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efficiency. The economic aspects of energy developments and use were discussed as related to patterns of consumption, trade, and the Gross National Product of the Soviet Union and Eastern European countries. The overall energy supply and demands of these countries were projected to the 1980 and 1990 time frames. Finally an analysis was made of the Soviet political/military/energy strategy policies relative to the economic impact on Eastern and Western Europe.

This appendix discusses in depth the coal resources and recoverable reserves in the Soviet Union and Eastern Europe and provides a perspective for present and projected future energy requirements of these countries.



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ANALYSIS OF ENERGY RESOURCES AND
PROGRAMS OF THE SOVIET UNION AND EASTERN EUROPE.

Appendix B. Coal

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I INTRODUCTION

Coal has been a principal source of energy in Eastern Europe and the USSR for centuries. The presence of substantial high-quality coal deposits that could be readily recovered typically determined the dimensions of economic growth in this area. Efforts to obtain secure supplies of these and other essential raw materials frequently contributed to the sequence of conflicts that raged over this area. Although in recent years, a shift away from coal toward other fuels has reduced its percentage share of total energy supply in the region and in individual countries, the absolute amount of coal production has continued to grow. Therefore, knowledge of the coal resources and recoverable reserves in the USSR and Eastern Europe will provide a perspective for present and projected future energy requirements.

A. Coal Rank

Coals are ranked^{*} by the amount of volatile matter they contain. Common terms for coal rank are:

<u>USSR and Eastern Europe</u>	<u>U.S. Equivalent</u>
Hard coal	Anthracite and bituminous
Brown coal	Sub-bituminous and lignite
Peat	Peat

* U.S. Bureau of Mines - rank denotes the degree of progressive alteration and devolatilization of coal.

A more detailed classification system is employed by Soviet workers to express quality characteristics of coals of different rank. This system, based on the coals of the Donets and Kuznetsk deposits, is compared with U.S. data in Table B-1. Although this classification will be used

Table B-1
COMPARISON OF CLASSIFICATION SYSTEMS

Name	Soviet System*			US Equivalent [†] Name and Description, if any
	Symbols	Volatiles (Percent)	Carbons (Percent)	
Anthracite	A	< 8	--	Anthracite
Lean	T	<17	90-95	
Dry steam	PS	12-18	88-94	Bituminous (Low-medium volatile)
Coking coal	K	18-26	87-92	
Fatty steam	PZH	26-36	84-90	
Gassy	G	36-44	78-89	Bituminous (high volatile)
Dry long flame	D	>42	75-86	
Dry long flame	DB	>42	<75	Sub-bituminous
Brown coal	B	>42	<75	Lignite

* J. A. Hodgkins, Soviet Power (Prentice-Hall, Inc., Englewood Cliffs, N.J., 1961).

† P. Averitt, R., U.S. Geological Survey Bulletin 1275 (1969).

at times in this appendix, the principal emphasis will be on the common terms given above.

B. Resources and Reserves

Resources and reserves are two related but separate aspects of the energy raw materials occurring in the USSR and Eastern Europe. These terms are defined according to the practice of the U.S. Geological Survey.*

- Resources are deposits of fuels with known characteristics. The term includes mineral deposits that have been identified by geologists, as well as those less positively identified in known districts and lesser known areas. Resources are therefore the amounts deposited by nature, and ordinarily will refer to very large numbers.
- Reserves are the relatively smaller amounts of identified resources that may be recovered economically by present or foreseeable technology. Reserves are therefore less plentiful than resources. Reserves may be further subdivided by degree of certainty, and it is common to encounter "proved" (or "proven"), "probable," or "possible" categories.

To distinguish between resources and reserves is, unfortunately, not a simple matter, because the USSR employs a different classification system:

Soviet System of Reserve Classification

<u>Category</u>	<u>Description: U.S. Equivalent</u>
A	Proved reserves
B	Probable reserves
C	Inferred reserves
C ₁	Initial development done
C ₂	Preliminary exploration done
D	Speculative reserves
D ₁	Reconnaissance data only
D ₂	Predicted on geologic principles

Problem: Data often are aggregates of several categories (A+B+C₁, etc.)

* "United States Mineral Resources," U.S. Geological Survey Professional Paper 820, D. A. Brobst and W. P. Pratt, Editors, 1973.

Although it purports to describe "reserves," this system actually describes "resources" as used above, because provision for recoverability is not included.* Thus, the statistics given in individual categories of the Soviet classification will be too great by the amount of deposits that cannot be recovered. In order to obtain values comparable to U.S. reserve data, a recoverability factor must be applied to the Soviet data. Although in many cases such factors may be found from the literature, in other cases they may only be estimated on the basis of experience with similar deposits, leading to an element of uncertainty in arriving at recoverable reserves of Soviet energy materials. A further problem is that the Soviets often report reserve (actually resource) data as aggregates of several categories (A+B+C, etc.). This practice complicates analysis of actual recoverable reserves, because of its inherent uncertainty regarding deposit characteristics. Although there is little alternative to employing such data in this analysis, great care has been taken to (1) recognize data of comparable degrees of certainty and (2) analyze them in such a fashion as to facilitate comparison with values for similar materials occurring in the United States. Emphasis has been placed on reserves as defined by the Geological Survey; less certain or ambiguous Soviet data are classed as resources. This practice, although conservative in some respects, provides a realistic account of the potential development of energy sources.

* The Soviets use the term "minable" in referring to the coal believed to be worth mining, not that which can be extracted. See J. A. Hodgkins, Soviet Power (Prentice-Hall, Inc., Englewood Cliffs, N.J., 1961).

II COAL RESOURCES OF THE USSR

Assessment of the coal resources of the Soviet Union is a complex statistical puzzle. There are a number of estimates of varying detail, each purporting to be the accurate estimate. All such estimates probably need to be taken with a certain degree of skepticism. In this work, we shall employ two principal estimates, those of "geological reserves" and "minable reserves" that were reported by Soviet sources as of January 1, 1956,^{*} and again on January 1, 1966.[†] These estimates are slightly different in detail, as the 1956 estimate (cited by Hodgkins) includes both "geological" and "minable" reserves according to Soviet standards, while the 1966 estimate mentions only the "minable" reserves--yet the data in this category and in other categories of "proved" resources, etc. are virtually identical with those in the earlier work. For purposes of this analysis, we regard these estimates as essentially the same. Reliance is placed on these estimates because of their detail and similarity. However, the situation is complicated by a more recent, partial "reserve" estimate as of January 1, 1968. This estimate is considered a partial estimate because several coal-bearing regions included in the earlier estimates are omitted from the latest figures. We shall employ the more complete earlier estimates as the basis for evaluation of the Soviet coal situation.

To place these estimates in perspective, principal features are compared in Table B-2. The table shows that the 1956 and 1966 estimated total "geological reserves" (resources) of coal in the Soviet Union are about 8,670 billion tons. In contrast, the 1968 estimate is "only"

^{*} See J. A. Hodgkins, Soviet Power (Prentice Hall, Inc., Englewood Cliffs, N.J., 1961).

[†] V. V. Strishkov, "The Mineral Industry of the USSR," Minerals Yearbook, Vol. III. p. 765, U.S. Dept. of Interior (U.S. Government Printing Office, Washington, D.C., 1972).

Table B-2

COMPARISON OF RECENT USSR (SOURCE ESTIMATES
(Billions of

Basin	"Geological Reserves"		"Minable Reserves"	Categories A+B+C Hodgkins "Proved"		
	1/1/56 and 68	1/1/88		1/1/58 and 88	1/1/56	1/1/66
European Part						
Donets	40.6	128.0	190.0	57.16	39.14	40.5
Moscow	24.3	19.5	17.5	8.89	4.42	5.0
Donbass	344.5	244.5	262.4	4.10	6.89	7.9
L'vov-Volyn	1.8	-	1.4	1.65	0.76	-
Other deposits	1.6	-	1.5	0.06	0.4	-
Urals						
Kizel	1.06	-	1.06	0.61	0.58	-
Chelyabinsk	1.63	-	1.51	1.37	0.88	-
South Ural Basin	1.78	-	1.48	1.56	1.29	-
Other deposits	0.96	-	0.88	0.63	0.29	-
East of Urals						
Kuznetsk	905.30	725.0	804.17	70.88	52.51	66.2
Kansk-Achinsk	1,220.30	801.0	1,207.79	35.00	68.15	72.0
Minusinsk	36.94	32.5	36.30	2.31	2.68	2.6
Irkutsk	88.90	76.2	67.35	5.17	8.77	7.0
Taimyr	583.50	235.0	511.58	0.25	6.14	0.14
Tunouska	1,744.77	2,345.0	1,516.02	1.40	1.81	1.9
South Yakutsk	40.05	23.9	39.66	0.65	2.05	2.58
Karaganda	51.23	50.3	46.55	10.30	7.56	7.6
Ubagani	36.49	61.3	35.40	6.32	8.29	8.2
Ekibastuz	12.21	10.1	10.76	9.11	7.28	7.4
Maikubek	21.01	5.7	13.42	1.33	1.76	1.7
Lena	2,647.24	1,647.0	2,417.98	1.79	2.35	2.3
Bureya	25.02	-	24.94	1.08	0.81	-
Uglov	1.02	-	0.85	0.65	0.3	-
Suchan	1.43	-	1.40	0.19	0.2	-
Central Asia	40.78	67.6	38.29	3.55	4.3	4.2
Snkhalin	20.09	-	19.41	2.01	2.08	-
Suifun	1.66	-	1.62	0.37	0.02	-
Other Kazakhstan	16.94	-	14.42	1.81	2.40	-
		-	10.0		0.88	-
		-	7.2		5.46	-
		-	3.6		1.07	-
Other deposits		-	420.3		2.28	-
Total	8,689.3	8,800.0	7,765.3	241.21	237.2	281.0

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6,800 billion tons; note from the table that resources at several areas are omitted in the latest estimate. The latest estimate also differs from the earlier ones by including lignite only to a depth of 600 meters, rather than 1,800 meters, as formerly. The 1956 and 1966 estimates of "minable reserves" are identical (differing in original sources only in rounding). The "proved" reserves from the several deposits are also rather similar among the several estimates, with the exact amounts frequently varying within likely uncertainties in estimating (10-20 percent). Thus, further support is given for the use of the earlier estimates as a basis for analysis.

The total remaining coal resources of the USSR are thus taken to be 8,670 billion tons. This represents the largest accumulation of coal in the world, nearly three times as great as that of the United States (Table B-3). In fact, estimated Soviet coal resources within 300 meters of the surface alone (Table B-4) are roughly comparable to the total remaining U.S. resources Table B-3. Approximately two-thirds of Soviet resources are hard coal, with the remaining third being largely brown coal.

Table B-3

COMPARISON OF U.S.A. AND USSR COAL RESOURCES
(Billions of Metric Tons)

	<u>U.S.A.</u>	<u>USSR</u>	<u>U.S.A. as percent of USSR</u>
Total estimated remaining resources	2,912	8,670	33%
Proved and probable resources	1,415	1,183	120
Estimated recoverable reserves	168	154*	109

* SRI estimate.

Table B-4

SUMMARY OF COAL RESOURCES OF THE USSR
(Billions of Metric Tons)

<u>Remaining Resources</u>	<u>Totals</u>
By Degree of Reliability	
Proven	241.21
Probable	941.89
Possible	<u>7,486.41</u>
Total	8,669.51
By Depth Zones (meters)	
0-300	2,351.51
300-600	1,779.88
600-1,200	2,838.03
1,200-1,800	1,700.09
By Classification	
A & T	1,080.45
PS, K, PZH	1,952.71
G	819.32
D	1,330.02
DB	474.09
B	3,012.91

Clearly, the apparent coal resources of the Soviet Union are enormous. However, as Table B-4 shows, these resources are not well-known: "proven" and "probable" resources total "only" about 1,183 billion tons, roughly comparable to that of the United States. A principal reason for this smaller figure is that about half the Soviet coals occur in remote regions of Siberia, and their extent and character are not well-known. It may be expected that additional work in these remote regions will lead to increases in amounts of proved resources. Even with such work, however, it seems unlikely that the amounts of proved resources will be changed substantially in the near future.

A. Distribution of Soviet Coal Resources

Soviet coal resources are distributed among 173 basins and deposits, which vary greatly in size. Nearly two-thirds of the resources occur in areas that lack developed industry and have no railroad connection with the rest of the country. Table B-5 shows the regional distribution of USSR coal resources. It may be determined from the table that about 87 percent of total resources occur in Western and Southeastern Siberia (fourth column in Table B-5) and in Eastern Siberia (fifth column). Furthermore, four-fifths of these Siberian resources are classed as "possible," the least certain category. It is expected that refinements through further work will change the total numbers only slightly and that they will still be quite large. Still, these data need to be approached with some caution to avoid premature conclusions regarding Soviet development potential.

The next largest coal resources occur in the European, Northeastern, and Kazakhstan regions, respectively. Again, the bulk of the resources are only "possible," and therefore the totals should be employed with care.

The Caucasus, Urals, Transbaikal, and Middle Asian regions have the smallest resources, which are likely to be only of local importance.

A full appraisal of the character of Soviet coal resources requires detailed analysis of the deposits of each region, as described in

Table B-5

REGIONAL COAL RESOURCES OF THE USSR - JANUARY 1, 1956
(Billions of Metric Tons)

Remaining Resources	European Part	Caucasus	Urals	Western & Eastern Siberia (Southern)	Eastern Siberia (Northern)	Northeast	Transbaikalia, Far East Sakhalin	Kazakhstan	Middle Asia
By Degree of Reliability									
Proven	74.91	0.56	5.00	114.49	4.11	0.85	8.74	28.99	3.55
Probable	105.63	0.43	1.56	554.77	190.65	9.28	16.72	57.23	5.62
Possible	466.71	1.02	0.95	1,620.79	5,043.11	229.84	38.68	53.68	31.61
Total	647.28	2.01	7.51	2,290.05	5,237.87	239.97	64.14	139.90	40.78
By Depth Zones (meters)									
0-200	114.04	0.78	5.95	520.30	1,514.40	85.40	30.62	69.04	9.58
300-500	132.80	1.14	0.82	301.82	1,228.82	58.48	16.28	30.54	9.18
500-1,200	237.09	0.09	0.62	810.42	1,670.25	69.17	11.43	26.13	12.83
1,200-1,800	161.95	-	0.12	657.51	824.40	26.92	5.81	14.20	9.18
By Classification									
A & T	124.28	0.01	0.31	280.65	666.59	2.87	0.97	1.83	2.94
PS, K, PZH	149.47	0.12	1.06	223.27	1,384.15	106.99	2.25	72.69	12.77
G	166.99	1.73	0.23	361.62	247.70	3.84	27.34	2.18	4.64
D	121.63	-	-	143.17	1,047.80	1.72	9.41	0.04	6.25
DB	51.82	-	-	55.90	357.52	-	8.85	-	-
B	30.09	0.15	5.91	1,225.44	1,534.11	124.55	15.32	63.16	14.18

Table B-5 (concluded)

REGIONAL ESTIMATED "MINABLE RESERVES" FROM SOVIET SOURCES
(Billions of Metric Tons)

Minable Reserves	European Part	Caucasus	Urals	Western & Eastern Siberia		Northeast	Transbaikal, Far East Sakhalin	Kazakhstan	Middle Asia
				(Southern)	(Northern)				
Hard Coal	483.96	0.88	1.56	913.94	2,251.16	93.44	47.11	68.90	24.58
Brown Coal	22.59	0.13	5.39	1,212.36	1,448.69	90.41	14.85	53.63	13.71
Total	506.55	1.01	6.95	2,144.30	4,699.85	183.85	61.96	122.53	38.29
Totals									
Hard Coal									
Brown Coal									
Total									

Source: J. A. Hodgkins, Soviet Power: Energy Resources, Production, and Potential,
Prentice-Hall, Englewood Cliffs, N. J., 1961.

succeeding sections. Before entering upon such a discussion, however, it is necessary to clarify the situation with regard to "minable reserves."

Table B-6 presents Soviet estimates of "minable" reserves for these regions. As noted earlier, these figures include that portion of total coal resources which is presumed to be minable, and do not reflect what may actually be recovered. It is the actual recoverable reserves that are of importance in an appraisal of future energy developments. However, estimating recoverable reserves from the data on hand presents a serious problem in analysis, largely because of uncertainty in delineation of much of the reserves and lack of a clear relationship of proved reserves to depth zones.

The Soviet estimates are so enormous--nearly 80 percent of total resources are claimed to be minable--that it is difficult to place much credence in them. Several previous workers arrived at the same conclusion, and attempted to estimate the commercially minable reserves.* However, these earlier estimates are in such gross terms that it is difficult to apply them to individual coal areas, and as a result, there has been little choice but to fall back on the Soviet estimates and thus perpetuate them.

Even in Soviet terminology, "minable reserves" are not "proven." Thus, the estimated recoverable reserves presented in Table B-6 according to conventional American practice do not necessarily represent the ultimate recoverable reserves because they are based on imperfect knowledge of the remaining resources. It is clearly confusing to deal in so many distinct categories of reserves, each indirectly related (sometimes only in purporting to describe the same raw material).

In an attempt to arrive at a new appraisal of recoverable coal resources of the USSR, our guide has been information developed by the U.S. Geological Survey for American coal deposits. The basic assumption

* V. V. Strishkov, Coal Industry of the USSR, unpublished Ph. D. thesis, Columbia University, 1965. Soviet sources are cited to the effect that reserves are only about 1,000 billion tons.

Table B-6
COMPARATIVE ESTIMATE OF RECOVERABLE RESERVES
(Billions of Metric Tons)

	Total Estimated Remaining Resources	Resources at Shallow Depth	Thick Beds		Recoverability Factor (Percent)	Estimated Recoverable Reserves
			Resources (Percent of Shallow Resources)	Resources in Thick Beds		
U.S.A.*	2,912	1,259 [†]	29	362	50	181
USSR [‡]	8,670	2,352 [†]	40	941	50	470
			30	706		352
			20	470		235
			15	353		176
			10	235		117
		4,132 [§]	40	1,653	50	827
			30	1,240		620
			20	827		414
			15	620		310

* U.S. Geological Survey Bulletin 1275.

† Less than 300 meter depth.

‡ J. A. Hodgkins, Soviet Power: Energy Resources, Production and Potentials (Prentice-Hall, Inc., Englewood Cliffs, N.J., 1961).

§ Less than 600 meter depth.

is that coal deposits are largely similar geologically, and that basic physical relationships such as depth of burial and proportion of thick coal seams to the total will be roughly comparable among groups of coal fields.

Table B-6 presents data for the total estimated remaining coal resources of the United States, as determined by the Geological Survey, and also data for the resources occurring at shallow depths. Nearly 30 percent of the total U.S. resources are in thick beds. Employing the Geological Survey's rule of thumb that about half the resources can be recovered, the total estimated U.S. recoverable coal resources are about 180 billion tons.

The table also shows this same procedure applied to estimated Soviet coal resources. Because of the greater uncertainty about Soviet deposits, two different depths and a range of seam thickness percentages are employed. The calculations yield a range of recoverable resources, each significantly less than the Soviet estimate of "minable reserves" reported by Hodgkins. Even in the most optimistic case where all coal less than 600 meter depth is considered and where 40 percent of this coal is assumed to be in thick beds from which half the coal can be removed, the total estimated recoverable reserves are only about 10 percent of the Soviet-estimated minable reserves. In a more likely case where only coal less than 300 meter depth is included and the proportion in thick beds is assumed comparable to the U.S. situation, the Soviet recoverable reserves are "only" 352 billion tons, roughly twice as great as those of the United States.* This figure is regarded as a far more reasonable value for usable coal than the widely disseminated estimate of "minable reserves" originating from Soviet sources.

In the sections that follow, the procedure outlined above will be employed in arriving at a new estimate of recoverable reserves of Soviet

* This value is more than two times the recoverable reserves calculated from measured resources (Table B-3). This suggests that additional exploration work that delineates Soviet coal deposits with greater precision will substantially add to its recoverable coal.

coal deposits. (Exact totals may not compare because of rounding and provision for special features of individual basins.) The procedure will be to start from the amount of resources estimated to occur in stated depth zones (the selection of which will be guided by knowledge of the deposits). It will be assumed that roughly 30 percent of the resources in each zone occur in thick beds that can be mined, and further, that approximately half the resources in these thick beds can actually be recovered. This procedure was applied to data for each coal basin/deposit in each region in the tables to follow. Table B-7, a summary of data for each of the regions, shows that this procedure yields estimated recoverable coal reserves that are from 6 to 8 percent of the total Soviet "minable reserve" value. These lower values are regarded as a more realistic representation of the coal deposits that appear likely of development in the future. Details on each component estimate are shown in the individual tables and are discussed in the following sections.

Table B-7

COMPARISON OF ESTIMATED RECOVERABLE COAL RESERVES IN THE USSR
(Billions of Tons)

<u>Region</u>	<u>USSR Estimate</u>	<u>SRI Estimate</u>
European Part	506.55	45.03
Caucasus	1.01	0.29
Urals	6.95	1.08
Western & Southeastern Siberia	2,144.30	122.37
Eastern Siberia	4,699.85	227 to 411
Northeast	183.85	13.55
Transbaikal, Far East, Sakhalin	61.96	5.8
Kazakhstan	122.53	16.80
Middle Asia	38.29	2.36
Total	7,765.29	434.28 to 618.28

B. Geology of Selected Soviet Coal Deposits

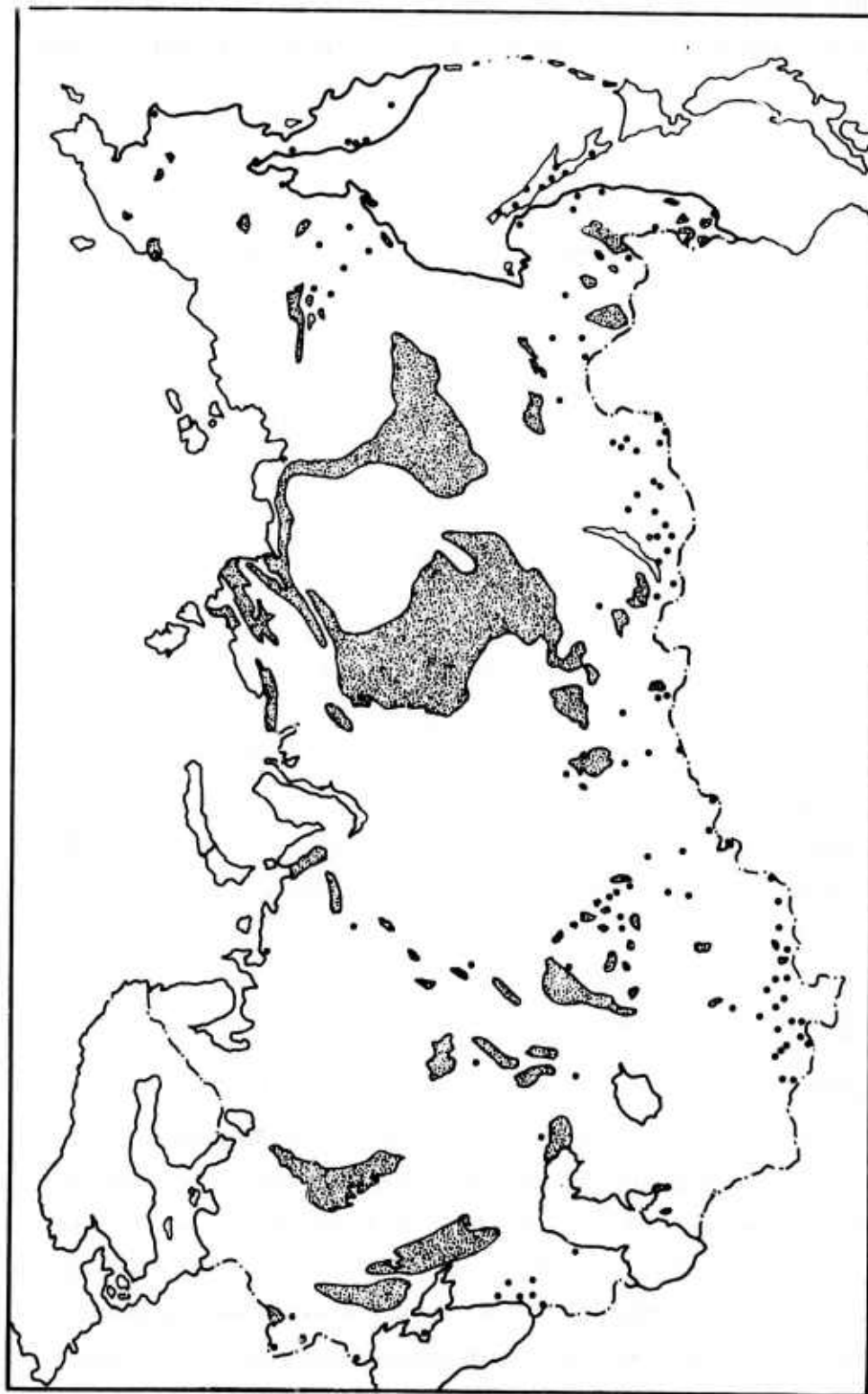
A brief account of the principal geological features of the main Soviet coal deposits that have experienced development to date is presented below. The discussion necessarily omits the apparently great but undeveloped coal resources of the central and eastern Siberian regions. For locations, refer to Figure B-1.

1. Donets Basin

The Donets Basin of the Ukraine dates back to the Carboniferous age (about 500 million years). It extends roughly east-west in the region north of the Black Sea. Four types of deposits are recognized; these show a progressive regional change in rank of coal. Lignite occurs in the west and represents about 15 percent of the total; sub-bituminous coal occurs in the west-central area and makes up 26 percent of the total; bituminous coals in the central area are 12 percent of the total, and sub-anthracite and anthracite in the southeast make up 28 percent, with "others" contributing the remaining 20 percent. The coal reserves are estimated as occurring to depths of at least 1,200 meters, although these are characteristically relatively thin seams (0.45 to 1.2 meters, average 0.95 meters). The numbers of seams increase toward the east, but they become thinner. The heating contents range from 4,840 to 6,500 kilocalories/kilograms (kcal/kg). Ash contents of the coals are moderate (13 to 20 percent), but sulfur contents are high (1.8 to 4.8 percent).

2. Karaganda Basin

The Karaganda Basin is also of Carboniferous age. The average thickness of seams is 1.8 meters. Important younger deposits of lignite occur above the main coal deposits. The heating value of coals is only about 5,320 kcal/kg, and that of lignite about 3,620 kcal/kg. The coals are low in sulfur content, but high in ash (more than 25 percent). The deposits have been deformed, representing operating problems.



Source: J.A. Hodgkins, Soviet Power (Prentice - Hall, Inc., Englewood Cliffs, N. J., 1961)

Figure B - I
COAL BASINS AND DEPOSITS IN THE USSR

3. Ekibastuz Deposit

This deposit is relatively small, with coal resources in four seams that total 150-175 meters thick. They are high ash content bituminous coals, with heating values of 4,050 kcal/kg.

4. Kuznetsk Basin

The Kuznetsk Basin is a large structural depression with substantial volumes of sediments. The coal deposits are of Permian age (about 250 million years) and have experienced deformation. Steeply inclined seams present major operating problems in some parts of the basin. Coal occurs in a few relatively thick seams. Rank ranges from sub-bituminous to sub-anthracite, depending on depth. Ash and sulfur contents are low, being 4.5 to 18 percent and 0.6 percent, respectively. The heating value is between 5,990 to 6,830 kcal/kg, and these coals are well-suited for coking.

5. Pechora Basin

The Pechora Basin of the northern part is an extensive area, but only part has been explored and developed. The entire basin has been extensively folded and eroded, with coal seams being often discontinuous and inclined. The seams are rather thin (0.3 to 1.3 meters). Additional operating problems are related to permafrost and associated ground-water dynamics. The coals range in rank from sub-bituminous to anthracite.

C. Detailed Coal Reserve Data

1. European Part

The European part of the USSR contains five basins and nine other coal regions or deposits estimated to contain about 75 billion tons of proved resources, 106 billion tons of probable resources, and 467 billion tons of possible resources, for a total of about 648 billion tons of remaining coal (Table B-8). The table also shows estimated resource distribution according to depth zones, rank classification, and "minable reserves," as defined according to Soviet practice.

Table B-8

COAL RESOURCES OF THE USSR (EUROPEAN PART) - JANUARY 1, 1956
(Billions of Metric Tons)

Remaining Resources	Donets basin	Lvov-Volyn Region	Dneper Basin	Moscow Basin	Kama Basin	Pechora Basin	Other Deposits	Totals
By Degree of Reliability								
Proven	57.16	1.65	3.05	8.89	-	4.10	0.06	74.91
Probable	79.53	0.10	0.99	5.32	-	19.40	0.29	105.63
Possible	103.93	-	0.14	10.10	30.32	321.00	1.25	466.74
Total	240.62	1.75	4.18	24.31	30.32	344.50	1.60	647.28
By Depth Zones (meters)								
0-300	28.39	0.06	4.18	24.31	-	57.00	0.10	114.04
300-600	50.05	1.55	-	-	-	81.10	?	132.7
600-1200	96.41	0.14	-	-	24.64	115.90	?	237.09
1200-1800	65.77	-	-	-	5.68	90.50	?	161.95
By Classification								
A and i	93.48	-	-	-	-	30.80	-	124.28
PS, K, PZH	32.46	0.01	-	-	-	117.00	-	149.47
G	65.05	1.74	-	-	-	103.20	-	169.99
D	28.13	-	-	-	-	93.50	-	121.63
DB	21.50	-	-	-	30.32	-	-	51.82
B	-	-	4.18	24.31	-	-	1.60	30.09
Minable Reserves*								
Hard coal	189.97	1.42	-	-	30.20	262.37	-	483.96
Brown coal	-	-	3.66	17.48	-	-	1.45	22.59
Total	189.97	1.42	3.66	17.48	30.20	262.37	1.45	506.55
SRI Estimate	14.46 [†]	0.24 [‡]	2.24	3.65	3.70 [†]	8.6	0.02	45.03

* Does not include recoverability factor.

[†] Includes coal to 1,200 meter depth.

[‡] Includes coal to 600 meter depth.

Unfortunately, the table does not break down the latter categories to reveal the amount of proved resources of a given rank occurring at stated depths. Still, these data are useful for the present analysis.

SRI's estimated recoverable reserves in the Donets Basin is about 11.5 billion tons. This estimate compares well to a recent (January 1, 1971) Soviet estimate* for Donets coal reserves in Categories A + B of about 13.7 billion tons. Considering the many factors that can lead to uncertainty, the agreement in these estimates (arrived at by completely different techniques) is regarded as lending support to the method employed in this work.

The two largest coal basins of this region are the Pechora and Donets Basins, together representing more than 90 percent of the total coal resources. Although the Pechora Basin has the largest apparent resources, most of these are in the "possible" category, and therefore somewhat uncertain. The Donets Basin, well-known as an important source of Soviet coal, has the largest proven resources (57 billion tons). In each basin, the deposits are of high heating value and are roughly equivalent to the bituminous coals of the American Midwest or eastern coal fields. A further similarity is a relatively high sulfur content, although much sulfur occurs as pyrite that can be removed through cleaning. The coals of the Donets Basin are generally in thin seams (less than 1 meter) and are mainly flat lying, with mining being carried out at an average depth of about 430 meters. The coals of the Pechora Basin are also flat lying, but are thicker (nearly 2 meters), and are mined from comparable depths.

The Dnieper (Dnepr), Moscow, and Kama Basins contain brown coal deposits. The principal proved resources occur in the Moscow Basin, with important amounts also being found in the Dnieper Basin. These coals have high moisture contents and lower heating value, but they are locally important fuel sources.

* "Economic Regions of the Ukrainian SSR," Academy of Sciences of the USSR, p. 78, Moscow, 1972.

The remaining deposits are small and do not appear to be likely targets for development.

The Soviet minable coal estimates total about 507 billion tons. However, applying the earlier described procedure, SRI estimates that recoverable reserves are only about 45 billion tons, most of which occurs in the Pechora and Donets Basins.

2. Caucasus

The Caucasus region has small coal resources, with the total in all classes being only about 2 billion tons. These resources are scattered among seven coal areas, most of which are very small (Table B-9). Nearly all the resources are hard coal.

The Soviet minable coal estimates are about half the total resources of 1 billion tons. SRI's estimate is that only about one-fourth of this total will be recoverable. No matter which estimate is employed, it represents a relatively small part of the total and will be of local importance only.

3. Urals

There are five principal coal areas of the Urals, and five other, smaller coal-bearing regions. The total estimated resources are small, only about 7.5 billion tons in all categories (Table B-10). Three-quarters of the resources are brown coal, with the principal hard coal resources occurring in the Kizel Basin on the western slope of the Urals. The brown coal has lower sulfur and ash content than does the hard coal, which requires cleaning and removal of sulfur and ash prior to use.

The Soviet minable reserve estimate is 6.95 billion tons for these coals. SRI's estimate is that only about 1 billion tons, relatively evenly distributed over several areas, can be considered recoverable in this region.

Table B-9

COAL RESOURCES OF THE USSR (CAUCASUS) - JANUARY 1, 1956

Remaining Resources	Tkibuli Deposits	Tkvarchal Deposits	Akhaltzikh Deposits	Northern Slope	Totals
By Degree of Reliability					
Proven	0.29	0.07	0.10	0.10	0.56
Probable	0.17	0.01	-	0.25	0.43
Possible	-	-	0.05	0.97	1.02
Total	0.46	0.08	0.15	1.32	2.01
By Depth Zones (meters)					
0-300	0.24	0.08	0.04	0.42	0.78
300-600	0.17	-	0.07	0.90	1.14
600-1200	0.05	-	0.04	-	0.09
1200-1800	-	-	-	-	-
By Classification					
A and T	-	-	-	0.01	0.01
PS, K, PZH	-	0.28	-	0.04	0.12
G	0.46	-	-	1.27	1.73
D	-	-	-	-	-
DB	-	-	0.15	-	0.15
Minable Reserves					
Hard coal	0.46	0.08	-	0.34	0.88
Brown coal	-	-	0.13	-	0.13
Total	0.46	0.08	0.13	0.34	1.01
SRI Estimate	0.06*	0.01	0.02*	0.20	0.29

* Includes coal to 600 meter depth.

Table B-10

COAL RESOURCES OF THE USSR (URALS)--JANUARY 1, 1956
(Billions of Metric Tons)

Remaining Resources	Kizel Basin	South Ural Basin	Chelyabinsk Basin	Orsk (East Ural Basin)	North-Sovinsk Region	Other Deposits	Totals
By degree of reliability							
Proven	0.61	1.56	1.37	0.62	0.21	0.63	5.00
Probable	0.32	0.20	0.19	0.41	0.29	0.15	1.56
Possible	0.13	--	0.07	--	0.57	0.18	0.95
Total	1.06	1.76	1.63	1.03	1.07	0.96	7.51
By depth zones (meters)							
0-300	0.32	1.76	1.04	1.03	1.07	0.73	5.95
300-600	0.20	--	0.45	--	--	0.17	0.82
600-1,200	0.43	--	0.13	--	--	0.06	0.62
1,200-1,800	0.11	--	0.01	--	--	--	0.12
By classification							
A and T	--	--	--	--	--	0.31	0.31
PS, K, PZH	1.06	--	--	--	--	--	1.06
G	--	--	--	--	--	0.23	0.23
D	--	--	--	--	--	--	--
DB	--	--	--	--	--	--	--
B	--	1.76	1.63	1.03	1.07	0.12	5.91
Minable reserves							
Hard coal	1.06	--	--	--	--	0.50	1.56
Brown coal	--	1.46	1.51	0.99	1.55	0.38	5.39
Total	1.06	1.46	1.51	0.99	1.55	0.88	6.95
SRI estimate	0.14*	0.26	0.22†	0.16	0.16	0.14†	1.08

* Includes coal to 1200 meter depth.

† Includes coal to 600 meter depth.

4. Western and Eastern Siberia

A total of six principal coal basins and eight small basins and deposits make up the Western and Eastern Siberian coal region (Table B-11). A total of 2,290 billion tons of coal resources are estimated to occur in this region (for all degrees of reliability in estimating). Slightly more than half of these resources are brown coal. The largest reserves are in the Kansk-Achinsk Basin. Only about 5 percent of the total estimated coal resources are classed as proven, and most of these occur in the Kuznetsk Basin. Kuznetsk Basin hard coals are the highest quality coals in the USSR, with low ash (about 11 percent) and sulfur content averaging 0.5 percent. These coals are used extensively for coking purposes and are shipped widely from this area.

The Kansk-Achinsk area has the second largest proven resources, which are mainly of brown coal. The heating value of these brown coals is high, and their sulfur content is low.

The third largest proven resources are found in the Irkutsk Basin, where hard coal predominates. The Minusinsk Basin has the next largest proven resources. These resources are exclusively hard coal, roughly comparable to similar coals from other regions.

The Soviet estimated minable reserves of coal in this area is 2,144 billion tons. The SRI estimate is that only about 5 percent of the total is recoverable through present technology, for a total of about 122 billion tons. Most of this coal is in the Kansk-Achinsk and Kuznetsk Basins, with lesser amounts in the Irkutsk Basin and other areas.

5. Eastern Siberia

This region has the largest estimated coal resources of any in the USSR, totalling about 5,240 billion tons in all degrees of reliability (Table B-12). These resources occur in five major basins and in two smaller deposits. However, less than 1 percent of the resources are proven, and nearly all are only "possible" resources.

Table B-11
COAL RESOURCES OF THE USSR (WESTERN AND EASTERN SIBERIA, SOUTHERN PART)--JANUARY 1, 1956
(Billions of Metric Tons)

	Gorlov		Kuznetsk		Kansk-		Minusinsk		Tuvinian		Irkutsk		Other		Total
	Basin		Basin		Achinsk		Basin		Oblast		Basin		Deposits		
By degree of reliability															
Proven	0.07		70.88		35.00		2.31		1.06		5.17		--		144.49
Probable	2.26		253.51		234.28		32.98		2.20		29.54		--		554.77
Possible	14.90		580.91		951.02		1.65		15.42		54.19		0.11		1,620.79
Total	17.23		905.30		1,220.30		36.94		18.68		88.90		0.11		2,290.05
By depth zones (meters)															
0-300	3.30		156.48		249.90		17.50		3.25		87.17		0.11		520.30
300-600	3.80		169.34		114.70		8.50		3.75		1.73		--		301.82
600-1,200	6.53		302.36		487.30		9.29		4.94		--		--		810.42
1,200-1,800	3.60		277.12		368.40		1.65		6.74		--		--		657.51
By classification															
A and T	17.23		263.42		--		--		--		--		--		280.65
PS, K, PZH	--		216.00		--		--		7.27		--		--		223.27
G	--		304.82		1.70		7.51		11.14		36.20		--		361.62
D	--		65.16		0.06		29.43		--		48.50		--		143.17
DB	--		55.90		--		--		--		--		--		55.90
B	--		--		1,218.54		--		--		4.20		0.11		1,225.44
Minable reserves															
Hard coal	15.06		804.17		1.59		36.30		10.83		63.89		0.11		913.94
Brown coal	--		--		1,207.79		--		--		3.46		--		1,212.36
Total	15.06		804.17		1,207.79		36.30		10.83		67.35		0.11		2,144.30
SRI estimate	0.50		48.87*		54.69*		2.60		1.05*		6.50		0.02		122.37

* Includes coal to 600 m.

Table B-12

COAL RESOURCES OF THE USSR (EASTERN SIBERIA, NORTHERN PART)--JANUARY 1, 1956
(Billions of Metric Tons)

	Taimyr Basin	Tunguska Basin	Ust-Yenisey Basin	South-Yakutsk Region	Lena Basin	Other Deposits	Total
By degree of reliability							
Proven	0.25	1.40		0.65	1.79	0.02	4.11
Probable	23.25	53.37	4.75	2.40	106.87	0.01	190.65
Possible	560.00	1,690.00	217.00	37.00	2,538.58	0.53	5,043.11
Total	583.50	1,744.77	221.75	40.05	2,647.29	0.56	5,237.87
By depth zones (meters)							
0-300	3.30	575.00	51.50	24.95	777.09	0.56	1,514.40
300-600	104.30	485.77	63.40	15.10	560.25	--	1,228.82
600-1,200	242.90	646.00	67.85	--	713.50	--	1,670.25
1,200-1,800	153.00	38.00	39.00	--	594.40	--	824.40
By classification							
A and T	143.10	522.00	--	--	1.49	--	666.59
PS, K, PZH	412.30	737.00	--	39.60	390.50*	--	1,384.15
G	--	52.00	--	0.45	--	--	247.70
D	--	243.00	55.00	--	749.80	--	1,047.80
DB	--	190.77	166.75	--	--	--	357.52
B	28.10	--	--	--	1,505.45	0.56	1,534.11
Minable reserves							
Hard coal	483.44	1,516.02	214.16	39.66	997.88		3,251.16
Brown coal	28.14†	--	--	--	1,420.10	0.45	1,448.69
Total	511.58	1,516.02	214.16	39.66	2,417.98	0.45	4,699.85
SRI estimate	None for this region; proven resources used = about 4 billion tons						

* Grade of this coal not represented in this analysis.

† Balance of reserves exceeds geological reserves.

Roughly half the total resources (about 2,500 billion tons) occur in the Lena Basin, where brown coal represents more than 1,500 billion tons. The remainder is hard coal. Most of the brown coal deposits have less than 1 percent sulfur, and low ash. Additionally, roughly one-third of these coals occur less than 300 meters beneath the surface.

The second largest coal basin, Tunguska, is farther to the west from the Lena Basin. A total of about 1,700 billion tons of coal resources are estimated to occur in this basin, all of which is hard coal (of one class or another). Although low in sulfur and moisture, these coals are higher in ash content. Again, about one-third of the deposits occur less than 300 meters beneath the surface.

The Taimyr Basin has the third largest resources, roughly 580 billion tons in all classes. These are nearly all hard coal, but some brown coal does occur locally. In contrast to the two major coal basins of this region, the Taimyr deposits are generally more deeply buried, with most lying below 300 meters.

The Ust-Yenisey Basin contains the fourth largest resources. These are entirely hard coal, with only about one-quarter the estimated resources occurring at shallow depths.

The Soviet minable reserve estimate for this region is truly enormous, totalling nearly 4,700 billion tons. SRI's estimate is that the bulk of coal in the Eastern Siberian region is unlikely to be recovered by present technology; the presence of permafrost in most (if not all) the areas of largest coal occurrence represents an important constraint on potentials for coal development. For these regions, therefore, it is believed that procedure derived from U.S. deposits for estimating recoverable reserves is probably not applicable. Accordingly, because of the relative uncertainty about deposit characteristics (less than one-tenth of 1 percent of the apparent resources are classed as "proven") and because of the serious problems confronting development of the deposits, no attempt is made to compute any estimate of recoverable reserves. Instead, the original Soviet estimate of proved resources

is employed in this analysis, and only about 4 billion tons of resources are considered likely targets for development in this region for the foreseeable future. It might be argued that this practice artificially underestimates the coal potential of the USSR. Yet, the concept of reserves implies development with present or soon available technology; these resources do not appear developable by this criterion.

6. Northeast

Coal resources of the Northeast region are scattered among some 11 principal areas and 17 other basins or deposits (Table B-13). The total estimated coal resources in the region are about 240 billion tons, nearly all of which is classed as "possible" resources. Almost half of the total resources occur in the Zyrmansk area, which has about three-quarters of the hard coal resources. The remaining deposits are generally poorly known and rather small.

The Soviet Movable reserve estimate for the Northeast region is about 184 billion tons. SRI's estimate is that only about 14 billion tons are recoverable, with most being located in the Zyrmansk and Anadyr areas.

7. Transbaikal, Far East, Sakhalin

The coal deposits of this vast region occur in a number of relatively small deposits or coal fields (Table B-14). The total estimated resources are only about 65 billion tons, with roughly 50 billion tons being hard coal. The largest deposits are in the Bureya Basin (25 billion tons) and the Sakhalin deposits (20 billion tons). However, these same deposits have only about 1 and 2 billion tons of proven resources, respectively. The Sakhalin deposits have the advantage that

Table B-13

COAL RESOURCES OF THE USSR (NORTHEAST) - JANUARY 1, 1956
(Billions of Metric Tons)

	Zyryansk Area	Omsukchansk Area	Omolonsk Area	Chaun- Chukotsk Area	Anadyr Area	Elgen Deposit	Avekov Deposit	Okhotsk Area
By Degree of Reliability								
Proven	0.34	0.01	-	-	0.01	0.03	0.01	0.20
Probable	2.26	0.03	-	-	-	0.50	-	3.30
Possible	100.00	2.83	0.55	1.30	97.70	2.40	13.90	6.50
Total	102.60	2.87	0.55	1.30	97.71	2.93	13.91	10.00
By Depth Zone (meters)								
0-300	34.30	0.89	0.52	0.10	24.51	2.93	6.96	10.00
300-600	24.40	0.79	0.03	0.20	24.10	-	6.95	-
600-1,200	31.30	1.07	-	0.60	35.40	-	-	-
1,200-1,800	12.60	0.12	-	0.40	13.70	-	-	-
By Classification								
A and T	-	2.87	-	-	-	-	-	-
PS, K, PZH	102.60	-	-	1.30	-	-	-	-
G	-	-	0.55	-	-	-	-	-
D	-	-	-	-	-	-	-	-
DB	-	-	-	-	-	-	-	-
B	-	-	-	-	97.71	2.93	13.91	10.00
Minable Reserves								
Hard	81.26	2.60	0.55	1.30	70.78	2.86	8.40	8.37
Brown	-	-	-	-	-	-	-	-
Total	81.26	2.60	0.55	1.30	70.78	2.86	8.40	8.37
SRI Estimate	5.15	0.13	0.78	0.05*	3.68	0.44	1.04	1.5

Table B-13 (Concluded)

	<u>Arkagalin Area</u>	<u>Bukhta- Ugolnaya</u>	<u>Kamchatka Peninsula</u>	<u>Totals</u>
By Degree of Reliability				
Proven	0.15	0.07	0.03	0.85
Probable	0.01	2.38	0.80	9.28
Possible	0.93	3.73	-	229.84
Total	1.09	6.18	0.83	239.97
By Depth Zone (meters)				
0-300	0.88	3.48	0.83	85.40
300-600	0.21	1.80	-	58.48
600-1,200	-	0.80	-	69.17
1,200-1,800	-	0.10	-	26.92
By Classification				
A and T	-	-	-	2.87
PS, K, PZH	-	-	-	106.99
G	-	6.18*	0.20	3.84
D	1.09	-	0.63	1.72
DB	-	-	-	-
B	-	-	-	124.55
Minaable Reserves				
Hard	0.72	6.18	0.83	93.44
Brown				90.41
Total	0.72	6.18	0.83	183.85
SRI Estimate	0.13	0.52	0.13	13.55

* Includes coal to 600 meters depth.

