

As is indicated in Fig. 6, these formations are considerably disturbed by a series of large faults which traverse the area, displacing the beds as much as 975 feet (300 mts) vertically. Obviously the beds in proximity to these large faults will be disturbed by smaller subsidiary folds and faults. This factor complicates any mining operations in these vicinities.

The lignite is, to all appearances, similar to the general run of better quality lignite found elsewhere in the Lebanon. It occurs in lenticular bodies, well up in the Nubian sandstone, in varying associations with basalt. The thickness of the seam is above the average found in other areas and the values are fairly good, particularly around the Arsoun district.

Historical:

All this area is recorded as having been exploited in 1835, and there is extensive evidence of old work over long outcrop distances. The lignite deposits in the vicinity of Merjlaya, 2 miles (3 kms) north of Ras-el-Harf village, were first worked by the Turks during the years 1835 - 1838, the mined product being transported by mule to Beirut, and thence shipped to Egypt. After this a small amount of extraction was done to supply a local silk factory.

Merjlaya, itself, in conjunction with Mar Youhanna, a few miles east, was worked extensively by the Germans during the period 1914-1918. The Germans went as far as to instal a Decauville tramway about 2.6 miles (4 kms) in length, extending from just below the adits right up to the road near Bhamdoun. The formation of this track is still in existence but badly broken and overgrown.

The Sources and Nature of the Lignite Occurrences.

The motive power for this haulage was supplied by stationary steam engines. No records are available of their production, but the construction of such a haulage indicated a fair figure. The tonnage mined during 1942 was only 778.

Conclusion:

The area as a whole, is suitably situated to be of particular interest from the delivery of coal to Beirut. Of the various properties mentioned, Merjlaya Mine, which is the most inaccessible from the point of view of transport is the only one in a state of development to be of immediate interest as regards production. The developed reserve of the mine, however, is small. The exploratory work at Arsoun and Bzebdine, particularly the former, should be intensified.

2. The Region around Abey.

Situation and Topography:

This region, particularly the Abey Mine, probably contains the largest lignite reserves of any deposit in the Lebanon. At Abey, itself, a conservative estimate by the writer puts the reserves down as at least 65,000 tons - a large figure for a single deposit in these parts.

The village of Abey is 20 miles (32 kms) from Beirut, at an altitude of 2760 feet (850 metres). The deposit lies 2 miles (3 kms) to the west of the village at the foot of a deep ravine. The country around here

The Sources and Nature of the Lignite Occurrences.

may be described as a series of large folds, with an amplitude around Abey of 975 to 1625 feet (300 - 500 metres) decreasing in a westerly direction down to the coast, a distance of 8 miles (13 kms) by footpath.

Geology:

This deposit, the outcrop of which can be traced for a distance of 2300 feet (700 metres), is interbedded in the sandstones of Lower Cretaceous age. These sandstones, although they are hard in situ, decompose and disintegrate in a short space of time, when exposed to air or moisture. This process of disintegration detaches layers of sandstone from off the galleries driven into it, and this is further assisted by the presence of thin layers of silt interbedded in the sandstone.

The lignite seam and the accompanying strata dip away towards the Mediterranean Sea in a westerly direction. Up the ravine, at the east end it disappears, but it is possible that it passes under the village of Abey, beyond which it would run against a Jurassic Basalt intrusion. At the lower western end of the ravine the seam folds downwards steeply and suddenly, and is probably thrown down below the floor of the Mediterranean Sea.

On the north side of this ravine, the seam appears to continue through the hill for another 2000 feet (600 mts) emerging on the south side of another valley near the village of Aaramoun. It is again visible on the north side of this latter valley. On the south side of the ravine below Abey, it is not possible to estimate the full depth of penetration of the seam.

Over the area described there are probably lignite deposits to the extent of 65,000 tons; this figure is arrived at by using a thickness of seam of 6 inches (15 cms).

The area is interspersed with numerous small faults, the two largest encountered in the workings to date, running North-West - South-East, and North-East - South-West and having a throw of 19 to 26 feet (6 - 8 metres) Exploitation of the deposit was carried out by the Germans during the Great War of 1914 - 1918, the actual mining being done in a very haphazard and unscientific manner.

