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A Summary of Subsurface Pressures and Test Data Recorded in the Otway Basin, with Some General Comments on Drillstem Testing Techniques

by

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SUMMARY

A review has been made of the techniques of drillstem testing with particular reference to methods of securing accurate static bottom hole pressures, which are an essential requirement of all tests. It is recommended that all permeable zones in exploration wells should be tested to obtain pressure and fluid data, regardless of whether hydrocarbons are likely to be present or not.

Pressure data for the Otway Basin have been compiled from the reports on drillstem and production testing. The pressures obtained in approximately thirty tests are considered representative of the original static formation pressures. The majority of these pressures were obtained from wells in the Port Campbell area where some shows of oil and gas were found. However, all of the hydrocarbon bearing zones tested were of very limited size, as shown by the substantial pressure declines which followed very small production.

A plot of pressure versus depth below sea level shows little variation between any of the wells so far examined, and the pressures are close to hydrostatic for the respective depths. This is not unexpected as the well locations fall mainly along a trend parallel to the coastline, this trend being roughly at right angles to the direction of the anticipated regional hydrodynamic gradient, which in any case is thought to be small.

Although many tests have been performed in wells drilled in the Otway Basin, relatively few tests have yielded reliable pressures. At this stage there is insufficient data either to construct a pressure net for the Otway Basin, or to attempt a hydrodynamic analysis. Operators are urged to give much greater attention to the correct engineering of tests along the lines suggested in the first part of this report.

INTRODUCTION

A review has been made of the results of drillstem testing in the Otway Basin with the aim of assembling pressure and fluid data. Such data comprise the basic material on which a hydrodynamic evaluation of the prospects of finding oil or gas in this basin may be made.

Approximately thirty tests recorded pressures which are considered to be sufficiently accurate for the above purpose, although there is still some doubt among authorities on this subject as to the degree of accuracy required. This is because the theories of hydrodynamics as applied to oil exploration have only been developed comparatively recently. Hill, Colburn and Knight (1961, p.68) stated that hydrodynamic work to 1956 had been accomplished with data of from ± 1 to 2 percent error, but that further research had been completed which required data of less than ± 0.1% to ± 0.01% error. Presently available testing equipment can measure pressures to ± 1%, but it should be remembered that if it is necessary to use a build-up analysis, the extrapolation error has to be added to the instrument error when assessing the overall accuracy of the calculated static pressure.

Of the thirty satisfactory tests so far examined, over half were from wells drilled in the Port Campbell area, and the sampling from the rest of the basin area is relatively sparse. Even this limited amount of data may of course be sufficient for certain broad deductions to be drawn. However in the case of the Otway Basin, it would appear that as most of the wells follow a general trend parallel to the coastline, this trend will be roughly at right angles to the general direction of the regional hydrodynamic gradient, which will be towards the sea.

Although the data so far available are very limited, it is felt that the study has proved of value in that the general characteristics of testing in the area have been examined, and an indication is given as to how future tests may be designed so as to provide additional information and more positive evaluations.

As already noted, the main value of such data is their potential application to a hydrodynamic evaluation. At this stage, it is not considered that we know enough about the techniques of hydrodynamics to judge the extent to which they are applicable under Australian conditions. The major water intake areas of, for example, the Surat and Otway Basins are mainly about 1000 - 1500 feet above sea level, so that the hydrodynamic gradients due to gravity will not be large in these basins. In a discussion at the 6th World Petroleum Congress following the presentation of his paper on the Moonie Field, Moran (1963, p.609) was asked if there was any indication of a hydrodynamic condition in that field. His reply was that based on the oil-water interface at Moonie, there is no pressure gradient in the vicinity of the field. He also said that the static pressure at Moonie, approximately 2500 p.s.i.g., is very close to the normal hydrostatic pressure for the depth involved.

Although there are enthusiastic proponents of the hydrodynamic theories of oil accumulation (Hill et al, 1961; Hubbert, 1963), a contrary opinion is presented by Weeks (1958, p.53), who considers that cases of oil accumulations which appear to support these theories may be explained by the geological history of the occurrence. As something which is relatively new, the hydrodynamic theories merit detailed study. There is certainly a world-wide interest in the subject, although to date little has been published concerning actual case histories. It is worthy of mention that several of the operators in Australia are convinced of the value of hydrodynamics, to the extent that in wildcat wells they are prepared to test all the porous zones for pressure and fluid information, irrespective of whether hydrocarbons are likely to be present or not. It is appreciated that a decision to test in these circumstances is at the discretion of the operator. However, the other suggestions made in this report for improving the accuracy of pressure measurements would, in most cases, not require any significant additional expenditure, and should at least be given consideration.

Part I

DRILLSTEM TESTING

Design of Drillstem Tests

As a preparation for the review of the results of drillstem testing in the Otway Basin, the literature on testing and methods of analysis was examined. The following section is intended to cover only those aspects of this subject which are considered relevant to obtaining suitably accurate pressure data.

The primary aim of testing is to recover an uncontaminated sample of the formation fluid. However, it is becoming more generally appreciated that a properly conducted test can provide much valuable pressure information. Considerable emphasis must be placed on the words "properly conducted", since the majority of tests do not merit this description. In a survey of over 10,000 tests conducted in the United States, Petty (1962) found that 1300 were misruns and only 43% of all tests provided all the necessary information for a complete analysis. From a study of the 6,260 "low or nil value tests" it was considered that by more effective use of the tools and a better use of the time on bottom, the failure rate could have been reduced to less than 10%. With this thought in mind, the various recommendations for the apportioning of the "on-bottom" time are set down in the following paragraphs.

At present, a Dual Closed-In Pressure (D.C.I.P.) test is fairly standard; in a test of this kind the operating sequence is initial flow, initial closed-in pressure, final flow, final closed-in pressure (see Fig. 1).

The basic equipment employed in the dual closed-in pressure test is shown in Fig. 2. The unique part of the tool is the five position sliding valve actuated by coarse threads when the running-in string is turned to the right. The tool is run into the hole with the valve in the closed position; turning the string to the right successively opens, closes, opens and closes the valve. The tester valve is also run in the closed position and opens hydraulically following a suitable delay after the setting of the packer.

The top pressure recorder is placed upstream of the choke and tester valve. It measures the pressure of the fluid stream passing through the tester. The bottom pressure recorder is blanked off from the main part of the test string. Because there is no fluid passing through this part of the tester there is usually no plugging of the perforations leading to the bottom recorder. A comparison of the pressures indicated by the two recorders, in addition to providing a check on the readings, can also be used to detect plugging of the top recorder perforations.

The choke is sometimes of the hydraulic adjustable type which opens under hydraulic control and so lessens the shock on the formation following the opening of the tester. When this type of choke is not employed a suitably-sized choke has to be selected, with a balance being struck between the greater cushioning effect of a small choke as against its increased tendency to plug. The choice will depend on the nature of the formation under test and hole conditions. The use of a water or mud cushion also affords protection against shock.

1. Initial Flow Period

During normal drilling operations the hydrostatic pressure exerted by the mud column should exceed the formation pressure at all depths in the hole in order to prevent the flow of formation fluids into the well bore. This excess pressure will be magnified if there is a piston effect while the tester is being run into the hole. The purpose of an initial flow period is to relieve the formation of this supercharging before commencing the initial build-up. Unfortunately, opinions differ widely as to the length of time necessary for dissipating any excess pressure. One testing company thinks that a period of 1 to 3 minutes is adequate, whereas another considers that a minimum of 5 minutes is necessary and that most formations will require 20 minutes.

Until the D.C.I.P. testers were developed, the method of bleeding off excess pressure was to leave an air space in the testing string above the tester valve. As a rule of thumb the air space was usually taken as 10% of the volume of mud below the packer. In the D.C.I.P. tester, the space between the tester valve and the D.C.I.P. valve has to be filled with fluid before the pressure build-up can commence. Therefore, in formations of limited producing capacity this spacing should not be too large.

Experience with individual formations may show the average time in which the pressure will fall below the true formation static pressure. Formations of limited capacity can suffer a permanent decline of pressure after even a very brief flow. Where this is the case, however, a further decline will occur during the final flow period and there will generally be no difficulty in identifying a formation of this type. From the production point of view such a reservoir will be of little significance.

In the following section a recommendation is made that the length of the initial closed-in period should be at least 60 minutes. Provided the operator is prepared to allow this length of time for the initial build-up, an initial flow period of 20 minutes would seem to be a reasonable time.

2. Initial Closed-in Period

There is virtually complete unanimity of opinion that the time allotted to the initial closed-in period should be at least 60 minutes where hole conditions are good. This build-up is the preferable one for determining the static reservoir pressure, since even if the pressure is not fully built up during this period the amount of extrapolation required will be less than that for the second build-up. Dean and Petty (1964) analysed a number of tests and produced the following breakdown:-

Length of Initial Closed-in Period (minutes)	Stabilised Formation Pressure Obtained
30	50% of tests
45	75% of tests
60	95% of tests

The above table illustrates the value of allowing at least 60 minutes for the initial closed-in period. If the 'capacity' (kh*) of the formation is very limited, e.g. kh 10, it is preferable to allow at least 2 hours for the initial build-up (Dolan, Einarsen and Hill; 1957).

* kh = permeability in millidarcys x formation thickness in feet.

3. Final Flow Period

The time allotted to the main flow period will be mainly determined by the type of recovery obtained, fluid sample requirements, and the overall on-bottom time available for the test. Following pressure considerations alone, Dean and Petty (1964) make the following recommendations for the disposition of time between the final flow and final closed-in periods:-

Nature of Flow	Ratio $\frac{\text{Length of Final Closed-in Period}}{\text{Length of Second Flow Period}}$
Very strong blow & fluids at surface	$\frac{1}{2}$
Strong blow	1
Medium blow	$1\frac{1}{2}$
Weak blow	2

Continual observation by means of a bubble hose makes it possible to tell if flow into the tester ceases; when this happens the tester should be closed and the final build-up commenced.

4. Final Closed-in Period

The static pressures obtained during the initial and final closed-in periods should theoretically agree. Where the two pressures do agree, confidence can be placed in the results obtained. However, this is not always the case, and the following conditions may account for differences in the results:-

a) Due to the more lengthy extrapolation involved in the final build-up analysis, the probable error is greater than for the initial build-up analysis.

b) The initial flow period may not have been long enough to relieve all the supercharging effect, so that the initial build-up gives a falsely high value. A decline of pressure from the first build-up together with a poor blow should lead one to suspect supercharging.

c) During the second flow period, which is longer than the initial, the radius of influence is extended beyond the damage radius around the well-bore, and may reach faults, zones of differing permeability, etc. Thus the build-up may have different characteristics, and extrapolation from a larger pressure reduction will affect the estimated equilibrium value.

d) In the case of a depletion condition i.e. a significant permanent pressure decline following a limited amount of production, the second build-up will be to a lower pressure. A decline of pressure associated with a good blow generally indicates depletion rather than supercharging effect.

e) A low-capacity formation is particularly susceptible to mud leakage from the annulus causing a false pressure rise.

f) Changes in flowrate can account for breaks in the plot, since a reduced flowrate, for example, can be regarded as being equivalent to a partial closing-in. Thus, during the flow period the pressure in some parts of the reservoir may start building up, whilst in other parts it is still falling.

ANALYSIS OF PRESSURE BUILD-UP

The equilibrium pressure value is obtained by dividing the pressure build-up curve into a convenient number of time intervals and plotting the successive pressures as a function of time. When there has been more than one flow period preceding the build-up or when the flowrate has varied, attempts have been made to incorporate these factors into the time function. However in the majority of cases the following basic equation has been found satisfactory for the analysis of pressure build-up under D.S.T. conditions. It is strictly valid only for the radial flow of a single phase fluid.

$$P_o - P_w = \frac{162.6\ QUB}{kh} \log_{10} \frac{T + \Theta}{\Theta} \quad \ldots\ldots\ldots\ldots (1)$$

Where P_o = Pressure at infinite boundary - psig

P_w = Pressure at well bore - psig

Q = Prod. rate - b.p.d.

U = Viscosity - cp

B = Formation volume factor

k = Permeability - md

h = Sand thickness - feet

T = Flow time) in same units

Θ = Shut in time)

By plotting P_w versus $\frac{T + \Theta}{\Theta}$ on semi-log paper and extrapolating to $\frac{T + \Theta}{\Theta} = 1$ we obtain the value of P_o (since when $\frac{T + \Theta}{\Theta} = 1$, $\log_{10} \frac{T + \Theta}{\Theta} = 0$ and from Equation (1) $P_o = P_w$).

The group $\frac{kh}{UB}$ is termed the transmissibility of the formation. Taking the change in pressure over one cycle of log paper $\left(\frac{T + \Theta}{\Theta} = 10\right)$, and calling this ΔP, then the value of transmissibility is obtained from the expression

$$\frac{kh}{UB} = \frac{162.6\ Q}{\Delta P}$$

If h, U and B are known, permeability can be readily calculated from this relationship.

When more than one fluid is flowing, or the flow is not radial because of formation inhomogeneities, the build-up plot may not give a straight line with a single slope. Also, when the flow rate is not constant over the test period Mann (1962) found that the rate during the latter part of the build-up had a relatively greater influence. In the normal case where the flow rate declines with time, Mann believes that the value of T is better expressed by a ratio of total production during the flow period preceding the build-up, to the flow rate at the end of the period, rather than by the time the valve is open. Mann found that the value of T required to give a fit to the data was usually two or three times the actual open period. When the actual open time is used, values for transmissibility can be over-estimated by factors of 1.5 to 2.4 and well damage is also over-estimated by similar amounts.

In cases where oil has been flowing below its saturation pressure the pressure build-up curve is S shaped as a result of gas going into solution with oil on closing the tester valve. The effect of various types of fluid barrier is to change the slope of the build-up curve. However, in the absence of these complicating factors it is generally found that a straight line plot is obtained for the latter part of the build-up. The many examples of this type of plot presented later in the report bear out this statement.

For gas wells the equivalent to Equation (1) is

$$P_o^2 - P_w^2 = \frac{1637\ QUZT_f}{K_g h} \log \frac{T + \Theta}{\Theta}$$

where Q = Gas flow rate - thousand cu. ft./day

Z = Gas compressibility factor

U = Gas viscosity - cp

T_f = Formation temperature - ^{o}R

The required plot is then P_w^2 versus $\log \frac{T + \Theta}{\Theta}$

PROBABLE ORDER OF ACCURACY OF RESULTS

The two possible sources of error in the static pressure value derived from a drillstem test are 1) the inherent error in the gauge itself and 2) an error arising from the analysis in cases where the build-up is not complete.

1. Gauge error

The modern Bourdon tube-type pressure gauge is stated to be accurate to $\pm\frac{1}{4}\%$ of the full scale reading. Thus a gauge with a rating of 0-8,000 p.s.i.g. should have an error not larger than $\pm$ 20 p.s.i. When there is only a limited selection of recorders available it frequently happens that an 8000 p.s.i.g. gauge is used to measure a pressure of around 1000 p.s.i.g., and in this case the error could be $\pm$ 2% of the actual pressure measured.

It should be remembered that pressure recorders run in testers are subject to a considerable amount of mechanical vibration during trips in the hole, and have to withstand frequent and sudden changes of pressure, for example when the tester is opened. Other factors, such as time since previous run, fatigue, mechanical wear of parts etc. all influence the accuracy of the gauge reading. It is, therefore, felt that the value of $\pm\frac{1}{4}\%$ should be regarded as the best accuracy obtainable; when adverse factors operate, the gauge may depart from the previous calibration. The possibility of a serious error is reduced when at least two gauges are employed.

2. Analysis Error

When the pressure to be measured has fully built up to its maximum steady value, the only error involved is that due to the gauge inaccuracy. However, when the build-up curve is incomplete, the equilibrium pressure has to be estimated, usually by the method known as the Horner plot (see Horner, 1951). The error is proportional to the amount of extrapolation involved, and Dean and Petty (1964) suggest that the probable error is equal to $\pm$ one quarter of the amount of extrapolation. For instance, if the maximum recorded pressure at the end of the build-up is 1800 p.s.i.g. and the Horner plot gives 2000p.s.i.g. as the estimated equilibrium pressure, the probable error then is $\pm$ 50 p.s.i. The source of this error is considered to be a departure from true radial flow of a single-phase fluid.

The overall error involved in the pressure estimation may be minimised as follows:-

a) The recorder used should have a pressure rating suitable for the pressures being measured. It is considered good practice to use a gauge only up to the 75% value of its full scale reading; this value should be as close as possible to the maximum pressure to be recorded. Also the clock used should be of a range suitable for the overall length of the test.

b) When it is not possible to allow the pressure to reach its static value, the build-up should be as close to the static value as possible.

Table I taken from an article by Van Poollen and Bateman (1958) summarises the errors in a large number of tests in the Williston Basin area of U.S.A. and shows the effect of shut-in time on the error.

Table I - A Summary of Statistical Data on Extrapolated Pressure Errors with Suggestions for Improvement

Portion of Recorded Chart Available for Extrapolation	Present Error in Extrapolation (Average)*	Suggestions Towards Improvement of Extrapolation	By Application of Suggestions, Error May be Reduced to
Initial Closed-in Pressure Curve	34 psi	Extend time to a minimum of 60 minutes	25 psi
Flow Period Curve Plus Final Closed-In Pressure Curve (Conventional Test)	± 31 psi	Extend Closed-in Period to 1 - 2 times Flow Period	± 13 psi
Initial Closed-In Pressure Curve Plus Flow Period Curve Plus Final Closed-In Pressure Curve (Dual CIP Test)	± 18 psi	Extend ICIP time a minimum of 60 minutes and Extend Final Closed-in Period to 1 - 2 Times Flow Period	± 6 psi

*Based on a static pressure of 2515 psig.

PRESSURE ANOMALIES

When a number of drillstem tests have been conducted in a well, the calculated or measured static pressures may be plotted as a function of the depth of measurement. The method of least squares can then be used to draw the best straight line through the points (see examples in appendices). If the confidence limits for each pressure measurement are drawn in, it is possible to see if the range of value for any point lies off the best straight line. Any such point must be considered an anomalous value, and a more detailed examination should be made of the test report to find out if any special conditions existed which might have contributed to a larger than normal error. Such factors as any previous flow from the test zone should be considered in relation to a possible depletion condition. The possibility of communication between different zones in the well should also be examined, since this can lead to an abnormal pressure estimation in a tested interval.

If, after checking all the possibilities of a false reading, a real anomaly appears to exist, then further consideration can be given to a likely interpretation in the light of geological conditions and hydrodynamic theory. The above applies to a reading which departs significantly from the trend of other readings in the same well. If the local or regional pressure pattern is well established by measurements in other wells, it is also possible to detect readings which differ from the expected value according to those patterns. It is the anomalous reading which can either enhance or reduce the hydrocarbon bearing possibilities of a prospect.

FUTURE TRENDS

Whilst the comments in the preceding sections are believed to be relevant to the types of tests currently being run, the continuing improvement of testing tools may result in many of the remarks being no longer applicable to new techniques introduced in the future. The dual closed-in test is fairly standard at present, but a tool has already been produced which will allow an unlimited number of flow and closed-in periods to be employed, if so desired. The valve is actuated by vertical movement of the drillpipe, rather than rotation as is now common.

Another tool recently introduced into Australia is the Schlumberger wire-line formation tester. As yet, the pressures measured with this tool, which are transmitted to the surface, are not as accurate as those obtained with a conventional DST gauge. However, the drawdown on a low capacity formation is considerably reduced in the case of the wireline tester as only a few gallons of formation fluid are produced. The tool can be adapted to carry an Amerada-type gauge so as to supplement the readings transmitted to the surface. In this way the progress of the build-up and flow can be followed during the test and accurate Amerada readings are also available.

An instrument for transmitting pressures to the surface in digital form is also being developed in America for use with drillstem testers.

In addition to the improvements in testing tools, it is to be expected that better methods of analysis will also be developed. This will apply particularly to cases where a number of closed-in and flow periods are employed. Computers will also be increasingly employed to analyse the data from tests, and will be especially suited to handle pressures in a digitised form.

RECOMMENDATIONS

In the opinion of the writer, it should be a standard practice to make a Horner plot on every incomplete pressure build-up in which a suitable curve is obtained. It is only in this way that the effect of the shut-in time on the amount of extrapolation required can be fully appreciated. Where the results of the two build-ups differ, it is important to try to determine the reason for the difference, since this may reveal important information about the formation under test. Alternatively, the discrepancy may be the result of unsatisfactory programming of the test, and a guide to improvement in the conduct of future tests is obtained.

It is necessary to emphasise that the prime responsibility for the safe conduct of a D.S.T. is vested by most operators in the drilling superintendent or his equivalent, rather than the geologist or petroleum engineer. The decision as to the permissible amount of 'on bottom' time in open hole testing is, therefore, normally made by the drilling superintendent, the main consideration being the length of time the packer can sit without danger of sticking. The chances of the packer sticking may be minimised by the suitable choice of a packer seat and adequate conditioning of the mud before the test, so as to prevent either settling of cuttings on the packer or excessive gelling. Many of the formations in the Otway Basin have proved difficult to test in open hole due either to lack of satisfactory packer seats or plugging of the tester. Therefore, it has sometimes been found necessary to run a string of production casing before carrying out the testing programme. In such cases the main restriction on the length of test will be the cost of rig time while testing; from a purely technical viewpoint, testing through casing presents an ideal opportunity to allow sufficient time for a full build-up of pressure and also the recovery of an uncontaminated formation fluid sample.

Examination of a number of drillstem test reports has shown that some of the information required for the interpretion of tests has not been included. The following items are particularly necessary for a full interpretation:-

1) Mud weight. This should be checked several times over a circulating cycle before testing. The hydrostatic mud pressure calculated from the average mud weight should be within ± 2% of the value given by the pressure recorder.

2) The depths of the pressure recorders, D.C.I.P.V. and tester valve should be measured carefully and reported. Pressures for hydrodynamic work are of little value unless they are accurately tied to depth.

3) The flow should be continually observed by means of a bubble hose and alteration in the flow rate noted.

4) Analysis of formation water should be as complete as possible. As a check on the degree of contamination a number of samples should always be taken and field checks made of salinity. In this way the best sample(s) for full analysis can be selected.

Tests on water samples which are considered most important, but unfortunately are often omitted, are:

Specific gravity.
Determination of bi-carbonates as well as carbonates.

Resistivity (together with the temperature at which it was measured).

pH

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PART II

REVIEW OF TESTING IN OTWAY BASIN

The final reports of subsidised wells drilled in the Otway Basin have been examined and the results of formation testing are summarised in the appendices to this record.

With respect to significant discoveries of oil and/or gas in this basin, these have been confined to apparently small isolated reservoirs found in Port Campbell No. 1, Port Campbell No. 3 and Flaxmans No. 1. Small gas flows and gassy water were also encountered in several other wells. However, to date no commercial supply of oil or gas has been discovered.

A brief summary of test results is given below.

Eumeralla No. 1	No recovery of hydrocarbons.
Fergusons Hill No. 1	Waarre Formation contained fresh water. Small flows of gas and gassy water from Otway Group.
Flaxmans No. 1	Waarre and Paaratte Formations produced gas cut water. Interval 10842 - 11528' in Otway Group produced gas at maximum rate of 250 Mcf/day. Flow died out after an extended period.
Geltwood Beach No. 1	No recovery of hydrocarbons.
Heathfield No. 1	Gassy salt water recovered from Merino Group.
Mount Salt No. 1	No recovery of hydrocarbons.
Port Campbell No. 1	Gas and oil indications in the Paaratte and Belfast Formations. Waarre Formation produced gas at maximum rate of 4.3 MMcf/day with increasing amounts of salt water steadily reducing gas flow.
Port Campbell No. 2	No evidence of free oil or gas. A permeable Waarre Formation produced gas cut water.
Port Campbell No. 3	Flowed gas in small amounts from the Paaratte and Waarre Formations and Otway Group.
Port Campbell No. 4	Waarre Formation produced salt water. Interval 5942 - 5970' flowed gas at maximum rate of 219 Mcf/day and oil emulsion in small quantities.
Pretty Hill No. 1	Strong salt water flow from "Basal Sandstone" in Otway Group.
Sherbrook No. 1	Slight gas shows in Paaratte - Belfast - Flaxmans Formations. Waarre Formation flowed fresh water.
Tullich No. 1	Gassy salt water obtained from the Merino Group.

COMMENTS ON PRESSURES RECORDED IN THE OTWAY BASIN

Table II summarises the results of the 29 tests in which static reservoir pressures were either directly measured or obtained by build-up analysis. Calculation of the potentiometric levels (by converting the pressure to the height of an equivalent column of fresh water) shows that all the levels are above M.S.L. with the exception of the five taken in Port Campbell No. 1 and one of the Port Campbell No. 4 readings. The tests in Port Campbell No. 1 were made using a now obsolete type of gauge of uncertain accuracy so that no great reliance can be placed on these results. Those readings above M.S.L. fall in the range 28 to 428 feet or an average of 228 feet. Allowing for a possible error of 50 psi or 115 feet of water for each measurement, very few of the readings are significantly greater or less than the average. Again, on the assumption that the Port Campbell No. 1 measurements are correct, the range of levels on the Port Campbell structure is far greater than the variations in the rest of the readings.

It is considered that whilst the collation of this data represents a start towards an understanding of hydrodynamic conditions in this basin, there are not yet sufficient data available to draw isopotential lines and then to consider which pressure readings represent definite anomalies.

