

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

Assessment of undiscovered conventionally recoverable petroleum resources
of North Africa (including Egypt, Libya, eastern Tunisia, Pelagian
shelf, and central Algeria)

By

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This report is preliminary and has not been reviewed for conformity with
U.S. Geological Survey editorial standards and stratigraphic nomenclature.

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ASSESSMENT OF ENERGY RESOURCES

This report was prepared as part of the World Energy Resources Program of the U.S. Geological Survey (USGS). The objective of the study is to assess the undiscovered conventionally recoverable resources remaining within the petroleum producing provinces. The study utilizes geological and petroleum engineering data, in conjunction with statistical techniques, to estimate undiscovered resources by a process involving a team of geologists and statisticians. The estimates represent the views of the U.S. Geological Survey estimation team and should not be regarded as an official Department of the Interior position.

Other U.S. Geological Survey publications relating to the assessment of undiscovered conventionally recoverable petroleum resources include the following:

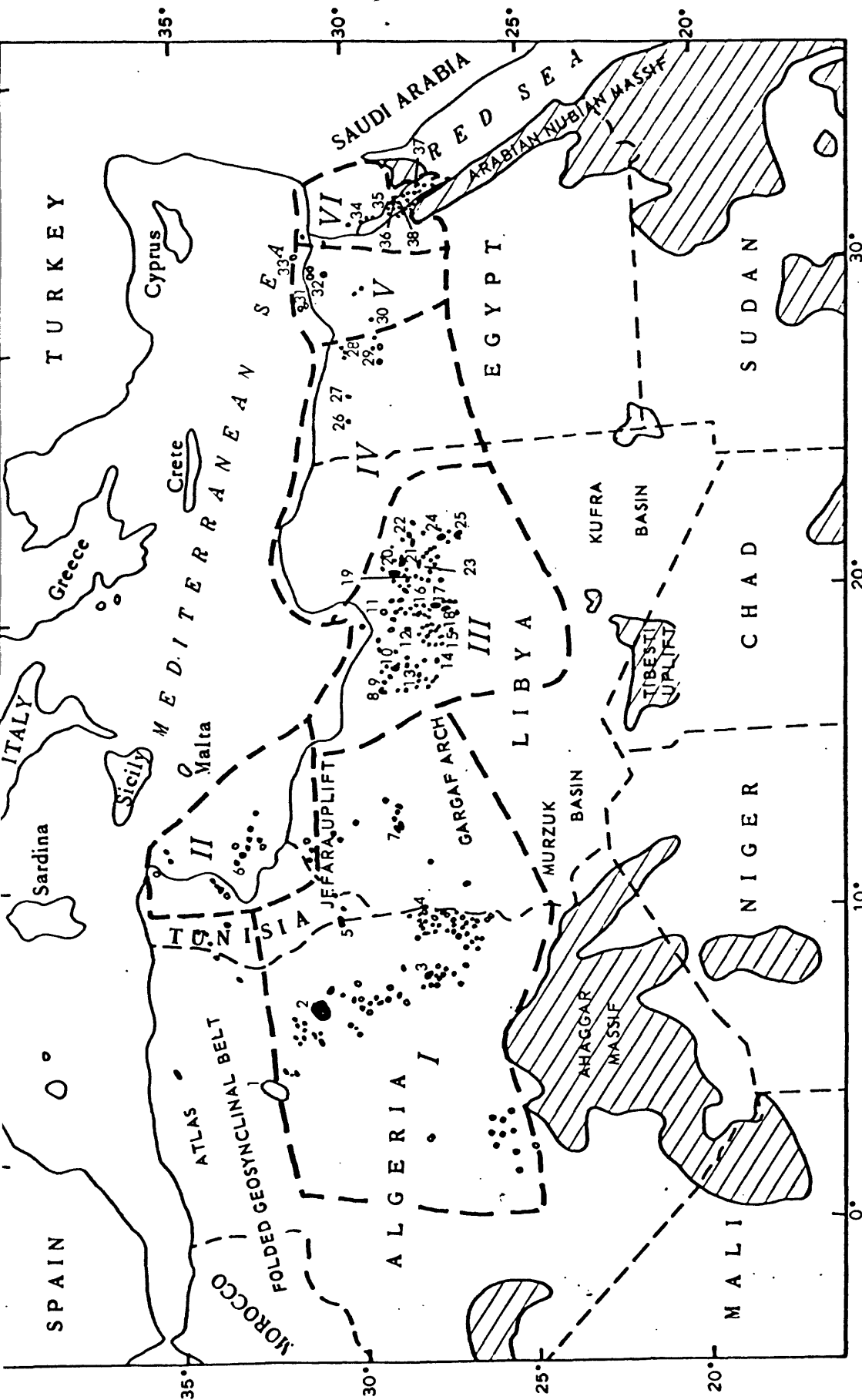
Open-File Reports	81-0986 - Persian Gulf basin and Zagros fold belt (Arabian-Iranian basin)
	81-1027 - Volga-Ural basin
	81-1142 - Indonesia
	81-1143 - Northeastern Mexico
	81-1144 - Southeastern Mexico, northern Guatemala, and Belize
	81-1145 - Trinidad
	81-1146 - Venezuela
	81-1147 - West Siberia and Kara Sea basins
	82-0296 - Middle Caspian basin
	82-1027 - East Siberian basin

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INTRODUCTION

The locations of the North Africa provinces are shown in figure 1. Estimates by the USGS of oil and gas resources in these basins are given in table 1 and figures 2-15. Data supplementary to these estimates are supplied in table 2.



ASSESSMENT AREAS:

- I. Erg Occidental, Erg Oriental, and Hamada basins II. East Tunisia-Pelagian Shelf-Northwest Libya province
 III. Sirte basin IV. Cyrenaica Shelf-Western Desert basin V. Nile Delta-Nile basin VI. Suez-Sinai province

 Precambrian rocks exposed at surface
  Oil field
  Gas field



EXPLANATION

Names of fields numbered on figure 1

Erg Occidental basin, Algeria

1. Hassi R' Mel

Erg Oriental basin, Algeria

2. Hassi Messaud
3. Tamendjelt
4. Alrar
5. El Borma

East Tunisia - Pelagian shelf

6. Ashtart

Hamada basin, Libya

7. Hamadah

Sirte basin, Libya

8. Mabruk
9. Bahi
10. Dahra-Hofra
11. Hateiba
12. Raguba
13. Ed Dib
14. Sabah
15. Beda, Samah, and Bel Hedan
16. Nasser
17. Waha
18. Defa
19. Intisar - "A"
20. Amal
21. Aguila
22. Abu Tiffel
23. Gialo
24. Messla
25. Sarir

Western Desert basin, Egypt

26. Umbarka
27. Meleiha
28. El Alamein
29. Abu al Gharadig

Nile Delta, Egypt

30. East Mubarak
31. Abu Qir
32. Abu Madi
33. El Temsah

Suez-Sinai province, Egypt

34. Asl
35. Abu Rudeis - Sidri
36. Belaiym
37. Morgan
38. July

Table 1.--Assessment of undiscovered conventionally recoverable petroleum resources of North Africa (Egypt, Libya, eastern Tunisia, Pelagian shelf, and central Algeria)

Resource assessment by USGS as of 7/29/82; see also figures 2 to 15.

Region	Crude oil in billions of barrels (BB)			Natural gas in trillions of cubic feet (Tcf) and billions of barrels of oil equivalent (BBOE) @ 6,000 cuft/bbl.		
	<u>Low</u> (F ₉₅) ^{1/}	<u>High</u> (F ₅) ^{1/}	<u>Mean</u>	<u>Low</u> (F ₉₅) ^{1/}	<u>High</u> (F ₅) ^{1/}	<u>Mean</u>
I. Erg Occidental, Erg Oriental, and Hamada basins of central Algeria northwest Libya	2.3	15.4	7.7	5.6	52.7	25.1
II. Eastern Tunisia - Pelagian shelf - northwestern Libya	0.8	7.8	3.6	5.9	42.7	20.1
III. Sirte basin, Libya	2.9	19.3	9.4	4.3	39	17.7
IV. Cyrenaica shelf, Libya - Western Desert basin, Egypt	0.3	4.2	1.7	1.0	12.3	5.2
V. Nile Delta - Nile basin, Egypt	0.2	2.6	1.1	5.8	41.7	21.4
VI. Suez-Sinai province, Egypt	0.8	4.7	2.4	0.9	6.8	3.2
Total of the above North Africa provinces: ^{2/}	15.3	39.3	25.9	55.6	137.2	92.7

^{1/} F₉₅ denotes the 95th fractile; the probability of more than the amount F₉₅ is 95 percent. F₅ is defined similarly.

