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Drilling Performance Evaluation & Well Integrity with JIWA DBase

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ABSTRACT

Drilling reports encompass well surveys, mud logs, operational data, daily drilling reports and AFE (authorization for expenditure) is recapitulated for continuous learning and improvement to enhance further well design and drilling operations. It is closely related to well integrity and operational performance, which are key to the success of geothermal drilling under various stakeholders. The lack of proper data coordination can hinder effective evaluations. Hence, accurate and up-to-date data management with a capable database is necessary to ensure well-coordinated, compiled, accessible, and useful data. This paper aims to detail the implementation of JIWA DBase as a tool for drilling engineers in optimizing data management and evaluating well integrity and drilling performance.

1. INTRODUCTION

Drilling report in geothermal operation plays a crucial role in drilling operations, serving as a tool for continuous learning and improvement to optimize future drilling projects. Therefore, it is essential to pay attention to both well integrity and drilling performance as key success factors for geothermal projects. This is supported by well-structured and coordinated data reports.

According to the study by Damsky (2014), there are still challenges in managing drilling data in the geothermal industry. Some geothermal companies still lack a dedicated database to store their drilling data. Their drilling data was stored in various formats such as Excel, images, presentations, and Daily Drilling Reports without a comprehensive operational summary. These records were stored on servers or individual computers, leading to frequent discrepancies in file formats, datums/units (ft, inch, date, lb, ppg, ft/hr, etc.), and codes created by engineers. Consequently, this results in data inconsistency and lack of structure.

A common issue is that engineers often have to manually search and organize the information they need, and other personnel unfamiliar with the location of data storage folders may struggle to find the required information. Drilling data is gathered from two primary sources: manually entered reports, such as daily drilling reports in spreadsheets, and automated reports generated by sensors, like Mud Logging. Both types of data are crucial, emphasizing the need for a well-structured database that is effectively coordinated among various stakeholders involved. Furthermore, the quality control (QC) process is often overlooked, this process is important because without it the analysis results can be inaccurate.

To address these challenges, AILIMA has developed a web-based geothermal database application within the JIWA System, known as JIWA DBase. This tool provides drilling engineers with a single platform for managing and analyzing geothermal drilling data that leads to neatly compiled and quickly accessible data for various stakeholders so that data audits are well-coordinated and safe. Ultimately, it streamlines the decision-making process for managing exploration, development, and make-up well drilling (Sidqi et al., 2024). The objective of this study is to show the step-by-step process of utilizing the JIWA DBase for managing drilling project's data, starting from data gathering to data analysis.

2. LITERATURE REVIEW

Geothermal sectors face a challenge in managing drilling data, which is often unstructured, diverse, and dispersed. Efficient data management is crucial for optimizing operations and decision-making, involving systematic recording and summarization of Non-Productive Time (NPT) and operational insights. It enables automatic graph generation for better data representation and sorting, enhancing organization and accessibility. Collaborative use of shared datasets reduces time requirements, fostering increased productivity. A shared platform across groups and departments ensures data integrity through robust quality control measures and an approval system based on individuals' positions, contributing to effective decision-making processes (Peytchev, 2011).

Ensuring well integrity is crucial across its life cycle, involving technical, operational, and organizational solutions to minimize the risk of uncontrolled fluid release. This is especially pertinent in the context of geothermal drilling data management. The NORSOK standard D-010:2013 highlights the significance of robust pressure seals and structural soundness in preventing fluid escape during drilling. Beyond ensuring well safety, these measures contribute significantly to enhancing the efficiency and cost-effectiveness of geothermal drilling operations by addressing the intricate dynamics of drilling performance and data management.

Key considerations of drilling performance include efficiency, cost-effectiveness, drilling targets, and safety. For instance, in the domain of casing and cementing, decisions related to casing installation significantly impact costs in geothermal drilling. Incorrect choices or installation errors necessitate expensive remedial actions. Optimal selection of casing material and meticulous installation procedures are crucial elements contributing to cost-effectiveness. Regarding drilling targets, consider cementing as an example. It plays an integral role in achieving zonal isolation in geothermal wells, thereby preventing fluid migration between formations. Successful cementing ensures the wellbore's integrity, facilitating the attainment of drilling targets. Addressing safety concerns, both casing and cementing act as critical barriers in geothermal drilling, averting fluid migration and ensuring wellbore integrity. The performance of casing and cementing must be sufficient for safety and environmental protection.

By optimizing drilling operations, geothermal projects can improve efficiency, reach desired drilling targets, and enhance cost-effectiveness. The multifaceted nature of drilling performance, as discussed by Sveinbjornsson and Thorhallsson (2014), underscores its role in maximizing the economic potential of geothermal energy extraction while prioritizing safety.

3. METHODOLOGY

This paper aims to show the step process in drilling data input and analysis using JIWA DBase that is shown in **Figure 1**. and the details are outlined below:

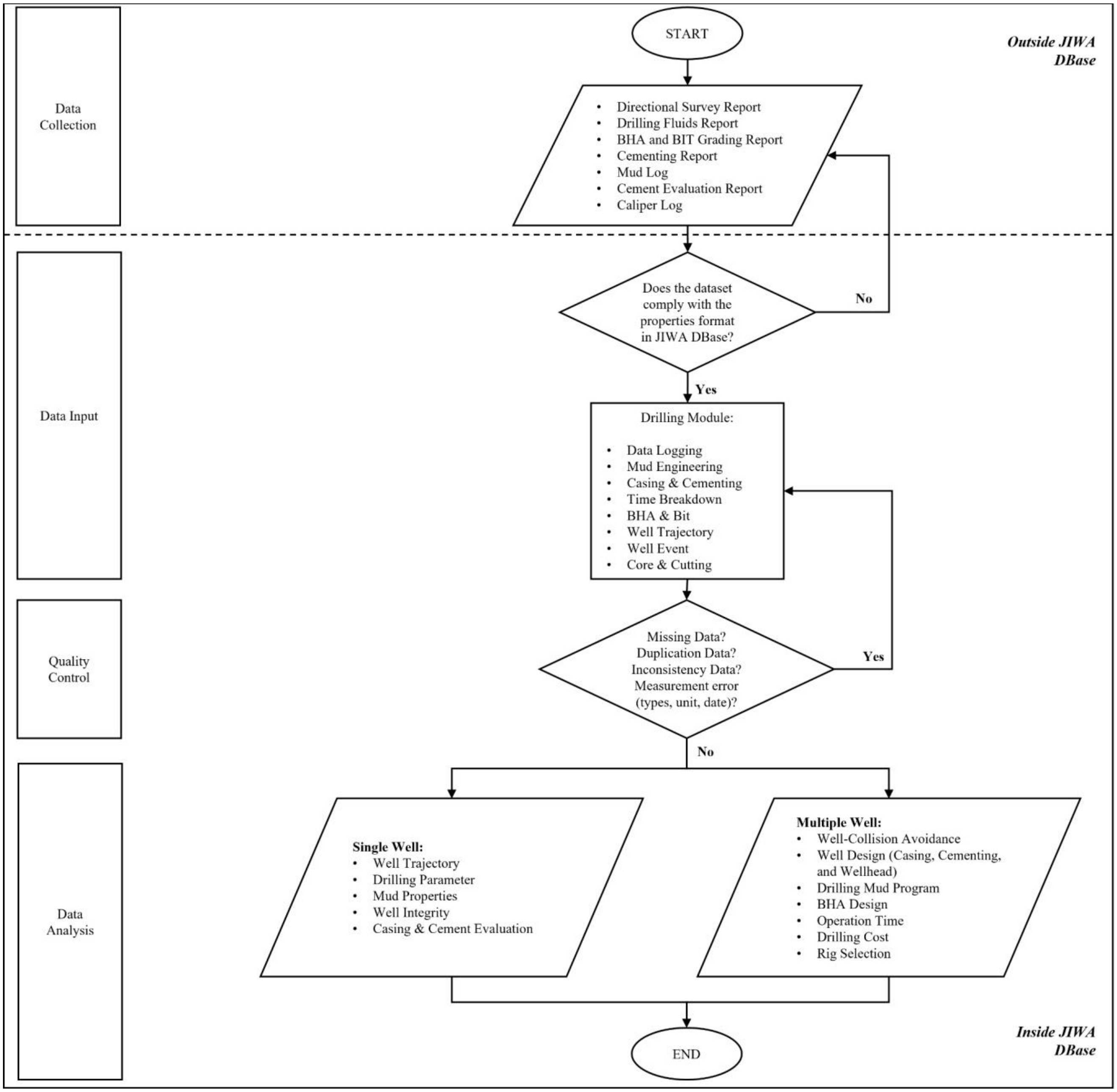


Figure 1: The workflow process of drilling data management and analysis with JIWA DBase.

