# ABSTRACT

The Maracaibo basin is a prolific oil province situated in an intra-montane basin between the Perijá and Andes mountain ranges in western Venezuela. It produces more than 2MM BOPD from Miocene, Eocene and Cretaceous reservoirs. The main, for some authors only, source rock is believed to be the upper Cretaceous La Luna formation, nevertheless seeps and crude oils of greatly varying compositions have been reported and interpreted as originating from different facies of that formation. The objective of the present study was to obtain an unbiased, quantitative classification of crude oils from the Maracaibo basin, establish the areal distribution of these families and correlate them with geologic variables representing sedimentary and tectonic conditions that are thought to be favorable for oil generation

Peak heights of C13 - C33 gas chromatograms from the saturate fraction of more than 90 crude oils and 20 oil seeps were statistically analyzed with simple Euclidean distance coefficients and Q-mode principal components; the resulting dendrogram shows six (6) natural families of crude oils that were mapped over the basin. Regional geologic maps of the La Luna Fm including statigraphic (isopach, facies, organic carbon, etc) and structural (number of faults, max. displacement, length of fault segments, etc) variables were then discretized and correlated with these families.

From this it can be concluded that the hypothesis of a single source rock is probably true for most of the basin, except for the southwestern portion, and at least three families can be correlated to geologic variables thus establishing a meaningful geologic-genetic classification.

# NEED FOR A NEW CLASSIFICATION

Existing hydrocarbon classifications are based on only one, or at the most, a few parameters. They can be grouped as:

COMMERCIAL: West Texas, North Sea, Arabian Light, Bachaquero, M eas, Oficina, etc.

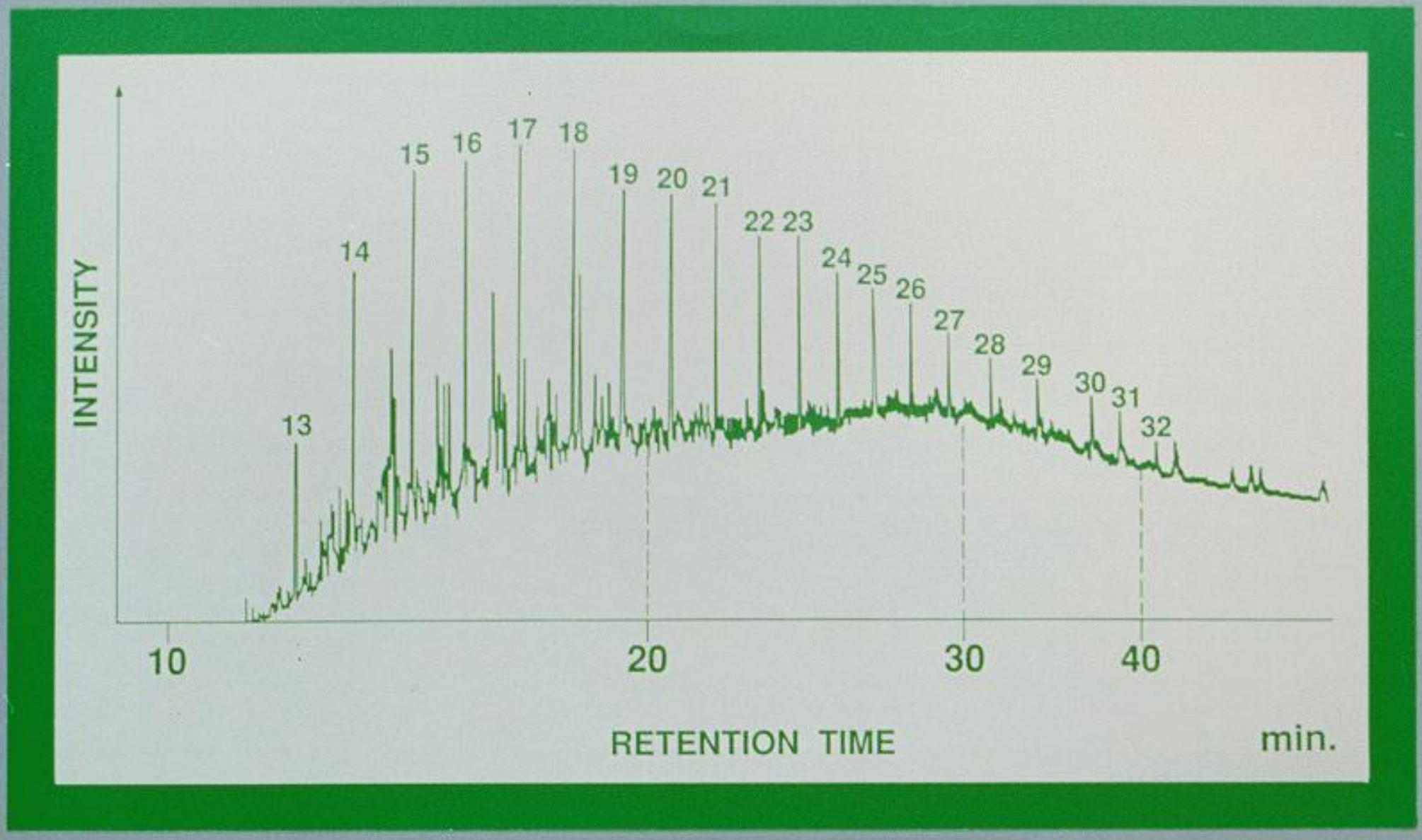
TECHNICAL: API Gravity, Viscosity etc.

GEOCHEMICAL: paraffinic, naphtenic, asphaltenic, "terrestrial" "marine", mixed, etc.

During routine crude analysis, many physical and chemical parameters are obtained. These are seldom used all together to obtain an integral classification which might reflect geologic-genetic factors.

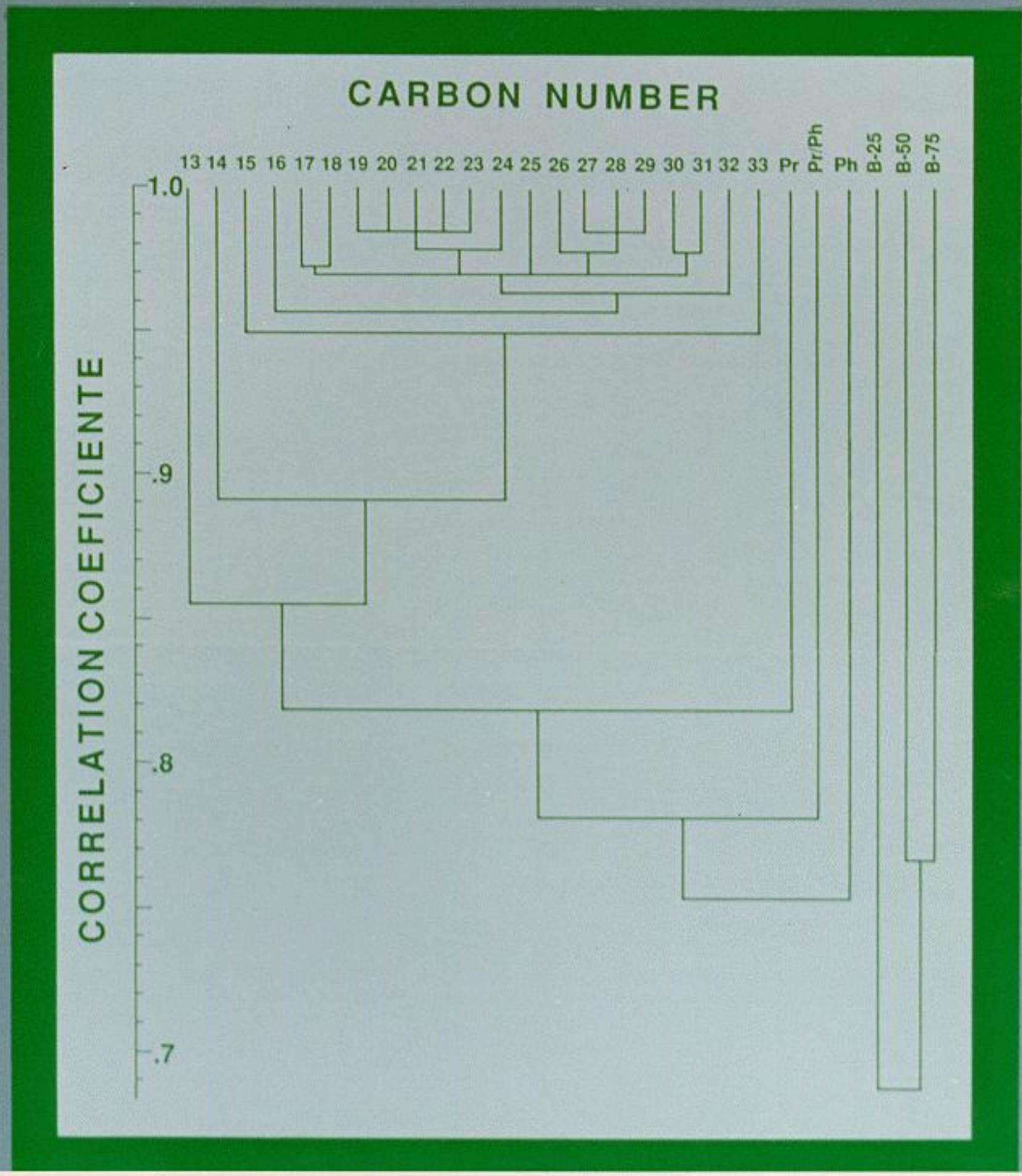
The purpose of this paper is to search for a geologic-genetic classification using widely reported geochemical parameters such as the chromatographic composition of the saturate fraction of crude oils.

