

In Situ Stresses Adjacent to Salt Formations of the Elk Point Group, Eastern Alberta and Western Saskatchewan

AER/AGS Special Report 118

In Situ Stresses Adjacent to Salt Formations of the Elk Point Group, Eastern Alberta and Western Saskatchewan

Advanced Geotechnology Inc.¹

¹ Former company (see page iii for current contact information)

April 2024

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ISBN 978-1-4601-5718-3

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Advanced Technology Inc. (2024): In situ stresses adjacent to salt formations of the Elk Point Group, eastern Alberta and western Saskatchewan; Alberta Energy Regulator / Alberta Geological Survey, AER/AGS Special Report 118, 319 p.

Publications in this series have undergone only limited review and are released essentially as submitted by the author.

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Published April 2024 by:

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Foreword

This Special Report is the public release of a consultant report by Advanced Geotechnology Inc. submitted to the Alberta Geological Survey in 2001. The report describes a three-phase investigation of in situ stresses in and adjacent to salt formations of the Devonian Elk Point Group in eastern Alberta and western Saskatchewan carried out in 2000 and 2001, with a focus on salt cavern design considerations for the potential storage of greenhouse gases.

The report contains a comprehensive literature review of salt rock mechanics, with a particular focus on storage caverns, provides an analysis of relevant data in the study area to determine the orientation and magnitudes of in situ stresses in and adjacent to the Lotsberg, Cold Lake, and Prairie Evaporite formations, and includes recommendations for further studies to quantify in situ stress and rock mechanical properties in salt formations, which could potentially host greenhouse gas storage caverns.

**IN-SITU STRESSES ADJACENT TO
SALT FORMATIONS OF THE ELK POINT GROUP**

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AGI FILE 10-122

August, 2001

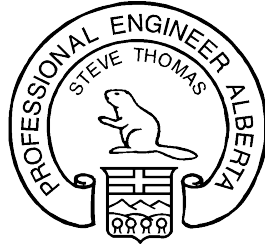
Submitted to:

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2 copies Alberta Geological Survey, Edmonton, Alberta
1 copy Advanced Geotechnology Inc., Calgary, Alberta

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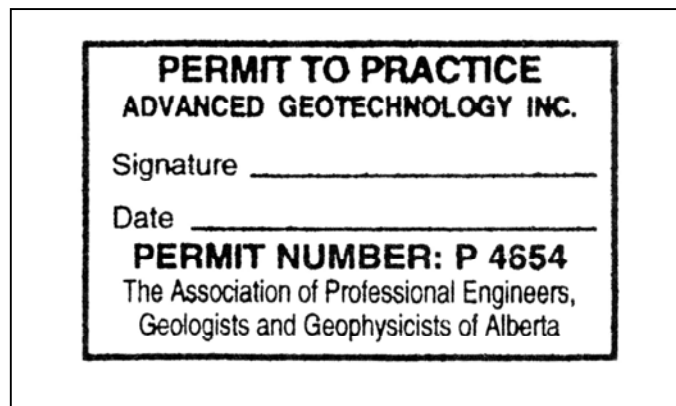
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(Original Version of the Report Signed, August 2001)

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EXECUTIVE SUMMARY

This report describes a three-phase investigation of in-situ stresses in and adjacent to salt formations of the Elk Point Group in eastern Alberta and western Saskatchewan. In-situ stresses will be required to design underground caverns in salt strata for the potential storage of greenhouse gases.

Phase 1 was conducted for an original study area in the Fort McMurray – Lloydminster corridor in Alberta. Published literature and public domain data on in-situ stresses in and adjacent to salt formations of the Elk Point Group were identified, reviewed, and analyzed. The assumption of isotropic stresses in the salt formations may be adequate for future preliminary cavern design studies, but the possibility of anisotropic stresses in these salts cannot be ruled out. Relevant rock mechanical properties were identified for similar salts from other basins, but no such data for the Elk Point Group salts were located. A comprehensive literature review of salt rock mechanics, particularly as applied to storage caverns was also conducted in Phase 1 and is included as part of this report

Phases 2 and 3 identified and analyzed stress magnitude and orientation data within a wider study area including the part of Alberta and a limited part of western Saskatchewan underlain by the Prairie Evaporite Formation. Bulk density logs were used to produce vertical stress and vertical stress gradient contour maps of the entire study area. Analysis of stress-induced borehole breakouts recorded on dipmeter logs determined that the average minimum horizontal stress in the Paleozoic-age formations above the Basal Red Beds, including strata in the Elk Point and Beaverhill Lake Groups, was 129° with a 95% confidence interval of 13° .

There were no horizontal in-situ stress magnitude data identified in the public domain for strata of the Elk Point Group over the expanded study area. It may be possible to invert in-situ stress magnitude data by back-analyzing borehole breakouts. An example of this stress prediction technique is provided, demonstrating the existence of horizontal stress anisotropy in the Elk Point Group for one well.

Recommendations are given for further studies to quantify in-situ stress and rock mechanical properties in salt formations which could potentially host greenhouse gas storage caverns.

SUMMARY

Literature Review on Salt Geomechanics

1. The geomechanical behaviour of salt is dominated by creep deformation, which is affected by stress and temperature conditions, and the physical properties of salt.
2. Deformation responses around underground openings can vary widely depending upon in-situ conditions and salt properties, therefore creep testing of samples from the location of interest is required to assess the expected response of a particular salt formation.
3. Elastic mechanical deformation properties of salt are relatively consistent for salts of similar composition, but strength properties can vary considerably. These elastic deformation and strength properties are required along with creep parameters for the design of stable caverns in salt.
4. No published data on the relevant mechanical properties of the Elk Point Group salts were identified in the literature review conducted for this study.
5. The in-situ stress state in salt formations is generally assumed to be isotropic in its virgin condition prior to the introduction of an underground opening.
6. Stress measurements in salt formations are difficult to perform, but, in some parts of the world, in-situ tests have shown that anisotropic stress conditions can exist.
7. Proprietary site-specific engineering reports for oilfield waste disposal or hydrocarbon storage caverns in salt may provide a source of measured or calculated in-situ stresses within the study area. Salt cavern development in Alberta is concentrated in the Fort Saskatchewan area within the Lotsberg Formation.
8. No publicly-available data from which to confidently estimate the magnitude of the minimum horizontal stress were identified. The assumption of isotropic stresses in the salt formations is considered a reasonable first approximation in the absence of hard data from hydraulic fracture tests or similar in-situ tests.

In-Situ Stress Data

1. In the original Phase 1 study area, 65 wells were used to determine the vertical stress at the top of the Prairie Evaporite Formation and 49 wells were used to determine the vertical stress at the top of the Basal Red Beds Formation. In the expanded study area, an additional 112 wells were used to determine the vertical stress at the top of the Prairie Evaporite Formation (90 from the expanded Alberta study area and 22 from the expanded Saskatchewan study area).
2. In total, there were 24 minimum horizontal stress orientations available in the entire study area for Paleozoic-age formations (8 from the Geological Atlas of the Western Canadian Sedimentary Basin and 16 from breakout analyses described in this report). This includes minimum horizontal stress orientations determined in: 9 wells in formations above the Beaverhill Lake Group, 10 wells within the Beaverhill Lake Group, and 9 wells within the Elk Point Group.
3. Numerous cores have been taken in and adjacent to the salt formations of the Elk Point Group in the study area. Stress relief petal or diskings fractures may be present in stiff carbonate and evaporite rocks in these cores, and could be oriented with paleomagnetism to provide additional estimates of horizontal stress orientations.
4. Colour contour maps were prepared for displaying vertical stress magnitudes and gradients at the top of the Basal Red Beds Formation in the original study area. The vertical stress ranges from 13.5 to 39.1 MPa at the top of the Basal Red Beds in the original study area. The vertical stress gradient at the top of the Basal Red Beds in the original study area ranges from 21.3 to 23.6 kPa/m. A region in the central part of the original study area possesses vertical stress gradients less than 22 kPa/m. This anomaly is associated with thicker occurrences of the relatively low-density Lotsberg and Cold Lake salt formations.
5. Contour plots show that the vertical stress at the top of the Prairie Evaporite Formation ranges from 7.4 to 31.7 MPa in the original study area and from 10.2 to 54.0 MPa in the expanded area. The vertical stress gradient at the top of the Prairie Evaporite Formation ranges from 21.3 to 23.9 kPa/m in the original study area, decreasing towards the eastern boundary of the Prairie Evaporite Formation. The vertical stress gradient at the top of the Prairie Evaporite Formation in the expanded

study area ranges from 21.5 to 24.7 kPa/m, with the lower vertical stress gradients being in the northeast and the higher vertical stress gradients being in the southwest. This trend is likely a result of northeastward-thickening Quaternary or Cretaceous deposits of relatively low density and the increase in density of formations above the Prairie Evaporite towards the southwest. Despite sparse data coverage in some parts of the study area such as Wood Buffalo National Park, the contour plots for the vertical stress and the vertical stress gradient are considered representative of in-situ conditions.

6. The dataset of 8 wells from the Geological Atlas of the Western Canadian Sedimentary Basin has an average minimum horizontal stress orientation of 137° with a 95% confidence interval of 16° , and a range from 118° to 148° . The average minimum horizontal stress orientation determined from the 16 wells analyzed in this report (weighted by breakout length) is 120° , with a 95% confidence interval of 16° , and a range from 101° to 152° , similar to the atlas measurements in the Paleozoic-age formations. It is important to note that the dataset from the atlas was from Paleozoic-age formations above the Beaverhill Lake Group whereas 15 of the 16 wells analyzed in this report had breakouts from the Beaverhill Lake Group and/or Elk Point Groups. The average minimum horizontal stress orientation (not weighted by breakout length) for all 24 wells is 129° , with a 95% confidence interval of 13° .
7. The occurrence of breakouts adjacent to salt formations of the Elk Point Group indicates that the horizontal stresses are likely slightly anisotropic in the salt strata. An example of inverse modelling based on a borehole breakout analysis in the Elk Point Group demonstrated that it is possible to estimate the ratio of maximum to minimum horizontal stress. A horizontal stress ratio of 1.24 to 1.37 was calculated using AGI's STABView borehole stability software and rock strengths estimated from log data.

CONCLUSIONS

1. No published data on minimum horizontal stress magnitudes or rock mechanical properties of the Elk Point Group salts were identified in the literature review conducted for this study.
2. Vertical stress magnitudes ranged from 13.5 to 39.1 MPa at the top of the Basal Red Beds in the original study area. Vertical stress gradients ranged from 21.3 to 23.6 kPa/m in this same area.
3. The vertical stress magnitude ranged from 7.4 to 54.0 MPa at the top of the Prairie Evaporite Formation in the entire study area. Vertical stress gradients ranged from 21.3 to 24.7 kPa/m in this area, increasing from the northeast to the southwest.
4. There was no significant difference between the vertical stress gradient at the top of the Prairie Evaporite Formation and the top of the Basal Red Beds in the original study area. Therefore, it is reasonable to assume that the vertical stress at the bottom of the Lotsberg Formation within the expanded study area can be estimated using the vertical stress gradient determined at the top of the Prairie Evaporite Formation.
5. The average minimum horizontal stress orientation for all 24 wells examined in the entire study area is 129° with a 95% confidence interval of 13° .
6. A slight rotation of the minimum horizontal stress to a more NNW - SSE orientation in the upper Paleozoic-age strata could be seen in the dataset. The average minimum horizontal stress orientation was 116° in the Elk Point Group, 124° in the Beaverhill Lake Group, and 139° above the Beaverhill Lake Group.

RECOMMENDATIONS

1. Rock creep, deformability and permeability properties should be determined from laboratory tests on good quality salt core. These properties are required to assess the expected response of the salt surrounding potential underground storage caverns. (High priority)
2. Micro-frac tests should also be conducted as part of any salt cavern development program to determine site-specific values of the maximum and minimum horizontal stress magnitudes. Although expensive, micro-frac tests are the only reliable means to determine whether the in-situ stresses are anisotropic. (Medium priority)
3. There are cores available from the original and expanded study areas that could provide additional information on horizontal stress orientations and magnitudes. Examination of a select group of cores would indicate whether or not stress relief fractures occur in strata adjacent to, or perhaps within, salt formations of the Elk Point Group. These stress relief fractures would provide a complementary method of determining horizontal stress orientations and help verify the hypothesis that horizontal stresses are anisotropic. (Medium-low priority)
4. Hydraulic fracturing data, which can be used to estimate the minimum horizontal stress magnitude, could be obtained or perhaps purchased from operators and/or service companies. Considerable effort would be required to collect, review and analyze such data because of the low data quality expected. Furthermore, it is not expected that any data will be available for the salt formations of primary interest. (Low priority)

1. INTRODUCTION

1.1 Background

The Alberta Geological Survey (AGS) is involved in studies related to carbon dioxide (CO₂) sequestration in Alberta. The options being considered for CO₂ disposal are:

- injection into coal beds,
- injection into depleted reservoirs,
- injection into saline aquifers, and
- injection into salt caverns.

There are several major CO₂ producers in the Ft. McMurray-Lloydminster area in northeastern Alberta. In this area, the Western Canada Sedimentary Basin thins, and there are very few coal beds, saline aquifers or depleted aquifers suitable for CO₂ sequestration. Therefore, salt¹ beds are considered a potentially viable target for disposal in this area.

Within the Western Canadian Sedimentary Basin, there are several salt-bearing units within the Elk Point Group. To assess the viability of disposal of CO₂ into caverns in one or more of these salt units, an understanding of the magnitudes and orientations of the in-situ stresses is required.

A multi-phase investigation has been undertaken to examine in-situ stresses in and adjacent to salt formations. Three study areas were identified by AGS for investigation: Phase 1 – the original study area bounded by latitude 53 - 58° N and longitude 110 - 112° W, which includes Ft. McMurray and Lloydminster, Phase 2 - an expanded Alberta study area covering the areal extent of the Prairie Evaporite Formation within Alberta, and Phase 3 - an expanded Saskatchewan study area bounded by latitude 49.5 - 56° N and longitude 109 - 110° W (Figure 1.1). Phase 1 of the study also included a literature review on rock salt behaviour and in-situ stress measurements in salt, and a review of data availability within the original study area. Phase 2 involved detailed analyses and interpretation of the data in the original study area and the preparation of a report for the

¹ Note on Nomenclature: For the purpose of this report “salt” or “salt formation” refers to halite salt, not other evaporite salts such as sylvite or carnallite.

original study area. In addition, data availability in the expanded Alberta study area was assessed. Phase 3 involved compiling additional data for a portion of western Saskatchewan. In this final phase the data in both the expanded Alberta and Saskatchewan study areas were analyzed and combined with the data from the original Phase 1 study area. This final report covers the study Phases 1 to 3.

1.2 Objectives

The main objectives of the investigation were to:

1. Review literature pertaining to the geomechanical response of salt to applied differential stress, salt mechanical properties and their variability within the Elk Point Group in the Western Canada Sedimentary Basin, in-situ stress measurements in and adjacent to salt and other evaporite formations (particularly as applied in Western Canada), and other regional in-situ stress studies for bedded salt and other evaporite rocks.
2. Identify well data and other publicly-available information relevant to the study area such as regional stress data, 4-arm dipmeter logs suitable for borehole breakout analysis and bulk density logs. Also, cored intervals and formation pressure measurements were reviewed in the original study area.
3. Analyze relevant data in the study area to determine the orientation and magnitudes of in-situ stresses in and adjacent to the salt formations of interest.

1.3 Scope of this Final Report

This report incorporates the findings from:

1. An interim report on Phase 1 which was delivered to the AGS in December, 2000,
2. A report on Phase 2 delivered to AGS in March, 2001, and
3. The data analysis and interpretation from Phase 3, ending August, 2001.

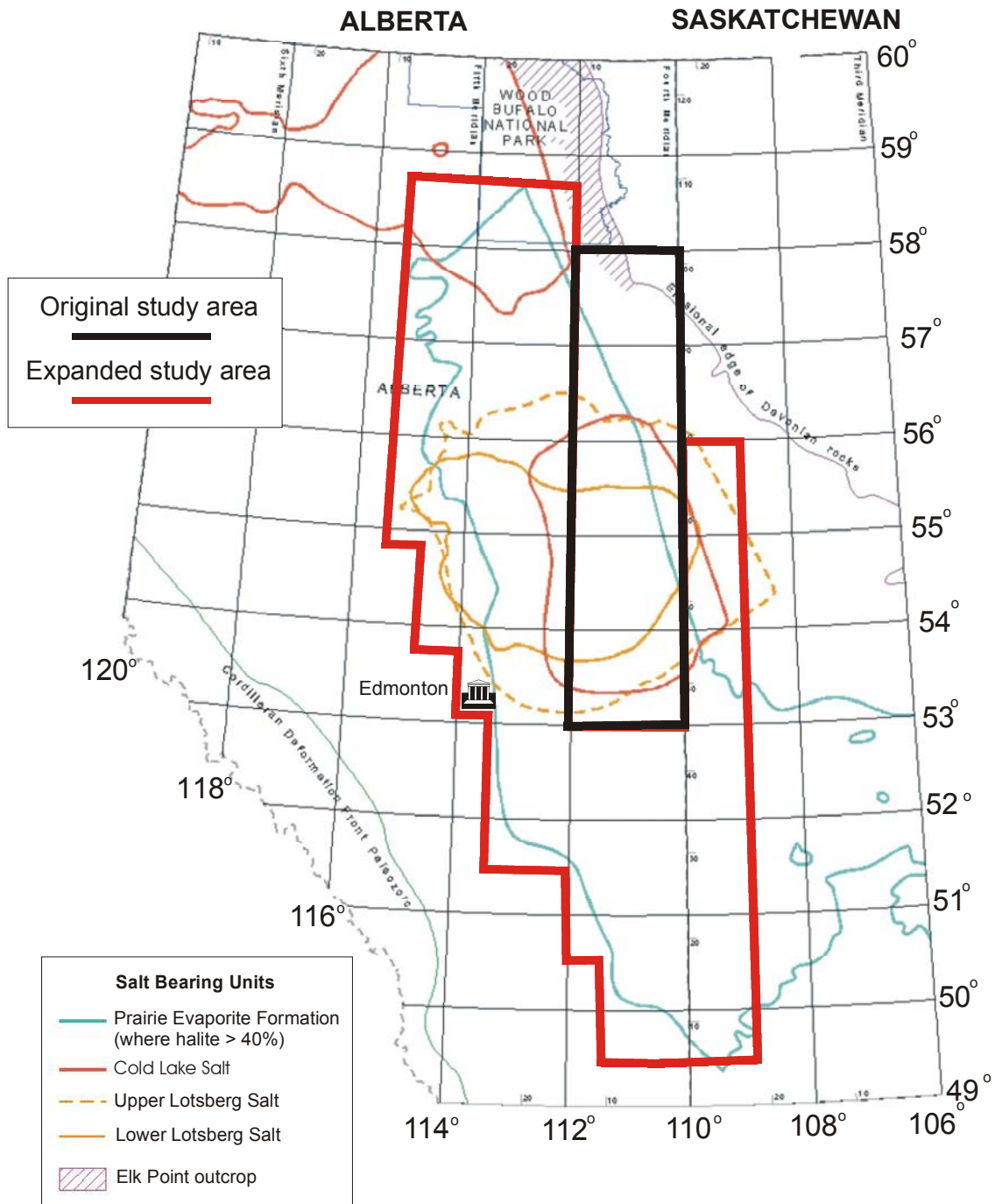


Figure 1.1: Map showing location of the original study area bounded by 53° to 58° latitude N and 110° to 112° longitude W outlined in black. The expanded study area is outlined in red including the Saskatchewan study area bounded by 49.5° to 56° latitude N and 109° to 110° longitude W. The areal extent of the salt bearing units as provided by the Alberta Geological Survey are also shown on the map.

1.4 Authorization and Chronology

Background information and a request for a proposal were received from Dr. Stefan Bachu of the AGS at a meeting with Advanced Geotechnology Inc. (AGI) on June 22, 2000. Preliminary maps showing the areal extent, depths and thicknesses of the various salt-bearing units in the study area were provided to AGI at that meeting. AGI proposal 20-175, dated August 1, 2000, was accepted by AGS, and a contract to conduct Phase 1 of the proposal was signed on August 3, 2000. Dr. Matt Grobe of the AGS acted as a resource to the project to access well information available from the AEUB. A draft version of an interim report for Phase 1 of the study was reviewed at a meeting between AGS and AGI in Calgary on December 1, 2000. A copy of the interim report for Phase 1 was sent to AGS on December 7, 2000 and further revisions were discussed at a meeting between AGI and AGS on December 20, 2000. Two copies of the revised interim report for Phase 1 were sent to AGS on January 5, 2001.

A proposal to conduct Phase 2 of the study was submitted to AGS on December 18, 2000. The proposal was discussed with Dr. Stephan Bachu at a meeting on December 20, 2000. A contract covering Phase 2 of the study was signed at that meeting. A draft report on Phases 1 and 2 of the study was discussed at a meeting with Dr. Stephan Bachu on February 14, 2001. The final report for Phases 1 and 2 was submitted to AGS on March 7, 2001.

A proposal to conduct Phase 3 of the study was submitted to AGS on March 28, 2001. The proposal was accepted and a contract was signed on April 10, 2001. On May 10, 2001, at the request of Dr. Bachu the Phase 3 study area was further expanded into western Saskatchewan and a contract amendment was agreed to by AGI on June 8, 2001. A draft version of the final report for Phases 1, 2, and 3 was reviewed with Dr. Bachu on August 30, 2001. Two copies of the final report and data were delivered to the AGS in September, 2001.

1.5 Sources of Information

The sources of information on in-situ stresses that were evaluated for this study included the following:

- AEUB well database and library,

- University of Calgary library,
- AGI library, rock mechanics journals and published paper collection
- personal contact with University and industry representatives including:
 - Prof. Doug Milne (University of Saskatchewan),
 - Prof. Emery Lajtai (University of Manitoba),
 - Prof. Brian Stimpson (University of Manitoba),
 - Prof. Robert Corthesy (Ecole Polytechnique),
 - Dr. Neil Chandler (AECL),
 - Dr. Frank Hansen (Sandia National Laboratories),
 - Dr. Alan Coode (IMC Colonsay),
 - Dr. Douglas Bingham (Alberta Environment),
 - Dr. J.C. Roegiers (University of Oklahoma),
 - Mr. Edward Dancsok (Saskatchewan Energy and Mines), and
 - Mr. Myron Sereda (Saskatchewan Energy and Mines).

Relevant well data were reviewed by AGI staff using the publicly available Alberta and Saskatchewan well data purchased from CDPubco and viewed in AGI's GEOVISTA software. Maps of the study area showing the various salt formations of the Elk Point Group were provided to AGI by AGS as hardcopies, and in digital form in CANVAS format. AGI acquired the CANVAS software to view and manipulate these maps for Phases 2 and 3 of the study.

2. SALT FORMATIONS OF THE ELK POINT GROUP

The Elk Point Group in the Western Canada Sedimentary Basin includes the following three evaporite formations:

- Prairie Evaporite Formation,
- Cold Lake Formation, and
- Lotsberg Formation (Upper and Lower).

These Middle Devonian formations are shown in the stratigraphic table of formations Figure 2.1. The Lotsberg is near the base of the Devonian sequence of the Elk Point Group. The Cold Lake Formation is slightly higher in the section, and the Prairie Evaporite lies close to the top of the group. The Elk Point Group is overlain by the Beaverhill Lake Group, also of Middle Devonian age. The type localities and lithologic descriptions which follow are abstracted from the Lexicon of Canadian Stratigraphy (CSPG, 1997).

2.1 Prairie Evaporite Formation

Type Locality: Imperial Davidson No. 1, in 16-8-27-1W3M, Saskatchewan, between 1326.5 and 1524m (4352 and 5000 ft). Typical development of the Prairie Evaporite occurs in the White Rose et al. Drake 4-29-32-22 well (LSD. 4-29-32-22W2) between 993.3 and 1186.9 m (3259 and 3894 ft).

Lithology: Halite, carnallite ($\text{KMgCl}_3 \cdot 6\text{H}_2\text{O}$) and sylvite (KCl) of various hues and degrees of crystallinity, but predominantly red and moderately coarsely crystalline. Locally blue halite is present. Seams of red or grey dolomitic mudstone and some anhydrite beds are present.

Thickness and Distribution: Maximum of 218 m (715 ft), with the thickest part occupying a belt from west of Saskatoon east to Melville and south to North Dakota. Extensive solutioning of salts has given rise to an irregular thickness to the formation and local absence of salt. Areas of major salt solutioning occur in south-central Saskatchewan. The Prairie Evaporite extends from north-central Alberta southeastward into Manitoba, and southward into North Dakota and Montana.

Relationship to Other Units: The basal contact is conformable with carbonates or anhydrite of the Winnipegosis Formation. The Prairie Evaporite is correlated with the Muskeg and Presqu'ile Formations in northern Alberta.

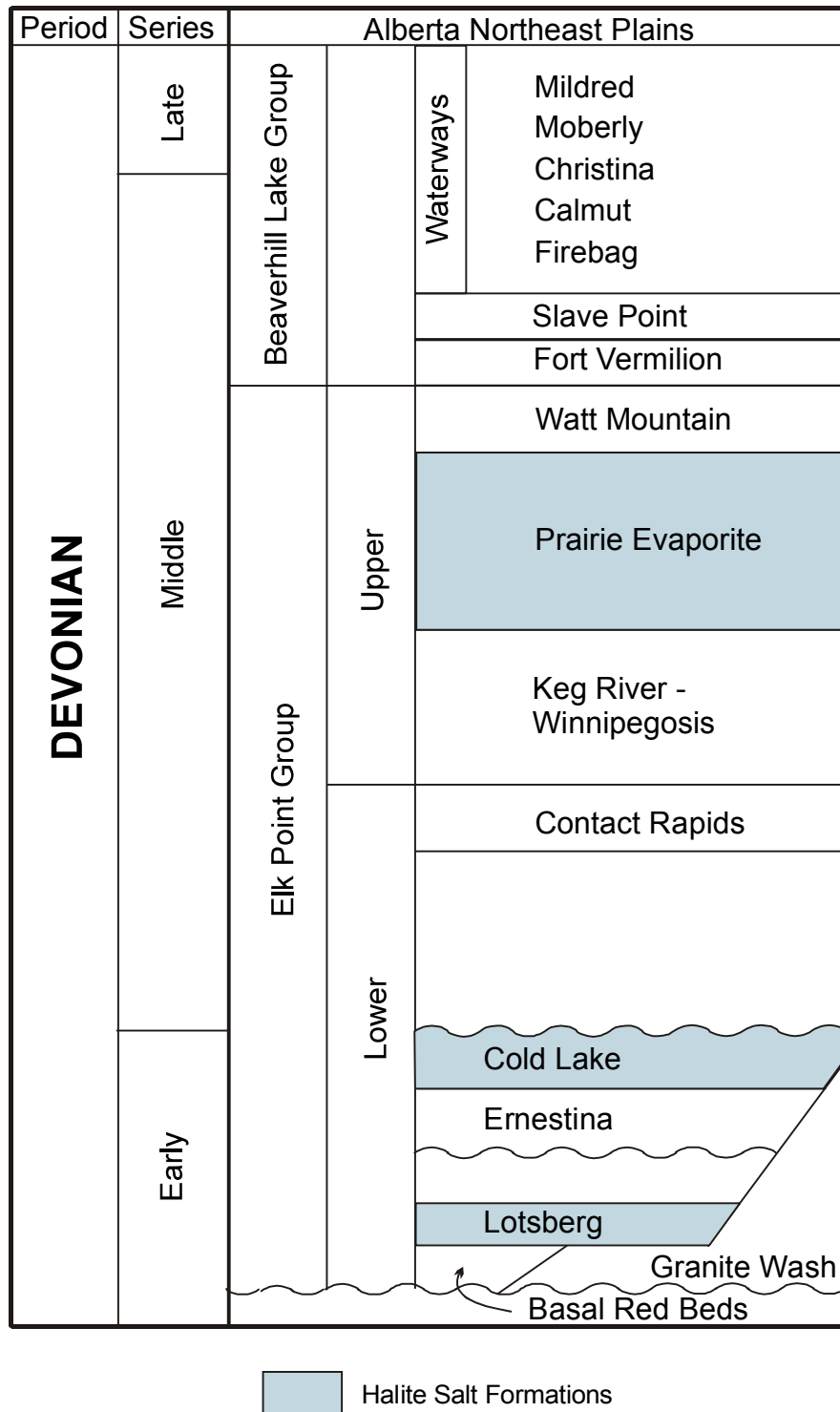


Figure 2.1: Stratigraphic cross section showing the halite salt formations of the Elk Point Group in the study area.

The Prairie Evaporite contains three main potash members: Esterhazy (17 m), Belle Plaine (14 m) and Patience Lake (18 m) members (Fuzesy, 1983). The White Bear member is 4 m thick. In Saskatchewan, these members consist primarily of variable proportions of halite, sylvite, and carnallite, and occur within the upper 70 m of the Prairie Evaporite Formation. It is inferred that most of the sylvite and a small proportion of the halite have been altered to carnallite by fluids rich in magnesium.

2.2 Cold Lake Formation

Type Locality: Canadian Seaboard 10-13-60-4W4M, in Alberta, between 982.1 and 1037.8 m (3222 and 3405 ft). Name derived from White Rose C & E Cold Lake 7-22-66-1W4M, between 811.7 and 863.2 m (2663 and 2832 ft).

Lithology: Halite, with thin basal red calcareous to dolomitic shale, 6 m (20 ft) thick in type well.

Thickness and Distribution: The Cold Lake Formation extends from the vicinity of the Meadow Lake escarpment (approx. 54°31'N. 105°40'W) through northwestern Saskatchewan and eastern Alberta to the south flank of the Peace River-Athabasca arch. It is present north of the arch, where it extends across northern Alberta into northeastern British Columbia east of the Fort Nelson arch, and into southern District of Mackenzie, east and north of the Tathlina Arch. In the District of Mackenzie it is considered a member of the Mirage Point Formation. It is up to 56 m (184 ft) thick in the eastern Alberta Basin, 79 m (259 ft) in northern Alberta, and 117 m (389 ft) in southern District of Mackenzie.

Relationship to Other Units: The Cold Lake Formation overlies the Ernestina Lake Formation and is overlain by the Contact Rapids Formation in western Saskatchewan and eastern Alberta, and by the Chinchaga Formation in northern Alberta, northeastern British Columbia and the southern District of Mackenzie. In general, the unit grades into Basal Red Beds of the Elk Point Group around the margins of the basin and across the Peace River-Athabasca arch. It grades into coarse clastics on the flank of the Peace River and Tathlina arches that are referred to as Elk Point Sands or Granite Wash. In central Alberta it grades westward into red, dolomitic shales overlying the Ernestina Lake Formation which are included in the Contact Rapids Formation.

2.3 Lotsberg Formation

Type Locality: Canadian Seaboard Ernestina Lake 10-13-60-4W4M, in Alberta, between 1057.7 m (3470 ft) and 1225.8 m (4020 ft).

Lithology: The type section is almost pure halite. More commonly thin beds of red and green calcareous shale occur and, in the centre of the basin, a red shale unit ranging from 30 to 60 m (100 to 200 ft) separates the salt sequence into two units.

Thickness and Distribution: The Lotsberg Formation ranges up to 229 m (750 ft) thick. It extends from the Meadow Lake Escarpment from approximately 53° to 53°45'N and 109°30' to 112°W northwards through western Saskatchewan and eastern Alberta to approximately 56°15'N.

Relationship to Other Units: In western Saskatchewan and eastern Alberta, the Lotsberg Formation rests on red sandstones and dolomites at the base of the Devonian. Where salt is not present, the Lotsberg Formation becomes part of the basal Devonian red bed unit in northern Alberta and southern District of Mackenzie, the Meadow Lake Formation of Saskatchewan and the La Loche Formation of the outcrop area in northeastern Alberta. The unit is overlain by the Ernestina Lake Formation.

3. LITERATURE REVIEW

3.1 Geomechanical Behaviour of Salt

The geomechanical behaviour of salt is complex. Under applied deviatoric stress conditions, salt deformation is typically dominated by creep (i.e., time-dependent deformation). The creep behaviour of salt under load is known to be affected by the deviatoric stress magnitude (stress difference), temperature, mean stress, degree of fluid saturation, mineralogical composition, and microstructure (including pore and crack porosity, grain size, and stress history). Rapid loading or unloading can also result in semi-brittle behaviour and the development of fractures near an underground opening or free surface (Jeremic 1994).

Following the application of a deviatoric stress to a test sample, the axial strain increases rapidly from the initial elastic strain during a primary or transient stage of creep, and then reaches a slower, longer-term secondary or steady-state stage of creep (Figure 3.1). Steady-state creep can be sustained for a long period of time, particularly under low deviatoric stresses. With continued deformation, the sample reaches a tertiary, accelerated stage of creep, and failure follows. The behaviour of the large mass of salt surrounding an opening in salt such as a tunnel or borehole is generally assumed to be in or near steady-state creep (Dusseault et al., 1987).

The mechanism by which salt creeps is not the same for all stress and temperature conditions (Senseny et al, 1992; Munson, 1997). Results from laboratory creep studies indicate that two deformation mechanisms tend to dominate under the temperature and stress conditions encountered in many underground excavations. These mechanisms are:

- dislocation glide with diffusion- or cross-slip-controlled climb, and
- pressure solution.

The mechanical deformation of salt grains is dominated by dislocation glide at high deviatoric stresses and temperatures. Under low deviatoric stresses, pressure solution is the dominant mechanism. The implication of multiple deformation mechanisms is that creep rates can be dramatically affected by changes in stress and temperature conditions if

Footnote: See Appendix A: Bibliography for the references cited in this section of the report.

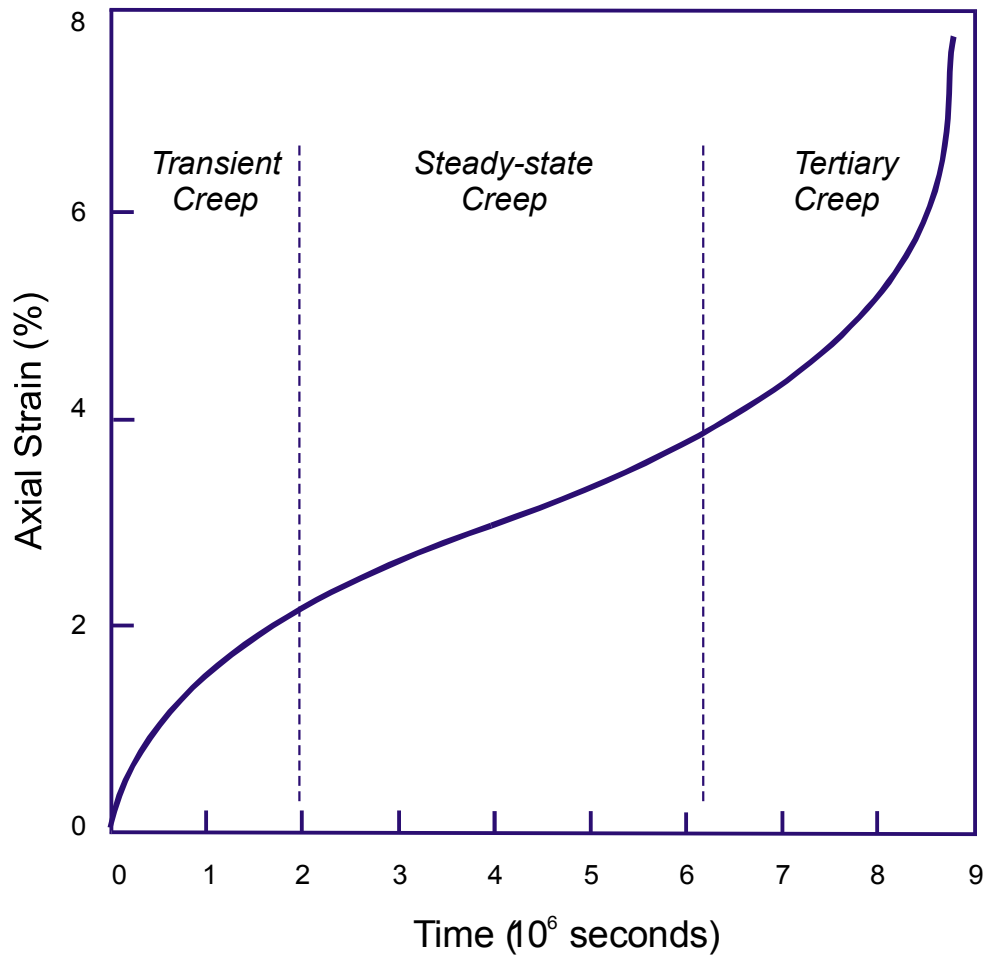


Figure 3.1: Schematic of strain-time curve showing the various stages of creep in a typical laboratory test on salt (modified after Jeremic, 1994).

these changes result in a shift from one dominant mechanism to the other (Dusseault 1989). Increased temperature generally increases the creep rate for a given set of conditions, and reduces the tendency for cracking at higher deviatoric stresses and lower confining stress (Wawersik, 1988; Dusseault, 1989; Senseny et al., 1992).

Dusseault et al. (1987) describe the shift in deformation mechanism from dislocation glide to pressure solution by defining the Prandtl limit (K). The Prandtl limit is defined as the shear stress above which crack growth and healing will control the creep of salt. Immediately adjacent to an opening, the salt rock mass will most likely be damaged by elastic-plastic processes if stresses around the hole exceed the salt strength. In-situ permeability and ultrasonic velocity measurements indicate that damage to salt in the form of microcracks is typically restricted to within about one excavation radius from the wall (Stormont and Daemen, 1992; Munson et al., 1995; Stormont, 1997). Within the disturbed zone around an excavation, Dusseault et al. (1987) propose that the deviatoric stress will equilibrate at twice the Prandtl limit. Further from the excavation, the deviatoric stresses are below this limit, and the dominant deformation mechanism shifts to dislocation glide and then to pressure solution with decreasing stress (Figure 3.2). Reeves et al. (1988) report that the Prandtl limit K is 8.8 MPa for New Brunswick potash, and ranges from 6.5 to 9.5 MPa for Saskatchewan potash, depending on the carnallite content.

The focus of much of the published experimental work has been to delineate the conditions under which different mechanisms are acting, and derive general equations which describe the dependence of salt creep rate on the most critical factors. These constitutive equations generally relate the creep rate to the deviatoric stress, temperature, and the activation energy associated with the dominant creep mechanism. For example, several authors (e.g. Dusseault 1989; Weertman 1968) describe secondary creep using a power law of the form:

$$\dot{\epsilon} = A \left(\frac{\sigma}{G} \right)^n \exp \left[\frac{-Q}{RT} \right] \quad (3.1)$$

where: $\dot{\epsilon}$ = steady-state creep rate, n = stress exponent, σ = deviatoric stress, Q = activation energy, T = temperature, A = material constant, R = universal gas constant, and G = shear modulus. Wawersik (1988) provides background on creep model alternatives and parameters for rock salt at temperatures below 160°C. He quotes values of effective activation energy between 50 and 90 kJ/mole for the rock salts considered.

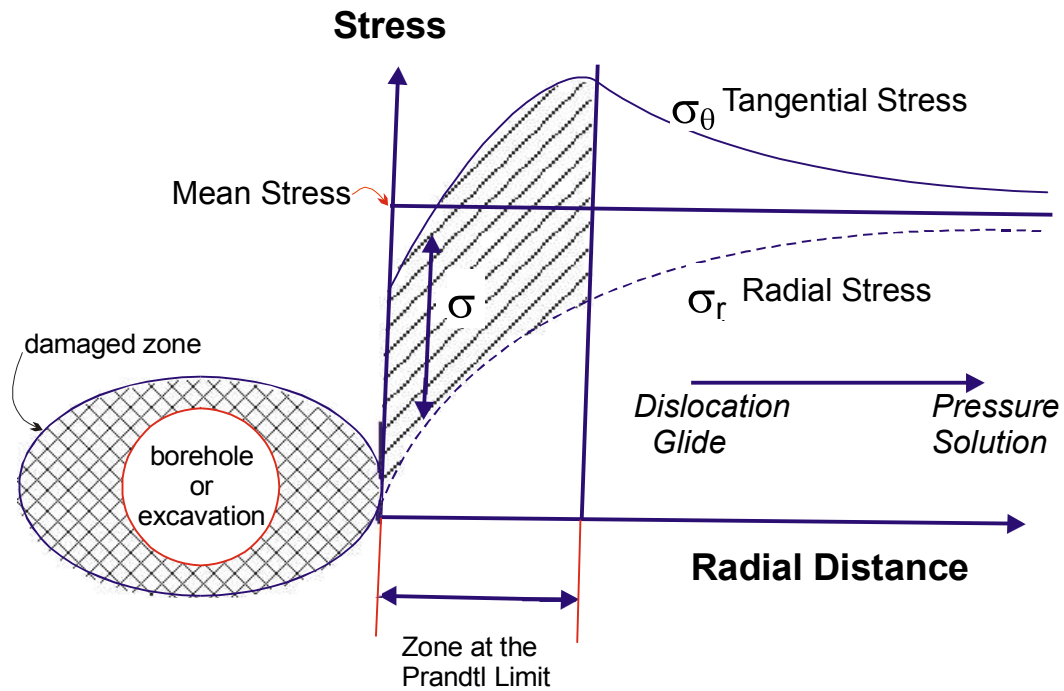


Figure 3.2: Schematic figure showing the distribution of radial (σ_r) and tangential (σ_{θ}) stresses with distance away from a borehole or excavation in salt. Inside the damaged zone, the deviatoric stress (σ) equilibrate at twice the Prandtl limit ($2K$). With increasing radial distance and decreasing σ , pressure solution dominates over dislocation glide (after Dusseault, 1989).

In this form the steady-state creep rate is proportional to the deviatoric stress raised to an exponent n , where n ranges from 3 to 9 assuming dislocation glide dominates (Hansen and Carter, 1981; Vouille et al., 1981; Blum and Fleischman, 1988; DeVries, 1988; Wawersik, 1988; Senseny et al., 1992). Several researchers have found that under relatively low deviatoric stress, creep behaviour is better described by a power-law with a lower stress exponent n , approximately equal to 1. This is interpreted as reflecting a dominance of pressure solution, rather than dislocation glide, as the mechanism of deformation under these conditions (Dusseault and Mraz, 1983; Hambley et al., 1988; Spiers et al., 1988; Dusseault, 1989; Campos de Orellana, 1996).

The parameters in Equation 3.1 are usually determined experimentally, measuring creep rate as a function of temperature and deviatoric stress. Wawersik (1988) found that the effective activation energy used in the power law is typically less than measured values for the dislocation core diffusion of chlorine ($Q = 146$ kJ/mole). Other more complex equations have also been developed for implementation in numerical modelling simulations of the closure of openings in salt (e.g., DeVries, 1988; Munson, 1997). Wawersik (1988) provides typical parameter values for three creep equations, and compares the fit of each to a data set based on five rock salts.

Mean stress or confining stress (σ_c) conditions also affect geomechanical behaviour. A high confining stress or mean stress acts to suppress the formation of microcracks (Dusseault et al., 1987), resulting in a lower creep rate when other factors are constant. The effect of confining stress is most significant for $0 < \sigma_3 < 3.4$ MPa, where microcracks would otherwise dramatically increase the creep rate under a given deviatoric stress (Senseny et al., 1992). Internal pressure in cavities in salt is therefore an important controlling factor on creep rate.

The effect of increasing moisture content is to generally increase creep rates (Spiers et al., 1988; Horseman, 1988; Dusseault, 1989; Senseny et al., 1992). The specific cause of this effect is not well understood, however, it is most prominent if the porosity is caused by a pervasive, connected network of microcracks, such as would be found within the disturbed zone adjacent to a borehole or opening. Further from the excavation, fluids are typically found within isolated pores as brine or as films along grain boundaries, which may play a role in creep by pressure solution at lower deviatoric stresses (Spiers et al.,

1988). The effect of moisture is less prominent when samples are confined, as this reduces both the crack porosity and permeability.

Creep studies of various salts from the southern USA show that impure bedded salts are slightly more creep resistant than pure salts (Hansen, 1988). His impure samples ranged from 86 to 98% halite with an average grain size on the order of 5 to 10 mm. The pure sample was 99.1% halite. An additional study by Hansen et al. (1988) suggests that the fraction of anhydrite present has a stronger correlation with creep behaviour than the fraction of halite. In general there is significant variation among presumably identical samples which reflects variability in testing conditions and other factors, thus obscuring a clear correlation with mineral composition (Senseny, 1988).

Grain size acts in combination with deviatoric stress and temperature to affect the creep rate of salt. Under relatively low deviatoric stress, creep behaviour by pressure solution is facilitated by a fine grain size, whereas creep resulting from the mechanical deformation of grains by dislocation glide is more prevalent in rocks with a larger grain size (Hambley et al., 1988; Spiers et al., 1988; Dusseault, 1989; Campos de Orellana, 1996). Fuzesy (1983) reports that halite found within the potash beds of the Prairie Evaporite Formation can have salt crystals as large as 5 to 15 mm. A fine grain size (1-2 mm) has been linked with enhanced creep rates in potash under conditions where pressure solution is dominant.

3.2 Rock Mechanical Properties of Salts

Rock mechanical properties typically measured in standard laboratory tests for non-creeping rock include Young's modulus, Poisson's ratio, and strength parameters that define peak and residual strength envelopes (e.g., cohesion and friction angle), and post-peak deformation behaviour (e.g., dilation angle). Young's modulus and Poisson's ratio are often cast in terms of a bulk and shear modulus. Given the highly non-linear and time-dependent behaviour of salt, these parameters are of less importance in predicting deformation response around underground openings in relatively deep settings where stresses and temperature conditions are conducive to creep (A. Coode, IMC Colonsay, pers. com.). Nonetheless, these parameters are required as input for numerical models simulating creep behaviour.

Hansen et al. (1988) summarize results from triaxial compression tests conducted on samples from ten different locations in the USA to obtain elastic deformation and strength properties. Their findings showed that elastic moduli do not vary significantly among sites, but the strength parameters do vary considerably, with no apparent correlation to petrographic analysis. Lajtai and Duncan (1988) showed that the compressive strength of potash depends upon the deviatoric stress, the confining stress and loading rate. Reeves and Stead (1991) describe a proprietary database, called SALTDATA, which contains data on the physical properties of rocks commonly associated with the mining of salt and potash in Saskatchewan. The reference tables in this proprietary database contain details of more than one thousand technical documents, from both European and North American sources. Typical rock mechanical properties for salt are given in Tables 3.1 and 3.2. Figure 3.3 shows typical failure criteria for potash and halite from Saskatchewan (Reeves et al., 1988).

Table 3.1: Typical mechanical properties for salt

Parameter	Value or Range
Young's modulus, E	30 GPa
Shear modulus, G	12 GPa
Poisson's ratio, ν	0.25
Unconfined compressive strength, UCS	15-18 MPa
Prandtl limit	6.5 – 9.5 MPa

Table 3.2: Elastic properties at room temperature for natural rock salts (after Senseny et al., 1992)

Site	Young's modulus (GPa)		Poisson's ratio	
	Mean	Range	Mean	Range
WIPP	N/A	29.6-36.5	N/A	0.17-0.26
Permian	26.6	19.0-33.4	0.33	0.04-0.41
Paradox	31.0	25.2-36.3	0.36	0.09-0.50
Jefferson Island	29.5	25.0-34.4	0.29	0.17-0.39
Week's Island	30.5	21.5-42.3	N/A	N/A
Cote Blance	24.1	N/A	0.41	N/A
Avery Island	30.6	21.0-38.2	0.38	0.31-0.47
Richton	31.5	26.7-36.4	0.36	0.21-0.55
Vacherie	31.1	26.7-37.6	0.34	0.29-0.39

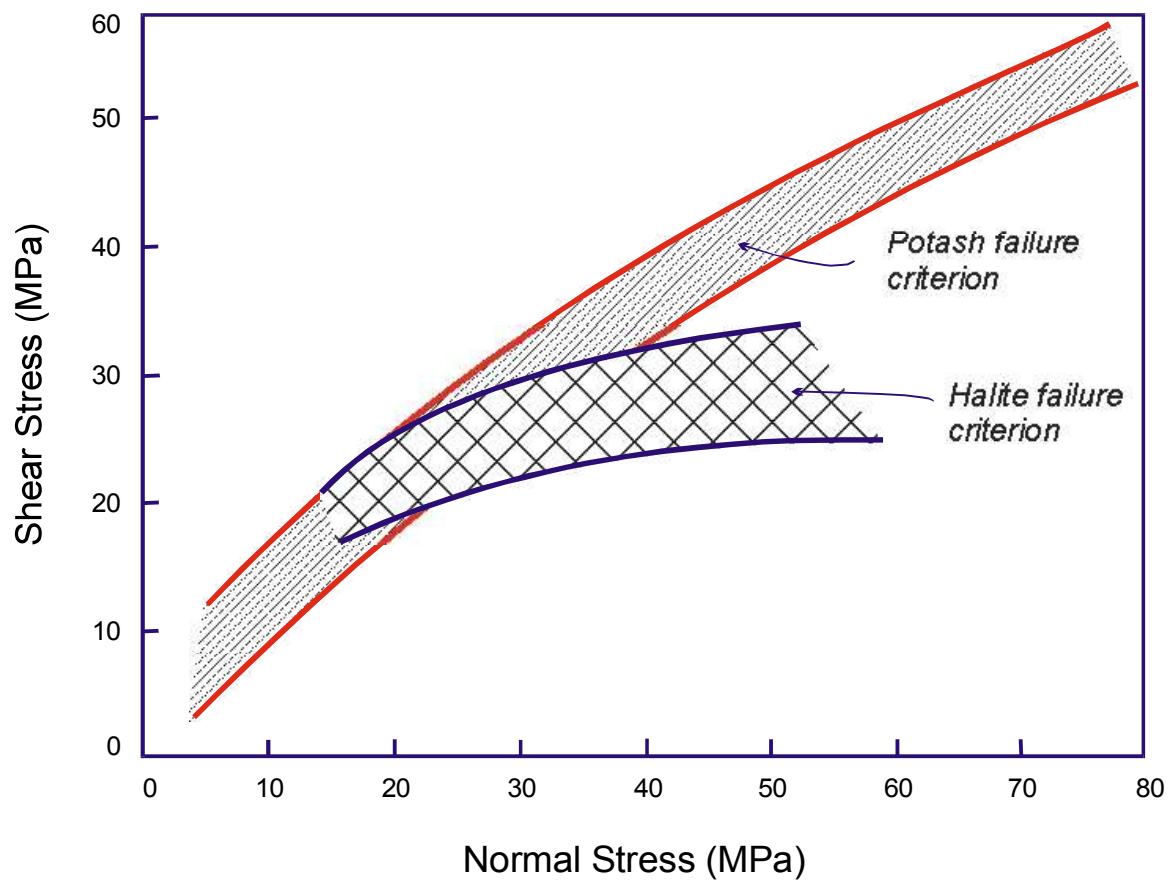


Figure 3.3: Typical failure criteria for potash and halite.
(Source: Reeves et al., 1988).

Holter (1969) provides an extensive overview of the Prairie Evaporite Formation in Saskatchewan. This report includes depositional history, mineralogy, geochemistry and a summary of wild cat, non-confidential and confidential wells intersecting one or more members of the Prairie Evaporite Formation. Additional information on potash in Saskatchewan is contained in a report by Fuzesy (1982).

There are only a few references in the literature to the mechanical properties of evaporites of the Western Canada Sedimentary Basin. In general, the focus is on the economically significant potash deposits in Saskatchewan. Lajtai and Duncan (1988) report results of uniaxial tests on Rocanville potash. Uniaxial strengths ranged from 15 to 18 MPa. King and Acar (1970) report results of uniaxial creep tests on 'model pillars' of Saskatchewan potash, under axial stresses between 34 and 48 MPa and temperatures of 80°C and 110°C. Samples were tested for periods of 1000 hours. At times greater than 200 hours, the creep strain could be related to time by a simple power law. The rate of creep in all cases decreased with time.

High temperatures can have a significant effect on the mechanical properties of salt. The average geothermal gradient in the study area is generally between 20-30°C/km, with the mean annual surface temperature varying between 5 and 7°C (Bachu and Burwash, 1994). The evaporite beds of the Elk Point Group are typically found between 300 and 1700 m below surface, hence the expected in-situ temperature range is between 11°C and 60°C. Senseny et al. (1992) provided data to show that the unconfined compressive strength of Lower San Andres Unit 4 salt is not significantly affected by an increase in temperature from 20 to 50°C.

At the temperatures expected within potential CO₂ disposal sites in the salt formations of the study area, there is considerable variability among creep rates measured in the samples from the different salt formations outside of Alberta. No doubt this variability relates to the specific characteristics of the suite of samples tested. In general, for deviatoric stresses within the expected range of failure strengths (from 10 to 25 MPa), the creep rates are consistently on the order of 10⁻¹⁰ to 10⁻⁹ s⁻¹. Creep rates of 10⁻¹⁰ s⁻¹ are typically observed in deep potash mines of Western Canada (Dusseault, 1989). In some Saskatchewan mines, creep rates in potash are 5 to 8 times larger than those in the adjacent salt beds (A. Coode, IMC Colonsay, pers. com.).

Obtaining reliable laboratory creep data for extrapolation to long-term in-situ behaviour requires creep tests to be sustained for days or weeks (Reeves et al., 1988). Special apparatus is required which can carefully control test parameters and monitor very small deformations over these periods of time. Given the complexities of the geomechanical behaviour of salt, and the wide variability in possible creep behaviour, creep tests on fresh, preserved 4" diameter core samples under representative applied stress and temperature conditions are recommended for calibration of predictive models (A. Coode, IMC Colonsay, pers. com.).

Microcrack damage to cores during recovery affects the mechanical properties of specimens. This has led some researchers to anneal salt samples under high hydrostatic pressure prior to creep testing in order to better reproduce the in-situ condition of the salt (Dusseault and Mraz, 1983; Allemandou and Dusseault, 1993). Istvan et al. (1997) describe a case where such recovery-induced damage to laboratory specimens may have led to conservative estimates of salt strength, causing mine designers to believe that the salt was too weak to support an excavation, whereas in fact, the excavation was quite stable. Hence, in order to obtain valid properties, rock mechanical testing should be conducted on representative samples unaffected by sample disturbance.

3.3 In-situ Stress Measurements in Salt

Because of the complexity of salt behaviour, a knowledge of the expected in-situ stress conditions is important for understanding how salt may respond to an excavation. The stress state within an undisturbed pure salt formation is typically (and perhaps conveniently) assumed to be isotropic, on the assumption that creep has occurred over geologic time, thus reducing deviatoric stresses (Jeremic, 1994). There are data to support this assumption in some salt settings. For example, Wawersik and Stone (1986) used hydraulic fracturing to show that the stress state in the Salado salt formation near Carlsbad, New Mexico was isotropic.

Stress measurements taken in a potash mine in Brazil have shown that anisotropic stress states can be sustained by some salts (R. Corthesy, Ecole Polytechnique, pers. com.). Anisotropic stresses in salt have also been reported in German salt mines (J.C. Roeigers, University of Oklahoma, pers. com.). Eriksson and Michalski (1986) present a compilation of results on deviatoric stresses in salt domes and bedded salts. They conclude

that the maximum virgin in-situ deviatoric stress in normal rock salt (halite) appears to be on the order of 1 to 2 MPa. However, they also conclude that a higher deviatoric stress may occur in association with the presence of impure rock salt, foreign non-salt materials, and geologic structures. Therefore naturally-occurring in-situ stress differences in salt formations cannot be ruled out, although the assumption of isotropic stresses may be sufficient for some purposes. Assuming an average vertical stress gradient of 24 kPa/m (Bell et al., 1994), the range of isotropic stresses for the depths of the Elk Point Group salt formations would be 7 to 40 MPa.

Drilling a borehole introduces a decrease in the radial confining stress, an increase in the tangential stress, and hence an increase in deviatoric stress in the zone surrounding the hole. Furthermore, the excavation of the borehole usually creates a damaged zone adjacent to the hole, and the potential for exposure to fluids which would not otherwise contact the salt. The damaged zone typically extends less than one borehole radius from an excavation. For example, Munson et al. (1995) describe this extent of damage for a shaft bored through salt. All these factors will influence the near-field stress regime, possibly the mechanism by which the salt deforms, and therefore the rate at which creep occurs near a borehole or excavation.

The creep behaviour of salt in the Elk Point Group is expected to have a non-linear dependence on the deviatoric stress over much of the stress range that would be encountered around a deep borehole or cavity in the heavy oil areas of Alberta and Saskatchewan. The internal pressure in a cavity excavated in salt will determine to a large extent the total amount of creep closure expected.

3.4 Waste Disposal and Hydrocarbon Storage Caverns

Previous investigations of salt formations have been conducted to assess the feasibility of long term storage of hydrocarbons or waste materials in evaporite deposits (Lentz, 1992; Crossley, 1997; Davidson et al., 1994; Gomm and Quast, 1989). Lentz (1992) described the process by which waste sand produced with heavy oil by Amoco Canada (later Ranger Oil) was disposed of into a salt cavern in the Elk Point area. The Lotsberg Formation was chosen for this purpose due to its purity and thickness, allowing for a cavern size up to 300,000 m³. Shale stringers in the Prairie Evaporite Formation were thought to have the

potential to disrupt the integrity of the cavern and the Cold Lake Formation was not sufficiently thick.

Site specific engineering reports from Alberta and Saskatchewan for waste disposal or hydrocarbon storage caverns in salt may provide a source of measured or calculated in-situ stresses in or close to the study area. These types of reports cannot be readily purchased for Saskatchewan, however, selected extracts may be viewed at the Saskatchewan Department of Energy and Mines office in Saskatoon.

A copy of Husky Oil Operations Limited's application dated December 12, 1995 to construct and operate a salt cavern facility in the Lloydminster area for oily waste disposal was obtained from the Saskatchewan Department of Energy and Mines. The application was reviewed for details on salt cavern geotechnical design parameters and stress measurements. This salt cavern application targets the Prairie Evaporite Formation which in this area has the following characteristics:

- it is relatively pure, coarse grained halite;
- it is relatively free of shale interbeds and other insolubles with the exception of the White Bear Marker which is a regional 0.5 m argillaceous dolomite stringer that occurs midway through the Prairie Evaporite;
- it is sufficiently thick (approximately 143 m) at the proposed site for the development of a large cavern; and
- it is directly overlain by the impermeable Second Red Beds of the Dawson Bay Formation and underlain by the Shell Lake Member of the Prairie Evaporites.

The proposed design capacity of the initial salt cavern is 330,000 m³. Proposed cavern development involves solution mining using normal circulation to create an initial 18 m high, 60 m diameter cavern, then progressive washing as the hanging string is raised to increase the cavern height to 133 m. Sonar surveys are proposed to confirm cavern size and shape. No mention is made of stress conditions expected in the Prairie Evaporite Formation or their impact on the cavern design.

A total of sixteen applications related to salt caverns and salt water disposal wells in Alberta were identified from the AEUB library database. Copies of these applications are available on microfiche from AEUB Information Services in Calgary. A listing of these applications is contained in Section 9 of Appendix A. Based on discussions with AEUB

Information Services staff, geological and geotechnical reports associated with such applications may be proprietary.

Of the AEUB applications reviewed, nine were related specifically to salt storage caverns in Alberta. The details of these applications are summarized in Table 5.4. Between 1971 and 1983, eight applications were made to the AEUB for development of salt caverns in the Lotsberg Formation in the Fort Saskatchewan area. A 1966 application for cavern development in the Hardisty area targeted the Elk Point Salt for storage of propane/butane. These caverns were all excavated using solution mining, and were designed to store hydrocarbon liquids or natural gas. With the exception of application 820504 which contains some information on operating and pressure testing criteria, and salt shear strength (21 MPa), the other applications contain no information on in situ stresses or relevant cavern geotechnical design parameters.

Table 3.3: Summary of AEUB Applications Related to Salt Caverns

No.	Year	Company	Location	Details of Application
830529	1983	Northwestern Utilities Ltd.	Fort Saskatchewan (Redwater)	Amends approval 3673 for four storage caverns in Upper Lotsberg Formation (1784 m depth, 91 m thick) to include an additional 150,000 m ³ storage cavern for sweet natural gas. Cavern to be 80 m diameter at base, and developed using two hanging string solution mining. No stress values or design parameters. Approval 3673A.
820504	1982	Northwestern Utilities Ltd.	Fort Saskatchewan (Redwater)	Application for four storage caverns in Upper Lotsberg Formation (1791 m depth, 80 m thick), each with minimum capacity of 120,000 m ³ for natural gas storage. Salt described as clear, very coarse crystalline halite with some red shale inclusions and some shale interbeds. Caverns 73 m diameter, spaced 162.5 m. Pressure testing at 18 kPa/m gradient. Maximum wellhead pressure 9.6 MPa during cavern development. Operating pressure 28.5 MPa (15.84 kPa/m gradient). Fracture pressure in excess of 40.7 MPa (22.6 kPa/m gradient). Caverns to be developed using single and two hanging string solution mining. Shear strength of 20.685 MPa for salt provided by Gabriel Fernandez (Consultant). Provides a table of seven gas storage facilities in salt formations in Canada and the USA. No stress values. Approval 3673.
790326	1979	Dome Petroleum Ltd.	Fort Saskatchewan	Amends approval 2358 for the development of two salt caverns in the Lotsberg Formation (1862 m depth, 67 m thick). Capacity 79,490 m ³ . Caverns 45 to 60 m diameter spaced 183 m on centre. Sonar logs used to check size and shape. No stress values or design parameters. Approval 2358A.
009520	1976	Dome Petroleum Ltd.	Fort Saskatchewan	Application for development of six storage caverns (500 MB each) in the Lotsberg Formation (6074' – 6311') for light hydrocarbon liquids. Solution mining using standard techniques. No stress or geotechnical design parameters. Approval 2358.
008154	1974	M-P Petroleum Ltd.	Fort Saskatchewan	Application for four underground caverns for LPG storage in the Upper Lotsberg Formation (5900' depth, 245' thick). Cavern capacity 500 MB (150' diameter spaced 667') measured using regular brine volume monitoring and sonar surveys. Salt clear, very coarse crystalline halite with some red shale inclusions and some shale interbeds. Anhydrite and carbonate interbeds not present. Core tested for insolubles for cavern design. No stress values or design parameters. Approval 2101.
007578	1974	Imperial Pipeline Company Ltd.	Redwater	Application to construct and operate a salt cavern storage facility for butane in the Upper Lotsberg Formation (235' thick at 5820' depth). Cavern capacity 350 MB. Cavern stability a function of cavern diameter, purity and thickness of salt. Spans of 140 to 165' stable by experience. Two hanging string method used. RM Hardy report on brine pond design included. No stress values or design parameters. Approval 2039.
007325	1973	Dome Petroleum Ltd.	Fort Saskatchewan	Application for construction and operation of an underground salt cavern storage facility with two caverns (300 MB each) for light hydrocarbon liquids. Caverns 150 to 200' diameter spaced 600' in the Lotsberg Formation (6100' depth, 200' thick). Halite with interbedded marls. Sonar logs used to measure cavern dimensions. No stress values or design parameters. Approval 1932.
005672	1971	Chevron Standard Ltd.	Fort Saskatchewan	Application to construct and operate six storage caverns for propane/butane (500 MB each) in the Lotsberg Formation (6100' depth, 240' thick). Clear halite with interbedded marls. Core taken in salt for solubility testing. Caverns 140 to 160' diameter spaced 660'. Sonar surveys used to measure cavern dimensions. No stress values or design parameters. Approval 1547.
003021	1966	Home Oil Company Ltd.	Hardisty	Application for disposal of brine produced during development of storage caverns in Elk Point Salt (4448' depth, 358' thick). Three or four caverns (400 MB each) to store propane/butane. Core taken to measure percent solubility by weight, natural density, solubility rate and residual solubility. No stress values or design parameters. Approval 878, 885.

4. IN-SITU STRESS DETERMINATION METHODOLOGY

4.1 Vertical Stress Magnitude

The in-situ stress state can be described by the magnitude of the vertical stress and the magnitudes and orientations of the maximum and minimum horizontal stress components. These stresses correspond to principal stress components if the vertical stress is a principal stress. To calculate effective stresses, the formation (or pore) pressure is also required.

The magnitude of the vertical stress (or vertical stress gradient)² at a given depth can be calculated by integrating a bulk density log from the ground surface to the depth of interest. Density logs comprise the standard suite of wireline logs ran in Alberta, and therefore tend to provide good spatial coverage of a study area. Since density logs are not usually run over surface casing sections, the bulk density of strata in these sections must be estimated. Water well records can be used in some cases to obtain lithologic information and water level data to constrain the estimate of bulk density of near-surface units. Alternatively, surficial geology maps can provide approximate thicknesses of near-surface sediments, and representative properties can be estimated from published values. Typical criteria for ranking the quality of bulk density logs are discussed in Section 5.2.1.

4.2 Horizontal Stress Magnitudes

As described by Bell et al (1994), there are numerous techniques that have been used in parts of Western Canada to measure the value of the minimum horizontal principal stress, σ_{Hmin} , the results of which have been compiled to provide regional stress estimates. The most reliable of these techniques are small volume microfracture tests conducted over isolated intervals, preferably done openhole with a low viscosity fluid such as water. Minifrac tests, which are usually done with tens of cubic meters of gelled frac fluid, provide a less reliable measurement of σ_{Hmin} . Because oil and gas operators are not required to release fracture treatment pressure records, these data are not recorded in the AEUB database, and are not publicly available.

² The vertical stress gradient at a particular depth is defined as the vertical stress magnitude normalized to the depth below surface. The local stress gradient is defined as the tangent to the vertical stress vs. depth curve at a specific depth.

Another type of fracture test that can sometimes provide a rough estimate of the upper bound value of σ_{Hmin} is a casing integrity, or formation leakoff test (CIT, LOT or FLOT). This type of test is required in Alberta after surface casing has been run and cemented in a well. Sometimes a FLOT is run after intermediate casing has been set, however it is not required by regulation. For a standard leakoff test, a short 3 to 5 m section of hole is drilled out through the cement shoe and then pressurized to test the integrity of the casing and cement. If the pressure is taken to a maximum, and the cement and casing remain intact, a small hydraulic fracture can be initiated in the formation with the drilling fluid. Usually the test is terminated at this point; however, if a quantity of mud is pumped into the fracture, and then the well is shut-in, the declining pressure record can give a rough measure of σ_{Hmin} , much like a minifrac test.

A rough estimate of the upper bound for σ_{Hmin} can sometimes also be derived from the calculated bottomhole instantaneous shut-in pressure obtained from propped fracture treatments. However, these data are also not readily available in the public domain. Special arrangements with service companies and operators who possess these data may be possible, but were not pursued as part of this study.

A complementary approach to determine horizontal stress magnitudes is to back analyze measurements of hole enlargement due to breakouts to estimate the ratio of horizontal stresses. If the strength and formation pressure of the strata containing the breakout are known, then the magnitude of the horizontal stress components can be approximated using a borehole stability model, such as STABView (Advanced Geotechnology Inc., 2000). If the stress state in a salt formation is assumed to be isotropic, the horizontal stress magnitudes and their spatial variation can be approximated from the vertical stress data.

4.3 Horizontal Stress Orientations

4.3.1 Borehole Breakouts

Under certain conditions, the azimuth of the long axis of an enlarged borehole cross-section can be used to determine the orientations of the in-situ principal horizontal stresses. Unequal horizontal stress components create compressive stress concentrations at the borehole wall in the direction of σ_{Hmin} , which, if large enough, will cause material to yield

and ultimately detach or “breakout.” The long axis caliper of a 4-arm dipmeter tool (or other oriented caliper tools such as Schlumberger’s FMS or FMI) will track this hole enlargement and yield the azimuth of σ_{Hmin} and σ_{Hmax} (Bell and Gough, 1979; Plumb and Hickman, 1985). Often in weak rocks such as shales, or in highly stressed areas, the borehole diameter enlarges in all directions. These types of enlargements, sometimes called “washouts” can still yield in-situ stress directions as long as spalling is greater in the direction of σ_{Hmin} . Hole enlargement from key seating of the drill string or from pipe wear must also be filtered from the breakout data. These hole segments can be avoided by eliminating data from intervals where the borehole is inclined more than about 5° from vertical. Typical criteria for ranking breakout quality are described in Section 5.3.2.

The orientation of the horizontal stress components in the original study area were initially estimated on the basis of regional stress data published in the Geological Atlas of Western Canada (Bell et al, 1994). Detailed variations in the horizontal stress orientation were determined from borehole breakouts in units within or adjacent to the Elk Point Group or the overlying Beaverhill Lake Group.

4.3.2 Coring-Induced Fractures

The orientation of certain types of coring-induced fractures can also be used to determine the direction of the principal horizontal stresses (Li and Schmitt, 1997). Figure 4.1 shows three types of coring-induced fractures most commonly used for this purpose. The first is called a “saddle” fracture. The direction of σ_{Hmax} parallels the long axis of the saddle, as indicated in Figure 4.1a. The second is called a “petal” fracture. Petal fractures initiate at the exterior of the core, and generally periodically repeat on opposite sides of the core (Figure 4.1b). The direction of σ_{Hmax} is parallel to the strike of these petal fractures. The third type of fracture is a “centreline” fracture which forms parallel to σ_{Hmax} .

In a typical study of coring-induced or natural fractures, the cores are assembled into continuous segments by fitting adjacent core pieces together. Such segments are typically bounded by mill points, spin-offs, rubble zones, core run connections, saw cuts, or missing pieces. A master orientation line (MOL) is then marked along the length of each segment. The orientations of all coring-induced fractures are measured using a computerized goniometer, which is a device for digitizing 3-dimensional features. A minimum of 3

points on the fracture surface are recorded to define fracture orientation in space relative to the MOL. The data are then restored to in-situ coordinates using either the orientation survey (if the core was oriented), an image log, or paleomagnetism (Gillen et al., 1998).

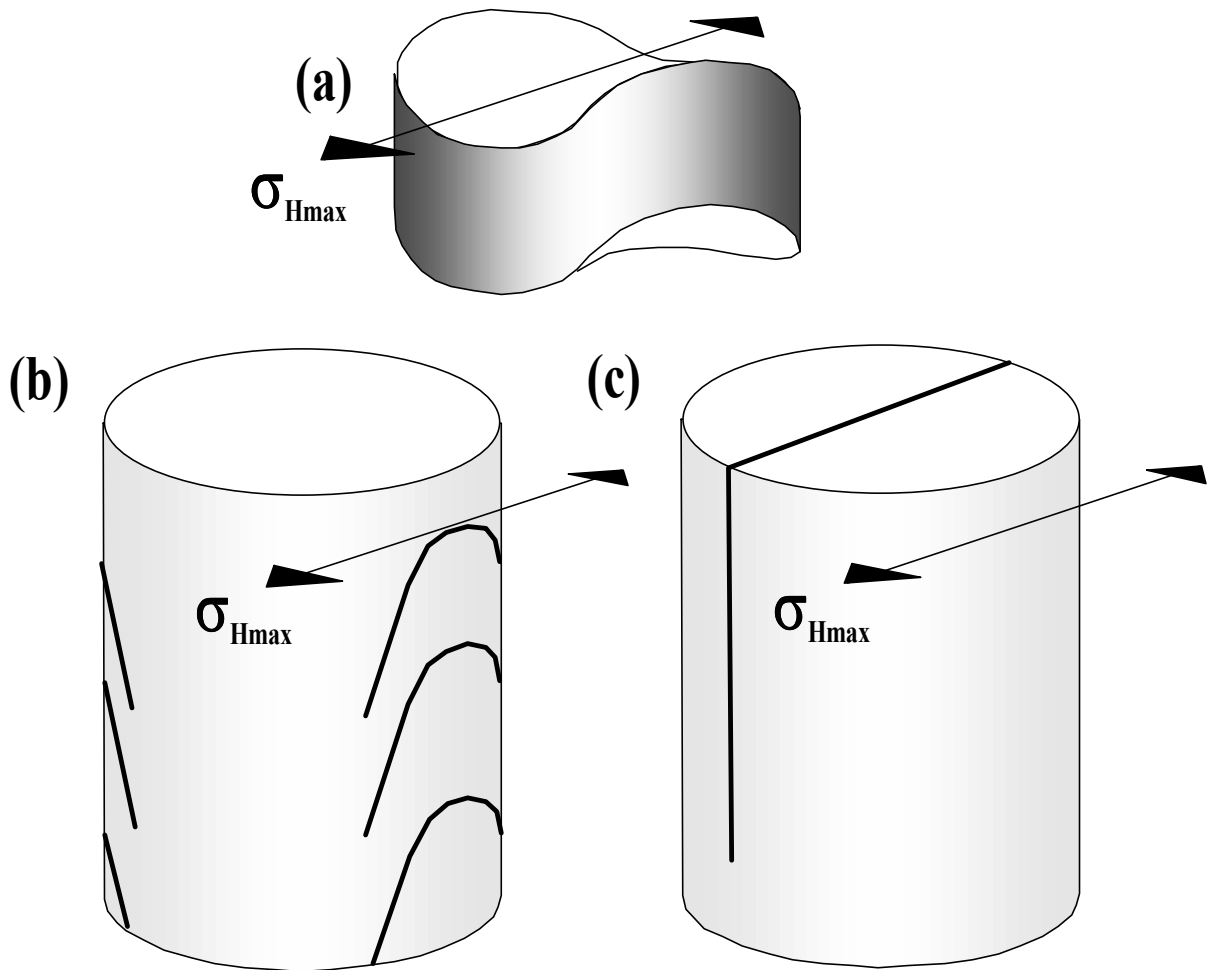


Figure 4.1: Induced fractures in core. (a) saddles fracture and (b) petal fractures and (c) a centre-line fracture. The orientation of σ_{Hmax} is indicated.

5. DATA REVIEW AND ANALYSIS

5.1 Relevant Wells in the Study Area

5.1.1 Original Study Area

A number of wells were initially identified in the public AEUB database which could provide information on the in-situ stresses in and adjacent to the salt formations of the Elk Point Group. Table 5.1 provides a summary of the relevant wells in the original study area of Phase 1 of this project, and the search criteria used in their review.

Bulk density logs for 92 wells identified in Phase 1 were reviewed for their suitability in determining vertical stress and vertical stress gradient values at the top of the Elk Point Group, Prairie Evaporite Formation, and at the top of the Basal Red Beds Formation. Details on the 92 wells included in the bulk density log review are contained in Table B.1 in Appendix B. In total, 65 and 49 wells were identified for vertical stress analysis to the top of the Prairie Evaporite Formation and Basal Red Beds Formation respectively. The analysis of these results is presented in Section 5.2.

Dipmeter logs from the Elk Point Group or Beaverhill Lake Group for 99 wells were also reviewed in Phase 1 as part of an assessment of horizontal stress orientations in the original study area. Details on the 99 wells are contained in Table B.2 in Appendix B. Only three wells with dipmeter coverage in the Elk Point Group were identified in the original study area, and two of these wells had dipmeter logs from 1956. These latter logs were not four-arm caliper logs and could not be used for breakout analysis. Although a determination of the minimum stress orientation within the Elk Point Group was preferred, the search was expanded to include dipmeter logs with coverage in the overlying Beaverhill Lake Group to increase the data set. A total of 96 additional wells having dipmeter logs with some coverage in the overlying Beaverhill Lake Group were identified, 24 of which were post-1970 with coverage over at least 15 m in the Beaverhill Lake Group. These wells were further reviewed for the availability of breakout data as described in Section 5.3.

In addition to identifying wells with bulk density and dipmeter data, 64 wells with core from the Elk Point Group were identified in Phase 1 for possible future examination and analysis of drilling- or coring-induced fractures. There are also 10 wells that have core

taken from the Beaverhill Lake Group (Table 5.1). Details on the wells with core are contained in Table B.3 in Appendix B. The quality and availability of this core is uncertain, but access to core provides the possibility of identifying saddle, petal and centreline fractures which can be used to estimate horizontal stress orientations. Following the search conducted in Phase 1 of the study, Dr. Bachu of the AGS asked that an examination of core from the original study area not be undertaken in subsequent phases of the study.

AGS supplied data from 10 formation leak-off tests in the original study area. No publicly-available hydraulic fracture tests in Devonian strata in the study area were found. The limitations introduced by the poor quality or paucity of data in terms of the assessment of horizontal stress magnitudes is discussed in Section 5.4.1.

As requested by the AGS, those wells in the study area for which both bulk density logs and DST data in the Elk Point Group are available were identified. A total of 31 DSTs for non-salt rocks of the Elk Point Group in the study area were found in the Geovista database. Details on these DSTs are contained in Table B.4 in Appendix B. The format and quality of these data are uncertain. The value of formation pressure measurements in a study of in-situ stresses in salt is questionable, as pore fluids cannot exist in pure halite salt strata. Following discussion of the Phase 1 search results with AGS, it was decided that DST data would not be examined further in subsequent phases of the study.

Based on the data in Table 5.1, it was determined in Phase 1 of the study that there were sufficient well data to proceed with analysis of the in-situ stress state in the original study area. The location of the wells identified in Phase 1 of the study containing bulk density logs, dipmeter logs, and core within the original study area are shown respectively in Figures 5.1, 5.2 and 5.3.

5.1.2 Expanded Study Area

The availability of relevant dipmeter and bulk density well log data in the expanded study areas in eastern Alberta and western Saskatchewan was investigated in Phase 2 and Phase 3 of this study, respectively. The analysis of these data was performed in Phase 3. The search results of the AEUB and Saskatchewan databases in the expanded study areas are

summarized in Table 5.2 and Table 5.3, respectively. Details on the bulk density and dipmeter wells identified in the search result are given in Appendix C.

The wells with bulk density log data in the expanded Alberta study area were divided into those covering the top of the Elk Point Group (843), and those covering the entire Elk Point Group (406). This last subset was further filtered in the Phase 3 analysis to include wells where the amount of incomplete bulk density data below the surface was minimized. Wells that were outside the Prairie Evaporite Formation area as identified by AGS were also removed from the data set. In addition, for areas with dense clusters of available bulk density data, a limited number of the higher quality wells were selected to reduce total number of wells for further analysis to the more reasonable number of 90.

Search results of the expanded western Saskatchewan area found 32 wells that had data coverage to at least the top of the Prairie Evaporite Formation. However, with further analysis it was determined that 8 of these wells were outside the Prairie Evaporite Formation area as defined by AGS and 2 of the wells had poor quality data. Therefore, 22 wells were used for vertical stress determination in the expanded Saskatchewan study area. A map showing the location of bulk density wells identified in the initial search results and the locations of wells used for analysis is shown in Figure 5.4.

A total of 120 wells with dipmeter log data in the Elk Point Group were identified in the expanded Alberta study area during Phase 2. A total of 61 microfiche supplied by AGS were screened to identify 13 wells that had all the necessary information available to analyze borehole breakouts.

A total of 32 wells with dipmeter log data in the Paleozoic-age formations were identified in the expanded Saskatchewan study area during Phase 3. Only 1 well had dipmeter log coverage over the Elk Point Group but it could not be used for the determination of the minimum stress orientation since it was logged with a three-arm dipmeter in 1967. A total of 25 wells with > 4m coverage in the Paleozoic-age formations were identified (Table 5.3). Microfiche from these 25 wells were used to identify 6 wells that had all the necessary information available to analyze borehole breakouts. The dipmeter wells were further analyzed in Section 5.3.

Table 5.1: Summary of data search results for the original study area

Total number of wells in study area	45,040
Density log data for vertical stress determinations	
Total number of wells in study area with bulk density logs	28,810
Total number of wells in study area with bulk density logs to top of Elk Point Group	84
Total number of wells in study area with bulk density logs to top of Prairie Evaporite Formation within the Prairie Evaporite Formation area as defined by AGS	65
Total number of wells in study area with bulk density logs to top of Basal Red Beds	49
Total number of wells in study area with bulk density logs to top of Elk Point Group and having some coverage over the upper 100 m below ground surface	23
Dipmeter data for horizontal stress orientation determinations	
Total number of wells in study area with dipmeter logs	1,317
Total number of wells in study area with dipmeter logs covering all or part of the Elk Point Group (2 wells in 1956, 1 well in 1976)	3
Total number of wells in study area with dipmeter logs covering all or part of the Beaverhill Lake Group	96
Subset of wells having greater than 15 m of log coverage	24
Subset of wells having greater than 15 m of log coverage and logged after 1970	24
Cored wells with the potential to assess horizontal stress orientations using paleomagnetism and coring- / drilling-induced fractures	
Total number of cored wells in the study area	12,052
Total number of cored wells in the study area that have some core taken from the Elk Point Group	64
Total number of cored wells in the study area that have some core taken from the Beaverhill Lake Group	10
Formation leak-off and hydraulic fracture tests	
Formation Leak-off test results made available to the study by AGS	10
Number of useful formation leak-off tests below 500m	0
Number of publicly available hydraulic fracture tests in the Devonian in the study area	0
Formation pressure measurements	
Drill stem tests in the Elk Point Group for wells with a bulk density log to the top of the Elk Point Group	31

Based on searches using the AEUB well database, provided by CDPubco.

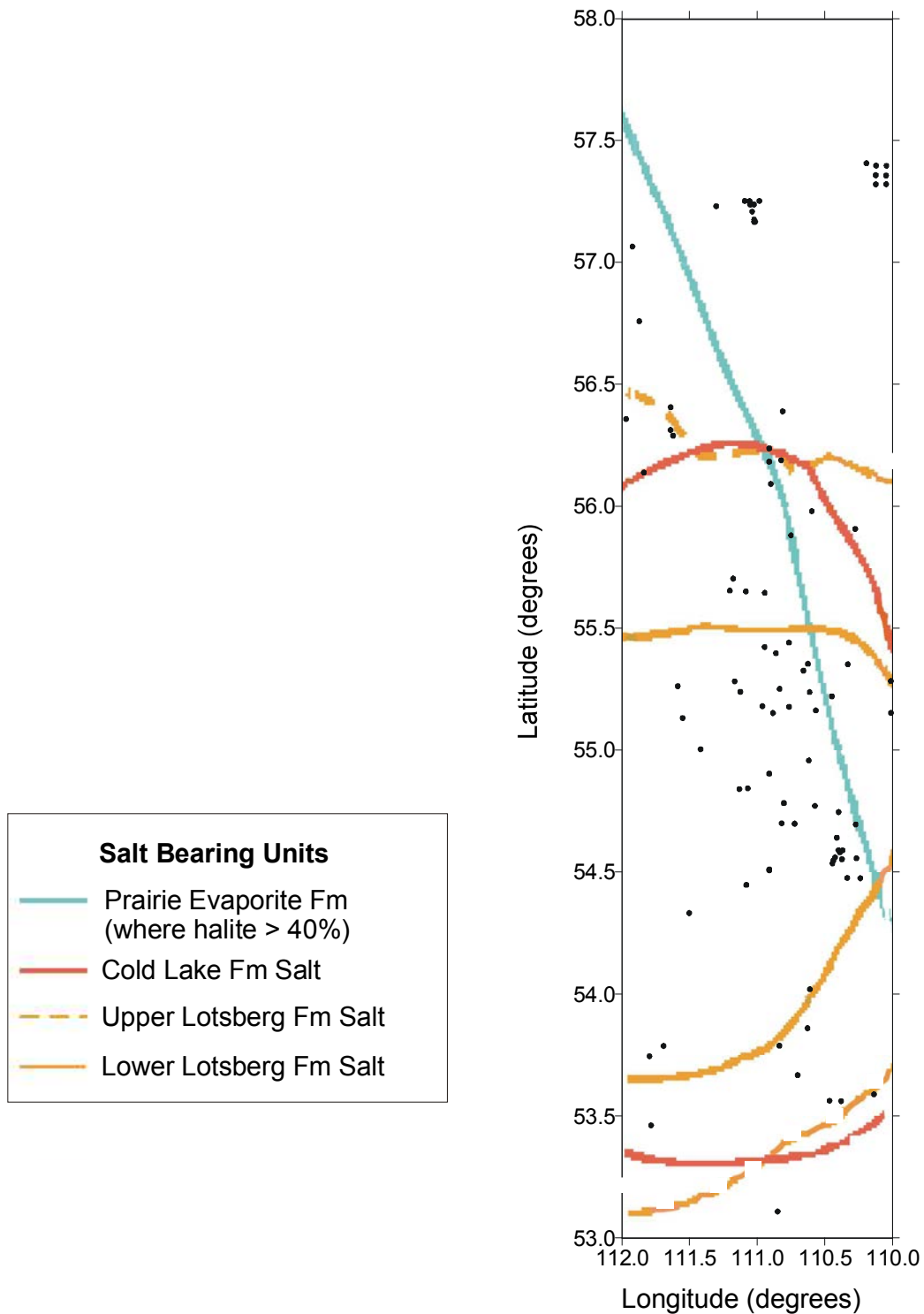


Figure 5.1: Original Phase 1 study area bounded by 53 - 58° latitude N and 110 - 112° longitude W showing location of available bulk density log data for the Elk Point Group (92 wells, 84 containing relevant information). Data from these wells were evaluated in Phase 2 to determine vertical stress magnitudes.

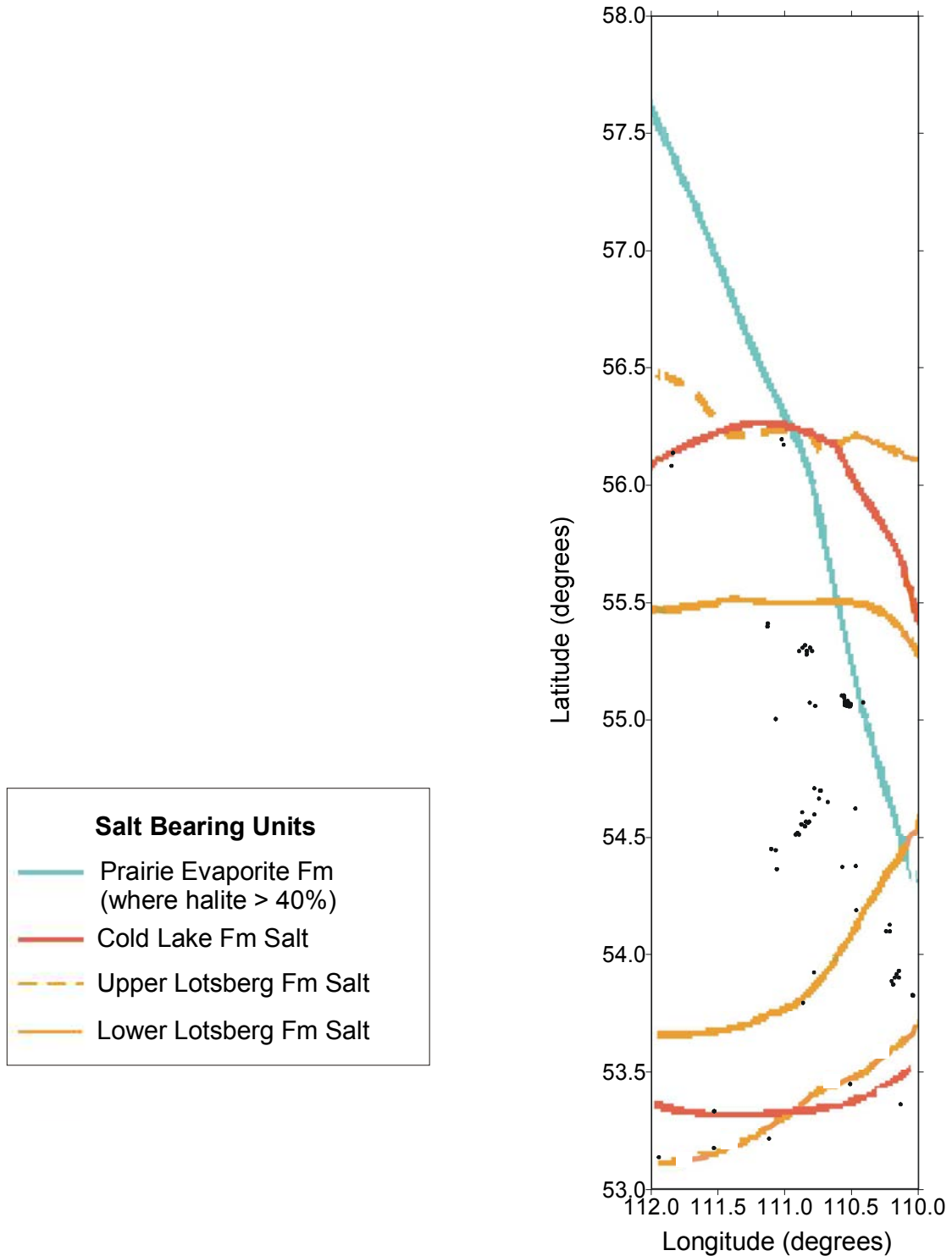


Figure 5.2: Original Phase 1 study area bounded by 53 - 58° latitude N and 110 - 112° longitude W showing available dipmeter log data for the Elk Point and Beaverhill Lake Groups (99 wells). Data for these wells were further examined in Phase 2 to derive horizontal stress orientations from borehole breakouts.

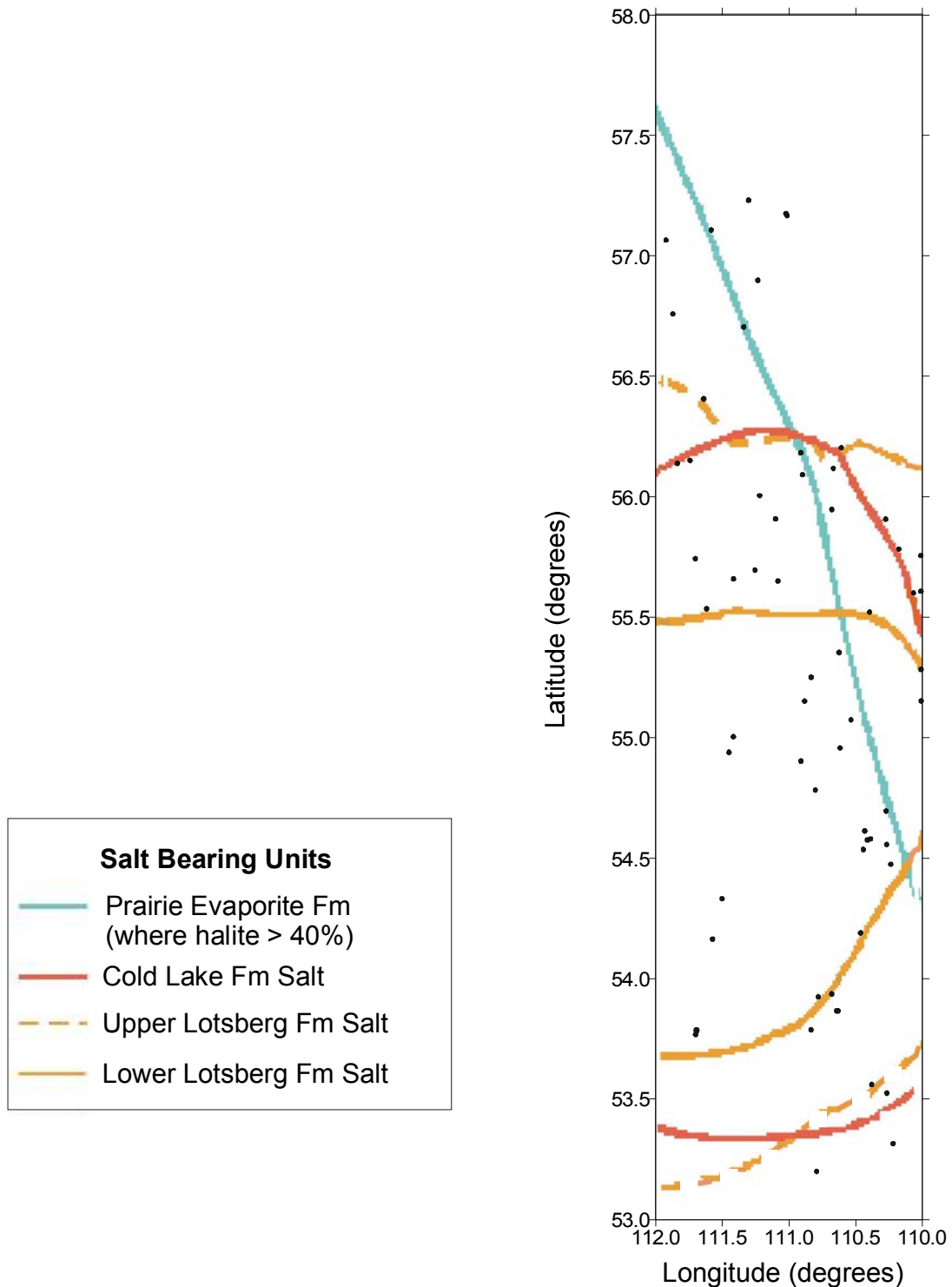


Figure 5.3: Original Phase 1 study area bounded by 53 - 58° latitude N and 110 - 112° longitude W showing location of wells containing core from the Elk Point Group (64 wells). No cores were analyzed in the study.

Table 5.2: Search result summary for the Phase 2 expanded study area in Alberta

Total number of wells in the expanded study area in Alberta	98,819
Density log data for vertical stress determinations	
Total number of wells in expanded Alberta study area with bulk density logs	53,403
Total number of wells in expanded Alberta study area with bulk density logs having coverage in the Elk Point Group	843
Number of wells that have coverage over entire Elk Point Group	406
Subset of wells selected wells for further analysis	90
Dipmeter data for horizontal stress orientation determinations	
Total number of wells in expanded Alberta study area with dipmeter logs	897
Total number of wells in expanded Alberta study area with dipmeter logs covering all or part of the Elk Point Group or Beaverhill Lake Group	120
Total number of wells in expanded Alberta study area with dipmeter logs covering all or part of both the Elk Point Group and Beaverhill Lake Group	84
Total number of wells in expanded Alberta study area with dipmeter logs covering only all or part of the Elk Point Group (i.e., no Beaverhill Lake Group coverage)	10
Total number of wells in expanded Alberta study area with dipmeter logs covering > 15 m coverage in Beaverhill Lake Group	26
	23
Cored wells with the potential to assess horizontal stress orientations using paleomagnetism and coring / drilling induced fractures	
Total number of cored wells in the expanded study area	12,445
Total number of cored wells in the expanded study area that have some core taken from the Elk Point Group	1,109
Total number of cored wells in the expanded study area that have some core taken from the Beaverhill Lake Group	233

Based on searches using the AEUB well database, provided by CDPubco.

Table 5.3: Search result summary for the Phase 3 expanded study area in Saskatchewan

Total number of wells in the expanded Saskatchewan study area	40,233
Density log data for vertical stress determinations	
Total number of wells in expanded study area with bulk density logs	14,822
Total number of wells in expanded study area with bulk density logs having coverage in the Prairie Evaporite Formation	30
Subset of wells selected for further analysis	22
Dipmeter data for horizontal stress orientation determinations	
Total number of wells in expanded study area with dipmeter logs	71
Total number of wells in expanded Saskatchewan study area with dipmeter logs covering all or part of the Elk Point Group	1
Total number of wells in expanded Saskatchewan study area with dipmeter logs with > 4 m coverage in the Paleozoic-age formations	25

Based on searches using the AEUB well database, provided by CDPubco.

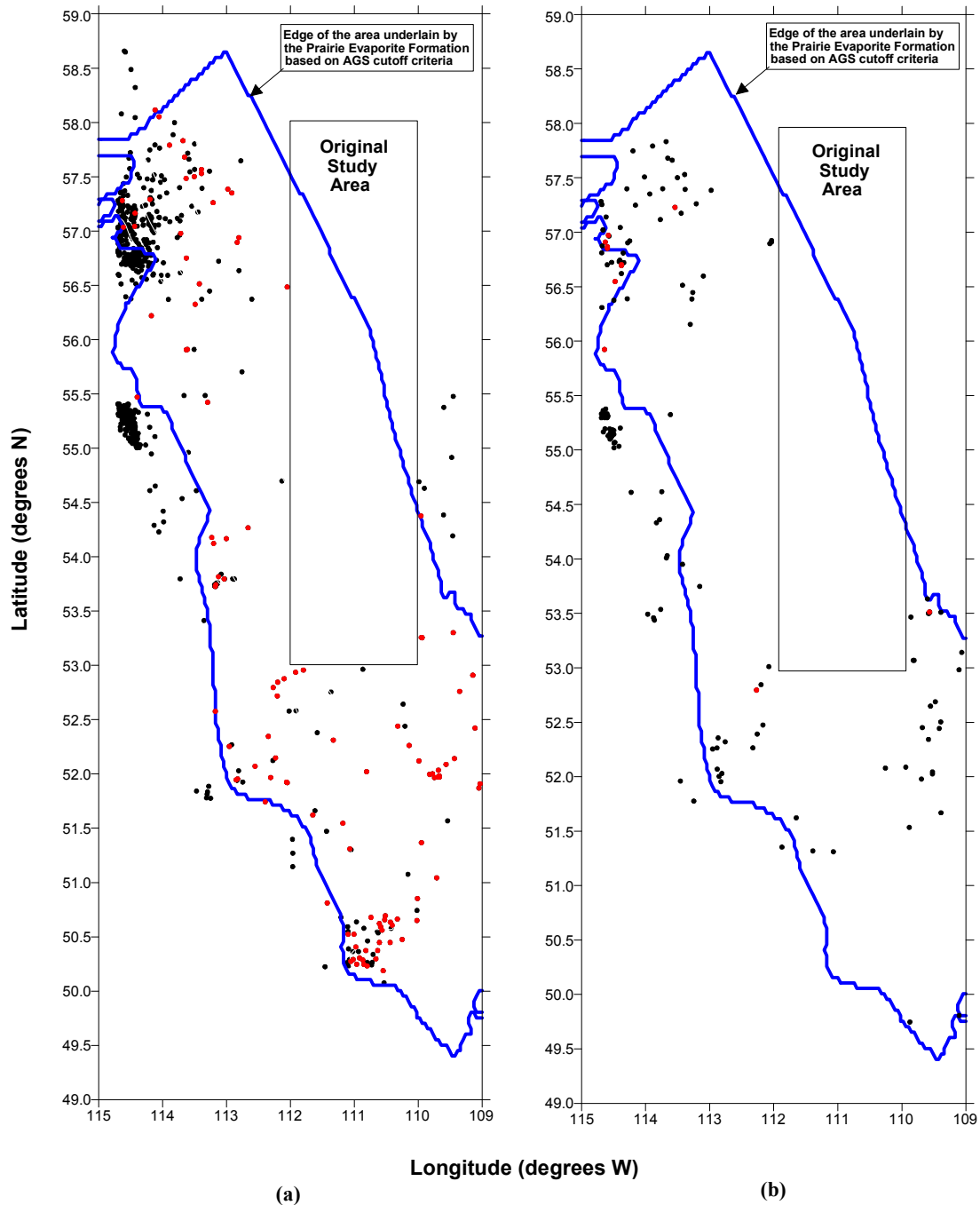


Figure 5.4: Expanded study area showing (a) location of 883 wells with available bulk density log data covering the Elk Point Group (843 from the expanded Alberta area and 30 from the expanded Saskatchewan area) and (b) location of 145 wells screened for available dipmeter log data (120 from the expanded Alberta area and 25 from expanded Saskatchewan area). The 11 dipmeter wells and 112 bulk density wells used in the final Phase 3 analysis are shown in red.

5.2 Bulk Density Log Data for Vertical Stress

The vertical stress magnitude and average vertical stress gradients were determined from bulk density log data to evaluate the in-situ stress conditions within the Elk Point Group salt formations. In consultation with AGS, the top of the Prairie Evaporite Formation was selected as the top of the Elk Point Group salt formations, and the top of the Basal Red Beds was selected as the bottom of the salt formations in the original study area. The top of the Basal Red Beds was chosen because: (1) the top is easy to identify from logs which makes it accurate and consistent across the study area, and (2) the Basal Red Beds are generally uniformly located below the lower Lotsberg Formation as opposed to the top of the Cambrian or Precambrian age formations which are often picked as the base of the Elk Point Group. For the expanded study area, the vertical stress was not determined at the bottom of the Elk Point Group because of the difficulty in selecting a formation that is uniformly distributed over the entire study area which could be selected as a base of the Elk Point Group.

Contour maps of the top of the Prairie Evaporite Formation (depth and elevation) and vertical stress (magnitude and gradient) were developed for the areal extent of the Prairie Evaporite Formation in the entire study area. Contour maps of the top of the Basal Red Beds Formations (depth and elevation) and vertical stress (magnitude and gradient) were developed for areal extent of the Elk Point Group salt formations in the original study area. These maps provide the necessary information to estimate in-situ stress conditions in salt formations of the Elk Point Group. Table D.1 of Appendix D and Table E.1 of Appendix E provide a detailed summary of the vertical stress analysis based on bulk density logs for the original and expanded areas, respectively.

5.2.1 Log Quality Analysis

As a first step in the analysis of vertical stresses in the study area, the quality of the bulk density log data was assessed. The log quality for all the wells used for vertical stress analysis in the original and expanded areas are given in summary Tables D.1 and E.1. Due to discrepancies in reported and recorded bulk density data, it was found that 84 of the 92 wells in the original study area had coverage to the top of the Elk Point Group. All 92 wells are included in the analysis summary in Table D.1 for completeness.

The quality of bulk density log data in the original study area was assessed using the criteria listed in Table 5.4. The log quality was classified as poor, fair, good, or very good. Logs run before 1985 were given a poor or fair quality rating because tools prior to this year (when service companies such as Schlumberger launched their improved litho-density tools - LDT) were less accurate due to the lower count rates used and lower vertical resolution. Log quality was also assessed based on hole size since density tools such as the LDT give good values for smooth holes up to 381 mm in diameter (Schlumberger Educational Services, 1989). In addition, when the bulk density correction exceeds 100 kg/m^3 , the measured bulk density is poorly compensated for mudcake and surface borehole effects, which leads to lower quality measurements. Rough holes indicated by spiky data and higher bulk density correction values are also prone to anomalously low densities due to poor pad contact with the formation. Details of the bulk density log quality determined for each well are given in Table D.1 of Appendix D and Table E.1 of Appendix E. Figures showing the bulk density profile, vertical stress, and local vertical stress gradients for each well listed in Table D.1 are given in Appendix D, Figures D.1.1 to D.1.92.

A summary of the quality of bulk density logs used in the vertical stress calculations at the top of the Prairie Evaporite Formation, and top of the Basal Red Beds, is shown in Figure 5.5. The locations of wells used for with vertical stress analysis, and their respective bulk density log quality, are shown in Figure 5.6.

Table 5.4: Criteria used to determine bulk density quality in this study

Quality	Criteria
Poor	Rough hole, spiky and anomalous data present; large washout intervals (borehole diameter $>380 \text{ mm}$); large intervals with high density correction ($>100 \text{ kg/m}^3$); logged with older, less accurate density tools prior to 1985.
Fair	Intermittent intervals with rough borehole, washouts, intervals of high density correction, logged prior to 1985.
Good	Very short intervals with rough borehole, washout, higher density correction ($>100 \text{ kg/m}^3$), logged after 1985.
Very Good	No anomalous spikes, smooth borehole, hole not washed out (hole diameter $<380 \text{ mm}$), good density correction between $0\text{-}100 \text{ kg/m}^3$, logged after 1985 with more accurate tools.

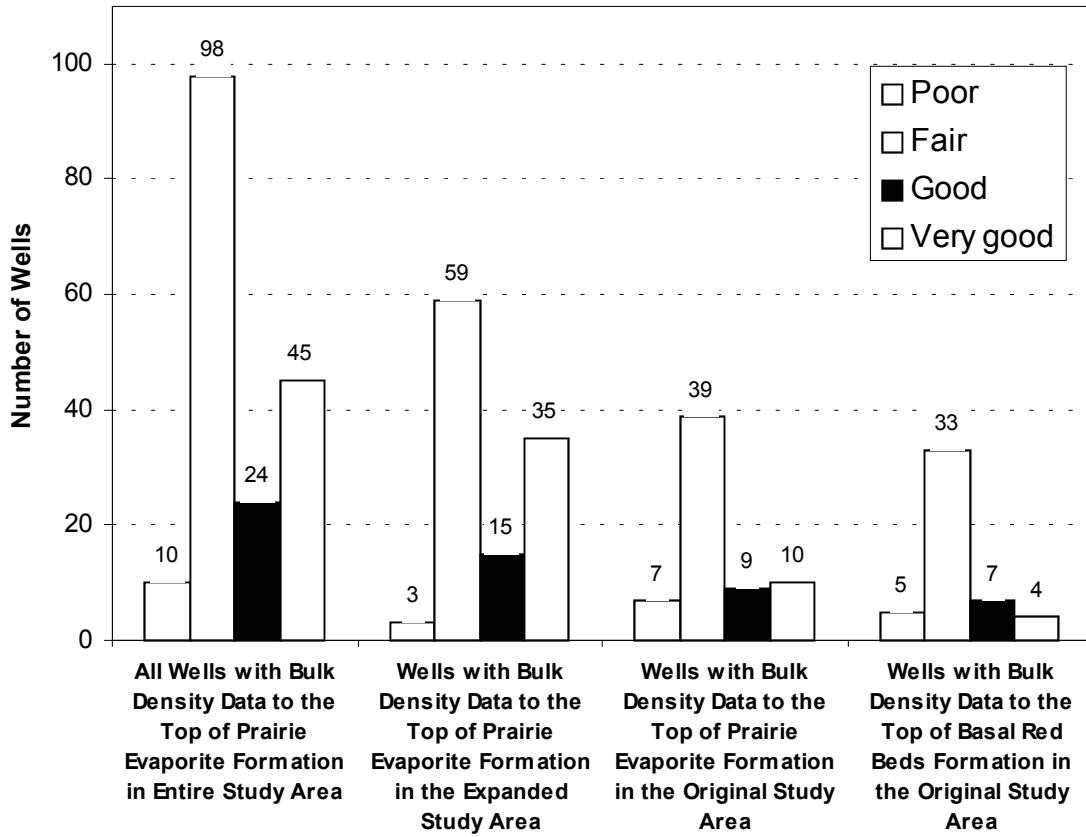


Figure 5.5: Summary of bulk density log quality of the wells used to determine the vertical stress in the original study and expanded study areas.

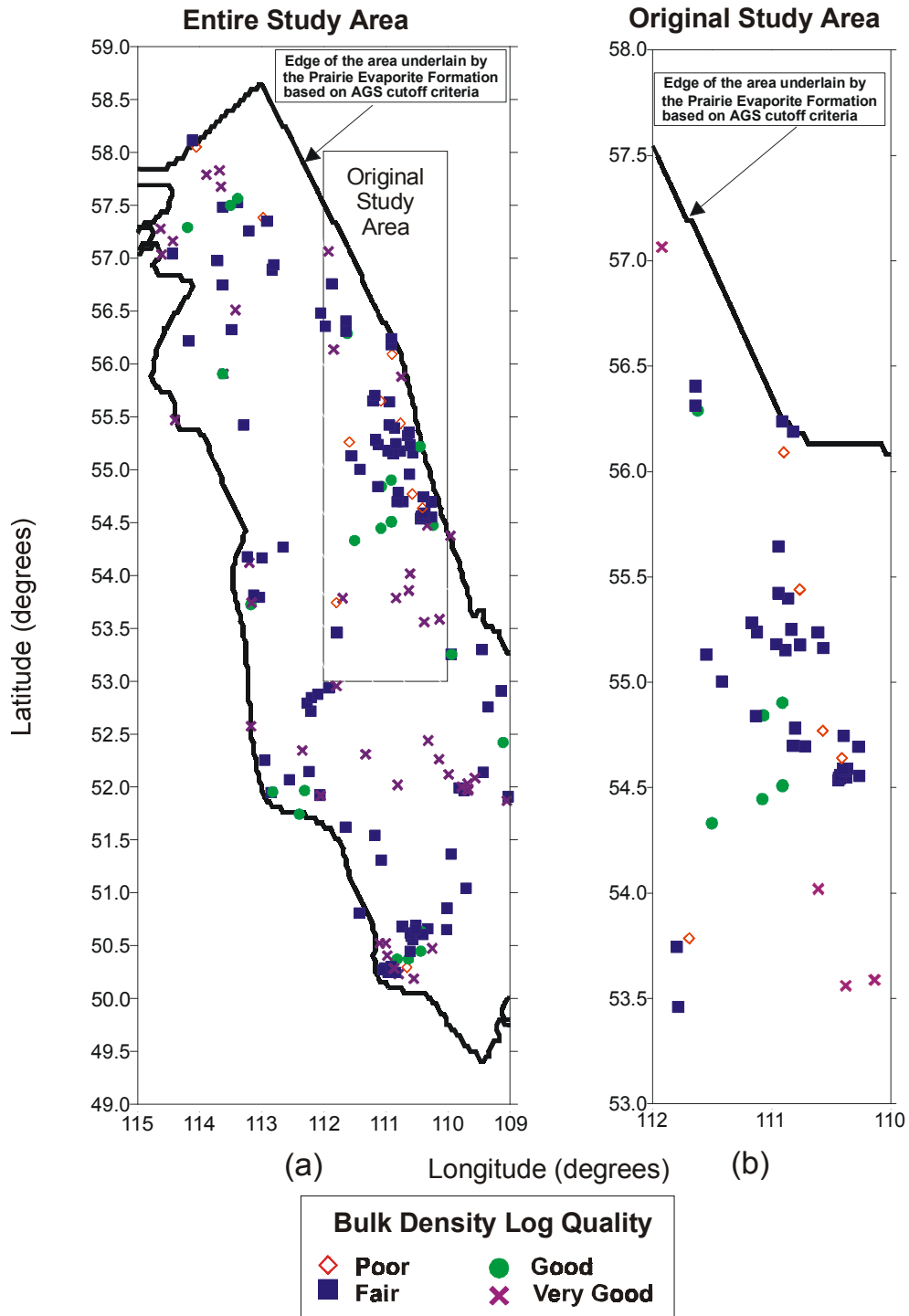


Figure 5.6: Map showing bulk density log quality for wells used to calculate vertical stresses at (a) the top of the Prairie Evaporite Formation (65 wells in the original study area, 112 wells in the expanded study area) and (b) the top of the Basal Red Beds Formation (49 wells in the original study area).

5.2.2 Estimation of Near-surface Bulk Density

The average vertical stress gradient is calculated by integrating the bulk density log curve. For most wells in the database, bulk density data were not recorded over the section covered by surface casing. Bulk density information of fair or better quality within 100 m of surface and above the Prairie Evaporite Formation was available in 8 wells within the original study area (Table 5.5). These latter data were used to calculate an average near-surface bulk density for wells in the original study area. Based on the data in Table 5.5 an average bulk density of 2150 kg/m^3 was used for wells without near-surface data in both the original and expanded study areas.

As shown in Figure 5.7, the possible error in estimated vertical stress or vertical stress gradient increases as the proportion of the well length lacking bulk density measurements increases, and/or the difference between the assumed average value of 2150 kg/m^3 and actual bulk density in this zone increases. For example, assuming an uncertainty of 100 kg/m^3 in the bulk density estimate in the uphole section behind casing, the majority of the wells have less than a 2% possible error in the determined vertical stress magnitude or gradient. As the relative proportion of well length lacking bulk density data decreases, e.g., vertical stress calculations for the deeper Basal Red Beds, the possible error also decreases. The proportion of well length lacking bulk density data for wells from surface to the top of the Prairie Evaporite and to the top of the Basal Red Beds is given in Table D.1 of Appendix D. The proportion of well length lacking bulk density data for wells from surface to the top of the Prairie Evaporite is given in Table E.1 of Appendix E. These values can be used to estimate the possible error in vertical stress and stress gradient estimates. The proportion of well length lacking bulk density data above the Prairie Evaporite Formation is shown in Figure 5.8.

Table 5.5: Average bulk density for wells with coverage in the upper 100 m from surface and data of fair or better quality within the area underlain by the Prairie Evaporite Formation of the original study area

Well Name	UWI	Average Bulk Density (kg/m ³)		
		0-100 m	0-200 m	100-200 m
Esso Marie OV 15-20-64-2	1AA/15-20-064-02W4/00	2101	2113	2122
Esso 79 SWD Coldlk 7-18-64-3	100/07-18-064-03W4/00	2128	2144	2158
Esso 81 SWD Ethellk 3-29-64-3	100/03-29-064-03W4/00	2125	2168	2203
Esso Medley OV 6-8-66-2	1AA/06-08-066-02W4/00	2254	2211	2177
Esso Medley OV 14-28-66-3	1AA/14-28-066-03W4/00	2199	2179	2163
BP PCI Marglk 10-8-66-5	100/10-08-066-05W4/00	2248	2133	2034
Cigol et al Horse 11-10-85-13	100/11-10-085-13W4/00	2063	2111	2113
Suncor Clarke 2-32Prev-89-12	100/02-32-089-12W4/00	2117	2182	2191
Mean		2154	2155	2145
Standard Deviation		71	36	55

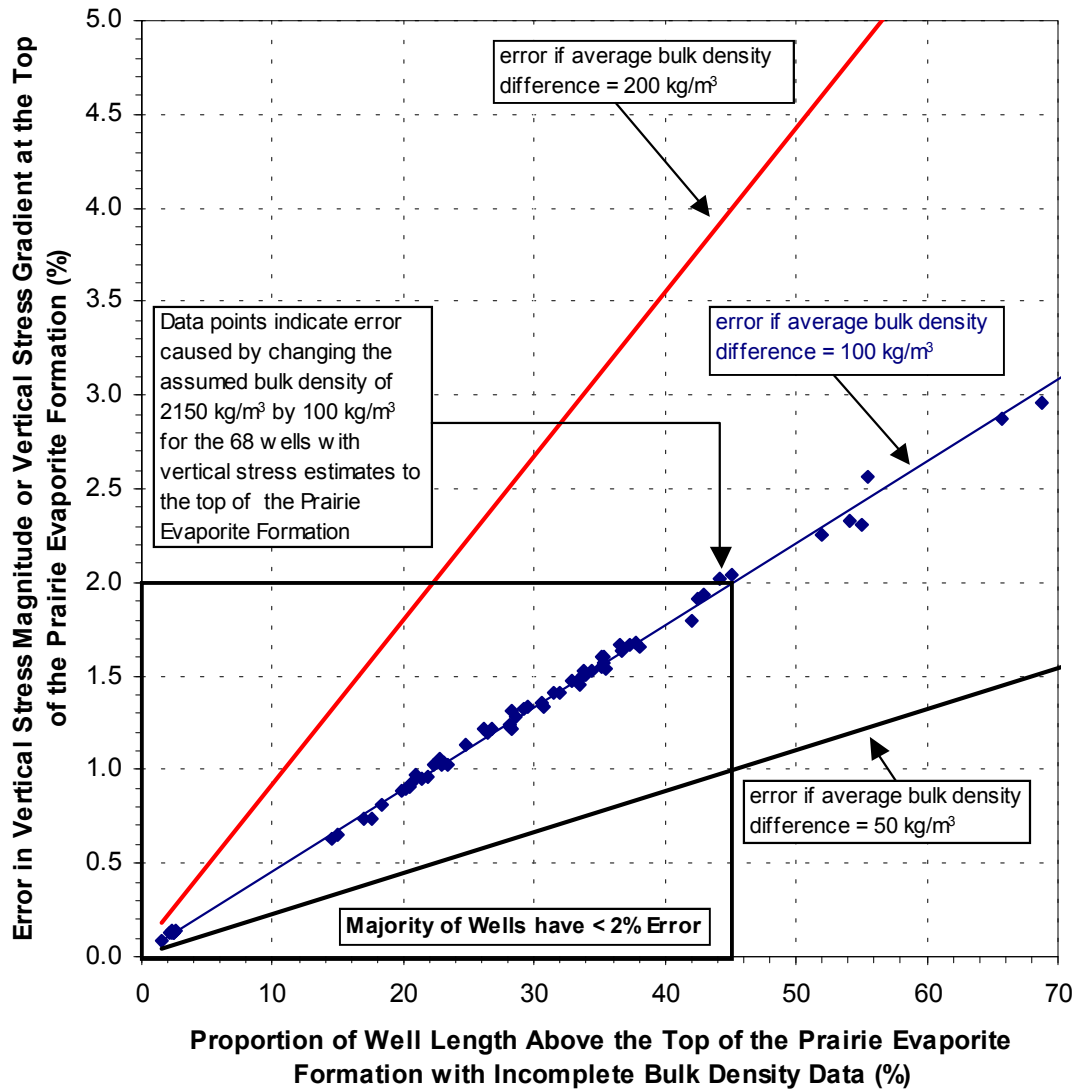


Figure 5.7: Possible error in vertical stress and vertical stress gradient determination at the top of the Prairie Evaporite Formation related to proportion of well length lacking bulk density data, and difference between average and actual near-surface bulk density.

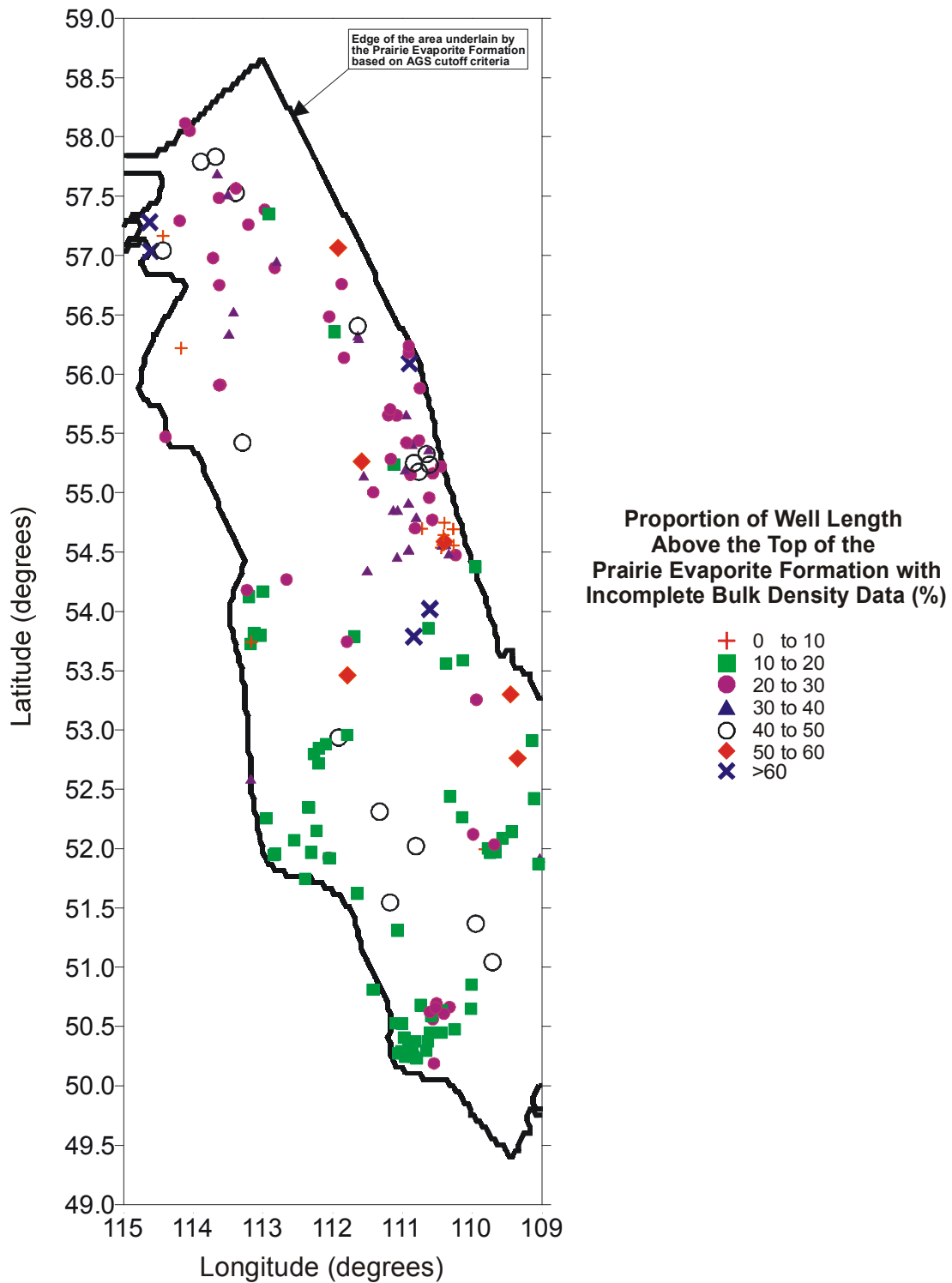


Figure 5.8: Complete study area showing location of wells used for the calculation of vertical stress magnitude to the top of the Prairie Evaporite Formation. The proportion of well length above the Prairie Evaporite Formation with an incomplete bulk density data set is shown with different symbols.

5.2.3 Calculation of Vertical Stress

In the original study area, a total of 68 bulk density logs in digital format were acquired from International Datashare Corp. (IDC) in Calgary to analyze the vertical stress magnitude at the top of the Prairie Evaporite Formation. A total of 49 bulk density logs were analyzed to calculate the vertical stress to the top of the Basal Red Beds Formation in this area. In the expanded study areas, a total of 112 bulk density logs (90 for the expanded Alberta area and 22 for the expanded Saskatchewan area) were acquired from IDC. The locations of the wells are represented as black dots in a set of colour contour plots which have been prepared to show spatial variations in the parameter. Vertical stress magnitudes and gradients were determined using the methodology outlined in Section 4.1.

A typical bulk density log through the Elk Point Group is shown in Figure 5.9. Contour plots of elevation, depth, vertical stress magnitude, and vertical stress gradient for the top of the Prairie Evaporite Formation in the complete study area are shown in Figures 5.10 and 5.11. The same plots of the Basal Red Beds Formation in the original study area are shown in Figures 5.12 and 5.13

Figure 5.10a and Figure 5.10b show that the top of the Prairie Evaporite Formation dips to the southwest and ranges from 300 to 1400 m depth below ground surface in the original study area and from 400 to 2250 m in the expanded study area. The northeast portion of the original study area is not underlain by this formation. In the expanded study area of western Saskatchewan, the top of the Prairie Evaporite dips generally towards the south. Anomalies in overburden thickness are a result of topography, subsurface salt dissolution on the northeast edge, and varying depositional environments on the southwest edge. As shown in Figure 5.11, the vertical stress at the top of the Prairie Evaporite Formation ranges from 7.4 to 31.7 MPa in the original study area and from 10.2 to 54.0 MPa in the expanded study area. The vertical stress gradient at the top of the Prairie Evaporite Formation ranges from 21.3 to 23.9 kPa/m in the original study area, decreasing towards the eastern boundary of the Prairie Evaporite Formation. The vertical stress gradient at the top of the Prairie Evaporite Formation in the expanded study area ranges from 21.5 to 24.7 kPa/m, with the lower vertical stress gradients in the northeast and the higher vertical stress gradients in the southwest. This trend is mainly a result of northeastward-thickening Quaternary and Cretaceous sediments of relatively lower density, and the increase in density of formations above the Prairie Evaporite towards the southwest.

Figure 5.12 indicates that the top of the Basal Red Beds Formation ranges from about 500 to 1700 m below ground surface in the original study area, increasing in depth towards the southwest. The northeast corner of the study area is not underlain by salt formations of the Elk Point Group and was therefore not contoured. The vertical stress at the top of this formation ranges from 13.5 to 39.1 MPa, increasing to the southwest. The vertical stress gradient at the top of the Basal Red Beds Formation in the original study area ranges from 21.3 to 23.6 kPa/m. A concentric zone of lower vertical stress gradients is evident at the top of this formation. This anomaly is associated with thicker occurrences of the relatively low-density Lotsberg and Cold Lake salt formations in this part of the original study area.

