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TRANSMITTAL OF GEOCHEMICAL DATA
RELATED TO B.M.R.
D.D.H. MT YOUNG & McARTHUR RIVER
OP 191, 198
PR 82/03

ONSHORE

PR82/3

PR82/03

AMOCO PRODUCTION COMPANY
Tulsa, Oklahoma
January 22, 1982

82022ART0105

TO: S. C. Bane, APC (Int'l), Houston

SUBJECT: Transmittal of Geochemical Data to Bureau of Mineral Resources, Canberra City, A.C.T.

ATTN: J. A. Boyer

As you will recall, in July of 1981, Larry Ross visited the Northern Territory Department of Mines, Darwin, and the Bureau of Mineral Resources, Canberra City, looking for additional cores from our petroleum license area in the Northern Territory.

Cores were found and sampled in both the Department of Mines core storage in Darwin and the BMR in Canberra City, and shipped to the Research Center, Tulsa, for organic geochemical analyses. In exchange for the core samples, Amoco Production Company (Int'l) agreed to submit three copies of a report on the methods and results of the analyses to the Assistant Director (Petroleum Exploration) of BMR within six months of the sampling date (September 4, 1981).

Therefore, in accordance with the agreement, please find enclosed three copies of the analytical results and descriptions of the source rock evaluation techniques. As all negotiations are conducted through APC (Int'l) Houston, I request that you transmit the three attached reports to:

Assistant Director (Petroleum Exploration)
Bureau of Mineral Resources
P.O. Box 378
Canberra City, A.C.T. 2601
Australia

If there are any questions concerning the agreement or analytical data, please contact L. M. Ross (x3095), Tulsa Research.

ERIC R. MICHAELIS

By Robert R Thompson
R. R. Thompson

LMR:ceh
Enclosures

AMOCO PRODUCTION COMPANY
ELEMENTAL ANALYSES

Depth M	Normalized Elemental Analysis Wt. Carbon	Hydrogen	Oxygen	Nitrogen	Atomic Ratio O/C	Atomic Ratio H/C
BMR Mt. Young No. 2 DDH						
58.2-58.4	77	3.1	18	1.8	.17	.48
61.6-61.7	88	2.5	7	2.9	.05	.34
63.1-63.2	86	2.6	10	1.2	.08	.36
BMR McArthur River No. 2						
79.7-79.8	80	6.7	11	2.0	.10	1.01
80.5	85	3.7	9	2.3	.07	.52
84.0-84.1	86	3.7	8	2.1	.06	.51

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AMOCO PRODUCTION COMPANY
THERMAL & SOLVENT EXTRACTION DATA

Depth M	Formation	Total Organic Carbon Wt % (TOC)	Volatile HC ppm	Vol. HC/TOC	U. Limit Vol. HC Dec. C	Generated HC ppm	Generated HC/TOC	Gen Peak Maximum Deg. C	Vol. HC Vol & Gen	Bitumen bbl/AF	Bitumen ppm	Bitumen TOC
Kratos DDH-8 76.2-79.2	Corcoran	0.1										
Kratos DDH-11 181.4-184.4	Corcoran	0.5	Below Detection Limits			13	<.01	550		1	40	.01

