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GEOLOGICAL EFFECT OF HYDROCARBON DISSIPATION AND EPIGENETIC ALTERATION IN NORTHEAST OF ORDOS BASIN

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Abstract

Obvious feature of the dissipation of Neopaleozoic nature gas has been known in the north part of the mid-north of Ordos Basin where the nature gas had concentrated, especially in the vastly area of the north-east part,Such as a great quantity of the Cretaceous oil seepages are being founded in the Wulangeer ancient uplifted area of the northern part of the basin,According to the relevant tests of geological and geochemical, they indicated that the oil seepages were the gasol which was formed by the upper maturity coaliferous gas, which came from the Neopaleozoic coal formations of the south part. Also, because of mutual action of the superficial blanket where the natural gas went through and effusion and the surrounding light ground, various of reductive alterations were formed. Such as large scale of green-color alteration zone was formed in the Zhiluo formation of the north-east of the basin and bleach phenomenon was occured on the top of the Yanan formation.Studies have shown that this kind of rock was formed in the strong reduction environment and was deoxidized secondly with oxidizing rocks by the fluid that is the mixture of the effusion hydrocarbon and the atmospheric water.

Through the study of fluid inclusion of the Shanxi formation in the north part of the basin, it indicated that the dissipative direction of the nature gas was from the south to the north, finally converged in the northeast part of the study area. According to the ideal gas condition equation, the preliminary calculation of the dispersed proportion of natural gas was 39.7 percent.

According to the testing in the study area, high contents of series of the aliphatic acid carbomethoxy group compound was founded in the organic material of uranium bearing sandstone of Zhiluo formation, and research shows that they were formed through the reaction of the dispersed Neopaleozoic nature gas and the groundwater solution containing the uranylion. Similarly, the truth also proved that the north – east part of Dongsheng area had experienced the large-scale dissipative and reductive alteration affected by the nature gas.

The understand of the above mentioned shows that the study of green-color alteration and bleach phenomenon can denote the direction of hydrocarbon migratory and dissipative in the basin. Simultaneously, further research of dispersed amount of the hydrocarbon has important significance to the comprehensive evaluation of the hydrocarbon estimation. In addition, since

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the green-color alteration zone in the north-east of the basin controlled the output of large-scale uranium mineralization, strengthening the study can present very important applied values to found the sandstone-type uranium deposit in the basin.

Key words: *hydrocarbon dissipation, green-color alteration, bleach phenomenon, fluid alteration, the northeast part of the Ordos Basin.*

1. Introduction

Study area mainly located in Dongsheng region of northeastern Ordos basin, the outcrop strata including Yan'an formation ($J_{1\text{-}2}y$) of Middle - Lower Jurassic, Zhiluo (J_2z) and Anding (J_2a) formations of Middle Jurassic, and Lower Cretaceous. The mainly energy minerals distribution is that oil occurrence in Yanchang formation of upper Triassic (T_3y) and Yan'an formation of lower Jurassic ($J_{1\text{-}2}y$); gas occurrence in Taiyuan formation of upper Carboniferous (C_3t) and Xiashihezi formation of middle-lower Permian; the horizontal distribution feature in interspace is that oil in south, gas in center and north, and uranium deposit in margin of the basin. That the discoveries of sandstone-type uranium deposit of Zhiluo formation in Dongsheng region, the ore-controlling green sandstone alteration zone and large scale sandstone bleaching on the top of Yan'an formation in mining area, and that there are lots of Cretaceous oil seepages in Wulangeer in northern study area (Fig 1) are attracting special attentions.

In central-north of the basin, there are many upper Paleozoic gas fields from west to east, such as Sulige, Wushenqi, Yulin, Zhenchuangpu gas filed and so on. Through the analysis of the Shanxi formation's fluid inclusion of Yulin and Zhenchuangpu gas fields [1], the natural gas migration direction are considered to northeast and north trending, and then forming "escaping windows" for gas dissipation to air in Dongsheng-Wulangeer region. Through detail research, the process induced obviously hydrocarbon dissipation alteration phenolmenon, such as the forming of the green sandstone, bleaching and so on, and the gas dissipation actively influenced the metallogenesis of Dongsheng sandstone type uranium deposit [2, 3]. As hydrocarbon dissipation alteration is an important approach to research the gas dissipation scale, it is also important to accurately evaluate petroleum resources.

2. Geological background and characteristics of hydrocarbon dissipation

2.1. Direction and scale of hydrocarbon dissipation

Research of Paleozoic hydrocarbon inclusions indicates that liquid hydrocarbon only distribute in Dongsheng-Shenmu region of northeastern and eastern Ordos basin, but not distributing in Sulige-Wushenqi-Yulin gas field region. Inclusion capture pressure indicates that it's high in south and low in north, which shows gas migrate from south to north, and finally congregate in the northeast of the study area (Fig 1).