^{2/} Totals are derived by statistical aggregation; only the mean total equals the sum of the component parts.

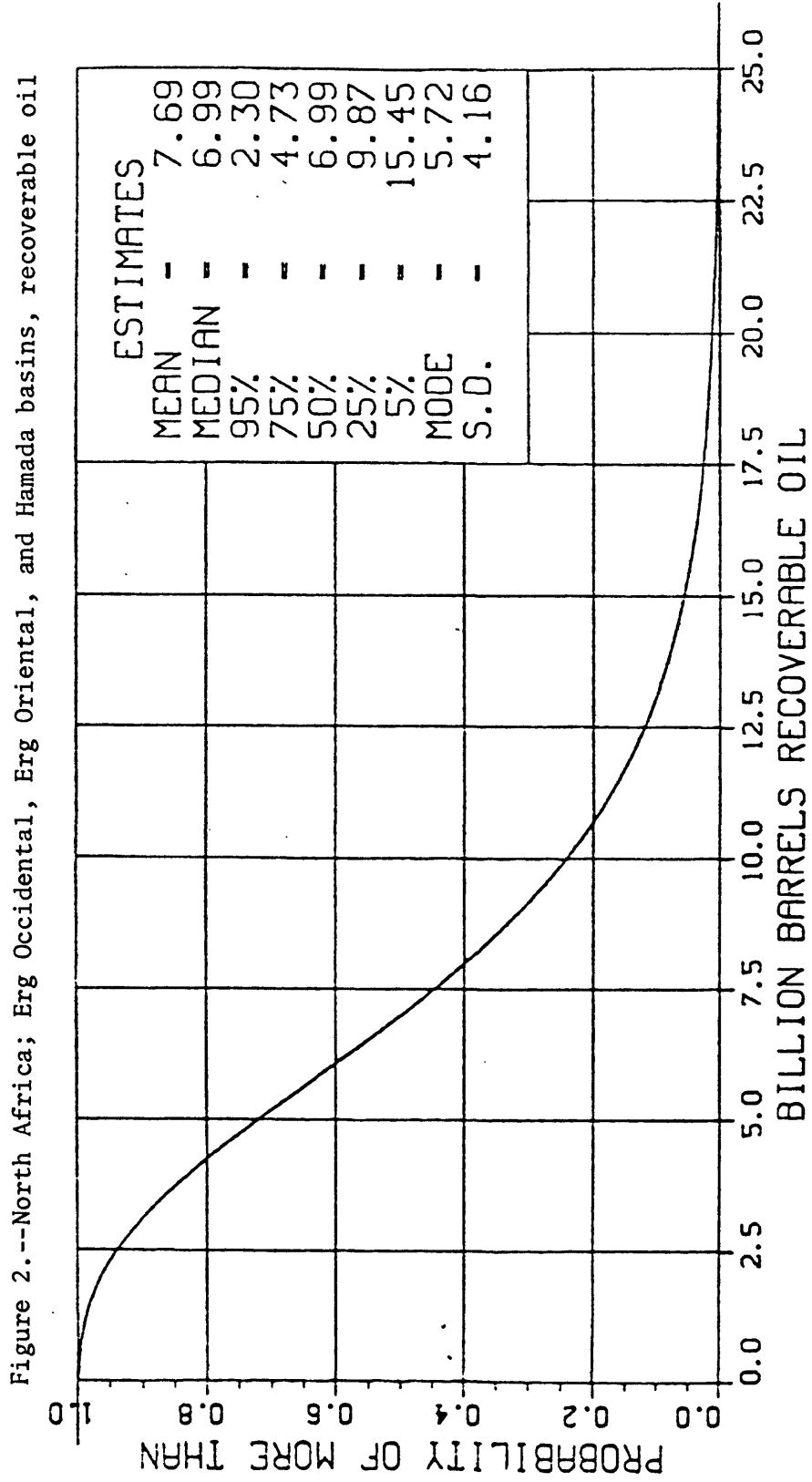


Figure 3.--North Africa; Erg Occidental, Erg Oriental, and Hamada basins, total recoverable gas

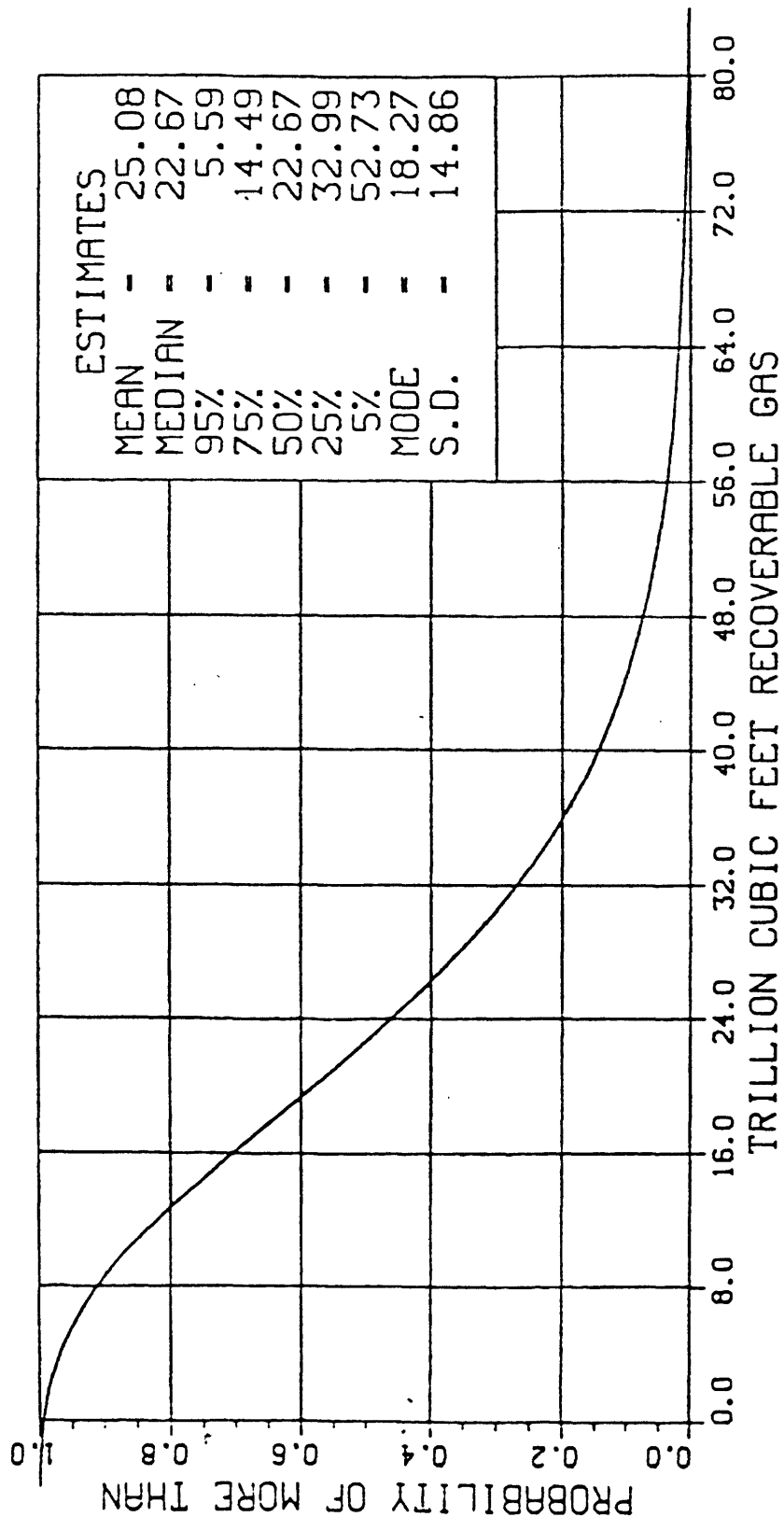


Figure 4.--North Africa; East Tunisia-Pelagian Shelf-Northwest Libya province, recoverable oil

