

BEFORE THE PUBLIC UTILITIES COMMISSION
OF THE STATE OF CALIFORNIA



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Application of Southern California Gas
Company (U904G) in Compliance with
Ordering Paragraph 6 of Decision 24-12-076.

Application 26-01-009

**COMMENTS OF THE PUBLIC ADVOCATES OFFICE
ON SOCALGAS OUTAGE REPORTS**

NOEL OBIORA

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June 1, 2026

MATTHEW TAUL

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I. INTRODUCTION

The Public Advocates Office at the California Public Utilities Commission (Cal Advocates) submits these comments pursuant to the *Email Ruling Memorializing Direction Provided at Workshop* (Email Ruling) issued on April 16, 2026, in the above-captioned proceeding. Following the Aliso Canyon Biennial Assessment Workshop hosted on April 15, 2026, Administrative Law Judge (ALJ) Ormond directed SoCalGas to submit narrative information regarding outages that occurred both outside and inside SoCalGas territory in the past decade.¹ SoCalGas served its *Compliance Filing of Southern California Gas Company Regarding External Outages* (External Outage Report) on May 1, 2026, and its *Compliance Filing of Southern California Gas Company Regarding Outages Within its Service Territory* (Internal Outage Report) on May 15, 2026. The Email Ruling invites parties to file and serve comments on the two SoCalGas Outage Reports.² Cal Advocates offers the following comments in response to the outage reports.

Cal Advocates' review of both outage reports finds that neither the External Outage Report nor the Internal Outage Report demonstrate that additional inventory at Aliso Canyon is necessary. The reports instead suggest that current inventory levels have proven adequate to manage external weather events and internal pipeline incidents without significant customer curtailments.

II. COMMENTS

A. SoCalGas' Outage Reports Do Not Demonstrate That Extra Inventory at Aliso Canyon Helps During Outages

SoCalGas' Outage Reports summarize the constraints on its natural gas system over the past decade. These constraints include the utility's decision-making on maintaining consistent deliveries to its gas and electric-generation customers. The External Outage Report shows how cold season weather events affected gas supply.

¹ Email Ruling at 2.

² Email Ruling at 3.

According to the SoCalGas report, these events have become routine in recent years.³ The Internal Outage Report discusses how ruptures, landslides, planned pipeline abandonment or replacements, and other pipeline incidents caused capacity loss across the SoCalGas territory.

Cal Advocates is in the process of issuing discovery and analyzing these events. Upon initial review the narrative does not show that these outages necessitate an increase in the maximum inventory and its associated maximum allowable operating (reservoir) pressure at Aliso Canyon.⁴ In the External Outage Report, none of the instances cited in the past ten years led to Emergency Flow Orders (EFO).⁵ SoCalGas reports only one instance of curtailment, which affected noncore electric generation customers.⁶ SoCalGas managed the external weather events in a manner that avoided impacts on gas customers while Aliso Canyon was at or lower than its current maximum allowable operating pressure.

Similarly, the Internal Outage Report likewise does not show a need to increase Aliso Canyon's maximum inventory.⁷ SoCalGas highlights pressure reductions resulting from pipeline incidents, including the multiple Stress Crack and Corrosion (SCC) threats discussed in the report.⁸ While the SCC section of the report does not mention the effect felt by its customers, SoCalGas later indicates several instances where it curtailed gas

³ “A multi-year review of historical weather data demonstrates that nearly every winter season since 2017 as included at least one weather event capable of materially disrupting upstream gas supplies.” SoCalGas’ External Outage Report at 3.

⁴ “In fact, SoCalGas’s analysis results indicate an increase in Aliso Canyon inventory may be more appropriate.” *Application of Southern California Gas Company in Compliance with Ordering Paragraph 6 of Decision 24-12-076* (Application) at 4.

⁵ An Emergency Flow Order (EFO) is a formal directive issued by SoCalGas when gas supplies are critically low. It requires noncore customers to curtail usage to protect core (residential) service and system pressure. The absence of EFOs during the reported outages indicates that SoCalGas successfully managed those events without declaring an emergency.

⁶ SoCalGas’ External Outage Report at 20.

⁷ The author finds in its multiple peak-day analyses that 86.2 Bcf for Aliso Canyon’s Maximum inventory is more ‘feasible’ than the current 68.6 Bcf. *Chapter I – Reliability Impacts, Prepared Direct Testimony off Andrew J. Sawin*, at 14-22.

⁸ SoCalGas’ Internal Outage Report at 5-6.

customers from the San Joaquin Valley, North Coastal System, and San Diego county.² However, SoCalGas does not claim or show that additional storage inventory in the Aliso Canyon Storage Field is necessary to address these curtailments to gas customers.¹⁰ The narrative does not identify any reliability or deliverability issues resulting directly from operating the Aliso Canyon Storage Field at its current inventory levels, nor how Aliso Canyon operating at SoCalGas' preferred inventory of 86.2 Bcf could have prevented the gas curtailments.

The outage reports show that the current inventory of Aliso Canyon has worked for the past several years, with SoCalGas handling external and internal gas flow restriction incidents without significant curtailments. It is unclear how higher inventory at Aliso is either necessary or would help with the instances identified in the report. Instead, these reports seem to confirm, or at least indicate, that the current Aliso Canyon inventory level can aid affordability, maintain gas reliability, and is within the safe limits as identified by CalGEM most recently in 2024.¹¹

III. CONCLUSION

Cal Advocates appreciates the opportunity to provide comments in response to the SoCalGas Outage Reports. The Commission should consider the limitations in SoCalGas' Outage Reports when it evaluates the need for additional Aliso Canyon inventory.

² SoCalGas' Internal Outage Report at 7-10.

¹⁰ In its YouTube video at 1:01, SoCalGas' System Natural Gas Flow, SoCalGas visualizes how on a typical day natural gas flow from Aliso Canyon does not supply San Joaquin Valley or the Coastal Zone, with only small delivery to Southern Zone toward San Diego. <https://youtu.be/QBhkna3Mfr8?si=rdHjdo20cCi2XgpN&t=61>

¹¹ SoCalGas notes that as of February 1, 2026, CalGEM's most recent review of Aliso Canyon inventory increase was its June 5, 2024 review of 68.8 Bcf. SoCalGas has not requested a review of an increased inventory of 86.2 Bcf. *See* Attachment: SoCalGas Response to Cal Advocates DR-01.

Respectfully submitted,

/s/ Noel Obiora
Noel Obiora
Attorney

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June 1, 2026

ATTACHMENT:
SoCalGas Response to Cal Advocates
DR-01

**APPLICATION OF SOUTHERN CALIFORNIA GAS COMPANY IN COMPLIANCE WITH
ORDERING PARAGRAPH 6 OF DECISION 24-12-076
(A.26-01-009)**

**(DATA REQUEST #1 OF CAL ADVOCATES)
Date Requested: February 24, 2026
Submitted: March 10, 2026**

These Responses are based upon the best available non-privileged responsive information that SoCalGas was able to locate through a diligent search within the time allotted to respond to this request. SoCalGas reserves the right to supplement, amend, or correct the Responses. The Responses are provided solely in connection with California Public Utilities Commission (CPUC) proceeding A.26-01-009. SoCalGas objects to the instructions submitted by Cal Advocates on the grounds that they are overbroad and unduly burdensome. Special interrogatory instructions of this nature are expressly prohibited by California Code of Civil Procedure Section 2030.060(d).

QUESTION 1:

Produce all written communication between SoCalGas and CalGEM regarding Aliso Canyon Gas Storage Facility inventory from January 1, 2024 to February 1, 2026.

For each written communication that SoCalGas no longer has the record for, state the date of the communication, the subject matter discussed and the CalGEM and SoCalGas representatives involved.

RESPONSE 1:

SoCalGas objects to this request as overly broad and unduly burdensome. SoCalGas also objects to this request to the extent it assumes facts not established. SoCalGas further objects to this request under Rule 10.1 of the Commission’s Rules of Practice and Procedure to the extent it seeks the production of information that is neither relevant to the cost recovery issues in the pending proceeding nor is likely reasonably calculated to lead to the discovery of admissible evidence. Subject to and without waiving the foregoing objections, SoCalGas responds as follows.

Please see attached files.



20240626 SoCalGas 2024.6.5_Ltr_AlisoCa 20240329 SoCalGas 2024 01 18 SoCalGas
Letter to CalGEM re Cnyon Pressure Increas:Response Data Requletter to CalGEM w At



Thomas D. McMahon
Director, Underground Storage
555 West Fifth Street
Los Angeles, CA 90013
TMcMahon@socalgas.com

Sent by Email
[\(Douglas.Ito@conservation.ca.gov\)](mailto:Douglas.Ito@conservation.ca.gov)

June 26, 2024

Doug Ito
State Oil and Gas Supervisor
California Department of Conservation
Geologic Energy Management Division
715 P Street, MS 1803
Sacramento, CA 95814

Re: Request to Increase Maximum Reservoir Pressure for the Aliso Canyon Storage Facility

Dear Mr. Ito:

On January 18, 2024, Southern California Gas Company (SoCalGas) submitted a letter to the California Geologic Energy Management Division (CalGEM) recommending the evaluation of a higher maximum reservoir pressure for the Aliso Canyon Storage Facility (Aliso Canyon). On March 29, 2024, pursuant to CalGEM's request, SoCalGas provided additional supporting information.


On June 5, 2024, CalGEM provided that it had reviewed well, wellhead, reservoir, caprock, and surface equipment testing and construction data and that its review indicated that the proposed maximum pressure increase at Aliso Canyon is consistent with the design parameters of the facility equipment and reservoir and is supported by recent testing of the wells, wellhead, and other surface equipment. In addition, CalGEM stated that the increase in maximum reservoir pressure does not pose a risk to the storage facility and is therefore approved. CalGEM also provided that SoCalGas should coordinate with the California Public Utilities Commission (CPUC) for any additional testing CPUC may feel is necessary to ensure that all surface pipelines are operating as expected prior to operating at the new maximum operating pressure.

Pursuant to CalGEM's letter, SoCalGas subsequently coordinated with the CPUC, and the CPUC did not identify any additional testing necessary to ensure that all surface pipelines are operating as expected prior to operating at the new maximum operating pressure. Accordingly, SoCalGas is proceeding forward with increasing the reservoir pressure at Aliso Canyon.

Please advise if you if you have any questions.

California Department of Conservation
Geologic Energy Management Division
June 26, 2024
Page 2

Thank you,

A handwritten signature in black ink that reads "Thomas D. McMahon". The signature is written in a cursive style with a large, stylized initial 'T'.

Thomas D. McMahon, PG
Director, Underground Storage

cc: Jeanette Hand, CalGEM
Emily Reader, CalGEM
Jean Spencer, CPUC
Matt Epuna, CPUC
Kristina Boyaci, CPUC



June 5, 2024

Transmitted Via E-Mail

Thomas McMahon
Southern California Gas Company
12801 Tampa Ave.
Northridge, CA 91326

RE: REQUEST TO INCREASE MAXIMUM RESERVOIR PRESSURE FOR THE ALISO CANYON STORAGE FACILITY

Dear Thomas McMahon:

The California Geologic Energy Management Division (CalGEM) has reviewed the Southern California Gas Company's (SoCalGas) letter dated January 18, 2024, and titled Maximum Reservoir Pressure for the Aliso Canyon Storage Facility. In the letter, SoCalGas requested that CalGEM evaluate a higher maximum reservoir pressure for the facility and indicated that allowing a maximum reservoir pressure of 3,198 psia will allow full utilization of the 68.8 billion cubic feet (Bcf) capacity recently approved by the California Public Utilities Commission (CPUC). Monitoring adherence to the new maximum reservoir pressure would be achieved through ensuring that the tubing pressure at observation well Porter 69G does not exceed 2700 psi.

CalGEM has reviewed well, wellhead, reservoir, caprock, and surface equipment testing and construction data. Our review indicates that the proposed maximum pressure increase at Aliso Canyon is consistent with the design parameters of the facility equipment and reservoir and is supported by recent testing of the wells, wellhead, and other surface equipment. The increase in maximum reservoir pressure does not pose a risk to the storage facility and is therefore approved. SoCalGas should coordinate with CPUC for any additional testing CPUC may feel is necessary to ensure that all surface pipelines are operating as expected prior to operating at the new maximum operating pressure.

Sincerely,

A handwritten signature in black ink that reads "Doug Ito".

Doug Ito
State Oil and Gas Supervisor



Thomas D. McMahon
Director, Underground Storage
12801 Tampa Avenue
Northridge, CA 91324
562-806-4429

Sent by Email
(jeanette.hand@conservation.ca.gov)

March 29, 2024

Jeanette Hand
Underground Gas Storage Program Manager
California Department of Conservation
Geologic Energy Management Division
715 P Street, MS 1803
Sacramento, CA 95814

Re: Maximum Reservoir Pressure for the Aliso Canyon Storage Facility

Dear Ms. Hand:

On January 18, 2024, Southern California Gas Company (SoCalGas) submitted a letter to the California Geologic Energy Management Division (CalGEM) recommending CalGEM evaluate a higher maximum reservoir pressure for the Aliso Canyon Storage Facility (Aliso Canyon). On March 19, 2024, CalGEM responded to SoCalGas's letter, providing that it had reviewed the information submitted and requesting additional information. Pursuant to CalGEM's request, SoCalGas submits the following responses and attached information demonstrating that the maximum pressure rating for equipment is appropriate and that the surface facilities are ready for service at a shut-in tubing pressure (SITP) at Porter 69G of 2,700 psig.

1. Documentation that the maximum pressure rating for equipment at the wellheads and surface facilities at Aliso Canyon is appropriate for the new requested Shut In Tubing Pressure (SITP) of 2,700 psig.