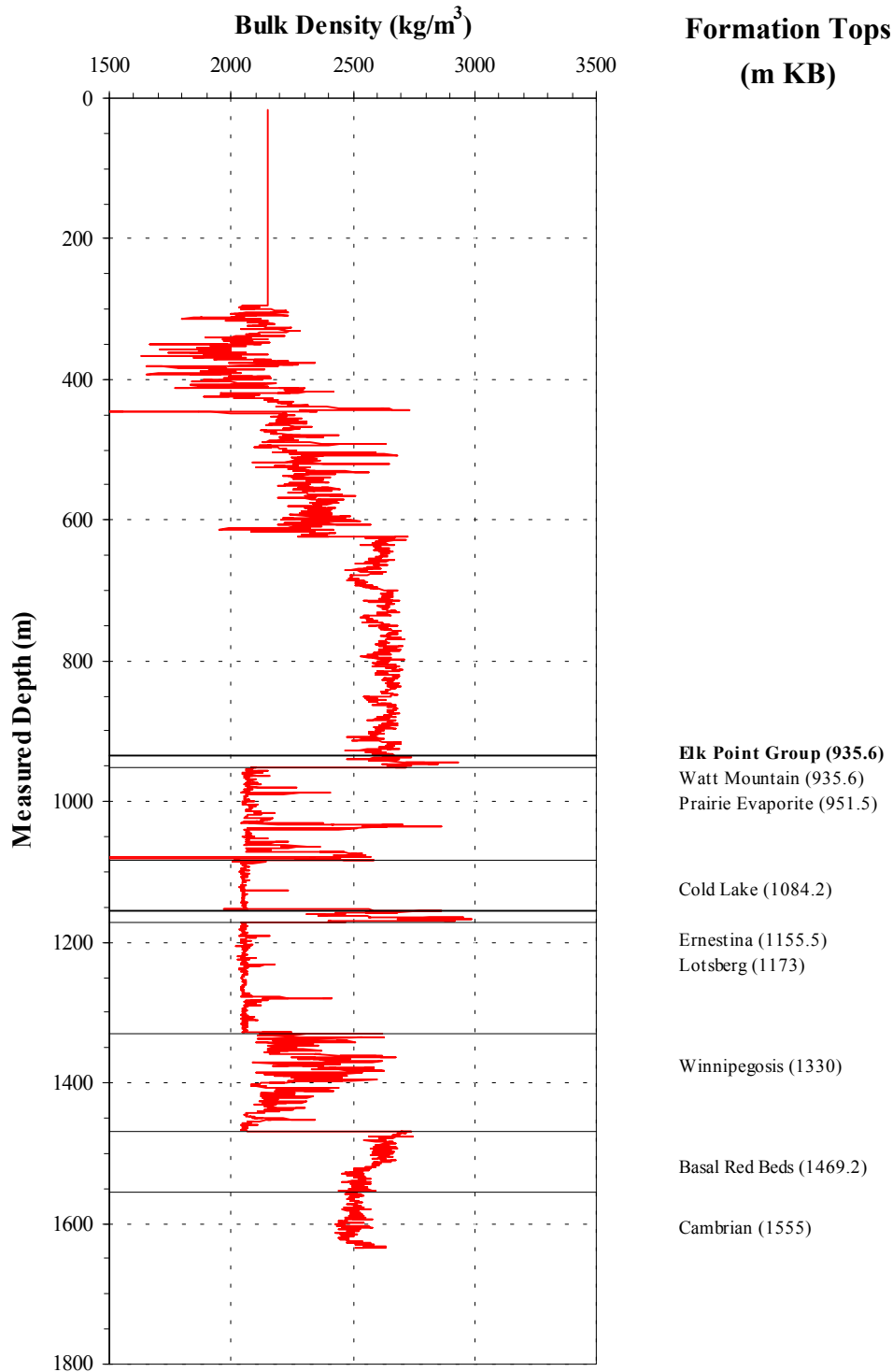


Figure 5.9: Typical digital bulk density log data through the Elk Point Group from Saskoil Sugden 8-1-62-11W4.

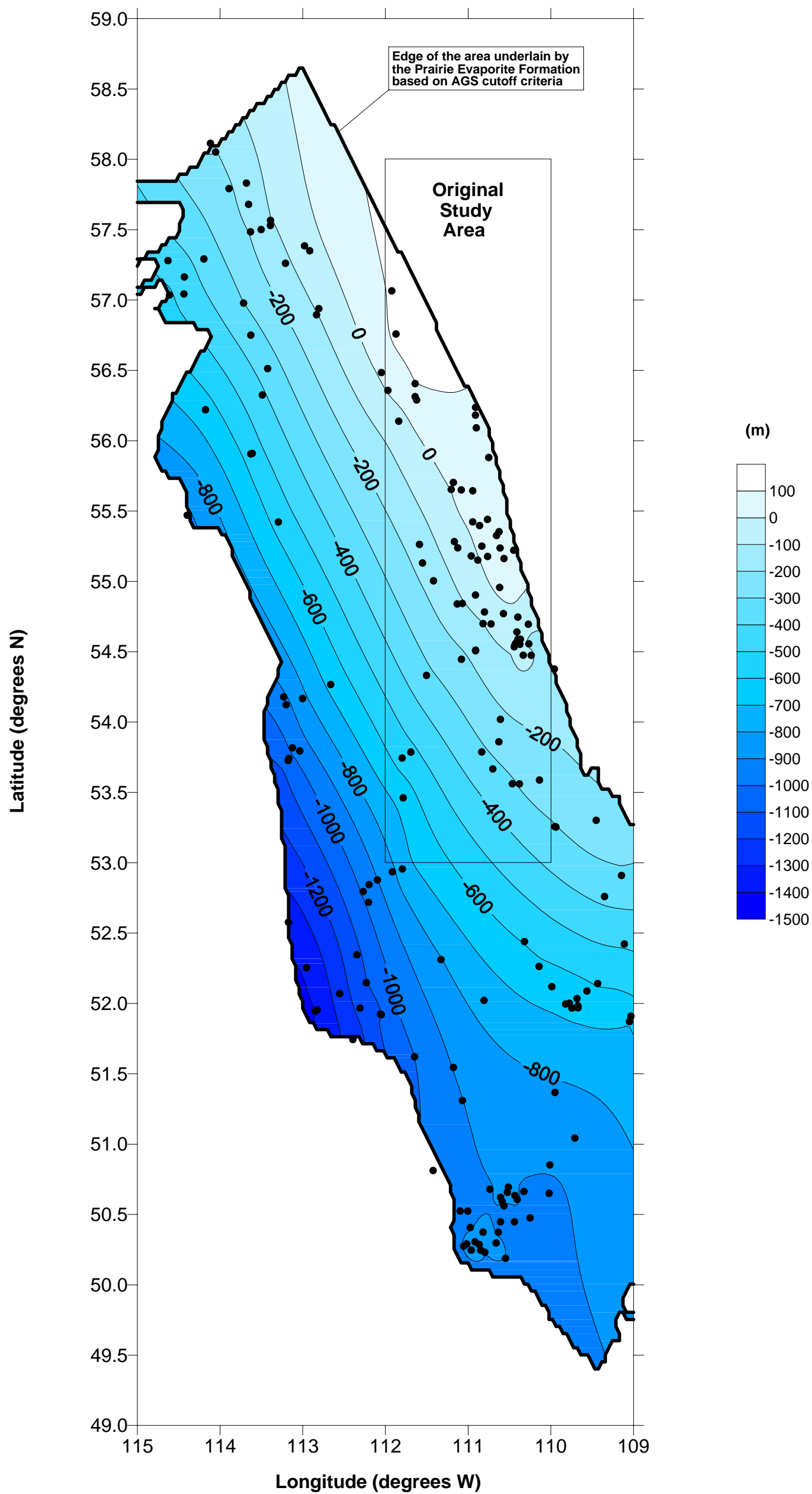


Figure 5.10 (a): Map of original study and expanded study areas showing elevation (m) of the top of the Prairie Evaporite Formation. Wells used for elevation contours are indicated by a small black circle.

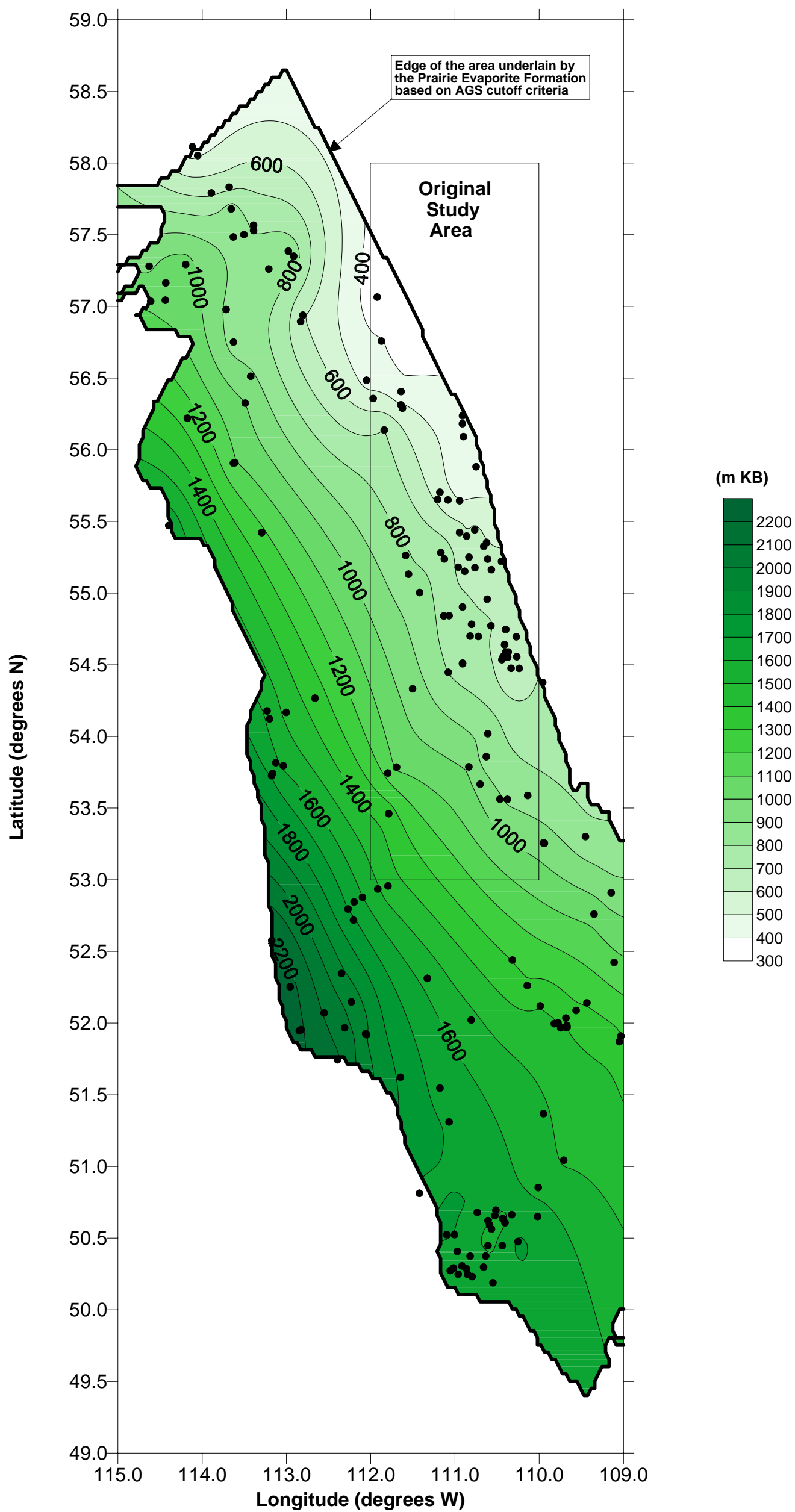


Figure 5.10 (b): Map of original study and expanded study areas showing depth (m KB) of the Prairie Evaporite Formation. Wells used for depth contouring are indicated by a small black circle.

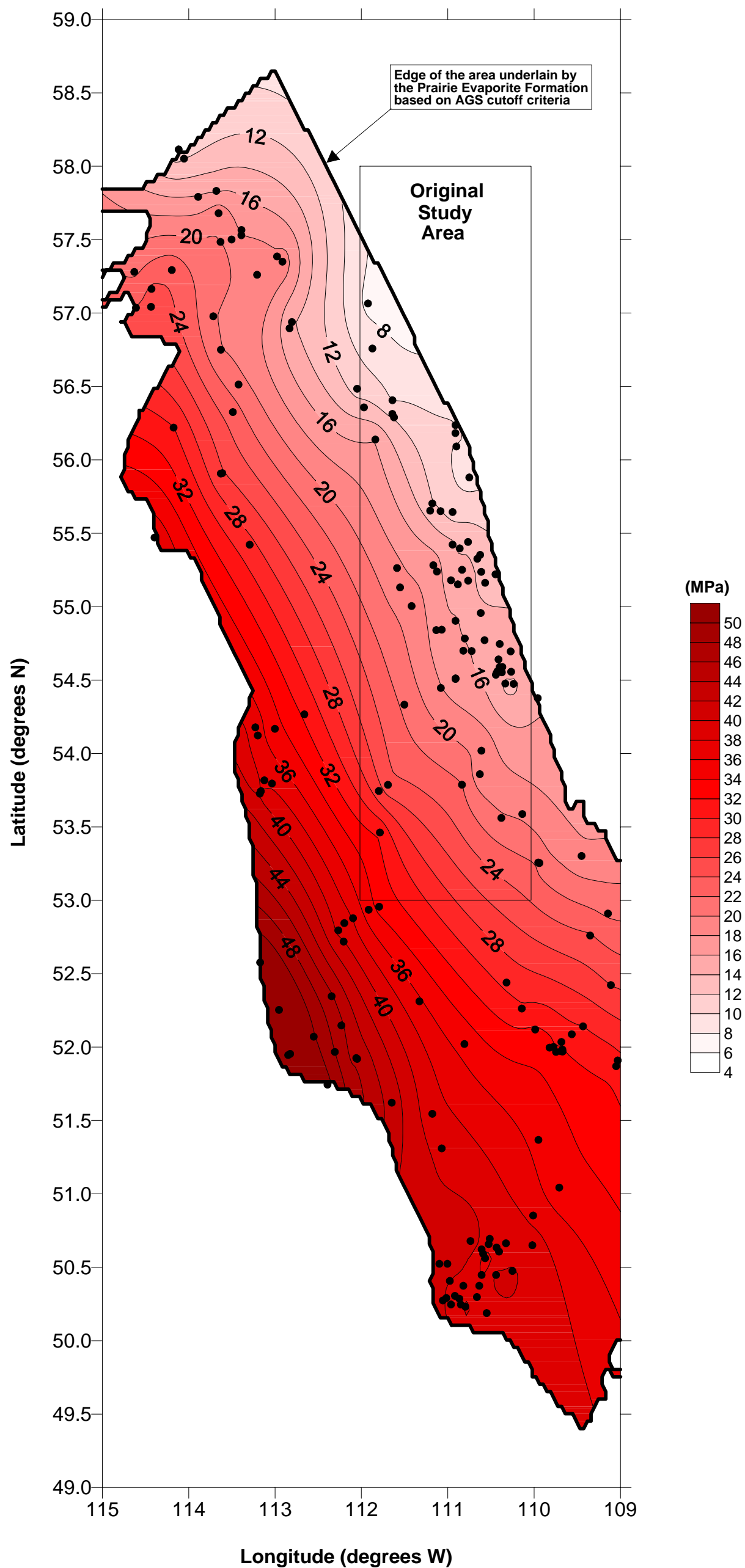


Figure 5.11 (a): Map of original study and expanded study areas showing the vertical stress magnitude (MPa) at the top of the Prairie Evaporite Formation. Wells used in vertical stress calculations are indicated by a small black circle.

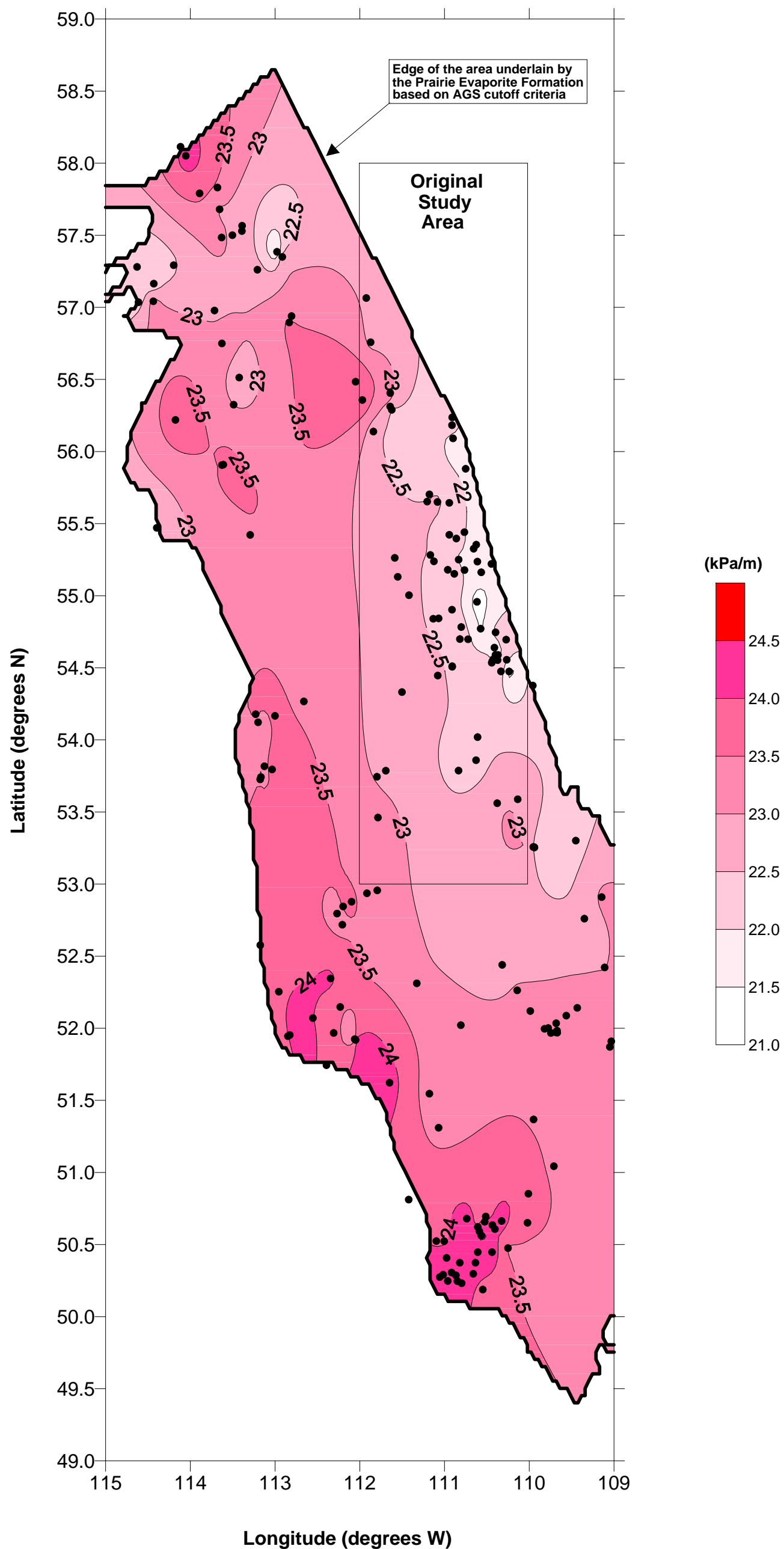


Figure 5.11 (b): Map of original study and expanded study areas showing the vertical stress gradient (kPa/m) at the top of the Prairie Evaporite Formation. Wells used in vertical gradient calculations are indicated by a small black circle.

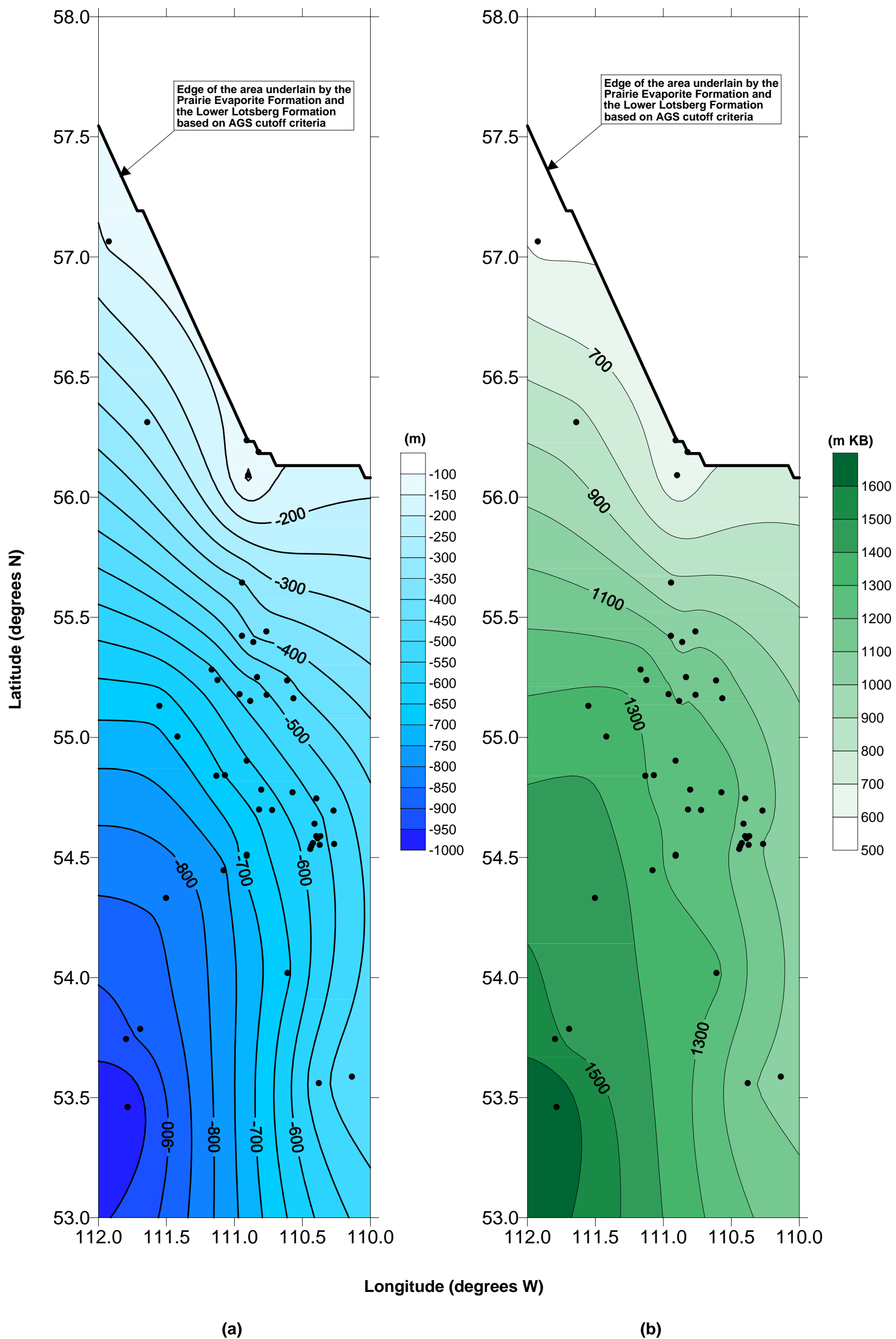


Figure 5.12: Original study area showing (a) elevation (m) at the top of the Basal Red Beds Formation and (b) depth (m KB) to the top of the Basal Red Beds Formation. Wells used in calculations are indicated by a small black circle.

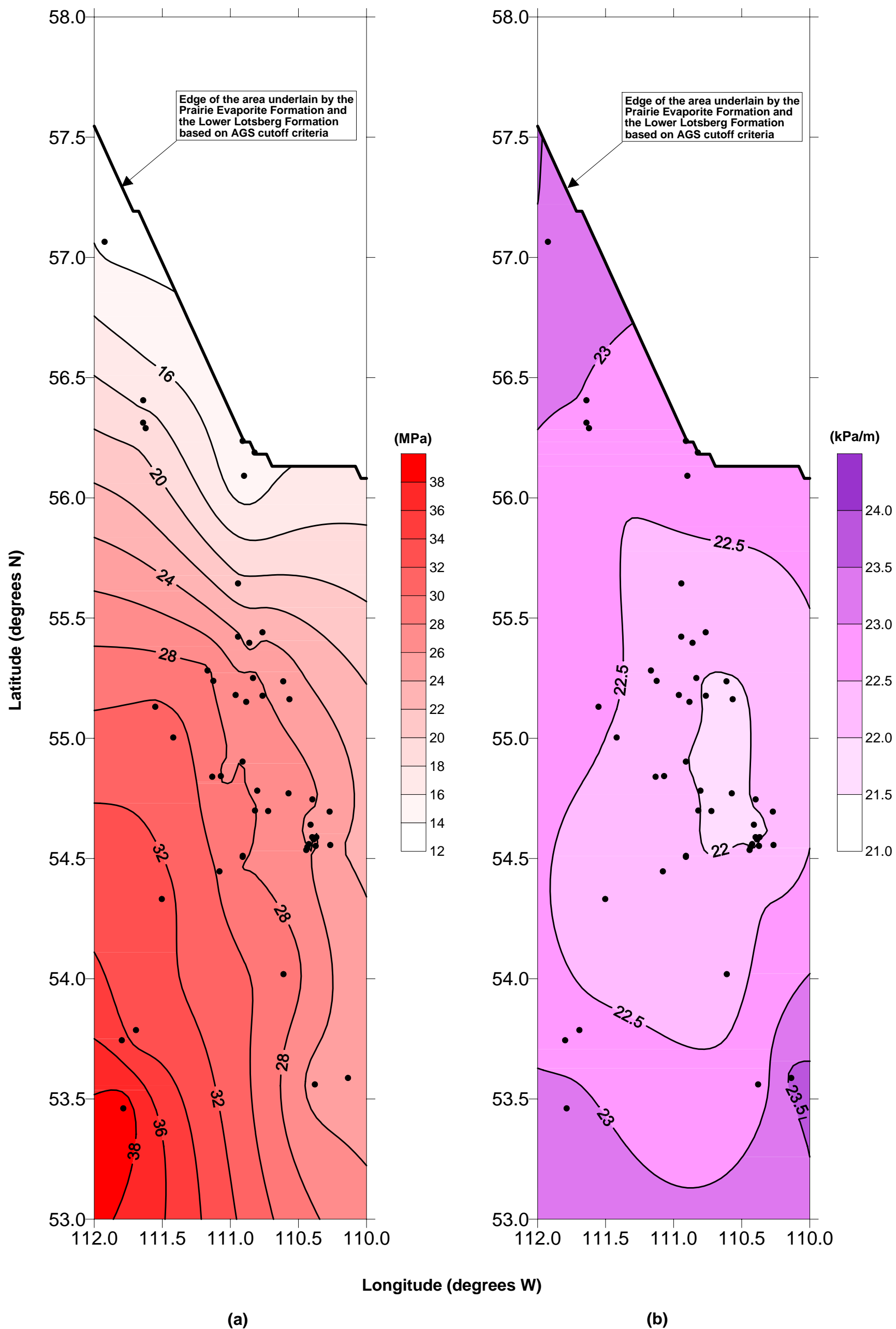


Figure 5.13: Original study area showing (a) vertical stress magnitude (MPa) at the top of the Basal Red Beds Formation and (b) vertical stress gradient (kPa/m) at the top of the Basal Red Beds Formation. Wells used in calculations are indicated by a small black circle.

5.3 Horizontal Stress Orientation

5.3.1 Regional Stress Data

The work of Bell et al. (1994) in the Geological Atlas of Western Canada shows that the horizontal stress trajectories over much of the Western Canada Sedimentary Basin are regionally consistent. For Paleozoic-age strata in the original and expanded study areas, there are 8 wells in the atlas with measured breakout orientations (Figure 5.14). The original study area, expanded Alberta study area, and expanded Saskatchewan study area have breakout orientations from one, six and one well(s), respectively.

A statistical summary of the borehole breakout data is given below each roseplot figure. The average minimum horizontal stress orientation of the breakout data is reported as the vector mean in the summary. The bi-directional azimuth values (0-360°) in the statistical summary were converted to unidirectional values (0-180°) within the text to simplify comparisons. For example, 330° is the same orientation as 150° since they are 180° apart. The confidence interval in the statistical summary represents the 95% confidence interval, in degrees, around the reported vector mean. In other words, one can say with 95% confidence that the breakout azimuth, and hence the minimum horizontal stress orientation is within the reported confidence interval.

The dataset of 8 atlas wells has an average minimum horizontal stress orientation of 137° with a confidence interval of 16° and with a range from 118° to 156°. Although not found in these 8 wells, some of the wells identified in the atlas also have a second population. This population is classified as subordinate or "minor" by the authors, and is generally orientated NE-SW. A roseplot showing the minimum horizontal stress orientation for these 8 wells is shown in Figure 5.15. These measurements indicate a NW-SE direction for the minimum horizontal stress for Paleozoic-age formations. Similar trends are also shown in the Mesozoic strata of the study area.

During the investigation of breakout data in the original study area, it was determined that two of the wells shown in the atlas and on Figure 5.14 for the Paleozoic-age formations in the study area are mislocated. The southernmost well (SOUTHROY JARVIE 7-4-63-26W4M) is actually located west of the original study area but within the expanded study area. The central well plotted on the map from the Atlas was missing in the summary data

table in the atlas. The northernmost well (GULF RESDELN 7-24-83-7W4M) is located properly.

It is important to note that the breakouts identified in the atlas for the Paleozoic-age strata in the study area are located above the Beaverhill Lake Group, and therefore do not appear in the search results in this study for the original and expanded Alberta study areas (we had elected to look for breakouts only in the Beaverhill Lake and Elk Point Groups). Also, note that since the dipmeter search in the expanded Saskatchewan area included all Paleozoic-age formations, the one well identified in the atlas within the expanded Saskatchewan area having breakout in the Paleozoic-age formations was included in the search. However, this well did not have caliper orientation data presented on the microfiche dipmeter log provided for this study and, therefore, could not be used to determine a stress orientation.

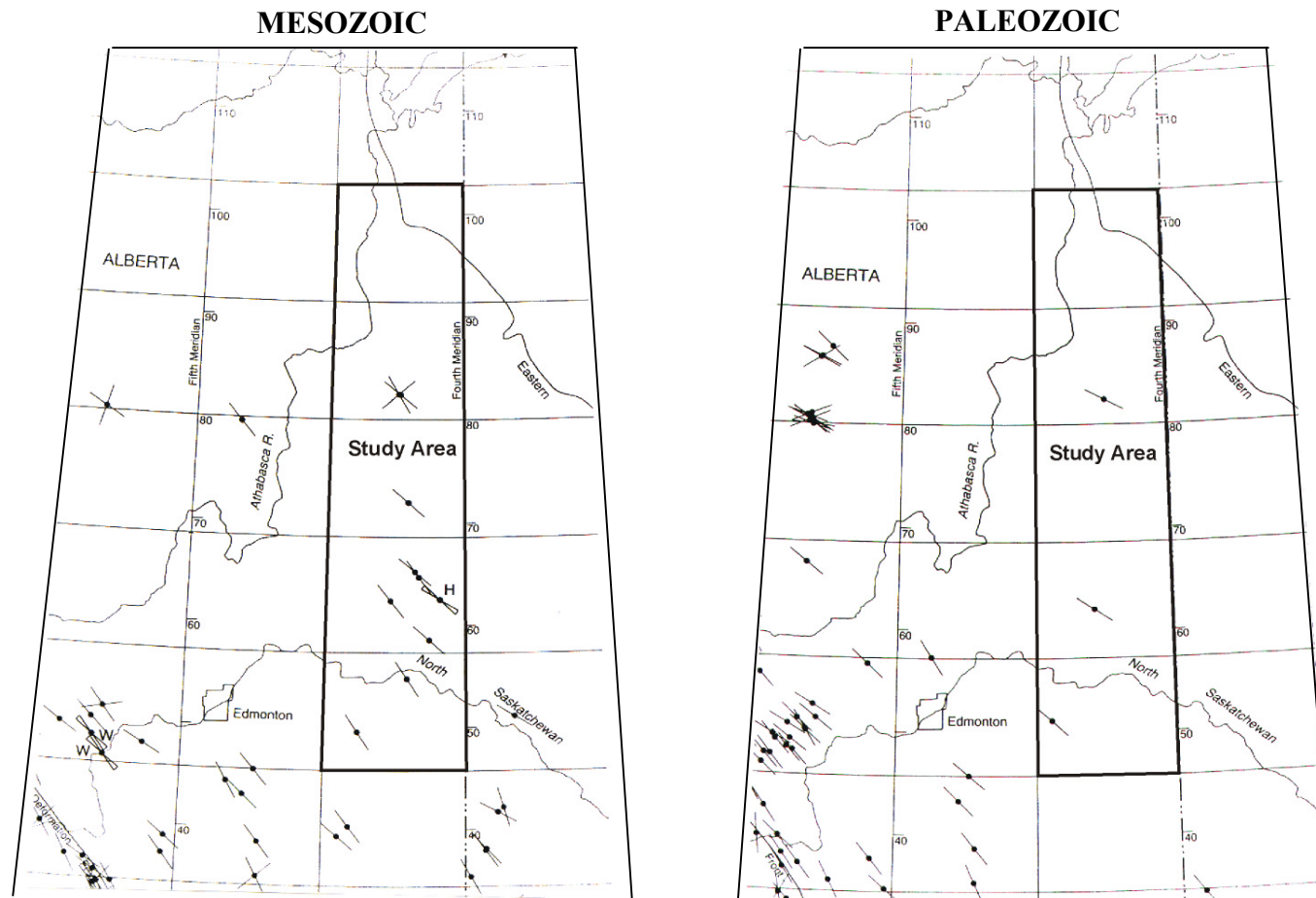
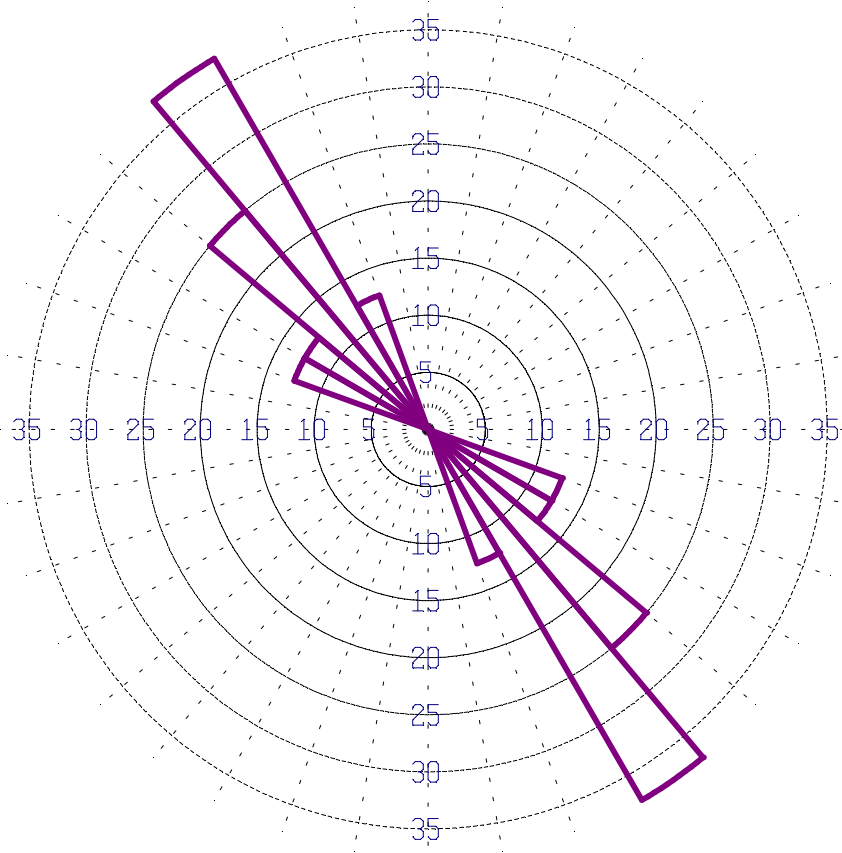


Figure 5.14: Orientation of the minimum horizontal stress in Mesozoic and Paleozoic-age strata of the original study area (Source: Geological Atlas of the Western Canada Sedimentary Basin, Bell et al., 1994)



Population 1

Calculation Method ... Frequency
Class Interval 10 Degrees
Filtering Deactivated
Data Type Bidirectional
Rotation Amount 0 Degrees
Population 8
Maximum Percentage ... 37.5 Percent
Mean Percentage 20 Percent
Standard Deviation ... 10.54 Percent
Vector Mean 317.02 Degrees
Confidence Interval .. 16.22 Degrees
R-mag 0.92

Figure 5.15: Roseplot of the minimum horizontal stress orientation from the 8 wells in the complete study area from the Geological Atlas of Western Canada, Bell et al. (1994).

5.3.2 Borehole Breakout Data

Examination of microfiche logs for the 99 wells from the original study area was undertaken to determine which, if any, dipmeter logs showed borehole breakouts. Details on the dipmeter logs for each well are contained in Table B.2 of Appendix B. Table 5.5 summarizes the results of the dipmeter log review. Of the 99 wells identified, 31 did not have dipmeter logs on microfiche. Of the remaining 68 wells, the dipmeter logs from only five wells in the original study area were found to contain breakout data that could be confidently analyzed for horizontal stress orientations.

Microfiche for the dipmeter wells identified in the expanded Alberta and Saskatchewan study areas were examined to determine which dipmeter logs contained breakouts. Details on the dipmeter logs for each well are contained in Table C.2 and Table C.4 of Appendix C for the expanded Alberta and Saskatchewan study areas, respectively. Tables 5.6 and 5.7 summarize the results of the dipmeter log review for the expanded study areas. A total of 11 wells were identified that had breakouts that could be analyzed for horizontal stresses in the expanded study area.

Table 5.5: Summary of the breakout data search results from dipmeter logs in the original study area with coverage in the Elk Point and Beaverhill Lake Groups

No. of Wells	Search Results
99	Total number of wells with dipmeter logs with some coverage in the Beaverhill Lake or Elk Point Groups within original study area
31	Wells without the dipmeter log recorded on the microfiche
68	Wells with the dipmeter log recorded on the microfiche*
45	Subset of wells without breakout within the Beaverhill Lake or Elk Point Group
16	Subset of wells without all the necessary data for breakout analysis (e.g., missing a caliper curve or caliper orientation information)
2	Subset of wells with apparent breakout caused by pipe wear or drag in a deviated hole (not included in analysis)
5	Subset of wells with breakouts within the Beaverhill Lake or Elk Point Group (2 of which are questionable or poor quality)

*26 dipmeter logs from the 68 wells with dipmeter logs recorded on the microfiche were obtained from MJ Systems in Calgary, as the dipmeter logs for these wells were not recorded on microfiche provided by the AEUB.

Table 5.6: Summary of the breakout data search results from dipmeter logs with coverage in the Elk Point Group in the expanded Alberta study area

No. of Wells	Search Results
120	Total number of wells with dipmeter logs with some coverage in the Elk Point and Beaverhill Lake Groups within expanded study area
61	Wells without the dipmeter log recorded on the microfiche
47	Wells with the dipmeter log recorded on the microfiche
44	Subset of wells without all the necessary data for breakout analysis
	21 logs pre-1966 with 3-arm dipmeter caliper that do not show curves for individual calipers
	23 (missing a relevant caliper or pad 1 azimuth curve)
13	Subset of wells with all curves required for breakout analysis available
10	Wells with breakout present

Table 5.7: Summary of the breakout data search results from dipmeter logs with coverage in the Paleozoic-age formations in the expanded Saskatchewan study area

No. of wells	Search Results
25	Total number of wells with dipmeter logs with > 4 m coverage in the Paleozoic-age formations in the expanded Saskatchewan study area
3	Wells without the dipmeter log recorded on the microfiche
22	Wells with the dipmeter log recorded on the microfiche
16	Subset of wells without all the necessary data for breakout analysis; missing a relevant caliper or pad 1 azimuth curve
6	Subset of wells with all curves required for breakout analysis available
1	Wells with breakout present

The quality of breakout data was established using the criteria listed in Table 5.8. Of the 5 dipmeter logs containing breakouts in the original study area, two of these had breakouts of questionable or poor quality. The remaining three dipmeter logs had one good quality breakout in the Elk Point Group, and two good quality breakouts in the Beaverhill Lake

Group. There were more breakout data in the expanded area since log data were available over the thicker Elk Point Group. The details of the breakout quality for the 11 wells analyzed in the expanded area are given Table E.2 of Appendix E.

Table 5.8: Criteria used to determine breakout quality in this study

Quality	Criteria
Poor	Relatively straight azimuth trace, ratty caliper(s), difference in caliper readings <4% (i.e., small enlargement)
Fair	Straight azimuth trace, relatively smooth caliper traces, difference in caliper readings <4%
Good	Straight azimuth trace, smooth calipers, difference in caliper readings >4%, C1-C3 and C2-C4 both >gauge
Very Good	Straight azimuth trace, smooth calipers, difference in caliper readings >4%, smaller caliper reading within 2% of gauge

Analysis of the 16 dipmeter logs containing breakouts involved calculating the breakout azimuth and the amount of hole enlargement on a per metre basis over the length of each breakout interval. As was the case for the original data of Bell et al. (1994), most of the breakouts showed the development of only one breakout population while a few have a second population. The minor second population was filtered out between 0 and 80 degrees (NE-SW orientation) and was not included in the determination of the minimum horizontal stress orientation. The results of the breakout analyses for the original area are contained in Table D.2 with roseplots of the breakout data for each well in Figures D.2.1 to D.2.6 of Appendix D. The results of the breakout analyses for the expanded area are contained in Table E.2 with roseplots of the breakout data for each well in Figures E.2.1 to E.2.14 of Appendix E. The roseplots use an azimuth class interval of 10° and indicate the mean orientation and confidence interval for each breakout interval.

The results of the analysis of the minimum horizontal stress orientation data are summarized for each well in Figure 5.16. A summary of the minimum stress orientation for each well is also given in Table 5.9. Figure 5.17 is a roseplot for the 16 wells analyzed

in the entire study area weighted by the length of the breakout interval. The average minimum horizontal stress orientation calculated from the 16 wells analyzed varies from azimuth 101° to 152° , similar to the measurements of Bell et al. (1994) in the Paleozoic-age formations. The average minimum horizontal stress orientation is 120° with a confidence interval of 5° . The average orientation of the minor population from 5 wells varies from an azimuth of 40° to 76° . The average minor population of the wells is 58° with a confidence interval of 12° .

All wells exhibiting borehole breakout in the Elk Point Group employed a salt-based mud for drilling except for the 14-9-92-4W5 well which used an oil-based mud. Since none of the wells analyzed for breakout within the Elk Point Group employed a water-based mud during drilling, one can assume that borehole enlargement was not caused by salt dissolution. This leads to confidence that the breakouts seen in the Elk Point Group were caused by stress anisotropy.

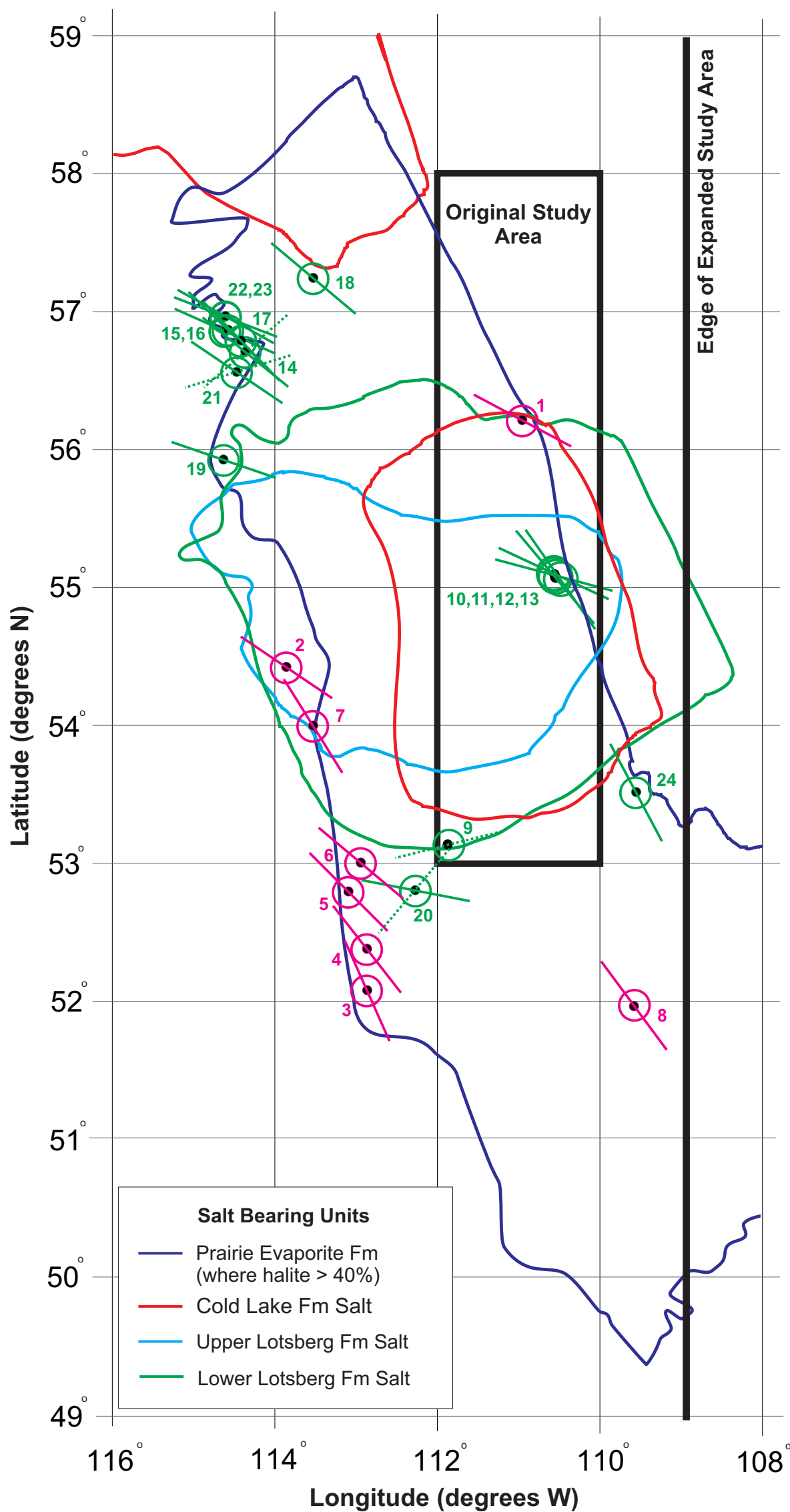
An interesting observation is the trend of a more NNW-SSE minimum horizontal stress orientation in the Elk Point Group, Beaverhill Lake Group, and Paleozoic-age formations above the Beaverhill Lake Group. The average minimum horizontal stress orientation determined in the Elk Point Group was 116° with a confidence interval of 5° (Figure 5.18). The average minimum horizontal stress orientation determined in the Beaverhill Lake Group for 114 metres of breakout was 124° with a confidence interval of 8° (Figure 5.19). The average minimum horizontal stress orientation determined from 9 wells in Paleozoic-age formations above the Beaverhill Lake Group was 139° with a confidence interval of 16° (Figure 5.20). However, Bell et al. (1993) noted that the minimum stress orientation was similar over various formations and ages. The mean of the average minimum horizontal stress orientation for all 24 wells is 129° with a confidence interval of 13° (Figure 5.21).

Table 5.9: Summary of borehole breakout data for all 24 wells in the complete study area (8 wells from the Geological Atlas of Western Canada, Bell et al., 1994, and 16 new wells analyzed in this study)

No.	Well Name	Combined		Average Population 1		
		Average Population 1 (degrees)	Average Population 2 (degrees)	Elk Point Group (degrees)	Beaverhill Lake Group (degrees)	Above Beaverhill Lake Group (degrees)
1	Gulf Resdeln 7-24-83-7	118	-	-	-	118
2	Southroy Jarvie 7-4-63-26	124	-	-	-	124
3	Bears paw et al Fenn West 8-11-36-21	156	-	-	-	156
4	CNRL Erskine 16-24-39-21	142	-	-	-	142
5	Guyer et al Malmo 14-10-44-22	135	-	-	-	135
6	Altex Perl Bittern Lk 11-27-46-21	130	-	-	-	130
7	Baytex et al FBA 14-9-58-24	148	-	-	-	148
8	Saskoil Norcen Plover Lake 9-6-35-26	143	-	-	-	143
9	Voyager et al Bruce 6-14-48-14	-	76	-	-	-
10	AEC D1 Fisher 1-21-70-4	145	-	-	145	-
11	AEC A8 Fisher 8-21-70-4	101	-	-	101	-
12	AEC B3 Fisher 3-22-70-4	115	-	-	115	-
13	AEC Fisher 6-33-70-4	140	-	-	140	-
14	Unocal et al Trout 8-10-89-3	129	49	132	128	-
15	Murphy Trout 9-3-89-3	114	-	114	-	-
16	Unocal et al Kidney 9-5-91-7-4	134	74	109	140	-
17	Unocal Kidney 10-32-90-4	136	-	127	136	-
18	PCI Liege 11-8-95-22	130	-	109	-	-
19	Dorset et al Martenck 11-12-80-5	109	-	117	99	-
20	Suncor Strome 11-16-44-16	101	40	-	102	-
21	Murphy et al Graham 12-18-87-3	124	73	126	116	-
22	NCE Ener Senex 14-9-92-4	119	-	119	-	-
23	Colin et al Kidney 10-19-91-4	111	-	111	-	-
24	Sceptre Murphy T'Flags A1-26-52-25	152	-	-	-	152
Mean of Average		129	62	118	122	139

* Wells 1 to 8 from Geological Atlas of Western Canada, Bell et al, 1994

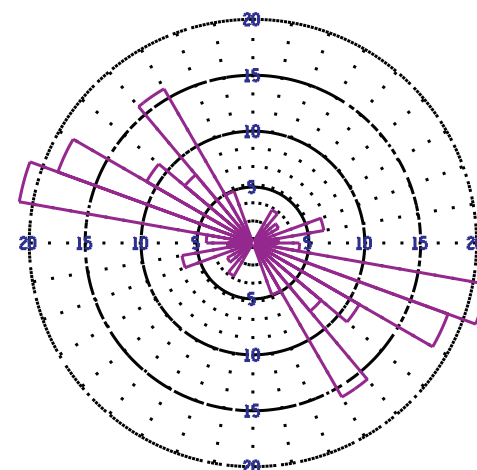
** No population 1 data for well No.9



WELL BREAKOUT SUMMARY

GEOLOGIC ATLAS DATA	
1	Well Name: Gulf Resdeln 7-24-83-7W4 Breakout depth: n/a Breakout in: Paleozoic Breakout Azimuth: 118 degrees (pop.1)
2	Well Name: Southroy Jarvie 7-4-63-26W4 Breakout depth: n/a Breakout in: Paleozoic Breakout Azimuth: 124 deg (pop.1)
3	Well Name: Bearspaw et al Fenn West 8-11-36-21W4 Breakout depth: n/a Breakout in: Paleozoic Breakout Azimuth: 156 deg (pop.1)
4	Well Name: CNRL Erskine 16-24-39-21W4 Breakout depth: n/a Breakout in: Paleozoic Breakout Azimuth: 142 deg (pop.1)
5	Well Name: Guyer et al Malmo 14-10-44-22W4 Breakout depth: n/a Breakout in: Paleozoic Breakout Azimuth: 135 deg (pop.1)
6	Well Name: Altex Perl Bittern Lk 11-27-46-21W4 Breakout depth: n/a Breakout in: Paleozoic Breakout Azimuth: 130 deg (pop.1)
7	Well Name: Baytex et al FBA 14-9-58-24W4 Breakout depth: n/a Breakout in: Paleozoic Breakout Azimuth: 148 deg (pop.1)
8	Well Name: Saskoil Norcen Plover Lake 9-6-35-26W3 Breakout depth: n/a Breakout in: Paleozoic Breakout Azimuth: 142.5 deg (pop.1)
NEW DATA ANALYZED IN THIS STUDY	
9	Well Name: Voyager et al Bruce 6-14-48-14W4 Breakout depth: 1475-1469 m KB Breakout in: Watt Mountain Formation Breakout Azimuth: 76 deg (pop.2)
10	Well Name: AEC D1 Fisher 1-21-70-4W4 Breakout depth: 510-515 m KB Breakout in: Beaverhill Lake Group Breakout Azimuth: 145 deg (pop.1)
11	Well Name: AEC A8 Fisher 8-21-70-4W4 Breakout depth: 520-535 m KB Breakout in: Beaverhill Lake Group Breakout Azimuth: 101 deg (pop.1)
12	Well Name: AEC B3 Fisher 3-22-70-4W4 Breakout depth: 496-502 m KB Breakout in: Beaverhill Lake Group Breakout Azimuth: 115 deg (pop.1)
13	Well Name: AEC Fisher 6-33-70-4W4 Breakout depth: 495-501 m KB Breakout in: Beaverhill Lake Group Breakout Azimuth: 140 deg (pop.1)
14	Well Name: Unocal et al Trout 8-10-89-3W5 Breakout depth: 1091-1100, 1107-1115, 1326-1332 m KB Breakout in: Beaverhill Lake Group, Prairie Evaporite Fm Breakout Azimuth: 129 degrees (pop.1), 49 deg (pop.2)
15	Well Name: Murphy Trout 9-3-89-3W5 Breakout depth: 1291-1292, 1298-1300, 1403-1414 m KB Breakout in: Prairie Evaporite Fm Breakout Azimuth: 114 deg (pop.1)
16	Well Name: Unocal et al Kidney 9-5-91-7-4W5 Breakout depth: 1016-1029, 1134-1141, 1264-1266, 1288-1295 m KB Breakout in: Beaverhill Lake Group, Watt Mountain Fm, Prairie Evaporite Fm Breakout Azimuth: 134 deg (pop.1), 74 deg (pop.2)
17	Well Name: Unocal Kidney 10-32-90-4W5 Breakout depth: 1138-1147 m KB Breakout in: Beaverhill Lake Group Breakout Azimuth: 136 deg (pop.1)
18	Well Name: PCI Liege 11-8-95-22W4 Breakout depth: 919-941, 1041-1050, 1248-1260 m KB Breakout in: Beaverhill Lake Group, Prairie Evaporite Fm Breakout Azimuth: 130 deg (pop.1)
19	Well Name: Dorset et al Martenck 11-12-80-5W5 Breakout depth: 1339-1345, 1521-1528 m KB Breakout in: Beaverhill Lake Group, Watt Mountain Fm Breakout Azimuth: 109 deg (pop.1)
20	Well Name: Suncor Strome 11-16-44-16W4 Breakout depth: 1470-1491, 1710-1736 m KB Breakout in: Beaverhill Lake Group, Prairie Evaporite Fm Breakout Azimuth: 101 deg (pop.1), 40 deg (pop.2)
21	Well Name: Murphy et al Graham 12-18-87-3W5 Breakout depth: 1152-1154, 1478-1479, 1493-1498, 1567-1579 m KB Breakout in: Beaverhill Lake Group, Prairie Evaporite Fm, Keg River Fm, Granite Wash Fm Breakout Azimuth: 124 deg (pop.1), 73 deg (pop.2)
22	Well Name: NCE Ener Senex 14-9-92-4W5 Breakout depth: 1203-1207, 1232-1235 m KB Breakout in: Prairie Evaporite Fm Breakout Azimuth: 119 deg (pop.1)
23	Well Name: Colin et al Kidney 10-19-91-4W5 Breakout depth: 1152-1158, 1198-1217 m KB Breakout in: Prairie Evaporite Fm Breakout Azimuth: 111 deg (pop.1)
24	Well Name: Sceptre Murphy T'Flags A1-26-52-25W3 Breakout depth: 578-583 m KB Breakout in: Saskatchewan Group (Duperow Fm)

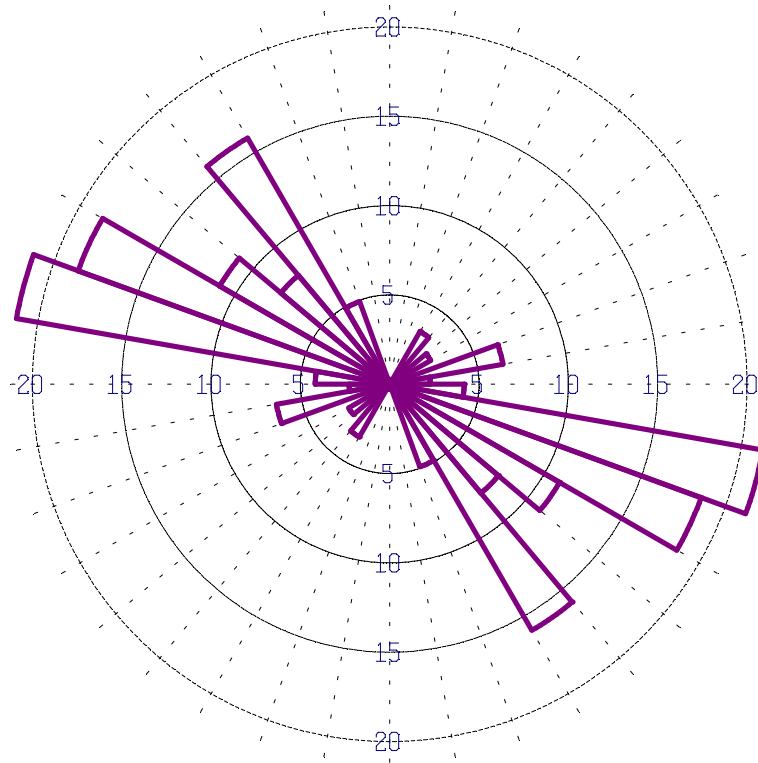
Roseplot of Breakout Data for All Wells Analyzed in this Study



Average Orientation of the Minimum Horizontal Stress for Population 1 in the 16 Wells Analyzed = 121°
Confidence Interval = 5°

DATA SOURCE	Description
	Breakout azimuth from the Geological Atlas of the Western Canadian Sedimentary Basin (Bell et al., 1994)
	Population 1 breakout azimuth determined from dipmeter logs
	Population 2 breakout azimuth determined from dipmeter logs

Figure 5.16: Minimum horizontal stress orientation determined from borehole breakouts using dipmeter logs in the Paleozoic-age formations for the entire study area.



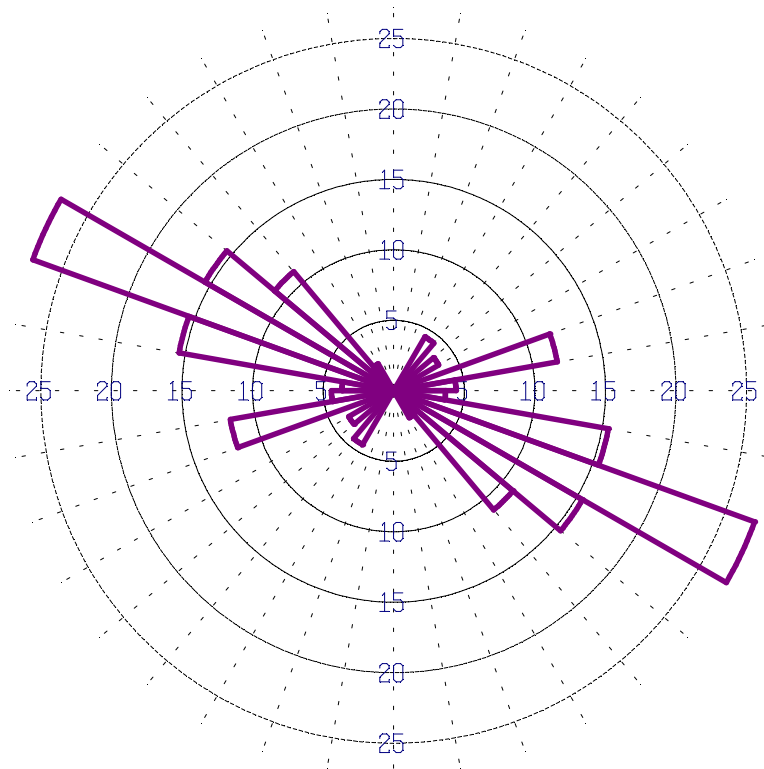
Population 1

Calculation Method ... Frequency
Class Interval 10 Degrees
Filtering Activated
Minimum Azimuth ... 80 Degrees
Maximum Azimuth ... 180 Degrees
Data Type Bidirectional
Rotation Amount 0 Degrees
Population 222
Maximum Percentage ... 25.2 Percent
Mean Percentage 12.5 Percent
Standard Deviation ... 8.57 Percent
Vector Mean 300.76 Degrees
Confidence Interval .. 4.71 Degrees
R-mag 0.82

Population 2

Calculation Method ... Frequency
Class Interval 10 Degrees
Filtering Activated
Minimum Azimuth ... 0 Degrees
Maximum Azimuth ... 80 Degrees
Data Type Bidirectional
Rotation Amount 0 Degrees
Population 37
Maximum Percentage ... 45.9 Percent
Mean Percentage 20 Percent
Standard Deviation ... 15.87 Percent
Vector Mean 58.31 Degrees
Confidence Interval .. 11.5 Degrees
R-mag 0.82

Figure 5.17: Roseplot data of the combined borehole breakout data for all 16 wells analyzed in the study weighted by the length of the breakout interval.



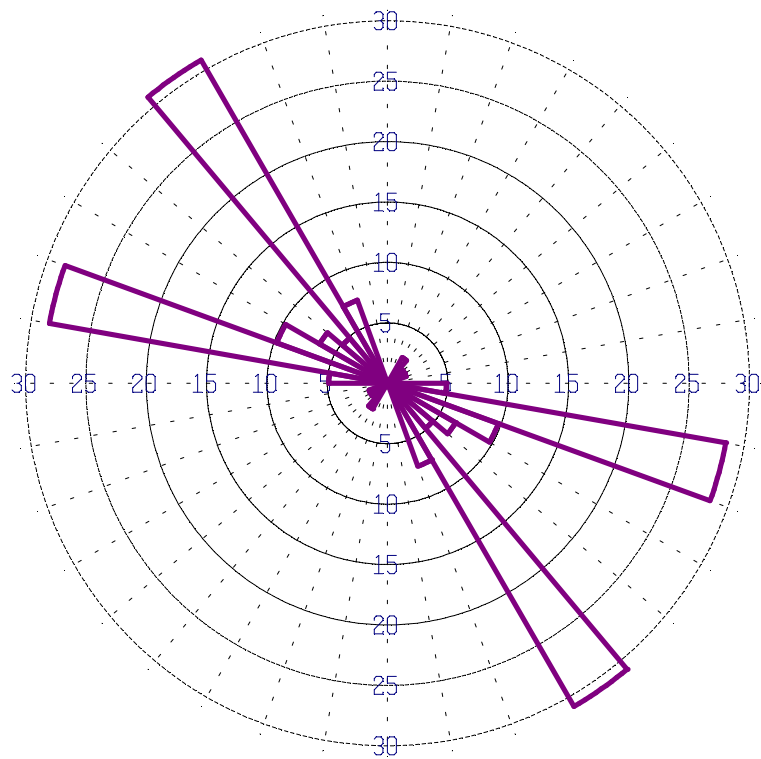
Population 1

Calculation Method ... Frequency
 Class Interval 10 Degrees
 Filtering Activated
 Minimum Azimuth ... 80 Degrees
 Maximum Azimuth ... 180 Degrees
 Data Type Bidirectional
 Rotation Amount 0 Degrees
 Population 103
 Maximum Percentage ... 35.9 Percent
 Mean Percentage 14.3 Percent
 Standard Deviation ... 12.01 Percent
 Vector Mean 296.16 Degrees
 Confidence Interval .. 4.79 Degrees
 R-mag 0.91

Population 2

Calculation Method ... Frequency
 Class Interval 10 Degrees
 Filtering Activated
 Minimum Azimuth ... 0 Degrees
 Maximum Azimuth ... 80 Degrees
 Data Type Bidirectional
 Rotation Amount 0 Degrees
 Population 28
 Maximum Percentage ... 57.1 Percent
 Mean Percentage 25 Percent
 Standard Deviation ... 21.09 Percent
 Vector Mean 61.57 Degrees
 Confidence Interval .. 13.23 Degrees
 R-mag 0.82

Figure 5.18: Roseplot data of the borehole breakout data within the Elk Point Group in the 16 wells analyzed in the study weighted by length of the breakout interval.



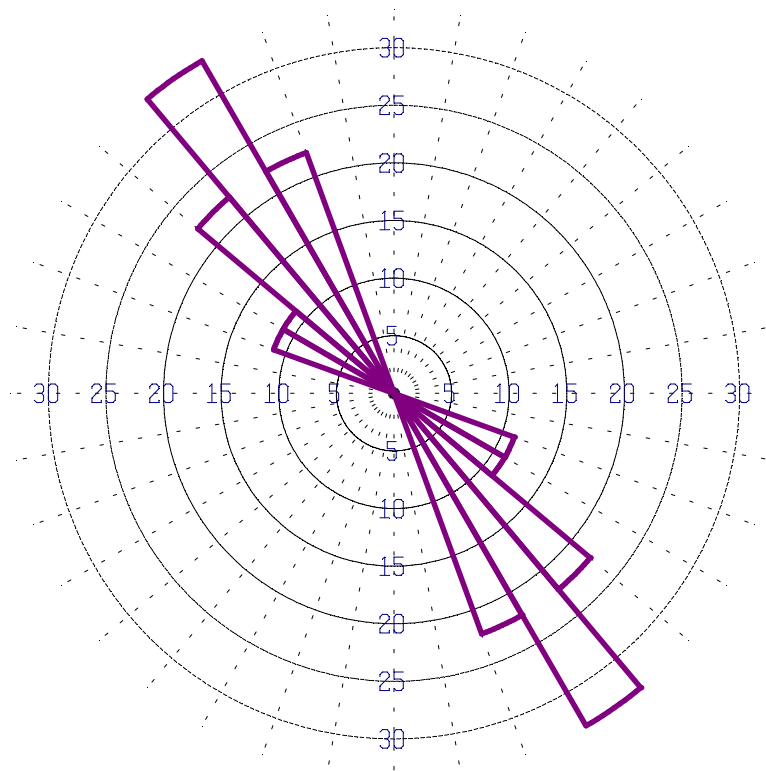
Population 1

Calculation Method ... Frequency
 Class Interval 10 Degrees
 Filtering Activated
 Minimum Azimuth ... 80 Degrees
 Maximum Azimuth ... 180 Degrees
 Data Type Bidirectional
 Rotation Amount 0 Degrees
 Population 114
 Maximum Percentage ... 33.3 Percent
 Mean Percentage 14.3 Percent
 Standard Deviation ... 11.79 Percent
 Vector Mean 304.28 Degrees
 Confidence Interval .. 7.7 Degrees
 R-mag 0.76

Population 2

Calculation Method ... Frequency
 Class Interval 10 Degrees
 Filtering Activated
 Minimum Azimuth ... 0 Degrees
 Maximum Azimuth ... 80 Degrees
 Data Type Bidirectional
 Rotation Amount 0 Degrees
 Population 9
 Maximum Percentage ... 33.3 Percent
 Mean Percentage 20 Percent
 Standard Deviation ... 8.76 Percent
 Vector Mean 48.83 Degrees
 Confidence Interval .. 18.01 Degrees
 R-mag 0.89

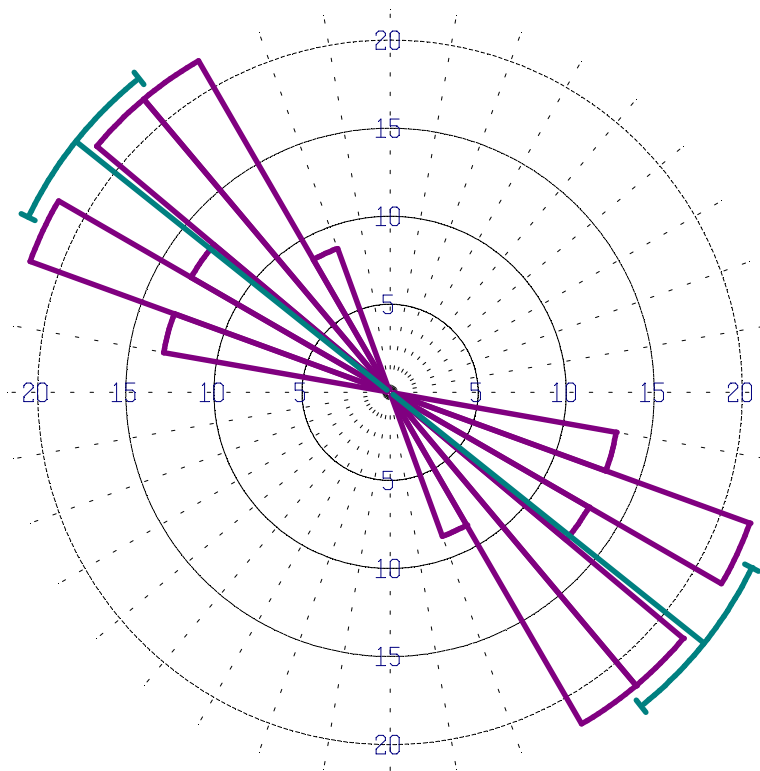
Figure 5.19: Roseplot data of the borehole breakout data within the Beaverhill Lake Group for the 16 wells analyzed in the study weighted by length of the breakout interval.



Population 1

Calculation Method ... Frequency
Class Interval 10 Degrees
Filtering Deactivated
Data Type Bidirectional
Rotation Amount 0 Degrees
Population 9
Maximum Percentage ... 33.3 Percent
Mean Percentage 20 Percent
Standard Deviation ... 8.76 Percent
Vector Mean 318.77 Degrees
Confidence Interval .. 16.2 Degrees
R-mag 0.91

Figure 5.20: Roseplot data of the average minimum horizontal stress orientation in Paleozoic-age formations above the Beaverhill Lake Group (8 wells from the Geological Atlas of Western Canada, Bell et al., 1994 and 1 well from the expanded Saskatchewan study area). Note that these breakout data are not weighted by the length of the breakout interval: A single value of the breakout azimuth irrespective of the length of breakout was assigned to each well.



Population 1

Calculation Method ... Frequency
Class Interval 10 Degrees
Filtering Activated
 Minimum Azimuth ... 80 Degrees
 Maximum Azimuth ... 180 Degrees
Data Type Bidirectional
Rotation Amount 0 Degrees
Population 23
Maximum Percentage ... 21.7 Percent
Mean Percentage 16.7 Percent
Standard Deviation ... 5.51 Percent
Vector Mean 308.61 Degrees
Confidence Interval .. 12.75 Degrees
R-mag 0.86

Figure 5.21: Roseplot data of the average minimum horizontal stress orientation determined from population 1 data for all 24 wells (16 from this study and 8 from the Geological Atlas of the Western Canadian Sedimentary Basin).

5.4 Horizontal Stress Magnitudes

5.4.1 Formation Leak-off Test and Hydraulic Fracture Data

Formation leak-off test (FLOT) data in the original Phase 1 study area was provided by Dr. Matt Grobe (AGS) in conjunction with the AEUB in Calgary. Of the 10 tests provided to AGI none are below 500 m depth. As shown in Figure 5.22, there is considerable scatter in the data. We do not believe that these data are of high value for estimating the horizontal stress magnitudes in or adjacent to the Elk Point Group. Following discussion of the Phase 1 search results with AGS, it was decided that formation leak-off test data would not be examined further in subsequent phases of the study.

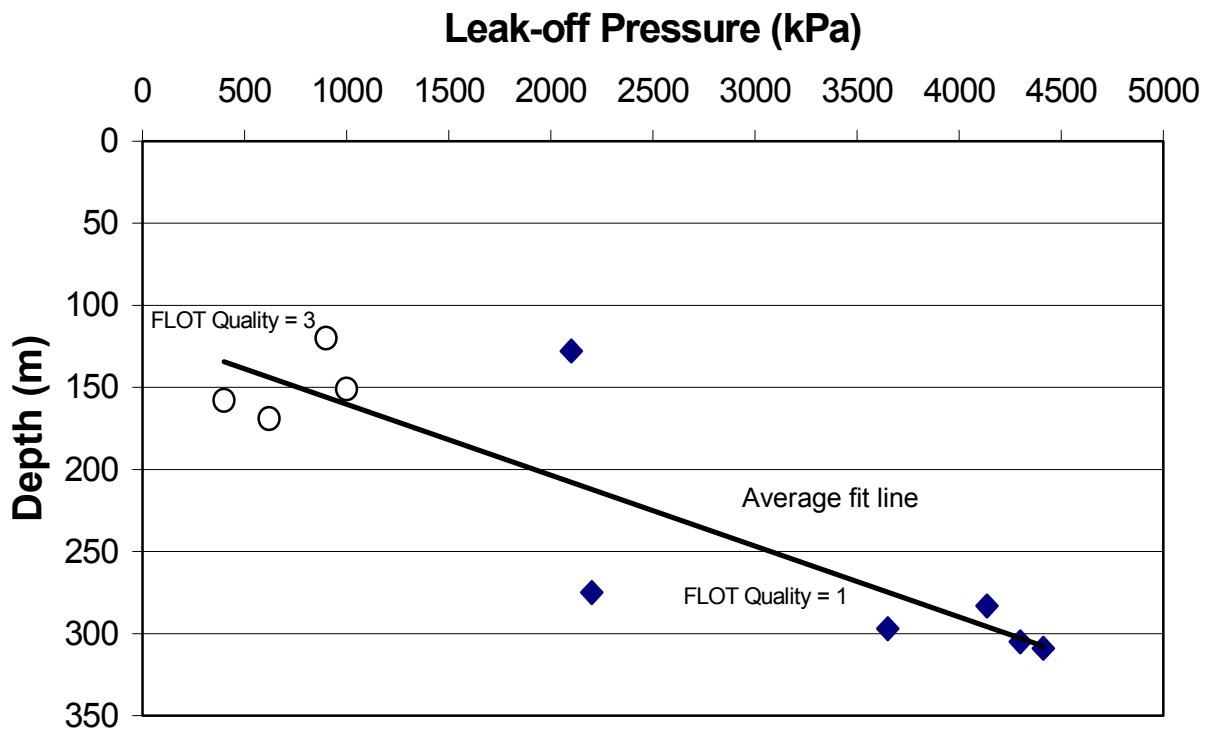


Figure 5.22: Summary of formation leak-off test data in the original study area that were provided by the AGS.

There were no publicly-available hydraulic fracture data identified in the original study area. Data of this type may be available for purchase from selected service or operating companies, but would require considerable effort and cost to locate, process and analyze. These tasks were beyond the scope of the current study, but could be conducted at some later date.

Without good quality data from either formation leakoff tests or hydraulic fracture tests, there is not enough information available to confidently estimate variations in the magnitude of the minimum horizontal stress in the original or expanded study areas. In the absence of hard data, and given the propensity of salt to creep over geologic time, a first-order estimate of the magnitude of the mean horizontal stress would be a value equal to the vertical stress.

5.4.2 Back-Analysis of Horizontal Stress Ratios from Borehole Breakouts

A back-analysis of borehole breakouts in Voyager et al Bruce 6-14-48-14W4 was conducted using AGI's STABView borehole stability software (Advanced Geotechnology Inc., 2000) to investigate whether the horizontal stress ratio can be estimated from caliper data (Figure 5.23). McLellan et al. (1999) demonstrated how back-analysis procedures can be used to estimate the best-fit horizontal stresses to match enlarged hole ellipticity observed on caliper logs. Caliper measurements in the Voyager 6-14 well indicate an average hole ellipticity (major to minor axis ratio, a/b) of about 1.07 for the interval from 1459 to 1475 m KB. Note that inverse modelling does not determine a unique solution for the horizontal in-situ stress ratio, so a range of results is given.

Estimates of rock mechanical properties were obtained from compressional sonic logs, giving a peak cohesion value of 6 to 7 MPa, and peak friction angle from 30 to 40°. The ratio of maximum to minimum horizontal stress was calculated to fall between 1.24 to 1.37. These values are dependent on the rock strength properties in the interval and assume that the entire yielded zone predicted by STABView detaches to create the breakout. Better stress ratio estimates can be obtained when rock mechanical properties are measured on core samples or determined from logs and minimum horizontal in-situ stresses are interpreted from extended leak-off or minifrac tests. Back-analysis of borehole breakouts was not conducted for Phase 3 of this study.

Cross Section of Yielded Zone

NYZA = 0.02
R/rw = 1.00
R = 80 mm
rw = 80 mm
a = 85 mm
b = 80 mm
a/b = 1.07
a/rw = 1.07
b/rw = 1.00
Skin = 0.00
Density = 1270 kg/m³
BHP-Pf = 3.6 MPa

$C_p = 6.0 - 7.0$ MPa
 $C_r = 2.0$ MPa
 $\phi_p = 40^\circ$
 $\phi_r = 30 - 40^\circ$
 $\sigma_{Hmax}/\sigma_{Hmin} = 1.24 - 1.37$

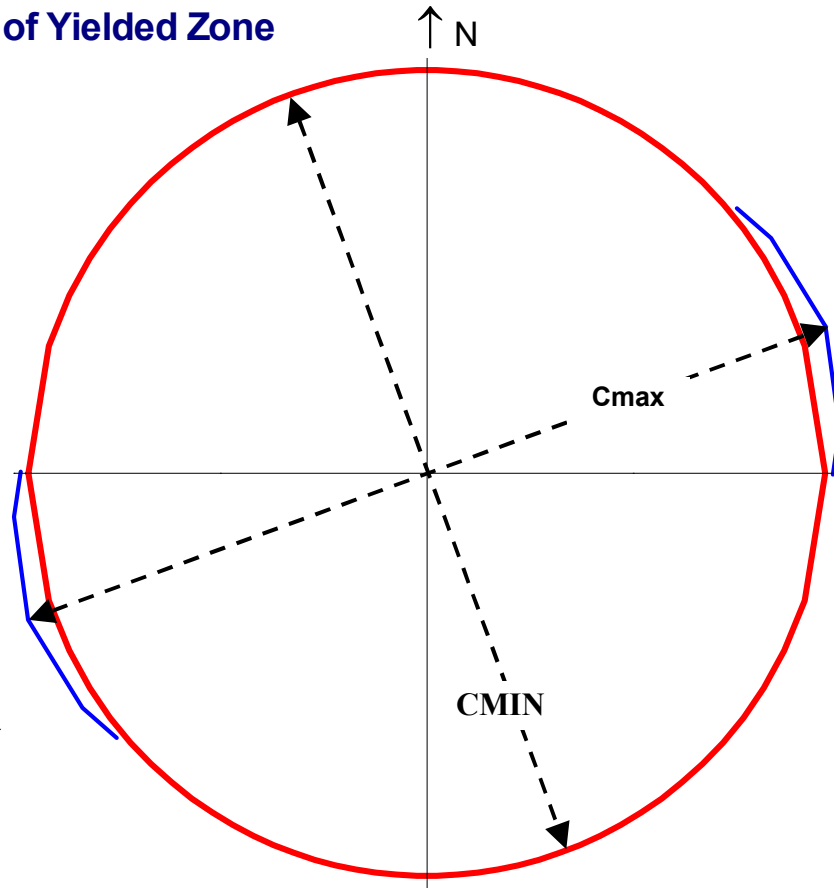


Figure 5.23: Back-analysis of a borehole breakout to estimate the horizontal stress ratio using Advanced Geotechnology's STABView software. Breakout data are from 1459 to 1475 mKB in the Watt Mountain Formation, Voyager et al. Bruce 6-14-48-14W4.

6. DISCUSSION OF RESULTS

A three phase investigation was undertaken to quantify in-situ stresses in and adjacent to salt formations of the Elk Point Group. Phase 1 included: (1) a literature review on the subject of stresses and rock mechanical properties in salt, (2) data compilation and review for the original study area. Phase 2 included: (1) analysis of data from the original study area, and (2) data compilation and review for an expanded Alberta study area. Phase 3 included: (1) analysis data from the expanded Alberta study area, (2) compilation, review and analysis of data from the expanded Saskatchewan study area and (3) compilation of the results from all three phases.

6.1 Literature Review

The literature review shows that the geomechanical behaviour of salt adjacent to underground openings is complex, often involving brittle fracturing near the opening resulting from elastic deformation, and creep deformation in a zone around the opening. Creep deformation dominates the long-term response under deviatoric stress conditions. Creep rates are a function of many parameters and can vary widely from one setting to the next, or from one salt to the next. Because the factors controlling creep deformation are formation-specific and depth-specific, the relevant creep response parameters of the salt formations of interest are best-determined on well-preserved core samples in controlled laboratory tests. Tests of this type have been undertaken on salt and potash samples at the University of Saskatchewan, the University of Manitoba, and by the mining industry in Saskatchewan. Anecdotal evidence (A. Coode, IMC Colonsay) suggests that creep rates for potash can be 5 to 8 times greater than those for halite in some Saskatchewan settings.

Although there have been numerous rock mechanical tests conducted on potash that are described in published literature, there were no reported rock mechanical properties on halite from the Elk Point Group identified in the literature review. One shear strength value of 21 MPa (believed to be either an unconfined or triaxial compressive strength value) for the Upper Lotsberg Formation is contained in Northwestern Utilities Ltd.'s AEUB application 820504. In general, published values for elastic deformation properties of salt do not vary over a wide range, but strength parameters vary considerably for different salts.

Of the AEUB applications related to salt cavern development that were reviewed, none contained specific cavern geotechnical design parameters. Solution mining is the only reported method employed for cavern development, using either a single or two-hanging string approach to control cavern geometry. Large caverns of this type for gas and liquid petroleum storage or oily waste disposal are common in the Lotsberg Formation in the Fort Saskatchewan area, the Prairie Evaporite Formation near Lloydminster, and the Elk Point Group salt near the Hardisty area. Upper limit operating pressures and cavern spacing are selected to avoid fracturing of the salt formation, and lower limit operating pressures are selected to avoid excessive creep closure during drawdown. Cavern diameters up to 80 m have been approved in Alberta (e.g., Northwestern Utilities Ltd., AEUB application no. 830529).

6.2 Data Review

There were no suitable formation leakoff or hydraulic fracture test data identified in the public domain for analyses of minimum horizontal stress magnitudes in the original study area. Core from the original and expanded study areas is available for analysis using paleomagnetic orientation methods to supplement the information from dipmeter logs on horizontal stress orientation.

In the original study area, 65 wells were used to determine the vertical stress at the top of the Prairie Evaporite Formation and 49 wells were used to determine the vertical stress at the top of the Basal Red Beds Formation. In the expanded study area, 112 wells were used to determine the vertical stress at the top of the Prairie Evaporite Formation (90 from the expanded Alberta study area and 22 from the expanded Saskatchewan study area).

In total, there were 24 minimum stress orientations available in the complete study area for Paleozoic-age formations (8 from the Geological Atlas of the Western Canadian Sedimentary Basin and 16 from this report). This includes 9 wells with minimum stress orientation determined in formations above the Beaverhill Lake Group, 10 wells with minimum stress orientation determined within the Beaverhill Lake Group, and 9 wells with minimum stress orientation determined within the Elk Point Group.

6.3 Analysis of Vertical Stresses

The analysis of bulk density log data provided estimates of the vertical stresses and vertical stress gradients at the top of the Prairie Evaporite Formation in the original and expanded study area. The analysis of bulk density data provided estimates of the vertical stresses and vertical stress gradients at the top of the Basal Red Beds Formation (which were used to define the bottom of the Elk Point Group) in the original area. The vertical stress ranged from 13.5 to 39.1 MPa at the top of the Basal Red Beds in the original study area. The vertical stress gradient at the top of the Basal Red Beds Formation in the original study area ranges from 21.3 to 23.6 kPa/m. A concentric zone of lower vertical stress gradient is evident at the top of this formation. This anomaly is associated with thicker occurrences of the relatively low-density Lotsberg and Cold Lake Formations in this region of the original study area.

Contour plots indicate that the vertical stress at the top of the Prairie Evaporite Formation ranges from 7.4 to 31.7 MPa in the original study area and from 10.2 to 54.0 MPa in the expanded area. The vertical stress gradient at the top of the Prairie Evaporite Formation ranges from 21.3 to 23.9 kPa/m in the original study area, decreasing towards the eastern boundary of the Prairie Evaporite Formation. The vertical stress gradient at the top of the Prairie Evaporite Formation in the expanded study area ranges from 21.5 to 24.7 kPa/m, with the lower vertical stress gradients being in the NE and the higher vertical stress gradients being in the SW. This trend may be a result of northeastward-thickening Quaternary or Cretaceous deposits of relatively low density, and the increase in density of formations above the Prairie Evaporite towards the SW. Despite sparse data coverage in some parts of the study area such as the Wood Buffalo National Park, the contour plots for the vertical stress and the vertical stress gradient are considered representative of in-situ conditions.

6.4 Analysis of Horizontal Stresses

The horizontal stress orientations calculated from breakouts in the study area generally agree with those from the Geological Atlas of Western Canada (Bell et al., 1994), although there were some data inconsistencies noted in the atlas.

The dataset of 8 wells from the Geological Atlas of the Western Canadian Sedimentary Basin has an average minimum stress orientation of 137° (confidence interval 16°) with a range from 118° to 148° . The average minimum horizontal stress orientation determined from the 16 wells analyzed in this report is 120° with a confidence interval of 16° with a range from azimuth 101° to 152° , similar to the atlas measurements in the Paleozoic-age formations. It is important to note that the dataset from the Atlas was from Paleozoic-age formations above the Beaverhill Lake Group whereas 15 of the 16 wells analyzed in this report had breakouts from the Beaverhill Lake Group and/or Elk Point Groups. The average minimum horizontal stress orientation for all 24 wells is 129° with a confidence interval of 13° .

A rotation of the minimum horizontal stress in the upper Paleozoic formations to a more NNW – SSE orientation can be seen in the dataset. The average minimum horizontal stress orientation determined in the Elk Point Group was 116° (confidence interval 5°), the average minimum horizontal stress orientation determined in the Beaverhill Lake Group was 124° (confidence interval 8°), and the average minimum horizontal stress orientation determined in other Paleozoic formations above the Beaverhill Lake Group was 139° (confidence interval 16°). Bell et al. (1993) note, that in general, the minimum stress orientation was similar over most formations of a variety of ages.

Deviatoric horizontal stresses result in a non-uniform distribution of compressive stresses at the periphery of an underground opening. This may in turn effect localized brittle damage and non-uniform creep rates at different locations around the opening. If knowledge of the deviatoric stress magnitude is deemed necessary for cavern design, privately-held hydraulic fracture test data could possibly be accessed. Small volume, controlled micro-fracture tests are recommended prior to cavern development to obtain site-specific design data.

STABView software was used to back analyze the range of horizontal in-situ stress ratios possible for a breakout in one well in the study area. However, because there were no publicly-available data on the magnitude of the minimum horizontal in-situ stress, the absolute magnitudes of the two horizontal stresses in the original study area are not known. To reduce the uncertainty in this type of stress ratio prediction, the mechanical properties of the rock in question should be determined from cores or calculated from sonic logs.

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APPENDIX A

BIBLIOGRAPHY ON SALT GEOMECHANICS (MARCH 1, 2001)

APPENDIX A: Bibliography on Salt Geomechanics (March 1, 2001)

- A.1 In-Situ Stress**
- A.2 Mechanical Properties**
- A.3 Creep Response of Tunnels, Caverns and Boreholes in Salt**
- A.4 Geology of Salt Deposits in Western Canada**
- A.5 Waste Storage and Disposal in Salt**
- A.6 Casing Failures in Salt**
- A.7 Hydrocarbon Storage in Salt**
- A.8 Sandia National Laboratory Publications (Restricted and Public)**
- A.9 EUB Applications Related to Salt Caverns**

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Call Number SAND97-1017A

Title Rock mechanics : tools and techniques : proceedings of the 2nd North American Rock Mechanics Symposium, NARMS '96, a regional conference of ISRM, Montreal, Quebec, Canada, 19-21 June 1996 /
Author(s) Aubertin, Michel INTERNATIONAL SOCIETY FOR ROCK MECHANICS
Pubdate 1996
Location Nuclear Waste Management Programs Library
Call Number TA706.N67 1996 v.1
Location Nuclear Waste Management Programs Library
Call Number TA706.N67 1996 v.2

Title Using three dimensional structural simulations to study the interactions of multiple excavations in salt.
Author(s) Sandia National Laboratories, Hoffman, Edward L.
Pubdate January 1998
Location Technical Library/NM
Call Number SAND97-1017C

Title Micromechanics and homogenization techniques for analyzing the continuum damage of rock salt.
Author(s) Sandia National Laboratories, DeVries, Kerry L.
Pubdate February 1998
Location WIPP Library
Call Number SAND98-0466C
Location Nuclear Waste Management Programs Library
Call Number SAND98-0466C
Location Technical Library/NM
Call Number SAND98-0466C

Title Permeability of natural rock salt from the Waste Isolation Pilot Plant (WIPP) during damage evolution and healing.
Author(s) Sandia National Laboratories, Pfeifle, Tom W.
Pubdate March 1998
Location WIPP Library
Call Number SAND98-0417C
Location Nuclear Waste Management Programs Library
Call Number SAND98-0417C
Location Technical Library/NM
Call Number SAND98-0417C

Title Selected bibliography on ground subsidence caused by dissolution and removal of salt and other soluble evaporites.
Author(s) Geological Survey (U.S.) Ege, John Rooda
Pubdate 1979
Location Nuclear Waste Management Programs Library
Call Number USGS-OFR-79-1133

Title Experimental determination of the relationship between permeability and microfracture-induced damage in bedded salt.
Author(s) Sandia National Laboratories, Pfeifle, Tom W.
Pubdate February 1998
Location WIPP Library
Call Number SAND98-0411C
Location Nuclear Waste Management Programs Library
Call Number SAND98-0411C
Location Technical Library/NM

Call Number SAND98-0411C

Title Application of isochronous healing curves in predicting damage evolution in salt structure.

Author(s) Sandia National Laboratories, Chan, Kwai S.

Pubdate February 1998

Location WIPP Library

Call Number SAND97-3146J

Location Nuclear Waste Management Programs Library

Call Number SAND97-3146J

Location Technical Library/NM

Call Number SAND97-3146J

Title Rock mechanics models evaluation report.

Author(s) Fluor Technology, Inc. Morrison-Knudsen Engineers, Inc.

Pubdate August 1987

Location Nuclear Waste Management Programs Library

Call Number DOE/CH/46656-09

Location Nuclear Waste Management Programs Library

Call Number DOE/CH/46656-09

Title A study of the extent of the disturbed rock zone surrounding long-term excavations in rock salt.

Author(s) Sandia National Laboratories, Miller, Joel D.

Pubdate August 1998

Location WIPP Library

Call Number SAND98-1755A

Location Nuclear Waste Management Programs Library

Call Number SAND98-1755A

Location Technical Library/NM

Call Number SAND98-1755A

Title Assessing the disturbed rock zone (DRZ) around an eight hundred meter vertical shaft in salt using ultrasonic waves.

Author(s) Sandia National Laboratories, Holcomb, David Joseph

Pubdate February 1999

Location Technical Library/NM

Call Number SAND99-0442A

Title Numerical modeling of deformation in salt basins : technical report /

Author(s) Battelle Memorial Institute. Chang, C. Y. Battelle Memorial Institute.

Pubdate [1987]

Location Nuclear Waste Management Programs Library

Call Number BMI/ONWI-649

Title Surface displacements and pillar stresses associated with nuclear waste disposal in salt.

Author(s) MINNESOTA UNIV., MINNEAPOLIS Hardy, M. P. Union Carbide Corporation.

Pubdate June 1977

Location Nuclear Waste Management Programs Library

Call Number Y/OWI/SUB-7118/P1

Title Comparison and evaluation of field and numerical results from the Site A heater test at Avery Island

Author(s) RE/SPEC Inc. Wagner, Ralph A. Battelle Memorial Institute.

Pubdate [1985].

Location Nuclear Waste Management Programs Library

Call Number ONWI-300

Title Computation of the extent of the disturbed rock zone surrounding long-term excavations in rock salt.
Author(s) Sandia National Laboratories, Miller, Joel D.
Pubdate April 1999
Location WIPP Library
Call Number SAND99-0858A
Location Nuclear Waste Management Programs Library
Call Number SAND99-0858A
Location Technical Library/NM
Call Number SAND99-0858A

Title NWTS in situ test needs workshop : August 29/30, 1978.
Author(s) NWTS In Situ Test Needs Workshop Dames & Moore.
Pubdate 1978.
Location Nuclear Waste Management Programs Library
Call Number ONWI-7

Title Parametric study involving thermo/viscoelastic analyses of a room and pillar configuration : technical report /
Author(s) Battelle Memorial Institute. Wagner, Ralph A. Battelle Memorial Institute.
Pubdate 1983.
Location Nuclear Waste Management Programs Library
Call Number ONWI-115

Title Key geomechanics issues at the Waste Isolation Pilot Plant.
Author(s) Sandia National Laboratories, Hansen, Francis D.
Pubdate June 1999
Location WIPP Library
Call Number SAND99-1281C
Location Nuclear Waste Management Programs Library
Call Number SAND99-1281C
Location Technical Library/NM
Call Number SAND99-1281C

Title Critical parameters for a high-level waste repository.
Author(s) United States. Binnall, E. P. Lawrence Livermore Laboratory.
Pubdate 1985-1987.
Location Nuclear Waste Management Programs Library
Call Number NUREG/CR-4161, v.1
Location Nuclear Waste Management Programs Library
Call Number NUREG/CR-4161, v.2
Location Nuclear Waste Management Programs Library
Call Number NUREG/CR-4161, v.3

Title Assessing the disturbed rock zone (DRZ) around a 655 meter vertical shaft in salt using ultrasonic waves : an update.
Author(s) Sandia National Laboratories, Hardy, Robert Douglas
Pubdate February 2000
Location Technical Library/NM
Call Number SAND2000-0668C

Title Low temperature creep mechanics in rock salt.
Author(s) Sandia National Laboratories, Wawersik, Wolfgang R.
Pubdate September 1982

- Location** Nuclear Waste Management Programs Library
Call Number SAND82-2071A
Location Technical Library/NM
Call Number SAND82-2071A
- Title** The Effect of a random variation of rock salt creep on closure calculations for an excavated opening in a complex stratigraphy.
Author(s) Sandia National Laboratories, Branstetter, Linda J.
Pubdate September 1982
Location Nuclear Waste Management Programs Library
Call Number SAND82-2256A
Location Technical Library/NM
Call Number SAND82-2256A
- Title** Using hydraulic fracturing and mineback to determine in situ stresses in rock salt.
Author(s) Sandia National Laboratories, Wawersik, Wolfgang R.
Pubdate April 1988
Location Nuclear Waste Management Programs Library
Call Number SAND88-1113A
Location Technical Library/NM
Call Number SAND88-1113A
- Title** Three-dimensional finite element simulation of creep deformation in rock salt.
Author(s) Sandia National Laboratories, Weatherby, Joe Randall
Pubdate March 1993
Location Nuclear Waste Management Programs Library
Call Number SAND92-1537C
Location Technical Library/NM
Call Number SAND92-1537C
- Title** Recursive adaptive meshing and discrete fracture modeling in rock salt.
Author(s) Sandia National Laboratories, Chieslar, Jack D.
Pubdate September 1992
Location Nuclear Waste Management Programs Library
Call Number SAND92-1628A
Location Technical Library/NM
Call Number SAND92-1628A
- Title** Creep rupture of rock salt
Author(s) Munson, Darrell E. Sandia National Laboratories,
Pubdate February 1994
Location Technical Library/NM
Call Number SAND93-3902J
- Title** A Constitutive model for representing coupled creep, fracture, and healing in Rock Salt.
Author(s) Sandia National Laboratories, Chan, Kwai S.
Pubdate January 1996
Location Technical Library/NM
Call Number SAND95-1150A
- Title** Buoyancy flow in fractured rock with a salt gradient in the groundwater--an initial study /
Author(s) Swedish Nuclear Fuel and Waste Management Company (SKB), Claesson, Johan Lund University.
Pubdate February 1992.
Location Nuclear Waste Management Programs Library

- Call Number** SKB-TR-92-05
- Title** Buoyancy flow in fractured rock with a salt gradient in the groundwater : a second study of coupled salt and thermal buoyancy /
- Author(s)** Swedish Nuclear Fuel and Waste Management Company (SKB), Claesson, Johan Lund University.
- Pubdate** November 1992.
- Location** Nuclear Waste Management Programs Library
- Call Number** SKB-TR-92-41
- Title** Brine migration test : Asse Salt Mine, Federal Republic of Germany : final report /
- Series** GSF-Bericht ;
- Author(s)** GSF - Gesellschaft für Strahlen- und Umweltforschung München Rothfuchs, T. Battelle Memorial Institute.
- Pubdate** c1988.
- Location** WIPP Library
- Call Number** GSF-R 6/88
- Location** Nuclear Waste Management Programs Library
- Call Number** GSF-R 6/88
- Title** Consolidation of crushed rock salt, part I : experimental results for dry salt analyzed using a hot-pressing model.
- Author(s)** Sandia National Laboratories, Holcomb, David Joseph
- Pubdate** October 1988
- Location** WIPP Library
- Call Number** SAND88-1469
- Location** Nuclear Waste Management Programs Library
- Call Number** SAND88-1469
- Location** Technical Library/CA
- Call Number** SAND88-1469
- Title** Transmittal of English translations of German papers on sealing and backfilling.
- Author(s)** Battelle Memorial Institute.
- Pubdate** March 1987
- Location** Nuclear Waste Management Programs Library
- Call Number** ONWI-015-87-050
- Title** ANALYSIS OF CREEP DATA FOR VARIOUS NATURAL ROCK SALTS
- Author(s)** Herrmann, Walter Sandia National Laboratories,
- Pubdate** December 1981
- Location** WIPP Library
- Call Number** SAND81-2567
- Location** Nuclear Waste Management Programs Library
- Call Number** SAND81-2567
- Location** Technical Library/NM
- Call Number** SAND81-2567
- Title** Measurements of very large deformations in "Potash Salt" in conjunction with an ongoing mining operation.
- Author(s)** Sandia National Laboratories, Sattler, Allan R.
- Pubdate** June 1980
- Location** WIPP Library
- Call Number** SAND79-2254
- Location** Nuclear Waste Management Programs Library
- Call Number** SAND79-2254

- Location** Technical Library/NM
Call Number SAND79-2254
- Title** Evaluation of potential crushed-salt constitutive models.
Author(s) Sandia National Laboratories, Callahan, Gary D. RE/SPEC Inc.
Pubdate December 1995
Location WIPP Library
Call Number SAND95-2143
Location Nuclear Waste Management Programs Library
Call Number SAND95-2143
Location Technical Library/CA
Call Number SAND95-2143
- Title** Preliminary constitutive properties for salt and nonsalt rocks from four potential repository sites technical report.
Author(s) Battelle Memorial Institute. Pfeifle, Tom W. RE/SPEC Inc.
Pubdate July 1983
Location Nuclear Waste Management Programs Library
Call Number ONWI-450
Location Nuclear Waste Management Programs Library
Call Number ONWI-450
- Title** The Permeability of salt-crystal interfaces to brine /
Series ORNL (Oak Ridge National Laboratory) ;
Author(s) Oak Ridge National Laboratory, Gilpatrick, L. O. Oak Ridge National Laboratory,
Pubdate 1982.
Location Nuclear Waste Management Programs Library
Call Number ORNL-5874
- Title** Proceedings of the National Waste Terminal Storage Program Information Meeting, Columbus, Ohio, October 30-November 1, 1979 : sponsored by the U.S. Dept. of Energy, Richland Operations Office.
Author(s) National Waste Terminal Storage Program Information Meeting National Waste Terminal Storage Program Office (U.S.).
Pubdate 1979]
Location Nuclear Waste Management Programs Library
Call Number ONWI-62
- Title** Mechanical behavior of Avery Island halite, a preliminary analysis : technical report /
Author(s) Battelle Memorial Institute. Carter, Neville L. RE/SPEC Inc.
Pubdate 1980.
Location Nuclear Waste Management Programs Library
Call Number ONWI-100
- Title** Evaluation of salt bodies and their overburden in the Netherlands for the disposal of radioactive waste : e. geological barrier model.
Author(s) Geological Survey of the Netherlands (RGD). Ruizendaal, A. Netherlands.
Pubdate November 1993
Location Nuclear Waste Management Programs Library
Call Number NWML/1999/0061
- Title** Physical properties data for rock salt /
Series NBS monograph ; 167
Author(s) Gevantman, L. H.

Pubdate 1981.
Location Nuclear Waste Management Programs Library
Call Number NBS-MONO-167
Location Technical Library/NM
Call Number TN 902 - -G337-81

Title The effect of a random variation of rock salt creep on calculations of storage room closure for the WIPP project.
Author(s) Sandia National Laboratories, Branstetter, Linda J.
Pubdate December 1982
Location WIPP Library
Call Number SAND82-0024
Location Nuclear Waste Management Programs Library
Call Number SAND82-0024
Location Technical Library/CA
Call Number SAND82-0024

Title Review and comparison of transient creep laws used for natural rock salt.
Author(s) Sandia National Laboratories, Herrmann, Walter
Pubdate April 1981
Location WIPP Library
Call Number SAND81-0738
Location Nuclear Waste Management Programs Library
Call Number SAND81-0738
Location Technical Library/NM
Call Number SAND81-0738

Title IMPLEMENTATION OF A TRANSIENT CREEP MODEL FOR NATURAL ROCK SALT AS A MATERIAL RESPONSE SUBROUTINE FOR SANCHO
Author(s) Sandia National Laboratories, Montgomery, Stephen T. Sandia National Laboratories,
Pubdate August 1981
Location Nuclear Waste Management Programs Library
Call Number SAND81-1163
Location Technical Library/NM
Call Number SAND81-1163

Title REVISED THEORY OF WATER TRANSPORT IN ROCK SALT
Author(s) Hadley, G. Ronald Sandia National Laboratories,
Pubdate October 1981
Location WIPP Library
Call Number SAND80-2398
Location Nuclear Waste Management Programs Library
Call Number SAND80-2398
Location Technical Library/NM
Call Number SAND80-2398

Title Interim summary of Sandia creep experiments on rock salt from the WIPP study area, southeastern New Mexico
Author(s) Sandia National Laboratories, Wawersik, Wolfgang R.
Pubdate February 1979
Location WIPP Library
Call Number SAND79-0115
Location Nuclear Waste Management Programs Library
Call Number SAND79-0115

Location Technical Library/CA
Call Number SAND79-0115
Location Technical Library/NM
Call Number SAND79-0115

Title Constitutive models applied in the analysis of creep of rock salt.
Author(s) Sandia National Laboratories, Dawson, Paul Richard
Pubdate April 1979
Location WIPP Library
Call Number SAND79-0137
Location Nuclear Waste Management Programs Library
Call Number SAND79-0137
Location Technical Library/CA
Call Number SAND79-0137

Title Compressibility of granulated rock salt.
Author(s) Sandia National Laboratories, Stinebaugh, Robert E.
Pubdate August 1979
Location WIPP Library
Call Number SAND79-1119
Location Nuclear Waste Management Programs Library
Call Number SAND79-1119
Location Technical Library/NM
Call Number SAND79-1119

Title THERMAL PROPERTIES MEASUREMENT ON ROCK SALT SAMPLES FROM THE SITE OF THE PROPOSED WASTE ISOLATION PILOT PLANT
Author(s) Sweet, James N. Sandia National Laboratories,
Pubdate May 1980
Location Nuclear Waste Management Programs Library
Call Number SAND80-0799
Location Technical Library/NM
Call Number SAND80-0799

Title CREEP HEALING OF FRACTURES IN ROCK SALT
Author(s) Costin, Laurence S. Sandia National Laboratories,
Pubdate August 1980
Location WIPP Library
Call Number SAND80-0392
Location Nuclear Waste Management Programs Library
Call Number SAND80-0392
Location Technical Library/CA
Call Number SAND80-0392

Title MODEL FOR TRANSIENT CREEP OF SOUTHEASTERN NEW MEXICO ROCK SALT
Author(s) Herrmann, Walter Sandia National Laboratories,
Pubdate November 1980
Location WIPP Library
Call Number SAND80-2172
Location Nuclear Waste Management Programs Library
Call Number SAND80-2172
Location Technical Library/CA
Call Number SAND80-2172

- Title** A Comparison of unified creep-plasticity and conventional creep models for rock salt based on predictions of creep behavior measured in several in situ and bench-scale experiments.
- Author(s)** Sandia National Laboratories, Morgan, Harold S.
- Pubdate** April 1988
- Location** WIPP Library
- Call Number** SAND87-1867
- Location** Nuclear Waste Management Programs Library
- Call Number** SAND87-1867
- Location** Technical Library/CA
- Call Number** SAND87-1867
-
- Title** Interim report on the effects of brine-saturation and shear stress on consolidation of crushed, natural rock salt from the Waste Isolation Pilot Plant (WIPP).
- Author(s)** Sandia National Laboratories, Zeuch, David Henry
- Pubdate** July 1991
- Location** WIPP Library
- Call Number** SAND91-0105
- Location** WIPP Library
- Call Number** SAND91-0105
- Location** Nuclear Waste Management Programs Library
- Call Number** SAND91-0105
- Location** Technical Library/NM
- Call Number** SAND91-0105
-
- Title** In situ measurements of rock salt permeability changes due to nearby excavation.
- Author(s)** Sandia National Laboratories, Stormont, John C.
- Pubdate** July 1991
- Location** WIPP Library
- Call Number** SAND90-3134
- Location** Nuclear Waste Management Programs Library
- Call Number** SAND90-3134
- Location** Technical Library/CA
- Call Number** SAND90-3134
-
- Title** Multiaxial creep of natural rock salt.
- Author(s)** Sandia National Laboratories, Mellegard, K. D.
- Location** WIPP Library
- Call Number** SAND91-7083
- Location** Nuclear Waste Management Programs Library
- Call Number** SAND91-7083
- Location** Technical Library/CA
- Call Number** SAND91-7083
-
- Title** Indicator tests for the creep of rock salt from borehole Moss Bluff 2, Moss Bluff Dome, Texas
- Author(s)** Wawersik, Wolfgang R. Sandia National Laboratories,
- Pubdate** November 1992
- Location** Technical Library/CA
- Call Number** SAND92-2122
- Location** Technical Library/NM
- Call Number** SAND92-2122
-
- Title** Dilation-induced permeability changes in rock salt
- Author(s)** Stormont, John C. Sandia National Laboratories,
- Pubdate** November 1993

- Location** WIPP Library
Call Number SAND93-2670C
Location Nuclear Waste Management Programs Library
Call Number SAND93-2670C
Location Technical Library/NM
Call Number SAND93-2670C
- Title** Triaxial creep measurements on rock salt from the Jennings dome, Louisiana, Borehole LA-1, Core #8
Author(s) Wawersik, Wolfgang R. Sandia National Laboratories,
Pubdate May 1994
Location Technical Library/CA
Call Number SAND94-1432
- Title** Mechanical behavior of New Mexico rock salt in triaxial compression up to 200 degrees C.
Author(s) Sandia National Laboratories, Wawersik, Wolfgang R.
Pubdate July 1979
Location WIPP Library
Call Number SAND77-1192
Location Nuclear Waste Management Programs Library
Call Number SAND77-1192
- Title** Mechanical behavior of New Mexico rock salt in triaxial compression up to 200 degrees C.
Author(s) Sandia National Laboratories, Wawersik, Wolfgang R.
Pubdate July 1979
Location Nuclear Waste Management Programs Library
Call Number SAND77-1192C
- Title** Untersuchungen zur dichte und schallgeschwindigkeit des steinsalzes der Asse in situ und im labor.
Author(s) GSF - Gesellschaft für Strahlen- und Umweltforschung München Gommlich, G. Institut für Tiefklagurung Abteilung für Endlagertechnologie.
Pubdate 1993
Location Nuclear Waste Management Programs Library
Call Number GSF-R-22/93
- Title** Distribution of chloride in a salt-saturated grout in contact with rock salt.
Author(s) Army Engineer Waterways Experiment Station, Wakeley, Lillian D.
Pubdate September 1985
Location Nuclear Waste Management Programs Library
Call Number WES/MP/SL-85-15
- Title** Fluid and ionic transport properties of deformed salt rock : final report, January 1984-June 1985 /
Series Nuclear science and technology (Commission of the European Communities)
Author(s) Commission of the European Communities Peach, C. J. Commission of the European Communities.
Pubdate 1987.
Location Nuclear Waste Management Programs Library
Call Number EUR-10926-EN
- Title** Experimental consolidation of granulated rock salt with application to sleeve buckling.
Author(s) RE/SPEC Inc. Hansen, Francis D. Oak Ridge National Laboratory,
Pubdate 1976.
Location Nuclear Waste Management Programs Library
Call Number ORNL-SUB-4269-21

Title Thermal conductivity of rock salt from Louisiana salt domes /
Author(s) Oak Ridge National Laboratory. Morgan, M. T. United States.
Pubdate June 1979.
Location Nuclear Waste Management Programs Library
Call Number ORNL/TM-6809

Title Influence of deformation on the fluid transport properties of salt rocks = Invloed van deformatie op de vloeistoftransporteigenschappen van zoutgesteenten /
Series Geologica ultraiectina no. 77
Author(s) Peach, Colin Jack, Rijksuniversiteit te Utrecht.
Pubdate 1991.
Location Technical Library/NM
Call Number TN 900 - -P42 -91

Title THERMAL PROPERTIES MEASUREMENT ON ROCK SALT SAMPLES FROM THE SITE OF THE PROPOSED WASTE ISOLATION PILOT PLANT
Author(s) Sweet, James N. Sandia National Laboratories,
Pubdate 1980
Location Nuclear Waste Management Programs Library
Call Number SAND80-0799A
Location Nuclear Waste Management Programs Library
Call Number SAND80-0799A

Title Field tests of stress measurement techniques in rock salt.
Author(s) Sandia National Laboratories, Stormont, John C.
Pubdate April 1984
Location WIPP Library
Call Number SAND83-2507
Location Nuclear Waste Management Programs Library
Call Number SAND83-2507
Location Technical Library/CA
Call Number SAND83-2507

Title Analysis of borehole inclusion stress measurement concepts proposed for use in the Waste Isolation Pilot Plant in situ testing program.
Author(s) Sandia National Laboratories, Morgan, Harold S.
Pubdate June 1982
Location WIPP Library
Call Number SAND82-1192
Location WIPP Library
Call Number SAND82-1192
Location Nuclear Waste Management Programs Library
Call Number SAND82-1192
Location Technical Library/NM
Call Number SAND82-1192

Title Preliminary deformation-mechanism map for salt (with application to WIPP).
Author(s) Sandia National Laboratories, Munson, Darrell E.
Pubdate January 1979
Location Nuclear Waste Management Programs Library
Call Number SAND79-0076
Location Technical Library/NM
Call Number SAND79-0076

Title Structural analysis of Weeks Island Mine/petroleum repository.
Author(s) Sandia National Laboratories, Hilton, Peter D.
Pubdate August 1979
Location Nuclear Waste Management Programs Library
Call Number SAND79-0595
Location Technical Library/NM
Call Number SAND79-0595

Title ANALYSIS OF STEADY STATE CREEP OF SOUTHEASTERN NEW MEXICO BEDDED SALT
Author(s) Herrmann, Walter Sandia National Laboratories,
Pubdate March 1980
Location WIPP Library
Call Number SAND80-0558
Location Nuclear Waste Management Programs Library
Call Number SAND80-0558
Location Technical Library/CA
Call Number SAND80-0558

Title Borehole-inclusion stressmeter measurements in bedded salt.
Author(s) Sandia National Laboratories, Cook, C. Wayne
Pubdate July 1980
Location Nuclear Waste Management Programs Library
Call Number SAND79-0377
Location Technical Library/NM
Call Number SAND79-0377

Title Proceedings of the International Conference and Exposition on Fatigue, Corrosion Cracking, Fracture Mechanics and Failure Analysis, 1985, Salt Lake City, V 02, Corrosion Cracking
Author(s) Goel, V. S. American Society for Metals
Pubdate 1986
Location Technical Library/CA
Call Number TA 409 - -C67 -85 2

Title Creep tests on clean and argillaceous salt from the Waste Isolation Pilot Plant.
Author(s) Sandia National Laboratories, Mellegard, K. D.
Pubdate May 1993
Location WIPP Library
Call Number SAND92-7291
Location Nuclear Waste Management Programs Library
Call Number SAND92-7291
Location Technical Library/NM
Call Number SAND92-7291

Title Review of waste package verification tests : Semiannual report covering the period April 1985 - September 1985.
Author(s) Brookhaven National Laboratory, Soo, P. United States.
Pubdate January 1986
Location Nuclear Waste Management Programs Library
Call Number NUREG/CR-3091, v.7

Title Thermoelastic/plastic analysis of waste-container sleeve : III. Influence of salt strength on sleeve loading.
Author(s) RE/SPEC Inc. Pariseau, William G. Oak Ridge National Laboratory,

- Pubdate** 1975.
Location Nuclear Waste Management Programs Library
Call Number ORNL-SUB-4269-2
- Title** Field evaluation of stress measurement techniques in rock salt.
Author(s) Sandia National Laboratories, Stormont, John C.
Pubdate September 1983
Location Nuclear Waste Management Programs Library
Call Number SAND83-2051A
Location Technical Library/NM
Call Number SAND83-2051A
- Title** Field tests of stress measurement techniques in rock salt.
Author(s) Sandia National Laboratories, Stormont, John C.
Pubdate December 1983
Location Nuclear Waste Management Programs Library
Call Number SAND83-2507C
Location Technical Library/NM
Call Number SAND83-2507C
- Title** RECENT MEASUREMENTS OF POWER LAW STRESS EXPONENTS - ACTIVATION ENERGIES AND CREEP TRANSIENTS - ABSTRACT
Author(s) Sandia National Laboratories, Wawersik, Wolfgang R. Sandia National Laboratories,
Pubdate April 1981
Location Nuclear Waste Management Programs Library
Call Number SAND81-1117A
Location Technical Library/NM
Call Number SAND81-1117A
- Title** COMPUTER MODELING OF STRESS STATES ASSOCIATED WITH FLUID MIGRATION EXPERIMENTS
Author(s) Trucano, Timothy Guy Sandia National Laboratories,
Pubdate September 1981
Location Nuclear Waste Management Programs Library
Call Number SAND81-2008
Location Technical Library/NM
Call Number SAND81-2008
- Title** ON THE DESCRIPTION OF LOW STRESS - LOW TEMPERATURE CREEP OF ROCK SALT - ABSTRACT
Author(s) Wawersik, Wolfgang R. Sandia National Laboratories,
Pubdate March 1982
Location Technical Library/NM
Call Number SAND82-0797A
- Title** A Transient creep model for salt during stress loading and unloading.
Author(s) Sandia National Laboratories, Munson, Darrell E.
Pubdate September 1982
Location WIPP Library
Call Number SAND82-0962
Location Nuclear Waste Management Programs Library
Call Number SAND82-0962
Location Technical Library/NM
Call Number SAND82-0962

- Title** Consolidation and permeability of crushed WIPP salt under hydrostatic and shear stress states.
Author(s) Sandia National Laboratories, Brodsky, Nancy S.
Pubdate February 1992
Location Nuclear Waste Management Programs Library
Call Number SAND92-0383A
Location Technical Library/NM
Call Number SAND92-0383A
- Title** Extension of the M-D model for treating stress drops in salt
Author(s) Munson, Darrell E. Sandia National Laboratories,
Pubdate June 1993
Location Technical Library/NM
Call Number SAND93-0377C
- Title** Stress measurements in rock salt using hydraulic fracturing.
Author(s) Sandia National Laboratories, Wawersik, Wolfgang R.
Pubdate April 1986
Location WIPP Library
Call Number SAND86-1034C
Location Nuclear Waste Management Programs Library
Call Number SAND86-1034C
- Title** Effects of temperature, temperature gradients, stress, and irradiation on migration of brine inclusions in a salt repository /
Author(s) Oak Ridge National Laboratory, Jenks, Glenn Herbert, Oak Ridge National Laboratory.
Pubdate July 1979.
Location Nuclear Waste Management Programs Library
Call Number ORNL-5526

9. EUB Applications Related to Salt Caverns (Source: EUB Library)

Record number: 16867
Application number: BT1A
Company: NUCO PETROLEUMS LTD.
Summary: FOR A SCHEME TO DISPOSE OF PRODUCED SALT WATER INTO THE BEAVERHILL LAKE FORMATION IN THE LLOYDMINSTER FIELD
Department: DEVELOPMENT
Descriptors: Water disposal
Area/Field: LLOYDMINSTER
Date registered: 19550101
Decision/Approval/Order: DECISION NOT AVAILABLE
Date of hearing: 19550922
Hearing location: PETROLEUM AND NATURAL GAS CONSERVATION BOARD, CALGARY
Notice date: 19550901
Number of interventions: 1
Note: NOTICE AND DECISION NOT AVAILABLE APPLICATION NOT AVAILABLE
Date created: May 27, 1997
Updated: July 21, 1997
Status: Completed

Record number: 222
Application number: 910420
Company: Amoco Canada Petroleum Company Ltd.
Summary: To add a well for water disposal to dispose of brine water associated with salt cavern sand
Department: Drilling and Production
Descriptors: Water disposal; Waste disposal
Area/Field: Lindbergh
Date registered: 19910315
Decision/Approval/Order: Approval 7139
Note: Approval 6424 is rescinded
Box number: 965
Date created: May 27, 1997
Updated: June 23, 1997
Status: Completed

Record number: 27084
Application number: 830529
Company: Northwestern Utilities Ltd
Summary: AMEND APPROVAL NO. 3673. FOR THE CONSTRUCTION AND OPERATION OF ONE ADDITIONAL SALT STORAGE CAVERN FOR THE PURPOSE OF STORING NATURAL GAS
Department: DEVELOPMENT
Descriptors: Gas storage; Amendment; Gas storage
Area/Field: REDWATER
Date registered: 19830603
Decision/Approval/Order: Approval 3673A
Notice date: 19830810

Objection date: 19830901
Date created: May 27, 1997
Updated: December 07, 1997
Status: Completed

Record number: 31696
Application number: 820506
Company: Northwestern Utilities Ltd
Summary: DISPOSE OF BRINE PRODUCED IN ASSOCIATION
WITH THE CONSTRUCTION OF THE CAVERN
STORAGE FACILITIES

Department: DEVELOPMENT
Descriptors: Gas storage; SALT; Underground storage
Area/Field: FORT SASKATCHEWAN; REDWATER
Date registered: 19820526
Decision/Approval/Order: Approval 3673
Notice date: 19820820
Objection date: 19820914
Related application: 820504; 820505
Date created: May 27, 1997
Updated: December 07, 1997
Status: Completed

Record number: 31698
Application number: 820504
Company: Northwestern Utilities Ltd
Summary: CONSTRUCTION AND OPERATION OF A SALT
CAVERN STORAGE FACILITY FOR THE PURPOSE
OF STORING NATURAL GAS

Department: DEVELOPMENT
Descriptors: Gas storage; SALT; Underground storage
Area/Field: FORT SASKATCHEWAN; REDWATER
Date registered: 19820526
Decision/Approval/Order: Approval 3673 ; Approval 3674
Notice date: 19820820
Objection date: 19820914
Related application: 820505; 820506
Date created: May 27, 1997
Updated: December 07, 1997
Status: Completed

Record number: 20453
Application number: 790326
Company: DOME PETROLEUM LIMITED
Summary: TO AMEND APPROVAL NO. 2358 FOR THE
CONSTRUCTION AND OPERATION OF TWO
ADDITIONAL SALT STORAGE CAVERNS

Department: DEVELOPMENT
Descriptors: Gas storage; Amendment; Underground storage
Area/Field: FORT SASKATCHEWAN
Date registered: 19790516
Decision/Approval/Order: Approval 2358A
Notice date: 19790807
Objection date: 19790823

Date created: May 27, 1997
Updated: December 07, 1997
Status: Completed

Record number: 23385
Application number: 770520
Company: DOME PETROLEUM LIMITED
Summary: FOR THE DISPOSAL OF BRINE PRODUCED IN
CONJUNCTION WITH THE CONSTRUCTION AND
OPERATION OF SALT CAVERN STORAGE
FACILITIES IN THE FORT SASKATCHEWAN AREA

Department: DEVELOPMENT
Descriptors: Waste disposal; WASTE DUMP
Area/Field: FORT SASKATCHEWAN
Date registered: 19770704
Decision/Approval/Order: Approval 2520
Notice date: 19770719
Objection date: 19770810
Date created: May 27, 1997
Updated: December 08, 1997
Status: Completed

Record number: 30714
Application number: 770101
Company: CHEVRON STANDARD LIMITED
Summary: FOR STORAGE AND DISPOSAL OF LIQUID
HYDROCARBONS

Department: Gas
Descriptors: Gas storage; Liquefied natural gas; Underground storage; Salt
Area/Field: FORT SASKATCHEWAN
Date registered: 19770203
Decision/Approval/Order: Approval 1547D
Box number: 1003
Date created: May 27, 1997
Updated: December 08, 1997
Status: Completed

Record number: 26819
Application number: 008154
Company: M-P PETROLEUM LTD.
Summary: TO CONSTRUCT AND OPERATE A SALT CAVERN
L.P.G STORAGE FACILITY

Department: DEVELOPMENT
Descriptors: Gas storage; Underground storage
Area/Field: FORT SASKATCHEWAN
Date registered: 19741028
Decision/Approval/Order: Approval 2101
Notice date: 19750107
Objection date: 19750210
Date created: May 27, 1997
Updated: December 08, 1997
Status: Completed

Record number: 27004
Application number: 007756
Company: DOME PETROLEUM LIMITED
Summary: AMENDMENT OF APPROVAL NO. 1932 FOR A
SCHEME TO CONSTRUCT AND OPERATE A SALT
CAVERN STORAGE FACILITY
Department: DEVELOPMENT
Descriptors: Gas storage; Amendment; Underground storage
Area/Field: FORT SASKATCHEWAN
Date registered: 19740501
Decision/Approval/Order: Approval 2042
Notice date: 19740703
Objection date: 19740725
Date created: May 27, 1997
Updated: December 08, 1997
Status: Completed

Record number: 27470
Application number: 007659
Company: SHELL CANADA LIMITED
Summary: AMENDMENT OF APPROVAL NO. 1849 FOR THE
INJECTION AND STORAGE OF NATURAL GAS
LIQUIDS

Department: Gas
Descriptors: Gas storage; Liquefied natural gas; Salt
Area/Field: SIMONETTE
Date registered: 19740314
Decision/Approval/Order: Approval 1849A
Date created: May 27, 1997
Updated: December 08, 1997
Status: Completed

Record number: 26489
Application number: 007578
Company: IMPERIAL PIPELINE COMPANY, LIMITED
Summary: TO CONSTRUCT AND OPERATE A SALT CAVERN
STORAGE FACILITY

Department: DEVELOPMENT
Descriptors: Gas storage; Underground storage
Area/Field: REDWATER
Date registered: 19740131
Decision/Approval/Order: Approval 2039
Notice date: 19740625
Objection date: 19740715
Special report: REPORT - BRINE POND, DESIGN
RECOMMENDATIONS, REDWATER, ALBERTA,
731116; BRINE POND REDWATER, ALBERTA,
DESIGN RECOMMENDATION, 740124

Date created: May 27, 1997
Updated: December 08, 1997
Status: Completed

Record number: 28900
Application number: 007325
Company: DOME PETROLEUM LIMITED
Summary: FOR CONSTRUCTION AND OPERATION OF AN UNDERGROUND SALT CAVERN STORAGE FACILITY

Department: DEVELOPMENT
Descriptors: Gas storage; Liquefied natural gas; Salt
Area/Field: FORT SASKATCHEWAN
Date registered: 19730904
Decision/Approval/Order: Approval 1932
Box number: APPL. NO. 33
Accession number: 16-4-60
Date created: May 27, 1997
Updated: December 08, 1997
Status: Completed

Record number: 31143
Application number: 006461
Company: CHEVRON STANDARD LIMITED
Summary: TO AMEND APPROVAL NO. 1547 FOR APPROVAL TO OPERATE A FRACTIONATION PLANT AND RELATED SURFACE FACILITIES ASSOCIATED WITH THE STORAGE OF LIQUID PETROLEUM GASES IN SALT CAVERNS

Department: Gas
Descriptors: Gas storage; Liquefied natural gas; Salt
Area/Field: FORT SASKATCHEWAN
Date registered: 19720630
Decision/Approval/Order: Approval 1547A
Box number: {APPL. NO. 3
Accession number: ARC 18-13-65
Date created: May 27, 1997
Updated: November 28, 1997
Status: Completed

Record number: 29507
Application number: 005673
Company: CHEVRON STANDARD LIMITED
Summary: FOR APPROVAL FOR THE CONSTRUCTION AND OPERATION OF A SALT CAVERN STORAGE FACILITY

Department: Gas
Descriptors: Underground storage; Gas storage; Salt
Area/Field: FORT SASKATCHEWAN
Date registered: 19710329
Decision/Approval/Order: Approval 1534
Date of hearing: 19710511
Hearing location: ENERGY RESOURCES CONSERVATION BOARD, CALGARY

Notice date: 19710415
Objection date: 19710505
Number of interventions: 2
Exhibits: 5

Related application: 005672
Special report: PROPOSED BRINE PONDS - FORT SASKATCHEWAN
FRACTIONIZATION PLANT,; DATED 710400

Note: NO TRANSCRIPTS ON FILE
Box number: APPL. NO. 17
Accession number: 16-4-72
Date created: May 27, 1997
Updated: December 08, 1997
Status: Completed

Record number: 29508
Application number: 005672
Company: CHEVRON STANDARD LIMITED
Summary: FOR STORAGE AND DISPOSAL OF LIQUID
HYDROCARBONS

Department: Gas
Descriptors: Gas storage; Liquefied natural gas
Area/Field: FORT SASKATCHEWAN
Date registered: 19710329
Decision/Approval/Order: Approval 1547
Date of hearing: 19710511
Hearing location: ENERGY RESOURCES CONSERVATION BOARD,
CALGARY

