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The Shamut Coal Deposit, North-Central Armenia

By Brenda S. Pierce, Gourgen Malkhasian, and Artur Martirosyan

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All data relating to the Shamut coal deposit — stratigraphic, coal quality, and resource information — are contained in this one comprehensive, interpretive report

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THE SHAMUT COAL DEPOSIT, NORTH-CENTRAL ARMENIA

By Brenda S. Pierce,[1] Gourgen Malkhasian,[2] and Artur Martirosyan[2]

[1] U.S. Geological Survey, 956 National Center, Reston, VA 20192.
[2] U.S. Geological Survey Armenian Staff, #5 1st Byway of Aigedzor, Yerevan, Armenia.

INTRODUCTION

There are six known coal fields in Armenia — Shamut, Antaramut, Ijevan, Jermanis, Jajur, and Nor Arevik (fig. 1) — as well as other minor coal deposits or occurrences. Armenia also contains oil shale deposits at Dilijan, Aramus, Jajur, and Nor Arevik (fig. 1).

The Shamut coal deposit (location number 6, fig. 1) is located near the village of Shamut in north-central Armenia approximately 20 km southeast from the town of Alaverdi in the Lori Administrative District. The Shamut coal field is located near the Martsiget River, which is a tributary to the Debed River.

SOURCE OF DATA

For the first time, all data relating to the Shamut coal deposit (stratigraphic, coal quality, and resource information) are contained in one comprehensive, interpretive report. This report is the result of a multiyear study of coal exploration and resource assessment of Armenia. Reported here is a synopsis of previously inaccessible data contained either in the State Archives (Fund) of the former U.S.S.R. Ministry of Geology and current Republic of Armenia's Ministry of Environment or the former Soviet and current Republic of Armenia Academy of Sciences. All reports within the State Archives and Academy of Sciences related to coal in Armenia were obtained, translated, and analyzed. Contained here are all the basic data found relating to the Shamut coal deposit. We have supplemented the archival information with some additional data from our earlier published works.

As part of our study of Armenian coals, we built stratigraphic data bases of all the coal information from the original archival reports. The stratigraphic data bases are reproduced here in tabular format, with all data credited to the original author. Additionally, all available coal quality data and coal resource estimates are reported here.

In addition, we took the stratigraphic data bases created and recalculated the coal resource estimates on the basis of the original data. The results are sometimes the same as those of the original estimations from the archival reports and sometimes not. Both situations are reported and described in detail.

The Shamut coal deposit has been mentioned in many internal archival reports, including those by Paffenholtz (1934; 1948), Aslanian (1949), Nazarian (1950), Asatiani and Aragunova (1953), Kacharava (1953), and Aloyan and Hakopian (1995); a subsequent study was done of all coal deposits in Armenia (Pierce and others, 1994). The main stratigraphic work on the Shamut coal bed comes from Kacharava (1953), and the main geochemical data come from Asatiani and Aragunova (1953). Minor additional stratigraphic data come from Aloyan and Hakopian (1995), and additional coal quality data come from Pierce and others (1994).

STRATIGRAPHIC DATA

Most authors who studied the Shamut coal deposit (Kacharava, 1953; Asatiani and Aragunova, 1953; Aloyan and Hakopian, 1995) reported three coal beds, with many minor coal lenses and large beds of carbonaceous shale throughout the section. Aloyan and Hakopian's (1995) coal-bearing suite ranges in thickness from 65 to 125 m, and the specific coal strata range from 5 to 25 m in thickness. The coal-bearing strata are interbedded with carbonaceous shale, sandstone, clay, and claystone. According to Kacharava (1953), the coal-bearing section is continuous along at least 4 km, extending from the village of Shamut eastward to the village of Atan.

The Shamut stratigraphic data base, reproduced in table 1, comes from stratigraphic data contained in Kacharava (1953) and Aloyan and Hakopian (1995). Like most coal exploration work in Armenia, the majority of the work at Shamut was done in the 1950's. Kacharava's report is by far the most comprehensive, containing data from boreholes, trenches, shafts, and adits. Aloyan and Hakopian's study contains information from only three additional boreholes. Age designations contained in the data base are also from these authors.

The coal quality data found in the data base table (table 1) are taken directly from Kacharava (1953), although Asatiani and Aragunova (1953) performed the coal quality analyses. Kacharava (1953) recombined and reformatted some of the data from Asatiani and Aragunova (1953); therefore, his data were used in the data base table. Asatiani and Aragunova's (1953) data are reproduced in full in this report, but in separate tabular format (see tables 3 — 14), and are more fully described in the section "Coal Quality of the Shamut Deposit."

In creating the Shamut data base, we entered exactly what was contained in the Kacharava (1953) and Aloyan and Hakopian (1995) reports as original data. For vertical exploration work such as boreholes, data entry was a straightforward process. However, for horizontal exploratory work, such as adits and trenches, we had to develop a way to represent horizontal data in the vertical data base. The adits and trenches were divided into sections, depending upon their length and number of lithologies. Similar lithologies were grouped together horizontally. This (horizontal) point then became a data point in the vertical data base, with the coordinate being directly above the midway point of the subsection of the adit or trench. The lithology entered into that vertical point represented the dominant lithology within the horizontal section of adit or trench, and the thickness entered was the average thickness of the dominant lithology in that section.

Throughout the Soviet Union, an internal system of coordinates was used on all working (nonmilitary) maps. This internal coordinate system was a systematic *x-y* coordinate system. We converted the internal system of coordinates of the Shamut data to latitude and longitude. Both coordinate sets for the Shamut data are presented (table 2).

The exploration data — boreholes, adits, shafts, and trenches — are also graphically presented in figure 2. The map comes from work done by both Kacharava (1953) and Aloyan and Hakopian (1995). All but a very few of the data locality sites are on this map; those that are not present are outside the map boundaries. Because this was the only existing map in the archives of the Shamut coal field, we included information as appropriate.

Kacharava (1953) and Aloyan and Hakopian (1995) designated the three coal beds in the Shamut deposit as coals 1, 2, and 3. However, Kacharava (1953) labeled the coal beds 1 through 3 starting at the top and working downward, and Aloyan and Hakopian (1995) started at the bottom and worked upward. Therefore, to simplify things and avoid confusion, we have renamed these three coals "upper," "middle," and "lower." This systematic renaming applies to the stratigraphic data base, as well as the chemical tables.

COAL QUALITY OF THE SHAMUT DEPOSIT

The Armenian Government reports the Shamut coal deposit as having an average calorific value of 6,750 cal/g, moisture equal to 4.9 percent, ash yield (on a dry basis) equal to 48 to 49 percent, a volatile matter (on a dry basis) of 44.5 percent, density equal to 1.76 g/cm^3, a carbon content of 73.74 percent, a hydrogen content of 5.94 percent, a nitrogen content of 1.77 percent, an oxygen plus sulfur content of 18.5 percent, and a bitumen yield of 1.75 percent (unpub. data, Ministry of Environment, Republic of Armenia, 1999). Pierce and others (1994) reported a relatively high ash yield for this coal deposit, ranging from 49 to 75 percent (on a dry basis), and calorific values ranging only from 2,369 to 5,947 cal/g (on a moist, mineral-matter-free basis).

Most of the coal quality data on the Shamut coal bed come from Asatiani and Aragunova (1953). They conducted the coal quality analyses of samples collected by Kacharava in his study of the Shamut coal deposit in the early 1950's. Asatiani and Aragunova (1953) conducted quite an extensive series of tests on the Shamut coal deposit, probably more than for any other coal deposit in Armenia. These authors performed the regular proximate and calorific value tests (table 3 and table 4), ultimate analyses (table 5) and oxide analyses (table 6). In addition, they experimented with "enriching" (cleaning) the Shamut coal. They took several very large analytical samples, each 300 to 350 kg in weight. The enrichment process included several different methods, such as "manual enrichment," sieving, and float-sink separation on unground coals.

In the first test, these authors manually enriched five samples from the upper coal bed, three samples from the middle coal bed, and two samples from the lower coal bed and then analyzed each sample for moisture, ash yield, volatile matter, sulfur, calorific value, and density (table 7). Unfortunately, the text does not explain what is meant by "manually enriching" the coal and does not include a description of the size categories tested. As the authors later sieved, fractionated, and ground the samples, perhaps manual enrichment simply meant picking the cleanest looking coal particles to test. Whatever method the authors used did yield better quality coal. The average ash yields (dry basis) for Shamut beds with no enrichment (table 4) are as follows: upper bed = 57.95 percent, middle bed = 57.07 percent, and lower bed = 62.10 percent. Compare this to the manually enriched results (table 7): upper bed = 46.44 percent, middle bed = 50.94 percent, and lower bed = 50.16 percent. Thus, it is clear that the Shamut coal is cleanable.

Asatiani and Aragunova (1953) also took bulk samples, 300 to 350 kg in weight, from the three Shamut coal beds and performed different analyses upon these. When these bulk samples were taken, the coal naturally broke into certain size fractions. The first test to which Asatiani and Aragunova (1953) subjected a portion of these bulk samples was to measure the natural size fractions into which the coal broke and perform float-sink density separations within each naturally occurring size fraction. The results of these tests are found in table 8. The percent of the bulk sample found originally at each size fraction is also shown in table 8, as well as the percent recovery within each density separate within each size fraction. Only ash yield determinations were performed upon the density separates of each size fraction.

After this set of analyses, Asatiani and Aragunova (1953) then took a portion of each bulk sample and subjected it to crushing and sieving to predetermined size fractions. They then measured the percent recovery at each size fraction and the ash yield at each one; they did not perform any density separations on these size fractions. These results are found in table 9.

Another set of washability analyses was performed on the Shamut coals with size fractionation and density separation (table 10). Again, it is unclear from Asatiani and Aragunova's (1953) text exactly how these samples were prepared. They explain, though, that "the large size fractions" were crushed to the three size fractions shown in table 10. Although not specifically stated, we assume that they took any fractions remaining from the three bulk samples, combined them in a single sample, and crushed the combined sample to the three size classes shown in table 10.

These three sets of analyses seem to indicate that the Shamut coal (really, carbonaceous shale) beds have very high ash yields and are very difficult to clean. Asatiani and Aragunova (1953) concluded that sieving would not work as a cleaning method and that the enrichment process was too difficult because they had to grind the coal too small to get a good ash yield. However, because the authors never ground the samples that they also subjected to density separation (table 8) and they did not subject to density separation those samples that they ground (table 9), these tests are probably not very indicative of the Shamut coals' ability to be cleaned. A preferred technique of grinding and float-sink separations on the same samples might have produced better results at liberating some of bound rock and coal and might have shown better resultant ash yields.

There is one last set of washability analyses that Asatiani and Aragunova (1953) performed on their Shamut samples. This series of analyses was not performed on their three bulk samples, but on smaller samples from each bed (five samples for the upper coal bed, three samples for the middle bed, and two for the lower bed). In the process of testing their hypothesis that the Shamut coals were gaseous by type, the authors performed coking tests on what they termed as "thoroughly and finely enriched" samples. The authors do not elaborate on their preparation method other than to say that they enriched their coal samples by hand and with great difficulty. Once the samples were prepared, they were analyzed for moisture, ash yield, volatile matter, sulfur (table 11), and cokability. It is unfortunate that there is not a better explanation of the preparation technique provided in this section, because the authors actually reduced the ash yield considerably when compared to the results of all the other washability testing (compare ash yields in table 11 with ash yields of table 8 and table 9).

In addition to these enrichment tests, Asatiani and Aragunova (1953) performed three other sets of analytical calculations or tests on the Shamut coals. First, they calculated the refractory index (*RI*) of samples from all three of the beds within the Shamut deposit. The authors calculated the refractory index (table 12) on the basis of the oxide data by using the following formula:

$$\mathrm{RI} = \frac{\mathrm{SiO_2} + \mathrm{Al_2O_3}}{\mathrm{CaO} + \mathrm{MgO} + \mathrm{Fe_2O_3}}$$

Secondly, Asatiani and Aragunova (1953) experimented with coking the Shamut coal and with the ability of the Shamut coals to yield tar (table 13). The Shamut coal is not a coking coal. Thirdly, Asatiani and Aragunova (1953) experimented with producing bitumen from the Shamut coals, but probably because of high ash yield, the Shamut coals did not produce much bitumen (table 14).

COAL RESOURCE CALCULATIONS OF SHAMUT

RESOURCE TERMINOLOGY

The methods used in the United States and the former Soviet Union to calculate and report coal resource and reserve tonnages are very similar (Pierce and others, 1996). The system used in the United States was developed at the U.S. Geological Survey (USGS) (Wood and others, 1983) and the former U.S. Bureau of Mines. The system currently used in many of the Commonwealth of Independent States was developed by the Ministry of Geology of the former U.S.S.R. Both systems classify coal resources and reserves on the basis of the degree of geologic control and economic feasibility of recovery. Both systems have mechanisms for exclusions based upon the ash yield, depth, bed thickness, and parting thickness.

Both systems are based upon the distribution and spacing of known data. As a result, both systems have reporting categories referring to degrees of confidence or uncertainty. In the USGS system, the resource reliability categories are termed “measured,” “indicated,” “inferred,” and “hypothetical,” and in the U.S.S.R. Ministry of Geology the categories are termed “A,” “B,” “C_1," “C_2," and “P_1 and P_2.” The USGS “measured” equates to the Soviet “A” + “B,” “indicated” is the same as “C_1," “inferred” is correlative to “C_2," and “hypothetical” is equivalent to “P_1" and “P_2.” Each resource or reserve category is dependent upon the density of the exploration network. These categories are directly dependent upon their distance from known data points, either coal in boreholes or in outcrop, each category increasing the distance from known coal localities and correlatively decreasing the certainty with which the tonnage estimate is given.

ARCHIVAL RESOURCE ESTIMATES

Kacharava (1953) was the first to calculate resource tonnages for the Shamut coal deposit (table 15). He calculated the Shamut resources by using only his designated uppermost and middle coal and carbonaceous shale beds, excluding the lowermost coal zone because of its thinness. According to resource calculation standards of the 1950's, Kacharava (1953) calculated the resource tonnage by using a minimum bed thickness of 70 cm, maximum ash yield of 60 percent (dry basis), and minimum calorific value of 1,500 cal/g, excluding all resources outside these parameters. Unfortunately, he did not first calculate the total resource and then recalculate by using these exclusions; thus, we don’t know the actual full resource at this deposit, according to Kacharava (1953). Kacharava’s (1953) resource estimates, in metric tonnes, for the Shamut coal deposit are as follows:

Uppermost coal:

C_1	751,700	
C_2	1,433,000	
C_1+C_2		2,184,700

Middle coal:

C_1	1,157,700	
C_2	280,600	
C_1+C_2		1,438,300

Both beds combined:

C_1	1,909,400
C_2	1,713,600

Total resources of both beds, C_1+C_2 = 3,623,000 metric tonnes

These resource calculations are for an area of 733,830 m^2 for the upper bed and 508,775 m^2 for the middle bed (area of horizontal projection). The resource numbers in Kacharava’s (1953) report must be considered somewhat suspect. The bed designations in Kacharava (1953) do not always agree internally between his borehole descriptions and resource calculation column descriptions. In addition, Kacharava’s (1953) reported areas are slightly incorrect. We used a digitizer as a planimeter and recalculated the areas of his resource blocks and found that all of

Kacharava's areas are slightly less than those we calculated. The original and recalculated areas are found in table 16.

Although Kacharava (1953) reported this resource tonnage as both C_1 (indicated) and C_2 (inferred), the Armenian Government currently reports Shamut's reserves at 3,623,000 metric tonnes of C_2 (inferred) and 5,000,000 metric tonnes of P (hypothetical) coal (Pierce and others, 1997). It is unclear where the hypothetical resource numbers came from, when they were generated, and why the reporting category of C_1 was downgraded to C_2.