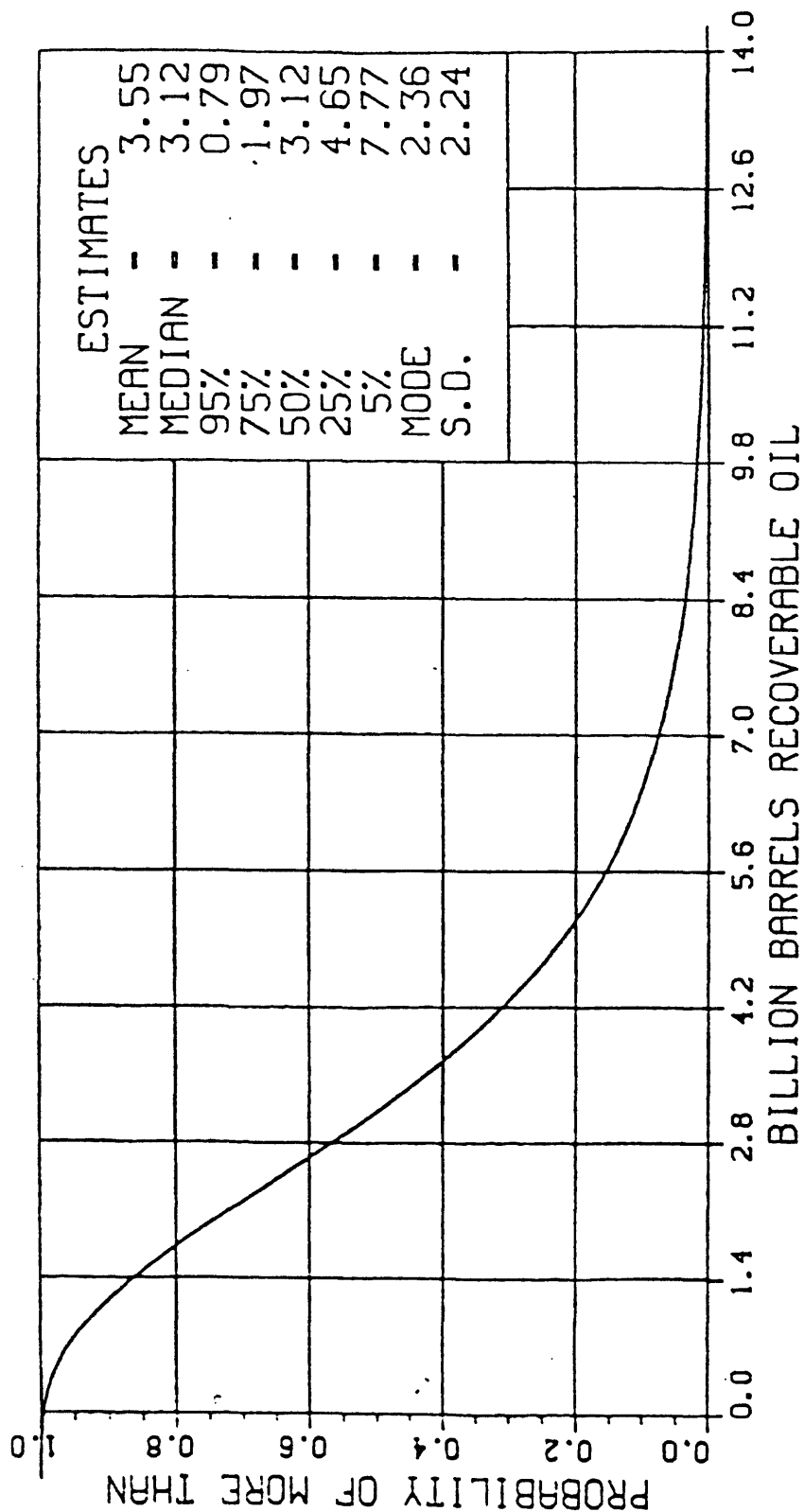


Figure 5.--North Africa; East Tunisia-Pelagian Shelf-Northwest Libya province, total recoverable gas