Conclusion:

In another Section of this treatise the region around Abey and also that around Ras-el-Harf will be dealt with in a comprehensive manner. The reason for this is that both these properties were being exploited by the Société de Briquetage des Matières Combustibles, who used most of the mined product in their briquetting factory at Dora, Beirut, and were the only progressive firm connected with lignite. Moreover, both areas were conveniently situated to the town of Beirut, and for distribution throughout the Lebanon, should such an eventuality arise. For this and other supplementary reasons, it was decided after studying the other deposits in the Lebanon, to concentrate on Abey at the commencement. If required, the other deposits would receive further attention at a later date.

THE SOUTHERN LEBANON.

Situation and Topography.

The principal coal-bearing deposits are situated in the Aitouli region. (Fig 7.). Aitouli village, itself, is about 19 miles (30 kms) east of Saïda, and 4.5 miles (7 kms) west of Djezzine. The lignite occurrences lie between 1.3 miles (2 kms) north, and 2.6 miles (4 kms) south of Aitouli.

The main feature of the topography in this area is a North-South mountain range, 3,900 feet (1200 metres) high, capped by a rocky cliff and having a steep western flank which is deeply dissected by many ravines. The villages of Aitouli, Petit Mrah (Hamr Abou Jdid), Grand Mrah (Maknouniye), Zehalta and others are situated on spurs and ridges jutting out from this western flank, some 340 yards (300 metres) below the crest.

The Saïda - Djezzine main road by-passes this mountain at the northern end and two motorable roads run off southwards, skirting along this western flank. The lower of these two roads goes to Aitouli only. The Upper goes to Zehalta, and is being constructed towards Jebaa, further south. The villages of Petit and Grand Mrah are accessible by footpath only.

The topography of the country is such that, on the normal slope of the hills, the outcrops are eroded away, covered with scree and detritus of more resistant limestone and sandstone, and covered with surface slips of the overlying sandstone masses. The lignite, itself, and the commonly associated shales are not resistant to weathering and erosion. Consequently it is only where the streams have cut deep ravines into the hillside,

that a full succession, including the lignite, is revealed. Accordingly, the discoveries of the lignite in this area are mostly made in these ravines.

Geology:

The folding of the rock masses of the Lebanon in the Aitouli district, which have caused the lignite horizon to outcrop at various points, is illustrated in Fig. 8.

