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Application of New Logging Techniques in Volcanic Rocks Exploration in Sichuan Basin

Reporter：Yuyu Wu

SW Oil & Gas Field Company. CNPC

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Backgrounds

- The Volcanic Fm of SC Basin Developed in the early lower Permian, which closely related to crust uplift caused by Dongwu movement.
- SC basin was considered to be located at the edge of Emerishan basalts, which is one of the most recognized volcanic provinces in the world, the lithology in the basin was mainly overflow facies basalt.
- Early drilling also proved to be basalt with low matrix porosity,
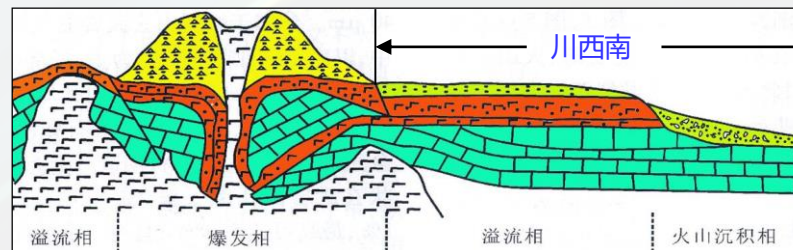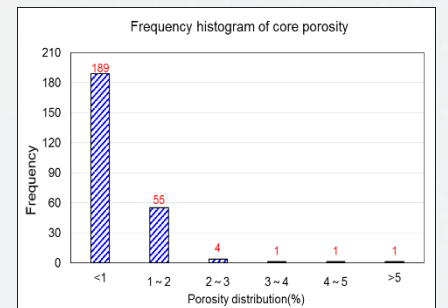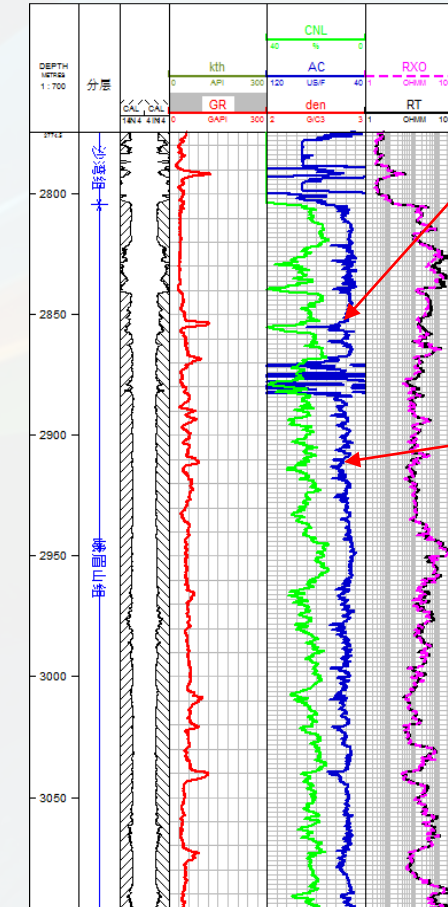
Stratigraphic framework of SC basin
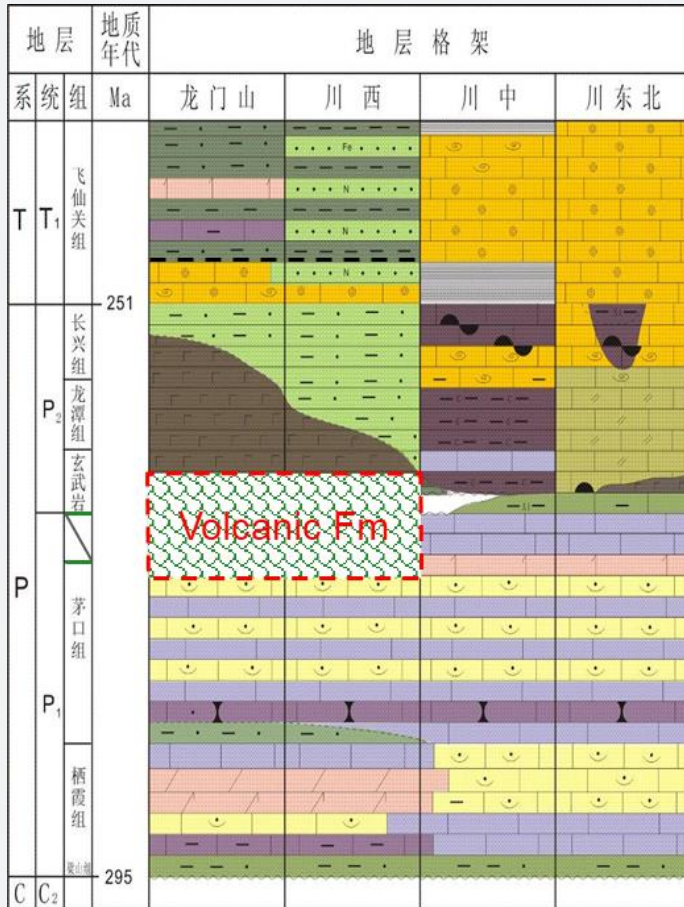
Basalt distribution of SC basin
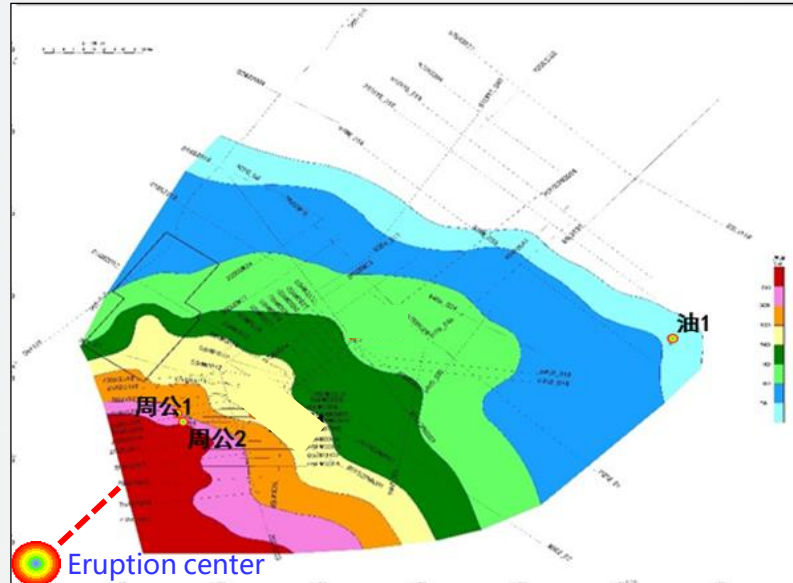
- Eruption center far away from SC basin