Table II

Summary of Static Reservoir Pressures in the Otway Basin

Well Name	Datum Level (ft. above sea level)	D.S.T. No.	Interval (ft. below datum)	Formation	Depth of measurement (ft. below datum)	Pressure p.s.i.g.	Potentiometric Level ft. above+ below- sea level
Flaxmans No. 1	221	16	6875-6881	Waarre	6890	2900	+ 28
Geltwood Beach No. 1	30	1	3859-3901	Merino	3875	1708	+ 100
Geltwood Beach No. 1	"	2	4708-4780	Merino	4740	2070	+ 71
Geltwood Beach No. 1	"	3	4983-5055	Merino	5000	2197	+ 104
Geltwood Beach No. 1	"	4	6039-6081	Merino	6050	2634	+ 63
Heathfield No. 1	244	1	3660-3754	Merino	3643	1597	+ 289
Mount Salt No. 1	186	1	9813-9892	Belfast	9850	4310	+ 290
Port Campbell No. 1	347	3	5756-5766	Waarre	5770	2125	- 515
Port Campbell No. 1	"	4	5695-5701	Waarre	5705	2105	- 497
Port Campbell No. 1	"	5	4815-4820 4830-4840	Paaratte	4850	1850	- 230
Port Campbell No. 1	"	7	4498-4515	Paaratte	4520	1750	- 131
Port Campbell No. 1	"	8	4463-4475	Paaratte	4480	1735	- 126
Port Campbell No. 2	282	12	8338-8350	Waarre	8330	3670	+ 428
Port Campbell No. 4	440	2	4963-4985	Waarre	4950	2004	+ 118
Port Campbell No. 4	"	3	5005-5062	Waarre	5000	2035	+ 140
Port Campbell No. 4	"	11	6404-6444	Otway	6400	2665	+ 195
Port Campbell No. 4	"	12	5874-5903	Otway	5850	2380	+ 87
Port Campbell No. 4	"	13	5672-5702	Otway	5650	2253	- 7

Well Name	Datum Level (ft. above sea level)	D.S.T. No.	Interval (ft. below datum)	Formation	Depth of measurement (ft. below datum)	Pressure p.s.i.g.	Potentiometric Level ft. above+ below- sea level
Port Campbell No. 4	440	14	6900-6929	Otway	6850	2866	+ 209
Port Campbell No. 4	"	15	6691-6765	Otway	6650	2730	+ 95
Port Campbell No. 4	"	17	6555-6601	Otway	6525	2726	+ 211
Port Campbell No. 4	"	23	5263-5307	Waarre	5250	2140	+ 132
Port Campbell No. 4	"	24	4020-4040	Belfast	4000	1620	+ 181
Tullich No. 1	272	1	1596-1631	Merino	1600	674	+ 229
Tullich No. 1	"	2	2075-2110	Merino	2080	889	+ 245
Tullich No. 1	"	3	2947-2982	Merino	2932	1237	+ 197
Tullich No. 1	"	4	3721-3786	Merino	3750	1634	+ 296
Tullich No. 1	"	6	4815-4880	Merino	4840	2118	+ 323
Tullich No. 1	"	7	4980-5045	Merino	5000	2163	+ 267

APPENDIX 1

Eumeralla No. 1

D.S.T. No. 1 5822 - 6034 feet, Merino Group

Recovered 390 feet of mud and 90 feet of muddy water, field salinity 11,300 ppm Cl.

No closed-in pressures were taken.

Water Analysis

	ppm
Cl	11,170
HCO_3	366
SO_4	487
Ca	3,110
Mg	13
Fe (soluble)	3
SiO_2 (soluble)	14
Na (by difference)	4,003
Total solids	19,166

D.S.T. No. 2 6226 - 6257 feet, Merino Group

Recovered 180 feet of mud and 90 feet of water cut mud of salinity 9,100 ppm Cl.

No closed-in pressures were taken.

Water Analysis

	ppm
Cl	9,072
HCO_3	306*
SO_4	458*
Ca	2,506
Mg	6
Fe (soluble)	2
SiO_2 (soluble)	18
Na (by difference)	3,319
Total solids	15,687

* re-calculated

APPENDIX 2

Fergusons Hill No. 1

Production Test No. 5	11,380 - 11,416 feet, Otway Group. Recovered 130 feet of gas cut water and 200 feet of gas cut mud.
Production Test No. 7	11,380 - 11,416 feet, Otway Group. Recovered 150 feet of gas cut mud.
Production Test No. 8	5,660 - 5,690 feet, Otway Group. Recovered 1818 feet of gas cut mud.
Production Test No. 9	5,436 - 5,464 feet, Otway Group. Very slight gas flow, unmeasurable.
Production Test No. 11	2,096 - 2,106 feet, Waarre Formation. Formation water standing 537 feet below RT. No hydrocarbons.

Water Analysis

	ppm
Cl	240
HCO_3	690
SiO_2	40
Na	345
K	16.5
Mg	27
Fe (ic)	8
Total ions	1366.5

R_w 4.45 ohm.m @ 75°F.

pH 8.2

N.B. No pressure recorders were run in any of the above tests.

APPENDIX 3

Flaxmans No. 1

D.S.T. No. 2 — 5,356 - 5,396 feet, Paaratte Formation
Recovered gas cut water. Packer seat failed after 16 minutes. No usable pressures.

Water Analysis

	ppm
Cl	11,610
HCO_3	1,380
SO_4	206
NO_3	3
Ca	258
Mg	62
SiO_2 (soluble)	13
Na (by diff.)	7,726
T.D.S.	21,258

R_w 0.33 ohm.meter @ 65°F.

pH 7.5

D.S.T. No. 3 — 6,891 - 6,913 feet, Waarre Formation

Flowed gas to surface in 22 minutes. Recovered 6,254 feet of fluid made up as follows:

340 feet gas cut mud.

1,350 feet gas cut muddy water.

4,564 feet gas cut water.

Final flowing pressure (bottom hole) 2,550 p.s.i.g. No closed-in pressure taken.

Water Analysis

	ppm
Cl	12,440
HCO_3	534
SO_4	86
Ca	1,255
Mg	60
Fe (sol.)	5
Silica (sol.)	20
Na (by diff.)	6,990
T.D.S.	21,390

pH 7.0

R_w 0.33 ohm.m @ 66°F; 0.16 ohm.m @ 159°F.

D.S.T. No. 16

6,875 - 6,881 feet, Waarre Formation
Some gas at surface. Recovered almost a full string (6,871 feet) of water.
Final Flowing Pressure (B.H.) 2,800 psig (174 min.)
Final Closed-in Pressure* (90 mins.)
Estimated depth of recorder 6,890 feet.

*Fully built up.

Water Analysis

	ppm
Cl	13,240
HCO_3	610
SO_4	160
SiO_2 (soluble)	10
Ca	1,090
Mg	46
K	180
Na	7,360
T.D.S.	22,696

pH 7.2

R_w 0.3 ohm.m @ 75°F

0.335 ohm.m @ 62°F

Production Test No. 1

10,842 - 11,528 feet, Otway Group.
Maximum rate of gas production 250 Mcf/day.
Little condensate 51.2°A.P.I. gravity.
No bottom hole pressures measured. Surface pressure fell to zero during extended flow period.

N.B. Further testing of this zone gave no substantial flow of gas.

APPENDIX 4

Geltwood Beach No. 1

D.S.T. No. 1 3859 - 3901 feet, Merino Group.

Recovered 270 feet of mud and 3600 feet of water (for analysis see below).

Top recorder @ 3849 feet; Bottom Recorder @ 3897 feet.

The initial build-up was complete and the following static reservoir pressures were recorded:-

1701 p.s.i.g. @ 3849 feet; 1714 p.s.i.g. @ 3897 feet.

Average pressure = 1708 p.s.i.g. corrected to 3875 feet

Rate of inflow = 55 barrels in 30 minutes, equivalent to 2640 barrels per day.

Analysis of water:-

	ppm
Cl	12,400
SO_4	1,660
CO_3	109
Na	7,710
Ca	456
Mg	364
Total	22,699

D.S.T. No. 2 4708 - 4780 feet, Merino Group

Recovered 450 feet of gas-cut mud and 3100 feet of salt water (for analysis see below).

Top Recorder @ 4698 feet; Bottom Recorder @ 4776 feet.

Office Corrected Pressures:-

	Top Recorder p.s.i.g.	Bottom Recorder p.s.i.g.	
Initial Hydrostatic :	2361	2405	
Initial Flow :	500	598	(1 minute)
Initial Closed-in :	2033	2056	(15 minutes)
Second Flow :	1561	1593	(62 minutes)
Final Closed-in :	1838	1879	(15 minutes)
Final Hydrostatic :	2314	2357	

The analysis of the initial build-up (Fig. 4) gave the following estimated equilibrium pressures:-

2060 p.s.i.g. @ 4698 feet; 2078 p.s.i.g. @ 4776 feet
Average pressure corrected to 4740 feet = 2070 p.s.i.g.

On the second build-up estimated equilibrium pressures were as follows:-

1950 p.s.i.g. @ 4698 feet; 1988 p.s.i.g. @ 4776 feet
Average pressure corrected to 4740 feet = 1970 p.s.i.g.

Although there is an apparent pressure decline indicated by the 100 p.s.i. difference between the two build-ups, it is considered that one or both of the build-ups may be inaccurate for the following reasons:-

1) The initial flow period was only one minute and this time may not have been sufficient to dissipate any supercharging in the formation. Since the position of the D.C.I.P.V. is not stated, it is not possible to ascertain if there was sufficient space between this valve and the tester valve to allow for expansion of any compressed fluid.

2) The semi-log plot of the initial build-up shows an upward trend (see Fig. 4), and it is possible that in the relatively short 15 minutes second build-up, the final portion of the plot has not been reached, so giving an extrapolated equilibrium pressure lower than the true value.

On the evidence available the initial build-up value has to be accepted, whilst noting the possibility that it could be slightly higher than the true value because the initial flow period may not have been long enough to dissipate supercharging.

Water Analysis:

	ppm
Cl	17,162
SO_4	16
CO_3	55
Na	9,545
Ca	1,224
Mg	122
Total	28,122

D.S.T. No. 3   4983 - 5055 feet, Merino Group

Recovered 100 feet of very slightly gas cut mud and 400 feet of salt water.

Top Recorder @ 4973 feet; Bottom Recorder @ 5051 feet.

Office Corected Pressures:

		Top Recorder p.s.i.g.	Bottom Recorder p.s.i.g.	
Initial Hydrostatic	:	2447	2512	
Initial Flow	:	54	107	(3 minutes)
Initial Closed-in	:	2062	2091	(15 minutes)
Final Flow	:	226	273	(40 minutes)
Final Closed-in	:	1809	1849	(15 minutes)
Final Hydrostatic	:	2416	2466	

Analysis of the initial build-up (Fig. 5) gave the following estimated equilibrium pressures:-

2172 p.s.i.g. @ 4973 feet; 2232 p.s.i.g. @ 5051 feet
Average pressure corrected to 5000 feet = 2197 p.s.i.g.

The estimated equilibrium pressures from the second build-up were as follows:-

2153 p.s.i.g. @ 4973 feet; 2193 p.s.i.g. @ 5051 feet

Average pressure corrected to 5000 feet = 2168 p.i.s.g.

The agreement between the two build-ups is reasonable and because of the shorter extrapolation in the initial build-up analysis, the value from this is the one to be accepted.

D.S.T. No. 4 6039 - 6081 feet, Merino Group

Recovered 90 feet of slightly gas cut mud and 360 feet of salt water (for analysis see below).

Top Recorder @ 6029 feet; Bottom Recorder @ 6077 feet

Office Corrected Pressures:-

		Top Recorder p.s.i.g.	Bottom Recorder p.s.i.g.	
Initial Hydrostatic	:	2869	2914	
Initial Flow	:	83	120	(2 minutes)
Initial Closed-in	:	2513	2520	(15 minutes)
Second Flow	:	209	240	(54 minutes)
Final Closed-in	:	2133	2137	(15 minutes)
Final Hydrostatic	:	2830	2898	

The analysis of the initial build-up* gave the following estimated equilibrium pressures:-

2610 p.s.i.g. @ 6029 feet; 2660 p.s.i.g. @ 6077 feet
(See Fig. 6)

Average pressure corrected to 6050 feet = 2634 p.s.i.g.

The second build-up gives an estimated equilibrium pressure of 2782 p.s.i.g. corrected to 6050 feet. However the agreement between the values obtained from the two recorders is not good, and because of the lengthy extrapolation involved this build-up should be disregarded.

*Initial Build-up

Time (minutes)	Pressure (p.s.i.g.) Top Recorder	Bottom Recorder
0	52	79
1.5	1996	1884
3.0	2228	2139
4.5	2314	2276
6.0	2376	2346
7.5	2412	2397
9.0	2442	2440
10.5	2469	2466
12.0	2482	2491
13.5	2498	2507
15.0	2513	2520

<u>Water Analysis</u>

	ppm
Cl	12,090
SO_4	149
CO_3	164
Na	6,162
Ca	1,609
Mg	16
Total Salts	20,190

<u>Summary of Pressures in Geltwood Beach No. 1</u>

Depth below RTKB (feet) D	Pressure (p.s.i.g.) P
3875	1708
4740	2070
5000	2197
6050	2634

Let equation of best straight line through these 4 points be

$$D = b + mP \text{ ---------------- } (1)$$

For least squares fit

$$\Sigma D = 4b + m\Sigma P \text{ -------------- } (2)$$

$$\Sigma D.P. = b\Sigma P + m\Sigma P^2 \text{ --------- } (3)$$

$$\Sigma D = 19,665$$

$$\Sigma D.P. = 43,351,000$$

$$\Sigma P^2 = 18,966,929$$

Substituting in (2) and (3)

$$19,665 = 4b + m\,8609 \text{ ---------------- } (2)$$
$$43,351,000 = b.8609 + m\,18,966,929 \quad (3)$$

$$169,295,985 = 34,436\,b + m\,74,114,881 \text{ ---- } (2)$$
$$173,404,000 = 34,436\,b + m\,75,867,716 \text{ ---- } (3)$$

$$4,108,015 = 1,752,835\,m$$

$$m = 2.3436$$
$$b = -128$$

Equation (1) becomes <u>$D = -128 + 2.3436P$</u>

Substituting the measured values of P in this equation gives the following values for D:-

Pressure P (p.s.i.g.)	D from $=^n(1)$ ft.	Actual D ft.	Deviation ft.
1708	3875	3875	0
2070	4723	4740	-17
2197	5021	5000	+21
2634	6045	6050	- 5

R.M.S. deviation $= \sqrt{\frac{755}{4}}$ = 13.75 feet

Average deviation = 0.64%

Gradient of line = 0.427 p.s.i./foot i.e. very close to the hydrostatic gradient for water.

The calculated line represents a close fit to the data, as can be seen on Fig. 7. For purposes of comparison between wells the following line gives the pressures relative to sea level:-

'D' = -158 + 2,3436P

where 'D' = depth below sea level.

APPENDIX 5

Heathfield No. 1

D.S.T. No. 1 3660 - 3754 feet, Merino Group

Recovered 80 feet of drilling mud.

Top Recorder @ 3643 feet; Bottom Recorder @ 3750 feet.

Office Corrected Pressures

	Top Recorder	Bottom Recorder	
Initial Hydrostatic :	1845 psig	1890 psig	
Initial Flow :	17 "	62 "	6 minutes
Initial Closed-in :	1411 "	1439 "	15 "
Final Flow :	47 "	89 "	30 "
Final Closed-in :	1021 "	1064 "	15 "
Final Hydrostatic :	1830 "	1876	

Analysis of the initial build-up (Fig. 8) on the top gauge gave the following estimated equilibrium pressure:

1594 psig @ 3643 feet.

The initial build-up on the bottom gauge was unsatisfactory due to 'stepping'.

The following pressures were obtained from analysis of the final build-up:

1600 psig @ 3643 feet: 1655 psig @ 3750 feet.
(extrapolated from last 3 points)

The agreement between the pressure from the initial and final build-ups is good in spite of the lengthy extrapolation involved in the latter case.

APPENDIX 6

Mount Salt No. 1

D.S.T. No. 1 . 9813 - 9892 feet, Belfast Mudstone.

Recovered 4070 feet of muddy fresh water (cushion), 300 feet of slightly salty water and mud and 4070 feet of salt water (total length of fluid column 8440 feet).

Field Pressures

Initial Hydrostatic	:	5230 psig	
Flow Period	:	4310 "	(90 minutes)
Closed-in	:	4310 "	(15 minutes)
Final Hydrostatic	:	5170 "	

Depths of recorders not stated, but mid-position estimated at 9850 feet.

Water Analysis

	grains/gallon	ppm
Cl	1549	22,073
SO_4	164.6	2,346
CO_3	20.5	292
Na	876.7	12,493
Ca	76.6	1,092
Mg	71.2	1,014
Total	2758.6	39,310

The above noted pressure of 4310 psig at an assumed depth of 9850 feet gives a potentiometric level of approximately 282 feet above sea level. As a check on the pressure recorder, a calculation of the hydrostatic pressure exerted by the fluid recovery is as follows:-

	pressure
4000 feet of fresh water	1732 psig
370 feet of mud (10 ppg)	192 "
4070 feet of salt water (sp.gr.1.03)	1815 "
Total	3739 psig

The last reported mud weight before the test was 9.8 ppg, which would give a calculated hydrostatic pressure of 5020 psi. Although a spot reading of mud weight is not fully satisfactory for a check of this sort it does indicate that the average recorder reading of 5230 psig for the initial hydrostatic pressure could be too high. Thus from a comparison both with mud weight and fluid recovery in the test it appears that the recorders were reading high.

APPENDIX 7

Port Campbell No. 1 Summary of Testing

D.S.T. No. 1 5653 - 5718 feet, Waarre Formation.

(Open hole) Strong blow of gas with wellhead pressure increasing to 1600 p.s.i.g. Recovered 900 feet of gas cut mud. Recorded Pressures (depth of recorder not given).

Initial Flow Pressure	2320 p.s.i.g.
Final Flow Pressure	2310 p.s.i.g.

These pressures were obtained with a Johnston Recorder of a now obsolete type, and their estimated accuracy is ± 200 p.s.i. No closed-in pressures were taken.

D.S.T. No. 2 (Through casing) 5908 - 5920 feet, 5924 - 5928 feet, Waarre Formation Light flow of air (gas?) Recovered 5,190 feet of gas cut salt water with 270 feet of gas cut mud. Depth of recorder not given.

Recorded pressures:

Initial Hydrostatic	:	3100 p.s.i.g.
Initial Flow	:	1500 p.s.i.g.
Final Flow	:	2175 p.s.i.g.
Final Hydrostatic	:	2900 p.s.i.g.

Salinity of Water 13,700 p.p.m. NaCl.

D.S.T. No. 3 5756 - 5766 feet, Waarre Formation

(Casing) Slight flow of air and gas which stopped after 10 minutes. Recovered 180 feet of gas cut mud and 5,134 feet of gas cut salt water, salinity 12,700 p.p.m. NaCl.

Recorded pressures:-

Initial Hydrostatic	:	2990 p.s.i.g.
Initial Flow	:	2050 p.s.i.g.
Final Flow	:	2125 p.s.i.g.
Closed in	:	2125 p.s.i.g.
Final Hydrostatic	:	2880 p.s.i.g.

Depth of recorder not given. Packer set at 5744 feet.

D.S.T. No. 4 5695 - 5701 feet, Waarre Formation.

(Casing) Slight flow of gas diminishing to nothing after 30 minutes. Recovered 270 feet of gas cut mud and 5050 feet of gas cut dirty salt water with much colloidal material. Salinity of sample from just above the packer 8,300 p.p.m. Cl.

Pressures Recorded (depth of recorder not given):-

Initial Hydrostatic	:	3050 p.s.i.g.
Initial Flow	:	1175 p.s.i.g.
Final Flow	:	2105 p.s.i.g.
Closed-in	:	2105?p.s.i.g.
Final Hydrostatic	:	2908 p.s.i.g.

D.S.T. No. 4 (cont'd)

Water Analyses*

	Sample from just above the packer	Sample from 1010 feet above the packer	Sample from 2421 feet above the packer	Sample from 4780 feet above the packer
	ppm	ppm	ppm	ppm
Cl	8,020	7,876	7,394	4,930
CO_3	127	211	192	302
HCO_3	4,657	4,428	4,128	4,244
SO_4	102	106	102	219
Ca	66	67	107	167
Mg	77	69	54	157
Fe (soluble)	2	4	8	12
Na (by Difference)	6,659	6,512	5,975	4,099
Total Solids	19,710	19,273	17,960	14,130
pH	8.8	8.8	8.7	8.8

* By State Laboratories, Melbourne.

Water Analyses**

	Sample from just above the packer	Sample from 1010 feet above the packer	Sample from 2421 feet above the packer	Sample from 4780 feet above the packer
	ppm	ppm	ppm	ppm
Na	6,370	6,000	6,100	4,300
K	130	134	126	106
Ca	70	13	63	35
Mg	65	53	55	55
Cl	7,864	7,814	7,442	4,919
SO_4	85	95	95	241
HCO_3	4,130	4,130	4,100	4,350
Total Solids @ 180°C	17,151	17,216	16,320	12,950
Rw @ 24°C	0.417 ohm.m.	0.385 ohm.m.	0.417 ohm.m.	0.58 ohm.m.
pH @ 24°C	7.85	7.83	8.00	7.70

**By Bureau of Mineral Resources.

Note: The differences in the two sets of analyses reported above illustrate the errors which can arise in sampling and analysis, and illustrate the degree of accuracy which can be expected in this type of analysis.

Production Test No. 1a   5656 - 5666 feet, Waarre Formation

Landed 2" tubing at 5649 feet and displaced mud with water. Swabbed approximately 47.7 barrels of water and well came in. After flowing gas for 9½ hours the rate was measured at 4.2 million cu. ft/day (assumed sp.gr. 0.6), with a tubing pressure of 1600 p.s.i.g. After another 1½ hours flow the well was closed in and the wellhead pressure built up to a steady 1760 p.s.i.g. in 2½ hours. The well was again opened and flowed gas with salt water at a rate of 250 gallons per hour (maximum salinity 10,480 ppm Cl). Fluid rate increased from 100 gallons per hour to 300 gallons per hour during the flow period. The tubing head pressure declined from an initial value of 1825 p.s.i.g. to a final value of 1075 p.s.i.g. Much of this decline was due to the tubing filling up with water. The final measured gas rate before closing in was 1.446 million cu. ft./day. Total flow period was 3¾ days. After closing in the tubing pressure rose to a steady value of 1525 p.s.i.g. in 7 hours.

Water Analyses

	Samples Taken from Separator after Flowing for			
	1 hour	26 hours	31 hours	84 hours
	ppm	ppm	ppm	ppm
Na	380	860	8,000	4,200
K	25	41	130	73
Ca	95	35	70	45
Mg	17	12	60	70
Cl	469	610	8,678	5,486
SO_4	86	83	122	46
HCO_3	840	1,710	6,700	2,820
Total Solids @ 180°C	1,664	3,330	18,000	11,828
Rw @ 24°C	3.125 ohm.m.	2.31 ohm.m.	0.37 ohm.m.	0.56 ohm.m
pH @ 24°C	7.1	7.65	7.85	7.8

Analysis by Bureau of Mineral Resources.

Following the above test the well was squeeze cemented in an attempt to shut off the water. The following interval was then retested:

Production Test No. 1b 5657 - 5663 feet, Waarre Formation

Ran hookwall packer on tubing to 5638 feet. Displaced mud in tubing with water, set packer and swabbed tubing from 3000 feet. Well flowed gas with a small amount of drilling mud and clear condensate of 62° A.P.I. gravity (no water). After flowing for 16 hours the well was closed in for 24 hours before running an Amerada subsurface pressure survey. Pressure recorded at 5630 feet was 1710 p.s.i.g. and the temperature 157°F. Wellhead static pressure was 1421 p.s.i.g. by the Amerada gauge and 1420 p.s.i.g. by the test gauge.

The well was again flowed, the measured rate being 2.510 million cu. ft./day with 0.224 gallons of clear condensate (A.P.I. gravity 65°) per thousand cubic feet. The choke size was increased and the flow rate rose to 4.36 million c.ft./day. The well began making water after being flowed for 68 hours. After a further 27 hours flow the well was closed in. Total quantities of fluid produced in this flow period were:-

8.131 million cu.ft. of gas
34 barrels of condensate
17.5 barrels of water

After a closed in period of 19 hours the Amerada gauge was again run and recorded a pressure of 1355 p.s.i.g. at 5630 feet. This represented a decline of 355 p.s.i. since the previous survey.

The well was again flowed in an attempt to obtain a 4 point back pressure curve for calculating the open-flow potential. However the well was slow to stabilise at the various rates and the points when plotted did not line up satisfactorily. The test was therefore terminated, with the conclusion that the reservoir under test was small and not of commercial size, since the production of 8 million cu. ft. of gas in the present test had lowered the reservoir pressure by 355 p.s.i.

D.S.T. No. 5 4815 - 4820 and 4830 - 4840 feet, Paaratte Formation

Recovered 2880 feet of water diluted gas cut mud and 720 feet of gas cut salt water, salinity 4934 ppm Cl.

