UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Assessment of undiscovered conventionally recoverable petroleum resources of Northwestern, Central, and Northeastern Africa (including Morocco, northern and western Algeria, northwestern Tunisia, Mauritania, Mali, Niger, eastern Nigeria, Chad, Central African Republic, Sudan, Ethiopia, Somalia, and southeastern Egypt)

By

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Open-File Report 83-598

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

[1] Missoula, Montana

1983

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Assessment of undiscovered conventionally recoverable petroleum resources of Northwestern, Central, and Northeastern Africa (including Morocco, northern and western Algeria, northwestern Tunisia, Mauritania, Mali, Niger, eastern Nigeria, Chad, Central African Republic, Sudan, Ethiopia, Somalia, and southeastern Egypt)

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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 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 estimating 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 Siberian and Kara Sea basins
- 82-0296 - Middle Caspian basin
- 82-1027 - East Siberian basin, U.S.S.R.
- 82-1056 - North Africa
- 82-1057 - Timan-Pechora basin, U.S.S.R.; Barents-northern Kara shelf

ACKNOWLEDGEMENTS

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INTRODUCTION

The locations of the northwestern, central, and northeastern Africa provinces are shown on figure 1. Estimates by the USGS of oil and gas resources in these basins are given in table 1 and figures 2-21. Data supplementary to these estimates are supplied in table 2.

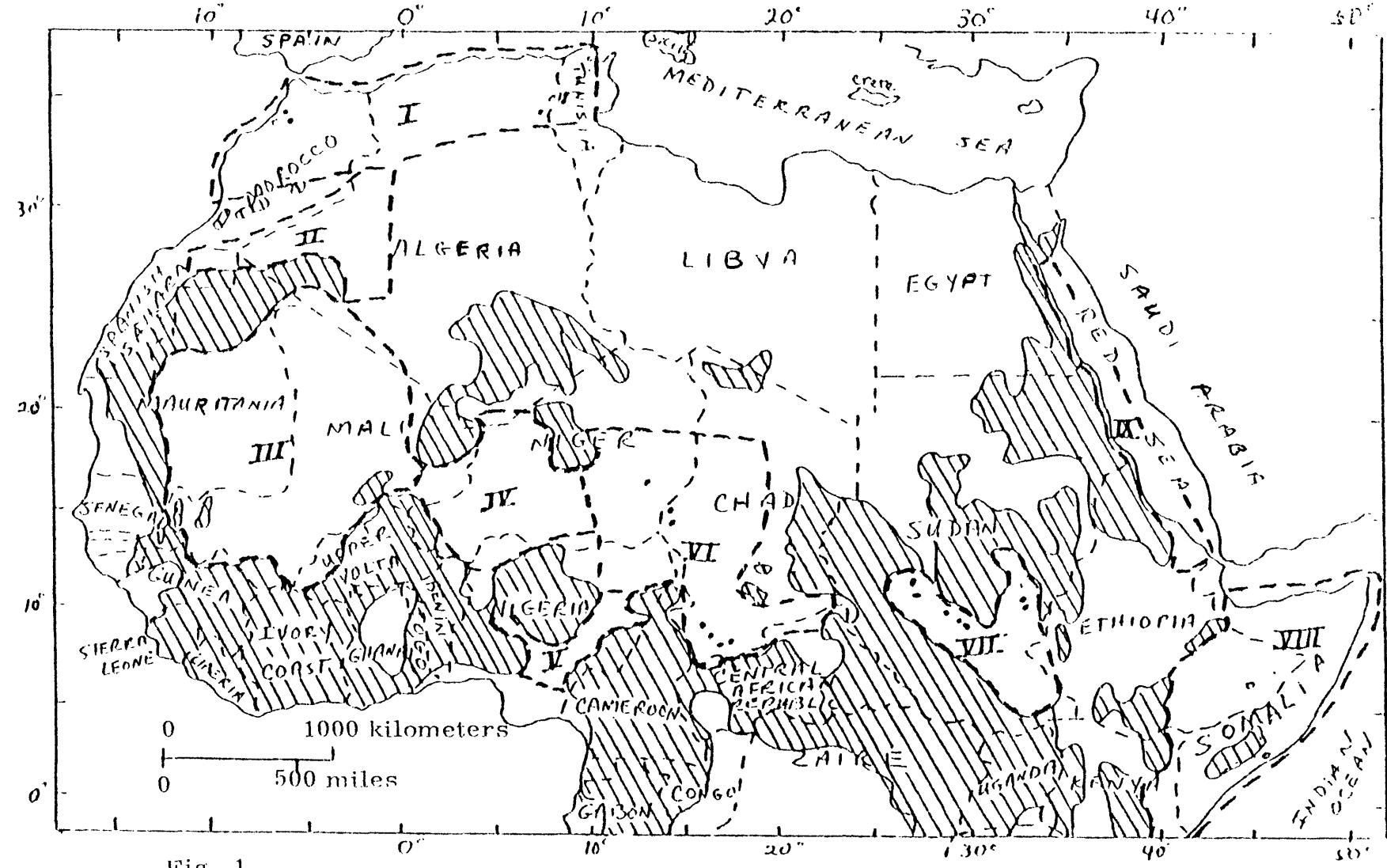


Fig. 1

Assessment areas: I Atlas folded geosynclinal belt; II Tindouf, Bechar, and Reggana basins; III Taoudeni basin; IV Niger basin; V Benue trough - "Niger embayment"; VI Chad, Bornu, and Doba basins; VII Upper Nile basin (Sudan); VIII Somali basin; IX Red Sea basin

Precambrian rocks exposed at surface

● Oil field (not to scale) ⊂ Gas field (not to scale)

Table 1.--Assessment of undiscovered conventionally recoverable petroleum resources of Northwestern, Central, and Northeastern Africa (Morocco, northern and western Algeria, northwestern Tunisia, Mauritania, Mali, Niger, eastern Nigeria, Chad, Central African Republic, Sudan, Ethiopia, and Somalia)

Resource assessment by USGS as of 12/7/82; see also figures 2 through 21.

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 cu ft/bbl		
	Low F_{95} [1/]	High F_5 [1/]	Mean	Low F_{95} [1/]	High F_5 [1/]	Mean
I. Atlas folded geosynclinal belt of northwestern Africa	0.13	4.21	1.49	0.43	11.55	4.13
II. Tindouf, Bechar, and Reggane basins of northwestern Africa	0.00	0.52	0.10	0.00	12.60	5.20
III. Taoudeni basin of northwestern Africa	0.00	0.82	0.16	0.00	5.24	1.28
IV. Niger basin of central Africa	0.00	0.46	0.07	0.00	2.77	0.46
V. Benue trough - "Niger embayment" of central Africa	0.00	4.05	1.41	0.06	18.49	7.33
VI. Chad, Bornu, and Doba basins of central Africa	1.16	10.00	4.84	4.50	32.1	16.25
VII. Upper Nile basin (Sudan) of central Africa	1.62	14.1	7.27	4.96	38.4	19.37
VIII. Somali basin of northeastern Africa	0.00	9.8	3.82	3.85	40.3	18.61
IX. Red Sea basin of northeastern Africa	0.00	0.82	0.20	0.00	28.9	13.4
Total of above northwestern, central, and northeastern Africa provinces: [2/]	11.12	30.65	19.36	55.65	125.17	86.03

[1/] F_{95} denotes the 95th fractile; the probability of more than the amount F_{95} is 95 percent. F_5 is defined similarly.

[2/] Totals are derived by statistical aggregation; only the mean total equals the sum of the component parts.

Assessment date - 12/7/82

Figure 2.--Northwest Africa; Atlas folded geosynclinal belt, recoverable oil.