Conventional logging of Z1 well

Backgrounds

Recently, the SWOGC, CNPC, organized several rounds of research. It is believed that volcanic eruption center may also exist inside the SC basin, and deployed a risk exploration well, the T1 well.

Challenges:

➤ What is the lithology of the well?
➤ What is the real physical properties? How to evaluate them?
➤ What is the reservoir fluid types, water or gas?
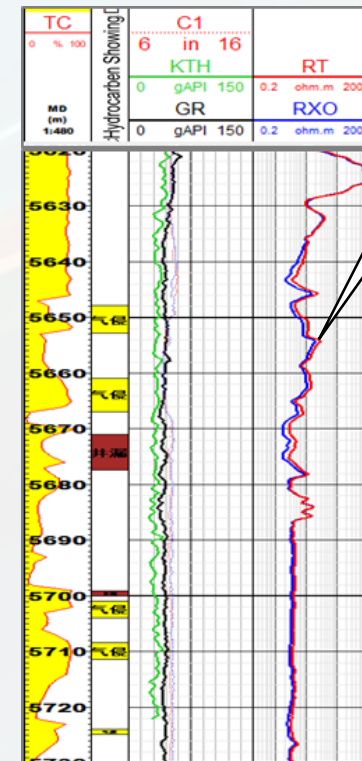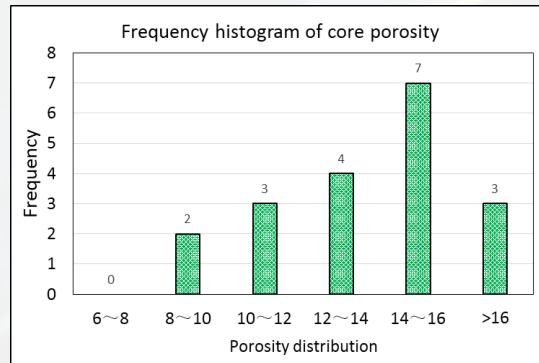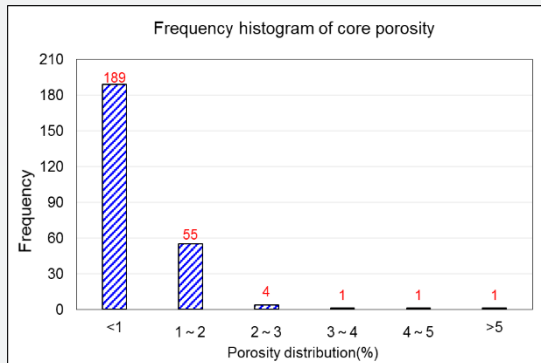
Z1 well

