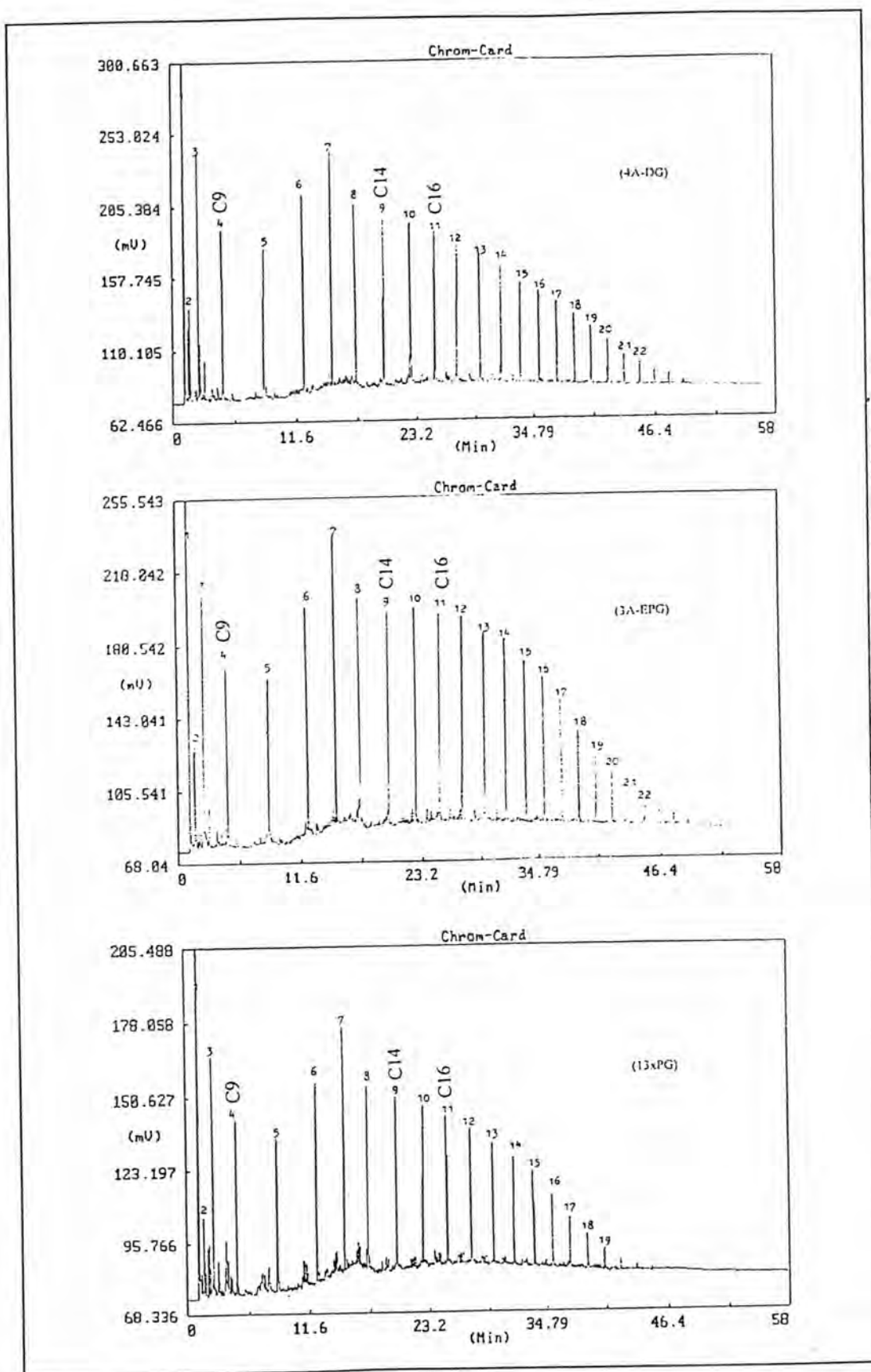


Figure B7 GC chromatograms of oil product from hydrocracking over Ni(10%)-Sn(5%)-F(2%) catalyst as a function of molecular sieve support type