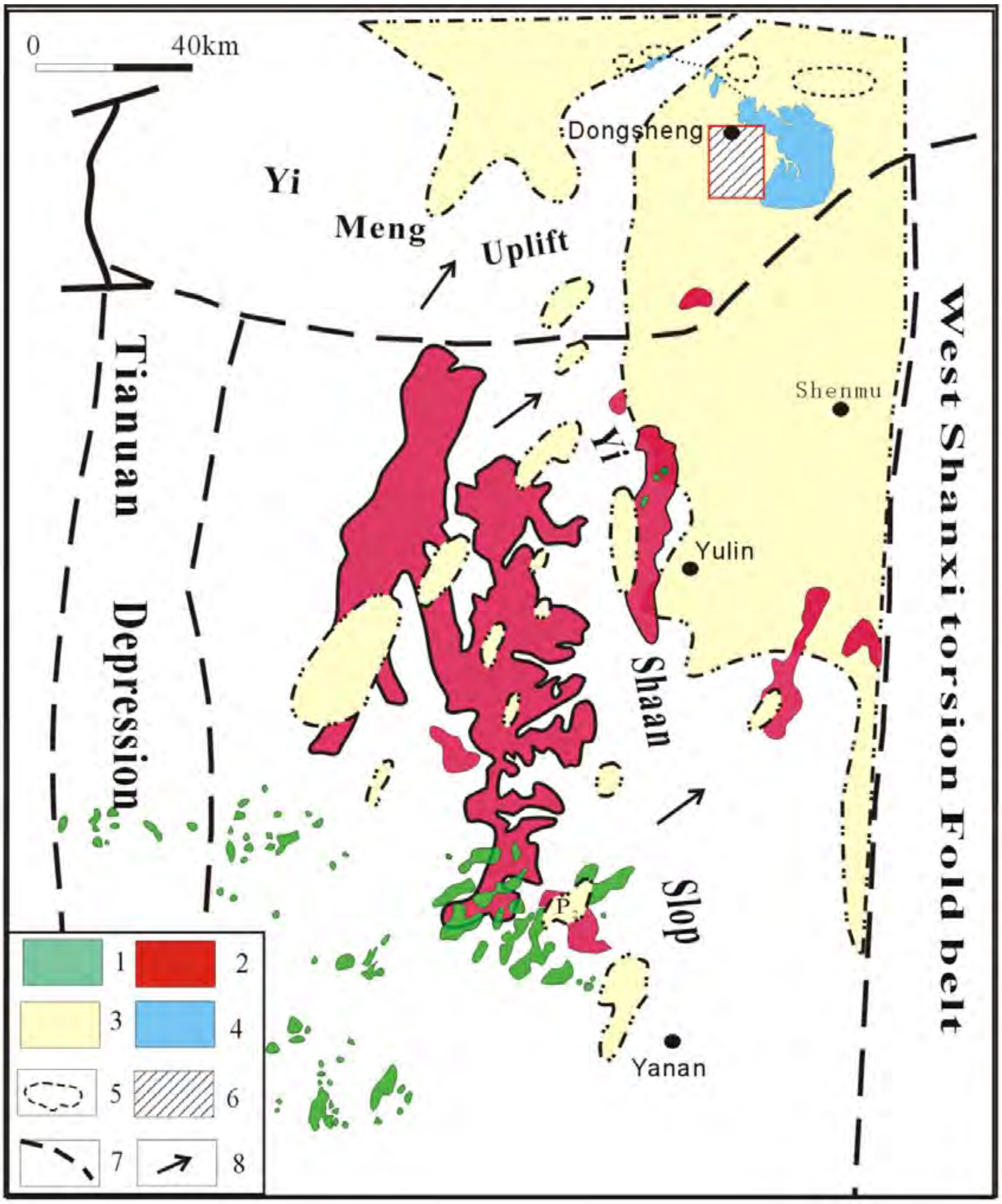

Figure 1. The regional distribution map about accumulation – dissipation and altered of oil and gas in mid-north of Ordos Basin (1. oil field; 2. gas field; 3. gas measurement showed on the Upper Permian; 4. bleach distribution; 5. oil shows; 6. Dongsheng uranium deposit and green distribution area; 7. boundary of building block; 8. the direction of oil and gass migration)

2.2. Natural gas dissipation content

It is difficult to quantitatively evaluate hydrocarbon dissipation, there are little reports about the topic which is a international problem that no important progress is acquired in domestic or abroad. The authors think that oil-gas migration may induce three consequences: congregated to oil-gas pools (i.e. “converge”, expressed by A); dispersed to underground rock layers and fluid (i.e. “disperse”, expressed by B, the disperse part still reserve original physical-chemical attribute, which should be account into potential resource when evaluating oil-gas resource);lost as to expose in the earth surface and into air or occuring fluid-rock interaction (i.e. “lost”, expressed by C). The two of latter are named hydrocarbon dissipation (expressed by D, D=B+C). For the former (A) which is the most discussed, and straight to recognize the formation mechanism of hydrocarbon reservoir and influence the hydrocarbon exploration and resource evaluation. For the second, i.e. the disperse part still reserving original physical-chemical attribute, which little research to it or indirect report in resource evaluation. For the latter (C), there are little discussion in hydrocarbon resource evaluation and reserve account.

At present, it is only primary account roughly about gas dissipation content (i.e. D value), which are according as the discrepancy of inclusion capture pressure when diagenesis and the equation of ideal gas state, then accounting the hydrocarbon dissipation content about 39.7% (D value) in study area.

Above research roughly aquired the dissipation content except gas reserves (i.e. D value), but that can’t farther distinguish and account what are the disperse content in underground rock layers and fluid (B value, which is important as potential resource content), and lost content (C value, which either disperse in air or as a reactant acting on rocks and minerals). Because the part of hydrocarbon dissipation produced alteration effect of rock-fluid process, through the research of hydrocarbon dissipation alteration, it may be an important approach to resolve hydrocarbon dissipation content, to distinguish B and C values, which are primary farther research direction of hydrocarbon dissipation and is important about rational evaluating oil-gas resource.

2.3. Characteristics of Cretaceous oil seepage and Jurassic fatty acid compound

In south of Wulangeer paleo-uplift range 100km lenghen in EW and 13km width in SN which is not far away the northern study area, 45 Cretaceous oil seepage had been found. All oil seepages mainly occurrence in Shiqianfeng group of Permian and lower strata, there is no oil seepage in Jurassic and Triassic of Mesozoic, which indicate that the origin of oil-gas is closely relate upper Paleozoic. abundance cognitions about genesis of Cretaceous oil seepage for the formers had been made,that the oil seepages were from coal gas of upper Paleozoic because of followings [4, 5]: ① Cretaceous oil sand physical attribute similar to Shihezi and Shiqianfeng groups of Permian, the crude oil proportion light, volatility strong and golden fluorescence, which different from Hetao basin where crude oil big viscosity and isn't easy in volatility, so the origin of oil are different. ② Isoprenoid alkane and carbon isotope value of Cretaceous oil seepage similar with Permian, but which are different with Ordovician and Yanchang formation of Triassic. ③ As for hydrocarbon maturity, the results of organic geochemistry indicate that the component of Cretaceous oil sand is maturity crude oil, which is from higher maturity upward migration coal series source rock, then biology degradation and light hydrocarbon re-infiltrate. But in the oil seepage region, the Ro are below 0.8 or 0.5 percent of Carboniferous-Permian and Jurassic coal series strata, and organic matter keep in low maturity evolution stage, which indicate the oil seepage is condensate oil that is form higher maturity upper Paleozoic coal gas dissipation, so the oil source isn't among in study area, but is from upper Paleozoic coal gas of southern.