3.1 Data Collection

Drilling data is divided into two types: structured data and unstructured data. Structured data is typically presented in tabular form in standard and easily readable formats, such as MWD/LWD tools data, surface and subsurface facility data, and monitoring data in XML and CSV format. On the other hand, unstructured data varies in size and format and does not conform to previous data models such as downhole videos, well logs, and field operation documentations. In this stage, the data is collected from several drilling reports such as daily drilling reports, drilling fluids reports, BHA and BIT grading reports, cementing reports, mud logs, etc. In JIWA DBase, unstructured data issues are resolved through systematic data structures in every drilling module.

3.2 Input Data and Quality Check

3.2.1 Input Data

The Drilling module in JIWA DBase is intricately structured and designed, with each module meticulously tailored to achieve specific objectives. It encompasses various modules, including mud engineering, data logging, casing and cementing, well trajectory, well event, time breakdown, BHA & BIT, and rig. For instance, the time breakdown module is specifically crafted to offer detailed insights into Non-Productive Time (NPT), empowering users to identify and analyze operational inefficiencies. This thoughtful organization ensures that users can efficiently extract pertinent information, enabling them to make informed decisions and gain valuable insights to optimize their drilling operations.

Furthermore, the data input process in the JIWA DBase Drilling modules has been thoughtfully developed to facilitate users in entering drilling data with precision and detail. The systematic approach guides users through aligning externally sourced drilling data with the corresponding modules. This process entails careful considerations for various format properties specific to drilling, including units relevant to depth and date, file formats specific to drilling reports, and drilling specifications. This approach ensures a seamless and accurate data input experience for users.

To address the consistency problem in qualitative data, JIWA DBase's data entry is delivered in nested structures of relational data, extensive lookups of input forms or tables, and digital documents, images, and video attachments. Examples of aforementioned features are shown in **Figure 2**. below.

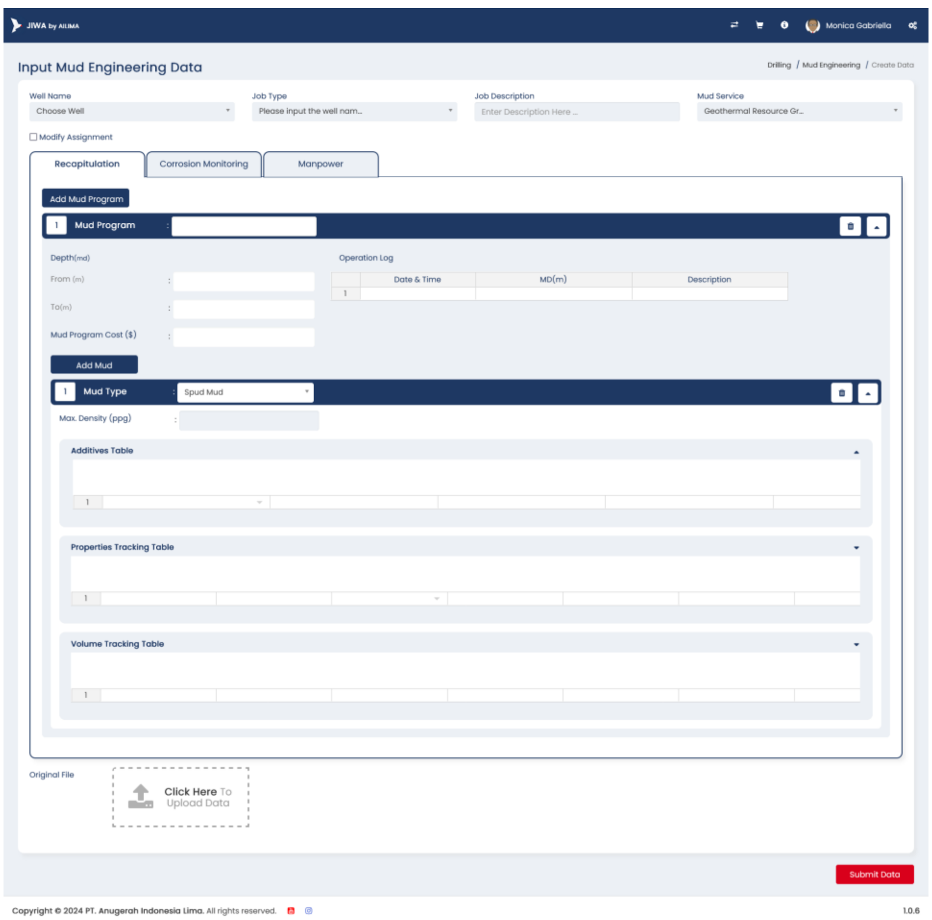


Figure 2: Form of Data input in Mud Engineering module of JIWA DBase.

3.2.2 Quality Check

Ensuring the integrity of input data is a crucial step in maintaining the quality of drilling data stored in JIWA DBase. To ascertain completeness, consistency, and identify potential duplicate entries, a quality check process is embedded in the system. The system can check for missing data, duplication, and scrutinizes the data for any discrepancies. This thorough validation process is integral to guaranteeing the reliability of the information stored in JIWA DBase. After the validation of drilling data, JIWA DBase performs a Quality Check process to ensure accuracy. This involves plotting for tabular data and utilizing tools for error-checking, data comparison, sorting, and editing. Users can refine the drilling data by removing inconsistencies and errors. JIWA DBase's strong design emphasizes a comprehensive data quality control process, enhancing the reliability of information for decision-making in drilling operations. Additionally, an approval system linked to individuals' positions ensures that only validated and accurate drilling data progresses to the next stages of analysis and decision-making. Illustrated in **Figure 3.** It serves as a quality check for data validation, ensuring that the tabular form in the "Wait on Cement (hours)" column is restricted to numerical entries only.

3.2.3 After data submission

JIWA DBase is designed to help users understand the methods used for specific datasets. With JIWA DBase's plotting feature, users can review how suitable and effective the methods were at each stage, boosting confidence in subsequent data analysis. For instance, users can check the quality of methods applied to the well trajectory design. **Figure 4.** shows an example of the plotting quality check to identify duplicate data or inconsistencies in the True Vertical Depth (TVD) data.

3.2.4 Metadata

JIWA DBase is a web-based geothermal database that provides information about specific reports. This is particularly useful in the geothermal industry, especially during drilling projects, where various stakeholders are involved. Users can easily use this database to find out who is involved (for instance, rig contractor, casing providers, well testing services, etc.), when and where projects are happening (well pad, geographic coordinate, spud date, rig release), financial details (total cost, rig cost, tangible items costs, well survey costs, etc.), and access to original project reports. The plotting feature is designed to help users understand the data better, making analyses more accurate.