Table 8-14

COAL RESOURCES OF THE USSR (TRANSBAIKAL, FAR EAST, SAKHALIN) - JANUARY 1, 1956

	Transbaikial		Pureya		Bikinsk		Suifun		Suchan		Uglov		Maikhinsk		Sputinsk		Sakhalin		Other		Totals
	Deposits	Basin	Basin	Deposits	Basin	Deposits	Basin	Basin	Basin	Basin	Basin	Deposits	Basin	Deposits	Basin	Deposits	Basin	Deposits	Basin		
By Degree of Reliability																					
Proven	1.63	1.08	1.43	1.43	0.37	0.19	0.65	0.32	0.10	0.10	0.32	0.10	0.32	0.10	0.10	0.32	0.10	0.32	0.10	0.96	8.74
Probable	1.43	9.24	0.51	0.51	0.15	0.34	0.26	0.28	0.35	0.35	0.28	0.35	0.28	0.35	0.35	0.28	0.35	0.28	0.35	0.28	16.72
Possible	5.31	14.70	0.96	0.96	1.14	0.90	0.11	-	-	-	-	-	-	-	-	14.20	1.36	-	-	-	38.68
Total	8.37	25.02	2.90	2.90	1.66	1.43	1.02	0.60	0.45	0.45	0.60	0.45	0.60	0.45	0.45	20.09	2.60	2.60	2.60	2.60	64.14
By Depth Zone (meters)																					
0-300	6.72	6.19	2.71	2.71	0.75	0.29	0.51	0.50	0.35	0.35	0.50	0.35	0.50	0.35	0.35	10.38	2.22	2.22	2.22	2.22	30.62
300-600	1.53	7.20	0.19	0.19	0.85	0.24	0.38	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	5.33	0.36	0.36	0.36	0.36	16.28
600-1,200	0.12	7.63	-	-	0.06	0.59	0.13	-	-	-	-	-	-	-	-	2.88	0.02	0.02	0.02	0.02	11.43
1,200-1,800	-	4.00	-	-	-	0.31	-	-	-	-	-	-	-	-	-	1.50	-	-	-	-	5.81
By Classification																					
A and T	-	0.02	-	-	-	0.34	-	-	-	-	-	-	-	-	-	0.05	0.56	0.56	0.56	0.56	0.97
PS, K, PZH	-	-	-	-	0.03	0.32	-	-	-	-	-	-	-	-	-	1.80	0.10	0.10	0.10	0.10	2.25
G	-	25.00	-	-	-	0.66	-	-	-	-	-	-	-	-	-	0.85	0.24	0.24	0.24	0.24	27.34
D	1.18*	-	-	-	1.63	0.11	-	-	-	-	-	-	-	-	-	7.08	-	-	-	-	9.41
D8	3.80	-	-	-	-	-	0.11	-	-	-	-	-	-	-	-	4.94	-	-	-	-	8.85
B	3.39	-	2.90	2.90	-	-	0.91	0.60	0.45	0.45	0.60	0.45	0.60	0.45	0.45	5.37	1.70	1.70	1.70	1.70	15.32
Minable Reserves																					
Hard	4.06	24.94	-	2.90	1.62	1.40	0.10	-	-	-	-	-	-	-	-	14.09	0.89	0.89	0.89	0.89	47.11
Brown	3.19	-	-	-	-	-	0.75	0.59	0.46	0.46	0.59	0.46	0.59	0.46	0.46	5.32	1.64	1.64	1.64	1.64	14.85
Total	7.25	24.94	2.90	2.90	1.62	1.40	0.85	0.59	0.46	0.46	0.59	0.46	0.59	0.46	0.46	19.41	2.53	2.53	2.53	2.53	61.96
SRI Estimate	1.01	2.01*	0.41	0.41	0.11	0.08*	0.13*	0.09*	0.07*	0.07*	0.09*	0.07*	0.09*	0.07*	0.07*	1.56	0.33	0.33	0.33	0.33	5.8

* Includes coal to 600 meter depth.

nearly half the total resources occur less than 300 meters beneath the surface. The remaining deposits are generally small and poorly known.

The Soviet minable reserves estimate for this region is nearly 62 billion tons. SRI estimates that about 6 billion tons are ultimately recoverable, with most being located in the Bureya Basin and Sakhalin.

8. Kazakhstan

Estimated total resources in this region are about 140 billion tons, occurring in some 31 basins and deposits (Table B-15). More than half the total is hard coal. About half occurs at shallow depths (less than 300 meters).

The Karaganda Basin contains about 51 billion tons, nearly all of which is hard coal. This coal is of high quality. Especially favorable is its low sulfur content (average about 1 percent). This basin also has the largest amount of proven resources, about 10 billion tons.

The second largest coal resources are the brown coal deposits of the Ubagani Basin, where about 36 billion tons are estimated to occur. Although less well-known (only about 6 billion tons proven resources), these deposits occur mainly at shallow depths.

The Maikyuben deposits are the third largest total coal resources of the region, and the second largest brown coal deposit. Again, while fewer resources have been proven, these resources occur primarily at shallow depths that should facilitate further exploration.

The Ekibastuz hard coal deposits are the fourth largest total coal resources. They are the second largest proven resources of hard coal, which has favorably low sulfur and ash contents.

Table B-15
COAL RESOURCES OF THE USSR (KAZAKHSTAN) - JANUARY 1, 1956
(Billions of Metric Tons)

	Karaganda Basin	Ubagani Basin	Ekibastuz Deposit	Lenger Deposit	Maiktyuben	Other Deposits	Totals
By Degree of Reliability							
Proven	10.30	6.32	9.11	0.12	1.33	1.81	28.99
Probable	25.76	10.53	1.30	0.20	13.11	6.32	57.23
Possible	15.17	19.64	1.80	1.70	6.57	8.80	53.68
Total	51.23	36.49	12.21	2.02	21.01	16.94	139.90
By Depth Zone (meters)							
0-300	9.74	29.83	4.62	0.08	14.02	10.75	69.04
300-600	9.04	6.66	5.84	0.35	6.36	2.29	30.54
600-1,200	19.64	-	1.75	1.11	0.63	3.00	26.13
1,200-1,800	12.81	-	-	0.48	-	0.90	14.20
By Classification							
A and T	-	-	-	-	-	1.83	1.83
PS, K, PZH	49.73	-	12.16	-	-	11.10	72.69
G	0.63	-	0.05	-	-	1.50	2.18
D	-	-	-	-	-	0.04	0.04
DB	-	-	-	-	-	-	-
Σ	1.17	36.49	-	2.02	21.01	2.47	63.16
Minable Reserves							
Hard	45.58	-	10.76	-	-	12.56	68.90
Brown	0.97	35.40	-	1.98	13.42	1.86	53.63
Total	46.55	35.40	10.76	1.98	13.42	14.42	122.53
SRI Estimate	5.76*	4.47	1.83*	0.07†	2.1	1.61	16.80

* Includes coal to 1,200 meter depth.

† Includes coal to 600 meter depth.

The Soviet minable reserve estimate for this region is about 122 billion tons. SRI estimates that the recoverable reserves will be about 17 billion tons, with most occurring in the Karaganda and Ubagani Basins and in Maikyuben.

9. Middle Asia

Although a number of coal deposits occur in Middle Asia, they are small and widely scattered (Table B-16). The total estimated resources in all reliability categories is only about 41 billion tons. About three-fifths of the resources are hard coal. Roughly one-quarter of the resources occur at shallow depths, although this varies among the several deposits of the vast region.

The Soviet estimated minable reserves of this region are about 38 billion tons. SRI estimates that recoverable reserves are only about 2 billion tons, scattered among the several deposits in this region.

D. Comparison of SRI Reserve Estimates with Recent Soviet Data

As noted in the earlier discussion, the SRI estimated recoverable reserves are based on deposit characteristics. Such a comparison is inherently uncertain, because of different criteria used in arriving at the data. Nonetheless, it is useful to compare them with a recent Soviet estimate of the "balance of reserves" (Table B-17). The table shows the following:

- SRI's estimate is slightly more conservative than the Soviet estimate for the basins that have experienced major developments in the past--e.g., Donets, Pechora, Kuznetsk, Kansk-Achinsk, Karaganda, Ekibastuz, Ubagansk, and Central Asia. This suggests that relatively small parts of the total deposits in these areas might actually be recovered. If the suggestion is correct, it means that the useful life of the most famous coal fields in the USSR would be somewhat limited.

Table B-16

COAL RESOURCES OF THE USSR (MIDDLE ASIA) - JANUARY 1, 1956

	Hissar Region	South Hissar Region	South Tadzhik	Ziddin Deposit	Magian Deposit	Fan-Yagnob Deposit	Other Zerвшan	Nazar- Ailoksk
By Degree of Reliability								
Proven	0.06	0.01	-	0.02	0.01	0.34	-	-
Probable	0.11	0.01	-	0.07	0.04	0.37	-	0.02
Possible	3.61	1.55	2.46	1.35	1.02	1.07	1.93	0.42
Total	3.78	1.67	2.46	1.44	1.07	1.78	1.93	0.44
By Depth Zone (meters)								
0-300	0.33	0.34	-	1.44	0.15	0.75	0.72	0.28
300-600	0.72	0.35	-	-	0.13	0.32	1.15	0.11
600-1,200	1.37	0.70	1.23	-	0.31	0.48	0.06	0.05
1,200-1,800	1.36	0.28	1.23	-	0.48	0.23	-	-
By Classification								
A and T	0.45	-	-	-	-	-	-	0.44
PS, K, PZH	3.27	1.67	2.46	1.44	-	0.98	-	-
G	0.06	-	-	-	-	0.80	1.93	-
D	-	-	-	-	1.07	-	-	-
DB	-	-	-	-	-	-	-	-
B	-	-	-	-	-	-	-	-
Minable Reserves								
Hard	1.96	1.67	2.46	1.44	1.06	1.77	1.93	0.44
Brown	-	-	-	-	-	-	-	-
Total	1.96	1.67	2.46	1.44	1.06	1.77	1.93	0.44
SRI Estimate	0.16*	0.05	-0-	0.22	0.02	0.11	0.11	0.04

* Includes coal to 600 meter depth.

Table B-16 (Continued)

	Shuroabad - Ravnous	Mionadus Deposit	Sulyukta Deposit	Angrren Deposit	Tashkent Region	Shurab Deposit	Kyzyl- Kiya	North Fergana
By Degree of Reliability								
Proven	0.02	-	0.17	1.52	-	0.13	0.11	0.15
Probable	0.04	0.03	0.16	0.40	-	1.14	0.17	0.47
Possible	0.62	1.44	0.43	0.90	0.64	1.81	2.10	1.93
Total	0.68	1.47	0.76	2.82	0.64	3.08	2.38	2.55
By Depth Zone (meters)								
0-300	0.12	0.24	0.11	0.95	-	0.39	0.07	0.57
300-600	0.14	0.25	0.23	0.98	-	0.71	0.55	0.65
600-1,200	0.17	0.48	0.22	0.73	0.28	1.24	1.21	0.75
1,200-1,800	0.25	0.50	0.20	0.16	0.36	0.74	0.55	0.57
By Classification								
A and T	-	0.67	-	-	-	-	-	-
PS, K, PZH	0.68	0.80	-	-	-	-	-	-
G	-	-	-	-	-	-	-	-
D	-	-	-	-	-	-	-	-
DB	-	-	-	-	-	-	-	2.55
B	-	-	0.76	2.82	0.64	3.08	2.38	-
Minable Reserves								
Hard	0.68	1.47	-	-	-	-	-	2.54
Brown	-	-	0.68	2.80	0.64	2.82	2.27	-
Total	0.68	1.47	0.68	2.80	0.64	2.82	2.27	2.54
SRI Estimate	0.02	0.04	0.05*	0.29*	-0-	0.17*	0.09*	0.18*

* Includes coal to 600 meter depth.

Table B-16 (Concluded)

	Aldyyar Deposit	Kok-Yangar Deposits	East Pergana Basin	Minkush Region	Other Deposits	Totals
By Degree of Reliability						
Proven	0.02	0.22	0.27	0.47	0.03	3.55
Probable	0.13	0.08	1.66	0.70	0.26	5.62
Possible	0.33	1.77	1.16	3.04	1.69	31.61
Total	0.48	2.07	3.09	4.21	1.98	40.78
By Depth Zone (meters)						
0-300	0.12	0.57	1.17	1.01	0.25	9.58
300-600	0.07	0.68	0.67	0.92	0.55	9.18
600-1,200	0.11	0.53	0.85	1.27	0.79	12.83
1,200-1,800	0.18	0.29	0.40	1.01	0.39	9.18
By Classification						
A and T	-	-	1.03	-	0.35	2.94
PS, K, FZH	-	-	1.02	-	0.45	12.77
G	0.48	-	1.04	-	0.33	4.64
D	-	2.07	-	-	0.56	6.25
DB	-	-	-	-	-	-
B	-	-	-	4.21	0.29	14.18
Minable Reserves						
Hard	0.47	2.07	3.01	-	1.61	24.58
Brown	-	-	-	4.21	0.29	13.71
Total	0.47	2.07	3.01	4.21	1.90	38.29
SRI Estimate	0.03*	0.09	0.28*	0.29	0.12	2.36

* Includes coal to 600 meter depth.

Table B-17
SOVIET COAL DEPOSITS: COMPARISON OF SRI AND SOVIET ESTIMATES
(Billions of Metric Tons)

<u>Basins/Deposits</u>	<u>Soviet Estimated "Balance Reserves" (A+B+C₁) *</u>	<u>SRI Estimated Recoverable Reserves</u>
Donets	39.1	14.5
Pechora	6.9	1.5
Moscow	4.4	3.7
Kuznetsk	52.5	48.9
Kansk-Agansk	68.2	54.7
Minusinsk	2.7	2.6
Irkutsk	6.8	6.5
Yuzhno-Yakutsk	2.1	2.1
Karaganda	7.6	5.8
Ekibastuz	7.3	1.8
Maikyuben	1.8	1.8
Ubagansk	6.3	1.8
Central Asia	4.3	2.4
Tunguska	1.9	1.4
Lena	2.3	1.8
Taimyr	0.2	0.3
Total]	214.4	151.1 [†]

* Soviet estimate

† This is equivalent to about 72 percent of the Soviet estimate of "balance of reserves."

- SRI's estimates are within 10-20 percent of the Soviet estimates for basins that either are generally smaller, contain lower grade coal, or are remote from industrial or population centers. In this category are the reserves of the Moscow Basin (brown coal), and the remote deposits of Irkutsk, Yuzhno-Yakutsk, and Maikyben. These deposits may be shallow enough that their development potential can be readily determined by knowledgeable personnel.
- SRI's estimates of recoverable coal resources in certain Soviet coal deposits are much smaller than those from Soviet sources. In this category are the large remote basins of Tunguska, Lena, and Taimyr. These basins are least well-known, and the Soviet estimates reflect this lack of knowledge. It is possible that there may be substantial, ultimately recoverable reserves in these areas, but these deposits present serious technical problems in development for the foreseeable future; hence, the low estimate of recoverable reserves.

Thus, it appears from these data that Soviet reserve estimates may imply a hierarchy that may not be apparent from the data alone. Soviet-reported reserves at well-known deposits seem to be in excess of recoverable reserves, perhaps in an attempt to disguise the actual reserve life of these fields. Smaller remote deposits are apparently reported more accurately in terms of recoverable reserves because of their lesser importance (or quality). More remote undeveloped deposits may be intentionally understated in the realization that their contribution to the total USSR energy potential will likely be small for the foreseeable future.

E. Coal Exploration, Mining, and Processing Technology

1. Introduction

The state of the art of coal exploration, mining, and processing technology in the USSR and Eastern Europe is (as is the case elsewhere) a consequence of many inter-related factors. Among these factors are the traditions and practices of mining and miners in the coal fields of these

countries; the detailed characteristics of the coal seams and associated deposits; and the influence of the available industrial base upon the level of technology that can be routinely applied in coal recovery and use. Each of these factors, unfortunately, is often difficult to measure directly even in the best of circumstances; this task is even more difficult when the analysis is made from afar. Therefore, in the present work the state of the art of coal development in the USSR and Council of Mutual Economic Assistance (CMEA) countries has been assessed through indirect means, mainly employing publicly available statistical data pertaining to coal production. The use of production data for assessment is justifiable because the amount of production achieved from particular mining methods incorporates data on the several contributing factors without requiring the factors to be known individually. Production data, and productivity data derived from them, are therefore useful indicators of the level of technology. This approach is taken to illustrate the several stages of coal resource development.

2. Exploration

Before production can be contemplated or begun, it is essential to have thorough knowledge of the quality of the coal deposits, their character and occurrence, and the quantity of original resources that can be recovered through development. Exploration for coal deposits requires a systematic and coordinated program of geological, geophysical, and mining engineering work. Although the geology of coal deposits is often simple in general, it may be complex in detail, which may significantly affect the attractiveness of deposits for development.

Most exploration work entails drilling to intersect the coal seam for sampling and for providing thickness data as an input into reserve calculations. Table B-18 shows data for drilling machines used in the Soviet coal industry. These machines are generally capable of

Table B-18
OPERATING CHARACTERISTICS OF DRILLING MACHINES

Models	SVB-2	BS-110/25	FB5-110	Ural-61	NBS-2	BAP-290	P-20	P-25	BSSha-1N	BSV-1E	SVBK-200	BASha-250
1. Weight (tons)	8.5	1.2	0.495	22	20	18	60	40	29.3	27	25	33
2. Depth of drilling (meters)	25	25	25	15	30	25	18	24	24	20	15	25
		Vertical or inclined to 70°		Vertical/inclined 65°		Vertical/inclined						
3. Diameter of blasthole (millimeters)	150-200	110	110-120	155	155	250-290	214	190-214	200	214	200	230-275
4. Working efficiency (meters/shift)	50-125*	60-80† 35-40*	140† 40-50*	--	--	--	60	To 75	112‡	To 42	To 106	To 15
(meters/hour)	--	--	--	4.5	4.2*	2.4	--	--	--	--	--	--
in rocks of Hardness Factor "f" on Protodiyaknoff's Scale	3-5	3-4	--	10-14	--	--	12-15	12-14	6-11	6-12	3-10	13-14
5. Travel mechanism	Crawler	Skid-mounted walkers					Crawlers		Crawlers			
6. Travel speed (kilometers)	1.6	0.3	--	0.7					--	0.85	0.95	0.75
7. Compressor capacity (cubic meters/minute)	--	--	--	9.2	13	18-22	10	18-20	--	14.8	10	30.9
8. Axial end thrust (tons)	--	--	--	--	--	--	35	15	--	--	15	25
9. Other models												
	Blast-hole dia. 150-155 millimeters											
	BM-150, BW-150K, 5PRA-2											
	Blast-hole dia. 100-108 millimeters											
	BNP, BA-100M, BWK-2B, NBS1, SUVF											

* In rocks.

† In coal.

‡ Theoretical.

Source: M. N. Raina, "Opencast Mining Technique in the USSR," *Journal of Mines, Metals & Fuels*, pp. 361-80 (October 1970).

drilling to relatively shallow depths of 25 meters (82 feet) or less, and appear to be generally similar to those used in the West, although some of their characteristics cannot be used for a detailed comparison with the characteristics of Western equipment.

The amount of exploratory coal drilling carried out in the USSR and CMEA is not reported in a manner comparable to that for oil and gas, and it is impossible to state the amount of exploration currently underway. Much of such drilling will probably be part of the normal development work associated with operating mines, so that isolation of drilling data will pose a further problem for the estimating process. Much of the coal exploration in the USSR appears to be concentrated in the currently worked fields of the Ukraine and Central Asia. There is little evidence of much work being undertaken to improve the knowledge of the apparently larger reserves present in the more remote regions of Siberia.

The physical properties of coal are different from the surrounding rocks--coal is softer and much more brittle. These properties complicate the sampling process, because drills are able to cut through coal at a much faster rate than is possible in rock. Recovery of core samples of coal is commonly poor, introducing uncertainty into the process of estimating quality and reserves. In an attempt to avoid this problem, a device has been designed to signal the driller when the drilling rate increases rapidly upon entry into the coal seam.* Although this device may be useful in concept, it will probably be no substitute for the experience of the operator.

Exploration and development of the principal coal regions of the USSR are shown in the following sections. These data show that the Donets Basin is, and has been, a mainstay of the coal industry, producing

* Razved I Okhrana Nedr, No. 4, p. 21, 1973

substantial amounts of hard coal for an extended period. Other deposits of the Ukraine also produce important amounts of hard coal, making this region the most prolific coal field of the country. The Kuznetsk Basin is a third major contributor of hard coal. Smaller but still important amounts of hard coal come from the Karaganda, Eastern Siberian, Pechora, and Urals Basins.

Production of brown coal has been centered in the Moscow Basin and the Urals Basins, which together represent roughly half the total production. Other basins contribute far less brown coal production to the total.

As we have seen, the principal coal resources (and recoverable reserves) of the USSR occur in regions remote from the centers of population where energy is consumed. The distance factor emphasizes the coal fields that are located relatively near the consuming centers, making the somewhat smaller resources of the European and Ural coal fields assume major importance. Historically, and continuing to the present day, nearly two-thirds of Soviet coal production has come from these western coal fields. The remaining production has come mainly from the Kuznetsk and Karaganda Basins of the southern Siberian region.

3. Mining

Table B-19 shows estimated coal reserves in the Soviet Union by mining method (USSR coals are mined by both surface and underground methods). The total A + B + C reserves are employed as a baseline figure. With one exception, these data are determined as of January 1, 1966; it is assumed that the estimates include coal recoverable from all mining methods. Data for developed strippable reserves as of January 1, 1969 were compiled under the working assumption that "developed" reserves would be roughly equivalent to "proved" reserves included in the more

Table B-19

USSR ESTIMATED COAL RESERVES BY MINING METHOD
(Billions of Metric Tons)

Basin	Total Reserves A+B+C ₁ 1/1/66	Total Developed Strippable 1/1/69	Developed Strippable		Total Deep Minable
			Hard Coal	Brown Coal	
Total USSR					
European and Ural	54.66	0.65		0.65	53.98
Kazakhstan and Central Asia	26.50	1.65	1.65	--	24.85
Kuznetsk	52.51 ⁺	4.06	3.78	0.28	48.45
Kansk-Achinsk	35.00	4.38	--	4.38	30.62
Minusinsk	2.68	0.10	0.10	--	2.58
Other Krasnyarsk Kray	2.4	0.06	0.06	--	2.34
Eastern Siberia	56.0	0.93	0.38	0.55	55.07
Far East and Sakhalin	11.5	1.32	--	1.32	10.18
Total	241.22	13.15	5.97	7.18	228.07

* Total Reserves (first column) minus Total Developed Strippable (second column).

+ 1966 estimates for this basin are in excess of resources for the entire Eastern Siberian region: total region = 56 billion tons (A+B+C₁), Kansk-Achinsk = 68 billion tons for the same categories. This is clearly impossible. Therefore, the lower, 1950 estimate of 35 billion tons "proved" reserves is used instead.

general categories. Strippable reserves represent only about 6 percent of the total best-known reserves, with the bulk of these deposits requiring deep mining. Most strippable reserves are in the Kansk-Achinsk area and are exclusively brown coal. The second largest strippable reserve is in the hard coal deposits of the Kuznetsk Basin, and the third largest strippable reserve is in the hard coals of Kazakhstan and central Asia. Soviet estimates of the "maximum possible" production of coal by surface mining is shown in Table B-20.

There has been a strong increase in surface mining in recent years, rising from only about 4 percent of total production in 1940 to 27 percent in 1970. Figure B-2 shows trends in coal production by mining method. The present status of coal mining technology in the USSR will be described separately for each mining method.

Table B-20

"MAXIMUM POSSIBLE" SURFACE MINE COAL PRODUCTION

Basin	Production (Million Tons)
Kuznets	208
Minusinsk	54
Kansk-Achinsk	1,055
North Kazakhstan	265
Western Siberia	109
Far East	110
Total	1,800

Source: Ugol, No. 7, 1971.

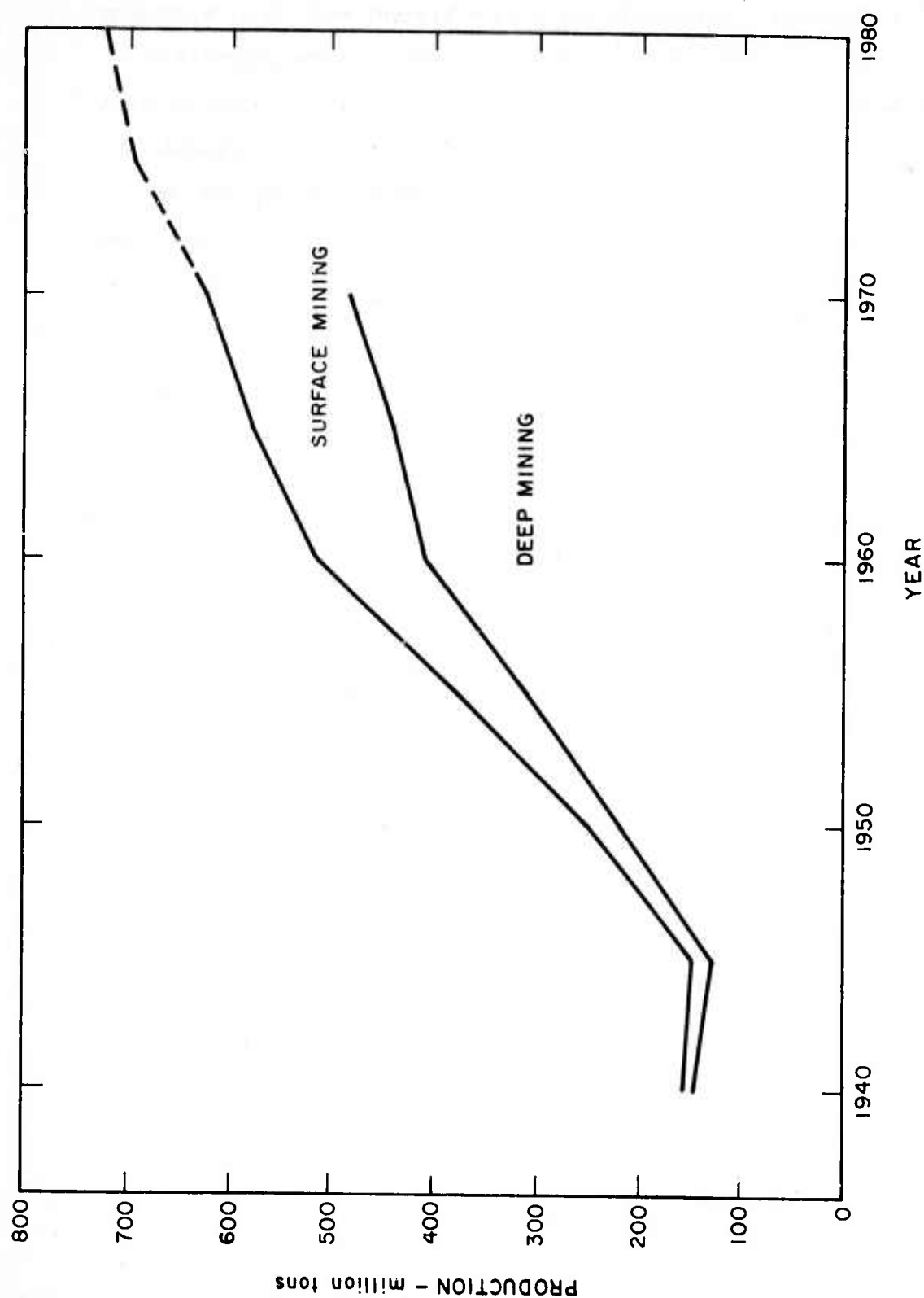


Figure B-2

TRENDS IN COAL PRODUCTION IN THE USSR BY MINING METHOD

4. Mining Equipment

The trends in numbers of coal mining machines being used in the USSR are shown in Table B-21. For deep mining, there has been rapid growth over the last years in the use of "mining combines" (long wall mining), which dominate in production. Similar growth in "entry-driving combines" (continuous mining) has occurred during the same period. These highly mechanized mining methods have replaced the more conventional methods, evidenced by the decline in numbers of cutting machines and loaders. Drag conveyors are still extensively employed in haulage, although belt conveyors and locomotives remain important.

These trends parallel those of the U.S. coal industry during the same period. In contrast, however, the U.S. coal industry has emphasized continuous mining, and longwall mining is a relatively small part of total production in the United States, although it has been increasing in recent years. Longwall mining is especially well-suited in mining coal from level seams of uniform thickness, providing an indirect indication of the character of coal seams now under development in the USSR. Probably, longwall systems are being used in some of the newer fields, and the conventional mining method continues to be employed in some of the older fields or in those where the coal has been disturbed by folding or faulting. USSR longwall systems described in typical publications appear to be more complex mechanically than those used in the West,* apparently in an attempt to reduce operating manpower requirements and improve productivity. However, the longwall systems in the USSR are limited to seams less than 3.5 meters (11.5 feet) thick, and work is in progress to mine thicker seams in one pass. Another problem appears to be posed by the supporting capacity of longwall roof supports,

* See, for example, Ugol, No. 5, p. 37, 1973 and Razrabotka Mestorozhdenii Radioaktiynykh Rvd, p. 298, Moscow, 1970.

Table B-21

NUMBER OF COAL MINING MACHINES IN THE USSR

USSR Equipment		US Equivalent		1940	1950	1960	1965	1970	1971	
Nomenclature		Nomenclature								
<u>Deep Mining</u>										
Mining combines	Narrow-web	Longwall-wide conveyor		24	688	4,249	4,368	4,154	4,253	
		Longwall-narrow conveyor		--	--	207	1,160	2,597	2,874	
Cutting machines		3,421	4,815	3,798	1,516	604	444			
Entry-driving combines		--	19	601	525	903	990			
Loaders		36	2,581	6,569	6,199	4,508	4,480			
Drag-conveyors		--	18,996	43,624	45,456	38,406	37,712			
Belt-conveyors		2,920	6,725	12,860	13,866	12,293	12,431			
Electric locomotives		1,841	7,253	16,254	16,134	13,803	13,775			
<u>Surface Mining</u>										
One-bucket excavators		Shovels or draglines		93	474	943	1,167	1,299	1,345	

Source: The National Economy: USSR Statistical Yearbook.

estimated to be less than one-third of those used in the West.* The problem appears to be related to the hydraulic system that operates the supports, and represents an area of further engineering work.

Detailed technical characteristics of longwall mining equipment employed in the USSR are shown in Tables B-22, B-23, B-24, and B-25. These data, taken from Vorobjev and Deshmukh,† indicate that a family of longwall machines has been developed for relatively mechanized coal mining in a variety of seam conditions. The development of several types of machines for each seam-thickness range indicates the diversity and scope of the Soviet coal-mining equipment industry.

Work is also in progress to employ pneumatic breaking of coal as a substitute for blasting.‡ The pneumatic method appears to be similar to the compressed air coal breaking used in conventional U.S. mining. Thus, regardless of the developments in continuous mining and longwall mining, conventional mining systems will continue to be required for the recovery of coal from certain types of deposits.

The technical progress in Soviet deep mining may be illustrated by reports for the "Donbass" (Donets Basin) and "Kuzbass" (Kuznetsk Basin).

- Donbass. "The Donbass combine is successfully incorporating the new progressive mining techniques."§ As a result the number of working faces decreased 7.8 percent, and the number of faces equipped with new technology increased 12 percent. The production from narrow-web (longwall) machines rose from 9.9 million tons in 1970 to 12.8 million tons in 1972, and the amount of coal from highly mechanized faces rose from 2.4 to 5.1 million tons in the same period.

* Ugol, No. 5, p. 37, 1973

† B. M. Vorobjev and R. T. Deshmukh, Advanced Coal Mining, Vol. I and II (Asia Publishing House, New York, N.Y., 1966).

‡ Ugol, No. 5, p. 68, 1973.

§ Ugol, No. 5, p. 9, 1973.

Table B-22

PERFORMANCE DATA OF COAL COMBINES FOR SEAMS OF 0.8 TO 2.0 METERS IN THICKNESS

Characteristics	Type of Combine			
	<u>Donbass-1</u>	<u>Donbass-2</u>	<u>L.G.D.</u>	<u>KR-1</u> <u>K-26</u>
Capacity (tons/minute)	0.83-1.65	1.66-3.32	1.2-3.0	1.75-3.1
Thickness of seam (meters)	0.8 -1.6	0.85-1.6	0.8-1.6	0.9-1.5
Width of web (meters)	1.2 -1.6	1.6	1.2-1.6	1.0
	1.8 -2.0	1.8	1.8-2.0	1.6
		2.0		1.8
Rate of advance (meters/minute)				
(a) Cutting	0.27-0.54-0.81	0-1.05	0-2.5	0-1.05
(b) Flitting	14.5	9.3	To 9.0	9.3
Aggregate power (kWh)	97	162	112	162
Weight of machine (tons)	6.1-7.7	9.6-12.09	7.34	12.5
Method of operation	Cutting only one way to the rise and flitting back to the dip along the face.			Shuttle operating, turning in the stables.

PERFORMANCE DATA OF COAL COMBINES FOR SEAMS OF 1.7 TO 3.5 METERS IN THICKNESS

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Table B-24

PERFORMANCE DATA OF COAL COMBINES FOR SEAMS OF 0.4 to 0.9 METERS IN THICKNESS

	Type of Combine				
	UKMG-2	Gornyak-1	Kirovets	Shakhter-2	UKT-2
Capacity (tons/minute)	0.9	0.5 -1.5	0.7 -1.0	0.35-0.84	0.84-1.16
Thickness of seam (meters)	0.4-0.6	0.6 -0.9	0.5 -0.8	0.5 -0.85	0.5 -0.75
Width of web (meters)	1.65	1.65-1.8-2.0	1.65-1.8	1.65-2.0	1.5 -1.6
Rate of advance (meters/minute)					
(a) Cutting	0.0-0.97	0.27-0.54	0.0-0.97	0.0 -0.86	0.0 -0.86
(b) Flitting	7.0	14.5	7.0	8.6	8.6
Aggregate power (kWh)	34	97*	97*	47	47
Weight of machine (tons)	3.3	6.85-7.16	4.5	3.82-4.14	5.3 -5.45
Method of operation	Cutting only one way to the rise and flitting back to the dip along the face.				
					88
					7.6 -7.7
					Shuttle operation, turning in stables.

* Two electric motors.

Note: By the beginning of 1959, about 650 combines of these types were used in the coal mines of the U.S.S.R.

Table B-25

TECHNICAL DATA ON NARROW-WEB COMBINES

Characteristics	Type of Combine				
	<u>DU-1</u>	<u>DU-3</u>	<u>KU-1</u>	<u>UDK</u>	<u>K-52 M</u>
Capacity (tons/minute)	1.65-2.5	1.0 -2.5	2.5 -3.3	2.8 -4.0	2.9
Thickness of seam (meters)	0.95-1.4	1.25-1.5	0.85-1.25	0.9-1.25	0.9-1.5
Gradient of seam (degrees)	To 20	To 25	To 25	To 25	To 25
Width of web (meters)	1.0	1.0	1.0	1.0	0.5
					0.6
					0.75
Rate of advance (meters/minute)					
(a) Cutting	0.33-0.66	0.68-1.03			
	0.99-1.32-1.65	1.37-1.71-2.11	0-2.0	0-2.5	To 3.9
(b) Flitting	17.8	17.1	-	-	10-11
Aggregate power (kWh)	97	65	32	130	75
Weight of machine (tons)	7.08-7.35	-	8.9	9.6	6.4

However, thin seams remain to be mechanized efficiently in contrast to the developments of recent U.S. technology. In the USSR, "inefficient modern equipment" slows down work in thin seams. Thus, while coal seams less than 1 meter thick constitute 63 percent of total reserves, their actual share in production is only 43 percent.

- Kuzbass. Concentration of mining enterprises and installation of new longwall equipment was undertaken in the early 1970s.* Production of coal in mechanized faces reached 11.9 million tons in 1972, representing 46.7 percent of the total coal production. Multiple-layer longwall mining is reported for the V.I. Lenin mine, in a seam 9-10 meters thick. Nevertheless, there remains excessive manual work, even in the mechanized mines, which "significantly cuts the productivity."

Representative productivity data for principal coal fields of the USSR are shown in Tables B-26, B-27, B-28, and B-29.

Table B-26 represents a summary of coal production by different types of longwall deep mining equipment in major coal basins. These data are useful to indicate the overall coal output achievable under the stated conditions. Unfortunately, it is not possible to convert these data to productivity per man-day for comparison with U.S. statistics, owing to a lack of information on the workforce at these mines.

The data in the following tables, however, shed some light on the productivity question.

Table B-27 shows that the productivity of coal basins in the USSR averages about 330 tons per working face per day as of 1970. In contrast, a typical U.S. face crew would produce at least 500 tons per day (or more if longwall systems were used). The productivity from the Karaganda and Pechora Basins is nearly double the average figure, and is attributable to the practice of surface mining.

* Ugol, No. 5, p. 3, 1973

Table B-26

USSR COAL PRODUCTION BY TYPE OF LONGWALL EQUIPMENT

Coal Basin	Mine	Type of Coal	Type of Cutter-Loader	Thickness of seam (meters)	Length of face (meters)	Section (face) OWS (meters)	Monthly coal output per face (tons)
Kuzbass	Berezovskay	Coal	K-52 m	1.5-1.9	360	-	75,751
Donbas	Privolnanskay uznay	Coal	LCD	-	-	-	80,033
Kuzbass	Chertinskay uznay	Coal	K-52 m	1.27	146	11.3	30,211
Donbas	Lutugin	Anthracite	KR-2	1.3	175	10.0	40,280
Karaganda	No. 23	Coal	Donbass-1	1.9	280	9.4	42,435
Donbass	No. 54	Anthracite	USB-2 (Plough)	1.2	177	20.0	13,000

Table B-27

INCREASE OF LOADING ON WORKING FACE
(Tons per Day)

	Loading on Working Face		
	1960	1965	1970
Department of Coal Industry of USSR	197	253	331
Basins			
Donets	198	245	313
Kuznets	196	255	312
Karaganda	367	447	602
Pechora	298	420	594
Podmoskorskyi	182	232	373

Table B-28

AVERAGE LOADING AND PRODUCTIVITY ON WORKING FACE

	Average Loading on Working Face (tons/day)			Average Labor Produc- tivity on Working Face (tons/output)		
	1965	1970	Percent Variation	1965	1970	Percent Variation
All working faces (WF)	253	331	+27.8	5.18	6.35	+22.6
In Btu number						
WF with coal loading	262	367	+40.2	5.23	6.66	+27.4
Complexity mechanized WF	442	710	+60.7	10.47	13.68	+30.7
WF with narrow grip	464	452	- 2.5	6.30	6.62	+ 5.0
WF with wide grip	252	280	+11.0	4.95	5.08	+ 2.5
WF without coal loading	230	212	- 7.8	5.35	5.37	-

Table B-29

COMPARISON OF PRODUCTIVITY DATA FOR MAJOR
COAL PRODUCING BASINS

	Length of Working Face (meters)		Speed of Movement (meters/day)		Productivity of Seam (tons/square meter)	
	1965	1970	1965	1970	1965	1970
Department of Coal Industry of USSR	67	108	1.91	2.27	3.45	2.90
Basins						
Donets	146	165	1.76	2.08	2.22	2.21
Kuznetz	62	95	1.83	2.35	3.96	3.29
Karaganda	91	121	1.23	2.10	3.53	3.59
Pechora	59	105	2.47	2.86	3.35	3.05
Podmoskovskiy	60	70	2.04	2.32	3.54	3.48

B-28 shows a general increase in average labor productivity, especially for the most mechanized faces, over the last five years.

Table B-29 shows a comparison in length of working face, speed of advance, and productivity for the major producing basins. Although the working face has lengthened and the speed of advance has increased in all basins, the productivity either has remained essentially the same (Donets, Podmoskovskiy) or has actually declined. This suggests that the manual or set-up time counteracts mechanical improvements and tends to constrain actual productivity.

The average working thickness of coal seams mined was 1.32 meters. The average depth of deep mines was about 360 meters, with the minimum working depth being 1,150 meters. Most deep mine production was from longwall mining (85 percent), followed by continuous mining, room and pillar, and other methods with relatively small production. The average longwall length was 120 meters, and the average advance of the face was about 38 meters per month. The average capacity of each longwall section was 354 tons per day.

Longwall mining has been plagued by problems. Difficulties with equipment, lack of rail cars, and operating problems have acted against the increased productivity achievable in longwall methods. The productivity of narrow-web longwall systems was one-third to one-half behind planned levels, with up to 70 percent of equipment being inoperative for extended periods. Poor quality of equipment and shortages of spare parts have led to shutdowns of several sections for as much as one-third of operating time.

For surface mining, the data suggest an even more rapid growth than in deep mining. Evidence of this growth is shown by the increase in mining equipment noted earlier in Table B-21. It was reported* that

* Ugol, No. 7, 1971.

as of January 1, 1971, the USSR contained 68 surface coal mines producing 163 million tons. This production was broken down by size of mine as follows:

<u>Number of Surface Coal mines</u>	<u>Output Capacity, (million tons/year)</u>
10	1.5 - 2.5
13	2.5 - 5.0
<u>45</u>	> 5.0
Total 68	

Clearly, most surface coal mines in the USSR are enormous (the largest U.S. surface coal mine is about 8 million tons, with the majority being less than 2 million tons).

The choice of equipment used for surface coal mining in the USSR differs from typical U.S. practice. It is estimated that bucket wheel excavators account for about 14 percent of Soviet-produced coal in 1970 and that this percentage will increase to 66 percent by 1985. This is an ambitious target. Bucket wheel excavators are complex machines that are capable of high production rates if applied to suitable conditions. However, most U.S. miners are reluctant to tie up so much production capacity in any one machine, and prefer to employ smaller power shovels and loaders that offer greater flexibility in the event of equipment failure.

Many of the differences in equipment preference between the USSR and U.S. surface coal operators appear to stem from contrasting development approaches. In the United States, the tendency is to minimize original capital investment, whereas in the USSR they seem to prefer reduction of operating manpower while tolerating an increased maintenance labor force. Regardless of these differences, however, the USSR has substantially increased its capacity for coal production by surface mining and appears likely to continue to do so in the future. Whatever

the Soviets can attain (or even closely approach), the targets set for such development remain an important question whose answer is uncertain.

In 1970, the average surface mine output in the USSR was 2.26 million tons per year, and the average labor productivity was 288 tons per man-month. The highest productivity was attained by mines that use a direct dumping system and do not require transportation. The average cost of surface mined coal was 2.72 rubles, while the average cost of excavating 1 cubic meter was 0.43 rubles. If the official rate of exchange were to be used as a standard of comparison, these costs would be virtually identical to those in modern U.S. surface mines; however, caution is required in such a comparison, owing to uncertainty about the actual exchange rate.

The USSR has done long range planning for surface coal mines. Some results from this work are summarized in Table B-30.* Production is expected to roughly triple by the year 2000--a goal expected to be achieved by more than tripling average mine output and worker productivity through a major effort to employ bucket wheel (or "rotary") excavators. Such machines are used very effectively in West German coal fields where the digging is easy, but the successful transfer of this technology to other coal fields (especially those of the United States) has been disappointing. If the USSR is unable to employ bucket wheel excavators in mining its coal to the degree anticipated, productivity goals will probably not be met, and hence, production targets will probably be missed. The degree to which the bucket wheel technique can be adapted to meet the special conditions of the Soviet coal fields may thus control the achievement of these ambitious surface mining goals.

* Ugol, No. 7, 1971

Table B-30

LONG RANGE PLANNING FOR SOVIET SURFACE COAL MINING

	<u>1970</u>	<u>1980</u>	<u>1990</u>	<u>2000</u>
Total Projected Surface Production (million tons)				
Variant I (108 mines)		349.4	687.5	1,307.1
Variant II (93 mines)		341.4	599.1	1,153.1
Average Annual Mine Output (million tons)	2.26	4.46	-	12.0
Coefficient of Extraction (cubic meters/ton)	4.	3.4 to 3.8	-	2.8
Maximum Possible Average Labor Productivity (tons/man-month)	283.3	509.	800.	1,088.
Production by Rotary Excavators (percent)	13.8%	64.1%	68.9%	78.5%

Source: Ugol, No. 7, 1971.