Through organic matter content testing of uranium-bearing sandstone in Zhiluo formation in Dongsheng region, which contain much higher aliphatic acid methyl ester compound [6]; Zhao et al., [11] did a simulation experiment that natural gas of Ordos basin reacted with solution of uranyl-bearing to react, they discovered the primary production is UO_2, at the same time, the production contain CH_3OH.The principle is that the process of methanol and aliphatic acid may form aliphatic acid methyl ester compound. The fact suggest that there are big scale gas dissipation and deoxidize alteration in Dongsheng region, thereby, there are abundance aliphatic acid methyl ester compound in Zhiluo formation which is one "relic" of hydrocarbon dissipation alteration.

3. Geological effect of hydrocarbon dissipation alteration-green alteration and bleaching phenomenon

Shallow surface layer passed away and dissipated by gas which interacts with adjacent fluid-rock, then it forms kinds of epigenetic deoxidize alteration and so on. such as the large scale green alteration zone in Zhiluo formation, which its length is more than 300km and width about 2 ~ 35km, or large scale sandstone bleaching phenomenon on the top of Yan'an formation (J_2y) of southeastern Ordos basin. The mineralogy and geochemistry of sandstone indicate that these phenomenon are typical production of hydrocarbon alteration and formed under the strong deoxidize setting.

3.1. Petrology characteristics of greenization and bleaching phenomenon

It is easy to distinguish the specimen of greenish and normal grey sandstone (Fig. 2a, b), use polarization microscope can distinguish them also: the former is green (Fig. 2c), but the latter is shallow grey under microscope. The green of sandstone is because of green clay mineral "belt", XRD (Table 1) and SEM analysis indicate the clay mineral main component are chlorite (Fig. 2d), which is to say, the reason of “greenish” is owing to take place important aleration-chloritization. The green sandstone clastic components are primary quartz, and much feldspar, lithic and mica, a few heavy minerals, such as essonite, zircon and so on, no pyrite and carbon basically.

There are large scale bleaching sandstone continue about 120 km length in EW, distributing on the top of Yan’an formation of Middle Jurassic in north of Dongsheng (Ordos) city which in north-east of the basin, partly in the east of the basin (Fig. 2e). Sometimes bleaching sandstone is with red sandstone interlay abreast.

Some researchers think the bleaching rocks are paleo-weathered crust, but no weather crust between Yan’an and Zhiluo formations was discovered, it is continual sediments between them. Through section analysis, bleaching sandstone clastic components mainly are monocrystal quartz, which content at 70%~85%, lithic content at 10%~20%; cements are primary tegular and vermicular kaolinite.

The results of SEM indicate cements of bleaching sandstone are kaolinite aggregate (Fig. 2f); XRD analysis of clay minerals suggest that it is simple of bleaching sandstone minerals components, mainly are kaolinite (K), account for 84~90%, a few illite and smectite interbed (I/S) and illite (I), account for 1~9%, which are indicate these rocks formed at acid environment.

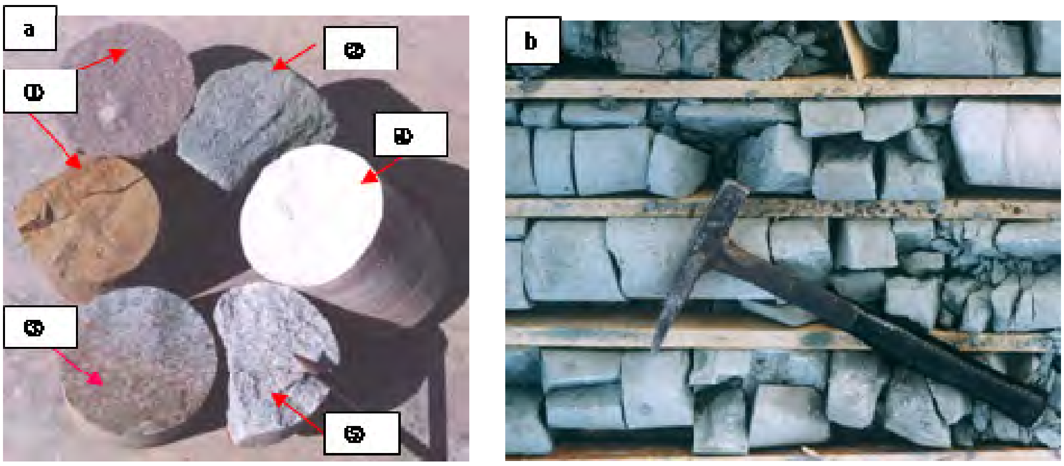

Figure 2a, 2b. Hydrocarbon dissipation alteration phenomenon and its hydrocarbon liquid inclusion in field and microscop

a: various types altered sandstone in drilling core from Shenshangou-Huangtiemiantu channel in Dongsheng uranium deposit area: ①Early stage fluid oxidation rock ②Grayish green sandstone ③Oxidized residues in grayish green sandstone ④Bleached sandstone ⑤). Primary grey sandstone;

b: Core from the green alteration zone zone in the Dongsheng uranium deposit; Well 16-32,~57.5m;