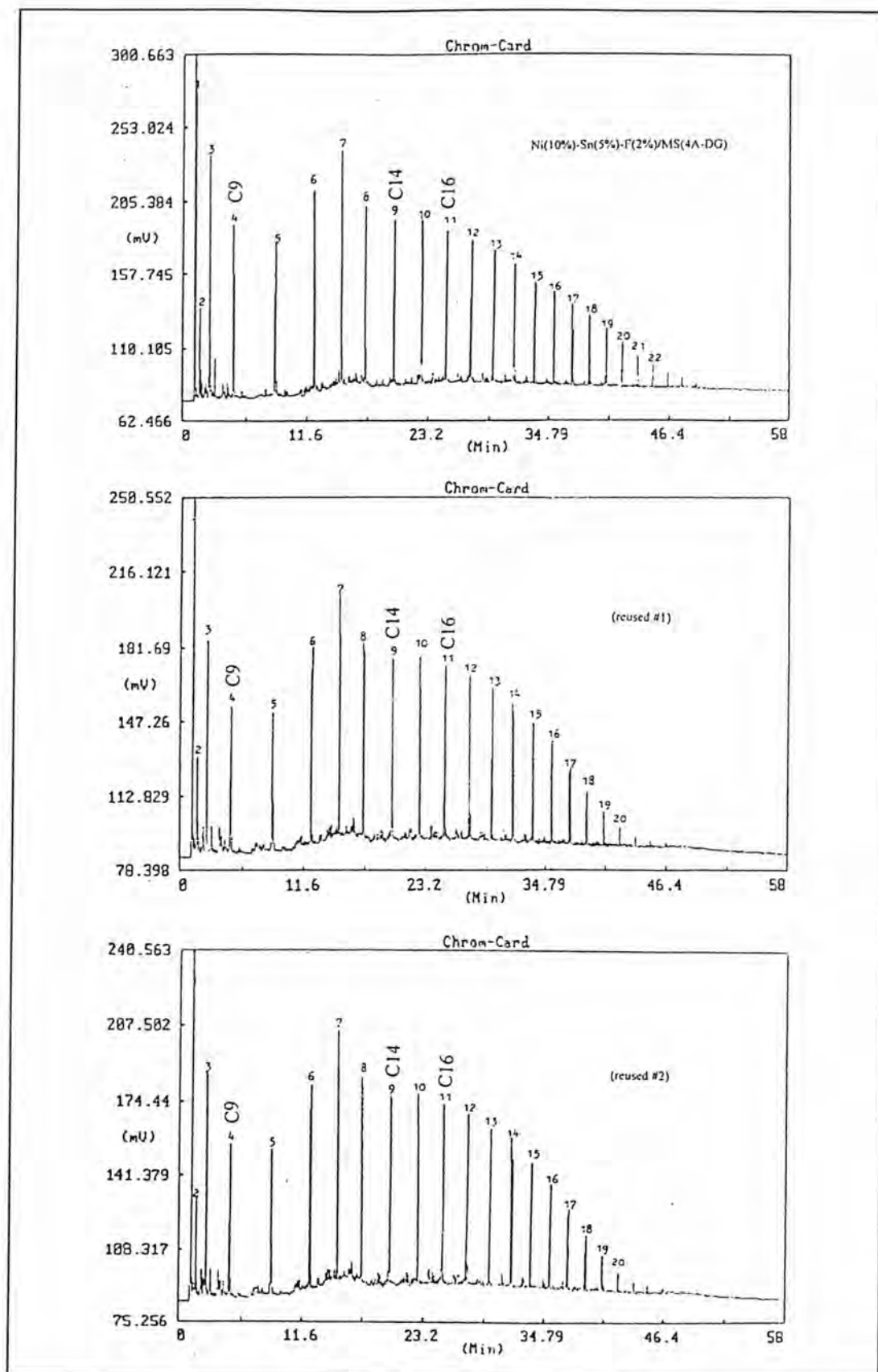


Figure B8 GC chromatograms of oil product from hydrocracking over reused Ni(10%)-Sn(5%)-F(2%) on molecular sieve (4A-DG type) catalyst

