BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

RECORD

RECORD 1987/17

PETROLEUM AND MINERALS REVIEW CONFERENCE,
18 - 19 March, 1987

Factors affecting the availability of Australia's undiscovered crude oil resources.

Speaking notes and figures

by

D. J. Forman and A. L. Hinde

RECORD 1987/17

PETROLEUM AND MINERALS REVIEW CONFERENCE,
18 - 19 March, 1987

Factors affecting the availability of Australia's undiscovered crude oil resources.

Speaking notes and figures

by

D. J. Forman and A. L. Hinde

Petroleum and Minerals Review Conference March 1987
Factors affecting the availability of Australia's undiscovered crude oil resources

D.J. Forman and A.L. Hinde

Mr Chairman, ladies, and gentlemen

One task of the Bureau of Mineral Resources is to attempt to assess Australia's undiscovered petroleum resources and the prospects for future supply from these resources. In this talk I will describe BMR's most recent assessments of undiscovered crude oil and condensate resources, I will discuss what part of these resources may be economic by the year 2000, and I will outline the new method that we propose to use to estimate the future annual production of crude oil from these resources.

Slides 1 and 2

These two cumulative probability distributions show BMR's most recent assessments of Australia's undiscovered resources of crude oil and condensate, which were prepared by the trap by trap creaming method. Each distribution shows the probability, on the vertical axis, of discovering at least the amount of the resource shown on the horizontal axis.

The slide on the left shows BMR's assessment of Australia's undiscovered crude oil resources which was released last August. It indicates that Australia has a potential for further discoveries of somewhere between about 1000 and 5000 million barrels of crude oil, with an average of 2400 million barrels.

The slide on the right shows BMR's recent assessment of Australia's undiscovered condensate resources, which has not previously been released. It indicates that Australia has a potential for further discoveries of somewhere between about 300 and 1000 million barrels of condensate, with an average of 550 million barrels. Because production of condensate from undiscovered fields between now and the year 2000 is likely to be small, I will discuss only crude oil from here on.

Slides 3 and 4

The slide on the left shows eight of Australia's most prospective sedimentary areas ranked in order of the average estimate of their undiscovered oil resources, in millions of barrels. According to the assessment, the most prospective areas are the offshore parts of the Bonaparte and Carnarvon Basins.

The slide on the right shows the distribution of our undiscovered crude oil resources according to the age of the sedimentary sequence within which they occur. The slide shows a low value corresponding to the 95 percent probability shown in green, an average value shown at the top of the pale green, and a high value corresponding to the five percent probability shown at the top of the yellow. According to the assessment, the Jurassic to Recent sequence has the greatest potential for further oil discoveries.

Slides 5 and 6

This slide shows the distribution of our crude oil resources according to the type of trap within which they occur. The amount of Australia's identified resources of crude oil is shown below, in purple, and the average amount of our undiscovered crude oil is shown above, in blue. Whereas most of our identified oil occurs in anticlines and palaeotopographic highs, most of our undiscovered oil is expected to occur in anticlines and fault traps.

These assessments are of limited use for energy policy planning on their own. In fact we need a lot more information, such as what part of the undiscovered resources may be economic by the year 2000 and what will be the future production from these undiscovered resources.

Slides 7 and 8

Fortunately we can use our assessment to get a better idea of what part of our undiscovered crude oil resources may be economic by the year 2000. Australia's undiscovered crude oil resources are subdivided into two categories, referred to as hypothetical resources and speculative resources.

The left hand slide shows the assessment of hypothetical resources, which averages about 1900 million barrels. These resources occur in stratigraphic sequences that have proved to contain petroleum in the same area or in similar adjacent areas. They occur in the better explored areas where discovery and production is possible by the year 2000.

The right hand slide shows the assessment of speculative resources, which averages about 500 million barrels. These resources occur in stratigraphic sequences that have not proved to contain petroleum in the same area or in similar adjacent areas. They occur mainly in poorly explored deep water areas where discovery and production is unlikely by the year 2000.

Slides 9 and 10

This slide shows how the part of our hypothetical undiscovered crude oil resources that may be economic by the year 2000 depends on the difference between the smallest size of field that is included in the assessment and the smallest size of field that can be economically produced. The 95 percent, average, and five percent values for the assessment of Australia's hypothetical undiscovered oil resources are plotted on the left of the slide where the multiple of the smallest size of field included in the assessment of each area is shown as one. The graphs show how the 95, average, and five percent estimates change as the multiple of the smallest size of field included in the assessment is increased by up to 1000 times. Because the smallest size of field included in the assessment is smaller than the smallest size of field that can be produced at today's oil prices, or the prices that might prevail in the year 2000, it is obvious that only a part of our hypothetical undiscovered resources will be economic by the year 2000.

Slides 11 and 12

This slide shows the estimate of production of crude oil that we prepared in 1985. The vertical axis shows amounts of crude oil in millions of barrels per year and the horizontal axis shows the time period from 1974 to 1994. The estimate of future production from undiscovered resources is shown as a widening range of values from 1986 onwards and the significance of the estimate is enhanced by also including an estimate of demand, which is the top line in the slide, and an estimate of production from identified oil fields, which is the bottom line.

This particular estimate of future production of crude oil from undiscovered resources had two main failings. Firstly, the method by which it was prepared was very subjective and secondly, it used a single estimate of new-field wildcat drilling throughout the period.

Slides 13 and 14

We are currently developing a computer program for estimating future production of crude oil from undiscovered resources that will be less subjective, because it incorporates a large amount of historic data including the data that we use in the trap by trap creaming method of assessing undiscovered petroleum resources. The program also attempts to make allowance for possible future variations in the level of new-field wildcat drilling.

The program will simulate drilling Australia's petroleum prospects, and when discoveries are simulated it will estimate their sizes, the year of discovery, the lead time from discovery to production, and the annual production. The slide shows what the program will do, broken up into four parts:

. a drilling model which estimates onshore and offshore new-field wildcat drilling from 1987 to 2000;

. a field size model which estimates the average amount of petroleum each prospect could contain and the probability that it does contain petroleum;

. a discovery rate model which estimates when each field may be discovered;

. and a field production model which estimates the annual production from each field.

. the final product is an estimate of the annual production of crude oil from 1987 to 2000.

I will now briefly outline the methodology and the data used in each of these four models.

Slides 15 and 16

The drilling model uses data derived from Australia's drilling statistics to estimate annual new-field wildcat drilling from 1987 to 2000. The left hand slide shows Australia's annual new-field wildcat drilling from 1960 to 1986, with separate scales for onshore and offshore. For the purpose of our computer program, we have assumed that uptrends and downtrends of similar duration and size to those shown on the slide will also occur from 1987 to 2000. To estimate the duration and size of these future uptrends and downtrends, we have converted the data in the left hand slide into the cumulative probability distributions in the right hand slide.

The cumulative probability distribution on the top left of the right hand slide shows the probabilities of how long the uptrends and downtrends may last. The two cumulative probability distributions on the bottom of the right hand slide show the probabilities of how much the amount of annual drilling, onshore and offshore, may change from one year to the next.

Now the duration and size of a single uptrend or downtrend can be estimated, firstly by random selection of the number of years for which the trend may last and, secondly by random selections of the change in the amount of annual drilling for each year in the trend. This process can be repeated for each succeeding downtrend or uptrend until the year 2000 is reached.

There is one more problem to deal with, however. Examination of the offshore drilling profile from 1976 to 1986 shows a pattern of peaks and troughs very similar to the onshore profile, except that the onshore lags the offshore by about two years. The cumulative probability distribution in the top right of the right hand slide shows the estimated probabilities of how long this lag may be in the future.

These various distributions, therefore, provide most of the data needed in the drilling model to estimate onshore and offshore new-field wildcat drilling from 1987 to 2000.

