THE COAL AND MINERAL RESOURCES

OF

SHANSI PROVINCE, CHINA

ANALYTICALLY EXAMINED

BY

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1912
[112373]

山西省全圖

MAP OF SHANSI PROVINCE
N. CHINA

一之分萬十七百二度尺

50 0 100 200 里

20 0 10 20 30 40 50 60 Miles (Engl.)

Note: *The location of the circles, indicating samples, are sometimes, by insufficient information, approximate only. Then the circles are put as near as possible to the respective district only.*

Samples of
- *Coal marked*
- *Iron Ore*
- *Copper Ore*
- *Lead & Silver*
- *Pyrites*
- *Heavy Spar, Gypsum*
- *Marble & cet.*

If minerals are known to exist but no sample has been obtained the circle is left empty.

MONGOLIA

SHENSI PROVINCE

CHIHLI PROVINCE

HONAN PROVINCE

Railway (Working)

Railway under Construction

Prop. steamer Route on the Yellow River

Yellow River

Great Wall

Frontiers

Prov. Rly.

Main Road

Mountain

Lake

Prov. River

Ordn.

記號 界國 界省道 長城 鐵道 鐵豫定 河 山脈 湖沙 國大道 縣道 府 縣 村

GEN. STAB. LIT. ANST. 1912.

Introduction.

Geography of Shansi.

Shansi is one of the most northern of the 18 provinces belonging to China proper. It lies in the bend of the Yellow River and forms the barrier of mountains which causes this watercourse to deviate from its normal easterly course in a right-angled southern direction. The western and southern boundaries are therefore naturally defined by this great river. The northern limits are less distinct; being practically the frontier between the newly colonized agricultural lands and the grassy prairies of Mongolia. Towards the east the frontier coincides roughly with the first range of hills which rise from the Chihli plain. The shape of this province is oblong or elliptical with a major axis running North and South, somewhat inclined towards N. E. and S. W. and with a length of 500 miles. The minor axis is somewhat less than half this figure. The capital city, Tai Yuan Fu, which is nearly the centre of the province, is 250 miles to the S. W. of Peking and can now be reached from thence by railway communication in a day. The minimum distance to the coast of the Yellow Sea is 170 miles. Except a few highly elevated plains, of which the T'ai Yuan is the most important (with dimensions: 30 and 100 miles), mountains are very largely preponderant and a typical view of the scenery is shown in Photo No. 1 — Flowing through the Tai Yuan plain and winding its way through the mountains towards the S. W. is the largest river in Shansi, the Fen-Ho, a tributary to the Yellow River.*

* The climate is distinctly continental with hot summers and cold winters; the extremes for Tai Yuan Fu being as a rule: — 10° F and + 100° F.

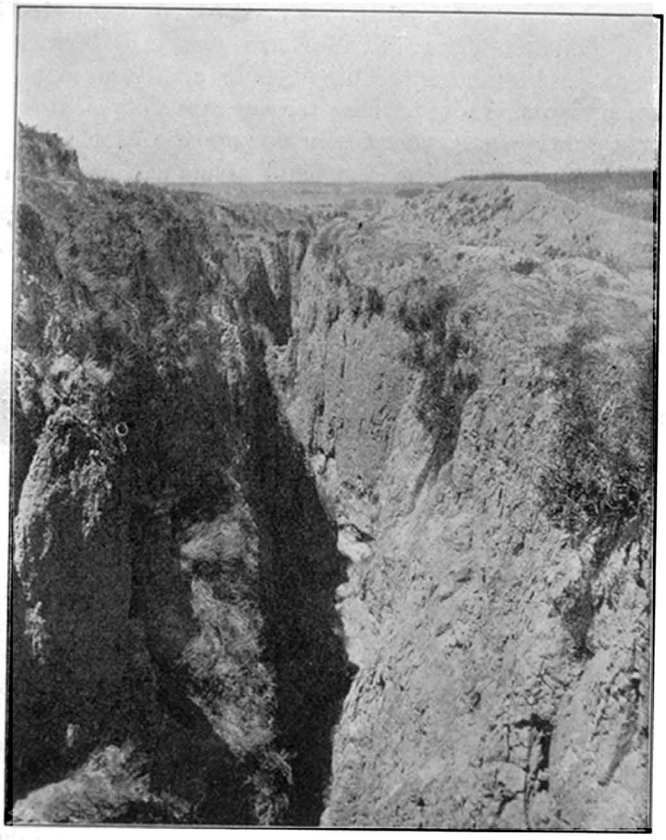
Characteristic View
over the mountains in Western Shansi. The archaic range in the distance.

The highest ridges rise to an elevation of over 10 000 feet, the greatest altitudes being found in the archaic formations 80 miles to the west of Tai Yuan Fu and among the geologically unique group of mountains called Wu Tai Shan, situated in the north-eastern part of Shansi.

The Loess Formation.

While describing the general nature of surface development in Shansi, it would be an omission not to mention a special characteristic, which gives a peculiar aspect to the scenery: that is the Huang T'u or Loess formation, which is met here in greater abundance than in most other provinces. It generally envelops the foot of every hill but can also occur at the very summit of the mountains. Its presence or absence has a marked influence not only on the general aspect of the landscape but also on the fertility of the soil and the higher or lower density of the population. Without this Loess and its beneficient influence, Shansi would be a forbidding, inhospitable, and uninhabited mass of crags and rocks.

The Loess is a brownish- yellow half petrified aggregation of fine sandy, calcareous particles, fairly cohesive, so that a hoe or pick-axe is necessary to dig it out; a spade is inadequate for that



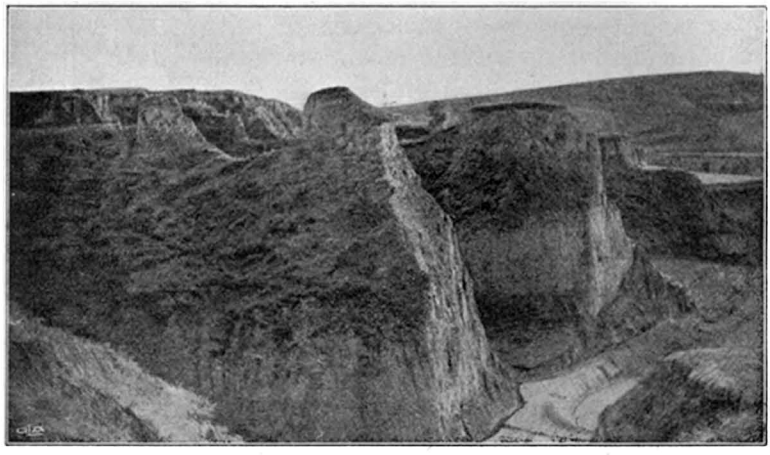
Loess Gulley
immediately E. of T'ai Yuan Fu.

purpose. It has a great tendency to vertical cleavage and forms spontaneously the most appalling fissures and precipices often 500 feet deep. By the lack of cohesive strength, the Loess is easily eroded and carried away by mountain streams, and during the rainy season it is easy to observe the destructive work actually being carried on. The torrent eats insidiously at the base of the high Loess cliff and suddenly the whole outer portion of the cliff is loosened by a vertical cleavage and, with thunderous noise, falls into the stream only to be quickly devoured by its untiring enemy.

The Loess, being very fertile, is almost always subjected to agricultural exploitation. The hillsides are cut into terraces, sometimes 30 or 40 one above the other, with a difference in level of five to twenty feet. Indeed, these terraces are so typical for Shansi that their absence would completely change the aspect of the land. Here, as elsewhere in China, the hand of man, through the work of countless generations, has had an influence on the surface development only surpassed in magnitude by the mighty agents of Nature herself.

Climate and Agriculture.

Although the fertility of the Loess soil is undoubted, it is a fact that the agriculturist of Shansi often views his fields with an



Loess Cliffs
at Shou Yong Shansi.

anxious eye. The low-lying rich land which can be irrigated by rivers and streams is so scarce that it constitutes perhaps less than one percent of the whole. The crops grown on the terraces are entirely dependent for their growth on the rainfall, a factor more unreliable here than elsewhere. The lamentable destruction of forests has carried in its train its own punishment, converting

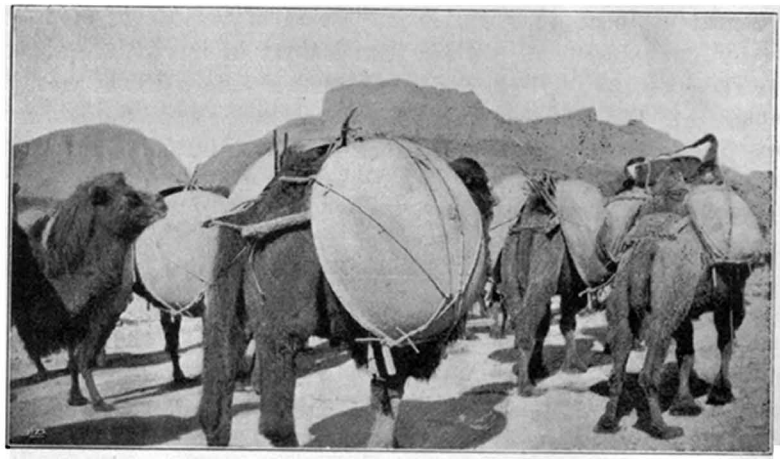
the climate into an undesirable succession of periods of arid heat, drought and dust, and sudden inundations of torrential rains. — It is only on the highest and most remote ridges to the west and northwest of Tai Yuan Fu that patches of wood some ten odd miles across have, by their very distance from civilisation, escaped the ruthless avidity of man.

Population.

On the fine, fertile plains and in the curious nooks and corners in the hills, there lives a population which according to the latest and very recent census numbers a trifle over ten millions. It stands to reason that this people, almost isolated as they are by their difficult access from other provinces, have developed characteristics peculiar to themselves. Other provincials call them grasping and avaricious, fond of money, "The Jews of China", but it is a fact that their comparative solidity, reliability, and financial acumen have gained for them the reputation of being the Bankers of the Empire and we find them in this capacity in the most distant parts of China. Could hereafter commercial confidence be established, and the great fortunes now hoarded by the wealthy bankers of Taiku, Chi Hsien, and Pingyao be put in general circulation, a brilliant future would indeed await this province.

Trade.

The trade of the province consists mainly in removing products from the climatically more favoured southern districts towards the north. Caravans of mules, donkeys, camels, and also trains of carts and human carriers convey a large amount of goods such as tobacco, wheat, flour, cotton, medicine, oil; and wine, salt, tea, and fruit such as grapes and pears also travel that way. The main export is Coal and Iron from the Eastern Anthracite Plateau down to the great plains of Chihli and Honan. The Shansi coal and iron is so famous that other parts of China — and shall we say the whole world — seem to know Shansi mainly by the huge quantities of coal and iron ore which are known to exist beneath its soil. — A far-reaching change in commercial conditions has of course been caused by the construction of the Cheng-Tai railway,



Shansi Iron being exported
by the time-honoured methods.

which taps the great Tai Yuan plain, runs right through the Anthracite and Iron district of Ping Ting Chou and from thence descends into the Chihli plain, joining tha Peking-Hankow line at Shih Chia Chuang. I shall further treat this new and all important progressive factor, let it suffice to say here that it has taken over a great deal of the coal- and iron-export and in these latter days even the grain traffic from the Tai Yuan plain.

Characteristics of the Shansi People.

Another curious kind of export not to be counted in tons and pounds is the annual departure of thousands of young men to take up their place in banking and other financial positions all over the Empire. We have already touched upon this important characteristic of the Shansi people. Although from an agricultural and industrial point of view this land is poor and the balance of export and import is unfavourable, still there is much capital hoarded up here, sent home by degrees by the thousand and one representatives abroad. The Shansi men ply their banking trade in Canton as well as in Mukden, in Shanghai as well as in Urga, Uliassutai, Dolon Nor, may, as far as in Turkestan, in Kaschgar.

Yarkand, Khotan. They are even active outside China. They are in Kiakta, Verknie—Udinsk, and Irkutsk. Yea, even in Moscow there is a large settlement of prosperous Chinese largely from Shansi. I have seen them in Siberian towns running the biggest shops in the place, I have seen men from Fen Chou Fu selling Russian goods to the Russians themselves, and it set me thinking to observe how, when some specially knotty problem arose, requiring some intelligence to solve, the simple-minded Russians went to the shrewd Chinaman for advice: he represented the brains in the village.

"The old Westerners" (Lao Hsi'erh) as runs their usual pet nick-name are a peaceful, law-abiding people. Except during the Boxer madness of 1900, outrages on the property or life of foreigners have rarely or never taken place. Their own officials they obey with a mixture of indulgent affection and reverence. There have been times when that loyalty has been put to severe tests. For example when the patriotic and capable governor TING PAO CHUAN, to the astonishment of the world, with drastic and sudden measures completely suppressed the growing of the Opium plant during the years 1908 and 1909, a matter affecting vitally the livelihood of hundreds of thousands of the people of Shansi. Except for a short-lived disturbance in the central poppy-growing district, the reform was accomplished, truly a portentous sign of the inherent strength of China.

Administration.

The province is administered by a committee having as its chairman the Governor as representative of the Emperor. The other members are the FAN TAI or Minister of Finance, the TI FA SSU or Minister of Justice, the TI HSÜEH SSU, or Minister of Education, the TAO TAI for Industries and Commerce, and the Police TAO TAI. For the purpose of administration the province is divided in counties and these sub-divided in districts. There are 9 Fu-cities, 10 primary Chou-cities, 6 secondary Chou-cities, 8 secondary Ting-cities, and 85 Hsien-cities. The officials of these latter districts come in direct contact with the people. They govern a piece of land roughly 100 li or 33 miles square with 100 000 inhabitants each. These Hsiens are the foundation of Chinese ruling organisation.

A result of the new Constitutional movement in China is the establishment of Provincial Assemblies in each province, the idea of which is to educate the people up to a complete parliamentary system. At present it is however only a kind of advisory council to the Governor. — It is composed of prominent representatives amongst the gentry and scholars from the whole province. Shansi is fortunate enough to have, in spite of its secluded position, quite a number of enlightened and progressive representatives, and the Chairman, Mr. LIANG SHAN CHI, is a statesman of uncommonly sound and liberal mind. — The Shansi Provincial Assembly has new and extensive buildings in the capital.

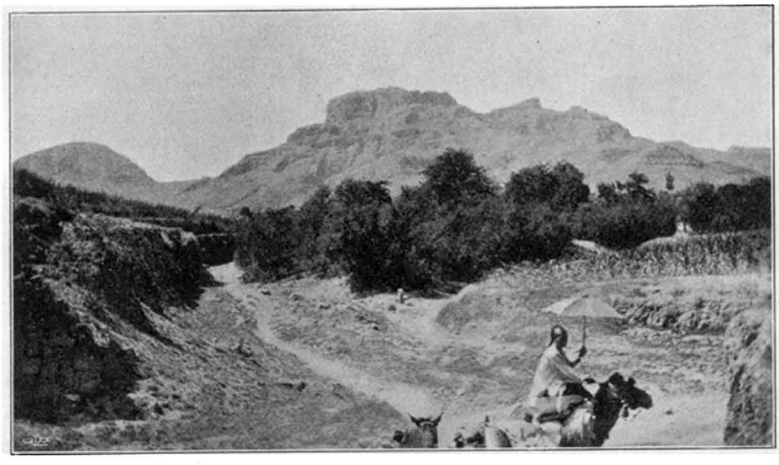
Geology of Shansi.

From the geography, population, and administration of Shansi we turn to a matter more intimately associated with the subject treated in our article, i. e. the Geology of this part of China. I have already mentioned what a dominating rôle mountains play in the surface configuration of Shansi and, in view of the fact that these mountains hide incalculable wealth of coal and minerals, it stands to reason that a knowledge of the geology of Shansi is a »sine qua non» for the intelligent understanding of the review in question.

It is a lucky coincidence that the geology of Shansi has in many parts been examined by such an authority as Baron FERDINAND VON RICHTHOFEN, whose classical work "China" reveals the master-mind of a genius. His original work will always be the foundation of all geological knowledge of Shansi. He visited this district in 1870, 71, and 72. Later there have been other investigators, who have added much information of interest such as Mr. J. G. H. GLASS, C. I. E., M. Inst. C. E., sent out by the Pekin Syndicate to examine their recently acquired concession (subsequently relinquished in the year 1907 by re-selling to China). This was in 1899. Then there was the Expedition sent out by the Carnegie Institution of Washington under Prof. BAILEY WILLIS, who with the aid of Messrs SARGENT and BLACKWELDER, during the years 1903 and 1904, made a very thorough examination of certain parts of Shansi. In 1908 and 1909 H. D. MARTIN, Esq. Mining Engineer, was deputed by the newly formed Pao Chin (Shansi Protection)

Mining Company to investigate and report upon coal and mineral deposits in various parts of the province. In our subsequent tables of analyses the samples collected by him will be marked Pao Chin No. —. But the larger part of the samples analysed have been collected by the efforts of the author and his students by an organised method to be explained in the next chapter.

I propose to begin with a general geological survey of Shansi with the characteristics of the various divisions and then give a specialised description of the different districts with items of interest regarding the mines and quantitative figures of the samples originating from them.



The Foot-Hills
of Shansi rising from the Chihli Plain.

RICHTHOFEN enumerates the following main divisions: He divides Shansi by a latitudinal line across the pass immediately north of the great Tai Yuan basin, i. e. slightly to the north of the middle of the province, and distinguishes to the south of this line the districts as below:

1) The Carboniferous Plateau covering practically the whole region, and 2) the geologically distinct and non-coal-bearing S. W. corner. The North he divides in 1) The district of faults in N. E. Shansi forming ranges of mountains running S. W.—N. E.

right into the province of Chihli, and 2) The Lias Plateau in the N. W.

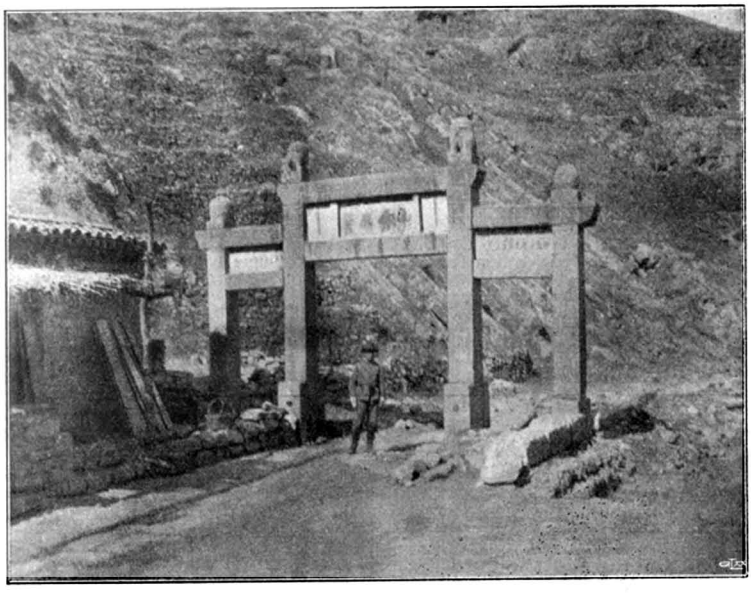
Quite apart from this classification we find in some places special geological formations such as the Wutai-Shan massive in the N. E. being composed of gneiss, sandstone, and a specially characteristic type of chlorite-schist, green in colour, together with much hornblende and serpentine, quite different from the normal geology of Shansi. RICHTHOFEN mentions also the archaic range that begins immediately S. of the Tai Yuan plain and follows the Fen Ho valley in its course towards the S. S. W. on its left shore. This monument of the oldest times, a veritable backbone of the

View towards the East
from the high archaic range in Western Shansi.

province, is named the Ho-Shan and is built up by a narrow gneiss and granite formation, rising to a height of 7 000 to 8 000 ft. RICHTHOFEN maintains that this is the only archaic range known by him in the southern plateau district. But I have found a similar range in the west between Fen Ho and the Yellow River. Mr. WEINMANN, Bergassessor, late Prof. of Peking University, who travelled lately over this country, confirms this statement, but adds that not one but two such ranges exist in the west. In is interesting to note that here as elsewhere the hardness of

these archaic rocks have protected the range from erosion to some degree, so that it rises far above the surrounding country. I have mentioned the highest point to the west of Tai Yuan. This is on the archaic range and has been measured by me (with aneroid) as 9 440 feet above sea-level.

