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No. 389

ENERGY: STATUS AND DEVELOPMENT -- XX

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NATIONAL POLICY

REGIONAL AUTHORITIES DRAFT PLAN TO EXPLOIT NORTHWEST'S ENERGY RESOURCES

Yinchuan NINGXIA RIBAO in Chinese 10 Jun 83 p 1

[Text] From 27 to 31 May, the Symposium on Development of Northwest Energy Resources, for the purpose of developing the northwest's energy resources and of serving the four modernizations, was held in Xi'an.

This meeting was jointly sponsored by 30 institutes, universities, colleges, research units, and design units of the four northwest provinces and autonomous regions. Accepting invitations to participate were over 200 concerned scholars, experts, teachers, technicians, and economic workers from Shaanxi, Gansu, Ningxia, and Qinghai, as well as from national organs. Everybody demonstrated the superiority of the northwest's energy resources from different angles, uniformly pointing out that only by bringing this superiority into full play, building the northwest into a mighty source of energy, and spurring its industrial and agricultural development can we vigorously promote its economy and realize the grand goal of quadrupling the overall industrial and agricultural output value by the end of this century. The conference summed up the delegate's opinions and drafted and approved the "Proposal to Accelerate the Development of the Energy Resources of the Northwest" for the Party Central Committee and the State Council.

Representatives from our autonomous region participating in the symposium conducted discussions on developing northwest energy resources, speeding up the development of electric power, transmitting power to the power grids of northern, central, and southwestern China, and other matters. They also made suggestions about the problem of developing our autonomous region's energy resources. It was unanimously hoped to be able to bring about as quickly as possible a joint power network for Ningxia, Shaanxi, Gansu, and Qinghai; to pay close attention to earlier work on sources of thermal power in the Helan Mountains (including the development of the Lingwu coal fields and the construction of a large-scale power plant) and to build as fast as possible the railway from Zhongwei to Xi'an (or Baoji); and to choose a definitive plan for developing the section of the Huang He at Heishan Xia so as to achieve rational development and utilization of that section's water resources. Our autonomous region's representatives also presented the current situation of and scientific basis for the development of hydraulic resources of the Heishan Xia section. The symposium accepted the suggestion of our autonomous region's representatives and showed "A Comparison of Plans for the Development of the Heishan Xia Section," a movie containing scientific and technological reference material on possible plans to be chosen for the development of the Heishan Xia section.

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CSO: 4013/260

POWER NETWORK

BRIEFS

DATONG-BEIJING 500KV POWER LINE--The Datong-Beijing 500 kv power line which runs across the Taihang Mountain Range is now under construction. At present, the assembly and erection of all 740 base towers have been completed, and power line installation has begun. This work is expected to be completed and go into operation by the end of this year. In Hebei Province, the project extends 163 km and has 417 base towers, or 56 percent of the total number of towers to be erected. The work involved is difficult and must meet very high quality standards; over 100 towers must be erected on steep mountain slopes. Since the project began in July of last year, the power lines have been extended over five counties, including Hui and Laiyuan counties. The leadership and members commune in these counties have actively supported the construction work in terms of manpower and materials, so that transportation of tower parts, excavation, and the work of compensating for damaged crops and trees were smoothly carried out. Members of the Beijing Power Transmission Company, which is in charge of the project, and the more than 10,000 civilian workers of the five counties built roads through the mountains and cleared the tower bases; they transported 7,600 tons of sand, cement, and tower parts to the construction sites for the pouring of concrete footings and erecting the towers. During construction, employees of the company and civilian workers paid close attention to the quality of work, and did their best to overcome many difficulties such as water shortage and hoisting tower parts. As a result, the quality of the base construction project satisfied state-specified standards. [Text] [Shijiazhuang HEBEI RIBAO in Chinese 14 Jun 83 p 1] 3012

CSO: 4013/261

HYDRAULIC RESOURCES OF WESTERN SICHUAN, NORTHERN YUNNAN ASSESSED

Beijing NENG YUAN [JOURNAL OF ENERGY] in Chinese No 2, 25 Apr 83 pp 17-19

[Article by Wang Yuzhi [3769 3768 2655]: "Assessment of Hydraulic Resources of Western Sichuan and Northern Yunnan"]

[Text] The region of western Sichuan and northern Yunnan, located in southwest China and covering an area of 420,000 square kilometers, contains the heaviest concentration of hydraulic resources in the nation. In theory, it has one-fifth of the water power potential of the entire country, but at present it has been little developed and utilized. In order to develop the hydraulic resources of this region, formulate a rational energy structure, and determine the correct method of developing the rivers, this article makes a hydrological assessment of the region's hydraulic resources.

The region of western Sichuan and northern Yunnan has abundant rainfall; among the large rivers are the Nu Jiang, the Lancang Jiang, the Jinsha Jiang, the Yalong Jiang, the Dadu Jiang, the Min Jiang and the Qingyi Jiang. It is estimated that the hydraulic potential of the 60 odd rivers in the region amounts to 145 million kilowatts; multi-year average of electric output is 1.27 trillion kilowatt-hours (see Table 1), and its hydraulic index is as high as 3.03 billion kilowatt-hours per square kilometer which is 4.9 times the national average hydraulic index and ranks among areas with higher hydraulic coefficient in the world.

The exploitable hydraulic resources of the region amount to about 130 million kilowatts, with annual electricity output at 740 billion kilowatt-hours which accounts for about 39 percent of the power output potential of the whole country and exceeds the water power potential of the United States.

The region is endowed not only with rich hydraulic resources but also favorable conditions for their development, which include the following:

1. Large River Flow Volume and Small Seasonal and Annual Variation

The region is close to the Indian Ocean, under the influence of the southwestern monsoon which affects both the precipitation and the volume of river flow. The total river flow of the region is 251.36 billion cubic meters, about 10 percent of the nation's total volume. The Jinsha Jiang is especially rich in

Table 1. Water Power Potential in Western Sichuan and Northern Yunnan

River	From - to	Drainage area (km^2)	Flow volume (m^3/sec)	Drop (meters)	Water power potential	
					10,000 kW	100 million kWh
Nu	Gongshan - Lushui	6800	1520	4648	807.42	707.4
Lancang	Yanjing - Gongguoqiao	17061	977	3633	918.66	804.5
Jinsha	Yushu - Yibin	260000	4750	30630	6492.05	5687.0
Yalong	Yayusi - River mouth	(129930)	(1800)	16827	2489.13	2495.8
Min	Heyuan - Guanxian	22950	2500	12190	742.87	650.7
Dadu	Banma - River mouth	77400	1470	12165	2398.87	2101.4
Qingyi	Yaojiqiao - River mouth	13300	(562)	5515	341.82	299.4
Total		397511	11217	85608	14550.82	12746.3

Note: 1. Figures in ( ) included in other drainage area
2. Drop in elevation figure is the total of the main flow and the tributary.

flow; at its mouth, the flow reaches 4,750 cubic meters per second, 3 times the flow of the Huang He. The Nu Jiang, the Yalong Jiang, and the Dadu He all have a flow of more than 1,400 m^3/sec. The seasonal variation of the rivers is comparatively small, with the uneven index of river flow, Cl, within the year less than 0.35; the variation from year to year is also quite stable, the Cv index measuring annual variation is less than 0.5. The average of a heavy flow year is only about 1-3 times the multi-year average. Most of the rivers north of the Chang Jiang have a Cl value above 0.4, and a Cv value above 0.6 which can be as high as 1.0; in comparison, the variation of the river flow in the region is small. The reservoir capacity required to regulate the river flow in the region is small which consequently raises the utilization rate of these rivers. From a preliminary cascade deployment, the reservoirs of large rivers can basically achieve annual and multi-year regulation. The small flow variation can also improve the guaranteed output of hydraulic stations, hence increase the guaranteed power output produced by the electric power system.

2. Large Drop in Elevation of the Rivers and Concentrated Hydraulic Resources

The large rivers which have their sources in the northern Qinghai-Xizang Plateau flow from north to south through the region's high mountains and narrow gorges, cutting deep, narrow, and steep river courses. The drop in the elevation ratio of the large rivers is mostly above .2 percent, with the Qingyi Jiang reaching 1.02 percent; whereas the average drop in elevation of the Huang He is only .087 percent. The drop in elevation is often more than 3,500 meters; the stretch of the Jinsha Jiang from the river's source to Yibin drops 5,142 meters, representing 95 percent of the total drop in elevation of the Chang Jiang. In certain sections of the river, the descent rate and drop in elevation are even greater. For example, the 17-km-long Hutiao Gorge on the Jinsha Jiang has a drop of 210 meters and a descent rate of 1.23 percent; the 39-km stretch from Jiayuqiao to the mouth at Dongboxiong on the Nu Jiang drops 300 meters with a descent rate of .77 percent. Some rivers are characterized by tortuous bends and parallel river courses, such as on the Yalong Jiang from Warli to Bazhe bend. Here, the direct-line distance from the diversionary power station intakes to the station itself is approximately 20 km, the length of the river bend, however, is 140 km, with a drop of 320 meters; the Seqiu He, a tributary of the Lancang Jiang, 30 km before it runs into the latter, runs parallel to it and the watershed between the two isn't even 6 km in width; measuring across the watershed, the drop in elevation is 100 meters. The drop in elevation of smaller rivers is even greater, such as the Wasigou, a tributary of the Dadu He has a descent rate of 4.3 percent, reaching as much as 7.2 percent at the maximum. The Heibai Shui, a tributary of the Jinsha Jiang has a descent rate of 1.1 percent, with a maximum of 4 percent. This large descent rate and drop in elevation is suited for high-head development of hydroelectric stations which calls for simple construction and can bring fast results.

The water power potential is determined by the descent rate and the flow volume of a river. Because the large rivers have a higher volume of flow and a higher descent rate, whereas the medium and small rivers may have a high descent rate but smaller volume of flow, most of the hydraulic resources in the region concentrate on the large rivers, with the medium and small tributaries representing only 21 percent of the total water power potential of the region. The Lancang Jiang's mainstream has 90 percent of the water power of its whole drainage area, the Nu Jiang 87 percent, and the Jinsha, the Yalong, and the Dadu He 75 percent respectively. The average power output per unit length of these large rivers mostly exceeds 10,000 kilowatts (see Table 2). Some of the rivers shaped by their drainage basins collect most of their water upstream by absorbing numerous tributaries, which produces a lot of water power through a sharp descent to their middle and lower reaches. For example, the Nu Jiang above the confluence with the Yuqu collects 64 percent of its water, with a flow of 1,100 m^3/sec, which enters an area of mountains and gorges in a torrential course of several hundred kilometers with a drop in elevation of 1,000 meters. The power output per river distance unit reaches 37,000 kilowatts/kilometer. At Shuangqiangkou the Dadu He already has one-third of its total flow volume and below it traverses 600 km of valleys and gorges, dropping 1,800 km in elevation and generating a unit output of 25,000 kilowatts/kilometer. The Hutiao Gorge on the Jinsha Jiang has a unit output of 170,000 kilowatts/kilometer, which is rare in the world. The concentration of hydraulic resources makes possible the construction of large-scale hydroelectric stations and lower investment cost per kilowatt, and it can thus meet the rising demand for electricity.

Table 2. Unit Power Output of Main Rivers in Western Sichuan and Northern Yunnan

River	Average descent (percent)	Maximum descent (percent)	Drop in elevation (meters)	Average unit output (10,000 kw/km)	Remarks
Nu	.24		4820	1.76	
Lancang	.22	1.07	4590	1.16	
Jinsha	.14	1.26	5142	1.67	
Yalong	.25	.68	3870	1.30	Mouth
Dadu	.39	.93	4177	1.96	Banma- of
Min	.48	1.00	3560	0.93	river
Qingyi	1.02	1.79	2840	0.78	

3. The High Utilization Rate of the River's Drop in Elevation

On the large rivers, with the exception of their catchment basins, where the flows are dispersed and less developable, there are many favorable water conservancy sites where cascade deployment of hydroelectric stations can be connected. The amount of work for each dam or reservoir need not be very extensive where the river's drop in elevation can be utilized. For example, the Jinsha Jiang, of which only the upper reaches above the Tongtian River with a drop in elevation of 1,500 meters are not suitable for deploying cascade electric stations, from Dengailong to the Shigu He, there are seven possible sites and eight comparable sites, from Shigu to Pingshan, there are eight sites and four possible sites, thus most of the 3,500-meter drop in elevation can be utilized. Even taking into account certain overlapping of the cascades, 73 percent of the drop in elevation can be utilized. On the Yalong Jiang, with the exception of 300 meters of drop in elevation in its upper reaches and in the Ganzi area where the conditions are less favorable, there are sites for deploying cascade reservoirs and connected dams; considering reverse flow and depth, 74 percent of the drop can be utilized.

4. Small Investment Produces Huge Amount of Economical Power

With the exception of the northern plateau, where river courses are wide and shallow, river courses cut deep "V" shapes in the mountain and gorge areas. The valleys are often 800-1,000 meters deep and 100-200 meters wide but with a water surface of only 30-100 meters in width. The rivers in this region are characterized by high, flanking mountains, deep water, and narrow river beds which can reduce loss due to reservoir in inundation and the amount of work required for hydraulic construction, thereby lowering construction cost. For example, the average unit of relocating people and inundating arable land of the Jinsha Jiang, from Shigu down, is 0.004 person/kilowatts, and 0.008 mu/kilowatts. The average unit of relocation for the nine medium and large hydroelectric stations which have been built in the country is 0.22 person/kilowatts, inundated land 0.27 mu/kilowatts; the difference is quite considerable. According to the preliminary planning, a large-scale hydroelectric station in the region costs 700-800 yuan per kilowatt, with the cost of the completed Gongzui hydroelectric station producing electricity at 750 yuan per kilowatt. We know, therefore, that it is possible to have hydroelectric energy in this region with relatively small investment.

5. Prospect for Industrial Development in the Region Favorable to Hydroelectric Development

Western Sichuan and northern Yunnan are rich not only in hydraulic resources, but also in mineral and forest resources. The mineral resources, rich both in quantity and in variety, include iron, copper, lead, tin, titanium, and vanadium, and nonferrous metals such as iron sulfide, potassium, mica, asbestos, etc. Forest resources are second only to those in the Northeastern provinces. These resources provide an excellent material foundation for developing refining and chemical industries in the region. Economical power sources are essential to the development of these industries, as they consume large quantities of electricity. Besides hydraulic power, other sources of power in this region are insignificant. For example, the structure of power resources of Sichuan Province consists of 80 percent water power, 16 percent coal and 4 percent natural gas. It is obvious the development of hydroelectric power should be the main emphasis of the region's energy industry; only with the development of hydroelectric power can the refining and chemical industries take off. In another example, the distance between the hydroelectric station at Ertan on the Yalong Jiang and the vanadium, titanium and magnetite at Panzhihua is less than 30 km; the total installed capacity of the station is 3,000 megawatts, with an annual electricity output of 15.92 billion kilowatt-hours. In order to develop the iron, vanadium, and titanium resources at Panzhihua, it is necessary to build the hydroelectric station at Ertan to provide an economical source of energy. Thus the integration of resources in the region will benefit hydroelectrical development. In addition, some of the favorably endowed hydroelectric stations in the region are geographically close to major mining and refining centers which allows convenient supply of electricity and cuts down the transmission cost from the hydroelectric stations.

The above are favorable conditions for developing hydraulic resources in western Sichuan and northern Yunnan, but there are also certain difficulties and problems, such as narrow river courses and large flow volume making channeling difficult; the complex topgraphy makes transportation more difficult, there are thick riverbed deposits, and seismic activity is strong and frequent. There are also scientific and technological problems to be solved, such as the selection of hydraulic engineering models for high-head, high-volume projects the manufacture of large-capacity generators, and seasonal utilization and systematic regulation of electric power based on hydroelectric sources, all require detailed study.

Summing up the discussion above, the region is rich in hydraulic resources; endowed with favorable conditions for development, it has a broad range of choices and great value for development which makes economic sense. In the situation where energy resources in the Southwest favor water power over coal, it is the main source of energy for developing the national economy in the southwest. Its potential is not only sufficient to meet the regional demand but national demand as well by "sending electricity from the west to the east." Therefore it is one of our country's important energy bases.

A rational plan for developing the region's hydraulic resources must be formulated. Judging from the distribution of hydraulic resources and their characteristics, it is more suitable to meet the region's demand for electricity by rapidly developing medium- and small-scale hydroelectric power. In the well-developed river networks, water resources are distributed throughout the region. Although the hydraulic potential of medium and small rivers compared to the whole region is not large in proportion, its absolute value, amounting to 30.56 megawatts, should not be ignored. Thirty rivers have water power potential greater than 0.6 million kilowatts. These rivers, with a large descent rate and a concentrated drop in elevation, provide many possible sites to build run-of-river hydroelectric stations. The favorable conditions to develop medium and small rivers should be utilized to build medium and small hydroelectric stations, to keep the investment small and construction time short.

In consideration of the national power demand, when it comes to developing hydraulic resources of large rivers, it is more advantageous to develop sections in the middle and lower reaches of the river. The water power potential tends to be concentrated in the middle and lower reaches which can produce a larger quantity of electricity; the variation of river flow is also more stable than in the upper reaches, resulting in a higher rate of utilization of the river; industry and agriculture are more developed and transportation more convenient; river valleys are wider than in the upper reaches, making large-scale reservoirs possible, which function both for generating electricity and preventing floods.

The development of the hydroelectric resources of western Sichuan and northern Yunnan must take into consideration not only the demand for electricity in the region but also the demand for electricity in the nation. In order to improve the present situation of energy shortage, it has been proposed to increase the proportion of hydroelectricity as an energy source. In view of the goals of the four modernizations, it is a matter of time to develop the hydraulic resources in western Sichuan and northern Yunnan and to build hydroelectric power bases. Therefore, the present task calls for organizing our available means and making technical preparation for the systematic development of hydroelectric resources in the Southwest.

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CSO: 4013/216

AUTHORITIES LAY GROUNDWORK FOR MIN JIANG DEVELOPMENT PLAN

Fuzhou FUJIAN RIBAO in Chinese 18 Jun 83 p 3

[Article by Chen Xicong: "Initial-State Work on the Planning and Development of the Min Jiang River Valley Accelerated; Commission Convenes Its First Full Session, Proposes Guiding Ideology for Development"]

[Text] At the First Full Session of the Min Jiang River Valley Planning and Development Commission held the other day, this reporter learned that initial work on the planning and development of the Min Jiang River Valley is now making accelerated progress.

By the end of May, the Min Jiang River Valley Planning Commission, after having consulted various specialists, scholars, and engineering experts as well as hydropower, transportation and communications, and other appropriate departments, had compiled a "Min Jiang River Valley Plan Report" providing a basis for future unified planning, comprehensive development and utilization, and the protection of the rich resources of the Min Jiang River Valley. Sanming and Jianyang prefectures, focal points of planned development, have their own separate specialized agencies. Sanming Prefecture has surveyed and drawn up topographic maps of the channel which runs for 127 km. from Yongan to Shaxikou, and has collected data on geology of the Sha Xi Basin, as well as hydrologic and socioeconomic data. It has proposed for the Sha Xi river section a development scheme involving six cascades in which three such cascades will be developed at Gongchuan, Shaxian, and Gaosha in the near future. These will produce 90,000 kilowatts of power and will allow passage for 100-ton vessels. At present, topographic surveys and other work have been completed at the dam sites of Gongchuan and Zhuzhou. Jiangyang Prefecture has put forward a preliminary proposal to develop the Futun Xi cascade and a major channel dredging plan. It has also undertaken a shipping channel economic survey and taken steps to rebuild locks and dams which now obstruct navigation; plans for navigation locks are in the works. It has also built a steel-hulled, shallow-draft motorized barge which is about to start trial runs. At present, more than 60 specialists in geology, hydrology, hydropower, water transportation, shipping channels and economics have been assembled from all over the province to compile a report for navigation and hydropower on the key river section of the Futun Xi from Xunchang to Shaxikou. In the early phase of the work, the East China Surveying and Design Institute of the Ministry of Water Resources and Electric Power and the Water Transport Planning and Design Institute of the Ministry of Communications both dispatched specialists, engineering and technical personnel to assist in the surveying and planning.

In order to examine and approve the "Plan Report" and study the initial phase of the planned development of the Min Jiang River Valley, the province's Min Jiang River Valley Planning and Development Commission held its first session 11-13 June. It investigated the preliminary stage of work and proposed guidelines for the planned development of the Min Jiang River Valley: Under the prerequisite of protecting resources, promote industrial and agricultural production for the maximum comprehensive benefits by fully and effectively making use of the river valley's mountain water, and soil resources--especially the water resources.

9648
CSO: 4013/294

BRIEFS

ERJIANG COMPLETED--Wuhan, 30 July (XINHUA)--Construction of the first hydroelectric power station on China's longest river, the Yangtze, was completed Friday evening when its last 125-megawatt generating unit went on line in the Central China Power Grid. With a total generating capacity of 965 megawatts, the Erjiang power station is the country's second largest already completed. The largest is the 1,160-megawatt Liujiaxia hydroelectric power station on the upper reaches of the Yellow River. The Erjiang power station has produced 6.9 billion kilowatt-hours of electricity since July 1981, when its first generating unit went into operation. The Erjiang station may produce an annual average of more than 5.4 billion kilowatt-hours, mainly for developed areas in East China, including Shanghai. Another power station at Gezhouba, the 1,750-megawatt Dajiang project, is not under intensive construction and is expected to go into operation in 1986. [Text] [Beijing XINHUA in English 0728 GMT 30 Jul 83 OW]

CSO: 4010/89

THERMAL POWER

COMPLETION OF TAIZHOU EXPECTED TO BOOST ECONOMY OF SOUTHEASTERN ZHEJIANG

Kunming YUNNAN RIBAO in Chinese 8 Jun 83 p 4

[Article by Lin Zhongping [2651 1350 1627] and Tang Qingzhong [0781 1987 1813]: "A Visit to the Taizhou Power Plant"]

[Text] On the coast of the East China Sea, in the city of Jiaojiang on the shore of Taizhou Bay, there has recently been built a large-scale thermal power plant called the Zhejiang Taizhou Power Plant, which people praise as "the wings of an economy that is taking off in southeastern Zhejiang."

In the last third of May, this reporter visited the power plant's construction site to see the moving of a black dragon of coal on a conveyor from the pier to the plant building. He also saw a towering smokestack emitting thin white smoke and many high-voltage power lines stretching across rows of transmission powers, sending a powerful current to distant places.... At present, in this phase of the project, unit No. 1 has already joined the network to produce electricity while the installation of unit No. 2 is being accelerated.

Construction on the Taizhou Power Plant, one of 70 key national construction projects, began in 1979. The state has invested 170 million yuan, calling for operations to begin this year. This plant has installed two generating units with an installed capacity of 125,000 kilowatts each. Once the whole plant begins operating, it will be capable of generating about 1.5 billion kilowatt-hours of electricity per year.

The person in charge of the power plant told this reporter that the key equipment already installed by the plant, such as high-voltage turbogenerators and high-pressure boilers, has all been designed and manufactured by our country itself. The technology is fairly advanced and the coal consumption low: Each kilowatt-hour generated needs only 0.36 kilograms of coal, saving 0.3 kilograms more than ordinary power plants.

The Taizhou Power Plant's geographic setting is superior, as sea transport can connect it with every large port in the country. Since shipping coal by water eases the pressure on rail transportation, it can also lower the cost of generating electricity. Here, besides the ability to use large quantities of sea water to cool equipment, there are also reservoirs nearby, assuring a supply of water for both producing electricity and daily life. In the past, most of Zhejiang Province's power sources were distributed over its northern and western parts. The eastern and southern parts lacked electric power, which held back the development of industrial and agricultural production in Taizhou, Wenzhou, Lishui, and other areas. After the Taizhou Power Plant's construction, its power lines will link the power network of Jinhua to the west with that of Tonghua to the east, thus benefitting load regulation. Once this power plant is completed in its entirety, it can ease enormously the severe lack of power in the eastern and southern areas of Zhejiang and provide the impetus for an economic boom there.

In the course of the Taizhou Power Plant's construction, Taizhou's prefectural party committee and administrative office have given energetic support: They have provided manpower, materials, and land whenever necessary. Linhai, Jiaojiang, Wenling, Xianju, Huangyan, and other cities and counties have postponed a number of local capital construction projects and have gone all out to support this major project. Thanks to the hard work of energetic supporters and builders, the power plant took only 19 months' time to go from scratch to the first unit's incorporation into the power network and production of electricity, 67 days ahead of the schedule set by the state. At present, the installation of the second unit's boilers is reported to be complete, and its generator is being installed. It may join the network before the end of August. The power plant's conveyor system is also being constructed at the same pace. Power lines from the Taizhou plant to Jinhua, Wenling, Tiantai, Linhai, Fenghua, and Jiaojiang have already been put up, and the 220,000-volt lines from Taizhou to Wenzhou may be hooked up by the end of October of this year. The 220,000-volt lines to Ningbo are being surveyed and designed. Once these power lines are up, they will complete Zhejiang's power network.

Preparatory work for the second phase of the Taizhou Power Plant's construction is now being intensified. With electric power leading the way, a multitude of enterprises will flourish. After the Taizhou plant's unit No. 1 unit began generating electricity, it has spurred the expansion of industrial and agricultural production: In April of this year, state enterprises in the Taizhou area alone had a total output value nearly 20 percent greater than at the same time last year.

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CSO: 4013/260

MATOU POWER PLANT: BACKBONE OF SOUTHERN HEBEI POWER GRID

Shijiazhuang HEBEI RIBAO in Chinese 26 Jul 83 p 1

[Text] Matou Power Plant's No. 7 generator, a major unit, has now joined the southern Henan power grid and is supplying electricity to it.

The planning of the No. 7 generator construction project was approved and handed down by the State Planning Commission in September 1979; the budget estimates called for investments of more than 112 million yuan. The entire project included: the construction of an 8,400-square-meter main plant building, a natural cooling tower with a cooling surface area of 4,500 square meters and a height of 100.5 meters, and a mechanically ventilated cooling tower with a drip area of 210 square meters, the installation of a 200,000-kilowatt condenser-type turbine generator, a high-temperature, high-pressure steam, 670 tons/hr coal dust boiler, a 240,000KVA main transformer, two steel ball coal pulverizers, two blowers, two intakes, two dust ejectors, two feedcoal machines, two circulation pumps, three feedwater pumps, and other main and auxiliary equipment.

External projects included the expansion of a 1.02-million-square-meter coal yard, the building of a 3.3-kilometer special rails pur, the addition of a 143-meter-long coal unloading trough, and the replacement of a 7-kilometer-long ash discharge pipe. At the same time, 9,600 square meters of worker housing was built, as was a 1,800-square-meter messhall and a 2,600-square-meter auditorium.

After this generator, with its total installed capacity of 200,000 kilowatts, is completed and becomes operational, the capacity of the southern Hebei power grid will be greatly augmented and the strained power supply situation in the province will be eased significantly.

CSO: 4013/309

THERMAL POWER

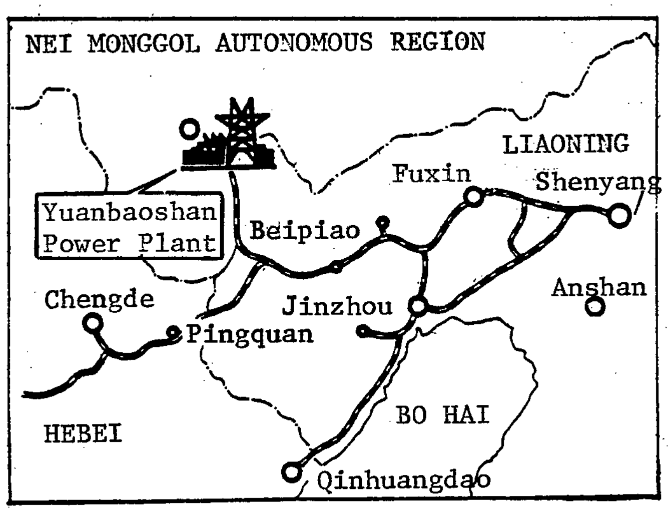
IMPORTED 600 MW GENERATOR BEING ASSEMBLED AT YUANBAOSHAN

Beijing RENMIN RIBAO in Chinese 8 Aug 83 p 2

[Excerpts] At the foot of Yuanbaoshan, in the Ju Ud League in eastern Nei Monggol, a pit-mouth power plant--Yuanbaoshan Power Plant--is now under construction.

This electric power plant, near China's key development project of the Yuanbaoshan Open-pit Coal Mine, has a designed total installed capacity of 2,100 megawatts. Installed capacity in the first stage of the project is 900,000 kilowatts. One 300,000-kilowatt generator is already producing electricity and another generator, this one imported and at 600,000 kilowatts the largest single unit in the nation, is now being assembled on an accelerated schedule. When this unit goes on stream, it will play a major role in easing the strained power use situation in Liaoning and other areas.

More than 98 percent of the imported, world-class electric power generating equipment has now arrived at the construction site. More than 3,000 construction personnel of the First Construction Company of the Beijing Power Industry Management Bureau, the organization responsible for the construction of the project, are working day and night so that the project can be turned over for operations in 1985.

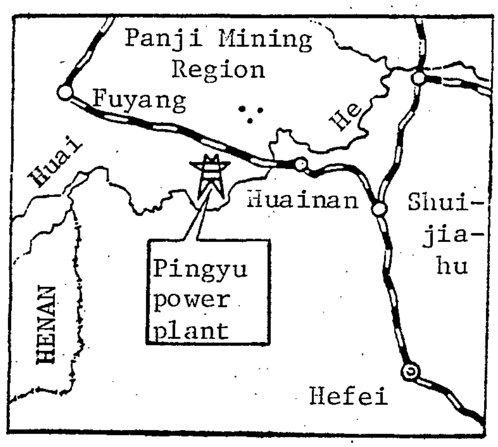


CSO: 4013/306

WORK BEGINS ON HUAINAN'S PINGYU POWER PLANT

Beijing RENMIN RIBAO in Chinese 20 Aug 83 p 2

[Text] Another large-scale pit-mouth power plant, the Huainan Pingyu Power Plant, is now under way in Anhui's Huainan Mining Region, commonly referred to as an "ocean of coal."