# ANALYSIS OF DATA
# INFORMATION CONTENT



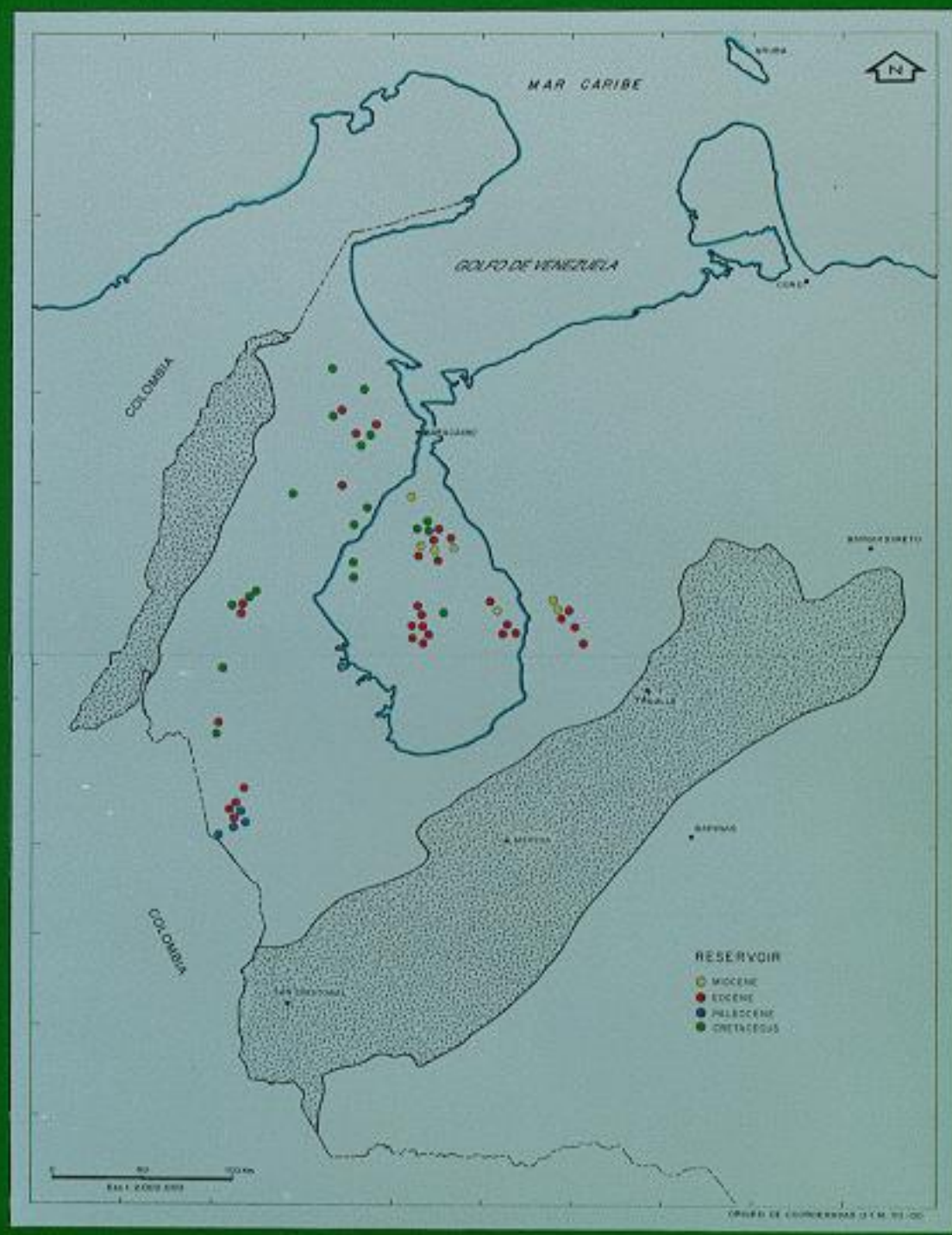

## GAS CHROMATOGRAM
## (SATURATE FRACTION)

# DATA


CARBON NUMBER
13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 Pr Pr/Ph Ph B-25 B-50 B-75
CORRELATION COEFICIENTE
1.0
.9
.8
.7

# HOD

## MARACAIBO BASIN DATA DISTRIBUTION




## PROCEDURE

1 - From peak heights of C13 - C33 establish Data Matrix Dij ,where
i = sample , and
j = variable.

2 - Matrix of product-moment correlation coefficients.

3 - R-mode principal component analysis of the variables, computation of factor scores for each sample.

4 Q-mode cluster analysis based on an unweighted average, within group-pair distance algorithm, according to James M. Parks, 1970, FORTRAN IV Program for Q-Mode Cluster Analysis on Distance Function with Printed Dendrogram. Kansas Geological Survey Computer Contribution No. 46, 32p.

Geologic Parameters are required in order to establish meaningful Hydrocarbon Facies.

Source Rocks

- La Luna Fm. Isopach
- La Luna Fm. COT
- La Luna Fm. Lithofacies

Reservoir Rocks

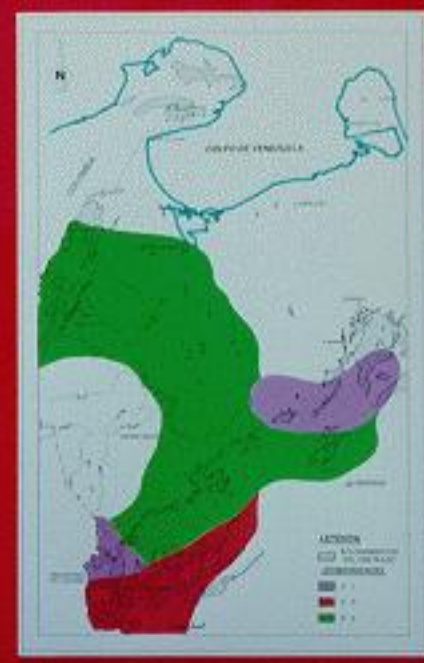
- Miocene % sandstone
- Eocene % sandstone

Energy

- Fault map
- number of fault segments
- fault length
- maximum displacement

Representative maps are shown. These data were discretized on a 50 * 50 km grid and used in a statistical correlation analysis in order to identify geologic-genetic Hydrocarbon Facies.