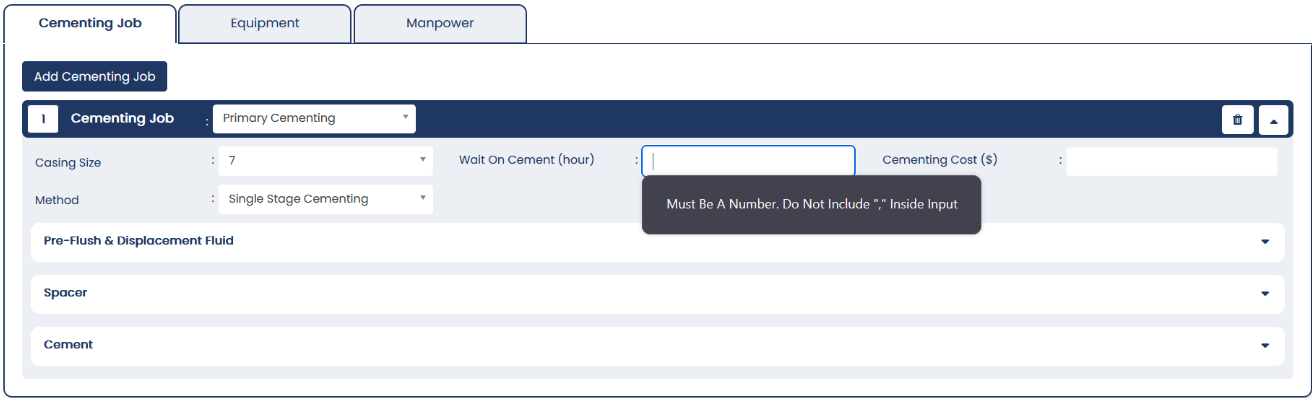


Figure 3: Example of Validation Quality Check in Cementing Sub-Module JIWA DBase.

Figure 4: Example of Plotting Quality Check in Well Trajectory Module JIWA DBase.

3.3 Data Analysis

Upon successfully passing through the quality check process, where the data attains completeness, consistency, and high-quality attributes as a result of undergoing the approval process, subsequent analysis can be facilitated through the consolidation of data into discernible patterns or diagrams. This is accomplished by establishing connections among interrelated data points and leveraging the functionalities of query and data filtering techniques, thus ensuring an optimal and effective approach to visualizing the data. JIWA Dbase can perform analyses on single or multiple wells.

In this paper, we showcase JIWA DBase utilization on offset well data analysis to support cost efficiency, target improvement, and ensure safety in executing future drilling projects.

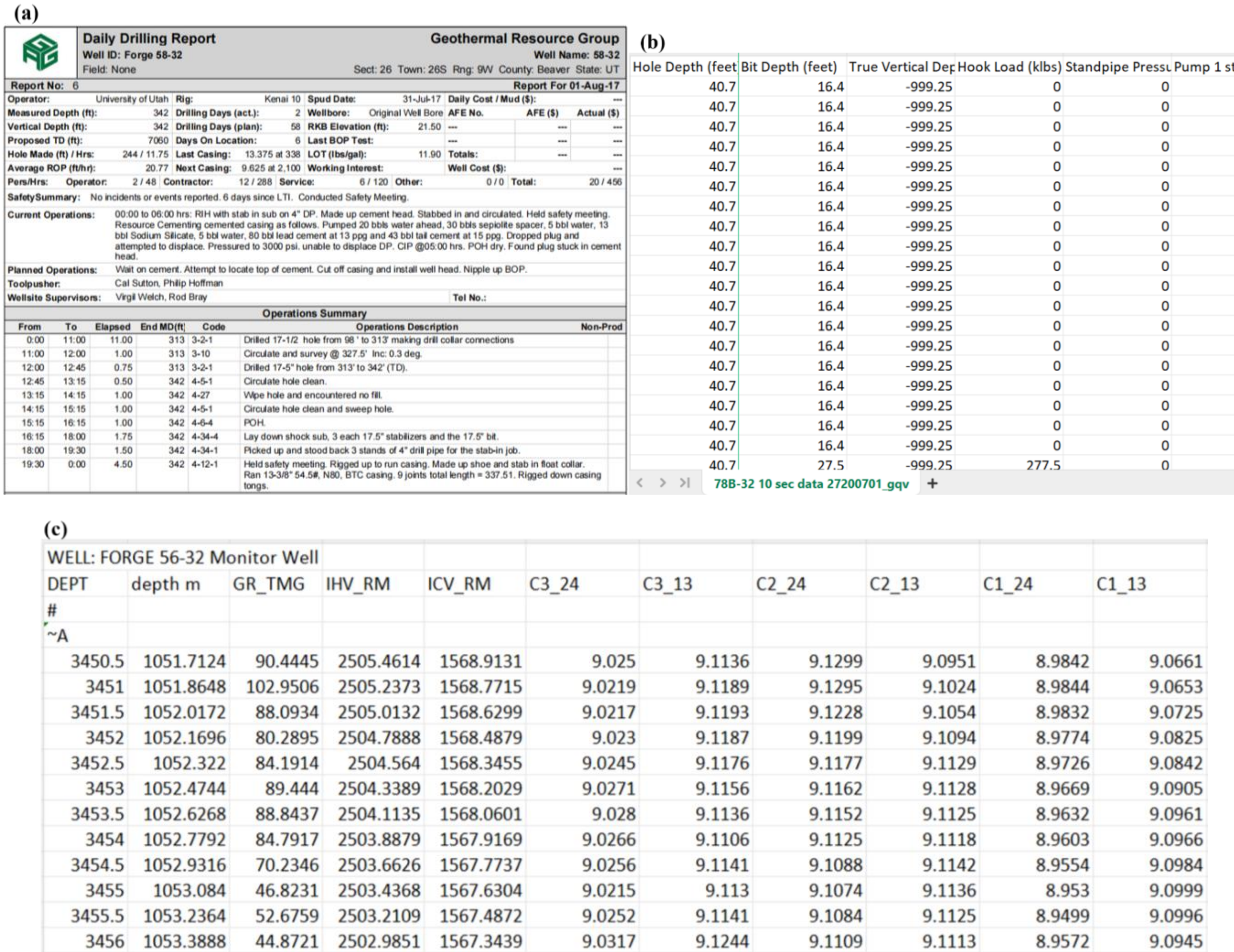
4. FIELD DATA

The FORGE site is located 250 km south of Salt Lake City and 16 km north of Milford. The site covers an area of approximately 5 km2 and is situated within the Utah Renewable Energy Corridor. It includes six drilled wells, namely 56-32 (a deep vertical well), 16A (78)-32 (a highly deviated deep well), and 68-32, 78-32, 78-32B, and 56-32, which serve as seismic monitoring wells. The project area is rural and covers approximately 15.5 miles2. **Figure 5**. shows an aerial view of the surface locations for the Utah FORGE wells (Geothermal Resource Group, Inc., 2021).

Figure 5: Aerial view of the surface locations for the Utah FORGE wells (Geothermal Resource Group, Inc., 2021)

In this paper, the drilling data is sourced from the open-source Geothermal Data Resource (GDR) and Utah FORGE website by taking drilling report data from well 78B-32, 56-32, and 58-32 in the Utah FORGE site due to limitations in data availability.

Caliper log data were collected from well 56-32 in the production section with an 8.75" hole, ranging from a depth of 3450.5 ft to 9127 ft, resulting in six recorded caliper measurements. The operation summary data and well cost are obtained from the operation summary recap and daily cost End of Well Report (EOWR) and Daily Drilling Reports Well 78B-32. Additionally, the drilling parameter data is extracted from the Pason Drilling Parameter Report for well 78B-32 in the surface section with a 22" hole at depth of 128.3 meters (421 feet). Additionally, Operation summary data obtained from Daily Drilling Report Well 58-32, where it reached a total depth of 7,536 ft with an inclination of 2.30° at TD, completing the drilling process in 58 days. Detailed information is presented in **Table 1.** As shown in **Figure 6.** These are examples of drilling data from the End of Well Report, Daily Drilling Reports, drilling parameter data from mud logging and caliper log.