T1 well

VS

low resistivity with 2.7 Ω.m

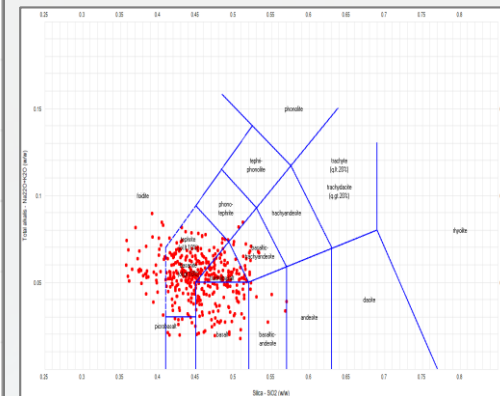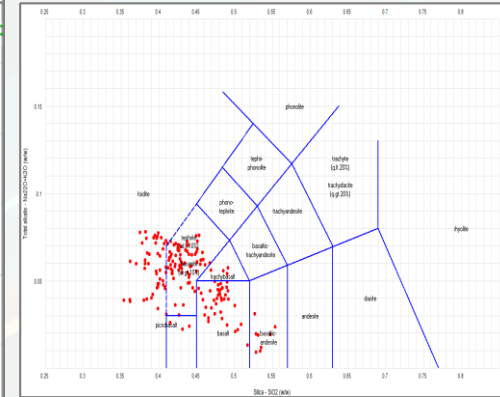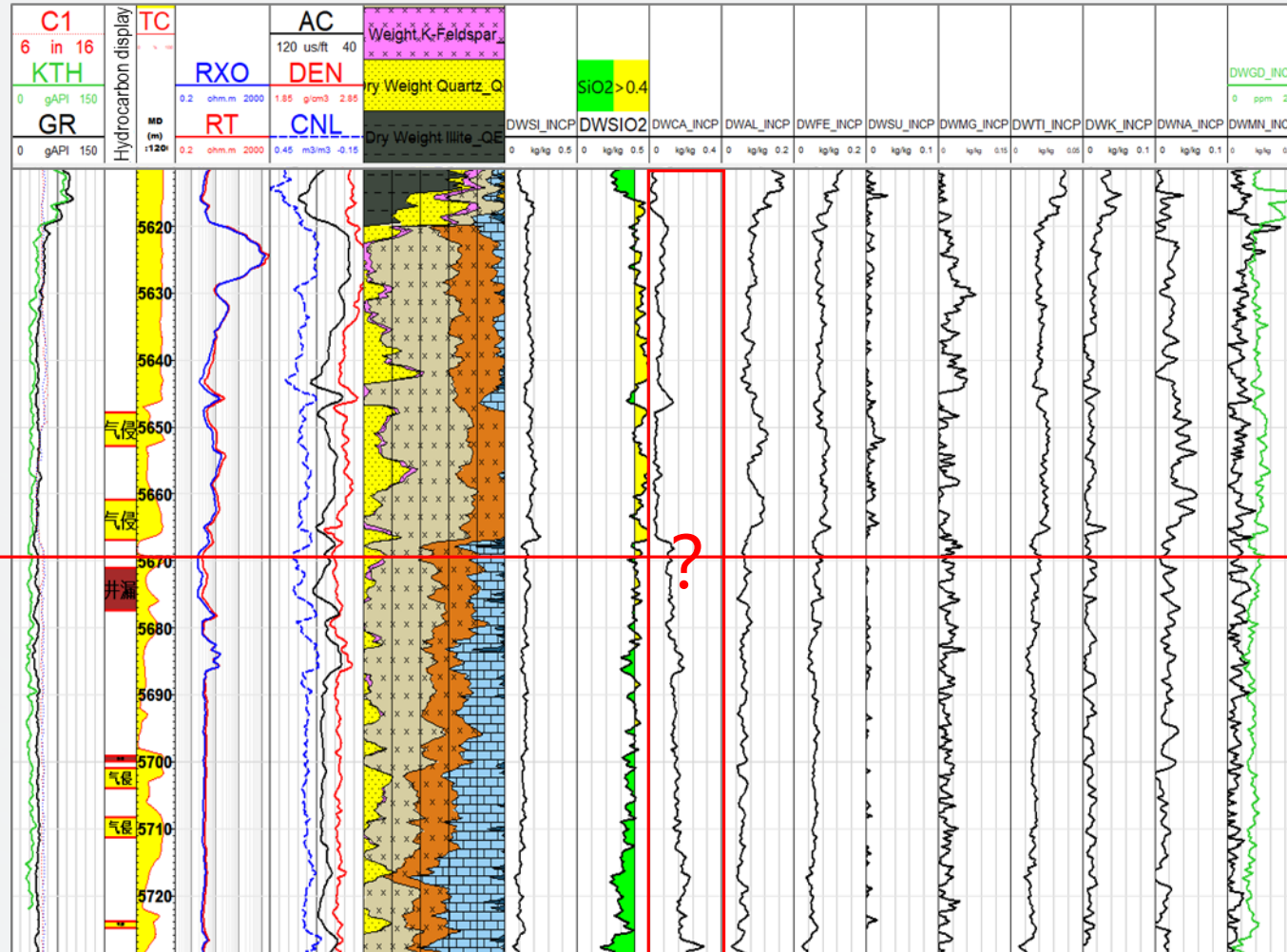gas gathering ignited while drilling

VS

VS

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➤ Lithology Type

After removing the heterogenous components, the lithology of volcanic rocks in T1 well were mainly basic alkali basalt and basalt.

LithoScanner Logging of T1 Well
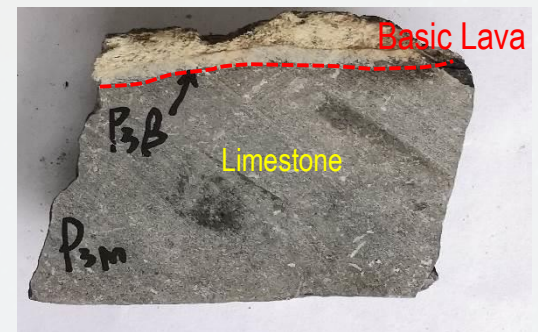
Logging Evaluation

➢ **Cycle Analysis**

- 3 mainly structure types had been recognized from image logging of T1 well: lave, brecciated and mass structure, the breccia size gradually enlarged and breccia content gradually increased.
- T1 well can be divided into three secondary eruptive cycles after fine interpretation from image logging.