Notice date: 19710415
Objection date: 19710505
Number of interventions: 2
Exhibits: 1
Box number: APPL. NO. 16
Accession number: 19-6-30
Date created: May 27, 1997
Updated: December 08, 1997
Status: Completed

Record number: 24877
Application number: 009520
Company: DOME PETROLEUM LIMITED
Summary: FOR THE STORAGE AND DISPOSAL OF LIQUID
HYDROCARBONS IN UNDERGROUND CAVERNS
IN THE FORT SASKATCHEWAN AREA

Department: DEVELOPMENT
Descriptors: Gas storage; Underground storage
Area/Field: FORT SASKATCHEWAN
Date registered: 19760727
Decision/Approval/Order: Approval 2358
Notice date: 19761129
Objection date: 19761222
Date created: May 27, 1997
Updated: December 08, 1997
Status: Completed

Record number: 18781
Application number: 003021
Company: HOME OIL COMPANY LIMITED
Summary: APPROVAL OF A SCHEME FOR DISPOSAL OF BRINE

PRODUCED DURING DEVELOPMENT OF STORAGE
CAVERNS IN SALT
DEVELOPMENT
Department: DEVELOPMENT
Descriptors: Water disposal; Underground storage; Water disposal;
HYDROCARBON
Area/Field: HARDISTY
Date registered: 19660718
Decision/Approval/Order: Approval 878 ; Approval 885
Notice date: 19660804
Objection date: 19660815
Date created: May 27, 1997
Updated: December 08, 1997
Status: Completed

APPENDIX B

DATA SUMMARY TABLES – ORIGINAL STUDY AREA

- Table B.1** Bulk density log data available in the original study area for the Elk Point Group
- Table B.2** Dipmeter log data available in the original study area for the Elk Point and Beaverhill Lake Groups
- Table B.3** Core available in the original study area for the Elk Point Group
- Table B.4** DST data available in original study area for wells that had bulk density log data

Table B.1: Bulk density log data available in the original study area for the Elk Point Group (source: AEUB well database)

No.	UWI	Well Name	Year Logged	Top Log Interval (m KB)	Bottom Log Interval (m KB)	Total Depth (m KB)	Top Elk Point GP (m KB)	Top of Fm in the Elk Point Group Logged with Density	Bottom Fm Depth (m KB)	Lowest Formation Logged by Density	EUB Digital Data?
1	00/06-05-048-06W4/0	HUSKY D.H. WILDMERE 6-5-48-6	1970	610	975	1405	1180	ELK POINT GRP	1377	ORDOVICIAN	N
2	00/02-19-053-01W4/0	HUSKY 2C FROG LAKE 2-19-53-1	1996	132	1133	1140	842	ELK POINT GRP	1080	BASAL RED BEDS	Y
3	00/10-17-054-05W4/00	HUSKY DH ETHELWYN 10D-17-54-5	1971	366	965		948	ELK POINT GRP	964	PRAIRIE EVAPORITE	N
4	00/16-27-055-12W4/0	CHEMCELL DUVERNAY NACL 16-27-55-12	1969	187	1448		1066	ELK POINT GRP	1442	BASAL RED BEDS	N
5	00/16-13-071-01W4/0	AEC ET AL SCHELTENS 16-13-71-1	1985	184	824	825	751	ELK POINT GRP	751	ELK POINT GRP	N
6	00/07-12-071-11W4/0	RAX ET AL MILLS 7-12-71-11	1978	309	1373		799	ELK POINT GRP	1331	BASAL RED BEDS	N
7	00/06-26-072-11W4/0	PAN AM A-1 BEHAN 6-26-72-11	1969	427	1035		800	ELK POINT GRP	1030	CONTACT RAPIDS	N
8	00/07-08-082-06W4/0	GULF RESEDELN 7-8-82-5	1981	370	654		424	ELK POINT GRP	603	GRANITE WASH	N
9	00/07-32-083-06W4/0	NORTHSTAR ET AL SURMONT 7-32-83-6	1980	25	703	703	457	ELK POINT GRP	703	TOTAL DEPTH	N
10	W0/05-23-094-07W4/0	CHEVRON STEEPBANK EX 8-22-94-7	1981	12	414	416	329	ELK POINT GRP	397	METHY FM	N
11	00/03-14-095-07W4/0	HUSKY TENN NOVA 3-14-95-7	1981	45	403	404	275	ELK POINT GRP	404	PRECAMBRIAN	N
12	00/03-15-095-07W4/0	HUSKY TENN NOVA 3-15-95-7	1981	43	381	393	281	ELK POINT GRP	377	PRECAMBRIAN	N
13	00/04-22-095-07W4/0	HUSKY TENN NOVA 4-22-95-7	1981	45	383	383	252	ELK POINT GRP	371	GRANITE WASH	N
14	00/01-24-095-07W4/0	CDCOG TENN MUSKEGR 1-24-95-7	1980	129	412	412	283	ELK POINT GRP	405	GRANITE WASH	N
15	AA/12-07-095-08W4/0	ESSO 90PC OSLO 12-7-95-8	1990	10	311	312	184	ELK POINT GRP	307	PRECAMBRIAN	N
16	00/15-08-096-01W4/0	GULF FIREBAG 15-8-96-1	1976	15	134	135	129	ELK POINT GRP			N
17	00/08-09-053-03W4/0	HUSKY 8B MARWAYNE 8-9-53-3	1996	132	1393	1400	869	WATT MTN	1149	PRECAMBRIAN	Y
18	00/06-12-053-04W4/0	STERLING ET AL DEWBERRY 6-12-53-4	1998	425	1104	1105	899	WATT MTN	1082	WINNIPEGOSIS	N
19	03/16-23-056-05W4/0	CANSALT L-2 NACL LIND 16-23-56-5	1989	156	1218	1253	824	WATT MTN	1133	LOTSBERG	N
20	11/15-13-058-05W4/2	MURPHY SWD 5 LIND 15-13-58-5	1987	178	1549	1573	870	WATT MTN	1502	BASAL SANDSTONE UNIT	N
21	00/08-01-062-11W4/0	SASKOIL SUGDEN 8-1-62-11	1991	296	1635	1635	936	WATT MTN	1555	CAMBRIAN	N
22	02/01-28-063-02W4/0	RENAISSANCE COLD LAKE 1-28-63-2	1989	170	794	805	618	WATT MTN	744	WINNIPEGOSIS	N
23	02/08-26-063-03W4/0	CON BEACON PARA COLDLK 8-26-63-3	1992	177	1243	1249	589	WATT MTN	1174	CAMBRIAN	N
24	02/06-13-063-08W4/0	CDNOXY SWD 2 SUGDEN 6-13-63-8	1986	270	1461	1462	783	WATT MTN	1474	PRECAMBRIAN	N
25	AA/15-20-064-02W4/0	ESSO MARIE OV 15-20-64-2	1979	20	1206	1207	652	WATT MTN	1203	PRECAMBRIAN	N
26	00/07-18-064-03W4/0	ESSO 79 SWD COLDLK 7-18-64-3	1979	20	1291	1288	686	WATT MTN	1288	PRECAMBRIAN	N
27	00/01-19-064-03W4/0	ESSO 85 SWD ETHELLK 1-19-64-3	1985	250	1232	1293	657	WATT MTN	1221	PRECAMBRIAN	N
28	00/11-22-064-03W4/0	ESSO 83 SWD ETHELLK 11-22-64-3	1983	252	1276	1279	654	WATT MTN	1279	PRECAMBRIAN	N
29	00/03-29-064-03W4/0	ESSO 81 SWD ETHELLK 3-29-64-3	1981	20	1309	1309	672	WATT MTN	1303	PRECAMBRIAN	N
30	00/08-33-064-03W4/0	ESSO 83 INJ ETHELLK 8-33-64-3	1993	256	1318	1318	706	WATT MTN	1316	PRECAMBRIAN	N
31	00/05-06-064-06W4/0	MOBIL GARTH 5-6-64-6	1989	20	1403	1404	736	WATT MTN	1384	PRECAMBRIAN	N

Table B.1: Bulk density log data available in the original study area for the Elk Point Group (source: AEUB well database)

No.	UWI	Well Name	Year Logged	Top Log Interval (m KB)	Bottom Log Interval (m KB)	Total Depth (m KB)	Top Elk Point GP (m KB)	Top of Fm in the Elk Point Group Logged with Density	Bottom Fm Depth (m KB)	Lowest Formation Logged by Density	EUB Digital Data?
32	00/12-06-064-08W4/0	MOBIL GARTH 12-6-64-6	1985	18	1412	1413	744	WATT MTN	1394	PRECAMBRIAN	N
33	00/03-04-065-03W4/0	ESSO SWD LEMING ETHELLK 3-4-65-3	1976	395	1318	1319	692	WATT MTN	1309	PRECAMBRIAN	N
34	AA/09-20-065-03W4/0	ESSO 81 ETHELLK OV 9-20-65-3	1999	37	1211	1262	624	WATT MTN	1258	PRECAMBRIAN	N
35	AA/06-08-066-02W4/0	ESSO MEDLEY OV 6-8-66-2	1979	18	1213	1218	677	WATT MTN	1210	PRECAMBRIAN	N
36	AA/14-28-066-03W4/0	ESSO MEDLEY OV 14-28-66-3	1979	16	1251	1254	644	WATT MTN	1245	PRECAMBRIAN	N
37	00/10-08-066-05W4/0	BP PCI MARGLK 10-8-66-5	1984	15	1352	1354	707	WATT MTN	1335	PRECAMBRIAN	N
38	00/10-10-066-06W4/0	BP LEMING 10-10-66-6	1981	157	1363	1363	720	WATT MTN	1351	PRECAMBRIAN	N
39	02/10-05-067-04W4/0	AMOCO 10B4 MOORE 10-5-67-4	1985	168	1338	1340	694	WATT MTN	1321	PRECAMBRIAN	N
40	00/07-11-067-06W4/0	ESSO AEC 85 FISHCK 7-11-67-6	1985	250	1340	1342	701	WATT MTN	1327	PRECAMBRIAN	N
41	00/12-31-067-07W4/0	ESSO AEC 85 FISHCK 12-31-67-7	1985	15	1333	1334	698	WATT MTN	1322	PRECAMBRIAN	N
42	00/07-34-067-08W4/0	ESSO AEC 85 FISHCK 7-34-67-8	1985	249	1385	1386	753	WATT MTN	1374	PRECAMBRIAN	N
43	00/11-19-068-06W4/0	ESSO AEC 85 FISHCK 11-19-68-6	1985	15	1317	1340	715	WATT MTN	1392	PRECAMBRIAN	N
44	07/08-12-069-05W4/0	AECOG (NE) FISHER 8D-12-69-5	1990	196	922	921	665	WATT MTN	904	CONTACT RAPIDS	N
45	00/11-26-069-10W4/0	ARCO HEART LAKE 11-26-69-10	1967	189	190	1432	832	WATT MTN	1421	BASAL RED BEDS	N
46	00/05-21-071-04W4/0	AMOCO AEC KIRBY 5-21-71-4	1980	154	1159	1160	591	WATT MTN	1160	PRECAMBRIAN	N
47	00/06-30-071-05W4/0	AMOCO AEC IPIATIK 6-30-71-5	1980	282	1222	1222	648	WATT MTN	1222	PRECAMBRIAN	N
48	00/10-17-071-06W4/0	AMOCO AEC IPIATIK GRIST 10-17-71-6	1980	156	1225	1225	642	WATT MTN	1217	PRECAMBRIAN	N
49	00/10-26-071-07W4/0	AEC PHILLIPS WIAU 10-26-71-7	1980	10	1230	1230	672	WATT MTN	1225	PRECAMBRIAN	N
50	00/16-36-072-01W4/0	AEC ET AL FOSTERCK 16-36-72-1	1985	199	771	805	657	WATT MTN	754	CONTACT RAPIDS	N
51	00/11-18-072-04W4/0	AMOCO AEC IPIATIK 11-18-72-4	1979	284	1188	1189	610	WATT MTN	1178	CONTACT RAPIDS	N
52	00/10-22-072-06W4/0	AMOCO KIRBY 10-22-72-6	2000	299	1214	1214	672	WATT MTN	1205	BASAL RED BEDS	N
53	00/11-14-072-08W4/0	AEC PHILLIPS WIAU 11-14-72-8	1980	151	1278	1279	721	WATT MTN	1254	BASAL RED BEDS	N
54	00/10-33-072-08W4/0	AEC PHILLIPS WIAU 10-33-72-8	1980	10	1292	1292	746	WATT MTN	1271	BASAL RED BEDS	N
55	00/10-14-073-05W4/0	AMOCO AEC IPIATIK KIRBY 10-14-73-5	1979	281	1119	1120	600	WATT MTN	938	LOTSBERG FM	N
56	00/11-30-074-05W4/0	AMOCO KIRBY 11-30-74-5	1977	0	1108	1110	606	WATT MTN	943	LOTSBERG FM	N
57	00/10-09-074-06W4/0	AMOCO KIRBY 10-9-74-6	1977	188	1094	1094	583	WATT MTN	1079	BASAL RED BEDS	N
58	00/06-24-074-07W4/0	AMOCO KIRBY 6-24-74-7	1977	190	1142	1144	632	WATT MTN	1137	BASAL RED BEDS	N
59	02/10-01-077-07W4/0	HOME LEISMER A10-1-77-7	1987	191	958	959	466	WATT MTN	952	PRECAMBRIAN	N
60	00/03-07-077-07W4/0	HOME LEISMER 3-7-77-7	1998	128	788	788	521	WATT MTN	775	CONTACT RAPIDS	N
61	00/02-08-077-08W4/0	NORCEN POR LEISMER 2-8-77-8	1982	168	782	782	568	WATT MTN	767	WINNIPEGOSIS	N
62	00/10-28-077-08W4/0	ALTANA HUBER CHRISTINA 10-28-77-8	1971	118	788	789	513	WATT MTN	729	WINNIPEGOSIS	N
63	00/10-05-080-02W4/0	HOME WINNEFRED LAKE 10-5-80-2	1967	116	558	558	478	WATT MTN	537	CONTACT RAPIDS	N

Table B.1: Bulk density log data available in the original study area for the Elk Point Group (source: AEUB well database)

No.	UWI	Well Name	Year Logged	Top Log Interval (m KB)	Bottom Log Interval (m KB)	Total Depth (m KB)	Top Elk Point GP (m KB)	Top of Fm in the Elk Point Group Logged with Density	Bottom Fm Depth (m KB)	Lowest Formation Logged by Density	EUB Digital Data?
64	00/11-32-080-04W4/0	HOMESTEAD CANOXY COWPAR 11-32-80-4	1976	62	365	503	395	WATT MTN	490	WINNIPEGOSIS	N
65	00/10-29-082-12W4/0	HUSKY ET AL DIVIDE 10-29-82-12	1988	201	964	965	689	WATT MTN	941	CONTACT RAPIDS	N
66	00/10-08-083-06W4/0	GULF RESDELN 10-8-83-6	1981	120	624	625	482	WATT MTN	560	WINNIPEGOSIS	N
67	00/01-14-083-06W4/0	TEXCAN COTTONWOOD 1-14-83-6	1969	113	685	685	433	WATT MTN	678	PRECAMBRIAN	N
68	00/15-14-084-11W4/0	JACOS WD HANGST 15-14-84-11	1990	183	883	885	522	WATT MTN	872	PRECAMBRIAN	N
69	02/09-27-084-11W4/0	PCI PCEJ HANGST 9-27-84-11	1988	80	863	865	498	WATT MTN	852	PRECAMBRIAN	N
70	00/14-24-085-06W4/0	RAX NEWBY 14-24-85-6	1988	119	470	471	337	WATT MTN	449	CONTACT RAPIDS	N
71	00/16-27-085-11W4/0	TEXCAN CS HORSE 16-27-85-11	1969	183	779	779	418	WATT MTN	771	PRECAMBRIAN	N
72	00/11-10-085-13W4/0	CIGOL ET AL HORSE 11-10-85-13	1970	97	875	875	526	WATT MTN	872	PRECAMBRIAN	N
73	00/02-32-089-12W4/0	SUNCOR CLARKE 2-32PREV-89-12	1981	86	717	717	398	WATT MTN	713	PRECAMBRIAN	N
74	00/06-18-093-12W4/0	AOSTRA WDW1 ATHABASCA 6-18-93-12	1991	179	599	600	315	WATT MTN	583	PRECAMBRIAN	N
75	00/13-23-094-07W4/0	CHEVRON WDW STEEPBANK 13-23-94-7	1991	180	396	398	284	WATT MTN	329	WINNIPEGOSIS	N
76	02/14-28-055-06W4/0	AMOCO INJ LINDBERGH 14-28-55-6	1991	188	1398	1398	989	PRAIRIE EVAPORITE	1282	LOTSBERG FM	N
77	00/06-01-052-13W4/0	VOYAGER PLAIN 6-1-52-13	1978	749	2100	2100	1356	PRAIRIE EVAPORITE	2008	BASAL SANDSTONE UNIT	N
78	00/02-13-055-13W4/0	WESTMIN HAIRY 2-13-55-13	1984	334	1734	1745	1170	PRAIRIE EVAPORITE	1723	PRECAMBRIAN	N
79	02/02-03-065-03W4/0	ESSO 83 SWD ETHELLK 2-3-65-3	1984	256	1312	1313	712	PRAIRIE EVAPORITE	1259	CAMBRIAN	N
80	00/07-07-072-03W4/0	AEC FOSTER CREEK 7-7-72-3	1996	170	836	839	624	PRAIRIE EVAPORITE	813	CONTACT RAPIDS	Y
81	00/06-25-073-03W4/0	AEC FOSTER CREEK 6-25-73-3	1997	149	812	825	685	PRAIRIE EVAPORITE	685	PRAIRIE EVAPORITE	Y
82	00/09-25-073-05W4/0	AMOCO KIRBY 9-25-73-5	1980	223	845	845	601	PRAIRIE EVAPORITE	835	CONTACT RAPIDS	N
83	00/14-29-079-05W4/0	LAKEWOOD ET AL CHARD 14-29-79-5	1991	128	604	604	426	PRAIRIE EVAPORITE	571	CONTACT RAPIDS	N
84	00/06-23-094-07W4/0	CHEVRON STEEPBANK 6-23-94-7	1992	189	424	438	334	WINNIPEGOSIS FM	334	WINNIPEGOSIS	N
85	00/01-03-095-07W4/0	CDCOG TENN MUSKEGR 1-3-95-7	1980	119	408	408	306	PRAIRIE EVAPORITE	318	KEG RIVER	N
86	00/01-20-095-07W4/0	HUSKY TENN MUSKEGR 1-20-95-7	1980	105	338	338	105	BASE OF DRIFT	324	PRECAMBRIAN	N
87	00/14-11-096-01W4/0	GULF FIREBAG 14-11-96-1	1976	9	132	133	130	ELK POINT GRP			N
88	00/06-26-096-01W4/0	GULF FIREBAG 6-26-96-1	1976	14	162	162	161	ELK POINT GRP			N
89	00/07-29-096-01W4/0	GULF FIREBAG 7-29-96-1	1976	11	113	114	112	ELK POINT GRP			N
90	00/02-08-097-01W4/0	GULF FIREBAG 2-8-97-1	1976	7	126	127	123	ELK POINT GRP			N
91	00/02-11-097-01W4/0	GULF FIREBAG 2-11-97-1	1976	12	171	171	170	ELK POINT GRP			N
92	00/13-12-097-02W4/0	GULF FIREBAG 13-12-97-2	1976	10	147	147	145	ELK POINT GRP			N

Table B.2: Dipmeter log data available in the original study area for the Elk Point and Beaverhill Groups (source: AEUB well database)

No.	UWI	Well Name	Year Logged	Top Log Interval (m KB)	Bottom Log Interval (m KB)	Total Depth (m KB)	Top Fm Depth (m KB)	Top Formation Logged with Dipmeter	Top of Lowest Logged Fm (m KB)	Interval of Interest (m)	Lowest Formation Logged by Dipmeter
1	00/07-14-057-06W4/0	TEXEX ET AL ELK POINT 7-14-57-6	1956	546	1585	1589	403	BLAIRMORE GRP	1587	1039	PRECAMBRIAN
2	00/10-13-060-04W4/0	TEXEX ET AL CHAR LAKE 10-13-60-4	1956	597	1433	1437	551	BEAVERHILL LAKE FM	1433	836	PRECAMBRIAN
3	02/10-30-048-10W4/0	NUL KINSELLA 10-30-48-10	1978	579	937	938	542	SWS	811	126	IRETON
4	00/06-14-048-14W4/0	VOYAGER ET AL BRUCE 6-14-48-14	1982	891	2087	894	890	CALMAR	892	1195	NISKU
5	00/14-09-049-08W4/0	PCP MANNVILLE SOUTH 14-9-49-8	1983	520	813	813	488	SWS	782	31	WOODBEND GRP
6	00/16-31-050-01W4/0	CNRL B LLOYD 16-31-50-1	1981	534	705	706	521	COLONY MBR	697	9	WOODBEND GRP
7	00/14-22-050-11W4/0	SIGNALTA ET AL BIRCH 14-22-50-11	1971	506	718	721	493	BASE FISH SCALES	712	6	IRETON FM
8	00/11-34-051-04W4/0	CDNOXY P9 MORGAN EX 11-34-51-4	1980	115	622	623	254	COLORADO GRP	615	7	WOODBEND GRP
9	00/06-32-055-06W4/0	AMOCO LINDBERGH 6-32-55-6	1996	450	681	683	450	VIKING	678	3	WOODBEND GRP
10	AR/10-11-056-01W4/0	AMOCO AQ JOHN LAKE EX 10-11-56-1	1983	400	634	635	392	VIKING	605	29	BEAVERHILL LAKE
11	AB/15-11-056-01W4/0	AMOCO AB JOHN LAKE EX 15-11-56-1	1983	333	630	630	311	SWS	601	29	BEAVERHILL LAKE
12	00/15-26-056-02W4/0	TEXACO FROG LAKE 15-26-56-2	1983	390	603	604	381	VIKING	585	19	BEAVERHILL LAKE
13	00/13-35-056-02W4/0	ESSO FROG LAKE 13-35-56-2	1984	400	621	621	383	VIKING	590	31	BEAVERHILL LAKE
14	00/14-06-057-01W4/0	CNRL JOHN LAKE 14-6-57-1	1984	450	667	667	424	VIKING	620	47	BEAVERHILL LAKE
15	00/14-18-057-01W4/0	TEXACO FROG LAKE 14-18-57-1	1984	390	641	642	389	VIKING	602	40	BEAVERHILL LAKE
16	00/13-01-057-02W4/0	TEXACO FROG LAKE 13-1-57-2	1984	420	640	635	414	VIKING	620	21	BEAVERHILL LAKE
17	00/15-12-057-02W4/0	CNRL JOHN LAKE 15-12-57-2	1984	390	620	620	373	VIKING	584	35	BEAVERHILL LAKE
18	00/07-15-059-02W4/0	CNRL CHANDLER 7-15-59-2	1989	470	589	590	446	SPARKY MBR	576	13	BEAVERHILL LAKE
19	00/07-16-059-02W4/0	SUNCOR ET AL CHANDLER 7-16-59-2	1983	25	584	585	234	COLORADO GRP	570	14	BEAVERHILL LAKE
20	00/07-27-059-02W4/0	TRANSWEST CHANDLER 7-27-59-2	1983	450	554	558	411	SPARKY MBR	544	11	BEAVERHILL LAKE
21	00/06-20-062-04W4/0	GENESIS ET AL FTKENT 6-20-62-4	1985	275	525	527	259	VIKING	520	6	WOODBEND GRP
22	00/11-24-062-04W4/0	GENESIS ET AL FTKENT 11-24-62-4	1985	268	504	505	202	BASE FISH SCALES	495	9	BEAVERHILL LAKE
23	00/09-13-062-08W4/0	AMOCO ET AL SUGDEN 9-13-62-8	1994	143	499	547	157	SWS	489	10	WOODBEND GRP
24	00/01-13-063-08W4/0	CDNOXY ET AL SUGDEN 1-13-63-8	1985	251	500	511	223	BASE FISH SCALES	497	3	WOODBEND GRP
25	00/11-14-063-08W4/0	NUMAC 11A WOLF LAKE 11-14-63-8	1997	300	513	513	315	GRAND RAPIDS	499	14	WOODBEND GRP
26	02/16-06-064-06W4/0	MOBIL GARTH 16-6-64-6	1981	300	525	525		NO PICKS			
27	00/03-07-064-06W4/0	MOBIL GARTH 3-7-64-6	1990	290	513	515		NO PICKS			
28	AA/14-20-064-06W4/0	MOBIL GARTH OV 14-20-64-6	1980	335	547	550	317	VIKING	541	7	WOODBEND GRP
29	AA/02-21-064-06W4/0	MOBIL GARTH EX 2-21-64-6	1983	315	504	505	263	JOLI FOU FM	495	9	WOODBEND GRP
30	AA/03-27-064-06W4/0	MOBIL GARTH EX 3-27-64-6	1982	300	521	514		NO PICKS			
31	AA/09-27-064-06W4/0	MOBIL GARTH EX 9-27-64-6	1981	300	530	530		NO PICKS			

Table B.2: Dipmeter log data available in the original study area for the Elk Point and Beaverhill Groups (source: AEUB well database)

No.	UWI	Well Name	Year Logged	Top Log Interval (m KB)	Bottom Log Interval (m KB)	Total Depth (m KB)	Top Fm Depth (m KB)	Top Formation Logged with Dipmeter	Top of Lowest Logged Fm (m KB)	Interval of Interest (m)	Lowest Formation Logged by Dipmeter
32	AA/09-28-064-06W4/0	MOBIL GARTH OV 9-28-64-6	1980	160	520	526	205	SWS	517	3	WOODBEND GRP
33	00/16-01-064-07W4/0	MOBIL SUGDEN 16-1-64-7	1980	280	519	521	273	VIKING	506	13	WOODBEND GRP
34	02/07-13-065-04W4/0	ESSO 83 B3-20 COLDLK 7-13-65-4	1984	20	195	564		NO PICKS			
35	00/06-27-065-05W4/0	BP LEMING 6-27-65-5	1981	159	561	562	224	SWS	559	2	BEAVERHILL LAKE
36	00/07-31-065-05W4/0	BP LEMING 7-31-65-5	1981	153	551	551	225	SWS	550	2	WOODBEND GRP
37	00/11-01-065-06W4/0	BP MARGUERITE LAKE 11-1-65-6	1981	150	550	552	227	SWS	549	2	WOODBEND GRP
38	00/07-08-065-06W4/0	BP MARGUERITE LAKE 7-8-65-6	1981	154	561	561	227	SWS	560	1	WOODBEND GRP
39	11/12-08-066-05W4/0	BP PCI 21 MARGLK 12-8-66-5	1981	150	528	529		NO PICKS			
40	14/12-08-066-05W4/0	BP PCI 24 MARGLK 12-8-66-5	1981	155	526	526		NO PICKS			
41	17/12-08-066-05W4/0	BP PCI 13-81 OB MARG LK 12-8-66-5	1981	156	522	533		NO PICKS			
42	00/06-13-066-08W4/0	BP MARGUERITE 6-13-66-6	1981	157	519	521	210	SWS	517	3	WOODBEND GRP
43	00/12-30-069-07W4/0	AEC FISHER 12-30-69-7	1988	436	534	543	423	CLEARWATER SD	533	1	BEAVERHILL LAKE
44	00/08-20-070-03W4/0	AEC FISHER 8-20-70-3	1997	124	531	533	319	GRAND RAPIDS	519	12	BEAVERHILL LAKE
45	03/05-14-070-04W4/0	AEC 03 FISHER 5-14-70-4	1996	355	538	538	293	GRAND RAPIDS	522	16	BEAVERHILL LAKE
46	05/05-14-070-04W4/0	AEC 06 FISHER 5-14-70-4	1996	375	560	562	299	GRAND RAPIDS FM	546	14	BEAVERHILL LAKE
47	00/11-14-070-04W4/0	AECOG C11 FISHER 11-14-70-4	1998	124	514	515	297	GRAND RAPIDS	499	15	BEAVERHILL LAKE
48	00/12-14-070-04W4/0	AEC 01 FISHER 12-14-70-4	1996	450	550	557	306	GRAND RAPIDS	541	9	BEAVERHILL LAKE
49	00/07-15-070-04W4/0	AECOG A7 FISHER 7-15-70-4	1998	380	507	510	295	GRAND RAPIDS	500	7	BEAVERHILL LAKE
50	00/08-15-070-04W4/0	AEC 02 FISHER 8-15-70-4	1996	390	540	540	301	GRAND RAPIDS	540	0	BEAVERHILL LAKE
51	00/11-15-070-04W4/0	AEC FISHER 11-15-70-4	1996	405	515	517	295	GRAND RAPIDS	500	15	BEAVERHILL LAKE
52	00/13-15-070-04W4/0	AEC 13A FISHER 13-15-70-4	1997	124	514	515	290	GRAND RAPIDS	500	14	BEAVERHILL LAKE
53	00/15-15-070-04W4/0	AEC B15 FISHER 15-15-70-4	1997	359	504	510	291	GRAND RAPIDS	496	8	BEAVERHILL LAKE
54	00/09-16-070-04W4/0	AEC A9 FISHER 9-16-70-4	1997	350	510	517	293	GRAND RAPIDS	503	8	BEAVERHILL LAKE
55	00/10-16-070-04W4/0	AEC FISHER 10-16-70-4	1997	371	529	529	304	GRAND RAPIDS	515	14	BEAVERHILL LAKE
56	00/15-16-070-04W4/0	AEC A15 FISHER 15-16-70-4	1997	114	518	524	295	GRAND RAPIDS	510	8	BEAVERHILL LAKE
57	00/16-16-070-04W4/0	AEC B16 FISHER 16-16-70-4	1997	100	522	522	295	GRAND RAPIDS	509	14	BEAVERHILL LAKE
58	00/01-21-070-04W4/0	AEC B1 FISH 1-21-70-4	1997	360	510	515	298	GRAND RAPIDS	504	6	BEAVERHILL LAKE
59	02/01-21-070-04W4/0	AEC 1A FISHER 1-21-70-4	1997	400	511	514	292	GRAND RAPIDS	498	13	BEAVERHILL LAKE
60	03/01-21-070-04W4/0	AEC C1 FISHER 1-21-70-4	1997	325	500	510	291	GRAND RAPIDS	497	4	BEAVERHILL LAKE
61	04/01-21-070-04W4/0	AEC D1 FISHER 1-21-70-4	1997	375	515	565	141	COLORADO GRP	500	15	BEAVERHILL LAKE

Table B.2: Dipmeter log data available in the original study area for the Elk Point and Beaverhill Groups (source: AEUB well database)

No.	UWI	Well Name	Year Logged	Top Log Interval (m KB)	Bottom Log Interval (m KB)	Total Depth (m KB)	Top Fm Depth (m KB)	Top Formation Logged with Dipmeter	Top of Lowest Logged Fm (m KB)	Interval of Interest (m)	Lowest Formation Logged by Dipmeter
62	00/02-21-070-04W4/0	AEC C2 FISHER 2-21-70-4	1997	350	500	509	288	GRAND RAPIDS	494	6	BEAVERHILL LAKE
63	00/08-21-070-04W4/0	AEC A8 FISHER 8-21-70-4	1997	350	500	514	147	COLORADO GRP	500	0	BEAVERHILL LAKE
64	00/10-21-070-04W4/0	AEC A10 FISHER 10-21-70-4	1997	369	519	520	297	GRAND RAPIDS	505	14	BEAVERHILL LAKE
65	02/10-21-070-04W4/0	AEC B10 FISHER 10-21-70-4	1997	350	515	515	290	GRAND RAPIDS	498	17	BEAVERHILL LAKE
66	02/15-21-070-04W4/0	AEC 15B FISHER 15-21-70-4	1997	350	510	518	293	GRAND RAPIDS	502	8	BEAVERHILL LAKE
67	00/02-22-070-04W4/0	AECOG D2 FISHER 2-22-70-4	1997	375	507	507	290	GRAND RAPIDS	494	13	BEAVERHILL LAKE
68	00/03-22-070-04W4/0	AEC 83 FISHER 3-22-70-4	1997	375	500	511	291	GRAND RAPIDS	496	4	BEAVERHILL LAKE
69	00/04-22-070-04W4/0	AEC 4C FISHER 4-22-70-4	1997	96	518	519	295	GRAND RAPIDS	504	14	BEAVERHILL LAKE
70	04/05-22-070-04W4/2	AEC 104 FISHER 5-22-70-4	1996	450	525	554		NO PICKS			
71	05/05-22-070-04W4/0	AECOG 105 FISHER 5-22-70-4	1997	390	530	529		NO PICKS			
72	06/05-22-070-04W4/0	AECOG A5 FISHER 5-22-70-4	1997	73	220	522		NO PICKS			
73	00/06-22-070-04W4/0	AEC 6A FISHER 6-22-70-4	1997	110	515	522		NO PICKS			
74	00/07-22-070-04W4/0	AECOG(E) A7 FISHER 7-22-70-4	2000	130	516	516		NO PICKS			
75	00/11-22-070-04W4/0	AEC 11B FISHER 11-22-70-4	1997	350	514	515	345	LOWER GRAND RAPIDS	500	14	BEAVERHILL LAKE
76	04/11-22-070-04W4/0	AECOG 2B11 FISHER 11-22-70-4	1997	70	513	516		NO PICKS			
77	00/12-22-070-04W4/0	AEC FISHER 12-22-70-4	1996	400	515	515	345	LOWER GRAND RAPIDS	501	14	BEAVERHILL LAKE
78	03/12-22-070-04W4/0	AEC 12C FISHER 12-22-70-4	1997	347	516	518	340	LOWER GRAND RAPIDS	503	14	BEAVERHILL LAKE
79	02/14-22-070-04W4/0	AEC C14 FISHER 14-22-70-4	1997	340	502	506	295	GRAND RAPIDS	491	12	BEAVERHILL LAKE
80	00/03-23-070-04W4/0	AECOG A3 FISHER 3-23-70-4	1998	123	513	515	296	GRAND RAPIDS	501	13	BEAVERHILL LAKE
81	00/14-28-070-04W4/0	AECOG A14 FISHER 14-28-70-4	1998	125	513	511	293	GRAND RAPIDS	496	17	BEAVERHILL LAKE
82	00/07-32-070-04W4/0	AEC FISHER 7-32-70-4	1996	375	525	523	289	GRAND RAPIDS	508	17	BEAVERHILL LAKE
83	00/06-33-070-04W4/0	AEC FISHER 6-33-70-4	1997	400	500	502	287	GRAND RAPIDS	487	14	BEAVERHILL LAKE
84	00/08-13-070-06W4/0	AEC FISHER 8-13-70-6	1988	491	585	581	477	MCMURRAY	551	34	BEAVERHILL LAKE
85	00/05-23-070-06W4/0	AEC FISHER 5D-23-70-6	1987	275	544	545	261	VIKING	535	10	BEAVERHILL LAKE
86	00/10-34-072-06W4/0	AMOCO AEC KIRBY 10-34-72-6	1980	160	588	589	331	GRAND RAPIDS	571	18	BEAVERHILL LAKE
87	02/12-01-073-06W4/0	AEC 07 KIRBY 12-1-73-6	1983	108	569	568	324	BASE OF DRIFT	560	9	BEAVERHILL LAKE
88	00/07-03-073-06W4/0	AMOCO AEC IPIATIK 7-3-73-6	1980	160	577	578	328	GRAND RAPIDS	559	18	BEAVERHILL LAKE
89	00/10-03-073-06W4/0	AMOCO AEC IPIATIK KIRBY 10A-3-73-6	1984	160	579	580	309	BASE OF DRIFT	561	18	BEAVERHILL LAKE
90	00/06-05-073-06W4/0	AMOCO AEC KIRBY 6-5-73-6	1990	100	572	573	338	GRAND RAPIDS	550	22	BEAVERHILL LAKE
91	00/11-09-073-06W4/0	AMOC AEC IPIATIK 11-9-73-6	1995	160	534.9	535	288	BASE OF DRIFT	514	21	BEAVERHILL LAKE

Table B.2: Dipmeter log data available in the original study area for the Elk Point and Beaverhill Groups (source: AEUB well database)

No.	UWI	Well Name	Year Logged	Top Log Interval (m KB)	Bottom Log Interval (m KB)	Total Depth (m KB)	Top Fm Depth (m KB)	Top Formation Logged with Dipmeter	Top of Lowest Logged Fm (m KB)	Interval of Interest (m)	Lowest Formation Logged by Dipmeter
92	00/10-11-073-06W4/0	AEC AMOCO IPIATIK KIRBY 10-11-73-6	1984	160	605	605	308	BASE OF DRIFT	586	19	BEAVERHILL LAKE
93	00/04-15-073-06W4/0	AECOG ET AL KIRBY 4-15-73-6	1997	96	528.5	529		NO PICKS			
94	00/12-11-074-08W4/0	ISH KIRBY 12-11-74-8	1997	440	530	529		NO PICKS			
95	00/12-14-074-08W4/0	ISH KIRBY 12-14-74-8	2000	440	519.3	521	280	VIKING	519	0	WOODBEND GRP
96	00/14-05-082-12W4/0	TRANSWEST DIVIDE 14-5-82-12	1987	275	535	536	202	SWS	520	16	WOODBEND GRP
97	00/10-29-082-12W4/0	HUSKY ET AL DIVIDE 10-29-82-12	1988	382	461	965	379	WABISKAW MBR	439	22	WOODBEND GRP
98	00/16-03-083-07W4/0	GULF RESEDELN 16-3-83-7	1981	175	505	505	225	GRAND RAPIDS	451	54	BEAVERHILL LAKE
99	AA/11-15-083-07W4/0	GULF RESEDELN 11-15-83-7	1997	400	500	502	316	CLEARWATER	489	11	BEAVERHILL LAKE

Table B.3: Core available in the original study area for the Elk Point Group (source: AEUB well database)

No.	UWI	Well Name	Year	Top Core Interval (m KB)	Bottom Core Interval (m KB)	Analyzed	Formation Names covered by Core	Top Fm (m KB)
1	00/10-03-049-06W4/0	HUSKY DH WILDMERE 10-3-49-6	1967	678.8	680.3	N	LLOYDMINSTER MBR	643.1
							WOODBEND GRP	679.7
				1110.7	1154	N	WATT MTN	1099.7
							PRAIRIE EVAPORITE	1112.5
2	A0/12-15-050-02W4/0	BLACKFOOT DEVONIAN TEST SYNDICATE #1	1948	802.2	884.2	N	DEVONIAN SYSTEM	741.3
				934.5	962.6	N	BEAVERHILL LAKE	805.9
				964.7	1041.2	N	ELK POINT GRP	1010.1
							FIRST SALT	1024.1
3	00/14-29-052-02W4/0	CALSTAN PACIFIC MARWAYNE 14-29-52-2	1958	780.3	826	N	BEAVERHILL LAKE	690.1
				902.2	917.4	N	ELK POINT GRP	901.9
				1062.2	1074.1	N	PRAIRIE EVAPORITE	915.6
				1118.9	1148.8	N	RED RIVER FM	1115.9
							CAMBRIAN	1148.2
4	00/08-09-053-03W4/0	HUSKY 8B MARWAYNE 8-9-53-3	1996	1029	1038	Y	WINNIPEGOSIS	1025
5	02/14-28-055-06W4/0	AMOCO INJ LINDBERGH 14-28-55-6	1991	1260	1289.3	Y	ERNESTINA LK	1258.7
						Y	LOTSBERG	1281.5
6	00/11-22-055-12W4/0	WHITE ROSE DUVERNAY 11-22-55-12	1961	1255.8	1286.6	N	FIRST SALT	1125.3
							WINNIPEGOSIS	1258.8
7	02/10-27-055-12W4/0	WESTERN CHEMICALS NO. 27-10S	1953	1086.6	1087.5	N	ELK POINT GRP	1077.5
8	00/15-27-055-12W4/0	WESTERN DUVERNAY 27-15	1952	1068.3	1209.1	N	BEAVERHILL LAKE	833
							ELK POINT GRP	1069.2
9	02/15-27-055-12W4/0	CHEMICALS DUVERNAY SBP A15-27-55-12	1960	1079	1093.9	N	ELK POINT GRP	1067.1
							FIRST SALT	1082.3
10	00/16-27-055-12W4/0	CHEMCELL DUVERNAY NACL 16-27-55-12	1969	1342	1449.6	N	LOTSBERG	1339.6
							BASAL RED BEDS	1441.7
11	00/05-26-056-05W4/0	CANSALT 3 LINDBERGH NACL 5-26-56-5	1966	805	936.7	N	ELK POINT GRP	796.1
							FIRST SALT	859.5
							SECOND SALT	907.7
12	00/07-26-056-05W4/0	ELK POINT WELL NO. 1	1946	848	997	N	FIRST SALT	845.8
				1030.8	1197.6	N	SECOND SALT	1060.7
							THIRD SALT	1128.4

Table B.3: Core available in the original study area for the Elk Point Group (source: AEUB well database)

No.	UWI	Well Name	Year	Top Core Interval (m KB)	Bottom Core Interval (m KB)	Analyzed	Formation Names covered by Core	Top Fm (m KB)	
13	00/02-21-057-05W4/0	ANGLO-CAN. ELK POINT NO. 11	1949	1020.2	1033.6	N	PRAIRIE EVAPORITE	884.5	
					1324.9	1356	Y	WINNIPEGOSIS	1027.2
								CONTACT RAPIDS	1070.2
								COLD LAKE	1115.9
								ERNESTINA LK	1159.8
								LOTSBERG	1180.5
								BASAL RED BEDS CAMBRIAN	1301.5 1350.3
14	00/07-14-057-06W4/0	TEXEX ET AL ELK POINT 7-14-57-6	1956	859.2	872	Y	BEAVERHILL LAKE	631.5	
						Y	WATT MTN	866.2	
15	00/10-13-060-04W4/0	TEXEX ET AL CHAR LAKE 10-13-60-4	1956	808	811.1	Y	PRAIRIE EVAPORITE	746.5	
					1251.2	1299.4	Y	BASAL RED BEDS	1225.3
								EARLIE	1297.8
16	00/13-03-060-11W4/0	CNRL ASHMONT 13-3-60-11	1949	799.8	807.1	N	BEAVERHILL LAKE	802.2	
					848	848.6	N	ELK POINT GRP	1036.3
					912.9	915.6	N	PRAIRIE EVAPORITE	1056.1
					975.4	982.1	N	WINNIPEGOSIS	1197.3
					1051.3	1059.2	N	CONTACT RAPIDS	1232.9
					1260.7	1267.1	N	BASAL RED BEDS	1546.9
					1267.7	1274.7	N	EARLIE	1604.8
					1581	1594.1	N	ELDON	1627.6
					1687.4	1694.7	N	BASAL SANDSTONE UNIT	1664.2
17	00/08-01-062-11W4/0	SASKOIL SUGDEN 8-1-62-11	1991	1727	1728.5	N	PRECAMBRIAN	1741	
					1103	1121	Y	COLD LAKE	1084.2
					1160	1166.2	Y	ERNESTINA LK	1155.3
18	02/01-28-063-02W4/0	RENAISSANCE COLD LAKE 1-28-63-2	1989	751	752.8	N	WINNIPEGOSIS	744	
19	AA/15-20-064-02W4/0	ESSO MARIE OV 15-20-64-2	1979	1140	1206.2	Y	BASAL RED BEDS	1092.5	
							CAMBRIAN	1144.5	
20	00/07-18-064-03W4/0	ESSO 79 SWD COLDLK 7-18-64-3	1979	1217	1288	Y	BASAL RED BEDS	1171	
							CAMBRIAN	1218.5	
21	00/01-32-064-03W4/0	ESSO 83 SWD ETHELLK 1-32-64-3	1984	1273	1335.1	Y	BASAL RED BEDS	1225	
							CAMBRIAN	1274.5	

Table B.3: Core available in the original study area for the Elk Point Group (source: AEUB well database)

No.	UWI	Well Name	Year	Top Core Interval (m KB)	Bottom Core Interval (m KB)	Analyzed	Formation Names covered by Core	Top Fm (m KB)
22	00/08-33-064-03W4/0	ESSO 83 INJ ETHELLK 8-33-64-3	1983	1260	1317	Y	BASAL RED BEDS	1211
							CAMBRIAN	1262.5
23	00/12-08-065-03W4/0	ESSO 79 SWD ETHELLK 12-8-65-3	1979	1222	1267.4	Y	BASAL RED BEDS	1175
							CAMBRIAN	1225
24	AA/06-08-066-02W4/0	ESSO MEDLEY OV 6-8-66-2	1979	1173	1217.5	Y	BASAL RED BEDS	1142.5
							CAMBRIAN	1182
25	00/07-11-067-06W4/0	ESSO AEC 85 FISHCK 7-11-67-6	1985	1305	1332	Y	BASAL RED BEDS	1261
							CAMBRIAN	1308
26	00/11-19-068-06W4/0	ESSO AEC 85 FISHCK 11-19-68-6	1985	1298.8	1330	Y	BASAL RED BEDS	1275.8
							CAMBRIAN	1324
27	07/08-12-069-05W4/0	AECOG (NE) FISHER 8D-12-69-5	1990	856	897.5	Y	WINNIPEGOSIS FM	855.4
28	00/04-03-069-10W4/0	MOBIL PAN AM HEART LAKE 4-3-69-10	1958	1136	1151.2	N	ELK POINT GRP	929.9
29	00/11-26-069-10W4/0	ARCO HEART LAKE 11-26-69-10	1967	1018.6	1061.9	Y	WINNIPEGOSIS	1018.6
							CONTACT RAPIDS	1060.7
30	02/05-22-070-04W4/2	AEC 102 FISHER 5-22-70-4	1996	801	834	Y	WINNIPEGOSIS	794.5
31	00/16-13-071-01W4/0	AEC ET AL SCHELTENS 16-13-71-1	1985	750	768	Y	ELK POINT GRP	751.4
32	00/10-17-071-06W4/0	AMOCO AEC IPIATIK GRIST 10-17-71-6	1980	643	656.6	Y	WATT MTN FM	641.8
				1187	1199	Y	BASAL RED BEDS	1185
33	00/16-36-072-01W4/0	AEC ET AL FOSTERCK 16-36-72-1	1985	693.5	693.5	Y	KEG RIVER FM	677.1
34	00/10-22-072-06W4/0	AMOCO KIRBY 10-22-72-6	1980	862	880	Y	WINNIPEGOSIS	860
35	00/09-25-073-05W4/0	AMOCO KIRBY 9-25-73-5	1980	777	794	Y	PRAIRIE EVAPORITE	601
							WINNIPEGOSIS	784
36	00/01-28-075-03W4/0	HOME WINEFRED LAKE 1-28-75-3	1967	669	708.1	Y	PRAIRIE EVAPORITE	648.6
							WINNIPEGOSIS	680
							CONTACT RAPIDS	699.2
37	00/02-34-075-11W4/0	FINA CAL AM WAPPAU 2-34-75-11	1966	974.1	989.1	N	KEG RIVER	951.6
38	00/10-22-076-01W4/0	HOME WINEFRED LAKE 10-22-76-1	1967	564.2	591	Y	WATT MTN	534.6
							WINNIPEGOSIS	572.1
39	00/01-25-076-01W4/0	HOME SWEEZY 1-25-76-1	1969	518.2	545.6	Y	WINNIPEGOSIS	512.7
40	00/03-07-077-07W4/0	HOME LEISMER 3-7-77-7	1980	726	744.3	Y	PRAIRIE EVAPORITE	534.5
							WINNIPEGOSIS	726.5

Table B.3: Core available in the original study area for the Elk Point Group (source: AEUB well database)

No.	UWI	Well Name	Year	Top Core Interval (m KB)	Bottom Core Interval (m KB)	Analyzed	Formation Names covered by Core	Top Fm (m KB)
41	00/02-25-077-09W4/0	CHRISTINA RIVER HARDY NO. 1 WELL	1949	342	794.6	N	BEAVERHILL LAKE	370.3
							ELK POINT GRP	548.6
							PRAIRIE EVAPORITE	578.2
							WINNIPEGOSIS	765
42	00/11-12-077-10W4/0	PACIFIC MAY RIVER 11-12-77-10	1958	884.2	887.3	N	KEG RIVER	856.5
43	00/07-13-078-01W4/0	HOME SWEEZY 7-13-78-1	1969	478.5	506	Y	WINNIPEGOSIS	476.7
44	00/03-25-078-02W4/0	HOME WINEFRED LAKE 3-25-78-2	1967	530.7	583.1	Y	WINNIPEGOSIS	514.8
45	00/06-07-078-11W4/0	R O CORP CHRISTINA RIVER 6-7-78-11	1958	971.1	994	N	KEG RIVER	957.1
46	00/10-05-080-02W4/0	HOME WINNEFRED LAKE 10-5-80-2	1967	522.1	540.4	Y	WINNIPEGOSIS	519.1
							CONTACT RAPIDS	537.1
47	00/05-23-080-05W4/0	R O CORP JANVIER 5-23-80-5	1958	484.3	491.9	N	ELK POINT GRP	353.6
				521.8	522.7	Y	RED BEDS	543.8
				684.9	692.5	N		
48	00/09-01-080-08W4/0	R O CORP PONY CREEK 9-1-80-8	1958	371.9	508.4	N	BEAVERHILL LAKE	397.8
				509	549.2	N	ELK POINT GRP	515.7
49	00/06-08-081-08W4/0	R O CORP ET AL CORNER LK 6-8-81-8	1958	842.2	847.6	N	ELK POINT GRP	640.1
				856.5	862.6	N		
50	00/02-23-082-05W4/0	R O CORP COTTONWOOD 2-23-82-5	1958	417.6	420.6	N	ELK POINT GRP	378.3
51	00/07-08-082-06W4/0	GULF RESDELN 7-8-82-6	1981	302.5	311.5	Y	BEAVERHILL LAKE	305
				585.5	654	Y	WINNIPEGOSIS	511.8
							GRANITE WASH	603.2
52	00/10-29-082-12W4/0	HUSKY ET AL DIVIDE 10-29-82-12	1988	891	900.2	Y	WINNIPEGOSIS	878.9
53	00/06-36-082-12W4/0	R O CORP ET AL DIVIDE 6-36-82-12	1958	944.9	952.5	N	ELK POINT GRP	733
54	00/04-20-083-04W4/0	DOME GORDON LAKE 4-20-83-4		454.5	459.3	Y	PRAIRIE EVAPORITE	406.9
				477.6	479.1	N		
55	00/10-08-083-06W4/0	GULF RESDELN 10-8-83-6	1981	561.9	570.9	Y	WINNIPEGOSIS	559.7
				571	625	Y		
56	00/16-27-085-11W4/0	TEXCAN CS HORSE 16-27-85-11	1969	694	699.8		KEG RIVER	693.4
57	AA/08-10-089-09W4/0	TH INDUSTRIAL MINERALS #1	1936	0	273.4	N	BEAVERHILL LAKE	30.6
							SLAVE POINT	149.4
							PRAIRIE EVAPORITE	150.4

Table B.3: Core available in the original study area for the Elk Point Group (source: AEUB well database)

No.	UWI	Well Name	Year	Top Core Interval (m KB)	Bottom Core Interval (m KB)	Analyzed	Formation Names covered by Core	Top Fm (m KB)
58	00/02-32-089-12W4/0	SUNCOR CLARKE 2-32PREV-89-12	1981	345	713.5	N	WATT MTN	397.8
							PRAIRIE EVAPORITE	406.2
							WINNIPEGOSIS	606
							CONTACT RAPIDS	675
59	00/13-16-091-08W4/0	BAYSEL STEEPBANK 13-16-91-8	1957	459.6	461.2	N	ELK POINT GRP	302.1
				477.6	477.9		GRANITE WASH	463.3
60	00/04-32-093-10W4/0	BEAR VAMPIRE #2	1949	147.8	269.1	N	ELK POINT GRP	157
							RED BEDS	262
61	00/06-18-093-12W4/0	AOSTRA WDW1 ATHABASCA 6-18-93-12	1991	487	532.9	Y	WINNIPEGOSIS	479
62	00/06-23-094-07W4/0	CHEVRON STEEPBANK 6-23-94-7	1996	350	359	Y	WINNIPEGOSIS	334
63	00/13-23-094-07W4/0	CHEVRON WDW STEEPBANK 13-23-94-7	1991	360	369.5	Y	WINNIPEGOSIS	329
64	AA/12-07-095-08W4/0	ESSO 90PC OSLO 12-7-95-8	1990	129.6	310.9	Y	BEAVERHILL LAKE	129.5
							ELK POINT GRP	183.5
							METHY FM	213
							CONTACT RAPIDS	268

Table B.4: DST data available in the original study area for wells that had bulk density log data (source: AEUB well database)

No.	UWI	Well Name	DST Description	DST Description
1	00/10-17-054-05W4/00	HUSKY DH ETHELWYN 10D-17-54-5	1971/08/14 FM:PRAIRIE EVAPORITE FM - MECHANICALLY GOOD STRADDLE DST FM Dep: 1112.50-1127.80 Rec Depth:1106.40 SP: 11797 FFP: 159 VO: 60 (min.) HP:13548 ,13548 SIP:11836 /11349 /0 /0 SIT:60 /90 /0 /0 FP:124 /179 /0 /0 /0 /0 /0 FT:15 /60 /0 /0 Recovery: MUD 1.50 M	
2	00/16-13-071-01W4/0	AEC ET AL SCHELTENS 16-13-71-1	1985/02/21 FM:ELK POINT GRP - MECHANICALLY GOOD LIMITED RECOVERY DST FM Dep: 753.00-761.00 Rec Depth:740.10 SP: 4646 FFP: 2563 VO: 148 (min.) HP:8090 ,7943 SIP:2563 /4646 /0 /0 SIT:0 /148 /0 /0 FP:431 /0 /0 /0 /0 /0 /0 FT:10 /0 /0 /0 Recovery: MUD-CUT WATER 40.00 M Recovery: BRACKISH WATER 200.00 M	1985/02/23 FM:ELK POINT GRP - MECHANICALLY GOOD STRADDLE DST FM Dep: 754.00-759.50 Rec Depth:741.00 SP: 4764 FFP: 3462 VO: 55 (min.) HP:8114 ,7973 SIP:4764 /4758 /0 /0 SIT:60 /182 /0 /0 FP:263 /855 /1109 /3462 /0 /0 /0 FT:5 /55 /0 /0
3	00/07-12-071-11W4/0	RAX ET AL MILLS 7-12-71-11	1978/02/25 FM:ERNESTINA LK FM - LOTSBERG FM MECHANICALLY GOOD STRADDLE DST FM Dep: 1121.10-1136.90 Rec Depth:1121.70 SP: 3758 FFP: 185 VO: 60 (min.) HP:14727 ,14665 SIP:3758 /2358 /0 /0 SIT:60 /90 /0 /0 FP:241 /103 /0 /0 /0 /0 /0 FT:10 /60 /0 /0 Recovery: MUD 3.00 M	1978/02/26 FM:ERNESTINA LK FM - LOTSBERG FM MECHANICALLY GOOD STRADDLE DST FM Dep: 1111.90-1127.80 Rec Depth:1112.50 SP: 1724 FFP: 165 VO: 60 (min.) HP:0 ,0 SIP:0 /0 /0 /0 SIT:60 /90 /0 /0 FP:0 /0 /0 /0 /0 /0 /0 FT:15 /60 /0 /0 Recovery: 0.00 M
4	00/06-26-072-11W4/0	PAN AM A-1 BEHAN 6-26-72-11	1989/02/10 FM:COOKING LAKE FM - BEAVERHILL LAKE FM MECHANICALLY GOOD LIMITED RECOVERY DST FM Dep: 557.50-615.70 Rec Depth:614.20 SP: 3930 FFP: 1620 VO: 120 (min.) HP:6867 ,6860 SIP:3930 /3909 /0 /0 SIT:60 /60 /0 /0 FP:917 /1620 /0 /0 /0 /0 /0 FT:120 /0 /0 /0 Recovery: SULPHUROUS WATER 51.80 M Recovery: MUD 18.30 M	1989/02/24 FM:PRAIRIE EVAPORITE FM - WINNIPEGOSIS FM MECHANICALLY GOOD LIMITED RECOVERY DST FM Dep: 978.40-988.50 Rec Depth:973.20 SP: 10563 FFP: 110 VO: 60 (min.) HP:11880 ,11397 SIP:386 /8177 /0 /0 SIT:30 /30 /0 /0 FP:290 /290 /0 /0 /0 /0 /0 FT:60 /0 /0 /0 Recovery: MUD 6.10 M
5	00/07-08-082-06W4/0	GULF RESEDLN 7-8-82-6	1981/03/14 FM:WINNIPEGOSIS FM - MECHANICALLY GOOD STRADDLE DST FM Dep: 582.00-602.00 Rec Depth:577.10 SP: 296 FFP: 251 VO: 60 (min.) HP:8078 ,8078 SIP:217 /296 /0 /0 SIT:60 /60 /0 /0 FP:365 /137 /217 /251 /0 /0 /0 FT:10 /60 /0 /0 Recovery: MUD 19.00 M	
6	00/01-24-095-07W4/0	CDCOG TENN MUSKEGR 1-24-95-7 (CONTACT RAPIDS 385 m KB)	1980/03/04 FM:METHY FM - GRANITE WASH MECHANICALLY GOOD CONVENTIONAL DST FM Dep: 384.00-412.00 Rec Depth:374.00 SP: 78 FFP: 56 VO: 60 (min.) HP:4374 ,4374 SIP:300 /300 /0 /0 SIT:60 /120 /0 /0 FP:300 /300 /0 /0 /0 /0 /0 FT:10 /30 /0 /0 Recovery: MUD 1.00 M	

Table B.4: DST data available in the original study area for wells that had bulk density log data (source: AEUB well database)

No.	UWI	Well Name	DST Description	DST Description
7	00/08-09-053-03W4/0	HUSKY 8B MARWAYNE 8-9-53-3	1995/11/19 FM:WINNIPEGOSIS FM - MECHANICALLY GOOD LIMITED RECOVERY DST FM Dep: 1025.00-1046.00 Rec Depth:1027.91 SP: 665 FFP: 294 VO: 32 (min.) Recovery: MUD 30.00 M 1988/06/10 FM:WINNIPEGOSIS FM - TOTAL DEPTH	
8	00/06-12-053-04W4/0	STERLING ET AL DEWBERRY 6-12-53-4	MECHANICALLY GOOD LIMITED RECOVERY DST FM Dep: 1071.00-1105.00 Rec Depth:1061.00 SP: 4275 FFP: 90 VO: 62 (min.) HP:13872 ,13858 SIP:2957 /4274 /0 /0 SIT:57 /118 // FP:131 /82 /158 /89 /0 /0 /0 FT:12 /62 // Recovery: MUD 1.00 M	1988/06/11 FM:WINNIPEGOSIS FM - MECHANICALLY GOOD STRADDLE DST FM Dep: 1063.20-1067.00 Rec Depth:1051.90 SP: 0 FFP: 0 VO: 61 (min.) HP:13748 ,13748 SIP:68 /48 /0 /0 SIT:62 /118 // FP:117 /117 /117 /117 /0 /0 /0 FT:9 /61 //
9	00/08-01-062-11W4/0	SASKOIL SUGDEN 8-1-62-11	1991/07/18 FM:BASAL RED BEDS - CAMBRIAN SYSTEM MECHANICALLY GOOD STRADDLE DST FM Dep: 1525.00-1556.00 Rec Depth:1529.94 SP: 13702 FFP: 5210 VO: 60 (min.) HP:19787 ,19732 SIP:13513 /12665 /0 /0 SIT:60 /120 // FP:806 /2158 /2578 /4938 /0 /0 /0 FT:10 /60 // Recovery: MUD 75.00 M Recovery: SALT WATER 323.00 M	
10	02/01-28-063-02W4/0	RENAISSANCE COLD LAKE 1-28-63-2	1989/07/05 FM:WINNIPEGOSIS FM - MECHANICALLY GOOD STRADDLE DST FM Dep: 744.00-752.00 Rec Depth:747.00 SP: 466 FFP: 224 VO: 16 (min.) HP:9266 ,9273 SIP:468 /330 /0 /0 SIT:54 /27 // FP:330 /220 /330 /220 /0 /0 /0 FT:12 /16 // Recovery: MUD 25.00 M	
11	02/08-26-063-03W4/0	CON BEACON PARA COLDLK 8-26-63-3	1992/12/13 FM:WINNIPEGOSIS FM - MECHANICALLY GOOD CONVENTIONAL DST FM Dep: 764.80-799.00 Rec Depth:767.00 SP: 8618 FFP: 4411 VO: 60 (min.) Recovery: MUD 152.00 M Recovery: WATER 175.00 M	1992/12/15 FM:ERNESTINA LK FM - LOTSBERG FM MECHANICALLY GOOD CONVENTIONAL DST FM Dep: 914.00-928.00 Rec Depth:917.64 SP: 5978 FFP: 255 VO: 30 (min.) Recovery: MUD 1.00 M
12	02/06-13-063-08W4/0	CONOXY SWD 2 SUGDEN 6-13-63-8	1986/12/28 FM:BASAL RED BEDS - CAMBRIAN SYSTEM MECHANICALLY GOOD CONVENTIONAL DST FM Dep: 1350.00-1384.00 Rec Depth:1344.40 SP: 12750 FFP: 12743 VO: 60 (min.) HP:18181 ,17940 SIP:12741 /12748 /0 /0 SIT:60 /90 // FP:11645 /11776 /12003 /6 /0 /0 /0 FT:10 /60 // Recovery: MUD-CUT SALT WATER 240.00 M Recovery: SALT WATER 780.00 M	

Table B.4: DST data available in the original study area for wells that had bulk density log data (source: AEUB well database)

No.	UWI	Well Name	DST Description	DST Description
13	00/10-10-066-06W4/0	BP LEMING 10-10-66-6	1981/03/05 FM: BASAL RED BEDS - PRECAMBRIAN SYSTEM MECHANICALLY GOOD CONVENTIONAL DST FM Dep: 1310.00-1362.00 Rec Depth: 1312.00 SP: 11496 FFP: 11447 VO: 120 (min.) HP: 16484 , 16484 SIP: 11356 /11497 /0 /0 SIT: 60 /120 /0 /0 FP: 11197 /11426 /0 /0 /0 /0 FT: 5 /120 /0 /0 Recovery: MUD 80.00 M Recovery: MUD-CUT SALT WATER 870.00 M	1981/03/06 FM: WINNIPEGOSIS FM - MECHANICALLY GOOD STRADDLE DST FM Dep: 910.00-935.00 Rec Depth: 899.00 SP: 1432 FFP: 1355 VO: 60 (min.) HP: 11162 , 11162 SIP: 8446 /0 /0 /0 SIT: 60 /120 /0 /0 FP: 177 /813 /0 /0 /0 /0 FT: 5 /60 /0 /0 Recovery: MUD 72.00 M Recovery: MUD-CUT SALT WATER 14.00 M
14	00/11-26-069-10W4/0	ARCO HEART LAKE 11-26-69-10	1967/03/22 FM: LOTSBERG FM - BASAL RED BEDS MECHANICALLY GOOD CONVENTIONAL DST FM Dep: 1414.30-1432.00 Rec Depth: 1407.60 SP: 545 FFP: 110 VO: 30 (min.) HP: 18292 , 18326 SIP: 552 /269 /0 /0 SIT: 30 /45 /0 /0 FP: 138 /138 /0 /0 /0 /0 FT: 5 /30 /0 /0 Recovery: MUD 1.50 M 1967/03/23 FM: CONTACT RAPIDS FM - MECHANICALLY GOOD STRADDLE DST FM Dep: 1082.00-1103.40 Rec Depth: 1074.40 SP: 207 FFP: 76 VO: 35 (min.) HP: 13865 , 13745 SIP: 248 /186 /0 /0 SIT: 30 /90 /0 /0 FP: 16706 /0 /0 /0 /0 /0 FT: 5 /35 /0 /0 Recovery: MUD 1.50 M	1967/03/22 FM: ERNESTINA LK FM - MECHANICALLY GOOD STRADDLE DST FM Dep: 1155.80-1163.10 Rec Depth: 1146.00 SP: 1496 FFP: 82 VO: 30 (min.) HP: 14920 , 14865 SIP: 1158 /153 /0 /0 SIT: 30 /55 /0 /0 FP: 159 /117 /0 /0 /0 /0 FT: 5 /30 /0 /0 Recovery: MUD 1.50 M 1967/03/23 FM: WINNIPEGOSIS FM - MECHANICALLY GOOD STRADDLE DST FM Dep: 1021.70-1054.60 Rec Depth: 1015.00 SP: 290 FFP: 138 VO: 30 (min.) HP: 13231 , 13190 SIP: 296 /331 /0 /0 SIT: 30 /90 /0 /0 FP: 200 /159 /0 /0 /0 /0 FT: 5 /30 /0 /0 Recovery: MUD 1.50 M
15	00/10-17-071-06W4/0	AMOCO AEC IPIATIK GRIST 10-17-71-6	1980/02/22 FM: BEAVERHILL LAKE FM - MECHANICALLY GOOD STRADDLE DST FM Dep: 515.00-530.00 Rec Depth: 506.00 SP: 2948 FFP: 83 VO: 60 (min.) HP: 6099 , 6099 SIP: 3090 /3090 /0 /0 SIT: 60 /120 /0 /0 FP: 269 /323 /0 /0 /0 /0 FT: 10 /60 /0 /0 Recovery: OIL-CUT MUD 3.00 M	1980/03/08 FM: ERNESTINA LK FM - LOTSBERG FM MECHANICALLY GOOD STRADDLE DST FM Dep: 973.00-983.00 Rec Depth: 963.00 SP: 97 FFP: 32 VO: 90 (min.) HP: 12428 , 12510 SIP: 333 /166 /0 /0 SIT: 90 /120 /0 /0 FP: 333 /166 /0 /0 /0 /0 FT: 10 /60 /0 /0 Recovery: MUD 0.50 M
16	00/16-36-072-01W4/0	AEC ET AL FOSTERCK 16-36-72-1	1985/03/07 FM: KEG RIVER FM - MECHANICALLY GOOD WIRELINE FORMATION TEST FM Dep: 680.50-680.50 Rec Depth: 680.50 SP: 7147 FFP: 0 VO: 0 (min.)	
17	00/11-14-072-08W4/0	AEC PHILLIPS WIAU 11-14-72-8	1980/01/30 FM: LOTSBERG FM - BASAL RED BEDS MECHANICALLY GOOD STRADDLE DST FM Dep: 1250.00-1260.00 Rec Depth: 1240.70 SP: 263 FFP: 200 VO: 60 (min.) HP: 16648 , 16811 SIP: 351 /282 /0 /0 SIT: 60 /90 /0 /0 FP: 328 /328 /0 /0 /0 /0 FT: 5 /60 /0 /0 Recovery: MUD 7.00 M 1980/02/01 FM: PRAIRIE EVAPORITE FM - WINNIPEGOSIS FM MECHANICALLY GOOD STRADDLE DST FM Dep: 905.00-915.00 Rec Depth: 895.70 SP: 10853 FFP: 303 VO: 60 (min.) HP: 11978 , 12021 SIP: 10973 /10607 /0 /0 SIT: 60 /90 /0 /0 FP: 328 /313 /0 /0 /0 /0 FT: 5 /60 /0 /0 Recovery: MUD 7.00 M	1980/02/01 FM: WINNIPEGOSIS FM - MECHANICALLY GOOD STRADDLE DST FM Dep: 910.00-920.00 Rec Depth: 900.70 SP: 11730 FFP: 217 VO: 60 (min.) HP: 12088 , 12240 SIP: 11911 /11478 /0 /0 SIT: 60 /105 /0 /0 FP: 320 /313 /0 /0 /0 /0 FT: 5 /60 /0 /0 Recovery: MUD 7.00 M

Table B.4: DST data available in the original study area for wells that had bulk density log data (source: AEUB well database)

No.	UWI	Well Name	DST Description	DST Description
18	00/10-14-073-05W4/0	AMOCO AEC IPIATIK KIRBY 10-14-73-5	1979/02/04 FM:WINNIPEGOSIS FM - MECHANICALLY GOOD STRADDLE DST FM Dep: 793.00-820.00 Rec Depth:785.00 SP: 5383 FFP: 5331 VO: 60 (min.) HP:4247 .0 SIP:5534 /5534 /0 /0 SIT:30 /120 /0 /0 FP:4615 /5534 /0 /0 /0 /0 /0 FT:10 /60 /0 /0 Recovery: MUD-CUT SALT WATER 60.00 M	
19	00/10-09-074-06W4/0	AMOCO KIRBY 10-9-74-6	1977/02/21 FM:WINNIPEGOSIS FM - MECHANICALLY GOOD STRADDLE DST FM Dep: 810.20-813.80 Rec Depth:812.30 SP: 6543 FFP: 345 VO: 30 (min.) HP:10446 ,10411 SIP:614 /634 /0 /0 SIT:30 /60 /0 /0 FP:248 /290 /0 /0 /0 /0 /0 FT:10 /30 /0 /0 Recovery: MUD 12.20 M 1977/02/21 FM:WINNIPEGOSIS FM - MECHANICALLY GOOD STRADDLE DST FM Dep: 801.00-804.70 Rec Depth:802.50 SP: 6440 FFP: 345 VO: 30 (min.) HP:10411 ,10446 SIP:634 /614 /0 /0 SIT:30 /75 /0 /0 FP:248 /290 /324 /0 /0 /0 /0 FT:10 /30 /0 /0 Recovery: MUD 1977/02/21 FM:WINNIPEGOSIS FM - MECHANICALLY GOOD WIRELINE FORMATION TEST FM Dep: 786.40-786.40 Rec Depth:786.40 SP: 5992 FFP: 0 VO: 0 (min.)	1977/02/21 FM:ERNESTINA LK FM - MECHANICALLY GOOD WIRELINE FORMATION TEST FM Dep: 917.40-917.40 Rec Depth:917.40 SP: 4426 FFP: 0 VO: 0 (min.) HP:10446 ,10411 SIP:614 /634 /0 /0 SIT:30 /60 /0 /0 FP:248 /290 /0 /0 /0 /0 /0 FT:10 /30 /0 /0 1977/02/21 FM:WINNIPEGOSIS FM - MECHANICALLY GOOD WIRELINE FORMATION TEST FM Dep: 813.20-813.20 Rec Depth:813.20 SP: 110 FFP: 0 VO: 0 (min.) HP:10411 ,10446 SIP:634 /614 /0 /0 SIT:30 /75 /0 /0 FP:248 /290 /324 /0 /0 /0 /0 FT:10 /30 /0 /0
20	02/10-01-077-07W4/0	HOME LEISMER A10-1-77-7	1975/02/08 FM:GRANITE WASH - PRECAMBRIAN SYSTEM MECHANICALLY GOOD CONVENTIONAL DST FM Dep: 929.60-959.20 Rec Depth:932.40 SP: 221 FFP: 207 VO: 20 (min.) HP:12126 ,12067 SIP:207 /207 /0 /0 SIT:20 /20 /0 /0 FP:207 /207 /0 /0 /0 /0 /0 FT:20 /20 /0 /0 Recovery: 0.00 M	
21	00/10-28-077-08W4/0	ALTANA HUBER CHRISTINA 10-28-77-8	1971/02/03 FM:PRAIRIE EVAPORITE FM - WINNIPEGOSIS FM MECHANICALLY GOOD STRADDLE DST FM Dep: 727.90-740.70 Rec Depth:721.50 SP: 9880 FFP: 1951 VO: 60 (min.) HP:6963 ,9067 SIP:9880 /9349 /0 /0 SIT:70 /60 /0 /0 FP:579 /1951 /0 /0 /0 /0 /0 FT:5 /60 /0 /0 Recovery: MUD-CUT SALT WATER 170.70 M	1971/02/03 FM:BEAVERHILL LAKE FM - MECHANICALLY GOOD STRADDLE DST FM Dep: 375.50-378.90 Rec Depth:369.10 SP: 676 FFP: 345 VO: 60 (min.) HP:4565 ,4571 SIP:676 /0 /0 /0 SIT:60 /60 /0 /0 FP:324 /345 /0 /0 /0 /0 /0 FT:5 /60 /0 /0 Recovery: WATER-CUT MUD 25.90 M
22	00/10-05-080-02W4/0	HOME WINNEFRED LAKE 10-5-80-2	1987/03/11 FM:PRAIRIE EVAPORITE FM - CONTACT RAPIDS FM MECHANICALLY GOOD CONVENTIONAL DST FM Dep: 516.80-557.80 Rec Depth:556.80 SP: 4289 FFP: 2427 VO: 150 (min.) HP:5288 ,5288 SIP:3896 /3620 /0 /0 SIT:60 /150 /0 /0 FP:276 /1951 /0 /0 /0 /0 /0 FT:150 /0 /0 /0 Recovery: SALT WATER 131.10 M Recovery: MUD 73.20 M	

Table B.4: DST data available in the original study area for wells that had bulk density log data (source: AEUB well database)

No.	UWI	Well Name	DST Description	DST Description
23	00/11-32-080-04W4/0	HOMESTEAD CANOXY COWPAR 11-32-80-4	1976/01/21 FM:PRAIRIE EVAPORITE FM - WINNIPEGOSIS FM MECHANICALLY GOOD CONVENTIONAL DST FM Dep: 487.70-498.90 Rec Depth:491.90 SP: 4557 FFP: 1386 VO: 60 (min.) HP:5633 .5543 SIP:4551 /4420 /0 /0 SIT:60 /90 /0 /0 FP:621 /1379 /0 /0 /0 /0 /0 FT:10 /60 /0 /0 Recovery: SALT WATER 112.80 M	
24	00/10-08-083-06W4/0	GULF RESDELN 10-8-83-6	1981/02/22 FM:WINNIPEGOSIS FM - MECHANICALLY GOOD STRADDLE DST FM Dep: 579.00-589.50 Rec Depth:570.00 SP: 3150 FFP: 1125 VO: 60 (min.) HP:7738 .7885 SIP:3266 /2795 /0 /0 SIT:60 /115 /0 /0 FP:559 /0 /0 /0 /0 /0 /0 FT:5 /60 /0 /0 Recovery: MUD 65.00 M	
25	00/01-14-083-06W4/0	TEXCAN COTTONWOOD 1-14-83-6	1989/02/15 FM:KEG RIVER FM - MECHANICALLY GOOD STRADDLE DST FM Dep: 548.00-564.50 Rec Depth:556.60 SP: 4261 FFP: 3799 VO: 60 (min.) HP:6729 .6647 SIP:3868 /4006 /0 /0 SIT:60 /90 /0 /0 FP:1165 /3530 /0 /0 /0 /0 /0 FT:5 /60 /0 /0 Recovery: SALT WATER 320.00 M	
26	00/15-14-084-11W4/0	JACOS WD HANGST 15-14-84-11	1990/02/22 FM:WINNIPEGOSIS FM - MECHANICALLY GOOD WIRELINE FORMATION TEST FM Dep: 781.60-781.60 Rec Depth:781.60 SP: 9980 FFP: 0 VO: 0 (min.) 1990/02/22 FM:WINNIPEGOSIS FM - MECHANICALLY GOOD WIRELINE FORMATION TEST FM Dep: 747.10-747.10 Rec Depth:747.10 SP: 9595 FFP: 0 VO: 0 (min.)	1990/02/22 FM:WINNIPEGOSIS FM - MECHANICALLY GOOD WIRELINE FORMATION TEST FM Dep: 781.50-781.50 Rec Depth:781.50 SP: 10028 FFP: 0 VO: 0 (min.) 1990/02/22 FM:WINNIPEGOSIS FM - MECHANICALLY GOOD WIRELINE FORMATION TEST FM Dep: 747.10-747.10 Rec Depth:747.10 SP: 9597 FFP: 0 VO: 0 (min.)
27	00/06-01-052-13W4/0	VOYAGER PLAIN 6-1-52-13	1978/09/12 FM:ERNESTINA LK FM - MECHANICALLY GOOD STRADDLE DST FM Dep: 1581.00-1585.00 Rec Depth:1583.00 SP: 6965 FFP: 192 VO: 60 (min.) HP:18809 .18809 SIP:1204 /6965 /0 /0 SIT:30 /90 /0 /0 FP:209 /192 /0 /0 /0 /0 /0 FT:10 /60 /0 /0 Recovery: MUD 1.00 M	
28	00/02-13-055-13W4/0	WESTMIN HAIRY 2-13-55-13	1983/09/08 FM:BASAL RED BEDS - MECHANICALLY GOOD REVERSE-CIRCULATION DST FM Dep: 1635.00-1644.00 Rec Depth:1627.30 SP: 668 FFP: 90 VO: 60 (min.) HP:21024 .21024 SIP:180 /682 /0 /0 SIT:60 /90 /0 /0 FP:144 /144 /198 /126 /0 /0 /0 FT:15 /60 /0 /0 Recovery: 0.00 M3	
29	00/07-07-072-03W4/0	AEC FOSTER CREEK 7-7-72-3	1996/01/24 FM:WINNIPEGOSIS FM - MECHANICALLY GOOD LIMITED RECOVERY DST FM Dep: 777.00-802.00 Rec Depth:779.91 SP: 5335 FFP: 5334 VO: 60 (min.) To Surface: GAS: 0 (min.) Max Fl: 0.3 E3m3/d Final Fl: 0.0 E3m3/d	

Table B.4: DST data available in the original study area for wells that had bulk density log data (source: AEUB well database)

No.	UWI	Well Name	DST Description	DST Description
30	00/01-03-095-07W4/0	CDCOG TENN MUSKEGR 1-3-95-7	<p>1980/02/18 FM:KEG RIVER SS - MECHANICALLY GOOD CONVENTIONAL DST FM Dep: 375.00-408.00 Rec Depth:378.00 SP: 1738 FFP: 255 VO: 60 (min.) HP:3456 ,3373 SIP:329 /1728 /0 /0 SIT:60 /120 /0 /0 FP:247 /247 /0 /0 /0 /0 /0 FT:10 /30 /0 /0 Recovery: SALT WATER 0.30 M</p> <p>1980/02/20 FM:BEAVERHILL LAKE FM - MECHANICALLY GOOD STRADDLE DST FM Dep: 258.00-290.00 Rec Depth:260.00 SP: 790 FFP: 527 VO: 30 (min.) HP:25505 ,25505 SIP:2468 /8226 /0 /0 SIT:60 /120 /0 /0 FP:0 /6582 /0 /0 /0 /0 /0 FT:10 /30 /0 /0 Recovery: MUD 72.00 M</p>	<p>1980/02/20 FM:BEAVERHILL LAKE FM - PRAIRIE EVAPORITE FM MECHANICALLY GOOD STRADDLE DST FM Dep: 300.00-318.00 Rec Depth:302.00 SP: 1110 FFP: 773 VO: 30 (min.) HP:3108 ,3021 SIP:977 /977 /0 /0 SIT:60 /120 /0 /0 FP:355 /622 /0 /0 /0 /0 /0 FT:10 /30 /0 /0 Recovery: WATER-CUT MUD 65.00 M</p>
31	00/01-20-095-07W4/0	HUSKY TENN MUSKEGR 1-20-95-7	<p>1980/03/11 FM:GRANITE WASH - PRECAMBRIAN SYSTEM MECHANICALLY GOOD CONVENTIONAL DST FM Dep: 310.00-338.00 Rec Depth:300.30 SP: 223 FFP: 11 VO: 30 (min.) HP:3427 ,3427 SIP:1108 /1108 /0 /0 SIT:30 /120 /0 /0 FP:1108 /1108 /0 /0 /0 /0 /0 FT:10 /30 /0 /0 Recovery: MUD 1.00 M</p> <p>1980/03/12 FM:BEAVERHILL LAKE FM - MECHANICALLY GOOD STRADDLE DST FM Dep: 202.00-224.00 Rec Depth:192.30 SP: 764 FFP: 747 VO: 30 (min.) HP:2304 ,2304 SIP:901 /901 /0 /0 SIT:30 /120 /0 /0 FP:901 /901 /0 /0 /0 /0 /0 FT:10 /30 /0 /0 Recovery: MUD 65.00 M</p>	<p>1980/03/12 FM:BEAVERHILL LAKE FM - KEG RIVER FM MECHANICALLY GOOD STRADDLE DST FM Dep: 226.00-254.00 Rec Depth:216.30 SP: 903 FFP: 675 VO: 60 (min.) HP:2287 ,2287 SIP:892 /1003 /0 /0 SIT:30 /120 /0 /0 FP:167 /836 /0 /0 /0 /0 /0 FT:10 /30 /0 /0 Recovery: MUD 92.00 M</p> <p>1980/03/12 FM:BEAVERHILL LAKE FM - MECHANICALLY GOOD STRADDLE DST FM Dep: 190.00-200.00 Rec Depth:191.00 SP: 484 FFP: 202 VO: 30 (min.) HP:2004 ,2004 SIP:1202 /701 /0 /0 SIT:30 /120 /0 /0 FP:200 /200 /0 /0 /0 /0 /0 FT:10 /30 /0 /0 Recovery: MUD 9.00 M</p>

APPENDIX C

DATA SUMMARY TABLES – EXPANDED STUDY AREA

- Table C.1** Bulk density log data available in the expanded study area for the Elk Point Group (source: AEUB well database)
- Table C.2** Dipmeter log data available in expanded study area for the Elk Point Group (source: AEUB well database)
- Table C.3** Bulk density log data available in the expanded Saskatchewan area for the Elk Point Group (source: AEUB well database)
- Table C.4** Dipmeter log data available in the expanded Saskatchewan area for the Paleozoic-age Formations (source: AEUB well database)

APPENDIX C

DATA SUMMARY TABLES – EXPANDED STUDY AREA

- Table C.1** Bulk density log data available in expanded study area for the Elk Point Group
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Table C.1: Bulk density log data available in the expanded study area for the Elk Point Group (source: AEUB well database)

No.	UWI	Run Date	Top Log Interval (m KB)	Bottom Log Interval (m KB)	Top Formation Code	Bottom Formation Code	Top and Bottom Coverage in Elk Point Group	Fraction of Unknown Bulk Density Data from Surface to Bottom Log Interval	Wells Proposed for Analysis
1	00/01-01-091-05W5/0	1986/04/01	15	1446	0000	7940	N	0.01	
2	00/01-03-073-04W5/0	1991/11/30	300	1619	0000	7820	N	0.19	
3	00/01-03-089-03W5/0	1987/09/26	25	1468	0000	9800	Y	0.02	
4	00/01-04-070-03W5/0	1988/02/24	470	1739.1	2060	7820	N	0.27	
5	00/01-05-071-03W5/0	1992/08/04	275	1779.7	0000	7820	N	0.15	
6	00/01-06-090-03W5/0	1998/02/14	1085	1508	0004	9800	Y	0.72	
7	00/01-07-036-18W4/0		354	2121	0000	7700	N	0.17	
8	00/01-07-074-04W5/0	1993/03/07	195.2	1643.9	0000	7820	N	0.12	
9	00/01-07-093-04W5/0	1987/03/06	295	1326	0000	9800	Y	0.22	
10	00/01-08-094-03W5/0	1993/01/05	807.6	1352.2	7170	9800	Y	0.60	
11	00/01-11-073-04W5/0	1998/08/20	273.5	1626	0000	7820	N	0.17	
12	00/01-11-090-03W5/0	1994/02/12	1012.8	1481.6	7170	7880	N	0.68	
13	00/01-11-091-05W5/0	1986/02/20	16	1371.5	0000	9760	Y	0.01	
14	00/01-11-101-02W5/0		609.6	1082.6	7440	9800	Y	0.56	
15	00/01-12-060-21W4/0		20	1492	0000	7700	N	0.01	
16	00/01-15-090-05W5/0	1988/08/07	450	1535	0000	9999	Y	0.29	
17	00/01-15-093-02W5/0	1995/08/24	787	1310.1	7170	9999	Y	0.60	
18	00/01-16-074-04W5/0	1990/10/07	1330	1668.8	7170	7820	N	0.80	
19	00/01-17-092-04W5/0	1987/03/15	794	1298.1	7170	9800	Y	0.61	
20	00/01-19-089-03W5/0	1988/11/16	1141	1531	7440	9800	Y	0.75	
21	00/01-20-090-03W5/0	1993/03/22	960.6	1443.79	7170	7880	N	0.67	
22	00/01-20-094-03W5/0	1996/02/09	30	1345.7	0000	9800	Y	0.02	Y
23	00/01-22-089-03W5/0	1988/02/08	20	1481	0000	9800	Y	0.01	
24	00/01-23-095-05W5/0	1985/03/11	246	1239.5	0000	9800	Y	0.20	
25	00/01-24-071-04W5/0	1989/02/26	181	1743.2	0000	7820	N	0.10	
26	00/01-24-090-03W5/0	1985/11/11	854	1389	7170	9800	Y	0.61	
27	00/01-25-096-05W5/0	1987/01/16	15	1272	0000	9800	Y	0.01	Y
28	00/01-28-089-03W5/0	1988/10/26	20	1521.2	0000	9999	Y	0.01	
29	00/01-28-092-04W5/0	1988/03/05	20	1335	0000	9800	N	0.01	Y
30	00/01-29-101-24W4/0	1985/03/15	281	1068	7170	9999	Y	0.26	Y
31	00/01-30-089-03W5/0	1986/12/21	356	1529	0000	9800	Y	0.23	
32	00/01-31-095-04W5/0	1985/01/26	290	1208.2	0000	9999	N	0.24	
33	00/01-32-089-02W5/0	1995/11/13	20	1459.4	0000	7880	N	0.01	
34	00/01-33-090-01W5/0	1986/01/31	793.5	1223.4	7440	9999	Y	0.65	
35	00/01-34-089-04W5/0	1991/02/09	1050.2	1491.7	7170	9999	Y	0.70	
36	00/01-36-093-04W5/0	1995/01/08	63.7	1285.5	0000	7880	N	0.05	
37	00/02-01-074-05W5/0	1988/08/12	275	1645	0000	7820	N	0.17	
38	00/02-01-090-04W5/0	1993/07/11	1445.6	1453.3	7820	7880	N	0.99	
39	00/02-01-094-02W5/0	1997/02/19	10	1329.9	0000	9800	Y	0.01	Y
40	00/02-02-042-14W4/0	1987/05/27	830	1624.7	2360	7860	N	0.51	
41	00/02-03-070-03W5/0	1993/10/19	400	1688	0000	7820	N	0.24	
42	00/02-03-072-04W5/0	1990/11/18	450	1807.5	0000	7820	N	0.25	
43	00/02-03-090-03W5/0	1992/08/25	1028	1478.7	7170	7880	N	0.70	

Table C.1: Bulk density log data available in the expanded study area for the Elk Point Group (source: AEUB well database)

No.	UWI	Run Date	Top Log Interval (m KB)	Bottom Log Interval (m KB)	Top Formation Code	Bottom Formation Code	Top and Bottom Coverage in Elk Point Group	Fraction of Unknown Bulk Density Data from Surface to Bottom Log Interval	Wells Proposed for Analysis
44	00/02-04-015-11W4/0	1997/10/16	362	1691.4	0000	7700	N	0.21	
45	00/02-04-071-03W5/0		1249.7	1706.9	7160	7820	N	0.73	
46	00/02-04-072-04W5/0	1992/11/27	1725	1816.5	7440	7820	N	0.95	
47	00/02-04-089-03W5/0	1987/10/17	1021	1535	7170	9800	Y	0.67	
48	00/02-05-073-04W5/0	1986/08/21	13	1658.1	0000	7820	N	0.01	
49	00/02-05-074-04W5/0	1988/02/12	205.3	1628.4	0000	7820	N	0.13	
50	00/02-05-090-02W5/0	1988/02/29	963	1491	7170	9800	Y	0.65	
51	00/02-06-072-03W5/0	1993/03/05	250	1694.5	0000	7820	N	0.15	
52	00/02-06-074-04W5/0	1988/09/06	318	1652	0000	9999	N	0.19	
53	00/02-07-090-02W5/0	1993/03/30	25	1396.3	0000	7880	N	0.02	
54	00/02-10-055-22W4/0	1985/09/27	505	1876.2	1600	7960	N	0.27	
55	00/02-10-074-05W5/0	1987/11/01	180.5	1693	0000	7820	N	0.11	
56	00/02-10-089-03W5/0		30.5	1450.8	0000	9800	Y	0.02	
57	00/02-10-102-23W4/0	1985/02/06	325.7	1074.9	0000	9800	Y	0.30	Y
58	00/02-11-089-03W5/0	1988/03/16	1046.5	1501	7320	9800	Y	0.70	
59	00/02-12-093-05W5/0	1987/03/01	10	1337.3	0000	9800	Y	0.01	Y
60	00/02-13-073-04W5/0	1991/01/29	1350	1605.5	7170	7820	N	0.84	
61	00/02-13-073-05W5/0	1991/03/02	1624.5	1649.8	7620	7820	N	0.98	
62	00/02-14-090-05W5/0	1992/03/19	3.7	1491.8	0000	7880	N	0.00	
63	00/02-14-091-05W5/0	1986/08/25	30	1401	0000	9800	Y	0.02	
64	00/02-15-072-04W5/0	1990/11/23	450	1788.5	0000	7820	N	0.25	
65	00/02-15-074-05W5/0	1987/12/01	1000	1779.4	6580	7820	N	0.56	
66	00/02-15-089-03W5/0	1987/11/18	20	1552.1	0000	9800	Y	0.01	
67	00/02-16-074-05W5/0		195	1795.7	0000	7820	N	0.11	
68	00/02-18-071-03W5/0	1990/01/08	1751.3	1793.6	7580	7820	N	0.98	
69	00/02-18-072-03W5/0	1991/01/26	1397.5	1724.5	7100	7820	N	0.81	
70	00/02-18-090-02W5/0	1986/02/20	868	1350	7170	9800	Y	0.64	
71	00/02-20-051-23W4/0		200	1854.5	0000	7700	N	0.11	
72	00/02-20-073-04W5/0	1985/02/23	1300	1636	7100	9999	Y	0.79	
73	00/02-20-091-02W5/0	1986/02/10	240	1282	0000	9800	Y	0.19	
74	00/02-21-073-04W5/0	1992/01/28	265	1627	0000	7820	N	0.16	
75	00/02-21-091-03W5/0	1985/03/17	5	1394.7	0000	9800	Y	0.00	
76	00/02-21-092-04W5/0	1987/10/31	15	1294.3	0000	9800	Y	0.01	
77	00/02-23-070-04W5/0	1993/07/10	1790	1863.6	7440	7820	N	0.96	
78	00/02-23-072-04W5/0	1991/01/21	310	1663.4	0000	7820	N	0.19	
79	00/02-23-073-04W5/0	1991/02/17	1518.2	1609.2	7440	7820	N	0.94	
80	00/02-23-091-05W5/0	1988/08/01	848	1367.2	7170	9800	Y	0.62	
81	00/02-24-088-03W5/0	1987/09/23	1018	1434	7170	9800	Y	0.71	
82	00/02-25-096-05W5/0	1995/01/22	1140	1222.1	7820	9800	Y	0.93	
83	00/02-26-072-04W5/0	1992/07/21	250	1628	0000	7820	N	0.15	
84	00/02-27-089-03W5/0	1988/10/26	25	1500.2	0000	9800	Y	0.02	
85	00/02-28-070-03W5/0		190.5	1751.1	0000	7820	N	0.11	
86	00/02-28-072-04W5/0	1992/02/08	1588	1946.5	7440	9999	Y	0.82	

Table C.1: Bulk density log data available in the expanded study area for the Elk Point Group (source: AEUB well database)

No.	UWI	Run Date	Top Log Interval (m KB)	Bottom Log Interval (m KB)	Top Formation Code	Bottom Formation Code	Top and Bottom Coverage in Elk Point Group	Fraction of Unknown Bulk Density Data from Surface to Bottom Log Interval	Wells Proposed for Analysis
87	00/02-28-073-04W5/0	1988/02/15	204	1620	0000	7820	N	0.13	
88	00/02-28-094-01W5/0	1987/01/25	856	1463.2	7170	9800	Y	0.59	
89	00/02-30-072-04W5/0	1990/12/31	300	1674.2	0000	7820	N	0.18	
90	00/02-30-088-03W5/0	1987/08/20	350	1586.8	0000	9800	Y	0.22	
91	00/02-30-094-03W5/0	1994/12/07	813.5	1324	7170	7880	N	0.61	
92	00/02-31-072-03W5/0	1992/01/25	249	1605	0000	7820	N	0.16	
93	00/02-31-089-03W5/0	1987/11/04	20	1507	0000	9800	Y	0.01	
94	00/02-31-093-02W5/0	1998/01/20	709	1375	7160	9800	Y	0.52	
95	00/02-32-070-03W5/0	1988/08/09	560	1778.7	2480	7820	N	0.31	
96	00/02-32-073-04W5/0	1992/01/21	1565	1627	7440	7820	N	0.96	
97	00/02-32-089-03W5/0	1987/06/11	1024	1507.7	7170	9800	Y	0.68	
98	00/02-33-072-04W5/0	1990/03/17	286	1639	0000	9999	N	0.17	
99	00/02-34-060-01W5/0		780.2	1858.5	2480	7700	N	0.42	
100	00/02-34-090-02W5/0	1988/03/28	18	1341.3	0000	9800	Y	0.01	
101	00/02-35-071-04W5/0	1992/06/29	250	1801	0000	7820	N	0.14	
102	00/02-35-072-04W5/0	1990/11/24	1545	1625	7440	7820	N	0.95	
103	00/02-35-073-05W5/0	1985/03/04	197.8	1649.8	0000	7820	N	0.12	
104	00/02-36-072-04W5/0		210	1644.7	0000	7820	N	0.13	
105	00/02-36-090-03W5/0	1984/12/05	37	1404	0000	9800	Y	0.03	
106	00/03-01-074-05W5/0	1989/04/06	1400	1650.6	7170	7820	N	0.85	
107	00/03-01-090-04W5/0	1993/08/04	1443	1461.9	7820	7880	N	0.99	
108	00/03-01-093-05W5/0	1987/09/30	17	1369.8	0000	9800	Y	0.01	Y
109	00/03-03-090-03W5/0	1992/12/03	1030.4	1489.2	0000	7880	N	0.69	
110	00/03-04-031-12W4/0	1984/04/04	350	1876.5	0000	7777	N	0.19	
111	00/03-04-094-04W5/0		990.6	1311.9	7440	7940	N	0.76	
112	00/03-05-072-03W5/0		1023.5	1684.5	6960	7820	N	0.61	
113	00/03-05-095-03W5/0	1996/02/18	1240.5	1299.5	7820	7880	N	0.95	
114	00/03-07-074-04W5/0	1992/12/10	190.4	1643.2	1860	7820	N	0.12	
115	00/03-07-094-03W5/0	1986/02/19	380	1312	0000	9800	Y	0.29	
116	00/03-08-093-04W5/0	1987/10/28	806	1315	7170	9800	Y	0.61	
117	00/03-11-072-04W5/0		191	1800	0000	7820	N	0.11	
118	00/03-15-027-08W4/0		899.2	1718.5	2140	7700	N	0.52	
119	00/03-15-089-03W5/0	1987/07/11	350	1509	0000	9800	Y	0.23	
120	00/03-17-096-04W5/0	1995/01/07	300	1148	0000	7820	N	0.26	
121	00/03-18-092-04W5/0	1987/12/20	825	1351	7170	9800	Y	0.61	
122	00/03-18-093-04W5/0	1988/01/24	10	1345.9	0000	9800	Y	0.01	Y
123	00/03-18-094-03W5/0	1994/03/23	1025.5	1304	7580	7880	N	0.70	
124	00/03-19-094-03W5/0	1994/12/20	808.9	1322.8	7170	7880	N	0.61	
125	00/03-20-093-03W5/0	1996/01/05	615	1319.4	6700	7880	N	0.47	
126	00/03-20-094-03W5/0	1996/03/09	15	1351	0004	7940	N	0.01	
127	00/03-22-111-04W5/0		109.1	904	0000	9800	Y	0.12	
128	00/03-24-090-03W5/0	1984/10/18	25	1410	0000	9999	Y	0.02	
129	00/03-25-083-02W5/0		1100	1500	7440	7880	N	0.73	

Table C.1: Bulk density log data available in the expanded study area for the Elk Point Group (source: AEUB well database)

No.	UWI	Run Date	Top Log Interval (m KB)	Bottom Log Interval (m KB)	Top Formation Code	Bottom Formation Code	Top and Bottom Coverage in Elk Point Group	Fraction of Unknown Bulk Density Data from Surface to Bottom Log Interval	Wells Proposed for Analysis
130	00/03-27-089-03W5/0	1986/03/23	982.5	1515	7170	9999	Y	0.65	
131	00/03-29-070-03W5/0	1992/07/22	764	1758	6440	7820	N	0.43	
132	00/03-30-109-03W5/0		93	843.4	7100	9800	Y	0.11	
133	00/03-32-015-05W4/0		193	1717.2	0000	9160	Y	0.11	Y
134	00/03-32-094-03W5/0	1996/01/14	10	1307.9	0000	7880	N	0.01	
135	00/03-34-089-03W5/0	1985/12/03	1003	1512.7	7170	9800	Y	0.66	
136	00/03-35-095-05W5/0	1988/03/24	810	1279	7440	9800	Y	0.63	
137	00/03-35-101-22W4/0		609.6	1022.6	7540	7960	N	0.60	
138	00/04-01-045-16W4/0	1983/12/03	284	1802	0000	7777	N	0.16	
139	00/04-01-073-05W5/0	1990/03/01	180	1669.2	0000	7820	N	0.11	
140	00/04-02-073-04W5/0	1991/07/05	1400	1616.2	7320	7820	N	0.87	
141	00/04-02-074-05W5/0	1984/01/19	184.5	1661	0000	7820	N	0.11	
142	00/04-02-090-04W5/0	1997/11/26	559	1494	0000	9800	Y	0.37	
143	00/04-02-093-05W5/0	1988/03/12	20	1356	0000	7940	N	0.01	
144	00/04-03-070-03W5/0		175	1708	0000	7820	N	0.10	
145	00/04-04-070-03W5/0	1991/10/03	1650	1719	7440	7820	N	0.96	
146	00/04-05-093-04W5/0	1987/09/22	30	1314	0000	9999	Y	0.02	Y
147	00/04-06-074-04W5/0	1989/06/12	218.9	1649.2	0000	7820	N	0.13	
148	00/04-06-090-03W5/0	1993/06/15	25	1520.1	0000	9999	N	0.02	
149	00/04-06-098-01W5/0	1990/01/27	35	1210.4	0000	9760	Y	0.03	Y
150	00/04-07-073-04W5/0	1989/12/17	1593	1656	7440	7820	N	0.96	
151	00/04-07-093-04W5/0	1987/08/21	805	1344	7170	7940	N	0.60	
152	00/04-08-073-04W5/0	1989/03/24	1541	1651	7440	7820	N	0.93	
153	00/04-08-095-04W5/0	1987/03/16	794	1291.1	7440	9800	Y	0.61	
154	00/04-08-097-02W5/0		847.3	1272.8	7440	9800	Y	0.67	
155	00/04-09-074-04W5/0	1989/09/25	295.5	1642.5	0000	7820	N	0.18	
156	00/04-10-073-04W5/0		1519.4	1652.5	7440	7820	N	0.92	
157	00/04-10-073-05W5/0	1985/02/12	1533	1702.2	7440	7820	N	0.90	
158	00/04-11-055-22W4/0	1994/12/16	216.4	1939	0000	8040	N	0.11	
159	00/04-11-089-03W5/0	1987/11/01	15	1514	0000	9800	Y	0.01	
160	00/04-11-098-23W4/0		187.8	1185.1	0000	7940	N	0.16	
161	00/04-12-073-04W5/0	1998/09/24	635.8	1626.6	0004	7820	N	0.39	
162	00/04-12-090-05W5/0	1987/03/17	1097.7	1522.2	0000	9800	Y	0.72	
163	00/04-13-090-03W5/0	1986/02/06	10	1472	0000	9800	Y	0.01	
164	00/04-14-073-05W5/0	1994/02/18	1590	1663	7440	7820	N	0.96	
165	00/04-15-073-05W5/0	1993/02/20	1680	1753.7	7440	7820	N	0.96	
166	00/04-15-074-04W5/0	1993/02/19	298.2	1659.8	0000	7820	N	0.18	
167	00/04-15-074-05W5/0		209	1773	0000	7820	N	0.12	
168	00/04-16-095-02W5/0	1988/03/11	316.1	1373.5	0000	9800	Y	0.23	Y
169	00/04-17-070-03W5/0	1990/12/17	1678.5	1722.5	7620	7820	N	0.97	
170	00/04-17-072-03W5/0	1995/02/16	1533	1687	7440	7780	N	0.91	
171	00/04-17-073-04W5/0	1992/02/08	1600.7	1644.4	7580	7820	N	0.97	
172	00/04-17-093-04W5/0	1987/11/12	793.5	1319	7170	9800	Y	0.60	Y

Table C.1: Bulk density log data available in the expanded study area for the Elk Point Group (source: AEUB well database)

No.	UWI	Run Date	Top Log Interval (m KB)	Bottom Log Interval (m KB)	Top Formation Code	Bottom Formation Code	Top and Bottom Coverage in Elk Point Group	Fraction of Unknown Bulk Density Data from Surface to Bottom Log Interval	Wells Proposed for Analysis
173	00/04-17-094-03W5/0	1994/03/17	1039.4	1319.1	7580	7880	N	0.79	
174	00/04-18-038-01W4/0	1994/08/02	837.4	1570.8	3220	9000	Y	0.53	Y
175	00/04-18-073-04W5/0	1990/02/10	180	1654.3	0000	9999	N	0.11	
176	00/04-18-090-02W5/0	1992/03/07	497	1389.99	0000	7880	N	0.36	
177	00/04-19-071-03W5/0	1991/12/10	300	1734.9	0000	7820	N	0.17	
178	00/04-19-095-04W5/0	1985/01/06	50	1270.3	0000	9999	N	0.04	
179	00/04-20-070-03W5/0	1991/09/07	1650	1737.8	7440	7820	N	0.95	
180	00/04-20-089-03W5/0	1987/10/14	20	1554.4	0000	9800	Y	0.01	
181	00/04-20-094-03W5/0	1993/02/12	25	1332	0000	7940	N	0.02	
182	00/04-21-071-04W5/0	1984/12/23	1650	1781	7440	7820	N	0.93	
183	00/04-24-073-04W5/0		290	1614	0000	7820	N	0.18	
184	00/04-25-090-03W5/0	1984/03/25	182	1357	0000	9999	Y	0.13	
185	00/04-25-093-24W4/0	1984/03/22	40	1281.5	0000	7940	N	0.03	
186	00/04-26-073-04W5/0	1985/01/05	184	1611.1	0000	7820	N	0.11	
187	00/04-26-089-04W5/0	1989/07/20	1099.5	1509	0000	9800	Y	0.73	
188	00/04-26-104-01W5/0		129.8	855.9	7100	9800	Y	0.15	Y
189	00/04-28-035-20W4/0		1200	2249	2060	7700	N	0.53	
190	00/04-28-085-04W5/0		1188.7	1651.1	7170	9800	Y	0.72	
191	00/04-29-071-03W5/0	1994/02/01	680	1724.7	2480	7820	N	0.39	
192	00/04-29-071-04W5/0	1984/11/18	1700	1830	7440	7820	N	0.93	
193	00/04-29-098-21W4/0	1985/02/09	324.5	1185.1	0000	9800	Y	0.27	Y
194	00/04-30-091-04W5/0	1990/02/28	996.4	1370	7440	9800	Y	0.73	
195	00/04-31-070-03W5/2	1992/09/05	380	1808.2	0000	7820	N	0.21	
196	00/04-31-072-03W5/0		214.9	1607.2	0000	7820	N	0.13	
197	00/04-33-069-03W5/0	1984/03/06	203	1732	0000	7820	N	0.12	
198	00/04-33-072-04W5/0	1992/01/23	1604.5	1647	7580	7820	N	0.97	
199	00/04-33-073-04W5/0	1992/02/27	250	1616.1	0000	7820	N	0.15	
200	00/04-33-096-04W5/0	1987/01/14	50	1210.5	0000	9800	Y	0.04	Y
201	00/04-35-071-04W5/0	1991/10/22	1781.2	1824.8	7620	7820	N	0.98	
202	00/04-36-072-04W5/0		340	1622	2060	7820	N	0.21	
203	00/04-36-073-05W5/0	1989/03/31	300	1650.2	0000	7820	N	0.18	
204	00/04-36-092-05W5/2	1986/09/20	1011	1348	0000	7880	N	0.75	
205	00/05-01-090-02W5/0	1985/01/16	50	1383.8	0000	9800	Y	0.04	
206	00/05-02-020-03W5/0		925	2194	6420	9480	Y	0.42	Y
207	00/05-02-089-03W5/0	1987/12/18	35	1502.2	0000	9800	Y	0.02	
208	00/05-02-094-01W5/0	1987/01/11	813	1407.4	7170	9800	Y	0.58	
209	00/05-06-104-23W4/0		350.5	878.4	7520	9800	Y	0.40	Y
210	00/05-07-090-02W5/0	1992/09/04	949	1421.3	0000	7940	N	0.67	
211	00/05-07-092-04W5/0	1987/09/17	809	1335	7170	9800	Y	0.61	
212	00/05-08-094-04W5/0	1986/02/09	950	1273.6	7440	9800	Y	0.75	
213	00/05-08-100-22W4/2	1985/03/29	650	1212.1	0000	7920	N	0.54	
214	00/05-11-020-06W4/0		1052.2	2228.7	6440	9800	Y	0.47	Y
215	00/05-11-065-02W5/0		897.5	1815	3360	7820	N	0.49	

Table C.1: Bulk density log data available in the expanded study area for the Elk Point Group (source: AEUB well database)

No.	UWI	Run Date	Top Log Interval (m KB)	Bottom Log Interval (m KB)	Top Formation Code	Bottom Formation Code	Top and Bottom Coverage in Elk Point Group	Fraction of Unknown Bulk Density Data from Surface to Bottom Log Interval	Wells Proposed for Analysis
216	00/05-11-088-24W4/0		458.7	1200.6	7160	7960	N	0.38	
217	00/05-12-089-02W5/0	1986/03/21	15	1527	0000	9800	Y	0.01	
218	00/05-12-092-05W5/0	1987/12/07	15	1363	0000	9800	Y	0.01	
219	00/05-12-092-24W4/0		0	1240.5	0000	9800	Y	0.00	Y
220	00/05-12-099-04W5/0	1985/02/17	501.3	1237.4	7170	9999	Y	0.41	
221	00/05-13-070-04W5/0	1993/06/20	820	1842	3260	7820	N	0.45	
222	00/05-13-073-04W5/0	1990/02/27	290.4	1619	0000	7820	N	0.18	
223	00/05-14-094-02W5/0	1998/02/06	739.7	1397.1	7170	9800	Y	0.53	
224	00/05-17-089-04W5/0	1994/06/23	20	1509.2	0000	7880	N	0.01	
225	00/05-19-073-03W5/0	1993/06/08	1500	1595	7440	7820	N	0.94	
226	00/05-20-098-01W5/0		762	1132	7440	7940	N	0.67	
227	00/05-22-072-04W5/0	1991/02/09	1612	1655.9	7620	7820	N	0.97	
228	00/05-22-089-03W5/0	1986/02/07	458	1517.8	0000	9800	Y	0.30	
229	00/05-25-092-05W5/0	1987/09/06	20	1357	0000	9800	Y	0.01	Y
230	00/05-27-070-04W5/0	1994/01/23	857.2	1866.5	0000	7820	N	0.46	
231	00/05-29-073-03W5/0	1994/01/18	560	1747.6	2480	7960	N	0.32	
232	00/05-29-091-02W5/0	1985/03/30	780.8	1289.4	7170	9800	Y	0.61	
233	00/05-30-094-04W5/0		334	1363.7	0000	9800	Y	0.24	
234	00/05-32-017-02W4/0	1986/11/03	339	1716.3	0000	7700	N	0.20	
235	00/05-32-071-03W5/0		1222	1651	7100	7820	N	0.74	
236	00/05-32-089-03W5/0	1988/02/29	1033	1479	7170	9800	Y	0.70	
237	00/05-35-072-04W5/0	1990/06/14	299	1631.4	0000	7820	N	0.18	
238	00/05-36-089-04W5/0	1993/09/03	1416	1464.4	7820	7880	N	0.97	
239	00/06-01-034-24W4/0	1992/10/05	385.2	2525.2	0000	7700	N	0.15	
240	00/06-02-070-03W5/0		185.9	1669.7	0000	7820	N	0.11	
241	00/06-02-090-05W5/0	1987/10/29	17	1533	0000	9999	Y	0.01	
242	00/06-02-091-03W5/0	1985/02/22	41	1397	0000	9999	Y	0.03	
243	00/06-02-097-19W4/0	1986/02/21	238	1770	0000	9999	Y	0.13	Y
244	00/06-03-087-22W4/0	1988/03/01	845	1238	7540	9800	Y	0.68	Y
245	00/06-03-090-03W5/0	1985/08/26	1000	1526	7170	9800	Y	0.66	
246	00/06-04-037-16W4/0	1989/12/13	10	2048	0000	9000	Y	0.00	Y
247	00/06-04-087-03W5/0	1989/03/15	3	1622.9	0000	9800	Y	0.00	Y
248	00/06-05-074-04W5/0	1988/02/15	1172.4	1638.3	7160	7820	N	0.72	
249	00/06-06-098-01W5/0		812.9	1201.5	7540	9800	Y	0.68	
250	00/06-07-065-23W4/0		406.2	1520	0000	7720	N	0.27	
251	00/06-07-095-02W5/0	1985/03/16	679.6	1323	7170	7940	N	0.51	
252	00/06-07-097-23W4/0		888.8	1438.4	7480	7960	N	0.62	
253	00/06-08-089-04W5/0	1989/04/04	5	1528.6	0000	9800	Y	0.00	
254	00/06-09-090-03W5/0	1993/02/09	15	1503	0000	7880	N	0.01	
255	00/06-09-091-02W5/0		1005.8	1354.8	7440	7940	N	0.74	
256	00/06-11-033-24W4/0	1987/01/22	1800	2553.5	6440	7700	N	0.70	
257	00/06-11-090-03W5/0	1987/12/05	19.5	1526.5	0000	9800	Y	0.01	
258	00/06-11-096-01W5/0	1986/01/06	305	1444.5	0000	9800	Y	0.21	Y

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No.	UWI	Run Date	Top Log Interval (m KB)	Bottom Log Interval (m KB)	Top Formation Code	Bottom Formation Code	Top and Bottom Coverage in Elk Point Group	Fraction of Unknown Bulk Density Data from Surface to Bottom Log Interval	Wells Proposed for Analysis
259	00/06-12-070-04W5/0	1993/07/28	1700	1789.9	7440	7820	N	0.95	
260	00/06-12-090-03W5/0	1985/11/01	455	1485.7	0000	9800	Y	0.31	
261	00/06-12-093-02W5/0	1994/02/27	25	1307.5	0000	9800	Y	0.02	Y
262	00/06-14-090-05W5/0	1988/05/15	1053	1520	7170	9800	Y	0.69	
263	00/06-14-091-02W5/0		944.3	1254.9	7440	7940	N	0.75	
264	00/06-14-101-01W5/0		609.6	1082	7440	9800	Y	0.56	
265	00/06-19-092-03W5/0		1280.2	1350.9	7820	7940	N	0.95	
266	00/06-21-089-01W5/0		932.1	1487.4	7170	9800	Y	0.63	
267	00/06-21-089-03W5/0	1987/01/26	1100	1554.5	7440	9800	Y	0.71	
268	00/06-22-033-25W4/0	1992/08/26	449	2643.2	0000	7700	N	0.17	
269	00/06-23-089-04W5/0	1987/09/02	408.5	1522.6	0000	9800	Y	0.27	
270	00/06-25-019-04W4/0		896.6	1691.6	6420	9160	Y	0.53	Y
271	00/06-25-072-05W5/0	1994/03/17	1590	1674.2	7440	7820	N	0.95	
272	00/06-26-090-03W5/0	1985/09/26	180	1385	0000	9999	Y	0.13	
273	00/06-26-093-02W5/0	1996/03/17	10	1308	0000	7880	N	0.01	
274	00/06-26-094-05W5/0	1985/03/07	352	1345	0000	9999	Y	0.26	
275	00/06-28-016-05W4/0		914.4	1768.1	6420	9160	Y	0.52	Y
276	00/06-28-018-05W4/0		835	1697	2480	9160	Y	0.49	
277	00/06-28-042-02W4/0		290	1942	0000	9800	Y	0.15	Y
278	00/06-28-089-03W5/0	1992/03/04	1053	1589	0000	9999	N	0.66	
279	00/06-29-092-04W5/0	1987/09/05	15	1294.1	0000	9800	Y	0.01	Y
280	00/06-30-016-06W4/0		975.4	1755	3000	9160	Y	0.56	Y
281	00/06-30-039-11W4/0		1005.8	1581	2480	7700	N	0.64	
282	00/06-30-086-13W4/0		96.9	779.7	2800	9800	Y	0.12	Y
283	00/06-31-089-03W5/2	1995/06/27	1015.5	1469.5	0000	7820	N	0.69	
284	00/06-31-098-22W4/0		762	1213.1	7520	9800	Y	0.63	
285	00/06-33-089-02W5/0	1993/03/13	968	1446	7170	9999	Y	0.67	
286	00/06-33-094-03W5/0	1994/12/31	150	1319.3	0000	7880	N	0.11	
287	00/06-35-091-05W5/0	1988/08/07	20	1356.5	0000	9800	Y	0.01	
288	00/06-36-018-05W4/0		367.7	1662.1	0000	9160	Y	0.22	Y
289	00/06-36-019-01W4/0		852	2226.8	2480	9800	Y	0.38	Y
290	00/06-36-092-04W5/0		1188.7	1362.2	7820	9800	Y	0.87	
291	00/06-36-096-02W5/0	1988/02/03	400	1333.2	0000	9800	Y	0.30	Y
292	00/07-01-087-05W5/0	1991/01/24	1101.3	1625.9	7170	9800	Y	0.68	
293	00/07-01-096-05W5/0	1984/02/10	628	1145	0000	9800	Y	0.55	
294	00/07-02-073-05W5/0	1989/03/01	1655.5	1668.4	7620	7820	N	0.98	
295	00/07-02-095-04W5/0	1995/01/26	10	1268.3	0000	7880	N	0.01	
296	00/07-03-098-25W4/0		882.1	1272.5	7440	7940	N	0.69	
297	00/07-04-090-04W5/0	1990/12/08	1074.3	1503.1	7170	7880	N	0.71	
298	00/07-05-070-02W5/0		1070	1783.1	0000	7880	N	0.09	
299	00/07-05-094-03W5/0	1993/01/24	15	1324.1	0000	7940	N	0.01	
300	00/07-06-093-04W5/0	1988/01/07	15	1327.8	0000	9800	Y	0.01	Y
301	00/07-06-100-17W4/0		518.2	1044.5	7440	9800	Y	0.50	Y

Table C.1: Bulk density log data available in the expanded study area for the Elk Point Group (source: AEUB well database)

No.	UWI	Run Date	Top Log Interval (m KB)	Bottom Log Interval (m KB)	Top Formation Code	Bottom Formation Code	Top and Bottom Coverage in Elk Point Group	Fraction of Unknown Bulk Density Data from Surface to Bottom Log Interval	Wells Proposed for Analysis
302	00/07-08-089-03W5/0	1987/09/11	40	1541.5	0000	9800	Y	0.03	
303	00/07-08-089-04W5/0	1993/12/15	10.8	1512.5	0000	7820	N	0.01	
304	00/07-08-093-01W5/0	1986/01/26	15	1385.4	0000	9800	Y	0.01	Y
305	00/07-09-092-04W5/0	1986/09/21	300	1299	0000	9800	Y	0.23	
306	00/07-10-091-04W5/0	1985/02/05	50	1396	0000	9800	Y	0.04	
307	00/07-11-019-05W4/0		821.7	2131.2	6420	9800	Y	0.39	Y
308	00/07-11-098-03W5/0		91.4	1220.1	0000	7940	N	0.07	
309	00/07-12-022-01W4/0		906.5	1759	6440	9160	Y	0.52	Y
310	00/07-13-090-03W5/0	1984/01/31	180	1421	0000	9800	Y	0.13	
311	00/07-13-092-24W4/0		300	1185	0000	7960	N	0.25	
312	00/07-13-093-05W5/0	1992/12/24	807	1311	7170	7880	N	0.62	
313	00/07-14-093-02W5/0	1995/02/13	794.5	1290.5	0000	7880	N	0.62	
314	00/07-15-040-02W4/0	1994/05/19	823	1500	7200	7880	N	0.55	
315	00/07-15-064-25W4/0		296	1665	0000	7720	N	0.18	
316	00/07-16-092-04W5/0	1988/02/04	21	1290.2	0000	9800	Y	0.02	
317	00/07-17-056-21W4/0		187.5	1781.6	0000	8040	N	0.11	
318	00/07-17-094-03W5/0	1995/02/15	810	1318.4	0000	7880	N	0.61	
319	00/07-18-019-03W4/0		420	1734	1600	9160	Y	0.24	Y
320	00/07-19-061-01W5/0		216	2249.5	0000	9000	Y	0.10	
321	00/07-21-072-04W5/0	1994/07/06	300	1659.3	0000	7820	N	0.18	
322	00/07-22-017-05W4/0	1984/12/30	828	1640	6420	9160	Y	0.50	
323	00/07-22-074-22W4/0		562.4	1446.3	6580	7960	N	0.39	
324	00/07-25-034-21W4/0	1986/01/06	337	2279.2	0000	9040	Y	0.15	Y
325	00/07-26-021-11W4/0		189.5	1899.5	0000	9160	Y	0.10	Y
326	00/07-26-093-02W5/0	1996/02/19	793	1306.8	7170	7880	N	0.61	
327	00/07-27-070-04W5/0	1993/06/26	1830	1877	7580	7820	N	0.97	
328	00/07-27-092-04W5/0		990.6	1297.8	7440	7940	N	0.76	
329	00/07-28-091-03W5/0		1005.8	1349	7540	7940	N	0.75	
330	00/07-29-017-06W4/0	1984/12/05	1006.5	1750.8	6420	9160	Y	0.57	
331	00/07-29-101-01W5/0		579.1	974.8	7440	7940	N	0.59	
332	00/07-31-016-08W4/0	1979/10/20	780.9	1770.9	2130	9160	Y	0.44	
333	00/07-31-092-04W5/0	1987/03/15	20	1320	0000	9800	Y	0.02	Y
334	00/07-31-093-04W5/0		720.5	1341.1	7170	9800	Y	0.54	
335	00/07-34-055-21W4/0		207	1873.7	0000	8060	N	0.11	
336	00/07-34-071-04W5/0	1992/11/14	1758.1	1791	7440	7820	N	0.98	
337	00/07-34-088-02W5/0		947.5	1599	7160	9800	Y	0.59	
338	00/07-34-092-04W5/0		712.9	1268	7170	7880	N	0.56	
339	00/07-36-084-23W4/0		584.9	1051	7104	7820	N	0.56	
340	00/07-36-100-04W5/0		376.7	1060.7	7170	9800	Y	0.36	
341	00/08-01-019-04W4/0		422	1716	1600	9160	Y	0.25	
342	00/08-01-092-04W5/0		914.4	1300.9	7170	7880	N	0.70	
343	00/08-02-046-14W4/0	1984/12/12	650	1664	1860	9990	Y	0.39	Y
344	00/08-02-093-04W5/0	1988/03/14	806	1314	7170	7880	N	0.61	

Table C.1: Bulk density log data available in the expanded study area for the Elk Point Group (source: AEUB well database)

No.	UWI	Run Date	Top Log Interval (m KB)	Bottom Log Interval (m KB)	Top Formation Code	Bottom Formation Code	Top and Bottom Coverage in Elk Point Group	Fraction of Unknown Bulk Density Data from Surface to Bottom Log Interval	Wells Proposed for Analysis
345	00/08-03-063-27W4/0		1066.8	1938.2	6780	7960	N	0.55	
346	00/08-03-088-05W5/0	1989/03/31	500	1538	0000	9800	Y	0.33	
347	00/08-03-094-01W5/0	1997/08/21	796.5	1375.7	7170	7940	N	0.58	
348	00/08-03-094-02W5/0	1996/12/22	797	1340.2	7170	9999	Y	0.59	
349	00/08-07-093-02W5/0	1997/03/28	801	1327.2	7170	9800	Y	0.60	
350	00/08-08-020-09W4/2		1500	2209	7320	9800	Y	0.68	Y
351	00/08-08-090-03W5/0	1986/01/19	25	1535	0000	9800	Y	0.02	
352	00/08-10-089-03W5/0	1987/11/14	590	1488	0000	9999	Y	0.40	
353	00/08-11-093-02W5/0	1995/09/19	28	1255	0000	7880	N	0.02	
354	00/08-12-090-03W5/0	1985/03/01	50	1477.9	0000	9760	Y	0.03	
355	00/08-14-040-03W4/2	1994/05/31	874	1488.6	7040	7880	N	0.59	
356	00/08-14-090-03W5/0		10	1464	0000	9800	Y	0.01	
357	00/08-14-093-02W5/0	1995/10/02	766	1284.1	7170	7880	N	0.60	
358	00/08-15-096-04W5/0	1985/02/10	303.6	1280	0000	9999	Y	0.24	
359	00/08-16-098-22W4/0	1985/02/23	220	1229	0000	8020	N	0.18	
360	00/08-17-020-04W4/0		455.1	2202.8	1600	9800	Y	0.21	Y
361	00/08-17-085-25W4/0	1986/02/13	25	1407.1	0000	9800	Y	0.02	Y
362	00/08-17-105-01W5/0		104.9	848.6	7100	9800	Y	0.12	Y
363	00/08-18-090-03W5/0	1985/01/09	15	1499	0000	9800	Y	0.01	
364	00/08-21-089-03W5/0	1988/01/14	1106	1526	7440	9800	Y	0.72	
365	00/08-22-019-05W4/0		975.4	1759.9	2480	9160	Y	0.55	Y
366	00/08-23-017-04W4/0	1985/01/05	935.5	1780.5	6420	9160	Y	0.53	Y
367	00/08-23-043-16W4/0	1984/07/09	329	1802	0000	7920	N	0.18	
368	00/08-25-087-03W5/0		929	1478	7170	9800	Y	0.63	
369	00/08-25-090-03W5/0	1986/02/14	20	1353	0000	9800	Y	0.01	
370	00/08-28-091-02W5/0	1984/03/19	738	1286	7170	9800	Y	0.57	
371	00/08-29-093-04W5/0	1988/03/03	1000	1299.2	7440	9800	Y	0.77	
372	00/08-34-055-20W4/0	1990/04/02	251	1760.9	0000	8040	N	0.14	
373	00/08-36-092-05W5/0	1987/08/04	15	1331	0000	9800	Y	0.01	Y
374	00/09-01-074-05W5/0	1992/06/24	650.5	1655.7	6440	7820	N	0.39	
375	00/09-03-055-22W4/0	1986/05/03	216	1912	0000	8040	N	0.11	
376	00/09-03-089-03W5/0	1987/05/28	1013	1462.2	7170	7880	N	0.69	
377	00/09-03-094-02W5/0	1997/08/01	798.2	1349.3	7170	7940	N	0.59	
378	00/09-05-074-04W5/0	1989/05/20	1380	1625.4	7100	7820	N	0.85	
379	00/09-05-091-04W5/0	1986/12/25	25	1362.2	0000	9800	Y	0.02	
380	00/09-06-095-04W5/0	1986/03/12	699.5	1277.5	7170	9800	Y	0.55	
381	00/09-07-090-03W5/0		849.2	1516.1	7160	9800	Y	0.56	
382	00/09-07-093-02W5/0	1997/07/10	782.5	1305.2	7170	9999	Y	0.61	
383	00/09-08-094-03W5/0	1994/11/22	820.5	1339	7170	7880	N	0.61	
384	00/09-10-088-03W5/0	1985/09/09	952	1490	7160	9800	Y	0.64	
385	00/09-10-089-03W5/0	1987/02/19	352	1539	0000	9800	Y	0.23	
386	00/09-10-095-04W5/0	1987/03/13	15	1290	0000	9800	Y	0.01	Y
387	00/09-11-091-05W5/0	1987/07/24	390	1337.9	0000	9800	Y	0.29	

Table C.1: Bulk density log data available in the expanded study area for the Elk Point Group (source: AEUB well database)

