

The Igneous Rock Lithology and Logging Curve Characteristics of the Eastern Sag of Liaohe Basin

Xu Shi

College of GeoExploration Science and Technology
Jilin University
Changchun, China
e-mail: xushiyx@163.com

Liu Zong-li

College of GeoExploration Science and Technology
Jilin University
Changchun, China
e-mail: 953978142@qq.com

Wang Zhu-wen

College of GeoExploration Science and Technology
Jilin University
Changchun, China
e-mail: wangzhuwen@163.com

Mou Dan

College of GeoExploration Science and Technology
Jilin University
Changchun, China
e-mail: mudan-main@163.com

Abstract—The eastern sag of Liaohe basin is magmatic activity center of Liaohe depression from Mesozoic to Cenozoic, igneous rock is widely development, the main lithology are trachyte, basalt, diabase and so on. Igneous rock lithology is related to the composition, structure, construction and causes of rock, many types of rock, hard to name and identification, is very important to petroleum exploration, and reservoir development by precisely distinguish igneous rock lithology and summarizes the logging response characteristics. It will well identify the igneous rock lithology and summarize the logging response characteristics by using the analysis of data of rock chips, combining with the intuitively display of the lithology in the crossplot. Different lithology is not the same as the response to the same logging project with conventional logging, basalt present in the characteristics of low GR, low RLLD, high DEN; trachyte has high GR characteristics, obviously different from the other lithology in this region; gabbro present high RLLD, high DEN, low CNL characteristics, GR relative to diabase and basalt increased significantly; diabase has low GR and high AC characteristics.

Keywords- *Igneous rock; Rock chips; Crossplot; Conventional log; Logging response characteristics*

I. INTRODUCTION

The eastern sag of Liaohe basin is magmatic activity center of Liaohe depression from Mesozoic to Cenozoic, igneous rock is widely development, the main lithology are trachyte, basalt, diabase and so on [1]. At present, wells that drilled in igneous rock have more than 570 in the eastern sag of Liaohe basin, among them there are more than 200 Wells have good oil and gas shows, more than 50 wells have industrial flows [2], the discovery of a variety of igneous reservoirs in trachyte, diabase, basalt, etc. The geological study of igneous rock lithology identification in igneous rock reservoir is very important, which is the foundation of reservoir characteristics research, calculation of reserves and geological modeling. Igneous rock lithology is related to the composition, structure,

construction and causes of rock, many types of rock, hard to name and identification [3-5], is very important to petroleum exploration, and reservoir development by precisely distinguish igneous rock lithology and summarizes the logging response characteristics. It will well identify the igneous rock lithology and summarize the logging response characteristics by using the analysis of data of rock chips, combining with the intuitively display of the lithology in the crossplot. It has the important practical significance for oil and gas exploration, development of specific lithologic reservoir.

II. REGIONAL GEOLOGICAL BACKGROUND IN THE EASTERN SAG OF LIAOHE BASIN

Liaohe basin is the area that has found igneous rock reservoirs and obtained large scale oil and gas reserves early in China [6], is a representative of the world's volcanic rock basin. Belongs to the typical continental fault basin, is known as China's "geological grand view garden", structure fragily, lithology diversity, large lateral variation. Combined with the eastern sag of fracture development well, narrow tectonic belt, sedimentary facies change quickly, with complex and special geological conditions [7]. Lead the exploration research work faced with the problem of complex structure, formation fragily and vary widely, various types of reservoirs which difficult to distinguish and predict, severely restricted the breakthrough development of the oil and gas exploration.