Aloyan and Hakopian (1995) undertook a more recent study to reestimate the previously reported 3 million metric tonnes of coal, and these two authors report 6.671 million metric tonnes of $C_1 + C_2$ coal (table 15). The minimum thickness exclusion that Aloyan and Hakopian (1995) used was 0.5 m as compared to Kacharva's (1953) 0.7 m thickness. Aloyan and Hakopian also calculated resources for a larger area than Kacharava, and Aloyan and Hakopian included the lower bed in their resource calculations, whereas Kacharava did not. Unfortunately, the areas (in square meters) that Aloyan and Hakopian (1995) report for their resource tonnage are incorrect (table 16), and therefore their resource calculations also must be slightly wrong.

In addition to the standard resource calculations, Aloyan and Hakopian (1995) calculated resources available for in-situ gasification. For these resources, they did not exclude any minimum thicknesses nor maximum ash yields. Rather, they included almost everything, thereby increasing the Shamut resources from 6.67 million metric tons to 15.7 million metric tons (table 15).

RECALCULATION OF RESOURCE ESTIMATES

We attempted to correlate the stratigraphic data between those found in Kacharava (1953) and those found in Aloyan and Hakopian (1995) in order to give resource estimates for each specific coal bed interval (upper, middle, and lower) as well as for the entire carbonaceous interval, since both reports make these three bed distinctions. We calculated the resource tonnage on the three beds designated by Kacharava (1953) and Aloyan and Hakopian (1995) for illustrative purposes. However, we believe that these numbers do not adequately represent the resource of Shamut, and so, in addition to the exercise of individual bed calculation, we estimated the entire resource. Perhaps the most important reason for not using the coal bed designations 1, 2, and 3 used by the previous authors for resource calculations is that these beds are not always really coals, but rather, are often carbonaceous shales. The authors must have designated their three coals on the basis of visual determinations rather than on coal quality data, because many of the coal beds have more than 50 percent ash yield. Additionally, there are beds within the stratigraphic section that have less than 50 percent ash yield but were excluded from the original authors' resource calculations because they weren't designated as one of these main coals. For these reasons, we decided to calculate the resources of the entire section. Another reason for calculating all of the beds together is that the designated beds are very close together and therefore, if used, would probably be used together, making a single resource. Kacharava (1953) reports that the upper bed in the Shamut deposit is the best, thickest, most extensive, and most important resource. However, Aloyan and Hakopian (1995) report that the lowest bed is the best and most important. Kacharava (1953) did not even calculate resources on the lowest bed because of its reported poor quality and lenslike nature.

Therefore, we decided to include everything “coaly,” as described by the geologists in the original reports in our resource calculation. However, because of the distinct difference made between coaly and slightly carbonaceous made by those authors, we did not include the latter in the calculation. We also did not include any partings in our resource calculations, even on a millimeter scale, simply because the original authors also made these exclusions.

Once we recalculated the resources of the three designated coal beds, based upon the original reports' stratigraphic data, it was obvious that there were some problems in the recalculation. The biggest disagreement arose when we recalculated the resources of the lowermost coal bed. In the 1953 report (Kacharava), the lowest bed is reported to have no resources. Yet, when we used his and Aloyan and Hakopian's (1995) stratigraphic data, we show that the lowermost bed contains considerable resources (almost 1.5 million metric tonnes, table 15). Another reason for some discrepancies between the data lay in the differences of the areas calculated, as described above. The area, in square meters, used in the resource calculation formula will have a direct effect on the tonnage figures calculated. Our recalculation of the three designated Shamut coal beds, at more than 4 million metric tonnes of $C_1 + C_2$ coal, is between that of Kacharava (1953) and Aloyan and Hakopian (1995).

Our recalculation of total resources of $C_1 + C_2 + P_1$ coal using all available data equals almost 15 million metric tonnes of coal for the Shamut deposit. This tonnage figure is closest to Aloyan and Hakopian's (1995) resource calculation for in-situ gasification, where they did not exclude any minimum thicknesses or ash yields. The area used in our total calculation and theirs for the gasification is exactly the same. Even though these two resource numbers were increased considerably over the previous numbers (Kacharava's (1953) and Aloyan and Hakopian's (1995) standard calculation), these figures still might be considered a minimum resource for the Shamut deposit, because all partings were excluded.

CONCLUSIONS

Kacharava (1953) reports Shamut resources for two coal beds, in the category of $C_1 + C_2$ (indicated + inferred), to be 3.6 million metric tonnes. Aloyan and Hakopian (1995) report a total resource tonnage for three coal beds, in the category of $C_1 + C_2$, of almost 6.7 million metric tonnes. We report a $C_1 + C_2$ resource tonnage, on three beds, using a combination of these authors' data, of 4.2 million tonnes.

However, these numbers should be considered as minimums for the Shamut deposit because these authors calculated resources on only two or three beds, excluding many coal beds with ash yields less than 50 percent from their calculations, and because they applied restrictions and exclusions to their data.

We calculated a total $C_1 + C_2 + P_1$ resource for Shamut, using all coaly lithologies of these authors, of almost 15 million metric tonnes. This total agrees with Aloyan and Hakopian's (1995) recalculation to determine resources for in-situ gasification. They calculated $C_1 + C_2 + P_1$ tonnages of more than 15 million metric tonnes, in which they made no exclusions.

The Shamut coal and carbonaceous shale deposit of north-central Armenia may be one of the largest deposits in Armenia. However, the variable and often poor quality is certainly a consideration in the potential use of this deposit. The ash yield of the Shamut coal deposit ranges from 19 to 70 percent. Washability experiments on the Shamut carbonaceous shales yielded mixed results, but we believe that better quality control in the tests is needed and further washability testing is certainly recommended because the Shamut coals will most probably yield better quality coal upon cleaning.

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Figure 1. Location of coal, carbonaceous shale, and oil shale deposits in Armenia.

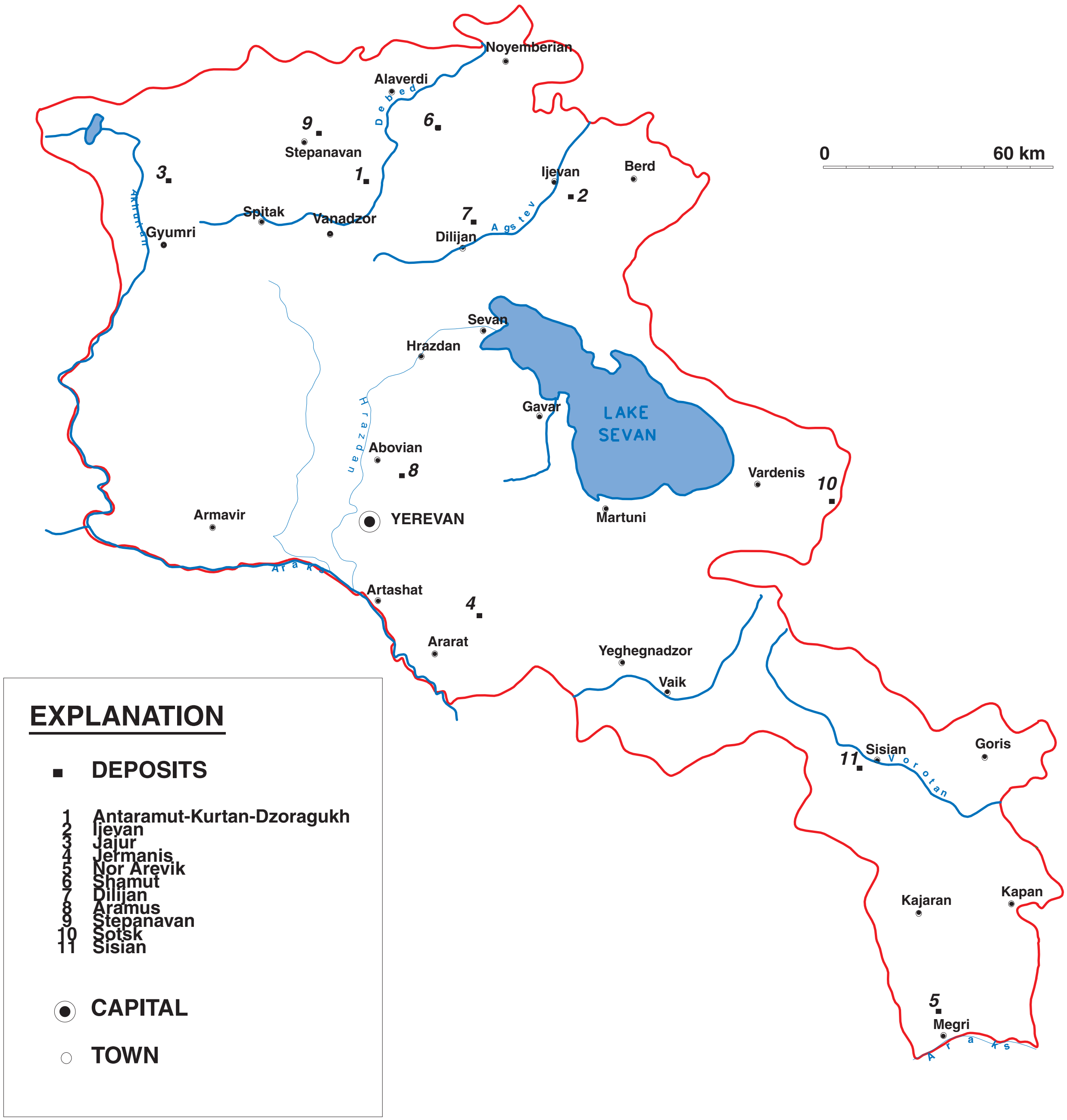

Figure 2. Geologic and Location Map of the Shamut Coal and Carbonaceous Shale Deposit. Modified from Kacharava (1953) and Aloyan and Hakopian (1996).

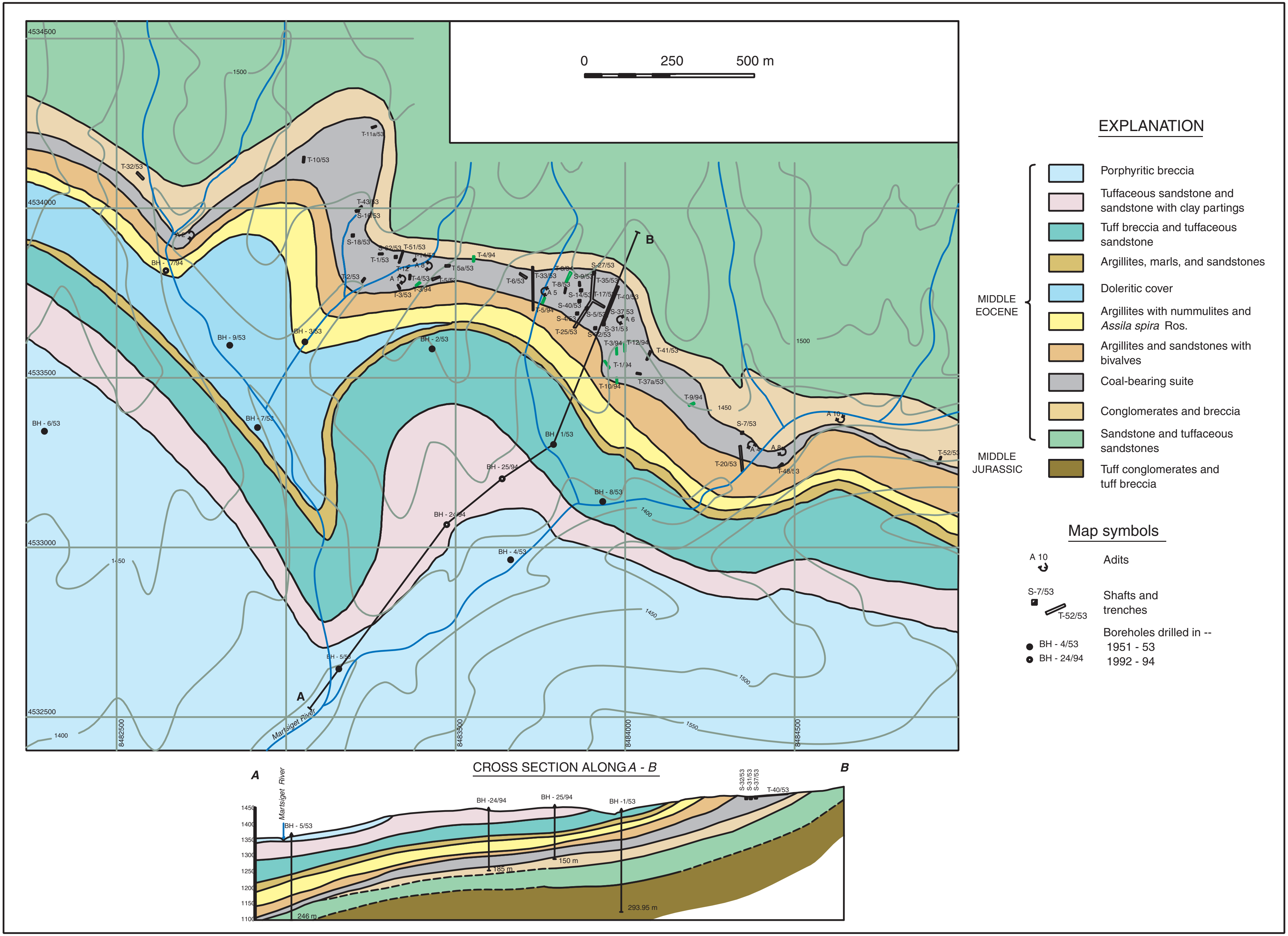

Table 1. Lithologic columns and coal quality data from exploratory adits, trenches, shafts, and boreholes of the Shamut coal deposit.