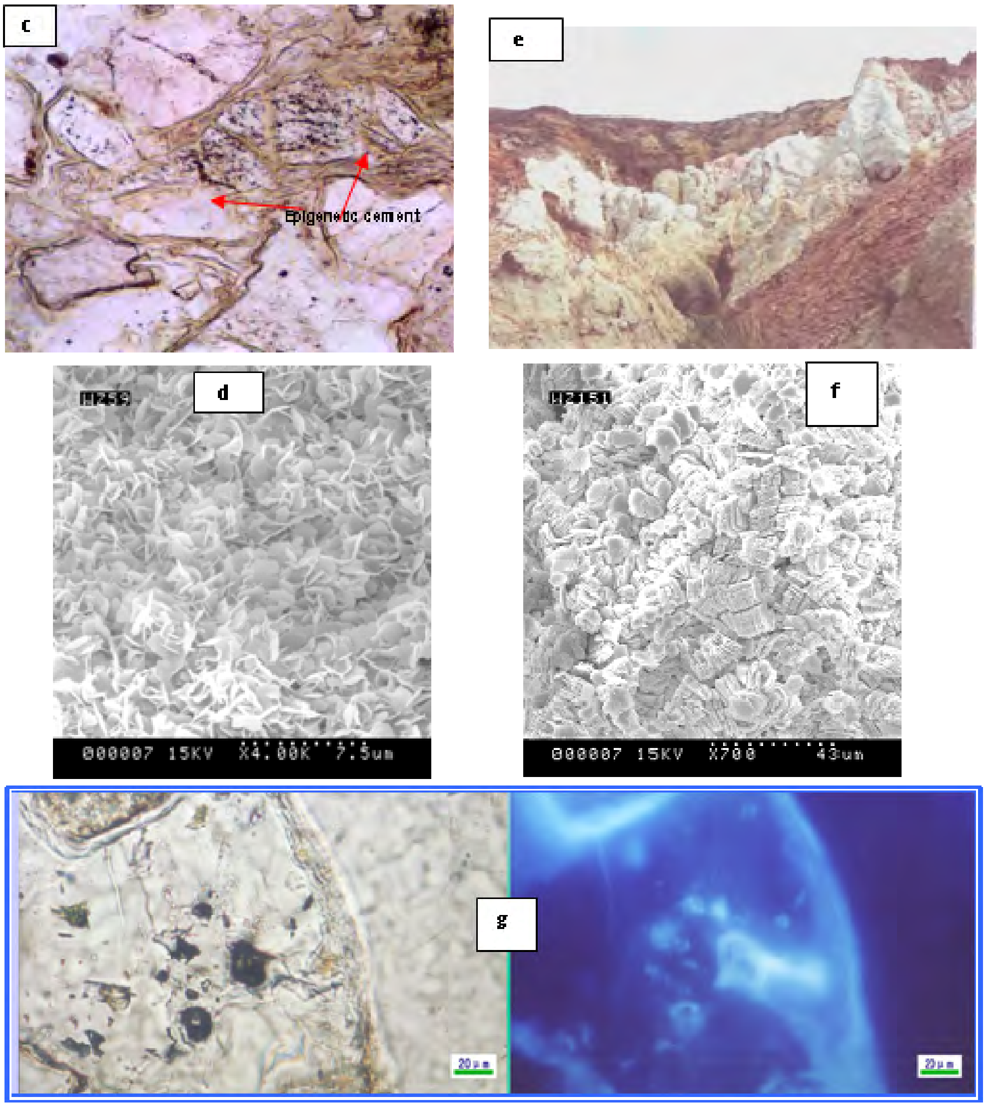

Figure 2c, 2d, 2e, 2f, 2g. Hydrocarbon dissipation alteration phenomenon and its hydrocarbon liquid inclusion in field and microscop

c: Green alteration sandstone cement composed of green chlorite; rock thin section wds 03-1;

d: The foliaceous chlorite in gray green sandstone, intergranular cement;

e: Great scale bleaching phenomenon and the red sandstone associated with bleaching sandstone, Shenshangou channel in Dongsheng area;

f: The slabby automorphism kaolinite of bleach sandstone in SEM;

g: Gaseous and gaseous-liquid hydrocarbon inclusions in bright crystalline calcite showing gray, colorless-gray, blue fluorescence light in Upper Zhiluo Formation (Left photo: under polariscope, Right photo: UV induced fluorescence photograph) ;

Table 1. Clay minerals XRD analysis of sandstone (relatively %)

Sample	Lithology	C(%)	K(%)	It(%)	S(%)
W04-21	Sub- loosen Kelly sandstone containing early brown oxidize relic	18	69	2	21
W04-26	Sub-loose green sandstone	9	24	6	61
W04-61	Sub-loose green grey sandstone	7	12	7	74
WB-77	Bleaching pebbled medium sandstone	6	84	9	1
ZL15	Bleaching sandstone		90	1	9
WB-77	Bleaching sandstone		90	8	2
W04-66	Loose grey sandstone	11	44	5	40

3.2. Rock geochemistry characteristic

3.2.1. The feature of macroelement content

The study of green alteration, bleaching and normal rock major elements indicate that (Table 2), the content of SiO_2, TiO_2, MgO and so on has a little change in all types of rock, Fe_2O_3 + FeO and Na_2O + K_2O content in bleaching rock is obviously lower than normal or other rock, which states that it has experienced a strong iron loss and formed in the acid environment and the content of Al_2O_3 with higher levels is also a reflection of kaolinite existing. The Fe_2O_3/FeO content of bleaching rock and the oxidative rock is obviously high, which shows that the process of oxidativation is existence, and bleaching rock is transformed from the oxidation rock suffered the deoxidize change. Compare to the alteration of green and the original grey rock, the indicators of the other major elements are no great differences except the content of Fe_2O_3 and FeO. .It is illuminated that the green rocks paralled the oxidation rock only exist significant differences in the formation environment.