The Huainan Pingyu Power Plant is one of the state's major construction projects. Plans call for the first 600-megawatt generator, capable of producing 4 billion kilowatt-hours of electricity a year, to join the grid in 1987 as part of the first stage of the project. Future plans call for the installation of four 600-megawatt generators. After the Huainan Pingyu Power Plant has been completed, it will be one of the backbone power plants of the East China Grid, turning the coal from Huainan's Panji mines into a major source of electric power and feeding electricity into the East China Grid via 500-kilovolt ultra-high tension power lines.

The Huainan Pingyu Power Plant is located in the city of Huainan, on the north bank of the Huai He, to the east of the Fuyang-Hebei Railroad, only 17 kilometers from the No 1 shaft of Panji in the Huainan New Mining Region and has excellent coal, water, and transportation available to it. Building a large-scale pit-mouth power plant next to a coal mine makes it possible to take one source of energy and turn it into two, increasing the proportion of electric power in the overall energy consumption picture and represents also a technological advancement.

The manufacturing technology for the main machinery of the 600-megawatt generator of the Huainan Pingyu Power Plant came from the United States and it was fabricated by the Harbin Boiler Works, the Harbin Steam Turbine Plant, and the Harbin Electrical Machinery Plant. To date, this generator is the largest to be built in China. Technologically advanced and highly automated, its own energy consumption is low while its economic return is high. Compared to the coal consumption level of domestic power plants now in operation, it can save close to 200,000 tons of standard coal a year.

Planning for this project is being handled by the Huadong [East China] Electric Power Design Institute while the actual construction is being handled by the Anhui No 2 Electric Power Construction Company. Today, work is proceeding on putting in roads, water, and power and on grading the site. Electric power experts are of the opinion that after this power plant has been built, it will usher in a new era for China in the manufacturing of electric power generating equipment and in the construction of electric power plants.

CSO: 4013/317

THERMAL POWER

200MW GENERATOR AT MATOU POWER PLANT JOINS GRID

Shijiazhuang HEBEI RIBAO in Chinese 26 Jul 83 p 1

[Text] At 8:00 am on 25 July, the last Chinese-manufactured 200,000 KW generator of the Matou Power Plant expansion project, following 72 hours of continuous operation at peak load, officially joined the power grid. Engineering quality met design specifications as well as State requirements. The Matou Power Plant now has a total installed capacity of 850 megawatts, making it the largest thermal power plant in North China.

This generator--the No. 7 generator at Matou--represents the fourth stage of the plant's expansion project, work on which began at the end of July 1981. Engineering and technical personnel and workers of the Matou Project Office of the Hebei Electric Power Construction Company, the First Construction and Engineering Company of Handan, the Shijiazhuang Railway Branch Bureau, and North China mine construction units, under the organization of the Matou Power Plant Project Headquarters, pooled their knowledge and strength to complete the installation of this generator ahead of schedule.

While the No. 7 generator is Chinese-built, the trial domestic manufacture of all the major auxiliary equipment marks a first for the country. In order to guarantee engineering quality, engineering and technical personnel, along with the workers who installed the equipment, worked with the factory reps, offering advice and making suggestions, to tackle key problems; they completed the technical data measurements and tests on all the equipment not conducted at the factory right at the construction site. Under the combined organization of the Provincial Electric Power Bureau and the Headquarters, they finally corrected more than 60 cases of major equipment defects such as overheating of boiler screen superheaters and poorly designed and manufactured dust ejectors, making sure that installation was up to technical specifications and gaining experience in perfecting the main machinery and standardizing auxiliary equipment for the domestic manufacture of 200MW generators.

CSO: 4013/309

BRIEFS

XIAHUAYUAN EXPANSION PROJECT--As part of the phase-4 expansion project of the Xiahuayuan power plant, the second 100,000 kw turbine generator unit has reached the testing stage and is expected to go into operation in July. The first 100,000 kw turbine generator began operation in November 1982. At this point, the phase-4 expansion project is almost finished. The phase-4 expansion project consists of the installation of two Chinese-made turbine generators with a total capacity of 200,000 kw. These two generator units are highly automated, with boilers under centralized control. The generators use dual-water internal cooling. The matching Chinese-made 410-ton high-pressure boilers are equipped with high-energy automatic ignition devices; the designed coal consumption rate is 374 grams per kilowatt-hour. At the present time, the phase-5 project of this power plant has been approved by the State Planning Commission. This project will consist of the design and installation of two 200,000 kw generator units, with a total investment of 90 million yuan. Preliminary design and pre-construction preparation are currently under way; actual construction is expected to begin before the end of this year. Once the generator units from the phase-4 and phase-5 expansion projects go into operation, the total capacity of the power plant will increase from 80,000 kw to 480,000 kw. The increased capacity will not only relieve the strained status of the Beijing power network and improve the quality of power supply, it will also provide ample electric energy for industrial and agricultural production and for residential use in the Zhangjiakou region. [Text] [Shijiazhuang HEBEI RIBAO in Chinese 12 Jun 83, p 1] 3012

SHAOGUAN EXPANSION--The project to expand the Shaoguan Power Plant in Guangdong Province by adding a 200 mw generator is now being stepped up. This generator will produce 4.8 million kilowatt-hours of electricity daily, reducing the use of coal per kilowatt-hour by 18 percent. [Beijing RENMIN RIBAO in Chinese 19 Aug 83 p 2]

CSO: 4013/331

SPEED IS WATCHWORD IN MINE CONSTRUCTION STRATEGY

Beijing NENG YUAN [JOURNAL OF ENERGY] in Chinese No 2, 25 Apr 83 pp 1-7, 13

[Article by Minister of Coal Industry Gao Yangwen: "We Must Make Great Efforts to Create a New Situation in Modernizing the Coal Mining Industry"]

[Excerpts] The 12th Party Congress has set a goal of quadrupling the gross national agricultural and industrial output value within the next 20 years, from 1981 to the end of the century. To fulfill this goal, comrade Hu Yaobang pointed out in the report: "At present, the short-falls in energy and transportation constitute an important factor restricting China's economic growth, to guarantee a certain speed in developing the national economy, we must strengthen energy exploitation and reduce energy consumption. Within the next 20 years, we must tightly grasp the key links of agriculture, energy, communications, education, and science and treat them as the strategic focal points of economic development. We must understand that if the state's key construction projects are not guaranteed, if energy and communications facilities show no improvement, and if the national economy is unhealthy, individual developments will surely face severe restrictions. Even if there is development in areas at times, the balance of production and sales will not be fulfilled and, as a result, the development will not last long." Coal consumption constitutes 70 percent of China's energy consumption. The energy problem is the coal problem. The 4.6 million coal workers must conscientiously and clearly understand this important and glorious historical mission that we are shouldering. We must equip our ideology with the spirit of the 12th Party Congress, make great effort to initiate a new situation in coal mining modernization, and dedicate our effort to the party's great goal.

Inspiring Enthusiasm, Forging Ahead, Initiating a New Situation in the Coal Mining Industry

China has entered a new historical development stage. In this new stage, why have the party and the state made the coal mining industry one of the strategic focal points in economic development? First, it is because of coal's position in the national economy; everyone knows that coal is the real food of industry. The other reason is that coal mining does not meet the national economy's development needs. The shortage of coal has already become a weak link restricting China's economic growth. Today, eastern

China needs an additional 20 to 30 million tons of coal annually. As 100,000 tons of coal can lead to 100 million yuan in output value, 20 to 30 million tons of coal will lead to 20 to 30 billion yuan in value and, as a result, the state is losing 4 to 6 billion yuan in taxes and benefits annually. This is a simple example of how coal restricts economic growth. Those of us in the coal business must understand the importance of the coal mining industry so as to increase our sense of glory and our devotion to our work. On the other hand, we must understand the backwardness of coal mining, raise our sense of responsibility and the urgency of improving the present situation, catch up with the times and quickly create a new situation in the coal mining industry.

To create a new situation in the coal mining industry, we must solve problems arising from two broad respects. First, we must have accurate strategic planning and work without confusion. Therefore, we must clearly define our strategic goals, strategic focal points, and strategic steps. With strategic goals which suit the objective reality, enthusiasm will be enhanced and spirits inspired, and the broad masses of coal mining workers will be united in marching forward. With accurate strategic planning, work can be launched with order and confidence. Second, we must take a new path, instead of the old path. If we completely rely on old practices, we will not be able to shoulder the historical mission of creating a new situation. We must research a new path of initiating a new situation under the new era, the new stage.

1. Strategic Plan for Initiating a New Situation in the Coal Mining Industry

Strategic plan: The strategic plan of the coal mining industry in the new era is that under the prerequisite of raising economic results and promoting energy conservation, a doubling of the coal output will guarantee a quadrupling of the state's gross annual industrial and agricultural output value. This means that in the 20 years from 1981 to the end of the century, we must strive to double the national raw coal output, to increase the annual production from 600 million tons to 1.2 billion tons, to improve coal quality, to increase coal varieties, and to develop further processing so as to create conditions for energy conservation, thus guaranteeing the quadrupling of the gross annual national industrial and agricultural output value.

There are essential differences in comparing our present goal of achieving 1.2 billion tons of coal annually with past attempts to raise coal output. There are four basic requirements in the present attempt: 1) a stable growth rate over a long period of time instead of erratic ups and downs; 2) a healthy development, rational plans, proportionate ratio, advanced means and better labor quality; 3) safer production and construction; and 4) better economic results. There also must be fast construction speed, good investment return, and improvement in coal quality and varieties. The processing and comprehensive utilization of coal must be developed and management must be strengthened.

The enterprises' economic results, the energy conservation results and the state's comprehensive economic results must be greatly raised. Our goal is not purely a demand for quantity, but is a more comprehensive concept.

Strategic focal points: To guarantee the realization of strategic goals, we must grasp the key links and clearly define the strategic focal points. The strategic focal points for producing 1.2 billion tons of coal should be based on the following: First, we must pay close attention to the technological transformation of existing coal mines; second, when we construct new mines, we must concentrate our effort on opening large strip mines. At the same time, we must emphasize the construction of medium- and small-sized mines. Large mines must be constructed in stages and enter production in stages; third, we must make a great effort to support and develop local coal mines; and fourth, we must promote education and science.

(1) The existing mines are the base and advanced position of the coal mining industry. The present 600 million tons of coal are produced by them. Even by the time 1.2 billion tons of coal are produced annually 18 years from now, these mines will still occupy a very important position. This front, having great potential but backward technology, must be transformed through new skills, new technology, and new equipment, so that the development of the coal mining industry can be built on the basis of advanced scientific technology. Since the new mines constructed in the past few years are of small scale, slow speed and that few of them are put into operation, a certain period of time and process is needed to rapidly increase new production capability. In the near future, the increase of coal output must depend on the existing mines. Many years of experience has proven that technological transformation of old mines is inexpensive, but effective. By grasping this link, we can maintain a certain growth rate in coal output in the near future and also push production technology to a new level, laying a foundation for future modernization. Therefore, we must systematically, discriminately, by stages and by groups, carry out large-scale technological transformation. Not only coal mines, but machine manufacturing, geological surveying, capital construction, and other coal-related efforts also need technological transformation. Through technological transformation, we must increase output, reduce labor, raise efficiency, reduce the number of accidents, and greatly improve economic results.

(2) Local coal mines are important components of the coal mining industry. If this front is not stable, big problems will arise. In addition to the previously mentioned technological transformation policies to support and develop local coal mines are needed. The State Council has formulated four economic policies. But in the new era and under the conditions, we must systematically study and research policies of other respects, using these policies to arouse the enthusiasm of local areas, collectives, and all trades and professions in the coal mining business.

(3) To realize the goal of producing 1.2 billion tons of coal annually, the construction of new mines will be a major factor. Without a large number of new mines being put into operation, there will not be a great increase

in coal output in the second decade and the needs of economic development will not be met. Due to the accumulation of problems for so many years, capital construction is our weak link. We must quickly improve the scope and speed of capital construction. At present, the state is trying its best to solve the investment problem. Our work is the key to improving output. If we do not improve our work and do not improve construction scope and speed, we will not be able to produce 1.2 billion tons of coal a year. Therefore, we must pay close attention to capital construction, with one hand on production and the other on capital construction. In a certain sense, capital construction is the work of first priority.

First, we must open more large strip mines, the construction period of which is at least 2 to 3 years shorter than that of large underground mines. Their fast [construction time], fast production, small labor requirement, low cost, high efficiency, and safe working conditions, together with a large-scale pit-mouth power plant can solve great problems. In constructing large strip mines, we must liberate our thinking, break free from convention and adopt advanced skills, techniques, and large-scale, highly efficient equipment. Large strip mines must be opened wherever resources permit. If large strip mines are not possible, try medium- or small-sized strip mines. Whenever strip mines are possible, we must not open underground mines. Assuming new mines will produce 600 million tons of coal per year in the future, 200 million tons should come from strip mines.

Second, we must integrate large-, medium- and small-sized coal mines, while focusing on medium- and small-sized mines. Today, particularly, we must open as many medium- and small-sized mines as possible by giving them priority. Medium- and small-sized mines will have a big proportion in the increased national capability over the next 18 years (including unified distribution, local and communal mines). What we need to concentrate on is the scheduled increase of 600 million tons of coal per year under the supervision and leadership of the Ministry of Coal Industry. Besides the 200 million tons from strip mines, 200 million tons out of the remaining 400 million tons should be produced by medium- or small-sized coal mines. The special features of medium- and small-sized mines are low investment, short construction time and quick returns. We have made detailed calculations on the projected 600-million-ton annual coal output increase. To achieve this goal, we must, on average, increase output by 33 million tons per year over the next 18 years. If all the mines that we are going to build are of large scale, assuming 6 years of construction time and 3 years to reach production, up to the year 2000 they will produce 390 million tons. If the mines are of medium- or small-size, and assuming 4 years of construction period and 2 years to reach production, up to the year 2000, they will produce 440 million tons, producing 50 million tons more than large-sized mines. In addition, in the year 2000, they will produce 80 million tons more than large-sized mines. This is a theoretical calculation. In practice, all the mines we build cannot be medium- and small-sized mines, but their economic results are pronounced. Therefore, from now on, medium- or small-sized mines are a priority and must be built whenever conditions are suitable.

Third, large coal mines should be constructed and be put into operation in stages, or their construction and operation should come after that of smaller mines, as this can also achieve the result of producing more coal in a shorter time. Therefore, the geology, design, building sequence, construction, and the turning over of production must also undergo reform.

Fourth, we must pay close attention to the exploitation of key regions, which are Shanxi, eastern China, northeastern China, Nei Monggol, Henan Province, Hebei Province, Guizhou, and north of the Wei He. We must accelerate construction of five large strip mines and ten coal mine bases and particularly pay close attention to the energy bases centering around Shanxi.

(4) We must promote education and science. Comrade Deng Xiaoping has stated that science and technology are the key to fulfilling the four modernizations, and education is the base for developing science and technology. Compared with other sectors, coal education and science are more backward, and therefore need to be stressed. For a long time, education, science, and technology and scientific management have been neglected on the coal mining front, and the development of intellectual and material resources has not been coordinated. Education and science have already restricted the development of the coal mining industry and the strategic plan of "doubling guarantees quadrupling." Besides the adverse influence of the leftists, another major reason for some of the errors committed in the past is the low scientific and technological level, low cultural level, and shortsightedness, which unavoidably led to a blind, one-sided approach. Cadres at all levels must greatly raise their ideological knowledge. We must, instead of just in words, put science and education on the position of the strategic focal points. Education and science are causes which affect the future. The present work will affect the '90's and beyond. Therefore, we must race against time, lay a good foundation in these two respects, and train more able personnel who will contribute to our future endeavors.

Strategic plan: Based on the two-stage strategic plan of national economic construction, the coal mining industry will also be developed in two stages. Due to its special position, coal mining must march in the front.

First 10 years: We must make great efforts to create two conditions. First the coal mining industry must open up a new situation, lay a good foundation and particularly, build several large strip mines, creating conditions for its development in the second 10 years. Then, there must be an annual increase in coal output so as to create conditions for the state to accumulate funds [for capital construction]. The average annual increase is 18 million tons, while the outside goal is 20 million tons. Capital construction should be developed earlier, to 180 to 200 million tons by 1990.

Second 10 years: Entering the strengthening period of comprehensive development. The national average annual increase of raw coal output will be 40 million tons. Capital construction will continue to be about 200 million tons.

In the first 10 years, since transportation and communications problems in western China will not be totally solved, coal mines of eastern China must work harder to develop their role. We must continue to expand construction and increase production capability in the east, which has both the resources and prospects for development. Here we must further emphasize here that a comprehensive analysis of the role of the coal mines in the east, i.e., whether they have potential to increase production, is needed. In the past, some said that the coal mines of the eastern region were over-worked to the point of exhaustion. Now, we can see that this is a one-sided concept. Of course, some mines are a little over-worked and some of them are already in the final stages. From an analysis of the whole region, this idea is unrealistic, giving people the misconception that the eastern region has no more potential, that its production level must be reduced or, at best, can only be maintained at its current level. However, the reality is that most coal mines can be rebuilt or expanded and they still have the potential to increase production. When the state needs coal, we must lengthen the original lifespan of coal mines, intensify extraction, and, by adopting scientific methods and technological transformation, produce as much coal as possible. The west, especially in the second 10 years, must also work hard. From a national range, the intensive exploitation of the east will still not completely solve this region's needs. Coal from the west must be shipped to the east, coal from the north must be shipped to the south, and coal from the regions inside Shanhaiguan must be shipped to regions outside Shanhaiguan. We can only try to reduce the burden on transportation not reverse the overall situation.

The above is the tentative scheme for the new situation of the coal mining industry in the new period. Can these strategic goals, strategic focal points, and strategic steps be fulfilled? After repeated research and analysis, we think that it is possible.

First, there is coal underground. There is a reserve of 640 billion tons, and reserve estimates will increase every year. This is a material condition which creates a favorable situation.

Second, the present moment is one of the best periods for the coal mining industry since the founding of the state. The previously listed seven bases are our most favorable conditions. Since energy is one of the strategic focal points, the coal mining industry will surely receive extensive support and close attention from different quarters. As long as we make good use of our favorable conditions and do a good job, the state's coal mining workers will surely be mobilized to initiate a new situation and our strategic goal will be fulfilled.

Third, is 1.2 billion tons an idle boast? Is it an "overly high quota"? No, because this is calculated and analysed on the basis of research and investigation after summarizing historical experience and lessons. Moreover, this is not a purely imaginative idea, but one with planning.

To increase the annual production from 600 million tons to 1.2 billion tons in 20 years, the average annual increase will be 3.4 percent, while the actual increase will be 30 million tons. Let us first analyse this speed. From 1950 to 1980, the average annual increase rate of national raw coal output was 10 percent. During the First Five-Year Plan, it reached 14.5 percent. It still reached 5.2 percent in the Fifth Five-Year Plan, when the increase was comparatively low. The expected 3.4 percent annual increase over the next 20 years is no higher than the past. The growth rate will of course be affected by the base figure.

But if the base figure increases, the material foundation will also increase. Moreover, we must understand that in the past 30 years, the management of the coal mining industry was characterized by frequent and severe disruption and sabotage. While in the future, with improved scientific, technological, and management levels and conditions basically different from that of the past, it will be developed under new conditions. The annual increment of 30 million tons was almost attained in the past. During the Third Five-Year Plan and the Fourth Five-Year Plan, 25 million tons had been achieved. It was 27 million tons during the Fifth Five-Year Plan. Since the present base figure is larger and more favorable to increased output, it is possible to increase it a little more.

We also have absorbed the lesson of the "adventurist progress" of the "ten-year-plannings" formulated in 1978. At that time, influenced by "leftist" ideology, it was suggested that coal output in 1985 be raised to 1 billion tons, and then to 2 billion tons by the end of the century, with an annual increase of 50 million, 60 million and 70 million tons. That obviously was not realistic. The present goal was formulated after the "leftist" guidance ideology in economic work had been abolished and the coal mining industry had begun to take on a stable, healthy development trend. The Party Central Committee formulated the goal of "quadrupling" after extensive investigation and research, including the "doubling" of coal output.

The above are the basic foundation and reasons for our goal of "doubling." It is clear that it is essentially different compared with the goal raised in 1978. It is not "high quota," or pure talk, but one which is possible to attain after great effort.

Of course, this is only a plan. It surely will not be an easy task to turn into reality.

First, the time is short and the increment large. Doubling means that the increase in output over the next 18 years must be the same, or more than, the increase in output over the past 30 years. This is a very difficult task. To make up the 1.2 billion tons of coal, the existing unified distribution coal mines, local coal mines, and new mines which are going to be constructed must race against time, shouldering heavy responsibilities. Scheduled to produce 400 million tons annually in the future, the increased output required of the present centralized coal mines does not seem large. In reality, however, since 40 million tons will be lost due to the abandonment of some coal fields, and 30 million tons will be lost due to old age and lower production, these 70 million tons together will make the actual increase for centralized coal mines over the next 18 years 120 million tons. As extraction skills, technological equipment, and management levels of local coal mines lag behind that of the centralized coal mines, their technological transformation will be more difficult. Since the development of coal mines in some provinces will even be restricted by the areas' resource potential, there will be more difficulties in basic construction.

In the 30-odd years since the founding of the state, the coal shafts and strip mines with an output capacity of more than 30,000 tons produced a total of 380 million tons. To demand them to produce 500 million tons over the next 18 years and raise their capital construction to 200 million tons is something that has never been done. Judging from geology, design, construction, material supply and the overall balance and external coordination, the present situation does not fit such a large scale and there surely will be many difficulties in the future.

Moreover, the coal mining industry has many weaknesses which do not suit the requirement of modernization in the new era.

To initiate a new situation, we must, step by step, solve these problems, overcome these shortcomings, improve unsuitable conditions and the backward outlook. Without determination and willpower, without great care, consideration and hard, solid work, it will not be effective.

The next thing is external problems. Railroad transportation, unable to meet the demand and unimproveable in the immediate future, will still be a factor restricting the development of the coal mining industry. Low coal prices dampen the enthusiasm of the enterprises. There are still problems concerning investment capital and material. According to our predictions, a large sum of money is needed to increase production by 600 to 700 million tons of coal.

We must conscientiously tackle all these problems.

2. We Must Walk a New Path

To initiate a new situation, to fulfill the strategic goal of doubling output, we must walk a new path. Work according to convention and walk on old paths just will not work.

For example, in capital construction, if we are like the past, i.e., try one area today, another area tomorrow, and yet another area the day after, changing areas back and forth and shifting work forces here and there, or in construction, where backward equipment and confused management still exist, and with the thought that it takes 8 to 9 years to build a coal mine, and another 8 to 9 years to attain the designed capacity, after two periods of 8 to 9 years it will already be the end of the century, the goal of new mines producing 500 million tons and shouldering 400 million tons of coal output will not be possible.

Take another example: There are already 4.6 million coal mining personnel throughout the nation. If we adopt the old way and double the number of staff in order to double output, the development of the coal mining industry will be delayed.

Then there are safety problems. If we do not control or reduce the number of severe accidents, the image of coal mines will not be changed, and it will be more difficult to employ new workers, to acquire trainees, and for coal miners to marry.

Coal quality and coal varieties are also a big problem. We will not be able to double coal output to guarantee the quadrupling of gross annual national industrial and agricultural output value if the present conditions of few coal varieties and products not being marketable continue and fail to create conditions for energy conservation.

Therefore, to create a new situation and to fulfill the strategic goals, we must take a new path. To conclude, there are four broad respects.

The development and implementation of new science and technology.

The development of science and technology is the great strategic issue in the strengthening of our economy. Recently, Comrade Zhao Ziyang clearly pointed out in the national science and technology reward conference: "To strengthen the economy and to quadruple the gross annual national industrial and agricultural output value, we must depend on the improvement of science and technology." "On the basis of old techniques, old equipment, old material, old skills and old products, and according to the present technology indices, we will not be able to quadruple." "This goal can be realized by technological improvement." To double coal output, we must also depend on the improvement of science and technology.

The development of advanced science and technology is an important strategic task for the whole coal mining front, especially organs of scientific research, technology, design and manufacture. On the new course, we have talked quite a bit on this issue. Collectively, it means that we are requiring science and technological work to serve the five transformations in the coal mining industry. From now on, we must proceed from reality, aim for an advanced scientific and technological level, organize methods to tackle problems and, with a goal in mind, promote different advanced technology.

We need very good planning in tackling problems. For example, we must use large-scale, high-efficiency equipment to exploit large strip mines. Particularly, since most large strip mines are along the far northern borders we must solve the problems of freezing and solidification. Science and technology sectors and manufacturing quarters must pool their efforts in researching foreign technology, adopting methods such as importing key technology or joint manufacture, solving key problems and coming up with the appropriate mining skills.

As for coal extraction, we must persist in the method of comprehensive mechanized mining, improve the mechanized equipment of coal extraction in thin coal seams, slanted coal seams, thick coal seams and under broken roof, raise the flexibility, adaptability and reliability of equipment and attempt to attain 600 comprehensive mechanized coal faces by the end of this century. Not only coal extraction, but tunnelling is also a weak link.

Extraction styles and methods must also be reformed. This will include research of rational exploitation planning, research and promotion of working in slanted coal faces, extraction without coal pillars, and promotion of underwater extraction.

As for safety techniques, we must use advanced safety measures and equip two or three model coal mines. What is needed most is to perfect gas ventilation systems, alarm systems, alarm system installation and preventive measures for coal dust, roof, and water damage.

For new mine construction, we must have a complete set of high-efficiency mechanized equipment, adopt good techniques in comprehensive flood prevention and in opening deep mines and pay more attention to special techniques such as freeze methods and the adoption of heavy drilling equipment in opening mines.

As for geological prospecting, we must launch research in surveying methods and estimation means of mineral deposits' hydrogeology and mine geology, improve the drilling technique of wire-line coring and digital seismograph geophysical technology, etc. We must adopt comprehensive prospecting and raise prospecting speed and quality.

We must solve the technical problems concerning coal washing, automatic washing, dewatering, drying and continual cycling, improve the quality and recovery of top-grade coal, and research technical problems in gasification and liquefaction.

As for coal transportation, we must develop large conveyor belts, adopt advanced automated storage and transportation systems, and speed up research in pipeline transportation.

We must also solve the technical problems in coal extraction, in the reshaping of abandoned coal fields, and in environmental protection.

All in all, from geological prospecting, design, construction, production, manufacture, washing and processing to storage and transportation, different links of the whole front must study new topics, adopt new skills, new technology and new equipment. By the end of this century, the technological outlook of some of China's coal mines, particularly that of large strip mines, must be the same, or almost the same, as the world's advanced level, while that of most key coal mines must be of the technological level of advanced countries in the 70's and 80's.

To fulfill these goals, we face heavy tasks in science and technology and the topics for research will be many. But as we do not have much time, we must not waste time on one topic, but try to achieve results as soon as possible. That means we must pay close attention to the whole coal mining front, gathering scientific and technological personnel from production, construction, scientific research, and education to tackle major problems. Our scientific and technological capability is already weak. If it is not well-organized, not well-coordinated, or plagued by internal rivaries, the capability will be further weakened. We must break through the practice of isolation, extensively absorb advanced technology from inside or outside the country, and extensively develop coal mining science and technology.

To accelerate the development of new science and technology, we must raise the enthusiasm of enterprises in using advanced technology. Today, many enterprises are acting in a manner described by Comrade Zhao Ziyang: No motivation to use new technology because there are no benefits; it is alright not to use new technology because there is no pressure forcing them to use it; even if they want to use new technology, they cannot because they have no capital, which means they have no strength. We must, policy-wise and system-wise, conscientiously study ways to solve these problems. We must open a path for the advancement of technology, enable new scientific research achievements to change at the right time into productive forces, and as early as possible display its economic results.

Based on the strategic plan for the initiation of a new situation and the goal of producing 1.2 billion tons of coal annually, the requirement of the first production campaign is: coal output must maintain a steady growth rate which suits the strategic goal; a new situation must be opened up in basic construction so that the scale, the speed, and the quality of work can be improved.

We must acknowledge that although we have prepared for this new situation and new task, the preparations are insufficient. The preparation in geology, design, organization and management, technology and work forces are insufficient. From now on we must systematically develop capital construction. Different fields must work together to speed up the preparation work and open coal mines whenever they are ready. The whole coal mining capital construction front must be urgently mobilized to expand the scope of construction, speed up construction, and to strive for the goal of having 600 million tons on stream, 500 million tons in operation and 400 million tons actually attained within the next 18 years.

We Must Have a Leading Group Which Can Initiate a New Situation

An important task at the start of 1983 is the restructuring of leading groups in enterprises and organizational reform in provincial bureaus. We must handle this properly in order to build up a leading group which suits the demand of the four modernizations and which can shoulder the heavy responsibility of initiating a new situation.

We Must Have a Plan for the New Situation and the New Course

To initiate a new situation and to fulfill the strategic goal, we must have a plan. We must have a plan and an assumption on what we are going to do in 1983, before 1985, in the first 8 years, and in the second 10 years.

This is not an ordinary work plan. It must reflect the ideology of the initiation of the new situation. It must be both advanced and practical, a grand plan with goals and measures.

This plan must be agreed upon by the Ministry of Coal Industry, the provincial mining bureaus and the various enterprises and units. In addition to an overall plan, we must have individual plans for the construction of new mines, the technological transformation of old mines, the washing and processing of coal and its utilization, the upgrading of economic results, safety measures, staff and worker education, welfare improvement, the development of science and education, and the strengthening of political and ideological work.

With this plan, we can systematically, orderly, and methodically launch our work without confusion.

With this plan, we can continue to discover weak links and organize our capability to solve one problem after another, so that the coal mining industry can grow steadily.

With a plan like this, we can mobilize the masses, understand exactly what the strategic goals are, and contribute according to our positions.

12365
CSO: 4013/216

STATE COUNCIL MAKES MAJOR POLICY DECISION ON SMALL COAL MINES

Beijing ZHONGGUO MEITAN BAO in Chinese 11 May 83 p 1

[Article: "Liberalization of Policies for Accelerated Small Coal Mine Development. State Council Approves and Forwards Ministry of Coal Industry's 'Report on Eight Measures for Accelerating the Development of Small Coal Mines,' Requiring all Jurisdictions To Implement It."]

