CONFIDENTIAL

Western Australian Institute of Technology

Department of Chemistry

GEOCHEMICAL EVALUATION OF THE OTWAY BASIN

1980

G.W. Woodhouse
R. Alexander
R.I. Kagi

OTWAY BASIN WOODHOUSE, ALEXANDER & KAGI. 1980

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OIL and GAS DIVISION

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CONTENTS

TABULATED DATA

ORGANIC CONTENT OF SEDIMENTS (UNC)

SAMPLE	%SOM(UNC)	%TOC(UNC)	SOM(mg)/TOC(g)	Ct
ROWANS 1 1524-1551m	.032	0.45	71.5	0.42
ROWANS 1 1707-1759m	.065	1.90	34.3	1.84
PECTEN 1/1A 1625-1734m	.047	1.25	37.6	1.21
PECTEN 1/1A 1807-1826m	.040	0.92	43.3	0.89
NTH EUMERAL. 1 978-1015m	.106	3.74	28.3	3.65
NTH EUMERAL. 1 1494-1579m	.089	1.42	62.8	1.34
NTH EUMERAL. 1 1920-1990m	.077	1.36	56.8	1.29
PORTLAND 3 1453-1456m	.207	2.16	95.9	1.98
PORTLAND 3 1608-1625m	.454	1.88	241.6	1.49
FLAXMANS 1 1664m	.064	2.06	31.0	2.01
FLAXMANS 1 1707-1798m	.019	1.18	16.2	1.16
FLAXMANS 1 1817m	.060	1.56	38.4	1.51
FLAXMANS 1 1945m	.044	1.15	38.3	1.11
FLAXMANS 1 2398m	.014	0.24	57.9	0.23
FLAXMANS 1 2709m	.252	0.45	565.0	0.23
ARGONAUT 1 1645m	.085	1.94	43.8	1.87
ARGONAUT 1 3449m	.074	1.12	65.9	1.06
ARGONAUT 1 3555m	.076	2.12	35.9	2.05
MOUNT SALT 1 3003m	.056	2.30	24.4	2.25
MOUNT SALT 1 3061m	.444	1.22	363.8	0.84
BELFAST 1 1419m	.084	1.45	57.9	1.38
NAUTILUS 1 1584m	.020	0.37	54.5	0.35
NAUTILUS 1 1860m	.100	1.48	67.8	1.39
NAUTILUS 1 2009m	.089	1.43	62.4	1.35
VOLUTA 1 1792m	.119	1.55	76.7	1.45
VOLUTA 1 1919m	.062	2.88	21.5	2.83
VOLUTA 1 2042m	.053	1.22	43.6	1.17
VOLUTA 1 2319m	.074	1.81	40.8	1.75
VOLUTA 1 2462m	.044	1.35	32.6	1.31
VOLUTA 1 3038m	.066	1.38	47.9	1.32
VOLUTA 1 3192m	.096	1.48	64.8	1.40
VOLUTA 1 3324m	.076	0.92	83.0	0.85
VOLUTA 1 3509m	.051	0.74	68.6	0.70
VOLUTA 1 3654m	.062	0.87	71.0	0.82
CAROLINE 1 1830m	.407	1.62	251.4	1.27
CAROLINE 1 2426m	.092	1.56	59.0	1.48
CAROLINE 1 3069m	.096	1.40	68.5	1.32
HEYWOOD 10 1613-1616m	.096	1.17	81.9	1.09
GLENELG 1 1976-1977m	.042	1.46	28.8	1.42
PRETTY HILL 1 732m	.080	2.63	30.4	2.56
PRETTY HILL 1 832m	.046	1.07	43.0	1.03
PRETTY HILL 1 ~~2548m~~ 1024m	.073	1.11	65.6	1.05
MUSSEL 1 2099m	.354	4.59	77.1	4.29
MUSSEL 1 2236m	.344	4.64	74.1	4.35
FERGUSONS HILL 1 478-479m	.086	1.70	50.5	1.63
FERGUSONS HILL 1 616m	.047	1.41	33.3	1.37
FERGUSONS HILL 1 947m	.023	0.27	85.3	0.25
PORT CAMPBELL 2 1628m	.059	1.84	32.1	1.79
PORT CAMPBELL 2 1802m	.065	1.89	34.5	1.83
PORT CAMPBELL 1 1307m	.477	4.15	115.0	3.74
PORT CAMPBELL 1 1585m	.240	3.71	64.8	3.50
KALANGADOO 1 765m	.043	1.27	33.9	1.23
KALANGADOO 1 896m	.045	2.02	22.3	1.98
KALANGADOO 1 1456m	.031	0.57	54.7	0.54
LAKE BONNEY 1 2332-2438m	.029	0.66	43.6	0.64
LAKE BONNEY 1 2438-2530m	.036	0.62	58.0	0.59
LAKE BONNEY 1 2719m	.055	0.73	75.6	0.68
LAKE BONNEY 1 2734-2835m	.045	0.95	47.4	0.91
BURRUNGULE 1 1640-1713m	.076	2.05	37.2	1.98
BURRUNGULE 1 2179-2341m	.031	0.68	45.8	0.65
BURRUNGULE 1 2341-2438m	.029	0.63	45.7	0.61

ORGANIC CONTENT OF SEDIMENTS

SAMPLE	%SOM	%TOC	SOM(mg)/TOC(g)	SAT(mg)/TOC(g)	%SaOM
ROWANS 1 1524-1551m	.025	0.44	57.4	12.3	.005
ROWANS 1 1707-1759m	nd	nd	nd	nd	nd
PECTEN 1/1A 1625-1734m	nd	nd	nd	nd	nd
PECTEN 1/1A 1807-1826m	nd	nd	nd	nd	nd
NTH EUMERAL. 1 978-1015m	nd	nd	nd	nd	nd
NTH EUMERAL. 1 1494-1579m	.058	1.39	41.6	7.7	.011
NTH EUMERAL. 1 1920-1990m	.069	1.35	51.0	18.6	.025
PORTLAND 3 1453-1456m	.106	2.07	51.1	7.0	.014
PORTLAND 3 1608-1625m	.077	1.56	49.7	12.0	.019
FLAXMANS 1 1664m	nd	nd	nd	nd	nd
FLAXMANS 1 1707-1798m	nd	nd	nd	nd	nd
FLAXMANS 1 1817m	.043	1.55	27.9	2.4	.004
FLAXMANS 1 1945m	nd	nd	nd	nd	nd
FLAXMANS 1 2398m	nd	nd	nd	nd	nd
FLAXMANS 1 2709m	.020	0.25	79.2	28.5	.007
ARGONAUT 1 1645m	nd	nd	nd	nd	nd
ARGONAUT 1 3449m	.048	1.10	43.3	5.7	.006
ARGONAUT 1 3555m	nd	nd	nd	nd	nd
MOUNT SALT 1 3003m	nd	nd	nd	nd	nd
MOUNT SALT 1 3061m	.044	0.88	50.3	9.0	.008
BELFAST 1 1419m	.027	1.40	19.2	2.3	.003
NAUTILUS 1 1584m	nd	nd	nd	nd	nd
NAUTILUS 1 1860m	.069	1.45	47.4	3.8	.005
NAUTILUS 1 2009m	.060	1.40	43.0	4.0	.006
VOLUTA 1 1792m	.033	1.48	22.2	3.1	.005
VOLUTA 1 1919m	nd	nd	nd	nd	nd
VOLUTA 1 2042m	nd	nd	nd	nd	nd
VOLUTA 1 2319m	.062	1.80	34.5	4.1	.007
VOLUTA 1 2462m	nd	nd	nd	nd	nd
VOLUTA 1 3038m	.037	1.35	27.5	3.6	.005
VOLUTA 1 3192m	.048	1.44	33.5	4.2	.006
VOLUTA 1 3324m	.027	0.87	31.2	2.9	.003
VOLUTA 1 3509m	.044	0.74	59.5	6.8	.005
VOLUTA 1 3654m	.044	0.86	51.1	11.5	.010
CAROLINE 1 1830m	nd	nd	nd	nd	nd
CAROLINE 1 2426m	.065	1.54	42.1	2.0	.003
CAROLINE 1 3069m	nd	nd	nd	nd	nd
HEYWOOD 10 1613-1616m	.067	1.15	58.4	4.4	.005
GLENELG 1 1976-1977m	nd	nd	nd	nd	nd
PRETTY HILL 1 732m	.042	2.60	16.1	1.4	.004
PRETTY HILL 1 832m	nd	nd	nd	nd	nd
PRETTY HILL 1 2548m	.042	1.09	38.9	4.2	.005
MUSSEL 1 2099m	.220	4.48	49.2	3.6	.016
MUSSEL 1 2236m	.265	4.58	57.9	3.4	.015
FERGUSONS HILL 1 478-479m	.030	1.66	18.1	0.7	.001
FERGUSONS HILL 1 616m	nd	nd	nd	nd	nd
FERGUSONS HILL 1 947m	nd	nd	nd	nd	nd
PORT CAMPBELL 2 1628m	.048	1.83	26.3	3.2	.006
PORT CAMPBELL 2 1802m	nd	nd	nd	nd	nd
PORT CAMPBELL 1 1307m	.239	3.94	60.5	0.9	.004
PORT CAMPBELL 1 1585m	.205	3.68	55.6	4.5	.017
KALANGADOO 1 765m	nd	nd	nd	nd	nd
KALANGADOO 1 896m	nd	nd	nd	nd	nd
KALANGADOO 1 1456m	nd	nd	nd	nd	nd
LAKE BONNEY 1 2332-2438m	nd	nd	nd	nd	nd
LAKE BONNEY 1 2438-2530m	nd	nd	nd	nd	nd
LAKE BONNEY 1 2719m	nd	nd	nd	nd	nd
LAKE BONNEY 1 2734-2835m	nd	nd	nd	nd	nd
BURRUNGULE 1 1640-1713m	.059	2.03	28.9	2.7	.005
BURRUNGULE 1 2179-2341m	nd	nd	nd	nd	nd
BURRUNGULE 1 2341-2438m	nd	nd	nd	nd	nd

COMPOSITIONAL DATA

SAMPLE	%SAT	%AROM	%NSO	PRIST/PHYT	PRIST/NC17	PHYT/NC18	PAP	AROM/SAT	CPI(1)	CPI(2)	21+22/28+29
ROWANS 1 1524-1551m	21.4	44.7	34.0	2.58	1.01	.21	nd	2.09	1.28	1.24	0.71
ROWANS 1 1707-1759m	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PECTEN 1/1A 1625-1734m	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PECTEN 1/1A 1807-1826m	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
NTH EUMERAL. 1 978-1015m	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
NTH EUMERAL. 1 1494-1579m	18.4	43.4	38.2	1.93	1.06	.42	nd	2.36	2.12	2.11	1.76
NTH EUMERAL. 1 1920-1990m	36.5	39.8	23.7	3.36	1.21	.28	nd	1.09	1.09	1.75	1.81
PORTLAND 3 1453-1456m	13.7	56.7	29.7	2.30	.88	.38	nd	4.15	1.15	1.08	1.12
PORTLAND 3 1608-1625m	24.2	51.3	24.6	4.78	2.59	.54	nd	2.12	1.17	1.15	0.61
FLAXMANS 1 1664m	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
FLAXMANS 1 1707-1798m	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
FLAXMANS 1 1817m	8.7	59.7	31.7	4.70	1.67	.49	nd	6.89	1.47	1.35	0.24
FLAXMANS 1 1945m	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
FLAXMANS 1 2398m	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
FLAXMANS 1 2709m	35.9	43.8	20.3	1.95	.53	.11	nd	1.22	1.60	1.36	1.56
ARGONAUT 1 1645m	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
ARGONAUT 1 3449m	13.3	61.1	25.7	6.82	2.98	.23	nd	4.60	1.36	1.21	0.69
ARGONAUT 1 3555m	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
MOUNT SALT 1 3003m	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
MOUNT SALT 1 3061m	18.0	41.7	40.3	2.19	.65	.29	nd	2.32	1.34	1.23	1.79
BELFAST 1 1419m	12.1	55.5	32.4	3.31	1.10	.26	nd	4.58	1.87	1.72	0.71
NAUTILUS 1 1584m	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
NAUTILUS 1 1860m	8.0	39.8	52.2	3.64	2.51	.67	nd	4.97	1.56	1.44	0.43
NAUTILUS 1 2009m	9.3	52.5	38.1	4.83	4.69	.46	nd	5.64	1.31	1.29	0.54
VOLUTA 1 1792m	14.0	48.0	38.0	3.99	.72	.18	nd	3.44	2.51	2.42	0.30
VOLUTA 1 1919m	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
VOLUTA 1 2042m	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
VOLUTA 1 2319m	11.7	54.2	34.0	2.48	.73	.32	nd	4.62	1.27	1.22	1.17
VOLUTA 1 2462m	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
VOLUTA 1 3038m	12.9	60.8	26.3	3.51	1.55	.42	nd	4.70	1.21	1.15	0.72
VOLUTA 1 3192m	12.5	55.2	32.3	4.55	1.88	.29	nd	4.43	1.12	1.14	0.92
VOLUTA 1 3324m	9.4	64.6	25.9	5.50	1.89	.28	nd	6.85	1.16	1.10	1.22
VOLUTA 1 3509m	11.5	52.2	36.3	3.42	.91	.27	nd	4.55	.98	.97	1.24
VOLUTA 1 3654m	22.4	51.1	26.5	3.97	.99	.22	nd	2.28	1.05	1.03	1.62
CAROLINE 1 1830m	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
CAROLINE 1 2426m	4.9	65.2	30.0	3.60	1.88	.29	nd	13.42	1.08	1.04	1.49
CAROLINE 1 3069m	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
HEYWOOD 10 1613-1616m	7.5	72.0	20.5	4.65	1.20	.15	nd	9.60	1.68	1.36	0.57
GLENELG 1 1976-1977m	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PRETTY HILL 1 732m	8.8	49.5	41.7	4.10	1.17	.40	nd	5.60	1.96	1.71	0.81
PRETTY HILL 1 832m	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PRETTY HILL 1 2548m	10.7	71.6	17.6	3.30	.93	.36	nd	6.68	2.73	2.69	1.17
MUSSEL 1 2099m	7.4	75.2	17.4	4.29	2.87	.45	nd	10.17	1.38	1.32	0.51
MUSSEL 1 2236m	5.8	68.2	26.0	3.78	4.04	1.13	nd	11.69	1.32	1.22	0.56
FERGUSONS HILL 1 478-479m	3.9	38.2	57.9	5.00	1.18	.27	nd	9.67	2.01	1.89	0.04
FERGUSONS HILL 1 616m	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
FERGUSONS HILL 1 947m	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PORT CAMPBELL 2 1628m	12.0	59.5	28.4	3.49	1.18	.39	nd	4.95	1.57	1.53	0.47
PORT CAMPBELL 2 1802m	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PORT CAMPBELL 1 1307m	1.6	74.1	24.3	5.14	3.83	.62	nd	47.65	1.16	1.14	0.39
PORT CAMPBELL 1 1585m	8.1	61.2	30.7	4.73	3.33	.57	nd	7.56	1.67	1.60	0.38
KALANGADOO 1 765m	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
KALANGADOO 1 896m	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
KALANGADOO 1 1456m	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
LAKE BONNEY 1 2332-2438m	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
LAKE BONNEY 1 2438-2530m	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
LAKE BONNEY 1 2719m	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
LAKE BONNEY 1 2734-2835m	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
BURRUNGULE 1 1640-1713m	9.3	62.9	27.8	2.40	1.02	.38	nd	6.76	1.71	1.64	1.41
BURRUNGULE 1 2179-2341m	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
BURRUNGULE 1 2341-2438m	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd

PYROLYSIS DATA

SAMPLE	Cr(%)	Ct(%)	Cr/Ct	Ct-Cr
ROWANS 1 1524-1551m	0.11	0.42	.26	0.31
ROWANS 1 1707-1759m	nd	1.84	nd	nd
PECTEN 1/1A 1625-1734m	nd	1.21	nd	nd
PECTEN 1/1A 1807-1826m	nd	0.89	nd	nd
NTH EUMERAL. 1 978-1015m	nd	3.65	nd	nd
NTH EUMERAL. 1 1494-1579m	0.63	1.34	.47	0.71
NTH EUMERAL. 1 1920-1990m	0.35	1.29	.27	0.94
PORTLAND 3 1453-1456m	1.40	1.98	.71	0.58
PORTLAND 3 1608-1625m	1.10	1.49	.74	0.39
FLAXMANS 1 1664m	nd	2.01	nd	nd
FLAXMANS 1 1707-1798m	nd	1.16	nd	nd
FLAXMANS 1 1817m	0.83	1.51	.55	0.68
FLAXMANS 1 1945m	nd	1.11	nd	nd
FLAXMANS 1 2398m	nd	0.23	nd	nd
FLAXMANS 1 2709m	0.04	0.23	.17	0.19
ARGONAUT 1 1645m	nd	1.87	nd	nd
ARGONAUT 1 3449m	0.40	1.06	.38	0.66
ARGONAUT 1 3555m	nd	2.05	nd	nd
MOUNT SALT 1 3003m	nd	2.25	nd	nd
MOUNT SALT 1 3061m	0.51	0.84	.61	0.33
BELFAST 1 1419m	0.58	1.38	.42	0.80
NAUTILUS 1 1584m	nd	0.35	nd	nd
NAUTILUS 1 1860m	0.56	1.39	.40	0.83
NAUTILUS 1 2009m	0.64	1.35	.47	0.71
VOLUTA 1 1792m	0.49	1.45	.34	0.96
VOLUTA 1 1919m	nd	2.83	nd	nd
VOLUTA 1 2042m	nd	1.17	nd	nd
VOLUTA 1 2319m	0.85	1.75	.49	0.90
VOLUTA 1 2462m	nd	1.31	nd	nd
VOLUTA 1 3038m	0.76	1.32	.58	0.56
VOLUTA 1 3192m	0.76	1.40	.54	0.64
VOLUTA 1 3324m	0.37	0.85	.44	0.48
VOLUTA 1 3509m	0.35	0.70	.50	0.35
VOLUTA 1 3654m	0.32	0.82	.39	0.50
CAROLINE 1 1830m	nd	1.27	nd	nd
CAROLINE 1 2426m	0.82	1.48	.55	0.66
CAROLINE 1 3069m	nd	1.32	nd	nd
HEYWOOD 10 1613-1616m	0.20	1.09	.18	0.89
GLENELG 1 1976-1977m	nd	1.42	nd	nd
PRETTY HILL 1 732m	1.23	2.56	.48	1.33
PRETTY HILL 1 832m	nd	1.03	nd	nd
PRETTY HILL 1 2548m	0.38	1.05	.36	0.67
MUSSEL 1 2099m	2.43	4.29	.57	1.86
MUSSEL 1 2236m	2.75	4.35	.63	1.60
FERGUSONS HILL 1 478-479m	0.86	1.63	.53	0.77
FERGUSONS HILL 1 616m	nd	1.37	nd	nd
FERGUSONS HILL 1 947m	nd	0.25	nd	nd
PORT CAMPBELL 2 1628m	0.92	1.79	.51	0.87
PORT CAMPBELL 2 1802m	nd	1.83	nd	nd
PORT CAMPBELL 1 1307m	2.21	3.74	.59	1.53
PORT CAMPBELL 1 1585m	1.75	3.50	.50	1.75
KALANGADOO 1 765m	nd	1.23	nd	nd
KALANGADOO 1 896m	nd	1.98	nd	nd
KALANGADOO 1 1456m	nd	0.54	nd	nd
LAKE BONNEY 1 2332-2438m	nd	0.64	nd	nd
LAKE BONNEY 1 2438-2530m	nd	0.59	nd	nd
LAKE BONNEY 1 2719m	nd	0.68	nd	nd
LAKE BONNEY 1 2734-2835m	nd	0.91	nd	nd
BURRUNGULE 1 1640-1713m	1.09	1.98	.55	0.89
BURRUNGULE 1 2179-2341m	nd	0.65	nd	nd
BURRUNGULE 1 2341-2438m	nd	0.61	nd	nd

OIL and GAS DIVISION

N-ALKANE DISTRIBUTIONS

SAMPLE	CN12	CN13	CN14	CN15	CN16	CN17	CN18	CN19	CN20	CN21	CN22	CN23	CN24	CN25	CN26	CN27	CN28	CN29	CN30	CN31
ROWANS 1 1524-1551m	6.8	7.1	13.9	8.8	13.5	5.1	9.5	2.8	3.4	2.0	2.3	2.4	2.5	3.0	2.6	3.6	2.5	3.5	2.1	2.6
ROWANS 1 1707-1759m	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PECTEN 1/1A 1625-1734m	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PECTEN 1/1A 1807-1826m	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
NTH EUMERAL. 1 978-1015m	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
NTH EUMERAL. 1 1494-1579m	5.4	5.1	9.2	8.1	8.8	5.7	7.5	6.5	6.0	4.7	4.0	4.6	3.0	5.6	2.2	5.2	1.8	3.1	1.2	2.3
NTH EUMERAL. 1 1920-1990m	2.1	2.2	5.0	4.9	8.2	7.4	9.4	8.6	7.9	6.4	4.8	5.4	2.9	5.8	3.1	4.3	2.4	3.8	1.4	3.8
PORTLAND 3 1453-1456m	4.8	6.2	10.1	11.0	11.0	8.6	8.6	6.4	4.5	3.4	2.9	2.6	2.3	2.5	2.5	2.7	2.7	3.0	1.9	2.4
PORTLAND 3 1608-1625m	3.4	3.9	6.6	4.3	5.1	3.8	3.8	3.1	3.4	3.7	4.3	5.1	6.0	6.9	6.0	7.3	5.7	7.3	5.1	5.2
FLAXMANS 1 1664m	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
FLAXMANS 1 1707-1798m	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
FLAXMANS 1 1817m	4.1	5.3	6.4	5.2	6.1	5.1	3.7	2.8	2.1	2.1	2.2	3.2	3.5	5.9	6.0	9.2	6.9	11.0	4.1	5.0
FLAXMANS 1 1945m	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
FLAXMANS 1 2398m	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
FLAXMANS 1 2709m	7.1	3.8	20.1	4.2	13.9	3.3	8.0	3.5	5.1	4.2	4.1	3.9	2.7	2.7	2.0	2.4	1.8	3.6	0.9	2.6
ARGONAUT 1 1645m	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
ARGONAUT 1 3449m	5.3	3.3	13.1	5.0	10.0	3.2	5.9	3.0	3.9	3.3	3.5	4.1	3.8	4.8	5.3	5.8	3.8	6.0	2.5	4.6
ARGONAUT 1 3555m	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
MOUNT SALT 1 3003m	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
MOUNT SALT 1 3061m	5.8	4.8	11.7	9.9	12.5	9.7	9.8	6.5	5.9	3.5	3.3	2.0	1.9	2.3	1.8	2.1	1.6	2.3	1.0	1.5
BELFAST 1 1419m	8.6	5.4	15.5	9.0	15.4	7.6	9.8	3.2	3.2	1.6	2.1	1.6	1.5	1.9	1.4	3.2	1.6	3.6	1.3	2.6
NAUTILUS 1 1584m	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
NAUTILUS 1 1860m	3.7	3.8	6.4	5.4	5.8	3.7	3.8	3.1	3.1	3.4	3.3	4.9	4.6	7.4	5.7	9.3	6.2	9.4	3.0	3.8
NAUTILUS 1 2009m	4.6	3.6	7.7	4.5	6.7	2.3	4.8	3.1	3.2	3.4	3.6	4.7	4.5	6.5	5.9	7.9	5.4	7.6	4.7	5.2
VOLUTA 1 1792m	6.4	4.4	19.7	7.6	16.1	7.9	8.2	2.8	2.7	1.3	1.2	1.1	0.9	1.3	1.0	3.6	1.8	6.6	1.9	3.3
VOLUTA 1 1919m	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
VOLUTA 1 2042m	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
VOLUTA 1 2319m	4.6	6.4	10.6	9.6	12.3	11.3	10.5	6.5	4.3	2.5	2.8	2.2	1.9	2.0	1.9	2.5	1.9	2.7	1.5	1.9
VOLUTA 1 2462m	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
VOLUTA 1 3038m	6.7	5.8	9.6	6.5	8.3	5.8	6.1	4.5	3.5	3.4	3.5	3.1	3.3	4.0	4.2	5.3	4.2	5.2	3.1	3.9
VOLUTA 1 3192m	8.3	6.4	11.5	6.1	9.3	4.7	6.7	4.0	4.4	3.0	3.4	3.6	3.6	4.0	3.8	4.4	3.2	3.7	3.0	2.7
VOLUTA 1 3324m	4.7	5.9	7.6	6.0	6.3	5.1	6.3	5.8	5.0	4.8	5.2	4.5	4.9	4.7	4.0	4.8	3.8	4.5	2.7	3.3
VOLUTA 1 3509m	6.5	6.7	7.9	6.6	7.0	5.7	5.7	4.9	4.9	4.9	4.4	4.4	4.3	4.2	4.6	4.0	3.8	3.7	3.1	2.6
VOLUTA 1 3654m	7.3	6.9	8.5	6.8	7.6	5.2	5.9	5.4	5.4	4.8	4.8	4.7	4.9	4.8	4.0	3.5	2.9	3.0	2.0	1.6
CAROLINE 1 1830m	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
CAROLINE 1 2426m	7.0	4.7	15.2	5.9	13.6	4.9	8.7	3.5	4.3	2.8	5.3	3.1	2.8	3.0	3.3	3.3	2.7	2.7	1.6	1.5
CAROLINE 1 3069m	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
HEYWOOD 10 1613-1616m	10.9	7.5	21.2	6.2	17.1	5.2	8.8	2.4	3.8	1.1	1.3	1.0	1.0	1.1	1.3	1.6	1.2	3.1	1.1	2.9
GLENELG 1 1976-1977m	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PRETTY HILL 1 732m	3.9	3.4	13.1	16.0	19.9	13.2	9.3	5.3	2.9	1.5	1.1	0.8	0.7	0.7	1.0	2.1	0.9	2.4	0.5	1.1
PRETTY HILL 1 832m	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PRETTY HILL 1 2548m	3.4	4.4	13.3	12.1	15.5	11.0	8.4	4.9	2.8	2.1	1.4	2.5	1.8	5.3	1.8	5.2	1.1	1.9	0.4	0.5
MUSSEL 1 2099m	6.2	4.0	5.3	4.0	3.9	2.7	4.0	3.5	3.3	3.5	3.9	5.0	4.9	6.5	5.8	8.5	5.9	8.9	4.6	5.8
MUSSEL 1 2236m	4.0	4.2	6.0	4.6	4.6	4.1	3.9	3.3	4.7	3.9	3.9	4.8	5.3	6.3	5.4	7.6	5.9	7.9	3.8	5.7
FERGUSONS HILL 1 478-479m	8.9	9.3	22.8	7.1	11.9	2.3	2.0	0.4	1.8	0.2	0.3	0.6	0.6	1.2	2.2	4.0	2.6	10.0	4.1	7.7
FERGUSONS HILL 1 616m	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
FERGUSONS HILL 1 947m	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PORT CAMPBELL 2 1628m	3.1	4.6	7.6	6.6	8.7	7.3	6.4	4.9	4.5	3.0	2.8	3.0	2.6	3.8	3.2	6.5	4.5	8.0	3.9	5.1
PORT CAMPBELL 2 1802m	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
PORT CAMPBELL 1 1307m	3.9	4.2	4.1	4.3	4.1	2.9	3.4	3.9	3.3	3.3	3.4	4.2	5.0	6.5	6.4	9.3	8.2	8.8	5.7	5.2
PORT CAMPBELL 1 1585m	5.8	6.2	6.9	6.2	6.1	3.1	3.9	3.5	2.8	2.7	2.8	3.3	3.5	5.8	4.1	8.7	5.5	9.2	4.0	5.9
KALANGADOO 1 765m	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
KALANGADOO 1 896m	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
KALANGADOO 1 1456m	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
LAKE BONNEY 1 2332-2438m	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
LAKE BONNEY 1 2438-2530m	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
LAKE BONNEY 1 2719m	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
LAKE BONNEY 1 2734-2835m	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
BURRUNGULE 1 1640-1713m	6.0	5.8	8.5	7.8	9.7	8.0	8.8	7.1	6.8	4.2	3.4	2.7	2.3	3.0	2.1	4.7	2.1	3.3	1.4	2.2
BURRUNGULE 1 2179-2341m	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
BURRUNGULE 1 2341-2438m	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd

KEY

%SOM = Percentage of soluble organic matter in the sediment sample (W/W)

%SAT = Percentage by weight of saturated compounds in the extract

%AROM = Percentage by weight of aromatic compounds in the extract

%NSO = Percentage by weight of asphaltenes plus resins in the extract

PRIST = Pristane

PHYT = Phytane

NC17 = n-heptadecane (i.e. n-alkane with 17 carbon atoms)

NC18 = n-octadecane (i.e. n-alkane with 18 carbon atoms)

PAP = Percentage of aromatic protons in the aromatic fraction

CPI = Carbon Preference Index

n-Alkane Composition: CN12 etc. = n-alkane with 12 carbon atoms etc. (Values are weight percent of the n-alkane fraction)

TOC = Total organic carbon (soluble + insoluble)

C_T = Total insoluble organic carbon

C_R = Residual organic carbon

HC = Hydrocarbon

nd = No data

21+22/28+29: Sum of percentages of n-alkanes with carbon numbers 21 and 22 divided by sum of percentages of n-alkanes with carbon numbers 28 and 29

%SaOM = Percentage of saturated organic matter in the sediment sample (W/W)

KEY FOR SOURCE ROCK RICHNESS DATA

Due to a modification of our approach to geochemical source rock studies it is now possible that two values for both percentage soluble organic matter and percentage total organic carbon may be encountered for any given source rock sample. These values will appear in the "Organic Content of Sediments" table under the headings %SOM and %TOC and/or in the "Organic Content of Sediments (UNC)" table under the headings %SOM(UNC) and %TOC(UNC). The methods by which each of these values is derived are as follows:

1. (a) %SOM(UNC) - A known weight of sediment sample is extracted with dichloromethane: methanol (10:1), the mixture is filtered to remove the extracted sediment, and finally the filtrate is heated to remove the extracting solvent from the extracted material. Then,

$$\%\text{SOM(UNC)} = \frac{\text{wt extracted material}}{\text{wt sediment extracted}} \times \frac{100}{1}$$

<u>N.B:</u> Extracted material will contain some elemental sulphur and inorganic salts such as sodium chloride.

(b) %TOC(UNC) - The total insoluble organic carbon (C_T) is determined on the extracted sediment sample. Then,

$$\%\text{TOC(UNC)} = C_T + (\frac{12}{14} \times \%\text{SOM(UNC)})$$

2. (a) %SOM - The sediment is extracted as outlined above and the extract is subject to column chromatography yielding a saturate, an aromatic and an NSO fraction. Then,

$$\%\text{SOM} = \frac{\text{wt saturates + wt aromatics + wt NSO}}{\text{wt sediment extracted}} \times \frac{100}{1}$$

<u>N.B:</u> This value will be less than %SOM(UNC) but is a more accurate indication of the level of SOM in the sample.

(b) %TOC - $\%TOC = C_T + (\frac{12}{14} \times \% \text{ SOM})$

<u>N.B</u>: This value will be marginally less than % TOC(UNC) but is a more accurate indication of the level of TOC.

It should also be noted that the value of SOM(mg)/TOC(g) will vary slightly depending on whether %SOM and %TOC or %SOM(UNC) and %TOC(UNC) are used to calculate the value.

THEORY AND METHOD

THEORY AND METHOD

1. PREPARATION OF SEDIMENT SAMPLES FOR EXTRACTION

Cuttings and core samples were provided dried but presumably untreated in cloth or plastic bags. The dried sediment was firstly crushed to 0.32 cm chips using a Van Gelder jaw crusher and finally powdered to 0.15 mm using a Tema Grinder.

2. EXTRACTION OF SEDIMENT SAMPLES

Crushed sediment (maximum of 250g) and 320 mls of purified dichloromethane: methanol (10:1) were placed in a 500 ml conical flask. A double surface condenser was fitted to the flask, and the sample was then extracted under the influence of ultra-sonic vibration (60-70°C) using a Buehler Ultramet II sonic bath for 2 hours. The solvent was then separated from the sediment using a large Buchner filtration system. The extract was recovered by careful evaporation of the solvent on a steam bath and weighed. The weight of extract was used to calculate %SOM(UNC) using the following formula:

$$\%\text{SOM(UNC)} = \frac{\text{Wt. extract}}{\text{Wt. sediment extracted}} \times \frac{100}{1}$$

3. SEPARATION OF EXTRACT INTO CONSTITUENT FRACTIONS

The extracts were separated into saturated, aromatic and NSO (asphaltenes plus resins) fractions by column chromatography on silicic acid. The crude extract was applied to the top of a silicic acid column (sample to adsorbent ratio 1:50) and the saturated compounds were eluted with n-pentane, aromatic compounds with a 50:50 mixture of ether and n-pentane, and finally the NSO fraction was eluted with a 20:1 mixture of methanol and dichloromethane. The neat fractions were recovered by careful removal of the solvent by fractional distillation and weighed.