3.2.2. The principal geochemical indexes

The rock formation and the fluid action environment is often related to the reducibility substances such as the content of organic matter (orgc), total sulfur (Σ S), Fe^{3+} / Fe^{2+}, TFe and others.Among these geochemical indicators above-mentioned, it is general that original grey rock (not suffered the epigenetic alteration) is used as the normal or the background value as the standards of reference or comparison. The results of analysis are in table 3. Among the chemical analysis methods, gas chromatographic method can be used for the organic carbon, total sulfur (Σ S) with the ICPS method, and Fe_2O_3/FeO with the solvent titration capacity testing.

The results of table 3 showed that:

① Fe^{3+} / Fe^{2+}: among the phenomenon of the oxidizing alteration、the bleaching, green alteration, the original grey rock (follows as the same description order),the average figures were 3.28, 1.78, 0.41, 0.87;

Table 2. The data of the microelement content of the various typles alteration rocks

Sample	lithologic	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	FeO	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5
WZ-85	Green sandstone	68.03	0.59	13.06	2.77	-	0.06	1.85	3.26	1.93	3.27	0.10
WZ-154		74.34	0.27	12.46	2.30	-	0.02	1.36	0.44	1.90	3.73	0.05
DS-16		65.19	0.55	14.05	4.98	3.34	0.03	2.75	1.00	1.77	3.17	0.14
D-23*		72.50	0.48	12.94	1.01	2.03	0.03	1.79	0.75	1.86	3.25	0.06
D-36*		61.80	0.75	15.39	3.34	4.90	0.06	3.32	0.75	1.18	3.68	0.06
D-53*		67.94	0.58	12.14	1.12	2.50	0.06	1.97	3.55	1.86	2.95	0.08
W04-217		72.91	0.91	11.36	3.08	1.54	0.02	1.53	0.91	1.59	2.37	0.29
W04-469		75.91	0.42	10.55	2.99	1.68	0.05	0.92	0.45	1.61	2.81	0.12
average		69.83	0.57	12.74	2.7	2.34	0.04	1.93	1.39	1.71	4.20	0.11
DWW23	Bleaching rock	67.18	0.61	22.12	0.81	0.22	<0.01	0.36	0.14	0.14	0.54	0.02
DWW46		66.43	1.00	22.00	1.14	0.22	<0.01	0.51	0.23	0.03	0.69	0.02
ZL15		73.84	0.41	18.00	0.44	-	0.01	0.17	0.11	0.06	0.45	0.01
WZ157		71.14	0.63	19.21	0.49	-	0.01	0.26	0.07	0.19	1.46	0.02
WZ48		67.22	0.84	21.95	0.70	-	0.01	0.27	0.11	0.14	0.86	0.02
DL14		65.17	0.48	9.81	3.05	-	0.05	1.73	8.09	1.93	1.96	0.11
average		68.50	0.66	18.85	1.11	0.22	0.02	0.64	1.46	0.42	0.99	0.03
D-17*	Primary gray rock	66.57	0.30	10.51	1.08	1.26	0.30	1.08	7.23	2.06	2.70	0.06
D-34*		67.43	0.88	13.38	2.35	1.58	0.88	1.84	2.37	1.66	2.88	0.08
D-52*		59.52	0.32	9.76	0.83	1.58	0.32	1.08	11.60	1.77	2.68	0.05
Ds-19		69.68	0.35	12.71	2.64	1.13	0.35	1.64	1.54	1.84	3.49	0.10
Ds-31		71.37	0.70	12.17	3.20	1.52	0.70	1.42	1.07	2.65	3.31	0.07
Ds-34		74.65	0.25	11.42	1.59	1.61	0.25	1.36	0.95	1.61	3.23	0.03
WZ63		71.83	0.57	13.40	3.35	-	0.57	1.30	0.67	1.79	3.34	0.09
average		68.72	0.48	11.91	2.15	1.45	0.48	1.39	3.63	1.91	3.09	0.07
DWW-18	Oxidizing rock	54.86	0.37	8.96	2.28	0.93	0.07	1.27	14.77	1.49	2.04	0.05
DWW-47		39.62	0.25	7.20	1.82	0.37	0.46	0.99	25.98	0.47	1.44	0.04
SF-41		74.67	0.52	12.89	2.26	-	0.03	0.87	0.73	2.67	3.42	0.07
SF-46		72.69	0.82	13.39	3.00	-	0.01	0.51	0.35	2.70	3.36	0.10
SF-43		58.95	0.45	11.38	10.74	-	0.01	0.13	0.22	2.54	3.26	0.11
WZ-139		72.61	0.34	12.40	2.29	-	0.04	1.43	2.03	1.95	3.32	0.06
average		62.23	0.46	11.04	3.73	0.65	0.10	0.87	7.35	1.97	2.81	0.07