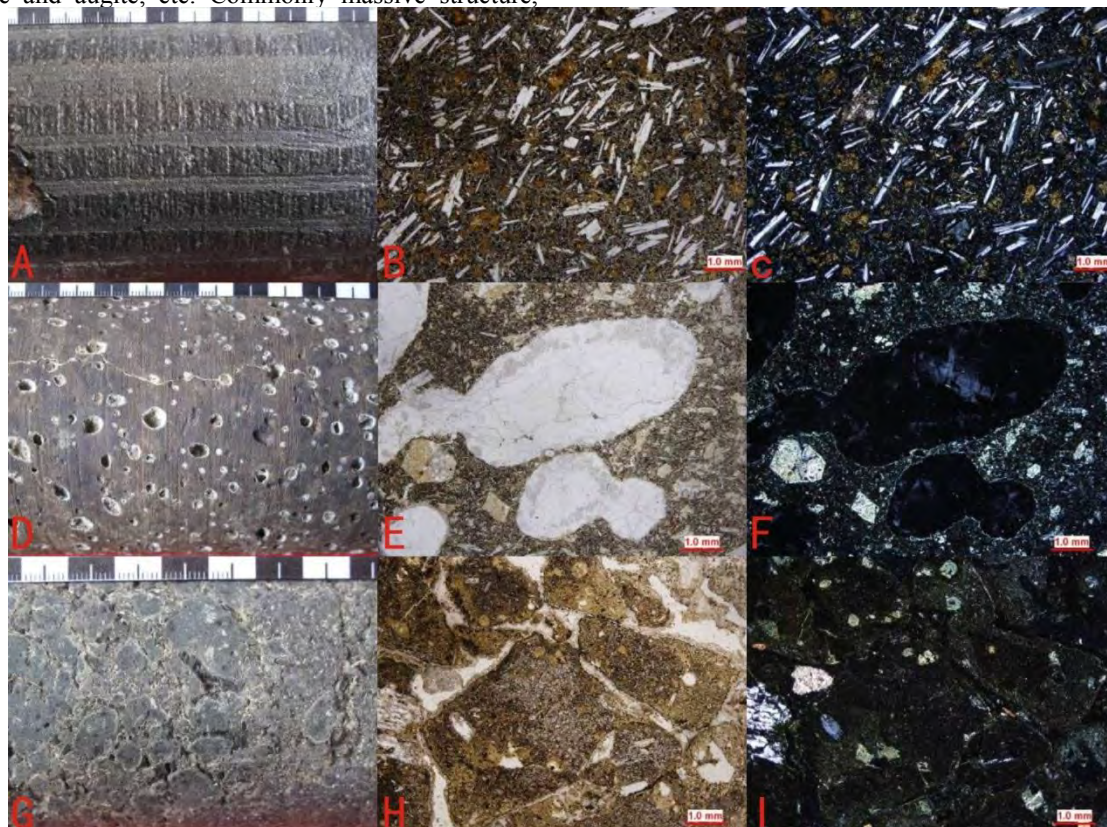
III. IGNEOUS ROCK MINERAL COMPOSITION AND LOGGING RESPONSE CHARACTERISTICS

Igneous rock has complex types, which conventional log data has limitations to reveal, so if too accurate to distinguish lithology, not only was difficult, but also practical significance was not significant. Combined with reservoir conditions of the eastern sag of Liaohe basin, the igneous rocks is divided into 5 types, namely, basalt and trachyte, brecciated trachyte, diabase, gabbro.

A. Basalt

Basalt is basic lava, the SiO₂ content of 45%-52%, the color is deep, colors commonly in this area mainly for agouti melanic and celadon, weathering surface purple or dark brown. Commonly semi crystalline structure, with porphyritic structure, isubstrate is ntergranular texture and tholeiitic texture. Phenocryst mineral composition are mainly basic plagioclase, monoclinic pyroxene, enstenite, olivine, etc; substrate mainly is basic plagioclase, variable pyroxene and augite, etc. Commonly massive structure,

porosity and almond, the amygdala formed by filling pores is mainly for the zeolite, silica and calcium etc; visible rope structure, pillow structure and columnar joint structure, etc. According to its environment, the content of phenocryst, matrix structure, the characteristics of structure, etc. basalt can be further divided into: dense basalt (dense texture, stomatal undevelopment); stomatal basalt (porosity-almond structure development); brecciated basalt (cracks development, basalt has breccia)(Fig .1).