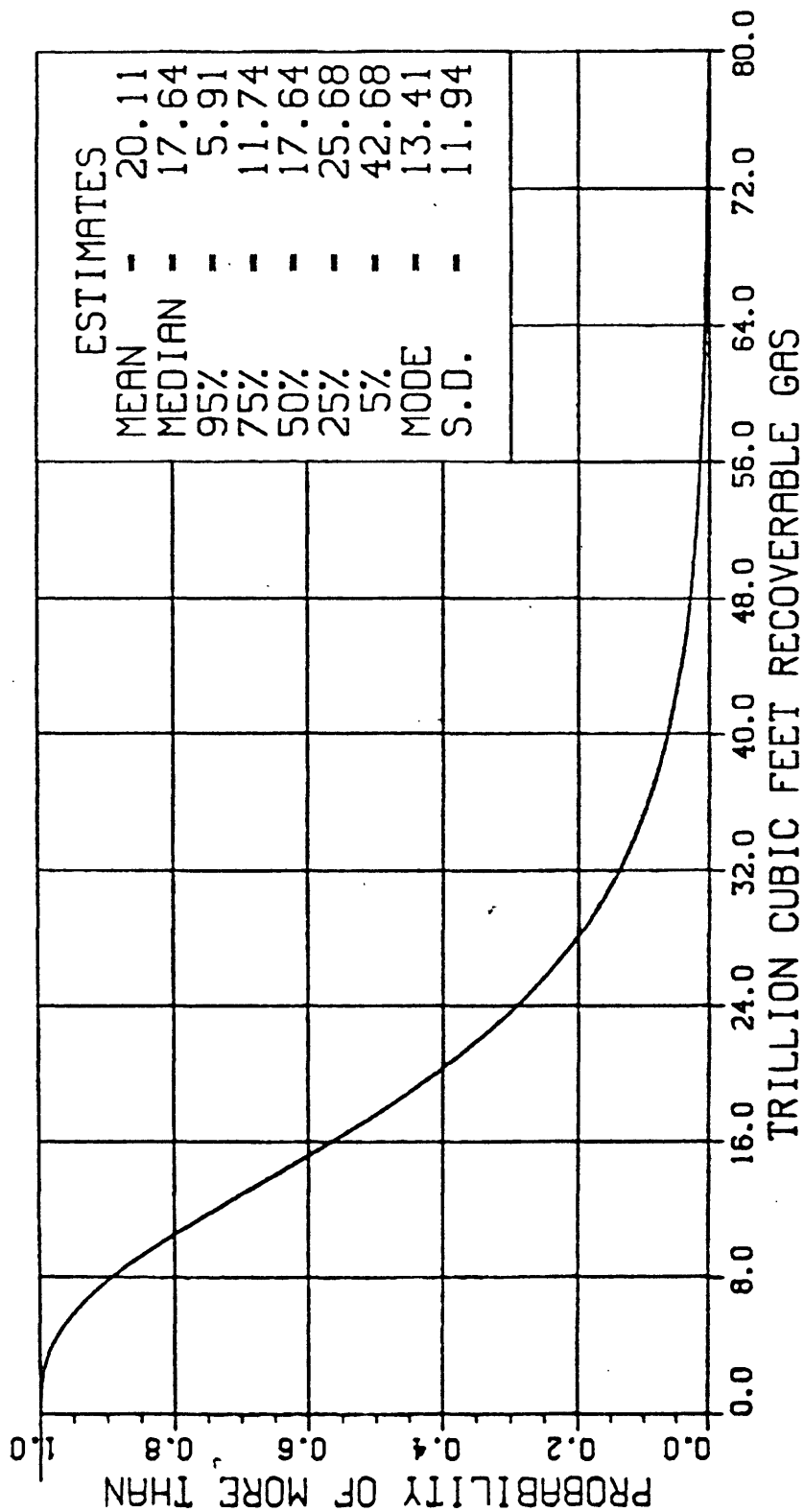


Figure 6.--North Africa; Sirte basin, Libya, recoverable oil

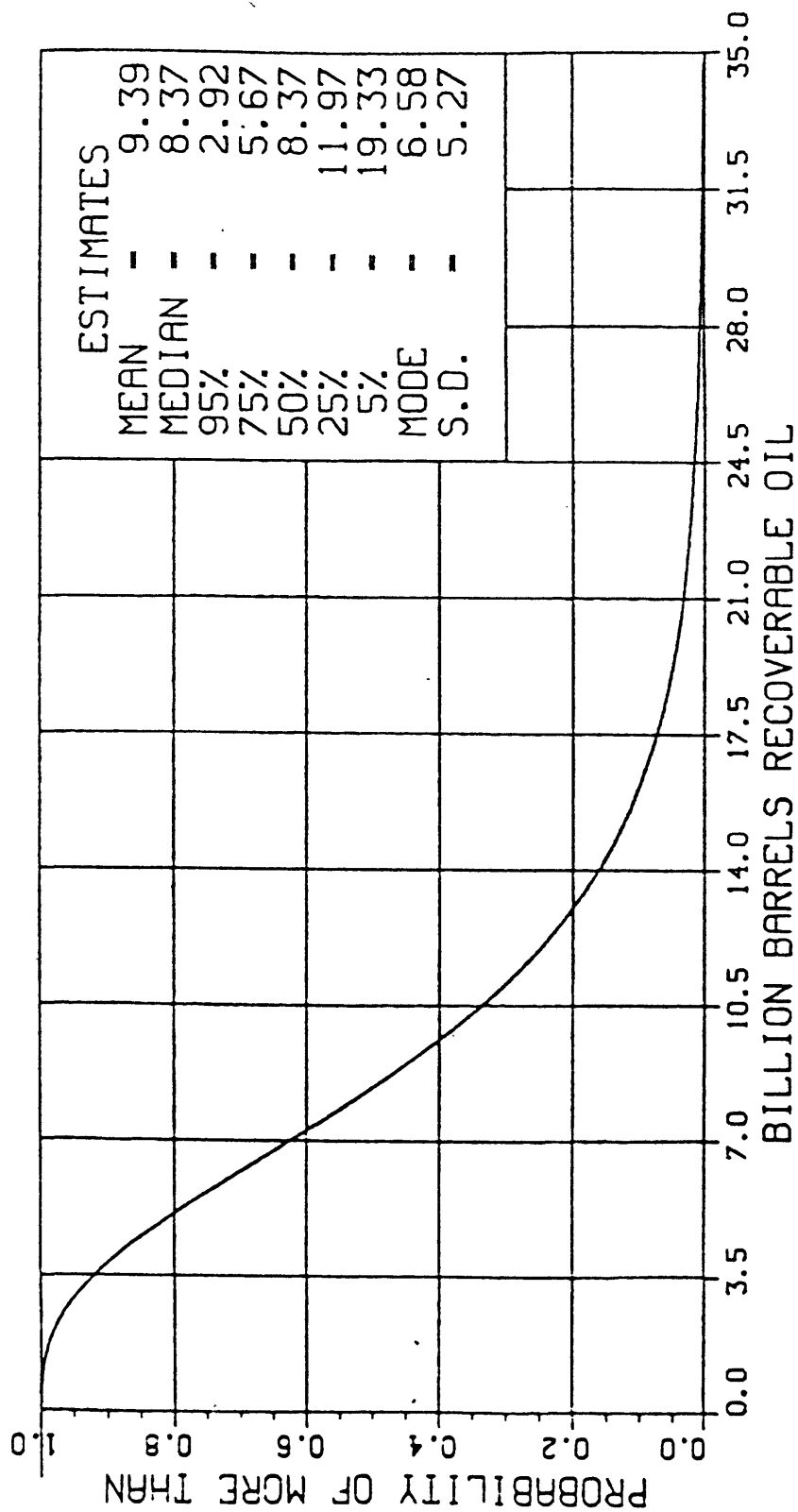


Figure 7.--North Africa; Sirte basin, Libya, total recoverable gas