[Data contained in this table represent data within the stratigraphic data base created to calculate coal resources. All data within this table, except for boreholes 17/94, 24/94, and 25/94, are from Kacharava (1953). Data from boreholes 17/94, 24/94, and 25/94 are from Aloyan and Hakopian (1995). Because the authors of these two reports named the three coal intervals of the Shamut coal deposit by using different conventions (that is, Kacharava (1953) named the coals from the top downward and Aloyan and Hakopian (1995) from the bottom upward), we have renamed the beds upper, middle, and lower for the sake of clarity. A distinction between the terms “coaly” and “slightly carbonaceous” was made between the original authors, and we have represented that in the primary lithology column; however, for the sake of space, we omitted the word “slightly” from the carbonaceous descriptions. Methods of representing adit and trench descriptions are discussed in the text. Point localities are found on the locality map in figure 2. Measurements of interval tops and bottoms are in meters (m). ID = identifier, Top = interval top; Btm = interval bottom; Ash = ash yield, dry basis, in percent; CV = calorific value, as determined, in calories per gram (cal/g); d = density, in grams per cubic centimeter (g/cm^3); M = moisture, in percent; S = sulfur, in percent; VM = volatile matter, dry basis, in percent; BH = borehole; Shft = shaft]

Point ID	Top (m)	Btm (m)	Primary Lithology	Age	Ash (%)	CV (cal/g)	d (g /cm^3)	M (%)	S (%)	VM (%)
Adit 1	0.00	0.20	Soil	Quaternary						
	0.20	0.50	Clay shale	Middle Eocene						
	0.50	1.11	Lower coaly shale	Middle Eocene	46.00		1.79	2.00		34.50
	1.11	1.16	Clay shale	Middle Eocene						
	1.16	1.79	Lower coal	Middle Eocene	44.34		1.76	1.76		33.41
	1.79	2.49	Sandy clay	Middle Eocene						
Adit 10	0.00	1.00	Conglomerate							
Adit 11	0.00	1.00	Clay with coal lens							
Adit 12	0.00	1.00	Conglomerate							
Adit 2	0.00	0.20	Clay							
	0.20	0.40	Coaly shale							
	0.40	1.85	Clay							
	1.85	2.15	Coaly shale		49.67	3433	1.88	1.86		44.58
	2.15	2.45	Clay							
	2.45	2.70	Coaly clay shale		60.79	2190	2.00	2.48		34.78
	2.70	3.35	Clay							
	3.35	3.55	Coaly clay shale		70.41	1614	2.18	2.32		38.99
	3.55	3.85	Clay							
	3.85	4.00	Marl							
	4.00	4.50	Clay							
	4.50	4.78	Coaly clay shale		70.38	1609	2.16	2.72		26.06
	4.78	4.95	Clay							
	4.95	5.27	Coaly clay shale		70.38	1609	2.16	2.72		26.06
	5.27	5.97	Clay							

	5.97	6.11	Coaly clay shale						
	6.11	6.50	Clay						
	6.50	6.57	Coaly clay shale						
	6.57	6.64	Clay						
	6.64	6.74	Coaly clay shale	63.83	2052	2.03	3.42		40.31
	6.74	7.13	Clay						
	7.13	7.34	Coaly shale	54.24	2943	1.84	2.92		44.08
	7.34	7.52	Clay						
	7.52	7.63	Coaly shale						
	7.63	8.33	Clay						
	8.33	8.43	Coal						
	8.43	8.53	Clay						
Adit 3	0.00	0.05	Clay						
	0.05	0.67	Upper coal	45.07		1.82	2.46		31.71
	0.67	0.77	Clay						
	0.77	0.97	Marl						
	0.97	1.17	Upper coal						
	1.17	1.87	Clay						
	1.87	2.07	Upper coal	43.96		1.79	3.11		27.46
	2.07	2.29	Clay						
	2.29	2.44	Upper coal						
	2.44	3.14	Clay						
	3.14	3.21	Coal						
	3.21	4.26	Clay						
	4.26	4.41	Clay marl						
	4.41	5.21	Middle coaly shale	58.49		1.92	2.76		35.67
	5.21	5.53	Clay						
	5.53	5.69	Middle coal	43.96		1.80	3.10		32.78
	5.69	5.79	Clay						
	5.79	6.54	Middle coal	43.96		1.80	3.10		32.78
	6.54	6.76	Clay marl						
	6.76	7.05	Clay						
	7.05	7.22	Sandstone						
	7.22	7.44	Clay						
	7.44	7.54	Sandstone						
	7.54	7.64	Lower coal						
	7.64	7.77	Clay						
	7.77	7.82	Lower coal						
	7.82	8.44	Clay						
	8.44	8.72	Sandstone						
Adit 4	0.00	0.05	Sandstone						
	0.05	0.40	Upper coaly shale	37.09	4590	1.62	3.50	3.91	53.57
	0.40	0.43	Clay						
	0.43	0.77	Upper coaly shale	36.07	4753	1.63	3.80	4.45	52.45
	0.77	0.86	Sandstone						
	0.86	0.99	Upper coal	38.69	4345	1.70	3.78	1.68	46.05
	0.99	1.02	Clay						

	1.02	1.04	Sandstone						
	1.04	1.28	Clay						
	1.28	1.51	Middle coal	40.59	3686	1.76	2.70	3.71	44.46
	1.51	1.56	Clay						
Adit 5	0.00	0.05	Clay						
	0.05	0.18	Coaly shale						
	0.18	0.31	Clay						
	0.31	0.36	Coaly clay shale						
	0.36	0.41	Clay						
	0.41	0.67	Coaly shale						
	0.67	0.82	Clay						
	0.82	1.07	Coaly shale	58.88	3286	1.95	10.50	0.27	57.01
	1.07	1.32	Clay						
	1.32	1.84	Coaly clay shale	62.06	1430	2.09	10.68	2.04	57.55
	1.84	2.00	Clay						
Adit 6	0.00	0.10	Clay						
	0.10	0.15	Coaly shale						
	0.15	0.27	Clay						
	0.27	0.45	Coaly clay shale	68.72	1353	2.07	7.90	0.23	58.92
	0.45	0.59	Clay						
	0.59	0.77	Sandstone						
	0.77	0.95	Coaly clay shale	70.84	825	2.08	8.96	0.19	64.80
	0.95	3.25	Clay with coal lens						
	3.25	3.47	Coaly clay shale						
	3.47	3.50	Clay						
Adit 7	0.00	0.10	Clay with coal lens						
	0.10	0.28	Coaly clay shale	75.04	572	2.09	7.34	0.37	60.46
	0.28	0.88	Clay with coal lens						
	0.88	1.05	Upper coaly shale	57.92	1669	1.81	9.01	0.41	40.48
	1.05	1.95	Clay with coal lens						
	1.95	2.05	Upper coaly shale						
	2.05	2.10	Sandstone						
	2.10	2.20	Upper coaly shale						
	2.20	2.25	Sandstone						
	2.25	3.15	Upper coaly shale	57.37	1550	1.94	7.76	0.30	41.86
	3.15	3.40	Clay						
	3.40	3.65	Upper coaly clay shale	74.08	926	2.09	7.48	0.32	59.29
	3.65	3.90	Clay shale						
	3.90	4.15	Upper coaly clay shale	65.65	1241	2.07	7.04	0.30	34.66
	4.15	4.20	Clay						
	4.20	4.30	Upper coaly clay shale						
	4.30	4.50	Sandstone						
	4.50	4.90	Upper coaly clay shale	66.72	912	2.10	7.42	0.24	44.21
	4.90	5.20	Clay shale						
	5.20	5.30	Upper coaly clay shale						
	5.30	5.40	Clay shale						
	5.40	5.50	Upper coaly clay shale						

	5.50	6.20	Clay						
	6.20	6.50	Clay shale						
	6.50	6.70	Middle coaly clay shale	68.68	616	2.13	6.26	1.77	42.91
	6.70	6.95	Clay						
	6.95	7.30	Middle coaly clay shale	63.32	1144	1.83	9.35	0.35	42.23
	7.30	7.45	Middle coaly shale	52.29	2105	1.96	8.40	0.32	34.91
	7.45	7.58	Middle coaly clay shale	61.55	1101	2.08	7.56	0.28	43.10
	7.58	7.68	Sandy clay						
	7.68	7.96	Middle coal	36.97	3243	1.72	1.46	0.59	41.00
	7.96	8.01	Clay shale						
	8.01	8.61	Middle coaly shale	47.76	2585	1.76	0.72	20.42	38.97
	8.61	8.66	Clay shale						
	8.66	8.96	Middle coaly clay shale	60.82	614	1.94	8.72	0.33	38.25
	8.96	9.26	Clay with coal lens						
	9.26	9.34	Middle coaly clay shale	50.44	2437	1.76	10.64	0.52	43.22
	9.34	9.69	Clay						
	9.69	9.79	Middle coal	41.35	2747	1.68	11.28	0.53	46.67
	9.79	10.74	Clay						
	10.74	10.91	Middle coal	37.73	2862	1.70	13.88	0.50	41.02
	10.91	11.46	Clay shale						
	11.46	11.61	Sandstone						
	11.61	11.81	Clay shale						
	11.81	12.11	Sandstone						
	12.11	12.91	Clay with coal lens						
	12.91	13.04	Lower coaly shale	56.37	2286	1.91	10.38	0.46	42.04
	13.04	13.12	Clay						
	13.12	13.24	Lower coal	36.02	3258	1.65	12.66	0.36	39.19
	13.24	13.39	Clay shale						
	13.39	13.66	Lower coaly clay shale	68.25	850	1.88	7.59	0.79	57.44
	13.66	13.81	Clay						
	13.81	14.09	Lower coaly shale	53.96	2405	1.83	8.76	0.53	46.77
	14.09	14.59	Clay with coal lens						
Adit 8	0.00	0.20	Clay						
	0.20	0.52	Upper coaly shale						
	0.52	0.61	Clay						
	0.61	0.97	Upper coaly shale						
	0.97	1.42	Clay						
	1.42	2.08	Middle coaly shale						
	2.08	2.18	Clay						
	2.18	2.63	Middle coaly shale						
	2.63	3.08	Clay						
	3.08	3.80	Lower coaly shale						
	3.80	3.90	Clay						
	3.90	4.26	Lower coaly shale						
	4.26	4.58	Clay						
	4.58	5.48	Lower coaly shale	58.06	2540	1.88	5.70	4.28	46.61
	5.48	5.52	Clay						

	5.52	5.64	Lower coaly shale		56.05	2866	1.87	5.70	3.62	48.40
	5.64	6.14	Clay							
Adit 9	0.00	0.50	Diluvium							
	0.50	1.00	Sandstone							
BH 1/53	0.00	34.80	Sandstone	Middle Eocene						
	34.80	51.40	Sandstone with fauna	Middle Eocene						
	51.40	81.35	Clay	Middle Eocene						
	81.35	81.89	Clay shale	Middle Eocene						
	81.89	82.02	Coaly shale	Middle Eocene	50.32	3690	1.69	2.88	2.06	46.72
	82.02	82.70	Sandstone	Middle Eocene						
	82.70	82.76	Upper coal	Middle Eocene	24.52	5778	1.44	2.54	2.02	44.83
	82.76	83.02	Upper coal	Middle Eocene	41.44	4582	1.61	3.06	1.50	47.53
	83.02	83.13	Upper coaly shale	Middle Eocene	53.95	2661	1.87	2.72	0.73	46.49
	83.13	83.29	Upper coal	Middle Eocene	41.51	3772	1.67	2.30	1.34	30.03
	83.29	83.43	Clay	Middle Eocene						
	83.43	83.75	Upper coal	Middle Eocene	42.84	3648	1.28	2.34	2.37	30.74
	83.75	84.08	Clay	Middle Eocene						
	84.08	84.40	Clay shale	Middle Eocene						
	84.40	84.75	Middle coal	Middle Eocene	38.83	4447	1.23	2.50	4.20	51.76
	84.75	84.98	Sandstone	Middle Eocene						
	84.98	85.42	Clay shale	Middle Eocene						
	85.42	85.92	Middle coal	Middle Eocene	34.65	4748	1.54	3.00	2.02	41.14
	85.92	86.03	Sandstone	Middle Eocene						
	86.03	86.17	Clay shale	Middle Eocene						
	86.17	86.31	Middle coal	Middle Eocene						
	86.31	86.65	Clay shale	Middle Eocene						
	86.65	86.72	Middle coal	Middle Eocene						

	86.72	87.28	Middle coaly clay shale	Middle Eocene
	87.28	87.54	Clay shale	Middle Eocene
	87.54	87.77	Sandstone	Middle Eocene
	87.77	88.27	Lower coaly clay shale	Middle Eocene
	88.27	109.10	Clay shale	Middle Eocene
	109.10	112.50	Sandstone	Middle Eocene
	112.50	114.80	Conglomerate	Middle Eocene
	114.80	115.70	Sandstone	Middle Eocene
	115.70	131.10	Conglomerate	Middle Eocene
	131.10	133.10	Clay	Middle Eocene
	133.10	135.10	Sandstone	Middle Eocene
	135.10	136.90	Conglomerate	Middle Eocene
	136.90	139.10	Sandstone	Middle Eocene
	139.10	149.20	Clay	Jurassic
	149.20	158.00	Sandstone	Jurassic
	158.00	161.20	Tuff conglomerate	Jurassic
	161.20	211.35	Tuffstone	Jurassic
	211.35	212.05	Conglomerate	Jurassic
	212.05	234.60	Sandstone	Jurassic
	234.60	237.30	Tuff conglomerate	Jurassic
	237.30	238.00	Tuffstone	Jurassic
	238.00	258.50	Tuff conglomerate	Jurassic
	258.50	259.00	Tuffstone	Jurassic
	259.00	287.00	Tuff breccia	Jurassic
	287.00	289.75	Porphyrite	Jurassic
	289.75	293.95	Tuff breccia	Jurassic
BH 10/53	0.00	2.70	Drift	Middle Eocene
	2.70	6.60	Tuffstone	Middle Eocene
	6.60	8.10	Sandstone	Middle Eocene
	8.10	12.55	Porphyrite	Middle Eocene
	12.55	41.05	Tuffstone	Middle Eocene

	41.05	52.05	Sandstone	Middle Eocene
	52.05	77.45	Tuffstone	Middle Eocene
	77.45	85.40	Porphyrite with calcite	Middle Eocene
	85.40	97.00	Marl	Middle Eocene
	97.00	101.00	Sandstone	Middle Eocene
	101.00	104.00	Marl	Middle Eocene
	104.00	108.00	Sandstone	Middle Eocene
	108.00	145.50	Porphyrite with calcite	Middle Eocene
	145.50	149.00	Tuffstone	Middle Eocene
	149.00	163.95	Sandstone	Middle Eocene
	163.95	165.95	Marl	Middle Eocene
	165.95	169.45	Sandstone	Middle Eocene
	169.45	177.65	Marl	Middle Eocene
	177.65	180.80	Sandstone	Middle Eocene
	180.80	183.00	Tuff conglomerate	Middle Eocene
	183.00	184.20	Sandstone	Middle Eocene
	184.20	188.30	Porphyrite	Middle Eocene
	188.30	194.00	Tuffstone	Middle Eocene
	194.00	249.00	Porphyrite	Middle Eocene
	249.00	288.20	Sandstone	Middle Eocene
	288.20	313.70	Sandstone with fauna	Middle Eocene
	313.70	315.90	Sandstone	Middle Eocene
	315.90	320.95	Tuff conglomerate	Middle Eocene
BH 11/53	0.00	3.00	Alluvium	Middle Eocene
	3.00	144.90	Tuff breccia	Middle Eocene

	144.90	166.40	Porphyrite	Middle Eocene						
	166.40	175.10	Tuff breccia	Middle Eocene						
	175.10	237.40	Tuffstone	Middle Eocene						
	237.40	281.70	Sandstone	Middle Eocene						
	281.70	283.00	Tuffstone	Middle Eocene						
	283.00	321.50	Sandstone	Middle Eocene						
	321.50	354.05	Clay	Middle Eocene						
	354.05	354.85	Coaly clay shale	Middle Eocene	70.46	1981	2.10	2.56	3.30	68.26
	354.85	365.25	Carbonaceous clay shale	Middle Eocene						
	365.25	372.95	Tuff breccia	Middle Eocene						
BH 12/53	0.00	4.50	Alluvium	Middle Eocene						
	4.50	39.30	Porphyrite	Middle Eocene						
	39.30	64.40	Tuff breccia	Middle Eocene						
	64.40	87.70	Tuffstone	Middle Eocene						
	87.70	114.70	Porphyrite	Middle Eocene						
	114.70	150.50	Tuff breccia	Middle Eocene						
	150.50	220.00	Tuffstone	Middle Eocene						
	220.00	238.00	Tuff breccia	Middle Eocene						
	238.00	260.00	Sandstone	Middle Eocene						
	260.00	264.20	Clay	Middle Eocene						
	264.20	269.00	Sandstone	Middle Eocene						
	269.00	283.00	Clay	Middle Eocene						
	283.00	288.00	Sandstone	Middle Eocene						
	288.00	306.00	Clay	Middle Eocene						
	306.00	308.00	Sandstone	Middle Eocene						

	308.00	343.00	Clay	Middle Eocene
	343.00	353.00	Sandstone	Middle Eocene
	353.00	391.50	Clay shale with coal	Middle Eocene
	391.50	397.00	Tuffstone	Middle Eocene
	397.00	438.55	Breccia	Middle Eocene
BH 13/53	0.00	6.50	Alluvium	Middle Eocene
	6.50	100.20	Tuff breccia	Middle Eocene
	100.20	128.20	Tuffstone	Middle Eocene
	128.20	153.60	Tuff breccia	Middle Eocene
	153.60	162.30	Marl	Middle Eocene
	162.30	170.20	Sandstone	Middle Eocene
	170.20	178.70	Marl	Middle Eocene
	178.70	190.30	Sandstone	Middle Eocene
	190.30	219.00	Argillaceous sandstone	Middle Eocene
	219.00	298.90	Tuff breccia	Middle Eocene
BH 14/53	0.00	2.00	Diluvium	Middle Eocene
	2.00	10.00	Tuff breccia	Middle Eocene
	10.00	17.90	Tuffstone	Middle Eocene
	17.90	20.20	Tuff breccia	Middle Eocene
	20.20	32.20	Tuffstone	Middle Eocene
	32.20	58.60	Tuff breccia	Middle Eocene
	58.60	77.00	Tuffstone	Middle Eocene
	77.00	184.40	Porphyrite with calcite	Middle Eocene
	184.40	186.30	Tuffstone	Middle Eocene
	186.30	193.80	Sandstone	Middle Eocene