To return to South Shansi, we propose to establish an imaginary section right across so as to get a clear conception of the strata. With surprising regularity there exists the following order upwards: On a basis of archaic rocks we find the following as a



The Monument,
marking the frontier between Chihli and Shansi.

characteristic and constantly occurring group: 1) "Kohlenkalk" (Limestone), then the 2) Carboniferous strata, above these the coal-free plateau-forming 3) Sandstone. It must be added that BAILEY WILLIS claims that there exists an unconformity between the former strata, establishing a break or hiatus consisting of the Later Ordovician, Silurian, Devonian and lower Carbonic periods. He claims therefore that the RICHTHOFEN term Sinian Limestone as

being "Kohlenkalk" is not correct because of this hiatus. For practical purposes it is enough to keep in mind the simple gradation of Limestone, Coal measures and Sandstone.

An apparent exception to this rule seems to exist in the south-east, where the great Anthracite field is situated. The upper sandstone is missing here. But on further investigation we find that this is the work of erosion by water, further west near the Ho Shan ridge the same action has been retarded, resulting in the elevation of the country to a new plateau, 5 000 to 6 000 ft above the sea, and consisting just of the regular sandstone which would be spread all over the southern part of Shansi but for the occasional strong erosion as exemplified above.

Other irregularities are of course the Granite and Gneiss ranges mentioned, the Ho Shan E. of Fen Ho and the one or two similar ones to the west. Then there is the enormous fault, bordering on the basin of Ping Yang Fu, which makes up the rocky wall called the Ngo-Shan which here follows the Fen Ho on its western side. This great fault by the break in the formations, which is of such a nature as to cause a depression of the strata on the Ping Yang plain, and a sudden elevation to the west by an almost vertical fissure, is of such dimensions that the difference between the same formations must be counted in thousands of feet.

The south-western Corner is also an exception in so far that the regular group of formations belonging to the coal plateau does not exist here. By a well-defined line following the Kuei Ho and the lower parts of the Fen Ho, this district is separated from the former strata. What we find here are the same old formations as in the N. E. The denudation however is very strong and the remains form rather low and gentle hills consisting of archaic rocks and crystalline slates etc. etc. As could be expected no carboniferous formations are found here, we are on the shore of the great coal ocean.

Regarding the geology of Northern Shansi, I have mentioned that RICHTHOFEN draws a dividing line immediately N. of the Tai Yuan basin. It is however pretty well certain that this line is by no means a straight one. Especially to the west, judging from our specimens analysed, it is more than probable that the carboniferous formations of S. Shansi continue here towards the north probably even so far as past Ning Wu Fu (see the map). I have

been told that in the So Ping Fu district there is no coal, and this would point to the said dividing line existing somewhere between Ning Wu and So Ping. Towards the east it is perfectly correct that the southern slope of Wu Tai Shan marks the separation of the two districts.

From the very farthest N. W. corner of the province I have also received specimens of coal and iron ore. In what formation these occur I am unable to state, having no geological facts from this region.

The ranges in the north-east have been examined by the same eminent authority quoted above. They consist of a gridiron shaped collection of ridges running from the S. W. to the N. E. They are built up of exceedingly ancient crystalline rocks, foremost of which is gneiss. They are of such an agé that the Cambrian period is the youngest represented.

Amongst these parallel ranges we find a special feature, in the form of a vast depression, resulting from a fault in the normal strata. This is the Ta T'ung plain, important because of holding in its basin the largest town in N. Shansi, i. e. Ta T'ung Fu, and also interesting because of the mines of excellent coal to be found within. I shall show analyses of this coal, which received a "mention honourable" already from RICHTHOFEN, because of its marked superiority.

Regarding the Wu-Tai-Shan massive, south of Ta T'ung, we have already pointed out the abnormal formations which make up this the highest mountain in Shansi.

It remains to deal with the north-west. In contrast to the very old ranges in the N. E. we find here a big plateau of normally stratified Jura sandstone. Nowhere in N. China do we find this young sediment formation in such deep and regular stratification. It is found under the bottom of the gulleys and rises about 2 000 ft above in nearly horizontal layers.

The Object of our Research-work.

I have so far tried to give a general review of the main geological features of Shansi. However necessary such a description may be to the subject in question, the reader will remark that nothing new has been added to the results of research of those

gone before. True, but it must be understood that the geological review must be considered as only an introduction to the chief point in view, that is a chemical examination of numerous specimens from a considerable number of places in Shansi. It is my belief that very little has been done in this direction; we have been told about the great extent of coal and mineral deposits here, but doubtless very few analyses have been made with the purpose of finding out the *quality* of those resources. In the year 1909 this idea occurred to me and being convinced that such research-work would be of considerable interest and, may be, practical value, I lost no time in evolving a scheme to have specimens collected, classified, and then analysed.

How the Samples of Minerals were Obtained.

The minerals were obtained in several ways. In the first place the Governor of the province, at that time H. E. PAO FEN, and subsequently H. E. TING PAO CHUAN were approached with a request to order the Hsien- or District Magistrates to have specimens from their resp. regions of jurisdiction sent in to me. Furthermore I put the matter before my own students in the Science Department and requested their co-operation in collecting minerals during their holidays, the University paying a certain sum towards travelling expenses. In the third place, several letters were written to missionaries in many different places, and these gentlemen kindly did their best, sending interesting specimens from distant and out-of-the-way places. Thanks are especially due to the Rev. A. TRÜDINGER, C. I. M., YI CHENG, and the Rev. ROBERT GILLIES, Ho Tsin, who sent not only coal and minerals but much valuable information besides. Finally, several specimens were collected by the author or his special messenger, as also by other travellers and explorers.

Objections in Principle to this Examination.

I am fully aware that there may be objections in principle to such a system as above, and this from two points of view. The remark lies near at hand: "How can it be certain that the specimen in question actually represents the quality of minerals in

that district?" The second is: "Without knowledge of the quantity of coal or mineral and the place where the specimen was collected how can a true idea of the practical value of the deposit in question be realized?" I am perfectly ready to admit that these are somewhat grave objections, but in China where the absence of a proper Geological Survey is painfully felt, one must certainly act upon the principle of "half a loaf" and besides, I tried to eliminate the error as much as possible by having several samples collected from neighbouring places. As regards the second objection, this certainly holds good in the matter of iron and other metalliferous minerals, but regarding the coal, these samples have almost always been gathered from mines and it is pretty well certain that the quantities they represent are well nigh inexhaustible. Besides we can safely put our faith in RICHTHOFEN'S statement that there is one great coal-field underlying the whole of Southern Shansi.

The majority of specimens were received in the Chem. Dept. of the University during the year 1910. The work of analysing was begun in the autumn of the same year, but minerals were coming in continually, the last being gathered in June 1911 and analysed immediately afterwards. It goes without saying that this work can never be considered complete, but ought to be continued for a permanency.

I propose to deal with the mineral resources of Shansi in the same way and in the same order as adopted for the geological description. We shall therefore begin with the south-eastern corner.

Mineral Districts Classified.

We remember that the geol. section across S. Shansi was from east to west: A precipitous wall of limestone 2 000 to 3 000 ft high rising from the Honan plain. Then the iron- and anthracite-carrying plateau continuing 50 miles to the west. Then a rise of 2 000 ft where the normal layer of sandstones largely hid the coal-measures (in some places these are accessible, when the erosion by the rivers has been exceptionally strong). Then farther to the west, the high granite range of Hoshan, the backbone of Shansi, then the valley of Fen Ho, then the great fault, building

the Ngo Shan ridge, then the same coal plateau as in the east but here carrying bituminous coal, then one or two archaic ranges, then coal plateau again, and ultimately the Yellow River.

The Anthracite Region.

To begin again from the east, RICHTHOFEN claims that the Anthracite Region continues right from Tse Chou Fu in the S. E. corner even as far as Yu Hsien in the north, just south of Wu Tai Shan. I think that an investigation of our analyses will not fully bear out this statement.

Supposing that we climb up from the Honan plain by the great high-road from Huai Ching Fu to Tse Chou Fu, we arrive after an arduous journey into a region famous from ancient time for its coal and iron-production.

We meet on the way literally tens of thousands of men and animals all conveying iron and anthracite down to Honan plain. I visited this important highway of commerce in 1904 and was impressed by the great quantity of goods conveyed in such extraordinary small units as by man or mule-load. The whole of the enormous incline was black with moving figures and looked exactly like those tracks which radiate from an ant-hill.

The lively city of Tse Chou Fu, which has been promoted from the rank of a »Hsien» to a »Fu», but still goes under its old name, Feng T'ai Hsien, is the centre of one of the great iron and coal producing districts in Shansi. I have been told that coal has actually been ploughed up on the fields and certainly the price of this commodity tells a tale. It sells for 0·8 cash per catty in the city, i. e. 2 s. per ton.

RICHTHOFEN describes the anthracite found here as follows: »Excellent Anthracite of great hardness and strength, with laminated structure, wholly black, partly conchoidal partly jagged fracture.» I read in my notebook the remarks on the sample from this region subjected to analysis, as follows: »Hard, and shiny like shoe-blacking, laminated and conchoidal fracture.» The coincidence of characteristics is evident.

The analysis of this sample of Feng T'ai Coal is as follows.

Analyses of Coal Specimens from the »Anthracite Region» and Special Information regarding this Region.

Coal No. 1.

Outward properties as above.

Moisture	2·13 %
Volatile Hydrocarbons	9·20 »
Total Volatile	11·33 »
Coke	88·67 »
Ash	8·80 »
Fixed Carbon	79·87 »
Sulphur	0·57 »
Calorific Value (Goutal's formula)	7 954

The analysis shows an anthracite of somewhat gaseous nature with a fairly high percentage of ash.

Another sample, the analysis of which is to be found in Mr. GLASS' report for the Pekin Syndicate, and was performed by Messrs PATTINSON & STEAD, shows the following figures:

Coal No. 2.

Moisture	2·86 %
Total Volatile	8·31 »
Coke	91·69 »
Ash	12·04 »
Sulphur	0·35 »

The place of origin was not specified, but the district is the same.

If we proceed further west, we encounter other mines half-way between Ch'in Shui and Yang Ch'eng Hsien (vide map).

A sample of coal from here was supplied by the Rev. A. Trüdinger and analysed by the student KUO-HSIEN-I as below. It is locally called T'an or Lump Coal and is used by the blacksmiths in their forges.

Coal No. 3.

Anthracite, does not smudge. Bright, hard appearance, very strong and compact. Pure black, high lustre, brilliant, very few grey and brown surface colours. Analysis:

Moisture	3·5 %
Volatile Hydrocarbons	8·66 »
Total Volatile	12·16 »
Coke	87·84 »
Ash (yellowish grey)	13·50 »
Fixed Carbon	74·34 »
Sulphur	0·35 »
Calorific Value	7 569

This shows a less favourable quality with a high percentage of ash.

I have also received specimens from the east part of this district, viz. from Lin Ch'üan Hsien (see map). This analysis was made by myself and shows a coal somewhat similar in quality to No. 3.

Coal No. 4.

Moisture	3·50 %
Volatile Hydrocarbons	9·7 »
Total Volatile	13·20 »
Coke	86·80 »
Ash (light grey)	10·02 »
Fixed Carbon	76·78 »
Sulphur	0·64 »
Calorific Value (by Goutal's formula)	7 821

The physical properties of Coal No. 4 are: Brittle, crystallized, rhombic fracture, partly high lustre. Black, bright streak.

North of Tse Chou Fu we find on the map the hsien-city Kao P'ing Hsien, also the seat of important coal-mines. A sample from here was analysed by the student Mr. Liu Shih Hsün with the following result.

Coal No. 5.

Described as »Anthracite, hard and smooth appearance».

Moisture	1·30 %
Volatile Hydrocarbons	8·80 »
Total Volatile	10·10 »
Coke	89·90 »
Ash (reddish col.)	10·28 »
Fixed Carbon	79·62 »
Sulphur	0·92 »
Calorific Value (Goutal)	7 786

It seems that the percentage of ash is generally rather too great for a high-grade coal.

From the Tse Chou district we have been able to procure samples from all the hsiens belonging to it and I will now show some more analyses of coal belonging to this prefecture. We have two samples from the district Yang Ch'eng on the high-road between Tse Chou and Ping Yang Fu and 30 miles west of the former place.

Coal No. 6.

Analysed by E. T. NYSTRÖM.
Place of origin: Yang Ch'eng Hsien.
Like Asphalt, high lustre, black streak, partly brilliant shiny.

Moisture	3·34 %
Volatile Hydrocarbons	10·33 »
Total Volatile	13·67 »
Coke	86·33 »
Ash (light grey)	7·47 »
Fixed Carbon	78·86 »
Sulphur	0·39 »
Calorific Value (Goutal)	8 058

Coal No. 7.

Analysed by Mr. WANG CHIN YUN.
Origin: Yang Ch'eng Hsien.

Moisture	2·8 %
Volatile Hydrocarbons	8·45 »
Total Volatile	11·25 »
Coke	88·75 »
Ash	11·30 »
Fixed Carbon	77·45 »
Sulphur	0·68 »
Calorific Value (Goutal)	7 720

These samples also show semi-anthracites with a somewhat high percentage of ash.

The adjacent district, Ch'in Shui Hsien — according to Baron von RICHTHOFEN — is not supposed to contain any coal-mines. But as a matter of fact I have received two samples with the mark of origin as above. The Rev. A. TRÜDINGER wrote to me that Ch'in Shui

and Yang Ch'eng both produce coal and iron. RICHTHOFEN says that the over-lying sandstone is so thick and undisturbed here as to conceal all the coal-measures. But he admits the presence of mines in Yang Ch'eng immediately to the S. E. Now, seeing that the rather important Chin Shui river passes through the hsien with the same name and must have exercised a powerful erosive action, it is not unlikely that R. has put down his statement on insufficient information.

Coal No. 8.

Analysed by E. T. NYSTRÖM.

Character: Soft, brittle appearance, not shiny.

Moisture	1·28 %
Volatile Hydrocarbons	9·95 »
Total Volatile	11·23 »
Coke	88·77 »
Ash (light grey)	8·00 »
Fixed Carbon	80·77 »
Sulphur	0·45 »
Calorific Value	8 000

Coal No. 9.

Character: Very bright, glassy black on some surfaces. A few grey spots.

Analysed by Mr. WANG CHIN YUN.

Moisture	1·15 %
Volatile Hydrocarbons	9·79 »
Total Volatile	10·94 »
Coke	89·06 »
Ash	11·60 »
Fixed Carbon	77·46 »
Sulphur	1·80 »
Calorific Value	7 691

If we proceed on the main road from Yang Ch'eng towards the west, we arrive, after passing the water-divide between the Ch'in Shui and the Fen Ho, to the district city Yi Ch'eng Hsien. RICHTHOFEN mentions only anthracite mines here, but admits also, that here is the dividing line between Bituminous and Anthracitic Coals

He did not visit the mines himself. As a matter of fact I have found in the I Ch'eng district both kinds of coal, as shown below, which rather proves RICHTHOFEN'S statement about the frontier line existing here between the two different kinds of coal.

Coal No. 10.

Anthracite from I Ch'eng Hsien.
Analysed by Mr. WANG CHIN YUN.
Origin: 60—70 li (20—23 miles) S. E. of city.
Bright and brilliant on some surfaces, brittle.

Moisture	0·74 %
Volatile Hydrocarbons	6·60 »
Total Volatile	7·34 »
Coke	92·66 »
Ash	9·25 »
Fixed Carbon	83·41 »
Sulphur	1·40 »
Calorific Value	7 833

Coal No. 11.

Bituminous Coal from I Ch'eng, Kuan Tse Mu.
Supplied by the Rev. A. TRÜDINGER, analysed by Mr. KUO KANG.
Very bright, laminated, black, shiny, smudges a little.

Moisture	0·66 %
Volatile Hydrocarbons	33·14 »
Total Volatile	33·80 »
Coke	66·20 »
Ash	3·30 »
Fixed Carbon	62·90 »
Sulphur	0·68 »
Calorific Value	8 320

This is an excellent bituminous coal.

Assuming RICHTHOFEN'S dividing line between anthracite and bitum. coal (i. e. the Ho Shan or its imaginary continuation to the S. W.) as correct, we find on the map the two districts Fo Shan and Yo Yang Hsien as well within the former region. RICHTHOFEN describes the coal from here as anthracite and the following two analyses confirm this statement; although it must be admitted that the

samples in question are rather too rich in volatile matter to be called true anthracites.

Coal No. 12.

Origin: Fo Shan Hsien.

Character: Small coal. Grey-black, graphitic surface. Irregular, laminated appearance.

Analysis by Mr. TSAI CHIN YING.

Moisture	1·00 %
Volatile Hydrocarbons	15·15 »
Total Volatile	16·15 »
Coke	83·85 »
Ash	10·15 »
Fixed Carbon	73·70 »
Sulphur	5·37 »
Calorific Value (Goutal)	7 835

The amount of sulphur appears remarkably high.

Coal No. 13.

Origin: Yo Yang Hsien, near P'ing Yang Fu.

Analysed by Mr. YANG CHAO HSIANG.

Moisture	0·5 %
Volatile Hydrocarbons	18·60 »
Total Volatile	19·10 »
Coke	80·90 »
Ash	15·65 »
Fixed Carbon	65·25 »
Sulphur	0·67 »
Calorific Value	7 350

These two samples are from the Ping Yang prefecture. We proceed now to the »Fu» district east of this and north of the Tse Chou region. We enter the Lu An Fu prefecture, famous throughout China for Coal and Iron production (»Lu-Iron»). The special place for Iron smelting is not Lu An Fu itself but a village called Yin Ch'eng in the neighbouring district Ch'ang Chih Hsien. I have also a sample of coal from here. The iron ore for the Ch'ang Chih works is not mined locally but comes from Kao P'ing Hsien.

Coal No. 14.

Origin: Ch'ang Chih Hsien.
Analysis by Mr. WANG CHIN YUN.