Pressures Recorded (depth of recorder not given):-

Initial Hydrostatic	:	2600 p.s.i.g.
Beginning of Flow	:	700 p.s.i.g.
End of Flow	:	1850 p.s.i.g.
Closed-in	:	1850 p.s.i.g.
Final Hydrostatic	:	2500 p.s.i.g.

D.S.T. No. 6 4696 - 4702 feet, Parratte.

Recovered 180 feet of water diluted slightly gas cut mud and 270 feet of slightly gas cut water, salinity 1065 ppm Cl.

The pressures recorded during the flow and closed in periods were too small to measure with the recorder used.

D.S.T. No. 7 4498 - 4515 feet, Paaratte Formation

Recovered 270 feet of gas cut mud and 3690 feet of gas cut water. Gas had sharp smell. Salinity of water 1136 ppm Cl. The last 90 feet of tubing pulled was filled with medium grain, well sorted sand.

Pressures recorded:-

Initial Hydrostatic	:	2325 p.s.i.g.
Beginning of Flow	:	1600 p.s.i.g.
End of Flow	:	1750 p.s.i.g.
Closed-in	:	1750 p.s.i.g.
Final Hydrostatic	:	2175 p.s.i.g.

D.S.T. No. 8 4463 - 4475 feet, Paaratte Formation

Recovered 210 feet of slightly gas cut mud and 3600 feet of slightly gas cut water, salinity 994 ppm Cl.

Pressures recorded:-

Initial Hydrostatic	:	2130	p.s.i.g.	
Beginning of Flow	:	1300	"	
End of Flow	:	1735	"	(60 minutes)
Closed-in	:	1735	"	(30 minutes)
Final Hydrostatic	:	2050	"	

Water Analysis

	ppm
Cl	1,160
CO_3	184
HCO_3	1,694
SO_4	19
Ca	22
Mg	3
Na (by difference)	1,510
T.D.S.	4,592
pH	8.8

Summary of Pressures Recorded in Port Campbell No. 1

D.S.T. No. 1 (5653-5718 feet)	No closed-in pressures taken.
D.S.T. No. 2 (5908-5929 feet) (5924-5928 ")	No closed-in pressures taken.
D.S.T. No. 3 (5756-5766 feet)	C.I.P. 2125 p.s.i.g. Depth of recorder not given but estimated to be at 5770 feet. Pressure taken after flowing 5314 feet of mud and water.
D.S.T. No. 4 (5695-5701 feet)	C.I.P. 2105 p.s.i.g. Depth of recorder not given but estimated to be at 5705 feet. Pressure taken after flowing 5320 feet of mud and water.
Prod. Test No. 1a (5656-5666 feet)	No subsurface pressures taken.
Prod. Test No. 1b (5657-5663 feet)	C.I.P. 1710 p.s.i.g. @ 5630 feet. This pressure was taken with an Amerada gauge after the well had been closed in for 24 hours, and can be regarded as accurate. However, the zone had been produced for several days prior to taking the measurement and this does not represent the original static reservoir pressure. After producing a further 8.1 million cu. ft. of gas the Amerada was run to 5630 feet and this time recorded a pressure of 1355 p.s.i.g., i.e. a fall of 355 p.s.i. from the previous value.
D.S.T. No. 5 (4815-4820 feet) (4830-4840 feet)	C.I.P. 1850 p.s.i.g., taken after flowing 3600 feet of mud and water. Depth of recorder not given but estimated to be at 4850 feet.
D.S.T. No. 6 (4696-4702 feet)	No usable pressures obtained.
D.S.T. No. 7 (4498-4515 feet)	C.I.P. 1750 p.s.i.g., taken after flowing 3960 feet of mud and water. Depth of recorder estimated at 4520 feet.
D.S.T. No. 8 (4463-4475 feet)	C.I.P. 1735 p.s.i.g. taken after flowing 3810 feet of mud and water. Estimated depth of recorder 4480 feet.

Least Squares Fit to Pressures

in Port Campbell No. 1

D.S.T. No.	Estimated Depth of Recorder ft. below RT.	Pressure p.s.i.g.	Calc. D from least squares fit feet	Deviation
8	4480	1735	4473	-7
7	4520	1750	4523	+3
5	4850	1850	4856	+6
4	5705	2105	5703	-2
3	5770	2125	5770	0

$$\Sigma D = 25,325$$

$$\Sigma P = 9,565$$

$$\Sigma DP = 48,925,575$$

$$\Sigma P^2 = 10,441,875$$

For least squares fit

$$25,325 = 5b + m.\ 9565$$

$$48,925,575 = b.\ 9565 + m.\ 18,441,875$$

$$m = 3.3246$$

$$b = -1295$$

$$\underline{D = -1295 + 3.3246\ P}$$

R.M.S. deviation = $\sqrt{\frac{98}{5}}$ = 4.4 feet

Average deviation = 0.09%

In view of the fact that the recorder depths had to be estimated, and the pressure recorders were of a rather coarse type, it is considered that the very close fit of the best line to the measured points is purely fortuitous. It is interesting to note that the gradient over this section of the hole is 0.30 psi/ft, equivalent to an oil of specific gravity 0.7.

APPENDIX 8

Port Campbell No. 2

D.S.T. No. 3 5650 - 5874 feet, Paaratte - Belfast Formations

Recovered 1295 feet of mud.

A maximum closed-in pressure of 1800 psig was obtained after a 35 minute build-up period following the flow.

Depth of recorder not given but taken as 5650 feet.

D.S.T. No. 11 8395 - 8405 feet, Waarre Formation.

Recovered 1320 feet of gas cut mud and 7050 feet of gas cut water, salinity 7,300 ppm Cl.

I.C.I.P.	3510 psig	) Depth of recorder taken
F.C.I.P.	3510 "	) as 8390 ft.

D.S.T. No. 12 8338 - 8350 feet, Waarre Formation

Recovered 1020 feet of gas cut mud and 7,308 feet of gas cut water, salinity 7500 - 8000 ppm Cl.

I.C.I.P. 3670 psig (Assumed depth of recorder 8330 feet).

Comments on Pressures Noted Above

The pressure recorded in D.S.T. No. 3 is low for the depth and it is probable that a depletion condition exists (no actual formation fluid was produced).

Of the two tests on the Waarre Formation, D.S.T. No. 12 recovered the larger amount of fluid and recorded the higher closed-in pressure. This reading is therefore considered the more acceptable value for the Waarre.

APPENDIX 9

Port Campbell No. 3 (Non-subsidised well; data supplied by courtesy of Frome Broken Hill Co. Pty. Ltd.)

D.S.T. No. 1 4956 - 4963 feet, Otway Group.

Gas to surface in 2 minutes, rate too small to measure. Also flowed muddy water at rate of 2½ to 3 b.p.h. Salinity of water 14,000 - 17,300 ppm Cl. R_w 0.33 ohm. meter at 63°F. B.H. Temp. 150°F.

I.C.I.P. 1500 p.s.i.g. (Depth of recorder not stated; estimated to be at 4950 feet.)

This C.I.P. was taken after flowing the well for 65 minutes. The pressure built up to a steady value in approximately 30 minutes.

D.S.T. No. 2 4716 - 4726 feet, Waarre Formation.

Gas to surface in 14 minutes, no surface pressure. Swabbed 46.8 barrels of gas cut water and mud. Recovered in tubing 17.6 barrels of gas cut water, salinity 14,500 - 14,700 ppm Cl, R_w 0.27 ohm. meter @ 76°F.

The pressure chart from this test was unreadable.

D.S.T. No. 3 4608 - 4620 feet, Waarre Formation.

Gas to surface in 15 minutes, no pressure. Swabbed 25.5 barrels of gas cut muddy water. Recovered in tubing 17.3 barrels of gas cut water. Water salinity 10,000 - 11,200 ppm Cl, R_w 0.31 ohm. meter @ 71°F. A lot of loose medium to coarse clean sand was found in the tool.

Only a hydrostatic mud pressure was recorded on the chart

D.S.T. No. 4 4164 - 4176 feet, Paaratte Formation.

Small amount of gas to surface in 12 minutes. Swab held up at 690 feet. Flowed well for 105 minutes. Recovered 15 barrels of gas cut muddy water in the tubing. Water salinity 4400 ppm Cl. Tool plugged with sand.

No closed in pressures were taken. Maximum steady pressure during flow period 1730 p.s.i.g.

D.S.T. No. 4a 4164 - 4176 feet, Paaratte Formation.

Swabbed 27.75 barrels of gas cut muddy water. Salinity 4400 - 4600 ppm Cl. Recovered 15.25 barrels of gas cut muddy water in tubing, salinity 4400 ppm Cl. Rw 0.81 ohm. meter @ 70°F.

No closed in pressures were taken. Maximum steady pressure during flow period 1790 p.s.i.g.

D.S.T. No. 5 3856 - 3868 feet, Wangerrip Group

Air blow died in 25 minutes. Swabbed 29.5 barrels of water, salinity 2600 ppm Cl. Recovered 14.7 barrels of muddy water in tubing, salinity 2600 ppm Cl.

No closed in pressures were taken. Maximum steady pressure while flowing 1600 p.s.i.g.

N.B. All the above pressures were measured with a now obsolete type of pressure recorder. Their accuracy is therefore likely to be rather poor by present standards. Also, the actual depth of the recorders was not stated.

Comments on Pressure Recorded in Port Campbell No. 3

The only closed-in pressure recorded in this series of tests was in D.S.T. No. 1. However this C.I.P. was taken after a 65 minute flow period and is much lower than flowing bottom hole pressures at shallower depths measured in subsequent tests.

D.S.T.'s 4 and 4a both covered the same interval and D.S.T. 4a recorded a slightly higher flowing pressure, possibly as a result of the plugging which occurred.

In relation to its depth, the flowing pressure of 1600 psig at 3850 feet recorded in D.S.T. No. 5 is low, but the pressure remained steady at this value, indicating that flow had stopped.

Thus it would appear that none of the pressures recorded in this well can be regarded as representing the static formation pressures, and all the values noted are probably below the original pressures.

APPENDIX 10

Port Campbell No. 4

Testing Results. Tests 1, 2, 3 Open hole, carried out with D.C.I.P.V (5 position)
Tests 4-24 inc. through casing with 3 position T.C.V.

D.S.T. No. 1 4943 - 4985 feet, Waarre Formation
Misrun, packer seat failed.

D.S.T. No. 2 4963 - 4985 feet, Waarre Formation.
Recovered 90 feet of mud and muddy water, and 1036 feet of brackish water. Salinity 9900 ppm Cl. R_w 0.381 ohm. meter @ 61 $^{\circ}$F.
Bottom gauge plugged, pressures doubtful.
Top gauge @ 4953 feet.
D.C.I.P.V. @ 4868 feet: Tester valve @ 4958 feet.
Office corrected pressures for top recorder:-

Initial Hydrostatic	: 2531	p.s.i.g.	
Initial Flow	: 298	"	(5 minutes)
Initial Closed-in	: 2005*	"	(30 minutes)
Final Flow	: 525	"	(34 minutes)
Final Closed in	: 2005*	"	(45 minutes)
Final Hydrostatic	: 2531		

*These maximum readings were obtained immediately on closing the tester.
Max. pressure = 2005 p.s.i.g. @ 4953 feet
= 2004 p.s.i.g. @ 4950 feet

D.S.T. No. 3 5005 - 5062 feet, Waarre Formation.
Recovered 90 feet of mud, 180 feet mud cut water and 4340 feet of brackish water. Salinity 10600 ppm Cl R_w 0.346 ohm. meter @ 61 $^{\circ}$F.
Bottom gauge read same throughout the test, neglect same.
Top gauge @ 4990 feet.
D.C.I.P.V. @ 4890 feet; Tester valve at 4980 feet.

Office corrected values for top recorder:-

Initial Hydrostatic	: 2533	p.s.i.g.	
Initial Flow	: ?	"	(5 minutes)
Initial Closed-in	: 2031	"	*(30 minutes)
Final Flow	: 2027	"	(30 minutes)
Final Closed-in	: 2029	"	*(45 minutes)
Final Hydrostatic	:	"	

*Maximum readings obtained immediately on closing the tester.
Maximum pressure = 2031 p.s.i.g. @ 4990 feet
= 2035 p.s.i.g. @ 5000 feet

D.S.T. No. 4 7878 - 7950 feet, Otway Group.
Recovered 80 feet mud. Zone appears tight. No usable pressures.

D.S.T. No. 5 7418 - 7460 feet. Otway Group.
Recovered 280 feet of mud and mud filtrate. Zone appears tight. No usable pressures.

D.S.T. No. 6 7302 - 7325 feet, Otway Group.
Misrun. Tester plugged by sand.

D.S.T. No. 7 7305 - 7325 feet, Otway Group.
Recovered 60 feet mud. Zone appears tight, no usable pressures.

D.S.T. No. 8

7235 - 7254 feet and 7302 - 7325 feet, Otway Group. Swabbed 0.5 barrel mud and recovered 190 feet of mud from pipe. Bottom 90 feet contained honey coloured jelly-like fine globules of paraffin yielding fluorescence and cut. Low permeability zone, no usable pressures.

D.S.T. No. 9

5947 - 5970 feet, Otway Group.
Flowed gas at rates from 160 to 219 Mcf/day.
Liquid produced at rates between 215 and 240 b.p.d. consisting of 85% salt water, salinity 12,000 ppm Cl and R_w 0.36 ohm. meter @ 59°F, and emulsified crude oil of 38.2 API gravity. Maximum well head flowing pressure 65 p.s.i.g.
Top Recorder @ 5898 feet; Bottom Recorder @ 5923 feet.
T.C.V. @ 5789 feet; Tester valve @ 5893 feet.

Office Corrected Pressures.

	Top Recorder	Bottom Recorder	
Initial Hydrostatic:	3040 p.s.i.g.	3064 p.s.i.g.	
Initial Closed-in :	2456 "	2473 "	(60 mins.)
Flow Period :	Clock ran off		43¼ hrs.)

The Final Well Report states that this zone was not properly isolated, and this may account for the curve on the build-up plots (Fig. 10). The two build-ups show very good agreement and give an average equilibrium pressure of 2506 p.s.i.g. corrected to 5900 feet. However, as the interval was not fully isolated this value is open to doubt.

D.S.T. No. 10

6404 - 6444 feet, Otway Group
Recovered 500 feet mud. Gauges indicate tester plugged. Unsatisfactory test. See D.S.T. No. 11

D.S.T. No. 11

6404 - 6444, Otway Group.
Swabbed 5 barrels of mud and 15 barrels of salt water.
Reversed 4000 feet of salt water out of tubing.
Salinity of sample from below T.C.V. 13,500 ppm Cl, R_w 0.36 ohm.meter @ 58°F.
Top Recorder @ 6370 feet; Bottom Recorder @ 6400 feet
T.C.V. @ 6295 feet; Tester valve @ 6360 feet.

Office Corrected Pressures:

	Top Recorder	Bottom Recorder	
Initial Hydrostatic:	3144 p.s.i.g.	3162 p.s.i.g.	
Initial Closed-in :	2615 "	2621 "	(15 mins)
Flow Period :	1177 "	1186 "	(315 mins)
Final Closed-in :	2281 "	2292 "	(60 mins)
Final Hydrostatic :	3111 "	3093 "	

Analysis of the initial build-up* gives the following equilibrium pressures:-
2675 p.s.i.g. @ 6370 feet: 2642 p.s.i.g. @ 6400 feet.
Note that although the lower gauge was reading slightly higher than the top gauge, the extrapolated pressure for the top gauge is the higher of the two (see Fig. 11). This could result from a gauge inaccuracy or may arise from the limitations of the analysis used.

Average pressure corrected to <u>6400 ft. = 2665 p.s.i.g.</u>

*Initial Build-up

Time (mins.)	Top Recorder	Bottom Recorder
0	785	853
1.5	2389	2565
3	2471	2576
4.5	2515	2584
6.0	2544	2594
7.5	2564	2599
9.0	2580	2607
10.5	2591	2610
12.0	2602	2615
13.5	2608	2618
15.0	2615	2621

D.S.T. No. 12

5874 - 5903 feet, Otway Group.
Flowed gas at estimated 160,000 cu. ft./day. Liquid rate 57 barrels/day consisting of 45 barrels/day water and 12 barrels/day emulsion. On pulling tester, 35 to 40 gallons of fluid was recovered containing 10% crude oil, gravity 46° A.P.I. @ 60°F. Salinity of water 12,700 ppm Cl. and R_w = 0.362 ohm. meter @ 60°F.
Top Recorder @ 5817 feet; Bottom Recorder @ 5862 feet
T.C.V. @ 5720 feet; Tester Valve @ 5824 feet.
Office Corrected Pressures:-

	Top Recorder p.s.i.g.	Bottom Recorder p.s.i.g.
Initial Hydrostatic:	2912	2934
Initial Closed-in :	2301	2318 (65 mins.)
Flow Period :	*	304 (23¾ hrs.)
Final Closed-in :	*	1650 (120 mins.)
Final Hydrostatic :	*	2962

*24 hour clock only.

Analysis of the initial build-up* gave the following equilibrium pressures:
2370 @ 5817 feet; 2380 p.s.i.g. @ 5862 feet (Fig.12)

Average pressure corrected to 5850 feet = 2380 p.s.i.g.

*Initial build-up

Time (mins.)	Pressure (p.s.i.g.) Top Recorder	Bottom Recorder
0	650	739
6.5	2097	2143
13.0	2168	2191
19.5	2199	2217
26.0	2219	2239
32.5	2239	2257
39.0	2257	2273
45.5	2270	2286
52.0	2283	2300
58.5	2292	2308
65.0	2301	2318

D.S.T. No. 13

5672 - 5702 feet, Otway Group.
Fluid level found by swabs at 4000 feet after two hours. Swabbed total of 10.5 barrels of mud and water. On pulling out recovered 180 feet of water, salinity 13,200 ppm Cl. and R_w 0.31 ohm. meter @ 60°F.

Top Recorder @ 5628 feet: Bottom Recorder @ 5663 feet.
T.C.V. @ 6663 feet; Tester Valve @ 5628 feet.

Office Corrected Pressures:

	Top Recorder p.s.i.g.	Bottom Recorder p.s.i.g.
Initial Hydrostatic:	2823	2820
Initial Closed-in :	2208	2220 (60 mins.)
Flow Period :	110	117 (275 mins.)
Final Closed-in :	1659	1674 (60 mins.)
Final Hydrostatic :	2823	2820

Analysis of the initial build-up* gave the following equilibrium pressures:-
2244 p.s.i.g. @ 5628 feet; 2257 p.s.i.g. @ 5663 feet (Fig. 13)

Average pressure corrected to 5650 feet = 2253 feet.

*Initial build-up

Time (mins.)	Pressures (p.s.i.g.) Top Recorder	Bottom Recorder
0	520	579
6	1982	2045
12	2084	2114
18	2135	2154
24	2159	2175
30	2175	2191
36	2186	2202
42	2195	2207
48	2201	2215
54	2206	2217
60	2208	2220

D.S.T. No. 14

6900 - 6929 feet, Otway Group.
Swabbed 3.5 barrels of mud cut water in two runs.
Water salinity 10,500 ppm Cl.

Top Recorder @ 6837 feet; Bottom Recorder @ 6871 feet.
T.C.V. @ 6763 feet; Tester Valve @ 6825 feet.

Office Corrected Pressures:-

	Top Recorder p.s.i.g.	Bottom Recorder p.s.i.g.
Initial Hydrostatic:	3368	3436
Initial Closed-in :	2743	2801 (60 mins.)
Flow Period :	49	91 (6½ hours)
Final Closed-in :	2489	2557 (60 mins.)
Final Hydrostatic :	3368	3436

Analysis of the initial build-up* gave the following equilibrium pressures:-
2839 p.s.i.g. @ 6837 feet; 2897 p.s.i.g. @ 6871 feet (Fig. 14)

Average pressure corrected to 6850 feet = 2866 p.s.i.g.

*Initial Build-up

Time (mins)	Pressures (p.s.i.g.) Top Recorder	Bottom Recorder
0	159	200
6	283	528
12	554	1578
18	1958	2517
24	2515	2653
30	2631	2711
36	2677	2745
42	2706	2767
48	2723	2782
54	2735	2793
60	2743	2801

D.S.T. No. 15

6691 - 6765 feet, Otway Group.
Swabbed 6 barrels of mud cut water. On pulling out, recovered 180 feet of water from tubing. Water salinity 12,500 ppm Cl., R_w 0.414 ohm. meter @ 54°F. Trace of brown, waxy globules of oil recovered from tubing.

Top Recorder @ 6643 feet; Bottom Recorder @ 6682 feet.

Office Corrected Pressures:

	Top Recorder	Bottom Recorder	
Initial Hydrostatic:	3244 p.s.i.g.	3338 p.s.i.g.	
Initial Closed-in :	2657 "	2690 "	(60 mins)
Flow Period :	256 "	277 "	($7\frac{3}{4}$ hrs.)
Final Closed-in :	Valve did not close		
Final Hydrostatic :	3244	3338	

Analysis of the initial build-up* gave the following equilibrium pressures:-
2710 p.s.i.g. @ 6643 feet; 2760 p.s.i.g. @ 6682 feet (Fig. 15)

Average pressure corrected to 6650 feet = 2730 p.s.i.g.

*<u>Initial Build-up</u>

Time (mins.)	Top Recorder	Bottom Recorder
0	159 p.s.i.g.	235 p.s.i.g.
6	2423 "	2377 "
12	2502 "	2512 "
18	2549 "	2568 "
24	2580 "	2602 "
30	2602 "	2629 "
36	2619 "	2647 "
42	2633 "	2663 "
48	2644 "	2674 "
54	2653 "	2684 "
60	2657 "	2690 "

D.S.T. No. 16

6555 - 6601 feet, Otway Group.
Mud level fell in annulus. Found communication behind casing between perforations at 6404 - 6444 feet and 6555 - 6601 feet. After squeeze cementing to isolate the zones, the test was repeated.

D.S.T. No. 17

6555 - 6601 feet, Otway Group.
Fluid level located by swab at 4000 feet. Four swabs recovered a total of 10 barrels of water. On pulling out, a further 2000 feet (11.5 barrels) of water was recovered from the tubing. Water salinity 13,800 ppm Cl, R_w 0.351 ohm. meter @ 60°F.
Top Recorder @ 6510 feet; Bottom Recorder @ 6545 feet.
T.C.V. @ 6440 feet; Tester Valve @ 6520 feet.

Office Corrected Pressures:

	Top Recorder	Bottom Recorder	
Initial Hydrostatic:	3098 p.s.i.g.	3141 p.s.i.g.	
Initial Closed-in :	2717 "	2737 "	(55 mins)
Flow Period :	883 "	893 "	($4\frac{1}{2}$ hrs.)
Final Closed-in :	2277 "	2292 "	(30 mins)
Final Hydrostatic :	3098 "	3141	

The initial build-up appeared complete, and the pressures at the end of the initial closed-in period are taken as the equilibrium values.

Pressure @ 6510 feet = 2717 p.s.i.g.;

Pressure @ 6545 feet = 2737 p.s.i.g.
Average pressure @ 6525 feet = 2726 p.s.i.g.

D.S.T. No. 18

5942 - 5957 feet, Otway Group.
Gas to surface after 20 minutes. Swab run to 5865 feet recovered 200 feet of emulsified mud. Further three swab runs recovered 2 barrels of emulsified mud. Small amount of gas flared between swab runs. On pulling out, 270 feet of oil emulsified mud was recovered from the tubing.

Top Recorder @ 5905 feet; Bottom Recorder @ 5945 feet.
T.C.V. @ 5845 feet; Tester Valve @ 5915 feet.

Office Corrected Pressures:

	Top Recorder	Bottom Recorder	
Initial Hydrostatic	2777 p.s.i.g.	2809 p.s.i.g.	
Initial Closed-in	2155 "	2202 "	(55 mins)
Flow Period	56 "	91 "	(19½ hrs)
Final Closed-in	309 "	459 "	(30 mins)
Final Hydrostatic	2777 "	2809 "	

Analysis of the initial build-up (see Fig. 16) gave the following equilibrium pressures:

2352 p.s.i.g. @ 5905 feet; 2358 p.s.i.g. @ 5945 feet.
Average pressure corrected to 5925 feet = 2355 p.s.i.g.

This zone had been previously tested in D.S.T. No. 9, in which test the pressure was calculated as 2506 p.s.i.g. @ 5900 feet. However, the zone was not properly isolated for that test, and the results were in doubt. The value of the equilibrium pressure calculated for D.S.T. No. 18 is lower than the value calculated from the straight line fit to the remaining points by approximately 70 p.s.i. Further testing of the zone in D.S.T. No. 19 gives a still lower equilibrium pressure; the evidence therefore suggests a fall of pressure each time fluid is produced from this zone; the original pressure in the zone was undoubtedly higher than the value given above.

D.S.T. No. 19

5942 - 5980 feet, Otway Group.
Flowed small amount of gas. Swab located fluid level approximately 200 feet above C.I.P.V. Swabbed one barrel of mud slightly oil cut. On pulling out recovered 150 feet of slightly oil-cut mud.

Top Recorder @ 5912 feet; Bottom Recorder @ 5947 feet.
T.C.V. @ 5842 feet; Tester Valve @ 5907 feet.

