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RECORDS:

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TESTING OF SOME AUSTRALIAN BENTONITES
FOR POSSIBLE USE IN DRILLING MUDS

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Introduction

The information contained in this Record was originally presented at the 1965 Annual Conference of A.P.E.A., held in Adelaide, S.A.

The basic data from which the paper was prepared were obtained during research carried out in the Petroleum Technology Section Laboratory, Bureau of Mineral Resources, Geology and Geophysics, into the properties of Australian Bentonites.

The results of the laboratory tests indicate that further research into the use of locally available bentonites is merited.

TESTING OF SOME AUSTRALIAN BENTONITES FOR POSSIBLE USE IN DRILLING FLUIDS

by

Paul G. Duff

A survey of completion reports covering 82 out of 129 wells drilled in Australia during 1963 showed the average bentonite consumption to be approximately 16 tons per well. On this basis, the consumption of bentonite used for drilling muds in 1964 would have been around 3,500 tons.

Most of the bentonite used in Australian drilling is of U.S.A. origin. This bentonite from Wyoming has unique properties which are ideal for the preparation of fresh water muds.

Any bentonite used in the drilling muds, other than "spud muds" or muds used when drilling lost circulation zones, should be of premium quality and should conform to the A.P.I. specifications.

A low-yielding bentonite, though much cheaper, is likely to create in the mud an initial high solids content, which may prove difficult to control when drilling through mud-making formations or when high mud weights are required.

A bentonite with a high content of fine sand will cause an excessive wear on pump liners, gun nozzles, gun swivels etc.

A bentonite which displays a high water loss will require costly treatment to reduce this to a suitable value. This treatment may cause a rise in viscosity which in turn will have to be reduced by other chemical treatment.

Again, if the Bingham Yield value of the bentonite slurry is too high, difficulty will be experienced in maintaining correct annular velocities at depth; pumps will be overloaded and engines will overheat. The use of a low Bingham Yield slurry will allow higher annular velocities to be used efficiently resulting in a clean hole being maintained.

Much more could be said of the role that good bentonite mud plays in efficient mud hydraulics, but such discussion is not within the scope of this paper. It is sufficient to say that a bentonite conforming to A.P.I. specifications should be used in the initial makeup of all good water base muds. Unfortunately, all Australian bentonitic clays tested to date in the Petroleum Technology Laboratory of the Bureau of Mineral Resources have fallen far short of the A.P.I. specifications.

Explanation of Terms Used

The term "Viscosity" used when discussing drilling muds refers to the Apparent Viscosity (A.V.) measured either on the single speed Stormer Viscosimeter or on the variable-speed Fann V.G. meter. The A.V. is measured in centipoises.

The A.V. is made up of two components, the Plastic Viscosity (P.V.) and the Bingham Yield (Y). It is defined as the force per unit area required to maintain a unit difference in velocity between two parallel layers unit distance apart.

The P.V. may be simply described as that part of the total viscosity or A.V. which is created by the mechanical friction between the solid particles in the mud, between the solids and the liquid that surrounds them and by the shearing of the liquid itself. The P.V. is controlled by dilution, generally with water, and like the A.V. is measured in centipoises. The measured value is that of the shearing stress in excess of yield value, that will induce a unit rate of shear.

The Bingham Yield (Y) is that part of the viscosity which is produced by electro-chemical action between unsatisfied charges on the bentonite and other particles. The effect of this attraction may be changed by the addition of chemicals, such as caustic-tannin phosphates or ligno sulphonates. The Y is measured in pounds per 100 sq. ft, representing the difference between the shearing stress and the product of the plastic viscosity and the rate of shear.

The water loss (W.L.) is the amount of clear liquor that can be expressed from a mud over a standard area at a pressure of 100 p.s.i.g. applied for 30 minutes. W.L. is measured in cubic centimetres.

A.P.I. Specifications for Bentonite For Use in Drilling Muds

Originally the A.P.I. specification for bentonite was concerned only with moisture content, water loss and sieve analysis.

Having ensured that the bentonite satisfied the A.P.I. standards, the purchaser was then concerned with the volume of 15 cps. A.V. mud that could be produced from one ton of the material.