The sum weight of the three fractions was used to calculate the %SOM using the following formula:

$$\%\text{SOM} = \frac{\text{Wt. AROM.} + \text{Wt. SAT.} + \text{Wt. NSO}}{\text{Wt. SEDIMENT EXTRACTED}} \times \frac{100}{1}$$

This parameter can be used to assess the suitability of the sediments as source rocks according to the classification shown (later in this section) in the table "Classification of Source Rock Richness".

The weight of saturated compounds was used to calculate the percentage of saturated compounds in the sediment according to the following formula:

$$\%\text{SaOM} = \frac{\text{Wt. Saturates}}{\text{Wt. Sediment Extracted}} \times \frac{100}{1}$$

This parameter can be used to assess the suitability of the sediments as oil source rocks according to the classification shown in the table "Classification of Source Rock Richness".

The weight of each fraction was used to calculate the % by weight of each fraction in the extract according to the following formula:

$$\%\ \text{Fraction} = \frac{\text{Wt. Fraction}}{\text{Wt. All Fractions}} \times \frac{100}{1}$$

The composition of the extracts can provide information about their levels of maturity and/or source type (LeTran et al., 1974; Philippi, 1974). Generally, marine extracts have relatively low concentrations of saturated and NSO compounds at low levels of maturity, but these concentrations increase with increased maturation. Terrestrially derived organic matter usually has a low level of saturates and large amount of aromatic and NSO compounds irrespective of the level of maturity.

4. GLC ANALYSIS OF SATURATED COMPOUNDS

Capillary GLC traces were recorded for each saturate fraction. The following information was obtained from these traces:

(a) n-Alkane Distribution - The C_{12}-C_{31} n-alkane distribution was determined from the area under peaks representing each of these n-alkanes. This distribution can yield information about both the level of maturity and the source type (LeTran et al., 1974).

(b) Carbon Preference Index - Two values were determined:

$$\text{CPI}(1) = \frac{(C_{23} + C_{25} + C_{27} + C_{29})\text{Wt\%} + (C_{25} + C_{27} + C_{29} + C_{31})\text{Wt\%}}{2 \times (C_{24} + C_{26} + C_{28} + C_{30})\text{Wt\%}}$$

$$\text{CPI}(2) = \frac{(C_{23} + C_{25} + C_{27})\text{Wt\%} + (C_{25} + C_{27} + C_{29})\text{Wt\%}}{2 \times (C_{24} + C_{26} + C_{28})\text{Wt\%}}$$

The CPI is believed to be a function of both the level of maturity (Cooper and Bray, 1963; Scalan and Smith, 1970) and the source type (Tissot and Welte, 1978). Marine extracts tend to have values close to 1 irrespective of maturity whereas values for terrestrial extracts decrease with maturity from values as high as 20 but don't usually reach a value of 1.

(c) $C_{21}+C_{22}/C_{28}+C_{29}$ - This parameter provides information about the source of the organic matter (Philippi, 1974). Generally, a terrestrial source gives values <1.2 whereas a marine source results in values >1.5.

(d) Pristane/Phytane Ratio - This value was determined from the areas of peaks representing these compounds. The ratio renders information about the depositional environment according to the following scale (Powell and McKirdy, 1975):

<3.0	Marine depositional environment (i.e. reducing environment)
3.0-4.5	Mixed depositional environment (i.e. reducing/oxidising environment)
>4.5	Terrestrial depositional environment (i.e. oxidising environment)

(e) Pristane/$\underline{n}$-C_{17} Ratio - This ratio was determined from the areas of peaks representing these compounds. The value can provide information about both the source type and the level of maturation (Lijmbach, 1975). Very immature crude oil has a pristane/$\underline{n}$-C_{17} ratio >1.0, irrespective of the source type. However, the following classification can be applied to mature crude oil:

<0.5	Marine source
0.5-1.0	Mixed source
>1.0	Terrestrial source

In the case of sediment extracts these values are significantly higher and the following classification is used:

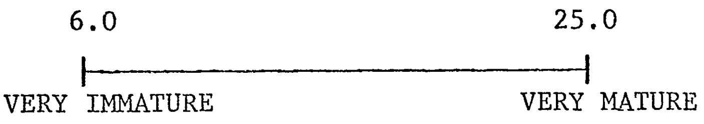
<1.0	Marine source
1.0-1.5	Mixed source
>1.5	Terrestrial source

(f) Phytane/*n*-C_{18} Ratio - This ratio was determined from the areas of peaks representing these compounds. The value usually only provides information about the level of maturity of petroleum. The value decreases with increased maturation.

(g) Relative Amounts of *n*-Alkanes and Naphthenes - Since *n*-alkanes and naphthenes are the two dominant classes of compounds in the saturate fraction, a semi-quantitative estimate of the relative amounts of these compounds was made. This information can be used to assess the degree of maturation and/or the source type of the petroleum (Philippi, 1974; Tissot and Welte, 1978). Very immature petroleum has only small proportions of *n*-alkanes, but as maturity increases the relative amount of *n*-alkanes increases. In addition, terrestrial petroleum has a greater proportion of high molecular weight naphthenes than marine petroleum.

5. DETERMINATION OF THE PAP VALUE

The PAP value (percentage of aromatic protons in the aromatic fraction) was determined by proton magnetic resonance spectroscopy on the aromatic fraction. This parameter is a quantitative measure of the level of maturation of petroleum (Alexander et. al., 1979).



6. C_R, C_T AND TOC DETERMINATIONS

The total insoluble organic carbon value (C_T) was determined on the extracted sediment sample. The value was determined by treating a known weight of sediment with dilute HCl to remove carbonate minerals, and then heating the residue to 1000°C in a atmosphere of pure oxygen. The carbon dioxide produced was adsorbed on a "Carbosorb" tower. The weight of carbon dioxide produced was then used to calculate C_T(%) in the sediment.

The C_R (residual carbon) value was also determined on the extracted sediment sample which had been freed of carbonate minerals by treatment with dilute HCl. The sample, firstly, was pyrolysed at 900°C for 10 minutes in an atmosphere of nitrogen to remove that portion of the insoluble carbon which is still capable of being converted to crude petroleum, and then heated to 1000°C in an atmosphere of pure oxygen. The weight of carbon dioxide produced was used to calculate $C_R(\%)$.

The ratio C_R/C_T is influenced by the degree of diagenesis and the nature of the kerogen (Gransch and Eisma, 1966; LeTran et. al., 1974). However, the influence of the degree of diagenesis is believed to be most significant, and therefore as maturation increases the C_R/C_T ratio approaches a value of 1.0. The following values were used to assess the level of maturity of the sediments:

<0.6	Low
0.6 - 0.8	Moderate
>0.8	High

The C_T-C_R value can be used to assess the potential of sediments to generate oil or gas. The following classification is used:

<0.3%	Poor
0.3 - 0.6%	Moderate
>0.6%	Good

Total organic carbon (TOC) was determined using the following formula:

$$\mathrm{TOC}(\%) = C_T(\%) + \left(\frac{12}{14} \times \%\mathrm{SOM} \right) \quad \text{and/or}$$

$$\%\mathrm{TOC(UNC)} = C_T(\%) + \left(\frac{12}{14} \times \%\mathrm{SOM(UNC)} \right)$$

The %SOM is multiplied by 12/14 because on average the SOM is 12 parts carbon and 2 parts hydrogen.

It is well recognized that a TOC(%) value of 0.5 or greater is a minimum requirement for a sediment sample to be considered a source rock. To classify sediments the following criteria are used:

<0.5%	Poor
0.5 - 1.0%	Moderate
>1.0%	Good

7. SOLUBLE/TOTAL ORGANIC CARBON RATIOS

The ratios of SOM(mg)/TOC(g) and SAT(mg)/TOC(g) were determined from the appropriate data. The SOM(mg)/TOC(g) ratio can be used as a maturation indicator, especially if the parameter is plotted against depth for a given sedimentary sequence. In an absolute sense it is less reliable as a maturation indicator, although previous work (Tissot et. al., 1971; LeTran et. al., 1974) suggest that the following criteria can be used to determine maturity with this parameter:

<50	Low maturity
50-100	Moderate maturity
>100	High maturity

The ratios of SOM(mg)/TOC(g) and SAT(mg)/TOC(g) can be used collectively to provide information about source type. For example, if SOM(mg)/TOC(g) is >100, suggesting a high level of maturity, but the SAT(mg)/TOC(g) <20 it is very likely that the organic matter is terrestrial. Conversely, the same SOM(mg)/TOC(g) value with a SAT(mg)/TOC(g) value >40 suggests a marine source type.

CLASSIFICATION OF SOURCE ROCK RICHNESS

CLASSIFICATION	SOM*		SaOM**	
	%	PPM	%	PPM
POOR	< 0.05	< 500	< 0.02	< 200
MODERATE	0.05-0.10	500-1000	0.02-0.04	200-400
GOOD	>0.10	>1000	>0.04	>400

* SOM = soluble organic matter

** SaOM = saturated organic matter

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COMMENTS AND CONCLUSIONS

TABULATED SUMMARY OF DATA INTERPRETATION

SAMPLE	SOURCE ROCK RICHNESS				MATURITY		SOURCE TYPE				DEPOSITIONAL ENVIRONMENT
	%TOC	%SOM	%SaOM	C_T-C_R	SOM/TOC	C_R/C_T	PRIST/n-C_{17}	21+22/ 28+29	%SAT	n-ALKANES	PRISTANE/PHYTANE
ROWANS 1 1524-1551m	*	*	*	**	++	+	MAR/TER	TER	MAR/TER	MAR/TER	Reducing
ROWANS 1 1707-1759m	*** u	** u									
PECTEN 1/1A 1652-1734m	*** u	* u									
PECTEN 1/1A 1807-1826m	** u	* u									
NTH EUMERAL 1 978-1015m	*** u	*** u									
NTH EUMERAL 1 1494-1579m	***	**	*	***	+	+	MAR/TER	MAR	MAR/TER	MAR/TER	Reducing
NTH EUMERAL 1 1920-1990m	***	**	**	***	++	+	MAR/TER	MAR	MAR	MAR/TER	Reducing/Oxidizing
PORTLAND 3 1453-1456m	***	***	*	**	++	++	MAR	TER	TER	MAR/TER	Reducing
PORTLAND 3 1608-1625m	***	**	*	**	+	++	TER	TER	MAR/TER	TER	Oxidizing
FLAXMANS 1 1664m	*** u	** u									
FLAXMANS 1 1707-1798m	*** u	* u									
FLAXMANS 1 1817m	***	*	*	***	+	+	TER	TER	TER	TER	Oxidizing
FLAXMANS 1 1945m	*** u	* u									
FLAXMANS 1 2398m	* u	* u									
FLAXMANS 1 2709m	*	*	*	*	++	+	MAR	MAR/TER	MAR	MAR	Reducing
ARGONAUT 1 1645m	*** u	** u									
ARGONAUT 1 3449m	***	*	*	***	+	+	TER	TER	TER	MAR/TER	Oxidizing
ARGONAUT 1 3555m	*** u	** u									
MOUNT SALT 1 3003m	*** u	** u									
MOUNT SALT 1 3061m	**	*	*	**	++	++	MAR	MAR	MAR/TER	MAR	Reducing
BELFAST 1 1419m	***	*	*	***	+	+	MAR/TER	TER	TER	MAR/TER	Reducing/Oxidizing
NAUTILUS 1 1584m	* u	* u									
NAUTILUS 1 1860m	***	**	*	***	+	+	TER	TER	TER	TER	Reducing/Oxidizing
NAUTILUS 1 2009m	***	**	*	***	+	+	TER	TER	TER	TER	Oxidizing
VOLUTA 1 1792m	***	*	*	***	+	+	MAR	TER	TER	MAR/TER	Reducing/Oxidizing
VOLUTA 1 1919m	*** u	** u									
VOLUTA 1 2042m	*** u	** u									
VOLUTA 1 2319m	***	**	*	***	+	+	MAR	TER	TER	MAR/TER	Reducing
VOLUTA 1 2462m	*** u	* u									
VOLUTA 1 3038m	***	*	*	**	+	+	TER	TER	TER	TER	Reducing/Oxidizing
VOLUTA 1 3192m	***	*	*	***	+	+	TER	TER	TER	MAR/TER	Oxidizing
VOLUTA 1 3324m	**	*	*	**	+	+	TER	MAR/TER	TER	MAR/TER	Oxidizing
VOLUTA 1 3509m	**	*	*	**	++	+	MAR	MAR/TER	TER	MAR	Reducing/Oxidizing
VOLUTA 1 3654m	**	*	*	**	++	+	MAR	MAR	MAR/TER	MAR	Reducing/Oxidizing
CAROLINE 1 1830m	*** u	*** u									
CAROLINE 1 2426m	***	**	*	***	+	+	TER	MAR/TER	TER	MAR/TER	Reducing/Oxidizing
CAROLINE 1 3069m	*** u	** u									
HEYWOOD 10 1613-1616m	***	**	*	***	++	+	MAR/TER	TER	TER	MAR/TER	Oxidizing
GLENELG 1 1976-1977m	*** u	* u									
PRETTY HILL 1 732m	***	*	*	***	+	+	MAR/TER	TER	TER	MAR/TER	Reducing/Oxidizing
PRETTY HILL 1 832m	*** u	* u									
PRETTY HILL 1 2548m 3.	***	*	*	***	+	+	MAR	TER	TER	MAR/TER	Reducing/Oxidizing
MUSSEL 1 2099m	***	***	*	***	+	+	TER	TER	TER	TER	Reducing/Oxidizing
MUSSEL 1 2236m	***	***	*	***	++	++	TER	TER	TER	TER	Reducing/Oxidizing
FERGUSONS HILL 1 478-479m	***	*	*	***	+	+	MAR/TER	TER	TER	MAR/TER	Oxidizing
FERGUSONS HILL 1 616m	*** u	* u									
FERGUSONS HILL 1 947m	* u	* u									
PORT CAMPBELL 2 1628m	***	*	*	***	+	+	MAR/TER	TER	TER	TER	Reducing/Oxidizing
PORT CAMPBELL 2 1802m	*** u	** u									
PORT CAMPBELL 1 1307m	***	***	*	***	++	+	TER	TER	TER	TER	Oxidizing
PORT CAMPBELL 1 1585m	***	***	*	***	++	+	TER	TER	TER	TER	Oxidizing
KALANGADOO 1 765m	*** u	* u									
KALANGADOO 1 896m	*** u	* u									
KALANGADOO 1 1456m	** u	* u									
LAKE BONNEY 1 2332-2438m	** u	* u									
LAKE BONNEY 1 2438-2530m	** u	* u									
LAKE BONNEY 1 2719m	** u	** u									
LAKE BONNEY 1 2734-2835m	** u	* u									
BURRUNGULE 1 1640-1713m	***	**	*	***	+	+	MAR/TER	MAR/TER	TER	MAR/TER	Reducing
BURRUNGULE 1 2179-2341m	** u	* u									
BURRUNGULE 1 2341-2438m	** u	* u									

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KEY FOR "TABULATED SUMMARY OF DATA INTERPRETATION"

Source Rock Richness

*	Poor source rock
**	Moderate source rock
***	Good source rock
u	Data obtained from screening procedures

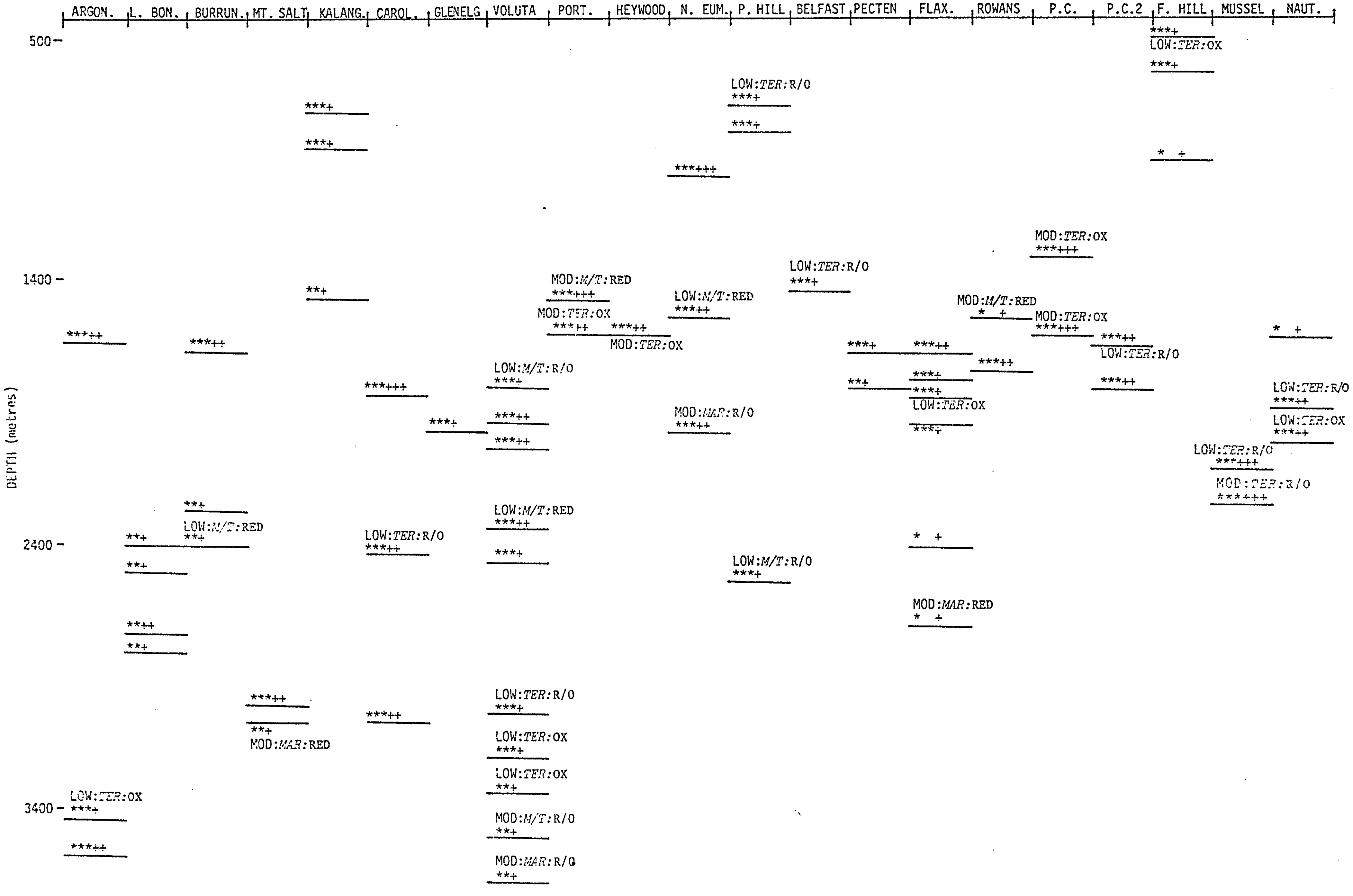
Maturity

+	Low level of maturity
++	Moderate level of maturity
+++	High level of maturity

Source Type

MAR	Dominantly marine source material
TER	Dominantly terrestrial source material
MAR/TER	Significant marine and terrestrial source input

SUMMARY OF DATA INTERPRETATION ACCOUNTING FOR SAMPLE DEPTH



KEY FOR "SUMMARY OF DATA INTERPRETATION ACCOUNTING FOR SAMPLE DEPTH"

* Represents level of Total Organic Carbon

***	Good
**	Moderate
*	Poor

\+ Represents level of Soluble Organic Matter

+++	Good
++	Moderate
+	Poor

The expression A : B : C is a summary of maturity : source type : depositional environment.

maturity - LOW = LOW
MOD = MODERATE

source type - *MAR* = Marine
M/T = Mixed
TER = Terrestrial

depositional environment - RED = Reducing
R/0 = Reducing/Oxidizing
OX = Oxidizing

INTRODUCTION

A total of 88 samples from 21 wells within the Otway Basin (South Australia to Victoria) were provided for geochemical assessment of this basin. The samples ranged in age from Lower Cretaceous to Lowermost Tertiary.

The approach used was to firstly select a large representative number of the samples (61) and screen them for total organic carbon (TOC) and soluble organic matter (SOM). The data obtained from screening is referred to as %TOC(UNC) and %SOM(UNC), and the explanation for this nomenclature is contained in the notes in the section "Tabulated Data". Based on the results from screening 30 of the 61 samples were selected for more detailed analysis. It should be noted that detailed analysis provides for a more accurate assessment of %TOC and %SOM, and that TOC and SOM data obtained by this method will be simply referred to as %TOC and %SOM (see notes in section "Tabulated Data"). Further, for samples studied in detail the %TOC and %SOM data is used for source rock richness assessment, but for samples which were only screened the %TOC(UNC) and %SOM(UNC) data has to be used for this purpose.

Since, for most of the wells studied, only one or two samples were investigated in detail it is difficult to make specific geochemical interpretation for each sedimentary sequence. Rather, the approach has been to make an overall assessment of the basin with some specific comments about certain regions within the basin.

SOURCE ROCK RICHNESS

Although it is generally accepted that 0.5% TOC is the minimum requirement for a petroleum source rock we believe that a good source rock should contain >1.0% TOC. Therefore we have selected the following criteria to catagorize the organic richness of these sediments based on %TOC data:

< 0.5%	TOC	Poor
0.5 - 1.0%	TOC	Moderate
>1.0%	TOC	Good

On this basis 44 samples are good source rocks, 12 moderate and 5 poor (see "Tabulated Summary of Data Interpretation" table in this section). It is of interest that most of the samples classified as poor appeared to be sandstone and are therefore expected to have low %TOC, and that most of the samples classified as moderate were the deeper Lake Bonney, Burrungule and Voluta sediments. Further, the shallowest North Eumeralla sample and the Mussel and Port Campbell #1 samples are particularly rich in organic carbon.

When using soluble organic matter for assessment of source rock richness it is important to remember that the data has been obtained by two methods. In most cases the %SOM(UNC) value for a given sample will be about 1.5 times the %SOM value for the same sample. However, there are a few cases (e.g. Flaxmans #1 2709m and Portland 3 1608-1625m) where the %SOM(UNC) value is at least 5 times the %SOM value, and this usually occurs for samples rich in elemental sulphur. The following criteria have been selected to classify sediments on the basis of their soluble organic matter:

0.0 - 0.05%	Poor
0.05 - 0.10%	Moderate
>0.10%	Good

The "Tabulated Summary of Data Interpretation" shows that (1) the Portland, North Eumeralla and Heywood samples, which have relatively similar geographical locations, all have at least moderate levels of soluble organic matter; (2) the Caroline, shallow Voluta and deep Nautilus sediments also contain at least moderate levels; (3) the Port Campbell #1 and Mussel samples are good source rocks based on soluble organic matter; (4) the other samples are generally poor source rocks based on soluble organic matter.

Since crude oil consists largely of saturated compounds sediments can be classified as "oil source rocks" using the parameter "% saturated organic matter in the sediment sample (%SaOM)". The following criteria have been applied:

<0.02%	SaOM	Poor
0.02 - 0.04%	SaOM	Moderate
>0.04%	SaOM	Good

On this basis all samples for which the parameter was measured except North Eumeralla #1 1920-1990m are poor source rocks for crude oil. Although this parameter can be influenced by migration, the consistently poor oil source rocks over such a wide geographical area suggests that the low saturate levels are due to source type and/or a low level of maturity.

The potential of these sediments to generate oil or gas can be assessed using the C_T-C_R data. The following criteria are used:

<0.3%	C_T-C_R	Poor
0.3 - 0.6%	C_T-C_R	Moderate
>0.6%	C_T-C_R	Good

The "Tabulated Summary of Data Interpretation" shows that all of the samples for which this parameter was determined except Flaxmans #1 2709m have at least moderate potential for oil or gas generation, and in fact 21 of the 30 samples have good petroleum generation potential.

MATURITY

Although the SOM(mg)/TOC(g) and C_R/C_T data is used in this study for maturity assessment it should be noted that these parameters (C_R/C_T in particular) are somewhat influenced by source type. It should also be noted that PAP data was not obtained but if any conflict develops over the maturity of these samples this data can be readily obtained. Further, n-alkane distributions and CPI indexes were not used as maturation indicators because in a study of this nature the large effect of source type on these parameters makes it difficult to compare the data for samples from different sedimentary sequences.

The following criteria have been used for maturity assessment:

SOM(mg)/TOC(g)	C_R/C_T	
0 - 50	<0.6	Low
50 - 100	0.6 - 0.8	Moderate
100	>0.8	High

The "Tabulated Summary of Data Interpretation" shows that (1) the Portland, Heywood and deepest North Eumeralla samples, which have relatively similar geographical locations, have reached moderate levels of maturity and are more mature than samples at similar depths in other parts of the basin; (2) the deepest Voluta, Mount Salt, Flaxmans and Mussel samples appear to have reached moderate levels of maturity; (3) there is some suggestion that the Port Campbell #1 and the Rowans samples are approaching moderate levels of maturity but this suggestion is inconsistent with the level of maturity of samples at similar depths in nearby sedimentary sequences; (4) nearly 2/3 of the samples have low levels of maturity.

Overall, it appears that even the most mature samples studied have only reached moderate levels of maturity, that is, have just entered the "oil window", and it seems very likely that none of the wells has passed through this window.

SOURCE TYPE

Four parameters were used for assessment of the type of organic matter in these sediments, namely pristane/$\underline{n}$-C_{17}, $(C_{21}+C_{22})/C_{28}+C_{29})$, the proportion of saturates in the extract (%SAT), and the $\underline{n}$-alkane distribution (including CPI index). Although it has been established by Lijmbach from Shell in Holland that crude oils from a marine source have pristane/$\underline{n}$-C_{17} <0.5 and those from a terrestrial source have values >1.0, in a personal communication with him he indicated that these boundary values are significantly greater for sediment extracts. Our own work supports this suggestion. Therefore, the following criteria were used to assess source type based on pristane/ $\underline{n}$-C_{17} ratios:

<1.0	Marine source
1.0 - 1.5	Mixed source
>1.5	Terrestrial source

The criteria for assessment based on $(C_{21}+C_{22})/C_{28}+C_{29})$ are discussed in the "theory and methods" section while those for the %SAT data are as follows:

<15%	Terrestrial source
15 - 30%	Mixed source
>30%	Marine source

The assessment of source type based on $\underline{n}$-alkanes was carried out by inspection of the $\underline{n}$-alkane histograms. It should be noted that the latter two parameters in particular are influenced by maturity.

The source type based on each parameter is shown for the samples studied in detail in the "Tabulated Summary of Data Interpretation". Based on the individual assessments an overall assessment of source type was made and these are shown on the figure "Summary of Data Interpretation Accounting for Sample Depth". The most interesting observations are (1) the samples studied from the off-shore wells Argonaut, Nautilus and Mussel are dominated by terrestrial organic matter; (2) the samples from the two Port Campbell wells and Fergusons Hill, which have similar geographical locations, were dominantly terrestrial; (3) the Voluta samples contained both marine and terrestrial organic matter at shallower depths, became dominantly terrestrial at intermediate depths and finally were quite marine at maximum depth; (4) the Pretty Hill, North Eumeralla and Flaxmans samples show an increasing marine input with depth while the deeper Mount Salt sample contains mainly marine organic matter; (5) all other samples varied from mixed marine/ terrestrial to dominantly terrestrial in their organic type.

Overall, the samples studied have a strong terrestrial input but there are parts of the basin where the deeper, more mature samples are dominated by marine organic matter.

DEPOSITIONAL ENVIRONMENT

In the past it has been simply believed that terrestrial organic matter gives rise to gas and marine organic matter is the source of crude oil. However, it is now recognized that although this is generally true terrestrial organic matter deposited in a reducing environment may give rise to crude oil. Of the samples studied 10 of the 18 classified as containing dominantly terrestrial organic matter were deposited in an oxidizing environment and at the best are likely to give rise to gas. The other 8 terrestrial samples were deposited in a reducing/oxidizing environment and therefore may give rise to some oil as well as gas. Of the 8 samples believed to contain significant proportions of marine and terrestrial organic matter 5 were deposited in a reducing environment and thus may well be oil prone. The other 3 samples were deposited in a reducing/oxidizing environment and are hence less oil prone. The marine samples, which were deposited in reducing to reducing/oxidizing environments are the most oil prone.

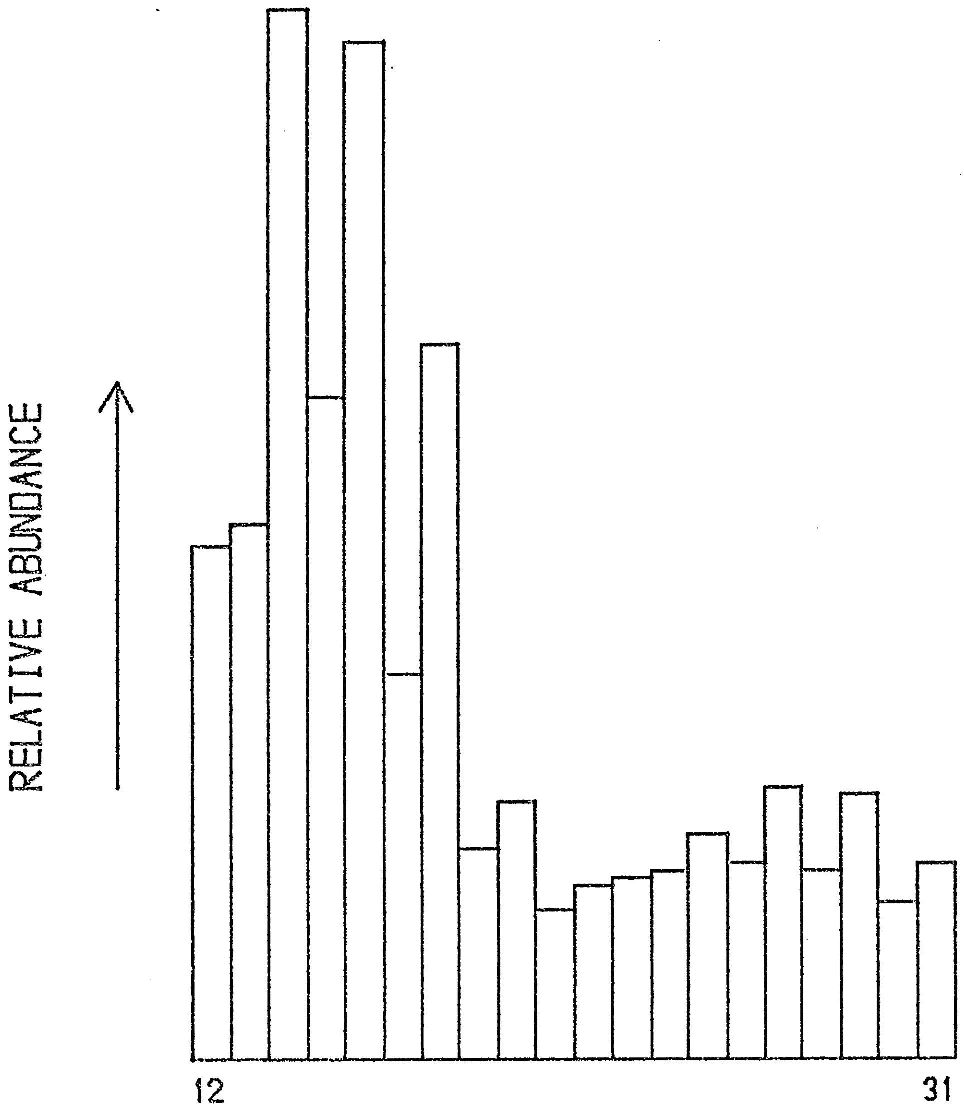
CONCLUSIONS

Although the basin is generally well-endowed with organic carbon few parts have levels of soluble organic matter indicative of significant petroleum generation. In addition the % saturated organic matter in the sediments strongly suggests that there has not been significant crude oil generation. The apparent lack of petroleum generation is very likely due to the general low (at best moderate) level of maturation to which these samples have been subjected.