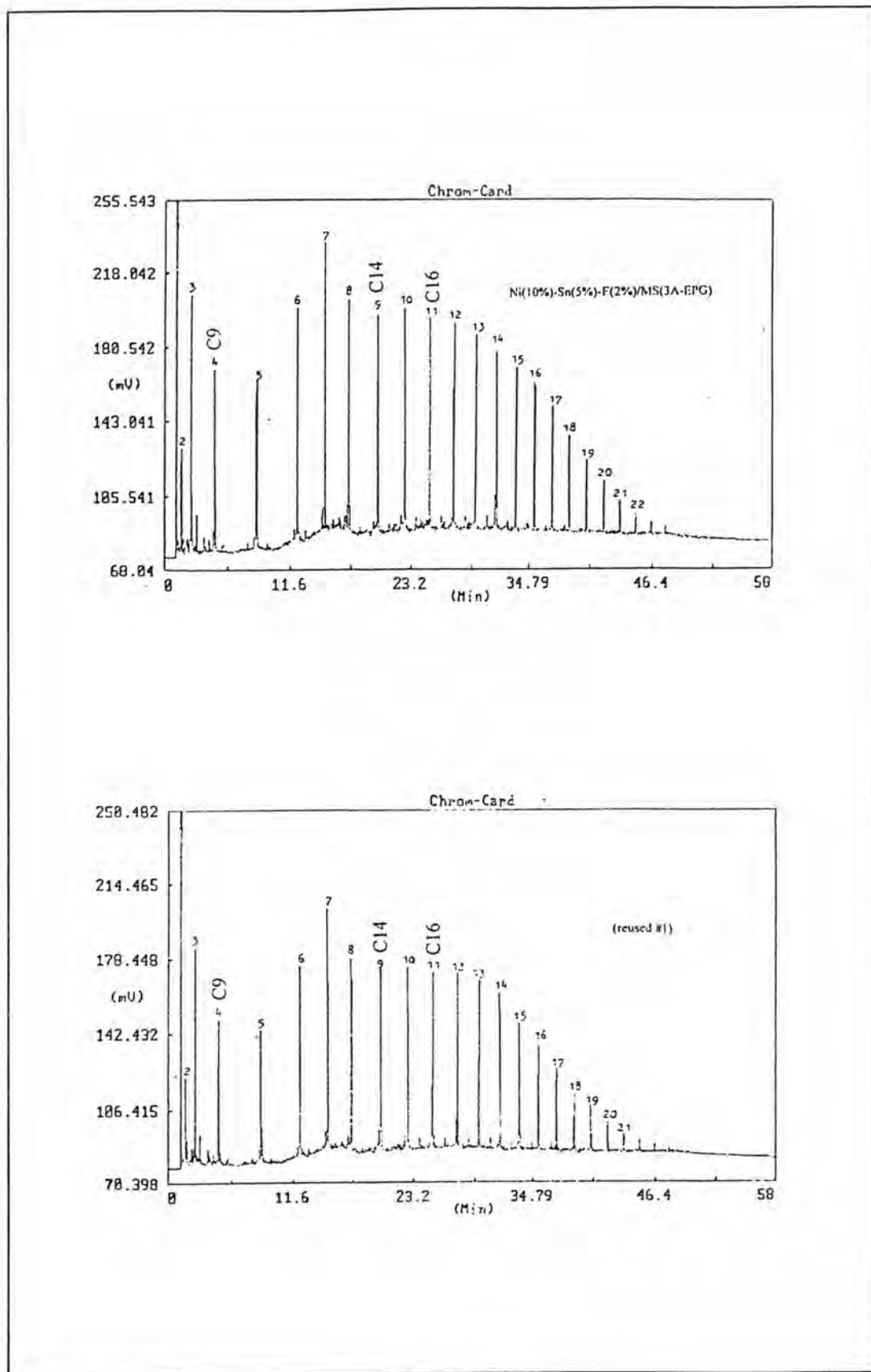


Figure B9 GC chromatograms of oil product from hydrocracking over reused Ni(10%)-Sn(5%)-F(2%) on molecular sieve (3A-EPG type) catalyst