Office Corrected Pressures:

	Top Recorder	Bottom Recorder
Initial Hydrostatic	2907 p.s.i.g.	2968 p.s.i.g.
Initial Closed-in	2051 "	2053 (60 mins.)
Initial Flow	141 "	131 (14 hours)
Final Closed-in	-	-
Final Hydrostatic	2863 "	2923

Analysis of the initial build-up gave the following estimated equilibrium pressures:

2168 p.s.i.g. @ 5912 feet; 2187 p.s.i.g. @ 5947 feet (Fig. 17)

Average pressure @ 5925 feet = 2175 p.s.i.g.

This pressure represents a fall of 180 p.s.i. compared with the estimated value for the previous test of this zone (see remarks below D.S.T. No. 18).

D.S.T. No. 20

5942 - 5980 feet, Otway Group.
In an attempt to clear cement assumed to be blocking the formation, 10 barrels of water were squeezed to the perforations. The R.T.T.S. packer, without tester and pressure devices, was set at 5920 feet. After displacing the mud in the tubing with water, the circulating sub was closed and water pumped into the formation. The formation broke down at 1700 p.s.i.g. and 10 barrels of water were pumped away at a rate of 6 barrels per minute at 1900 p.s.i.g. The tubing was then swabbed to the packer and gas appeared at the surface after 90 minutes. After 12 hours flow, 5 barrels of oil emulsion and muddy water was recovered by swabbing. The emulsion consisted of 18% mud solids, 27% mud filtrate and water of salinity 9100 ppm Cl, and 55% oil of 44.8° A.P.I. gravity @ 60°F. A small amount of oil emulsion was recovered from the tubing.

D.S.T. No. 21

5870 - 5878 feet, Otway Group.
Gas to surface immediately after opening T.C.V. Gas passed through separator for 9 hours at average rate of 84.5 M.c.f./day. Total liquid recovered during last 6 hours was ¾ barrel of mud-water-oil emulsion consisting of 5% solids, 60% water and 35% oil of 34.7° A.P.I. gravity. Recovered 270 feet of oil and 450 feet of oil - water emulsion from the tubing.
Water salinity 13,600 p.p.m. Cl, R_w 0.325 ohm. meter @ 62°F.

Top Recorder @ 5825 feet; Bottom Recorder @ 5860 feet.
T.C.V. @ 5776 feet; Tester Valve @ 5835 feet.

Office corrected pressures:

	Top Recorder	Bottom Recorder	
Initial Hydrostatic	:2708 p.s.i.g.	2785 p.s.i.g	
Initial Closed-in	:1925 "	1931 "	(65 mins)
Flow Period	: 325 "	317 "	(11 hrs.)
Final Closed-in	:1759 "	1759 "	(180 mins)
Final Hydrostatic	:2708 "	2785	

Analysis of the initial build-up (see Fig. 18) gave the following equilibrium pressures:

2104 p.s.i.g. @ 5825 feet; 2132 p.s.i.g. @ 5860 feet.

Average pressure 2118 p.s.i.g. @ 5842.5 feet
≡ 2121 p.s.i.g. @ 5850 feet

On the final build-up, the extraploated equilibrium pressure was 1897 p.s.i.g. corrected to 5850 feet (Fig. 19) This result indicates depletion of a small zone.

D.S.T. No. 22 5870 - 5903 feet, Otway Group.

Gas to surface in 1 minute. Flowed gas with negligible amount of fluid. Gas rate 40 M.c.f./day. During 8 hour period the well produced $\frac{1}{4}$ to $\frac{1}{2}$ barrel of oil with 60 to 70% water cut, salinity 14,600 p.p.m. Cl. On pulling out 11 stands of fluid were recovered comprising 50% oil and 50% water, salinity 14,500 p.p.m. Cl., R_w 0.33 ohm. meter @ 62°F.

Top Recorder @ 5825 feet; Bottom Recorder @ 5860 feet.
T.C.V. @ 5776 feet; Tester Valve @ 5835 feet.

Office corrected pressures:

	Top Recorder	Bottom Recorder	
Initial Hydrostatic:	2688 p.s.i.g.	2716 p.s.i.g.	
Initial Closed-in :	1871 "	1869 "	(60 mins)
Flow Period :	413 "	379 "	(27 hrs.)
Final Closed-in :	1510 "	1491 "	(240 mins)
Final Hydrostatic :	2677	2660	

Analysis of the initial build-up (see Fig. 20) gave the following extrapolated equilibrium pressures:

1949 p.s.i.g. @ 5825 feet; 1935 p.s.i.g. @ 5860 feet.

Average pressure corrected to <u>5850 feet = 1945 p.s.i.g</u>.

Analysis of the second build-up (Fig. 21) was hampered by the indefinite flow period. However on the assumption that the well was open for a total of 12 hours, an average equilibrium pressure of 1731 p.s.i.g. @ 5850 feet was obtained. Again there is evidence that this is a small reservoir which has been depleted during the flow period. Note that this test was over an extended interval from that tested in D.S.T. No. 21.

D.S.T. No. 23 5263 - 5307 feet, Waarre Formation.
Swabbed total of 35 barrels of mud and water with a salinity of 14,300 p.p.m. Cl, R_w 0.324 ohm - meter at 62°F.

Top Recorder @ 5227 feet; Bottom Recorder @ 5262 feet.
T.C.V. @ 5147 feet; Tester Valve @ 5227 feet.

Office Corrected Pressures:

	Top Recorder	Bottom Recorder	
Initial Hydrostatic:	2367 p.s.i.g.	2408 p.s.i.g.	
Initial Closed-in :	2133 "	2141 "	(60 mins)
Flow Period :	- *	2106 "	(198 ")
Final Closed-in :	- *	2135 "	(60 ")
Final Hydrostatic :	- *	2408	

*Clock failed

The initial build-up on both recorders was complete and the following static pressures were observed:

2133 p.s.i.g. @ 5227 feet; 2141 p.s.i.g. @ 5262 feet

Average pressure corrected to <u>5250 feet = 2140 p.s.i.g</u>.

This value is in close agreement with that measured in D.S.T. No. 3 viz. 2035 p.s.i.g. @ 5000 feet.

D.S.T. No. 24

4020 - 4040 feet, Belfast Formation sandstone. Swab located liquid level 450 feet from the surface. Recovered total of 48.5 barrels in 5 swabs, R_w 1.9 ohms. meter @ 60°F, salinity 1750 p.p.m. Cl.

Top Recorder @ 3977 feet; Bottom Recorder @ 4012 feet.
T.C.V. @ 3968 feet; Tester Valve @ 3972 feet.

Office Corrected Pressures:

	Top Recorder	Bottom Recorder	
Initial Hydrostatic	1931 p.s.i.g.	1971 p.s.i.g.	
Initial Closed-in	1605 "	1631 "	(60 mins)
Flow Period	1251 "	1480 "	(150 ")
Final Closed-in	1574 "	1602 "	(50 ")
Final Hydrostatic	1931 "	1971	

According to the test data the T.C.V. was run almost immediately above the tester valve so that there was no space for the relief of supercharging. However, in a very permeable formation this might not be significant. There is approximately 30 p.s.i. difference between the first and second build-ups. This is unlikely to result from depletion and may indicate that the second build-up is not complete. On balance it seems reasonable to accept the value from the initial build-up as giving the static reservoir pressure.

Average pressure corrected to 4000 feet = 1620 p.s.i.g.

Summary of Pressures Recorded in Port Campbell No. 4

D.S.T. No.	'D' Depth -ft below R.T.	P Pressure p.s.i.g.	Calculated D from least squares fit. (feet)	Deviation feet	Probable Extrapol. Error (¼ extrap.) psi	Prob. Gauge Error ¼F.S.R. psi	Probable Overall Error psi
2	4950	2004	4944	-6	0	±22.5	±22.5
3	5000	2035	5015	+15	0	±22.5	±22.5
11	6400	2665	6447	+47	±15	±22.5	±37.5
12	5850	2380	5799	-51	±15	±22.5	±37.5
13	5650	2253	5510	-140	± 9	±22.5	±31.5
14	6850	2866	6904	+54	±25	±22.5	±47.5
15	6650	2730	6594	-56	±20	±22.5	±42.5
17	6525	2726	6585	+60	0	±22.5	±22.5
23	5250	2140	5254	+ 4	0	±22.5	±22.5
24	4000	1620	4072	+72	0	±22.5	±22.5

Only those pressures which appear to be representative of the initial static reservoir conditions have been included in the above table.

The calculated least squares fit to the above data is:-

$$D = 390 + 2.2727\,P$$

The gradient of 0.44 p.s.i./ft. is close to that for fresh water.

R.M.S. deviation = 63 feet
Average % error = 1.1

APPENDIX 11

Pretty Hill No. 1

D.S.T. No. 1a 6690 - 6732 feet, Otway Group Basal Sandstone.

Recovered 5360 feet muddy salt water, salinity 14,000 ppm Cl, R_w 0.36 ohm.m. @ 55°F. Full water analysis not supplied.

Field Pressures

Initial Hydrostatic	3310 psig	
Beginning of flow	2660 psig)	Flow period
End of flow (rising)	2830 psig)	11 minutes

The tester was run without a closed-in pressure valve.

APPENDIX 12

Sherbrook No. 1

D.S.T. No. 5 3342 - 3378 feet, Paaratte - Belfast - Flaxmans Formations

Recovered 60 feet of mud, filtrate salinity 6500 ppm Cl.

Initial closed-in pressure 1340 p.s.i.g. Obtained after 16 minutes build-up following 2 minute flow period. Still showing slight upward trend at end of build-up period. Depth of recorders not stated, taken as 3360 feet.

Note: A full Halliburton report with analysis of the build-up, is not at present available for this test.

D.S.T. No. 6 3763 - 3800 feet, Waarre Formation.

Recovered 2036 feet of fresh water. 30 feet of loose sand recovered in the test tool had caused plugging.

Field Pressure Readings

		Average Pressure of 2 Recorders		
Initial Hydrostatic	:	2035 psig		
Initial Flow	:	-	"	(2 minutes)
Initial Closed-in	:	1458 (rising)	"	(14 ")
Final Flow	:	1410	"	(16 ")
Final Closed-in	:	1445 (rising)	"	(10 ")
Final Hydrostatic	:	2035	"	

The two build-ups were not complete and plugging troubles would make any analysis of the build up curves difficult.

Water Analysis

	ppm
Cl	263
CO_3	114
HCO_3	793
SO_4	3
F	0.3
Na	518
K	18
Ca	11
Mg	8
Fe (soluble)	2
SiO_2 (soluble)	3
Total solids (by hypothetical combination)	1733
pH	9.4

APPENDIX 13

Well: Tullich No. 1

D.S.T. No. 1 1596 - 1631 feet, Merino Group

Recovered 220 feet of fresh water cut mud.

Top Recorder @ 1581 feet: Bottom Recorder @ 1628 feet.

Office Corrected Pressures

		Top Recorder p.s.i.g.	Bottom Recorder p.s.i.g.	
Initial Hydrostatic	:	812	834	
Initial Flow	:	28	51	(5 minutes)
Initial Closed-in	:	621	641	(20 ")
Final Flow	:	113	133	(45 ")
Final Closed-in	:	540	157	(20 ")
Final Hydrostatic	:	812	834	

Analysis of the initial build-up gave the following estimated equilibrium pressures:-

664 p.s.i.g. @ 1581 feet: 688 p.s.i.g. @ 1628 feet (Fig. 22)

Average pressure corrected to 1600 feet = 674 p.s.i.g. The estimated equilibrium pressures from the final build-up were as follows:-

654 p.s.i.g. @ 1581 feet: 672 p.s.i.g. @ 1628 feet.

Average pressure corrected to 1600 feet = 661 p.s.i.g.

The agreement between the two build-ups is good, and the small difference is probably accounted for by the longer extrapolation on the final build-up.

D.S.T. No. 2 2075 - 2110 feet, Merino Group.

Recovered 130 feet of muddy brackish water.

Top Recorder @ 2060 feet: Bottom Recorder @ 2106 feet.

Office Corrected Pressures:-

		Top Recorder p.s.i.g.	Bottom Recorder p.s.i.g.	
Initial Hydrostatic	:	1053	1079	
Initial Flow	:	17	44	(5 minutes)
Initial Closed-in	:	809	823	(20 minutes)
Final Flow	:	60	82	(60 minutes)
Final Closed-in	:	651	665	(20 minutes)
Final Hydrostatic	:	1053	1073	

Analysis of the initial build-up* gave the following estimated equilibrium pressures:-

876 p.s.i.g. @ 2060 feet: 905 p.s.i.g. @ 2106 feet (Fig. 23)

Average pressure corrected to 2080 feet = 889 p.s.i.g.

Estimated equilibrium pressures from the second build-up** were as follows:-

838 p.s.i.g. @ 2060 feet: 851 p.s.i.g. @ 2106 feet (Fig. 25)

Average pressure corrected to 2080 feet = 843 p.s.i.g.

The agreement between the two build-ups is reasonable, and the difference is probably accounted for by the longer extrapolation necessary on the second build-up.

Initial Build-up

Time (minutes)	Pressure (p.s.i.g.) Top Recorder	Bottom Recorder
0	17	44
2	478	448
4	627	603
6	694	678
8	730	728
10	754	756
12	771	778
14	784	794
16	792	807
18	801	816
20	809	823

**Final Build-up

Time (minutes)	Pressure (p.s.i.g.) Top Recorder	Bottom Recorder
0	60	82
2	338	330
4	443	441
6	503	508
8	546	552
10	571	585
12	600	610
14	617	627
16	632	641
18	647	652
20	651	665

D.S.T. No. 3 2947 - 2982 feet, Merino Group

Recovered 1500 feet of gassy salt water

Top Recorder @ 2932 feet

Stylus on bottom recorder was not engaged, and no readings were obtained from it.

Office Corrected Pressures:-

		Top Recorder p.s.i.g.
Initial Hydrostatic	:	1489
Initial Flow	:	139 (5 minutes)
Initial Closed-in	:	1237 (20 minutes)
Final Flow	:	697 (45 minutes)
Final Closed-in	:	1220 (20 minutes)
Final Hydrostatic	:	1468

Pressures on both the initial and final closed-in periods were fully build-up.

On initial closed-in period, static reservoir pressure = 1237 p.s.i.g. @ 2932 feet

D.S.T. No. 4 3721 - 3786 feet, Merino Group

Recovered 500 feet of very gassy salt water-mud and 3160 feet of very gassy salt water.

Top Recorder @ 3705 feet: Bottom Recorder @ 3782 feet.

Office Corrected Pressures:-

	Top Recorder p.s.i.g.	Bottom Recorder p.s.i.g.	
Initial Hydrostatic:	1943	1954	
Initial Flow :	-	1525	(5 minutes)
Initial Closed-in :	1521	1651	(23 minutes)
Final Flow :	1619	1649	(45 minutes)
Final Closed-in :	1621	1649	(20 minutes)
Final Hydrostatic :	1875	1915	

Pressures on both the initial and final closed-in periods were fully built-up.

Static reservoir pressures:

1621 p.s.i.g. @ 3705 feet: 1651 p.s.i.g. @ 3782 feet.

Average pressure corrected to 3750 feet = 1634 p.s.i.g.

D.S.T. No. 5 4120 - 4185 feet, Merino Group

Recovered 15 feet of mud, no usable pressures.

D.S.T. No. 6 4815 - 4880 feet, Merino Group.
Recovered 450 feet of gassy, muddy salt water.

Top Recorder @ 4799 feet: Bottom Recorder @ 4876 feet.

Office Corrected Pressures:-

	Top Recorder p.s.i.g.	Bottom Recorder p.s.i.g.
Initial Hydrostatic:	2439	2489
Initial Flow :	67	103
Initial Closed-in :	2006	2042
Final Flow :	209	237
Final Closed-in :	1794	1807
Final Hydrostatic :	2309	2343

Analysis of the initial build-up gave the following estimated equilibrium pressures:-

2096 p.s.i.g. @ 4799 feet: 2137 p.s.i.g. @ 4876 feet (Fig. 24)

Average pressure corrected to 4840 feet = 2118 p.s.i.g.

The second build-up gave higher equilibrium pressures than the above; this may be attributed to an "S" shaped build-up curve in which the straight line portion had not been reached. The values obtained in this build-up should therefore be discarded.

D.S.T. No. 7 4980 - 5045 feet, Merino Group

Recovered 400 feet of muddy gassy water.

Top Recorder @ 4964 feet; Bottom Recorder @ 5041 feet.

Office Corrected Pressures:-

	Top Recorder (p.s.i.g.)	Bottom Recorder (p.s.i.g.)	
Initial Hydrostatic:	2629	2677	
Initial Flow :	41	89	(5 minutes)
Initial Closed-in :	2019	2046	(20 minutes)
Final Flow :	174	203	(120 minutes)
Final Closed-in :	1477	1512	(20 minutes)
Final Hydrostatic :	2426	2451	

Analysis of the initial build-up* gave the following estimated equilibrium pressures:-

2152 p.s.i.g. @ 4964 feet; 2176 p.s.i.g. @ 5041 feet (Fig. 25)

Average pressure corrected to 5000 feet = 2163 p.s.i.g.

The second closed-in period was only 20 minutes following a flow period of 2 hours, and the extrapolation is too lengthy to give a reliable equilibrium pressure.

*Initial build-up

Time (minutes)	Pressures - p.s.i.g. Top Recorder	Bottom Recorder
0	41	89
2	1544	1490
4	1720	1736
6	1814	1840
8	1875	1901
10	1917	1945
12	1949	1974
14	1970	2000
16	1989	2020
18	2006	2035
20	2019	2046

Tullich No. 1

The following table summarises the pressures recorded in tests in which either a fully built-up closed-in pressure or a suitable build-up curve was obtained.

D.S.T. Number	D Depth ft. below RTKB	P pressure p.s.i.g.	Calc. D from least squares fit. feet	Deviation feet
1	1600	674	1609	+9
2	2080	889	2094	+14
3	2932	1237	2880	-52
4	3750	1634	3777	+27
6	4840	2118	4869	+29
7	5000	2163	4971	-29

Equation of straight line by least squares method.

$$D = 87 + 2.258\ P \quad \text{where} \quad \begin{array}{l} D = \text{Depth below RTKB, ft.} \\ P = \text{Pressure - p.s.i.g.} \end{array}$$

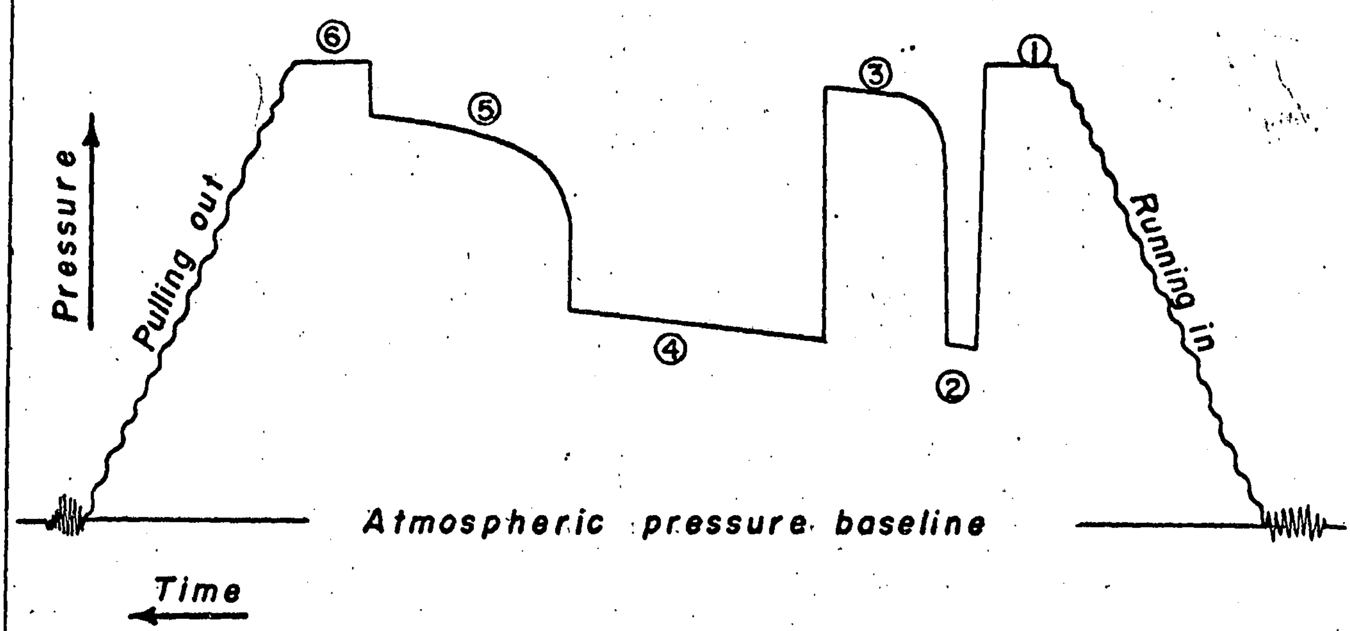
R.M.S. deviation = 30 feet = 0.9%

Gradient = 0.4425 p.s.i./ft.

The gradient is equivalent to a saline water of specific gravity 1.021.

A plot of the calculated pressures versus depth is shown on Fig. 26.

EXAMPLE OF D.S.T. PRESSURE CHART FOR THE DUAL CLOSED-IN TEST

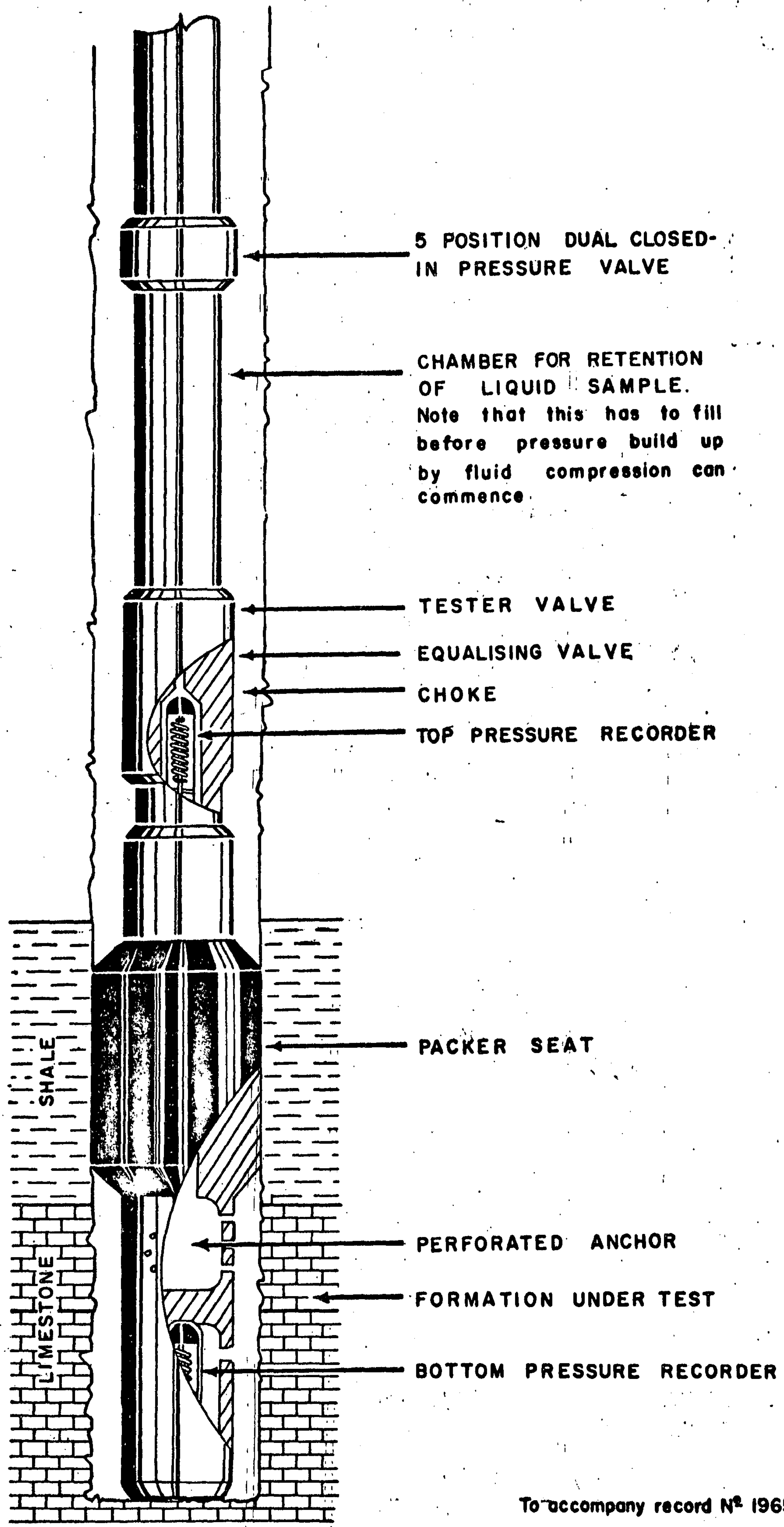


1 Initial hydrostatic pressure
2 Initial flow period
3 Initial closed-in period
4 Final flow period
5 Final closed-in period
6 Final hydrostatic pressure

To accompany Record Nº 1965/99.
Bureau of Mineral Resources, Geology & Geophysics. August 1965.

X AUS-2-53 (27)

BASIC DUAL CLOSED-IN PRESSURE TESTER



To accompany record Nº 1965/99

Bureau of Mineral Resources, Geology and Geophysics. August 1965.