	193.80	356.70	Tuff	Middle Eocene
	356.70	383.50	Argillaceous sandstone	Middle Eocene
	383.50	527.00	Tuff breccia	Middle Eocene
BH 15/53	0.00	0.50	Diluvium	Middle Eocene
	0.50	179.25	Tuff breccia	Middle Eocene
	179.25	218.20	Tuffstone	Middle Eocene
	218.20	225.90	Tuff breccia	Middle Eocene
	225.90	239.30	Argillaceous sandstone	Middle Eocene
	239.30	257.60	Sandstone	Middle Eocene
	257.60	306.60	Tuff breccia	Middle Eocene
	306.60	322.40	Porphyrite with calcite	Middle Eocene
	322.40	334.40	Sandstone	Middle Eocene
	334.40	366.30	Tuffstone	Middle Eocene
	366.30	424.00	Porphyrite with calcite	Middle Eocene
	424.00	428.00	Sandstone	Middle Eocene
	428.00	525.00	Porphyrite with calcite	Middle Eocene
BH 17/94	0.00	2.00	Diluvium	Quater-nary
	2.00	24.30	Dolerite	Middle Eocene
	24.30	25.30	Hydrothermal rock	Middle Eocene
	25.30	26.30	Carbonaceous sandstone	Middle Eocene
	26.30	27.80	Carbonaceous argillite	Middle Eocene
	27.80	50.00	Carbonaceous sandstone	Middle Eocene
	50.00	106.00	Carbonaceous argillite	Middle Eocene
	106.00	112.00	Argillite with coal	Middle Eocene
	112.00	119.00	Carbonaceous Argillite	Middle Eocene

	119.00	121.00	Clay	Middle Eocene						
	121.00	128.90	Argillite	Middle Eocene						
	128.90	140.00	Sandstone	Middle Eocene						
	140.00	142.00	Conglomerate	Middle Eocene						
	142.00	144.50	Argillite	Middle Eocene						
	144.50	150.00	Carbonaceous conglomerate	Middle Eocene						
	150.00	180.00	Argillite	Middle Eocene						
BH 2/53	0.00	56.30	Sandstone							
	56.30	64.80	Dolerite							
	64.80	65.80	Sandstone							
	65.80	66.80	Dolerite							
	66.80	97.75	Sandstone							
	97.75	114.50	Clay							
	114.50	130.60	Sandstone							
	130.60	130.79	Upper coaly shale		46.06	4145	1.85	0.19	2.18	41.30
	130.79	130.93	Sandstone							
	130.93	132.58	Upper coaly clay shale		62.03	1595	2.07	1.65	1.15	51.17
	132.58	132.67	Sandstone							
	132.67	134.00	Upper coaly shale		59.27	2076	2.01	1.21	1.41	46.26
	134.00	134.09	Sandstone							
	134.09	135.00	Upper coaly clay shale		63.09	1496	2.09	0.87	1.05	53.88
	135.00	135.68	Argillaceous sandstone							
	135.68	136.30	Middle coaly shale		48.63	3990	1.64	0.58	2.69	50.25
	136.30	136.69	Argillaceous sandstone							
	136.69	137.15	Middle coaly clay shale		60.89	1595	2.00	0.42	1.84	49.12
	137.15	137.68	Argillaceous sandstone							
	137.68	139.71	Sandstone							
	139.71	139.95	Lower coaly clay shale		67.13	1546	2.12	0.24	2.00	49.04
	139.95	140.29	Sandstone							
	140.29	141.05	Lower coaly clay shale		61.91	1613	2.04	0.63	2.27	53.46
	141.05	166.75	Sandstone							
	166.75	169.40	Conglomerate							
BH 24/94	0.00	6.00	Diluvium	Quater-nary						
	6.00	6.80	Clay	Middle Eocene						
	6.80	9.00	Carbonaceous sandstone	Middle Eocene						

9.00	10.00	Clay with coal lenses	Middle Eocene	
10.00	15.10	Carbonaceous sandstone	Middle Eocene	
15.10	23.80	Argillite	Middle Eocene	
23.80	24.30	Conglomerate	Middle Eocene	
24.30	24.80	Clay	Middle Eocene	
24.80	25.50	Carbonaceous tuffstone	Middle Eocene	
25.50	27.60	Carbonaceous argillite	Middle Eocene	
27.60	27.90	Limestone	Middle Eocene	
27.90	39.50	Carbonaceous sandstone	Middle Eocene	
39.50	41.00	Carbonaceous conglomerate	Middle Eocene	
41.00	42.70	Sandstone	Middle Eocene	
42.70	44.50	Conglomerate	Middle Eocene	
44.50	62.00	Carbonaceous sandstone	Middle Eocene	
62.00	69.00	Carbonaceous porphyrite	Middle Eocene	
69.00	82.50	Carbonaceous sandstone	Middle Eocene	
82.50	85.00	Carbonaceous tuff	Middle Eocene	
85.00	107.60	Carbonaceous argillite	Middle Eocene	
107.60	108.40	Argillite	Middle Eocene	
108.40	121.00	Carbonaceous argillite	Middle Eocene	
121.00	122.00	Clay	Middle Eocene	
122.00	132.50	Argillite with coal	Middle Eocene	
132.50	133.50	Clay shale with coal	Middle Eocene	
133.50	146.50	Argillite with coal	Middle Eocene	
146.50	147.18	Upper coal	Middle Eocene	63.60
147.18	148.06	Coaly clay shale	Middle Eocene	

	148.06	148.94	Middle coal	Middle Eocene	54.60
	148.94	149.72	Carbonaceous argillite	Middle Eocene	
	149.72	150.11	Lower coal	Middle Eocene	73.90
	150.11	150.30	Carbonaceous argillite	Middle Eocene	
	150.30	150.78	Lower coal	Middle Eocene	73.10
	150.78	150.97	Coaly clay shale	Middle Eocene	
	150.97	151.85	Lower coal	Middle Eocene	68.20
	151.85	152.43	Argillite	Middle Eocene	
	152.43	153.20	Lower coal	Middle Eocene	72.80
	153.20	163.00	Argillite with coal	Middle Eocene	
	163.00	170.00	Carbonaceous sandstone	Middle Eocene	
	170.00	174.60	Conglomerate	Middle Eocene	
	174.60	175.30	Sandstone	Middle Eocene	
	175.30	178.00	Conglomerate	Middle Eocene	
	178.00	185.00	Sandstone	Middle Eocene	
BH 25/94	0.00	4.00	Alluvium	Quater-nary	
	4.00	8.70	Carbonaceous sandstone	Middle Eocene	
	8.70	9.00	Clay	Middle Eocene	
	9.00	13.20	Carbonaceous sandstone	Middle Eocene	
	13.20	13.70	Porphyrite	Middle Eocene	
	13.70	33.60	Carbonaceous sandstone	Middle Eocene	
	33.60	34.00	Clay	Middle Eocene	
	34.00	82.30	Carbonaceous sandstone	Middle Eocene	
	82.30	133.50	Carbonaceous argillite	Middle Eocene	
	133.50	135.50	Upper coal	Middle Eocene	65.20

	135.50	136.20	Argillite	Middle Eocene	
	136.20	137.00	Middle coal	Middle Eocene	70.10
	137.00	137.15	Argillite	Middle Eocene	
	137.15	140.00	Lower coal	Middle Eocene	78.60
	140.00	150.00	Carbonaceous argillite	Middle Eocene	
BH 3/53	0.00	6.80	Diluvium	Quater-nary	
	6.75	35.00	Sandstone	Middle Eocene	
	35.00	54.50	Clay	Middle Eocene	
	54.50	64.90	Porphyrite	Middle Eocene	
	64.90	67.55	Clay	Middle Eocene	
	67.55	75.50	Porphyrite	Middle Eocene	
	75.50	76.90	Clay	Middle Eocene	
	76.90	77.70	Porphyrite	Middle Eocene	
	77.70	77.80	Clay	Middle Eocene	
	77.80	80.10	Porphyrite	Middle Eocene	
	80.10	82.60	Clay	Middle Eocene	
	82.60	84.40	Marl	Middle Eocene	
	84.40	100.55	Clay	Middle Eocene	
	100.55	110.40	Sandstone	Middle Eocene	
	110.40	114.30	Conglomerate	Middle Eocene	
	114.30	148.30	Sandstone	Middle Eocene	
BH 4/53	0.00	6.50	Tuffstone	Middle Eocene	
	6.50	13.20	Tuffstone	Middle Eocene	
	13.20	23.50	Tuffstone	Middle Eocene	
	23.50	138.40	Sandstone	Middle Eocene	

	138.40	147.65	Clay	Middle Eocene						
	147.65	149.65	Clay shale	Middle Eocene						
	149.65	167.08	Sandstone	Middle Eocene						
	167.08	167.14	Coaly clay shale	Middle Eocene						
	167.14	167.33	Sandstone	Middle Eocene						
	167.33	168.19	Upper coaly clay shale	Middle Eocene	67.22	1447	2.07	0.86	0.61	49.59
	168.19	168.28	Upper coaly shale	Middle Eocene	48.19	3938	1.66	0.74	1.00	27.92
	168.28	168.37	Upper coal	Middle Eocene						
	168.37	169.10	Sandstone	Middle Eocene						
	169.10	169.95	Upper coal	Middle Eocene	43.30	3914	1.61	0.94	1.58	41.77
	169.95	170.19	Sandstone	Middle Eocene						
	170.19	170.80	Coaly shale	Middle Eocene						
	170.80	172.50	Middle coal	Middle Eocene	44.56	3828	1.63	0.80	2.04	42.54
	172.50	172.59	Clay shale	Middle Eocene						
	172.59	172.97	Middle coaly clay shale	Middle Eocene	62.33	1558	2.10	1.50	5.58	43.93
	172.97	173.11	Clay shale	Middle Eocene						
	173.11	173.82	Middle coaly clay shale	Middle Eocene	72.25	816	2.42	0.90	1.49	58.98
	173.82	174.30	Clay shale	Middle Eocene						
	174.30	174.55	Coaly clay shale	Middle Eocene	72.99	800	2.31	1.50	0.63	57.33
	174.55	177.65	Clay shale	Middle Eocene						
	177.65	190.35	Sandstone	Middle Eocene						
	190.35	193.90	Tuff breccia	Middle Eocene						
	193.90	210.55	Conglomerate	Middle Eocene						
BH 5/53	0.00	1.00	Alluvium	Middle Eocene						
	1.00	4.00	Tuff breccia	Middle Eocene						

	4.00	61.05	Tuffstone	Middle Eocene						
	61.05	70.70	Sandstone	Middle Eocene						
	70.70	74.70	Tuffstone	Middle Eocene						
	74.70	79.20	Sandstone	Middle Eocene						
	79.20	81.50	Tuffstone	Middle Eocene						
	81.50	88.10	Porphyrite	Middle Eocene						
	88.10	96.30	Sandstone	Middle Eocene						
	96.30	102.40	Tuff	Middle Eocene						
	102.40	108.35	Sandstone	Middle Eocene						
	108.35	113.30	Clay	Middle Eocene						
	113.30	123.50	Tuffstone	Middle Eocene						
	123.50	179.20	Sandstone	Middle Eocene						
	179.20	181.50	Clay	Middle Eocene						
	181.50	196.40	Sandstone	Middle Eocene						
	196.40	203.60	Clay	Middle Eocene						
	203.60	205.10	Sandstone	Middle Eocene						
	205.10	209.00	Clay	Middle Eocene						
	209.00	213.60	Sandstone	Middle Eocene						
	213.60	214.07	Coaly clay shale	Middle Eocene	72.14		2.52	1.28	0.36	32.16
	214.07	214.16	Sandstone	Middle Eocene						
	214.16	215.20	Coaly clay shale	Middle Eocene	85.02	2771	1.84	1.82	2.59	38.17
	215.20	224.90	Clay	Middle Eocene						
	224.90	231.10	Sandstone	Middle Eocene						
	231.10	246.00	Tuffstone	Middle Eocene						
BH 6/53	0.00	27.90	Tuffstone	Middle Eocene						

27.90	34.50	Sandstone	Middle Eocene						
34.50	55.00	Tuffstone	Middle Eocene						
55.00	63.80	Marl	Middle Eocene						
63.80	82.20	Sandstone	Middle Eocene						
82.20	82.40	Tuffstone	Middle Eocene						
82.40	135.00	Sandstone	Middle Eocene						
135.00	233.35	Porphyrite with calcite	Middle Eocene						
233.35	309.95	Sandstone	Middle Eocene						
309.95	310.42	Clay shale	Middle Eocene						
310.42	310.78	Coaly shale	Middle Eocene	50.38	2771	1.84	1.40	2.59	31.90
310.78	311.05	Clay shale	Middle Eocene						
311.05	311.38	Coaly shale	Middle Eocene	56.73	2771	2.05	2.02	3.55	23.82
311.38	313.30	Clay shale	Middle Eocene						
313.30	313.96	Upper coaly shale	Middle Eocene	56.35	2933	1.87	3.62	3.57	48.13
313.96	314.01	Sandstone	Middle Eocene						
314.01	314.76	Upper coaly shale	Middle Eocene	57.86	2691	1.92	3.20	3.08	49.64
314.76	315.42	Clay	Middle Eocene						
315.42	316.08	Upper coaly shale	Middle Eocene	57.08	2634	1.92	2.70	3.52	53.12
316.08	319.79	Clay	Middle Eocene						
319.79	320.49	Middle coaly shale	Middle Eocene	58.00	2607	1.93	2.90	2.61	52.82
320.49	328.85	Clay	Middle Eocene						
328.85	329.32	Coaly clay shale	Middle Eocene	65.65	2116	2.00	2.48	2.55	55.89
329.32	335.25	Sandy clay	Middle Eocene						
335.25	335.53	Lower coaly shale	Middle Eocene	50.44	3173	1.87	1.60	0.62	51.90
335.53	336.03	Sandy clay	Middle Eocene						

	336.03	336.31	Lower coaly shale	Middle Eocene	52.06	3421	1.80	2.28	3.53	59.03
	336.31	337.30	Sandy clay	Middle Eocene						
	337.30	337.90	Lower coaly shale	Middle Eocene	55.96	3655	1.83	2.36	2.61	49.65
	337.90	344.25	Clay	Middle Eocene						
	344.25	355.30	Tuff breccia	Middle Eocene						
BH 7/53	0.00	2.00	Loam	Quater-nary						
	2.00	54.70	Dolerite	Middle Eocene						
	54.70	158.80	Sandstone	Middle Eocene						
	158.80	159.35	Sandy clay	Middle Eocene						
	159.35	163.00	Sandstone	Middle Eocene						
	163.00	169.45	Breccia	Middle Eocene						
BH 8/53	0.00	4.30	Drift	Quater-nary						
	4.30	98.50	Sandstone	Middle Eocene						
	98.50	99.00	Upper coaly shale	Middle Eocene	51.88	2847	1.76	2.32	1.70	42.04
	99.00	99.74	Sandstone	Middle Eocene						
	99.74	99.93	Middle coaly shale	Middle Eocene	51.01	2716	1.77	2.66	2.71	50.04
	99.93	100.02	Clay shale	Middle Eocene						
	100.02	100.25	Middle coaly clay shale	Middle Eocene	54.58	2820	1.85	3.20	1.69	49.49
	100.25	100.80	Sandstone	Middle Eocene						
	100.80	102.50	Middle coaly shale	Middle Eocene	53.80	2870	1.79	3.34	2.02	43.34
	102.50	102.59	Sandstone	Middle Eocene						
	102.59	102.68	Lower coaly clay shale	Middle Eocene	64.61	1770	1.97	3.70	2.00	46.00
	102.68	103.05	Sandstone	Middle Eocene						
	103.05	103.24	Lower coaly shale	Middle Eocene	51.14	3277	1.78	3.34	2.77	51.84
	103.24	103.70	Lower coaly clay shale	Middle Eocene	75.43		2.21	4.02	1.30	59.88