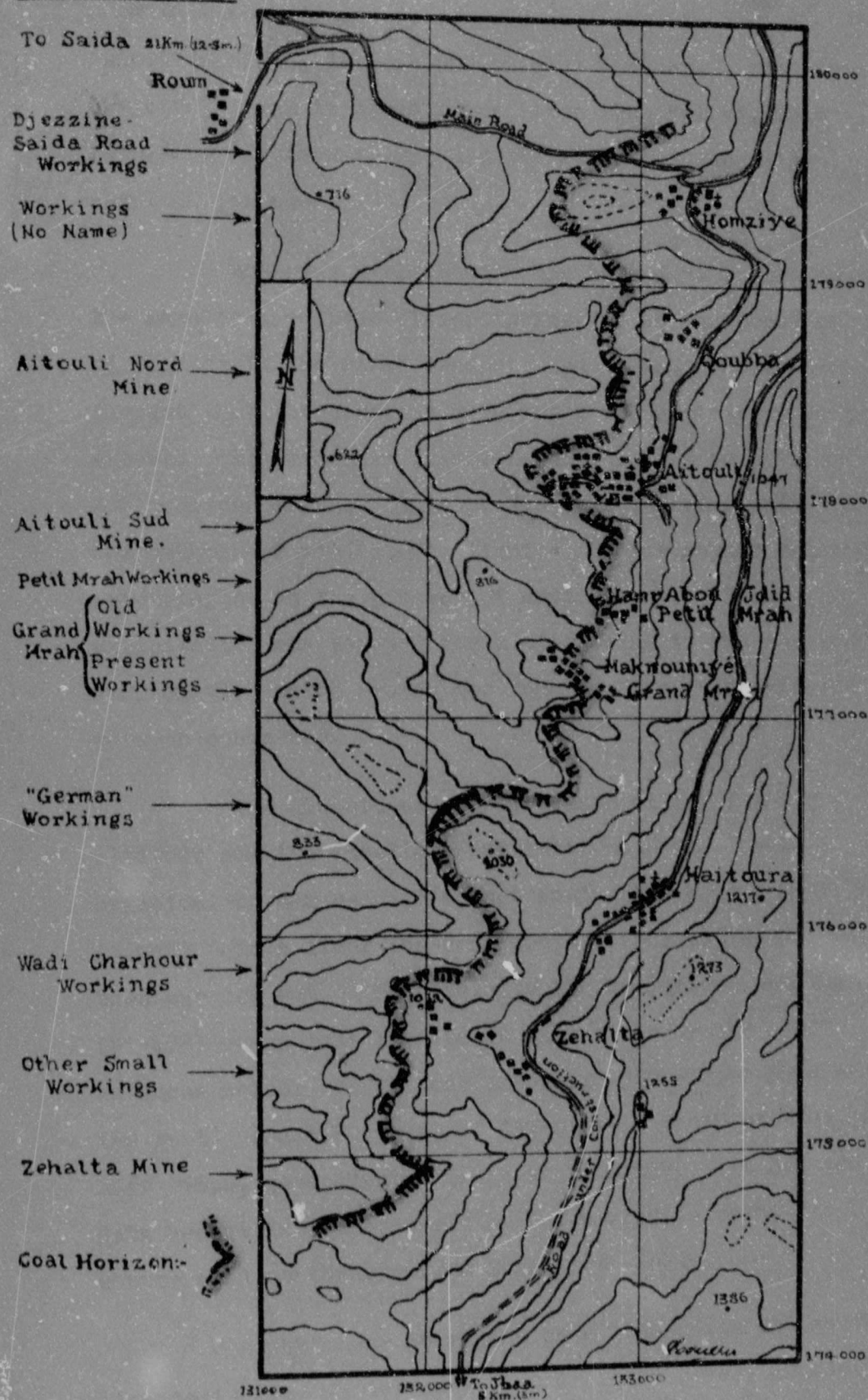
The outcrop or sources of outcrops, are located on the steep western flank of the above mentioned mountain range, some 1300 feet (400 metres) below the crest (at "A" in Fig. 8.), and dip eastwards into the mountain side, this dip varying from 10 to 25 degrees.

The lignite occurs in lenticular seams, interspersed in the Nubian Sandstone of the Lower Cretaceous. These lenticular seams are frequently of considerable extent, and in several mines have been opened up for distances of several hundred yards without any signs of "pinching out". The thickness and quality of the lignite also appears to remain consistent over similar distances. The lignite seams occur at different horizons in the sandstone within a width normal to the succession, of about 100 yards. Usually two or three seams are found in one locality, but at Grand Mrah (present workings), no less than five successive seams, one above the other, have been prospected.

Compared with other deposits in the Lebanon, it would appear that those in the Aitouli vicinity are more extensive individually, and generally above the average.

NAMES OF LIGNITE
WORKINGS IN AREA.

FIG. 7.



SKETCH PLAN OF AITOU LI AREA
SHOWING LIGNITE HORIZON AND WORKINGS.

Scale 1 : 25000

0 0.5 1 1.5 Kilometres.

Contour Interval : 50 metres.

The seams tend to be rather thin, but recent analysis show that the lignite is of good quality with a high calorific value, low ash and sulphur content. The seams are hard, break in large lumps, free from "dirt", thus requiring little sorting, and the fines are generally about 20 per cent.

Wherever exploitation has been done in the past the results have been disappointing due to the presence of schists in the mined product, and it was consequently thought that the deposits were not worth exploiting to any extent. Nevertheless it was found possible to extract 400 tons per month. This product was inferior owing to the methods of mining, the lignite and the schist remaining intermingled in the process of cutting out. Eventually exploitation was stopped for a time owing to the technical difficulties which proved too much for the inexperienced workmen concerned.

