Intended for

McMurtrey, Hartsock, Worth & St. Lawrence

Date

December 17, 2025

Phase 2 Responsive Report of Timothy K. Parker PG, CEG, CHG

Indian Wells Valley Basin, California

RAMBOLL Bright ideas. Sustainable change.

Phase 2 Responsive Report of Timothy K. Parker PG, CEG, CHG

Indian Wells Valley Basin, California

Project name	**Indian Wells Valley Litigation Support**
Project no.	**1940115313**
Recipient	**McMurtrey, Hartsock, Worth & St. Lawrence**
Document type	**Final**
Version	**1.0**
Date	**December 17, 2025**
Prepared by	**Timothy K. Parker, PG, CEG, CHG**
Description	**Expert Responsive Report**

Timothy K. Parker, PG, CEG, CHG

Table of Contents

List of Figures

List of Tables

List of Appendices

Acronyms and Abbreviations

2D	two-dimensional
3D	three-dimensional
AEM	airborne electromagnetic
AF	acre-feet
AFY	acre feet per year
Basin	Indian Wells Valley Groundwater Basin
BBRM	Bootstrap-Brute-Force Recharge Model
BCM	Basin Characterization Model
bgs	feet below ground surface
B&C	Brown & Caldwell
District	Indian Wells Valley Water District
DOJ	United States Department of Justice
DRI	Desert Research Institute
DWR	Department of Water Resources
ET	evapotranspiration
GSA	Groundwater Sustainability Agency
GSP	Groundwater Sustainability Plan
HCF	Hydrogeologic Conceptual Framework
HGZ	hydrogeologic zone
IWV	Indian Wells Valley
IWVGA	Indian Wells Valley Groundwater Authority
LAA	Los Angeles Aqueduct
MAF	million-acre feet
MBD	Meadowbrook Dairy
NAWS	Naval Air Weapons Station China Lake
SGMA	Sustainable Groundwater Management Act
S	Storativity
Ss	specific storage
Sy	specific yield
SVM	Searles Valley Minerals Inc.

TWG	Indian Wells Valley Technical Working Group
USGS	United States Geological Survey

Executive Summary

I have been retained as the Technical Consulting Hydrogeologist for the Indian Wells Valley Water District (District) to provide background and context on the basin hydrogeologic analysis conducted by consultants for the District, and provide estimates of safe yield and storage applying state-of-the-art and industry best practices. I have also been retained to review and evaluate the opinions and analyses of other experts in this matter.

The following is a summary of my opinions provided in this expert responsive report. The responsive opinions itemized below are based on (1) review of the affirmative expert reports for Indian Wells Valley Groundwater Authority (IWVGA) (Kincaid 2025), for U.S. Department of Justice representing the U.S. Naval Air Weapons Station China Lake (DOJ-NAWS) (McKenna 2025), for Searles Valley Minerals Inc. (Yeh and Wicks 2025), and for Meadowbrook Dairy (Teasdale 2025), and supporting documents, (2) my education, training, experience, (3) detailed study of the geology and hydrogeology of the Indian Wells Valley (IWV) Basin and surrounding region, (4) evaluation of the specific geological and hydrological characteristics of the pertinent geological formations and geologic structure in the Basin and surrounding region, and (5) other specific resources, materials and tools referred to and identified within this report.

- **Responsive Opinion 1**: The 2025 IWVGA hydrogeologic conceptual model (HCM) and associated 2025 IWVGA model the experts for the IWVGA and DOJ-NAWS rely on does not adequately or accurately represent the IWV Groundwater Basin aquifer system.
- **Responsive Opinion 2**: The water budget is underestimated due to a mountain-front recharge estimate that is unreasonably low, a methodology used that is not applicable, and a flawed calibration with a 2-dimensional (2D) model.
- **Responsive Opinion 3**: The water budget is additionally underestimated as a result of not including incidental recharge.
- **Responsive Opinion 4**: Dr. Kincaid's estimate of recharge for IWV Basin is literature-review-based, not scientifically rigorous and thus unreliable.
- **Responsive Opinion 5**: The storage method is the better approach for safe yield estimate in the Indian Wells Valley.
- **Responsive Opinion 6**: The analogy between the Owens Valley Basin and IWV Basin developed by Dr. McKenna is based on incorrect assumptions and a misunderstanding of the water budget for Owens Valley Basin, and provides an erroneous estimate of recharge for the IWV Basin.
- **Responsive Opinion 7**: Climate change predictions are not considered in safe yield determinations.

In summary, based on my review of the recharge and water budget estimates, and the inadequacies and inaccuracies of the 2025 IWVGA model, the recharge and safe or sustainable yield estimates of Dr. McKenna and Dr. Kincaid are demonstrably low and recommend these metrics should not be relied upon for groundwater management planning decisions, and the 2025 IWVGA model should not be relied for basin management alternatives or to estimate the basin safe yield.

1. Introduction

1.1 Overview

I have been retained by Indian Wells Valley Water District (District) to provide expert testimony in the matter of the groundwater rights adjudication of the Indian Wells Valley Groundwater Basin[1] (IWV Basin, or Basin) (*Mojave Pistachios, LLC; et al. v. Indian Wells Valley Water District; et al., Case No. 30-2021-01187275-CU-OR-CJC*). I submitted my Phase 2 expert report on this matter on August 15, 2025 that presents my affirmative opinions and the technical analyses that support those opinions. This expert responsive report is in response to the opinions and analyses presented in the following expert reports, submitted August 15, 2025:

- Expert Report of Dr. Sean A. McKenna (McKenna 2025). Prepared on behalf of DOJ-NAWS.
- Expert Report of Dr. Todd Kincaid (Kincaid 2025). Prepared for Richards Watson Gershon on behalf of IWVGA.

I have also reviewed the expert reports and opinions from Dr. Vivek Bedekar (Bedekar 2025a), Dr. Matthew Tonkin (Tonkin 2025a), Mr. Eddy Teasdale (Teasdale 2025), and Dr. Johnson Yeh and Ms. Lauren Wicks (Yeh and Wicks 2025).

The opinions presented herein are based on my review of the above-referenced reports and supporting materials, relevant data, and professional judgment. I hold these opinions to a reasonable degree of scientific certainty, though they are subject to change, pending further review of existing and new and ongoing work, documents and data. This responsive report is limited to specific issues identified in the reviewed expert reports and supporting materials and does not necessarily address all technical matters or potential areas of disagreement. I may provide additional comments as further information becomes available or as the case progresses. I further understand that other experts may develop additional opinions and estimates related to this adjudication and I reserve the right to carefully examine and analyze in sufficient detail any materials, models and underlying new data needed to develop updated opinions and responses.

My affirmative report provides details of my experience and professional training, along with my curriculum vitae including a list of publications that I have authored and professional association affiliations. Consistent with my affirmative work, Ramboll is compensated at the hourly rate of $320.00 per hour for my responsive work in this matter.

1.2 Summary of Safe Yield and Water Budget Estimates

To provide context for my responsive opinions and to help highlight and contrast the differences between opinions of the experts for the reader, Table 1-1 below summarizes the safe yield estimates for the IWV Basin as reported in the Phase 2 export reports. Table 1-1 also summarizes the estimates for the main components of the water budget for IWV Basin, as well as some pertinent differences between the groundwater flow models and HCMs. The unshaded area of Table 1-1 represents information of the District, Meadowbrook Dairy (MBD) and Searles Valley Minerals Inc. (SVM) and the dark shaded area represents the information of IWVGA and DOJ-NAWS. The MBD, SVM and District experts Mr. Teasdale, Dr. Yeh and Ms. Wicks, and Mr. Parker, respectively, use the HCM of Ramboll and work products of the Technical Work Group to estimate the IWV Basin

[1] California Department of Water Resources (DWR) Basin No. 6-054.

safe yield based on the groundwater storage change approach. The differences in the groundwater storage change approach include local refinements of specific yield values and groundwater elevation changes in polygons within Meadowbrook Dairy area based on site-specific evaluation and data used by Teasdale (2025), which were not included in the estimates developed by the Technical Work Group used in my Phase 2 expert report (Parker 2025). As an additional approach, the District expert Dr. Tonkin evaluates multiple lines of evidence to come up with an independent estimate of safe yield, relying on the above-referenced reports and information, and also on the work of Dr. Bedekar who has independently and critically reviewed the groundwater flow models identified in Table 1-1.

The District experts, Dr. Tonkin, Dr. Bedekar, and myself, relied on the HCM and groundwater flow model developed by Ramboll for the District (Ramboll 2025; District model) to support evaluation of safe yield in the IWV Basin, while experts for IWVGA and DOJ-NAWS, Dr. Kincaid and Dr. McKenna, relied on the HCM and groundwater flow model developed by the Desert Research Institute (DRI) (Rybarski and Bacon, 2025; 2025 IWVGA model), to support their opinions on recharge and safe yield in the IWV Basin. The estimates of safe yield, water budgets including recharge, groundwater flow models and HCMs differ as outlined below (this is not meant to be all encompassing and additional information is provided in subsequent sections and in the responsive reports of Dr. Tonkin and Dr. Bedekar).

- There have been a minimum of three groundwater flow model versions of the Indian Wells Valley Groundwater Basin developed by DRI for the U.S. Naval Air Weapons Station (NAWS), or a combination of NAWS and IWVGA that are listed below. The District began requesting access to these models early in the Groundwater Sustainability Plan (GSP) preparation process, and when it finally became evident that access would not be provided, the District contracted with Ramboll to prepare a groundwater flow model for its own use (Ramboll 2025 – District model).
    - 2016 McGraw et al. (2016 NAWS model)
    - 2020 Pohlmann et al. (2020 IWVGA model)
    - 2025 Rybarski and Bacon (2025 IWVGA model)
- The simulation period is 1912-2022 for the 2025 IWVGA model (Rybarski and Bacon 2025) and 1980-2023 for the District model (Ramboll 2025). Observed water levels for calibration are mostly available starting in 1980, except in two monitoring wells used by Rybarski and Bacon (Attachment 3 in Rybarski and Bacon 2025).
- The estimates of safe yield for Mr. Parker (on behalf of the District), Mr. Teasdale (on behalf of MBD) and Dr. Yeh and Ms. Wick (on behalf of SVM) rely on the groundwater storage change method using the most recent ten-year period of data on water levels, area and aquifer parameters, while Dr. Tonkin uses these analyses, the District model and other factors for his safe yield estimate. The experts Dr. Kincaid (on behalf of IWVGA) and Dr. McKenna (on behalf of DOJ-NAWS) use the recharge estimate from McGraw et al. (2016) based on the Bootstrap Brute-Force Recharge Model (BBRM – Epstein et al. 2010) and historic, literature-based values to estimate safe yield on the basis of natural recharge, but do not acknowledge the recharge estimate using the U.S. Geological Survey (USGS) Basin Characterization Model (BCM) prepared under contract to an IWVGA member, except to lump it into the literature review performed by Dr. Kincaid.

- The mountain-front recharge in the 2025 IWVGA model is significantly lower than in the District model. The empirical BBRM used to initially estimate mountain-front recharge in the 2025 IWVGA model is not best available science and how the estimated recharge amount was reduced and distributed is undocumented (see Sections 2.2.2 and 2.2.3). The District model applies mountain-front recharge derived from the USGS BCM, a best available science process-based, physically informed hydrologic model designed to simulate the full water balance, and recommended and endorsed by the California Department of Water Resources (DWR).
- The 2025 IWVGA model only considers mountain-front recharge and underflow from Rose Valley Basin as sources of recharge, ignoring other significant 'incidental' sources of recharge such as return flow from agricultural and urban irrigation, and leakage from urban water system supply and the Los Angeles Aqueduct. In contrast, the District model relies on a comprehensive conceptual water balance including incidental recharge sources, consistent with best modeling practices (see Section 2.3).
- The total recharge estimates are considerably different between the 2025 District and 2025 IWVGA models, as a result of significant differences in mountain-front recharge estimates, small difference in Rose Vally Basin underflow, incidental recharge included or not, and estimates of evapotranspiration (ET).
- The pumping discharge volumes are relatively similar for all the experts, although data uncertainty was a factor in the IWV Technical Work Group selecting 1980 through 2023 for the flow model period, and 2014 through 2023 for the groundwater storage change method. California Sustainable groundwater Management Act (SGMA) was signed into law in 2014 and basin hydrologic data collection became more concentrated and focused to address state mandates. Note that historical hydrologic datasets generally have higher uncertainty the older they are due to less sophisticated measurement techniques, sparse data collection networks, limited data preservation, and potentially significant human modifications to the environment over time, factors that combine to make older data inherently less precise and reliable than modern records.
- ET estimates are significantly different between the 2025 IWVGA and District models. The 2025 IWVGA model assumes ET to decrease from 7,600 acre-feet per year (AFY) in water year 1921 to 4,122 AFY in water year 2022 using mapped vegetation and extinction depths and estimated ET rates; the basis for this is the assumption that predevelopment ET in 1920 must equal basin recharge (McGraw et al. 2016), which is estimated from the BBRM and then reduced and distributed in an undocumented two-dimensional (2D) flow model and then applied in the three-dimensional (3D) flow model. The District model independently used a combination of the mapped vegetation and groundwater model flooded cells to apply ET rates, cross referenced with OpenET, and did not consider estimated recharge as part of the analysis.
- The average storativity and distribution differs significantly in the 2025 IWVGA and Ramboll models, at 0.21 and 0.13 respectively. The 2025 IWVGA model storativity values are representative of unconfined aquifer conditions throughout the simulated aquifer system, including beneath the thick clay aquitard confining unit. The Ramboll model storativity values represent both shallow unconfined and deeper confined aquifer conditions, more typical of aquifer system characteristics in an alluvial basin.
- The 2025 IWVGA model is thinner (i.e., less deep) than the District model apparently due to use of a regional study applying gravity data to estimate thickness of unconsolidated

sediments, only considering unconsolidated sediments as part of the aquifer system, and not fully considering all the extensive datasets available in the Basin (see Section 2.1.2). The total volume of the District model is 577 million acre-feet (MAF) vs. 416 MAF and 340 MAF of total volume for the 2025 IWVGA model with and without the areas representing bedrock, respectively.

- The HCMs forming the foundation for the groundwater flow models differ significantly. The District HCM (Ramboll 2019, 2024) takes into account all the available basin well completion reports and associated data (lithology, geophysical logs, aquifer tests, etc.), water level data, water quality data, 2D seismic reflection survey data collected in 1982, 1986, 1992 and 2020, and airborne electromagnetic surveys conducted in 2017 and 2023. It is unclear what datasets were used in 2016 NAWS model (McGraw et al. 2016) and 2020 IWVGA model (Pohlmann et al. 2020) for developing the IWVGA foundational HCMs; the thick lacustrine clay recognized in the previous work of DRI for DOJ-NAWS was not included in these models. Rybarski and Bacon (2025) adds the thick Pleistocene lacustrine clay feature and compartmentalizes the clay with numerous faults with two of the faults affecting groundwater flow.

Finally, the 2016 NAWS model has been updated twice, in 2020 as part of the GSP process with the 2020 IWVGA model (Pohlmann et al. 2020) and then the 2025 IWVGA model (Rybarski and Bacon 2025), with major updates including the model geometry (2025 model volume is 37% less than 2020 model volume, Rybarski and Bacon 2025), hydraulic property distribution, fault distribution and characteristics, ET zone extent and rate, and redistribution of mountain-front recharge along the basin boundaries. However, despite those significant updates to the model, the total amount of recharge has remained unchanged since 2016 at 7,650 AFY. It is worth noting that the recharge has remained unchanged even though one of the IWVGA members, Kern County, contracted with the USGS in 2017 to conduct an independent IWV-specific evaluation of natural recharge under a state grant funded by DWR, and results from this study indicate higher mountain-front recharge of 8,650 AFY than IWVGA estimates of 5,250 and 5,731 AFY (see Section 2.4.3.1).

Table 1-1: Summary of Safe Yield Estimates and Water Budget Components

Entity	Expert	**Model Calibration Period** - Safe Yield Period	Estimated Safe Yield (AFY)	Mountain-Front Recharge (AFY)	Rose Valley Interbasin Flow/ Mountain-Front Recharge (AFY)	Incidental Recharge (AFY)	Total Recharge (AFY)	Pumping Discharge (AFY)	Evapotranspiration Discharge (AFY)	Storativity	Model Volume (MAF)	Hydrogeologic Conceptual Model
MBD	Teasdale	2014-2023	15,400	NA	NA	NA	NA	23,900	4,500 - 4,600	Ave 0.13	577	Detailed basin geometry and aquifer parameters from borehole lithology, AEM and seismic datasets, includes major faults
SVM	Yeh and Wicks		15,400	NA	NA	NA	NA	23,900				
District	Parker	2014-2023	14,300	NA	NA	NA	NA	23,900	NA			
	2025 Model*	**1986-2023**	NA	8,200	2,600	2,500	13,300	24,100	2,300 - 1,600			
	Tonkin	1980-2023	12,300-14,400	9,200	2,600	2,600	14,400	23,500	2,300 - 1,600			
IWVGA / DOJ-NAWS	**2016 Model****	**1920-2013**	NA	5,250	2,400	0	7,650	12,300 (1960-1974) 23,300 (1975-2013)	3,300 - 6,800	Ave 0.22	432	Relatively homogeneous aquifer parameters, no major faults
	2020 Model***	**1920-2016**	NA	5,250	2,400	0	7,650	13,700 (1960-1974) 24,300 (1975-2016)	2,852 - 7,600	Ave 0.225	660^^	More heterogeneous aquifer parameters, added major faults
	2025 Model^	**1912-2022**	NA	5,731	1,919	0	7,650	13,147 (1960-1974) 26,033 (1975-2016)	4,122 - 7,600	Ave 0.21	416 (with bedrock) 340 (without bedrock)	Added compartmentalized thick Pleistocene lacustrine clay and more faults, adjusted aquifer parameters
	Kincaid	Undefined	6,100 - 8,400	NA	NA	0	7,200 –9,900	NA	NA			
	McKenna	Undefined	< 7,650	NA	NA	0	4,300 – 6,355 7,462 – 8,745 7,650	NA	4,000			

AFY = acre-feet per year; MAF = million acre-feet; MBD = Meadowbrook Dairy; NA = Not applicable / Not available. SVM = Searles Valley Minerals Inc.

*Ramboll, 2025. **McGraw et al. 2016. ***Pohlmann et al. 2020. ^Rybarski and Bacon 2025. ^^ 660 MAF from Rybarski and Bacon (2025), 432 MAF from volume calculated based on model files.

2. Responsive Opinions

2.1 Responsive Opinion 1: The 2025 IWVGA HCM and Associated Model Do Not Adequately or Accurately Represent the Indian Wells Valley Groundwater Basin Aquifer System

The 2025 IWVGA HCM and associated model documented in Rybarski and Bacon (2025) do not adequately or accurately represent the IWV Basin aquifer system for the following reasons:

- The IWV aquifer system extends deeper and has overall lower storativity than represented by the 2025 IWVGA model as a result of relying on a regional gravity model and not fully considering the extensive basin datasets available, respectively (Responsive Opinion 1).
- The water budget is underestimated due to:
  (1) using a simplistic, empirical methodology to estimate total mountain-front recharge that is not applicable to the Basin and an undocumented, scientifically indefensible approach to distribute and reduce estimated recharge (see Responsive Opinion 2),
  (2) not including incidental recharge in the water budget (see Responsive Opinion 3), and
  (3) separately using a scientifically non-rigorous approach based on literature that is unreliable (see Responsive Opinion 4).

The correction to the 2025 IWVGA HCM and model to incorporate the relatively thick Pleistocene lacustrine clay in the north half of the Basin is a good improvement that captures the work of the 1992 Indian Wells Valley Groundwater Project, a cooperative effort of the U.S. Bureau of Reclamation, Indian Wells Valley Water District, Searles Valley Minerals Inc. (formerly North American Chemical Company), and Naval Air Weapons Station (Monastero et al. 2002, and Tetra Tech EM, Inc. 2003). How the distribution of aquifer parameters (hydraulic conductivity and specific yield/specific storage) outside of the Pleistocene lacustrine clay were decided in the HCM for the initial values in the 2016, 2020 and 2025 NAWS/IWVGA models is still not clear, and we do not agree with the estimated recharge or aquifer parameters applied therein.

2.1.1 Incorporation of Thick Pleistocene Lacustrine Clay into 2025 IWVGA Model

We appreciate the detailed work of Rybarski and Bacon (2025) in refining the extent of the Pleistocene lacustrine clay in the northern half IWV Basin as part of the second update to the 2016 NAWS groundwater flow model, and we have not been able to fully evaluate that work in the given time. However, as accepted by all experts, the majority of the recharge in the IWV Basin occurs along the mountain-fronts into alluvial deposits, and most of that recharge originates from the Sierra Nevada Mountains. Nearly all the pumping in the IWV Basin occurs not in the Pleistocene lacustrine clay but in coarse grained alluvial, fluvial and delta sediments that underlie and run north-south along the west side and east-west to the south of the extent of the Pleistocene lacustrine clay.

2.1.2 Determination of Unconsolidated Sediments by Regional Gravity Methods Compared to Local Datasets

Rybarski and Bacon (2025) rely on the USGS report (Shah and Boyd 2018) based on regional scale gravity data to interpret the thickness of unconsolidated sediments in the IWV Basin, despite the fact that borehole lithology and borehole geophysical data combined with 2D seismic reflection

survey results are available in IWV to make such determinations (Figure 2-1). Gravity data is sensitive to density contrasts and not directly to sediment consolidation; further, consolidation typically occurs gradually and is not a sharp change that would result in a density contrast that could be "visible" to a gravity survey (Blakely 1995; Lowrie 2007; Telford et al. 1990).

Additionally, Shah and Boyd (2018) recognized a limitation of the study to identify the unconsolidated sediments thickness (emphasis added): "*However, because only the upper two layers have density contrasts large enough to represent unconsolidated sediments, we capped the sediment thickness at 600 m [meters]. Deeper model layers* ***are assumed*** *to represent sedimentary bedrock*." (Shah and Boyd 2018). Therefore, the use of the unconsolidated thickness of 600 meters from Shah and Boyd 2018, as applied in Figure 2-7 in Rybarski and Bacon (2025), may be misleading in terms of the actual thickness of unconsolidated sediment in the IWV.

Shah and Boyd (2018) also defines the term unconsolidated sediment to differentiate from consolidated sediment as follows: "*The surficial layer of unconsolidated sediments can generally be thought of as sedimentary deposits that have not yet lithified into sedimentary rock*." Monastero et al. (2002) identifies the depth to lithified sediments on the basis of the Schlumberger geophysical log for the borehole SNORT 1, completed in granitic basement at a depth of 7,300 feet (2,225 meters) below ground surface: "*The steady increase in velocity beginning at 1,550 meters (5,085 feet) and continuing to 1,658 meters (5,439 feet) marks the top of the Ricardo Group rocks. The relatively high velocities of the rocks from that point to the bottom of the log indicate a significant amount of lithification*" (Figure 2-2). In layman's terms, the interpretation of Monastero et al. is that sediments in borehole SNORT 1 are consolidated beginning at approximately 5,000 feet (1,550 meters) below ground surface based on hard data collected in the IWV basin.

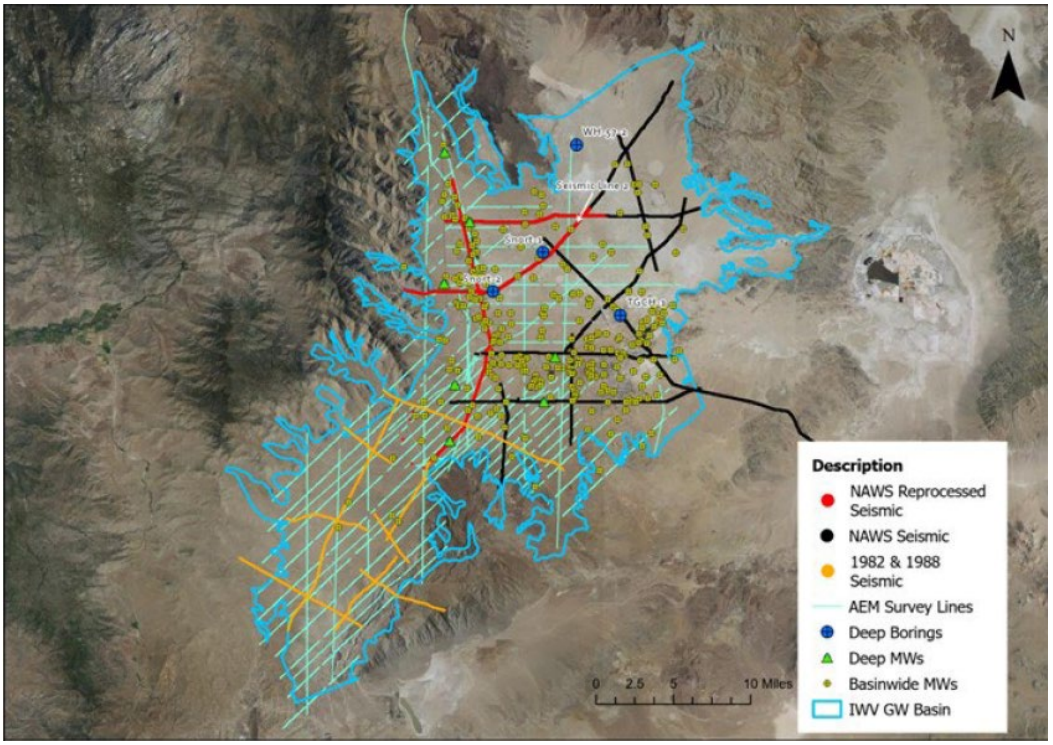


Figure 2-1: Locations and Distribution of Data Available in IWV Basin to Support Evaluation of Unconsolidated Sediment Thickness

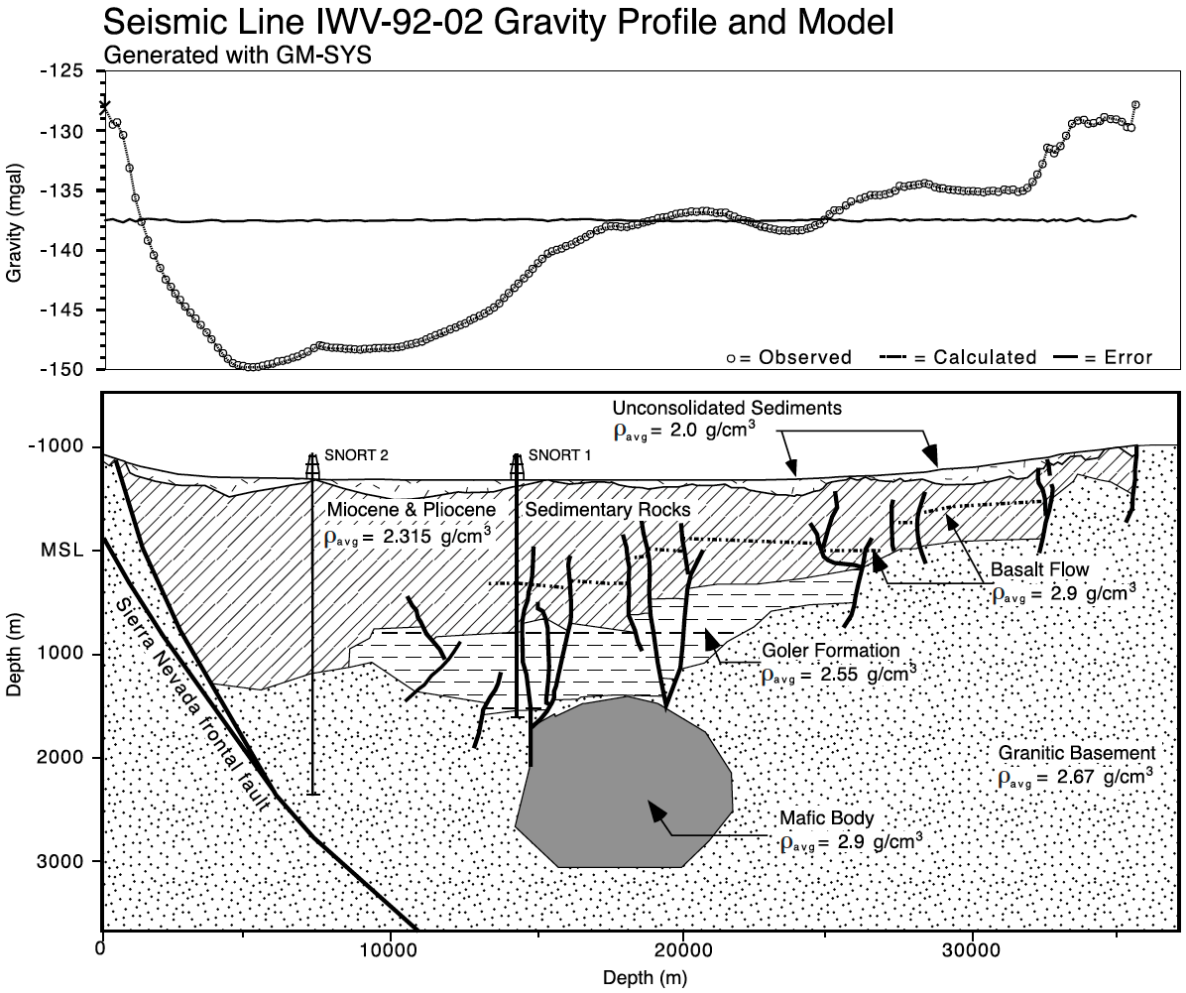


Figure 2-2: Seismic Line IWV-92-02 (from Monastero et al. 2002)

This gravity profile coincides with the location of seismic line IWV-92-02, and illustrates how the underlying geology, in this case the mafic body at depth, can affect the gravity results and interpretation. Modeling was done with GM-SYS software. Densities were derived from samples taken in cores from TGCH 1, SNORT 1, and SNORT 2 and are, in some cases, average densities for thicker sequences. Locations of faults and approximate thickness of sedimentary sections were taken from the interpreted reflection seismic profile. Circles in the upper part of the figure represent actual gravity measurements; the solid line running through the circles is the resulting gravity profile derived from the model (bottom cross section).

Monastero et al. (2002) also comments on the SNORT 2 borehole completed to a depth of 10,000 feet (3,048 meters) below ground surface that encountered granitic basement at 6,550 feet (1,996 meters) below ground surface: "*It is noteworthy that in SNORT 2 there are no occurrences of red or reddish-brown rocks, nor any well-lithified rocks at all, that could be correlated with rocks of either the Goler or Cudahy Camp Formations. In fact, other than the basement itself and basement clasts in the breccia layers there was little competent rock encountered in the hole during drilling. This circumstance indicates that older rocks were either never deposited in this location or they were eroded subsequent to deposition*." In layman's terms, sediments in the borehole SNORT 2 appear to not be consolidated to the total depth of 6,550 feet (1,995 meters). Lithology log for SNORT 2 is provided in Appendix 1.

Productive aquifer systems can be composed of unconsolidated, semi-consolidated and consolidated sediments; the more consolidated the sediments, the less water that they may store and produce, depending upon a number of variables. As provided above, the hydrogeologic data and information available in the IWV Basin suggests that the aquifer system is very deep (SNORT 2), down to granitic basement in part of the Basin, and contains productive sands with depth that vary spatially. Acknowledging that these porous units may be variably unconsolidated and semi-consolidated, they are still saturated sediments that are part of the aquifer system that should not be discounted on the basis of defining whether or not they are unconsolidated from a regional gravity study.

2.1.3 The Limited Aquifer System Thickness, High Storativity and Low Estimated Recharge Do Not Accurately Represent the Physical System, Yet the Model Still Can Be Calibrated

The limited thickness of unconsolidated sediments used in Rybarski and Bacon (2025) as the basis for the 2025 IWVGA groundwater flow model results in underestimating the transmissivity of IWV Basin. Figure 2-3 illustrates a comparison of the transmissivity of the IWV Basin in the 2025 IWVGA and District models. The difference in transmissivity between the two models also helps explain how both models can be reasonably well calibrated based on calibration metrics with different conceptual water balance, including total recharge.