	103.70	106.20	Sandstone	Middle Eocene						
	106.20	108.60	Clay shale	Middle Eocene						
	108.60	125.00	Sandstone	Middle Eocene						
BH 9/53	0.00	10.00	Drift	Quater-nary						
	10.00	53.00	Dolerite	Middle Eocene						
	53.00	135.20	Sandstone	Middle Eocene						
	135.20	135.34	Clay	Middle Eocene						
	135.34	135.72	Upper coaly shale	Middle Eocene	57.86	2901	1.86	2.60	3.54	51.17
	135.72	136.61	Argillaceous sandstone	Middle Eocene						
	136.61	137.02	Middle coal	Middle Eocene	52.03	3456	1.80	2.14	2.26	55.60
	137.02	143.08	Argillaceous sandstone	Middle Eocene						
	143.08	143.17	Lower coal	Middle Eocene	29.26	5317	1.59	1.10	2.51	43.56
	143.17	144.25	Argillaceous sandstone	Middle Eocene						
	144.25	145.45	Middle coal	Middle Eocene	44.37	4292	1.72	1.94	2.78	40.00
	145.45	146.00	Argillaceous sandstone	Middle Eocene						
	146.00	146.50	Lower coaly shale	Middle Eocene	54.44	3128	1.85	2.04	3.14	45.68
	146.50	148.91	Argillaceous sandstone	Middle Eocene						
	148.91	149.15	Lower coaly clay shale	Middle Eocene	57.06	2658	1.88	2.58	2.88	43.38
	149.15	170.80	Sandstone	Middle Eocene						
Shft 1/53	0.00	0.50	Diluvium							
	0.50	3.00	Coaly clay shale							
Shft 10/53	0.00	0.20	Diluvium							
	0.20	6.20	Clay with fauna							
Shft 11/53	0.00	1.50	Diluvium							
	1.50	2.10	Clay							
	2.10	3.00	Sandstone							
Shft 12/53	0.00	1.00	Diluvium							
	1.00	1.80	Clay with fauna							
Shft 13/53	0.00	1.30	Diluvium							
	1.30	3.00	Coaly clay							
Shft 14/53	0.00	0.40	Diluvium							

	0.40	0.50	Coal
	0.50	0.80	Clay
	0.80	1.30	Coal
	1.30	1.80	Clay
	1.80	2.40	Coal
	2.40	2.85	Clay
Shft 15/53	0.00	0.40	Diluvium
	0.40	3.20	Clay
Shft 16/53	0.00	0.20	Diluvium
	0.20	0.60	Clay
	0.60	0.80	Sooty coal
	0.80	0.90	Clay
	0.90	1.00	Sooty coal
	1.00	1.40	Clay
	1.40	1.90	Sooty coal
	1.90	2.30	Clay
	2.30	2.80	Sooty coal
	2.80	2.90	Clay
	2.90	3.10	Sooty coal
	3.10	6.00	Clay
Shft 17/53	0.00	0.70	Diluvium
	0.70	2.20	Clay
Shft 18/53	0.00	1.40	Diluvium
	1.40	2.00	Clay with coal lens
Shft 19/53	0.00	2.00	Diluvium
	2.00	6.10	Clay
Shft 2/53	0.00	0.80	Diluvium
	0.80	4.50	Clay with fauna
Shft 20/53	0.00	0.50	Diluvium
	0.50	2.20	Clay with coal lens
Shft 21/53	0.00	0.40	Diluvium
	0.40	2.40	Clay
Shft 22/53	0.00	0.70	Diluvium
	0.70	2.40	Clay
Shft 23/53	0.00	0.50	Diluvium
	0.50	3.30	Clay
Shft 24/53	0.00	0.30	Diluvium
	0.30	3.10	Clay
Shft 25/53	0.00	3.10	Diluvium
Shft 26/53	0.00	0.20	Diluvium
	0.20	3.50	Clay
	3.50	4.80	Sandstone
Shft 27/53	0.00	0.10	Diluvium
	0.10	0.60	Clay with coal lens
	0.60	1.10	Sooty coal
	1.10	3.31	Clay
	3.31	3.55	Marl

	3.55	3.85	Clay
	3.85	3.95	Coaly clay
	3.95	7.20	Clay
Shft 28/53	0.00	4.80	Diluvium
	4.80	6.00	Porphyrite
Shft 3/53	0.00	2.40	Diluvium
	2.40	3.20	Clay
Shft 30/53	0.00	0.20	Diluvium
	0.20	3.50	Tuffstone
	3.50	6.00	Porphyrite
Shft 31/53	0.00	0.15	Diluvium
	0.15	5.75	Clay
	5.75	6.30	Sooty coal
	6.30	6.70	Clay
	6.70	7.30	Sooty coal
	7.30	7.40	Sandstone
	7.40	7.70	Sooty coal
	7.70	8.00	Clay
Shft 32/53	0.00	0.80	Diluvium
	0.80	3.00	Clay
	3.00	3.60	Coal
	3.60	4.10	Clay
	4.10	4.40	Sooty coal
	4.40	4.50	Clay
Shft 33/53	0.00	0.30	Diluvium
	0.30	1.30	Clay
Shft 34/53	0.00	1.40	Diluvium
	1.40	5.00	Argillaceous sandstone
Shft 35/53	0.00	1.90	Diluvium
Shft 36/53	0.00	0.50	Diluvium
	0.50	4.10	Argillaceous sandstone
Shft 37/53	0.00	0.70	Diluvium
	0.70	1.10	Clay
	1.10	1.30	Sooty coal
	1.30	1.55	Clay
	1.55	1.95	Sooty coal
Shft 38/53	0.00	1.00	Diluvium
	1.00	2.00	Clay
Shft 39/53	0.00	1.10	Diluvium
	1.10	1.30	Sooty coal
	1.30	1.40	Clay
	1.40	1.55	Sooty coal
	1.55	3.00	Clay
Shft 4/53	0.00	0.40	Diluvium
	0.40	2.80	Clay with fauna
	2.80	3.80	Coal
	3.80	5.30	Coaly clay

	5.30	5.45	Clay
	5.45	6.20	Coal
	6.20	7.00	Clay
	7.00	8.10	Coaly clay
Shft 40/53	0.00	0.10	Diluvium
	0.10	2.00	Coaly clay
	2.00	2.40	Clay with fauna
Shft 41/53	0.00	1.00	Diluvium
	1.00	1.50	Clay with fauna
Shft 42/53	0.00	0.70	Diluvium
	0.70	1.60	Clay
Shft 43/53	0.00	0.80	Diluvium
	0.80	1.70	Clay
Shft 44/53	0.00	0.15	Diluvium
	0.15	1.30	Clay
Shft 45/53	0.00	0.80	Diluvium
	0.80	2.00	Argillaceous sandstone
	2.00	6.50	Clay
Shft 46/53	0.00	0.30	Diluvium
	0.30	2.20	Argillaceous sandstone
	2.20	5.70	Clay
Shft 47/53	0.00	0.60	Diluvium
	0.60	5.00	Clay
Shft 48/53	0.00	1.40	Diluvium
	1.40	3.20	Clay
Shft 49/53	0.00	0.30	Diluvium
	0.30	1.20	Sandstone
Shft 5/53	0.00	0.80	Diluvium
	0.80	9.60	Clay with fauna
	9.60	10.80	Coal
	10.80	12.00	Coaly clay
Shft 50/53	0.00	0.40	Diluvium
	0.40	3.00	Clay
Shft 51/53	0.00	0.10	Diluvium
	0.10	1.40	Clay
	1.40	2.80	Clay with coal lens
Shft 52/53	0.00	0.10	Diluvium
	0.10	0.80	Clay
	0.80	0.90	Marl
	0.90	1.20	Clay
	0.00	0.20	Diluvium
Shft 53/53	0.20	3.70	Clay
Shft 54/53	0.00	0.15	Diluvium
	0.15	4.40	Clay
Shft 55/53	0.00	0.30	Diluvium
	0.30	4.00	Clay
	4.00	4.20	Argillaceous sandstone

	4.20	5.00	Clay
Shft 56/53	0.00	1.10	Diluvium
	1.10	1.35	Sandstone
	1.35	4.60	Clay
	4.60	4.85	Sandstone
Shft 57/53	0.00	0.50	Diluvium
	0.50	4.00	Clay
	4.00	4.60	Sandstone
Shft 58/53	0.00	0.30	Diluvium
	0.30	3.40	Clay
Shft 59/53	0.00	0.40	Diluvium
	0.40	1.50	Clay
Shft 6/53	0.00	1.40	Diluvium
	1.40	3.90	Clay
Shft 60/53	0.00	0.40	Diluvium
	0.40	6.35	Clay
Shft 61/53	0.00	0.15	Diluvium
	0.15	8.05	Clay
Shft 62/53	0.00	0.25	Diluvium
	0.25	2.10	Clay
	2.10	2.50	Coaly clay
	2.50	5.25	Clay
Shft 63/53	0.00	0.40	Diluvium
	0.40	1.00	Clay
	1.00	1.50	Sandstone
Shft 64/53	0.00	0.15	Diluvium
	0.15	2.10	Clay
Shft 65/53	0.00	0.15	Diluvium
	0.15	0.90	Clay
	0.90	1.70	Sandstone
Shft 66/53	0.00	0.15	Diluvium
	0.15	5.50	Sandstone
	5.50	7.95	Clay
Shft 67/53	0.00	0.15	Diluvium
	0.15	3.45	Clay
Shft 68/53	0.00	0.50	Diluvium
	0.50	2.55	Clay with coal lens
Shft 69/53	0.00	0.45	Diluvium
	0.45	1.85	Clay with coal lens
Shft 7/53	0.00	0.40	Diluvium
	0.40	1.10	Clay
	1.10	1.30	Sandstone
	1.30	6.90	Clay
	6.90	7.30	Sandstone
	7.30	7.50	Clay
	7.50	8.70	Coal
	8.70	8.90	Clay

Shft 8/53	0.00	0.25	Diluvium				
	0.25	3.85	Clay				
	3.85	4.50	Coaly clay				
Shft 9/53	0.00	0.40	Diluvium				
	0.40	3.50	Clay				
	3.50	4.00	Sandstone				
Trench 20	0.00	0.20	Clay				
	0.20	1.13	Upper coal	45.49	2.13	13.40	28.94
	1.13	1.50	Clay with coal lens				
Trench 48	0.00	0.40	Loam				
	0.40	9.17	Clay				
	9.17	10.23	Upper coal				
	10.23	11.23	Clay				

Table 2. Borehole, shaft, trench and adit elevation, location, and depth information for data from Kacharava (1953) and Aloyan and Hakopian (1995).

[The internal coordinate system is explained in the text. Elevations and total depth are in meters. ID = identifier]

Point ID	Elevation (m)	North Coordinate Internal system	Latitude	East Coordinate Internal system	Longitude	Point ID total depth (m)
Borehole 1/53	1406.46	4533316.12	40.93338	8483803.62	44.78577	293.95
Borehole 10/53	1483.32	4533834.84	40.93799	8481504.78	44.78304	320.95
Borehole 11/53	1298.76	4531815.16	40.92002	8481873.91	44.78348	372.95
Borehole 12/53	1300.00	4530375.00	40.90720	8483115.00	44.78495	438.55
Borehole 13/53	1350.00	4529825.00	40.90231	8484550.00	44.78666	298.90
Borehole 14/53	1550.00	4530960.00	40.91241	8485950.00	44.78833	527.00
Borehole 15/53	1500.00	4531050.00	40.91321	8484210.00	44.78626	525.00
Borehole 17/94	1440.00	4533850.00	40.93813	8482675.00	44.78443	180.00
Borehole 2/53	1489.90	4533590.02	40.93581	8483450.47	44.78535	169.40
Borehole 24/94	1420.00	4533100.00	40.93145	8483420.00	44.78532	185.00
Borehole 25/94	1440.00	4533270.00	40.93297	8483650.00	44.78559	150.00
Borehole 3/53	1429.56	4533604.94	40.93595	8483073.23	44.78490	148.30
Borehole 4/53	1376.62	4532987.99	40.93046	8483712.47	44.78567	210.55
Borehole 5/53	1326.67	4532606.55	40.92706	8483155.45	44.78500	246.00
Borehole 6/53	1444.59	4533344.19	40.93363	8482253.83	44.78393	355.30
Borehole 7/53	1405.29	4533361.17	40.93378	8482931.04	44.78474	169.45
Borehole 8/53	1404.63	4533151.20	40.93191	8483941.63	44.78594	125.00
Borehole 9/53	1412.33	4533590.17	40.93582	8482845.94	44.78463	170.80
Shaft 1/53	1462.52	4533848.06	40.93811	8483278.87	44.78515	3.00
Shaft 10/53	1430.00	4533362.00	40.93378	8484328.00	44.78640	6.20
Shaft 11/53	1477.05	4533656.97	40.93641	8483814.69	44.78579	3.00
Shaft 12/53	1473.88	4533716.21	40.93694	8483835.56	44.78581	1.80
Shaft 13/53	1478.19	4533707.21	40.93686	8483849.25	44.78583	3.00
Shaft 14/53	1488.00	4533762.00	40.93734	8483873.00	44.78586	2.85
Shaft 15/53	1483.65	4533967.05	40.93917	8483236.33	44.78510	3.20
Shaft 16/53	1486.00	4533988.00	40.93936	8483214.00	44.78507	6.00
Shaft 17/53	1480.00	4533928.00	40.93882	8483196.00	44.78505	2.20
Shaft 18/53	1475.00	4533915.00	40.93871	8483195.00	44.78505	2.00
Shaft 19/53	1503.02	4534067.00	40.94006	8483227.00	44.78509	6.10
Shaft 2/53	1459.22	4533823.13	40.93789	8483300.00	44.78517	4.50
Shaft 20/53	1467.91	4533828.00	40.93793	8483177.00	44.78503	2.20
Shaft 21/53	1464.28	4533782.05	40.93752	8483140.21	44.78498	2.40
Shaft 22/53	1450.00	4533783.00	40.93753	8483181.00	44.78503	2.40
Shaft 23/53	1455.00	4533784.00	40.93754	8483160.00	44.78501	3.30
Shaft 24/53	1515.00	4534112.50	40.94046	8483167.50	44.78502	3.10
Shaft 25/53	1509.15	4534091.05	40.94027	8483211.20	44.78507	3.10
Shaft 26/53	1540.00	4534246.00	40.94165	8482361.50	44.78406	4.80
Shaft 27/53	1485.00	4533811.00	40.93778	8483914.00	44.78591	7.20
Shaft 28/53	1485.00	4533781.00	40.93751	8483909.00	44.78590	6.00
Shaft 3/53	1470.00	4534076.00	40.94014	8482588.00	44.78433	3.20
Shaft 30/53	1495.16	4533809.26	40.93776	8483916.01	44.78591	6.00

