dip of the axis of the arch here, is due to the fact that it is down-faulted against the Jurassic along a line roughly parallel to the line of outcrop of the purple-red volcanics. The shale outcrop is not continuous. It is found near the apex of the arch, and again 1300 feet (400 metres) down on the north-north-west side. Narrow beds of good quality lignite are found in the shales at both places.

(a) The Upper Region. (Map Reference 1686.2535. Altitude 5850 feet.)

Most of the old workings had caved in owing to the winter conditions, and it was not possible to examine many coal outcrops. The beds dip at 45 degrees eastwards. The lignite occurs in two bands each about 9 inches thick, separated by 3 feet of shales. The upper band is of better quality than the lower. Various prospect adits have revealed lignite of average appearance about 12 inches thick.

Analysis of Upper Region.

An analysis of the Upper band yielded:

- Moisture ....... 5.6%
- Volatiles ....... 35.0%
- Fixed Carbon ....... 22.8%
- Ash ....... 42.2%
- Sulphur ....... 7.8%
- Calorific Value ....... 7,560. (4260)
  B.T.U.s and Cals/kilo.

(b) The Lower Region. (Map Reference 1686.2542. Altitude 5525 feet.)

About 1300 feet (400 metres) along the outcrop of volcanics, down the northern slope of the arch, the lignite has again been picked up in a seam 7 inches (18 cms) thick. Three adits have been driven, one of which extends 55 feet (17 metres) in. The seam appears
Detailed Accounts of Deposits.

...to be consistent and of fair quality.

Analysis of Lower Region.

An analysis of the lignite here showed:

- Moisture: 8.0%
- Volatiles: 32.5%
- Fixed Carbon: 28.9%
- Ash: 38.6%
- Sulphur: 10.3%
- Calorific Value: 8,350 B.T.U. and 2,580 Cals./kilo.

B.7. MAZRAAT BENI A'SAAR (Map Reference 1652.2589. Fig.14).

Location.

The village of Mazraat Beni A'Saab lies on the road that runs eastwards from above Beit Mender, through Qanate, and on to Chekka 19 miles (30 kms) distant. It is about three miles (5 kms) from the main road near Beit Mender, and lies at an altitude of about 3575 feet (1100 metres).

South-east of the village, the Nubian Sandstone slopes up at 15 to 20 degrees with a strike north-east and south-west. The drainage is down the dip slope, and from time to time wadis have been cut deep enough into Nubian Sandstone to expose the underlying volcanics, which themselves outcrop extensively at the heads of the valleys. Carbonaceous shales are sometimes associated with these volcanics here, as elsewhere in the Becharre area. These shales are sometimes coal-bearing.

About 0.5 mile up the wadi on the east side of the village of Mazraat, there is an outcrop of carbonaceous...
SKETCH PLAN OF MAZRAAT BENI A' SAAB

Scale 1: 400

Plan

25°

27°

30°

N

Debris

Waste Shales and Debris

Waterfall

Sections

East Side of Wadi

332° Mag Bg

Nubian Sandstone

Shales with Lignite

Purple-Red Volcanics

West Side of Wadi

156° Mag Bg

Shales with Lignite

Purple-Red Volcanics

320° Mag Bg

Nubian Sandstone

White-Grey Tuffs

Dark Blue-Green Veined Volcanics
shales which are coal-bearing. This outcrop was worked in 1938 by an Iranian Company, but their period of exploitation was short as technical and other difficulties put an end to the work.

Nature of the Seam.

Here again the shales have been deposited in a basin of the purple-red volcanics. Again too, they are associated with a more recent volcanic intrusion of blue grey veined basalt, which in its lens-shaped formation, resembles that overlying the coal at Blaouza Mine. This basalt outcrops on the west side of the wadi, but appears to be absent on the east. The shales dip more steeply on the east side (27°), than on the west (17°).

There is no direct evidence concerning the depth of the shales, but they are certainly from 5 to 10 feet (1.5 - 3.0 metres) in thickness. The lignite appears as a seam, 12 to 24 inches (30 - 60 cms) thick, near the top of the shales, but the quality is below the average. The best quality lignite on the east side is in the lower workings, and the quality deteriorates up the dip. On the east side these lower adits have been the most extensively worked, but water difficulties eventually caused the exploiters to abandon work.