Slides 17 and 18

This slide shows the types of data that are used in the field size model to estimate the average amount of petroleum that each of Australia's undrilled prospects could contain and to estimate the probability that the prospect does contain petroleum. The data are identical to those used in the trap by trap creaming method of assessing undiscovered petroleum resources.

The average amount of petroleum that each prospect could contain is estimated using an estimate of the closure area of each prospect and an estimate of the amount of petroleum per unit area that may be retained in the prospect.

The individual probability that each prospect does contain petroleum is estimated using other types of information, such as existence risk, success rate, and the smallest size of field included in the assessment. The average prospect sizes are then multiplied by the probabilities to estimate the risked average prospect sizes.

I have no slides for the discovery rate model because it is mainly computational. It uses the output from the drilling model and the field size model to estimate when each field may be discovered. This is carried out in three steps. Firstly, the order in which the prospects may be drilled is estimated by ordering the prospects according to the hypothesis that the probability of drilling a prospect next is proportional to its risked average prospect size raised to the power lambda.

Secondly, the year in which each prospect may be drilled is estimated, simply by matching up the ordered prospects with the number of new-field wildcat wells for each year. Thirdly, the computer simulates drilling the prospects, and when discoveries are simulated it estimates their sizes and the year of discovery.

Slides 19 and 20

This slide shows part of the data used in the field production model to estimate annual production from the undiscovered fields. The slide shows two histograms for the lead times between discovery and production of Australia's producing oil fields, with onshore above and offshore below. The histogram for the onshore fields shows that while it may take up to 21 years to bring an oil field into production, most of them are brought into production in the first year. The histogram for offshore fields shows that while it may take up to 23 years to bring an oil field into production, a good proportion of them are brought into production within three to seven years of discovery. Assuming that future lead times will follow the same pattern, we can use these histograms to estimate likely lead times for the undiscovered fields.

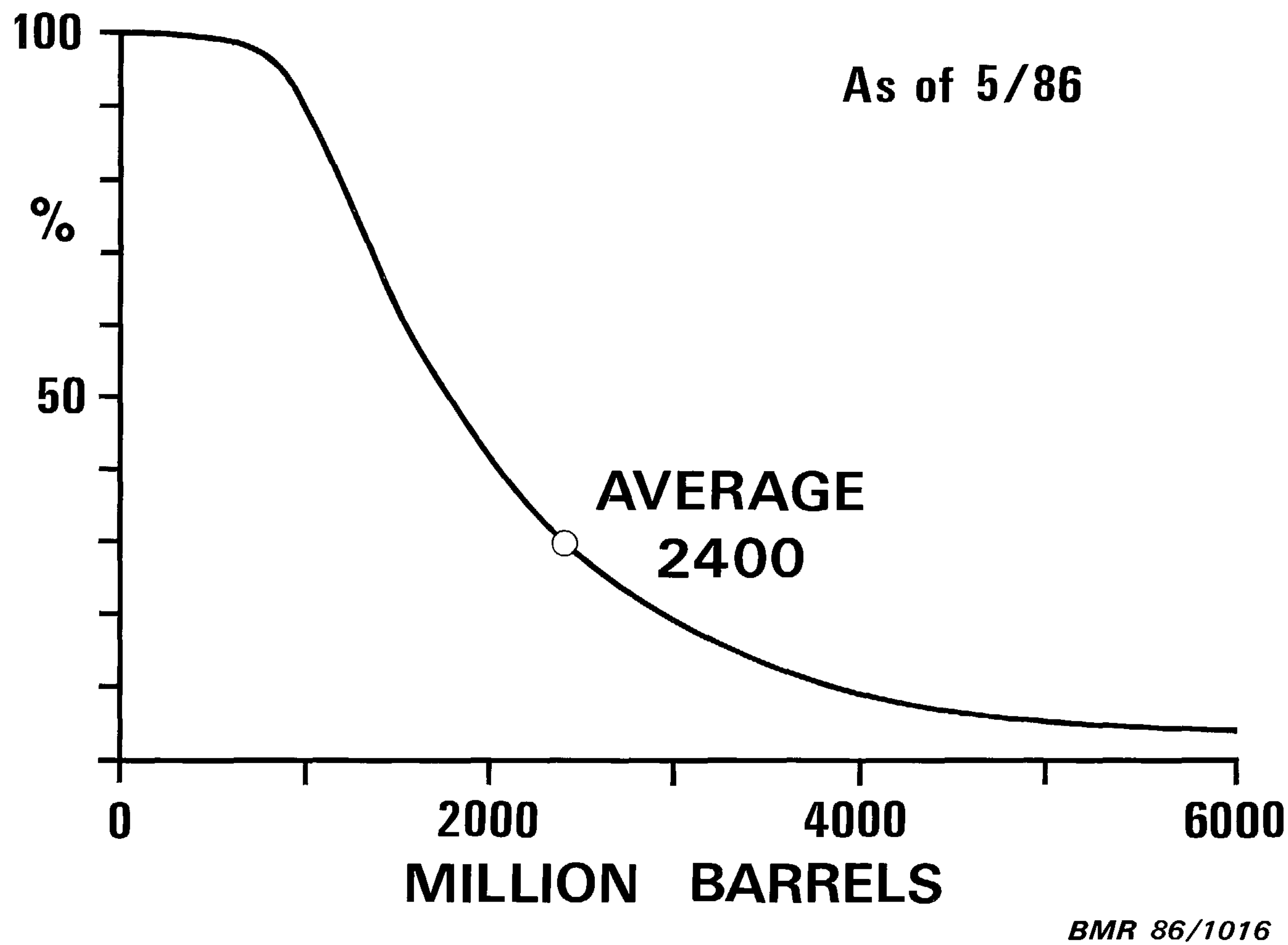
We have also collected all of the annual production statistics for Australia's producing oil fields, and have compiled them into histograms that can be used to estimate the annual production from the undiscovered fields.

Hence, given a field size and the year of discovery, The field production model will estimate the lead time and a production profile for each field, and will estimate its future annual production. It then adds up the annual production for all the fields in the iteration. Repeated for many thousands of iterations, the final product is a probability distribution of annual production for each year from 1987 to 2000.

In summary, BMR has assessed Australia's undiscovered resources of crude oil and condensate by a new method that gives a considerable amount of information on their distribution and magnitude. A part of these resources occurs in deep water areas or in very small fields and may not be economic by the year 2000.