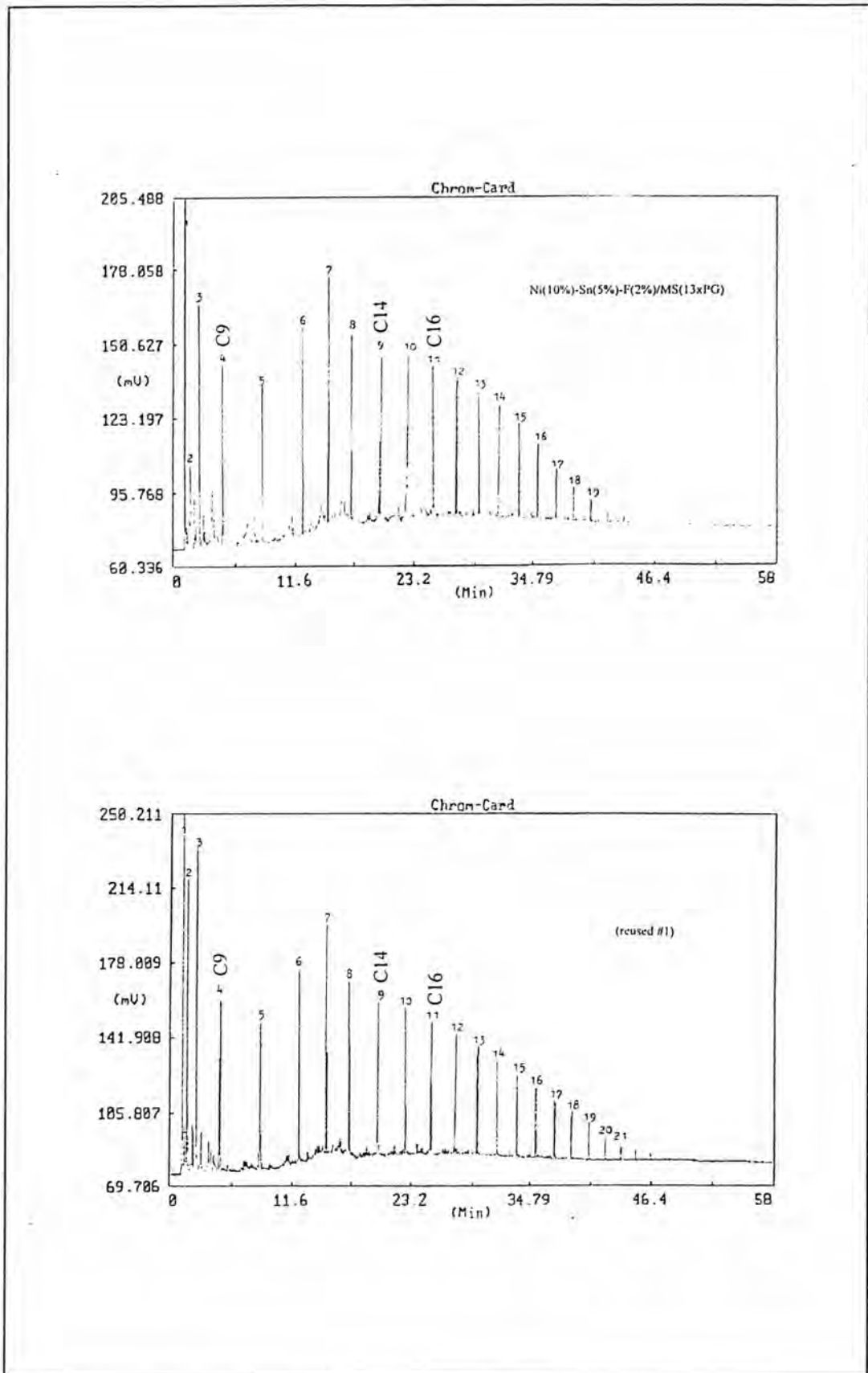


Figure B10 GC chromatograms of oil product from hydrocracking over reused Ni(10%)-Sn(5%)-F(2%) on molecular sieve (13xPG) catalyst