[Text] On 22 April, the State Council issued a notice approving and forwarding the Ministry of Coal Industry "Report on Eight Measures for Accelerating the Development of Small Coal Mines," and required that all jurisdictions implement it according to actual circumstances.

The notice pointed out that China has abundant and widespread coal resources, and that development of the coal industry requires adherence to a program of walking on "two legs," i.e., while emphasizing development of the country's uniform allocation coal mines, to develop local state-owned coal mines and small coal mines as well, and particularly to speed their development in coal-short areas. This is a matter of major importance that is of benefit to the country and the people to which all jurisdictions and all sectors should lend active support. The notice requires all provincial, municipal, and autonomous region people's governments to strengthen leadership for development of small coal mines, and requires all departments in charge of coal at all levels uniformly to channel management to proper authorities and make rational use of resources.

The notice emphasized that poor coal mine safety is currently a serious problem, and that leaders at all levels must earnestly deal with it, devote a high degree of attention to it, and take effective action so that small coal mines will possess necessary conditions for safe production, and so that safe production can be genuinely assured.

The eight measures on hastening development of small coal mines from the Ministry of Coal Industry that the notice forwarded were as follows:

1. Adoption of Various Forms for Developing Operation of Mines by the Masses. Places having coal resources and transportation, particularly coal-short areas, should actively mobilize and organize communes and

brigades for collective operation of mines; they should encourage all trades and industries to operate mines; and they should permit the masses to pool funds to operate mines. In addition, they should encourage coal-short places to use various methods to operate mines in partnership with places having coal.

2. Making the Most of the Role of Market Regulation Under Planned Guidance. All coal produced by commune and brigade collectives and by pooling of funds by the masses, or by specialized contracting of mine operations that is made a part of national or local plans for distribution should be paid for on the basis of quality, and the sale price should be such that the coal mine is assured a fair profit. All coal produced that is not a part of the plan may be sold at will at agreed-upon prices.

Coal mines and the masses are to be allowed to use various kinds of transportation equipment for the shipment of coal, and they may haul coal over long distances for sale without interference from any jurisdiction. When railway transportation is required, the coal must be made part of the plan, and may be transported only following approval for inclusion in the plan.

Taxes on small coal mines will be levied on the basis of profits in accordance with law. Coal-short areas and places in which coal mining conditions are difficult may apply for discretionary reduction or exemption from taxes for a fixed period of time.

There is to be self-determination in administration and management and in wages and welfare benefits for staff and workers of small coal mines. However, it is necessary to make sure that sufficient funds are held back from distributions to maintain simple reproduction and necessary expansion of reproduction.

3. All Provincial (or Autonomous Region) Coal Bureaus, Coal Companies, Mining Bureaus, and Geology Departments Are To Follow the Principles of Overall Planning and Rational Use of Resources and Actively Provide Coal Resources for Mine Operations by the Masses. Within state-owned mining districts, overall unified planning is to be done by mining bureaus or state-owned mines. All odds and ends of coal that cannot be mined in large mines may be designated for extraction by small mines. Resources that state-owned mines are unable to use for a long period of time may also be designated, within certain limits, for extraction by small mines. In places where contention exists, proper readjustments may be made so long as rational use of resources of state-owned mines and safe production are assured. In addition, all places having resources and requisite transportation should go all out in development of small coal mines. However, they must strictly carry out the State Council's "Decisions on Maintaining Regular Production in State-owned Mining Enterprises." Neither reckless mining and indiscriminate digging nor blind production is to be permitted. It is forbidden to operate small coal mines beneath railroads, highways, reservoirs, dikes, and protected places of cultural interest, or under

major structures. In addition, mining should be done in conjunction with city and rural planning to protect the environment.

4. Encouraging Multiple Use and Partnership Operations. The local use of coal produced by small mines should be encouraged, particularly in places lacking convinient communications and transportation. Vigorous efforts to improve small pit-mouth electric power plants and small-scale coal gas, construction materials, and chemical industries should be encouraged. Multiple uses should be encouraged in product processing and various forms of partnerships should be carried out in other industries.

5. Minimal safety conditions for production must be provided in the operation of small coal mines; safe production principles should be adhered to; and both "Mine Safety Regulations" and "Mine Safety Control Regulations" issued by the State Council should be carried out as should "Small Mine Safety Rules" issued by the Ministry of Coal Industry.

6. Active Support for Operation of Mines by the Masses From All Levels of Government and All State-owned Coal Enterprises. Funds for the operation of mines should be provided by the operators themselves for the most part, but where genuine difficulties exist, and particularly in coal-short areas, the Agricultural Bank of China in all areas may issue loans as conditions require.

Except for explosives, which will be centrally provided by materials supply departments, supply of all other materials and equipment required by small coal mines that are a part of state and local plans are to be assured, with no diversions from other sources. Insofar as possible, material departments and coal management departments should help solve the problem of materials and equipment needed in mines from which coal is to be sold outside of plan that cannot be purchased in the market.

Coal bureaus in each province, and all state-owned coal enterprises should organize small coal mine technical service personnel to help small coal mines work out plans for development and restructuring, and to improve safety conditions, to improve capabilities to withstand disasters, and to upgrade steadily small coal mine technical levels, equipment levels, and economic effectiveness.

7. Operation of Small Coal Mines Is To Be Examined and Approved by Provincial (or Autonomous Region) Governments or Departments in Charge of Coal, Mining Licenses Being Issued To Those Who Qualify. Industrial and commercial administration departments are to issue business permits to those holding mining permits. A conscientious check is to be made of small mines already in operation, and supplemental approval procedures carried out. Small coal mines that have mining permits and business permits are under protection of national laws.

8. In the Development of Small Mines, Numerous Problems Requiring Coordination Have Occurred. Coal Departments in Charge at All Levels Should Channel Them to Proper Authority for Handling, and Do a Conscientious Job. In order to assist provinces (or autonomous regions) summarize experiences, formulate policies, use and manage state assistance funds well, and do a good job in coordinating relations, plans should be drawn to build local coal mine joint service companies and use economic methods to promote development of small coal mines at all places.

9432
CSO: 4013/251

DATONG COAL: 30 MILLION TONS BY 1985, 40 MILLION TONS BY 1990

Taiyuan SHANXI RIBAO in Chinese 17 Jun 83 p 2

[Article by Wang Rongping [3769 2837 1627]: "Country's Largest Coal Base Now Being Developed"]

[Summary] The Datong Coalfield extends from the Niuxin Mountain Range in the north to Honghao Shan in the south and from the Datong Basin in the east to the Xishi Mountain Range in the west. It covers an area of 1,827 square kilometers and has total reserves of 37.58 billion tons. The Datong mining district now has 13 mines and 15 pairs of shafts, the majority of which will be in production for 50 years and more.

Not only does the Datong Coalfield have rich reserves but also the quality of its coal is good. People refer to coal as the "staple" of industry, and Datong coal is praised as the "flour and rice" of industry. Datong coal contains little sulfur, its ash content is low, it ignites quickly, and it throws off a lot of heat. One kilogram of this coal yields 7,500 to 8,000 kilocalories in heat value, equal to the quantity of heat emitted by 0.8 kilograms of petroleum. Of the coal now being mined in China, Datong coal is the motive-power coal of the best quality.

Railroad locomotives throughout the country use coal; in parts of North China and East China coal is used to generate electricity. In the glass and in the nation's ceramic industries, Datong coal is a considerable proportion of the coal used. Datong coal is in great demand in 24 provinces and municipalities, and it is sold internationally in nine countries and regions.

Production in the Datong Mining District occupies first place in the country in output and in profits turned over to the state. Last year, the bureau produced 26.2 million tons of raw coal, close to 40 percent of the total output of all coal mines in the province, and it turned over more than 300 million yuan in profits to the state, accounting for 60 percent of the profits turned over to the state by the provincial coal system. This year's actual output could reach 27 million tons.

The output of the Datong Mining Bureau is now the highest in the country, but it is still rapidly developing. By 1985, mainly by tapping of the potential of old mine pits, the annual output will reach 40 million tons; by tapping the potential of the old mine pits there will be a further increase of 2 million tons, and the capacity of the new mine pits is 8 million tons. The Yanzishan Mine, now being constructed, has a designed capacity of 4 million tons; the Jinhuagong Mine, now being expanded, will increase its designed capacity by 1.2 million tons (the original mine pit's capacity was 1.95 million tons), so that after extension the capacity will reach 3.15 million tons. The Sitaigou Mine Pit and the Gaoshan Mine Pit, now being prepared for construction, have a designed capacity of 4 million tons and 450,000 tons respectively. Also to be expanded in the Sixth Five-Year Plan period are the Wangcun, Yungang, and Silaogou mines, for a net increase in output capacity of 2.4 million tons.

Within the decade of the 1980's, the annual output of the Datong Mining Bureau will increase by 16 million tons.

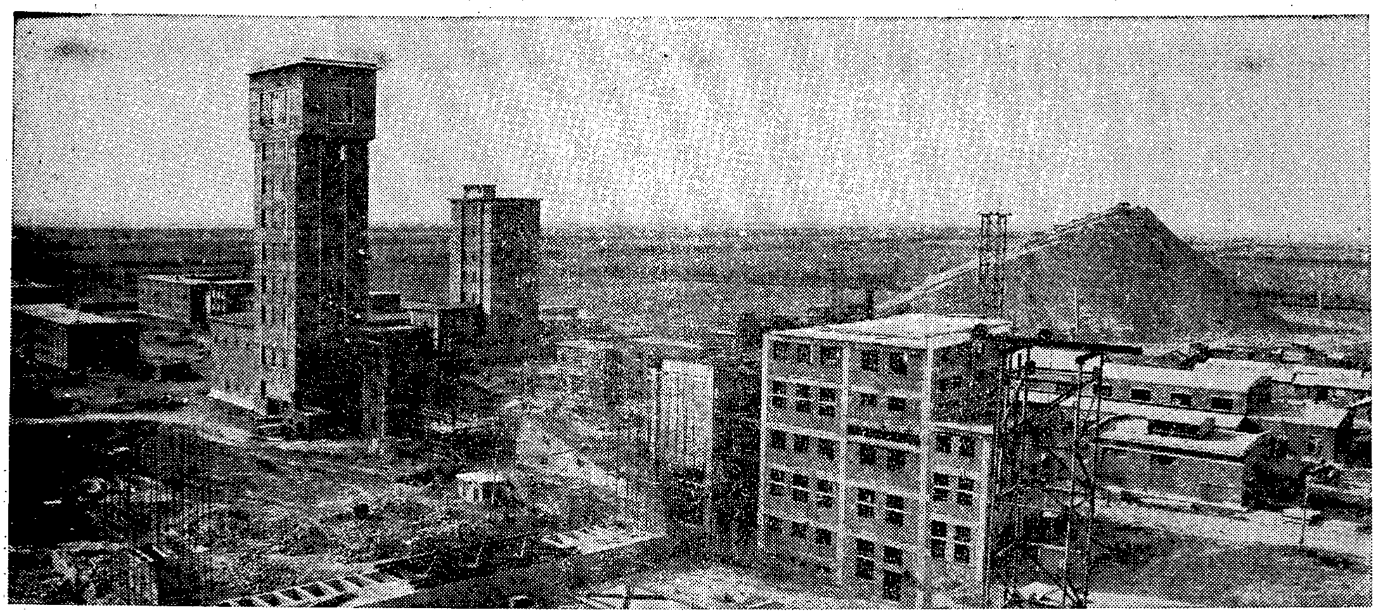
9727
CSO: 4013/275

COAL

TIEFA COMPLETES FIVE OF NINE NEW MINES

Shenyang LIAONING RIBAO in Chinese 3 Jul 83 p 4

[Photograph and caption]



Of the total of nine pairs of shafts in the Tiefa Mining Region, five have been completed, two are now being sunk, and the remaining two are in the preparation stage. By the end of the century, when the entire project has been completed and enters production, coal production will hit 16 million tons. Above is a pair of new shafts under construction.

CSO: 4013/314

HUGE EXPANSION UNDER WAY ON NATION'S LARGEST COKING COAL BASE

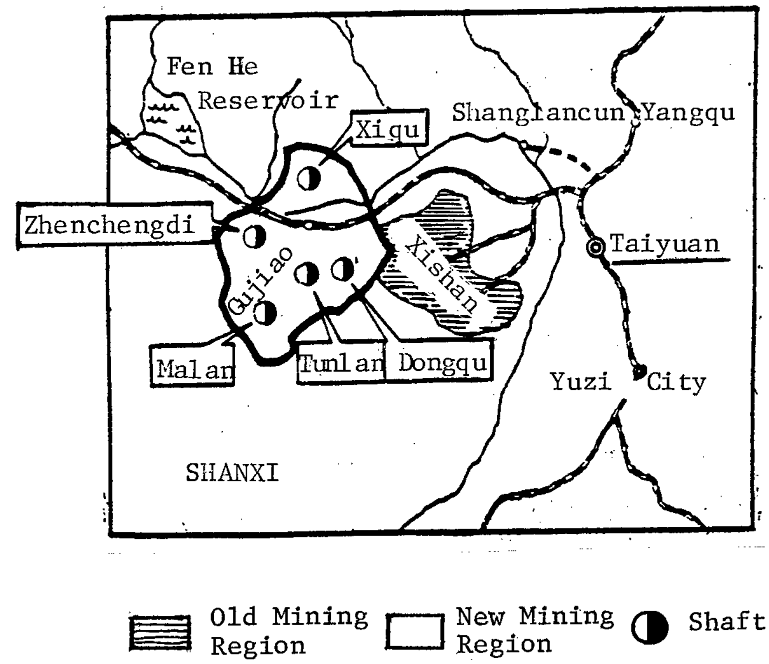
Jinan DAZHONG RIBAO in Chinese 25 Jul 83 p 4

[Article: "Gujiao Mining Region: Nation's Largest Coking Coal Base"]

[Summary] "Work on the Gujiao Mining Region, China's largest coking coal production base, is now being intensified. Stretching 16.5 kilometers from north to south and 20 kilometers from east to west, the entire site is one vast scene of busy construction."

"Situated a little over 100 li west of the city of Taiyuan in the Luliang Range, the region has verified reserves of 4.57 billion tons, 70 percent of which is coking coal grade." Overall planning for the region calls for the construction of five pairs of large-scale shafts, four of which will have an annual capacity of more than 3 million tons each; total annual designed output is 16.5 million tons. When construction of the entire mining region has been completed, it can supply one-fourth of the raw material needs for smelting and metallurgical coke of the entire country. It will also be capable of supplying one-fifth of the nation's current dressed coal output.

Today, the main railroad line running from Taiyuan through the three mining areas of Dongqu, Xiqu, and Zhenchengdi has been formally handed over for operations. Xiqu, the mine to be opened first, is a large-scale mine that will produce 3 million tons a year. Today, the main tunnel has been completed, and, as part of the first stage of construction, two comprehensive mechanized work faces are being prepared and surface production and support facilities will become operational in 1984. Another mine, Zhenchengdi, with an annual production capacity of 1.5 million tons, has a total of five shafts. Two of these have been sunk and work on the remaining three is now being stepped up. Work on the coal dressing plants for two of the mines is being started in succession. Work on living and service facilities for the mining region is taking shape.



Fen He
Reservoir
Xiqu
Shanglancun
Yangqu
Zhenchengdi
Taiyuan
Gujiao
Xishan
Malan
Tunlan
Dongqu
Yuzi
City
SHANXI
Old Mining Region
New Mining Region
Shaft

CSO: 4913/302

ONE OF NATION'S BIGGEST DRESSING PLANTS TAKING SHAPE AT YANZHOU

Jinan DAZHONG RIBAO in Chinese 10 Aug 83 p 4

[Article: "The Modern Xinglongzhuang Coal Dressing Plant"]

[Excerpts] The Yanzhou Mining District, one of the nation's key construction projects, is now building a modern coal dressing plant capable of processing 3 million tons of coal a year--the Xinglongzhuang Coal Dressing Plant. Three huge steel structures now tower over the construction site at different heights, various equipment, mains, cables, and power lines are being installed, and heavy traffic clogs the site.

The engineer in charge of the technical work at the site told me [this reporter] that the Xinglongzhuang Coal Dressing Plant is one of two big dressing plants now being built in the country (the other is Kailuan). Assembled by the Shanghai Baoshan Iron and Steel Works, its major equipment is being imported from the United States. The dressing equipment consists of world-class "Batac" jigs, heavy-medium cyclones, vacuum filters, centrifugal water separators, and other sophisticated equipment. Also being used are electronic programmable sequential controls. The plant is designed to wash 10,000 tons of raw coal a day, or 720 tons an hour. It is capable of taking raw coal and turning it into fine coal with an ash content of only 7 percent (ordinary plants achieve a content of 9-10 percent). It will not only supply fine, low-ash-content coal to the Baoshan Iron and Steel Works, it will make fine coal available for export as well.

After 2 years' work, 42 of the 67 projects in the plan have been started and 14 of these have been completed; the building area covers more than 18,300 square meters and the plant itself is already taking shape.

Construction is slated for completion in the first half of 1984 and by the fourth quarter trial operations will be conducted after which the plant will be turned over for production.

CSO: 4013/331

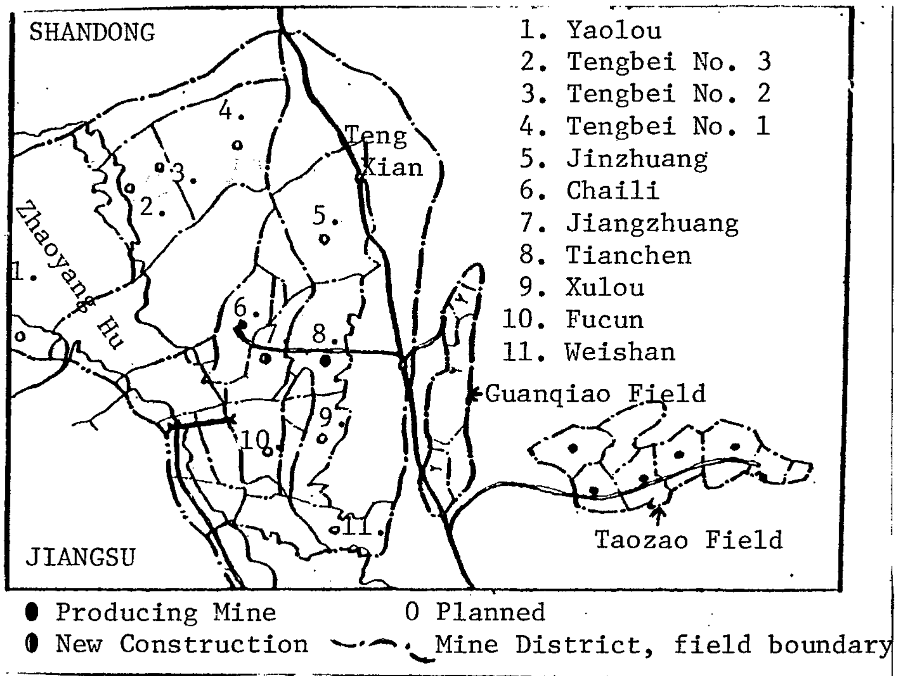
SHANDONG'S ZAOTENG MINING DISTRICT IS SCENE OF EXTENSIVE CONSTRUCTION EFFORT

Jinan DAZHONG RIBAO in Chinese 11 Aug 83 p 2

[Excerpts] The Zaoteng mining district includes the old Zaozhunag mines and the Teng Xian mines, now under construction. Construction of the new district is progressing steadily and it is assuming a new image to become one of the large-scale, modern mining districts in southwestern Shandong Province--after Yanzhou Mining District.

The mining district is made up of the Taozao, Guanqiao and Teng Xian coal fields, of which Taozao and the Guanqiao fields were fully exploited at an earlier date. There are eight producing mines with a yearly designed capacity of 4.71 million tons. In fact, the actual capacity has now reached the vicinity of 5 million tons a year. The Teng Xian field to be developed in the near future is an ideal area to develop as a follow-on to the older fields as it is adjacent to the Taozao and Guanqiao fields and linked to them by the Jin-Pu Railroad. According to material made available by geology departments, this coal field has proven reserves of 3.3 billion tons. The field not only covers a large area and has huge reserves, the quality of the coal is good, the geological structure is reasonably simple and conditions for development are excellent. Transportation is exceptionally convenient as the coal produced here may be shipped to any point in the country on the nearby Jin-Pu Railroad or moved out via the Jing-Hang Canal. A major effort to accelerate the development of this new region will breathe new life into the worked-out Zaozhuang mining district and boost production capacity to let the region play a greater role in the four modernizations.

The party and state attach great importance to the construction of the Zaoteng mining district. Preliminary plans call for the construction of 10 new shafts, seven of which will be large-scale shafts and three medium. Total designed output capability will be more than 11 million tons; planned are eight new coal dressing plants capable of processing more than 12 million tons of raw coal a year. Also to be built are a considerable number of public projects and cultural and service facilities to support production and construction and to serve the needs of the staff and workers of the mining district. The construction of this mining district is now being intensified and some initial results have been realized. By the year 2000, the new district could be completely finished and the entire region could be producing 14 million tons of raw coal and 6 million tons of dressed coal a year.


SHANDONG
1. Yaolou
2. Tengbei No. 3
3. Tengbei No. 2
4. Tengbei No. 1
5. Jinzhuang
6. Chaili
7. Jiangzhuang
8. Tianchen
9. Xulou
10. Fucun
11. Weishan
Teng Xian
Zhaoyang Hu
Guanqiao Field
Taozao Field
JIANGSU
Producing Mine
0 Planned
New Construction
Mine District, field boundary

CSO: 4013/328

PINGZHUANG MINING REGION: ANOTHER HUGE ENERGY BASE TAKING SHAPE

Beijing RENMIN RIBAO in Chinese 13 Aug 83 p 2

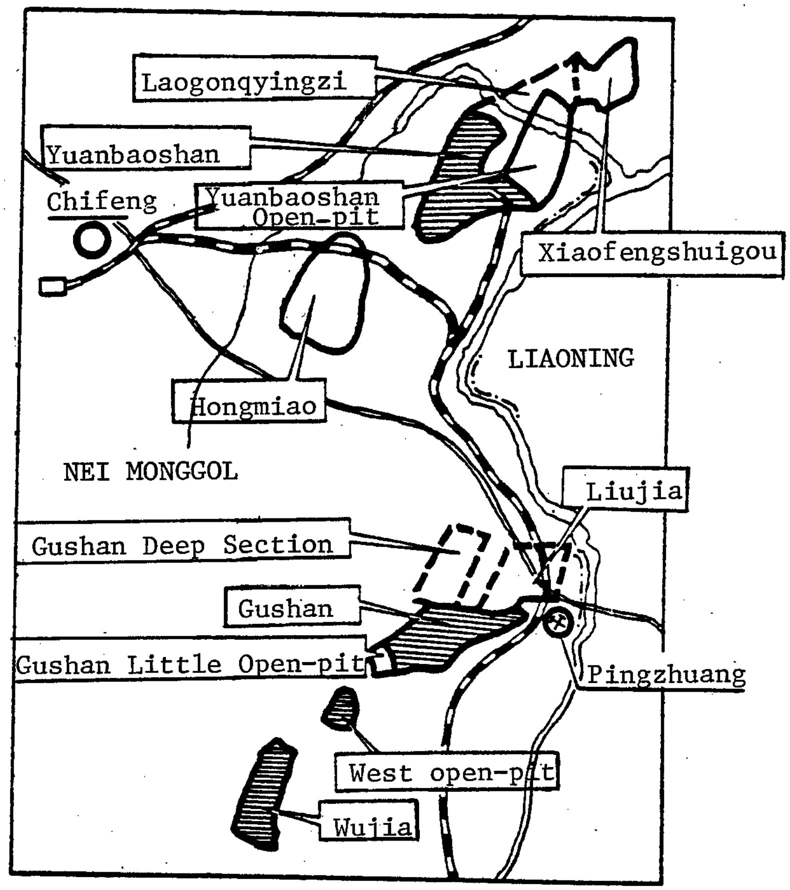
[Text] In the Pingzhuang Mining Region in eastern Nei Monggol, China is hard at work opening up another huge energy base. Here, the vast reserves and convenient transportation present favorable conditions for mining. Today, the verified coal reserves stand at 1.84 billion tons and the Sha-(He) Tong (Liao) Railroad and the Jinzhou-Chifeng Railroad run through the mining region. Nearby, a large-scale pit-mouth power plant--the Yuanbaoshan Power Plant--is now under construction which will make use of much of the brown coal output from Pingzhuang.

Construction began on Pingzhuang in 1958 and today's designed capacity is 4.02 million tons. Based on national requirements, the region's production capacity will be boosted to around 16 million tons by the year 1995.

Work on the Yuanbaoshan open-pit mine will begin within the next few years; advanced bucket-wheel excavators will be used. Today, early-stage preparatory work has already begun and foreign cooperation in the project is planned; joint manufacture of some of the heavy equipment is also being discussed.

Work on Fengshuigou, with a designed annual output of 900,000 tons, is being intensified and the first stage of the project will be on stream in 1984, with construction scheduled to be completed in 1986.

In addition, the Gushan Little Open-pit Mine, the Hongmiao shafts, the Hongmiao open-pit mines, and other expansion projects are either now underway or in the planning stage.



= Producing Mine

= Under Construction

= To Be Built

CSO: 4013/305

HUATING MINES TO PRODUCE 12.3 MILLION TONS A YEAR BY END OF CENTURY

Lanzhou GANSU RIBAO in Chinese 24 Aug 83 p 1

[Text] The blueprints for the construction of the Huating Mines, one of the big modern mining regions in Gansu Province, are now open before us: Before the end of this century, the production from these mines will top 12.3 million tons a year, an increase of more than 12 times that of the present yearly output of 900,000 tons.

The overall planning for the construction of this mining district was done by the Lanzhou Mine Design Institute and recently reviewed by the Gansu Coal Industry Company. More than 100 specialists and technical personnel from throughout the provincial coal system as well as responsible parties from the provincial planning committee, the provincial economic committee, and the provincial science association, after first-hand investigation and verification, unanimously approved the plan.

Huating coal is China's best coal for gasification and constitutes 54 percent of the province's proven coal reserves. Developing Xuating's coal, which is relatively easy to mine, is a major way to achieve the doubling of Gansu's raw coal production. According to the plans, the number of pairs of shafts will be increased from three to nine. New technology and modern management methods will be employed to accomplish comprehensive utilization and environmental protection. Concurrently, the marginal and shallow coal fields will be designated for exploitation by small local coalpits and organized as a commodity coal base with a yearly production of 5 million tons. Special railroad spurs and living facilities will be built at the same time.

CSO: 4013/337

YANZHOU MINING DISTRICT: FUTURE ENERGY BASE FOR EAST CHINA

Beijing RENMIN RIBAO in Chinese 12 Sep 83 p 2

[Text] Traveling south from the capital on the Beijing-Shanghai Railroad, one passes to the east of Taishan and then enters the boundless expanses of a vast plain. One of the biggest coal bases in China -- the Yanzhou Mining District -- is under construction here.

The Yanzhou Mining District is a major state construction project and spans 12 counties and cities in southwestern Shandong. The total area of the coal field is 3,400 suqare kilometers. Rich in reserves, it has verified coal deposits of 9.1 billion tons. The varieties of coal include excellent smelting and coking coal as well as coal for motive power, all with very low sulphur and ash content. The coal seams are gently sloping, great for large-scale mechanized mining. Communications and transportation are convenient here -- both the Beijing-Shanghai Railroad and the Yanzhou-Heze Railroad run through the field -- and after the Yanzhou-Shijiu Railroad, now under construction, has been completed, it will be linked to Shijiusuo, the special coal port on the shores of the Yellow Sea. The inland waterway of the Beijing-Hangzhou Canal runs right through the middle of the coal field and after it is dredged, the coal can be shipped out directly by barge. The high quality coal produced by the Yanzhou Mining District will supply the economically growing East China region in a steady stream and play a major role in easing the tight energy situation in Shanghai.

The development of the Yanzhou coal fields began back in 1965, when it was placed on the agenda as a major construction project for East China. During the "Great Cultural Revolution," construction of the mining district was disrupted.

The pace of construction was stepped up after the 3rd Plenary Session of the 11th CPC Central Committee, and four large and medium mines -- Nantun, Beisu, Tangcun, and Xinglongzhuang -- have now been built in succession with an output capacity of 5.25 million tons a year.

The Xinglongzhuang coal mine, with an output of 3 million tons a year, is the first large-scale, modern coal mine to be designed and built by China, taking only 6 and one-half years to build from beginning to end. It went into production officially in December 1981. This mine is completely mechanized.

The Xinglongzhuang Coal Dressing Plant is currently one of two big dressing plants being built in China. The major part of the equipment is imported from the United States. This equipment includes world-class coal sorting and washing facilities, vacuum filters, and centrifugal water separators, and the entire system, capable of processing 10,000 tons of raw coal a day, employs electronic programmable sequential controls. The major part of the construction has now been completed and equipment is in the process of being installed. When finished, the plant will handle all of the raw coal produced by Xinglongzhuang and supply the fine coal to the Baoshan Iron and Steel Works in Shanghai; coal will also be exported.

Three large and medium mines -- Baodian, Dongtan, and Yangcun -- are now under construction in the Yanzhou Mining District. They have an annual output capacity of 7.6 million tons. The 3 million-ton-a-year Baodian mine, begun in 1977 with Japanese investments, is now undergoing a down-shaft accelerated modernization of tunnelling and mining machinery which is slated for completion by the end of next year [1984]. Begun late in 1979, the Dongtan mine has an annual capacity of 4 million tons. Today, surface construction is taking shape and underground work is being stepped up.

The Yanzhou Mining District also includes the Jiting coal field. Today, the initial stage of construction of this coal field developing steadily. It is estimated that by the end of the century the Yanzhou Mining District will have an annual output of more than 20 million tons, equivalent to 80 percent of the current coal production of Shandong's unified distribution mines.