A, B, C: X1 well, 2880.2m, basalt petrology characteristics of core image, ppl, cpl; D, E, F: X6 well, 1985.61m, stomatal basalt petrology characteristics of core image, ppl, cpl; G, H, I: X7 well, 2773.4m, brecciated basalt petrology characteristics of core image, ppl, cpl.
Figure 1. Basalt petrology characteristics

B. Trachyte

Trachyte is volcanic lava which composition same as syenite, the SiO₂ content of 57%-63%, main characteristics are widespread alkali feldspar phenocryst. colors commonly in this area mainly for agouti melanic, after weathering for brown gray and red meat, semi crystalline structure, commonly with porphyritic structure and poly spot structure, phenocryst mainly is euhedral sanidine, orthoclase or andesine, sometimes appear pyroxene or darkening amphibole and biotite; matrix is given priority to with microcrystalline sanidine, commonly has typical trachytic texture, sometimes appear spheres and small amounts of vitreous. Structure commonly is block, flow or porosity and almond, but lower than the development degree of basalt. Due to the broken effect or quenching effect, brecciated trachyte formed from Dense trachyte in diagenetic process (Fig .2).

C. Gabbro

Gabbro mainly with dark grey, structure is of mid-thick particles and gabbro, massive structure, the main mineral

composition is basic plagioclase, monoclinic pyroxene, occasionally has secondary mineral with a small amount of hornblende, quartz, biotite and alkali feldspar etc, pyroxene always automorphic-half-automorphic (Fig .3).

D. Diabase

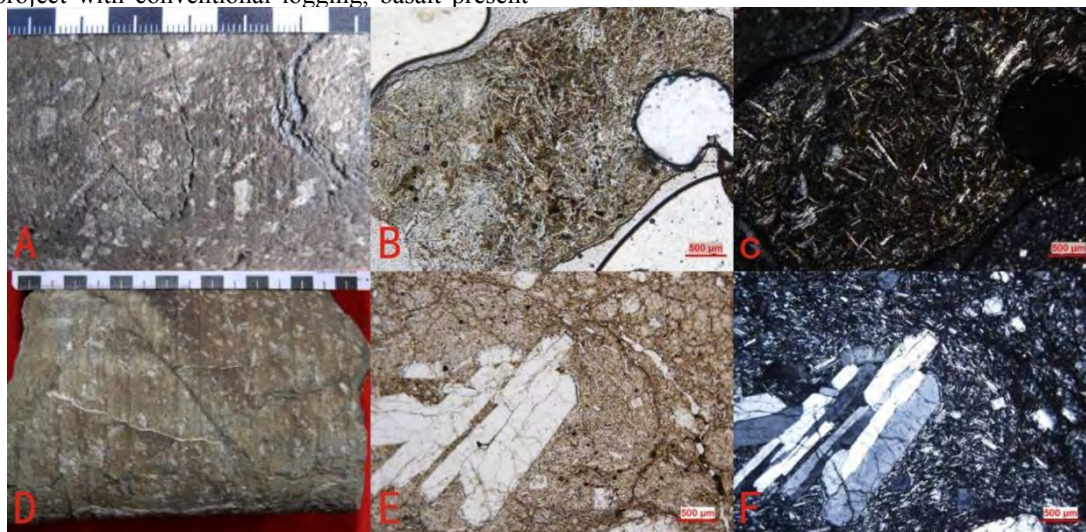
Diabase is gabbro hypabyssal rocks. blackish green, has fine-medium grained texture, commonly diabasic structure in microscope, meas: plagioclase is the form of a long platy clutter distribution, xenomorphic pyroxene filling in the framework that built by plagioclase its built a of filling his form of pyroxene. The mineral components is similar from diabase to basalt, mainly composed by the basic plagioclase and pyroxene (Fig .4).