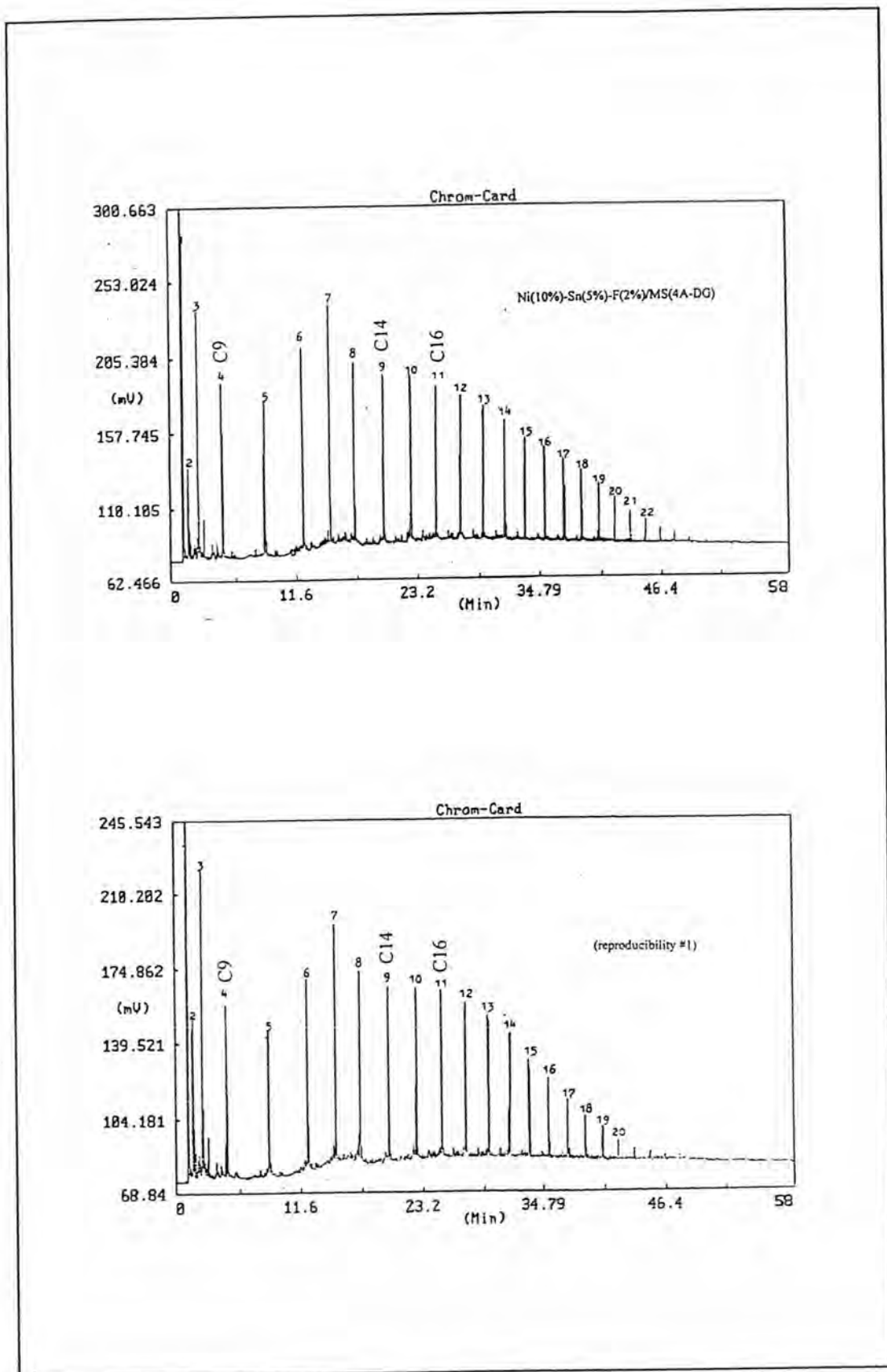


Figure B11 GC chromatograms of oil product from reproducibility of hydrocracking over Ni(10%)-Sn(5%)-F(2%) on molecular sieve (4A-DG type) catalyst