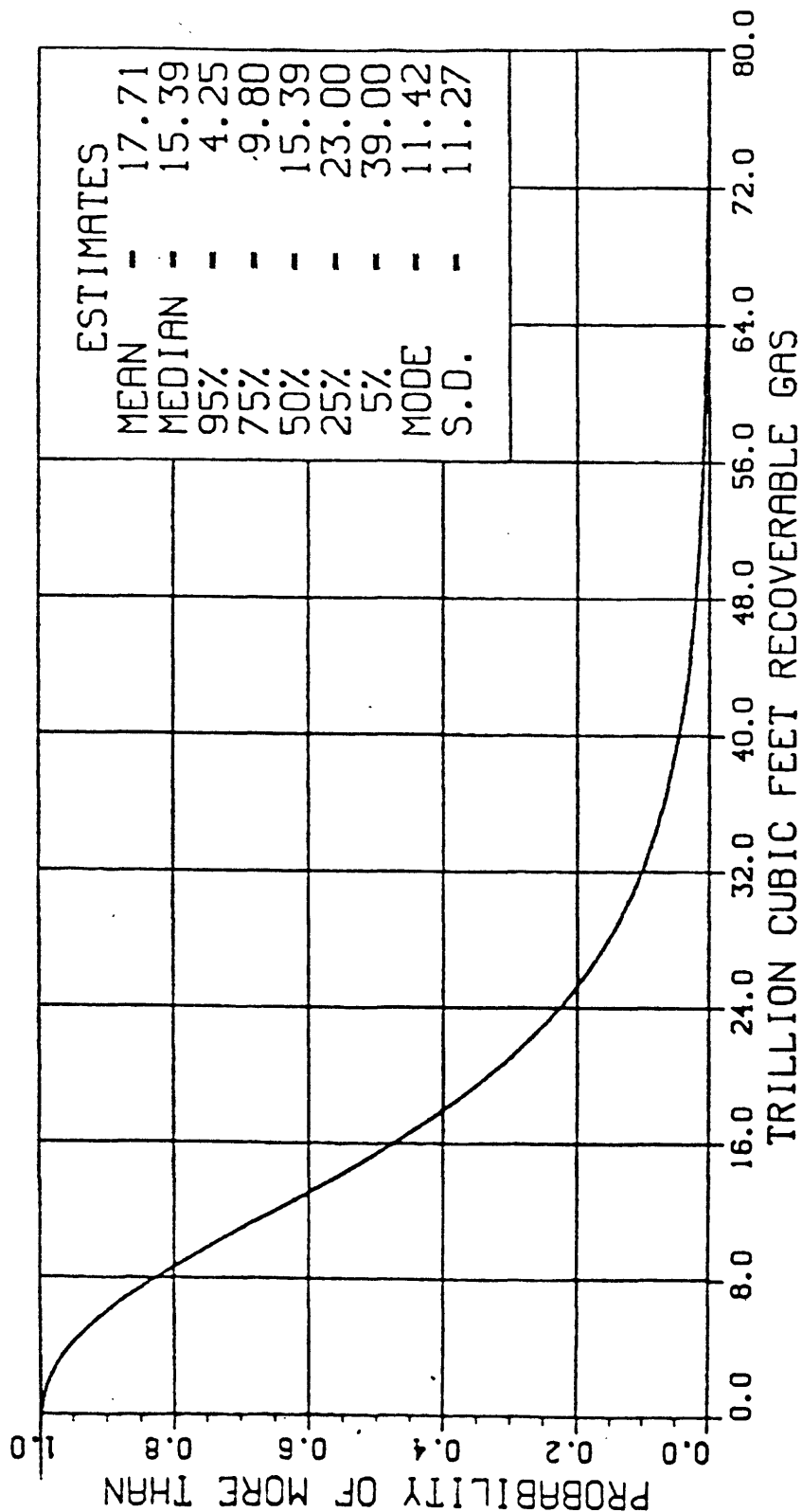


Figure 8.--North Africa; Cyrenaica shelf-Western Desert, Egypt, recoverable oil

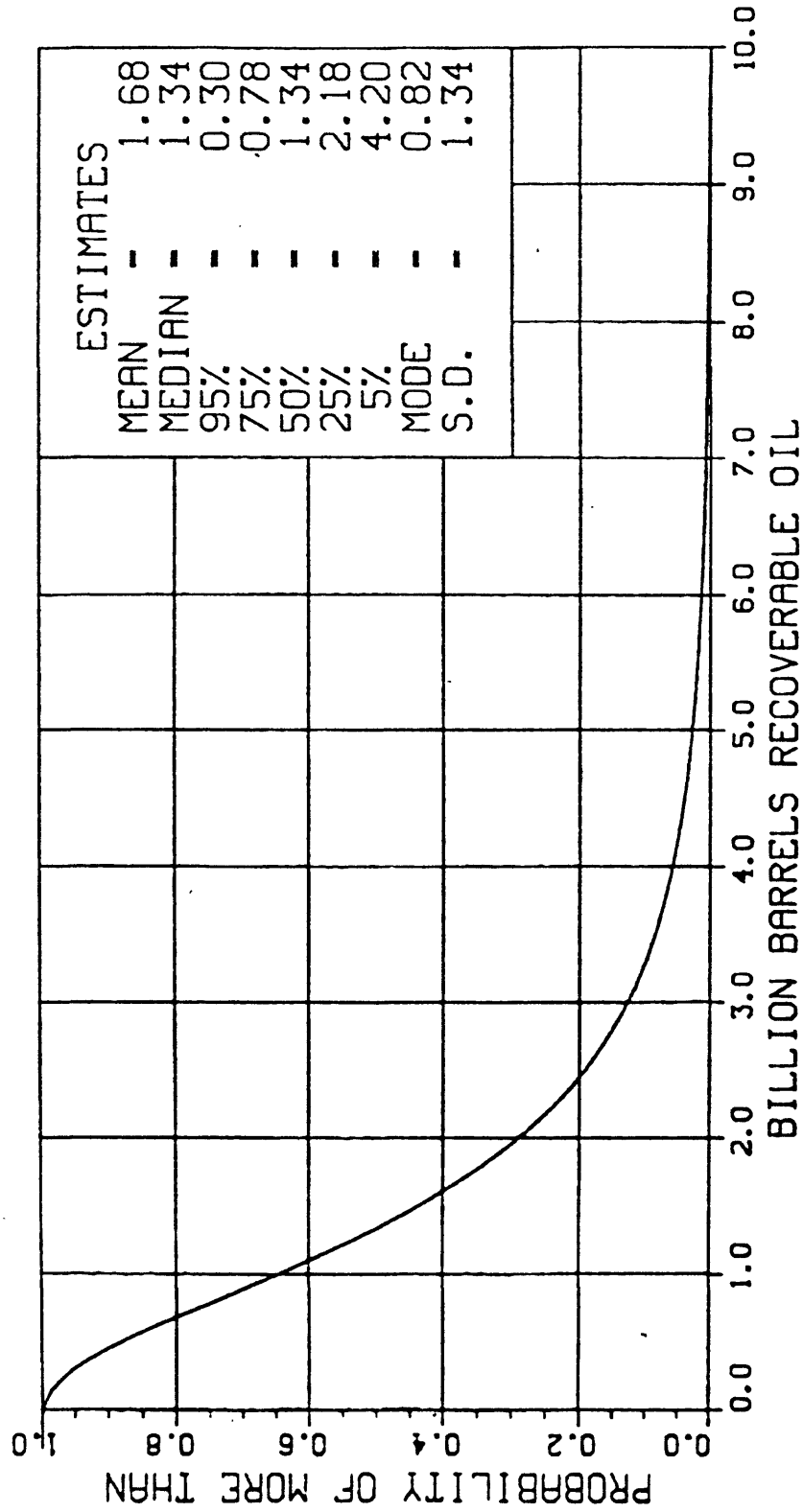


Figure 9.--North Africa; Cyrenaica shelf-Western Desert, Egypt, total recoverable gas