E. Logging response characteristics

Logging response characteristics of igneous rock is rock composition, structure, tectonic, hydrothermal alteration, the growing degree of the cracks, and the comprehensive reflection of fluid properties, the chemical composition, mineral composition of igneous rock is the intrinsic factors of logging response [8]. By selecting GR

and DEN, CNL, AC, RLLD on the basis of rock chips and logging data, statistics the distribution range and logging response value of the same lithology in different sections, summarize the logging response characteristics of igneous rock. Table .1 is the lithologic logging response value in the eastern sag of liaohe basin. Table .1 lists that different lithology is not the same as the response to the same logging project with conventional logging, basalt present

in the characteristics of low GR, low RLLD, high DEN; trachyte has high GR characteristics, obviously different from the other lithology in this region; gabbro present high RLLD, high DEN, low CNL characteristics, GR relative to diabase and basalt increased significantly; diabase has low GR and high AC characteristics.



A, B, C: X2 well, 3054.52m, brecciated trachyte petrology characteristics of core image, ppl, cpl;
D, E, F: X3 well, 2360m, trachyte petrology characteristics of core image, ppl, cpl
Figure 2. Trachyte petrology characteristics



A, B, C: X4 well, 2151.31m, gabbro petrology characteristics of core image, ppl, cpl
Figure 3. Gabbro petrology characteristics



A, B, C: X5 well, 3105.6m, diabase petrology characteristics of core image, ppl, cpl
Figure 4. Diabase petrology characteristics

TABLE 1. The lithologic logging response value in the eastern sag of liaohe basin

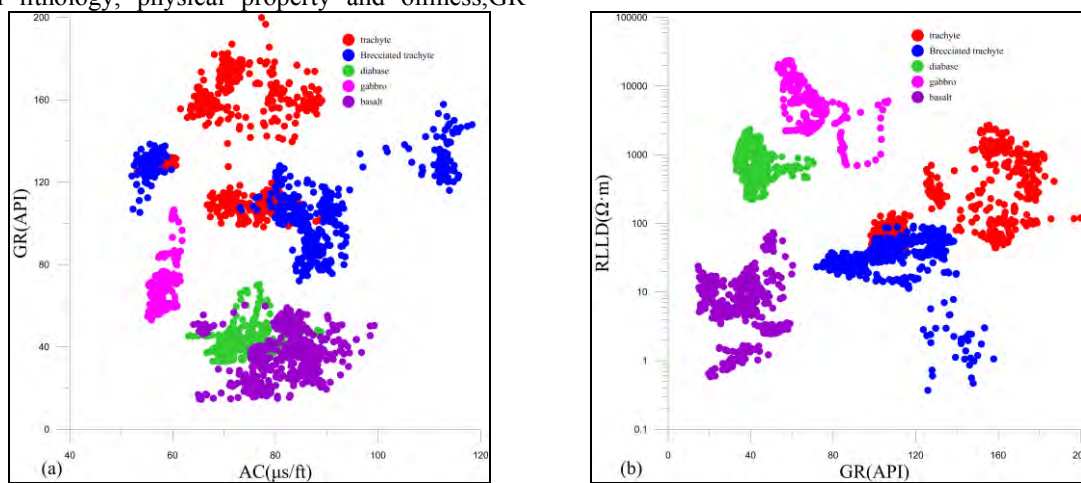
lithology	CNL(%)	DEN(g/cm ³)	GR(API)	AC(μs/ft)	RLLD(Ω·m)
trachyte	12-32	2.30-2.60	100-180	64-88	0-800
brecciated trachyte	23-38	2.10-2.65	100-150	75-115	30-90
basalt	28-56	2.20-2.80	15-55	72-92	0-20
diabase	34-44	2.32-2.48	32-52	68-80	200-1800
gabbro	13-18	2.44-2.76	55-90	55-61	0-14000

IV. CROSSPLOT METHOD TO IDENTIFY LITHOLOGY OF IGNEOUS ROCK

Crossplot method is a kind of logging data interpretation technology [9]. It is to put the two kinds of logging data in on the plan, according to the meeting point set for parameter value and scope of the coordinates of a kind of method, can put a large amount of data reflected by graphic method. Data logging crossplot method is a simple and effective way to identify lithology of igneous rock [10]. On crossplot can intuitively see boundaries and the regional distribution of all kinds of lithologic, more clearly identify igneous rocks. In the eastern sag of liaohe basin reservoir lithology is given priority to with the basic igneous rock, similar composition, lithologic differences mainly rock structure and sedimentary facies belt.