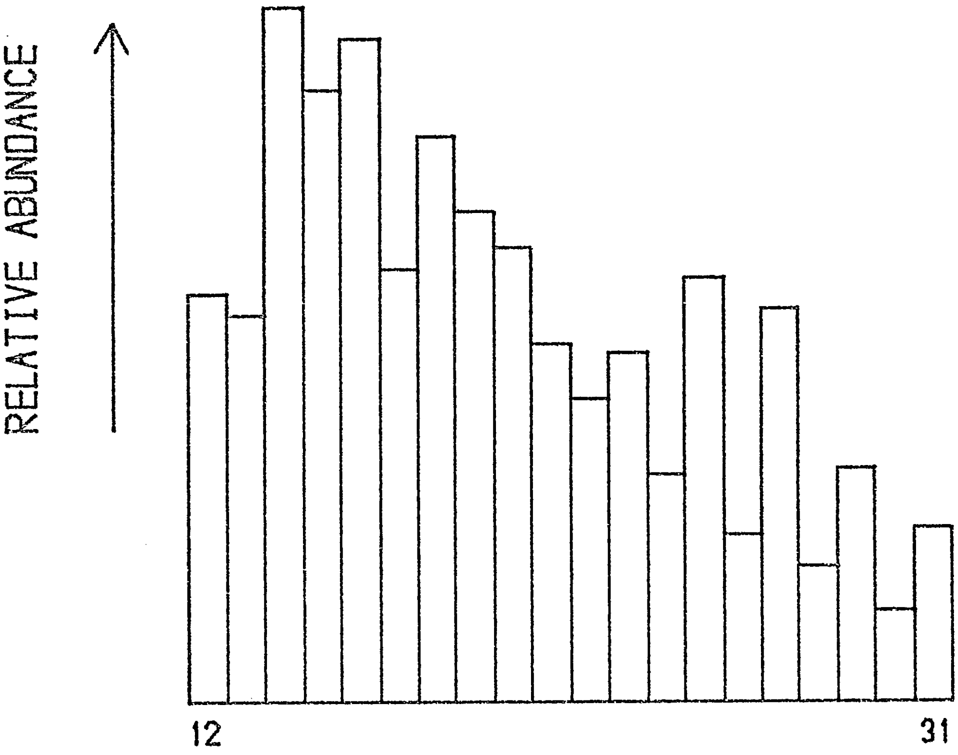
There is a strong input of terrestrial organic matter into most parts of the basin suggesting that it is prone to generate a considerable amount of gas. However, there are also parts of the basin, particularly the deeper more mature sediments, which are quite marine and hence oil prone. Unfortunately, these marine sediments only contain moderate levels of organic carbon.

Finally, it is our opinion that if future drilling is to take place in this basin it would be necessary to penetrate sediments deeper than the * deepest sediments investigated in this study.