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Total Extract Chromatogram

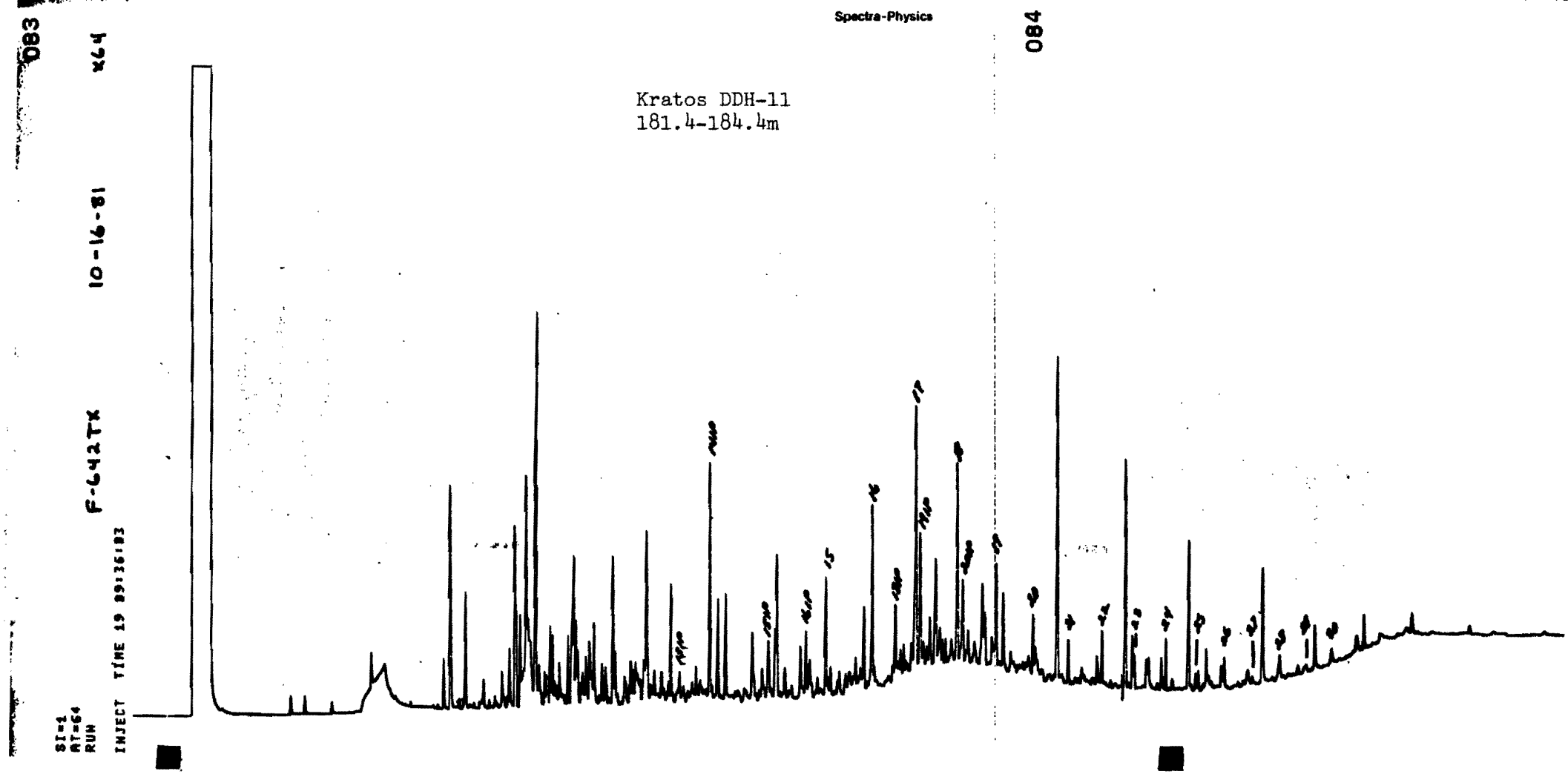

Figure 1

PR82/03

Total Extract Chromatogram

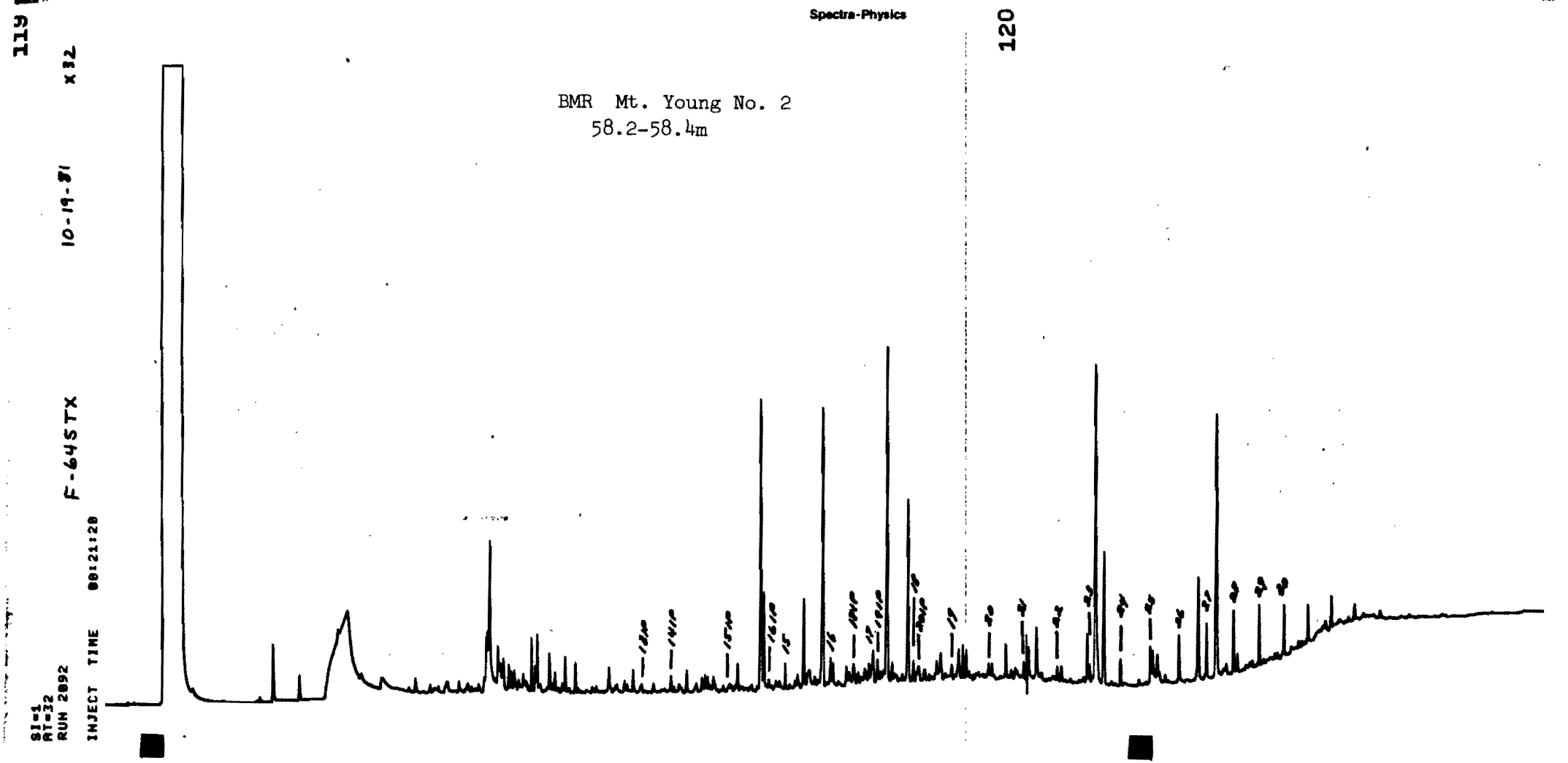

Figure 2

AMOCO PRODUCTION COMPANY
ELEMENTAL ANALYSES

Depth M	Normalized Elemental Analysis Wt. Carbon	Hydrogen	Oxygen	Nitrogen	Atomic Ratio O/C	Atomic Ratio H/C
Kratos DDH-11						
181.4-184.4	86	3.3	9	1.6	.08	.46