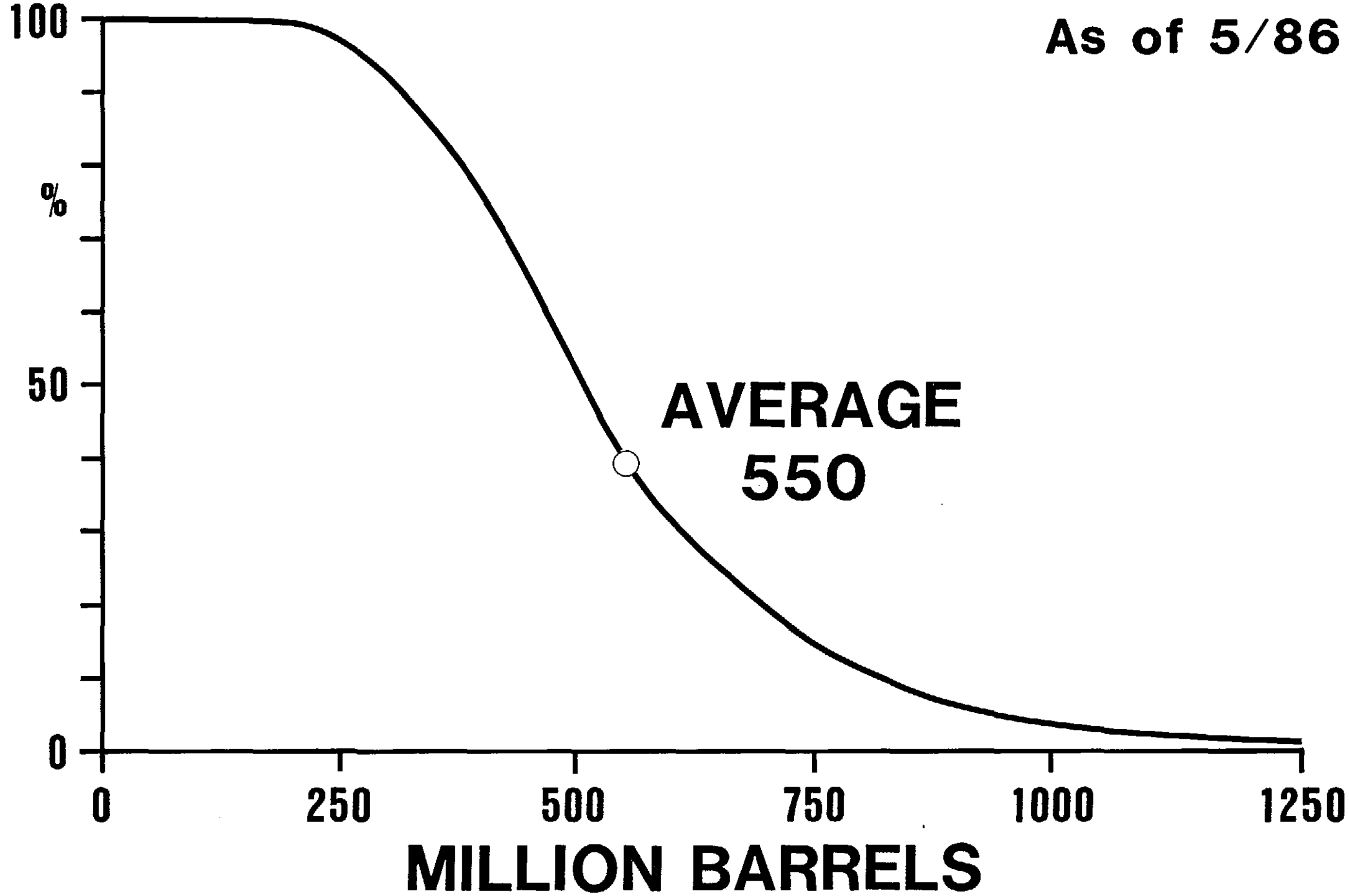
A new computer program is being written to estimate the future production of crude oil from Australia's undiscovered resources. The program will simulate drilling Australia's petroleum prospects, and when discoveries are simulated it will estimate their sizes, the year of discovery, the lead time from discovery to production, and their annual production.

The program relies heavily on past experience as a guide to the future. The past experience is input to the program as cumulative probability distributions or histograms that cover a wide range of uncertain factors and have the effect of reducing the subjectivity of the estimate. We would of course be able to alter these input data to illustrate specific cases as an aid to policy analysis. The objective is to produce a probability distribution of annual production of crude oil from presently undiscovered resources for each year from 1987 to 2000.