Under this old specification some Australian bentonite clays appeared to have good prospects, especially when lightly treated with alkaline sprays and allowed to weather for long periods.

The new "Tentative Standard, A.P.I. Specification for Oil Well Drilling Fluid Materials, A.P.I. Std. 13A, First Edition, March 1962", introduced a specification for P.V. which immediately rules out Australian bentonitic clays which had previously been looked upon with interest.

The specification for bentonite (for a slurry of 21 gm of bentonite in 350 ml of distilled water, or 6% by weight) included in the 1962 A.P.I. standard are as follows:

Plastic Viscosity ... ... 8.0 cp. Minimum

Filtrate (Water Loss) ... ... 14 cc. Maximum

Wet Screen Analysis ... ...

Residue on U.S. Screen No.200 .. 2.5% Maximum

Moisture ... ... 12% Maximum

Testing of Some Australian Bentonitic Clays

The results of numerous tests carried out on two Western Australian, six Queensland, six New South Wales, one Papuan and two New Zealand bentonites are shown in figures 1, 2, 3 and 4.

In all cases a premium grade Wyoming bentonite was used for comparison in the various test series and the testing procedure was as follows:

Crude samples were crushed and hot-air dried before grinding to pass a 200 mesh sieve; the ground material was then further hot-air dried.

Using distilled water, bentonite slurries of 4.5.6.7.8, 9% by weight were prepared. An initial mix of 10 minutes was given each slurry which was then allowed to stand overnight before a further 30 minute high speed mix. The slurries were next allowed to stand for 24 hours for complete hydration and, finally, a 30 minute high speed mix was again given immediately before testing.

The A.V., P.V., and Y values were determined using the Fann meter. The pH was determined with "Hydrion" papers and the water loss was measured in a standard filter press.

The two best Queensland bentonite clays from the same area were tested in the above manner. It may be seen from fig. 1 that the A.V. value was good. However, samples which were subsequently obtained from the same seam gave A.V. values which fell in the shaded portion of fig. 1. The good results originally obtained have not been repeated to date.

The pH of all Queensland clay slurries was approx. 7, whereas the Wyoming bentonites supplied to Australian drilling companies have a pH of approx. 9.

It will be noted in fig. 2 that the maximum value obtained for the P.V. of Queensland clays was 2.5 for a 6% slurry.

Efforts to obtain fair and representative samples have been unsuccessful because of the heterogenous nature of the deposit.

One Western Australian bentonite shows promise in that a 6% slurry gives A.V. of 9 cp. (fig. 1) and a water loss of 17.5 cc. (fig. 4) compared with the Wyoming's bentonite A.V. of 13 cp. and W.L. of 11.5 cc. However, for the same 6% slurries the P.V. of Wyoming bentonite is 8 cp. (fig. 2) while the Western Australian clay gives a P.V. of only 3 cp. The pH measured on slurries prepared from this Western Australian clay was between 9 and 10, which suggests that it has been treated in some way.

The New Zealand bentonite was forwarded as a finished product and labelled "treated and pulverised". In this case the A.V. is high enough to attract attention but, again, the P.V. is much too low for the A.P.I. requirements. The pH of a 6% slurry was approximately 9.

Other Queensland samples from three different areas, six New South Wales samples, another Western Australian sample, an untreated New Zealand sample and one Papuan clay, all give results which lie in the shaded area of fig. 1 and are unsuitable for mud making. The plastic viscosity of all these samples was below 2 cp. at a concentration of 6%.

Base Exchange

After testing the various bentonitic clays in the "as received" condition, attempts were made to improve their properties by a simple base exchange; sodium salts were used in an endeavour to replace calcium ion with sodium.

Samples were steeped for long periods in various concentrations of sodium carbonate; they were allowed to dry out before being re-wetted. This continued drying and wetting was carried out over periods of up to five months. After this treatment an improvement in A.V. was noted, but little or no increase in P.V. was obtained.

The increase in A.V. was, therefore, due to a rise in the Bingham Yield value, indicating that no base exchange had taken place, and that the viscosity rise was due simply to sodium carbonate contamination.