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PR82/03

Total Extract Chromatogram

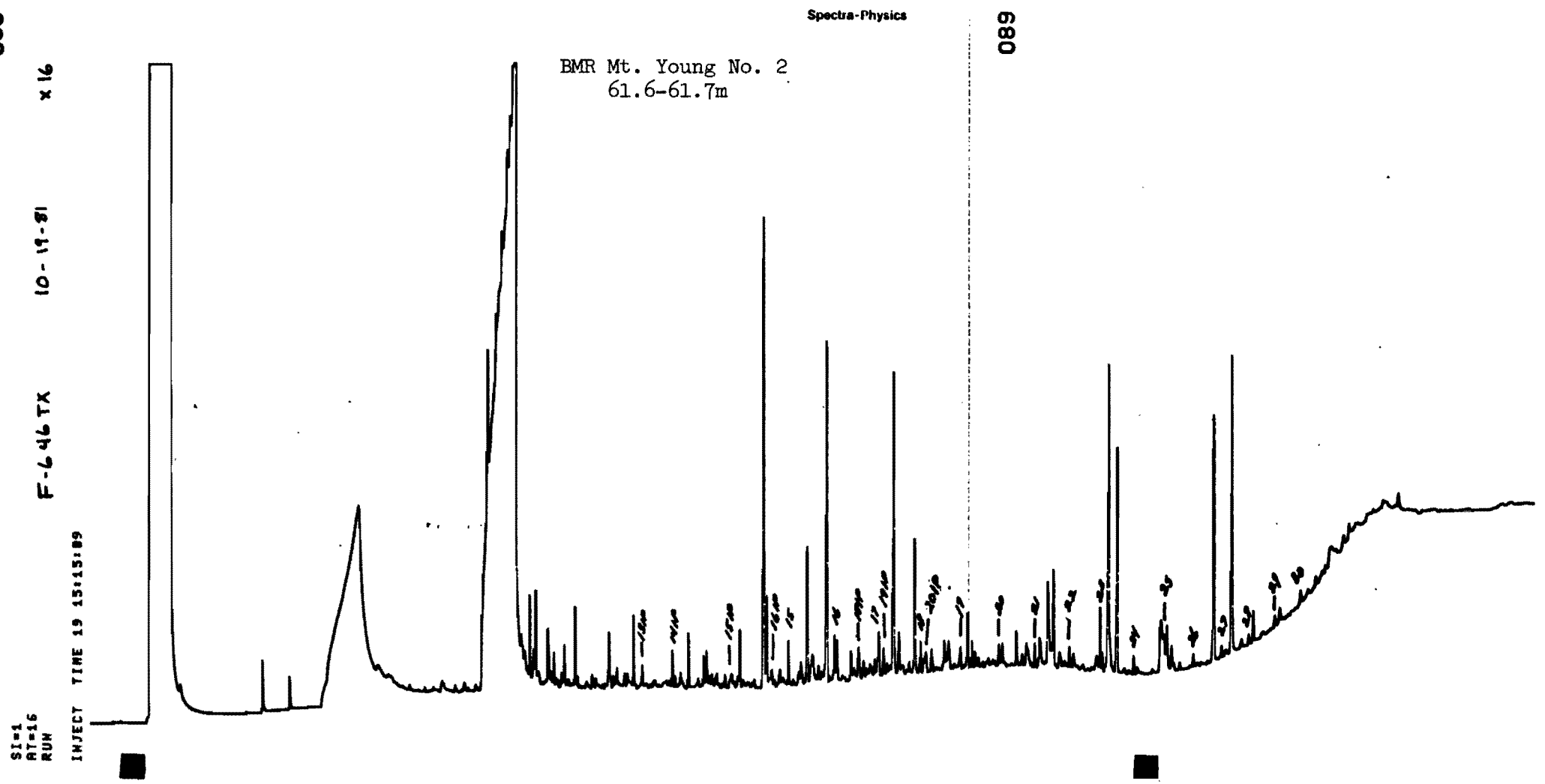

Figure 3

PRB2/03

Total Extract Chromatogram

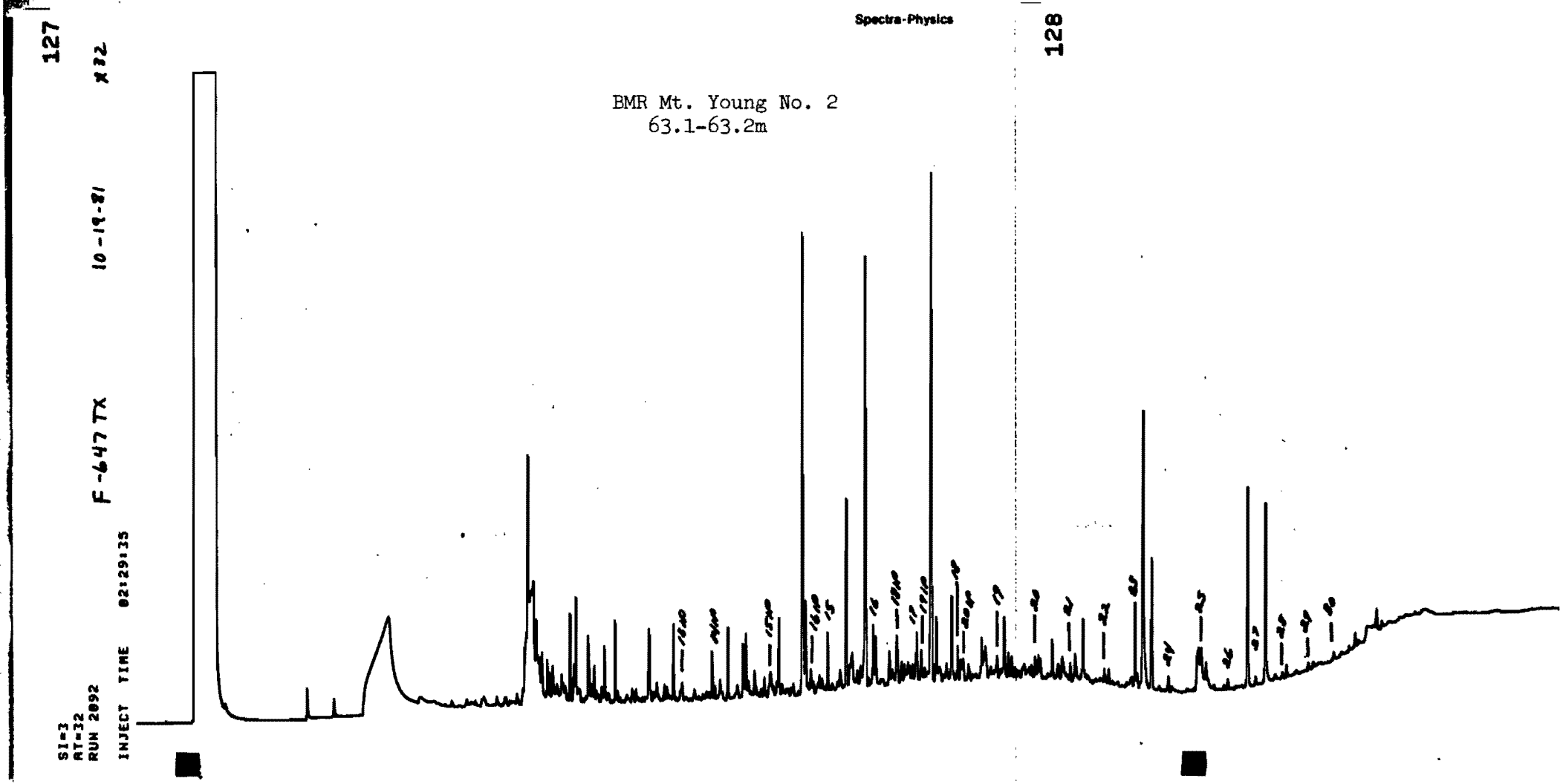

Figure 4

PR 82/03

Total Extract Chromatogram

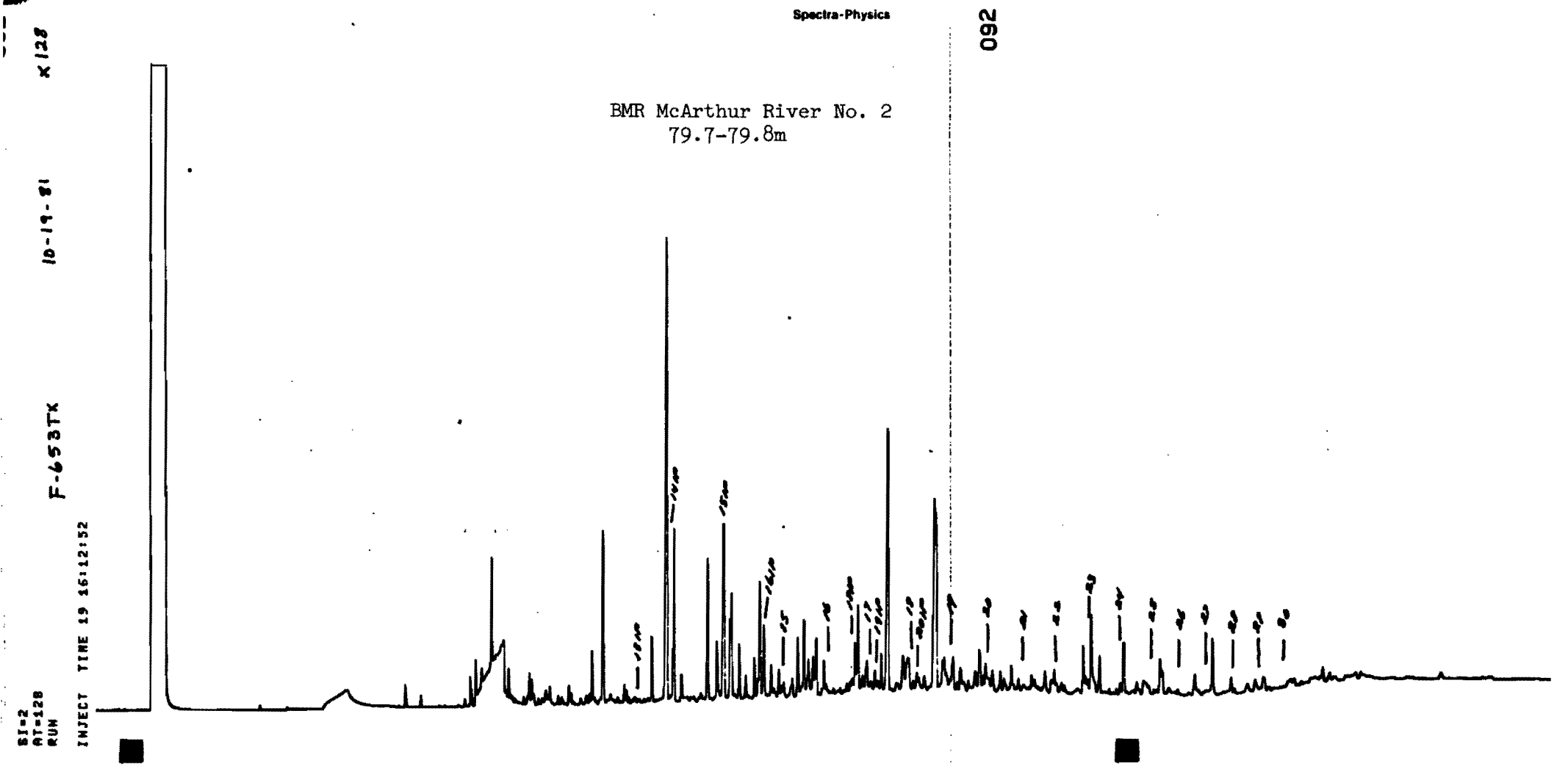

Figure 5

Total Extract Chromatogram

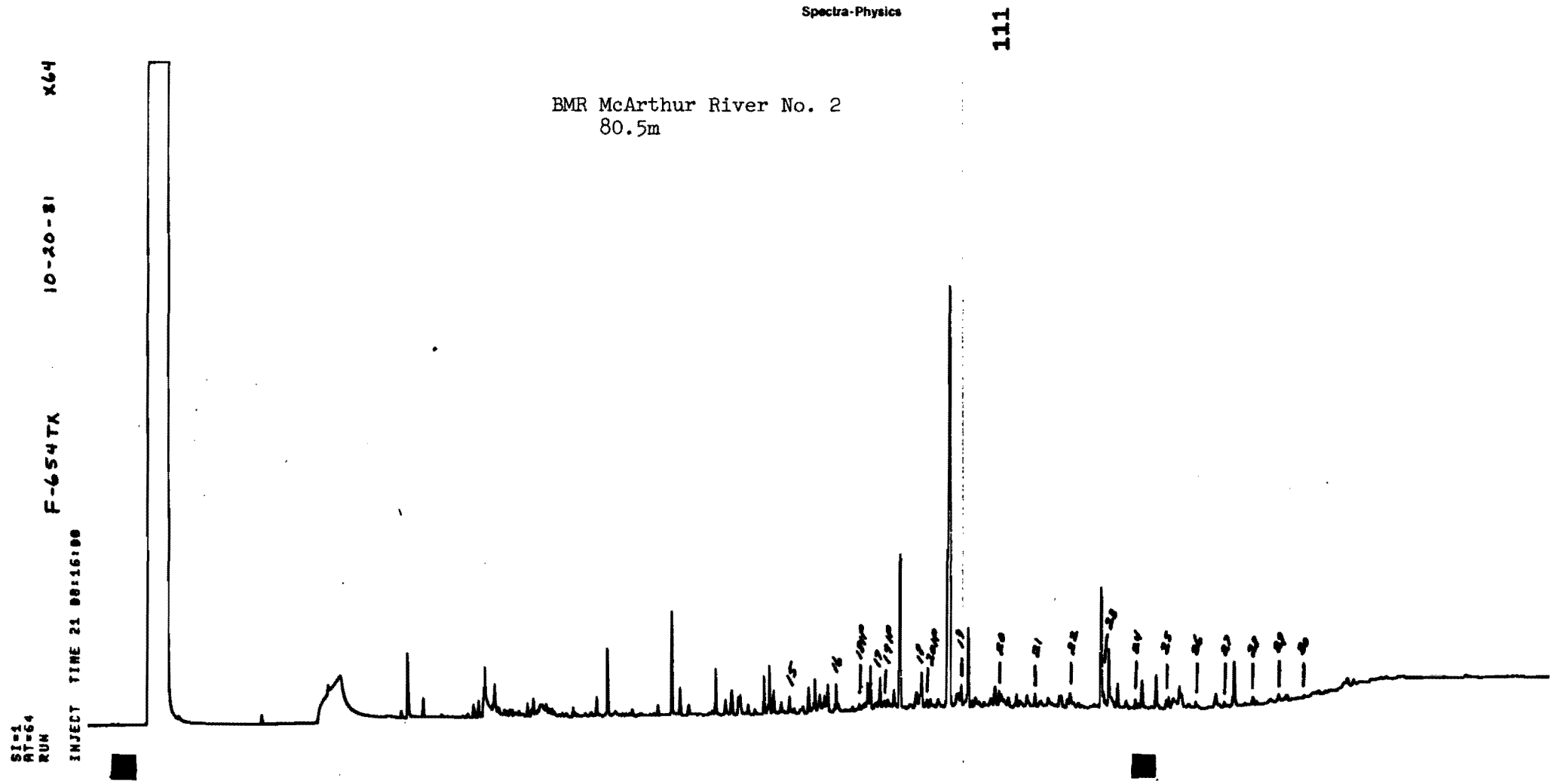

Figure 6

PR82/03

Total Extract Chromatogram

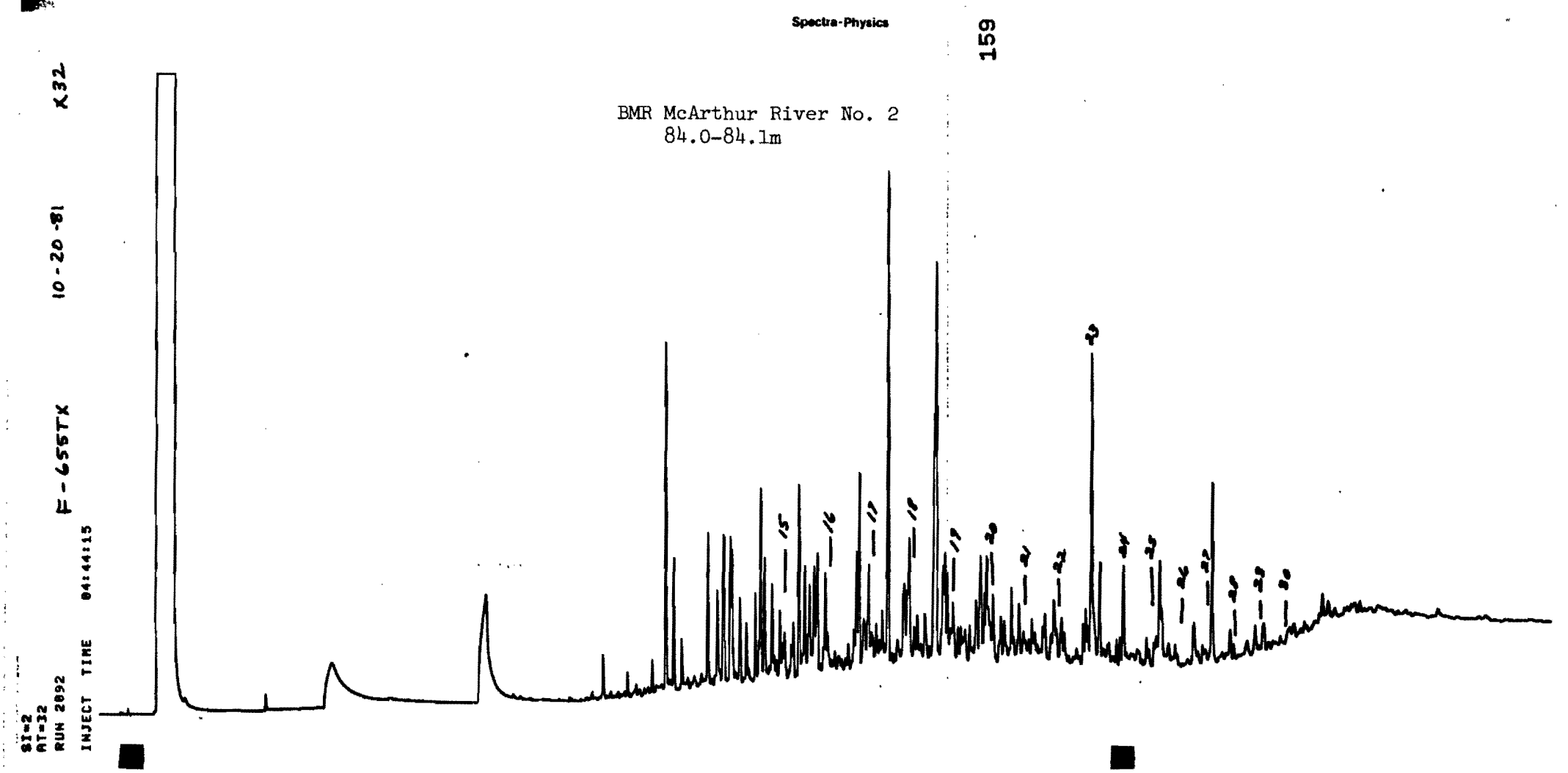

Figure 7

PR82/03

DESCRIPTION AND EVALUATION OF SOURCE ROCK ANALYSES

A variety of analyses on the extractable and nonextractable organic matter are used to determine the organic richness of source rock samples and their stages of petroleum generation. Ranges of values listed in the following pages are for ideal cases; such a listing does not include subtleties of interpretation necessary when analytical problems are encountered, or when the samples are weathered or contaminated.