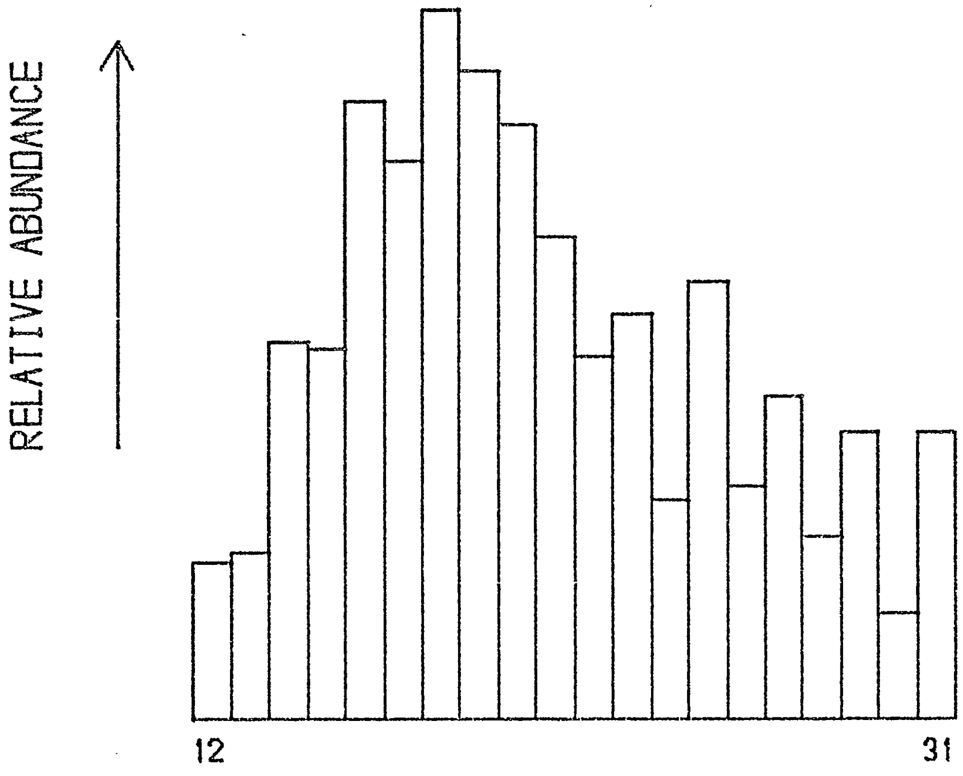
n-ALKANE DISTRIBUTIONS



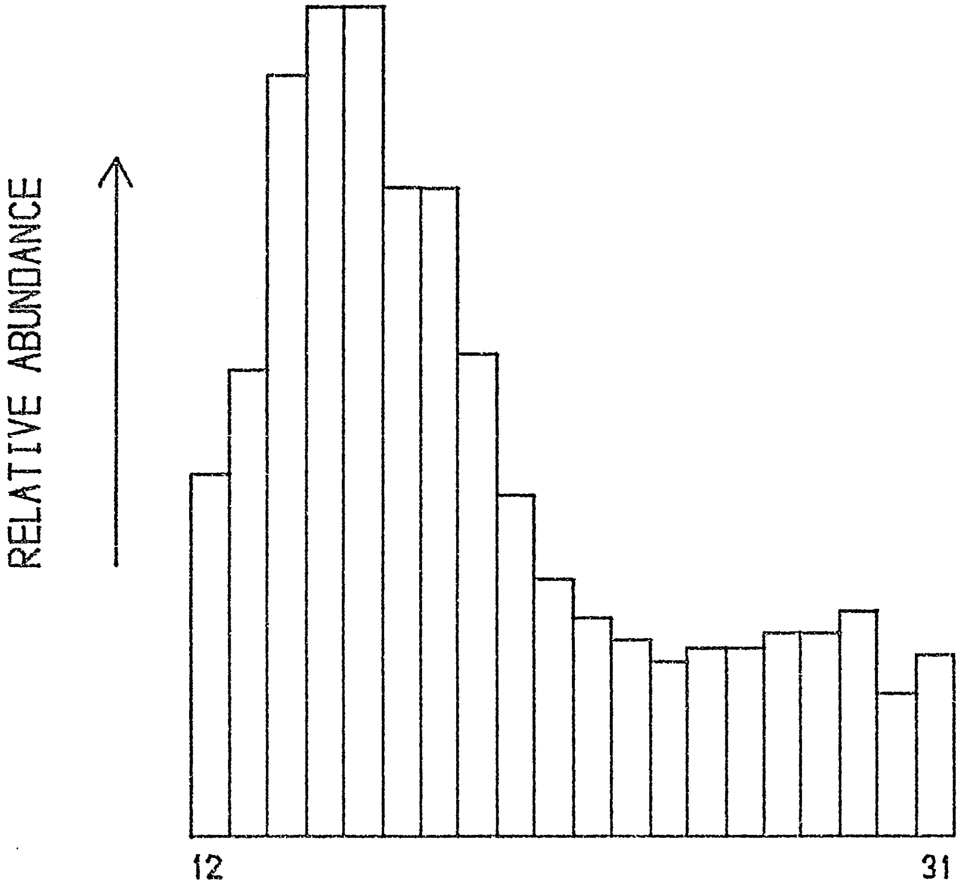
ROWANS 1 1524-1551m



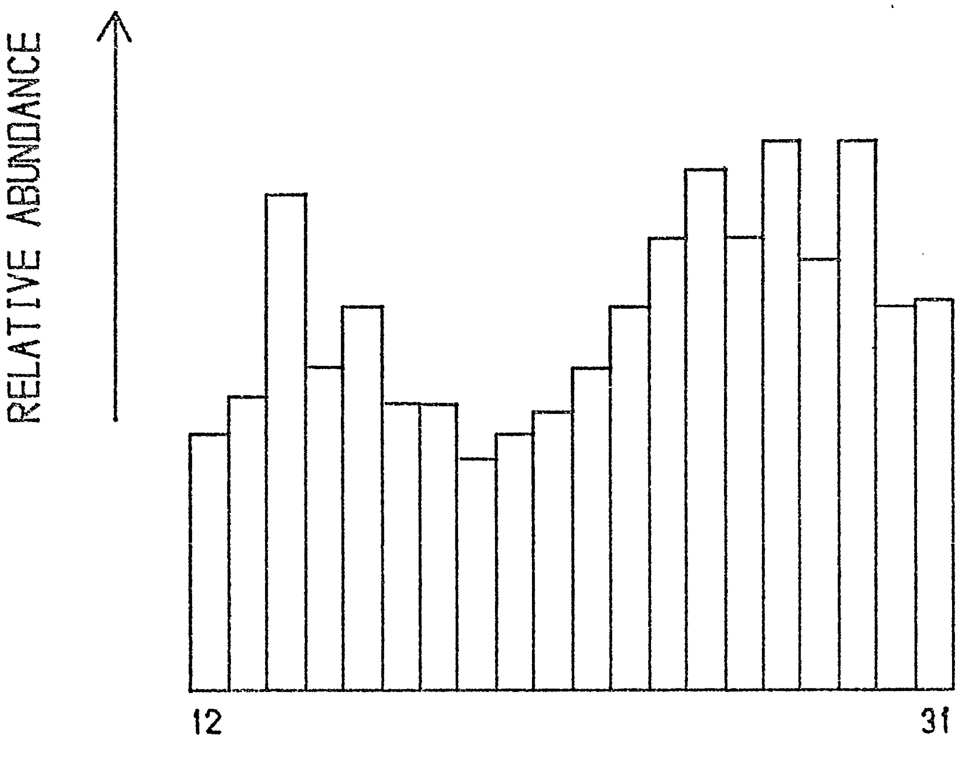
NORTH EUMERALLA 1 1494-1579m



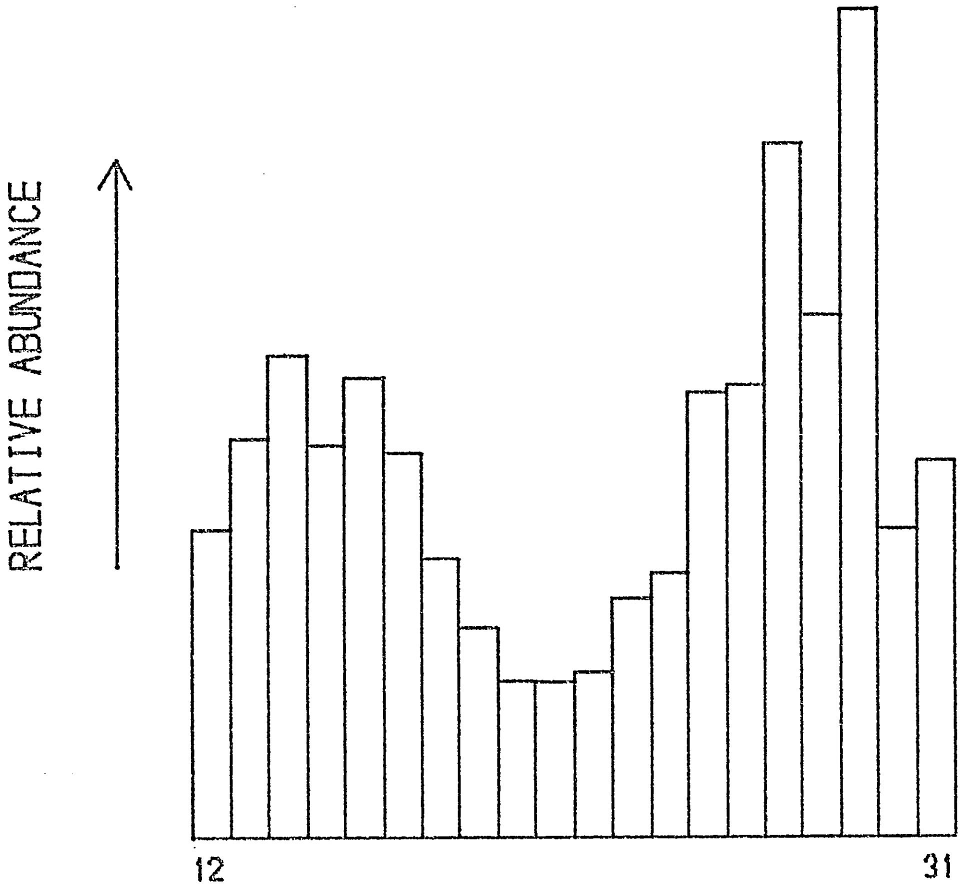
NORTH EUMERALLA 1 1920-1990m



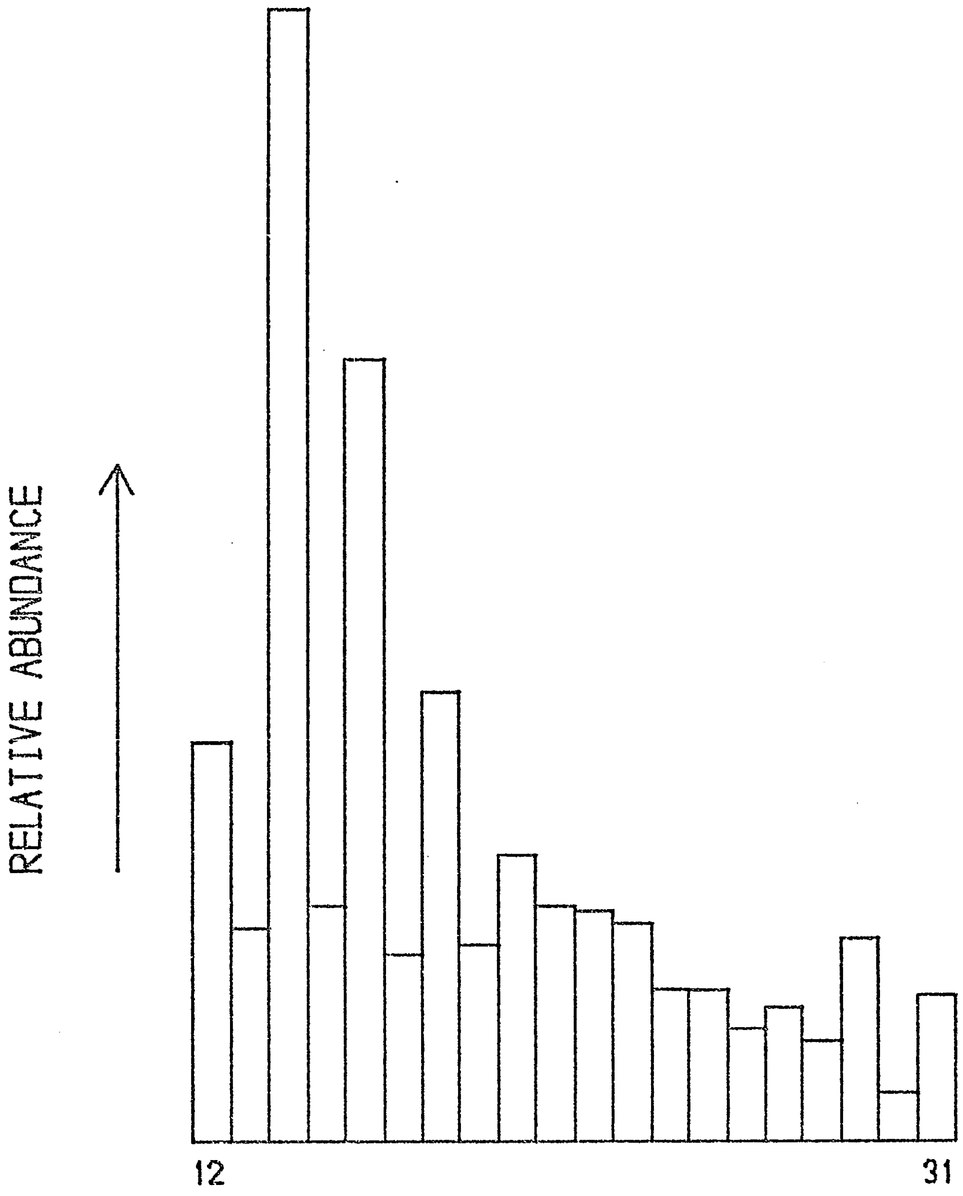
PORTLAND 3 1453-1456m



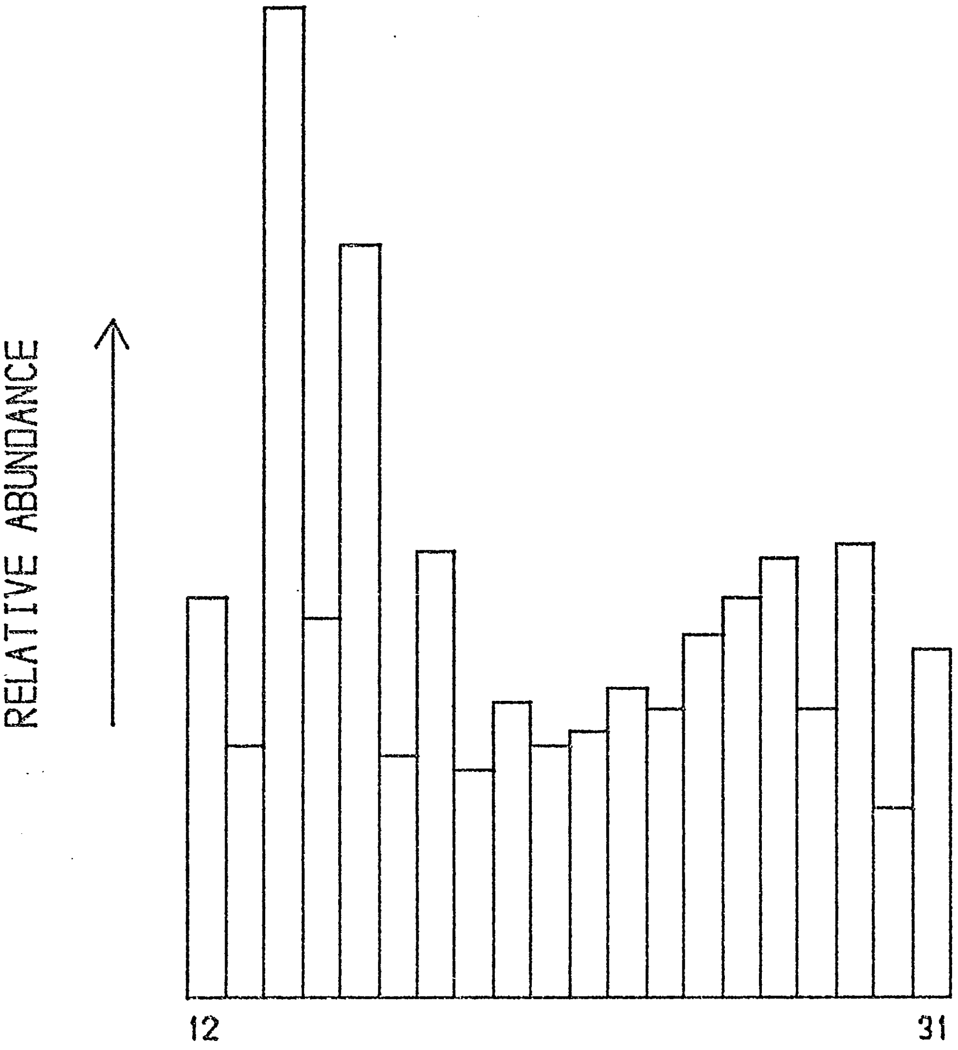
PORTLAND 3 1608-1625m



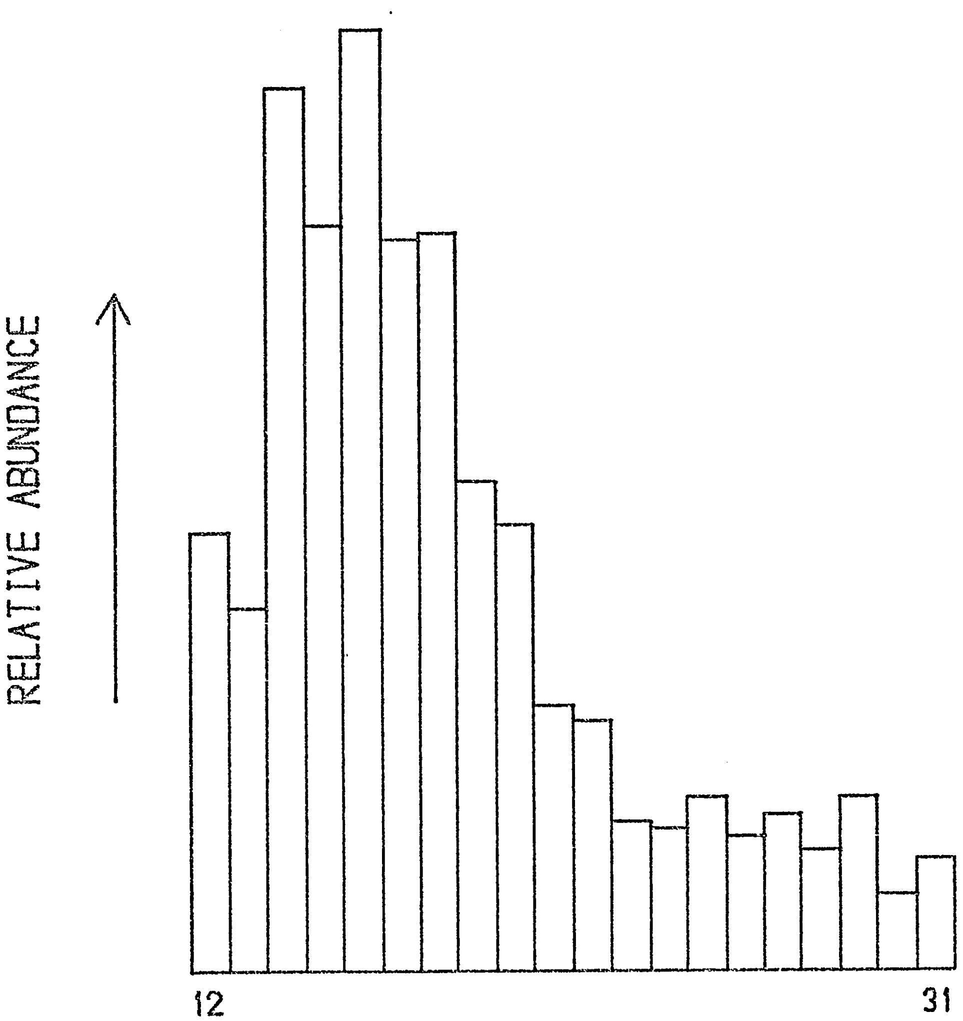
FLAXMANS 1 1817m



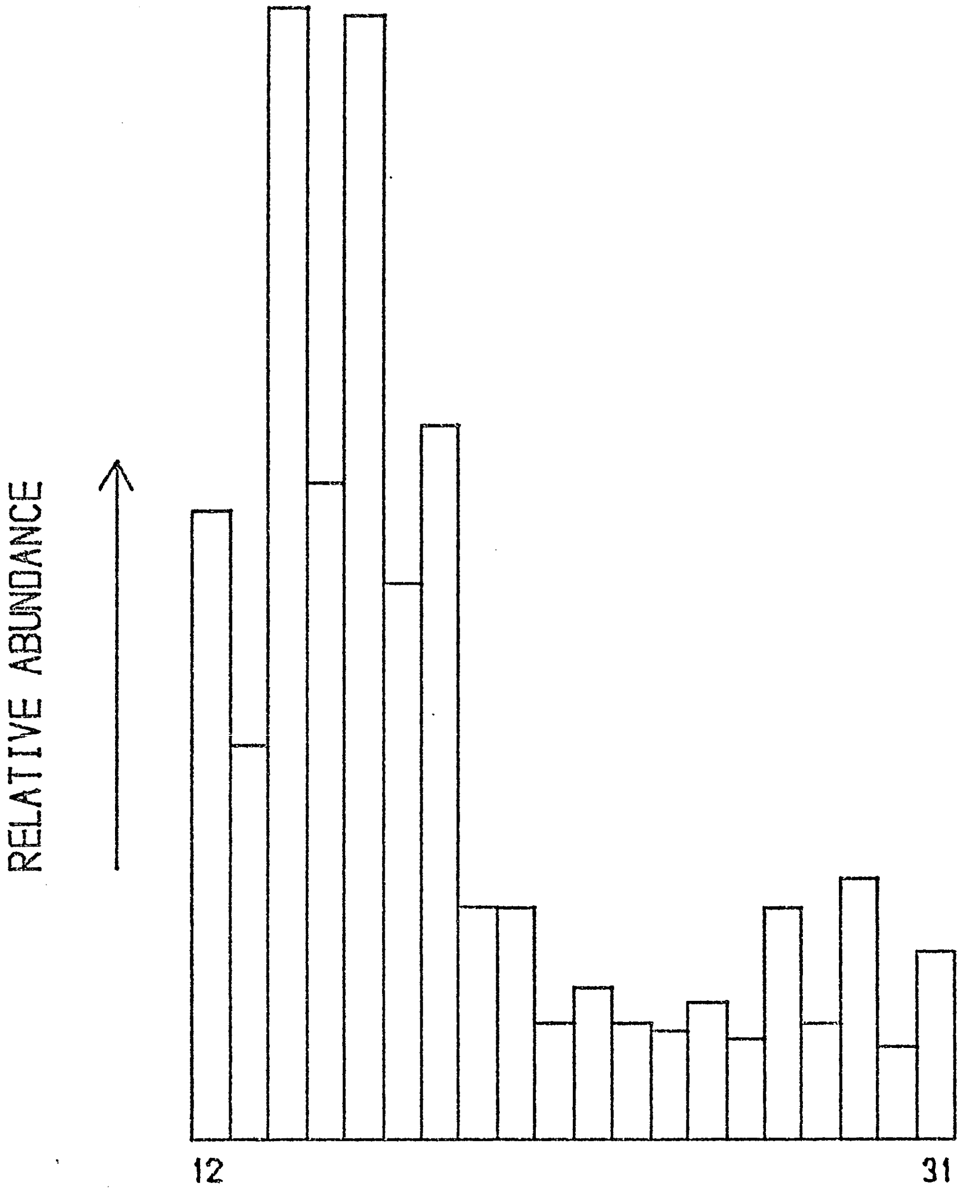
FLAXMANS 1 2709m



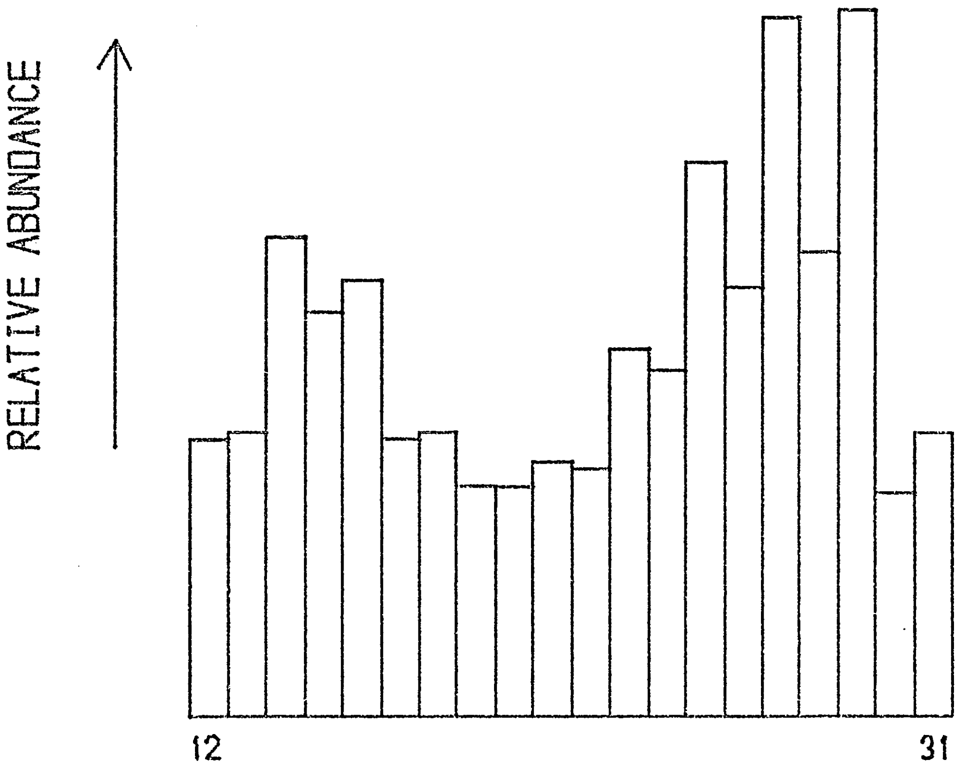
ARGONAUT 1 3449m



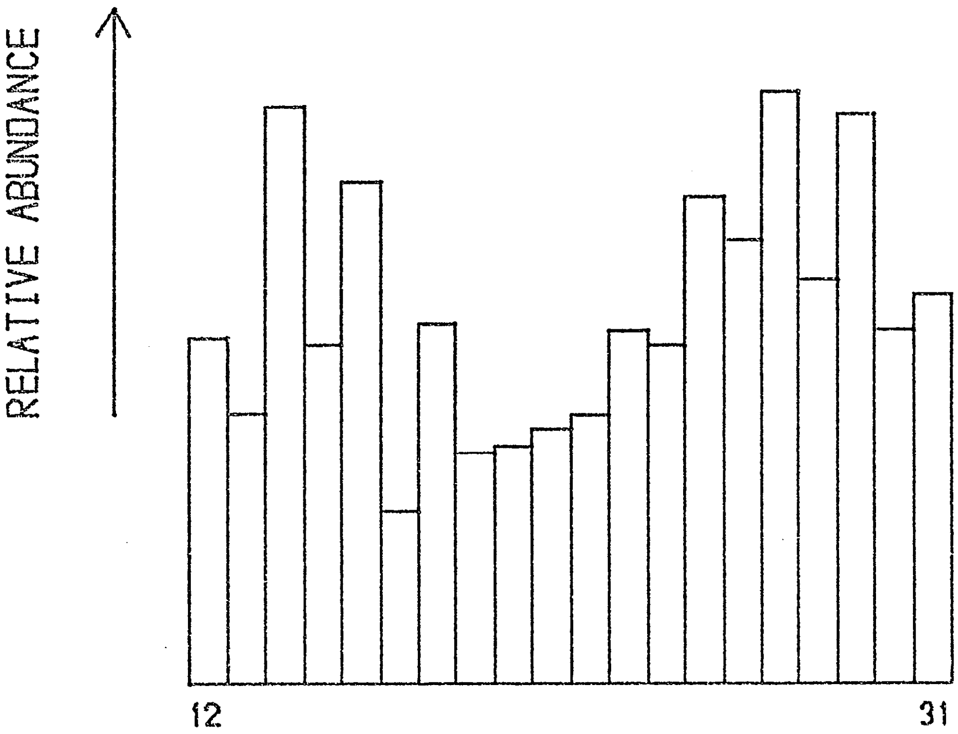
MOUNT SALT 1 3061m



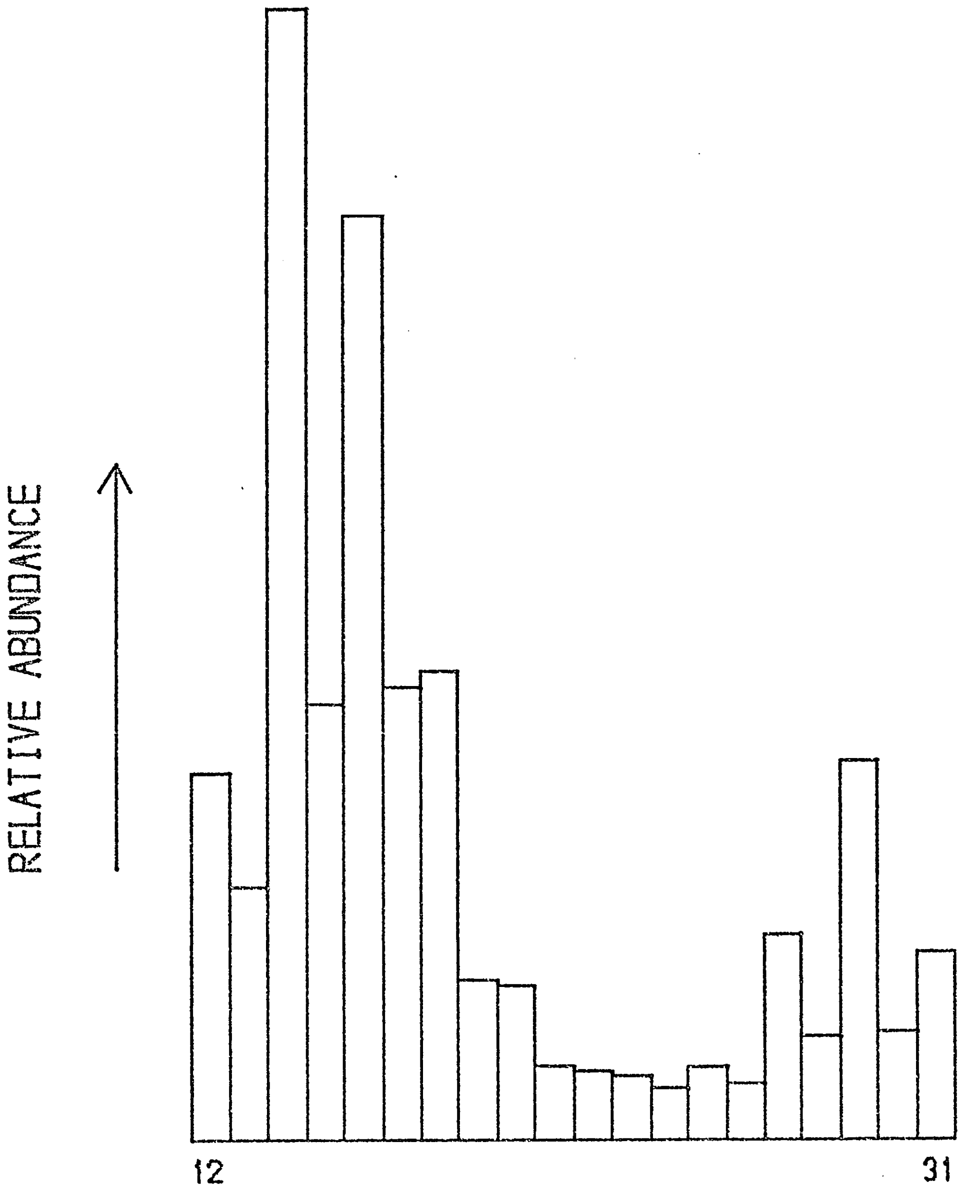
BELFAST 1 1419m



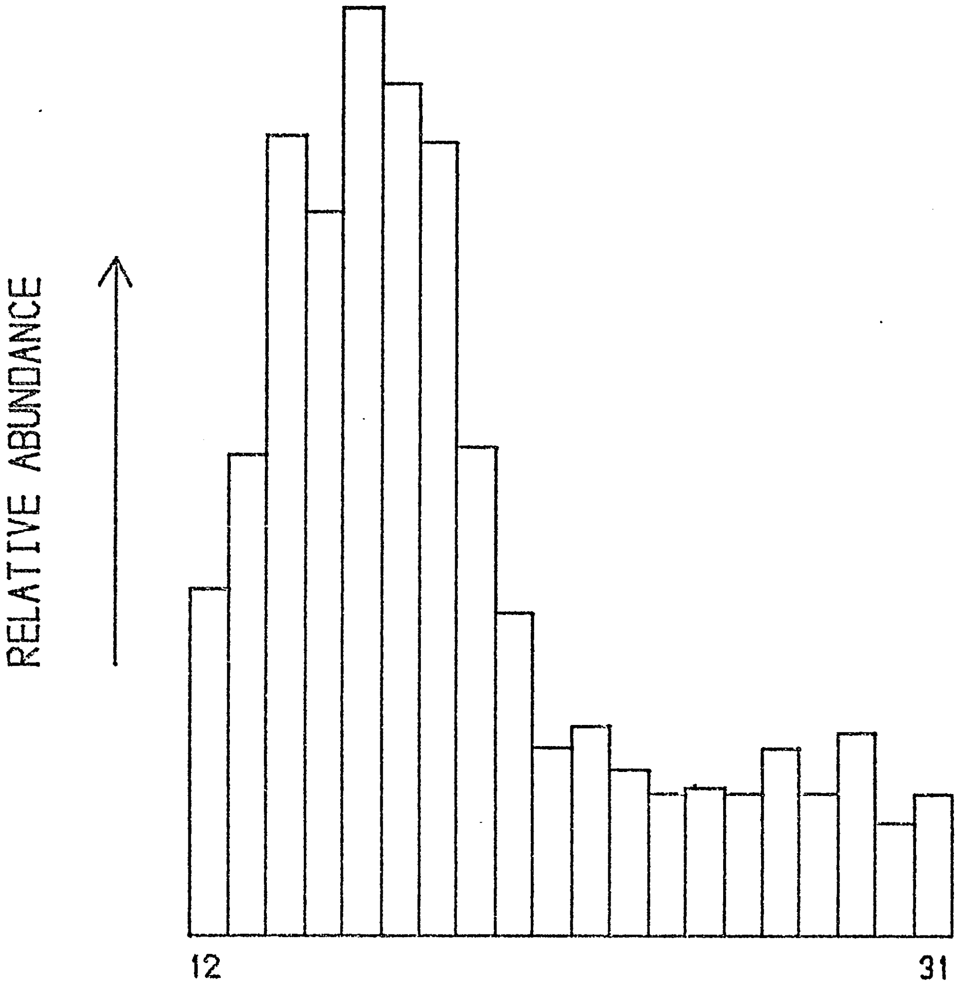
NAUTILUS 1 1860m



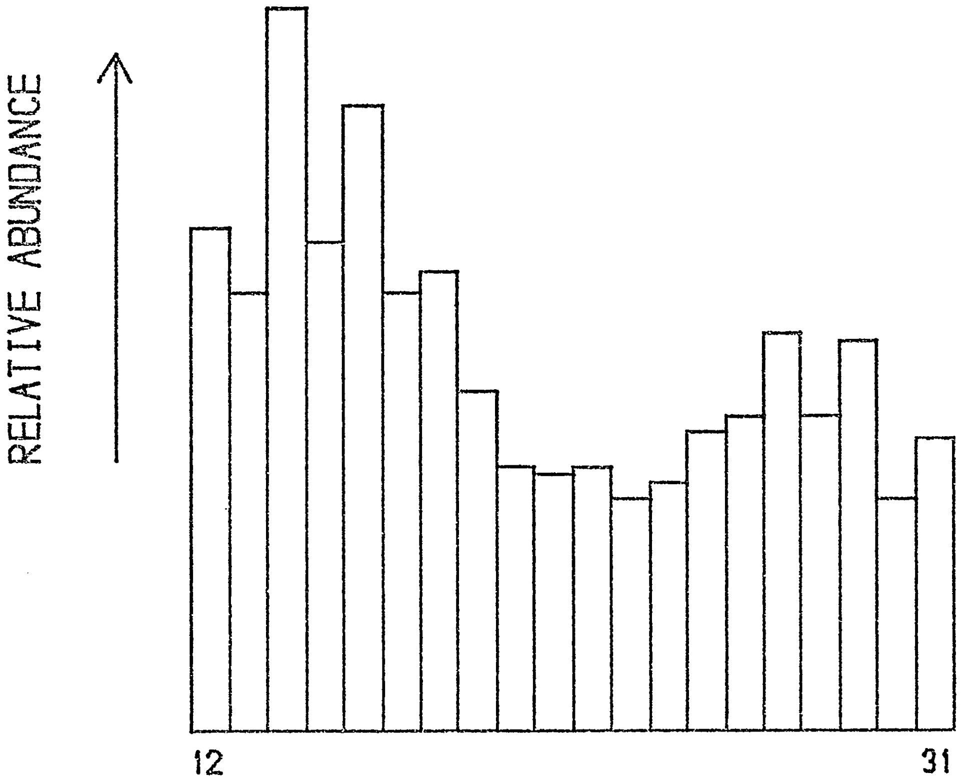
NAUTILUS 1 2009m



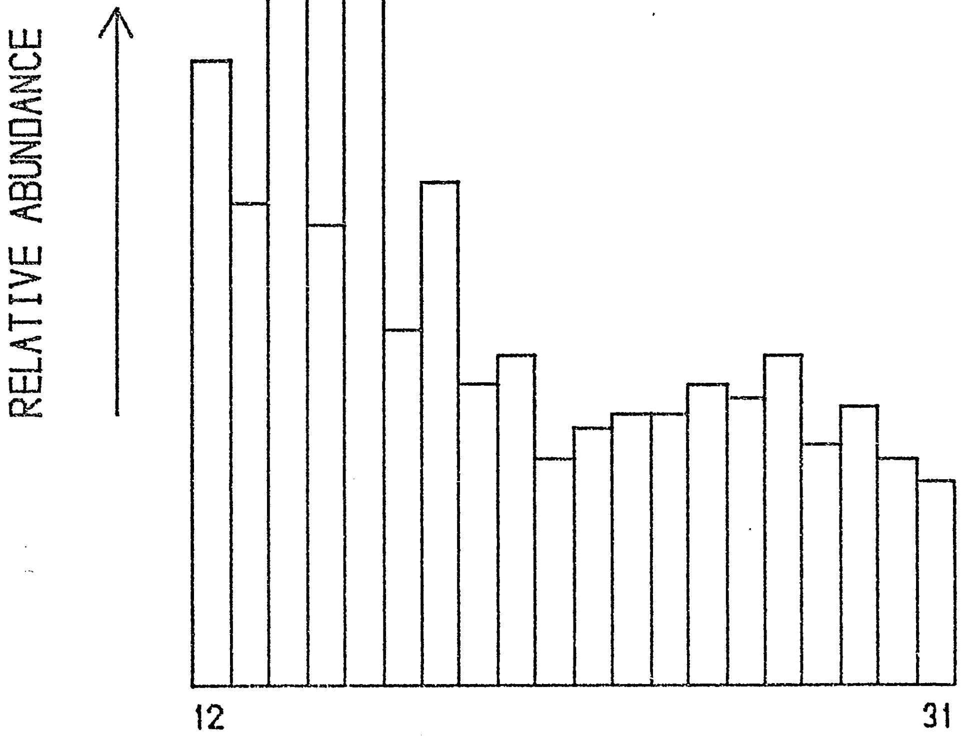
VOLUTA 1 1792m



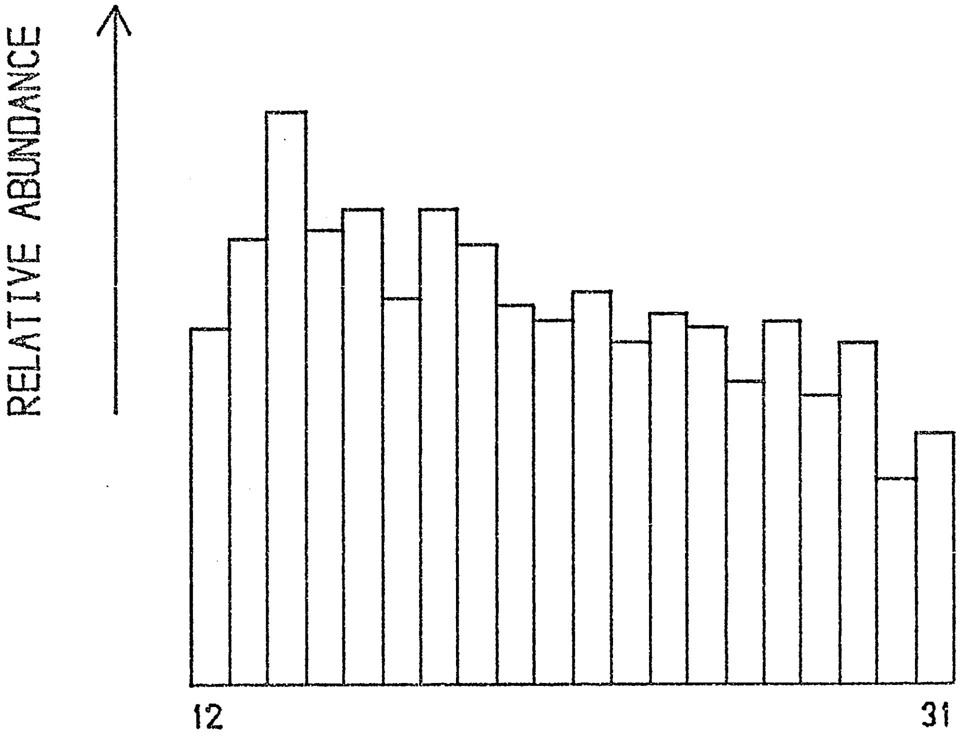
VOLUTA 1 2319m



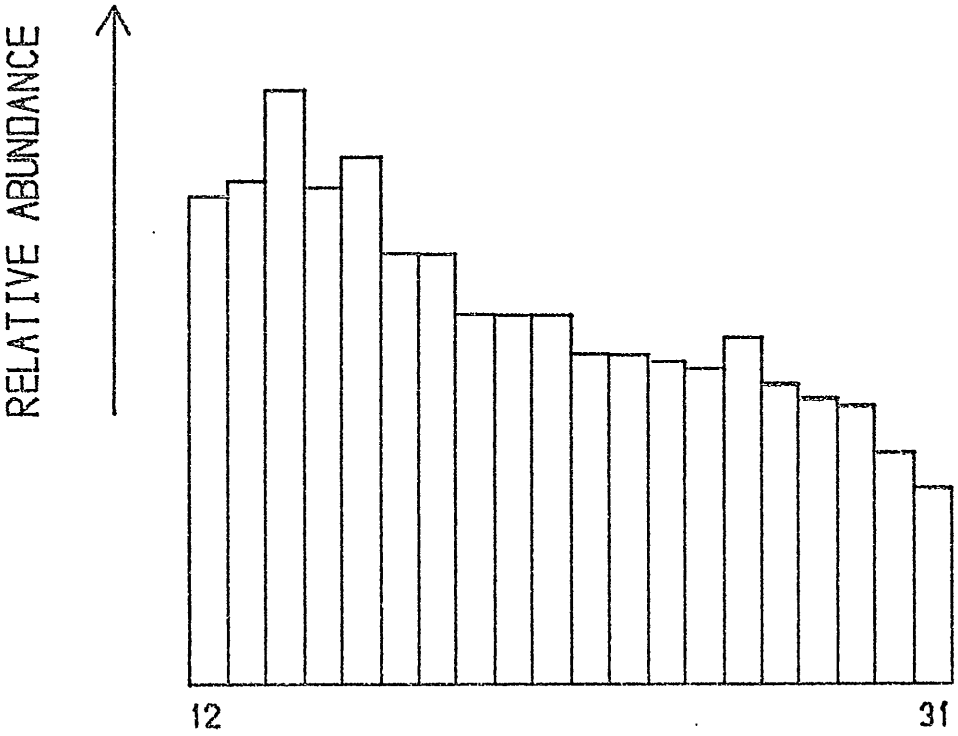
VOLUTA 1 3038m



