

FEATURE OF DISTRIBUTION AND SUGGESTION ON  
THE DEVELOPMENT AND UTILIZATION OF OIL  
SHALES IN CHINA

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ABSTRACT

Oil shales are widely distributed in China. The geological time of the major oil shale deposits of China belongs to the Mesozoic and Cenozoic era. One of the most important characteristics of the oil shale resources in China is the association of coal seams with oil shale beds. Some of the Tertiary oil shales are highly up to 13 percent in oil yield. The suggestion on the development and utilization of oil shale deposits is put forward.

Oil shales are widely distributed in China. The total resources hold the fourth place in the world. There are more than 180 oil shale deposits, among them, about 60 oil shale deposits have been explored and evaluated.

Stratigraphic Distribution of Oil Shales

It is well known that the geological time of major oil shale deposits in the world belongs to the Palaeozoic era, such as the Ordovician oil shale deposits along the shore of the Baltic Sea in the Soviet Union and of the Southampton I. at the north part of the Hudson B. in Canada, Devonian Domanik oil shale at the west edge of Ural in the Soviet Union and the huge oil shale resources contained in the marine Devonian black shale in the center of America, Permian huge oil shale resources discovered at the Parana Basin in Brazil and the Karoo Basin in the South Africa.

The lack of the large marine Palaeozoic oil shale deposits in China comparable to the world is related to the tectonic structure environment. It is not suitable for the preservation of oil shale that the violent tectonic movement and the higher geothermal gradient strengthen the rank of organic matter metamorphism in many areas during the Mesozoic and Cenozoic era, although the oil shale-forming structure-sediment environments occurred throughout the geological time from Cambrian to Tertiary period.

The sapanthracite ( It is called stone coal as the saying goes) and carbonaceous shale facies of southern Shaanxi and northwestern Hubei Province has a similarity to that of the large oil shale deposits, which are associated with carbonate rock abroad from the Cambrian to Silurian period. Ordovician and Silurian graptolite shale

in the South China is analogous to the horizon of oil shale from abroad.

Marine depositional environment developed in the South China during the Devonian period, the horizon equivalent to sapropelite and oil shale may be inferred from that of anthracite and carbonaceous shale located in the West Guangdong Province.

It is impossible for oil shale to be preserved because the rank of coal metamorphism of the Carboniferous era is highly up to the stage anthracite, like that of Ceshui Coal Measures in the South China and Taiyuan Formation of Qinshui, Yangquan and Jiaozuo etc. in the North China, but Taiyuan Formation in which the low rank of coal metamorphism is present includes several beds of oil shales, for instance, Taiyuan Formation of the Hedong coalfield in Shanxi Province contains seven beds of oil shales yielding less than 7 percent, while the degree of coalification is up to the stage of gas coal. Oil shale beds associated with flame coal and gas coal in the Taiyuan Formation Hungyuan coalfield range from 2.2 to 0.7 meters in thickness, yielding up to 8 percent. Within the Yanzhou coalfield in Shandong Province, 15th coal seam ( rank of coal metamorphism up to gas coal ) may exhibit laterally facies change into oil shale. This kind of oil shale deposits associated with coal seam has a little amount of reserves.

The geological time of large industrial value oil shale deposits of China began from the Permian period. For example, the Early Permian Daxigou Formation which occurs in a distance of 100 km from the eastern Jimusaer westward to the Yaomoshan in Xinjiang Autonomous Region contains two beds of oil shales, yielding up to 2.8 to 5.2 percent, the reserves of oil shales is greater without associated with coal seam. It is possible that oil shales occur at the horizon analogous to Wujianpin carbonate in the west Hunan Province, but the degree of coalification remains up to the stage of gas coal to fat coal.

The most notable Triassic oil shale deposits preserved in the Yechang group of the north Shaanxi Province offer a huge area, for instance, a bed of oil shale which occurred between Binxian and Tongchuan is 9.5 to 14.6 meters in thickness, but coalification is up to the stage of gas coal. The Yechang group representing lacustrine facies which deposited over a extensive area of the Eerduosi ( Ordos ) Basin contains the resource of potential oil shale and a little of coal-bearing deposits, but coalification appears to be the early stage of the rank of coal metamorphism.

The Jurassic oil shale basins where oil shales trend to be associated with coal seam are small in area except the Eerduosi ( Ordos ) Basin, several examples are the basins of Yaojie, Huating, Shiguaizi and Weixian but coalification is believed to be the stage from flame coal to gas coal, highestly up to fat coal.

Cretaceous oil shale deposits, mostly associated with volcaniclastic rock, are widely distributed in Liaoning and Jilin Province but are very small in area, for instance, Fengning and Weichang in Hebei Province, Yixian, Chaoyang, Wangqing and Jianpin in Liaoning Province.