## COGOLLO GROUP FACIES

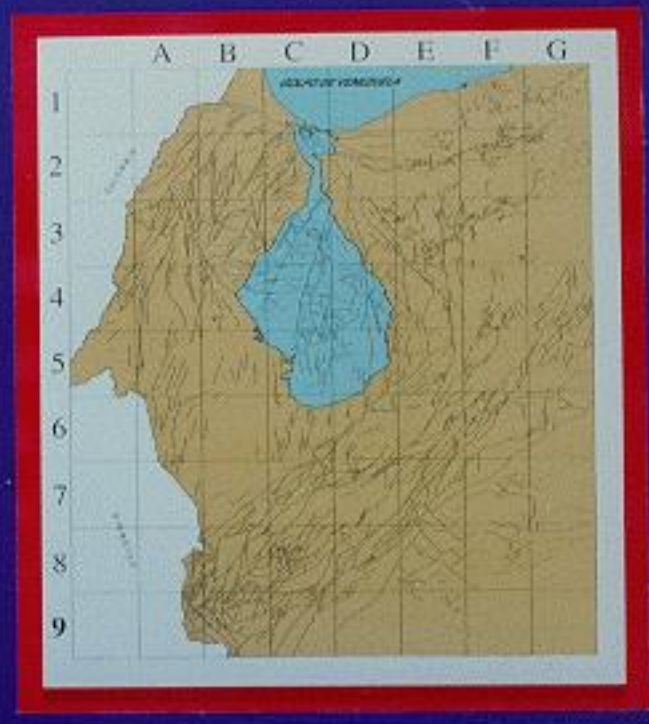


## EOCENE FACIES

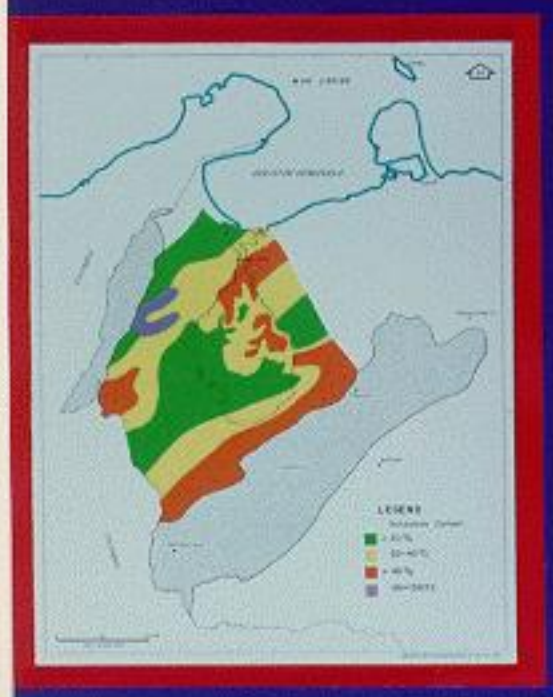
## LA LUNA Fm MICROLITHOFACIES

## LA LUNA Fm FACIES

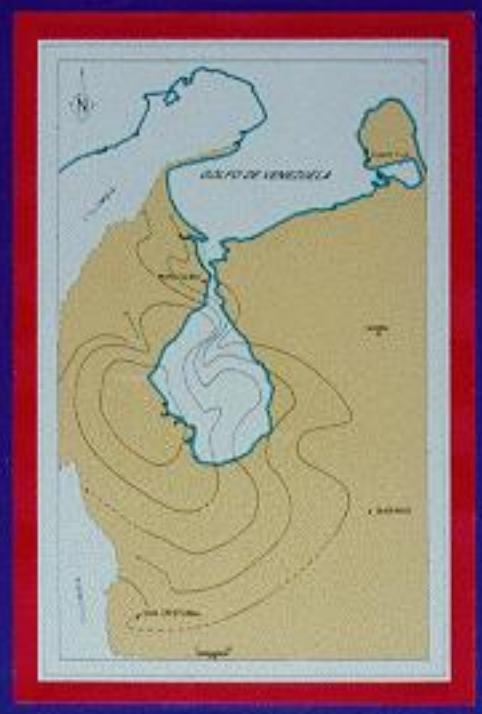
## FAULT DISTRIBUTION



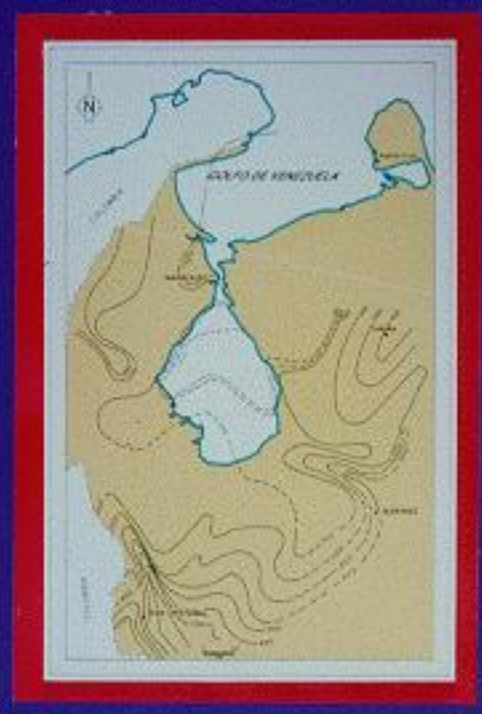

## MIOCENE FACIES



## LA LUNA Fm DISTRIBUTION OF ORGANIC CARBON

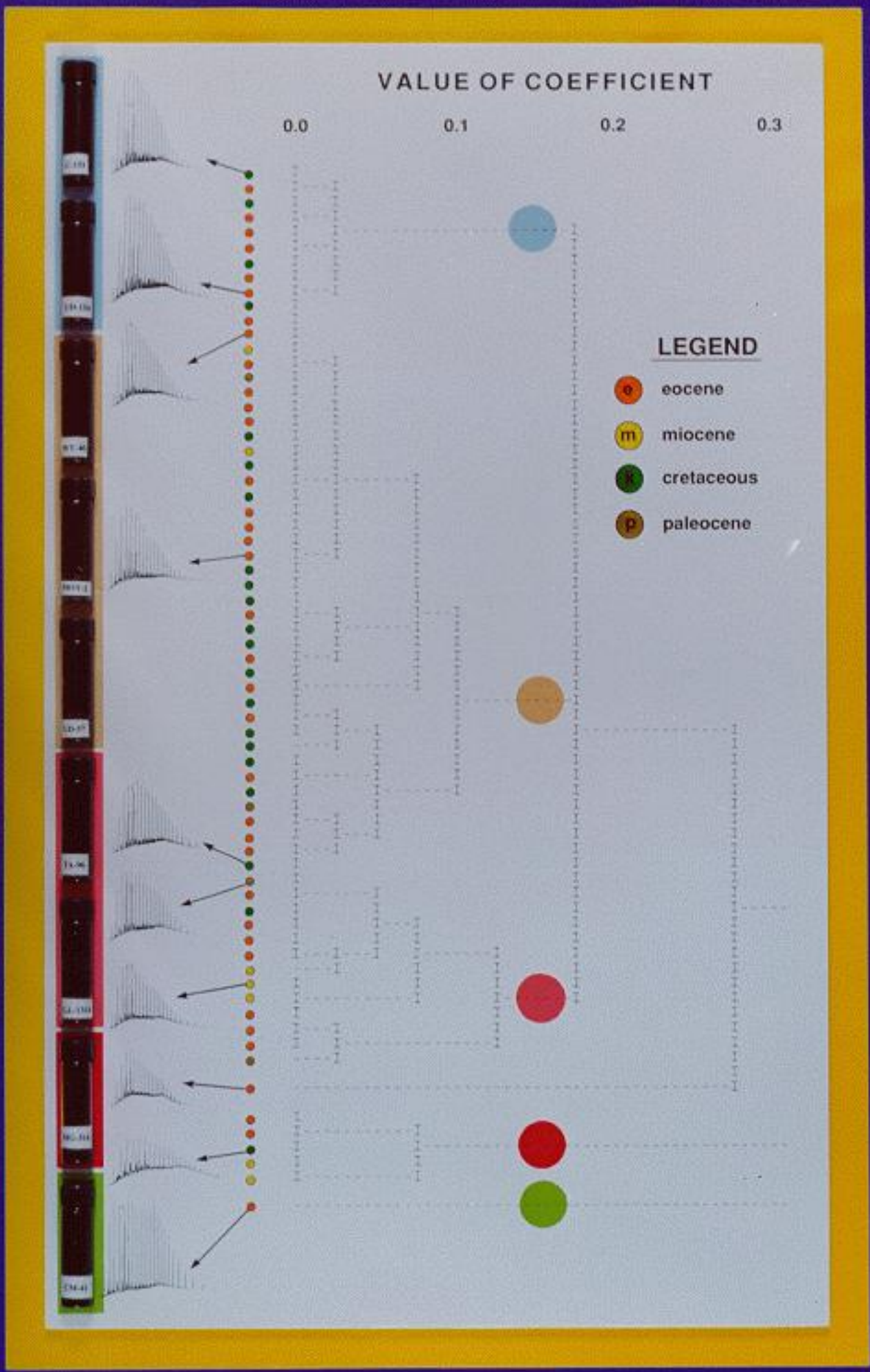


## LA LUNA Fm ISOPACH

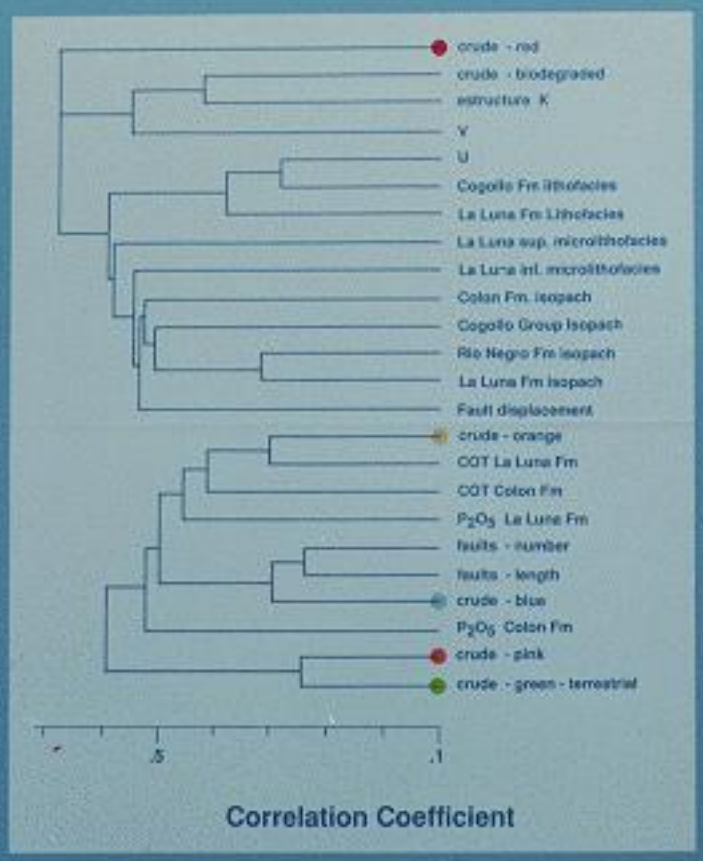


DISEÑO : ARTES GRAFICAS INTEVEP S.A.

# CLASSIFICATION

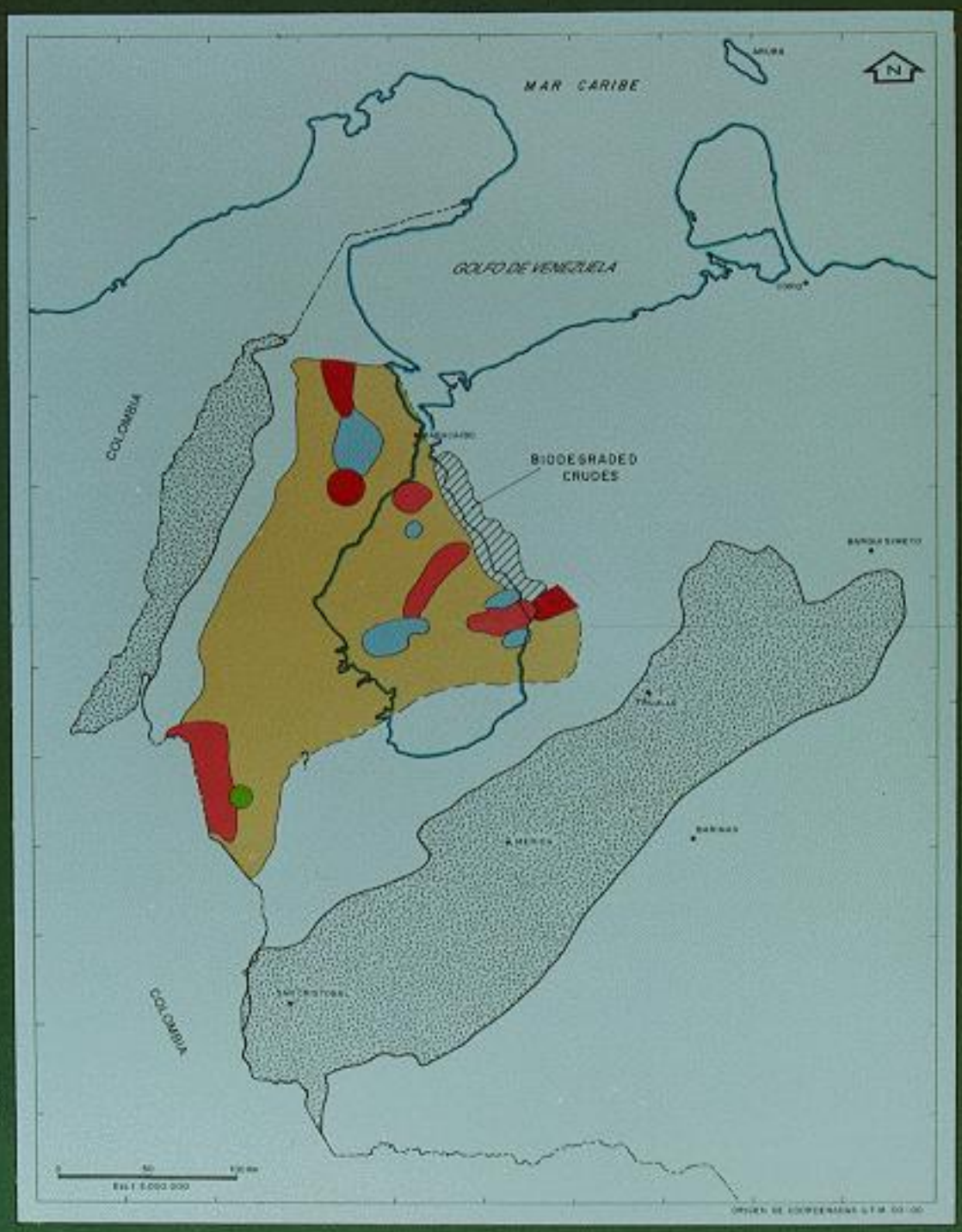



Q-mode cluster analysis of C14-C33 data established six natural groups. Representative chromatograms and samples are shown for each family of crudes.