Shaft 31/53	1468.99	4533662.02	40.93645	8483937.38	44.78593	8.00
Shaft 32/53	1467.64	4533652.15	40.93637	8483923.43	44.78592	4.50
Shaft 33/53	1474.00	4533780.50	40.93751	8483965.00	44.78597	1.30
Shaft 34/53	1460.70	4533681.63	40.93663	8484027.99	44.78604	5.00
Shaft 35/53	1460.00	4533726.50	40.93703	8484036.00	44.78605	1.90
Shaft 36/53	1462.95	4533774.12	40.93745	8484051.72	44.78607	4.10
Shaft 37/53	1462.87	4533727.73	40.93704	8484035.42	44.78605	1.95
Shaft 38/53	1460.82	4533655.01	40.93639	8483972.69	44.78598	2.00
Shaft 39/53	1469.45	4533662.15	40.93646	8483976.76	44.78598	3.00
Shaft 4/53	1500.06	4533694.86	40.93675	8483865.02	44.78585	8.10
Shaft 40/53	1476.47	4533726.81	40.93703	8483873.60	44.78586	2.40
Shaft 41/53	1458.81	4533651.25	40.93636	8484009.83	44.78602	1.50
Shaft 42/53	1451.60	4533615.02	40.93604	8483991.71	44.78600	1.60
Shaft 43/53	1438.30	4533551.94	40.93547	8484009.96	44.78602	1.70
Shaft 44/53	1465.00	4533725.00	40.93702	8483956.00	44.78596	1.30
Shaft 45/53	1533.68	4534431.55	40.94330	8482356.39	44.78405	6.50
Shaft 46/53	1547.83	4534432.14	40.94331	8482377.73	44.78408	5.70
Shaft 47/53	1537.63	4534434.64	40.94333	8482395.41	44.78410	5.00
Shaft 48/53	1534.15	4534437.97	40.94336	8482421.16	44.78413	3.20
Shaft 49/53	1526.81	4534641.08	40.94517	8482431.56	44.78414	1.20
Shaft 5/53	1484.42	4533701.93	40.93681	8483885.12	44.78587	12.00
Shaft 50/53	1533.64	4534585.07	40.94467	8482388.15	44.78409	3.00
Shaft 51/53	1475.00	4533750.00	40.93724	8483950.00	44.78595	2.80
Shaft 52/53	1473.00	4533741.00	40.93716	8483960.00	44.78596	1.20
Shaft 53/53	1558.00	4534580.00	40.94462	8482300.00	44.78398	3.70
Shaft 54/53	1552.00	4534515.00	40.94405	8482308.50	44.78399	4.40
Shaft 55/53	1547.81	4534584.66	40.94467	8482371.80	44.78407	5.00
Shaft 56/53	1594.89	4535582.77	40.95355	8482230.50	44.78390	4.85
Shaft 57/53	1499.11	4534169.58	40.94097	8483371.27	44.78526	4.60
Shaft 58/53	1530.53	4534085.69	40.94023	8483435.22	44.78534	3.40
Shaft 59/53	1519.65	4534049.17	40.93990	8483459.65	44.78536	1.50
Shaft 6/53	1424.00	4533451.00	40.93458	8484045.00	44.78606	3.90
Shaft 60/53	1585.42	4535101.80	40.94927	8482224.66	44.78389	6.35
Shaft 61/53	1599.46	4535089.23	40.94916	8482118.16	44.78377	8.05
Shaft 62/53	1465.00	4533786.00	40.93756	8483333.00	44.78521	5.25
Shaft 63/53	1408.00	4533380.00	40.93394	8484460.00	44.78655	1.50
Shaft 64/53	1407.00	4533348.00	40.93366	8484480.00	44.78658	2.10
Shaft 65/53	1408.31	4533321.87	40.93343	8484481.92	44.78658	1.70
Shaft 66/53	1410.30	4533292.92	40.93317	8484486.36	44.78659	7.95
Shaft 67/53	1422.09	4533327.05	40.93347	8484537.43	44.78665	3.45
Shaft 68/53	1486.20	4533742.94	40.93717	8483928.58	44.78592	2.55
Shaft 69/53	1489.15	4533763.57	40.93736	8483937.98	44.78593	1.85
Shaft 7/53	1415.20	4533345.92	40.93364	8484375.66	44.78645	8.90
Shaft 8/53	1462.00	4533835.00	40.93799	8483290.00	44.78516	4.50
Shaft 9/53	1475.00	4534084.00	40.94021	8482575.00	44.78431	4.00
Adit 1	1454.56	4533783.93	40.93754	8483352.00	44.78524	2.49
Adit 10	1431.11	4533393.69	40.93407	8484641.70	44.78677	1.00
Adit 11	1515.00	4534232.00	40.94153	8485415.00	44.78769	1.00
Adit 12	1430.00	4533240.00	40.93270	8485110.00	44.78733	1.00
Adit 2	1439.07	4533914.50	40.93870	8482620.17	44.78437	8.53

Adit 3	1464.98	4533744.67	40.93719	8483818.73	44.78579	8.72
Adit 4	1399.80	4533327.60	40.93348	8484367.22	44.78644	1.56
Adit 5	1473.14	4533753.41	40.93727	8483761.61	44.78572	2.00
Adit 6	1461.12	4533665.99	40.93649	8483978.77	44.78598	3.50
Adit 7	1485.43	4533820.86	40.93787	8483471.33	44.78538	14.59
Adit 8	1392.76	4533309.04	40.93331	8484463.23	44.78656	6.14
Adit 9	1463.08	4533320.87	40.93342	8484816.44	44.78698	1.00
Trench 20	1418.75	4533232.83	40.93263	8484348.87	44.78642	1.50
Trench 48	1406.59	4533267.49	40.93294	8484454.58	44.78655	11.23

Table 3. Proximate, calorific value, and total sulfur analyses of the Shamut coal deposit — undesignated beds.

All data are from Asatiani and Aragunova (1953), except for the last four samples, data for the last four samples are from Pierce and others (1994).

Sample locality (SL) symbols used in the first column:

Asatiani and Aragunova, 1953
Adit 2 - 1' = adit 2, secondary adit 1
Adit 2 - 2' = adit 2, secondary adit 2
Adit 3 = ?' = adit 3, secondary adit number unknown or unclear
Trnch = trench
BH = borehole

Pierce and others, 1994
6 Trnch = a composite of 6 random (grab) trench samples
BH samples from exploration done by Aloyan and Hakopian (1995)

Pos = sample position. For adit samples, @ = distance in meters (m) from adit entrance or position where sample was taken; the distance is followed by the sample thickness in meters. For trench samples, the thickness is given in meters. For borehole samples, the interval sampled is given in meters below the ground surface.

Other terms: M = moisture, in percent; Ash = ash yield, dry basis, in percent; VM = volatile matter, dry basis, in percent; FC = fixed carbon, dry basis, in percent; S = sulfur, as-determined basis, in percent; CV-1 = calorific value, dry, ash-free basis, in calories per gram (cal/g); CV-2 = calorific value, dry, ash-free basis, in British thermal units per pound (Btu/lb); d = density, in grams per cubic centimeter (g/cm^3); NA = not analyzed or not reported; Trnch = trench

SL	Pos	M (%)	Ash (%)	VM (%)	FC (%)	S (%)	CV-1 (cal/g)	CV-2 (Btu/lb)	d (g/cm^3)
Adit 1	@14.0 m 0.35 m	1.8	52.19	42.71	NA	0.57	4718	8492	1.87
Adit 1	@14.0 m 0.35 m	3.9	68.11	60.18	NA	0.53	4750	8550	2.18
Adit 1 - 2'	NA	2.49	19.17	49.92	NA	4.82	7776	13997	1.41
Adit 1 - 2'	NA	2.77	49.6	47.74	NA	1.83	6990	12582	1.69
Adit 1 - 2'	@4.0 m 0.61 m	2	46	34.5	NA	NA	NA	NA	1.79
Adit 1 - 2'	@4.0 m 0.63 m	1.76	44.34	33.41	NA	NA	NA	NA	1.76
Adit 1 - 2'	@5.50 m 0.20 m	3.2	23.03	35.62	NA	4.07	8321	14978	1.52
Adit 1 - 2'	@5.50 m 0.14 m	2.9	35.78	48.62	NA	1.31	8343	15017	1.39
Adit 1 - 2'	@5.50 m 0.10 m	1.9	36.88	47.96	NA	2.74	8103	14585	1.69
Adit 1 - 2'	@5.50 m 0.30 m	2.9	47.71	85.94	NA	1.76	6881	12386	1.78
Adit 1 - 2'	@5.50 m 0.30 m	1.92	34.15	44.72	NA	2.83	7357	13243	1.64

Adit 1 - 3'	@1.30 m 0.67 m	2.31	37.98	33.29	NA	NA	NA	NA	1.71
Adit 1 - 3'	@1.60 m 0.95 m	2.4	65.16	35.88	NA	NA	NA	NA	1.91
Adit 1 - 3'	@9.9 m 0.61 m	1.58	34.02	29.38	NA	NA	NA	NA	1.6
Adit 1 - 3'	@12.0 m 0.84 m	2.2	36.56	32.29	NA	NA	NA	NA	1.64
Adit 2	near entry 0.21 m	6.6	74.3	62.33	NA	0.17	2916	5249	2.83
Adit 2	near entry 0.95 m	7	70.64	56.53	NA	0.72	3000	5400	2.3
Adit 2	near entry 0.52 m	5	63.26	55.7	NA	0.78	3979	7162	2
Adit 2	near entry 0.26 m	7.2	61.42	51.5	NA	0.33	4251	7652	2.01
Adit 2	@10.0 m 0.35 m	3.08	72.49	30.57	NA	NA	NA	NA	2.23
Adit 2	@15.0 m 0.30 m	2.8	70.29	33.45	NA	NA	NA	NA	2.16
Adit 2	@20.0 m 0.32 m	2.8	62.67	36.99	NA	NA	NA	NA	2.1
Adit 2	@31.0 m 0.30 m	3.42	63.83	40.31	NA	NA	5874	10573	2.03
Adit 2	@31.0 m 0.30 m	2.72	70.38	25.05	NA	NA	5614	10105	2.15
Adit 2 - 1'	@1.8 m 0.60 m	2.92	54.26	44.08	NA	NA	6625	11925	1.84
Adit 2 - 2'	@1.0 m 0.31 m	2.32	70.41	38.99	NA	NA	5238	9428	2.18
Adit 2 - 2'	@2.1 m 0.35 m	2.48	60.79	34.78	NA	NA	5728	10310	2
Adit 2 - 2'	@4.5 m 0.28 m	1.86	49.67	44.58	NA	NA	8715	15687	1.88
Adit 3	@5.0 m 1.20 m	3.02	52.92	35.43	NA	NA	8265	14877	1.84
Adit 3	@8.0 m 1.20 m	2.04	47.59	29.22	NA	NA	6566	11819	1.81
Adit 3	@11.0 m 1.20 m	1.56	46.32	32.39	NA	NA	6479	11662	1.76
Adit 3	@14.0 m 1.00 m	1.58	44.68	31.97	NA	NA	6679	12022	1.75

Adit 3 - 1'	@1.5 m 0.70 m	2.2	52.15	47.22	NA	2.56	6367	11461	1.83
Adit 3 - 1'	@1.7 m 0.45 m	1.92	40.98	28.64	NA	NA	NA	NA	1.74
Adit 3 - 1'	@1.50 m 0.42 m	4.18	58.75	44.15	NA	2.14	6889	12400	1.84
Adit 3 - 1'	@1.50 m 0.24 m	2.1	49.41	42.07	NA	2.9	6799	12238	1.77
Adit 3 - 2'	@1.5 m 0.20 m	3.11	43.95	27.46	NA	NA	NA	NA	1.79
Adit 3 - 2'	@2.0 m 0.20 m	2.1	49.66	33.01	NA	1.57	6807	12253	1.77
Adit 3 - 2'	@2.0 m 0.20 m	2.2	33.8	45.01	NA	2.01	7665	13797	1.61
Adit 3 - 2'	@2.0 m 0.20 m	2.72	45.04	47.28	NA	1.97	5887	10597	1.69
Adit 3 - 2'	@2.0 m 0.72 m	2.6	42.55	36.85	NA	2.12	6683	12029	1.68
Adit 3 - 2'	@6.5 m 0.62 m	2.46	45.07	31.71	NA	NA	NA	NA	1.82
Adit 3 - 2'	@9.8 m 0.80 m	2.76	58.49	35.67	NA	NA	NA	NA	1.92
Adit 3 - 2'	@10.5 m 0.10 m	7.4	39.46	38.53	NA	1.09	7520	13536	1.69
Adit 3 - 2'	@10.5 m 0.12 m	3.5	55.95	51.13	NA	1.9	6612	11902	1.82
Adit 3 - 2'	@10.5 m 0.16 m	2.44	38.13	49.63	NA	1.28	7606	13691	1.59
Adit 3 - 2'	@11.5 m 1.26 m	2.8	40.02	40.98	NA	1.71	6581	11846	1.68
Adit 3 - 2'	@11.8 m 0.15 m	3.12	40.2	30.7	NA	NA	NA	NA	1.69
Adit 3 - 2'	@11.9 m 0.75 m	3.1	43.96	32.78	NA	NA	NA	NA	1.8
Adit 3 - 2'	@12.5 m 0.14 m	2.7	34.76	36.59	NA	3.27	7705	13869	1.59
Adit 3 - 2'	@12.5 m 0.42 m	3.06	39.75	34.57	NA	1.75	7351	13232	1.65
Adit 3 - 2'	@12.5 m 0.16 m	2.9	41.03	44.35	NA	1.88	7354	13237	1.63
Adit 3 - ?’	@9.0 m 0.26 m	4.18	52.59	49.64	NA	1.29	4711	8480	1.89

Adit 3 - ?'	@9.0 m 0.14 m	3.8	46.92	43.28	NA	1.59	7988	14378	1.83
Adit 3 - ?'	@9.0 m 0.12 m	3.8	48.48	49.03	NA	1.01	7818	14072	1.64
Adit 4	@7.5 m 0.10 m	2.6	54.36	56.64	NA	2.23	3768	6782	1.83
Adit 4	@7.5 m 0.20 m	3.8	36.07	52.45	NA	4.45	7728	13910	1.63
Adit 4	@7.5 m 0.24 m	3.78	38.69	46.05	NA	1.68	7351	13232	1.7
Adit 4	@7.5 m 0.25 m	2.7	40.59	44.46	NA	3.71	6377	11479	1.76
Adit 4	@7.5 m 0.35 m	3.5	37.09	53.57	NA	3.91	7562	13612	1.62
Adit 4	@7.5 m 1.87 m	3.5	39.27	54.47	NA	3.75	6533	11759	1.64
Adit 4	@9.0 m 0.35 m	4	50.04	47.1	NA	3.19	7525	13545	1.86
Adit 4	@9.0 m 0.34 m	4.76	57.53	44.64	NA	2.58	5299	9538	2.01
Adit 5	@15.0 m 0.26 m	10.5	58.88	57.01	NA	0.27	8929	16072	1.95
Adit 5	@15.0 m 0.52 m	10.68	62.06	57.55	NA	2.04	4221	7598	2.09
Adit 6	@24.0 m 0.18 m	7.9	68.72	58.92	NA	0.23	4697	8455	2.07
Adit 6	@24.0 m 0.18 m	8.96	70.84	84.8	NA	0.19	3108	5594	2.08
Adit 7	@10.0 m 0.30 m	9	63.73	48.18	NA	2.68	3978	7160	2.08
Adit 7	@10.0 m 0.21 m	9.28	61.94	43.17	NA	0.25	3960	7128	2
Adit 7	@10.0 m 0.20 m	10.3	52.39	53.51	NA	0.34	4718	8492	1.8
Adit 7	@10.0 m 0.39 m	8.4	59.17	48.96	NA	0.49	5098	9176	2.03
Adit 7	@10.0 m 0.17 m	9.8	54.97	51.72	NA	0.34	5467	9841	2
Adit 7	@30.0 m 0.23 m	11	51.23	46.22	NA	0.41	6497	11695	1.79
Adit 7	@30.0 m 0.26 m	8.8	58.17	50.08	NA	0.35	5099	9178	2