The major oil shale deposits of China formed during the Tertiary period. Oil shales occur in many basins like those of Huangxian, Wutu and Linquniushan in Shandong Province, Maoming, Changchang and Changpo in Guangdong Province, Qinxian, Hepu and Tengxian in Guangxi autonomous Region, Huadian, Shulan, Meihe and Yanbian in Jilin Province, Fushun, north Shenyang and Xianliaohe Plain in Liaoning Province, North China Plain, Talianhe in Heilongjiang Province, among them, oil shale deposits of Fushun, Maoming and Huadian have been developed and utilized. Within the Fushun-Mishan fracture zone the horizon equivalent to Fushun oil shale bed overlies coal seams.

In brief, there is little of independent large basins where oil shales are shallowly buried, except several basins in Xinjiang Autonomous Region and the Eerduosi ( Ordos ) Basin. The horizon of oil shale occurrence will be explored in the Mesozoic and Cenozoic strata of the East China in the future. One of the most important characteristics of the oil shale resources in China is the association of coal seams with oil shale beds.

#### Characteristics of Oil Shale Quality

Oil shale quality in various basins differs greatly from each other. Oil shale quality of typical basins according to the geological time is as follow:

Table 1. Comparison of Results of Proximate Analysis of Various Oil Shale Deposits

District	Period	Oil yield (%)	A <sup>g</sup> (%)	V <sup>r</sup> (%)	S <sub>Q</sub> <sup>g</sup> (%)	W <sup>g</sup> (%)	Q <sub>DT</sub> <sup>f</sup> (J/g)
Huangxian	Tertiary	15.63	50.25	29.36	1.06	2.93	13800
Huadian	Tertiary	13.57	54.43	34.57	0.76	9.07	12560
Fushun	Tertiary	6.14	71.44	21.05	—	3.04	6138
Maoming	Tertiary	6.21	77.58	79.14	0.90	2.95	5246
Louzigou	Cretaceous	6.83	76.39	75.75	0.81	1.09	15780
Yaojie	Jurassic	10.00	58.37	63.02	0.88	1.68	11978
Fengning	Jurassic	5.55	86.35	79.99	2.39	0.84	3722
Yijinhuoluqi	Jurassic	6.40	65.40	63.90	2.43	1.70	2566
Tongchuan	Triassic	5.80	71.36	16.66	3.40	4.70	—
Wulumuqi	Permian	6.80	75.00	23.00	—	1.25	9106
Puxian	Carboniferous	7.68	27.52	28.71	5.78	1.06	16805
Yanzhou	Carboniferous	17.23	37.75	54.74	7.66	—	20934

Table 2. Comparison of Results of Ultimate Analysis of Various Oil Shale Deposits

( to be continued )

District	Period	C (%)	H (%)	N (%)	O (%)	S (%)	O+S (%)
Huangxian	Tertiary	33.51	3.68	0.76	—	—	58.61
Fushun	Tertiary	12.32	1.95	0.52	—	0.15	—
Huadian	Tertiary	16.00	8.00	0.40	—	—	—
Maoming	Tertiary	55.80	9.58	1.86	31.31	0.43	—
Louzigou	Cretaceous	19.47	2.37	0.44	5.45	—	—

Table 3. Statistical Values of Ash Content Analysis of Several Oil Shale Deposits

District	Period	SiO <sub>2</sub> (%) <sup>2</sup>	Al <sub>2</sub> O <sub>3</sub> (%) <sup>3</sup>	Fe <sub>2</sub> O <sub>3</sub> (%) <sup>3</sup>	CaO (%)	MgO (%)	SO <sub>3</sub> (%)
Huangxian	Tertiary	51.22	7.96	9.00	19.71	1.90	5.57
Huadian	Tertiary	59.99	27.86	8.94	12.13	2.81	2.06
Maoming	Tertiary	60.53	25.31	9.05	1.11	1.48	0.34

As shown above, Palaeozoic oil shales are relatively low in moisture content, high in sulfur and calorific value, and mostly low in oil yield. Tertiary oil shales, like those of Huangxian and Huadian Basin, are highly up to 13 percent in oil yield. This type of oil shale resource will therefore be substituted for petroleum in the future.

#### Suggestion on the Development and Utilization of Oil Shales

According to the characteristics of oil shale resources of China and current economic and technical conditions the suggestion is as follows:

Large-scale independent oil shale deposits such as the Permian in Xinjiang Autonomous Region and Yechang group in the Eerduosi ( Ordos ) Basin are widely distributed and their reserves are very large. This kind of oil shale deposits serves as large industrial base.

The oil shale bed overlying all the coal seams has a considerable thickness. This kind of deposits such as Maoming has higher oil yield, coal reserves are very small, therefore, oil shale should primarily be open up.

Where oil shale bed overlies the main super thick coal seam, the thicker coal seam is, the greater the thickness of oil shale bed is, but its oil yield is very low. The examples are Fushun and north Shenyang. Coal seam and oil shale should be exploited under open mining. Utilization of oil shale must chiefly be taken into account in the underground retorting if it is deeply buried.

The oil shale bed which exhibits vertically and/or laterally

facies change into coal seam has great thickness and higher oil yield . Oil shale should separately be exploited as coal seam.

The oil shale which preponderates in small basin where coal seam poorly developed has low oil yield. Oil shale should be exploited according to local condition.