# HYDROCARBON FACIES AND GEOLOGIC PARAMETERS

# HYDROCARBON FACIES



# CONCLUSIONS

A relationship between geologic parameters and hydrocarbon facies was found in the Maracaibo basin:

- the orange facies is related to the organic carbon content of the La Luna Fm.; it is the dominant oil type in the Maracaibo basin.

- the blue facies, related to faulting, probably represents La Luna crudes migrated through the Central Lake fault system.

- the green facies, positively identified as of terrestrial origin, is strongly related to the pink facies, and could have similar origin.

The distribution of hydrocarbon facies can be mapped over the Maracaibo basin, and related to resource evaluation parameters.

## FUTURE RESEARCH

Relate hydrocarbon facies to reservoir characteristics in order to estimate the expected size, API gravity and depth of prospective targets.

Estimate the amount of remaining oil to be found in the Maracaibo basin using the existing trend surface of hydrocarbon concentration.

ARUBA

MAR CARIBE

N

GOLFO DE VENEZUELA

CORO

COLOMBIA

MARACAIBO

BARQUISIMETO

TRUJILLO

BARINAS

MERIDA

COLOMBIA

SAN CRISTOBAL

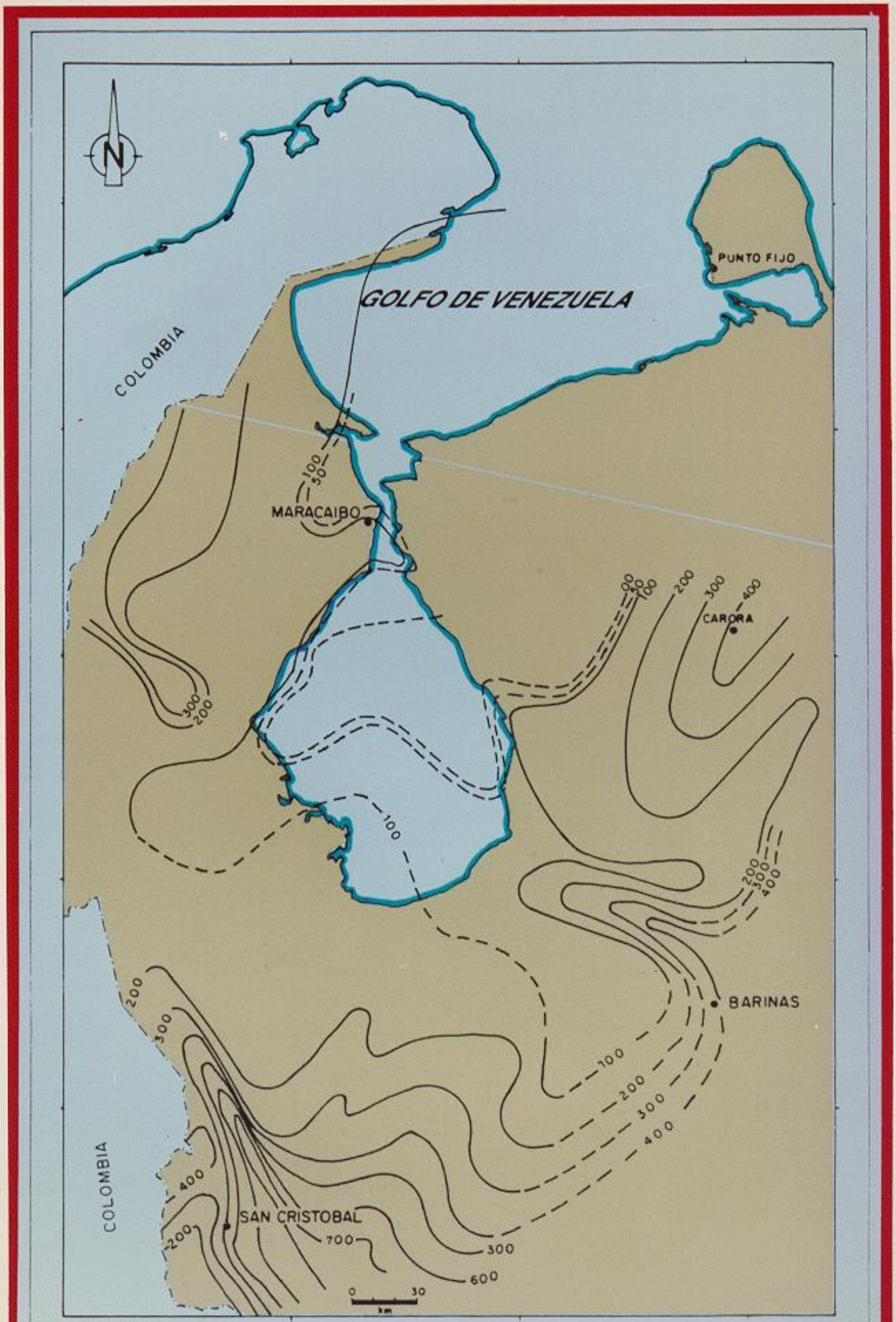
RESERVOIR

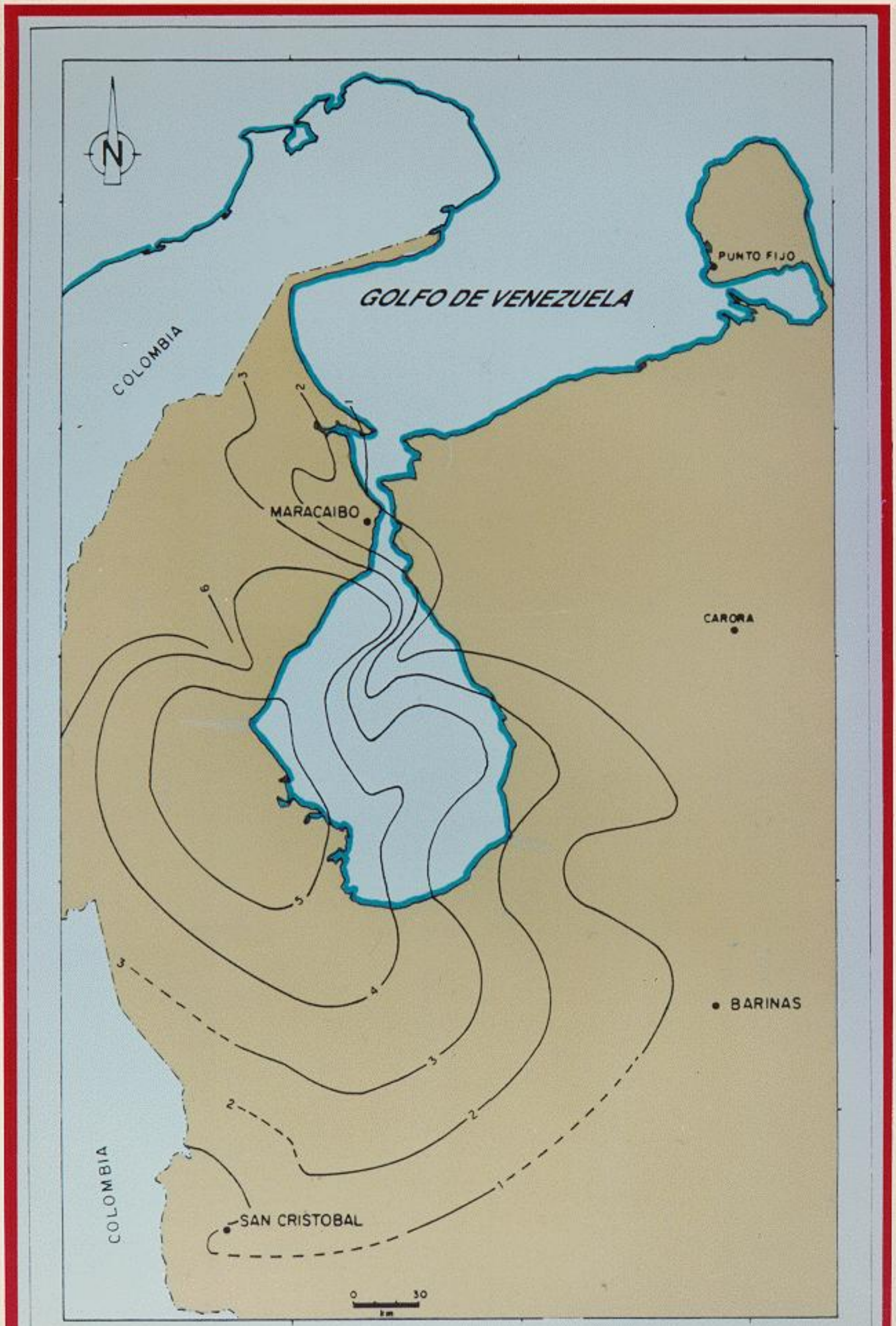
- MIOCENE
- EOCENE
- PALEOCENE
- CRETACEOUS

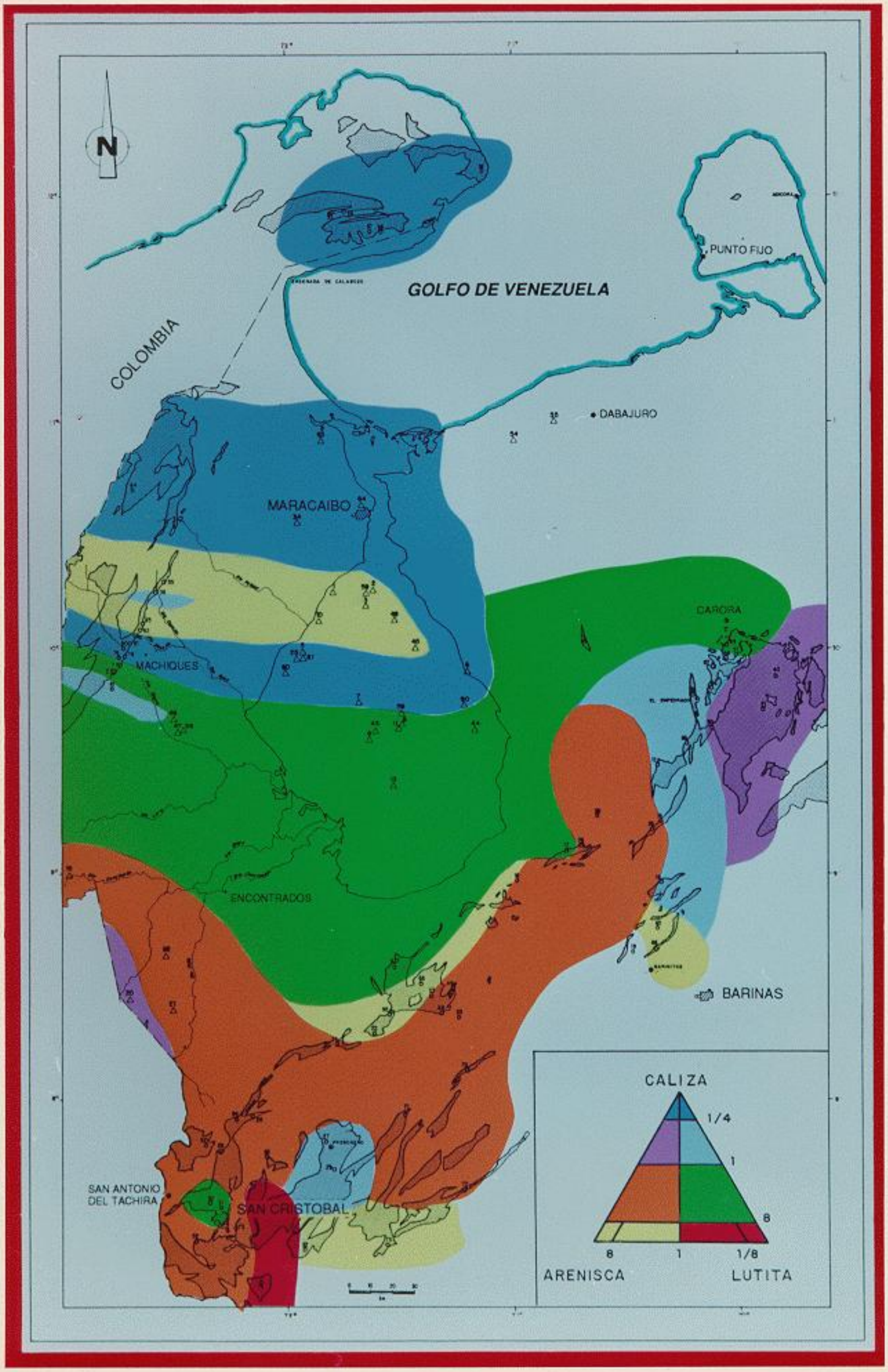
0 50 100 Km

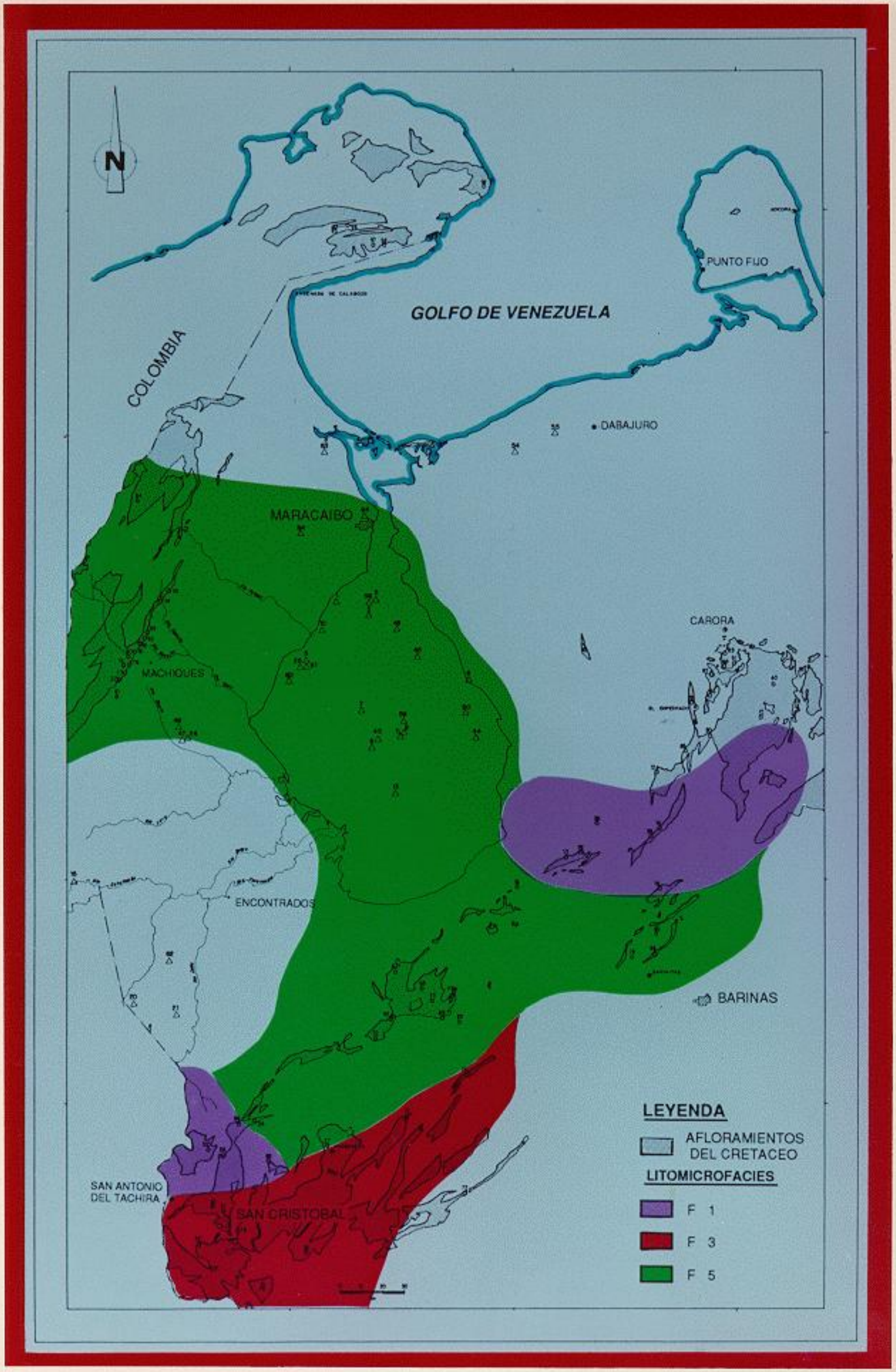
Esc 1:2.000.000

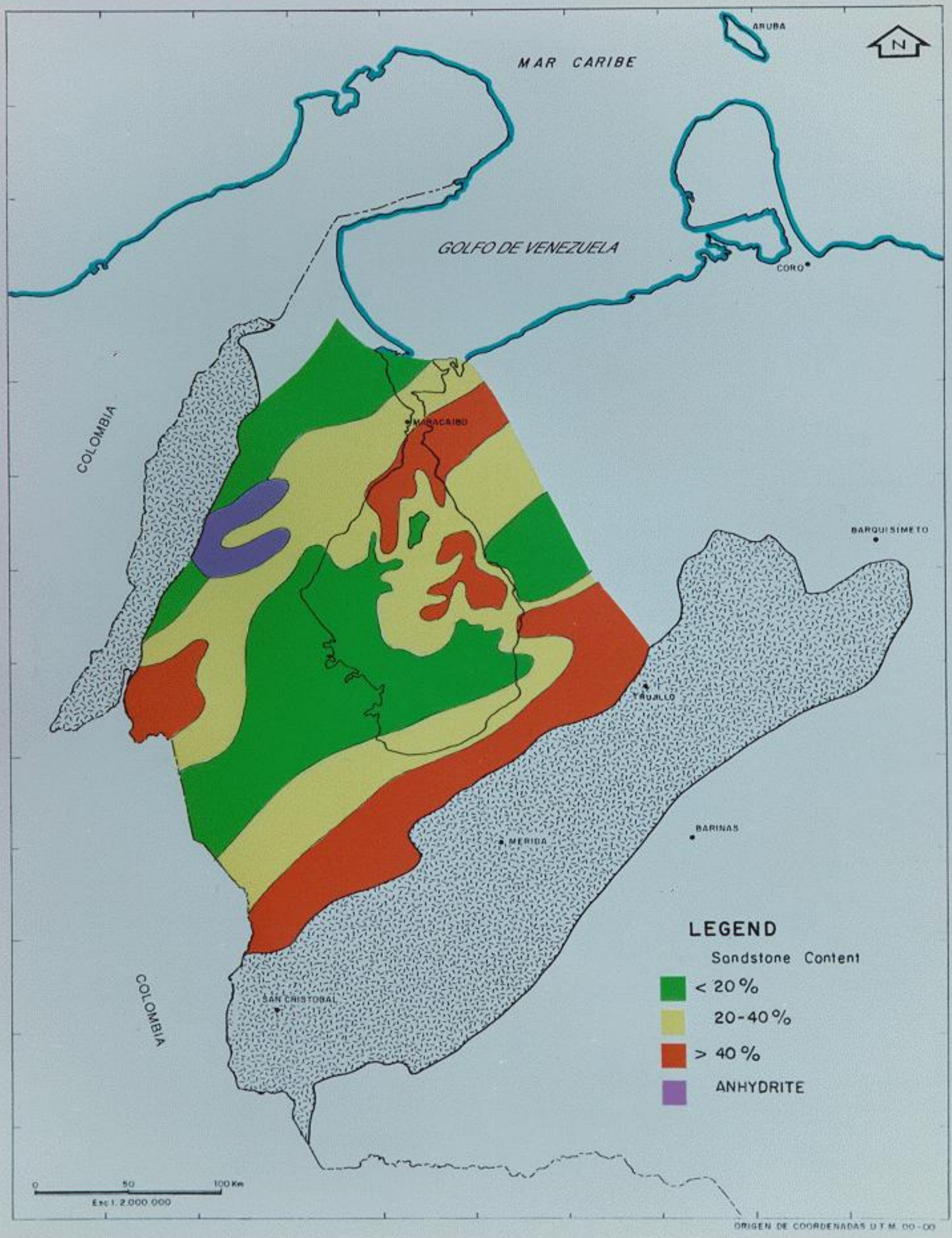
ORIGEN DE COORDENADAS U.T.M. 00 - 00

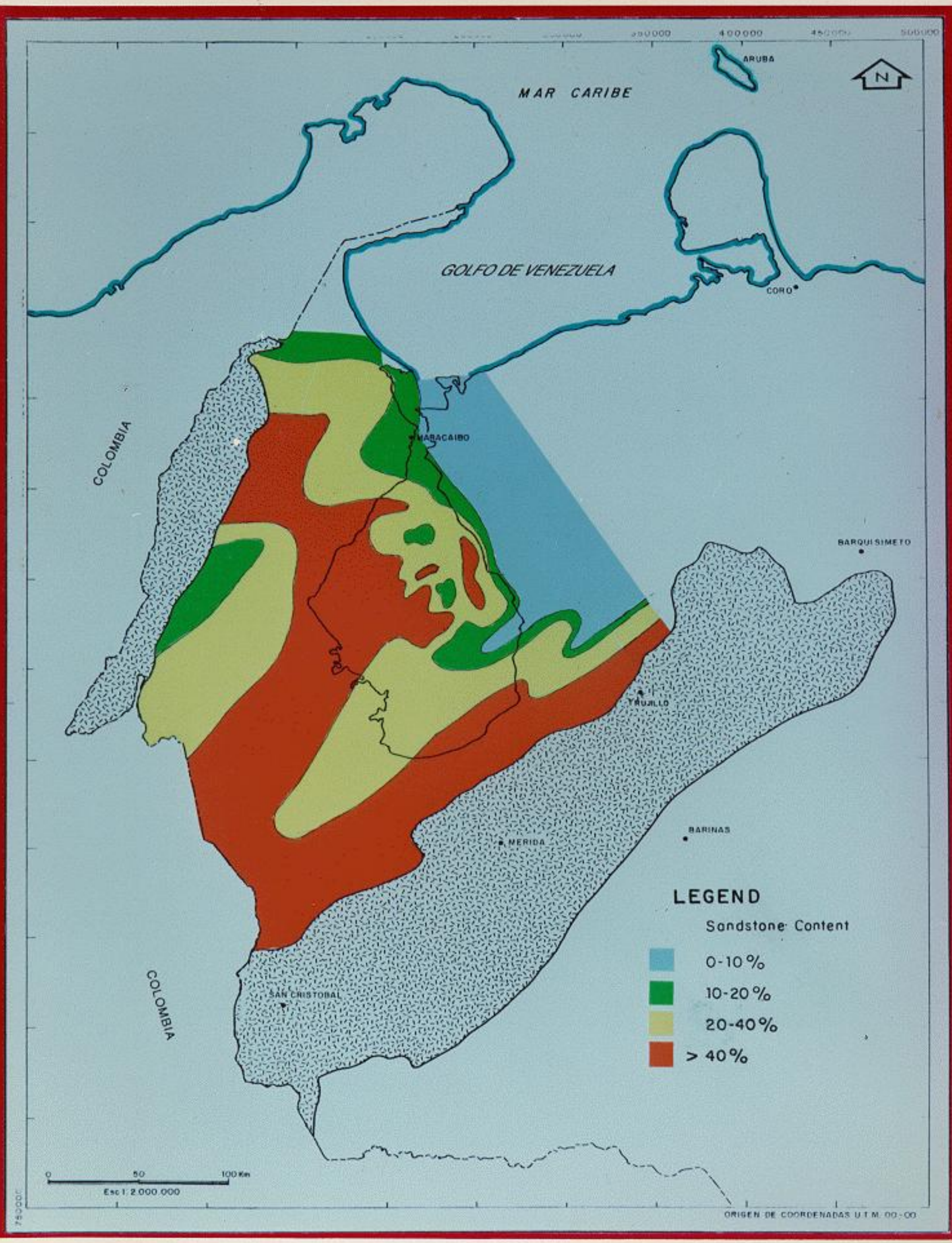

N
GOLFO DE VENEZUELA
COLOMBIA
PUNTO FIJO
MARACAIBO
CARORA
BARINAS
SAN CRISTOBAL
COLOMBIA
100
50
300
200
100
200
300
400
100
200
300
400
200
300
400
100
200
300
400
200
700
300
600
0
30
km


N
GOLFO DE VENEZUELA
COLOMBIA
PUNTO FIJO
MARACAIBO
CARORA
BARINAS
SAN CRISTOBAL
COLOMBIA
0
30
km


N
COLOMBIA
GOLFO DE VENEZUELA
PUNTO FIJO
DABAJURO
MARACAIBO
CARORA
MACHIQUES