Additionally, the storativity parameters (specific yield in this case assumes the aquifer system is unconfined) are overestimated in the 2025 IWVGA model, which again helps explain how both the models can be reasonably well calibrated based on calibration metrics with different conceptual water balance, including underestimated recharge. Underestimating recharge by itself should result in the groundwater flow model simulating greater declines in groundwater elevations than measured groundwater levels in wells. Alternatively, overestimating storativity by itself should result in the groundwater flow model simulating lesser declines in groundwater elevations than measured groundwater levels in wells. The combination of underestimating recharge and overestimating storage parameters mean the modeled groundwater levels may be brought into balance to closely simulate measured groundwater levels through calibration. The storativity distribution is shown in Figure 2-4. See also Section 2.2 and Figure 2-8, and the expert responsive reports of Dr. Tonkin and Dr. Bedekar for more specific information on issues with the IWVGA models related to recharge, aquifer parameterization and calibration.

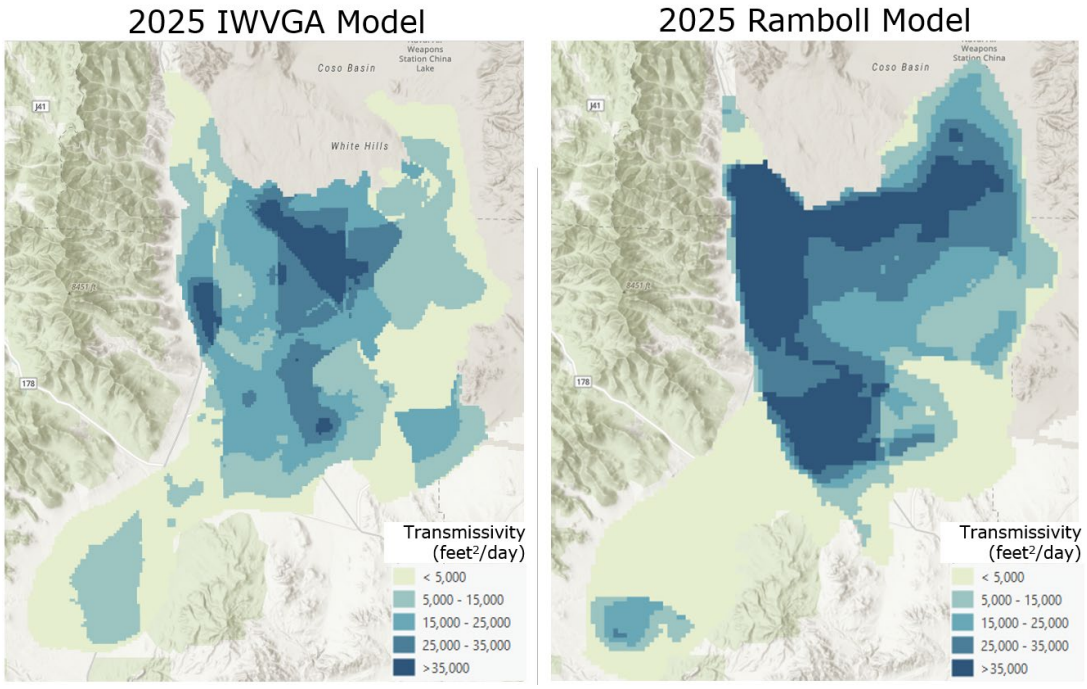


Figure 2-3: Comparison of Transmissivity Distribution in 2025 IWVGA model (Rybarski and Bacon 2025) and 2025 Ramboll model (Ramboll 2025)
Transmissivity is calculated based on initial saturated thickness and hydraulic conductivity for the cells in which the water table is located, and based on cell thickness and hydraulic conductivity for other cells.

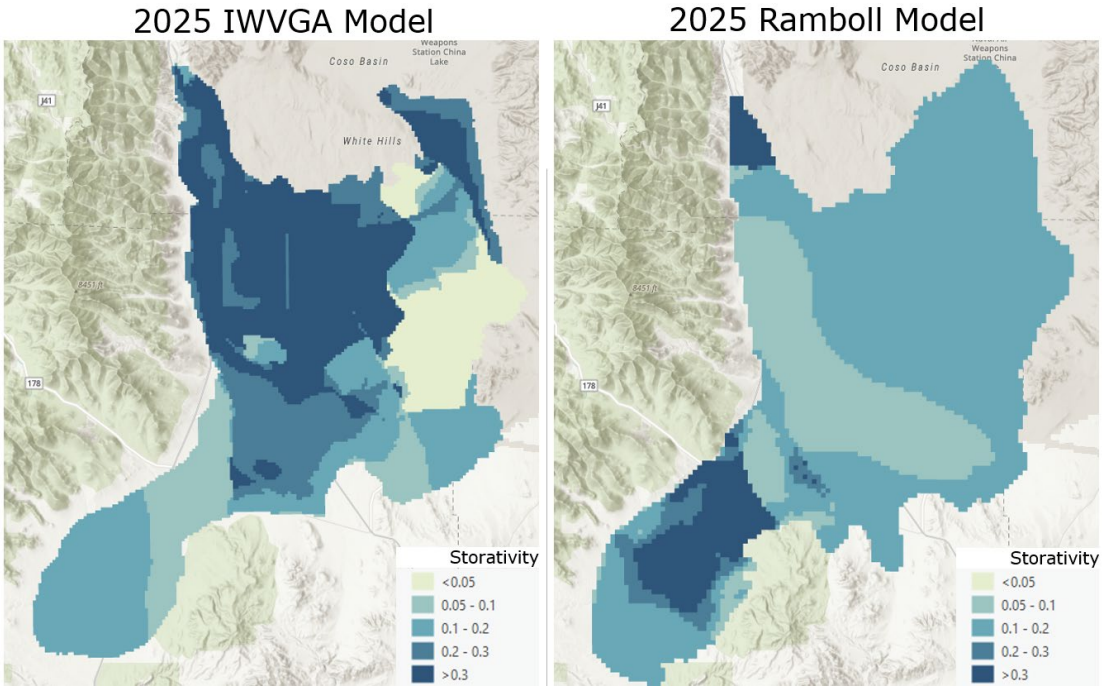


Figure 2-4: Comparison of Storativity Distribution in 2025 IWVGA model (Rybarski and Bacon 2025) and 2025 Ramboll model (Ramboll 2025)
Storativity is calculated based on specific yield, specific storage and initial saturated thickness for the cells in which the water table is located and based specific storage and cell thickness for other cells.

2.1.4 Ramboll Approach to HCM and Aquifer Parameterization Representing the Physical System

For development of the Ramboll HCM that formed the basis for the initial hydraulic conductivity and specific yield distribution in the groundwater flow model, net sand and net clay percentages for each hydrogeologic zone (HGZ) were calculated from interpretation of available detailed well completion report lithologic descriptions, available geophysical logs and aquifer test results for HGZ1 and HGZ2, and from the reprocessed seismic lines for HGZ3 and HGZ4 (Figure 2-1). This information was used to qualitatively assess the appropriate hydraulic conductivity and specific yield range for each HGZ. To determine the percentage sand from the lithology logs, lithologic descriptions were divided into three categories: coarse, mixed sediments, and fine. Coarse sediments included descriptions where sand, gravel or cobble is the descriptor in the lithology logs. Fine sediments included descriptions where clay or silt is the descriptor. Mixed lithology has both coarse and fine sediments in the descriptor. The well lithologic data are supplemented with interpretation of 61 geophysical logs, where the resistivity logs are used to determine where the layers consist of predominantly sand (resistivities over 30 ohmm). In areas where total dissolved solids are above 1,000 milligrams per liter, the resistivity is too greatly influenced by the salinity and not included in the analysis – this includes most of the subsurface area occupied by the thick Pleistocene lacustrine clay. Figure 2-5 shows an example of how the lithology and resistivity logs were interpreted.

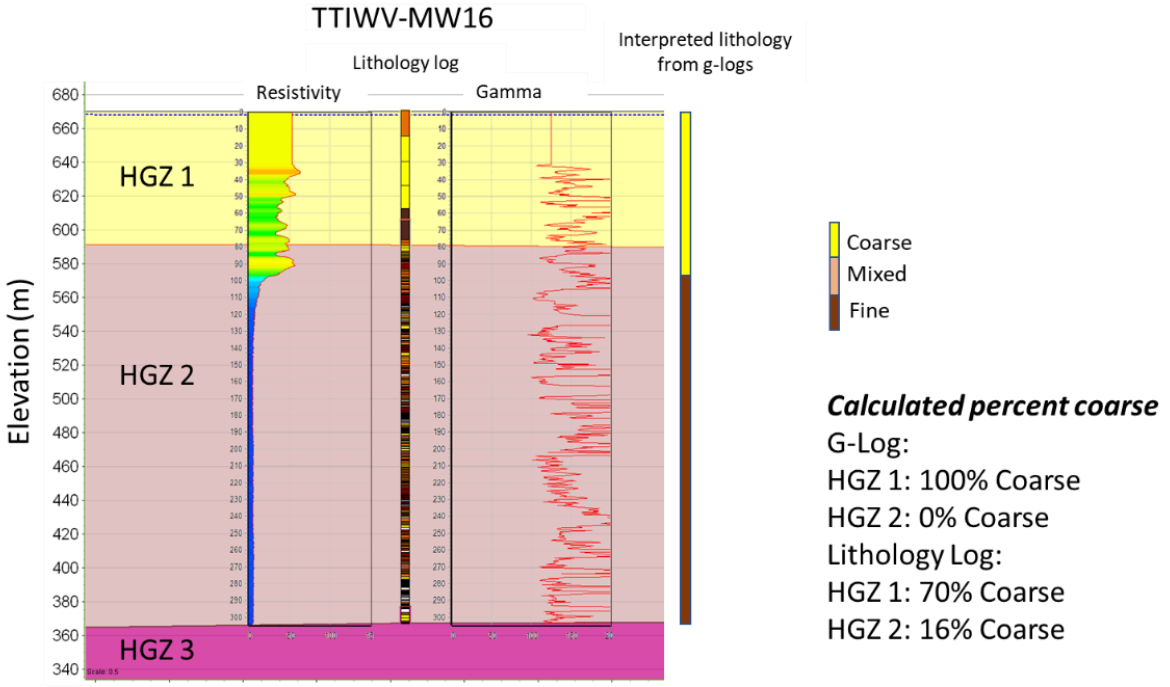


Figure 2-5: Example of Lithology and Geophysical Logs Interpretation as the Basis of Ramboll HCM (from Ramboll 2024)

The net sand and net clay calculated from the reprocessed seismic sections (Collier Geophysics 2021, 2023) is used to assess the appropriate range of specific yield values for HGZ3 and HGZ4. The technique used in this study is commonly applied in the oil and gas industry to identify potential reservoirs. This analysis mapped the percentage of net sand units along the reinterpreted seismic lines. Figure 2-6 provides an example from seismic line 92-02, which shows the net sand along the seismic section. Figure 2-7 illustrates the net clay along the same section. These results are presented in Table 2-1.

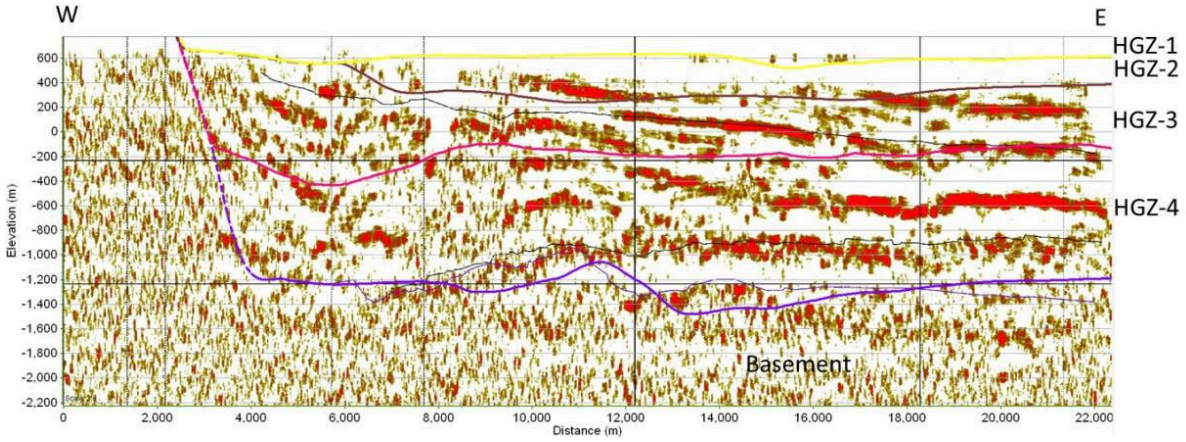


Figure 2-6: Seismic line 92-02 showing the net sand (dark red colors) interpreted from the reprocessed seismic line (from Ramboll 2024)
On this line, HGZ3 consists of 19% net sand and HGZ4 consists of 11% net sand.

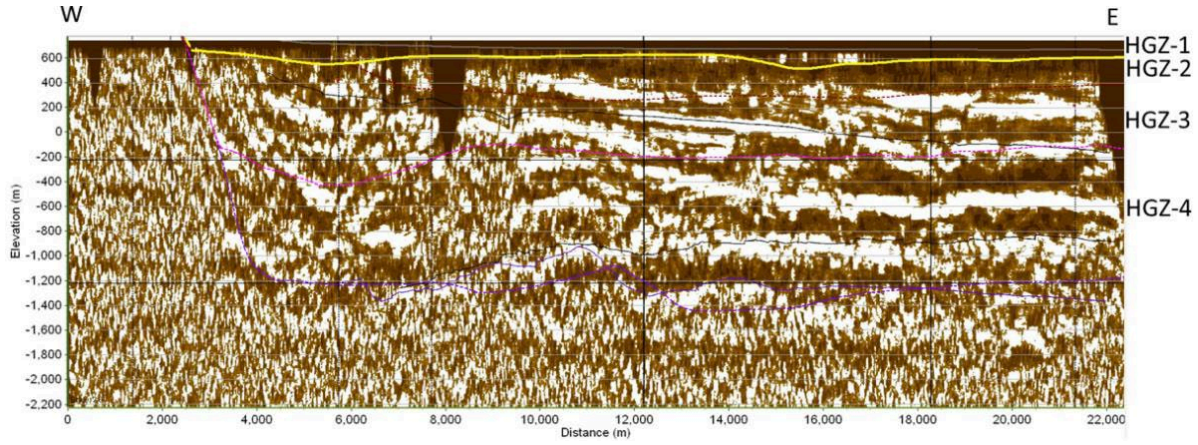


Figure 2-7: Seismic line 92-02 showing the net clay (dark brown colors) interpreted from the reprocessed seismic line (from Ramboll 2024)
Note: due to poor resolution of the upper portion of the figure, net clay is not well defined in this area.

Table 2-1: Calculated Net Sand/Net Clay in HGZ3 and HGZ4, Averaged for Each Seismic Line (from Ramboll 2024)

Line	Net Sand in HGZ3 (%)	Net Sand in HGZ4 (%)	Net Clay in HGZ3 (%)	Net Clay in HGZ4 (%)
82-01	7.3	10.1	52.6	53.1
88-02	9.3	8.6	46.8	49.0
88-08	12.6	9.3	53.6	59.3
88-01	9.9	13.8	63.6	58.2
88-07	14.3	9.5	45.5	52.7
88-05	13.4	15.8	56.5	54.7
88-04	15.1	17.9	56.4	48.4
82-03	11.7	10.6	46.1	45.8
92-01	13.2	13.9	48.4	49.4
00-07	23.3	15.7	26.3	33.7
92-02	18.9	11.1	34.6	37.7
00-06	16.6	4.1	44.5	66.4
Average	**13.8**	**11.7**	**47.9**	**50.7**

There is very little direct empirical data on specific yield obtained from previous studies and limited results of aquifer test conducted in the IWV Basin, although previous studies do make specific yield assumptions based on observations. The USGS conducted a thorough study of specific yield from different sediment types at numerous locations in California (USGS 1967) that correspond well with the values reported from other general studies, including Heath (1983) and Robson (1994), and with the values from the IWV Basin, as reported by Kunkel and Chase (1969). These were used as a basis for the range of specific yield applied to each HGZ for estimating groundwater storage.

Similarly, net sand and net clay were used as proxies for hydraulic conductivity, as they reflect areas where higher sand percentages are likely to correlate with greater hydraulic conductivity values. It further allows for informed selection of parameters that capture the natural variability across different depositional environments in the Basin where data are present. The detailed analysis of sediment textures and the distribution of coarse- and fine-grained materials for each HGZ is described in Ramboll's storage paper (Ramboll 2024), which is used for the selection of initial hydraulic conductivity values and storativity estimates for the model. In addition to these empirical resources, the selection of hydraulic properties was refined using professional judgment, considering both depositional context and the range of values typically observed for similar hydrogeologic settings based in part on literature values. This multi-faceted approach to defining the model's hydraulic properties enhances the model's ability to reflect realistic groundwater behavior, despite the limited direct aquifer testing data available.

The 2025 Ramboll model storage properties include the specific yield for unconfined layers 1 and 2 (HGZ1) and the specific storage for confined layers 3 through 6 (HGZ2 and HGZ3). These parameters determine how much water can be released from storage in response to changes in hydraulic head, affecting how the aquifer responds to recharge, withdrawal, and other stressors.

The initial specific yield and specific storage values used in the model were assigned based on geological material characteristics to reflect typical values for each type of material as described above and refined as part of model calibration (see Table 2-2 and Figure 2-4). he initial assigned

values are consistent with established ranges reported in groundwater literature (e.g., Todd 1980), such that the model parameters are reasonable and grounded in hydrogeologic principles.

Table 2-2: 2025 Ramboll Model Storage Properties (Ramboll 2025, Table 5-2)

Storage Property	Lithology	Value
Specific Yield	Alluvium fans	0.08
	Lacustrine deposits	0.11
	Fluvial deposits	0.08
Specific Storage (1/ft)	Semi-confined - confined system	3.4e-4 to 8.05e-07

In summary, we believe that the HCM and groundwater flow model developed by Rybarski and Bacon (2025) rely on faulty assumptions for the thickness of unconsolidated sediments (too low), recharge estimate (too low), and transmissivity values (too low), and on storativity parameters that are unreasonably high. The regional work of Shah and Boyd (2018) as applied to the DOJ-NAWS/IWVGA HCM and subsequent limited thickness of the groundwater flow model results in an underestimation of the unconsolidated sediment thickness that is erroneous. The detailed basin-specific work of Monastero et al. (2002) using borehole lithology and borehole geophysics is best available science and more accurately depicts the thickness of unconsolidated sediments down to more than 5,000 feet (1,550 meters) in SNORT 1 and down to granitic basement at approximately 6,500 feet (2,000 meters) in SNORT 2. In contrast, Ramboll approach to HCM development is consistent with available data and uses best available science to provide initial estimates for aquifer parameters. The limited thickness and other issues of the 2025 IWVGA model are discussed in more detail in the responsive reports of Dr. Matt Tonkin (Tonkin 2025b) and Dr. Vivek Bedekar (Bedekar 2025b).

2.2 Responsive Opinion 2: The Water Budget Is Underestimated Due to a Mountain-Front Recharge Estimate that Is Unreasonably Low, a Methodology Used that Is Not Applicable, and a Flawed Calibration with a 2-Dimensional Model

The total estimated mountain-front recharge and sustainable yield adopted by the IWVGA in the GSP is based on work conducted 10 years ago by McGraw et al. (2016) during development of the 2016 NAWS model. The recharge value from this study, which Dr. Kincaid (2025) and Dr. McKenna (2025) believe is a reasonable estimate of total recharge for IWV Basin, is problematic for the following reasons:

1) As discussed below (Section 2.3), this estimate of total recharge only represents mountain-front recharge and interbasin groundwater flow from Rose Valley Basin and is therefore an incomplete accounting of recharge for IWV Basin,

2) Measured pumping and water level data suggest that IWV Basin receives more recharge than 7,650 AFY (Section 2.2.1),

3) The mountain-front recharge values from McGraw et al. (2016) were derived from simplified empirical relationships without consideration of local variability in precipitation, geomorphology, or soils (Section 2.2.2), and

4) McGraw et al. (2016) used a technically flawed and undocumented approach to "calibrate" the recharge (Section 2.2.3).

Notably, the McGraw et al. (2016) groundwater flow model has been updated twice (2020 and 2025) but the contentious recharge value upon which the IWVGA GSP sustainable yield value is based has not been reassessed, a recharge value that is currently being relied upon for groundwater management decisions totaling hundreds of millions of dollars.

2.2.1 Safe Yield Calculated with Measured Groundwater Pumping and Water Levels Supports Additional Recharge

In support of their assessment of safe yield for the IWV Basin, the IWV Technical Working Group (TWG)[2] calculated annual yield values utilizing reported pumping volumes, changes in groundwater storage, and specific yield[3] values presented in the IWVGA GSP and annual reports (Appendix A of TWG 2024) (see Section 2.5, below, for additional detail on the safe yield calculation based on change in groundwater storage – referred to as the "storage method" in Dr. Kincaid's expert report). The change in groundwater storage values presented in these documents was based on observed changes in water level data, while the specific yield values came from the 2020 IWVGA model (Pohlmann et al. 2020). The 2020 IWVGA model was calibrated with a total groundwater recharge of 7,650 AFY and uses the same groundwater pumping summarized in the IWVGA GSP. Use of these data sources unchanged from the IWVGA GSP documents produces an average apparent safe yield for the period from 2016 through 2022 of 11,623 AFY (Appendix A of TWG 2024), noting that 2016-2022 is a drier-than-average time period.

The discrepancy between the 7,650 AFY of recharge utilized by the 2020 IWVGA model and the 11,623 AFY safe yield value derived from the change in groundwater storage analysis utilizing data incorporated in or used in support of the 2020 IWVGA model can be explained in two ways, or combination thereof:

1. If groundwater recharge in IWV Basin only comes from mountain-front recharge and interbasin groundwater flow from Rose Valley Basin, the estimated recharge of 7,650 AFY is too low.
2. The difference represents additional sources of recharge (e.g., return flow) not considered in the IWVGA model water budget (as well as potential additional mountain-front recharge and interbasin groundwater flow from Rose Valley Basin).

The discrepancy in the numbers indicates a disconnect between the 2020 IWVGA model and the observed (measured) groundwater level changes and recorded groundwater pumping. This raises questions as to the reliability of the recharge assumptions incorporated in the 2020 IWVGA model and reused in the 2025 IWVGA model, which Dr. Kincaid (2025) and Dr. McKenna (2025) believe reasonably characterizes total groundwater inflow to the IWV Basin. Since groundwater models are non-unique, meaning similar model performance can be obtained under various combinations of

[2] The TWG consists of technical representatives of beneficial users of groundwater, including the Indian Wells Valley Water District represented by Krieger & Stewart Engineering Consultants, Parker Groundwater, Ramboll, and S.S. Papadopulos & Associates, Meadowbrook Dairy represented by Luhdorff & Scalmanini Consulting Engineers, and Searles Valley Minerals Inc. represented by Geoscience Support Services, Inc. Mojave Pistachios, represented by Aquilogic, also participated in the TWG for the development of the safe yield paper (TWG 2024).

[3] Specific yield, or storage coefficient, refers to the fraction of water released from unconfined aquifer storage per unit volume of aquifer.

assumed inputs, outputs, and flow parameters, an acceptable level of calibration could still be obtained for unrepresentative recharge values.

2.2.2 Reliance on Simplistic Empirical Recharge Relationships

The initial estimate of mountain-front recharge by McGraw et al. (2016) relied primarily on empirical relationships presented by Anderson et al. (1992) and Epstein et al. (2010) (i.e., the Bootstrap-Brute-Force Recharge Model, BBRM). These equations were developed for basins primarily in Arizona and Nevada, respectively, and utilize basin-scale precipitation averages and generalized β-coefficients to estimate recharge. Such methods, while helpful for preliminary or reconnaissance-level studies, are not as robust as other methods. Furthermore, empirical relationships are valid only within the domain of its calibration data (i.e., Nevada basins for the model used by Epstein et al. [2010], i.e., BBRM), therefore, the relationships are not transferable to other hydrologic settings outside Nevada.

In the Lower Walker River Basin, Nevada, the USGS compared five empirical recharge methods—including the BBRM—to a process-based simulation using the Precipitation-Runoff Modeling System (PRMS) (Allander et al. 2014). While the BBRM may theoretically be applicable for this basin in Nevada, the USGS concluded "*each of these methods* [i.e., empirical methods including the BBRM] *yielded a disparity of recharge estimates. This is the nature of using simplified empirical approaches for estimating recharge*". Following this observation, the USGS used PRMS to estimate recharge for the Lower River Basin, which is a process-based approach, similar to the USGS BCM.

Modern recharge estimation techniques, such as the USGS BCM (Flint et al. 2021) used to estimate the mountain-front recharge in the District model, integrate site-specific factors including elevation, slope, aspect, soil permeability, vegetation cover, and precipitation intensity on a daily timestep. These models allow for spatially distributed estimates of recharge and runoff at resolutions suitable for basin-scale management applications. Furthermore, use of annual precipitation values (or, as typically used with these empirical relationships, annual precipitation averaged over a given period of time) is not accurate enough. Large storm events can generate significant amounts of recharge that are not captured in an annual snapshot, especially if recharge is restricted based on a defined threshold (e.g., areas with greater than eight inches of precipitation per year). As illustrated in the TWG safe yield paper (TWG 2024), recharge from areas receiving less than eight inches of precipitation per year can produce significant recharge in wetter years. Using average precipitation values and restricting the areas to a threshold based on these annual averages fails to capture recharge from high-intensity, low-frequency storm events that can have a meaningful impact on the IWV Basin water budget.

There is a lack of precedent for BBRM in California basin studies. A literature review could not identify other basins in California where the BBRM has been used to estimate recharge for groundwater model and/or water budget development as part of SGMA implementation or adjudication process. The BBRM is not listed as one of the tools for estimating recharge in the DWR Water Budget Best Management Practice (DWR 2016) or DWR Handbook for Water Budget Development (DWR 2020). In contrast to the BBRM, the USGS BCM is listed as one of the tools available in California to estimate natural recharge in DWR Water Budget Best Management Practice (DWR 2016) and as a tool to estimate recharge from precipitation and runoff in DWR Handbook for Water Budget Development (DWR 2020). Similarly, in contrast to the BBRM, the USGS BCM has been used extensively in basins in California to estimate recharge as part of the water budget development within SGMA GSPs or as part of water management, including, but not limited to, in

Owens Valley GSP (Owens Valley Groundwater Authority 2021) and Antelope Valley groundwater flow model (Siade et al. 2014), which are located north and south of IWV, respectively, Petaluma River Watershed (Traum et al. 2022), Lucerne Valley (Stamos et al. 2022), Borrego Valley (Faunt et al. 2015). The widespread regulatory acceptance of the USGS BCM stems from its reliance on physical processes to estimate recharge, calibration to streamflow data, and ability to represent snowpack dynamics and soil-water processes—features critical to basins receiving runoff from the Sierra Nevada and adjacent ranges such as IWV Basin.

Notably, concerning the use of the USGS BCM in the IWV versus the BBRM, IWVGA Member Kern County contracted with the USGS in 2017 to conduct an IWV-specific application of the BCM under a state grant funded by DWR. Progress updates were provided several times at IWVGA Board meetings with IWVGA consultants present including on January 18, 2018 and June 21, 2018 (IWVGA Meeting 1-18-2018.pdf, IWV Final USGS Recharge 06212018.pdf). The results of the USGS IWV Basin specific BCM were posted in February 2019 at IWV BCM.[4] Additionally, the USGS provided a draft journal paper (Saleh et al. 2021) for review and input by stakeholders to the District that was forwarded to the IWVGA consultant Stetson Engineers, Inc.; the draft journal paper was never circulated for review and the USGS never received comments to our knowledge.

2.2.3 Flawed "Calibration" Using a Two-Dimensional Flow Model

Following their empirical estimation, McGraw et al. (2016) used a two-dimensional (2D) MODFLOW model to "calibrate" recharge by adjusting its magnitude and distribution until simulated groundwater heads produced general agreement with measured values from assumed pre-development conditions (circa 1920). The utility of the 2D model should have been restricted to determining the distribution of recharge among the mountain-front areas, not for adjusting the magnitude. Since groundwater head is a function of both hydraulic conductivity and recharge, and since the assumed transmissivity (i.e., hydraulic conductivity multiplied by the aquifer saturated thickness) was held constant during the 2D calibration, the model implicitly assumed that the transmissivities used from the 1973 Dutcher and Moyle study were correct. This assumption is unsupported, especially since Dutcher and Moyle (1973) note that the accuracy of their estimates needs to be verified through groundwater flow modeling. The resulting "calibrated" recharge is therefore conditional upon *unverified estimates of transmissivity*.

The methodological issue becomes more serious in the next modeling step. The recharge value derived from the 2D model – already conditioned on a specific assumed transmissivity – was imported into a separate three-dimensional (3D) steady-state model with different basin geometry and variable aquifer thickness. In the 3D model, McGraw et al. (2016) then calibrated hydraulic conductivity while holding recharge fixed at the value established in the 2D calibration (7,650 AFY). This introduces a fundamental inconsistency: calibrating hydraulic conductivity in the 3D model effectively redefines transmissivity, thereby invalidating the earlier "calibration" of recharge that depended upon it. The transmissivity distribution has been further updated in 2020 (Pohlmann et al. 2020) and 2025 (Rybarski and Bacon 2025), but the recharge value "calibrated" based on the 2D model remained unchanged. The highly variable transmissivity distributions for the 1973, 2016, 2020 and 2025 models, which are reflections of multiple attempts to parameterize the physical aquifer system, are illustrated in Figure 2-8.

[4] https://www.usgs.gov/centers/california-water-science-center/science/using-basin-characterization-model-bcm-estimate

In addition, the 2D model was apparently subject to errors, as it appears that tables associated with recharge estimates in McGraw et al. (2016) contained multiple calculation errors, as noted by Dr. McKenna (2025) (emphasis added): "*The first is the lower and upper bounds on the amount of precipitation appears to have a typographical error in McGraw et al. (2016) where "10" was entered instead of "16" as the lower bound of the precipitation in the 5th row of the table.* ***That error was carried through the calculation*** *of the precipitation midpoint to be 14 instead of 17 inches and into the volume of precipitation and recharge. Additionally, the total area in acres shown in Table 1 of McGraw et al. (2016) is not equal to the sum of the numbers in the rows above it*" (McKenna 2025, page 20); and "*The difference* ***appears to be from an error*** *in the application of the recharge coefficients to the precipitation volumes*." (McKenna 2025, page 21).