Table 3. An part of geochemical index value in Dongsheng area of the Ordos Basin

Sample	Orgc	∑S	TFe	Fe^{2+}	Fe^{3+}	Fe^{3+} /Fe^{2+}	geochemical nature
	(%)						
DWW18	0.06	0.03	1.59	0.72	0.87	1.21	The oxidizing rock
DWW47	0.06	0.05	1.27	0.29	0.98	3.38	
DWW44	0.09	0.02	7.41	1.13	6.28	5.56	
DS－12	0.09	0.03	—	0.99	4.12	4.16	
DS－28	0.10	0.03	—	1.76	3.69	2.10	
average	0．08	0．03	3．42	0．98	3．19	3．28	
XW3	0.04	0.27	1.31	0.82	0.49	0.60	primary gray rock
W04--130	0.03	0.51	—	1.1	0.90	0.82	
W04--136	0.05	0.19	—	0.65	0.91	1.4	
W04--139	0.16	0.29	—	0.89	0.47	0.53	
DS31	0.24	0.88	—	1.18	1.23	1.04	
DS34	0.04	0.52	—	0.52	0.57	1.10	
DS30	0.66	0.70	—	2.82	1.77	0.63	
average	0．17	0．48	1．31	1．14	0．91	0．87	
XW4	0.01	0.01	1.72	1.21	0.51	0．42	The Green sandstone
XW5	<0.01	0.04	1.79	1.29	0.50	0．39	
XW6	0.01	0.02	2.00	1.45	0.55	0．38	
W04--121	0.02	<0.005	—	1.22	0.65	0．53	
W04--02	0.04	<0.005	—	1.60	0.79	0．49	
W04--125	0.07	<0.005	—	1.64	0.47	0．29	
W04--126	0.01	<0.005	—	1.78	0.51	0．29	
W04--133	0.05	<0.005	—	0.76	0.56	0．72	
DS－13	0.02	0.02	—	1.10	0.45	0．41	
DS－29	0.08	0.02	—	1.56	0.33	0．21	
average	0．03	0．02	1．84	1．36	0．53	0．41	
DWW23	0.06	0.03	0.57	0.17	0.40	2.35	Bleaching rock
DWW46	0.10	0.03	0.80	0.17	0.63	3.71	
*A3-12-7						0.28	
*A3-0-14						0.76	
average	0．08	0．03	0．69	0．17	0．52	1．78	

Clearly, the figure of the rocks suffered the oxidizing alteration (It is three times more than the original Gray rock or the background) is the maximum, it is illustrated that virgin rock experienced the process of catagenesis oxidization, it is the lowest in green alteration zone, reflecting that the most amount of $Fe_3{}^+$ was changed into Fe^{2} $^+$and there exist the strong reducibility formation environment;

② The content of TFe: the content of TFe in alteration rocks as the above-mentioned were 3.42, 0.69, 1.84, 1.31; the most obvious characteristic is that it is the lowest in the bleaching rocks, which demonstrated the characteristics that the content of Fe was strongly moved out and the rock was then bleaching.

③T content of organic carbon (orgc): the content of organic carbon as above-mentioned were 0.08, 0.08, 0.03, 0.17; original rock with the highest content, and the content of the alteration in the green zone, the bleaching rock, oxidation rock is often lower. And Total sulfur (Σ S) reflects the content of sulphide in Pyrite, the number of which is respectively 0.03, 0.03, 0.02, 0.48; original rock with the highest amount, on the contrary, the green alteration zone、the bleaching rock and the oxidation rock with the lowest amount. These features completely illustrated that the green, the bleaching and the oxidation rock had experienced the process of oxidization.

④ The content of organic carbon and total sulfur in the green alteration zone and the bleaching rocks was the lowest. Similar with the oxidizing rock, combination with the field observations (there were the residual of the oxidizing alteration in the two types of alteration rock), so it is think that the ancient oxidizing rock had undergoned twice deoxidizations (the Fe^{3+} / Fe^{2+} features of which also proved this), and thus the green and bleaching rocks retained the characteristics that the content of organic carbon and total sulfur was the lowest in the rocks. And bleaching rocks was formed in the huge loss of iron in the acidic environment (TFe content is the minimum), while the formation of the green rock is among the reduction environment.

3.2.3. The characteristics of micro-element

Analysing the microelement of green alteration, bleaching rock and normal rock in the study area (Table 4), it is illustrated that in the alteration rocks all other elements such as Sc, V, Cr, Co, Ni, Cu, Zn, Ga, Ge, Rb, Y, Nb, Ag, Sn, Cs, Ta, W, Pb completely had varying degree losses, except for that the elements of Sr, Sb was enriched and the elements of Mo, Ba, Zr was slightly enriched or remained unchanged which illustrated that the most of the microelements had some in degree losses in the process of the fluid action.

As for the figure of Th / U of the normal rock, green alteration, the bleaching and the oxidation rock were selectively 0.58, 0.9, 4.4, 3.2. The bleaching process obviously provided a source of uranium mineralization for the sandstone type deposits of the uranium because of the chemical nature of thorium being relatively stable and uranium being brought out in the process of the bleaching and oxidizing effect.

3.2.4. Features of REE content

The analysis of rare-earth element of the above types shows that (Table 5 and Figure 3), ① The alteration rock REE curves are more consistent, which suggests that the alteration rock formion has the same substances source in conjunction; With the results of the study that the oxidation sandstone is oxidated by the grey sandstone; and the bleaching sandstone is reduced by oxidation sandstone in the acid environment, and in this process concomitance the iron strongly loss, the green sandstone is formed in the alkaline reduction environment changed by oxidation sandstone, but there is no obvious loss of the elements.

②The original grey color rock of Σ REE is 196.227 (μ g / g, the same below),

Table 4. Characteristics of microelements in Dongsheng area of Ordos Basin (μ g / g)