SoCalGas provides the following information demonstrating that the equipment at the wellheads and surface facilities are appropriate for the 2,700 psig SITP at Porter 69G.

a. Wellhead Records

The wellhead assembly generally consists of, but is not limited to, valves,¹ casing spools, wellhead cross, seals, and tree caps. At Aliso Canyon, the wellhead assemblies for active gas storage wells are designed to a 5,000 psig rating and are pressure tested at the end of each well

¹ The wellhead valves may include the Master Valve, Swab Valve, Wing Valves, and Annulus Valves.

workover after being reinstalled onto the well. In addition, the wellhead assemblies are visually inspected and function tested on an annual basis. The wellhead design and testing information for the Aliso Canyon active gas storage wells are provided in the folder “Item 1.a. Wellhead Records.”

b. Pressure Ratings for Well Lateral and Surface Facility Lines

The operating and design pressures for Aliso Canyon active gas storage well lateral and surface facility lines are summarized in Table 1 below.

Table 1

Lines	Operating Pressure (psig)	Design Pressure (psig)	MAOP (psig)	MOP (psig)
SIMP Well Laterals ²	300 – 3,500	3,500	3,500	3,500
Withdrawal Headers ³	300 – 700	710	710	700
Compressor Discharge	300 – 3,500	3,850	3,500	3,500
Headers and Laterals	300 – 3,500	3,500	3,500	3,500

c. Well Lateral Records

Aliso Canyon active gas storage well laterals are tested during the fabrication process and prior to installation in the field. Test records and design data sheets for the Aliso Canyon active gas storage well laterals are provided in the folder “Item 1.c. Well Lateral Records”.

d. Relief Valve Testing Records

SoCalGas inspects relief valves on an annual basis at Aliso Canyon. The most recent relief valve test records for Aliso Canyon active gas storage wells are included in the folder “Item 1.d. Relief Valve Testing Records.”

e. Compressor Shutdown Setpoints

The compressor discharge pressure is continuously monitored, and pressure limits are put in place based on authorized bottom hole pressure limits. Currently, a high-pressure alarm is activated if the compressor discharge pressure reaches 2,975 psig. If the discharge pressure increases to 3,000 psig, a compressor shutdown sequence is triggered.

2. Documentation of the readiness for service of Aliso Canyon surface facilities at the proposed pressures.

² “SIMP Well Laterals” refers to the piping between wellheads and the lateral header block valve.


³ The withdrawal headers are a not part of the surface facility system which operates at a high pressure.

Readiness for service, or fitness for service, of surface storage facilities (e.g., compressors, pressure vessels, aboveground and belowground piping, valves, auxiliary systems, and other aboveground assets) is validated through compliance with applicable federal and state regulations governing the design, construction, operation, and maintenance of these assets. Surface facilities supporting the withdrawal and injection of natural gas into and from active gas storage wells follow the Code of Federal Regulations (CFR) Title 49, Part 192 for pipeline design, construction, operations, and maintenance.

With respect to surface facilities at Aliso Canyon, SoCalGas validates fitness for service by confirming compliance with applicable federal and state regulations governing the design, construction, operation, and maintenance of these assets. As provided in response to Item 1, monitoring and maintenance activities have been performed and the proposed pressure is within the design and operation conditions of the surface facilities.

Please advise if you need additional information or if you have any questions.

Thank you.

A handwritten signature in black ink that reads "Thomas D. McMahon". The signature is written in a cursive, flowing style.

Thomas D. McMahon, PG
Director, Underground Storage

Enclosures



Thomas D. McMahon
Director, Underground Storage
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TMcMahon@socalgas.com

Sent by Email
(*Courtney.Smith@conservation.ca.gov*)

January 18, 2024

Ms. Courtney Smith
Chief Deputy Director of Programs
State of California Department of Conservation
Geologic Energy Management Division
715 P Street, MS 1803
Sacramento, CA 95814

Re: Maximum Reservoir Pressure for the Aliso Canyon Storage Facility

Dear Ms. Smith:

As part of the Aliso Canyon Comprehensive Safety Review, on July 19, 2017, the California Department of Conservation's Geologic Energy Management Division (CalGEM or Division)¹ determined the facility's minimum and maximum reservoir pressure at the time to be 1,080 pounds per square inch absolute (psia) and 2,926 psia, respectively.² CalGEM provided the Porter 69G well (P69G) would function as an observation well and the shut-in tubing pressure (SITP) measurement would be used to estimate reservoir pressure. CalGEM further provided a maximum SITP of 2,476 pounds per square inch gauge (psig) would confirm the reservoir pressure remains below 2,926 psia. CalGEM subsequently translated the maximum reservoir pressure of 2,926 psia to 68.6 billion cubic feet (Bcf) of inventory.

CalGEM's establishment of these pressures was based upon a review which included a proposal from SoCalGas and consultation with independent experts at Lawrence Berkeley National Laboratory, Lawrence Livermore National Laboratory, and Sandia National Laboratories (collectively, National Labs). SoCalGas engaged a third-party consultant to provide a recommendation for the minimum and maximum reservoir pressure at Aliso Canyon. The expert report recommended a 3,600 psia maximum reservoir pressure and a 900 psia minimum reservoir

¹ Formerly known as the Division of Oil, Gas, and Geothermal Resources (DOGGR).

² Attachment 1, State of California Department of Conservation, Division of Oil, Gas and Geothermal Resources, *Enclosure 1, Updated Comprehensive Safety Review Findings*, July 19, 2017, at 2.

pressure.³ SoCalGas provided the expert report to CalGEM and proposed a maximum operating pressure of 3,595 psia and minimum operating pressure of 1,080 psia.⁴ At the request of CalGEM, geotechnical experts at the National Labs reviewed the minimum and maximum operating pressures proposed by SoCalGas and concurred that 1,080 psia and 3,595 psia pressures are reasonable operating thresholds going forward.⁵

Subsequently, CalGEM provided that the minimum reservoir pressure should be 1,080 psia.⁶ With regard to the maximum reservoir pressure, CalGEM provided that, although the independent experts believed that a maximum pressure of 3,595 psia is prudent, a more conservative maximum pressure should be approved until all wells in the Aliso Canyon Storage Facility have either been plugged and abandoned or tested and remediated in accordance with Order No. 1109.⁷ As many of the wells at the facility were at the time isolated from the reservoir with a mechanical plug and fluid filled tubing and casing, CalGEM provided that maintaining reservoir pressure below normal hydrostatic pressure would provide an additional safety factor. CalGEM further explained that, once the isolated wells had been permanently plugged and abandoned or completed all testing in accordance with Order No. 1109, it would consider a higher operating pressure.⁸ SoCalGas has permanently abandoned or completed all testing of wells in accordance with Order No. 1109. Moreover, today all active gas storage wells have successfully passed at least two Storage Integrity Management Program (SIMP) assessments.⁹ These SIMP assessments include testing well integrity above the original discovery pressure of the facility of approximately 3,600 psia.

On August 31, 2023, the California Public Utilities Commission (CPUC or Commission) increased the maximum storage level at Aliso Canyon to 68.6 Bcf to maintain energy reliability and to help protect against high natural gas and electric prices.¹⁰ Under the current maximum reservoir pressure limit, Aliso Canyon's inventory is currently not able to exceed approximately 59 Bcf. For example, the surface pressure observed at P69G on December 21, 2023 was 2,433

³ Attachment 2, GeoMechanics Technologies, *Estimated Geomechanical Properties for the Aliso Canyon Storage Field*, July 15, 2016, at 4 and 24.

⁴ Attachment 3, Southern California Gas Company Letter to State of California Department of Conservation, Division of Oil, Gas and Geothermal Resources, *Re: Aliso Canyon Geomechanical Reports Regarding Minimum and Maximum Reservoir Pressure*, July 22, 2016.

⁵ Attachment 4, National Labs Letter to State of California Department of Conservation, Division of Oil, Gas and Geothermal Resources, *Re: Aliso Canyon Minimum Operating Pressure*, September 8, 2016, at 1-2.

⁶ Attachment 5, State of California Department of Conservation, Division of Oil, Gas and Geothermal Resources, *Recommended Minimum and Maximum Reservoir Pressure for the Aliso Canyon Storage Facility*, July 17, 2017, at 1.

⁷ *Id.* at 2.

⁸ Attachment 1, State of California Department of Conservation, Division of Oil, Gas and Geothermal Resources, *Enclosure 1, Updated Comprehensive Safety Review Findings*, July 19, 2017, at 2.

⁹ SIMP is a comprehensive program to enhance the safety of SoCalGas's underground storage facilities through integrity management practices.

¹⁰ Decision (D.) 23-08-050.

State of California Department of Conservation
Geologic Energy Management Division
January 18, 2024
Page 3

psig (approximately 2,871 psia at the top of the storage reservoir) with a corresponding storage inventory of 58.8 Bcf (see Table 1, Attachment 6).

Based on this information, SoCalGas recommends CalGEM evaluate a higher maximum reservoir pressure for the facility. SoCalGas analyzed the P69G surface pressure increase as a function of the increase in working gas inventory above 45 Bcf (see Figure 1, Attachment 7) and extrapolated to an inventory capacity of 68.6 Bcf. At 68.6 Bcf, the SITP observed at P69G is expected to be 2,666 psig with a corresponding reservoir pressure of 3,160 psia. A maximum reservoir pressure of 3,198 psia (or 2,700 psig SITP at P69G) would accommodate variations between actual versus estimated P69G pressure at higher inventory levels and is below the original discovery pressure of the facility and SIMP integrity pressure testing levels.

Please let me know if you have any questions or require additional information.

Sincerely,



Thomas D. McMahon, PG
Director, Underground Storage

Enclosures

cc: Jeanette Hand, CalGEM
Emily Reader, CalGEM
Jean Spencer, CPUC

ATTACHMENT 1

(Updated Comprehensive Safety Review Findings, July 19, 2017)



ENCLOSURE 1

Department of Conservation Division of Oil, Gas, and Geothermal Resources

July 19, 2017

Updated Comprehensive Safety Review Findings

This Enclosure 1 sets forth findings that support the State Oil and Gas Supervisor's determination that the safety requirements of Senate Bill 380 have been fulfilled and that injection may resume at the Aliso Canyon gas storage facility (Facility). *The issuance of these findings does not lift the prohibition on injection at the Facility. The Supervisor will issue an Order wherein he lifts the injection prohibition subject to additional temporary requirements. These temporary requirements are meant to further demonstrate the integrity and safety of the Facility as the injection operations resume.*

This statement of findings incorporates the findings in the January 17, 2017 letter (Enclosure 2). Some findings below are updates to the findings in the January letter. To the extent that the findings below and in the January letter may overlap, the more current findings below replace the previous findings. The updates and additional findings made, based on the comprehensive safety review and a joint inspection of the Facility by the Division of Oil, Gas, and Geothermal Resources (DOGGR), California Public Utilities Commission (CPUC), and the California Air Resources Board (CARB), are as follows:

- Forty-nine (49) of the 114 injection wells at the Facility passed the two batteries of tests Public Resources Code section 3217 requires to ensure external and internal well mechanical integrity. DOGGR has reviewed and verified the results of the tests and has made the test results publicly available on its website. DOGGR has issued well-specific findings letters for each of these wells.
- Sixty-five (65) of the 114 injection wells at the Facility have passed at least the first battery of tests. Southern California Gas Company (SoCalGas) took these wells out of service and safely isolated them from the gas storage field consistent with Public Resources Code section 3217. DOGGR has reviewed and verified the results of the tests, and has made the test results and documentation of the isolation of the wells publicly available on its website. DOGGR has issued well-specific findings letters for each of these wells. As Public Resources Code section 3217 requires, the 65 wells have one year to pass all tests (i.e. the second battery of tests) or be permanently plugged and abandoned consistent with regulations and any additional conditions DOGGR may impose on a case-by-case basis.
- Each of the 49 wells eligible to be used for injection have been equipped with tubing-and-packer completions that isolate the tubing-casing annulus. For each of the 49 wells, the production tubing was pressure tested to verify the integrity of the primary mechanical barrier. Public Resources Code section 3217 and the Supervisor's Order No. 1109 require that injection and production of gas occurs through the interior tubing, and shall not occur through the annulus between the tubing and casing.

- Every well is equipped with real-time pressure monitoring of the tubing and casing. The pressure is continuously reported and monitored in SoCalGas's operations center with alarms for any significant pressure changes. This technology facilitates the operator's compliance with Public Resources Code section 3217's requirement to conduct ongoing pressure monitoring of wells.
- DOGGR has determined that, to comply with Public Resources Code section 3217, the appropriate maximum bottom-hole reservoir pressure at the top of the reservoir structure, as represented by the productive interval in the Porter 69G well, is not more than 2,926 pounds per square inch absolute (psia); and the appropriate minimum reservoir pressure is 1,080 psia. DOGGR's approval of these limits is based upon review of the proposed pressure limit submitted by SoCalGas; consultation with geotechnical experts at Lawrence Berkley National Laboratory, Lawrence Livermore National Laboratory, Sandia National Laboratory (collectively, "National Labs"), and the University of Texas; and consideration of public comments on the proposed pressure limits. As many of the wells at the Facility are currently isolated from the reservoir with a mechanical plug and fluid filled tubing and casing, maintaining a reservoir pressure below hydrostatic pressure provides an additional safety factor. Once the isolated wells have been permanently plugged and abandoned or completed all testing and remediation in accordance with Order No. 1109, DOGGR would consider a renewed proposal by SoCalGas to inject at a higher operating pressure. A maximum surface operations pressure of 2,476 pounds per square inch gauge will ensure that the reservoir pressure remains below 2,926 psia.
- SoCalGas satisfied the requirement of Order No. 1109 to include an effective geologic and geotechnical hazard mitigation protocols in the Risk Management Plan (RMP) filed under California Code of Regulations, title 14, section 1724.9, subdivision (g). DOGGR carefully considered all data submitted by SoCalGas and followed up with SoCalGas as necessary to collect additional data to ensure that the RMP would be complete according to the mandates of Order No. 1109 and the regulation. DOGGR also consulted with the National Labs regarding potential geologic and geotechnical hazards that may affect the Facility. The National Labs recommended that two studies be conducted to provide a more detailed understanding of the seismic hazards at the facility. The National Labs concluded that they "do not believe that the recommended detailed seismic studies require immediate action, but they should be planned and executed in a deliberate manner." As a result, DOGGR conditioned approval of the RMP on additional study in conjunction with the National Labs to evaluate seismic risk mitigation measures beginning in 2017.
- SoCalGas satisfied the requirement of Order No. 1109 to include an effective facility-wide emergency response plan in the RMP filed under California Code of Regulations, title 14, section 1724.9, subdivision (g). Updates and improvements to the emergency response plan, including possible enhancements based on input from local first responders, are anticipated prior to, and even after, DOGGR approves the RMP. Completion of the iterative process to enhance the emergency response plan is not required for resumption of injection at the Facility and is infeasible, as DOGGR anticipates that emergency response plans in general will be revised if and when new information warranting an update becomes available.
- SoCalGas has completed a leak survey for the entire facility and reported all results to the CPUC.