Analysis.

Four samples, taken in the accessible parts of the workings, gave the following results:

<table>
<thead>
<tr>
<th></th>
<th>No.1</th>
<th>No.2</th>
<th>No.3</th>
<th>No.4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture</td>
<td>7.5%</td>
<td>10.0%</td>
<td>4.0%</td>
<td>10.0%</td>
</tr>
<tr>
<td>Volatiles</td>
<td>26.7%</td>
<td>29.5%</td>
<td>37.4%</td>
<td>32.5%</td>
</tr>
<tr>
<td>Fixed Carbon</td>
<td>47.0%</td>
<td>29.5%</td>
<td>17.4%</td>
<td>5.4%</td>
</tr>
<tr>
<td>Ash</td>
<td>5.4%</td>
<td>5.4%</td>
<td>5.0%</td>
<td>2.9%</td>
</tr>
<tr>
<td>Sulphur</td>
<td>5.560</td>
<td>7.020</td>
<td>6.100</td>
<td>8.530</td>
</tr>
<tr>
<td>Calorific Value</td>
<td>3090</td>
<td>3900</td>
<td>3390</td>
<td>4740</td>
</tr>
</tbody>
</table>
Comment.

It is impossible to say how far to the north-west and south-west, the lignite extends. It is only on the south-east that the boundary is clear. Further prospecting is necessary to form a definite opinion of the deposit.

There are also several other deposits of carbonaceous shales in this neighbourhood associated with the purple-red volcanics and the blue-grey basalts, but the lignite occurs only in thin stringers.

C.8. FURTHER CARBONACEOUS OUTCROPS IN THE BECHARRE DISTRICT.

Brief reference may be made to five other occurrences situated in the Becharre district. These are at Douair, Upper Qadicha Valley, Douma, Brissiette and above Qnaiouer.

DOUAIR. (Map Reference 1705*2536. Altitude 5690 feet : 1750 metres).

This outcrop is best reached by footpath from Hadet to Douair, the distance being about 4.5 miles (7 kms) (Hadet is 25 miles from Tripoli). About 10 feet (3 metres) below the Nubian Sandstone, in volcanic tuffs, occurs a seam of coal about 6 inches (15 cms) thick with much grey tuff embedded. Thinner veins of coal occur above this. Three test adits have each revealed the seam.

The analysis of a picked sample gave a value of 7,960 B.T.U.s (4420 Cals/kilo), 33.4% Volatiles, 21.4% Fixed Carbon, 45.2% Ash, and 4.9% Sulphur.
UPPER QADICHA VALLEY. (Map Reference 1777, 2549
Altitude 4875 feet: 1500 mets)

This carbonaceous outcrop lies in the Nubian Sandstone on the south side of the Qadicha Valley about 32.5 miles (52 kms) from Tripoli. It may be reached by climbing up from the Recharre Mine, or down from the Qadicha Caves.

A bed of carbonaceous shale, 3 feet thick, outcrops between some black, pillar basalts (below) and the Nubian Sandstone (above), over a distance of 490 feet (150 metres). The structure, however, is considerably complicated by hill creep, and is masked by surface scree. Nothing that could be reasonably called coal was found. A sample from a 3 inch band would scarcely burn and yielded 84% ash.

DOUMA. (Map Reference 1634, 2513.
Altitude 4710 feet: 1450 metres.)

This outcrop, the only one reported in the area, is best reached by means of a footpath that climbs eastwards from the village of Douma, from which it is 3 miles distant. Douma, itself, is situated 21 miles (34 kms) from the coastal town of Batroun. The shales contain no coal and are of poor quality.

BRISSIETTE. (Map Reference 1717, 2560.
Altitude 4350 feet: 1340 metres)

Along the Hadet-Hasroun road, where the side road branches off by the "Dimane" sign, an outcrop of carbonaceous shale may be seen about 40 feet (12 metres) above the road, on the south side. Several small adits driven into these shales, which are of indifferent quality, have revealed no coal.
A carbonaceous outcrop occurs on the south side of the Hadet-Beit-Mender road, near where the track to Qnaicuer branches off the main road.