Image Logging of T1 Well

Lava structure

Brecciated structure

Mass structure
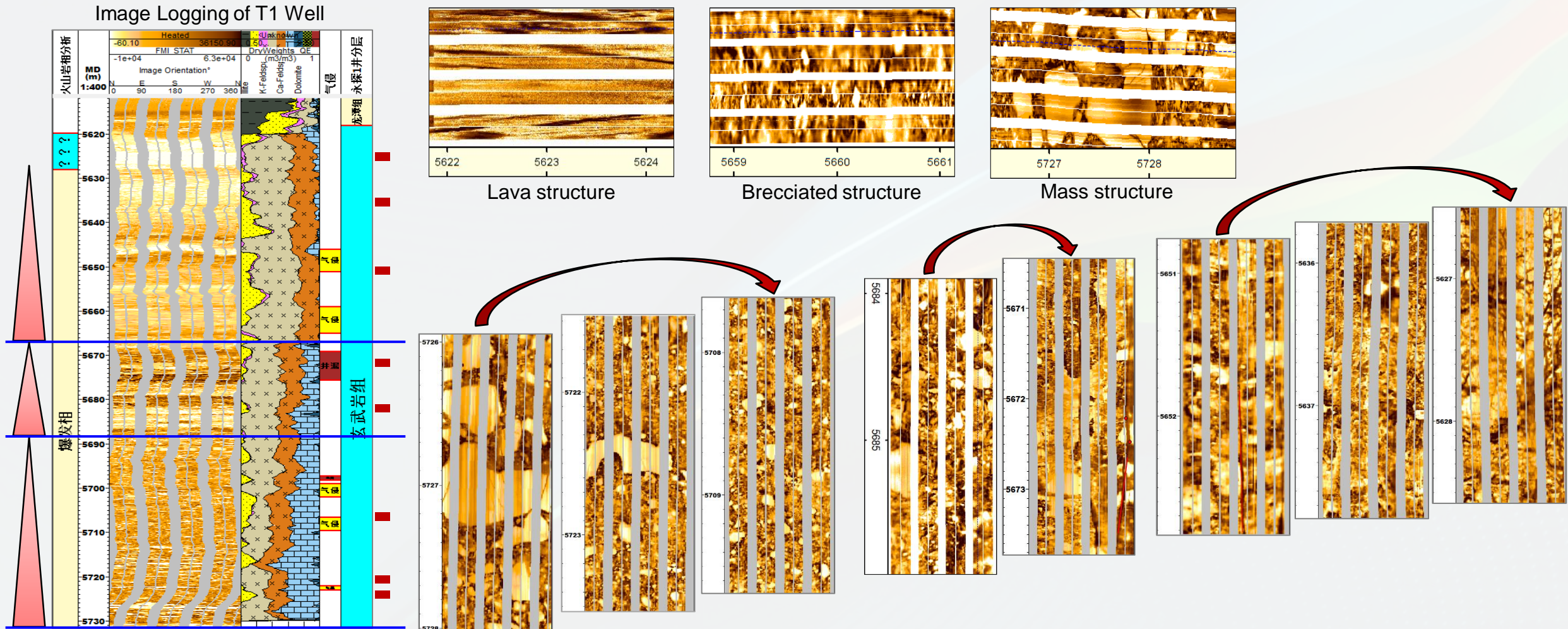
Logging Evaluation

➢ **Petrophysical Property**

- Volcanic rocks are composed of many kinds of minerals with complex compositions, thus have no fixed matrix density and AC value.

- Matrix density, AC and CNL were reversely calculated from mineral content obtained by Lithoscanner logging, these values vary with depth.