Other technological improvements projected in coming years include the following:

- Large capacity excavators (200-250 cubic meters).
- Large capacity handling equipment in the classes from 120, 180, 300, 500 tons.
- Drills capable of producing holes of 4.2 meters to a depth of 90 meters.
- Rotary excavators with productivity of 12,500 cubic meters/hr.

It may be noted that U.S. experience with grant equipment is disappointing, owing to engine and tire problems as well as lack of flexibility in event of equipment malfunction. Although the projected improvements are possible, the technological problems associated with such development will be severe, and could delay realization of the projected production targets.

Table B-31 shows anticipated development of other specific subsystems for surface coal mining in the USSR. Truck transport is expected to increase by more than half, while rail will continue to grow slowly and conveyors will increase almost tenfold. Other aspects of the mining operation are projected to change less rapidly.

5. Coal Preparation

Coal preparation or processing is carried out to remove ash and waste materials and thereby increase coal quality for its various uses and applications. The trend in numbers of such plants in the USSR has increased steadily over time, reaching about 128 million tons in 1970 (Figure B-3).

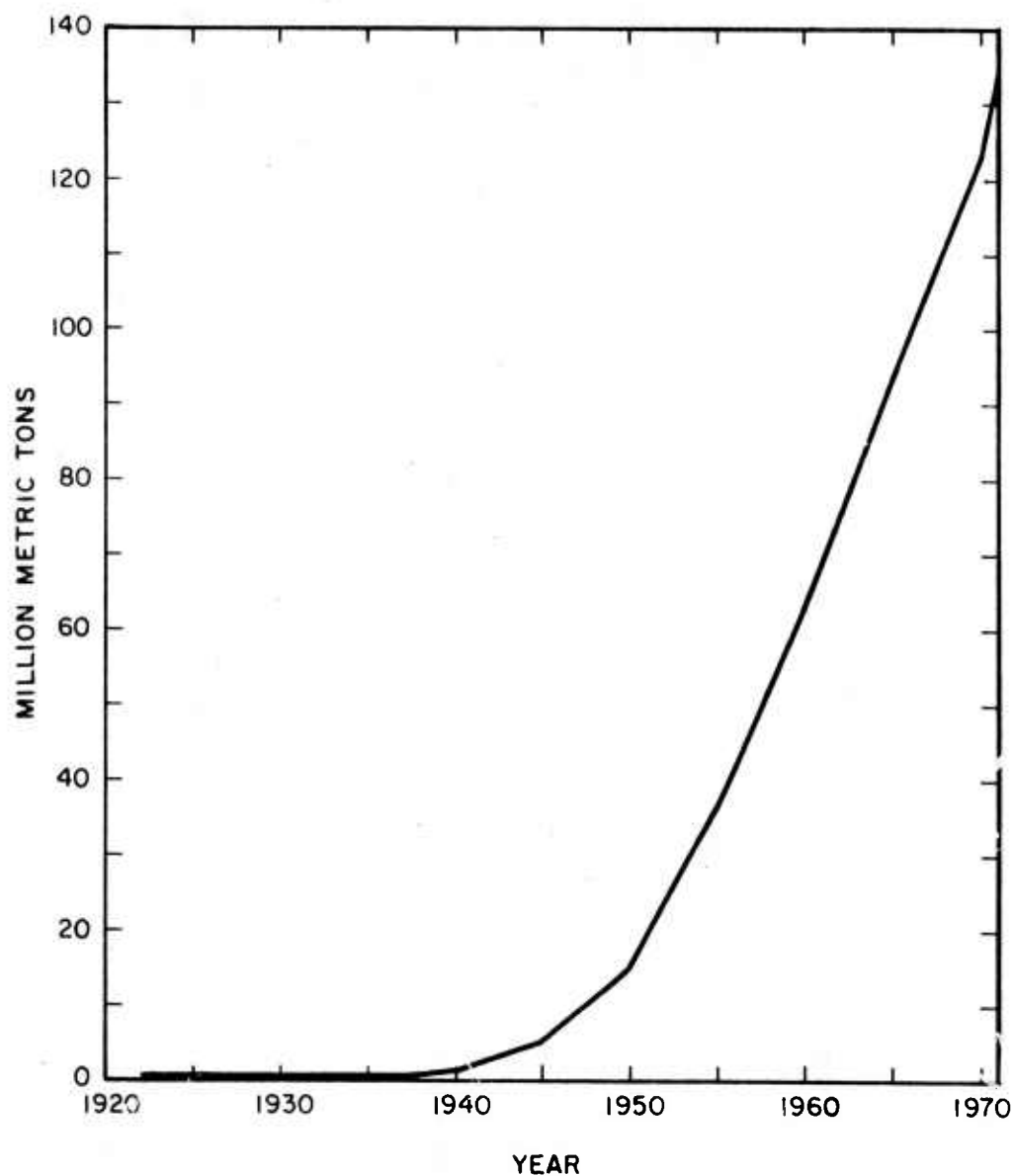
The methods of coal preparation in the USSR have changed in the period from 1965 to 1970.* The use of the mineral suspension process

* Ugol, No. 1, 1972.

Table B-31

SPECIFIC SUBSYSTEMS OF SURFACE COAL MINING
(Percent of Total Production from Subsystems)

<u>Subsystems of Mining</u>	<u>1970</u>	<u>1975</u>	<u>1980</u>	<u>1985</u>	<u>1990</u>	<u>2000</u>
Involving transport vehicles	56.0%	60.4%	62.7%	67.1%	74.4%	78.0%
Railroad transport	39.4	46.2	46.0	42.4	41.2	46.0
Truck transport	16.1	12.5	14.4	20.2	27.5	27.1
Conveyors	0.5	1.7	2.3	4.5	5.7	4.9
Direct Dumping (without transport)	33.5	30.0	30.1	27.3	22.4	20.7
Transport Dump	5.1	4.1	2.3	2.1	1.4	0.4
Special (Complex hydromechanization)	4.9	4.8	4.4	3.1	1.6	0.7
Other	0.5	0.7	0.5	0.4	0.2	0.2
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%



Source: Ugol, N. 12, 1972

Figure B - 3
PROCESSING OF COAL IN CONCENTRATING MILLS
(PREPARATION PLANTS)
(Includes Ferrous Metals Industry)

approximately doubled--from 8.9 percent of the total processing to 19 percent. Flotation showed a small increase--from 6.8 percent to 8.7 percent. Cleaning chutes, on the other hand, decreased from 31.7 percent to 20.6 percent. The remainder of coal preparation was apparently limited to washing and mechanical separation which appear to have remained relatively constant during this interval.

The average annual output of a coal preparation plant increased from 1.2 million tons in 1965 to 1.5 million tons in 1970. The goal of the current five-year plan is to increase this output to 1.9 million tons by 1975.

Technology for improved flotation reagents, washery circuits, filters, screens, and centrifuges received increasing attention, but remained as problem areas. A further problem is to improve the mining methods so as to facilitate removal of ash and waste materials during the preparation process. Trends in coal preparation are indicated by the following tabulation:

<u>Method</u>	<u>Percent of All Methods Used in 1965</u>	<u>Percent of All Methods Used in 1970 (estimated)</u>
Jigging	36.2	33.2
Washing	30.7	22.2
Air	17.7	11.1
Heavy media flotation	8.4	24.7
Other flotation	6.8	8.2
Concentration table	0.2	0.6

Source: Coal Industry 1917-1967, Moscow 1969.

6. Productivity in Coal Mining in the USSR

A summary of statistics regarding labor productivity in the coal mines of the USSR is presented in the following five tables.

Table B-32 shows trends in productivity by mining method in various coal basins. The table shows that productivity increased most in surface coal mines, rising overall by roughly three times in the 20 years from 1950 to 1970. During this same period, productivity of deep mines increased by less than two times. However, the surface mines were about four times more productive to start with; this difference was accentuated as productivity of surface mines increased at a much greater rate. The magnitude of this increase is also indicated by Figure B-4, which shows the change in monthly average of labor productivity.

Another way of expressing productivity is in the number of workers required to produce one thousand tones of coal (Table B-33). The improvement of productivity is demonstrated by the decrease in labor consumption.

Table B-34 shows the rates of growth of labor productivity. The average annual productivity growth decreased in the late 1950s, but resumed an increase in the 1960s. These increases were experienced by most of the major coal basins of the USSR.

Table B-35 shows the distribution of mines according to labor productivity level. The table shows that most mines of the USSR have productivity more than 30 tons/month. The number of mines with high productivity have increased substantially in the period from 1965 to 1970. The largest number of mines have productivity from 30 to 40 tons/month.

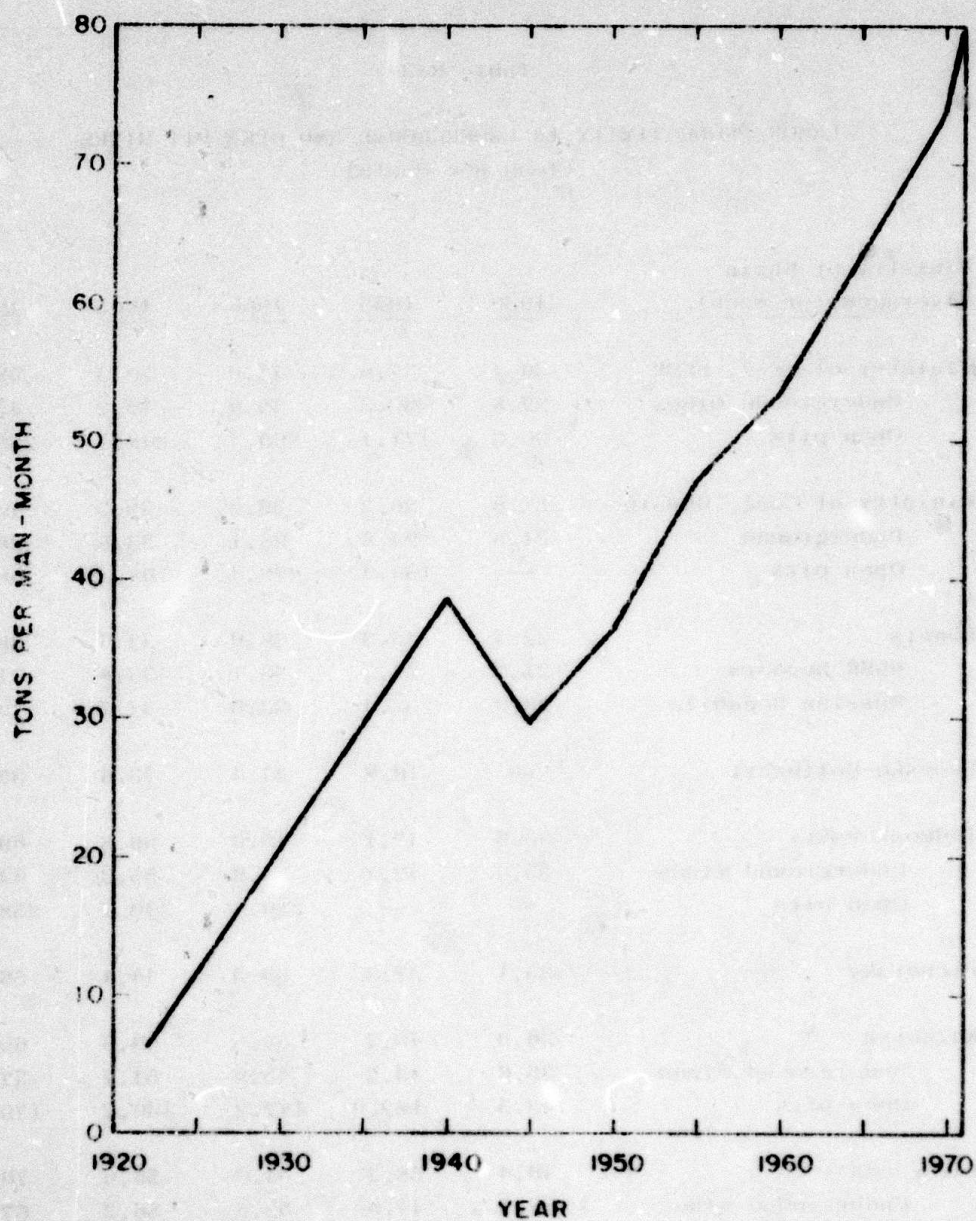
Table B-36 shows factors relative to coal mine productivity in terms of projected increases from 1970 to 1975. Factors increasing labor productivity are tabulated, together with those that would result in productivity decreases. The increases, however, are greatly in excess of decreases, and it is clear that Soviet planners are counting on productivity increases in the next five years. The principal increases are

Table B-32

LABOR PRODUCTIVITY IN UNDERGROUND AND OPEN PIT MINES
(Tons per Month)

Ministry or Basin (Averages for each)	1950	1955	1960	1965	1970
Ministry of Coal, USSR	30.1	37.6	41.9	50.3	58.5
Underground mines	27.8	32.5	35.0	40.2	45.8
Open pits	96.3	171.1	209.1	248.1	289.0
Ministry of Coal, Ukraine	21.8	26.2	29.7	35.3	40.2
Underground	21.8	24.8	28.1	33.8	38.9
Open pits	--	194.4	279.4	198.3	208.3
Donets	22.7	25.8	28.9	33.6	38.3
USSR borders	21.7	24.7	28.1	33.4	37.9
Russian Republic	28.0	32.4	33.5	34.7	40.5
Lvovsko-Volynskiy	--	10.8	27.6	43.6	55.2
Todmoskovskiy	35.6	42.1	45.9	59.8	69.4
Underground mines	35.6	42.1	43.9	55.3	64.9
Open pits	--	--	229.8	310.7	258.9
Pichorsky	25.1	37.7	39.5	44.4	56.9
Kuznetsk	36.3	46.7	53.5	60.6	69.7
Underground mines	35.6	43.2	45.9	51.7	57.7
Open pits	143.3	182.0	177.2	160.7	179.0
Karaganda	40.4	58.2	54.0	58.6	70.3
Underground mines	32.5	47.0	52.6	56.2	67.6
Open pits	139.3	207.4	131.4	182.3	218.4

NOT REPRODUCIBLE



Source: Ugol, N. 12, 1972

Figure B - 4

MONTHLY AVERAGE OF LABOR PRODUCTIVITY IN COAL PRODUCTION

Table B-33

LABOR CONSUMPTION - NUMBER OF WORKERS PER THOUSAND TONS

Type of Work and Process	By July 1, 1951	By January 1, 1970	± Change in Labor Consumption
Underground Mining			
Mining works	348	202	-146
Preparatory works	132	96	- 36
Underground transport	122	74	- 48
Maintenance and repairs of mining routes	59	59	--
Ventilation	28	8	- 20
Drainage	16	8	- 8
Maintenance and repair of mining machinery	25	43	+ 18
Delivery and storage of explosives	6	5	- 1
Lifting	24	14	- 10
Underground preparation of coal	5	3	- 2
Total	765	512	-253
Surface Mining			
Lifting	21	13	- 8
Hauling	46	13	- 32
Preparation of coal	34	19	- 15
Ventilation and lighting	28	14	- 14
Repairs of mining machinery	28	14	- 14

Table B-33 (Concluded)

<u>Type of Work and Process</u>	<u>By July 1, 1951</u>	<u>By January 1, 1970</u>	<u>± Change in Labor Consumption</u>
Surface Mining (continued)			
Maintenance of surface equipment			
Storage, delivery, and processing	13	19	+ 6
of pit materials		10	+ 3
Industrial-economic maintenance			
of mines	27	27	--
Coal storage and coal loading			
Total	<u>34</u>	<u>10</u>	<u>- 24</u>
	238	140	- 98

Table B-34

RATES OF GROWTH OF LABOR PRODUCTIVITY

Years	Coal	Coal	Basins					
	Industry	Industry	Donets	Lvovsko-	Pechonskyl	Kuznetsk	Karaganda	
	of USSR	of Ukraine		Volinskyl				Podmeskovskyl
Rates of Growth								
Labor Production (%)								
1951-1955	116.9%	113.8%	113.7%	--	118.2%	150.2%	121.3%	144.6%
1956-1960	107.7	113.3	112.0	255.5	104.3	104.8	106.2	111.9
1961-1965	114.8	120.3	116.3	157.9	125.9	112.4	112.6	106.8
1966-1970	113.9	115.1	114.0	126.6	117.4	128.1	111.6	120.3
Average Annual								
Increase in Labor								
Productivity (%)								
1951-1955	3.2	2.6	2.6	--	3.4	8.5	3.9	7.7
1956-1960	1.5	2.5	2.3	20.6	0.8	0.9	1.2	2.3
1961-1965	2.8	3.75	3.05	9.6	4.7	2.4	2.4	1.3
1966-1970	2.65	2.85	2.65	4.85	3.25	5.1	2.20	3.8

Table B-35
DISTRIBUTION OF MINES ACCORDING TO LABOR PRODUCTIVITY LEVEL

Department, Basin	No. of Mines	Coal Productivity (Tons/Month)											
		10- 15.0	15.1- 20.0	20.1- 25.0	25.1- 30.0	30.1- 40.0	40.1- 50.0	50.1- 60.0	60.0- 70.0	70.0- >70.0			
Ministry of Coal Industry of USSR													
1965	966	12	57	90	126	251	193	125	61	51			
1970	827	3	14	62	90	223	162	114	69	90			
Ministry of Coal Industry of Ukraine													
1965	483	9	43	66	77	140	86	45	9	8			
1970	397	1	13	50	52	119	86	40	20	16			
Donets													
1965	544	9	53	72	90	168	93	44	8	7			
1970	438	2	12	53	60	146	96	42	17	10			
Lvovsko-Volynskiy													
1965	18	--	--	--	--	6	8	4	--	--			
1970	19	--	--	1	--	3	6	2	3	4			
Podmoskovskoye													
1965	104	--	--	2	4	10	35	23	16	14			
1970	89	--	--	2	4	11	21	17	10	24			
Pechonskoye													
1965	27	--	--	--	--	8	8	6	1	1			
1970	25	--	--	--	--	5	5	1	2	6			
Kuznetsk													
1965	74	--	--	--	--	15	16	21	12	8			
1970	78	--	--	--	--	13	12	22	10	18			
Karaganda													
1965	37	--	--	--	--	5	11	9	6	6			
1970	32	--	--	--	--	--	3	8	7	14			

Table B-36

FACTORS INFLUENCING LABOR PRODUCTIVITY

	Projected Labor Productivity Increases		
	1970	1975	Percent
Factors increasing labor productivity			
Rate of production			
Annual load/mine (1,000 tons)	711	762	7.2%
Average daily load/working face (tons)	331	500	51.1
Annual load/open-pit mine (1,000 tons)	2,436	3,200	31.4
Changes in structure of coal production			
Increase of coal production by open-pit method (percent)	25.9%	30.3%	+4.4%
Changes in geographical distribution of coal, by basins	*	*	
Mechanization and automation of production (percent)			
Mechanization of loading on working faces of gently sloping and medium steep seams	84.7	92.0	+7.3
Automated complexes used on gently sloping and medium steep seams	--	2.2	+2.2
Complex mechanization of coal production on working face	29.9	58.9	+29.0
Mechanization of lift of coal on working faces of steep seams	0.4	15.6	+15.2
Mechanization of tunneling by application of tunneling combines	16.8	37.1	+20.3
Technological perfection of open-pit method	*	*	
Underground transport conveyors	*	*	
Factors decreasing labor productivity			
Increase of extraction coefficient in open-pit mines (cubic meters/ton)	3.94	4.75	+20.6%
Decrease of number of working days	307	305	- 2 days

* No individual projected values are given in source.

expected from (a) increased rate of coal production (increased load per working face), and (b) mechanization and automation of production. The projected increases during this period appear within reach, and could be accomplished during the near term. If these increases are not achieved, production will fall short of Soviet goals--an event that will affect the overall energy balance of the USSR.

F. Transportation of Coal in the USSR

1. Overview and Statistical Data

The transportation of coal in the USSR is predominantly by rail. In 1970, 644 million metric tons of coal and coke were shipped by this mode of transport. This tonnage constituted about 88% of total aggregate coal shipments in that year. Table B-37 shows coal shipments by mode of transport in the USSR in 1970. There is, of course, some overlap in the data since coal shipped by other modes has generally been shipped first by rail to the point of transshipment. In the case of river and inland waterway shipments, the coal is sometimes reloaded on rail at the end of the movement by waterway. In the case of truck transport, some shipments, such as in the northern part of the Far East, may be entirely by truck because of the absence of rail lines.

Coal constituted 22 percent of the total tonnage of all types of freight shipped by rail in the USSR in 1970. Coal is expected to continue to be an important fraction, 20 percent, of such freight in 1975. Table B-38 shows coal and coke shipments by rail for 1965, 1970, and 1975, as projected by the Gosplan (Five-Year Plan Institute). For perspective and comparison, the shipments of several other important raw materials are also shown.

From Table B-38 it can be determined that rail shipments of coal and coke increased at the rate of 2.1 percent per year during the

Table B-37

COAL SHIPMENTS IN THE USSR BY MODE OF TRANSPORT - 1970
(Millions of Metric Tons)

<u>Mode of Transport</u>	<u>Shipments</u>	<u>Percent of Total</u>
Rail	644	88%
Truck	65	9
River (barge)	18	2
Ocean (ship)	9	1
Total	736	100%

Source: Zheleznodorozhnyi Transport v Debiatoi Piatilekte (Railroad Transport in the 9th Five-Year Plan), p. 10, 1972 and Transport i Sviaz (Transportation and Communication), pp. 144, 168, 230, 1972.

Table B-38

RAILROAD FREIGHT TRANSPORT OF COAL AND
OTHER COMMODITIES--USSR
(Millions of Metric Tons)

<u>Commodity</u>	<u>1965</u>	<u>1970</u>	<u>1975</u> <u>(5 Year Plan)</u>
Coal and coke	580	644	725
Petroleum and petroleum products	221	302	410
Ore	192	246	320
Lumber	173	176	190
Mineral building materials (including cement)	570	688	880
Grain	88	105	115
Chemical and mineral fertilizers	43	71	110

Source: Zheleznodorozhnyi Transport v Debiatoi Piatilekte (Railroad Transport in the 9th Five-Year Plan), p. 10, 1972.

1965-1970 period and are scheduled to increase by 2.4 percent per year in the period of the present five-year plan.

The current five-year plan (ninth five-year plan, 1971-75) calls for an increase in coal production from 624 million metric tons in 1970 to 695 million metric tons in 1975. This is equivalent to an average annual increase of 2.2 percent per year, and is consonant with the planned 2.4 percent per year average increase in coal shipments by rail.

2. Coal Movement by Rail and Connecting Waterways

Table B-39 shows regional transport data (exports) for coal moving from the major coal-producing basins to the various economic regions of destination. Table B-40 shows the transport (imports) of coal to the economic regions from the basins, and Table B-41 shows the movement by mode of transport to, from, and within each region.

From Table B-39 it can be seen that the Donets Basin (in the Ukraine) and the Kuznetsk Basin (in Western Siberia) are the largest coal producing and exporting areas of the USSR. In these two basins alone, 330 million metric tons of coal were extracted in 1970, compared to total USSR coal output of 624 million metric tons in that year. Of these 330 million metric tons, about half was exported to other economic regions. In the case of Donets coal, exports were primarily to the economic regions immediately around and to the north of the Basin--i.e., to the central European heartland of Russia. Kuznetsk Basin coal, however, is shipped primarily to major industrial cities in the Urals more than 1,000 miles away--certain rail lines were built specifically to enhance the coordination between the Kuznetsk coal areas and the iron and steel complexes in Sverdlovsk, and other cities of the Urals, originally linked only by the main Trans-Siberian railroad. Kuznetsk coal is also shipped to the southwest into Kazakhstan and Central Asia.

Table B-39

COAL BASIN EXPORTS BY ECONOMIC REGION OF DESTINATION - 1970
(Millions of Metric Tons)

<u>Basin or Region of Origin</u>	<u>Coal Mined</u>	<u>Coal Exported</u>	<u>Region of Destination</u>	<u>Regional Imports</u>
Donets Basin "Donbass"			Central Blacksoil	11.7
A. Donets-Dnieper region (Ukraine)	183.9	70.3	Central	9.0
B. Northern Caucasus region (Russian Federated Soviet Republic)	33.6	22.0	Northwestern	10.4
			Belorussia	4.0
			Baltic	6.5
			Southwest	19.8
			Moldavia	2.3
			Southern	14.7
			Caucasus	2.9
Total	217.5	92.3	Volga	9.0
			Volga-Vyatka	2.0
Lvov-Volynian Basin (Southwestern Region)		4.4	Belorussia	4.4
Kuznets Basin (Kuzbass)			Kazakhstan	10.0
(Western Siberian Region)			Central Asia	0.9
A. Coking coal for use in metallurgy	38.2	25.5	Urals	37.8
B. Non-coking coal for use as energy-fuel	74.3	36.8	A. Coking coal	16.0
Total	112.5	62.3	B. Non-coking coal	20.8
			Volga	3.5
			Volga-Vyatka	5.0
			Central	5.4
			Western Siberia	0.7
Pechora Basin (Northwestern Region)	21.4	7.4	Urals	0.2
			Central	4.2
			Baltic States	3.0
Moscow Basin (Central Region)	35.8	5.6	Central Blacksoil	4.0
			Volga Vyatka	0.4
			Northwest	0.8
			Belorussia	0.4
Karakanda Basin (Kazakhstan)	38.8	17.3	Urals	11.5
			Volga	4.3
			Central Asia	1.5

Table B-39 (Concluded)

<u>Basin or Region of Origin</u>	<u>Coal Mined</u>	<u>Coal Exported</u>	<u>Region of Destination</u>	<u>Regional Imports</u>
Ekibastuz Basin (Kazakhstan)		7.6	Western Siberia Urals	6.6 1.0
Kansko-Achinsk Basin (Eastern Siberia)		2.4	Western Siberia Kazakhstan	2.0 0.4
Cheremkhovo Basin (Eastern Siberia)		3.9	Western Siberia Far East	0.4 3.5
Bukachacha Basin (Eastern Siberia)	1.0 app.	0.4	Far East	0.4
Raichikhinsk Basin (Far Eastern Region)		0.2	Eastern Siberia	0.2
Kizel Basin (Urals Economic Region)	12.7	5.8	Volga-Vyatka Northwest Central	2.0 2.2 1.6
Chelyabinsk Basin (Urals Economic Region)	30.3	1.0	Volga	1.0

Table B-40

ECONOMIC REGIONAL IMPORTS OF COAL BY COAL BASIN SOURCE (1965, 1970)
(Millions of Tons)

Importing Region	Amounts Imported		Coal Source (by Basin)
	1965	1970	
Northwestern		10.4 0.8 <u>2.2</u>	Donbass (Donets Basin) Moscow Basin Kizel Basin
Total	12.9	13.4	
Central		9.0 4.4 5.2 <u>1.6</u>	Donbass Kuzbass (Kuznetsk Basin) Pechora Basin Kizel Basin
Total	17.9	20.2	
Volga-Vyatka		2.0 5.0 0.4 <u>2.0</u>	Donbass Kuzbass Moscow Basin Kizel Basin
Total	9.2	9.4	
Central Blacksoil		11.7 <u>4.0</u>	Donbass Moscow Basin
Total	14.7	15.7	
Volga		9.0 3.5 4.3 <u>1.0</u>	Donbass Kuzbass Karaganda Basin Chelyabinsk Basin
Total	19.4	17.8	
Urals		0.2 11.5 36.8 <u>1.0</u>	Pechora Basin Karaganda Basin Kuzbass Ekibastuz Basin
Total	47.8	49.5	
Western Siberia		6.6 2.0 <u>0.4</u>	Ekibastuz Basin Kansko-Achinsk Basin Cheremkhov Basin
Total	4.7	9.0	
Eastern Siberia		0.9 <u>0.2</u>	Kuzbass Raichikhinsk Basin
Total	0.6	1.1	
Far Eastern		3.5 <u>0.4</u>	Cheremkhovo Basin Bukachacha Basin
Total	2.5	3.9	

Table B-40 (Concluded)

<u>Importing Region</u>	<u>Amounts Imported</u>		<u>Coal Source (by Basin)</u>
	<u>1965</u>	<u>1970</u>	
Southwestern			
Total	17.7	<u>19.8</u> 19.8	Donbass
Southern			
Total	12.0	<u>14.7</u> 14.7	Donbass
Baltic			
Total	9.9	<u>6.5</u> <u>3.0</u> 9.5	Donbass Pechora Basin
Caucasus			
Total	3.6	<u>2.9</u> 2.9	Donbass
Central Asia			
Total	2.2	<u>0.9</u> <u>1.5</u> 2.4	Kuzbass Karaganda Basin
Kazakhstan			
Total	7.8	<u>10.0</u> <u>0.4</u> 10.4	Kuzbass Kansko-Achinsk
Belorussia			
Total	8.6	<u>4.0</u> <u>4.4</u> <u>0.4</u> 8.8	Donbass Lvov-Volynian Basin Moscow Basin
Moldavia			
Total	2.4	<u>2.3</u> 2.3	Donbass

Note: The Northern Caucasus and Dnieper Regions, both of which contain the Donets Basin, do not import coal.

Table B-41

REGIONAL TRANSPORT DATA FOR COAL BY MODE OF TRANSPORT, 1970
(Millions of Metric Tons)

Region and Mode of Transport	Total Dispatch	Total Arrival	Intra-regional Transport	Magnitude of Exports over Imports (+) or of Imports over Exports (-).
Northwestern				
Railroad	26.8	31.5	19.8	-4.7
Ocean	0.8	1.3	0.8	-0.4
River	1.9	2.7	1.5	-0.9
Total	29.5	35.5	22.1	-8.0
Central				
Railroad	28.2	41.3	22.7	-13.1
Ocean	-	-	-	-
River	0.1	1.6	-	-1.5
Total	28.3	42.9	22.7	-14.6
Volge-Vyatke				
Railroad	0.9	8.3	0.2	-7.4
Ocean	-	-	-	-
River	0	1.3	0	-1.3
Total	0.9	9.6	0.2	-8.7
Central Blacksoil				
Railroad	0.9	16.3	0.6	-15.3
Ocean	-	-	-	-
River	0.2	0.1	0.1	0
Total	1.1	16.4	0.7	-15.3
Volge				
Railroad	6.1	19.7	3.7	-13.5
Ocean	0	0	0	0
River	2.3	2.3	0.5	-0.1
Total	8.4	22.0	4.2	-18.6
Urals				
Railroad	48.2	90.6	41.1	-44.4
Ocean	-	-	-	-
River	1.8	0.1	0.1	+1.7
Total	48.0	90.7	41.2	-42.7
Western Siberia				
Railroad	119.2	65.9	57.0	+53.3
Ocean	-	-	-	-
River	0.7	0.7	0.7	0
Total	119.9	66.6	57.7	+53.3
Eastern Siberia				
Railroad	40.0	34.0	33.3	+6.0
Ocean	0.1	0.1	0.1	0
River	0.5	0.7	0.5	-0.2
Total	40.6	34.8	33.9	+5.8
Far Eastern				
Railroad	25.5	29.3	25.5	-3.8
Ocean	1.8	1.9	2.0	-0.1
River	2.4	2.2	2.0	+0.2
Total	29.7	33.4	29.5	-3.7

Table B-41 (Concluded)

Region and Mode of Transport	Total Dispatch	Total Arrival	Intra-regional Transport	Magnitude of Exports over Imports (+) or of Imports over Exports (-)
Southwestern				
Railroad	15.9	29.6	11.5	-13.8
Ocean	-	-	-	-
River	0	1.7	0	-1.6
Total	15.9	31.3	11.5	-15.4
Southern				
Railroad	0.4	13.2	0.1	-12.8
Ocean	1.1	2.0	1.2	-0.9
River	0	0.8	0	-0.8
Total	1.5	16.0	1.2	-14.5
Baltic				
Railroad	1.6	10.4	1.4	-8.8
Ocean	0	0	0	0
River	0.4	0.5	0	-0.1
Total	2.0	10.9	1.4	-8.9
Caucasus				
Railroad	4.1	5.6	3.4	-1.5
Ocean	0	0.7	0	-0.7
River	0	0	0	0
Total	4.1	6.3	3.4	-2.2
Central Asia				
Railroad	6.4	3.2	5.8	-1.7
Ocean	0.1	0	0	0
River	0.1	0.2	0.1	0
Total	6.6	3.4	5.9	-1.7
Kazakhstan				
Railroad	58.7	44.2	33.8	+14.5
Ocean	0	0	0	0
River	0.2	0.2	0.2	0
Total	58.9	44.4	34.0	+14.5
Belorussia				
Railroad	2.6	8.0	0.3	-5.4
Ocean	-	-	-	-
River	0	1.1	0	-1.1
Total	2.6	9.1	0.3	-6.5
Moldavia				
Railroad	0	2.3	0	-2.3
Ocean	-	-	-	-
River	0	0	0	0
Total	0	2.3	0	-2.3
Northern Caucasus and Donets-Dnieper Regions				
Railroad	263.7	178.5	178.5	+85.1
Ocean	1.4	0.2	0.2	+1.2
River	6.0	0.1	0.1	+6.0
Total	271.1	178.8	178.8	+92.3

Note: The regional export statistics (Table B-39) plus the "intra-regional transport" figures in this table will add up to the figures given in the "total dispatch" column; the regional import statistics (Table B-40) plus "intra-regional transport" figures will add up to the figures given in the "total arrival" column.

Table B-40 shows that the largest imports of coal were into the Urals economic region and, as could be inferred from the previous discussion, most of this comes from the Kuznetsk Basin via the Trans-Siberian rail line. In fact, the rail line from Novosibirsk westward to Omsk and beyond has been characterized as the most heavily used rail line in the world.

The Central economic region (which includes Moscow, the capital of the USSR) and the Southwestern economic region were, after the Urals, the importers of the next largest amounts of coal. About three-fourths of total imports into those two regions were from the Donets Basin via the well-developed rail systems linking these areas.

Table B-41 shows the total coal traffic by region and mode of transport in the region, for coal arrivals, dispatches, and intraregional movements. As would be expected, a great deal of intraregional movement of coal occurs in economic regions that contain major coal basins. Thus, the Northern Caucasus and the Donets-Dnieper economic regions, which jointly contain the Donets Coal Basin, have a large quantity of intraregional shipments of coal by rail. In fact, two-thirds of all coal dispatched in these two regions is for destinations within them. The regions constitute, of course, the giant industrial heartland of Russia.

Other economic regions with relatively high intraregional shipments (though dwarfed by comparison with the Donets-Dnieper and Northern Caucasus) are Western Siberia (containing the Kuznetsk Basin) and Kazakhstan (containing the Karaganda Basin).

Inter-regional movements of coal in the USSR are shown in Figures B-5, B-6, B-7, and B-8. These figures show the patterns of coal transportation from producing basins to the consuming areas. Figure B-5 shows movements from the main coal producing regions (Donbass and Kuzbass)

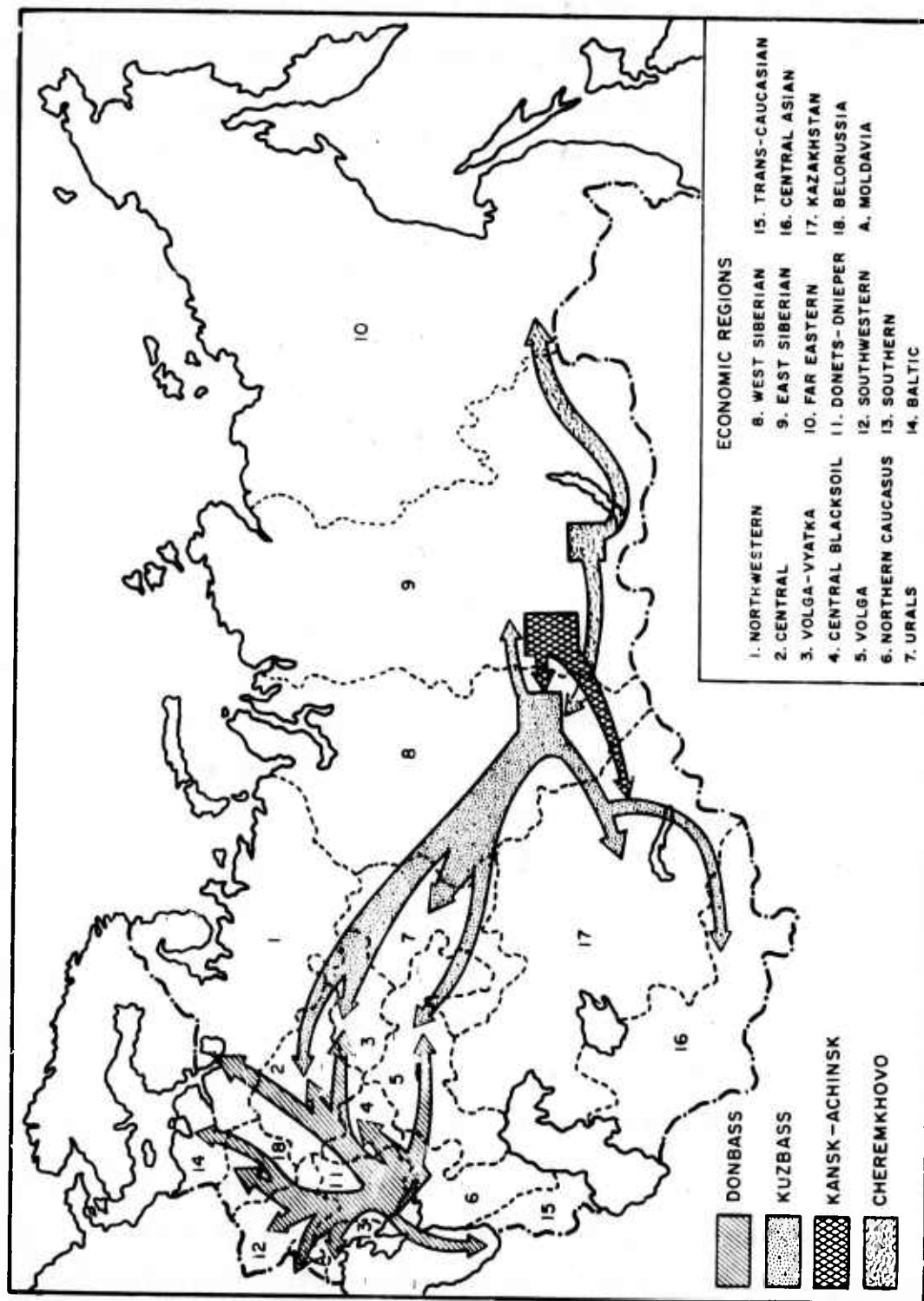


Figure B-5
INTER-REGIONAL COAL MOVEMENTS --MAP I

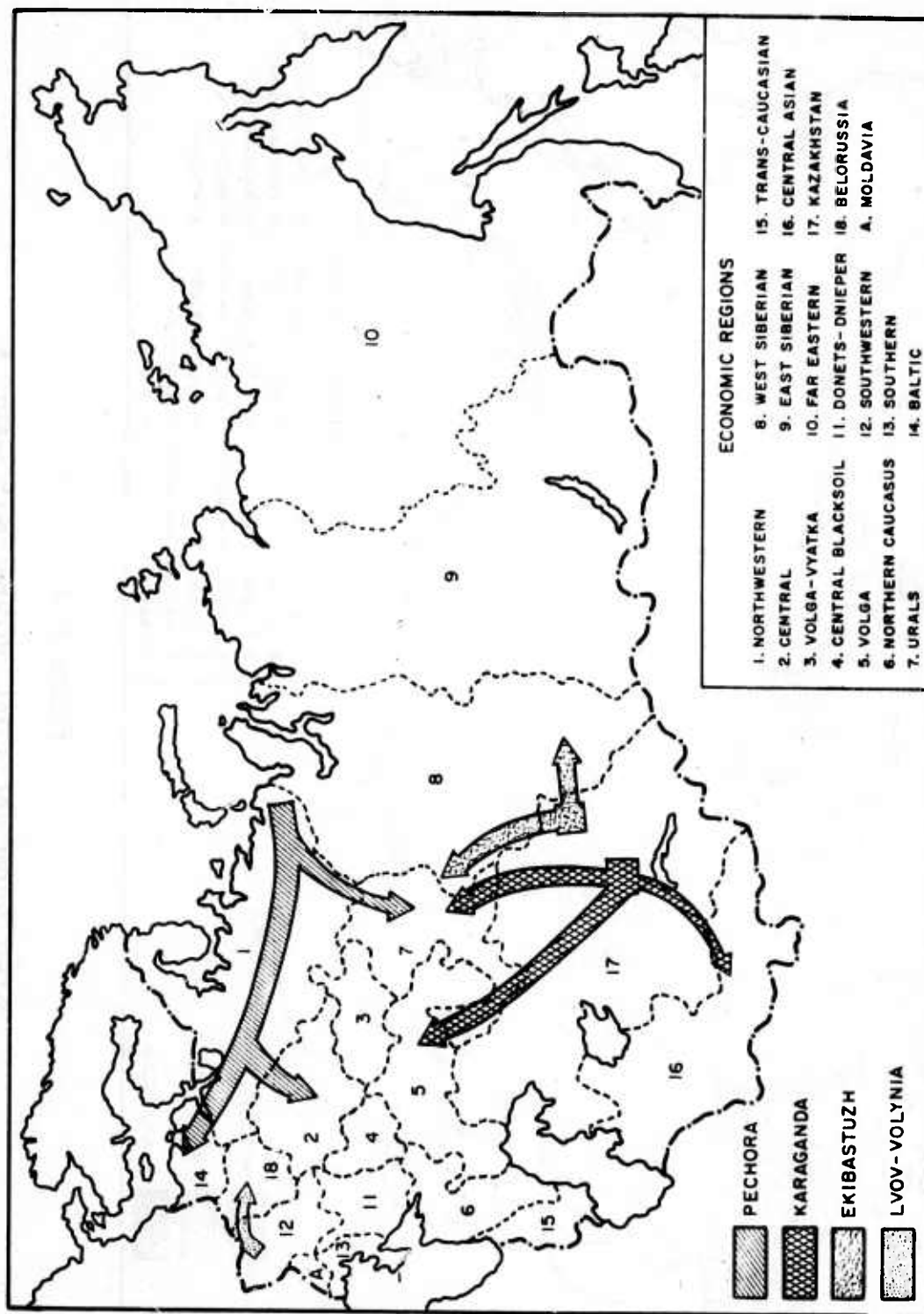


Figure B-6
INTER-REGIONAL COAL MOVEMENTS -- MAP 2

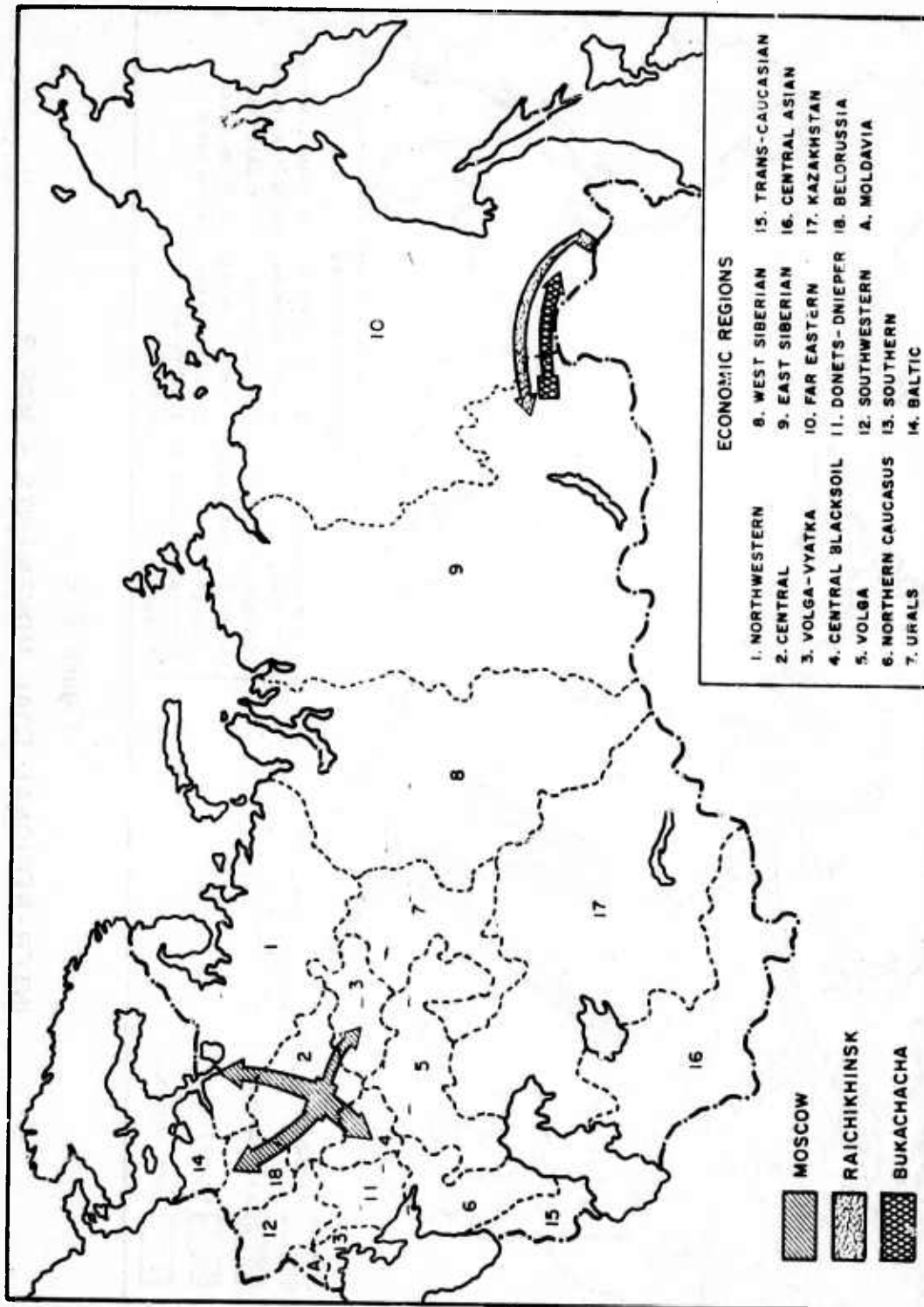


Figure B-7

INTER-REGIONAL COAL MOVEMENTS --MAP 3

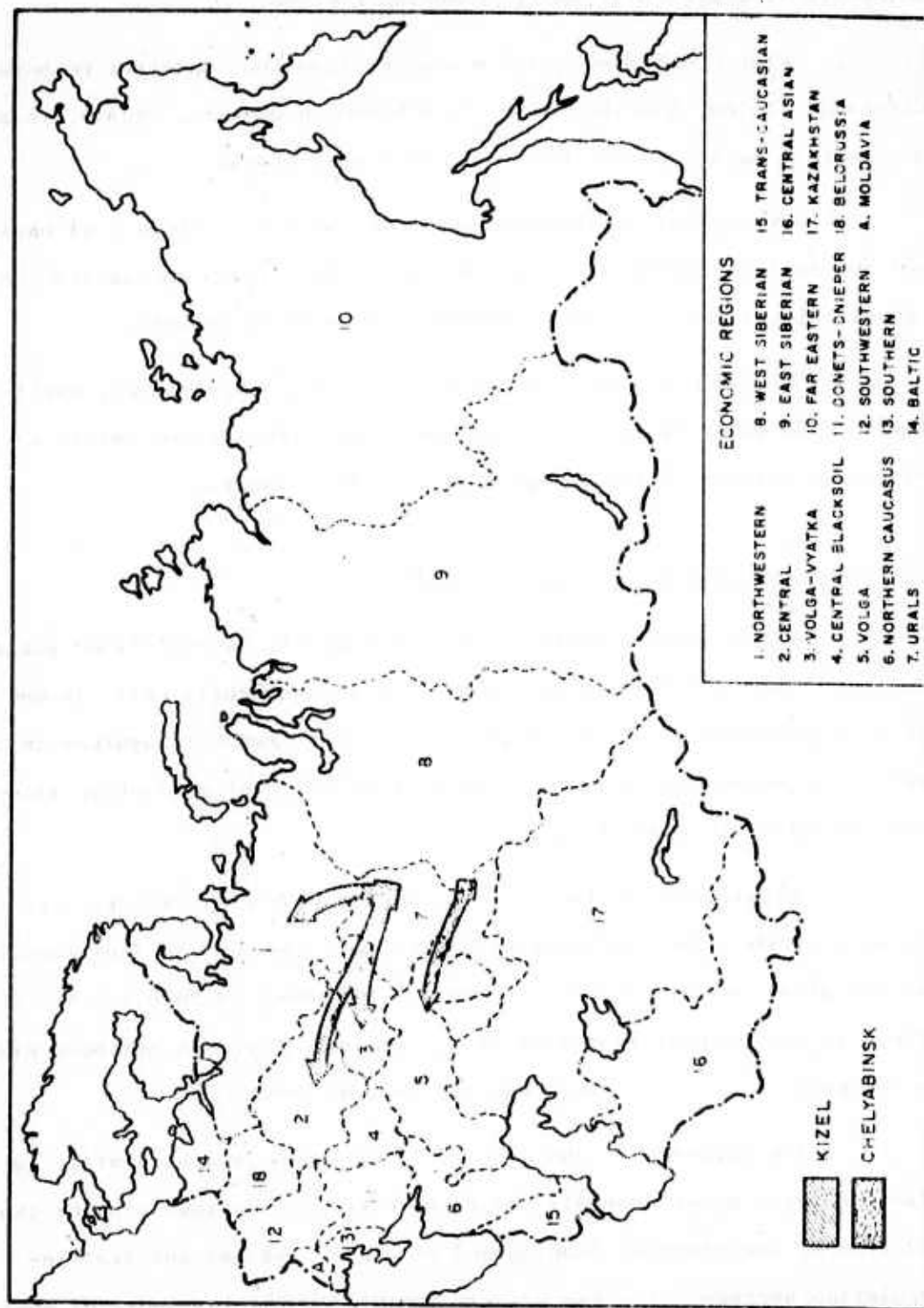


Figure B-8
INTER-REGIONAL COAL MOVEMENTS -- MAP 4

to consuming regions of the European and Ural sectors. Also shown are movements from presently small producing regions.