No.	UWI	Run Date	Top Log Interval (m KB)	Bottom Log Interval (m KB)	Top Formation Code	Bottom Formation Code	Top and Bottom Coverage in Elk Point Group	Fraction of Unknown Bulk Density Data from Surface to Bottom Log Interval	Wells Proposed for Analysis
388	00/09-12-090-03W5/0	1993/11/30	960.5	1437	7170	9800	Y	0.67	
389	00/09-13-090-03W5/0	1993/12/26	911.2	1396.7	7170	7880	N	0.65	
390	00/09-14-090-03W5/0	1984/12/22	40	1438.8	0000	9800	Y	0.03	
391	00/09-14-093-02W5/0	1995/01/10	772.5	1331	7170	9800	Y	0.58	
392	00/09-15-073-04W5/0	1993/01/21	250	1619.9	0000	7820	N	0.15	
393	00/09-16-089-04W5/0	1995/09/30	1427	1454.1	7820	7880	N	0.98	
394	00/09-17-072-04W5/0	1992/12/15	250	1666	0000	7820	N	0.15	
395	00/09-18-032-17W4/0	1988/08/09	361	2158	0000	7700	N	0.17	
396	00/09-18-089-03W5/0	1987/04/07	27	1536	0000	9760	Y	0.02	
397	00/09-18-094-03W5/0	1994/02/17	1036	1358.5	7440	9800	Y	0.76	
398	00/09-19-089-03W5/0	1987/07/16	20	1534	0000	7940	N	0.01	
399	00/09-21-018-05W4/0	1984/12/08	895	1645	6420	9160	Y	0.54	
400	00/09-21-092-04W5/0	1987/07/31	15	1284.5	0000	9999	Y	0.01	
401	00/09-22-090-05W5/0	1987/07/28	10	1515	0000	9800	Y	0.01	
402	00/09-25-091-05W5/0	1991/01/25	924.8	1315.5	7440	7880	N	0.70	
403	00/09-26-095-05W5/0	1987/01/19	15	1219	0000	9800	Y	0.01	Y
404	00/09-27-015-08W4/0		971.4	1710	6420	9160	Y	0.57	Y
405	00/09-30-091-03W5/0		1005.8	1335	7170	7940	N	0.75	
406	00/09-30-092-04W5/0	1987/03/24	805.5	1309	7170	9800	Y	0.62	
407	00/09-32-070-03W5/0	1990/01/04	475	1749.2	2060	7820	N	0.27	
408	00/09-32-092-04W5/0	1987/07/30	10	1505	0000	9999	Y	0.01	Y
409	00/09-33-055-20W4/2	1990/08/08	261	1765.2	0000	8020	N	0.15	
410	00/09-36-055-26W4/0		202	1972.5	0000	7700	N	0.10	
411	00/09-36-095-02W5/0		601.7	1578	7168	9800	Y	0.44	
412	00/10-01-017-08W4/0	1985/02/03	1020	1718	6420	9160	Y	0.59	Y
413	00/10-01-073-05W5/0	1991/12/31	275	1669.7	0000	7820	N	0.16	
414	00/10-01-095-05W5/0		666.9	1314.6	7170	9800	Y	0.51	
415	00/10-02-073-04W5/0	1994/03/05	1100	1607.5	6700	7820	N	0.68	
416	00/10-02-094-05W5/0		975.4	1338.4	7440	9800	Y	0.73	
417	00/10-03-073-04W5/0		1325.9	1630.7	7170	7820	N	0.81	
418	00/10-03-090-03W5/0	1993/02/25	1027	1481.1	7170	9999	Y	0.69	
419	00/10-04-070-03W5/0	1991/11/09	400	1719.6	0000	7820	N	0.23	
420	00/10-04-075-03W5/0	1993/12/06	700	1855	6440	9760	Y	0.38	Y
421	00/10-04-089-04W5/0	1995/09/19	1455	1462.3	7820	7880	N	1.00	
422	00/10-05-093-03W5/0		488	1309.4	6700	9800	Y	0.37	Y
423	00/10-05-094-03W5/0	1995/07/31	802.8	1304.2	7170	7880	N	0.62	
424	00/10-06-015-08W4/0		953.5	1680	6420	9160	Y	0.57	
425	00/10-06-088-01W5/0	1985/03/03	50	1559.3	0000	9800	Y	0.03	
426	00/10-08-070-03W5/0	1991/11/30	1650	1723.0	7440	7820	N	0.96	
427	00/10-08-073-04W5/0	1989/03/20	1602.8	1645	7620	7820	N	0.97	
428	00/10-08-095-03W5/0	1995/02/07	1235.7	1330.1	7820	8060	N	0.93	
429	00/10-09-069-24W4/0		722.1	1663	2620	7920	N	0.43	
430	00/10-09-075-24W4/0		1417.3	1648.1	7620	7940	N	0.86	

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No.	UWI	Run Date	Top Log Interval (m KB)	Bottom Log Interval (m KB)	Top Formation Code	Bottom Formation Code	Top and Bottom Coverage in Elk Point Group	Fraction of Unknown Bulk Density Data from Surface to Bottom Log Interval	Wells Proposed for Analysis
431	00/10-09-090-03W5/0	1985/06/12	1076	1540	0000	9800	Y	0.70	
432	00/10-10-055-22W4/0		579.1	1881.5	1860	8040	N	0.31	
433	00/10-10-074-05W5/0		192	1730	0000	7820	N	0.11	
434	00/10-11-072-05W5/0	1984/12/08	1600	1736	7440	7820	N	0.92	
435	00/10-12-066-15W4/0		615.7	1591.1	7160	9800	Y	0.39	Y
436	00/10-13-073-04W5/0	1991/02/27	1525	1604.2	7440	7820	N	0.95	
437	00/10-13-092-05W5/0	1987/03/19	324	1337	0000	9800	Y	0.24	
438	00/10-14-100-23W4/0	1985/02/27	319	1248	2640	9999	Y	0.26	Y
439	00/10-15-038-21W4/0		1371.6	2870	6440	9800	Y	0.48	Y
440	00/10-15-085-22W4/2		944.9	1321.9	7580	9800	Y	0.71	
441	00/10-16-027-08W4/0		183	1704	0000	7700	N	0.11	
442	00/10-16-073-04W5/0	1991/03/07	1587.7	1630.2	7620	7820	N	0.97	
443	00/10-16-088-03W5/0	1987/10/26	540	1515.5	0000	9800	Y	0.36	
444	00/10-16-088-18W4/0		333.8	993	7160	8020	N	0.34	
445	00/10-16-089-20W4/0		609	1048.2	7500	8020	N	0.58	
446	00/10-16-091-18W4/0		187.5	970.8	0000	9800	Y	0.19	Y
447	00/10-17-073-04W5/0		185	1650	0000	7820	N	0.11	
448	00/10-17-094-03W5/0	1993/02/26	819.8	1337.6	7170	7880	N	0.61	
449	00/10-18-070-03W5/0	1989/12/13	650	1752.5	2480	7820	N	0.37	
450	00/10-18-091-01W5/0	1988/03/16	14	1271.4	0000	9800	Y	0.01	
451	00/10-18-092-04W5/0	1994/01/21	812.5	1294.6	7170	7880	N	0.63	
452	00/10-19-072-04W5/0	1993/07/18	1893.5	1936.3	7580	7820	N	0.98	
453	00/10-19-094-03W5/0	1994/11/05	822	1362	7170	9800	Y	0.60	
454	00/10-20-073-04W5/0		188.5	1625.5	0000	7820	N	0.12	
455	00/10-21-089-03W5/0	1994/01/17	1436.9	1447.5	7820	7880	N	0.99	
456	00/10-22-073-04W5/0	1984/02/10	180	1614	0000	7820	N	0.11	
457	00/10-22-098-03W5/0	1991/01/23	258.5	1251	0000	9760	Y	0.21	Y
458	00/10-23-072-04W5/0		289	1627	0000	7820	N	0.18	
459	00/10-23-089-04W5/0	1993/03/02	1457	1486	7820	7880	N	0.98	
460	00/10-26-073-05W5/0	1984/12/10	183.4	1724	0000	7820	N	0.11	
461	00/10-26-097-01W5/0		152.4	1232.3	0000	7940	N	0.12	
462	00/10-27-069-03W5/0	1987/02/03	1350	1688.1	7100	7820	N	0.80	
463	00/10-27-073-05W5/0	1984/02/03	180	1660	0000	7820	N	0.11	
464	00/10-27-089-03W5/0	1992/10/23	1028	1486.7	7170	9800	Y	0.69	
465	00/10-27-092-04W5/0		853	1281	0000	7880	N	0.67	
466	00/10-28-107-03W5/0		377.3	859.8	7520	8020	N	0.44	
467	00/10-29-077-18W4/0		877.8	1331.7	7540	8060	N	0.66	
468	00/10-29-089-23W4/0		262	1161	6960	7960	N	0.23	
469	00/10-30-032-23W4/0	1988/09/19	392.2	2560.4	0000	7700	N	0.15	
470	00/10-30-036-16W4/0		203.3	2004.7	0000	7700	N	0.10	
471	00/10-30-070-03W5/0	1988/03/17	1739	1798	7620	7820	N	0.97	
472	00/10-32-069-03W5/0	1991/11/23	473	1720	2180	7820	N	0.28	
473	00/10-32-073-04W5/0	1984/01/25	187.5	1625	0000	9999	N	0.12	

Table C.1: Bulk density log data available in the expanded study area for the Elk Point Group (source: AEUB well database)

No.	UWI	Run Date	Top Log Interval (m KB)	Bottom Log Interval (m KB)	Top Formation Code	Bottom Formation Code	Top and Bottom Coverage in Elk Point Group	Fraction of Unknown Bulk Density Data from Surface to Bottom Log Interval	Wells Proposed for Analysis
474	00/10-32-090-04W5/0	1986/12/23	25	1412.4	0000	9800	Y	0.02	
475	00/10-33-061-27W4/0		220.7	2087.3	0000	8040	N	0.11	
476	00/10-33-072-04W5/0	1990/01/30	1575	1638	7440	9999	Y	0.96	
477	00/10-33-087-25W4/0	1986/02/25	20	1405.1	0000	9800	Y	0.01	Y
478	00/10-33-089-04W5/0	1993/06/29	10	1459.3	0000	7880	N	0.01	
479	00/10-33-093-25W4/0		610.5	1424.6	7167	9800	Y	0.43	Y
480	00/10-34-071-04W5/0	1991/07/21	420	1807.8	0000	7820	N	0.23	
481	00/10-34-073-05W5/0	1991/02/18	604	1660	2480	7820	N	0.36	
482	00/10-34-089-04W5/0	1991/11/17	1089.8	1525	7440	9800	Y	0.71	
483	00/10-34-091-18W4/0		189.9	920.2	0000	7960	N	0.21	
484	00/10-34-091-24W4/0		1027.8	1222.9	7720	7940	N	0.84	
485	00/10-34-093-02W5/0	1997/02/20	773	1333.9	7170	7940	N	0.58	
486	00/10-35-073-05W5/0	1989/02/14	237	1659.5	0000	7820	N	0.14	
487	00/10-35-090-05W5/0		259.1	1499	0000	9760	Y	0.17	
488	00/10-36-098-21W4/0		228.3	1197.3	0000	9800	Y	0.19	Y
489	00/11-01-094-05W5/0	1986/03/02	331	1300.7	0000	9800	Y	0.25	
490	00/11-03-072-04W5/0	1992/07/11	275	1808	0000	7820	N	0.15	
491	00/11-05-015-06W4/0		942	1747	2480	9160	Y	0.54	Y
492	00/11-05-089-03W5/0	1987/10/07	30	1543	0000	9800	Y	0.02	
493	00/11-05-095-03W5/0	1996/02/28	1242.3	1282.9	7820	7880	N	0.97	
494	00/11-07-089-03W5/0	1987/07/19	20	1576	0000	9800	Y	0.01	
495	00/11-08-089-04W5/0	1990/11/27	1143	1514	7440	9800	Y	0.75	
496	00/11-08-092-03W5/0		1219.2	1321.3	7820	9800	Y	0.92	
497	00/11-08-095-22W4/0	1985/03/09	45	1380.2	0000	9800	Y	0.03	Y
498	00/11-09-074-04W5/0	1990/01/25	305.8	1644	0000	7820	N	0.19	
499	00/11-10-073-04W5/0	1994/03/05	1590	1627	7620	7820	N	0.98	
500	00/11-10-075-22W4/0		1224.7	1654.5	7860	8060	N	0.74	
501	00/11-10-089-03W5/0	1987/10/18	19.3	1543.8	0000	9800	Y	0.01	
502	00/11-10-089-03W5/2	1987/10/30	1069.4	1533.4	7170	9800	Y	0.70	
503	00/11-10-093-04W5/0		1219.2	1317.3	7820	9800	Y	0.93	
504	00/11-12-089-04W5/0	1988/07/02	10	1568	0000	9800	Y	0.01	
505	00/11-13-015-09W4/0		952.9	2186	6420	9800	Y	0.44	
506	00/11-13-073-04W5/0	1991/01/15	1525	1610	7440	7820	N	0.95	
507	00/11-13-098-01W5/0	1989/02/22	365	1243.1	0000	7940	N	0.29	
508	00/11-14-018-08W4/0	1985/02/22	1040	1749	6420	9160	Y	0.59	Y
509	00/11-14-090-03W5/0	1985/11/10	932	1430	7170	9800	Y	0.65	
510	00/11-15-034-15W4/0	1992/12/31	296	1974.4	0000	7920	N	0.15	
511	00/11-15-085-17W4/0		609.6	1027.8	7540	9800	Y	0.59	
512	00/11-15-089-03W5/0	1986/12/31	352	1538.5	0000	9999	Y	0.23	
513	00/11-15-092-04W5/0	1988/02/07	360	1322.2	0000	9800	Y	0.27	
514	00/11-16-044-16W4/0	1983/12/22	321	1807	0000	7960	N	0.18	
515	00/11-17-072-04W5/0		1615	1673.8	0000	7820	N	0.96	
516	00/11-17-089-04W5/0	1995/09/07	25	1594.6	0000	7880	N	0.02	

Table C.1: Bulk density log data available in the expanded study area for the Elk Point Group (source: AEUB well database)

No.	UWI	Run Date	Top Log Interval (m KB)	Bottom Log Interval (m KB)	Top Formation Code	Bottom Formation Code	Top and Bottom Coverage in Elk Point Group	Fraction of Unknown Bulk Density Data from Surface to Bottom Log Interval	Wells Proposed for Analysis
517	00/11-18-018-08W4/0	1985/01/13	1039.8	2241.5	6420	9800	Y	0.46	Y
518	00/11-18-028-14W4/0	1989/08/19	351	2039.2	0000	7700	N	0.17	
519	00/11-18-090-02W5/0		947.6	1404.8	7440	9800	Y	0.67	
520	00/11-20-016-07W4/0		986.8	2211.4	2480	9800	Y	0.45	
521	00/11-21-071-04W5/0		190	1836	0000	7820	N	0.10	
522	00/11-21-091-03W5/0	1986/02/28	100	1379	0000	9800	Y	0.07	
523	00/11-21-104-03W5/0		426.7	956.5	7440	8060	N	0.45	
524	00/11-22-016-08W4/0		987.1	1734.9	6420	9160	Y	0.57	
525	00/11-22-089-03W5/0	1994/01/11	10	1467.5	0000	7880	N	0.01	
526	00/11-23-070-04W5/0	1994/01/09	1780	1859	7440	7820	N	0.96	
527	00/11-23-071-05W5/0	1995/03/19	1800	1933.5	7440	7820	N	0.93	
528	00/11-23-090-02W5/0	1984/12/21	810.5	1356	0000	9800	Y	0.60	
529	00/11-23-092-04W5/0		1188.7	1293.9	7820	7940	N	0.92	
530	00/11-24-070-04W5/0	1993/12/23	841.5	1842	0000	7820	N	0.46	
531	00/11-24-093-25W4/0	1986/02/27	356.5	1312.5	0000	9800	Y	0.27	Y
532	00/11-25-024-02W4/0		1050	1675	6600	7920	N	0.63	
533	00/11-26-092-04W5/0		880	1297	0000	7880	N	0.68	
534	00/11-26-093-02W5/0	1995/12/14	20	1368.2	0000	7940	N	0.01	
535	00/11-29-089-04W5/0	1987/01/28	1200	1528	7440	9800	Y	0.79	
536	00/11-29-094-03W5/0	1994/12/11	15	1301.5	0000	7880	N	0.01	
537	00/11-31-092-04W5/0	1986/03/29	25	1325.5	0000	9800	Y	0.02	Y
538	00/11-32-070-01W5/0		181.3	1532	0000	7820	N	0.12	
539	00/11-32-093-03W5/0	1995/01/05	110	1288.5	0000	7880	N	0.09	
540	00/11-32-094-03W5/0	1994/01/19	10	1277.1	0000	7880	N	0.01	
541	00/11-33-070-03W5/0	1984/08/07	275	1724.5	0000	9999	N	0.16	
542	00/11-34-089-03W5/0	1992/08/15	1040	1496.7	7170	7880	N	0.69	
543	00/11-35-038-10W4/0	1992/01/06	750	2140	1860	9999	Y	0.35	Y
544	00/11-35-087-05W5/0	1988/03/17	1099	1536	7100	9800	Y	0.72	
545	00/11-36-073-05W5/0	1988/03/11	210	1647.5	0000	7820	N	0.13	
546	00/11-36-093-04W5/0	1995/02/11	1230.5	1267.6	7820	7880	N	0.97	
547	00/12-01-069-02W5/0		1554.5	1759.3	7440	7940	N	0.88	
548	00/12-01-073-04W5/0	1995/01/07	302	1606.8	0000	9999	N	0.19	
549	00/12-01-074-05W5/0	1989/11/09	191	1651	0000	7820	N	0.12	
550	00/12-01-080-24W4/0	1987/12/15	302	1465.5	2620	9800	Y	0.21	
551	00/12-02-073-04W5/0	1992/11/12	1545	1619	7440	7820	N	0.95	
552	00/12-02-074-05W5/0	1985/02/14	197	1664	0000	7820	N	0.12	
553	00/12-03-070-03W5/0	1993/04/11	300	1719.9	0000	7820	N	0.17	
554	00/12-04-074-04W5/0	1988/09/24	189.5	1635	0000	9999	N	0.12	
555	00/12-04-099-21W4/0	1988/02/23	214.7	1177.5	0000	9800	Y	0.18	Y
556	00/12-05-071-04W5/0	1992/10/28	250	1872.5	0000	7820	N	0.13	
557	00/12-06-073-04W5/0	1992/01/15	245	1654.4	0000	7820	N	0.15	
558	00/12-07-015-07W4/0		920	1675	6420	9160	Y	0.55	Y
559	00/12-07-089-25W4/0		1066.8	1382.6	7440	7960	N	0.77	

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No.	UWI	Run Date	Top Log Interval (m KB)	Bottom Log Interval (m KB)	Top Formation Code	Bottom Formation Code	Top and Bottom Coverage in Elk Point Group	Fraction of Unknown Bulk Density Data from Surface to Bottom Log Interval	Wells Proposed for Analysis
560	00/12-07-090-02W5/0	1985/10/25	25	1438	0000	9800	Y	0.02	
561	00/12-07-094-23W4/0		914.4	1361.8	7440	7960	N	0.67	
562	00/12-08-094-03W5/0	1994/03/03	1038	1299.3	7620	7880	N	0.80	
563	00/12-09-038-21W4/0	1984/02/08	389	2368.5	0000	9000	Y	0.16	Y
564	00/12-09-070-03W5/0	1991/08/23	1640	1721.5	7440	7820	N	0.95	
565	00/12-09-073-04W5/0	1990/02/18	188.3	1633.2	0000	7820	N	0.12	
566	00/12-10-071-03W5/0	1993/03/29	1620	1680.5	7440	7820	N	0.96	
567	00/12-10-073-05W5/0	1993/12/29	1835.8	1862.5	7620	7820	N	0.99	
568	00/12-10-074-05W5/0		190.8	1735.8	0000	7820	N	0.11	
569	00/12-10-089-04W5/0	1987/11/18	545	1516	0000	9800	Y	0.36	
570	00/12-11-093-04W5/0	1987/12/18	816	1337	7170	9999	Y	0.61	
571	00/12-11-094-02W5/0	1997/03/01	1275.6	1341.3	7820	7880	N	0.95	
572	00/12-12-015-07W4/0		900	2152	2480	9800	Y	0.42	Y
573	00/12-12-071-04W5/0	1995/01/21	1765	1810	7580	7820	N	0.98	
574	00/12-12-093-02W5/0	1995/01/09	758.9	1273.9	7170	7880	N	0.60	
575	00/12-13-055-22W4/0	1995/10/05	1700	1909.6	7860	8040	N	0.89	
576	00/12-13-070-04W5/0	1993/12/06	1790	1851	7440	7820	N	0.97	
577	00/12-13-089-03W5/0	1989/03/27	20	1467.9	0000	9800	Y	0.01	
578	00/12-14-070-04W5/0	1993/11/12	1829.1	1872.1	7580	7820	N	0.98	
579	00/12-14-072-04W5/0	1990/12/06	400	1718.2	0000	7820	N	0.23	
580	00/12-14-073-04W5/0	1991/02/15	250	1622.6	0000	7820	N	0.15	
581	00/12-15-073-04W5/0	1993/02/22	240	1622	0000	7820	N	0.15	
582	00/12-16-092-04W5/0	1988/10/11	20	1276	0000	9800	Y	0.02	
583	00/12-16-094-03W5/0	1999/01/24	440	1320.5	0000	7880	N	0.33	
584	00/12-17-093-04W5/0	1987/08/16	12	1334	0000	9999	Y	0.01	Y
585	00/12-17-095-04W5/0	1993/02/15	1213	1259.5	7820	7880	N	0.96	
586	00/12-18-072-03W5/2	1988/11/11	1560	1672	7440	7820	N	0.93	
587	00/12-18-087-03W5/0	1986/01/17	285	1589.6	0000	9800	Y	0.18	Y
588	00/12-19-014-04W4/0	1988/01/25	454.8	2211.4	0000	9800	Y	0.21	
589	00/12-19-072-03W5/0		203	1665	0000	7820	N	0.12	
590	00/12-20-072-04W5/0	1990/12/13	300	1725.7	0000	7820	N	0.17	
591	00/12-20-094-03W5/0	1995/02/27	12.2	1312.2	0000	9999	N	0.01	
592	00/12-21-015-08W4/0		933.2	1685	6420	9160	Y	0.55	Y
593	00/12-21-073-04W5/0	1993/01/25	569.2	1619.9	3040	7820	N	0.35	
594	00/12-22-073-04W5/0	1991/01/26	596	1618.2	6440	7820	N	0.37	
595	00/12-22-089-03W5/0	1987/09/17	18	1507.4	0000	9800	Y	0.01	
596	00/12-23-073-04W5/0	1985/02/06	188.3	1616	0000	9999	N	0.12	
597	00/12-23-073-05W5/0		600	1659	3360	7820	N	0.36	
598	00/12-24-073-05W5/0	1983/12/07	24	1654	0000	9999	N	0.01	
599	00/12-24-089-04W5/0	1993/08/23	10	1497.5	0000	7880	N	0.01	
600	00/12-24-090-03W5/0	1985/11/16	10	1368.8	0000	9800	Y	0.01	
601	00/12-25-073-05W5/0		1500	1662	7440	7820	N	0.90	
602	00/12-26-089-04W5/0	1989/03/21	1100	1507.8	7440	9800	Y	0.73	

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603	00/12-27-089-03W5/0	1992/02/20	200	1483.5	0000	7880	N	0.13	
604	00/12-28-069-03W5/0	1991/01/13	400	1719	0000	7820	N	0.23	
605	00/12-28-072-04W5/0		1610	1659.5	7580	7820	N	0.97	
606	00/12-28-089-03W5/0	1991/12/12	1040	1499.2	7170	7880	N	0.69	
607	00/12-29-015-08W4/0		977.5	1701	6420	9160	Y	0.57	
608	00/12-29-073-04W5/0	1989/03/13	300	1629.1	2060	7820	N	0.18	
609	00/12-30-073-04W5/0	1991/02/02	225	1645	0000	7820	N	0.14	
610	00/12-30-089-03W5/0	1987/10/07	20	1535	0000	9800	Y	0.01	
611	00/12-30-096-04W5/0	1987/04/01	752	1237.1	7440	9800	Y	0.61	
612	00/12-31-072-04W5/0	1990/01/29	185.2	1663.2	0000	7820	N	0.11	
613	00/12-31-073-04W5/0	1984/06/19	182.9	1645	1860	9999	Y	0.11	
614	00/12-31-088-02W5/0	1988/03/06	15	1500.8	0000	9800	Y	0.01	
615	00/12-33-015-07W4/0		939	1681	6420	9160	Y	0.56	Y
616	00/12-33-069-03W5/0	1991/08/08	400	1726	0000	7820	N	0.23	
617	00/12-34-069-03W5/0	1991/12/14	400	1709.9	0000	7820	N	0.23	
618	00/12-35-071-02W5/0	1987/01/13	595	1554	3060	7820	N	0.38	
619	00/12-35-072-04W5/0	1990/09/22	1500	1624.7	7440	7820	N	0.92	
620	00/12-35-073-05W5/0	1984/11/17	179	1661.2	0000	9999	N	0.11	
621	00/12-35-092-05W5/0	1988/08/11	829	1392	7170	9800	Y	0.60	
622	00/12-36-087-01W5/0	1987/01/29	15	1408	0000	9800	Y	0.01	Y
623	00/13-01-093-02W5/0	1996/03/13	20	1248	0000	7880	N	0.02	
624	00/13-02-055-22W4/0	1988/06/26	213.8	1950.4	0000	8040	N	0.11	
625	00/13-03-098-02W5/0	1987/01/22	528	1204	7170	9800	Y	0.44	Y
626	00/13-07-073-03W5/0	1994/01/30	603	1735.3	6440	7820	N	0.35	
627	00/13-07-092-04W5/0	1987/01/06	25	1321.9	0000	9760	Y	0.02	
628	00/13-08-093-04W5/0	1988/08/27	25	1339.7	0000	9800	Y	0.02	Y
629	00/13-09-086-21W4/0	1991/03/17	882.3	1225.1	7580	9800	Y	0.72	
630	00/13-10-074-04W5/0	1995/12/21	1200	1700.4	7170	7820	N	0.71	
631	00/13-10-098-04W5/0	1988/02/15	15	1271	0000	9999	Y	0.01	Y
632	00/13-11-091-05W5/0	1995/03/27	21	1404.8	0000	7880	N	0.01	
633	00/13-12-087-01W5/0	1985/02/12	944	1457	7170	9800	Y	0.65	
634	00/13-12-089-04W5/0	1987/08/07	20	1587	0000	9800	Y	0.01	
635	00/13-13-085-04W5/0	1982/02/20	1068	1671	7100	9800	Y	0.64	
636	00/13-13-093-02W5/0	1995/03/10	810.8	1301.1	7170	9999	Y	0.62	
637	00/13-14-089-03W5/0	1988/10/11	25	1544	0000	9999	Y	0.02	
638	00/13-14-089-04W5/0	1989/10/14	470	1557.3	0000	9800	Y	0.30	
639	00/13-14-090-05W5/0	1988/03/15	1058.5	1523	7170	9800	Y	0.70	
640	00/13-15-072-04W5/0	1995/02/07	1662.4	1698	7580	7820	N	0.98	
641	00/13-17-071-03W5/0	1991/08/03	1413	1772.2	7170	7820	N	0.80	
642	00/13-17-089-03W5/0	1988/09/28	15	1551.5	0000	9800	Y	0.01	
643	00/13-17-092-01W5/0	1995/01/29	702.8	1249.6	0000	9800	Y	0.56	
644	00/13-18-095-01W5/0	1989/02/08	485	1408	0000	9999	Y	0.34	Y
645	00/13-19-034-20W4/0	1987/06/23	610	2309	0000	9040	Y	0.26	Y

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No.	UWI	Run Date	Top Log Interval (m KB)	Bottom Log Interval (m KB)	Top Formation Code	Bottom Formation Code	Top and Bottom Coverage in Elk Point Group	Fraction of Unknown Bulk Density Data from Surface to Bottom Log Interval	Wells Proposed for Analysis
646	00/13-19-073-04W5/0	1993/02/10	250	1642.2	0000	7820	N	0.15	
647	00/13-23-089-04W5/0	1988/11/13	20	1520	0000	9800	Y	0.01	
648	00/13-25-089-04W5/0	1997/08/31	525	1549.1	0000	7880	N	0.34	
649	00/13-28-089-02W5/0	1986/03/14	977.1	1503.8	7170	9800	Y	0.65	
650	00/13-29-072-04W5/0	1989/02/22	25	1775.7	0000	7820	N	0.01	
651	00/13-30-072-03W5/0	1989/03/02	314.2	1620.37	0000	9999	N	0.19	
652	00/13-30-093-02W5/0	1997/03/14	809.2	1388.9	6700	9800	Y	0.58	
653	00/13-31-090-04W5/0	1987/02/25	336	1437	0000	9800	Y	0.23	
654	00/14-01-094-02W5/0	1988/02/24	902	1422.4	7440	9800	Y	0.63	
655	00/14-02-089-04W5/0	1991/09/03	25	1563.7	0000	9800	Y	0.02	
656	00/14-02-099-22W4/0		731.5	1158.2	7540	7960	N	0.63	
657	00/14-03-093-03W5/0	1986/01/22	396	1317	0000	9999	Y	0.30	
658	00/14-05-097-21W4/0		199.9	1271.9	0000	8020	N	0.16	
659	00/14-07-072-03W5/0	1989/11/24	308	1726	0000	7820	N	0.18	
660	00/14-07-072-04W5/0	1984/11/14	1550	1705	7440	7820	N	0.91	
661	00/14-08-090-04W5/0	1986/03/27	1024	1554	7170	9800	Y	0.66	
662	00/14-09-092-04W5/0	1987/06/25	15	1320	0000	9800	Y	0.01	
663	00/14-11-039-17W4/0	1987/11/06	1260	2022	3360	9000	Y	0.62	Y
664	00/14-11-090-03W5/0	1985/09/13	1009	1506	7170	9800	Y	0.67	
665	00/14-12-016-06W4/0		900	1692	6420	9160	Y	0.53	
666	00/14-12-070-04W5/0	1993/11/19	1750	1826	7440	9999	Y	0.96	
667	00/14-12-073-04W5/0	1990/03/20	1496	1617	7440	7820	N	0.93	
668	00/14-12-090-03W5/0	1994/01/13	958.2	1436.6	7170	7880	N	0.67	
669	00/14-13-055-22W4/0	1989/12/30	212.8	1887.8	0000	8040	N	0.11	
670	00/14-15-073-03W5/0		250	1584	0000	7820	N	0.16	
671	00/14-16-090-03W5/0	1985/10/05	10	1499.5	0000	9800	Y	0.01	
672	00/14-17-015-06W4/0		974.1	1697.1	6420	9160	Y	0.57	
673	00/14-18-070-03W5/0	1989/12/14	700	1773	2480	7820	N	0.39	
674	00/14-18-089-02W5/0	1988/03/23	1051	1564	7170	9800	Y	0.67	
675	00/14-18-094-03W5/0	1994/11/28	795	1303.5	7170	7880	N	0.61	
676	00/14-19-091-04W5/0	1988/02/04	1017	1356	7440	9800	Y	0.75	
677	00/14-19-092-01W5/0	1995/01/22	701	1247.9	0000	9800	Y	0.56	
678	00/14-20-073-04W5/0	1992/02/20	602.6	1625.8	6440	7820	N	0.37	
679	00/14-20-097-04W5/0	1988/03/17	759	1276	7170	7940	N	0.59	
680	00/14-22-092-04W5/0	1988/08/25	380	1317.2	0000	9999	Y	0.29	
681	00/14-26-072-04W5/0	1992/01/28	1560	1630	7440	9999	Y	0.96	
682	00/14-27-070-04W5/0	1993/12/08	1790	1866.7	7440	7820	N	0.96	
683	00/14-29-092-04W5/0	1987/11/06	15	1303	0000	9800	Y	0.01	Y
684	00/14-31-070-03W5/0	1989/02/19	1788	1823	7620	7820	N	0.98	
685	00/14-31-087-01W5/0	1988/01/01	1098.5	1492	7440	9800	Y	0.74	
686	00/14-31-089-03W5/0	1988/03/18	1037	1508.2	7170	9800	Y	0.60	
687	00/14-32-019-04W4/0		424.9	1731	1600	9160	Y	0.25	Y
688	00/14-33-090-04W5/0	1987/03/05	289	1396.7	0000	9800	Y	0.21	

Table C.1: Bulk density log data available in the expanded study area for the Elk Point Group (source: AEUB well database)

No.	UWI	Run Date	Top Log Interval (m KB)	Bottom Log Interval (m KB)	Top Formation Code	Bottom Formation Code	Top and Bottom Coverage in Elk Point Group	Fraction of Unknown Bulk Density Data from Surface to Bottom Log Interval	Wells Proposed for Analysis
689	00/14-35-034-17W4/0	1989/01/15	339	2091.7	0000	9040	Y	0.16	Y
690	00/14-35-071-05W5/0	1993/03/22	355	1870	0000	7820	N	0.19	
691	00/14-35-088-03W5/0	1993/03/13	1144	1449.7	7440	7880	N	0.79	
692	00/14-35-089-04W5/0	1991/03/01	990.3	1508.8	0000	9800	Y	0.66	
693	00/14-35-092-04W5/0		854	1281.6	0000	7880	N	0.67	
694	00/14-36-020-01W4/0	1994/01/26	725	1701.6	2060	7920	N	0.43	
695	00/14-36-088-04W5/0	1988/07/10	1049	1601.4	7170	9800	Y	0.66	
696	00/14-36-092-05W5/0	1987/09/08	15	1344	0000	9800	Y	0.01	Y
697	00/14-36-092-05W5/2	1987/09/08	15	1344	0000	9800	Y	0.01	
698	00/15-01-090-04W5/0	1988/03/15	500	1502	0000	9800	Y	0.33	
699	00/15-02-090-03W5/0	1984/11/17	10	1529	0000	9800	Y	0.01	
700	00/15-02-095-04W5/0	1997/02/06	10	1267.7	0000	7880	N	0.01	
701	00/15-03-090-04W5/0	1987/10/30	1004	1512.5	7170	9800	Y	0.66	
702	00/15-03-094-02W5/0	1986/02/22	847	1381	7440	9800	Y	0.61	
703	00/15-04-092-04W5/0	1987/03/14	20	1288	0000	9800	Y	0.02	
704	00/15-05-089-04W5/0	1991/03/24	25	1526.7	0000	9800	Y	0.02	
705	00/15-05-095-03W5/0	1998/01/27	698	1277.1	7170	7880	N	0.55	
706	00/15-06-094-03W5/0	1995/02/13	8.2	1287.3	0000	9999	N	0.01	
707	00/15-07-013-04W4/0	1991/01/13	211	1698.4	0000	7700	N	0.12	
708	00/15-07-093-04W5/0	1987/09/09	20	1341	0000	9999	Y	0.01	Y
709	00/15-08-061-18W4/0		279	1358	0000	7920	N	0.21	
710	00/15-08-089-04W5/0	1993/12/21	1449.8	1457.5	7820	7880	N	0.99	
711	00/15-08-092-03W5/0	1989/03/18	823.8	1335	0000	9999	Y	0.62	
712	00/15-09-074-04W5/0	1990/08/25	295	1646.2	0000	7820	N	0.18	
713	00/15-09-092-04W5/0	1986/12/08	20	1299	0000	9800	Y	0.02	
714	00/15-10-055-22W4/0		1652	1853.2	7860	8040	N	0.89	
715	00/15-10-089-02W5/0	1985/03/28	446	1476	2640	9760	Y	0.30	
716	00/15-11-090-05W5/0	1988/08/21	295	1529.5	0000	9800	Y	0.19	
717	00/15-12-073-05W5/0	1994/02/15	624	1652.3	6440	7820	N	0.38	
718	00/15-12-090-03W5/0	1986/03/08	21	1465.5	0000	9800	Y	0.01	
719	00/15-13-073-04W5/0	1993/06/03	298.8	1661.1	0000	7820	N	0.18	
720	00/15-14-015-06W4/0		859.5	1688.9	2480	9160	Y	0.51	
721	00/15-14-089-04W5/0	1989/11/09	450	1540.8	0000	9800	Y	0.29	
722	00/15-15-089-03W5/0	1987/11/05	17	1533.5	0000	9999	Y	0.01	
723	00/15-17-089-02W5/0	1986/02/28	55	1562.8	0000	9800	Y	0.04	
724	00/15-19-096-18W4/0		171.6	1221.9	0000	9800	Y	0.14	Y
725	00/15-20-073-03W5/0		365.8	1593.8	2180	7820	N	0.23	
726	00/15-20-095-20W4/0		211.8	1246.9	0000	9800	Y	0.17	Y
727	00/15-21-091-04W5/0	1986/12/25	334	1338.2	0000	9800	Y	0.25	
728	00/15-22-089-03W5/0	1987/08/30	17.8	1522.3	0000	9800	Y	0.01	
729	00/15-23-091-05W5/0	1986/02/05	830.4	1353.5	7170	9800	Y	0.61	
730	00/15-24-089-04W5/0	1993/06/21	1435	1491.5	7820	7880	N	0.96	
731	00/15-24-090-03W5/0	1988/01/04	15	1382	0000	9800	Y	0.01	

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No.	UWI	Run Date	Top Log Interval (m KB)	Bottom Log Interval (m KB)	Top Formation Code	Bottom Formation Code	Top and Bottom Coverage in Elk Point Group	Fraction of Unknown Bulk Density Data from Surface to Bottom Log Interval	Wells Proposed for Analysis
732	00/15-25-091-05W5/0		934	1360.8	7440	9760	Y	0.69	
733	00/15-25-091-05W5/2	1986/12/24	934	1329	7440	7880	N	0.70	
734	00/15-25-092-05W5/0	1987/11/26	10	1361	0000	9800	Y	0.01	Y
735	00/15-26-093-02W5/0	1996/01/23	807.5	1322	7170	7880	N	0.61	
736	00/15-29-092-04W5/0	1992/03/15	778	2612	6700	7880	N	0.30	
737	00/15-30-034-20W4/0	1986/06/14	1325	2393	3000	9040	Y	0.55	Y
738	00/15-30-089-03W5/0	1987/09/07	20	1489.4	0000	9800	Y	0.01	
739	00/15-30-093-03W5/0	1995/09/23	2.9	1254.6	0000	7880	N	0.00	
740	00/15-31-104-04W5/0		487.7	975.4	7440	9800	Y	0.50	
741	00/15-34-043-10W4/0	1989/04/04	555	2148	1860	9800	Y	0.26	Y
742	00/15-34-089-03W5/0	1992/03/20	20	1509.3	0000	9800	Y	0.01	
743	00/15-34-092-04W5/0		834	1286.5	0000	7880	N	0.65	
744	00/15-34-093-24W4/0		617.5	1349.7	7170	8000	N	0.46	
745	00/15-36-089-04W5/0	1993/02/21	1417	1457.7	7820	7880	N	0.97	
746	00/15-36-093-02W5/0	1998/01/08	740.5	1341.8	7160	9800	Y	0.55	
747	00/16-01-056-22W4/0		198.1	1908	0000	7700	N	0.10	
748	00/16-01-080-24W4/0	1988/01/24	319.8	1484.9	2620	9760	Y	0.22	Y
749	00/16-01-089-05W5/0	1987/10/02	1059	1537	7170	9800	Y	0.69	
750	00/16-02-096-02W5/0		703	1371.5	7170	9760	Y	0.51	
751	00/16-03-030-09W4/0		746.8	1820.3	1860	9160	Y	0.41	Y
752	00/16-03-055-22W4/0	1986/02/25	218.7	1946.3	0000	8040	N	0.11	
753	00/16-03-080-23W4/0	1988/01/06	893	1490.5	7440	9800	Y	0.60	
754	00/16-03-100-02W5/0	1986/01/26	534	1158.3	7440	9800	Y	0.46	Y
755	00/16-04-074-04W5/0	1993/08/08	1500	1661	7440	9999	Y	0.90	
756	00/16-07-092-04W5/0	1987/03/18	15	1338	0000	7940	N	0.01	
757	00/16-08-092-04W5/0	1988/03/21	998	1439	7440	9800	Y	0.69	
758	00/16-09-060-22W4/0	1984/06/17	321.5	1806.8	0000	8040	N	0.18	
759	00/16-09-073-02W5/0		1478.3	1887	7580	7820	N	0.78	
760	00/16-10-046-13W4/0	1984/06/08	273	1472	0000	7700	N	0.19	
761	00/16-10-091-03W5/0		946.4	1407.6	7440	9800	Y	0.67	
762	00/16-11-071-04W5/0	1990/01/22	185	1785.6	0000	7820	N	0.10	
763	00/16-11-093-02W5/0	1995/02/03	767.3	1274.6	7170	7880	N	0.60	
764	00/16-11-100-04W5/0	1986/01/21	12	1159	0000	9800	Y	0.01	Y
765	00/16-13-090-03W5/0	1987/12/17	901	1408	7170	9800	Y	0.64	
766	00/16-15-031-12W4/0		823	1770	1860	7700	N	0.46	
767	00/16-15-034-20W4/0	1988/03/26	1962	2284.5	7320	7920	N	0.86	
768	00/16-15-090-05W5/0	1988/02/01	20	1524	0000	9800	Y	0.01	
769	00/16-16-034-15W4/0	1988/07/07	1200	2442.3	6440	9999	Y	0.49	Y
770	00/16-16-073-04W5/2	1993/02/04	1600	1668.2	7440	7820	N	0.96	
771	00/16-16-089-03W5/0	1988/03/14	1074.5	1539	7170	9800	Y	0.70	
772	00/16-17-089-03W5/0	1994/03/25	1490.7	1503.3	7820	7880	N	0.99	
773	00/16-20-092-04W5/0	1986/12/30	18	1272	0000	9800	Y	0.01	Y
774	00/16-21-089-03W5/0	1987/11/05	20	1488	0000	9800	Y	0.01	

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No.	UWI	Run Date	Top Log Interval (m KB)	Bottom Log Interval (m KB)	Top Formation Code	Bottom Formation Code	Top and Bottom Coverage in Elk Point Group	Fraction of Unknown Bulk Density Data from Surface to Bottom Log Interval	Wells Proposed for Analysis
775	00/16-21-111-04W5/0		426.7	925.1	7440	9800	Y	0.46	
776	00/16-22-059-22W4/0	1985/02/16	314	1843.4	0000	8040	N	0.17	
777	00/16-22-094-22W4/0	1984/03/10	25	1343.7	0000	9800	Y	0.02	Y
778	00/16-23-093-02W5/0	1986/02/20	345	1354	0000	9800	Y	0.25	Y
779	00/16-23-096-25W4/0	1984/03/15	33.8	1461	0000	9999	Y	0.02	Y
780	00/16-25-092-02W5/0	1994/02/10	705.5	1251.5	7170	9800	Y	0.56	
781	00/16-27-032-24W4/0	1987/04/22	456.5	2598.4	0000	7700	N	0.18	
782	00/16-27-089-04W5/0	1987/11/16	517.9	1488.5	0000	9800	Y	0.35	
783	00/16-27-102-24W4/0		457.2	991.8	7520	9800	Y	0.46	Y
784	00/16-30-090-03W5/0	1986/03/11	10	1406	0000	9800	Y	0.01	
785	00/16-30-091-03W5/0	1986/03/26	379	1369	0000	9800	Y	0.28	
786	00/16-31-092-01W5/0	1985/03/21	2	1284	0000	9800	Y	0.00	Y
787	00/16-35-059-02W5/0	1988/03/17	254.1	1398.7	0000	9800	Y	0.18	Y
788	00/16-36-026-15W4/0	1988/06/23	1250	1983.4	6600	7700	N	0.63	
789	00/16-36-041-15W4/0	1984/01/07	1350	1808.5	7200	9000	Y	0.75	
790	00/16-36-041-23W4/0	1984/04/27	890	2289	1600	9999	Y	0.39	Y
791	02/01-10-055-22W4/0	1995/03/09	219	1911	0000	8040	N	0.11	
792	02/01-35-089-04W5/0	1994/12/21	10	1484	0000	7880	N	0.01	
793	02/02-10-055-22W4/0	1985/08/20	900	1932.5	2480	8040	N	0.47	
794	02/03-31-100-22W4/0		762	1265.5	7520	9800	Y	0.60	
795	02/03-36-092-05W5/0	1986/08/25	20	1346	0000	9999	Y	0.01	Y
796	02/04-18-072-03W5/0	1989/10/02	289	1684.7	0000	7820	N	0.17	
797	02/05-17-089-03W5/0	1988/10/05	25	1523.6	0000	9800	Y	0.02	
798	02/06-01-019-07W4/0		640.1	1783.1	0000	9160	Y	0.36	
799	02/06-07-019-08W4/0		975.4	1780.6	2480	9040	Y	0.55	
800	02/06-11-015-06W4/0		929.3	1703.8	6420	9160	Y	0.55	
801	02/06-15-045-15W4/0	1985/11/12	251.5	1737	0000	7960	N	0.14	
802	02/06-17-094-04W5/0	1985/02/28	382	1325	0000	9800	Y	0.29	
803	02/06-18-046-06W4/0		487.7	1389.9	0000	8500	Y	0.35	Y
804	02/06-26-015-07W4/0		956.8	1677.9	6420	9160	Y	0.57	Y
805	02/06-30-018-08W4/0		1040.3	2261.6	6420	9800	Y	0.46	
806	02/06-30-019-07W4/0		1005.8	2265.9	3500	9480	Y	0.44	
807	02/07-10-055-22W4/0		1642	1858.7	7700	8010	N	0.88	
808	02/07-21-087-02W5/0	1987/02/04	1113.7	1532	7440	9800	Y	0.73	
809	02/07-29-065-01W5/0		205	2113	0000	9000	Y	0.10	
810	02/08-01-090-03W5/0	1985/10/20	130	1508.5	0000	9999	Y	0.09	
811	02/08-14-090-03W5/0	1992/12/14	963	1427.6	0000	7880	N	0.67	
812	02/08-24-025-15W4/0	1986/08/06	362	2054.1	0000	9000	Y	0.18	
813	02/08-34-055-20W4/0	1991-02/14	238	1760	0000	8040	N	0.14	
814	02/09-03-055-22W4/0	1986/05/30	209.5	1918	0000	8020	N	0.11	
815	02/09-10-055-22W4/0		1813.6	1878.2	7700	7700	N	0.97	
816	02/10-10-055-22W4/0		1641	1882.1	7720	8040	N	0.87	
817	02/10-10-093-01W5/0		944.9	1333.5	7540	9800	Y	0.71	

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No.	UWI	Run Date	Top Log Interval (m KB)	Bottom Log Interval (m KB)	Top Formation Code	Bottom Formation Code	Top and Bottom Coverage in Elk Point Group	Fraction of Unknown Bulk Density Data from Surface to Bottom Log Interval	Wells Proposed for Analysis
818	02/10-14-033-24W4/0	1988/02/26	397	2530	0000	7777	N	0.16	
819	02/10-19-091-04W5/0	1990/03/17	1002	1384	7440	7940	N	0.72	
820	02/11-32-094-03W5/0	1996/07/05	15	1293.4	0000	7880	N	0.01	
821	02/12-01-072-04W5/0		1743	1793.8	7580	7820	N	0.97	
822	02/12-25-073-05W5/0	1989/06/05	1156.3	1675.8	6960	7820	N	0.69	
823	02/12-27-069-03W5/0		175	1710	0000	7820	N	0.10	
824	02/12-35-092-04W5/0	1994/01/27	796	1302.7	7170	7940	N	0.61	
825	02/13-01-091-05W5/0	1987/07/08	1027	1408.5	7440	9800	Y	0.73	
826	02/13-02-055-22W4/0	1988/05/28	212	1946	0000	8040	N	0.11	
827	02/13-08-089-03W5/0	1987/01/06	1049.7	1527	7170	9760	Y	0.69	
828	02/13-08-089-03W5/2	1987/01/06	1049.7	1527	7170	9760	Y	0.69	
829	02/13-11-055-22W4/0	1985/07/05	209	1903.1	0000	8020	N	0.11	
830	02/13-13-055-22W4/0	1990/11/28	214.5	1898.7	0000	8040	N	0.11	
831	02/13-23-089-03W5/0	1990/03/24	10	1520.2	0000	7880	N	0.01	
832	02/14-13-055-22W4/0	1990/01/30	213.2	1889.2	0000	8040	N	0.11	
833	02/14-13-090-03W5/0	1986/03/13	20	1403	0000	9800	Y	0.01	
834	02/15-15-089-04W5/0	1989/05/18	35	1521.9	0000	9800	Y	0.02	
835	02/16-03-055-22W4/0	1986/01/24	10	1907.5	0000	8040	N	0.01	
836	02/16-07-072-03W5/0	1991/07/19	1450	1719.2	7100	7820	N	0.84	
837	02/16-14-055-22W4/0	1994/12/18	216	1837.6	0004	7960	N	0.12	
838	03/07-10-055-22W4/0	1985/11/26	219	1898.4	0000	8020	N	0.12	
839	03/07-10-055-22W4/2	1985/11/26	219	1898.4	0000	8020	N	0.12	
840	03/10-10-055-22W4/0		1643.8	1863.2	0000	8010	N	0.88	
841	03/14-13-055-22W4/0	1990/03/06	180	1901.6	0000	8040	N	0.09	
842	03/15-22-094-04W5/0	1987/12/07	400	1333.3	0000	9800	Y	0.30	
843	04/07-10-055-22W4/0	1985/10/29	220.5	1902	0000	8020	N	0.12	
844	04/07-10-055-22W4/2	1985/10/29	220.5	1902	0000	8020	N	0.12	
845	04/07-34-055-21W4/0	1991/03/30	859.7	1868	3000	9999	Y	0.46	Y
846	04/13-13-055-22W4/0	1990/12/26	217.5	1882.7	0000	8040	N	0.12	
847	04/14-13-055-22W4/0	1990/04/10	190	1882.9	0000	8040	N	0.10	
848	04/15-10-055-22W4/0	1985/04/18	10	1964	0000	8040	N	0.01	
849	05/14-13-055-22W4/0	1991/02/01	225	1870	0000	8040	N	0.12	
850	05/16-10-055-22W4/0	1985/06/03	207	1858.8	0000	8040	N	0.11	
851	06/14-11-055-22W4/0		211.5	1926.3	0000	8040	N	0.11	
852	D0/12-21-035-06W4/0	1993/06/05	1001.5	1858.6	6960	8610	Y	0.60	Y
853	W0/13-12-029-11W4/0		1082	1727.9	6410	7700	N	0.63	

Table C.2: Dipmeter log data available in the expanded study area for the Elk Point and Beaverhill Lake Groups (source: AEUB well database)

No.	UWI	Run Date	Top Log Interval (m KB)	Bottom Log Interval (m KB)	Top Formation Code	Bottom Formation Code	Top of Beaverhill Lake Fm (m KB)	Dipmeter Log Recorded on Microfiche	All Data Needed for Breakout Analysis Present
1	00/01-11-091-05W5/0	1986/02/21	1051	1369	7440	9760	953.3	Y	
2	00/01-11-101-02W5/0	1969/03/31	518	1081	7440	9800	431.9	N	
3	00/01-23-095-05W5/0	1985/03/11	871	1238	7440	9800	751	N	
4	00/01-25-057-24W4/0	1984/11/12	1100	1633	6780	7440	1517.2	N	
5	00/01-28-089-03W5/0	1988/10/26	1412	1520	7820	9999	1072.5	Y	Y
6	00/01-29-101-24W4/0	1985/03/15	576	1067	7540	9800		N	
7	00/02-01-074-05W5/0	1988/08/12	1595	1646	7440	7820	1429	N	
8	00/02-03-088-20W4/0		346	573	7160	7440	551.7	N	
9	00/02-04-072-03W5/0		975	1762	6960	7880	1414	N	
10	00/02-10-071-04W5/0		1524	1791	7100	7820	1572.5	Y	
11	00/02-10-102-23W4/0	1985/02/07	573	1074	7540	9800		N	
12	00/02-14-071-04W5/0	1964/10/30	1524	1756	7100	7820	1535.9	N	
13	00/02-15-071-04W5/0		1524	1753	7100	7820	1531.9	N	
14	00/02-17-058-25W4/0	1984/09/29	1051	1799	3360	7440	1628.3	N	
15	00/02-19-073-04W5/0		1585	1646	7440	7820	1414.9	Y	
16	00/02-20-091-02W5/0	1986/02/09	935	995	7440	7620	794	Y	
17	00/02-21-071-04W5/0		1698	1772	7440	7820	1549.6	Y	
18	00/02-24-073-05W5/0		1524	1650	7440	7820	1424	Y	
19	00/02-27-071-04W5/0		1524	1764	7100	7820	1548.7	Y	
20	00/02-34-071-04W5/0		1676	1786	7440	7820	1562.4	N	
21	00/03-04-031-12W4/0	1984/04/04	1200	1877	6660	9999	1585.5	N	
22	00/03-17-065-25W4/0		1006	1523	6960	7500	1412.1	Y	
23	00/03-35-095-05W5/0	1988/03/25	1100	1300	7820	9999	770.5	Y	
24	00/04-01-039-20W4/0		1325	1878	3360	7440	1857	Y	
25	00/04-01-045-16W4/0	1983/12/03	1600	1802	7520	9999	1440	N	
26	00/04-08-071-04W5/0		1798	1891	7440	7820	1662.7	Y	
27	00/04-08-097-02W5/0		625	1273	7170	9800	701	N	
28	00/04-22-073-05W5/0		1524	1668	7440	7820	1447.8	Y	
29	00/04-23-073-05W5/0		1602	1663	7440	7820	1437.1	Y	
30	00/04-24-070-04W5/0		1792	1839	7440	7820	1614.8	Y	
31	00/04-28-035-20W4/0		1495	2255	6440	7700		N	
32	00/04-29-098-21W4/0	1985/02/09	691	1184	7540	9800		N	
33	00/04-33-039-16W4/0	1984/03/27	1200	1600	6580	9999	1498	N	
34	00/04-33-070-04W5/0		1798	1893	7440	7820	1663.3	Y	
35	00/04-35-073-05W5/0		1585	1648	7440	7820	1429.5	Y	
36	00/04-36-092-05W5/2	1986/09/20	751	1409	0000	9800		N	
37	00/05-06-094-04W5/0	1986/02/10	951	1272	7440	9800	615.5	N	
38	00/05-08-100-22W4/0	1985/03/29	651	1231	7460	7960		N	
39	00/05-22-089-03W5/0	1986/02/07	1416	1517	7820	9800	1088.5	N	
40	00/05-02-052-27W4/0		1463	2012	6580	7440	1984.9	N	
41	00/05-02-097-19W4/0	1986/02/26	755	950	7520	7860		Y	
42	00/06-03-087-22W4/0	1988/03/01	885	1235	7540	9800		Y	

Table C.2: Dipmeter log data available in the expanded study area for the Elk Point and Beaverhill Lake Groups (source: AEUB well database)

No.	UWI	Run Date	Top Log Interval (m KB)	Bottom Log Interval (m KB)	Top Formation Code	Bottom Formation Code	Top of Beaverhill Lake Fm (m KB)	Dipmeter Log Recorded on Microfiche	All Data Needed for Breakout Analysis Present
43	00/06-07-097-23W4/0		1259	1438	7860	7960		Y	
44	00/06-08-089-04W5/0	1989/04/05	1450	1530	7820	9800	1094	Y	
45	00/06-14-038-17W4/0		1716	1718	7440	7440	1628	N	
46	00/06-18-035-20W4/0	1983/12/07	1675	2198	6660	7440	2026	N	
47	00/06-21-089-03W5/0	1987/01/26	1375	1559	7820	9999	1084.2	N	
48	00/06-35-046-15W4/0		344	2113	0000	9800	1322	N	
49	00/07-04-062-26W4/0		1010	1579	6580	7440	1517.9	N	
50	00/07-09-092-04W5/0	1986/09/21	981	1297	7440	9800	841	Y	
51	00/07-14-062-26W4/0		1252	1557	7100	7440	1505.7	N	
52	00/08-10-089-03W5/0	1987/11/14	1080	1488	7440	9999	1076.5	Y	Y
53	00/08-14-038-21W4/0		1185	1923	2140	7440	1873.5	N	
54	00/08-16-098-22W4/0	1985/02/23	751	1227	7520	8020		N	
55	00/08-19-027-10W4/0	1988/10/20	1100	1550	6440	9999	1493	Y	Y
56	00/08-28-091-02W5/0	1984/03/19	900	1284	7440	9800	765	Y	
57	00/08-34-034-25W4/0	1984/05/27	1897	2471	6440	9999	2428	Y	
58	00/09-03-089-03W5/0	1987/03/28	1207	1463	7440	7880	1055	Y	Y
59	00/09-05-091-04W5/0	1986/12/26	1001	1364	7440	9999	932.5	Y	Y
60	00/09-10-088-03W5/0	1985/09/09	952	1492	7160	9800	1083.5	N	
61	00/09-14-090-03W5/0	1984/12/22	1051	1437	7440	9800	980.5	N	
62	00/09-33-052-26W4/0		1676	1908	7100	7440	1863.9	N	
63	00/10-05-070-03W5/0		1448	1712	7100	7820	1489.6	Y	
64	00/10-06-073-04W5/0		1570	1650	7440	7820	1427.7	N	
65	00/10-08-071-04W5/0		1773	1833	7440	7820	1614.2	Y	
66	00/10-14-070-04W5/0		1676	1871	7440	7820	1644.4	Y	
67	00/10-14-100-23W4/0	1985/02/27	751	1247	7540	9800		N	
68	00/10-16-027-08W4/0		183	1704	0000	7700	1502	N	
69	00/10-18-039-20W4/0	1984/03/16	1500	2074	6660	7440	1938.5	N	
70	00/10-18-052-27W4/0		1387	2001	3340	7440	1976.6	N	
71	00/10-20-085-21W4/0		793	1240	7480	9800		Y	
72	00/10-26-071-04W5/0		1646	1782	7440	7820	1559.4	Y	
73	00/10-30-032-23W4/0	1988/09/19	2000	2550	6660	7700	2295	N	
74	00/10-32-090-04W5/0	1986/12/23	1053	1411	7440	9800	977	Y	Y
75	00/10-33-070-04W5/0		1707	1872	7440	7820	1651.1	Y	
76	00/10-35-069-04W5/0		1737	1772	7580	7780	1558.1	N	
77	00/10-36-082-22W4/0		622	838	7169	7440	816.9	N	
78	00/11-08-095-22W4/0	1985/03/10	901	1383	7540	9800		Y	Y
79	00/11-12-080-05W5/0		762	1791	6540	9800	1329.8	Y	Y
80	00/11-13-098-01W5/0	1989/02/22	990	1210	7820	7880	623	Y	
81	00/11-15-073-24W4/0		549	1178	2800	7440	1076.2	N	
82	00/11-16-044-16W4/0	1983/12/22	1075	1807	3360	7960	1470	Y	Y
83	00/11-23-071-05W5/0	1995/03/19	1850	1934	7440	7820	1771.5	N	
84	00/11-35-027-14W4/0		884	1727	1860	7440	1693.8	N	

Table C.2: Dipmeter log data available in the expanded study area for the Elk Point and Beaverhill Lake Groups (source: AEUB well database)

No.	UWI	Run Date	Top Log Interval (m KB)	Bottom Log Interval (m KB)	Top Formation Code	Bottom Formation Code	Top of Beaverhill Lake Fm (m KB)	Dipmeter Log Recorded on Microfiche	All Data Needed for Breakout Analysis Present
85	00/11-36-071-05W5/0	1985/04/09	1832	1911	7440	7820	1685	N	
86	00/12-01-073-05W5/0		1555	1668	7440	7820	1439.3	N	
87	00/12-03-073-05W5/0		1593	1684	7440	7820	1463.3	Y	
88	00/12-08-073-04W5/0		1555	1650	7440	7440	1420.4	Y	
89	00/12-09-038-21W4/0	1984/02/08	389	2370	0000	9000	2012	N	
90	00/12-10-065-02W5/0		1150	1600	6960	7440	1552	N	
91	00/12-13-073-05W5/0		1585	1661	7440	7820	1432.6	Y	
92	00/12-13-089-03W5/0	1989/03/28	1170	1468	7440	9800	1021	Y	Y
93	00/12-18-087-03W5/0	1986/01/18	1055	1592	7100	9999	1136	Y	Y
94	00/12-21-058-25W4/0	1985/02/13	1116	1799	6580	7440	1690	Y	
95	00/12-33-071-04W5/0		1761	1852	7440	7820	1632.2	Y	
96	00/13-01-036-21W4/0		383	2415	0000	9040	2070	N	
97	00/13-09-086-21W4/0	1991/03/18	1050	1250	7860	9999	682.5	Y	
98	00/13-13-085-04W5/0	1982/02/19	1068	1671	7100	9800	1188	Y	
99	00/13-14-089-04W5/0	1989/10/16	950	1600	0000	9999	1098	N	
100	00/13-14-090-05W5/0	1988/03/15	1225	1523	7440	9800	1093	Y	
101	00/13-18-095-01W5/0	1989/02/09	1200	1409	7820	9999	850	Y	
102	00/13-20-085-02W5/0		1250	1642	7540	9800		N	
103	00/14-03-093-03W5/0	1986/01/22	1001	1316	7440	9800	846.5	N	
104	00/14-05-097-21W4/0		823	1272	7580	8020		Y	
105	00/14-09-092-04W5/0	1987/06/25	1101	1319	7820	9800	849	Y	Y
106	00/15-20-095-20W4/0		793	1246	7440	9800	630.9	N	
107	00/15-30-034-20W4/0	1986/06/15	1640	2025	6660	7440	1993	Y	
108	00/15-34-093-24W4/0		914	1347	7520	8000		Y	
109	00/16-22-094-22W4/0	1984/03/10	620	1343	7170	9800		N	
110	00/16-23-096-25W4/0	1984/03/17	725	1450	7170	8000		N	
111	00/16-25-040-16W4/0	1984/09/04	800	1450	1860	9999	1386.5	Y	
112	00/16-26-051-27W4/0		1715	2036	7100	7440	1988	N	
113	02/02-14-055-22W4/0		0	1911	0000	8020	1417.6	N	
114	02/03-36-092-05W5/0	1986/08/25	1001	1346	7440	9999	869	N	
115	02/05-26-084-05W5/0		1300	1655	7440	9999	1232	N	
116	02/10-19-091-04W5/0	1990/03/17	1075	1385	7620	7940	892	Y	Y
117	02/11-06-036-02W4/0		850	1591	2760	9160	1188.5	N	
118	AA/11-17-091-13W4/0	1997/01/08	48	175	0000	7440	167.5	Y	
119	AA/11-21-091-13W4/0	1997/01/10	36	166	0000	7440	151.2	Y	
120	AA/11-28-091-13W4/0	1997/01/12	42	161	0000	7440	149	Y	

Table C.3: Bulk density log data available in the expanded Saskatchewan area for the Elk Point Group (source: AEUB well database)

No.	UWI	Year Logged	Top Log Interval (m KB)	Bottom Log Interval (m KB)	Top Formation Code	Bottom Formation Code	Top of Prairie Evaporite Formation (m KB)	Percent of Unknown Bulk Density Data above the Prairie Evaporite Formation	Within Prairie Evaporite Area Defined by AGS?
1	01/01-10-066-27W3/0	1969	161.2	759		545003	671.5	24	N
2	01/01-25-062-25W3/0	1968	167.6	1151.2	224002	900001	693.1	24	N
3	01/07-01-044-24W3/0	1972	579.1	1858.1	224002	900001	1069.2	54	Y
4	01/07-16-024-27W3/0	1969	609.6	1611.2	224002	601003	1491.1	41	Y
5	01/10-01-028-29W3/0	1968	666	2153.1	224002	900001	1511.8	44	Y
6	01/10-09-050-24W3/0	1971	426.7	1032.1	224002	703003	830.6	51	Y
7	01/12-28-045-22W3/0	1967	145.1	1168.6		601105	938.5	15	Y
8	01/15-08-035-27W3/0	1976	139.3	1551.4		511505	1414.3	10	Y
9	01/15-34-034-27W3/0	1980	256.9	2095.8		801005	1389.9	18	Y
10	01/16-36-036-25W3/0	1980	191.1	1998		900001	1292.4	15	Y
11	11/01-05-035-26W3/0	1997	250	2114.5		900001	1398	18	Y
12	11/02-11-075-23W3/0	1997	177	566.3	231107	551003	490	36	N
13	11/06-15-035-27W3/0	1998	260	2104.5		900001	1392.3	19	Y
14	11/11-29-035-26W3/0	1997	301.1	2084.1		531003	1355	22	Y
15	11/11-29-068-23W3/0	1993	97.4	988.5		900001	583	17	Y
16	11/15-13-060-24W3/0	1984	123.1	1034.5		801003	701	18	N
17	21/07-30-036-28W3/0	1997	303.5	2128	521003	900001	1355		Y
18	21/07-30-049-27W3/0	1998	212.7	949.4		541003	949	22	Y
19	21/09-22-062-27W3/0	1987	103	741.7	232507	543003	703.3	15	Y
20	21/12-30-049-27W3/0	1984	301.4	1733.7		900001	952	32	Y
21	31/01-03-074-24W3/0	1997	180.5	821.5		551003	569	32	N
22	31/05-13-030-26W3/0	1985	209	1497.5		541003	1491.5	14	N
23	31/07-30-049-27W3/0	1996	232.1	1075		541003	950.8	24	Y
24	31/14-17-065-26W3/0	1968	113.1	751.6		545003	685.8	16	N
25	31/16-05-035-26W3/0	1997	247	2114		900001	1394.1	18	Y
26	31/16-10-034-22W3/0	1980	497.4	2033.9		900001	1303.9	38	Y
27	41/03-09-040-22W3/0	1995	131	1256		541003	1130.5	12	Y
28	41/03-18-036-25W3/0	1997	244	2047.8		900001	1319.1	18	Y
29	41/04-05-035-26W3/0	1997	247.5	2127.2		900001	1404.8	18	Y
30	91/05-34-033-22W3/0	1999	158	1363.5		541003	1358	12	Y

**Table C.4: Dipmeter log data available in the expanded Saskatchewan area
for Paleozoic age formations (source: AEUB well database)**

No.	UWI	Top Formation Code	Bottom Formation Code	Top Log Interval (m KB)	Bottom Log Interval (m KB)	Paleozoic Formation	Paleozoic Formation Top (m KB)	Amount of coverage in Paleozoic (m)	Dipmeter Log Recorded on Microfiche	All Data Needed for Breakout Analysis Available on Microfiche
1	41/04-33-035-25W3/0	224002	521003	609.6	836.1	Madison Group	734.0	102.1	N	N
2	11/03-04-030-28W3/2	227304	511105	728.0	862.0	Madison Group	798.3	63.7	Y	Y
3	41/07-07-010-23W3/0	511105	521003	1572.0	1631.5	Torquay Fm	1574.0	57.5	Y	Y
4	01/10-04-041-24W3/0	224002	525003	468.2	732.7	Duperow Fm	678.2	54.5	N	N
5	01/09-06-035-26W3/0	438003	511505	820.8	874.8	Bakken Fm	829.1	45.7	Y	N
6	11/10-17-040-24W3/0	n/a	525003	238.0	712.0	Bird Bear Fm	671.0	41.0	Y	Y
7	11/07-19-031-24W3/0	224002	511105	600.2	835.2	Madison Group	794.6	40.6	Y	Y
8	01/13-21-035-25W3/0	219505	511505	536.8	788.2	Bakken Fm	758.3	29.9	N	N
9	01/02-16-036-28W3/0	226108	511505	651.1	848.9	Torquay Fm	826.0	22.9	Y	N
10	01/10-07-039-25W3/0	n/a	521003	127.1	737.9	Bird Bear Fm	718.0	19.9	Y	N
11	11/13-19-052-23W3/0	n/a	525003	123.1	669.0	Duperow Fm	650.0	19.0	Y	N
12	11/10-22-046-22W3/0	n/a	525003	125.9	612.0	Duperow Fm	597.4	14.6	Y	N
13	01/06-07-043-24W3/0	219003	525003	441.0	752.9	Duperow Fm	741.0	11.9	Y	N
14	11/02-21-040-26W3/0	219176	525003	399.9	815.0	Duperow Fm	803.5	11.5	Y	N
15	11/11-24-047-27W3/0	224002	525003	475.8	686.4	Duperow Fm	675.1	11.3	Y	N
16	11/11-18-048-21W3/0	224002	525003	349.9	593.1	Duperow Fm	581.9	11.2	Y	N
17	20/07-21-009-29W3/0	224002	430002	914.4	1332.0	Madison Group	1324.1	7.9	Y	N
18	11/09-24-047-27W3/0	231107	525003	499.9	675.1	Duperow Fm	667.5	7.6	Y	N
19	11/13-01-052-27W3/0	n/a	525003	125.9	602.6	Duperow Fm	595.0	7.6	Y	N
20	11/07-03-054-25W3/0	224002	525003	326.1	660.5	Duperow Fm	653.5	7.0	Y	N
21	11/06-23-052-25W3/0	224002	525003	250.5	531.9	Duperow Fm	525.2	6.7	Y	Y
22	11/13-24-052-25W3/0	226408	525003	369.0	579.0	Duperow Fm	572.5	6.5	Y	N
23	11/01-26-052-25W3/0	226408	525003	367.6	583.4	Duperow Fm	578.5	4.9	Y	Y
24	11/03-23-052-25W3/0	231307	525003	399.9	545.0	Duperow Fm	540.5	4.5	Y	N
25	11/09-29-042-25W3/0	234107	525003	630.0	684.0	Duperow Fm	679.9	4.1	Y	N

* Area bounded by 49.5-56.0 deg Latitude N and 109-110 deg Longitude W

** 71 total number of dipmeters in area

APPENDIX D

DATA ANALYSIS RESULTS FOR ORIGINAL STUDY AREA

Table D.1 Summary of vertical stresses for the Elk Point Group determined from bulk density data in the original study area

Figures D.1.1 to D.1.92 Bulk density profile, calculated vertical stress, local vertical stress gradient for analyzed bulk density wells

Table D.2 Detailed summary of breakout data in the Elk Point and Beaverhill Lake Groups

Figures D.2.1 to D.2.6 Roseplots of breakout data in the Elk Point and Beaverhill Lake Groups

Table D.3 Summary of breakout analysis data in the original study area for the Elk Point and Beaverhill Lake Groups

Table D.1: Vertical Stress for the Elk Point Group determined from bulk density data

No.	Well Name	Year Logged	Top Log Interval (m KB)	Bottom Log Interval (m KB)	Top Elk Point Group (m KB)	Vertical Stress at Top of Elk Point Group (MPa)	Normalized Vertical Stress Gradient at Top of Elk Point Group (kPa/m)	Top Prairie Evaporite Fm (m KB)	Vertical Stress at Top of Prairie Evaporite Fm (MPa)	Normalized Vertical Stress Gradient at Top of Prairie Evaporite Fm (kPa/m)	Top Basal Red Beds Fm (m KB)	Vertical Stress at Top of Basal Red Beds Fm (MPa)	Normalized Vertical Stress Gradient at Top of Basal Red Beds Fm (kPa/m)	Bulk Density Log Quality	Stress Magnitude Difference b/w Prairie Evaporite and Basal Red Beds (MPa)	Stress Gradient Difference b/w Prairie Evaporite and Basal Red Beds (kPa/m)	% of Unknown Bulk Density Data above Prairie Evaporite Fm	% of Unknown Bulk Density Data above Basal Red Beds Fm	Comments
1	HUSKY D.H. WILDMERE 6-5-48-6	1970	610.0	975.0	1180.8			1194.8						poor					bulk density data does not reach top of Elk Point Grp.
2	VOYAGER PLAIN 6-1-52-13	1978	750.0	2100.0	1340.0	31.3	23.3	1356.0	31.7	23.4	1683.0	39.1	23.2	fair	7.4	-0.1	55	44	
3	HUSKY 2C FROG LAKE 2-19-53-1	1996	132.0	1134.0	842.9	19.3	22.9	856.5	19.7	23.0	1080.5	25.5	23.6	very good	5.8	0.6	15	12	
4	HUSKY 8B MARWAYNE 8-9-53-3	1996	132.0	1393.2	869.0	19.9	22.9	883.0	20.3	22.9	1106.0	25.1	22.7	very good	4.9	-0.2	14	12	
5	STERLING ET AL DEWBERRY 6-12-53-4	1988	425.0	605.0	898.8			913.3						very good					bulk density data does not reach top of Elk Point Grp.
6	HUSKY DH ETHELWYN 10D-17-54-5	1971	365.8	964.2	948.1			964.1						poor					this well has incorrect digital data
7	AMOCO INJ LINDBERGH 14-28-55-6	1991	671.0	1289.3	969.0	21.6	22.3	989.0	22.1	22.3				very good			67		Lotsberg Fm at TD
8	CHEMCELL DUVERNAY NAEL 16-27-55-12	1969	186.5	1448.4	1065.9	24.2	22.7	1081.7	24.6	22.7	1441.7	32.7	22.7	poor	8.1	-0.1	17	13	
9	WESTMIN HAIRY 2-13-55-13	1983	335.0	1745.0	1158.0	26.5	22.9	1170.0	26.8	22.9	1532.5	34.8	22.7	fair	8.0	-0.2	28	22	
10	CANSALT L-2 NAEL LIND 16-23-56-5	1989	155.0	1219.0	822.4	18.2	22.2	838.4	18.7	22.3				very good			18		Lotsberg Fm at TD
11	MURPHY SWD 5 LIND 15-13-58-5	1987	586.0	1546.0	869.9	19.5	22.4	886.0	19.9	22.5	1323.3	29.5	22.3	very good	9.6	-0.2	66	44	
12	SASKOIL SUGDEN 8-1-62-11	1991	296.0	1635.0	935.6	21.2	22.7	952.0	21.6	22.7	1469.2	32.5	22.2	good	10.9	-0.6	31	20	
13	RENAISSANCE COLD LAKE 1-28-63-2	1989	170.0	799.6	614.0	13.0	21.1	634.5	13.5	21.3				good			26		Winnipegosis FM at TD, some washed out zones
14	CON BEACON PARA COLDLK 8-26-63-3	1992	195.0	924.8	589.0	13.0	22.1	605.6	13.5	22.2				very good			32		bulk density data does not reach top of Basal Red Beds
15	CDNOXY SWD 2 SUGDEN 6-13-63-8	1986	270.0	1459.6	783.0	17.7	22.6	797.5	18.1	22.7	1337.0	29.8	22.3	good	11.7	-0.4	33	20	
16	ESSO MARIE OV 15-20-64-2	1979	21.0	1207.0	652.0	14.4	22.1	669.2	14.8	22.1	1092.5	24.0	22.0	fair	9.2	-0.1	3	2	
17	ESSO 79 SWD COLDLK 7-18-64-3	1979	20.2	1294.6	666.2	14.9	22.4	680.3	15.3	22.4	1171.0	26.2	22.4	fair	10.9	-0.1	2	1	
18	ESSO 85 SWD ETHELLK 1-19-64-3	1985	250.0	1229.6	656.9	14.5	22.1	671.3	14.9	22.2	1177.2	26.0	22.1	fair	11.1	-0.2	37	21	
19	ESSO 83 SWD ETHELLK 11-22-64-3	1983	253.4	1277.0	654.0	14.4	22.1	668.7	14.8	22.1	1164.4	26.0	22.3	fair	11.2	0.2	37	21	
20	ESSO 81 SWD ETHELLK 3-29-64-3	1981	20.0	1310.0	671.7	14.7	21.9	686.4	15.1	21.9	1190.6	26.0	21.8	fair	10.9	-0.1	2	1	
21	ESSO 83 INJ ETHELLK 8-33-64-3	1983	257.0	1317.0	705.0	15.2	21.6	720.0	15.6	21.6	1210.0	26.3	21.7	fair	10.7	0.1	35	21	
22	MOBIL GARTH 5-6-64-6	1988	270.0	1405.0	736.0	16.4	22.2	752.5	16.8	22.3	1252.5	27.6	22.0	good	10.8	-0.3	35	21	
23	MOBIL GARTH 12-6-64-6	1985	271.0	1414.0	741.0	16.6	22.4	758.4	17.0	22.4	1280.0	28.3	22.1	good	11.3	-0.3	35	21	
24	ESSO 83 SWD ETHELLK 2-3-65-3	1984	256.0	1314.0	696.0	15.1	21.7	712.0	15.5	21.8	1213.8	26.5	21.8	fair	10.9	0.0	35	21	
25	ESSO SWD LEMING ETHELLK 3-4-65-3	1978	396.4	1320.0	690.0	14.6	21.2	707.0	15.1	21.3	1204.4	25.7	21.3	fair	10.6	0.0	56	33	
26	ESSO 81 ETHELLK OV 9-20-65-3	1981	20.0	1264.6	624.5	13.5	21.6	640.4	13.9	21.7	1173.0	25.4	21.7	poor	11.5	0.0	2	1	
27	ESSO MEDLEY OV 6-8-66-2	1979	20.0	1214.6	672.6	15.0	22.3	690.0	15.4	22.3	1141.0	25.5	22.3	fair	10.1	0.0	2	1	
28	ESSO MEDLEY OV 14-28-66-3	1979	20.0	1254.6	644.0	14.2	22.1	660.2	14.6	22.1	1184.0	26.3	22.2	fair	11.7	0.1	2	1	
29	BP PCI MARGLK 10-8-66-5	1984	15.0	1353.0	708.0	15.6	22.0	720.2	15.9	22.1	1262.4	27.3	21.6	fair	11.4	-0.5	1	1	
30	BP LEMING 10-10-66-6	1981	156.0	1363.0	720.1	15.9	22.1	735.0	16.3	22.2	1273.3	28.1	22.1	fair	11.8	-0.1	21	12	
31	AMOCO 10B4 MOORE 10-5-67-4	1983	165.0	1339.6	693.5	14.8	21.4	707.4	15.2	21.4	1257.8	27.1	21.6	poor	12.0	0.1	23	13	
32	ESSO AEC 85 FISHCK 7-11-67-6	1985	250.0	1344.6	700.6	15.6	22.2	717.0	16.0	22.3	1261.0	27.7	22.0	fair	11.7	-0.3	34	20	
33	ESSO AEC 85 FISHCK 12-31-67-7	1985	248.0	1333.0	698.0	15.5	22.3	716.0	16.0	22.4	1257.5	27.8	22.1	good	11.7	-0.3	34	19	
34	ESSO AEC 85 FISHCK 7-34-67-8	1985	250.0	1389.6	753.0	16.8	22.3	769.0	17.2	22.4	1312.0	29.1	22.2	fair	11.9	-0.2	32	19	
35	ESSO AEC 85 FISHCK 11-19-68-6	1985	250.0	1339.6	715.0	15.8	22.1	729.8	16.2	22.2	1276.0	28.1	22.0	good	11.9	-0.2	34	19	
36	AECOG (NE) FISHER 8D-12-69-5	1990	196.0	915.0	664.9	14.1	21.2	680.0	14.5	21.3				fair			28		Contact Rapids Fm at TD
37	ARCO HEART LAKE 11-26-69-10	1967	189.0	1435.3	831.5	18.8	22.6	847.0	19.2	22.6	1370.7	30.7	22.4	fair	11.5	-0.3	22	13	
38	AEC ET AL SCHELTENS 16-13-71-1	1985	184.0	825.0	750.4	16.3	21.8							good					Elk Point Fm at TD
39	AEC ET AL FOSTERCK 16-36-72-1	1985	199.0	770.8	657.0	14.2	21.6							fair					Contact Rapids Fm at TD
40	AMOCO AEC KIRBY 5-21-71-4	1980	153.9	1150.9	591.0	12.8	21.6	626.6	13.2	21.7	1142.5	25.0	21.9	fair	11.9	0.2	25	13	
41	AMOCO AEC IPIATIK 6-30-71-5	1980	285.0	1214.9	648.1	14.1	21.8	662.3	14.5	21.9	1190.3	26.1	21.9	fair	11.6	0.0	42	24	
42	AMOCO AEC IPIATIK GRIST 10-17-71-6	1980	156.0	1224.8	647.0	14.6	22.5	662.0	14.9	22.6	1189.9	26.5	22.3	fair	11.6	-0.3	23	13	
43	AEC PHILLIPS WIAU 10-26-71-7	1980	230.0	1229.6	671.5	14.8	22.0	688.0	15.2	22.1	1208.6	26.7	22.1	fair	11.5	0.0	33	19	
44	RAX ET AL MILLS 7-12-71-11	1978	313.9	1376.5	798.6	18.1	22.7	814.1	18.5	22.7	1330.0	30.3	22.7	fair	11.7	0.0	38	23	
45	AEC FOSTER CREEK 7-7-72-3	1990	169.7	837.0	600.7	13.0	21.6	624.3	13.5	21.7				very good			26		Contact Rapids Fm at TD
46	AMOCO AEC IPIATIK 11-18-72-4	1979	285.0	1187.0	609.0	13.3	21.8	627.0	13.7	21.9	1153.0	25.3	22.0	fair	11.6	0.1	45	24	
47	AMOCO KIRBY 10-22-72-6	1980	300.0	1208.8	671.5	14.7	21.8	689.0	15.1	22.0	1205.0	26.6	22.0	fair	11.4	0.1	43	25	

Table D.1: Vertical Stress for the Elk Point Group determined from bulk density data

No.	Well Name	Year Logged	Top Log Interval (m KB)	Bottom Log Interval (m KB)	Top Elk Point Group (m KB)	Vertical Stress at Top of Elk Point Group (MPa)	Normalized Vertical Stress Gradient at Top of Elk Point Group (kPa/m)	Top Prairie Evaporite Fm (m KB)	Vertical Stress at Top of Prairie Evaporite Fm (MPa)	Normalized Vertical Stress Gradient at Top of Prairie Evaporite Fm (kPa/m)	Top Basal Red Beds Fm (m KB)	Vertical Stress at Top of Basal Red Beds Fm (MPa)	Normalized Vertical Stress Gradient at Top of Basal Red Beds Fm (kPa/m)	Bulk Density Log Quality	Stress Magnitude Difference b/w Prairie Evaporite and Basal Red Beds (MPa)	Stress Gradient Difference b/w Prairie Evaporite and Basal Red Beds (kPa/m)	% of Unknown Bulk Density Data above Prairie Evaporite Fm	% of Unknown Bulk Density Data above Basal Red Beds Fm	Comments
48	AEC PHILLIPS WIAU 11-14-72-8	1980	150.0	1279.6	721.0	16.0	22.2	737.6	16.5	22.3	1253.8	27.9	22.2	fair	11.4	-0.1	20	12	
49	AEC PHILLIPS WIAU 10-33-72-8	1980	160.0	1290.0	745.0	16.7	22.4	760.0	17.1	22.5	1271.0	28.4	22.3	fair	11.3	-0.2	21	12	
50	PAN AM A-1 BEHAN 6-26-72-11	1969	426.7	1044.2	799.8	18.1	22.6	815.3	18.4	22.6				poor			52		Contact Rapids Fm at TD
51	AEC FOSTER CREEK 6-25-73-3	1997	148.0	825.0	663.3	14.3	21.6	684.6	14.9	21.7				very good			21		Prairie Evaporite Fm at TD, *
52	AMOCO AEC IPIATIK KIRBY 10-14-73-5	1979	281.9	1119.7	599.9	13.0	21.7	616.8	13.5	21.8				fair			45		Lotsberg Fm at TD
53	AMOCO KIRBY 9-25-73-5	1980	224.0	839.9	588.0	12.7	21.7	602.0	13.1	21.8				fair			37		Contact Rapids Fm at TD
54	AMOCO KIRBY 11-30-74-5	1977	187.5	1107.9	605.9	13.3	21.9	621.6	13.7	22.0	1070.0	23.7	22.2	poor	10.0	0.1	30	17	some bulk density data logged through cased hole
55	AMOCO KIRBY 10-9-74-6	1977	187.8	1094.7	583.4	12.9	22.2	602.3	13.4	22.3	1042.5	23.2	22.3	fair	9.8	0.0	31	18	Top of Granite Wash used for bottom of Lotsberg
56	AMOCO KIRBY 6-24-74-7	1977	189.9	1142.4	632.2	14.0	22.1	650.1	14.4	22.2	1094.0	24.3	22.2	fair	9.9	0.0	29	17	Top of Granite Wash used for bottom of Lotsberg
57	HOME LEISMER A10-1-77-7	1975	190.8	951.0	479.5	10.6	22.2	495.3	11.0	22.3	919.6	20.5	22.3	fair	9.4	0.0	38	20	
58	HOME LEISMER 3-7-77-7	1980	128.0	788.0	520.4	11.7	22.5	534.8	12.1	22.6				poor			23		Contact Rapids Fm at TD
59	NORCEN POR LEISMER 2-8-77-8	1982	167.0	782.0	568.0	12.7	22.4	583.1	13.1	22.5				fair			28		Winnipegosis Fm at TD
60	ALTANA HUBER CHRISTINA 10-28-77-8	1971	118.3	787.9	523.0	11.7	22.3	539.3	12.1	22.5				fair			21		Winnipegosis Fm at TD
61	LAKEWOOD ET AL CHARD 14-29-79-5	1991	128.0	605.0	405.0	8.8	21.7	426.7	9.3	21.9				very good			29		Contact Rapids Fm at TD
62	HOME WINNEFRED LAKE 10-5-80-2	1967	116.1	557.9	479.1	10.3	21.6	505.7	11.0	21.7				poor			22		density profile looks different, Contacts Rapids Fm at TD, *
63	HOMESTEAD CANOXY COWPAR 11-32-80-4	1976	61.8	364.8	393.9			410.0						fair					bulk density data does not reach Elk Pt. Group
64	GULF RESEDELN 7-8-82-6	1981	370.0	654.0	419.0	9.0	21.4	444.2	9.7	21.7	624.6	14.2	22.8	poor	4.6	1.1	83	59	Top of Granite Wash used for bottom of Lotsberg
65	HUSKY ET AL DIVIDE 10-29-82-12	1988	201.0	964.0	689.0	15.6	22.6	703.0	15.9	22.7				very good			28		Contact Rapids Fm at TD
66	GULF RESEDELN 10-8-83-6	1981	120.0	624.0	477.5	10.6	22.2	500.1	11.2	22.4				fair			23		Winnipegosis Fm at TD
67	TEXCAN COTTONWOOD 1-14-83-6	1969	113.0	685.8	432.8	9.6	22.3				673.4	15.4	22.9	fair					No Prairie Evaporite, Granite Wash used for bottom of Lotsberg
68	NORTHSTAR ET AL SURMONT 7-32-83-6	1980	125.0	704.0	446.0	9.8	22.0	453.0	10.0	22.0	665.4	15.1	22.7	fair	5.1	0.7	27	18	Edge of Prairie Evaporite Fm
69	JACOS WD HANGST 15-14-84-11	1990	181.0	883.0	521.6	11.7	22.4	529.0	11.9	22.4	852.0	19.2	22.5	good	7.3	0.1	33	21	Top of Granite Wash used for bottom of Lotsberg
70	PCI PCEJ HANGST 9-27-84-11	1988	183.6	860.9	499.0	11.4	22.8	505.7	11.5	22.8	833.5	19.1	22.9	fair	7.5	0.1	35	21	Top of Granite Wash used for bottom of Lotsberg
71	RAX NEWBY 14-24-85-6	1988	119.0	470.0	336.0	7.4	21.9	343.0	7.5	22.0				good					Contact Rapids Fm at TD*
72	TEXCAN CS HORSE 16-27-85-11	1969	181.7	779.7	417.6	9.7	23.1	425.8	9.9	23.2	756.5	17.4	22.9	fair	7.5	-0.2	42	24	Top of Granite Wash used for bottom of Lotsberg
73	CIGOL ET AL HORSE 11-10-85-13	1970	96.6	875.9	526.0	12.6	23.9	534.0	12.8	24.0				fair					
74	SUNCOR CLARKE 2-32PREV-89-12	1981	86.0	717.0	397.8	9.1	22.8	406.5	9.3	22.9				fair					
75	AOSTRA WDW1 ATHABASCA 6-18-93-12	1991	179.0	599.0	314.3	7.2	22.9	323.5	7.4	22.9	576.5	13.5	23.5	very good	6.1	0.6	54	30	
76	CHEVRON STEEPBANK EX 8-22-94-7	1981	11.0	414.6	328.5	7.3	22.2							fair					Elk Pt Fm at TD
77	CHEVRON STEEPBANK 6-23-94-7	1992	188.0	424.0										very good					no picks for Watt Mtn or Elk Pt Group
78	CHEVRON WDW STEEPBANK 13-23-94-7	1991	180.0	396.0	284.0	5.9	20.9							very good					Winnipegosis Fm at TD
79	CDCOG TENN MUSKEGR 1-3-95-7	1980	119.0	410.0	286.6	6.1	21.2							fair					Well Renamed: HUSKY TENN MUSKEGR 1-3-95-7
80	HUSKY TENN NOVA 3-14-95-7	1981	44.0	405.0	275.0	6.6	21.9							fair					
81	HUSKY TENN NOVA 3-15-95-7	1981	43.0	391.0	260.7	5.6	21.6							fair					
82	HUSKY TENN MUSKEGR 1-20-95-7	1980	104.0	339.0	224.4	4.8	21.4							fair					
83	HUSKY TENN NOVA 4-22-95-7	1981	45.0	385.0	251.7	5.7	22.5							fair					density seems way to high over Elk Pt. Gp.
84	CDCOG TENN MUSKEGR 1-24-95-7	1980	129.0	413.0	283.0	6.1	21.5							fair					
85	ESSO 90PC OSLO 12-7-95-8	1990	143.0	311.0	183.5	3.9	21.4							fair					density to low, not analyzed, Casing@143 m KB
86	GULF FIREBAG 15-8-96-1	1976	12.1	134.0	129.6	2.9	22.2							poor					
87	GULF FIREBAG 14-11-96-1	1976	9.1	131.7	150.2	2.7	20.8							fair					
88	GULF FIREBAG 6-26-96-1	1976	14.0	162.5	162.4	3.5	21.5							fair					
89	GULF FIREBAG 7-29-96-1	1976	11.0	113.3	112.6	2.4	21.1							fair					
90	GULF FIREBAG 2-8-97-1	1976	6.0	125.0	109.8									fair					
91	GULF FIREBAG 2-11-97-1	1976	12.8	173.6	172.5	3.7	21.5							fair					bulk density data does not reach top of Elk Point Grp.
92	GULF FIREBAG 13-12-97-2	1976	7.3	126.0	143.3									fair					bulk density data does not reach top of Elk Point Grp.

* These wells have tops picked for the Prairie Evaporite Formation but are outside the Prairie Evaporite Formation area as outlined by AGS. They have not been included in the contour plots.

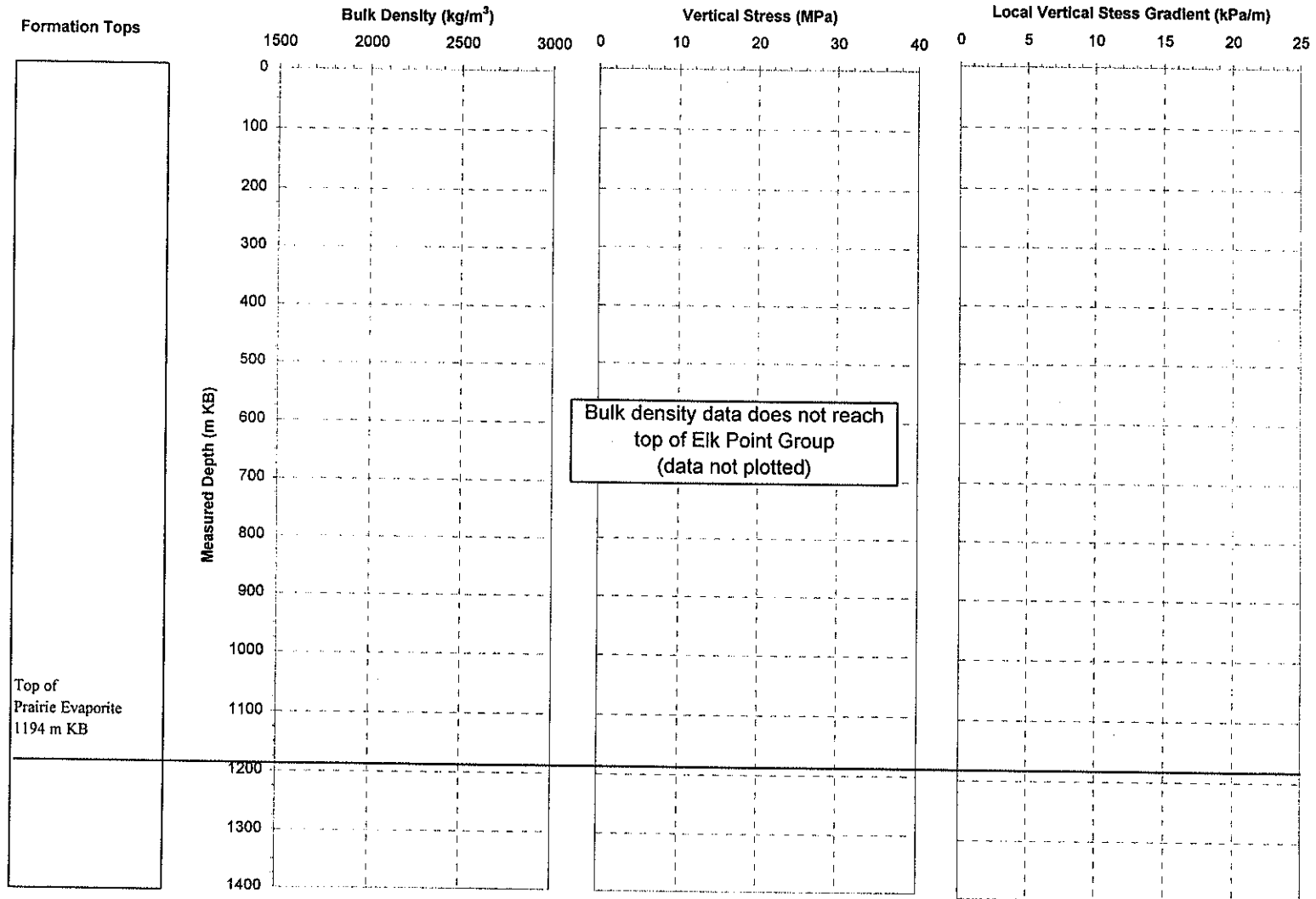


Figure D.1.1: Calculated vertical stress and vertical stress gradients for Husky D.H. Wildmere 6-5-48-6.

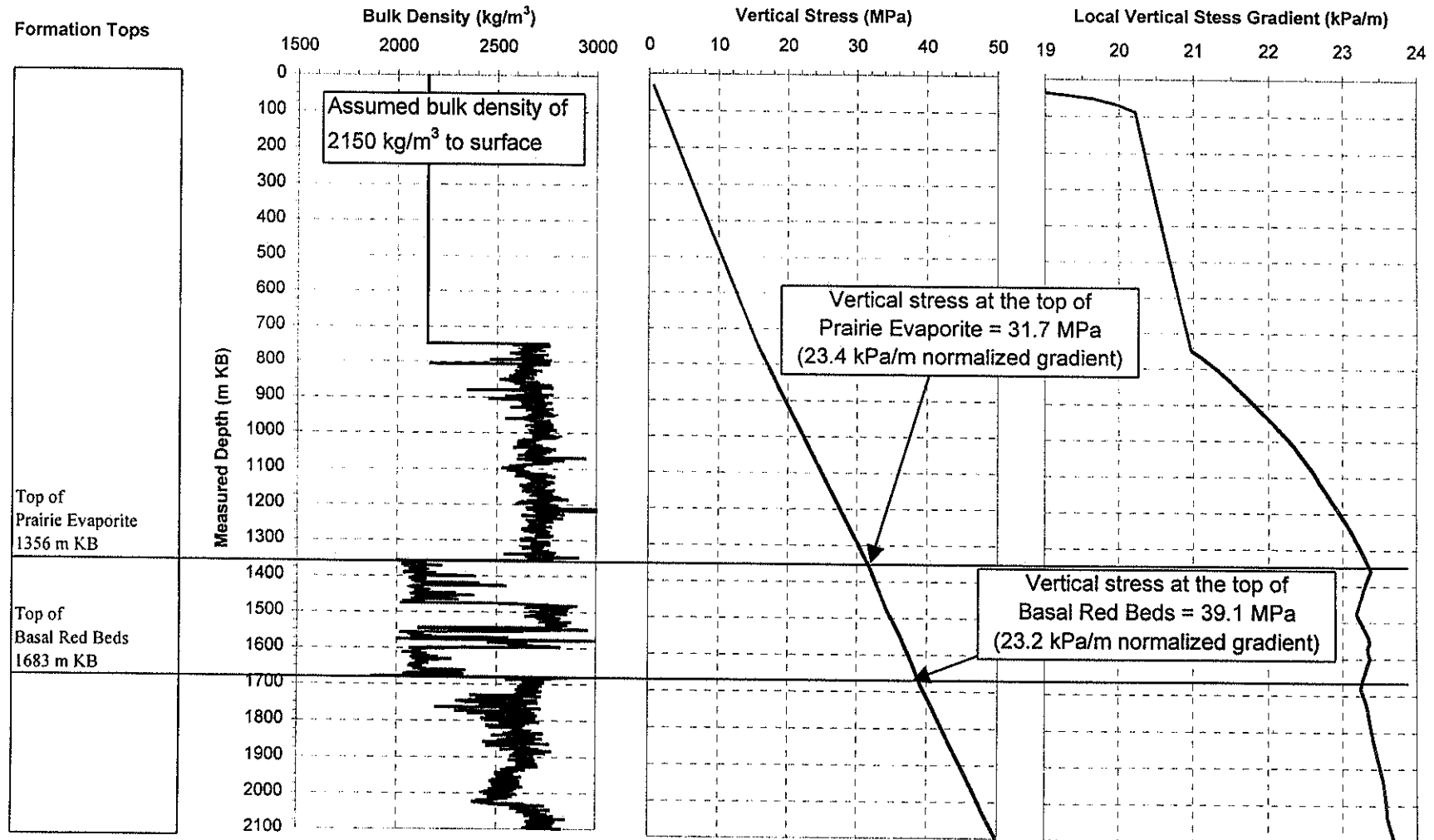


Figure D.1.2: Calculated vertical stress and vertical stress gradients for Voyager Plain 6-1-52-13.

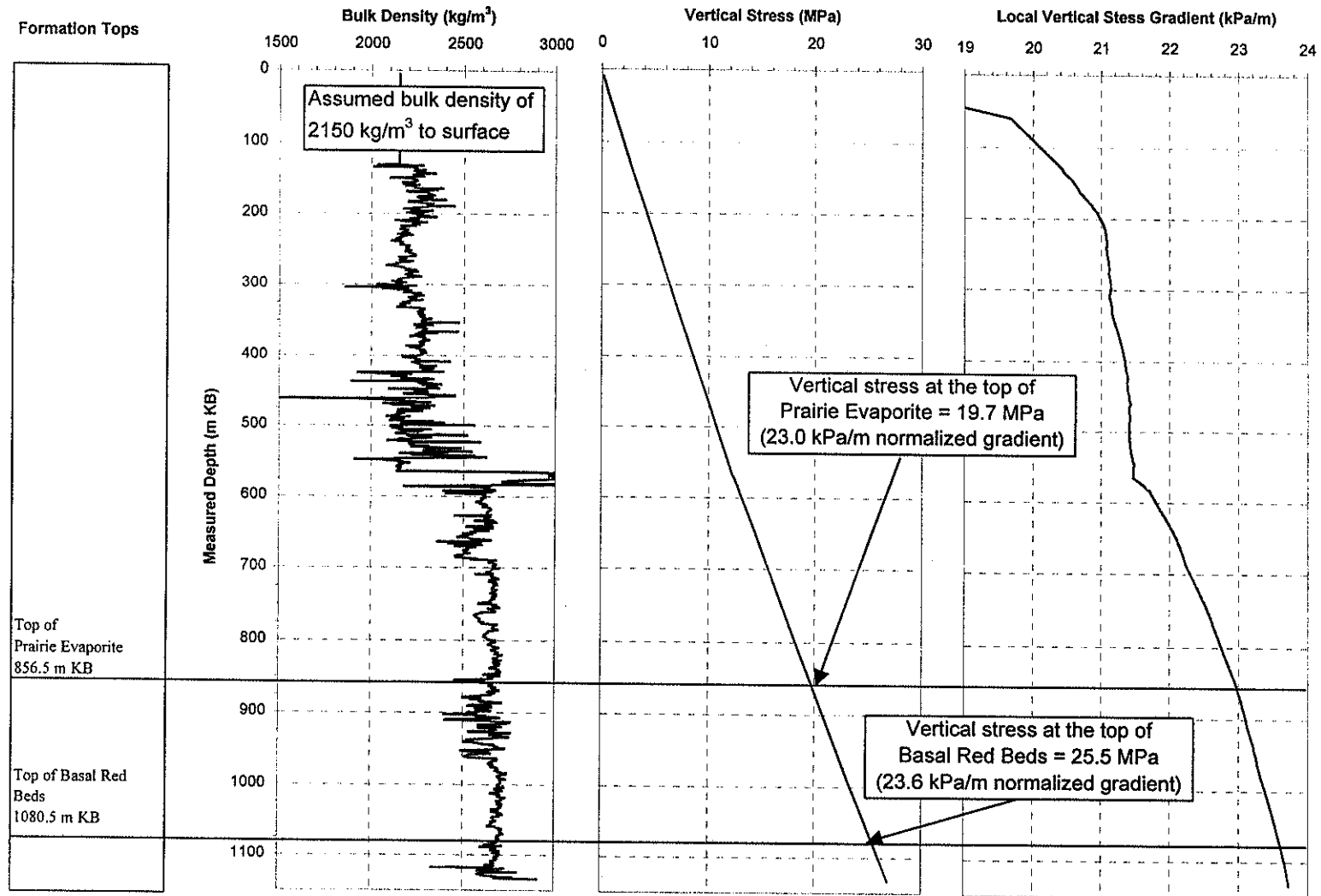


Figure D.1.3: Calculated vertical stress and vertical stress gradients for Husky 2C Frog Lake 2-19-53-1.

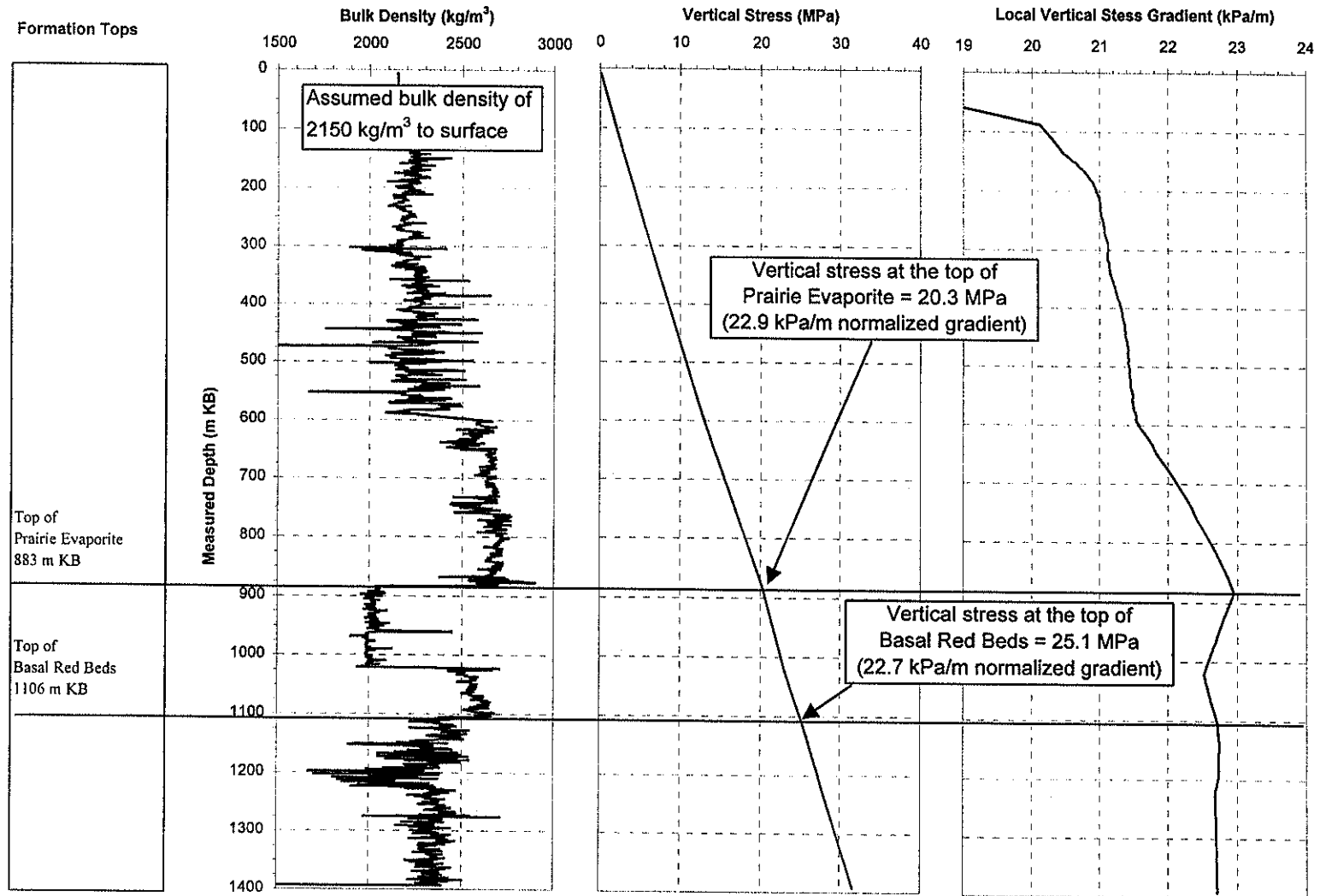


Figure D.1.4: Calculated vertical stress and vertical stress gradients for Husky 8B Marwayne 8-9-53-3.

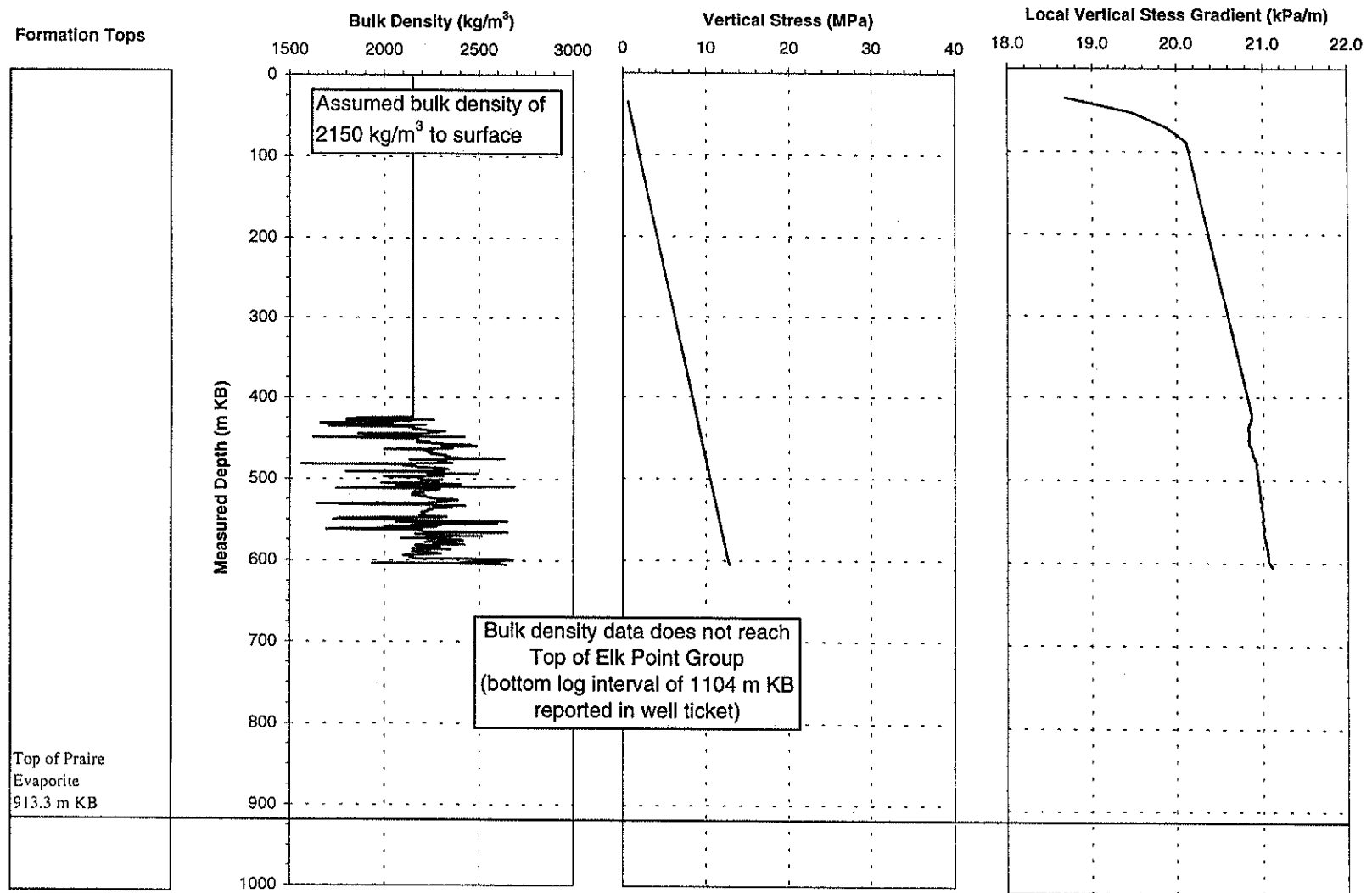


Figure D.1.5: Calculated vertical stress and vertical stress gradients for Sterling et al Dewberry 6-12-53-4.

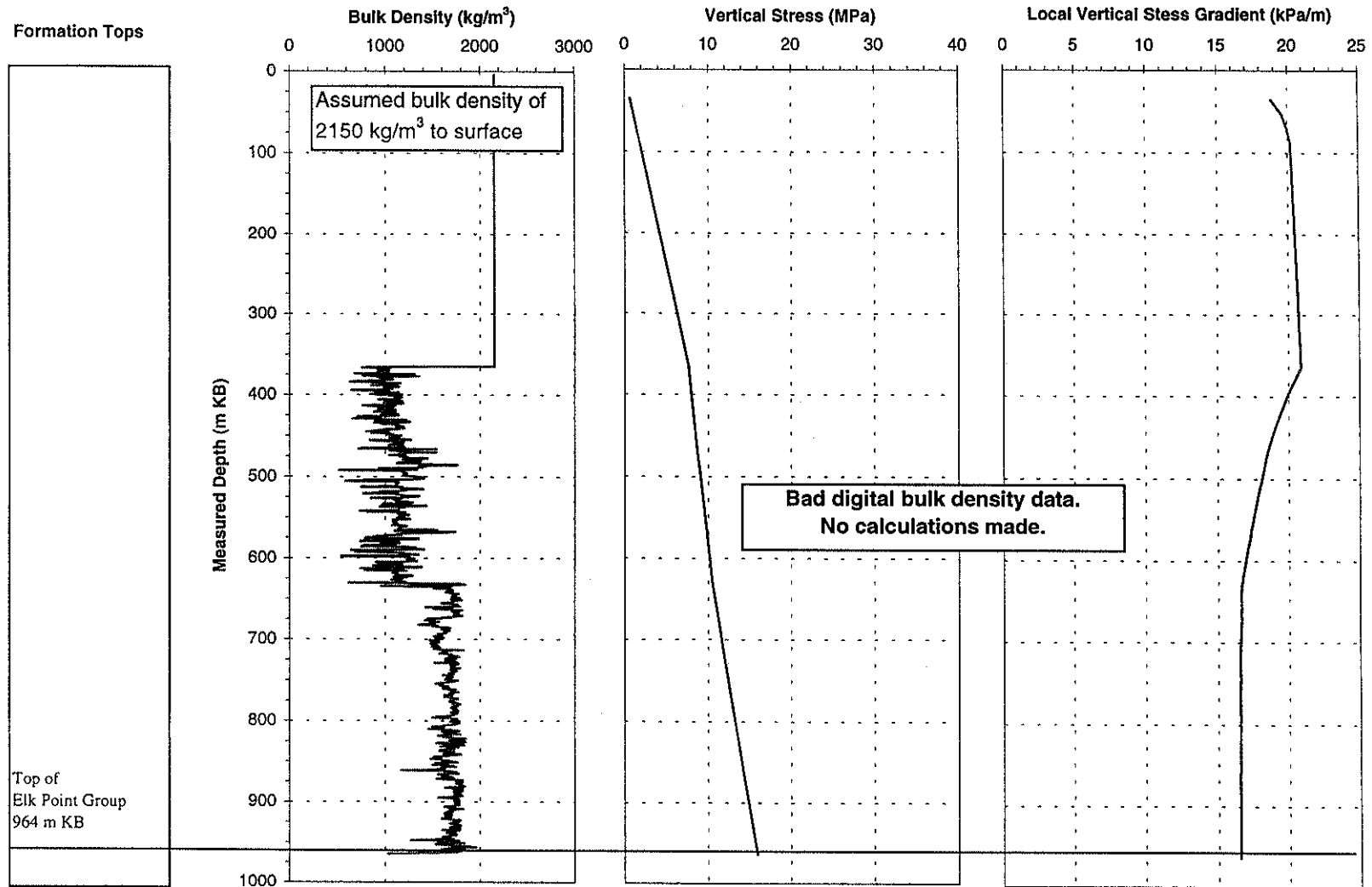


Figure D.1.6: Calculated vertical stress and vertical stress gradients for Husky DH Ethelwyn 10D-17-54-5.

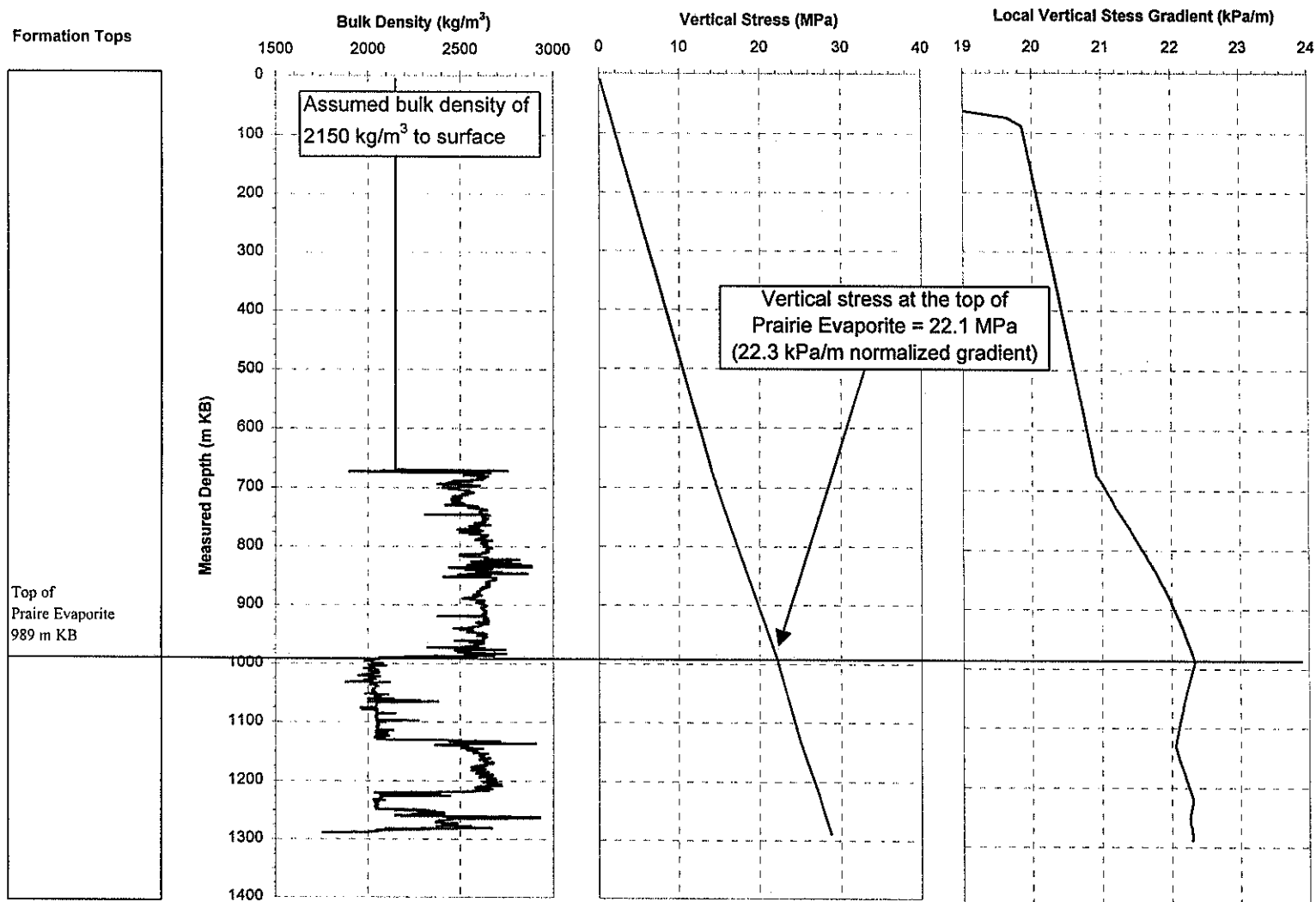


Figure D.1.7: Calculated vertical stress and vertical stress gradients for Amoco INJ Lindbergh 14-28-55-6.

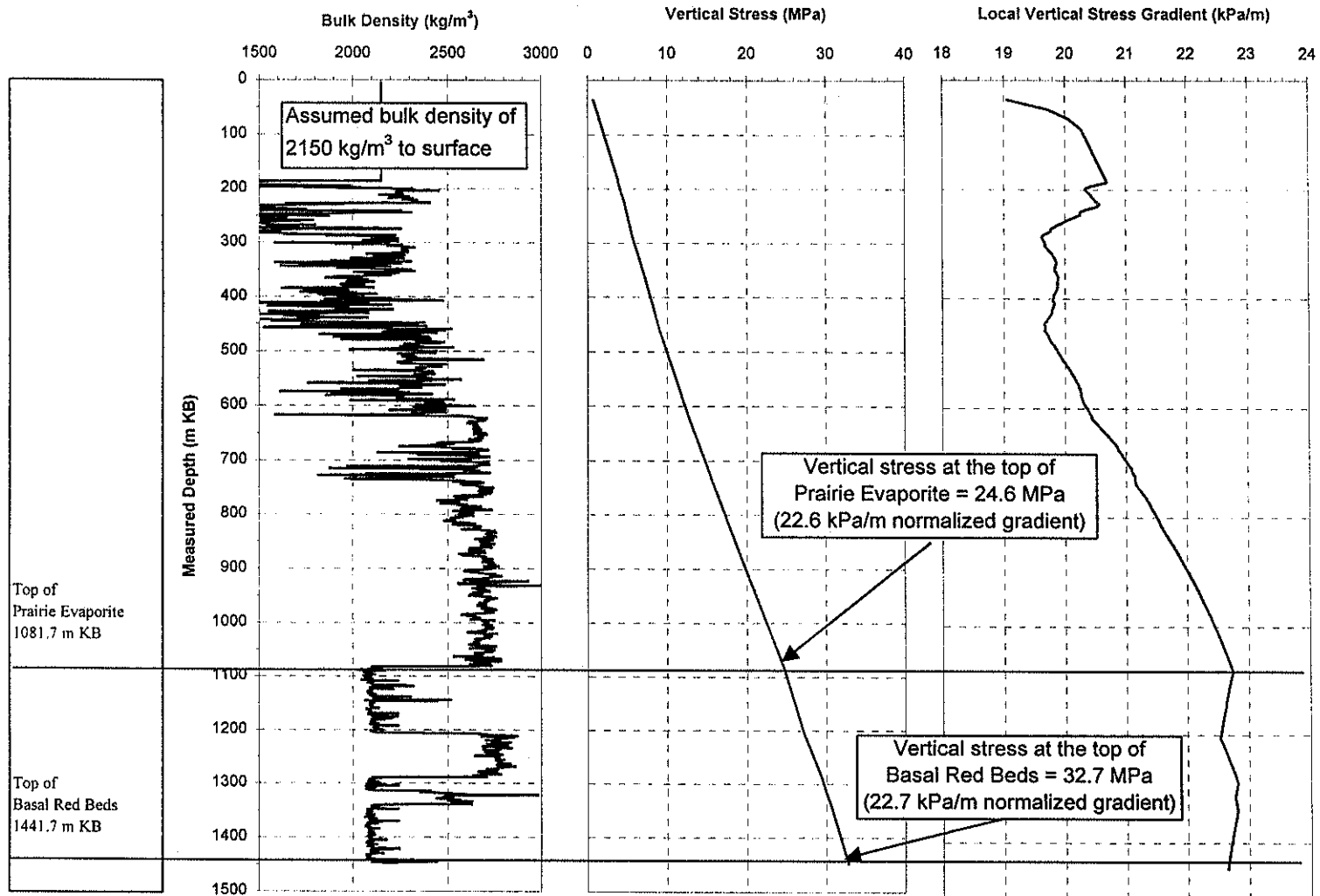


Figure D.1.8: Calculated vertical stress and vertical stress gradients for Chemcell Duvernay NaCl 16-27-55-12 .

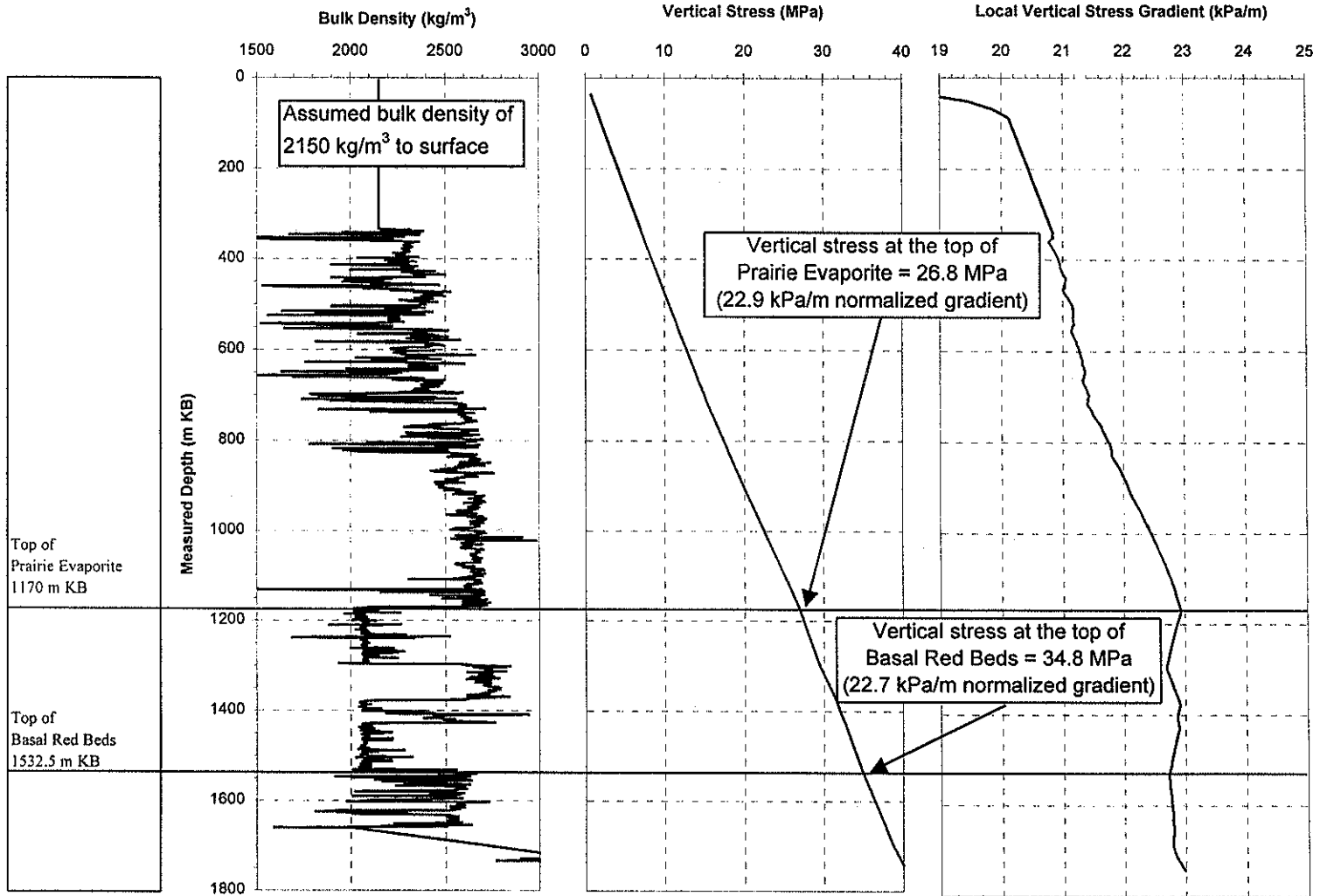


Figure D.1.9: Calculated vertical stress and vertical stress gradients for Westmin Hairy 2-13-55-13 .