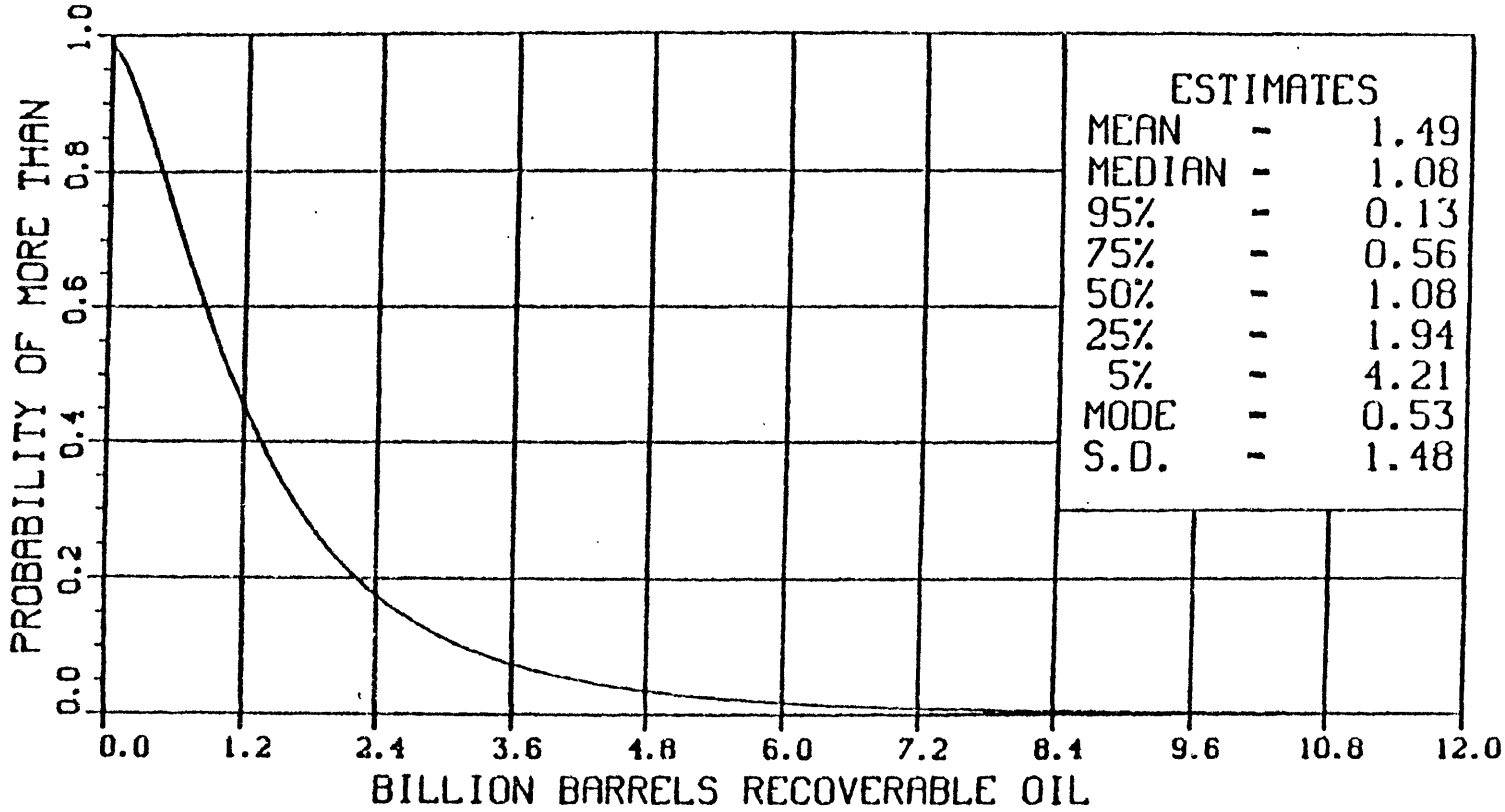
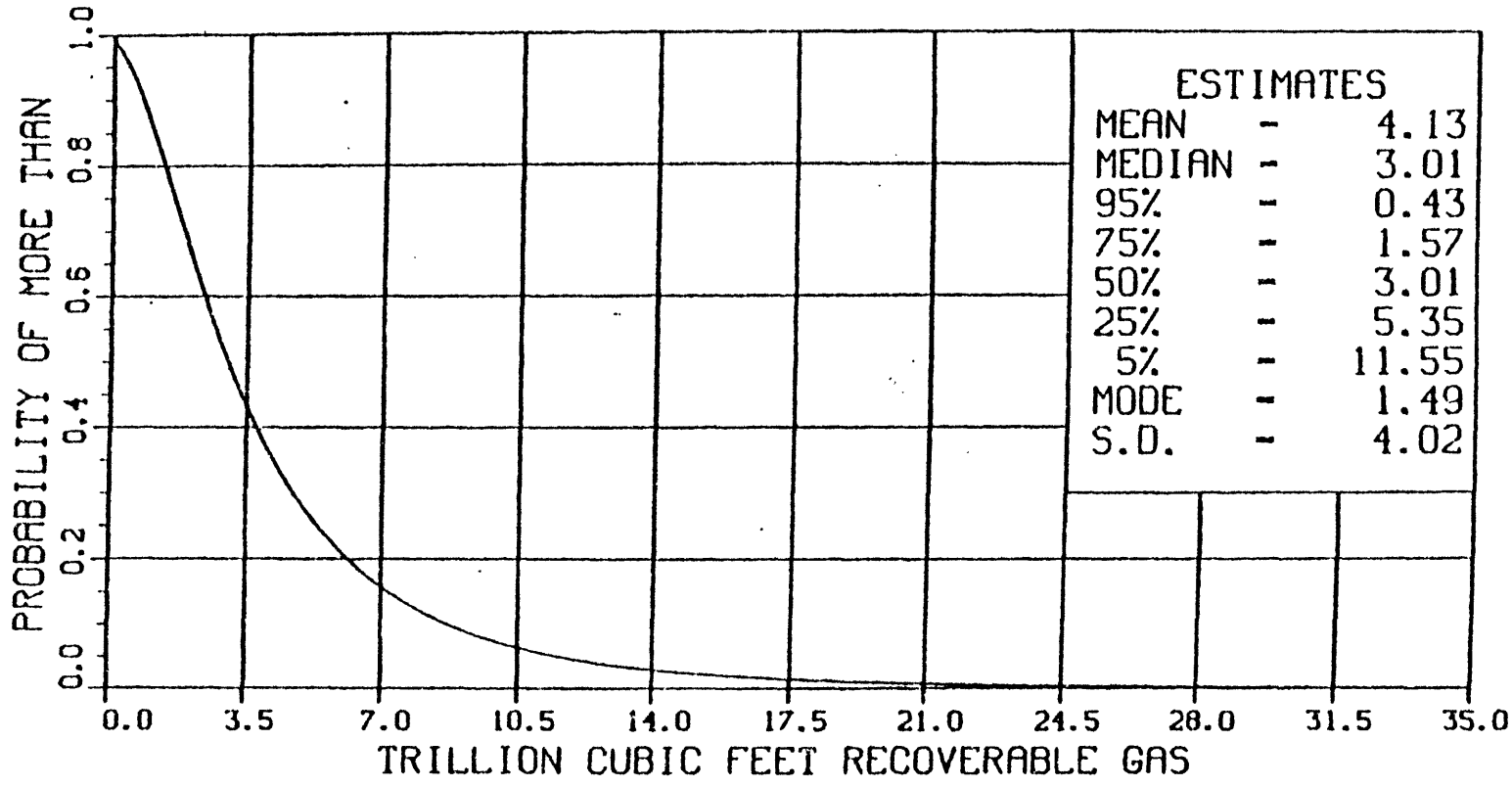
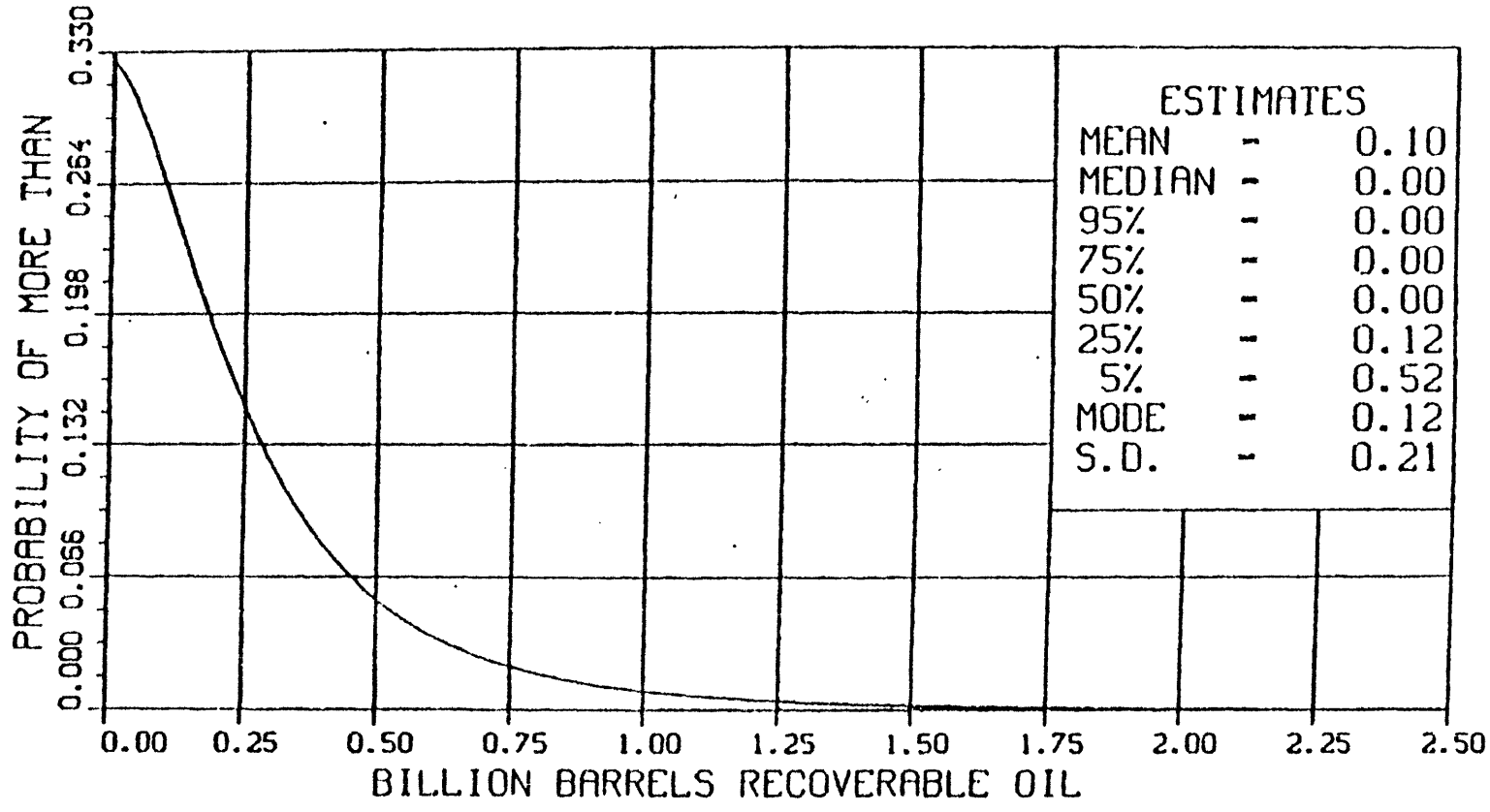


Figure 3.--Northwest Africa; Atlas folded geosynclinal belt, total recoverable gas.



Assessment date - 12/7/82

Figure 4.--Northwest Africa; Tindouf, Bechar, and Reggane basins, recoverable oil.



Assessment date - 12/7/82

Figure 5.--Northwest Africa; Tindouf, Bechar, and Reggane basins, total recoverable gas.

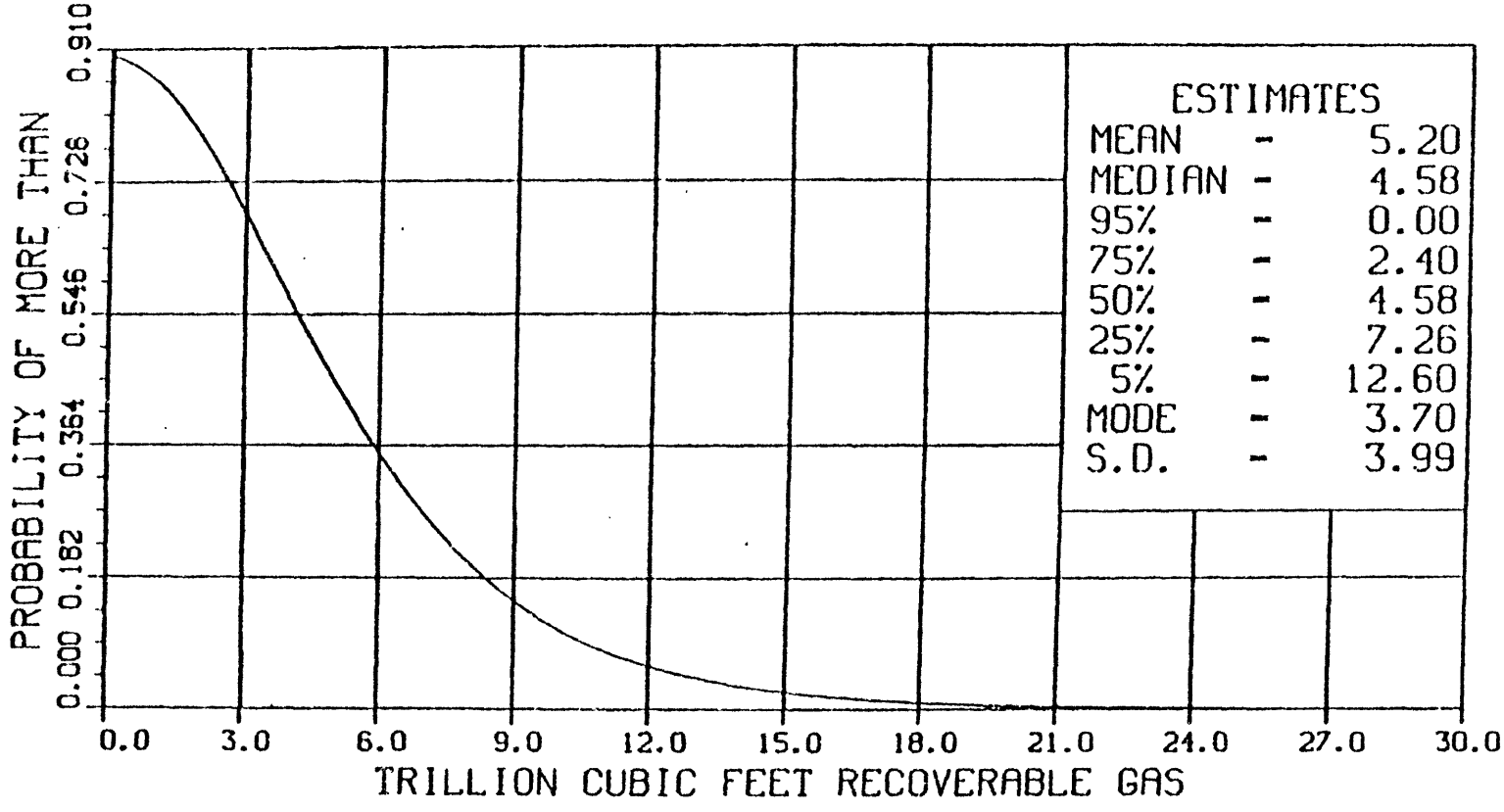


Figure 6.--Northwest Africa; Taoudeni basin, recoverable oil.