Moisture	2·56 %
Volatile Hydrocarbons	10·41 »
Total Volatile	12·97 »
Coke	87·03 »
Ash	8·52 »
Fixed Carbon	78·51 »
Sulphur	1·10 »
Calorific Value	7 997

This coal is very similar to the samples from the Tse Chou prefecture, and would be called a semi-anthracite.

Having rather few specimens from the central south-eastern district, I despatched a special messenger to procure samples. He visited among other places the mines on the frontier between the Lu An and Liau prefectures and the sample brought thence was analysed by Mr. YANG CHAO HSIANG as below.

Coal No. 15.

From the mine Sung Shu P'ing, 25 li (8 miles) S. of Liau Chou city.

Character: Dull black, asphalt lustre. Smudges the skin.

Moisture	0·9 %
Volatile Hydrocarbons	17·2 »
Total Volatile	18·10 »
Coke	81·90 »
Ash (grey)	6·40 »
Fixed Carbon	75·50 »
Sulphur	1·80 »
Calorific Value (Goutal)	8 180

This coal comes very near to being called bituminous. It smudges the skin and the analysis shows much gaseous matter.

Another specimen from the Liau Chou prefecture, but without specified mention of origin, was analysed by Mr. KUO KANG as below.

Coal No. 16.

From Liau Chou.

Moisture	1·04 %
Volatile Hydrocarbons	16·66 »
Total Volatile	17·70 »
Coke	82·30 »
Ash	8·80 »
Fixed Carbon	73·50 »
Sulphur	1·03 »
Calorific Value	7 962

This analysis coincides very well with No. 15 above.

Another sample from Liau Chou was analysed by another student nd shows the following figures:

Coal No. 17.

Analysed by Mr. KUO HSIEN I.

Origin: Liau Chou.

Character: Black and brilliant, laminated and streaky.

Moisture	0·79 %
Volatile Hydrocarbons	16·15 »
Total Volatile	16·94 »
Coke	83·06 »
Ash (white)	8·24 »
Fixed Carbon	74·82 »
Sulphur	0·75 »
Calorific Value (Goutal)	8 010

This sample No. 17 shows quite a good agreement with the two above. We are therefore compelled to throw doubt on RICHTHOFEN's theory about the unbroken continuity of the anthracite district right from Tse Chou to Yu Hsien. The three samples from Liau Shou prefecture contain too much gas to be called anthracites.

Proceeding still further north, we arrive at the district city Ho Shun Hsien, which is still within the Liau Chou prefecture. My special messenger brought me a sample from a mine 30 li or 10 miles south of Ho Shun. Analysis as follows.

Coal No. 18.

Analysed by Mr. KUO KANG.

Origin: Mine Kung Chia Kou, 30 li S. of Hu Shun Hsien.
Character: Pure brilliant black, granular fracture, does not smudge.

Moisture	1·60 %
Volatile Hydrocarbons	11·81 »
Total Volatile	13·41 »
Coke (scarcely cohesive, black)	86·59 »
Ash (darkish grey)	3·30 »
Fixed Carbon	83·29 »
Sulphur	0·51 »
Calorific Value	8 428

It seems that we are now approaching the true anthracite district of P'ing Ting Chou.

My special messenger brought also another sample from this neighbourhood, viz. from a mine 40 li S. of Lo P'ing Hsien. This is styled by the miners »good coal» and as such is sent away and is much sold within a radius of 40 to 50 li.

Coal No. 19.

Analysed by E. T. Nyström.
Origin: Mine 40 li S. of Lo P'ing Hsien.
Character: Moderate lustre, fairly brittle, some fractures exceedingly granular in layers. Does not smudge the skin to any great extent.

Moisture	1·70 %
Volatile Hydrocarbons	8·41 »
Total Volatile	10·11 »
Coke	89·89 »
Ash (greyish white)	6·14 »
Fixed Carbon	83·75 »
Sulphur	2·06 »
Calorific Value	8 141

When coking, shows very small flame, and little gas. Smell of SO_2. The coke is absolutely non-cohesive and powdery.

Note the amount of sulphur which is abnormally high.

Another sample from the same district was analysed by Mr. Yang Jen Hsien with the following result.

Coal No. 20.

Origin: 40 li S. of Lo P'ing Hsien.

Character: Brittle and bright black. Laminated fracture. Smudges somewhat.

Moisture	0·80 %
Volatile Hydrocarbons	5·50 »
Total Volatile	6·30 »
Coke	93·70 »
Ash (greyish-white)	9·50 »
Fixed Carbon	84·20 »
Calorific Value	7 776

RICHTHOFEN describes the coal in the Lo P'ing district as »superior anthracite, costing at the mines no more than 7 d. per ton»!

We shall now turn our attention to the famous P'ing Ting Chou coal district. This is by far the most important mining district in Shansi and this for several reasons. Not only is a superior anthracite (the quality of which we shall show by our analyses) found here, but also an easily smelted iron-ore and — what is not to be despised — good fire-clays for making furnace bricks. But we have still to mention the greatest factor of all and which is most unusual in this backward corner of the world, the P'ing Ting district can boast of good railway communication with the great plain, which is not far off to the east. It is more than probable that the well-known mineral deposits in this district constituted the strongest inducement for establishing the Cheng-T'ai railway, which runs from Shih Chia Chuang on the plain right through the P'ing Ting prefecture to T'ai Yuan Fu.

The coal samples we have received from the vicinity of P'ing Ting Chou show throughout a good quality of real anthracite.

Our first sample from this region is from the Shansi Mining Company's coal-mine at Tieh Lu Kou, 25 li W. of P'ing Ting city. We shall afterwards describe more fully this colliery which is equipped with foreign machinery and the largest of its kind in Shansi.

Coal No. 21.

Sample collected and analysed by E. T. NYSTRÖM.

Origin: Pao Chin Mining Company's mine at T'ieh Lu Kou. 25 li or 8 miles W. of P'ing Ting Chou.

Character: Anthracite. Beautiful, clean coal, does not smudge at all. Hard, smooth, and pure glossy black, large, flat fractures, no granules, rather brittle, but is sold in big lumps.

Moisture	0·46 %
Volatile Hydrocarbons	6·12 »
Total Volatile	6·58 »
Coke	93·42 »
Ash (light grey)	7·62 »
Fixed Carbon	85·80 »
Sulphur	0·89 »
Calorific Value (Goutal)	7 932

When coking, scarcely any flame was visible, the coke was absolutely incoherent and powdery, as might be expected. This is quite a good anthracite, but the remark may be ventured that Ash and Sulphur represent no inconsiderable figures.

Another sample No. 22 from the P'ing Ting prefecture, which was supplied by the Rev. — CRUMPACKER on a different occasion, was analysed by Mr. P'AN LIEN RU and shows a similar nature to the one above.

Coal No. 22.

Origin: P'ing Ting Chou.

Character: Styled »Best Coal». Black, shiny, a few white surface colours. Somewhat conchoidal fractures.

Moisture	1·14 %
Volatile Hydrocarbons	4·56 »
Total Volatile	5·70 »
Coke	94·30 »
Ash	9·12 »
Fixed Carbon	85·18 »
Sulphur	0·50 »
Calorific Value	7 798

Another specimen also supplied by the Rev. — CRUMPACKER and coming from P'ing Ting Chou, was analysed by Mr. WANG CHIN YUN with the following result.

Coal No. 23.

Origin: P'ing Ting Chou.

Character: Very bright pure black anthracite. Exceedingly

brilliant on large surfaces. Fairly compact and cohesive. Is much used in the city af P. T. C.

Moisture	0·98 %
Volatile Hydrocarbons	6·71 »
Total Volatile	7·69 »
Coke	92·31 »
Ash	3·42 »
Fixed Carbon	88·89 »
Sulphur	1·70 »
Calorific Value	8 328

All these analyses of coal from P. T. C. show a coal of high quality. RICHTHOFEN calls it equal to the best Pennsylvanian anthracite. If we consider also that the main coal-seam measures no less than 20 to 30 feet, we can realize what a wonderful wealth lies hidden here.

The anthracite from P. T. C. has not only been analysed by us. The Pekin Syndicate, during the tenure of its concession in Shansi and following on the report of their engineer Mr. GLASS, had a specimen tested by Messrs PATTINSON & STEAD, consulting chemists.

Coal No. 24.

Origin: P'ing Ting Chou.

Analysed by Messrs PATTINSON & STEAD.

Moisture	2·80 %
Total Volatile	9·50 »
Coke	90·50 »
Ash	11·61 »
Sulphur	0·58 »

The moisture seems excessive for such a hard, glassy substance as the local anthracite.

As I have already indicated I am compelled by our analyses to draw the conclusion that real anthracite does not extend over the whole area, as supposed by RICHTHOFEN, viz. the entire S. E. part of Shansi, but the deposits of non-gaseous coal seem rather to aggregate themselves round certain spots, to use a simile: granting that the »Richthofen anthracite area» covers a surface roughly elliptical in form, then the true anthracites would be found at its »foci» that is at Tse Chou Fu and P'ing Ting Chou.

Now, for example, if we leave the P'ing Ting neighbourhood and proceed further west, the coal soon changes to bituminous. Vide the mine of bituminous coal, worked by the Pao Chin Mining Co. at Yung Chia Kou, 40 li N. of the district city of Shouyang, which is 70 li or 23 miles W. of P'ing Ting Chou. I have samples also from this region, and will quote the figures below, but even without these, we have, as an additional proof, the fact, well known to mining men in Shansi, that the coal turned out by the Shouyang mines can be made into good coke.

Coal No. 25.

Origin: Pao Chin Sample No. 22, Shou Yang, Tuan Wang Chen.

Analyst: Mr. WANG CHIN YUN.

Character: Dull black. Cohesive compact.

Moisture	5·49 %
Volatile Hydrocarbons	18·15 »
Total Volatile	23·64 »
Coke	76·36 »
Ash	12·70 »
Fixed Carbon	63·66 »
Sulphur	1·08 »
Calorific Value	7 595

Another specimen however shows much less gas. This is Pao Chin Co. No. 18 also from Shou Yang. This was analysed as follows.

Coal No. 26.

Analysed by E. T. NYSTRÖM.

Character: Granular, crystallized fracture, grey-black lustre.

Moisture	1·19 %
Volatile Hydrocarbons	15·50 »
Total Volatile	16·69 »
Coke	83·31 »
Ash (light grey)	7·22 »
Fixed Carbon	76·09 »
Sulphur	1·37 »
Calorific Value	8 108

The district adjacent to and west of Shouyang, is called Yü Tse Hsien. The city itself lies about 30 miles S. S. W. of Shouyang and is rather an important place, not only because the great trade route to South Shansi branches off here, but also from the fact that here is situated the junction between the Cheng T'ai line and the new T'ung-P'u railway, which is being built by the Chinese themselves and is to be the great central trunk line from N. to S. The coal trade here is also very large. The coal comes from the hills to the north of the city, and show, upon analysis, the following composition.

Coal No. 27.

Origin: Yü Tse Hsien.
Analyst: Mr. YANG JEN HSIEN.
Character: Semi-Anthracite.

Moisture	1·10 %
Volatile Hydrocarbons	9·20 »
Total Volatile	10·30 »
Coke	89·70 »
Ash	16·40 »
Fixed Carbon	73·30 »
Sulphur	0·75 »
Calorific Value	7 271

Coal No. 28.

Origin: Pao Chin Sample No. 22, Lung Wang Shan, Yu Tse Hsien.
Analyst: Mr. P'AN LIEN RU.
Character: Crystalline fractures with large surfaces like rock-crystal, dull black, but occasional fractures shiny.

Moisture	0·67 %
Volatile Hydrocarbons	10·48 »
Total Volatile	11·15 »
Coke	88·85 »
Ash (grey-brown)	5·50 »
Fixed Carbon	83·35 »
Sulphur	1·56 »
Calorific Value	8 215

Coal No. 29.

Origin: Yu Tse Hsien, Lung Wang Shan.
Analyst: Mr. P'AN LIEN RU.
Character of coal: Laminated fracture, exceedingly brilliant in streaks.

Moisture	0·01 %
Volatile Hydrocarbons	9·19 »
Total Volatile	9·20 »
Coke	90·80 »
Ash	3·90 »
Fixed Carbon	86.90 »
Sulphur	0·68 »
Calorific Value	8 317

Coal No. 30.

Origin: Pao Cin Co. Sample No. 31, Yu Tse, Lung Wang Shan.
Analyst: Mr. TSAI CHIN YING.
Character of coal: Pure black, very bright granular fracture. Distinct laminae.

Moisture	0·85 %
Volatile Hydrocarbons	21·35 »
Total Volatile	22·20 »
Coke	77·80 »
Ash (grey white)	3·85 »
Fixed Carbon	73·95 »
Sulphur	2·63 »
Calorific Value	8 395

Coal No. 31.

Origin: Pao Chin Co. No. 36, Yu Tse Lung Wang Shan.
Analyst: Mr. LIU SHIH HSUN.
Character of coal: Hard and deep black.

Moisture	0·34 %
Volatile Hydrocarbons	9·80 »
Total Volatile	10·14 »
Coke	89·86 »
Ash	10·40 »

Fixed Carbon	79·46 %
Sulphur	0·84 »
Calorific Value	7 788

Coal No. 32.

Origin: Pao Chin Co. Sample No. 38. Yu Tse, Lung Wang Shan.
Analyst: Mr. KUO KANG.

Moisture	0·09 %
Volatile Hydrocarbons	11·60 »
Total Volatile	12·50 »
Coke	87·50 »
Ash	8·55 »
Fixed Carbon	78·95 »
Sulphur	1·24 »
Calorific Value	7 987

Coal No. 33.

Origin: Pao Chin No. 27. Yu Tse, Lung Wang Shan.
Analyst: Mr KUO HSIEN I.
Character of coal: Quadratic fissures. Good black colour. Fairish lustre.

Moisture	1·05 %
Volatile Hydrocarbons	10·90 »
Total Volatile	11·95 »
Coke	88·05 »
Ash (grey)	14·75 »
Fixed Carbon	73·30 »
Sulphur	1·07 »
Calorific Value	7 438

This series of analyses does not show good agreement throughout, but the majority indicate a coal of 87—89 % Coke, that is a semi-anthracite, similar to so many samples we find tabulated above. We can draw the conclusion that, outside the »*foci*» of true anthracite, the above percentage of coke seems to be quite the rule when the south-eastern part of Shansi is considered.

I much regret not having received any coal samples from the district north of P'ing Ting named Y-Hsien, which is supposed by RICHTHOFEN to be the »*Ultima Pars*» of the anthracite district; much

coal is exported from here, and it would have been a matter of interest to have some samples analysed. But as it is, we have only had specimens of iron-ore from here. I have reason to believe however that the coal from Y-Hsien is of similar nature to that at P'ing Ting Chou, viz. a true anthracite.

Conclusions regarding the Shansi Anthracites.

We have now finished our analyses of coal from the so-called anthracite district. To recapitulate our conclusions, we have found the true anthracites concentrated in two areas the »foci» of the elliptic area in question and outside these foci mostly semi-anthracites of 87—89 % coke. The ash-percentage is mostly disappointingly high. Although of course the coals are quite good enough for most industrial purposes, it is worth noting that they do not for example rise to the excellence of most British coals brought to the Market. We have in our possession the valuable »Guide to the Purchaser of Coal» called »Analyses of British Coals and Coke» compiled by Mr. ALLAN GREENWELL, editor of the Colliery Guardian. We find that these British coal show an ash-percentage of 2, 3, 4 percent as a rule. Now, by investigating our 33 analyses above, we must put the Shansi coals in a very much inferior position.

The S. W. Corner of Shansi is free from Coal.

According to the order in which I treated the geologically distinct areas of Shansi, it would now be the time to turn our attention to the S. W. corner of the province. It is my intention, however, to go through the question of coal resources first. And, as I already pointed out, the curious fact exists that the S. W. corner does not contain coal. RICHTHOFEN mentions this and points out that the Kuei Ho marks the boundary. I can fully bear out this statement. We have not received a single specimen of coal coming from the S. of the Kuei Ho river, although several minerals of a metalliferous nature have been procured thence.

Extent of the Bituminous Coal Region.

In consequence, while dealing with the coal resources, we shall now turn to the S. W. coal plateau, called by RICHTHOFEN the bituminous coal district. I must add here that when speaking about a »plateau», I do so in a geological sense only. As far as the surface goes, the land is far from looking like a plateau (see Photo 1). But in view of the fact that the strata are mainly horizontal, the name has its justification, geologically at least.

If the area of anthracites or semi-anthracites in Shansi is imposingly large, we must view with still greater respect the extent of the bituminous deposits; 13 500 square miles of the former and 20 000 square miles of the latter, giving a total area 4 times larger than the coal-fields in Great Britain. These figures are borrowed from Mr. GLASS' report, but already RICHTHOFEN mentions his belief that the bituminous coals cover an even greater area than the other category. My analyses and samples substantiate this thoroughly, and I believe that except for a few breaks here and there (for example at So P'ing) the whole of western Shansi can show a good sprinkling of bituminous coal deposits.

Analyses of Samples and General Information regarding the Bituminous Coal in Shansi.

I propose now to begin the description of the bituminous area by proceeding as in the case of the anthracites from S. to North.

Not far to the north of the confluence of the Fen Ho and the Yellow River (see map) is the district city of Hsiang Ning Hsien. This being the site of important mines, I was fortunate enough to obtain valuable assistance from the Ho Tsin C. I. M. missionary, the Rev. Robert Gillies, who not only sent samples but much interesting information besides. He writes: »The coal-field of Hsiang Ning is certainly an important one. The best mines are within 30 li from the Yellow River in the hills bordering the Ho Tsin plain and about 60 li from Ho Tsin city. I should judge about 200 tons of Coal come down to the plain every day and circulate

through all the counties south of us and is carried by boat as far as Kai Feng (Honan) and Sianfu (Shensi)».

The first sample from here was analysed by myself and shows the following composition:

Coal No. 34.

Origin: Hsiang Ning Hsien.

Character: Good black colour, high lustre.

Moisture	0·68	%
Volatile Hydrocarbons	19·43	»
Total Vol.	20·11	»
Coke	79·89	»
Ash (very light grey)	8·05	»
Fixed Carbon	71·84	»
Sulphur	0·66	»
Calorific Value	8 031	(Goutal)

This shows a fairly good not over-bituminous coal.

Coal No. 35.

Origin: S. W. of Hsiang Ning Hsien.

Character: Granular fracture, partly bright.
Colour deep black, smudges considerably.

Moisture	0·04	%
Volatile Hydrocarbons	19·30	»
Total Volatile	19·70	»
Coke	80·30	»
Ash (grey)	14·00	»
Fixed Carbon	66·30	»
Sulphur	0·90	»
Calorific Value	7 500	

Coal No. 36.

Origin: S. W. of Hsiang Ning Hsien, locally spoken of as Hotsin Coal.

Character: Large plain fractures.
Pure black colour. Somewhat shiny, smudges much.

Moisture	0·03	%
Volatile Hydrocarbons	11·00	»

Total Volatile	11·30 %
Coke, coherent strong	88·70 »
Ash (greyish yellow)	25·40 »
Fixed Carbon	63·30 »
Sulphur	1·50 »
Calor. Value	6 507

These two show a much inferior quality. If we proceed towards the east up the valley of the Fen Ho, we come to another district called Lin Fen Hsien. Three samples from Lin Fen were tested with the following results:

Coal No. 37.