- SoCalGas has provided DOGGR with a written procedure for dealing with any production tubing leaks and production casing/tubing annulus pressure increases, which includes response procedures and follow up actions; up-to-date protocols for sustained surface casing pressure; and uniform definitions for labeling annuli.
- SoCalGas is implementing an inspection and leak detection protocol that is consistent with DOGGR's emergency regulations, the requirements of Senate Bill 887 (Pavley, Chapter 673, Statutes of 2016), and best practices identified in consultation with CARB.
- SoCalGas has an effective work plan in place for compliance with the requirements in DOGGR's emergency regulations for function testing downhole devices.

To further confirm the integrity of the Facility after resuming injection, simultaneous with lifting the prohibition on injection, the Supervisor will order SoCalGas to take additional temporary measures, and conduct certain tests, immediately before and soon after resuming injection. DOGGR and the CPUC initially identified these temporary post-emergency requirements in their October 21, 2016 joint letter to SoCalGas:

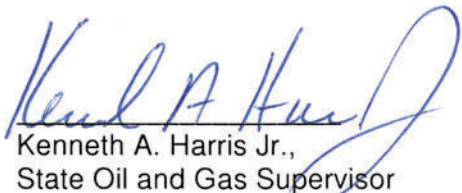
- At least once during the two-week period prior to resuming injection, SoCalGas will be required to complete a leak survey for the entire facility with all results reported to the CPUC and the Division within three days of completion, and conduct a downwind flight to measure total site methane emissions.
- SoCalGas will be required to complete a leak survey for the entire Facility within 72 hours after resuming injection operations, with results reported to the CPUC and CARB within three days of completion of the survey. Reportable leaks must be immediately reported to the appropriate agencies as required by law.
- In addition to the daily monitoring for leaks required under DOGGR's regulations, SoCalGas will be required to complete leak surveys for the entire Facility immediately after one month of injection operations and quarterly thereafter for one year (five surveys total), with results reported to the CPUC and CARB within seven days of completion.
- SoCalGas will be required to report daily reservoir pressure estimates to the CPUC and DOGGR during the first 30 days of resuming injection.
- SoCalGas will be required to report daily reservoir injection and withdrawal volume measurements to the CPUC and DOGGR during the first 30 days of resuming injection.
- SoCalGas will be required to continue to work diligently to complete testing or fully plug and abandon each well that was isolated within one year of isolation.
- SoCalGas will be required to address any outstanding data gaps in the project file for the Facility.
- After injection has resumed, SoCalGas will be required to conduct at least two downwind flights to measure total site methane emissions to demonstrate the absence of significant leaks at the Facility.

- SoCalGas will be required to continue to conduct research on seismic risk to the satisfaction of DOGGR using a third party consultant approved by DOGGR and the National Labs.

The following examples of the CPUC and DOGGR closely coordinating contributed to the Supervisor's findings stated above:

- The CPUC and DOGGR conducted joint Technical Safety Compliance field inspections that included field verifications to function test critical safety control devices associated with the gas injection and withdrawal system.
- The CPUC and DOGGR developed a Master List for pre-injection safety assurances and will ensure SoCalGas complies with the measures in the Master List so that wells and pipelines on the site are brought back to pressure in a safe manner.
- The CPUC and DOGGR required SoCalGas to equip all wells returned to operations with continuous annulus pressure monitoring devices with alarms.

Based on the foregoing, including the findings in Enclosure 2 and all site inspections and public comments, the Supervisor finds the comprehensive safety review is complete. That review demonstrates the integrity of the wells at the Facility, that the risks of failures identified during the review have been addressed, and that the Supervisor has satisfied all other statutory and regulatory requirements consistent with Public Resources Code section 3217. Further, the Supervisor finds that DOGGR will continue to collaborate with the CPUC to ensure that SoCalGas complies with all regulations and other measures designed to ensure the safety of the Facility.



Kenneth A. Harris Jr.,
State Oil and Gas Supervisor
Division of Oil, Gas, and Geothermal Resources

ATTACHMENT 2

(GeoMechanics Technologies, Estimated Geomechanical Properties for the Aliso Canyon Storage Field, July 15, 2016)

*Estimated Geomechanical Properties for the
Aliso Canyon Gas Storage Field*

Prepared for:

Southern California Gas Company

July 15, 2016

Prepared By:



103 E. Lemon Ave, Monrovia CA, 91016

1-626-305-8460

www.geomechanicstech.com

Table of Contents

1. EXECUTIVE SUMMARY.....4

2. INTRODUCTION AND BACKGROUND.....5

2.1 Aliso Canyon Gas Storage Field Geologic Overview..... 5

2.1.1 Reservoir Rock: 8

2.1.2 Cap Rock: 10

2.1.1 Structure: 12

3. GEOMECHANICAL ASSESSMENT OF ALISO CANYON GAS STORAGE FIELD.....12

2.2 Estimating Caprock and Reservoir Mechanical Properties..... 12

2.3 Estimating In-Situ Stresses and Reservoir Fracture Pressure 14

2.3.1 Regional Stress Review..... 14

2.3.2 Stress Estimate from Field Testing 18

4. CONCLUSIONS AND DISCUSSIONS24

5. REFERENCES.....25

List of Figures

Figure 1: Location Map of SoCalGas Storage Fields in Southern California 6

Figure 2: Aliso Canyon Gas Storage Field Pressure and Inventory History Examples 7

Figure 3: Aliso Canyon Gas Storage Field -- Sesnon - S4 Structure Map 8

Figure 4: Aliso Canyon Gas Storage Field – A-A’ Cross Section 9

Figure 5: Aliso Canyon Gas Storage Field –D-D’ Cross Section 10

Figure 6: Type log for Aliso Canyon Gas Storage Field..... 11

Figure 7: (Top Left) Sonic Log and (Top Right) Bulk Density Log from well Porter 69K. 13

Figure 8: World Stress Map for the Aliso Canyon Area..... 15

Figure 9: Southern California Stress Regime..... 16

Figure 10: Lower hemisphere stereographic projection of borehole elongation directions from
borehole studied for the East Ventura Basin..... 18

Figure 11: Well Porter 39A leak off test at Aliso Canyon Gas Storage Field on Dec. 27, 2015. 20

Figure 12: Well SS 4-0 stage 1 injection test performed by Halliburton at Aliso Canyon Gas
Storage Field on Nov. 7, 2005..... 21

Aliso Canyon Gas Storage Field Geomechanical Properties Estimate

Figure 13: Well FF 38B injection test performed by Halliburton at Aliso Canyon Gas Storage Field on Jan. 17, 2003. 22

Figure 14: Well FF 38C injection test performed by BJ Services at Aliso Canyon Gas Storage Field on Mar. 4, 2003. 23

List of Tables

Table 1: Estimated Dynamic Mechanical Material Properties for Aliso Canyon Caprock and Storage Reservoir Formations. 13

Table 2. Estimated Minimum, Maximum and Average Shear Strength of the reservoir for Aliso Canyon Gas Storage Reservoir..... 14

DISCLAIMER

LEGAL NOTICE: This report was prepared by GeoMechanics Technologies as an account of work sponsored by Southern California Gas Company. Neither GeoMechanics Technologies, members of GeoMechanics Technologies, nor any person acting on behalf of GeoMechanics Technologies:

1. Makes any warranty or representation, express or implied, with respect to the accuracy, completeness, or usefulness of the information contained in this report, or that the use of any apparatus, method, or process disclosed in this report may not infringe privately owned rights; or
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1. EXECUTIVE SUMMARY

The objective of this study has been to estimate mechanical stiffness and strength properties, in-situ stresses and fracture gradient for the Aliso Canyon Gas Storage Field in Los Angeles County, California. The storage reservoir is in the Sesnon-Frew members located at depths between about 7,100ft and 10,000ft. The caprock is the overlying shaly Modelo Formation with average thickness of 350ft. For the period from about 1999 to 2015, maximum operating surface pressure for the field has been about 3,000 psig.

Maximum safe operating pressures for a reservoir depend on four primary geomechanical factors: 1) the mechanical properties of the reservoir and overburden; 2) the in-situ stresses and fracture pressure in the reservoir; 3) stresses induced in the reservoir by gas cycling; and 4) stresses induced in the caprock material by gas cycling. No direct measurements of mechanical properties are currently available for the rock samples from the field. For this investigation we therefore estimate mechanical properties based on sonic and bulk density logs for the caprock and reservoir storage formations. In-situ stresses and fracture pressure in the reservoir are estimated from regional stress data available and review of injection fracture tests performed in the field.

Our geomechanical review, based on currently available data, supports the following conclusions:

1. We estimate the fracture gradient in the reservoir to be on the order of about 0.6 to 0.7 psi/ft, or about 4,300 to 5,000 psi bottom-hole pressure at a depth of about 7,200ft, at current reservoir conditions. This is lower than original fracture gradient for the field because reservoir pressure has been significantly reduced from original conditions. Fracture gradient in the upper caprock are likely to be on the order of 0.75 to 0.8 psi/ft, more consistent with native stress conditions in the LA Basin, assuming it has not experienced pressure depletion.
2. Operating the gas field at a maximum bottom-hole pressure of about 3,600 psi, the approximate original reservoir pressure, should not exceed the fracture gradient in the field based on current available data, and assuming a well is gas filled.

2. INTRODUCTION AND BACKGROUND

GeoMechanics Technologies has been contracted by Southern California Gas Company to estimate mechanical stiffness and strength properties, in-situ stresses and fracture gradients for the Aliso Canyon Gas Storage Field in Los Angeles County, California. Maximum safe operating pressures for a reservoir depend on four primary factors: 1) the mechanical properties of the reservoir and overburden; 2) the in-situ stresses and fracture pressure in the reservoir; and, 3) stresses induced in the reservoir by gas cycling. Our assessment has considered each these factors for the Aliso Canyon Gas Storage Field.

The scope of this study is as follows:

- Review geology, stratigraphic column and lithology data;
- Review drilling data and available well logs;
- Review leak-off tests and any available hydraulic fracture data;
- Review any available core measurement data;
- Review historical and current operating pressures;
- Estimate mechanical stiffness and strength properties and in-situ stresses; and,
- Estimate fracture gradients.

2.1 Aliso Canyon Gas Storage Field Geologic Overview

The Aliso Canyon Gas Storage Field is located in the San Fernando Valley in Los Angeles County, California approximately 24 miles NW of Los Angeles (Figure 1). Aliso Canyon field was discovered in 1938 and converted to a gas storage facility in 1972 after the depletion of the oil reservoir. The storage reservoir comprises the Senson and Frew zones – which are within the Modelo and Llajas formations respectively, and is located at depths between 7,100ft and 10,000ft (AGA 2004).

Figure 2 presents the pressure history and inventory history from 1999 through 2015. During the period from about 2005 to 2015, the minimum wellhead operating pressures were about 1,000 psi during low pressure cycles and the maximum wellhead operating pressures were about 3,000 psi during high pressure cycles.