DESCRIPTION OF ANALYSES

Organic Carbon: Organic carbon is an easily measured index of the quantity of organic matter in a rock; it is determined by burning the carbonate-free rock in an oxygen atmosphere and measuring the evolved carbon dioxide. Percent organic carbon is one indicator of petroleum generation ability.

Thermal Evolution Analysis (TEA): TEA pyrolysis of powdered whole rock measures both the pre-existing volatile and oil-like hydrocarbons in the rock and the remaining ability of the sample to generate hydrocarbons. The volatile hydrocarbons are measured during low temperature heating of the rock, and the generated hydrocarbons are measured during higher temperature heating. The quantity of generated hydrocarbons is a primary measure of the source richness for thermally immature samples. The ratio of generated hydrocarbons to total organic carbon is an index of the liquid and/or gas generating ability of the kerogen. Temperature of the generated hydrocarbon peak maximum appears to indicate the thermal maturity of the kerogen.

Solvent Extraction: Organic matter in the rock sample that is removed by organic solvent extraction is called bitumen. The amount and character of the bitumen is a function of the quantity and quality of the kerogen and the stage of thermal maturity.

Bitumen is separated by liquid column chromatography into saturated and aromatic hydrocarbon fractions. Saturates are the most oil-like part of the bitumen.

Gas Chromatography: Gas chromatographic analysis (similar to a boiling point separation) of either the bitumen or saturated hydrocarbons gives the molecular distribution and relative proportions of paraffins and naphthenes, as well as the amounts of specific genetic marker hydrocarbons such as pristane and phytane. Odd-carbon predominance (C_{24}-C_{30} range), deficiency of normal paraffins, or erratic molecular distribution in the bitumen or saturated hydrocarbon chromatogram implies,

depending on the appearance, thermal immaturity, biodegradation, or contamination.

Visual Kerogen Analysis: Microscopic examination of kerogen (insoluble organic matter) separated from the rock matrix by hydrochloric and hydrofluoroic acid treatment gives information about the morphology of the kerogen particles and hence the type of hydrocarbons generated. Structured type kerogens are usually associated with gas generation, whereas amorphous kerogens are associated with oil generation.