Figure B-6 shows coal movements from the important Pechora and Karaganda fields, together with other lesser producers. Again, this coal movement is mainly to the European and Ural sectors.

Figure B-7 shows movements from the Moscow brown coal basin and two smaller deposits in the Far East. The figure emphasizes the relative localization of coal movements from these deposits.

Figure B-8 shows coal movements from two relatively small deposits in the Urals area. These coals are also shipped mainly to the consuming centers of the European part of the country.

3. Soviet Coal Transport to 1975

Actual coal production has consistently overfulfilled goals in the USSR, the coal transportation system, predominantly rail, is one of the most advanced and intensively used freight transport systems in the world. Increases in freight car production and coal production since 1960 are shown in Table B-12.

In addition to the increase in the number of freight cars produced in the USSR, one must also take into account the fact that the average gross weight of freight cars has increased by 20 percent since 1960. In the current five-year plan, even more emphasis has been placed on the production of greater capacity freight cars.

The increase in the density of railroad freight traffic is also receiving major emphasis under the current five-year plan by the addition of computerized loading and unloading systems and traffic-regulation systems. The use of unit-trains for the transport of coal

over long distances has also developed during the past few years and has increased the efficiency and reduced the costs of the coal transport system in the country.

Since Soviet planners intend, as much as possible, to substitute oil and gas for coal, to restrict coal movements to intraregional areas, and to hold increases in coal production to low levels, coal transport capability is expected to be adequate in the foreseeable future.

Table B-42

INCREASES IN FREIGHT CAR AND COAL PRODUCTION IN THE USSR

<u>Year</u>	<u>Annual Coal Production (million metric tons)</u>	<u>Average Annual Increase (percent/year)</u>	<u>Annual Freight Car Production (Number of freight cars)</u>	<u>Average Annual Increase (percent/year)</u>
1960	509.7		36,400	
		2.5		1.7
1965	577.1		39,600	
		1.6		8.1
1970	624.1		58,300	
		2.7		1.8
1971	640.9		63,700	
		1.6*		10.7*
1975	694.1*		96,800*	

* Planned production.

Sources: Zheleznodorozhnyi transport v devyati letii, 1971-75
(R.R. Transport in the Ninth Five-Year Plan, 1971-75).
Transport i svyaz; statisticheskii obzor (Transport and
Communication; Statistical Review), 1972.
Stanford Research Institute.

G. Summary of Soviet Coal Production and Potential

In 1971, the Soviet Union produced about 641 million tons of run-of-mine* coal of all ranks. This production was from 10 major coal fields and numerous smaller coal areas. Production was about as follows:

Hard coal	486 million tons
Brown coal	155 million tons

These data continue production trends from recent years, as given in Table B-43. This table shows the continuing growth in coal production since the Second World War. The table also shows growth in surface mining during this same interval.

In 1971 there were about 1,000 operating deep mines, with an average production of about 462,000 tons annually. There were also some 68 surface mines, with an average production of 2.6 million tons per year.

Tables B-44, B-45, and B-46 show production trends for hard coal (anthracite and bituminous) and brown coal (sub-bituminous and lignite) in the principal coal producing basins of the USSR over recent years. The largest production of hard coal has been in the Ukraine and Donets areas, although production in the Kuznetsk Basin has grown rapidly in the same period. Brown coal production was historically greatest in the Moscow Basin, but the Urals Basins and those of Kazakhstan have strongly rivalled these areas in recent years.

It seems likely that production from developed fields will begin to decline as easily mined deposits are depleted. In this case, the pace of production from Eastern fields will be stepped up to provide the

* Soviet statistics are based on uncleaned or "run-of-mine" coal, whereas U.S. practice is to report only the amount of marketable coal (with or without first cleaning the coal. To be comparable with U.S. statistics, Soviet data must be corrected for losses, as will be shown in the conclusion of this section.

Table B-43

SUMMARY OF COAL PRODUCTION IN THE USSR
(Thousand Tons)

	1940	1945	1950	1955	1960	1965	1970	1975	1980
By Rank of Coal									
Hard Coal									
Bituminous coal	95,330	79,300	136,321	206,517	296,912	351,414	400,603		
Anthracite	32,296	15,995	38,971	57,533	78,013	76,467	75,803		
Brown Coal	25,567	47,638	73,564	112,449	138,261	149,850	147,708		
Total	153,193	142,933	248,856	376,499	513,186	577,731	624,114	695,000	720,000
Peat	33,000	22,000	36,000	51,000	54,000	56,000*	57,000		
By Mining Method									
Underground	146,884	125,153	221,715	311,565	407,646	437,214	457,487		
Percent	96%	88%	89%	83%	79%	76%	73%		
Surface	6,309	17,781	27,141	64,934	105,540	140,517	166,627		
Percent	4%	12%	11%	17%	21%	24%	27%		

* Estimated.

Table B-44

PRODUCTION OF ANTHRACITE IN THE USSR
(Thousand Tons)

<u>Deposits</u>	<u>1940</u>	<u>1945</u>	<u>1950</u>	<u>1955</u>
Ukraine	22,867	9,195	24,206	37,140
Donets Basin	32,102	15,651	38,506	57,148
Moscow Basin	--	--	--	--
Kuznetsk Basin	--	--	--	--
Pechora Basin	--	--	--	--
Urals Basins	195	344	452	385
Karaganda Basin	--	--	--	--
Middle Asia	--	--	--	--
Eastern Siberia	--	--	--	--
Far East	--	--	--	--
Georgian SSR	--	--	--	--
Total	55,164	25,190	63,164	94,673

Table B-45

PRODUCTION OF BITUMINOUS COAL IN THE USSR
(Thousand Tons)

<u>Deposits</u>	<u>1940</u>	<u>1945</u>	<u>1950</u>	<u>1955</u>
Ukraine	52,956	18,966	48,682	74,949
Donets Basin	53,407	21,283	51,173	78,186
Moscow Basin	--	--	--	--
Kuznetsk Basin	21,137	28,994	36,814	56,537
Pechora Basin	262	3,319	8,687	14,153
Urals Basins	4,567	7,721	10,372	11,676
Karaganda Basin	6,181	9,412	12,088	20,751
Middle Asia	422	367	701	984
Eastern Siberia	6,773	5,585	11,001	16,214
Far East	1,664	1,963	3,582	4,916
Georgian SSR	<u>618</u>	<u>650</u>	<u>1,672</u>	<u>2,559</u>
Total	147,987	98,260	184,772	280,925

Table B-16

PRODUCTION OF BROWN COAL IN THE USSR
(Thousand Tons)

<u>Deposits</u>	<u>1940</u>	<u>1945</u>	<u>1950</u>	<u>1955</u>
Ukraine	364	38	940	8,594
Donets Basin	--	--	--	--
Moscow Basin	9,949	20,021	30,622	39,302
Kuznetsk Basin	--	--	--	--
Pechora Basin	--	--	--	--
Urals Basins	6,939	17,002	21,337	34,795
Karaganda Basin	117	1,854	4,217	6,062
Middle Asia	1,498	1,322	3,536	5,349
Eastern Siberia	1,754	2,059	4,061	6,959
Far East	4,931	5,057	8,466	11,141
Georgian SSR	--	--	46	147
Total	25,552	47,353	73,225	112,449

needed coal supplies. Much of this development can be by surface mining, although attention will increasingly need to be given to deep mining, even in these remote areas, so as to attempt to recover the larger coal reserves that are too deeply buried to be mined by surface methods.

The ash content of coal from the Donets Basin was about 23 percent in 1970. However, preparation and cleaning facilities are inefficient at removing ash and wastes, resulting in significant losses in fuel efficiency (both through cleaning losses and through inefficiencies of use). The principal consequences are:

- Inefficient combustion
- High rail cost from transport of wastes
- Requirements for special coals for blending
- Lengthy and costly coal haulage

Losses in coal in 1971 were estimated to be as follows:

User	Loss (million tons)
Electric power plants	24
Rail haulage of waste	33
Transport	<u>14</u>
Total	71

Soviet coal users cannot rely on a regular supply of the coal required to satisfy their needs. The several production and preparation problems noted here and in previous sections indicate that the effectiveness in coal use is impaired. These problems of coal production and use seem likely to constrain Soviet ability to expand rapidly to meet growing demand. Furthermore, if these problems are encountered in the established, developed coal fields of the USSR, similar or even greater problems could be encountered in the development of new deposits. Thus, although the USSR's coal resources and reserves are substantial and represent a major energy base, the practical difficulties of geography, geology, extraction

technology, preparation technology, and utilization technology mitigate against the prospective theoretical advantages of a large coal potential.

III COAL IN THE CMEA COUNTRIES

A. Overview

The locations of coal deposits in Eastern Europe and the European part of the USSR are shown in Figure B-9.* This map is included as an aid in providing an overall regional perspective for the component countries.

In the following sections, data are presented on patterns of coal production by sectors in most of the CMEA countries. These data were taken from statistics compiled by the United Nations.† Unfortunately, UN data are not organized in a fashion that permits direct comparison with sectoral energy consumption data commonly maintained by many U.S. or Western sources.‡ To avoid the risk of introducing significant errors, no attempt has been made here to convert or adjust the UN data to more familiar grouping. Nevertheless, such data are valuable in providing an indication of the dimensions of coal uses by different economic sectors of the CMEA countries.

* "Coal-Bearing Deposits of Europe," Subcommittee for the Map of Coal-Bearing Deposits of Europe, Commission for the Geological Map of the World, International Geological Congress, Moscow, 1972.

† United Nations, "Annual Bulletin of Coal Statistics for Europe, 1971," Vol. VI, UN Economic Commission for Europe, New York, N.Y., 1972.

‡ See, for example, "Patterns of Energy Consumption in the United States," a report by Stanford Research Institute to the Executive Office of the President, 1972.

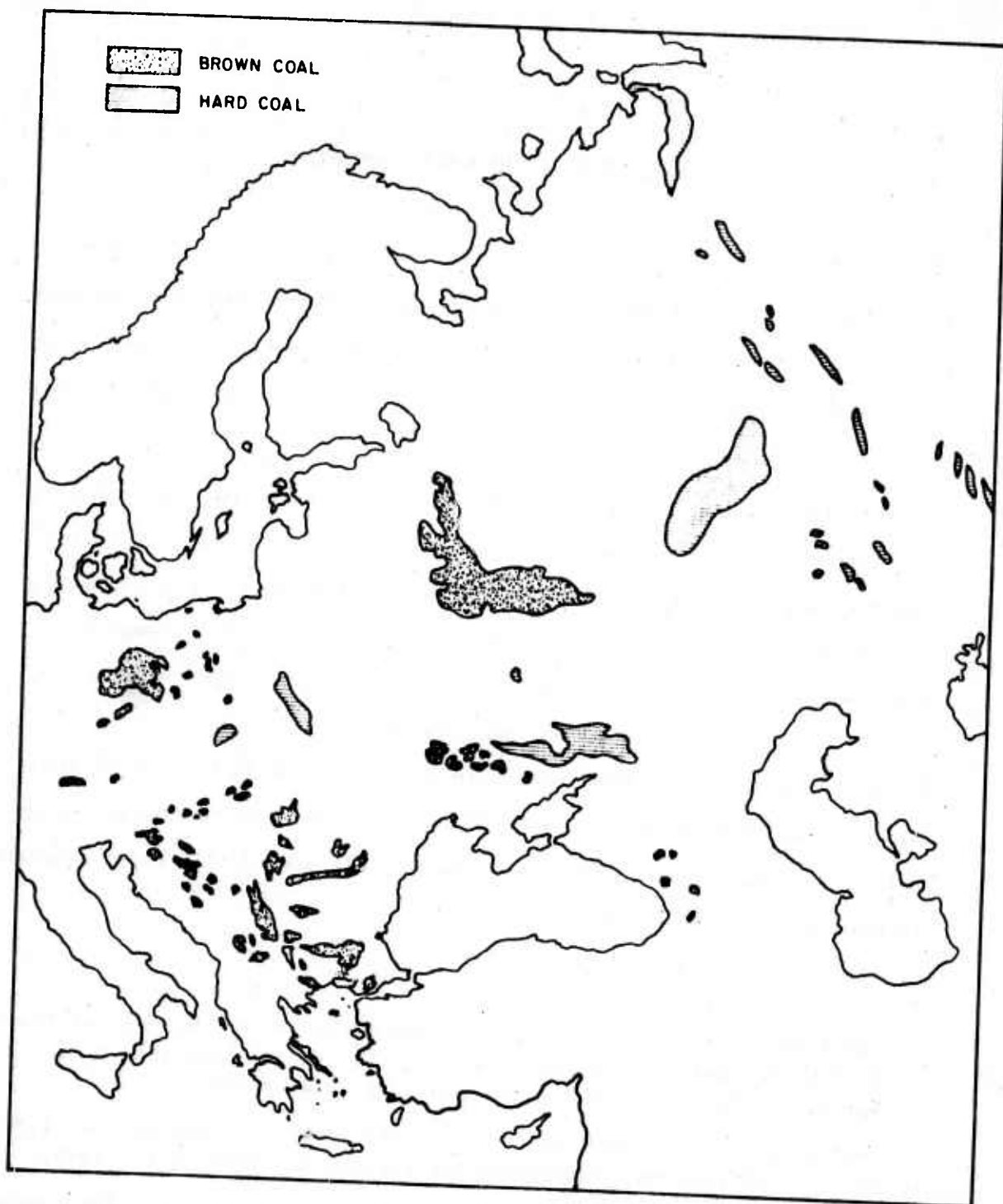


Figure B-9
COAL DEPOSITS IN EASTERN EUROPE

B. Coal Movement as Reflection of Resources and Demand

A widespread trade in coal among the countries of Eastern Europe has been established for many years. This trade includes both hard and brown coals, as well as lesser amounts of patent fuel, coke, and brown coal briquets. The complexities of this coal trade are often obscured by the manner of reporting data for type of coal or by country. Tables of statistics are useful, but frequently do not enable us to recognize the patterns of coal movement in trade. Accordingly, the statistics* were used to construct the coal movement chart shown in Figure B-10. The chart is organized to show the source of imports of coal to the countries of Eastern Europe, as well as the destination of coal exports from these countries. In the chart, items of particular interest can be investigated by following the flow lines for specific coal types to or from any particular country.

For example, the USSR is the second largest exporter of hard coal, most of which goes to Bulgaria, the German Democratic Republic (East Germany), and Czechoslovakia. Poland and Czechoslovakia are the next largest exporters of hard coal.

The German Democratic Republic is the largest importer of hard coal, receiving imports from the USSR, Czechoslovakia, the Federal Republic of Germany (West Germany), Poland, and others.

Coke is the next largest coal-related commodity traded in Eastern Europe. Most comes from the USSR, with important amounts from

* From United Nations, "Annual Bulletin of Coal Statistics for Europe, 1971," Vol. VI, UN Economic Commission for Europe, New York, N.Y., 1972. The data were checked against the annual statistics published by the individual countries.

Czechoslovakia and Poland as well. The principal destinations of this coke are the German Democratic Republic and Hungary.

In addition, however, coal is exported from the Eastern European countries to 21 other countries. In Western Europe significant quantities go to Austria; the Federal Republic of Germany, Denmark, Finland, France, and Italy also receive important quantities. Significant quantities also go to countries in Africa, South America, and Asia.

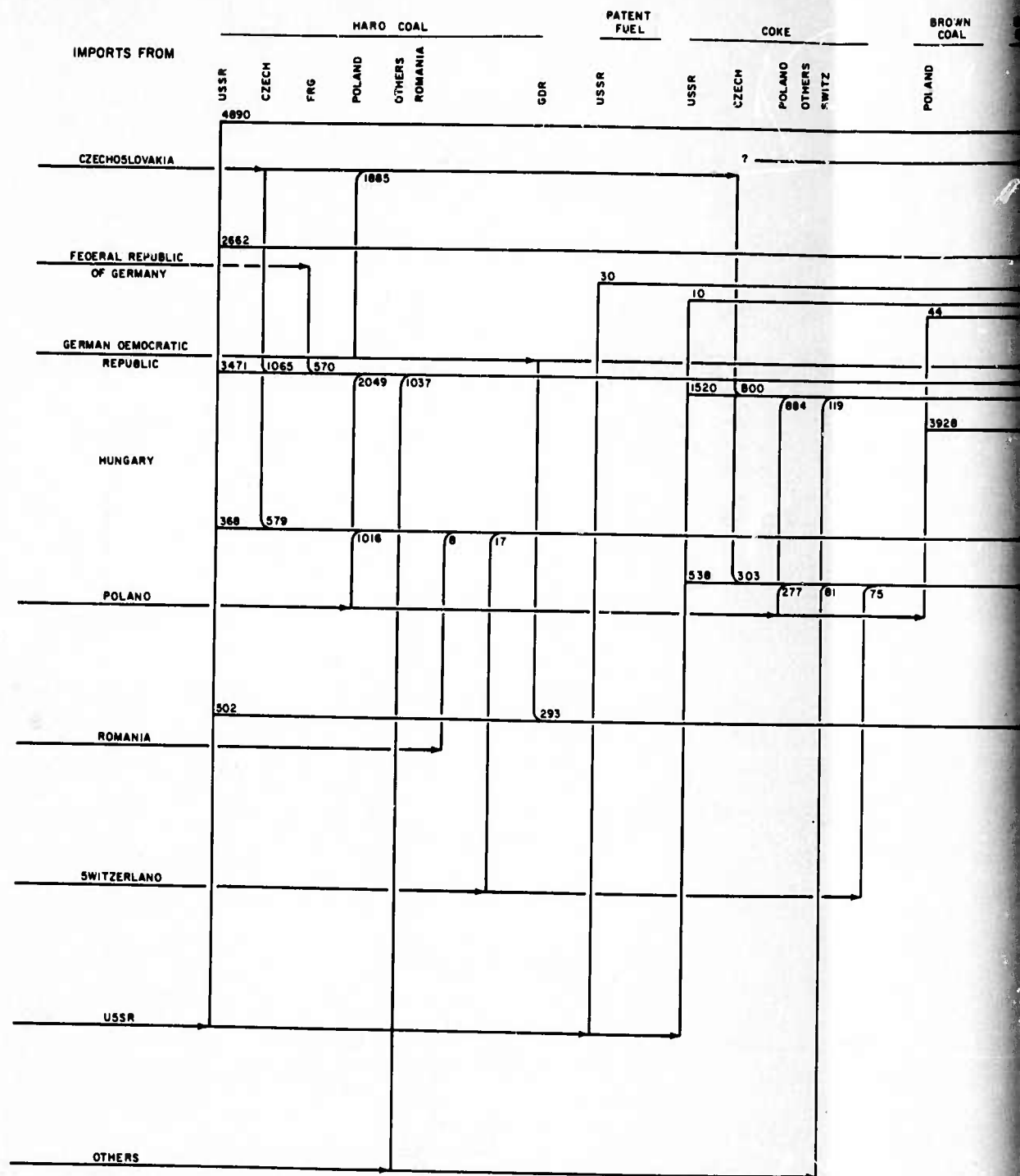
The principal use of Figure B-10 is that it simplifies identification of the main sources and destinations of coal and coal products among the trading partners involved. The patterns of trade are further indicative of the resource picture in each country. For example, as will be shown later, the German Democratic Republic lacks sizable reserves of hard coal. To support the needs of its iron and steel industry, it is therefore forced to import hard coal and coke from its neighbors. The same is true (but to a lesser degree) for Hungary. Most of these imports are from other CMEA countries. Thus, there appears to be an Eastern European steel-associated coal community as a counterpart to that of Western Europe.

C. Bulgaria

1. Coal Deposits of Bulgaria

The locations of Bulgarian energy resources are shown in Figure B-11. The principal resources are of lignite in the Maritsa Basin, although substantial deposits also occur in the vicinity of Sofia. The next largest deposits are brown coal, both in the Maritsa Basin and in the western uplands. There are also important hard coal deposits in the northern part of the Maritsa Basin.

Table B-47 shows the estimated coal resources of Bulgaria according to resource categories A + B + C. Most of the resources are



Source: United Nations, "Annual Bulletin of Coal Statistics for Europe," Vol. VI, UN Economic Commission for Europe, New York, N.Y., 1972.

* Except USSR = 1968 data

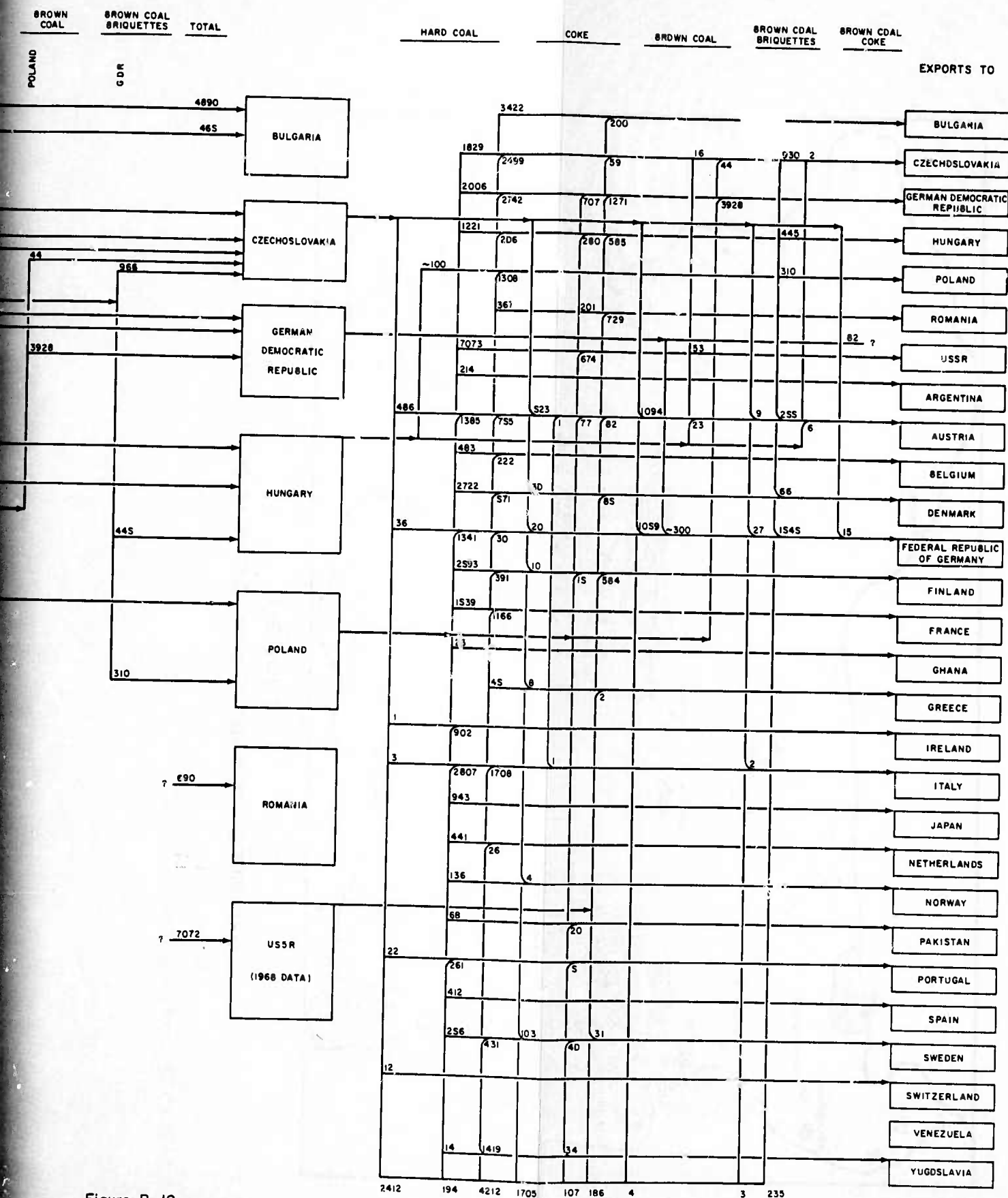


Figure B-10

EXPORT OF COAL IN EASTERN EUROPE, 1970*
(Thousand Metric Tons)

lignite, with the largest deposits being in the East Maritsa basin. These deposits are distributed in five main fields that are scattered throughout the country (refer to Figure B-9, given previously). The lignite seams occur at sufficiently shallow depths to permit surface mining, and occasionally reach about 12 feet in thickness.

The hard coal and brown coals of Bulgaria occur in the central part of the country. However, these coals occur as extensively folded and faulted seams, making mining difficult. Also, these coals are of poor quality, usually containing high quantities of refuse that must be removed by cleaning prior to their use.

It is likely that not all the estimated coal resources of Bulgaria will be developable and thereby recovered for use. However, because geological data on many of these deposits are incomplete, the probable recoverable reserves can only be estimated. Assuming that most future development effort will be concentrated in lignite and brown coal, that half of these resources will be amenable to surface mining, and that three-quarters of those resources can be recovered, we derive a total estimated recoverable reserve of about 1.7 billion tons for Bulgaria's coal deposits.

2. Coal Transport in Bulgaria

Most of the mineral and coking coal produced in Bulgaria comes from the Stara Planina basins near Sofia (1). See Figure B-12 for locations of Bulgarian cities by number. In 1970 about 1.2 million tons of mineral coal were mined in this region. The production of brown coal and lignite, which amounted to 28.9 million tons in 1970, is far more important as an energy fuel for Bulgaria's industries. The brown coal reserves are located in the Struma River basin and include the cities of Dimitrovo (2), Stanke Dimitrov (3), and Bresani (4). The

Table B-47

COAL RESOURCES OF BULGARIA

Basin	Area (km ²)	Depth (meters)	Resources (A+B+C) (Million Tons)			
			Hard Coal	Brown Coal	Lignite	C2
Svogensk	150	400	15	-	-	60
Zelenigrad	n.a.	n.a.	< 1	-	-	-
Balkansk	120	5-600	-	-	-	-
Dimitrovsk	70	n.a.	40	-	-	22
Bobovdolsk	n.a.	700	-	140	-	20
Pirinsk	n.a.	1500	-	120	-	20
Burgassk	n.a.	n.a.	-	20	-	20
East Maritssk	200	n.a.	-	32	-	20
West Maritssk	70	n.a.	-	-	-	8
Sophia	n.a.	n.a.	-	-	3,485	175
Belobrezhsk	n.a.	n.a.	-	-	203	40
Aldomirsk	n.a.	n.a.	-	-	305	700
Kyustendilsk	n.a.	n.a.	-	-	76.5	32.3
Staninsk	n.a.	n.a.	-	-	32.3	-
Chukurovsk	n.a.	n.a.	-	-	35	-
			-	-	41.8	-
			-	-	23.8	-
Total			56	312	4,202	1,097
						5,667

n.a. - not available.

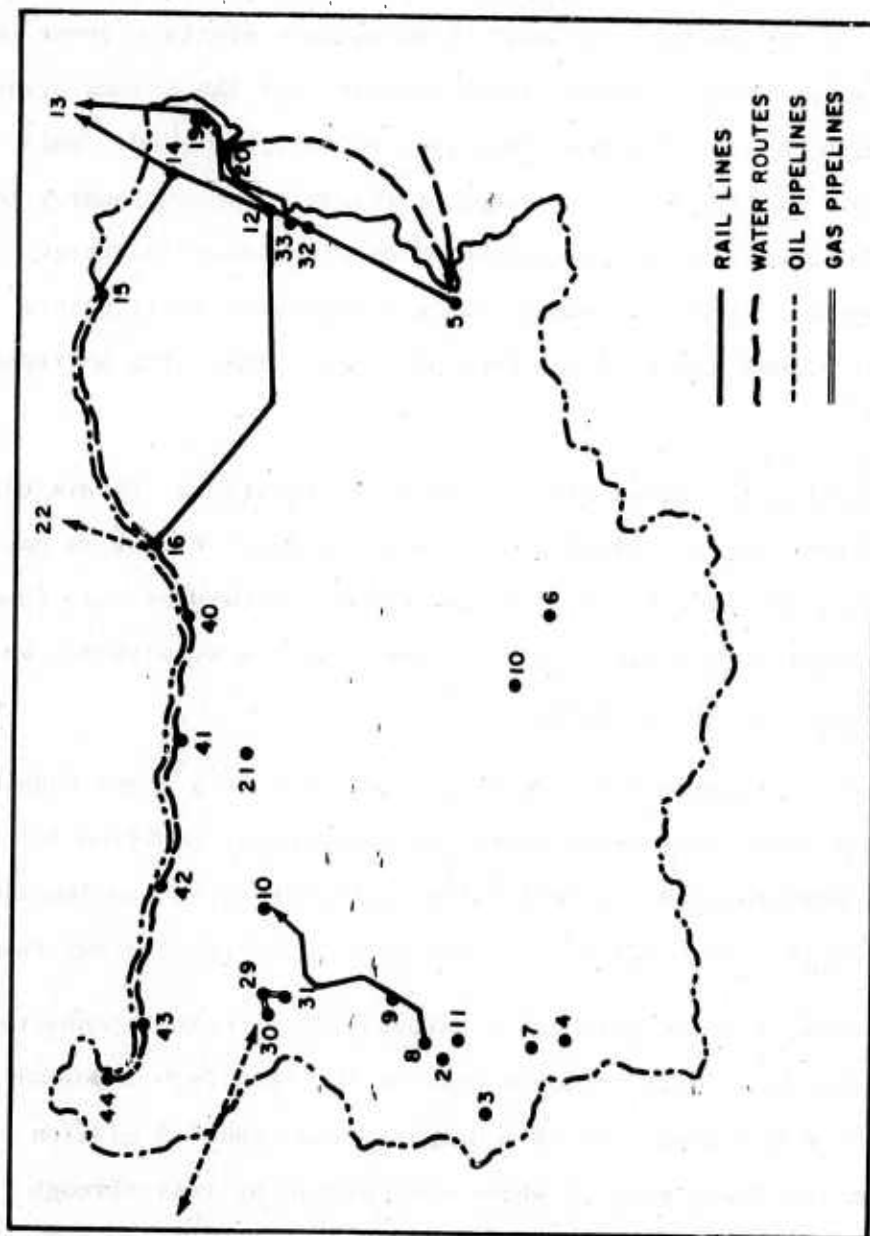


Figure B - 12
FUEL TRANSPORT IN BULGARIA

second major brown coal producing area is located near Burgas (5), a Black Sea port. The main lignite reserves are located in the Maritsa valley near Dimitrovgrad (6), in the Sofia basin, and in the lower Struma valley near Blagoyevgrad (7).

Most of the brown coal and lignite is used in thermal electric stations located in the basins, and most of Bulgaria's electric power is generated at plants in Dimitrovgrad, Sofia, Burgas, and the Struma River cities of Dimitrovo, Stanke Dimitrov, Bresani, and Blagoyevgrad. Bulgaria produced 19.5 billion kilowatt-hours of thermal electric energy in 1970. Most of the 2.2 billion kilowatt-hours of hydroelectric energy produced in Bulgaria in 1970 was generated in a number of small plants located along the Struma River in the Rhodope region, including Dimitrovo and Blagoyevgrad.

Bulgaria's major steel making plants are located at Pernik (8) --20 kilometers from the coal mines of Dimitrovo, to which Pernik is connected by rail--and Kremikovtsi (9), located 130 kilometers by rail from Dimitrovo. The steel plants use local iron ore mined in Kremikovtsi and in the Rhodope along the Struma River.

The Maritsa lignite field is also the center of a large copper industry and other nonferrous metal producing industries, centered in Plovdiv (10) and Dimitrovgrad. Cement works in Dimitrovgrad and Temelkovo (11), near Dimitrovo's brown coal fields, use local coal for thermal fuel.

Varna (12), a large port and a ship-building, cement producing, and textile manufacturing city, obtains most of its fuel from imported coal, primarily from the USSR. In 1970 Bulgaria imported 5.2 million tons of coal from the USSR, most of which was shipped by rail through Romania and then along the Constanta (13)-Tolbukhin (14) rail line to Tolbukhin (80 kilometers). From Tolbukhin, some coal was transported along the 80-kilometer Tolbukhin-Silistria line to Silistria (15); the

rest was transported 50 kilometers southward to Varna, from which some was sent by rail to Ruse (16), 200 kilometers from Varna. Silistria is a manufacturing and commercial-residential area, and Ruse is a Danube River port capable of handling tankers of up to 20,000 tons. Ruse is also a center for manufacturing industries associated with engineering, food processing, and machinery, particularly agricultural machinery.

3. Bulgaria Coal Production and Use

Figure B-13 is a schematic of production and consumption patterns of Bulgarian coal in 1971. This figure is based on data compiled by the United Nations; in keeping with U.N. practice, cleaned brown coal and lignite are lumped together. The figure shows that public thermal power plants were the largest single users of coal. Most of this coal was from domestic brown coal production, but imported hard coal made up about 14 percent of the total for power plants (representing roughly half the total imports). The next largest consumer was the industrial and construction sector, where the bulk of remaining hard coal imports were used, together with domestic brown coal. The rest of the coal imports were used for transportation and household purposes.

The above noted increase of production in recent years reflects the shift toward surface mining, especially in the lignite fields. The share of surface mining was only about 36 percent of total production in 1955, but rose to 66 percent in 1967, and further increases are projected. Although there are important mining difficulties in working the lignite deposits (such as low bearing capacity of soil, adhesion of clay to excavators, and landslides), the favorable low cost is encouraging, being only about one-fourth that of deep mining.

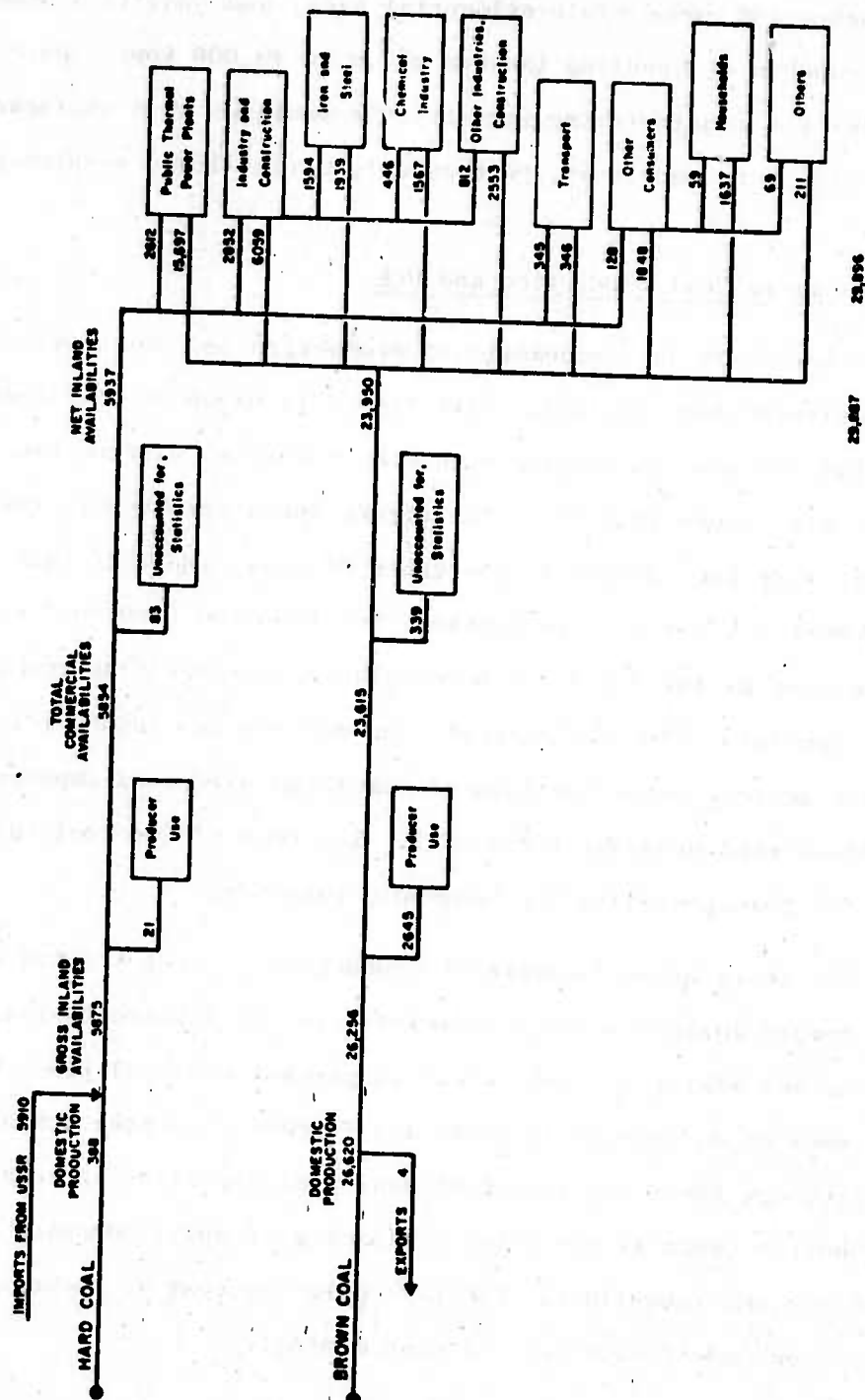


Figure B-13
 PATTERNS OF COAL PRODUCTION AND CONSUMPTION IN BULGARIA
 1971
 (Thousand Metric Tons)

D. Czechoslovakia

1. Coal Deposits of Czechoslovakia

Czechoslovakia may be divided geologically into two sections: the western section is rich in brown coal with lesser amounts of hard coal, while the eastern section is rich in hard coal.

Figure B-14 shows the locations of energy resources in Czechoslovakia. The principal source of bituminous coal is the Ostrava-Karvina Basin of northern Moravia. This basin is a continuation of Polish coal fields, and has produced roughly four-fifths of all Czechoslovakian hard coal. The total coal-bearing strata are nearly 4,200 meters thick, containing some 220 coal seams. The upper seams (Ostrava group) are thin, while the lower (Karvina) seams are thicker. Coal from this basin is noted for its high quality (low ash and sulfur) and is used for coking purposes. Smaller bituminous coal deposits occur in the Kladno, Plzen, Trutnov, and Rosice basins.

The largest brown coal deposits are in the Most basin of the northwestern part of the country. The seams vary in thickness, reaching 40 meters, with an average of 20 meters. The coal occurs under relatively shallow cover, and can be mined by surface, as well as deep, mining methods. Additional brown coal occurs in the Handlova basin of Slovakia, where deep mining of relatively thin seams is practiced to produce coal for power plant purposes.

There are many lignite deposits in several areas of Czechoslovakia, as shown in Figure B-14. These deposits are developed for local fuel and for power plant use.