Adit 7	@30.0 m 0.26 m	9.9	49.87	59.3	NA	0.43	7295	13131	1.79
Adit 7	@30.0 m 0.67 m	9.6	58.69	50.61	NA	0.44	5192	9346	2
Adit 7 - ?’	0.28 m thick	8.76	53.96	46.77	NA	0.53	5853	10535	1.83
Adit 7 - ?’	0.27 m thick	7.59	68.25	57.44	NA	0.79	2999	5398	1.88
Adit 7 - ?’	0.12 m thick	12.66	36.02	39.19	NA	0.36	5830	10494	1.65
Adit 7 - ?’	0.13 m thick	10.38	56.37	42.04	NA	0.46	5846	10523	1.91
Adit 7 - ?’	0.17 m thick	13.88	37.73	41.02	NA	0.5	5337	9607	1.7
Adit 7 - ?’	0.10 m thick	11.28	41.35	46.67	NA	0.53	5280	9504	1.68
Adit 7 - ?’	0.08 m thick	10.64	50.44	43.22	NA	0.52	5630	10134	1.76
Adit 7 - ?’	0.30 m thick	8.72	60.82	38.25	NA	0.33	1717	3091	1.94
Adit 7 - ?’	0.60 m thick	10.72	47.76	38.97	NA	20.42	5542	9976	1.76
Adit 7 - ?’	0.28 m thick	11.46	36.97	41	NA	0.59	5811	10460	1.72
Adit 7 - ?’	0.13 m thick	7.56	61.55	43.1	NA	0.28	3097	5575	2.08
Adit 7 - ?’	0.13 m thick	8.4	52.29	34.91	NA	0.32	4816	8669	1.96
Adit 7 - ?’	0.35 m thick	9.35	63.32	42.23	NA	0.35	3440	6192	1.83
Adit 7 - ?’	0.20 m thick	6.25	68.68	42.91	NA	1.77	2098	3776	2.13
Adit 7 - ?’	0.40 m thick	7.42	66.72	44.21	NA	0.24	2867	5161	2.1
Adit 7 - ?’	0.25 m thick	7.04	65.65	34.66	NA	0.3	3398	6116	2.07
Adit 7 - ?’	0.25 m thick	7.48	74.08	59.29	NA	0.32	3861	6950	2.09
Adit 7 - ?’	0.90 m thick	7.76	57.37	41.86	NA	0.3	3942	7096	1.94
Adit 7 - ?’	0.17 m thick	9.01	57.92	40.48	NA	0.41	4358	7844	1.81
Adit 7 - ?’	0.18 m thick	7.34	75.04	60.46	NA	0.37	2474	4453	2.09

Adit 8	@23.0 m 0.32 m	3	39.71	48.46	NA	5	7494	13489	1.75
Adit 8	@23.0 m 0.65 m	3.3	23.94	45.07	NA	5.03	8290	14922	1.64
Trnch 35	1.17 m thick	9.78	76.13	48	NA	NA	NA	NA	2.63
Trnch 35	1.05 m thick	10.18	60.25	40.22	NA	NA	NA	NA	2.28
Trnch 35	1.41 m thick	11.55	68.52	30.88	NA	NA	NA	NA	2.52
Trnch 35	0.84 m thick	10.55	68.82	63.81	NA	NA	NA	NA	2.52
Trnch 35	0.23 m thick	10.68	60.86	35.35	NA	NA	NA	NA	2.29
Trnch 35	0.47 m thick	13.72	57.91	36.73	NA	NA	NA	NA	2.31
Trnch 35	0.80 m thick	16.74	54.18	41	NA	NA	NA	NA	2.21
Trnch 20	0.93 m thick	13.4	45.49	28.94	NA	NA	NA	NA	2.13
Trnch 25	0.75 m thick	13.08	65.81	41.11	NA	NA	NA	NA	2.44
Trnch 25	0.52 m thick	14.68	42.19	35.07	NA	NA	NA	NA	3.09
Trnch 25	0.84 m thick	17.84	49.03	32.62	NA	NA	NA	NA	2.23
Trnch 25	0.75 m thick	18.24	54.51	39.25	NA	NA	NA	NA	3.3
BH 1	82.01-82.16 m	2.88	50.32	46.72	NA	2.06	7548	13586	1.69
BH 1	82.70-82.77 m	2.54	34.53	44.83	NA	3.02	7854	14137	1.4
BH 1	82.77-83.07 m	3.06	41.44	47.53	NA	1.5	8072	14530	1.61
BH 1	83.12-83.25 m	2.72	53.95	46.49	NA	0.73	5942	10696	1.87
BH 1	83.25-83.43 m	2.3	41.51	30.03	NA	1.34	6601	11882	1.67
BH 1	83.59-83.75 m	2.34	42.84	30.74	NA	2.37	6535	11763	1.28
BH 1	84.50-84.75 m	2.5	38.83	51.76	NA	4.2	7456	13421	1.23
BH 1	85.42-85.92 m	3	34.65	41.14	NA	3.02	7491	13484	1.54

BH 2	130.6-130.8 m	0.8	46.06	41.3	NA	2.18	7803	14045	1.85
BH 2	130.95-132.65m	1.5	62.03	51.17	NA	1.15	4264	7675	2.07
BH 2	132.75-134.0 m	1.3	59.27	46.26	NA	1.41	5151	9272	2.01
BH 2	134.1-135.0 m	1.1	63.09	53.88	NA	1.05	4098	7376	2.09
BH 2	135.7-136.3 m	0.9	48.63	50.25	NA	2.69	7823	14081	1.64
BH 2	136.7-137.2 m	0.98	60.89	49.12	NA	1.84	5482	9868	2
BH 2	139.1-140.0 m	1.1	67.13	49.04	NA	2	4756	8561	2.12
BH 2	140.40-141.05m	1.3	61.91	53.46	NA	2.27	4289	7720	2.04
BH 4	167.35-168.25m	1.1	67.22	49.59	NA	0.61	4463	8033	2.07
BH 4	168.35-168.45m	0.74	48.19	27.92	NA	1	7658	13784	1.66
BH 4	169.10-169.95m	0.94	43.3	41.77	NA	1.58	6969	12544	1.61
BH 4	170.80-172.50m	0.8	44.56	42.54	NA	2.04	6960	12528	1.68
BH 4	172.60-173.00m	1.5	62.35	43.93	NA	5.58	4199	7558	2.1
BH 4	173.15-173.90m	0.9	72.25	58.98	NA	1.49	2967	5341	2.42
BH 4	174.30-174.55m	1.5	72.99	57.33	NA	0.63	3007	5413	2.31
6 Trnch		22.92	63.44	23.31	13.25	0.11	4858	8744	NA
BH 1		5.36	71.78	18.73	9.49	2.38	5683	10229	NA
BH 2		4.01	71.39	24.91	3.7	1.11	3439	6191	NA
BH 3		4.77	77.86	19.37	2.77	0.57	3078	5541	NA

Table 4. Proximate, calorific value, and total sulfur analyses of the Shamut coal deposit — bed specific.

[All data from Asatiani and Aragunova (1953). SL = sample locality; Pos = sample position. For adit samples, @ = distance in meters (m) from adit entrance of position where sample was taken; the distance is followed by the sample thickness in meters. 2d adit = undesignated secondary adit. For trench samples, the thickness is given in meters. For borehole samples, the interval sampled is given in meters below ground surface. M = moisture, in percent; Ash = ash yield, dry basis, in percent; VM = volatile matter, dry basis, in percent; S = sulfur, dry basis, in percent; CV-1 = calorific value, dry basis, in calories per gram (cal/g); CV-2 = calorific value, dry basis, in British thermal units per pound (Btu/lb); d = density, in grams per cubic centimeter (g/cm^3); BH = borehole]

Coal bed	SL	Pos	M (%)	Ash (%)	VM (%)	S (%)	CV-1 (cal/g)	CV-2 (Btu/lb)	d (g /cm^3)
Upper bed	Adit 1	@14.0 m 0.85 m	4.45	63.08	53.72	0.61	4546	8183	1.9
	Adit 2	near adit entry 0.78 m	6	61.17	47.45	0.4	5101	9182	1.88
	Adit 3	2d adit 0.93 m	3.4	40.69	40	1.3	6800	12240	1.77
	Adit 5	2d adit 1.38 m	8.98	59.66	50.58	0.44	5448	9806	1.87
	Adit 8	2d adit 1.02 m	5.53	59.98	51.42	0.55	5399	9718	1.87
	BH 2	139.80-141.05	1.2	63.45	52.18	2.31	4478	8060	1.91
	BH 4	170.62-174.55	1.17	57.59	47.45	3.12	5350	9630	1.85
Middle bed	Adit 2	near entry 1.16 m	5	71.34	60.14	0.72	3255	5859	2.05
	Adit 7	@10 m 1.26 m	8.26	60.95	49.97	0.35	5223	9401	1.88
	Adit 7	near end 1.42 m	8.34	55.46	46.49	0.41	6330	11394	1.83
	BH 2	135.70-137.15	0.94	54.32	49.58	1.9	5901	10622	1.81
	BH 4	169.00-169.81	0.94	43.3	41.77	1.6	6969	12544	1.69
Lower bed	Adit 4	@9 m 0.69 m	4	53.12	50	3	6377	11479	1.8
	Adit 6	2d adit 0.34 m	7.73	68.56	58.77	0.29	4012	7222	2.01

	BH 2	130.80-135.00	1.3	61	51.58	1.4	4934	8881	1.88
Unreadable in original text table	BH 4?	167.08-168.38	1.45	65.73	53.21	0.65	4200	7560	1.96

Table 5. Ultimate analyses and forms of sulfur of the Shamut coal deposit.

[SL = sample locality; NS = number of samples; H = hydrogen, dry basis, in percent; C = carbon, dry basis, in percent; N = nitrogen, dry basis, in percent; O = oxygen, dry basis, in percent; O+S = oxygen plus sulfur, dry basis, in percent; PS = pyritic sulfur, dry basis, in percent; SS_d = sulfate sulfur, dry basis, in percent; OS = organic sulfur, dry basis, in percent; SS = sulfate sulfur, dry basis, in percent; ukn = unknown; Trnch = trench; BH = borehole]

Coal bed	SL	NS	H (%)	C (%)	N (%)	O (%)	S (%)	O+S (%)	PS (%)	OS (%)	SS (%)
Asatiani and Aragunova, 1953											
Upper	Adit 1	ukn	6.25	73.73	1.71			18.31			
	Adit 2	ukn	6	76.15	1.69			16.16			
	Adit 3	ukn	5.22	79.28	1.61			13.19			
	Adit 5	ukn	5.58	78.15	1.55			14.72			
	Adit 8	ukn	6.04	69.41	1.61			22.94			
Middle	Adit 2	ukn	6.72	62.92	1.81			28.55			
	Adit 7	ukn	6.08	73	1.96			18.96			
	Adit 7	ukn	5.91	79.28	1.81			13			
Lower	Adit 4	ukn	5.15	82.24	1.98			10.63			
	Adit 6	ukn	6.4	63.19	1.95			28.46			
Pierce and others, 1994											
ukn	Trnch	6	1.51	21.4	0.76	12.74	0.15		0.13	0.01	0.01
ukn	BH	1	1.45	17.25	0.45	6.55	2.52				
ukn	BH	1	1.09	14.56	0.28	11.52	1.16				
ukn	BH	1	1	10.04	0.22	10.28	0.6				

Table 6. Oxide data from the Shamut coal deposit.

[Oxides analyzed on the ash fraction of the coal. All data in percent. SL = sample locality; — = not detected; tr = trace; range = range for all samples, exact number of samples is not given]

Coal bed	SL	SiO_2 (%)	Al_2O_3 (%)	Fe_2O_3 (%)	CaO (%)	MgO (%)	SO_3 (%)	MnO (%)
Asatiani and Aragunova, 1953								
Upper	Adit 1	55.6	21.44	10.56	7	1.29	1.43	—
	Adit 2	55.72	23.46	10.04	4.48	2.23	1.49	—
	Adit 3	53.48	23.56	7.04	10.92	1.44	3.19	—
	Adit 5	50.08	23.72	10.28	5.6	2.19	4.76	tr
	Adit 8	53.8	23.04	6.98	10.82	1.55	3.45	tr
Middle	Adit 2	53.5	22.4	0.14	7.74	1.93	2.55	tr
	Adit 7	52.6	22.72	5.28	8.68	3.02	2.72	—
	Adit 7	54.4	23.32	10.28	6.16	2.73	2.38	—
Lower	Adit 4	44.8	17.44	10.56	14.84	2.73	7.82	—
	Adit 6	55.27	20.36	7.04	12.16	1.87	3.06	—
Aloyan and Hakopian, 1995								
Lower + middle	range	44.8-54.4	17.44-23.32	5.28-10.56	6.16-14.84	1.87-3.02	2.38-7.32	—

Table 7. Proximate, calorific value, and density analyses of manually enriched coal samples from the Shamut coal deposit.

[All data from Asatiani and Aragunova (1953). No explanation of the washability procedure was given by the authors. SL = sample locality; ST = sample thickness, in meters (m); M = moisture, in percent; A = ash yield, dry basis, in percent; VM = volatile matter, dry basis, in percent; S = sulfur, dry basis, in percent; CV-1 = calorific value, dry basis, in calories per gram (cal/g); CV-2 = calorific value, dry basis, in British thermal units per pound (Btu/lb); d = density, in grams per cubic centimeter (g/cm^3)]

Coal bed	SL	ST (m)	M (%)	A (%)	VM (%)	S (%)	CV-1 (cal/g)	CV-2 (Btu/lb)	d (g /cm^3)
Upper	Adit 1	0.85	4.05	48.73	44.13	0.86	6954	12517	1.75
	Adit 2	0.78	4.55	45.6	42.9	0.67	7121	12818	1.73
	Adit 3	0.93	2.92	42.82	40.54	2.58	7050	12690	1.69
	Adit 5	1.38	6	43.3	41.18	2.15	7532	13558	1.7
	Adit 8	1.02	4.52	51.77	46.92	0.98	6723	12082	1.79
Middle	Adit 2	1.16	4.9	60.42	52.03	3.7	5232	9418	1.92
	Adit 7	1.26	6	49.24	44.62	3.14	6915	12447	1.76
	Adit 7	1.42	5.98	43.17	41.06	2.55	7315	13167	1.69
Lower	Adit 4	0.69	3.92	41.12	39.83	3.79	7389	13300	1.67
	Adit 6	0.34	6.12	59.2	50.34	3.81	5257	9463	1.88

Table 8. Washability analyses of the Shamut coals, using natural size fractions from three bulk samples. (*A*) Upper coal bed; (*B*) Middle coal bed; (*C*) Lower coal bed.