Here a band of shales, not less than 3 feet thick, outcrops in Jurassic tuffs. Several test adits were driven in, but only one revealed a thin seam of coal. The examination of outcrops indicated that the shales are not extensive, and it is likely that what was found is all that remains of a lens that formerly extended towards Beit Mender, but which has since been largely eroded away.

II. THE KARTABA AREA.

9. KARTABA MINE. (Fig. 15). (Map Reference 1610.2393 Altitude 3670 feet: 1130 metres.)

Location.

The village of Kartaba is situated 21 miles (35 kms) south-east of J'Beil. Just below the village itself, there exists a deposit of lignite which has been exploited by the Germans during the War 1914-1918. The deposit, characteristic of those of the Northern Lebanon, lies in the volcanic tuffs of Jurassic age, a few feet above the conspicuous purple-red volcanics.

Nature of the Seam.

The deposit is in the form of a lens, the average thickness being 20 to 24 inches (50 - 60 cms). The direction of the dip varies, depending on the position in the lens, but the general dip is east.
FIG. 16

SKETCH PLAN OF KARTABA MINE

No. 1 ADIT WORKINGS.

Scale 1:200

130 ft. to Entrance. (348°).
FIG. 17.

SKETCH PLAN OF KARTEBA MINE

No. 2 ADIT WORKINGS

Scale 1:250 Approx.
Detailed Accounts of Deposits.

The coal is of a higher calorific value and contains less pyrite than many others in the Lebanon, but, as is usual, the ash content is high. It would appear that the deposit to date is half worked out, the remaining tonnage being about 3,000.

Analysis.

An analysis of two samples gave the following results:

<table>
<thead>
<tr>
<th></th>
<th>No. 1 Adit.</th>
<th>No. 2 Adit.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volatiles</td>
<td>37.21%</td>
<td>31.90%</td>
</tr>
<tr>
<td>Fixed Carbon.</td>
<td>26.54%</td>
<td>26.90%</td>
</tr>
<tr>
<td>Ash</td>
<td>36.25%</td>
<td>41.20%</td>
</tr>
<tr>
<td>Sulphur</td>
<td>9.24%</td>
<td>6.40%</td>
</tr>
<tr>
<td>Calorific Value</td>
<td>9,160</td>
<td>8,230</td>
</tr>
<tr>
<td></td>
<td>(5200)</td>
<td>(4570)</td>
</tr>
</tbody>
</table>

Comment.

It must be mentioned here that in the investigation of the Kartaba Area, the three deposits at Kartaba, Aalmate and Bkarta proved of most interest, especially from the aspect of transport from mine to road depots, and consequently they were studied in greater detail.

In exploiting the deposit at Kartaba, the Germans used two methods. One was to sink small vertical shafts until the lignite seam was reached, and then to mine around the bottom of the shaft, extracting as much lignite as possible under the circumstances. The second method employed was possibly a result of the information obtained from these shafts. This was to drive adits through the non-coal-bearing ground, until the coal seam was reached, and then to commence extraction. As is evidenced in all other deposits worked during this period, no systematic method was employed, with the inevitable result that the workings resembled 'rabbit-warrens'.
In No. 1 Adit (Fig. 16), the haphazard method of mining is particularly bad, and water is troublesome. In No. 2 Adit (Fig. 17), it would not be difficult to develop into the virgin ground ahead of the worked-out areas. This adit enters the lens, which is apparently oval-shaped, along the major axis, travelling in a north-westerly direction. It was driven on a slight up-grade. When the seam dipped over, water collected at the face, and work was stopped.

It is possible that as the seam dips into the heart of the lens, it will widen out. Afterwards, it may be expected to commence rising and decreasing in thickness.

At present the property is being exploited by the Compagnie Perso-Libano-Syrienne, as are also Aalmate and Bkarta, but on a very small scale. During the 2½ years they have been working, only 250 tons of lignite have been extracted. The reasons for this restricted output appear to be:

(1) Difficulty in working due to the presence of water. Although the workings are not actually flooded, the seam, itself, in the dip workings is being covered in water. As no pumps were installed, these dips had to be abandoned.

(2) Labourers were not willing to work for 4/2d. per day, and were demanding 6/3d. per day.

(3) Most of the material had been removed to the Aalmate Mine, where the owners preferred working.