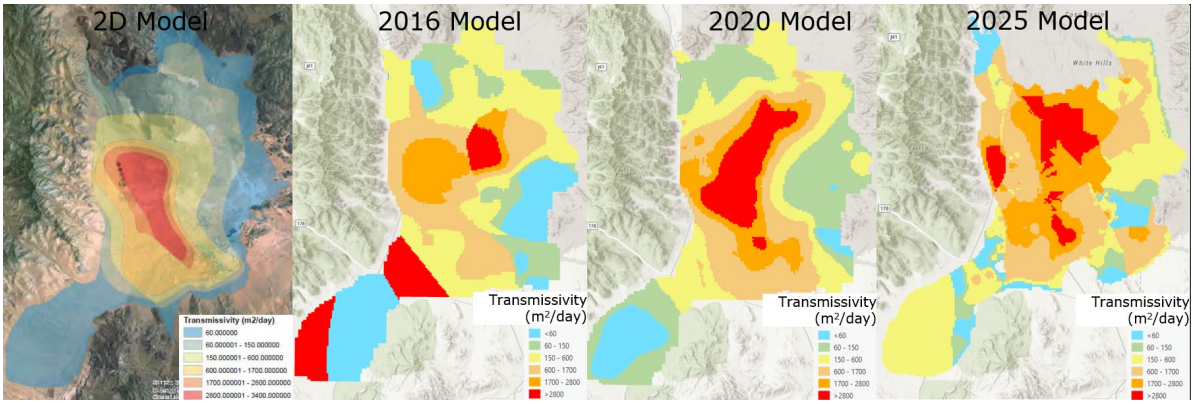


Figure 2-8: Transmissivity Distribution in the 2D Model (Figure from Mc Graw et al. 2016 Showing Transmissivity Distribution from Dutcher and Moyle 1973) as Compared to 2016 (Mc Graw et al. 2016), 2020 (Pohlmann et al. 2020) and 2025 (Rybarski and Bacon 2025) 3D NAWS/IWVGA Models

Finally, the main purpose of the model developed by McGraw et al. (2016), as stated by the authors, was to develop a groundwater management tool that would accurately reproduce observed rates of drawdown in order to provide more robust predictions of future groundwater conditions under various operational scenarios. It does not appear that establishing a comprehensive water budget to be used for sustainable yield or safe yield purposes was an intended use of the model.

2.3 Responsive Opinion 3: The Water Budget Is Additionally Underestimated as a Result of Not Including Incidental Recharge

The water budgets for the IWV developed by Dr. McKenna (2025) and Dr. Kincaid (2025) fail to consider incidental recharge and therefore are incomplete. Dr. McKenna and Kincaid both opine that the only sources of recharge to the IWV are mountain-front recharge and underflow/mountain-front recharge from Rose Valley Basin, and state that other source(s) of recharge are "*not credible*" (McKenna 2025) and "*should not be rely on*" (Kincaid 2025). This omission is inconsistent with literature on water budgets developed for other basins in California, including other arid and semi-arid basins with deep water tables (see Section 2.3.2 below).

In addition, the groundwater model cited by Dr. McKenna and Kincaid to support their opinions (Rybarski and Bacon 2025) does not account for or consider other source(s) of recharge. This results in a groundwater model that 1) does not rely on a complete, comprehensive water budget, 2) is inconsistent with historical conceptual water budgets, and 3) is inconsistent with best

management practices for development of groundwater models (e.g., USGS 2004; DWR 2016). This limitation was identified early in the GSP preparation process by IWVGA consultants, Stetson Engineers, Inc., in their review of the initial groundwater model (McGraw et al., 2016) developed by DRI for NAWS (Stetson Engineers, Inc., 2017). Specifically, Stetson Engineers, Inc. (2017) outlined the following limitations and recommendations based on their review of the 2016 Mc Graw et al. model (emphasis added):

- "Inflow to the basin will include natural and ***anthropogenic recharge***"
- "The existing model [i.e., 2016 Mc Graw et al. model] simulates the major natural inflow to the basin - mountain-front recharge and runoff off the surrounding mountains […] ***For the GSP water budgets, other anthropogenic sources of water (i.e. wastewater and irrigation return flows) will need to be accounted for in the water budgets***."
- "Future estimates for sustainable yield for the GSP will need to consider proposed recharge projects and **potential anthropogenic sources**"

It appears that those limitations and recommendations were not considered in updating the 2016 NAWS model to the 2020 NAWS/IWVGA model as part of the GSP process (Pohlmann et al. 2020) and that the 2025 IWVGA model still fails to take into account other sources of recharge, such as wastewater and irrigation return flows, and to accurately represent all inflows into the IWV Basin.

2.3.1 Return Flows and Other Incidental Recharge

Dr. McKenna (2025) and Dr. Kincaid (2025) have asserted that recharge to the IWV Basin is limited exclusively to mountain-front recharge and interbasin groundwater flow from Rose Valley Basin, citing high evapotranspiration (ET) rates and large depths to groundwater as evidence that other recharge mechanisms are negligible or impractical. A comprehensive and defensible basin groundwater budget must account for all significant recharge processes, including, for example, return flow from applied water. The exclusion of return flow and any other incidental recharge results in an underestimation of total recharge and, consequently, an inaccurate determination of the basin's safe yield.

Return flow from applied water represents the portion of water used for irrigation, landscaping, or other surface uses that percolates below the root zone and re-enters the saturated zone. This process is a recurring and measurable component of recharge in basins where water is applied for consumptive use. Even in environments characterized by deep water tables and high potential ET, the fraction of applied water that exceeds crop or vegetation demand infiltrates downward through the unsaturated zone, contributing to groundwater recharge over time.

2.3.2 Evidence from Comparable California Desert Basins

Excluding incidental recharge from the basin water budget is also inconsistent with hydrologic literature from other arid and semi-arid basins in California. Return flows, leakage from wastewater ponds, leakage from water distribution pipelines, leakage from the Los Angeles Aqueduct (LAA) and other forms of incidental recharge have been recognized and incorporated into water budgets and groundwater models in numerous basins across California, including in arid and semi-arid basins with comparable settings to the IWV basin. Below is a non-exhaustive list of such Basins.

- Mojave River Basin: Mojave River Basin is an adjudicated area located just to the east of Antelope Valley Basin. The USGS developed a groundwater model for the basin, which has depths to water over 100 feet in much of the area (Stamos et al. 2001). The groundwater

model includes recharge from irrigation return flow, septic tanks, artificial recharge, and treated wastewater (Stamos et al. 2001).

- Lucerne Valley: the USGS developed a groundwater flow model for the Lucerne Valley, which accounts for anthropogenic recharge sources, including irrigation-return flow from agriculture. Lucerne Valley is an arid basin, and on average, irrigation-return flow from agriculture accounts for more than 50 percent of the total recharge (Stamos et al. 2022).
- Borrego Valley: The USGS developed a groundwater flow model for the Borrego Valley, which accounts for anthropogenic recharge sources, including irrigation-return flow from agricultural fields. Borrego Valley is also classified as an arid environment, and recharge from irrigation return flows was estimated to be about 20–30 percent of agricultural and recreational pumpages (Faunt et al. 2015).
- Antelope Valley, located south of IWV basin:
    - Antelope Valley Basin underwent an adjudication process in the early 2000s. Return flows from agricultural irrigation, urban landscape irrigation, septic tanks in urban areas, and infiltration of treated wastewater from ponds were quantified and considered during the adjudication process (Beeby at al. 2010) and then recognized as a significant source of recharge to Antelope Valley Basin.
    - The USGS developed a groundwater flow model for Antelope Valley Basin, which, consistent with the adjudication and previous studies of the basin, accounts for additional sources of recharge, including return flows from agricultural irrigation, urban landscape irrigation and septic tanks in urban areas, and infiltration of treated wastewater from ponds (Siade et al. 2014). Depth to water in the basin is generally between 100 to 300 feet, and the USGS model includes lag times in return flow using the unsaturated zone package in MODFLOW. The simulations indicate that return flows reach the water table in less than 10 years in many areas of the basin (Siade et al. 2014), as illustrated in Figure 2-9.
- Owens Valley, located north of IWV basin, and used by Dr. McKenna as a comparison for IWV Basin, based on its similar physiographic setting and well-understood hydrologic system and water budget (McKenna 2025):
    - The water budget for the Owens Valley basin developed by Danskin (1998) and used as a reference by Dr. McKenna, includes return flows from irrigation and watering of livestock as a source of recharge, while the depth to water in the alluvial fan deposits and volcanic rocks ranges from many tens to many hundreds of feet (Danskin 1998).
    - The Owens Valley GSP includes the following sources of additional recharge for the basin: deep percolation from irrigated agricultural fields (i.e., return flows), and seepage from losing reaches of the Owens River, Los Angeles Aqueduct, and irrigation ditches (Owens Valley Groundwater Authority 2021).

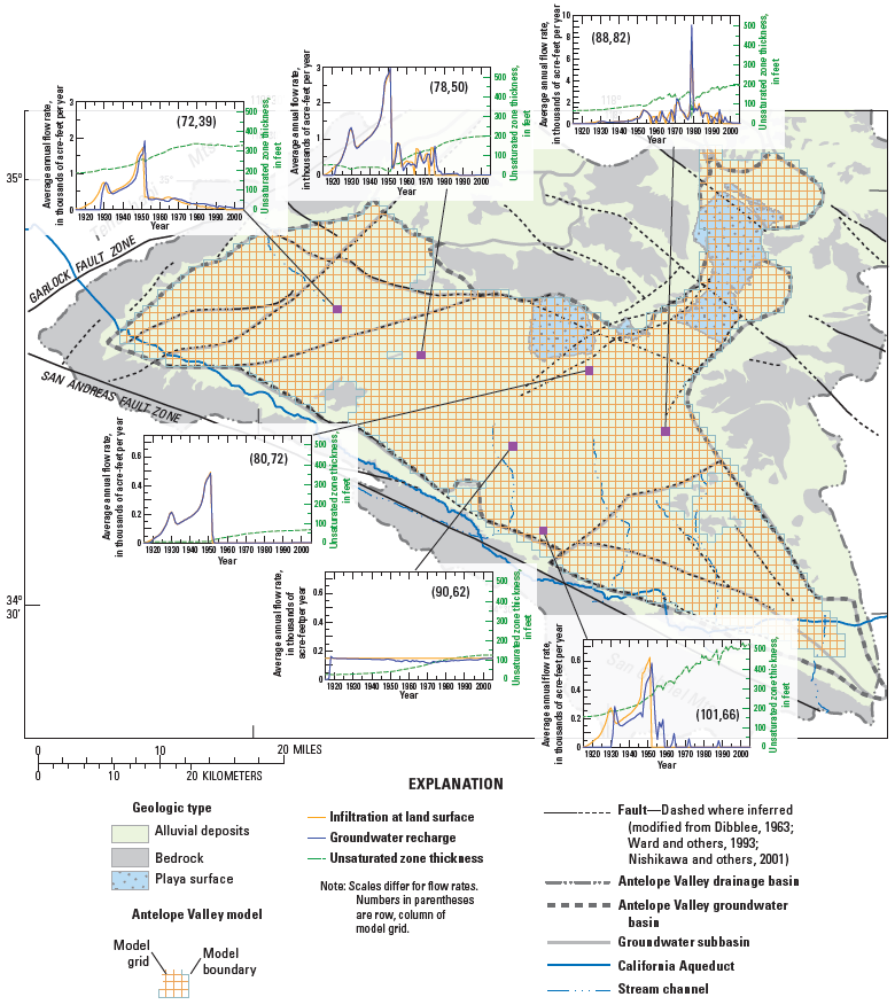


Figure 2-9: Hydrographs of Simulated Groundwater Recharge (blue line) Compared to Infiltration at Land Surface (yellow line) in USGS Antelope Valley Groundwater Model (from Siade et al. 2014)

2.4 Responsive Opinion 4: Dr. Kincaid's Estimate of Recharge for IWV Basin is Literature-Review-Based, Not Scientifically Rigorous and Thus Unreliable

2.4.1 Approach

In his expert report, Dr. Kincaid estimates a range of natural recharge for the IWV Basin based on selected estimates of mountain-front recharge and "total groundwater inflow" from previous studies conducted since 1969. These previously published literature-based recharge estimates were averaged and bounded by one standard deviation to produce the range of natural recharge used for Dr. Kincaid's Opinion 4.

This approach is not scientifically rigorous. Compiling and averaging recharge values from literature is typically used as a general indication of a potential range of recharge, or to check an independently derived estimate for reasonableness. The resulting average and range of recharge values represent a statistical abstraction rather than a hydrologically grounded assessment since this process disregards differences in methods, data type and quality, or spatial and temporal coverage between the various studies. This is especially true considering that some of the studies listed adopt recharge from a previous study and simply redistribute the total, causing that estimate to be double counted (e.g., Berenbrock and Martin 1991; Watt 1993).

2.4.2 Inconsistency of Base Periods

Each published recharge estimate is reflective of hydrologic conditions over a specific base period, defined by precipitation, land use, and groundwater extraction patterns at the time of the study. These base periods vary across the studies cited by Dr. Kincaid (2025). Combining them without normalization introduces temporal inconsistency that renders the composite dataset hydrologically meaningless.

Comparing or averaging recharge values derived for dissimilar climatic or hydrologic periods (e.g., pre-development versus post-pumping conditions, wet versus dry periods) is not a valid approach. Each estimate is period-specific and cannot be extrapolated across various time periods.

2.4.3 Misinterpretation of Recharge from Previous Estimates

Dr. Kincaid notes a declining trend in estimates of recharge through time, which he attributes to a "*progressive scientific understanding of the hydrologic processes*" in IWV Basin and a "*non-bias consensus that there is less groundwater inflow*" than estimated by earlier researchers. Within the selected subset of previous studies, Dr. Kincaid considers them all to be "equally defensible". However, Dr. Kincaid limited his analysis to previous estimates of mountain-front recharge and interbasin groundwater flow from Rose Valley Basin, even though some of the studies included estimates of recharge from other sources (e.g., Bean 1989; Todd Engineers 2014). Therefore, Dr. Kincaid's analysis of "total" groundwater recharge often misrepresents the total recharge estimated by the cited studies. By purposely ignoring additional sources of estimated recharge, Dr. Kincaid's estimates of inflow to IWV Basin are biased low.

Additional recharge sources considered in the cited studies but omitted from Dr. Kincaid's analysis include:

- Bean (1989): Leakage from the LA Aqueduct, geothermal leakage, and percolation from wastewater treatment ponds (~2,500 AFY).[5]
- Berenbrock and Martin (1991): Localized irrigation return flow and percolation from wastewater treatment ponds (~1,100 AFY).
- Gillespie and Thyne (1996): Additional groundwater flow from Rose Valley Basin (Dr. Kincaid's analysis only considered mountain-front recharge to Rose Valley Basin, not the total interbasin groundwater flow from Rose Valley Basin to IWV Basin reported by Gillespie and Thyne), and surface flow from Rose Valley Basin (of which Gillespie and Thyne assumed all would become groundwater recharge in IWV Basin).
- Todd Engineers (2014): Distribution system leakage, percolation from wastewater treatment ponds, and return flow from irrigation (~2,300 – 2,800 AFY).

2.4.3.1 Recent USGS Estimates of Natural Recharge in IWV Basin

The most recent study cited by Dr. Kincaid was conducted by the USGS in 2018 (though the online summary is dated 2019[6]). The study was completed under a contract between IWVGA Member Kern County and the USGS and funded by the state under a 2015 grant application and agreement with DWR. This study involved application of the USGS BCM to IWV Basin, and it includes two different base periods, both of which are used in Dr. Kincaid's analysis. This study alone illustrates the influence base period can have on estimates of recharge since use of the same model produces an estimate of recharge from mountain-front areas of approximately 8,680 AFY for the period from 1981 through 2010 and 5,976 AFY for the period from 2000 through 2013. Of importance, this USGS estimate does not include Rose Valley interbasin groundwater flow into IWV but includes Rose Valley surface water flows into IWV as noted by USGS online as "valley floor" inflow from Rose Valley. Based on recorded precipitation at the China Lake NAF station[7], the period from 2000 through 2013 was nearly 30% drier than 1981 through 2010, which is reflected in the mountain-front recharge estimates.

The two most recent estimates of interbasin groundwater flow from Rose Valley into the IWV Basin are 1,900 AFY (Rybarski and Bacon 2025) and 2,600 AFY (Ramboll 2025). This means that Dr. Kincaid's analysis underestimates the "total"[8] reported recharge from the USGS study for the period from 1981 through 2010 by more than 1,500 AFY. The sum of mountain-front recharge and interbasin groundwater flow from Rose Valley Basin calculated by the USGS for the 1981 through 2010 period is therefore 10,580 AFY to 11,280 AFY, using the two most recent Rose Valley interbasin groundwater flow estimates. This already exceeds Dr. Kincaid's estimated maximum range for total groundwater inflow to IWV Basin of 9,900 AFY, and it does not even consider the fate of runoff calculated by the USGS, and anthropogenic sources of recharge like return flow and

[5] Additional recharge from granitic regional underflow estimated by Bean (1989) has since been disproven and its omission is consistent with summaries of previous recharge presented by the TWG (2024).

[6] https://www.usgs.gov/centers/california-water-science-center/science/using-basin-characterization-model-bcm-estimate

[7] Precipitation data available at: https://wrcc.dri.edu/WRCCWrappers.py?sodxtrmts+041733+por+por+pcpn+none+msum+5+01+F

[8] Total groundwater recharge listed in Kincaid's tables and figures is misleading because it only represents the sum of mountain-front recharge and underflow from Rose Valley. Other sources of recharge included in the cited previous studies have been omitted.

distribution system leakage (not considered in the USGS study, which only quantified natural recharge and excluded estimating Rose Valley interbasin groundwater flow into IWV).

2.5 Responsive Opinion 5: The Storage Method is the Better Approach for Safe Yield Estimate in the Indian Wells Valley

The Equation of Hydrologic Equilibrium, also referred to as the water balance equation, is expressed as:

Inflow = Outflow +/- Change in Groundwater Storage.....(1)

This equation can be further expressed as:

Inflow = Outflow (Excluding Pumping) + Pumping +/- Change in Groundwater Storage.....(2)

By moving Outflow (Excluding Pumping) to the left side of the equation, Equation 2 can be written as:

Inflow – Outflow (Excluding Pumping) = Pumping +/- Change in Groundwater Storage.....(3)

Using Equation 3, there are two ways to apply the Equation of Hydrologic Equilibrium for the determination of safe yield:

Safe Yield = Inflow – Outflow (Excluding Pumping).....(4)

or

Safe Yield = Pumping +/- Change in Groundwater Storage.....(5)

Dr. Kincaid (2025) refers to the first approach (Equation 4) as the "recharge method" and the second approach (Equation 5) as the "storage method". Both approaches should be evaluated over a representative base period.

2.5.1 Variables and Data Involved

Both applications of the Equation of Hydrologic Equilibrium for the determination of safe yield are mathematically and conceptually equivalent formulations of the same physical balance. Dr. Kincaid (2025) favors the recharge method (i.e., Equation 4) because it involves fewer variables. However, this line of reasoning confuses the difference between simplicity and accuracy. In reality, the reliability of each method depends on the quality and availability of data.

The storage method (i.e., Equation 5) relies primarily on:

- Recorded groundwater pumping,
- Measured groundwater elevations from a basin-wide monitoring network, and
- Reasonably constrained estimates of specific yield derived from a calibrated basin-scale groundwater flow model.

The base period evaluated by the TWG in the safe yield paper (TWG 2024) (2014 through 2023) includes the most complete and accurate dataset available for the IWV Basin since it spans the period of increased water level measurements and mandatory pumping records resulting from the passage and implementation of SGMA. The only estimated parameter in this approach – the specific yield values – is supported by a groundwater flow model with an acceptable level of calibration to measured groundwater level measurements across the Basin and through time.

In contrast, the recharge method relies on estimates for unmeasurable inflow and outflow terms (e.g., mountain-front recharge, underflow inflow, ET). No direct measurements of these fluxes exist for the IWV Basin, and most published estimates vary widely depending on the assumptions and models used. Furthermore, each inflow or outflow term has multiple variables associated with it (as indicated in Dr. Kincaid's expert report), each with their own level of uncertainty (also acknowledged in Dr. Kincaid's report).

2.5.2 Limitations and Uncertainty of the Recharge Method

The recharge method depends fundamentally on the accuracy of inflow and outflow estimates, which are highly uncertain. In order to reduce the number of variables, estimates of pre-development ET have often been used in IWV Basin as a proxy for pre-development recharge. This is problematic for several reasons:

- Pre-development ET cannot be measured directly, and historical estimates and hydrologic datasets generally have higher uncertainty the older they are. This is due to less advanced measurement techniques and sparse data collection networks in the past, which together make older data inherently less accurate and reliable than modern records.
- Previous ET studies have also shown that ET has changed (decreased) through time due to groundwater pumping and changes in groundwater elevation (McGraw et al. 2016). Therefore, estimates of ET after the development of groundwater resources in IWV Basin are not reflective of pre-development ET and cannot be utilized for proxy estimates of recharge.

Even the use of more modern estimates of ET based on measured values is extremely limited. For example, the analysis of ET presented by McGraw et al. (2016) notes the need for extensive corrections, data screenings, and generalized assumptions. Furthermore, while this study represents perhaps the most comprehensive collection of ET measurements available for the Basin, it still only covers nine months of one year. The estimated ET rates are also dependent on the depth to water, for which limited water level data in the vicinity of the measurements were only available 14 years prior to the study. Notably, the highest ET rates were measured not in the summer but winter, which suggests that the ET being measured was not related to primarily groundwater consumption but surface water and soil moisture intake from winter precipitation. Finally, McGraw et al. note that it is difficult to convert the estimated ET rates into volumetric rates over larger areas within the playa since the ET values are only representative of the footprint area associated with the measurements (in this case, the bare playa). Extrapolating these estimates to larger areas would be, in the words of McGraw et al., "*speculative at best*."

Therefore, recharge- or discharge-based safe yield estimates for IWV Basin are inherently uncertain, sensitive to poorly constrained assumptions, and lack empirical validation against observed aquifer responses (i.e., changes in water level). Because of the uncertainty associated with the recharge method, ET and recharge estimates by experts for IWVGA and DOJ-NAWS result in wide ranges, which impacts the accuracy of the safe yield estimates (Table 1-1).

2.5.3 Use of Specific Yield in the Storage Method

Another of Dr. Kincaid's concerns regarding the storage method is that it will likely result in "a*n over-estimation of safe yield because the uncertainties associated with the estimation of S* [or storativity] (*Sy* [or specific yield] *in unconfined conditions and Ss* [or specific storage] *in confined conditions) tend to favor higher values*." However, safe yield, as calculated using the storage

method, is equal to pumping plus or minus change in groundwater storage (Equation 5). The plus or minus means that, for a basin with increasing storage under a given base period and associated pumping conditions, the change in groundwater storage would add to, or increase, the amount of groundwater that can be pumped sustainably. Conversely, a decrease in groundwater storage represents overdraft and that amount would be subtracted from the groundwater pumping, causing a lower estimate of safe yield.

Change in groundwater storage is calculated as:

Change in Groundwater Storage = Change in Water Level x Basin Area x Specific Yield.....(6)

Higher specific yield values therefore lead to higher values of change in groundwater storage; either a greater increase in storage or a greater decline in storage, depending on the change in observed water level (positive or negative, respectively). Dr. Kincaid's concern about higher specific yield values is therefore only valid for groundwater basins with increasing groundwater storage, where an overestimate of the change in groundwater storage would add to the pumping over the base period (thereby increasing estimated safe yield). In a basin where the average change in groundwater storage is negative, the use of higher specific yield values and an overestimated decrease in groundwater storage causes the safe yield *to be underestimated*. Therefore, even if specific yield values used in the storage method were overestimated, the use of them for an overdrafted basin, like IWV Basin, would result in a more conservative estimate of safe yield. Furthermore, since specific yield is much greater than specific storage, use of specific yield values in potentially confined areas would also cause safe yield to be underestimated if the change in groundwater storage is negative.

2.6 Responsive Opinion 6: The Analogy Between the Owens Valley Basin and IWV Basin Developed by Dr. McKenna is Based on Incorrect Assumptions and a Misunderstanding of the Water Budget for Owens Valley Basin, and Provides an Erroneous Estimate of Recharge for the IWV Basin

Dr. McKenna (2025) relies on a comparison with Owens Valley Basin to opine that recharge for IWV Basin from mountain-front recharge cannot be more than 6,355 AFY and more likely is near 4,300 AFY. This opinion is based on an erroneous analysis and misinterpretation of mountain-front recharge in Owens Valley documented in Danskin (1998).

2.6.1 Fatal Flaws in Dr. McKenna Analysis

In his analysis, Dr. McKenna attempted to calculate the ratio of recharge to precipitation in Owens Valley Basin by dividing the "mountain-front recharge" presented in Danskin (1998) by the volume of precipitation falling on all watershed areas receiving more than eight inches of annual precipitation. Based on the numbers used by Dr. McKenna, the ratio of recharge to precipitation is between 0.9 and 1.4%. Dr. McKenna then applies this ratio to IWV Basin volume of precipitation falling on watershed areas receiving more than eight inches of annual precipitation. The fatal flaw in Dr. McKenna's analysis, besides the fact that all basins are unique and different, is that the "mountain-front recharge" amount used for Owens Valley Basin from Danskin (1998) only represents the recharge "*between tributary streams*" (i.e., 26,000 AFY), which 1) is a "*relatively small component of the groundwater budget*" according to Danskin (1998), 2) only represents recharge from a small portion of Owens Valley watershed areas, and 3) cannot be used to calculate a recharge to precipitation ratio for all watershed areas receiving more than eight inches of precipitation. Danskin (1998) indicates that recharge to precipitation ratios for those areas located

along the southwest side of the valley is 75% (much higher than the ratios calculated by Dr. McKenna). Danskin (1998) does not provide detailed calculations, but information in Lee (1912), which is the basis for Danskin's water budget, provides a useful example:

- Lee (1912) estimates recharge from precipitation upon intermediate mountain slopes of Independence Region within Owens Valley. This recharge is a portion of the recharge "*between tributary systems*" referred to by Danskin (1998).
- Total area for intermediate mountain slopes of Independence Region is approximately 29.4 square miles (18,800 acres), which represents less than 2% of the watershed areas receiving more than eight inches of precipitation (i.e., 1.2M acres according to Dr. McKenna).
- Total estimated recharge from these 29.4 square miles is 19,690 AFY, over 70% of the total estimated precipitation of 27,580 AFY (Lee 1912).
- Dr. McKenna has misinterpreted the values in Danskin (1998) and concluded that 26,000 AFY of recharge occurred over an area of 1.2M acres receiving 1.8M AFY of precipitation, while information in Lee (1912) indicates that 19,690 AFY of recharge occurs over an area of 18,800 acres receiving 27,580 AFY of precipitation.

The comparison as presented by Dr. McKenna is incorrect and provides erroneous and misleading estimates of recharge for IWV Basin. While all groundwater basins are different, and using analog to estimate recharge is generally inappropriate because of variability of many complex factors, such as soil characteristics, land use, elevations, climate, and variability in data availability and relevant time periods, I have applied Dr. McKenna's methodology following correction of Owens Valley recharge to illustrate what the results would have been if Dr. McKenna would have interpreted the recharge estimates in Danskin correctly.

2.6.2 Analysis Based on Applying Corrected Owens Valley Hydrologic Ratios to IWV

In this section, I am using the methodology and precipitation numbers outlined by Dr. McKenna (2025), but instead selecting the appropriate recharge components from Danskin (1998), representing recharge to the Owens Valley Basin attributable to the adjacent watershed areas as follows:

- Recharge from gaged tributary streams (i.e., mountain-front runoff that results in flows to tributary streams and subsequent groundwater recharge)
- Mountain-front recharge from ungaged drainage areas between gaged tributary streams (which is the only portion of recharge considered by Dr. McKenna)

Table 2-3 below provides the corrected calculation of the "mountain-front recharge" to precipitation ratio for Owens Valley based on the methodology and precipitation volumes from Dr. McKenna. In Owens Valley, there are additional sources of "natural recharge", including infiltration of precipitation on the valley floor and runoff from bedrock outcrops within the valley fill, but these processes are not occurring in IWV Basin and are therefore not included in the ratios calculated below. The corrected recharge to precipitation ratios are between 6.6 and 7.0%, between 4 and 7 times higher than calculated by Dr. McKenna.

Table 2-3: Corrected Calculations for Recharge to Precipitation Ratios for Owens Valley Basin

	Precipitation Volume[1] (AFY)	Natural Recharge from Precipitation in Adjacent Watershed Areas to Owens Valley[2] (AFY)			Recharge/ Precipitation Ratio[3]
		Recharge From Gaged Tributaries	Recharge From Ungaged Tributaries	Total	
Minimum	1,590,260	90,000	15,000	105,000	0.066
Maximum	2,219,228	115,000	35,000	150,000	0.068
Average	1,854,124	103,000	26,000	129,000	0.070

[1] McKenna (2025), Table 3. [2] Danskin (1998), Table 10. [3] = Total Recharge [2] / Precipitation [1]

Applying the corrected Owens Valley Basin recharge-to-precipitation ratios to Dr. McKenna's estimated precipitation for IWV Basin yields the estimates of recharge in Table 2-4.

Table 2-4: Annual Recharge Volumes for IWV Basin using the Corrected Recharge/Precipitation Ratios Calculated for Owens Valley Basin

	Precipitation Volume[1] (AFY)	Recharge/Precipitation Ratio[2]	Estimated Recharge[3] (AFY)
Minimum	193,820	0.066	12,797
Maximum	402,975	0.068	24,238
Average	304,932	0.070	21,216

[1] McKenna (2025), Table 4. [2] As calculated in Table 2-3 above. [3] = Precipitation [1] x Recharge/Precipitation Ratio [2]

These results indicate that using the corrected recharge-to-precipitation relationship, the estimated mountain-front recharge for IWV Basin based on comparison with Owens Valley Basin as outlined by Dr. McKenna, is between 12,800 and 24,200 AFY, with an average estimate of approximately 21,200 AFY. As expected, this is of course much higher than any of the experts' analysis results.

In the 2025 Ramboll model, the average native recharge from mountain-front recharge, surface runoff, and subsurface inflow from Rose Valley (i.e., recharge without incidental recharge) is 10,800 AFY (Ramboll, 2025), which is lower than the estimates using Owens Valley Basin analog. This is expected for a basin that has lower elevations, warmer climate and drier conditions, and illustrates the challenges of applying analogs for estimating recharge, given the unique characteristics of each groundwater basin.

2.7 Responsive Opinion 7: Climate Change Predictions Are Not Considered in Safe Yield Determinations

Climate change model predictions are not included in determining the safe yield of the basin, as such predictions are speculative, and safe yield determinations rely on historic records, data and information. The potential for climate changes in the future can be considered in the physical solution for the basin. However, as Dr. Kincaid (2025) opines on climate change impacts on safe

yield estimates without properly considering the range of uncertainty associated with climate change models, I am providing this responsive opinion.

Dr. Kincaid (2025) has asserted that recharge to the IWV Basin is likely declining. This statement is misleading and fails to acknowledge the high uncertainty associated with climate change predictions for future precipitation, evapotranspiration, and temperature. There is a wide range of modeled climate outcomes, both illustrating the uncertainty associated with forecasting future conditions and complexity of the model processes. A comprehensive evaluation of potential outcomes due to climate change in IWV Basin is beyond the scope of the safe yield evaluation, but a few examples outlined below illustrate the shortcomings of Dr. Kincaid's statement.

Rybarski and Bacon (2025) use the 2025 IWVGA model to evaluate impacts of predicted changes in precipitation and temperature on groundwater storage. They selected 20 global climate models (GCMs) and first evaluated the expected change to mountain-front recharge. Four of the eight highlighted GCMs (i.e., 50%) result in a net increase in groundwater recharge (Figure 6-9, Rybarski and Bacon 2025). After selecting five of the GCMs, they performed model simulations to assess impacts on groundwater storage. Three out of the five scenarios result in net increase of groundwater storage by 2070 (Figure 6-27, Rybarski and Bacon 2025). Therefore, Dr. Kincaid's statement about declining future recharge is not consistent with the evaluation performed by Rybarski and Bacon (2025) using the groundwater model Kincaid relied on for other assessments.

The USGS IWV-specific BCM evaluation also includes evaluation of future conditions based on three climate models selected by the USGS. The results are not summarized in the online version[9], but are described in the draft paper (Saleh et al. 2021). For the three climate scenarios, the models estimate an increase in recharge in the mid-century period for all IWV sub-areas except for the 8 percent (750 acre-feet) decrease projected by one of the climate models (HadGEM2-CC) for the Argus range during that period. Two of the models also estimate an increase in recharge in the end-of-century period, while the third model estimates a decrease in recharge. The average change from historical to future indicating more recharge and runoff in general, is attributed to the increase in extreme years allowing for the precipitation to exceed the recharge threshold more often (Saleh et al. 2021). These results underscore the necessity for incorporating increasing periodicity of extreme precipitation events into model simulations and further indicate the uncertainty associated with climate change impacts on future recharge.