100
50
%
As of 5/86
AVERAGE
2400
0
2000
4000
6000
MILLION BARRELS
BMR 86/1016

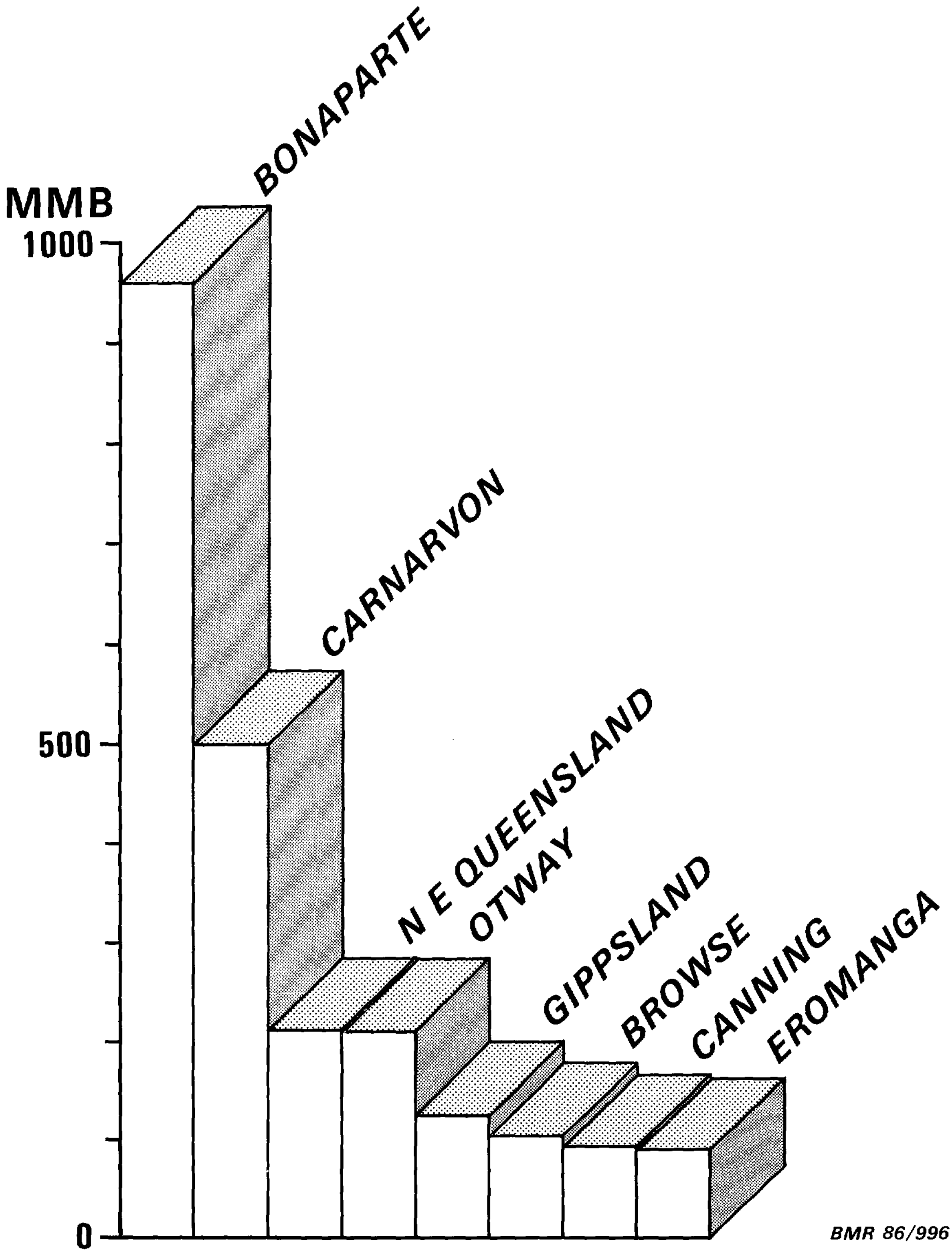
Slide 1



Slide 2

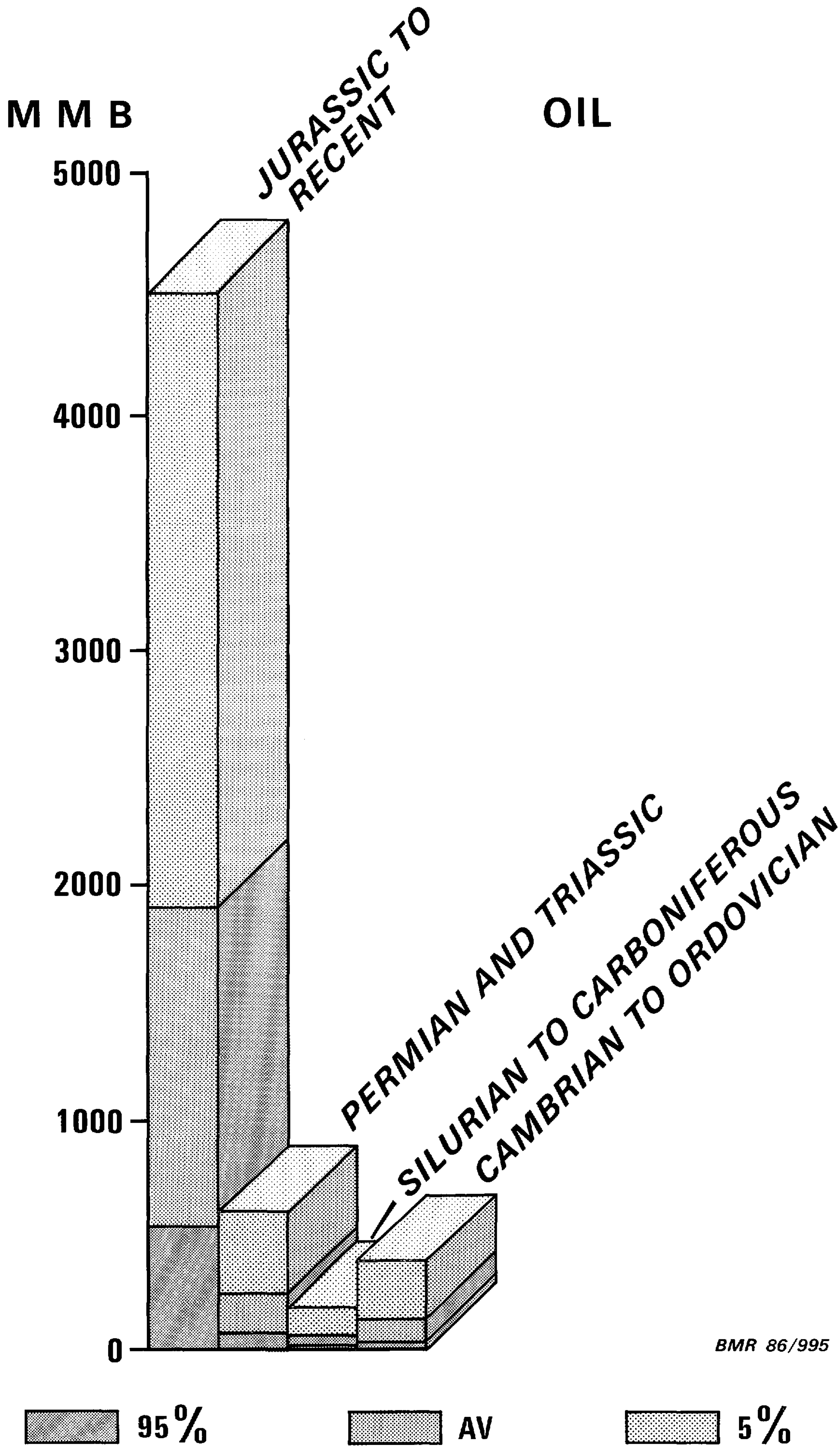
BMR 87/208

UNDISCOVERED CRUDE OIL RESOURCES