(4) The deposit extends directly underneath the village of Kartaba, and already various buildings and dwellings have been undermined, but no apparent damage has been done; some of the occupants have discovered this fact of undermining, and are threatening action if further work proceeds in the direction of their property.

(5) Owners of the ground on which the property exists, are
creating difficulties, the exact nature of which are somewhat obscure, but apparently they are connected with royalties.

Overlooking the question of undermining the village, the deposit at Kartaba is very promising, and has two particular features which render it worthy of further consideration:

(a) The seam is two to three times the average thickness of the majority of deposits in the Lebanon, thus giving a correspondingly greater output for every foot advanced.

(b) The depot for the mined product can be established at the entrance to the mine, and motor trucks can drive right up to this dump. Direct transport can therefore, be effected straight from the mine to J'Beil on the main coastal road, a distance of 21 miles. The Haifa-Beirut-Tripoli Railway also passes through J'Beil.

10. AALMATE MINE. (Fig. 18)
(Map Reference 1554.2418, Altitude 3090 feet: 950 metres)

Location.

Aalmate village is situated about 12 miles (19 metres) from J'Beil on the J'Beil-Kartaba road. 0.5 mile north-east of the village there is a small lens of lignite, that has been worked fairly extensively in the past, especially by Italians prior to 1914.

Nature of the Seam.

The lens, from present observation appears to be semi-oval in shape (Fig. 18). The dip is variable and is generally from east to west. The figure gives a plan of the existing workings, and shows dips and thicknesses of coal. It is likely that the workings are more
extensive than they are shown to be in the plan, as falls barred the way to some parts of the mine and complete mapping was impossible.

There are three clearly defined seams of coal in this mine. No. 1, the uppermost, has an average width of 14 inches (35 cms), and is a fair quality lignite, extractable in large lumps. Directly below No. 1 Seam, lies No. 2 with an average width of 24 inches (60 cms). Part of this seam could be mined with No. 1 Seam. Again, directly below No. 2 Seam, comes No. 3 Seam, which is inferior and of no commercial value.

Analysis.

Analysis of samples of the three seams, taken in the mine gave the following results:

<table>
<thead>
<tr>
<th></th>
<th>No.1 Seam</th>
<th>No.2 Seam</th>
<th>No.2 Seam</th>
<th>No.3 Seam</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volatiles</td>
<td>34.25%</td>
<td>31.30%</td>
<td>34.24%</td>
<td>25.29%</td>
</tr>
<tr>
<td>Fixed Carbon</td>
<td>23.45%</td>
<td>23.80%</td>
<td>19.52%</td>
<td>11.91%</td>
</tr>
<tr>
<td>Ash</td>
<td>42.30%</td>
<td>44.90%</td>
<td>46.24%</td>
<td>62.80%</td>
</tr>
<tr>
<td>Sulphur</td>
<td>11.24%</td>
<td>7.21%</td>
<td>5.24%</td>
<td>8.07%</td>
</tr>
<tr>
<td>Calorific Value</td>
<td>7,520</td>
<td>7,530</td>
<td>7,020</td>
<td>4,700</td>
</tr>
<tr>
<td>B.T.U.s and Cals/kilo</td>
<td>(4180)</td>
<td>(4190)</td>
<td>(3900)</td>
<td>(2630)</td>
</tr>
</tbody>
</table>

Comment.

Referring again to Fig. 18, adits "A" to "G" are those that have been chiefly worked. "H" shows some coal, though of poor quality, on the southern side of the fault that cuts the adit. Carbonaceous shales have been up in a test pit dug some 70 yards west-south-west of "H", and again at "J", on the south-west side of the fault. It is not unlikely that the lignite is more extensive than the plan shows, but the small faults that are found in the area may have up till now prevented it from being traced. It is also possible that this deposit extends further west, but prospect pits, adits or diamond drill holes would be necessary to prove this.
It is estimated that the remaining available tonnage in No. 1 Seam is 700; that of No. 2 Seam 1,000. Mining has been haphazard. The most satisfactory method of extracting the remaining tonnage would be to continue driving the adits, of which there are quite a number, until the perimeter of the lens is reached and commence extraction on the Longwall Retreating System.