Fig.3

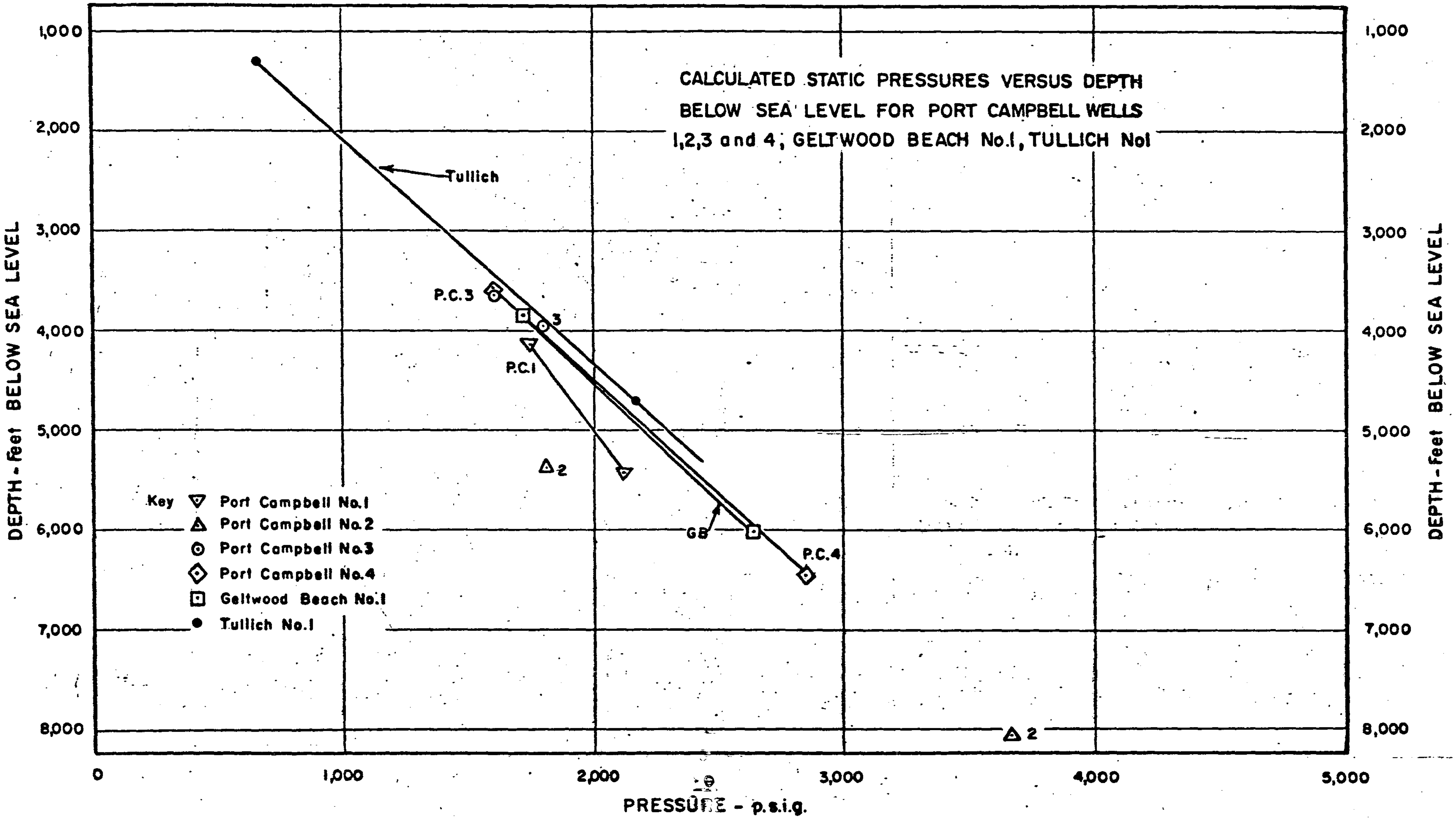

CALCULATED STATIC PRESSURES VERSUS DEPTH BELOW SEA LEVEL FOR PORT CAMPBELL WELLS 1,2,3 and 4, GELTWOOD BEACH No.1, TULLICH No1
DEPTH - feet BELOW SEA LEVEL
1,000
2,000
3,000
4,000
5,000
6,000
7,000
8,000
PRESSURE - p.s.i.g.
0
1,000
2,000
3,000
4,000
5,000
Tullich
P.C.3
3
P.C.1
2
GB
P.C.4
Key
Port Campbell No.1
Port Campbell No.2
Port Campbell No.3
Port Campbell No.4
Geltwood Beach No.1
Tullich No.1

Fig. 4

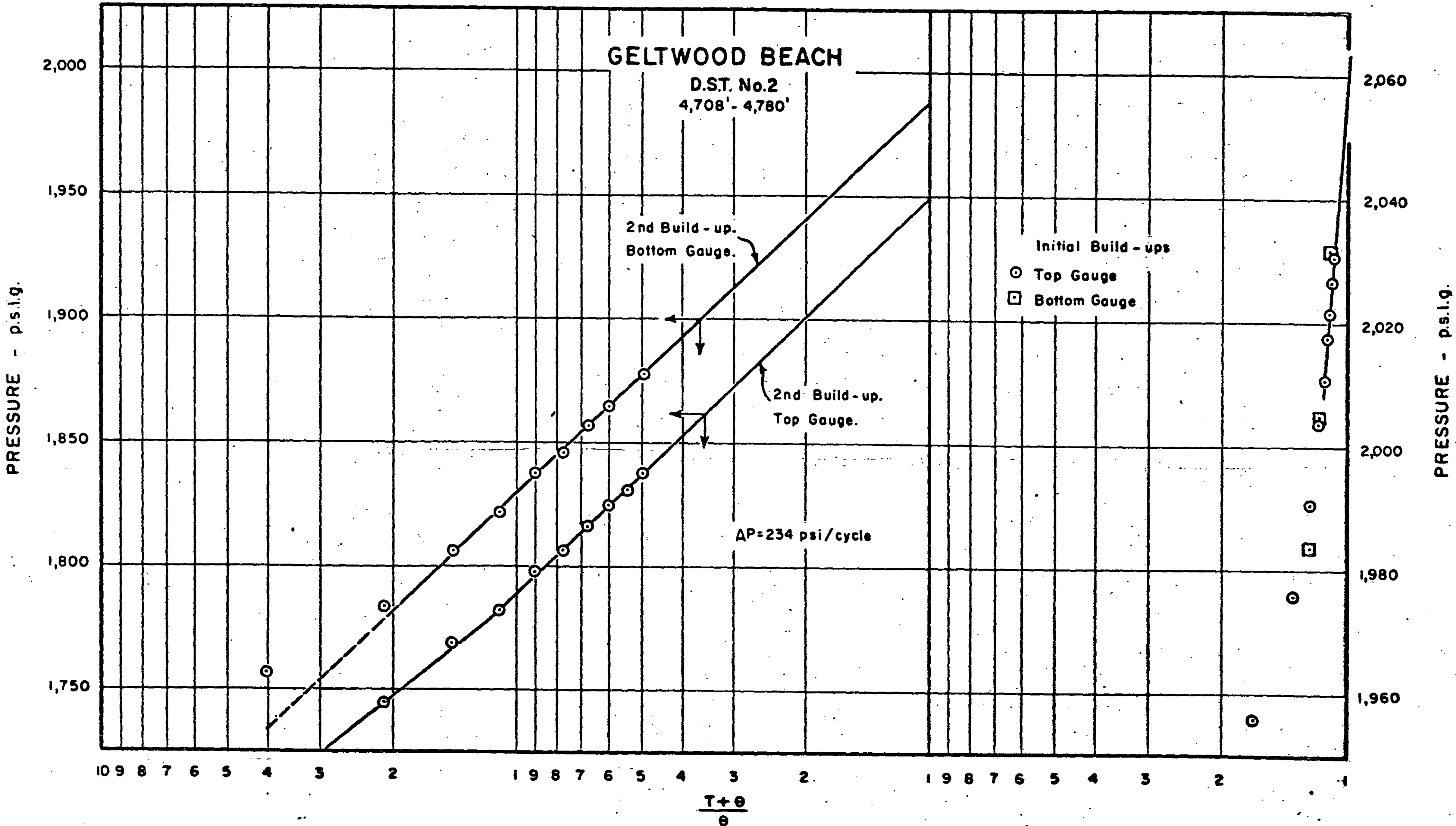
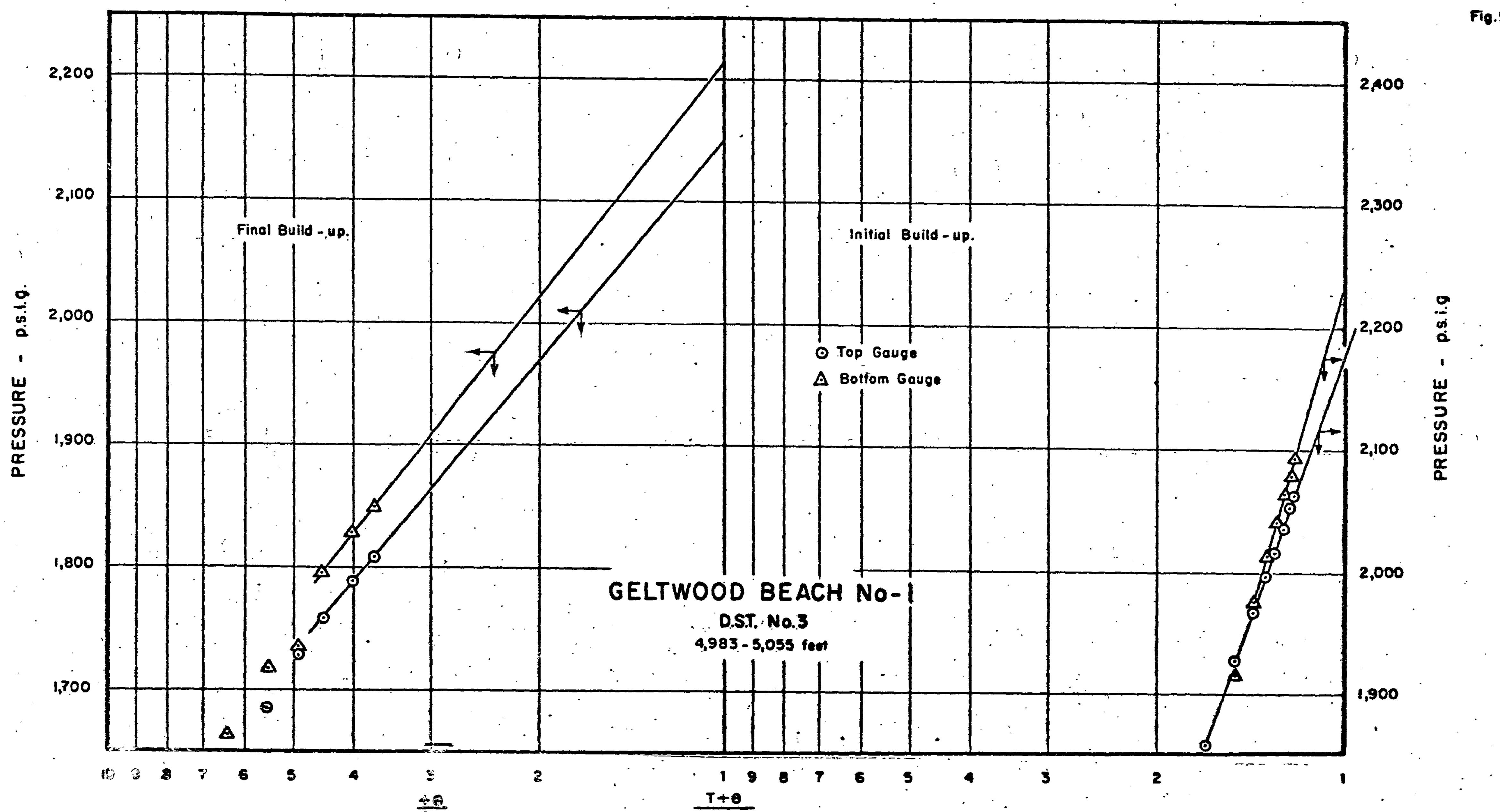

GELTWOOD BEACH
D.S.T. No.2
4,708' - 4,780'
2nd Build - up.
Bottom Gauge.
2nd Build - up.
Top Gauge.
Initial Build - ups
Top Gauge
Bottom Gauge
ΔP=234 psi/cycle
PRESSURE - p.s.i.g.
2,000
1,950
1,900
1,850
1,800
1,750
2,060
2,040
2,020
2,000
1,980
1,960
10 9 8 7 6 5 4 3 2 1 9 8 7 6 5 4 3 2 1 9 8 7 6 5 4 3 2 1
(T+θ)/θ

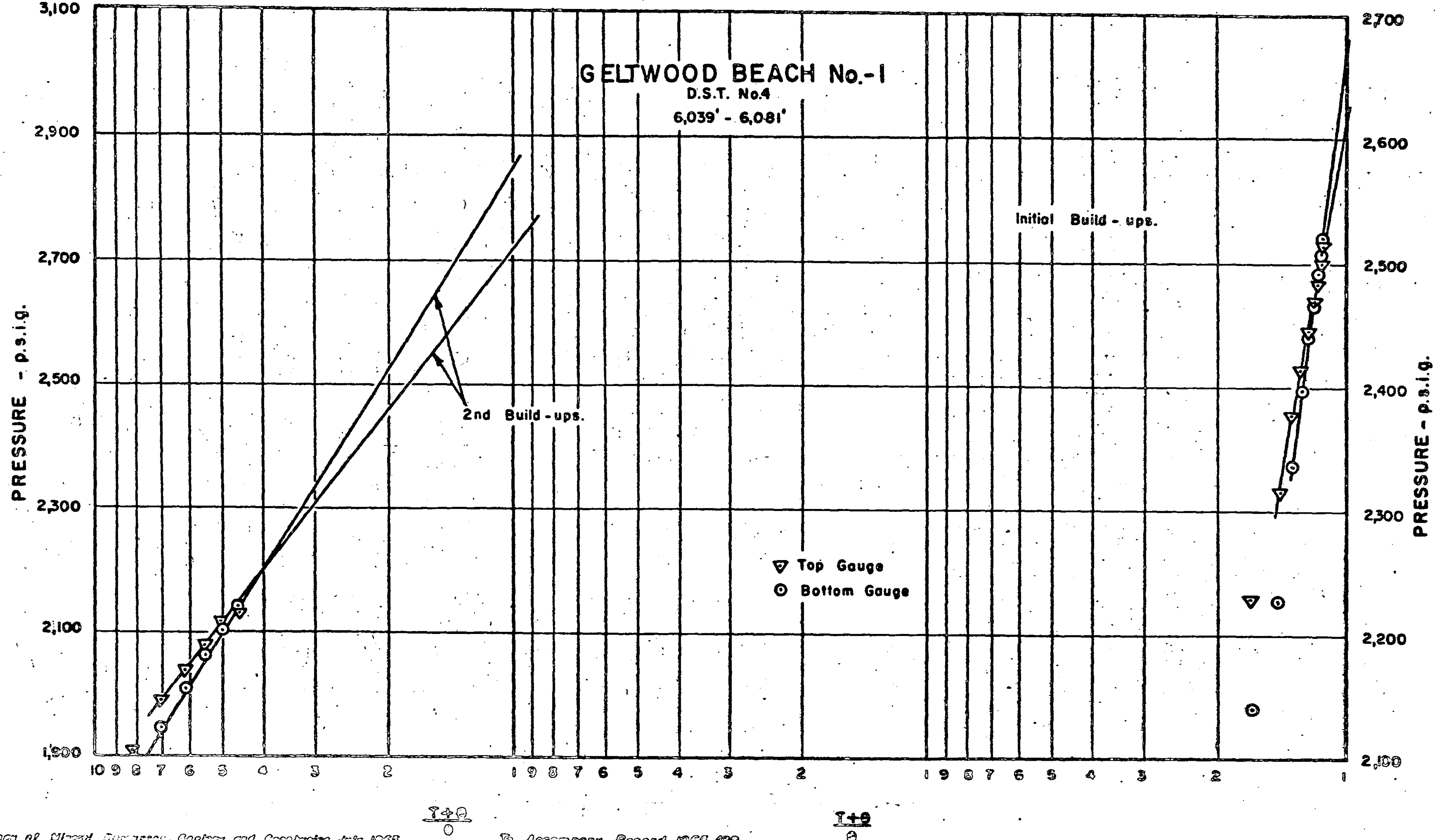
Fig.5



To Accompany Record No. 1965/99

X AUS - 2 - 53 (3)

Fig. 6



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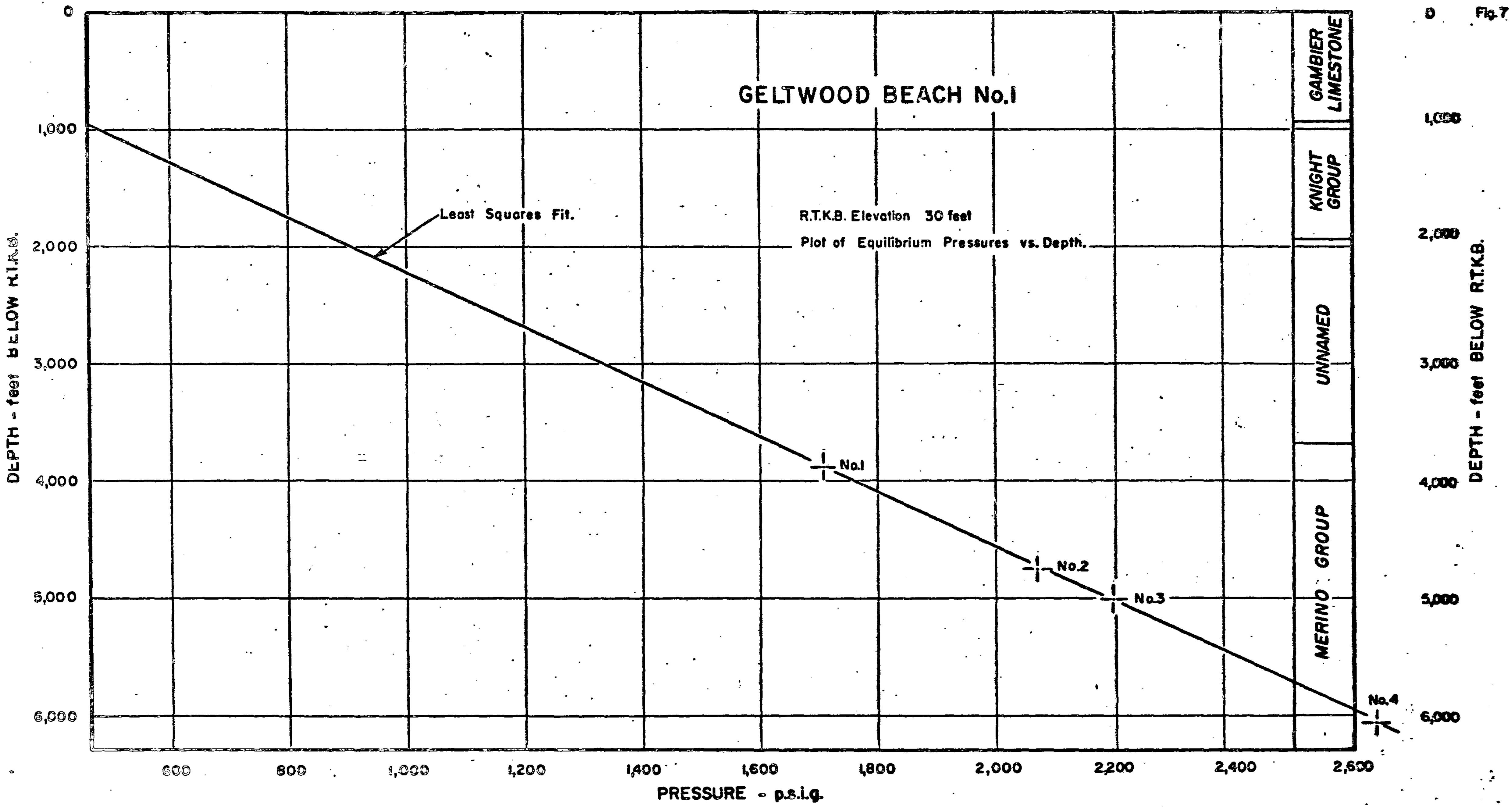


Fig.7
GELTWOOD BEACH No.1
Least Squares Fit.
R.T.K.B. Elevation 30 feet
Plot of Equilibrium Pressures vs. Depth.
No.1
No.2
No.3
No.4
GAMBIER LIMESTONE
KNIGHT GROUP
UNNAMED
MERINO GROUP
DEPTH - feet BELOW R.T.K.B.
0
1,000
2,000
3,000
4,000
5,000
6,000
600
800
1,000
1,200
1,400
1,600
1,800
2,000
2,200
2,400
2,600
PRESSURE - p.s.i.g.

X AUS -2-53 (5)

Fig.8

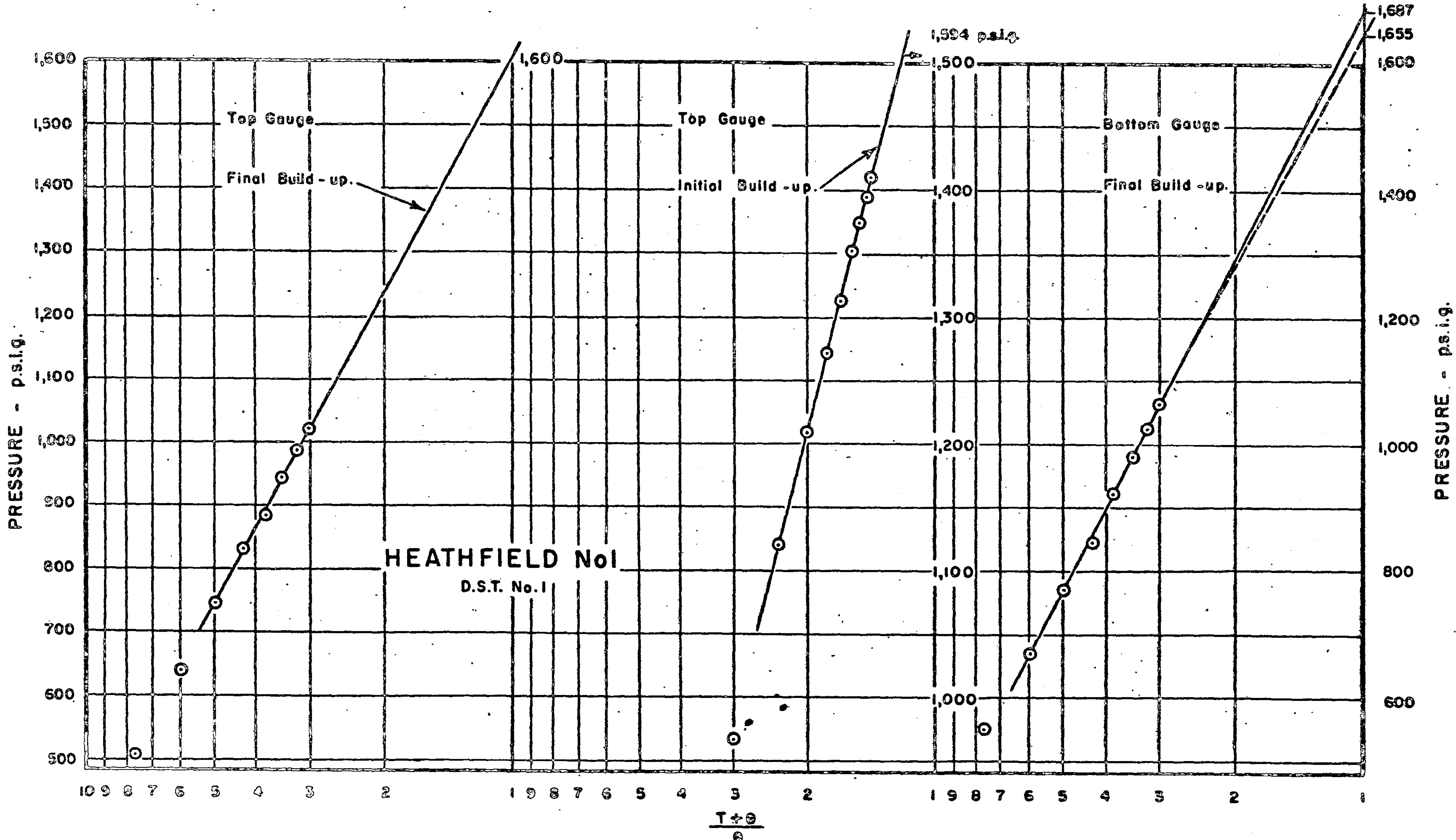

HEATHFIELD No1
D.S.T. No.1
Top Gauge
Final Build-up.
Top Gauge
Initial Build-up.
Bottom Gauge
Final Build-up.
1,594 p.s.i.g.
1,687
1,655
PRESSURE - p.s.i.g.
PRESSURE - p.s.i.g.
T+θ / θ