ENCONTRADOS
BARINAS
SAN ANTONIO
DEL TACHIRA
SAN CRISTOBAL
CALIZA
1/4
1
8
8
1
1/8
ARENISCA
LUTITA


N
COLOMBIA
GOLFO DE VENEZUELA
PUNTO FIJO
DABAJURO
MARACAIBO
MACHIQUES
CARORA
ENCONTRADOS
BARINAS
SAN ANTONIO
DEL TACHIRA
SAN CRISTOBAL
LEYENDA
AFLORAMIENTOS
DEL CRETACEO
LITOMICROFACIES
F 1
F 3
F 5


ARUBA
N
MAR CARIBE
GOLFO DE VENEZUELA
CORO
COLOMBIA
MARACAIBO
BARQUISIMETO
TRUJILLO
MERIDA
BARINAS
SAN CRISTOBAL
COLOMBIA
LEGEND
Sandstone Content
< 20 %
20-40 %
> 40 %
ANHYDRITE
0
50
100 Km
Esc 1.2.000.000
ORIGEN DE COORDENADAS U.T.M. 00-00


350000
400000
450000
500000
ARUBA
N
MAR CARIBE
GOLFO DE VENEZUELA
CORO
COLOMBIA
MARACAIBO
BARQUISIMETO
TRUJILLO
BARINAS
MERIDA
SAN CRISTOBAL
COLOMBIA
LEGEND
Sandstone Content
0-10 %
10-20 %
20-40 %
> 40 %
0
50
100 Km
Esc 1: 2.000.000
750000
ORIGEN DE COORDENADAS U.T.M. 00-00

MAR CARIBE

ARUBA

N

GOLFO DE VENEZUELA

CORO

COLOMBIA

MARACAIBO

BIODEGRADED
CRUDES

BARQUISIMETO

TRUJILLO

?