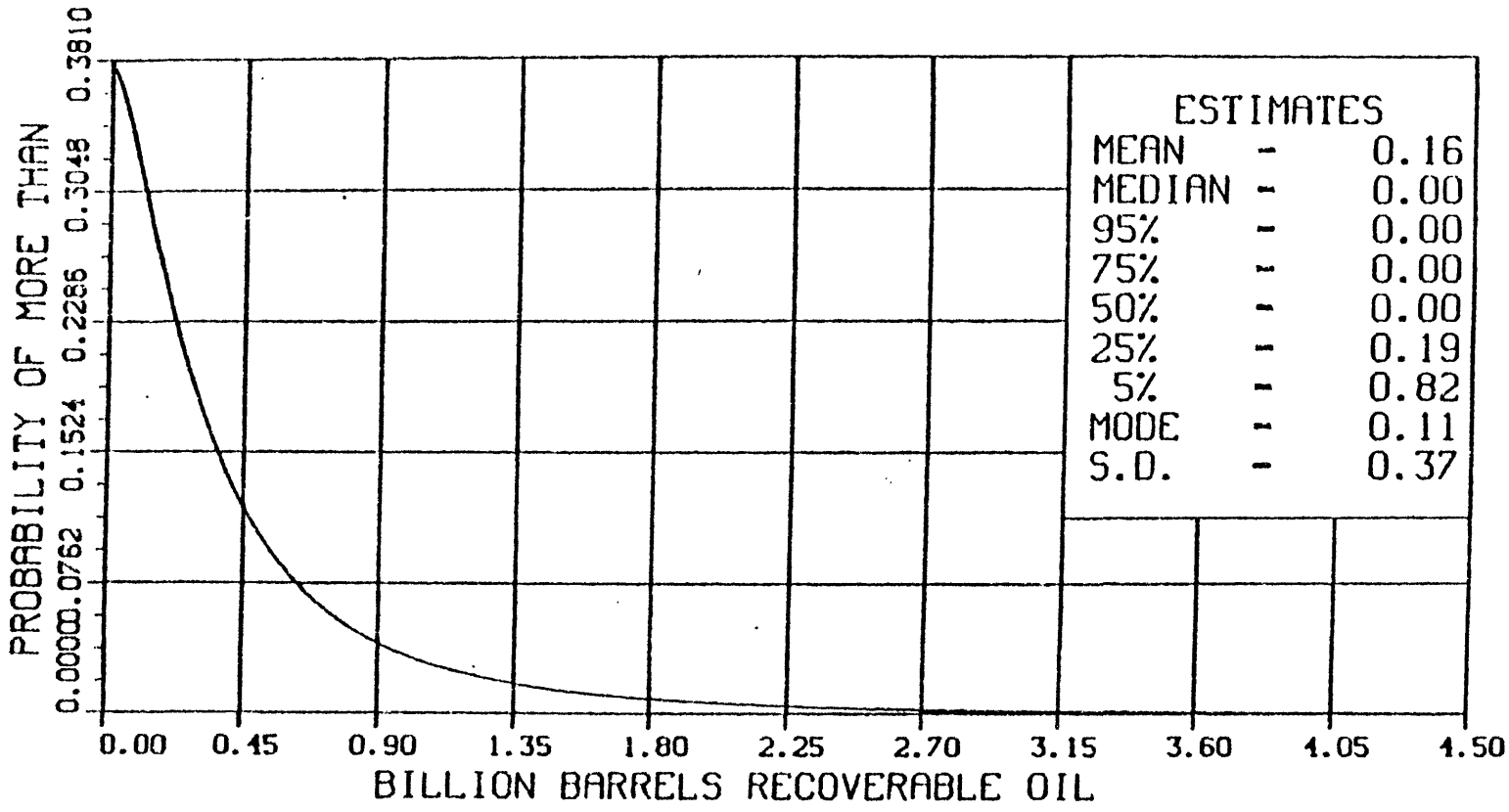


Figure 7.--Northwest Africa; Taoudeni basin, total recoverable gas.

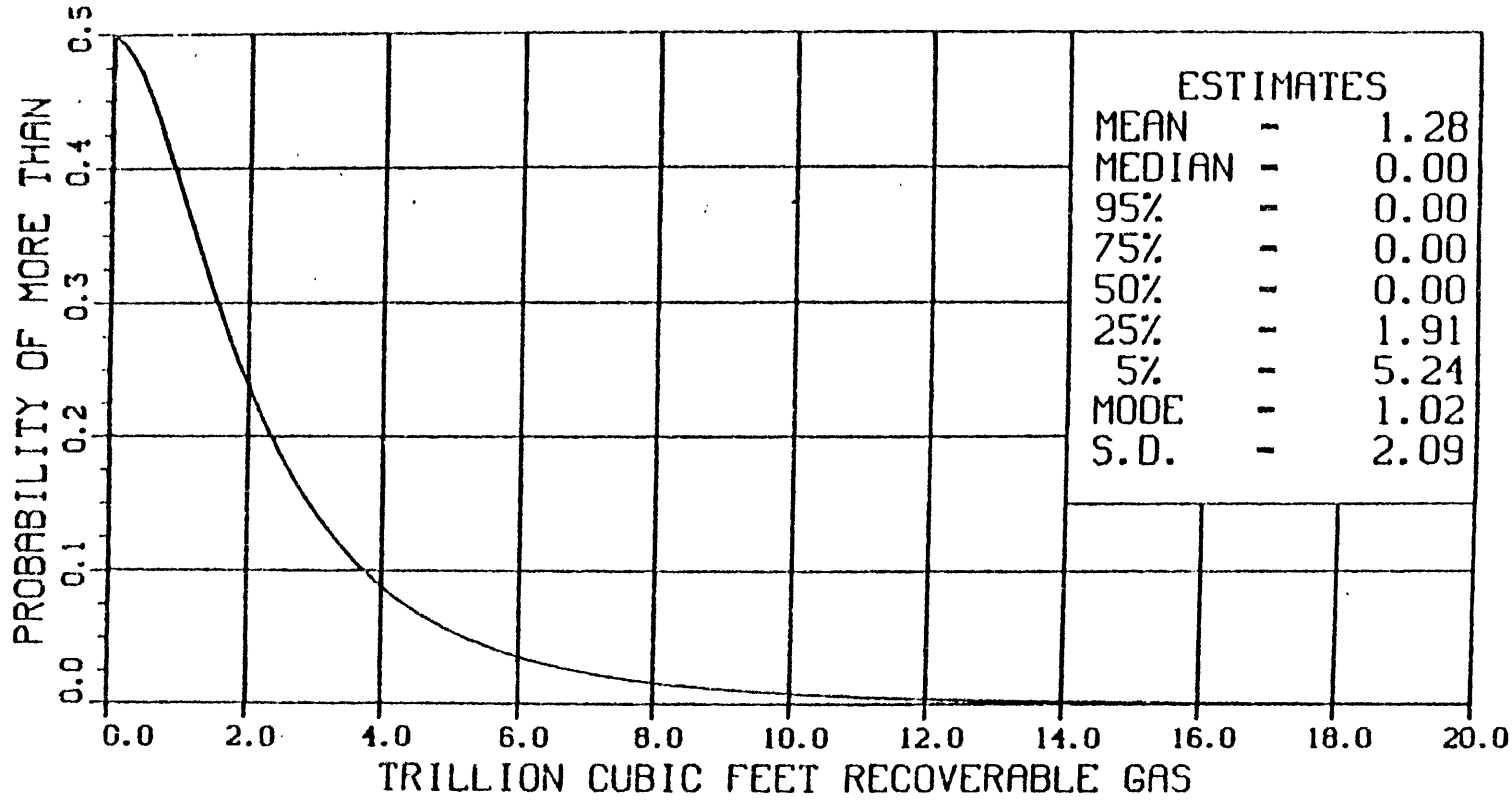


Figure 8.--Central Africa; Niger basin, recoverable oil.

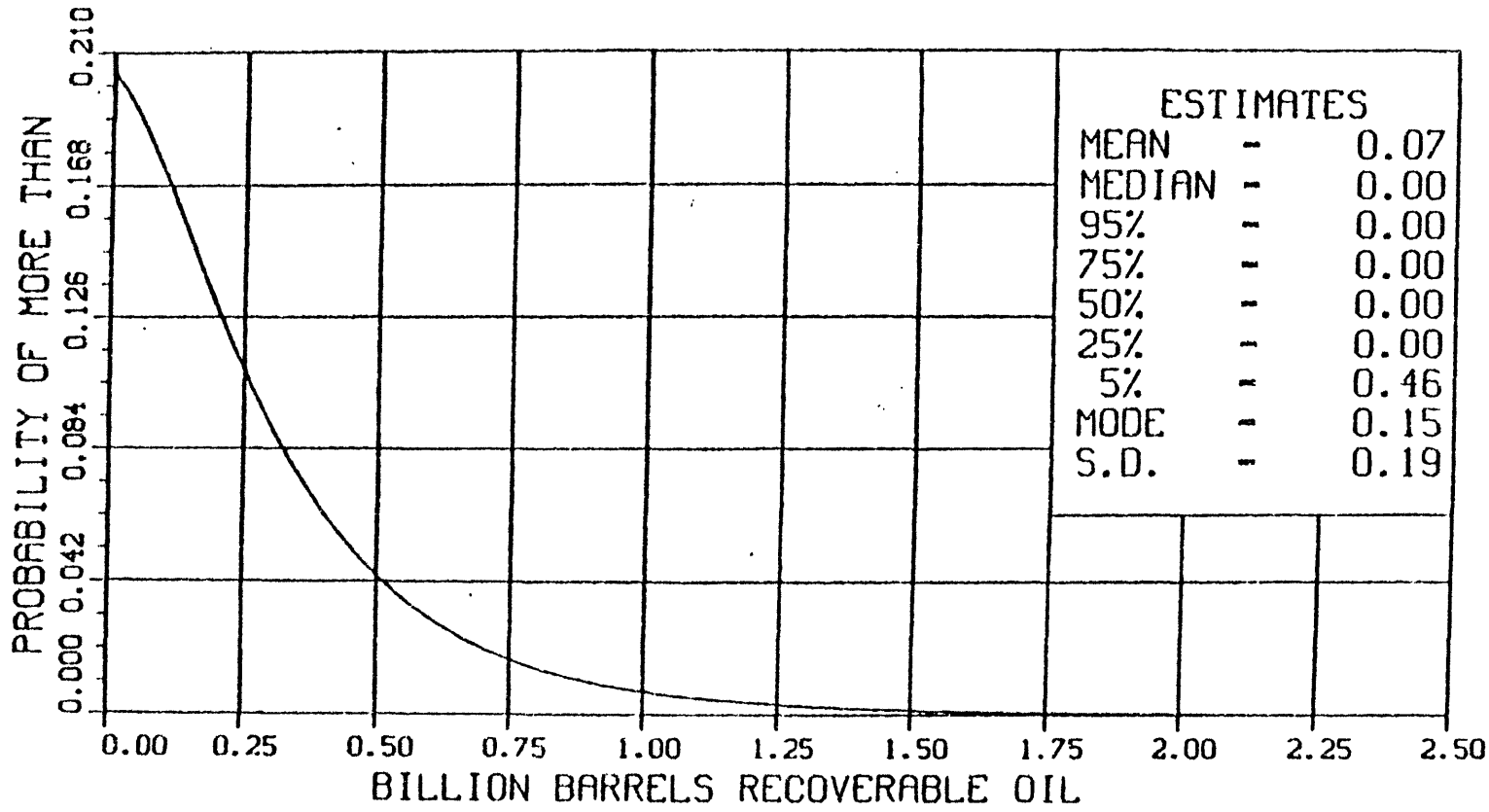


Figure 9.--Central Africa; Niger basin, total recoverable gas.