Fig.9

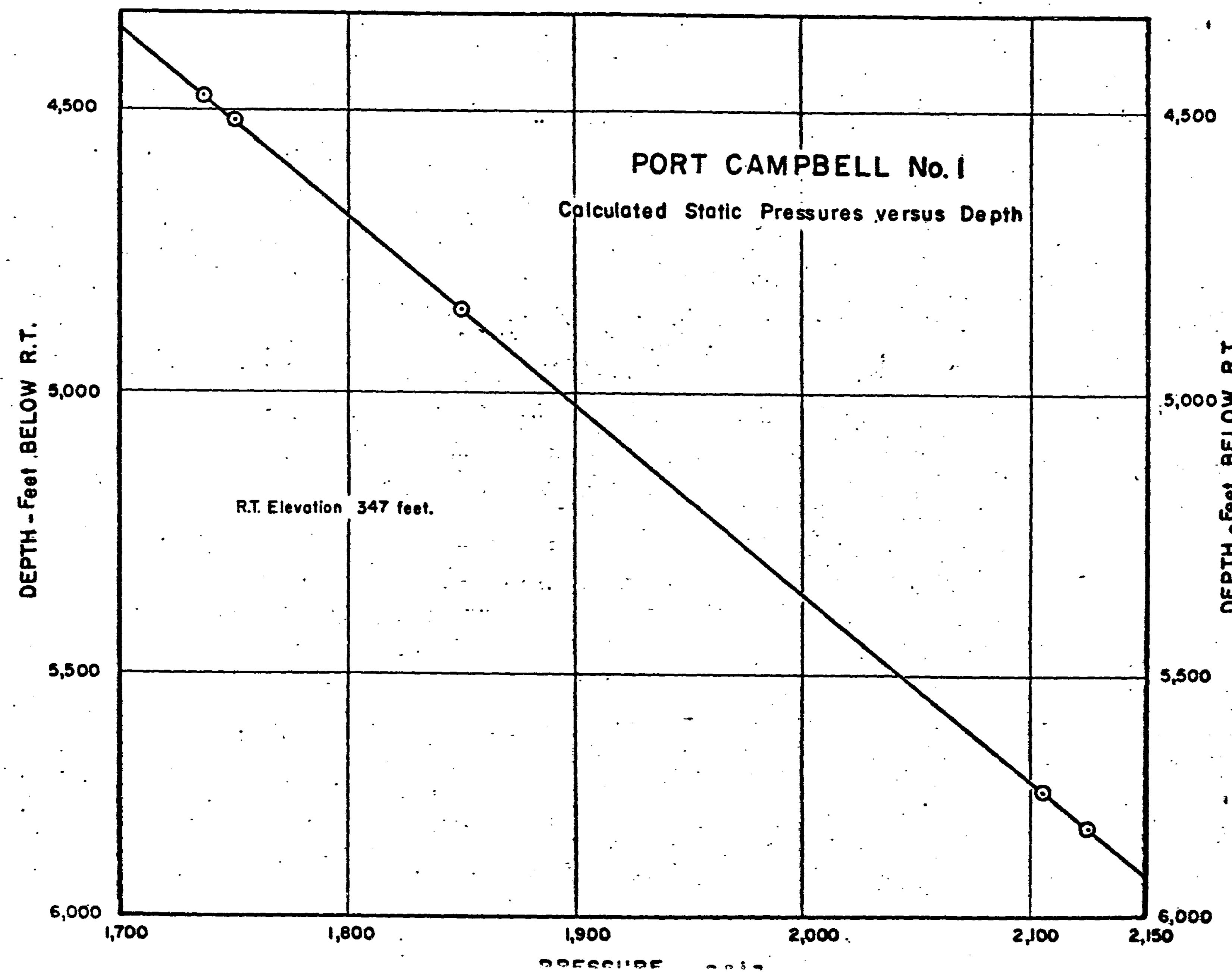
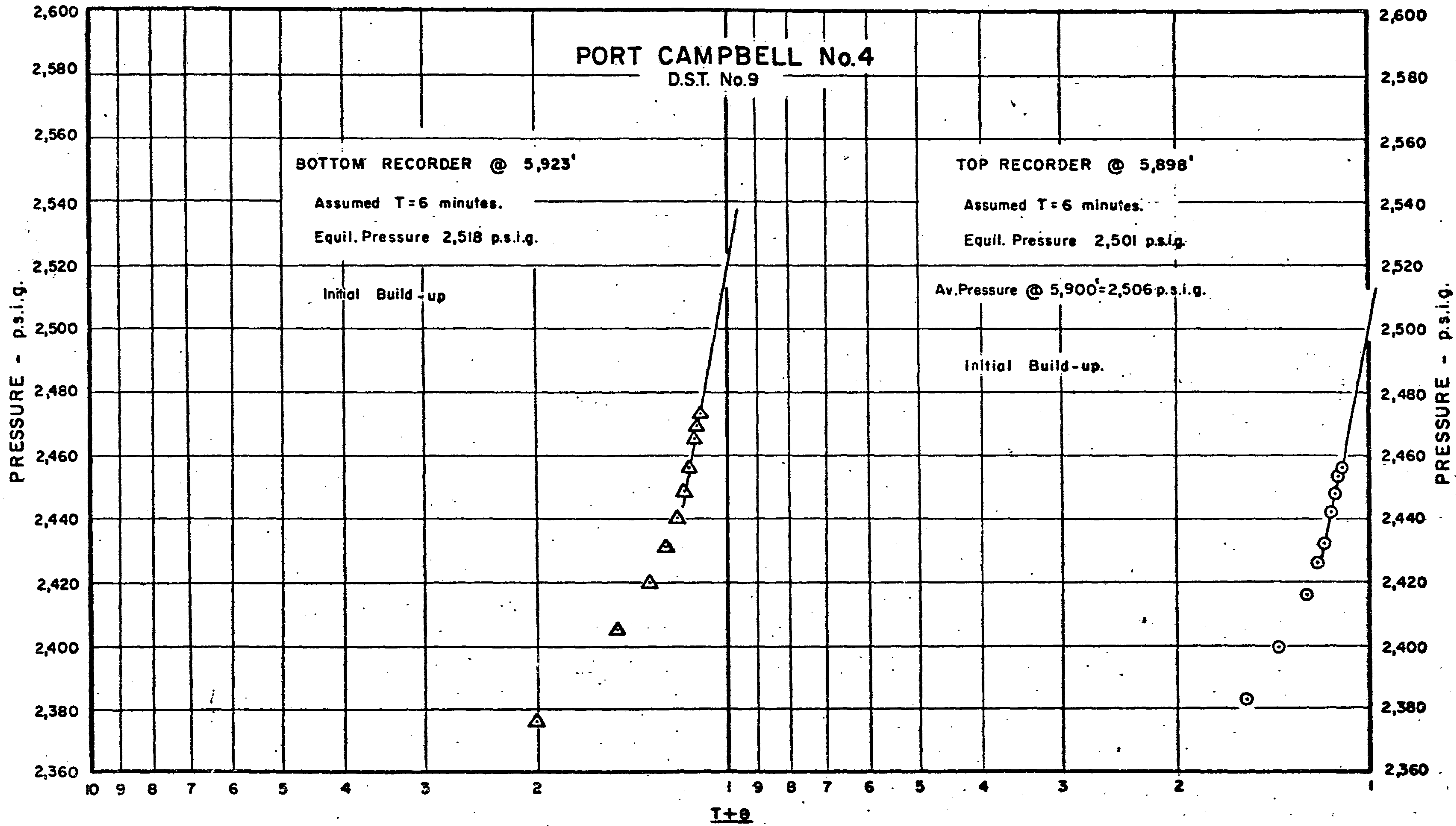
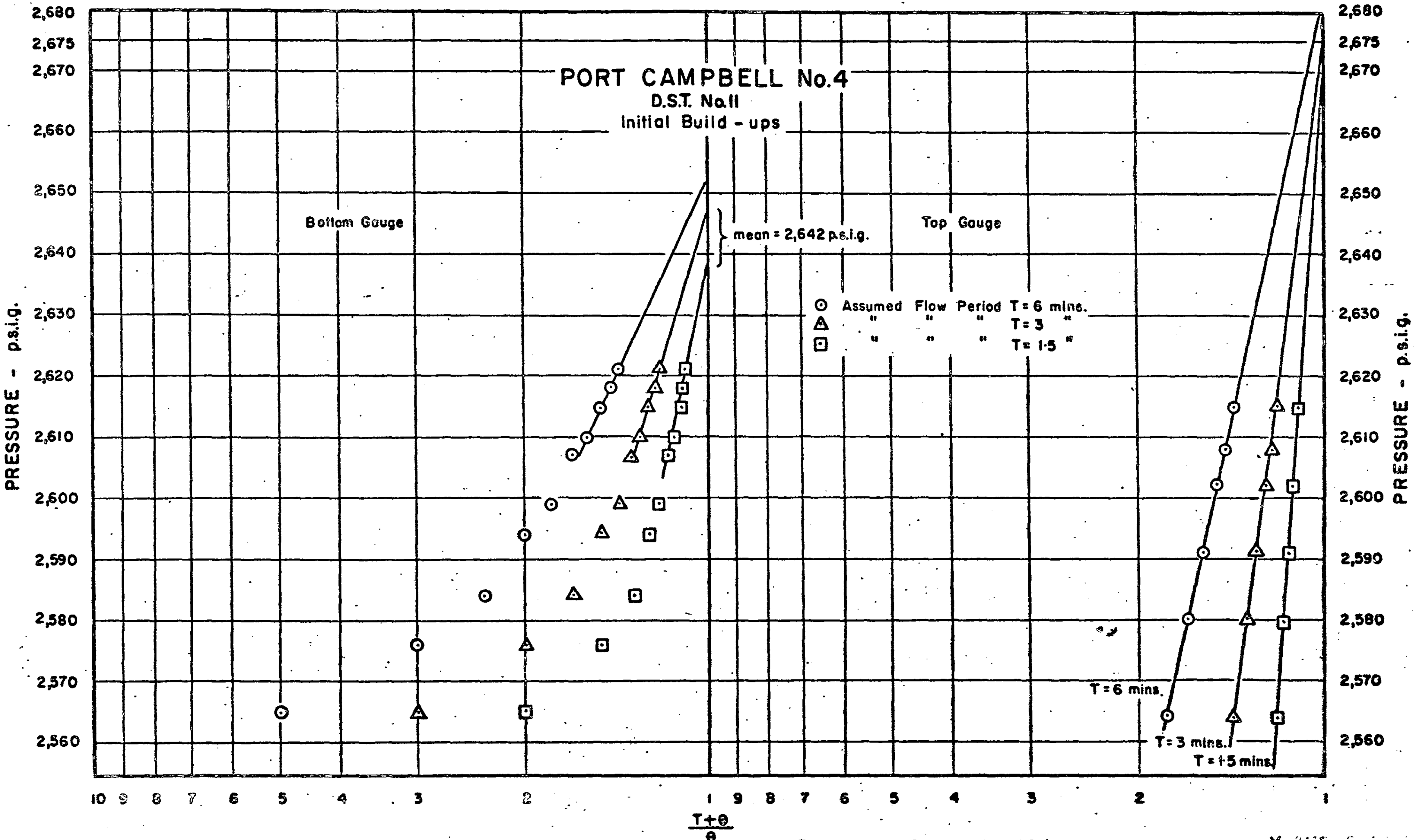

PORT CAMPBELL No. I
Calculated Static Pressures versus Depth
R.T. Elevation 347 feet.
DEPTH - Feet BELOW R.T.
4,500
5,000
5,500
6,000
1,700
1,800
1,900
2,000
2,100
2,150
PRESSURE

Fig. 10

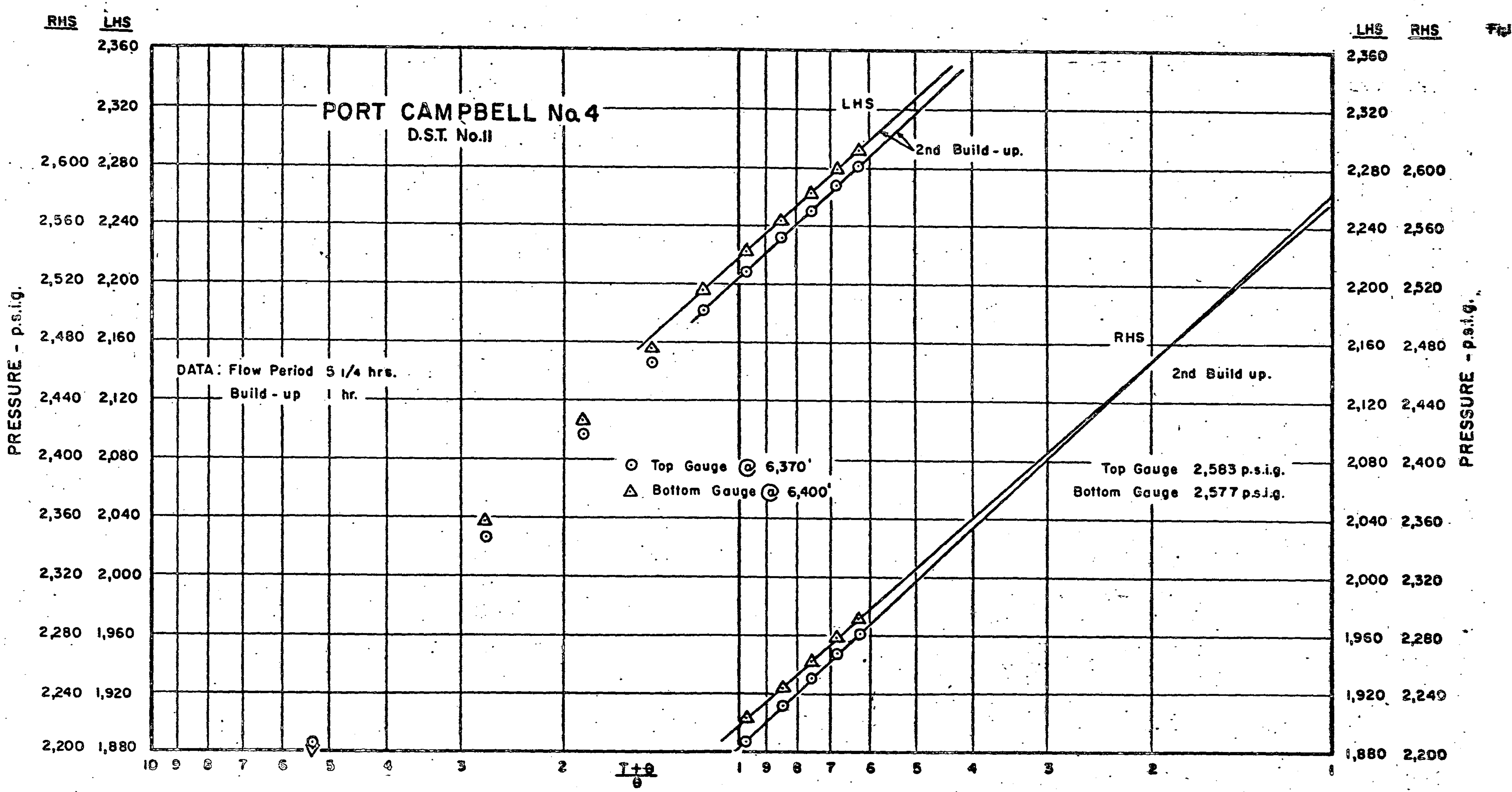


PORT CAMPBELL No.4
D.S.T. No.9
BOTTOM RECORDER @ 5,923'
Assumed T=6 minutes.
Equil. Pressure 2,518 p.s.i.g.
Initial Build-up
TOP RECORDER @ 5,898'
Assumed T=6 minutes.
Equil. Pressure 2,501 p.s.i.g.
Av. Pressure @ 5,900'=2,506 p.s.i.g.
Initial Build-up.
PRESSURE - p.s.i.g.
2,600
2,580
2,560
2,540
2,520
2,500
2,480
2,460
2,440
2,420
2,400
2,380
2,360
10 9 8 7 6 5 4 3 2 1 9 8 7 6 5 4 3 2 1
(T+θ)/θ

Fig.11



PORT CAMPBELL No.4
D.S.T. No.11
Initial Build - ups
Bottom Gauge
Top Gauge
mean = 2,642 p.s.i.g.
Assumed Flow Period T = 6 mins.
" " " T = 3 "
" " " T = 1·5 "
T = 6 mins.
T = 3 mins.
T = 1·5 mins.
PRESSURE - p.s.i.g.
2,680
2,675
2,670
2,660
2,650
2,640
2,630
2,620
2,610
2,600
2,590
2,580
2,570
2,560
10 9 8 7 6 5 4 3 2 1 9 8 7 6 5 4 3 2 1
$\frac{T+\theta}{\theta}$



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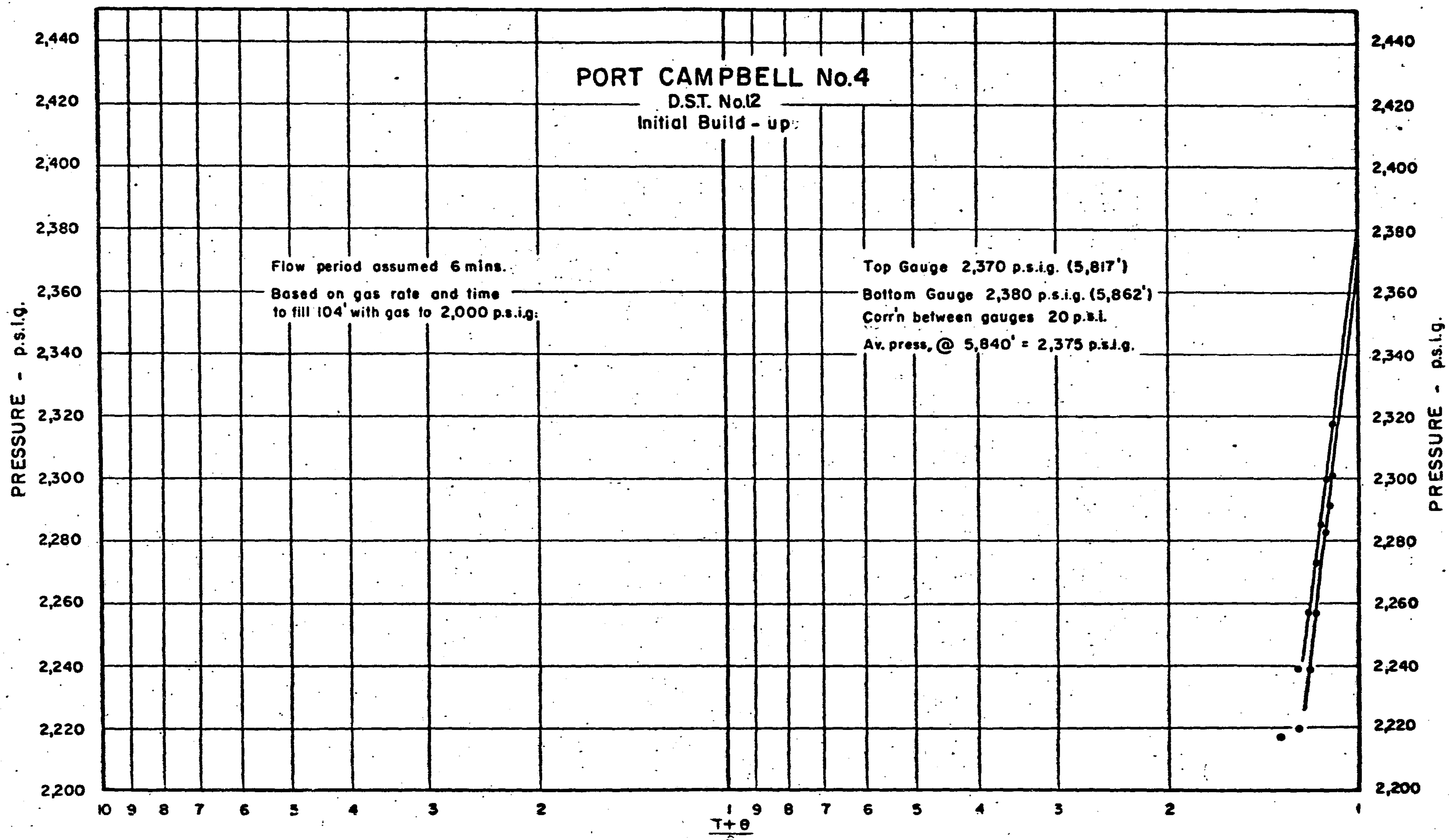
To Accompany Record No. 1965/99.

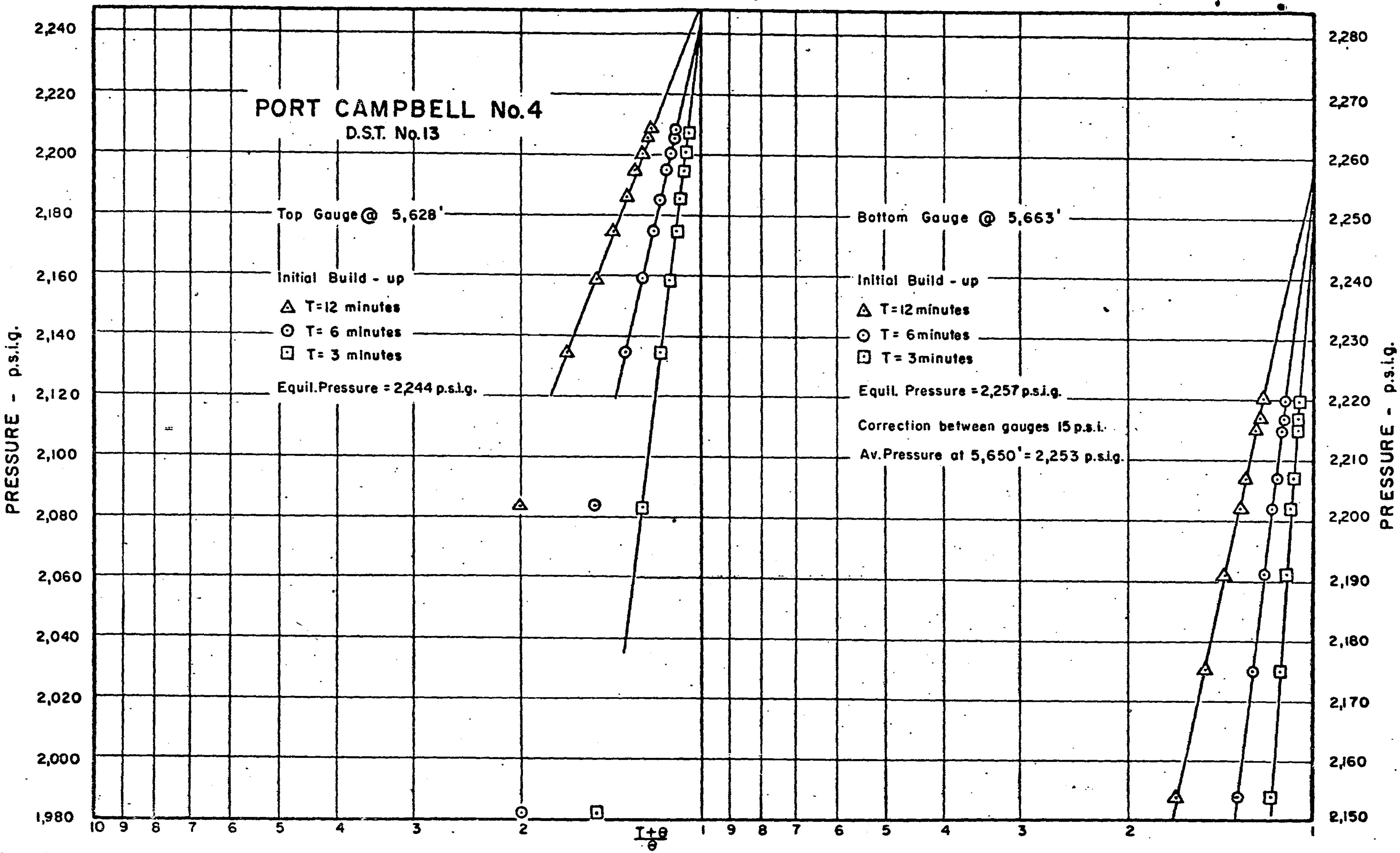
X AUS -2- 53 (10)

Fig 2



PORT CAMPBELL No.4
D.S.T. No.12
Initial Build - up
Flow period assumed 6 mins.
Based on gas rate and time to fill 104' with gas to 2,000 p.s.i.g.
Top Gauge 2,370 p.s.i.g. (5,817')
Bottom Gauge 2,380 p.s.i.g. (5,862')
Corr'n between gauges 20 p.s.i.
Av. press. @ 5,840' = 2,375 p.s.i.g.
PRESSURE - p.s.i.g.
2,440
2,420
2,400
2,380
2,360
2,340
2,320
2,300
2,280
2,260
2,240
2,220
2,200
10 9 8 7 6 5 4 3 2 1 9 8 7 6 5 4 3 2 1
T+θ / θ