Aliso Canyon Gas Storage Field Geomechanical Properties Estimate

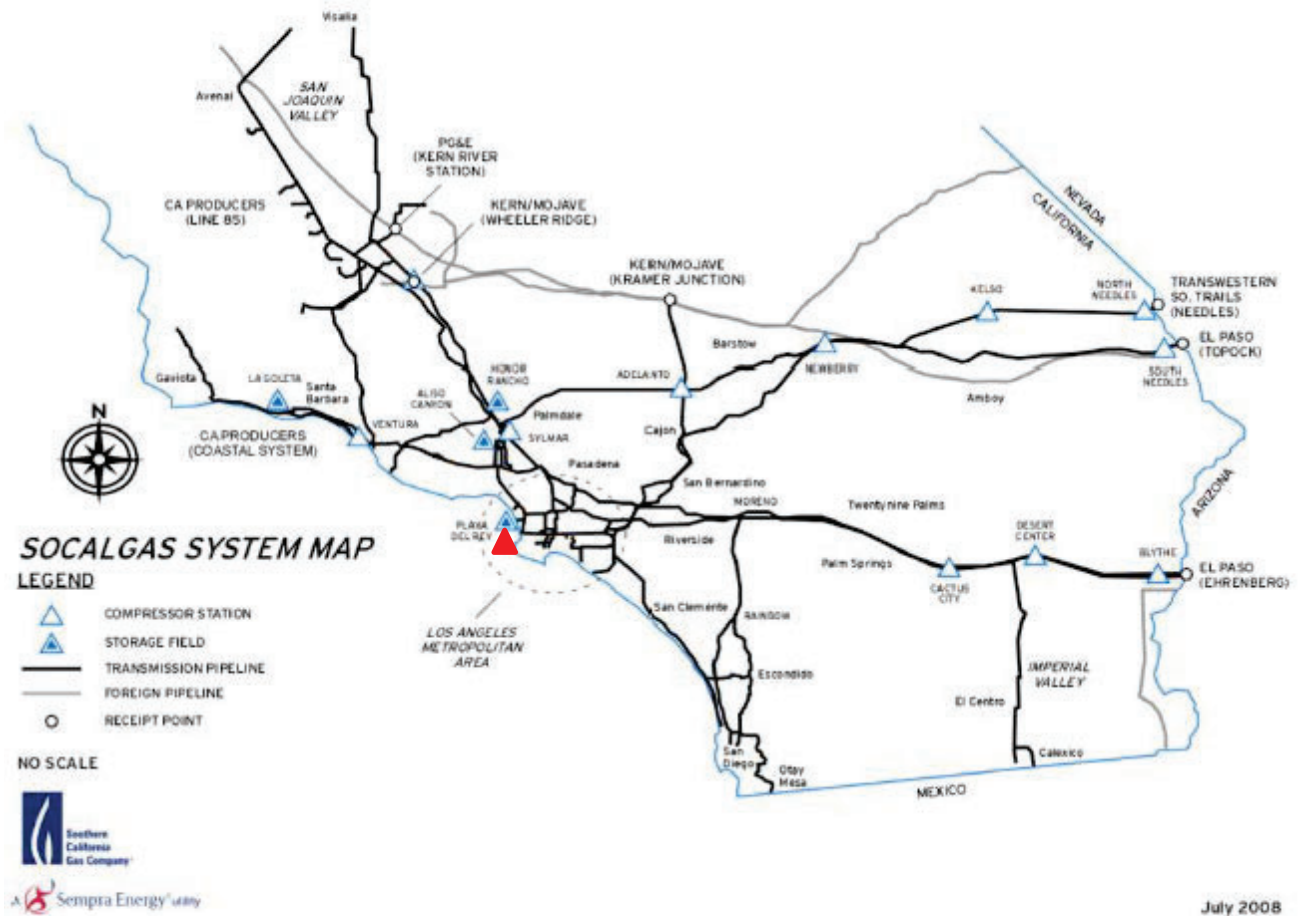


Figure 1: Location Map of SoCalGas Storage Fields in Southern California

SoCalGas, 2016

Aliso Canyon Gas Storage Field Geomechanical Properties Estimate

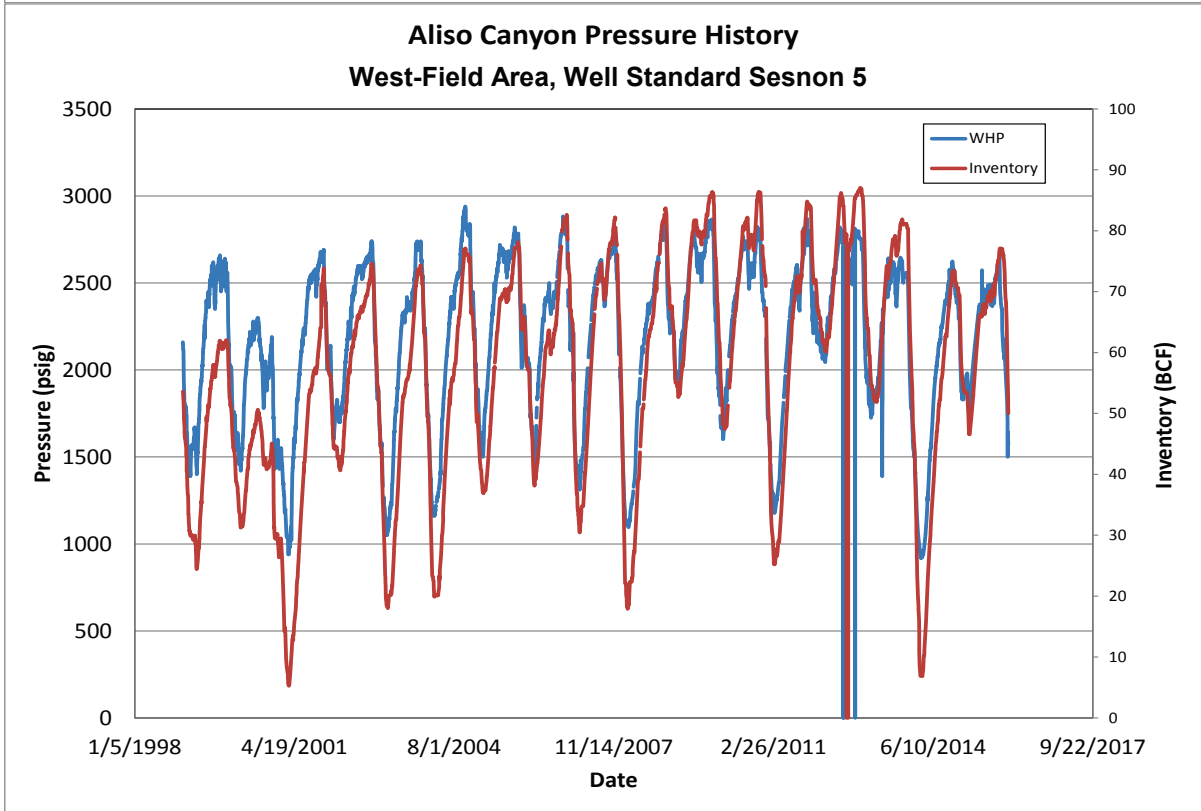
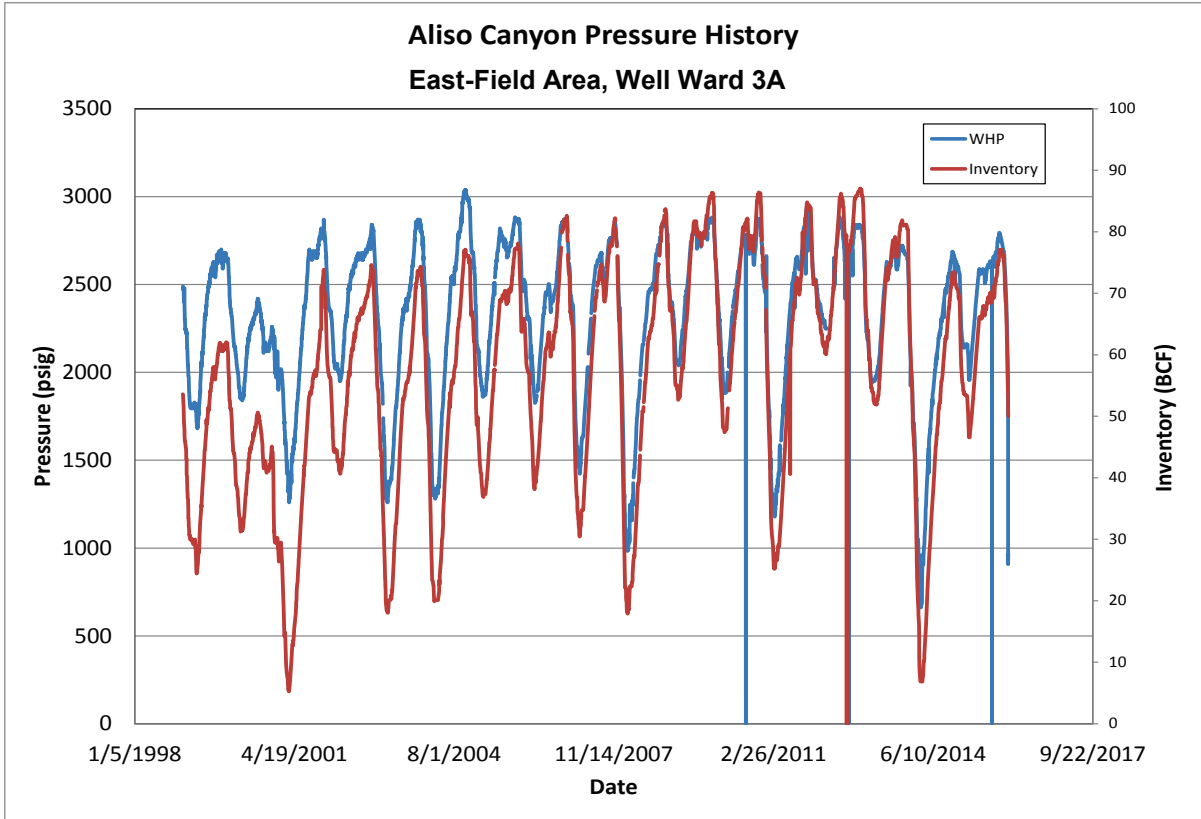


Figure 2: Aliso Canyon Gas Storage Field Pressure and Inventory History Examples
SoCalGas, 2016

2.1.1 Reservoir Rock:

The Sesnon and Frew zones are the gas storage reservoirs for the Aliso Canyon field. The Sesnon zone is within the Modelo Formation. The Sesnon zone is approximately 200ft to 400ft thick, and is gray, medium to coarse-grained, well sorted sandstone with interbedded limey siltstone and occasional pebbles (DOGGR, 1957). The Sesnon zone is normally found at about 350ft below the top of Modelo Formation (DOGGR, 1957). The Miocene age Sesnon zone lies unconformably upon the Eocene age Frew zone.

The Frew zone is the upper member within the Llajas Formation, deposited on top of undifferentiated Cretaceous marine sediments. The Frew zone consists of coarse-grained, friable sandstone with occasional igneous pebbles and interbedded silty shale (DOGGR, 1957). DOGGR (1999) reported porosity measurements of 17 to 30%.

Figure 3 is the Sesnon S4 structure map. Figures 4 and 5 are NS and EW cross sections, respectively, across the Aliso Canyon gas storage field.