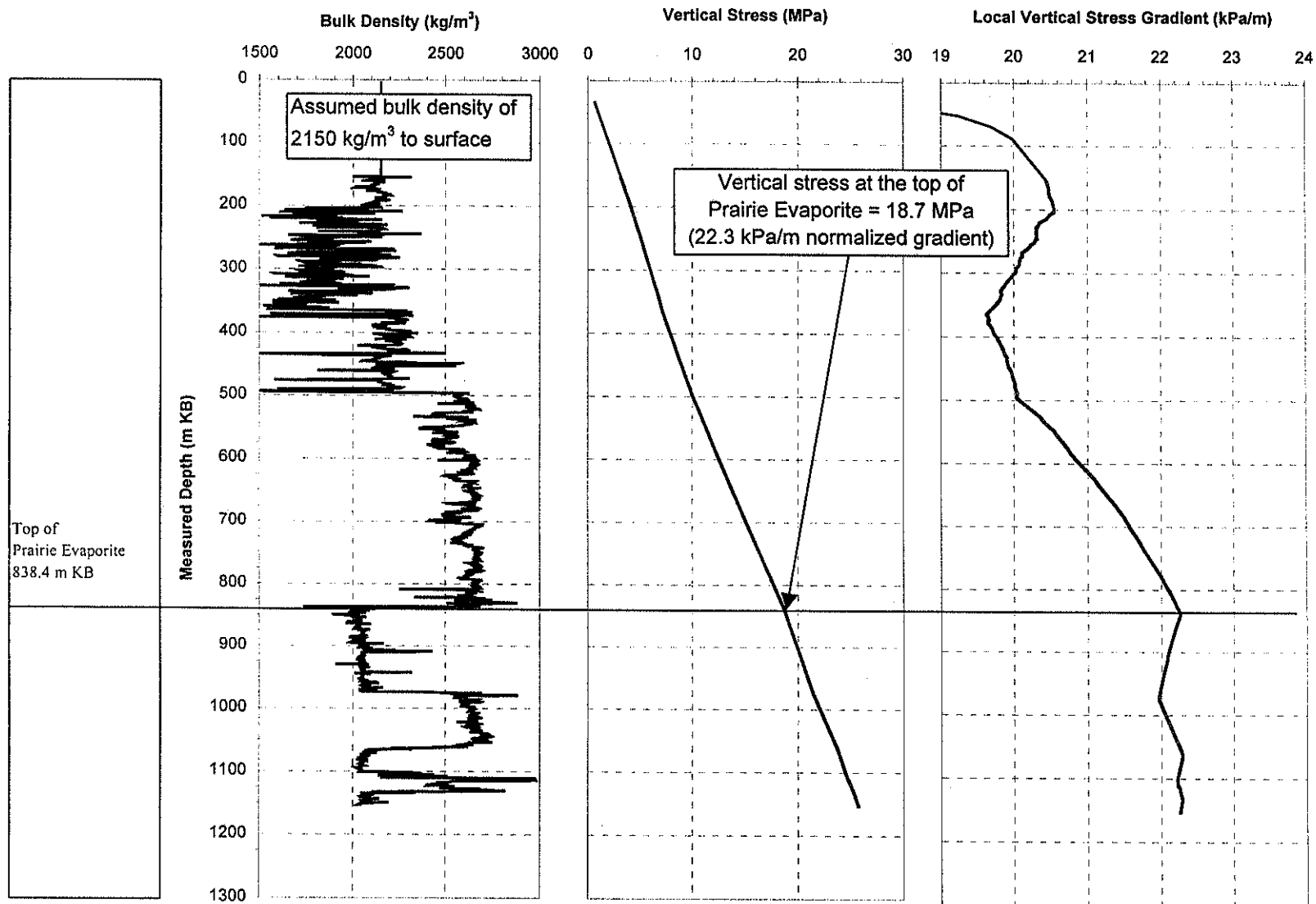


Figure D.1.10: Calculated vertical stress and vertical stress gradients for Cansalt L-2 NaCl Lind 16-23-56-5 .

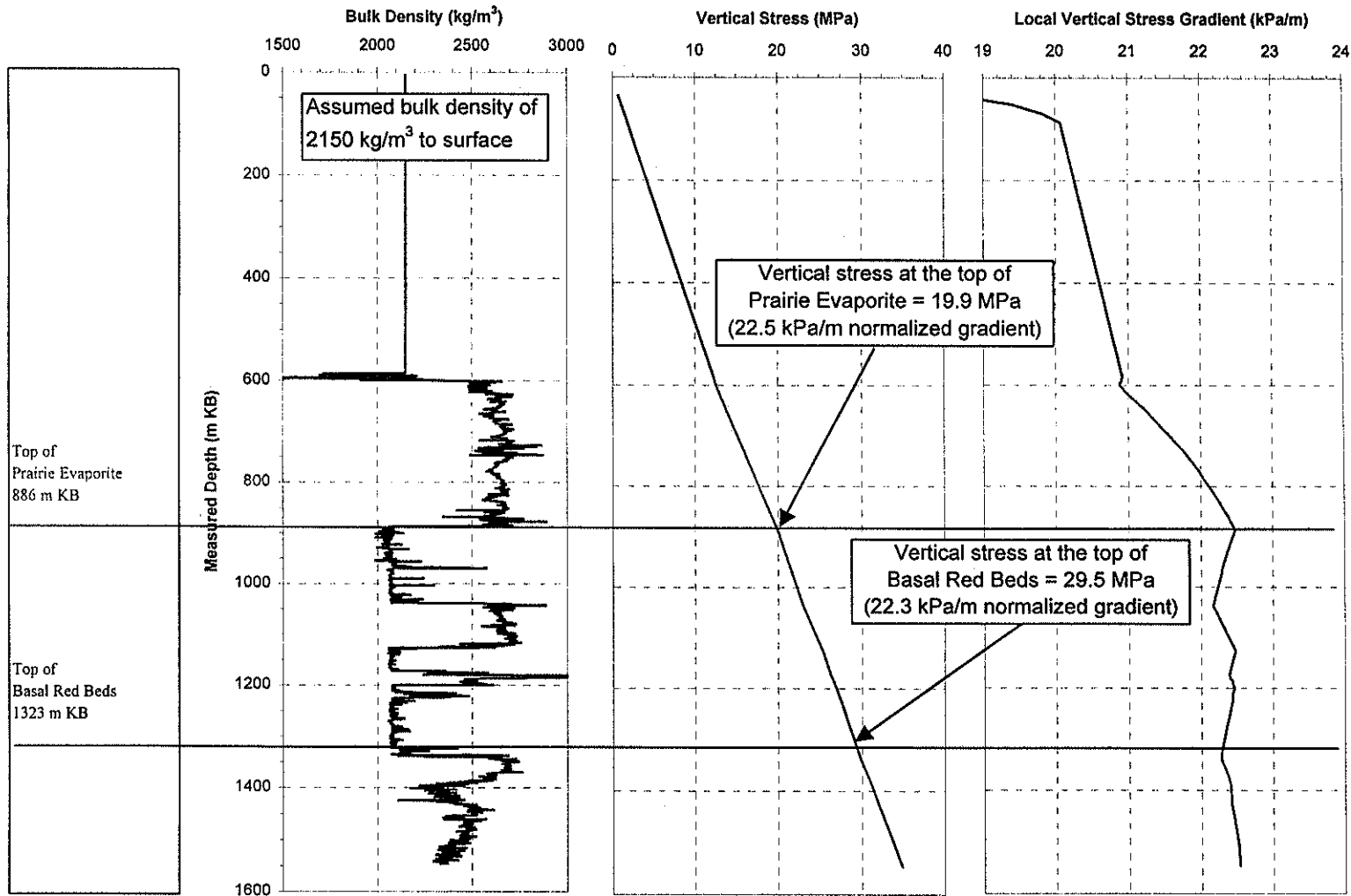


Figure D.1.11: Calculated vertical stress and vertical stress gradients for Murphy SWD 5 Lind 15-13-58-5.

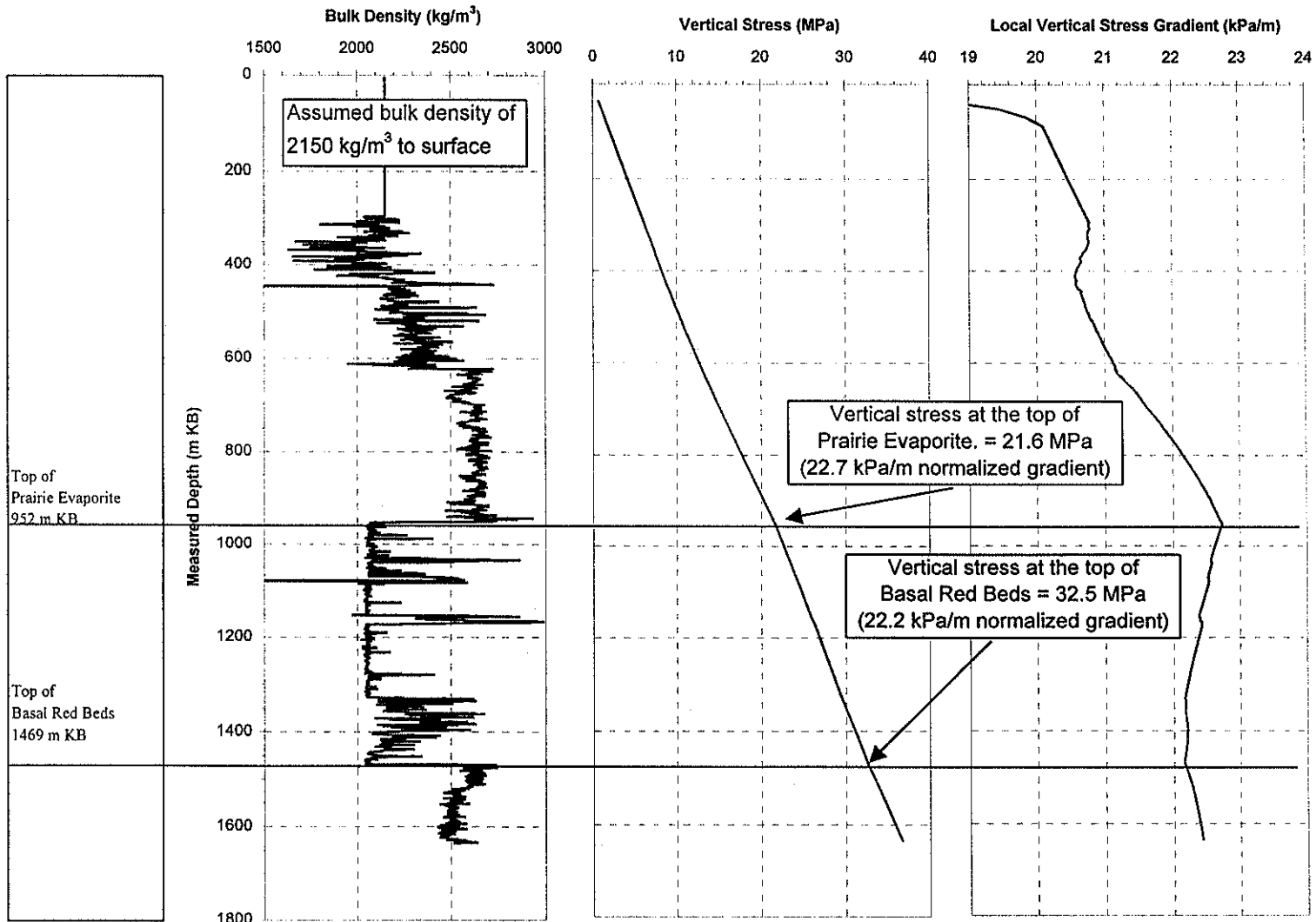


Figure D.1.12: Calculated vertical stress and vertical stress gradients for Saskoil Sugden 8-1-62-11.

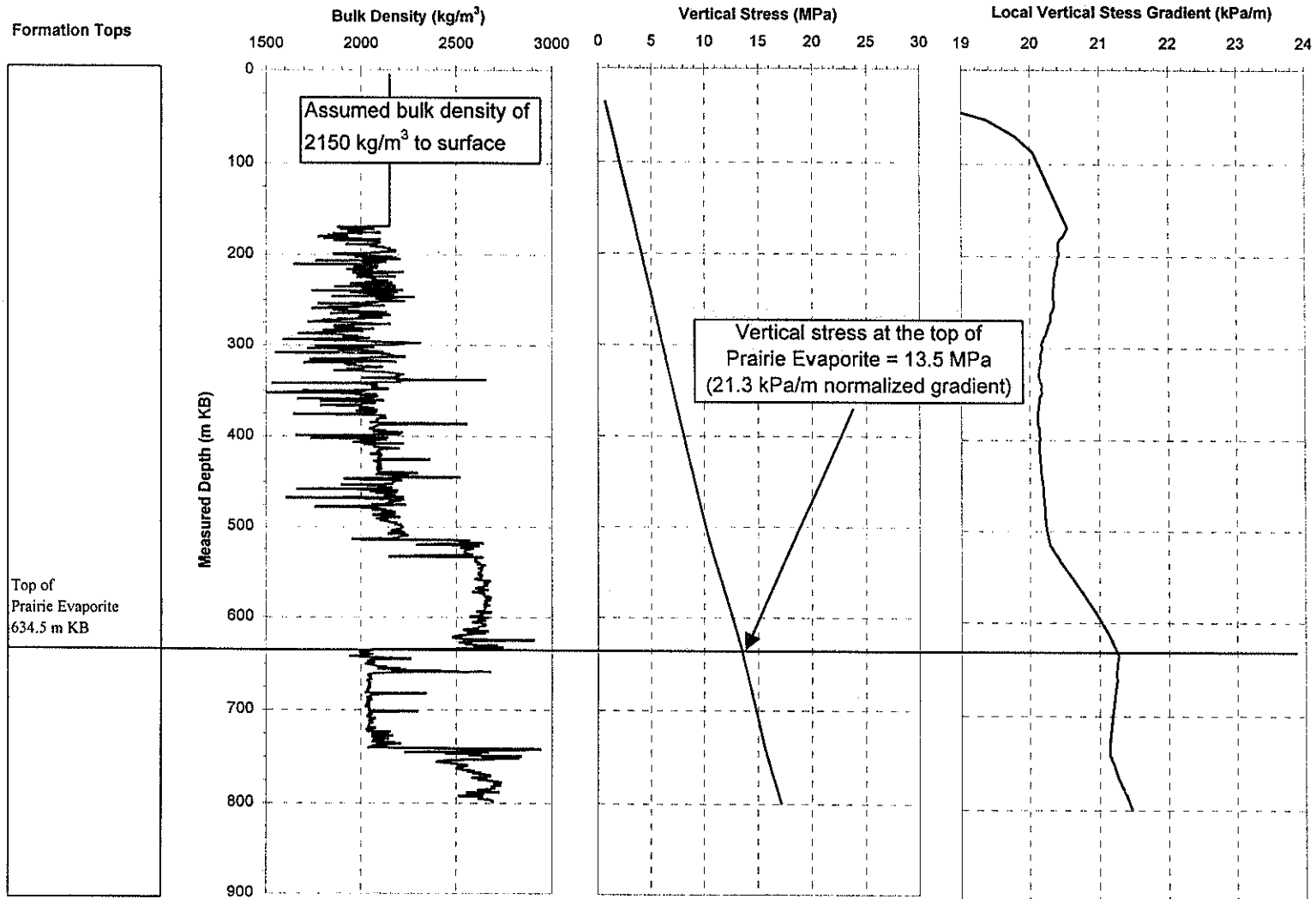


Figure D.1.13: Calculated vertical stress and vertical stress gradients for Renaissance Cold Lake 1-28-63-2.

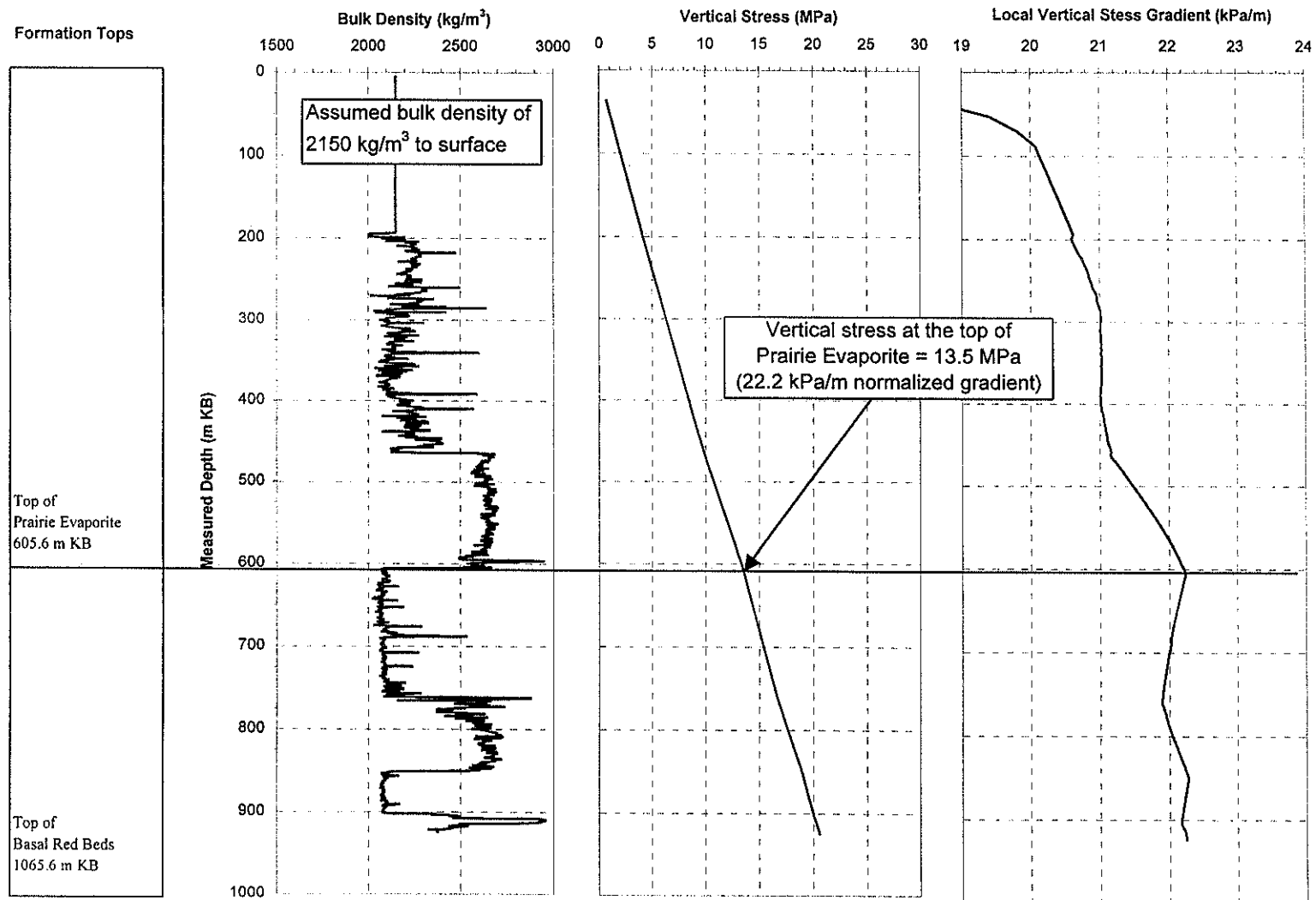


Figure D.1.14: Calculated vertical stress and vertical stress gradients for Con Beacon Para Coldk 8-26-63-3.

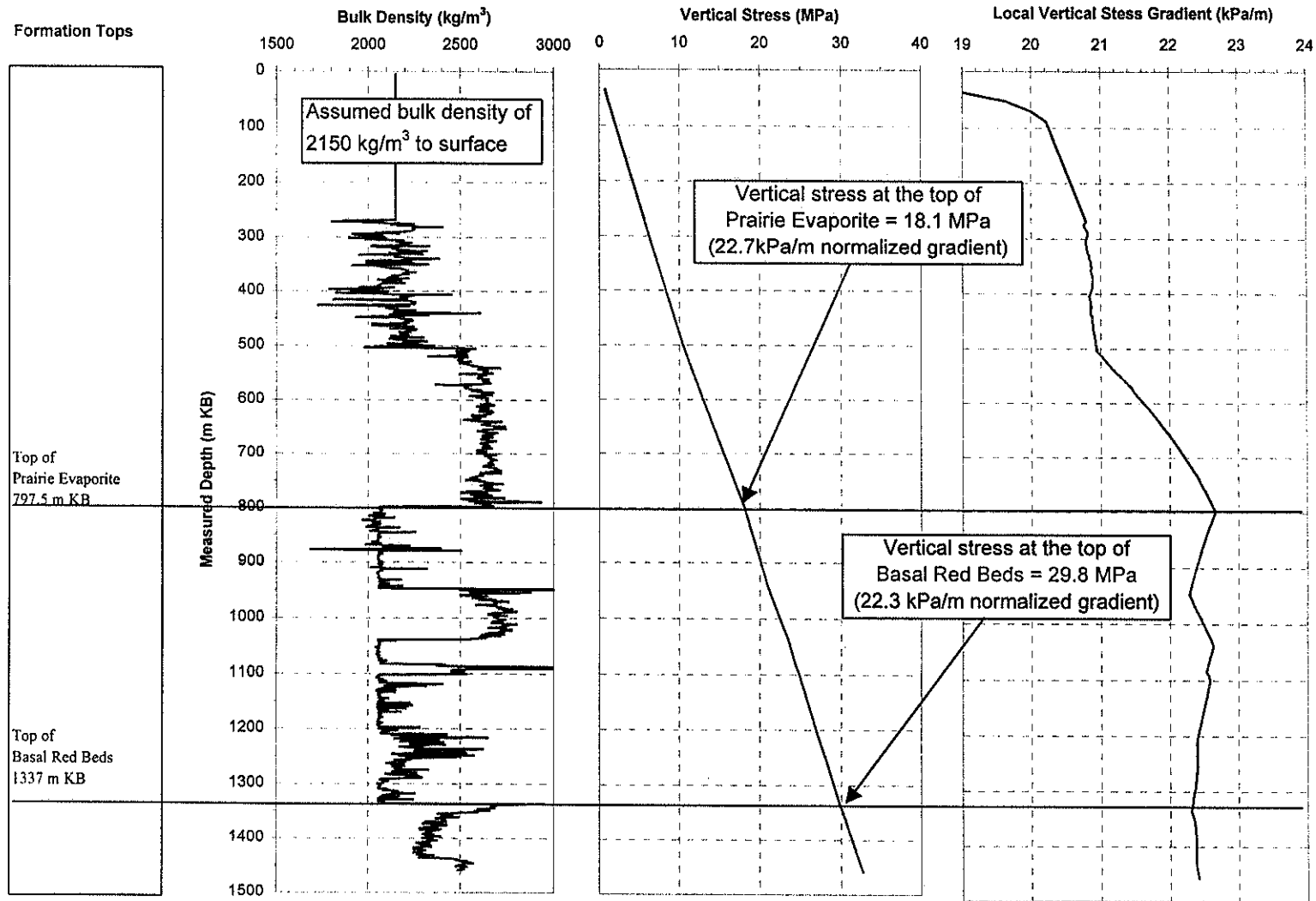


Figure D.1.15: Calculated vertical stress and vertical stress gradients for Cdoxy SWD 2 Sugden 6-13-63-8.

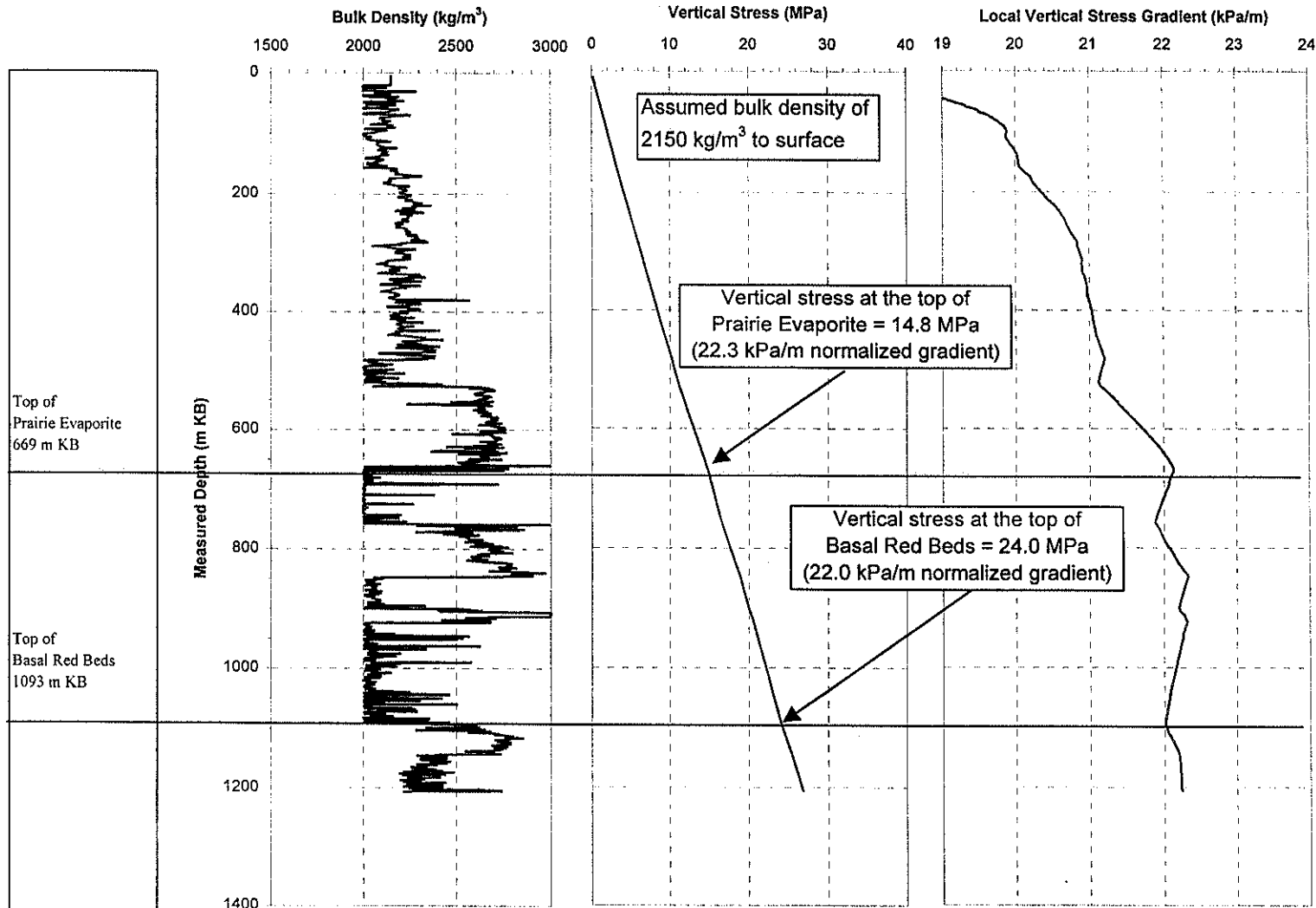


Figure D.1.16: Calculated vertical stress and vertical stress gradients for Esso Marie OV 15-20-64-2.

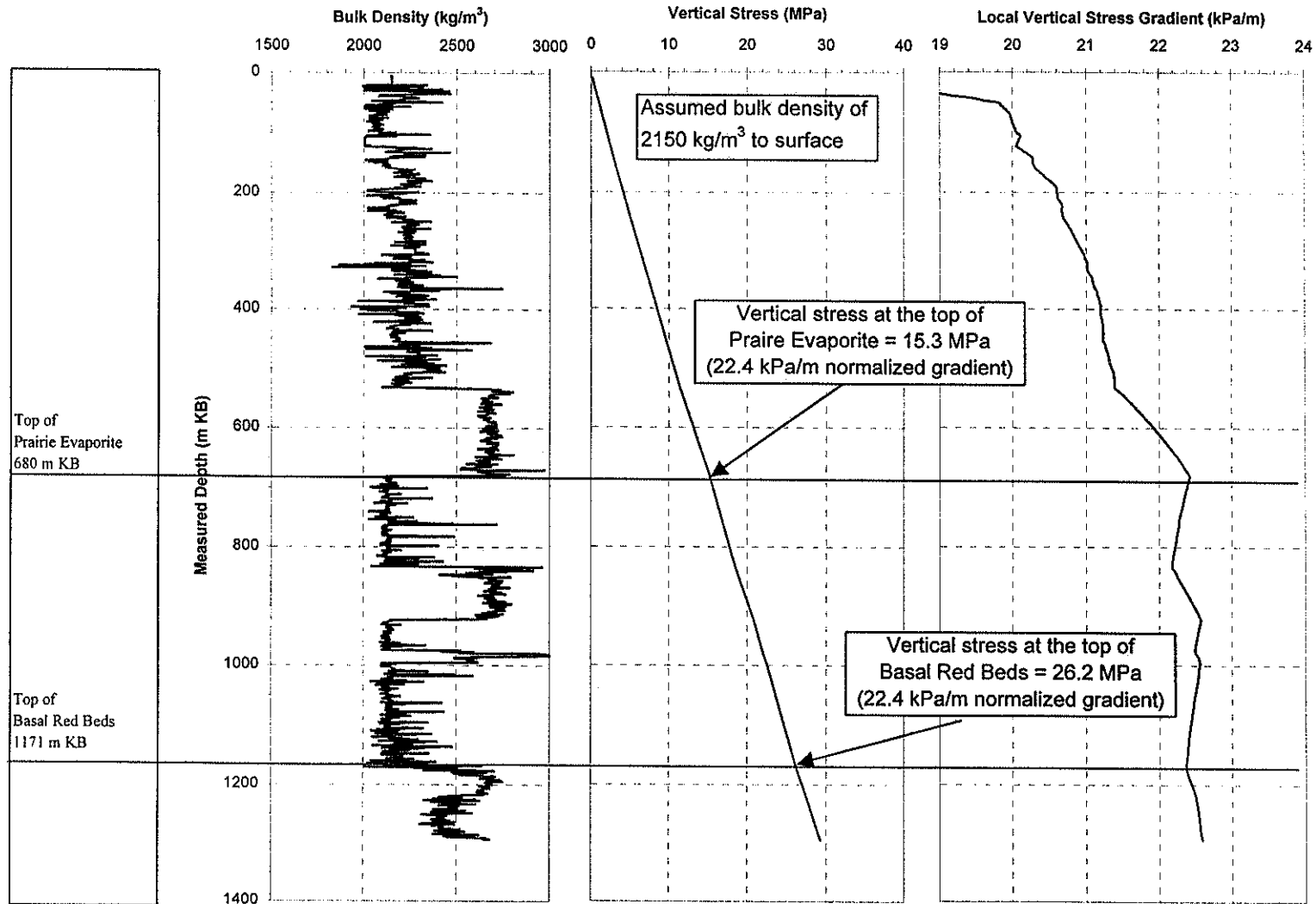


Figure D.1.17: Calculated vertical stress and vertical stress gradients for Esso 79 SWD 7-18-64-3.

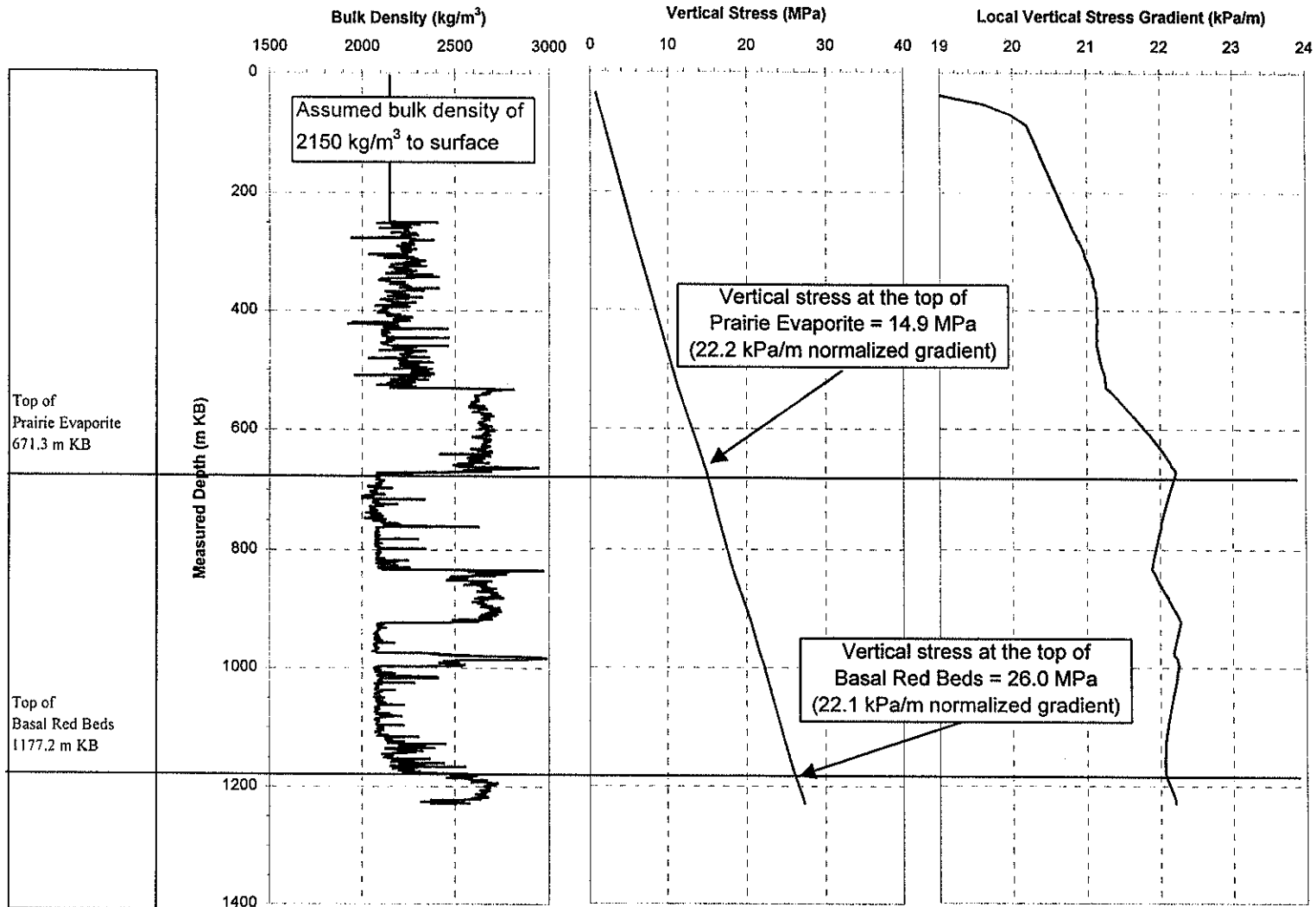


Figure D.1.18: Calculated vertical stress and vertical stress gradients for Esso 85 SWS Ethelk 1-19-64-3.

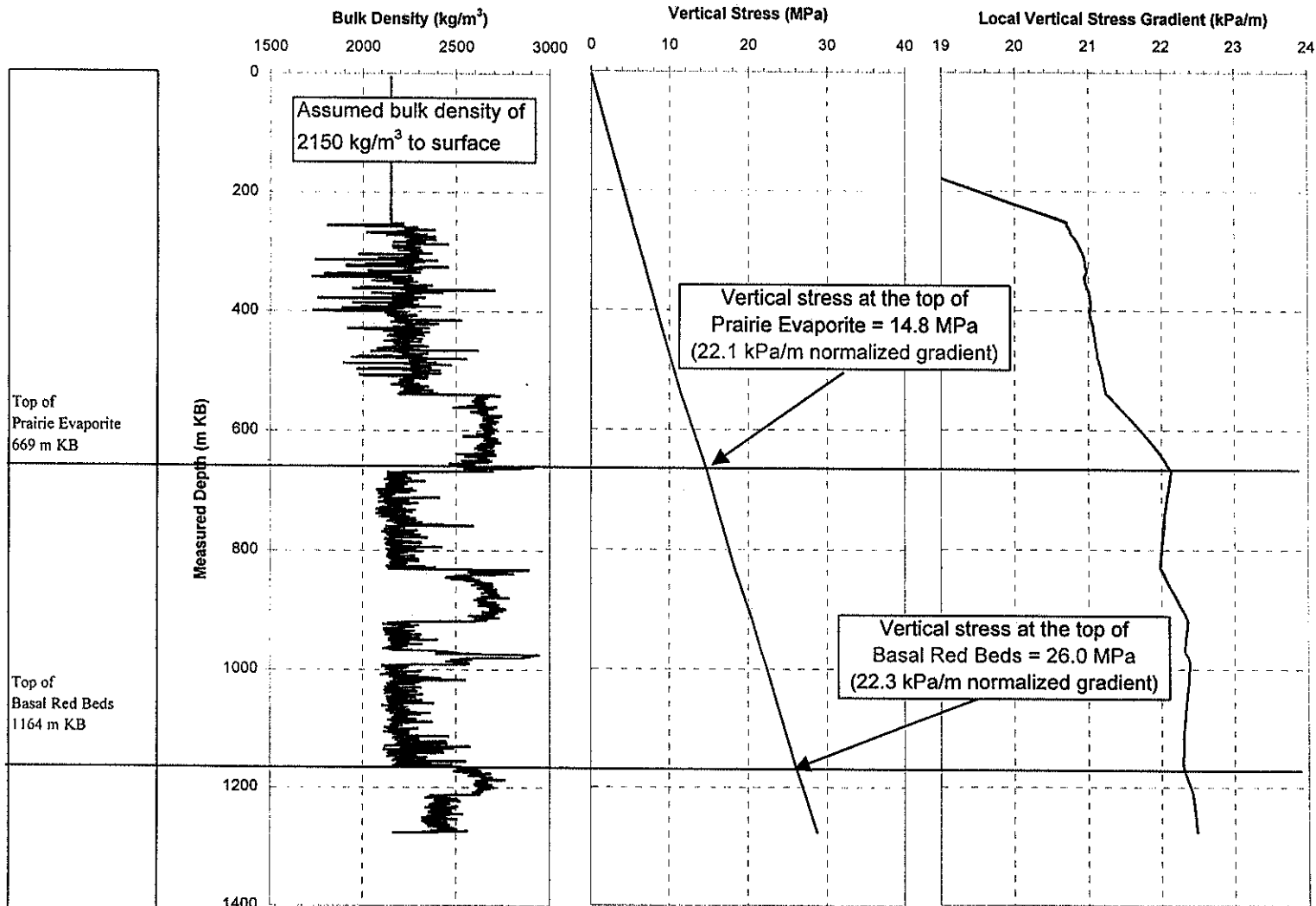


Figure D.1.19: Calculated vertical stress and vertical stress gradients for Esso 83 SWD Ethelk 11-22-64-3.

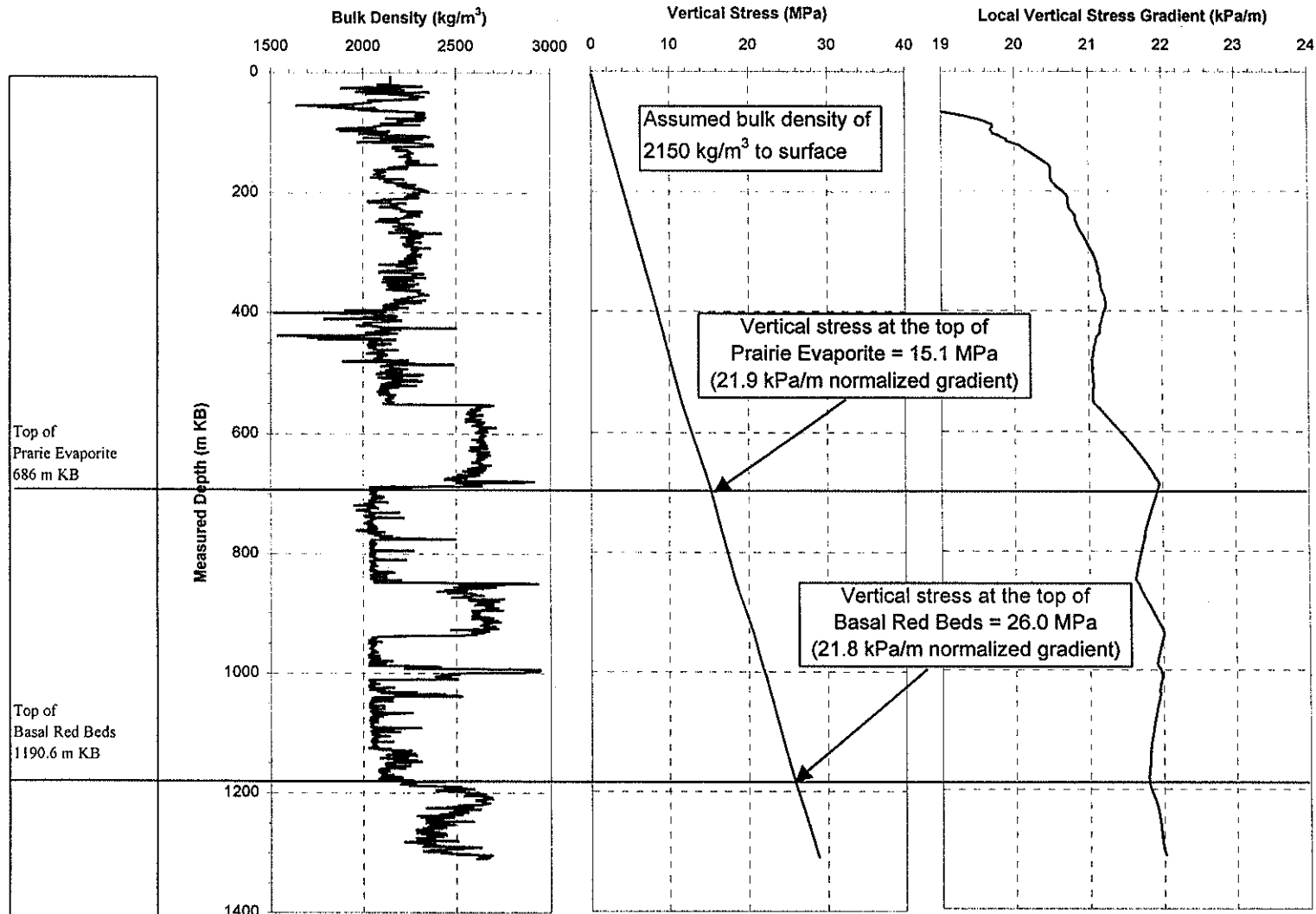


Figure D.1.20: Calculated vertical stress and vertical stress gradients for Esso 81 SWD Ethelk 3-29-64-3.

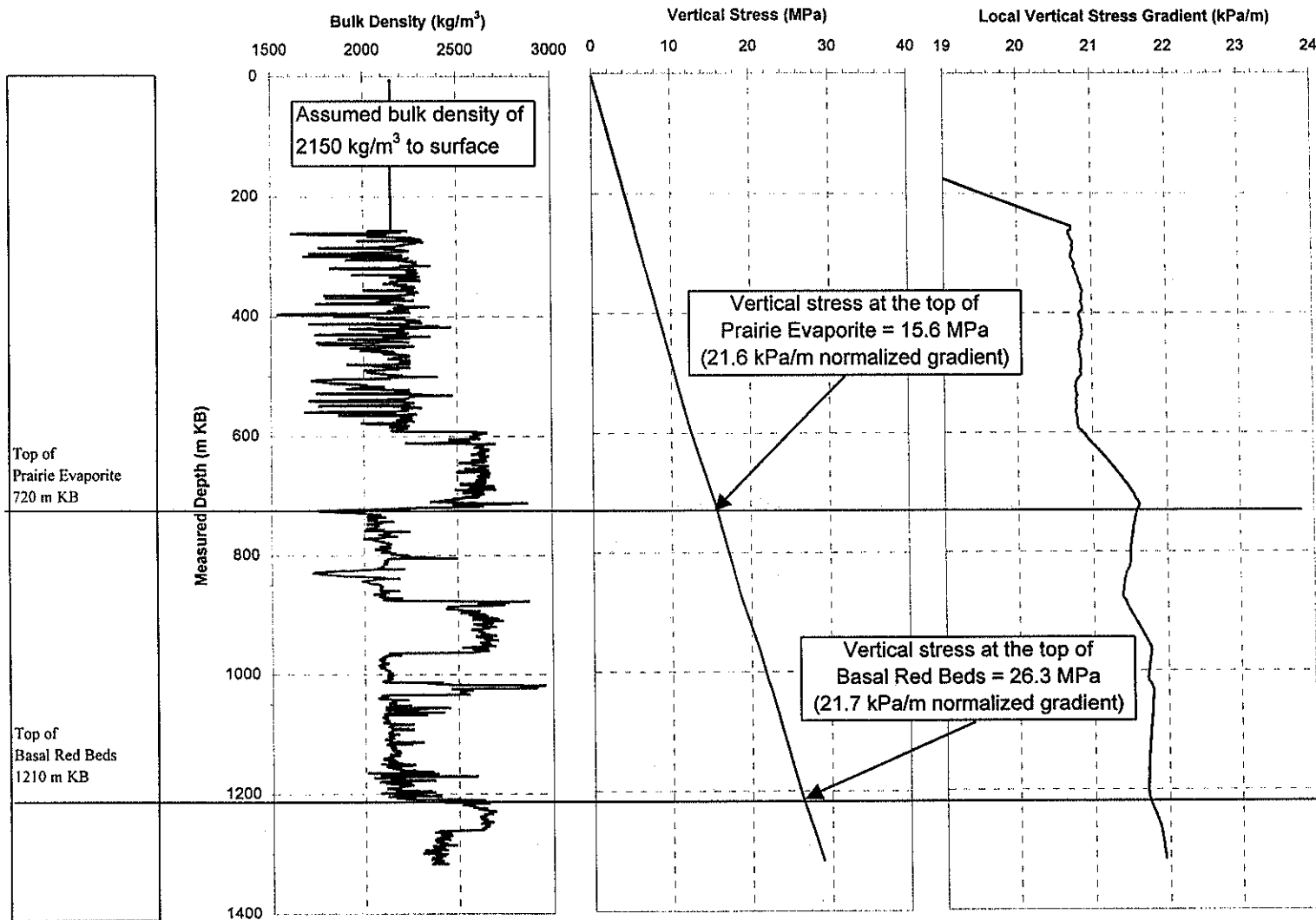


Figure D.1.21: Calculated vertical stress and vertical stress gradients for Esso 83 INJ Ethelk 8-33-64-3.

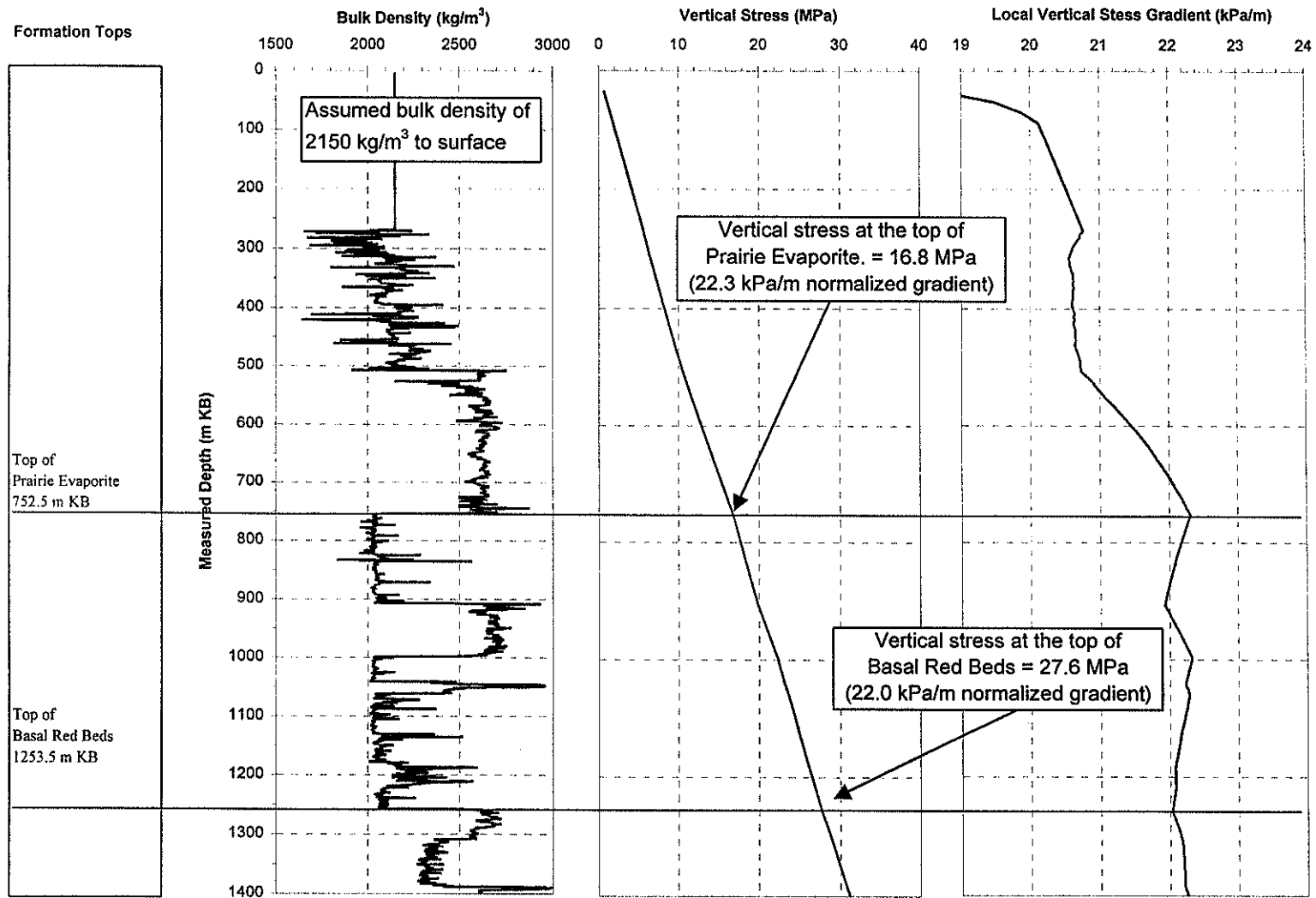


Figure D.1.22: Calculated vertical stress and vertical stress gradients for Mobil Garth 5-6-64-6.

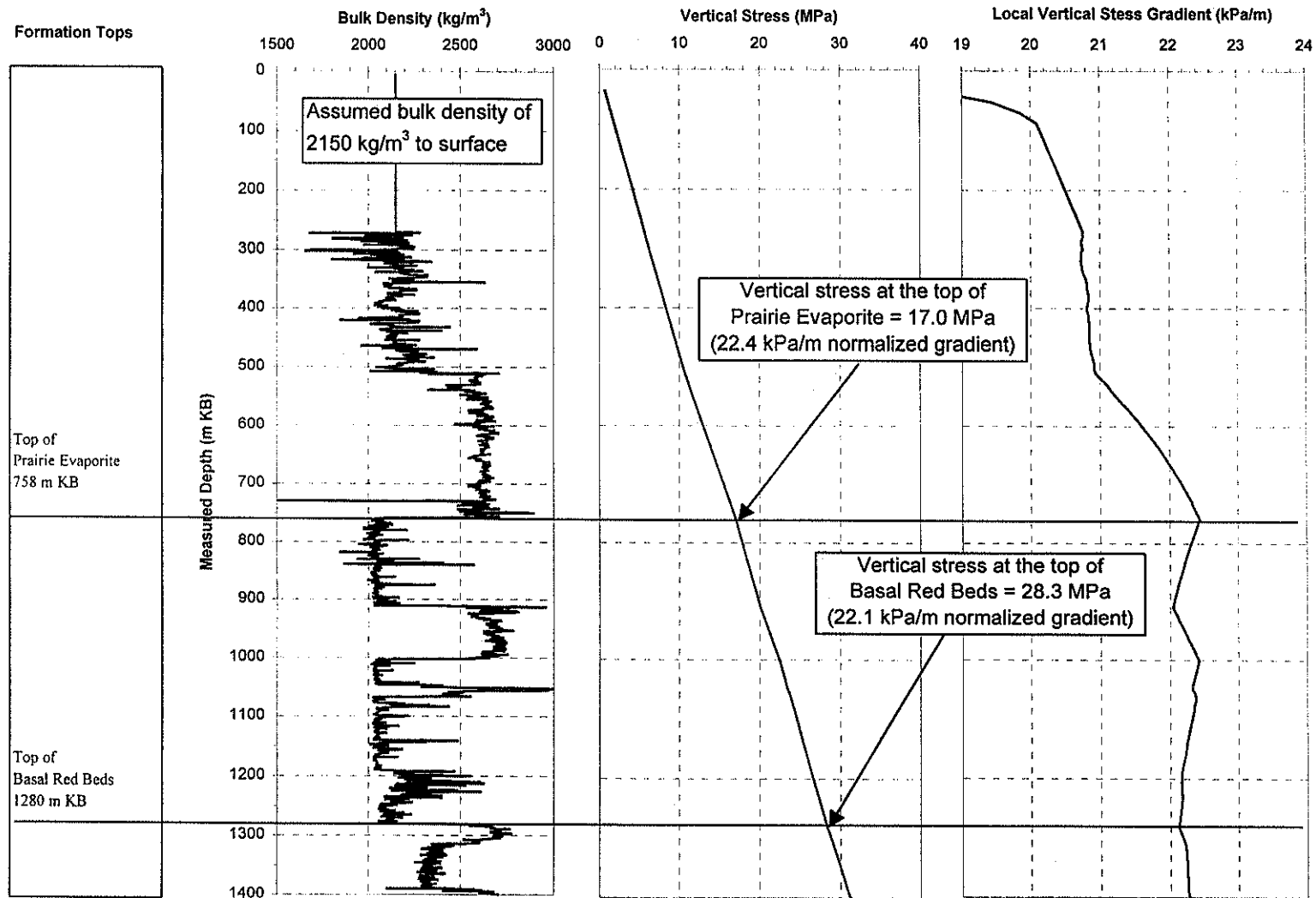


Figure D.1.23: Calculated vertical stress and vertical stress gradients for Mobil Garth 12-6-64-6.

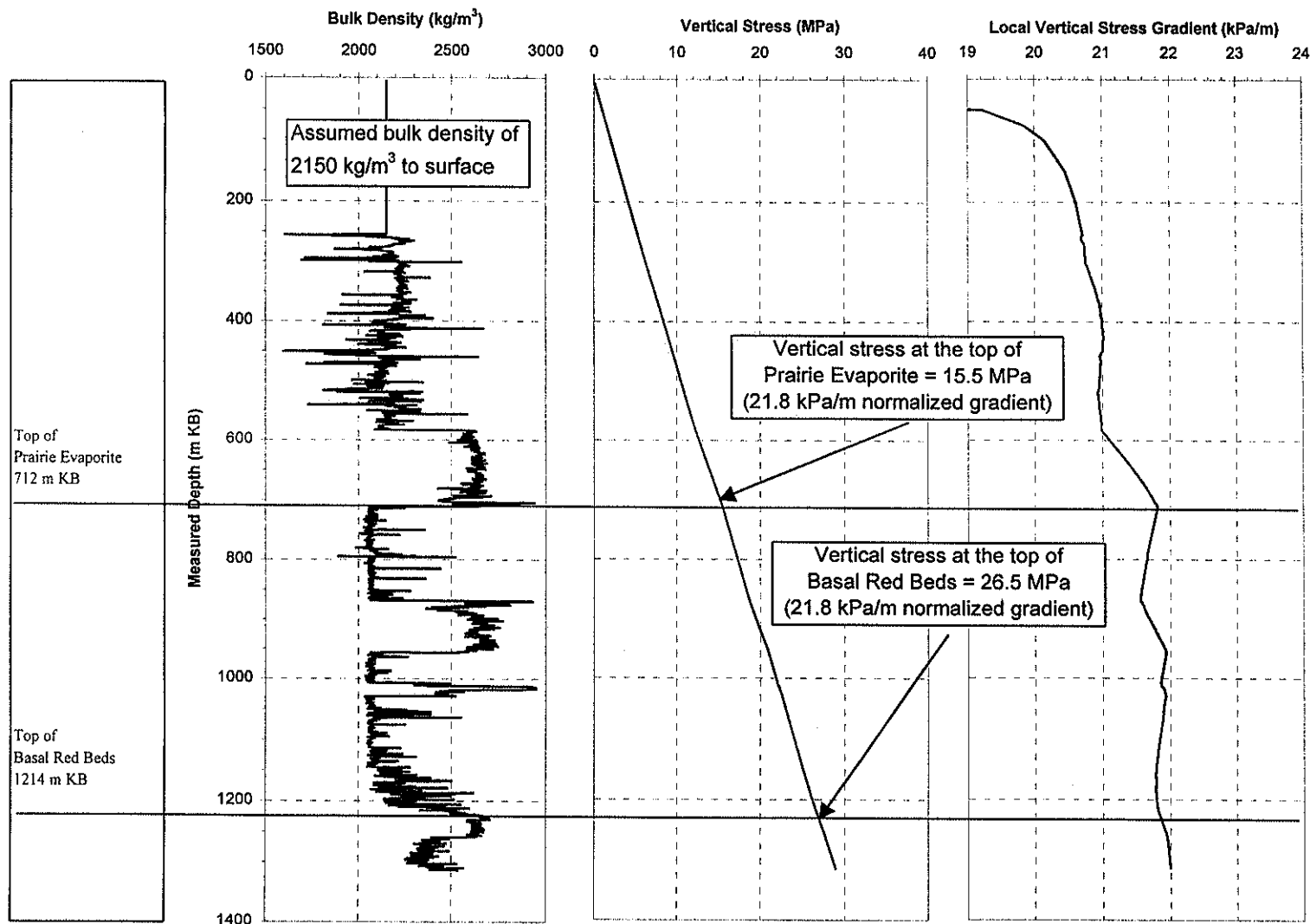


Figure D.1.24: Calculated vertical stress and vertical stress gradients for ESSO 83 SWD Ethellk 2-3-65-3.

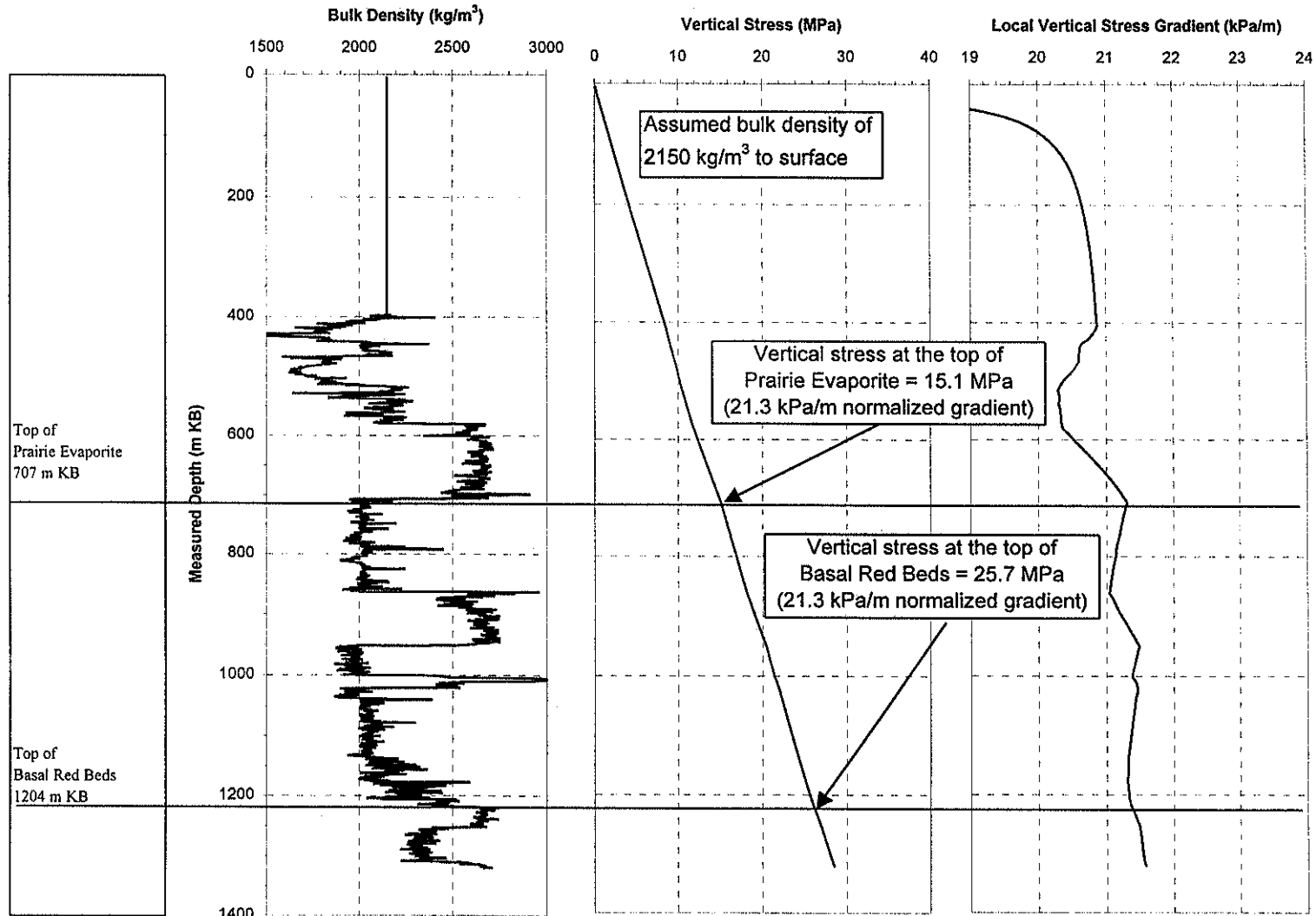


Figure D.1.25: Calculated vertical stress and vertical stress gradients for ESO SWD Ethelk 3-4-65-3.

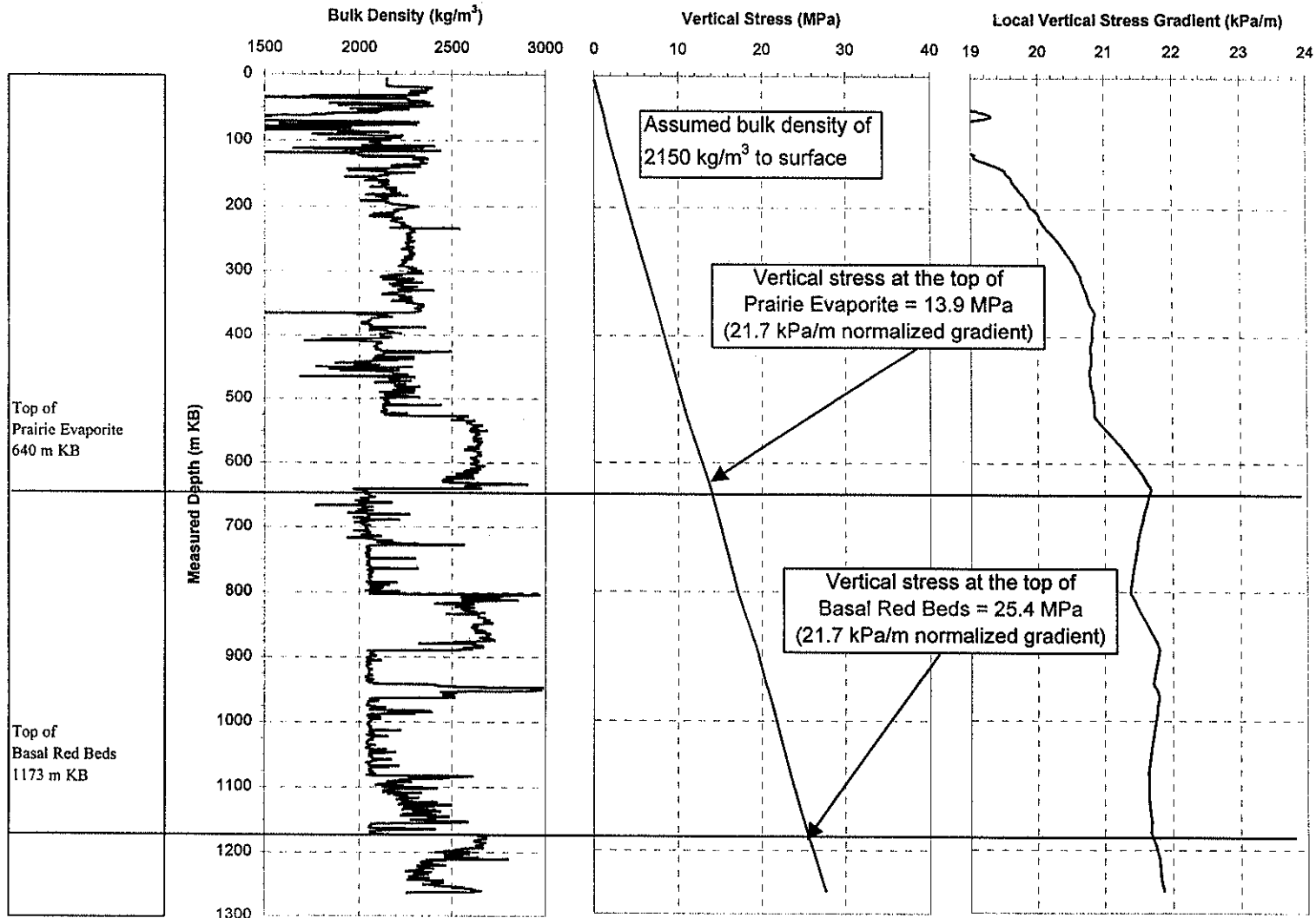


Figure D.1.26: Calculated vertical stress and vertical stress gradients for ESSO 81 Ethelk OV 9-20-65-3.

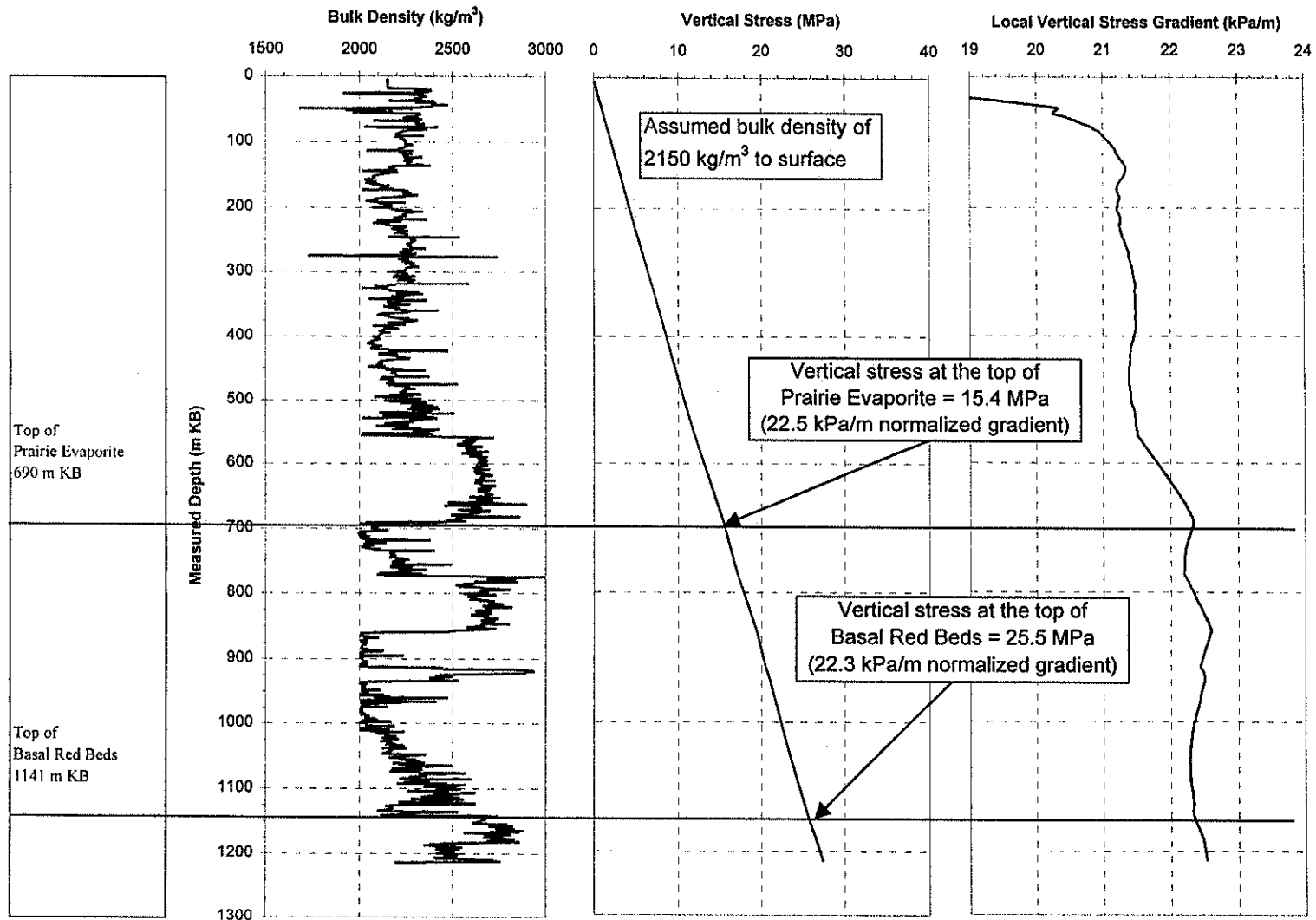


Figure D.1.27: Calculated vertical stress and vertical stress gradients for ESSO Medley OV 6-8-66-2.

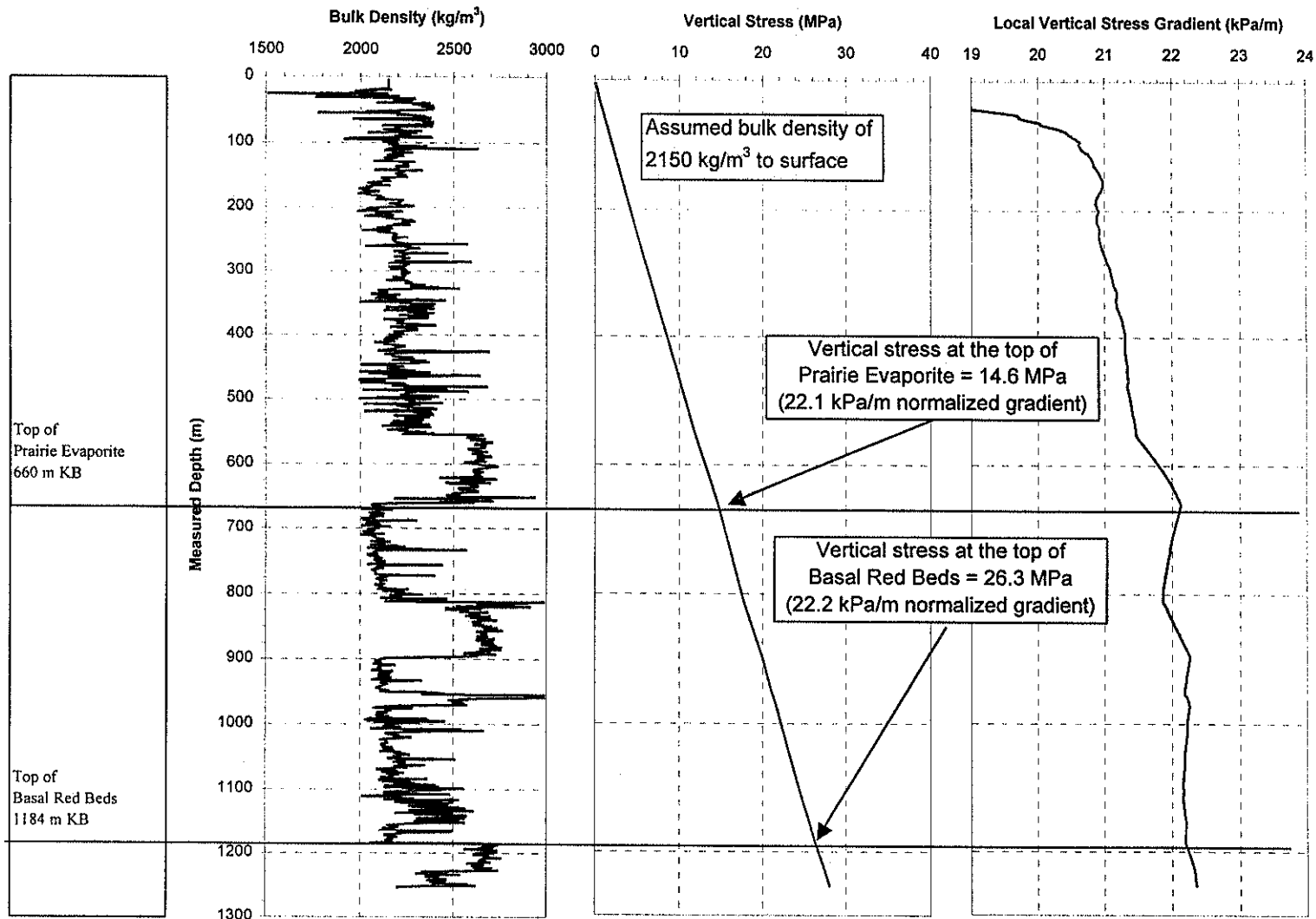


Figure D.1.28: Calculated vertical stress and vertical stress gradients for ESSO Medley OV 14-28-66-3.

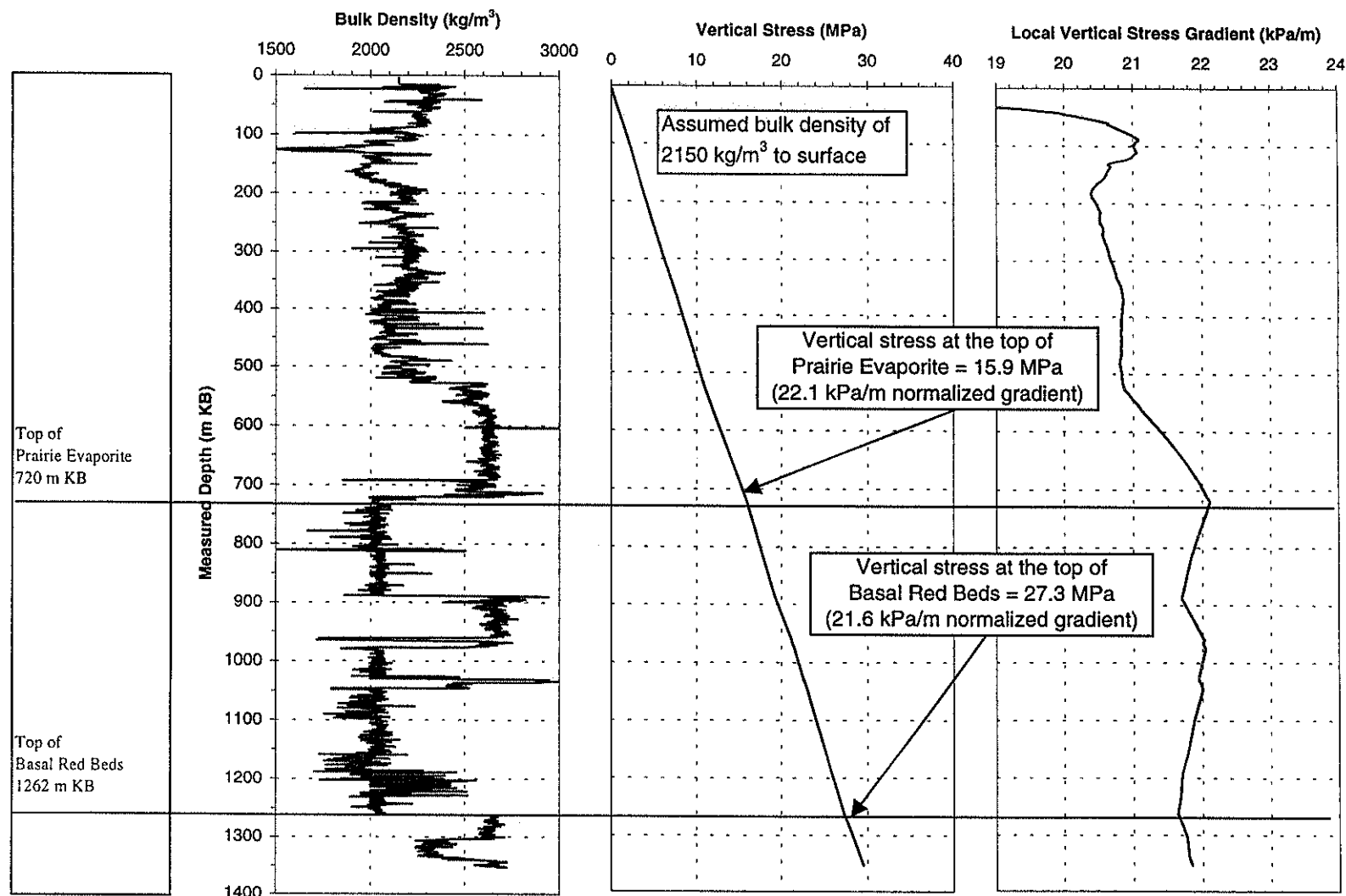


Figure D.1.29: Calculated vertical stress and vertical stress gradients for BP PCI Marglk 10-8-66-5.

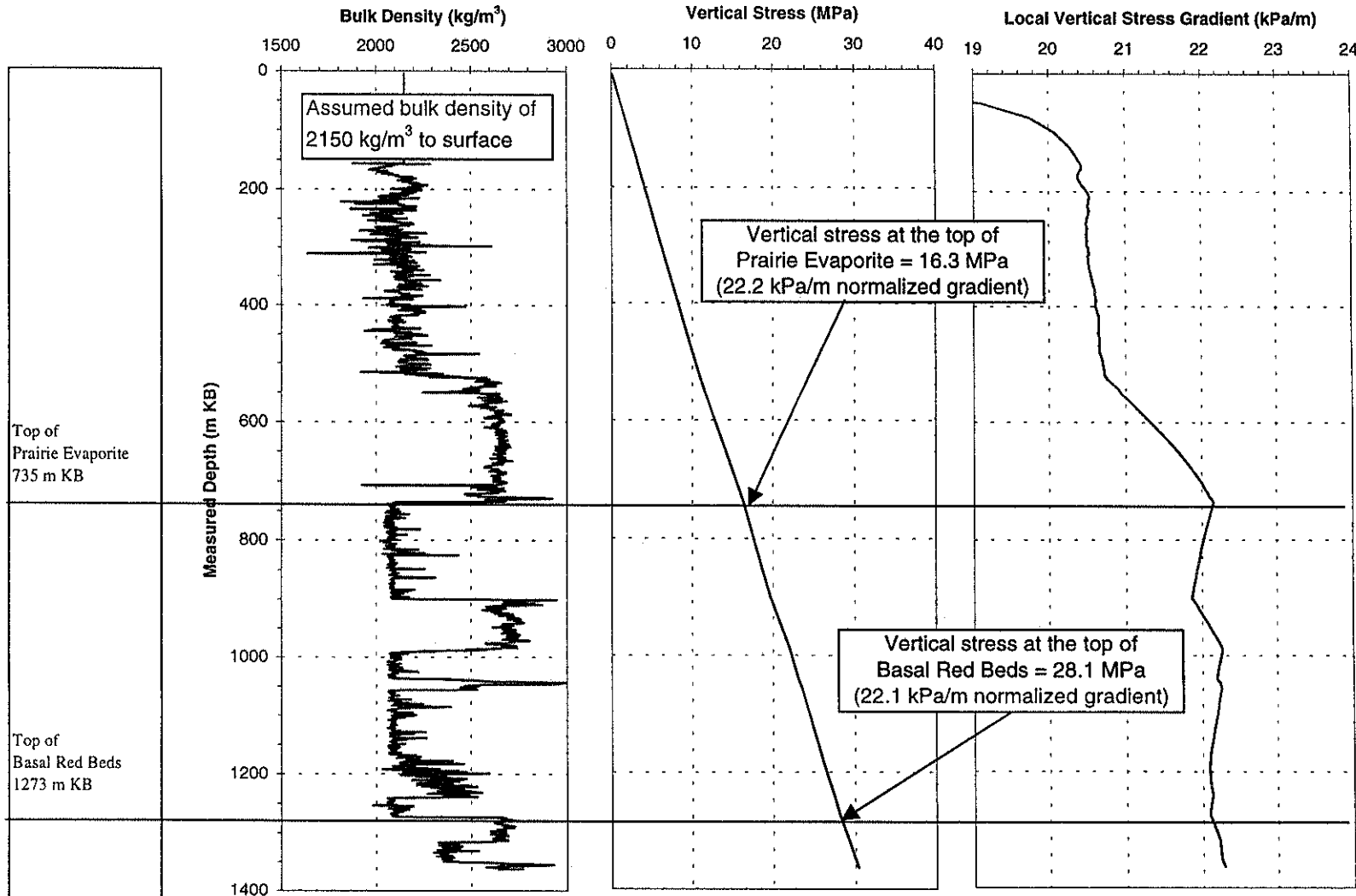


Figure D.1.30: Calculated vertical stress and vertical stress gradients for BP Leming 10-10-66-6.

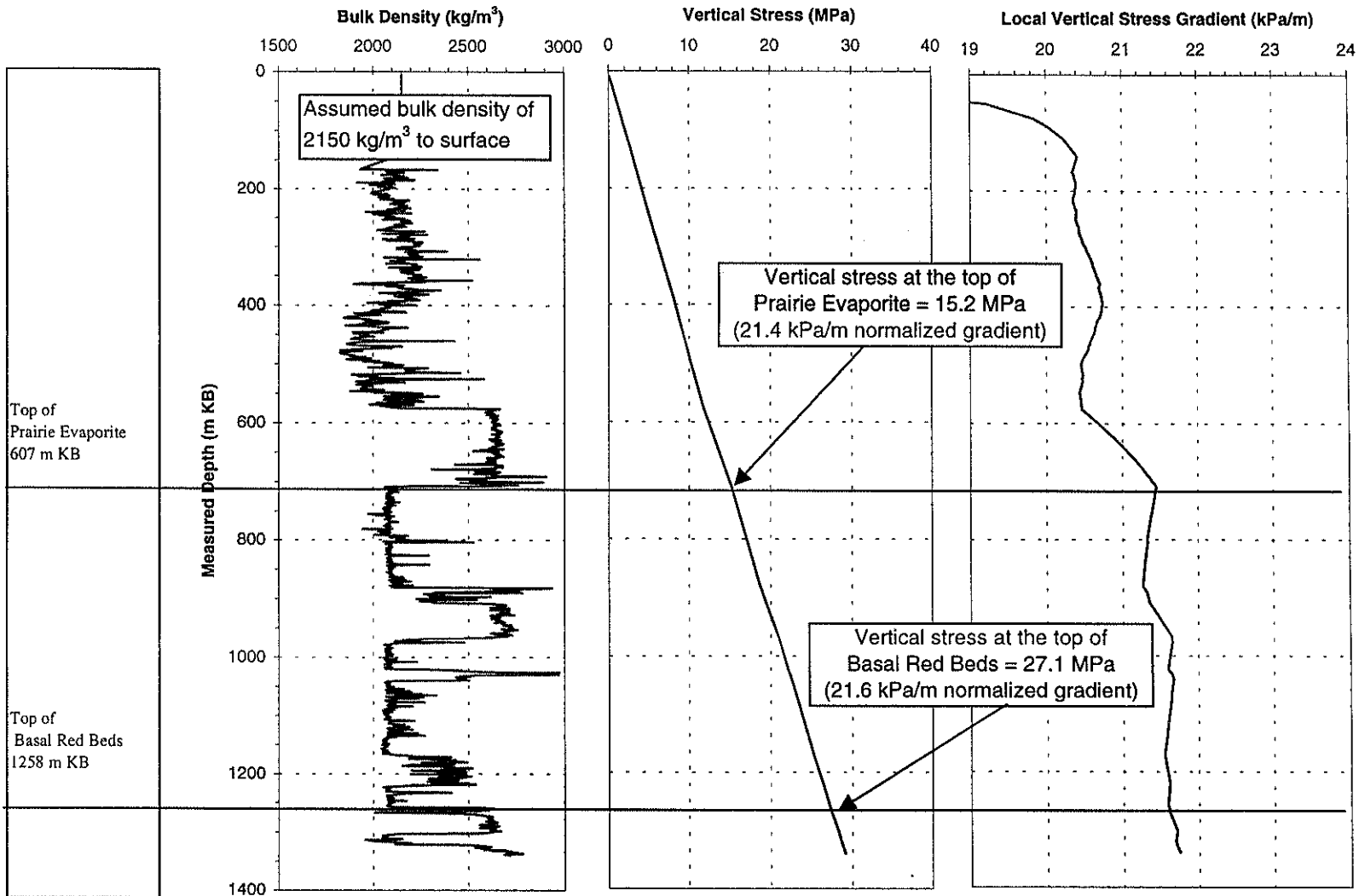


Figure D.1.31: Calculated vertical stress and vertical stress gradients for Amoco 10B4 Moore 10-5-67-4.

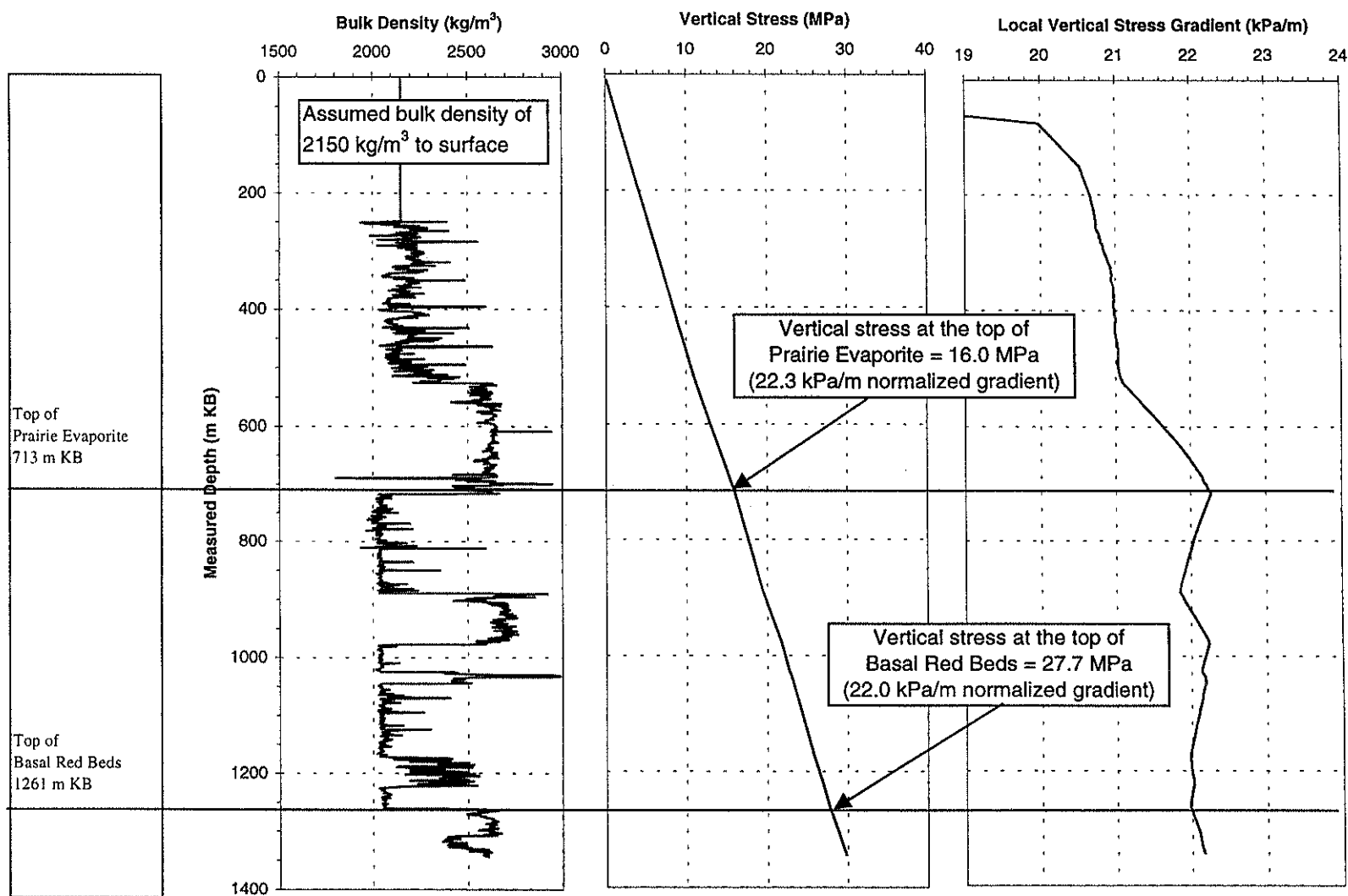


Figure D.1.32: Calculated vertical stress and vertical stress gradients for Esso AEC 85 Fishck 7-11-67-6.

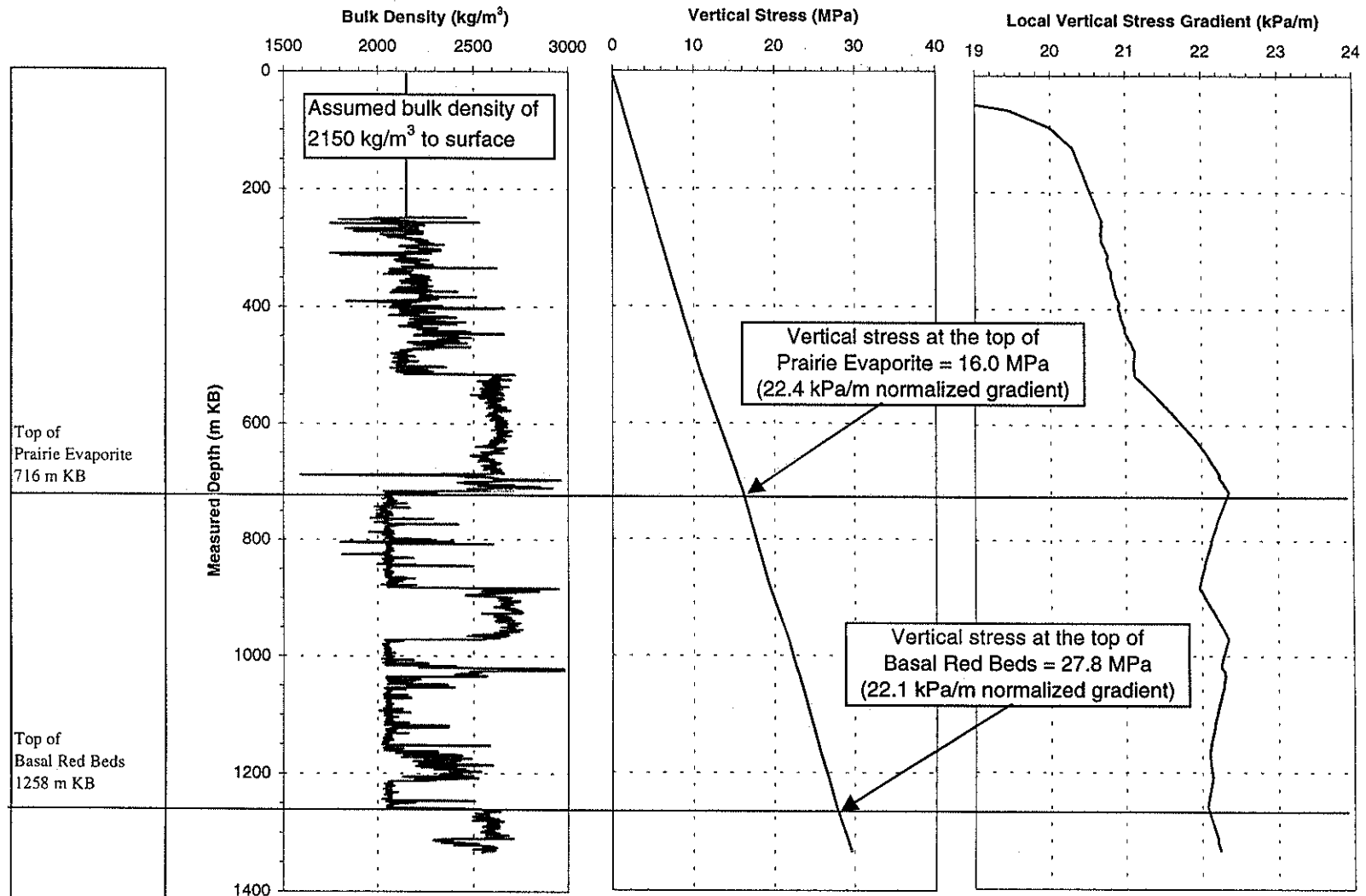


Figure D.1.33: Calculated vertical stress and vertical stress gradients for Esso AEC 85 Fishck 12-31-67-7.

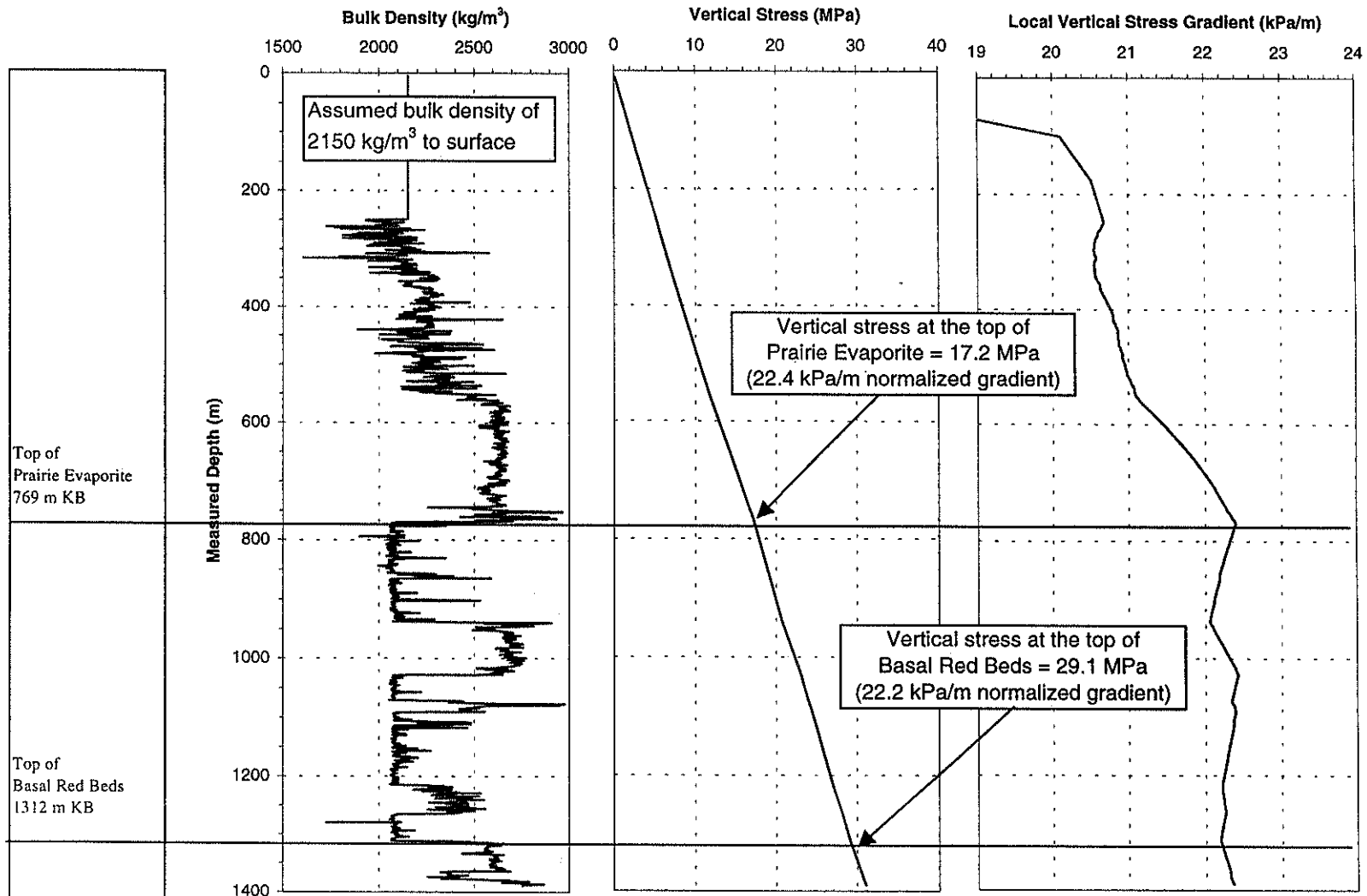


Figure D.1.34: Calculated vertical stress and vertical stress gradients for Esso AEC 85 Fishck 7-34-67-8.

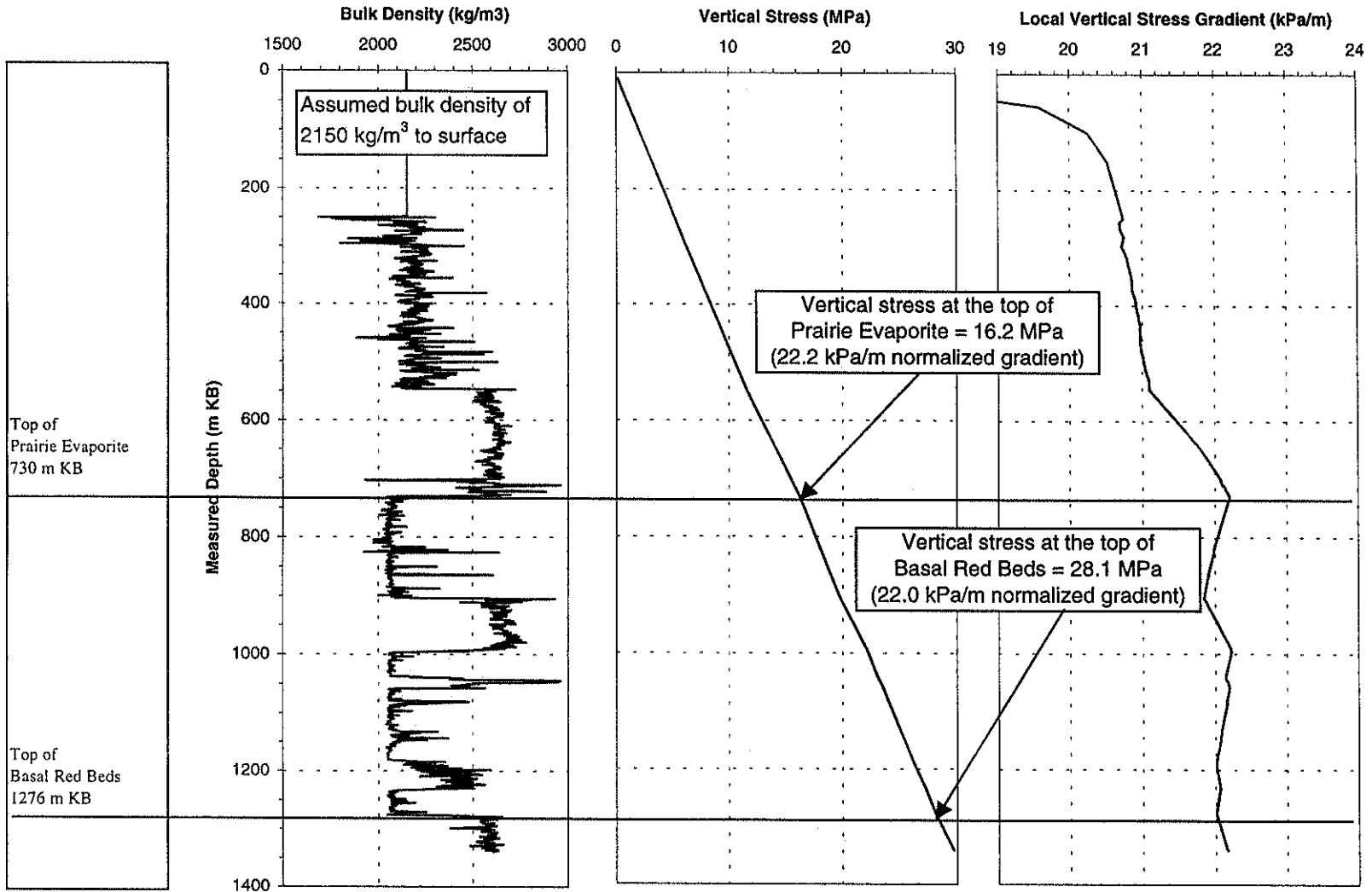


Figure D.1.35: Calculated vertical stress and vertical stress gradients for ESSO AEC 85 FISHCK 11-19-68-6.

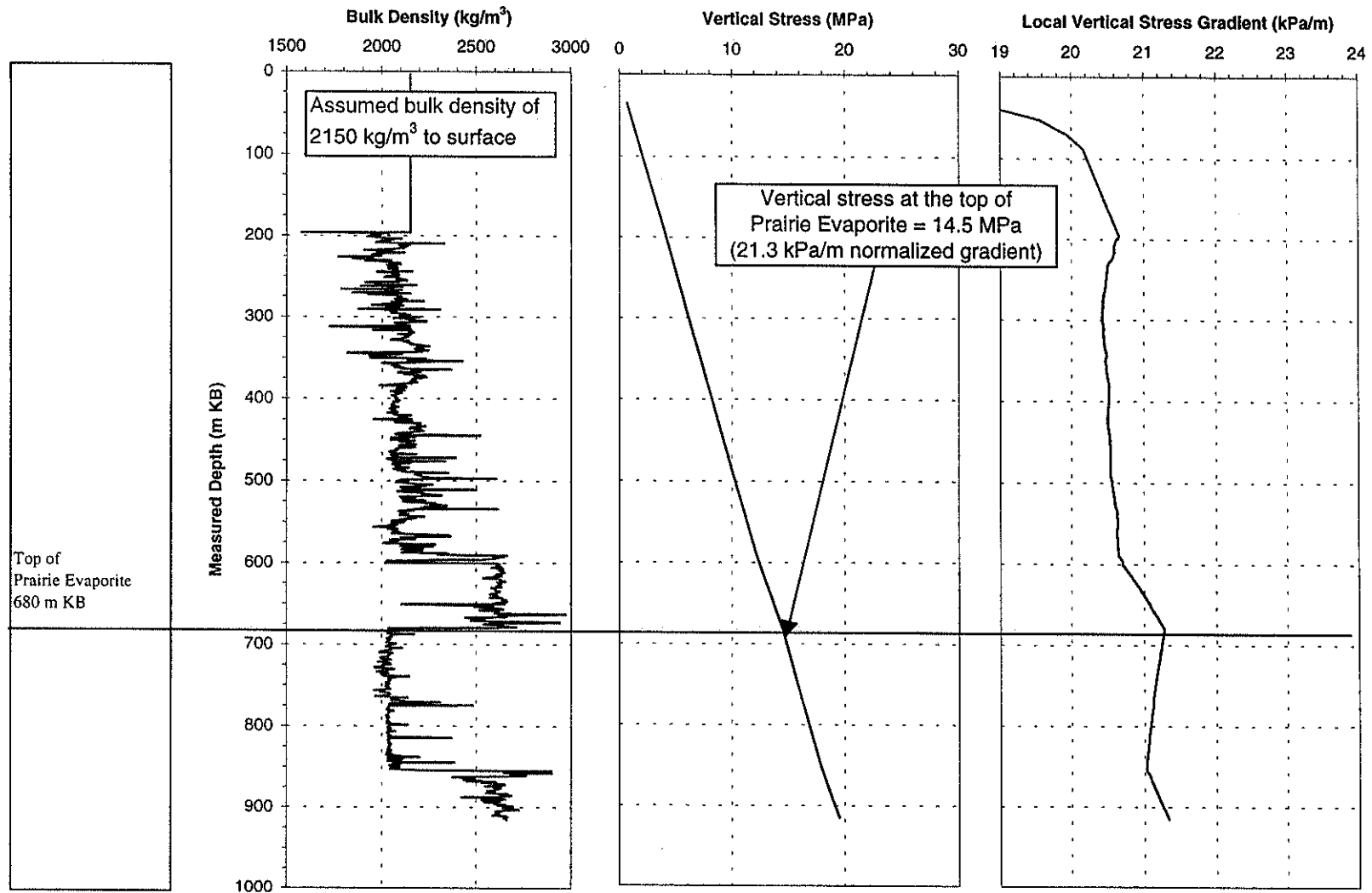


Figure D.1.36: Calculated vertical stress and vertical stress gradients for AECOG (NE) Fisher 8D-12-69-5.

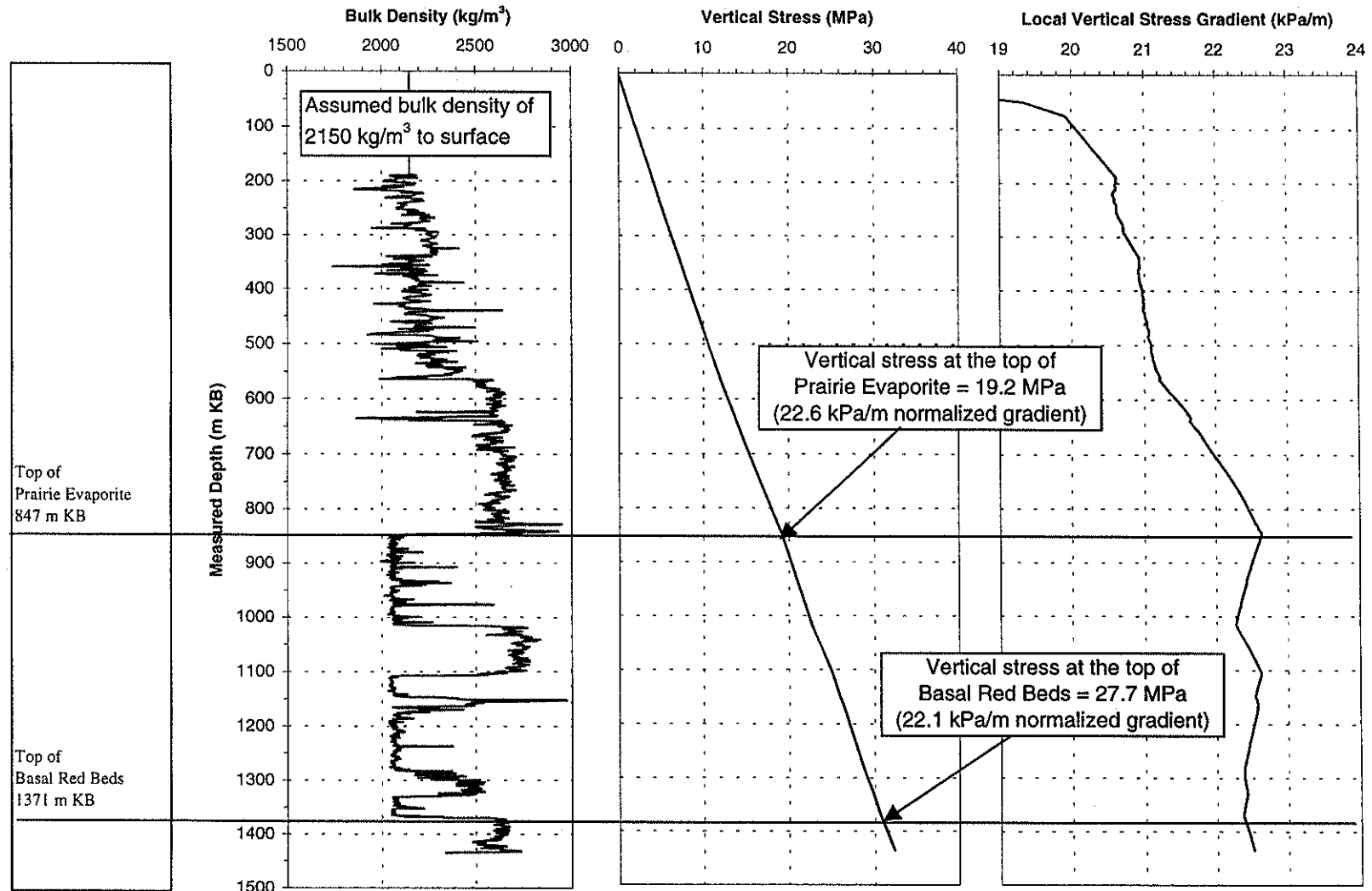


Figure D.1.37: Calculated vertical stress and vertical stress gradients for Arco Heart Lake 11-26-69-10.

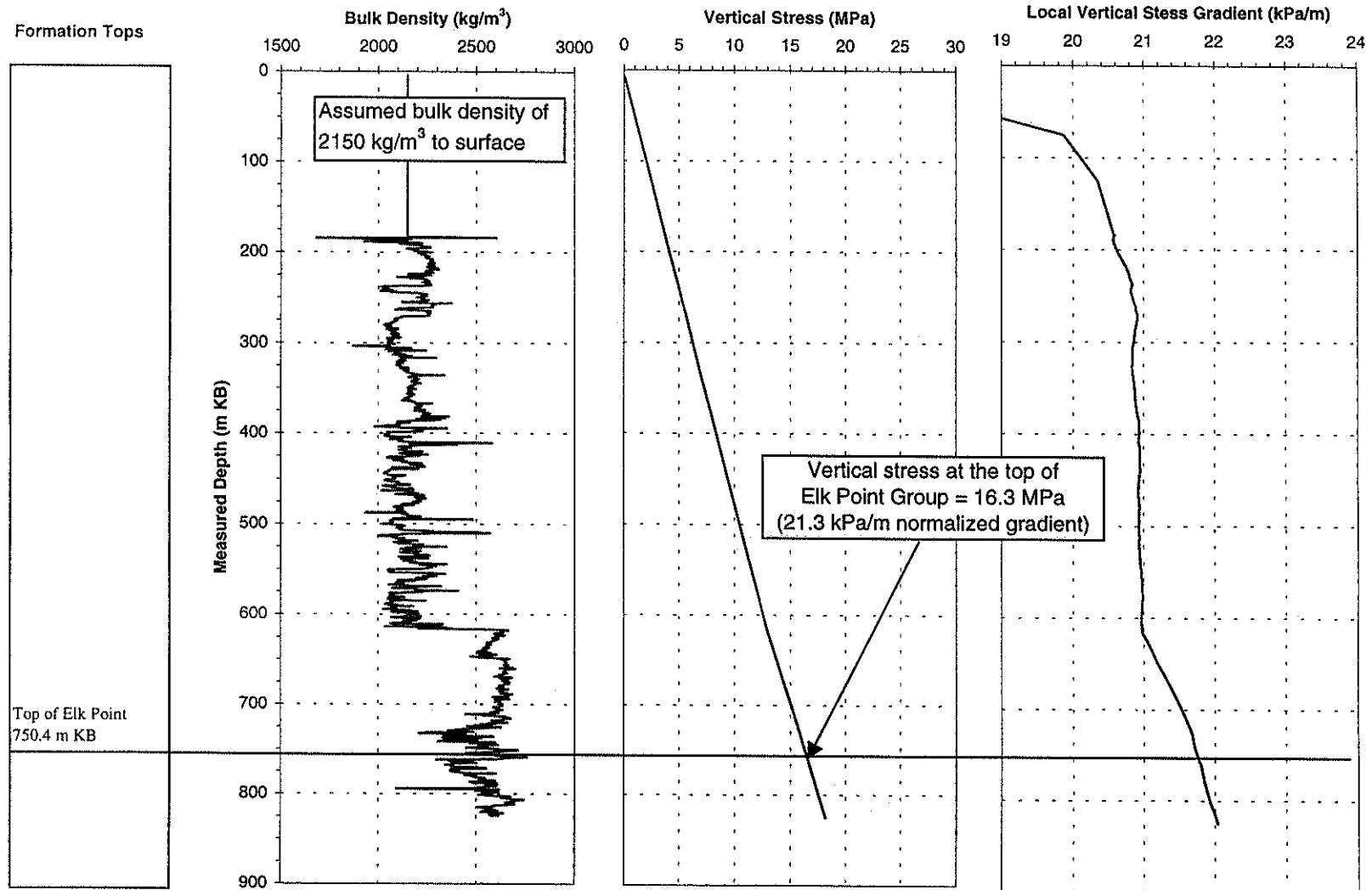


Figure D.1.38: Calculated vertical stress and vertical stress gradients for AEC et al Scheltens 16-13-71-1.

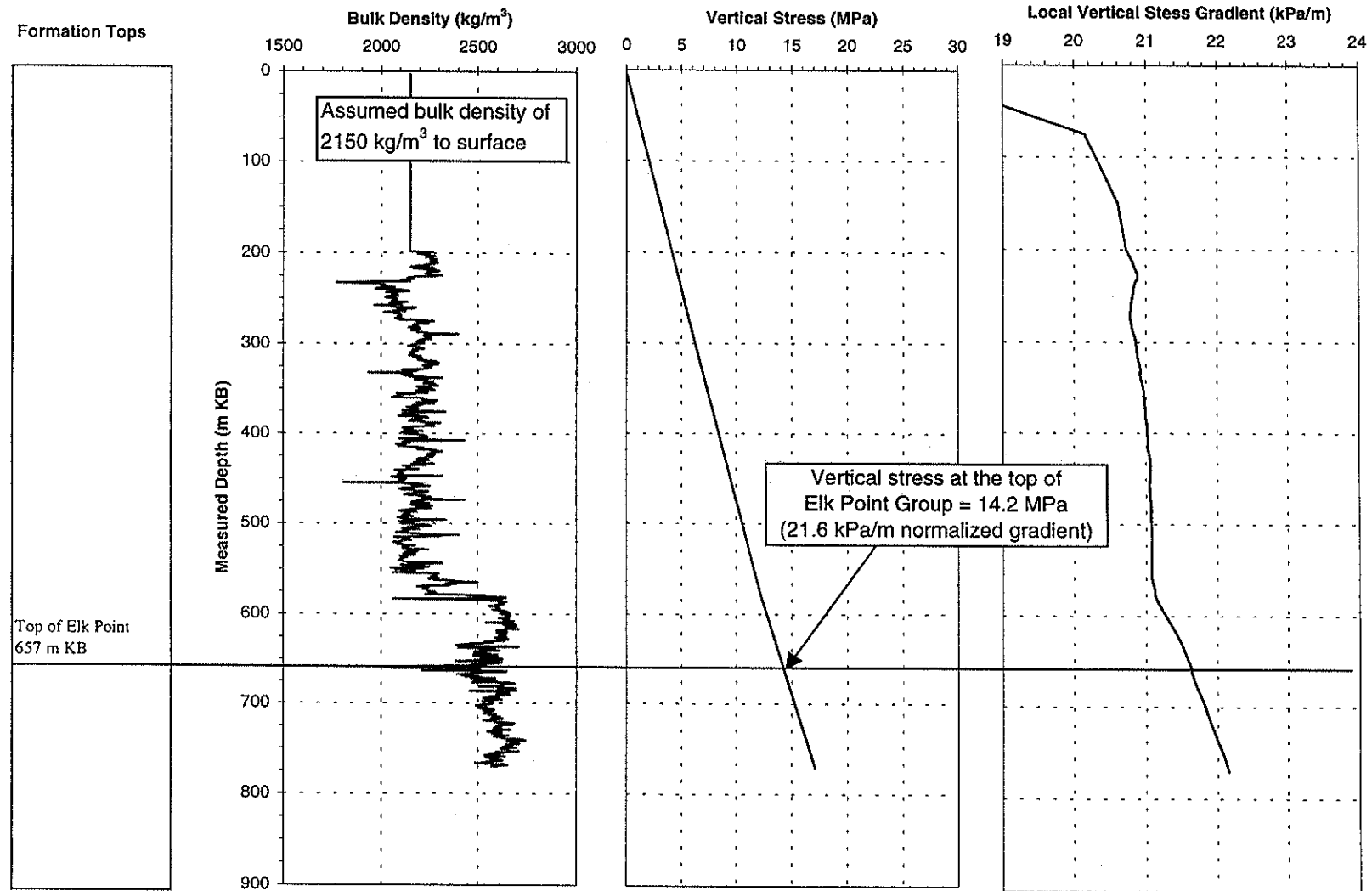


Figure D.1.39: Calculated vertical stress and vertical stress gradients for AEC Foster Creek 16-36-72-1.

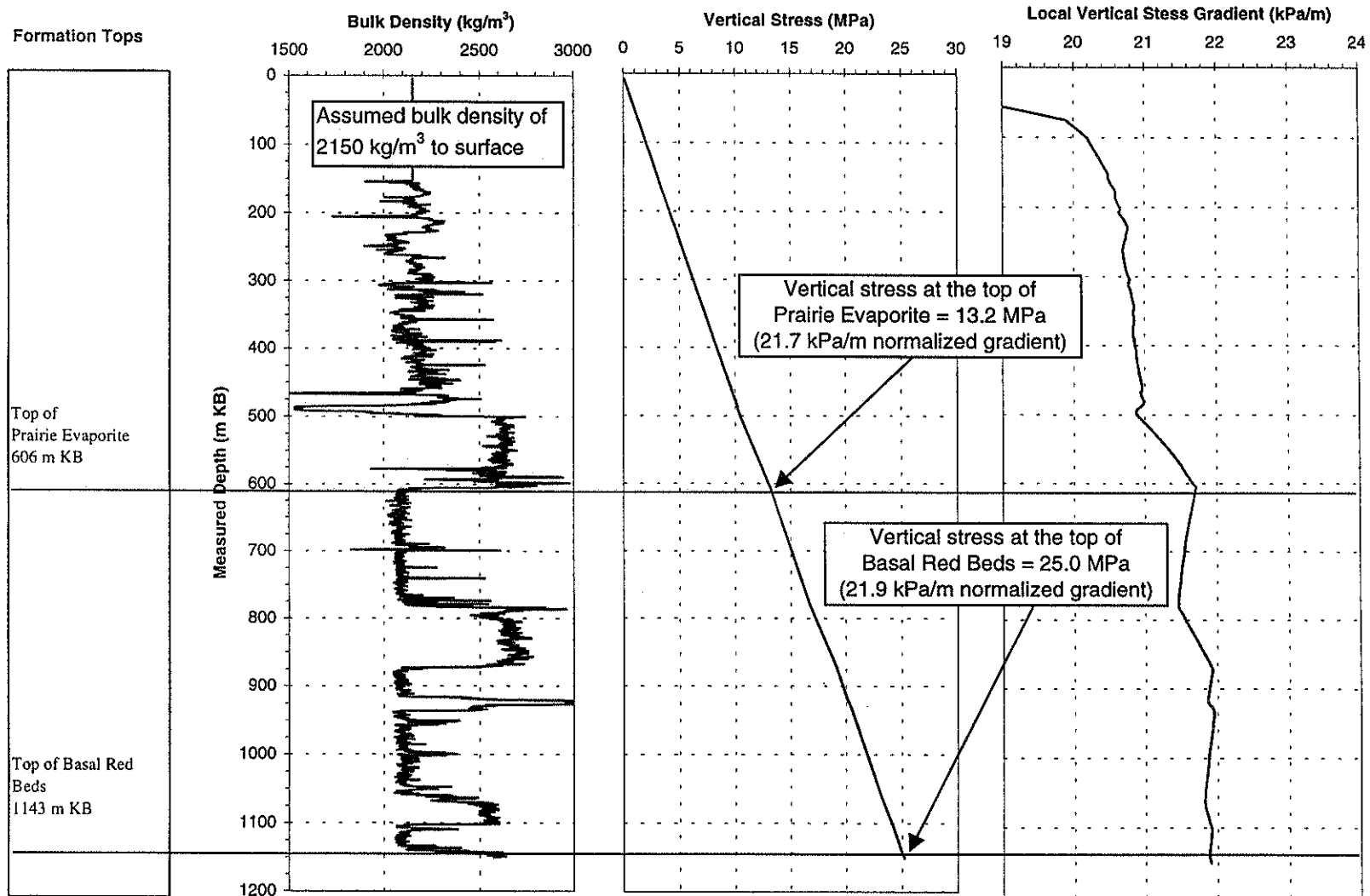


Figure D.1.40: Calculated vertical stress and vertical stress gradients for Amoco AEC Kirby 5-21-71-4.

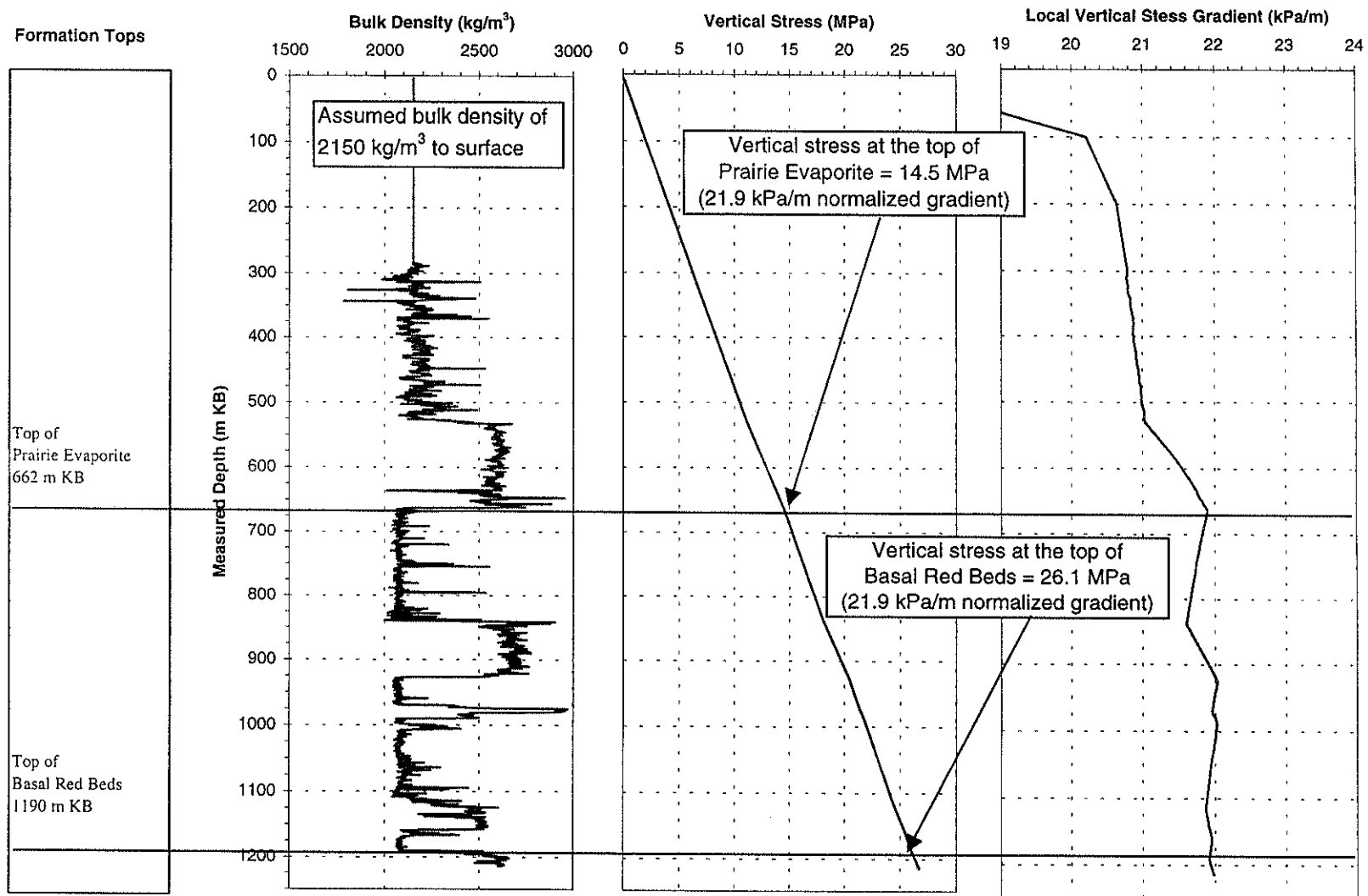


Figure D.1.41: Calculated vertical stress and vertical stress gradients for Amoco AEC Ipiatik 6-30-71-5.