Fig. 13



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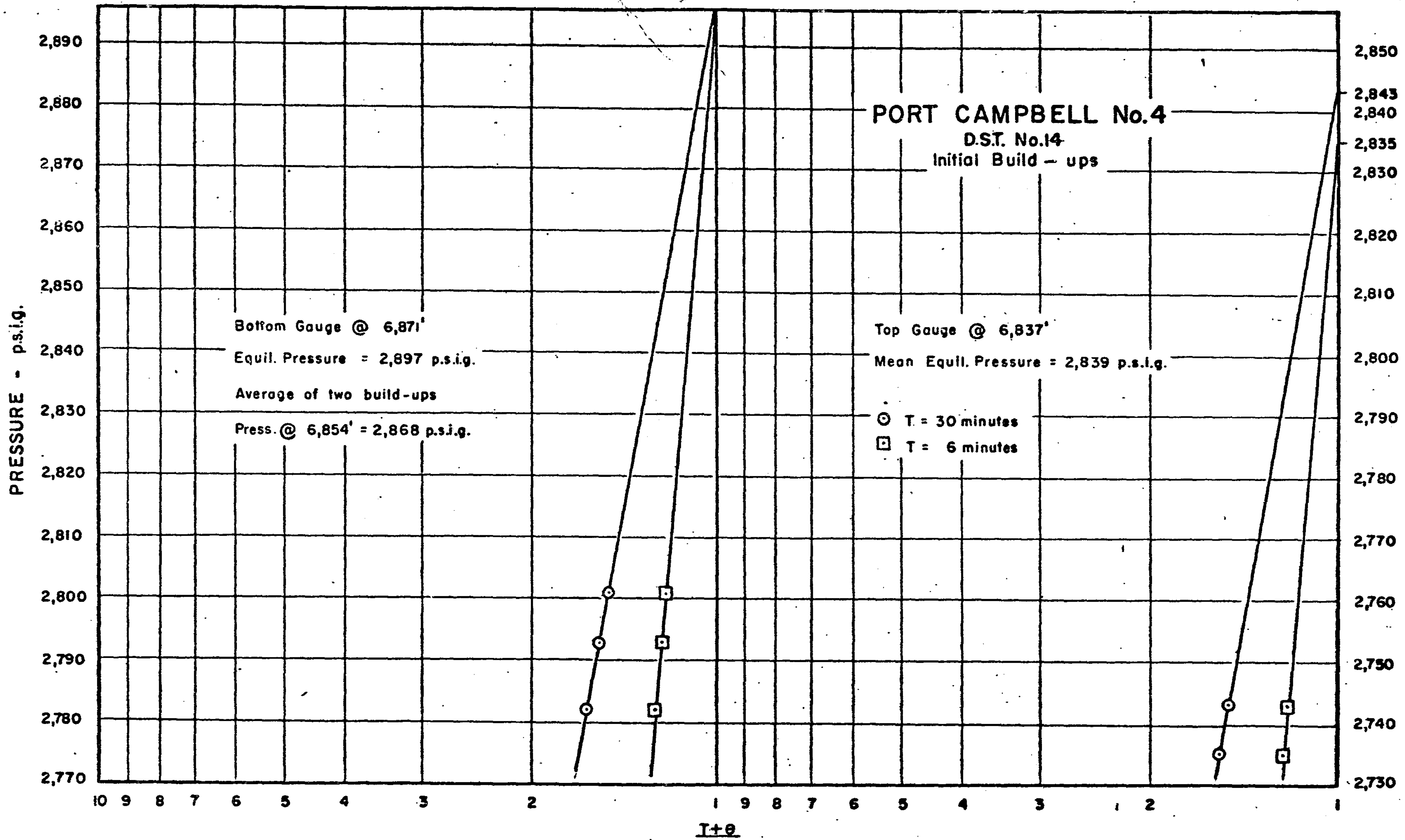
X AUS-2-53-(12)

Fig. 14



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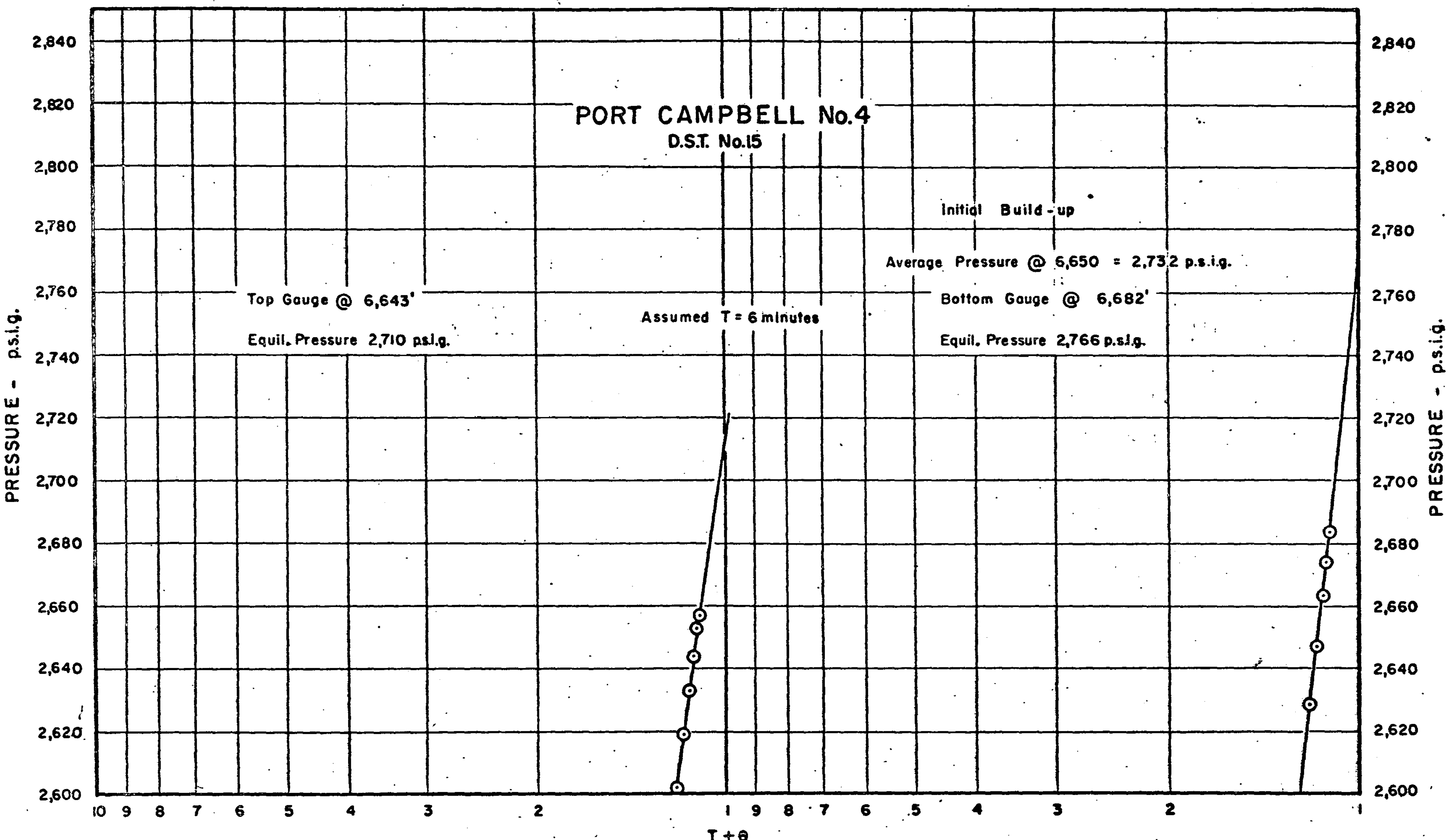
To Accompany Record 1965/99.

X AUS -2-53(13)

Fig. 15



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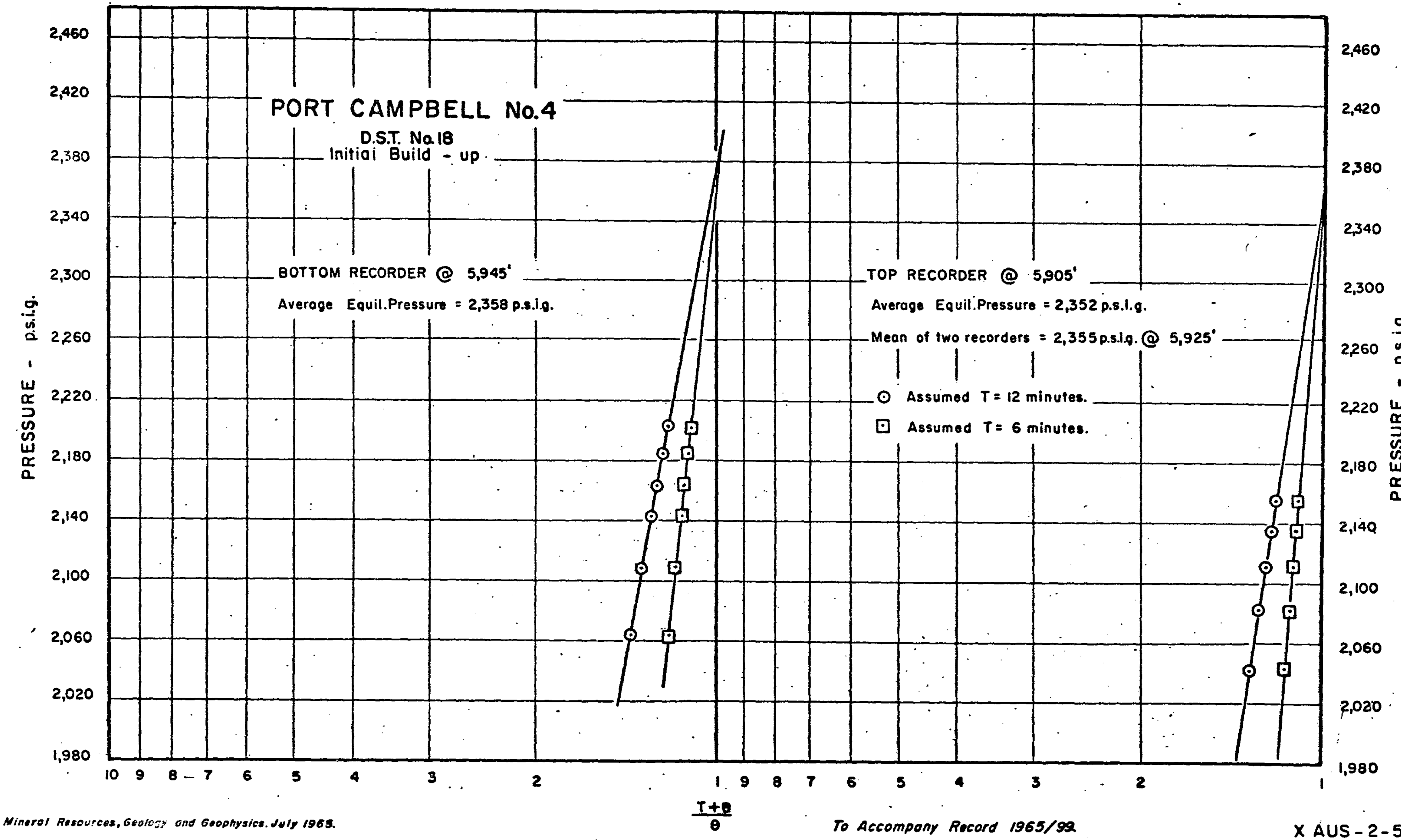
X AUS-2-53(14)

Fig. 16



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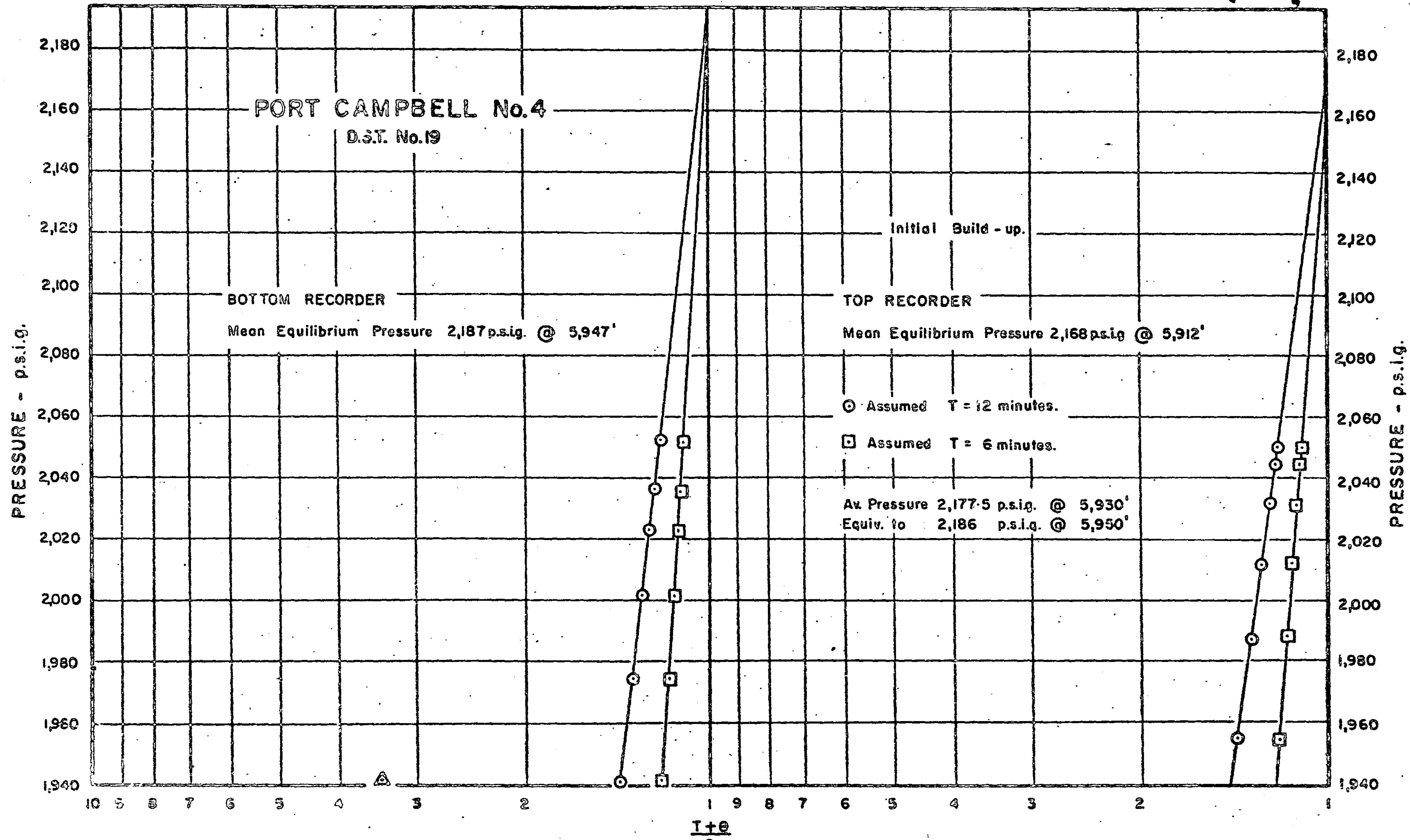
To Accompany Record 1965/99.

X AUS-2-53 (15)

Fig.17



Bureau of Mineral Resources, Geology and Geophysics. July 1965.

To Accompany Record 1965/99.

X AUS - 2 - 53 (16)

Fig. 18

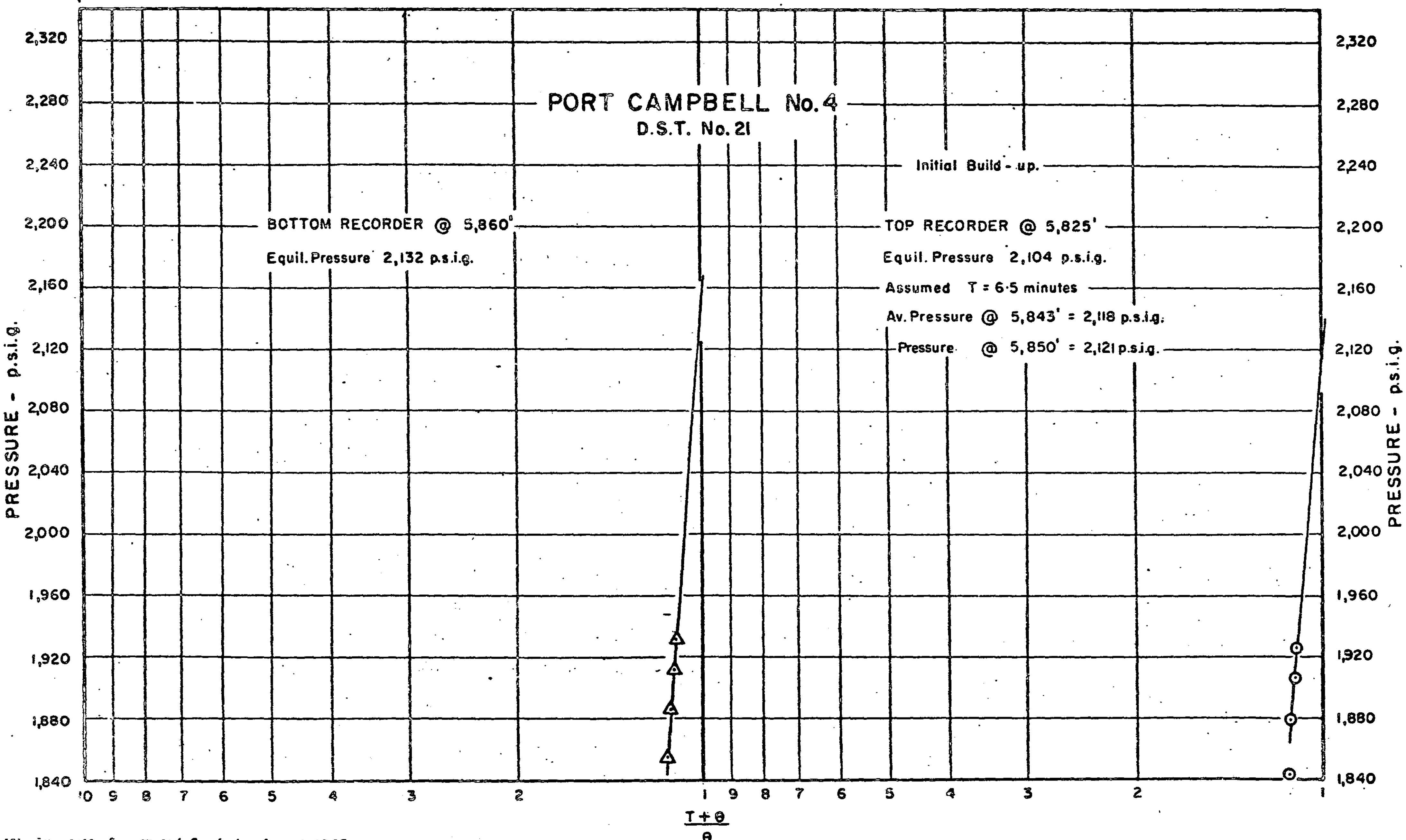
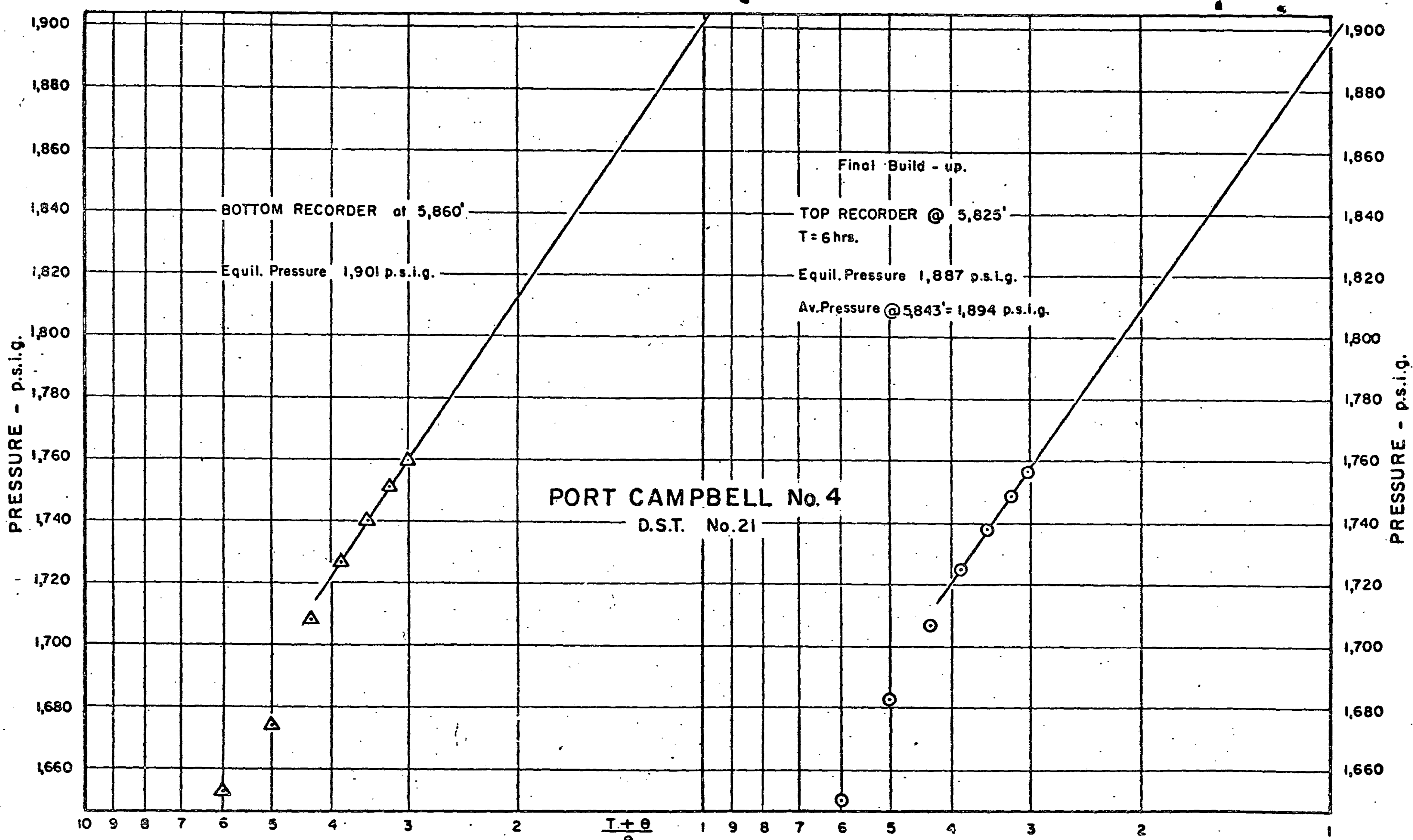

PORT CAMPBELL No. 4
D.S.T. No. 21
Initial Build-up.
BOTTOM RECORDER @ 5,860'
Equil. Pressure 2,132 p.s.i.g.
TOP RECORDER @ 5,825'
Equil. Pressure 2,104 p.s.i.g.
Assumed T = 6·5 minutes
Av. Pressure @ 5,843' = 2,118 p.s.i.g.
Pressure @ 5,850' = 2,121 p.s.i.g.
PRESSURE - p.s.i.g.
2,320
2,280
2,240
2,200
2,160
2,120
2,080
2,040
2,000
1,960
1,920
1,880
1,840
10 9 8 7 6 5 4 3 2 1 9 8 7 6 5 4 3 2 1
T+θ / θ

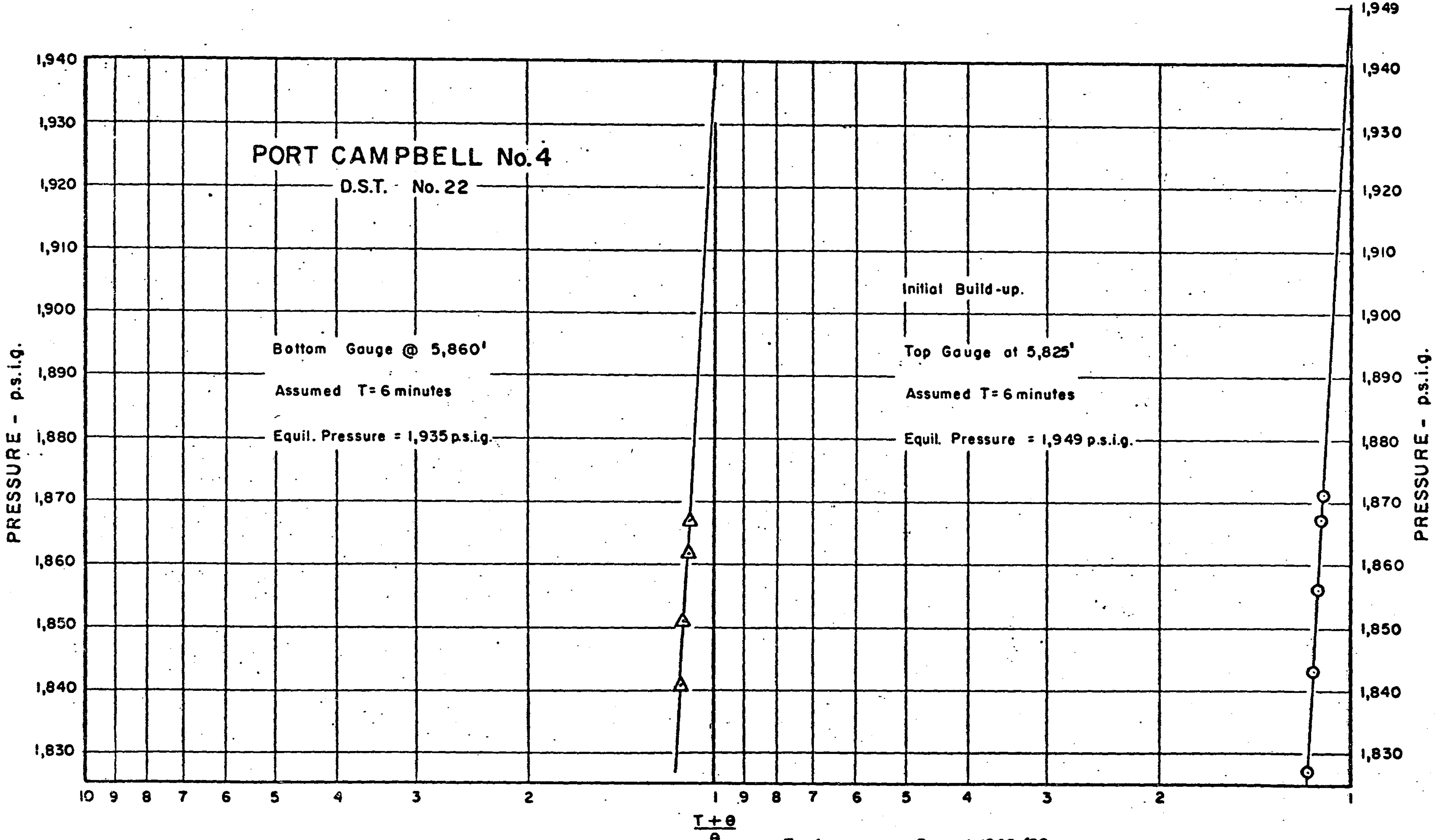
Fig. 19



...reau of Mineral Resources, Geology and Geophysics. August 1965.