Table B-48 presents a summary of the estimated coal resources of Czechoslovakia. Most of the resources consist of brown coal, with total estimated resources of about 15 billion tons; hard coal is a close

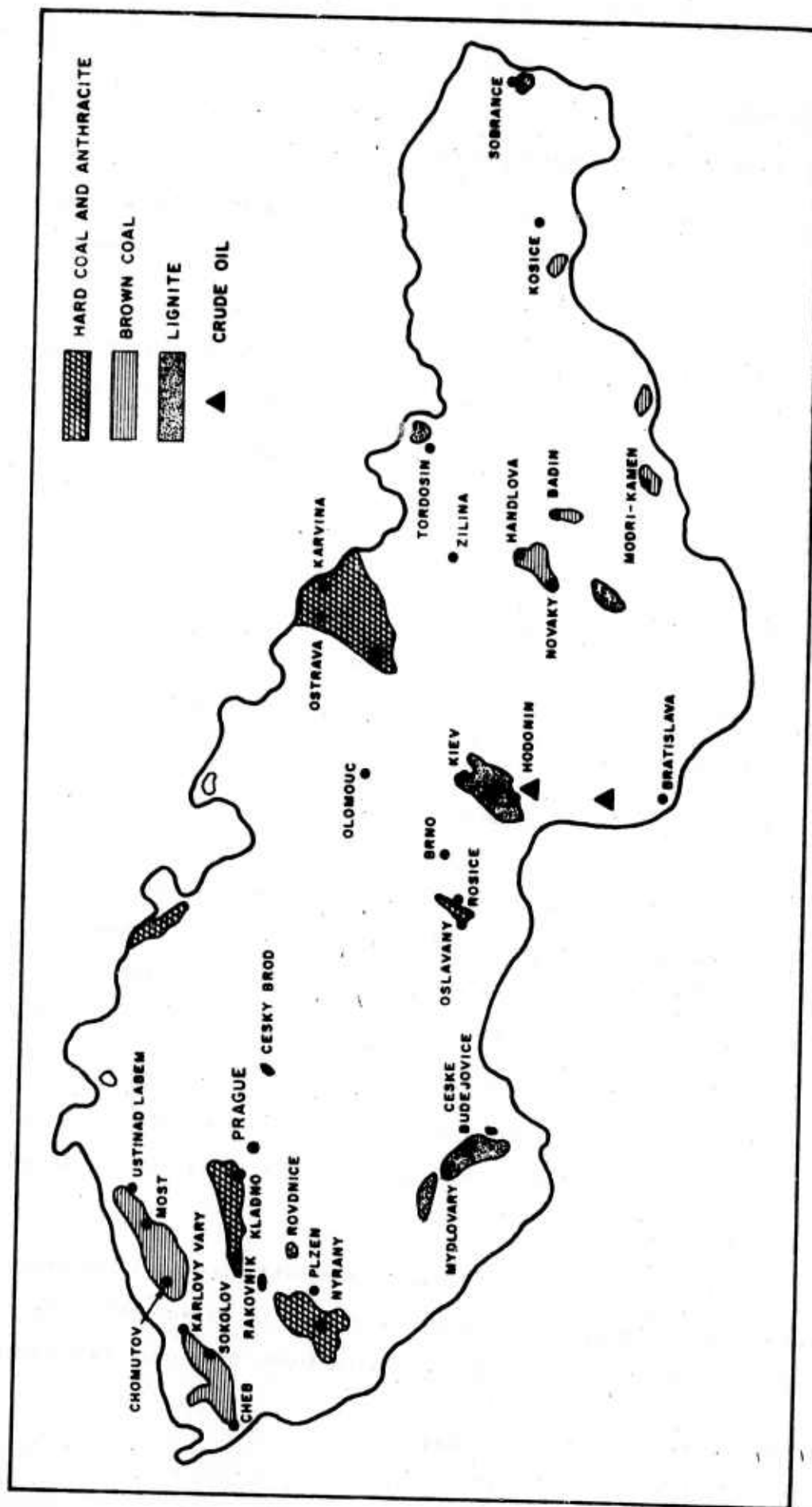


Figure B-14
DISTRIBUTION OF FUELS/ENERGY RESOURCES OF CZECHOSLOVAKIA

Table B-48

SUMMARY OF COAL RESOURCES
OF CZECHOSLOVAKIA - 1967
(Million Tons)

	<u>Proved</u>	<u>Possible</u>	<u>Total</u>
Hard coal	2,680	10,220	12,900
Brown coal	<u>4,676</u>	<u>10,055</u>	<u>14,731</u>
Total	7,356	20,275	27,631

second, with a total of nearly 13 billion tons. However, the proved reserves of hard coal are only about one-fifth of the total resources, while the proved reserves of brown coal are only about one-third of the total resources.

Assuming that proved reserves may be recoverable, the amount of recoverable reserves may be calculated by applying a factor to allow for mining recoverability. Hard coals are assumed to require mainly deep mining, with only about 50 percent recovery. On the basis of this assumption, the estimated recoverable reserve is about 1.4 billion tons. On the other hand, brown coals are assumed to be largely surface minable, with a recovery of about 75 percent, leading to an estimated recoverable reserve of about 3.5 billion tons.

2. Coal Transport in Czechoslovakia

Most of the 28.2 million tons of bituminous and all of the 81.3 million tons of brown coal produced in Czechoslovakia in 1970 were used in power plants or industrial plants within the vicinity of the various coal basins. About 24 million tons of the bituminous coal was

mined in the Moravian coal fields, which are an extension of the Upper Silesian coal fields of Poland. The Moravian coal fields center around Ostrava (1). See Figure B-15 for locations of Czechoslovakian cities by number. The chief industries in the Ostrava region consist of coke and byproduct processing, and iron and steel production.

Coking coal is transported by rail from Ostrava to the smaller steel plants of Kladno (2), 400 kilometers; Plzen (3), 460 kilometers; Brno (4), 250 kilometers; and Kosice (5), 300 kilometers.

The Kladno and Plzen fields supplied most of the remaining 4.2 million tons of bituminous coal produced in Czechoslovakia in 1970, and most of this coal was used for coking purpose in the steel plants of the two cities.

The most important brown-coal producing regions in the country are the Sakolov (6) and the Most (7)-Teplice (8) Basins in Northern Bohemia. Most of the 4 billion kilowatt-hours of electrical energy produced in Czechoslovakia in 1970 was generated in thermal electric stations in Northern Bohemia which were fueled by local brown coal. A few thermal electric generating plants are located in the Ostrava coal region, and about 10 percent or 400 million kilowatt-hours were produced in hydroelectric stations located along the Vah and Orava rivers in the Slovakian cities of Dolny Kubin (9) and Rusomberok (10).

The Northern Bohemian fields also contain an extensive chemical industry which, like East Germany's chemical industry, is based to a large extent on the manufacture of brown coal byproducts.

In 1970 Czechoslovakia imported 2.7 million tons of mineral coal from the USSR. This coal was transported 100 kilometers by rail from Uzhgorod (11) to the iron-ore mining and iron and steel making center of Kosice.

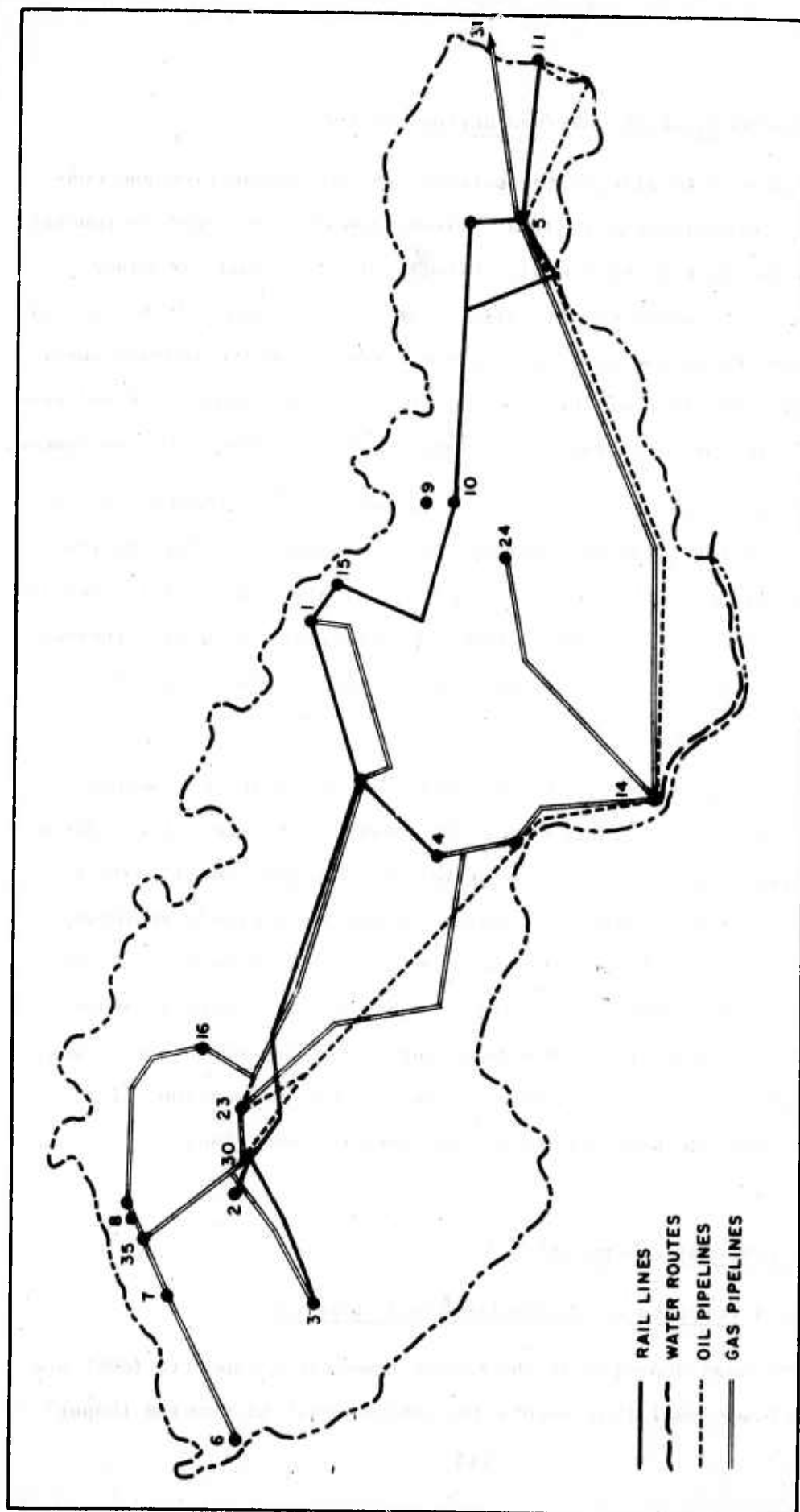


Figure B - 15
FUEL TRANSPORT IN CZECHOSLOVAKIA

3. Czechoslovakian Coal Production and Use

Figure B-16 illustrates patterns of coal production and consumption in Czechoslovakia in 1971. Production of brown coal is roughly three times as great as hard coal. Exports of brown coal are minor, with most being consumed domestically. The largest amount of brown coal (more than one-third the total production) goes to public thermal power plants, with about another third being used by "other industries and construction," and the remaining third being scattered among other consumers.

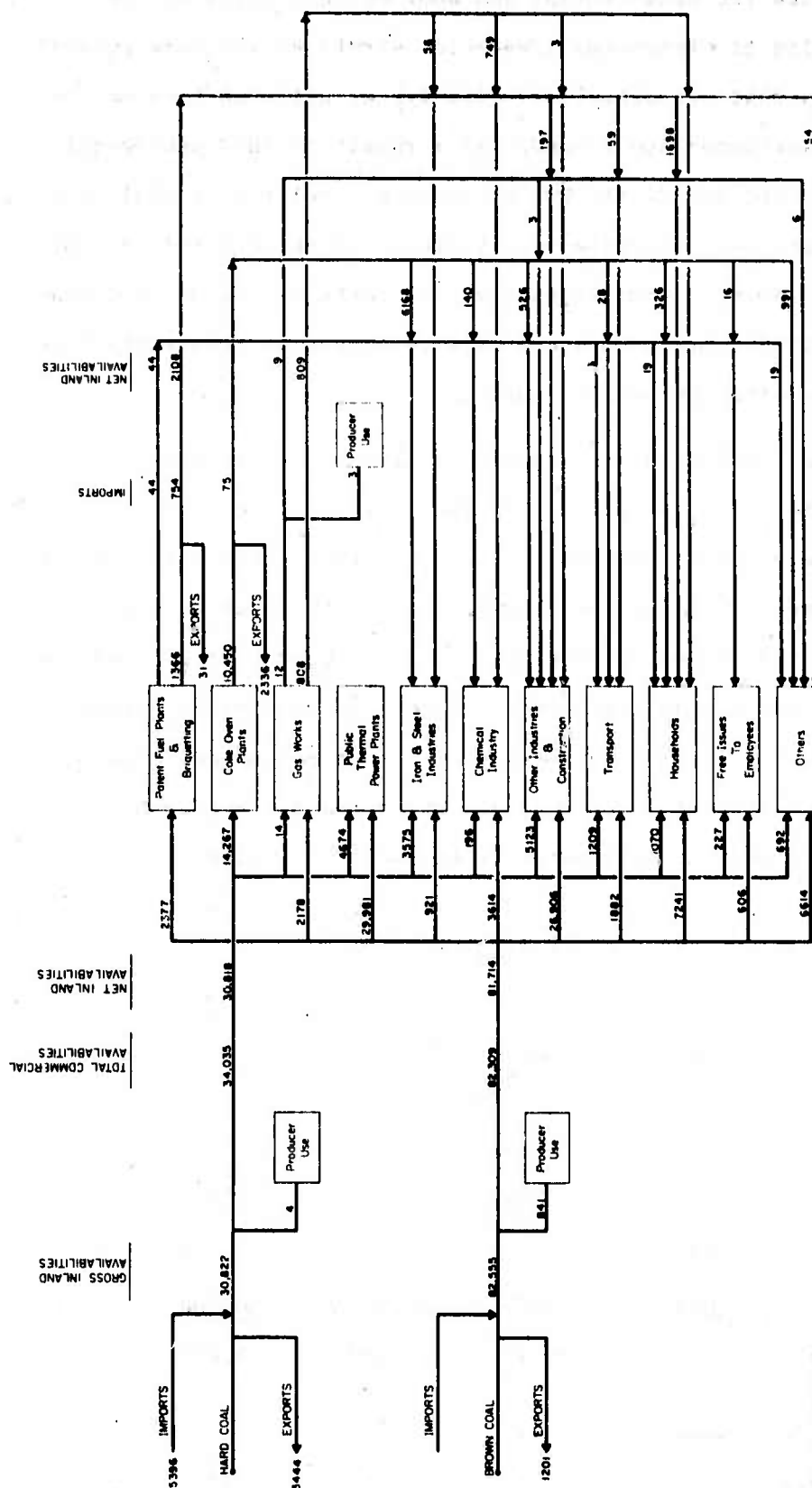
About 11 percent of hard coal production is exported. The remainder is used for domestic purposes, and is supplemented by imports (which typically exceed exports). Roughly half the hard coal is used in coke-oven plants, with the next largest amounts going to public thermal power plants, iron and steel industries, and other industries and construction.

Minor amounts of brown and hard coal are used in transport, households, and various other uses. The products of patent fuel plants, coke oven plants, and gas works are employed as supplemental fuels for other sectors. For example, the output of coke-oven plants represents an important additional input to the iron and steel industry, the char from gas works represents an important supply to the chemical industry, and briquettes represent a major added supply for household use. Thus, for a complete assessment of Czechoslovakian coal consumption, it is necessary to include both the direct and indirect coal uses.

E. German Democratic Republic

1. Coal Deposits of German Democratic Republic

The coal deposits of the German Democratic Republic (GDR) are principally brown coal that occurs in Carbonaceous and Permian (Upper



Source: United Nations

Figure B - 16
PATTERNS OF COAL PRODUCTION AND CONSUMPTION IN CZECHOSLOVAKIA
1971
(Thousand Metric Tons)

Paleozoic) strata in the east-central and southeastern parts of the country, and lignite of Cretaceous (Mesozoic) strata in the same general regions. These deposits are generally flat-lying, although they may be locally faulted, intruded, and eroded. As a result of this geological history, the coal deposits of the GDR are commonly relatively small and discontinuous; especially in comparison to those of the Federal Republic of Germany and the former German provinces now parts of Poland or Czechoslovakia. Much of this brown coal and lignite occurs in near-surface deposits that can be mined by surface methods.

The total estimated coal resources of the GDR are about 30 billion tons (Table B-49); nearly all of these are brown coal (Figure B-17). The recoverable resources (deposits occurring in thick beds sufficiently near the surface to permit surface mining) are estimated to be approximately equivalent to the proved reserves, or roughly 18 billion tons, occurring mainly in the southeastern area adjacent to the Polish border. As surface mining is contemplated for most of these resources, a recoverability of about 80 percent is assumed and the probable recoverable reserves of GDR brown coal are estimated to be about 14 billion tons.

Table B-49

SUMMARY OF COAL RESOURCES
OF GERMAN DEMOCRATIC REPUBLIC
(Million Tons)

	<u>Year</u>	<u>Proved</u>	<u>Possible</u>	<u>Total</u>
Hard coal	1956	50*	-	50
Brown coal	1964	<u>18,000</u>	<u>12,000</u>	<u>30,000</u>
Total		18,050	12,000	30,050

* Estimated.

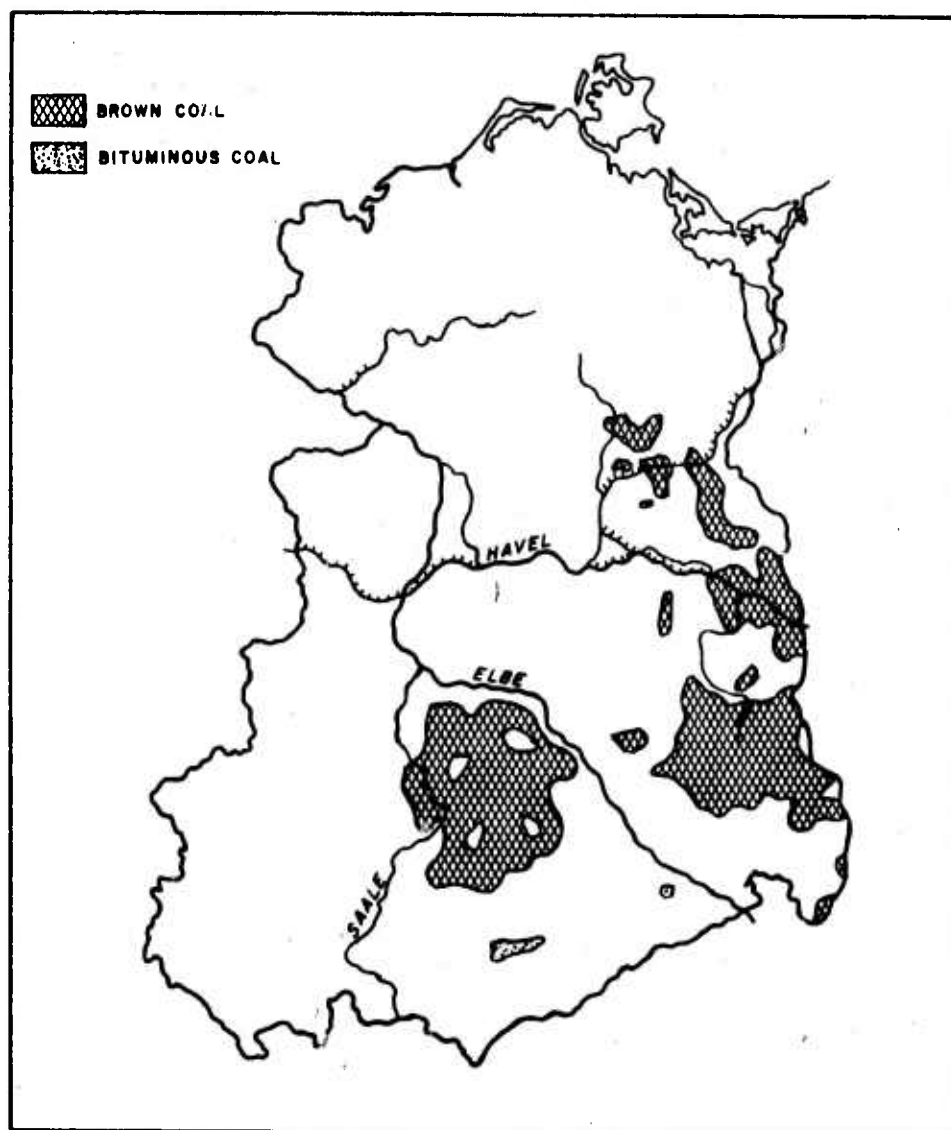


Figure B-17

COAL RESOURCES OF GERMAN DEMOCRATIC REPUBLIC

2. Coal Transport in the GDR

The principal bituminous coal basin in East Germany is located at Zwickau (1), which produced 1.1 million tons of mineral coal in 1970. See Figure B-18. Most of the coal produced in the GDR consists of brown coal which is mined in the Leipzig-Halle basin, particularly in the vicinity of Kothen (9), Leipzig (3), and Zeitz (4), and in the Lower Lausitz basin near Finsterwald (5), Cottbus (6), and Bautzen (7). East German brown coal productions in 1970 amounted to 280,582,000 tons, slightly over half of which came from the Lower Lausitz basin.

The 1.1 million tons of bituminous coal produced in Zwickau in 1970 was carried along the 80 kilometer electrified Zwickau-Dresden rail line to Dresden, where it was used both as heating fuel and coking coal in metallurgical plants; and a small amount continued along the 150 kilometer Dresden-Berlin line to East Berlin (9), where it was used in the GDR's only bituminous coal fueled electric power plant, the Klingenberg station in East Berlin.

Over 90 percent of the 67.3 million kilowatt-hours of electric power generated in the GDR in 1970 was produced in thermal electric stations fueled by brown coal, and almost all of these stations are located in the Leipzig-Halle and Lausitz coal basins.

The brown coal is compressed into coal briquettes at the mining site and then shipped by rail and the Elbe River to electric power plants within the area--generally over distances of no more than 100 kilometers. Dresden, Leipzig, and Halle (10) are major coal-holding rail stations, and the river port of Riesa (22) on the Elbe handles primarily local brown coal traffic.

Some of the coal near Finsterwald (5) is shipped along a 40 kilometer electrified rail line to Schwarze-Pumpe (12), where it is converted into synthetic gas, motor oil, and other manufactured byproducts.

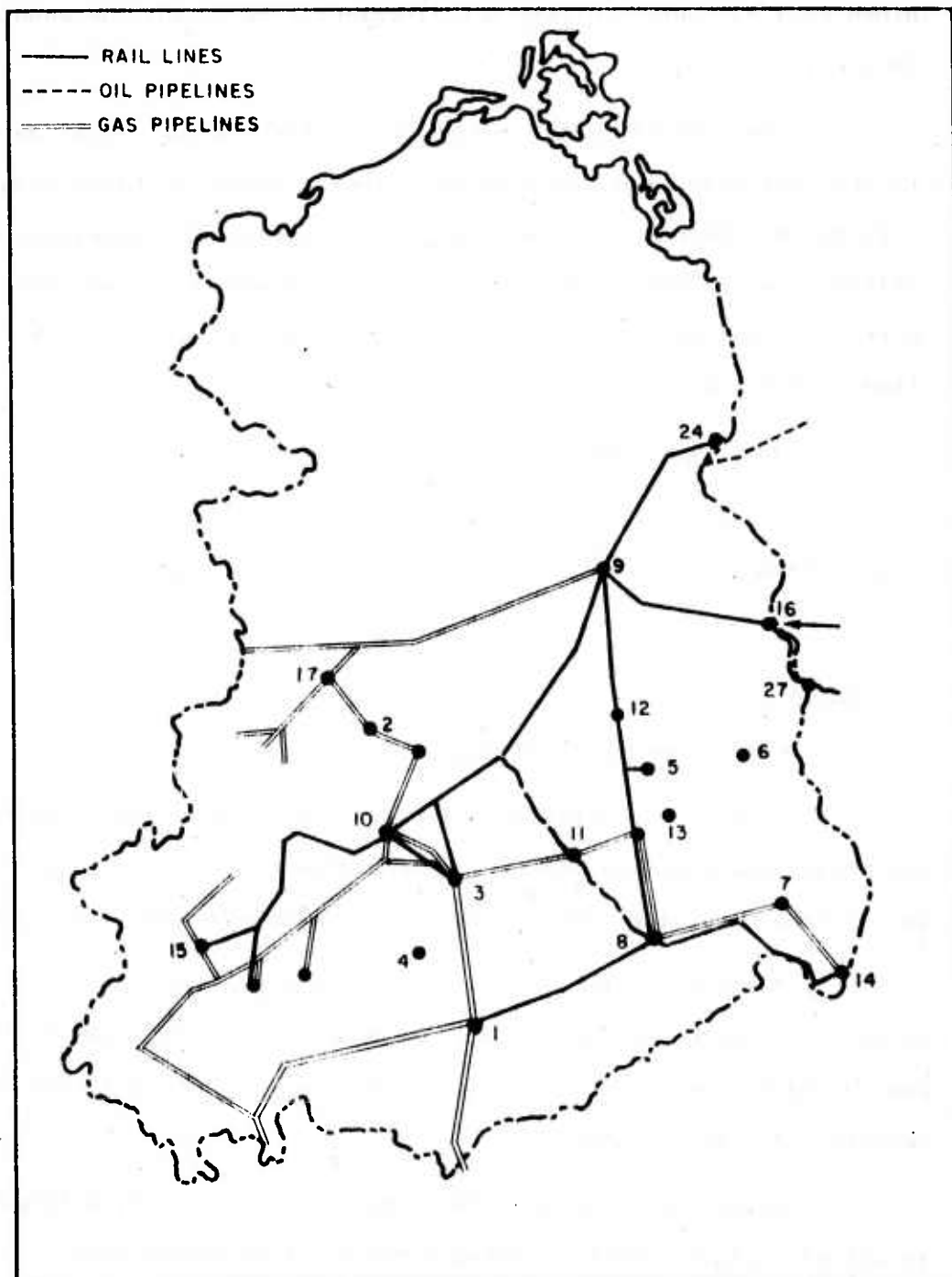


Figure B-18
FUEL TRANSPORT IN GERMAN DEMOCRATIC REPUBLIC

At Lauchhammer (13), which is situated in the Lausitz brown-coal basin, brown coal is converted into metallurgical coke as well as manufactured fuel oil.

The metallurgical plants at Frankfurt-am-Oder (13) and Eisenhuttenstadt (14) also import mineral fuel. Brown and bituminous coal imports from Poland (via the Elbe River) amounted to approximately 8 million tons in 1970, and bituminous coal imports from the USSR, transported by rail through Poland to Frankfurt-am-Oder, amounted to 3.3 million tons in the same year.

3. GDR Coal Production and Use

Almost all East German production is brown coal, with very minor amounts of hard coal. Table B-50 shows coal and coke production.

F. Hungary

1. Coal Deposits of Hungary

Hungary has relatively small scattered deposits of bituminous and sub-bituminous coal and lignite. These deposits occur in strata ranging in age from Carboniferous (Paleozoic) to Cretaceous (Mesozoic) and Tertiary.

Table B-51 shows estimated coal resources of Hungary as of 1967. Relatively little coal has been developed to the stage where they are considered proved resources; most of Hungary's coals are in the less certain "possible" category.

Brown coal comprises the largest coal resource of Hungary, with relatively little hard coal being present. Proved resources of brown coal are only about 13 percent of the total estimated brown coal resources. Assuming that these reserves are recoverable and that mining recoverability is about 75 percent, then the estimated recoverable reserves will be roughly 1.3 billion tons. For hard coal, assuming that the proved

Table B-50
COAL AND COKE PRODUCTION IN GERMAN DEMOCRATIC REPUBLIC
(Thousand Tons)

	1946	1950	1955	1960	1965	1969	1970	1971
Hard Coal		2,805	2,682	2,721	2,212	1,334	1,049	
Imports (including anthracite)				8,135	9,464	6,750	8,192	7,953
Hard coal coke			2,705	3,206	3,209	2,391	2,572	2,316
Hard coal coke imports				2,527	3,205	2,777	3,123	3,045
Brown Coal	108,400	137,050	200,612	225,465	250,839	254,553	260,582	262,814
Brown coal briquets				56,047	60,380	56,869	57,078	55,439
Brown coal exports	29,000	37,697	50,967	6,339	5,962	3,509	3,786	2,760
Brown coal coke								
Low temperature			6,368	6,691	6,291	5,334	4,968	4,415
High temperature			458	1,008	1,051	1,100	1,308	1,759

reserves are recoverable and that mining recoverability is about 50 per-cent, the estimated recoverable reserve will be roughly 0.05 billion tons.

Table B-51
SUMMARY OF COAL RESOURCES
OF HUNGARY--1967
(Million Tons)

	<u>Proved</u>	<u>Possible</u>	<u>Total</u>
Hard Coal	95.2	1,077.2	1,172.4
Brown Coal	<u>1,751.1</u>	<u>10,592.3</u>	<u>12,343.4</u>
Total	1,846.3	11,669.5	13,515.8

2. Coal Transport in Hungary

All of the 4.2 million tons of bituminous coal and the 1.2 million tons of coking coal produced in Hungary in 1970 were mined in the Mecsek region near the city of Pecs (1), an engineering, leather, and woodworking center. See Figure B-19. All of the coking coal and most of the bituminous fuel coal is transported by rail to the new (post-World War II) iron and steel-making complex at Dunaujvaros (2)--a distance of 100 kilometers by rail. The remainder is transported 160 kilometers by rail to Budapest (3), another steel-making center and the capital of Hungary, and Ozd (4) and Diosgyör (5), whose iron and steel-making industries date back to the 19th century.

Ozd and Diosgyör are situated near iron ore deposits, but these cities and Dunaujvaros must import iron ore from the USSR and coal from the USSR and Poland. Coal imports from Poland's Upper Silesian fields amounted to 2.5 million tons in 1970, and those from the USSR, to 937,000 tons. The Polish coal entered Hungary by rail at Ozd, on the Czech-Hungarian border and at Esztergom (55), which is 30 kilometers northwest of Budapest. From Budapest the coal continued 50 kilometers

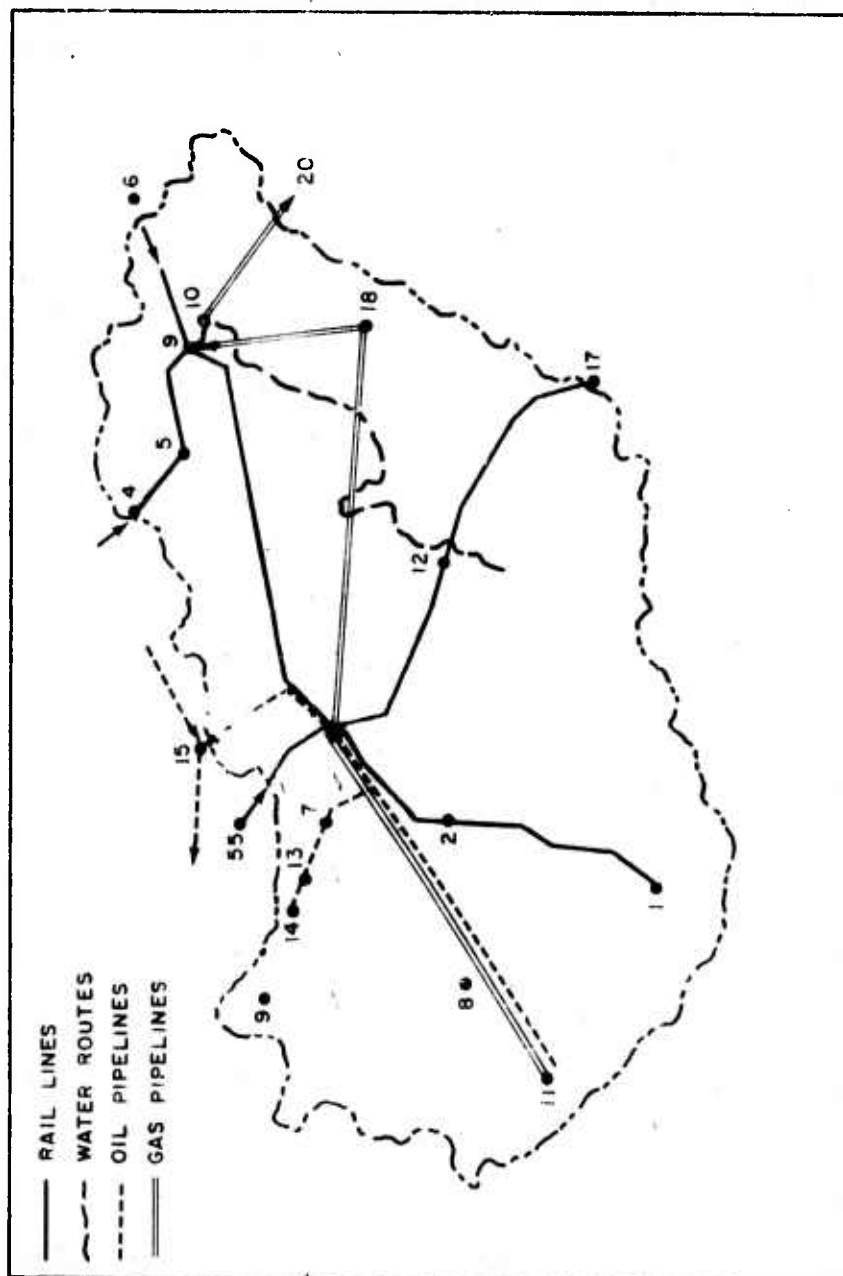


Figure B - 19
FUEL TRANSPORT IN HUNGARY

southward by rail to the metallurgical plant complex at Jánaujváros. Soviet coal entered by rail from Mukachevo (6) from where it was transported 150 kilometers to Kiosgyör and Ozd.

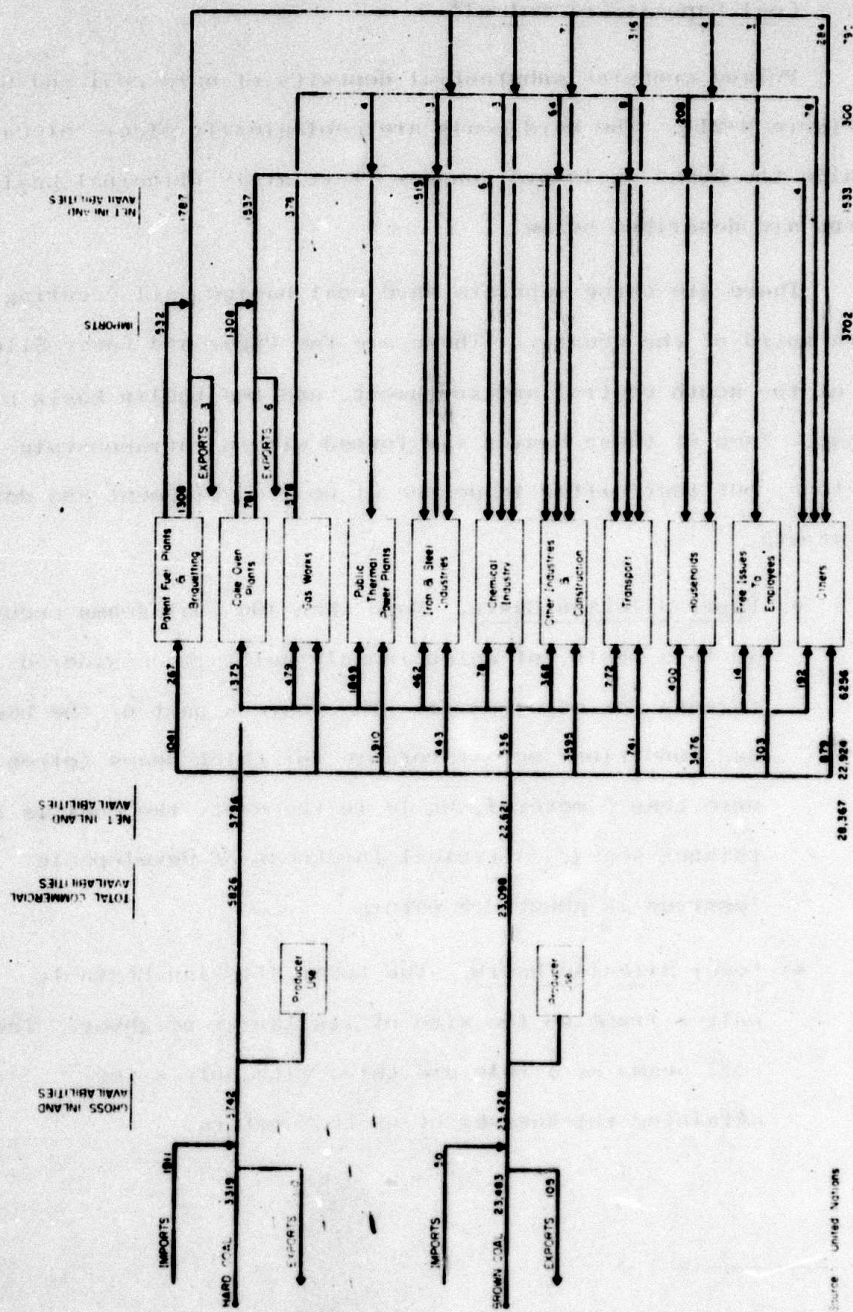
The 23.7 million tons of brown coal produced in Hungary in 1970 was from the western coal basin stretching along a 75 kilometer line from Tatabánya (7) almost to Ajka (8). The brown coal in this region is used in electric power plants largely utilized by the local aluminum smelting industry located in the coal basin. This basin is also an area with heavy deposits of bauxite, and is centered in the cities of Ajka, Tatabánya, Almásfüzitő (13) and Mosonmagyaróvár (9). Hungary produced 14.5 billion kilowatt-hours of thermal generated electrical energy in 1970. Most of the 8.2 million kilowatt-hours of hydroelectric energy produced in 1970 was generated by the Tokaj (10) plant on the Tisza river.

3. Coal Production and Use in Hungary

Figure B-20 illustrates patterns of coal production and consumption in Hungary as of 1971. Brown coal constitutes most of the total production, nearly all of which is used for domestic purposes with relatively few exports. Most brown coal is used in public thermal power plants, with the next largest consumers being other industries and construction and households.

Imports of hard coal equivalent to approximately half the total domestic production are required to augment domestic supplies. Most hard coal is used by public thermal power plants, coke oven plants, transport, iron and steel industries, and gas works.

An indirect fuel supply is represented by the output or by-products from patent fuel plants, coke oven plants, and gas works. These fuels are used mainly in iron and steel industries and households, although smaller amounts are used by various other consumers.



G. Poland

1. Coal Deposits of Poland*

Poland contains substantial deposits of hard coal and brown coal (Figure B-21). The hard coals are geologically older, of Carboniferous age, while the brown coals are younger (Tertiary). Principal basins for each type are described below.

There are three separate hard coal basins, all occurring in the southern third of the country. These are the Upper and Lower Silesian Basins of the south central and southwest, and the Lublin Basin of the southeast. Each of these basins was formed within intramountain depressions, but they differ in degree of coal development and deformation of the strata.

- Upper Silesian Basin. More than 400 coal seams occur in this basin, of which roughly half are considered targets for development. The western part of the basin had conditions more favorable for thick seams (often more than 5 meters), while in the east, the coal is in thinner seams. A typical thickness of developable reserves is about 0.8 meters.
- Lower Silesian Basin. The Lower Silesian Basin is only a fraction the size of its larger neighbor. The coal seams as a rule are thin, with only a few attaining thicknesses of up to 2 meters.

* M. Tyska, Editor. Mineralogenic Atlas of Poland (Poland Geological Institute, 1970).

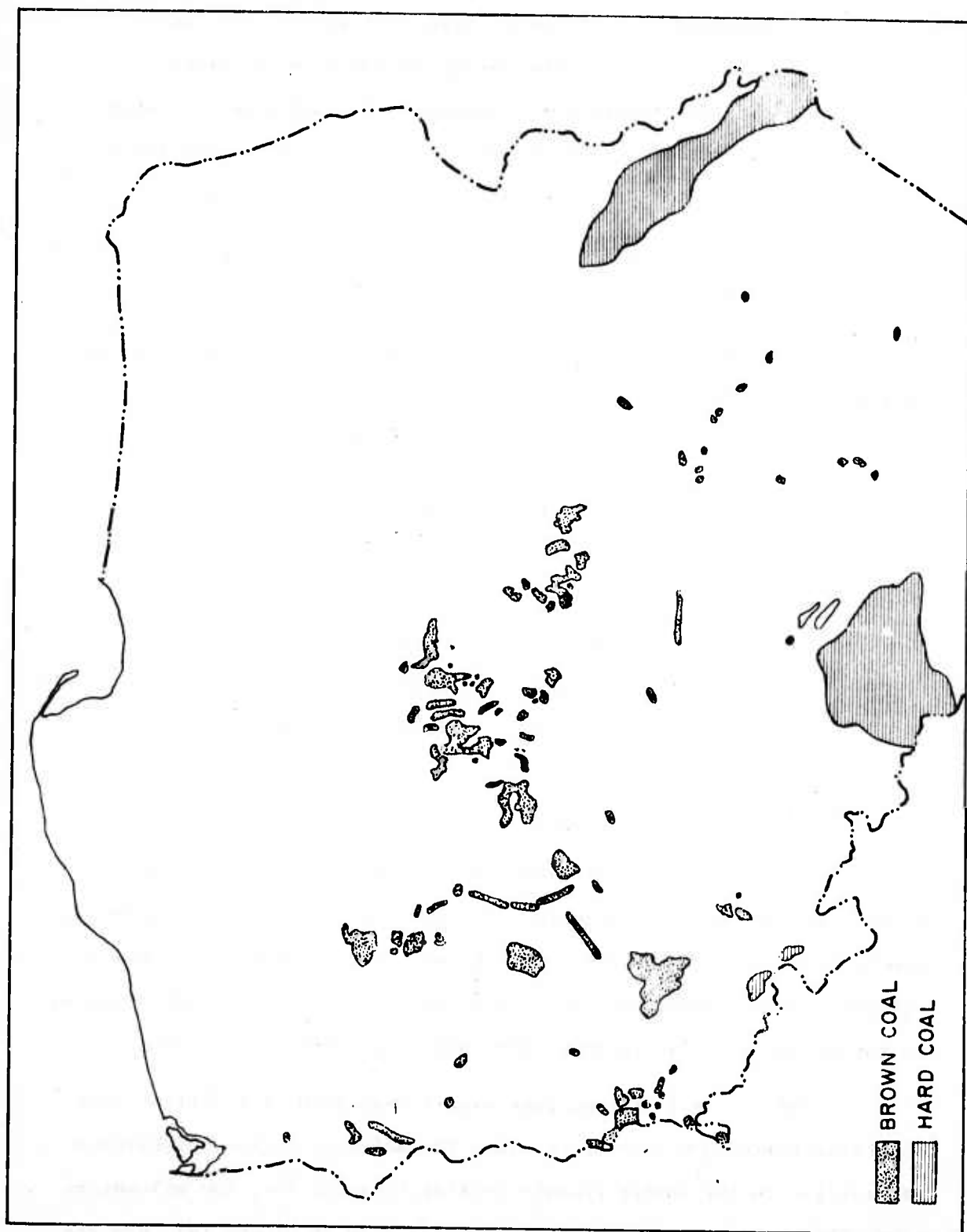


Figure B-21
COAL RESOURCES OF POLAND

- Lubin Basin. The Lubin Basin has been less completely explored than the other hard coal basins. In the examined part of the basin, the beds are inclined slightly toward the southwest. This appears favorable for ultimate development of these deposits. The Lubin Basin contains several types of brown coal deposits.

Brown coal deposits are located in several areas of the central, west central, and southwestern part of Poland.

Table B-52 presents a summary of Poland's coal resources as of 1967, and Table B-53 presents the resources by basin.

Table B-52
SUMMARY OF COAL RESOURCES
OF POLAND--1967

	<u>Proved</u>	<u>Possible</u>	<u>Total</u>
Hard Coal	11,841	93,522	105,363
Brown Coal	<u>3,819</u>	<u>15,040</u>	<u>18,859</u>
Total	15,660	108,562	124,222

2. Coal Transport in Poland

The principal coal fields of Poland are located in Upper Silesia in the region of Katowice (1), and a minor base is situated near Wroclaw (2) in Lower Silesia. (See Figure B-22.) Most of the 140.1 million tons of bituminous and 32.8 million tons of brown coal produced in the Silesian fields in 1970 were used within Poland's borders.

Of the 28.8 million tons exported in 1970, 7.1 million tons were transported 300 kilometers along the Katowice-Krakow (3)-Przemysl' (4) railine to the Soviet freight station Mosteska (5); 600 kilometers along the Wroclaw-Warsaw (6)-Beatystok (7) line to Grodno (8), and the Katowice-Warsaw-Grodno line; and 500 kilometers along the Katowice-Warsaw-

Table B-53

COAL RESOURCES OF POLAND
BY BASIN

Basin	Area (km ²)	Depth (Meters)	Resources (BILLION TONS)		
			Hard Coal	Brown Coal	Total
Upper Silesia	4,500	1,000	95.2	-	95.2
Lower Silesia	n.a.	n.a.	0.89	-	0.89
Southwest					
Turuv	48	n.a.	-	*	*
Legnits	100	150-180	-	2.4	2.4
Sinava	45	100-200	-	1.0	1.0
Mosty	n.a.	70-80	-	0.18	0.18
Muzhakuv	n.a.	n.a.	-	0.09	0.09
Gubin City	n.a.	n.a.	-	0.20	0.20
Western					
Tsybink	n.a.	60-100	-	0.13	0.13
Tshtsyanka	n.a.	46	-	0.22	0.22
Central and Eastern					
Koninsk	n.a.	20-50	-	0.40	0.40
Adamuvsk	n.a.	50	-	0.17	0.17
Vladislavuv	n.a.	25-30	-	0.05	0.05
Kozhmin	n.a.	30-40	-	0.06	0.06
Rogozno	19	170	-	0.70	0.70
Belkhatuv	120	> 200	-	2.0	2.0
Zlochev	15	200	-	0.26	0.26

n.a. - not available

* Undetermined amount being worked by large mines.