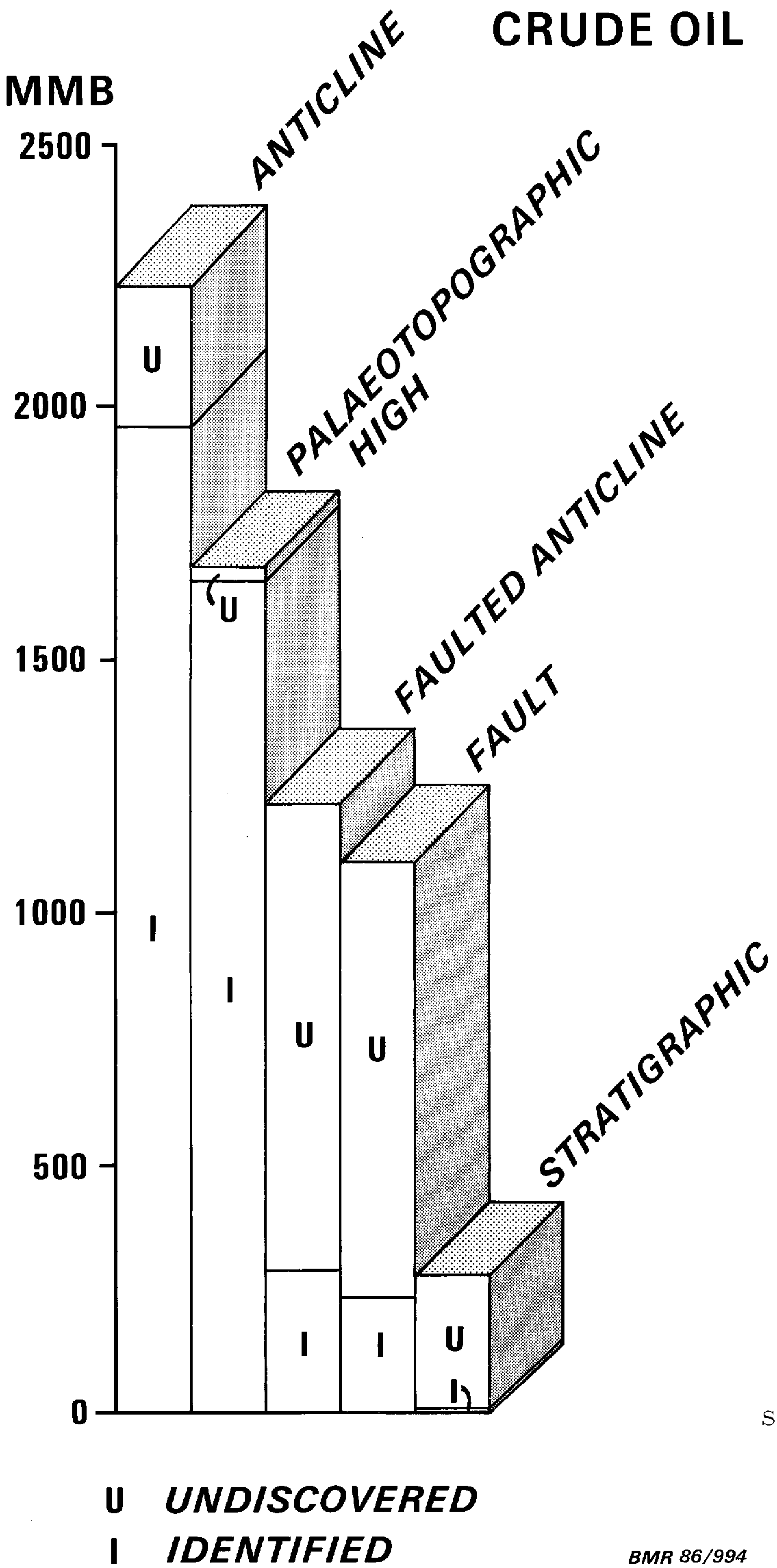


Slide 3

Slide 4

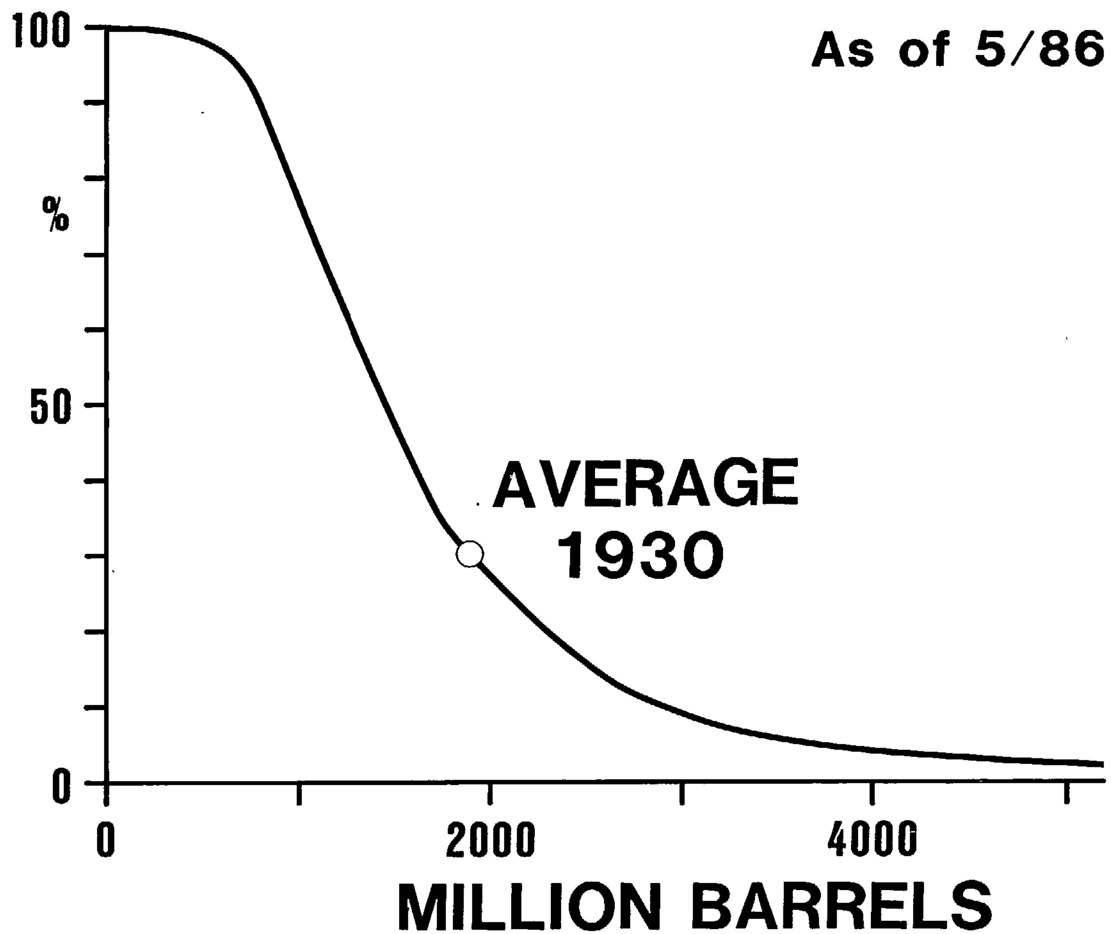


M M B
OIL
5000
4000
3000
2000
1000
0
JURASSIC TO RECENT
PERMIAN AND TRIASSIC
SILURIAN TO CARBONIFEROUS
CAMBRIAN TO ORDOVICIAN
BMR 86/995
95%
AV
5%