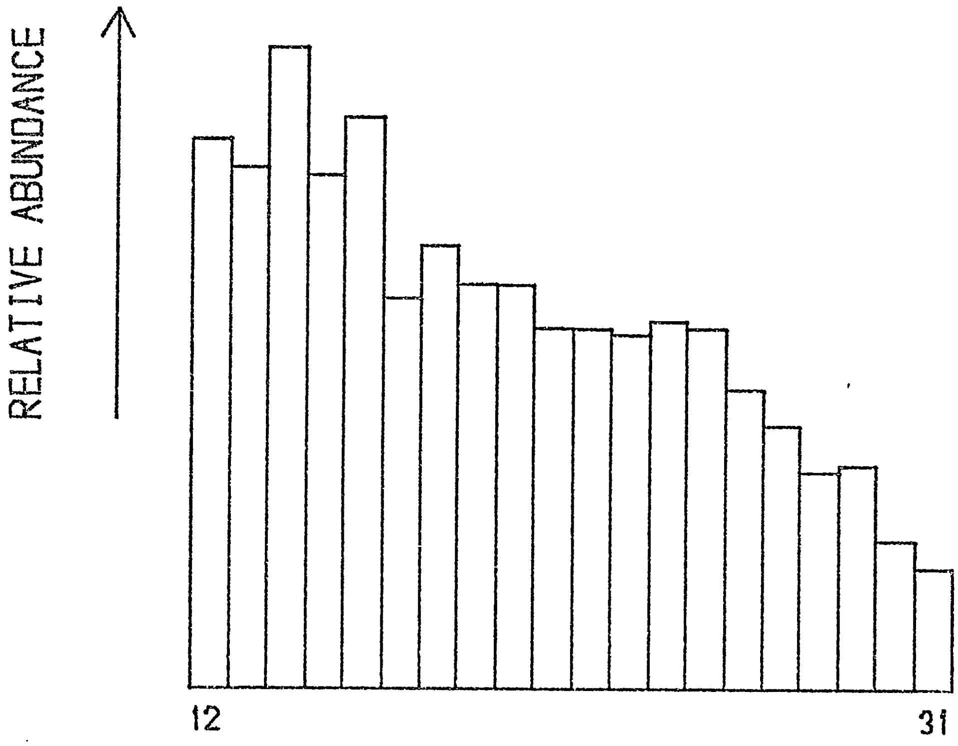
VOLUTA 1 3192m



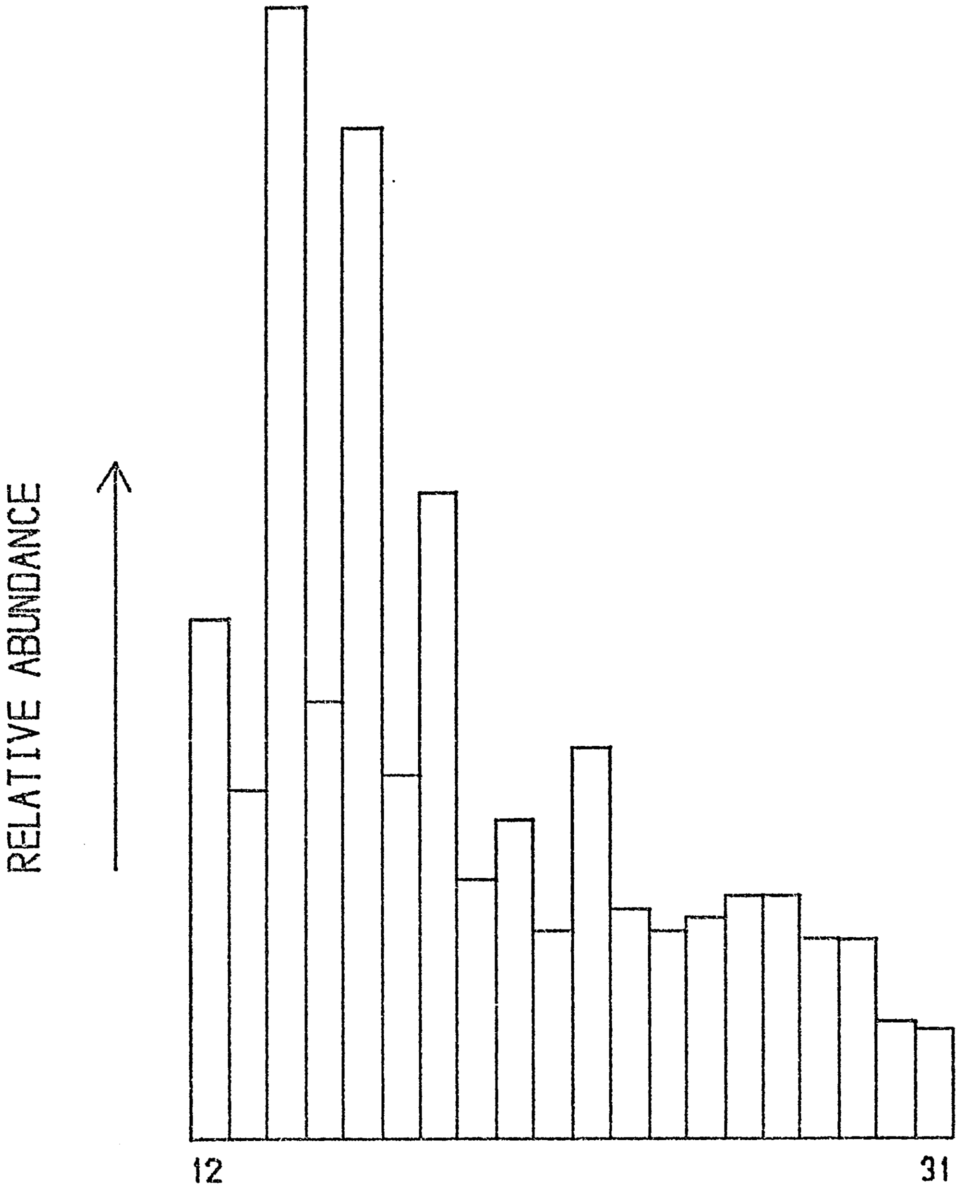
VOLUTA 1 3324m



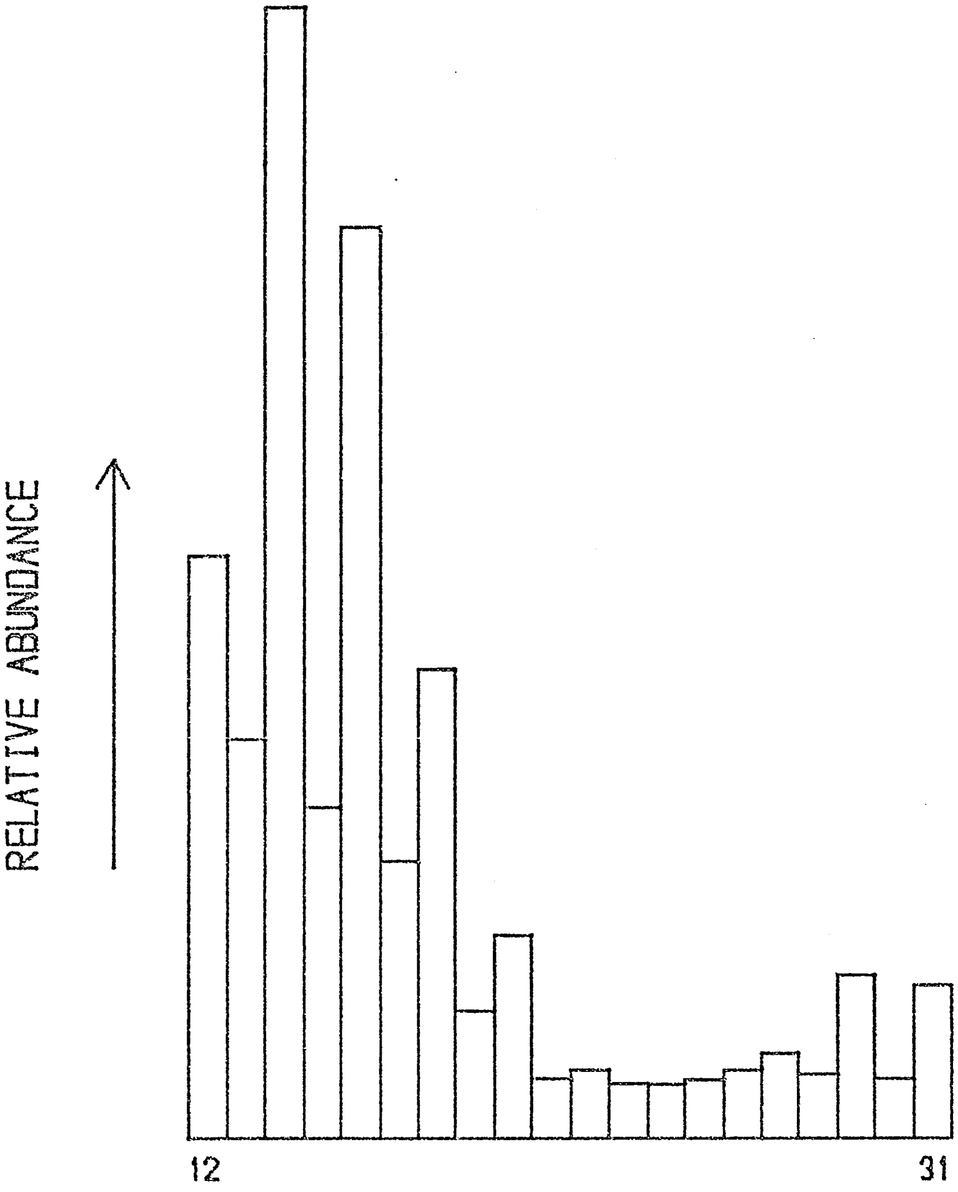
VOLUTA 1 3509m



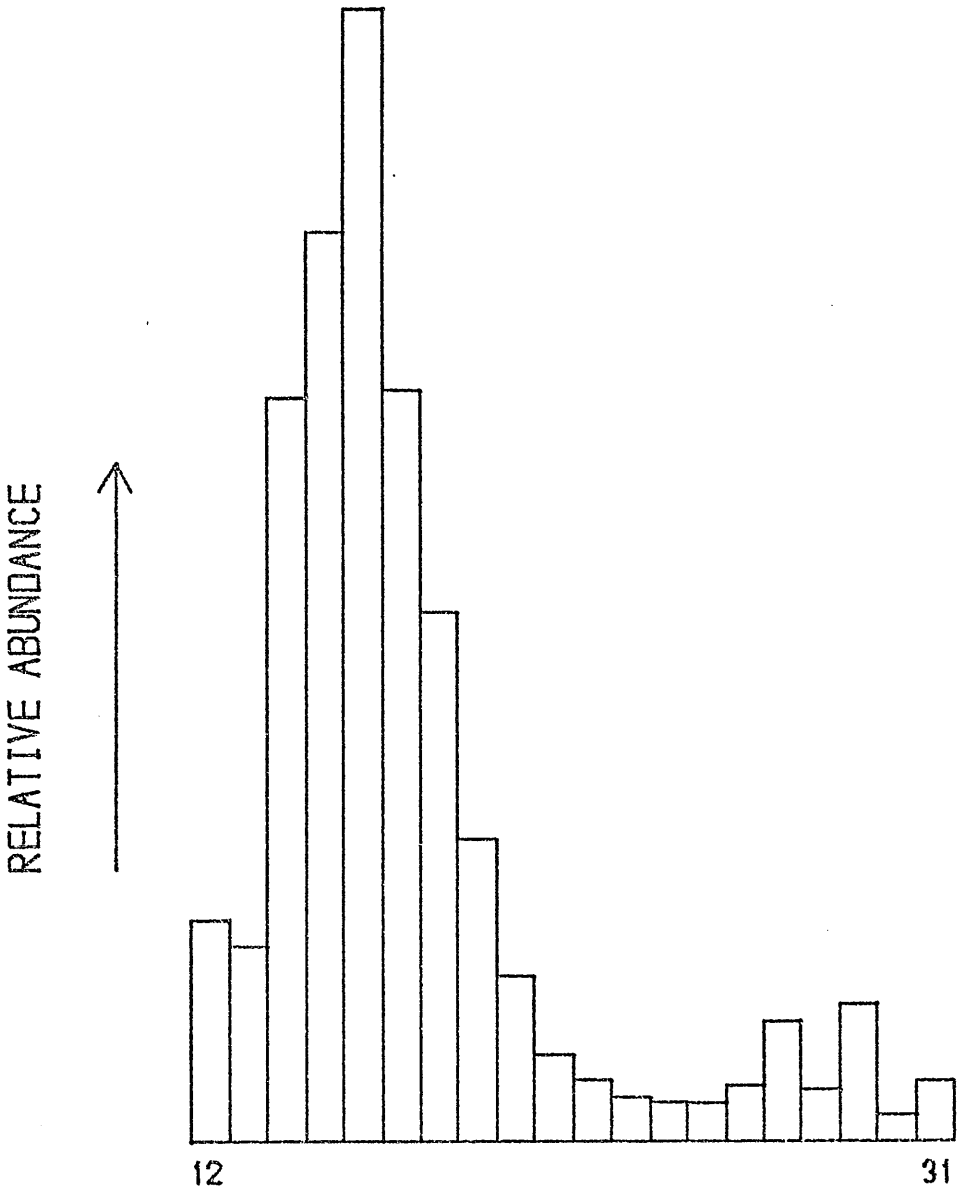
VOLUTA 1 3654m



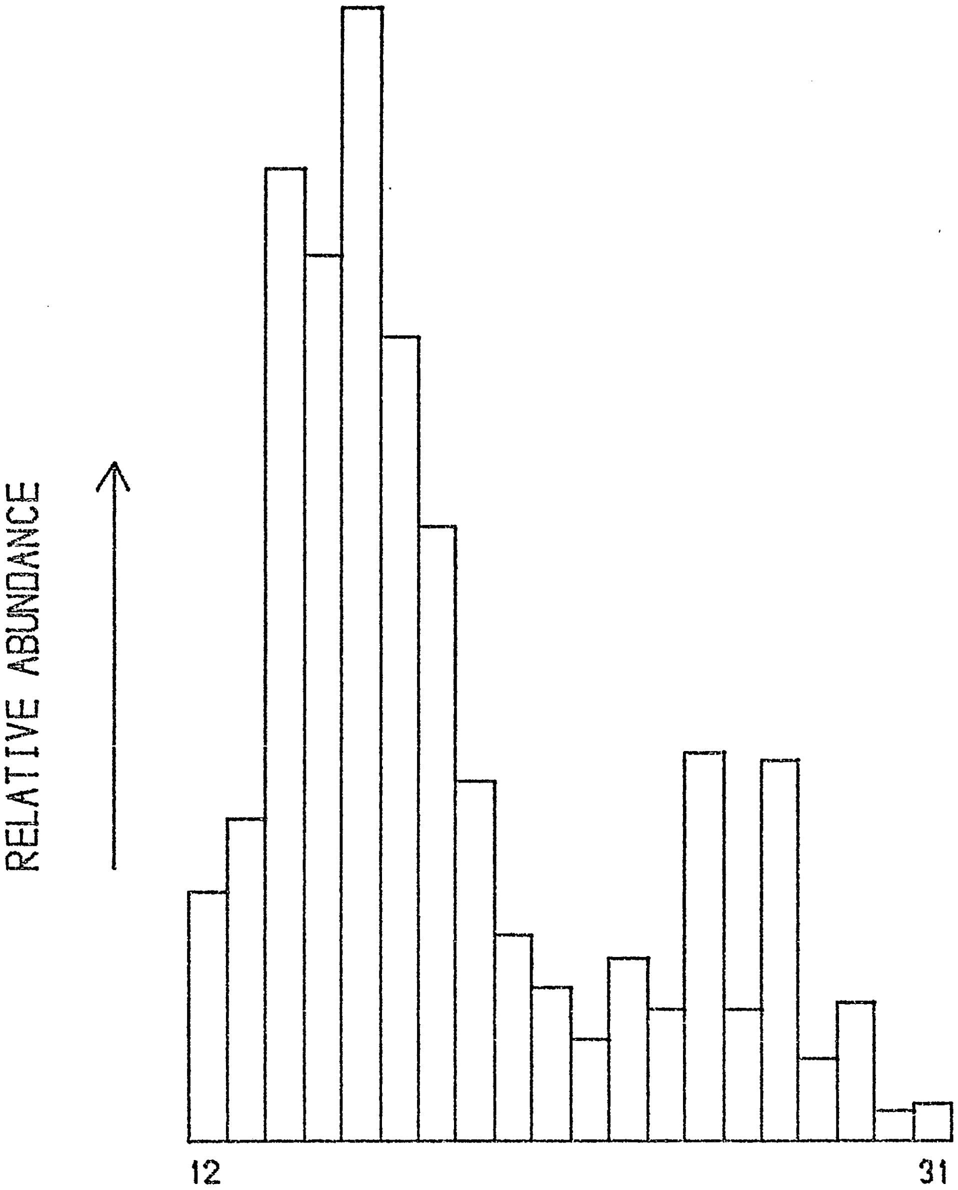
CAROLINE 1 2426m



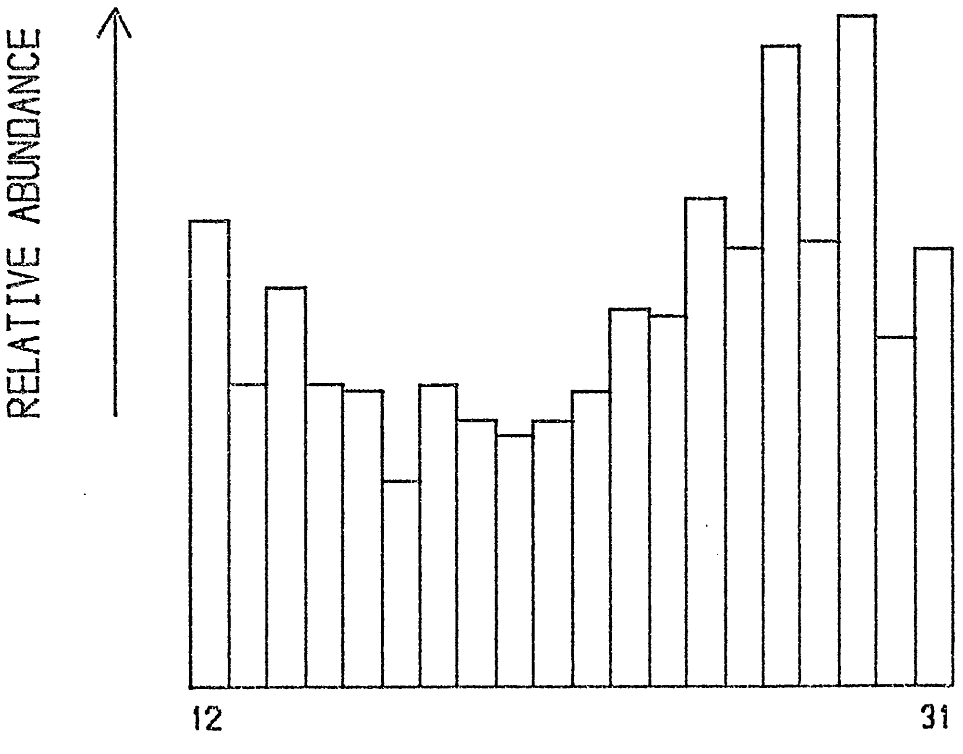
HEYWOOD 10 1613-1616m



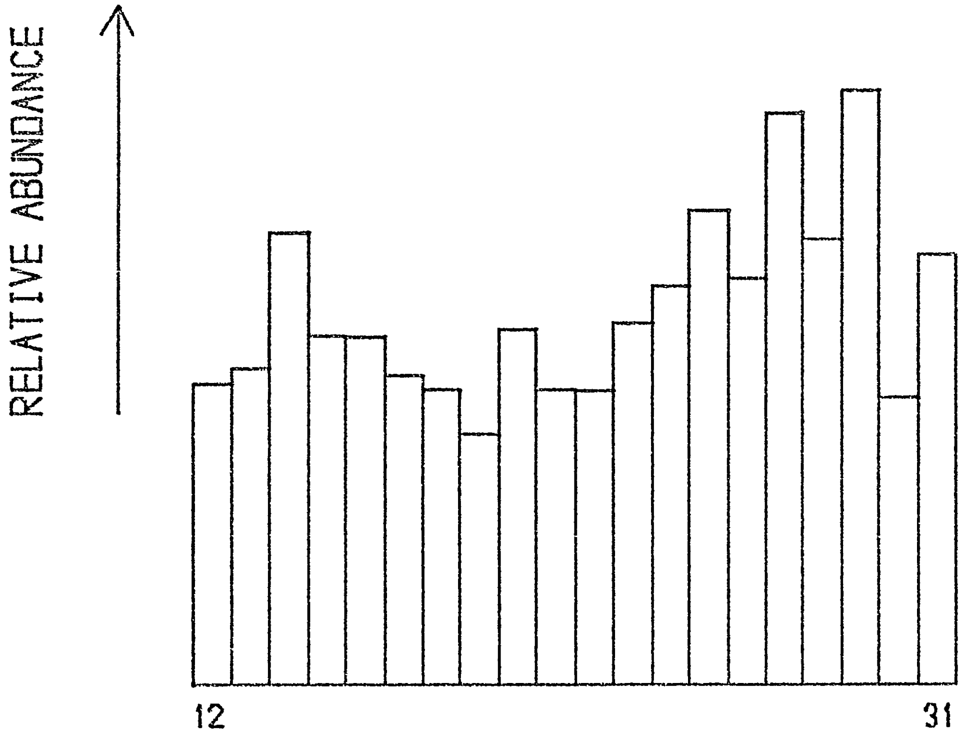
PRETTY HILL 1 732m



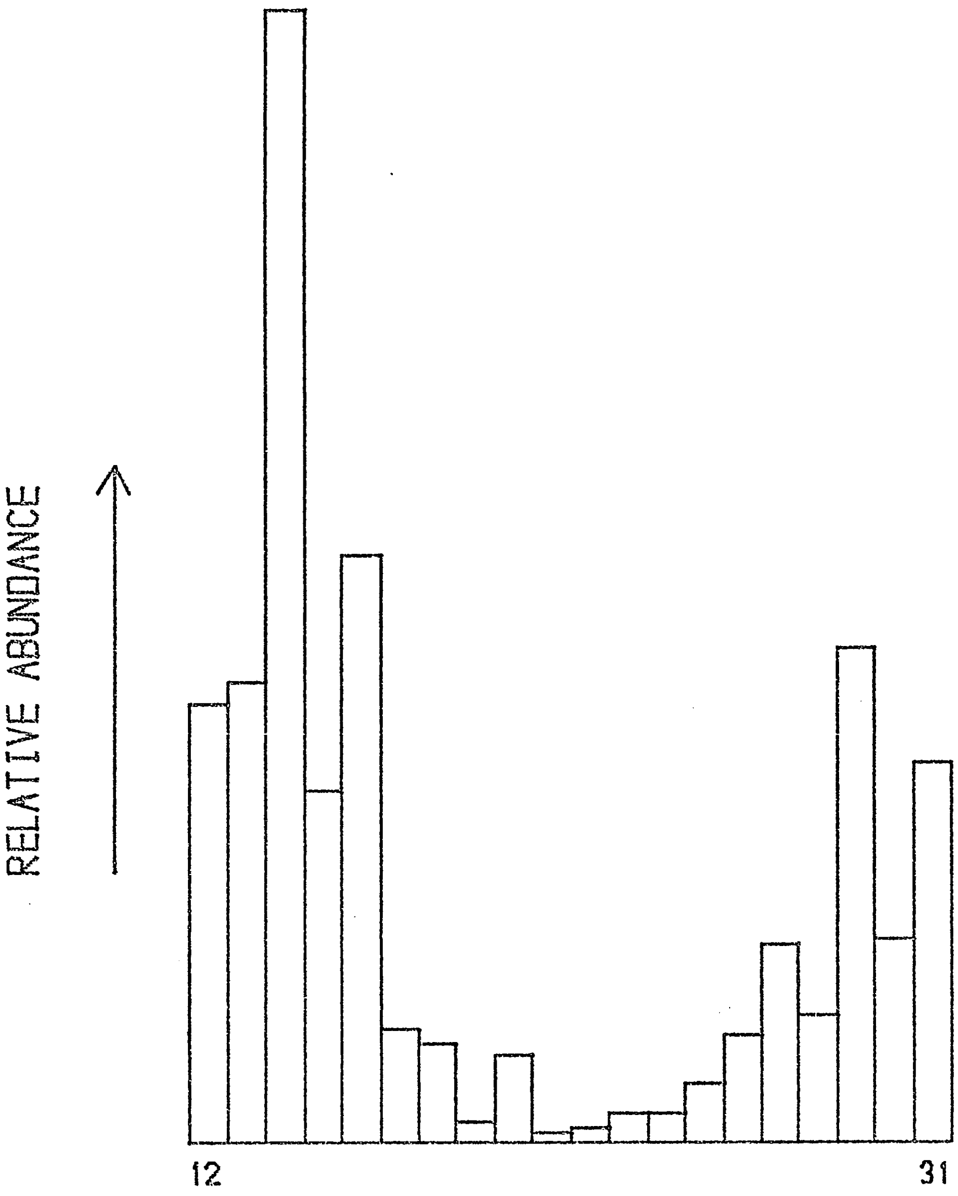
PRETTY HILL 1 2548m



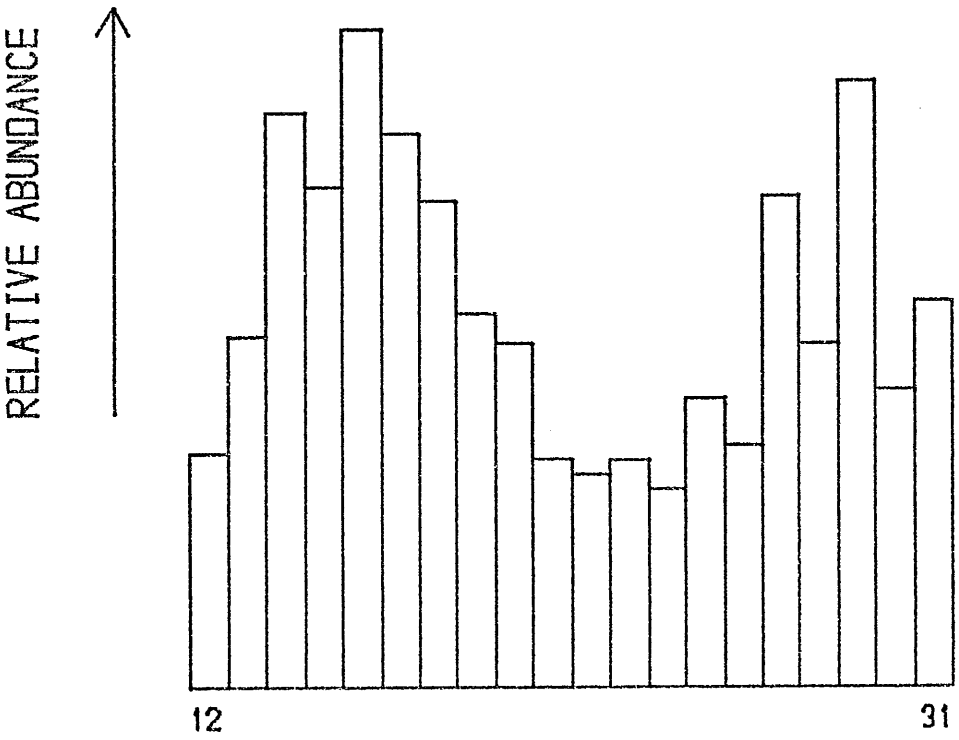
MUSSEL 1 2099m



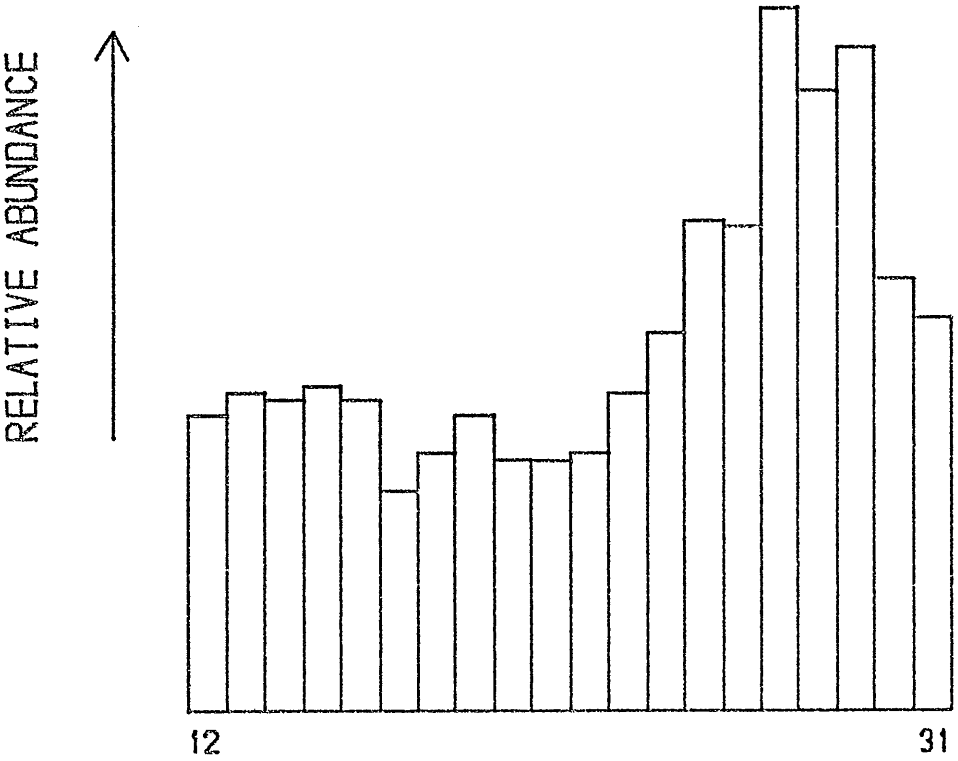
MUSSEL 1 2236m



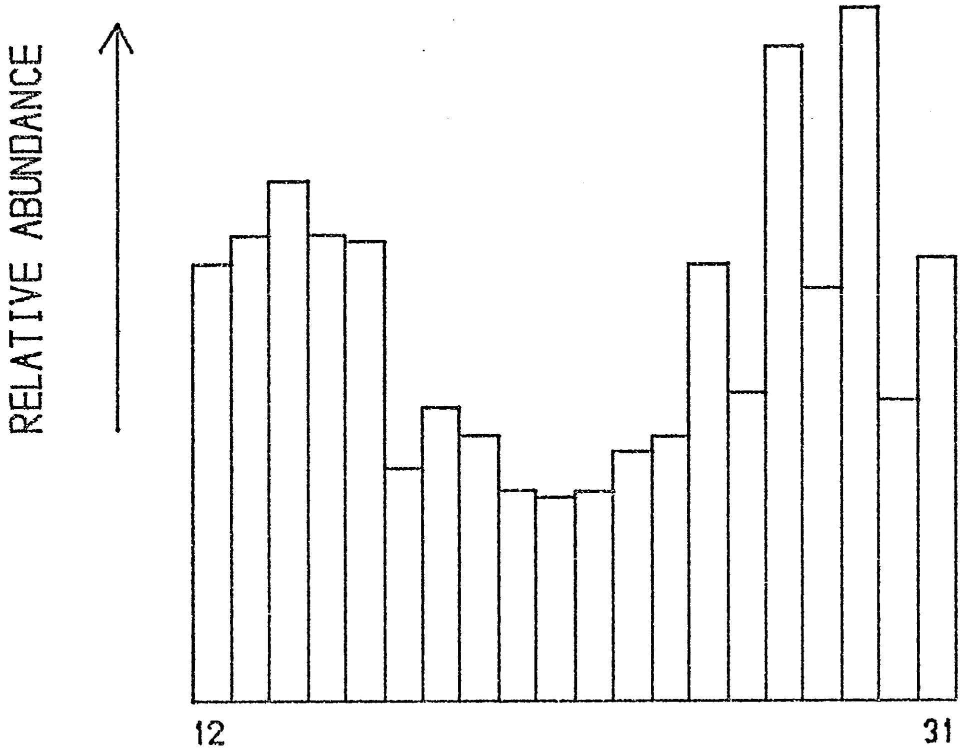
FERGUSONS HILL 1 478-479m



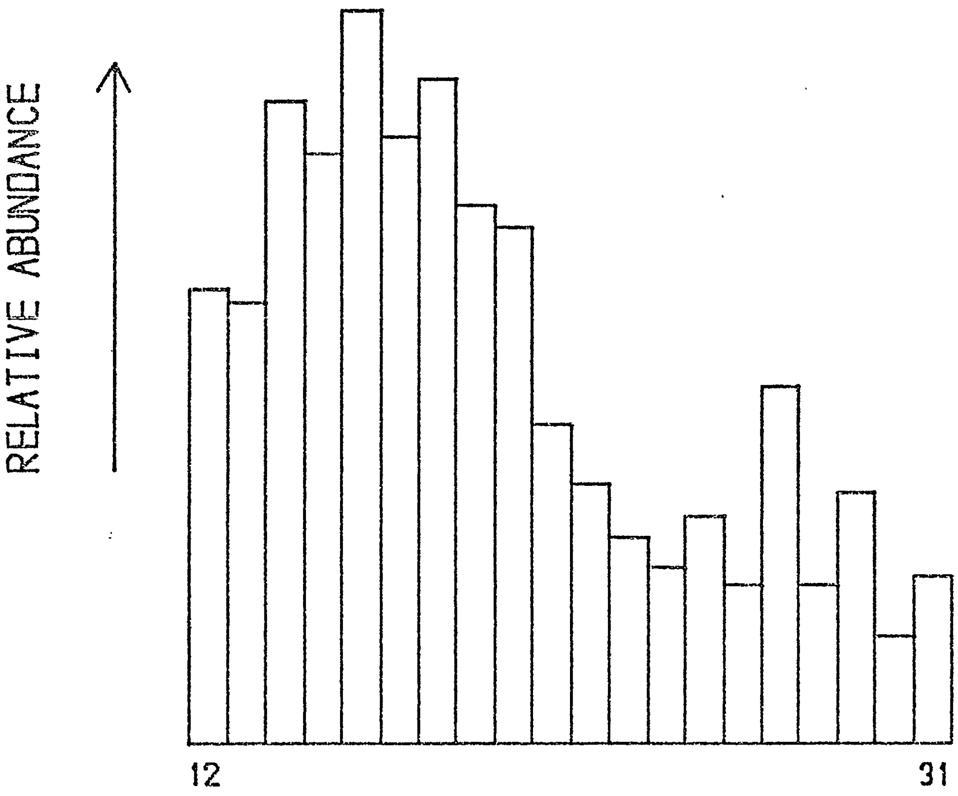
PORT CAMPBELL 2 1628m



PORT CAMPBELL 1 1307m

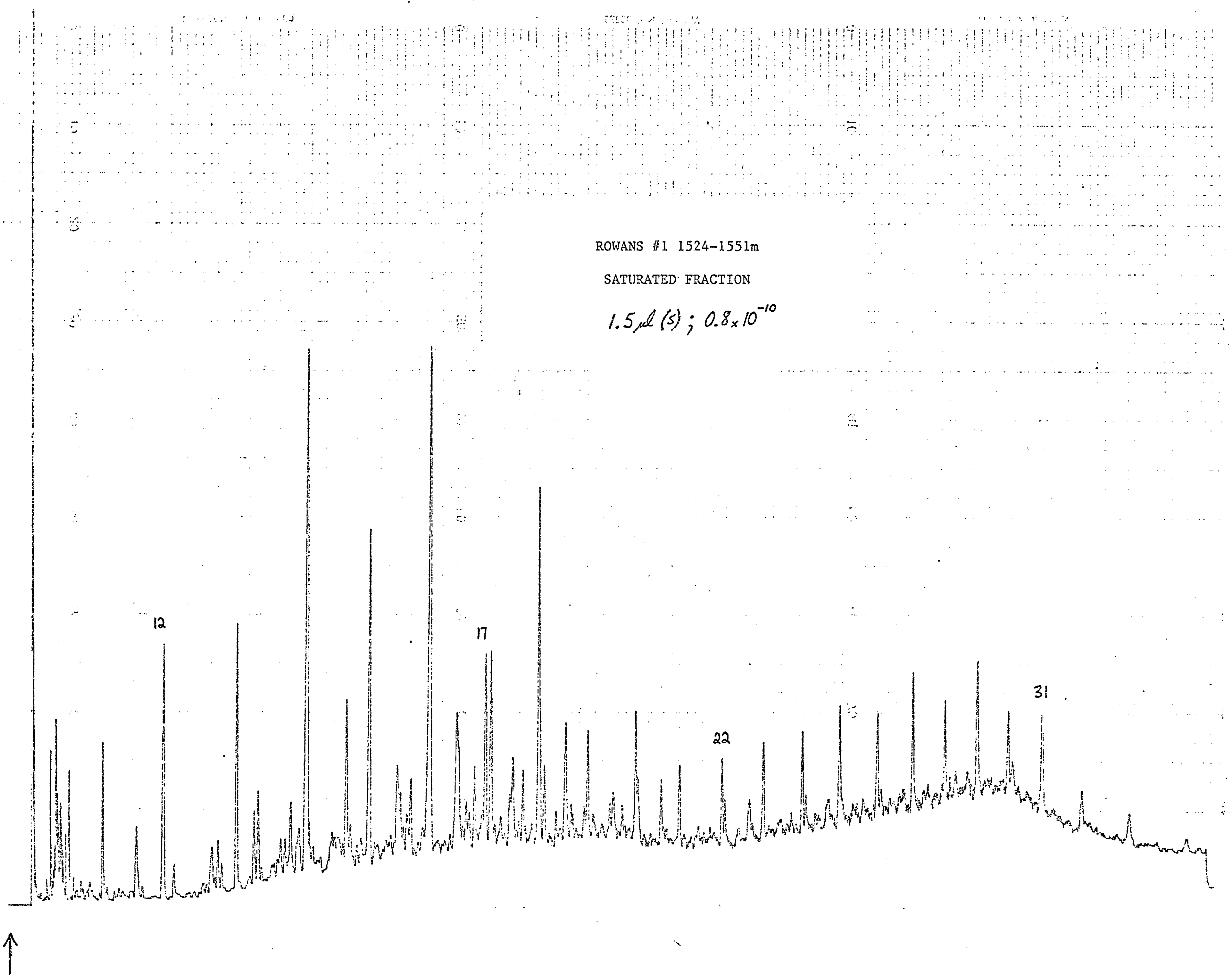


PORT CAMPBELL 1 1585m



BURRUNGULE 1 1640-1713m

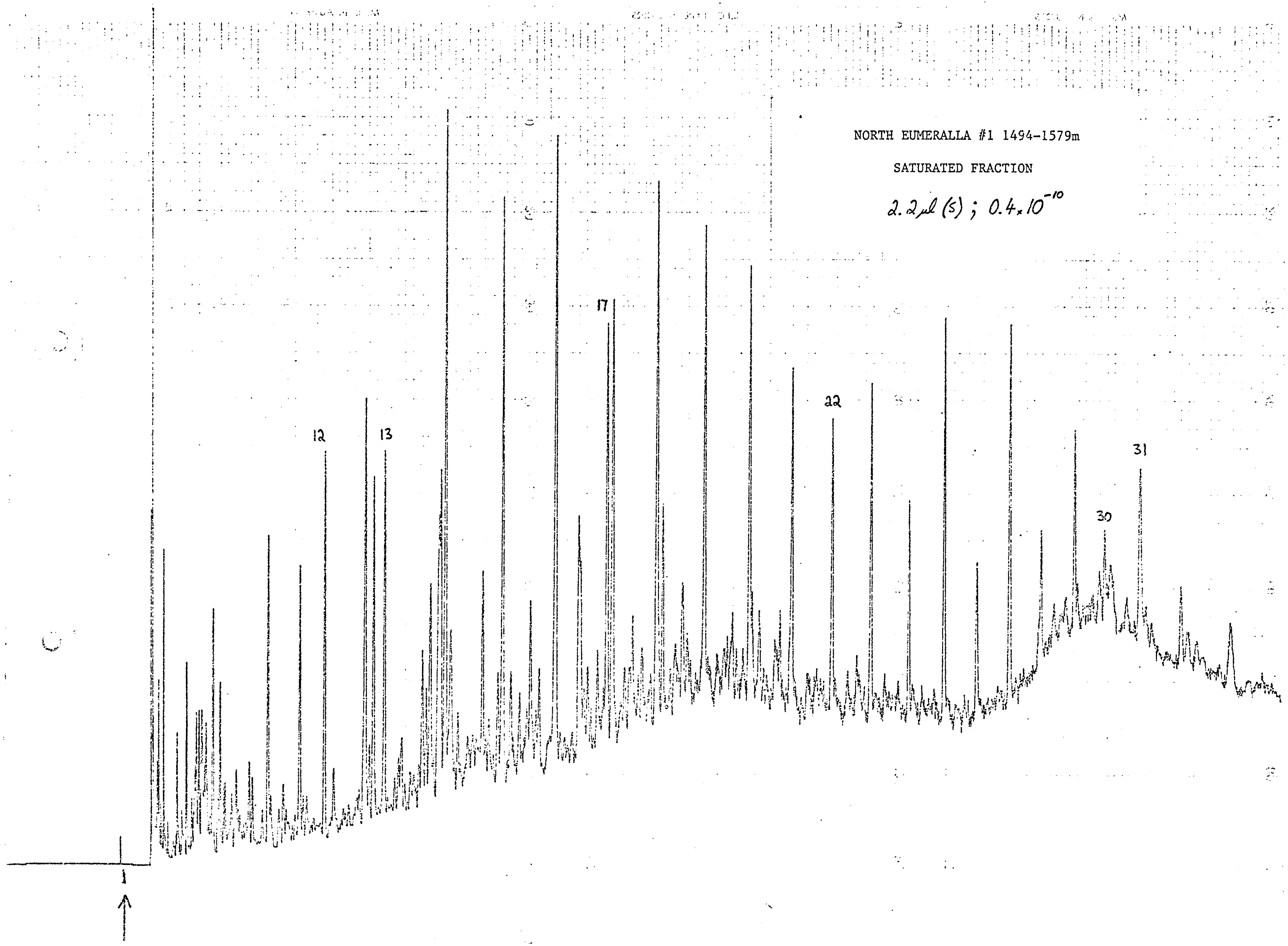
CAPILLARY GLC TRACES



ROWANS #1 1524-1551m

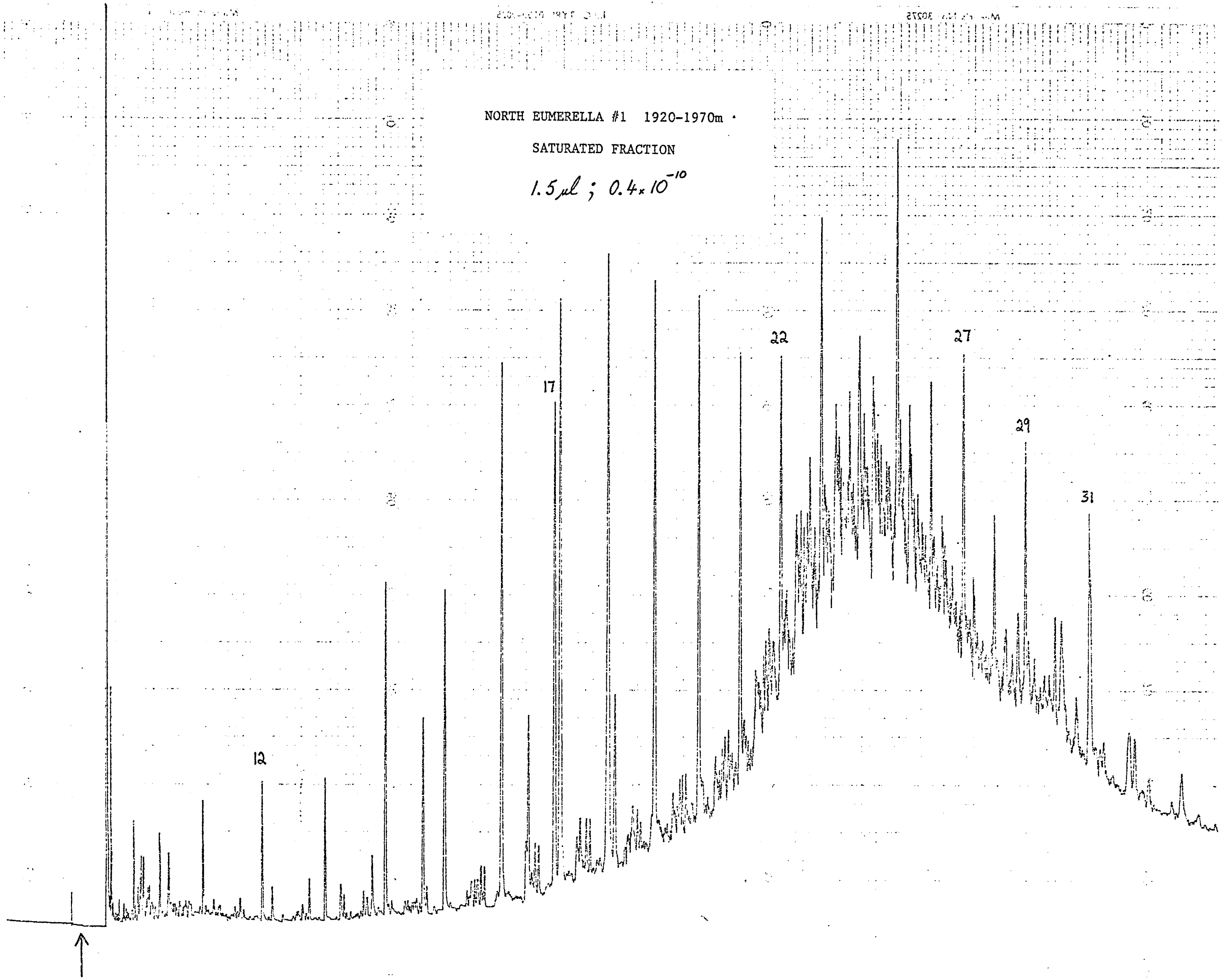
SATURATED FRACTION

1.5µl (s); 0.8x10^{-10}