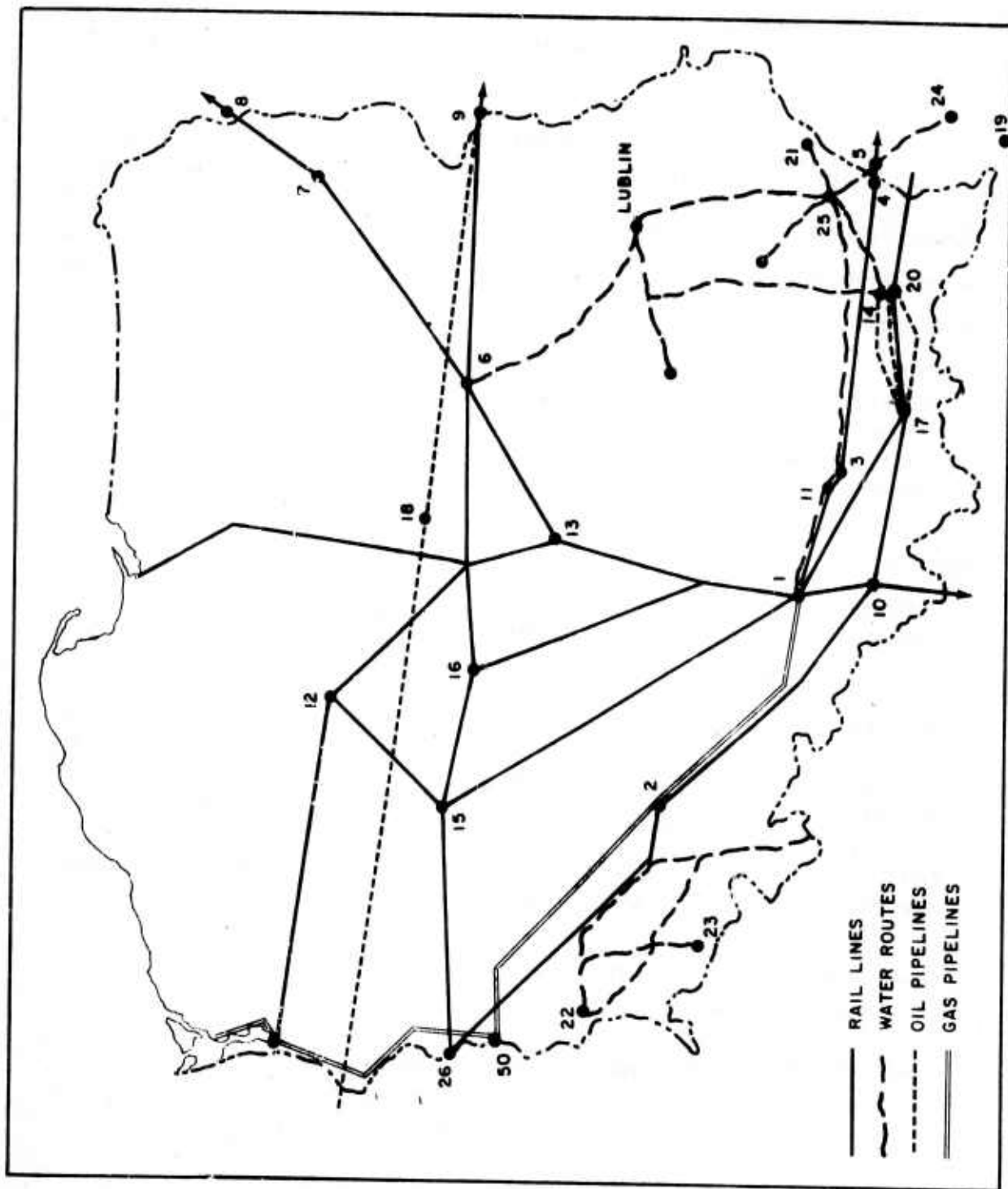


Figure 9-22
FUEL TRANSPORT IN POLAND

Brest (9) line. The total delivered cost of this coal to the USSR in 1970 was 98.0 million rubles.

Roughly 4.0 million tons of brown coal, in addition to several million tons of bituminous coal, were transported 450 kilometers by river barge up the Oder river-Gliwice Canal system to Eisenhüttenstadt (50) and Frankfurt-am-Oder (26) in the German Democratic Republic, where it was used as fuel and some was converted to coke in local metallurgical plants. The remainder of Poland's exported coal was sent south along the 100 kilometer Katowice-Bielsko Biala (10) line to Czechoslovakia, Hungary, and Austria.

Internally, most of the coal is burned in power stations and industrial boilers in Katowice and the other smaller cities that form the Upper Silesian metallurgical complex.

Coal is also transported by rail to Nova Huta (11) (50 kilometers), a large steel-making complex using Silesian iron ore as well as imported USSR iron ore; to Warsaw (6) (325 kilometers), a center of iron and steel making, transport machinery production, the thermal electric power as well as the national capital; to Bydgoszcz (12) (475 kilometers), a paper and wood manufacturing center; to the chemical, textile, and electric power producing cities of Lodz (13) (200 kilometers) and Wrocław (14) (200 kilometers); and finally to Poznań (15) (350 kilometers), a major city for engineering and electric power production.

The largest thermal electric power plant is located at Konin (16), about 325 kilometers from Katowice, from which coal is sent by rail to Konin. Twenty-nine percent of the 13,900 megawatts of energy produced in Poland's 384 electric power plants in 1970 was generated by 30 large plants of 100 megawatt or greater capacity. The average expenditure in 1970 for one kilowatt-hour of generated electricity amounted to 14.9 pounds of coal. Sixty-nine percent of the electric energy produced in 1970 was used by industry.

In 1970 Poland imported 446 million kilowatt-hours of electricity, of which 333 million were transmitted along 500 kilovolt transmission lines running from the Southern Regional Unified Energy System of the USSR at Mukachevo (19). Poland's total cost of imported Soviet electricity that year was 3.7 million rubles.

3. Polish Coal Production and Use

Figure B-23 shows patterns of coal production and consumption in Poland for 1971. Four-fifths of total production was hard coal. (See also Table B-54.) Exports amounted to about 20 percent of hard coal production, greatly in excess of imports. The main uses of hard coal were for public thermal power plants, other industries and construction, and coke oven plants. Smaller, but important amounts of hard coal were used by the chemical industry, transport, the iron and steel industry, gas works, and patent fuels plants.

Brown coal was used primarily by public thermal power plants, which accounted for about 80 percent of total domestic production (Table B-55). About 10 percent of the total production was exported. Lesser domestic uses for brown coal included patent fuel plants and households.

Byproduct or processed fuels derived from coal represent an important supplementary source of energy, especially for the iron and steel industry, other industry and construction, and households.

The largest single coal use in Poland is for generation of electricity by thermal power plants. In 1971, these plants used 53.4 million tons of hard and brown coal.

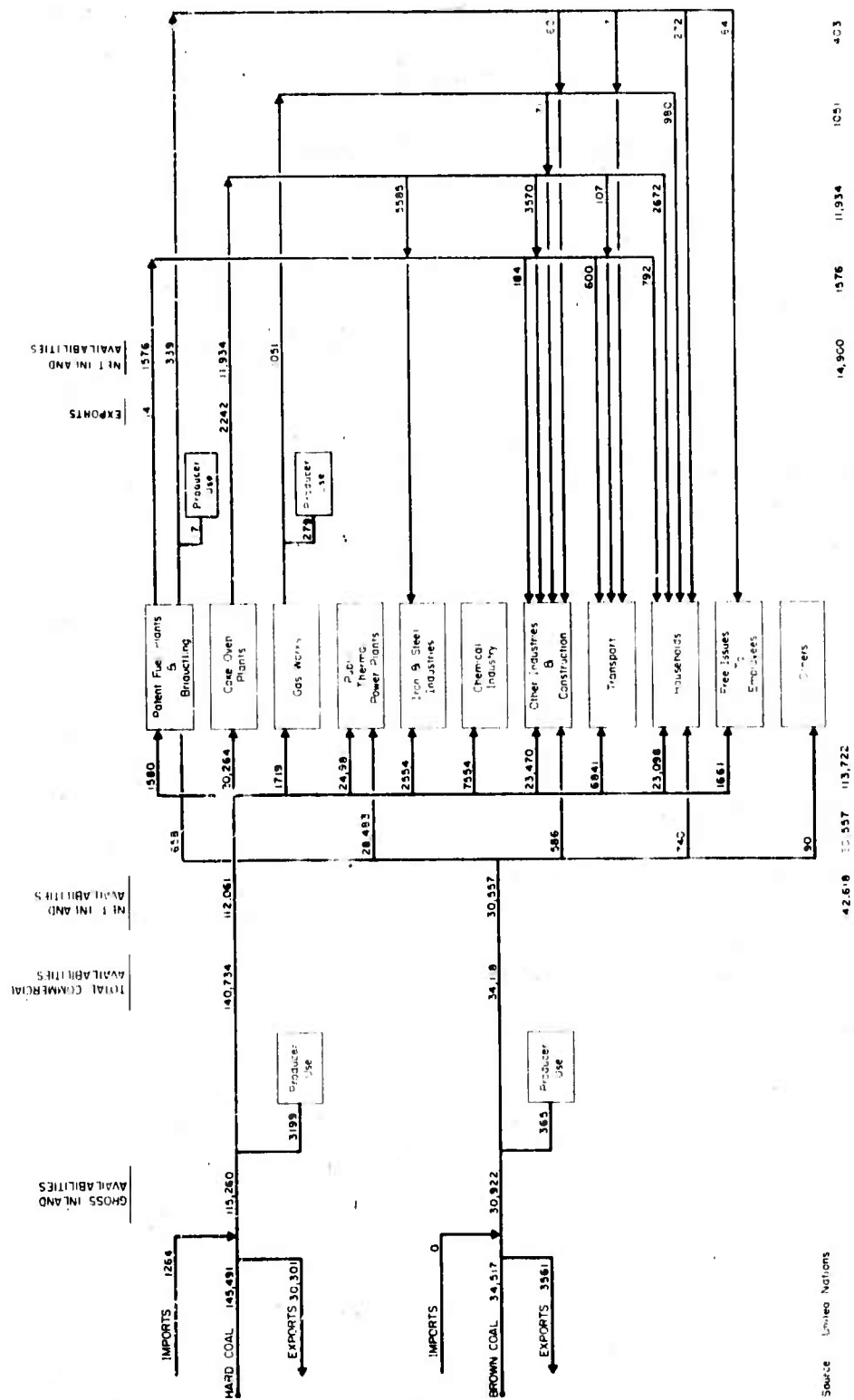


Figure B-23
PATTERNS OF COAL PRODUCTION AND CONSUMPTION IN POLAND

Table B-54

POLAND: HARD COAL PRODUCTION
(Million Tons)

	<u>1950</u>	<u>1960</u>	<u>1965</u>	<u>1970</u>	<u>1971</u>
East	4.1	8.8	9.8	12.3	12.6
N.E.	9.2	14.6	16.6	19.1	19.3
Central Gorny Slask	28.9	41.5	47.7	53.5	54.7
Southern Gorny Slask	9.0	12.9	17.1	26.5	28.7
Western Gorny Slask	23.1	23.5	21.1	25.3	26.6
Walbrzych and Nowa Ruda	<u>3.7</u>	<u>3.1</u>	<u>3.2</u>	<u>3.4</u>	<u>3.6</u>
Total	78.0	104.4	118.8	140.1	145.5
Imports	-	.776	1.21	1.095	1.264
Exports	26.6	17.5	21.0	28.8	30.3
Percent of Production					
From walls	43.4%	60.0%	71.7%	80.9%	82.0%
From drifts	21.1	17.2	10.9	8.2	7.5
Raised by Hydraulic					
Filling (percent)	20.7	34.9	11.3	11.2	38.5
Roof Falling	-	-	43.7	47.1	50.2
Graded Coal	88.0	95.9	98.0	99.1	99.2
Mechanical Mining					
from Forefields	33.1*	51.7	66.6	83.2	85.9

* 1951.

Table B-55

POLAND: LIGNITE (BROWN COAL) PRODUCTION DATA

	<u>1950</u>	<u>1960</u>	<u>1965</u>	<u>1970</u>	<u>1971</u>
Production (thousand tons)	4,836	9,327	22,626	32,766	34,517
Exports	3,726	5,455	5,199	3,972	3,561
Imports	-	-	-	-	-
Total Number of Mines	9	7	9	8	9
Deep Mines	6	5	3	2	2
Total Employment (thousands)	3.4	5.6	13.2	13.1	13.7
Manual Workers	3.0	4.9	11.6	11.1	11.7
Production Per Man-Shift in Open Cast Mines (tons)	15.83	17.55	13.76	21.65	21.80
Coal in % of Total Production					
Open Cast Mines	87.0%	93.4%	97.3%	98.8%	98.7%
Graded Coal	-	20.8	9.8	7.9	8.6
Mechanical Mining and Loading (percent)	84.6%	93.4%	97.1%	98.4%	98.6%

II. Romania

I. Coal Deposits of Romania

There are few coal deposits in Romania. Those that do occur are found mainly in the Tertiary strata of the Comanesti Basin. (See Figure B-24.) These are brown coals and lignite, occurring typically in small, scattered deposits. The coal is of poor quality and contains many impurities and refuse which must be removed prior to most industrial uses.

Table B-56 presents a summary of estimated coal resources of Romania as of 1966.

Table B-56
SUMMARY OF COAL RESOURCES
OF ROMANIA--1966

	<u>Proved</u>	<u>Possible</u>	<u>Total</u>
Hard Coal	--	590	590
Brown Coal	--	1,367	1,367
Total	0	1,957	1,957

2. Coal Transport in Romania

Romania produced 7.6 million tons of mineral coal in 1970, 1.2 million tons of which consisted of coking coal. In the same year Romania also produced 14.1 million tons of brown coal and lignite. About 6 million tons of bituminous coal was mined in the Petroseni Basin (1), and about 1.6 million in the Banat Basin, which runs from Resita (2) to Orsova (5) in the Danube gorge. (See Figure B-25.)

Most of the Petroseni coal is transported along the Petroseni-Deva (3)-Hunedoara (4) rail line (100 kilometers) to the iron ore mining

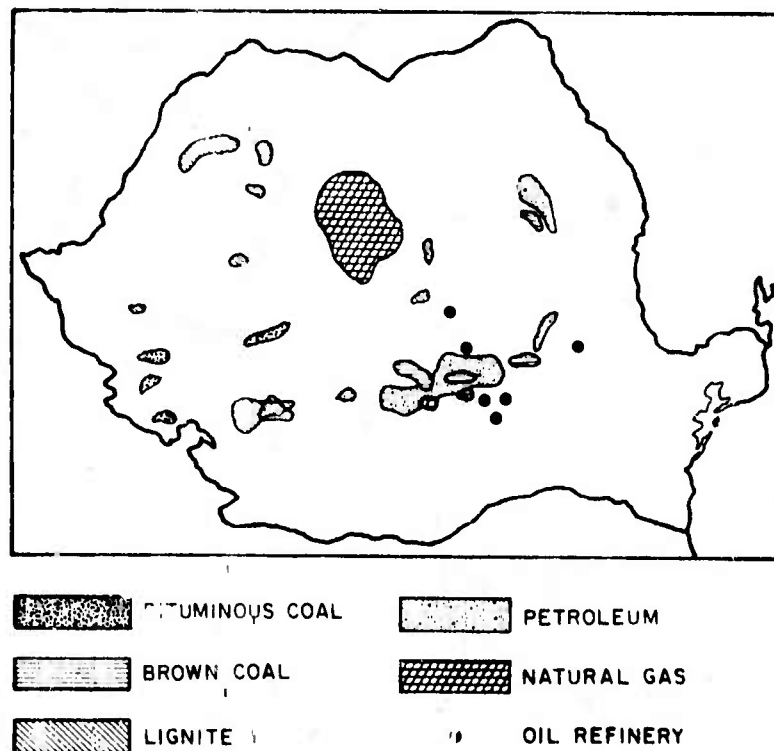


Figure B-24

FUEL RESOURCES OF ROMANIA

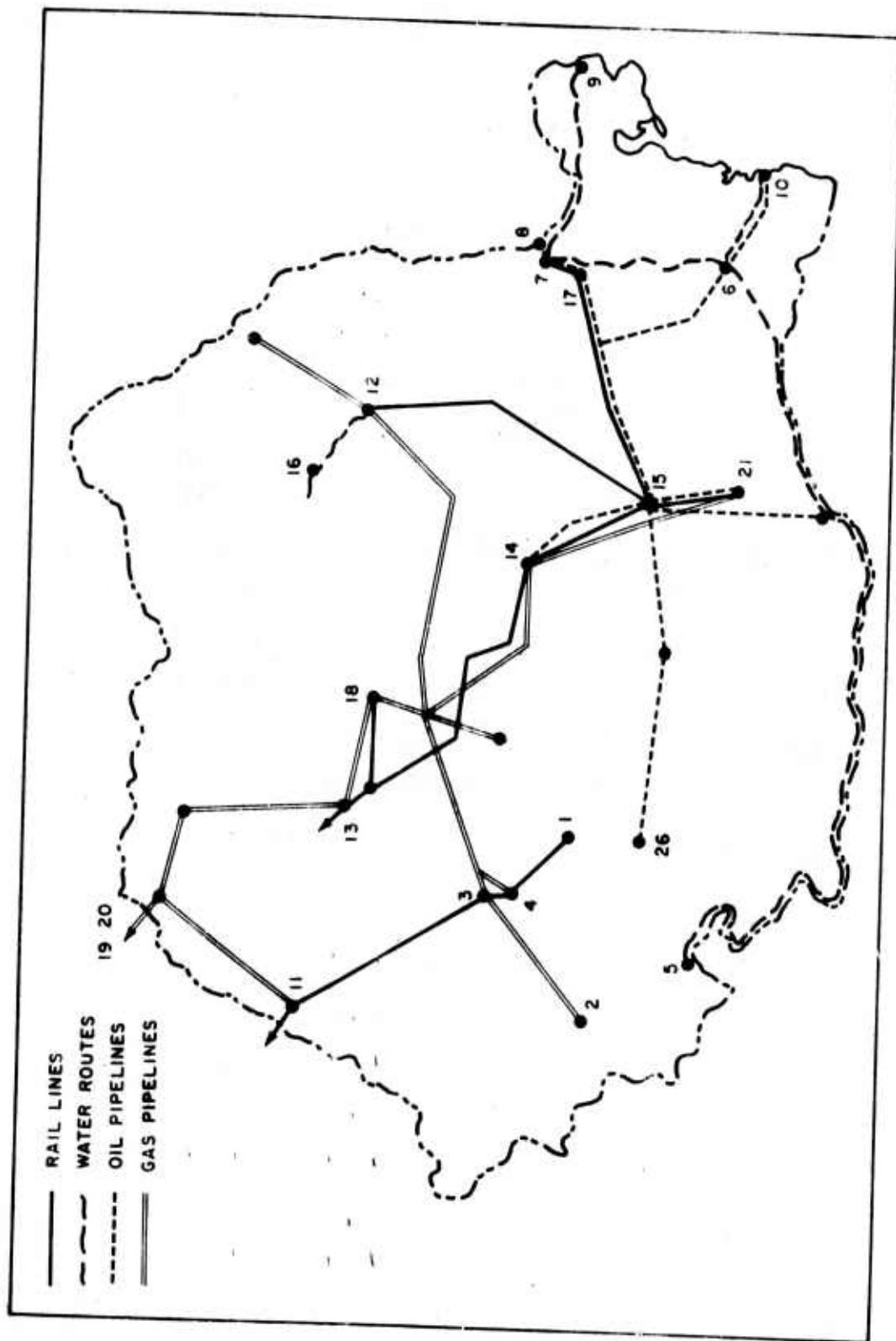


Figure B - 25
FUEL TRANSPORT IN ROMANIA

and iron and steel making plants of Hunedoara. Most of the coal from the Banat Basin is loaded on to river barges at Orsova and shipped down the Danube to Cernavoda (6) (600 kilometers), where the barges pick up local iron ore, and then go on to the large metallurgical complex at Galati (7) (200 kilometers). Some of the Banat Basin coal remains at Resita, where it is used as coking coal for Resita's old but small metallurgical industry.

In 1970 Romania imported iron ore and about 1.2 million tons of mineral coal from the USSR. These imports entered both by rail (via the 20 kilometer Reni (8)-Galati rail line) and by ocean barge through the ports of Sulina (9) and Constanta (10). From these ports coal was then shipped by river barge primarily to the metallurgical plant-complex at Galati. About 1.4 million tons of Polish coal from Upper Silesia were transported to Romania by rail in 1970. From Hungary the coal enters Romania at Oradea (11), a city with large chemical plants in addition to engineering, food-processing, and textile industries. From Oradea most of the coal is transported along the Oradea-Deva-Hunedoara rail line (180 kilometers) to Hunedoara's metallurgical plants, where the coal is used primarily for coking.

The largest brown coal deposits are found in the Eastern Carpathian Basin near Bacau (12) and the Western Carpathian Basin near Cluj (13), although substantial quantities of brown coal and most of the nation's lignite are produced in the Southern Carpathians near Brasov (14) and Ploesti (15). Indeed, the Bucharest-Ploesti-Brasov-Cluj area has become the major industrial region of Romania, largely because of the mineral fuel deposits located in this area.

The brown coal and lignite are compressed into briquettes at the mining site and used as fuel in local thermal electric power plants. Romania produced 32.3 billion kilowatt hours of thermal electric energy in 1970, almost entirely from brown coal, lignite or natural gas. In

addition, Romania produced 2.8 billion kilowatt-hours in hydroelectric generating plants, including the Hidrocentrala V. I. Lenin on the Bistrita river at Piatra Neami (16).

3. Coal Production and Use in Romania

Figure B-26 illustrates the patterns of production and consumption of Romanian coal in 1969 and 1970.

The principal coal users in Romania are the public thermal power plants. The next largest user are the coke oven plants, followed by transport and other industry and construction. Table B-57 presents data on coal and coke production in Romania.

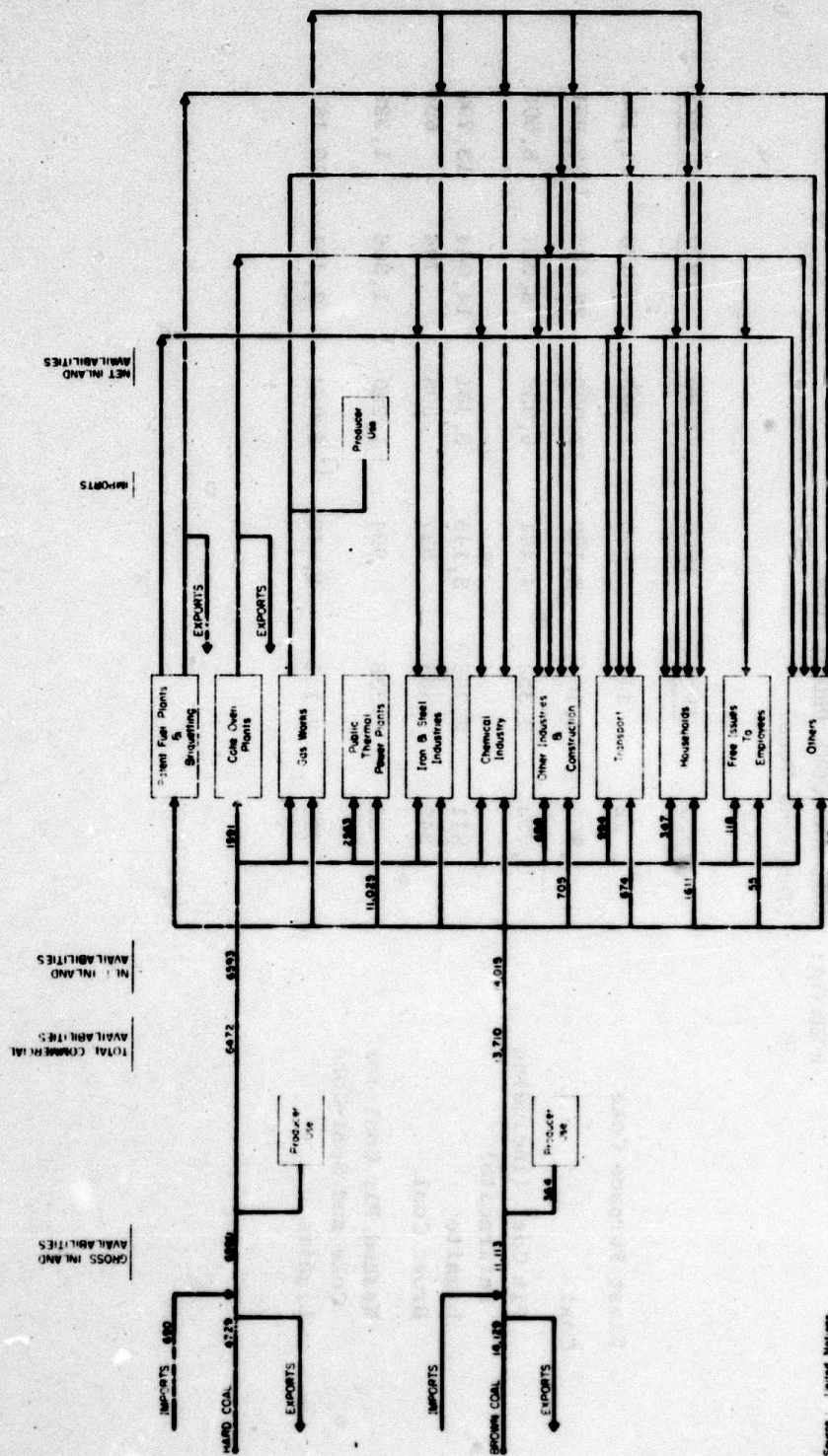


Figure B - 26
 PATTERNS OF COAL PRODUCTION AND CONSUMPTION IN ROMANIA
 1970
 (Thousand Metric Tons)

Source: United Nations

Table B-57

ROMANIA: COAL AND COKE PRODUCTION
(Thousand Tons)

	<u>1950</u>	<u>1955</u>	<u>1960</u>	<u>1965</u>	<u>1970</u>	<u>1971</u>
Blast Furnace Coke	72	144	820	1,135	1,070	1,108
Coal	3,893	6,104	8,163	12,095	22,835	22,951
Pit Coal (including anthracite)	2,733	3,353	4,481	6,036	8,087	8,505
Lignite	811	2,293	3,145	5,461	14,044	13,792
Brown Coal	349	458	537	598	704	654
Washed Pit Coal for Coke and Semi-Coke	65	238	994	1,220	1,306	1,329
Lignite	772	2,141	1,853	5,064	13,461	13,187

IV COAL TRANSPORT IN THE USSR

A. Donets Basin Coal Transport (Figure B-27)

1. Central Blacksoil and Central Regions

Three main railway lines carry coal from the Donets Basin to the Central-Blacksoil and Central economic regions of the country. Along these three main lines, 20.7 million metric tons of Donbass coal were transported in 1970, of which 10.7 million tons were distributed in the Central Blacksoil and 10 million tons in Moscow and the cities of the Central region. The first of these lines is the Southeastern-Michurinsk line, which loads coal in the Donbass holding-stations of Rostov-na-Donu (1), Gornaya (3), Zverevo (2), Tikhaya (1), and Millerovo (7) for shipment to the Central Blacksoil cities of Tiski (9) (a major railway junction) and Voronezh (13) (located 300 km from Donbass), which uses coal primarily for fuel in chemical and machine-construction plants. This line continues through Gryazi (14) and into the Central region to Ryazan (15) (a large cement, oil processing, and nonferrous metal processing center, as well as a major railway junction) and Moscow (16), the capital of the USSR and a large industrial center with heavy machinery manufacturing plants, transport machinery plants, electronics factories, glassworks, and other industries. Moscow is located 850 km from the Donbass.

The second main railway line carrying coal from the Donets Basin is the Southeastern-Yelets line. Of the three main lines, the Yelets line handles the greatest amount of coal. This line begins in the Donbass coal-loading stations of Gornaya, Dolzhanskaya (8), and Kondrashevskaya (17) and runs north into the Central-Blacksoil cities of Valueki (18) and Yelets (19). The latter is a major center for the production of cement and building materials and is within a few miles by rail from Tipetsk, a major

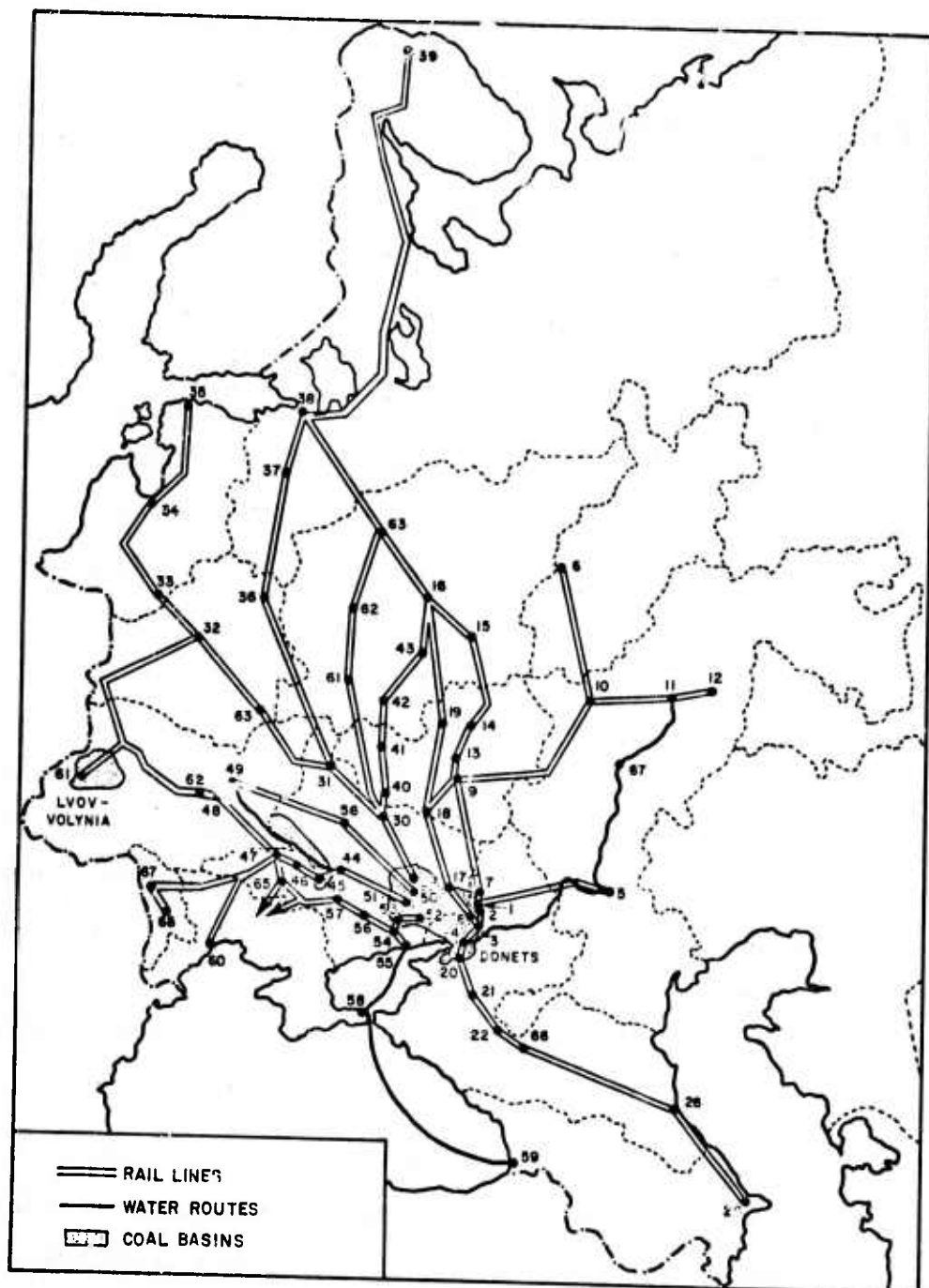


Figure B-27
DONETS COAL TRANSPORT

iron and iron-alloy production center 475 km from the Donbass. From Yelets this line continues into the Central region to Moscow.

The third line running from the Donbass to the Blacksoil and Central regions begins in the coal-loading station of Krasnyi-Timan, which is the largest coal station in the Donbass, and runs to Kharkov (30), 175 km from the Donets Basin. Kharkov is one of the largest railway junctions and coal-transfer stations in the USSR as well as a major industrial center for light industry and the production of transport machinery. From Kharkov coal is transported along the Kursk line to the Central-Blacksoil cities of Belgorod (40) and Kursk (41), which is 300 km from the Donbass and has a major electric power plant complex, and into the Central region to the cities of Orel (42), Tula (43), and Moscow. Orel (450 km from the Donbass) has major steel-rolling and food-processing plants, and Tula (700 km from the Donbass) is one of the largest iron and steelmaking and steel fabricating centers in the nation. Both cities are major railway junctions.

2. Northwestern Region

In 1970, 10.4 million tons of coal was transported from the Donets Basin along two main rail-lines to Leningrad and the cities of the Northwestern region.

Both of the main coal-transport routes running from the Donets Basin to Leningrad and the cities of the Northwestern region begin in the coal station of Krasnyi Timan (29) and lead to Kharkov (30), from where they divide into two lines. Some of the coal is shipped along the Kharkov-Smolensk line through Bryansk (61), Smolensk (62), and Tikhoslavl (63), a major railway junction 1,025 km from the Donbass, and then along the October line from Tikhoslavl and into the Northwestern region to Leningrad (38), the main railway junction (1,375 km from the Donbass) and industrial center (metallurgy, machine and instrument manufacturing, chemical, food-processing, and light industry) of the Northwest economic region.

The second coal-route from Kharkov to Leningrad runs through the railroad junction of Sumy (31), along the Eastern Belorussian line through Vitebsk (36) (a major railway junction 875 km from the Donbass, from which some of the coal is dispatched to various points in Belorussia), and into the Northwestern region to Dno (37). From Dno the coal is transported along the October line system to Leningrad (38)--a total rail distance of 1,400 km from the Donbass. Some of the Donetsk coal transported to Leningrad is carried further north along the October line to Murmansk (39), a metallurgical, chemical, and lumber center. This coal, transported 2,600 km from the Donetsk Basin, is cheaper in Murmansk than the energy coal from the Pechora Basin, lying 2,500 km by rail to the east inside the boundaries of the Northwestern region itself.

3. The Belorussian and Baltic Regions

In 1970, 4.4 million metric tons of Donbass coal were transported by rail to Belorussia and 7.5 million metric tons of Donbass coal were transported by rail to the Baltic region.

All of the Donbass coal for Belorussia is carried from the Donbass station of Krasnyi Timan to the railway junctions of Kharkov (30) and Sumy (31). At Sumy (300 km west of the Donetsk Basin), some of the coal is carried, together with coal destined for Leningrad, along the East Belorussian line to Vitebsk (36). However, the much greater load of Donbass coal for Belorussia and the Baltic region (about 10 million tons) is transported from Sumy through the northeastern corner of the Southwestern region to the main Belorussian line, which runs to Gomel (63), a major railway junction 625 km from the Donbass and one of the main industrial centers of Belorussia, specializing in machine production, particularly agricultural machinery, mining machinery, and transport machinery; food-processing; and light industry. Gomel is also the center of the large, coal-fueled "Vasilevich" electric-power station. From Gomel the main

Belorussian coal line continues on to Minsk (32), the capital of the Belorussian republic and a major railway junction, 900 km from the Donbass. From Minsk, which, like Gomel, is the center of a large machine-production industry, numerous light-industrial plants, food-processing plants, and a fuel-powered electric station, Donbass coal is distributed to other points in Belorussia along the Belorussian line.

In 1970, 4.4 million tons of Donbass coal was transported along these two major lines to Belorussia.

From Minsk 7.5 million tons of Donbass coal continued north to the Baltic rail-line for distribution in the Baltic States. The main coal-receiving stations in the Baltic region are Vilnius (33), Riga (34), and Tallinn (35). Vilnius is the capital of Lithuania (1,050 km from the Donbass) and a peat-mining center as well as a center for machine manufacturing, light industry, food-processing, and lumber plants. Riga (34), the capital of Latvia (275 km from Vilnius) and the largest industrial center of the Baltic economic region, has machine-manufacturing, light-industrial, chemical, cement and construction-material plants, and a coal-operated electric power station. Tallinn (35) is the capital of Estonia (300 km from Riga) and an international port through which Donbass coal is exported abroad. Tallinn has machine manufacturing, food-processing, and various light-industrial plants. There are also several synthetic-textile plants, paper manufacturing plants, and cellulose plants. Tallinn is a major ship-building center. Tallinn's electric-power plant uses locally mined shale for fuel.

4. Southwestern, Moldavian, and Southern Regions

In 1970 approximately 18 million metric tons of Donbass coal was transported by rail into the southwestern economic region. Similarly, 14 million and 2 million tons, respectively, were shipped to the southern and the Moldavian economic regions.

The first of the three main coal transport routes leading into these regions departs from the Donets coal-loading station of Nikitovka (50) westward along the Donets line to Poltava (56) in the Donets-Dnieper region to Kiev (49), the capital of the Ukraine (525 km from the Donbass). Kiev is a major railway junction with large machine-production plants (particularly transport machinery such as railroad locomotives and river vessels), light-industrial and food-processing plants, and building-material production plants. Kiev's electric power plant is atomic. Some of the coal transported from the Donbass to Kiev along the Nikitovka-Poltava-Kiev route of the Donets rail-line is sent 50 km south of Kiev to Fastov (48), another machine-producing city and a central railroad junction connecting the Southwestern and Lvov railroad systems.

The greatest amount of Donbass coal freight transported westward is dispatched from the Donbass station of Yasinovataya (51) to the great industrial centers of Dniepropetrovsk (44) and Dnieprodzerzhinsk (45) on the Dnieper River, 200 km from the Donbass. Some of the USSR's largest iron and steel making plants, machine-production, and chemical plants are located in these two cities. Part of the coal dispatched to these cities is distributed along the Dnieper River industrial region from Dniepropetrovsk to Kiev (49) on the Dnieper rail-line, and 3-1/2 million tons are transferred to river barges and shipped up the Dnieper River. In 1970, 1,630,000 tons of the Donbass coal shipped by barge from Dniepropetrovsk reached Kiev.

From Dniepropetrovsk the main rail-line continues on to Pyatikhati (46), a machine-production and metal-finishing center 300 km from the Donbass. From Pyatikhati Donbass coal is transported 75 km west to Znamenka (47), a major junction between the Dnieper, Southern, and Southwestern-Lvov rail-lines. Znamenka also has machine-production and food-processing plants.

From Znamenka part of the Donbass coal continues westward to Fastov (48) in the Southwestern region, and part is sent south into the Southern and Moldavian economic regions. One or two million tons of the coal transported to Fastov continues westward along the Lvov line to Lvov (61), 1,100 km by rail from the Donbass. Lvov lies in the center of a large mineral-coal mining and industrial (machine-production, light-industry, lumber, food-processing) region. Lvov coal, however, is used locally (about 6 million metric tons) and about 4-1/2 million metric tons is sent to and utilized in the Baltic economic region.

In 1970 about 80 million tons of Donbass coal were transported westward along these two main rail-lines--and most of this along the Yasinovataya-Dniepropetrovsk-Znamenka line. In the same year 19.8 million tons of this coal continued on to Kiev and Fastov in the Southwestern region (18.2 million tons by rail and 1.6 million by river barge).

Znamenka (47), as mentioned above, is a major rail junction. At Znamenka the Yasinovataya-Dniepropetrovsk-Znamenka coal route merges with another rail-line which starts out from the southern Donets stations of Szlovaiskoe (52) and Dolya (53) and runs south 50 km to the station of Volnovakha (54).

At Volnovakha several million tons of Donbass coal are transported to the seaport of Zhdanov on the Sea of Azov (55) (the port proper is called Mariupol). Zhdanov is a large steel finishing, machine-production, ship-building, chemical, basic metallurgical, and coal fired electric power producing center. In 1970, 870,000 tons of Donbass coal were shipped by sea 125 miles from Zhdanov to Kerch (58), the coal-importing port of the Southern region and a center for machine-production, metal-finishing, and the production of building materials as well as the location of a large coal-based electric power plant.

Another 660,000 tons of Donbass coal was dispatched 475 miles in 1970 from Zhdanov to the Caucasian region's coal-importing port, Batum (59), which contains oil refineries, machine-production plants, and a large food-processing and wood-finishing industry.

At Volnovakha (51), most of the Donbass coal is shipped westward rather than south to Zhdanov and continues on to Pologi (56), which has a large chemical and building-material industry (150 km by rail from the Donbass), and then along the Dnieper rail-line to Zaporozhe (57), a giant industrial complex containing metallurgical and chemical plants, machine-production (especially heavy transport machinery), building material, food-processing and various light industrial plants. Located 250 km by rail from the Donbass, Zaporozhe is also a major railway junction.

From Zaporozhe some Donbass coal is transported along the Dnieper-Crimean line, and the remainder is transported 225 km west to Krivoy Rog (65), which is located in a rich iron-ore region and which contains machine and construction-material plants, and various forms of light industry as well as food-processing plants. From Krivoy-Rog the main coal rail-line continues on to the railroad junction of Znamenka (47).

At Znamenka, the Szlovaiskoe-Dolya-Zaporozhe-Krivoy Rog-Znamenka line merges with the Yasinovataya-Dniepropetrovsk-Pyatikhati-Znamenka line. As mentioned earlier, some of the coal arriving in Znamenka is dispatched to Fastov in the Southwestern region, but most of the coal is sent into the Southern region along two main rail-lines.

The first main rail-line to the Southern region runs from Znamenka to Odessa (60), the largest port for Soviet foreign commerce and the second largest Soviet port (second to Baku, landlocked on the Caspian Sea). Odessa, 675 km by rail from the Donbass, is also a major industrial center with ship-building and transport-machinery plants, oil refineries, chemical plants, textile, food-processing, and machine plants,

and a coal-based electric power plant. (The port per se of Odessa is called Ilyichevsk).

The second line from Znamenka runs through the southern region along the Podgorodnaya line to the Moldavian cities of Beltsy (67), a machine-building and food-processing center, and Kishinev (68), the capital of Moldavia, 1,000 km by rail from the Donbass. Kishinev has a large coal-fired electric power station and contains machine-producing, food-processing, and chemical industries. Kishinev is the largest industrial city in Moldavia.

In 1970, 14.1 million tons of Donbass coal were dispatched to Odessa and the Southern region by rail from the Yasinovataya-Znamenka and Szlovaiskoe-Dolya-Volnovakha-Zaporozhe-Znamenka lines of the Dnieper and Donets rail systems, and 660,000 tons were shipped to the Crimea by the Szlovaiskoe-Dolya-Volnovakha-Zhdanov rail and Zhdanov-Kerch ocean lines.

In the same year 2.3 million tons of Donbass coal were shipped along the Szlovaiskoe-Dolya-Volnovakha-Zaporozhe-Znamenka-Kishinev line of the Donets, Dnieper, and Kishinev-Odessa rail systems to Kishinev and other points in Moldavia.

5. The Caucasus Region

Several million tons of Donbass coal are transported southeast from the Donbass stations of Rostov-na-Donu (4) and Bataysk (20) along the Northern Caucasian rail-line. This line passes through the cities of Tikhoretsk (21), a machine-producing center; Armavir (22), a machine-producing, wood, glassware, and food-processing center; Nevinnomysskaya (66), the location of a coal-based electric power plant as well as chemical plants; Makhachkala (26), a Caspian Sea port 875 km from the Donbass as well as a major industrial center for shipbuilding and the production of heavy machinery (particularly transport machinery) and light

metallurgy. From Makhachkala the main coal route continues southward to the eastern run of the Caucasian rail-line to Baku (28), the largest Soviet port in terms of freight traffic turnover. Baku is 1,200 km from the Donbass. Besides being a major seaport and oil-drilling region, Baku is the center of a large metallurgical and heavy machine production industry and is an electric power producing center.

In 1970, 2.2 million tons of Donbass coal entered the Caucasus by rail through Baku on the Caspian, and 660,000 tons entered the Black Sea port of Batum (59) via the Zhdanov-Kerch-Batum ocean route mentioned earlier.

6. Volga and Volga-Vyatka Regions

In 1970, 9 million metric tons of Donbass coal were dispatched to the Volga region, of which approximately 7 million metric tons were transported along the two main railroad routes, the Likaya-Volgograd-Volga rail system and the Kondrashevskaya-Valuiki-Liski-Penza-Syrzan-Kubyshev line. Two million metric tons were transported by barge from Rostov up the Don to Volgograd (5). Two million metric tons of Donbass coal were also transported by rail to Gorkii in the Volga-Vyatka economic region.

From the river-port station of the Donbass, Rostov-na-Donu (4), about 2 million tons of coal were transported up the Don River and Don-Volga canal by barge in 1970 to Volgograd, a giant industrial city containing iron and steelmaking plants, light metal product (e.g., aluminum-processing) plants, building-material plants, heavy machinery (including transport machinery), production plants, and chemical and petrochemical plants as well as a large coal-fired electric power plant. Volgograd, 400 km up the Don River from the Donets coal basin, is also a major rail and river junction with rail and river connections to the Sea of Azov and the Black Sea, the Caspian Sea, and Moscow.

Volgograd receives most of its coal by rail from the Donbass coal-dispatch station, Likhaya (1), 300 km by rail from Volgograd.

From Volgograd coal is dispatched up the Volga River (about 1/2 million tons in 1970), as well as along the Volga rail-line, to various industrial centers located on the banks of the river, including the city of Saratov (67), with its oil-refining, iron and steelmaking, and heavy-machinery manufacturing industries. Saratov is 675 km from Volgograd.

In addition to Rostov-na-Donu and Likhaya, the Donbass coal-dispatch station of Kondrashevskaya (17) dispatches several million tons of coal to the Volga region along the northern Donets and Balashov lines. From Kondrashevskaya the coal is transported north to Valuiki (18), an important rail-junction discussed earlier, and then northeast (along the Balashov line) through the rail-junction of Liski (9) (also described earlier) to Penza (10) in the Volga region, 800 km by rail from the Donbass. Penza has paper, machine-producing, and food-processing plants and light metal working plants.

From Penza some of the coal continues east along the Kuibyshev line to Syzran (11) and Kuibyshev (12), 1,025-1,175 km from the Donbass. Both cities have large iron and steel and machine-manufacturing plants, chemical plants, and coal-based electric power plants.