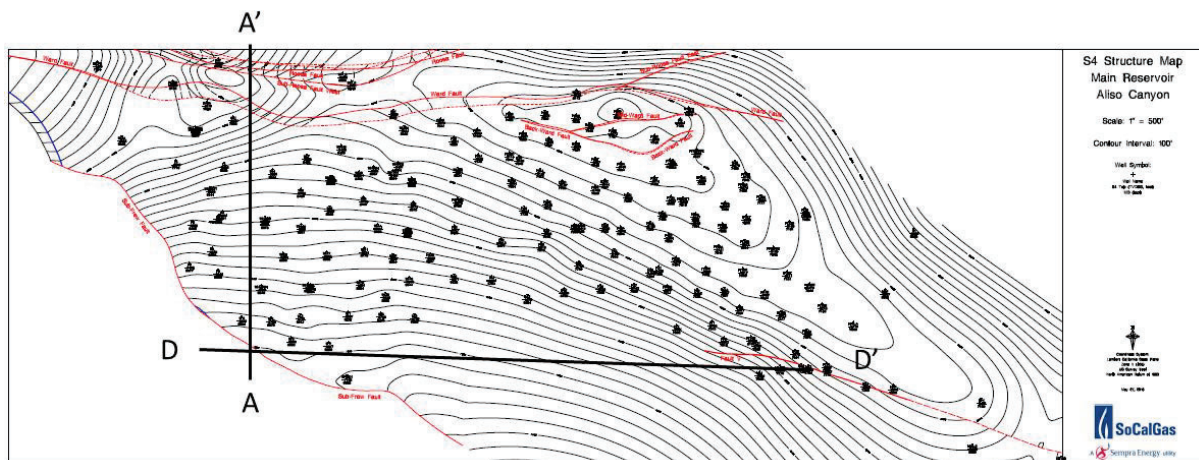


Figure 3: Aliso Canyon Gas Storage Field -- Sesnon - S4 Structure Map

SoCalGas, 2016

Aliso Canyon Gas Storage Field Geomechanical Properties Estimate

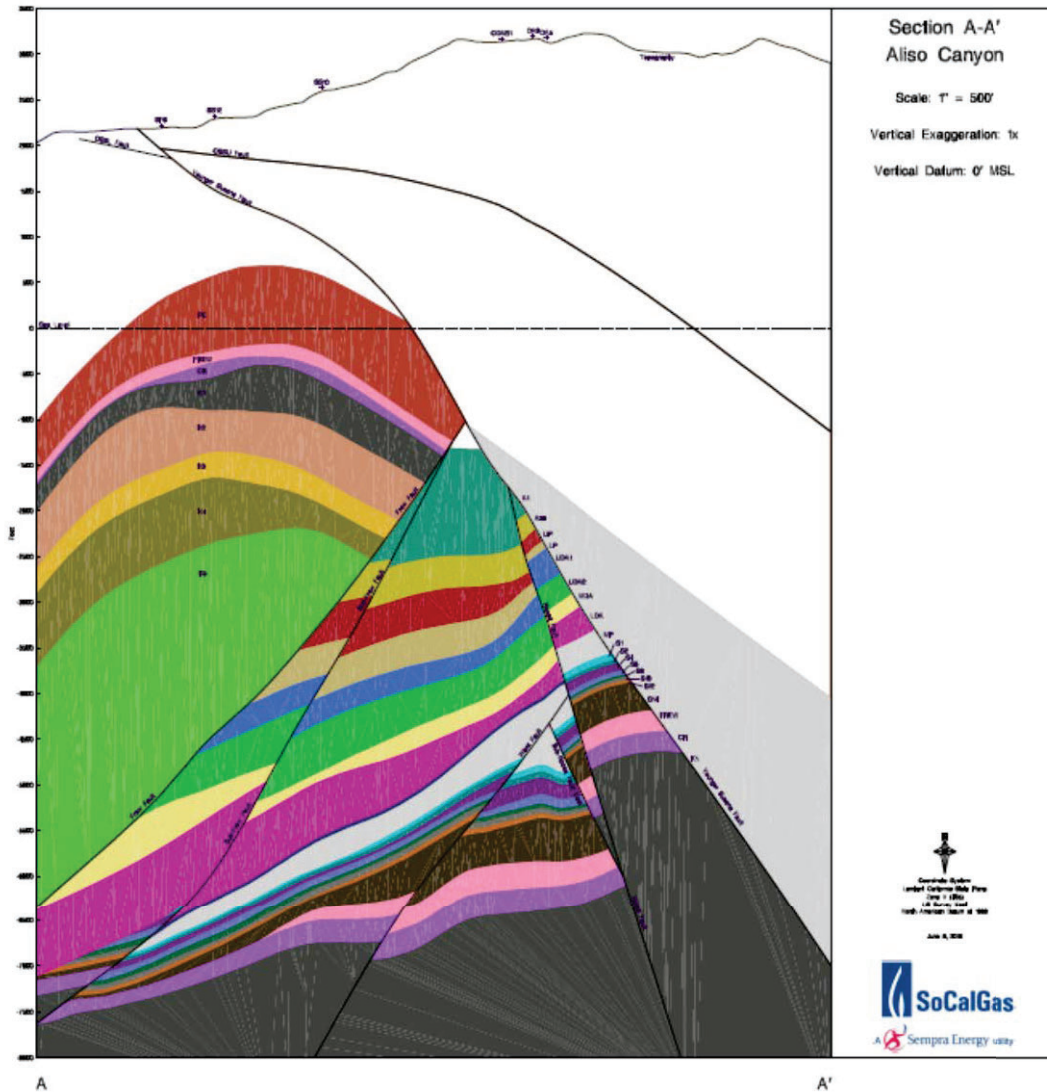


Figure 4: Aliso Canyon Gas Storage Field – A-A' Cross Section

SoCalGas, 2016; Cross section location is shown in Figure 3

Aliso Canyon Gas Storage Field Geomechanical Properties Estimate

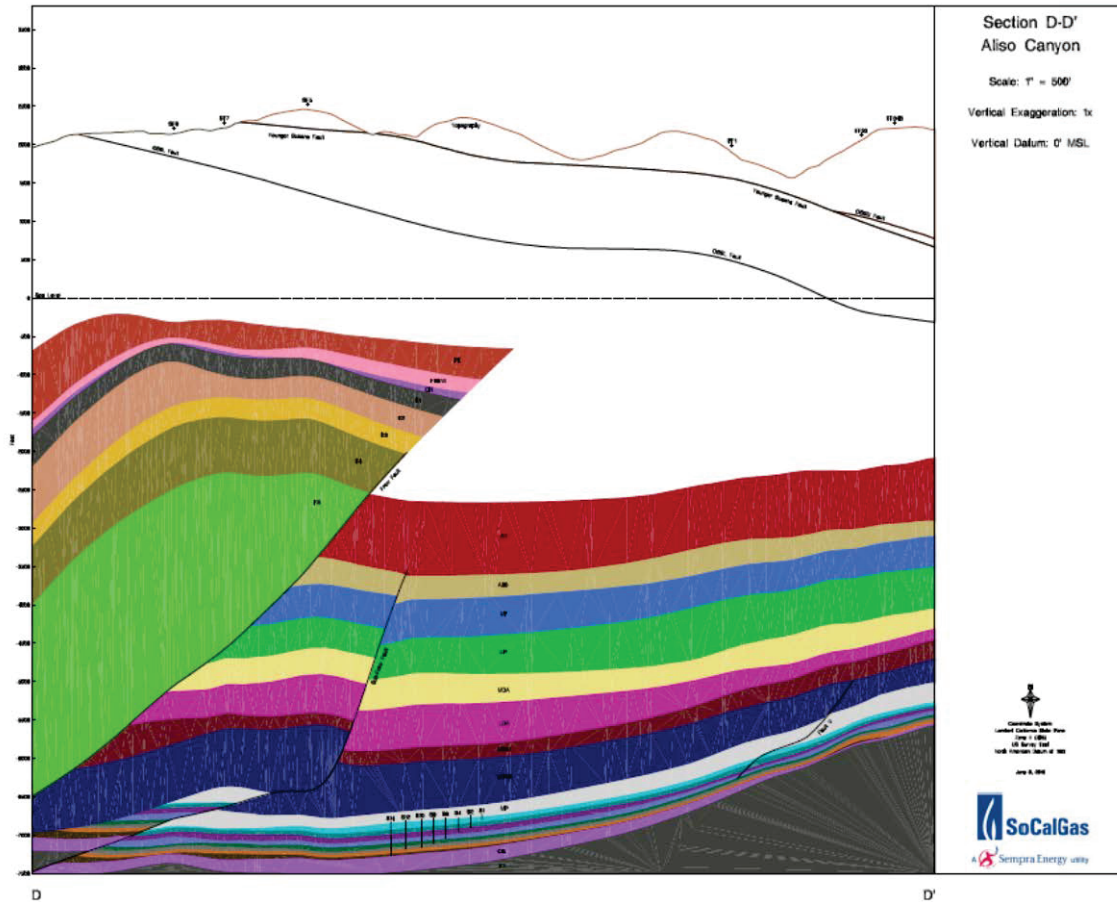


Figure 5: Aliso Canyon Gas Storage Field –D-D’ Cross Section

SoCalGas, 2016, Cross section location is shown in Figure 3

2.1.2 Cap Rock:

The cap rock is referred to as Mohnian shale, and it is the uppermost portion of the Modelo formation, which averages about 350ft thickness in the Aliso Canyon gas storage field (DOGGR, 1959). Figure 6 is the stratigraphic column for the Aliso Canyon gas storage field.

Aliso Canyon Gas Storage Field Geomechanical Properties Estimate

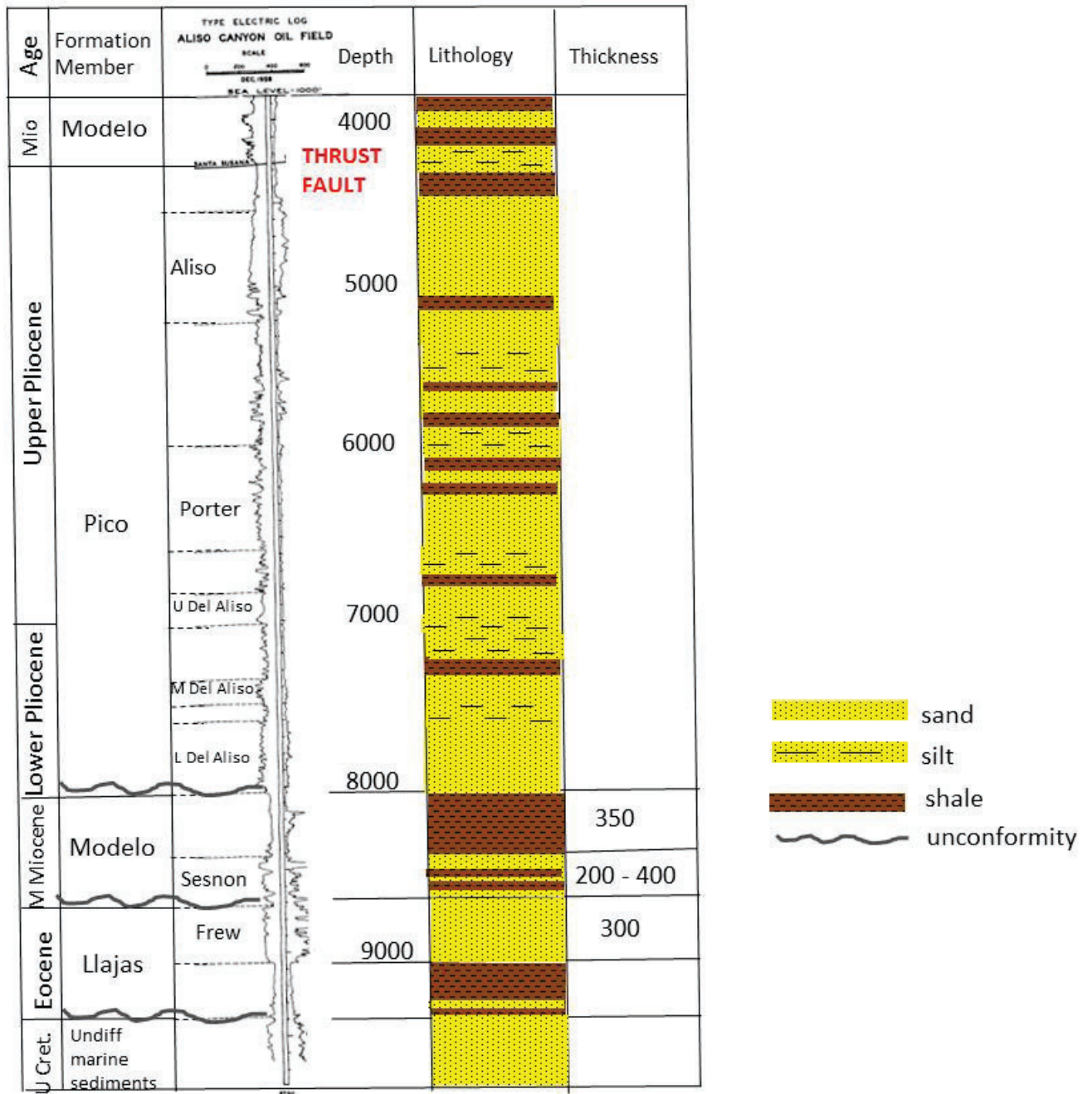


Figure 6: Type log for Aliso Canyon Gas Storage Field

Modified from DOGGR, 1999

2.1.1 Structure:

The structure in the Aliso Canyon Gas Storage Field is a southeast plunging anticline, bounded on the north by the Santa Susana Fault Zone, and on the west by the southwesterly dipping Frew thrust fault. The Frew Fault never outcrops and is truncated by the younger Santa Susana Fault (USGS, 1987). West of the Frew fault, Cretaceous rock is thrust over the Pliocene Pico Formation as shown in Figure 5 (USGS, 1987).

3. GEOMECHANICAL ASSESSMENT OF ALISO CANYON GAS STORAGE FIELD

2.2 Estimating Caprock and Reservoir Mechanical Properties

The key mechanical properties required to assess formation geomechanical response to pressure cycling are the stiffness properties (Young's Modulus and Poisson's Ratio) and the strength properties (Shear Strength and Friction Angle) for the reservoir and caprock material. The Young's Modulus describes the magnitude of rock strain in one direction induced by stresses in the same direction. The Poisson's ratio is a measure of the lateral expansion or contraction of the rock induced by stresses in the vertical direction. The material shear strength determines the amount of shear stress that the rock can withstand at a given confining load before failing and the friction angle describes how the shear strength increases with confining load.

The most accurate way to estimate rock properties is by direct laboratory measurements on core samples. Unfortunately, direct rock mechanical properties information for the Aliso Canyon Gas Storage Field is not available. Additionally, the sonic log results were not available in electronic version. We applied digitization and mathematical interpolation methods to regenerate the compressional DTC sonic log. Then we used the digitized sonic log data and bulk density log data from well Porter 69K to estimate the dynamic Young's Modulus (E) in the caprock and storage zone formations, as summarized in Table 1 below. Figure 7 presents the sonic log (compressional wave velocity) and formation bulk density log from well Porter 69K. The average Poisson's

Aliso Canyon Gas Storage Field Geomechanical Properties Estimate

ratio for the caprock and the reservoir are estimated to be approximately 0.35 and 0.3 respectively. Therefore, the average Dynamic Young's Modulus values for the caprock and reservoir rock are estimated to be 3.34E5 psi and 4.32E5 psi, respectively.

Corresponding Bulk Modulus (K) and Shear Modulus (G) are calculated as shown in Table 1.

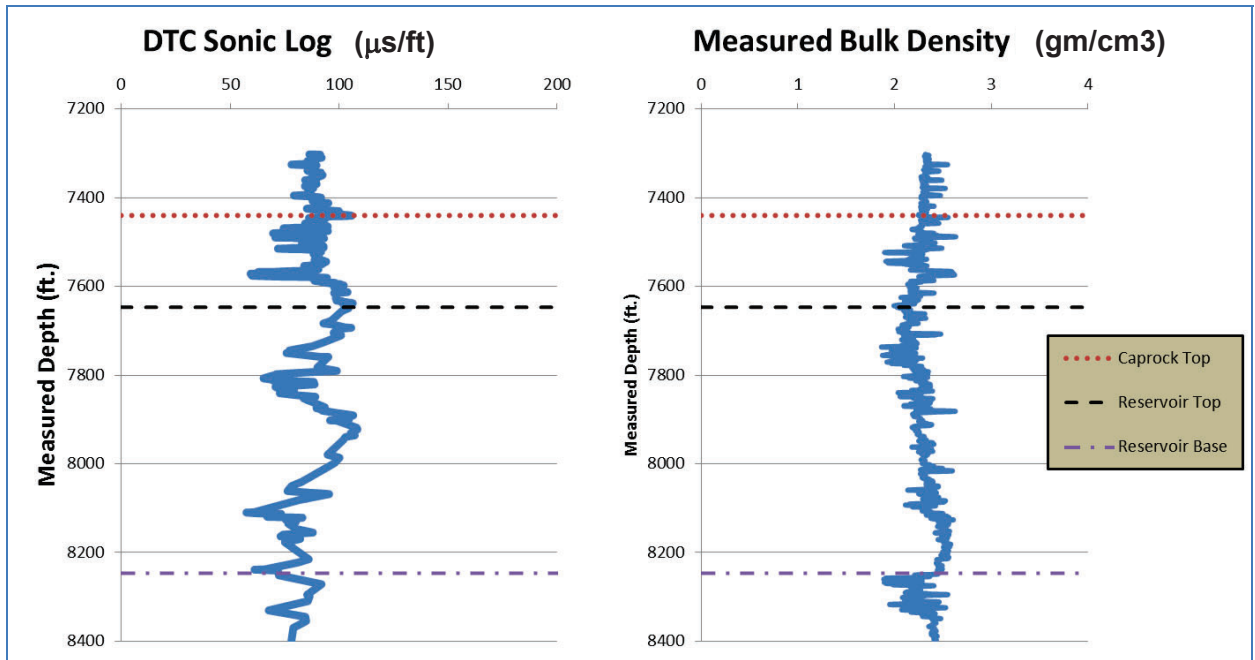


Figure 7: (Top Left) Sonic Log and (Top Right) Bulk Density Log from well Porter 69K.