(a)

Daily Drilling Report — Geothermal Resource Group

Well ID: Forge 58-32 — Well Name: 58-32

Field: None — Sect: 26 Town: 26S Rng: 9W County: Beaver State: UT

Report No: 6 — Report For 01-Aug-17

Operator:	University of Utah	Rig:	Kenai 10	Spud Date:	31-Jul-17	Daily Cost / Mud ($):	---
Measured Depth (ft):	342	Drilling Days (act.):	2	Wellbore:	Original Well Bore	AFE No. / AFE ($) / Actual ($)	
Vertical Depth (ft):	342	Drilling Days (plan):	58	RKB Elevation (ft):	21.50	--- / ---	---
Proposed TD (ft):	7060	Days On Location:	6	Last BOP Test:		--- / ---	---
Hole Made (ft) / Hrs:	244 / 11.75	Last Casing:	13.375 at 338	LOT (lbs/gal):	11.90	Totals: ---	---
Average ROP (ft/hr):	20.77	Next Casing:	9.625 at 2,100	Working Interest:		Well Cost ($):	---

Pers/Hrs: Operator: 2 / 48 Contractor: 12 / 288 Service: 6 / 120 Other: 0 / 0 Total: 20 / 456

SafetySummary: No incidents or events reported. 6 days since LTI. Conducted Safety Meeting.

Current Operations: 00:00 to 06:00 hrs: RIH with stab in sub on 4" DP. Made up cement head. Stabbed in and circulated. Held safety meeting. Resource Cementing cemented casing as follows. Pumped 20 bbls water ahead, 30 bbls sepiolite spacer, 5 bbl water, 13 bbl Sodium Silicate, 5 bbl water, 80 bbl lead cement at 13 ppg and 43 bbl tail cement at 15 ppg. Dropped plug and attempted to displace. Pressured to 3000 psi. unable to displace DP. CIP @05:00 hrs. POH dry. Found plug stuck in cement head.

Planned Operations: Wait on cement. Attempt to locate top of cement. Cut off casing and install well head. Nipple up BOP.

Toolpusher: Cal Sutton, Philip Hoffman

Wellsite Supervisors: Virgil Welch, Rod Bray — Tel No.:

Operations Summary

From	To	Elapsed	End MD(ft)	Code	Operations Description	Non-Prod
0:00	11:00	11.00	313	3-2-1	Drilled 17-1/2 hole from 98 ' to 313' making drill collar connections	
11:00	12:00	1.00	313	3-10	Circulate and survey @ 327.5' Inc: 0.3 deg.	
12:00	12:45	0.75	313	3-2-1	Drilled 17-5" hole from 313' to 342' (TD).	
12:45	13:15	0.50	342	4-5-1	Circulate hole clean.	
13:15	14:15	1.00	342	4-27	Wipe hole and encountered no fill.	
14:15	15:15	1.00	342	4-5-1	Circulate hole clean and sweep hole.	
15:15	16:15	1.00	342	4-6-4	POH.	
16:15	18:00	1.75	342	4-34-4	Lay down shock sub, 3 each 17.5" stabilizers and the 17.5" bit.	
18:00	19:30	1.50	342	4-34-1	Picked up and stood back 3 stands of 4" drill pipe for the stab-in job.	
19:30	0:00	4.50	342	4-12-1	Held safety meeting. Rigged up to run casing. Made up shoe and stab in float collar. Ran 13-3/8" 54.5#, N80, BTC casing. 9 joints total length = 337.51. Rigged down casing tongs.	

(b)

Hole Depth (feet	Bit Depth (feet)	True Vertical Dep	Hook Load (klbs)	Standpipe Pressu	Pump 1 st
40.7	16.4	-999.25	0	0	
40.7	16.4	-999.25	0	0	
40.7	16.4	-999.25	0	0	
40.7	16.4	-999.25	0	0	
40.7	16.4	-999.25	0	0	
40.7	16.4	-999.25	0	0	
40.7	16.4	-999.25	0	0	
40.7	16.4	-999.25	0	0	
40.7	16.4	-999.25	0	0	
40.7	16.4	-999.25	0	0	
40.7	16.4	-999.25	0	0	
40.7	16.4	-999.25	0	0	
40.7	16.4	-999.25	0	0	
40.7	16.4	-999.25	0	0	
40.7	16.4	-999.25	0	0	
40.7	16.4	-999.25	0	0	
40.7	16.4	-999.25	0	0	
40.7	16.4	-999.25	0	0	
40.7	16.4	-999.25	0	0	
40.7	27.5	-999.25	277.5	0	

78B-32 10 sec data 27200701_gqv

(c)

WELL: FORGE 56-32 Monitor Well

DEPT	depth m	GR_TMG	IHV_RM	ICV_RM	C3_24	C3_13	C2_24	C2_13	C1_24	C1_13
#										
~A										
3450.5	1051.7124	90.4445	2505.4614	1568.9131	9.025	9.1136	9.1299	9.0951	8.9842	9.0661
3451	1051.8648	102.9506	2505.2373	1568.7715	9.0219	9.1189	9.1295	9.1024	8.9844	9.0653
3451.5	1052.0172	88.0934	2505.0132	1568.6299	9.0217	9.1193	9.1228	9.1054	8.9832	9.0725
3452	1052.1696	80.2895	2504.7888	1568.4879	9.023	9.1187	9.1199	9.1094	8.9774	9.0825
3452.5	1052.322	84.1914	2504.564	1568.3455	9.0245	9.1176	9.1177	9.1129	8.9726	9.0842
3453	1052.4744	89.444	2504.3389	1568.2029	9.0271	9.1156	9.1162	9.1128	8.9669	9.0905
3453.5	1052.6268	88.8437	2504.1135	1568.0601	9.028	9.1136	9.1152	9.1125	8.9632	9.0961
3454	1052.7792	84.7917	2503.8879	1567.9169	9.0266	9.1106	9.1125	9.1118	8.9603	9.0966
3454.5	1052.9316	70.2346	2503.6626	1567.7737	9.0256	9.1141	9.1088	9.1142	8.9554	9.0984
3455	1053.084	46.8231	2503.4368	1567.6304	9.0215	9.113	9.1074	9.1136	8.953	9.0999
3455.5	1053.2364	52.6759	2503.2109	1567.4872	9.0252	9.1141	9.1084	9.1125	8.9499	9.0996
3456	1053.3888	44.8721	2502.9851	1567.3439	9.0317	9.1244	9.1109	9.1113	8.9572	9.0945

Figure 6: The example of (a) Daily Drilling Report of well 58-23, (b) Drilling Parameter of well 78B-32, (c) Caliper data of well 56-32 (Geothermal Resource Group, Inc., 2021)

Table 1: Summary of data used in this paper.

Well	Report or Log	Relevant Information
56-32	Caliper log	Caliper size, Depth, Bit size
58-32	Daily Drilling Reports	Operation summary
78B-32	End of Well Report, Daily Drilling Reports, and Pason drilling parameter	Depth (ft), Torque (psi), ROP (ft/hr), WOB (klbs), RPM, Temperature in & out (degree), Mud Flow in (gpm), SPP (psi), Operation summary and Daily cost

5. RESULT AND DISCUSSION

After the data has been submitted and processed through the drilling module in JIWA DBase, the results obtained from the analyzed data using JIWA Plotting in JIWA DBase are presented.

5.1 Single Well Analysis

Single well analysis in the Drilling module of JIWA DBase is data that can be analyzed in detail manner without any comparison or involvement with other wells. In this study, the data to be evaluated includes Drilling Parameters in the Data Logging Module in JIWA DBase and Well Integrity in the Casing & Cementing Module in JIWA DBase.