No further base exchange tests were carried out. Instead, further samples were tested after prolonged grinding of the dry untreated clay, which had already passed through a 200 mesh sieve. The particle size of the finely ground material was between 70 and 30 microns.

This fine grinding did improve the P.V. values of the samples, but the improvement was inadequate; the improved P.V. values of 6% slurries were still much below the A.P.I. minimum requirement of 8 cp.

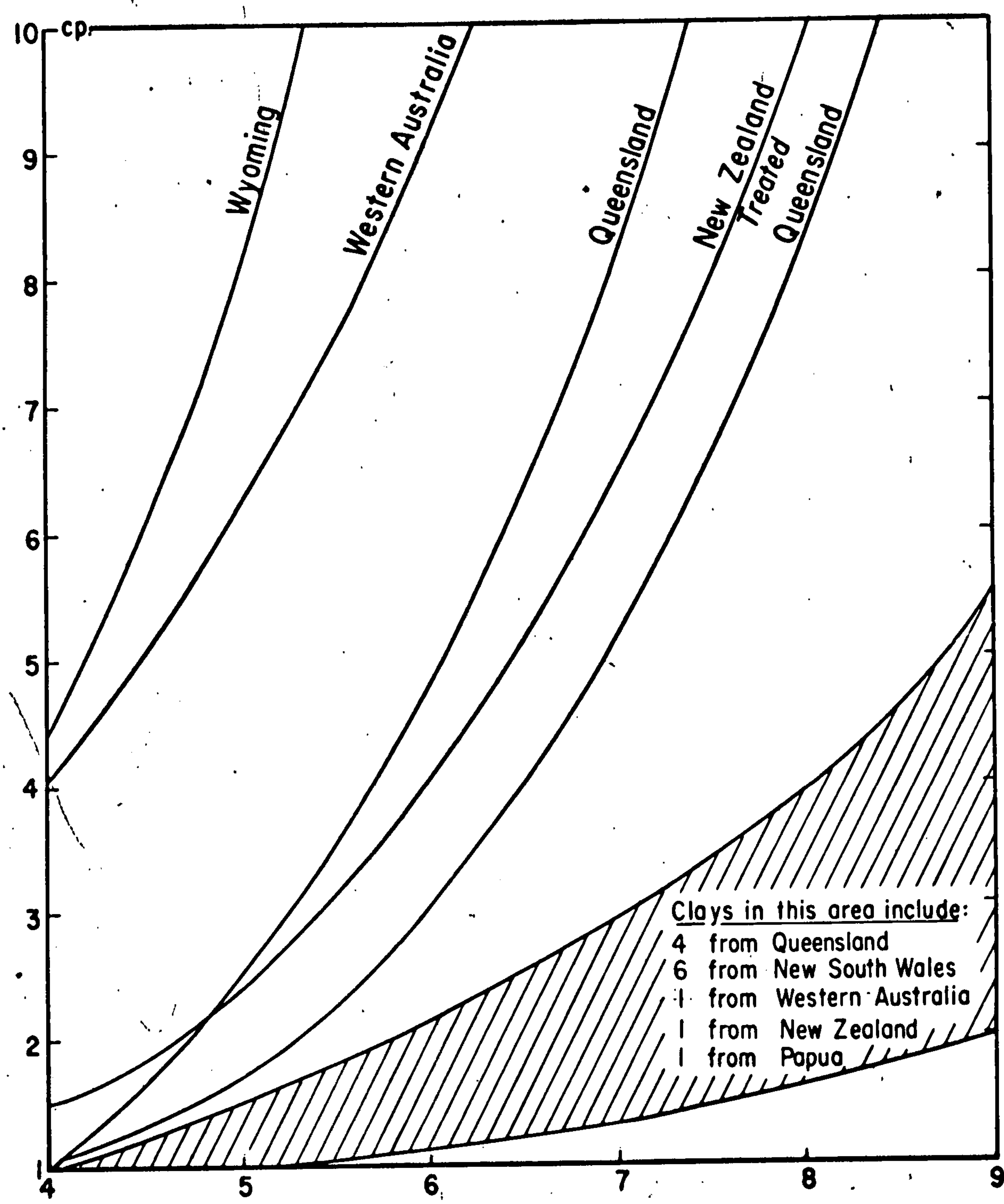
Conclusions

The search for the premium grade bentonites in Australia should be intensified, and any deposits that may be found should be fully evaluated by sampling and laboratory testing.