The color of the pollen and spores in the kerogen assemblage gives an indication of the level of thermal maturity of the kerogen. Palynomorphs change from yellow (immature), through various shades of brown (mature), to black (expended). These color changes have been subdivided into a seven-stage (1-7) visual carbonization scale for use in Amoco.

Vitrinite Reflectance: The percentage of light reflected by microscopic vitrinite particles is another index of thermal maturity. This measurement is made using a photometer equipped microscope and polished slides of the kerogen embedded in plastic.

Elemental Analysis: This is a measurement of the four principal elements in kerogen-carbon, hydrogen, oxygen, and nitrogen. The concentrations of these four elements are normalized so that the values total 100%. The percent carbon and O/C are indices to thermal maturity; the hydrogen content and H/C ratio are indices to both thermal maturity and the liquid generating ability of immature kerogens.

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PR82/03

AMOCO PRODUCTION COMPANY
THERMAL & SOLVENT EXTRACTION DATA

Depth M	Formation	Total Organic Carbon Wt % (TOC)	Volatile HC ppm	Vol. HC/TOC	U. Limit Vol. HC Deg. C	Generated HC ppm	Generated HC/TOC	Gen Peak Maximum Deg. C	Vol. HC Vol & Gen	Bitumen bbl/AF	Bitumen ppm	Bitumen TOC
BMR Mt. Young No. 2 DDH												
56.8-56.9	Wollogorang	0.3								<1	23	.01
58.2-58.4	Wollogorang	0.4	6	<0.1	317	12	<.01	490	.33	1	40	.01
61.6-61.7	Wollogorang	0.7	6	<0.1	270	12	<.01	550	.33	<1	18	<.01
63.1-63.2	Wollogorang	1.2	18	<0.1	300	24	<.01	440	.43			
BMR Bauhinia Downs No. 3												
51.7-51.8	Dungaminnie	0.2										
54.9-55.0	Dungaminnie	0.1										
131.5	Dungaminnie	<0.1										
145.5-145.6	Dungaminnie	<0.1										
BMR McArthur River No. 2												
79.7-79.8	Barney Creek	3.5	214	0.1	370	589	.02	550	.27	2	98	<.01
80.5	Barney Creek	1.9	71	<0.1	348	286	.02	550	.20	2	111	.01
84.0-84.1	Barney Creek	2.7	107	<0.1	324	601	.02	509	.15	1	63	<.01
Tawallah Pocket No. 1												
44.3-44.4	Amelia Dolo	.1										
48.3-48.4	Amelia Dolo	<.1										

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PETROLEUM GENERATING CAPABILITY

Rating	Total Organic Carbon Wt. %	Generated Hydrocarbons PPM by TEA*
Nonsource	<0.4	< 600
Poor	0.4-0.6	600-1800
Fair	0.6-1.0	1800-3000
Good	1.0-1.5	3000-6000
Very Good	>1.5	>6000

*Thermal evolution analysis on thermally immature samples

KEROGEN TYPE

Petroleum Type	Visual Kerogen Type	Generated Hydrocarbons*/ Total Organic Carbon	Elemental H/C**	Bitumen/Total Organic Carbon***
Gas	Structured	<.15	<0.8	<.05
Gas and condensate	Mixed	.15-.25	<1.0	<.05
Oil	Amorphous (sometimes mixed)	>.25	>1.0	>.05 <.30****

*From thermal evolution analysis for thermally immature kerogens
**For thermally immature samples
***For uncontaminated samples, and where bitumens are not thermally cracked to gas
****Values >.30 indicate non-indigenous oil or contamination; saturate hydrocarbon/bitumen ration >.70 also indicates non-indigenous oil or contamination.

KEROGEN THERMAL MATURITY

Diagenesis Stage	Pre-peak Generation	Early peak oil-early gas	Peak oil-early peak gas (Oil expulsion)	Past peak oil-peak gas	Advanced
Visual Scale	1-3	4	5	6-7	7
Vitrinite Reflectance %	<.5	.5-.8	.8-1.2	1.2-2.0	> 2.0
Elemental % C	<78	78-81	81-85	85-90	> 90
Elemental H/C	>1.0 (oil source)	>1.0 (oil source)	>.80 (oil source)	.40-.80	< .40
TEA Gen HC/TOC*	>.25 (oil source)	> .25 (oil source)	>.15	< .15	< .05
TEA Vol HC/TOC*	<.05	> .05 (oil source)	>.05 (oil source)	< .05	< .01
TEA Gen HC Max °C	460-490	480-510	490-530	510->540	> 540
Bitumen/TOC*	<.05	> .05 (oil source)	>.05 (oil source)	< .05	< .01
Bitumen Chromatogram	Immature (odd-carbon predominance, sterane hump)	Immature (odd-carbon predominance, sterane hump)	Mature, oil-like molecular distribution	Mature	Insufficient extract for analysis

*Total organic carbon wt. %

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