NORTH EUMERALLA #1 1494-1579m

SATURATED FRACTION

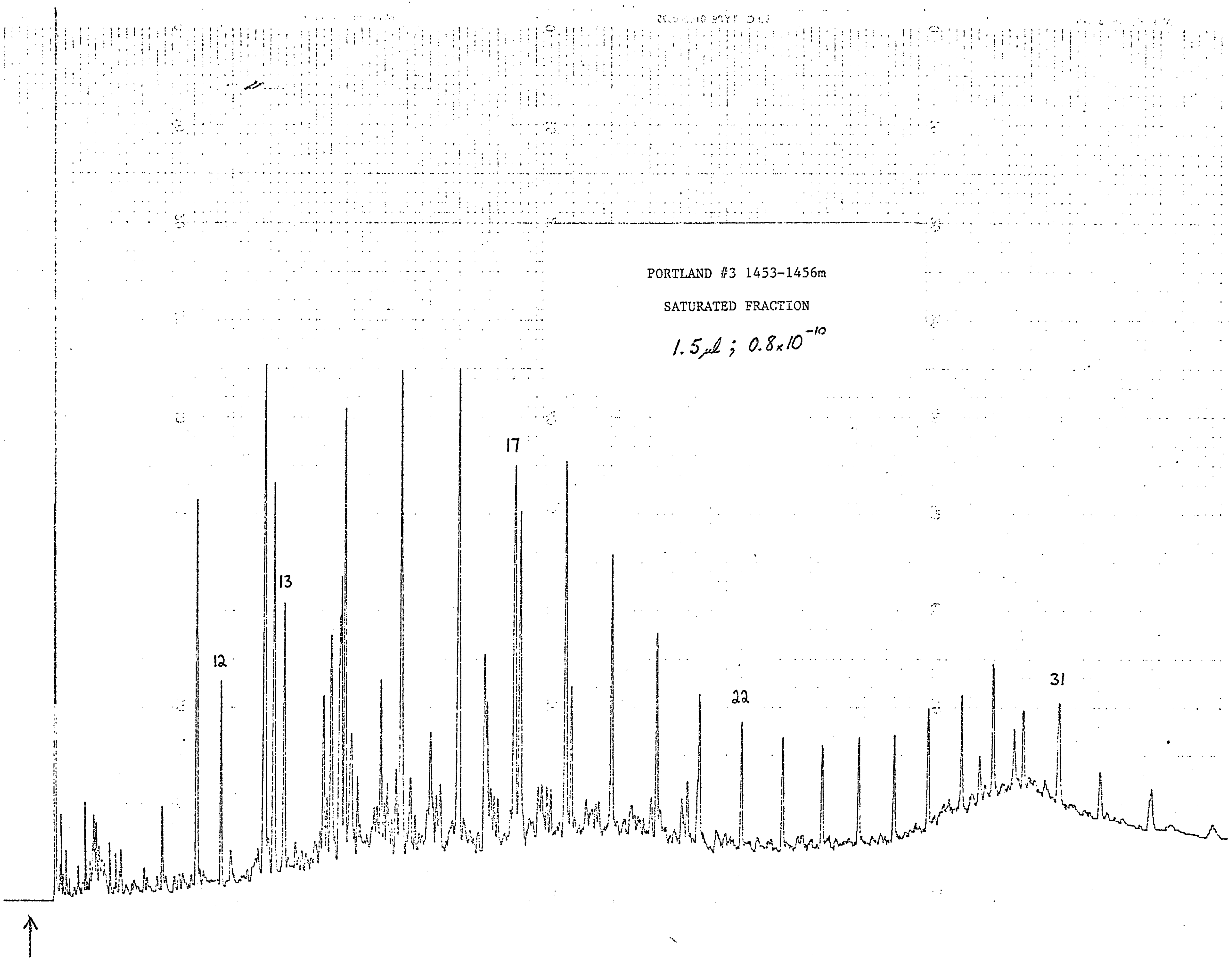
2.2µl (s) ; 0.4×10⁻¹⁰



NORTH EUMERELLA #1 1920-1970m ·

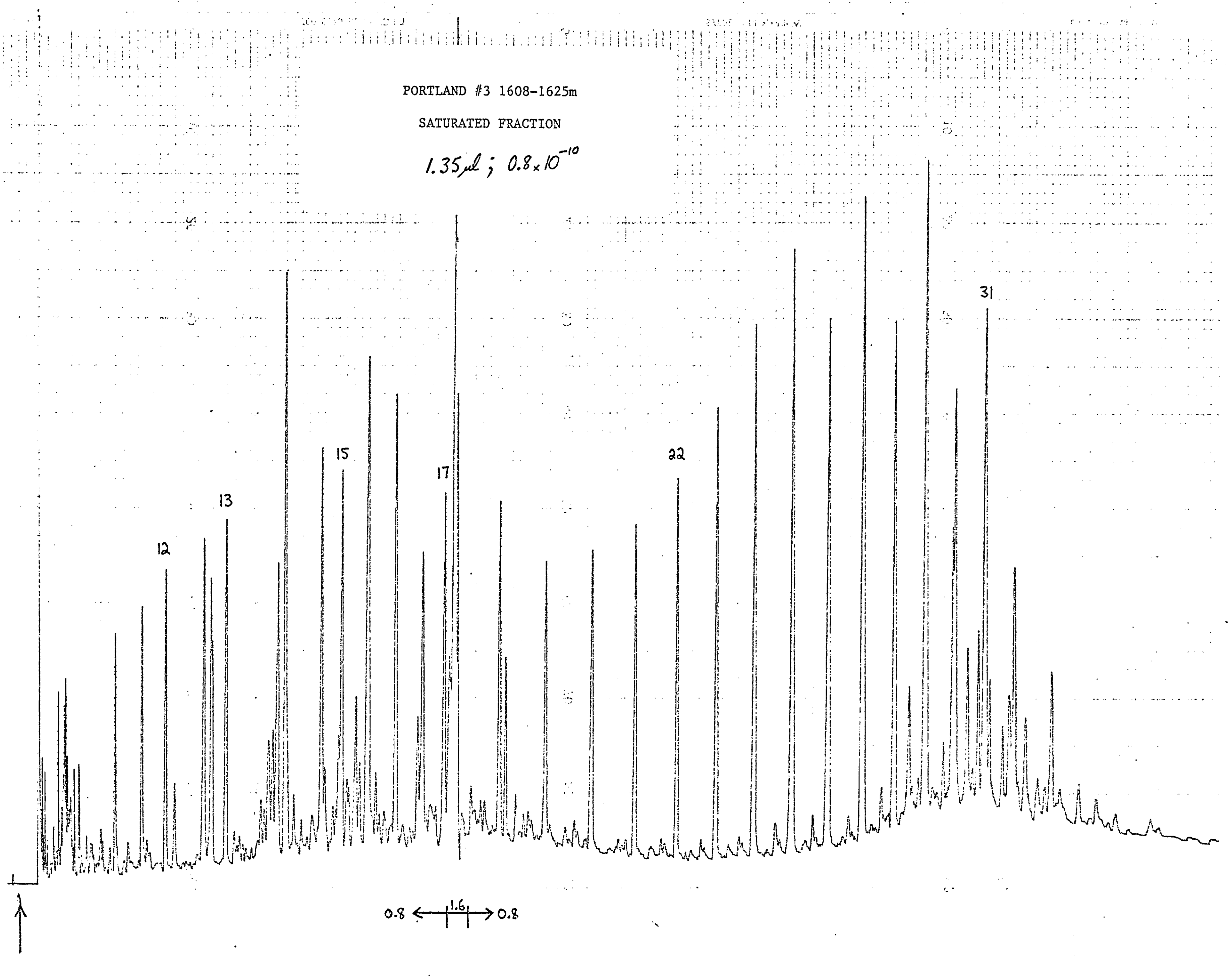
SATURATED FRACTION

1.5µl ; 0.4×10^{-10}


PORTLAND #3 1453-1456m

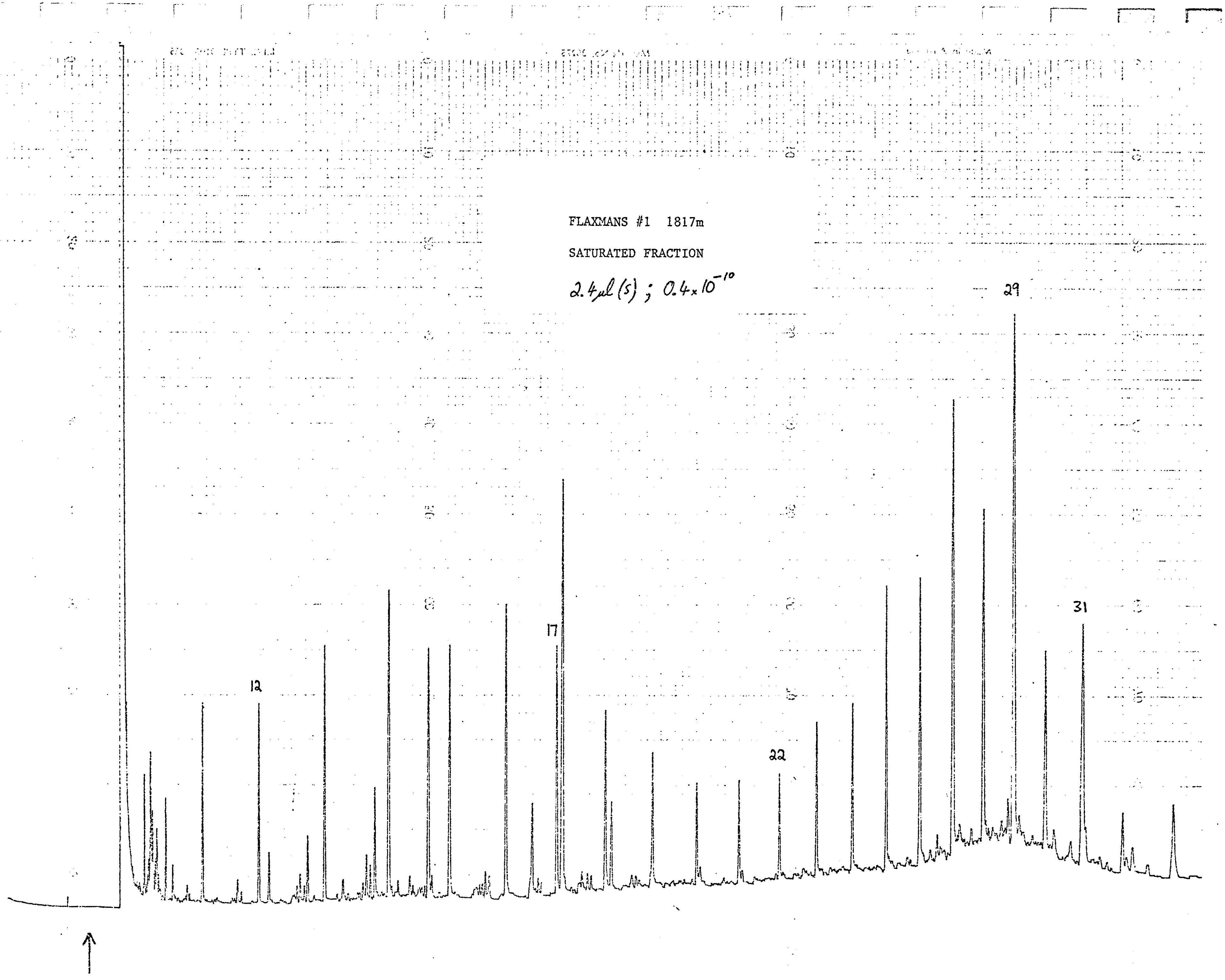
SATURATED FRACTION

1.5µl ; 0.8×10^{-10}


PORTLAND #3 1608-1625m

SATURATED FRACTION

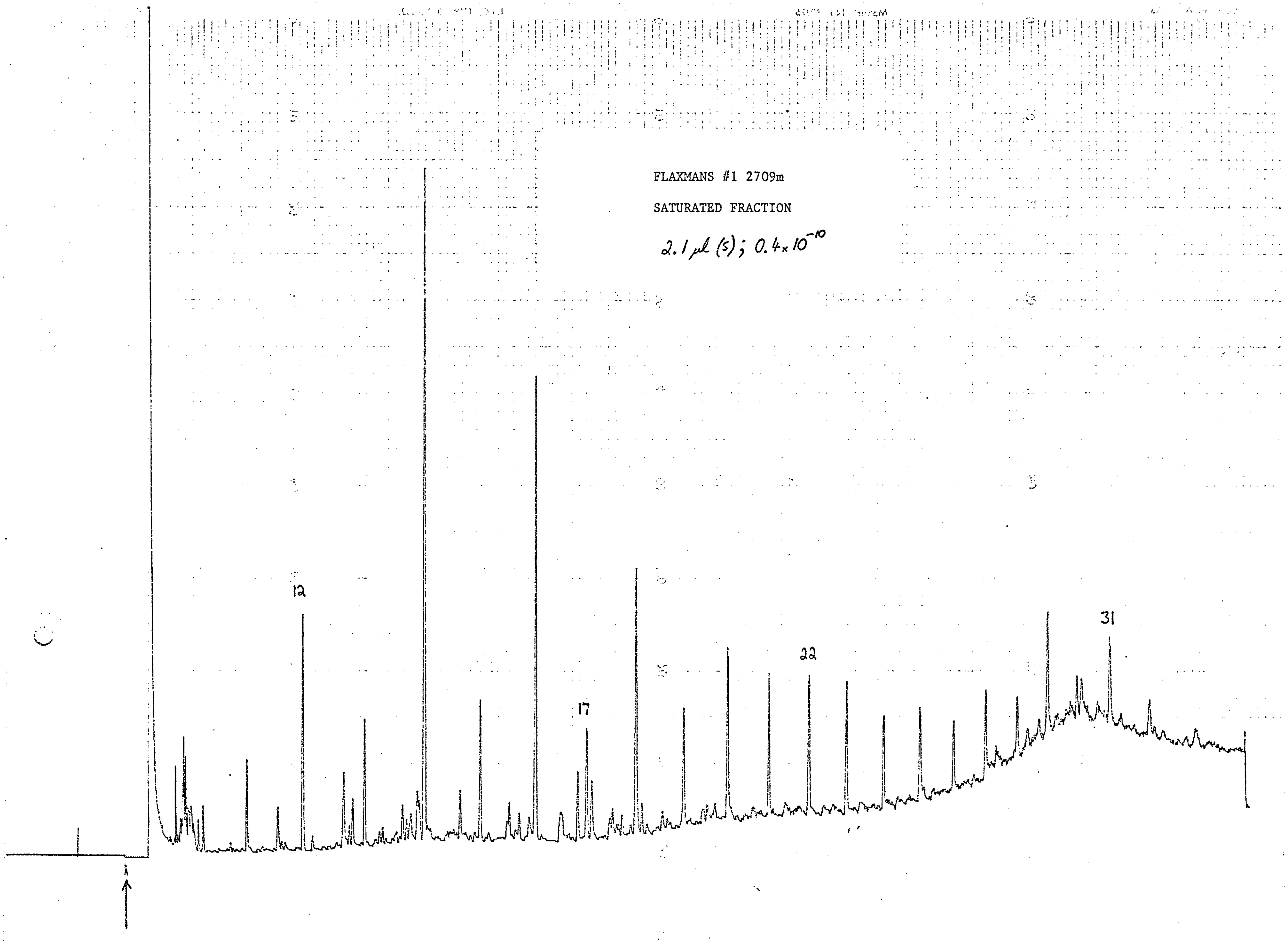
1.35μl ; 0.8×10⁻¹⁰



FLAXMANS #1 1817m

SATURATED FRACTION

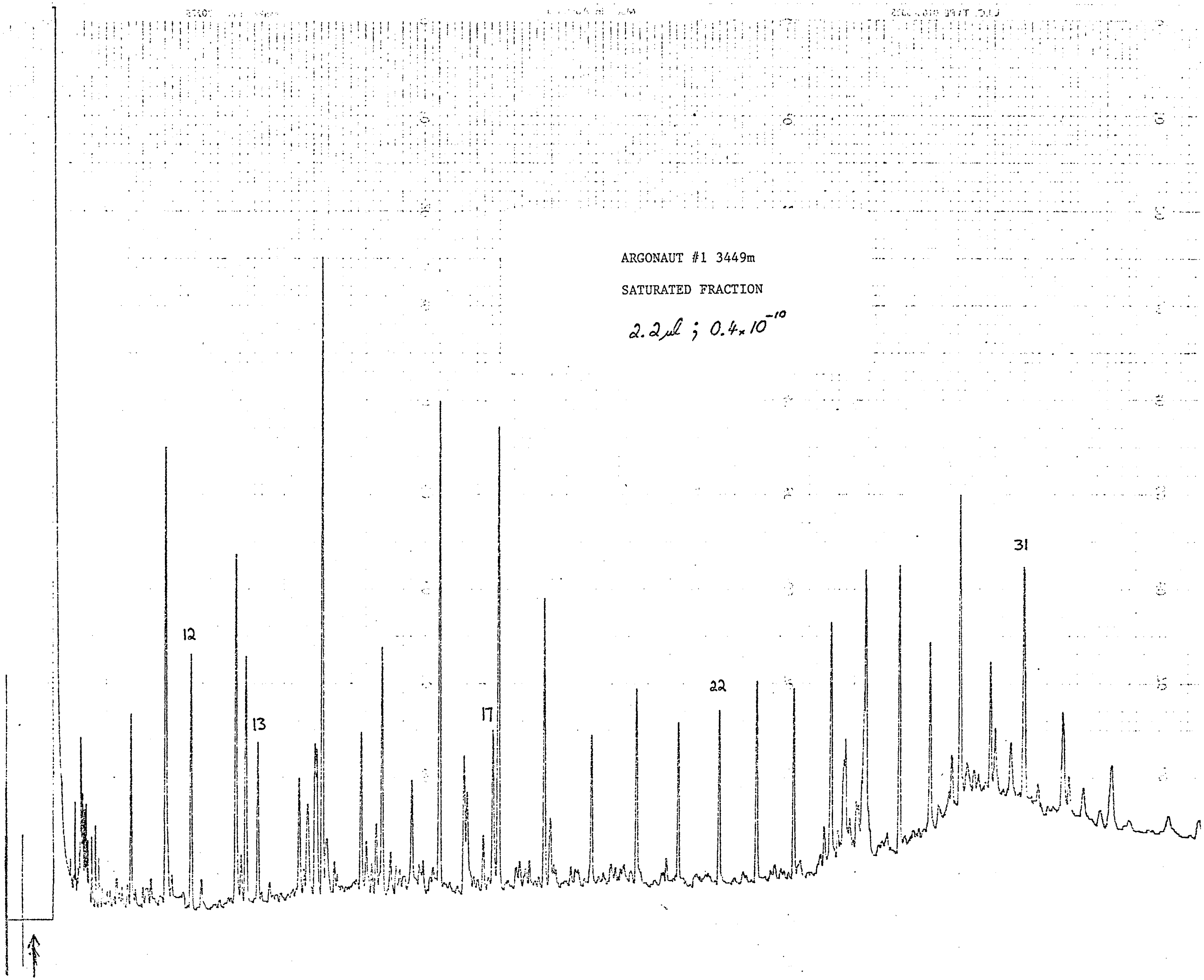
2.4μl(s) ; 0.4×10⁻¹⁰



FLAXMANS #1 2709m

SATURATED FRACTION

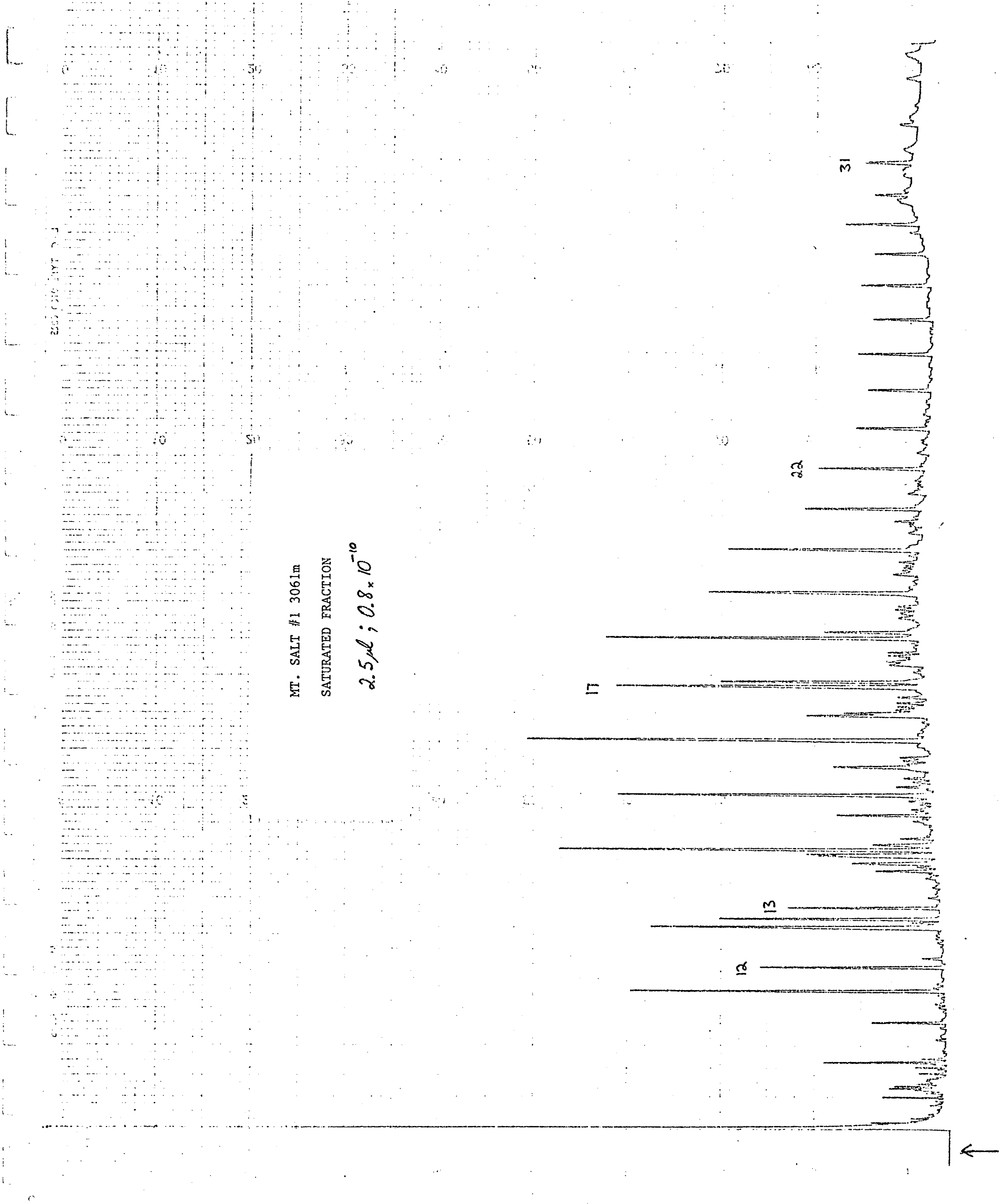
2.1 μl (s); 0.4 × 10^{-10}

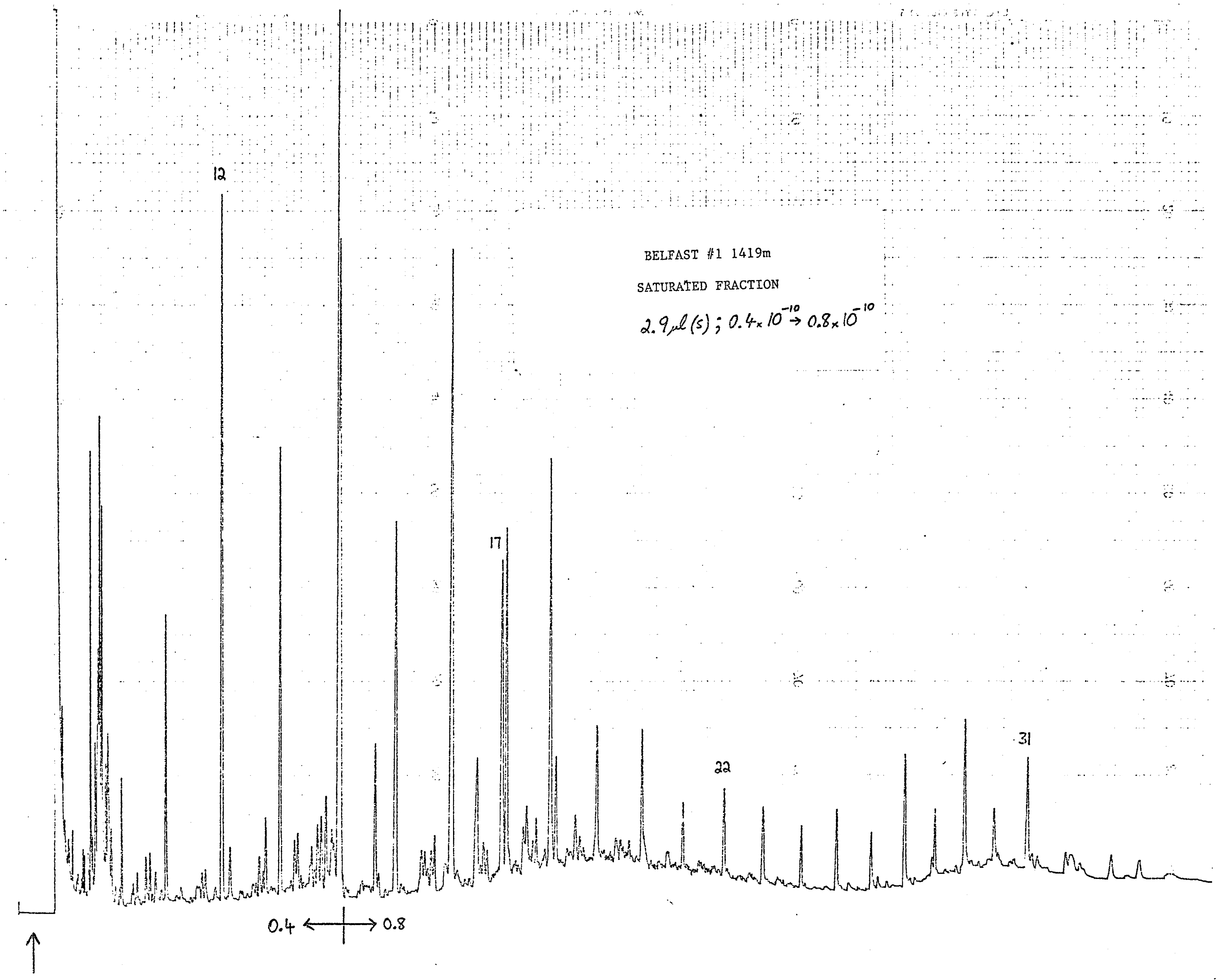


ARGONAUT #1 3449m

SATURATED FRACTION

$2.2\mu l$; 0.4×10^{-10}

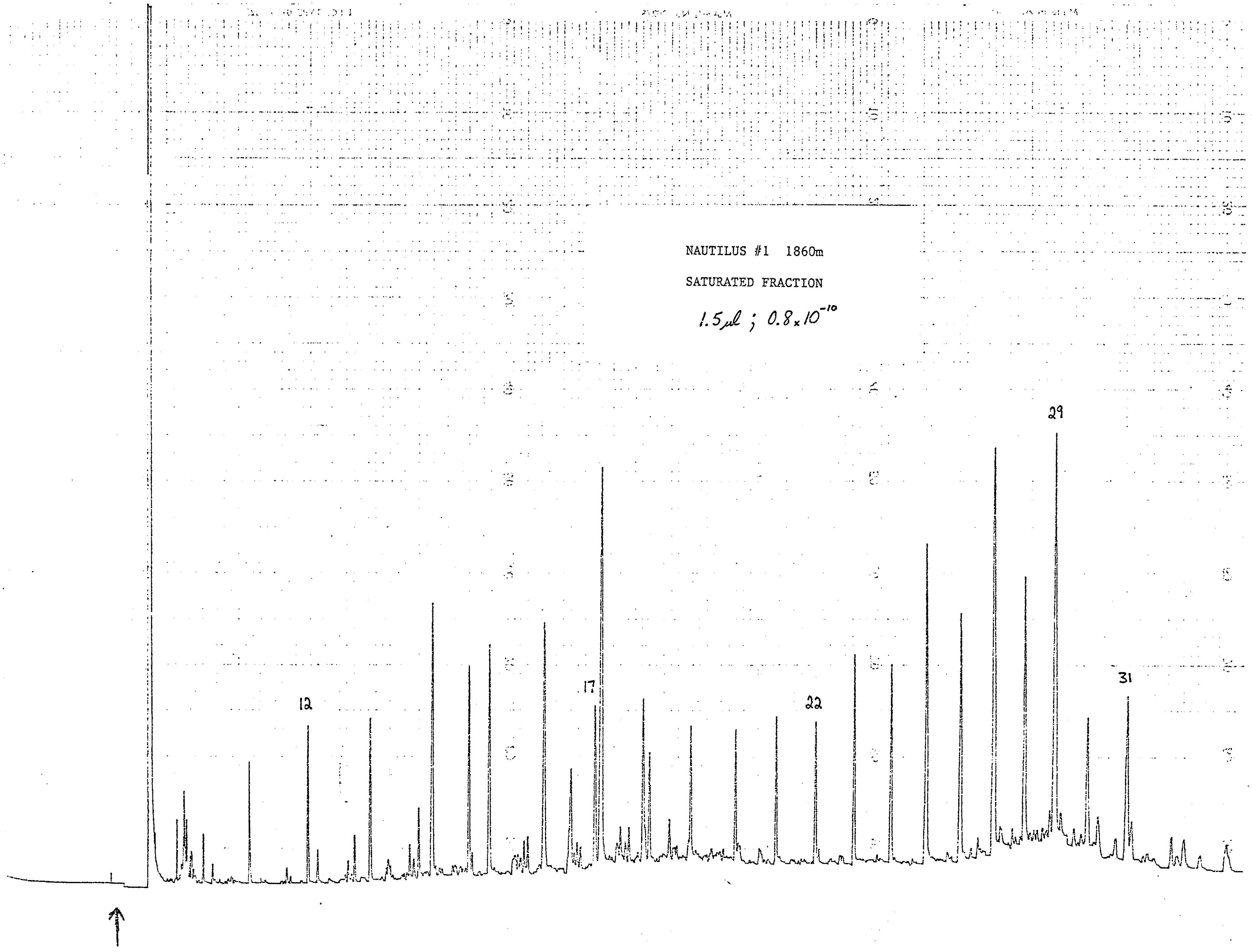

MT. SALT #1 3061m
SATURATED FRACTION
$2.5 \mu l ; 0.8 \times 10^{-10}$



BELFAST #1 1419m

SATURATED FRACTION

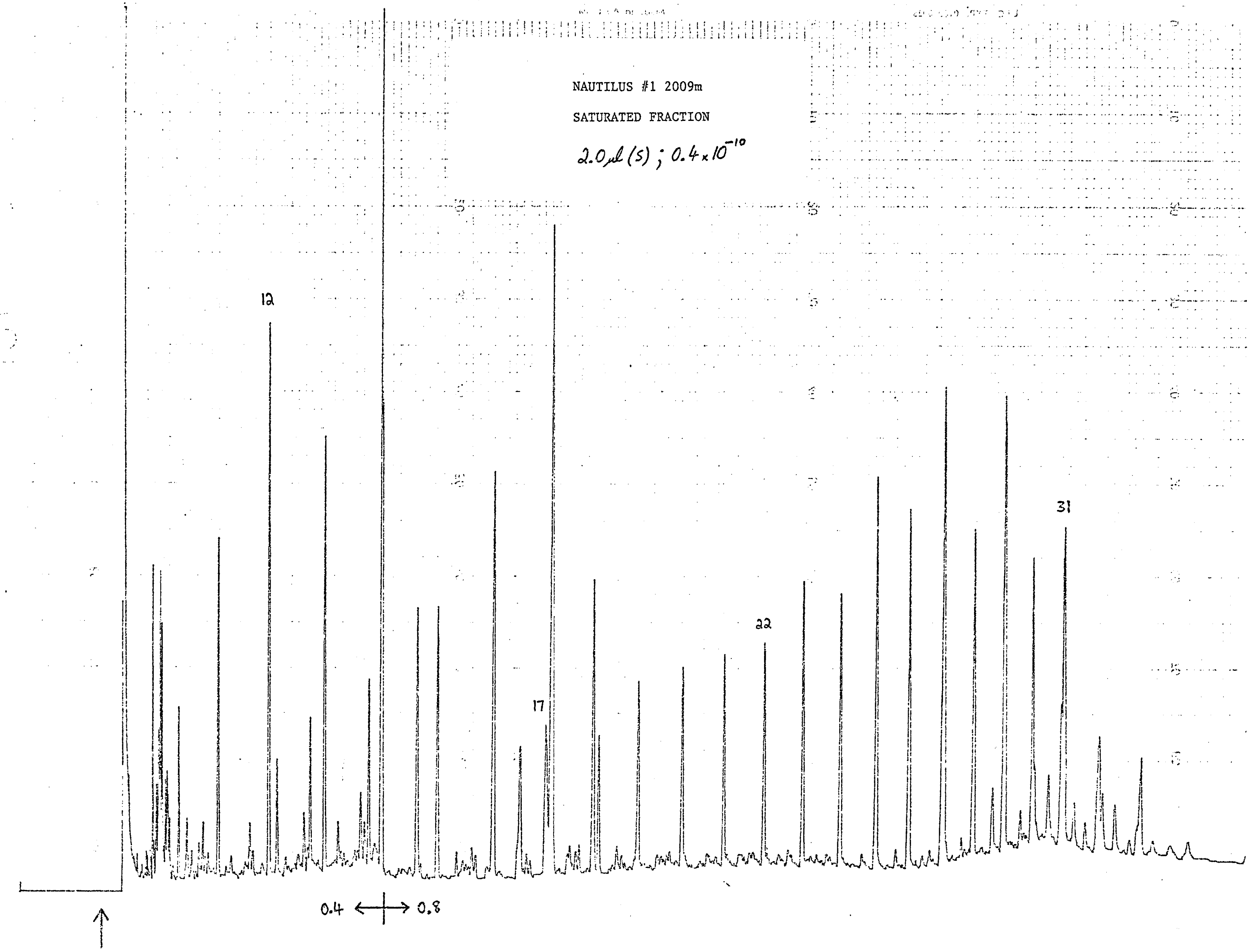
$2.9 \mu l (s) ; 0.4 \times 10^{-10} \rightarrow 0.8 \times 10^{-10}$