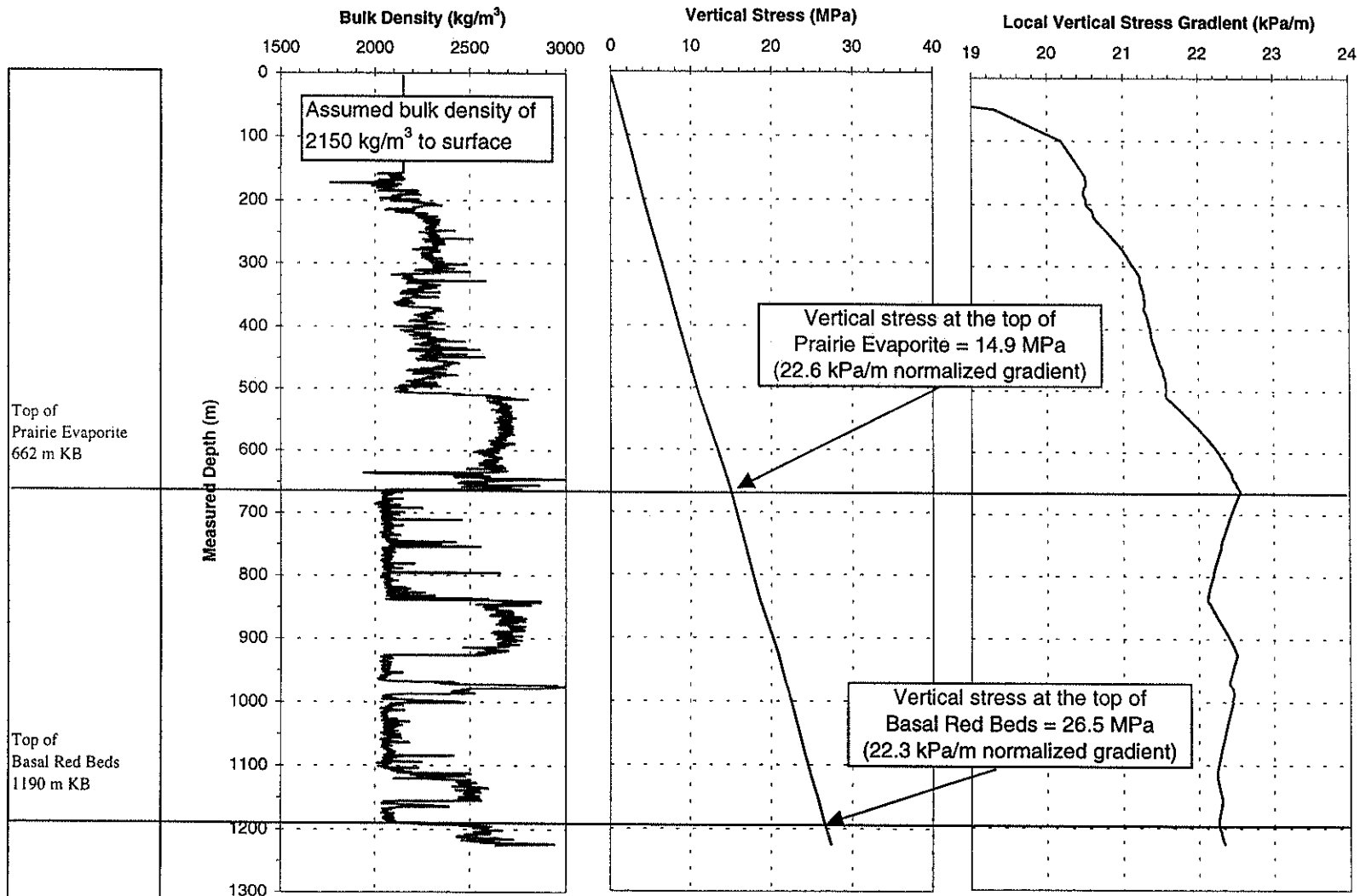


Figure D.1.42: Calculated vertical stress and vertical stress gradients for Amoco AEC Ipiatik Grist 10-17-71-6.

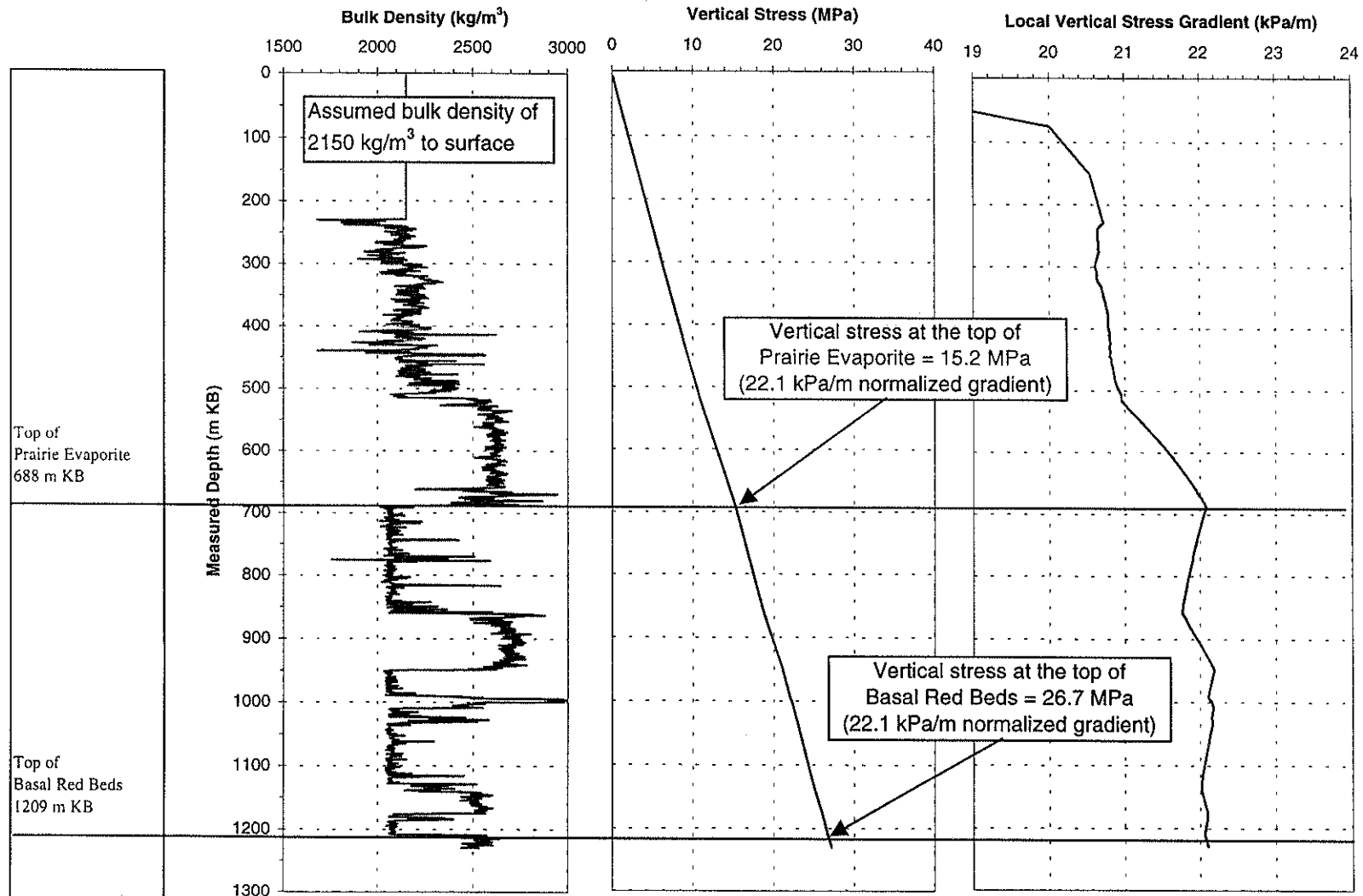


Figure D.1.43: Calculated vertical stress and vertical stress gradients for AEC Phillips Wiau 10-26-71-7.

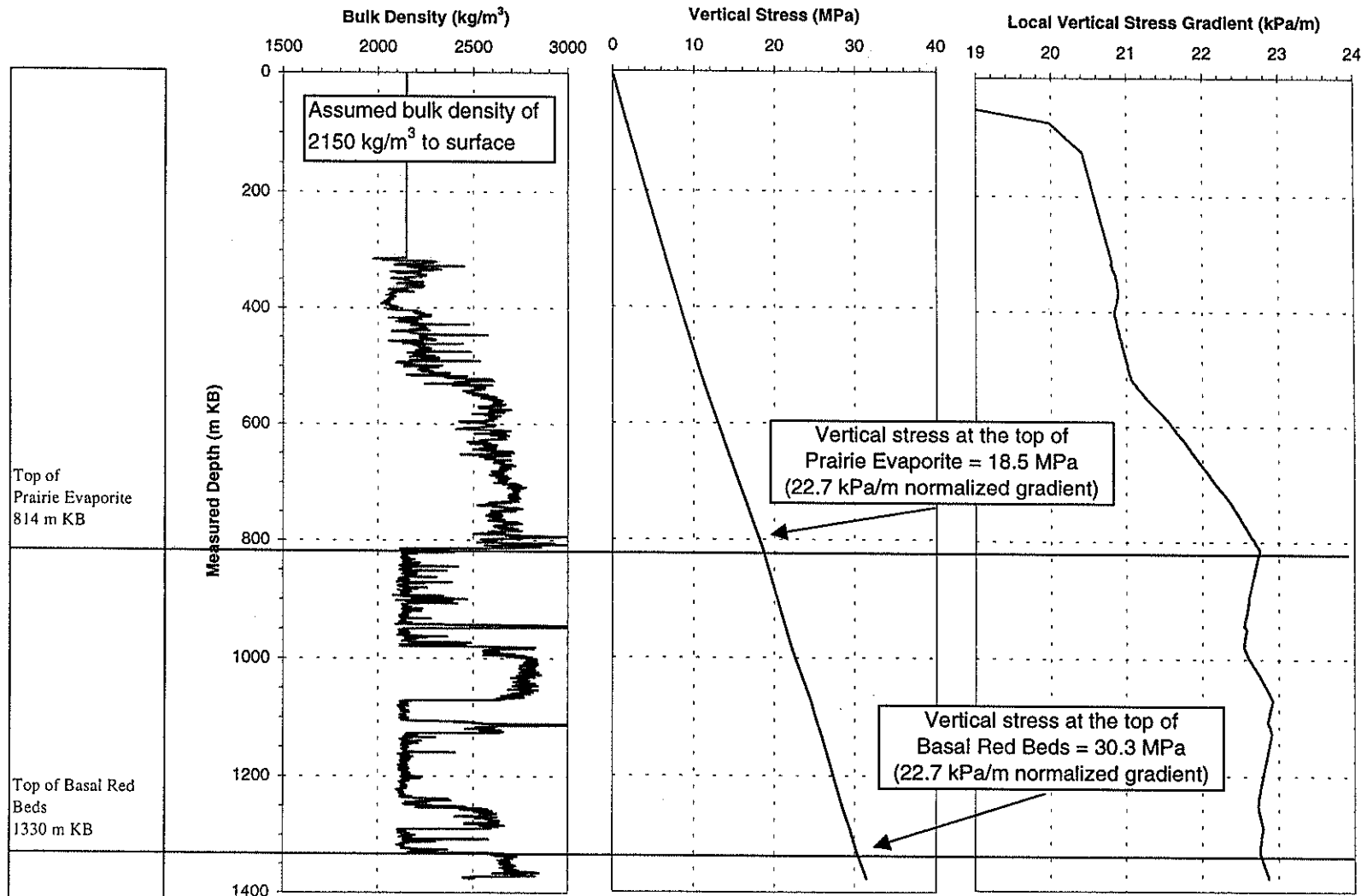


Figure D.1.44: Calculated vertical stress and vertical stress gradients for Rax et al Mills 7-12-71-11.

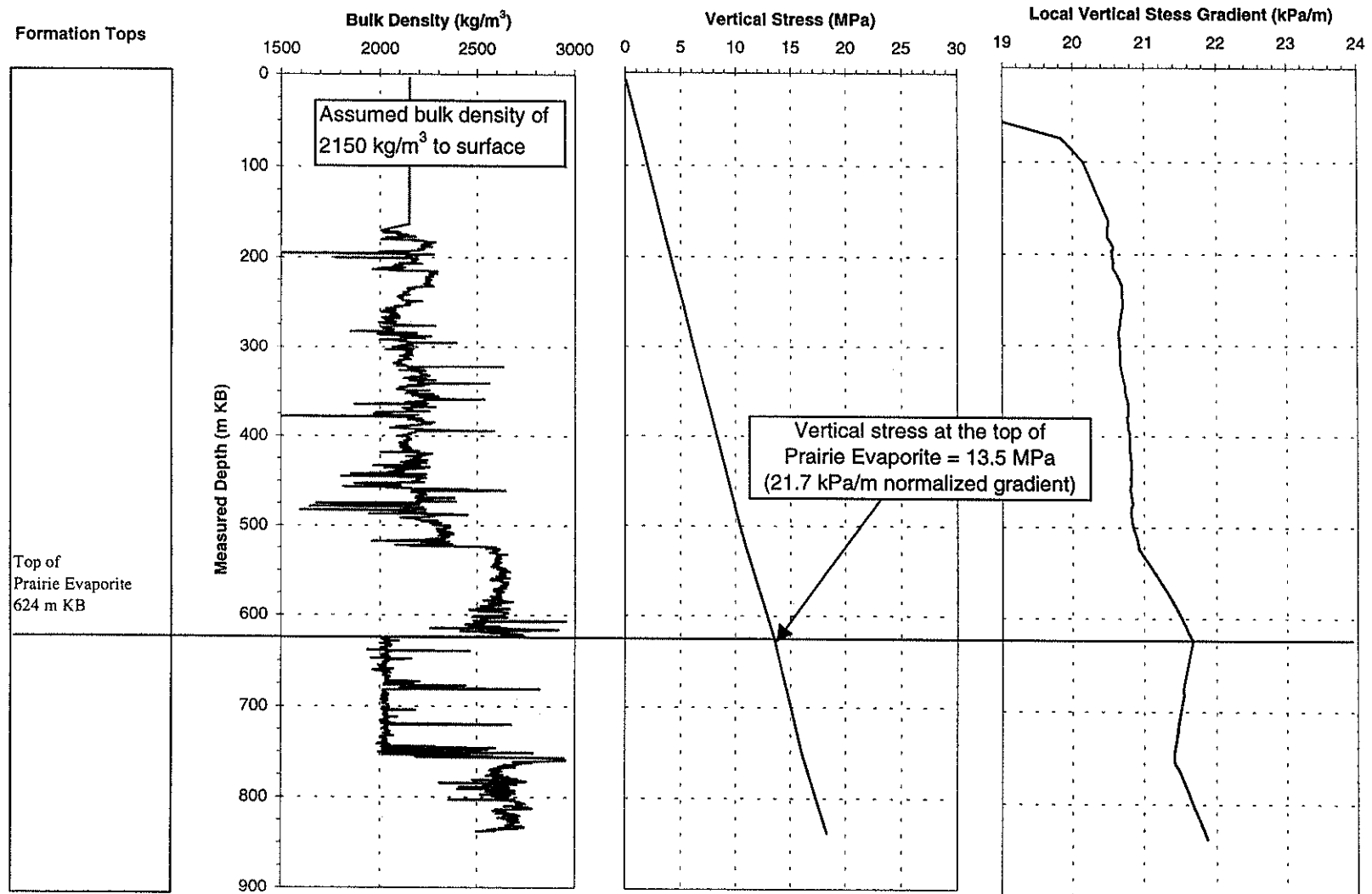


Figure D.1.45: Calculated vertical stress and vertical stress gradients for AEC Foster Creek 7-7-72-3.

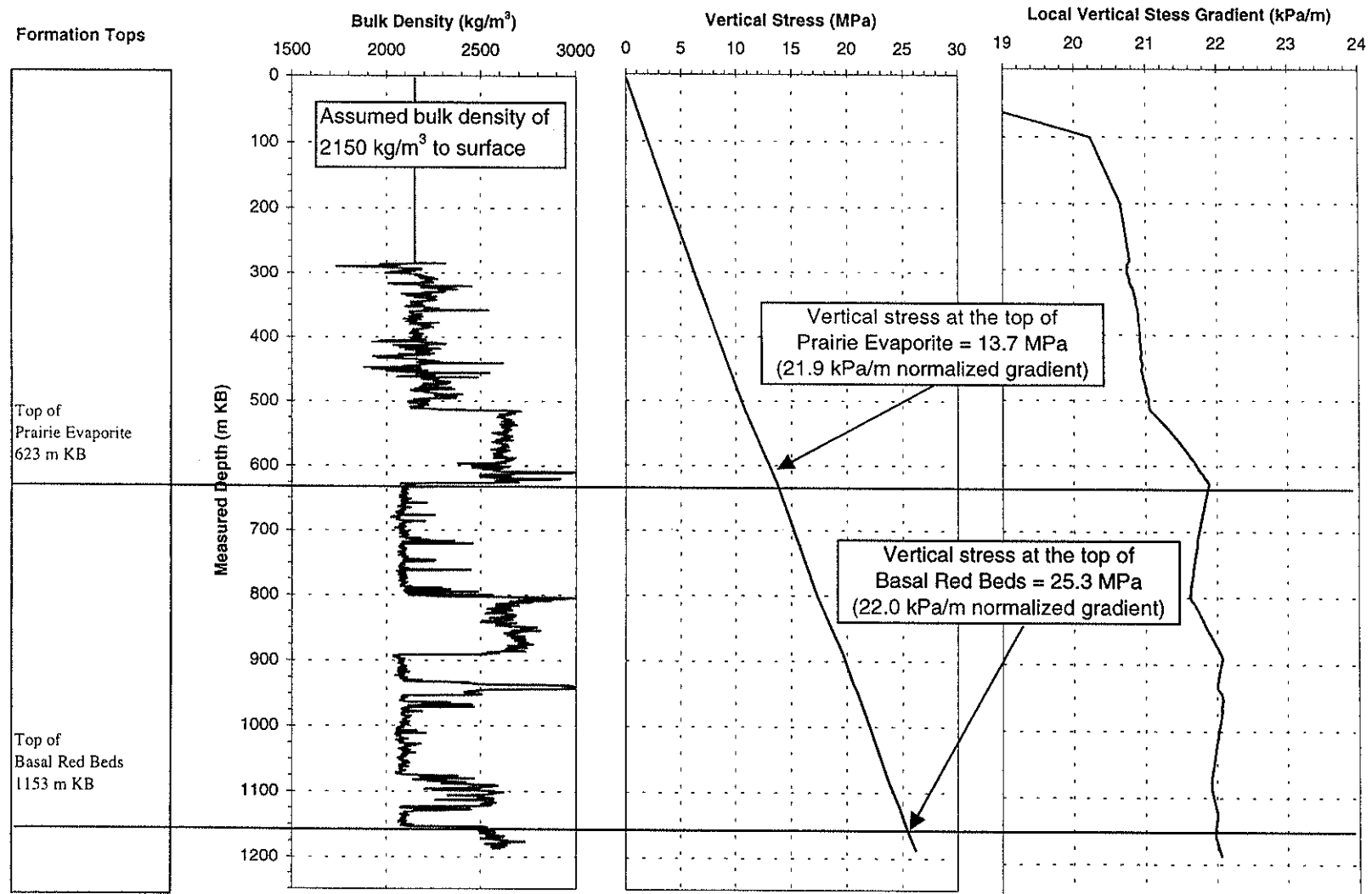


Figure D.1.46: Calculated vertical stress and vertical stress gradients for Amoco AEC Ipiatik 11-18-72-4.

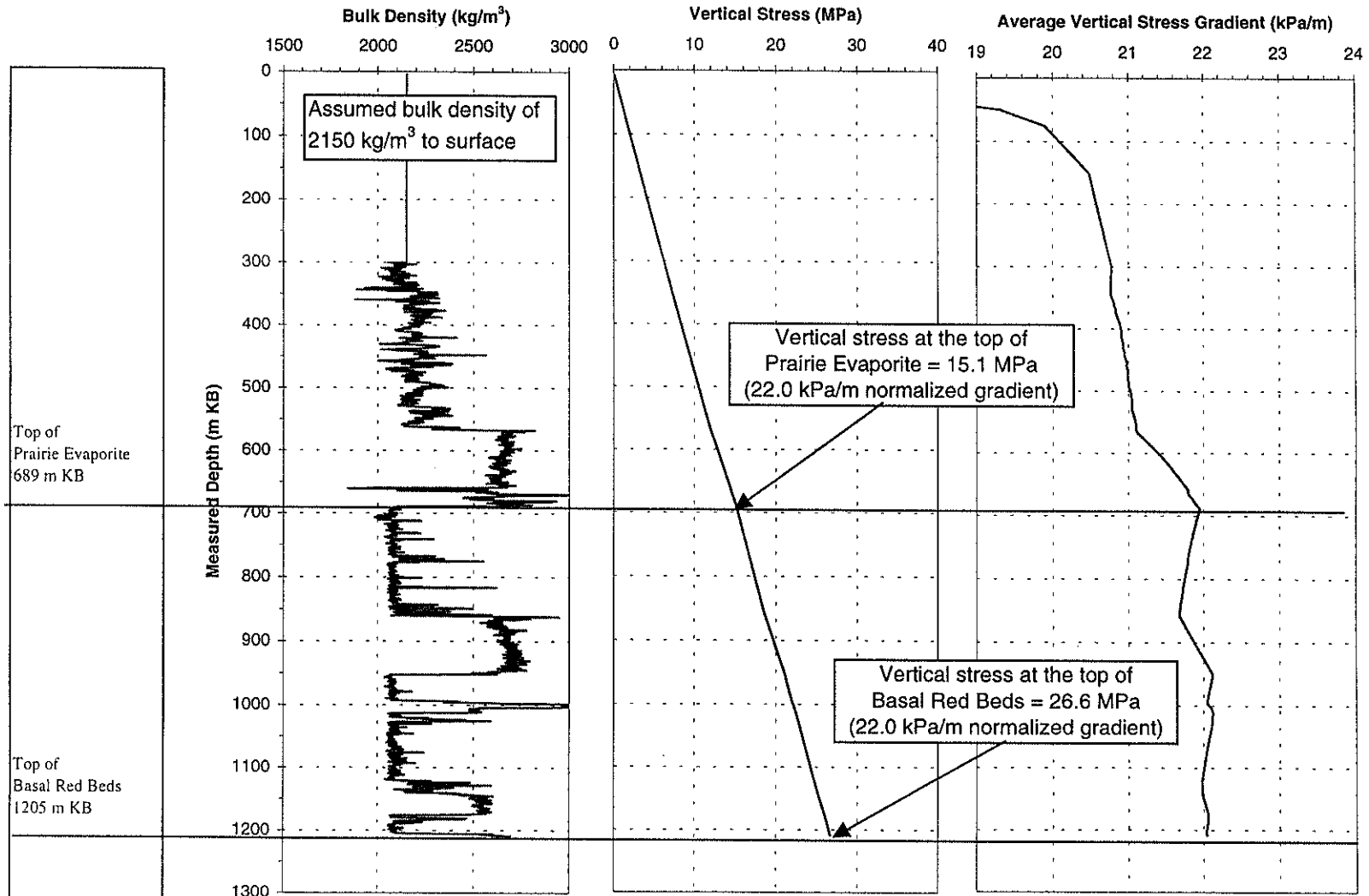


Figure D.1.47: Calculated vertical stress and vertical stress gradients for AMOCO Kirby 10-22-72-6.

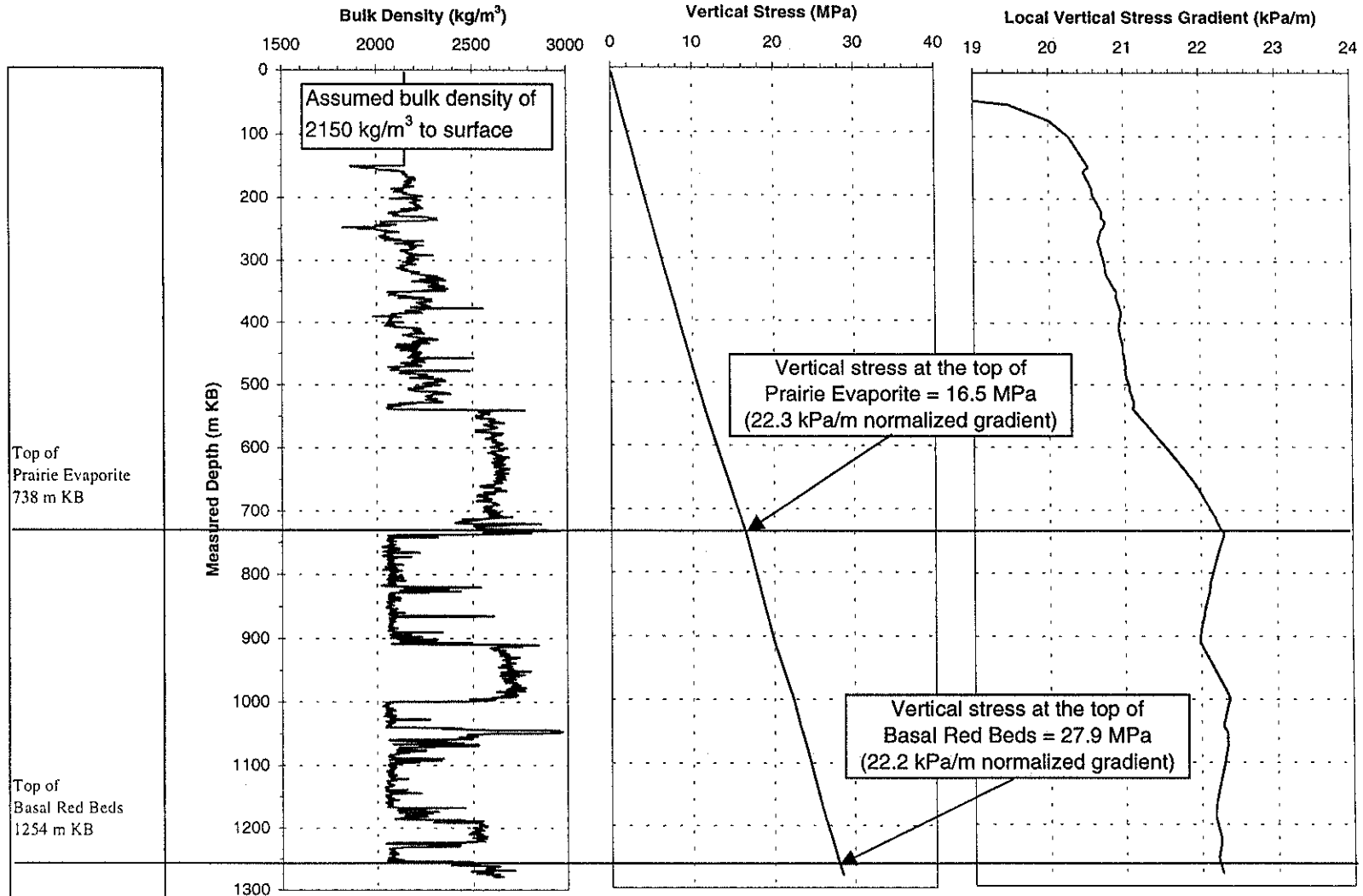


Figure D.1.48: Calculated vertical stress and vertical stress gradients for AEC Phillips Wiau 11-14-72-8.

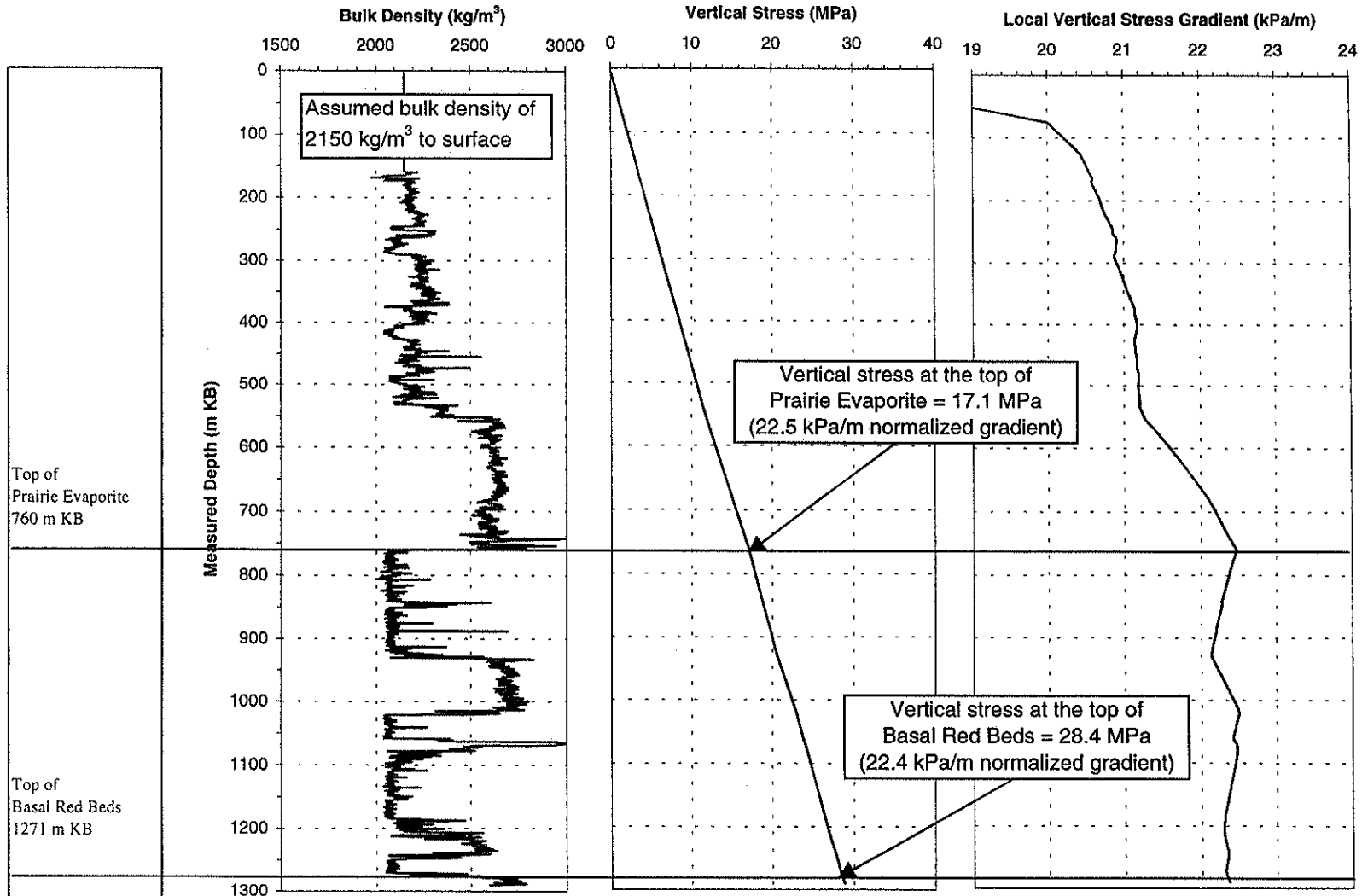


Figure D.1.49: Calculated vertical stress and vertical stress gradients for AEC Phillips Wiau 10-33-72-8.

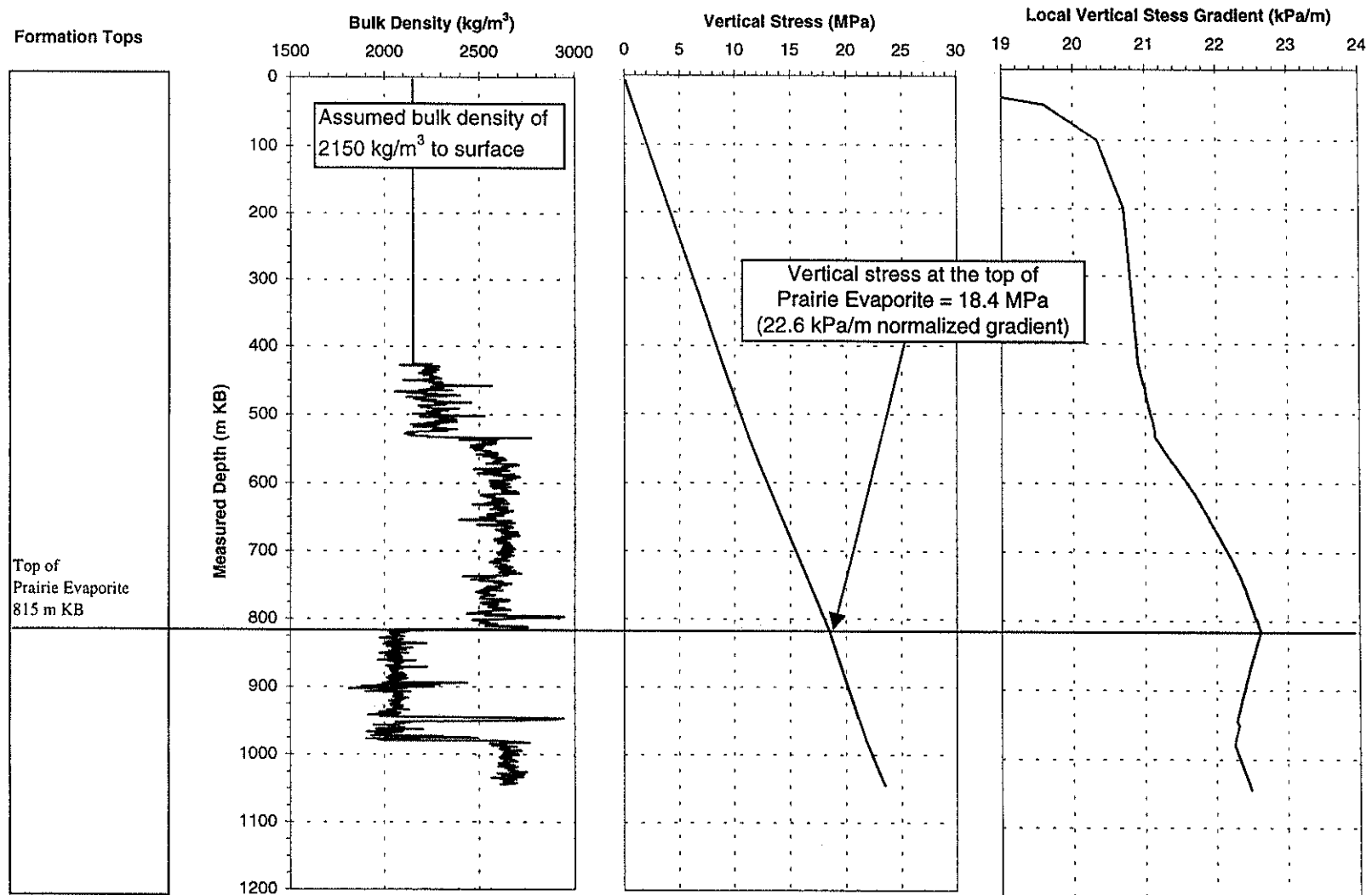


Figure D.1.50: Calculated vertical stress and vertical stress gradients for Pam Am A-1 Behan 6-26-72-11

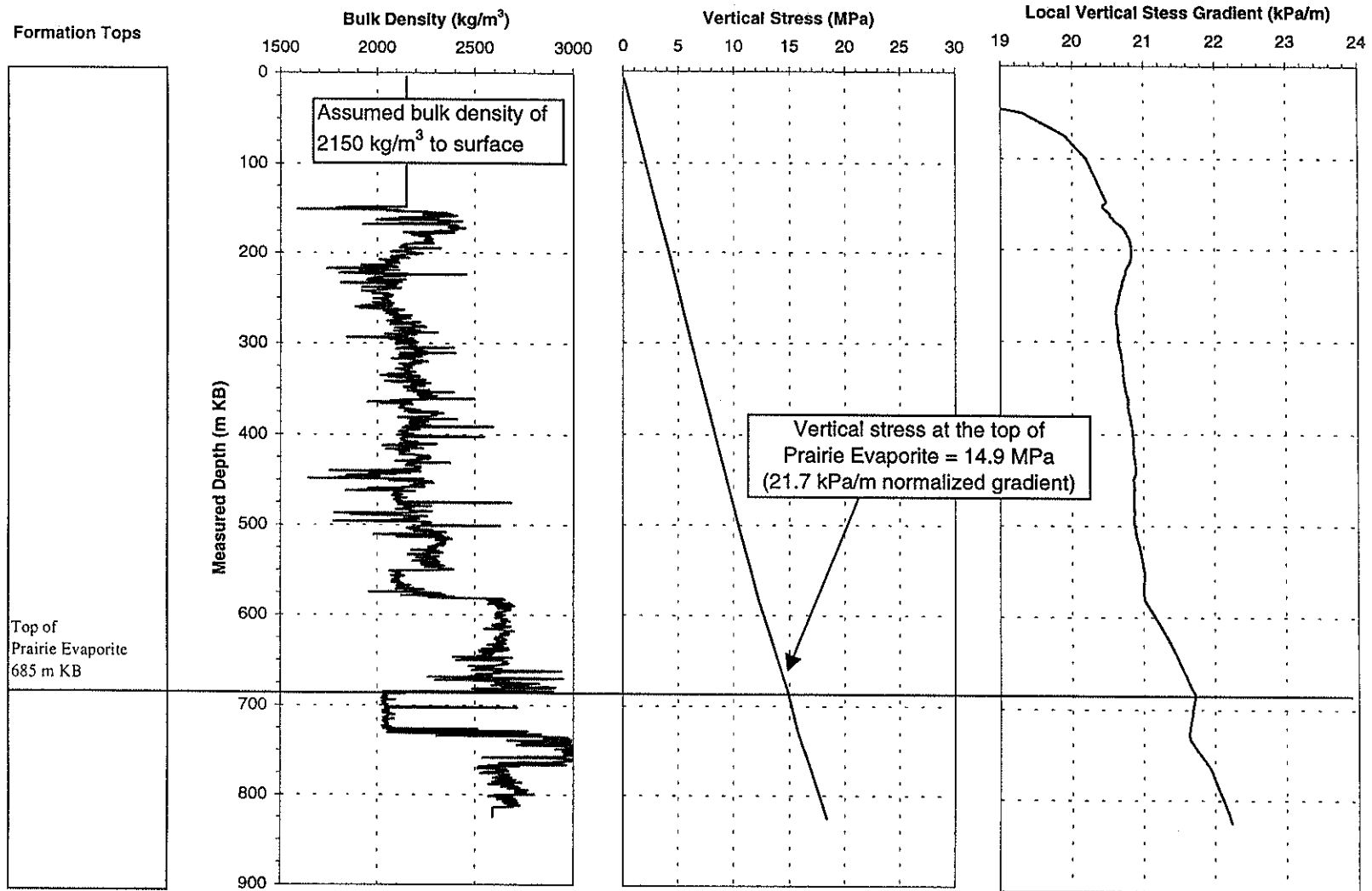


Figure D.1.51: Calculated vertical stress and vertical stress gradients for AEC Foster Creek 6-25-73-3.

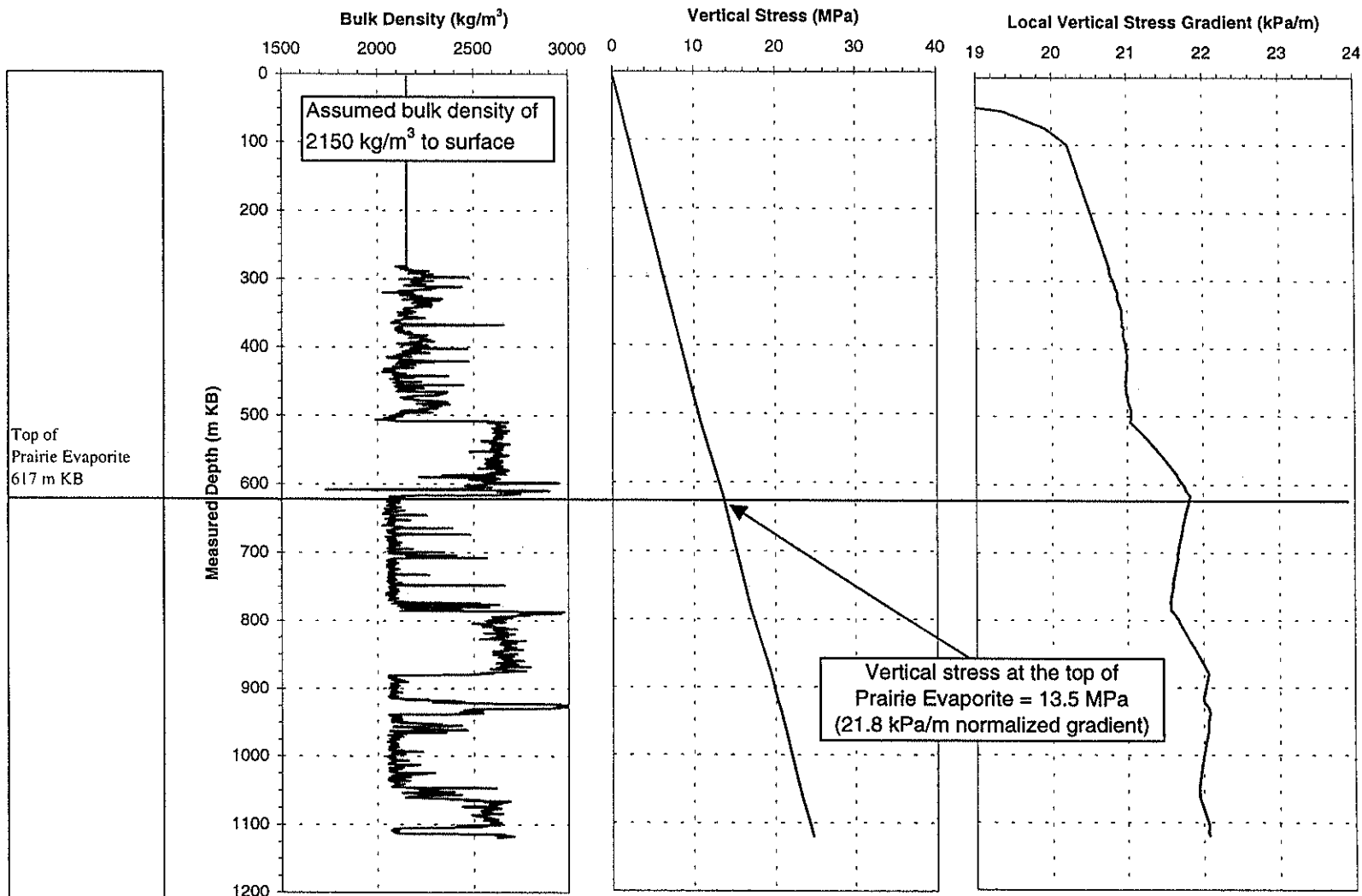


Figure D.1.52: Calculated vertical stress and vertical stress gradients for Amoco AEC Ipiatik Kirby 10-14-73-5.

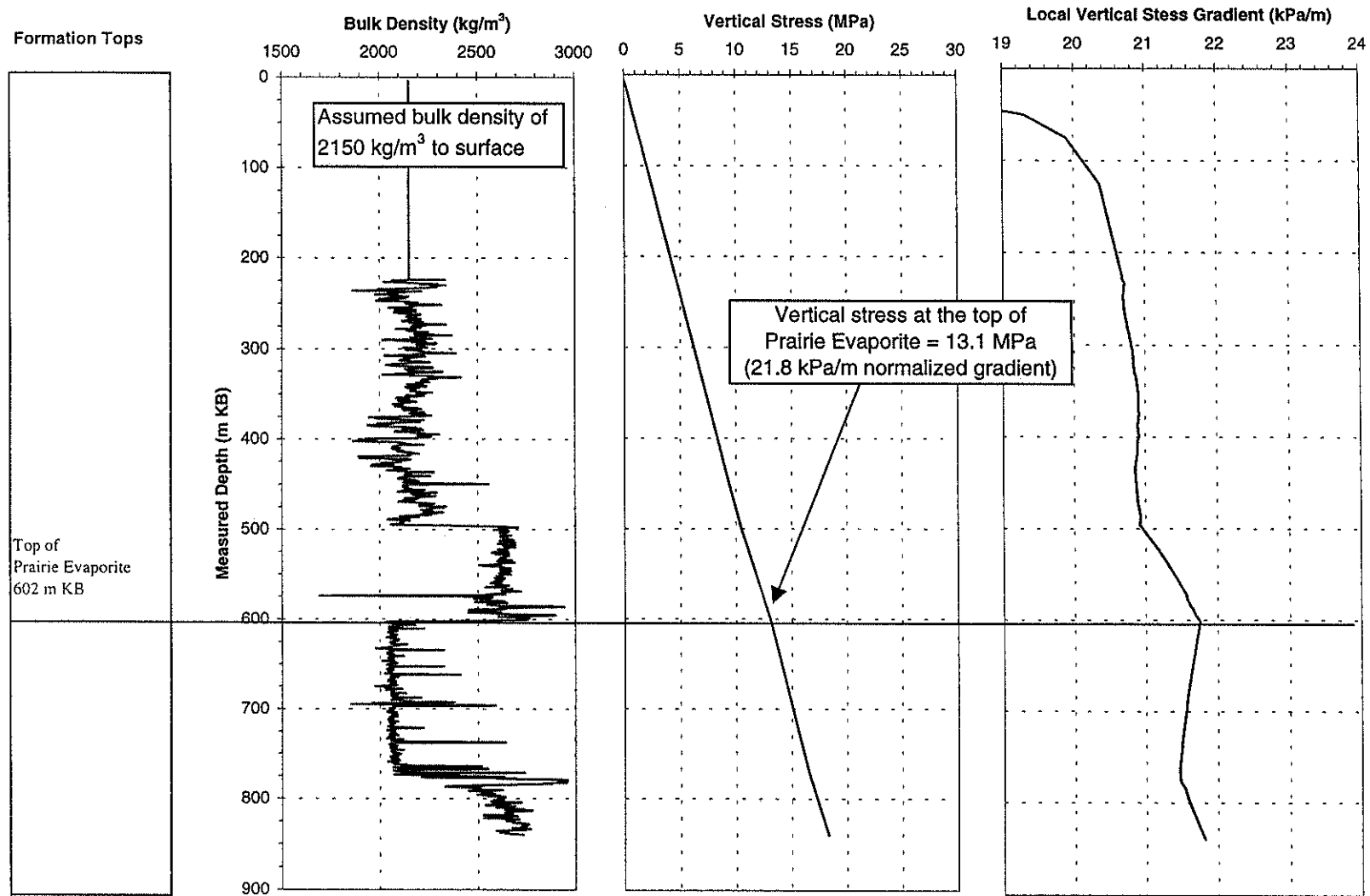


Figure D.1.53: Calculated vertical stress and vertical stress gradients for Amoco Kirby 9-25-73-5.

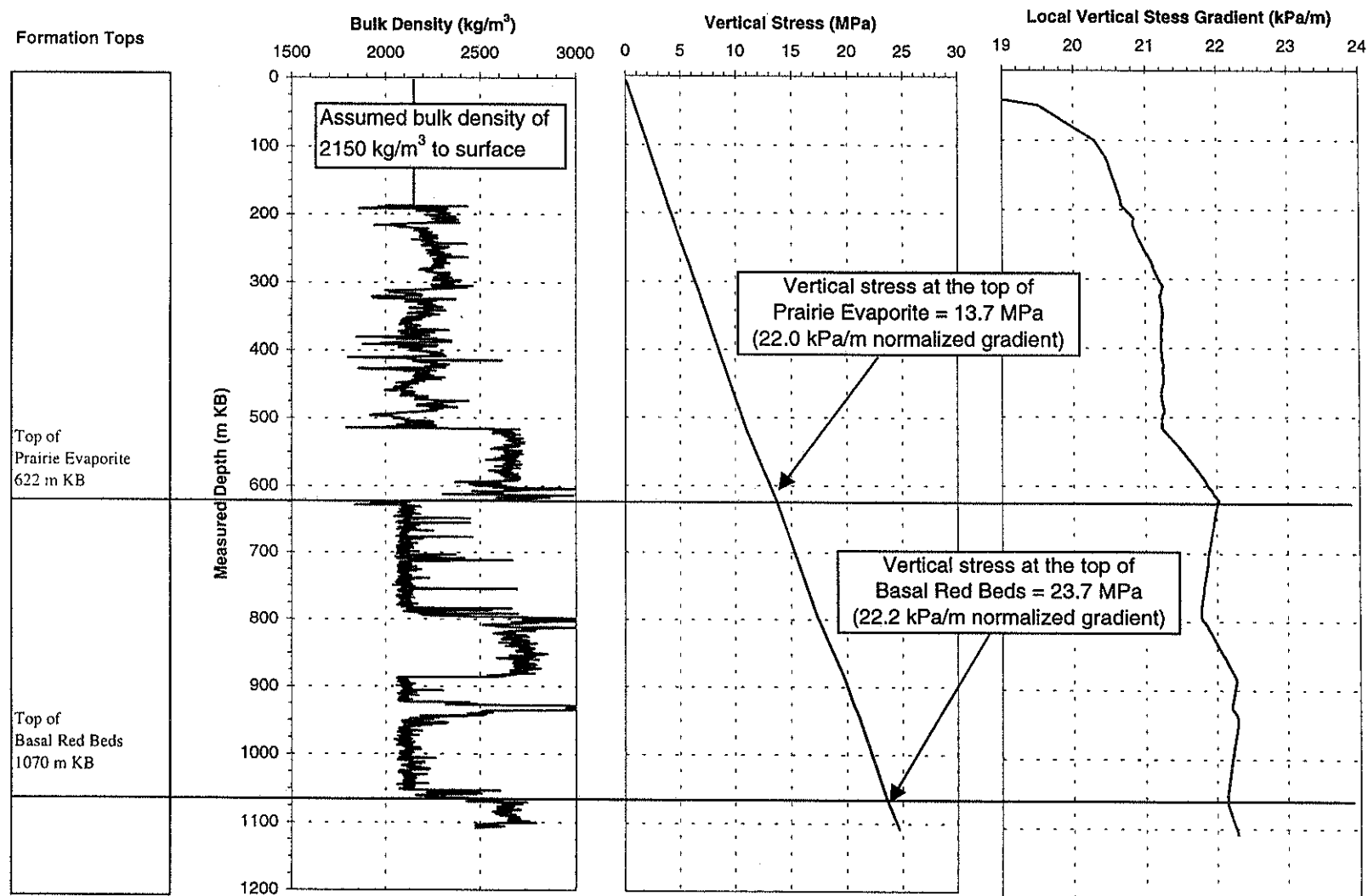


Figure D.1.54: Calculated vertical stress and vertical stress gradients for Amoco Kirby 11-30-74-5.

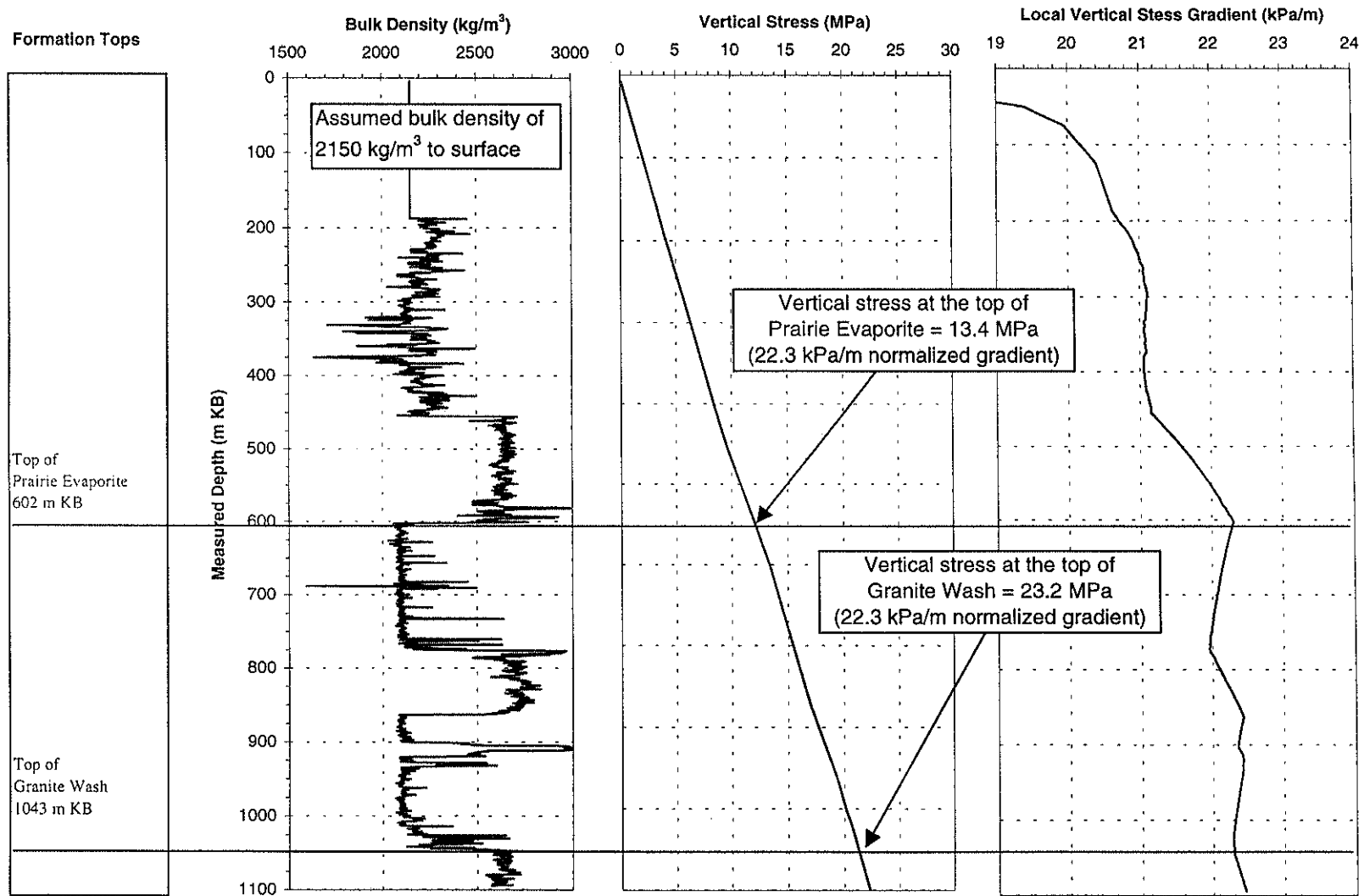


Figure D.1.55: Calculated vertical stress and vertical stress gradients for Amoco Kirby 10-9-74-6.

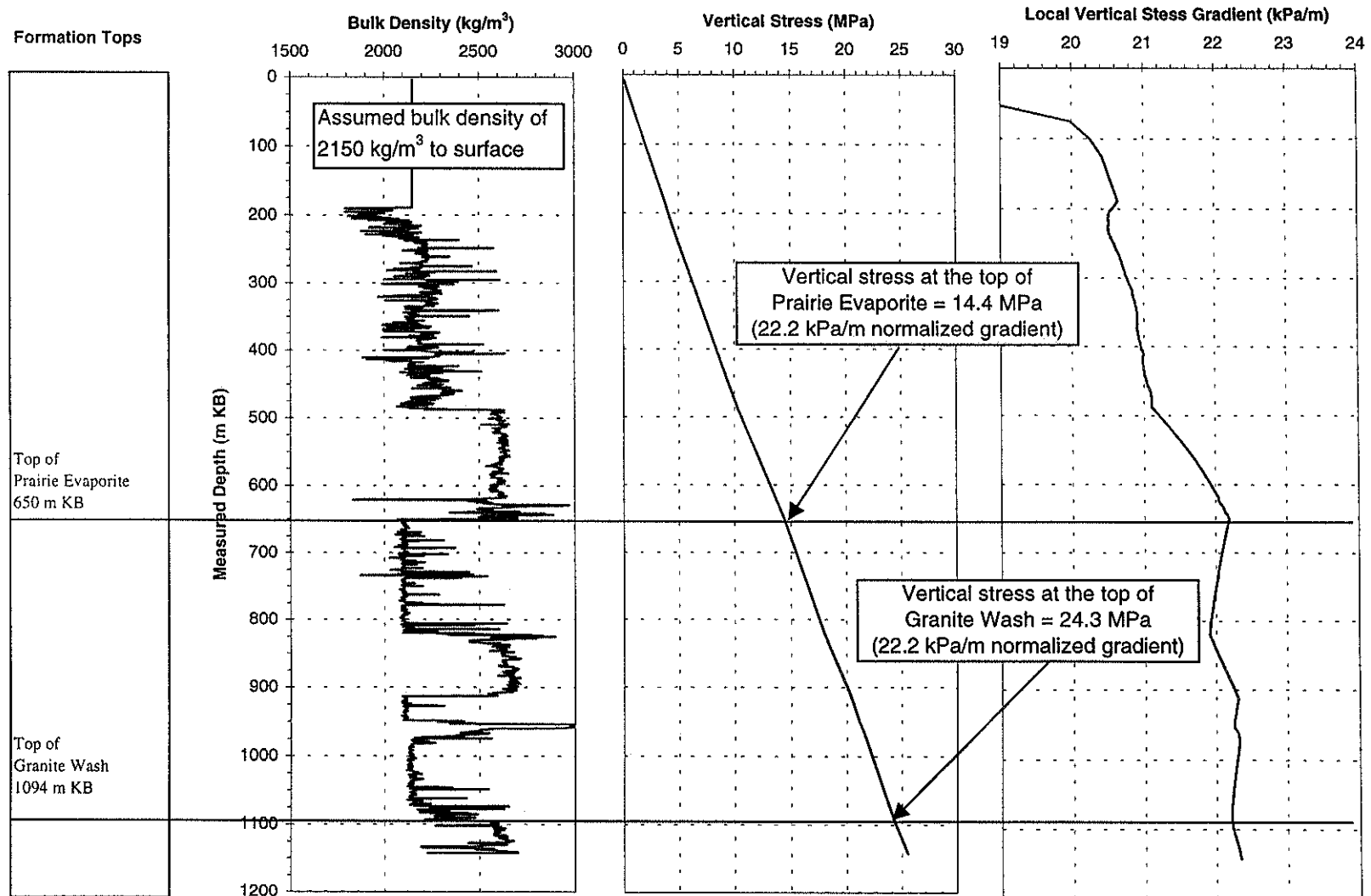


Figure D.1.56: Calculated vertical stress and vertical stress gradients for Amoco Kirby 6-24-74-7.

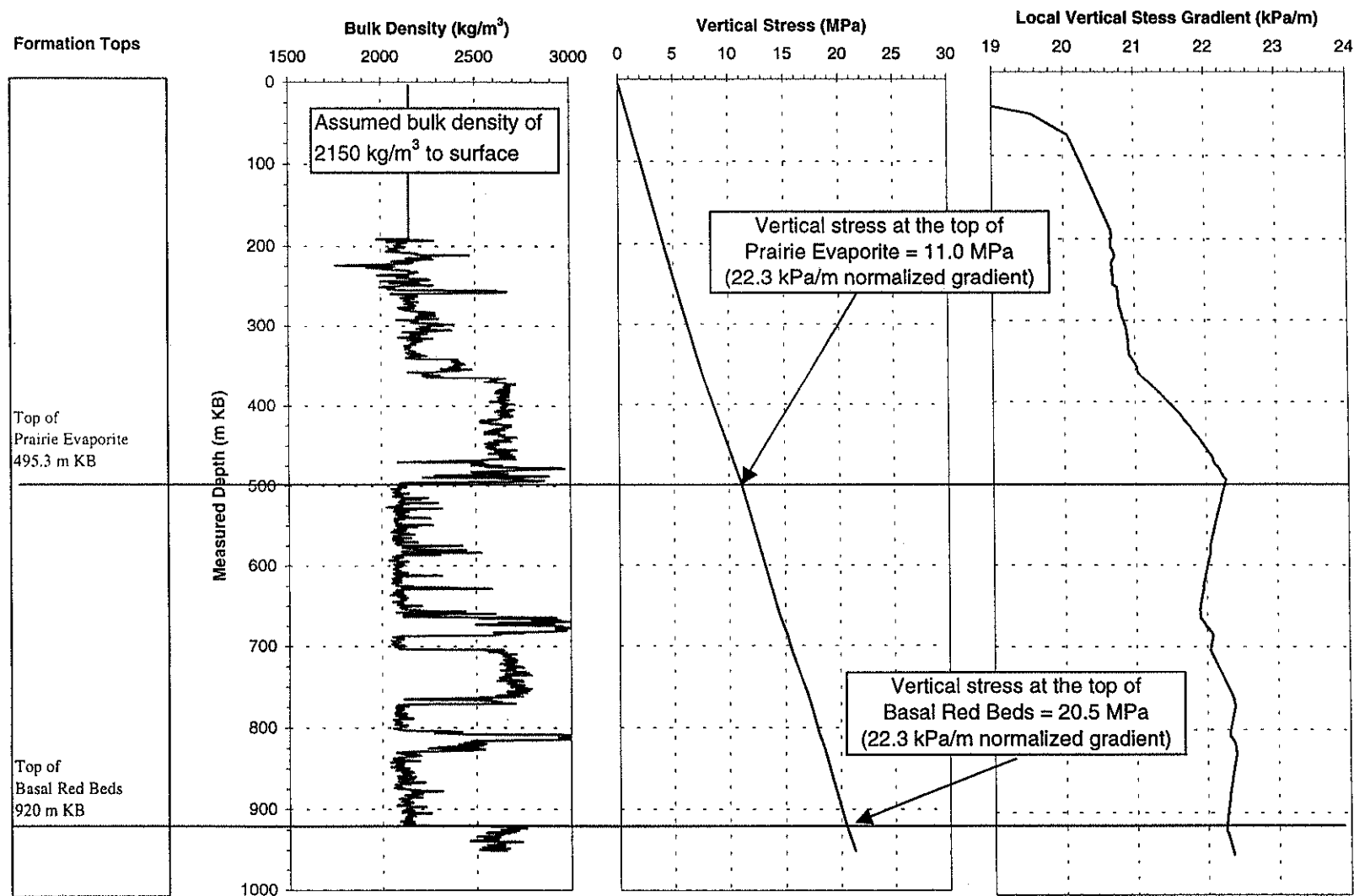


Figure D.1.57: Calculated vertical stress and vertical stress gradients for Home Leismer A10-1-77-7.

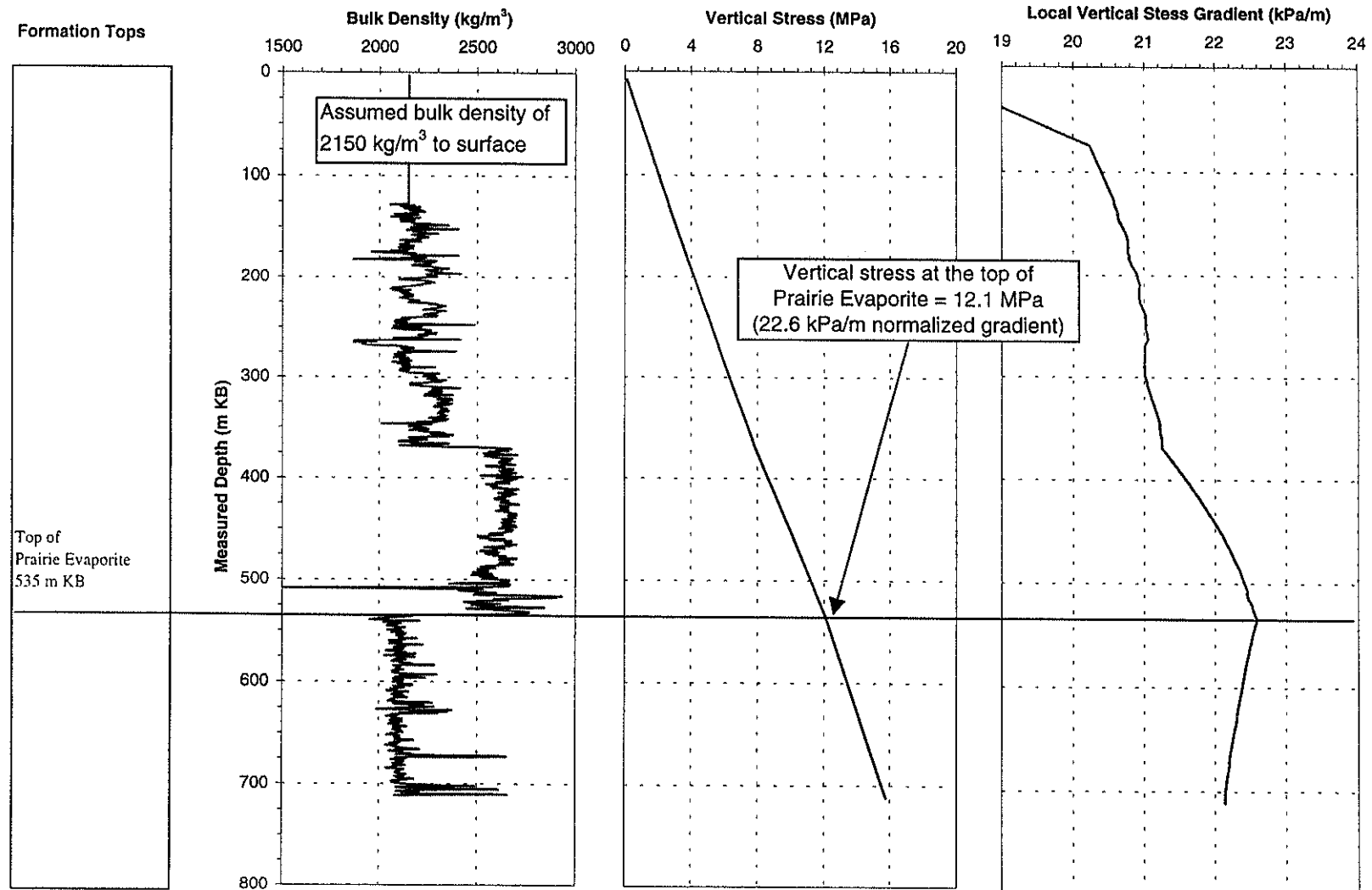


Figure D.1.58: Calculated vertical stress and vertical stress gradients for Home Leismer 3-7-77-7.

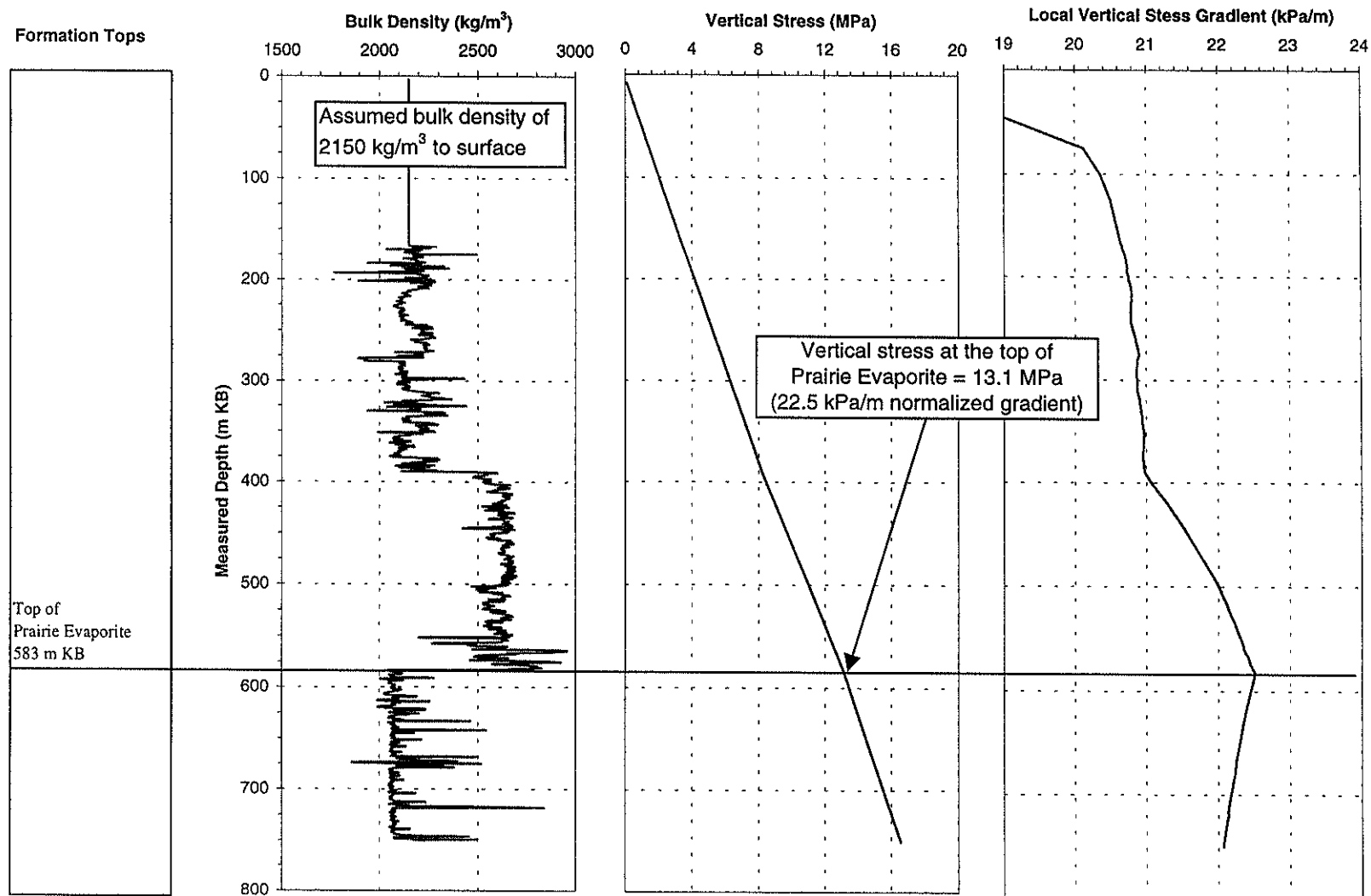


Figure D.1.59: Calculated vertical stress and vertical stress gradients for Norcen Por Leismer 2-8-77-8.

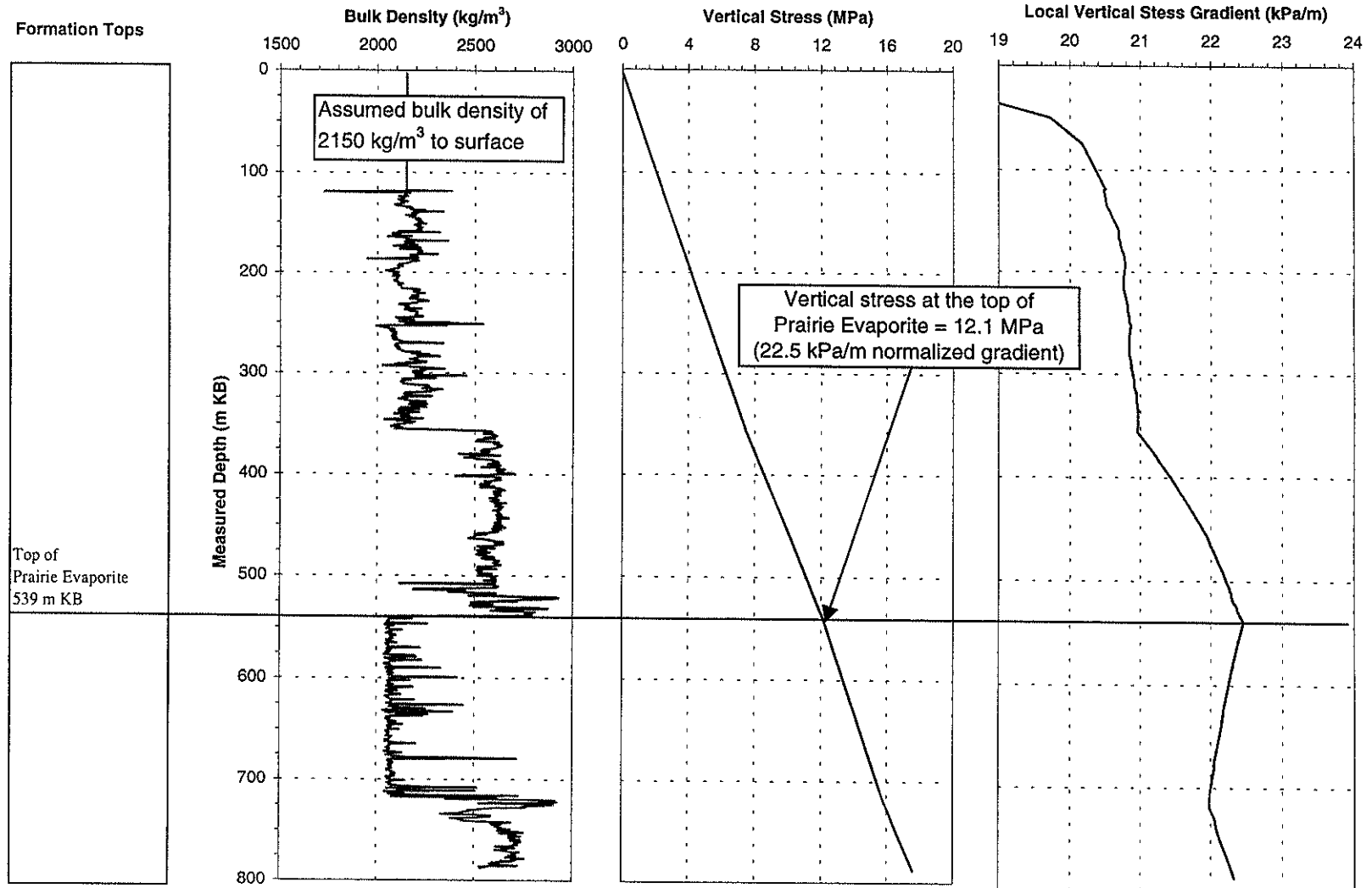


Figure D.1.60: Calculated vertical stress and vertical stress gradients for Altana Huber Christina 10-28-77-8.

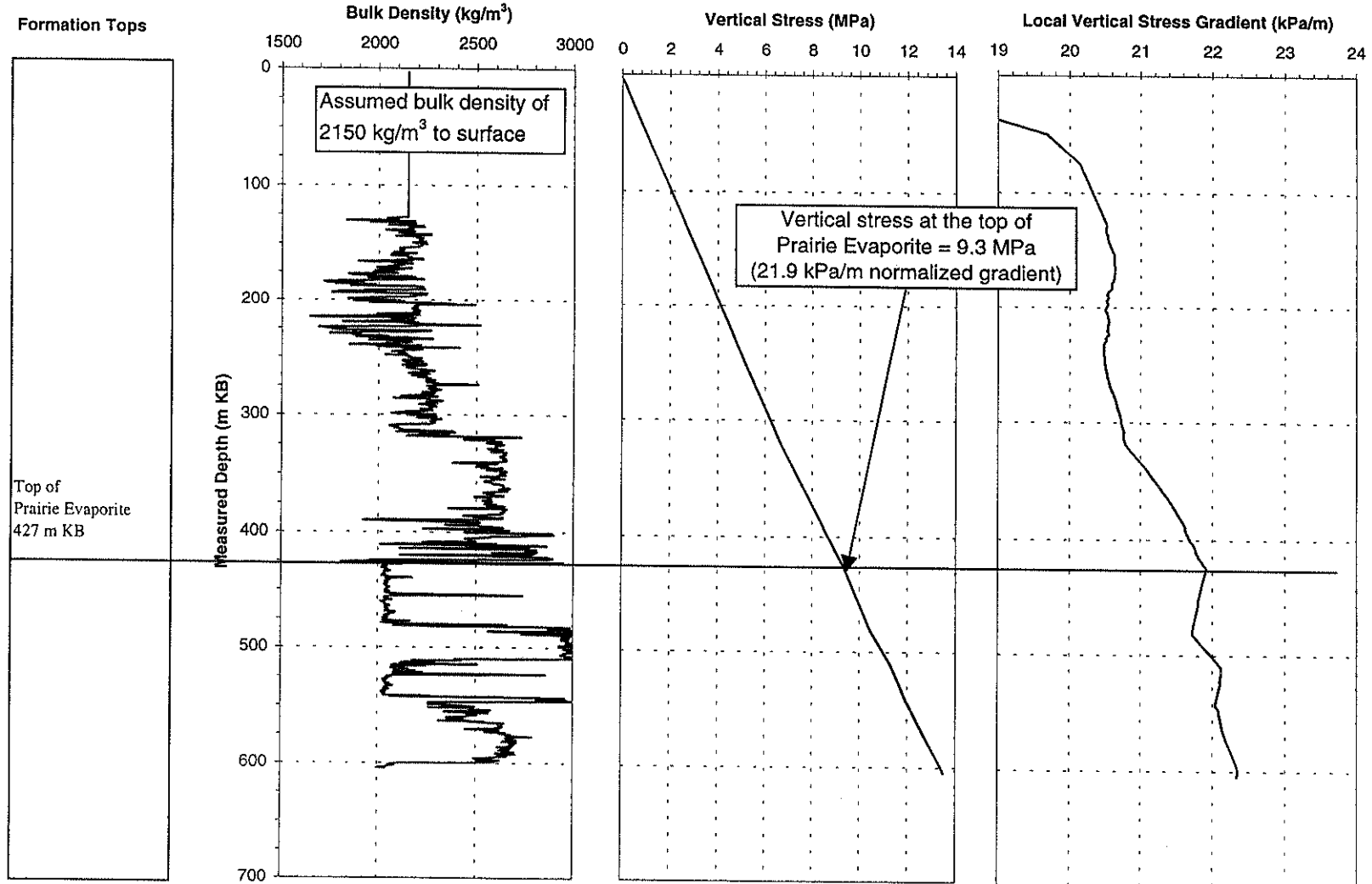


Figure D.1.61: Calculated vertical stress and vertical stress gradients for Lakewood et al Chard 14-29-79-5.

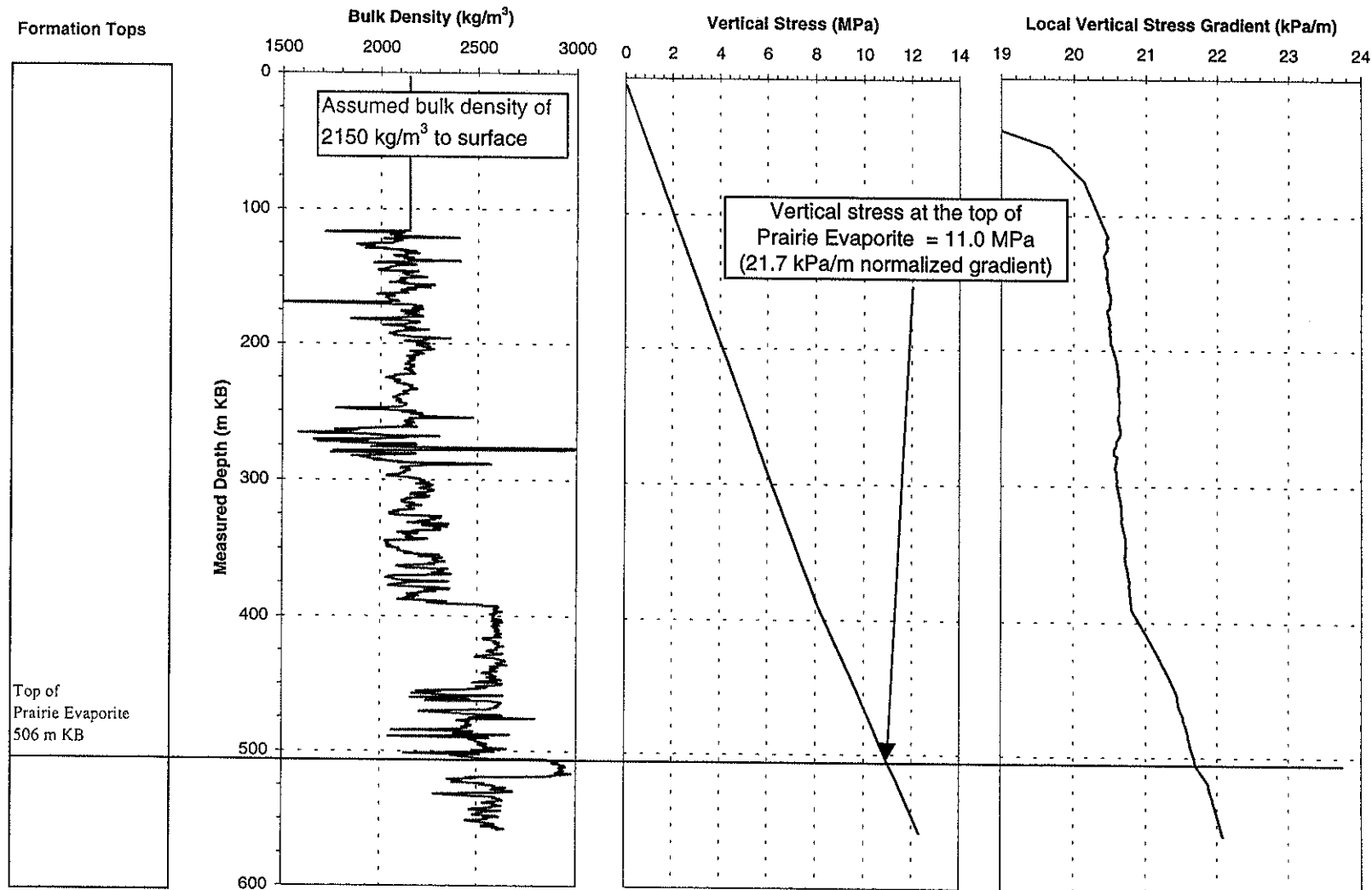


Figure D.1.62: Calculated vertical stress and vertical stress gradients for Home WinneFred Lake 10-5-80-2.

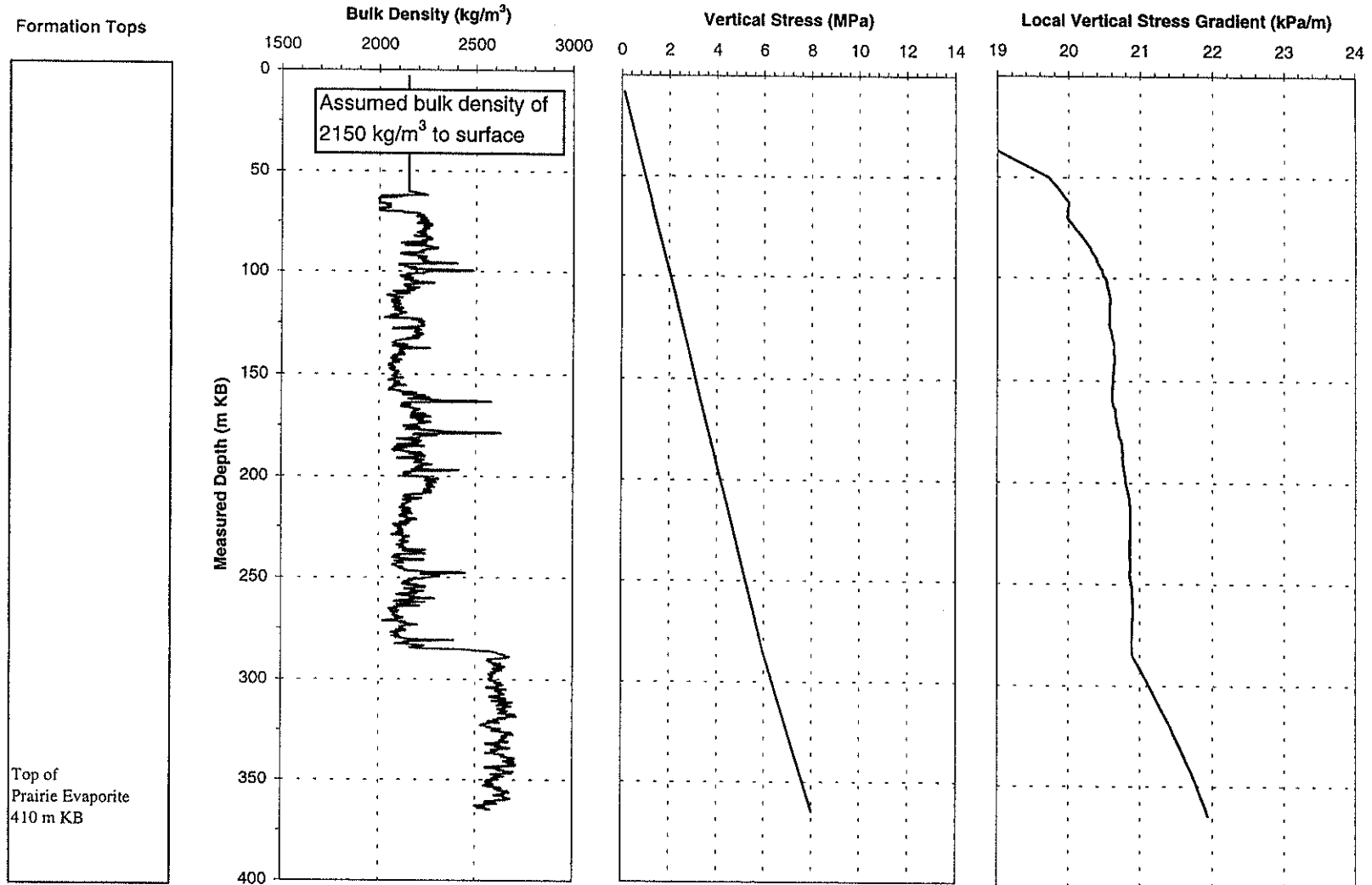


Figure D.1.63: Calculated vertical stress and vertical stress gradients for Homestead Canoxy Cowpar 11-32-80-4.

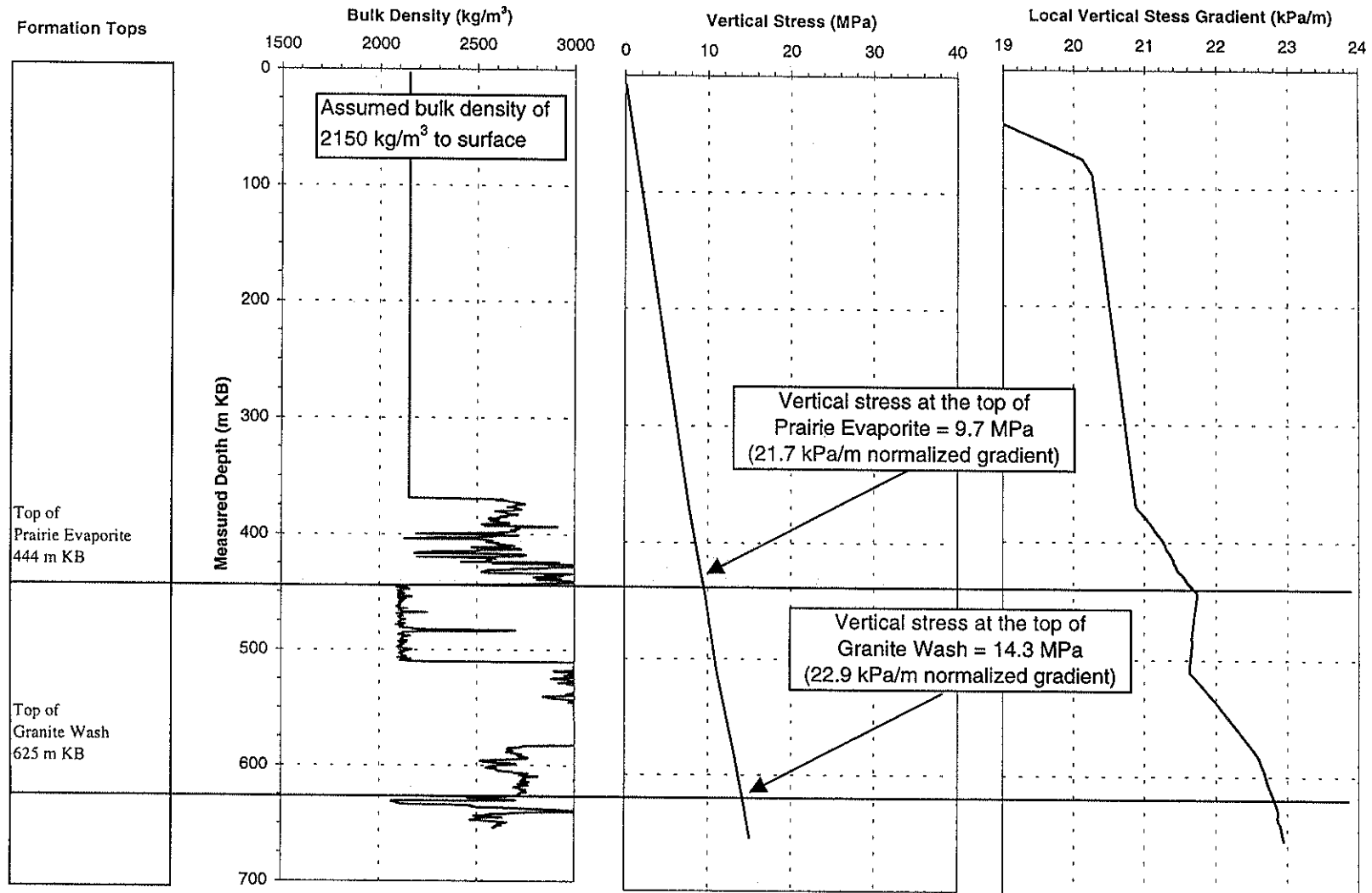


Figure D.1.64: Calculated vertical stress and vertical stress gradients for Gulf Resdeln 7-8-82-6.

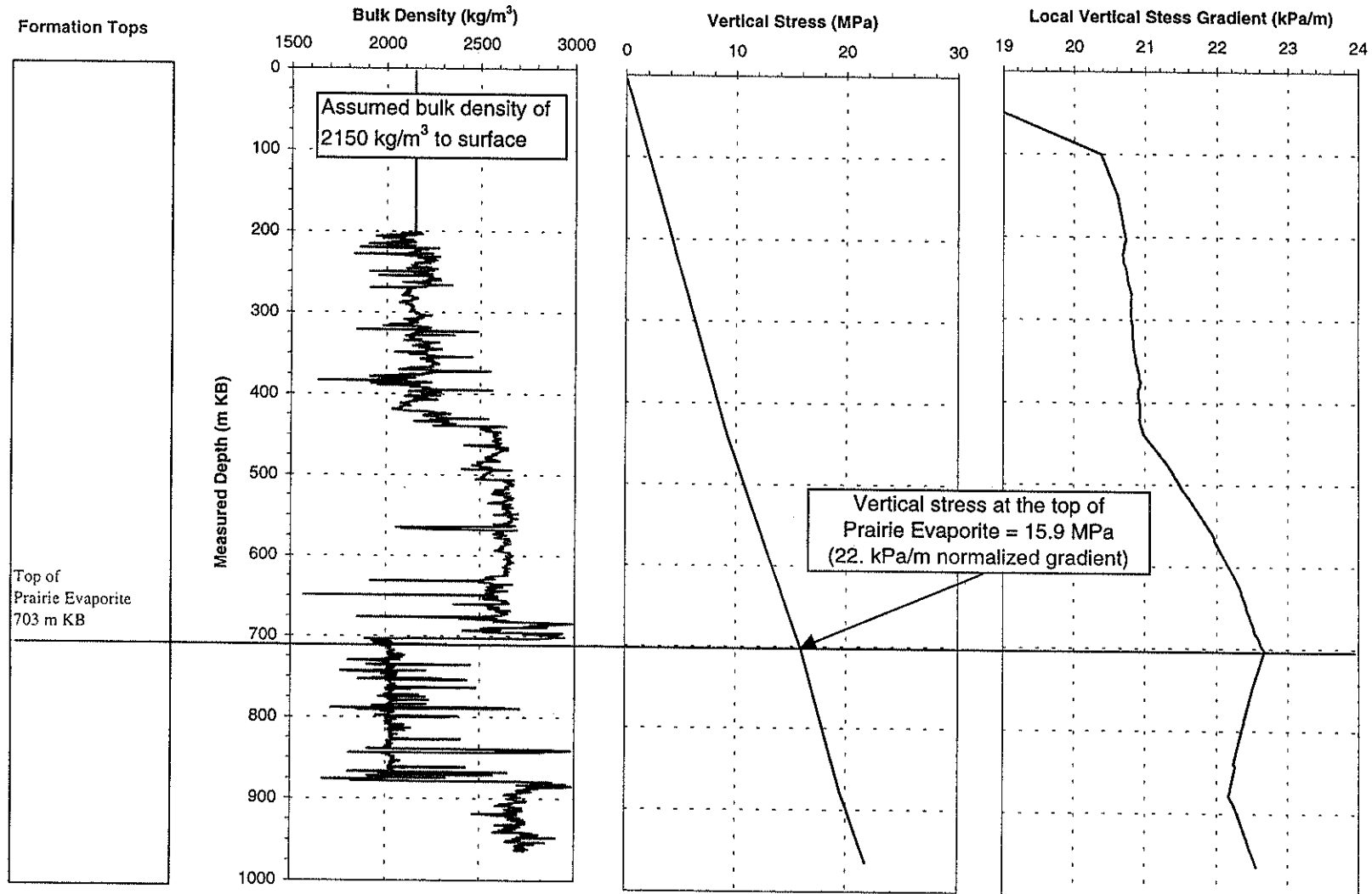


Figure D.1.65: Calculated vertical stress and vertical stress gradients for Husky et al Divide 10-29-82-12.

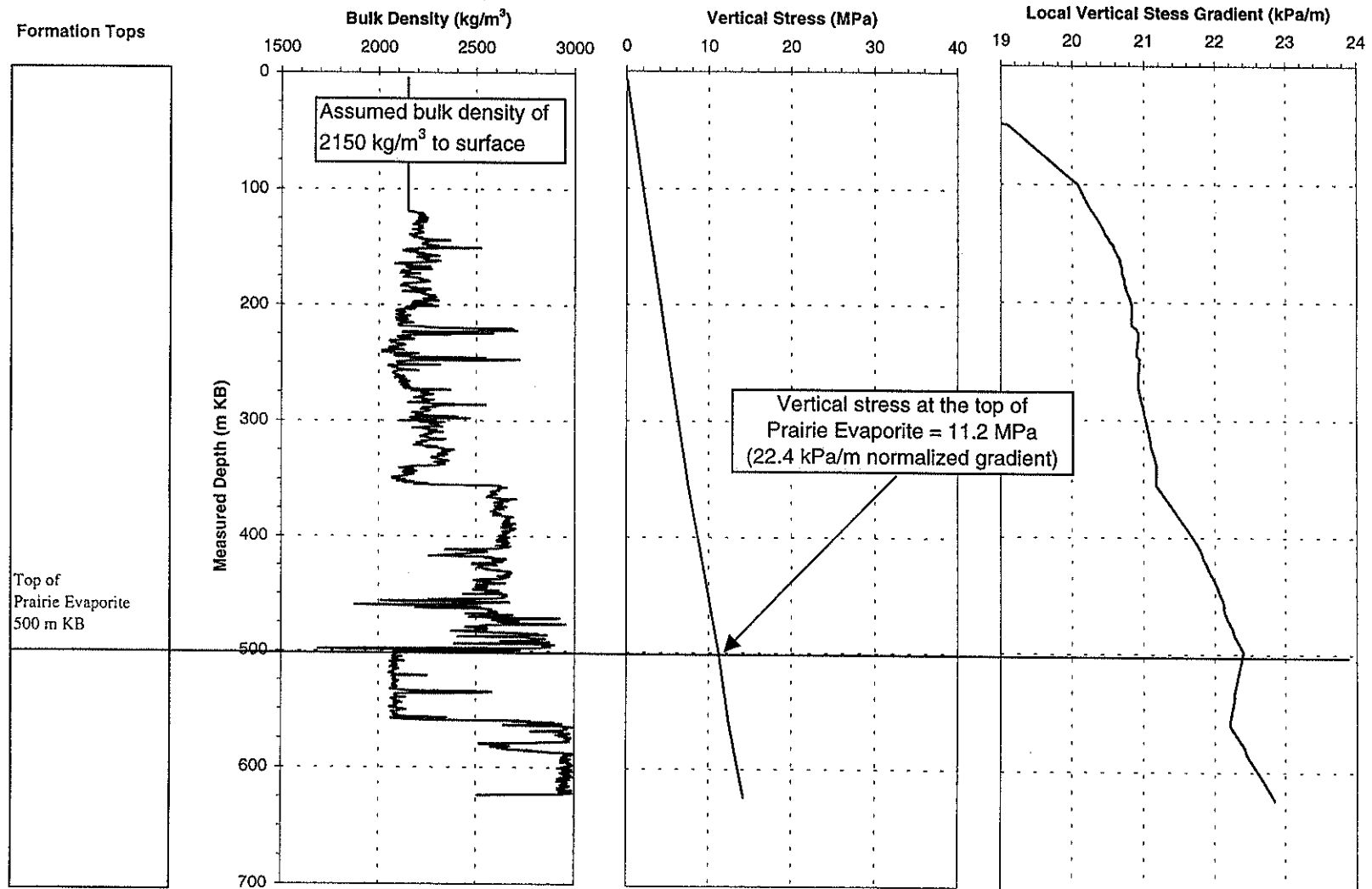


Figure D.1.66: Calculated vertical stress and vertical stress gradients for Gulf Resdeln 10-8-83-6.

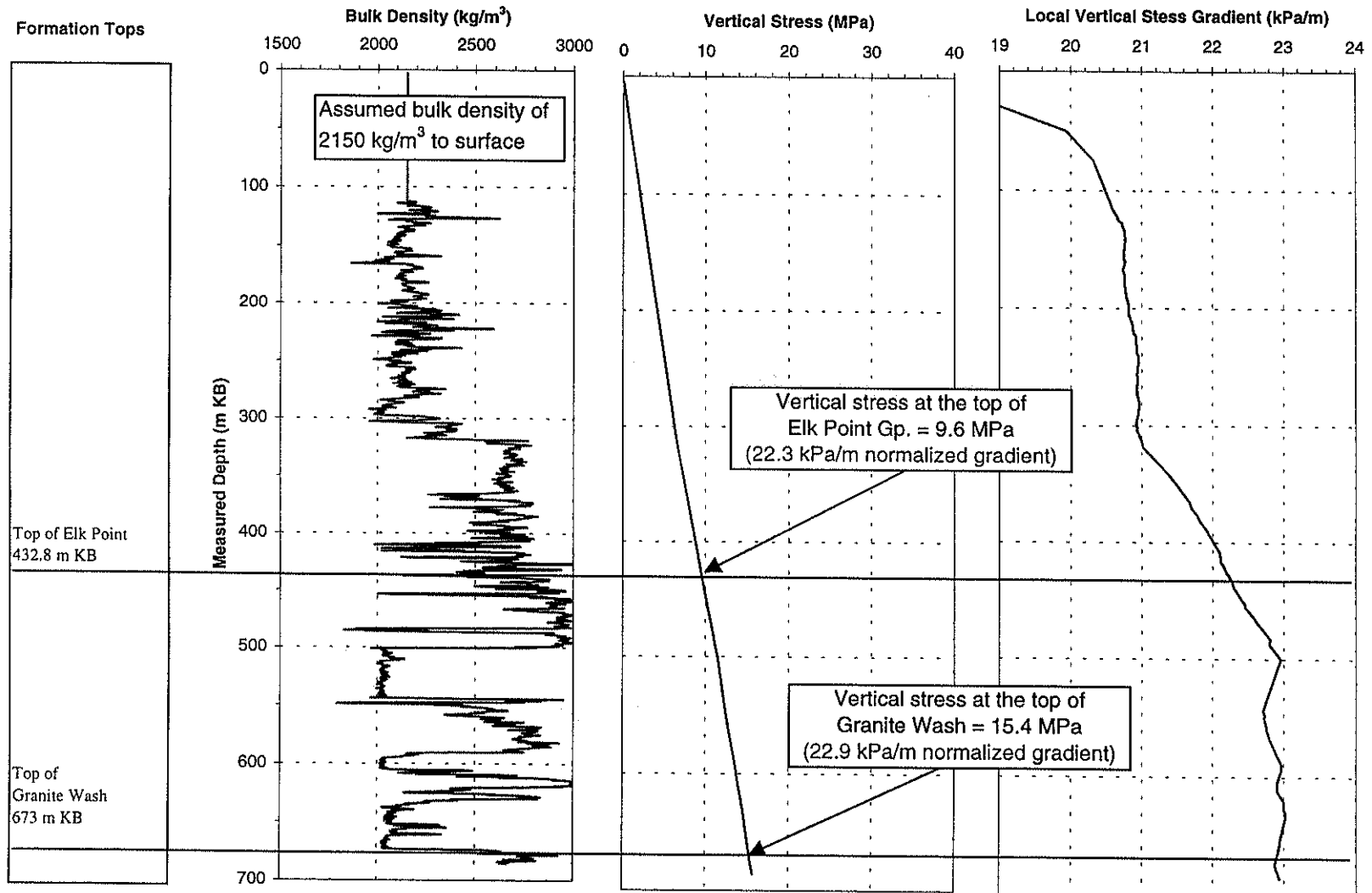


Figure D.1.67: Calculated vertical stress and vertical stress gradients for Texcan Cottonwood 1-14-83-6.

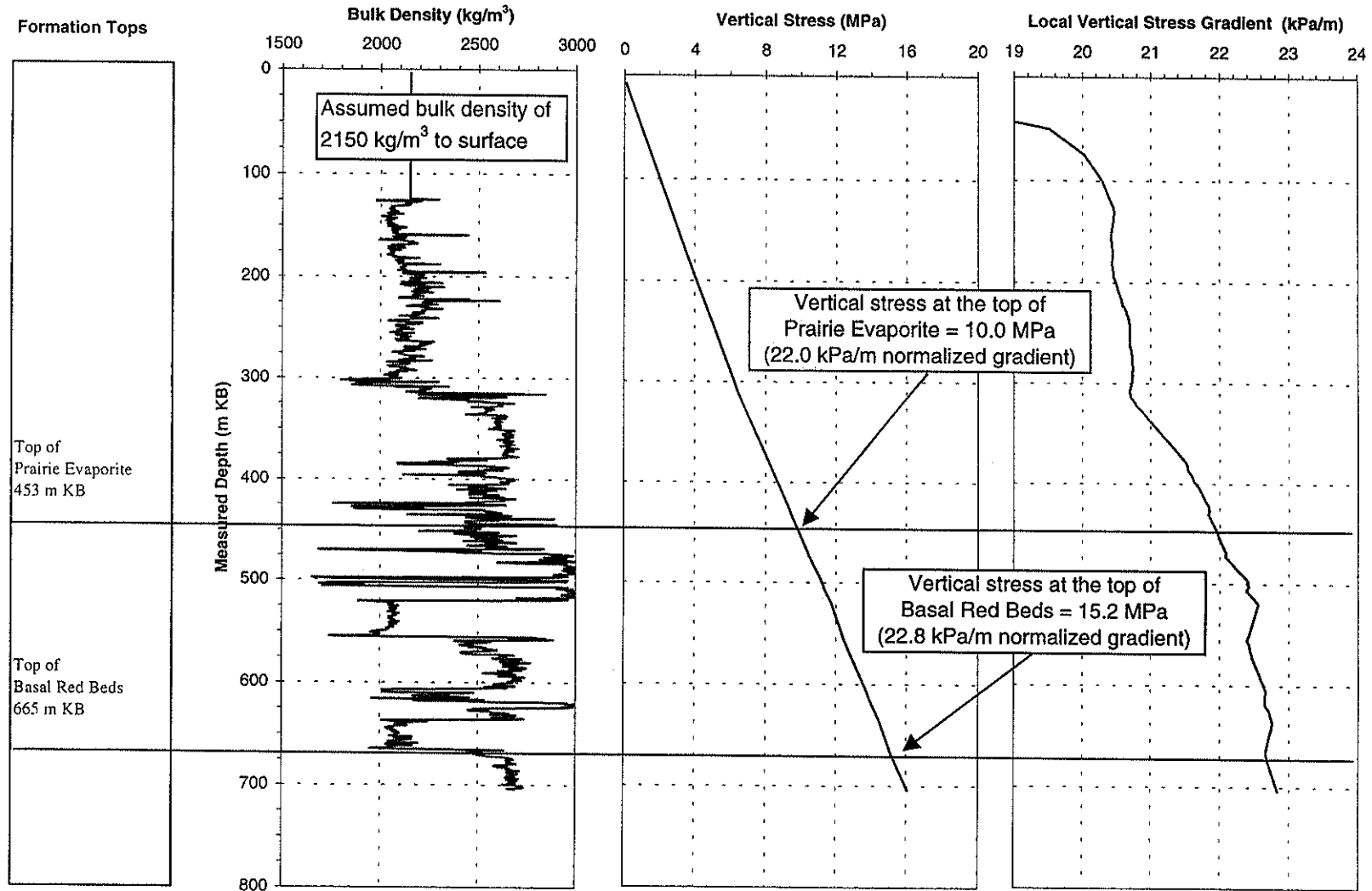


Figure D.1.68: Calculated vertical stress and vertical stress gradients for Northstar et al Surmont 7-32-83-6.

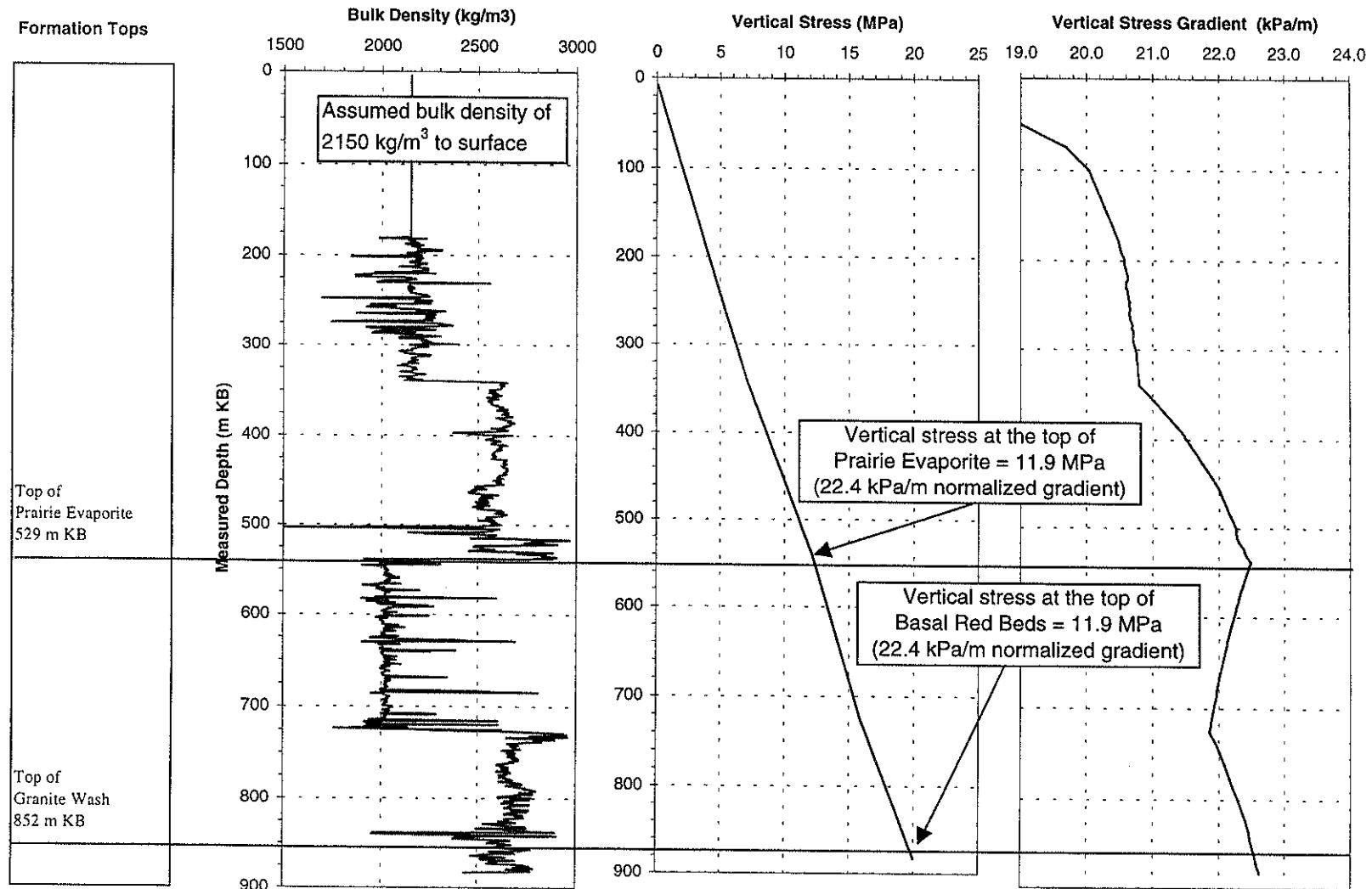


Figure D.1.69: Calculated vertical stress and vertical stress gradients for JACOS WD HANGST 15-14-84-11.

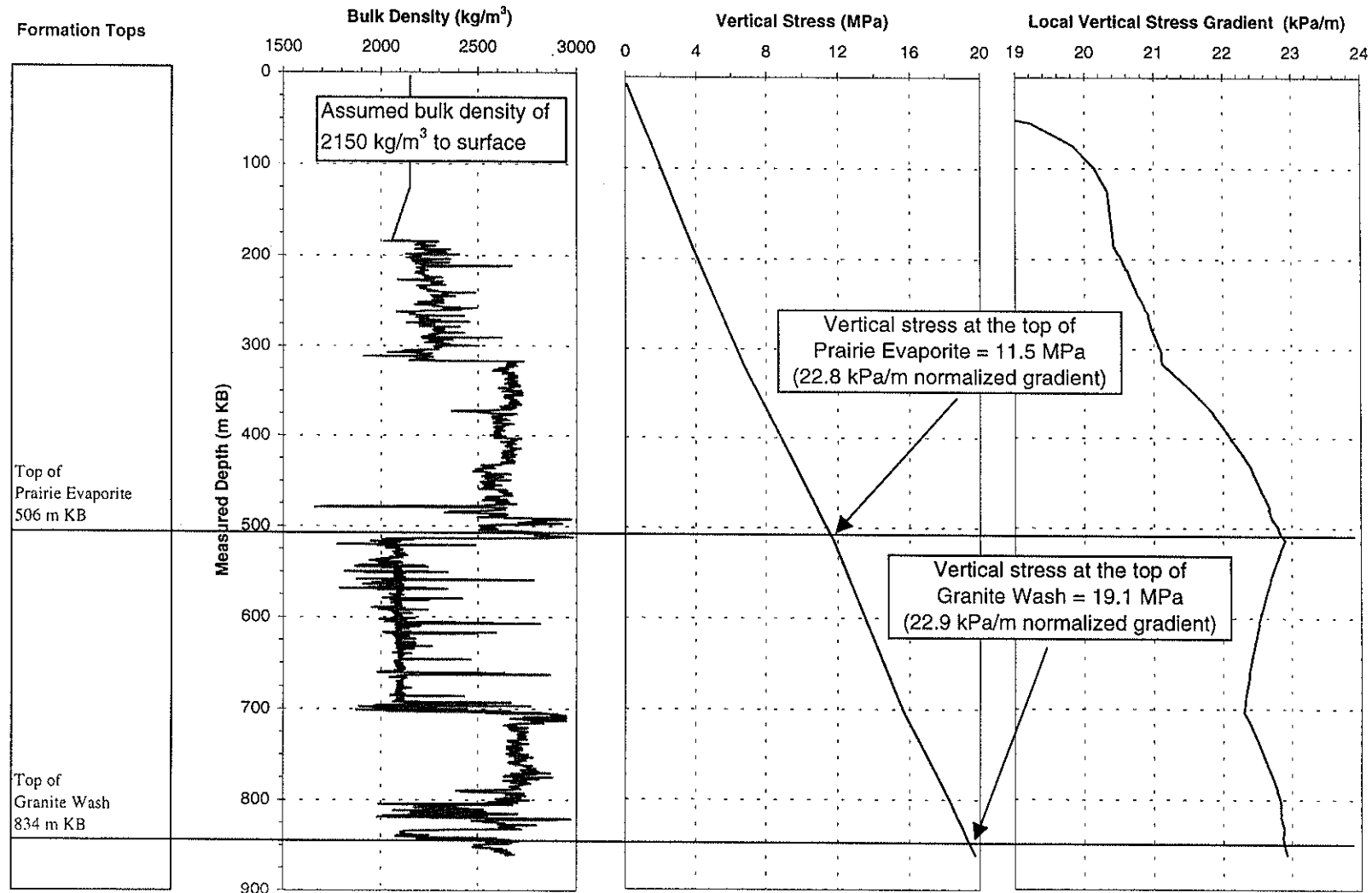


Figure D.1.70: Calculated vertical stress and vertical stress gradients for PCI PCEJ Hangst 9-27-84-11.

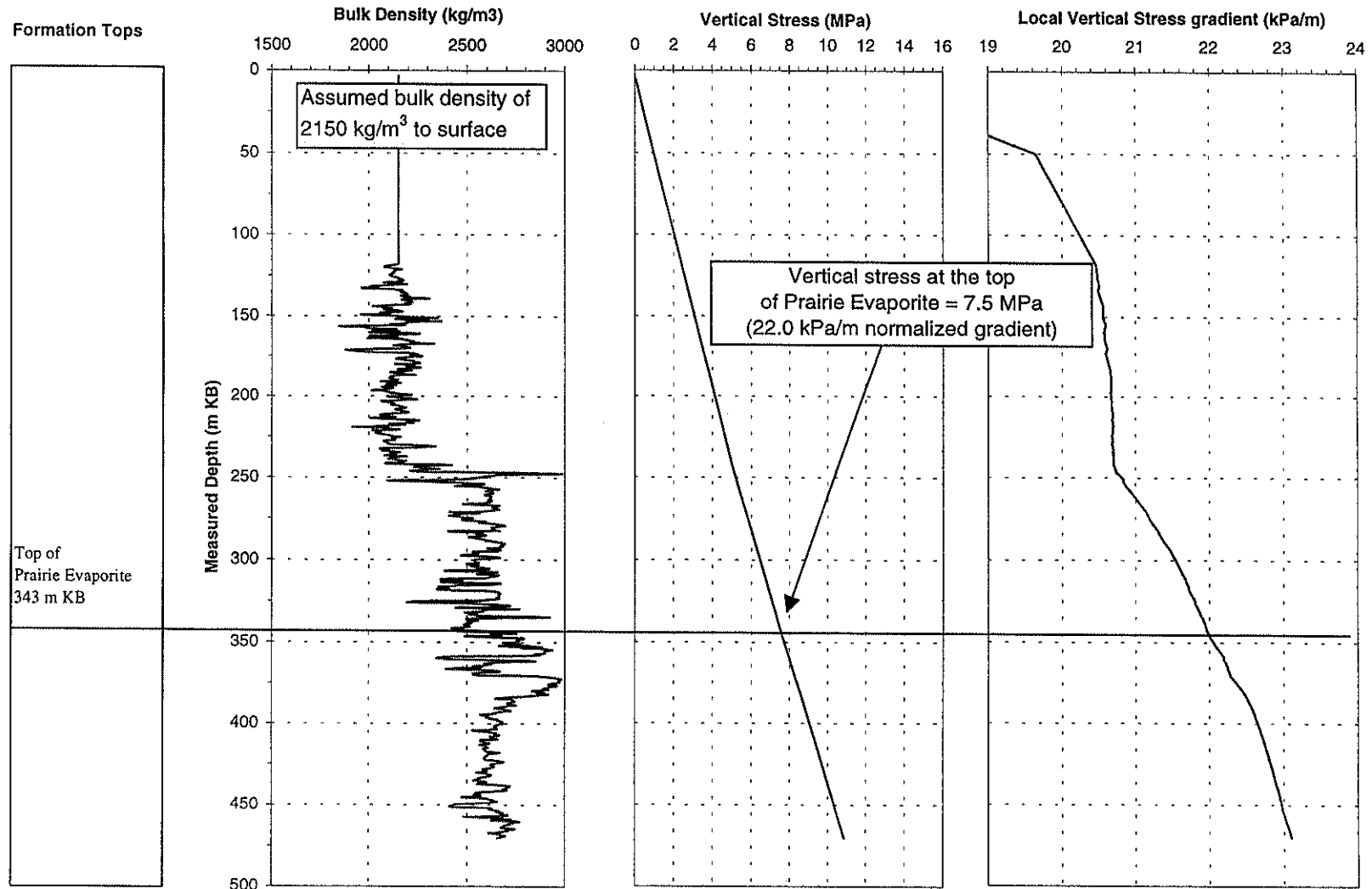


Figure D.1.71: Calculated vertical stress and vertical stress gradients for Rax Newby 14-24-85-6.

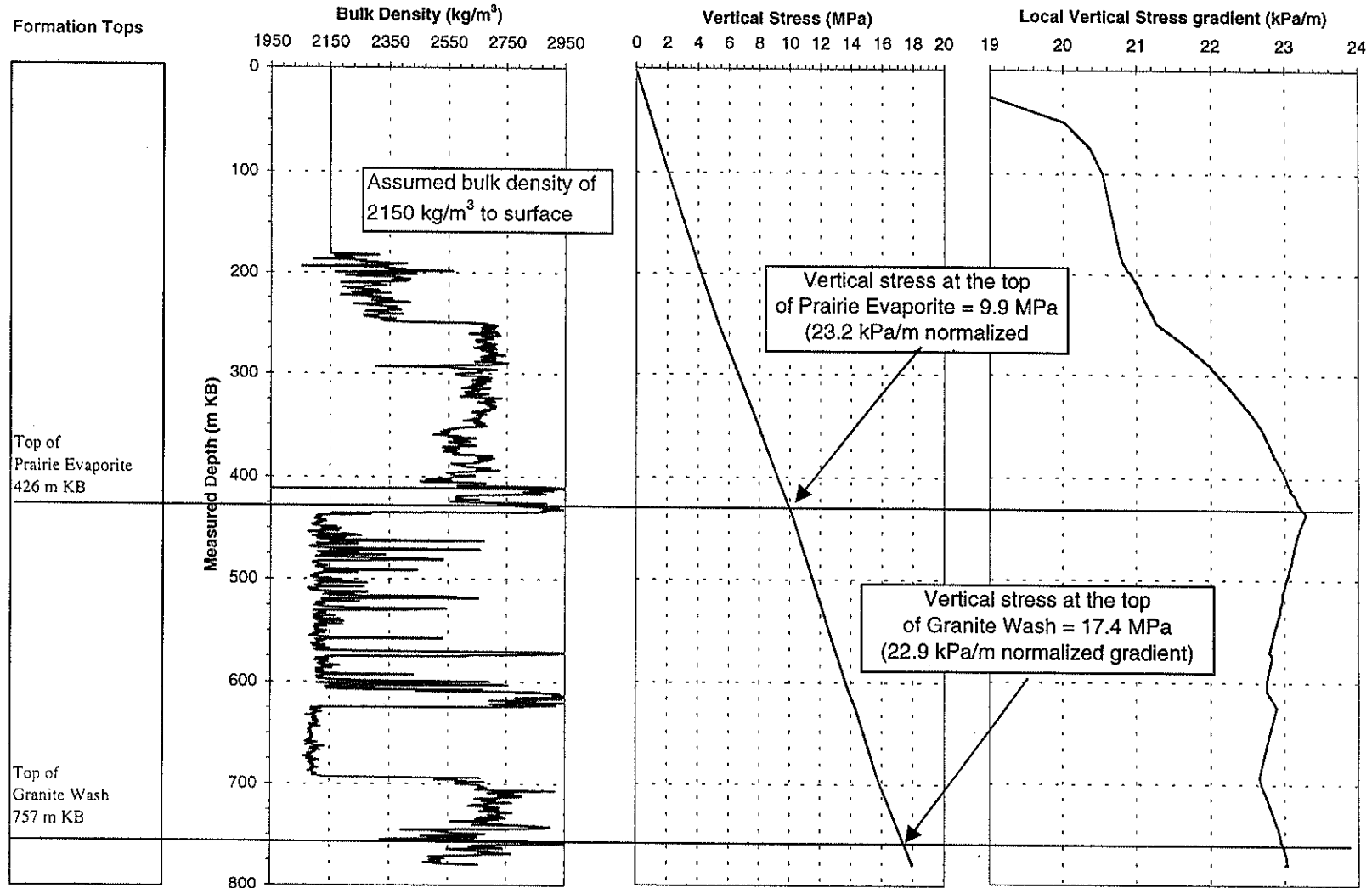


Figure D.1.72: Calculated vertical stress and vertical stress gradients for Texcan CS Horse 16-27-85-11.

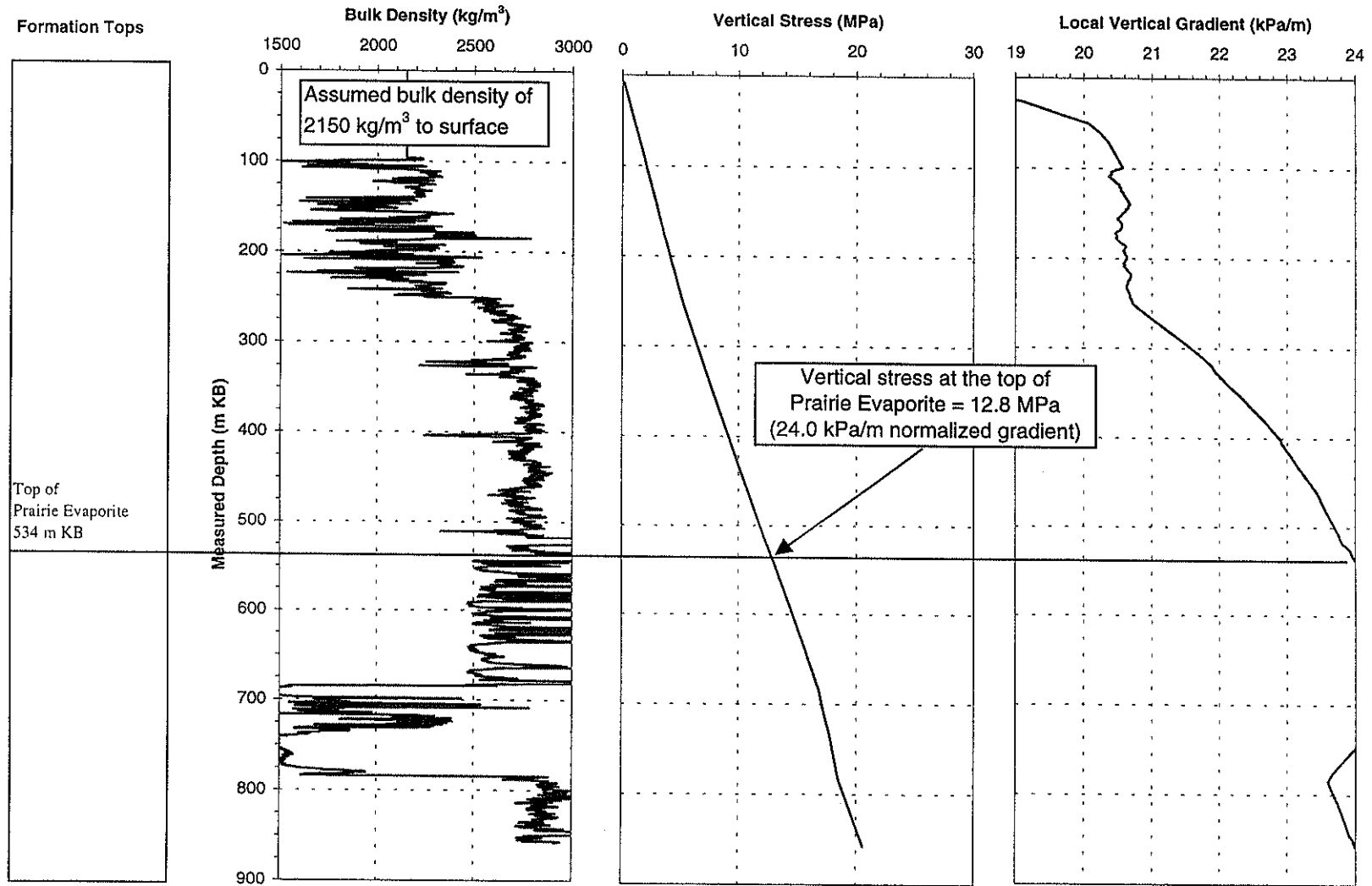


Figure D.1.73: Calculated vertical stress and vertical stress gradients for Cigol et al Horse 11-10-85-13.