5.1.1 Drilling Parameter

The analysis of drilling parameters is performed to assess the selection of bit types, formation evaluation, and determine the optimal Rate of Penetration (ROP). This is intended to ensure that future projects can avoid similar mistakes, enhance efficiency, and reduce both time and costs. **Figure 7.** showed multiple parameter plots, namely, ROP, WOB, RPM, and Torque in the 22" hole of well 78B-32 at 107 to 128.3 m MD. In the plot, the relationship between ROP and WOB is depicted by the red, brown, and blue lines. It shows that ROP and Torque decrease while WOB increases which could indicate poor bottom hole cleaning, this can lead to increased costs of drilling operations and other drilling-related issues. Therefore, to achieve good hole cleaning, it is essential to pay attention to the design of the drilling fluids used. The plot between ROP and RPM reveals that the RPM values tend to remain stable while ROP fluctuates, indicating that when ROP decreases and RPM increases, it may suggest a hard formation. Conversely, if both ROP and RPM increase, it could indicate a soft formation, these indications can be supported by lithology data or cutting results from drilling. Additionally, based on the plot results, there is no significant decrease in ROP or increase in Torque, which might be an indication of a stuck pipe. The RPM values that remain stable can suggest the absence of issues in the wellbore during the operation.

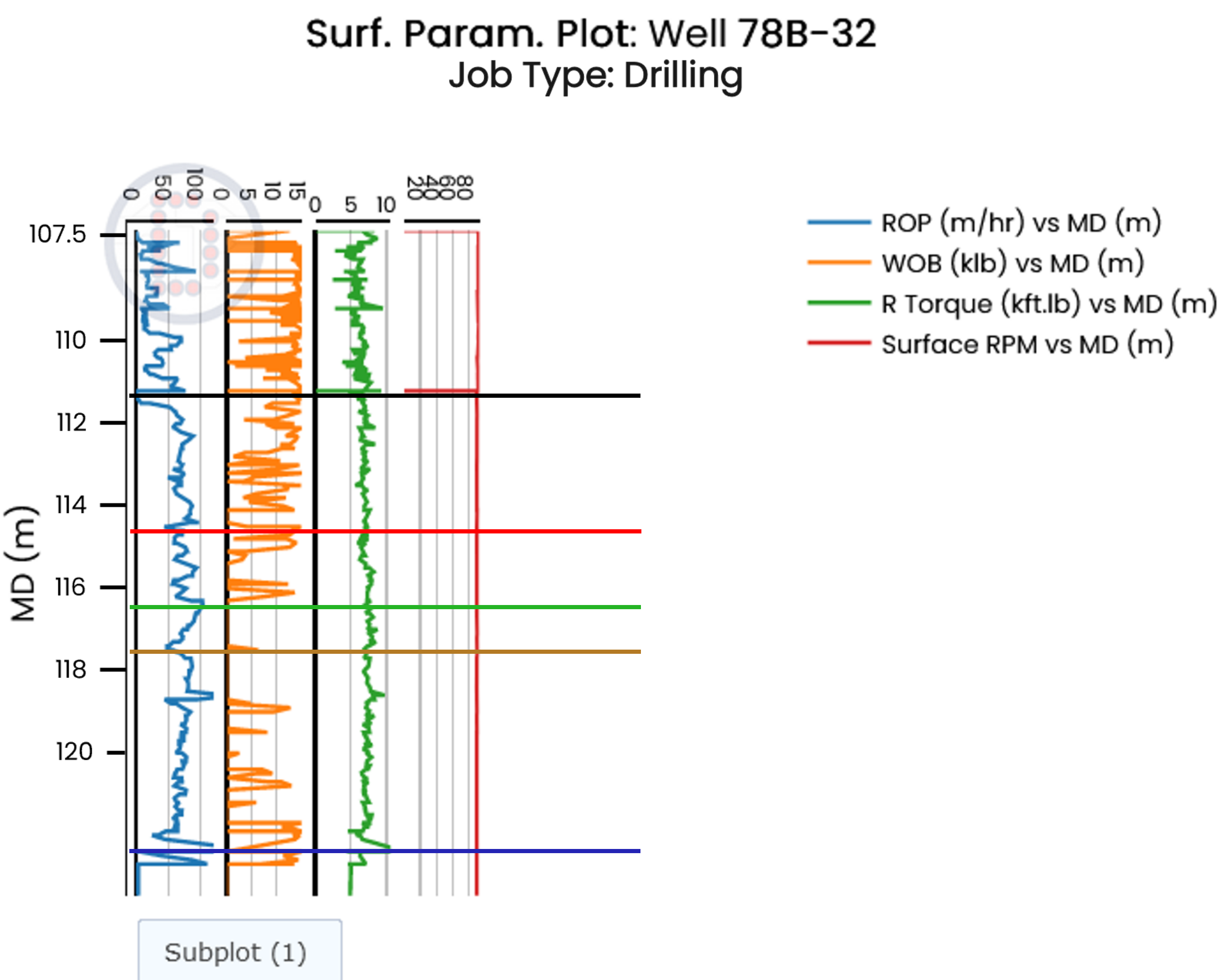


Figure 7: Subplot of Depth vs ROP, WOB, Torque and RPM in holes 22" of well 78B-32 using JIWA Plotting.

In **Figure 8**, it is shown that the boxplot provides a good point representation, allowing us to observe the statistical results from median, max, min to mean, and easily identify outliers from the distribution of each parameter. It is known that the maximum flow rate in the 16" casing at a depth of 39.3 m - 128.3 m is 800 gpm, hence values above 800 gpm can be considered as outliers.

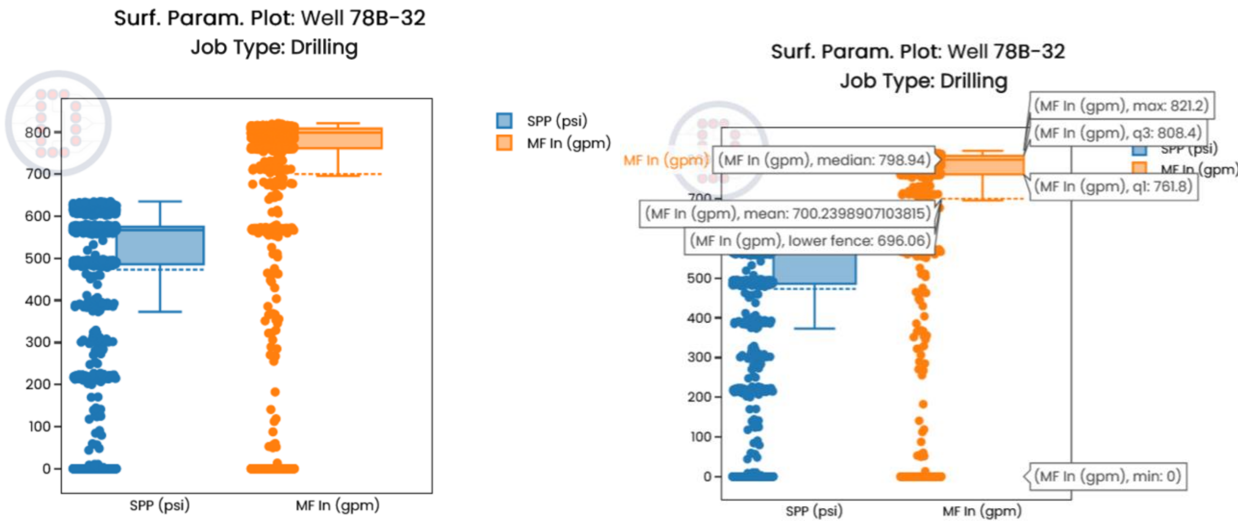


Figure 8: Boxplots for outliers' detection in Mud Flow in and SPP (left), an example of the boxplot values for Mud Flow in (right) in 16" casing well 78B-32 using JIWA Plotting.

In Figure 9, the results of temperature changes in well 78B-32 are displayed. It can be observed that there is an increase in temperature at a depth of 1756 m - 2895.6 m, thus indicating that this depth is typically speculated as a reservoir area during drilling, although further data analysis must be conducted with data integration, especially via a Pressure-Temperature-Spinner (PTS) survey data after drilling is completed. In addition, temperature gradients at several depths below may indicate differences in porosity or fractures in the formation.