NAUTILUS #1 1860m

SATURATED FRACTION

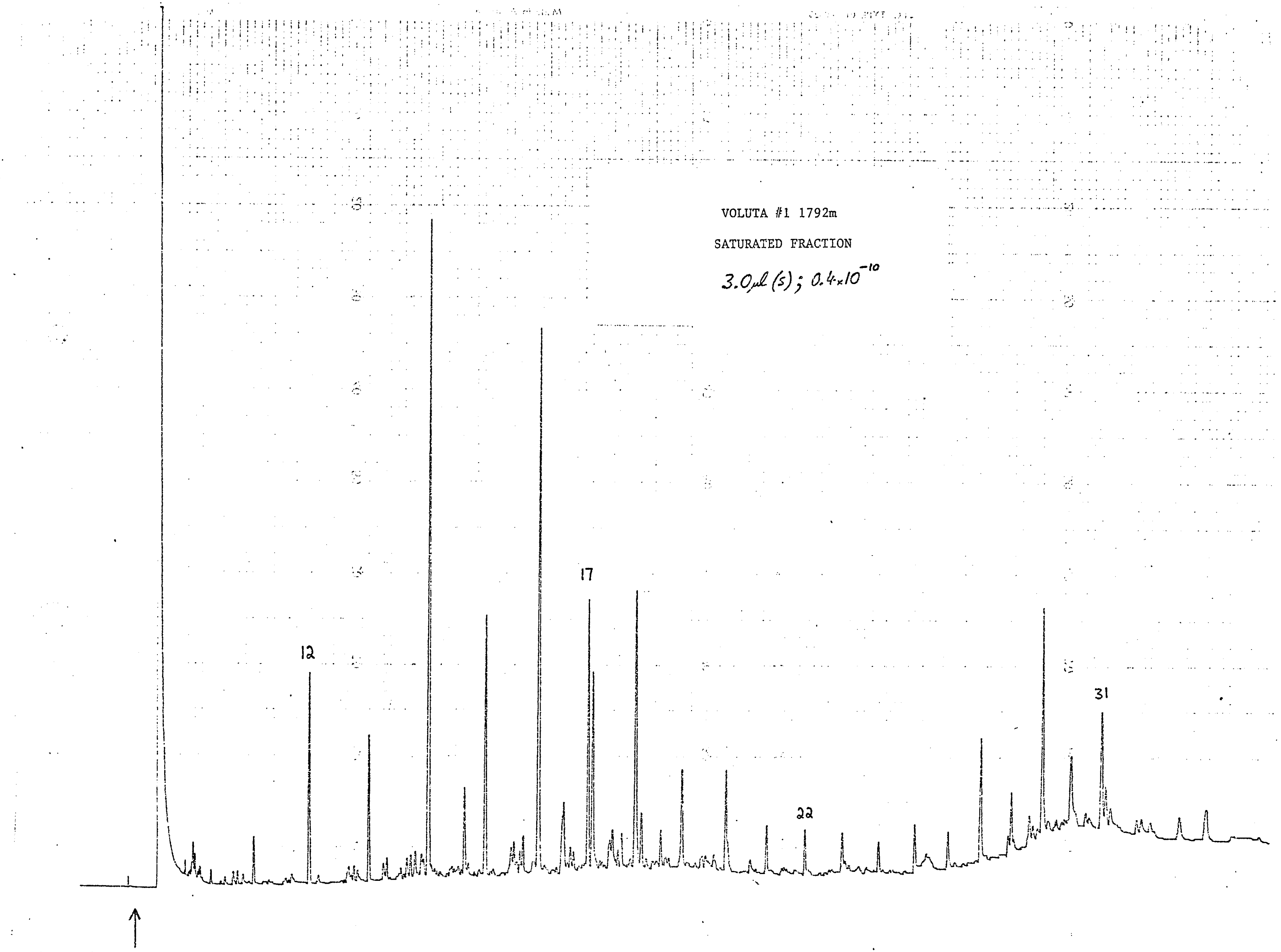
1.5µl ; 0.8×10⁻¹⁰



NAUTILUS #1 2009m

SATURATED FRACTION

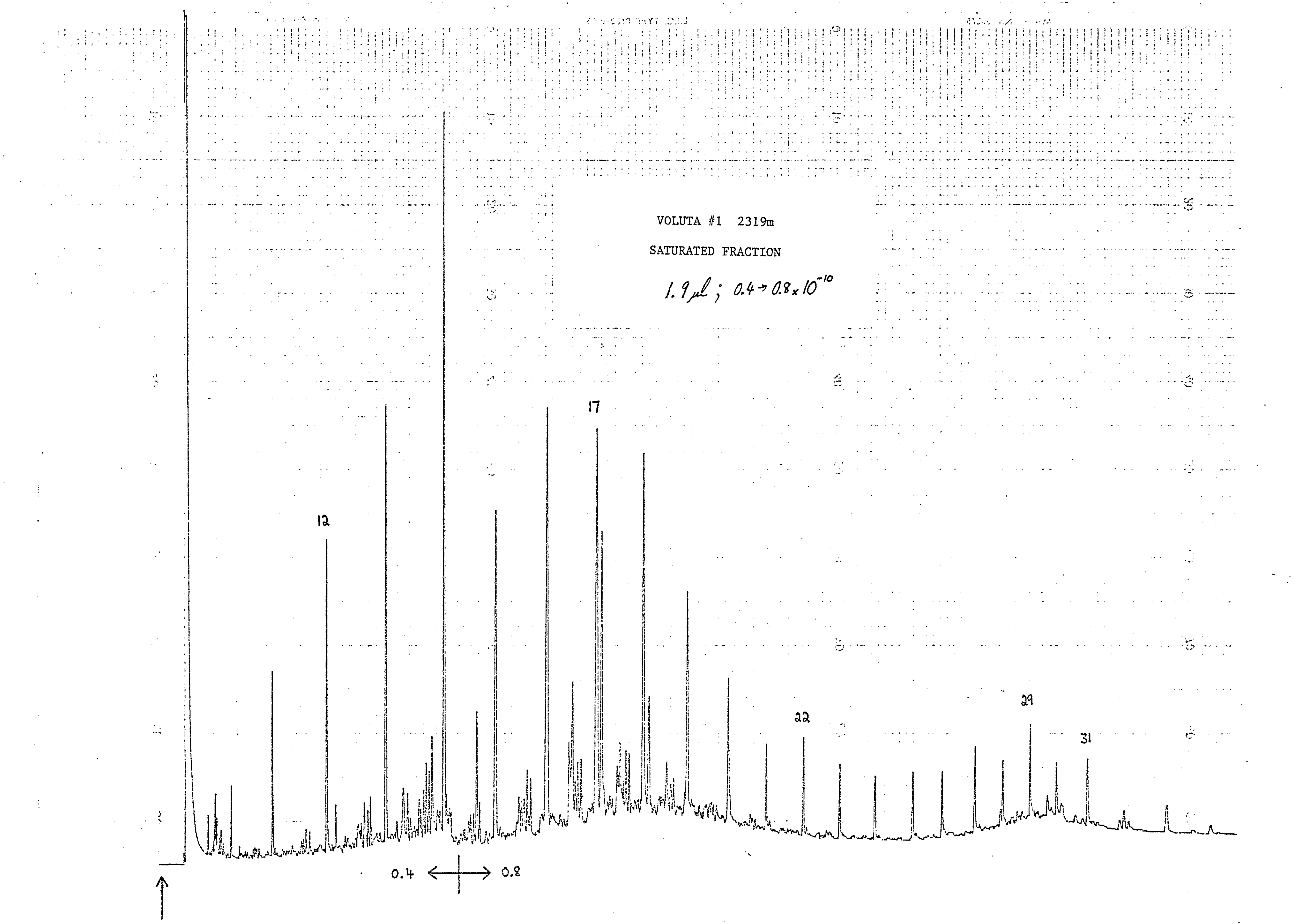
2.0μl (s) ; 0.4×10⁻¹⁰



VOLUTA #1 1792m

SATURATED FRACTION

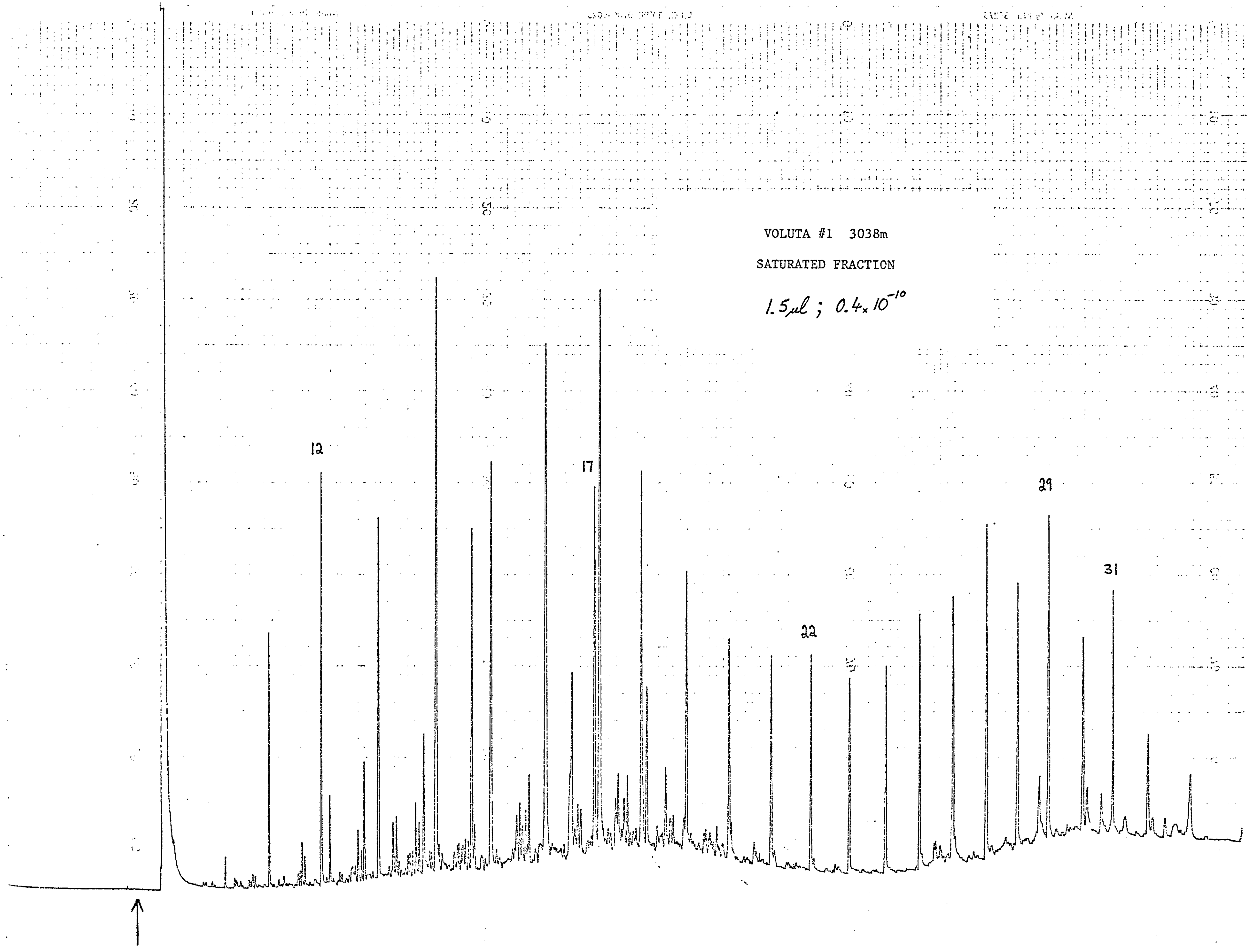
$3.0 \mu l (s); 0.4 \times 10^{-10}$



VOLUTA #1 2319m

SATURATED FRACTION

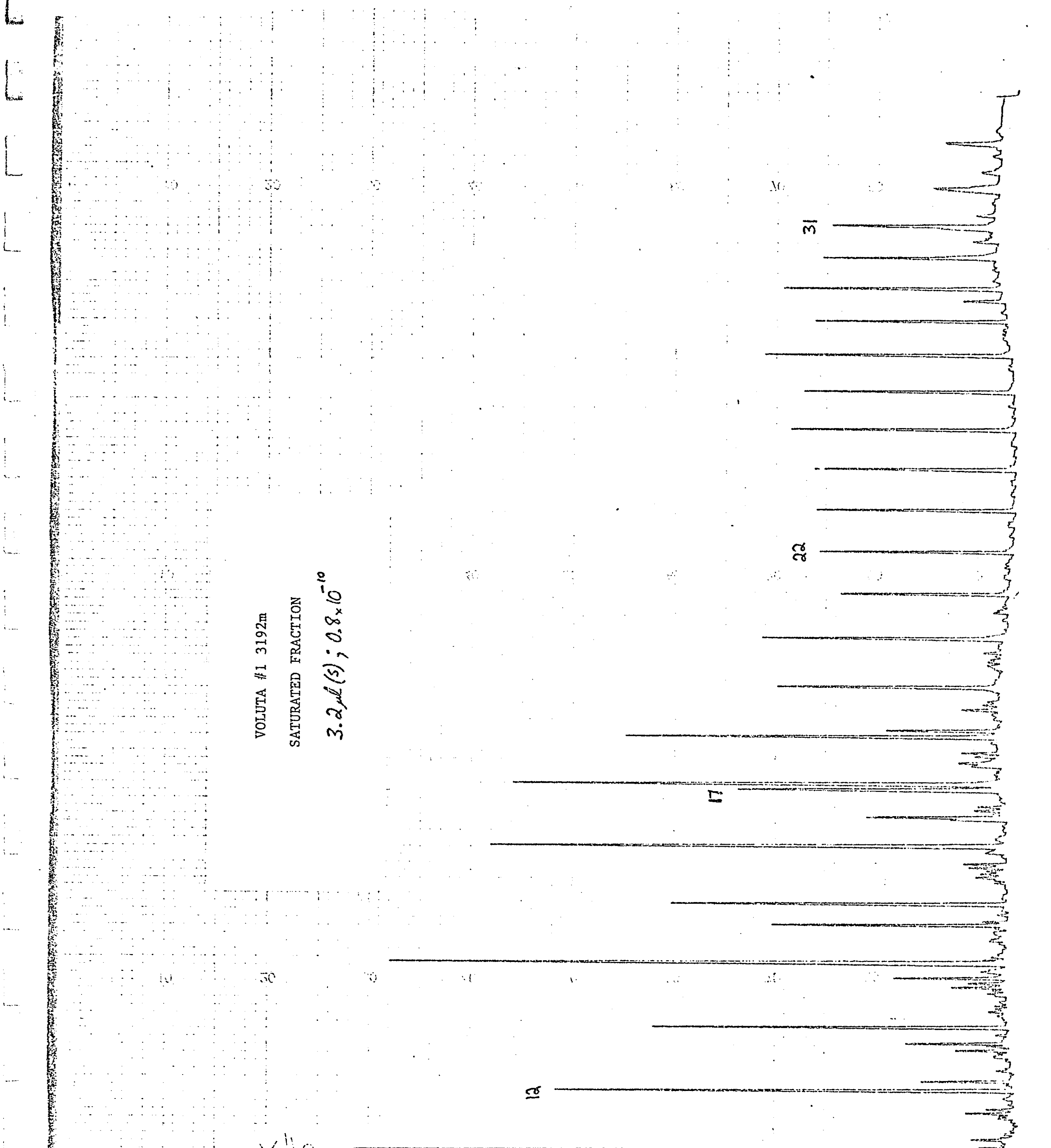
1.9μl; 0.4→0.8×10^{-10}



VOLUTA #1 3038m

SATURATED FRACTION

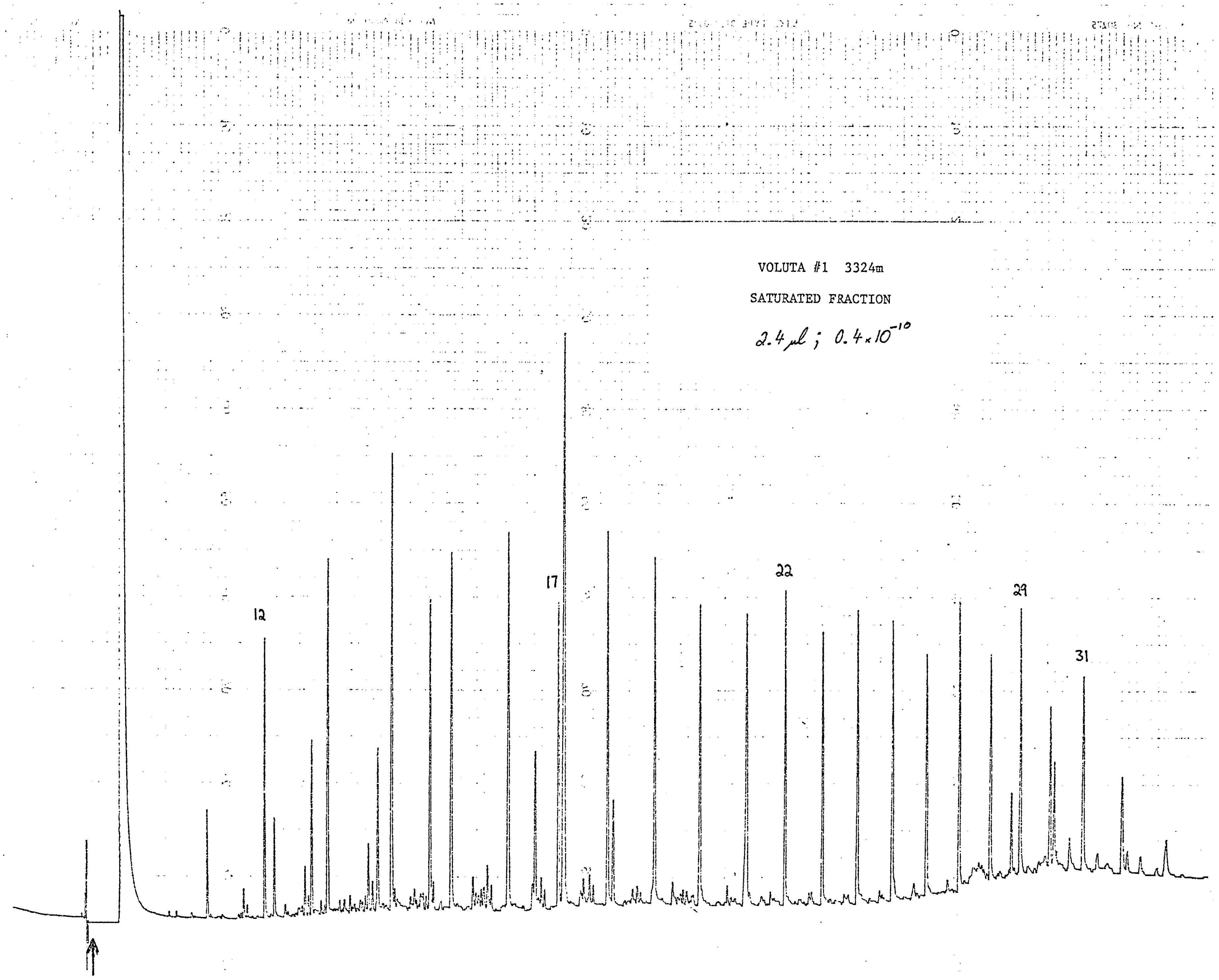
1.5μl ; 0.4×10^{-10}



VOLUTA #1 3192m

SATURATED FRACTION

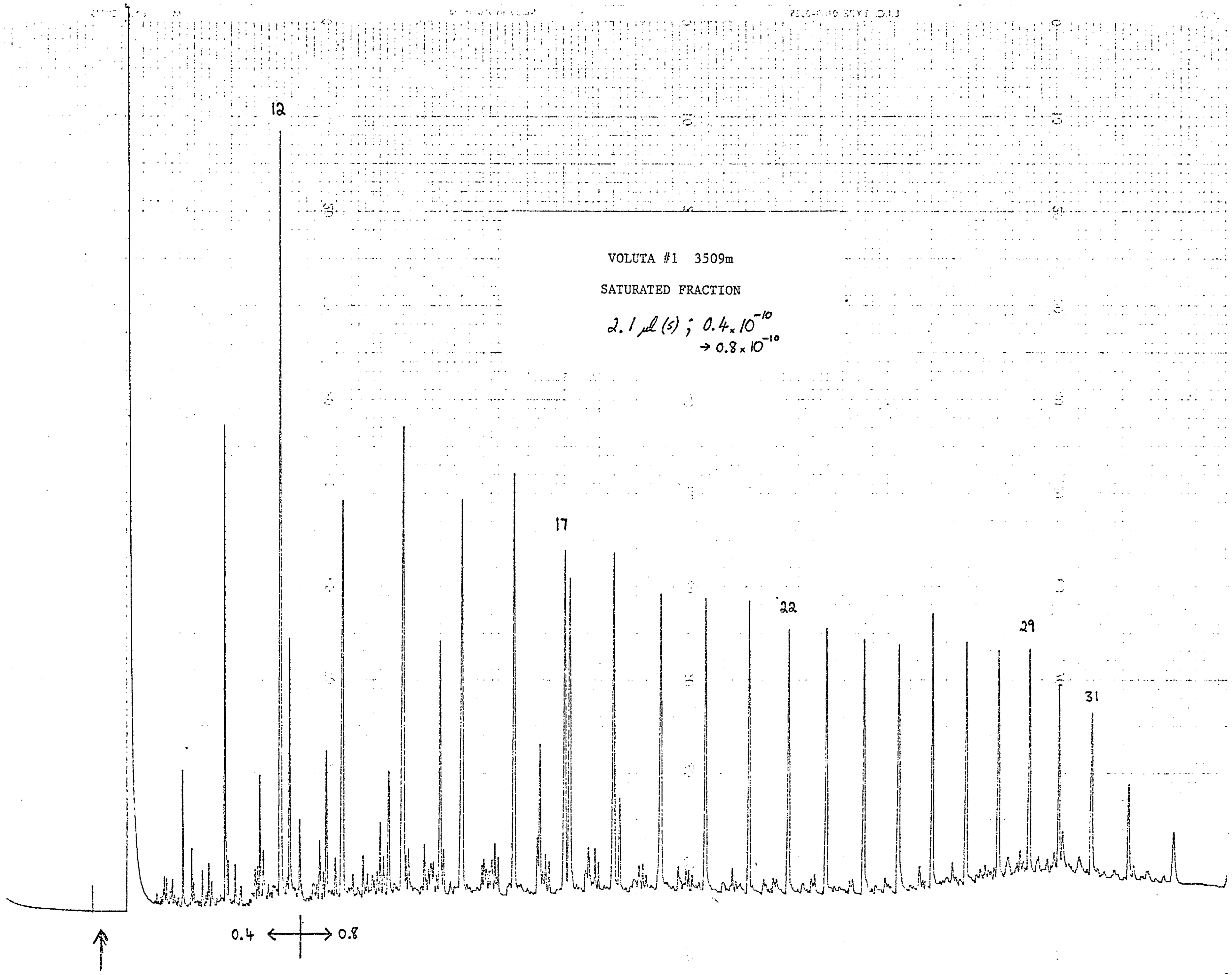
$3.2\mu l(S); 0.8\times10^{-10}$



VOLUTA #1 3324m

SATURATED FRACTION

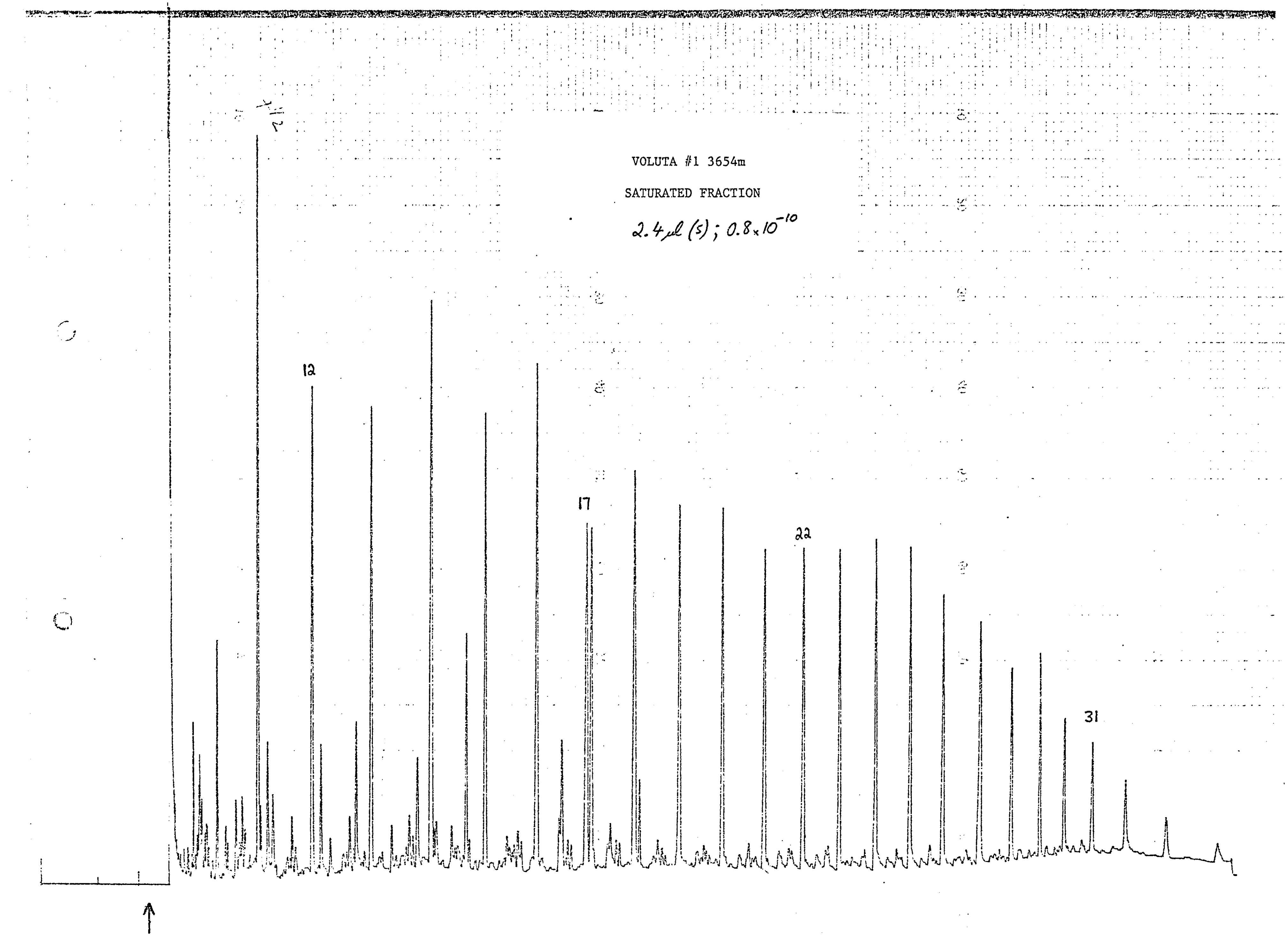
2.4 μl ; 0.4×10^{-10}



VOLUTA #1 3509m

SATURATED FRACTION

$2.1\,\mu l\,(s)\,;\ 0.4 \times 10^{-10} \rightarrow 0.8 \times 10^{-10}$



VOLUTA #1 3654m

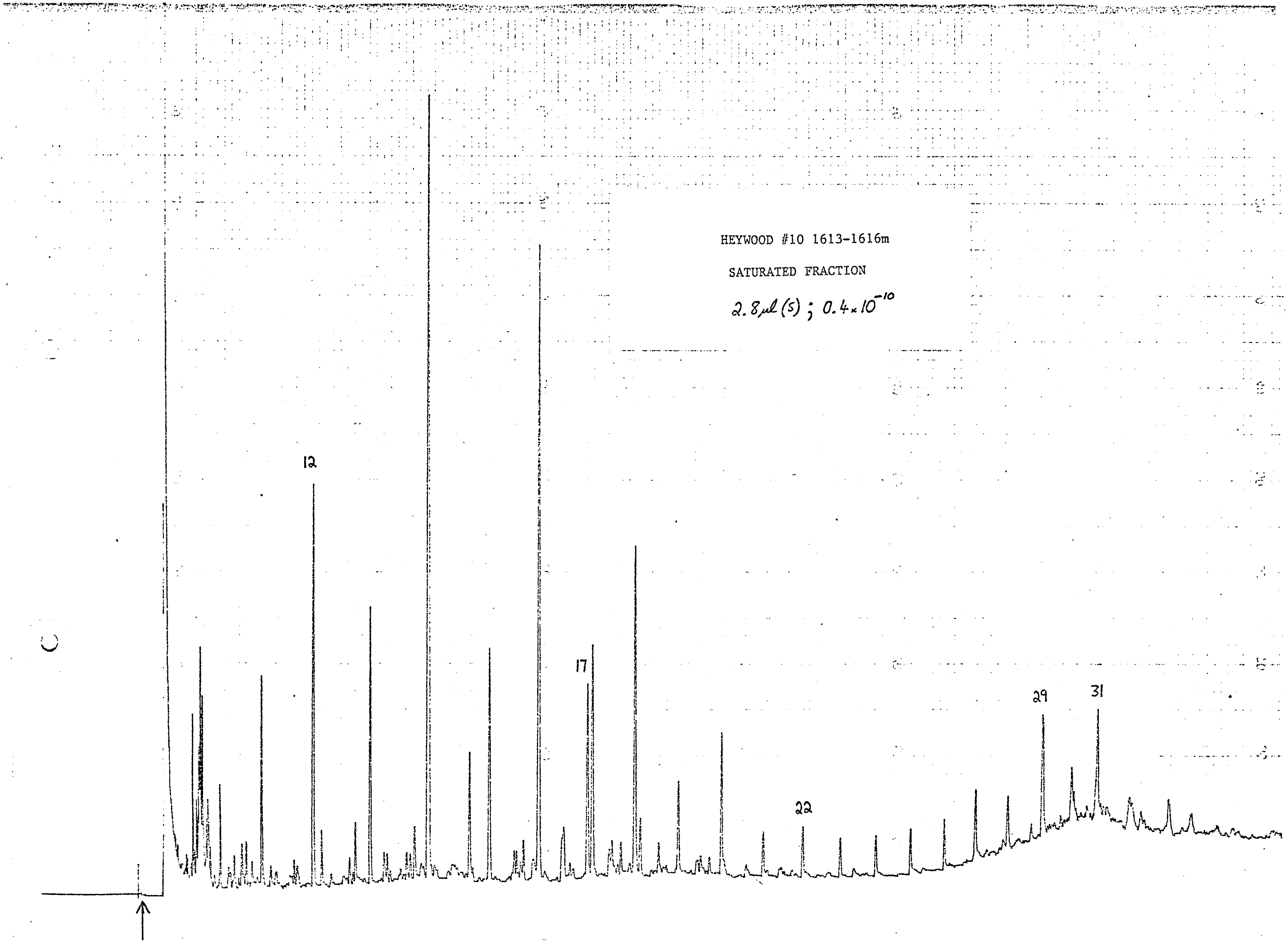
SATURATED FRACTION

2.4μl (s); 0.8×10^{-10}


CAROLINE #1 2426m

SATURATED FRACTION

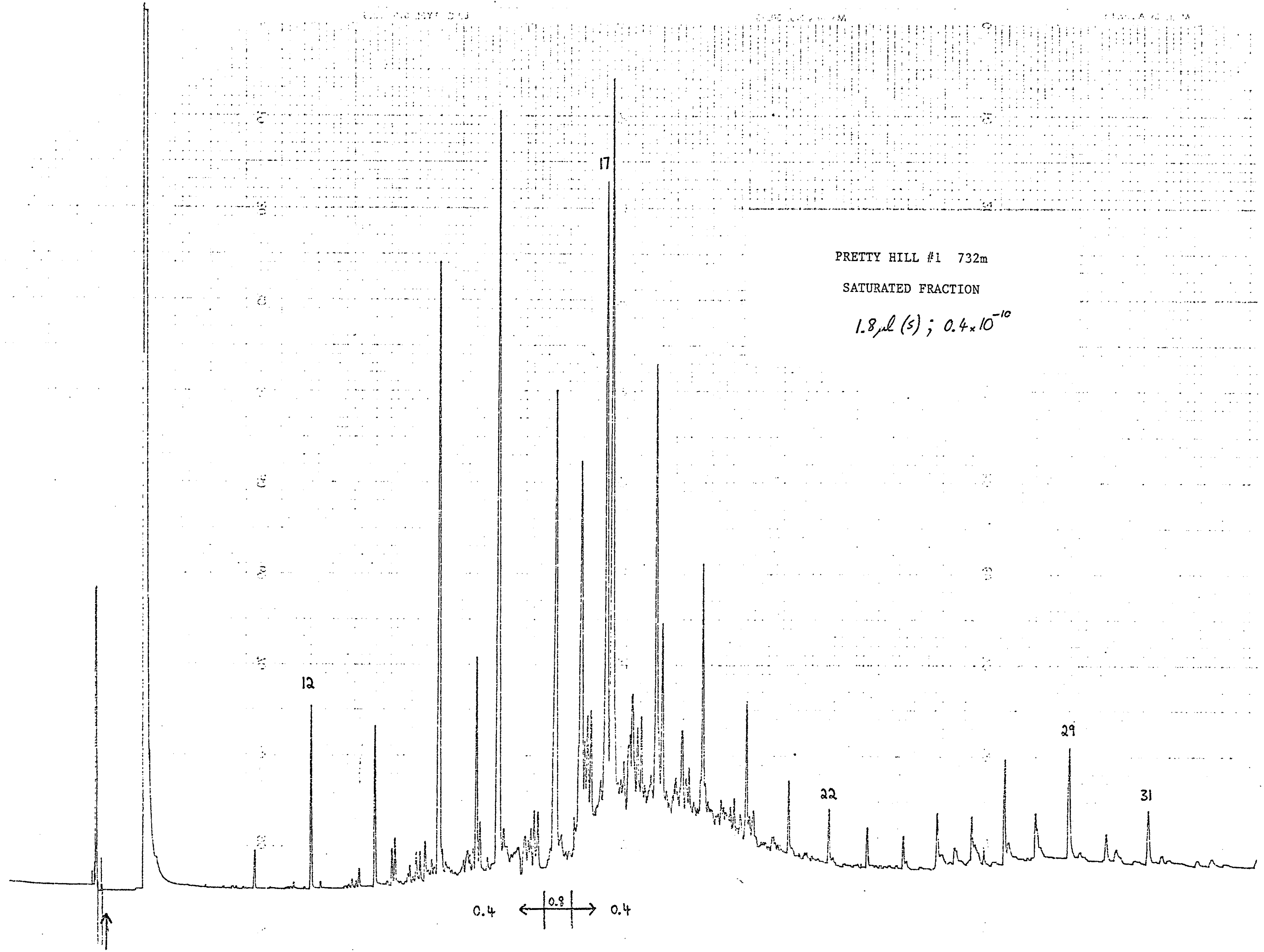