CSO: 4013/337

FANG YI UNDERSCORES SCIENTIFIC ASPECTS OF UPGRADING COAL INDUSTRY

HK011316 Beijing JINGJI RIBAO in Chinese 27 Aug 83 p 1

[Article by Fang YI: "Concentrate on Research in the Coal Industry"]

[Text] Energy provides the basis for a two-fold increase in annual industrial and agricultural output value. Coal is the core of our conventional source of energy, accounting for around 70 percent of all energy. To develop coal production, realize its comprehensive utilization, and to improve the coal industry economically, we must rely upon developing the key role of coal scientifically. Coal is not only fuel, it is also an important chemical raw material. It can be converted into thousands of valuable chemical products. There is great potential to produce tremendous economic results.

Today, coal mines are overstaffed, their efficiency is low, and the results achieved are unsatisfactory. This is a very serious problem. For the same opencut coal mine, the productivity of our full-time workers is less than 2 tons, while in foreign countries it is as high as 40, 50 or even 100 tons. This hammers home the backwardness of the scientific and technical levels of our coal mines, of our cultural and educational levels, and of our management level. To improve efficiency, we must adopt advanced technology and advanced equipment. We cannot rely solely on physical strength to shovel coal. By following the road to technical progress, we cannot only raise output but, at the same time, bring about a great change in the quality of the coal industry and the image of coal mines.

In the past, people often were under the erroneous impression that coal was nothing but a primary product. All that was left of it after burning was the ashes preceded by a puff of smoke. In fact, like petroleum, coal is a high polymer hydrocarbon. It is not only an important source of energy, but also an important organic chemical raw material. Coal not only makes up 70 percent of the energy consumption in China, it also makes up 60 to 70 percent of the heavy industrial raw materials. Of the raw materials for the production of China's chemical fertilizers, coal makes up 53 percent, while the consumption of coal as a raw material for iron and steel represents 75 percent of the coal consumption for metallurgy. If we turn coal into gas fuel, gas raw material, and liquid fuel, developing the petrochemical industry and producing methyl albumen, synthetic rubber, and other valuable chemical products, the economic results can be over a dozen times and even several tens of times greater. Also, the problem of sulfur dioxide pollution can be solved. All these products are of great economic and political significance and hold out great prospects for development.

Coal departments have called for the completion of five changes in the coming 10 or 20 years: a change from manual to mechanized operations; a change from inability to control major accidents to basic control of them; a change from production of raw coal alone to in-depth processing and the production of many products; a change from a single-product economy to a diversified economy; and a change from small tonnage to large tonnage in regard to the method of transportation. The problems put forth in connection with these five changes are scientific and technical ones that must be solved urgently by scientific and technical units. Another thing is that we must properly organize the passing on of technology, the diffusion of technology, and the introduction of technology, turning the results of scientific research into productivity.

In sum, from whatever standpoint, there is much to be done in regard to scientific research in the coal industry. The coal industry is an important and glorious undertaking, one that has much room for development.

CSO: 4013/327

COAL

BRIEFS

CONSTRUCTION OF COKING COAL MINE BEGINS--Harbin, 3 August (XINHUA)--Construction of a coking coal shaft mine with an annual production capacity of 900,000 tons has started at Qitaihe in the eastern part of China's northermost Heilongjiang Province, according to coal mining authorities here today. Heilongjiang is one of China's major quality coking coal producers. The new coal field, which includes the newly started mine covers an area of 340 square kilometers and has 30 coal seams totalling 600 meters thick. Out of the nearly 1 billion tons of known reserves, coking coal accounts for 50 percent and blending coal, 35 percent. They all contain low sulphur and low phosphorus and have low ash content. Their calorific capacity is 2,000 to 3,000 kilocalories higher than that of ordinary coal. The rest of the reserves is anthracite and gas coal. Seven more mines with a combined production capacity of more than 5 million tons are to be built in the coal field in the coming years. A new, rising coking coal producing center, Qitaihe is now cutting about 6 million tons a year, and most of the dressed coking coal is shipped to the Anshan iron and steel complex, China's largest, in Liaoning Province in the northeast. [Text] [OW050501 Beijing XINHUA in English 0735 GMT 3 Aug 83]

CSO: 4010/89

OIL AND GAS

ACADEMY OF SCIENCES, OIL MINISTRY JOIN FORCES TO TACKLE KEY PROBLEMS

OW070144 Beijing XINHUA Domestic Service in Chinese 0104 GMT 2 Sep 83

[Article by reporter Zhu Weixin]

[Excerpts] Beijing, 2 Sep (XINHUA)--Breaking through the boundaries of different departments, the Chinese Academy of Sciences [CAS] and the Ministry of Petroleum Industry have established relations of all-round and long-term cooperation in science and technology. Thanks to their joint efforts, these cooperative relations have shown great development over the past 6 months or so.

China's petroleum industry is faced with the questions of how to increase the output of oil to be kept as a reserve supply and how to raise the efficiency of oil extraction. These questions can only be resolved by relying on science and technology. To this end, at the suggestion of the Ministry of Petroleum Industry, a joint work conference on scientific and technological cooperation was held last Decmeber by the Ministry and the Chinese Academy of Sciences.

Immediately after the conference, the pertinent academic departments and research institutes of the Chinese Academy of Sciences went into action. Scientists and technicians were sent to various oilfields, where they investigated practical production work and joined the scientific and technical personnel on the petroleum industry front in planning research projects with a view to solving key problems encountered in production. Over the past 6 months or so, the Chinese Academy of Sciences has dispatched several hundred scientists and technicians from nearly 40 of its research institutes. With the active support and assistance of the Ministry of Petroleum Industry and the oilfields involved, they have decided on more than 100 specific research projects. Accordingly, a number of scientific research contracts and agreements have been signed. Research work on many of them has been started.

Up to now, the Chinese Academy of Sciences has decided to cooperate with the scientific and technical personnel of the Zhongyuan oilfield in geological research. Emphasis is placed on studying such questions as the formation of oil and gas in the Dongpu depression and in the areas of northern Henan and western Shandong in the hope of providing a scientific basis for achieving better results in oil exploration. In the Karamay oilfield, continued efforts will be devoted to multidisciplinary studies to acquire a better understanding of the laws governing the formation of the stratigraphy and the distribution of oil-containing strata in the Junggar Basin.

Work at the Daqing and Shengli oilfields has entered the stage of extracting oil with a high water content. An urgent problem that has to be solved is how to raise oil-extraction efficiency by applying various technical measures. The Chemistry Department of the Chinese Academy of Sciences will conduct research at these oilfields on three subjects, namely, oil extraction, a hot process for extracting concentrated oil, and chemical agents for use at oilfields.

Manpower is being organized for research projects on oceangraphic hydrology, marine meteorology, and the survey and analysis of the motion of ocean currents, which are closely related to offshore oil exploration.

CSO: 4013/329

SONGLIAO BASIN TECTONICS AND HYDROCARBON OCCURRENCE

Beijing SHIYOU KANTAN YU KAIFA [PETROLEUM EXPLORATION AND DEVELOPMENT] in Chinese No 6, 1982 pp 39-48

[Article by Cheng Xueru [4453 1331 0320] of the Scientific Research and Design Institute, Daqing Oil Fields: "Positions of Plate Tectonics in the Songliao Basin and the Characteristics of Occurrence of Hydrocarbons"]

[Text] The Songliao Basin is a basin on the continental crsut. It is on the arched belt of the Upper Mantle at the eastern part of the Eurasian Plate. The basin was formed under crustal rifting resulting from the initial tension rifts of the continent caused by hot doming on this arched background. In the early period, there were rift valley characteristics. During the middle and latter periods, the influence of crustal isostatic adjustment and the underthrust of the Pacific Plate caused the original rift depression belt to evolve into a depression and form a new intracratonic composite basin.

Although the Songliao Basin is a basin of the continental facies, a large area of nutrition-rich deep water lacrustrine facies deposit was formed under the control of the two global plate movements during the mid-Cretaceous Period to become a good oil source rock. Because a long period of high heat flow and high earth temperatures controlled the diagenesis and the organic metamorphism of the basin, its oil genesis layer shows a shallow oil genesis threshold, quick evolution, and a short maturity zone. The deep depressions and the deep water facies where the rift valleys of the early period and the depressions of the later period coincided horizontally and the regions on both sides have the richest content of oil.

Different schools of thought in tectonics in China understand the tectonic characteristics of the Songliao Basin differently. This article is an attempt to analyze the type of the Songliao Basin from the viewpoint of plate tectonics. And it further discusses the characteristics of occurrence of hydrocarbons in this type of basin.

I. The Basic Geological Structure of the Songliao Basin

The Songliao Basin is located on the inner edge of the Eurasian Plate. It is a large diamond-shaped basin having a north-northeastern orientation and covers 260,000 square kilometers. Its occurrence and development were controlled by deep, large rifts and it possesses visible characteristics of a three-tier structure.

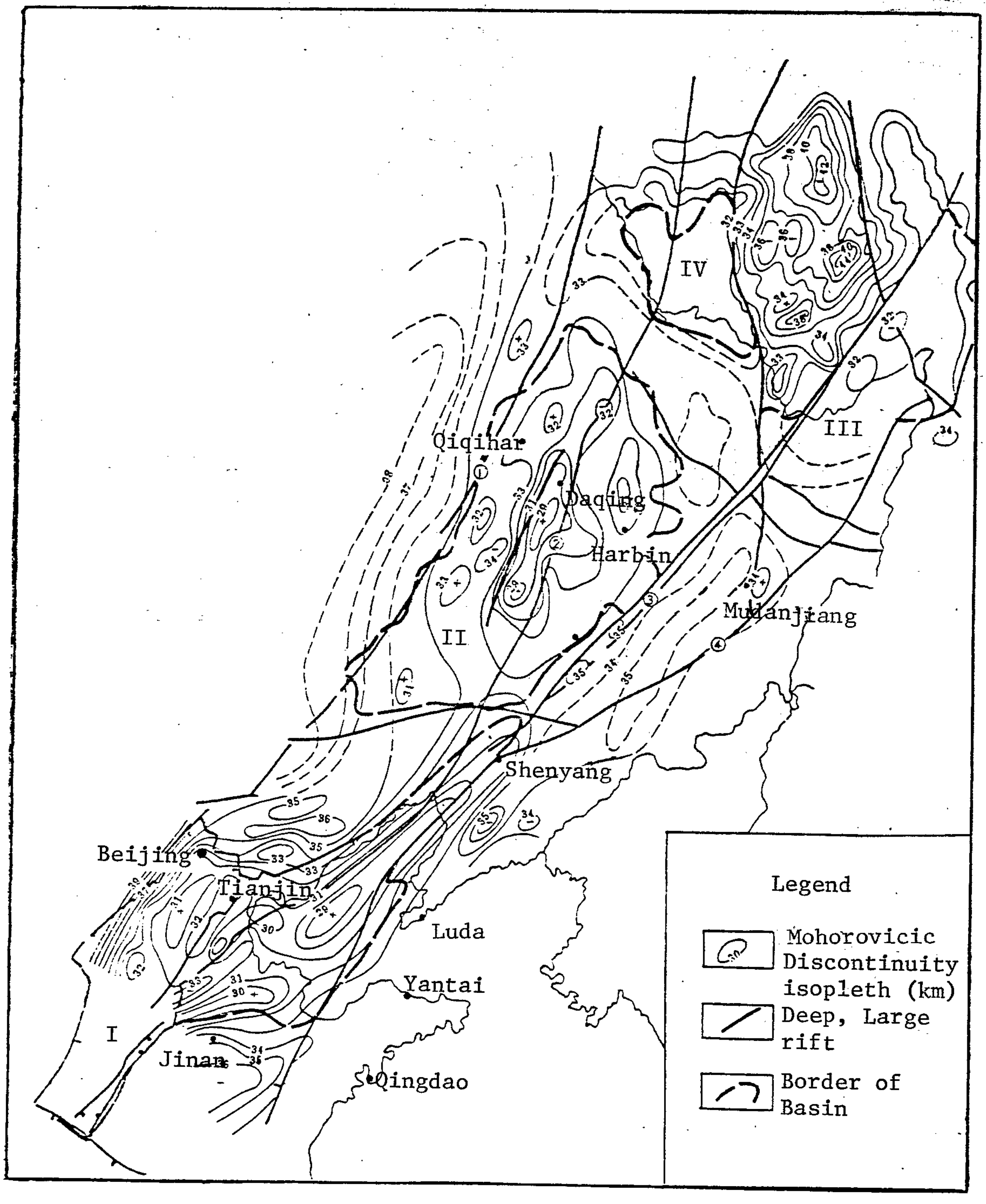
(I) Control of the Basin by Deep and Large Rifts

According to interpretation and analysis of geological and geophysical data and satellite pictures, the sides of the basin are controlled by deep and large rifts or crustal rifts. The interior of the basin is cut by rifts. There are three crustal rifts in the north northeast direction along the extension of the direction of the basin (Figure 1). The Nenjiang crustal rift and the Yilan-Yitong crustal rift are separately situated on the western edge and the eastern edge of the basin. It is generally belived that the former at least underwent visible activity from the middle to the late Jurassic Period. A lot of volcanic rock and sedimentary rock of the upper Jurassic Series developed near the rift. It is still unclear when the earliest period of development of the latter occurred. Most people believe that the strong rift activity period was from the late Cretaceous Period to the Tertiary Period. We believe that on the basis of the discovery of the geostrata of the Dengluku Group (Erlongshan stratum) of the Cretaceous System and the Yehe Group in the graben east of Siping and the Quantou Group red stratum in the Yanshou area, the period when activity began should at least be in the early Cretaceous Period.

The Sunwu-Shuangliao crustal rift at the center of the basin is the third crustal rift along the extended direction of the basin. Seismic reflection data show that the bedrock is a large rift belt. The rift distance is 2,000 to 2,900 meters. The rift extends intermittently and joins the Beian graben and the Sunwu graben in the north and connects to the large rift on the west side of the lower Liao He in the south. This is also reflected in the Mohorovicic discontinuity. Basalt of the late Jurassic Period can be seen in the Sunwu and Shuangshan areas. At the Yangdachengzi area we see basalt intrusions into the Quantou Group. Diorite and granite are seen in the Mingshui, Zhaozhou, and Fuyu areas. In the Wudalianci, Kedong, and Shuangshan areas there are also extrusions of basalt of the new periods, indicating that the period of major activity of this crustal rift should be in the late Jurassic Period and the early and middle Cretaceous Period (still active in the late Cretaceous Period).

The periods of major activity of the three crustal rifts mentioned above become younger from west to east, i.e., the Nenjiang crustal rift was active during the middle and late Jurassic Period, the Sunwu-Shuangliao crustal rift was active during the late Jurassic Period to the early Cretaceous Period, the Yilan-Yitong curstal rift was active from the middle and late Cretaceous Period to the Tertiary Period. They served to control the occ occurrence and development of the Songliao Basin. The Sunwu-Shuangliao crustal rift served a major function in the occurrence and formation of the basin.

Figure 1. The deep and large rifts of the northeast subregion and depths of mohorovicic discontinuity.



Key:

1. Nenjiang crustal rift
2. Sunwu-Shuangliao crustal rift
3. Yilan-Yitong crustal rift
4. Mishan-Dunhua overlying crustal rift

I. Bohai Bay Basin
II. Songliao Basin
III. Sanjiang Basin
IV. Wuyun-Zeya Basin

(II) Analysis of the Three-tiered Structure of the Basin

Here, the three-tiered structure refers to the deep crust of the basin, the basement of the basin and the Mesozoic and Cenozoic groups of the basin.

1. Tectonic Contour of the Mohorovicic Discontinuity

Figure 1 shows that the Songliao Basin and the extended regions to the north and south are a Mohorovicic arched belt. It consists of three Upper Mantle upwarpings, the strike is about 20° northeast, the crust is 29 to 33 kilometers thick, and the thickness of the crust on the east and west sides is over 35 kilometers.

The area of upwarping of the Upper Mantle in Bohai Bay starts from north of Shenyang in the north and reaches the Huanghua depression in the south, and it is surrounded by the 33-kilometer isopleth. The thinnest part, from Xinglongtai to the central part of the Bohai, is 29 to 30 kilometers thick.

In the area of upwarping of the Upper Mantle in the Songliao region, a 33-kilometer isopleth of the crust generally coincides with the modern basin. The area from Beian to Qian'an is encircled by a 32-kilometer isopleth, and the thinnest part is less than 29 kilometers. The west wing of the upwarping is precipitous and the east wing is gentle. At Zhaozhou and Changling, the area protrudes eastward.

The Wuyun-Zeya Upper Mantle upwarping area north of the Songliao Upper Mantle upwarping is encircled by a 32-kilometer isopleth. The mountain areas on both sides are 34-38 kilomters thick and at some individual places the thickness reaches 44 kilometers.

The Mohorovicic arched belt is one of the three major arched belts on the eastern part of the Eurasian land mass. It shows that the deep tectonics of the crust of the large oil-and-gas containing basin are characterized by upward upwarping, forming a visible mirror reflection of the basin. This shows that the sedimentary formation of the cap layer, tectonic variations, and the movement of crustal material of the deep parts are internally linked.

2. The Tectonic Appearance of the Basement of the Basin

The sedimentary basement of the Mesozoic and Cenozoic groups of the basin is part of the Tianshan-Xingan Hercynian folding belt consisting of three anticlinoriums and two synclinoriums. Their basic characteristics are as follows: The length of the anticlinorium and the synclinorium is generally about 200 kilometers, the direction of the axis is 25° to 40°, gradually increasing from west to east and reaching a maximum of 50°. The southern parts of all axial lines of the anticlinoriums and the synclinoriums tend to turn westward. Many granite intrusions are found at the axis.

The rifts are developed at the base and their strikes can be groups into four general directions, towards the northeast, the northwest, near south and north and near east and west. Most are high-angle orthogonal faults, generally 20 to 40 kilometers long. The horizontal plane consists of six rift belts. The rift belts have all developed at the boundary of different tectonic units and they serve importantly in the tectonic structure of the basin. For example, the two rift belts of Durbud-Beizhengzhen and Mingshui-Gudian control the formation and development of the central depression, the Nongan rift belt controls the formation of the Ninxian-Wangfu depression and Dehui depression.

A lot of granite intrusions occur on the rift belt. There are more granite of the Hercynian Period in the rift belts in the west northwest and northeast directions. The granite of the Yanshan Period has mostly developed in the rift belts of the north-northeast and the east-west directions.

3. Tectonic Characteristics of the Cap Layer of the Basin

According to seismic reflection data, the differences between the tectonic appearances of the deep layers below the Quantou Group and the overlying medium and shallow layers are very great. The basic appearance of the former is one upwarping and two depressions. At the central part of the basin is an ancient central rift upwarping belt which divides the basin into a fault depression on the east and a fault depression on the west. The structures are basically symmetric and rifts are developed. The basic appearance of the latter is gentle undulation with alternating depressions and upwarping. The secondary tectonics are distributed like belts, there are no large rifts, but small rifts are developed. In general, the basin is divided into an eastern part and a western part by a line from Keshang in the north via Fuyu to Shuangshan in the south. To the west is a long and deep band-like depression, the axis is in a north-northeastern direction, the depression consists of three second level depressions, the Mesozoic and Cenozoic groups are 4,000 to 7,000 meters thick. The thickest place is over 9,000 meters thick. On the edge of the depression are a few anticlines and tectonic ridges. Further to the west is a large area of gentle eastward inclining monoclines at an angle of inclination within 1°. The angle is slightly larger at the turning point of the depression and at some points, the angle can reach 5° to 10°. At these places, the geostrata are incomplete. The thickness of the sedimentary rock is less than 2,000 meters. On the east is a block relief area with alternating depressions and upwarping. The relief of the basement is large and the buried depths vary from 1,000 to 4,000 meters. The geostrata of the lower part are complete, the upper Cretaceous Series is lacking. The second level tectonics are lined up in rows and in clusters, the direction of the Cathysian tectonic lines are visible, generally 40° to the northeast. At some places, the angle reaches 60° to 70°.

When the three-tiered structures of the basin were linked together, it was discovered that the continuity between the structure of the Mesozoic and Cenozoic groups and the structure of the basement was not outstanding, but the relationship with the deep crustal structure was closer. The relationship can generally be summarized in the following points:

(1) The largest area of settlement of the Mesozoic and Cenozoic eras was consistent with the highest position of the Mohorovicic arch. The Mohorovicic discontinuity of the deepest depressions in the Gulong, Da'an, and Heidimiao regions was the most shallow.

(2) The crust of the depressions was relatively thin whether they were formed early or late. This was the result of crustal isostatic adjustment. Data of the Songliao Basin show that each upward arching of 1 kilometer of the Upper Mantle has to be compensated for by sedimentary rock about 2 to 2.5 kilometers thick.

(3) The sedimentary area of the Dengluku Group of the lower Cretaceous Series is similar to the 31-kilometer isopleth of the basin. The area branches out in three directions. This shows that the upper part of the arched portion of the Upper Mantle during the early period of the basin was subjected to tension forces and formed a rift depression.

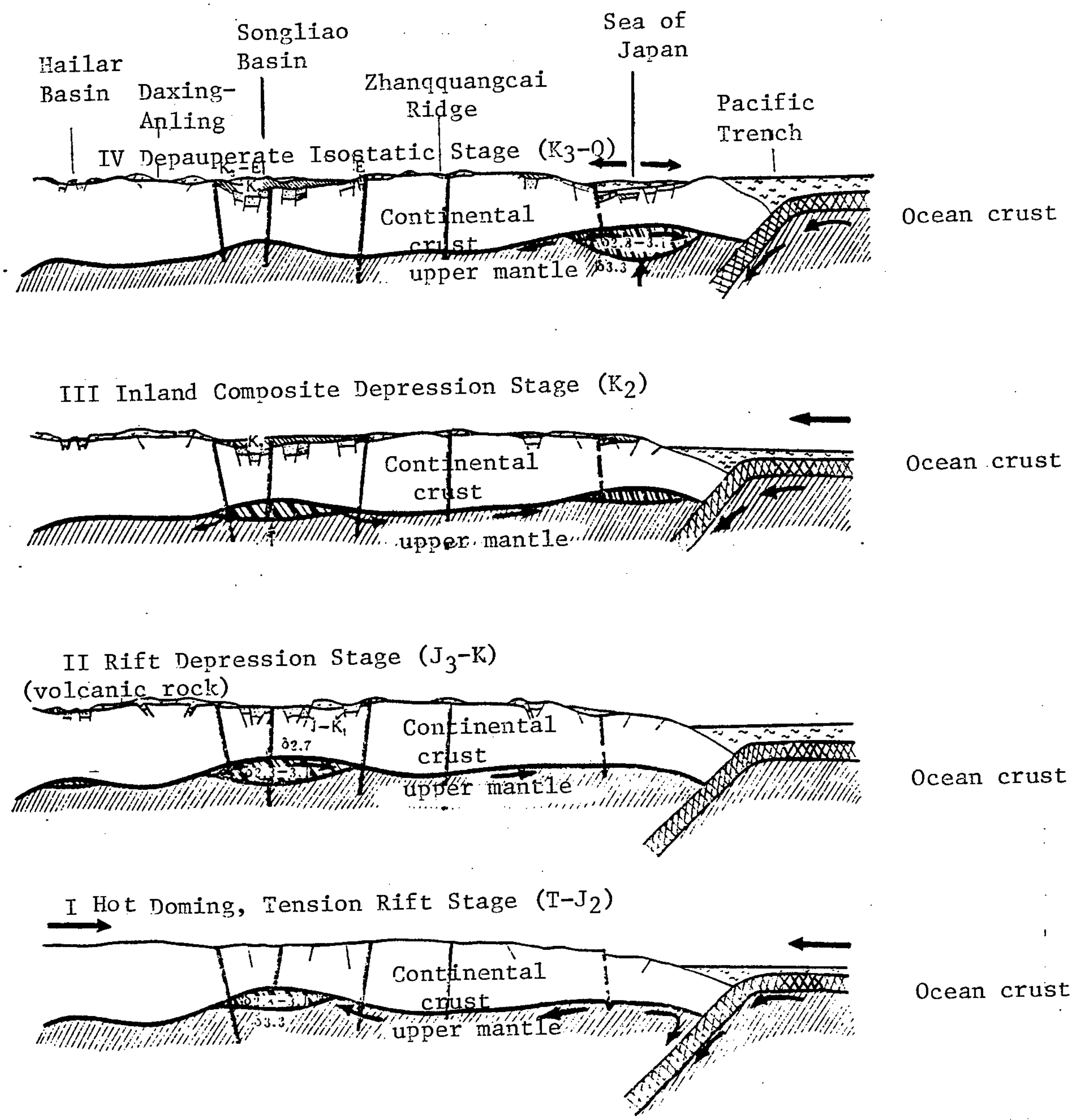
II. Characteristics of the Evolution of the Basin

The geological history of the basin can be divided into the following four stages (Figure 2):

1. Hot doming tension rift stage: The early period of the basin began on the Hercynian geosynclinal back-fold with violent magma activity, large area upwarping of the crust, and on the background of forming a new craton. From the Tertiary Period to the early and middle Jurassic, the Upper Mantle arched and underwent hot doming and caused tension rift tectonics. The position of the basin was in a denuded state. Small areas of graben type deposits and distribution of volcanic rocks appeared only during the middle and late Jurassic Period.

2. Rift depression stage: The initial stage of forming the basin was the Dengluku Period of the Early Cretaceous Period. At the time, the middle section of the Sunwu-Shuangliao crustal rift was very active, and rift activity of the other sections was also violent, forming visible grabens and horsts in the north northeast direction. The thickness of the geostrata on the two sides of the Mingshui Gudian rift belt and the Lamadian rift reached 2,000 to 3,000 meters, reflecting a precipitous rift topography on the edge of the valley. The second section of the deposits of the Dengluku Group is a visible narrow, long belt controlled by rifts. It is 350 kilometers long, 30 to 70 kilometers wide, its shape is similar to the

Figure 2. Illustration of the formation of the Songliao Basin and its evolutionary stages.



Lake Baikal rift valley and the Red Sea rift valley. Although the area of the third and fourth sectiosn of the deposits of the Dengluku Group had expanded, they were still controlled by rifts branching in three directions.

The time of formation of the rift depression was about 5 million years ago, the rate of deposition was 247 to 400 meters/million years, averaging 296 meters/million years. Generally, the rate of platform depositions was less than 25 meters/million years, and the rate in the geosynclinal regions was 90 meters/million years. The rate of deposition of the rift valleys was 200 to 300 meters/million years. The rate of deposition of the rift depression of the North China region was 220 meters/million years. The rapidity of deposition of the early period of the Songliao Basin can be seen.

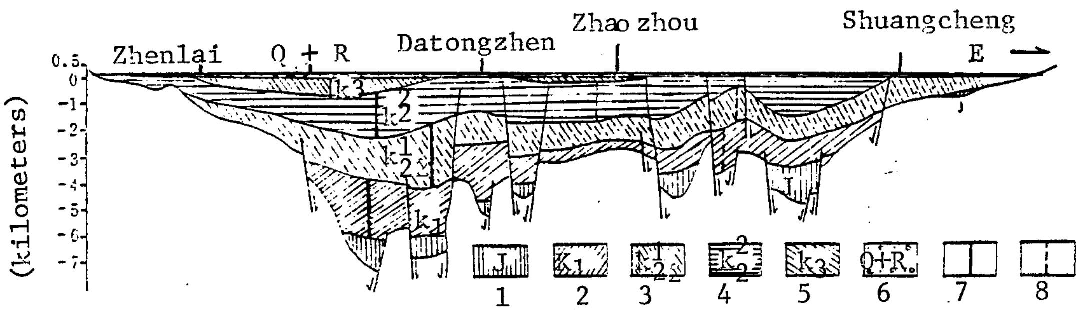
The data described above show that during the early period, the Songliao Basin was a rift valley basin. The deposits belonged to the rift valley type. They quickly compensated and refilled the crevasses and developed frequent cyclic quasi-flysch formations.

3. Inland composite depressions stage: The duration of formation of rift depressions of the basin was not long, the lithosphere gradually cooled. Under the control of crustal isostasy, and under the influence of the activity of the Pacific Plate, the basin settled as a whole unevenly. During the early period, there were settling centers, one in the east and one at the center. During the middle and latter periods, the eastern settling center gradually disappeared and became an early depression development area. Most of the central parts were depressions developed over a long period. The western part was a slope that developed over a long period. Gradual settlement occurred over a large area, and the geostrata overlapped gradually towards the west. The general manifestation was that the area of settlement continued to expand, and the axial line swayed and moved westward (Figure 3).

The crustal movement during this period mainly involved a relative quick rate of stable settlement accompanied by intermittent undulation and uplift. During the latter period, there were slight folding movements. Throughout the entire middle period of the Cretaceous Period, the total scale of settlement reached 3,500 meters. The rate of settlement was smaller than that of the rift depression state, and the rate lessened gradually as time went on. During the early period, the rate was 81.9 to 155 meters/million years. During the latter period, it was 35.2 to 58,5 meters/million years, and the total average was 78 meters/million years.

The relationship between sedimentation and settlement shows that the rate of settlement and sedimentation of the Quantou Group were both large and sedimentation was basically even compensatory sedimentation. The rate of settlement of the central part of the basin from the Qingshandou Group to the Middle period of sedimentation of the Nenjiang Group was fast but the rate of sedimentation was slow, creating a large-scale depression, a vast enclosed confluent water-detaining, deep-water lacustrine region and a good oil source rock of 1,100 meters thick. Two major material sources in the south and north and other secondary material sources on the edge of the depression and the edge of the basin formed a deposit of mainly arenaceous rock. Under the control of regular upward and downward undulation, a relatively large uplift occurred every 15 to 20 million years and caused the depository strata to become wedged into the oil genesis strata and to form three sets of oil genesis and depository cap compositions which were very ideal oil depository compositions. The Changyuan oil depository belt at Daqing is a very good example.

Figure 3. Cross-section of the migration of the sedimentary axis of the tectonic strata of the Songliao Basin.