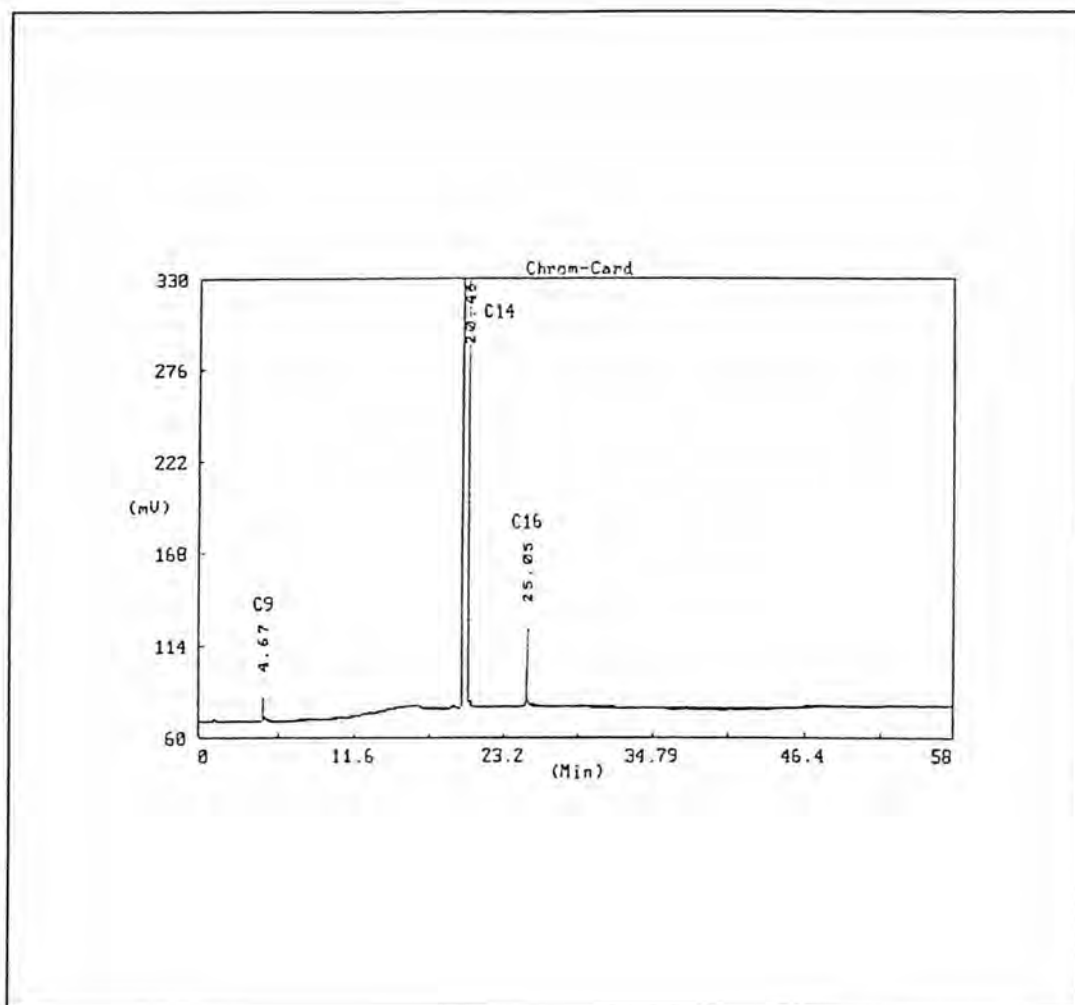


Figure B12 GC chromatograms of standard C₉-C₁₄-C₁₆ hydrocarbons

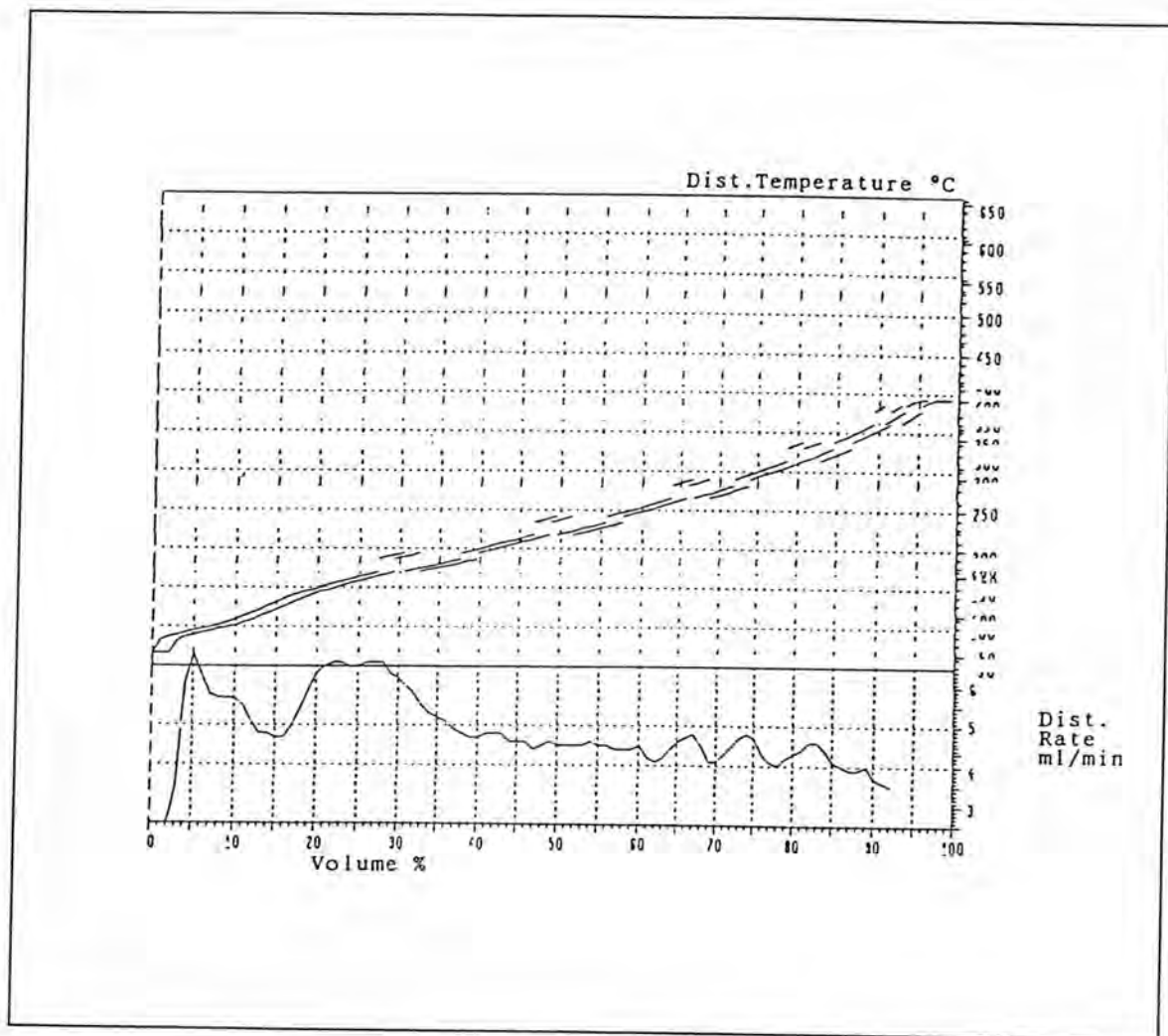


Figure C1 Graphs of distillation data of oil product from hydrocracking over Ni(10%)-Sn(5%)-F(2%) on