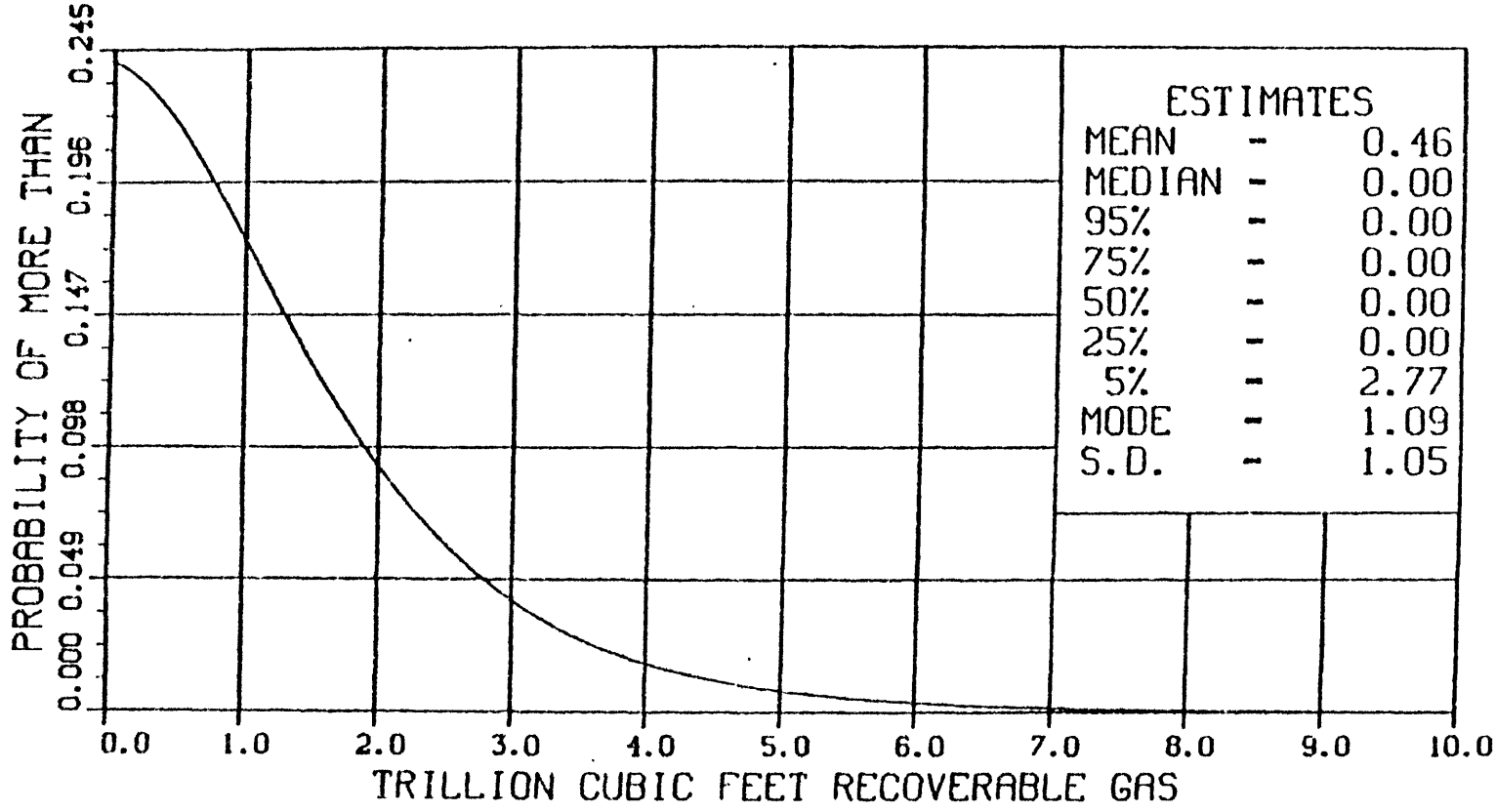
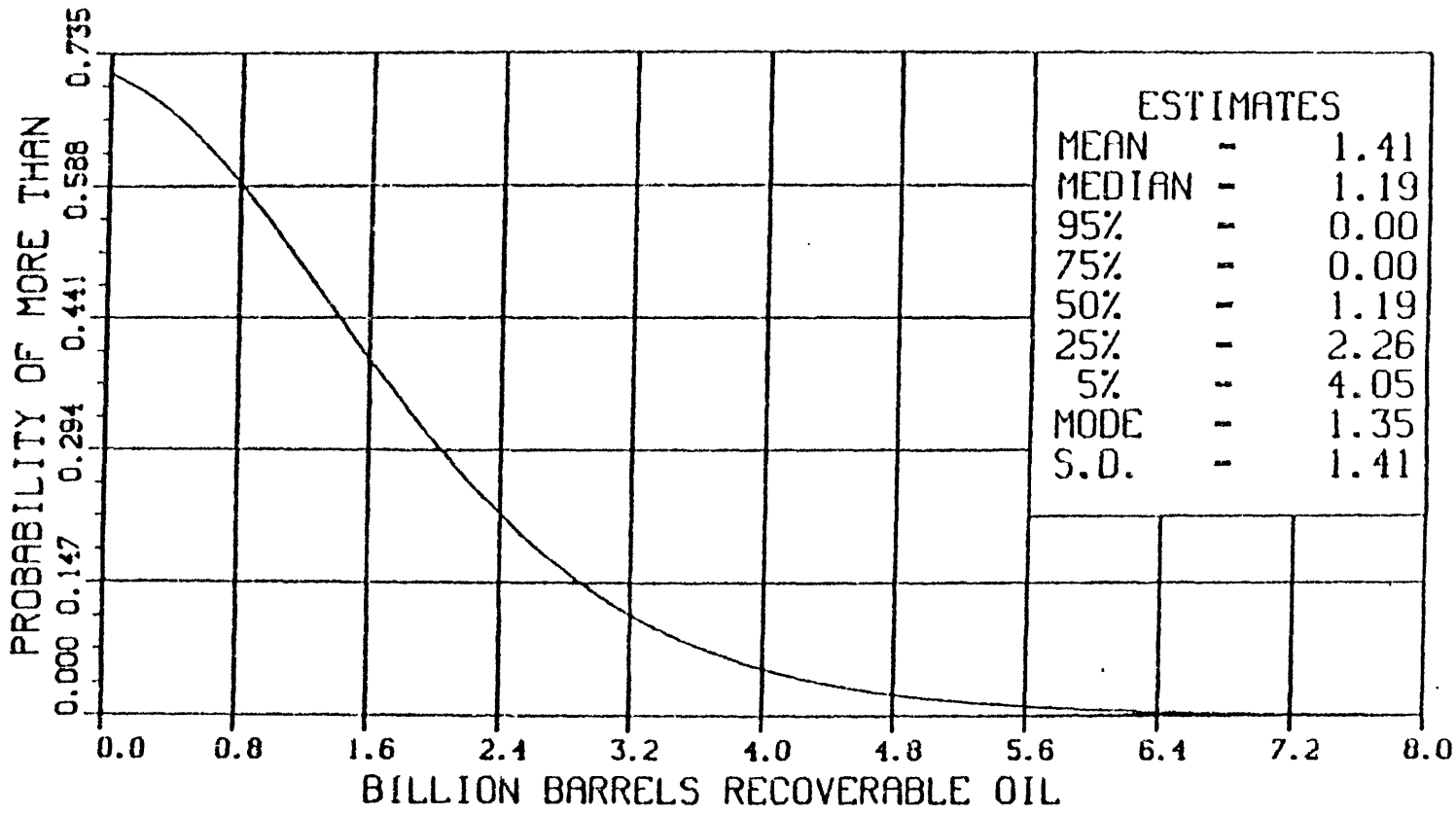
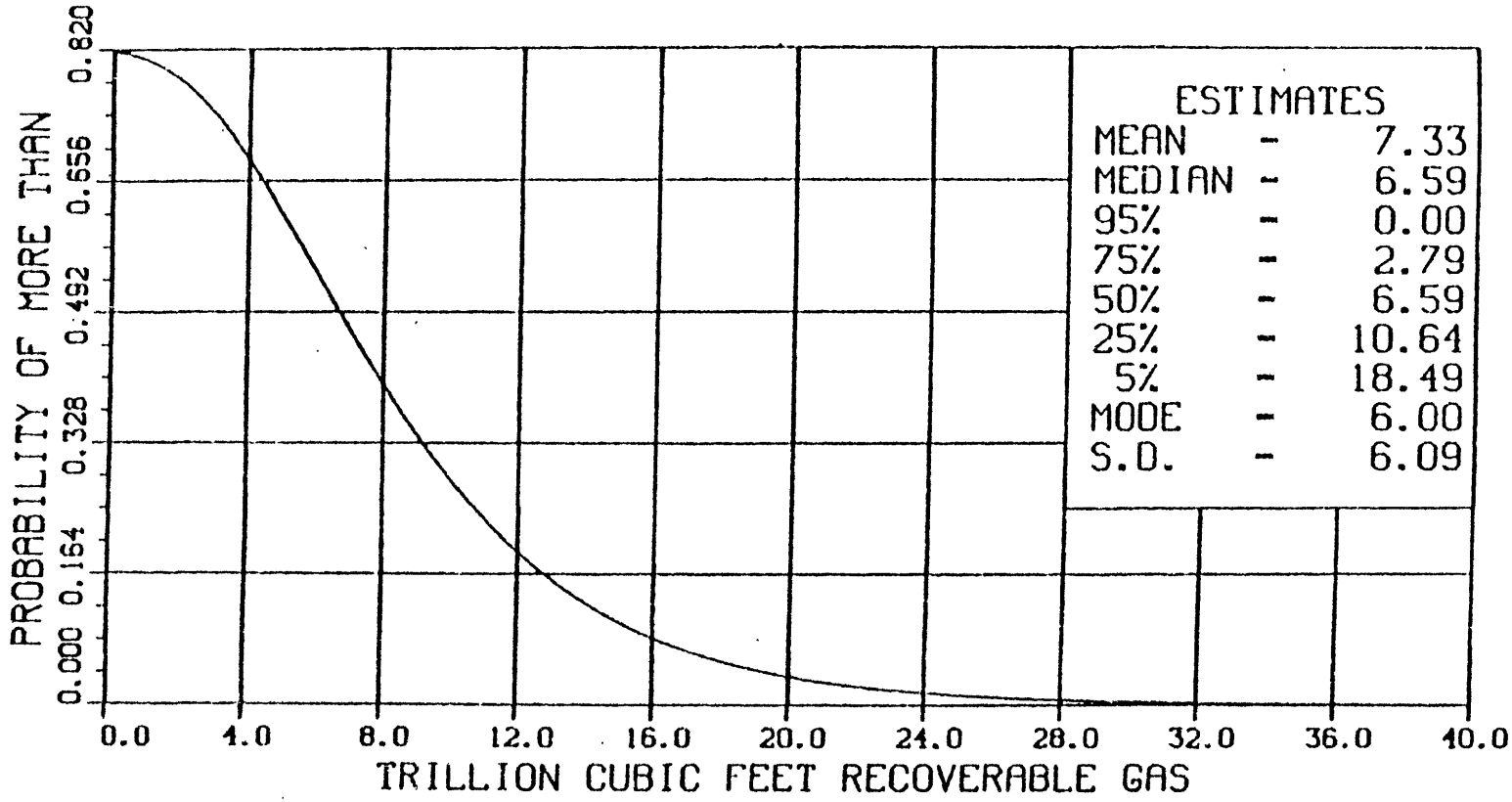


Figure 10.--Central Africa; Benue trough - "Niger embayment," recoverable oil.