BARINAS

MERIDA

SAN CRISTOBAL

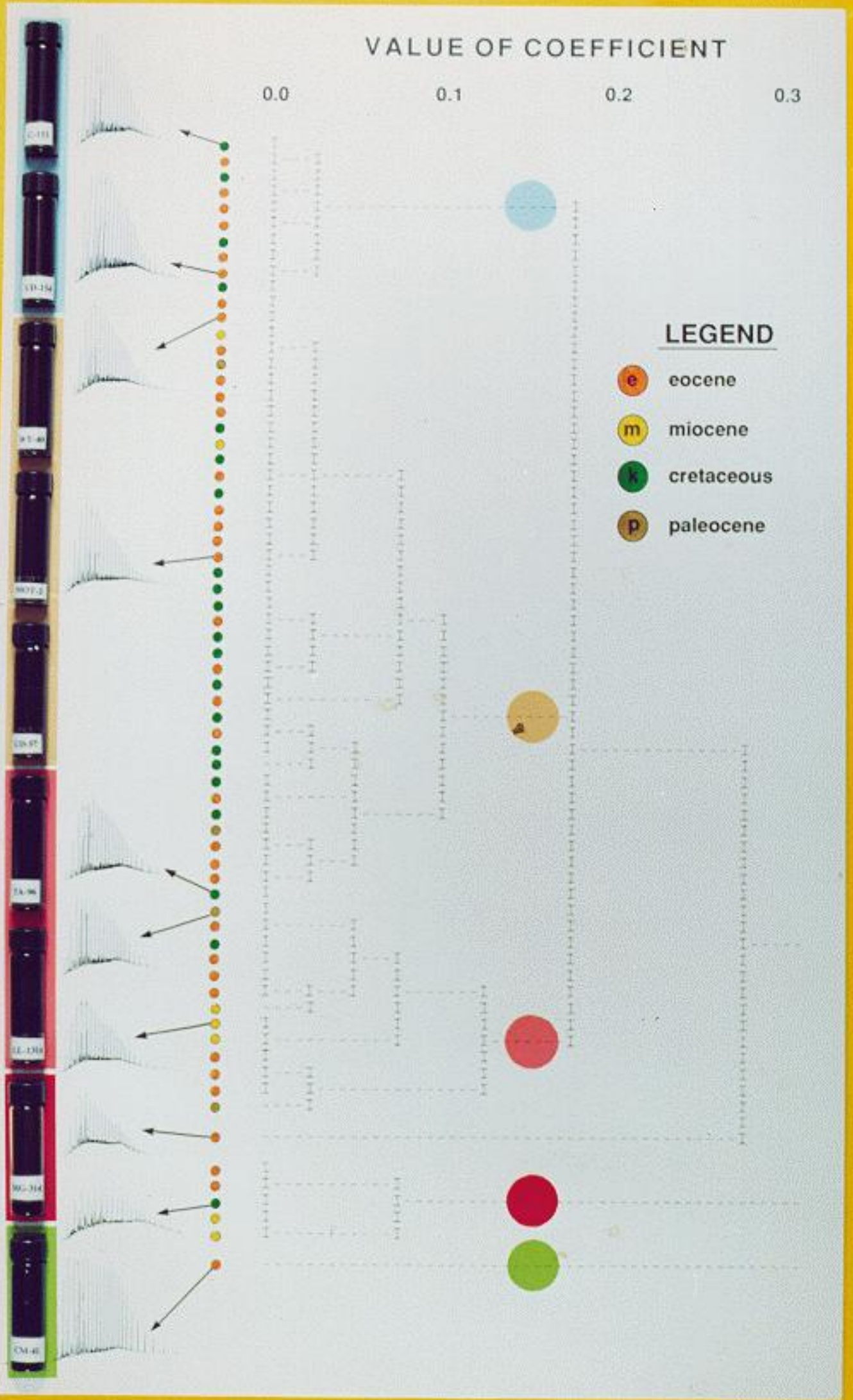
COLOMBIA

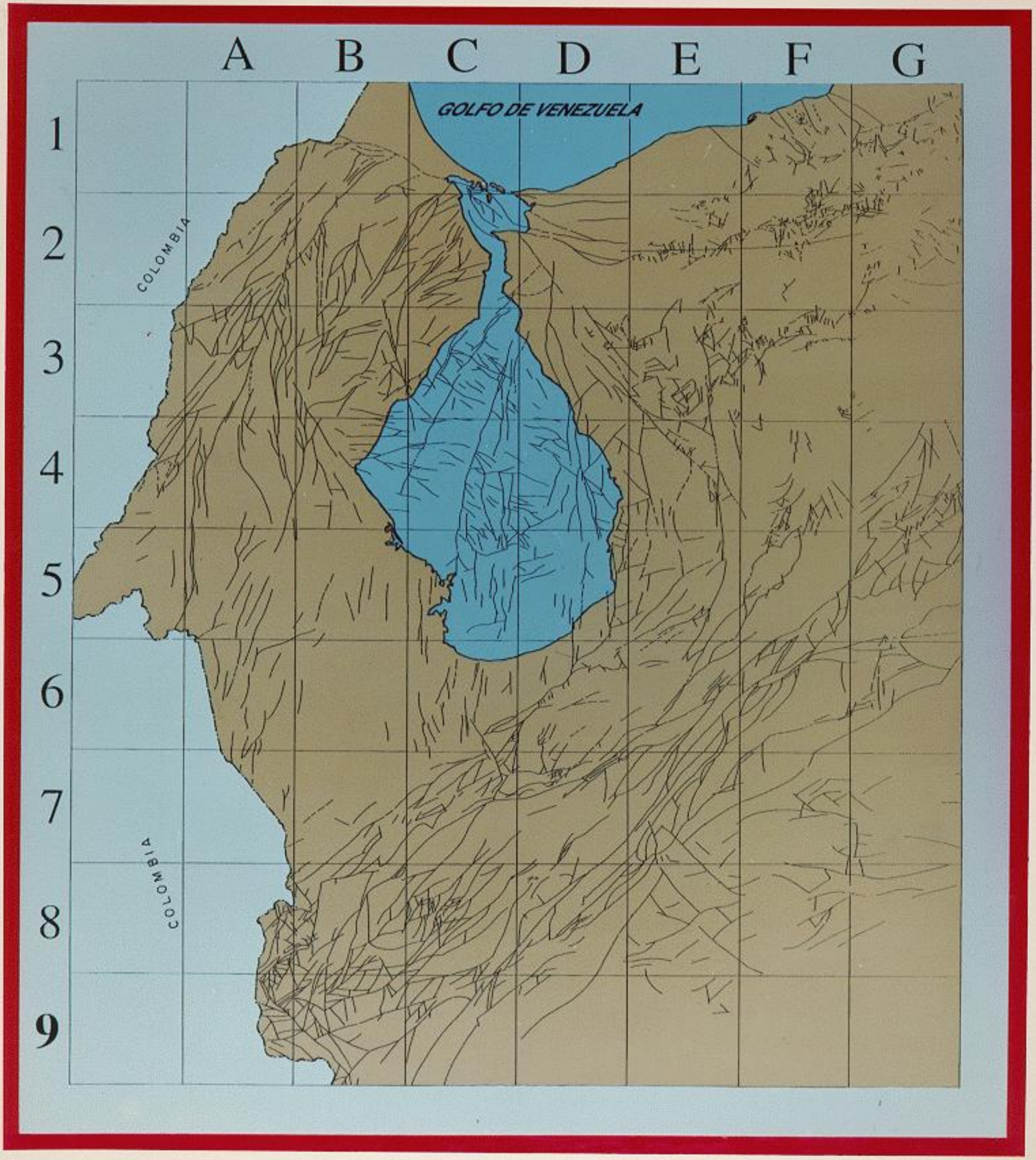
0 50 100 Km

Esc 1: 2.000.000

ORIGEN DE COORDENADAS U.T.M. 00-00

# CLASSIFICATION




A
B
C
D
E
F
G
1
2
3
4
5
6
7
8
9
GOLFO DE VENEZUELA
COLOMBIA
COLOMBIA

MAR CARIBE

ARUBA

GOLFO DE VENEZUELA

COLOMBIA

CORO

MARACAIBO

BARQUISIMETO

TRUJILLO

MERIDA

BARINAS

SAN CRISTOBAL

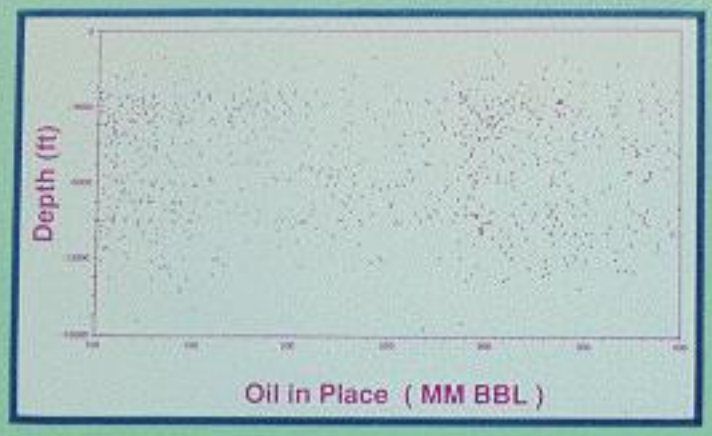
COLOMBIA

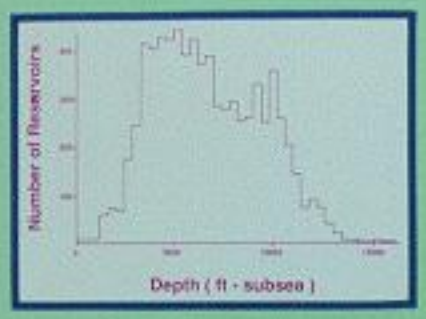
100 TREND OF HYDROCARBON CONCENTRATION
($10^3$ BBLS / ha)