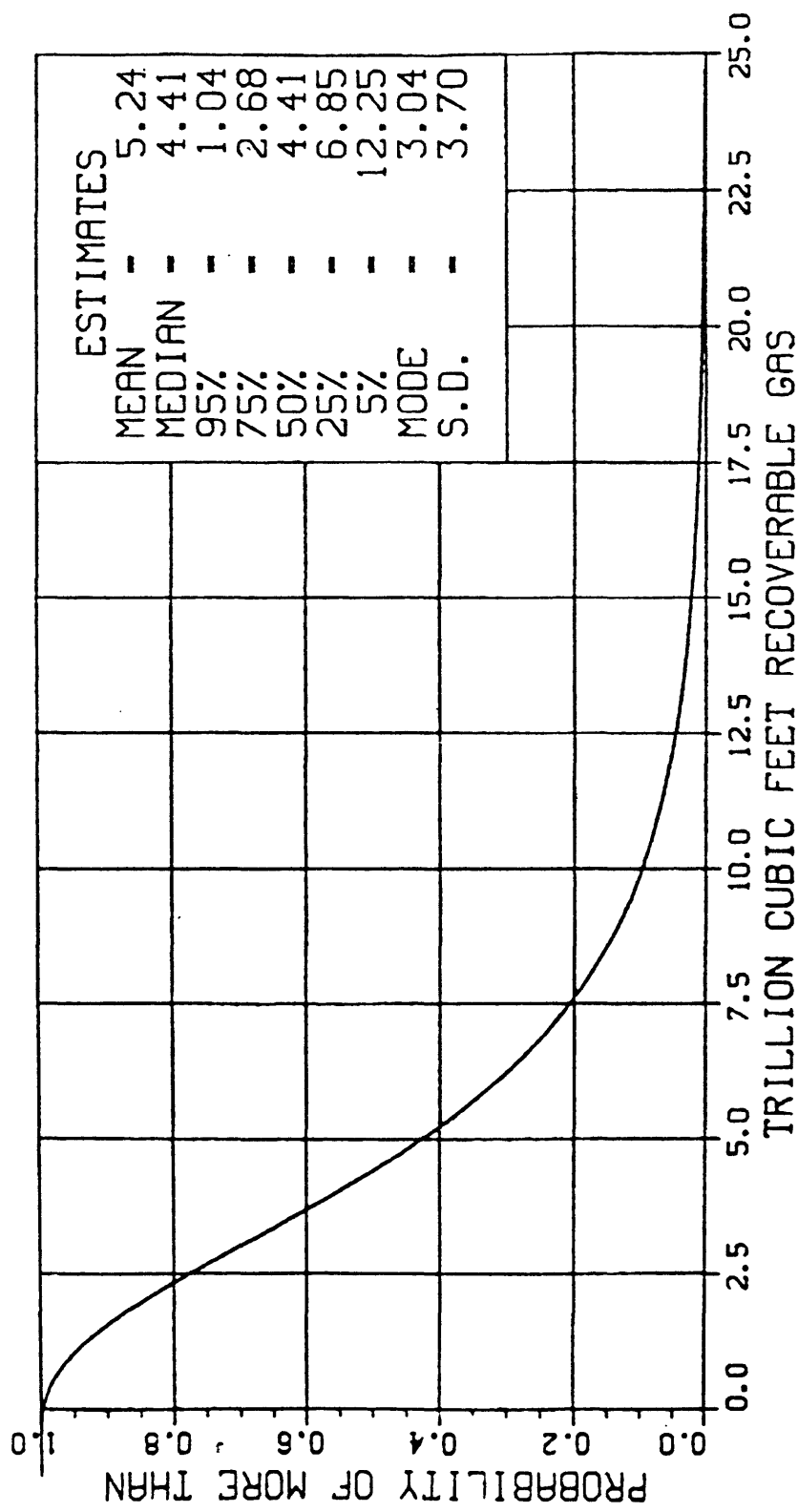


Figure 10.--North Africa; Nile Delta-Nile basin, Egypt, recoverable oil

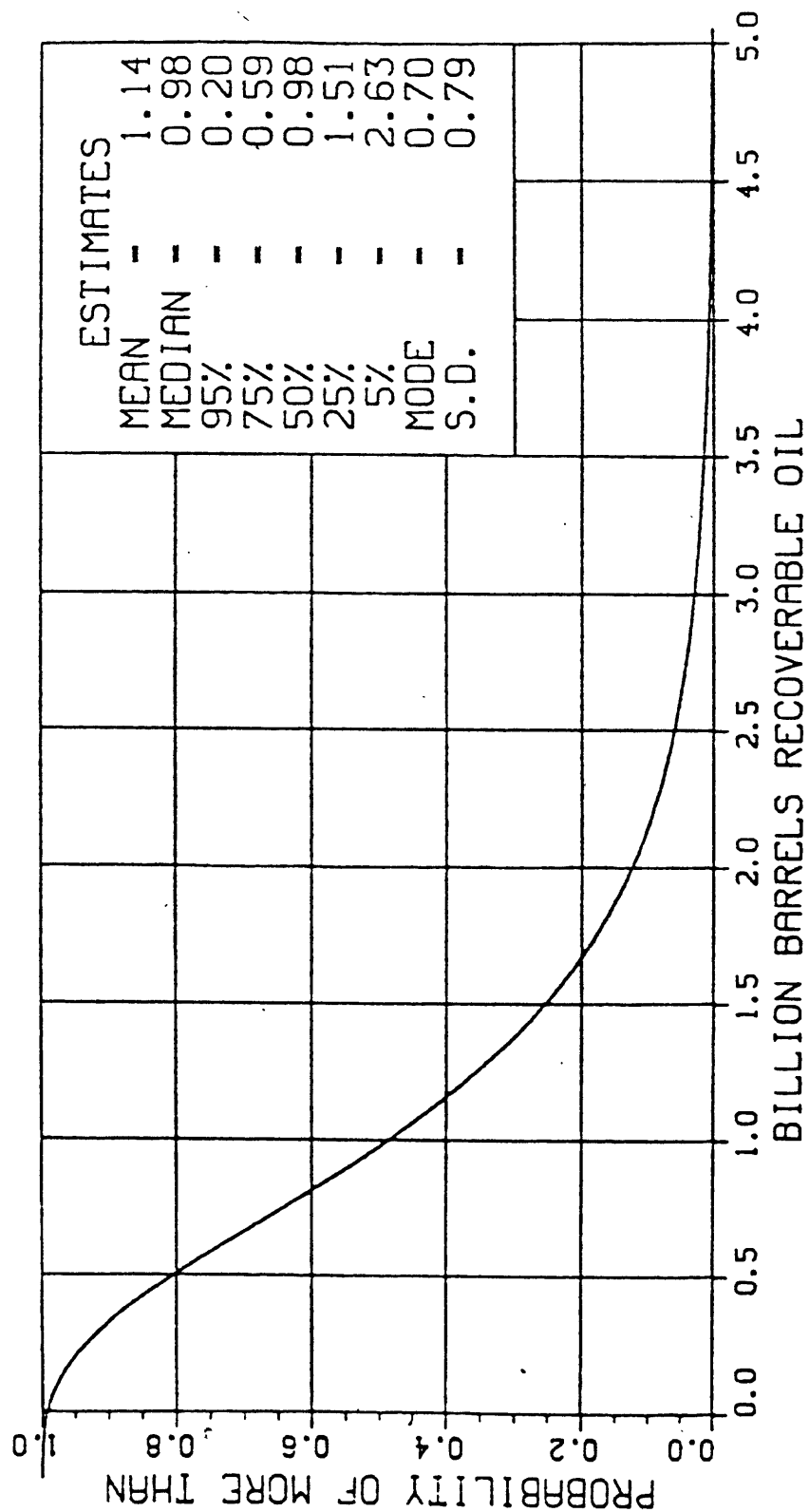


Figure 11.--North Africa; Nile Delta-Nile basin, Egypt, total recoverable gas