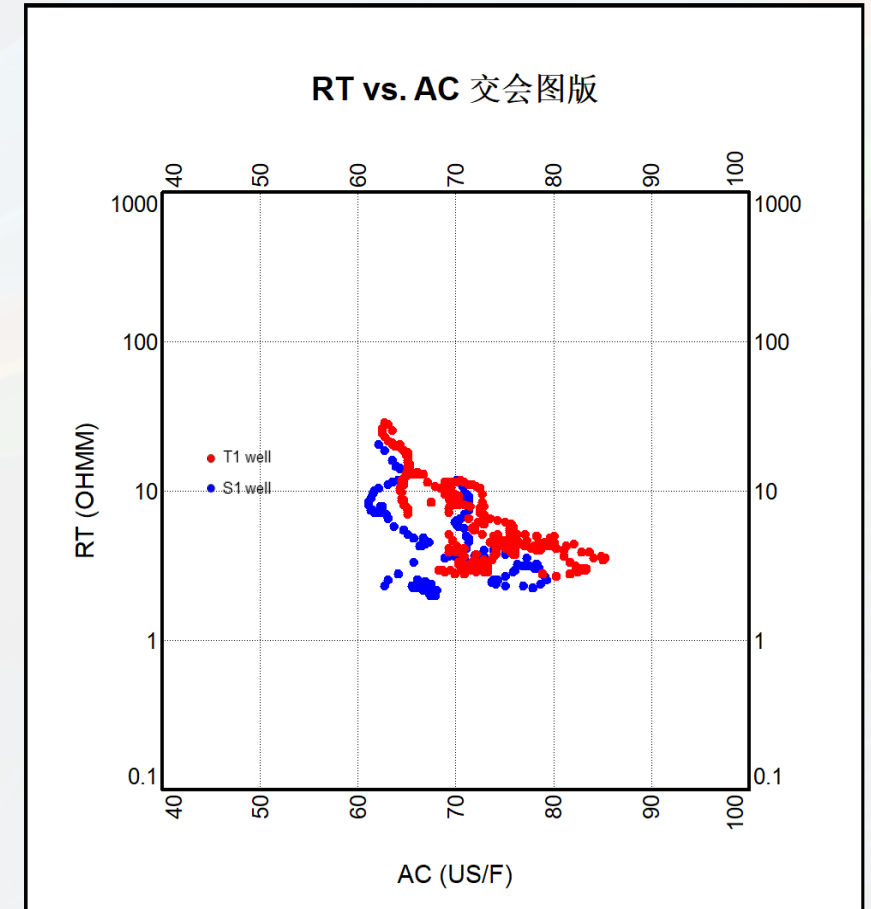Logging porosity evaluation of T1 Well
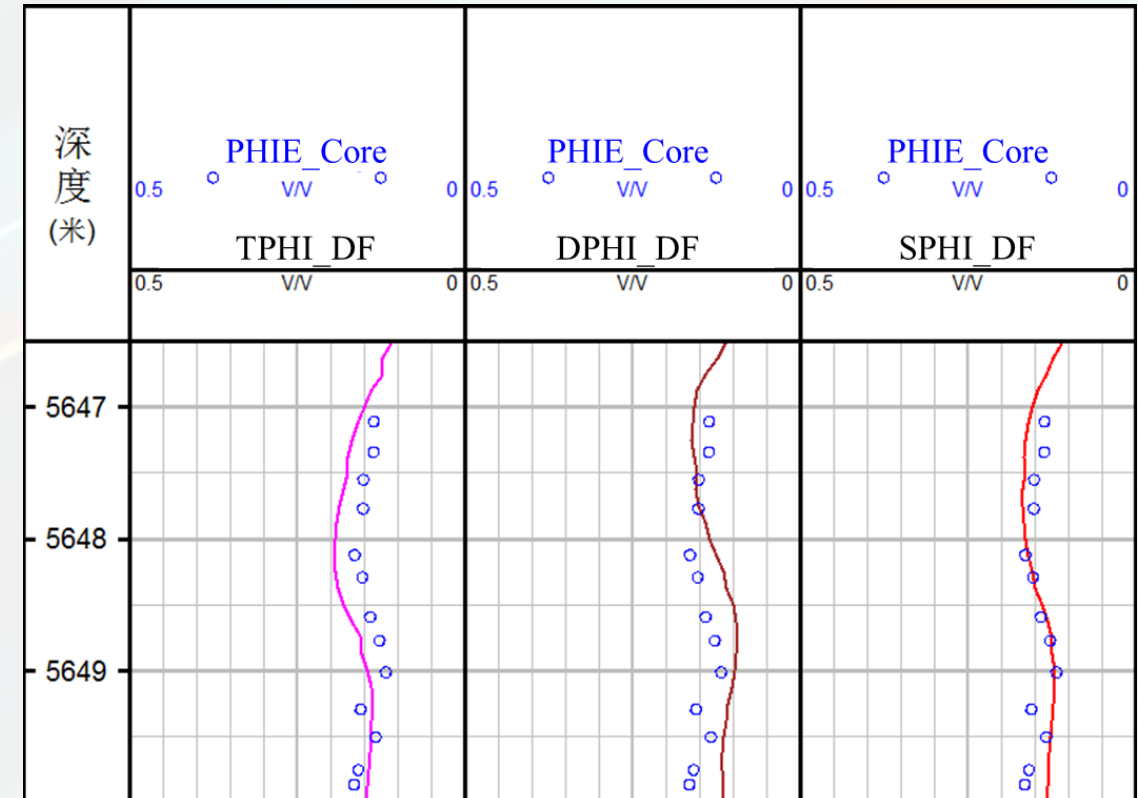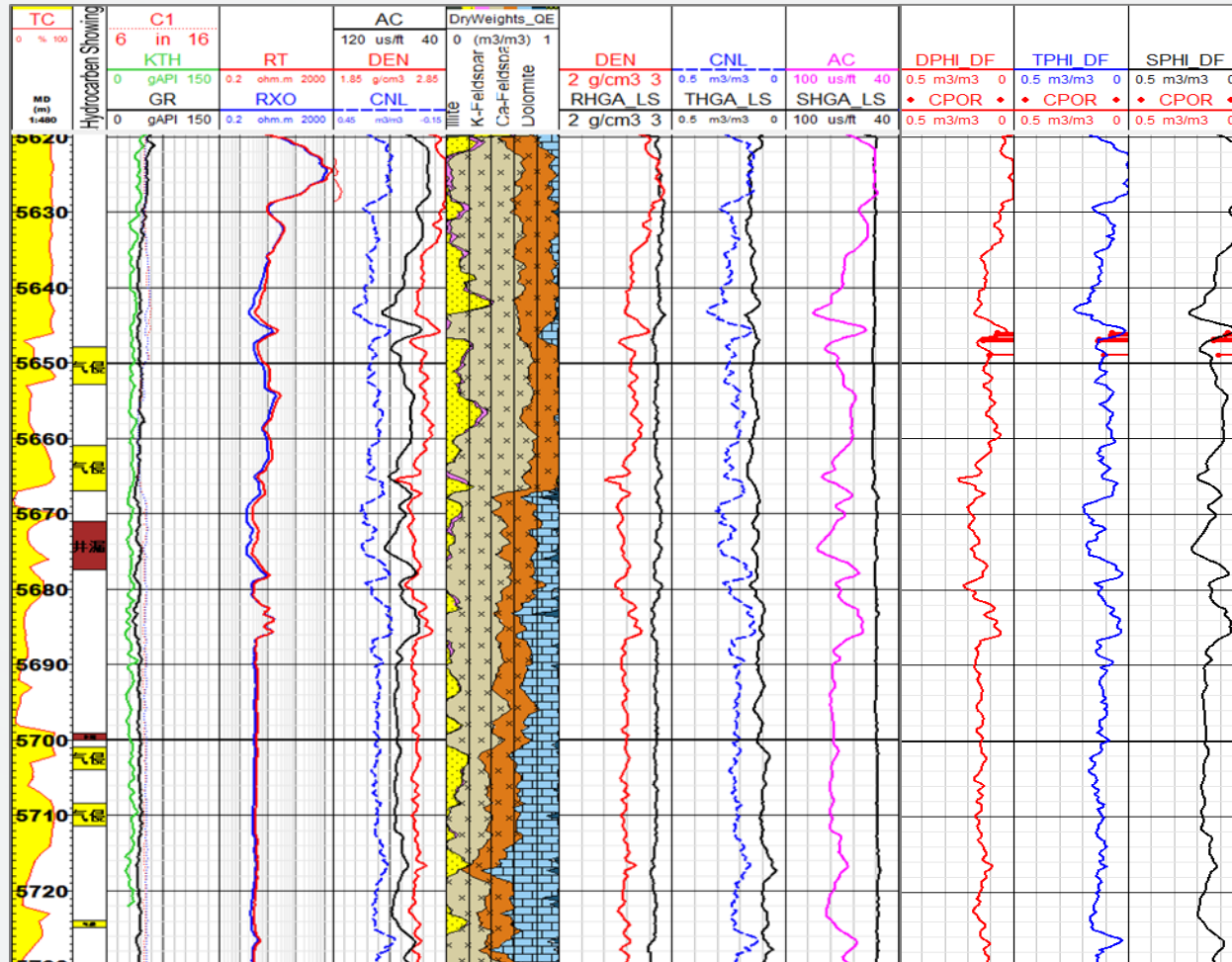
➤ **Fluid Identification**