The other main coal route leading from Penza runs north along the Gorkii way to the Volga River port of Gorkii (6) in the Volga-Vyatka economic region. In 1970, Gorkii received 2 million tons of Donbass coal via the Kondrashevskaya-Penza-Gorkii coal route. Gorkii is a major industrial city with oil refineries, chemical and heavy machinery plants, textile and transport-machinery factories, food-processing plants, and a coal-based electric power station.

7. Local Coal Available along Donbass Transport System

Most of the 10-1/2 million tons of coal mined in the Lvov-Volynia Basin (61) in 1970 was used within the immediate vicinity, although 4.4 million tons were sent north along the Lvov line into Belorussia via Minsk (32), 550 km from Lvov, and to Vilnius (33), 650 km from Lvov, for distribution in the Baltic States.

All of the 9 million tons of brown coal mined in the Dnieper Basin in 1970 was distributed within the vicinity of the basin over distances of no more than 30 to 40 km.

The uses of Donets, Lvov, and Dnieper coal within the Ukraine are as follows:

<u>Purpose</u>	<u>% of Coal Used</u>
Electric power stations	36.1
Residential fuel needs	18.8
Transportation	15.5
Industrial boilers	13.0
Metallurgy	10.6

Following are delivered costs in rubles per ton of conventional fuel of various coals in different areas of the European part of the USSR:

Cities of Coal Demand	Coal According to Basin of Origin			
	Donbass	Lvov	Dnieper	Kuzbass
	(Cost in Rubles per Ton in City of Demand)			
Lvov	9.7	10.2		
Vinnitsa	9.2	10.9		
Kiev	8.8	11.1	9.0	
Poltava	8.2		8.3	
Donetsk	7.8			
Odessa	9.1			
Kharkov	8.1			
Minsk	9.4	11.0		
Vilnius	9.8	11.0		
Moscow	9.3		7.6	
Gorkii	9.5		7.2	
Volgograd	8.2		7.7	
Zaporozhe	8.2			
Dniepropetrovsk	8.1			

Although there is insufficient information for a complete comparison, it is nevertheless clear that the delivered cost of Donbass coal is less than that of certain local coals in the cities of their respective localities. This, of course, reflects the quality of the coals and the mining costs relative to that of coal from the Donbass, and also attests to the density of traffic and high utilization of railroad rolling stock in coal transport in the USSR.

B. Kuznetsk Coal Transport from Western Siberia (Figure B-28)

In 1970 about 112.5 million metric tons of coal were mined in the Kuznetsk Basin, of which 62.3 million were transported to other economic regions and the remainder was used within the boundaries of Western Siberia.

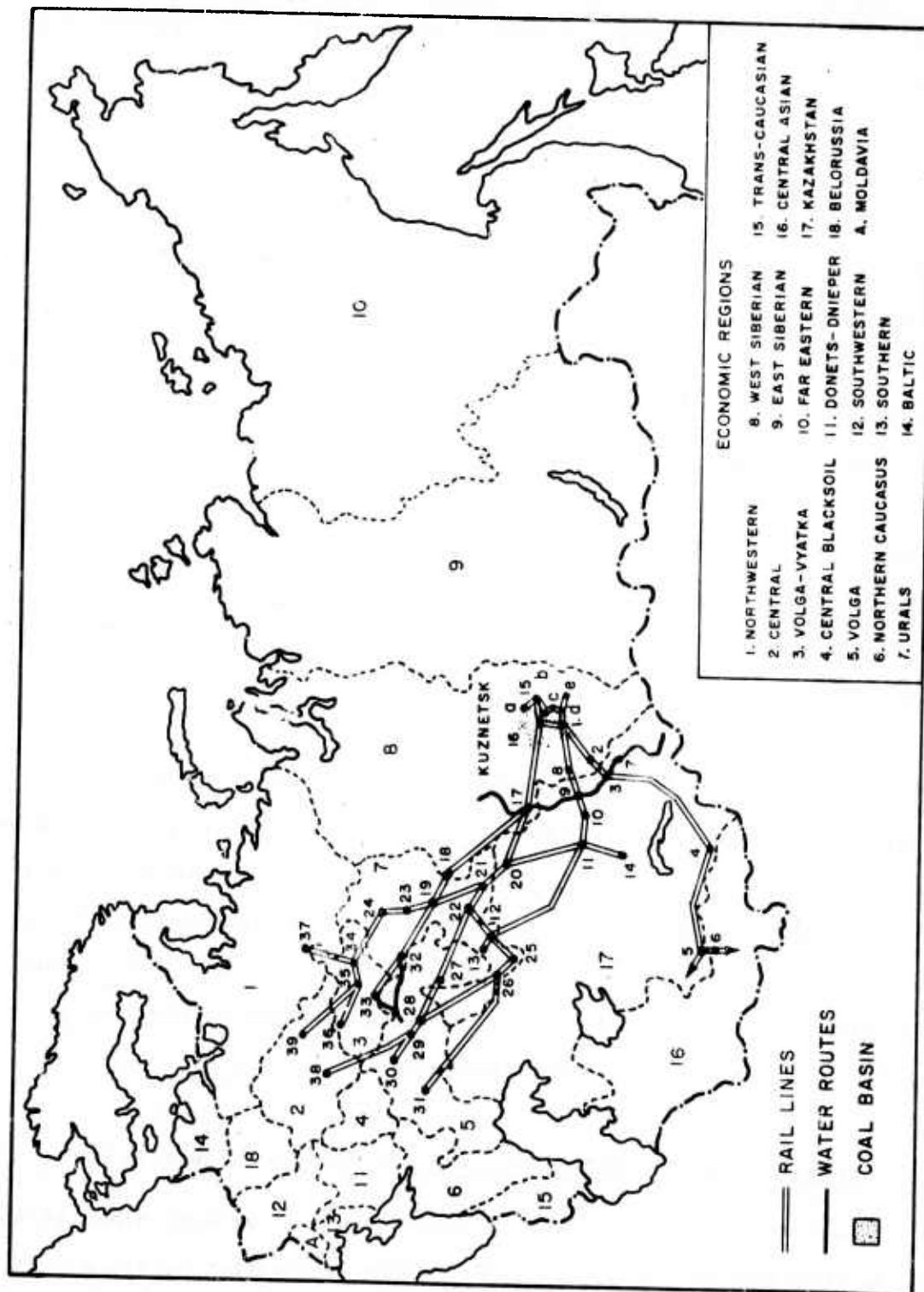


Figure B-28
KUZNETSK COAL TRANSPORT

The main coal-loading rail-stations and the coal-receiving stations (for industrial use within Western Siberia) are located along the north-south line from Tomsk (a) and Anzhero-Sudzhinsk (15) to Kemerovo (b), Leninsky-Kuznetsky (c), Prokopyevsk (d) and Novokuznetsk (e) and then along the east-west lines from Prokopyevsk (d) to Barnaul (1) and from Anzhero-Sudzhinsk (15) to Novosibirsk (6). All of these stations are 30 to 150 km from each other, and all are major industrial centers with iron and steelmaking and steel fabrication complexes, nonferrous metal (including aluminum) plants, heavy machinery producing plants (including transport and power machinery), chemical plants, iron-ore mines, and about a dozen coal-based electric power plants.

1. Coal Transport to Kazakhstan and Central Asia

In 1970, 10 million metric tons of Kuzbass coal were transported to Kazakhstan along the West Siberian and Northern Kazakh and Southern Kazakh rail lines. In the same year 900,000 tons of Kuzbass coal were carried along the West Siberian-Southern Kazakh line to Tashkent and the Central Asian economic region.

There are two main coal routes leading out of the Kuznetsk Basin (Kuzbass) from Barnaul (1) to Kazakhstan and Central Asia. The first route follows the West Siberian line to Kulunda (8) and Pavlodar (9), located 475 km from the Kuzbass. Pavlodar is an industrial city with light (nonferrous) metallurgy, machine construction, and food-processing plants as well as a coal-fired electric power station.

From Pavlodar the Kuzbass coal route leads to Tselinograd (11), 425 km west of Pavlodar, a major railroad junction where northbound coal from the Karaganda Basin (14) intersects the eastward bound Kuzbass coal. Tselinograd is also an industrial center for the production of machinery and the manufacture of building materials. The Kuzbass coal, together with some of the Karaganda coal, continues on from Tselinograd westward along the Northern Kazakh line into the Southern Urals.

The second main coal route from the Kuzbass to Kazakhstan runs from Barnaul to Aleysk (2) and Semipalatinsk (3), 400 km from the Kuzbass, which is both a rail-station and a river port in Kazakhstan on the Irtysh River. In 1970, 190,000 tons of Kuzbass coal were transferred to river barges and dispatched up the Irtysh to Ust-Kamenogorsk (7)--a distance of 175 km. Both Semipalatinsk and Ust-Kamenogorsk have light metallurgy (nonferrous) plants, steel-finishing, and heavy machinery plants as well as large food-processing factories. Ust-Kamenogorsk, in addition, is surrounded by a circle of metallic-ore mines (copper, zinc, lead, manganese, etc.) and by several hydroelectric power plants.

The main Kuzbass coal route from Semipalatinsk is along the Southern Kazakh line to Alma-Ata (4), 900 km southwest of Semipalatinsk, a center of light-metallurgy, steel-finishing, the manufacture of construction materials, and the production of heavy machinery. Alma-Ata also has a coal-based electric power plant.

From Alma-Ata the coal continues along the Southern Kazakh line to Arys (5), 700 km by rail from Alma-Ata and 1,950 km from the Kuzbass. Arys has chemical and machine-manufacturing plants as well as light-metallurgical and cement factories. From Alma-Ata some of the coal continues along the Kazakh line, and part of it goes south along the Main Central Asian line to Tashkent (6), 125 km south of Arys, and the cities of Central Asia.

2. Kuzbass Coal Exports to Urals

In 1970, 41.5 million metric tons of Kuzbass coal was transported to the Urals along the West-Siberian-Sverdlovsk, West Siberian-Central Urals, and West Siberian-Northern Kuzakh-Southern Urals rail-lines. Of this 41.5 million tons, 25.5 million (52 percent) consisted of coking coal (two-thirds of all of the coking coal mined in the Kuzbass) and 16 million of energy coal.

Most of the coal transported from the Kuzbass to the Urals economic region is dispatched from the stations of Anzhero-Sudzhinsk (15) and Novosibirsk (16).

From these points the main coal route follows the West Siberian line to Kulomzino station in the city of Omsk (17). Between Novosibirsk and Omsk occurs the greatest density of freight traffic of all the rail-lines in the USSR. For example, 70 to 80 million metric tons of coal were transported along the 600 km run from Novosibirsk to Omsk in 1970, i.e., 45 billion ton-km of traffic in coal alone in that year.

Omsk itself is a large industrial center which uses several million tons of coal per year in its metallurgical plants, oil refineries, transport machinery factories, chemical and food-processing plants, and in its coal-based electric power stations.

From Omsk, Kuzbass coal is transported in three directions. Some of the coal is shipped up the Irtysh River (700,000 tons in 1970) to Tara, Tobolsk, and other cities of Western Siberia. About one-third of the coal leaving Omsk (about 16 million metric tons per year) is sent northwest into the Urals economic region and along the Sverdlovsk line to Vagay (18) and Sverdlovsk (19), 825 km from Omsk and 1,425 km from the Kuzbass.

Sverdlovsk itself is a giant industrial city with heavy metallurgical plants, machinery (including transport machinery) plants, chemical and building material producing plants, as well as food-processing and light industrial plants. The area surrounding Sverdlovsk (the Central Urals districts) contains coal and iron-ore mines, nonferrous-ore mines, peat, oil, and copper fields, oil-refineries, and fuel-based and atomic energy-based electric power stations. The energy needs of the Sverdlovsk-Central Urals area are met by local coal, Kuzbass coal, fuel-oil, gas (piped from Chelyabinsk), atomic energy, and hydroelectric energy. Slightly more than half of the coal transported from the Kuzbass to the

Urals is coking coal used in metallurgical plants, rather than energy coal, which comes primarily from the Urals itself and from Kazakhstan. In 1970 the Kuzbass coal used for energy purposes in the Urals constituted 16 million tons, or about 39 percent of the total from Kuzbass.

From Sverdlovsk (19) Kuzbass coal is shipped in two directions. The smaller shipment is sent along the Northern Urals line to Kuzino (23) and Perm (24), 300 km northwest of Sverdlovsk. Perm is the largest industrial city in the Northern Urals, with oil-refineries, chemical plants, machinery, and food-processing plants, and both a fuel-based and a hydro-powered electric energy plant. From Perm, Kuzbass coal is transported west into the Volga-Vyatka region.

In addition to the Sverdlovsk-Perm line, Kuzbass coal is also shipped along the Sverdlovsk-Kambarka line. Kambarka (32), 500 km west of Sverdlovsk, is a major rail and river junction (Kama River), from which Kuzbass coal is transported into the Volga-Vyatka region.

While the Sverdlovsk line handled slightly less than a third of the Kuzbass coal freight departing from the West Siberian city of Omsk, over two-thirds of the coal leaving Omsk was carried along the Central Urals line to Petropavlovsk (20), a major railway junction in the northern tip of Kazakhstan (250 km west of Omsk and 850 km by rail from the Kuzbass), where Karaganda coal coming north from Karaganda (11) and Tselinograd (11) merges with the westbound Kuzbass coal for the 250 km run along the Central Urals line to Kurgan (21). At Kurgan the Karaganda coal is then transported north to Sverdlovsk while the Kuzbass coal continues another 225 km west to Chelyabinsk (22), the major industrial center and railroad junction of the Southern Urals.

Like Sverdlovsk, Chelyabinsk is the center of a giant industrial region with iron and other metallic-ore mines, coal basins, fuel-based

electric power plants, ferrous metallurgical and light metallurgical plants, chemical plants, heavy-machinery and food-processing plants. The energy base of Chelyabinsk consists of Kuzbass coal as well as local brown coal, Karaganda coal, oil, and gas which is piped from Gazli in Central Asia to Chelyabinsk and Sverdlovsk. Again, most of the Kuzbass coal in Chelyabinsk--as well as in Sverdlovsk--is used as coking coal in metallurgical plants, and only about a third of imported Kuzbass coal is used for energy fuel.

Most of the Kuzbass coal leaving Chelyabinsk is sent west along the Central Urals-Kuibyshev line to the Volga region, and the remainder is sent south along the Southern Ural line to Kartaly (12), where it is joined by Kuzbass coal coming westward along the Northern Kazakh line from Tselinograd. Kartaly is a major railroad junction 1,600 km from the Kuzbass via the West Siberian-Ural line and 1,625 km via the West Siberian-Kazakh line. Kartaly is also an industrial city producing building materials and heavy machinery.

From Kartaly, most of the Kuzbass coal is shipped westward 12 km to Magnitogorsk (13), a major iron-mining and industrial center, with metallurgical and chemical plants, machinery and building material production plants, food-processing plants, and a coal-based electric power plant.

The remainder of Kuzbass coal leaving Kartaly moves southward along the Southern Ural line to Orsk (25), another industrial city 250 km south of Kartaly. Orsk contains oil-refineries, chemical plants, light-metallurgical plants, steel-finishing and machinery-producing factories, and food-processing plants as well as a mineral-fuel based electric power plant. About 20 km southwest of Orsk is the iron-metallurgical industrial center of Novotroitsk, which is connected by an auxiliary rail-line to Orsk.

From Orsk the main Kuzbass coal route continues 350 km east to Orenburg (26), which has steel-finishing and machinery plants, and then further west into the Volga economic region.

3. Kuzbass Coal Exports to Volga Region

In 1970, 3.3 million metric tons of Kuzbass energy coal were transported along the West Siberian-Central Urals-Kuibyshev line and the West Siberian-Southern Urals-Volga line to the Volga economic region. Most of this Kuzbass coal was sent to Kuibyshev.

The main dispatch point for Kuzbass coal heading toward the Volga economic region is Chelyabinsk (22), to which coal was transported from Novosibirsk (16) through Omsk (17), Petropavlovsk (20), and Kurgan (21). From Chelyabinsk, Kuzbass coal is carried along the Central Ural line to Ufa (27) in the Volga region. Ufa, 350 km to the west of Chelyabinsk and 1,725 km by rail from the Kuzbass, is a principal industrial center, with oil refineries, chemical plants, a paper industry, light metallurgical, steel-finishing, and machinery plants, and food-processing plants, as well as a mineral-fuel based electric power station.

From Ufa, coal is transported along the Kuibyshev line to Kuibyshev (28), located 150 km from Ufa. (Kuibyshev was described in the section on Donbass coal transport.)

As noted earlier, some of the Kuzbass coal in Chelyabinsk was transported south to Kartzly (12), from which a small amount was sent to Orsk (25) and Orenburg (26).

From Orenburg a further small amount of Kuzbass coal is sent northwest to Saratov (31), 2,750 km by rail (West Siberian-Southern Urals-Volga rail-line) from the Kuzbass. Soviet economists in the Gosplan Institute (State Economic Planning Institute) have been cutting back Kuzbass coal shipments to Saratov and the southern Volga area and plan to cease

such shipments altogether in the next few years since cost estimates indicate that Donbass coal is much cheaper than Kuzbass coal for this area.

Most of the Kuzbass coal leaving Orenburg is transported northwest along the Southern Urals-Kuibyshev railroad to Kuibyshev where it is joined by Kuzbass coal moving west along the Central Urals-Kuibyshev line through Chelyabinsk and Ufa to Kuibyshev. From Kuibyshev, Kuzbass coal continues along the Kuibyshev rail-line across the Volga River to Syrzan (29), which was described in the section on Donbass coal transport.

From Syrzan, a very small amount of Kuzbass coal (as in the case of Saratov and for the same reasons) continues along the Kuibyshev rail-line to Penza (30), another industrial city and electric power center already described.

Most of the coal leaving Syrzan is sent northwest along the Syrzan-Saransk-Ryazan line into the Central economic region.

4. Kuzbass Coal Transport to Volga-Vyatka Region

In 1970, 3.0 million metric tons of Kuzbass coal was transported to the Volga-Vyatka economic region. Of this 1.5 million tons were sent along the Northern Urals-Kirov and the Sverdlovsk-Kazan rail-lines, and another 1.5 million were shipped by river barge from Kambarka along the Kama and Volga rivers to Kazan.

As noted earlier, Kuzbass coal was sent to Sverdlovsk (19) along the West Siberian-Sverdlovsk line through the cities of Novosibirsk (16), Omsk (17), and Vagay (18) to Sverdlovsk (19). The coal was then dispatched in two directions from Sverdlovsk: along the Sverdlovsk line to Kambarka (32) and along the northern Urals line to Kuzino (23) and Perm (24). Kambarka and Perm (24) are in turn dispatch points for the transport of Kuzbass coal into the Volga-Vyatka economic region.

From Kambraka, Kuzbass coal is transported by two modes of transportation: by river barge along the Kama and Volga rivers to Kazan (33), a distance of 450 km, and by rail to Kazan. In 1970, 1.5 million metric tons of Kuzbass coal was carried by river barge from Kambraka to Kazan.

Kazan is a major river port and is located 2,050 km from the Kuzbass via the West Siberian-Sverdlovsk rail-line. Kazan is a major center for the production of transport machinery and building materials and, in addition, contains steel-finishing and food-processing plants. Kazan also has a mineral-fuel based electric power plant.

From Perm (24) Kuzbass coal is transported along the Northern Urals-Kirov line to Kirov (34), a railroad junction where Kuzbass coal is joined by a smaller amount of Pechora Basin coal heading south via the Northern-Kirov line from Kotlas (37) in the Northwestern economic region to Kirov. Kirov, which contains chemical, steel-finishing and machinery-manufacturing, and food-processing plants as well as a mineral-fuel based electric power plant, is 2,150 km from the Kuzbass via the West Siberian-Sverdlovsk-Northern Urals-Kirov rail-line.

From Kirov, Kuzbass coal is transported 75 km along the Gorkii rail-line to Kotelnich (35), which produces machines and building materials. From Kotelnich, Kuzbass coal is sent in two directions. Slightly more than half is sent along the Kotelnich-Yaroslavl line into the Central economic region, and the remainder continues along the Gorkii line to the city of Gorkii (36), located 2,600 km from the Kuzbass (via the West Siberian-Sverdlovsk-Northern Urals-Kirov-Gorkii line). (Gorkii was described in the Donbass coal transport section.)

5. Kuzbass Coal Transport to Central Region

In 1970, 3.1 million tons of Kuzbass coal were transported to the Central economic region, most of it along the West Siberian-Kuibyshev-Syrzan-Ryazan rail-lines, by way of the cities of Novosibirsk (16), Omsk (17), Petropavlovsk (20), Kuran (22), Ufa (27), and Kuibyshev (28). From Syrzan the coal is shipped to Ryazan (38) in the Central economic region. Ryazan is a major railway junction connected with Moscow, Tula, and the other great industrial and mining centers of the Central region. Ryazan itself contains chemical and steel-finishing plants, machine-producing factories, food-processing plants, and various light industries. Ryazan also has a coal-based electric power plant.

Some Kuzbass coal also enters the Central region from Kotelnich (35), to which it was sent via the West Siberian-Sverdlovsk-Northern Urals-Gorkii line through the cities of Novosibirsk (16), Omsk (17), Vagay (18), Sverdlovsk (19), Kuzino (23), Ierm (24), and Kirov (34). From Kotelnich the coal is sent to Yaroslavl (39). Along these lines Kuzbass coal is transported a distance of 3,100 km from the Kuzbass compared with 2,875 km from the Kuzbass to Ryazan (38). Yaroslavl contains light metallurgical industries, chemical plants, machine-building and steel-finishing plants, transport machinery factors, and food-processing plants as well as a coal-based electric power plant.

6. Comments on Economics of Kuzbass Coal

Soviet economists in the Gosplan Institute have complained about the technical deficiencies of local enrichment plants and sorting procedures in the Kuzbass. As a result of improper sorting, much good coking coal is wasted as energy fuel, and much of the coal reaching metallurgical plants and intended for coking is unenriched and has a high ash concentration. Over 2.5 million tons of Kuzbass coal were returned to the Prokopenvsk station alone in 1965 from Ural metallurgical

plants--resulting in wasted transportation and labor costs. Gosplan economists think that oxidized coal with a large ballast content should not be transported over long distances, since, in many instances, it must be thrown out upon arrival at its destination.

The average transportation distance for Kuzbass coal is 1,500 km--about three times the average distance over which Donbass coal is transported.

Two-thirds of the coking coal mined in the Kuzbass is sent to the Urals; the rest is used in metallurgical plants within the Kuzbass itself.

The future fuel balance of Western Siberia will continue to be dominated by coal--by 60 percent at the end of the seventies (from a current proportion of approximately 72 percent). In terms of Btu, the use of coal within Western Siberia is as follows: 43.9 percent for electric power stations, 17 percent for industrial boilers, 11.2 percent for metallurgical and technological needs, 9.1 percent for residential needs, 6.8 percent for transportation fuel, and 12 percent for various other needs.

C. Pechora Coal Transport (Figure B-29)

Coal from the Pechora Basin, which is located in the Northwestern corner of the Komi ASSR in the Northwestern economic region, is exported to the Urals, the Central, and the Baltic economic regions. Although 13.2 million of the 21.4 million metric tons of coal mined in the Pechora Basin in 1970 was of coking coal quality, only one-third--or about 4.4 million tons--of Pechora coking coal was actually used for coking in metallurgical plants. The other 8.8 million metric tons were consumed in thermal uses. Gosplan economists think this wasteful and would like to change this in the future. The coking coal comes primarily from

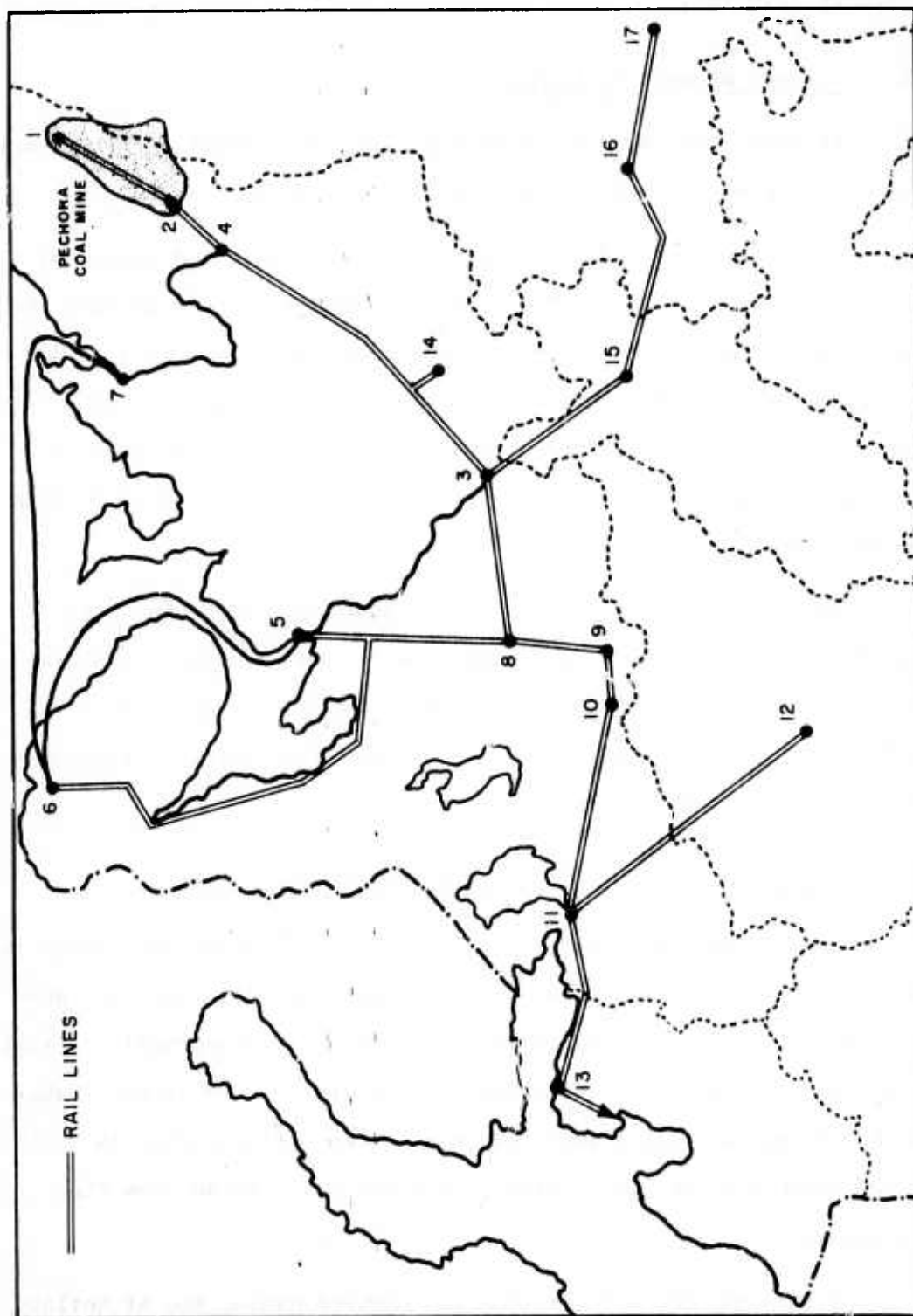


Figure B - 29
PECHORA COAL TRANSPORT

the mines at Vorkuta (1) and the fuel quality coal comes primarily from the mines at Inta (2).

1. Pechora Exports to Urals

In 1970, 200,000 tons of Pechora coal was exported through Kotlas and the Kotlas-Kirov-Perm railroad route to the Urals.

From Vorkuta and Inta, Pechora coal is dispatched along the Northern rail-line to Kotlas (3)--located a distance of 800 km from the Pechora Basin--from which a small amount is then sent southeast along the Kotlas-Kirov line to Kirov (15) and then directly east on the Sverdlovsk line to Perm (16) and Sverdlovsk (17). Traveling east on the Sverdlovsk line, Pechora coal passes westbound Kuzbass coal heading toward the Volga-Vyatka region.

Kotlas is a major rail and river junction on the Northern Dvina River and the Northern rail-line, and is also a major industrial city with machinery factories, ship-building and ship repair plants, chemical, light-metalurgical, and food-processing plants, as well as a coal-based electric power plant.

2. Transport of Pechora Coal within Northwest Region

Most of the coal--14 million tons in 1970--in Pechora Basin is transported to other points within the Northwest economic region. Some of the coal moving down the Northern line from the Pechora Basin is sent along an auxiliary track to Syktyvkar (14), a city with a large lumber industry, food-processing plants, and some machinery factories as well as a coal-based electric power plant. Syktyvkar is 650 km from the Pechora Basin.

At Pechora (4), 125 km from the Pechora Basin, and at Kotlas (3), some of the coal moving south from the Pechora Basin along the

Northern rail-line is transferred to river barges and shipped up the Pechora and Northern Dvina rivers. In 1970, 1,170,000 metric tons of Pechora coal was shipped northward along these two rivers--the greater part from Kotlas 500 km along the Northern Dvina to Arkhangelsk (5), 1,300 km from the Pechora Basin. The lesser part is shipped from Pechora 650 km along the Pechora River to Naryan-Mar (7), which is 775 km from the Pechora coal basin. Arkhangelsk is a major river port, sea port, and railroad station as well as a large industrial city. It contains chemical plants, food-processing plants, and a coal-based electric power plant.

From Arkhangelsk and Naryan-Mar, some coal is carried by ocean vessel across the White and Barents Seas to Murmansk (6)--a distance of 550 statute miles from Arkhangelsk and 600 miles from Naryan-Mar. In 1970, 830,000 metric tons of Pechora coal was transported by sea to Murmansk from these two cities. Murmansk has a large oil refinery, an electric power station run on mineral fuel, machinery, metal-finishing, and light metallurgical plants.

Arkhangelsk and Murmansk do not receive all of their Pechora coal by river and sea; most of the Pechora coal distributed to these cities is transported along the Northern and October rail-lines. From Kotlas (3) the railroad route continues to the railway junction of Konosha (8), 350 km southwest of Kotlas and 1,150 km from the Pechora Basin. From Konosha most of the coal is sent south, but a considerable amount is sent north along the October line to Arkhangelsk and Murmansk, which are 400 and 1,125 km, respectively, from Konosha. Konosha contains paper, lumber, and cellulose industries.

Running south from Konosha to Vologda (9), the main Pechora coal route then turns westward at Vologda, where it continues along the October line to Cherepovets (10) and Leningrad (11).

Vologda, 225 km south of Konosha, contains chemical plants, light metallurgical factories, machinery and metal-finishing plants, and food-processing plants.

Cherepovets, 225 km west of Vologda and 1,600 km by rail from the Pechora Basin, has large iron and steelmaking and fabricating plants which absorb most of the Pechora coking coal and a large amount of Pechora fuel coal. Cherepovets also has chemical, building material, and food-processing plants. (Leningrad, 425 km west of Cherepovets and 2,025 km from the Pechora Basin, was described in the Donbass coal transport section.)

3. Pechora Coal Exports to Central Region

From Leningrad, Pechora coal is transported southward along the October line to Moscow (12), located 600 km south of Leningrad and 2,625 km from the Pechora Basin. In 1970, 5.2 million metric tons of Pechora coal were transported along the Northern and October lines to Moscow and the Central economic region.

4. Pechora Coal Exports to Baltic Region

From Leningrad, Pechora coal is sent 350 km west to Tallin (13), already described. From Tallin, the coal is transported along the Baltic rail-line to the other cities in the Baltic economic region located on the line. In 1970, 2 million metric tons of Pechora coal was transported along the Northern, October, and Baltic rail-lines to the Baltic economic region. The 2 million tons imported from the Pechora Basin, together with the 7.5 million tons imported from the Donbass and the Lvov-Volynian basins, constituted the total coal imports of 9.5 million tons of the Baltic region in 1970.

5. Comments on Pechora Coal Transport

The average distance for the transport of Pechora coal is 1,800 to 1,900 km. Even within the Northwest region, the distances of transport are very great, and Murmansk, Arkhangelsk, Vologda, and Leningrad also import coal from other regions, particularly from the Donbass. Transportation accounts for nearly 30 percent of the total cost of delivered coal to points in the Northwestern region--which compares with a national USSR average of 13 percent.

The cost in rubles per ton of Pechora coal and Donets coal for various points in the Northwest region may be compared as follows:

<u>Cities of Coal Demand</u>	<u>Donets Coal</u> (Rubles per Ton, Delivered)	<u>Pechora Coal</u> (Rubles per Ton, Delivered)
Leningrad	10.4	19.5
Arkhangelsk	10.9	18.9
Vologda	9.9	18.4
Murmansk	12.7	-
Syktvykar	-	17.0

It may be noted that on the basis of the percentages given above, while mining costs appear to be somewhat higher in the Pechora compared to the Donbass, the greater part of the differential accrues to the transport portion.

In the near future, it is planned that the fuel balance in the Northwest will be restructured so that oil and gas will replace coal as an energy fuel. According to Gosplan economists, oil and gas from Tyumen could more effectively and more economically replace coal in the Northwest than in any other region in the country.

The present uses of Pechora coal within the Northwest are as follows: 37.7 percent for electric power stations, 27.7 percent for industrial boilers, 7.7 percent for coking and technological needs, 1.5 percent for residential needs, and 15.9 for transportation fuel.

D. Moscow Coal Transport (Figure B-30)

1. Industrial and Energetic Setting

Of the 35.8 million metric tons of coal mined in the Moscow Coal Basin in 1970, 30.2 million of 84 percent were transported within the Central economic region an average distance of 50 km. The coal basin is located 100 to 200 km south of the city of Moscow (1) in the region stretching from Tula (2) to Ryazhsk (3) and contains low quality brown coal with high ash content (30-35 percent; 40-50 percent in some mines), high sulphur content (an average of 4.6 percent), high moisture content (33 percent), and a tendency toward spontaneous combustion.

Seventy percent or 25.1 tons of the coal were transported from the mines over the circular web of rail-lines in the Moscow rail system surrounding the city of Moscow to local electric power plants, including the Novomoskovsk (4) plant located in the heart of the Moscow Basin. Other electric power stations deriving their energy fuel from the Moscow Coal Basin include the Shchekino (5), Cherepet (6), Bryansk (8), Kashira (7), Stupino (10), and Orekhovo-Zuevo (9) power plants.

Fourteen percent or 5.1 million tons of Moscow coal is used in industrial boilers, including the iron metallurgical plant-complex of Tula, which draws its energy coal from the Moscow Coal Basin and its iron ore from the Dedilov mines (11), which are located in the vicinity of the basin. In addition, slightly to the southwest of the Dedilov mines and the Moscow Coal Basin are large iron-quartz and high quality magnetite ores.

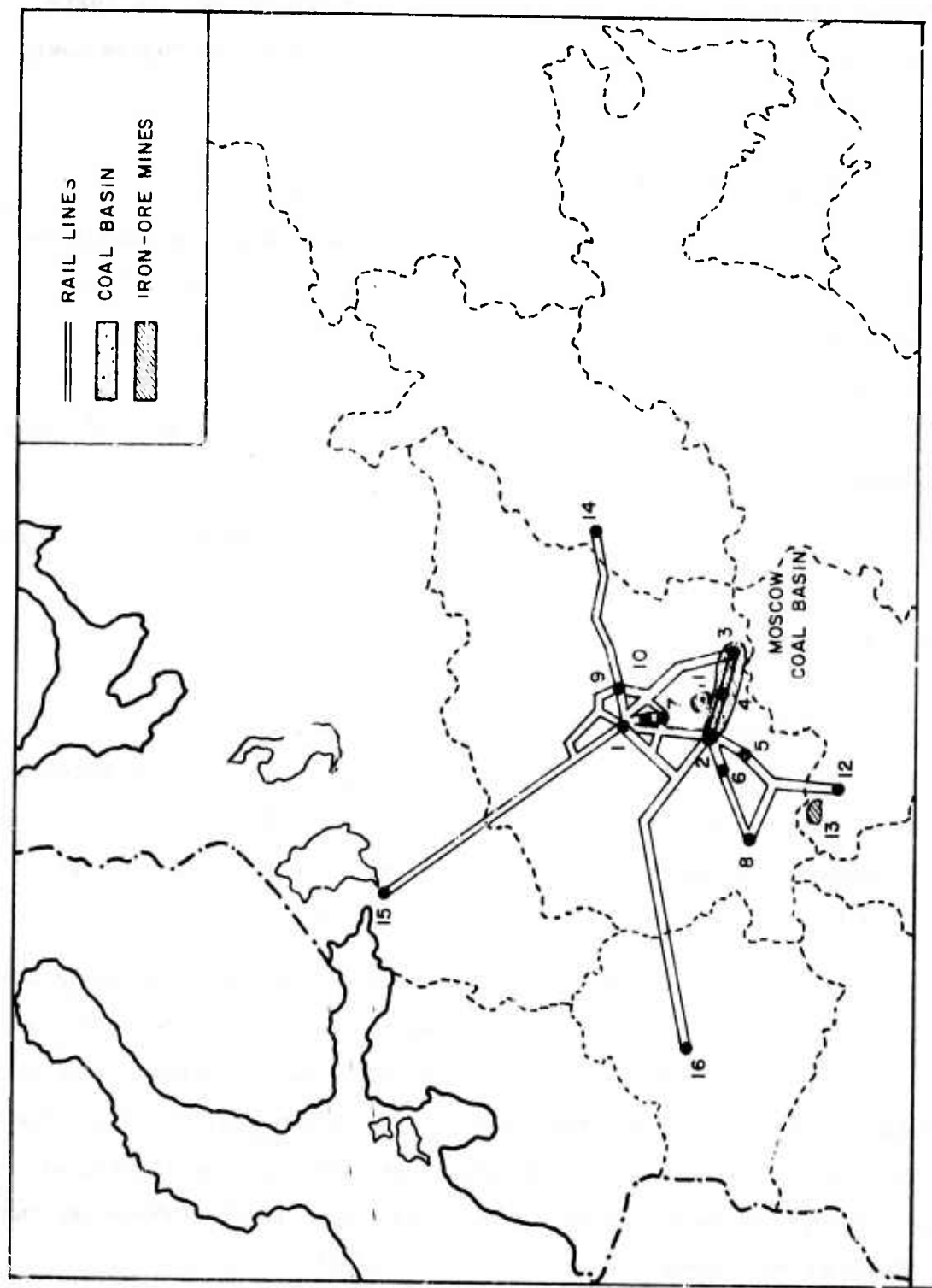


Figure B-30
MOSCOW COAL TRANSPORT

In addition to Tula and Moscow (which has a large transport-machinery industry, electronics, chemical, food-processing, and cast-steel plants), various other cities in the vicinity of the Moscow Basin also use Moscow coal for energy purposes.

2. Moscow Coal Exports to Central Blacksoil Region

Most of the exported coal from the Moscow Basin is dispatched along the Kursk rail-line into the Central Blacksoil economic region, and most of this coal is directed to the Novotula and Novolipets metallurgical plants in Kursk (12), which obtain their iron ore from the Midhailov mines (13). Kursk also has machinery, chemical, and food-processing plants.

In 1970, about 4 million metric tons of Moscow Basin coal were transported to the Central Blacksoil economic region along the Kursk rail-line.

3. Moscow Coal Exports to Other Regions

The Gosplan economists expect to cease all exports of Moscow coal to other regions in the next few years, and in 1970 the coal that was transported to other regions was insignificant in comparison with the overall coal imports of the receiving regions.

In 1970, about 400,000 tons of Moscow coal were dispatched along the Gorkii rail-line to Gorkii (14) in the Volga-Vyatka region. In the same year, about 800,000 tons were dispatched along the October line to Leningrad (15) in the Northwest region, and another 400,000 tons along the Belorussia rail-line to Minsk (16) in Belorussia. The industrial nature of each of these cities has been described in the section dealing with Donbass coal export.

I. Comments on Moscow Coal Transport

Gosplan economists expect to cut back mining at Moscow Coal Basin by 20 percent by 1980. After World War II, the Moscow mines were economically expedient because of the destruction of the transportation system. In 1945, the cost of transporting Donbass coal was one and a half times as great as the cost of mining it. But by 1950 the transportation costs of Donbass coal to the Central region were equal to only 18 percent of the mining costs, and in 1965 the delivered cost of Kuzbass coal, carried a distance of 3,500 km, was less than that of Moscow coal to the coal-users of the Central region. The costs involved in enrichment, condensation, and transportation made Moscow coal 27 percent more expensive (in terms of the production of 1 kilowatt-hour of electric energy) than Kuzbass coal (from open-surface mines) and 17 percent more expensive than Donbass coal (from underground mines) for the electric power stations of the Central economic region.

The uneconomical aspect of Moscow coal mining and transport is elucidated by the following table:

COMPARATIVE COST-ESTIMATE FOR COAL-FUEL FOR THE
ELECTRIC POWER STATIONS OF THE CENTRAL REGION
(Cost per Ton of Coal)

<u>Specific Production Stage</u>	<u>Unit of Measurement</u>	<u>Donbass</u>	<u>Moscow Basin</u>	<u>Kuzbass</u>
Mining	rubles/metric ton	6.4	3.7	2.4
Transport	same	1.3 (avg.: 880 km)	0.1 (avg.: 50 km)	4.3 (avg.: 3,540 km)
Enrichment	same	-	0.4	-
Effective loss (and therefore cost) as a result of the retention of pyrites	same	-	0.05	-
<u>Summary:</u>				
a. per ton of coal concentrates	rubles	7.7	4.2	6.7
b. per ton of conventional fuel (Btu/ton)	-	8.9	11.0	7.6
c. expenditure on fuel for the production of 1 Kwh of electricity	kopecks/Kwh	0.48	0.56	0.43

Note: The average fuel expenditure for 1 Kwh in the new electric power stations is 0.34 kg of conventional fuel. This is equivalent to 2.6 kopecks for Kwh of Kuzbass coal. At the current (August 1973) rate of exchange, this would be 2.9 mills/Kwh. Probably only Bonneville Dam power from the Pacific Northwest would be as cheap.

E. Karaganda Coal Transport (Figure B-31)

In 1970, 38.8 million metric tons of coal were mined in Karaganda Basin, and of this approximately 17.3 million were exported to other regions, and the remaining 21.5 million were used within the boundaries of Kazakhstan.

1. Industrial Setting of Kazakhstan

Kazakhstan is one of the fastest growing industrial regions in the USSR. In addition to nonferrous metallurgy, machinery-production, and chemical and food-processing industries, Kazakhstan also has a number of iron and steelmaking and steel-finishing plants and oil-processing plant-complexes. Practically all of the raw materials used in Kazakhstan's industries are mined within the region itself. Kazakhstan occupies first place in the world in its chrome and vanadium reserves, over half of Soviet copper and zinc reserves, two-thirds of Soviet silver reserves, and three-fourths of Soviet lead reserves. The region also has substantial reserves of gold, oil, gas, and iron ore.

The reserves of mineral, coking, and brown coal--which are distributed in a number of basins including Karaganda (A), Ekibastuzh (B), Lenger (C), and Ubagan (D)--are substantial; and the accelerated rate of mining, as well as the rate of increase in mining productivity, has been greater in Karaganda Basin than in any other coal basin in the USSR.

2. Karaganda Coal Transport to Urals

Some of the coal mined at Karaganda Basin is used in Karaganda (1) itself as energy fuel for the Karaganda electric power station and the Karaganda iron and steelmaking and steel fabrication plants, which obtain their iron ore from the Atasa (2) mines in Central Kazakhstan.

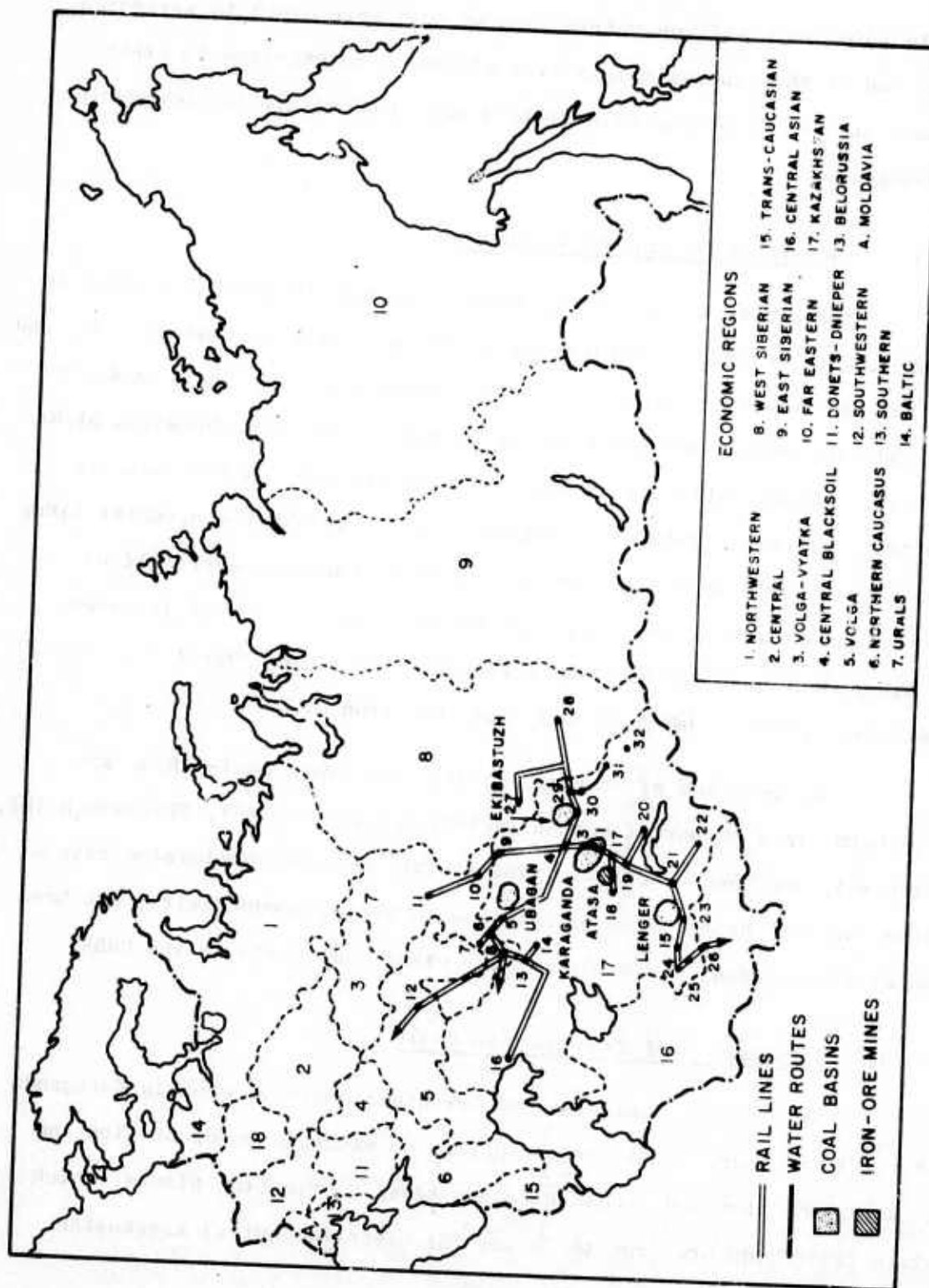


Figure B-31
 KARAGANDA COAL TRANSPORT
 (Karaganda and Ekibastuz Coal Basins)

Most of the coal is transported 50 km north to Temir-Tau (3) and Tselinograd (4). Temir-Tau has a coal-fueled electric power station and an iron and steel conversion plant. Tselinograd, 200 km from Karaganda, is a major railroad junction and industrial center described in the discussion on Kuzbass coal transport.