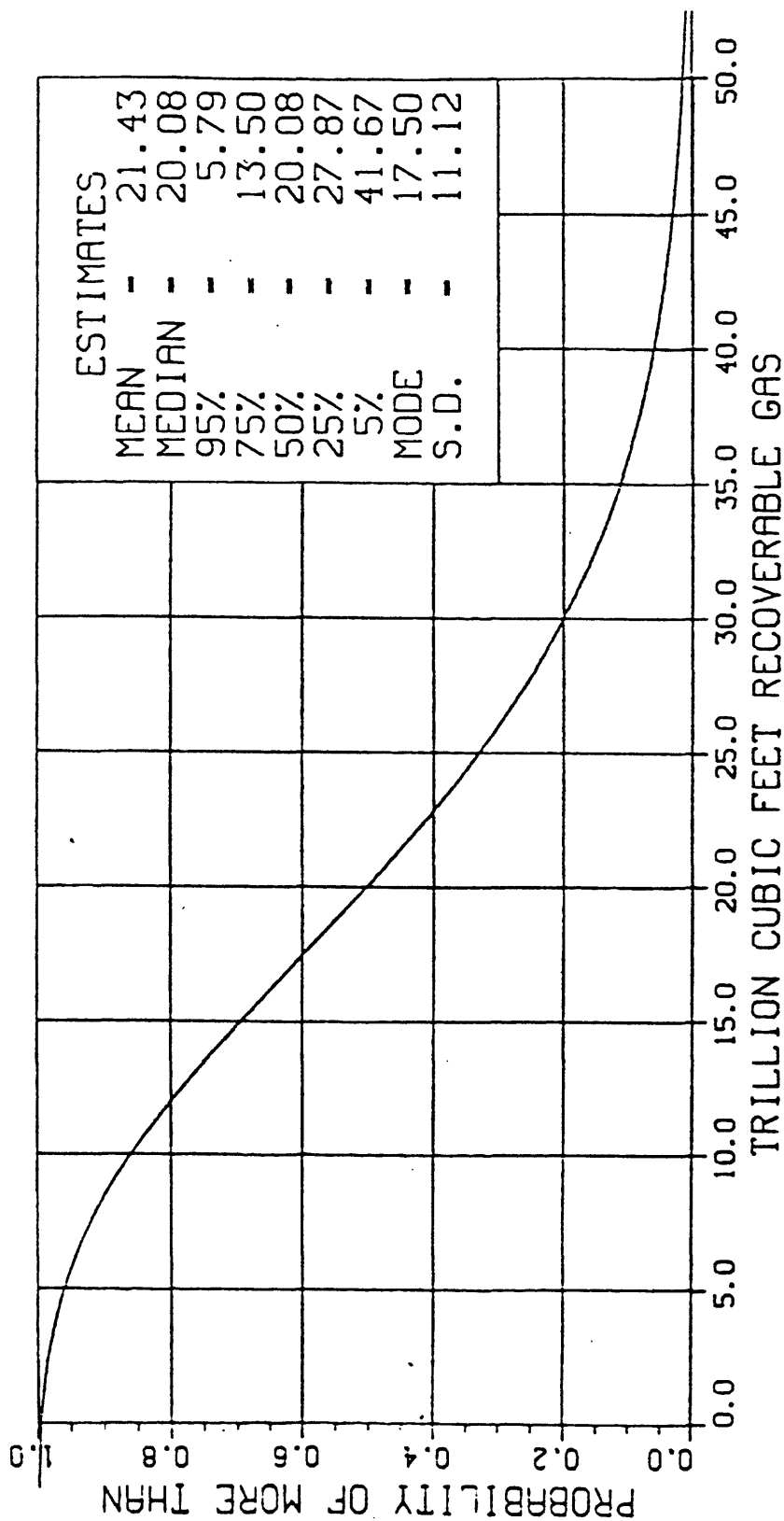


Figure 12.--North Africa; Suez-Sinai province, Egypt, recoverable oil

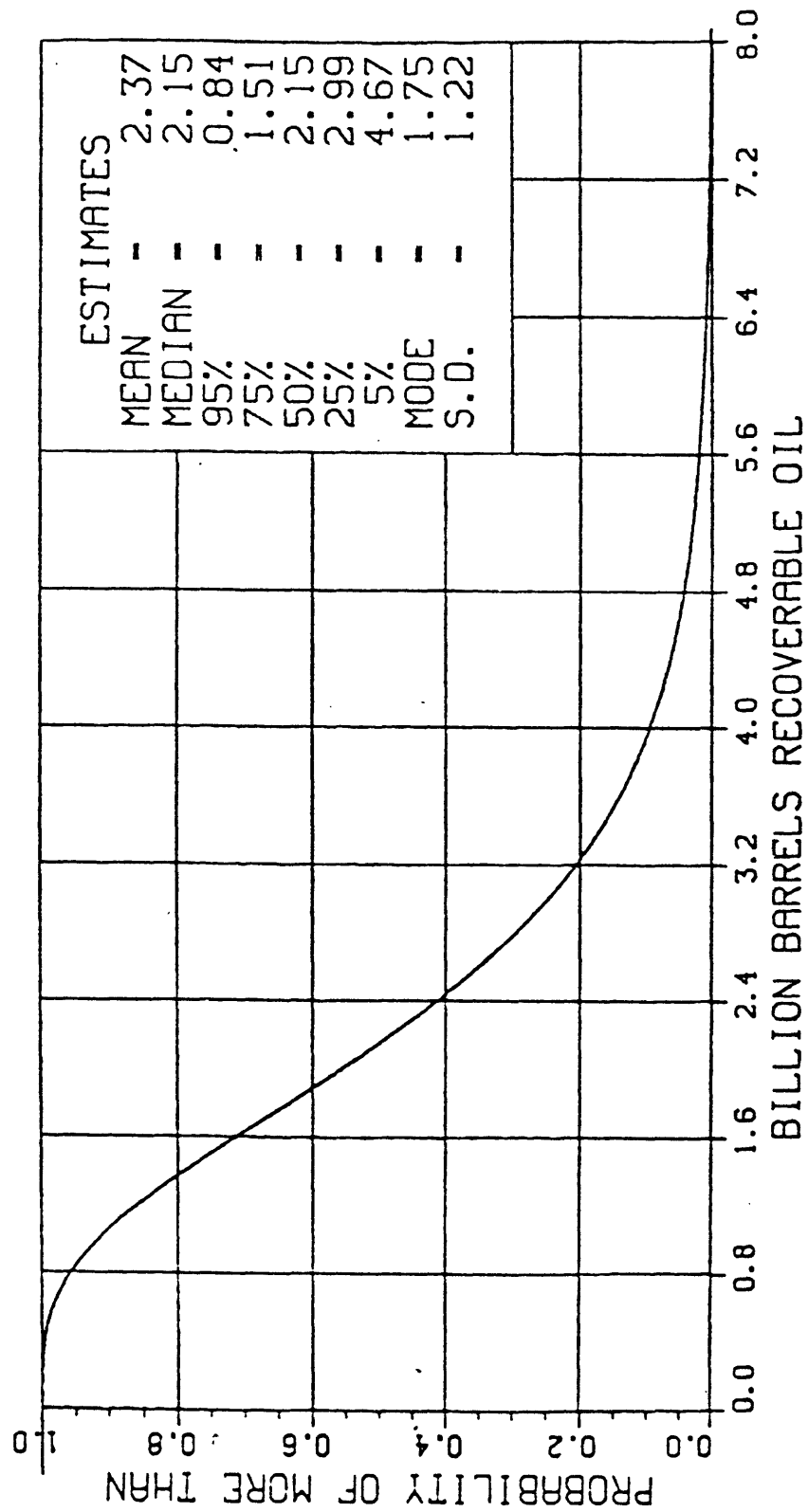
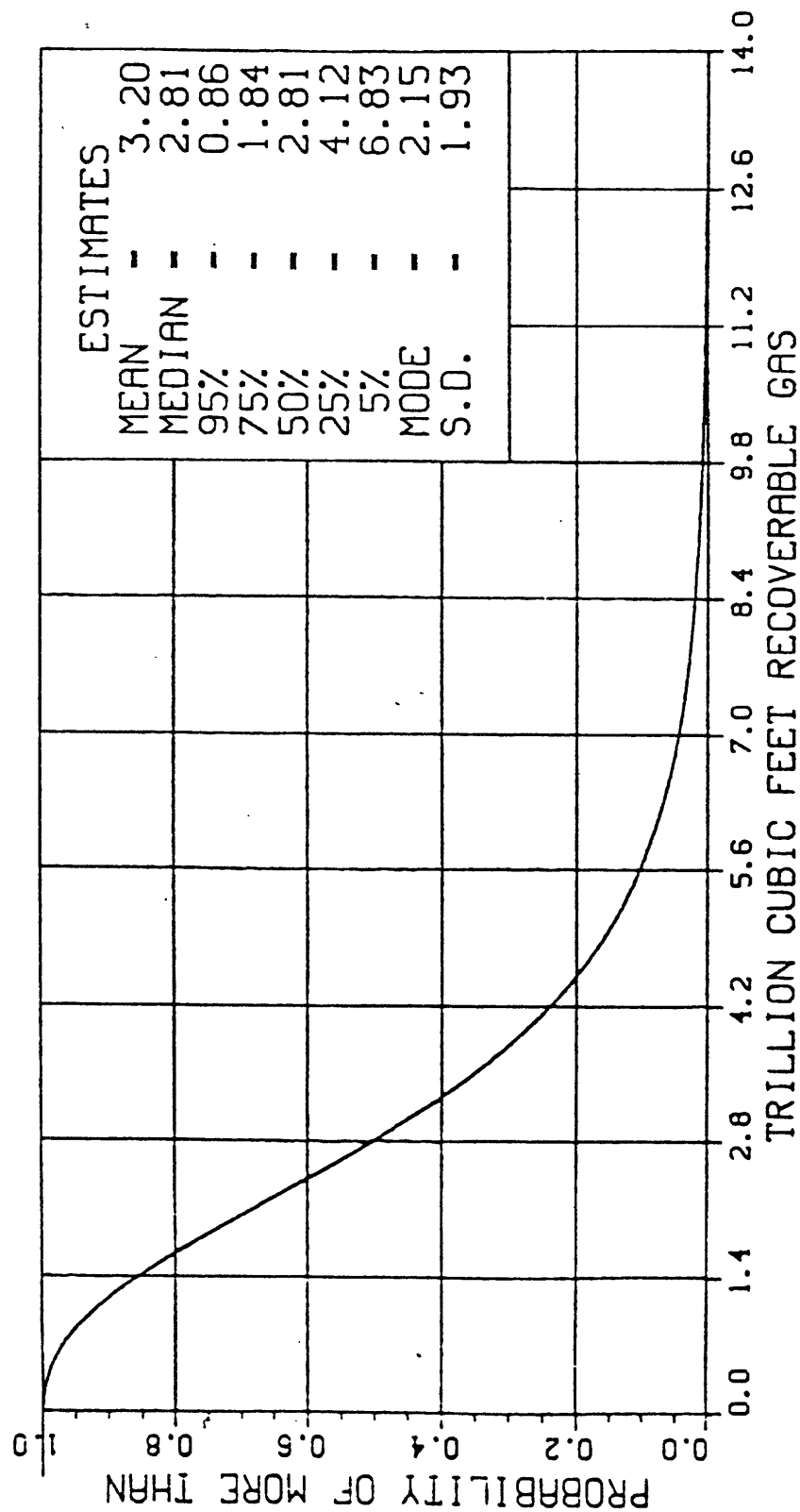