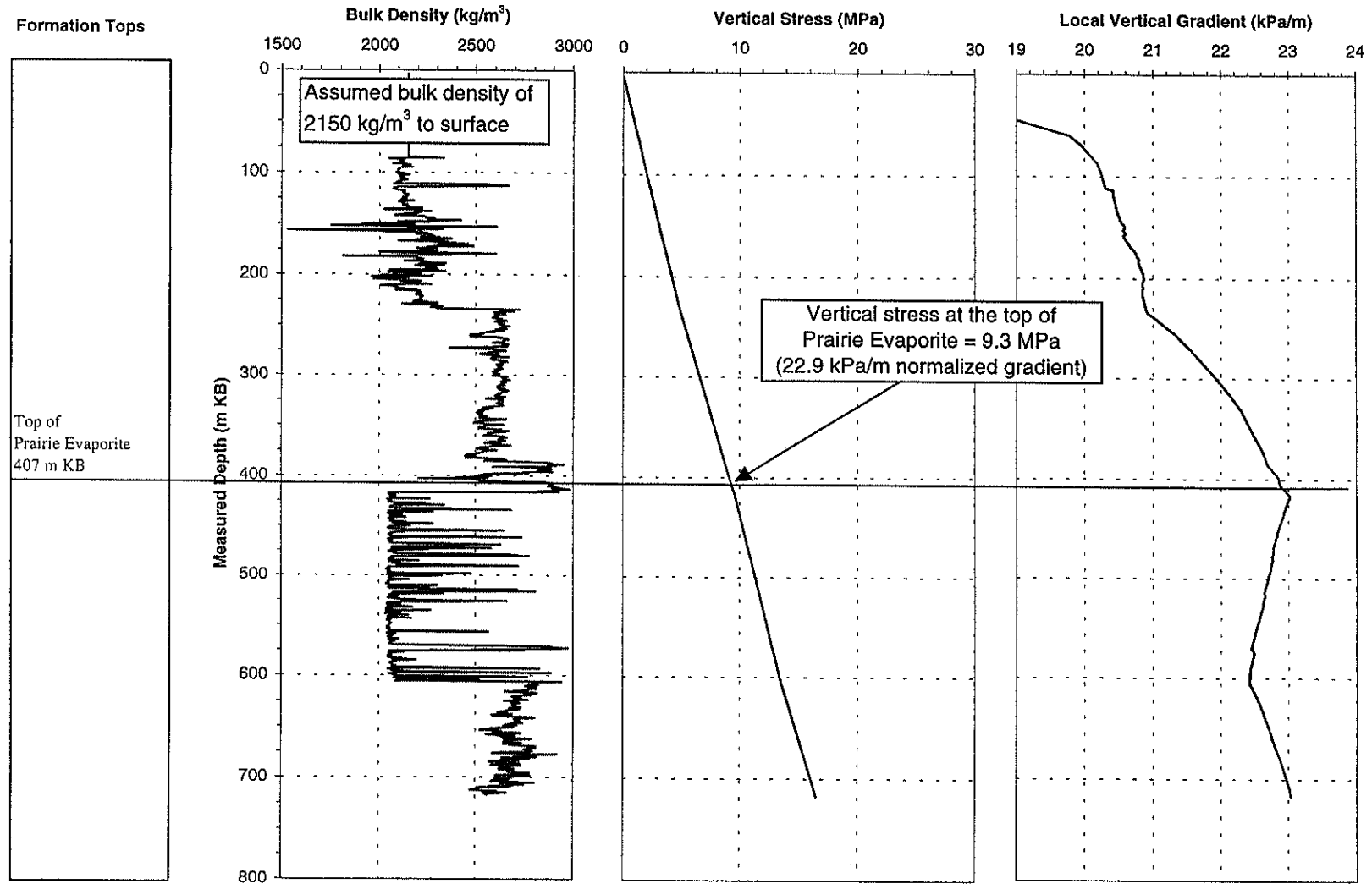


Figure D.1.74: Calculated vertical stress and vertical stress gradients for Suncor Clarke 2-32prev-89-12.

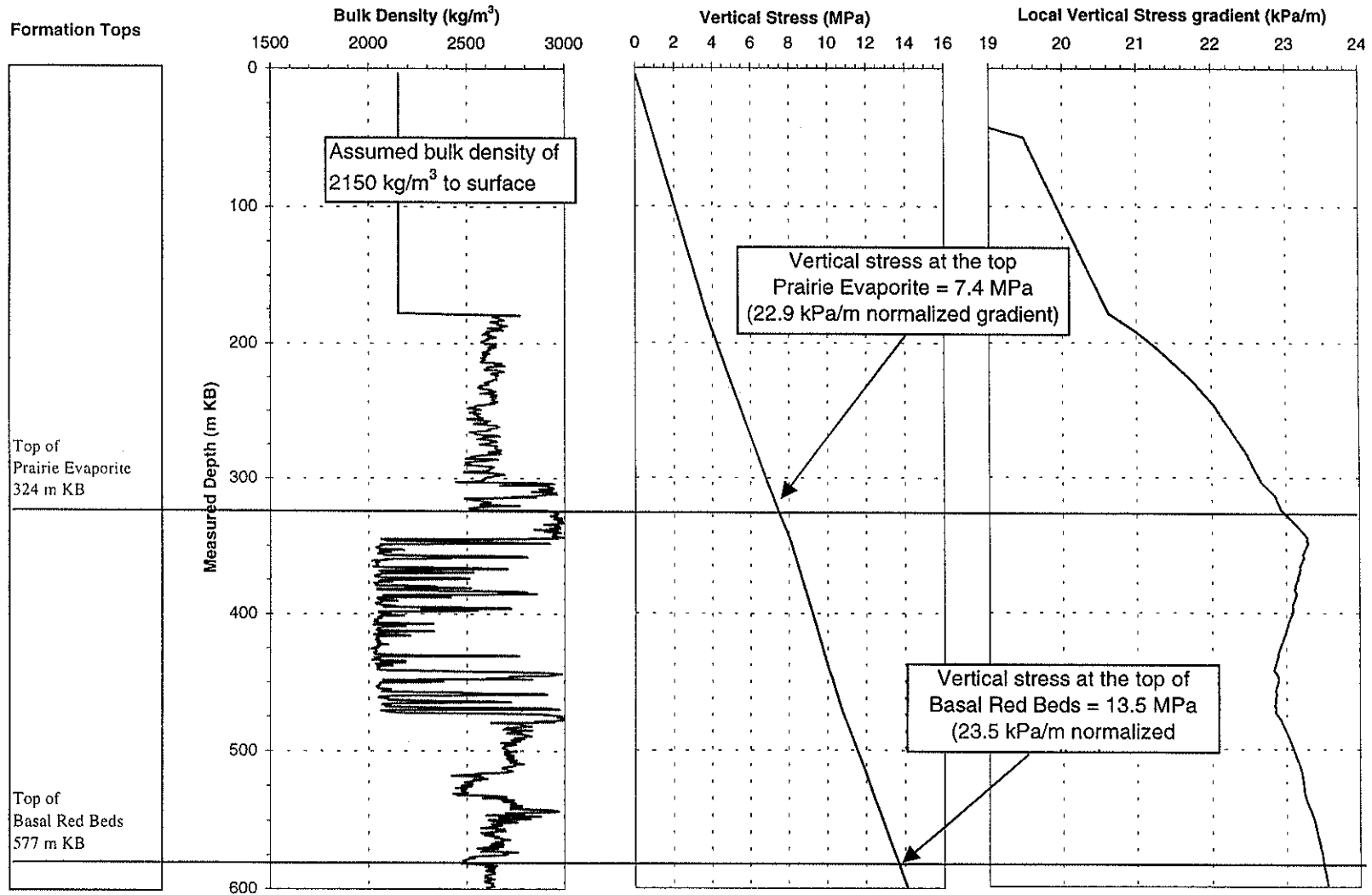


Figure D.1.75: Calculated vertical stress and vertical stress gradients for AOSTRA WDW1 Athasbasca 6-18-93-12.

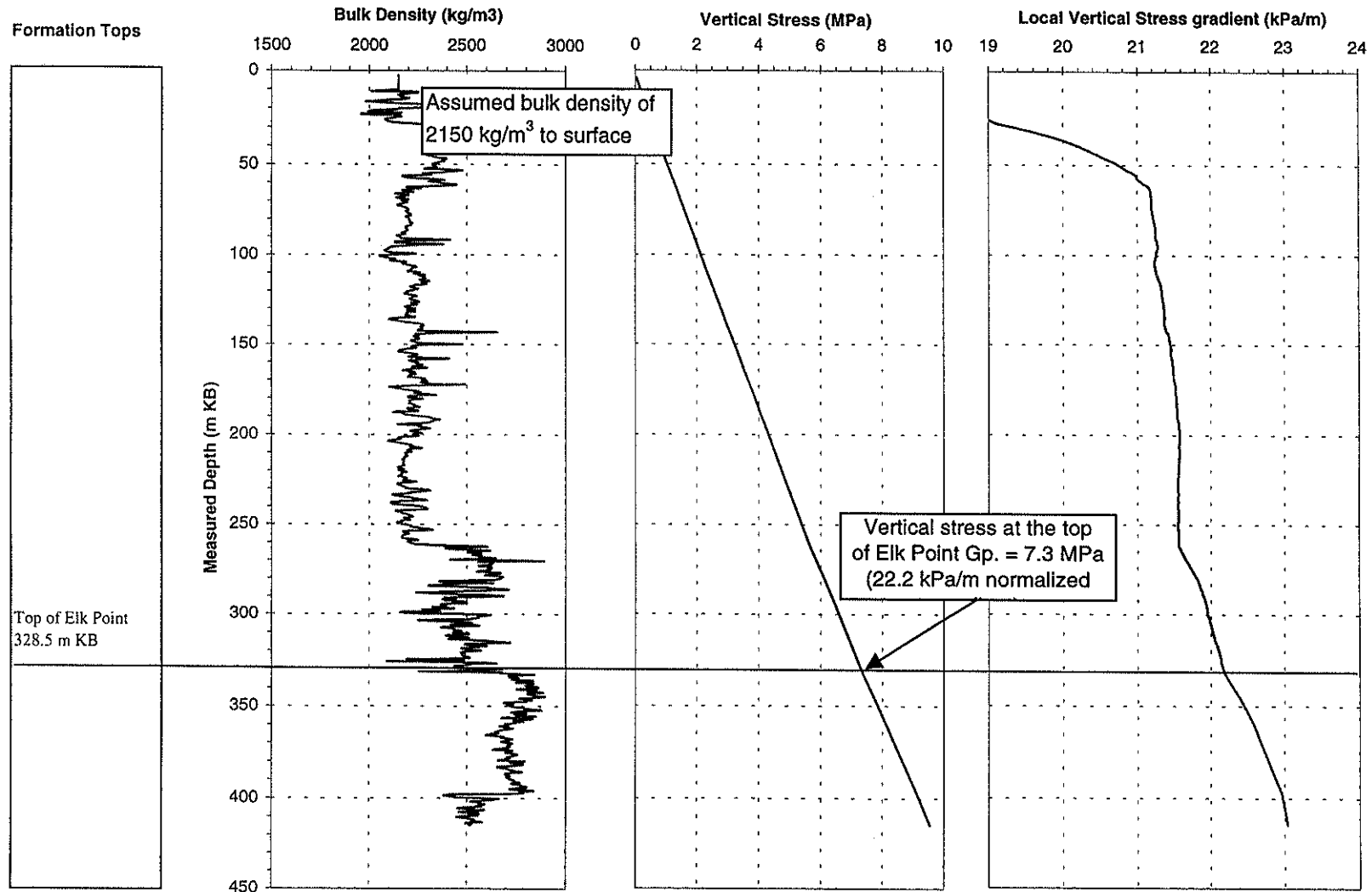


Figure D.1.76: Calculated vertical stress and vertical stress gradients for Chevron Steepbank EX 8-22-94-7.

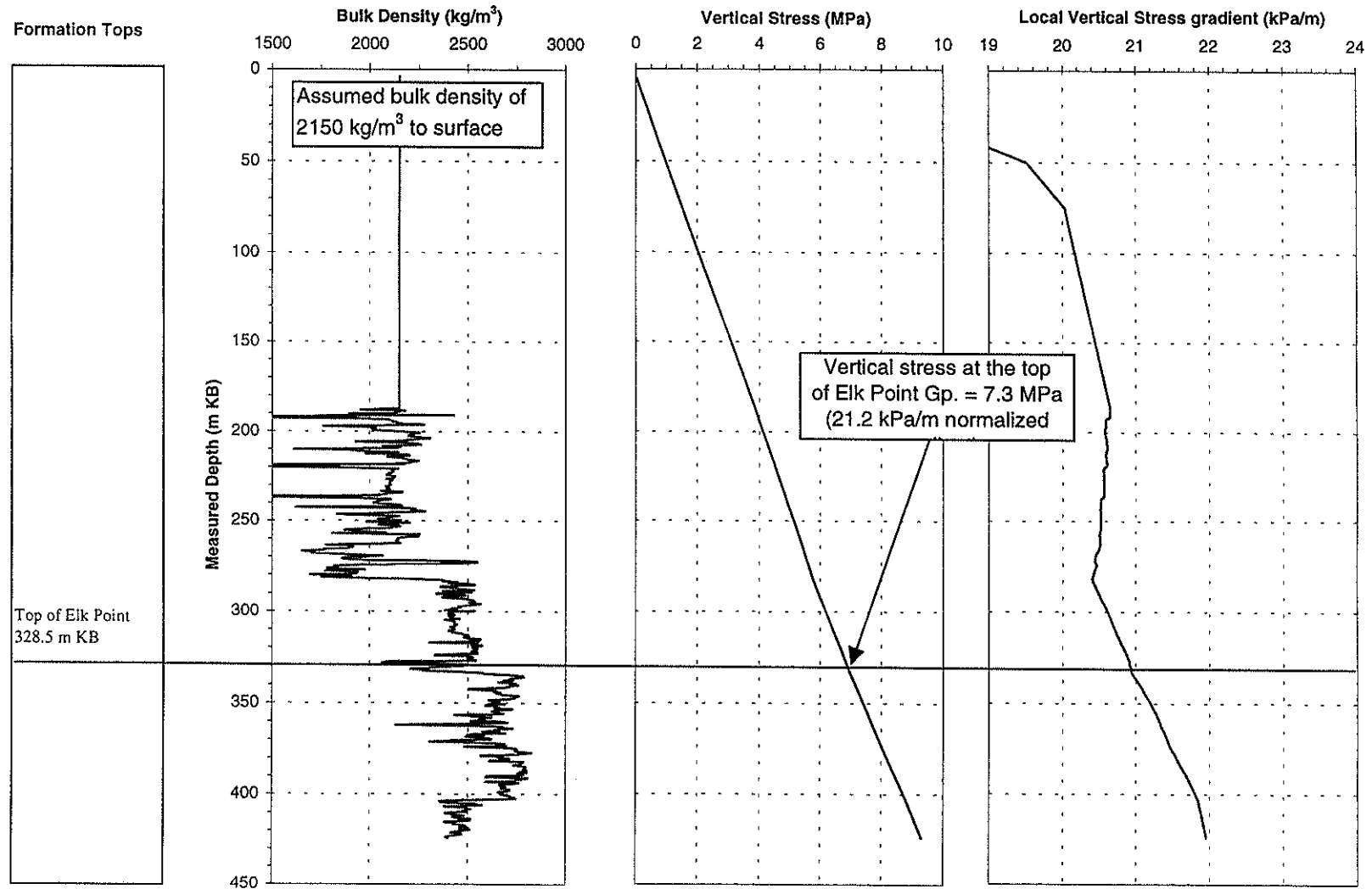


Figure D.1.77: Calculated vertical stress and vertical stress gradients for Chevron Steepbank 6-23-94-7.

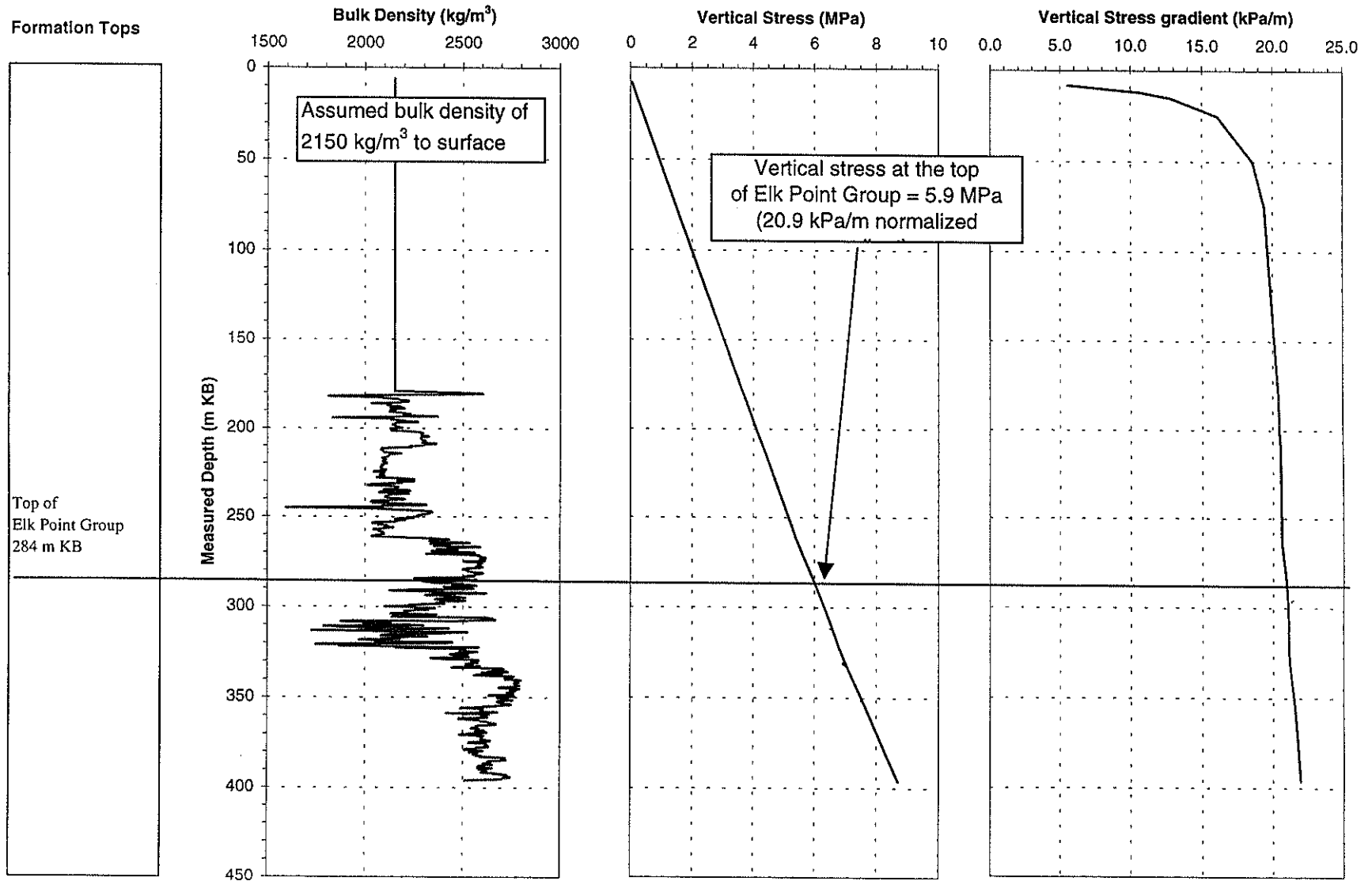


Figure D.1.78: Calculated vertical stress and vertical stress gradients for Chevron Steepbank 13-23-94-7.

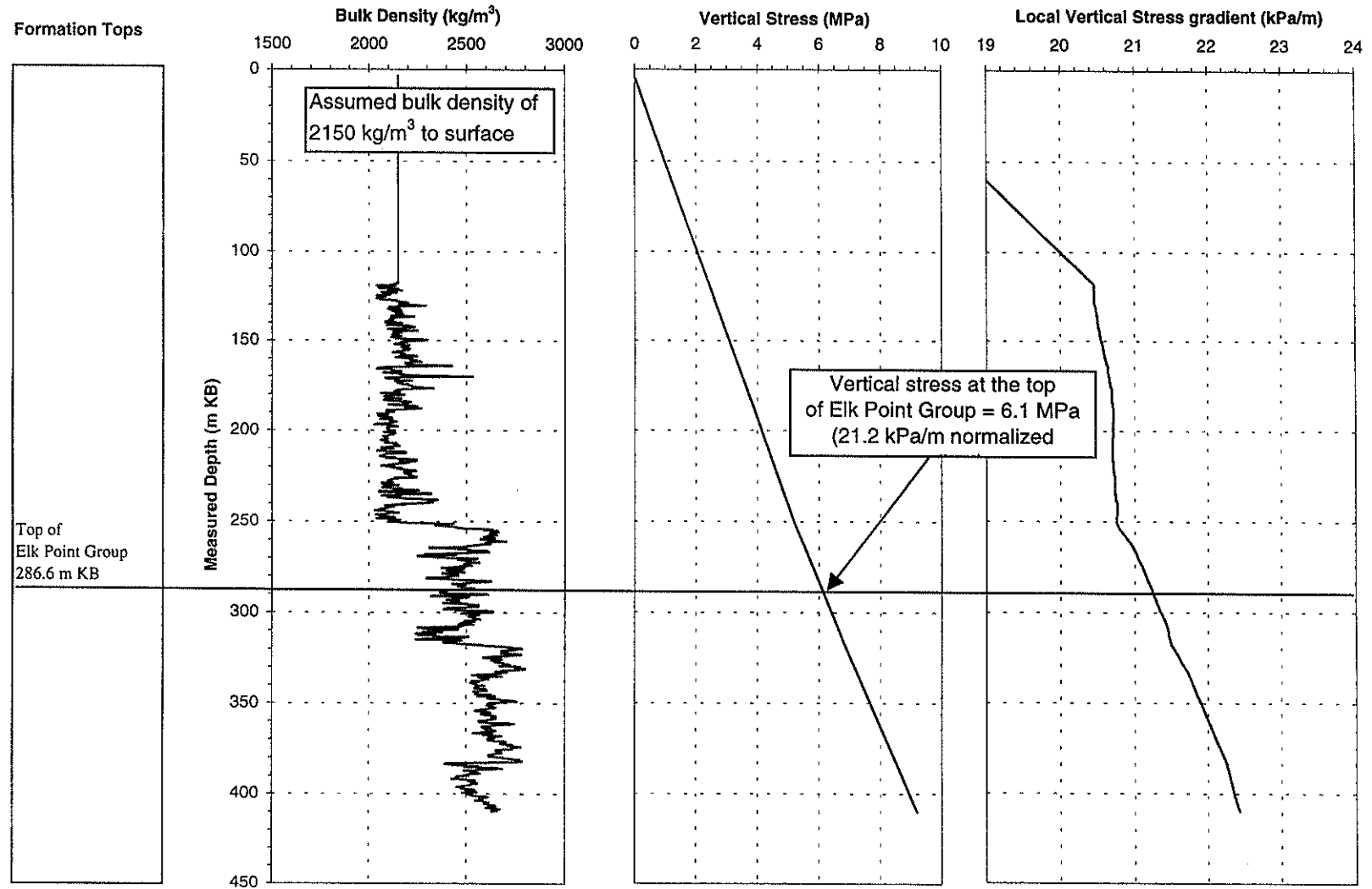


Figure D.1.79: Calculated vertical stress and vertical stress gradients for CDCOG Tenn Muskegr 1-3-95-7.

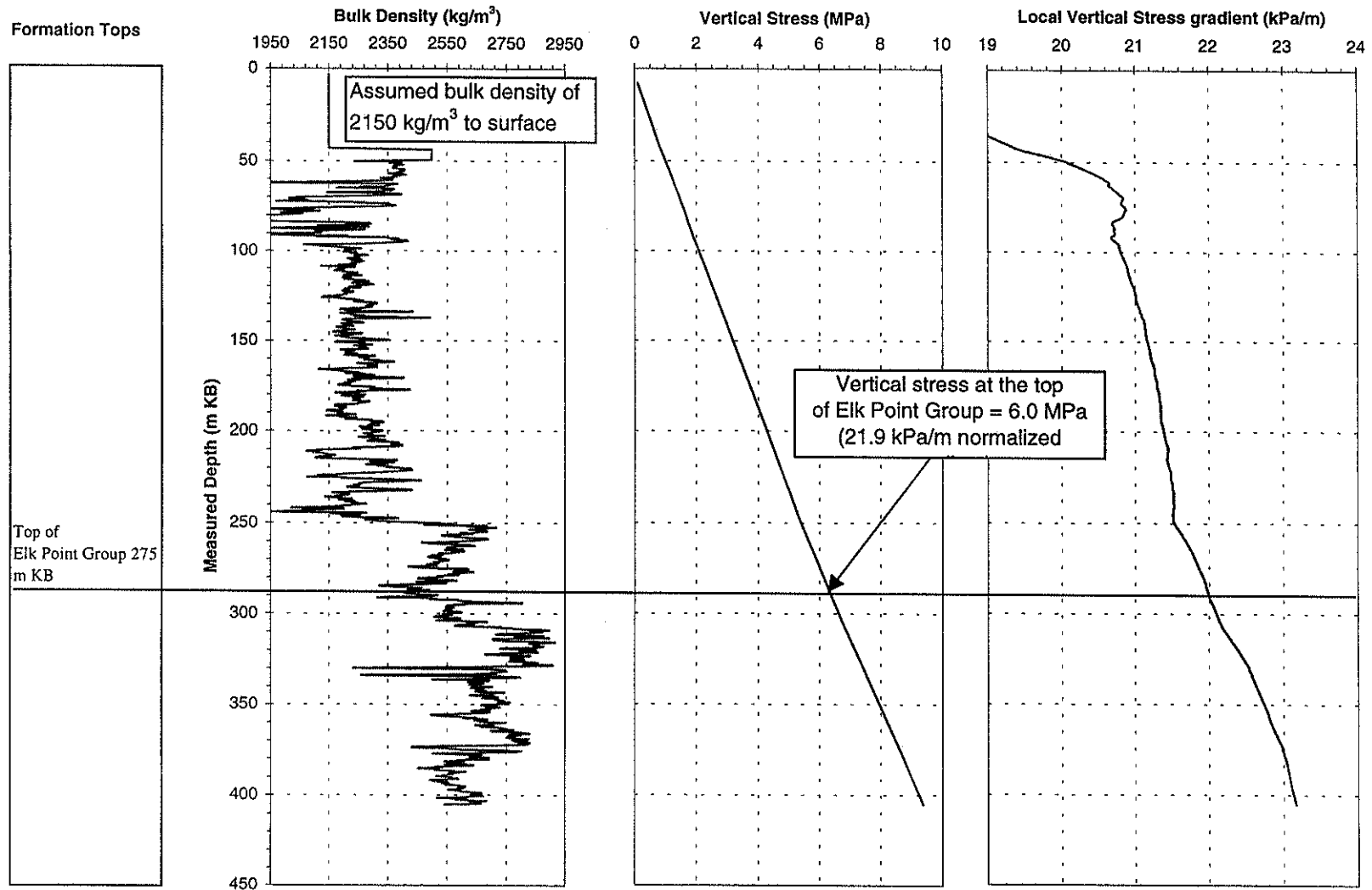


Figure D.1.80: Calculated vertical stress and vertical stress gradients for Husky Tenn Nova 3-14-95-7.

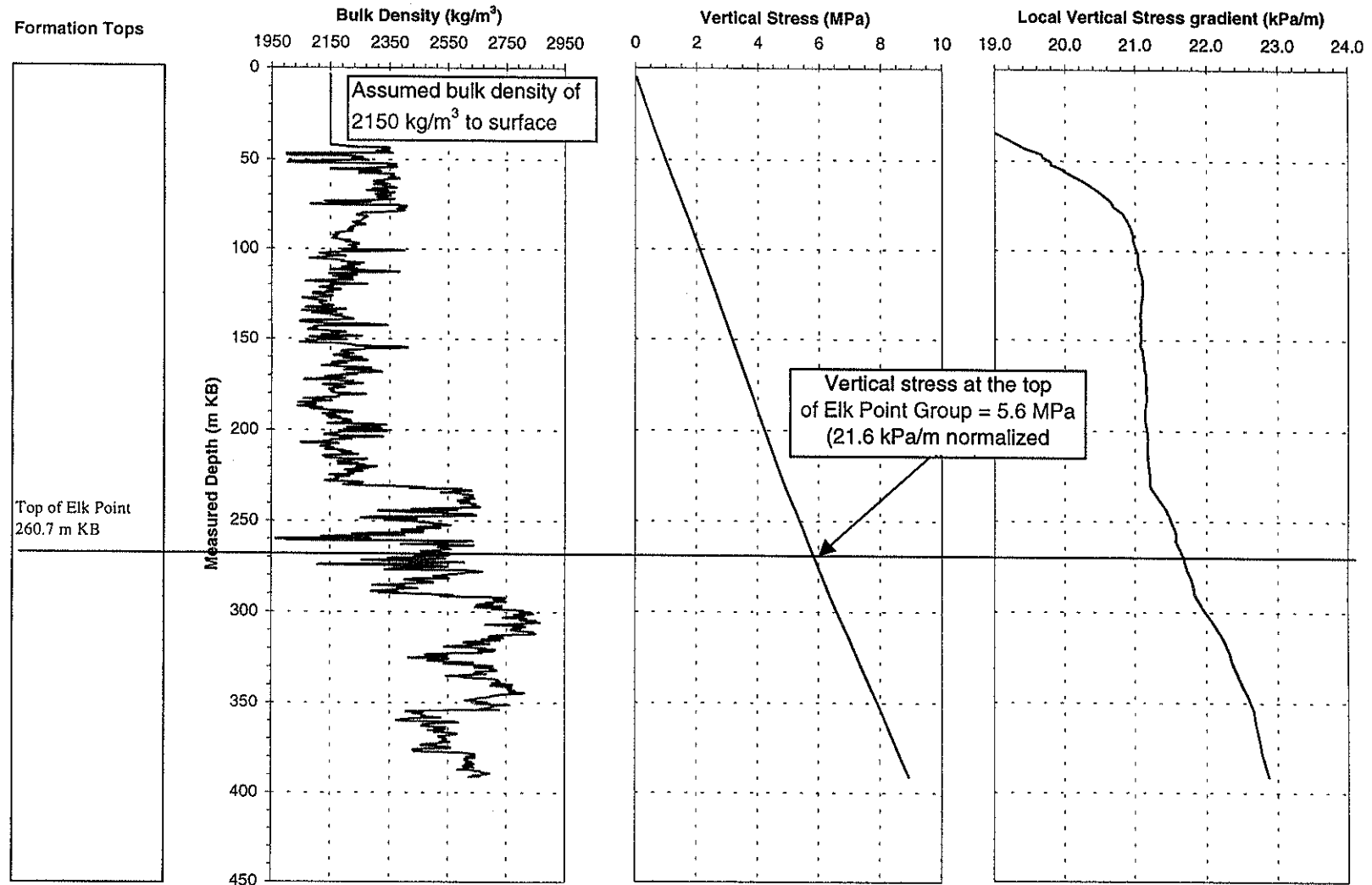


Figure D.1.81: Calculated vertical stress and vertical stress gradients for Husky Tenn Nova 3-15-95-7.

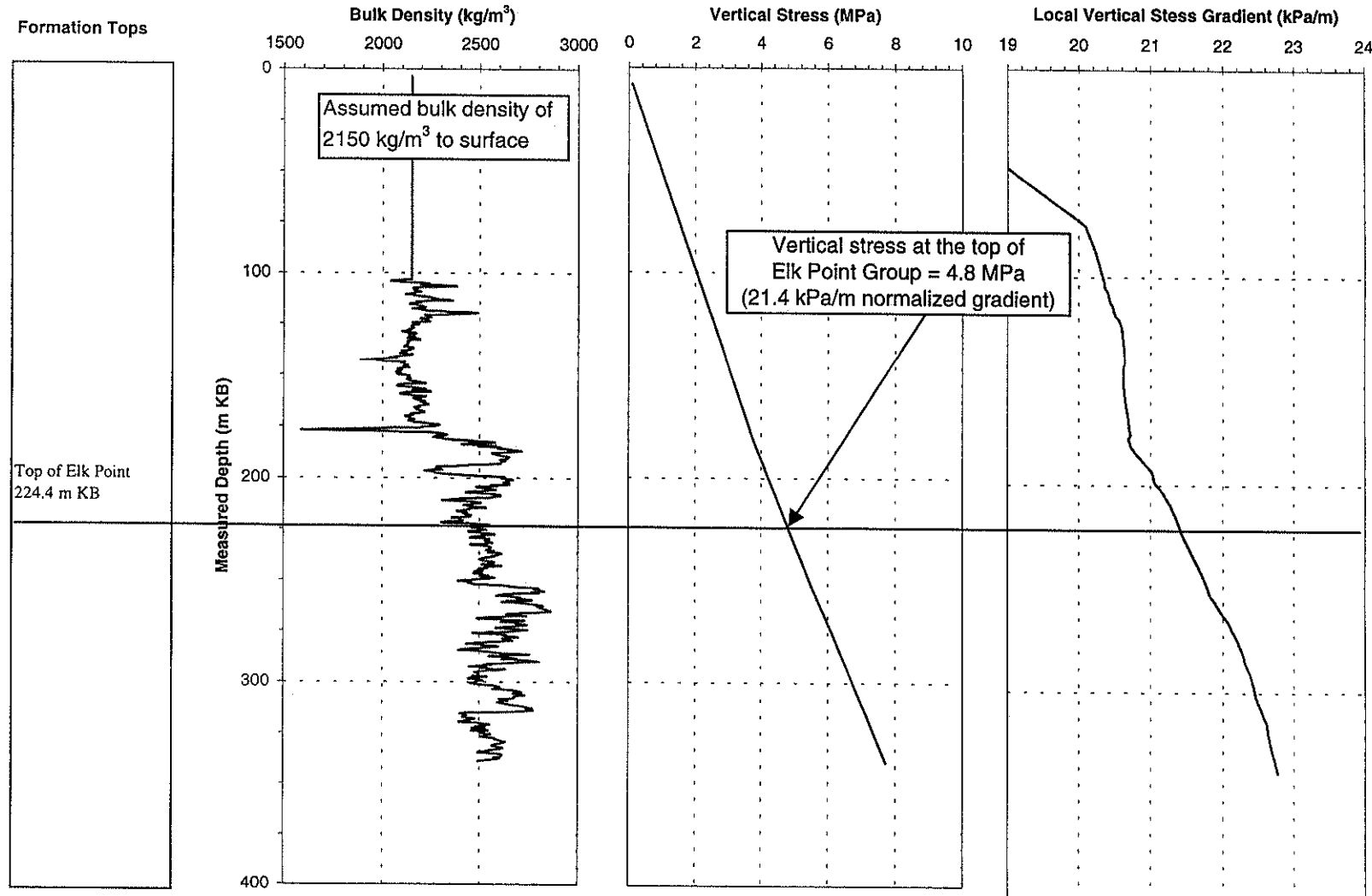


Figure D.1.82: Calculated vertical stress and vertical stress gradients for Husky Tenn Muskegr 1-20-95-7.

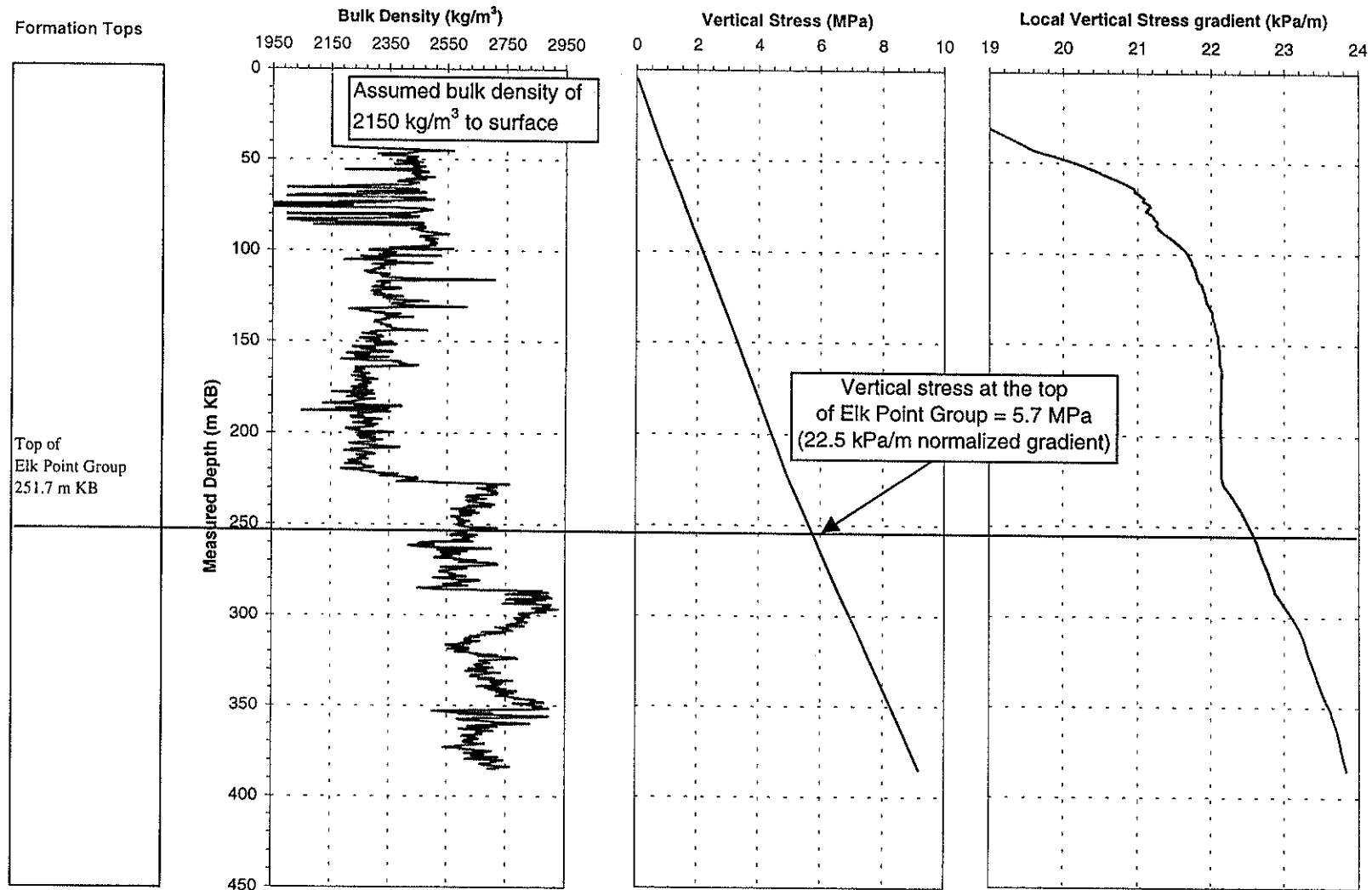


Figure D.1.83: Calculated vertical stress and vertical stress gradients for Husky Tenn Nova 4-22-95-7.

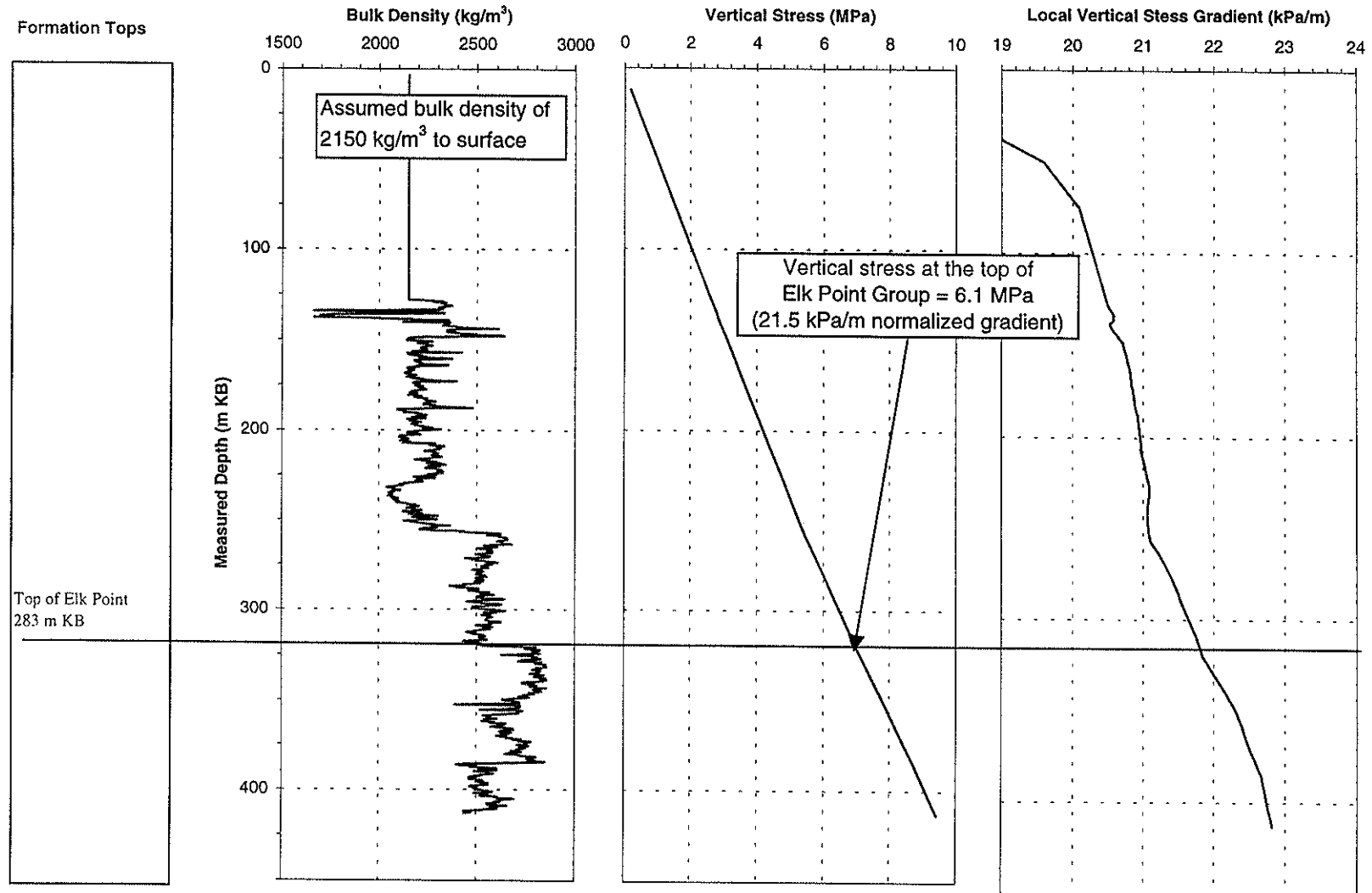


Figure D.1.84: Calculated vertical stress and vertical stress gradients for CDCOG Tenn Muskegr 1-24-95-7.

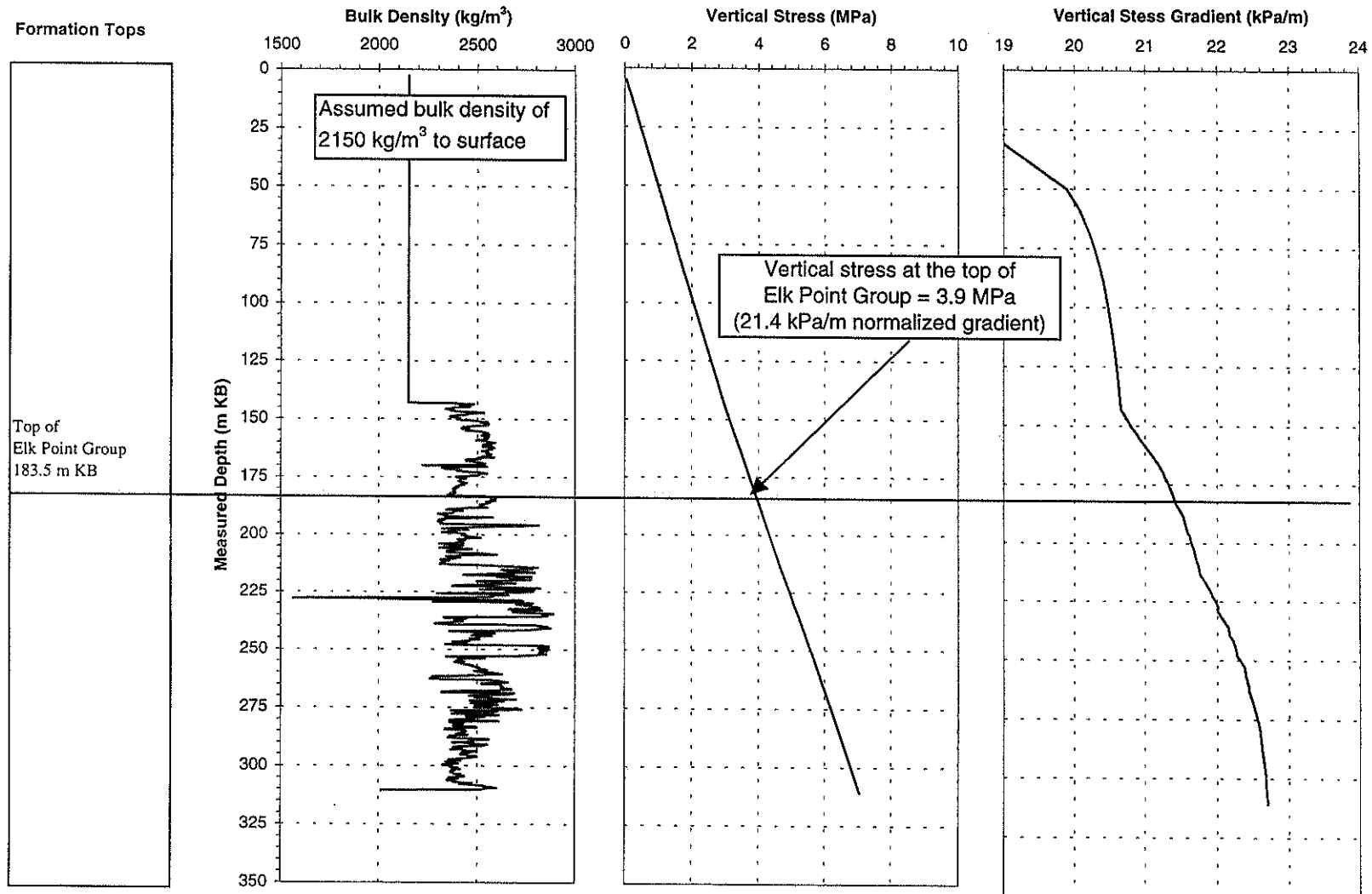


Figure D.1.85: Calculated vertical stress and vertical stress gradients for Esso 90PC Oslo 12-7-95-8.

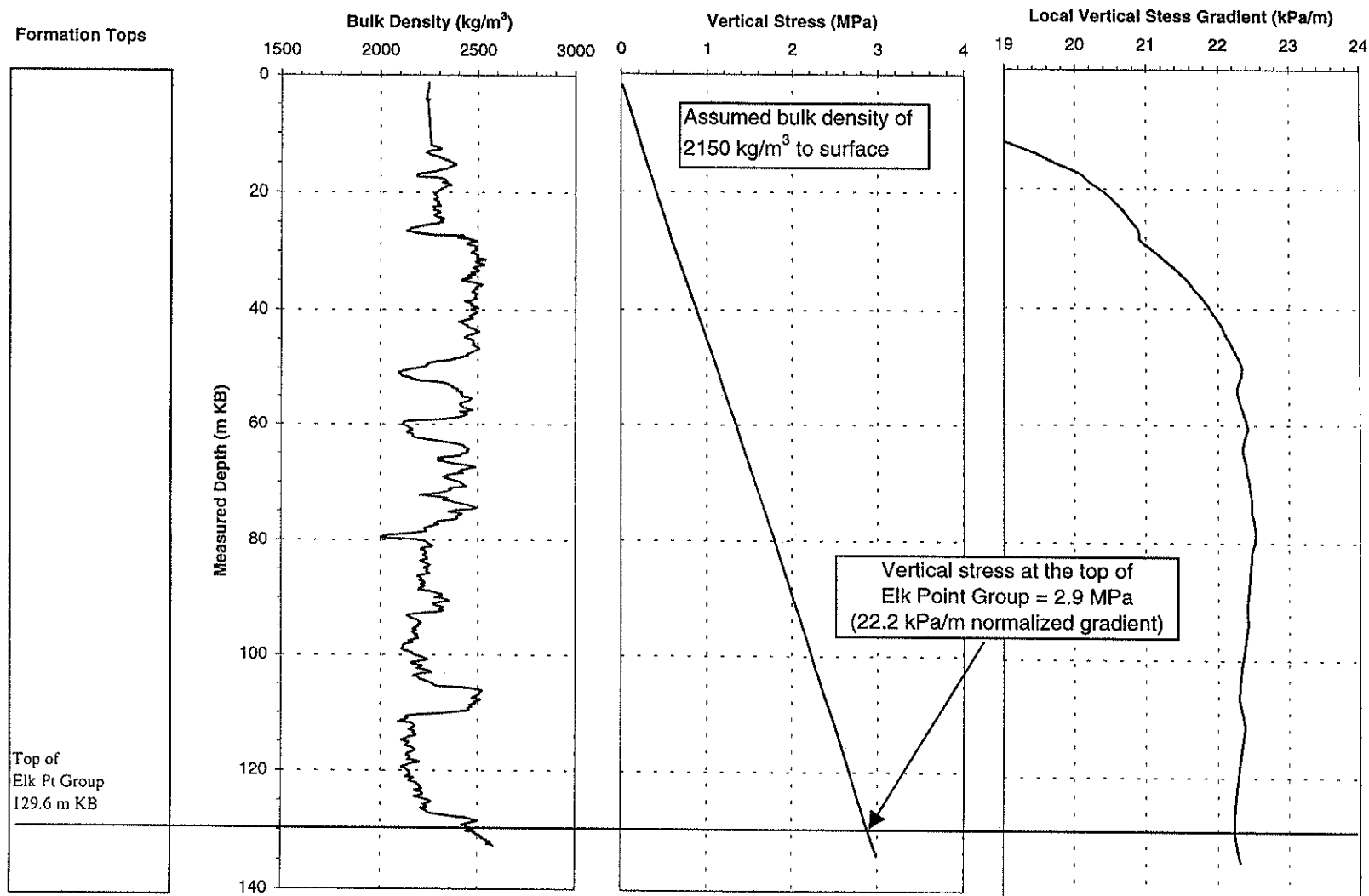


Figure D.1.86: Calculated vertical stress and vertical stress gradients for Gulf Firebag 15-8-96-1.

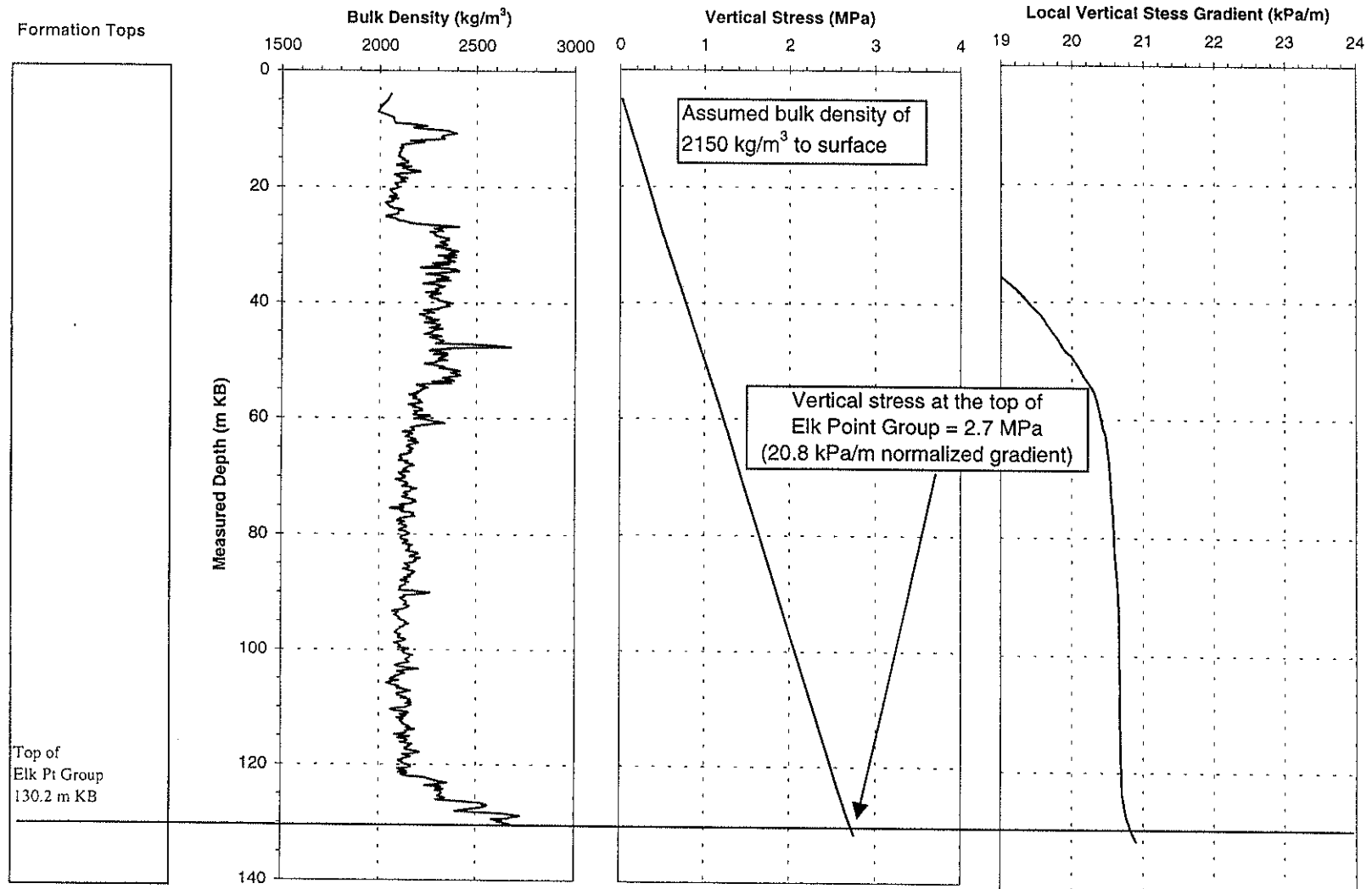


Figure D.1.87: Calculated vertical stress and vertical stress gradients for Gulf Firebag 14-11-96-1.

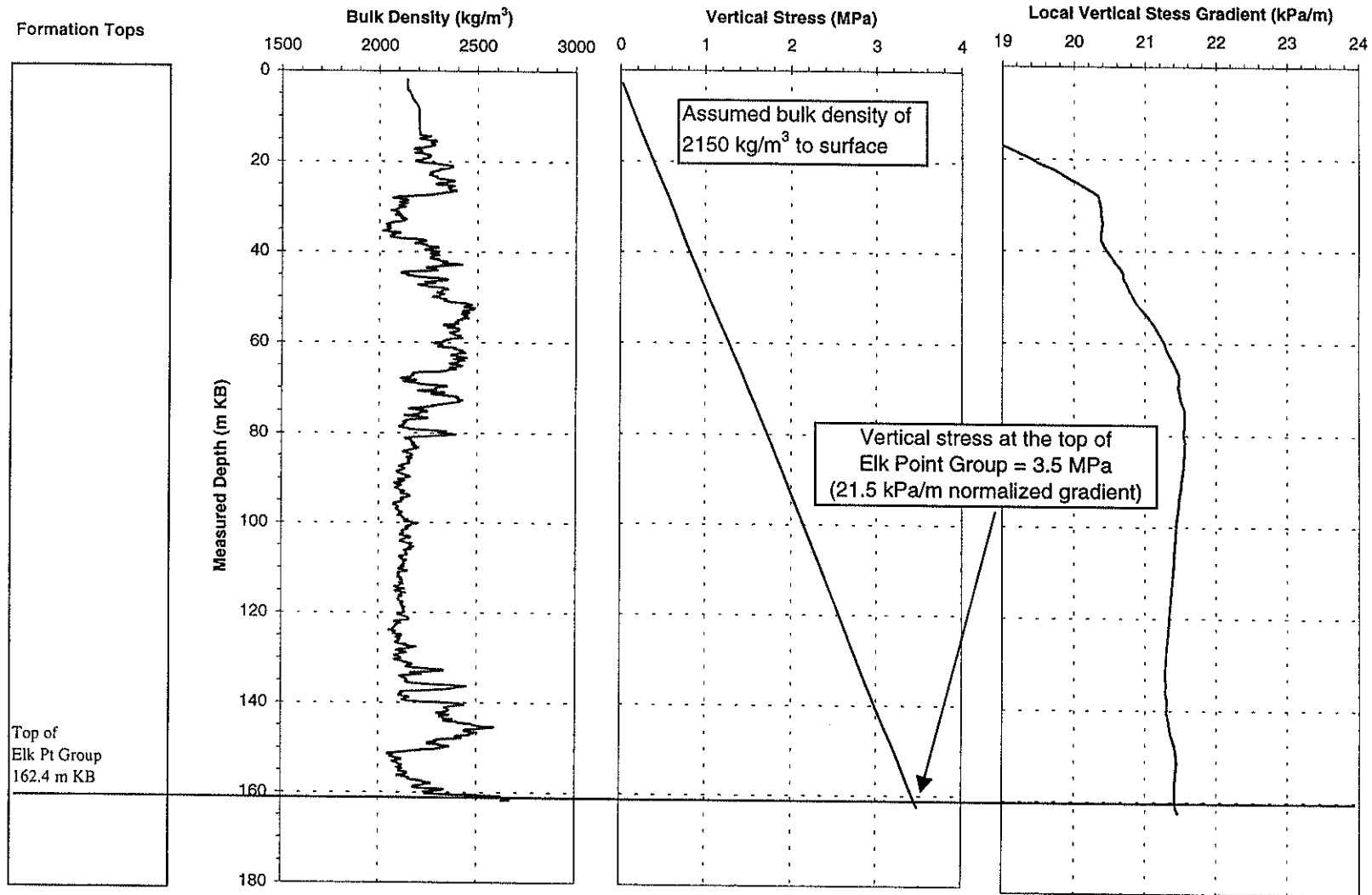


Figure D.1.88: Calculated vertical stress and vertical stress gradients for Gulf Firebag 6-26-96-1.

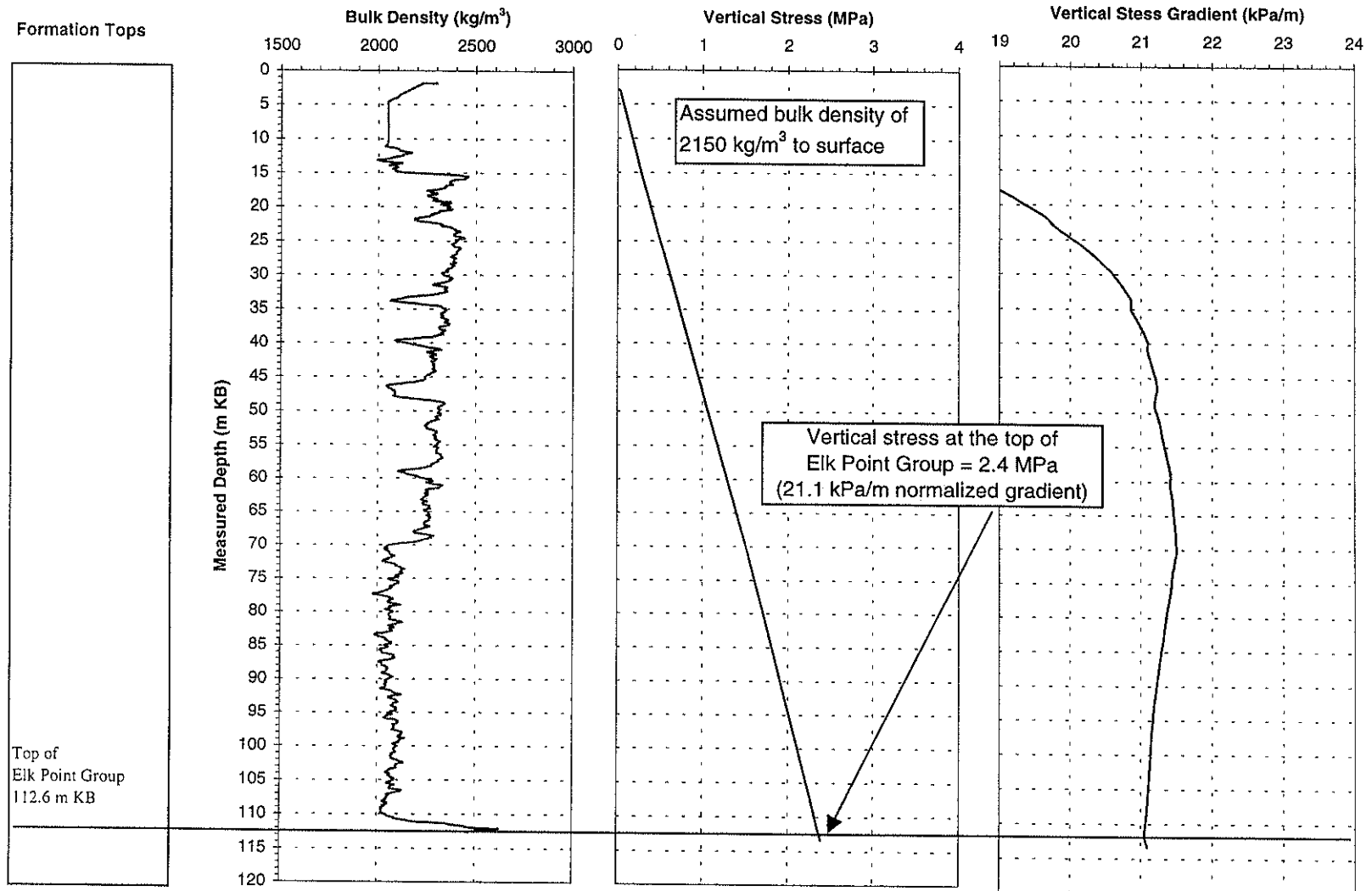


Figure D.189: Calculated vertical stress and vertical stress gradients for Gulf Firebag 7-29-96-1.

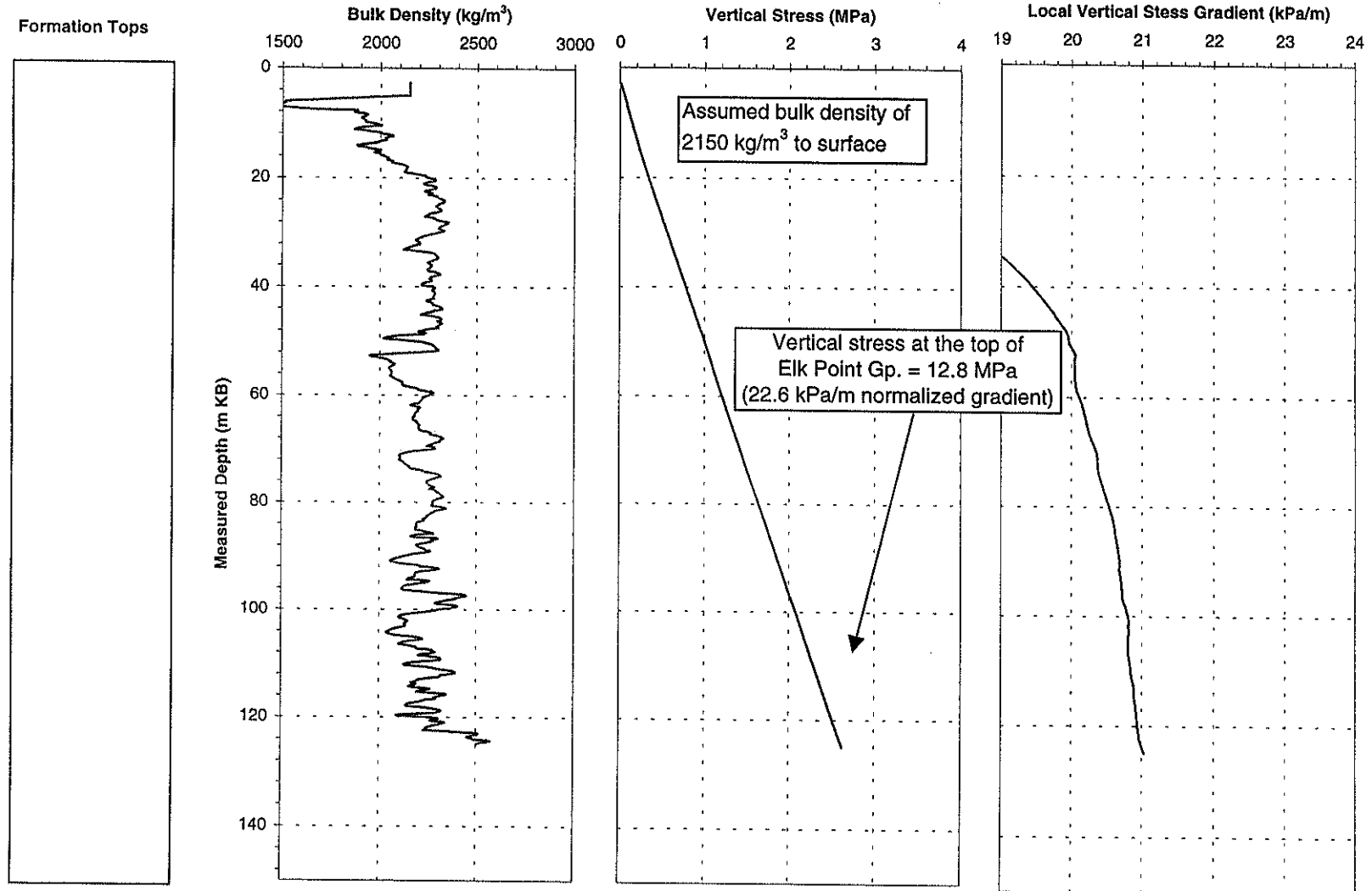


Figure D.1.90: Calculated vertical stress and vertical stress gradients for Gulf Firebag 2-8-97-1.

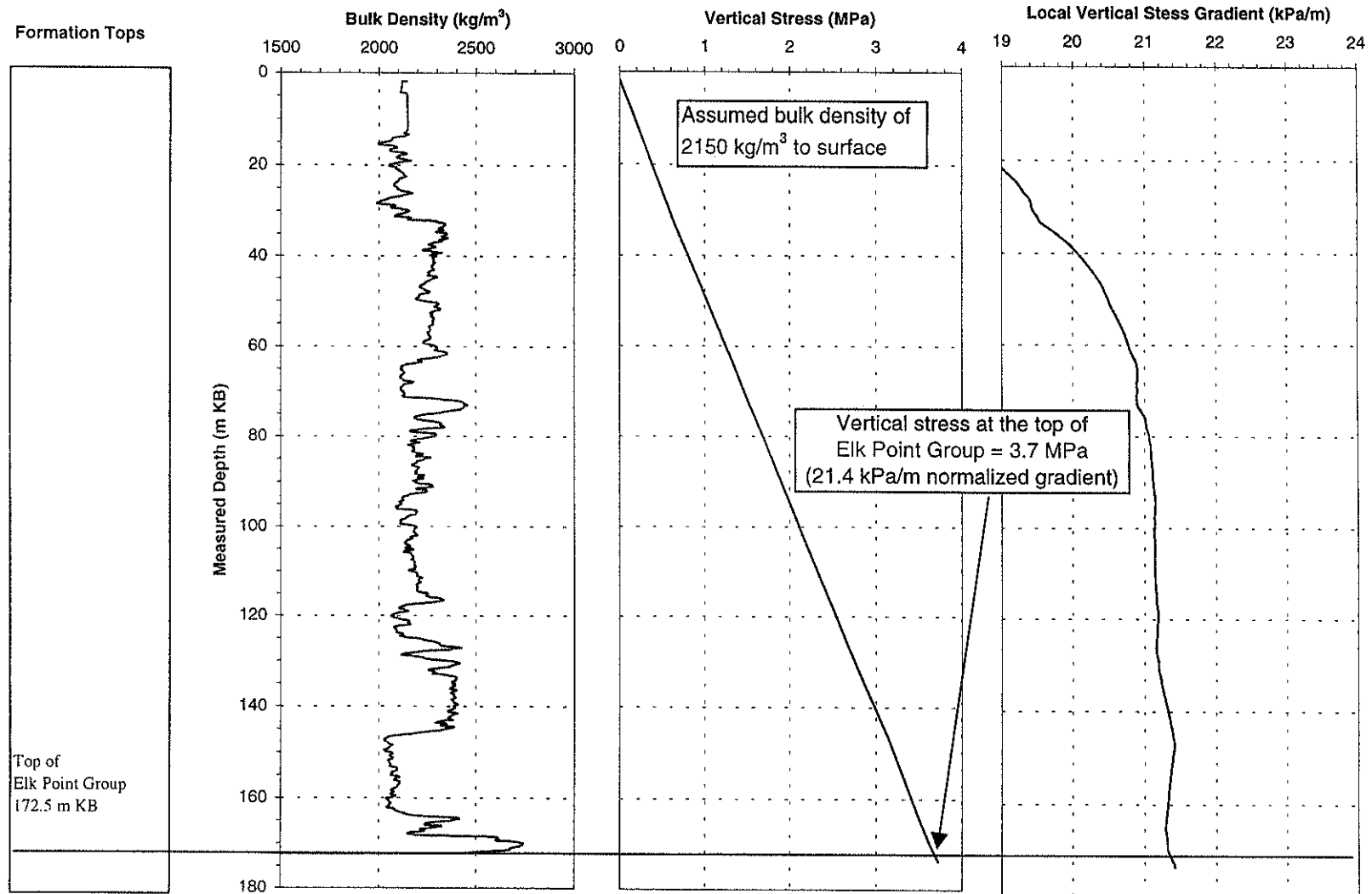


Figure D.1.91: Calculated vertical stress and vertical stress gradients for Gulf Firebag 2-11-97-1.

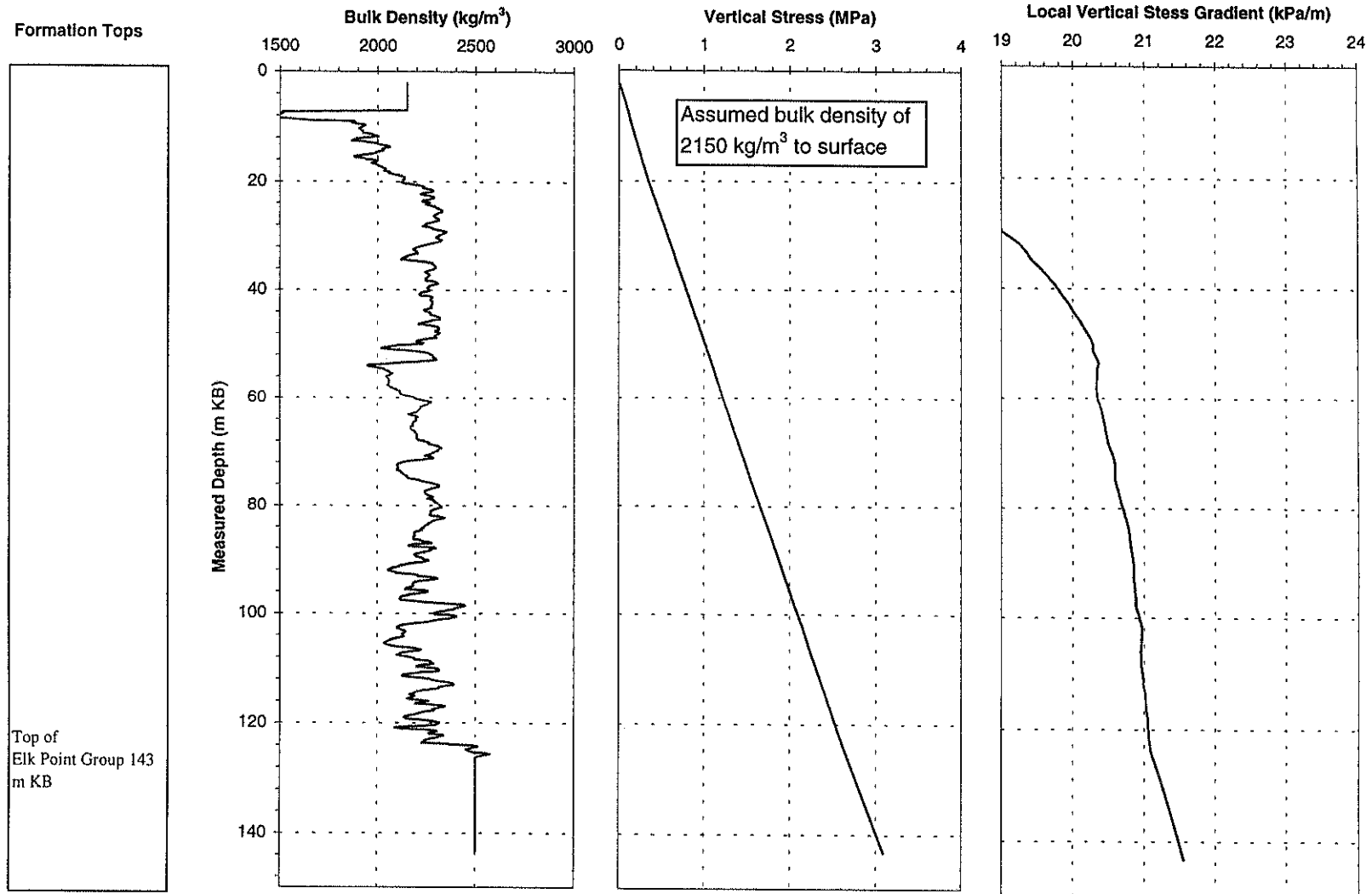


Figure D.1.92: Calculated vertical stress and vertical stress gradients for Gulf Firebag 13-12-97-2.

Table D.2: Detailed summary of breakout data in the Beaverhill Lake and Elk Point Groups

top: top of interval (m log depth)
 bottom: bottom of interval (m log depth)
 thickness: thickness of interval (m)
 P1AZ: azimuth of C1 caliper (degrees)
 P1AZc: azimuth of C1 caliper corrected to true north
 Cmax Az wrt true North: Breakout azimuth corrected to true north
 C1: C1-C3 caliper measurement (mm)
 C2: C2-C4 caliper measurement (mm)
 % enlarge % difference between C1 and C2 readings
 % gauge % difference between smaller caliper reading and hole gauge
 quality: quality of breakout
 formation formation that breakout occurs within

Well Name: Voyager et al Bruce 6-14-48-14 (100/06-14-048-14W4/00)

Borehole Diameter: 159 mm

Correction to True North: 20 (1982, Lat: 53, Long 112 = correction 20 deg E)

top (m KB)	bottom (m KB)	thickness (m)	P1AZ (deg)	CMAX Az (deg)	CMAX Az wrt true N (deg)	C1 (mm)	C2 (mm)	% enlarge	% gauge	quality	formation
1475	1476	1	230	230	250	181.25	161	12.58%	1.26%	v good	Watt Mtn
1474	1475	1	230	230	250	173	156	10.90%	-1.89%	v good	Watt Mtn
1473	1474	1	225	225	245	171	153	11.76%	-3.77%	good	Watt Mtn
1472	1473	1	240	240	260	175	156	12.18%	-1.89%	good	Watt Mtn
1471	1472	1	235	235	255	173	159	8.81%	0.00%	good	Watt Mtn
1470	1471	1	235	235	255	169	153	10.46%	-3.77%	good	Watt Mtn
1469	1470	1	232	232	252	165	153	7.84%	-3.77%	good	Watt Mtn
1468	1469	1	230	230	250	165	153	7.84%	-3.77%	good	Watt Mtn
1467	1468	1	235	235	255	161	153	5.23%	-3.77%	good	Watt Mtn
1466	1467	1	238	238	258	160	153	4.58%	-3.77%	good	Watt Mtn
1465	1466	1	238	238	258	160	153	4.58%	-3.77%	good	Watt Mtn
1464	1465	1	238	238	258	160	153	4.58%	-3.77%	good	Watt Mtn
1463	1464	1	240	240	260	159	153	3.92%	-3.77%	good	Watt Mtn
1462	1463	1	240	240	260	159	153	3.92%	-3.77%	good	Watt Mtn
1461	1462	1	240	240	260	158	153	3.27%	-3.77%	fair	Watt Mtn
1460	1461	1	240	240	260	157	153	2.61%	-3.77%	fair	Watt Mtn
1459	1460	1	242	242	262	156	153	1.96%	-3.77%	fair	Watt Mtn

Table D.2: Detailed summary of breakout data in the Beaverhill Lake and Elk Point Groups

Well Name: AEC D1 Fisher 1-21-70-4 (104/01-21-070-04W4/00)

Borehole Diameter: 311 mm

Correction to True North: 0 (corrected 18 deg E on log)

top (m KB)	bottom (m KB)	thickness (m)	PIAZ (deg)	CMAZ Az (deg)	CMAZ Az wrt true N (deg)	C1 (mm)	C2 (mm)	% enlarge	% gauge	quality	formation
510	511	1	145	145	145	320	311	2.89%	0.00%	poor	BH LK
511	512	1	145	145	145	320	311	2.89%	0.00%	poor	BH LK
512	513	1	145	145	145	315	311	1.29%	0.00%	poor	BH LK
513	514	1	145	145	145	320	311	2.89%	0.00%	poor	BH LK
514	515	1	145	145	145	320	311	2.89%	0.00%	poor	BH LK
515	516	1	145	145	145	320	311	2.89%	0.00%	poor	BH LK

Well Name: AEC A8 Fisher 8-21-70-4 (100/08-21-070-04W4/00)

Borehole Diameter: 200 mm

Correction to True North: 0 (corrected 18.3 deg E on log)

Comments: Dipmeter logged 09-Oct-96 while other logs ran 12-Feb-97

Comments: No PIAZ trace (tadpoles within breakout zone)

top (m KB)	bottom (m KB)	thickness (m)	PIAZ (deg)	CMAZ Az (deg)	CMAZ Az wrt true N (deg)	C1 (mm)	C2 (mm)	% enlarge	% gauge	quality	formation
520	521	1	285	285	285	209	200	4.50%	0.00%	fair	BH LK
521	522	1	285	285	285	209	198	5.56%	-1.00%	fair	BH LK
522	523	1	285	285	285	213	198	7.58%	-1.00%	fair	BH LK
523	524	1	285	285	285	217	198	9.60%	-1.00%	fair	BH LK
524	525	1	285	285	285	211	198	6.57%	-1.00%	fair	BH LK
525	526	1	280	280	280	209	196	6.63%	-2.00%	fair	BH LK
526	527	1	280	280	280	209	196	6.63%	-2.00%	fair	BH LK
527	528	1	280	280	280	209	196	6.63%	-2.00%	fair	BH LK
528	529	1	280	280	280	208	196	6.12%	-2.00%	fair	BH LK
529	530	1	280	280	280	209	196	6.63%	-2.00%	fair	BH LK
530	531	1	280	280	280	211	200	5.50%	0.00%	fair	BH LK
531	532	1	280	280	280	208	196	6.12%	-2.00%	fair	BH LK
532	533	1	280	280	280	206	196	5.10%	-2.00%	fair	BH LK
533	534	1	275	275	275	203	200	1.50%	0.00%	fair	BH LK
534	535	1	275	275	275	200	200	0.00%	0.00%	fair	BH LK

Table D.2: Detailed summary of breakout data in the Beaverhill Lake and Elk Point Groups

Well Name: **AEC B3 Fisher 3-22-70-4 (100/03-22-070-04W4/00)**

Borehole Diameter: 159 mm

Correction to True North: 0 (corrected 18.2 deg E on log)

Comments:

top (m KB)	bottom (m KB)	thickness (m)	PIAZ (deg)	CMAX Az (deg)	CMAX Az wrt true N (deg)	C1 (mm)	C2 (mm)	% enlarge	% gauge	quality	formation
496	497	1	115	115	115	167	162	3.09%	1.89%	poor	BH LK
497	498	1	115	115	115	167	159	5.03%	0.00%	poor	BH LK
498	499	1	115	115	115	171	162	5.56%	1.89%	poor	BH LK
499	500	1	115	115	115	173	159	8.81%	0.00%	poor	BH LK
500	501	1	115	115	115	173	159	8.81%	0.00%	poor	BH LK
501	502	1	115	115	115	173	159	8.81%	0.00%	poor	BH LK

Well Name: **AEC Fisher 6-33-70-4 (100/06-33-070-04W4/00)**

Borehole Diameter: 159 mm

Correction to True North: 0 (corrected 18.2 deg E on log)

Comments:

top	bottom	thickness	PIAZ	CMAX Az	CMAX Az wrt true N	C1	C2	% enlarge	% gauge	quality	formation
495	496	1	140	140	140	167	159	5.03%	0.00%	fair	BH LK
496	497	1	140	140	140	167	159	5.03%	0.00%	fair	BH LK
497	498	1	140	140	140	171	159	7.55%	0.00%	fair	BH LK
498	499	1	140	140	140	167	159	5.03%	0.00%	fair	BH LK
499	500	1	140	140	140	165	159	3.77%	0.00%	fair	BH LK
500	501	1	140	140	140	165	159	3.77%	0.00%	fair	BH LK

Table D.2: Detailed summary of breakout data in the Beaverhill Lake and Elk Point Groups

top: top of interval (m log depth)
 bottom: bottom of interval (m log depth)
 thickness: thickness of interval (m)
 P1AZ: azimuth of C1 caliper (degrees)
 P1AZc: azimuth of C1 caliper corrected to true north
 Cmax Az wrt true North: Breakout azimuth corrected to true north
 C1: C1-C3 caliper measurement (mm)
 C2: C2-C4 caliper measurement (mm)
 % enlarge % difference between C1 and C2 readings
 % gauge % difference between smaller caliper reading and hole gauge
 quality: quality of breakout
 formation formation that breakout occurs within

SD of corrected CMAX Az data from all wells: 53°

Well Name: **Voyager et al Bruce 6-14-48-14 (100/06-14-048-14W4/00)**

Borehole Diameter: 159 mm

Correction to True North: 20 (1982, Lat: 53, Long 112 = correction 20 deg E)

top (m KB)	bottom (m KB)	thickness (m)	P1AZ (deg)	CMAX Az (deg)	CMAX Az wrt true N (deg)	C (m)					formation	
1475	1476	1	230	230	250	181						Watt Mtn
1474	1475	1	230	230	250	173						Watt Mtn
1473	1474	1	225	225	245	171						Watt Mtn
1472	1473	1	240	240	260	175						Watt Mtn
1471	1472	1	235	235	255	173						Watt Mtn
1470	1471	1	235	235	255	169						Watt Mtn
1469	1470	1	232	232	252	165						Watt Mtn
1468	1469	1	230	230	250	165						Watt Mtn
1467	1468	1	235	235	255	161			-3.17%	good		Watt Mtn
1466	1467	1	238	238	258	160	153	4.58%	-3.77%	good		Watt Mtn
1465	1466	1	238	238	258	160	153	4.58%	-3.77%	good		Watt Mtn
1464	1465	1	238	238	258	160	153	4.58%	-3.77%	good		Watt Mtn
1463	1464	1	240	240	260	159	153	3.92%	-3.77%	good		Watt Mtn
1462	1463	1	240	240	260	159	153	3.92%	-3.77%	good		Watt Mtn
1461	1462	1	240	240	260	158	153	3.27%	-3.77%	fair		Watt Mtn
1460	1461	1	240	240	260	157	153	2.61%	-3.77%	fair		Watt Mtn
1459	1460	1	242	242	262	156	153	1.96%	-3.77%	fair		Watt Mtn

(Original defect on this page)

SD of corrected CMAX Az data:

9

Table D.2: Detailed summary of breakout data in the Beaverhill Lake and Elk Point Groups

Well Name: **AEC D1 Fisher 1-21-70-4 (104/01-21-070-04W4/00)**

Borehole Diameter: 311 mm

Correction to True North: 0 (corrected 18 deg E on log)

top (m KB)	bottom (m KB)	thickness (m)	PIAZ (deg)	CMAX Az (deg)	CMAX Az wrt true N (deg)	C1 (mm)	C2 (mm)	% enlarge	% gauge	quality	formation
510	511	1	145	145	145	320	311	2.89%	0.00%	poor	BH LK
511	512	1	145	145	145	320	311	2.89%	0.00%	poor	BH LK
512	513	1	145	145	145	315	311	1.29%	0.00%	poor	BH LK
513	514	1	145	145	145	320	311	2.89%	0.00%	poor	BH LK
514	515	1	145	145	145	320	311	2.89%	0.00%	poor	BH LK
515	516	1	145	145	145	320	311	2.89%	0.00%	poor	BH LK

SD of corrected CMAX Az data: 0

Well Name: **AEC A8 Fisher 8-21-70-4 (100/08-21-070-04W4/00)**

Borehole Diameter: 200 mm

Correction to True North: 0 (corrected 18.3 deg E on log)

Comments: Dipmeter logged 09-Oct-96 while other logs ran 12-Feb-97

Comments: No PIAZ trace (tadpoles within breakout zone)

top (m KB)	bottom (m KB)	thickness (m)	PIAZ (deg)	CMAX Az (deg)	CMAX Az wrt true N (deg)	C1 (mm)	C2 (mm)	% enlarge	% gauge	quality	formation
520	521	1	285	285	285	209	200	4.50%	0.00%	fair	BH LK
521	522	1	285	285	285	209	198	5.56%	-1.00%	fair	BH LK
522	523	1	285	285	285	213	198	7.58%	-1.00%	fair	BH LK
523	524	1	285	285	285	217	198	9.60%	-1.00%	fair	BH LK
524	525	1	285	285	285	211	198	6.57%	-1.00%	fair	BH LK
525	526	1	280	280	280	209	196	6.63%	-2.00%	fair	BH LK
526	527	1	280	280	280	209	196	6.63%	-2.00%	fair	BH LK
527	528	1	280	280	280	209	196	6.63%	-2.00%	fair	BH LK
528	529	1	280	280	280	208	196	6.12%	-2.00%	fair	BH LK
529	530	1	280	280	280	209	196	6.63%	-2.00%	fair	BH LK
530	531	1	280	280	280	211	200	5.50%	0.00%	fair	BH LK
531	532	1	280	280	280	208	196	6.12%	-2.00%	fair	BH LK
532	533	1	280	280	280	206	196	5.10%	-2.00%	fair	BH LK
533	534	1	275	275	275	203	200	1.50%	0.00%	fair	BH LK
534	535	1	275	275	275	200	200	0.00%	0.00%	fair	BH LK

SD of corrected CMAX Az data: 7

Table D.2: Detailed summary of breakout data in the Beaverhill Lake and Elk Point Groups

Well Name: **AEC B3 Fisher 3-22-70-4 (100/03-22-070-04W4/00)**

Borehole Diameter: 159 mm

Correction to True North: 0 (corrected 18.2 deg E on log)

Comments:

top (m KB)	bottom (m KB)	thickness (m)	P1AZ (deg)	CMAX Az (deg)	CMAX Az wrt true N (deg)	C1 (mm)	C2 (mm)	% enlarge	% gauge	quality	formation
496	497	1	115	115	115	167	162	3.09%	1.89%	poor	BH LK
497	498	1	115	115	115	167	159	5.03%	0.00%	poor	BH LK
498	499	1	115	115	115	171	162	5.56%	1.89%	poor	BH LK
499	500	1	115	115	115	173	159	8.81%	0.00%	poor	BH LK
500	501	1	115	115	115	173	159	8.81%	0.00%	poor	BH LK
501	502	1	115	115	115	173	159	8.81%	0.00%	poor	BH LK

SD of corrected CMAX Az data: 0

Well Name: **AEC Fisher 6-33-70-4 (100/06-33-070-04W4/00)**

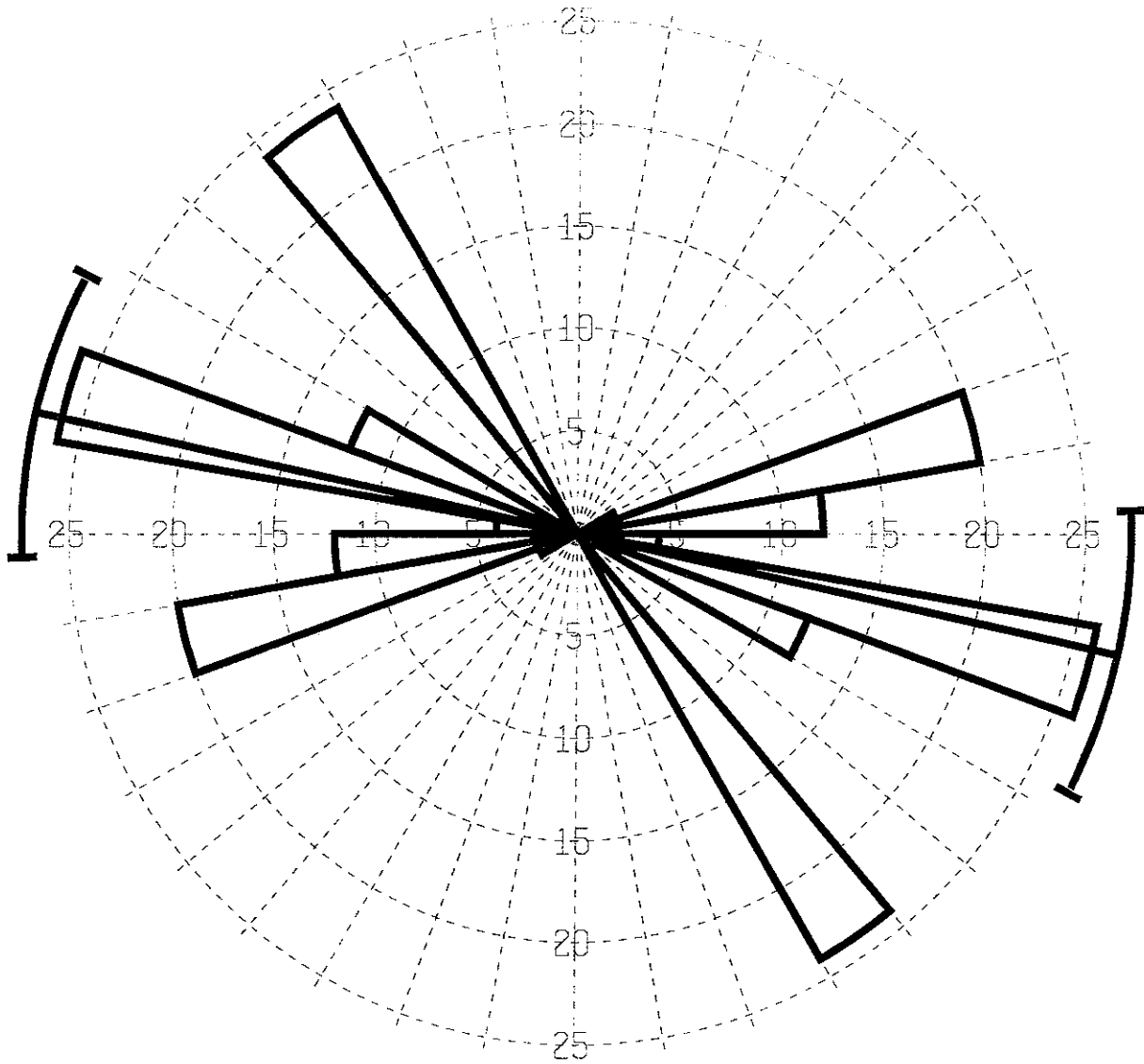
Borehole Diameter: 159 mm

Correction to True North: 0 (corrected 18.2 deg E on log)

Comments:

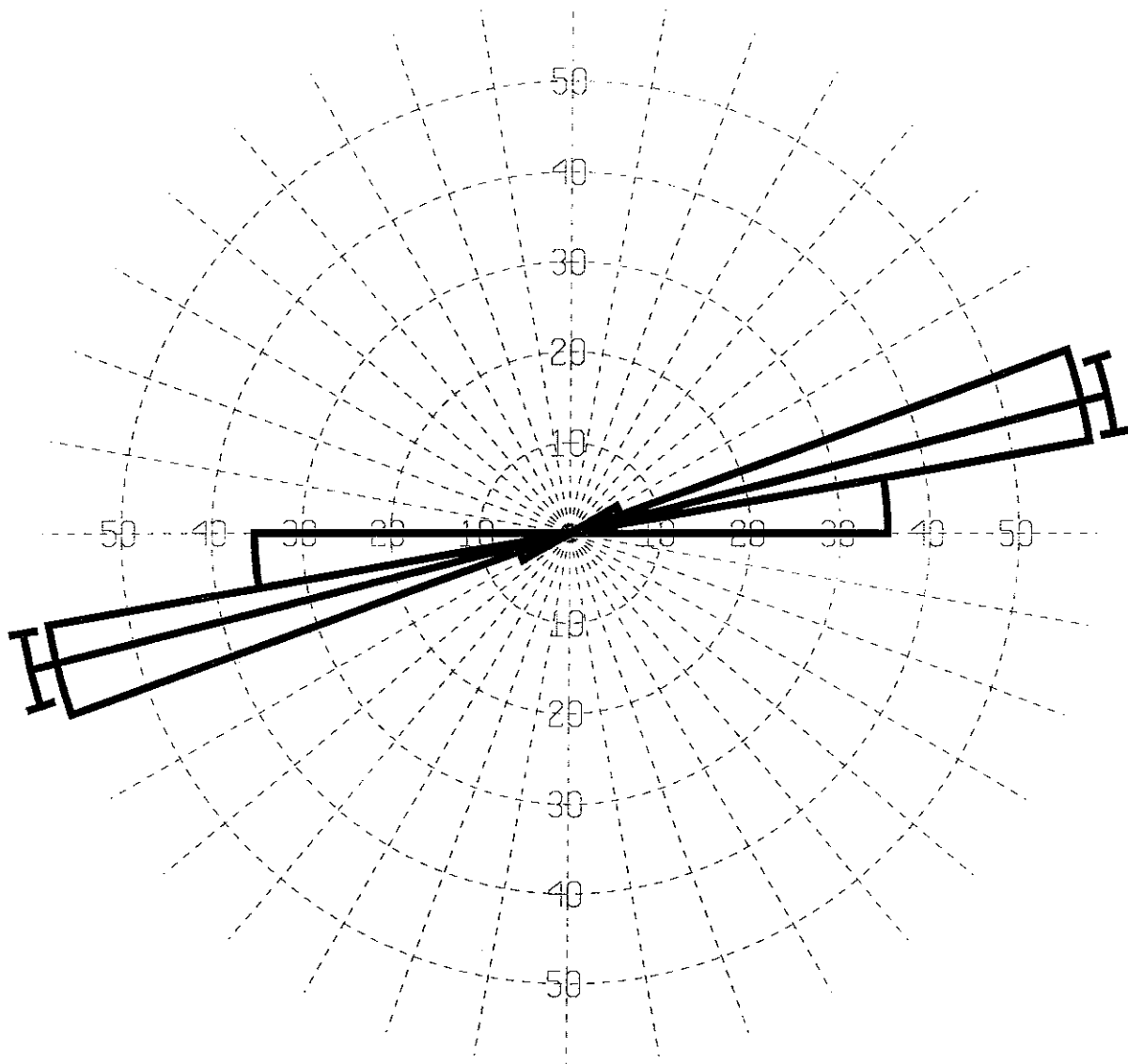
top	bottom	thickness	P1AZ	CMAX Az	CMAX Az wrt true N	C1	C2	% enlarge	% gauge	quality	formation
495	496	1	140	140	140	167	159	5.03%	0.00%	fair	BH LK
496	497	1	140	140	140	167	159	5.03%	0.00%	fair	BH LK
497	498	1	140	140	140	171	159	7.55%	0.00%	fair	BH LK
498	499	1	140	140	140	167	159	5.03%	0.00%	fair	BH LK
499	500	1	140	140	140	165	159	3.77%	0.00%	fair	BH LK
500	501	1	140	140	140	165	159	3.77%	0.00%	fair	BH LK

SD of corrected CMAX Az data: 0



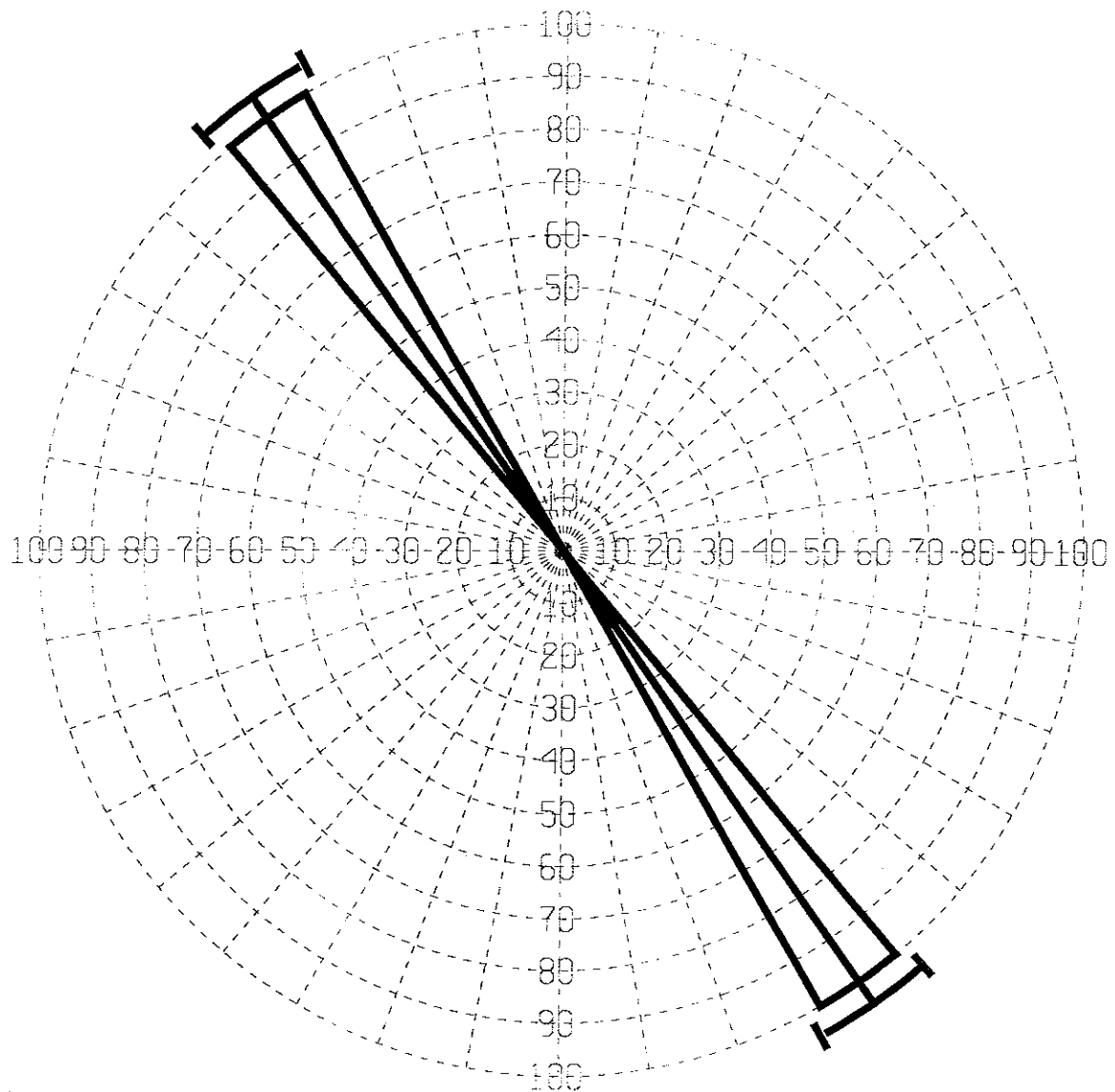
Calculation Method ... Frequency
Class Interval 10 Degrees
Filtering Deactivated
Data Type Bidirectional
Rotation Amount 0 Degrees
Population 50
Maximum Percentage ... 26 Percent
Mean Percentage 14.3 Percent
Standard Deviation ... 9.04 Percent
Vector Mean 282.55 Degrees
Confidence Interval .. 14.96 Degrees
R-mag 0.65

Figure D.2.1: Combined roseplot of borehole breakout data for all wells.



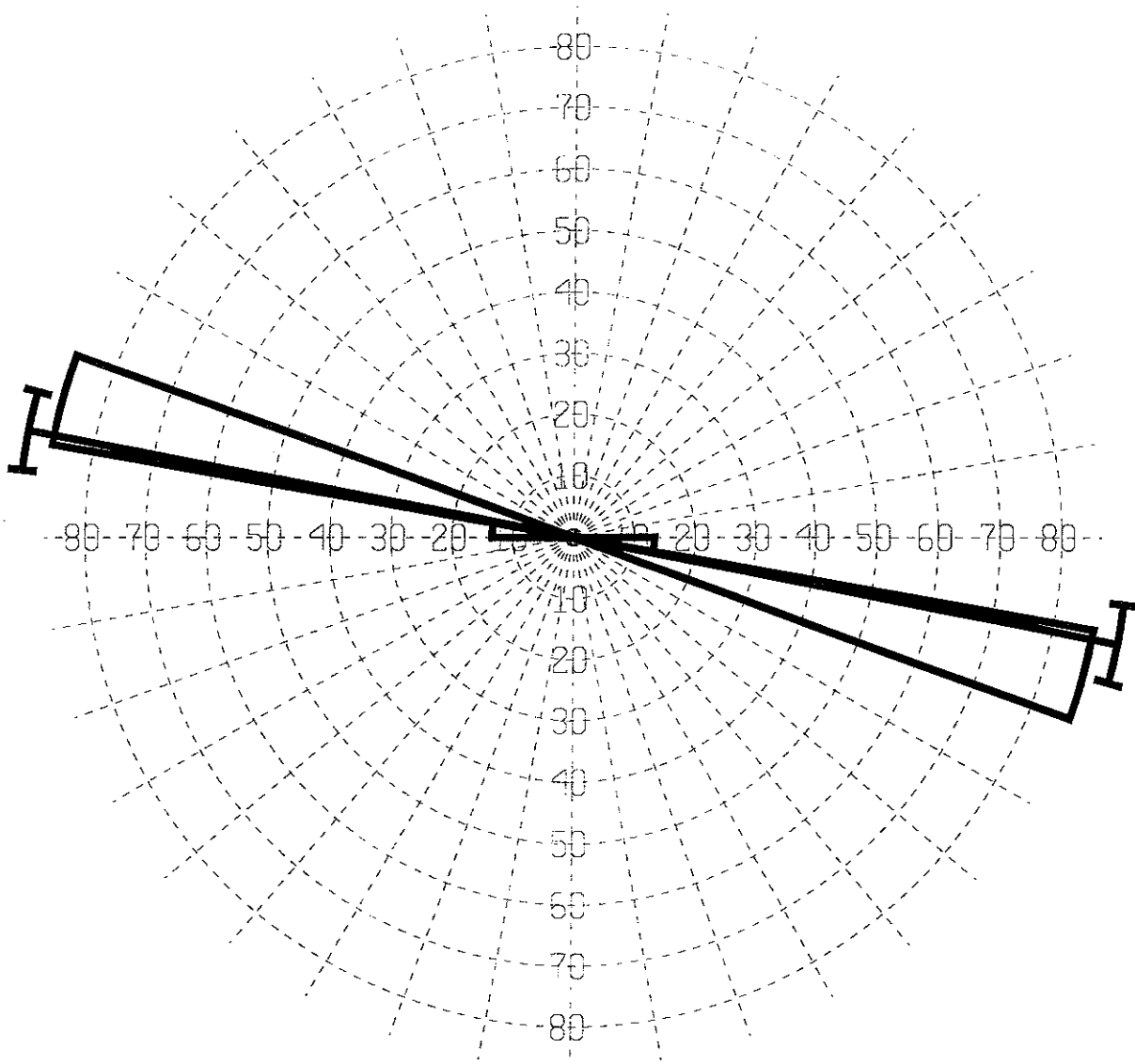
Calculation Method ... Frequency
Class Interval 10 Degrees
Filtering Deactivated
Data Type Bidirectional
Rotation Amount 0 Degrees
Population 17
Maximum Percentage ... 58.8 Percent
Mean Percentage 33.3 Percent
Standard Deviation ... 23.72 Percent
Vector Mean 75.78 Degrees
Confidence Interval .. 3.87 Degrees
R-mag 0.99

Figure D.2.2: Roseplot of borehole breakout data for Voyager et al Bruce 6-14-048-14W4.



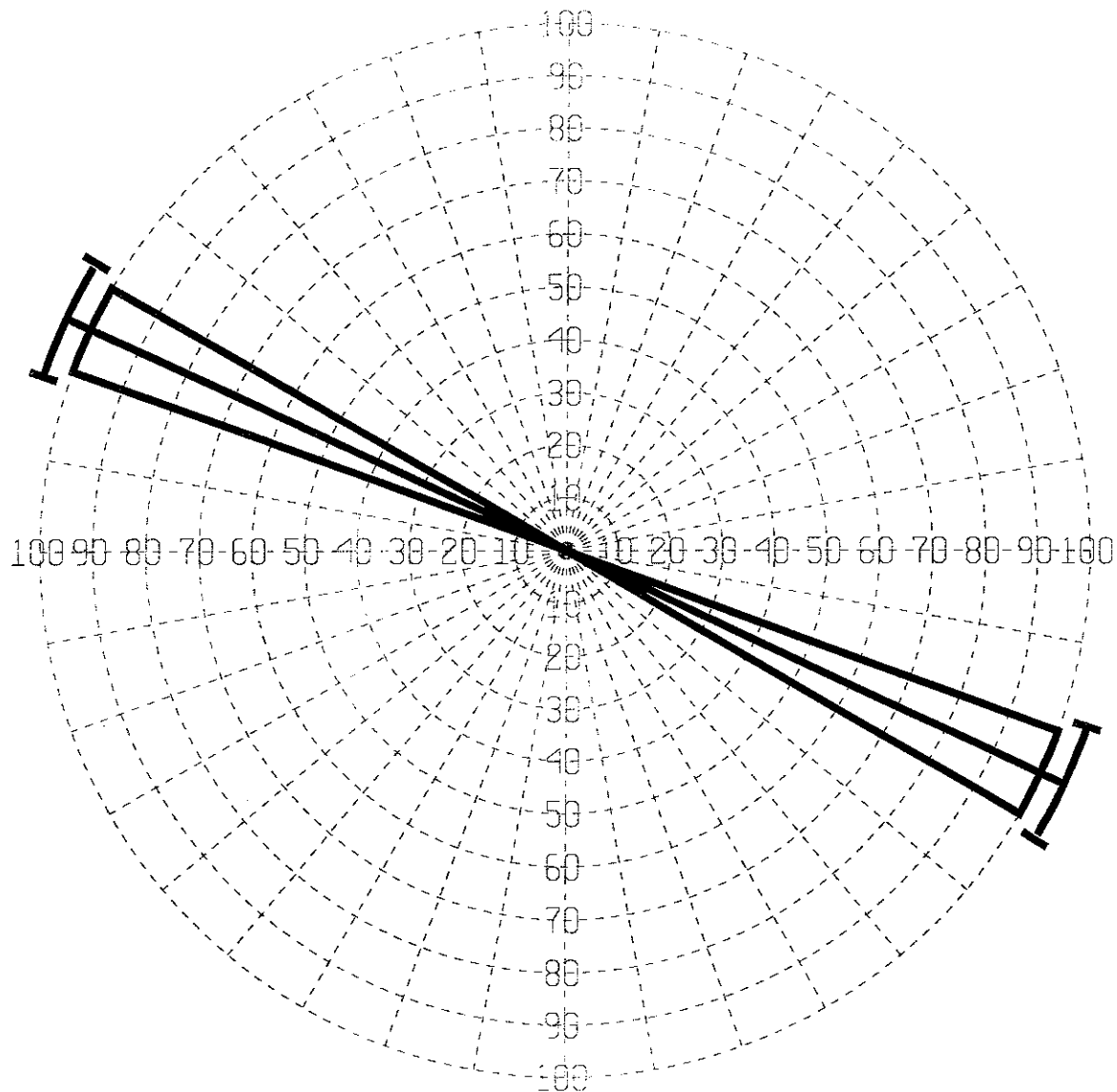
Calculation Method ... Frequency
Class Interval 10 Degrees
Filtering Deactivated
Data Type Bidirectional
Rotation Amount 0 Degrees
Population 6
Maximum Percentage ... 100 Percent
Mean Percentage 100 Percent
Standard Deviation ... 0 Percent
Vector Mean 325 Degrees
Confidence Interval .. 6.47 Degrees
R-mag 1

Figure D.2.3: Roseplot of borehole breakout data for AEC D1 Fisher 1-21-70-4W4.



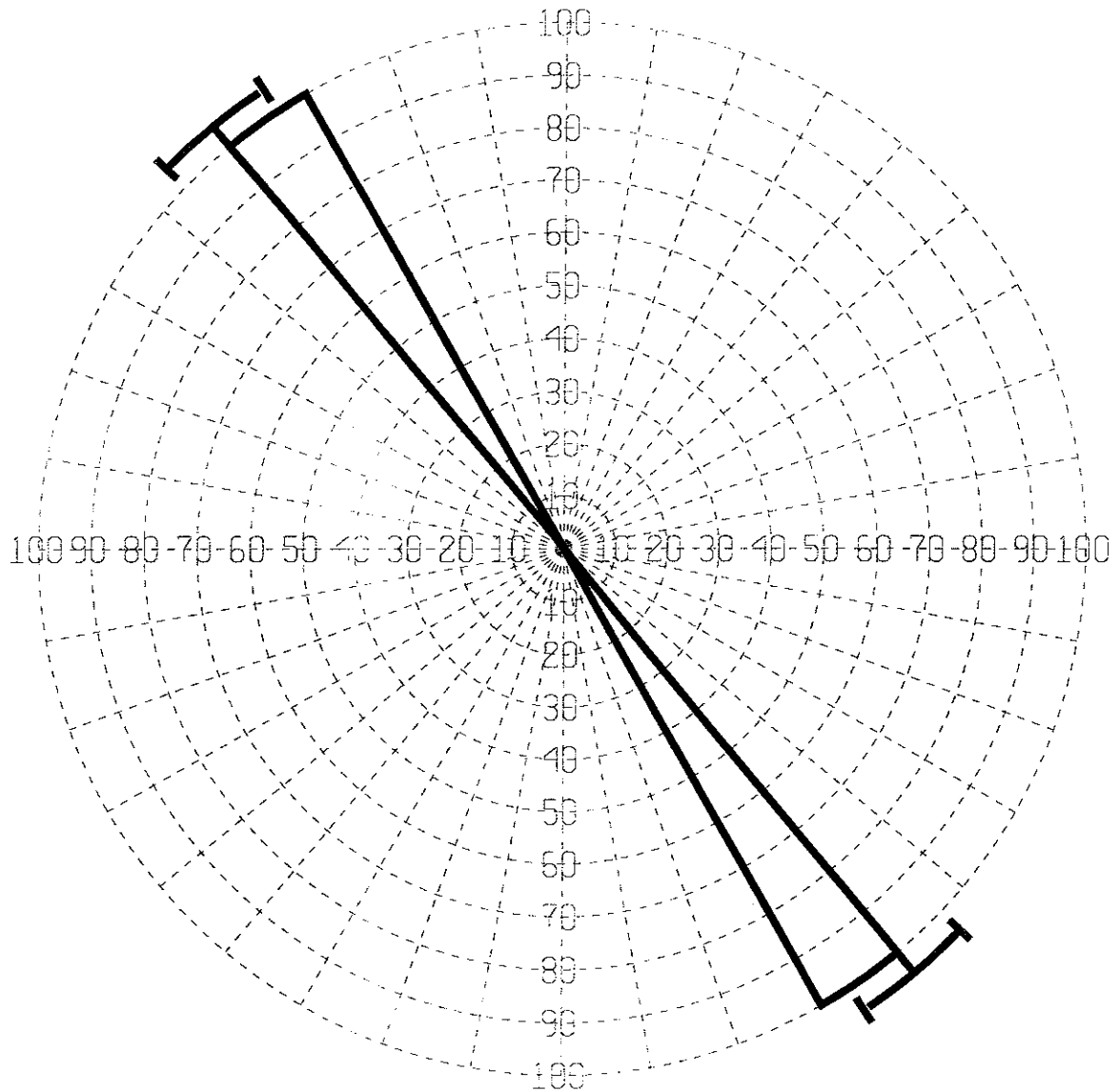
Calculation Method ... Frequency
Class Interval 10 Degrees
Filtering Deactivated
Data Type Bidirectional
Rotation Amount 0 Degrees
Population 15
Maximum Percentage ... 86.7 Percent
Mean Percentage 50 Percent
Standard Deviation ... 42.34 Percent
Vector Mean 281 Degrees
Confidence Interval .. 4.1 Degrees
R-mag 0.99

Figure D.2.4: Roseplot of borehole breakout data for AEC A8 Fisher 8-21-70-4W4.



Calculation Method ... Frequency
Class Interval 10 Degrees
Filtering Deactivated
Data Type Bidirectional
Rotation Amount 0 Degrees
Population 6
Maximum Percentage ... 100 Percent
Mean Percentage 100 Percent
Standard Deviation ... 0 Percent
Vector Mean 295 Degrees
Confidence Interval .. 6.47 Degrees
R-mag 1

Figure D.2.5: Roseplot of borehole breakout data for AEC B3 Fisher 3-22-70-4W4.



Calculation Method ... Frequency
Class Interval 10 Degrees
Filtering Deactivated
Data Type Bidirectional
Rotation Amount 0 Degrees
Population 6
Maximum Percentage ... 100 Percent
Mean Percentage 100 Percent
Standard Deviation ... 0 Percent
Vector Mean 320 Degrees
Confidence Interval .. 6.47 Degrees
R-mag 1

Figure D.2.6: Roseplot of borehole breakout data for AEC Fisher 6-33-70-4W4.