Analyst: Mr. Yang Chao Hsiang.
Origin: Lin Fen Hsien.

Moisture	0·01 %
Volatile Hydrocarbons	22·38 »
Total Volatile	22·48 »
Coke	77·52 »
Ash	20·40 »
Fixed Carbons	57·12 »
Sulphur	0·58 »
Calor. Value	6 930

Coal No. 38.

Origin: Lin Fen Hsien.
Analyst: Mr. Tsai Ching Yin.
Character of coal: Dull black, rhombic fractures, smudges much.

Moisture	1·46 %
Vol. Hydrocarbons	19·04 »
Total Volatile	20·50 »
Coke	79·50 »
Ash (pure grey)	8·23 »
Fixed Carbon	71·27 »
Sulphur	0·93 »
Calorific Value	8 008

Coal No. 39.

Origin: Lin Fen Hsien.
Analyst: Mr. Chang Chih.

Moisture	0·91 %
Volatile Hydrocarbons	34·64 »
Total Volatile	35·55 »
Coke	64·45 »
Ash	4·60 »
Fixed Carbon	59·85 »
Sulphur	0·90 »
Calorific Value	7 990

Baron von Richthofen speaks about the coal here and in Hung Tung as deep black, never anthracitic, laminated texture, brittle, partly brilliant, partly dull, of low specific gravity, not many impurities, easily lighted. Burns with luminous flame, soots moderately, makes coherent coke.

N. W. of Hsiang Ning we find on the map the secondary chou-city, Chi Chou. I have received one sample from here.

Coal No. 40.

Origin: Chi Chou.
Character: Dull black. Irregular fracture.
Analyst: Mr. Yang Jen Hsien.

Moisture	0·08 %
Volatile Hydrocarbons	27·32 »
Total Volatile	28·12 »
Coke	71·88 »
Ash	10·20 »
Fixed carbon	61·68 »
Sulphur	0·82 »
Calor. Value	7 778

If we traverse the basin of Ping Yang Fu towards the North, we cross the frontier of Hung T'ung Hsien, which is also situated on the main road and near the Fen Ho river. West of the P'ing Yang basin rises the considerable mountain Ngo Shan, which Richthofen has proved to be built up by a colossal fault in the strata. Here is the important coal-field of San Tiau Ho described by Baron von R. In Hung T'ung further north there are also mines, several specimens from which are shown analysed as below:

Coal No. 41.

Origin: Hung T'ung Hsien.

Character: Small granular fracture. Very bright in spots. Other parts greyish.

Analyst: Mr. P'AN LIEN RU.

Moisture;	2·10 %
Volatile Hydrocarbons	26·14 »
Total Volatile	28·24 »
Coke	71·76 »
Ash (white)	3·35 »
Fixed Carbon	68·41 »
Sulphur	2·34 »
Calorific Value	8 405

A fine bituminous coal but a high percentage of sulphur.

Coal No. 42.

Origin: Hung T'ung Hsien.

Character: Laminated, very brilliant in parts, other surfaces very dull. Fairly compact and strong.

Analyst: Mr YANG CHAO HSIANG.

Moisture	3·50 %
Volatile Hydrocarbons	27·60 »
Total Volatile	31·10 »
Coke	68·90 »
Ash	3·50 »
Fixed Carbon	65·40 »
Sulphur	4·49 »
Calorific Value	8 385

It is interesting to observe the coincidence between RICHTHOFEN'S remarks on the Hung T'ung Coal and the characteristics as quoted above. These coals seem rather unique in low ash but contain a high percentage of moisture and sulphur. Two more specimens were tested as follows:

Coal No. 43.

Origin: Hung T'ung Hsien.

Analyst: Mr. TSAI CHIN YIN.

Character: Dull black, much yellow and brown streaks, distinct laminae. When powdered, brown.

Moisture	0·82 %
Volatile Hydrocarbons	38·70 »
Total Volatile	39·52 »
Coke	60·48 »
Ash, (grey red)	14·14 »
Fixed carbon	46·34 »
Sulphur	2·81 »
Calorific Value	6 478

Coal No. 44.

Origin; Hung T'ung Hsien.

Character: Large plain surfaces, fracture granular and brilliant.

Analyst: Mr. CHANG CHIH.

Moisture	0·68 %
Volatile Hydrocarbons	25·80 »
Total Volatile	26·48 »
Coke	73·52 »
Ash	17·27 »
Fixed Carbon	56·25 »
Sulphur	1·02 »
Calorific Value	7 170

These are very inferior coals, but still of a distinct bituminous nature.

RICHTHOFEN's journeys did not take him much into the western half of the province and his data regarding the coal resources there are mainly founded on hearsay. Travelling there is not easy owing to the wild and often uninhabited nature of the country. I have procured a sample of coal from this region, viz. from Hsi Chou, the prefecture N. W. of the Ping Yang.

Coal No. 45.

Origin: Hsi Chou Pao Chin Co. sample No. 48.

Analyst: Mr. P'AN LIEN RU.

Character: Partly dull black, partly small bright granular fracture. Laminated. A few grey-white spots.

Moisture	3·58 %
Volatile Hydrocarbons	28·48 »
Total Volatile	32·06 »
Coke	67·94 »
Ash (grey white)	3·85 »
Fixed Carbon	64·09 »
Sulphur	0·68 »
Calorific Value	8 332

These deposits seem to contain quite an excellent quality of truly bituminous coal, but the commercial value can unfortunately be only local, this region being very wild and inaccessible and with no hopes of improved communications for many years to come.

North of Hsi Chou we encounter the Fen Chou prefecture, a large one, covering a considerable part of the middle west. This district is not so poor and the communications are better.

It was visited in the year 1911 by Mr. WEINMANN, Bergassessor, late Prof. of Peking University, who, at my request, kindly brought back several mineralogical samples thence.

Coal No. 46.

Origin: Ning Hsiang Hsien in Fen Chou prefecture, Na-Yu mine.
Analyst: Mr. P'AN LIEN RU.
Character: Dull black and bluish grey.

Analysis see page 37.

Moisture	1·74 %
Volatile Hydrocarbons	18·04 »
Total Volatile	19·78 »
Coke	80·22 »
Ash (grey)	15·76 »
Fixed Carbon	64·46 »
Sulphur, not analysed	
Calor. Value	7 342

Another sample also procured by Mr. WEINMANN gave the following results:

Coal No. 47.

Origin: Ning Hsiang Hsien.
Character: Laminated fairly bright.
Pure black, no visible gangue, streaky fracture.

Analyst: Mr. TSAI CHIN YIN.

Moisture	1·05 %
Volatile Hydrocarbons	17·10 »
Total Volatile	18·15 »
Coke	81·85 »
Ash (grey)	4·00 »
Fixed Carbon	77·85 »
Sulphur	1·60 »
Calor. Value	8 375

A third sample also from the same district and supplied by M WEINMANN, was analysed by another student, as follows:

Coal No. 48.

Origin: Ning Hsiang Hsien.
Analyst: Mr. LIU SHIH HSUN.
Character: Bright black, compact, no surface colours, brittle.

Moisture	1·95 %
Volatile Hydrocarbons	18·68 »
Total Volatile	20·63 »
Coke	79·37 »
Ash (grey)	11·38 »
Fixed Carbon	67·99 »
Sulphur	2—90 »
Calor. Value	7 735

A sample from near the prefectural city of Fen Chou was analysed by Mr. KUO HSIEN I.

Coal No. 49.

Origin: Near Fen Chou Fu.
Character: Not described.
Analyst: Mr. KUO HSIEN I.

Moisture	1·30 %
Volatile Hydrocarbons	19·80 »
Total Volatile	21·10 »
Coke	78·90 »
Ash	11·27 »
Fixed Carbon	67·63 »
Sulphur	1·21 »
Calorific Value	7 736

It may be added that S. W. of Fenchou Fu there is a mine with some foreign machinery installed, viz. boiler and steam-pump for keeping the mine dry. Many difficulties were encountered by the Chinese owners with regard to establishing modern machinery in these far-off and isolated parts. The author visited this place some years ago. A boiler had just fallen down the pit then, but coal was taken out from a neighbouring pit by the native methods.

Travelling now on the main road towards the capital over the great T'ai Yuan plain, we traverse the flourishing districts of Wen Shui and Chiao Ch'eng, the garden of Shansi, abundant with grape-vines, apricot and cherry-trees. The houses are about the best built in China and altogether we find here the finest part of the province. There are coal-mines in the hills bordering on the plain.

Coal No. 50.

Origin: Wen Shui Hsien, T'ien T'u Kou.
Character: Brownish colour.
Analyst: Mr. P'AN LIEN RU.
Analysis see page 39.

Coal No. 50.

Moisture	0·86 %
Volatile Hydrocarbons	12·22 »
Total Volatile	13·08 »
Coke	86 92 »
Ash	35·22 »
Fixed Carbon	51·70 »
Sulphur	1·90 »
Calorific Value	5 655

This is only seemingly a semi-anthracite. It is the enormous amount of ash, that raises the coke figure to such a degree.

Coal No. 51.

Origin: Hills west of Chiao Ch'eng.
Analyst: Mr CHAO KUO TSO.
Character: Dull grey-black, brittle, much grey and brown colouring.

Moisture	1·53 %
Volatile Hydrocarb.	13·65 »
Total Volatile	15·18 »
Coke	84·82 »
Ash (grey-white)	8·07 »
Fixed Carbon	76·75 »
Sulphur	0·88 »
Calorific Value	8 011

Coal No. 52.

Origin: 10 li W. of Chiao Ch'eng.
Analyst: Mr Chao Kuo Tso.

Moisture	0·38 %
Volat. Hydroca.	18·08 »
Total Volatile	18·46 »
Coke	81·54 »
Ash	7·79 »
Fixed Carbon	73·75 »
Sulphur, not analysed	
Calorific Value	8 045

These two seem certainly to be similar to the semi-anthracites of the Central Eastern District.

This is another example of the curious conditions I have found regarding the coal near to and all round the T'ai Yuan basin. We find by our analyses that the coals here cannot be classified according to their situation east and west of the plain as was the case with the other basins further south. Now, strictly speaking, the coals east of the plain should be anthracites and west of the same basin they should be bituminous. But I have already quoted the figures for the Shou Yang district (see map) and pointed out that a well-known bituminous mine is situated here. We find also quite anthracitic coals to the west: altogether a confusing state of things. But still more interesting is the perusal of the analysis of Coal No. 53, which came actually from well within the Anthracitic Area as described and established by Richthofen. Coal No. 53 is so far from being anthracite, that it can indeed be styled a typically, excellent bituminous coal.

Coal No. 53.

Origin: Mine Pei Fu 70 li or 23 miles S. of T'ai Ku Hsien Sample supplied by Dr. HEMMINGWAY, T'ai Ku.

Analyst: E. T. NYSTRÖM.

Character: Concave, conchoidal fracture. Some grey and brown surface colours, also »peacock» tints.

Moisture	4·29 %
Volat. Hydrocarbons	24·71 »
Total Volatile	29·00 »
Coke incoherent powder Red like Fe_2O_3	71·00 »
Ash: First test	2·42 »
Second	2·60 »
Average	2·51 »
Fixed Carbon	68·58 »
Sulphur	1·40 »
Calorific Value	8 456

I have also analysed Tai Yuan Fu household coal, coming from the mines 30 or 40 li to the W. and S. W. of the capital. The seams here are 3 to 5 feet in thickness, price at mine 100 cash for one big cartload of 1 500 catties or nearly 1 ton, that is 3 d. per ton! Transport to the city costs 1 cash per catty and the coal sells in T'ai Yuan for about 2 cash per catty.

Coal No. 54.

Origin: Yang Hsu Hsien which is the administrative name of the T'ai Yuan district. The hills west of the plain.

Analyst: E. T. NYSTRÖM.

Character: Granular fracture, high lustre.

Moisture	0·51 %
Volatile Hydrocarbons	13·98 »
Total Volatile	14·49 »
Coke	85·51 »
Ash (white)	13·68 »
Fixed Carbon	71·83 »
Sulphur	0·895 »
Calorific Value	7 522

Note the semi-anthracitic nature similar to so many coals from the east.

Mr. Weinmann on his recent travels collected several other samples, interesting because of their coming from such remote districts. I shall now show the analysis of a coal from the neighbourhood of Hsing Hsien, a poor and little known district to the N. W.

Coal No. 55.

Origin: 15 li N. of Hsing Hsien.
Analyst: Mr Chao Kuo Tso.
Character: Dull, sateen colour. Some yellow surface colours. Compact and cohesive.

Moisture	3·00 »
Volatile Hydrocarbons	28·40 »
Total Volatile	31·40 »
Coke	68·60 »
Ash (white)	6·45 »
Fixed Carbon	62·15 »
Sulphur	0·983 »
Calorific Value	8 102

This is again a true bituminous coal of fairish quality.

The region N. of the T'ai Yuan basin belongs to the Hsin Chou prefecture. I have had one coal from here also collected by Mr. Weinmann. The place is Tsing Lo Hsien, the mountainous district in the N. W. corner of Hsin Chou prefecture.

Coal No. 56.

Origin: 50 li N. of Tsing Lo Hsien.
Mine: She Mang Tse.
Analyst: Kuo Hsien I.
Character: Dull black, very brittle, slight rainbow colouring.

Moisture	2·10 %
Volatile Hydrocarbons	43·00 »
Total Volatile	45·10 »
Coke	54·90 »
Ash (grey)	5·40 »
Fixed Carbon	49·50 »
Sulphur	0·56 »
Calorific Value	6 940

A good and very bituminous coal.

RICHTHOFEN says that north of Y-Hsien, (see map) the anthracite district has its northern limit. Judging from the analysis below, this statement seems quite correct. Coal No. 57 comes from the district N. of Y Hsien called Wu-T'ai Hsien, all in the central East.

Coal No. 57.

Origin: Supplied by the Rev.— STONELAKE, from a mine 90 li or 30 miles from Hsin Chou in the direction of Wutai Shan.

Analyst: E. T. NYSTRÖM.

Character: Greyish black moderate lustre. Cohesive and compact. A little rainbow tint. Laminated flat fractures. Black shiny streak.

Moisture	1·17 %
Volatile Hydrocarbons	30·77 »
Total Volatile	31·94 »
Coke	68·06 »
Ash (grey-white)	11·84 »
Fixed Carbon	56·22 »
Sulphur	0·64 »
Calorific Value	7 490

We find that in the northern districts the coal is of a distinctly bituminous type. So are the following samples originating from a mine N. E. of Tsing Lo Hsien and 100 li or 33 miles West of Kuo Hsien (see map).

No. 58 and 59.

Origin: 100 li West of Kuo Hsien. Supplied by the Rev.— LOWER.

A. Coal. Smudgey, bituminous, layers of pyrites on top. Smooth flat fractures. Dull lustre in parts.

B. Coal. Smudges badly. Makes brownish powder. Parallel 1/8″ laminae. Much pyrites disseminated. Somewhat brownish black. Dull colour.

Analysis by E. T. NYSTRÖM.

	A.	B.
Moisture	2·00 %	2·28 %
Volatile Hydrocarbons	32·67 »	31·99 »
Total Volatile	34·67 »	34·17 »
Coke	65·33 »	65·83 »
Ash (light red-grey)	6·26 »	5·04 »

Fixed Carbon	59·07 »	60·79 %
Sulphur	1·75 »	2·69 »
Calorific Value	7 892	8 080

Enormous smoky flame when coking. Coke silver-grey and half-sintered. These are typical bituminous coals. They are from the district of Ning Wu Fu. More to the west we enter the district Pao Tei Chou, which borders on the Yellow River.

Mr. WEINMANN brought two samples from here, which were analysed with the following result.

Coal No. 60.

Origin: 4 li west of the city Pao Tei Chou, near Yellow River.

Character: Black, shiny, with much grey, white, and metallic colours. Structure distinctly laminated.

Analyst: Mr. YANG JEN HSIEN.

Moisture	2·3 %
Volatile Hydrocarbons	20·90 »
Total Volatile	23·10 »
Coke	76·90 »
Ash (grey)	8·40 »
Fixed Carbon	68·50 »
Calorific Value	7 980

Coal No. 61.

Origin: Pao T'ei Chou.

Character: Dull black appearance.

Analyst: Mr. YANG JEN HSIEN.

Moisture	0.80 %
Volatile Hydrocarbons	23·80 »
Total Volatile	24·60 »
Coke	75·40 »
Ash (white)	29·40 »
Fixed Carbon	46·00 »
Sulphur	0·70 »
Calorific Value	6 085

In view of the great amount of ash, this must be considered a highly bituminous coal.

About on the same latitude as Pao Tei, but much farther east, is the district Fan Shih Hsien, which also shows the presence of coal.

Coal No. 62.

Origin: Fan Shih Hsien.
Description: Very brown colour. Layers like slate, no lustre.
Analyst: Mr. YANG JEN HSIEN.

Moisture	1·7 %
Gases: 1	10·00 »
Total Volatile	11·70 »
Coke	88·30 »
Ash	15·70 »
Fixed Carbon	72·60 »
Sulphur	1·07 »
Calorific Value	7 347

All these mines are unfortunately in a very awkward position with regard to communications. I shall now treat another series of coal deposits, which thanks to their situation near a large plain and with a certain hope of railway communication, are of supreme importance for Northern Shansi. They are the coal-mines near Ta T'ung Fu, the largest city in N. Shansi, the administrative centre of a large area, »Fu» district in the N. E. We may mention here that a railway from Peking and Kalgan is now being built and is just entering the plain by this time. There exists a possibility that the excellent bituminous coal of Ta T'ung may be exported along this line. Our first sample of coal is from the mines at Lang Erh Kou and does not represent the best of the local coals. RICHTHOFEN mentions that the best coal comes from Hei Ku Tse 45 li W. S. W. of the city.

Coal No. 63.

Origin: Ta T'ung Coal district.
Analyst: Mr. CHAO KUO TSO.
Character: Somewhat brownish surface, rather dull black fracture.

Moisture	1·87 %
Volatile Hydrocarbons	28·78 »
Total Volatile	30·65 »
Coke	69·35 »

Ash (reddish-grey)	17·34 %
Fixed Carbon	52·01 »
Calorific Value	6 950

Here the geological formation is very curious. The Ta T'ung basin is bordered in the N. W. by a precipitous wall, made up of gneiss and Sinian limestones, and the same rocks constitute the floor of the coal measures. The strata are horizontal and are covered by sandstone. The mines extend along a line of 30 miles. The main mine at Hei Ku Tse has two shafts, one for water and the other — like a spiral staircase — for the carrying of coal.

Coal No. 64.

Origin: Pao Chin Co. Sample No. 150 from Ta T'ung.

Analyst: E. T. NYSTRÖM.

Character: Streaky, laminated, shiny. Much brown and yellow spots. Roughly cubical fracture. High lustre on some surfaces.

Moisture	4·45 %
Volatile Hydrocarbons	30·17 »
Total Volatile	34·62 »
Coke, not cohesive	65·38 »
Ash (dark brown like Fe_2O_3)	4·06 »
Fixed Carbon	61·32 »
Sulphur	1·29 »
Calorific Value	8 160

This is a good bitum. coal, but the colour of the ash and the high percentage of sulphur proves the presence of pyrites.