Figure 13.--North Africa; Suez-Sinai province, Egypt, total recoverable gas



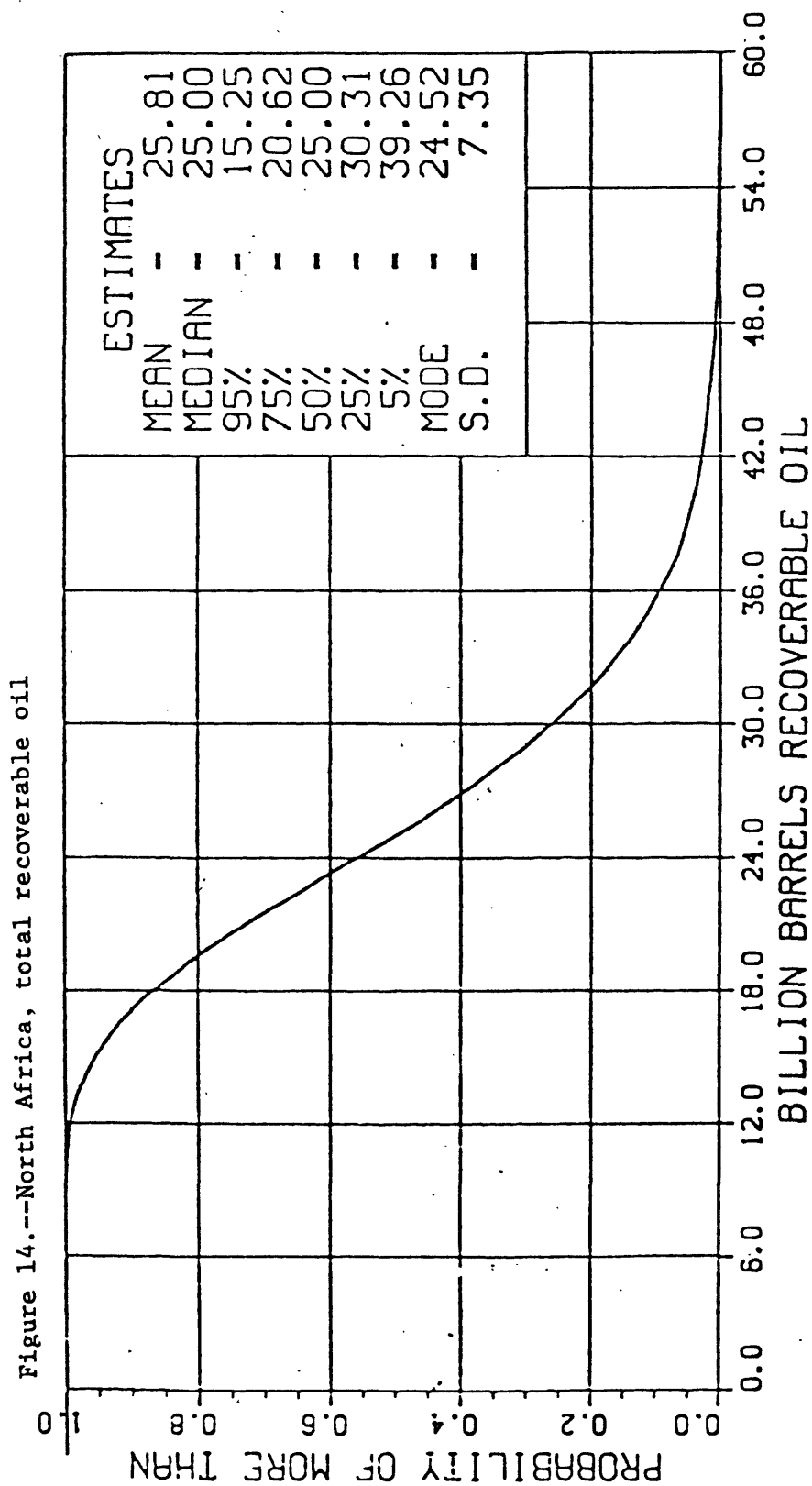


Figure 15.--North Africa, total recoverable gas

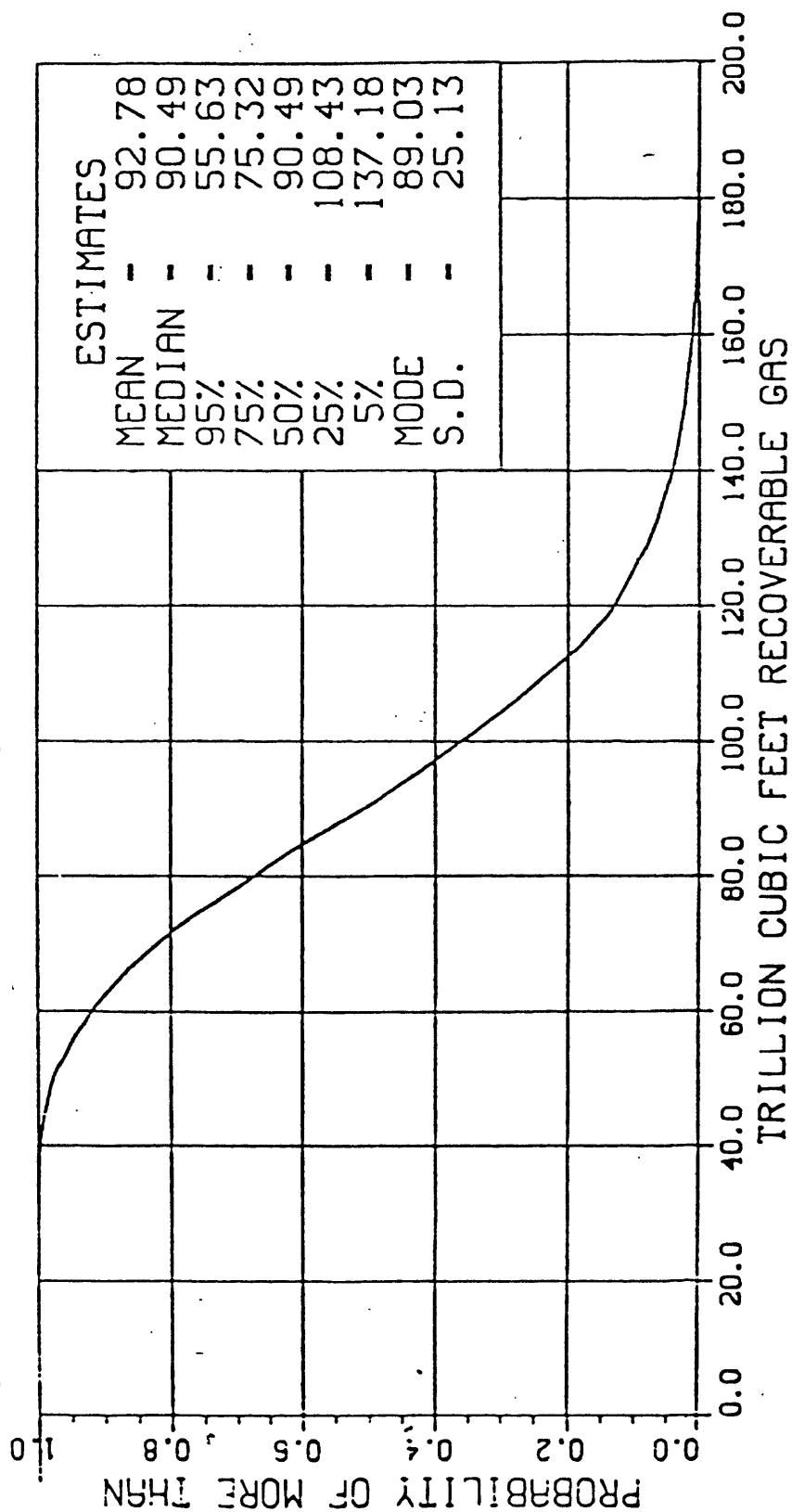


Table 2.--Supplementary and comparative data supporting the resource assessment for North Africa 1/

	<u>Crude Oil</u> (BB)	<u>Natural gas</u> (Tcf)
Cumulative production to 7/81		
Erg Occidental, Erg Oriental, and Hamada basins	5.5	5
Eastern Tunisia - Pelagian shelf- northwestern		
Libya province	0.4	+ <u>2/</u>
Sirte basin	13.7	+ <u>2/</u>
Cyrenaica shelf - Western Desert basin	0.15	+ <u>2/</u>
Nile Delta - Nile basin	0	+ <u>2/</u>
Suez-Sinai province	<u>2.5</u>	+ <u>2/</u>
Total	22.25	5+ (est.)
Measured reserves to 7/81		
Erg Occidental, Erg Oriental, and Hamada basins	7.5	50
Eastern Tunisia - Pelagian shelf - northwestern		
Libya province	0.6?	+ <u>2/</u>
Sirte basin	23.3	+ <u>2/</u>
Cyrenaica shelf - Western Desert basin	0.25	+ <u>2/</u>
Nile Delta - Nile basin	+ <u>2/</u>	+ <u>2/</u>
Suez-Sinai province	<u>3.5</u>	+ <u>2/</u>
Total	35.15	50+ (est.)
Original recoverable resources (ultimate) of the above provinces <u>3/</u>		
	<u>Oil</u>	<u>Gas</u>
Cumulative production	22.25	5+
Measured reserves	35.15	50+
Undiscovered resources (mean)	<u>25.8</u>	<u>92.8</u>
Total	83.20	147.8+

Total oil and gas = 108+ BBOE

1/ Cumulative production and reserves are composited estimates from various sources.

2/ Quantity positive but data unavailable. Total estimate, this paper.

3/ Does not include an estimate of inferred reserves.

COMMENTS

Erg Occidental, Erg Oriental, and Hamada basins

- Estimate of gas resources is uncertain because of disagreement in published figures on size of the supergiant Hassi R'Mel gas field, which range between 35 and 75 Tcf ultimate recovery.
- The Erg Occidental basin tends to be gas prone; most of the oil fields occur in the Erg Oriental basin.
- Widespread Triassic-Jurassic evaporite section is the major seal for most of the important oil and gas fields.
- A major share (75-85 percent) of the cumulative production and identified oil and gas reserves is from the supergiant Hassi Messaoud oil field (11 BB) and the supergiant Hassi R'Mel gas field (35-75 Tcf).
- Source rocks for both oil and gas are primarily the Silurian (Gotlandian) graptolite shale beds. However, deeply buried post-Silurian gas source rocks may be present in the western part of the Erg Occidental basin adjacent to the Saharan Atlas flexure.

Eastern Tunisia - Pelagian shelf - northwestern Libya province

- The sedimentary section is very thick, but few pre-Upper Cretaceous tests have been drilled.
- Available information indicates that no large fields have been discovered as yet, but a large part of the offshore area is not adequately tested. Resource assessment is difficult because of the relatively unknown character of the pre-Tertiary stratigraphic section and the deeper structure.
- Salt structures are important in the offshore area.

Sirte basin

- Except for the offshore area, the basin is relatively well explored. Indications are that reservoirs will be absent or poorer in offshore area.
- Potential exists for downdip stratigraphic traps on large structures, including horst blocks.
- Tertiary reef or carbonate mounds are targets for further exploration.

Cyrenaica shelf - Western Desert basin

- Lack of an evaporite section and other adequate regional seals are unfavorable factors.
- Lack of widespread mature source rocks may be unfavorable, although Silurian graptolite shale may be present at depth in northwestern Egypt, northeastern Libya, and in the offshore area.
- Structural history has resulted in many small Mesozoic and Cenozoic basins with irregular and localized distribution of source rocks, seals, and reservoirs.
- Area is not well known and potential is present for unusual and anomalous petroleum accumulations.

Nile Delta - Nile basin

- The Nile Delta appears to be gas prone, but deeper source rocks may be post-mature because of the high geothermal gradient offshore.
- Success ratio is relatively high, but field development is minimal, and little information is available on reserve estimates.

Suez-Sinai province

- Potential for stratigraphic traps beneath the salt section is relatively untested.
- Some difficulty is reported in getting good seismic records beneath the Miocene salt section.
- Thermal gradient is high, but production so far is almost exclusively oil. Explanations may be related to sapropelic nature of source rocks and insufficient depth of burial for gas.

General

- Offshore area to 1,000 m depth is included in assessments of Egypt, Libya, and Tunisia.
- Southern Egypt, southern Libya, and southern Algeria are not included in the assessments. These regions are considered to have minimum potential for petroleum resources because of insufficient depth of burial, absence of cap rocks, proximity to extensive outcrops of Paleozoic and Mesozoic rocks, and relatively continuous emergence and erosion of the region since middle to late Paleozoic time.