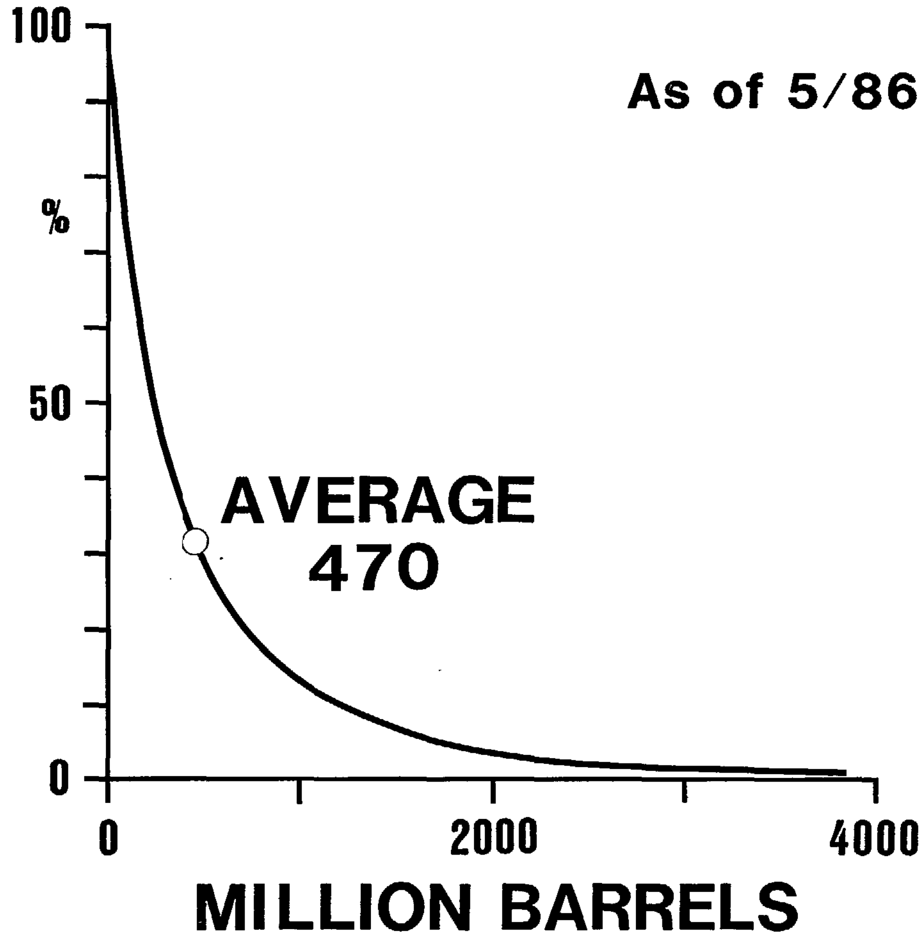
Slides 5 and 6

BMR 86/994



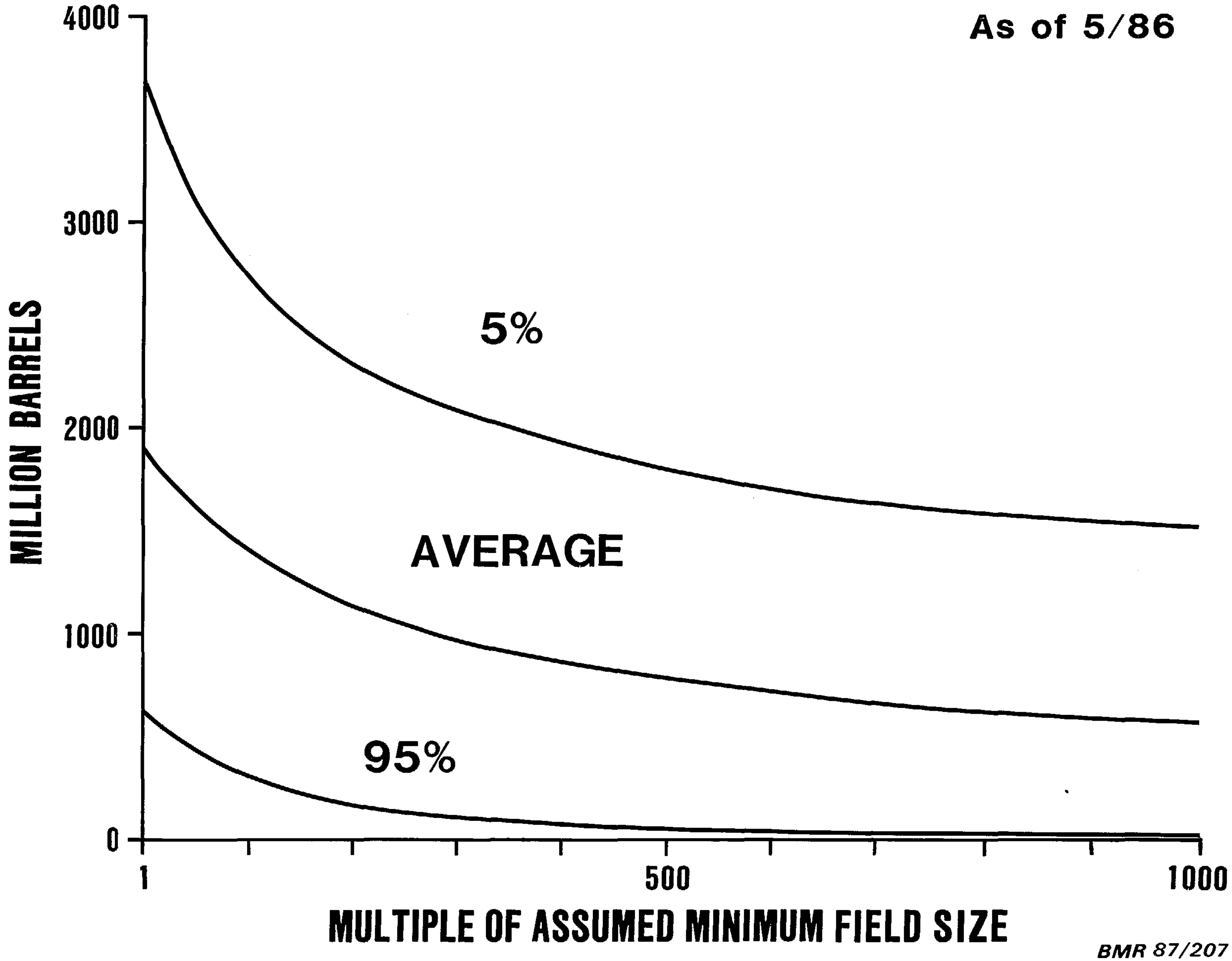
Slide 7

BMR 87/210

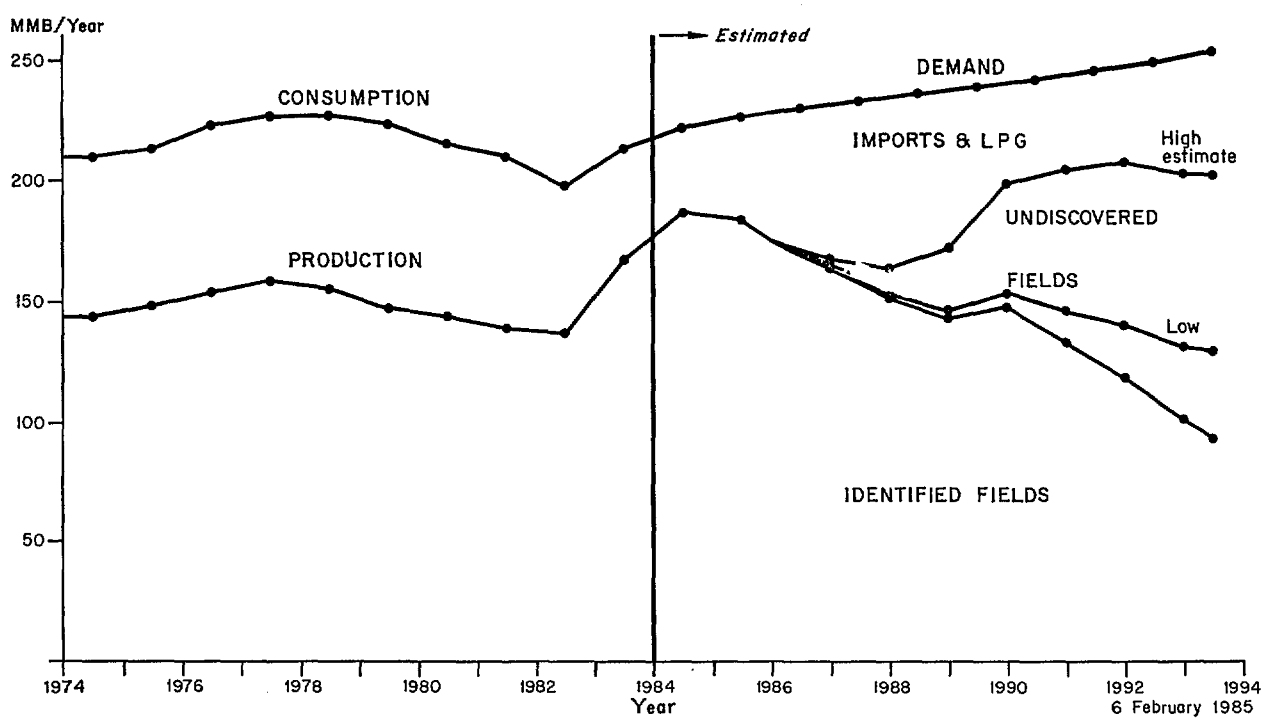


Slide 8

BMR 87/209



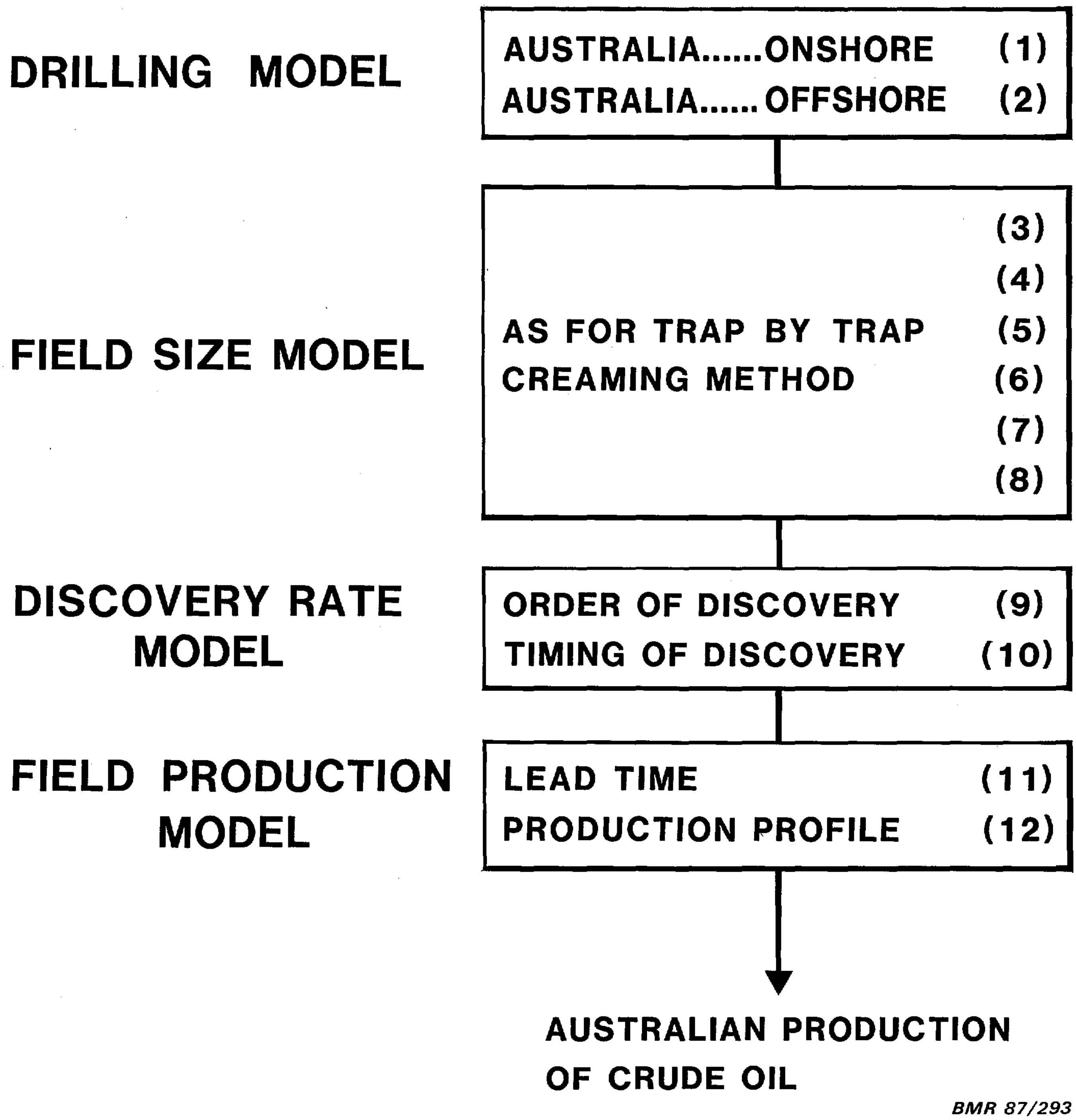
Slides 9 and 10