[All data from Asatiani and Aragunova (1953). The size fractions given within this table were naturally occurring within each coal sample; they were not induced by crushing the coal. One bulk sample (300-350 kg) per bed was analyzed. SF = size fraction (for example, -100+50 = 0.01x0.5 mm); DF = density fraction; RecC = percent recovery within the size fraction; RecS = percent recovery within the entire sample; A = ash yield, dry basis, in percent, at a particular density separate within a particular size fraction; RecTot = total recovery, in percent; ATot = ash yield of the total recovery yield, in percent]

A. Upper Coal Bed

SF	DF	RecC (%)	RecS (%)	A (%)	Total	
					RecTot (%)	ATot (%)
-100+50	1.5-1.6	22	3.37	50.21	22	50.21
	1.6-1.8	32.2	4.93	53.41	54.2	52.11
	+ 1.8	45.8	7	73.16	100	61.75
	Total	100	15.3	61.75		
-50+25	1.5-1.6	15.1	2.02	36.22	15.1	36.22
	1.6-1.8	26.3	3.51	55.13	41.4	48.23
	+1.8	58.6	7.83	71.67	100	61.97
	Total	100	13.36	61.97		
-25+13	1.4-1.5	3.2	0.31	31.32	3.2	31.32
	1.5-1.6	16.9	1.62	35.19	20.1	34.57
	1.6-1.8	26.1	2.5	52.35	46.2	44.61
	+1.8	53.8	5.15	75.4	100	61.18
	Total	100	9.58	61.18		
-13+6	1.4-1.5	5.3	0.96	25.45	5.3	29.45
	1.5-1.6	11.2	2.03	34.81	16.5	33.09
	1.6-1.8	25.4	4.6	49.36	41.9	43.95
	+1.8	58.1	10.51	74.45	100	61.25
	Total	100	18.1	61.25		
-6+3	1.4-1.5	10.2	2.3	21.45	10.2	21.45
	1.5-1.6	8.9	2.01	33.4	19.1	27.02
	1.6-1.8	16.3	3.68	46.81	35.4	36.13
	+1.8	64.6	14.61	71.25	100	58.82
	Total	100	22.6	58.82		

-3+1	1.4-1.5	13.3	1.23	18.42	13.3	18.42
	1.5-1.6	10.5	0.97	27.13	23.8	22.26
	1.6-1.8	18.8	1.75	43.95	42.6	31.83
	+1.8	57.3	5.35	69.45	100	53.36
	Total	99.9	9.31	53.36		

***B*. Middle Coal Bed**

SF	DF	RecC (%)	RecS (%)	A (%)	Total	
					RecTot (%)	ATot (%)
-100+50	1.5-1.6	24	3.9	55.93	24	55.93
	1.6-1.8	31	5.1	57.43	55	56.76
	+1.8	45	7.3	72.15	100	63.69
	Total	100		NR		
-50+25	1.4-1.5	2	0.2	33.99	2	33.99
	1.5-1.6	11	1.3	39.19	13	38.38
	1.6-1.8	25	3.1	53.15	38	48.1
	+1.8	62	7.53	74.83	100	64.67
	Total	100	12.14	NR		
-25+13	1.4-1.5	---	---	---	---	---
	1.5-1.6	17.8	1.94	38.43	17.8	38.43
	1.6-1.8	27.8	3.03	51.63	45.6	46.47
	+1.8	54.4	5.92	75.63	100	62.34
	Total	100	10.89	62.34		
-13+6	1.4-1.5	6.8	1.17	30.59	6.8	30.59
	1.5-1.6	9	1.54	36.25	15.8	33.81
	1.6-1.8	26	4.46	48.53	41.8	42.97
	+1.8	58.2	9.99	73.42	100	60.69
	Total	100		NR		
-6+3	1.4-1.5	9.9	2.33	23.29	9.9	23.29
	1.5-1.6	7.8	1.84	32.82	17.7	27.49
	1.6-1.8	18.9	4.46	44.8	36.6	36.43
	+1.8	63.4	14.95	69.35	100	57.3
	Total	100	23.58	57.3		

-3+1	1.4-1.5	12.6	1.04	18.22	12.6	18.22
	1.5-1.6	9.6	0.79	28.16	22.2	22.52
	1.6-1.8	20.8	1.73	40.89	43	31.4
	+1.8	57	4.73	67.58	100	52.03
	Total	100	8.29	52.03		

C. Lower Coal Bed

SF	DF	RecC (%)	RecS (%)	A (%)	Total	
					RecTot (%)	ATot (%)
-100+50	1.5-1.6	20.1	3.21	45.13	20.1	45.13
	1.6-1.8	34.4	5.51	48.21	54.5	47.07
	+1.8	45.5	7.28	71.15	100	58.02
	Total	100	16	58.02		
-50+25	1.5-1.6	17.3	2.04	33.55	17.3	33.5
	1.6-1.8	30.4	3.59	44.15	47.7	40.31
	+1.8	52.3	6.17	70.2	100	55.94
	Total	100	11.8	55.94		
-25+13	1.4-1.5	6.1	0.58	29.11	6.1	29.11
	1.5-1.6	18.2	1.74	33.23	24.3	32.2
	1.6-1.8	27.6	2.64	44.27	51.9	38.61
	+1.8	48.1	4.59	73.22	100	55.26
	Total	100	9.55	55.26		
-13+6	1.4-1.5	7.3	1.4	28.24	7.3	28.24
	1.5-1.6	15.6	3	32.15	22.9	30.9
	1.6-1.8	28.9	5.56	43.16	51.8	37.74
	+1.8	48.2	9.27	74.55	100	55.48
	Total	100	19.23	55.48		
-6+3	1.4-1.5	11.3	2.75	20.37	11.3	20.37
	1.5-1.6	10.1	2.46	31.12	21.4	25.44
	1.6-1.8	23.8	5.8	41.15	45.2	33.71
	+1.8	54.8	13.34	73.2	100	55.35
	Total	100	24.35	55.35		

-3+1	1.4-1.5	13.8	1.3	16.41	13.8	16.41
	1.5-1.6	10.7	1.01	26.12	24.5	20.65
	1.6-1.8	22.3	2.11	42.36	46.8	30.99
	+1.8	53.2	5.02	70.11	100	51.81
	Total	100	9.44	51.81		

Table 9. Washability analyses of Shamut coals using manually prepared size fractions from three bulk samples.

[All data from Asatiani and Aragunova (1953). Portions of three bulk samples (300-350 kg each, one sample per coal bed) were manually crushed and sieved to the size fractions shown in the table. SF = size fraction (for example, -100+50 = 0.01x0.5 mm); Rec = percent recovery, in percent; A = ash yield at that recovery, dry basis, in percent]

SF	Upper coal bed		Middle coal bed		Lower coal bed	
	Rec (%)	A (%)	Rec (%)	A (%)	Rec (%)	A (%)
-100+50 mm	15.3	61.21	16.3	62.81	16	56.31
-50+25 mm	13.36	62.11	12.14	61.45	11.8	56.04
-25+13 mm	9.58	62.2	10.89	63.22	9.55	57.22
-13+6 mm	18.1	62.35	17.16	63.79	19.23	57.95
-6+3 mm	22.6	59.41	23.58	61.53	24.35	56.21
-3+1 mm	9.31	57.32	8.29	58.72	9.44	53.11
-1+0 mm	11.75	58.21	11.64	61.49	9.63	56.46
Total	100	60.41	100	62.06	100	56.36

Table 10. Washability analyses of the Shamut coals using three manually prepared size fractions from a combined bulk sample.

[All data from Asatiani and Aragunova (1953). Although the authors stated that large size fractions were crushed to the three size fractions shown below, they did not explain how the samples were prepared. It is assumed that the authors took any large fractions left from the three bulk samples used in previous analyses, combined the large fractions, and crushed the combined large fractions into the three size classes shown in the table. SF = size fraction; DF = density fraction; RecC = percent recovery within the size fraction; RecS = percent recovery within the entire sample; A = ash yield, in percent, dry basis, at a particular density separate within a particular size fraction; RecTot = total recovery, in percent; ATot = ash yield of the total recovery yield, in percent]

SF (mm)	DF	Rec (%)	RecS (%)	A (%)	Total	
					RecTot (%)	ATot (%)
-13+6	1.5-1.6	7	1.21	30.5	7	30.5
	1.6-1.8	24	4.13	46.31	31	42.74
	+1.8	69	11.8	74.85	100	64.89
	Total	100	17.22	64.89		
-6+3	1.5-1.6	8	0.94	28.03	8	28.03
	1.6-1.8	19	2.23	45.14	27	40.07
	+1.8	73	8.59	71.19	100	62.79
	Total	100	11.76	62.79		
-3+1	1.5-1.6	12	0.59	21.2	12	21.2
	1.6-1.8	14	0.68	35.89	26	29.11
	+1.8	74	3.61	67.07	100	57.2
	Total	100	4.88	57.2		

Table 11. Washability analyses of the Shamut coals using manually washed size fractions from 10 samples.

[All data from Asatiani and Aragunova (1953). The exact preparation procedure is unreported. SL = sample locality; M = moisture, in percent; A = ash yield, dry basis, in percent; VM = volatile matter, dry basis, in percent; S = sulfur, dry basis, in percent]

Coal bed	SL	M (%)	A (%)	VM (%)	S (%)
Upper	Adit 1	2.5	38.83	45.57	0.94
	Adit 2	3	34.65	48.14	1.67
	Adit 3	2.2	33.8	42.01	2.01
	Adit 5	2.7	34.76	44.59	3.27
	Adit 8	2.7	40.59	44.46	3.71
Middle	Adit 2	2.88	50.32	46.72	2.06
	Adit 7	2.44	38.13	42.63	2.28
	Adit 7	3	34.65	41.52	2.02
Lower	Adit 4	1.9	36.88	42.96	2.74
	Adit 6	2.72	45.04	47.28	1.97

Table 12. Refractory index of samples from the Shamut coal beds.

All data from Asatiani and Aragunova (1953). SL = sample location; *RI* = refractory index. The refractory index was calculated by using the following formula:

$$RI = \frac{SiO_2 + Al_2O_3}{CaO + MgO + Fe_2O_3}$$

Coal bed	SL	*RI*
Upper	Adit 1	4.08
	Adit 2	4.73
	Adit 3	4.07
	Adit 5	4.13
	Adit 8	3.96
Middle	Adit 2	4.03
	Adit 7	4.43
	Adit 7	4.05
Lower	Adit 4	2.21
	Adit 6	3.59

Table 13. Results of tar yield and coking tests on the Shamut coals.

[All data from Asatiani and Aragunova (1953). Ttar = temperature of tar exsudation, in degrees Celsius; TY = tar yield, in percent; AW = adhered water, in percent; SC = semi-coke yield, in percent; GY = gas yield, in percent]

Coal bed	SL	Ttar (°C)	TY (%)	AW (%)	SC (%)	GY (%)
Upper	Adit 1	372	6.05	8.11	84.15	2.29
	Adit 2	345	5.43	7.55	82.49	4.54
	Adit 3	355	5	8	81.06	5.94
	Adit 5	363	6	7.55	81.72	4.73
	Adit 8	355	6.37	8.19	80.98	4.46
Middle	Adit 2	345	6.78	7.42	81.45	4.35
	Adit 7	366	5.72	6.38	84	3.9
	Adit 7	358	5.57	8.03	80.24	6.16
Lower	Adit 4	355	5.05	8.25	85	1.7
	Adit 6	372	6.45	8.11	83.15	2.29

Table 14. Bitumen A yield of the Shamut coals.

[All data from Asatiani and Aragunova (1953). SL = sample locality; BY = bitumen A yield per combustible mass, in percent]

Coal bed	SL	BY (%)
Upper	Adit 1	1.82
	Adit 2	1.68
	Adit 3	1.52
	Adit 5	1.7
	Adit 8	1.91
Middle	Adit 2	1.98
	Adit 7	1.8
	Adit 7	1.65
Lower	Adit 4	1.51
	Adit 6	1.92

Table 15. Resource calculations of the Shamut coal deposit from Kacharava (1953) and Aloyan and Hakopian (1995) and computerized recalculations for this report.

For a discussion of the resource reporting categories C_1, C_2, and so on, see the text sections entitled “Resource Terminology” and “Archival Resource Estimates.” All areas calculated are horizontal projection areas, not true area projections.

Exclusions:

Kacharava (1953)	Aloyan and Hakopian (1995)	This report
Minimum thickness = 0.7 m	Minimum thickness = 0.5 m	Top number has no exclusions
Ash yield (dry) = >60 percent	Ash yield (dry) = >60 percent	Bottom number (in parentheses) has a minimum thickness exclusion of 0.5 m
Calorific value = 1500-2000 cal/g	Calorific value = < 2000 cal/g	

Computerized area recalculation, using a digitizer as a planimeter, revealed that many of the areas of the resource blocks used by Kacharava (1953) and Aloyan and Hakopian (1995) were incorrectly calculated. The data under the column headings “Kacharava (1953)” and “Aloyan and Hakopian (1995)” are drawn directly from their reports. The areas of the resource blocks originally reported by Kacharava (1953) and Aloyan and Hakopian (1995) and the areas recalculated by computer are found in table 16.

Other terms used: m^2 = square meters; t = metric tonnes; ha = hectares; NA = not available or not calculated.

<table>
<tr><th rowspan="2">Coal Bed</th><th colspan="2">Kacharava (1953)</th><th colspan="2">Aloyan & Hakopian (1995)</th><th>Recalculation for in-situ gasification resource</th><th colspan="3">Computerized resource recalculation (this report)</th></tr>
<tr><th>Area (m^2)</th><th>Resources C_1+C_2 (t)</th><th>Area (m^2)</th><th>Resources C_1+C_2 (t)</th><th>Resources $C_1+C_2+P_1$ (t)</th><th>Area (m^2) (hectares)</th><th>Resources $C_1 + C_2$ (t)</th><th>Total Resources $C_1 + C_2 + P_1$ (t)</th></tr>
<tr><td>Upper</td><td>733830</td><td>2184700</td><td>615262</td><td>2841278</td><td rowspan="3">C_1 - 2,022,523
C_2 - 8,884,238
P_1 - 4,847,557

(area = 3,354,650 m^2 or 335.465 ha)</td><td>511,039
(51.1)</td><td>1,348,002
(1,331,688)</td><td rowspan="3">14,646,822

(area = 3,354,650 m^2 or 335.465 ha)</td></tr>
<tr><td>Middle</td><td>508775</td><td>1438300</td><td>945728</td><td>2192298</td><td>997,901
(99.79)</td><td>1,448,141
(1,389,638)</td></tr>
<tr><td>Lower</td><td>NA</td><td>NA</td><td>948287</td><td>1638036</td><td>1,028,096
(102.81)</td><td>1,437,020
(1,333,762)</td></tr>
<tr><td>Total</td><td></td><td>3623000</td><td></td><td>6671612</td><td>15754318</td><td></td><td>4,233,163
(4,055,088)</td><td>14646822</td></tr>
</table>

Table 16. Area of resource blocks used by (*A*) Kacharava (1953) and (*B*) Aloyan and Hakopian (1995) in resource calculations of the Shamut coal deposit, as originally reported, and as recalculated for this report.

[Recalculation was performed by using a digitizer as a planimeter. All areas in square meters (m^2)]

A. Kacharava (1953)

Upper Bed		
Block designation	Area as originally reported (m^2)	Recalculated area (m^2)
1-C_1	2100	2611
2-C_1	18950	22774
3-C_1	80700	81670
4-C_1	102100	103652
5-C_1	20425	22645
6-C_1	6150	7425
7-C_1	58550	64284
8-C_1	30500	32250
9-C_1	750	846
10-C_1	12300	12016
11-C_1	27800	32947
12-C_1	1975	
13-C_2	22625	23400
14-C_2	31750	33466
15-C_2	24850	26427
16-C_2	292275	302329
Total	733800	768742

Middle Bed		
Block designation	Area as originally reported (m^2)	Recalculated area (m^2)
1-C_1	5400	6362
2-C_1	18950	24370
3-C_1	34200	35039

4-C_1	60525	67720
5-C_1	22650	22572
6-C_1	16725	18677
7-C_1	28800	30215
8-C_1	11550	11852
9-C_1	7875	8669
10-C_1	73800	75799
11-C_1	74000	77942
12-C_2	95000	98964
13-C_2	59300	61453
	508775	539634

_B_. Aloyan and Hakopian (1995)

Upper Bed		
Block designation	Area as originally reported (m^2)	Recalculated area (m^2)
B-1-C_1	94375	97791
B-2-C_1	110250	106738
B-3-C_1	133125	134613
B-4-C_1	40012	38501
B-5-C_1	115000	121150
B-6-C_2	68125	68618
B-7-C_2	54375	55427
Total	615262	622838

Middle Bed		
Block designation	Area as originally reported (m^2)	Recalculated area (m^2)
B-1-C_1	5615	17929
B-2-C_1	59375	58267
B-3-C_1	106362	99424
B-4-C_1	116250	112810

B-5-C_1	208125	145078
B-6-C_1	143750	140263
B-8-C_2	178126	172077
B-9-C_2	128125	128535
Total	945728	874383

Lower Bed		
Block designation	Area as originally reported (m^2)	Recalculated area (m^2)
B-1-C_1	28750	27753
B-2-C_1	61875	57104
B-3-C_1	106875	106723
B-4-C_1	119375	115756
B-5-C_1	77787	72944
B-6-C_1	150000	128858
B-7-C_1	144375	141608
B-8-C_2	139875	138540
B-9-C_2	119375	175155
Total	948287	964441