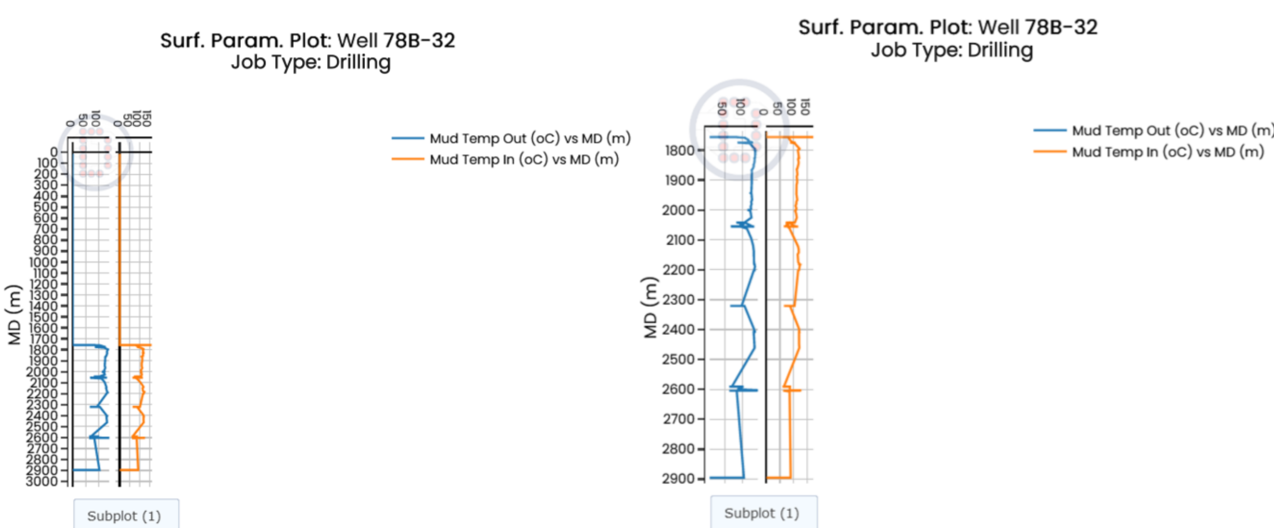


Figure 9: Graphic of Mud Temperature In and Mud Temperature Out at 1756 m - 2895.6 m in well 78B-32 from mud logging using JIWA Plotting.

5.1.2 Well Integrity

The measurement of the caliper in well 56-32 at the 8" open hole section at a depth of 1051.72m - 1219.2 m, a 12-Arm Caliper was used, and six sets of caliper measurement data were obtained in this study. **Figure 10.** shows that there are several size changes exceeding the size of the 8.75" bit used at different depths. These changes are indicated in the six measurement results, suggesting washout in the wellbore and a type of formation prone to collapse. However, this indication must be carefully checked via cutting returns, drilling events, and other relevant data that can be seamlessly integrated with JIWA DBase. This occurs at depths around ±1060 m - 1300m, ±1400m - 1500m, ±1700m - 1800m, and ±2300m -2350m.

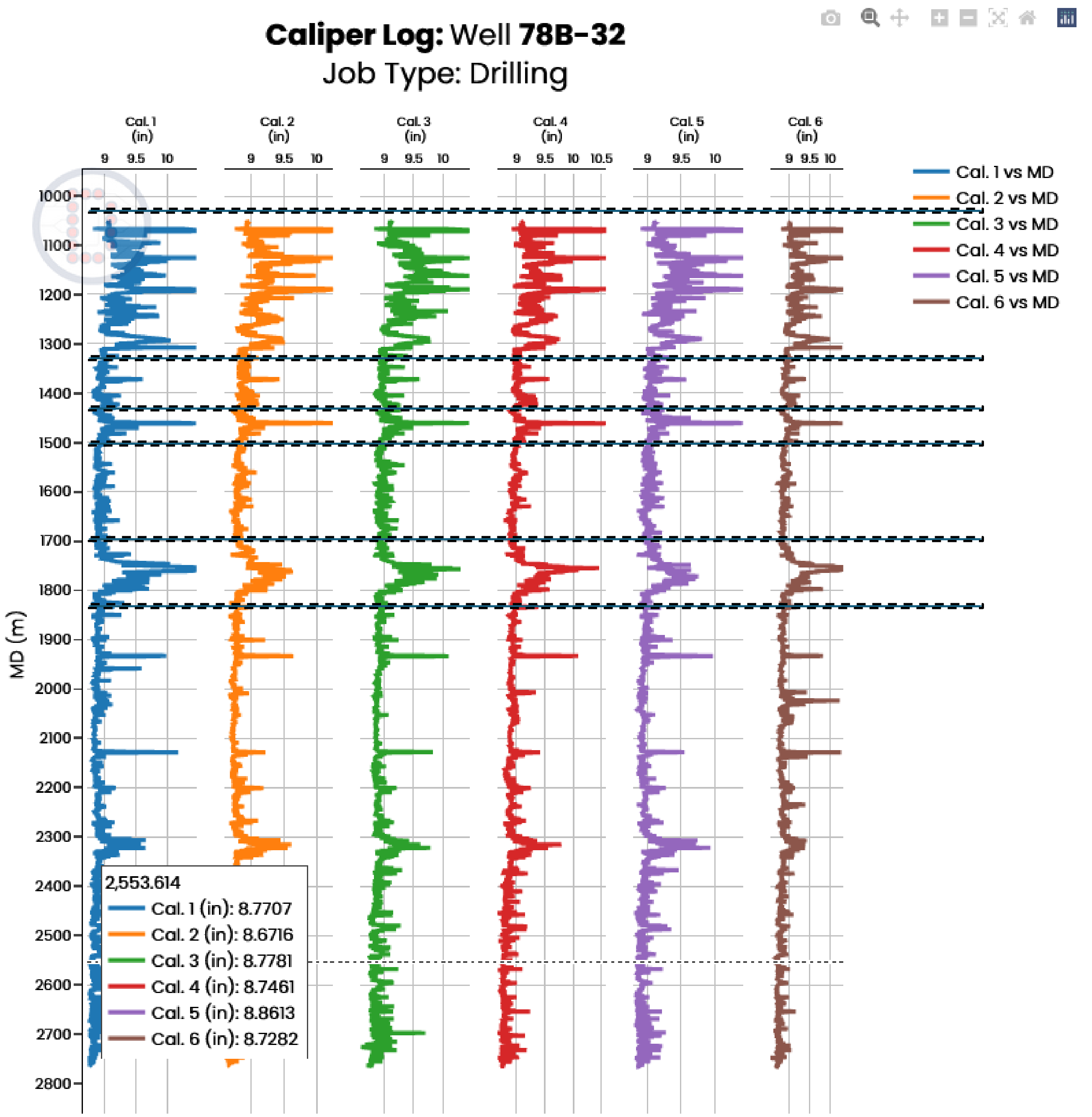


Figure 10: Caliper data plot in 8.5" hole well 56-32 at 1051.72m - 1219.2m.

5.2 Multiple Well Analysis

Field-scale Analysis in the drilling modules involves data that can be evaluated alongside other wells within JIWA DBase. The data can be analyzed by comparing data from each well in various graphical representations. In this study, Multiple wells analysis to be showcased are Operation time and well cost of wells 78B-32 and 58-32 due to data limitations.

5.2.1 Operation Time

Based on **Figure 11.** Well 78B-32 was drilled to a depth of 2895.6 m (9500 ft) and took a total time of 35 days. From the plot, it can be observed that the 10.625-inch hole (casing 7") section took a considerable amount of time compared to other sections, lasting for 24 days. It is noted that at a depth of 2600m, there was a slow rate during operations, taking 10 days due to the installation of fiber optic cable at a depth of 2590.8m (8500 ft) to the surface.