The projected future water balance for Owens Valley Basin, which is north of IWV Basin and has been used by Dr. McKenna for comparison based on similar settings, was developed using the USGS BCM as part of Owens Valley GSP (Owens Valley Groundwater Authority 2021). Owens Valley Groundwater Authority selected CCSM4 scenario 8.5 for this evaluation as it showed similar range in temperature changes as suggested by DWR for the area. Based on this climate scenario, the amount of recharge is expected to increase by 3% by 2045 (Owens Valley Groundwater Authority 2021).

These examples are not meant to be exhaustive but to illustrate the range of outcomes and large uncertainty associated with climate change scenarios and challenges with assessing impacts on groundwater recharge and resource management using the wide range of climate models available.

[9] https://www.usgs.gov/centers/california-water-science-center/science/using-basin-characterization-model-bcm-estimate

3. Summary and Recommendations

In summary, the following responsive opinions and recommendations are offered with respect to the expert reports of Dr. McKenna for the DOJ-NAWS and Dr. Kincaid for the IWVGA:

- The 2025 IWVGA HCM and 2025 IWVGA model are flawed by assuming the aquifer system is shallow and not considering the deeper transmissive sediments, and the range of storativity values in the 2025 IWVGA model are unreasonably high, leading to misinterpretation of the overall aquifer system. Therefore, the 2025 IWVGA model should not be used for safe yield estimates, predictions of groundwater level changes over time, or for groundwater management alternatives analysis (see also Tonkin 2025b and Bedekar 2025b).
- Dr. Kincaid and Dr. McKenna state that the mountain-front recharge estimate developed by McGraw et al. (2016) represents a reasonable characterization of total groundwater inflow. However, based on our analysis, it is an incomplete and internally inconsistent quantification of basin inflows to the IWV Basin, therefore it is unreliable and should not be used to represent the safe yield of the IWV Basin (see also Tonkin 2025b, and Bedekar 2025b).
- Return flow from the application of water at the surface and other incidental recharge mechanisms represent reliable sources of basin recharge that are included in water budget and safe yield estimates based on current state of practice in California in groundwater rights adjudications and other state documents (see also Tonkin 2025a,b). Therefore, the water budget and safe yield estimates of Dr. McKenna and Dr. Kincaid that specifically exclude incidental recharge should be considered erroneously low.
- Dr. Kincaid's literature-based approach to estimating natural recharge in the IWV Basin is incomplete, not scientifically rigorous and misleading. His compilation of recharge values from unrelated studies, each with differing assumptions, base periods, and data quality, produces a statistical construct rather than a valid estimate of basin recharge representing best practices. By omitting other significant recharge components reported in the cited literature, Dr. Kincaid's analysis presents an incomplete water budget and systematically underrepresents total groundwater inflow. The misinterpretation of recharge from the USGS IWV-specific BCM[10] summary further compounds this error, resulting in an underestimate of combined mountain-front recharge and interbasin groundwater flow from Rose Valley Basin by over 1,500 AFY relative to the USGS model results. Therefore, Dr. Kincaid's estimate of natural recharge should be discounted.
- Dr. McKenna's comparison of recharge-to-precipitation ratios between Owens Valley Basin and IWV Basin is incorrect since it is based on an incomplete interpretation of the Owens Valley Basin groundwater budget presented in Danskin (1998). By including only the minor "mountain-front recharge between tributary streams" term, Dr. McKenna excluded the dominant recharge source from precipitation (recharge from gaged tributaries) and underestimated natural recharge. Correcting this oversight increases the recharge-to-precipitation ratio for Owens Valley Basin from approximately 1 percent to 7 percent, that

[10] https://www.usgs.gov/centers/california-water-science-center/science/using-basin-characterization-model-bcm-estimate

when applied to IWV Basin result in recharge estimates that are even higher than the natural recharge simulated in the 2025 Ramboll groundwater flow model. This result also demonstrates that the recharge-to-precipitation relationship between the two basin is in fact not comparable.

- Estimates of natural recharge by Dr. Kincaid and Dr. McKenna in IWV Basin primarily leverage measured precipitation data and non-basin-specific relational equations to quantify a volume of recharge, which are completely disconnected from measured responses of the basin aquifer system. In contrast, the storage method relies on measured data related to actual basin behavior: reported groundwater extractions, observed groundwater level changes, and storage parameters derived from calibrated models. In addition, the storage method inherently accounts for all sources of groundwater inflow and outflow, regardless of whether individual components are explicitly quantified. In contrast, the recharge method depends on the explicit identification and estimation of each inflow and outflow term introducing large uncertainty. Therefore, Dr. Kincaid's assertion that the recharge method is preferable to the storage method due to fewer variables is conceptually flawed and technically unsupported, whereas the storage method offers a superior and reasonably accurate approach for determining safe yield in IWV Basin and should be considered more reliable.
- Climate change should not be included in determining the safe yield of the Basin, as it is speculative, and safe yield determinations rely on historic records, data and information. The potential for climate changes in the future can be considered in the physical solution for the Basin. However, review of the work by Rybarski and Bacon (2025) indicates results showing an increase in groundwater storage by 2070 in three of the five climate change simulations. Similarly, the USGS IWV-specific BCM study indicates an increase in recharge for two of the three climate models considered, due to the increase in extreme years allowing for the precipitation to exceed the recharge threshold more often. Owens Valley Groundwater Authority simulated one global climate model and that resulted in an increase in groundwater recharge by 2045. These studies contradict Dr. Kincaid's assertion of declining groundwater basin recharge.

4. References

Allander, K.K., Niswonger, R.G., and Jeton, A.E., 2014. Simulation of the Lower Walker River Basin hydrologic system, west-central Nevada, Using PRMS and MODFLOW models: U.S. Geological Survey Scientific Investigations Report 2014-5190, 93 p., *http://dx.doi.org/10.3133/sir20145190*

Alzraiee, A.H., Cromwell, G., and Engott, J.A., 2022. GSFLOW model to evaluate the effect of groundwater pumpage and climate stresses on the integrated hydrologic system of the Yucaipa subbasin, Yucaipa Valley watershed, San Bernardino and Riverside Counties, California: U.S. Geological Survey data release, https://doi.org/10.5066/P9K540DV.

Anderson, T.W., G.W. Freethey and P. Tucci, 1992. Geohydrology and Water Resources of Alluvial Basins in South-Central Arizona and Parts of Adjacent States, US Geological Survey Professional Paper 1406-B, 67 pp.

Bean, R.T., 1989. Hydrogeologic Conditions in Indian Wells Valley and Vicinity. Prepared for California Department of Water Resources, dated February.

Bedekar, V., 2025a. Phase II Report of Vivek Bedekar, PhD, PE. Review of the Numerical Groundwater Model Developed by Ramboll for the Indian Wells Valley (IWV) Groundwater Basin, California. December.

Bedekar, V., 2025b. Phase II Responsive Report of Vivek Bedekar, PhD, PE. December.

Beeby R., Durbin, T., Leever, W., Leffler, P., Scalmanini, J.C., Wildermuth, M., 2010. Summary Expert Report, Phase 3 – Basin Yield and Overdraft, Antelope Valley Area of Adjudication. July.

Berenbrock, C., and P. Martin, 1991. The Ground-Water Flow Systems in Indian Wells Valley, Kern, Inyo, and San Bernardino Counties, California. US Geological Survey Water-Resources Investigations Report 89-4191. Prepared in cooperation with the Indian Wells Valley Water District and the US Department of the Navy, China Lake Naval Weapons Center.

Blakely, R. J., 1995. Potential Theory in Gravity and Magnetic Applications. Cambridge University Press.

California Department of Water Resources (DWR), 2016. Best Management Practices for the Sustainable Management of Groundwater, Water Budget BMP. December.

Collier Geophysics, 2021. Indian Wells Valley Seismic Reprocessing Pilot Study Phase 1 and Phase 2 Combined Report. Prepared for Indian Wells Valley Water District.

Collier Geophysics, 2023. El Paso Basin Seismic Reprocessing Study Report. Prepared for Indian Wells Valley Water District.

DWR, 2016. Best Management Practices for the Sustainable Management of Groundwater - Modeling BMP. December.

DWR, 2020. DRAFT Handbook for Water Budget Development with or without Models. February.

Epstein, B., G.M. Pohll, J. Huntington, and R.W.H. Carroll, 2010. Development and uncertainty analysis of an empirical recharge prediction model for Nevada's desert basins. Nevada Water Resources Association. 5(1): 1-22.

Faunt, C.C., Stamos, C.L., Flint, L.E., Wright, M.T., Burgess, M.K., Sneed, Michelle, Brandt, Justin, Martin, Peter, and Coes, A.L. 2015. Hydrogeology, hydrologic effects of development, and simulation of groundwater flow in the Borrego Valley, San Diego County, California: U.S. Geological Survey Scientific Investigations Report 2015–5150, 135 p., http://dx.doi.org/10.3133/sir20155150.

Gillespie, J., and G. Thyne, 1996. Groundwater Recharge in the Western Indian Wells Valley – Interim Report, dated May 16.

Heath, R.C., 1983. Basic Ground-Water Hydrology. Water Supply Paper 2220.

Kincaid, T, 2025. Expert Opinion of Dr. Todd Kincaid, P.G. Regarding the Safe Yield of the Principal Aquifer in the Indian Wells Valley Groundwater Basin. Mojave Pistachios, LLC; et. al. v. Indian Wells Valley Water District; et. al. Case No. 30-2021-01187275. August 8.

Kunkel, Fred, and G.H. Chase, 1969. Geology and Ground Water in Indian Wells Valley, California. USGS Open-File Report 69-329. Prepared in cooperation with the Naval Weapons Center, China Lake, California. 89pp.

Lee, C.H., 1912, An intensive study of the water resources of a part of Owens Valley, California: U.S. Geological Survey Water-Supply Paper 294, 135 p.

Lowrie, W., 2007. Fundamentals of Geophysics. Cambridge University Press.

McGraw, D., Carroll, R., Pohll, G., Chapman, J., Bacon, S. and R. Jasoni, 2016. Desert Research Institute (DRI), Groundwater Resource Sustainability: Modeling Evaluation for the Naval Air Weapons Station, China Lake, California. Prepared for Naval Air Warfare Center Weapons Division, China Lake. September.

McKenna, SA, 2025. Expert Report of Sean A. McKenna, PhD. In the matter of: Mojave Pistachios, LLC, et al. vs. Indian Wells Valley Water District, et al. Case Number: 30-2021-01187275-CU-OR-CJC. August.

Monastero, F.C., Walker, J.D., Katzenstein, A.M., and A.E. Sabin, 2002. Neogene evolution of the Indian Wells Valley, east-central California, in Glazner, A.F., Walker, J.D., and J.M. Bartley, eds.; Geologic Evolution of the Mojave Desert and Southwestern Basin and Range: Boulder, Colorado, Geological Society of America Memoir 195, pages 199-228.

Owens Valley Groundwater Authority, 2021. Owens Valley Groundwater Basin Final Groundwater Sustainability Plan. December.

Pohlmann K., Garner C., Chapman J., and G. Pohll, 2020. DRI Draft Indian Wells Valley GSP Model Documentation. Appendix 3-H in Indian Wells Valley Groundwater Sustainability Plan. January.

Ramboll, 2024. Storage Estimate – Indian Wells Valley. Prepared for Indian Wells Valley Water District. September 2022, Revised June 2023 and February 2024.

Ramboll, 2025. Indian Wells Valley Groundwater Flow Model, Indian Wells Valley Basin, California. August.

Robson, S. G., 1993. Techniques for estimating specific yield and specific retention from grain-size data and geophysical logs from clastic bedrock aquifers, U. S. Geological Survey Water-Resources Investigations Report, WRI 93-4198, 19 pp., 1993.

Rybasrski., S.C., and S.N. Bacon, 2025. Documentation of the Indian Wells Valley 2025 Basin Groundwater Model Update. Prepared by Division of Hydrologic Science, Desert Research Institute, Reno, Nevada.

Saleh, D., L. Flint, and M. Stern, 2021. Assessing Natural Recharge in Indian Wells Valley, California: A Basin Characterization Model Case Study. Unpublished draft.

Shah, A.K, and Boyd, O.S., 2018. Depth to basement and thickness of unconsolidated sediments for the western United States—Initial estimates for layers of the U.S. Geological Survey National Crustal Model: U.S. Geological Survey Open-File Report 2018–1115, 13 p.

Siade, A.J., Nishikawa, Tracy, Rewis, D.L., Martin, Peter, and Phillips, S.P., 2014. Groundwater-flow and land-subsidence model of Antelope Valley, California: U.S. Geological Survey, Scientific Investigations Report 2014–5166, 136 p., *http://dx.doi.org/10.3133/sir20145166.*

Stamos, C.L., P. Martin, T. Nishikawa, and B.F. Cox, 2001. Simulation of Ground-Water Flow in the Mojave River Basin, California. U. S. Geological Survey Water-Resources Investigations Report 01-4002 Version 3. Prepared in cooperation with the Mojave Water Agency.

Stamos, C.L., Larsen, J.D., Powell, R.E., Matti, J.C., and Martin, P., 2022. Hydrogeology and simulation of groundwater flow in the Lucerne Valley groundwater basin, California: U.S. Geological Survey Scientific Investigations Report 2022–5048, 120 p., *https://doi.org/10.3133/sir20225048*.

Stetson Engineers, Inc., 2017. DRAFT Review of the Indian Wells Valley Groundwater Basin Model documented in Groundwater Resource Sustainability: Modeling Evaluation for the Naval Air Weapons Station, China Lake, California, by Desert Research Institute, September 2016 for Naval Air Warfare Center Weapons Division. December 6.

Teasdale, E.W., 2025. Expert Report on Safe Yield for Indian Wells Valley Groundwater Basin. August.

Indian Wells Valley Technical Working Group (TWG), 2024. Assessment of Safe Yield for the Indian Wells Valley Groundwater Basin. Indian Wells Valley Technical Working Group. September.

Telford, W. M., Geldart, L. P., & Sheriff, R. E., 1990. Applied Geophysics (2nd ed.). Cambridge University Press.

Tetra Tech EM Inc., 2003. Base-wide Hydrogeologic Characterization Summary Report at the Naval Weapons Station, China Lake, CA.

Todd, D.K., 1980. Groundwater Hydrology, 2nd ed., New York: John Wiley & Sons.

Todd Engineers, 2014. Indian Wells Valley Resource Opportunity Plan – Water Availability and Conservation Report. Prepared for Kern County Planning & Community Development Department, dated January 22.

Tonkin, M.J., 2025a. Phase II Report of Matthew J. Tonkin, PhD. Evaluation of the Safe Yield and Storage Properties of the Indian Wells Valley (IWV) Basin, California. August.

Tonkin, M.J. 2025b. Phase II Responsive Report of Matthew J. Tonkin, PhD. Responsive Opinions on the Safe Yield and Storage Properties of the Indian Wells Valley (IWV) Basin, California. December.

Traum, J.A., Teague, N.F., Sweetkind, D.S., and Nishikawa, T., 2022, Hydrologic and geochemical characterization of the Petaluma River watershed, Sonoma County, California: U.S. Geological Survey Scientific Investigations Report 2022–5009, 217 p., https://doi.org/ 10.3133/ sir20225009.

US Geological Survey (USGS), 1967. USGS Water Survey Paper, Publication 1662d.

USGS, 2004. Guidelines for Evaluating Ground-Water Flow Models U.S. Geological Survey Scientific Investigations Report 2004-5038. Reilly, T.E. and A.W. Harbaugh.

Yeh, JY and Wicks, L, 2025. Expert Report of Johnson Yeh, PhD, PG, CHG and Lauren Wicks, PG. MOJAVE PISTACHIOS, LLC; ET AL. V. INDIAN WELLS VALLEY WATER DISTRICT; ET AL. (CASE NO. 30-2021-01187275-CU-OR-CJC). August 15.

Watt, 1993. Estimating Recharge Distribution to Indian Wells Based on Vegetation Distribution in the Recharge Watershed. Appendix I in U.S. Bureau of Reclamation, 1993. Indian Wells Valley Groundwater Project: USBR Technical Report Volumes I and II.

Appendix 1 – SNORT 2 Lithology

HORIZON WELL LOGGING
(805)736-2114,(209)561-3421

Geothermal Mudlog

Company: U.S. NAVY

Well: SDS#2

Field: SNORT #2

Region: China Lake

Location:

County & State: [redacted]

Navy Rep. Kenneth Bonin Sr.

Elevation: 'G.L., 'K.B.

All Depths from K.B.

Spud Date: 6-7-94
Log Dates: 6-8-94 to
Log Depths: 512' to
Log Scale: 2"=100'
Logging Geologists:
Lewis Sutfin, Bill Gilmour

Hole Sizes

17.5" to 512'
12.25" to
6.125" to

Casing Sizes

13.375" @ 503'
9.625" @

Mud Types

Drilling Rig

Contractor: Welch & Howell #10
Pumps: #1 6.5 x 8, .082bbl/stk
#2 6.5 x 8, .082bbl/stk

Lithology Legend

CLAY	SAND	TUFF	GRNSTONE	VOLCANI-CLASTICS
CLAYSTONE	CONGL	RHYOLITE	PHYLLITE	SHELLS
SHALE	LIMESTONE	ANDESITE	QUARTZITE	CALCITE
SILTSTONE	DOLOSTONE	BASALT	PLUTONIC RX	

Rotary Torque & Fractures are Denoted by:
(:)=trace, (|)=strong trace
(x)=common, (X)=abundant

Number W/I Minerals Column are Expressed as % where
(-)=<1%, & (+)=>9%

ROP ———
WOB ----W----W--

DEPTH | LITHOLOGY | TORQUE | FRACTURES | MUD LOSS Bbls/Hr.

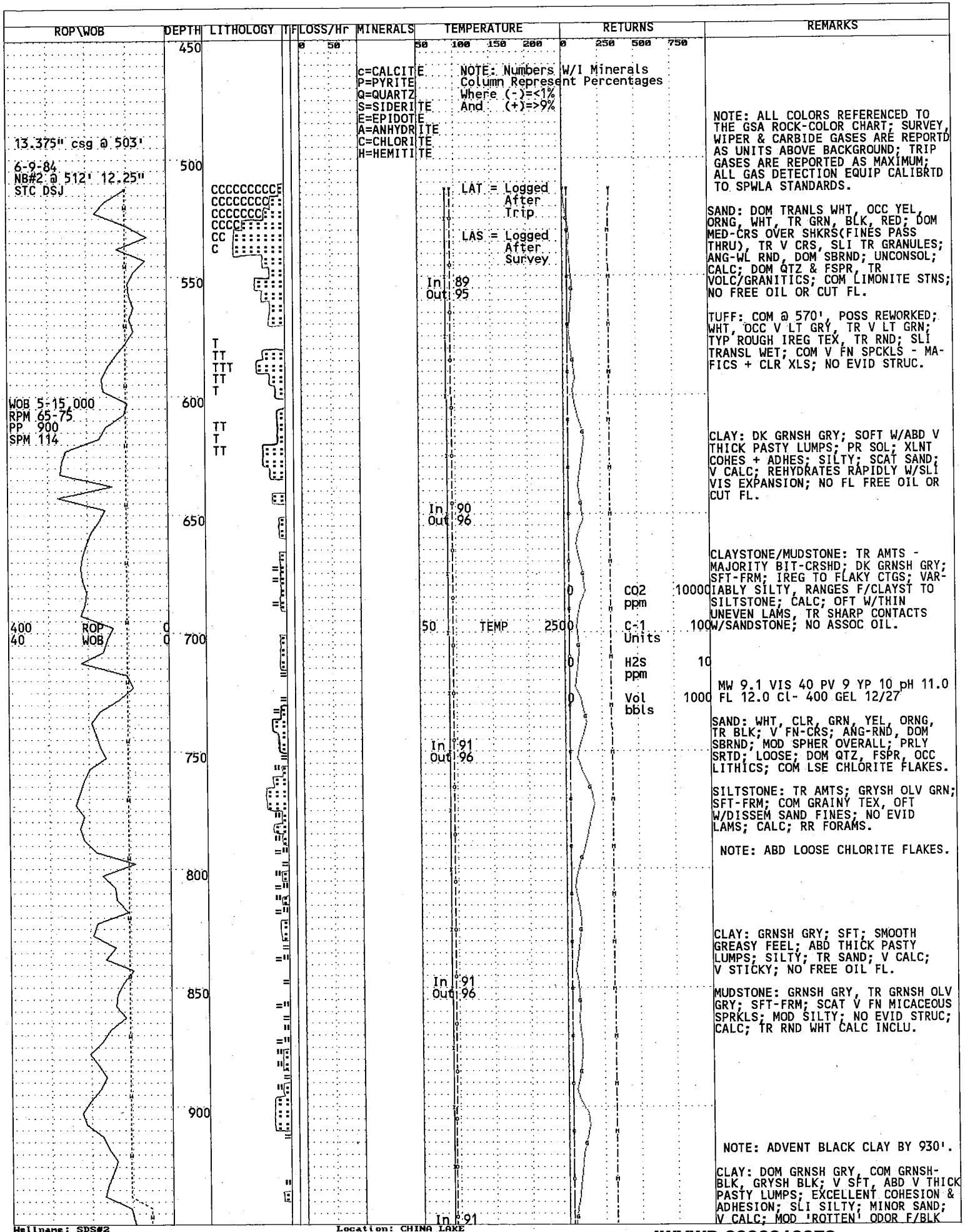
c=CHLORITE
P=PYRITE
Q=QUARTZ
S=SERICITE
E=EPIDOTE
A=ANHYDRITE
C=CHLORITE
H=HEMATITE
#=PERCENT

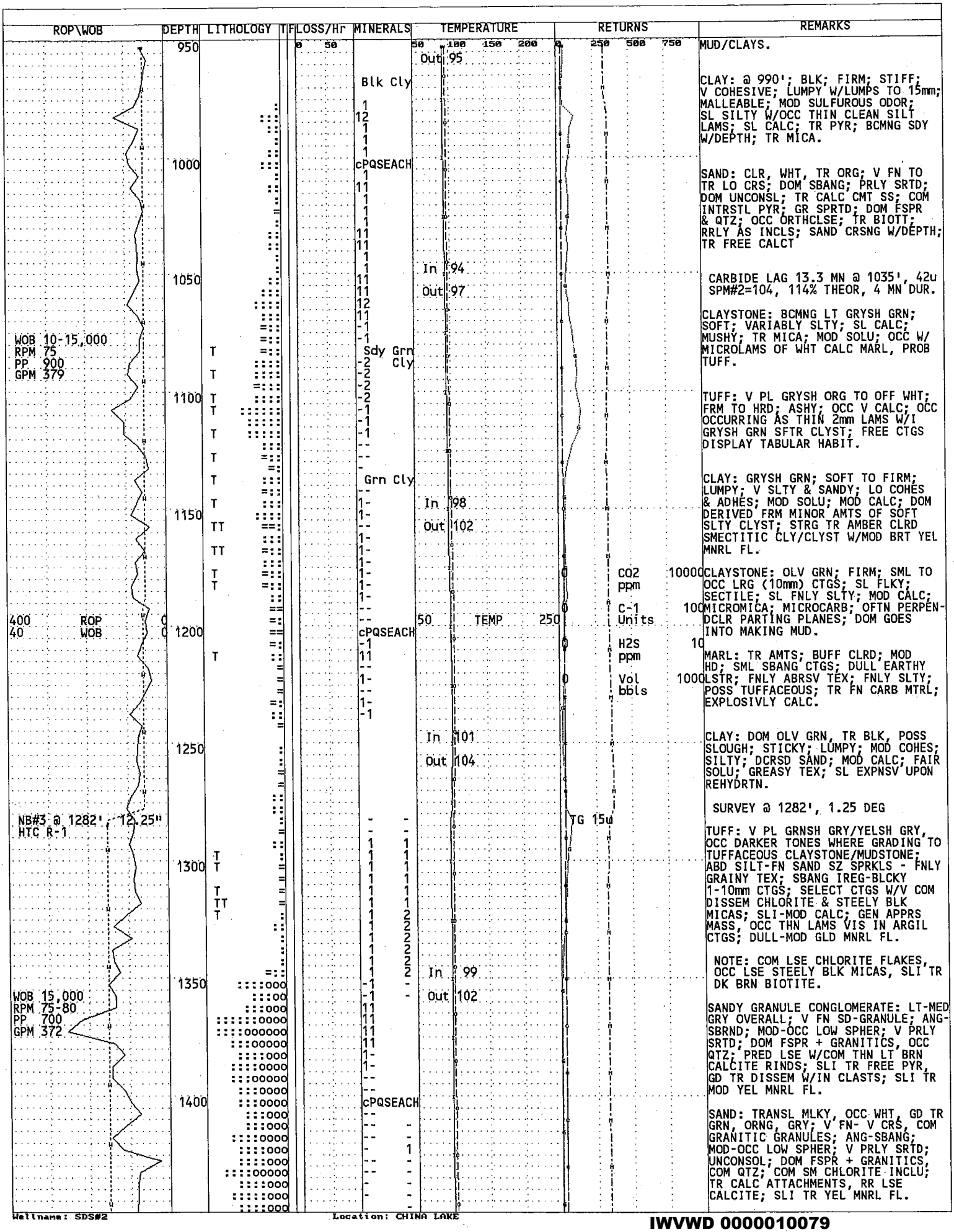
50 Temp F 250
TEMPERATURE IN —|—
TEMPERATURE OUT--o--

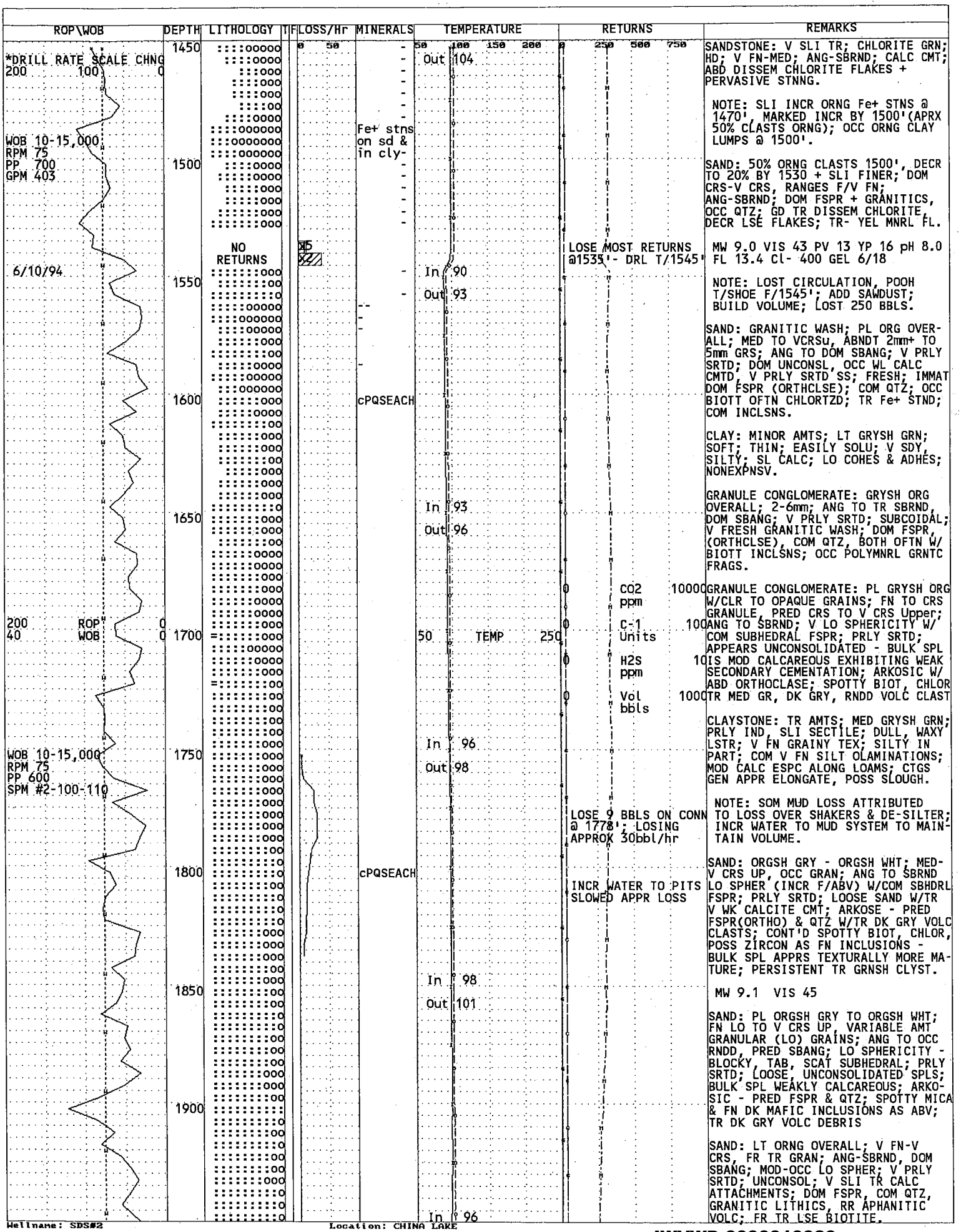
0	MUD VOLUME Bbls	800
0	CO2 ppm	8000
0	C-1 ppm	8000
0	H2S ppm	80