Base exchange methods should be used with caution, because the unused chemicals remaining in the bentonite may have adverse effects on the other chemicals added to the mud. Also, any excess chemical could have a dangerous effect, such as flash setting, when the bentonite is used in the light weight cements at depth.

APPARENT VISCOSITY

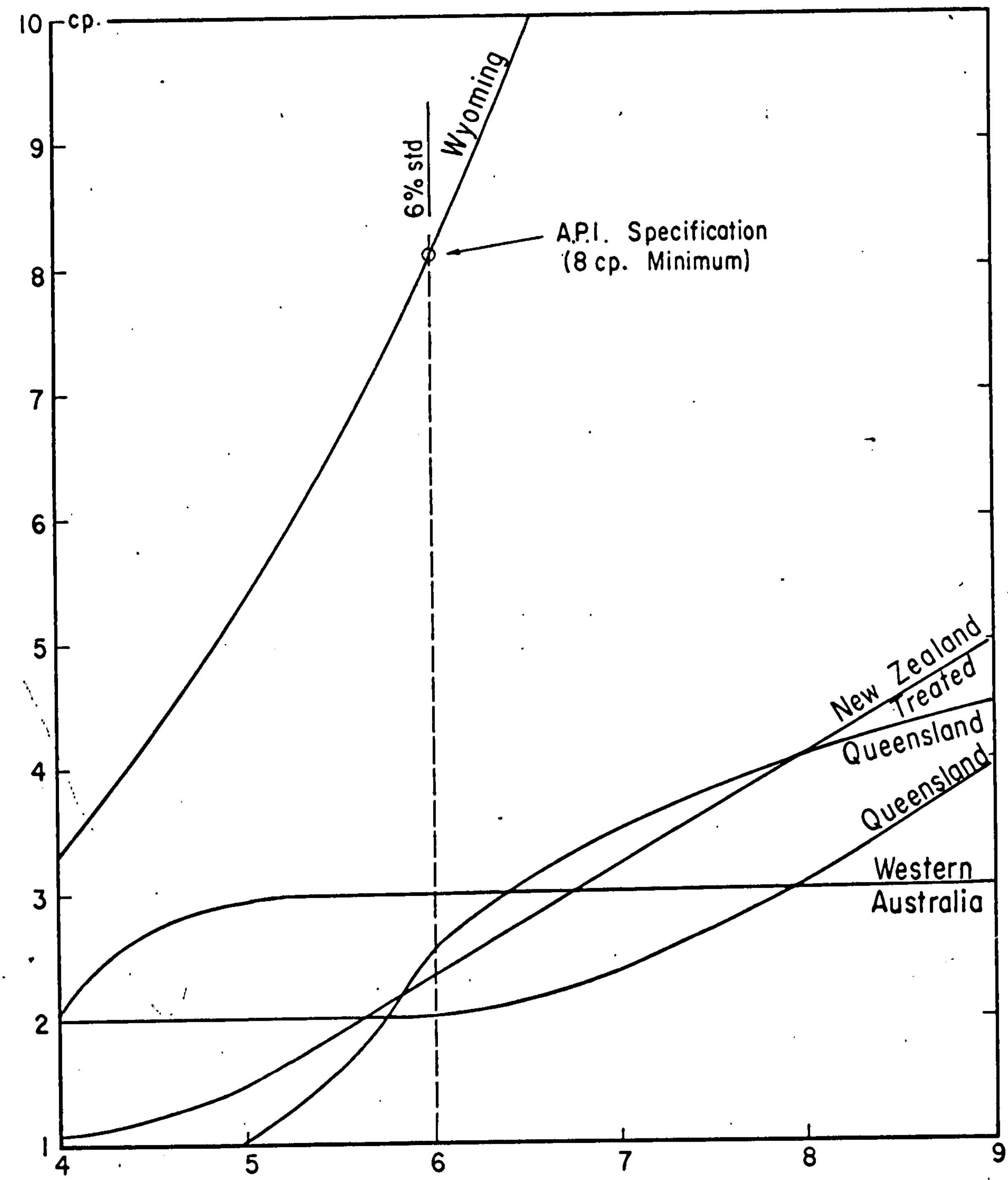
Fig. 1



PERCENTAGE OF DRY BENTONITE IN WATER

PLASTIC VISCOSITY

Fig. 2



PERCENTAGE OF DRY BENTONITE IN WATER

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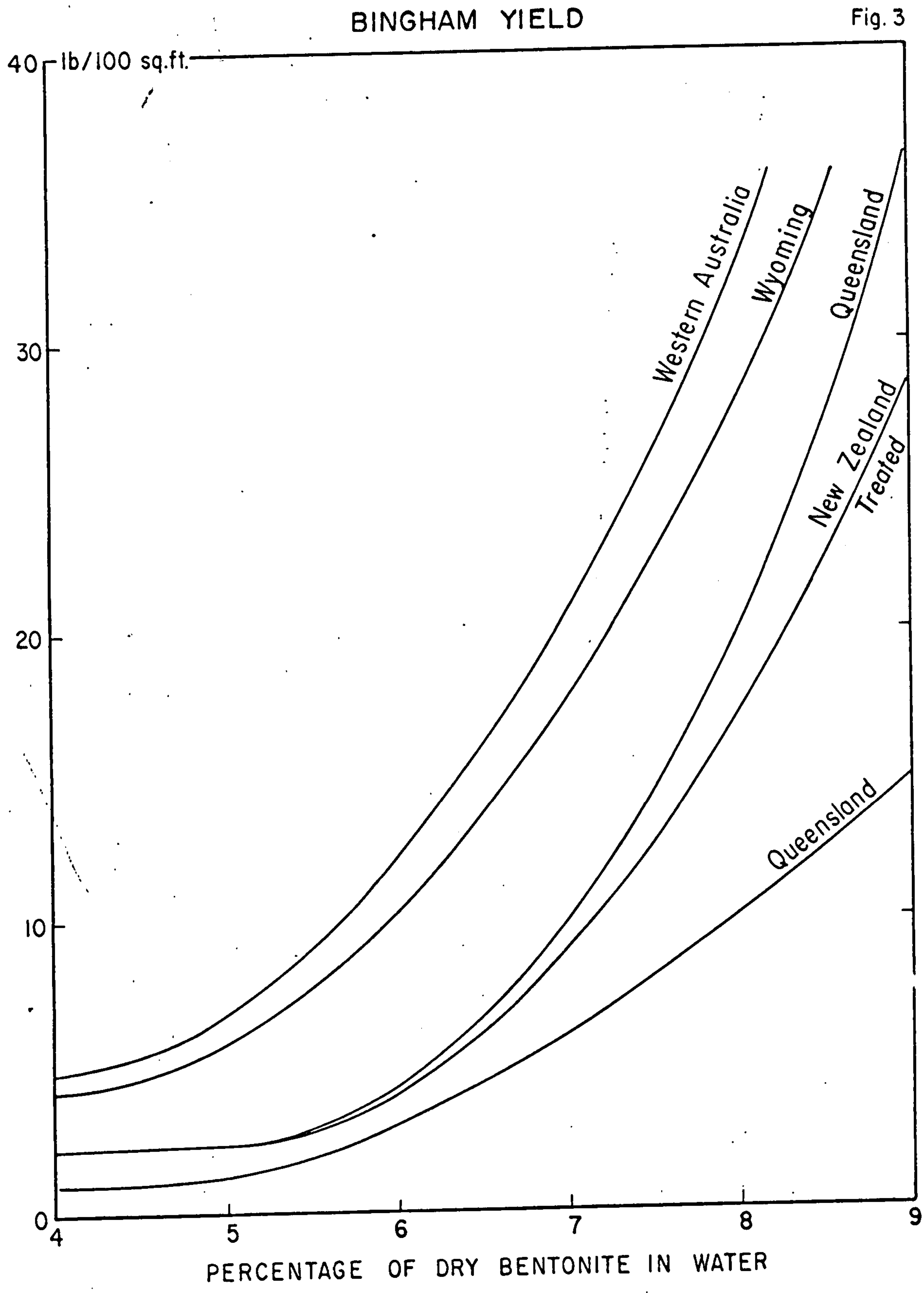
Fig. 3