Assessment date - 12/7/82

Figure 11.--Central Africa; Benue trough - "Niger embayment," total recoverable gas.



Assessment date - 12/7/82

Figure 12.--Central Africa; Chad, Bornu, and Doba basins, recoverable oil.

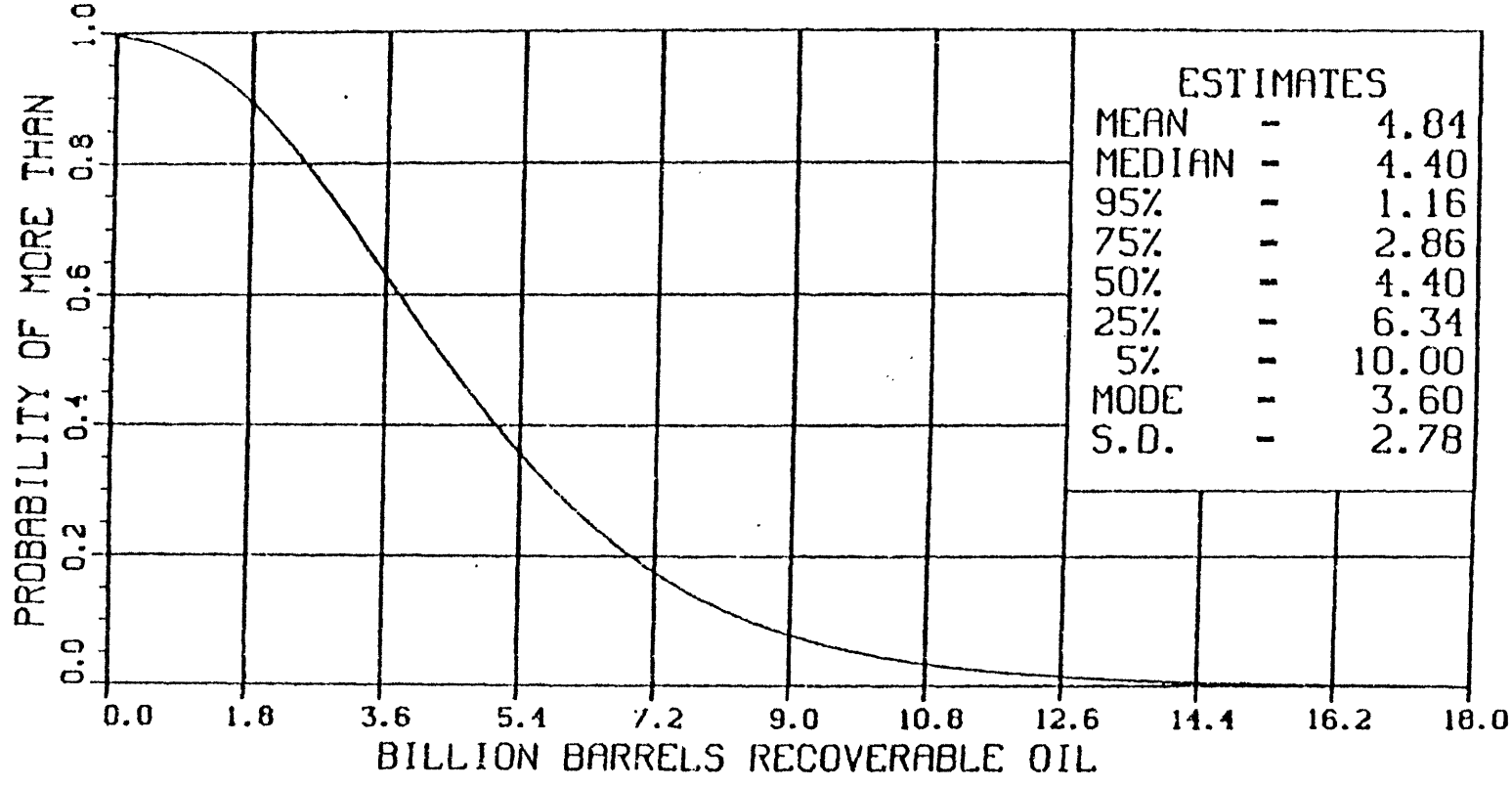


Figure 13.--Central Africa; Chad, Bornu, and Doba basins, total recoverable gas.

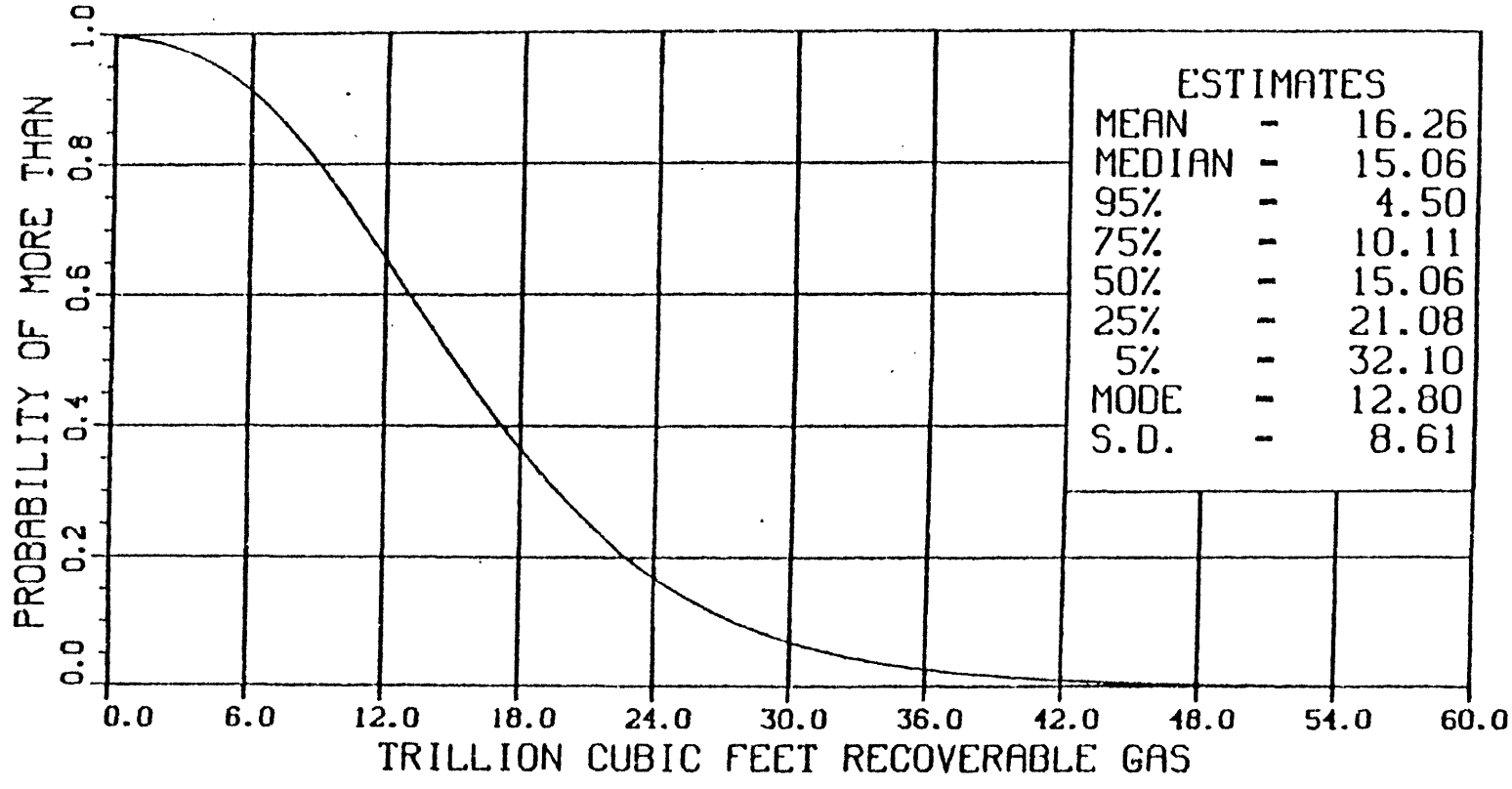


Figure 14.--Central Africa; Upper Nile basin (Sudan), recoverable oil.