Key:

1. Tectonic strata of the Jurassic System
2. Tectonic strata of the lower Cretaceous Series
3. Upper tectonic strata of the middle Cretaceous Series
4. Lower tectonic strata of the middle Cretaceous Series
5. Tectonic strata of the upper Cretaceous Series
6. Tectonic strata of the Cenozoic Group
7. Main sedimentary axis
8. Secondary sedimentary axis

At about the end of the middle Cretaceous Period, the Sea of Japan began to expand, the Yilan-Yitong graben was active, the westward push reached the basin and caused weak folding. The eastern part of the basin generally rose, local tectonic belts and secondary tectonic betls were formed, and there were reverse thrust faults.

4. Depauperate isostatic stage: After the Nenjiang Movement at the end of the middle Cretaceous Period, the crust of the basin gradually underwent isostatic adjustment. The entire basin rose, and the lacustrine basin of the late Cretaceous Period shrunk to 70,000 square kilometers. The center of settlement shifted westward by about 30 kilometers from that of the middle Cretaceous Period. Because the Changyuan Upwarping at Daqing formed two settlement centers, one in the west and the other in the east, the thickness reached 1,030 meters and 520 meters respectively, and the rate of

sedimentation was 41 to 21 meters/million years, averaging 26 meters/ million years.

The tectonic movement of the late Cretaceous Period was still an upward and downward undulation, mainly rising upward accompanied by weak folding movements. This increased the scale of closing of the Changyuan tectonics at Daqing by 150 meters. A group of small-scale tectonics was formed in the western part of the basin.

Summarizing tha above, we see that during the middle period of the Mesozoic Era, the Songliao Basin underwent subcrustal hot expansion and upwarping to form an initial tension rift of the continental block and early tension fractures occurred. Under the action of inland tension rifts, the most active crustal faults developed into rift depression basins. Under the control of regional crustal isostatic adjustment and the Pacific Plate which limited the activities, fracturing of the basin was suppressed and the basin was transformed into a depression to form a good oil containing basin. The adjustment of the plate systems during the latter period of the Mesozoic Era changed the appearance of the basin and activities gradually subsided. This was accompanied by compression type tectonic movements which stimulated further genesis, migration and concentration of oil and gas.

III. Properties of the Basin

There are several views concerning the position of the Songliao Basin in plate tectonics. Some people include it as a back-arc basin. Dong Chongguang [4547 1504 0342] believes it is a continental rift valley and belongs to a part of the eastern rift valley system in China. Recently, Zhang Kai [1728 1956] et al called it a double back-arc rift valley basin. This writer feels taht it possesses the properties of a rift valley but it is only an early one. It is situated near the edge of the Eurasian land mass. Volcanic activity of the Mesozoic Era was violent, and it is similar to a back-arc basin, but its position in regional tectonics and the thickness of the crust all indicate it belongs to a continental crustal basin. Its internal tectonic structure is very different from that of a back-arc basin but there are similarities with intracratonic basins in the North China Sea and Siberia.

The base of the Sonbliao Basin is a Hercynian folding belt. In other words, it is a basin on a new craton. The eastern boundary of this new craton may not be limited by the western coast of the Sea of Japan. The upper geostrata and the tectonic characterisitcs of the Japanese archipelago are basically consistent with those of the Zhang Guangcai [1728 1639 2008] Ridge, indicating that Japanese Archipelago may be the eastern edge of the original Hercynian folding belt. In the belt extending from Japan via Taiwan to the Philippines, there is a belt of periodtite of the late Jurassic Period. The east side of this belt is a geosynclinal area of the Cenozoic Era. This shows that this is generally the eastern boundary of the Eurasian Plate. According to studies by S.M. Li, the island arcs of the Triassic Period and the Cretaceous Period of the Eurasian Plate are all on the west side and east side of the Japanese Archipelago. Therefore, a true back-arc basin should be the first settlement belt as Li Siguang [2621 0934 0342] called it. The Songliao Basin should be a basin on the continental crust.

It is generally believed that the formation of intracratonic basins is related to the initial tension rift of the continent. The Songliao Basin possesses the basic characteristics of the basins formed by the initial rift, for example: sections of the basin are basically symmetric; early block fault movements were visible, during the latter period, cap layer tectonics were even and gentle, folding was weak; the thickness of the crust of the basin is greater than 30 kilometers, and it is a basin of the continental crust structure. In typical intracratonic basins, the crust becomes thin and forms an early hot tectonic dome followed by tension stress which causes early tension rifts and the basin begins to settle. The crust of the interior grabens of the North China Sea Basin and the Siberian Basin is a weak zone, the buried graben tectonics usually show a branched triple link. During the early period of evolution, there were relatively high heat flows. The triple link of the graben structure of the Songliao Basin can be preliminarily determined by the shape of the Mohorovicic discontinuity of the isopleth enclosure of 31 kilometers deep and the distribution of the Dengluku Group and data on the eastward and westward grabens in Binxian. The reflection of the vitreous mass of the Dengluku Group and the colors of spore-pollen shows a sudden change from the upper cap geostrata. This may indicate the occurrence of high heat flows during the early evolutionary stage of the basin.

The value of the heat flow in the ground of the Songliao Basin at present is 1.07 to 2.34×10^{-6} calories/square centimeters.second (HFU), averaging 1.70×10^{-6} calories/square centimeters.second. The geotemperature gradient is 2.1 to 6.1 °C/100 meters, and the average of the whole basin is 3.70 °C/100 meters. The average of the eastern part and the central part of the basin is 4.20 °C/100 meters. These figures are higher than those of ordinary intracratonic basins and are close to those of the western Siberian Basin.

The intracratonic composite basins that produce abundant oil and gas are mostly shallow marine facies deposits. Non-marine facies geostrata occur only in the early periods of the basin and on the edges of the basin, but the Songliao Basin is a large continental facies sedimentary stratum.

Summarizing the above, we believe that the Songliao Basin is a basin in the continental crust. It possesses the basic characteristics of an intracratonic basin but is slightly different. When we consider that the basin is on a post-Hercynian platform background, and that it was formed after the rift depression stage characteristic of the early rift valleys, we can conclude that a depression basin was formed after further development over the positions of the rift valleys on the background of crustal isostatic adjustment. The cause of formation is similar to that of the North China Sea Basin. Therefore, we call it a new intracratonic composite basin.

IV. Characteristics of Occurrence of Hydrocarbons of New Intracratonic Composite Basins

The new intracratonic composite basins have a good oil content. The occurrence of hydrocarbons frequently has the following characteristics:

(I) There Are Many Oil-Containing Layers and Series

These basins generally have two sets or more of oil source rock series. The Songliao Basin has an oil source rock series of the early rift depression stage, an oil source rock series of the middle composite settlement stage, and an oil source rock series of the late depression stage.

The oil source rock series of the rift depression stage is generally very important, for example, the Triassic System and the Jurassic System of the North China Sea Basin, the lower Tertiary System oil content of the Bohai Bay Basin and the Jianghan Basin. The deposits of those stages of the Songliao Basin are mainly the Dengluku Group of the lower Cretaceous Series. It is a set of compensatory quasi-flysch deposits of the diluvial, river and intermittent lacustrine facies of tall mountains and shallow waters with a strong material source and larger rivers along the fault zone caused by the Sunwu-Shuangliao crustal fault activity of a high settling rate. It is unfavorable for oil source rock series to develop well. This is different from the uniqueness of other basins.

During the Cretaceous Period, the maximum values of settlement of the world's intracratonic basins occurred three times, i.e., the Valanginian Stage, the Albian Stage to the Cenomanian Stage and the Senonian Stage. And to varying degrees, relatively large areas of non-compensatory dark mudstone deposits of the "blanket" type correspondingly occurred, forming good oil genesis layers. The two sets of oil source rocks of the Qingshankou Group and the Nenjiang Group in the Songliao Basin are products of two periods. This shows that the two large-scale settlements during the course of evolution of the Songliao BAsin of the Cretaceous Period are the results of plate tectonic activity of the intracratonic basin. Because the scale of settlement suddenly increased, sedimentary compensation was insufficient and non-compensatory sedimentation formed, making the lacustrine basin into a confluent water detaining basin. Because these two global ingressions brought about a damp climate, organisms prospered, richly nutritious lakes were formed and a typical oil source rock series of the composite settlement period was formed. The potential for oil genesis is large. Calculations using several different methods show that the total amount of oil produced by the whole basin can reach 48 to 61 billion tons.

At the center of the lacustrine basin, i.e., the position of the early rift valley, depressions continued to develop for a long time. The areas favorable for the genesis of oil circled by organic geochemical indicators exactly coincide with these tectonic depression facies. This shows that the deep depressions of deep water facies that have developed for a long period are most favorable to oil genesis, and it also shows that non-compensatory type sediments frequently form in composite depressions, and they are also most favorable to the genesis of oil and gas.

Depauperate isostatic period deposits usually do not have oil genesis conditions, and they cannot become oil containing rock series. But because the faults serve as channels for the migration of oil and gas, oil containing rock series are formed but the scale is usually not large. In the basin, these series are developed in the Da'an and Gulong areas.

(II) The Threshold of Oil Genesis Is Shallow, Evolution of Hydrocarbons Fast, Zones of Mature Facies Short

The evolution of hydrocarbons in the oil source rocks in the Songliao Basin has its visible and unique pattern in the vertical direction. We know from Figure 4 [omitted] that the depth of the oil genesis threshold is about 1,200 meters. The mature facies zone does not extend a long distance. The maximum value of the ratio between whole hydrocarbons and organic carbon is found at 1,999 meters. The ratio below 2,400 meters rapidly drops. As far as we know, the indications of the deepest direct oil (oil spots) deposits in the basin do not surpass 2,600 meters. Therefore, the main oil genesis belt is only 700 meters deep. The light oil and condensate oil belt is about 500 to 700 meters deep, less than that found in other sedimentary basins (Table 1).

This evolutionary characteristics may be the result of three main causes, the effect of the high geotemperature field, the heat gathering effect of the "blanket" type black mudstone and the length of time. The continental facies enclosed detension basin formed a "blanket" type black mudstone which had a good heat gathering and heat insulating function and retained a higher heat which accelerated the maturation of organic matter. But a more important reason is still the effect of the long duration of high geotemperature field.

It is generally believed that in the evolution of hydrocarbons, temperature plays a decisive role, and the history of geotemperature is determined in turn by the properties of the basin. In ordinary situations, the latter periods of intracratonic basins mostly remain in a low temperature environment because tension rifts are not too pronounced. The Songliao Basin is a new intracratonic composite basin. The Mohorovicic discontinuity is high. During the early period it possessed a rift valley property. Granite is widely distributed in the basement, causing particularly high heat flows and high geotemperature fields. Because it is near the edge of the continental edge, it is affected by the underthrust of the Pacific plate. This increases the convection of the Upper Mantle at the position of the basin, and after rift depressions are transformed to depressions, a relatively high geotemperature is retained, causing the organic matter to mature early in the evolution towards hydrocarbons. The oil genesis stage of a high geotemperature field occurs earlier than low geotemperature fields. This can be explained by contrasting the Los Angeles Basin and the Ventura Basin. The geological conditions of the two basins are similar. The oil source rocks are all found in the D and E layers of the late Miocene Epoch, but the geotemperature gradients are different (3.91° C/100 meters in the former and 2.66° C/100 meters in the latter), creating a difference in the depth of genesis of the 85° to 180° C hydrocarbons of the gasoline

Table 1. Comparative characteristics of the depths of maturation stages of oil source rocks of different basins

Name of basin		Song Liao	Bohai Bay (Huanghua)	Nanxiang	Jianghan	Yunta (U.S.)	Duala (Camaroon)
Period of oil source rock		Middle Cretaceous	Lower Tertiary System			Lower Tertiary	Middle, Upper Cretaceous
Geotemperature Gradient (c/100 meters)		3.7-4.2	3.5-3.7	3.7-4.1	2.3-3.0	2.5	3.5-4.0
Depth of Hot Maturation Stage (meters)	Threshold Value/Low Maturity	1200 1200-1900	2200 2200-3500	1600-1800 1600-2800	2200 2200-3700	3960 3960-5640	1450 1450-2200
	High Maturity/ Overmature	1900-2600 >2600	3500-4300 >4300	2800	3700-4600 >4600	5640-6100 >6100	2200-3000 >3000

fraction. In addition, according to studies by E.A. Perry and J. Hower (1972) clay rock was dehydrated during the early period of the mid-diagenesis stage, and dehydration occurs earlier in fields of high geotemperature than in fields of low geotemperature. Further upward, the duration is short in fields of high geotemperature and the duration is long in fields of low geotemperature. This may explain the characteristics of the shallow oil genesis threshold in the Songliao Basin and the short continuation of the mature facies belt.

The time factor is very important and indispensable. The geotemperature fields of many basins of the Tertiary Period are also high (such as the Bohai Bay Basin, the Nanxiang Basin), but the depth of the oil genesis threshold and the temperature are greater. The genesis of oil in the Songliao Basin occurs in the Cretaceous Series, which is older than the age of the oil source rocks from the Eocene Epoch to the Oligocene Epoch by 40 to 70 million years. According to the opinions of J. Connan et al, the effect of temperature is functionally related to time. According to the Arrhenious graph, the effect of the temperatures destructive to oil is the same for 118.4° C of 110 million years, 131.2° C of 60 million years, and 173.5° C of 10 million years. Therefore, the depths of the temperature of each stage of evolution of oil genesis in the Songliao Basin are slightly shallower.

In general, the threshold of oil genesis in the Songliao Basin is shallow, the mature facies belt is short, and these are the characteristics of new intracratonic composite basins of large continental facies of the Mesozoic

Era. It is the result of the organic match in time between the deep water lacustrine basin environment and settlement, deposition, tectonics and heat flow.

(III) The Content of Oil Is the Richest at Places Where the Early Rift Valley and the Later Depressions Coincide

Such locations are generally depressions joining topography, tectonics and sedimentation. They form deep depression zones in basins. The deposits are the thickest, and the lithological character is the finest and the most favorable to the formation of the source rock series. Because the lithological character and the lithological facies of the geostrata of the continental facies change greatly, and because weak tectonic movements create irregular secondary tectonics and local tectonics, it is difficult for oil and gas to migrate over a long distance, and thus a basic situation where deep depressions, deep water facies and their two sides contain the richest amount of oil is created. Practical surveys of the Songliao Basin show that the central deep depression zone is so. At present, 85 percent of the areas of industrial oil and gas flow of the total known reserve are from within this zone.

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OIL AND GAS

CHARACTERISTICS, OIL PROSPECTS OF PETROLEUM GEOLOGICAL STRUCTURES IN CHINA

Beijing SHIYOU XUEBAO [ACTA PETROLEI SINICA] in Chinese Vol 4, No 1, Jan 83 pp 1-10

[Article by Tian Zaiyi [3944 0961 5669] of the Petroleum Prospecting and Development Research Academy: "Characteristics of Petro-geological Structures in China and Evaluation of Their Prospects of Oil and Gas*"]

[Abstract] The tectonics of oil and gas containing basins in China are divided into two stages. Before the Indochina Movement they were primary intracratonic basins of marine facies deposits inside platforms that formed stable transitional platform basins of oil and gas. After the Indochina Movement during the Mesozoic and Cenozoic Eras, they were composite superimposed basins of continental facies deposits from internal disintegration of plates. Different types of basins of fault depressions, depressions, piedmont depressions and intermontane depressions containing oil and gas were formed.

When evaluating the oil and gas in sedimentary basins in China, the stable platform regions of marine facies deposits of the Palaeozoic Era are divided into ten evaluating units and the basins of continental deposits of the Mesozoic and Cenozoic Eras are divided into six evaluating units. The future of oil and gas of the coastal continental shelf ranks first, and its future development will surpass that of the present eastern region. The eastern region ranks second, and within a definite period, it can sustain the present production level, but detailed work must be done. The western region ranks third. We should strengthen prospecting work and strive to approach the level of the eastern region. We should look for gas in the area of marine facies deposits of the Palaeozoic Era as the primary effort and for oil as the secondary effort, and we should emphasize efforts to look for coal formed gas.

Foreword

The evaluation of oil and gas resources is an important research subject in the course of geological prospecting for petroleum. In the course of prospecting for oil and gas, we must carry out comprehensive scientific studies of the oil and gas basins, and solve the problem of how to rationally prospect for oil and gas fields to improve the economic benefits of prospecting.

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* This paper was read at the Second Annual Conference of the Chinese Petroleum Society in September 1981, at Changsha.

Evaluation of China's oil and gas resources coincides with the needs of our present petroleum prospecting work. As this work begins, this writer has published some preliminary views on the characteristics of petrogeological tectonics in China and the future of oil and gas as a reference for concerned comrades.

I. The Control of Tectonic Development Over Oil and Gas Basins

The distribution of oil and gas basins in the crust follows a fixed pattern. It is controlled by tectonics and the development of crustal movement. Different types of basins may have entirely different properties in time and space. During one period, a basin may be in an environment of a tension type crustal movement while during another period it may be in an environment of a compression type crustal movement. Therefore, a sedimentary basin can be a composite basin and it can be a superimposed basin. In the course of development of crustal movement, the basin may undergo evolution many times.

The degree of abundance of oil and gas in different types of sedimentary basins is also controlled by crustal movement. Because different geological environments may occur in a basin during different geological periods, therefore the properties of deposits, the degree of abundance of organic matter, permeability of the oil depositing layer, tectonic forms and tectonic evolution, and the distribution of oil and gas in time and space are all different.

Starting from the petro-geological viewpoint, the tectonic development of oil and gas basins in China can be divided into two stages. During the period before the Indochina Movement, China's ancient land mass was a primary intracratonic basin of marine facies deposits inside the platform that formed a stable-transitional platform type oil and gas basin. During the Mesozoic and Cenozoic eras after the Indochina Movement, China's ancient land mass was a composite superimposed basin of marine facies formed after the internal disintegration of blocks. This in turn formed different types of fault depressions, depressions, piedmont depressions and intermontane depressions which were oil and gas basins. Because of such an evolutionary process in geological tectonics, every oil and gas basin possessed its own unique pattern of distribution of oil and gas, and thus leading to two different areas of prospecting. We will discuss the following three problems concerning the control over oil and gas basins by the crustal structure:

I. Characteristics of Oil and Gas Basins Before the Indochina Movement

The ancient area of Asia where the ancient China land mass was located had three ancient land masses before the Palaeozoic Era, i.e., the ancient Siberian land mass, the ancient China-Korea-Tarim land mass, and the ancient Yangzi land mass. The middle band cycle at the end of the early Proterozoic Era consolidated to form the ancient China-Korea land mass. The Yangzi cycle at the end of the late Proterozoic Era consolidated into the ancient Yangzi land mass. Since the beginning of the Palaeozoic Era, the land masses underwent the Caledonian and Variscian cycles to consolidate into the ancient Asian land mass. Among these three ancient land masses were distributed the Sayanling-Ergune, Tianshan-Xingan and Kunlun and Qilian-Qinling geosynclinal folds, i.e., the ancient Asian geosynclinal area. The geosynclinal area began in the north in Siberia and extended towards the south, in the south it began from the China-Korea-Tarim land mass and extended towards the north passing through the Xingkai, Caledonian and Variscian cyclic sedimentary folds and finally closed in the northern Tianshan, Erlian and western Lamulun He area in Inner Mongolia. The Qinling, Qilian and Kunlun folded belt south of the ancient China-Korea-Tarim land mass began from the Altun Mountain in the west, passed Qilianshan and reached Dabieshan in the east and joined the ancient China-Korea-Tarim land mass behind the Caledonian fold. In the south along the Xingdukushen, Kunlun, Qinling line, a geosyncline of the late Palaeozoic Era was formed. The Variscian fold made it into a mountain area and further enlarged the ancient China-Korea-Tarim land mass.

In the late Permian Period, large inland basins appeared in northern China and in southern China, and marine facies developed well. In the middle and late Permian Period, the ancient geographic appearance remained unchanged. Seas were in the south and land was in the north. The area west of the Longmenshan-Xikang-Yunnan ancient land mass was a geosynclinal deposit and to the east was shallow marine deposits. In the late Triassic Period, the Indochina Fold was formed in the areas of the Bayan Har Mountains, Songpan-Ganzi, Qinling, and Sanjiang east of the Tethys Sea. Thus the ancient Asian continent expanded further towards the south.

The geological history briefly described above shows that the tectonic pattern and the ancient geographic profile of the ancient China land mass since the Sinian Period and up to the early and middle Triassic Period consisted of the China-Korea-Tarim platform in the south and the Yangzi platform in the north. In the geosynclinal areas were active deposits, volcanic rock was developed, and after crustal movement, they folded into mountains. In the deep water environment in the platform areas and the transitional zones at the edges were stable-transitional type deposits. During the later period, changes in crustal movement were small, and folds were level and gentle. They clearly indicate that oil and gas basins developed in the ancient platform areas and their transitional areas are the areas to seek for oil and gas.

2. Characteristics of Oil and Gas Basins After the Indochina Movement

Since the Mesozoic and Cenozoic eras, the ancient China land mass was at the southeastern part of the Eurasian Plate, sandwiched between the Pacific Plate and the Indian Plate. It was pushed by three forces which caused the China land block to split and disintegrate. This changed the pattern of the strike of east west tectonics since the Palaeozoic Era, and various types of sedimentary basins developed. The line along Helanshan, Longmenshan and the large rift along the Jinsha Jiang and the Hong He divided the land into an eastern and a western part. The eastern tectonic line had a north-east strike or a north northeast strike and it belonged to the tension type. The western tectonic line had a north northwest strike and it belonged to the compression type. The line of the deep rift along Qinling and Kunlun divided the land into a northern and a southern part. In the north were large depressions, and the folds were broad and gentle. In the south were small basins and the folds were tight. They could be divided into the following three types:

(1) Depression basins on the coast of the Pacific and rift valley basins near the oceans. During the Mesozoic and Cenozoic eras, the eastern part of the China continent was mainly on a tension type tectonic background. A series of depressions and rift valley basins emerged. In the history of development, the basins became younger and younger from west to east. The Sichuan and Ordos basins were formed in the middle and late Triassic Period. The Songliao basin, the North China basin, the Jianghan basin, the Northern Jiangsu basin and the southern Yellow Sea began in the Jurassic Period, and the East China Sea and the South China Sea began in the late Cretaceous Period. In the Xishan Period, the island arcs separated from the continent to form back arc tension rift basins. The central zone of the South China Sea possessed an ocean crust basement. The basement of the East China Sea was still a continental crust. The Central Mountain Range on Taiwan to the islands of Japan formed the central upwarping belt of the East China Sea. The area west of the upwarping belt was miogeosynclinal and the area to the east was eugeosynclinal.

According to the tectonic properties and the method of formation of the basement of basins, China can be divided into the following four regions:

The Northeast. The basement is the series of geosynclinal folds of the Xingan-Jilin-Heilongjiang geosynclinal folds beginning from the Jurassic Period. The early period was a fault depression stage controlled by a series of basement rifts in the north northeast direction. The middle period which was the Cretaceous Period was the stage of violent depressions. The late period which was the Tertiary Period was the contraction stage. The sediments were 4,000 to 7,000 meters thick. The cap layer's rift tectonics were not developed. Inside the basins, there were only volcanic activity during the Jurassic Period. These types of basins were formed mainly by crustal depressions.

The North China and the Continental Shelf Region. The basement was the China-Korea platform, the Yangzi platform and the series of South China folds. Since the Jurassic Period and especially since the Tertiary Period, a series of orthogonal tension faults mainly in the north northeast, northeast and north east east strike developed, and tectonic combinations of double faults and single faults, mainly single faults, developed. Rifts controlled the development and distribution of deposits and eruptions of basic volcanic rock forming a structural pattern of alternate upwarping and depression which controlled the genesis and development of basins. The basins turned toward the side of the fault, accumulation of deposits was thick and the oil genesis layers were good. In the ocean regions, another change occurred from the end of the Miocene Period to the Pliocene Period. Ingression occurred, and the island arcs separated from the continent. The formation of this type of basins was related to the stretching of the crust and the rise of the mantle columns.

The Ordos-Sichuan Region. This region developed on the China-Korea and Yangzi platforms. The basement is hard and it is the most stable part of the ancient China continent. The continental facies deposits of different periods inherited the ancient geographic profile of the marine facies period. Since the Triassic Period, the thickness of the continental facies deposits has reached 5,000 to 7,000 meters. The Tertiary Period geostrata are scarce and they are confined within the region of the basin which has turned towards the west. The tectonic characteristics include a level and gentle angle of inclination and few rifts. Only the Chuxiong basin was subjected to compression stress of the later period and tectonic variations became more dramatic. The formation of this type of basins is basically the product of depressions of basins crustal stretching.

The South China Region. This developed on the Yangzi platform and the basement of the south China folding belt. Since the Jurassic Period it has been a series of medium and small fault depression basins. The size is small and the thickness of the deposits is 2,000 to 4,000 meters. Most of the basins are fault depression basins formed under the control of tension rifts. The area east of Yuan Jiang had associated medium acidic to medium basic volcanic activity. The area to the west did not undergo violent volcanic activity.

(2) Inland piedmont basins and intermontane basins of ancient Asia. The Junggar, Tarim, and Hexi Corridor basins developed in the Palaeozoic folding belt and the regions of neighboring ancient continental blocks as piedmont depression basins. Inland basins began to form from the late Permian Period until the Cenozoic Era. The deposits on the side of the folded mountain range are thick and the folds are in rows and belts. The geostrata are precipitous near the mountain ridges. There are many faults and there are frequent reverse thrust faults. On the side of the ancient land mass, the deposits are thin and the tectonics are level and gentle. The Qaidam Basin is a large basin developed on the basement of the Hercynian folding zone. The Jurassic to the Cretaceous Period was the fault depression stage. The Tertiary Period was the depression stage. The deposits are thick at the center of the basin and thin at the edge. The folds are box-shaped and linear, there are many faults, and they are in reverse thrust from the center of the basin towards the sides. There are also a series of medium and small intermontane basins of Turfan, Santanghu, Yili, Guide, and Minhe within the region. These basins were produced on the whole depression background caused by compression stress. There was no violent volcanic activity inside the basins.

(3) The Tethys Region. It is in the Yunnan-Qinghai-Xizang area in the southwest part of the ancient China land mass, i.e., the broad region south of the deep and large Kunlun-Qinling-Longmenshan rift. It is the ancient Tethys Sea of the Mesozoic and Cenozoic eras. At present, it appears as an intermediate block basin of the Mesozoic and a high intermontane basin of the Cenozoic Era. During the Mesozoic Era, several intermediate blocks of different periods were hidden, such as the basement of the Qiangtang Area in northern Xizang which was a Caledonian folding zone. From the upper Palaeozoic to the Triassic periods it

was a deposit of fragmental rock and carbonatite of the shallow marine platform facies. Also for example, the Yunnan-Lanping-Simao Basin and Ruoergai and Changdu areas in Sichuan were all basements of the Caledonian folds. The Triassic System was thin and tectonic variations were weak. The stable deposits on these intermediate blocks were favorable to the genesis and concentration of petroleum.

The continental facies sedimentary basins of the Tertiary Period in the Yunnan-Qinghai-Xizang area developed on the basement of the Indochina-Yanshan fold. For example, the Kekexili, Lunpola, and Bango basins were a series of medium and small fault depression basins, they were small, their period of development was short, the thickness of the deposits was 2,000 to 4,000 meters. It is tentatively thought that these basins were the products of secondary tension caused by a compression stress background.

3. The Tectonic Environment Determines the Sedimentary Environment. Every oil and gas basin was a crustal depression that accepted deposits during a certain or several geological periods. The size of these depressions, the rate and depth of deposition, the filling substances and the presence or absence of oil genesis source materials, etc., are all closely related to the nature of the activity of the basement of the basin, the method of activity and the surrounding boundary conditions. This is because oil and gas basins emerge and develop in the course of crustal evolution, and the evolution of basins is controlled by crustal movement.

Analyses of the world's oil and gas basins show that all basins developed in platform regions have rigid basements, are stable, the area of sedimentation is large, the deposits are thin, and cap layer folding and rifting were not violent, such as the Sichuan and Ordos basins. Although the oil and gas basins formed since the Mesozoic and Cenozoic eras in China have their differences, there are common characteristics in their deposits and tectonic development. These are, a broad development of faults, a large-scale settlement, thick deposits, and sometimes frequent volcanic activity. Analysis of geological sections in the early period shows red or mixed colored coarse fragmental rock formations accompanied by volcanic rock. This is because during the initial period of activity of the basins, there were violent stretching and volcanic eruptions along the rifts occurred frequently. During the middle period, there were mostly turbid current deposits of the lacrustine sandy mudstone formation mixed with carbonatite or evaporite, and also delta deposits of river facies. This was a period of broad expansion of the basins. The deposits were stable, the bodies of water were deep, the water areas were broad, and they constituted favorable conditions for the genesis and concentration of oil and gas. During the late period, expansion activities ceased, rift depressions stopped, the basins reached the period of contraction, and the deposits were continental facies mollite formations.

II. Control of Oil and Gas Deposits by Oil and Gas Basins

For more than 30 years, China has obtained a wealth of data in the work of petro-geological prospecting. Analysis of prospecting shows that the pattern of distribution of oil and gas in any oil and gas basin is controlled by the basin. This means, the genesis, evolution, migration of oil and gas and the formation of oil and gas deposits are all based on the sedimentary basin as the basic geological structural unit, of course including boundary conditions. Therefore, when evaluating oil and gas resources, we must take the basin as a whole, study the history of formation of the basin, the strength and weakness of the movements, the structural loci. We must study the sedimentary facies, the mode of deposition, the developmental history of sedimentation. We must study the genesis, evolution and migration and the condition of formation of oil and gas, etc. We must point out favorable oil genesis zones and concentration zones. This problem is explained in the following seven aspects.

1. The Sedimentary Basin Is the Basic Geological Structural Unit in the Formation of Oil and Gas Fields

The sedimentary basin is a product of development of one or several periods of geological history. In these historical stages, the crust undergoes movement in the negative direction. The area is a depression occupied by an area of water. During the peak period of the area of water, the basin steadily and persistently sinks. The area of water expands, and the body of water deepens. It possesses closed conditions, and the water is in a reduction environment. In damp climate, life forms are prosperous, organic substances are abundant, and there is a definite quantity of oil genesis source material. In the sections of the geostrata, the sedimentary strata are cyclic because of crustal vibration and the activity between the supply of material sources and the forces of the water, therefore, there are areas of concentration of combined strata of oil genesis, oil depositing strata, and cap layers. Throughout the entire course of crustal dynamics, compacting of the geostrata and changes in tectonic folding will cause oil and gas to evolve and migrate to form many different types of oil and gas fields.