molecular sieve (4A-DG type) catalyst (ASTM D 86)

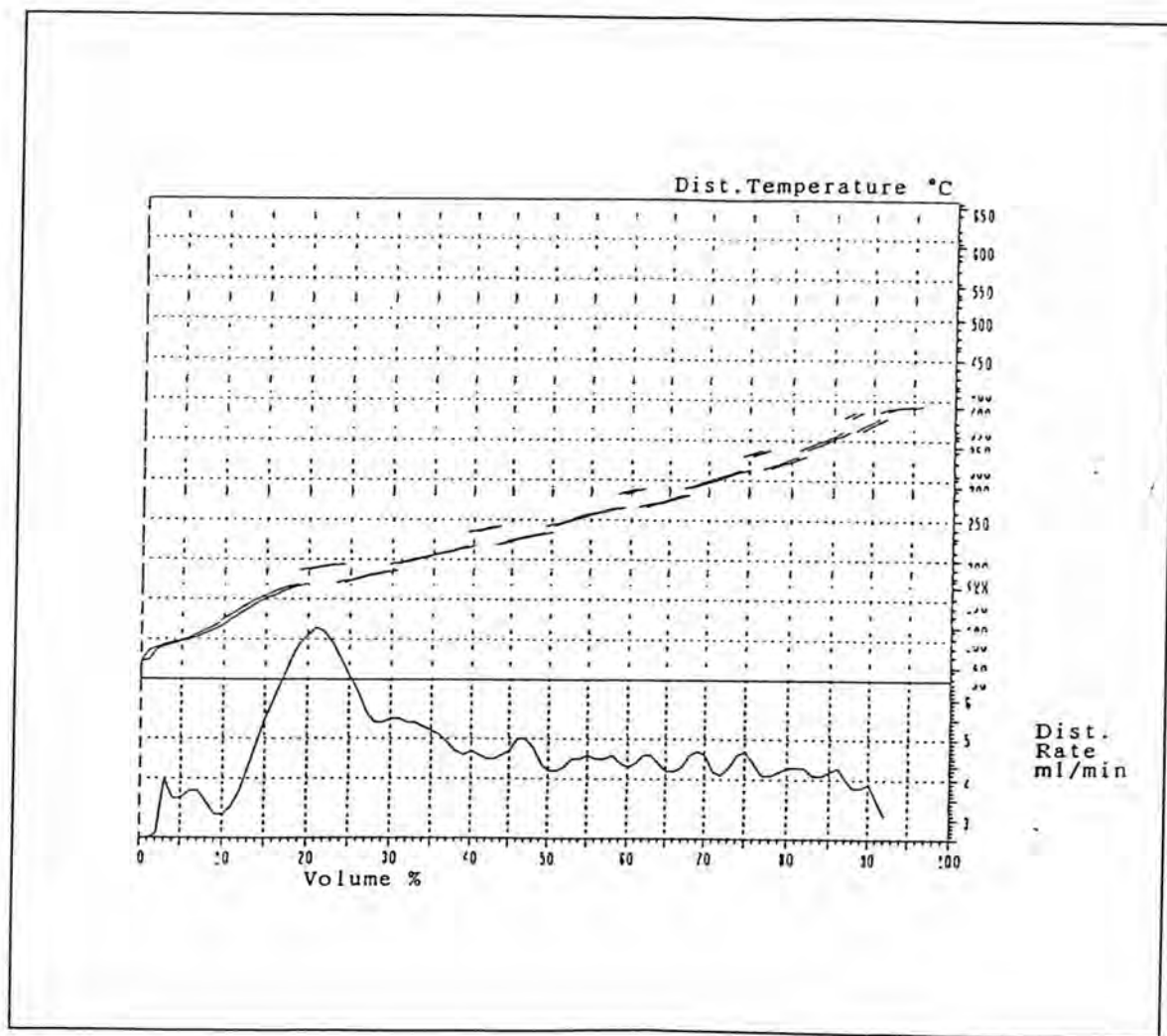


Figure C2 Graphs of distillation data of oil product from hydrocracking over Ni(10%)-Sn(5%)-F(2%) on molecular sieve (3A-EPG type) catalyst (ASTM D 86)