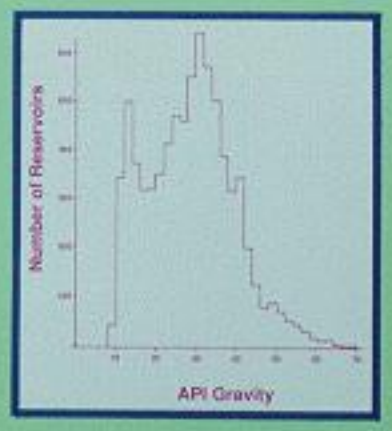
0 50 100 Km
Esc 1: 2.000.000

ORIGEN DE COORDENADAS U.T.M. 00-00

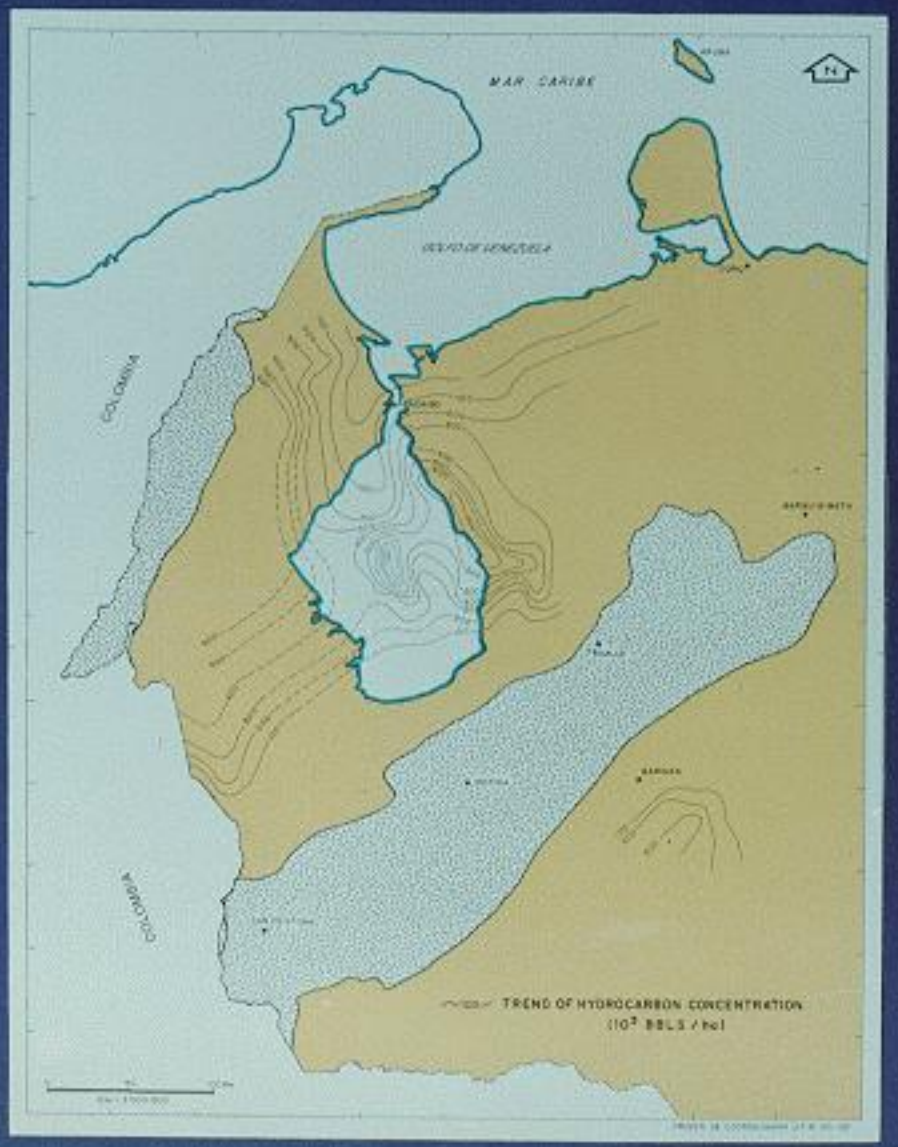
# RESERVOIR CHARACTERISTICS

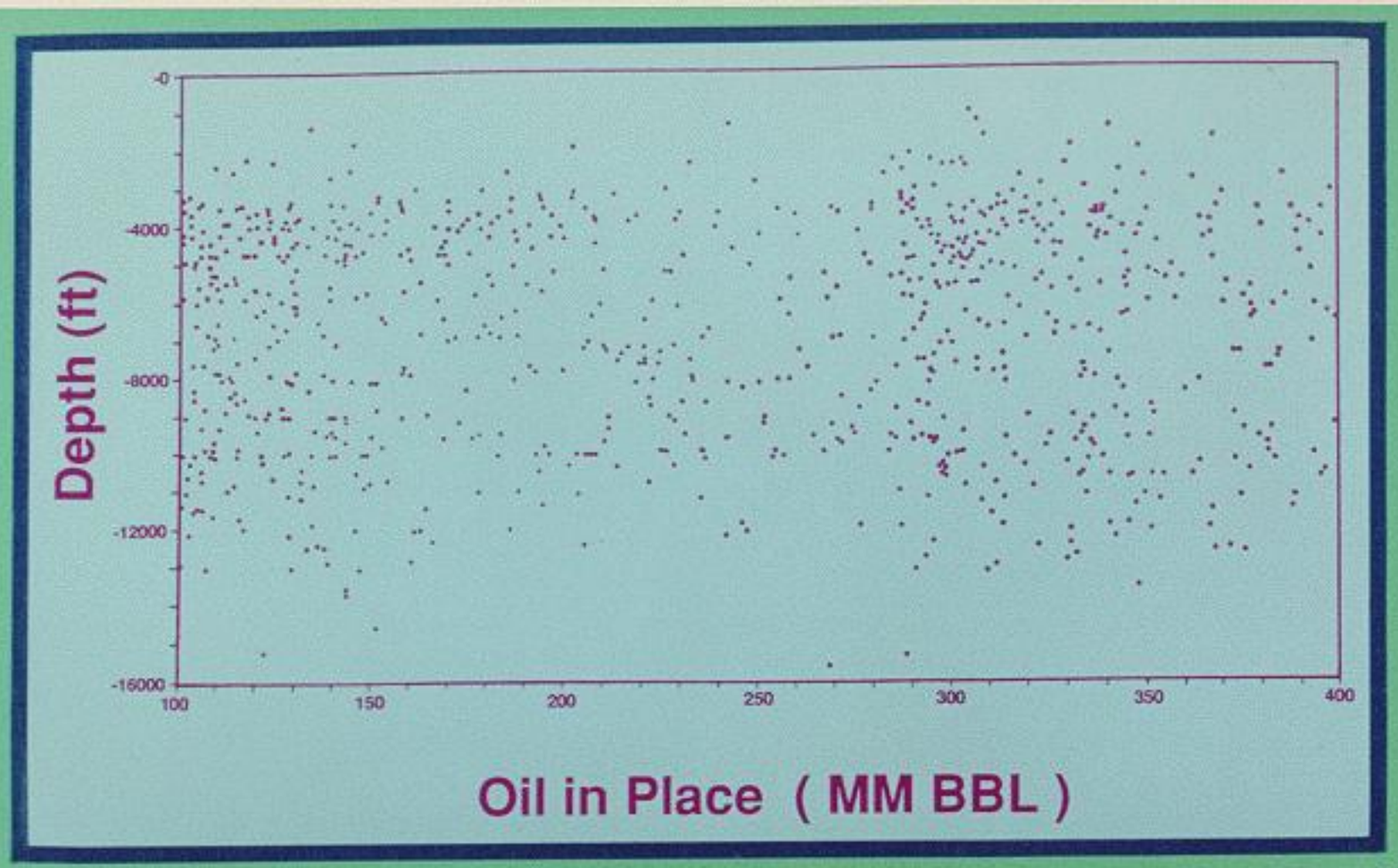


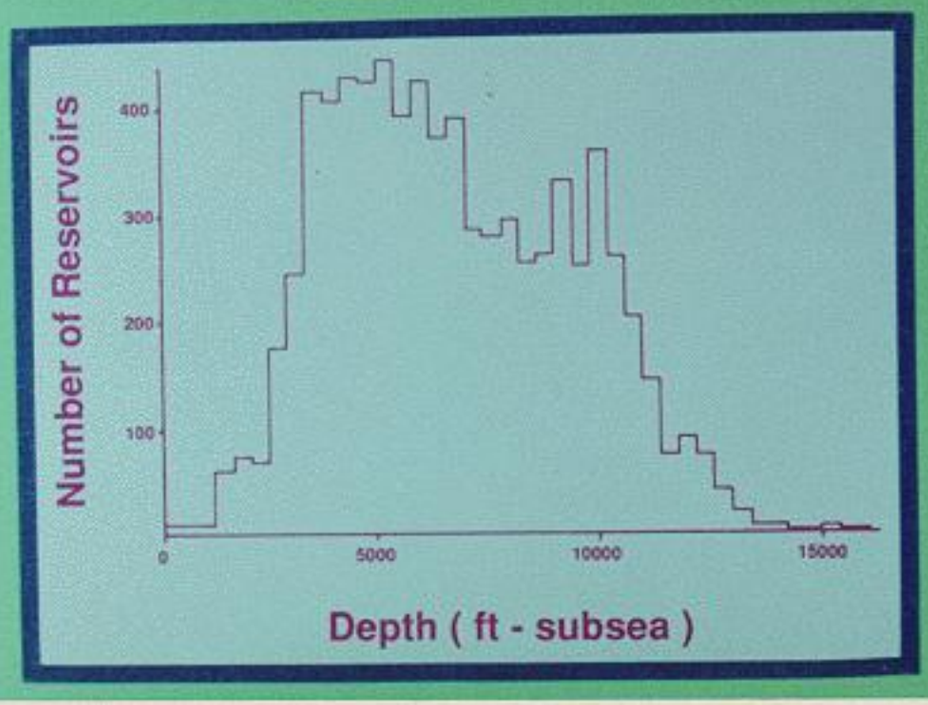



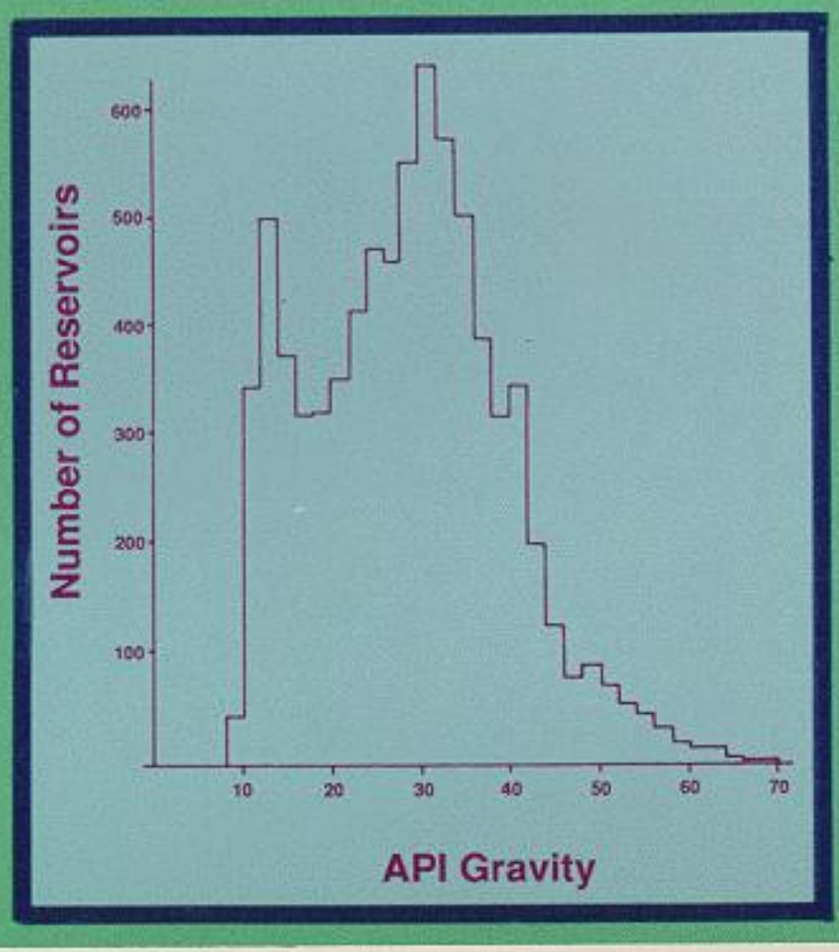




# TREND OF HYDROCARBON CONCENTRATION




Depth (ft)
-0
-4000
-8000
-12000
-16000
100
150
200
250
300
350
400
Oil in Place ( MM BBL )


Number of Reservoirs
400
300
200
100
0
5000
10000
15000
Depth ( ft - subsea )


Number of Reservoirs
600
500
400
300
200
100
10
20
30
40
50
60
70
API Gravity