- The Phie is consistent with the deep resistivity trend which usually indicated a poor oil and gas.
- The adjacent well,S1 well, which tested just water with rare gas, had a same relationship with T1 well.
- The hydrocarbon display from drilling logging strongly reflect a good gas-bearing.

Conventional Logging of T1 Well
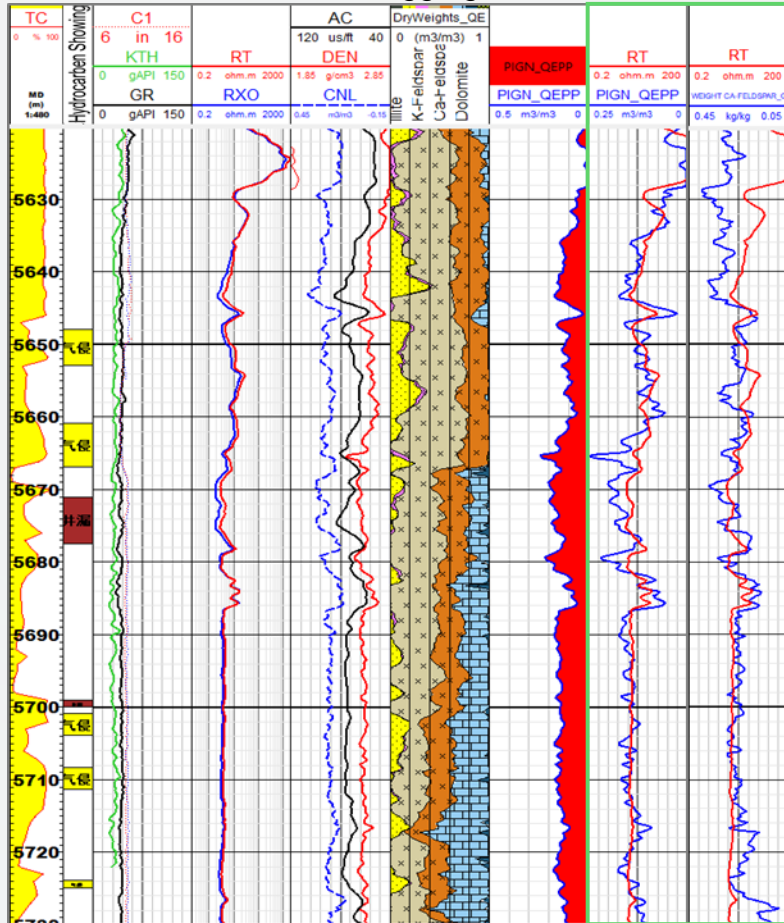
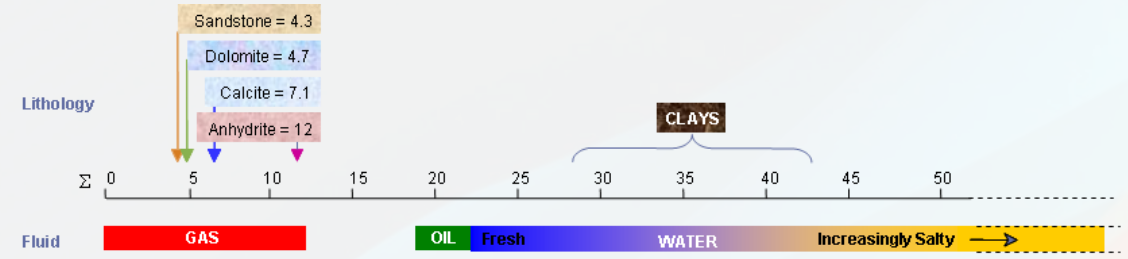| 序号	井段（m）	类别	TG（%）
1	5646.00～5651.00	气侵	7↑51
2	5659.00～5665.00	气侵	30↑69
3	5669.16～5675.53	井漏	
4	5697.18～5698.12	井漏	
5	5699.00～5702.00	气侵	27↑71
6	5706.00～5709.50	气侵	26↑69
7	5722.00～5723.00	气侵	15↑61