To Accompany Record 1965/99

X AUS-2-53 (18)



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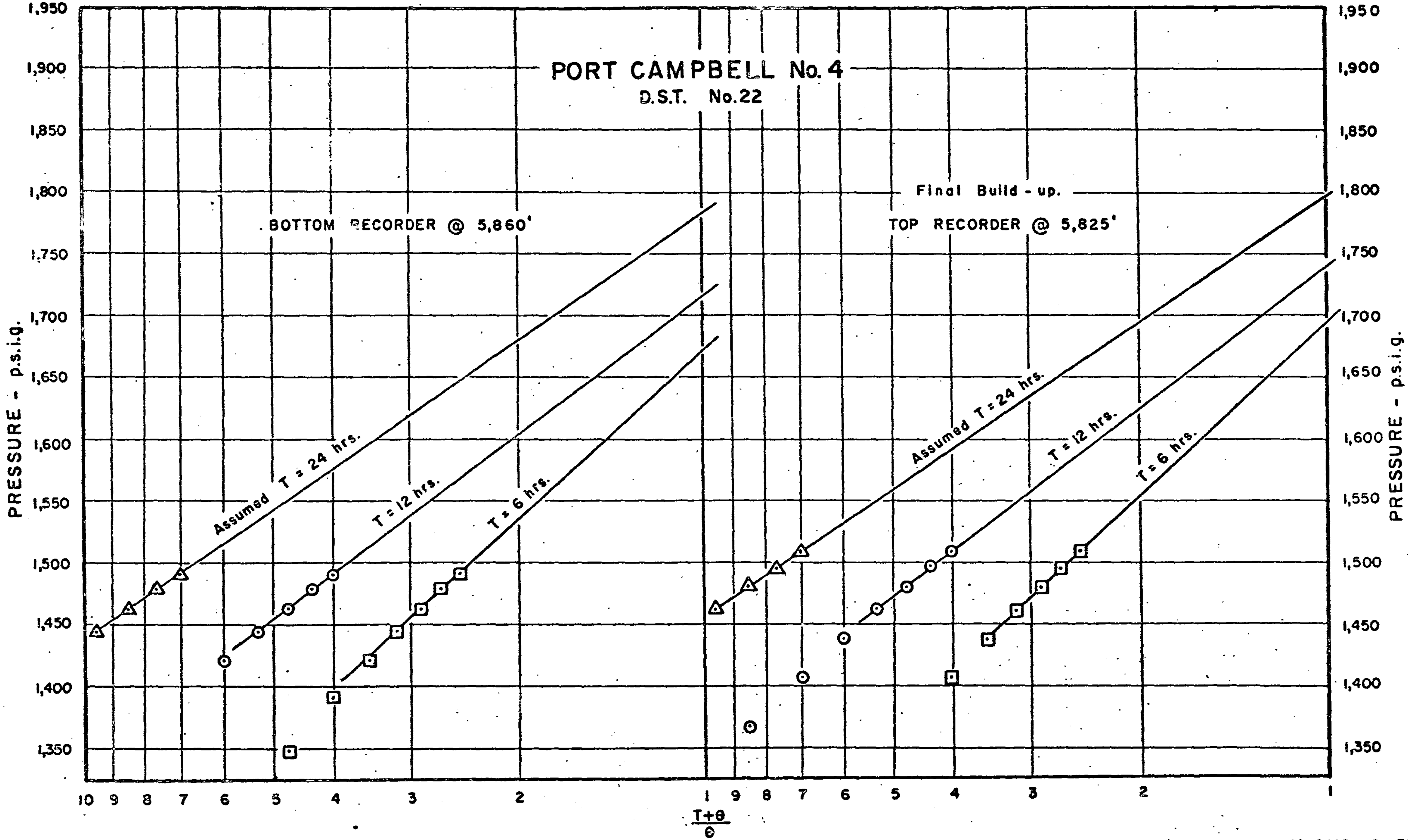
X AUS - 2 - 53(19)

Fig. 21



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X AUS -2-53(20)

Fig.22

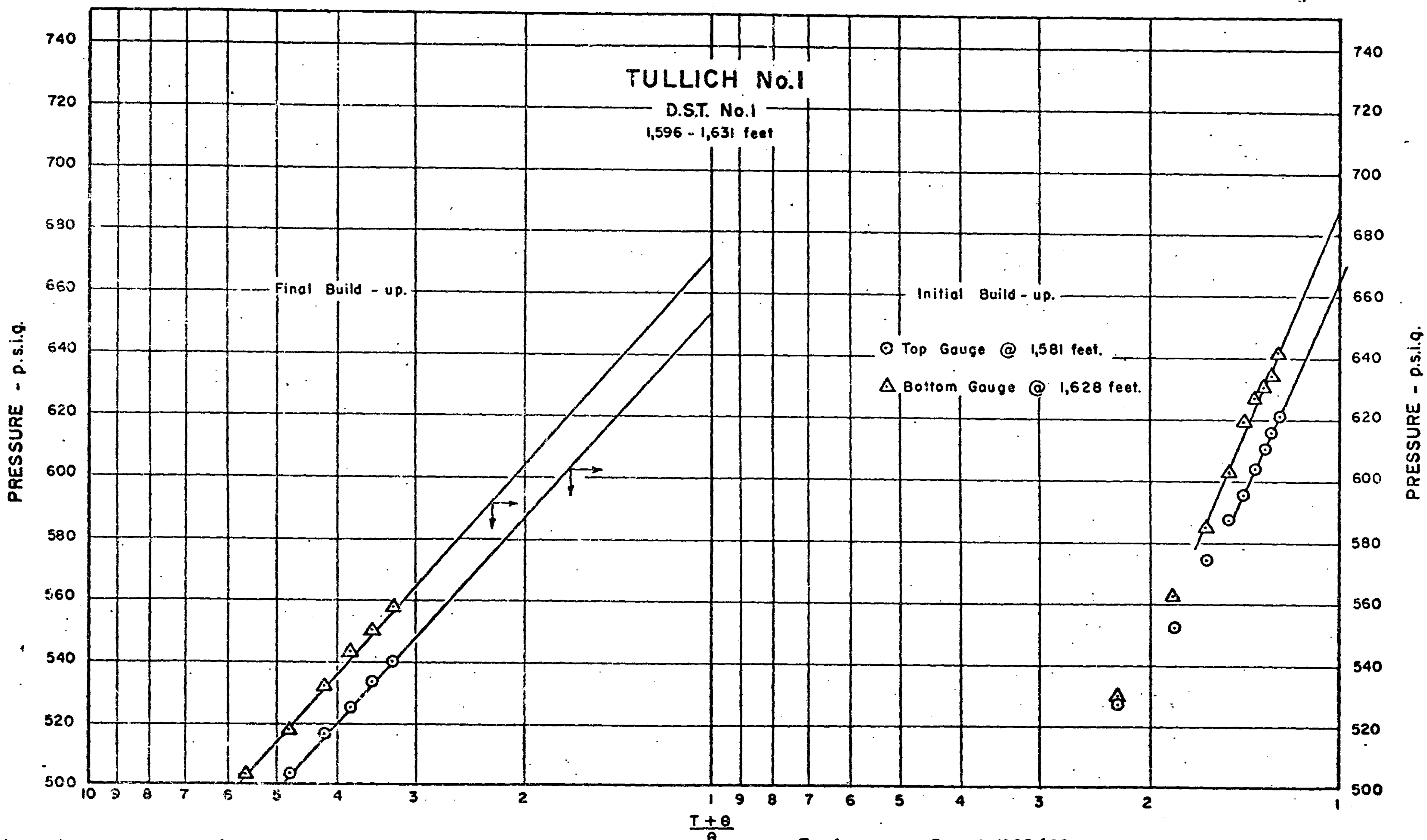
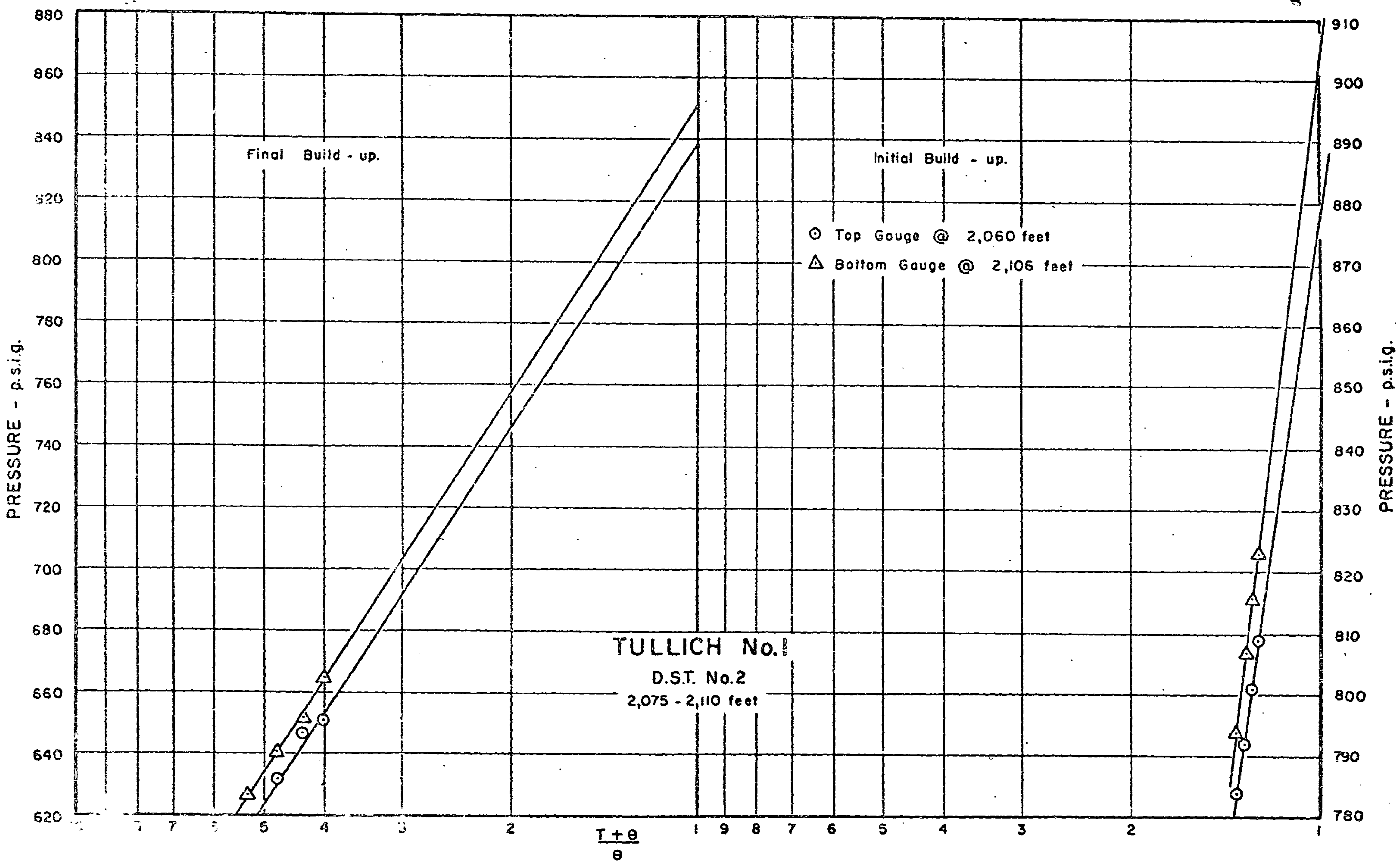
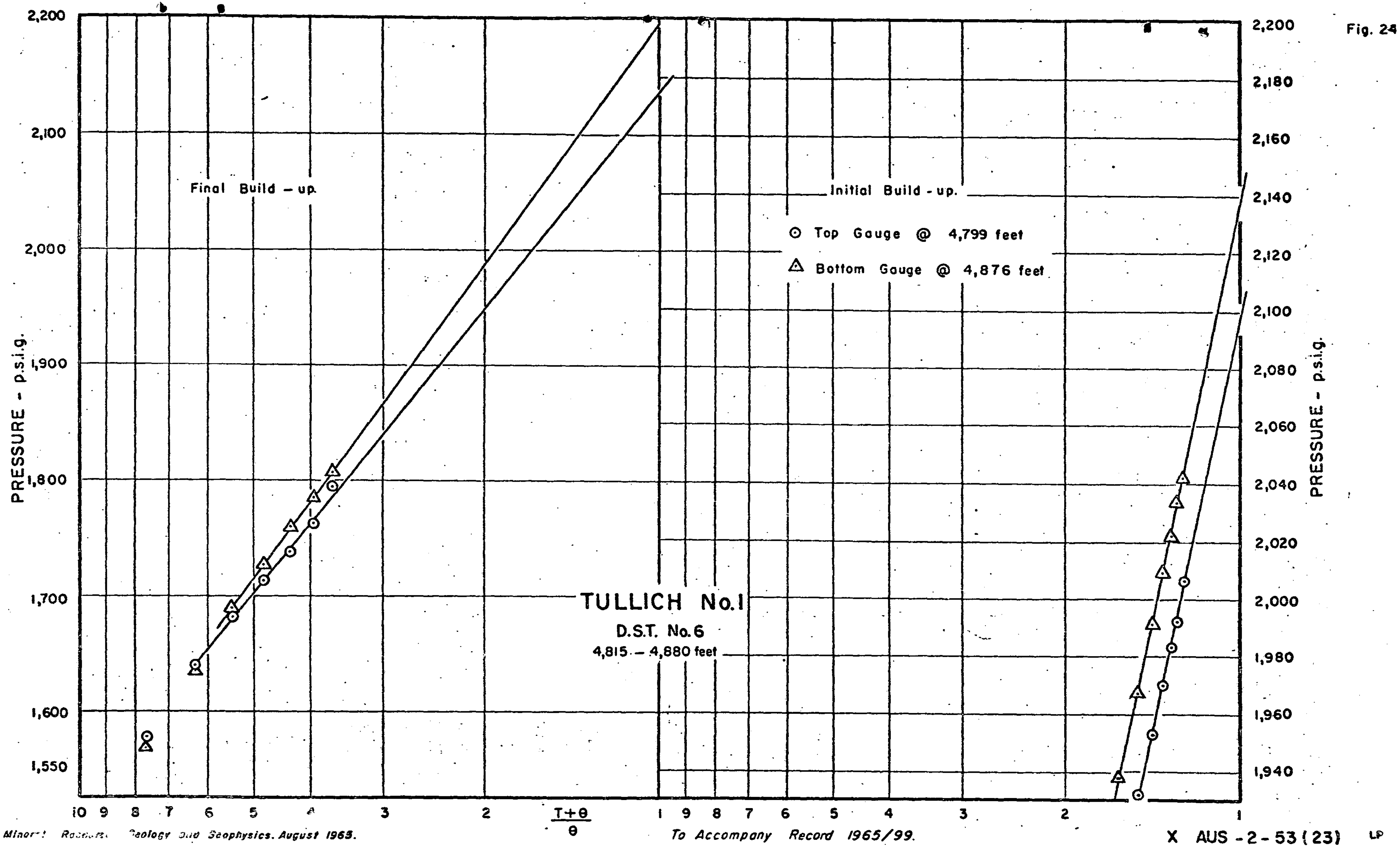

TULLICH No.1
D.S.T. No.1
1,596 - 1,631 feet
Final Build - up.
Initial Build - up.
⊙ Top Gauge @ 1,581 feet.
△ Bottom Gauge @ 1,628 feet.
PRESSURE - p.s.i.g.
PRESSURE - p.s.i.g.
740
720
700
680
660
640
620
600
580
560
540
520
500
10 9 8 7 6 5 4 3 2 1 9 8 7 6 5 4 3 2 1
T + θ / θ

Fig. 23



PRESSURE - p.s.i.g.
880
860
840
820
800
780
760
740
720
700
680
660
640
620
Final Build - up.
Initial Build - up.
Top Gauge @ 2,060 feet
Bottom Gauge @ 2,106 feet
TULLICH No.1
D.S.T. No.2
2,075 - 2,110 feet
$\frac{T+\theta}{\theta}$
910
900
890
880
870
860
850
840
830
820
810
800
790
780
PRESSURE - p.s.i.g.



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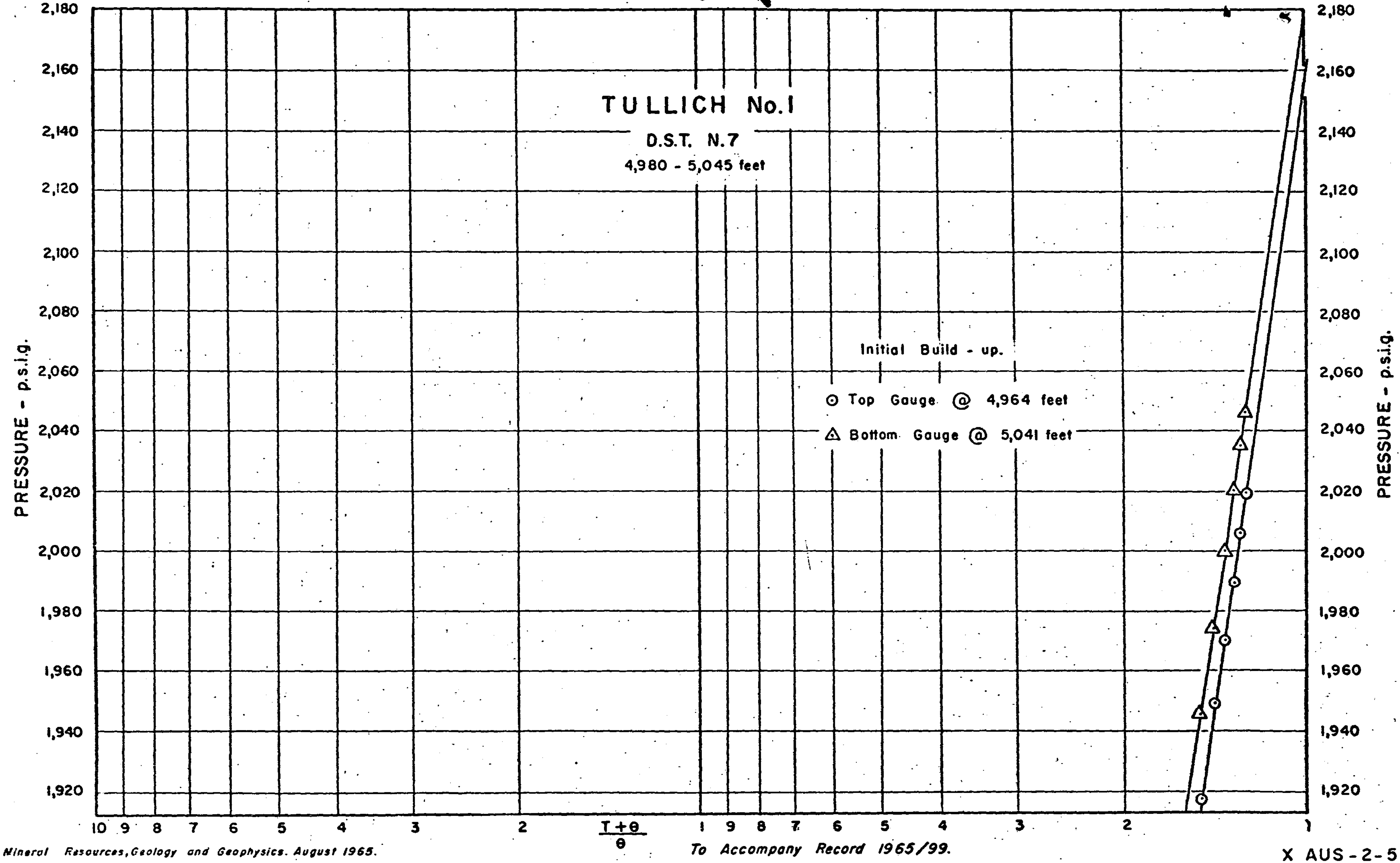
X AUS - 2 - 53 (23) LP

Fig.25

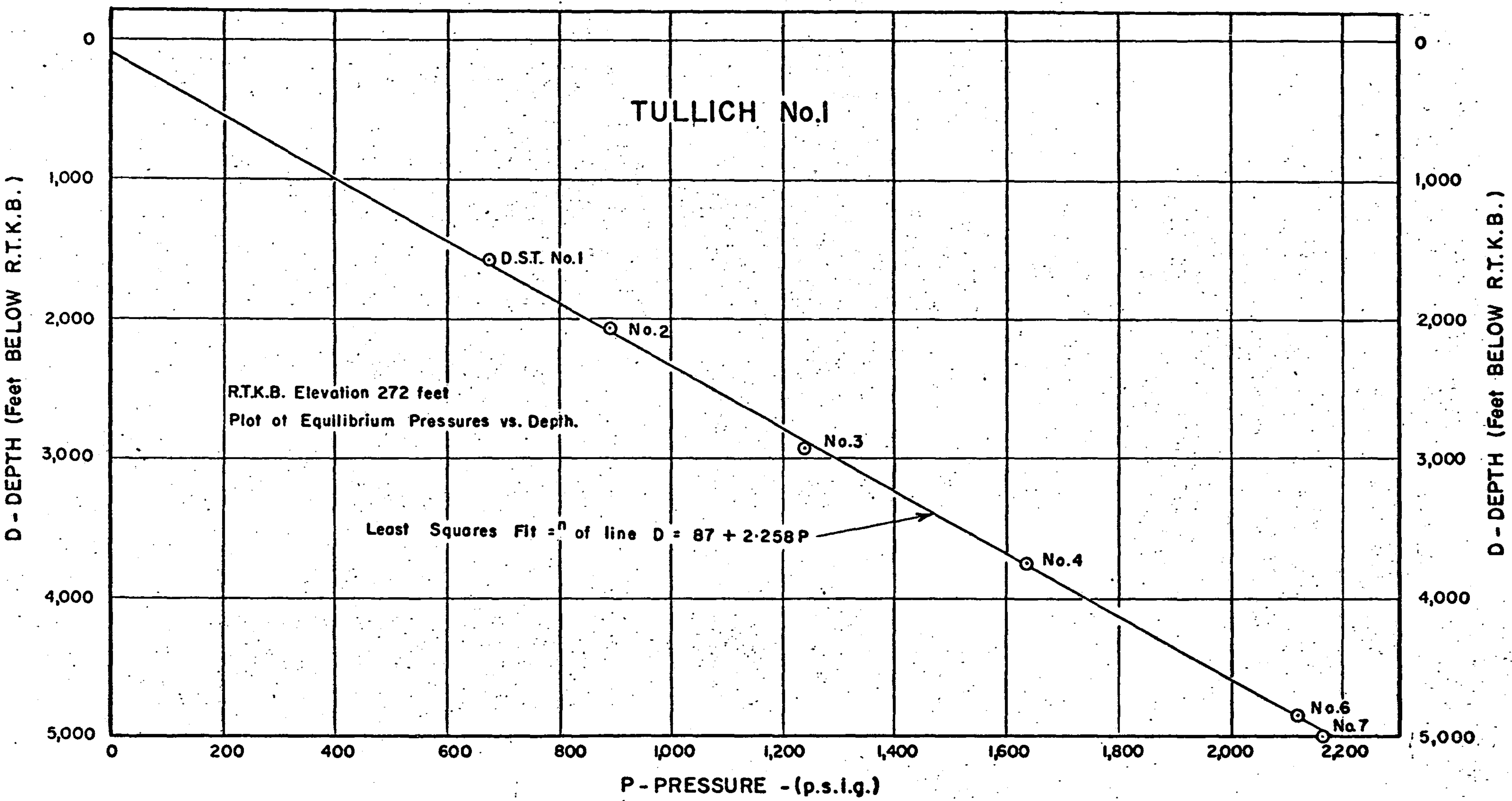


...eau of Mineral Resources, Geology and Geophysics. August 1965.

To Accompany Record 1965/99.

X AUS-2-53(24)

Fig.26



Bureau of Mineral Resources, Geology and Geophysics. July 1965.

To Accompany Record 1965/99.

X AUS-2-53 (25)

LP