REMARKS

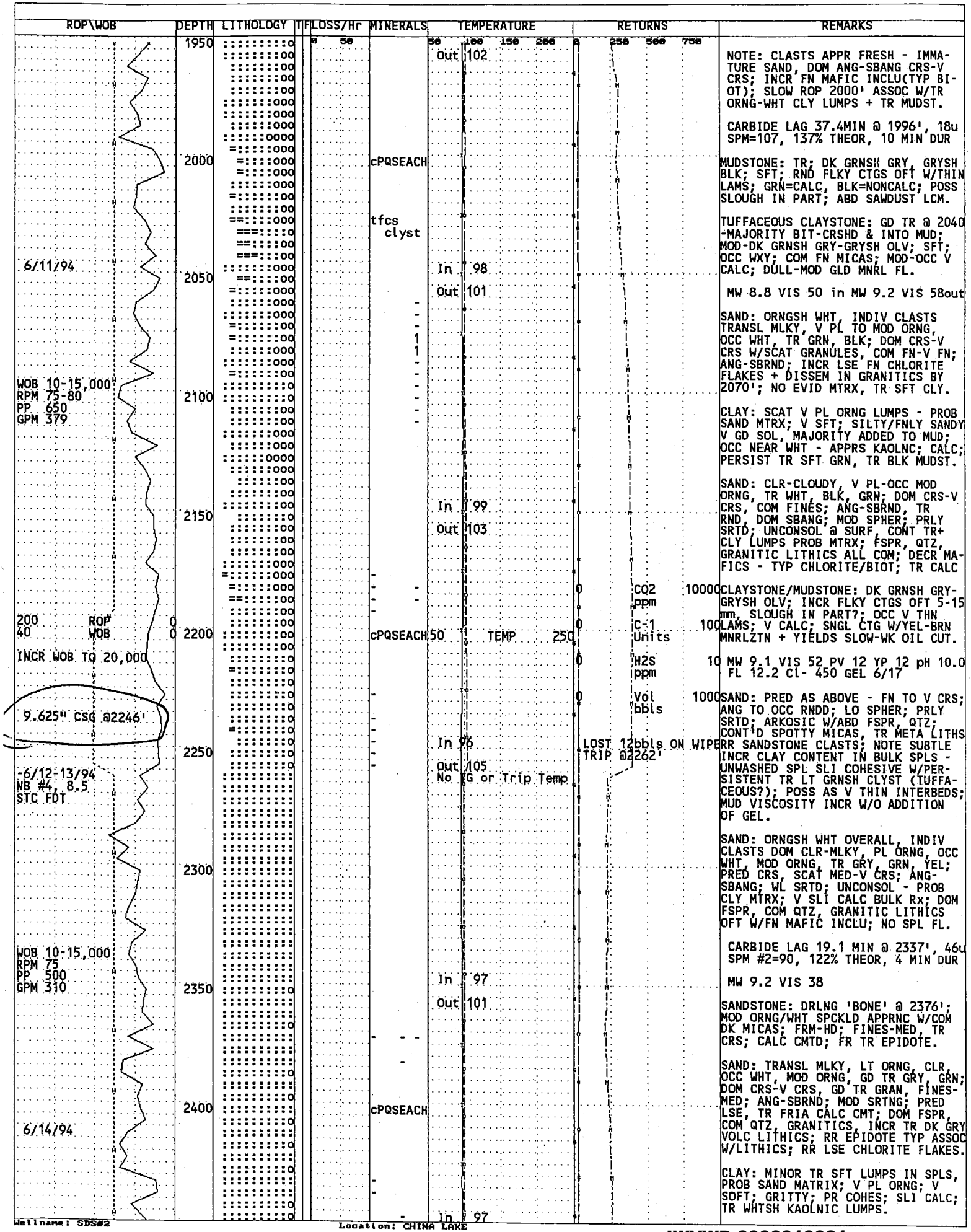
IWVWD 0000010077

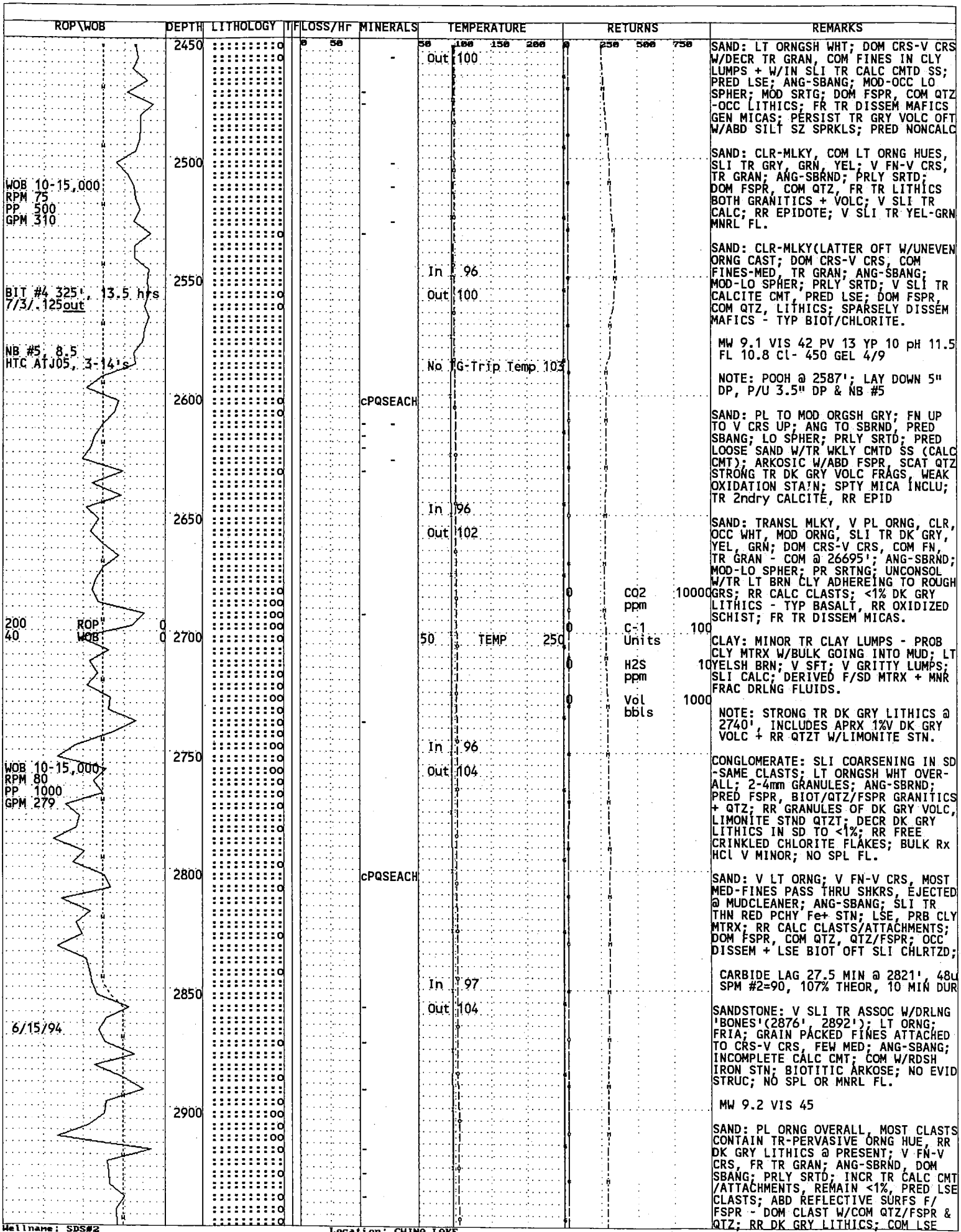



ROP\WOB
DEPTH
LITHOLOGY
T
FLOSS/Hr
MINERALS
TEMPERATURE
RETURNS
REMARKS
MUD/CLAYS.
CLAY: @ 990'; BLK; FIRM; STIFF; V COHESIVE; LUMPY W/LUMPS TO 15mm; MALLEABLE; MOD SULFUROUS ODOR; SL SILTY W/OCC THIN CLEAN SILT LAMS; SL CALC; TR PYR; BCMNG SDY W/DEPTH; TR MICA.
SAND: CLR, WHT, TR ORG; V FN TO TR LO CRS; DOM SBANG; PRLY SRTD; DOM UNCONSL; TR CALC CMT SS; COM INTRSTL PYR; GR SPRTD; DOM FSPR & QTZ; OCC ORTHCLSE; TR BIOTT; RRLY AS INCLS; SAND CRSNG W/DEPTH; TR FREE CALCT
CARBIDE LAG 13.3 MN @ 1035', 42u SPM#2=104, 114% THEOR, 4 MN DUR.
CLAYSTONE: BCMNG LT GRYSH GRN; SOFT; VARIABLY SLTY; SL CALC; MUSHY; TR MICA; MOD SOLU; OCC W/ MICROLAMS OF WHT CALC MARL, PROB TUFF.
TUFF: V PL GRYSH ORG TO OFF WHT; FRM TO HRD; ASHY; OCC V CALC; OCC OCCURRING AS THIN 2mm LAMS W/I GRYSH GRN SFTR CLYST; FREE CTGS DISPLAY TABULAR HABIT.
CLAY: GRYSH GRN; SOFT TO FIRM; LUMPY; V SLTY & SANDY; LO COHES & ADHES; MOD SOLU; MOD CALC; DOM DERIVED FRM MINOR AMTS OF SOFT SLTY CLYST; STRG TR AMBER CLRD SMECTITIC CLY/CLYST W/MOD BRT YEL MNRL FL.
CLAYSTONE: OLV GRN; FIRM; SML TO OCC LRG (10mm) CTGS; SL FLKY; SECTILE; SL FNLY SLTY; MOD CALC; MICROMICA; MICROCARB; OFTN PERPEN-DCLR PARTING PLANES; DOM GOES INTO MAKING MUD.
MARL: TR AMTS; BUFF CLRD; MOD HD; SML SBANG CTGS; DULL EARTHY LSTR; FNLY ABRSV TEX; FNLY SLTY; POSS TUFFACEOUS; TR FN CARB MTRL; EXPLOSIVLY CALC.
CLAY: DOM OLV GRN, TR BLK, POSS SLOUGH; STICKY; LUMPY; MOD COHES; SILTY; DCRSD SAND; MOD CALC; FAIR SOLU; GREASY TEX; SL EXPNSV UPON REHYDRTN.
SURVEY @ 1282', 1.25 DEG
TUFF: V PL GRNSH GRY/YELSH GRY, OCC DARKER TONES WHERE GRADING TO TUFFACEOUS CLAYSTONE/MUDSTONE; ABD SILT-FN SAND SZ SPRKLS - FNLY GRAINY TEX; SBANG IREG-BLCKY 1-10mm CTGS; SELECT CTGS W/V COM DISSEM CHLORITE & STEELY BLK MICAS; SLI-MOD CALC; GEN APPRS MASS, OCC THN LAMS VIS IN ARGIL CTGS; DULL-MOD GLD MNRL FL.
NOTE: COM LSE CHLORITE FLAKES, OCC LSE STEELY BLK MICAS, SLI TR DK BRN BIOTITE.
SANDY GRANULE CONGLOMERATE: LT-MED GRY OVERALL; V FN SD-GRANULE; ANG-SBRND; MOD-OCC LOW SPHER; V PRLY SRTD; DOM FSPR + GRANITICS, OCC QTZ; PRED LSE W/COM THN LT BRN CALCITE RINDS; SLI TR FREE PYR, GD TR DISSEM W/IN CLASTS; SLI TR MOD YEL MNRL FL.
SAND: TRANSL MLKY, OCC WHT, GD TR GRN, ORNG, GRY; V FN- V CRS, COM GRANITIC GRANULES; ANG-SBANG; MOD-OCC LOW SPHER; V PRLY SRTD; UNCONSOL; DOM FSPR + GRANITICS, COM QTZ; COM SM CHLORITE INCLU; TR CALC ATTACHMENTS, RR LSE CALCITE; SLI TR YEL MNRL FL.
WOB 10-15,000
RPM 75
PP 900
GPM 379
NB#3 @ 1282', 12.25"
HTC R-1
WOB 15,000
RPM 75-80
PP 700
GPM 372
400 ROP 0
40 WOB 0
Out 95
Blk Cly
In 94
Out 97
Sdy Grn Cly
In 98
Out 102
Grn Cly
50 TEMP 250
In 101
Out 104
In 99
Out 102
CO2 ppm 10000
C-1 Units 100
H2S ppm 10
Vol bbls 1000
TG 15u
Wellname: SDS#2
Location: CHINA LAKE

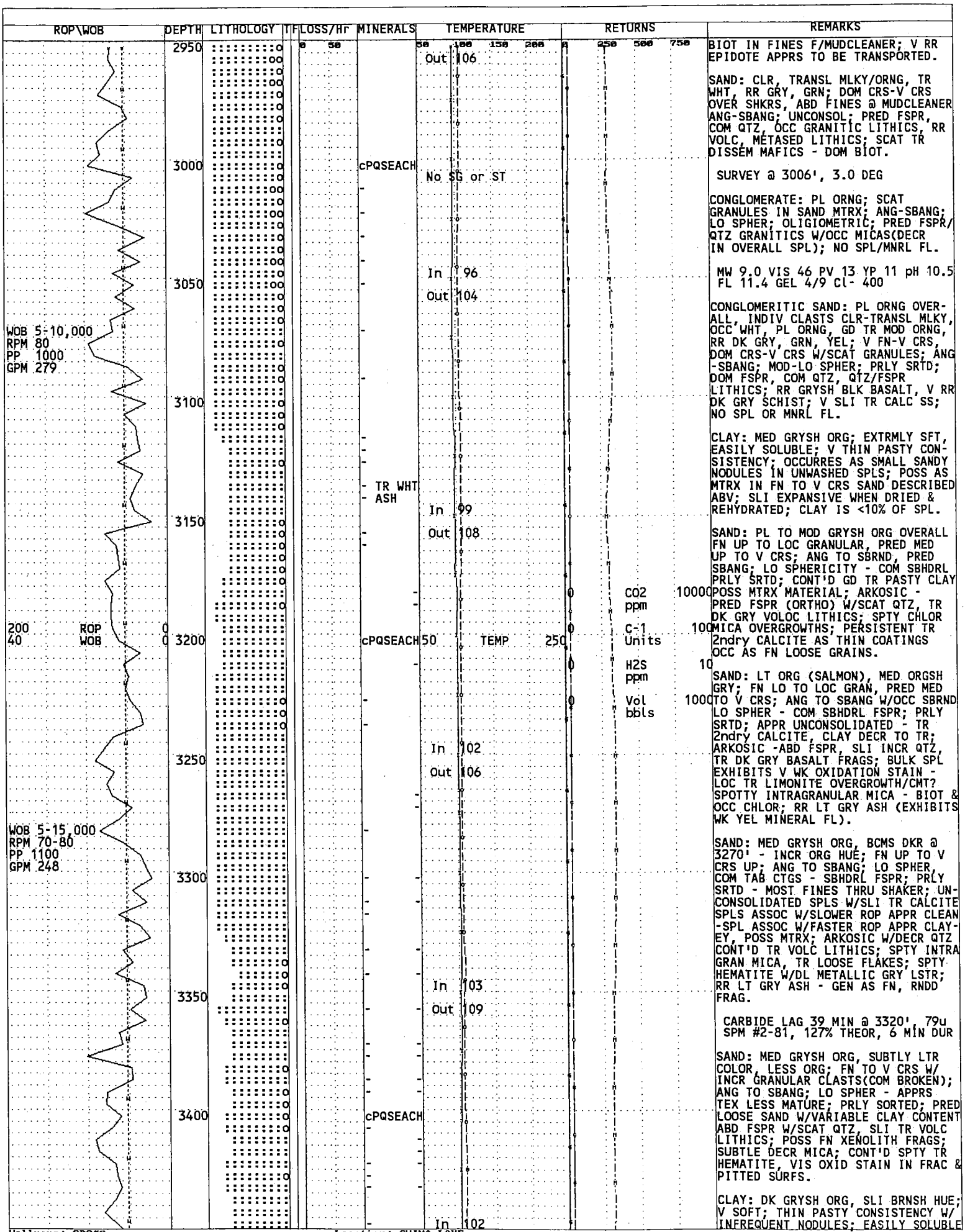


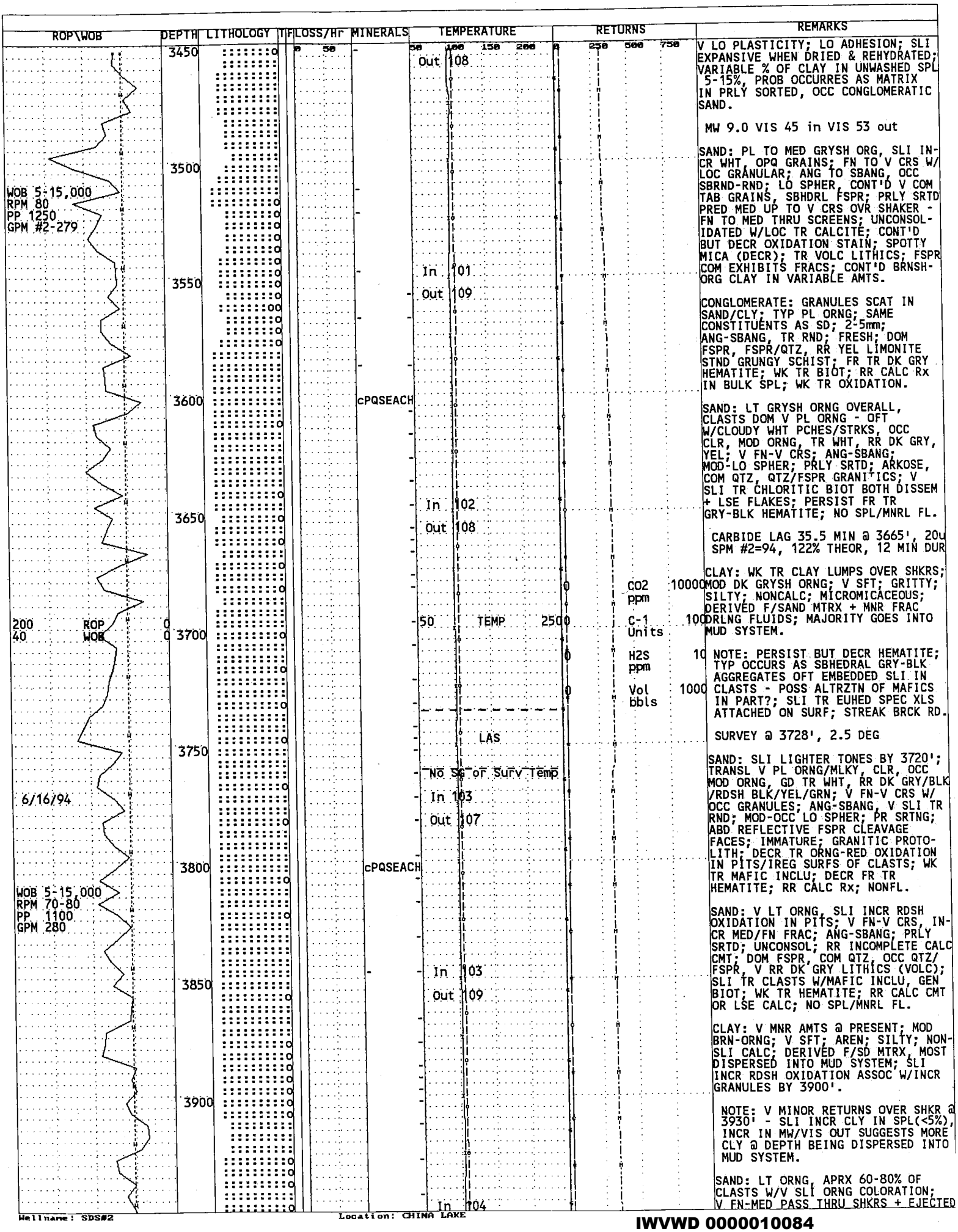
Wellname: SDS#2 Location: CHINA LAKE

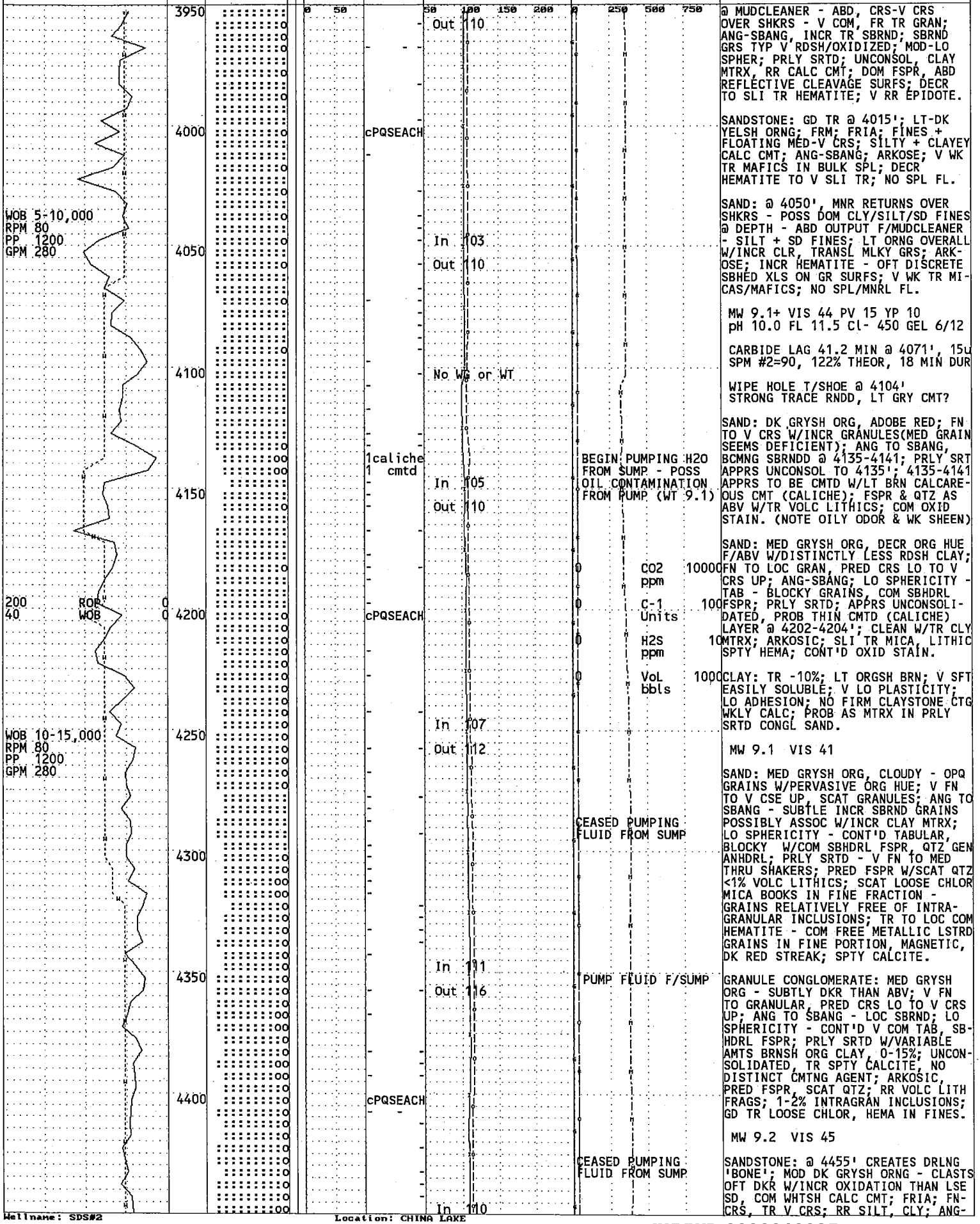


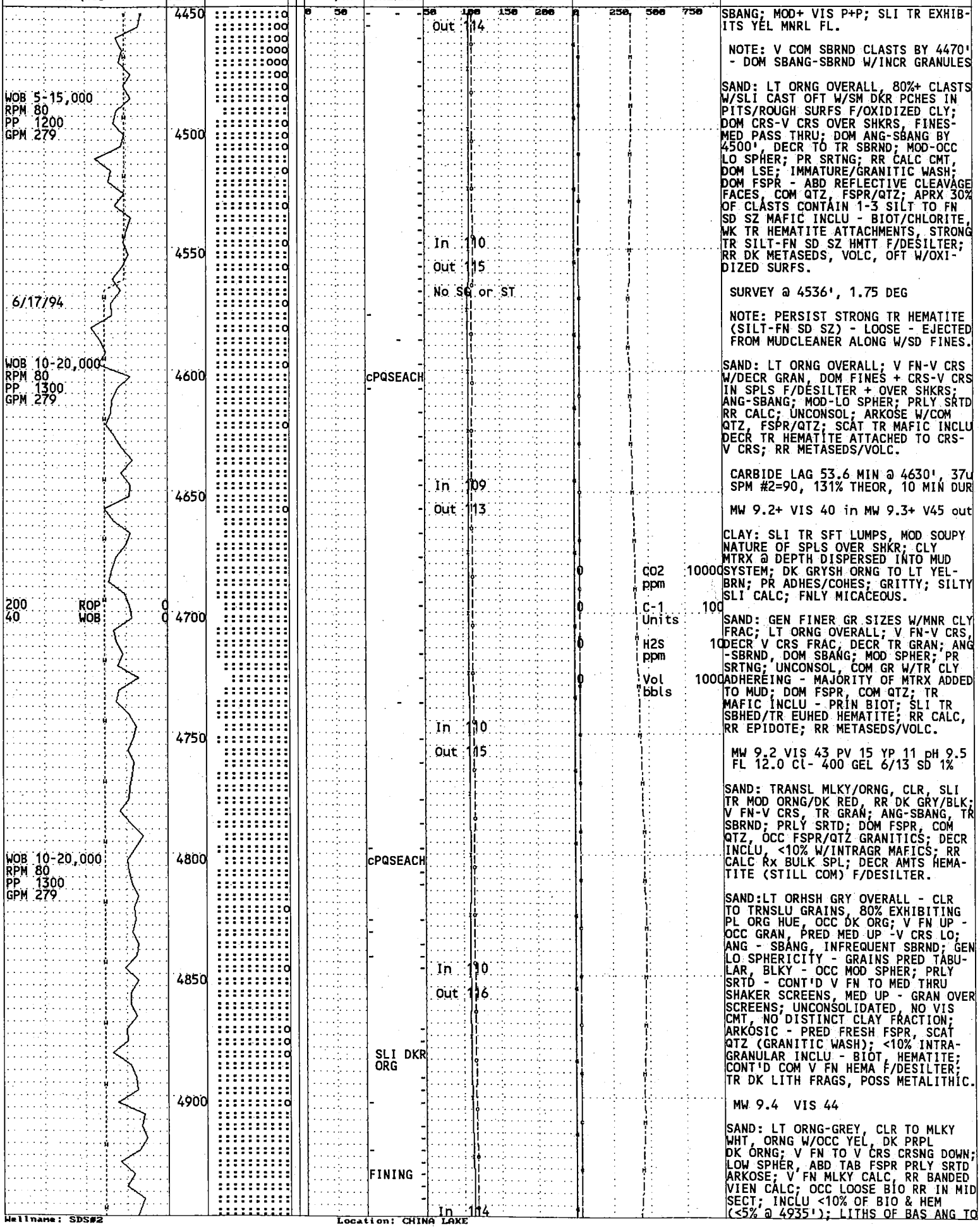


Wellname: SDS#2 Location: CHINA LAKE

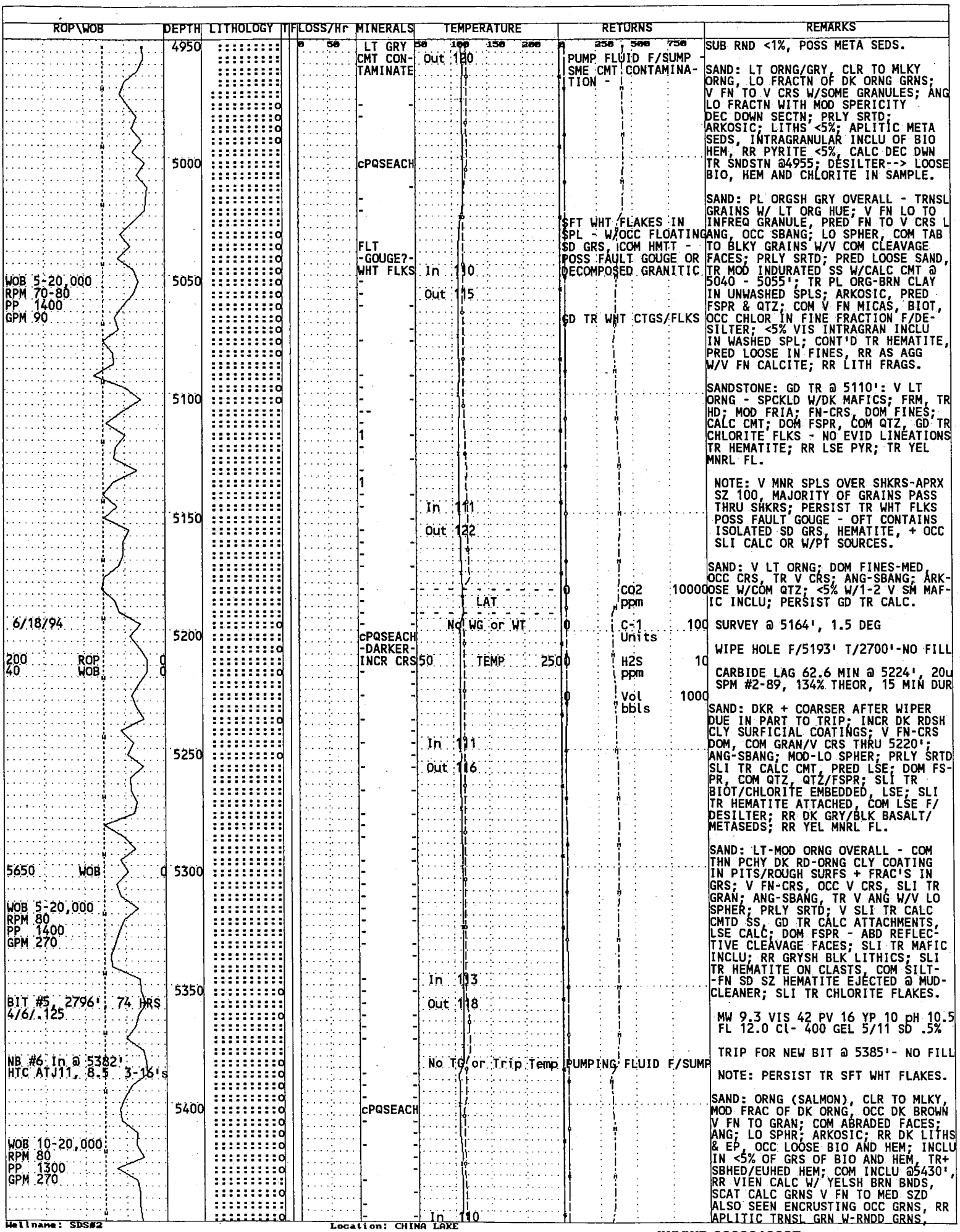

ROP\WOB
DEPTH
LITHOLOGY
TF
LOSS/Hr
0 50
MINERALS
TEMPERATURE
50 100 150 200
RETURNS
0 250 500 750
REMARKS
2950
3000
3050
3100
3150
3200
3250
3300
3350
3400
Out 106
cPQSEACH
No SG or ST
In 96
Out 104
WOB 5-10,000
RPM 80
PP 1000
GPM 279
TR WHT
ASH
In 99
Out 108
CO2 10000
ppm
200 ROP 0
40 WOB 0
cPQSEACH
50 TEMP 250
C-1 100
Units
H2S 10
ppm
Vol 1000
bbls
In 102
Out 106
WOB 5-15,000
RPM 70-80
PP 1100
GPM 248
In 103
Out 109
cPQSEACH
In 102
BIOT IN FINES F/MUDCLEANER; V RR EPIDOTE APPRS TO BE TRANSPORTED.
SAND: CLR, TRANSL MLKY/ORNG, TR WHT, RR GRY, GRN; DOM CRS-V CRS OVER SHKRS, ABD FINES @ MUDCLEANER ANG-SBANG; UNCONSOL; PRED FSPR, COM QTZ, OCC GRANITIC LITHICS, RR VOLC, METASED LITHICS; SCAT TR DISSEM MAFICS - DOM BIOT.
SURVEY @ 3006', 3.0 DEG
CONGLOMERATE: PL ORNG; SCAT GRANULES IN SAND MTRX; ANG-SBANG; LO SPHER; OLIGIOMETRIC; PRED FSPR/QTZ GRANITICS W/OCC MICAS(DECR IN OVERALL SPL); NO SPL/MNRL FL.
MW 9.0 VIS 46 PV 13 YP 11 pH 10.5 FL 11.4 GEL 4/9 Cl- 400
CONGLOMERITIC SAND: PL ORNG OVERALL, INDIV CLASTS CLR-TRANSL MLKY, OCC WHT, PL ORNG, GD TR MOD ORNG, RR DK GRY, GRN, YEL; V FN-V CRS, DOM CRS-V CRS W/SCAT GRANULES; ANG-SBANG; MOD-LO SPHER; PRLY SRTD; DOM FSPR, COM QTZ, QTZ/FSPR LITHICS; RR GRYSH BLK BASALT, V RR DK GRY SCHIST; V SLI TR CALC SS; NO SPL OR MNRL FL.
CLAY: MED GRYSH ORG; EXTRMLY SFT, EASILY SOLUBLE; V THIN PASTY CONSISTENCY; OCCURRES AS SMALL SANDY NODULES IN UNWASHED SPLS; POSS AS MTRX IN FN TO V CRS SAND DESCRIBED ABV; SLI EXPANSIVE WHEN DRIED & REHYDRATED; CLAY IS <10% OF SPL.
SAND: PL TO MOD GRYSH ORG OVERALL FN UP TO LOC GRANULAR, PRED MED UP TO V CRS; ANG TO SBRND, PRED SBANG; LO SPHERICITY - COM SBHDRL PRLY SRTD; CONT'D GD TR PASTY CLAY POSS MTRX MATERIAL; ARKOSIC - PRED FSPR (ORTHO) W/SCAT QTZ, TR DK GRY VOLOC LITHICS; SPTY CHLOR MICA OVERGROWTHS; PERSISTENT TR 2ndry CALCITE AS THIN COATINGS OCC AS FN LOOSE GRAINS.
SAND: LT ORG (SALMON), MED ORGSH GRY; FN LO TO LOC GRAN, PRED MED TO V CRS; ANG TO SBANG W/OCC SBRND LO SPHER - COM SBHDRL FSPR; PRLY SRTD; APPR UNCONSOLIDATED - TR 2ndry CALCITE, CLAY DECR TO TR; ARKOSIC -ABD FSPR, SLI INCR QTZ, TR DK GRY BASALT FRAGS; BULK SPL EXHIBITS V WK OXIDATION STAIN - LOC TR LIMONITE OVERGROWTH/CMT? SPOTTY INTRAGRANULAR MICA - BIOT & OCC CHLOR; RR LT GRY ASH (EXHIBITS WK YEL MINERAL FL).
SAND: MED GRYSH ORG, BCMS DKR @ 3270' - INCR ORG HUE; FN UP TO V CRS UP; ANG TO SBANG; LO SPHER, COM TAB CTGS - SBHDRL FSPR; PRLY SRTD - MOST FINES THRU SHAKER; UNCONSOLIDATED SPLS W/SLI TR CALCITE SPLS ASSOC W/SLOWER ROP APPR CLEAN-SPL ASSOC W/FASTER ROP APPR CLAYEY, POSS MTRX; ARKOSIC W/DECR QTZ CONT'D TR VOLC LITHICS; SPTY INTRA GRAN MICA, TR LOOSE FLAKES; SPTY HEMATITE W/DL METALLIC GRY LSTR; RR LT GRY ASH - GEN AS FN, RNDD FRAG.
CARBIDE LAG 39 MIN @ 3320', 79u SPM #2-81, 127% THEOR, 6 MIN DUR
SAND: MED GRYSH ORG, SUBTLY LTR COLOR, LESS ORG; FN TO V CRS W/ INCR GRANULAR CLASTS(COM BROKEN); ANG TO SBANG; LO SPHER - APPRS TEX LESS MATURE; PRLY SORTED; PRED LOOSE SAND W/VARIABLE CLAY CONTENT ABD FSPR W/SCAT QTZ, SLI TR VOLC LITHICS; POSS FN XENOLITH FRAGS; SUBTLE DECR MICA; CONT'D SPTY TR HEMATITE, VIS OXID STAIN IN FRAC & PITTED SURFS.
CLAY: DK GRYSH ORG, SLI BRNSH HUE; V SOFT; THIN PASTY CONSISTENCY W/ INFREQUENT NODULES; EASILY SOLUBLE
Wellname: SDS#2
Location: CHINA LAKE