RT vs. AC 交会图版

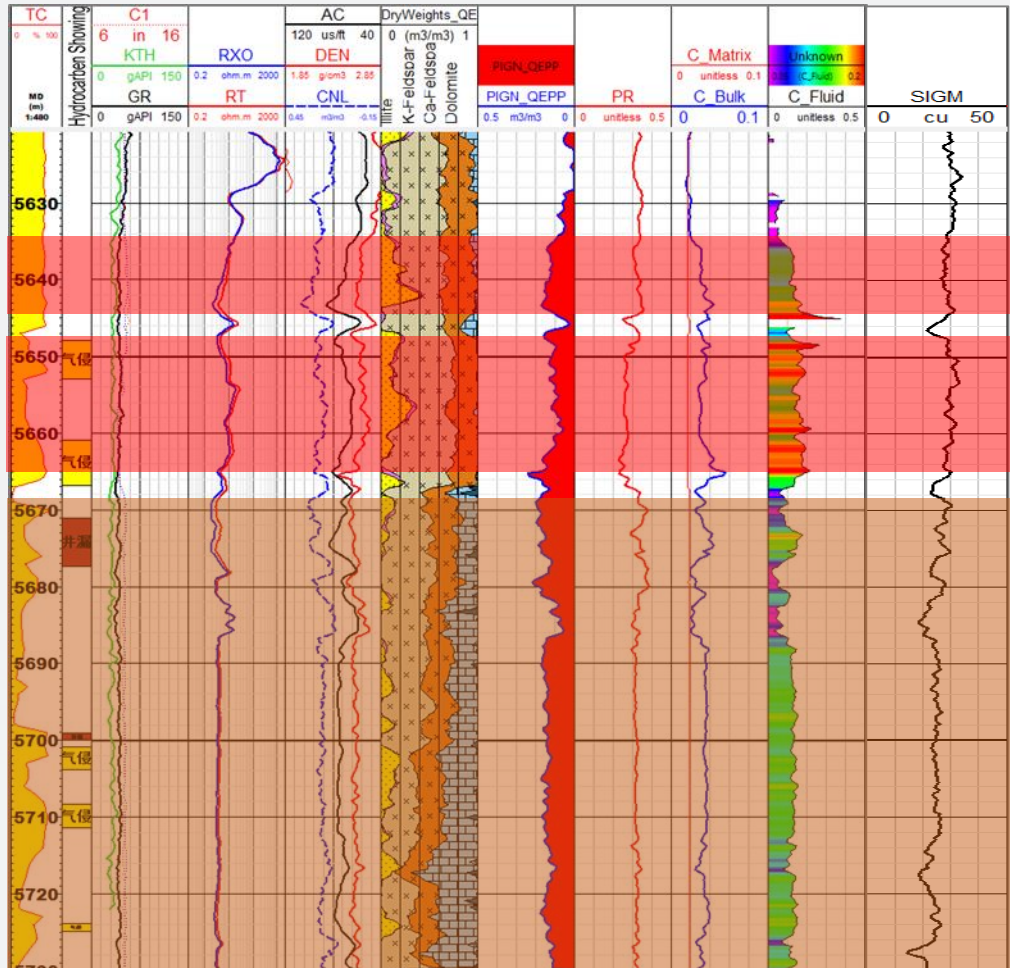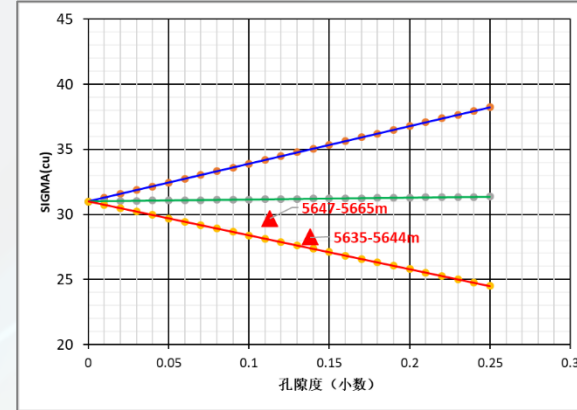➢ **Fluid Identification**