The advantages of this district are its low altitude and its immediate proximity to roads; also exploitation can be carried out during the winter months. At many points along the coal horizon prospecting has been carried out. Reference to the Geological Section (Fig. 8) shows that lignite in this vicinity may occur in three zones: "A" - near Aitouli, "B" - near Roum to the west, and "C" - east of Djezzine. South of Zehalta, near Jebaa, good lignite is known to exist. It has to date been rather inaccessible, but a road is being constructed southwards from Zehalta to Jebaa.

At "B" near Roum, and on a line north and south, lignite is also in evidence, but it is in a very crushed and shattered condition due to the steep folding of the formation at this point.

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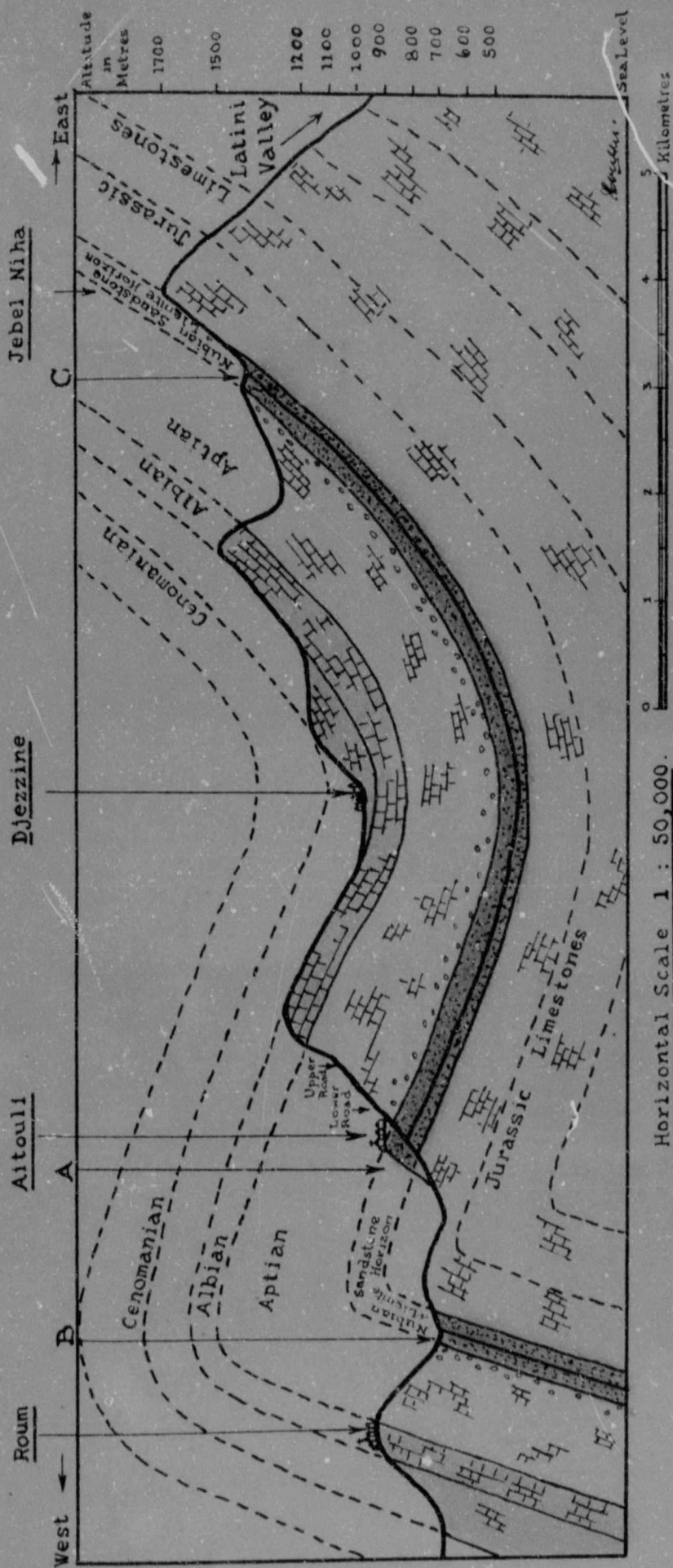
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East of Djezzine at "C" and on a line north and south, extensive coal seams exist, but have not been exploited to any extent. They are situated at a high altitude and work would only be possible during the summer months.