Table 1: Estimated Dynamic Mechanical Material Properties for Aliso Canyon Caprock and Storage Reservoir Formations.

Formation	E(psi)	Poisson's Ratio	K(psi)	G(psi)
Caprock	3.34E+05	0.35	3.71E+05	1.24E+05
Reservoir	4.32E+05	0.3	3.60E+05	1.66E+05

Aliso Canyon Gas Storage Field Geomechanical Properties Estimate

The shear strength limit for rock materials may be estimated with the Coulomb criterion, which relates the magnitude of the shear stress at failure $|\tau|$ to the inherent shear strength S_o , the angle of internal friction ϕ_f , and the confining stress σ is as follows:

$$|\tau| = S_o + \sigma \tan\phi_f \quad (2).$$

A range of material shear strength may be estimated from several correlations provided in the literature (Schlumberger, 1987; Vernik et. al, 1993). For example, the Vernik correlation relates shear strength to porosity (ϕ) through the expression given in equation (3) below.

$$S_o = 73660 (1 - 2.7\phi)^2 / (12 + 10\phi) [\text{psi}] \quad (3).$$

For an average reservoir porosity at Aliso Canyon Field of about 24%, the minimum shear strength would be on the order of about 680 psi, although depending on the formation porosity, this value may range from about 177 to about 3000 psi.

Table 2. Estimated Minimum, Maximum and Average Shear Strength of the reservoir for Aliso Canyon Gas Storage Reservoir

	Porosity , fraction	Estimated Shear Strength (Psi)
Approx. Minimum	0.10	3019
Approx. Maximum	0.30	177
Average	0.24	683

2.3 Estimating In-Situ Stresses and Reservoir Fracture Pressure

2.3.1 Regional Stress Review

Figure 8 is from the World Stress Map showing stress regime in the Aliso Canyon and surrounding area. Maximum horizontal compressive stress orientation is observed in the NNE-SSW direction. This trend is not unique but uniformly consistent throughout southern California as described by Townend and Zoback (2004). Wilde and Stock

Aliso Canyon Gas Storage Field Geomechanical Properties Estimate

(1997) studied 71 boreholes in Southern California (Figure 9) covering an area between T1S-5N; R9W-29W. A possible interpretation consistent with the available data is that Southern California has a thrust faulting stress regime with a NNE-SSW orientation of the maximum horizontal principal stress ($S_v < S_h < S_H$). A combination strike-slip and thrust faulting stress regime ($S_h < S_v < S_H$) is another interpretation that is consistent with the available data.

Wilde and Stock (1997) analyzed 14 wells in the East Ventura Basin west of the Aliso Canyon field. The dominant breakout azimuth is NW with an average direction of N44°W, implying a minimum compressive stress direction of S_h of N44°W, and a maximum compressive stress direction of S_H of N46°E +/- 16° (Figure 10; Wilder and Stock, 1997), roughly consistent with the tectonic setting of the East Ventura Basin.

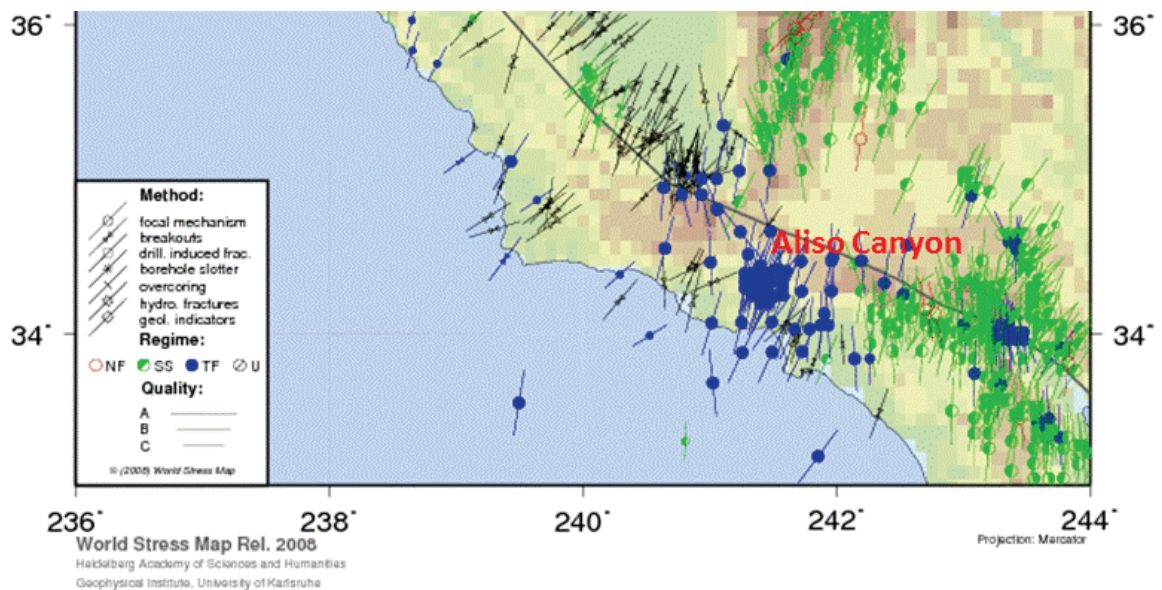


Figure 8: World Stress Map for the Aliso Canyon Area

Heidbach, O., Tingay, M., Barth, A., Reinecker, J., Kurfeß, D., and Müller, B., 2008

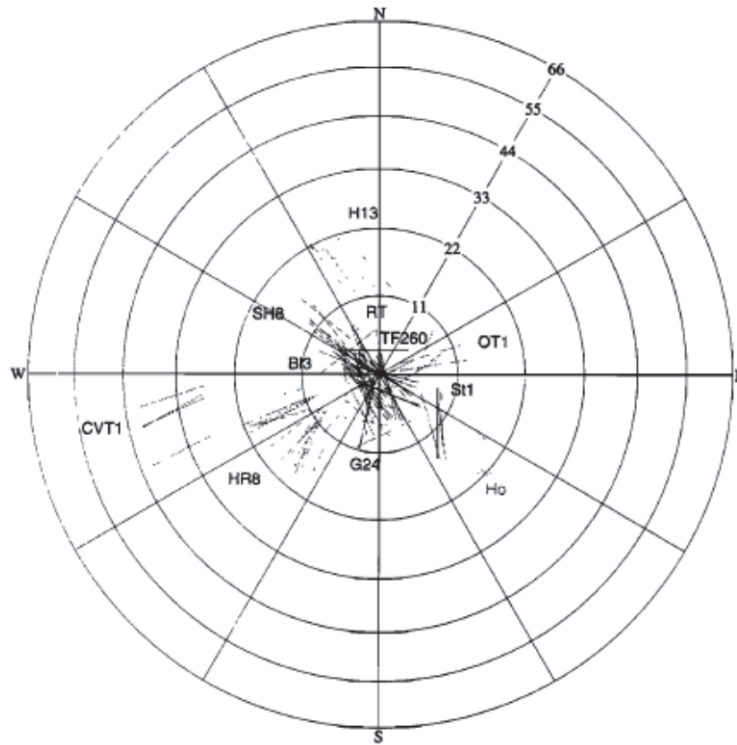


Figure 10: Lower hemisphere stereographic projection of borehole elongation directions from borehole studied for the East Ventura Basin.

Stock and Wilde, 1997

Breakout trend dominantly NW with a direction of maximum horizontal compression (S_H) of $N46^\circ E \pm 16^\circ$.

2.3.2 Stress Estimate from Field Testing

A leak-off test was performed on December 17, 2015 on well Porter 39A at the Aliso Canyon gas storage field as shown in Figure 11. The leak off test did not reach fracture pressure due to relatively low injection pressure and low flow rates (less than 1 bpm). However, by assuming maximum WHP of about 800 psi during leak off (as seen from the plot) at approximately 8,500 feet perforation depth with typical hydrostatic pressure gradient of 0.44 psi/ft, we can estimate the fracture gradient exceeds 0.54 psi/ft. An injection pressure test that was conducted on well Standard Sesnon (SS) 4-0 on November 7, 2005, which also indicated fracture gradient greater than 0.54 psi/ft (maximum treating pressure of about 4,200 psi at approximately 7,800 ft depth), as shown in Figure 12.

Aliso Canyon Gas Storage Field Geomechanical Properties Estimate

Two additional injection tests on wells Fernando Fee (FF) 38B and 38C indicated relatively higher fracture gradient. Figure 13 shows the observed maximum bottom hole gauge pressure of about 4,700 psi for the FF 38B injection test. The perforation depth is at approximately 7,000 ft, thus the fracture gradient is estimated to be about 0.67 psi/ft. Figure 14 presents the injection test data on well FF 38C. The measured bottom hole pressure is nearly 4,200 psi at about 7,200 ft depth, indicating the fracture gradient exceeds 0.58 psi/ft.

After reviewing additional test data at different injection stages for the same wells, we estimate the current fracture gradient in the storage zone is on the order of about 0.6 to 0.7 psi/ft.

Note that fracture pressure in a reservoir varies with reservoir pressure. With significant production and pressure depletion, as has occurred at Aliso Canyon Gas Storage Field, fracture pressures become lower due to a reduction in minimum horizontal stress. Conversely, with significant injection and pressure increase, fracture pressures become elevated due to an increase in minimum horizontal stress. Current reservoir pressures at Aliso Canyon Gas Storage Field is approximately 1,500 psi. This is significantly lower than original reservoir pressure on the order of about 3,600 psi. Hence the fracture gradient is now lower than native conditions. We estimate the native fracture gradient for the area is on the order of about 0.75 to 0.80 psi/ft.

Aliso Canyon Gas Storage Field Geomechanical Properties Estimate

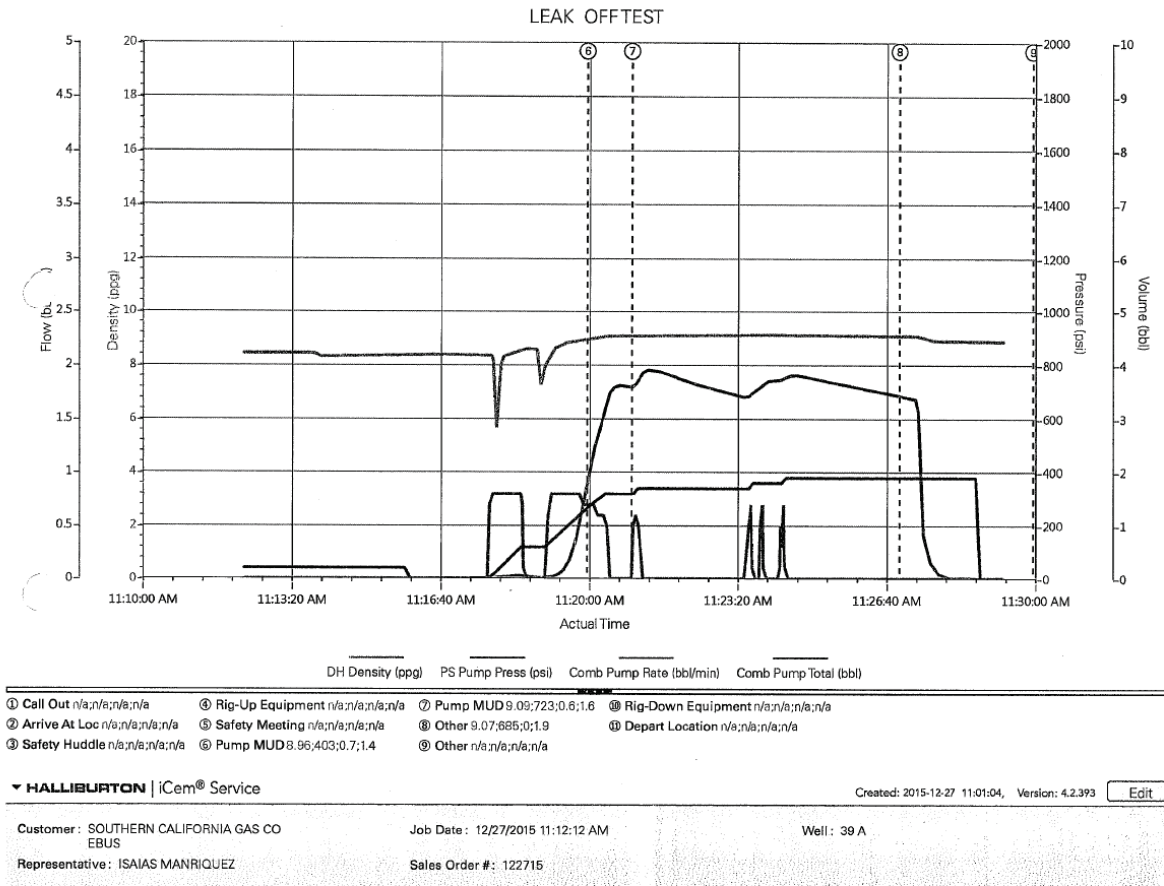


Figure 11: Well Porter 39A leak off test at Aliso Canyon Gas Storage Field on Dec. 27, 2015.