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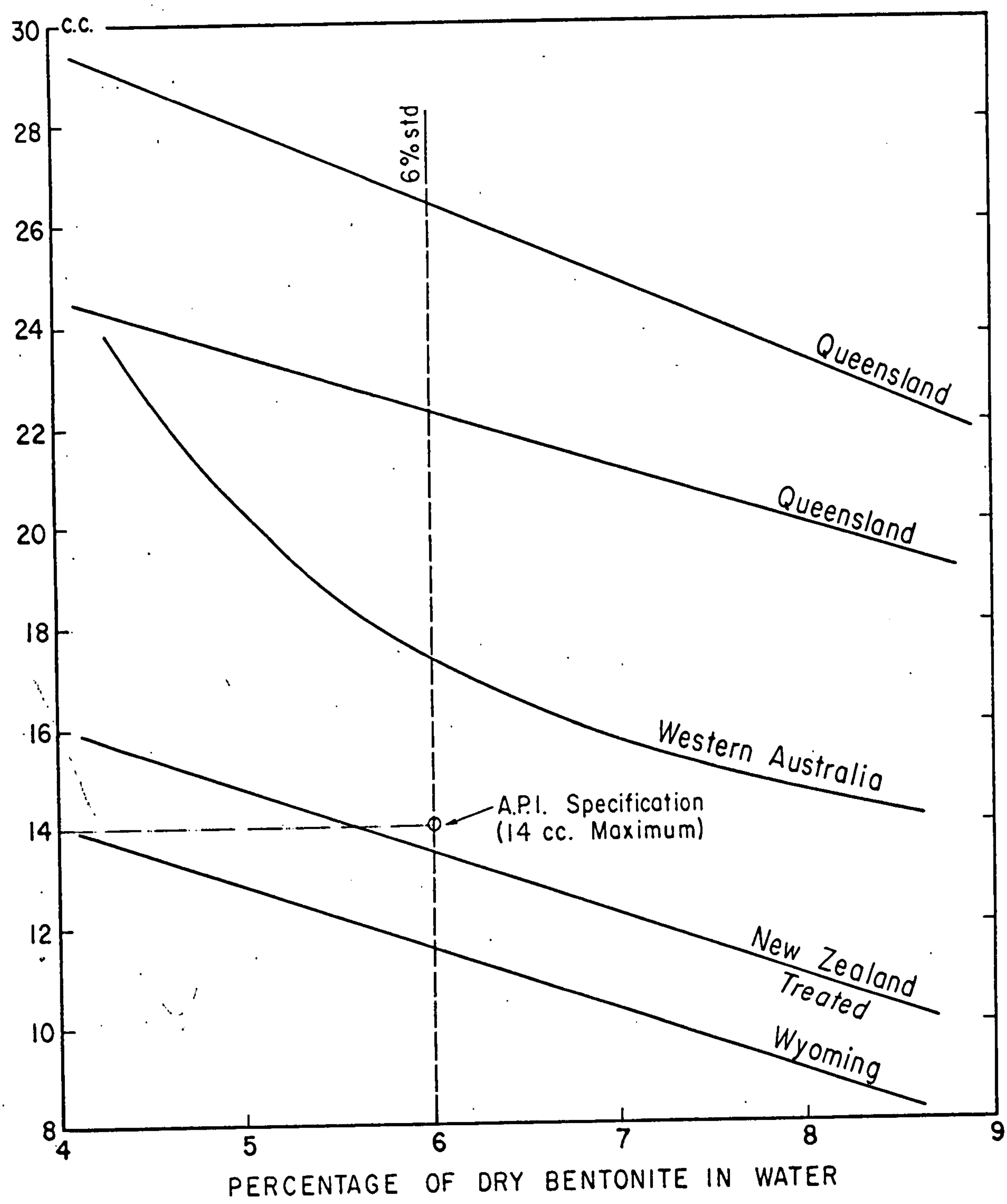
WATER LOSS

Fig. 4



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