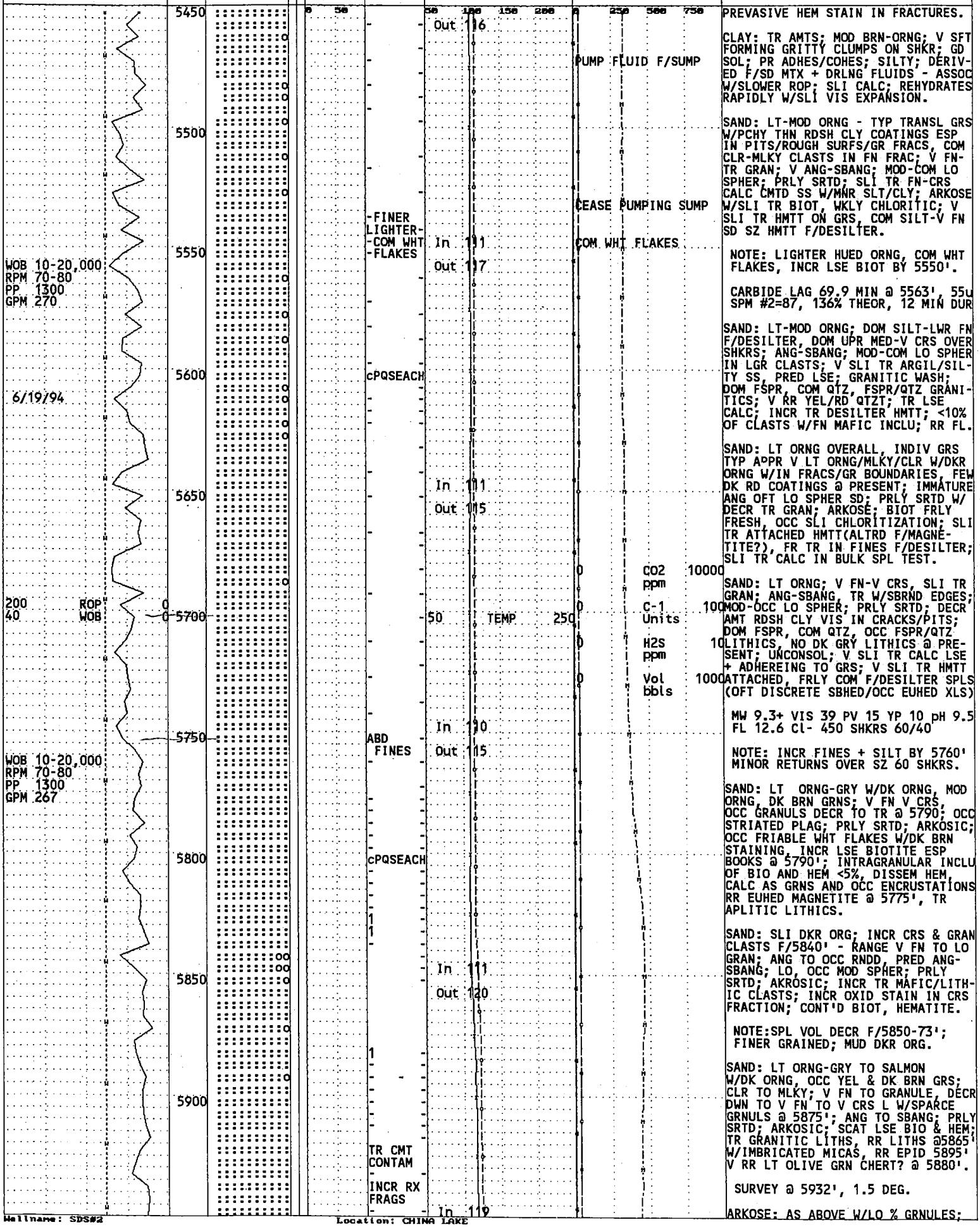

ROP\WOB
DEPTH
LITHOLOGY
TF
LOSS/Hr
MINERALS
TEMPERATURE
RETURNS
REMARKS
3450
3500
3550
3600
3650
3700
3750
3800
3850
3900
WOB 5-15,000
RPM 80
PP 1250
GPM #2-279
200 ROP 0
40 WOB 0
6/16/94
WOB 5-15,000
RPM 70-80
PP 1100
GPM 280
Out 108
In 101
Out 109
cPQSEACH
In 102
Out 108
50 TEMP 250
LAS
No SG or Surv Temp
In 103
Out 107
cPQSEACH
In 103
Out 109
In 104
CO2 10000 ppm
C-1 100 Units
H2S 10 ppm
Vol 1000 bbls
V LO PLASTICITY; LO ADHESION; SLI EXPANSIVE WHEN DRIED & REHYDRATED; VARIABLE % OF CLAY IN UNWASHED SPL 5-15%, PROB OCCURRES AS MATRIX IN PRLY SORTED, OCC CONGLOMERATIC SAND.
MW 9.0 VIS 45 in VIS 53 out
SAND: PL TO MED GRYSH ORG, SLI INCR WHT, OPQ GRAINS; FN TO V CRS W/ LOC GRANULAR; ANG TO SBANG, OCC SBRND-RND; LO SPHER, CONT'D V COM TAB GRAINS, SBHDRL FSPR; PRLY SRTD PRED MED UP TO V CRS OVR SHAKER - FN TO MED THRU SCREENS; UNCONSOLIDATED W/LOC TR CALCITE; CONT'D BUT DECR OXIDATION STAIN; SPOTTY MICA (DECR); TR VOLC LITHICS; FSPR COM EXHIBITS FRACS; CONT'D BRNSH-ORG CLAY IN VARIABLE AMTS.
CONGLOMERATE: GRANULES SCAT IN SAND/CLY; TYP PL ORNG; SAME CONSTITUENTS AS SD; 2-5mm; ANG-SBANG, TR RND; FRESH; DOM FSPR, FSPR/QTZ, RR YEL LIMONITE STND GRUNGY SCHIST; FR TR DK GRY HEMATITE; WK TR BIOT; RR CALC Rx IN BULK SPL; WK TR OXIDATION.
SAND: LT GRYSH ORNG OVERALL, CLASTS DOM V PL ORNG - OFT W/CLOUDY WHT PCHES/STRKS, OCC CLR, MOD ORNG, TR WHT, RR DK GRY, YEL; V FN-V CRS; ANG-SBANG; MOD-LO SPHER; PRLY SRTD; ARKOSE, COM QTZ, QTZ/FSPR GRANITICS; V SLI TR CHLORITIC BIOT BOTH DISSEM + LSE FLAKES; PERSIST FR TR GRY-BLK HEMATITE; NO SPL/MNRL FL.
CARBIDE LAG 35.5 MIN @ 3665', 20u SPM #2=94, 122% THEOR, 12 MIN DUR
CLAY: WK TR CLAY LUMPS OVER SHKRS; MOD DK GRYSH ORNG; V SFT; GRITTY; SILTY; NONCALC; MICROMICACEOUS; DERIVED F/SAND MTRX + MNR FRAC DRLNG FLUIDS; MAJORITY GOES INTO MUD SYSTEM.
NOTE: PERSIST BUT DECR HEMATITE; TYP OCCURS AS SBHEDRAL GRY-BLK AGGREGATES OFT EMBEDDED SLI IN CLASTS - POSS ALTRZTN OF MAFICS IN PART?; SLI TR EUHED SPEC XLS ATTACHED ON SURF; STREAK BRCK RD.
SURVEY @ 3728', 2.5 DEG
SAND: SLI LIGHTER TONES BY 3720'; TRANSL V PL ORNG/MLKY, CLR, OCC MOD ORNG, GD TR WHT, RR DK GRY/BLK /RDSH BLK/YEL/GRN; V FN-V CRS W/ OCC GRANULES; ANG-SBANG, V SLI TR RND; MOD-OCC LO SPHER; PR SRTNG; ABD REFLECTIVE FSPR CLEAVAGE FACES; IMMATURE; GRANITIC PROTOLITH; DECR TR ORNG-RED OXIDATION IN PITS/IREG SURFS OF CLASTS; WK TR MAFIC INCLU; DECR FR TR HEMATITE; RR CALC Rx; NONFL.
SAND: V LT ORNG, SLI INCR RDSH OXIDATION IN PITS; V FN-V CRS, INCR MED/FN FRAC; ANG-SBANG; PRLY SRTD; UNCONSOL; RR INCOMPLETE CALC CMT; DOM FSPR, COM QTZ, OCC QTZ/FSPR, V RR DK GRY LITHICS (VOLC); SLI TR CLASTS W/MAFIC INCLU, GEN BIOT; WK TR HEMATITE; RR CALC CMT OR LSE CALC; NO SPL/MNRL FL.
CLAY: V MNR AMTS @ PRESENT; MOD BRN-ORNG; V SFT; AREN; SILTY; NON-SLI CALC; DERIVED F/SD MTRX, MOST DISPERSED INTO MUD SYSTEM; SLI INCR RDSH OXIDATION ASSOC W/INCR GRANULES BY 3900'.
NOTE: V MINOR RETURNS OVER SHKR @ 3930' - SLI INCR CLY IN SPL(<5%), INCR IN MW/VIS OUT SUGGESTS MORE CLY @ DEPTH BEING DISPERSED INTO MUD SYSTEM.
SAND: LT ORNG, APRX 60-80% OF CLASTS W/V SLI ORNG COLORATION; V FN-MED PASS THRU SHKRS + EJECTED
Wellname: SDS#2
Location: CHINA LAKE



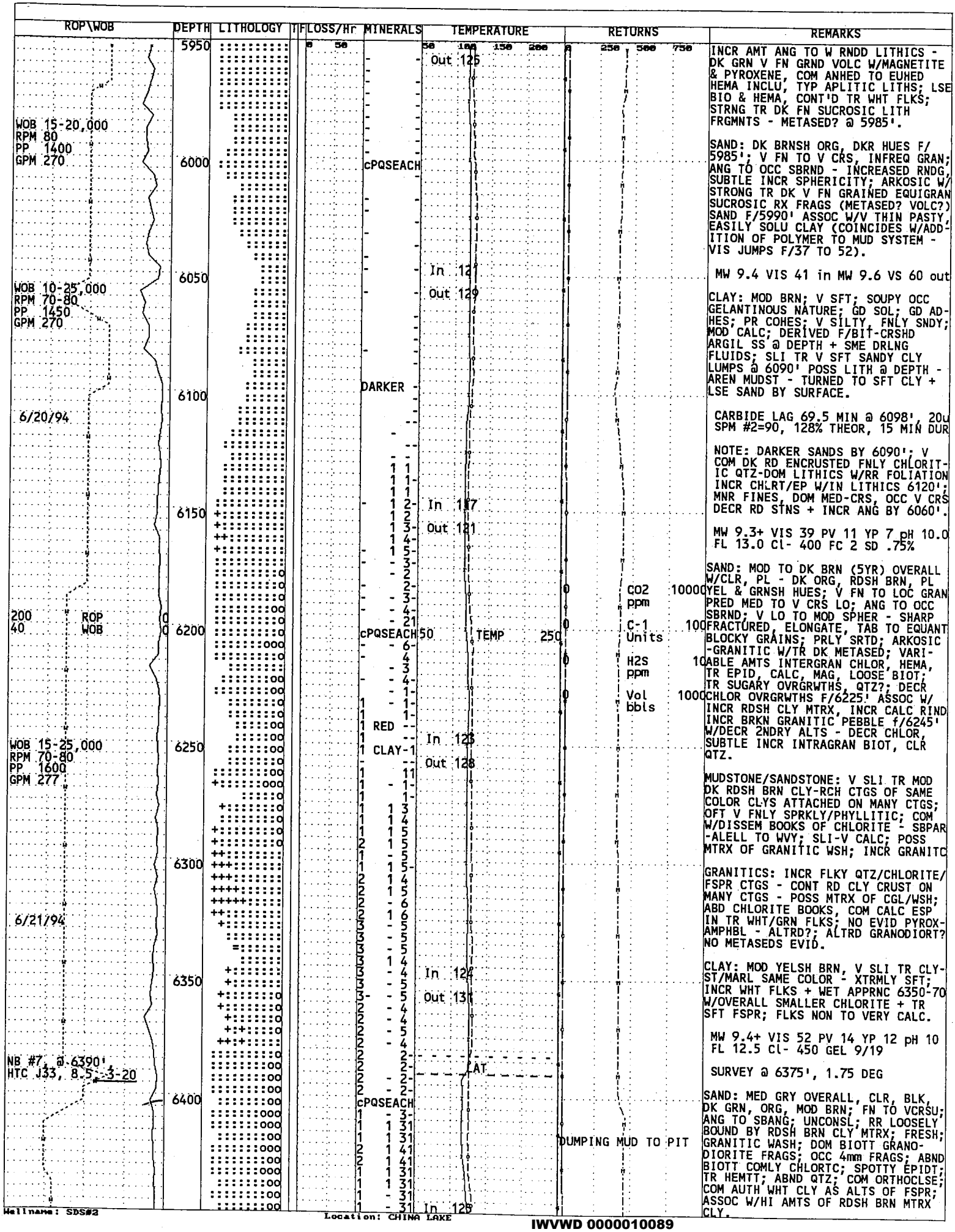


Wellname: SDS#2 Location: CHINA LAKE


ROP\WOB
DEPTH
LITHOLOGY
FLOSS/Hr
MINERALS
TEMPERATURE
RETURNS
REMARKS
4950
5000
5050
5100
5150
5200
5250
5300
5350
5400
LT GRY CMT CONTAMINATE
cPQSEACH
FLT -GOUGE?- WHT FLKS
In 110
Out 115
In 111
Out 122
LAT
No WG or WT
cPQSEACH -DARKER- INCR CRS
TEMP
In 111
Out 116
In 113
Out 118
No TG or Trip Temp
cPQSEACH
In 110
PUMP FLUID F/SUMP - SME CMT CONTAMINATION -
SFT WHT FLAKES IN SPL - W/OCC FLOATING SD GRS, COM HMTT - POSS FAULT GOUGE OR DECOMPOSED GRANITIC
GD TR WHT CTGS/FLKS
CO2 ppm
C-1 Units
H2S ppm
Vol bbls
PUMPING FLUID F/SUMP
WOB 5-20,000
RPM 70-80
PP 1400
GPM 90
6/18/94
200 ROP 0
40 WOB 0
5650 WOB 0
WOB 5-20,000
RPM 80
PP 1400
GPM 270
BIT #5, 2796', 74 HRS
4/6/.125
NB #6 In @ 5382'
HTC ATJ11, 8.5 3-16's
WOB 10-20,000
RPM 80
PP 1300
GPM 270
SUB RND <1%, POSS META SEDS.
SAND: LT ORNG/GRY, CLR TO MLKY ORNG, LO FRACTN OF DK ORNG GRNS; V FN TO V CRS W/SOME GRANULES; ANG LO FRACTN WITH MOD SPERICITY DEC DOWN SECTN; PRLY SRTD; ARKOSIC; LITHS <5%; APLITIC META SEDS, INTRAGRANULAR INCLU OF BIO HEM, RR PYRITE <5%, CALC DEC DWN TR SNDSTN @4955; DESILTER--> LOOSE BIO, HEM AND CHLORITE IN SAMPLE.
SAND: PL ORGSH GRY OVERALL - TRNSL GRAINS W/ LT ORG HUE; V FN LO TO INFREQ GRANULE, PRED FN TO V CRS L ANG, OCC SBANG; LO SPHER, COM TAB TO BLKY GRAINS W/V COM CLEAVAGE FACES; PRLY SRTD; PRED LOOSE SAND, TR MOD INDURATED SS W/CALC CMT @ 5040 - 5055'; TR PL ORG-BRN CLAY IN UNWASHED SPLS; ARKOSIC, PRED FSPR & QTZ; COM V FN MICAS, BIOT, OCC CHLOR IN FINE FRACTION F/DESILTER; <5% VIS INTRAGRAN INCLU IN WASHED SPL; CONT'D TR HEMATITE, PRED LOOSE IN FINES, RR AS AGG W/V FN CALCITE; RR LITH FRAGS.
SANDSTONE: GD TR @ 5110': V LT ORNG - SPCKLD W/DK MAFICS; FRM, TR HD; MOD FRIA; FN-CRS, DOM FINES; CALC CMT; DOM FSPR, COM QTZ, GD TR CHLORITE FLKS - NO EVID LINEATIONS TR HEMATITE; RR LSE PYR; TR YEL MNRL FL.
NOTE: V MNR SPLS OVER SHKRS-APRX SZ 100, MAJORITY OF GRAINS PASS THRU SHKRS; PERSIST TR WHT FLKS POSS FAULT GOUGE - OFT CONTAINS ISOLATED SD GRS, HEMATITE, + OCC SLI CALC OR W/PT SOURCES.
SAND: V LT ORNG; DOM FINES-MED, OCC CRS, TR V CRS; ANG-SBANG; ARKOSE W/COM QTZ; <5% W/1-2 V SM MAFIC INCLU; PERSIST GD TR CALC.
SURVEY @ 5164', 1.5 DEG
WIPE HOLE F/5193' T/2700'-NO FILL
CARBIDE LAG 62.6 MIN @ 5224', 20u SPM #2-89, 134% THEOR, 15 MIN DUR
SAND: DKR + COARSER AFTER WIPER DUE IN PART TO TRIP; INCR DK RDSH CLY SURFICIAL COATINGS; V FN-CRS DOM, COM GRAN/V CRS THRU 5220'; ANG-SBANG; MOD-LO SPHER; PRLY SRTD SLI TR CALC CMT, PRED LSE; DOM FSPR, COM QTZ, QTZ/FSPR; SLI TR BIOT/CHLORITE EMBEDDED, LSE; SLI TR HEMATITE ATTACHED, COM LSE F/DESILTER; RR DK GRY/BLK BASALT/METASEDS; RR YEL MNRL FL.
SAND: LT-MOD ORNG OVERALL - COM THN PCHY DK RD-ORNG CLY COATING IN PITS/ROUGH SURFS + FRAC'S IN GRS; V FN-CRS, OCC V CRS, SLI TR GRAN; ANG-SBANG, TR V ANG W/V LO SPHER; PRLY SRTD; V SLI TR CALC CMTD SS, GD TR CALC ATTACHMENTS, LSE CALC; DOM FSPR - ABD REFLECTIVE CLEAVAGE FACES; SLI TR MAFIC INCLU; RR GRYSH BLK LITHICS; SLI TR HEMATITE ON CLASTS, COM SILT--FN SD SZ HEMATITE EJECTED @ MUDCLEANER; SLI TR CHLORITE FLAKES.
MW 9.3 VIS 42 PV 16 YP 10 pH 10.5 FL 12.0 Cl- 400 GEL 5/11 SD .5%
TRIP FOR NEW BIT @ 5385'- NO FILL
NOTE: PERSIST TR SFT WHT FLAKES.
SAND: ORNG (SALMON), CLR TO MLKY, MOD FRAC OF DK ORNG, OCC DK BROWN V FN TO GRAN; COM ABRADED FACES; ANG; LO SPHR; ARKOSIC; RR DK LITHS & EP, OCC LOOSE BIO AND HEM; INCLU IN <5% OF GRS OF BIO AND HEM, TR+ SBHED/EUHED HEM; COM INCLU @5430', RR VIEN CALC W/ YELSH BRN BNDS, SCAT CALC GRNS V FN TO MED SZD ALSO SEEN ENCRUSTING OCC GRNS, RR APLITIC TRNSL GRN W-RNDD GRNS,
Wellname: SDS#2
Location: CHINA LAKE



Wellname: SDS#2 Location: CHINA LAKE


ROP\WOB
DEPTH
LITHOLOGY
TF
LOSS/Hr
MINERALS
TEMPERATURE
RETURNS
REMARKS
WOB 15-20,000
RPM 80
PP 1400
GPM 270
WOB 10-25,000
RPM 70-80
PP 1450
GPM 270
6/20/94
200 ROP
40 WOB
WOB 15-25,000
RPM 70-80
PP 1600
GPM 277
6/21/94
NB #7, @ 6390'
HTC J33, 8.5 3-20
Out 125
cPQSEACH
In 121
Out 129
DARKER
In 127
Out 121
cPQSEACH
TEMP
In 123
CLAY-1
Out 128
In 124
Out 131
CAT
cPQSEACH
In 129
CO2 1000 ppm
C-1 100 Units
H2S 10 ppm
Vol 1000 bbls
DUMPING MUD TO PIT
INCR AMT ANG TO W RNDD LITHICS - DK GRN V FN GRND VOLC W/MAGNETITE & PYROXENE, COM ANHED TO EUHED HEMA INCLU, TYP APLITIC LITHS; LSE BIO & HEMA, CONT'D TR WHT FLKS; STRNG TR DK FN SUCROSIC LITH FRGMNTS - METASED? @ 5985'.
SAND: DK BRNSH ORG, DKR HUES F/ 5985'; V FN TO V CRS, INFREQ GRAN; ANG TO OCC SBRND - INCREASED RNDG, SUBTLE INCR SPHERICITY; ARKOSIC W/ STRONG TR DK V FN GRAINED EQUIGRAN SUCROSIC RX FRAGS (METASED? VOLC?) SAND F/5990' ASSOC W/V THIN PASTY, EASILY SOLU CLAY (COINCIDES W/ADDITION OF POLYMER TO MUD SYSTEM - VIS JUMPS F/37 TO 52).
MW 9.4 VIS 41 in MW 9.6 VS 60 out
CLAY: MOD BRN; V SFT; SOUPY OCC GELANTINOUS NATURE; GD SOL; GD ADHES; PR COHES; V SILTY, FNLY SNDY; MOD CALC; DERIVED F/BIT-CRSHD ARGIL SS @ DEPTH + SME DRLNG FLUIDS; SLI TR V SFT SANDY CLY LUMPS @ 6090' POSS LITH @ DEPTH - AREN MUDST - TURNED TO SFT CLY + LSE SAND BY SURFACE.
CARBIDE LAG 69.5 MIN @ 6098', 20u SPM #2=90, 128% THEOR, 15 MIN DUR
NOTE: DARKER SANDS BY 6090'; V COM DK RD ENCRUSTED FNLY CHLORITIC QTZ-DOM LITHICS W/RR FOLIATION INCR CHLRT/EP W/IN LITHICS 6120'; MNR FINES, DOM MED-CRS, OCC V CRS DECR RD STNS + INCR ANG BY 6060'.
MW 9.3+ VIS 39 PV 11 YP 7 pH 10.0 FL 13.0 Cl- 400 FC 2 SD .75%
SAND: MOD TO DK BRN (5YR) OVERALL W/CLR, PL - DK ORG, RDSH BRN, PL YEL & GRNSH HUES; V FN TO LOC GRAN PRED MED TO V CRS LO; ANG TO OCC SBRND; V LO TO MOD SPHER - SHARP FRACTURED, ELONGATE, TAB TO EQUANT BLOCKY GRAINS; PRLY SRTD; ARKOSIC -GRANITIC W/TR DK METASED; VARIABLE AMTS INTERGRAN CHLOR, HEMA, TR EPID, CALC, MAG, LOOSE BIOT; TR SUGARY OVRGRWTHS, QTZ?; DECR CHLOR OVRGRWTHS F/6225' ASSOC W/ INCR RDSH CLY MTRX, INCR CALC RIND INCR BRKN GRANITIC PEBBLE f/6245' W/DECR 2NDRY ALTS - DECR CHLOR, SUBTLE INCR INTRAGRAN BIOT, CLR QTZ.
MUDSTONE/SANDSTONE: V SLI TR MOD DK RDSH BRN CLY-RCH CTGS OF SAME COLOR CLYS ATTACHED ON MANY CTGS; OFT V FNLY SPRKLY/PHYLLITIC; COM W/DISSEM BOOKS OF CHLORITE - SBPAR -ALELL TO WVY; SLI-V CALC; POSS MTRX OF GRANITIC WSH; INCR GRANITC
GRANITICS: INCR FLKY QTZ/CHLORITE/ FSPR CTGS - CONT RD CLY CRUST ON MANY CTGS - POSS MTRX OF CGL/WSH; ABD CHLORITE BOOKS, COM CALC ESP IN TR WHT/GRN FLKS; NO EVID PYROX-AMPHBL - ALTRD?; ALTRD GRANODIORT? NO METASEDS EVID.
CLAY: MOD YELSH BRN, V SLI TR CLYST/MARL SAME COLOR - XTRMLY SFT; INCR WHT FLKS + WET APPRNC 6350-70 W/OVERALL SMALLER CHLORITE + TR SFT FSPR; FLKS NON TO VERY CALC.
MW 9.4+ VIS 52 PV 14 YP 12 pH 10 FL 12.5 Cl- 450 GEL 9/19
SURVEY @ 6375', 1.75 DEG
SAND: MED GRY OVERALL, CLR, BLK, DK GRN, ORG, MOD BRN; FN TO VCRSU; ANG TO SBANG; UNCONSL; RR LOOSELY BOUND BY RDSH BRN CLY MTRX; FRESH; GRANITIC WASH; DOM BIOTT GRANODIORITE FRAGS; OCC 4mm FRAGS; ABND BIOTT COMLY CHLORTC; SPOTTY EPIDT; TR HEMTT; ABND QTZ; COM ORTHOCLSE; COM AUTH WHT CLY AS ALTS OF FSPR; ASSOC W/HI AMTS OF RDSH BRN MTRX CLY.
Wellname: SDS#2
Location: CHINA LAKE

ROP\WOB	DEPTH	LITHOLOGY	T	F	LOSS/Hr	MINERALS	TEMPERATURE	RETURNS	REMARKS
	6450	:::::::ooo			0 50	1 - 2-	50 100 150 200	0 250 500 750	CLAY: RDSH BRN; SOFT; SOUPY; EVEN CONSIS; V SDY; SL CALC; LO COHES; SOLU; NONEXPANSV; RRLY COATING GRS & CLASTS.
		:::::::::o				1 - 2-	Out 131		
6/22/94		:::::::ooo				2 - 2-			MW 9.2 VIS 41 PV 13 YP 11 pH 9.5 FL 13.2 Cl- 450 FC 2 SD 1.0%
		:::::::ooo				2 - 2-			
		:::::::ooo				1 - 11			CONGLOMERATIC SAND: INCR BRNSH ORG OVERALL W/INCR PL TO DK ORG; MED U TO GRAN W/INCR AMTS BRKN PEBBLE;- V ANG TO INFREQ SBRND, INCR ANG F/ 6510'; V LO TO OCC MOD SPHER - INCRLY SHARP FLAKES F/6520'; PR TO MOD SRTD - RAPIDLY DECR FINES; SPL DOM GRANITIC LITH FRAGS F/6525 W/SUBTLE DECR CHLOR OVRGRWTHS, RR RDSH CLY COATING; RR EPID; DECR FREE SBRND QTZ, RR GRN, BLUSH & RD CLYST (ALTERD); CONTD WHT, CHALKY AUTH CLAY F/FSPR; CHNG F/CRS ANG LITHIC SAND TO GRANITE V SUBTLE.
		::::::::				1 - 11			
		:::::o				1 - 22			
		::::::oo				1 - 22			
		:::::::o				1 - 22			
		:::::::oo				1 - 23			
	6500	:::::::ooo				1 - 2-			
		:::::::oo				1 - 21			
		:::::::oo				1 - 22			
		:::::::ooo				1 - 22			
		:::::ooo				1 - 22			
		:::::ooo				1 - 32			
		:::::::o				1 - 2-			
		:::::ooo				1 - 1-			
		:::::ooo				1 - 2-			
		:::::ooo				1 - 2-	In 125		GRANITE: GRYSH ORG OVERALL W/SLI PINKISH HUE; 2-8mm CHIPS, FLAKES; V ANG; V LO SPHER; TRNSL & ORG FSPR W/CLR QTZ; SPTY FN INTRAGRAN CHLOR, BIOT & MAG; RR FRAC W/CHLOR & EPID; LOC CHALKY ALTS OF FSPR - BIT GOUGE? TR BLU-GRN & MAROON WAXY, SECTILE CLYST - FRAC ALTS?
	6550	:::::::o				1 - 2-			
		:::::::oo				1 - 2-	Out 130	<-INCR H2O	
		:::::::ooo				1 - 1			
		::::::::				- -			
		::::::::				- -			
		::::::::				- -			
WOB 25-30,000		::::::::				- -			
RPM 75		::::::::				- -			
PP 1400		::::::::				- -			
GPM 264		::::::::				- -			
	6600	:::::::: oo				cPQSEACH			
		:::::::: o				1-			
		:::::::: o				- 2-			
		:::::::: :				- 1-			
		:::::::: :				- 2-			
		:::::::: :o				- 21			
		:::::::: :o				- 2-			
		:::::::: :o				- 1-			
		:::::::: :o				1 11			
		:::::::::o				1 12	In 127		ALKALINE FELDSPAR GRANITE: PL ORG OVERALL; PORPHORITIC; OCCURRING AS ANG SHARP CHIPS 2-10mm; OCC FRESH; COMLY ALTRD (OXIDIZED); COM BIOTT, OCC SL CHLORTZD; OCC ZONED CALCT FRAC FILL & LININGS; OCC SUB-SPHERICAL PHENOCRYSTS POSS REWRKD; ASSOC W/MINOR AMTS OF RDSH BRN CLY MTRL, POSS MYLONITE; DOM ORTH-OCLASE; COM QTZ; TR MGNTT; RR EPIDOTE; COM AMTS OF AUTH WHT CLY MTRL FROM ALTS OF FSPR; NO EVIDENCE OF ROUNDED EDGES ON LRGR FRAGS.
	6650	:::::::::o				1 12			
		:::::::::				1 12	Out 135		
		:::::::::				- 12			
		:::::::::				- 12			
		:::::::::				1 11			
		:::::::::				1 11			
6/23/94		:::::::::				1 21			
		:::::::::				1 11			
		:::::::::				1 11			
		:::::::::				1 21			
	6700						50 TEMP 250	Dump 15 bbls Mud	CARBIDE LAG 76 MN @ 6682', 22u SPM #2=85, 122% THEOR, 6 MN DUR.