	Sample	Sc	V	Cr	Co	Ni	Cu	Zn	Ga	Ge	Rb	Sr	Y	Zr
OGR	**XW3**	9.473	43.849	49.151	8.084	16.143	8.95	46.231	15.323	1.084	88.739	322.312	11.758	281.213
OR	**DWW18**	5.694	36.253	35.244	6.35	12.187	9.462	24.231	9.046	0.761	62.894	292.63	8.291	60.16
	DWW44	16.836	110	83.856	19.684	55.044	25.401	98.491	21.239	1.621	93.939	320.656	35.311	323.305
	DWW47	8.142	28.788	57.206	8.219	34.21	6.535	17.951	7.858	0.51	47.921	246.099	79.715	39.068
	average	10.224	58.347	58.269	11.418	33.814	13.799	46.891	12.714	0.964	68.251	286.462	41.106	140.84
BR	**WD04－115**	8.239	53.518	47.231	8.723	16.774	11.9	62.471	17.845	1.315	96.115	113.967	17.888	213.221
	WD04－120	0.471	46.32	46.856	4.555	9.115	12.96	10.443	16.077	1.239	43.479	53.875	10.729	187.822
	average	8.086	49.919	47.044	6.639	12.945	12.43	36.457	16.961	1.277	69.797	83.921	14.309	200.522
GAR	**XW4**	6.509	7.055	51.56	7.542	19.007	7.963	36.136	13.979	1.162	84.928	305.457	9.347	69.135
	XW5	7.147	57.917	58.218	6.446	19.397	13.442	35.746	13.416	1.161	75.291	328.457	8.055	101.312
	XW6	7.011	53.14	53.314	5.767	16.294	5.773	28.78	12.86	1.356	82.658	332.926	9.189	91.379
	DWW15	11.101	53.67	64.536	8.666	21.389	12.248	54.553	14.288	1.087	75.968	326.386	20.369	361.968
	average	7.942	52.946	56.907	7.105	19.022	9.857	38.804	13.636	1.192	79.711	323.307	11.74	155.949
AECC		11	99	63	20	57	38	86	20	1．2	150	690	27	160
	Sample	Nb	Mo	Ag	Sn	Sb	Cs	Ba	Ta	W	Pb	Th	U	Th/U
OGR	**XW3**	9.823	8.343	0.057	1.421	0.995	1.509	1000.348	0.626	1.431	14.205	7.992	13.663	0.58
OR	**DWW18**	4.076	0.905	0.033	0.78	1.201	1.028	743.228	0.255	0.754	7.686	2.236	0.799	
	DWW44	13.13	1.171	0.173	2.172	0.888	5.477	711.959	0.792	1.303	13.391	11.644	1.832	
	DWW47	2.296	1.557	0	0.781	1.015	0.992	484.994	0.174	0.851	7.281	1.642	0.898	4.4
	average	6.501	1.211	0.069	1.244	1.035	2.499	646.727	0.407	0.969	9.419	5.174	1.176	4.4
BR	**WD04－115**	8.774	3.566	0.11	1.82	1.08	1.982	881.64	0.667	1.833	13.779	5.778	1.43	
	WD04－120	7.3	3.985	0.21	1.543	1.152	1.48	308.799	0.473	1.517	8.953	5.41	2.095	
	average	8.037	3.776	0.116	1.682	1.116	1.731	595.22	0.57	1.675	11.366	5.594	1.763	3.2
GAR	**XW4**	5.849	0.823	0.03	1.171	1.474	1.464	998.574	0.383	1.222	11.526	3.637	1.222	
	XW5	8.098	1.061	0.097	1.192	1.389	1.166	997.901	0.469	1.002	14.926	4.443	2.566	
	XW6	6.199	0.82	0.064	1.388	0.907	1.177	978.895	0.471	1.005	10.849	3.688	1.534	
	DWW15	10.921	8.363	0.175	1.33	1.151	1.47	840.785	0.662	1.276	13.44	9.722	16.798	0.9
	average	7.767	2.767	0.092	1.27	1.23	1.319	954.038	0.496	1.126	12.685	5.373	5.53	0.9
AECC		11	34	2．0	0．05	4．1	0．5	1．5	610	3．5	2．4	15	17	5．6

OGR：Original grey rock; OR: Oxidizing rock; BR: Bleaching rock; GAR: Green alteration rock; AECC: Abundance of elements in Chinese crust (Li Tong, 1998;10^{-6})

the oxidation rock 179.129, 145.897 for the bleaching of rock, green alteration 119.862, which suggests that epigenetic alteration causes the total loss of these rare earth. The order of loss is: Green rock→bleaching rock→oxidation rock. In addition,as for the value of LREE / HREE, green alteration, bleaching rock are obviously higher than original grey rock, which shows that with the formation

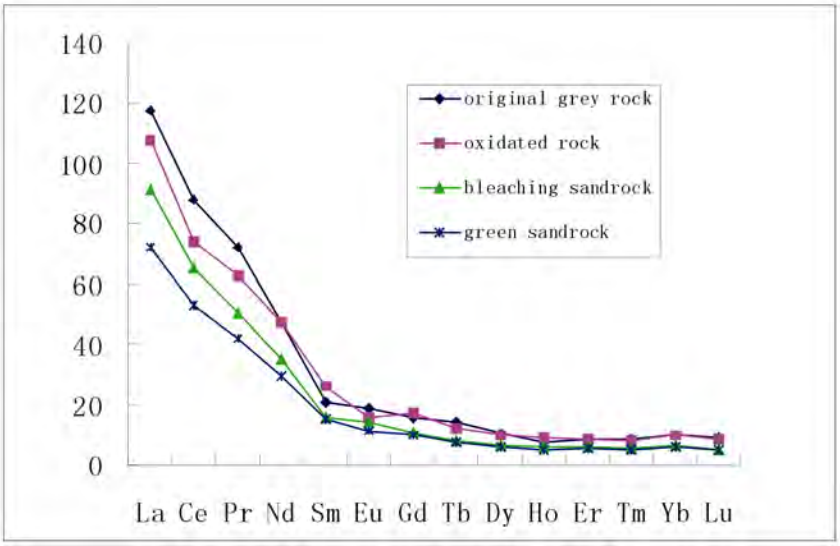

Figure 3. The partition of REE curve of the alteration rocks in study area

Table 5. The characteristics of REE content in the study area (μ g / g)