Coal No. 65.

Origin: Pao Chin Co. Sample No. 148. Ta T'ung mines.

Analyst: E. T. NYSTRÖM.

Character: Very shiny, looks like anthracite. Beautiful glossy black. Does not soil the skin. Smooth as glass, no spots, but a few grey streaks. Conchoidal fracture.

	First test	Sec. test
Moisture	5·65 %	5·67 %
Volatile Hydrocarbons	34·72 »	33·99 »
Total Volatile	40·37 »	39·66 »
Coke, hard and cohesive	59·63 »	60·34 »
Ash (yellowish light grey)	0·91 »	1·08 »

Fixed Carbon	58·72 %	59·26 %
Sulphur	0·83 »	
Calorific Value	average 8 035	

This is about the best coal I have found in Shansi. It may be remarked that the moisture is somewhat high, but I was much struck with the phenomenal purity with regard to ash. I could not believe it, so was compelled to analyse it twice over. Seeing also that sulphur is low and the coke is good and hard, the future for this coal must be great indeed. RICHTHOFEN's description coincides beautifully. He says, that the coal here is wholly black, very lustrous, does not smudge, looks like anthracite, gives little ash. RICHTHOFEN did not visit the N. W. so has not much information from that district.

A missionary in Kuei Hua Ch'eng (see map) wrote me that there are good coal-mines near that city, but the Mongols who own them do not trouble to extract coal from them.

Still further west we have the town of Saratsi. From this very remote district, I received a sample from the Rev. — ÖBERG, which is of much interest, showing that the bituminous nature of the northern coals is still maintained here.

Coal No. 66.

Origin: The Rev. — Öberg, 50 li N. W. of Saratsi.
Character: Small granular rectangular fracture. Shiny in parts.
Analyst: E. T. NYSTRÖM.

Moisture	1·16 %
Volatile Hydrocarbons	29·38 »
Total Volatile	30·54 »
Coke (much gas)	69·46 »
Ash (light brown, unlike other coals)	6·97 »
Fixed Carbon	62·49 »
Sulphur	0·78 »
Calorific Value	8 065

This is the last of our coal specimens; 66 in all. We shall afterwards give the conclusions we have arrived at from their analysis.

Iron Ore in Shansi.

Rivalling the coal in importance we find in Shansi metalliferous minerals, mainly iron ores. It will be seen that the samples of iron ore represent a surprising number of districts, and yet it must be remembered that, as a matter of course, we have not samples from all the districts where such deposits exist. Taking into consideration also that most specimens have been picked from mines, I have no hesitation in declaring that the iron resources of Shansi are considerable, although as usual their exploitation is hampered by lack of communication.

I can concur with the conclusions of Mr GLASS, whose report has been previously mentioned, that the iron ores are mainly Limonites and Haematites, occurring in the slates and sandstones in the carboniferous formations. They are found not only in nodules — from a few to several hundred pounds — but also in beds.

It is proved also that the ores, although rather poor as regards percentage of iron, are low in impurities of a harmful nature, and being as a rule porous, are very easily smelted. Samples of ore from Ping Ting Chou have been sent to Krupp in Germany and it was stated that a good steel, rather above the ordinary, was produced from the Shansi ore.

Classification of Iron Ores according to Districts.

We propose to treat the iron ores in a similar way as adopted for the coal samples and begin in the S. E. corner of the province, bearing in mind the way we divided the province, viz. in the 1) Anthracite district in the S. E., the 2) the coal-free S. W. corner, 3) the area of bituminous coal in the west, 4) the parallel archaic ranges in the N. E. and the 5) Lias plateau in the N. W.

Analysis and Description of Iron Ores.

We know that the iron industry of Shansi has come to be developed only at those places where much ore and coal lie adjacent

to a main high-road. We find such a district near Tse Chou Fu in the T'ai Yang district, N. W. of the former city. The iron ore occurs here conjointly with dolomites which harbour the ore in numerous cavities and hollows. Here is one of the more important iron centres in China and an enormous export takes place to the Honan plain on the same road which we have described when dealing with the anthracite of this region. This is indeed a country of fabulous mineral wealth, what with coal, iron, and fire-clay lying near to each other.

I propose to number the iron ores from 100.

Our first sample, or more correctly specimen, was analysed with the following result:

Iron Ore No. 100.

Origin: Feng T'ai Hsien, Sung Chuang Tsun.

Analyst: Mr. P'AN LIEN RU.

Character of Ore: Limonite, compact, reddish brown with purple parts.

Permang. Method = 1) 51·0 %, 2) 51·6 % iron. I may add here, that owing to the fact that the students were too much occupied both with mineral analyses and their regular University training, it was impossible to find time to test Sulphur and Phosphorus except in a few cases.

In the case of the T'ai Yang Iron district, however, I am able to quote here a complete analysis occurring in Mr GLASS' report and made by Mr. EDW. RILEY F. C. S. Lond.

Silica	4·07 %
Ferric Oxide	76·77 »
Alumin. »	3·46 »
Mangan. »	0·57 »
Calcium »	2·21 »
Phosphorus	0·25 »
Sulphur	0·074 »
Carbonic Acid	9·37 »
Combined Water	0·59 »
Moisture	1·61 »
	98·974 %
Metallic Iron	53·88 %

Another sample gave 45·50 (analysts PATTINSON & STEAD). We have analysed three other specimens:

Iron Ore No. 102.

Origin: Feng T'ai Hsien.
Character: Limonite or Pisolite. Like conglomerate. Purple with parts black and with yellow ochre. Clay odour, when moist.
Analyst: Mr. LIU SHIH HSUN.

Iron Metal	41·44 %

Iron Ore No. 103.

Origin: Feng T'ai Hsien, Tu Shan Tsun.
Character: Dark red, porous. Crystals of Quartz.
Analyst: Mr. CHAO KUO TSO.

Metallic Iron	57·12 %

Iron Ore No. 104.

Origin: Feng T'ai Hsien.
Character: Like conglomerate, big holes and hollows. Purple and brown.
Analyst: Mr. CHAO KUO TSO.

Specific Gravity	3·2 %
Metallic Iron	48·00 »
Sulphur	0·797 »

Iron Ore No. 105.

Origin: Yang Ch'eng Hsien, immediately W. of Feng T'ai Hsien.
Analyst: Mr. WANG CHIN YUN.
Character: Very porous conglomerate of dark purple and yellow fragments.

Metallic Iron	50·85 %

N. W. of Yang Ch'eng we find on the map the district Ch'in Shui Hsien. Here there is also much iron. Specimens were analysed as follows:

Iron Ore No. 106.

Origin: Ch'in Shui Hsien.

Character: Dark red and purple. Some white and yellow incrustations. Very compact.

Analyst: Mr. WANG CHIN YUN.

Metallic Iron . . . . . 50·4 %.

Iron Ore No. 107.

Origin: Ch'in Shui Hsien.

Character: Limonite. Dark-brown with coating of yellow ochre. Fairly porous.

Analyst: Mr. LIU SHIH HSUN.

Metallic Iron . . . . . 53·57 %.

Iron Ore No. 108.

Origin: Ch'in Shui Hsien.

Character: Dark red and purple. Compact. Some white incrustations.

Analyst: Mr CHAO KUO TSO.

Metallic Iron	59·92 %
Sulphur	0·73 »
Specific Gravity	2·9 »
Phosphorus	0·03 »

We have been fortunate to obtain samples of ore from all the Hsiens in this prefecture. The next one is Kao P'ing Hsien to the north.

Iron Ore No. 109.

Origin: Kao P'ing Hsien.

Character: Dark brown limonite. Black on some surfaces. Very minute crystals of pyrites sparsely distributed.

Metallic Iron . . . . . 52·64 %.

Also from the eastern part of the Tse Chou prefecture we have procured samples:

Iron Ore No. 110.

Origin: Lin Ch'uan Hsien.

Character: A shell of ore round some very soft sandstone in concentric layers.

Analyst: Mr. KUO KANG.

Iron . . . . . 49·0 %.

Iron Ore No. 111.

Origin: Lin Ch'uan Hsien.

Character: Very dark brown with white and yellow incrustations. Analysed twice.

Analyst: Mr. KUO KANG.

Metallic Iron . . . . . 17·33 %

We must remember that the district Fou Shan Hsien belongs to the Anthracite Area. Iron ore is also present here.

Iron Ore No. 112.

Origin: Fou Shan Hsien.

Character: Resembles conglomerate of fragments of yellow ochre surrounded by brownish-red mineral.

Analyst: Mr. KUO KANG.

Iron . . . . . 43·44 %

Iron Ore No. 113.

Origin: Fou Shan Hsien.

Character: Chalybite or Spathic Ore. Light purple-red and dark purple in parts. Very compact, not porous, nor very heavy.

Analyst: Mr. P'AN LIEN RU.

Metallic Iron . . . . . 31 %

This district, however, does not count as an important iron centre. We must retrace our steps towards the east into the Lu An prefecture to find the origin of the widely known product, called »Lu Iron». This is not produced at the capital itself but in an adjacent district called Ch'ang Chih Hsien. This is the centre of the Lu An Iron smelting works. There are 10 to 20 villages all specialising in this trade, and the iron is exported as far as Chihli, Honan, and Shantung. The local ore is of poor qual-

ity as a rule, and the smelters fetch their raw material from the neighbouring district Kao P'ing Hsien.

Iron Ore No. 114.

Origin: Ch'ang Chih Hsien.
Character: Poor-looking ore, very siliceous, dark brown.
Analyst: Mr. WANG CHIN YUN.
Iron . . . . . 26·88 %

Iron Ore No. 115.

Origin: Ch'ang Chih Hsien, 7—8 li off the former.
Character: Red when powdered.
Analyst: Mr. WANG CHIN YUN.
Fe . . . . . 51·52 %

If we proceed northwards we approach another extremely important iron centre, viz. the Ping Ting prefecture. I have already pointed out the astounding deposits of fine anthracite that mark this region as one of the foremost in Shansi, but it remains to mention the vast resources of iron ore, which are found here, and make this prefecture a parallel to the equally rich area of T'ai Yang or Tse Chou in the south. But P'ing Ting has the advantage over Tse Chou of having good railway communication with the consumer, i. e. the great plain of Chihli which lies quite close to the East. It is a region which seems to have been created for great industrial purposes. The best known deposits of ore are situated 20 li N. of the Pao Chin Co.'s coal-mines or say 40 li N.W. of P'ing Ting Chou.

I received several samples from P'ing Ting iron district, which were analysed as follows:

Iron Ore No. 116.

Origin: 40 li S. of Lo P'ing Hsien, P. T. Chou.
Character: Porous conglomerate of yellow ochre surrounded by dark purple hard ore.
Analyst: Mr. LIU SHIH SUN.
Iron . . . . . 44·03 %

RICHTHOFEN visited the Lo P'ing ironworks. He says that the communications to this town are only mule-paths, but that all materials for iron-making lie here close at hand. The ore, a mix-

ture of limonite and spathic ore, is won from a number of small mines, distributed in a valley. He describes the iron-smelting works as wonderfully simple. Nothing can be seen of high blast-furnaces or such. The iron is simply produced in crucibles or tubes of fire-clay, which contain the ore and coal mixed, and which are heated for some days in a rectangular pit, during which time the ore is reduced to a spongy mass of raw iron. This is taken out, heated again, and compressed by the repeated blows of sledge-

Iron Manufacture in Shansi by Native Methods.
The upper parts of the crucibles are visible.

hammers to a kind of very crude wrought iron which is exported in small bars on mules, or carried by men. The above sample was brought by my special messenger.

We have iron ore which is better situated than the Lo P'ing one. I mean the deposits nearer to the railway, and nearer to the prefectural city. Here there is also a great smelting industry, though as yet only using native methods. The erection of a modern steel-making plant is contemplated by the Pao Chin Mining Co.

Iron Ore No. 117.

Origin: P'ing Ting Chou.
Analyst: E. T. NYSTRÖM.

Metallic Iron . . . . . 46·4 %

Iron Ore No. 118.

Origin: P'ing Ting Chou, Ch'ang Ling Tsun.
Character: Brownish yellow, somewhat porous. Also yellow ochre surface colours.
Analyst: Mr. KUO KANG.

Iron . . . . . 57·12 %

Iron Ore No. 119.

Origin: P'ing Ting Chou, Tung Kou Tsun.
Character: Brown, like »clay-ironstone». Smooth fractures.
Analyst: Mr. KUO KANG.

Metallic Iron . . . . . 45·92 %

Iron Ore No. 120.

Origin: P'ing Ting Chou.
Character: Porous dark brown. White incrustations. Exactly similar to a Museum specimen marked »Limonite from Massachusetts.»
Analyst: Mr. CHAO KUO TSO.

Metallic Iron . . . . . 47·6 %

According to Mr. GLASS' report, the iron ore sells at the mine for 1 s. 7 d. per ton. Mr. EDW. RILEY, F. S. London, gives the following opinion of the local ore: Excellent for smelting. Phosphorus too high for ordinary Bessemer, but the ore is suitable for the Bassic Siemens process. Makes good foundry iron. Messrs PATTINSON & STEAD give a similar judgment. They analysed pig iron made of Shansi ore and arrived at the following figures:

Metallic Iron	92·16 %
Graphitic Carbon	3·50 »
Combined Carbon	0·25 »
Manganese	0·60 »

Silicon	2·60 %
Sulphur	0·03 »
Phosphorus	0·96 »

I have myself analysed native pig iron and arrived at a percentage of iron of 92·50 %, a satisfactory agreement with the above.

Further west, in Yu Tse Hsien, there is also iron ore to be found.

Iron Ore No. 121.

Character: Black purple and yellow, Limonite. Some incrustations of Carbonates. Compact, not porous.

Analyst: Mr. Tsai Chin Yin.

Metallic Iron	50·40 %

There remains only one specimen more from the anthracite district, and this comes from the region north of the railway, called Yu Hsien. Although this is a somewhat remote district, it would have been interesting to have more samples, it being known that much iron and coal is produced there and carried to the station Yang Ch'uan to be exported.

Iron Ore No. 122.

Origin: Yu Hsien, N.N.W. of P'ing Ting Chou.

Character: Conglomerate of fragments of hard, dark-purple haematite and soft yellow ochre. Very porous.

Analyst: Mr. Kuo Kang.

Metallic Iron	42·00 %

We have now dealt with the samples of iron ores from the anthracite districts. We have found ore in no less than eleven districts, but cannot help coming to the conclusion, on contemplating the map, that the iron is concentrated round the anthracite »foci», as previously described. It may be, however, that the miners have subjected just these regions to a more rigorous search, it being their object of course to find the iron ore as close to the anthracite as possible. Hence perhaps the reason why more iron deposits seem to exist here than elsewhere.

We propose now to turn to the south-west corner of the province. We must remember that the geology is quite different to the coal-plateau just described. Down here we find the granite range called Fung Tiao Shan and many more rocks of an archaic character.

Fung Tiao Shan rises to an altitude of 5 000 feet above the Yellow River and forms, with an almost precipitous incline to the north, an imposing landmark in this country. Regarding the mineral resources here, it seems that Nature refuses to deal unjustly with any part of Shansi. We have already mentioned the complete absence of coal here, but this is compensated by the presence of metalliferous minerals such as iron ore, copper ore, and galena.

Iron Ore No. 123.

Origin: Yu Hsiang Hsien, right down in the S.W. corner.

Character: Like coarse sand, with brilliant black crystals. Much sand and rock. Powder red = Iron Glance.

Analyst: Mr. Tsai Chin Ying.

Iron	40·88 %
Sulphur	0·39 »

This is interesting; it seems that the change in geology makes a difference in the nature of the ore; it is not often we find iron glance in Shansi.

On the north side of Fung Tiao Shan is situated the district An I Hsien. The most notable feature of this region is the great, and much exploited salt-lake, a source of considerable revenue for many merchants and the government. We shall later describe this remarkable salt-deposit. While dealing with the iron, we may mention here that iron-ore is also found in An I Hsien.

Iron Ore No. 124.

Origin: An I Hsien.

Character: Purple, with many cavities and hollows, also green copper-oxidation colours and yellow pyrites.

Analyst: Mr. Chao Kuo Tso.

Iron	14 %

In the Chiang Chou prefecture further west, and close to the Yellow River, we find on the map a district called Yuan Hsu Hsien. This seems to be remarkably rich in metalliferous minerals, we have obtained specimens both of iron, copper and lead ores from here. The iron ore was analysed, as follows:

Iron Ore No. 125.

Origin: Yuan Hsu Hsien, Pao Chin Co. Sample No. 107.

Character: Like spathic ore. Porous, partly like a sponge. White streaks and veins, parts very dark.

Analyst: Mr. P'AN LIEN RU.

Average two analyses . . . . . 45·5 % Iron.

Further N.W. in the same prefecture, we encounter the district Wen Hsi Hsien, also remarkably rich in iron and copper.

Iron Ore No. 126.

Origin: Wen Hsi Hsien, Pao Chin Co. Sample No. 76.

Character: Iron glance. Black blue lustre. Crystalline. Red-brown streak.

Analyst: Mr. YANG JEN HSIEN.

Iron . . . . . 44·8 %

Iron Ore No. 127.

Origin: Wen Hsi Hsien.

Character: Dark purple, like haematite, but with red and yellow surface colours. Mostly compact and heavy.

Analyst: Mr. LIU SHIH HSUN.

Iron . . . . . 52·82 %

Iron Ore No. 128.

Origin: When Hsi Hsien.

Character: Dark brown with a patch of pyrites, yellow ochre surface colours.

Analyst: Mr. WANG CHIN YUN.

Fe . . . . . 48·72 %

Where the Fen River approaches its confluence with the Yellow River, there lies the city of Ho Tsin, already mentioned because of its important coal trade. Not far from here, in a S. E. direction, on Ki Wang Shan, iron is worked or working contemplated (according to Mr. GILLIES). I have a sample of Ho Tsin Ore.

Iron Ore No. 129.

Origin: Ho Tsin Hsien.

Character: Dark purple-red haematite, with slight admixture of calcium carbonate. Compact, heavy.

Analyst: Mr. TSAI CHING YIN.

Metallic Iron . . . . . 61·6 %

By following the main road, which lies on the left shore of the Fen Ho, we arrive on our journey northwards to the prefecture of P'ing Yang Fu. Here, in the district Lin Fen Hsien, much iron is found. RICHTHOFEN does not seem to mention this, but as a matter of fact we have received no less than five samples from this place.

North of Ho Tsin both coal and iron are found. The coal has been described before.

Iron Ore No. 130.

Origin: Hsian Ning Hsien. N. of Ho Tsin.

Character: Limonite. Dull dark purple colour.

Analyst: Mr. TSAI CHING YIN.

Iron . . . . . 58·8 %

Iron Ore No. 131.

Origin: Lin Fen Hsien.

Character: Yellow ochre. Yellow earthy mineral, smudges badly at touch. Purple brown in certain strata. Crystals of pyrites.

Analyst: Mr. P'AN LIEN RU.

Insoluble in acids . . . . . 33·7 %
Metallic Iron . . . . . 34·0 %

Iron Ore No. 132.