Table D.3: Summary of breakout analysis data in the original study area for the Elk Point and Beaverhill Lake Groups

No.	UWI	Well Name	Year Logged	Top Log Interval (m KB)	Bottom Log Interval (m KB)	Dipmeter log recorded in microfiche obtained from AEUB	Dipmeter microfiche obtained from MJ	Missing data necessary for breakout analysis	Apparent breakout caused by pipe wear in deviated hole	Breakout present in Beaverhill Lake or Elk Point Groups	Notes
1	00/07-14-057-06W4/0	TEXEX ET AL ELK POINT 7-14-57-6	1956	546	1585						
2	00/10-13-060-04W4/0	TEXEX ET AL CHAR LAKE 10-13-60-4	1956	597	1433						
3	02/10-30-048-10W4/0	NUL KINSELLA 10-30-48-10	1978	579	937						
4	00/06-14-048-14W4/0	VOYAGER et al BRUCE 6-14-48-14	1982	891	2087	Y				Y	good breakout over Elk Point Group
5	00/14-09-049-08W4/0	PCP MANNVILLE SOUTH 14-9-49-8	1983	520	813						
6	00/16-31-050-01W4/0	CNRL B LLOYD 16-31-50-1	1981	534	705						
7	00/14-22-050-11W4/0	SIGNALTA ET AL BIRCH 14-22-50-11	1971	506	718	Y		Y			tadpoles but no dipmeter caliper
8	00/11-34-051-04W4/0	CDNOXY P9 MORGAN EX 11-34-51-4	1980	115	622						
9	00/06-32-055-06W4/0	AMOCO LINDBERGH 6-32-55-6	1996	450	681						
10	AR/10-11-056-01W4/0	AMOCO AQ JOHN LAKE EX 10-11-56-1	1983	400	634	Y					no breakout
11	AB/15-11-056-01W4/0	AMOCO AB JOHN LAKE EX 15-11-56-1	1983	333	630	Y		Y			can't see calipers due to other curves on microfiche
12	00/15-26-056-02W4/0	TEXACO FROG LAKE 15-26-56-2	1983	390	603						
13	00/13-35-056-02W4/0	ESSO FROG LAKE 13-35-56-2	1984	400	621						
14	00/14-06-057-01W4/0	CNRL JOHN LAKE 14-6-57-1	1984	450	667	Y		Y			tadpoles, caliper but no azimuth
15	00/14-18-057-01W4/0	TEXACO FROG LAKE 14-18-57-1	1984	390	641						
16	00/13-01-057-02W4/0	TEXACO FROG LAKE 13-1-57-2	1984	420	640						
17	00/15-12-057-02W4/0	CNRL JOHN LAKE 15-12-57-2	1984	390	620						
18	00/07-15-059-02W4/0	CNRL CHANDLER 7-15-59-2	1989	470	589						
19	00/07-16-059-02W4/0	SUNCOR ET AL CHANDLER 7-16-59-2	1983	25	584		Y				no breakout
20	00/07-27-059-02W4/0	TRANSWEST CHANDLER 7-27-59-2	1983	450	554						
21	00/06-20-062-04W4/0	GENESIS ET AL FTKENT 6-20-62-4	1985	275	525						
22	00/11-24-062-04W4/0	GENESIS ET AL FTKENT 11-24-62-4	1985	268	504						
23	00/09-13-062-08W4/0	AMOCO ET AL SUGDEN 9-13-62-8	1994	143	499						
24	00/01-13-063-08W4/0	CDNOXY ET AL SUGDEN 1-13-63-8	1985	251	500						
25	00/11-14-063-08W4/0	NUMAC 11A WOLF LAKE 11-14-63-8	1997	300	513		Y				no breakout
26	02/16-06-064-06W4/0	MOBIL GARTH 16-6-64-6	1981	300	525	Y		Y			tadpoles, caliper no azimuth, Dresser Atlas log
27	00/03-07-064-06W4/0	MOBIL GARTH 3-7-64-6	1990	290	513	Y		Y			tadpoles, caliper no azimuth, Dresser Atlas log

Table D.3: Summary of breakout analysis data in the original study area for the Elk Point and Beaverhill Lake Groups

No.	UWI	Well Name	Year Logged	Top Log Interval (m KB)	Bottom Log Interval (m KB)	Dipmeter log recorded in microfiche obtained from AEUB	Dipmeter microfiche obtained from MJ	Missing data necessary for breakout analysis	Apparent breakout caused by pipe wear in deviated hole	Breakout present in Beaverhill Lake or Elk Point Groups	Notes
28	AA/14-20-064-06W4/0	MOBIL GARTH OV 14-20-64-6	1980	335	547	Y		Y			can't see calipers due to other curves on microfiche
29	AA/02-21-064-06W4/0	MOBIL GARTH EX 2-21-64-6	1983	315	504	Y		Y			tadpoles, caliper no azimuth, Dresser Atlas log
30	AA/03-27-064-06W4/0	MOBIL GARTH EX 3-27-64-6	1982	300	521	Y		Y			tadpoles, caliper no azimuth, Dresser Atlas log
31	AA/09-27-064-06W4/0	MOBIL GARTH EX 9-27-64-6	1981	300	530	Y		Y			tadpoles, caliper no azimuth, Dresser Atlas log
32	AA/09-28-064-06W4/0	MOBIL GARTH OV 9-28-64-6	1980	160	520	Y		Y			can't see calipers due to other curves on microfiche
33	00/16-01-064-07W4/0	MOBIL SUGDEN 16-1-64-7	1980	280	519	Y		Y			can't see calipers due to other curves on microfiche
34	02/07-13-065-04W4/0	ESSO 83 B3-20 COLDLK 7-13-65-4	1984	20	195						
35	00/06-27-065-05W4/0	BP LEMING 6-27-65-5	1981	159	561						
36	00/07-31-065-05W4/0	BP LEMING 7-31-65-5	1981	153	551						
37	00/11-01-065-06W4/0	BP MARGUERITE LAKE 11-1-65-6	1981	150	550						
38	00/07-08-065-06W4/0	BP MARGUERITE LAKE 7-8-65-6	1981	154	561						
39	11/12-08-066-05W4/0	BP PCI 21 MARGLK 12-8-66-5	1981	150	528	Y					no breakout
40	14/12-08-066-05W4/0	BP PCI 24 MARGLK 12-8-66-5	1981	155	526	Y					no breakout (only 1 m Elk Point Group on log)
41	17/12-08-066-05W4/0	BP PCI 13-81 OB MARG LK 12-8-66-5	1981	156	522	Y					no breakout
42	00/06-13-066-06W4/0	BP MARGUERITE 6-13-66-6	1981	157	519						
43	00/12-30-069-07W4/0	AEC FISHER 12-30-69-7	1988	436	534	Y					no breakout over Beaverhill Lake Group
44	00/08-20-070-03W4/0	AEC FISHER 8-20-70-3	1997	124	531		Y				no breakout
45	03/05-14-070-04W4/0	AEC 03 FISHER 5-14-70-4	1996	355	538		Y		Y		apparent breakout caused by well deviation
46	05/05-14-070-04W4/0	AEC 06 FISHER 5-14-70-4	1996	375	560		Y		Y		apparent breakout caused by well deviation
47	00/11-14-070-04W4/0	AECOG C11 FISHER 11-14-70-4	1998	124	514	Y					no breakout
48	00/12-14-070-04W4/0	AEC 01 FISHER 12-14-70-4	1996	450	550	Y		Y			deviated, SHDT, Caliper 2-4 not presented on log
49	00/07-15-070-04W4/0	AECOG A7 FISHER 7-15-70-4	1998	380	507	Y					no breakout, SHDT
50	00/08-15-070-04W4/0	AEC 02 FISHER 8-15-70-4	1996	390	540		Y				no breakout, deviated well, digital dipmeter data available from the AEUB
51	00/11-15-070-04W4/0	AEC FISHER 11-15-70-4	1996	405	515		Y				no breakout, some poor breakout in McMurray Fm
52	00/13-15-070-04W4/0	AEC 13A FISHER 13-15-70-4	1997	124	514	Y					no breakout
53	00/15-15-070-04W4/0	AEC B15 FISHER 15-15-70-4	1997	359	504		Y				no breakout
54	00/09-16-070-04W4/0	AEC A9 FISHER 9-16-70-4	1997	350	510	Y					no breakout

Table D.3: Summary of breakout analysis data in the original study area for the Elk Point and Beaverhill Lake Groups

No.	UWI	Well Name	Year Logged	Top Log Interval (m KB)	Bottom Log Interval (m KB)	Dipmeter log recorded in microfiche obtained from AEUB	Dipmeter microfiche obtained from MJ	Missing data necessary for breakout analysis	Apparent breakout caused by pipe wear in deviated hole	Breakout present in Beaverhill Lake or Elk Point Groups	Notes
55	00/10-16-070-04W4/0	AEC FISHER 10-16-70-4	1997	371	529		Y				no breakout
56	00/15-16-070-04W4/0	AEC A15 FISHER 15-16-70-4	1997	114	518		Y				no breakout
57	00/16-16-070-04W4/0	AEC B16 FISHER 16-16-70-4	1997	100	522	Y					no breakout
58	00/01-21-070-04W4/0	AEC B1 FISH 1-21-70-4	1997	360	510		Y				no breakout
59	02/01-21-070-04W4/0	AEC 1A FISHER 1-21-70-4	1997	400	511		Y				no breakout
60	03/01-21-070-04W4/0	AEC C1 FISHER 1-21-70-4	1997	325	500		Y				no breakout
61	04/01-21-070-04W4/0	AEC D1 FISHER 1-21-70-4	1997	375	515		Y			Y	breakout in Beaverhill Lake Group
62	00/02-21-070-04W4/0	AEC C2 FISHER 2-21-70-4	1997	350	500		Y				no breakout
63	00/08-21-070-04W4/0	AEC A8 FISHER 8-21-70-4	1997	350	500		Y			Y	breakout in Beaverhill Lake Group
64	00/10-21-070-04W4/0	AEC A10 FISHER 10-21-70-4	1997	369	519	Y					no breakout
65	02/10-21-070-04W4/0	AEC B10 FISHER 10-21-70-4	1997	350	515		Y				no BO, some poor BO in McMurray FM
66	02/15-21-070-04W4/0	AEC 15B FISHER 15-21-70-4	1997	350	510		Y				no breakout
67	00/02-22-070-04W4/0	AECOG D2 FISHER 2-22-70-4	1997	375	507	Y					no breakout
68	00/03-22-070-04W4/0	AEC B3 FISHER 3-22-70-4	1997	375	500		Y			Y	breakout in Beaverhill Lake Group
69	00/04-22-070-04W4/0	AEC 4C FISHER 4-22-70-4	1997	96	518		Y				no breakout
70	04/05-22-070-04W4/2	AEC 104 FISHER 5-22-70-4	1996	450	525						
71	05/05-22-070-04W4/0	AECOG 105 FISHER 5-22-70-4	1997	390	530	Y					no breakout, digital data available from the AEUB
72	06/05-22-070-04W4/0	AECOG A5 FISHER 5-22-70-4	1997	73	220	Y					no breakout
73	00/06-22-070-04W4/0	AEC 6A FISHER 6-22-70-4	1997	110	515	Y					no breakout
74	00/07-22-070-04W4/0	AECOG(E) A7 FISHER 7-22-70-4	2000	130	516						digital dipmeter data available from the EUB
75	00/11-22-070-04W4/0	AEC 11B FISHER 11-22-70-4	1997	350	514	Y					no breakout
76	04/11-22-070-04W4/0	AECOG 2B11 FISHER 11-22-70-4	1997	70	513		Y				no breakout
77	00/12-22-070-04W4/0	AEC FISHER 12-22-70-4	1996	400	515		Y				no breakout
78	03/12-22-070-04W4/0	AEC 12C FISHER 12-22-70-4	1997	347	516		Y				no breakout
79	02/14-22-070-04W4/0	AEC C14 FISHER 14-22-70-4	1997	340	502		Y				no breakout
80	00/03-23-070-04W4/0	AECOG A3 FISHER 3-23-70-4	1998	123	513	Y					no breakout
81	00/14-28-070-04W4/0	AECOG A14 FISHER 14-28-70-4	1998	125	513		Y				no breakout

Table D.3: Summary of breakout analysis data in the original study area for the Elk Point and Beaverhill Lake Groups

No.	UWI	Well Name	Year Logged	Top Log Interval (m KB)	Bottom Log Interval (m KB)	Dipmeter log recorded in microfiche obtained from AEUB	Dipmeter microfiche obtained from MJ	Missing data necessary for breakout analysis	Apparent breakout caused by pipe wear in deviated hole	Breakout present in Beaverhill Lake or Elk Point Groups	Notes
82	00/07-32-070-04W4/0	AEC FISHER 7-32-70-4	1996	375	525						
83	00/06-33-070-04W4/0	AEC FISHER 6-33-70-4	1997	400	500		Y			Y	breakout in Beaverhill Lake Group
84	00/08-13-070-06W4/0	AEC FISHER 8-13-70-6	1988	491	585	Y					no breakout
85	00/05-23-070-06W4/0	AEC FISHER 5D-23-70-6	1987	275	544						
86	00/10-34-072-06W4/0	AMOCO AEC KIRBY 10-34-72-6	1980	160	588	Y		Y			no caliper orientation data indicated on log
87	02/12-01-073-06W4/0	AEC 07 KIRBY 12-1-73-6	1983	108	569	Y					no dipmeter coverage in Beaverhill Lake Grp.
88	00/07-03-073-06W4/0	AMOCO AEC IPIATIK 7-3-73-6	1980	160	577	Y				Y	no breakout
89	00/10-03-073-06W4/0	AMOCO AEC IPIATIK KIRBY 10A-3-73-6	1984	160	579	Y					no breakout
90	00/06-05-073-06W4/0	AMOCO AEC KIRBY 6-5-73-6	1990	100	572	Y					no breakout
91	00/11-09-073-06W4/0	AMOC AEC IPIATIK 11-9-73-6	1995	160	534.9	Y					no breakout
92	00/10-11-073-06W4/0	AEC AMOCO IPIATIK KIRBY 10-11-73-6	1984	160	605	Y		Y			caliper one not presented
93	00/04-15-073-06W4/0	AECOG ET AL KIRBY 4-15-73-6	1997	96	528.5	Y					no breakout
94	00/12-11-074-08W4/0	ISH KIRBY 12-11-74-8	1997	440	530						
95	00/12-14-074-08W4/0	ISH KIRBY 12-14-74-8	2000	440	519.3						
96	00/14-05-082-12W4/0	TRANSWEST DIVIDE 14-5-82-12	1987	275	535	Y		Y			can't see calipers through other curves
97	00/10-29-082-12W4/0	HUSKY ET AL DIVIDE 10-29-82-12	1988	382	461	Y					no breakout
98	00/16-03-083-07W4/0	GULF RESDELN 16-3-83-7	1981	175	505						
99	AA/11-15-083-07W4/0	GULF RESDELN 11-15-83-7	1997	400	500	Y		Y			only one caliper curve shown (Dresser Atlas log)

APPENDIX E

DATA ANALYSIS RESULTS FOR EXPANDED STUDY AREA

- Table E.1** Summary of vertical stresses for the Elk Point Group determined from bulk density data in the expanded study area
- Table E.2** Detailed summary of breakout data in the Saskatchewan, Beaverhill Lake, and Elk Point Groups
- Figures E.2.1 to E.2.14** Roseplots of breakout data in the Saskatchewan, Beaverhill Lake, and Elk Point Groups

Table E.1: Summary of vertical stresses for the Elk Point Group determined from bulk density data in the expanded area

No.	Log Kelly Bushing	Ground Level	Well Name	UWI	Year Logged	Latitude (deg N)	Longitude (deg W)	Top Log Interval (m KB)	Bottom Log Interval (m KB)	Top Prairie Evaporite Fm (m KB)	Elevation of Prairie Evaporite Fm (m)	Vertical Stress at Top of Prairie Evaporite Fm (MPa)	Normalized Vertical Stress Gradient at Top of Prairie Evaporite Fm (kPa/m)	Bulk Density Log Quality	% of Unknown Bulk Density Data above Prairie Evaporite Fm	Comments
1	647.4	642.8	GULF SENEX 4-21-94-3	00/01-20-094-03W5/0	1996	57.164	114.432	30	1351	1105	-458	24.4	22.1	v.good	2	
2	469.7	465.3	NORCEN POR EDRA 1-29-101-24	00/01-29-101-24W4/0	1985	57.791	113.891	280	1070	682	-212	16.1	23.7	v.good	40	
3	514.8	510.9	ALSL BIRCH RIVER 2-10-102-23	00/02-10-102-23W4/0	1985	57.832	113.681	325	1075	669	-154	15.7	23.4	v.good	48	
4	723.8	719.0	GULF AEC SUFFIELD 3-32-15-5	00/03-32-015-05W4/0	1978	50.297	110.661	193	1717	1617	-893	39.3	24.3	poor	12	
5	563.5	558.1	GULF SENNEX 4-5-93-4	00/04-05-093-04W5/0	1987	57.035	114.612	801	1314	1080	-517	24.1	22.3	v.good	74	bulk density only recorded up to 801 m
6	696.2	691.9	PCP PROVOST 4-18-38-1	00/04-18-038-01W4/0	1994	52.262	110.142	201	1571	1314	-617	30.3	23.1	v.good	15	
7	291.2	287.1	MUTEX IOE EDRA 4-26-104-1	00/04-26-104-01W5/0	1969	58.052	114.054	130	857	496	-204	12.0	24.3	poor	25	bad hole wash out b/w 500-650 m KB
8	676.7	672.1	CLM ET AL BIRCH RIVER 4-29-98-21	00/04-29-098-21W4/0	1985	57.530	113.390	325	1190	792	-115	18.1	22.9	fair	40	FDC tool with some zones of hole enlargement present
9	730.0	725.9	CS ET AL AEC SUFFIELD 5-2-20-3	00/05-02-020-03W4/0	1978	50.664	110.326	470	2194	1635	-905	39.6	24.2	fair	28	
10	793.1	788.5	AECOG (E) CS ET AL SUFF 5-11-20-6	00/05-11-020-06W4/0	1978	50.679	110.737	229	2228	1695	-902	41.1	24.3	fair	13	
11	809.0	805.7	DOME HOME LIEGE 6-2-97-19	00/06-02-097-19W4/0	1986	57.385	112.977	236	1231	849	-40	18.2	21.5	poor	27	hole washed out
12	860.8	856.7	PENN WEST PROVOST 6-4-37-16	00/06-04-037-16W4/0	1989	52.147	112.231	356	2048	1965	-1104	46.3	23.6	fair	18	enlarged hole present leading to lower bulk densities
13	666.2	661.7	AECOG (E) CS ET AL SUFFIELD 6-25-19-4	00/06-25-019-04W4/0	1977	50.635	110.435	189	1351	1564	-897	37.9	24.3	good	12	
14	749.2	744.6	AEC GULF BERADI SUFFIELD 6-28-16-5	00/06-28-016-05W4/0	1978	50.374	110.635	189	1768	1653	-903	40.3	24.4	good	11	
15	759.9	755.6	AECOG (E) GULF SUFF 6-30-16-6	00/06-30-016-06W4/0	1977	50.374	110.820	190	1755	1654	-894	39.7	24.0	good	11	
16	478.5	474.9	PAN AM A-1 TELEGRAPH 6-30-86-13	00/06-30-086-13W4/0	1967	56.484	112.049	97	780	463	15	11.1	24.0	fair	20	
17	658.1	654.1	CS ET AL AEC SUFFIELD 6-36-18-5	00/06-36-018-05W4/0	1978	50.562	110.566	362	1662	1560	-902	37.0	23.7	fair	23	
18	661.1	656.8	CS ET AL AEC SUFFIELD 7-11-19-5	00/07-11-019-05W4/0	1978	50.592	110.590	191	2131	1560	-899	38.2	24.5	fair	12	good quality older log
19	666.8	662.6	PACIFIC AMOCO EMPRESS 7-12-22-1	00/07-12-022-01W4/0	1974	50.852	110.011	210	1759	1558	-891	37.3	23.9	fair	13	
20	698.5	693.7	CS ET AL AEC SUFFIELD 7-18-19-3	00/07-18-019-03W4/0	1978	50.607	110.406	420	1737	1595	-897	38.4	24.0	fair	26	
21	818.5	814.2	BIG VALLEY RICH 7-25-34-21	00/07-25-034-21W4/0	1986	51.946	112.848	337	2279	2219	-1401	52.5	23.7	fair	15	zones of hole enlargement present
22	730.0	726.3	DENISON ET AL PRINCESS 7-26-21-11	00/07-26-021-11W4/0	1981	50.812	111.423	190	1899	1684	-954	40.1	23.8	fair	11	some minor washouts but generally good older log
23	684.8	680.7	SUNCOR BRUCE 8-2-46-14	00/08-02-046-14W4/0	1984	52.936	111.916	650	1663	1512	-827	34.9	23.1	fair	43	good quality older log
24	740.4	736.1	CS ET AL SUFFIELD 8-17-20-4	00/08-17-020-04W4/0	1978	50.694	110.514	456	2203	1640	-899	38.8	23.6	fair	28	good quality older log
25	261.5	257.9	IOD IOE CEGO BIRCH RIVER 8-17-105-1	00/08-17-105-01W5/0	1967	58.114	114.116	105	849	423	-162	10.2	24.0	fair	24	good quality older log
26	754.7	750.7	AECOG (E) SUFF 8-23-17-4	00/08-23-017-04W4/0	1985	50.448	110.440	202	1780	1663	-908	40.5	24.4	good	12	
27	755.2	751.2	CANSO ET AL AEC SUFFIELD 9-27-15-8	00/09-27-015-08W4/0	1980	50.291	111.017	191	1710	1649	-894	39.9	24.2	fair	11	
28	609.9	605.9	GPD NOEL ET AL SENEX 10-6-93-3	00/10-05-093-03W5/0	1968	57.043	114.437	487	1309	1060	-450	24.6	23.2	fair	46	good quality older log
29	689.1	684.5	SEA JOR EDRA 10-14-100-23	00/10-14-100-23W4/0	1985	57.680	113.655	320	1250	848	-159	19.5	23.0	v.good	37	
30	516.9	513.6	PAN AM D-1 CHIPEWYAN 10-16-91-18	00/10-16-091-18W4/0	1966	56.895	112.832	188	971	624	-107	14.7	23.6	fair	30	good quality older log
31	766.3	762.3	RENAISSANCE PROVOST 11-35-38-10	00/11-35-038-10W4/0	1992	52.311	111.327	750	2140	1570	-804	36.3	23.1	v.good	48	
32	669.7	665.3	EPIC BIRCH MINS 12-4-99-21	00/12-04-099-21W4/0	1988	57.566	113.390	215	1180	772	-102	17.6	22.8	good	27	some minor washouts leading to lower bulk density
33	850.6	845.9	CDNRES ET AL OBERLIN 12-9-38-21	00/12-09-038-21W4/0	1984	52.254	112.955	390	2370	2234	-1383	53.3	23.9	fair	17	
34	796.3	792.2	MARK RED WILLOW 14-11-39-17	00/14-11-039-17W4/0	1987	52.346	112.345	364	2022	1920	-1124	46.3	24.1	v.good	19	
35	854.2	850.0	CHEVRON LNK 14-35-34-17	00/14-35-034-17W4/0	1989	51.967	112.308	364	2091	2022	-1167	48.0	23.7	good	18	minor zones of hole enlargement
36	821.1	817.2	HESS CDN-SUP NAMUR 15-19-96-18	00/15-19-096-18W4/0	1969	57.350	112.915	172	1222	857	-35	19.5	22.8	fair	20	good quality older log
37	821.6	817.5	VIRAGO ET AL RICH 15-30-34-20	00/15-30-034-24W4/0	1986	51.954	112.825	361	2393	2210	-1388	54.0	24.5	good	16	minor zones of hole enlargement
38	749.2	745.2	MUTEX IOE SEAFORTH 15-20-95-20	00/15-20-095-20W4/0	1969	57.261	113.209	212	1247	869	-120	19.8	22.7	fair	24	
39	557.1	552.1	ICOR ET AL HOOLE 16-1-80-24	00/16-01-080-24W4/0	1988	55.909	113.611	320	1485	1105	-548	26.2	23.7	v.good	29	
40	830.2	824.5	BEST PACIFIC SPIERS 16-16-34-15	00/16-16-034-15W4/0	1985	51.925	112.060	404	2442	1950	-1120	44.9	23.0	fair	20	zones of hole enlargement in first run
41	691.3	687.9	DOME ET AL EAST PANNY 16-35-95-2	00/16-35-095-02W5/0	1988	57.292	114.196	254	1399	1046	-354	23.4	22.4	good	24	minor zones of hole enlargement
42	566.4	562.4	UNOCAL WOODENHOUSE 6-3-87-22	00/06-03-087-22W4/0	1988	56.513	113.424	349	1240	919	-353	20.7	22.6	v.good	38	missing 240 m of data in middle of log interval
43	746.6	740.8	NORTHROCK MEDHAT 6-36-19-1	00/06-36-019-01W4/0	1980	50.650	110.020	188	2226	1662	-915	39.2	23.6	fair	11	
44	748.9	744.9	CS ET AL AEC SUFFIELD 8-22-19-5	00/08-22-019-05W4/0	1978	50.622	110.608	456	1760	1645	-896	39.3	23.9	fair	27	good quality older log

Table E.1: Summary of vertical stresses for the Elk Point Group determined from bulk density data in the expanded study area

No.	Log Kelly Bushing	Ground Level	Well Name	UWI	Year Logged	Latitude (deg N)	Longitude (deg W)	Top Log Interval (m KB)	Bottom Log Interval (m KB)	Top Prairie Evaporite Fm (m KB)	Elevation of Prairie Evaporite Fm (m)	Vertical Stress at Top of Prairie Evaporite Fm (MPa)	Normalized Vertical Stress Gradient at Top of Prairie Evaporite Fm (kPa/m)	Bulk Density Log Quality	% of Unknown Bulk Density Data above Prairie Evaporite Fm	Comments
45	754.2	750.5	AECOG (E) SUFF 10C-1-17-8	00/10-01-017-08W4/0	1985	50.407	110.975	200	1720	1657	-902	40.0	24.2	v.good	12	
46	754.2	749.5	DEVLAN MARTEN HILLS 10-4-75-3	00/10-04-075-03W5/0	1993	55.471	114.397	421	1852	1674	-920	37.6	22.4	v.good	25	missing data b/w 711 and 1643 m KB
47	761.7	757.7	GULF AEC FALCON SUFFIELD 11-5-15-6	00/11-05-015-06W4/0	1978	50.232	110.797	190	1750	1662	-900	40.4	24.3	v.good	11	difficult pick for Prairie Evaporite Fm
48	789.3	785.1	AECOG (E) SUFF 11C-14-18-8	00/11-14-018-08W4/0	1985	50.524	111.005	206	1745	1698	-909	40.7	24.0	v.good	12	
49	797.8	793.9	AECOG (GS) SUFF 11-18-18-8	00/11-18-018-08W4/0	1985	50.524	111.097	262	2242	1708	-910	40.9	23.9	v.good	15	
50	718.6	714.0	CANSO ET AL AEC SUFFIELD 12-7-15-7	00/12-07-015-07W4/0	1979	50.247	110.962	189	1677	1611	-892	39.3	24.4	fair	11	
51	717.1	713.0	GULF AEC HAWK SUFFIELD 12-12-15-7	00/12-12-015-07W4/0	1978	50.246	110.848	184	2154	1610	-893	39.1	24.3	fair	11	
52	747.0	742.4	AECOG (E) 12-21-15-8	00/12-21-015-08W4/0	1980	50.274	111.056	192	1688	1644	-897	40.2	24.5	fair	11	difficult pick for Prairie Evaporite Fm
53	713.0	708.5	CANSO ET AL AEC SUFFIELD 12-33-15-7	00/12-33-015-07W4/0	1980	50.305	110.917	189	1682	1607	-894	38.8	24.2	fair	11	
54	708.1	704.1	CS ET AL AEC SUFFIELD 14-32-19-4	00/14-32-019-04W4/0	1978	50.657	110.526	424	1731	1604	-896	38.9	24.2	fair	26	
55	770.5	766.9	PAN AM UNION A-1 YNGSTN 16-3-30-9	00/16-03-030-09W4/0	1967	51.546	111.178	747	1820	1667	-897	38.8	23.3	fair	45	
56	852.9	849.3	CANSO ET AL AEC SUFFIELD 12-33-15-7	00/12-33-015-07W4/0	1984	52.577	113.174	882	2289	2218	-1365	52.4	23.6	v.good	40	
57	706.8	702.9	AECOG (E) HAWK SUFF 6-26-15-7	02/06-26-015-07W4/0	1978	50.286	110.866	192	1676	1597	-890	39.4	24.7	v.good	12	
58	791.4	788.4	PCP HEATHDALE 10-16-27-8	00/10-16-027-08W4/0	1980	51.310	111.070	183	1699	1693	-902	39.5	23.3	fair	11	
59	785.1	780.8	AMOCO RICHDALE 3-4-31-12	00/03-04-031-12W4/0	1984	51.622	111.648	350	1877	1785	-1000	43.3	24.2	fair	19	very good quality older log
60	852.5	848.4	MOBIL CRAIGMYLE 9-18-32-17	00/09-18-032-17W4/0	1988	51.744	112.394	361	2155	2116	-1264	50.6	23.9	good	17	
61	826.2	820.6	STELLARTON SPIERS 11-15-34-15	00/11-15-034-15W4/0	1992	51.919	112.049	296	1975	1885	-1059	45.8	24.3	v.good	15	
62	839.7	835.3	CHEVRON ET AL HACKETT 1-7-36-18	00/01-07-036-18W4/0	1982	52.071	112.553	354	2121	2090	-1250	50.2	24.0	fair	17	no curve available < 2000 kg/m3 for digitizing, therefore calculations would be high
63	728.3	723.8	SCEPTRE ET AL STROME 8-23-43-16	00/08-23-043-16W4/0	1984	52.718	112.205	329	1810	1712	-983	40.0	23.4	fair	19	good quality older log
64	706.8	702.2	SUNCOR STROME 11-16-44-16	00/11-16-044-16W4/0	1983	52.795	112.269	321	1807	1695	-988	39.5	23.3	fair	19	breakout also analyzed for this well
65	717.4	712.9	SUNCOR HOLMBERG 4-1-45-16	00/04-01-045-16W4/0	1983	52.845	112.198	284	1682	1666	-949	39.2	23.5	fair	17	good quality older log
66	698.4	693.8	SUNCOR KILLAM NORTH 6-15-45-15	02/06-15-045-15W4/0	1983	52.877	112.097	252	1737	1599	-901	37.9	23.7	fair	15	very good quality older log
67	707.8	703.3	SUNCOR ET AL KILLAM 16-10-46-13	00/16-10-046-13W4/0	1984	52.956	111.795	275	1670	1444	-736	33.4	23.2	v.good	19	Schlumberger's LDT run
68	632.0	626.4	DOW 27 NAACL FTSASK 9-3-55-22	00/09-03-055-22W4/0	1986	53.726	113.176	215	1910	1701	-1069	40.0	23.5	good	12	well deviated past the Prairie Evaporite Formation
69	633.3	625.9	NUL NGS FTSASK 7-34-55-21	00/07-34-055-21W4/0	1982	53.795	113.036	205	1875	1585	-952	37.7	23.8	fair	12	
70	636.2	632.5	PLPG FT SASK 16D-1-56-22	00/16-01-056-22W4/0	1975	53.817	113.125	198	1908	1617	-980	37.7	23.3	fair	12	
71	647.5	642.9	GULF ET AL THORHILD 16-22-59-22	00/16-22-059-22W4/0	1985	54.122	113.200	314	1844	1575	-928	36.6	23.3	v.good	20	
72	651.1	647.1	ANDERSON ET AL THORHILD 1-12-60-21	00/01-12-060-21W4/0	1980	54.167	113.002	186	1682	1474	-823	34.7	23.6	fair	12	good quality older log
73	668.8	664.8	AMOCO THORHILD 16-9-60-22	00/16-09-060-22W4/0	1984	54.178	113.229	322	1806	1584	-915	37.3	23.6	fair	20	good quality older log
74	679.8	674.9	CHEVRON ET AL LUCKY 15-8-61-18	00/15-08-061-18W4/0	1982	54.267	112.661	279	1358	1355	-675	31.7	23.4	fair	20	good quality older log
75	554.0	549.0	ICOR ET AL HOOLE 12-1-80-24	00/12-01-080-24W4/0	1987	55.906	113.629	302	1466	1117	-563	26.3	23.5	good	27	
76	740.3	735.7	PCP MEDICINE HAT 12-19-14-4	00/12-19-014-04W4/0	1988	50.188	110.549	455	2215	1640	-900	38.9	23.7	v.good	27	
77	632.2	628.0	AECOG (E) SUFF 7-22-17-5	00/07-22-017-05W4/0	1984	50.448	110.608	205	1640	1536	-904	37.8	24.6	fair	13	very good quality older log
78	618.0	613.4	SHELL FINA RUBEN 3-25-83-2	00/03-25-083-02W5/0	1979	56.220	114.175	15	1500	1261	-643	30.1	23.8	fair	1	good quality older log
79	587.3	583.7	GULF WABASCA 7-36-84-23	00/07-36-084-23W4/0	1975	56.325	113.489	183	1051	1001	-414	23.0	23.0	fair	37	missing data b/w 393 and 585 m KB
80	669.3	665.4	PAN AM A-1 JEAN LAKE 4-11-98-23	00/04-11-098-23W4/0	1966	57.484	113.631	188	1185	864	-194	20.0	23.2	fair	21	very good quality older log
81	654.1	649.2	CDN-SUP FRANCIS 7-22-74-22	00/07-22-074-22W4/0	1971	55.422	113.295	562	1682	1219	-565	28.6	23.5	fair	46	
82	704.2	700.4	CLM ET AL JEAN 8-16-98-22	00/08-16-098-22W4/0	1985	57.501	113.504	312	1225	855	-150	19.5	22.8	v.good	36	
83	584.7	580.4	CZAR ET AL LIEGE 7-13-92-24	00/07-13-092-24W4/0	1979	56.978	113.716	15	1185	885	-300	20.2	22.8	fair	30	missing data b/w 273 and 526 m KB
84	530.9	523.9	COLIN PANNY 1-31-95-4	00/01-31-095-04W4/0	1985	57.280	114.630	615	1209	975	-444	21.5	22.1	v.good	62	
85	802.4	797.9	HUSKY MEDICINE HAT 5-32-17-2	00/05-32-017-02W4/0	1988	50.475	110.251	339	1716	1711	-909	40.1	23.4	v.good	20	
86	512.4	508.0	GAO MINK 10-29-89-23	00/10-29-089-23W4/0	1983	56.751	113.628	189	1165	856	-344	20.1	23.5	fair	22	
87	521.2	517.9	PAN AM E-1 CHIPEWYAN 10-34-91-18	00/10-34-091-18W4/0	1967	56.939	112.805	190	920	604	-83	14.1	23.4	fair	31	very good quality older log
88	763.7	759.7	FCPI 12D PROVOST 12-21-35-6	D0/12-21-035-06W4/0	1993	52.021	110.808	750	1662	1525	-761	35.3	23.2	v.good	49	

Table E.1: Summary of vertical stresses for the Elk Point Group determined from bulk density data in the expanded study area

No.	Log Kelly Bushing	Ground Level	Well Name	UWI	Year Logged	Latitude (deg N)	Longitude (deg W)	Top Log Interval (m KB)	Bottom Log Interval (m KB)	Top Prairie Evaporite Fm (m KB)	Elevation of Prairie Evaporite Fm (m)	Vertical Stress at Top of Prairie Evaporite Fm (MPa)	Normalized Vertical Stress Gradient at Top of Prairie Evaporite Fm (kPa/m)	Bulk Density Log Quality	% of Unknown Bulk Density Data above Prairie Evaporite Fm	Comments
89	633.1	627.6	DOW 103B FTSASK NAEL 14-11-55-22	06/14-11-055-22W4/0	1988	53.742	113.166	18	1926	1657	-1024	37.8	22.8	v.good	1	bulk density of salt seems low at approx. 1500 kg/m ³
90	701.7	698.1	NCL PROVOST 8-14-40-3	00/08-14-040-03W4/0	1994	52.440	110.319	182	1503	1297	-595	29.5	22.7	v.good	14	
91	692.8	688.8	HUSKY D H BALDWINTON 7-1-44-24	01/07-01-044-24W3/0	1972	52.760	109.351	579	1858	1070	-377	24.2	22.6	fair	54	
92	628.2	624.5	HUSKY INC ET AL CABRI 7-16-24-27	01/07-16-024-27W3/0	1969	51.043	109.710	610	1611	1491	-863	34.8	23.4	fair	41	
93	694.0	690.1	TEXCAN ALSASK 10-1-28-29	01/10-01-028-29W3/0	1984	51.367	109.950	668	2158	1512	-818	35.4	23.4	fair	44	
94	602.0	598.0	HUSKY DH LOW LAKE 10-9-50-24	01/10-09-050-24W3/0	1971	53.301	109.452	426	1032	831	-229	18.5	22.3	fair	51	
95	622.4	619.0	ARCO BA POUNDMAKER 12-28-45-22	01/12-28-045-22W3/0	1967	52.909	109.145	145	1168	939	-316	21.7	23.1	fair	15	good quality older log
96	741.0	737.3	S P C HB LUSELAND 15-8-35-27	01/15-08-035-27W3/0	1976	51.996	109.821	140	1539	1414	-673	33.1	23.4	fair	10	
97	718.0	712.3	WASCANA SHOP CACTUS LK 15-34-34-27	01/15-34-034-27W3/0	1980	51.967	109.746	257	2095	1390	-672	32.4	23.3	fair	18	
98	700.7	696.5	SASKOIL SHOP LUSELAND 16-36-36-25W3	01/16-36-036-25W3/0	1980	52.142	109.434	190	2000	1292	-591	30.0	23.2	fair	14	good quality older log
99	728.1	724.4	WASCANA PLOVER LK SWD A1-5-35-26	11/01-05-035-26W3/0	1997	51.970	109.670	249	2121	1398	-670	32.1	23.0	v.good	18	
100	723.5	719.4	PENN WEST PLOVER LAKE SWD A6-15-35-27	11/06-15-035-27W3/0	1998	52.001	109.776	260	2105	1392	-669	32.2	23.1	v.good	18	
101	742.2	737.3	MURPHY CTS LK N 7-30-36-28	21/07-30-036-28W3/0	1997	52.119	109.988	303	2130	1396	-653	32.3	23.2	v.good	21	
102	646.3	641.8	HUSKY LLOYD SCD B7-30-49-27	21/07-30-049-27W3/0	1998	53.254	109.939	213	954	949	-302	21.0	22.1	good	22	hole somewhat washed out - vertical stress will be low
103	646.5	642.8	HUSKY LLOYD SWD B12-30-49-27	21/12-30-049-27W3/0	1984	53.257	109.952	300	1735	952	-306	21.9	23.0	fair	31	good quality older log, near Husky's disposal area within the Prairie Evaporite Fm
104	646.3	641.4	HUSKY LLOYD SCD C7-30-49-27	31/07-30-049-27W3/0	1996	53.256	109.941	232	1075	950	-304	20.8	21.9	good	24	hole somewhat washed out - vertical stress will be low
105	655.8	651.7	GULF SHOP DRUID DD 1C16-10-34-22	31/16-10-034-22W3/0	1980	51.909	109.031	498	2034	1303	-648	30.6	23.5	fair	38	good quality older log
106	638.5	633.5	SIFTO CANADA UTILITY 3-9-40-22	41/03-09-040-22W3/0	1995	52.422	109.111	135	1249	1129	-491	25.9	23.0	good	12	
107	692.6	687.6	WASCANA LUSELAND SWD D3-18-36-25	41/03-18-036-25W3/0	1997	52.088	109.563	244	2047	1319	-626	30.6	23.2	v.good	18	
108	662.3	656.3	AMOCO KRRBRT 4 STORAGE DD 5-34-33-22	91/05-34-033-22W3/0	1996	51.870	109.050	158	1361	1359	-697	31.4	23.1	v.good	11	
109	538.4	535.4	BONAVISTA ET AL BEACON HILL 9-22-62-27	21/09-22-062-27W3/0	1987	54.377	109.958	103	742	715	-177	15.8	22.2	v.good	14	
110	728.7	722.7	WASCANA PLOVER LK SWD C16-5-35-26	31/16-05-035-26W3/0	1997	51.983	109.672	247	2114	1394	-665	32.4	23.2	v.good	17	
111	734.9	730.4	WASCANA PLOVER LK SWD D4-5-35-26	41/04-05-035-26W3/0	1997	51.972	109.689	247	2129	1405	-670	32.6	23.2	v.good	17	
112	702.2	697.3	MURPHY PLOVER LAKE 11-29-35-26	11/11-29-035-26W3/0	1997	52.035	109.683	301	2084	1355	-653	31.4	23.2	v.good	22	

Table E.2: Detailed summary of breakout data in the Saskatchewan, Beaverhill Lake, and Elk Point Groups

Definition of Column Headings:

Top:	top of interval (m log depth)
Bottom:	bottom of interval (m log depth)
Thickness:	thickness of interval (m)
P1AZ:	azimuth of C1 caliper with respect to magnetic north (degrees)
P1AZc:	azimuth of C1 caliper corrected to true north
Cmax Az wrt true North:	Breakout azimuth corrected to true north
C1:	C1-C3 caliper measurement (mm)
C2:	C2-C4 caliper measurement (mm)
% Enlarge	% difference between C1 and C2 readings
% Gauge	% difference between smaller caliper reading and hole gauge
Quality:	quality of breakout (see report for details)
Formation or Group:	formation or group identified in well ticket that breakout occurs within

Table E.2: Detailed summary of breakout data in the Saskatchewan, Beaverhill Lake, and Elk Point Groups

Well Name **MURPHY ET AL GRAHAM 12-18-87-3**

UWI: 100/12-18-087-03W5/00

Borehole Diameter: 159 mm

Correction to True North: 23.27 degrees

Comments: Well drilled with NaCl Gel Chem mud but little breakout shown in well

Top (m KB)	Bottom (m KB)	Thickness (m)	PIAZ (degrees)	CMAZ (degrees)	CMAZ wrt true N (degrees)	C1 (mm)	C2 (mm)	% Enlarge	% Gauge	Quality	Formation or Group
1152	1153	1	105	105	128	228.5	190.0	20.3%	19.5%	good	BH LK Grp
1153	1154	1	80	80	103	256.5	215.0	19.3%	35.2%	good	BH LK Grp
1478	1479	1	320	230	253	287.0	302.0	5.2%	80.5%	poor	Prairie Evaporite Fm
1493	1494	1	270	270	293	292.0	254.0	15.0%	59.7%	good	Prairie Evaporite Fm
1494	1495	1	270	270	293	298.5	267.0	11.8%	67.9%	good	Prairie Evaporite Fm
1495	1496	1	270	270	293	304.8	292.0	4.4%	83.6%	good	Prairie Evaporite Fm
1496	1497	1	270	270	293	311.0	292.0	6.5%	83.6%	good	Prairie Evaporite Fm
1497	1498	1	270	270	293	311.0	292.0	6.5%	83.6%	good	Prairie Evaporite Fm
1567	1568	1	305	305	328	171.0	159.0	7.5%	0.0%	good	Keg River Fm
1568	1569	1	300	300	323	171.0	159.0	7.5%	0.0%	good	Keg River Fm
1569	1570	1	300	300	323	171.0	159.0	7.5%	0.0%	good	Keg River Fm
1570	1571	1	295	295	318	171.0	159.0	7.5%	0.0%	good	Keg River Fm
1571	1572	1	295	295	318	171.0	159.0	7.5%	0.0%	good	Keg River Fm
1572	1573	1	290	290	313	171.0	159.0	7.5%	0.0%	good	Keg River Fm
1573	1574	1	290	290	313	171.0	159.0	7.5%	0.0%	good	Keg River Fm
1574	1575	1	285	285	308	171.0	159.0	7.5%	0.0%	good	Keg River Fm
1575	1576	1	280	280	303	171.0	159.0	7.5%	0.0%	good	Keg River Fm
1576	1577	1	280	280	303	171.0	159.0	7.5%	0.0%	good	Granite Wash Fm
1577	1578	1	265	265	288	171.0	159.0	7.5%	0.0%	good	Granite Wash Fm
1578	1579	1	265	265	288	171.0	159.0	7.5%	0.0%	good	Granite Wash Fm

Table E.2: Detailed summary of breakout data in the Saskatchewan, Beaverhill Lake, and Elk Point Groups

Well Name **COLIN ET AL KIDNEY 10-19-91-4**

UWI: 102/10-19-091-04W5/00

Borehole Diameter: 159 mm

Correction to True North: 0 (log corrected to true north)

Comments: Possibly other areas of breakout but caliper curves masked by pad resistivity traces in places

Comments: Well name on log header is DORSET ET AL KIDNEY 10-19-91-4

Top (m KB)	Bottom (m KB)	Thickness (m)	PIAZ (degrees)	CMAZ Az (degrees)	CMAZ Az wrt true N (degrees)	C1 (mm)	C2 (mm)	% Enlarge	% Gauge	Quality	Formation or Group
1152	1153	1	290	290	290	225	220	2.27%	38.36%	fair	Prairie Evaporite Fm
1153	1154	1	288	288	288	235	225	4.44%	41.51%	fair	Prairie Evaporite Fm
1154	1155	1	286	286	286	250	230	8.70%	44.65%	fair	Prairie Evaporite Fm
1155	1156	1	284	284	284	240	225	6.67%	41.51%	fair	Prairie Evaporite Fm
1156	1157	1	282	282	282	230	220	4.55%	38.36%	fair	Prairie Evaporite Fm
1157	1158	1	280	280	280	225	200	12.50%	25.79%	fair	Prairie Evaporite Fm
1198	1199	1	195	105	105	175	180	2.86%	10.06%	fair	Prairie Evaporite Fm
1199	1200	1	195	105	105	175	185	5.71%	10.06%	fair	Prairie Evaporite Fm
1200	1201	1	195	105	105	175	195	11.43%	10.06%	fair	Prairie Evaporite Fm
1201	1202	1	195	105	105	180	195	8.33%	13.21%	fair	Prairie Evaporite Fm
1202	1203	1	195	105	105	185	200	8.11%	16.35%	fair	Prairie Evaporite Fm
1203	1204	1	200	110	110	190	200	5.26%	19.50%	fair	Prairie Evaporite Fm
1204	1205	1	200	110	110	185	200	8.11%	16.35%	fair	Prairie Evaporite Fm
1205	1206	1	200	110	110	175	195	11.43%	10.06%	fair	Prairie Evaporite Fm
1206	1207	1	200	110	110	175	195	11.43%	10.06%	fair	Prairie Evaporite Fm
1207	1208	1	200	110	110	180	195	8.33%	13.21%	fair	Prairie Evaporite Fm
1208	1209	1	200	110	110	175	195	11.43%	10.06%	fair	Prairie Evaporite Fm
1209	1210	1	205	115	115	180	195	8.33%	13.21%	fair	Prairie Evaporite Fm
1210	1211	1	205	115	115	180	195	8.33%	13.21%	fair	Prairie Evaporite Fm
1211	1212	1	210	120	120	175	190	8.57%	10.06%	fair	Prairie Evaporite Fm
1212	1213	1	210	120	120	175	190	8.57%	10.06%	fair	Prairie Evaporite Fm
1213	1214	1	210	120	120	180	190	5.56%	13.21%	fair	Prairie Evaporite Fm
1214	1215	1	210	120	120	180	190	5.56%	13.21%	fair	Prairie Evaporite Fm
1215	1216	1	210	120	120	165	180	9.09%	3.77%	fair	Prairie Evaporite Fm
1216	1217	1	210	120	120	160	175	9.38%	0.63%	fair	Prairie Evaporite Fm

Table E.2: Detailed summary of breakout data in the Saskatchewan, Beaverhill Lake, and Elk Point Groups

Well Name **NCE ENER SENEX 14-9-92-4**

UWI: 100/14-09-092-04W5/0

Borehole Diameter: 200 mm

Correction to True North: 25.08 (corrected 18.2 deg E on log)

Comments: Oil-based mud used, hole near gauge and breakout difficult to identify

Top (m KB)	Bottom (m KB)	Thickness (m)	PIAZ (degrees)	CMAX Az (degrees)	CMAX Az wrt true N (degrees)	C1 (mm)	C2 (mm)	% Enlarge	% Gauge	Quality	Formation or Group
1203	1204	1	200	110	135	200	205	2.50%	25.79%	fair	Prairie Evaporite Fm
1204	1205	1	195	105	130	200	205	2.50%	25.79%	fair	Prairie Evaporite Fm
1205	1206	1	190	100	125	200	210	5.00%	25.79%	fair	Prairie Evaporite Fm
1206	1207	1	190	100	125	200	205	2.50%	25.79%	fair	Prairie Evaporite Fm
1232	1233	1	355	265	290	200	210	5.00%	25.79%	fair	Prairie Evaporite Fm
1233	1234	1	355	265	290	200	210	5.00%	25.79%	fair	Prairie Evaporite Fm
1234	1235	1	345	255	280	200	210	5.00%	25.79%	fair	Prairie Evaporite Fm

Well Name **UNOCAL KIDNEY 10-32-90-4**

UWI: 00/10-32-090-04W5/0

Borehole Diameter: 158.9 mm

Correction to True North: 23.6

Comments: only one section of breakout at the top of the logged interval

Top (m KB)	Bottom (m KB)	Thickness (m)	PIAZ (degrees)	CMAX Az (degrees)	CMAX Az wrt true N (degrees)	C1 (mm)	C2 (mm)	% Enlarge	% Gauge	Quality	Formation or Group
1138	1139	1	5	95	119	170	175	2.94%	6.92%	fair	BH LK Grp
1139	1140	1	10	100	124	170	175	2.94%	6.92%	fair	BH LK Grp
1140	1141	1	15	105	129	170	175	2.94%	6.92%	fair	BH LK Grp
1141	1142	1	20	110	134	170	175	2.94%	6.92%	fair	BH LK Grp
1142	1143	1	25	115	139	170	175	2.94%	6.92%	fair	BH LK Grp
1143	1144	1	30	120	144	170	175	2.94%	6.92%	fair	BH LK Grp
1144	1145	1	30	120	144	167	172	2.99%	5.03%	fair	BH LK Grp
1145	1146	1	30	120	144	165	170	3.03%	3.77%	fair	Slave Point Fm
1146	1147	1	30	120	144	159	164	3.14%	0.00%	fair	Slave Point Fm

Table E.2: Detailed summary of breakout data in the Saskatchewan, Beaverhill Lake, and Elk Point Groups

Well Name **UNOCAL KIDNEY 9-5-91-4**

UWI: 00/09-05-091-04W5/0

Borehole Diameter: 158.9 mm Correction to True North: 23.5

Top (m KB)	Bottom (m KB)	Thickness (m)	PIAZ (degrees)	CMAZ Az (degrees)	CMAZ Az wrt true N (degrees)	C1 (mm)	C2 (mm)	% Enlarge	% Gauge	Quality	Formation or Group
1016	1017	1	125	125	149	190	180	5.56%	13.21%	poor	BH LK Grp
1017	1018	1	125	125	149	200	180	11.11%	13.21%	poor	BH LK Grp
1018	1019	1	130	130	154	200	180	11.11%	13.21%	poor	BH LK Grp
1019	1020	1	130	130	154	200	180	11.11%	13.21%	poor	BH LK Grp
1020	1021	1	130	130	154	200	180	11.11%	13.21%	poor	BH LK Grp
1021	1022	1	125	125	149	200	180	11.11%	13.21%	poor	BH LK Grp
1022	1023	1	125	125	149	195	180	8.33%	13.21%	poor	BH LK Grp
1023	1024	1	120	120	144	190	180	5.56%	13.21%	poor	BH LK Grp
1024	1025	1	110	110	134	195	180	8.33%	13.21%	poor	BH LK Grp
1025	1026	1	105	105	129	200	185	8.11%	16.35%	poor	BH LK Grp
1026	1027	1	100	100	124	205	190	7.89%	19.50%	poor	BH LK Grp
1027	1028	1	95	95	119	205	185	10.81%	16.35%	poor	BH LK Grp
1028	1029	1	90	90	114	190	175	8.57%	10.06%	poor	BH LK Grp
1134	1135	1	260	260	284	175	162	8.02%	1.89%	good	Watt Mountain Fm
1135	1136	1	250	250	274	185	162	14.20%	1.89%	good	Watt Mountain Fm
1136	1137	1	230	230	254	190	162	17.28%	1.89%	good	Watt Mountain Fm
1137	1138	1	230	230	254	195	165	18.18%	3.77%	good	Watt Mountain Fm
1138	1139	1	230	230	254	190	165	15.15%	3.77%	good	Watt Mountain Fm
1139	1140	1	230	230	254	185	165	12.12%	3.77%	good	Watt Mountain Fm
1140	1141	1	230	230	254	180	162	11.11%	1.89%	good	Prairie Evaporite Fm
1264	1265	1	285	285	309	175	170	2.94%	6.92%	fair	Prairie Evaporite Fm
1265	1266	1	290	290	314	175	170	2.94%	6.92%	fair	Prairie Evaporite Fm
1288	1289	1	285	285	309	175	159	10.06%	0.00%	fair	Prairie Evaporite Fm
1289	1290	1	290	290	314	172	159	8.18%	0.00%	fair	Prairie Evaporite Fm
1290	1291	1	290	290	314	175	163	7.36%	2.52%	fair	Prairie Evaporite Fm
1291	1292	1	285	285	309	172	159	8.18%	0.00%	fair	Prairie Evaporite Fm
1292	1293	1	290	290	314	172	159	8.18%	0.00%	fair	Prairie Evaporite Fm
1293	1294	1	290	290	314	175	163	7.36%	2.52%	fair	Prairie Evaporite Fm
1294	1295	1	290	290	314	175	163	7.36%	2.52%	fair	Prairie Evaporite Fm

Table E.2: Detailed summary of breakout data in the Saskatchewan, Beaverhill Lake, and Elk Point Groups

Well Name **MURPHY TROUT 9-3-89-3**

UWI: 00/09-03-089-03W5/0

Borehole Diameter: 200 mm

Correction to True North: 0 (log corrected 23 degrees to true north)

Comments: Breakout between 1403 and 1414 m KB seen in both the main and repeat passes

Top (m KB)	Bottom (m KB)	Thickness (m)	PIAZ (degrees)	CMAZ (degrees)	CMAZ wrt true N (degrees)	C1 (mm)	C2 (mm)	% Enlarge	% Gauge	Quality	Formation or Group
1291	1292	1	100	100	100	250	225	11.11%	41.51%	fair	Prairie Evaporite Fm
1298	1299	1	105	105	105	265	250	6.00%	57.23%	fair	Prairie Evaporite Fm
1299	1300	1	100	100	100	270	250	8.00%	57.23%	fair	Prairie Evaporite Fm
1403	1404	1	205	115	115	200	205	2.50%	25.79%	fair	Prairie Evaporite Fm
1404	1405	1	205	115	115	210	225	7.14%	32.08%	good	Prairie Evaporite Fm
1405	1406	1	205	115	115	225	230	2.22%	41.51%	good	Prairie Evaporite Fm
1406	1407	1	215	125	125	220	235	6.82%	38.36%	good	Prairie Evaporite Fm
1407	1408	1	215	125	125	220	240	9.09%	38.36%	good	Prairie Evaporite Fm
1408	1409	1	210	120	120	220	240	9.09%	38.36%	good	Prairie Evaporite Fm
1409	1410	1	210	120	120	220	240	9.09%	38.36%	good	Prairie Evaporite Fm
1410	1411	1	205	115	115	220	235	6.82%	38.36%	good	Prairie Evaporite Fm
1411	1412	1	205	115	115	220	230	4.55%	38.36%	good	Prairie Evaporite Fm
1412	1413	1	200	110	110	210	220	4.76%	32.08%	good	Prairie Evaporite Fm
1413	1414	1	200	110	110	200	210	5.00%	25.79%	good	Prairie Evaporite Fm

Table E.2: Detailed summary of breakout data in the Saskatchewan, Beaverhill Lake, and Elk Point Groups

Well Name **UNOCAL ET AL TROUT 8-10-89-3**

UWI: 00/08-10-089-03W5/0

Borehole Diameter: 159 mm

Correction to True North: 0 (log corrected 24 degrees to true north)

Comments: Breakout shows minor population between 1091 and 1100 m KB approx. 90 degrees from the major population

Top (m KB)	Bottom (m KB)	Thickness (m)	PIAZ (degrees)	CMAX Az (degrees)	CMAX Az wrt true N (degrees)	C1 (mm)	C2 (mm)	% Enlarge	% Gauge	Quality	Formation or Group
1091	1092	1	210	210	210	170	165	3.03%	3.77%	fair	BH LK Grp
1092	1093	1	215	215	215	180	170	5.88%	6.92%	fair	BH LK Grp
1093	1094	1	215	215	215	200	180	11.11%	13.21%	fair	BH LK Grp
1094	1095	1	220	220	220	210	175	20.00%	10.06%	fair	BH LK Grp
1095	1096	1	230	230	230	210	175	20.00%	10.06%	fair	BH LK Grp
1096	1097	1	235	235	235	200	165	21.21%	3.77%	fair	BH LK Grp
1097	1098	1	240	240	240	190	165	15.15%	3.77%	fair	BH LK Grp
1098	1099	1	245	245	245	185	160	15.63%	0.63%	fair	BH LK Grp
1099	1100	1	250	250	250	170	160	6.25%	0.63%	fair	BH LK Grp
1107	1108	1	230	140	140	170	175	2.94%	6.92%	poor	BH LK Grp
1108	1109	1	225	135	135	170	185	8.82%	6.92%	fair	BH LK Grp
1109	1110	1	225	135	135	170	190	11.76%	6.92%	fair	BH LK Grp
1110	1111	1	220	130	130	170	205	20.59%	6.92%	fair	BH LK Grp
1111	1112	1	215	125	125	170	200	17.65%	6.92%	fair	BH LK Grp
1112	1113	1	215	125	125	170	195	14.71%	6.92%	fair	BH LK Grp
1113	1114	1	210	120	120	170	190	11.76%	6.92%	fair	BH LK Grp
1114	1115	1	205	115	115	165	185	12.12%	3.77%	fair	BH LK Grp
1326	1327	1	135	135	135	285	260	9.62%	63.52%	good	Prairie Evaporite Fm
1330	1331	1	130	130	130	290	265	9.43%	66.67%	good	Prairie Evaporite Fm
1331	1332	1	130	130	130	295	270	9.26%	69.81%	good	Prairie Evaporite Fm

Table E.2: Detailed summary of breakout data in the Saskatchewan, Beaverhill Lake, and Elk Point Groups

Well Name **SUNCOR STROME 11-16-44-16**

UWI: 00/11-16-044-16W4/0

Borehole Diameter: 222 mm

Correction to True North: 20.1 degrees

Comments: Breakout shows minor population between 1710 and 1716 m KB approx. 90 degrees from the major population

Top (m KB)	Bottom (m KB)	Thickness (m)	PIAZ (degrees)	CMAZ Az (degrees)	CMAZ Az wrt true N (degrees)	C1 (mm)	C2 (mm)	% Enlarge	% Gauge	Quality	Formation or Group
1470	1471	1	360	270	290	235	238	1.28%	47.80%	poor	BH LK Grp
1471	1472	1	360	270	290	235	240	2.13%	47.80%	poor	BH LK Grp
1472	1473	1	355	265	285	235	242	2.98%	47.80%	poor	BH LK Grp
1473	1474	1	355	265	285	235	245	4.26%	47.80%	poor	BH LK Grp
1474	1475	1	350	260	280	240	248	3.33%	50.94%	poor	BH LK Grp
1475	1476	1	350	260	280	240	250	4.17%	50.94%	fair	BH LK Grp
1476	1477	1	350	260	280	240	250	4.17%	50.94%	fair	BH LK Grp
1477	1478	1	350	260	280	240	250	4.17%	50.94%	fair	BH LK Grp
1478	1479	1	350	260	280	240	250	4.17%	50.94%	fair	BH LK Grp
1479	1480	1	350	260	280	240	250	4.17%	50.94%	fair	BH LK Grp
1480	1481	1	355	265	285	240	250	4.17%	50.94%	fair	BH LK Grp
1481	1482	1	355	265	285	240	250	4.17%	50.94%	fair	BH LK Grp
1482	1483	1	355	265	285	240	250	4.17%	50.94%	fair	BH LK Grp
1483	1484	1	355	265	285	235	250	6.38%	47.80%	fair	BH LK Grp
1484	1485	1	350	260	280	235	250	6.38%	47.80%	fair	BH LK Grp
1485	1486	1	350	260	280	235	250	6.38%	47.80%	fair	BH LK Grp
1486	1487	1	350	260	280	235	245	4.26%	47.80%	fair	BH LK Grp
1487	1488	1	350	260	280	235	245	4.26%	47.80%	fair	BH LK Grp
1488	1489	1	345	255	275	235	250	6.38%	47.80%	fair	BH LK Grp
1489	1490	1	345	255	275	235	250	6.38%	47.80%	fair	BH LK Grp
1490	1491	1	340	250	270	245	250	2.04%	54.09%	poor	BH LK Grp
1710	1711	1	280	190	210	260	265	1.92%	63.52%	poor	Prairie Evaporite Fm
1711	1712	1	280	190	210	260	275	5.77%	63.52%	fair	Prairie Evaporite Fm
1712	1713	1	280	190	210	260	275	5.77%	63.52%	fair	Prairie Evaporite Fm
1713	1714	1	280	190	210	260	275	5.77%	63.52%	fair	Prairie Evaporite Fm
1714	1715	1	280	190	210	260	275	5.77%	63.52%	fair	Prairie Evaporite Fm
1715	1716	1	280	190	210	260	275	5.77%	63.52%	fair	Prairie Evaporite Fm

Table E.2: Detailed summary of breakout data in the Saskatchewan, Beaverhill Lake, and Elk Point Groups

1731	1732	1	210	210	230	275	260	5.77%	63.52%	fair	Prairie Evaporite Fm
1732	1733	1	215	215	235	265	255	3.92%	60.38%	poor	Prairie Evaporite Fm
1733	1734	1	215	215	235	265	255	3.92%	60.38%	poor	Prairie Evaporite Fm
1734	1735	1	215	215	235	275	265	3.77%	66.67%	poor	Prairie Evaporite Fm
1735	1736	1	210	210	230	275	265	3.77%	66.67%	poor	Prairie Evaporite Fm

Table E.2: Detailed summary of breakout data in the Saskatchewan, Beaverhill Lake, and Elk Point Groups

Well Name **DORSET ET AL MARTENCK 11-12-80-5**

UWI: 00/11-12-080-05W5/0

Borehole Diameter: 209.55 mm (8.25")

Correction to True North: 20.3 degrees

Comments: Log recorded in feet

Top (m KB)	Bottom (m KB)	Thickness (m)	PIAZ (degrees)	CMAZ Az (degrees)	CMAZ Az wrt true N (degrees)	C1 (mm)	C2 (mm)	% Enlarge	% Gauge	Quality	Formation or Group
1339	1340	1	80	80	100	350	340	2.94%	113.84%	poor	BH LK Grp
1340	1341	1	80	80	100	365	340	7.35%	113.84%	poor	BH LK Grp
1341	1342	1	80	80	100	370	355	4.23%	123.27%	poor	BH LK Grp
1342	1343	1	80	80	100	375	355	5.63%	123.27%	poor	BH LK Grp
1343	1344	1	80	80	100	365	355	2.82%	123.27%	poor	BH LK Grp
1344	1345	1	75	75	95	360	340	5.88%	113.84%	poor	BH LK Grp
1521	1522	1	5	95	115	270	330	22.22%	69.81%	poor	Watt Mountain Fm
1522	1523	1	5	95	115	270	405	50.00%	69.81%	poor	Watt Mountain Fm
1523	1524	1	10	100	120	330	410	24.24%	107.55%	poor	Watt Mountain Fm
1524	1525	1	10	100	120	270	370	37.04%	69.81%	poor	Watt Mountain Fm
1525	1526	1	10	100	120	270	350	29.63%	69.81%	poor	Watt Mountain Fm
1526	1527	1	5	95	115	270	300	11.11%	69.81%	poor	Watt Mountain Fm
1527	1528	1	5	95	115	270	370	37.04%	69.81%	poor	Watt Mountain Fm

Table E.2: Detailed summary of breakout data in the Saskatchewan, Beaverhill Lake, and Elk Point Groups

Well Name **PCI LEIGE 11-8-95-22**

UWI: 00/11-08-095-22W4/0

Borehole Diameter: 222 mm

Correction to True North: 23.4 degrees

Comments: PIAZ was calculated from adding hole azimuth (AZIM) to the relative bearing (RB)

Top (m KB)	Bottom (m KB)	Thickness (m)	PIAZ (degrees)	CMAZ Az (degrees)	CMAZ Az wrt true N (degrees)	C1 (mm)	C2 (mm)	% Enlarge	% Gauge	Quality	Formation or Group
919	920	1	310	310	333	230	225	2.22%	41.51%	fair	Waterways Fm
920	921	1	310	310	333	240	225	6.67%	41.51%	good	Waterways Fm
921	922	1	310	310	333	240	225	6.67%	41.51%	good	Waterways Fm
922	923	1	300	300	323	240	225	6.67%	41.51%	good	Waterways Fm
923	924	1	300	300	323	240	230	4.35%	44.65%	good	Waterways Fm
924	925	1	300	300	323	240	230	4.35%	44.65%	good	Waterways Fm
925	926	1	300	300	323	240	225	6.67%	41.51%	good	Waterways Fm
926	927	1	300	300	323	240	225	6.67%	41.51%	good	Waterways Fm
927	928	1	300	300	323	240	225	6.67%	41.51%	good	Waterways Fm
928	929	1	300	300	323	240	225	6.67%	41.51%	good	Waterways Fm
929	930	1	300	300	323	240	225	6.67%	41.51%	good	Waterways Fm
930	931	1	300	300	323	240	225	6.67%	41.51%	good	Waterways Fm
931	932	1	300	300	323	240	225	6.67%	41.51%	good	Waterways Fm
932	933	1	300	300	323	240	225	6.67%	41.51%	good	Waterways Fm
933	934	1	305	305	328	240	225	6.67%	41.51%	good	Waterways Fm
934	935	1	305	305	328	250	225	11.11%	41.51%	good	Waterways Fm
935	936	1	310	310	333	250	225	11.11%	41.51%	good	Waterways Fm
936	937	1	310	310	333	250	230	8.70%	44.65%	good	Waterways Fm
937	938	1	310	310	333	250	230	8.70%	44.65%	good	Waterways Fm
938	939	1	300	300	323	250	230	8.70%	44.65%	good	Waterways Fm
939	940	1	300	300	323	245	235	4.26%	47.80%	good	Waterways Fm
940	941	1	300	300	323	230	225	2.22%	41.51%	fair	Waterways Fm
1041	1042	1	5	95	118	225	235	4.44%	41.51%	fair	Prairie Evaporite Fm
1042	1043	1	5	95	118	225	235	4.44%	41.51%	fair	Prairie Evaporite Fm
1043	1044	1	5	95	118	225	235	4.44%	41.51%	fair	Prairie Evaporite Fm
1044	1045	1	0	90	113	260	270	3.85%	63.52%	fair	Prairie Evaporite Fm
1045	1046	1	350	260	283	260	270	3.85%	63.52%	fair	Prairie Evaporite Fm

Table E.2: Detailed summary of breakout data in the Saskatchewan, Beaverhill Lake, and Elk Point Groups

1046	1047	1	345	255	278	230	240	4.35%	44.65%	fair	Prairie Evaporite Fm
1047	1048	1	340	250	273	225	240	6.67%	41.51%	fair	Prairie Evaporite Fm
1048	1049	1	340	250	273	225	235	4.44%	41.51%	fair	Prairie Evaporite Fm
1049	1050	1	340	250	273	225	235	4.44%	41.51%	fair	Prairie Evaporite Fm
1248	1249	1	365	275	298	220	225	2.27%	38.36%	fair	Prairie Evaporite Fm
1249	1250	1	365	275	298	220	225	2.27%	38.36%	fair	Prairie Evaporite Fm
1250	1251	1	365	275	298	220	225	2.27%	38.36%	fair	Prairie Evaporite Fm
1251	1252	1	360	270	293	220	225	2.27%	38.36%	fair	Prairie Evaporite Fm
1255	1256	1	360	270	293	220	225	2.27%	38.36%	fair	Prairie Evaporite Fm
1256	1257	1	355	265	288	220	225	2.27%	38.36%	fair	Prairie Evaporite Fm
1257	1258	1	355	265	288	220	225	2.27%	38.36%	fair	Prairie Evaporite Fm
1258	1259	1	355	265	288	220	225	2.27%	38.36%	fair	Prairie Evaporite Fm
1259	1260	1	360	270	293	220	225	2.27%	38.36%	fair	Prairie Evaporite Fm

Well Name **SCEPTRE MURPHY T'FLAGS A1-26-52-25**

UWI: 11/01-26-052-25W3/2

Borehole Diameter: 251 mm

Correction to True North: 0 (log corrected using magnetic declination of 21 degrees)

Comments: Breakout occurs at bottom of hole and, therefore, may be influenced by drilling effects. Breakout does occur in both the main and repeat pass.

Top (m KB)	Bottom (m KB)	Thickness (m)	P1AZ (degrees)	CMAZ Az (degrees)	CMAZ Az wrt true N (degrees)	C1 (mm)	C2 (mm)	% Enlarge	% Gauge	Quality	Formation or Group
578	579	1	335	335	335	270	265	1.89%	66.67%	poor	Duperow Fm
579	580	1	335	335	335	270	265	1.89%	66.67%	poor	Duperow Fm
580	581	1	335	335	335	270	265	1.89%	66.67%	poor	Duperow Fm
581	582	1	330	330	330	270	265	1.89%	66.67%	poor	Duperow Fm
582	583	1	325	325	325	270	265	1.89%	66.67%	poor	Duperow Fm

Table E.2: Detailed summary of breakout data in the Saskatchewan, Beaverhill Lake, and Elk Point Groups

Definition of Column Headings:

Top:	top of interval (m log depth)
Bottom:	bottom of interval (m log depth)
Thickness:	thickness of interval (m)
P1AZ:	azimuth of C1 caliper with respect to magnetic north (degrees)
P1AZc:	azimuth of C1 caliper corrected to true north
Cmax Az wrt true North:	Breakout azimuth corrected to true north
C1:	C1-C3 caliper measurement (mm)
C2:	C2-C4 caliper measurement (mm)
% Enlarge	% difference between C1 and C2 readings
% Gauge	% difference between smaller caliper reading and hole gauge
Quality:	quality of breakout (see report for details)
Formation or Group:	formation or group identified in well ticket that breakout occurs within

SD of all corrected CMAX Az data from all wells: 53°
SD of Population 1 corrected CMAX Az data from all wells: 36°
SD of Population 2 corrected CMAX Az data from all wells: 35°

Table E.2: Detailed summary of breakout data in the Saskatchewan, Beaverhill Lake, and Elk Point Groups

Well Name: **MURPHY ET AL GRAHAM 12-18-87-3**

UWI: 100/12-18-087-03W5/00

Borehole Diameter: 159 mm

Correction to True North: 23.27 degrees

Comments: Well drilled with NaCl Gel Chem mud but little breakout shown in well

Top (m KB)	Bottom (m KB)	Thickness (m)	PIAZ (degrees)	CMAZ Az (degrees)	CMAZ Az wrt true N (degrees)	C1 (mm)	C2 (mm)	% Enlarge	% Gauge	Quality	Formation or Group
1152	1153	1	105	105	128	228.5	190.0	20.3%	19.5%	good	BH LK Grp
1153	1154	1	80	80	103	256.5	215.0	19.3%	35.2%	good	BH LK Grp
1478	1479	1	320	230	253	287.0	302.0	5.2%	80.5%	poor	Prairie Evaporite Fm
1493	1494	1	270	270	293	292.0	254.0	15.0%	59.7%	good	Prairie Evaporite Fm
1494	1495	1	270	270	293	298.5	267.0	11.8%	67.9%	good	Prairie Evaporite Fm
1495	1496	1	270	270	293	304.8	292.0	4.4%	83.6%	good	Prairie Evaporite Fm
1496	1497	1	270	270	293	311.0	292.0	6.5%	83.6%	good	Prairie Evaporite Fm
1497	1498	1	270	270	293	311.0	292.0	6.5%	83.6%	good	Prairie Evaporite Fm
1567	1568	1	305	305	328	171.0	159.0	7.5%	0.0%	good	Keg River Fm
1568	1569	1	300	300	323	171.0	159.0	7.5%	0.0%	good	Keg River Fm
1569	1570	1	300	300	323	171.0	159.0	7.5%	0.0%	good	Keg River Fm
1570	1571	1	295	295	318	171.0	159.0	7.5%	0.0%	good	Keg River Fm
1571	1572	1	295	295	318	171.0	159.0	7.5%	0.0%	good	Keg River Fm
1572	1573	1	290	290	313	171.0	159.0	7.5%	0.0%	good	Keg River Fm
1573	1574	1	290	290	313	171.0	159.0	7.5%	0.0%	good	Keg River Fm
1574	1575	1	285	285	308	171.0	159.0	7.5%	0.0%	good	Keg River Fm
1575	1576	1	280	280	303	171.0	159.0	7.5%	0.0%	good	Keg River Fm
1576	1577	1	280	280	303	171.0	159.0	7.5%	0.0%	good	Keg River Fm
1577	1578	1	265	265	288	171.0	159.0	7.5%	0.0%	good	Granite Wash Fm
1578	1579	1	265	265	288	171.0	159.0	7.5%	0.0%	good	Granite Wash Fm

SD of all corrected CMAX Az data: 34

SD of Population 1 corrected CMAX Az data: 27

SD of Population 2 corrected CMAX Az data: 0

Table E.2: Detailed summary of breakout data in the Saskatchewan, Beaverhill Lake, and Elk Point Groups

Well Name: **COLIN ET AL KIDNEY 10-19-91-4**

UWI: 102/10-19-091-04W5/00

Borehole Diameter: 159 mm

Correction to True North: 0 (log corrected to true north)

Comments: Possibly other areas of breakout but caliper curves masked by pad resistivity traces in places

Comments: Well name on log header is DORSET ET AL KIDNEY 10-19-91-4

Top (m KB)	Bottom (m KB)	Thickness (m)	PIAZ (degrees)	CMAZ Az (degrees)	CMAZ Az wrt true N (degrees)	C1 (mm)	C2 (mm)	% Enlarge	% Gauge	Quality	Formation or Group
1152	1153	1	290	290	290	225	220	2.27%	38.36%	fair	Prairie Evaporite Fm
1153	1154	1	288	288	288	235	225	4.44%	41.51%	fair	Prairie Evaporite Fm
1154	1155	1	286	286	286	250	230	8.70%	44.65%	fair	Prairie Evaporite Fm
1155	1156	1	284	284	284	240	225	6.67%	41.51%	fair	Prairie Evaporite Fm
1156	1157	1	282	282	282	230	220	4.55%	38.36%	fair	Prairie Evaporite Fm
1157	1158	1	280	280	280	225	200	12.50%	25.79%	fair	Prairie Evaporite Fm
1198	1199	1	195	105	105	175	180	2.86%	10.06%	fair	Prairie Evaporite Fm
1199	1200	1	195	105	105	175	185	5.71%	10.06%	fair	Prairie Evaporite Fm
1200	1201	1	195	105	105	175	195	11.43%	10.06%	fair	Prairie Evaporite Fm
1201	1202	1	195	105	105	180	195	8.33%	13.21%	fair	Prairie Evaporite Fm
1202	1203	1	195	105	105	185	200	8.11%	16.35%	fair	Prairie Evaporite Fm
1203	1204	1	200	110	110	190	200	5.26%	19.50%	fair	Prairie Evaporite Fm
1204	1205	1	200	110	110	185	200	8.11%	16.35%	fair	Prairie Evaporite Fm
1205	1206	1	200	110	110	175	195	11.43%	10.06%	fair	Prairie Evaporite Fm
1206	1207	1	200	110	110	175	195	11.43%	10.06%	fair	Prairie Evaporite Fm
1207	1208	1	200	110	110	180	195	8.33%	13.21%	fair	Prairie Evaporite Fm
1208	1209	1	200	110	110	175	195	11.43%	10.06%	fair	Prairie Evaporite Fm
1209	1210	1	205	115	115	180	195	8.33%	13.21%	fair	Prairie Evaporite Fm
1210	1211	1	205	115	115	180	195	8.33%	13.21%	fair	Prairie Evaporite Fm
1211	1212	1	210	120	120	175	190	8.57%	10.06%	fair	Prairie Evaporite Fm
1212	1213	1	210	120	120	175	190	8.57%	10.06%	fair	Prairie Evaporite Fm
1213	1214	1	210	120	120	180	190	5.56%	13.21%	fair	Prairie Evaporite Fm
1214	1215	1	210	120	120	180	190	5.56%	13.21%	fair	Prairie Evaporite Fm
1215	1216	1	210	120	120	165	180	9.09%	3.77%	fair	Prairie Evaporite Fm
1216	1217	1	210	120	120	160	175	9.38%	0.63%	fair	Prairie Evaporite Fm

SD of Population 1 corrected CMAZ Az data:

13

Table E.2: Detailed summary of breakout data in the Saskatchewan, Beaverhill Lake, and Elk Point Groups

Well Name: **NCE ENER SENEX 14-9-92-4**

UWI: 100/14-09-092-04W5/0

Borehole Diameter: 200 mm

Correction to True North: 25.08 (corrected 18.2 deg E on log)

Comments: Oil-based mud used, hole near gauge and breakout difficult to identify

Top (m KB)	Bottom (m KB)	Thickness (m)	PIAZ (degrees)	CMAZ Az (degrees)	CMAZ Az wrt true N (degrees)	C1 (mm)	C2 (mm)	% Enlarge	% Gauge	Quality	Formation or Group
1203	1204	1	200	110	135	200	205	2.50%	25.79%	fair	Prairie Evaporite Fm
1204	1205	1	195	105	130	200	205	2.50%	25.79%	fair	Prairie Evaporite Fm
1205	1206	1	190	100	125	200	210	5.00%	25.79%	fair	Prairie Evaporite Fm
1206	1207	1	190	100	125	200	205	2.50%	25.79%	fair	Prairie Evaporite Fm
1232	1233	1	355	265	290	200	210	5.00%	25.79%	fair	Prairie Evaporite Fm
1233	1234	1	355	265	290	200	210	5.00%	25.79%	fair	Prairie Evaporite Fm
1234	1235	1	345	255	280	200	210	5.00%	25.79%	fair	Prairie Evaporite Fm

SD of Population 1 corrected CMAZ Az data: 25

Well Name: **UNOCAL KIDNEY 10-32-90-4**

UWI: 00/10-32-090-04W5/0

Borehole Diameter: 158.9 mm

Correction to True North: 23.6

Comments: only one section of breakout at the top of the logged interval

Top (m KB)	Bottom (m KB)	Thickness (m)	PIAZ (degrees)	CMAZ Az (degrees)	CMAZ Az wrt true N (degrees)	C1 (mm)	C2 (mm)	% Enlarge	% Gauge	Quality	Formation or Group
1138	1139	1	5	95	119	170	175	2.94%	6.92%	fair	BH LK Grp
1139	1140	1	10	100	124	170	175	2.94%	6.92%	fair	BH LK Grp
1140	1141	1	15	105	129	170	175	2.94%	6.92%	fair	BH LK Grp
1141	1142	1	20	110	134	170	175	2.94%	6.92%	fair	BH LK Grp
1142	1143	1	25	115	139	170	175	2.94%	6.92%	fair	BH LK Grp
1143	1144	1	30	120	144	170	175	2.94%	6.92%	fair	BH LK Grp
1144	1145	1	30	120	144	167	172	2.99%	5.03%	fair	BH LK Grp
1145	1146	1	30	120	144	165	170	3.03%	3.77%	fair	Slave Point Fm

Table E.2: Detailed summary of breakout data in the Saskatchewan, Beaverhill Lake, and Elk Point Groups

1146	1147	1	30	120	144	159	164	3.14%	0.00%	fair	Slave Point Fm
SD of Population 1 corrected CMAX Az data:					18						

Well Name: **UNOCAL KIDNEY 9-5-91-4**

UWI: 00/09-05-091-04W5/0

Borehole Diameter: 158.9 mm Correction to True North: 23.5

Top (m KB)	Bottom (m KB)	Thickness (m)	PIAZ (degrees)	CMAX Az (degrees)	CMAX Az wrt true N (degrees)	C1 (mm)	C2 (mm)	% Enlarge	% Gauge	Quality	Formation or Group
1016	1017	1	125	125	149	190	180	5.56%	13.21%	poor	BH LK Grp
1017	1018	1	125	125	149	200	180	11.11%	13.21%	poor	BH LK Grp
1018	1019	1	130	130	154	200	180	11.11%	13.21%	poor	BH LK Grp
1019	1020	1	130	130	154	200	180	11.11%	13.21%	poor	BH LK Grp
1020	1021	1	130	130	154	200	180	11.11%	13.21%	poor	BH LK Grp
1021	1022	1	125	125	149	200	180	11.11%	13.21%	poor	BH LK Grp
1022	1023	1	125	125	149	195	180	8.33%	13.21%	poor	BH LK Grp
1023	1024	1	120	120	144	190	180	5.56%	13.21%	poor	BH LK Grp
1024	1025	1	110	110	134	195	180	8.33%	13.21%	poor	BH LK Grp
1025	1026	1	105	105	129	200	185	8.11%	16.35%	poor	BH LK Grp
1026	1027	1	100	100	124	205	190	7.89%	19.50%	poor	BH LK Grp
1027	1028	1	95	95	119	205	185	10.81%	16.35%	poor	BH LK Grp
1028	1029	1	90	90	114	190	175	8.57%	10.06%	poor	BH LK Grp
1134	1135	1	260	260	284	175	162	8.02%	1.89%	good	Watt Mountain Fm
1135	1136	1	250	250	274	185	162	14.20%	1.89%	good	Watt Mountain Fm
1136	1137	1	230	230	254	190	162	17.28%	1.89%	good	Watt Mountain Fm
1137	1138	1	230	230	254	195	165	18.18%	3.77%	good	Watt Mountain Fm
1138	1139	1	230	230	254	190	165	15.15%	3.77%	good	Watt Mountain Fm
1139	1140	1	230	230	254	185	165	12.12%	3.77%	good	Watt Mountain Fm
1140	1141	1	230	230	254	180	162	11.11%	1.89%	good	Prairie Evaporite Fm
1264	1265	1	285	285	309	175	170	2.94%	6.92%	fair	Prairie Evaporite Fm
1265	1266	1	290	290	314	175	170	2.94%	6.92%	fair	Prairie Evaporite Fm
1288	1289	1	285	285	309	175	159	10.06%	0.00%	fair	Prairie Evaporite Fm
1289	1290	1	290	290	314	172	159	8.18%	0.00%	fair	Prairie Evaporite Fm
1290	1291	1	290	290	314	175	163	7.36%	2.52%	fair	Prairie Evaporite Fm

Table E.2: Detailed summary of breakout data in the Saskatchewan, Beaverhill Lake, and Elk Point Groups

1291	1292	1	285	285	309	172	159	8.18%	0.00%	fair	Prairie Evaporite Fm
1292	1293	1	290	290	314	172	159	8.18%	0.00%	fair	Prairie Evaporite Fm
1293	1294	1	290	290	314	175	163	7.36%	2.52%	fair	Prairie Evaporite Fm
1294	1295	1	290	290	314	175	163	7.36%	2.52%	fair	Prairie Evaporite Fm

SD of all corrected CMAX Az data: 53

SD of Population 1 corrected CMAX Az data: 30

SD of Population 2 corrected CMAX Az data: 0

Well Name: **MURPHY TROUT 9-3-89-3**

UWI: 00/09-03-089-03W5/0

Borehole Diameter: 200 mm

Correction to True North: 0 (log corrected 23 degrees to true north)

Comments: Breakout between 1403 and 1414 m KB seen in both the main and repeat passes

Top (m KB)	Bottom (m KB)	Thickness (m)	PIAZ (degrees)	CMAX Az (degrees)	CMAX Az wrt true N (degrees)	C1 (mm)	C2 (mm)	% Enlarge	% Gauge	Quality	Formation or Group
1291	1292	1	100	100	100	250	225	11.11%	41.51%	fair	Prairie Evaporite Fm
1298	1299	1	105	105	105	265	250	6.00%	57.23%	fair	Prairie Evaporite Fm
1299	1300	1	100	100	100	270	250	8.00%	57.23%	fair	Prairie Evaporite Fm
1403	1404	1	205	115	115	200	205	2.50%	25.79%	fair	Prairie Evaporite Fm
1404	1405	1	205	115	115	210	225	7.14%	32.08%	good	Prairie Evaporite Fm
1405	1406	1	205	115	115	225	230	2.22%	41.51%	good	Prairie Evaporite Fm
1406	1407	1	215	125	125	220	235	6.82%	38.36%	good	Prairie Evaporite Fm
1407	1408	1	215	125	125	220	240	9.09%	38.36%	good	Prairie Evaporite Fm
1408	1409	1	210	120	120	220	240	9.09%	38.36%	good	Prairie Evaporite Fm
1409	1410	1	210	120	120	220	240	9.09%	38.36%	good	Prairie Evaporite Fm
1410	1411	1	205	115	115	220	235	6.82%	38.36%	good	Prairie Evaporite Fm
1411	1412	1	205	115	115	220	230	4.55%	38.36%	good	Prairie Evaporite Fm
1412	1413	1	200	110	110	210	220	4.76%	32.08%	good	Prairie Evaporite Fm
1413	1414	1	200	110	110	200	210	5.00%	25.79%	good	Prairie Evaporite Fm

SD of Population 1 corrected CMAX Az data: 15

Well Name: **UNOCAL ET AL TROUT 8-10-89-3**

UWI: 00/08-10-089-03W5/0

Borehole Diameter: 159 mm

Table E.2: Detailed summary of breakout data in the Saskatchewan, Beaverhill Lake, and Elk Point Groups

Correction to True North: 0 (log corrected 24 degrees to true north)

Comments: Breakout shows minor population between 1091 and 1100 m KB approx. 90 degrees from the major population

Top (m KB)	Bottom (m KB)	Thickness (m)	PIAZ (degrees)	CMAX Az (degrees)	CMAX Az wrt true N (degrees)	C1 (mm)	C2 (mm)	% Enlarge	% Gauge	Quality	Formation or Group
1091	1092	1	210	210	210	170	165	3.03%	3.77%	fair	BH LK Grp
1092	1093	1	215	215	215	180	170	5.88%	6.92%	fair	BH LK Grp
1093	1094	1	215	215	215	200	180	11.11%	13.21%	fair	BH LK Grp
1094	1095	1	220	220	220	210	175	20.00%	10.06%	fair	BH LK Grp
1095	1096	1	230	230	230	210	175	20.00%	10.06%	fair	BH LK Grp
1096	1097	1	235	235	235	200	165	21.21%	3.77%	fair	BH LK Grp
1097	1098	1	240	240	240	190	165	15.15%	3.77%	fair	BH LK Grp
1098	1099	1	245	245	245	185	160	15.63%	0.63%	fair	BH LK Grp
1099	1100	1	250	250	250	170	160	6.25%	0.63%	fair	BH LK Grp
1107	1108	1	230	140	140	170	175	2.94%	6.92%	poor	BH LK Grp
1108	1109	1	225	135	135	170	185	8.82%	6.92%	fair	BH LK Grp
1109	1110	1	225	135	135	170	190	11.76%	6.92%	fair	BH LK Grp
1110	1111	1	220	130	130	170	205	20.59%	6.92%	fair	BH LK Grp
1111	1112	1	215	125	125	170	200	17.65%	6.92%	fair	BH LK Grp
1112	1113	1	215	125	125	170	195	14.71%	6.92%	fair	BH LK Grp
1113	1114	1	210	120	120	170	190	11.76%	6.92%	fair	BH LK Grp
1114	1115	1	205	115	115	165	185	12.12%	3.77%	fair	BH LK Grp
1326	1327	1	135	135	135	285	260	9.62%	63.52%	good	Prairie Evaporite Fm
1330	1331	1	130	130	130	290	265	9.43%	66.67%	good	Prairie Evaporite Fm
1331	1332	1	130	130	130	295	270	9.26%	69.81%	good	Prairie Evaporite Fm

SD of all corrected CMAX Az data: 102

SD of Population 1 corrected CMAX Az data: 14

SD of Population 2 corrected CMAX Az data: 28

Well Name: **SUNCOR STROME 11-16-44-16**

UWI: 00/11-16-044-16W4/0

Borehole Diameter: 222 mm

Correction to True North: 20.1 degrees

Comments: Breakout shows minor population between 1710 and 1716 m KB approx. 90 degrees from the major population

Top (m KB)	Bottom (m KB)	Thickness (m)	PIAZ (degrees)	CMAX Az (degrees)	CMAX Az wrt true N (degrees)	C1 (mm)	C2 (mm)	% Enlarge	% Gauge	Quality	Formation or Group
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Table E.2: Detailed summary of breakout data in the Saskatchewan, Beaverhill Lake, and Elk Point Groups

1470	1471	1	360	270	290	235	238	1.28%	47.80%	poor	BH LK Grp
1471	1472	1	360	270	290	235	240	2.13%	47.80%	poor	BH LK Grp
1472	1473	1	355	265	285	235	242	2.98%	47.80%	poor	BH LK Grp
1473	1474	1	355	265	285	235	245	4.26%	47.80%	poor	BH LK Grp
1474	1475	1	350	260	280	240	248	3.33%	50.94%	poor	BH LK Grp
1475	1476	1	350	260	280	240	250	4.17%	50.94%	fair	BH LK Grp
1476	1477	1	350	260	280	240	250	4.17%	50.94%	fair	BH LK Grp
1477	1478	1	350	260	280	240	250	4.17%	50.94%	fair	BH LK Grp
1478	1479	1	350	260	280	240	250	4.17%	50.94%	fair	BH LK Grp
1479	1480	1	350	260	280	240	250	4.17%	50.94%	fair	BH LK Grp
1480	1481	1	355	265	285	240	250	4.17%	50.94%	fair	BH LK Grp
1481	1482	1	355	265	285	240	250	4.17%	50.94%	fair	BH LK Grp
1482	1483	1	355	265	285	240	250	4.17%	50.94%	fair	BH LK Grp
1483	1484	1	355	265	285	235	250	6.38%	47.80%	fair	BH LK Grp
1484	1485	1	350	260	280	235	250	6.38%	47.80%	fair	BH LK Grp
1485	1486	1	350	260	280	235	250	6.38%	47.80%	fair	BH LK Grp
1486	1487	1	350	260	280	235	245	4.26%	47.80%	fair	BH LK Grp
1487	1488	1	350	260	280	235	245	4.26%	47.80%	fair	BH LK Grp
1488	1489	1	345	255	275	235	250	6.38%	47.80%	fair	BH LK Grp
1489	1490	1	345	255	275	235	250	6.38%	47.80%	fair	BH LK Grp
1490	1491	1	340	250	270	245	250	2.04%	54.09%	poor	BH LK Grp
1710	1711	1	280	190	210	260	265	1.92%	63.52%	poor	Prairie Evaporite Fm
1711	1712	1	280	190	210	260	275	5.77%	63.52%	fair	Prairie Evaporite Fm
1712	1713	1	280	190	210	260	275	5.77%	63.52%	fair	Prairie Evaporite Fm
1713	1714	1	280	190	210	260	275	5.77%	63.52%	fair	Prairie Evaporite Fm
1714	1715	1	280	190	210	260	275	5.77%	63.52%	fair	Prairie Evaporite Fm
1715	1716	1	280	190	210	260	275	5.77%	63.52%	fair	Prairie Evaporite Fm
1731	1732	1	210	210	230	275	260	5.77%	63.52%	fair	Prairie Evaporite Fm
1732	1733	1	215	215	235	265	255	3.92%	60.38%	poor	Prairie Evaporite Fm
1733	1734	1	215	215	235	265	255	3.92%	60.38%	poor	Prairie Evaporite Fm
1734	1735	1	215	215	235	275	265	3.77%	66.67%	poor	Prairie Evaporite Fm
1735	1736	1	210	210	230	275	265	3.77%	66.67%	poor	Prairie Evaporite Fm

SD of all corrected CMAX Az data: 63

SD of Population 1 corrected CMAX Az data: 9

Table E.2: Detailed summary of breakout data in the Saskatchewan, Beaverhill Lake, and Elk Point Groups

SD of Population 2 corrected CMAX Az data: 23

Well Name: **DORSET ET AL MARTENCK 11-12-80-5**

UWI: 00/11-12-080-05W5/0

Borehole Diameter: 209.55 mm (8.25")

Correction to True North: 20.3 degrees

Comments: Log recorded in feet

Top (m KB)	Bottom (m KB)	Thickness (m)	PIAZ (degrees)	CMAX Az (degrees)	CMAX Az wrt true N (degrees)	C1 (mm)	C2 (mm)	% Enlarge	% Gauge	Quality	Formation or Group
1339	1340	1	80	80	100	350	340	2.94%	113.84%	poor	BH LK Grp
1340	1341	1	80	80	100	365	340	7.35%	113.84%	poor	BH LK Grp
1341	1342	1	80	80	100	370	355	4.23%	123.27%	poor	BH LK Grp
1342	1343	1	80	80	100	375	355	5.63%	123.27%	poor	BH LK Grp
1343	1344	1	80	80	100	365	355	2.82%	123.27%	poor	BH LK Grp
1344	1345	1	75	75	95	360	340	5.88%	113.84%	poor	BH LK Grp
1521	1522	1	5	95	115	270	330	22.22%	69.81%	poor	Watt Mountain Fm
1522	1523	1	5	95	115	270	405	50.00%	69.81%	poor	Watt Mountain Fm
1523	1524	1	10	100	120	330	410	24.24%	107.55%	poor	Watt Mountain Fm
1524	1525	1	10	100	120	270	370	37.04%	69.81%	poor	Watt Mountain Fm
1525	1526	1	10	100	120	270	350	29.63%	69.81%	poor	Watt Mountain Fm
1526	1527	1	5	95	115	270	300	11.11%	69.81%	poor	Watt Mountain Fm
1527	1528	1	5	95	115	270	370	37.04%	69.81%	poor	Watt Mountain Fm

SD of Population 1 corrected CMAX Az data: 19

Well Name: **PCI LEIGE 11-8-95-22**

UWI: 00/11-08-095-22W4/0

Borehole Diameter: 222 mm

Correction to True North: 23.4 degrees

Comments: PIAZ was calculated from adding hole azimuth (AZIM) to the relative bearing (RB)

Top (m KB)	Bottom (m KB)	Thickness (m)	PIAZ (degrees)	CMAX Az (degrees)	CMAX Az wrt true N (degrees)	C1 (mm)	C2 (mm)	% Enlarge	% Gauge	Quality	Formation or Group
919	920	1	310	310	333	230	225	2.22%	41.51%	fair	Waterways Fm
920	921	1	310	310	333	240	225	6.67%	41.51%	good	Waterways Fm
921	922	1	310	310	333	240	225	6.67%	41.51%	good	Waterways Fm

Table E.2: Detailed summary of breakout data in the Saskatchewan, Beaverhill Lake, and Elk Point Groups

922	923	1	300	300	323	240	225	6.67%	41.51%	good	Waterways Fm
923	924	1	300	300	323	240	230	4.35%	44.65%	good	Waterways Fm
924	925	1	300	300	323	240	230	4.35%	44.65%	good	Waterways Fm
925	926	1	300	300	323	240	225	6.67%	41.51%	good	Waterways Fm
926	927	1	300	300	323	240	225	6.67%	41.51%	good	Waterways Fm
927	928	1	300	300	323	240	225	6.67%	41.51%	good	Waterways Fm
928	929	1	300	300	323	240	225	6.67%	41.51%	good	Waterways Fm
929	930	1	300	300	323	240	225	6.67%	41.51%	good	Waterways Fm
930	931	1	300	300	323	240	225	6.67%	41.51%	good	Waterways Fm
931	932	1	300	300	323	240	225	6.67%	41.51%	good	Waterways Fm
932	933	1	300	300	323	240	225	6.67%	41.51%	good	Waterways Fm
933	934	1	305	305	328	240	225	6.67%	41.51%	good	Waterways Fm
934	935	1	305	305	328	250	225	11.11%	41.51%	good	Waterways Fm
935	936	1	310	310	333	250	225	11.11%	41.51%	good	Waterways Fm
936	937	1	310	310	333	250	230	8.70%	44.65%	good	Waterways Fm
937	938	1	310	310	333	250	230	8.70%	44.65%	good	Waterways Fm
938	939	1	300	300	323	250	230	8.70%	44.65%	good	Waterways Fm
939	940	1	300	300	323	245	235	4.26%	47.80%	good	Waterways Fm
940	941	1	300	300	323	230	225	2.22%	41.51%	fair	Waterways Fm
1041	1042	1	5	95	118	225	235	4.44%	41.51%	fair	Prairie Evaporite Fm
1042	1043	1	5	95	118	225	235	4.44%	41.51%	fair	Prairie Evaporite Fm
1043	1044	1	5	95	118	225	235	4.44%	41.51%	fair	Prairie Evaporite Fm
1044	1045	1	0	90	113	260	270	3.85%	63.52%	fair	Prairie Evaporite Fm
1045	1046	1	350	260	283	260	270	3.85%	63.52%	fair	Prairie Evaporite Fm
1046	1047	1	345	255	278	230	240	4.35%	44.65%	fair	Prairie Evaporite Fm
1047	1048	1	340	250	273	225	240	6.67%	41.51%	fair	Prairie Evaporite Fm
1048	1049	1	340	250	273	225	235	4.44%	41.51%	fair	Prairie Evaporite Fm
1049	1050	1	340	250	273	225	235	4.44%	41.51%	fair	Prairie Evaporite Fm
1248	1249	1	365	275	298	220	225	2.27%	38.36%	fair	Prairie Evaporite Fm
1249	1250	1	365	275	298	220	225	2.27%	38.36%	fair	Prairie Evaporite Fm
1250	1251	1	365	275	298	220	225	2.27%	38.36%	fair	Prairie Evaporite Fm
1251	1252	1	360	270	293	220	225	2.27%	38.36%	fair	Prairie Evaporite Fm
1255	1256	1	360	270	293	220	225	2.27%	38.36%	fair	Prairie Evaporite Fm
1256	1257	1	355	265	288	220	225	2.27%	38.36%	fair	Prairie Evaporite Fm

Table E.2: Detailed summary of breakout data in the Saskatchewan, Beaverhill Lake, and Elk Point Groups

1257	1258	1	355	265	288	220	225	2.27%	38.36%	fair	Prairie Evaporite Fm
1258	1259	1	355	265	288	220	225	2.27%	38.36%	fair	Prairie Evaporite Fm
1259	1260	1	360	270	293	220	225	2.27%	38.36%	fair	Prairie Evaporite Fm

SD of Population 1 corrected CMAX Az data: 40

Well Name: **SCEPTRE MURPHY T'FLAGS A1-26-52-25**

UWI: 11/01-26-052-25W3/2

Borehole Diameter: 251 mm

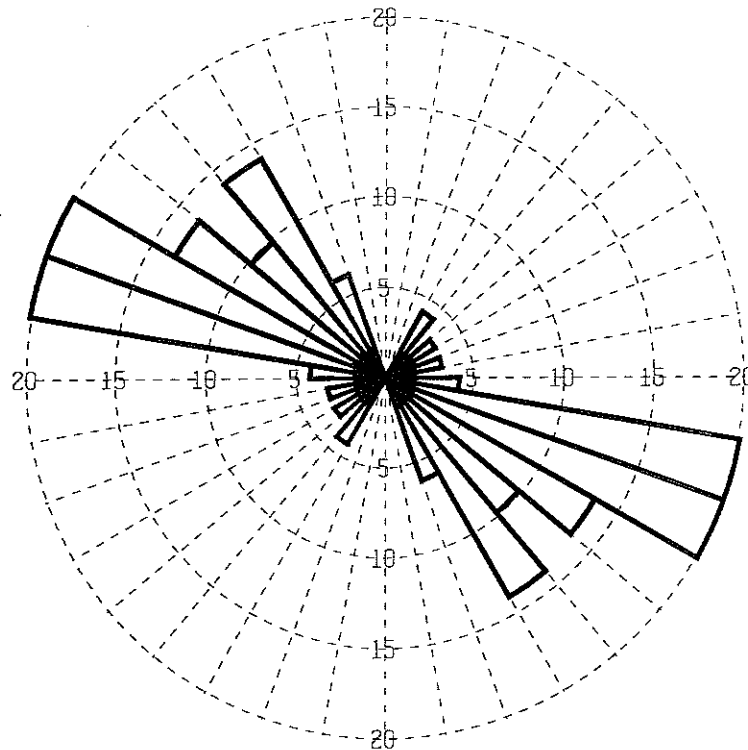
Correction to True North: 0 (log corrected using magnetic declination of 21 degrees)

Comments: Breakout occurs at bottom of hole and, therefore, may be influenced by drilling effects. Breakout does occur in both the main and repeat pass.

Top (m KB)	Bottom (m KB)	Thickness (m)	PIAZ (degrees)	CMAX Az (degrees)	CMAX Az wrt true N (degrees)	C1 (mm)	C2 (mm)	% Enlarge	% Gauge	Quality	Formation or Group
578	579	1	335	335	335	270	265	1.89%	66.67%	poor	Duperow Fm
579	580	1	335	335	335	270	265	1.89%	66.67%	poor	Duperow Fm
580	581	1	335	335	335	270	265	1.89%	66.67%	poor	Duperow Fm
581	582	1	330	330	330	270	265	1.89%	66.67%	poor	Duperow Fm
582	583	1	325	325	325	270	265	1.89%	66.67%	poor	Duperow Fm

SD of Population 1 corrected CMAX Az data: 8

ALL WELLS IN ANALYZED IN THE EXPANDED AREA



Population 1

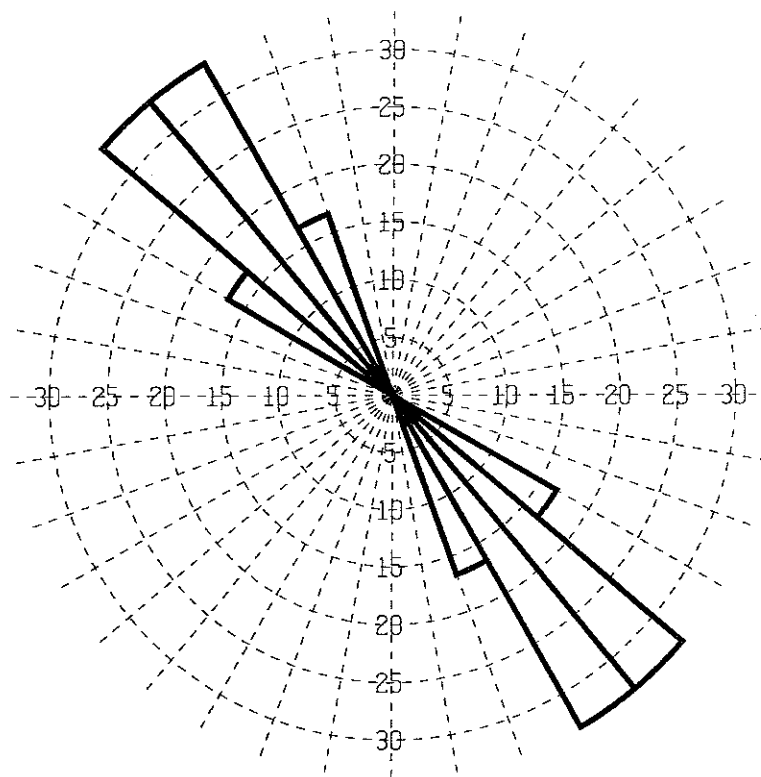
Calculation Method ... Frequency
 Class Interval 10 Degrees
 Filtering Activated
 Minimum Azimuth ... 80 Degrees
 Maximum Azimuth ... 180 Degrees
 Data Type Bidirectional
 Rotation Amount 0 Degrees
 Population 188
 Maximum Percentage ... 22.9 Percent
 Mean Percentage 14.3 Percent
 Standard Deviation ... 6.86 Percent
 Vector Mean 301.39 Degrees
 Confidence Interval .. 5.09 Degrees
 R-mag 0.82

Population 2

Calculation Method ... Frequency
 Class Interval 10 Degrees
 Filtering Activated
 Minimum Azimuth ... 0 Degrees
 Maximum Azimuth ... 80 Degrees
 Data Type Bidirectional
 Rotation Amount 0 Degrees
 Population 26
 Maximum Percentage ... 34.6 Percent
 Mean Percentage 20 Percent
 Standard Deviation ... 12.67 Percent
 Vector Mean 51.03 Degrees
 Confidence Interval .. 13.3 Degrees
 R-mag 0.83

Figure E.2.1: Roseplot of borehole breakout data in the Beaverhill Lake Group and Elk Point Group for all wells analyzed in the expanded area. A small 5 m breakout zone from the Saskatchewan Group from Sceptre Murphy T'Flags A1-26-52-25W3 is also included in the data set.

ALL WELLS FROM ATLAS IN EXPANDED AREA

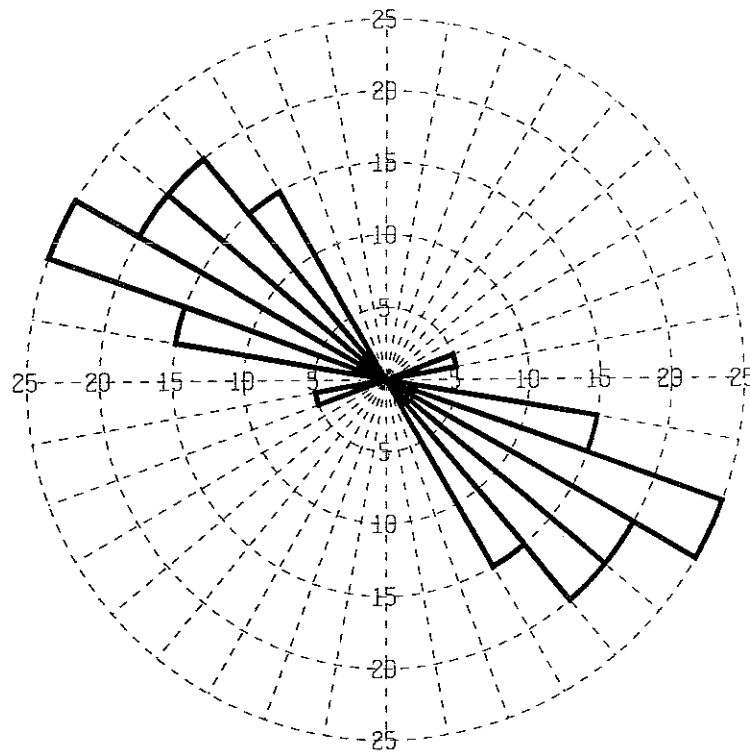


Population 1

Calculation Method ... Frequency
Class Interval 10 Degrees
Filtering Deactivated
Data Type Bidirectional
Rotation Amount 0 Degrees
Population 6
Maximum Percentage ... 33.3 Percent
Mean Percentage 25 Percent
Standard Deviation ... 8.91 Percent
Vector Mean 319.09 Degrees
Confidence Interval .. 17.46 Degrees
R-mag 0.93

Figure E.2.2: Roseplot of borehole breakout data for all wells given in the Geological Atlas of the Western Canadian Sedimentary Basin (Bell et al., 1994) in the expanded area. Note that only average values for each of the 6 wells are presented and data are not presented on a per metre basis as in other roseplots. It should be also noted that the recorded breakout in these wells, although from Paleozoic-age rocks, are determined from above the Beaverhill Lake Group and Elk Point Group.

MURPHY ET AL GRAHAM 12-18-87-3W5



Population 1

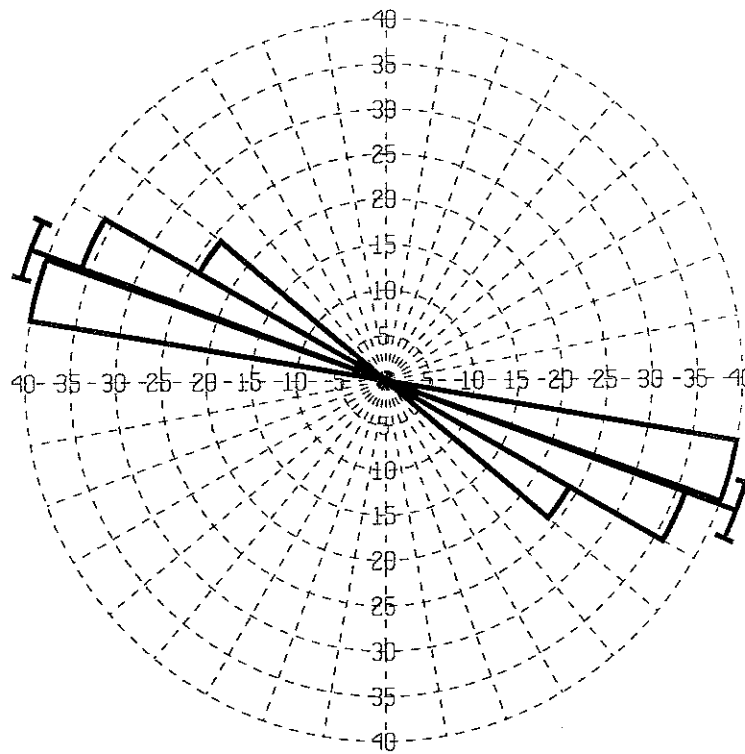
Calculation Method ... Frequency
Class Interval 10 Degrees
Filtering Activated
Minimum Azimuth ... 80 Degrees
Maximum Azimuth ... 180 Degrees
Data Type Bidirectional
Rotation Amount 0 Degrees
Population 19
Maximum Percentage ... 26.3 Percent
Mean Percentage 20 Percent
Standard Deviation ... 4.15 Percent
Vector Mean 304.23 Degrees
Confidence Interval .. 12.37 Degrees
R-mag 0.89

Population 2

Calculation Method ... Frequency
Class Interval 10 Degrees
Filtering Activated
Minimum Azimuth ... 0 Degrees
Maximum Azimuth ... 80 Degrees
Data Type Bidirectional
Rotation Amount 0 Degrees
Population 1
Maximum Percentage ... 100 Percent
Mean Percentage 100 Percent
Standard Deviation ... 0 Percent
Vector Mean 73 Degrees
Confidence Interval .. 15.84 Degrees
R-mag 1

Figure E.2.3: Roseplot of borehole breakout data in the Beaverhill Lake Group and Elk Point Group for Murphy et al Graham 12-18-87-3W5.

COLIN ET AL KIDNEY 10-19-91-4W4

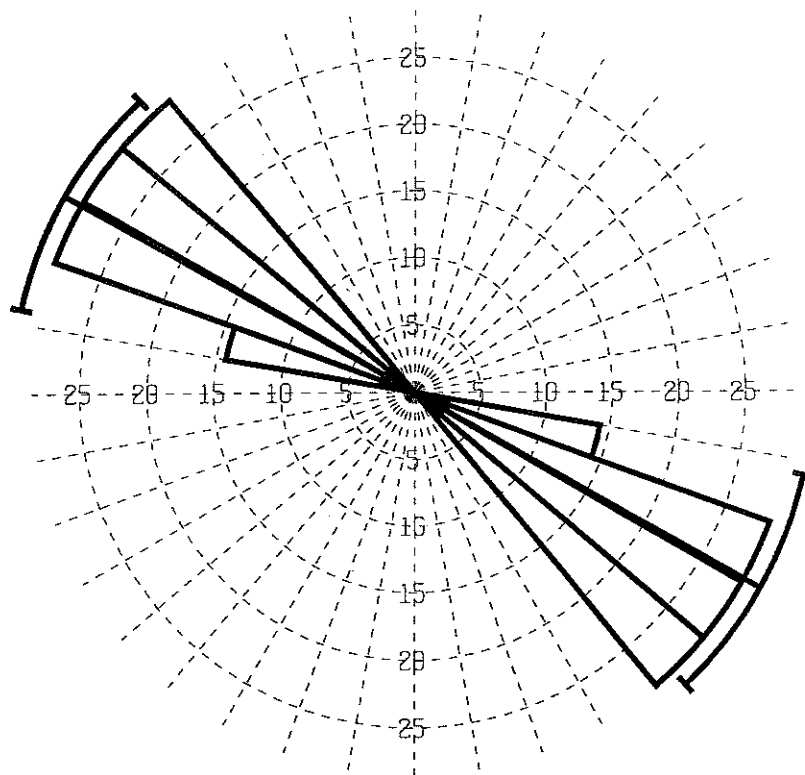


Population 1

Calculation Method ... Frequency
Class Interval 10 Degrees
Filtering Deactivated
Data Type Bidirectional
Rotation Amount 0 Degrees
Population 25
Maximum Percentage ... 40 Percent
Mean Percentage 33.3 Percent
Standard Deviation ... 7.45 Percent
Vector Mean 290.58 Degrees
Confidence Interval .. 4.52 Degrees
R-mag 0.98.

Figure E.2.4: Roseplot of borehole breakout data in the Elk Point Group for COLIN ET AL KIDNEY 10-19-91-4W4.

NCE ENER SENEX 14-9-92-4W5

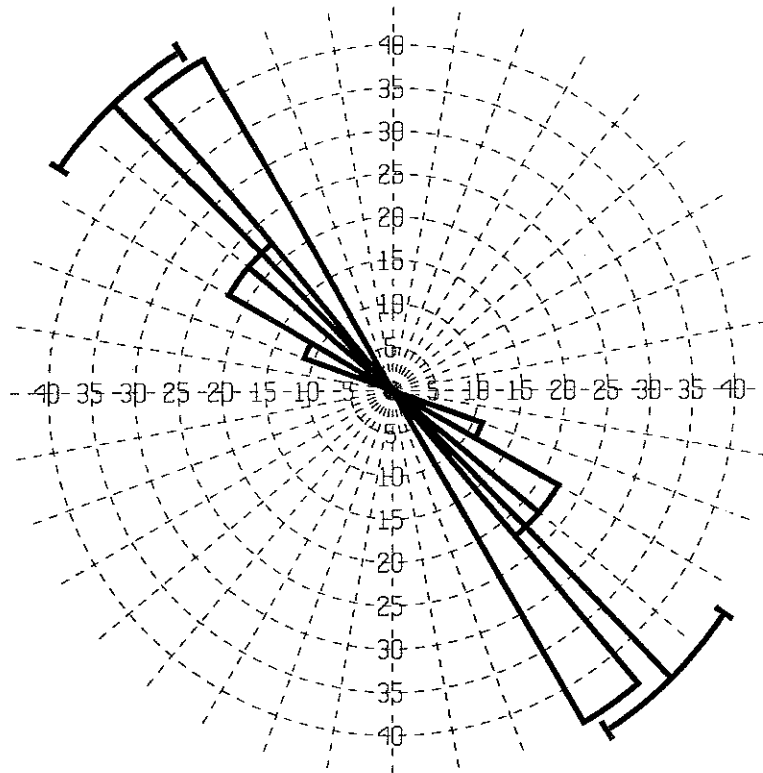


Population 1

Calculation Method ... Frequency
Class Interval 10 Degrees
Filtering Deactivated
Data Type Bidirectional
Rotation Amount 0 Degrees
Population 7
Maximum Percentage ... 28.6 Percent
Mean Percentage 25 Percent
Standard Deviation ... 6.61 Percent
Vector Mean 299.39 Degrees
Confidence Interval .. 17.33 Degrees
R-mag 0.92

Figure E.2.5: Roseplot of borehole breakout data in the Elk Point Group for NCE ENER SENEX 14-9-92-4W5.

UNOCAL KIDNEY 10-32-90-4W5

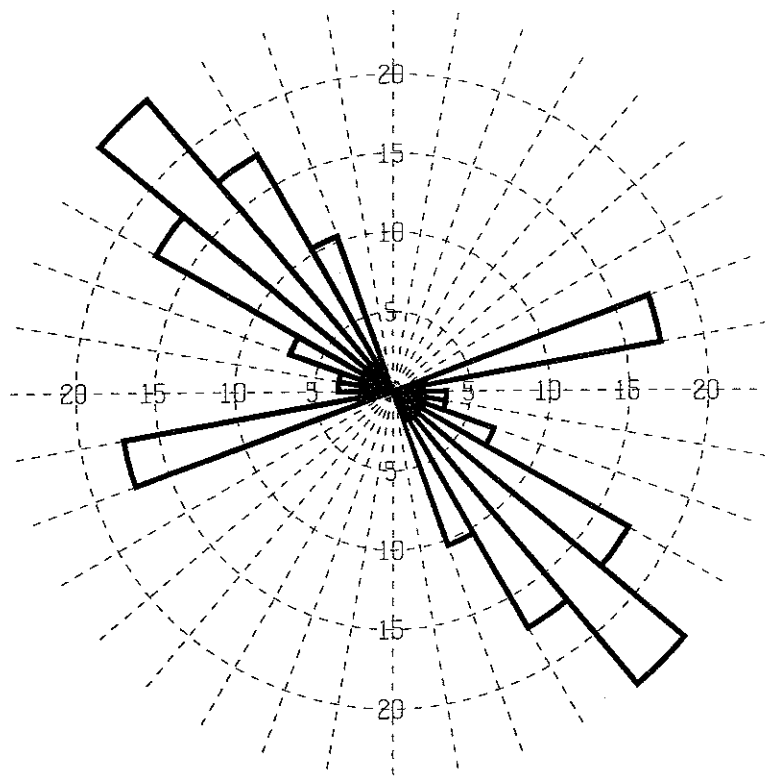


Population 1

Calculation Method ... Frequency
Class Interval 10 Degrees
Filtering Deactivated
Data Type Bidirectional
Rotation Amount 0 Degrees
Population 9
Maximum Percentage ... 44.4 Percent
Mean Percentage 25 Percent
Standard Deviation ... 12.94 Percent
Vector Mean 315.76 Degrees
Confidence Interval .. 11.98 Degrees
R-mag 0.95.

Figure E.2.6: Roseplot of borehole breakout data in the Beaverhill Lake Group for UNOCAL KIDNEY 10-32-90-4W5.

UNOCAL KIDNEY 9-5-91-4W5



Population 1

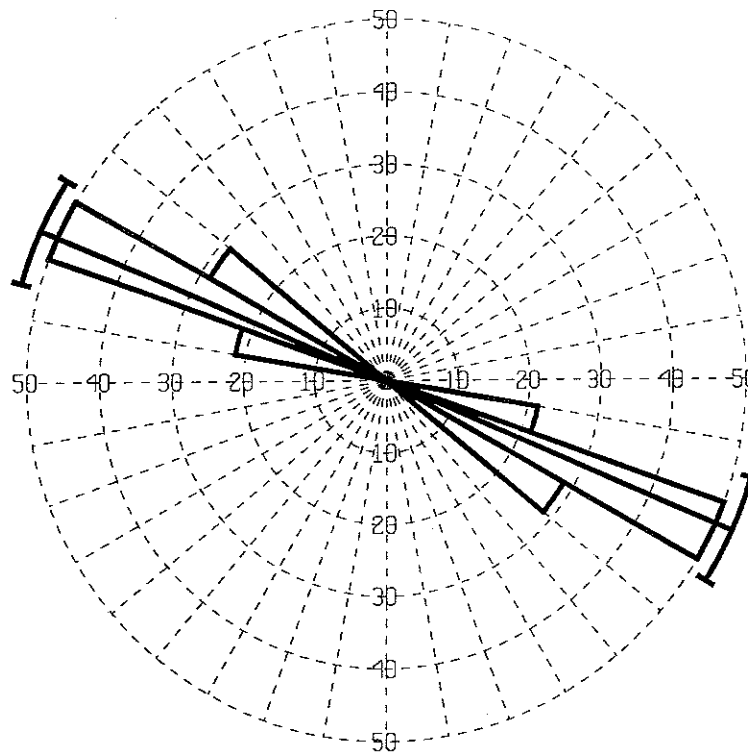
Calculation Method ... Frequency
Class Interval 10 Degrees
Filtering Activated
Minimum Azimuth ... 80 Degrees
Maximum Azimuth ... 180 Degrees
Data Type Bidirectional
Rotation Amount 0 Degrees
Population 24
Maximum Percentage ... 29.2 Percent
Mean Percentage 14.3 Percent
Standard Deviation ... 9.2 Percent
Vector Mean 314.33 Degrees
Confidence Interval .. 12.02 Degrees
R-mag 0.87

Population 2

Calculation Method ... Frequency
Class Interval 10 Degrees
Filtering Activated
Minimum Azimuth ... 0 Degrees
Maximum Azimuth ... 80 Degrees
Data Type Bidirectional
Rotation Amount 0 Degrees
Population 5
Maximum Percentage ... 100 Percent
Mean Percentage 100 Percent
Standard Deviation ... 0 Percent
Vector Mean 74 Degrees
Confidence Interval .. 7.09 Degrees
R-mag 1

Figure E.2.7: Roseplot of borehole breakout data in the Beaverhill Lake Group and Elk Point Group for UNOCAL KIDNEY 9-5-91-4W5.

MURPHY TROUT 9-3-89-3W5

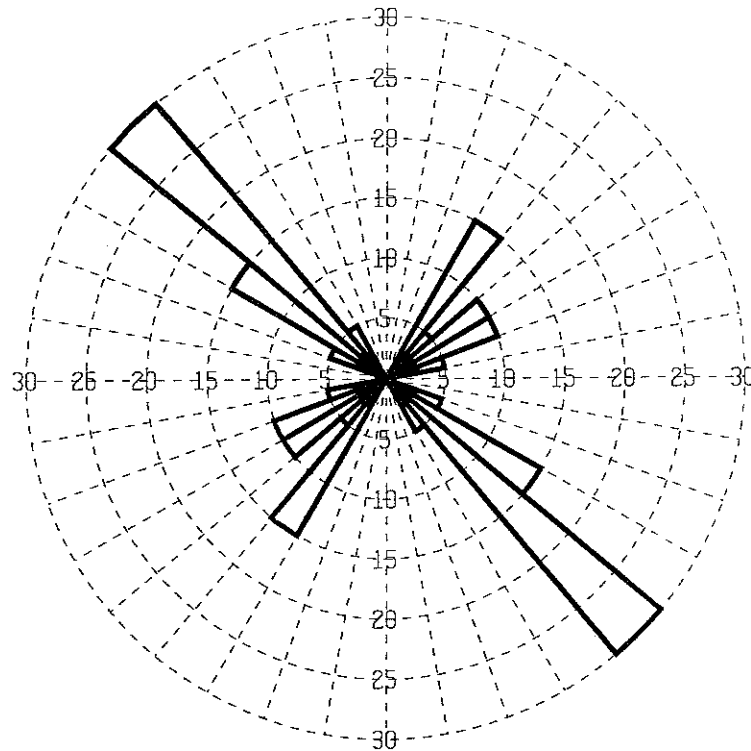


Population 1

Calculation Method ... Frequency
Class Interval 10 Degrees
Filtering Deactivated
Data Type Bidirectional
Rotation Amount 0 Degrees
Population 14
Maximum Percentage ... 50 Percent
Mean Percentage 33.3 Percent
Standard Deviation ... 13.3 Percent
Vector Mean 293.6 Degrees
Confidence Interval .. 8.55 Degrees
R-mag 0.96.

Figure E.2.8: Roseplot of borehole breakout data in the Elk Point Group for MURPHY TROUT 9-3-89-3W5.

UNOCAL ET AL TROUT 8-10-89-3W5



Population 1

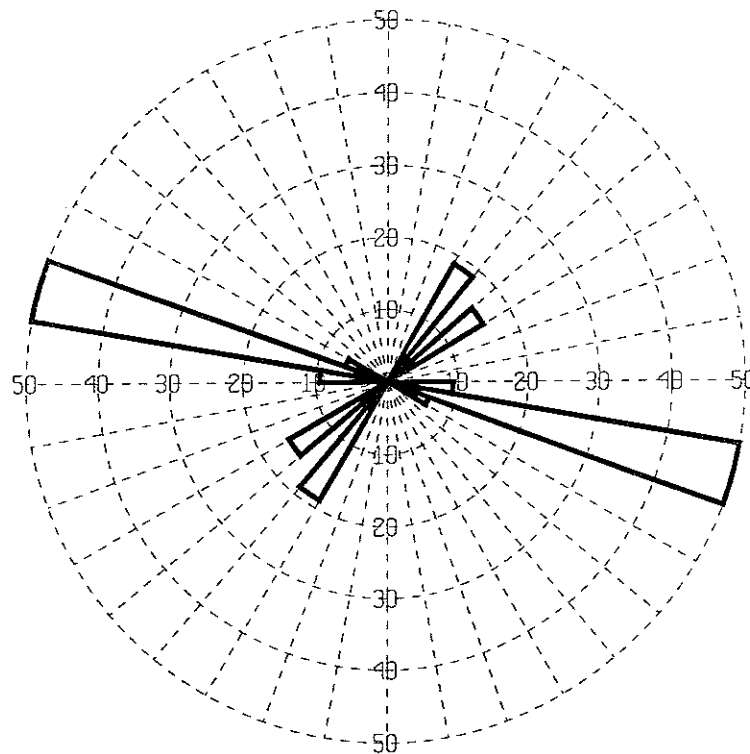
Calculation Method ... Frequency
Class Interval 10 Degrees
Filtering Activated
Minimum Azimuth ... 80 Degrees
Maximum Azimuth ... 180 Degrees
Data Type Bidirectional
Rotation Amount 0 Degrees
Population 11
Maximum Percentage ... 54.5 Percent
Mean Percentage 25 Percent
Standard Deviation ... 19.89 Percent
Vector Mean 309.12 Degrees
Confidence Interval .. 8.36 Degrees
R-mag 0.97

Population 2

Calculation Method ... Frequency
Class Interval 10 Degrees
Filtering Activated
Minimum Azimuth ... 0 Degrees
Maximum Azimuth ... 80 Degrees
Data Type Bidirectional
Rotation Amount 0 Degrees
Population 9
Maximum Percentage ... 33.3 Percent
Mean Percentage 20 Percent
Standard Deviation ... 8.76 Percent
Vector Mean 48.83 Degrees
Confidence Interval .. 18.01 Degrees
R-mag 0.89

Figure E.2.9: Roseplot of borehole breakout data in the Beaverhill Lake Group and Elk Point Group for UNOCAL ET AL TROUT 8-10-89-3W5.

SUNCOR STROME 11-16-44-16W4



Population 1

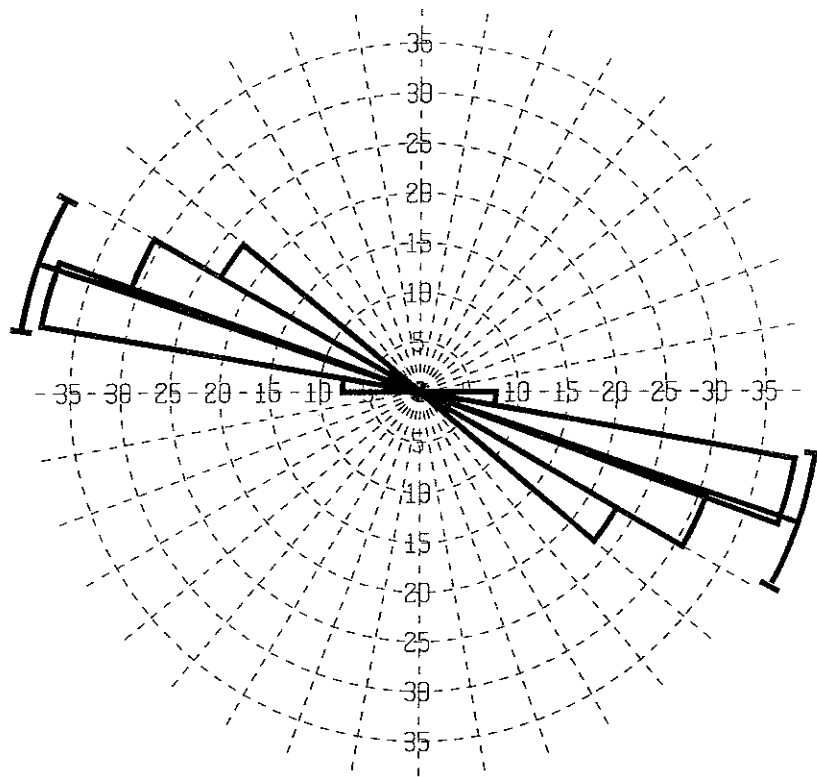
Calculation Method ... Frequency
Class Interval 10 Degrees
Filtering Activated
Minimum Azimuth ... 80 Degrees
Maximum Azimuth ... 180 Degrees
Data Type Bidirectional
Rotation Amount 0 Degrees
Population 21
Maximum Percentage ... 76.2 Percent
Mean Percentage 33.3 Percent
Standard Deviation ... 33.27 Percent
Vector Mean 281.43 Degrees
Confidence Interval .. 3.48 Degrees
R-mag 0.99

Population 2

Calculation Method ... Frequency
Class Interval 10 Degrees
Filtering Activated
Minimum Azimuth ... 0 Degrees
Maximum Azimuth ... 80 Degrees
Data Type Bidirectional
Rotation Amount 0 Degrees
Population 11
Maximum Percentage ... 54.5 Percent
Mean Percentage 50 Percent
Standard Deviation ... 5.25 Percent
Vector Mean 40.37 Degrees
Confidence Interval .. 13.81 Degrees
R-mag 0.92

Figure E.2.10: Roseplot of borehole breakout data in the Beaverhill Lake Group and Elk Point Group for SUNCOR STROME 11-16-44-16W4.

DORSET ET AL MARTENCK 11-12-80-5W5

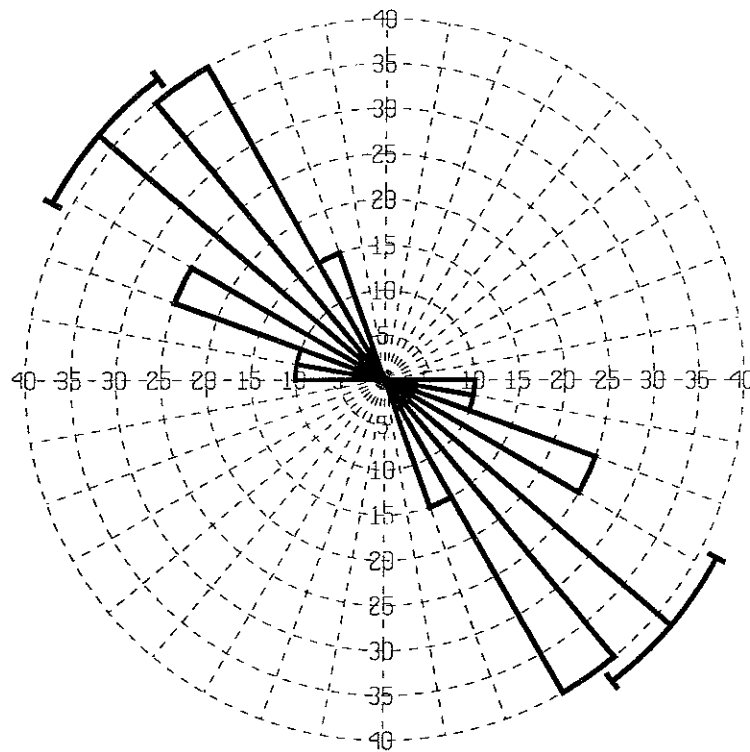


Population 1

Calculation Method ... Frequency
Class Interval 10 Degrees
Filtering Deactivated
Data Type Bidirectional
Rotation Amount 0 Degrees
Population 13
Maximum Percentage ... 38.5 Percent
Mean Percentage 25 Percent
Standard Deviation ... 12.16 Percent
Vector Mean 288.86 Degrees
Confidence Interval .. 9.98 Degrees
R-mag 0.95

Figure E.2.11: Roseplot of borehole breakout data in the Beaverhill Lake Group and Elk Point Group for DORSET ET AL MARTENCK 11-12-80-5W5.

PCI LEIGE 11-8-95-22W4

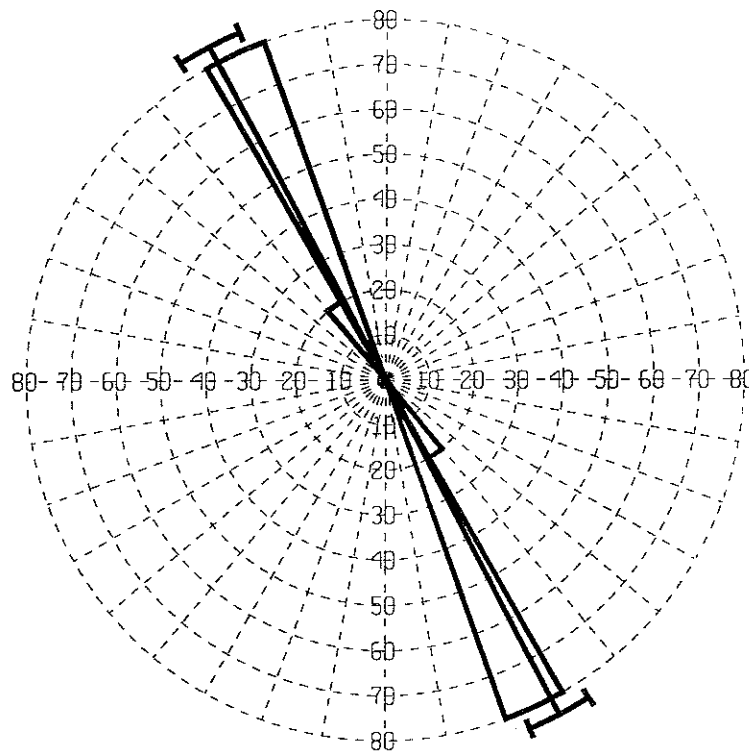


Population 1

Calculation Method ... Frequency
Class Interval 10 Degrees
Filtering Deactivated
Data Type Bidirectional
Rotation Amount 0 Degrees
Population 40
Maximum Percentage ... 40 Percent
Mean Percentage 20 Percent
Standard Deviation ... 12.02 Percent
Vector Mean 310.25 Degrees
Confidence Interval .. 12.36 Degrees
R-mag 0.78

Figure E.2.12: Roseplot of borehole breakout data in the Beaverhill Lake Group and Elk Point Group for PCI LEIGE 11-8-95-22W4.

SCEPTRE MURPHY T'FLAGS A1-26-52-25W3

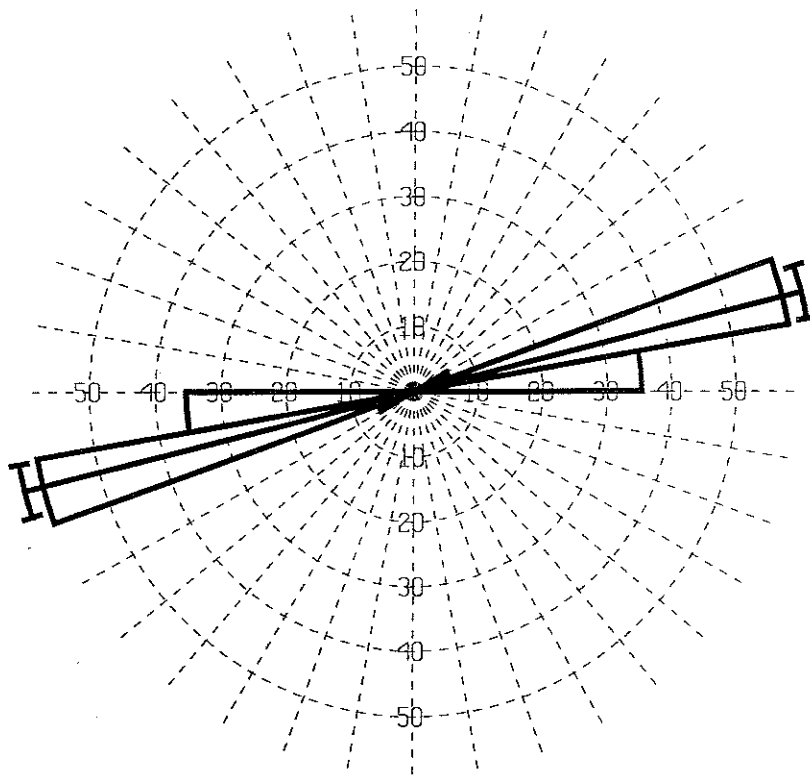


Population 1

Calculation Method ... Frequency
Class Interval 10 Degrees
Filtering Deactivated
Data Type Bidirectional
Rotation Amount 0 Degrees
Population 5
Maximum Percentage ... 80 Percent
Mean Percentage 50 Percent
Standard Deviation ... 34.64 Percent
Vector Mean 332.01 Degrees
Confidence Interval .. 5.03 Degrees
R-mag 0.99

Figure E.2.13: Roseplot of borehole breakout data in the Saskatchewan Group (Duperow Formation) for SCEPTRE MURPHY T'FLAGS A1-26-52-25W3.

VOYAGER ET AL BRUCE 6-14-48-14W4



Population 1
No breakouts observed.

Population 2
Calculation Method ... Frequency
Class Interval 10 Degrees
Filtering Activated
Minimum Azimuth ... 0 Degrees
Maximum Azimuth ... 80 Degrees
Data Type Bidirectional
Rotation Amount 0 Degrees
Population 17
Maximum Percentage ... 58.8 Percent
Mean Percentage 33.3 Percent
Standard Deviation ... 23.72 Percent
Vector Mean 75.78 Degrees
Confidence Interval .. 3.87 Degrees
R-mag 0.99

Figure E.2.14: Roseplot of borehole breakout data in the Elk Point Group for VOYAGER ET AL BRUCE 6-14-48-14W4. The breakout for this well has been re-classified as population 2 from the original work.

APPENDIX F

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