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oOo

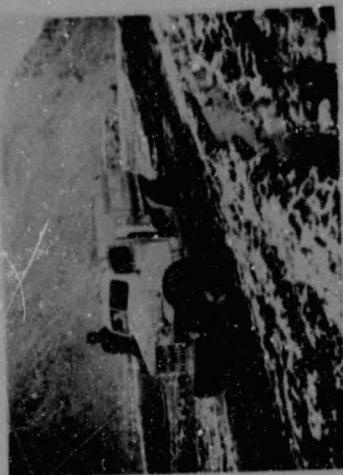
FIG. 8.



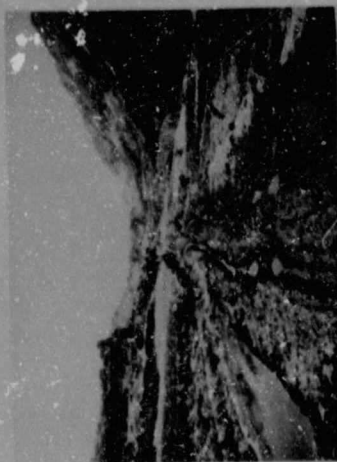
DIAGRAMMATIC GEOLOGICAL SECTION THROUGH AITOU LI - DJEZZINE AREA
 Illustrating Major Rock Folding which causes Lignite to Outcrop at A, B & C



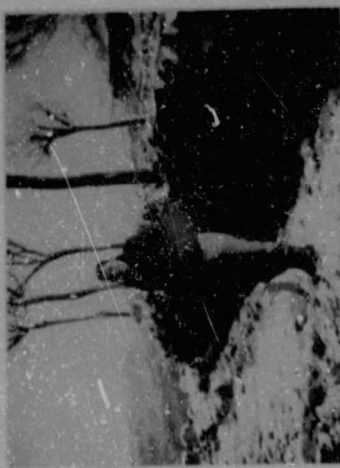
Yamoukou District.
From
top of Sijima. From
here the journey had to
be continued on foot.



Belas District.
The 4-wheel Drive Dodge
truck fits at this type of
country.



Yamoukou District.
Walking snow on the road,
(under visible) to Yamoukou.
Altitude 6,000 feet.



Belas District.
The outskirts of a village
covered during winter.



Yamnaev District.

Walking snow on the road,
(where visible) to Yamnaevine.
Altitude 6,000 feet.



Yamnaev District.

The "Edge o' Beyond". From
here the journey had to
be continued on foot.



Belaa District.

The outskirts of a village
deserted during winter.



Belaa District.

The 4-wheel drive Dodge
truck jibs at this type of
country.

VI. DIFFICULTIES OF EXPLOITATION.

The difficulties to be overcome for the successful exploitation of the Lebanese Lignite may be classified under:-

- (a) Lack of Technical Control and Supervision.
- (b) Lack of Practical Mining Experience.
- (c) Situation and Nature of Deposits.
- (d) Labour.
- (e) Transport.
- (f) Materials.
- (g) Attitude of Owners.

(a) Lack of Technical Control and Supervision.

When the question of technical control was considered it did not appear likely that sufficiently experienced mining engineers and foremen could be found in the Lebanon itself. There were engineers in the country, but their qualifications appeared to be fundamentally theoretical and not practicable. Also, it was the practice of mine owners to pay little or no attention to the advice of their engineers, or to give them much material assistance.

It was the neglect on the owners part to pay any attention to this side of the matter, that led to the necessity for the closing down of some of the mines by the Section des Mines. There is little doubt that to put them into operation again, direct technical supervision would be necessary to ensure that even the elementary rules of mining practice would be adhered to.

(b) Lack of Practical Mining Experience.

The mining operations that had been carried out in the Lebanon were extremely primitive and on a very small scale. Due, no doubt, to the lack of experience, little attempt had been made to introduce any systematic method of working the deposits, the main idea having apparently been to adopt a "hit and run" manner of working. As a result of this, there exist to-day, numerous entrances into individual deposits, some extending a considerable distance, others having been abandoned due to collapse of the roof.