2. The Pattern of Concentration of Oil and Gas Is Strictly Controlled by the Center of Oil Producing Depressions. Not all parts of a sedimentary basin can produce oil. Oil genesis is limited within the deepest depression of the basin and during the stage of lengthy, persistent and steady settlement of the sections. Because the sedimentary environment of the deep water facies is stable, it has closed conditions and it is a reduction environment, life forms propagate in large numbers and organic matter is abundant. They favor the accumulation and storage of organic matter and the formation of conditions for organic matter to convert to oil and gas. Inside a sedimentary basin, the scope of oil genesis is not necessarily the same as the area of water in the basin. For example, the Junggar Basin covers more than 100,000 square kilometers. The area of oil genesis of the Tertiary System is only a dozen thousand or so square kilometers. The area of the Song-Liao Basin is 260,000 square kilometers. The area of oil genesis of the Qingshankou Group is over 60,000 square kilometers. Sedimentary basins of the continental facies are characterized by having a large area but a small area of oil genesis. In prospecting, an important question is to determine where the center of the depression of oil genesis is.

Whether a sedimentary basin is a depression or a fault depression and whether it is a single depression or many depressions are controlled by the upwarping of the basement of the basin and the depressions of faults caused by upwarping and fault depressions. A single depression basin, such as the Ordos, Song-Liao, and Sichuan basins, is generally symmetric or basically symmetric in shape. The center of depression and the center of sedimentation develop continually and they frequently are at the center of the basin or slanted towards a certain region in a fixed pattern. Multiple depressions with alternating upwarpings and depressions form multiple depression centers, multiple sedimentary centers, and multiple regions of oil sources, such as the North China Basin. A single dustpan-shaped fault depression frequently has a depression center slanted towards the side of the fault. A double fault graben depression mostly has a depression center that has migrated towards the side of the fault with greater activity.

When determining the depression center of oil genesis, we should pay special attention to the shift of the center of depression during the oil genesis period. This is because in the course of evolution of the crust, the shift of the center of the depression is controlled by the geological structure of the ancient basement region and thus has a fixed direction and pattern. For example, the sedimentary center of the Kongdian Group in the North China Basin is near the west side and south side of each fault block. When the Shahejie Group deposits emerged, the sedimentary center migrated towards the eastern and northern part of each depression. During the Permian Period, the Junggar Basin had a large area, and there were two oil genesis depressions. During the Triassic Period, they shifted towards the southeast of the basin. In the Jurassic Period, they shifted to the south central part of the basin. By the Tertiary Period, the oil genesis depressions were limited to the Huoerguosi-Tuositai area.

3. The Polycyclic Nature of Sedimentation of the Oil Genesis Layers and the Oil Deposit Layers. Some of the bodies of water in oil and gas basins are shallow and others are deep because during the lengthy course of evolution of crustal movement, vibration of the crust caused the basins to rise and fall. At the same time, we must consider the lithological properties of the material source regions, denudation and hydrodynamic conditions which determine whether the supply of materials is sufficient or not, and seasonality, thus a cyclic nature is present in the sections of geostrata. The alternating occurrence of oil genesis layers and oil deposit layers also coincides with this pattern of sedimentary cycles.

The initial period of formation of a basin is frequently the initial period of the cycle of crustal movement. It is a stage when the rate of settlement is greater than the rate of sedimentation. The bodies of water become deeper, and the thickness of sedimentation is smaller than the rate of settlement. The sediments are coarse, screening is poor, and they are unfavorable to the genesis and deposition of oil. By the middle period of sedimentation, crustal movements enter a equilibrium stage. Settlement and sedimentation also enter an equilibrium, and the depth of the bodies of water basically remain unchanged. The thickness of the sediments equals the amplitude of settlement. But the general trend is still mainly a movement towards the negative direction. At this time, the oil genesis layer with finer deposits and the oil deposit layers that are coarser emerge alternately. Such activity repeats itself again and again and creates many cycles. The late period is the stage of elevation of the basins. The rate of settlement is smaller than the rate of sedimentation. The bodies of water become shallow. The thickness of sedimentation is greater than the amplitude of settlement. The sediments become coarse. Thus, from coarse to fine and from fine to coarse, the sediments form a complete cycle. The Cretaceous System of the Song-Liao Basin and the Tertiary System of the North China Basin are sedimentary cycles of sequences of geostrata of the same geological period. They are called polycycles of single structure layers. Every geological period of the Junggar Basin from the Permian Period to the Tertiary Period, and every geological period of the Sichuan Basin from the Sinian Period to the Jurassic Period have cycles of oil genesis layers and oil deposit layers called the polycycles of multiple structure layers.

4. The Sedimentary Facies Zone Controls the Distribution of Oil and Gas. The marginal facies zone of basins, the underwater upwarping facies zone, the slope facies zone on the wings of upwarpings, the river delta facies zone and the facies zone of sedimentary rock deposited by turbid currents in deep water are favorable facies zones for the concentration of oil and gas, and they are also favorable regions for finding high-yielding oil and gas fields.

The sedimentary facies zones of each oil and gas basin show that a complete variation of the facies zones frequently form from the edge to the center of the basin. The facies zones change from fragmental facies zones of the facies on the edge into the river facies, bog facies, delta facies, lakeshore facies and lacustrine facies in that order towards the interior. On the plane, a ring facies zone is frequently formed around the lake region. Oil is formed at the center of the basin. The favorable facies zones in these upwarped areas on the edge are the directions of migration of oil and gas. The migration of oil and gas is strictly controlled by the facies zones. For example, the oil fields of Daqing and Changyuan, the Karamay Oil Field, and the Shengtuo Oil Field frequently form large oil and gas fields. In the course of sedimentation, the regions of underwater upwarping and the slopes on the two sides of the upwarping are affected by the undulations of the bed rock which are controlled by crustal movements, therefore, these regions have shallow bodies of water, the deposits are thin, the facies zones are broad and the material nature is good. In a marine environment, bioherm and oolitic limestone are formed. If the region emerges from the water surface, eluviation may form karst caverns and crevasses which are more favorable to the deposition of oil. These ancient underwater upwarping zones existed for long periods. During the lengthy period of diagenesis, upwarpings and depressions formed a definite pressure difference, and thus favored concentration and formation of oil and gas during the early period, for example, the Renqiu Oil Fiend and the ancient upwarpings of Luzhou-Kaijiang, Leshan-Longnusi and Tianjingshan. The sedimentary rock deposits from turbid currents in the deep water lucastrine facies, such as the Dagang Oil Field, the Xinglongtai Oil Field and the Yuanyanggou Oil Fields are situated in the deep oil genesis depressions. The environment was favorable to the formation of oil during the early period. It is a favorable facies zone for seeking lithological oil deposits.

5. Facies of Shallow Sea Basing Have Good Conditions for Oil Genesis and Deposits. The boundary surface of the sediments of the facies of shallow sea basins is below the surface of the base of the waves and the oxidation boundary surface. The energy of the body of water is weak, and the depth is several dozen meters to several hundred meters. The area is a subtidal low energy zone. Sedimentation is stable. The sediments are dark colored sandy mudstone with thin layers of marlite and limestone. The sea water has a definite salinity, and organic substances are abundant. This environment has a definite oil genesis ability. For example, the western part of the Sichuan Basin, the Permian System and Triassic System in the area of Nanpanjiang, Ningming, and Chongzuo have such facies zones.

The facies of the edges of platforms are close to one side of shallow sea basins. The sedimentary boundary surface is above the surface of the base of the waves and the oxidation boundary surface. The action of the waves is strong. It is a subtidal high energy zone. The sediments are mostly fragmental limestone, biolimestone, sedimentary breccia, bioherm limestone mainly in block shaped biological frame structures. Crevasses for deposition and concentration are developed. They are favorable places for the concentration of oil and gas, such as the Dengying Group of the Sinian Period of the ancient Luzhou Upwarping and the Yangxin Series of the Permian Period.

The platform facies zones are the broad areas of the continental canopy on the front edge of the ancient land mass. The slope is small, and the variation in the depth of the water is great, from several meters to several hundred meters. The energy of the bodies of water is generally weak or medium and the areas mostly belong to sub-lacrustrine low energy zones. In the platform depressions and troughs, the sedimentary environment and the facies zones of the shallow sea basin are the same, there is a definite oil genesis ability, such as the Devonian System of such areas as southern Guizhou and central Guangxi. In the closed platform facies zone, sea water is relatively shallow, the amount of evaporation is large, salinity is high, energy is weak, the lithological character is mainly selenolite and argillaceous limestone. For example, this facies zone is developed in the Ordovician System and the Carboniferous System of Northern China and Tarim and the Triassic System in Sichuan. In the broad and open platform facies zone, the sea water is linked to the ocean. The energy of the body of water is medium, the sediments are argillaceous limestone, fragmental limestone and sandy mudstone. The beaches and reefs are developed, organic matter is abundant, there is a definite ability of oil genesis and there are also definite conditions for oil deposits. For example, the upper Palaeozoic Group and the Triassic System are both developed in Yunnan, Guizhou, Guangxi, Sichuan, Hunan, and Hubei.

6. The Formation of Oil and Gas Fields Is Controlled by the Tectonic Development of the Basin. The formation of oil and gas fields is a special field of study in petrogeology. Whether studying oil genesis or tectonic sedimentation, the final effort will always be to find out where and in what situation can oil and gas fields be discovered. All tectonic oil and gas deposits, whether they are lithological oil and gas deposits, geostrata oil and gas deposits, oil and

gas deposits in salt domes, or composite oil and gas deposits, have developed during the course of formation of the basins and the course of reformation during the later period. In different types of basins or different regions in the same basin, the formation and the types of oil and gas deposits are different.

The basins in our nation's northwest are piedmont and intermontane basins of the active compression zone. Anticlinal structures are developed and they are parallel to the neighboring folded mountain ranges distributed in linear or box-like rows or belts. The areas are large, the degree of closure is high, the structures gradually fold and weaken from the edge of the basin towards the interior and they are accompanied by reverse thrust faults. Frequently, oil and gas fields are found at the bottom wall of the reverse thrust. The Sichuan and Ordos basins have stable and rigid basements, folding of the cap layer does not easily occur, there are only even and gentle structures, and the closure is small. The depressions in the North China Basin are mostly dustpan-shaped single faults. This special tectonic type determined the unique pattern of distribution of oil and gas deposits. On one side of a rift, there are anticlinal oil deposits created by the inverse traction of syngenetic faults. In the deep depressions with a thick sedimentary rock layer, there are compressed anticlinal tectonic oil deposits. At the deep part of the depressions, ancient hidden mountain oil deposits are frequently found because of fault block activity of the bed rock. On the tectonic background of ancient hidden mountains, the geostrata of the Tertiary System frequently form overlapping tectonic oil deposits. Many superimposed geostrata of oil deposits or lithological tapered oil deposits are formed on the monoclinal strata on the other side of the depression.

7. The Pattern of Distribution of the Zones of Concentration of Oil and Gas Shows a Distribution in Rows, Belts, or Rings and Groups. The pattern of distribution of oil and gas fields in some oil and gas basins shows that they are distributed in rings and groups or in rows and belts around the center of the depressions. There are four main reasons: First, the center of the sedimentary basin is a rich oil source region. Second, there are nonconformity oil deposits formed by ancient hidden mountains or ancient upwarping in the deep depressions in the basins and there are also lithological oil deposits formed by turbid current sediments. Third, upwarping on the edge of the basin or underwater upwarping and the slopes on the two sides form favorable depositing rock facies zones. Fourth, the period of migration of oil and gas and the period of tectonic formation must be organically coordinated. In general, in the course of migration of oil and gas from the oil source region towards the upwarping zones, good concentration zones will form near the oil source whenever the trapping structures and the deposition and concentration facies zones are well coordinated. At the same time, we must also pay attention to second migrations of oil and gas, such as in the Laojinmiao Oil Field, which was not controlled by the oil genesis region of the primary sedimentary basin.

III. Evaluation of Oil and Gas Basins

The evaluation of oil and gas basins cannot be completed at once. We must gradually deepen our understanding. Therefore, the evaluation of basins represents only a definite historical stage. Here, we will start out from the petrogeological tectonic characteristics to evaluate China's oil and gas basins.

The sedimentary platform region of the marine facies of the Palaeozoic Era is divided into 10 units. The sedimentary basin of the continental facies of the Mesozoic and Cenozoic eras is divided into six units. They are separately described in order below.

1. The Sedimentary Region of the Marine Facies of the Palaeozoic. In this region, searching for gas should be the main effort and searching for oil should be secondary. We should also pay attention to searching for coal formed gas.

(1) Sichuan Basin. This basin is a localized sedimentary environment of the marine platform facies. The sedimentary cap layer from the Sinian Period to the Triassic Period is about 10,000 meters thick, forming a multi-period cyclic composition of oil genesis and deposits and various types of sediments of carbonatite and fragmental rock. There are favorable rock facies and lithological environments for the genesis and concentration of oil and gas. The structures are complete and well preserved. Past prospecting found some gas fields. In the future, we must strengthen prospecting. The Sinian System, Cambrian System, and Ordovician System of the deep parts in the Zigong and Weiyuan area in southern Sichuan were on the elevated southern slope of the Changning depression slanting towards the ancient upwarping of Leshan-Longnusi for a long time, therefore they were favorable regions for oil and gas migration. The northwestern part of Sichuan is a depression of mainly the Mesozoic Era. The Tianjingshan ancient upwarping includes the areas of Mianzhu, Jiangyou, and Guangyuan. Before the Permian Period the region was an upwarped wedge and up to the Cretaceous Period, it possessed a continuous upwarping characteristic. The Daxing and Xiongpo area is right next to the western Sichuan depression and is a secondary upwarping along the southeastern slope. The Jiulongshan area is a secondary upwarping on the edge of the basin at the northeastern end of the Zitong depression. These ancient upwarpings are all situated on the slopes of depressions. They are very favorable to trapping and concentrating oil and gas. Central Sichuan is a region where the amplitude of upwarping of the bedrock is large. In the Palaeozoic Era, Longnusi was the main body that formed a Caledonian upwarping. There is a greater future in finding oil and gas deposits of the lower Palaeozoic Group here. Since the Mesozoic Era, the scale of depressions of western and northern Sichuan enlarged. The Yingshan area in northern Sichuan became a northward inclined slope. It is favorable to seeking oil deposits in the Jurassic System and in the Triassic and the Permian systems in the deep parts.

(2) Wuling Depression. This region refers to eastern Sichuan and western Hunan and Hubei, i.e., the broad region between the ancient Luzhou upwarping and Xuefengshan. The geostrata of the Palaeozoic Era are developed and intact and they are shallow marine platform facies sediments. During the early period of the Mesozoic Era, they were influenced by the Indochina Movement. Some of the high anticlines of that region have begun to move. Qiyaoshan was a relatively higher upwarping which differentiated the two sides of the sedimentary facies of the Triassic System. The present tectonic scene was formed at the end of the Yanshan Period. It consists of mainly a series of blocking type parallel folded belts in the northeast direction. They are high in the southwest and low in the northeast. Anticlines are dense, synclines are broad and gentle, and the Permian and Triassic systems have emerged from most of them. The Cambrian and Ordovician systems have emerged from the axis of the high anticlines. Prospecting should mainly be carried out in the low anticlines. The main target layers should be the limestone and bioherm of the Permian and Triassic systems, and the secondary target layers should include the biolimestone and gravel limestone of the lower Ordovician System, dolomite and oolitic limestone of the middle and upper Cambrian Series, and the algae dolomite of the Dengying Group.

(3) Tarim Basin. This basin is an ancient block. Geostrata of the Palaeozoic Era are developed. The Cambrian and Ordovician systems are broad marine carbonatite and shallow sea fragmental rock sediments. The Keping area has lagoon facies deposits. After the Caledonian Movement, the Devonian System mainly consisted of terrestrial red fragmental rock. In the Carboniferous Period, sea water was widespread. The western part was a shallow marine platform facies with local lagoon facies. The lithological character consisted of carbonatite and sandy mudstone. Life forms were prosperous, organic matter was abundant and the basin was an oil genesis environment. The early Permian Period was a sandy mudstone facies. The late Permian Period was red fragmental rock of continental facies. During the Tertiary Period, the basin settled on a large scale and the burial was deep. Prospecting is more difficult.

(4) The upper Palaeozoic depressions of southern Guizhou and central Guangxi. This region is situated on the southwestern slopes of the Yangzi platform. The lower Palaeozoic Era has a different history of development. The upper Palaeozoic Era formed a unified depression. The geostrata of the Devonian and Carboniferous periods in the Anshun and Duyun area are very thick sediments of the platform trough type carbonatite and fragmental rock formations. The sediments of the Permian and the Triassic systems are widespread. The regional tectonic line has a northeast strike. Anticlinal folds are dense and mostly box-shaped. Synclines are wide and broad. Emergences of oil seepage are common. The upper Palaeozoic Era sediments in the Laibin, Yishan, and Liuzhou area in central Guangxi are thick and they are superimposed over the metamorphic rock of the lower Palaeozoic Era. The tectonic folds are level and gentle. Oil seepage is abundant but the conditions of the cap layer are poor.

(5) The slopes of the sediments of the upper Palaeozoic Era of Chongzuo, Yining and Shangsi. This region is situated on the southern slope of the lower Palaeozoic Era upwarping of west Damingshan. During sedimentation in the late Palaeozoic Era, it was on the ancient slopes that settled towards the south. The Permian and Triassic systems are thick. Shallow coastal reef facies are especially developed. The arrangement of the oil genesis and deposit cap layers is good. The degree of evolution of oil and gas is good. There are many emergences of oil seepage. It is an area worth prospecting.

(6) Nanpanjiang depression. The Ordovician-Silurian System is mostly lacking or has undergone metamorphism in this region. The Devonian System is a nonconformity over the Cambrian System. The Carboniferous System, the Permian System and the Triassic System are very developed with a thickness of about 10,000 meters. The Triassic System is a deep depression sediment, folds are dense in a comb shape and rifts are developed. The underlying Carboniferous and Permian systems have a relatively even and gentle structure. We can select the upwarpings in the depression or the wide synclinal zones for prospecting.

(7) The North China and Ordos regions. The China-Korea platform is a marine facies sediment developed during the late Proterozoic Group and the early Palaoezoic Era. It is favorable to the genesis and concentration of oil and gas. The development of the Wumishan Group and the Gaoyuzhuang Group of the Sinian System, the Fujunshan Group, Mantou Group, Maozhuang Group, and Gushan Group of the Cambrian System and the Ordovician System north of Dezhou and Shijiazhuang and in the eastern part of Gansu and the northern part of Shaanxi is good. They have localized marine or lagoon facies carbonatite and fragmental rock formations which are rich in organic matter, and conditions for oil genesis are good. Several dozen primary oil seepages have been found in the area of emergence. Oil seepages are expected to be found in the upwarping areas, such as the Cangxian Upwarping, the Shijiazhuang-Dezhou-Chengning Upwarping, Qingyang-Jingbian Upwarping. They are all regions worth prospecting.

(8) The Jiangsu-Anhui region. This region refers to the two depressions developed on the two sides of the Jiangnan Upwarping south of the Shandong-Jiangsu-Dabieshan Upwarping and north of the South China Upwarping. The sediments of geostrata of the Palaeozoic Era are complete and their development is good. The lithological character consists of cabonatite and fragmental rock. There are conditions for oil genesis and depository cap compositions and oil and gas migration, but during the latter period, crustal movement was violent, there were many faults, the structures were fragmented. Emergences of oil seepage are common. We can select the region of even and gentle folds in the Jurong, Nanling, Wuxi, and Guangde areas for prospecting.

(9) The Hunan-Jiangxi region. This region includes the broad areas from Xinhua, Changsha, and the area south of Yichun to Zhaoqing. It is the southern slope of the Yangzi platform. During the Guangxi Movement, this region rose. The lower Palaeozoic Group is missing everywhere and has undergone metamorphism. During the middle of the Devonian Period, it began to settle and was subjected to ingression. The Carboniferous, Permian and Triassic systems all have sediments. It is

coastal carbonatite and sandy mudstone facies. There are conditions for oil genesis, and oil seepages are common. Folding was violent. The axis is in the northeast direction. The Devonian System and the Carboniferous System have mostly emerged at the tectonic axis. This is an unfavorable factor.

(10) The intermediate block areas of the Tethys Sea. This region refers to the areas of Jiangtang, Ruoergai, Lanping-Simao, and Baoshan. The Jiangtang area consists of stable sediments of shallow marine platform type fragmental rock and carbonatite of the upper Palaeozoic Era and the Triassic Period. It possesses conditions for oil genesis and deposits. The Baoshan area is a platform facies sediment of the Palaeozoic Era. The Ruoergai and Lanping-Simao basins are all basements of Caledonian folds. The sediments of the Triassic System are thin. The tectonic changes are weak. Oil and gas seepages have been seen in the Triassic System of Maixixiang at Changla and Ruoergai. Petroleum prospecting work should take note of this.

2. Sedimentary Basins of the Continental Facies of the Mesozoic and Cenozoic eras. This region has been the traditional and key prospecting region in China. For a relatively long period in the future, it will continue to be an important region for prospecting.

(1) Ocean zones of the continental shelf. The broad regions of the continental shelf have undergone large scale settlement since the Mesozoic and Cenozoic eras. The sediments are thick, reaching a maximum of 10,000 meters. Sometimes there was frequent volcanic activity. In the early Tertiary Period, the regions were oil genesis formations of fresh water lacustrine facies. From the middle period of the mid Miocene and Oligocene series to the lower Miocene Series, the region consisted of coastal lacustrine facies or alternating marine and continental facies oil genesis formations. IN the late upper Tertiary System, it was a marine facies oil genesis formation and the conditions for oil genesis were good. During the early and middle period, it was controlled by fault depressions and there were many protrusions and concavities. Since the middle and late periods, large area settlement gradually occurred to form a large unified depression. Rifts are developed inside the basin. The folds are even and gentle, there are many tectonic types, including compressed anticlines, bedrock hidden mountains, rolling anticlinal reverse traction tectonics, overlapping tectonics and nonconformity oil deposits, lithological oil deposits and reef block oil deposits. Our preliminary evaluation shows that prospects for Zhujiangkou and the East China Sea are good, followed by Beibuwan, Yinggehai, the South China Sea and the Yellow Sea. These regions will become the largest petroleum industry bases in China.

(2) The eastern region. This is the broad region east of Helanshan-Longmenshan. Fault depression type basins, depression basins and rift valley basins are developed. The sediments contain very thick geostrata of the Mesozoic and Cenozoic eras. The oil genesis and deposit rocks are developed in this region and they are polycyclic. Because the lake basin underwent a lengthy developmental period of relatively stable and persistent settlement, the area of water is broad, the bodies of water are deep, life forms are prosperous, there are

better geological and geochemical conditions, and oil genesis conditions are very favorable. During the course of development of the Ordos Basin, the Sichuan Basin, and the Song-Liao Basin, the crust was stable, there were few rifts, and folds were even and gentle. The basements of the North China Basin, the Jianghan Basin, and the Northern Jiangsu Basin have many rifts which formed a rift tectonic zone of many protrusions and depressions. Local tectonics are developed, there are many types of traps, and they frequently form tectonic groups. The region has been prospected to a high degree. Some oil and gas fields have been found in the past, but the scope for future prospecting is still broad. We must carry out detailed work to find hidden complex oil and gas deposits. In the old prospected areas, we should look for upper step oil deposits on the side of the rifts and for lithological oil deposits and geo-strata overlapped oil deposits on the side of the slopes. In the deep parts of the depressions, we should look for lithological oil deposits with developed accumulated rock from turbid currents. We should continue to strengthen efforts to prospect the regions where the degree of prospecting is not high, such as the Nanbao depression, the zones between tides in ocean areas, the front zones of Taihangshan, the Kaifeng depression and the Jiyuan depression. We should expand efforts to prospect ancient hidden mountains and the Mesozoic Group of the deep parts.

(3) The large basins of the northwest. These basins are superior petroleum reserve bases in our nation. The areas of the basins are large, the sedimentary rock is thick, oil genesis and deposits are polycyclic, organic substances are abundant, oil genesis conditions are good. Because they are situated on a compression type tectonic background, the folds form rows and belts, and there are many types of oil traps. The Junggar Basin is the best. It continued to settle from the Permian Period to the Tertiary Period. It is a unified depression. According to available data, the capacity for oil genesis was the largest in the Permian System. The remaining periods also have good oil genesis environments. Analysis from the tectonic and lithofacies viewpoint shows that overall prospecting should be carried out as a priority in the northern part of the basin from Karamay to Delunshan, in Kalameili, in the large and small land bridges and especially in the lower wall of the reverse thrust faults. The tectonic groups of the folded zones of piedmont depressions are also favorable regions for prospecting.

The area of the Tarim Basin is large, covering 560,000 square kilometers. The sediments of the Triassic Period are limited. The Jurassic System, the Cretaceous System and the Tertiary System gradually expanded. The upper Cretaceous Series and the Tertiary System in the Kashi region are marine facies sediments of lagoon facies. The tectonics along Tianshan and Kunlunshan form rows and belts. The strike is parallel with the mountains, there are many rifts, and emergences of oil seepages are common. At the center of the basin, the folds become even and gentle and there are few rifts. The future of the Kashi and Kuche depressions is bright. Geophysical work must be further carried out at the center of the basin.

The oil sources of the Jurassic System in the Qaidam Basin are distributed in the northern part of the basin. The oil sources of the Tertiary System are distributed in the Mangya depression. Folds form rows and belts. Emergences of oil seepage are common. It is a region with a bright future. The Gasikule lake region is situated at the center of the oil producing depression. It should be prospected on an overall basis. Although the Yiliping depression and the Sanhu depression have oil sources, but because the tectonics is unclear, the upper overlapping rock layer is thick, the depression is keep, prospecting is difficult. Some geophysical work must still be done.

The Hexi Corridor includes the Jiuquan, Minle, and Huahaizi basins. The depressions of the Cretaceous Period have oil genesis conditions, and the Tertiary Period has conditions for oil deposits and tectonic traps. Oil deposits of the Cretaceous Period, hidden mountain oil deposits of new genesis and ancient deposits and also secondary tectonic oil deposits and lithological deposits of the Tertiary Period have been found. We should further strengthen prospecting and understand the relationships between the sedimentary depressions of the Cretaceous and their overlying strata. They still have a great potential.

(4) Small intermontane basins in the Hercynian folding zone in northern China. The Erlian, Hetao-Linhe, Hailar, Sanjiang, Yanji, Yinggen, and Santanghu basins are all sedimentary depressions of the Jurassic System, Cretaceous System and the Tertiary System. They have oil genesis and deposit rock strata and tectonic trapping conditions, and emergences of oil seepage are common. They are indeed worth the effort to search for oil.

(5) The small fault depression basins formed during the Yanshan Period and the Xishan Period in southern China. These basins have deposits of volcanic rock of the upper Jurassic Series, dark lacustrine facies sandy mudstone of the dark lacustrine facies that contains coal and sandy mudstone in oil genesis formations, lacustrine accumulations of volcanic rock of the Cretaceous System, oil genesis formations of the river and lacustrie facies of the Tertiary System, and red fragmental rock formations. The basins are small, there are many faults and the structure is complex. For example, it is possible to find oil flow of industrial value in the Baise Basin, Nanning Basin, Nanliujiang Basin, Sanshui Basin, Maoming Basin, and Nanxiong Basin.

(6) The Yunnan-Qinghai-Xizang region. Although the sedimentary basins of the Cenozoic Era formed on the basement of the Indochina and Yanshan folded zones, such as Lunpola, Kekexili, Jinggu, and Bange are small, but they have oil genesis rock layers and conditions for oil deposits and tectonic traps. There are many indications of oil and gas and this region is also an area to look for oil.

The general understanding is that the continental shelf in the ocean zones ranks first in priority for prospecting, and its future development will surpass that of the present eastern region. The eastern region ranks second. Within a definite period, it can maintain its current production level, but detailed work must be done. The broad region in the western part ranks third. We should strengthen prospecting work and strive to approach the effort in the eastern part. The search for gas in the marine facies sedimentary regions of the Palaeozoic Era should be the main effort and the search for oil should be secondary, and we should emphasize the search for coal formed gas.

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OIL AND GAS

REVIEW OF CHINA'S OIL ELECTRICAL SURVEYING METHODS

Baoding SHIYOU DIQIUWULI KANTAN [OIL GEOPHYSICAL PROSPECTING] in Chinese No 3, 15 Jun 83 pp 197-206

[Article by Xiong Shizhong [3574 6221 0112] and Zhou Qiu [0719 5876]: "Past and Future of China's Electrical Prospecting for Oil Resources"]

[Text] Abstract

China began oil electrical surveying in 1952, and the number of electrical survey teams had reached 36 by the end of the 1950's. As major oil prospecting efforts shifted in the early 1960's from China's northwestern region to the coastal seas in the east, and were subsequently affected by the "cultural revolution," electrical survey crews suffered drastic cutbacks and many crew members were forced to change lines. In the early 1970's, five electrical survey teams were reestablished; they not only continued to use conventional electrical prospecting methods, but also conducted pilot work on direct detection of petroleum. During this period, they conducted in-depth research on certain applied theories in electrical prospecting which led to the development of a complete set of digital processing programs. Based on the past three decades of practice in this field, it can be seen that electrical surveys still play an important role in such areas as regional reconnaissance, locating local uplifts with high resistance beds, and studying electrical fault planes under specific conditions. It is suggested that magnetotelluric sounding, artificial electric field sounding and other electrical prospecting methods should be actively developed and studied, and their comprehensive applications emphasized.