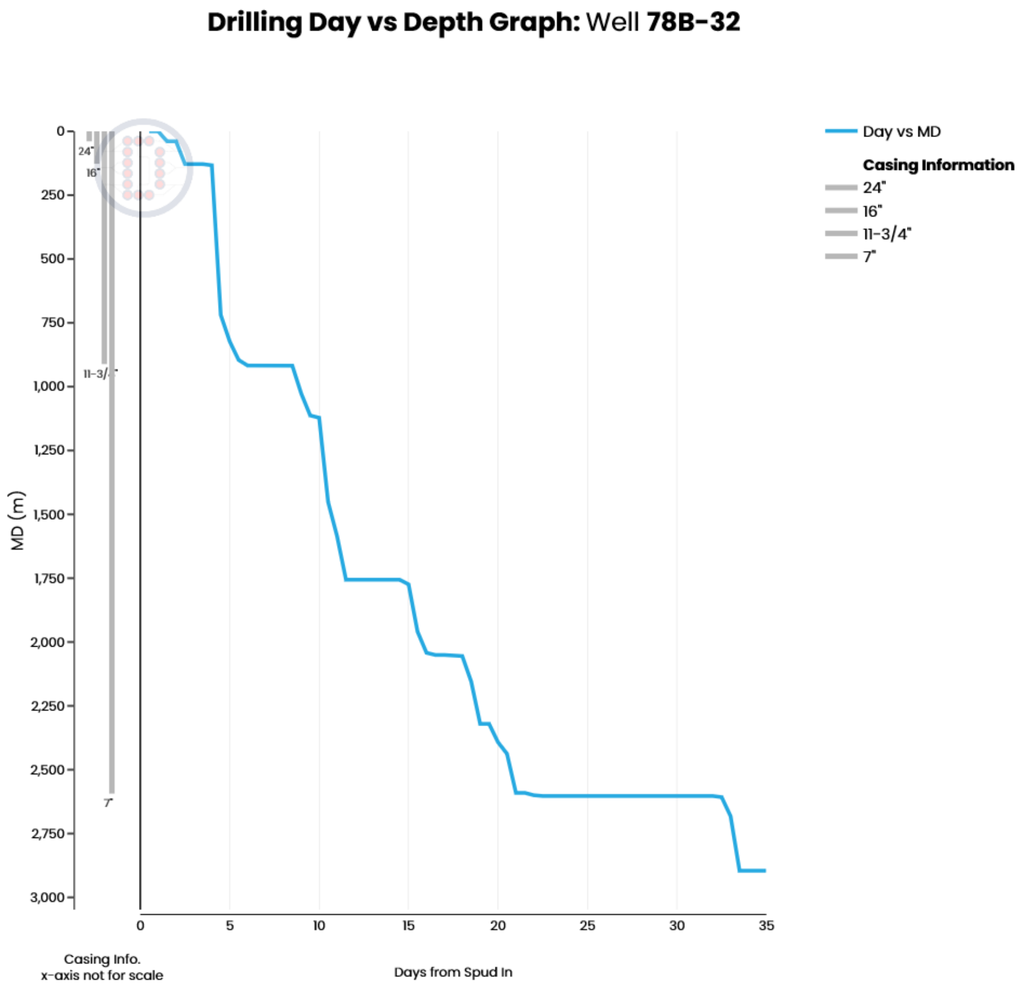


Figure 11: Operation time vs Depth in well 78B-32 using JIWA Plotting

In **Figure 12.** The distribution of total time in the drilling operations of well 78B-32. It is described that the value of job operation mobilization is 24 hours (2.86%), Drilling is 36 hours (4.29%), Reaming is 12 hours (1.43%), Trips is 12 hours (1.43%), Cementing operation is 12 hours (1.43%) and there is an unknown activity (another operation) shown on the chart, which appears to be an anomaly or the presence of missing data in the report as indicated by the JIWA DBase plotting. This unknown activity has the highest value, amounting to 744 hours (88.6 %). Therefore, it is imperative to reevaluate the completeness of the data to ensure that the analyzed data is more accurate.

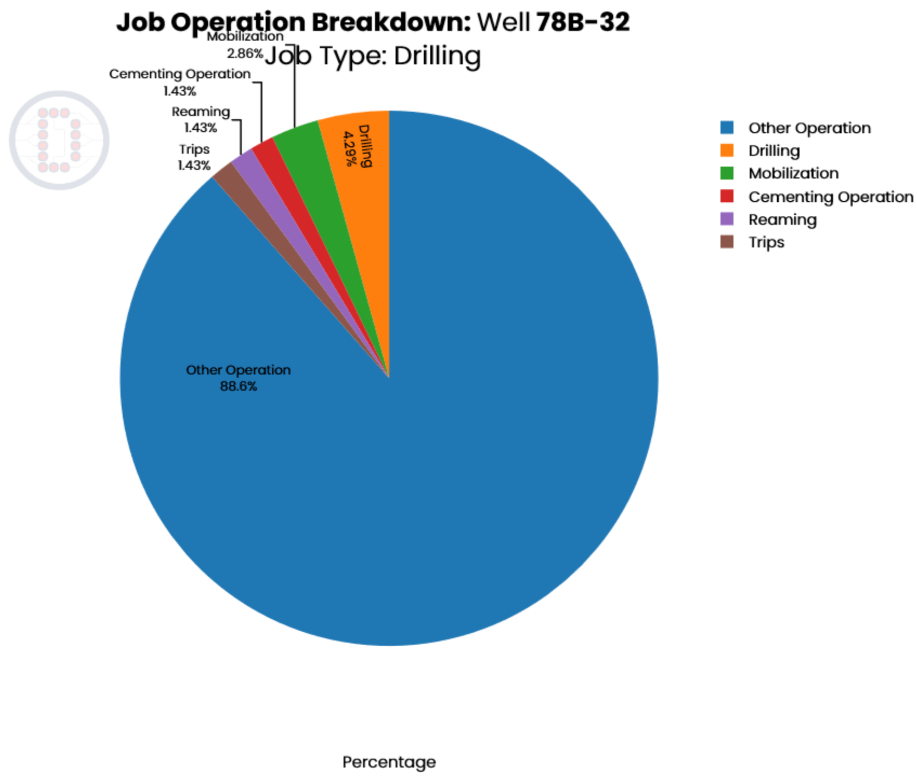


Figure 12: Pie chart operation time based on activity in well 78B-32 using JIWA Plotting

Figure 13. Represents the plotting of the operation time vs elevation (m asl) comparison between well 78B-32 and 58-32 (the previous well). It can be seen that well 78B-32 took less time than the previous well/offset well 58-32. There is a significant difference in the number of days, which can also contribute to reducing the operating costs compared to the previous well.