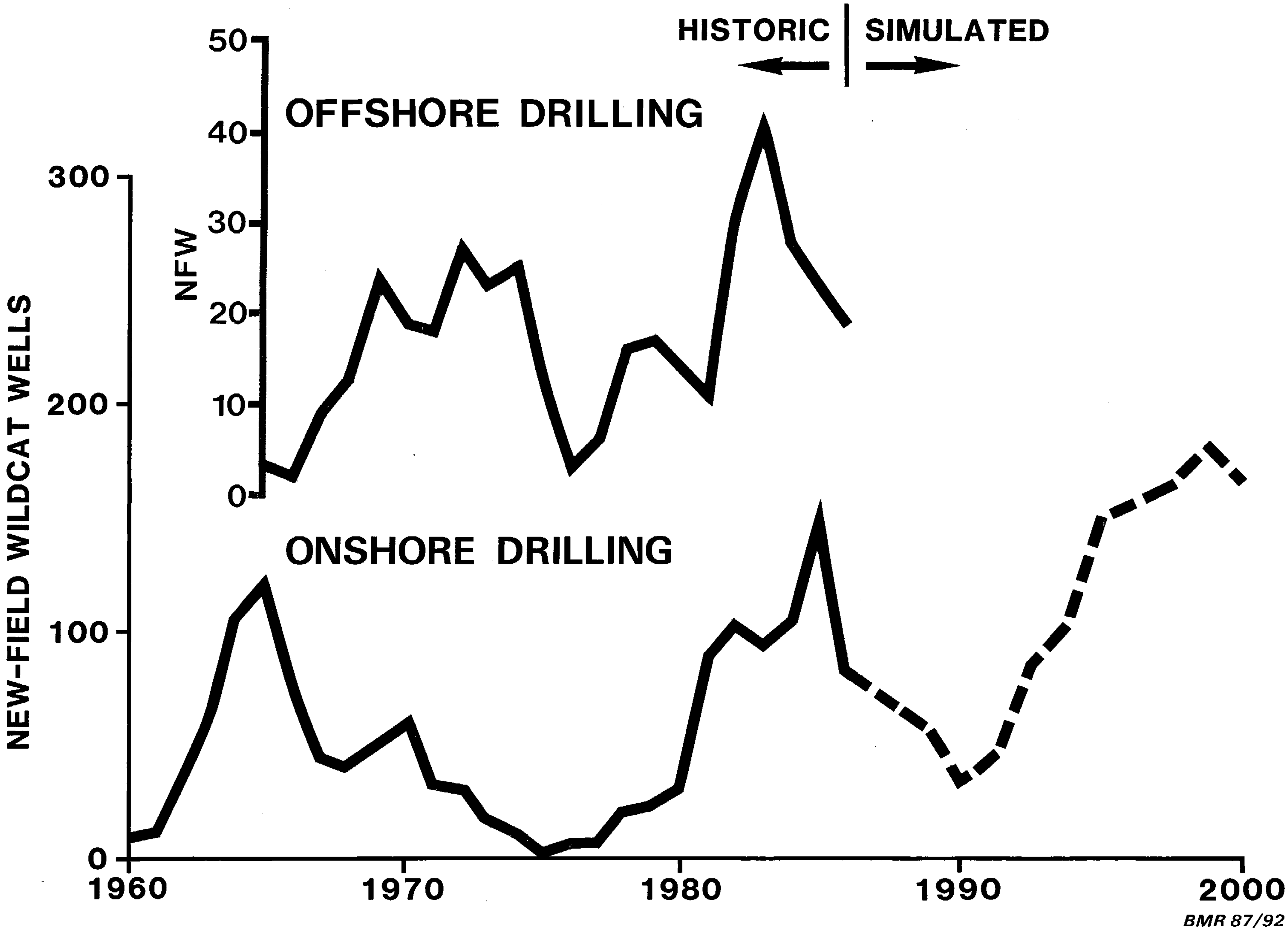
14-1/28

Slides 11 and 12

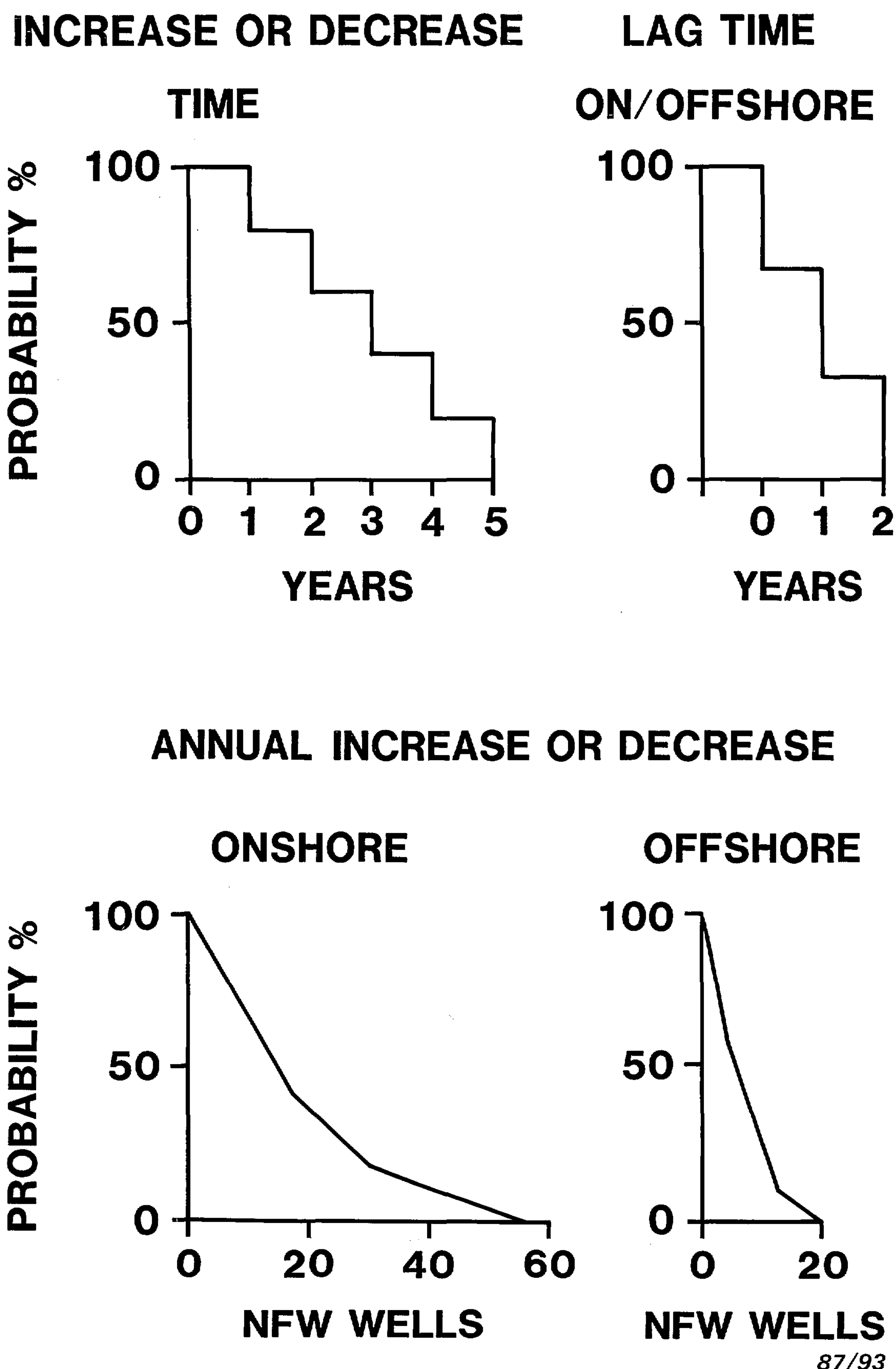
S E A P U P



Slides 13 and 14


HISTORIC
SIMULATED
OFFSHORE DRILLING
NFW
50
40
30
20
10
0
ONSHORE DRILLING
NEW-FIELD WILDCAT WELLS
300
200
100
0
1960
1970
1980
1990
2000
BMR 87/92