Looking Back on the Course of China's Oil Electrical Prospecting

After the founding of New China, the Xinjiang Petroleum Company (jointly run by China and the Soviet Union) formed two electrical survey teams in 1952, and began surveying Junggar Basin, employing EP-1 potentiometers and Soviet-built electrical sounding stations. In 1954, the State Petroleum Bureau organized two vertical electrical sounding teams in Sichuan Basin and Chaoshui Basin, using dry-battery powered potentiometers under the technical guidance of Karpov, a Soviet specialist. In 1955, China began importing Soviet-made ERS-23 electrical surveying stations for the use of electrical surveying teams in Yumen Oilfield. In late 1956, the Petroleum Ministry organized short-term training courses on telluric methods taught by Kavin, a Soviet expert. Subsequently, electrical survey teams were organized in Sichuan, Yumen, Ordos [northern part of Shaanxi and southwest corner of Nei Monggol] and Qaidam to carry out regional reconnaissance and some aerial surveys. At that time, telluric recording was mostly performed by use of remodeled EPO-4 oscilloscopes. Excellent results were achieved through the use of light and compact instruments which did not depend on cumbersome manual power supplies, thus attracting a great deal of attention. By 1958, telluric prospecting had become widely used in all exploration regions. In 1960, there were as many as 36 oil telluric survey teams.

In the 1960's, major oil exploratory efforts in China shifted from the northwest territory to the eastern region. The number of telluric teams in the northwest gradually decreased. Moreover, due to the lack of interference-free high-sensitivity instruments, it was difficult to detect relatively weak telluric current variations in the eastern and southwestern parts of our country, and the once-popular telluric prospecting method gradually lost ground after 1961. In 1962, some of the electrical survey teams were transferred from oil exploration regions to the eastern part of Jiyang Depression in Shandong Province to carry out electrical surveys of the entire area. Subsequently, they coordinated with other geophysical survey crews in the completion of multiple comprehensive profiles of North China Basin. In 1964, eight electrical survey teams operating in North China were merged into four teams. By the end of the 1960's, North China's electrical survey teams had changed considerably: some of them became seismic teams engaged in oil exploration or natural earthquake forecasting work; some were transferred to Shaanxi-Ganzu Region to help local seismic crews measure the thickness of loess layers; some were assigned to help local teams find water sources.

In the early 1970's, five electrical survey teams which had been scattered in different places were regrouped into one reconnaissance brigade under the Geophysical Exploration Bureau, thus stimulating oil electrical survey work which helped to accomplish the following: completed aerial reconnaissance of Zhoukou Depression; filled in missing electrical survey data of certain blank areas in Central Hebei; conducted numerous experiments in water detection and direct detection of oil. In the late 1970's, a new exploration region was opened in Erlian Basin, and fairly good geological results were achieved. Xinjiang still had one remaining electrical survey team which managed to carry on intermittently.

What merits pointing out is the fact that during this period, our electrical survey workers had done a great deal of experimental and exploratory work in an effort to change the outlook of China's oil electrical prospecting. In 1963, the Electrical Survey Teaching and Research Section of Beijing Geological College helped to perform a number of modeling experiments on direct current resistivity methods, and computed theoretical templates; to a certain extent, its single-step experiments were useful for correcting electrical sounding curve tails under the impact of non-horizontal media. Research on radio wave and artificial electric field sounding methods began in 1965. A prototype model for radio wave sounding was developed and put to trial use in tunnels and mining shafts, but was subsequently discontinued for various reasons. As it consumed too much power and was difficult to operate, the artificial wave sounding method failed to produce significantly improved data and was thus discontinued after 3 years of field tests. Development of the magnetotelluric sounding method began in 1973; with the help of the State Seismic Bureau's Geological Research Institute, a great deal of effort was put into research on magnetotelluric sounding direction, e.g., computation of electrical sounding theoretical curve templates, and development of data processing programs. Moreover, an instruments factory run by the Bureau of Geophysics developed magnetotelluric sounding instruments which produced remarkable results through nearly 10 years of use, and are now continuing to serve field tests. Experimental work in direct detection of oil by use of electrical sounding methods began in the mid-1970's. Some researchers tried to use weak anomalies in vertical electrical sounding curves to determine the presence of oil and gas pools; but as anomalies on sounding curves can be interpreted in a number of ways, and are prone to a multitude of interfering factors which make resolution impossible, the method lost credibility and was finally abandoned altogether. This was followed by experiments on the use of induced polarization method for direct detection of oil; in the beginning, the method was tested in proven oilfields with preliminary results. As the number of test areas increased, the experiments revealed some contradictions which could not be rationally interpreted by use of the polarization theory. It appears that until we have solved the many theoretical and mechanism problems related to direct detection of oil by use of electrical sounding methods, it is not safe to totally rely on oil pool verification methods for producing geological result or predicting oil and gas deposits. At present, the method is still being tested. From above, it can be seen that over the past three decades, petroleum electrical surveying has experienced the three stages of growth, cutback and stabilization, and has played a certain role as well. Petroleum electrical prospecting work will continue to develop and play a useful role in the 1980's.

Some Achievements in Electrical Prospecting

Petroleum electrical prospecting has two basic tasks:

1. Develop regional reconnaissance--study regional structures; survey the relief of bed rocks (high resistance beds) and approximate burial depths; indicate the position of large faults and their direction of growth; map out secondary tectonic elements within basins.

2. Conduct aerial surveys--circle local high resistance upwarps. Under favorable geological and electrical profile conditions, and if electrical sounding curves are clearcut, the electrical method can be used for conducting a rough study of lithological changes of certain strata, determining the distribution and scope of low resistance strata (or high resistance strata), etc., in surveyed areas.

It is often fast and effective when used for opening up new prospecting areas. In the 1950's, electrical prospecting work proved to be especially useful for mapping out regional contours, depths and scopes of downwarps in Northwest China.

Example 1:

Kaifeng Depression is a secondary tectonic unit of Huabei [North China] Basin; located between Neihuang Upwarp and Taikang Upwarp, it faces Luxi Upwarp in the east, borders on Wuzhi Rise in the west, and is linked to Jiyuan Basin. In the late 1950's, when the Hua'er Well was drilled in this depression, the strata below 1,818 meters were classified as Cretaceous red bed; thus, Kaifeng Depression was identified as a Mesozoic red basin with dim oil prospects, and no further work was carried out. In 1965, two electrical survey teams and two gravitational prospecting teams were sent here to carry out reconnaissance of the entire area. After producing a large profile which ran east to west through Kaifeng Depression and all the way to Jiyuan Basin, the electrical survey team discovered that the electrical market beds were located at great depths below the Kaifeng Depression; moreover, Kaifeng's low resistance strata were thicker than Jiyuan's, but its resistivity was lower than the latter's. It became evident that the telluric profile in Kaifeng Depression was not the same as the telluric profile in Jiyuan Basin. But electrical sounding curves in Kaifeng Depression were very similar in shape to those in the Jiyang, Jizhong [Central Hebei], and Huanghua depressions, and the resistivity of the overlying low-resistance layers above the electrical marker beds was consistently within the range of 2 to 3 ohm.meters. Thus, it was believed that the strata could be lower-Tertiary Shahejie Group beds. Subsequently, efforts were made to redetermine the core of Hua'er Well, and it was found that the strata below 1,800 meters should be classified as Tertiary. The results of surveying the entire area with the electrical method indicated that the electrical marker beds in Dongming region were situated approximately at the depth of 5,000 meters, and the downwarp had the greatest oil prospects. In the late 1970's, seismic and drilling efforts confirmed that the Dongming-Puyang Region was an oilfield.

Evidently, the method of using analogical or statistical comparison based on electrical sounding curve characteristics and regional resistivity variation patterns is often effective for studying the distribution and lithological changes of electrical property beds, determining the scope of deep downwarps, and indicating prospective oil and gas zones.

Example 2:

In the mid-1960's, the electrical method was used to complete aerial survey of Langfang's Hexiwu region in the northern part of Jizhong [Central Hebei] Depression. The electrical sounding charts showed signs of a high resistance anomaly belt extending northeastwards and flanked on both sides by low anomaly zones. The high resistance anomaly belt was interpreted as a concealed upwarp linked to Baodi Rise in the northeast and Niuzhen Rise in the southwest, separating Langfang and Wuqing into two depressions. But Langfang Depression did not show clearly in gravitational survey charts at all; the charts only revealed slightly concentrated Bouguer anomaly lines distributed in beltlike pattern. Thus, many of us did not recognize the existence of Langfang Depression then;

the region was generally referred to as "Jing-Jin Depression." Subsequently, the seismic method was employed for surveying the region a number of times, and it was not until recent years that the contour of the subsurface structure in Langfang's Hexiwu Region finally came to light, thus confirming the existence of Langfang Depression which had been deduced from electrical method data.

The preceding fact shows that in some places gravitational data are affected by local fields and the resolution is not as good as that of the electrical method. Moreover, as the seismic method is limited by seismogeological conditions, it is impossible to obtain good seismic data everywhere. It is under such circumstances that the electrical method can play a key role in obtaining quick results for determining depressions, rises and relatively large concealed upwarps, especially in the initial exploration of basins.

Example 3:

In the mid-1950's, the electrical method was used for surveying a vast area covering the entire Majiatan Region in Ningxia. Majiatan is situated at the edge of Ordos Basin; to its west lies a densely folded marginal zone with several tectonic lines or folds running approximately in the north northwest direction. Considerable attention was aroused when gravitational surveys revealed that Majiatan had a trap measuring approximately 160 square kilometers and characterized by gravitational highs with anomalies up to 5 milligals. Subsequently, an electrical survey team was assigned to the area and found out that Majiatan's gravitational high was attributed to the two high resistance bed upwarps; moreover, its eastern high point coincided with the gravitational high, and by far the areal indication was not as great as the gravitational indication. Later, seismic survey work was organized on the basis of the electrical survey results. The structure was confirmed, and its seismic position matched the electrical recording as well. Towards the end of the 1950's, oil drillers struck commercial deposits in the Majiatan structure.

Generally speaking, the gravitational method is fairly reliable for exploring large local anomalies, but it can only produce rough reliefs and approximate positions; small structures that are deep below the surface, small in size, and close to each other are impossible to distinguish on Bouguer anomaly charts. Although the electrical method is also volumetric, it has better resolution than the gravitational method, as shown in Example 3.

Example 4:

Located in the middle of Jizhong [Central Hebei] Depression is the Renqiu-Xinzhongyi Zone where gravitational surveying crews discovered a positive anomaly trapped by a 39 milligal contour covering approximately 55 square kilometers. In 1965, electrical surveys confirmed the presence of the anomaly. The electrical method found a contour trap of 850 ohms total longitudinal conductance, and its position basically agreed with the area of gravitational anomaly. Quantitative analysis of the electrical data indicated that the depth of the marker bed was 3,000-3,400 meters, and by deduction it was determined to be the reflection of high resistance bed upwarp. The upwarp, however, did not arouse much interest until the mid-1970's when the electrical data was finally confirmed by relatively comprehensive seismic surveys. Subsequent drilling proved that the high resistance bed upwarp was a cryptomountain, and its recorded depth was basically the same as the depth based on interpretation of electrical data. Today, the cryptomountain is well known as Renqiu Cryptomountain Oilfield.

It can thus be seen that vertical sounding is often an efficient method for exploring local structures if the terrain is relatively open and flat, the telluric profiles have distinct interlayer electrical gaps, the electrical marker beds do not exceed the maximum depth of 4,000 meters, and the local structures have sufficiently upwarped features.

Example 5:

In recent years, electrical method surveyors have been working in the Erlian Region which is part of a Hercynian folded zone in Tianshan-Nei Monggol-Da Hinggan Ling Mountains. The basin of this region consists of Paleozoic metamorphic rocks and volcanic rocks frequented by magmatic activities in the course of its geological history; the surface is characterized by widely scattered igneous rocks, alternating upwarped and downwarped formations, intersecting rifts, and very complex tectonic framework. The geological conditions in this region were not very conducive to electrical method work at all; but the results of the electrical surveys in Erlian Basin were fairly satisfactory:

1. During the initial reconnaissance stage, coordinated electrical and gravitational work enabled the surveyors to basically find out the regional tectonic framework and downwarp depth within a relatively short period of time, thus helping to map out the main line of strategy for seismic exploration. At present, some of the chief downwarps have already been confirmed by seismic and drilling efforts.

2. Out of the 26 local anomalies discovered in Erlian by use of the electrical method, 11 have already been confirmed as structures by seismic surveyors. Among them was the Saihan Tal anomaly which was first discovered in 1977 and subsequently confirmed by seismic data in 1981 (a seismic profile with electrical sounding lines was mapped out in 1978); the discovery was named Sai No 4 Structure, and commercial oil was struck in the following year.

3. With the electrical survey data, it was possible to determine the thickness and distribution scope of primary target strata to be explored, thus providing certain amount of basis for evaluating the oil-bearing prospects of this region.

4. With the electrical sounding curves, it was possible to study the sedimentary facies of major source beds, examine their sedimentation mode, and thus find favorable olefiant downwarps and source areas.

Besides the preceding examples, we would also like to illustrate the results of electrical prospecting method with some actual statistical figures.

Jizhong Depression was fairly well explored by the electrical sounding method as well as very intensive seismic surveys. All seismic explored regions were supported by electrical data. Statistics showed that out of 84 seismic explored cryptomountains, only 17 had no electrical data, while 60 out of the remaining 67 were either totally or basically consistent with the electrical anomalies, and the rate of consistency reached approximately 97 percent.

Based on the depths of marker beds which had been quantitatively interpreted from electrical data, statistics indicated that there were 58 wells in Jizhong Region which had reached the Paleozoic group or pre-Sinian system; as compared with the quantitatively interpreted results of corresponding electrical sounding points (performed prior to drilling), there were 42 points which had errors less than 15 percent, accounting for 72 percent of all the sounding points; and 16 points had errors exceeding 15 percent. This indicated that the quantitatively interpreted results based on electrical data were fairly dependable.

The Direction for Developing Electrical Surveying

From above, it can be seen that petroleum electrical surveying should play an important role in comprehensive geophysical exploration. Then, what direction is electrical prospecting to be developed for oil geophysical exploration of the future? The authors hold the following views:

The direction for developing petroleum electrical prospecting should be determined according to the current main tasks of petroleum geophysical exploration. We believe that the current main tasks of China's petroleum geophysical exploration frontline can be summed up into four points as follows:

1. In under-explored areas, conduct areal reconnaissances and map out regional structures for use in favorable oil-bearing zones;

2. In well-explored areas, look for complex-structured concealed oil and gas pools;

3. Solve structural problems of basements in both newly and previously explored regions.

4. Carry out oil prospecting in regions with complex features, e.g., volcanic rocks, limestone, etc.

As far as electrical prospecting is concerned, evidently it is not feasible to solely rely on the commonly-used vertical sounding method. Vertical sounding employs rather primitive and cumbersome instruments and field operation methods, and its adaptability to complex surface conditions is poor. Thus, it is necessary to improve methods, instruments, data processing and interpretation.

Methods

1. Energetically develop and study all kinds of electrical surveying methods.

In China, encouraging developments have already been achieved in the research on magnetotelluric method which holds great prospects for further development. It can play a significant role in regions with large and thick sedimentary rock formations, as well as concealed areas with high-resistance layers. One great advantage of this method lies in its dependence on natural field sources and does not require any cumbersome power generators or long power cables. Thus it is very convenient for field work. At present, there are vast stretches of land in the western part of China which are under-explored. There are broad prospects for the applicational use of this method. In well-explored oil/gas-bearing regions, basement structural problems often need to be solved as deeper formations are being explored and exploited; magnetotelluric sounding is suitable for such a task. Thus, adequate attention should be attached to this method in tomorrow's oil electrical prospecting.

Artificial field sounding can also penetrate through high-resistance strata. Moreover, it needs to record the field formation process on only polar pitch and can produce complete sounding curves with the same results as those produced by the ordinary electrical sounding method, thus greatly enhancing work efficiency. This method is much used in the Soviet Union for oil electrical prospecting with satisfactory geological results. The "pulsation instantaneous variation field method" introduced by the Americans in recent years is essentially not different from the artificial field sounding method. The authors recommend efforts should be put into research and development of this method.

Vertical sounding is a theoretically matured and fairly good prospecting method; its shortcoming lies in its rather shallow probing capability and inconveniences to field operations. But, under advantageous geological conditions, it can still play an important role.

The greatest feature of the telluric method lies in its capability to utilize natural field sources; it is easy to operate, fast, highly efficient and low cost. It is particularly suitable for determining the relief of high resistance strata surfaces, and providing basis for mapping out tectonic units. Thus, it is also worthwhile to organize an appropriate number of telluric teams. But special emphasis ought to be placed on improving the sensivity and anti-interference capability of instruments. Its shortcoming lies in its inability to produce data on the electrical properties of every single layer of a profile; moreover, it cannot independently produce the absolute burial depth of relevant high resistance marker beds. Thus, it should be used in coordination with electrical sounding.

2. Stress comprehensive use of all electrical prospecting methods.

Just as there is need to enhance comprehensive geophysical exploration, it is also necessary to develop comrehensive electrical prospecting methods so as to make full use of strong points and overcome weak points. For example, although magnetotelluric sounding can be used for solving many problems, it does not produce good results in the higher frequency range. Based on what we have learned from foreign materials, it is not easy to pick up signals at extremely high frequencies; even if such signals are received, they are very scattered. This is due to the fact that high-frequency signals are weak and prone to high degree of interferences. Thus, in magnetotelluric sounding work areas, vertical sounding should be used to probe the telluric profiles of shallow layers first, and when AB = 6 kilometers, switch to magnetotelluric sounding to probe telluric profiles ranging from the deep strata to the upper mantle. This way of combining both methods ought to produce complete resistivity curves. Besides, according to magnetotelluric sounding results in other countries of the world, the magnetotelluric method has relatively low efficiency and is thus unsuitable for areal surveys. It is more appropriate to use the telluric current method for reconnaissance or in-depth surveying. Of course, when the magnetotelluric method is used as control sounding, it will also require a certain number of sounding points. The combination of the two methods can effectively enhance production efficiency. Similarly, the combination of artificial field method and magnetotelluric sounding method can likewise achieve excellent results. According to reports, there are examples of combining different electrical prospecting methods in the Soviet Union.

3. Carry out pilot research on the use of electrical methods for direct detection of petroleum.

Research on direct detection of oil should not be confined to comparative studies in proven oil zones or computing drilling results after making predictions in unproven zones. The key lies in the necessity to get a clear grasp of theories concerning the contributing mechanism of all electrical anomalies. In the future, only a limited number of top quality personnel should be employed to do solid research work on direction detection of petroleum. For instance, perform laboratory simulation tests, theoretical computation of forward problems, etc. Field work should be closely combined with theoretical research.

Many different kinds of petroleum electrical prospecting methods were discussed above. In actual work, the choice of suitable methods should be based on specific geological conditions, which can be summed up in the following table:

USES OF PETROLEUM ELECTRICAL PROSPECTING METHODS UNDER DIFFERENT GEOLOGICAL CONDITIONS

BED ROCK DEPTH	HI RESISTANCE SCREEN LAYER	TERRENE CONDITIONS	SUITABLE ELECTRICAL PROSPECTING METHODS	SUITABLE REGIONS
≤ 4 km	without	fairly good	vertical sounding method	Erlian Basin, Hailar Basin
≤ 6 km	with/without	relatively complex	artificial field sounding method	basalt zones, igneous rock growth zones, salt dome structural growth zones
≥ 4 km	without	fairly good	coordinated use of vertical sounding, magnetotelluric sounding & telluric current methods	Tarim Basin, Junggar Basin, Qaidam Basin, Linhe Downwarp, etc.
≥ 4 km	with	relatively complex	combined use of artificial field & magnetotelluric sounding method	limestone zones, volcanic rock growth zones

It should be pointed out that as the depth increases, the resolution of the electrical method depreciates considerably, which is a great shortcoming. Thus, one of the major research topics in the realm of petroleum electrical exploration is to find a high resolution electrical prospecting method that is similar to electrical logging.

Instruments

To ensure the quality of geological results attained by the preceding electrical prospecting methods, it is necessary to realize as early as possible the modernization of electrical method instruments, including development of digitized, multi-use, light and compact instruments. Following are some ideas for instruments according to different electrical prospecting methods.

1. Vertical sounding

Enhance sensitivity of current oscilloscopes and greatly increase their dynamic ranges. If possible, it is even better to switch to magnetic tape or digital recording devices which can be used either for recording vertical sounding or telluric current prospecting. Power stations should be equipped with two light and compact generators with maximum current of 65 amps and total power capacity of 30 kilowatts, and can output rectangular impulses or sine curves below the ground surface. The power stations can serve artificial field sounding and other types of electrical prospecting methods.

2. Magnetotelluric sounding

Digital magnetotelluric sounding devices have been successfully developed in China; efforts should be made to further improve their high-frequency reception capability, and turn them into multi-use devices, i.e., besides magnetotelluric sounding, they should also serve artificial field sounding with the support of power stations.

3. Other electrical prospecting methods

For artificial field sounding, combine improved vertical-sounding power stations with digital magnetotelluric sounding instruments. Use improved oscilloscopes or recording devices, digital instruments for recording telluric current work. When employing induced polarization for direct detection of petroleum, try to use high power generation stations and magnetic recording devices. Otherwise, it will be difficult to record or pick up weak signals in low resistance zones.

As most operation regions in the future are situated in complex terrene conditions, it will be necessary to develop light and compact instruments which can adapt to all kinds of complex conditions.

Data Processing and Interpretation

1. Make full use of computerized processing of electrical method data.

In recent years, China has developed a full set of programs for processing magnetotelluric data. The forward solution and inversion of telluric curves under horizontally stratified medium conditions, and the two-dimensional forward solution for the finite element method have also been achieved. Moreover, China has successfully developed ways for forward solution and inversion of electrical sounding data. In the future, we should energetically develop the following: data processing methods for artificial field sounding and telluric current data; computation of horizontally heterogeneous media resistivity; a complete set of progressive-flow processing programs for the electrical method, i.e., from gathering of field data to indoor processing and geological interpretation.

With the application of computers, there will be ever-increasing volumes of electrical, gravitational and magnetic data to be processed; the processing of magnetotelluric sounding data alone will require an enormous amount of computer time. Thus, it is necessary to start preparing for the construction of a national center for computer processing of gravitational, magnetic and electrical data.

2. Improve interpretation

Besides using the template method in the qualitative, quantitative interpretation of electrical sounding data, emphasis should also be placed on the improvement of interpretation, e.g., mathematical statistics, trend analysis, and finite element method. The traditional concept of using electrical surveying method only for exploring structures must be changed: The use of electrical sounding data for regional lithological analysis should be looked into. Besides, the interpretation of curve distortion and methods of analysis should be studied; and efforts should be put into the research and development of horizontally heterogeneous media templates.

There is no doubt that the improvement of interpretation will help to improve the results of electrical exploration, and add to the vitality of oil electrical prospecting.

Conclusion

From the preceding analysis, it can be seen that petroleum electrical prospecting has played a useful role in China's oil geophysical exploration; if the methods, instruments, data processing and interpretation techniques can be improved, it can help accomplish the exploration tasks of tomorrow together with seismic, gravitational and magnetic prospecting methods. It will also be able to maximize the role of electrical method in regions that are difficult to explore with seismic method, and in regions with complex gravitational fields. It can be predicted that in the 1980's, China's oil electrical prospecting will enter a new era of development.

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BRIEFS

SICHUAN GAS, OIL QUOTA MET--Chengdu, 6 Jul (XINHUA)--Sichuan Province produced 2.65 billion cubic meters of natural gas in the first half of this year, fulfilling 53 percent of its annual quota, according to the provincial department of petroleum industry. The province also produced 53,000 tons of crude oil during the January-June period, meeting 67 percent of its annual plan, the department said. The department attributed the increases to the adoption of new technology and equipment. The department also reported the discovery of three new natural gas fields in the eastern part of Sichuan in the first 6 months of this year. Thirty-eight oil and gas test wells drilled in the province have proved to be of industrial value. Last year, Sichuan Province produced half of China's 10.8 billion cubic meters of natural gas. The province, with more than half of the country's natural gas reserves, now has 50 gas fields in operation. Following the increase in energy production, Sichuan recorded an industrial output value of 16.08 billion yuan (about 8 billion U.S. dollars) from January through June this year, 11.7 percent more than during the same period in 1982. [Text] [Beijing XINHUA in English 1147 GMT 6 Jul 83 OW]

CSO: 4010/89

CONSERVATION SEEN AS KEY TO IRON, STEEL INDUSTRY DEVELOPMENT

Beijing NENGYUAN [JOURNAL OF ENERGY] in Chinese No 3, 25 Jun 83 pp 5-7

[Article by Zhao Zhenguo [6392 2182 0948], Energy Office, Ministry of the Metallurgical Industry: "We Must Use Energy Conservation as the Key To Developing the Iron and Steel Industry"]

[Text] The iron and steel industry is a major energy consumer; its energy consumption accounts for about 12 percent of total national energy consumption. In recent years, the leadership at all levels and the employees have become deeply aware that saving energy, decreasing energy consumption, improving quality and increasing the number of varieties are the path which our steel industry's development must take. Therefore, they have achieved excellent results in conserving energy and increasing output. In 1981, the metallurgical systems steel output was up 12 percent from 1978, while its steel materials output was up 21 percent; in energy consumption there had been a decrease of 8.84 tons of standard fuel (or 12 percent), including a decrease of 7 million tons (or 11 percent) in coal consumption, a decrease of 1.56 million tons (or 29 percent) in oil consumptions, a decrease of 537 million cubic meters (or 42 percent) in natural gas consumption, and an increase of 730 million kWh (or 2.5 percent) in electricity consumption. The average energy consumption per ton of steel decreased from 2.52 tons of standard coal to 1.93 tons of standard coal (a decrease of 23.4 percent). Comparable energy consumption per ton of steel decreased from more than 1.5 tons to 1.3 tons of standard fuel (while the aggregate energy consumption per ton of steel in 32 key iron and steel enterprises decreased from 1.767 tons to 1.409 tons, and comparable energy consumption decreased from about 1.4 tons to 1.184 tons). The energy consumption per 10,000 yuan of output value decreased from 27.7 tons to 22.49 tons of standard coal (a decrease of 18.8 percent). The share of energy consumption in production cost decreased from 24.5 percent to 18.6 percent. Based on aggregate energy consumption indicators, during the course of 3 years, cumulative energy consumption totaled nearly 20 million tons of standard coal. The total value of the conservation was about 1.5 billion yuan.

Energy consumption per ton of steel and the energy consumption in the main processes between 1978 and 1981 are shown in Figures 1 and 2.

It is evident from the figures that although the iron and steel industry has made gratifying process along the path of conserving energy and increasing

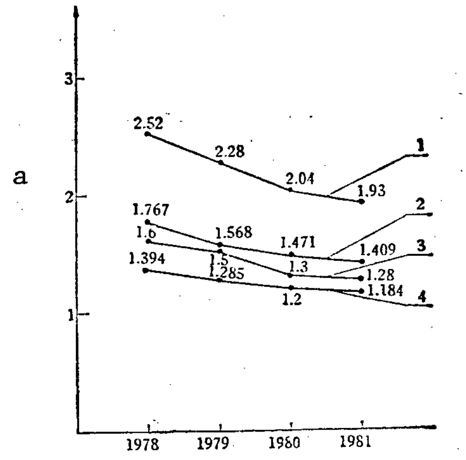
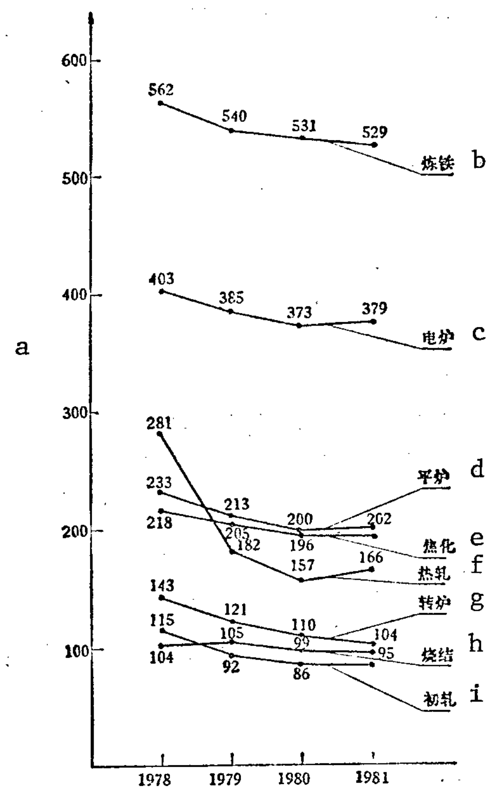


Figure 1. Energy Consumption Per Ton in China's Iron and Steel Industry

Key: a. Ton standard coal/ton steel

1. National average aggregate energy consumption per ton
2. Aggregate energy consumption per ton in key enterprises
3. National average comparable energy consumption per ton
4. Comparable energy consumption per ton in key enterprises



Key:

a. Kilograms standard coal per ton of product
b. Ironmaking
c. Electric furnace
d. Open hearth furnace
e. Coking
f. Hot rolling
g. Converter
h. Sintering
i. Initial rolling

Table 2. Energy Consumption of Main Processes in 32 Key Chinese Iron and Steel Enterprises

production, because of inadequate management and a low technical level, out-of-date processes and equipment and irrational structure, current overall energy consumption is rather high and there is still considerable potential for conservation. For example, the nationwide comparable energy consumption per tons of steel is still twice as high as for Japan and 50 percent higher than for the United States and England. If the iron and steel industry wishes to develop even further in the future, it must first make an energetic effort in energy conservation, change its high-energy-consumption structure as rapidly as possible, and decrease energy consumption. It must treat vigorous energy consumption as the key to rapid development.

Based on the development needs of the national economy, the iron and steel industry's overall militant objectives for the end of the century as mapped out by the Ministry of Metallurgy's preliminary plan are: use of new technologies and reorganization of the product mix to double output and triple profits in the iron and steel industry without major increases in energy consumption. The program requires that aggregate energy consumption per ton of steel drop from the current value of 2.04 tons of standard coal to 1.84 tons in 1985 and 1.65 tons in 1990 and reach 1.4 tons at the end of the century, and that comparable energy consumption per ton of steel decrease from 1.35 tons of standard coal to 1 ton.