	primary gray rock				oxidizing rock			Bleaching rock			green alteration rock				
	XW3	DS-31	DS-30	average	DWW18	DWW44	average	WD04－115	WD04－120	average	XW4	XW5	XW6	DWW5	average
La	55.025	29.1	49.4	44.508	18.555	62.869	40.712	35.687	33.604	34.646	21.681	27.419	22.37	37.953	27.356
Ce	88.467	64.7	104.6	85.925	29.801	115.376	72.589	68.153	59.707	63.93	42.882	49.773	41.627	72.651	51.733
Pr	9.403	9.5	10.9	9.934	3.686	13.693	8.69	7.737	6.218	6.978	4.794	5.553	4.727	8.092	5.792
Nd	30.51	27.9	43.2	33.87	13.123	54.958	34.041	28.795	21.56	25.178	17.44	20.96	16.891	29.94	21.299
Sm	4.115	4.4	5.9	4.805	2.277	9.209	5.993	4.425	2.948	3.687	2.984	3.242	2.914	4.941	3.52
Eu	0.928	1.7	2.3	1.643	0.6	2.107	1.354	1.59	0.884	1.237	0.915	0.929	0.967	1.128	0.985
Gd	3.428	4.3	7.2	4.976	2.182	8.594	5.388	3.909	2.91	3.41	2.493	2.605	2.317	4.695	3.028
Tb	0.381	0.86	1.2	0.814	0.276	1.137	0.707	0.564	0.343	0.454	0.391	0.315	0.326	0.682	0.429
Dy	1.997	4.3	5.9	4.066	1.344	6.553	3.949	3.043	1.936	2.49	1.844	1.76	1.735	3.621	2.249
Ho	0.449	0.66	0.85	0.653	0.271	1.262	0.767	0.618	0.369	0.494	0.351	0.35	0.36	0.734	0.449
Er	1.476	2.4	2.7	2.192	0.712	3.6	2.156	1.944	1.121	1.533	1.004	1.059	1.001	2.303	1.342
Tm	0.213	0.38	0.42	0.338	0.091	0.532	0.312	0.256	0.168	0.212	0.139	0.165	0.159	0.358	0.205
Yb	1.416	1.82	3.24	2.159	0.7	3.58	2.14	1.945	0.995	1.448	0.953	0.954	0.879	2.328	1.279
Lu	0.223	0.3	0.51	0.344	0.102	0.56	0.331	0.268	0.132	0.2	0.149	0.148	0.148	0.339	0.196
LREE				180.685			163.379			135.656					110.685
HREE				15.542			15.75			10.241					9.177
∑REE				196.227			179.129			145.897					119.862
LREE/ HREE				11.63			10.37			13.25					12.06

of the green and bleaching rock, the prosess of strong geochemical fractionating has been happened for the light and heavy rare-earth elements. Fluid action is strongest in the green and bleaching alteration stages, and the reaction and exchange of the elements in the fluid are also the strongest, resulting the apparent loss in theΣ REE and diversity between the LREE and HREE.

3.3. Geochemical behaviour of fluid

The fluid inclusion study has confirmed that the fluid pH about the bleaching sandstone formation is 6.7, showed geochemical environment of weak acid [7, 8] oxyhydrogen isotopes test in kaolinite in bleaching sandstone shows, $\delta^{18}O_{H2O}$ is 6.1 ‰, δD is -77 ‰. Projected on the discrimination map of oxyhydrogen iso-topes composition in kaolinite mineral [9], showing that the data points fall above the hydrothermal fluid kaolinite line, near the region of atmospheric precipitation line, which shows in the bleaching sandstone kaolinite cement is caused by hydro-thermal, rather than weathering.

The study of sandstone carbonate cement in Jurassic and the test about single inclusion (Fig 2g) composition in calcite veins showed that [2, 7] the small parcels of gaseous hydrocarbons take the mainly position, small part are the gas-liquid hydrocarbon packets and liquid hydrocarbon inclusions, the main ingredients are CO_2 and CH_4, to show in the study area having experienced a certain amount of natural gas dissipation.

The study about carbon-oxygen isotope test in calcium carbonate cementation in sandstone shows that the numerical distribution can be divided into two groups, showing two types of carbon sources: 0.306 ‰ ～ -23.62 ‰ and -8.09‰ ～ -19.99 ‰ [10]. Carbon sources relevant surface leaching and diagenesis in greater group, the less group is from the aforesaid bleaching sandstone, calcite cement in the green alteration sandstone, the distribution of $\delta^{13}C$ and $\delta\ ^{18}O$ ranges more focused on -23.62 ‰～-10.21‰, which average is -12.94 ‰; and -10.23 ‰ ～-17.13 ‰, which average is -13.22‰. It instructed that organic carbon provide some sources of carbon for the formation of calcite cements.

The basic composition of fluid that can be divided into two parts from isotopic analysis of fluid inclusions: One can be confirmed atmospheric precipitation of epigenesis of normal temperature by the anasys of hydrogen and oxygen isotopes of inclusion. The other, gaseous hydrocarbon contant CH_4, CO_2 and a small amount of H_2S, CO, H_2, N_2, and other components of the gas [7]. These reducible gases provide a powerful reducing environment to the green and bleaching rock formed by deoxidisation.

4. Conclusions

Through the various researches of the above mentioned, it is demonstrated that the Neopaleozoic gas had transformed and dissipated from the middle part to the northeast part of the Ordos Basin, the dissipation and alteration geologic effects had been obviously formed in Dongsheng area, it concretedly incorporates the aspects as follows:

(1) Through the researches of the temperature and pressure and katagenesis sequence of the Neopaleozoic hydrocarbon, which indicated that gas mainly migrated and dissipated to the north-east part of the basin; initial testing indicated that the total of dissipation measured up to 39.7 percent;

(2) One of the dissipation evidence of hydrocarbon is the existence of the Cretaceous oil seepage in the northeast of the basin. The features of organic geochemistry indicated that it comed from the coal-gas dissipated from Neopaleozoic and then the light condensate oil was formed.

(3) The second evidence of the dissipation of hydrocarbon is that the J_2Z sandstone in sandstone - type uranium deposit of Dongsheng incorporated a high level content of the fatty acid compounds, and the experiments showed that the natural gas affected with underground water solution containing uranium can generate the methanol, which affecting with aliphatic acid can form the methanol compounds of aliphatic acid.

(4) The third evidence of the dissipation of hydrocarbon is that a series of alteration effects of fluid affected with rock can be formed; the typical effects are the green-color alteration and the bleaching phenomenon. The characterristics of Geological and geochemical indicated that they wholly generated in a strong reduction environment and was the typical products of the "natural gas – water -rock" cross-coupling.

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