The headings of principal galleries, secondary galleries, etc. wind round in an extraordinary manner. Pillars originally left for support in an effort to adopt some form of Pillar and Room method, have been robbed, either partially or wholly, in an effort to obtain easy coal. Consequently, there now exist many areas which cannot be entered with safety, and the doubtful amount of "Pillar Coal" left renders the re-opening a hazardous and costly task. Other old areas are completely blocked with rubble and so disturbed that they must be considered lost to further extraction.

The use of timber supports underground has been badly neglected. The deposits worked by the Turks and the Germans were usually fairly reasonably timbered, but those worked in recent years received little attention in this respect. Timber is plentiful but to-day it is expensive, the cost being about £5 per ton. In many instances the owners choose to work only in those areas where the roof and sides were sufficiently strong to require little timbering.

This eventually led to the abandonment of many blocks of ground where the lignite was of sufficient thickness and quality to merit extraction with judicious use of timber. Thus much of the tonnage explored by galleries was lost.

Another difficulty, which, when present, defeated all local mining efforts, was the presence of water, particularly in dip workings. Many galleries which had been following the lignite seam on the level or to the rise, had to be abandoned when the seam commenced to dip and water collected. No pumps, hand or otherwise, had ever been introduced. Pumps were expensive and spares, etc., difficult to obtain. The most successful, therefore, were those to the rise. Where a virgin deposit was known to dip into the hillside, the exploiters were adverse to undertake the driving of tunnels in country rock in order to strike the seam at depth and work back up the rise, thus overcoming the drainage problem to a great extent. Generally speaking, however, the deposits were not greatly troubled with water.

As regards ventilation this was always "natural", and it is strange to record that on most properties, this, if not good, was never bad. The exploiters always appeared to have sufficient initiative to arrange a system of ventilation, either by subsidiary adits or by small vertical shafts or wells.

The actual mining of the galleries was a slow and tedious task, being done entirely by hand-pick and shovel. Even in recent times it was found impossible to permit the use of explosives, because it could never be correctly ascertained whether explosives so issued would be used for mining. It appeared that explosives were much in demand for "coastal fishing" operations, and no matter

Difficulties of Exploitation.

into whose charge the issue was placed, there was always a leakage. Moreover, the use of explosives in many workings would have been dangerous in inexperienced hands, as no matter how light a charge was used, the least shattering effect caused by the detonation would have disastrous results on the badly supported surrounding strata. Underground transport is also a tedious operation, this being done by small boys using wooden wheelbarrows or baskets. The installation of tracks underground was practically impossible owing to the twisting nature of most of the roadways.

(c) Situation and Nature of Deposits.

As has already been indicated, the lignite occurs in the Lebanese mountains, in the form of lenses. It is either interspersed in the sandstone of the Lower Cretaceous or in the volcanic tuffs at the summit of the Jurassic. It is found at altitudes varying from 1000 to 5200 feet (300 - 1600 metres), the higher altitude deposits being located in the Northern Lebanon, as at Becharre. Many of these deposits are situated in deep ravines, difficult of access, and were rendered visible by the action of streams weathering and erosion.

Local assumption of the presence of coal was made mainly from outcrop observations and the subsequent knowledge that the occurrences were lenticular in shape. The correlation of geological formations was scarcely considered. No diamond drilling had ever been attempted, but in some cases where the seam was thought to be near the surface, prospect pits were sunk in order to ascertain the thickness and quality of the seam (e.g. Kartaba).

One of the natural difficulties encountered in the mining operations is the thinness of the seam. Only in a few cases does this exceed 24 inches (60 cms) in thickness. This results in a large amount of barren rock having to be excavated in order to obtain the lignite. Generally speaking, the nature of the lignite is soft and friable, and as such, particularly in thin seams, a large percentage of fine coal is produced. The presence of impurities in the coal considerably lowers the quality of the mined product, and careful sorting or washing is necessary.

Faulted zones also present difficulties to the inexperienced miners, and in some parts of the Lebanon, the deposits are greatly faulted. The situation of the occurrences, especially in the higher regions, also brings about difficulties due to climatic conditions.

(d) Labour.

The labour problem was a serious one, especially during wartime. Apart from the belligerent state of affairs, however, the labour problem will, in all probability, always present some difficulty, even during the best of times, as the native of Syria and the Lebanon is not endowed with a nature suitable to underground work. Like the raw South African native at his kraal, the Syrian labourer in the country prefers to laze in the sun during summer and hibernate during winter.