About two-third of the Karaganda coal entering Tselinograd continues westward along the Northern Kazakh line toward the southern Urals. Some of the coal is dispatched at various points along the way, including Tisakovka (5), which is 600 km by rail from Karaganda Basin and which contains the Sokolov-Sarbaynsk ore-enrichment plant. Tisakovka is surrounded by rich deposits of phosphoritic iron ores.

From Kartaly (6), located in the Ural economic region 800 km from Karaganda, a large portion of the Karaganda coal is transported 100 km west to Magnitogorsk (7), a large steelmaking city described in the Kuzbass coal transport section. The Karaganda coal route also runs to Orsk, 250 km south of Kartaly. The Magnitogorsk iron and steel complex and the Orsk-Khalitov metallurgical plant each use Karaganda coking coal rather than energy coal (40 percent of the coke produced by the Magnitogorsk iron and steel complex is from Karaganda coal).

About a third of the coal arriving in Tselinograd from Karaganda continues north along the Northern Kazakh rail-line to Petropavlovsk (9), where it merges with Kuzbass coal heading west along the Central Urals line to Kurgan (10), and then turns north again, continuing on to Sverdlovsk in the Urals (11), a total rail distance of 1,200 km from Karaganda. The industrial production of each of these cities was described in the Kuzbass coal section.

In 1970, about 11-1/2 million metric tons of Karaganda coal were transported to Magnitogorsk, Orsk, and Sverdlovsk along the Northern Kazakh-Northern Urals and the Northern Kazakh-Central Urals rail systems.

3. Karaganda Coal Transport to Volga Region

The main coal route for Karaganda coal destined for the Volga region is along the Kuibyshev rail-line from Orsk (8) to Kuibyshev (12), 1,700 km by rail from Karaganda. In 1970, 4.3 million metric tons of Karaganda energy coal was transported along this rail-line to the Urals.

Some of the coal leaving Orsk, to which it came via the Northern Kazakh and Southern Urals lines via Tselinograd and Kartaly, is transported further south, where it enters back into Kazakhstan, to the cities of Aktuibensk (13), 1,225 km by rail from Karaganda. Aktuibensk contains a coal-fueled electric power station and a ferroalloy plant. The Khom-tau chromium mines (14) are close by Aktuibensk.

Further south from Aktuibensk along the Western Kazakh line is the city of Guryev (16), 1,825 km from Karaganda, which contains oil refineries, machinery plants, and steel fabrication plants, as well as a coal-fueled electric power station.

4. Central Asia and Southern Kazakhstan

The southern coal route for Karaganda coal runs from Karaganda to Zharyk (17), 125 km south of Karaganda on the Central Kazakh line. Zharyk is a railroad junction from which some of the coal is dispatched 375 km westward to the copper mines, factories, and building material plants of Dzhezkazgan (18).

Some of the coal continuing south on the Central Kazakh line is dispatched toward the east at Mointy (19), where it is carried by rail to Balkhash (20), 425 km from Karaganda. Balkhash also has copper mines, copper plants, and machinery production plants.

Continuing south along the Central Kazakh line, the Karaganda coal route divides into two directions at Berlik (21). Here some of the coal is transported east to Alma-Ata (22), 1,075 km by rail from Karaganda,

the capitol of Kazakhstan and a large industrial city with machinery and nonferrous metallurgical plants, building-material plants, food-processing plants, and a coal-fueled electric power station.

The southwesterly run of the Karaganda coal route from Berlik continues along the Southern Kazakh rail-line to Dzhambul (23), 950 km from Karaganda, the center of several industries including chemical, food-processing, and mineral fertilizer industries. Dzhambul is situated on a large phosphorite reserve, which is exploited by Dzhambul chemical plants for the needs of Kazakhstan and Central Asian agriculture.

Southwest of Dzhambul 175 km on the Karaganda coal route is the city of Chimkent (15), which has a coal-fueled electric power plant, chemical and machinery plants, and a large lead-processing plant. From Chimkent the Karaganda coal route continues west to Arys (24) and then south along the Central Asian line to Chengeldy (25), the last Kazakhstan city on the southern coal route, 1,300 km by rail from Karaganda. Chengeldy contains a coal-fueled electric power plant. From Chengeldy the route continues on to Tashkent (26), 1,350 km from Karaganda, and other cities in Central Asia.

Tashkent was described in the discussion on Kuzbass coal transport. In 1970, 1.5 million metric tons of Karaganda coal were transported south along the Central Kazakh, Southern Kazakh, and Central Asian rail-lines to Tashkent. Although the mines of Lenger Basin (C) in Southern Kazakhstan, as well as various minor Central Asian mines, are closer to Tashkent and the cities of Southern Kazakhstan, delivered Karaganda coal is half the cost of local Lenger Basin coal because of the severe difficulties and expenses incurred in mining local coal.

F. Ekibastuz Coal Transport (Figure B-31)

1. Ekibastuz Exports to Other Regions

The brown coal in Ekibastuz (B) Coal Basin is used entirely as energy fuel. Most of it is used in the vicinity of Ekibastuz and in Eastern Kazakhstan, but in the 1960s several million tons were exported to the Urals. However, Soviet planners citing the irrational economic costs in transporting Ekibastuz coal to the Urals, where Karaganda, Kuzbass, and local Ural coals could be used more more economically without the inordinate waste entailed in transporting Ekibastuz brown coal to such distant destinations, have cut back Ekibastuz exports to the Urals to an insignificant amount.

At the same time, Ekibastuz coal exports to the Omsk (27) and Barnaul (28) districts of Western Siberia, which are cheaper than local Kuzbass coal by 1 ruble per delivered ton, have been expanded from an insignificant amount in the sixties to about 6.6 million tons in 1970. (Omsk is 775 km by rail and Barnaul 625 km by rail from Ekibastuz.) In late 1971 and early 1972, an auxiliary track was laid from Ekibastuz Coal Basin (B) to Pavlodar (29) in order to speed up the transport of Ekibastuz coal to Western Siberia.

2. Ekibastuz Coal Transport within Kazakhstan

Most of the Ekibastuz coal used within Kazakhstan is transported within the vicinity of Ekibastuz Basin. Some is transported 250 km west to Tselinograd (4) (described in the Kuzbass coal transport section), but most of it is used in the electric power plants of Ekibastuz, and Pavlodar (29), 125 km east of Ekibastuz. In 1970, 190,000 tons of Ekibastuz coal were shipped by river barge from Pavlodar, down the Irtysh River, to the electric power plant of Yermysk (30), 25 km from Pavlodar, and the electric power plant and industrial boilers of Semipalatinsk (31),

300 km from Ekibastuz, and Ust-Kamenogorsk (32), 150 km from Semipalatinsk and 450 km from Ekibastuz.

The cost of mining Ekibastuz coal by strip mining methods is less than 2 rubles per ton of conventional fuel; the delivered cost of 1 ton of (conventional fuel) Ekibastuz coal to Ust-Kamenogorsk is 3.3 rubles per ton. The delivered cost of one ton of Ekibastuz coal in Omsk is 3.0 rubles per ton; that of Kuzbass coal (from open-pit mines) is 4.1 rubles per ton.

3. Comments on Karaganda and Ekibastuz Coals

The use of Karaganda and Ekibastuz coal is as follows: 32.4 percent for electric power stations, 14.1 percent for industrial boilers, 14.3 percent for metallurgy, 13.8 percent for residential needs, and 11.6 percent for transportation fuel.

In the future, Soviet planners would prefer to use the cheap open-pit mined coals of Kazakhstan as fuel for electric power stations and to transmit electricity to other economic regions, rather than ship coal. Imported Kuzbass coal is cheaper for Kazakhstan metallurgical plants than local Karaganda coal. The high ash content (23.9 percent) of Karaganda coal reduces the raw coal down to 51.2 percent of its original tonnage, as a result of the enrichment process, compared with 76.7 percent for Kuzbass coal. Moreover, Karaganda coal still has 9.5 percent as compared to 8.3 percent for Kuzbass coal, even after the enrichment process. The enrichment process costs 2.5 rubles per ton for Karaganda coal and 1.4 rubles per ton for Kuzbass coal.

The comparative costs of mining and transporting Karaganda coal to various points in Kazakhstan has been estimated by Soviet Gosplan economists as follows:

<u>Coal Origin</u>	<u>Destination</u>	<u>Delivered Cost per Ton of Conventional Fuel</u>
Karaganda	Lisakovka	8.4
Kuzbass		5.6
Karaganda	Tselinograd	7.3
Kuzbass		4.5
Karaganda	Alma-Ata	8.6
Kuzbass		5.6
Karaganda	Chimkent	8.9
Kuzbass		6.6
Karaganda	Guryev	10.4
Kuzbass		6.7

G. East Siberian Coal Transport (Figure B-32)

1. Kansko-Achinsk Basin

In 1970, approximately 20 million metric tons of primarily brown coal were mined at Kansko-Achinsk Basin (K), of which 2.4 million tons were exported to other regions and the remainder used within the confines of the Eastern Siberian economic region.

Within the region most of the Kansko-Achinsk coal is used in electric power stations in the basin itself--the Nazcirovo (1), Statsko-Bogotolsk (2), and Sraha-Borodin (3) power plants--as well as in Krasnoyarsk (4) and Kansk (5), which are two industrial cities located on the edge of the basin.

In addition to coal-fueled electric power plants, Krasnoyarsk and Kansk have major industries. Krasnoyarsk has chemical, paper-producing, and heavy machinery plants as well as food-processing and lumber plants. Krasnoyarsk is also the largest city in Eastern Siberia, containing over

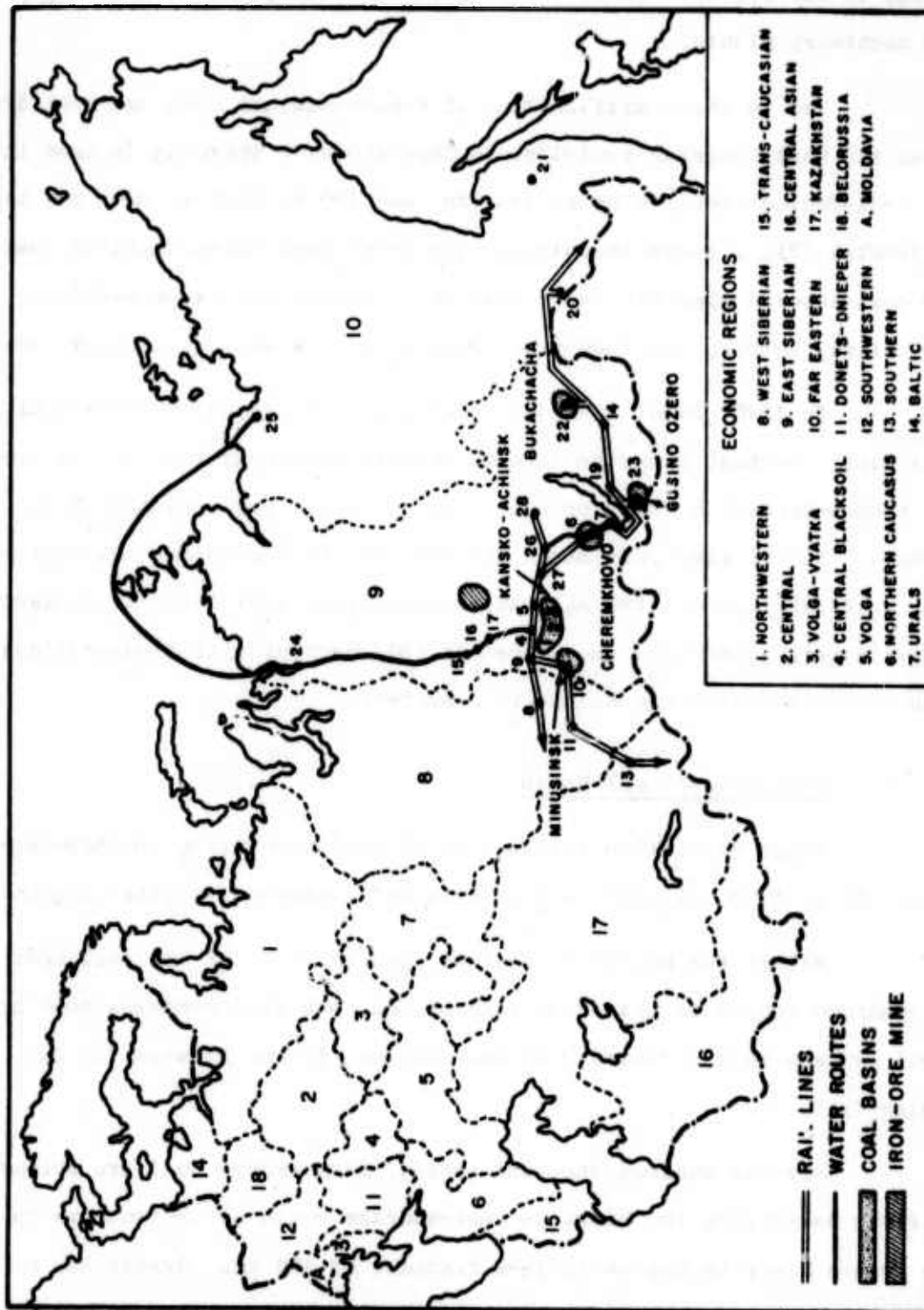


Figure B - 32
 EAST SIBERIAN COAL TRANSPORT

half of the population and most of the industry, and consuming most of the energy in the region. Kansk contains lumber mills, food-processing plants, and machinery plants.

Two to three million tons of Kansk-Achinsk coal are sent 575 km along the East Siberian rail-line to Chermkovo (6) where it is used in the coal-fueled electric power station, and 100 km further down the line to Irkutsk (7), a large industrial city which uses Kansk-Achinsk coal in its coal-powered electric power station. Irkutsk has large machinery production, lumber, and food-processing plants as well as leather works.

In 1970, about 2 million metric tons of Kansk-Achinsk coal were sent along the East Siberian line to Anzhero-Sudzhensk (8), 325 km from the Kansk-Achinsk Basin, for use in the electric power plants of the Kuzbass. In the same year about 400,000 tons of Kansk-Achinsk coal were sent to Kazakhstan via the Achinsk (9)-Minusinsk (10) line of the East Siberian rail system and the Minusinsk (10)-Barnaul (11)-Semipalatinsk (13) line of the Siberian and Kazakh rail systems.

2. Chermkhovo Coal Basin

About 25 million metric tons of coal were mined in Chermkhovo Basin (C) in 1970, of which 3.9 million were exported to other regions.

Within the region of Eastern Siberia, most of the coal from Chermkhovo (which is primarily mineral coal but also contains some brown coal) is used in the vicinity of Chermkhovo (6) and Irkutsk (7) for energy fuel.

Several hundred thousand tons of Chermkhovo coal are shipped by river barge from the Makarevo coal-storage basin at Chermkhovo up the Angara River to Bratsk (26)--a distance of 400 km. Bratsk has a cellulose and paper industry as well as lumber plants and a 4,600 megawatt power plant. From Bratsk some of the coal shipped by barge via the Angara

River, together with coal sent to Bratsk via the Cheremkhovo-Tayshet (27) and Tayshet-Bratsk rail-lines, is sent along the Bratsk line to Ustkut (28), which is located 250 km by rail from Bratsk and contains lumber and ship-repair and ship-machinery factories as well as a coal-fueled electric power station.

Some Cheremkhovo coal is shipped 750 km westward along the East Siberian line to Krasnoyarsk, from which half a million tons of energy coal is dispatched by river barge up the Yenisey River to the lumber and ships machinery plants of Eniseysk (15), Maklakov (16), and Abalakovo (17), many of the residents of which work in the Anyaro Pitsk iron ore mines (18). About 5,000 tons were shipped in the opposite direction all the way to Dudinka (24), 1,650 km from Krasnoyarsk, from which the coal was carried by ocean freighter 1,560 miles to the Far Eastern part of Tiski (25) on the Tena River.

Some of the coal of Cheremkhovo Basin is sent to Ulan-Ude (19), which is 475 km east of Cheremkhovo via the East Siberian rail-line. Besides having a large coal-fueled electric power station, Ulan-Ude also has chemical plants, transport machinery plants, and textile and food-processing plants.

In 1970, about 400,000 million metric tons of Cheremkhovo coal was sent westward along the East Siberian line to Anzhero-Sudzhensk (8) and other cities and stations in the Kuzbass.

In the same year 2.5 million tons of Cheremkhovo coal was sent eastward along the East Siberian and Baykal rail-lines into Blagoveshchensk (20), which is 2,200 km from Cheremkhovo and other cities in the Far East economic region. Blagoveshchensk is a center of shipbuilding, machinery production, food processing, and lumber-finishing.

3. The Bukachacha Basin

The Bukachacha Basin (22) in the Chita coal region contains coking coal of extraordinarily high quality. About 1 million tons of coal were mined at Bukachacha in 1970, and about 400,000 tons of this were sent to steel plants in the Far East, particularly to the steel plants of Kamsomolsk-na-Amure. This is a rail station and a river port (on the Amur River) and contains, in addition to an iron metallurgical industry, oil refineries, building materials plants, chemical plants, and ship building and lumber plants, as well as a coal-fueled electric power station.

The rest of Bukachacha coal is used in Chita (14), which is 350 km from Bukachacha and is a large industrial city with chemical and heavy machinery plants, food-processing, and saw mills and lumber plants.

4. Other Coal Basins in Far Eastern Region

The two other major coal basins in the Far East are the Minusinsk Basin (M) and the Gusino Ozero coal-fields (23). The Minusinsk coal was used in the coal-fueled electric power station of Minusinsk (11), and a small amount was exported together with Kansk-Achinsk coal to Kazakhstan. The brown coal of Gusino Ozero (23) was used in the electric power station of Ulan-Ude (19), located 125 km north of Gusino Ozero by rail.

5. Costs of and Comments on Eastern Siberian Coal

The following tabulation presents costs of Eastern Siberian coal:

<u>Basin</u>	<u>Cost of Mining</u> (Rubles/Metric Ton)	<u>Cost to Various Users</u>	
Kansko-Achinsk	1.1	Krasnoyarsk	2.9
		Irkutsk	4.6
Minusinsk	5.6	Krasnoyarsk	10.0
Cheremkhovo	2.6	Krasnoyarsk	5.5
		Irkutsk	4.3
		Ulan-Ude	5.6
		Chita	7.2
Bukachacha	7.5	Chita	10.1

Brown coal is mined in the Kansko-Achinsk, Minusinsk, and Chennogorsk basins and to a lesser extent in the Cheremkhovo Basin. High-quality, easily-transportable brown coal is mined at Minusinsk. Mineral coal is mined primarily at Cheremkhovo, Gusino Ozero, Norilsk, and Bukachacha, and at the latter particularly, high-quality coking coal is extracted.

The uses of coal within the Eastern Siberian region are as follows:

<u>Percent</u>	<u>Use</u>
42.5	Electric power stations
11.4	Industrial boilers
7.8	Metallurgy
4.9	Industrial and governmental heating
4.7	Residential needs
14.6	Transportation

Future plans call for the continuing conversion of railway locomotive and river transport engines from coal to diesel and electric and internal-combustion engines. However, coal will continue to be the dominant energy fuel in Eastern Siberia:

<u>Form of Fuel</u>	<u>Percent of All Fuels Used</u>	
	<u>1965</u>	<u>Next 5-10 years</u>
Coal	81.0	84-85
Fuel oil	3.8	4-5
Gas	-	5-7
Wood	15.2	2-3

Electric power stations will continue to multiply, and about 60 percent of their fuel will come from the Kansk-Achinsk Basin alone. (Huge power stations of 3.5-4 megawatt capacity will be built in the Kansk-Achinsk area and will form the greater part of the EES (Unified Electric-power Stations of Central Siberia).) However, the transmission of Eastern Siberian coal-fuel in the form of electricity over long distances significantly lowers its effectiveness and thus raises the cost of the energy by a considerable amount. In the next few years, smaller electric power stations will be built in Azeisk, Kharanor, Tugansk, and several other smaller mining areas.

H. Far East Coal Transport (Figure B-33)

In 1970, 25 million tons of coal were mined in the basins of the Far East, and of this about 200,000 tons were transported out of the region. The principal basins being mined in the Far Eastern region are the Bureya (B), Raichikhinsk (R), Primorye, Sakhalin (S), Magadan (M), and Yakutsk (Y) (or Lena) basins.

1. Raichikhinsk Basin

Raichikhinsk is the only basin in the Far East exporting coal to another region. In 1970, 200,000 tons of Raichikhinsk coal were transported along the Baykal rail-line to Chita (1). The industrial region in which Chita is situated is described in the section on Eastern Siberian coal transport. Some Raichikhinsk coal is also transported by

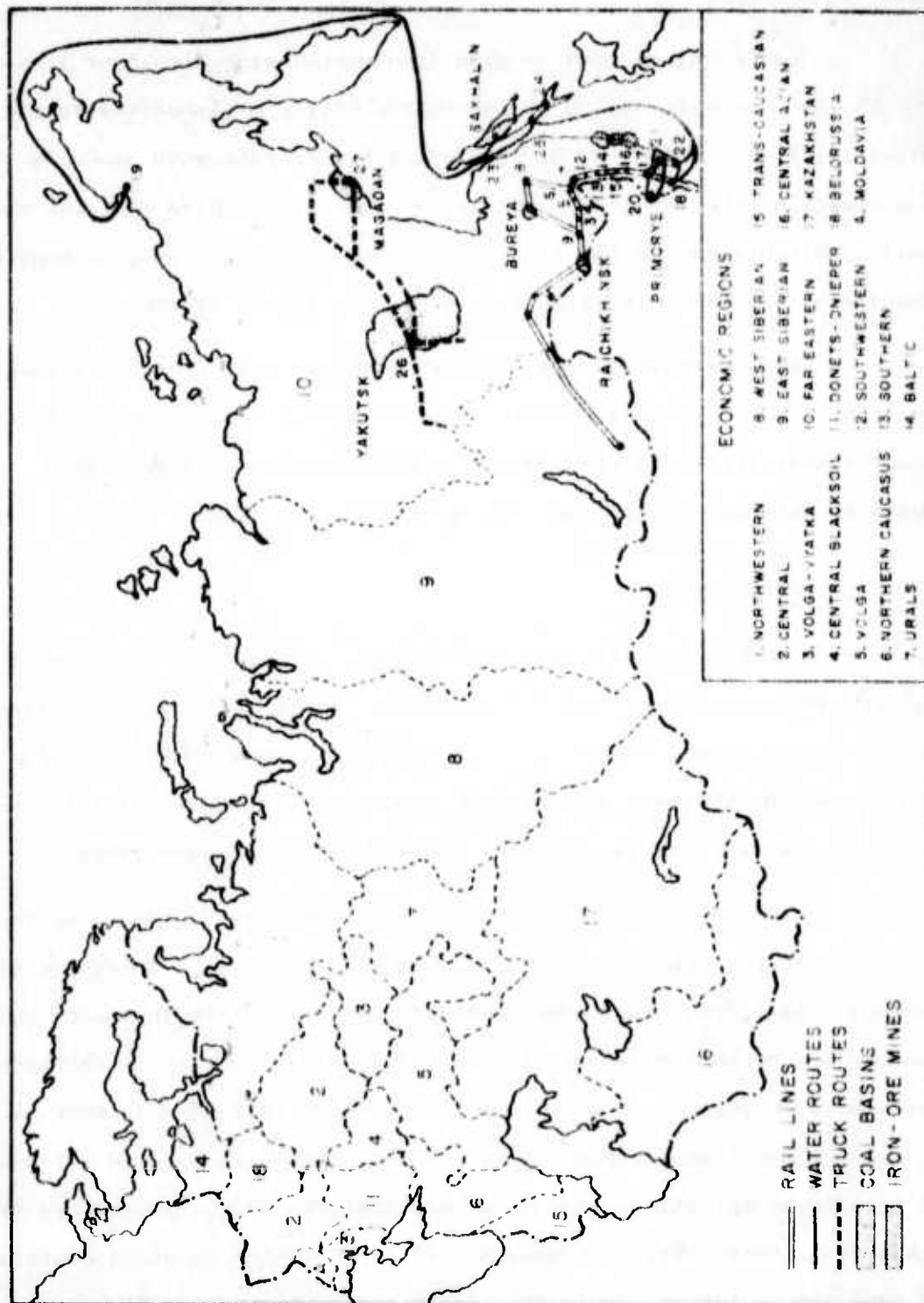


Figure B-33
 FAR EAST COAL TRANSPORT

rail to Blagoveshebensk (2), which was also described in the Eastern Siberian section.

Raichikhinsk coal is also transported along the Amur line of the Far Eastern rail system to the nearby cities of Isbestkovaya (3), Birakan (4), Bira (5), and Birobidshan (6). Szvestkovaya produces construction materials; Birazhen has a paper plant; Bira contains saw mills. Birobidshan is the largest of these towns and contains machine manufacturing plants, textile factories, and lumber plants.

From Birobidkan (6), the Raichikhinsk coal route continues along the Amur line to Khabarovsk (7). Khabarovsk has a coal-fueled electric power plant, oil refineries, heavy machinery manufacturing plants, building material plants, and food-processing and lumber plants.

2. Bureya Basin

The Bureya Basin has the largest coal reserves of all of the Far Eastern basins. Bureya coal is transported along the Khabarovsk lines in both directions: toward the industrial city of Komsomolsk-na-Amure (8) and toward the railroad junction and coal-holding station of Volochaev (9), which lies at the intersection of the Khabarovsk and Amur lines.

From Volochaev (9), some coal is transported west along the Amur rail-line to the machine-producing industrial centers of Belogorsk (10), Svobodnyi (11), and Blagoveshebensk (2). Westward from Volochaev and southward from Komsomolsk-na-Amur, Bureya coal is carried to Khabarovsk. From there, Bureya coal moves down the Primorye rail-line to Khor (12), a chemical and lumber producing city south of Khabarovsk, and various other lumber-producing cities, including Dormidontovka (13), Vyazemskaya (14), Bikin (15), Iman (16), and Ussurnsk (17), the latter of which contains, in addition to lumber, factories, machinery-producing plants and sugar mills.

From Ussurusk, Bureya coal continues on its southern run to Vladivostok (18), where some of it, together with some coals from the local Primorye area (P), are loaded onto ocean freighters and shipped northeast on the Sea of Japan to Kholmsk (25) on the western shore of Sakhalin Island. There it is distributed along the Sakhalin line to the paper mill and fishery cities down the west coast and over to Yuzhno-Sakhalinsk (24), the largest city of the island and a center of machinery production and food-processing as well as the lumber and paper industries.

From Kholmsk some of the coal continues to move by ocean freighter along the Pacific coast to the port of Pevek (19), a meat and dairy industry center, in the Chukotka district at the extreme northeastern corner of the USSR. In 1970, 1 million tons of Bureya and Primorye coal were shipped by ocean freighter from the Primorye region to the Chukotka district.

3. Primorye Basin

Most of the Primorye coal is brown coal which is used in the coal-fueled electric power stations of Tavrichanka (20), and Artem (21) (located within the basin) as well as in the electric power plants of Vladivostok (18) and Nakhodka (22). Each of these latter cities is a major rail station and ocean port. Vladivostok and Nakhodka both have large nonferrous metallurgical plants, which obtain their raw ore from the gold mines of Blagodatnyi (A) and the polymetallic ore mines of Tetyukhe (B) and Kabaleroovo (C). In addition, Vladivostok contains a large shipbuilding industry, food-processing plants and lumber plants. Nakhodka has machinery-production and building-material (including cement) plants.

4. Sakhalin Basin

The Sakhalin Basin is the source of energy-fuel for the electric power station of Aleksondrovsk-Sakhalinskii (23) as well as the paper mill

and fishery cities of western Sakhalin and the industrial city of Yuzhno-Sakhalinsk (24), which were described earlier in this section.

About 700,000 tons of Sakhalin coal, or about 14 percent of the total amount of coal mined in Sakhalin, were transported by ocean freighter to Nakhoda (22) in 1970. In the same year about 300,000 tons of coal were shipped by sea from Nakhodka to Sakhalin island (described earlier). This coal transport has been described as irrational and wasteful by leading Gosplan economists who hope to prevent these movements in the future.

5. Yakutsk and Magadan Coal Basins

Yakutsk and Magadan coals are used almost entirely in their respective mining regions. About 60,000 tons of Magadan coal are delivered over 150-200 km of hard-surfaced roads by truck to Yakutsk (26) and the same amount of Yakutsk coal is delivered by truck to Magadan (27).

6. Comments on Far Eastern Coal

Mineral coals come primarily from the Yakutsk and Sakhalin basins. Future plans call for the conversion of electric power stations in the Northeastern part of the region from coal-fuel to diesel and atomic fuel and to the use of local coal for coking.

Three-fourths of the brown coal comes from Raichikhinsk Basin and the Bureya Basin. Electric power stations use 32.4 percent, transport 23 percent, and industrial boilers 7.9 percent. The brown coal of Raichikhinsk, used in powering steam engines of the railway and water fleet, has a high ash content which produces much grit. This in turn causes enormous fuel losses (through waste) and the frequent need to remove the locomotives in order to clean out the ash and grit deposits. The conversion of transportation fuel from coal to diesel and electric power will reduce these costs and will allow certain smaller, high-cost/low-output mines to be shut down.

The comparative costs of delivered Raichikhinsk coal to various cities are as follows:

	<u>Cost</u> <u>(Rubles per Ton)</u>
Blagoveshchensk	4.6
Khabarovsk	5.0
Komsomolsk	5.9
Chita (Eastern Siberia)	11.1

I. Coal Basins of Urals (Figure B-34)

In 1970, over 70 million metric tons of coal were mined in the Urals region, of which 6.8 million tons were exported to other regions and the remainder used within the Urals. As mentioned in the earlier discussion on Kuzbass coal transport, the Urals embraces one of the most concentrated and diversified industrial regions in the country. Most of the coal mined in the Urals itself is brown coal used for energy fuel; most of the coal used in the coking plants of the iron and steelmaking complexes of the Urals is imported from the Kuzbass and Karaganda Basin.

1. Kizel Coal Basin

Most of the mineral coal (as opposed to brown coal) mined in the Urals comes from Kizel Basin, and most of the small amount of coal transported out of the Urals to other regions comes from this basin. In 1970, 12.7 million metric tons of mineral coal were mined at Kizel, of which 5.8 million were exported to other regions.

Coal is transported 100 km by rail from Kizel Basin to Perm (1), from which it is transported 425 km along the Sverdlovsk rail-line to Kirov (2) in the Volga-Vyatka region. In 1970, 5.8 million tons of Kizel coal was transported to Kirov along this railroad route; and of this, about

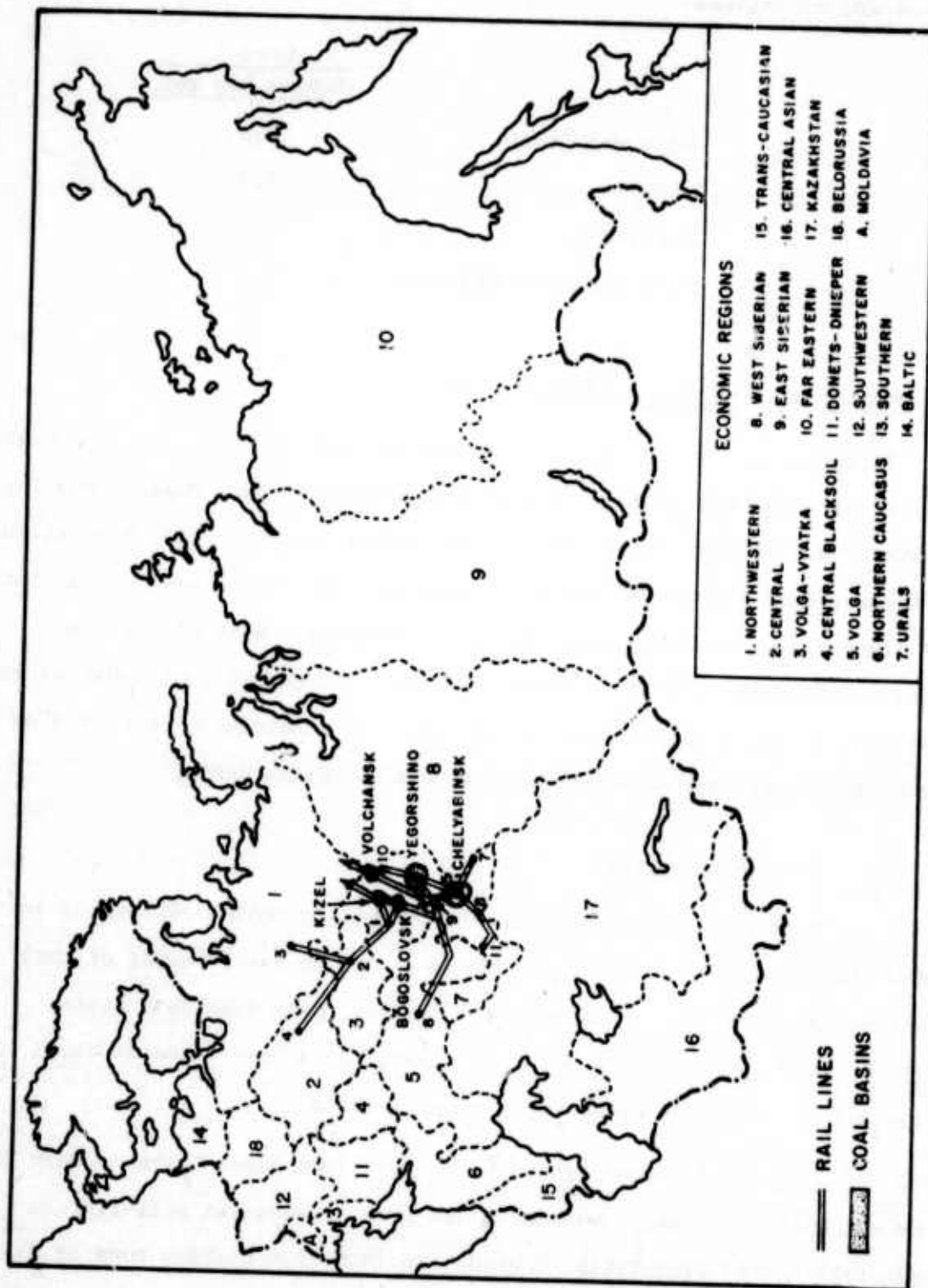


Figure B-34
COAL BASINS OF THE URALS REGION

2 million tons were distributed within the Volga-Vyatka region. (Kirov's industries were described in the Kuzbass coal transport section.)

From Kirov, some of the coal is taken 325 km north along the Kirov-Kotlas line of the Northern rail system to Kotlas (3) in the Northwestern region. Kotlas is a major rail junction connecting the Northern rail system (and thus the Northwestern economic region) with the Gorkii and Sverdlovsk rail lines (and thus with the Volga-Vyatka and Urals economic regions). Kotlas is also a major industrial city with shipbuilding and heavy machinery plants, paper mills, food-processing plant, and building-material plants. Kotlas also has a coal-fueled electric power plant. In 1970, 2.2 million metric tons of Kizel coal was transported along the Kuibyshev and Kirov-Kotlas rail lines to Kotlas and the Northwestern region.

Finally, a smaller amount of the coal transported from Kizel Coal Basin to Kirov continues along the Kirov-Yaroslavl rail-line to Yaroslavl(4) in the Central economic region. Yaroslavl, 1,025 km by rail from the Kizel Coal Basin, is a major industrial city with chemical plants, heavy machinery (including transport machinery) plants, textile factories, and food-processing plants, as well as a coal-fueled electric power station. In 1970, about 1.6 million metric tons of Kizel coal was transported along the Kuibyshev and Kirov-Yaroslavl rail lines to Yaroslavl and the Central economic region.

The Kizel coal remaining in the Urals is used primarily in Perm, whose industries were described in the section on Kuzbass coal transport. The Kizel coal dispatched to Perm is put to the following uses: 44 percent for electric power stations, 22 percent for coking plants, 13 percent for industrial boilers, 17 percent for residential needs, and 4 percent for various other needs.

2. Chelyabinsk Coal Basin

Chelyabinsk Coal Basin, which produces brown coal, is the largest basin in the Urals. In 1970, about 30.3 million metric tons were mined in this basin, and of this only 1 million tons were exported beyond the boundaries of the region.

About 75 percent of the coal mined at Chelyabinsk is used in the coal-fueled electric power stations of Chelyabinsk (5), Troitsk (6), 125 km by rail from Chelyabinsk, and Kurgan (7), 225 km by rail from Chelyabinsk. About 15 percent of the coal is used in industrial boilers in the iron and steelmaking and nonferrous metallurgical plants of Chelyabinsk, and the remainder is used for various other needs within Chelyabinsk. In 1970, about 1 million metric tons of Chelyabinsk coal were transported along the Kuibyshev rail-line to Kuibyshev (8), an industrial city described in the Donbass coal transport section.

3. Yegorshino Coal Transport

About 1.3 million tons of mineral coal were mined in Yegorshino Coal Basin in 1970. All of this coal was used within the Urals economic region, and about 17 percent of the coal mined at Yegorshino was used in the Yegorshino electric power plant as fuel. Twenty-two percent was used in coking plants in the iron and steel producing complex of Sverdlovsk (9), 300 km from Yegorshino Basin; and about 49 percent was used in industrial boilers in Sverdlovsk. The remaining 34 percent was used for local residential and transport needs.

4. Volchansk and Bogoslovsk Coal Basins

About 11 percent of the 25.7 million tons of brown coal mined in these basins in 1970 was used in the Serov electric power station of Serov-Sort (10). The remainder was transported by rail from Serov-Sort to Chelyabinsk Province, where 83 percent (93 percent of the remainder)

was used in electric power stations in Chelyabinsk (5), Kurgan (7), Troitsk (6), and Magnitogorsk (11). The distances by rail from the Volchansk and Bogoslovsk basins to each of these electric power plants are as follows: Chelyabinsk, 500 km; Kurgan, 725 km; Troitsk, 625 km; and Magnitogorsk, 900 km. The remaining 6 percent (or 7 percent of the coal shipped to Chelyabinsk Province) was used in industrial boilers in Chelyabinsk.

5. Comments on Mining Costs in the Urals

In spite of the transportation costs involved in inter-regional cargo, Kuznets and Karaganda coals are generally cheaper in the Urals than local coals--even near the Ural coal basins themselves. Thus, the cost of Kizel coal in Perm (in terms of conventional fuel) is 11.3 rubles per ton, compared with 5.8 for Kuzbass (surface-mined coal). This is due to the high mining costs involved in mining the underground, long-exploited mine shafts of Kizel Basin, which has the deepest mining shafts in the USSR. Similarly, the cost of Chelyabinsk brown coal in Chelyabinsk is 14.4 rubles per ton of conventional fuel, compared with 8.9 rubles per ton for Karaganda coal and 5.2 rubles per ton for Kuzbass coal. Most of the coal in Chelyabinsk Basin is mined underground and in addition, has a lower calorific content than the mineral coals of Karaganda and Kuznets Coal Basins.

SOVIET COAL (NON-COOKING) EXPORTS

Country of Destination	1970		Transport (Mode: Route)	Approximate Distance
	Amount (thousand tons)	Value (thousand rubles)*		
Austria	787	8,190	Rail: Chop-Budapest-Vienna	550 km
Belgium †	53	259	Rail: Brest-Berlin-Enschede-Brussels	1,500 km
Bulgaria	126	2,579	Rail: Reni-Galati-Varna	400 km
Hungary †	378	4,917	Rail: Chop-Miskolc	150 km
GDR †	3,319	44,054	Rail: Brest-Berlin	750 km
Greece	46	690	Rail: Reni-Galati-Sofia-Salonica	900 km
Denmark	544	2,307	Ocean freighter: Kaliningrad-Copenhagen	400 miles
Egypt	537	6,077	Ocean-freighter: Odessa-Alexandria	1,300 miles
Italy	2,039	11,733	Ocean-freighter: Odessa-Naples	1,700 miles
North Korea	587	9,392	Rail: Ussuriysk-Khasan-Korean rail system	150 km
Netherlands	33	150	Rail: Brest-Berlin-Enschede	1,200 km
Poland †	7,072	98,026	Rail: Brest-Warsaw	200 km
Romania †	410	4,996	Rail: Reni-Galati	60 km
FRG	32	224	Rail: Numerous rail lines, including Brest-Berlin-Hannover	900 km
Finland	449	4,498	Rail: Leningrad-Viborg	150 km
France	1,526	22,188	Rail: Numerous rail lines	100 km
Czechoslovakia	2,706	30,752	Rail: Uzhgorod-Kosice	400 miles
Sweden	555	3,723	Ocean freighter: Kaliningrad-Stockholm	8,500 miles
Cuba	51	849	Ocean freighter: Odessa-Havana	800 km
Yugoslavia	1,139	10,577	Rail: Reni-Galati-Bucharest-Belgrade	500 miles
Japan	2,855	31,119	Ocean freighter: Nakhodka-Niigata	500 km
Mongolia	2	29	Rail: Ulan Ude-Naushki-Ulan Bator	500 km

* f.o.b. Russian border.

† COMECON countries.

MINERAL COAL AND ANTHRACITE EXPORTS FROM THE USSR

Country of Destination	1970		1971	
	Amount (thousand tons)	Value (thousand rubles)*	Amount	Value
Austria	787	8,190	734	12,301
Belgium	53	259	30	352
Hungary†	378	4,917	346	4,861
Bulgaria†	136	2,579	246	5,135
GDR†	3,319	44,054	3,854	49,392
Greece	46	690	31	737
Denmark	544	2,307	529	3,559
Egypt	537	6,077	499	7,561
Italy	2,039	11,733	1,769	22,469
North Korea	587	9,392	500	8,211
Netherlands	33	150	-	-
Poland†	7,072	98,026	8,382	118,229
Romania†	410	4,996	406	5,196
FRG	32	224	31	215
Finland	9,449	4,498	511	7,297
France	1,526	22,188	1,420	22,687
Czechoslovakia†	2,706	30,562	2,915	34,360
Sweden	555	3,723	327	3,042
Cuba	51	848	78	1,361
Yugoslavia	1,139	10,577	1,144	17,441
Japan	2,855	31,119	2,450	32,773
Mongolia	2	29	2	38
Total	34,256	297,138	26,210	357,217
COMECON	14,021 (41% of total)		16,155 (62% of total)	

* f.o.b. Russian border.

† COMECON countries.

COKING COAL EXPORTS FROM THE USSR

Country of Destination	1970		1971	
	Amount (thousand tons)	Value (thousand rubles)*	Amount	Value
Bulgaria†	136	2,579	246	5,135
Hungary†	559	11,115	628	13,743
GDR†	1,498	28,902	1,294	26,779
Denmark	116	2,489	10	377
North Korea	106	3,009	159	4,549
Romania†	833	16,329	1,080	22,875
Finland	598	18,663	579	22,709
Sweden	126	2,579	147	3,742
Cuba	38	879	54	1,671
Mongolia	1	27	1	26
Czechoslovakia†	-	-	75	1,710
Total	4,011	86,571	4,273	103,316
COMECON	3,026 (76% of total)		3,323 (78% of total)	

* f.o.b. Russian border.

† COMECON countries.

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PADC is the principal AFSC organization charged with planning and executing the USAF exploratory and advanced development programs for electromagnetic intelligence techniques, reliability and compatibility techniques for electronic systems, electromagnetic transmission and reception, ground based surveillance, ground communications, information displays and information processing. This Center provides technical or management assistance in support of studies, analyses, development planning activities, acquisition, test, evaluation, modification, and operation of aerospace systems and related equipment.

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