Intervals for logging

Every 50' from 6750 (14)

6472'

6375'

6296'

5800

5900

6000

(1)

(1)

(1)

(1)

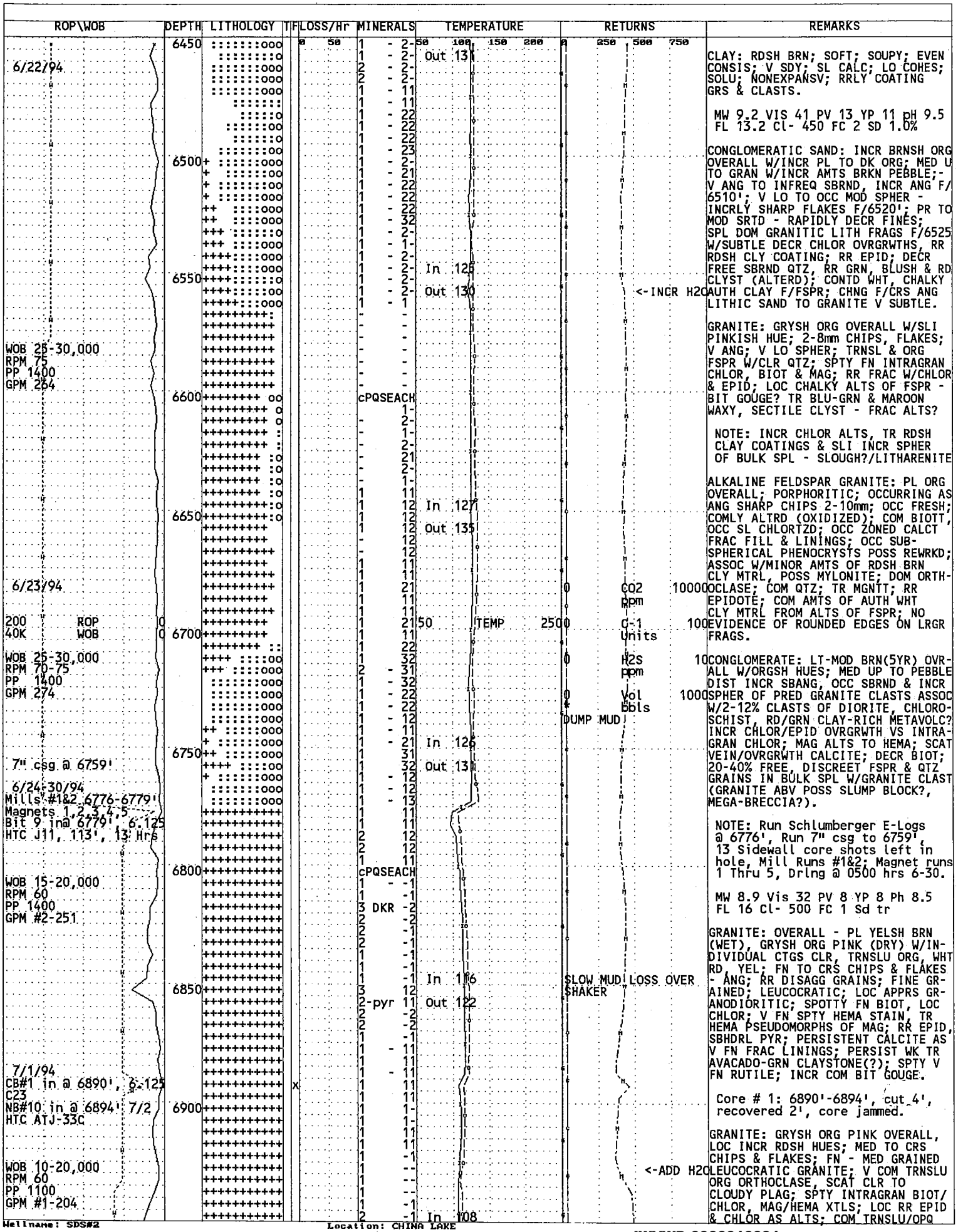
(1)

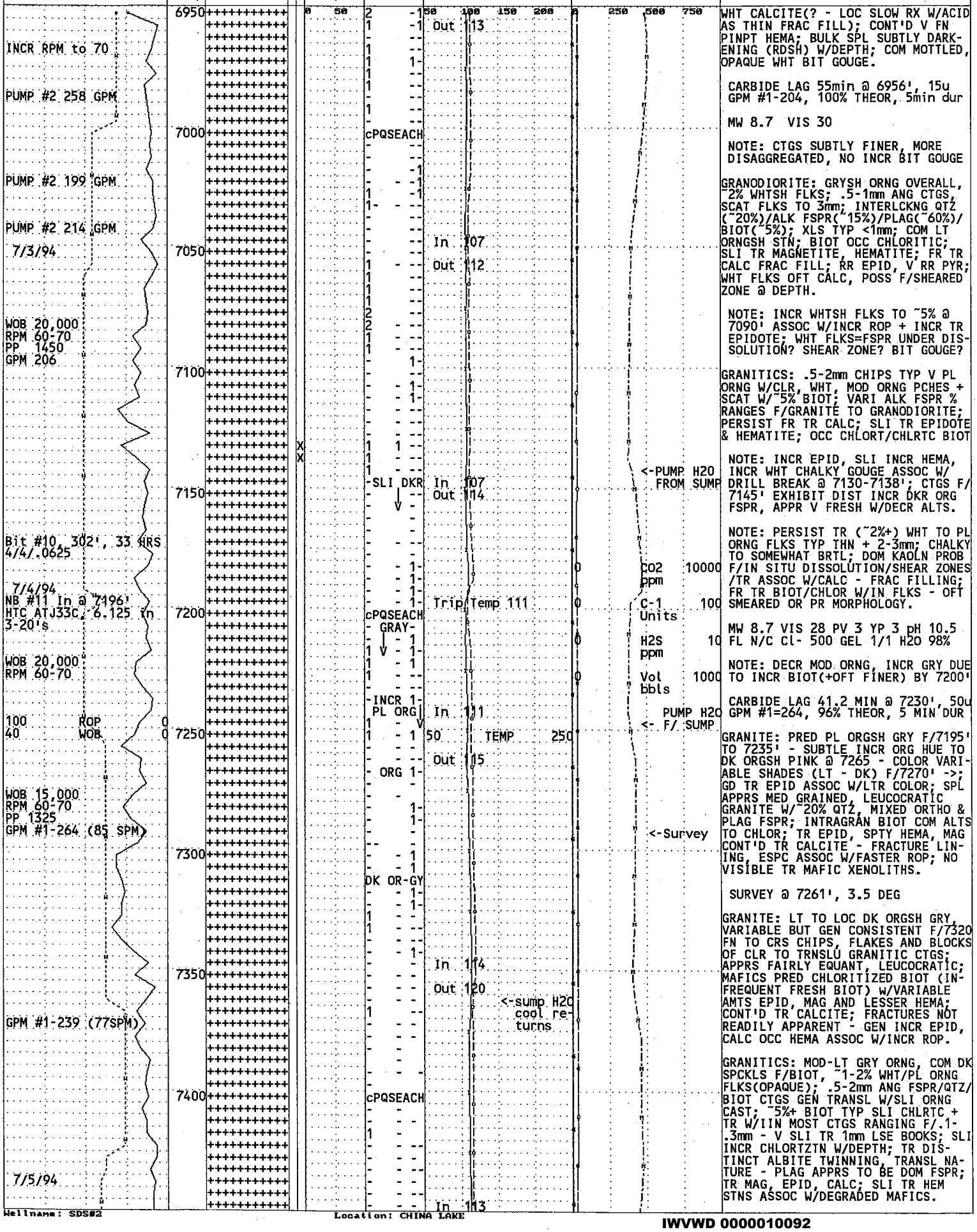
(1)

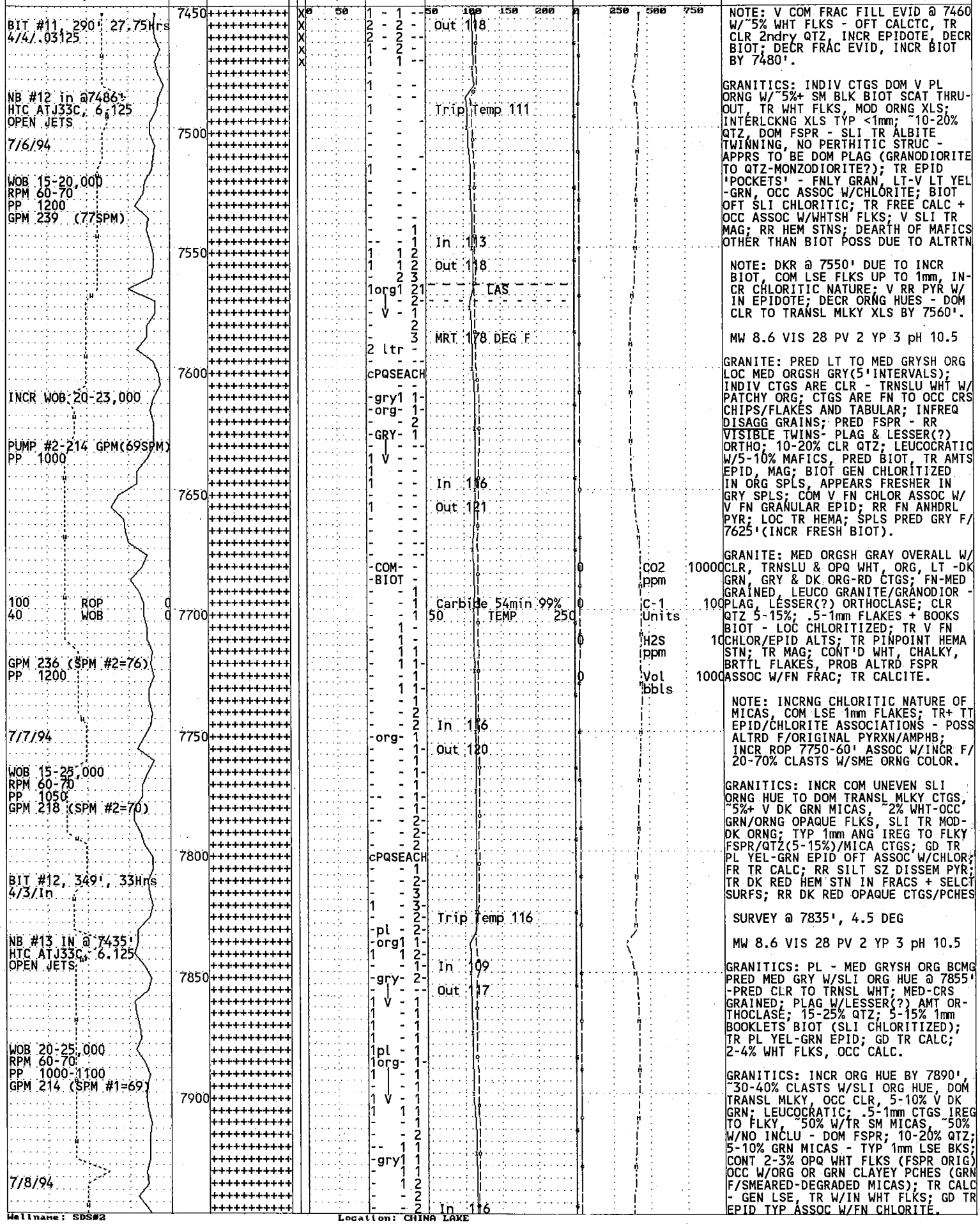
10.

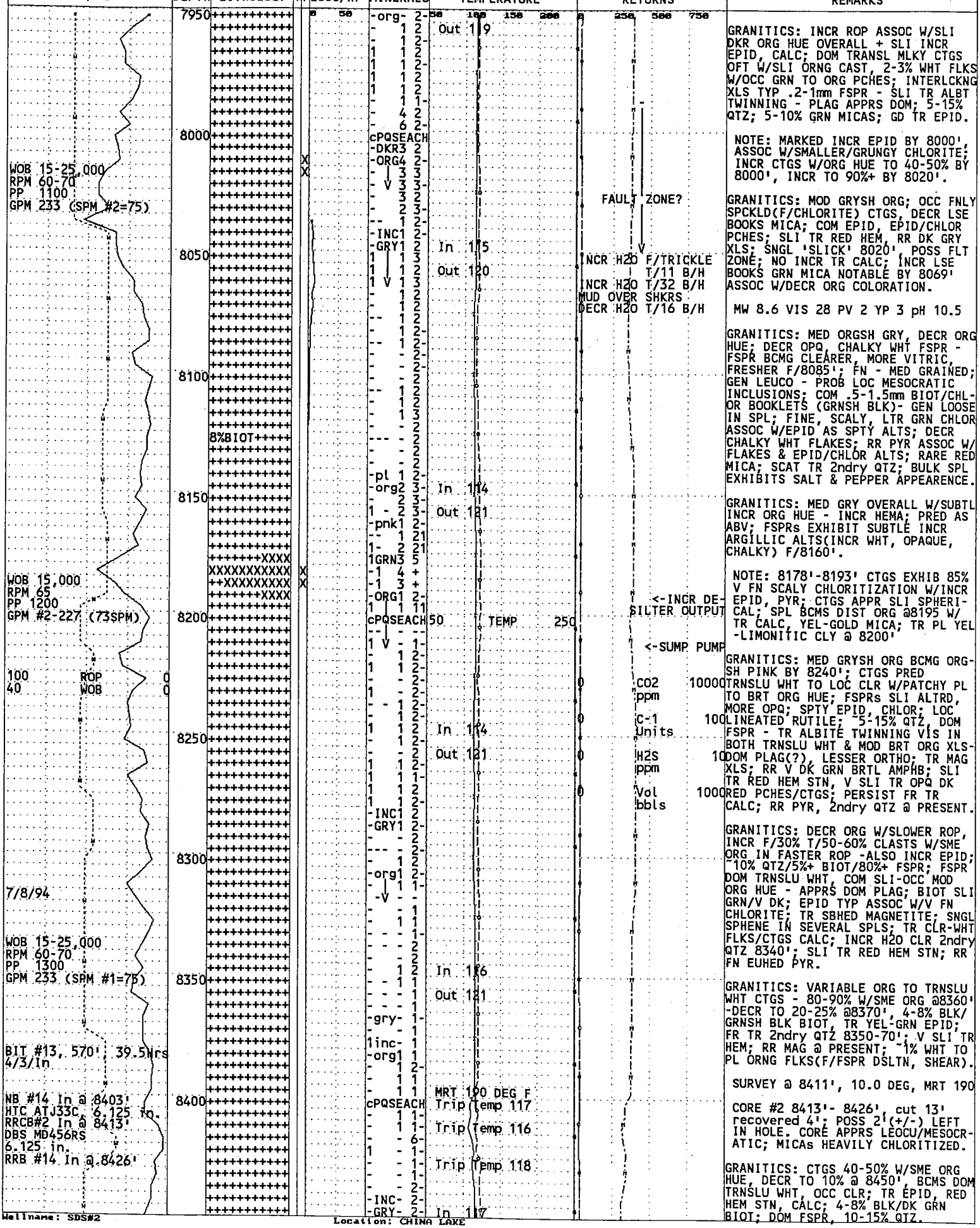
5800	3400
5700	3350
5100	3075
5006	
4750'	2800'
4455'	2550'
4350	2300'
4304	5250'
4134	~~5400~~ 5500
3950	
3662	

Wellname: SDS#2 Location: CHINA LAKE

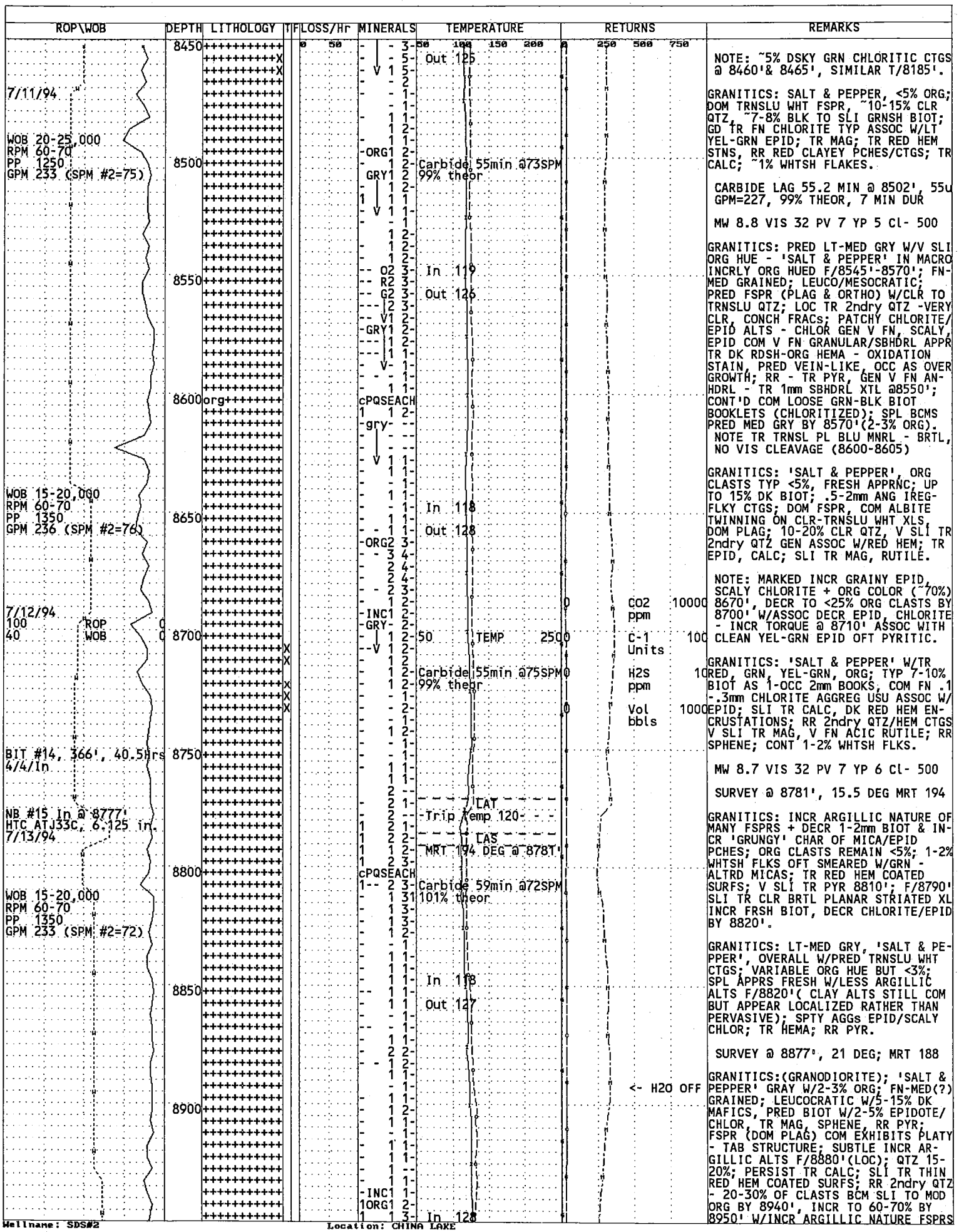

ROP\WOB
DEPTH
LITHOLOGY
TF
LOSS/Hr
MINERALS
TEMPERATURE
RETURNS
REMARKS
6/22/94
WOB 25-30,000
RPM 75
PP 1400
GPM 264
6/23/94
200 ROP 0
40K WOB 0
WOB 25-30,000
RPM 70-75
PP 1400
GPM 274
7" csg @ 6759'
6/24-30/94
Mills' #1&2 6776-6779'
Magnets 1,2,3,4,5
Bit 9 in@ 6779', 6.125
HTC J11, 113', 13 Hrs
WOB 15-20,000
RPM 60
PP 1400
GPM #2-251
7/1/94
CB#1 in @ 6890', 6.125
C23
NB#10 in @ 6894' 7/2
HTC ATJ-33C
WOB 10-20,000
RPM 60
PP 1100
GPM #1-204
Out 131
In 125
Out 130
In 127
Out 135
In 126
Out 131
In 116
Out 122
In 108
<-INCR H2O
<-ADD H2O
CO2 10000 ppm
C-1 100 Units
H2S 10 ppm
Vol 1000 bbls
DUMP MUD
SLOW MUD LOSS OVER SHAKER
TEMP 250
CLAY: RDSH BRN; SOFT; SOUPY; EVEN CONSIS; V SDY; SL CALC; LO COHES; SOLU; NONEXPANSV; RRLY COATING GRS & CLASTS.
MW 9.2 VIS 41 PV 13 YP 11 pH 9.5 FL 13.2 Cl- 450 FC 2 SD 1.0%
CONGLOMERATIC SAND: INCR BRNSH ORG OVERALL W/INCR PL TO DK ORG; MED U TO GRAN W/INCR AMTS BRKN PEBBLE;- V ANG TO INFREQ SBRND, INCR ANG F/ 6510'; V LO TO OCC MOD SPHER - INCRLY SHARP FLAKES F/6520'; PR TO MOD SRTD - RAPIDLY DECR FINES; SPL DOM GRANITIC LITH FRAGS F/6525 W/SUBTLE DECR CHLOR OVRGRWTHS, RR RDSH CLY COATING; RR EPID; DECR FREE SBRND QTZ, RR GRN, BLUSH & RD CLYST (ALTERD); CONTD WHT, CHALKY AUTH CLAY F/FSPR; CHNG F/CRS ANG LITHIC SAND TO GRANITE V SUBTLE.
GRANITE: GRYSH ORG OVERALL W/SLI PINKISH HUE; 2-8mm CHIPS, FLAKES; V ANG; V LO SPHER; TRNSL & ORG FSPR W/CLR QTZ; SPTY FN INTRAGRAN CHLOR, BIOT & MAG; RR FRAC W/CHLOR & EPID; LOC CHALKY ALTS OF FSPR - BIT GOUGE? TR BLU-GRN & MAROON WAXY, SECTILE CLYST - FRAC ALTS?
NOTE: INCR CHLOR ALTS, TR RDSH CLAY COATINGS & SLI INCR SPHER OF BULK SPL - SLOUGH?/LITHARENITE
ALKALINE FELDSPAR GRANITE: PL ORG OVERALL; PORPHORITIC; OCCURRING AS ANG SHARP CHIPS 2-10mm; OCC FRESH; COMLY ALTRD (OXIDIZED); COM BIOTT, OCC SL CHLORTZD; OCC ZONED CALCT FRAC FILL & LININGS; OCC SUB-SPHERICAL PHENOCRYSTS POSS REWRKD; ASSOC W/MINOR AMTS OF RDSH BRN CLY MTRL, POSS MYLONITE; DOM ORTH-OCLASE; COM QTZ; TR MGNTT; RR EPIDOTE; COM AMTS OF AUTH WHT CLY MTRL FROM ALTS OF FSPR; NO EVIDENCE OF ROUNDED EDGES ON LRGR FRAGS.
CONGLOMERATE: LT-MOD BRN(5YR) OVR-ALL W/ORGSH HUES; MED UP TO PEBBLE DIST INCR SBANG, OCC SBRND & INCR SPHER OF PRED GRANITE CLASTS ASSOC W/2-12% CLASTS OF DIORITE, CHLORO-SCHIST, RD/GRN CLAY-RICH METAVOLC? INCR CHLOR/EPID OVRGRWTH VS INTRA-GRAN CHLOR; MAG ALTS TO HEMA; SCAT VEIN/OVRGRWTH CALCITE; DECR BIOT; 20-40% FREE, DISCREET FSPR & QTZ GRAINS IN BULK SPL W/GRANITE CLAST (GRANITE ABV POSS SLUMP BLOCK?, MEGA-BRECCIA?).
NOTE: Run Schlumberger E-Logs @ 6776', Run 7" csg to 6759', 13 Sidewall core shots left in hole, Mill Runs #1&2; Magnet runs 1 Thru 5, Drlng @ 0500 hrs 6-30.
MW 8.9 Vis 32 PV 8 YP 8 Ph 8.5 FL 16 Cl- 500 FC 1 Sd tr
GRANITE: OVERALL - PL YELSH BRN (WET), GRYSH ORG PINK (DRY) W/IN-DIVIDUAL CTGS CLR, TRNSLU ORG, WHT RD, YEL; FN TO CRS CHIPS & FLAKES - ANG; RR DISAGG GRAINS; FINE GR-AINED; LEUCOCRATIC; LOC APPRS GR-ANODIORITIC; SPOTTY FN BIOT, LOC CHLOR; V FN SPTY HEMA STAIN, TR HEMA PSEUDOMORPHS OF MAG; RR EPID, SBHDRL PYR; PERSISTENT CALCITE AS V FN FRAC LININGS; PERSIST WK TR AVACADO-GRN CLAYSTONE(?); SPTY V FN RUTILE; INCR COM BIT GOUGE.
Core # 1: 6890'-6894', cut 4', recovered 2', core jammed.
GRANITE: GRYSH ORG PINK OVERALL, LOC INCR RDSH HUES; MED TO CRS CHIPS & FLAKES; FN - MED GRAINED LEUCOCRATIC GRANITE; V COM TRNSLU ORG ORTHOCLASE, SCAT CLR TO CLOUDY PLAG; SPTY INTRAGRAN BIOT/ CHLOR, MAG/HEMA XTLS; LOC RR EPID & CHLOR AS ALTS; COM TRNSLU/OPQ
Wellname: SDS#2
Location: CHINA LAKE

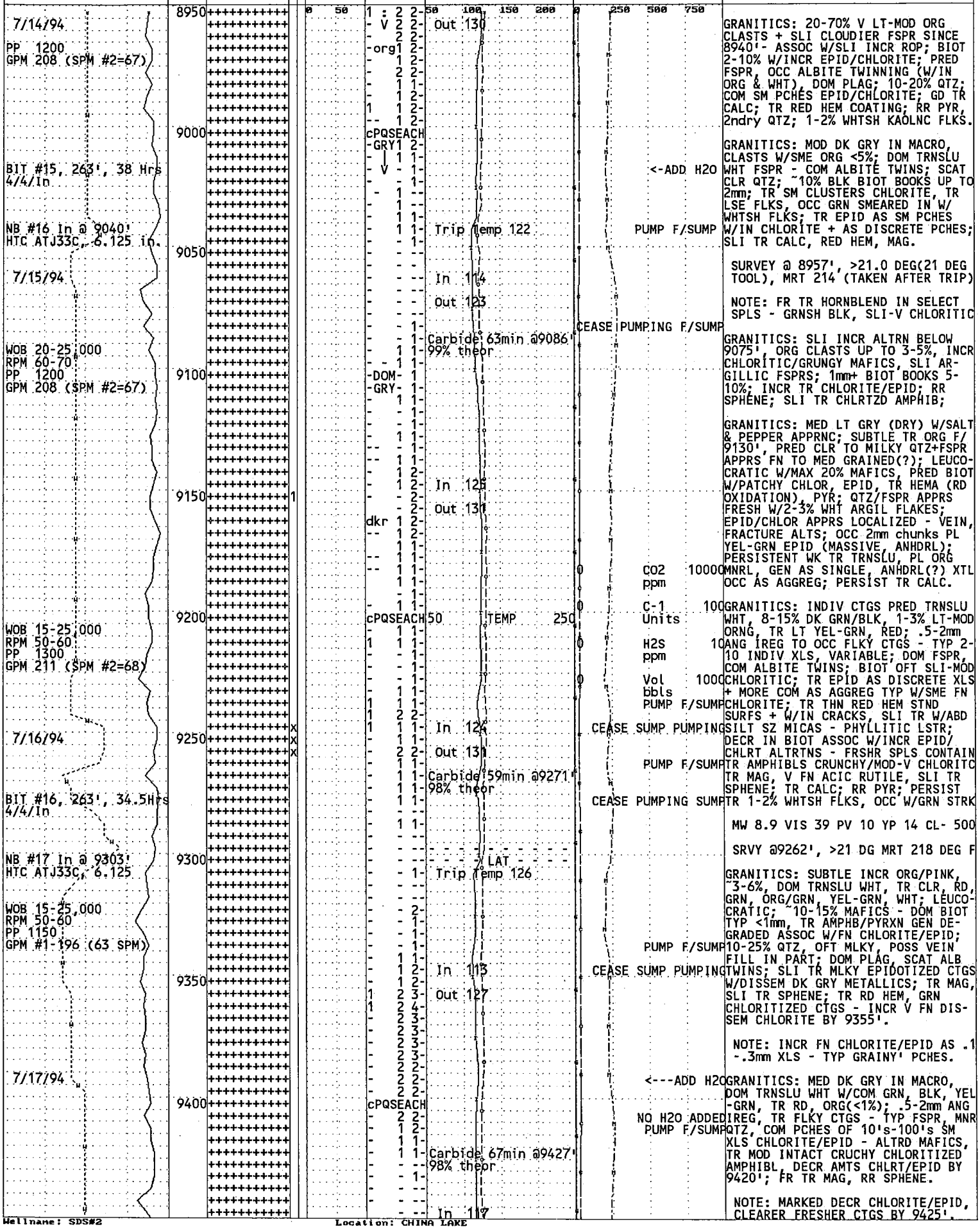

ROP\WOB
DEPTH
LITHOLOGY
T
F
LOSS/Hr
MINERALS
TEMPERATURE
RETURNS
REMARKS
INCR RPM to 70
PUMP #2 258 GPM
PUMP #2 199 GPM
PUMP #2 214 GPM
7/3/94
WOB 20,000
RPM 60-70
PP 1450
GPM 206
Bit #10, 302', 33 HRS
4/4/.0625
7/4/94
NB #11 In @ 7196'
HTC ATJ33C, 6.125 in
3-20's
WOB 20,000
RPM 60-70
100 ROP 0
40 WOB 0
WOB 15,000
RPM 60-70
PP 1325
GPM #1-264 (85 SPM)
GPM #1-239 (77SPM)
7/5/94
6950
7000
7050
7100
7150
7200
7250
7300
7350
7400
cPQSEACH
Out 113
In 107
Out 112
-SLI DKR
In 107
Out 114
Trip Temp 111
-GRAY-
cPQSEACH
-INCR 1-
PL ORG
In 111
50 TEMP 250
Out 115
ORG 1-
In 114
Out 120
<-sump H2O
cool re-
turns
DK OR-GY
cPQSEACH
In 113
<-PUMP H2O
FROM SUMP
CO2 10000
ppm
C-1 100
Units
H2S 10
ppm
Vol 1000
bbls
PUMP H2O
<- F/ SUMP
<-Survey
WHT CALCITE(? - LOC SLOW RX W/ACID AS THIN FRAC FILL); CONT'D V FN PINPT HEMA; BULK SPL SUBTLY DARKENING (RDSH) W/DEPTH; COM MOTTLED, OPAQUE WHT BIT GOUGE.
CARBIDE LAG 55min @ 6956', 15u GPM #1-204, 100% THEOR, 5min dur
MW 8.7 VIS 30
NOTE: CTGS SUBTLY FINER, MORE DISAGGREGATED, NO INCR BIT GOUGE
GRANODIORITE: GRYSH ORNG OVERALL, ~2% WHTSH FLKS; .5-1mm ANG CTGS, SCAT FLKS TO 3mm; INTERLCKNG QTZ (~20%)/ALK FSPR(~15%)/PLAG(~60%)/BIOT(~5%); XLS TYP <1mm; COM LT ORNGSH STN; BIOT OCC CHLORITIC; SLI TR MAGNETITE, HEMATITE; FR TR CALC FRAC FILL; RR EPID, V RR PYR; WHT FLKS OFT CALC, POSS F/SHEARED ZONE @ DEPTH.
NOTE: INCR WHTSH FLKS TO ~5% @ 7090' ASSOC W/INCR ROP + INCR TR EPIDOTE; WHT FLKS=FSPR UNDER DISSOLUTION? SHEAR ZONE? BIT GOUGE?
GRANITICS: .5-2mm CHIPS TYP V PL ORNG W/CLR, WHT, MOD ORNG PCHES + SCAT W/~5% BIOT; VARI ALK FSPR % RANGES F/GRANITE TO GRANODIORITE; PERSIST FR TR CALC; SLI TR EPIDOTE & HEMATITE; OCC CHLORT/CHLRTC BIOT
NOTE: INCR EPID, SLI INCR HEMA, INCR WHT CHALKY GOUGE ASSOC W/ DRILL BREAK @ 7130-7138'; CTGS F/ 7145' EXHIBIT DIST INCR DKR ORG FSPR, APPR V FRESH W/DECR ALTS.
NOTE: PERSIST TR (~2%+) WHT TO PL ORNG FLKS TYP THN + 2-3mm; CHALKY TO SOMEWHAT BRTL; DOM KAOLN PROB F/IN SITU DISSOLUTION/SHEAR ZONES /TR ASSOC W/CALC - FRAC FILLING; FR TR BIOT/CHLOR W/IN FLKS - OFT SMEARED OR PR MORPHOLOGY.
MW 8.7 VIS 28 PV 3 YP 3 pH 10.5 FL N/C Cl- 500 GEL 1/1 H2O 98%
NOTE: DECR MOD ORNG, INCR GRY DUE TO INCR BIOT(+OFT FINER) BY 7200'
CARBIDE LAG 41.2 MIN @ 7230', 50u GPM #1=264, 96% THEOR, 5 MIN DUR
GRANITE: PRED PL ORGSH GRY F/7195' TO 7235' - SUBTLE INCR ORG HUE TO DK ORGSH PINK @ 7265 - COLOR VARIABLE SHADES (LT - DK) F/7270' ->; GD TR EPID ASSOC W/LTR COLOR; SPL APPRS MED GRAINED, LEUCOCRATIC GRANITE W/~20% QTZ, MIXED ORTHO & PLAG FSPR; INTRAGRAN BIOT COM ALTS TO CHLOR; TR EPID, SPTY HEMA, MAG CONT'D TR CALCITE - FRACTURE LINING, ESPC ASSOC W/FASTER ROP; NO VISIBLE TR MAFIC XENOLITHS.
SURVEY @ 7261', 3.5 DEG
GRANITE: LT TO LOC DK ORGSH GRY, VARIABLE BUT GEN CONSISTENT F/7320 FN TO CRS CHIPS, FLAKES AND BLOCKS OF CLR TO TRNSLU GRANITIC CTGS; APPRS FAIRLY EQUANT, LEUCOCRATIC; MAFICS PRED CHLORITIZED BIOT (INFREQUENT FRESH BIOT) W/VARIABLE AMTS EPID, MAG AND LESSER HEMA; CONT'D TR CALCITE; FRACTURES NOT READILY APPARENT - GEN INCR EPID, CALC OCC HEMA ASSOC W/INCR ROP.
GRANITICS: MOD-LT GRY ORNG, COM DK SPCKLS F/BIOT, ~1-2% WHT/PL ORNG FLKS(OPAQUE); .5-2mm ANG FSPR/QTZ/BIOT CTGS GEN TRANSL W/SLI ORNG CAST; ~5%+ BIOT TYP SLI CHLRTC + TR W/IIN MOST CTGS RANGING F/.1-.3mm - V SLI TR 1mm LSE BOOKS; SLI INCR CHLORTZTN W/DEPTH; TR DISTINCT ALBITE TWINNING, TRANSL NATURE - PLAG APPRS TO BE DOM FSPR; TR MAG, EPID, CALC; SLI TR HEM STNS ASSOC W/DEGRADED MAFICS.
Wellname: SDS#2
Location: CHINA LAKE