$2.4\mu l$; 0.8×10^{-10}



HEYWOOD #10 1613-1616m

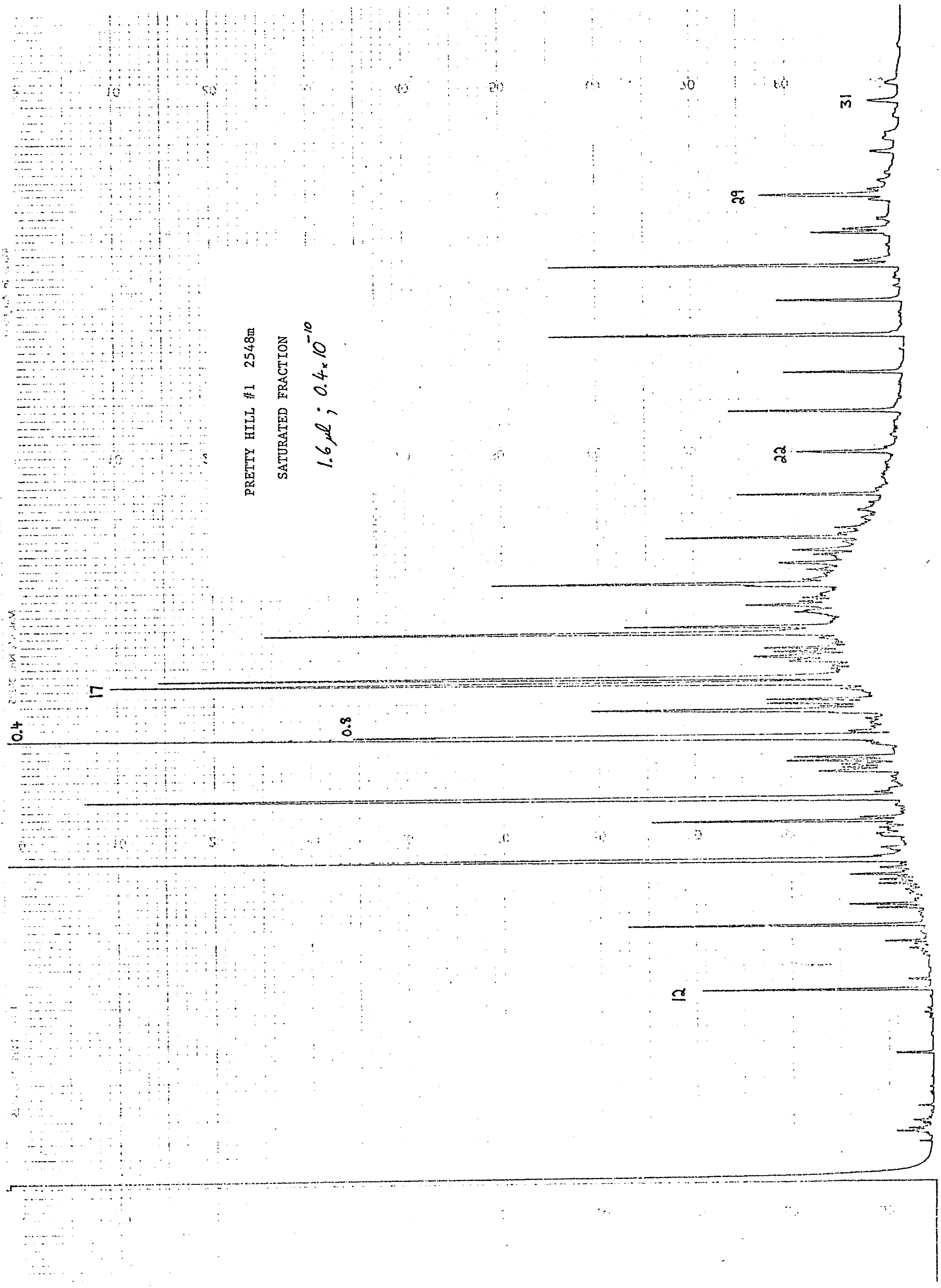
SATURATED FRACTION

$2.8 \mu l (s) ; 0.4 \times 10^{-10}$


PRETTY HILL #1 732m

SATURATED FRACTION

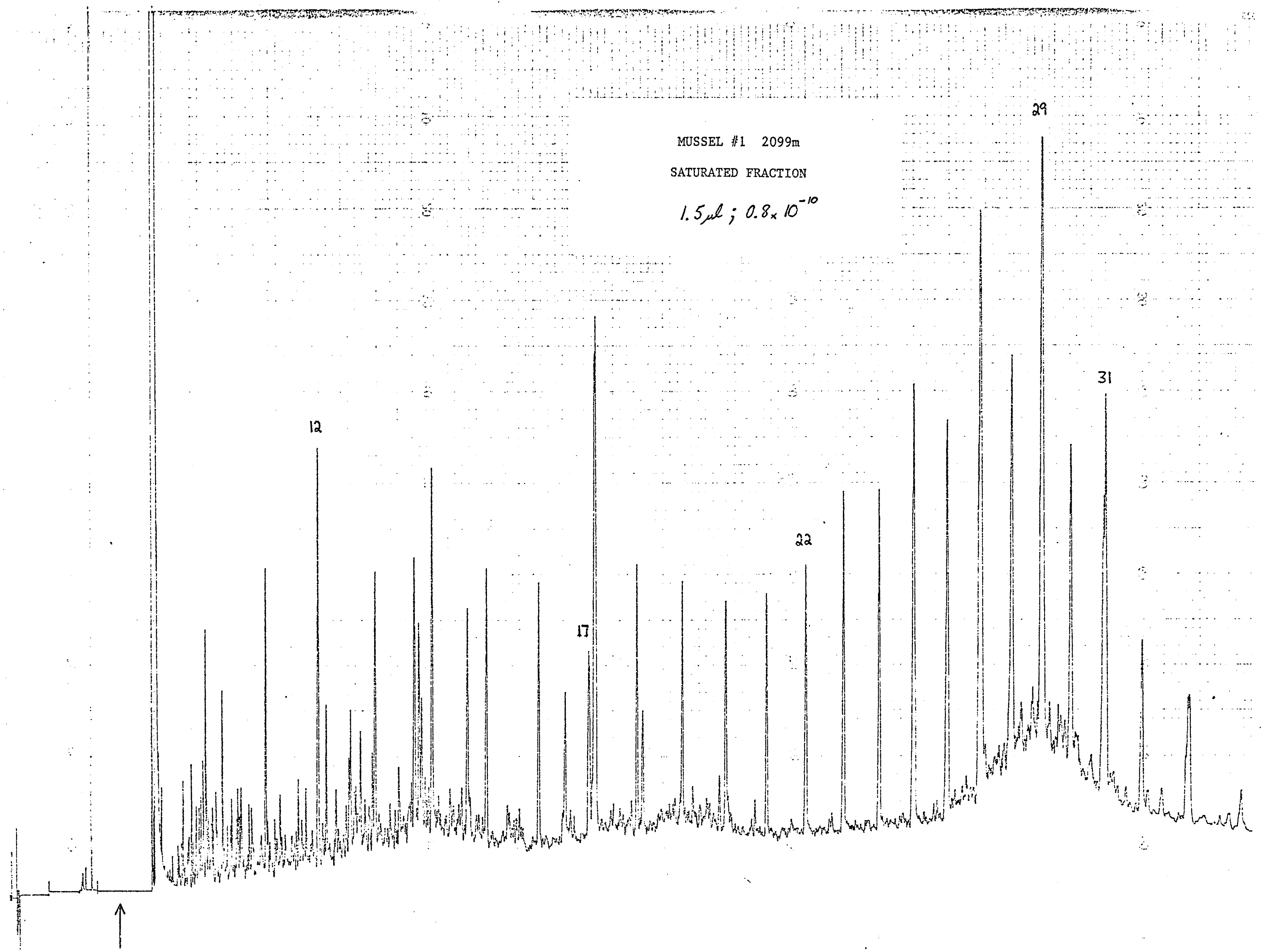
1.8μl (s) ; 0.4×10^{-10}



PRETTY HILL #1 2548m

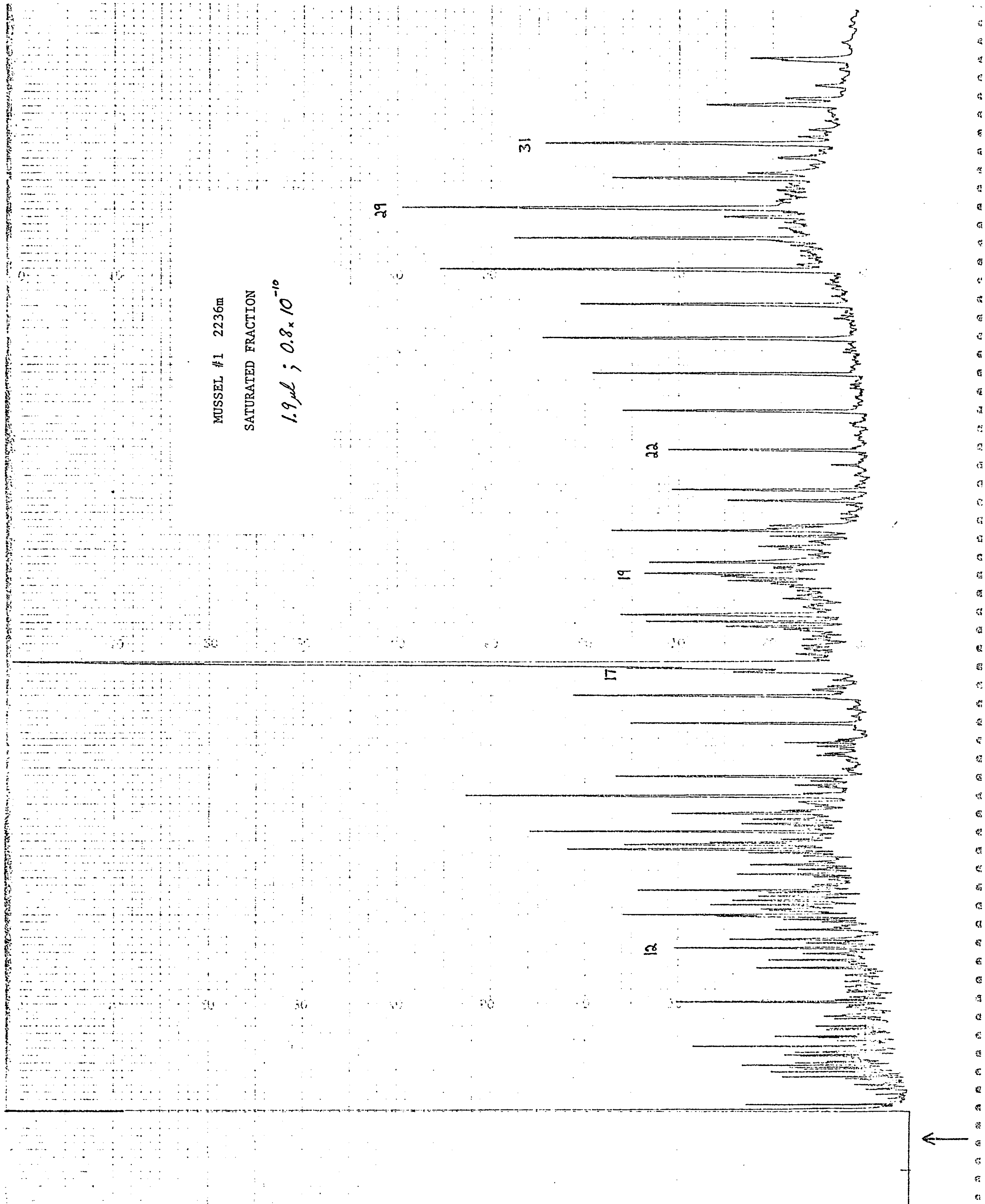
SATURATED FRACTION

1.6µl ; 0.4×10^{-10}

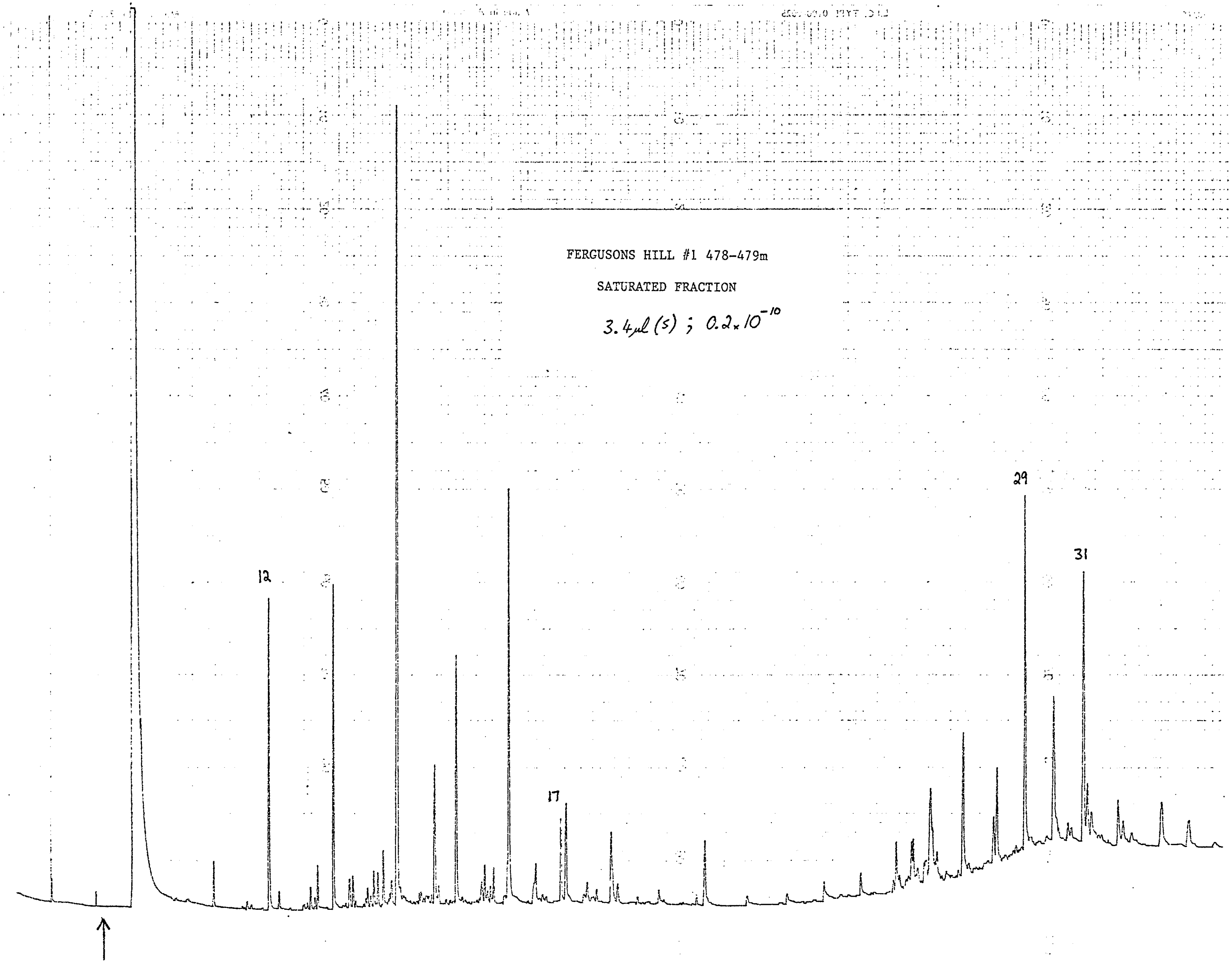

MUSSEL #1 2099m

SATURATED FRACTION

1.5µl ; 0.8×10^{-10}



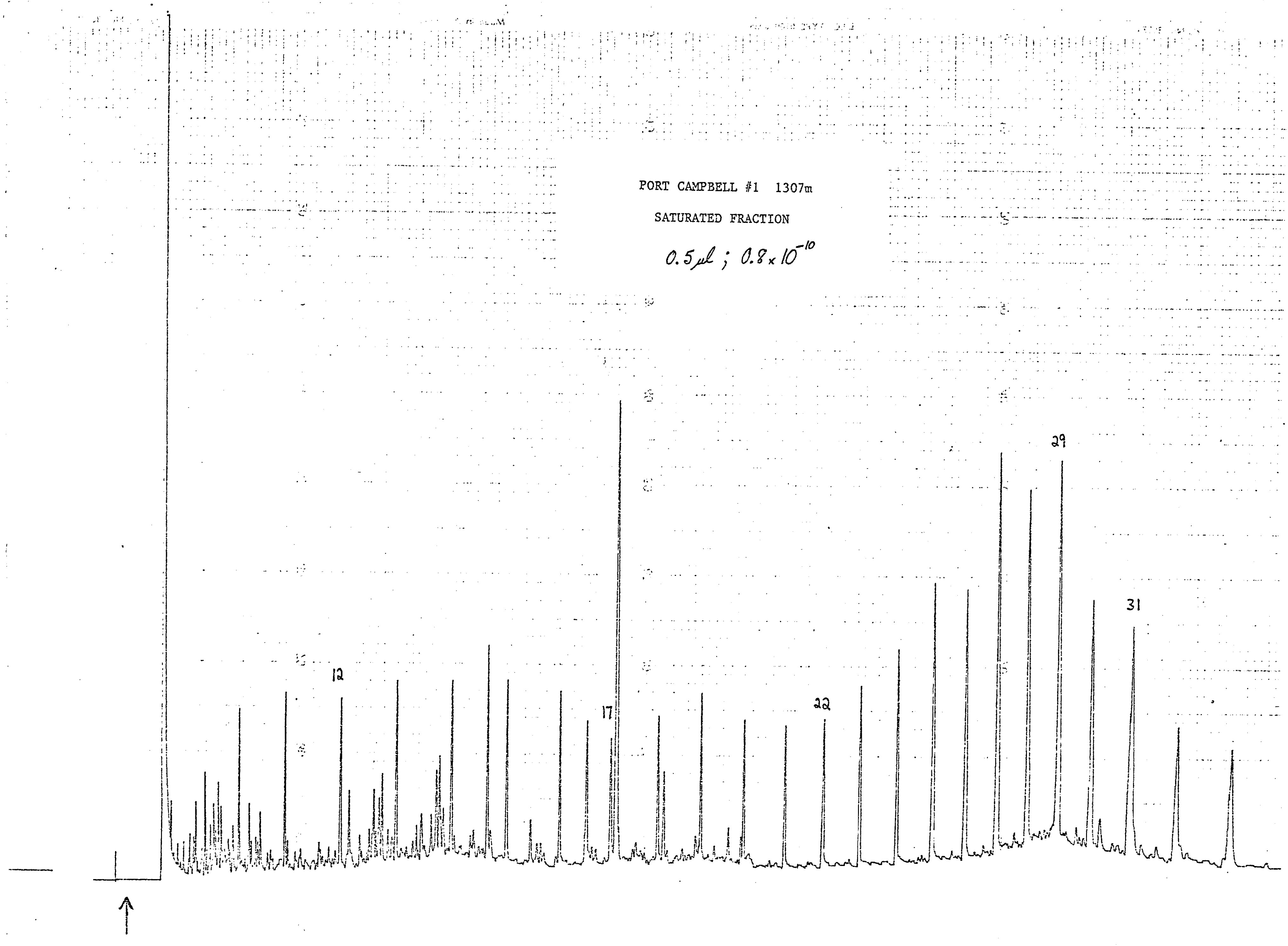
MUSSEL #1 2236m
SATURATED FRACTION
1.9μl ; 0.8×10^{-10}



FERGUSONS HILL #1 478-479m

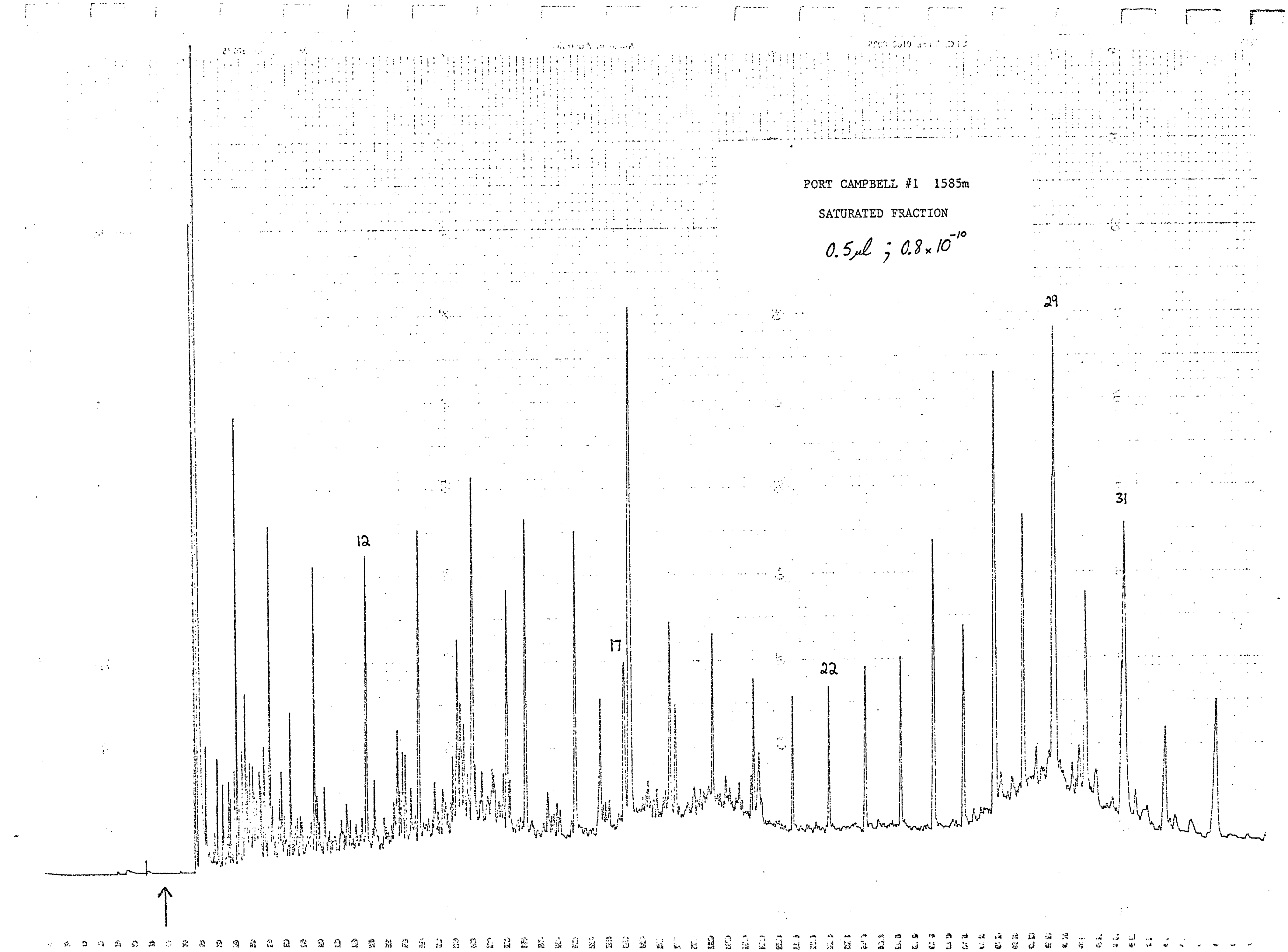
SATURATED FRACTION

3.4µl (s) ; 0.2×10^{-10}


PORT CAMPBELL #1 1307m

SATURATED FRACTION

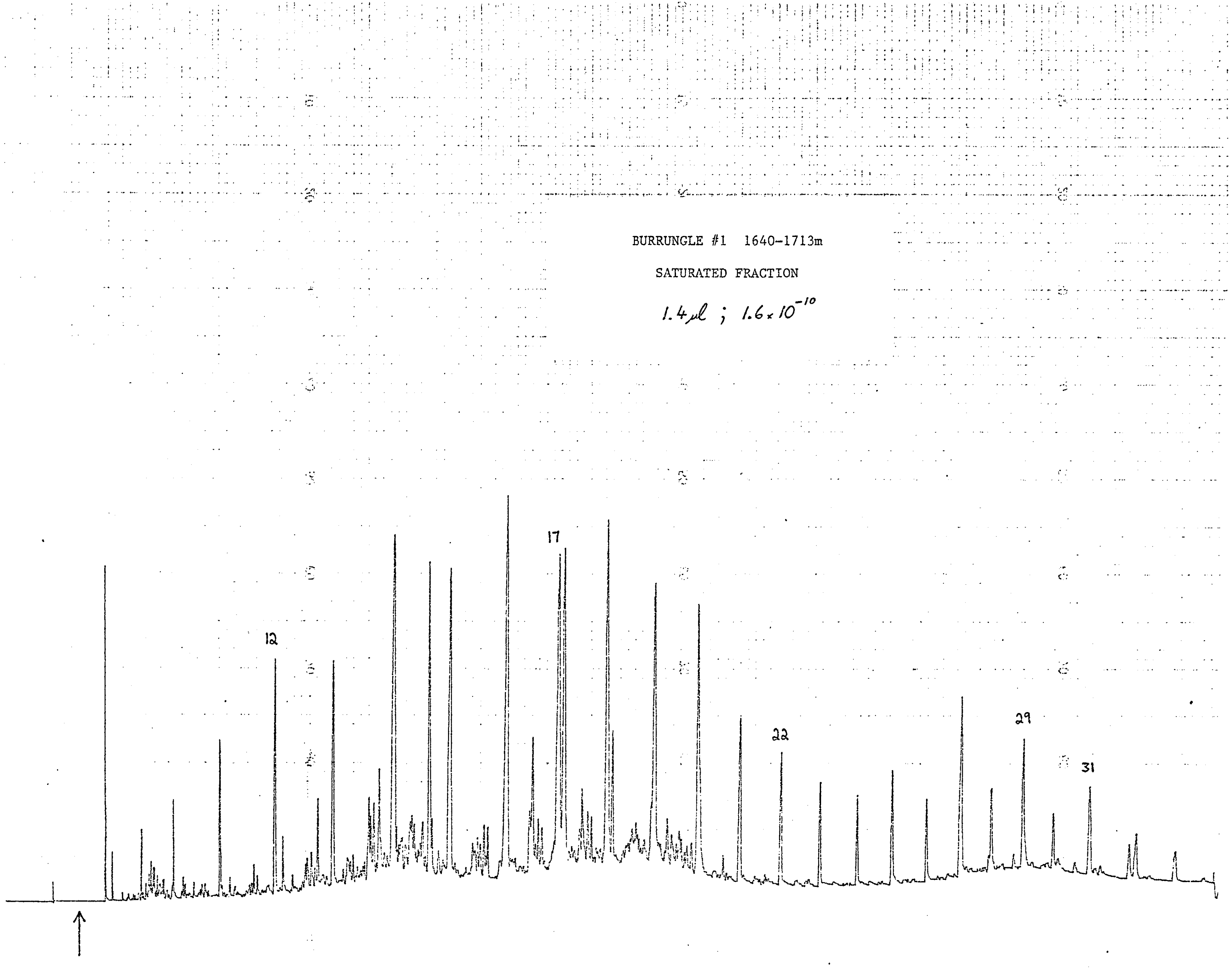
0.5μl ; 0.8 × 10^{-10}



PORT CAMPBELL #1 1585m

SATURATED FRACTION

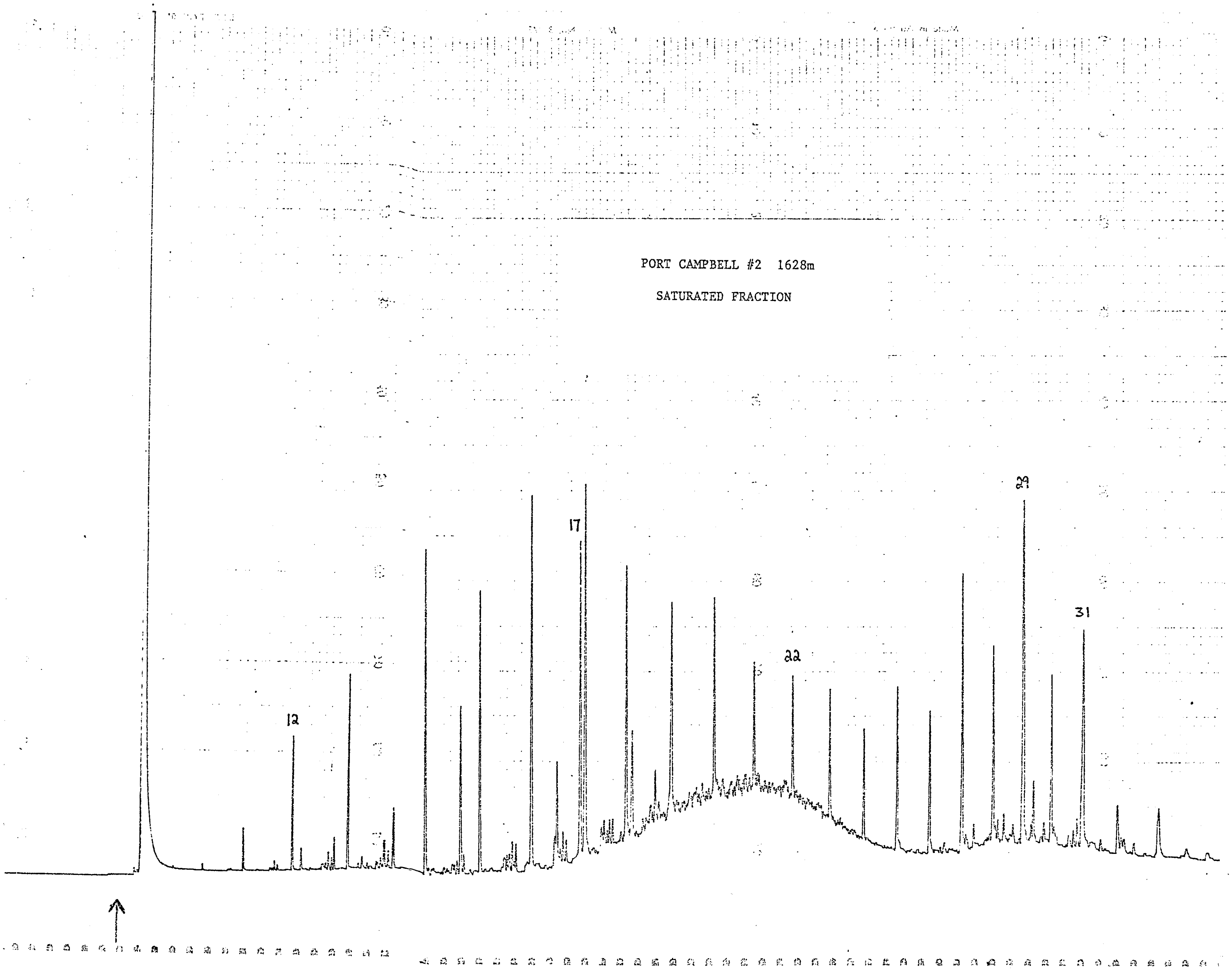
0.5μl ; 0.8×10^{-10}



BURRUNGLE #1 1640-1713m

SATURATED FRACTION

1.4 µl ; 1.6×10^{-10}



PORT CAMPBELL #2 1628m

SATURATED FRACTION