• 2 ways had been used to identify fluid types: Passion ratio vs. bulk compressibility Xplot and Sigma, which from LS logging.
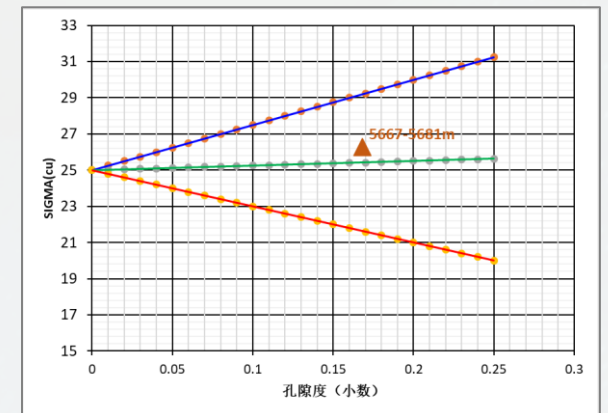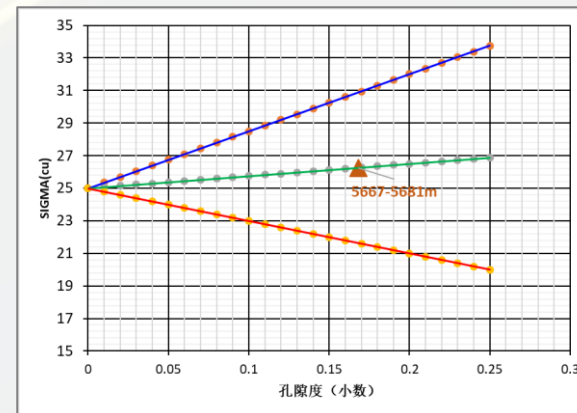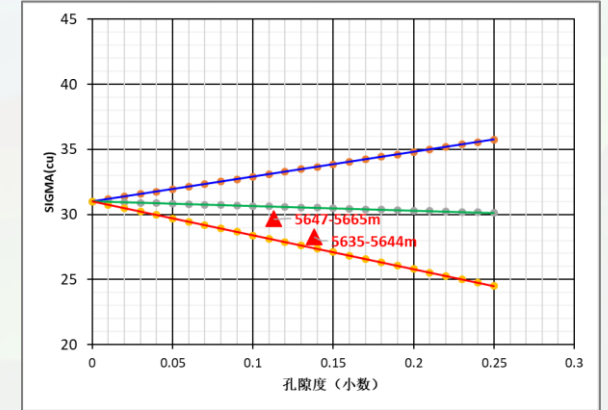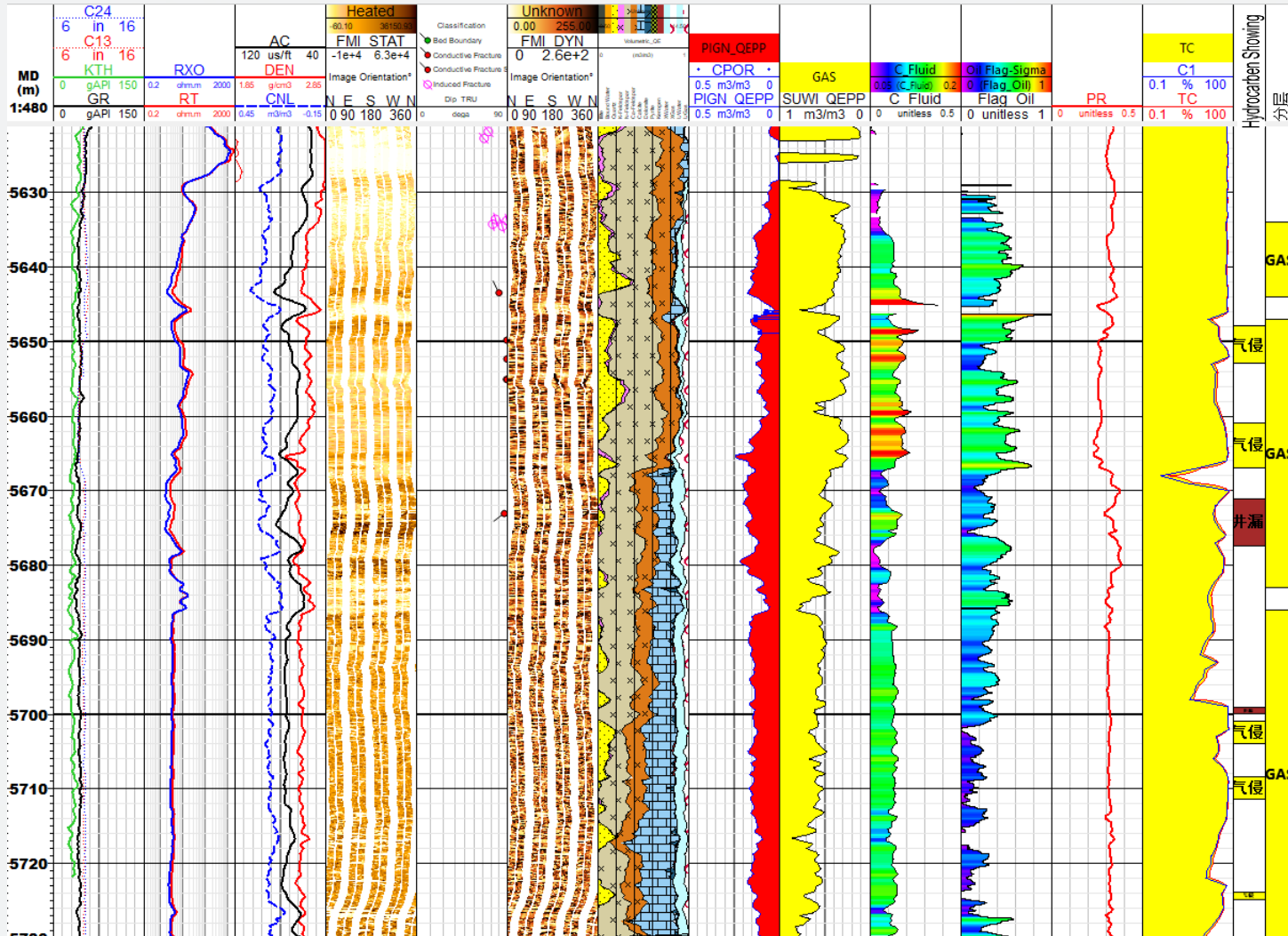
Fluid Identification of T1 Well

Sigma_water: 50

Sigma_water: 60

Test Result

Comprehensive logging interpretation of T1 Well

2 interval perferated, test gas production 220 000 cubic meters/day

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Conclusions

1、 LithoScanner can be used to quantitatively determine the content of major rock-forming mineralogy and elements, and combined with TAS chart, it can classify the chemical compositions of volcanic rocks effectively. According to the analysis of LithoScanner interpretation result after removing the heterogenous components, the lithology of volcanic rocks in T1 well were mainly basic alkali basalt and basalt.

2、 The LithoScanner can provide a relatively accurate formation variable matrix density and matrix DT slowness. The porosity calculated by the method of variable matrix DT slowness had the best agreement with the core porosity.

3、 Affected by a variety of factors, the resistivity of T1 well can be lower to 2.7 ohm.m, which made the resistivity method difficult to identify the fluid type of volcanic reservoir. While the macroscopic capture cross section of thermal neutron obtained by LithoScanner logging was applied effectively in fluid typing identification for T1 well.

4、 According to the analysis of volcanic rock structure by FMI imaging logging, the T1 well can be divided into three secondary eruptive cycles. The lithology of gas-bearing zones tested was mainly breccia tufa lava, which implied the key point of volcanic rock in further exploration in Sichuan basin.

Thanks for your attention !