RLLD related to the comprehensive reflection of formation lithology, physical property and oiliness, GR

related to the rock composition and sedimentary environment, which is the main curve to distinguish the lithology, therefore, use RLLD-GR crossplot as main combination for igneous lithology identification, to identify the lithology of igneous rock (trachyte, brecciated trachyte, basalt, diabase, gabbro) of eastern sag of liaohe basin aided by other combinations of RLLD, DEN, AC, CNL, GR, which obtain the good results. Fig .5 is crossplots of igneous lithology identification in the eastern sag of liaohe basin, GR can identify trachyte, brecciated trachyte; AC can identify gabbro; RLLD can identify the diabase, basalt. Fig .6 is crossplot chart of standard data of igneous rock from the eastern sag of liaohe basin, it can be seen that, GR increased gradually from basic rock to neutral rock; AC gradually decrease and RLLD gradually increase from extrusive rock to intrusive rock, the change of lithology sequence is well reflected in the chart.



(a)AC-GR crossplot; (b)GR-RLLD crossplot
Figure 5. Crossplots of igneous lithology identification in the eastern sag of liaohe basin

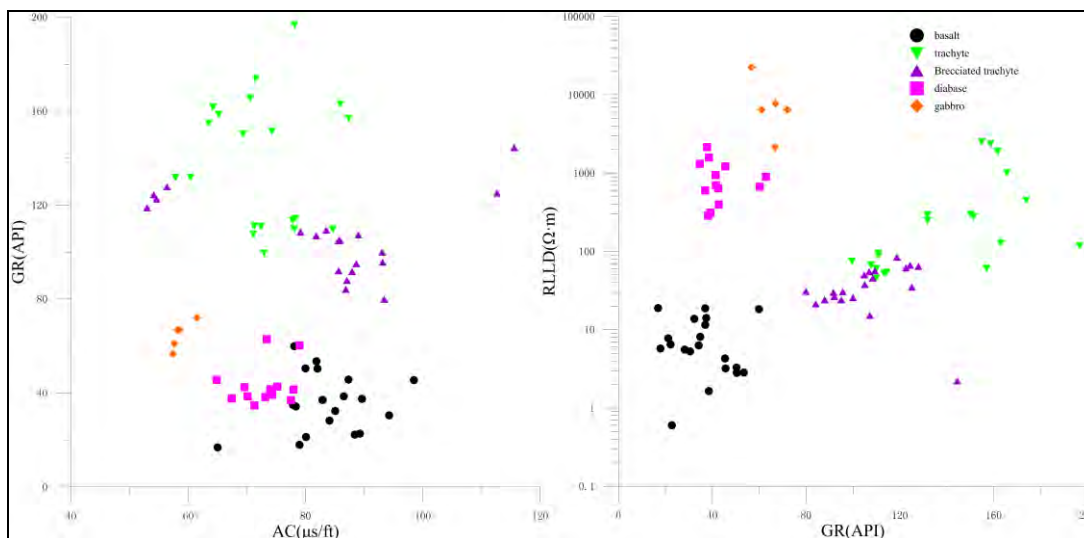


Figure 6. Crossplot chart of standard data of igneous rock from the eastern sag of liaohe basin

V. CONCLUSION

The effect is good that conventional logging parameters identification of five kinds of igneous rock lithology in the eastern sag of liaohe basin (trachyte, brecciated trachyte, basalt, diabase, gabbro), GR can

identify trachyte, brecciated trachyte; AC can identify gabbro; RLLD can identify the diabase, basalt.

Different lithology is not the same as the response to the same logging project with conventional logging, basalt present in the characteristics of low GR, low RLLD, high DEN; trachyte has high GR characteristics, obviously different from the other lithology in this region; gabbro

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