Origin: Lin Fen Hsien.

Character: Bright yellow small fragments. Fairly high specific gravity.

Analyst: Mr. YANG CHAO HSIANG.

Iron . . . . . 51·52 %

Iron Ore No. 133.

Origin: Lin Fen Hsien.

Character: Red ochre. Brick red soft ore in lumps and powder. Spec. gravity rather low.

Analyst: YANG CHAO HSIANG.

Iron . . . . . 43·12 %

Iron Ore No. 134.

Origin: Lin Fen Hsien.

Character: Purple, bright red and compact with fissures and infiltrations of yellow ochre and calcium carbonate.

Analyst: Mr. YANG CHAO HSIANG.

Fe . . . . . 62·1 %

Iron Ore No. 135.

Origin: Lin Fen Hsien.

Character: Brown Limonite with much yellow ochre surface covering. Porous but rather heavy.

Analyst: Mr KUO KANG.

Iron . . . . . 50·925 %

Yellow ochre seems to be typical for the Lin Fen ores.

Still further north we enter the district Hung T'ung Hsien. RICHTHOFEN describes the bituminous coal from here, but does not mention the iron. I have two samples from here, tested as below.

Iron Ore No. 136.

Origin: Hung T'ung Hsien.

Character: Like conglomerate. Fragments of Pisolite, Limonite and yellow ochre with fissures filled by calcium carbonate. Colour black purple and yellow.

Analyst: Mr. YANG CHAO HSIANG.

Iron . . . . . 54·60 %

Iron Ore No. 137.

Origin: Hung T'ung Hsien.

Character: Dark grey rock with round holes lika pumice stone. Other fractures granular.

Analyst: Mr. KUO KANG.

Iron . . . . . 11·2 %

In the farthest northern corner of the P'ing Yang prefecture and in the mountains west of the river and the main road, we find on the map the district Fen Hsi Hsien. From here originate two of our samples.

Iron Ore No. 138.

Origin: Fen Hsi Hsien, Ho T'an.

Character: Dark brown, purple, compact, heavy, with incrustations of calcium carbonate.

Analyst: Mr. CHANG CHIH.

Iron . . . . . 45·0 %

Iron Ore No. 139.

Origin: 90 li N. of Fen Hsi Hsien. Village Hsiao Ku Tsun.

Character: Concentric texture. Orange coloured soft centre. Covering of hard, brown ore.

Analyst: Mr. CHANG CHIH.

Iron . . . . . 51 %

From the central prefecture of Ho Chou in its Southern Part, district Chao Ch'eng Hsien, we procured the following sample.

Iron Ore No. 140.

Origin: Chao Ch'eng Hsien. Pai T'ieh Tsun.

Character: Dark purple with surface incrustations of calcium carbonate. Low spec. gravity.

Analyst: Mr. CHANG CHIH.

Iron . . . . . 28·6 %

Westwards from here we have the little known and remote prefecture called Hsi Chou. Coal exists here as already described. Iron is also represented in our list.

Iron Ore No. 141.

Origin: N. of Hsi Chou (Wen Yang Chen).

Character: Dark purple, very compact and rather heavy. Small vein of pyrites, incrustations of calcium carbonate.

Analyst: Mr. CHANG CHIH.

Iron . . . . . 56·0 %

North from here we enter the very extensive prefecture of Fen Chou Fu, more prosperous and much more easily accessible. Mr. WEINMANN who travelled through this region this year, brought some interesting samples from Ning Hsiang Hsien in the southern part of Fen Chou prefecture. The coal from here has already been mentioned and the fortunate conditions prevail that coal and iron lie close to each other as for instance at the village Na Yu in Ning Hsiang Hsien.

Iron Ore No. 142.

Origin: Ning Hsiang Hsien, Na Yu village. Coal and iron from adjoining mines.

Character: Dark brown, heavy, compact and somewhat shiny. A few spots of yellow ochre. Very similar to »Limonite from Massachusetts».

Analyst: Mr. P'AN LIEN RU.

Insoluble in acids	5·94 %
Spec. Gravity	3·66 »
Sulphur	0·4 »
Iron	56·0 »

In a better situation from a commercial point of view, owing to its close proximity to the great T'ai Yuan plain, lies the rich mining district of Hsiao I Hsien. I know of both coal, iron, and lead being present here. We have no less than six samples from here:

Iron Ore No. 143.

Origin: Hsiao I Hsien. Pao Chin Co. Sample No. 35.

Character: Brown Limonite.

Analyst: Mr. YANG JEN HSIEN.

Iron . . . . . 46·5 %

Iron Ore No. 144.

Origin: Hsiao I Hsien. Pao Chin Co. Sample No. 29.

Character: Dark brown Limonite, with a few big cavities. Heavy.

Analyst: Mr. YANG JEN HSIEN.

Iron . . . . . 32 %

Iron Ore No. 145.

Origin: Hsiao I Hsien. Pao Chin Co. No. 18.
Character: Roasted ore from mine. Porous.
Analyst: Mr. YANG JEN HSIEN.

Iron . . . . . 33 %

Iron Ore No. 146.

Origin: Hsiao Hsien.
Character: Dark brown limonite with white crystals of calc. carbonate. Shiny on some surfaces. Somewhat porous.
Analyst: Mr. P'AN LIEN RU.

Iron . . . . . 56 % and
Sulphur . . . . . 0.5 »

Iron Ore No. 147.

Origin: Hsiao I Hsien.
Character: Purple and dark brown haematite. Some yellow ochre. Porous but heavy.
Analyst: Mr. TSAI CHING YIN.

Iron . . . . . 57·4 %

Iron Ore No. 148.

Origin: Hsiao I Hsien.
Character: Dark brown, porous with cavities filled with yellow ochre and green serpentine.
Analyst: Mr. KUO TSIEN.

Iron . . . . . 53·76 %
Sulphur . . . . . 5·6 »

The hills west of the capital of the province also contain very much iron and mines are plentiful. I give the analysis of a sample as below:

Iron Ore No. 149.

Origin: Yang Hsu Hsien, W. of T'ai Yuan Fu.
Character: Porous ore, but heavy, similar to Limonite. Brown and black.
Analyst: Mr. YANG CHAO HSIANG.

Iron . . . . . 43·3 %

A picture of iron smelting, as it is carried on with local ore and coal, is given on our photograph No. .

Still further west, in the remote and mountainous district called Lin Hsien (see map), iron ore is also found and mined. I have reason to believe that iron abounds in all the mountainous regions west of Tai Yuan.

Iron Ore No. 150.

Origin: Lin Hsien.

Character: Red ochre ore. Soft purple red. Slight white incrustations.

Analyst: Mr. KUO HSIEN I.

Iron . . . . . 34·94 %

Iron Ore No. 151.

Origin: Lin Hsien.

Character: Compact, purple brown.

Analyst: Mr. KUO HSIEN.

Iron . . . . . 50·4 %

In the northern parts of Shansi iron ores are also represented; for instance in the Ning Wu prefecture (see map).

Iron Ore No. 152.

Origin: 20 li from Ning Wu Fu, Ling Kou Tsun.

Character: Soft, porous yellow ochre, somewhat brownish.

Analyst: Mr. CHAO KUO TSO.

Iron . . . . . 25·0 %

Iron Ore No. 153.

Origin: Ning Wu Fu.

Character: Porous brown ore, much yellow ochre.

Analyst: Mr. CHAO KUO TSO.

Iron . . . . . 38·8 %

Also in Tai Chou prefecture in the vicinity of Wu T'ai Shan, the intricate geology of which we have already indicated.

Iron Ore No. 154.

Origin: Wu T'ai Hsien.

Character: Light brown ore in concentric layers. Streaks and veins of magnetite.

Analyst: Mr. KUO KANG.

Iron . . . . . 13·64 %

Near the Ta T'ung depression in N. Shansi, which also holds so much excellent coal — as previously described — iron ore is also found, as proved by our sample as below.

Iron Ore No. 155.

Origin: 20 li from Ta T'ung Fu, Hsi Yen Szu.

Character: Very porous. Red and dark brown.

Analyst: Mr. CHAO KUO TSO.

Specific Gravity . . . . . 2·271 %

Iron . . . . . 28 »

There remains only one sample to describe. This is No. 155, which comes from the very N.W. corner of Shansi from the neighbourhood of the town Saratsi. When we remember that excellent bituminous coal is represented by our sample as previously mentioned, that a railway is now being rapidly built towards these regions from the east, and that there exists a chance that a steamer-service will be established from here on the Yellow River right into the very centre of Asia, we are compelled to attach more than ordinary importance to any mineral samples originating here. Both coal and iron ore was supplied from here by the Rev. — ÖBERG, Saratsi.

Iron Ore No. 156.

Origin: Saratsi.

Character: Typical Haematite. Compact, dark purple. Silky surface, with small infiltrations of minute crystals. Exactly like a Museum specimen called »Haematite».

Analyst: Mr. LIU SHIN HSUN.

Specific Gravity . . . . . 4·8 %

Iron . . . . . 66·26 »

This is a fine ore as far as percentage of iron goes.

After thus enumerating samples of iron ore we find by counting that the number of districts mentioned here as containing such ores reaches the imposing number of 30. And yet, it is of course quite possible that there exist several districts possessing iron depo-

sits, which are not represented in our collection. Under such circumstances it seems to me that it would be idle talk to say that the iron ore resources of Shansi are not immense. I can fully bear out RICHTHOFEN'S statement, that should China witness the same industrial development as Europe, then Shansi alone with its enormous iron resources could fill or nearly fill the requirements of the whole Empire.

Analyses and Description of Copper Ores.

We may think that nature has exhausted her gifts by dealing so generously with the province in the matter of coal and iron. But this is far from being the case. More precious metals, especially copper and lead, are also found in Shansi and exist in workable quantities in some districts, notably in Yuan Hsu and Wen Hsi Hsien in the southern part of Shansi. To begin with the copper-ores, we have received several samples in the laboratory, which were analysed by the students with the following results. So as to avoid confusion we will number these specimens from 200. It may also be mentioned that many of these ores are more of the nature of specimens than true samples.

Copper Ore No. 200.

Origin: Wen Hsi Hsien. Pao Chin Co. Sample No. 67.

Character: Green and rainbow-coloured pyrites. Gangue consists of Quartz.

Analysts: Messrs E. T. NYSTRÖM and CHAO KUO TSO.

Insoluble in Acids	17·86 %
Moisture	1·52 »
Copper (by Electrolysis)	33·5 ».

This is probably a picked specimen of especially rich percentage

Copper Ore No. 201.

Origin: Wen Hsi Hsien.

Description: Pyritic and green coloured veins in granitic rock. Also yellow ochre. Plenty of handsome oxidation colours.

Analyst: Mr YANG CHAO HSIANG.

Copper . . . . . 0·783 %.

Copper Ore No. 202.

Origin: Wen Hsi Hsien. Pao Chin Co. Sample No. 70.

Description: Yellow, brown and white gangue. Very strong, green infiltration. No visible pyrites. Strongly weathered.

Analyst: Mr WANG CHIN YUN.

Copper . . . . . 17·1 %

Copper Ore No. 203.

Origin: Yuan Hsu Hsien.

Description: Greenish grey, compact. Veins of Quartz and Grey Rock with crystals of Copper Pyrites and green oxidation colours.

Analyst: Mr. YANG JEN HSIEN.

Copper . . . . . 0·81 %.

Copper Ore No. 204.

Origin: Yuan Hsu Hsien. Pao Chin Co. Sample No. 99.

Description: Green surface colours of Copper Carbonate on soft slatey rock.

Analyst: Mr KUO HSIEN I.

Copper . . . . . 1·652 %.

Copper Ore No. 205.

Origin: Yuan Hsu Hsien.

Description: White Quartz with holes and cavities showing Copper oxidation colours and Galena, very little value, not analysed.

Copper Ore No. 206.

Origin: Tai Chou. Yang T'i Kou.

Description: Coming from large 34 feet vein of brown and white quartz. Assay gave no Gold or Silver. The specimen shows only slight copper colouring and was not analysed.

Copper Ore No. 207.

Origin: Tai Chou Yang T'i Kou.

Description: A few crystals of Copper Pyrites in quartz. Also green Hornblende and Iron Hydroxide in cavities. Very poor, not analysed.

The Pao Chin Company states that there are also copper ores in the following districts: Yü Hsien, Hsiang Ning Hsien and Hsia Hsien but that those in Wen Hsi and Yuan Hsu are the most rich. I have also been informed that a company has been established for working these ores by modern methods.

Analyses and Description of Lead and Silver Ores.

Having now dealt with the Copper Ores, I will proceed to examine the Lead and Silver minerals represented by our samples. I arrive at the conclusion that the Lead ores as a whole show better promise of gain than the Copper ores, the Lead ocurring in very many districts and often containing considerable quantities of silver. The students obtained very handsome silver buttons when assaying many samples of Shansi Galena.

The Pao Chin Co. in their report state that the P'ing Lu Galena is the best and about the others they say that the samples of Galena inspected may contain silver, but that this must be analysed. By our assay this suggestion has been verified.

The specimens of Galena are numbered from 250 and upwards.

Lead Ore No. 250.

Origin: P'ing Lu Hsien in S. Shansi.

Description: Bluish black Galena in rather much gangue of Calcium Carbonate (white).

Analyst: Mr YANG CHAO HSIANG, by assaying

Lead	56·9 %
Silver	9·8 ozs. per ton.

Lead Ore No. 251.

Origin: An I Hsien in S. Shansi.

Description: Brilliant cubical crystals. Graphite lustre. Some Gangue = Quartz.

Analyst: Mr PAN LIEN RU, by assaying

Lead . . . . . 57·0 %
Silver . . . . . 21·72 ozs. per ton

Lead Ore No. 252.

Origin: Yuan Hsu Hsien. Pao Chin No. 101.

Description: Galena infiltrated in green serpentine. Richer part of rock analysed by Mr P'AN LIEN RU.

Lead . . . . . 17·89 %.

Lead Ore No. 253.

Origin: Wen Hsi Hsien Pao Chin No. 82.

Description: Quartz, fairly pure, with crystals of Galena. Poor. Not analysed.

Lead Ore No. 254.

Origin: P'u Hsien (S. Shansi), Hsia Tsun.

Description: Galena.

Analyst: Mr. CHANG CHIH.

Silver . . . . . 15·5 ozs. per ton.

Lead Ore No. 255.

Origin: I Ch'eng Hsien. Fang Chien.

Description: Rather pure Galena with white gangue of Calcium Carbonate and Quartz. Also rust-brown Iron Hydroxide surface colours.

Assaying by Mr. YANG CHAO HSIANG.

Lead . . . . . 70·5 %
Silver . . . . . 32·667 ozs. per ton.

This is a very rich ore.

Lead Ore No. 256.

Origin: Lu An Fu. P'ing Shun Hsiang.

Description: Light brown Calc. Carbonate with dark brown and black crystals of ore. Very porous.

Assaying by cupelling by Mr. WANG CHIN YUN gave a very small silver button.

A man tried formerly to extract silver in this locality but the venture did not pay.

Lead Ore No. 257.

Same place as above.

Similar gangue with scattered crystals of Galena. Similar result.

In the Hsiao I Hsien district, S. W. of Tai Yuan Fu there seems to be an abundance of all kinds of minerals. I have seen a fine specimen of Galena from there, but unfortunately it has not been included in our collection.

Lead Ore No. 258.

Origin: Lin Hsien N. W. of T'ai Yuan Fu.

Description: Layers of Galena in soft yellow gangue of Calc. Carb.

Assaying by Mr. YANG JEN HSIEN.

Lead . . . . . 8·0 %.

Lead Ore No. 259.

Origin: Wu T'ai Hsien N. E. of T'ai Yuan.

Description: Called »Gold Ore» but assaying by Mr CHANG CHIH gave only

Silver . . . . . 6·2 ozs. per ton.

Lead Ore No. 260.

Origin: Wu T'ai Hsien.

Description: Called »Gold Ore». Brown quartz and micaceous rock.

Assaying by Mr. YANG CHAO HSIANG gave two minute buttons which dissolved wholly in Nitric Acid, therefore = Silver.

Lead Ore No. 261.

Origin: Hun Yuan Chou in N. E. Shansi.

Description: Fairly pure Galena with gangue of Quartz and Iron Hydroxide. Very rusty appearance.

Analyst: Mr. KUO HSIEN I.

Lead . . . . . 66.0 %

Silver . . . . . 5·33 ozs. per ton.

Lead Ore No. 262.

Origin: Feng Chen T'ing, near Ta T'ung Fu.

Description: Galena crystals with rusty brown gangue in layers. Porous yellow ochre on surface.

Assaying by Mr. Liu Shih Hsun.

Lead	76 %
Silver	124 ozs. per ton.

This is an exceedingly rich ore.

Lead Ore No. 263.

Origin: Feng Ched T'ing near Ta Tung Fu.

Description: Fairly pure Galena with gangue of Quartz and Calc. Carb. cavities filled with Ironrust.

Assay by Mr. Chao Kuo Tso.

Lead	63·76 %
Spec. Gravity	6·66 .

Analyses and Description of Pyrites.

Having now concluded the Lead and Silver Ores we propose to turn now to another kind of raw material of supreme importance especially for chemical manufacturing, and which is also found among the rich variety of Shansi minerals. We mean the Iron Pyrites which by the sulphur serves in other countries for the preparation of that pillar and foundation of Chemistry called Sulphuric Acid and here in Shansi is also used for the production of Sulphur itself.

I have numbered the samples of Pyrites from 300 upwards.

Pyrites No. 300.

Origin: Fen Hsi Hsien in the Central South.

Description: Crystals of pyrites in grey and white gangue.

Analysis by Mr. Yang Chao Hsiang.

Sulphur	40·8 %
Iron	33·6 ».

Pyrites No. 301.

Origin: Ho Chou.
Description: Small crystalline pyrites in transparent quartz.
Analyst: Mr. Kuo Hsien.

Sulphur . . . . . 11·8 %.

Pyrites No. 302.

Origin: Ling Shih Hsien.
Description: Not pure. Small crystals of pyrites with greyish white gangue.
Analyst: Mr. P'an Lien Ru.

Sulphur . . . . . 21·0 %
Iron . . . . . 19·71 ».

Pyrites No. 303.

Origin: Wen Shui Hsien, S. W. of T'ai Yuan Fu.
Description: Magnetic Iron Pyrites. Bronze-brown colour. No visible gangue.
Analyst: E. T. Nyström.
Manganese present.

Sulphur . . . . . 32·32 %.

The mineral was attracted by the magnet.

Pyrites No. 304.

Origin: West of Chin Szu temple in T'ai Yan Hsien.
Analyst: Mr. Chang Chih.

Sulphur . . . . . 45 %.

Pyrites No. 305.

Origin: S. W. of Chin Szu Temple.
Description: Big nodules in coal-measures. Silvery to grey brass colour. Mostly very pure and compact but with some veins of black, carbonaceous matter. Specimen 4 inches, ovoid shape.
Analyst: E. T. Nyström.

Moisture . . . . . 0·86 %
Sulphur . . . . . 42·85 ».