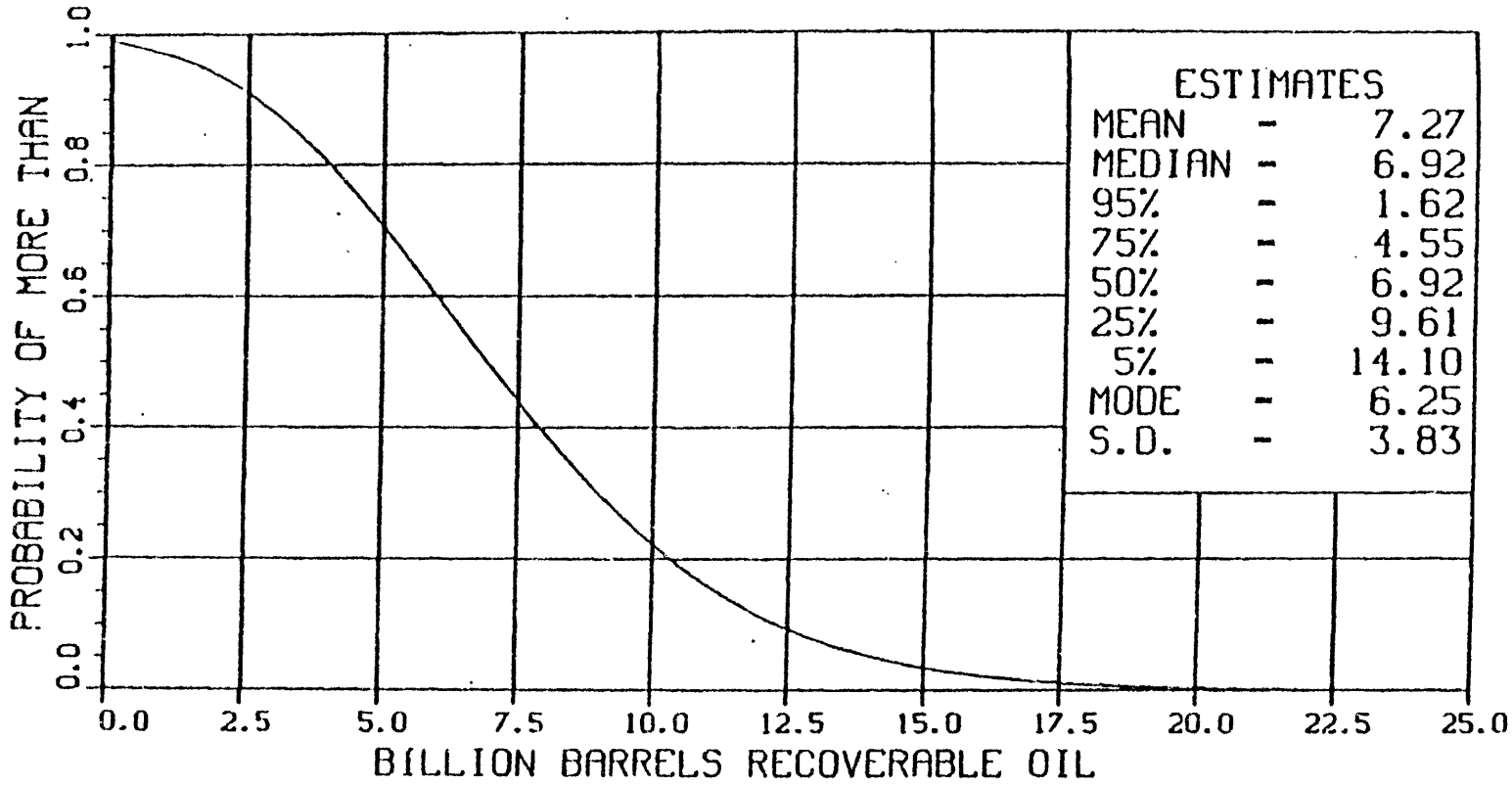


Figure 15.--Central Africa; Upper Nile basin (Sudan), total recoverable gas.

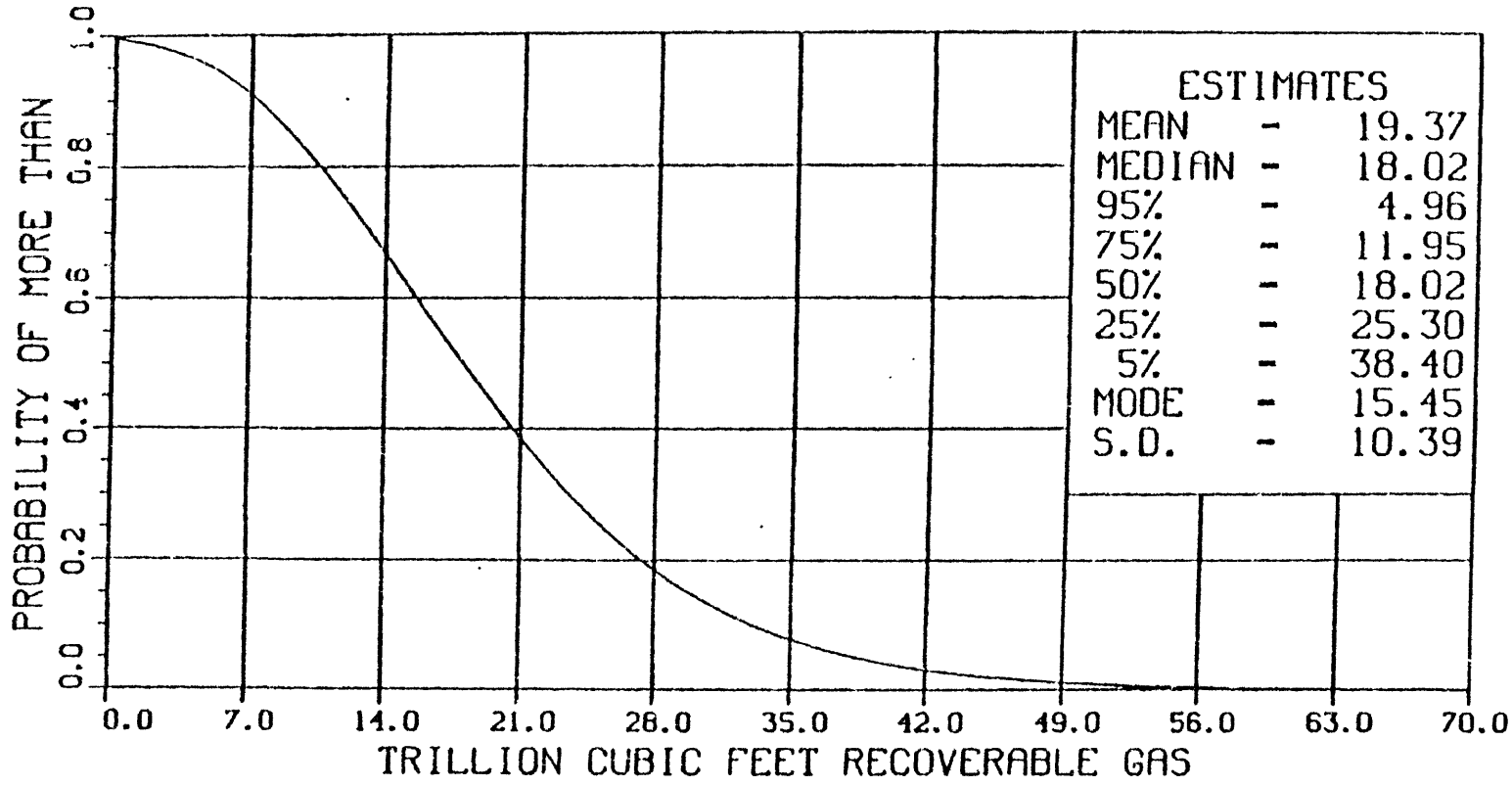


Figure 16.--Northeast Africa; Somali basin, recoverable oil.

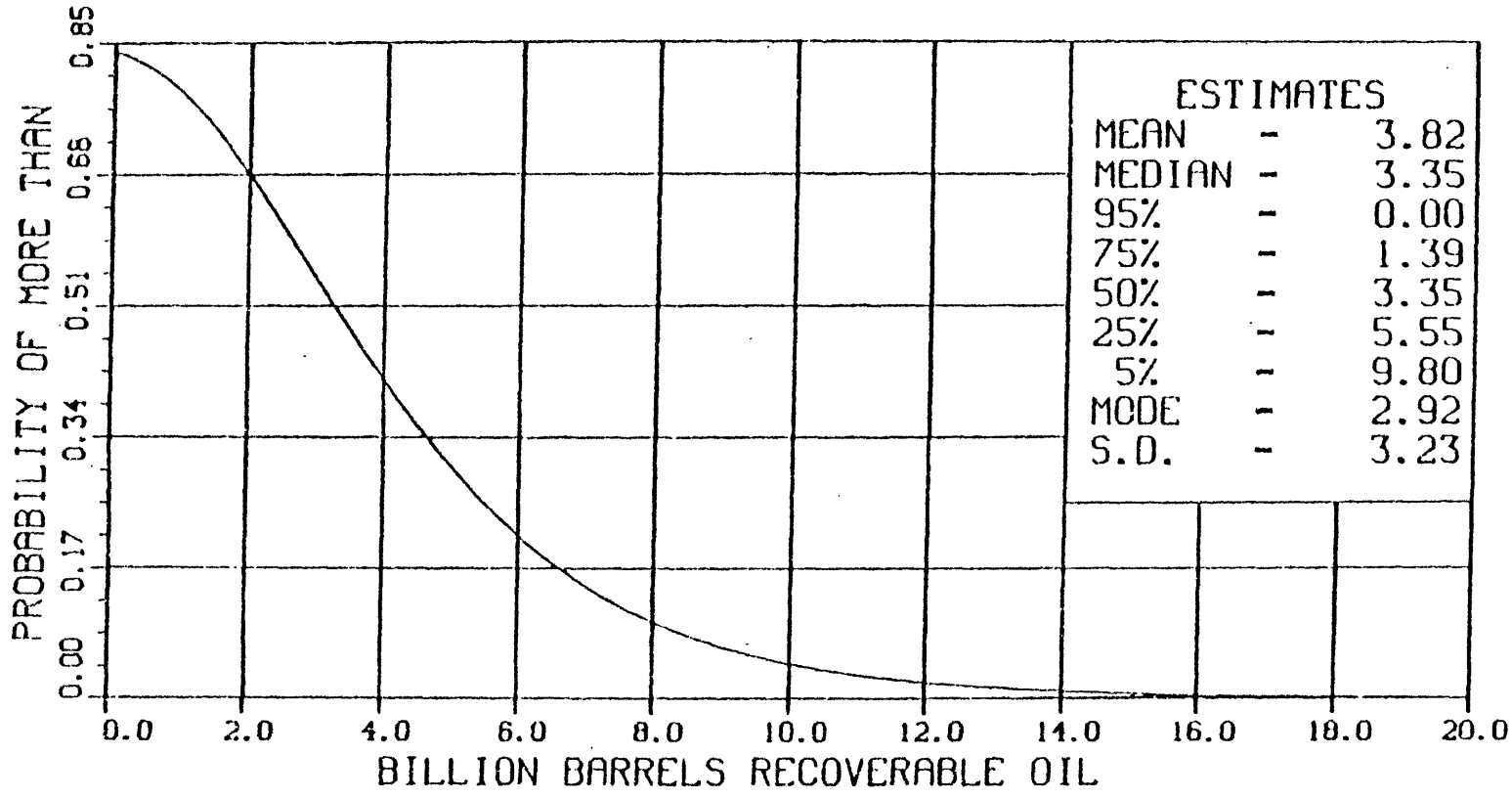


Figure 17.--Northeast Africa; Somali basin, total recoverable gas.