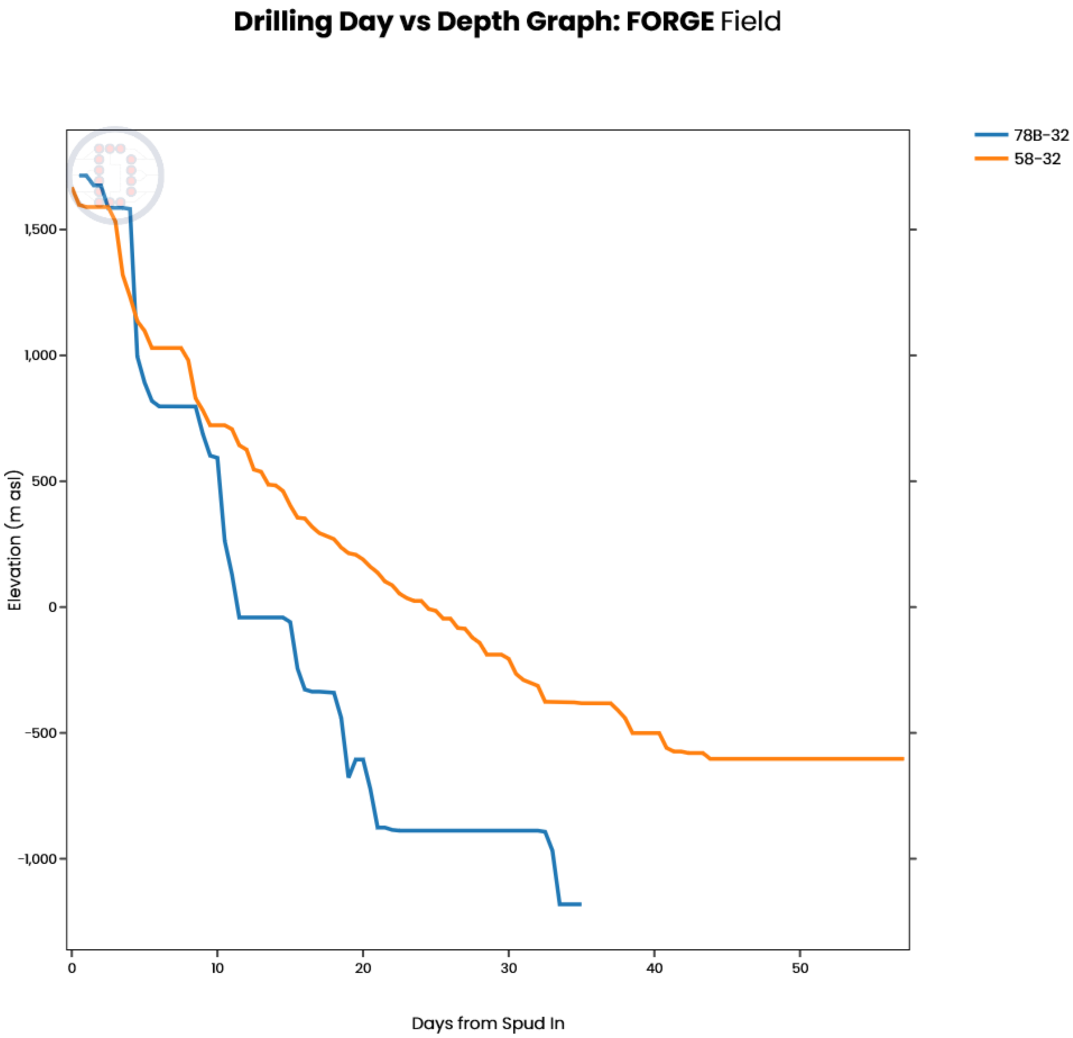


Figure 13: Days from Spud In vs Elevation (m ASL) in wells 78B-32 and 58-32 using JIWA Plotting

5.2.2 Well Cost

Figure 14. represents the cost plotting at each depth in well 78B-32. It is observed that in each section, specifically in Section 4 (casing 7") at the depth of 1027.2 m – 2603 m, the cost is higher compared to other sections. Upon further examination, it is found that at a depth of 2603 m in this section, a significant cost of ±$17,000 was incurred. This is attributed to the installation of fiber optic cable, as supported by the results shown in **Figure 11.** The installation at this depth took 10 days. Therefore, a further evaluation is needed to optimize the operational time effectively, efficiently, and minimize costs of future drilling targets.

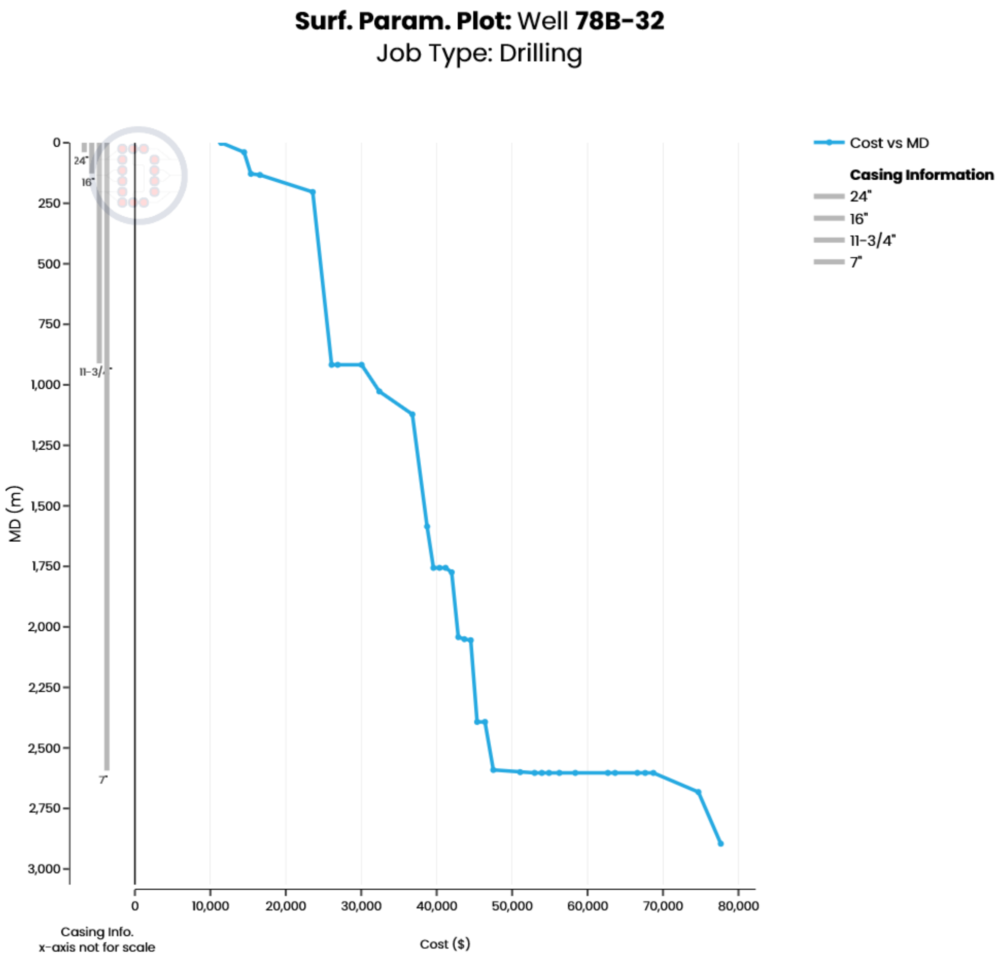


Figure 14: Depth vs Cost of well 78B-32.

6. CONCLUSION

In this paper, multiple drilling data analysis is showcased in JIWA Plotting. Drilling parameters analyzed via a group of scatter lines (subplot) for comparing the relationships between ROP, WOB, Torque, and RPM, and mud temperature analysis in the wellbore. Boxplots were employed to identify anomalies or discrepancies in SPP and Mudflow. Regarding well integrity analysis, a scatter line (composite) with values from six caliper measurements was used. In multiple well analyses, the author evaluated operation time and cost for well 78B-32 using a scatter line and pie chart. A comparison of operation time between wells 58-32 and 78B-32 was also conducted using a scatter line.

The results of each analysis are as follows: In single well analysis, it was found that for well 78B-32, there were no problems in the wellbore during operations, but there were indications of poor bottom hole cleaning from the plot results. The optimum ROP was also obtained, representing the average of the minimum and maximum ROP. Well integrity analysis indicated size widening beyond the bit size, indicating washout in that area, that can be further checked via lithology/formation data at each depth. From the multiple well analysis, it was found that at a depth of 2895.6 m, Section casing 7" for Well 78B-32 had a total drilling time of 35 days. A slow rate was observed at a depth of 2600 m due to the installation of Fiber optic, taking ten days, influencing the operational cost by approximately $17,000, the highest cost among sections. Anomalies or missing data were also identified in the pie chart plot for well 78B-32 using JIWA Plotting as an unknown activity, which had the highest value compared to other activities. Upon comparing the total operation time between well 78B-32 and well 58-32 (the previous well), it was found that well 78B-32 had a faster operation time. Therefore, the comparison with the previous well can assist engineers in further optimizing time and cost for greater efficiency, effectiveness, safety, and cost-effectiveness of future drilling programs. JIWA DBase allows drilling engineers to manage, audit, and analyze geothermal drilling data for handling future exploration, development, or make-up well drilling.

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