Pyrites from T'ai Yuan Hsien are much used for the manufacture of Iron Vitriol. The mineral is simply piled up in heaps, which are ignited and burn with the aid of no extraneous heat. The air oxidises the FeS_2 to $FeSO_4$, which is afterwards dissolved out of the mass by water, crystallized, and used for dyeing with indigo.

Pyrites No 306.

Origin: 40 li N. of Ho Shun Hsien in E. Shansi.

Description: Coal intermixed with yellow Pyrites. Oxidises without heat in the atmosphere. The natives use it for making vitriol just as the above.

Pyrites No. 307.

Origin: Tai Chou. Central North. Pao Chin Co. Sample No 139. Yang T'i Kou.

Description: Fairly perfect crystals of pyrites but much gangue. Not analysed.

Pyrites are used in Shansi also for another purpose, viz. for the manufacture of Sulphur. It is a well-known fact, that the molecule FeS_2, by heating with the air excluded, dissociates into FeS and S. Now, the natives — of course without any knowledge of the theory — prepare the sulphur in accordance with the above principle in the following way: Pyrites crushed into small pieces are introduced into a pot of fire-clay with a rather narrow neck. This neck is nearly closed by a few larger pieces of the same mineral. Then the pot is inverted, placed above a hole in the ground, and a coal fire is piled all around. The sulphur in the pyrites is disgorged by the heat, liquefies, and runs through the neck down into the hole. Then it is ladled up with a spoon and cast into moulds, forming round cakes, about 8 inches in diam. and 5 inches high. The product, though impure, is used mainly for gunpowder.

Analyses and Description of Gypsum, Heavy Spar, Fire-clays etc. etc.

We have now dealt with the coal, iron, copper, lead, silver and pyrites, found in Shansi. But there are also minerals of an apparently minor value, which, however, from an industrial point of view are far from being useless. I mean such raw materials as gypsum, heavy spar (barium sulphate) fire-clays, quartz, granite, marble, limestone and salt. We know that many of these are real pillars of Chemical Manufacture. Moreover iron-smelting and other metallurgical processes would be impossible without certain of the above raw materials. This province seems to have been prepared by Nature for the task of being a great manufacturing centre. It is only Man in his conservatism and indolence, who refrains from taking the gifts offered to him.

I shall begin the description of the above minerals with a few notes on the Gypsum and Heavy Spar and shall number them, beginning with 350. All the above mentioned samples are indicated by brown rings on the map.

Heavy Spar No. 350.

Origin: P'ing Lu Hsien. Pao Chin Co. Samples No. 83, 85 and 86. Erroneously called »Cerussite».

Description: Yellowish-white, very heavy rock with small veins of rust-brown colour.

Specific Gravity: 3·96.

I believe that this is the first time that the presence of such a mineral has been discovered in Shansi.

Heavy Spar No. 351.

Origin: Hsia Hsien (S. Shansi) Pao Chin Co. Samples No. 87 & 88. Also erroneously called »Cerussite».

Description and properties as above.

Gypsum No. 352.

Origin: Ling Shih Hsien. Hsu Chia Tien, 20 li from Ling S.

Description: Callad »Shih Gao». 1 1/2 in. thick vein with transversely inclined crystals of clear, alabaster-like Gypsum, seemingly very pure. Very handsome mineral.

Gypsum No. 353.

Origin: P'ing Yao Hsien, Central Shansi. P'u Tung Tsun.

Description: Small, matted crystals, grey and white. Far less pure than above.

Fire-Clay No. 354.

Origin: Ch'in Shui Hsien.

Description: Light purple grey, fatty touch, dark streaks.

Granite No. 355.

Origin: Wen Hsi Hsien. Pao Chin Co. Sample 68.

Description: Red Granite. Firm solid rock with black fragments intermixed.

Salt No. 356.

Origin: The great Salt Lake in S. Shansi. Adjoining to and formed by the Fung T'iao Shan. Near Yun Ch'eng.

Description: Crystallized by the Chinese in shallow ponds. Good cubical crystals up to 1/4 inch side. Slightly greyish white. Semi-transparent.

Moisture . . . . . 2·1 %. Nothing insoluble.

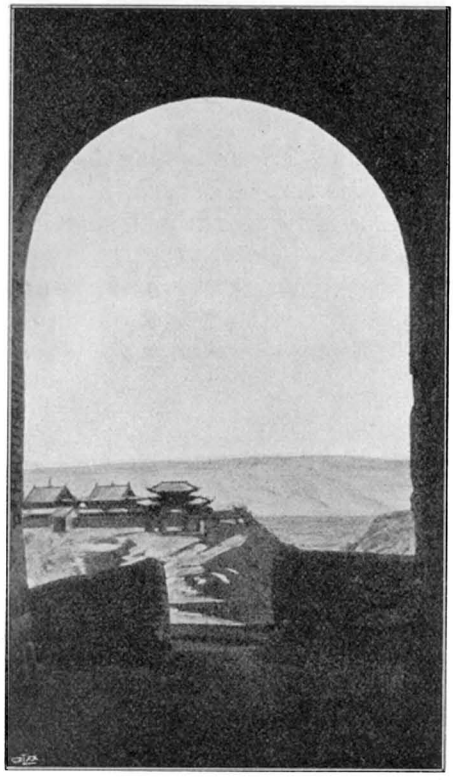
This is a very busy centre of manufacture, supplying as it does, a good deal of North China's need of salt. The lake, which has no drainage, contains the brine, but the method is to dig holes on the shore and let them fill, and numerous syndicates of natives are occupied with the evaporation and crystallizing of the salt. It is really a Government monopoly, but the officials farm out the industry as mentioned above to merchants who pay for the permission. Thus profit is made by both parties.

Granite No. 357.

Origin: Ho Tsin Hsien.

Description: Much brass-coloured mica, red felspar and quartz.

Silica . . . . . 78·48 %.



View over the Salt Lake.
The Fung T'iao mountain in background. Yün-Ch'eng city in foreground.

Clay No. 358.

Origin: Chao Ch'eng Hsien. Pai T'ieh.
Description: Soft white or purplish, greasy.

Silica	65 %.
Lime	12 ».

Clay No. 359.

Origin: Fen Chou Fu.
Description: Fire-Clay. Dark, soft, greasy, fairly brittle.

Moisture	2·25 %.
Loss on Ignition	12·55 ».

Quartz No. 360.

Origin: Mo An. 50 miles W. of T'ai Yuan Fu.

Description: Pure white, semi-transparent. In big lumps in a river-bed.

This specimen is interesting as coming from the archaic range mentioned in our introduction. The river-beds here abound in crystalline rocks more especially quartz and quartzites.

Heaps of Crystallized Salt ready for Sale.
At Yün-Ch'eng.

Clay No. 361.

Origin: Yu Tse Hsien. Meng Chia Ching.

Description: Clay for making basins of inferior porcelain for domestic use.

Light grey purple, greasy. Soft rich clay. Is ground and lixiviated with water.

Clay No. 362.

Origin: Yu Tse Hsien. Ho K'ou.

Description: Very similar to the above.

For making cooking utensils.

Clay No. 363.

Origin: Yu Tse. Meng Chia Ching.
Description: Slate clay for basins.
Soft greasy, for inferior porcelain.

Clay No. 364.

Origin: Same as 363.
Description: Light brownish yellow like loess earth.
Makes black or green glaze on earthenware.

It is fortunate that the iron-smelting districts, as a rule, contain excellent fire-clays for making furnaces and crucibles as for example the P'ing Ting Chou district especially in Lo P'ing Hsien, which fact is already mentioned by Baron VON RICHTHOFEN.

Limestone of course abounds everywhere, this forming one of the standard geological strata. Marble is more scarce, but an excellent variety is found in Wu T'ai Hsien.

Marble No. 365.

Origin: Wu T'ai Hsien.
Description: Crystalline, handsome stone, slightly greenish. A pure white variety also exists.

The tombstone of the organizer of Shansi University, Dr. Moir Duncan, erected on top of the Lung Wang Shan mountain, is made of this beautiful stone, and visible for miles around.

From the »Ultima Thule», or farthest Northern Region of Shansi we do not possess many specimens.

But I have been able to gather on my journeys an interesting sample of rock-crystal from the place Su Lu T'ou on the frontier between Shansi and Mongolia, N. E. of Kuei Hua Ch'eng.

Rock-Crystal No. 366.

Origin: 200 li N. E. of Kuei Hua Ch'eng.
Description: Large hexagonal crystals of a smoky brown or black colour. Used by the Chinese for dark spectacles.

Soda, Saltpetre, and Potash.

We have now finished the description of our samples and have only to add that other chemical raw materials such as soda, saltpetre and potash are also won, especially in the ground of the old sea-basins, where now the depressions of Ta T'ung, Hsin Chou, T'ai Yuan, et cetera, are situated. The earth in these places is lixiviated with water and the solution evaporated and crystallized in shallow ponds.

Absence of Petroleum.

Although in Shansi we have the four pillars of industry: Coal, iron, lime, and salt all present, yet there is one great factor of wealth that is totally absent and that is Petroleum. The Pao Chin Mining Co. has made determined efforts to find oil, and I have, at their request, analysed many samples of water for minute traces of oil but without positive result. This is all the more strange, as in the neighbouring province of Shensi, great oil resources have been found and are being technically exploited. But Shansi appears void of it.

I intend to give, on the last pages of this book, a general resumé of the main results at which I have arrived by our investigation. In the meantime I believe that a few remarks concerning the institution in which our research work has taken place, would be of interest and value in connection with the subject under review.

The Shansi Imperial University.

The Shansi Imperial University is a combined institution of two separate colleges, one Chinese and one Western. It is in the Western College mostly that European influence has been allowed to play a rôle. It was after the Boxer atrocities of 1900, when the Protestant missions generously had waived their claims on an indemnity, that Dr. Timothy Richard — that well-known and faithful

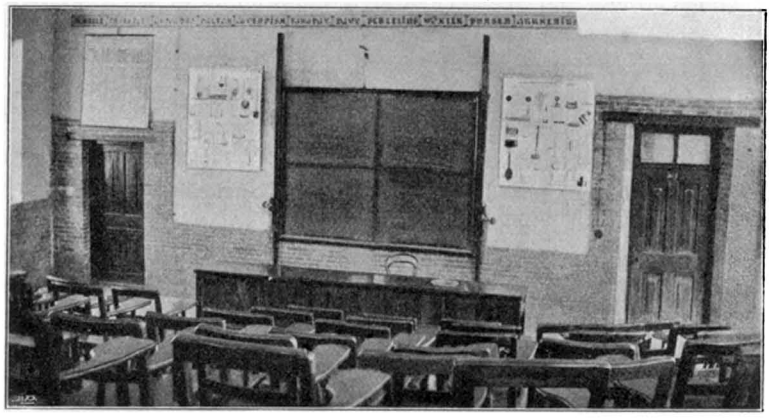
friend of China — proposed to Prince Ch'ing and Li Hung Chang, that the Chinese as a mark and a monument of their gratitude should establish the Western College in T'ai Yuan Fu, for the purpose of removing the very cause of such calamities as the Boxer trouble, i. e. the gross ignorance of European matters and intentions. Taels 50 000 or about £ 7 000 was allotted from the Provincial Treasury annually for the period of ten years, after which period the college should revert to the Chinese (as has already been the case).

The University is situated in the S. E. corner of the capital city of Shansi. One half of the site is occupied by the Chinese

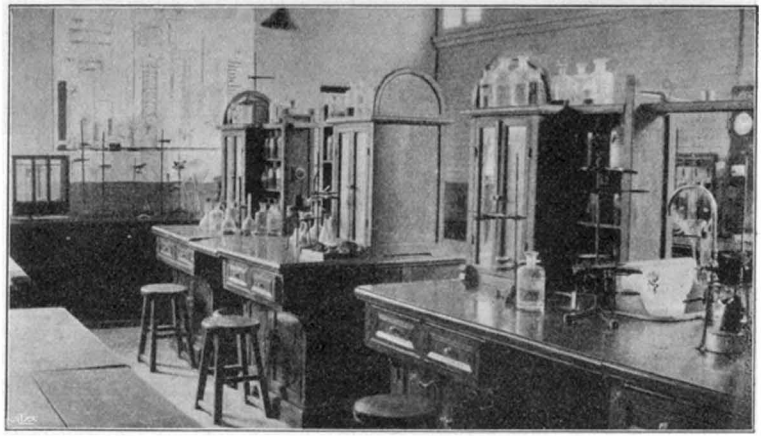
Shansi University.
Laboratory for Qualitative Analysis.

Dept. with dining-rooms and dormitories, the other half contains the Western College, which includes a Large Assembly Hall. Library, Museum, Office, Reception Room, Lecture Rooms, Laboratories for Chemistry, Physics, and Engineering; and Professors residences. There is also a special Electric Light plant erected in 1907, which supplies the entire University with light and power. The number of students in both departements is generally 400 to 500.

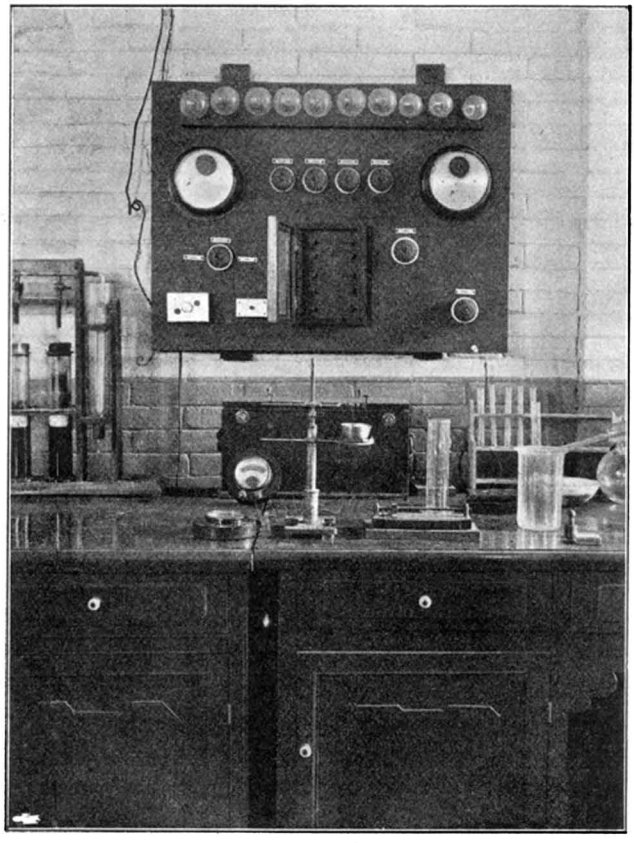
The Chemistry Dept. which is of special interest in connection with this article, was enlarged in 1907, by the donation of an extraordinary grant from the then Governor H. E. Pao Fen, and



Shansi University.
Chemistry Dept. Lecture Room.



Shansi University.
Interior of Laboratory for Advanced and Quantitative Work.



Shansi University.
Chem. Dept. Switchboard and Arrangement for Analysis by Electrolytic Deposition.

a new laboratory for Advanced and Quantitative work was established and furnished under my guidance, and I venture to believe that it is the most efficient and up-to-date institution of its kind in China. (See two photographs of the interior of the laboratory.) It was here that our analyses of Shansi minerals were made. The assaying was done in a special Assaying Room adjoining the main laboratory. It is however a matter of regret to me that so many of our mineral samples have not been examined as far as *all* their constituents go. This would have been extremely desirable

especially the test of our iron ores for Sulphur and Phosphorus. But this was impossible, the time of both professor and students being so much occupied with the ordinary University curriculum that our analyses of minerals could be carried on only during short intervals now and again.

Present Exploitation and Hopes re the Future.

We have, with little doubt as far as the quantity goes, arrived at the knowledge that enormous wealth is hidden beneath the soil of Shansi. But potential wealth is of small avail if no hope exists that it will be exploited to any extent. The question is therefore: Are the mineral resources of Shansi being commercially utilized at the present time? The second query is: What hope have we that modern technology will be applied for the furtherance of these vast problems?

The first question is answered thus: RICHTHOFEN estimates the annual output of coal from the Shansi mines at 1 700 000 tons, and the production of iron of all kinds at 160 000 tons, with a value of £ 900 000. These are comparatively very small figures in view of the enormous mineral resources of the province. The thought lies near at hand that modern methods in mining and metallurgy, combined with really determined and honest efforts, could work wonders here. It is really a question of morality: if confidence could be established by a constant exercise of upright conduct and integrity on the part of a group of technically educated men, then the capitalists would gladly invest their hoarded money in mining and other industrial enterprises, which could do justice to the intentions of Nature, which clearly prepared this province for becoming a great industrial centre.

As it is now, mines with modern machinery are very scarce in Shansi and they have to struggle with adverse circumstances. Not to do them injustice, we might however point out that it is no child's play to establish industries in »new» countries. We do not perhaps realize that in Western Countries the mutual assistance between various branches of manufacture is a fact which almost amounts to a »sine qua non». Here in China where a few plants of machinery lie scattered few and far between, perhaps with bad communications also, the repair and replacement of machinery

and such undertaking is a difficult matter and liable to cause grave disadvantages.

Under such circumstances, we must not despise the efforts which have actually taken place to exploit the mineral wealth in Shansi. We propose now to enumerate and describe the present state of these enterprises in the province.

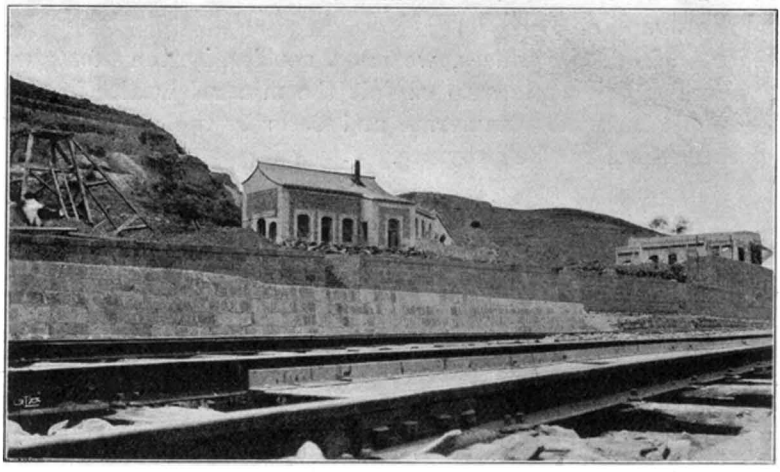
The Pao Chin Mining Company.

The chief organization for this purpose is the Pao Chin (»Shansi Protection«) Company, started as a result of the redemption of the Pekin Syndicate concession in 1907. The Pekin Syndicate, having obtained a very large concession in Shansi in 1898, had intended to establish modern mines themselves, but the movement »China for the Chinese« growing lately very strong (in 1907) the provincials determined to buy back the concession, which was accomplished by H. E. Ting Pao Ch'uan for a price of Ts 2 750 000 or about £ 350 000.

Then the Pao Chin Co. was started to take over the intended work of the Pekin Syndicate. They have at present concentrated their work on two spots, viz. at the Anthracite Mine near P'ing Ting Chou and the Bituminous Mine at Yung Chia Kou N. of Shou Yang (see map). We propose to describe with a few words the mine at the former place, having paid a special visit there in May 1911, for the purpose of obtaining particulars for this paper.