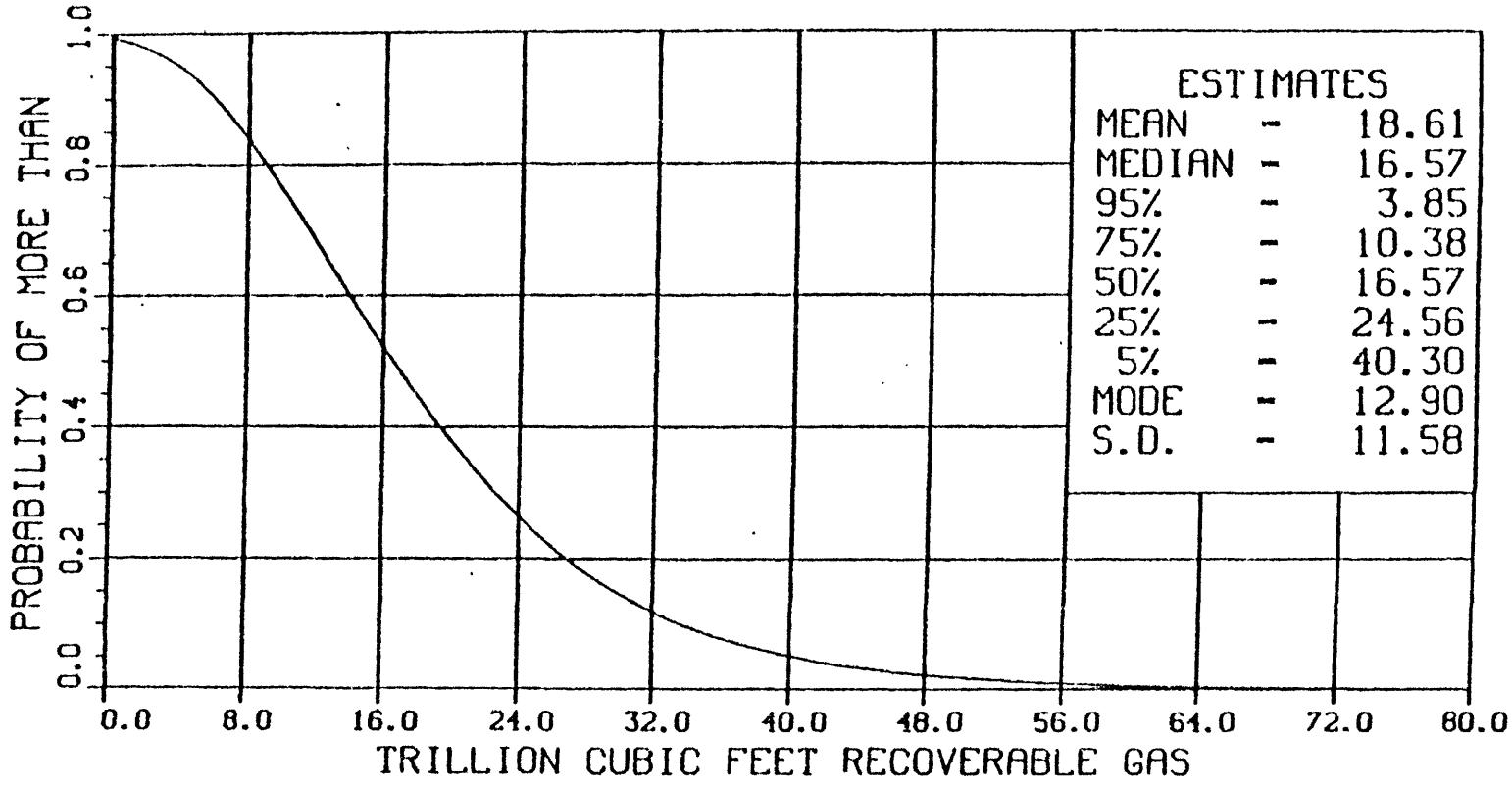
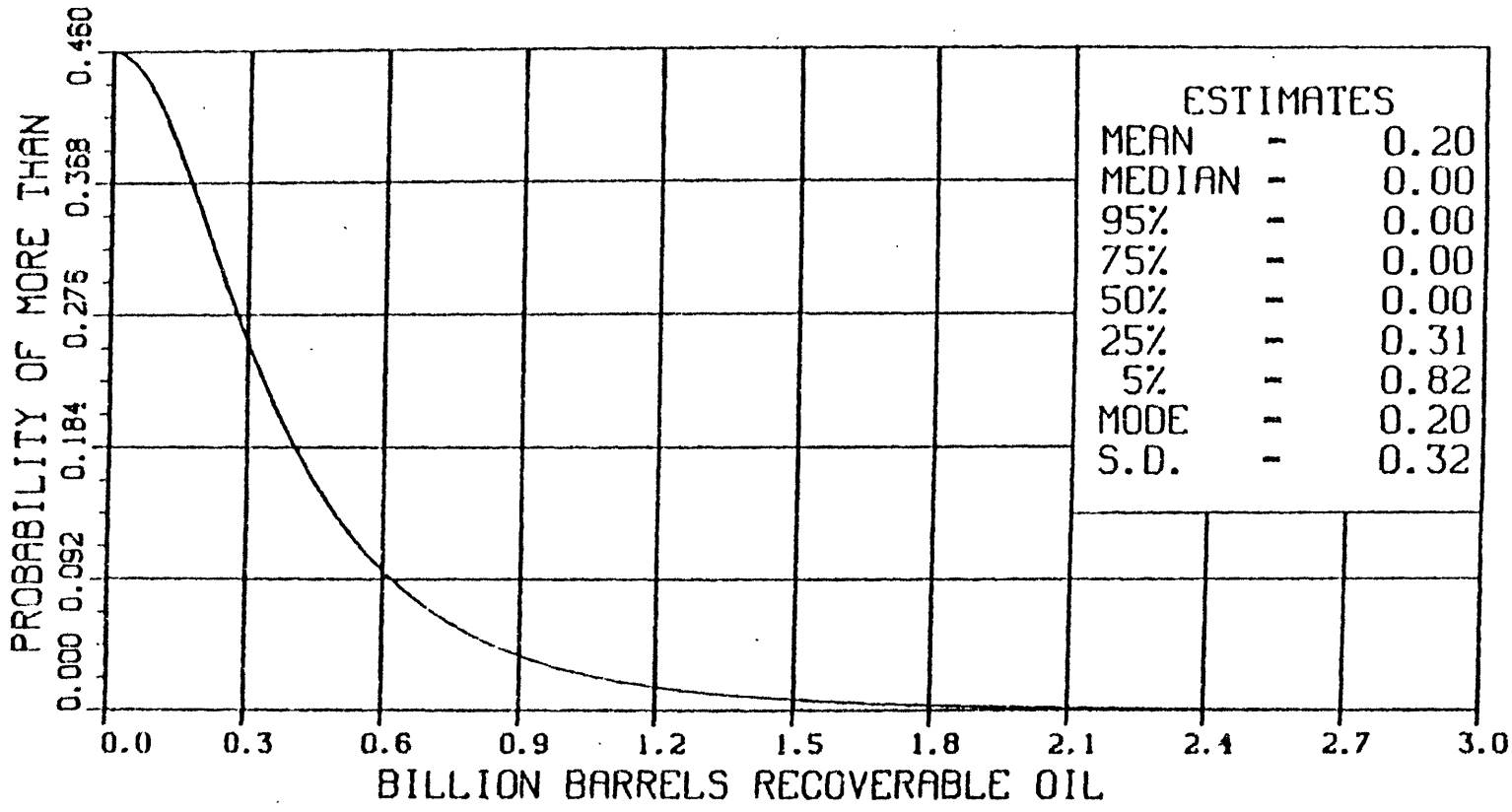
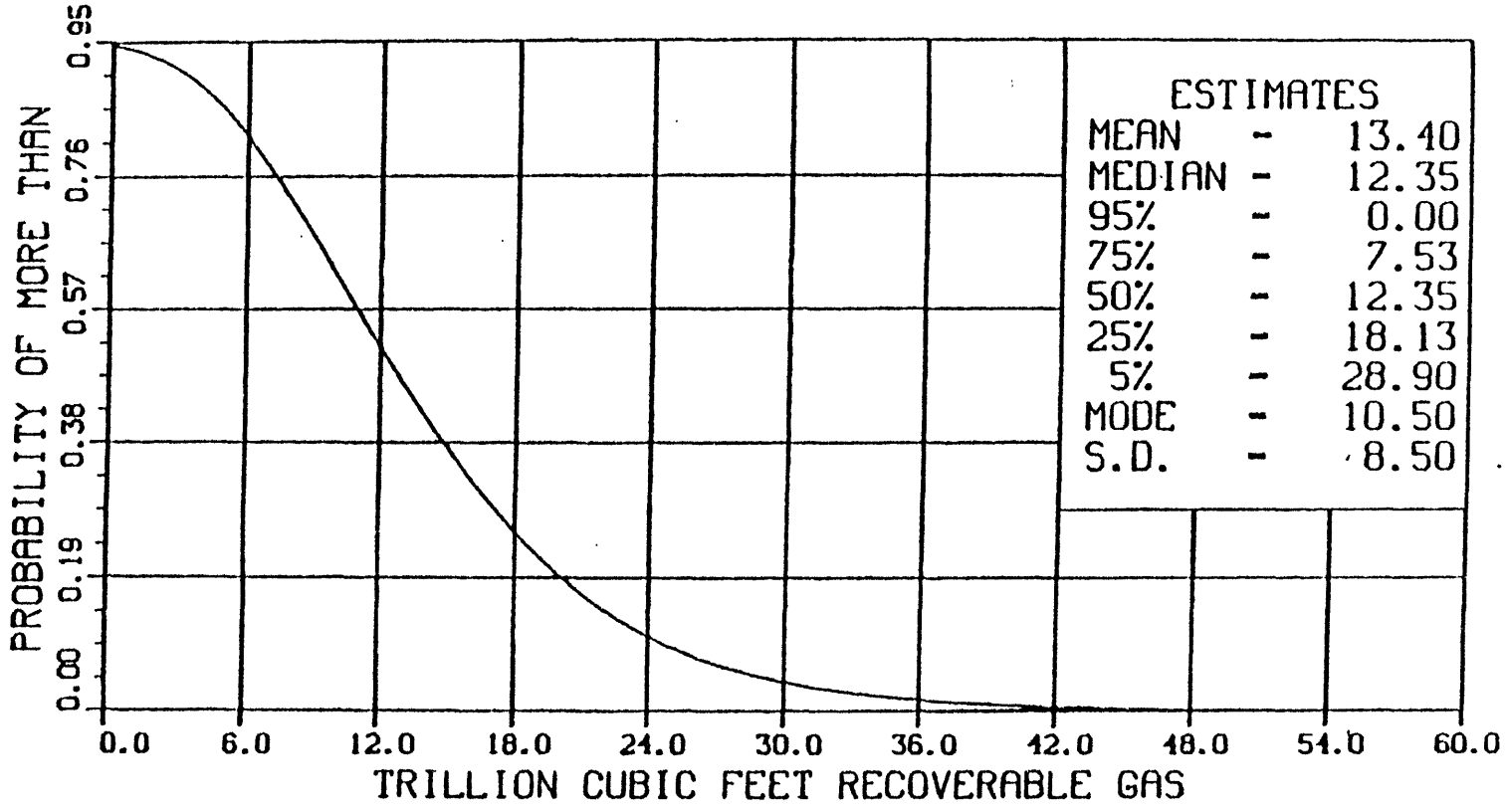


Figure 18.--Northeast Africa; Red Sea basin, recoverable oil.