Aliso Canyon Gas Storage Field Geomechanical Properties Estimate

HALLIBURTON

Southern California Gas Co
Aliso Canyon Gas Producer SS 4-O Stage 1
Acid With CT

6.2 HT. Graph

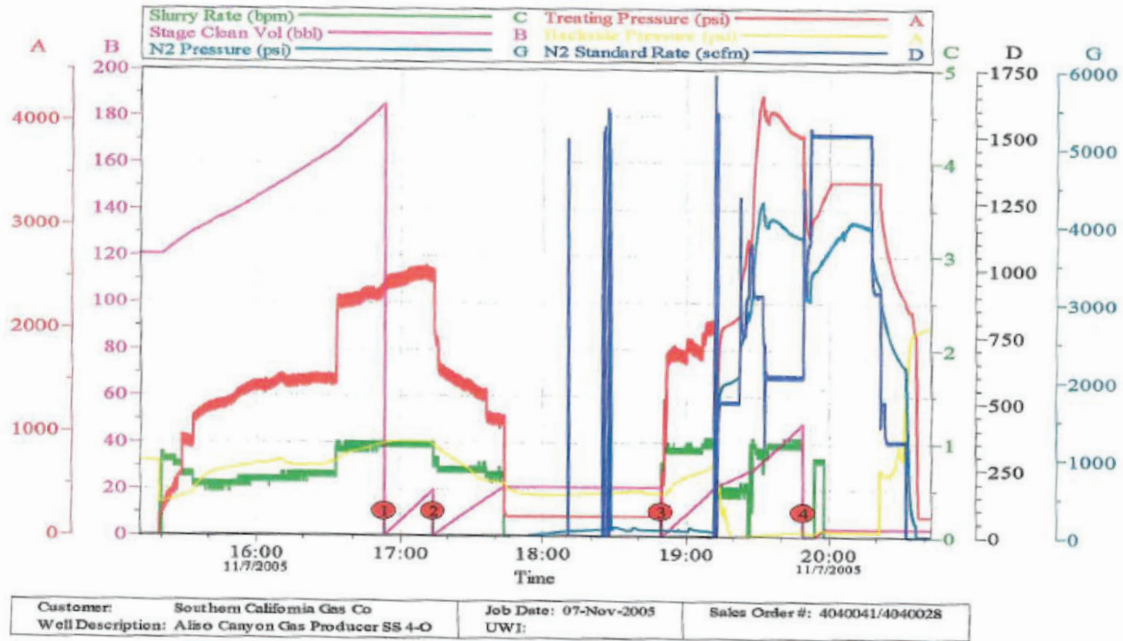


Figure 12: Well SS 4-0 stage 1 injection test performed by Halliburton at Aliso Canyon Gas Storage Field on Nov. 7, 2005.

Aliso Canyon Gas Storage Field Geomechanical Properties Estimate

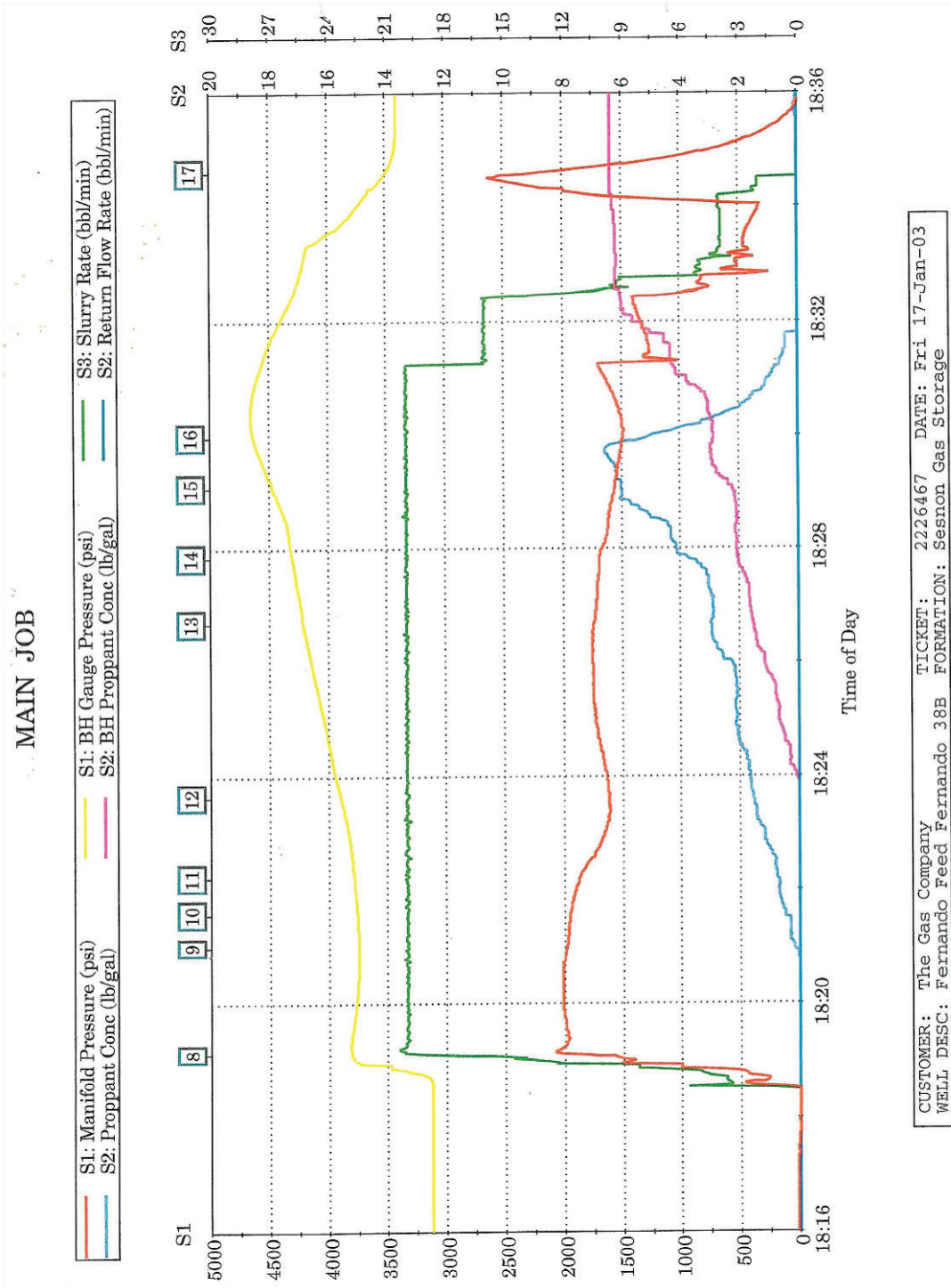
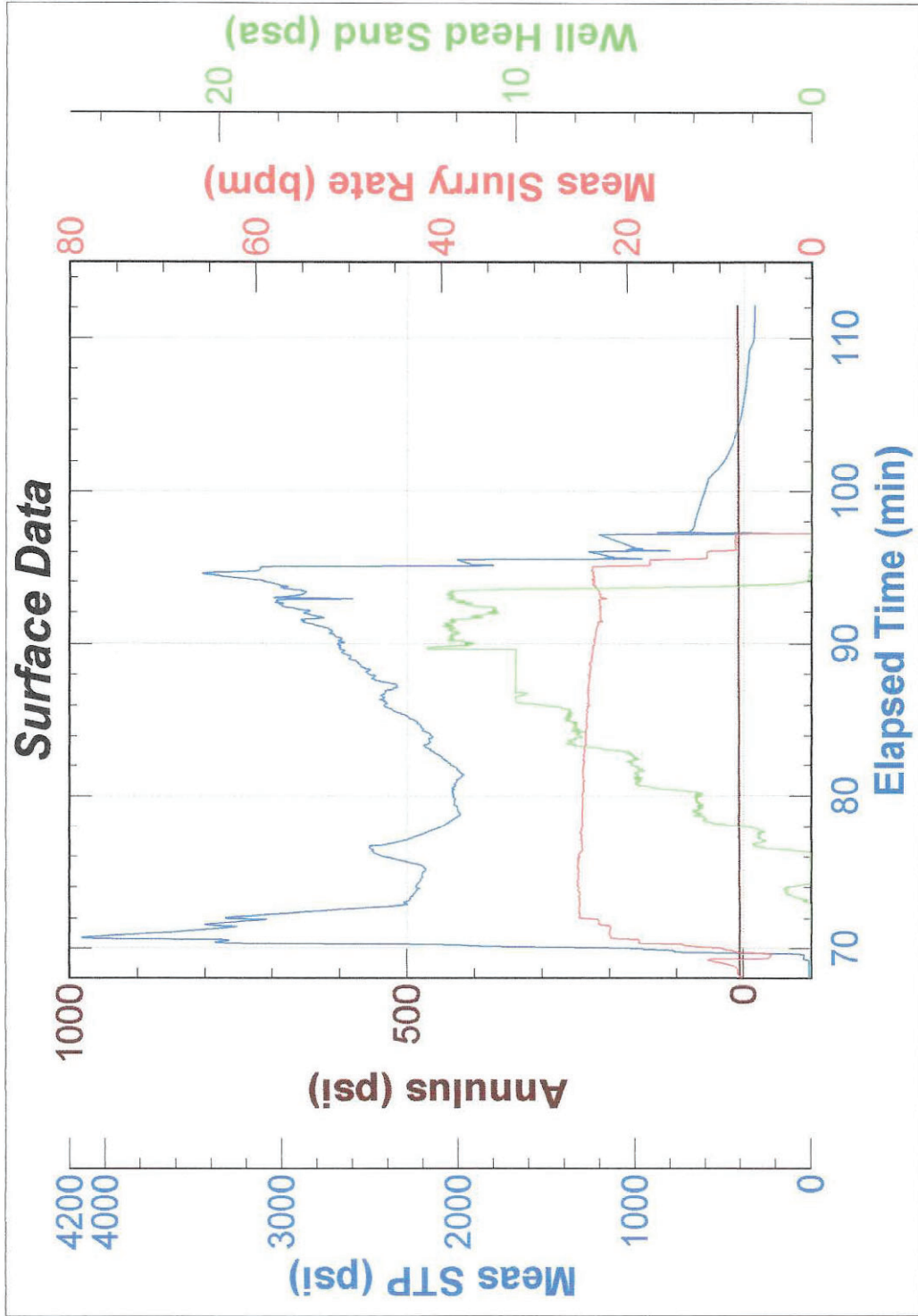


Figure 13: Well FF 38B injection test performed by Halliburton at Aliso Canyon Gas Storage Field on Jan. 17, 2003.

BJ BJ Services JobMaster Program Version 2.61
 Job Number: Southern California Gas
 Customer: Aliso Canyon Field 38C Stage 1
 Well Name: Aliso Canyon Field 38C Stage 1



Job Start: Tuesday, March 04, 2003

BJ Services

Figure 14: Well FF 38C injection test performed by BJ Services at Aliso Canyon Gas Storage Field on Mar. 4, 2003.

4. CONCLUSIONS AND DISCUSSIONS

GeoMechanics has estimated geomechanical properties for the Aliso Canyon Gas Storage Field based on currently available data. We estimate the fracture gradient in the reservoir to be on the order of about 0.6 to 0.7 psi/ft, or about 4300 to 5000 psi bottom-hole pressure at a depth of 7200ft, at current reservoir conditions. This is lower than original fracture gradient for the field because pressures have been significantly reduced from original conditions. Fracture gradient in portions of the upper caprock are likely to be on the order of 0.75 to 0.8 psi/ft, assuming pressure has not been depleted, which is consistent with native stress conditions in the LA Basin.

We note that the field has operated at a maximum surface pressure of about 3000 psi for the period from about 1999 to 2015. Assuming a well is gas filled, and taking into account the density of gas at about 3000 psi and about 90.5 degrees Celsius (approximate average temperature from surface to 7200 ft depth), the estimated bottom hole pressure is on the order of 3500 psi. This is lower than the estimated bottom hole fracture pressure. We therefore conclude that there is little risk for fracturing at current operating conditions. Operating the gas field at a maximum bottom-hole pressure of about 3,600 psi, the approximate original reservoir pressure, should not exceed the fracture gradient in the field based on current available data, and assuming a well is gas filled.

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ATTACHMENT 3

(Southern California Gas Company Letter to State of California Department of Conservation, Division of Oil, Gas and Geothermal Resources, Re: Aliso Canyon Geomechanical Reports Regarding Minimum and Maximum Reservoir Pressure, July 22, 2016)



Dan Neville
Storage Engineering Manager
Gas Storage Operations

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Northridge, CA 91326-1045

Tel: 818.700.3810
DNeville@SempraUtilities.com

VIA ELECTRONIC MAIL

July 22, 2016

Alan Walker
Supervising Oil & Gas Engineer
Department of Conservation
Division of Oil, Gas, and Geothermal Resources
801 K Street – MS 18-05
Sacramento, California 95814

Re: Aliso Canyon Geomechanical Reports Regarding Minimum and Maximum Reservoir Pressure

Dear Mr. Walker:

Attached is the report and letter by GeoMechanics Technologies on Aliso Canyon minimum and maximum reservoir pressure.

SoCalGas has elected to use initial reservoir pressure as the design basis for Aliso Canyon, thus the field-average maximum operating bottom hole pressure will be 3595 psi. Under current conditions, SoCalGas has elected to use 0 BCF working inventory as the design basis for Aliso Canyon, thus the field-average minimum operating bottom hole pressure will be 1080 psi.

We are planning to submit this report and letter as part of our Emergency Regulations submittal package. Please let me know if you require any additional information.