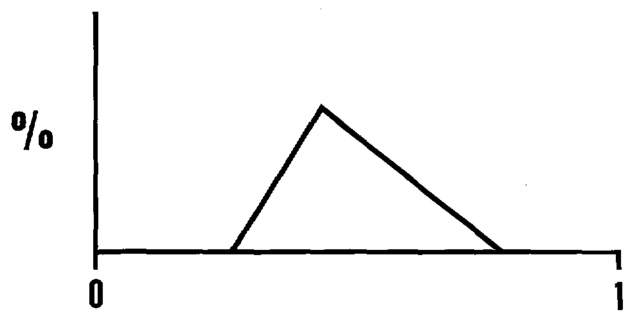
Slide 15


INCREASE OR DECREASE
TIME
LAG TIME
ON/OFFSHORE
PROBABILITY %
100
50
0
0 1 2 3 4 5
YEARS
100
50
0
0 1 2
YEARS
ANNUAL INCREASE OR DECREASE
ONSHORE
OFFSHORE
PROBABILITY %
100
50
0
0 20 40 60
NFW WELLS
100
50
0
0 20
NFW WELLS
87/93

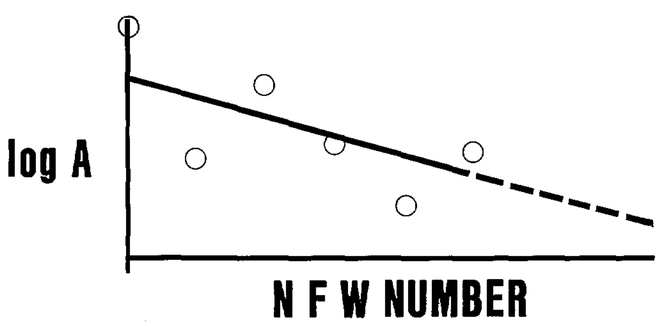
Slide 16

FIELD SIZE MODEL

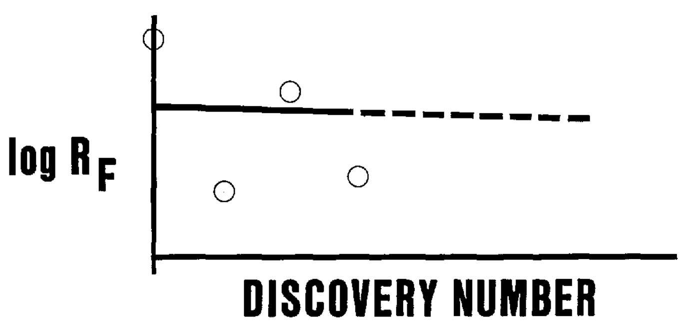
- EXISTENCE RISK (3)



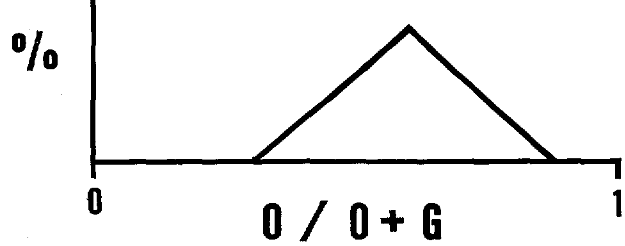
- SUCCESS RATE (4)



- CLOSURE AREA (5)



- RETENTION FACTOR (6)



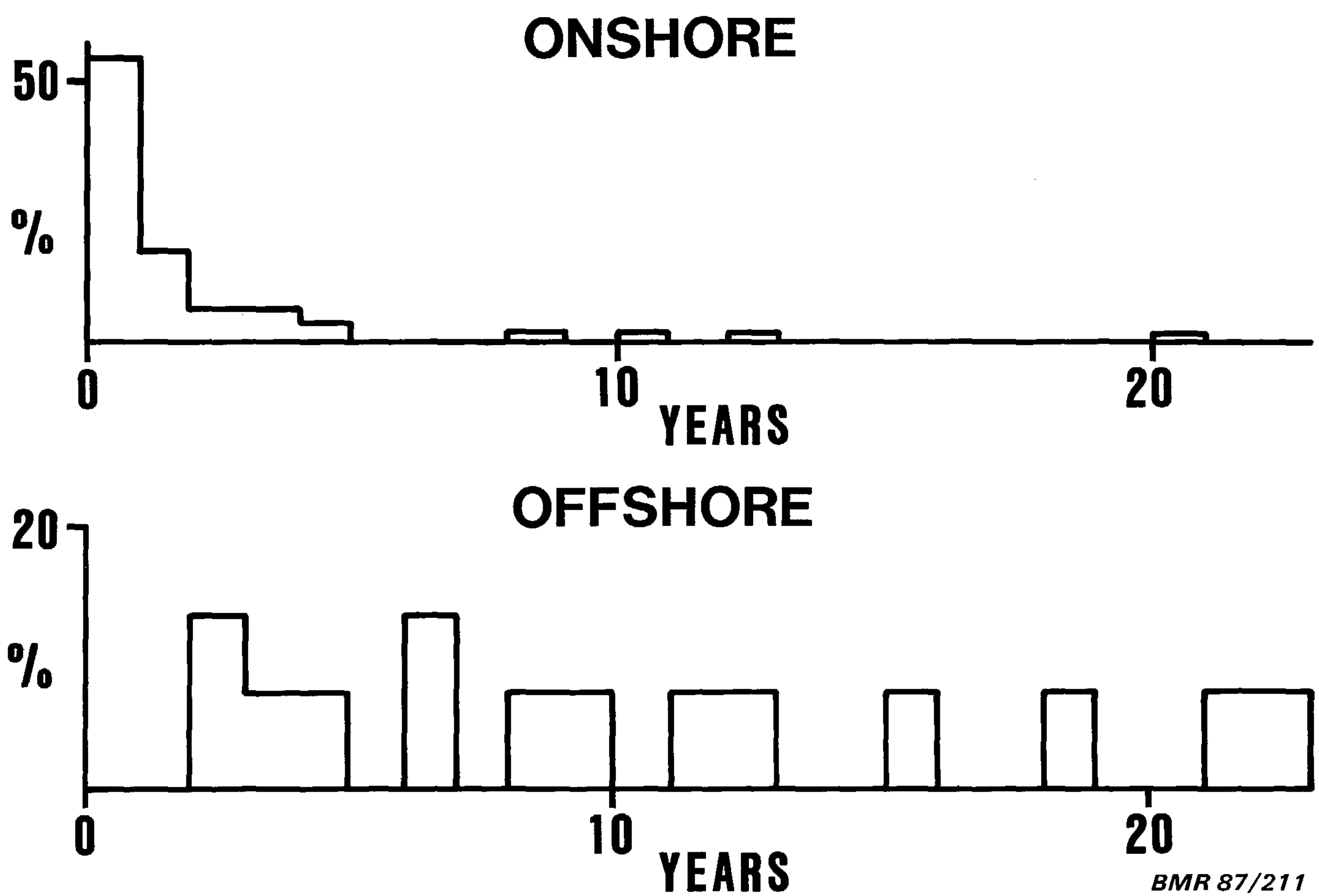
- OIL / OIL + GAS (7)

- MINIMUM FIELD SIZE (8)

BMR 87/212

Slides 17 and 18

LEAD TIME



Slides 19 and 20