In most cases production could be at least doubled without any other assistance, were more labour available. During war-time, when the wheat and Black Market problems are extremely complicated, it appears that the labourers prefer employment with the Government. This is due to

the fact that, although the wages paid by the Government are on a lower scale to those paid by some of the mines, the labourers prefer to be so employed as they receive a regular wheat ration from the Government. This ration is in addition to their home ration which they are allowed to purchase. The mine labourers receive only their home ration, and receive nothing from the mine. This is not due to the mine owners being unwilling to issue a ration in lieu of wages, but to the fact that during these times of careful wheat control, the owners are unable to purchase in bulk.

The labour is mainly recruited from surrounding villages. During the months of October to December, a fair amount of the available labour is absorbed by the agricultural requirements of these villages. Following on this, the inclemency of the weather during January and February, when snow and rain are prevalent, rendering working conditions extremely unpleasant, the labourers prefer to lay off until better weather arrives. Mine owners and exploiters have little hold over this labour, and consequently can never be sure of the regular attendance of their employees.

On the majority of mines, the wages paid cause considerable discontent. The wages paid to miners on most properties were 4/6d. per day, while unproductive labour received up to 3/4d. per day. These are war-time figures and are an increase of 300 per cent on pre-war wages. The cost of living, however, has increased by an even greater percentage.

(e) Transport.

Next to the difficulties of mining comes the ever present problem of transport, the cost of which, in civilian undertakings, constitutes 28 to 40 per cent of the total cost of the marketable product at the coast; the lower

figure being for briquettes and the higher for lump lignite.

As has already been explained, most of the lignite occurrences are situated in ravines, or on the slopes of hills accessible only by footpath. The construction of roads or even cobbled cart tracks to these deposits is seldom worth considering on account of the small outputs. Consequently, the only means of transport available from a mine to a depot on the motor road, is pack mule or donkey. This is a slow, and in war-time expensive means, the high cost being mainly due to the price of fodder for the animals. In all cases the mules or donkeys are hired from contractors in some neighbouring village. The method of payment is to provide barley for the animals and also pay a balance in cash. An average cost can be taken as 10/10d. per ton per mile (£ Syrian 3. per ton per kilometre). As a mule contractor could increase his price as it suited him, on the plea of increased cost of feeding, and could withhold his animals until he received the demanded increase, the above arrangement of supplying barley was introduced.

Here again, the means of transport is affected by the climatic conditions. During the months of January and February, many of the highly elevated deposits are difficult of access by motor truck due to snow, and in some cases cannot be reached at all by road.

The consideration of any military or civilian market for lignite, would render possible a reduction of 50 per cent in transport costs by the supply of animal fodder and motor transport through military sources.

(f) Material.

The lignite deposits in the Lebanon are so situated and of such small size individually, that little mechanical

installation, as usually associated with mining, is necessary. The relatively small outputs do not justify the expense and maintenance of mechanical plant. Mining to date has been entirely by pick and shovel. In times of war, however, even the requirements for such elementary mining methods as are practised, prove an expensive item in the costs. The materials necessary are practically unobtainable, by civilians in the Lebanon; the prices, when obtainable, are prohibitive. For example, the iron required for picks was costing 2/7d. per lb. A shovel costs at least 12/6d.

As regards timber, of which a fair amount is required for underground supports, it is doubtful whether any assistance can be rendered. Timber is available in the vicinity of most of the deposits; it is mainly pine, and the price varies from £4.10s.0d. to £6. per ton.

It would appear, therefore, that although the assistance in the supply of materials is not great, if such assistance were possible through military means, a further reduction in working costs would be attained.

(g) Attitude of Owners.

The attitude of owners and holders of exploitation permits is one of apathy. This is understandable when the cost of production and lack of a stable market is considered, both of which result in small outputs with little profit.

With the advent of war, the logical increase in mining operations to produce a substitute for imported coal, did not materialise to the extent it should have. To a large extent this was probably due to the fact that there were stocks of imported coal in Palestine and Syria at this period. Also local industries were definitely prejudiced

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