Based on this program, in 1985 steel output will have increased by 2 million tons from the 1980 level, and the output of steel products will be up by more than 2 million tons, while total energy consumption will have decreased by 2.8 million tons of standard coal. Thus the 5-year plan period basically involves continued conservation of energy and increased output. By 1990, steel output will have increased by an additional 6 million tons, while total energy consumption will be held at the 1980's level of 71 million tons; thus the Seventh 5-Year Plan will basically be a period of continued increases in production without increases in energy consumption. In the final 10 years, between 1990 and 2000, steel output will increase by 25 million tons and energy consumption will increase by only 24 million tons of standard coal. If this program is carried out, by the end of the century steel output will have doubled, and total energy consumption will have increased by only about a third. Therefore, two-thirds of the energy required to double steel output will come from utilization of existing energy potential and decreased energy consumption.

The principal approaches and measures by which the iron and steel industry will conserve energy in order to realize its objectives are as follows.

1. Continuing to intensify energy management and make a vigorous effort in basic energy conservation work.

We must further establish and improve the energy management system. We must link energy management closely with enterprise management and the economic responsibility system and include energy consumption indices among the evaluation indices, strengthen quota management, and tighten up shift and crew accounting.

We must strive to do effective energy resource measurement work. Currently measurement work in the iron and steel industry remains a glaring weak link, as particularly manifested in a low rate of installation of meters, a low rate of measurement, and poor accuracy. Before the end of 1984, the enterprises which consume 50,000 tons or more of standard coal a year must have a full complement of measuring equipment and manage it effectively; enterprises which consume 10,000 tons or more of standard coal a year must have a complement of measuring equipment by the end of 1985. During 1983, all enterprises must have a full complement of the "three meters" used by the public; they must eliminate the guaranteed operating expenses system and institute fees based on measured amounts. All measuring equipment must be centrally managed, and maintenance must be stepped up so that it operates normally and measures correctly. Instances of "eating from the large rice pot" must be overcome.

We must continue effective enterprise heat balance work. Since 1978 we have drafted enterprise heat balance tables, have adhered to the quarterly and annual reporting system, have made timely analyses of the quality of the enterprises' energy resource procurement and consumption and the levels of consumption in the main processes and equipment, and have found untapped potential for energy conservation and taken the requisite steps. We must vigorously carry out heat balance measurements on equipment. Since 1982, we have organized and drafted 10 temporary metallurgical furnace and kiln heat balance determination regulations for hot blast stoves, coke ovens, open-hearth furnaces, converters, electric furnaces, heating furnaces, soaking pits, heat treatment furnaces, boilers and refractories and have issued them to the enterprises for trial implementation and thorough heat balance determination work with furnaces and kilns. We must carry on energy-conservation upgrading of equipment and processes. Since 1979 we have drafted energy conservation regulations for such key energy-consuming processes as rolling mill heating furnaces, open hearth furnaces, electric furnaces, converters, breakdown rolling, coking, sintering, ironmaking, and refractories. Clear regulations were provided for management, operation, processes, equipment and energy conservation guidelines; the energy consumption indicators that the various processes and equipment can attain were classified as Superior, Class 1, Class 2, Class 3 and Unclassified, and energy-conservation upgrading activities were undertaken in the enterprises. This motivated the enterprises to conserve energy, made use of technical personnel and promoted technical modernization for energy conservation.

We must energetically pursue technical training in energy conservation. This may be carried out centrally by the ministry or may be run by the province and municipality metallurgical bureaus or by the enterprises themselves in order to strengthen the imparting of energy conservation knowledge to enterprise leadership cadres and operating personnel in pursuit of better energy conservation work.

2. Readjust Product Structure and Enterprise Structure

We must decrease the iron-to-steel ratio. Currently we used large amounts of foundry iron, about 8 million tons a year or 22 percent, and this makes the iron-to-steel ratio high; it was 1.024 in 1980 and 0.96 in 1981, while in the industrially developed countries it is about 0.7. In the future, we must systematically decrease the amount of foundry iron and lower the iron-to-steel ratio. The plan calls for a decrease to 0.92 in 1985 and to 0.85 by the end of the century. Using 1 ton less pig iron saves about 1 ton of standard coal.

Therefore, we must promote the replacement of iron by steel and decrease the number of cast iron products. Iron and steel enterprises must strive to decrease consumption of iron and steel materials, and in particular they must use more scrap steel and gradually raise the amount of steel used in converters to at least 15 percent, the amount used in open-hearth furnaces to at least 50 percent, and the amount used in electric furnaces to at least 90 percent.

In addition, we must gradually expand the proportion of continuous casting. The continuous casting rate was 6.6 percent in 1980 and 7.6 percent in 1981, while in the industrially developed countries it is about 80 percent. In the future we must strive to utilize continuous casting technology and gradually increase the number of continuous casting machines. Currently, the small continuous casting machine imported by the Kunming Steel Works and the small reverse-engineered continuous casting unit at the Handan Steel Works have gone into operation, and this year 15 more units will be set up. In the future we must also build a group of large continuous casting machines and gradually raise our continuous casting rate, achieving 13 percent by 1985 and 50 percent by the end of the century. Continuous casting instead of mold casting saves 30-70 kg of standard coal of per ton of semifinished product, while the finished product rate is increased by 6-10 percent and production costs decrease by 30-60 yuan per ton; quality is also improved.

As regards the internal structure of enterprises, we have many irrational situations such as steelmaking without ironmaking, ironmaking without steelmaking, exclusive rolling of steel, and integrated enterprises without complete complements of equipment. As a result, every year we produce 7 million tons of steel in cupola furnaces, ship 3 million tons of semifinished product to other locations for rolling into finished product, and subject more than 500 tons of steel to multiple dogging operations or multiple heating before obtaining a finished product. This results in a great deal of waste. In the future we must gradually correct this state of affairs and strive to develop small-scale continuous casting, abandon intermediate cogging and changeover from multiple heatings to a single heating in producing finished products. We must gradually make the enterprises acquire complete sets of facilities and decrease the shipping of semiproducts for rolling into finished products; and by the end of the century we must essentially eliminate steelmaking in cupola furnaces.

3. Actively Adopt New Technologies and Modernize Outmoded Processes and Equipment

In the future, the iron and steel industry's energy conservation must be based primarily on technical progress, and it must actively adopt new technologies and new processes and modernize old equipment. We must vigorously disseminate and popularize mature domestic and foreign advanced energy-saving technologies. At present we must focus on disseminating a large number of new technologies and processes such as the sintering of starting materials, high-alkalinity sintering of ores, step-by-step charging of large batches of material in blast furnaces, three-lance oxygen injection in open hearth furnaces to save oil [as published], continuous casting, higher temperatures of hot ingots, and energy-conservation modernization of kilns and furnaces. We are preparing to collect these effective energy-saving technologies and experiences in book form, and some of them will be included in the relevant technical regulations and management systems.

We must gradually modernize high-energy-consumption kilns and furnaces and motive power equipment. The energy consumption of metallurgical kilns and furnaces accounts for about 70 percent of the total energy consumption in the iron and steel industry, and in the future the focus of energy conservation must remain on them. During the Sixth 5-Year Plan we must make a major effort in energy-conserving technical modernization of kilns and furnaces; according to plan, we must modernize 160 heating furnace and soaking pits so that the number of outstanding class furnaces is increased from the current 20 percent to 40 percent and the annual average heat efficiency increases from the current 30 percent to 40 percent. We must resolutely eliminate substantial furnaces. Other kilns and furnaces must be upgraded as rapidly as possible. We must gradually phase out high-energy-consumption side-blown converters and local sintering processes, modernize low-efficiency boilers, and renovate high-energy-consumption motive power equipment in order to improve energy use efficiency.

4. Decrease Motive Power Consumption, Thoroughly Utilize Secondary Energy Resources

Currently coal gas emissions from blast furnaces, coke furnaces and converters are equivalent to 800,000 tons of standard coal a year; we must take vigorous steps to decrease these emissions. By 1985 the blast furnace coal gas emission rate must be decreased from the current 12 percent to 5 percent or less; the figure for coke ovens must be decreased from the current 6 percent to 2 percent or less; and in the case of converters, with the exception of a few enterprises where coal gas is now being recovered, such as the Shanghai No 1 Plant, the Sanming Iron and Steel Works and the like, steps must be taken to recover most of the emissions. By 1990 the problem of coal gas emissions from blast furnaces, coke ovens and converters must be essentially solved.

We must strive to decrease the consumption of motive power produced by water, electricity, wind, and steam.

We must make a large-scale effort to utilize waste heat. The iron and steel industry has abundant waste heat; surveys indicate that the usable heat in key enterprises is equivalent to 5 million tons of standard coal, only about 25 percent of which is now utilized. In the future, we must make major efforts in this area. Currently there are four main waste heat utilization methods; production of stem for production and domestic use; use of waste heat to generate electricity; use of waste hot water for civilian heating; and use of air in preheating stoves as a combustion booster in order to save fuel.

5. Scientific Organization of Production, Implementation of Economic Operation

Scientific organization of production, rational operation and shutting down of equipment, and implementation of economic operation have a direct effect on energy conservation; there is great potential for energy conservation in these measures. We should arrange our plans and organize production from an energy standpoint. We must persistently determine output in terms of energy and determine the number of furnaces in terms of output. We must strive to increase the equipment serviceability rate, and effective functioning rate and average hourly output and overcome the practices of "using a large horse to pull a small cart" and letting having energy using equipment idle, burn empty or operate at half load. Enterprises with insufficient work and incomplete utilization of capacity must pay particular attention to concentrating production, using their furnaces rationally, and increasing the effective utilization of energy-consuming equipment.

6. We Must Study and Implement Rational Energy Conservation Policies

Drafting and implementing rational energy conservation policies is the key to future large-scale decreases in energy consumption in the iron and steel industry. Some of the current energy policies, such as energy supply policy, energy conservation awards policy and energy conservation technology policy, are not conducive to energy conservation and objectively lead to "an imbalance between pains and pleasure" and "whipping the faster ox," thus leading to "putting the pacesetters in a difficult position" and "making things easy for the laggards," which hinders the thorough development of energy conservation. We suggest that the policy of energy performance contracting and conservation implemented down to the individual be instituted as rapidly as possible, along with a rational energy conservation awards and penalties system, in order to thoroughly motivate the enterprises and employees to practice conservation.

Like any other work, effective energy conservation work in the iron and steel industry depends on both policy and technology. We will conscientiously implement the spirit of the 12th party congress and will make the necessary contribution to the creation of a new situation throughout the iron and steel industry and to China's socialist modernization.

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OIL CONSERVATION STRATEGIES OUTLINED

Beijing NENG YUAN [JOURNAL OF ENERGY] in Chinese No 3, 25 Jun 83 pp 1-4

[Article by Tong Yihao [4547 0110 6275], Beijing Petroleum Design Academy: "An Investigation Into the Effective Use of 100 Million Tons of Petroleum"]

[Text] In 1981, China's petroleum refineries received an average of 100 yuan per ton of crude oil processed (including taxes paid to the higher levels and enterprise profits), while the figure was somewhat higher for petrochemical and chemical fiber enterprises. But if we make a calculation based on international market prices for crude oil and oil products, most of the petroleum refineries and petrochemical and chemical fiber plants lost money. It is only because China's crude oil prices are low, its finished petroleum product prices are high, and its prices for petrochemical products and chemical fibers are higher yet that this contradiction was covered up. In these terms, the value created by 100 million tons of oil in China is much less than that created in the industrially developed countries. The main reasons are discussed below.

I. Too much oil is burned, decreasing the amount of deep processing by oil refineries.

The depth of petroleum processing in China is insufficient. According to statistics, in 1981 the product yield for such products as gasoline, kerosene, diesel oil, lubricating oil and light chemical engineering oil in the country's oil refineries was 52.22 percent, 6.42 percent lower than during the First 5-Year Plan period. Calculated in terms of the amount of crude oil processed in 1981, this is equivalent to a decrease of 4.5 million tons in the production of light oil products, so that the nation received several billion yuan less. The main reason is that there are demanding requirements for the burning of oil, which make it necessary for the refineries to produce larger amounts of heavy oil and limits deep processing. in 1981, the country burned a total of more than 33 million tons of oil (including about 25 million tons of heavy oil), half of which was used in electric power stations, while another third was used in industrial boilers, furnaces, kilns and the like. If two-thirds of this quantity had been replaced by coal and the petroleum thus freed up had been used for export, the country could have had a net increase of about $2 billion in earnings.

II. Petroleum processing has not been organized in terms of marketing requirements, which has necessitated long-distance transport of large amounts of finished petroleum products.

According to 1981 marketing and oil refinery output statistics on the production and sales balance of such major petroleum products as gasoline, kerosene, diesel oil and lubricating oil in the major regions, in the Northeast output was 4.9 times requirements, while in the Southwest requirements were almost entirely met by shipments from elsewhere. The reason why oil refining output in the Northeast was so large, other than historical factors, was the large oil consumption in that region. The Northeast burns 37.6 percent of all oil burned in the country, and in order to meet its needs it has had to increase its refining capacity; the result is that more than 9 million tons of finished petroleum products are shipped elsewhere. Half of this amount must be shipped into the remainder of China via the Beijing-Shenyang line, and if it is being transported to the Southwest, it must also be carried on the Beijing-Guangzhou, Longhai, Baocheng and other trunk lines. This long-distance haulage not only increases expenditures and wastes oil products, but in addition it takes up rail transport capacity and hinders the shipping into the Northeast of the coal which it needs to replace oil. If the crude oil refining capacity of the Northeast were gradually decreased and if current abundant pipeline and water transport capabilities were thoroughly used to increase the oil available to several refineries in the Central South region, in overall terms no harm would be done to state financial revenues, while it would become easier to ship in the coal which the Northeast needs and to speed the pace of replacement of oil by coal.

III. Petrochemistry and chemical fibers enterprises start with crude oil, so that their utilization rate is low and comprehensive utilization is poor.

Many of China's petrochemical and chemical fiber plants start with crude oil, and the crude oil utilization rate and the degree of comprehensive utilization are both poor, so that economic results are limited. For example, the Lanhua Corporation uses a sand furnace to produce ethylene, requiring 8.4 tons of crude oil for every ton of ethylene produced, at a cost of more than 1,200 yuan, while the Yanshan Corporation uses 4 tons of light diesel oil per ton of ethylene produced, at a cost of about 860 yuan. The Jinshan and Liaoyang chemical fiber plants are both primarily producers of chemical fibers, and they require as a raw material only a small part of the light fraction of crude oil; if this were supplied by an oil refinery, not only would it be possible to save duplicated construction expenditures, but in addition it would make possible comprehensive utilization and organization in terms of an overall plan, which would improve economic results.

IV. Not all of the advantages of crude oil have been utilized, and it has not been possible to develop rational processing flowcharts.

Some of the types of petroleum which are already being extracted in China have very special characteristics. For example, the low-solidification-point crude oil from Karamay and Dagangyangsanmu in Xinjiang can be used to produce low-solidification-point diesel oil and lubricating oil without dewaxing; Xinglongtai crude oil and light oil from Liaoning has considerable aromatic hydrocarbon potential and should be used as a reforming feedstock for their production; the Shengli oilfield is capable of producing large amounts of aviation kerosene and superior-quality asphalt; the light oil from the Daqing oilfield is a good feedstock for cracking, while the diesel oil from Daqing has a good cetane number and its lubricating oil has high viscosity; Weigang crude oil from the Nanyang oilfield is a good starting material for the production of high-dropping-point ozocerite wax; the light fraction from the Donghan oilfield is of good quality, and so on. If the special characteristics of these crude oils were thoroughly utilized, optimal flowcharts were developed, and they were processed in special refineries, it would be possible to decrease production costs, improve quality and increase economic results. But many crude oils are mixed together indiscriminately for transport and refining, which has limited utilization of these special oils and has wasted resources.

V. Processing is dispersed, which increases losses and wastes energy.

In 1981, the use of capacity was 73 percent in the large petroleum refineries and petrochemical and chemical fiber plants (capacities over 1 million tons) which were included in the state plan; the rate was 69 percent in the case of the medium-sized (100,000 to 990,000 tons) plants and was somewhat lower for small plants. If we made adjustments by region or by province and municipality, if the medium- and small-sized plants with a low crude oil utilization rate and poor economic results were closed, merged or converted to other production, and if the large production assignments of the large petroleum refineries with relatively complete processing facilities and relatively good economic performance were increased somewhat, not only would energy consumption be decreased, but it would be possible to provide the country with more petroleum products and better economic results.

VI. Our technical level is low.

This circumstance shows up primarily as follows.

A. Relatively high energy consumption. According to statistics, the unit energy factor consumption (this is a method of calculating energy consumption which corrects for the different degrees of complexity of processing equipment in different refineries and is relatively reliable) in China's petroleum refineries was about 260,000 kcal, 10-15 percent higher than foreign levels. In the case of ordinary reduced-pressure distilling equipment, for example, the 1981 national average energy consumption per ton of crude oil was 200,000 kcal, 17 percent higher than abroad. In the case of ethylene equipment, the medium- and small-sized tube furnaces which we built ourselves in the 1960's mostly consume 20 million kcal to produce 1 ton of ethylene, while the 300,000-ton capacity light oil crackers which we imported in the 1970's to produce ethylene have a unit consumption of 8.5 million kcal; late 1970's new-design foreign equipment has decreased the figure to 6.1 million kcal. In the case of high-pressure polyethylene, the tube process equipment which we imported in the early 1970's consumes 1,691 kWh of electricity per ton, while the late 1970's imported equipment consumes only 1,060 kWh per ton, a decrease of 40 percent; the low-pressure, low-density polyethylene method recently developed abroad uses a pressure of only about 10 kg rather than 2,000 kg, and energy costs are decreased by 75 percent.

B. High materials consumption. In the case of ethylene glycol, the oxygen oxidation (S, D) process equipment which we imported in the early 1970's consumes 0.738 tons of ethylene and 1.022 tons of oxygen for each ton of ethylene glycol produced, while abroad the consumption in the use of the S, D process has been decreased to 0.663 tons of ethylene and 0.809 tons of oxygen per ton of ethylene glycol. Thus, equipment with a capacity of 60,000 tons of ethylene glycol per year would save 4,500 tons of ethylene and would decrease oxygen consumption by 20 percent and save 20 percent on energy. In the production of butadiene by oxidative dehydrogenation of butylene, domestic butylene consumption is 1.7 tons, while the foreign advanced level is 1.15 tons. Adding to this the limitations of the separation method, we are capable of using only half of the domestic cis-butyl rubber capacity. The 8-ton polypropylene equipment which the Yanshan Corporation in Beijing imported from the Mitsui Corporation in Japan in the early 1960's has a unit propylene consumption of 1.14 tons. Several years have passed, and Mitsui has improved the process, so that now the propylene consumption rate is only 1.015 tons. If the Yanshan Corporation's unit consumption could be brought down to the international level, the raw material saved every year could be used to produce an additional 10,000 tons of polypropylene.

C. Few varieties, poor product quality. In 1978 the octane number of regular automotive gasoline used abroad was 80-85, and that of premium gasoline was 85-90. The octane number of our regular gasoline is currently 70 and that of premium gasoline is 80-85. If the octane number of regular automotive gasoline was increased by 10 points, it would be possible to save 8 to 10 percent on gasoline every year. In 1981, we exported 1.31 million tons of gasoline, mostly with an octane number of 80, and foreign companies used it as a blending component. If the octane number of all of this imported gasoline was increased to 80-85, we would be able to earn an additional $15 million.

The above are China's main current problems in utilizing its 100 million tons of crude oil. How can we make this 100 million tons of oil yield the maximum economic results? First, we must increase our understanding of the importance of petroleum resources; second, we must restructure the system and gradually readjust our economic policy; third, we must rely on scientific and technical progress to increase deep processing and comprehensive utilization in petroleum refineries and petrochemical plants.

China has relatively abundant conventional energy resources. But proved reserves of petroleum are two orders of magnitude smaller than those of coal, while current petroleum reserves cannot keep pace. Much hope is placed in offsohre oil, but offshore exploration and development require large investments and take a long time, and joint development with foreign companies requires that we give them a percentage of output as well as compensation. Therefore, even in the Seventh 5-Year Plan we cannot hope for a large increase in China's petroleum output. We must thoroughly cherish and husband our petroleum resources, and refine as much of our petroleum as possible into fuel for internal combustion engines and jet engines, lubricating oil, ozocerite, asphalt, the three major synthetics (plastics, rubber and synthetic fibers) and other petrochemical products. Based on our real energy circumstances, we must develop a correct, long-term stable energy policy.

Second, we must restructure the system and readjust economic policy. Currently, the refineries, petrochemical plants and chemical fiber plants using petroleum as a raw material are in different systems: some are subordinate to the Ministry of Petroleum, some are subordinate to other central ministries and some enterprises have dual leadership, with the local role primary. Because the enterprises are under different types of leadership and because the state requires the provinces' financial organs to contract for payments to the higher levels, while refineries earn rather high profits, the various provinces (particularly those with many refineries) must request the state to fix the amounts of crude oil they process, which makes it very difficult to carry out readjustment based on the objective of increasing the economic results of every branch. Therefore, we must reform the current system by breaking down the barriers between departments, areas and branches and organizing a special petroleum processing corporation responsible to the State Council, which will make it possible to rationally distribute petroleum resources in terms of the existing petroleum refining base and the different characteristics of crude oils and with reference to petroleum transport flows, finished petroleum product transport conditions, and regional needs for petroleum products; in addition we must give unified consideration to the comprehensive utilization of the oil refining, petrochemical and chemical fiber industries, close, temporarily shut down, merge or convert the production of certain enterprises which do not use resources efficiently and which produce poor economic results, and reorganize and readjust existing enterprises in order to improve overall economic results.

Readjustment of economic policy refers primarily to readjustment of price and tax policy and foreign trade policy. There are currently many problems with our petroleum and petroleum products prices; in particular, our crude oil prices are too low, our gasoline and diesel oil price differential is too high, and the prices of liquid petroleum gas, heavy oil and asphalt are too low, which seriously harms state accumulation, oil conservation and the production of certain short-supply products. Therefore, it is time we resolved to correct the situation.

1. We must increase crude oil prices by about half, or the state must collect an energy tax from enterprises which use crude oil. The objective of this approach is to increase payments to the higher levels made by oilfields and decrease the profits of crude oil refining enterprises. The advantage of the approach is that state revenues will be increased, which will increase the funds available for oil prospecting and development. It will encourage refineries and petrochemical and chemical fiber plants to pay more attention to energy conservation, actively adopt new technologies, effectively institute deep processing and comprehensive utilization, decrease energy consumption and decrease production costs in order to increase profits.

2. We must raise the price of diesel oil. The price of diesel oil should be raised from the current level of 40 percent of the price of gasoline to about 80 percent of the price of gasoline, which will bring it more in line with the production costs of refining gasoline and diesel oil and will promote its conservation.

3. After summarizing the experience of collection of the oil-burning tax, the tax per ton should be increased by 20-30 yuan per ton burned, or cumulative taxes should be imposed on enterprises which do not complete replacement of oil by coal in accordance with plan, and economic measures should be taken to promote accelerated replacement of oil by coal.

4. We should raise the price of liquefied petroleum gas. In 1981 the refineries produced about 1.15 million tons of liquefied petroleum gas, of which less than a third has been comprehensively utilized, while the rest was burned. In order to use economic methods to encourage comprehensive utilization, we must raise the price of liquefied petroleum gas.

5. We should raise the price of asphalt. The price of asphalt is currently too low, and accordingly the enterprises do not have much enthusiasm about producing it; every year they produce 700,000 tons of road asphalt, which meets only half of urban construction needs, and there is virtually no distribution for highway construction. According to experiments by the relevant units, highway surfacing has a major bearing on vehicle gasoline savings; when vehicles are operated on macadamized roads they generally save 10-20 or 20-30 percent on gas compared with operation on sand and gravel roads. According to calculations, use of 1 ton of asphalt for highway repair would have saved 2 tons of gasoline. Therefore, on the current basis it would be rational to double the price of asphalt.

In foreign trade policy, we must gradually change over from export of crude oil to export of oil products, and then to export of finished petrochemical and chemical-fiber products in order to promote the development of the national economy and bring greater economic results into play.

The Ministry of Petroleum has made calculations for a program of decreasing the export of crude oil and processing 90 percent of crude oil domestically. This would make full use of existing petroleum refineries, comprehensive utilization by petrochemical and chemical fiber plants could develop considerably, and total state earnings could be increased by more than 11 billion yuan, while foreign trade earnings from crude oil and oil products would still be increased by $1 billion over the 1981 level.

In connection with readjustment of foreign trade policy, in order to speed up the replacement of oil by coal, the state should issue such regulations as giving the use of coal to replace oil in boilers priority over its export, not permitting provinces which burn large amounts of oil to export coal and the like, which would promote rational, effective, economical utilization of resources.

Third, we must rely on scientific and technical progress. To deal with the problems insufficient deep processing and poor comprehensive utilization which hinder the effective utilization of our 100 million tons of petroleum, and in connection with the needs of major technical modernization and capital construction in older enterprises, we suggest that the following topics be made main topics for key efforts.

1. Catalytic cracking of normal-pressure residue oil. Catalytic cracking of normal-pressure residue oil is a major way of increasing the yield of light oil; its industrial application abroad has already produced major results. In China, Daqing's normal-pressure residue oil has low residual carbon and low heavy metal content, and small-scale tests have shown that provided that suitable catalysis and new processes and equipment are used, this technique would be practicable. When this new technology was mastered, the light oil yield could be increased from 53 percent to 81 percent. Processing of 1 million tons of Daqing crude oil would increase the output of gasoline by 160,000 tons, the output of light diesel by 120,000 tons, the output of liquefied petroleum gas by 35,000 tons, and the profit per ton of crude oil by 107 yuan. This is a deep oil processing approach which requires relatively low investment and relatively low processing expenditures, while it gives a relatively high light oil yield rate, and output value and economic results are rather high; as replacement of oil combustion by coal combustion progresses, it would be possible to use the process more widely.

2. Development of superior quality acicular petroleum coke. This is a new raw material for the carbon industry, and the large-size super-high-power electrodes produced from it can be used in steel refining and can cut the time required for electric-furnace steelmaking by about half, while saving about 150 kWh per ton of steel, thus producing considerable economic results. In 1980, China imported it at $685 per ton, while imported electrodes made from it cost more than $2,000 per ton. Now Chongqing pyrolitic residue oil (made by the extended coking process) has been used to make acicular coke in pilot production tests. Based on estimates of domestic requirements, every year the refineries could earn an additional 29 million yuan in profits, while the state could save $30 million in foreign exchange.

3. Production and utilization of methyl t-butyl ether. Methyl t-butyl ether is a component of unleaded high-octane gasoline produced from the C_4 fraction of liquefied petroleum gas; it is also used in the main process of separating isobutylene for the production of butyl rubber and isopentyl rubber. Small-scale tests have already been conducted and expansion to production scale is underway. Based on the refineries' liquefied petroleum gas capabilities, if five sets of equipment (each with an annual capacity of 20,000 tons) were built by 1990, alkylated oils and catalytically cracked oils produced by continuous alkylation equipment could be used to blend more than 500,000 tons of 85-octane unleaded gasoline. If this were used domestically it could save 10-12 percent on gasoline compared with the current 70-octane products, while if used for export it could produce earnings of nearly $200 million.

4. Development of polypropylene apparatus. Polypropylene is a plastic with extensive uses, China currently produces about 150,000 tons a year and imports about 80,000 tons. If the propylene which we currently produce as a byproduct of ethylene manufacture were thoroughly utilized and in addition a third of the propylene produced by oil refinery catalytic crackers were used, we could double the output of polypropylene and increase output value by 440 million yuan and earnings by nearly 200 million yuan. There are two ways of doubling polypropylene output. One is to modernize and improve the 1,000-ton level intermittent benti [2609 7555] process polypropylene equipment using catalyst

No II. This is small-size equipment which is suited for thorough utilization of dispersed propylene resources. An installation capable of producing 2,000 tons a year requires an investment of 600,000 yuan, while its annual output value may be as high as 5 million yuan and earnings may be as high as 1.8 million, which is suitable for widespread use in refineries. The second possibility is to construct high-efficiency carrier-catalyst 10,000-ton continuous benti process polypropylene installations, which are suitable for use in enterprises with relatively large propylene resources; we must first construct pilot commercial facilities, then gradually disseminate them.

5. Oxidative dehydrogenation of butylene to produce butadiene. This is a process which was developed here as early as the 1960's. Butadiene is an important material for synthetic rubber, and accordingly this technology has been very important in developing our synthetic rubber production. But our oxidative dehydrogenation technology is inferior to advanced foreign processes, giving a low yield of butadiene, producing large amounts of organic acids and involving difficult waste management problems, with the result that two-thirds of the 60,000-ton capacity already built has been shut down. Recently a new nonchromium-containing ion-system catalyst has been developed; it has a low unit consumption of butylene and will give a third more butadiene from the same amount of raw materials, while decreasing production costs by 30 percent and thoroughly solving the problem of environmental pollution. If existing apparatus were put into wider use, it could increase butadiene production by 29,000 tons, equivalent to saving of the investment in two new installations and nearly 80 million yuan for waste management, and every year it would increase profits by 43.2 million yuan; thus its economic effect would be very considerable.

6. Separation and comprehensive utilization of the C_5 fraction from cracking. An ethylene facility with an annual capacity of 300,000 tons produces about 55,000 tons of C_5 fraction as a byproduct, which has a value of only 16.7 million yuan as a fuel. If a separation facility were built, it would be possible to separate 8,000 tons of isopentadiene (usable in isopentane rubber), 7,000-8,500 tons of pentadiene-(1,3), usable to make asphalt for macadam roads, and 5,000-6,500 tons of cyclopentadiene (which can be used as a third monomer for ethylene-propylene rubber or in high-specific-gravity aviation kerosene), and its output value could be increased to 33.8 million yuan, with profits of 14 million yuan, so that the investment in the separator could be recovered in only a year. If the separated isopentadiene were used for a synthetic isopentene rubber installation, it would yield a profit of 28-30 million yuan per year.

To summarize, effective pursuit of deep processing and comprehensive utilization in existing refineries, petrochemical plants and chemical fiber plants should be the main focus of effective use of our 100 million tons of petroleum; this will greatly increase economic results.

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