Sincerely,

Dan Neville
Storage Engineering Manager
Gas Storage Operations
SoCalGas

ATTACHMENT 4

(National Labs Letter to State of California Department of Conservation, Division of Oil, Gas and Geothermal Resources, Re: Aliso Canyon Minimum Operating Pressure, September 8, 2016)



8 September 2016

To: Alan Walker
Supervising Oil & Gas Engineer
Department of Conservation
Division of Oil, Gas, and Geothermal Resources
801 K Street, MS 18-05
Sacramento California 95814

Re: Aliso Canyon Minimum Operating Pressure

Mr. Walker:

At DOGGR's request, the National Laboratory team has reviewed the minimum and maximum operating pressures suggested by SoCalGas for the Aliso Canyon Field. Our analysis and recommendations are summarized below.

Minimum Operating Pressure:

SoCalGas has suggested that the minimum operating pressure for Aliso Canyon be set at 1080 psi bottom hole pressure. This value corresponds to ~30% of the reservoir discovery pressure (3595 psi). Given that the field has been previously cycled to this pressure with no reports of problematic subsidence, we concur that the 1080 psi recommendation is a reasonable operating threshold going forward.

Typically, reservoirs exhibit the largest subsidence during virgin consolidation, when the reservoir is first cycled to a new minimum pressure. This first drawdown typically results in significant irreversible (plastic) deformation. Subsequent pressure cycling that remains above the historic minimum pressure will induce smaller deformations that are largely reversible (elastic) in nature. Given that the proposed threshold is above the historic minimum pressure, the Aliso Canyon field has likely already experienced the maximum deformation that would be expected. We are unaware of any subsidence-related well damage issues reported by SoCalGas. We have therefore concluded that pressure cycling above the proposed threshold is unlikely to cause significant issues going forward.

In general, we recommend that NGS operators directly monitor subsidence at their operations. There are many land-based and satellite-based survey methods available. Such monitoring would be particularly important for a field undergoing virgin consolidation to a new minimum pressure. This data can provide a direct confirmation of the suitability of the design minimum operating pressure.

Maximum Operating Pressure:

SoCalGas has suggested that the maximum operating pressure for Aliso Canyon be set at 3595 psi bottom hole pressure. This value corresponds to the discovery pressure of the reservoir. We concur that this value is a reasonable operating threshold going forward.



There are two lines of evidence to support this threshold. First, the presence of a stable gas cap in the pre-development reservoir indicates that the Aliso Canyon storage formation was able to contain gas up to at least the discovery pressure (3595 psi) over geologic time scales. Operating below the discovery pressure is therefore unlikely to create new hydraulic fractures or other leakage pathways. Second, the third-party geotechnical analysis prepared by GeoMechanics Technologies has examined available leakoff test data for the Aliso Canyon site. We agree with the report's assessment that these measurements indicate a hydraulic fracture gradient in excess of ~0.6 psi/ft in the reservoir. Applying a safety factor of 0.9 would lead to a design fracture gradient of 0.54 psi/ft, or 3888 psi at 7200'. This value is in excess of that proposed by SoCalGas.

We note that the excess pressure necessary to create and propagate hydraulic fractures varies substantially with depth, due to the depth-dependence of the in situ stress and the buoyant nature of the natural gas column. A single maximum operating pressure threshold is not the best format for conveying this depth-dependence. Instead, a fracture gradient requirement is more straightforward for guaranteeing that pressures remain below critical values everywhere in the reservoir. In particular, the critical location for hydraulic fracturing is likely to be at the shallowest point in the gas cap, immediately below the reservoir / caprock interface. SoCalGas should ensure that their pressure monitoring and subsequent analysis is sufficient to guarantee that reservoir pressure remains below critical values at all locations.

Sincerely,



Joshua A. White
Lawrence Livermore National Laboratory



Scott A. Perfect
Lawrence Livermore National Laboratory



Barry M. Freifeld
Lawrence Berkeley National Laboratory

ATTACHMENT 5

(State of California Department of Conservation, Division of Oil, Gas and Geothermal Resources, Recommended Minimum and Maximum Reservoir Pressure for the Aliso Canyon Storage Facility, July 17, 2017)



Recommended Minimum and Maximum Reservoir Pressure for the Aliso Canyon Storage Facility

January 17, 2017

Introduction:

California Code of Regulations, title 14, section 1724.9, subdivision (b), as amended by the emergency regulations for underground gas storage facilities, requires that the Division of Oil, Gas, and Geothermal Resources (Division) specify a minimum and maximum reservoir pressure in the injection approval for each underground gas storage facility. Senate Bill 380 (Pavley, Chapter 14, Statutes of 2016), adopted as urgency legislation, established a statutory requirement that the minimum and maximum reservoir pressures approved by the Division for the Aliso Canyon Storage Facility shall be based on 1) a proposal from the operator, 2) consultation between the Division and independent experts, and 3) input from the public on the proposed minimum and maximum reservoir pressure at a public meeting. (Pub. Resources Code, § 3217, subd. (d) and (e).) Following are the recommendations from the Division's Underground Gas Storage Unit (UGS Unit) for proposed minimum and maximum reservoir pressures in the Aliso Canyon Storage Facility gas storage reservoir. These recommendations are based on a proposal from Southern California Gas Company (SoCalGas) and consultation with geotechnical experts at Lawrence Berkley National Laboratory, Lawrence Livermore National Laboratory, Sandia National Laboratory, and the University of Texas.

Recommendation:

The UGS Unit recommends that the minimum pressure in the Aliso Canyon Storage Facility gas storage reservoir be 1,080 psia. As discussed below, this minimum pressure coincides with what was proposed by SoCalGas.

The UGS Unit recommends that the maximum bottom-hole reservoir pressure at the top of the reservoir structure, as represented by the productive interval in the Porter 69G well, be not greater than 2,926 psia, which is 19% lower than the maximum pressure originally proposed by SoCalGas. The Porter 69G well is completed in the storage reservoir and will function as an observation well. Therefore, a shut-in tubing pressure (SITP) measurement will be used to estimate the reservoir pressure. The difference between the UGS Unit's recommendation and what was proposed by SoCalGas represents the normal hydrostatic gradient, which provides an important margin for well control and safety at this point in the well evaluation regime. As many of the wells in the Aliso Canyon Storage Facility are currently isolated from the reservoir with a mechanical plug and fluid filled tubing and casing, a reservoir pressure exceeding hydrostatic pressure represents a potential risk. Once the isolated wells have been plugged and abandoned or completed all testing and remediation in accordance with Order 1109, the Division would consider a renewed proposal by SoCalGas to inject at a higher operating pressure.

Technical Information and Consultation:

Upon commission from SoCalGas, a third-party geotechnical report titled "Estimated Geomechanical Properties for the Aliso Canyon Gas Storage Field" was completed by GeoMechanics Technologies on July 15, 2016. (Attachment 1) This report was transmitted to the Division of Oil Gas and Geothermal Resources (Division) on July 22, 2016 by a letter (Attachment 2) from Mr. Dan Neville, Storage Engineering Manager for SoCalGas. The report from GeoMechanics recommended a 3,600 psi maximum bottom-hole pressure and a 900 psi minimum bottom-hole pressure, and in its transmittal letter SoCalGas proposed maximum operating pressure of 3,595 psi and minimum operating pressure 1,080 psi.

The UGS Unit reviewed the report and the operator's proposal and forwarded them for independent review by geotechnical staff at the national laboratories – Barry Freifeld of Lawrence Berkley National Laboratory, Scott Perfect of Lawrence Livermore National Laboratory, and Doug Blankenship of Sandia National Laboratory. The UGS Unit then consulted with the national laboratories' geotechnical staff and other Division staff in the district office in Cyprus by teleconference on August 10, 2016. The national laboratories' geotechnical staff concurred with the GeoMechanics Report and the proposal from SoCalGas, finding that the requested maximum operating pressure of 3,595 psi and minimum operating pressure of 1,080 psi are within normal operating parameters (Attachment 3) and should be considered for approval.

Subsequently, Dan Neville, Storage Engineering Manager for SoCalGas, provided additional analysis of the SoCalGas' proposed minimum bottom-hole pressure in the form of a plot based on zero working gas inventory. (Attachment 4, page 2) The UGS Unit finds that the plot provided by SoCalGas further demonstrates the reasonableness of the proposed minimum operating pressure of 1,080 psi, as do the national laboratories' geotechnical staff.

In addition, the UGS Unit consulted with Dr. Richard A. Schultz regarding the proposed minimum and maximum reservoir pressures in the Aliso Canyon Storage Facility gas storage reservoir. Dr. Shultz is a professor at the University of Texas at Austin, an instructor for the TopCorp geotechnical training program, and a recognized specialist in overburden and geomechanics. Dr. Shultz also concurred with the GeoMechanics Report and the proposal from SoCalGas, finding that the requested maximum operating pressure of 3,595 psi and minimum operating pressure of 1,080 psi are within normal operating parameters (Attachment 3) and should be considered for approval.

Although the independent experts consulted by the UGS Unit believe that a maximum reservoir pressure of 3,595 psi and a minimum reservoir pressure of 1,080 psi is prudent, the UGS Unit finds that a more conservative maximum pressure should be approved until all wells in Aliso Canyon Storage Facility have either been plugged and abandoned or tested and remediated in accordance with Order 1109. The UGS Unit has estimated the hydrostatic pressure (using a pressure gradient of 0.433 psi/ft) in the reservoir from wells P-69G & P-68B, both completed in the Sesnon (S4) sand and located between the top and bottom of the reservoir structure as seen in Attachment 5. Maximum reservoir pressure is estimated using a gas gradient of 0.061 psi/ft from the top of the S1 sand in the reservoir to its base. Until the final disposition of all wells, the bottom-hole pressure in the reservoir should not exceed 2,926 psi at

the Porter 69G well, which has a true vertical depth (TVD) of 7,142 feet. All other wells in the reservoir may operate at a bottom-hole pressure of 2,926 psi plus the gas gradient for the difference between the TVD of Porter 69G and the TVD of each individual well.

Proposed Minimum and Maximum Pressure

<u>Recommendation</u>	<u>Minimum Pressure (psi)</u>	<u>Maximum Pressure (psi)</u>
GeoMechanics Technologies	900	3,600
SoCalGas	1,080	3,595
UGS Unit	1,080	2,926

ATTACHMENT 6

Date	Working Gas Inventory, BCF	P69G Surface Pressure, psig
09/16/2023	45	2,096
10/24/2023	50	2,234
11/12/2023	55	2,347
12/21/2023	58.8	2,433

Table 1 - Surface pressure at P69G over the September-December 2023 period.

ATTACHMENT 7

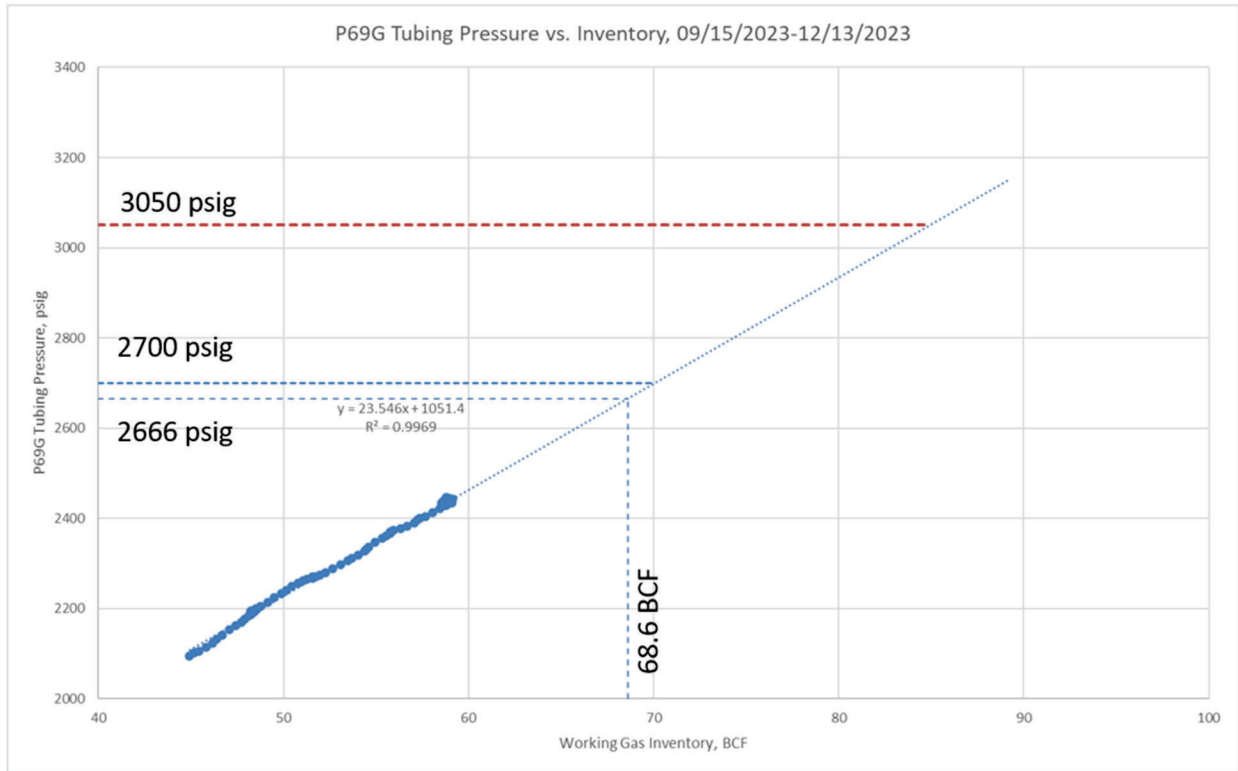


Figure 1 - Linear extrapolation of P69G tubing pressure vs. working gas inventory. The theoretical surface pressure at 68.6 BCF is 2,666 psig. A maximum surface pressure at P69G of 2,700 psig would accommodate variations between actual versus estimated P69G pressure at higher inventory levels and is below the original discovery pressure of the facility and SIMP integrity pressure testing levels. At the field discovery pressure of 3,595 psia, the surface pressure at P69G is 3,050 psig.