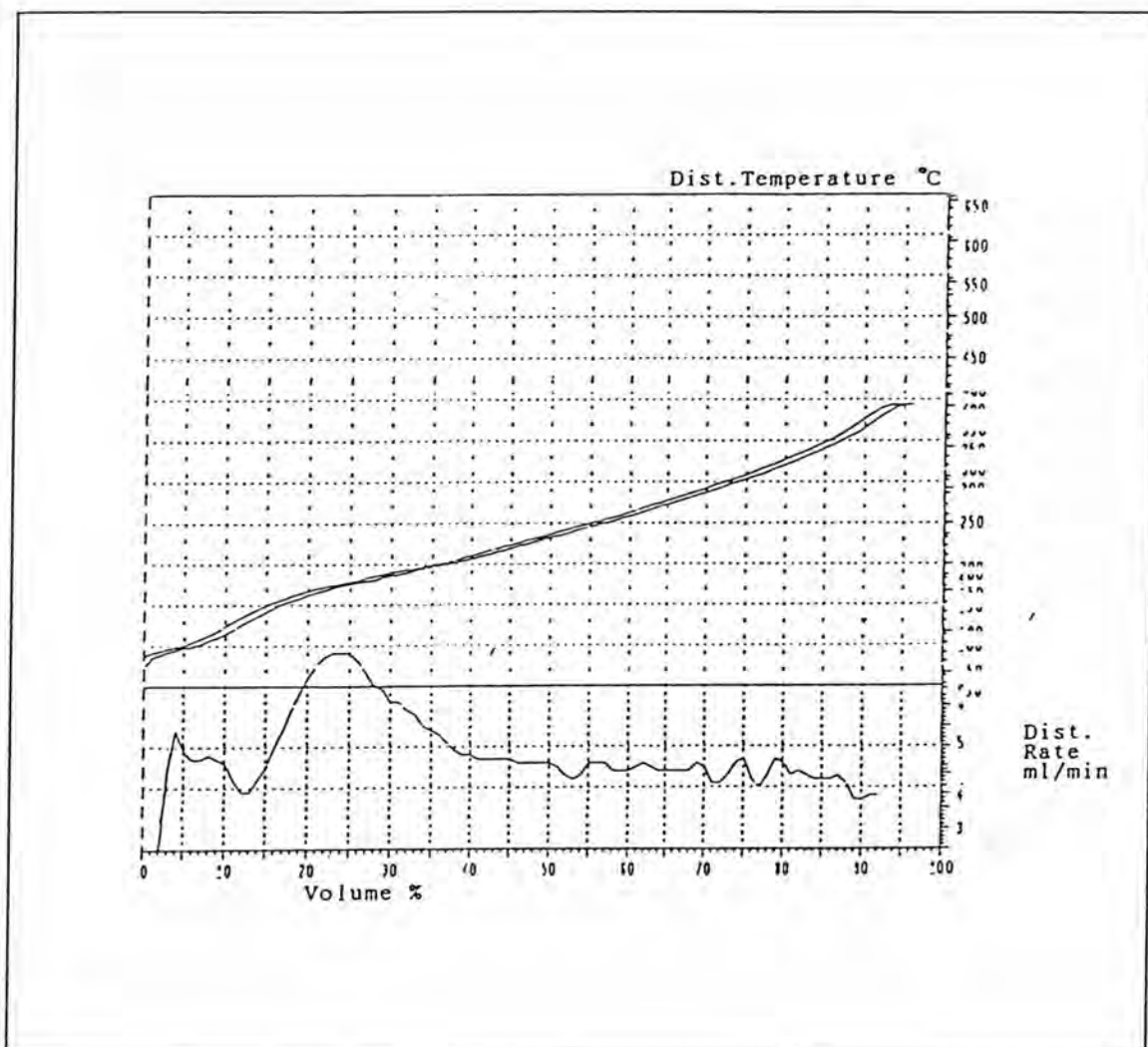


Figure C3 Graphs of distillation data of oil product from hydrocracking over Ni(10%)-Sn(5%)-F(2%) on molecular sieve (13xPG type) catalyst (ASTM D 86)

VITA

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