Transport of the mined lignite to the road depot, does not present undue difficulties at Aalmate. By mule, the distance from the mine to the road depot is 0.5 mile over easy terrain. There is also a cableway at the mine which stretches across the valley and deposits the load about 130 feet (40 metres) from the main road. This is only used when the weather is bad and mules or donkeys cannot cross the river, but there is no reason why this cableway should not be improved upon and used continually. The length of the cableway is 1300 feet, (400 metres) and it carries a load of 140 lbs. (65 kgs). Transport of the coal to a road depot is therefore, comparatively simple. From this depot to J'Beil on the coast, there exists an all weather road.

The visit to the mine was paid in exceedingly bad weather, with blinding rain, sleet and wind. There were no workmen in the mine, and this is usually the case when the weather is indolent. In ordinary circumstances, the daily output at Aalmate was 5 tons, with the employment of 25 men.

11. BKARTA MINE. (Figs. 5a and 19)

(Map Reference 1573.2433.
Altitude 4225 feet: 1300 metres).

Location.

Near the village of Bkarta which is situated 7.5 miles (12 km) north-east of Aalmate, there are
Scale. $\frac{1}{4}$ inch = 1 ft.

Figures represent thickness of Seam.

Drive being driven to surface.
Detailed Accounts of Deposits.

outcrops of lignite which can be traced for some distance and which are being opened up on a small scale. The mine is situated about 0·25 miles (400 metres) from a dump on the Ehmej - El Mourada road. The distance from this road depot to J'Beil is 17·5 miles (28 kms).

Nature of the Seam.

The seam occurs in the black basalts of the Jurassic, below the purple-red volcanics, the outcrop being visible at various points over a distance of 440 yards. Intense folding and faulting are much in evidence here, and complicate the structure. As disclosed by the workings to date, the seam has an average thickness of 26 inches (65 cms). The dip, however, which generally tends to be west, varies from 10 degrees upwards, in some cases being as much as 30 degrees.

Analysis.

The results of the analysis of two samples from the mine are as follows:-

<table>
<thead>
<tr>
<th></th>
<th>1. Selected.</th>
<th>2. &quot;Rur-of-Mine&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volatiles</td>
<td>33·29%</td>
<td>32·70%</td>
</tr>
<tr>
<td>Fixed Carbon</td>
<td>29·44%</td>
<td>23·70%</td>
</tr>
<tr>
<td>Ash</td>
<td>37·27%</td>
<td>43·60%</td>
</tr>
<tr>
<td>Sulphur</td>
<td>12·25%</td>
<td>9·20%</td>
</tr>
<tr>
<td>Calorific Value</td>
<td>8,600</td>
<td>7,690</td>
</tr>
<tr>
<td>B.T.U.s and</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cals/kilo</td>
<td>(4780)</td>
<td>(4270)</td>
</tr>
</tbody>
</table>

Comment.

A plan of the mine is given in Fig. 19. The main adit, running northwards, has followed the top of the coal lens, turning slightly westwards in so doing. The coal is of fair quality, but contains much pyrite in blebs, more so than most deposits in the Lebanon.
Thickesses of the seam at various points in the workings are also shown in the diagram. About three-quarters of the seam is extractable only as fines, the remainder being in fair-sized lumps. On the east side of the main adit, the seams thins rapidly, and it is evident that the adit is near and more or less parallel to the eastern limit of the lens.

The winze to the west-north-west runs approximately down the dip and along it the lignite maintains a good thickness and apparently constant quality. This winze runs into water 40 feet down the dip, but is reported to continue another 24 feet with the lignite unchanged. The gallery to the south-west of this gallery has been driven with the intention of reaching the surface in the neighbourhood of point "B". The apparent thinning of the seam in this gallery is due to the fact that the lignite has been left in the roof in the latter part of the gallery. The lens, however, almost certainly does thin out in this vicinity. On the east and south, the limits of the seam are defined, but the extent towards the west and north are unknown. Only further investigation towards the west will reveal the extent of the lignite in that direction. It is possible that the lens will extend some distance down the dip of the rocks.

This mine is one of the few in the Lebanon, in which a system of mining has been genuinely attempted. It is also the only mine in which systematic timbering has been carried out.
Author  Coulter J
Name of thesis  The occurrence and exploitation of lignite in the Lebanon  1944

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