ROP\WOB
DEPTH
LITHOLOGY
FLOSS/Hr
MINERALS
TEMPERATURE
RETURNS
REMARKS
BIT #11, 290', 27.75Hrs
4/4/.03125
NB #12 in @7486'
HTC ATJ33C, 6.125
OPEN JETS
7/6/94
WOB 15-20,000
RPM 60-70
PP 1200
GPM 239 (77SPM)
INCR WOB 20-23,000
PUMP #2-214 GPM(69SPM)
PP 1000
100 ROP 0
40 WOB 0
GPM 236 (SPM #2=76)
PP 1200
7/7/94
WOB 15-25,000
RPM 60-70
PP 1050
GPM 218 (SPM #2=70)
BIT #12, 349', 33Hrs
4/3/In
NB #13 IN @ 7435'
HTC ATJ33C, 6.125
OPEN JETS
WOB 20-25,000
RPM 60-70
PP 1000-1100
GPM 214 (SPM #1=69)
7/8/94
Trip Temp 111
In 113
Out 118
LAS
MRT 178 DEG F
2 ltr
cPQSEACH
In 116
Out 121
COM-
BIOT
Carbide 54min 99%
50 TEMP 250
In 116
Out 120
cPQSEACH
Trip Temp 116
In 109
Out 117
In 116
CO2 10000 ppm
C-1 100 Units
H2S 10 ppm
Vol 1000 bbls
NOTE: V COM FRAC FILL EVID @ 7460 W/~5% WHT FLKS - OFT CALCTC, TR CLR 2ndry QTZ, INCR EPIDOTE, DECR BIOT; DECR FRAC EVID, INCR BIOT BY 7480'.
GRANITICS: INDIV CTGS DOM V PL ORNG W/~5%+ SM BLK BIOT SCAT THRU-OUT, TR WHT FLKS, MOD ORNG XLS; INTERLCKNG XLS TYP <1mm; ~10-20% QTZ, DOM FSPR - SLI TR ALBITE TWINNING, NO PERTHITIC STRUC - APPRS TO BE DOM PLAG (GRANODIORITE TO QTZ-MONZODIORITE?); TR EPID 'POCKETS' - FNLY GRAN, LT-V LT YEL -GRN, OCC ASSOC W/CHLORITE; BIOT OFT SLI CHLORITIC; TR FREE CALC + OCC ASSOC W/WHTSH FLKS; V SLI TR MAG; RR HEM STNS; DEARTH OF MAFICS OTHER THAN BIOT POSS DUE TO ALTRTN
NOTE: DKR @ 7550' DUE TO INCR BIOT, COM LSE FLKS UP TO 1mm, IN-CR CHLORITIC NATURE; V RR PYR W/ IN EPIDOTE; DECR ORNG HUES - DOM CLR TO TRANSL MLKY XLS BY 7560'.
MW 8.6 VIS 28 PV 2 YP 3 pH 10.5
GRANITE: PRED LT TO MED GRYSH ORG LOC MED ORGSH GRY(5'INTERVALS); INDIV CTGS ARE CLR - TRNSLU WHT W/ PATCHY ORG; CTGS ARE FN TO OCC CRS CHIPS/FLAKES AND TABULAR; INFREQ DISAGG GRAINS; PRED FSPR - RR VISIBLE TWINS- PLAG & LESSER(?) ORTHO; 10-20% CLR QTZ; LEUCOCRATIC W/5-10% MAFICS, PRED BIOT, TR AMTS EPID, MAG; BIOT GEN CHLORITIZED IN ORG SPLS, APPEARS FRESHER IN GRY SPLS; COM V FN CHLOR ASSOC W/ V FN GRANULAR EPID; RR FN ANHDRL PYR; LOC TR HEMA; SPLS PRED GRY F/ 7625'(INCR FRESH BIOT).
GRANITE: MED ORGSH GRAY OVERALL W/ CLR, TRNSLU & OPQ WHT, ORG, LT -DK GRN, GRY & DK ORG-RD CTGS; FN-MED GRAINED, LEUCO GRANITE/GRANODIOR - PLAG, LESSER(?) ORTHOCLASE; CLR QTZ 5-15%; .5-1mm FLAKES + BOOKS BIOT - LOC CHLORITIZED; TR V FN CHLOR/EPID ALTS; TR PINPOINT HEMA STN; TR MAG; CONT'D WHT, CHALKY, BRTTL FLAKES, PROB ALTRD FSPR ASSOC W/FN FRAC; TR CALCITE.
NOTE: INCRNG CHLORITIC NATURE OF MICAS, COM LSE 1mm FLAKES; TR+ TT EPID/CHLORITE ASSOCIATIONS - POSS ALTRD F/ORIGINAL PYRXN/AMPHB; INCR ROP 7750-60' ASSOC W/INCR F/ 20-70% CLASTS W/SME ORNG COLOR.
GRANITICS: INCR COM UNEVEN SLI ORNG HUE TO DOM TRANSL MLKY CTGS, ~5%+ V DK GRN MICAS, ~2% WHT-OCC GRN/ORNG OPAQUE FLKS, SLI TR MOD-DK ORNG; TYP 1mm ANG IREG TO FLKY FSPR/QTZ(5-15%)/MICA CTGS; GD TR PL YEL-GRN EPID OFT ASSOC W/CHLOR; FR TR CALC; RR SILT SZ DISSEM PYR; TR DK RED HEM STN IN FRACS + SELCT SURFS; RR DK RED OPAQUE CTGS/PCHES
SURVEY @ 7835', 4.5 DEG
MW 8.6 VIS 28 PV 2 YP 3 pH 10.5
GRANITICS: PL - MED GRYSH ORG BCMG PRED MED GRY W/SLI ORG HUE @ 7855' -PRED CLR TO TRNSL WHT; MED-CRS GRAINED; PLAG W/LESSER(?) AMT OR-THOCLASE; 15-25% QTZ; 5-15% 1mm BOOKLETS BIOT (SLI CHLORITIZED); TR PL YEL-GRN EPID; GD TR CALC; 2-4% WHT FLKS, OCC CALC.
GRANITICS: INCR ORG HUE BY 7890', ~30-40% CLASTS W/SLI ORG HUE, DOM TRANSL MLKY, OCC CLR, 5-10% V DK GRN; LEUCOCRATIC; .5-1mm CTGS IREG TO FLKY, ~50% W/TR SM MICAS, ~50% W/NO INCLU - DOM FSPR; 10-20% QTZ; 5-10% GRN MICAS - TYP 1mm LSE BKS; CONT 2-3% OPQ WHT FLKS (FSPR ORIG) OCC W/ORG OR GRN CLAYEY PCHES (GRN F/SMEARED-DEGRADED MICAS); TR CALC - GEN LSE, TR W/IN WHT FLKS; GD TR EPID TYP ASSOC W/FN CHLORITE.
Wellname: SDS#2
Location: CHINA LAKE



IWVWD 0000010094

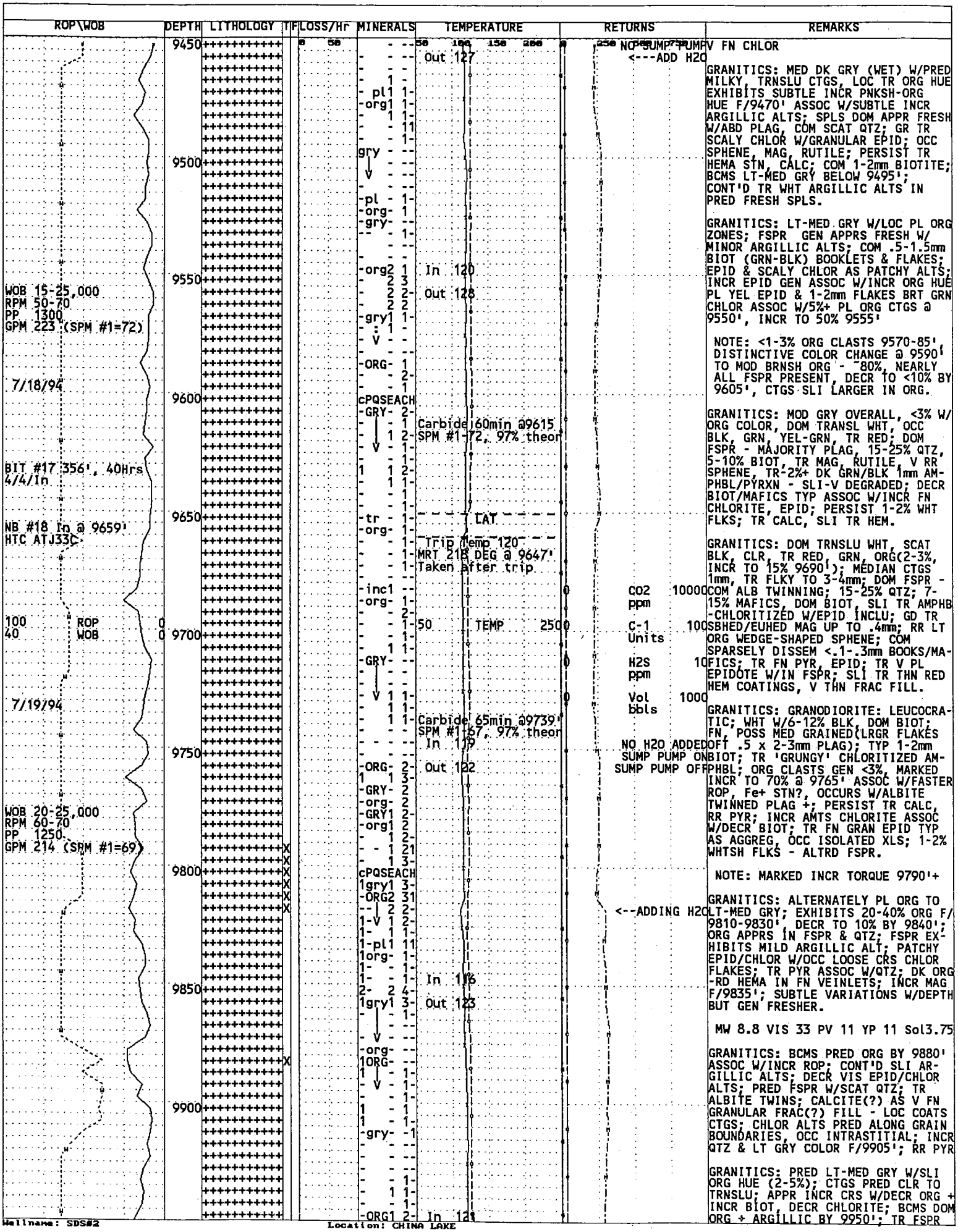

ROP\WOB
DEPTH
LITHOLOGY
T
F
LOSS/Hr
MINERALS
TEMPERATURE
RETURNS
REMARKS
7/11/94
WOB 20-25,000
RPM 60-70
PP 1250
GPM 233 (SPM #2=75)
WOB 15-20,000
RPM 60-70
PP 1350
GPM 236 (SPM #2=76)
7/12/94
ROP
WOB
BIT #14, 366', 40.5Hrs
4/4/In
NB #15 in @ 8777'
HTC ATJ33C, 6.125 in.
7/13/94
WOB 15-20,000
RPM 60-70
PP 1350
GPM 233 (SPM #2=72)
Carbide 55min @73SPM
99% theor
Out 125
In 119
Out 126
In 118
Out 128
Carbide 55min @75SPM
99% theor
Trip Temp 120
MRT 194 DEG @ 8781'
Carbide 59min @72SPM
101% theor
In 118
Out 127
In 128
CO2
ppm
C-1
Units
H2S
ppm
Vol
bbls
<- H2O OFF
NOTE: ~5% DSKY GRN CHLORITIC CTGS @ 8460'& 8465', SIMILAR T/8185'.
GRANITICS: SALT & PEPPER, <5% ORG; DOM TRNSLU WHT FSPR, ~10-15% CLR QTZ, ~7-8% BLK TO SLI GRNSH BIOT; GD TR FN CHLORITE TYP ASSOC W/LT YEL-GRN EPID; TR MAG; TR RED HEM STNS, RR RED CLAYEY PCHES/CTGS; TR CALC; ~1% WHTSH FLAKES.
CARBIDE LAG 55.2 MIN @ 8502', 55u GPM=227, 99% THEOR, 7 MIN DUR
MW 8.8 VIS 32 PV 7 YP 5 Cl- 500
GRANITICS: PRED LT-MED GRY W/V SLI ORG HUE - 'SALT & PEPPER' IN MACRO INCRLY ORG HUED F/8545'-8570'; FN-MED GRAINED; LEUCO/MESOCRATIC; PRED FSPR (PLAG & ORTHO) W/CLR TO TRNSLU QTZ; LOC TR 2ndry QTZ -VERY CLR, CONCH FRACs; PATCHY CHLORITE/EPID ALTS - CHLOR GEN V FN, SCALY, EPID COM V FN GRANULAR/SBHDRL APPR TR DK RDSH-ORG HEMA - OXIDATION STAIN, PRED VEIN-LIKE, OCC AS OVER GROWTH; RR - TR PYR, GEN V FN AN-HDRL - TR 1mm SBHDRL XTL @8550'; CONT'D COM LOOSE GRN-BLK BIOT BOOKLETS (CHLORITIZED); SPL BCMS PRED MED GRY BY 8570'(2-3% ORG). NOTE TR TRNSL PL BLU MNRL - BRTL, NO VIS CLEAVAGE (8600-8605)
GRANITICS: 'SALT & PEPPER', ORG CLASTS TYP <5%, FRESH APPRNC; UP TO 15% DK BIOT; .5-2mm ANG IREG-FLKY CTGS; DOM FSPR, COM ALBITE TWINNING ON CLR-TRNSLU WHT XLS, DOM PLAG; 10-20% CLR QTZ, V SLI TR 2ndry QTZ GEN ASSOC W/RED HEM; TR EPID, CALC; SLI TR MAG, RUTILE.
NOTE: MARKED INCR GRAINY EPID, SCALY CHLORITE + ORG COLOR (~70%) 8670', DECR TO <25% ORG CLASTS BY 8700' W/ASSOC DECR EPID, CHLORITE - INCR TORQUE @ 8710' ASSOC WITH CLEAN YEL-GRN EPID OFT PYRITIC.
GRANITICS: 'SALT & PEPPER' W/TR RED, GRN, YEL-GRN, ORG; TYP 7-10% BIOT AS 1-OCC 2mm BOOKS, COM FN .1-.3mm CHLORITE AGGREG USU ASSOC W/EPID; SLI TR CALC, DK RED HEM ENCRUSTATIONS; RR 2ndry QTZ/HEM CTGS V SLI TR MAG, V FN ACIC RUTILE; RR SPHENE; CONT 1-2% WHTSH FLKS.
MW 8.7 VIS 32 PV 7 YP 6 Cl- 500
SURVEY @ 8781', 15.5 DEG MRT 194
GRANITICS: INCR ARGILLIC NATURE OF MANY FSPRS + DECR 1-2mm BIOT & INCR 'GRUNGY' CHAR OF MICA/EPID PCHES; ORG CLASTS REMAIN <5%; 1-2% WHTSH FLKS OFT SMEARED W/GRN - ALTRD MICAS; TR RED HEM COATED SURFS; V SLI TR PYR 8810'; F/8790' SLI TR CLR BRTL PLANAR STRIATED XL INCR FRSH BIOT, DECR CHLORITE/EPID BY 8820'.
GRANITICS: LT-MED GRY, 'SALT & PEPPER', OVERALL W/PRED TRNSLU WHT CTGS; VARIABLE ORG HUE BUT <3%; SPL APPRS FRESH W/LESS ARGILLIC ALTS F/8820'(CLAY ALTS STILL COM BUT APPEAR LOCALIZED RATHER THAN PERVASIVE); SPTY AGGs EPID/SCALY CHLOR; TR HEMA; RR PYR.
SURVEY @ 8877', 21 DEG; MRT 188
GRANITICS:(GRANODIORITE); 'SALT & PEPPER' GRAY W/2-3% ORG; FN-MED(?) GRAINED; LEUCOCRATIC W/5-15% DK MAFICS, PRED BIOT W/2-5% EPIDOTE/CHLOR, TR MAG, SPHENE, RR PYR; FSPR (DOM PLAG) COM EXHIBITS PLATY - TAB STRUCTURE; SUBTLE INCR ARGILLIC ALTS F/8880'(LOC); QTZ 15-20%; PERSIST TR CALC; SLI TR THIN RED HEM COATED SURFS; RR 2ndry QTZ - 20-30% OF CLASTS BCM SLI TO MOD ORG BY 8940', INCR TO 60-70% BY 8950' W/INCR ARGILLIC NATURE FSPRS
Wellname: SDS#2
Location: CHINA LAKE



7 yrs

	A	B	C	D	E	F	G	H	I
1	Reference Document		FY10 CAFR pg32	FY11 CAFR pg32	FY12 CAFR pg36	FY13 CAFR pg35	FY14 CAFR pg35	FY15 CAFR pg36	FY16 CAFR pg36
2									
3	Fiscal Year		FY10	FY11	FY12	FY13	FY14	FY15	FY15 16
4									
5	Total Revenues *		9,856,115	9,722,393	8,951,263	12,189,476	11,240,634	11,680,736	13,392,913
6		Measure L Revenue **	0	0	0	1,499,559	2,510,692	2,613,889	2,690,000
7		Non-Measure L Revenue [row 5 minus row 6]	9,856,115	9,722,393	8,951,263	10,689,917	8,729,942	9,066,847	10,702,913
8	Total Expenditures *		10,848,185	10,673,024	11,583,132	10,191,227	11,597,656	12,012,003	11,688,630
9		Safety Expenditures *	7,050,693	6,952,928	6,638,131	5,999,976	7,264,984	7,098,082	6,755,693
10		Public Works Expenditures *	292,037	402,429	376,341	163,034	298,633	283,672	356,541
11		Non-Measure L Expenditures [row 8 minus rows 9 & 10]	3,505,455	3,317,667	4,568,660	4,028,217	4,034,039	4,630,249	4,576,396
12		**Revenues Over (Under) * Expenditures** [row 5 minus row 8]	-992,070	-950,631	-2,631,869	1,998,249	-357,022	-331,267	1,704,283
13									
14	Transfers In *		1,258,651	1,161,289	2,848,748	1,424,463	876,707	1,747,694	1,423,260
15	Transfers Out *		-1,296,509	-822,607	-4,709,144	-1,381,847	-998,990	-797,168	-1,675,905
16	Other Transfers *		0	0	334,452	0	350,000	698,621	250,000
17		**Total Other Financing Sources *** [sum rows 14, 15, 16]	-37,858	338,682	-1,525,944	42,616	227,717	1,649,147	-2,645
18									
19		**Net Change to Fund Balance * (Inflows-Outflows)** [sum rows 17,12]	-1,029,928	-611,949	-4,157,813	**2,040,865**	**-129,305**	**1,317,880**	**1,701,638**
20	Beginning Yr Fund Balance *		1,569,219	539,291	-72,658	-4,230,471	-2,189,606	-2,318,911	-1,001,031
21		**End of Yr Fund Balance *** [sum rows 19,20]	539,291	-72,658	-4,230,471	**-2,189,606**	**-2,318,911**	**-1,001,031**	**700,607**
22		* Directly from CAFR	** From Measure-L report						
23									
24	Reference Document		FY10 CAFR pg28	FY11 CAFR pg28	FY12 CAFR pg32	FY13 CAFR pg32	FY14 CAFR pg32	FY15 CAFR pg32	FY15 CAFR pg32
25	Fiscal Year		FY10	FY11	FY12	FY13	FY14	FY15	FY36 16
26	Total Assets *		1,624,112	1,050,994	1,032,292	2,651,731	2,492,041	3,532,381	5,255,115
27	Total Liabilities *		1,084,821	1,123,652	5,262,763	4,841,337	4,810,952	4,533,412	4,554,508
28									
29		Fiscal Year	FY10	FY11	FY12	FY13	FY14	FY15	
30		Inflows-Outflows	-1,029,928	-611,949	-4,157,813	2,040,865	-129,305	1,317,880	1,701,638
31		End of Yr Fund Balance	539,291	-72,658	-4,230,471	-2,189,606	-2,318,911	-1,001,031	700,607
32		Total Assets	1,624,112	1,050,994	1,032,292	2,651,731	2,492,041	3,532,381	5,255,115

750K SALE


ROP\WOB
DEPTH
LITHOLOGY
TF
LOSS/Hr
MINERALS
TEMPERATURE
RETURNS
REMARKS
9450
9500
9550
9600
9650
9700
9750
9800
9850
9900
WOB 15-25,000
RPM 50-70
PP 1300
GPM 223 (SPM #1=72)
7/18/94
BIT #17 356', 40Hrs
4/4/In
NB #18 In @ 9659'
HTC ATJ33C
100 ROP 0
40 WOB 0
7/19/94
WOB 20-25,000
RPM 60-70
PP 1250
GPM 214 (SPM #1=69)
Out 127
In 120
Out 128
Carbide 60min @9615
SPM #1-72, 97% theor
CAT
Trip Temp 120
MRT 218 DEG @ 9647'
Taken after trip
TEMP
In 119
Out 122
Carbide 65min @9739'
SPM #1-67, 97% theor
In 116
Out 123
In 121
NO H2O ADDED
SUMP PUMP ON
SUMP PUMP OFF
<---ADD H2O
<--ADDING H2O
CO2 ppm
H2S ppm
Vol bbls
Units
GRANITICS: MED DK GRY (WET) W/PRED MILKY, TRNSLU CTGS, LOC TR ORG HUE EXHIBITS SUBTLE INCR PNKSH-ORG HUE F/9470' ASSOC W/SUBTLE INCR ARGILLIC ALTS; SPLS DOM APPR FRESH W/ABD PLAG, COM SCAT QTZ; GR TR SCALY CHLOR W/GRANULAR EPID; OCC SPHENE, MAG, RUTILE; PERSIST TR HEMA STN, CALC; COM 1-2mm BIOTITE; BCMS LT-MED GRY BELOW 9495'; CONT'D TR WHT ARGILLIC ALTS IN PRED FRESH SPLS.
GRANITICS: LT-MED GRY W/LOC PL ORG ZONES; FSPR GEN APPRS FRESH W/ MINOR ARGILLIC ALTS; COM .5-1.5mm BIOT (GRN-BLK) BOOKLETS & FLAKES; EPID & SCALY CHLOR AS PATCHY ALTS; INCR EPID GEN ASSOC W/INCR ORG HUE
NOTE: <1-3% ORG CLASTS 9570-85', DISTINCTIVE COLOR CHANGE @ 9590' TO MOD BRNSH ORG - ~80%, NEARLY ALL FSPR PRESENT, DECR TO <10% BY 9605', CTGS SLI LARGER IN ORG.
GRANITICS: MOD GRY OVERALL, <3% W/ ORG COLOR, DOM TRANSL WHT, OCC BLK, GRN, YEL-GRN, TR RED; DOM FSPR - MAJORITY PLAG, 15-25% QTZ, 5-10% BIOT, TR MAG, RUTILE, V RR SPHENE, TR-2%+ DK GRN/BLK 1mm AMPHBL/PYRXN - SLI-V DEGRADED; DECR BIOT/MAFICS TYP ASSOC W/INCR FN CHLORITE, EPID; PERSIST 1-2% WHT FLKS; TR CALC, SLI TR HEM.
GRANITICS: DOM TRNSLU WHT, SCAT BLK, CLR, TR RED, GRN, ORG(2-3%, INCR TO 15% 9690'); MEDIAN CTGS 1mm, TR FLKY TO 3-4mm; DOM FSPR - COM ALB TWINNING; 15-25% QTZ; 7-15% MAFICS, DOM BIOT, SLI TR AMPHB -CHLORITIZED W/EPID INCLU; GD TR SBHED/EUHED MAG UP TO .4mm; RR LT ORG WEDGE-SHAPED SPHENE; COM SPARSELY DISSEM <.1-.3mm BOOKS/MAFICS; TR FN PYR, EPID; TR V PL EPIDOTE W/IN FSPR; SLI TR THN RED HEM COATINGS, V THN FRAC FILL.
GRANITICS: GRANODIORITE: LEUCOCRATIC; WHT W/6-12% BLK, DOM BIOT; FN, POSS MED GRAINED(LRGR FLAKES OFT .5 x 2-3mm PLAG); TYP 1-2mm BIOT; TR 'GRUNGY' CHLORITIZED AMPHBL; ORG CLASTS GEN <3%, MARKED INCR TO 70% @ 9765' ASSOC W/FASTER ROP, Fe+ STN?, OCCURS W/ALBITE TWINNED PLAG +; PERSIST TR CALC, RR PYR; INCR AMTS CHLORITE ASSOC W/DECR BIOT; TR FN GRAN EPID TYP AS AGGREG, OCC ISOLATED XLS; 1-2% WHTSH FLKS - ALTRD FSPR.
NOTE: MARKED INCR TORQUE 9790'+
GRANITICS: ALTERNATELY PL ORG TO LT-MED GRY; EXHIBITS 20-40% ORG F/ 9810-9830'; DECR TO 10% BY 9840'; ORG APPRS IN FSPR & QTZ; FSPR EXHIBITS MILD ARGILLIC ALT; PATCHY EPID/CHLOR W/OCC LOOSE CRS CHLOR FLAKES; TR PYR ASSOC W/QTZ; DK ORG -RD HEMA IN FN VEINLETS; INCR MAG F/9835'; SUBTLE VARIATIONS W/DEPTH BUT GEN FRESHER.
MW 8.8 VIS 33 PV 11 YP 11 Sol3.75
GRANITICS: BCMS PRED ORG BY 9880' ASSOC W/INCR ROP; CONT'D SLI ARGILLIC ALTS; DECR VIS EPID/CHLOR ALTS; PRED FSPR W/SCAT QTZ; TR ALBITE TWINS; CALCITE(?) AS V FN GRANULAR FRAC(?) FILL - LOC COATS CTGS; CHLOR ALTS PRED ALONG GRAIN BOUNDARIES, OCC INTRASTITIAL; INCR QTZ & LT GRY COLOR F/9905'; RR PYR
GRANITICS: PRED LT-MED GRY W/SLI ORG HUE (2-5%); CTGS PRED CLR TO TRNSLU; APPR INCR CRS W/DECR ORG + INCR BIOT, DECR CHLORITE; BCMS DOM ORG + ARGILLIC BY 9950'; TR FSPR
Wellname: SDS#2
Location: CHINA LAKE

ROP\WOB	DEPTH	LITHOLOGY	T	F	LOSS/Hr	MINERALS	TEMPERATURE	RETURNS	REMARKS
WOB 20-25,000 RPM 60-70 PP 1200 GPM 211 (SPM #1=68)	9950 10000	++++++++++			0 50	1 : - 2- - V - 2- -gry- 1- -org- 2- 1 | - 2- - V - 1- - 1 2- - 1 2- -gry1 2- - 1 2- cPQSEACH	50 100 150 200 Out 126	0 250 500 750 1000 NO H2O ADDED	W/PERVASIVE CHLORITE STNS; SLI TR PURPLE/GRN/RED/WHT ROUGH APHANITIC FLKS - FLT/JOINT GOUGE?/FRAC FILL; 5-8% BIOT IN FRSH SPLS; ~15-25% QTZ; DOM PLAG FSPR, OCC ALBITE TWINS; TR THN ORG-RED VEINING POSS MECHANISM F/ORG COLORATION; TR CALC, WHTSH FLKS, RED HEM STNS.