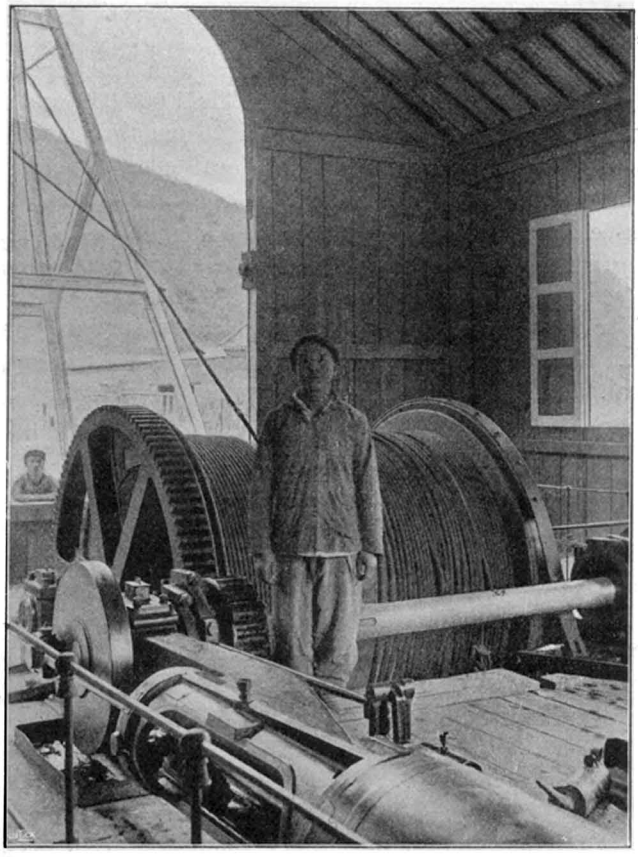
6 li or 2 miles west of the station Yang Ch'uan on the Tai Yuan-Shih Chia Chuang railway and the P'ing Ting prefecture, we encounter the Pao Chin Anthracite Mines. The first pit arrived at is T'ieh Lu Kou. Coal is hauled here by a 30-H. P. winding engine with vertical boiler, and wooden headgear. Water is removed only every three or four days. The pit is about 20 feet in diam. and 100 feet deep. and stone-lined. No guides and no cage are used. Large lumps of coal are simply tied together with chains and hauled to daylight with men guiding the rope. The output of this shaft was estimated by me at 100 tons a day only. A sample of coal (anthracite) was analysed by us and bears the number 21, which analysis is recommended for perusal.

Not far to the west is another larger plant called after its location Yen Tse Kou, but just at present no coal is brought out



Cheng T'ai Railway and the Pao Chin Co. Coal-mine
at Tieh Lu Kou.

Pao Chin Co. Coal-mine
at Yen-Tse-Kou.



Interior of Colliery
at Yen-Tse-Kou.

here, the men being occupied with sinking the pit. The main shaft is 16 ft in diam. and 140 feet deep at present. A large engine house (see photos) and steel-headgear adjoin this mine. There are two Babcock and Wilcox Water-tube Boilers and winding engine (see photo) and a compressed-air-engine from Allen and Maclellan of Glasgow. Also machine and repair shop with foundry.

Many difficulties and dangers have been encountered by the presence of fire damp (CH_4). Two German engineers were expected

to arrive there on May 29th, who were going to be employed at these mines.

This company intend to establish a modern iron-smelting plant near the same place with a capital of Tls 1 000 000 and an output of 30 tons a day. It was mentioned to me that some difficulty might arise from the fact that the local coal, though plentiful, cannot make the coke necessary for the blast-furnace, but coke would have to be carried right from the bituminous coal-mine near Shouyang. There is plenty of easily smelted iron-ore near Yang Ch'uan (see the map of our samples).

The bituminous coal-mine belonging to the company is situated 40 li N. of Shouyang Hsien (vide map). This produces a good steam-coal. I believe some European pumping machinery is established there.

The Pao Chin Co. also made certain efforts, through their engineer, H. D. Martin, Esq., to explore the mineral deposits of the province. The specimens collected by him are marked in our analyses with »Pao Chin Co. Sample No. X».

There are other mines with more or less foreign machinery doing a somewhat desultory work in other districts of Shansi. As for example the coal-mine, already mentioned in Hsiao I Hsien, and the copper mine in Wen Hsi Hsien in the South, but as yet these efforts are only a drop in the ocean.

Communications, Present and Future.

There is another factor, intimately connected with all industrial enterprise here and elsewhere, and that is the question of communications, as 40 years ago, RICHTHOFEN explained that the production of coal and iron in Shansi, even by native methods, would be enormously increased, if the freight expenses (man and mule-carrying and haulage with carts) did not raise the price so much, even at a short distance from the mine. Shansi province is in the unfortunate condition of not having any river of much use for transport. The only exception is the Fen River near its confluence with the Yellow River and also this river itself below the above-mentioned spot, which watercourse is navigated, albeit with difficulty, and can be used to convey coal from the Ho Tsin Mines as far as Si An Fu in Shensi and K'ai Feng in Honan. A new

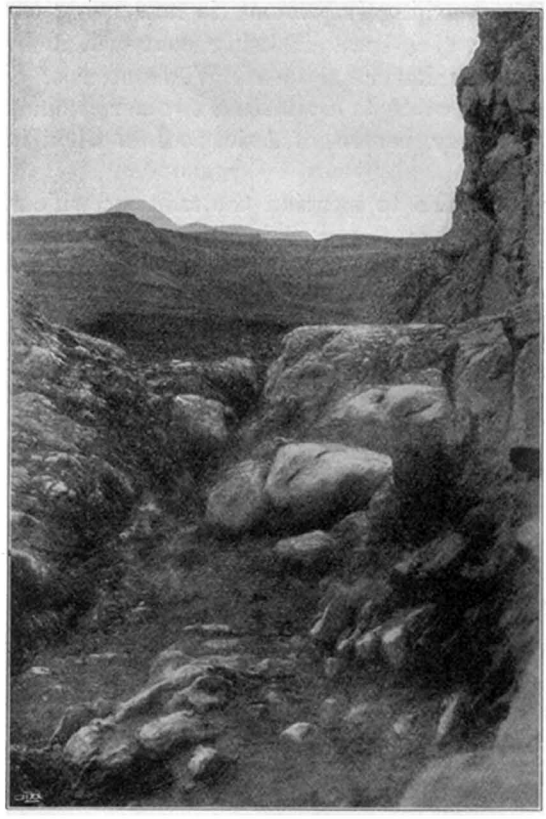
enterprise of far-reaching importance is now being carried out. A powerful steamer (tug-boat) is being conveyed in bits up to the bend of the Yellow River at the N. W. frontier of Shansi, and it will perhaps be possible to establish a steamer communication from there into the very centre of Asia, to Lan Chou in Kansu and still further on.

This impels me also to mention the railway which is now being rapidly built towards the starting-place of this steamer route, i. e. the Kalgan-Sui-Yuan Railway, which, joining the Peking-Kalgan line, has already been completed several months ago to T'ien Chen in the Ta T'ung prefecture in N. Shansi (see map).

The first train to arrive in T'ai Yuan Fu.

This will be of supreme importance not only because of its connection with the above proposed steamer route but also because it will tap the mine district of Ta T'ung, which as we have seen in the analyses contains such excellent bituminous coal. And still more interesting will this enterprise be if, as projected, the line be continued through Mongolia to Urga and Kiakta, ultimately joining the Trans-Siberian Line. This would then be part of the great high-way Paris-Peking by rail.

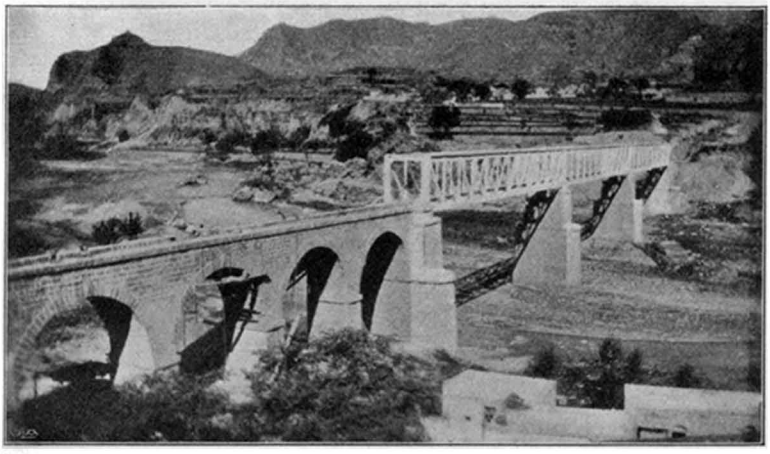
These may as yet be only schemes, but we have also in Shansi a railway which has been completed nearly four years and has



The old ›Mandarin‹
Road from the Chihli Plain to T'ai Yuan Fu.

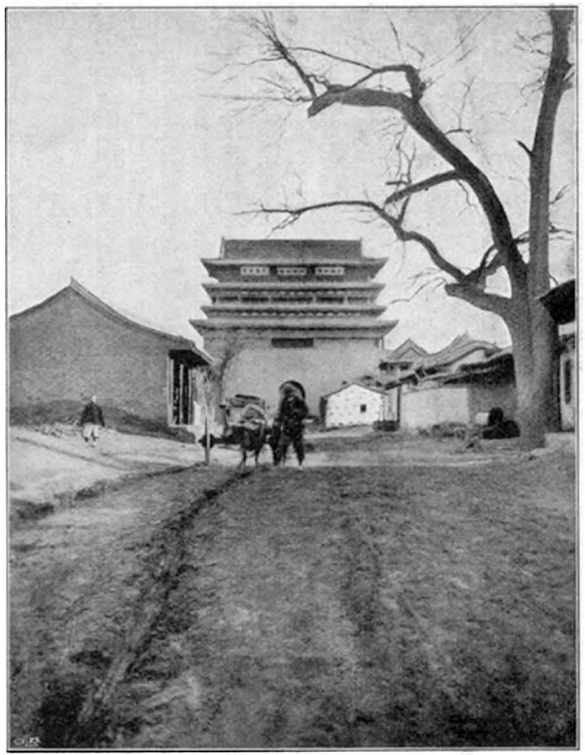
proved a veritable blessing. This is the T'ai-Yuan-Shih-Chia-Chuang line which runs into the very heart of Shansi and joins the capital with the great trunk-line on the Chihli plain, enabling a passenger to proceed by express in one day from T'ai Yuan Fu to Peking. I have already mentioned its importance for the P'ing Ting coal district. The conservative Shansi merchants first viewed the line with suspicion and declined to send freight by it, but during the past year a change has taken place and the railway has begun to pay well. It is a narrow-gauge line built and managed

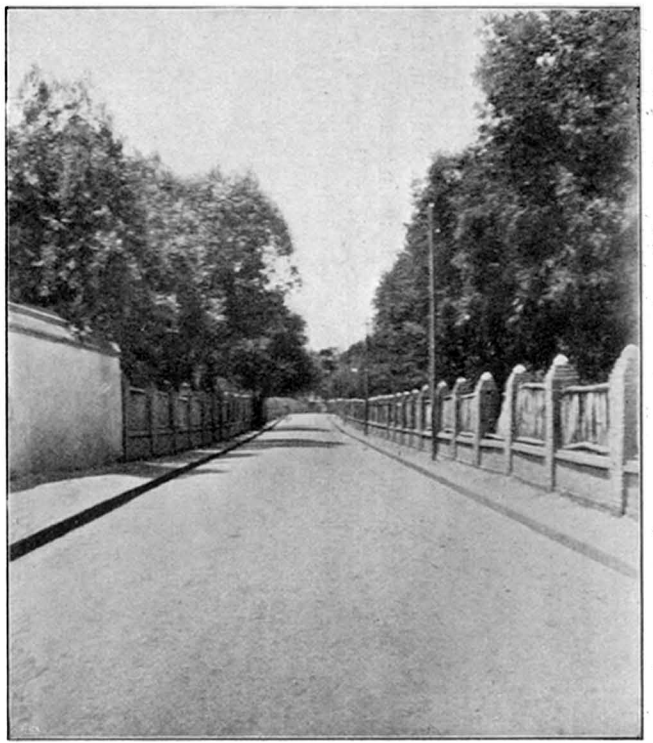
by Frenchmen. It is really part of the Chinese Imperial Rys. but is under the supervision of the French, as a guarantee for the fulfilment of the terms of the loan which was obtained by the Chinese for the construction of the line. It is one of the best kept lines in China, being maintained with the utmost order and efficiency under the strong hand of the manager, Monsieur Millorat. I give some photographs of the Old and the New. First a view of the old main road from the plain to T'ai Yuan Fu, showing more the nature of a stone-quarry than a main artery of traffic, and then the New, where the »Cheng-T'ai» railway is proudly entering the province on a handsome steel girder-bridge.



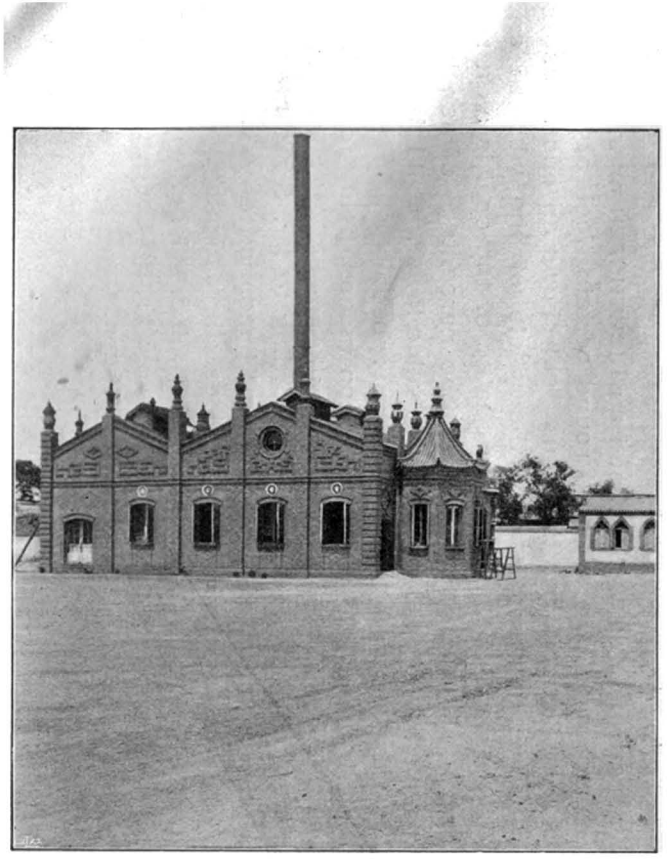
The Cheng T'ai Railway entering Shansi.

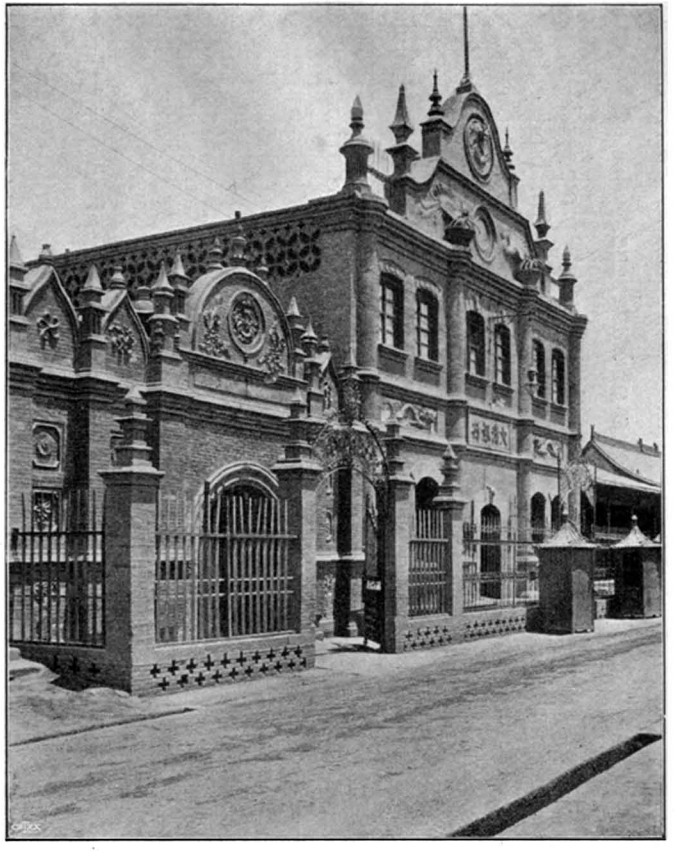
I have mentioned that this line was built by the French. The northern line at Ta T'ung is constructed with Chinese capital and by Chinese Engineers. — — — Branching out from the central (Cheng T'ai) line at Yü Tse (see map) we have now in construction another line the so-called T'ung P'u Railway, at present being built from Yü Tse through T'ai Ku and further to P'ing Yao. This is also Chinese built. It is intended to continue this line to the N. and S. when it should form the main central trunk-line of Shansi. It is now being built with the standard broad gauge.





Old and New Streets in T'ai Yuan Fu.





Electric Light Station and the Ta Ch'ing Bank in T'ai Yuan Fu.

General Signs of Progress.

The influence of railways on the general progress is here as elsewhere remarkable. We find in T'ai Yuan Fu land going up in value, new buildings springing up like mushrooms, excellent macadamised roads constructed, the population increased, and many other signs of increased prosperity. I print here some photos to illustrate this, viz. an old street before the arrival of the railway, one of the new, handsome, electrically lit and well-kept streets. Also some buildings such as the Electric Light Station and the Ta-Ch'ing Bank.

A Review of the Conclusions arrived at by our Work.

To recapitulate the results of our research work, we have arrived at the following conclusions.

Regarding the coal, the areas of Anthracite and Bituminous Coals are not so well defined as RICHTHOFEN maintains, but the former is concentrated round certain »foci» at Tse Chou and P'ing Ting. The Bituminous Coal shows an enormous extension, comprising almost the whole of the western and northern part of Shansi. The quality of the coal is as a rule inferior to the English product, the percentage of ash being very much higher and the caloric value lower. Still it is usually quite good enough for industrial purposes.

The Iron Ores are very common indeed, being found in at least thirty districts. They are easily smelted, but low in percentage of the pure metal. According to Mr. Glass they are not rich in harmful impurities, but I mention once more that this matter ought to be more closely investigated.

The Copper Ores are not plentiful and I believe not very rich as a rule, they are found mainly in the South in the two districts Wen Hsi and Yuan Hsu Hsien.

The Lead and Silver Ores (Galena) show more promise. They are rather frequent and often quite rich.

Pyrites are common in the central part of Shansi and are not poor in Sulphur.

Fire-clay, Gypsum, Heavy Spar, Limestone and Salt complete this picture of mineral wealth.

The Future of Shansi.

Regarding development we admit that not much has as yet been done. But it is not too bold to maintain that the present situation is full of promise. What with the lines of communication already accomplished or under construction, what with the general standard of education being raised by so many schools and colleges, what with many Shansi students studying abroad, who will come back to take their share in the work of progress, I consider that with regard to future progress, no pessimism need prevail. I believe that ultimately Shansi will take the place that Nature intended for her i. e.: The chief Coal and Iron producing country in the world.

August 1911.

E. T. Nyström.