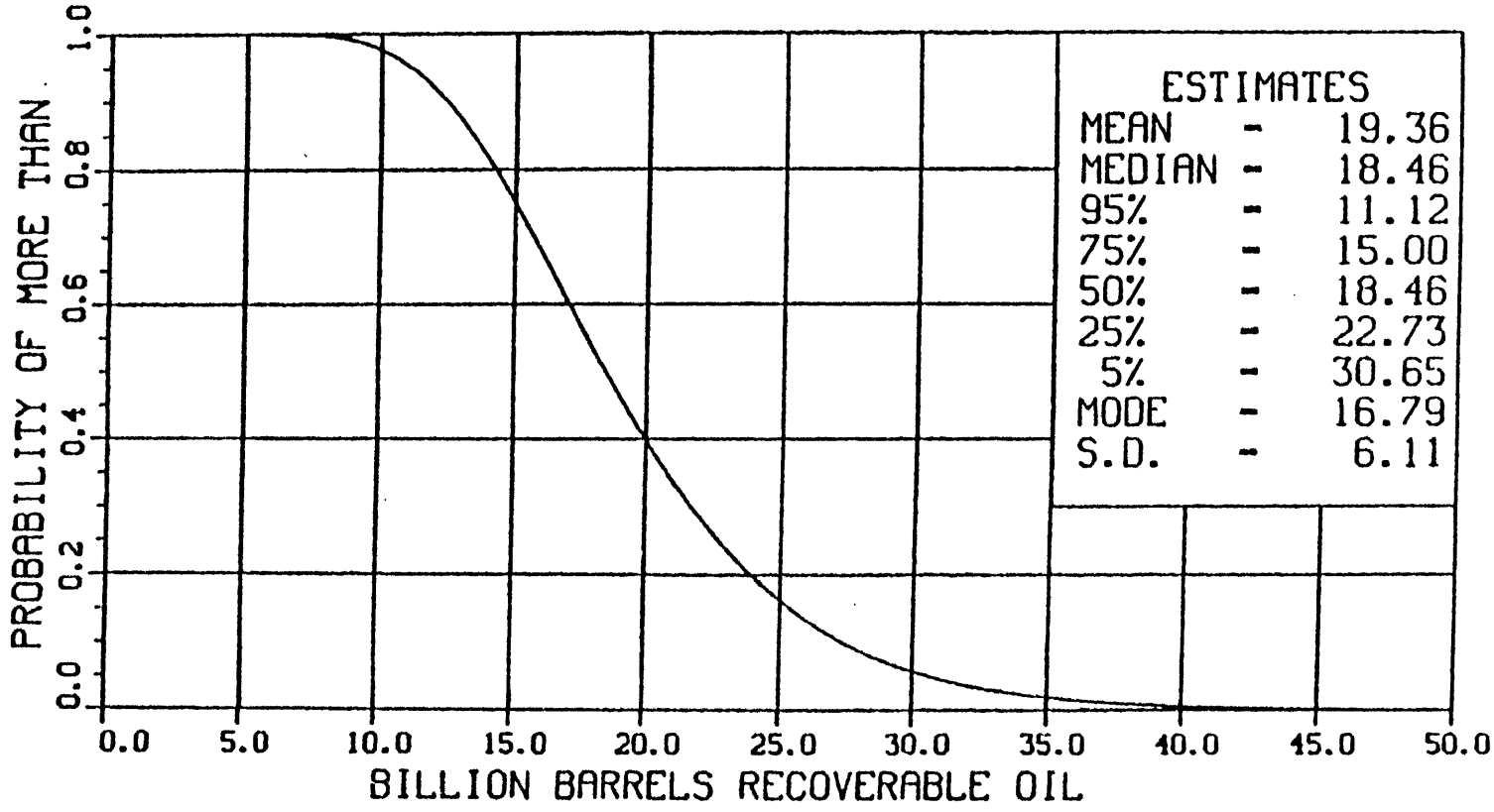
Assessment date - 12/7/82

Figure 19.--Northeast Africa; Red Sea basin, total recoverable gas.



Assessment date - 12/7/82

Figure 20.--Northwest, Central, and Northeast Africa, total recoverable oil.



Assessment date - 12/7/82

Figure 21.--Northwest, Central, and Northeast Africa, total recoverable gas.

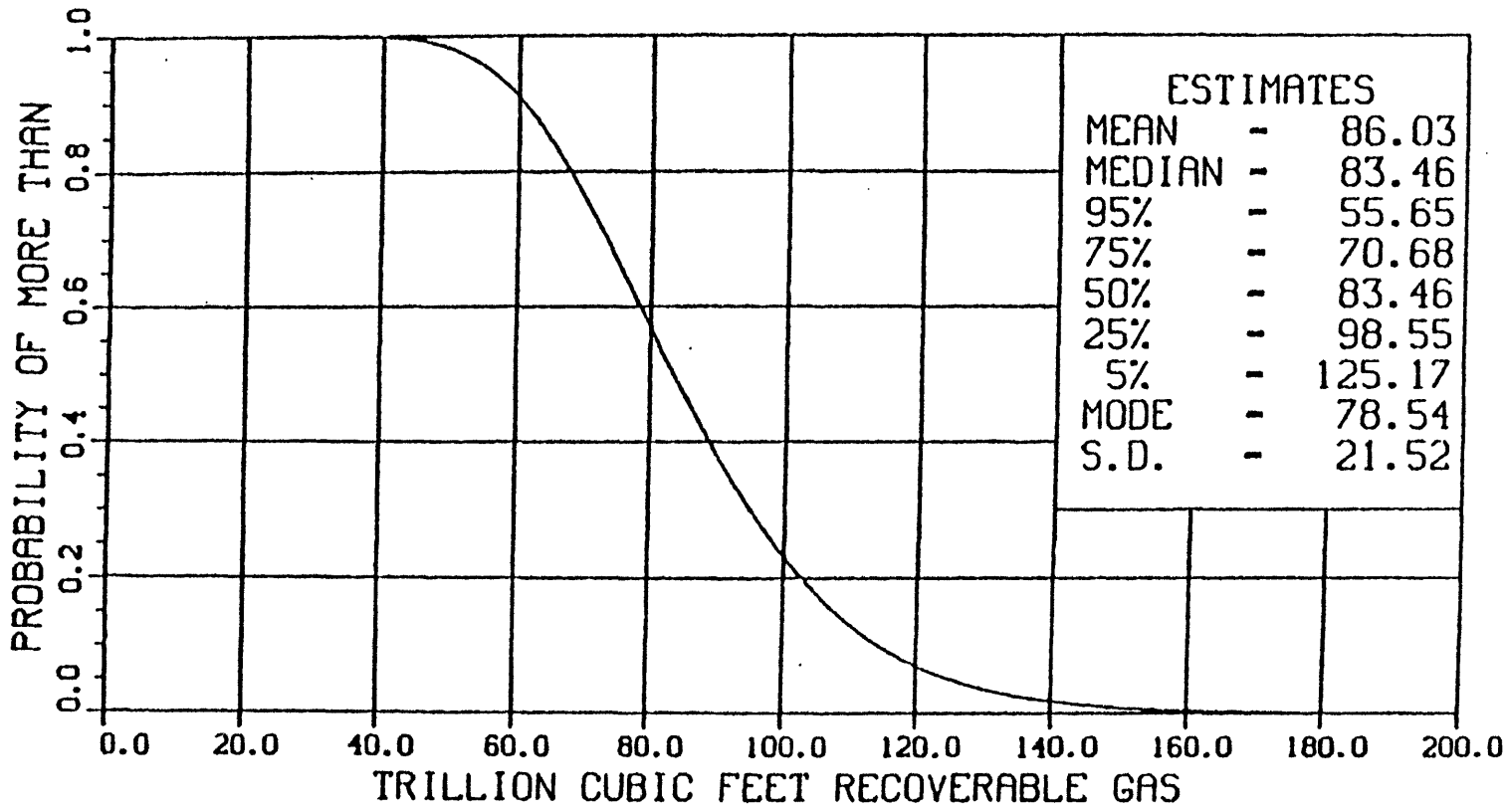


Table 2.--Supplementary and comparative data supporting the resource assessment for Northwestern, Central, and Northeastern Africa [1/]

	Crude oil (BB)	Natural gas (Tcf)
Cumulative production to 7/81		
Atlas folded geosynclinal belt	0.040	0.035?
Tindouf, Bechar, and Reggane basins	0.00	0.00
Taoudeni basin	0.00	0.00
Niger basin	0.00	0.00
Benue trough - "Niger embayment"	0.00	0.00
Chad, Bornu, and Doba basins	0.00	0.00
Upper Nile basin (Sudan)	0.00	0.00
Somali basin	0.00	0.00
Red Sea basin	0.00	0.00
Total	0.040	0.035
Measured reserves to 7/81		
Atlas folded geosynclinal belt	0.035	0.030
Tindouf, Bechar, and Reggane basins	0.00	0.00
Taoudeni basin	0.00	0.00
Niger basin	0.00	0.00
Benue trough - "Niger embayment"	0.00	0.00
Chad, Bornu, and Doba basins	1.00 (est)	+ [2/]
Upper Nile basin (Sudan)	2.00 (est)	+ [2/]
Somali basin	0.00	+ [2/]
Red Sea basin	0.00	0.00
Total	3.00 (est)	8+ (est)

Original recoverable resources (ultimate) of the above provinces [3/]

	Oil	Gas
Cumulative production	0.040	0.035
Measured reserves	3.00 (est)	8+ (est)
Undiscovered resources (mean)	19.36	86
Total	22.4	94+

Total oil and gas = 38+ 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

I. Atlas folded geosynclinal belt

- Much of the province contains a very thick but highly disturbed section of marine Paleozoic, Mesozoic, and early Tertiary carbonate and clastic beds with probable adequate petroleum source rocks. However, because of complex structural history, accumulations of oil and gas are likely to be small and difficult to explore.
- Pre-Tertiary source rocks are likely to be highly mature or overmature.
- There appear to be some hydrocarbon prospects in the small, elongate infolded Tertiary basins where some drilling has already been done with little success.

II. Tindouf, Bechar, and Reggane basins

- Basins contain a thick section of marine Paleozoic rocks with some gas potential and minor oil potential.
- Devonian and Carboniferous section contains carbonate mounds and reefs which may not have been adequately explored.

III. Taoudeni basin

- A high risk basin in a remote part of Africa. Finds would have to be large to be commercial.
- Most of the sedimentary section is early Paleozoic and late Precambrian with questionable source-rock quality, inadequate burial depths in much of the basin and lack of extensive regional seals.

IV. Niger basin

- Most of the basin contains less than 2,000 m of explorable sedimentary section, which is primarily continental and lacustrine Cretaceous beds.

V. Benue trough - "Niger embayment"

- Sedimentary section consists primarily of marine and continental Cretaceous clastic beds, much of which is exposed at the surface.
- Temperature gradient is probably high in all of the Benue trough with hot springs and geothermal deposits in eastern part of trough.

VI. Chad, Bornu, and Doba basins

- Existing fields may not be commercial at present because of lack of ready market and refining facilities.

- Oils are high wax, high pour point.

- Explored section is continental and lacustrine Cretaceous and Tertiary clastic beds with Cretaceous source rocks. Pre-Cretaceous beds are probably metamorphosed. Thermal gradient is probably high.

VII. Upper Nile basin (Sudan)

- Explored section is continental and lacustrine Cretaceous and Tertiary clastic beds. Pre-Cretaceous beds are probably metamorphosed. Source rocks are Cretaceous lacustrine beds. Thermal gradient is probably high.

- Oils are high wax, high pour point.

VIII. Somali basin

- Basin appears to be gas prone with probable lack of good source rocks.

- Most of the good onshore structures have been tested.

- Fault troughs in south part of area contain a very thick section of Mesozoic and Tertiary beds which may be prospective for gas.

- Jurassic and Cretaceous carbonate mounds or reefs and unconformities offer possibilities for stratigraphic traps.

- Offshore area is relatively untested, but size of area with less than 1,000-m water depth is limited.

IX. Red Sea basin

- Basin is gas prone. Thermal gradient is very high.

- Structure is very complex because of intense faulting and salt movement.