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ECONOMIC INTELLIGENCE REPORT

PETROLEUM RESOURCES OF THE URAL-VOLGA AREA OF THE USSR

CIA/RR 61

15 August 1955

CENTRAL INTELLIGENCE AGENCY

OFFICE OF RESEARCH AND REPORTS

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CIA-RDP79R01141A000500110002-1

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(ORR Project 25.635)

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FOREWORD

This report is a summary of and an annex to a comprehensive geologic report -- a petroleum resource study -- on the Ural-Volga area of the USSR [redacted] It also contains an evaluation of the subject based on the findings of the geologic report. The geologic report is summarized in Sections I and II (except II, D). A quantitative evaluation of the potential petroleum resources of the Ural-Volga area is given in Section II, D, and forecasts of petroleum production in the area are given in Section III. 50X1

Research for the geologic report was finished on 1 September 1954, and the report was submitted on 1 November 1954. The analysis and evaluation based on the geologic report and incorporated in the present report was completed on 1 December 1954. Supplementary data which became available before the present report was submitted for publication have been included.

Proposed input studies on the Ural-Volga area based on this report and other sources can now be made. Such studies will reveal the level of economic effort required to find and develop the petroleum resources of the area at the rate indicated by the forecasts contained herein.

It is emphasized that all estimates and forecasts in this report are in terms of crude oil as the principal component of petroleum resources and petroleum production. Natural gas liquids and natural gas are not included. Some estimates of crude oil in other sources are actually total liquid petroleum hydrocarbons: that is, crude oil plus natural gas liquids. In this report the practice of the US petroleum industry is followed of discriminating among crude oil, natural gas liquids, and natural gas when quantitative references are made to petroleum.

The difference between petroleum resources and reserves should be noted. Petroleum resources are the estimated ultimate quantities of petroleum which may be found and recovered. Petroleum reserves are the estimated remaining quantities of petroleum which can be recovered from known deposits under existing economic and operating conditions.

It has not been feasible with this report to attempt the usual coordination with other agencies. [redacted] 50X1

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PETROLEUM RESOURCES OF THE URAL-VOLGA AREA OF THE USSR*

Summary and Conclusions

Petroleum production in the Ural-Volga area, or "Second Baku," of the USSR shown in Figure 1,** comprising parts of Economic Regions VI, VII, and VIII,*** has increased much more rapidly than in the rest of the USSR. In 1938 the Ural-Volga area produced 1.2 million metric tons,**** or 4 percent, of the total Soviet crude oil production of 30.1 million tons. In 1954 its contribution is estimated to have been 41 percent, or 22.1 million tons, of the total Soviet crude oil production of 53.6 million tons, excluding natural gas liquids. The crude oil production forecast for 1970 is 73 million tons in the Ural-Volga area, or 61 percent of the total Soviet crude oil production of 119 million tons forecast for 1970. Figure 2***** reflects this differential growth rate of the petroleum industry in the USSR.

The potential crude oil resources of the Ural-Volga area are estimated to range from 5.5 billion to 7.6 billion tons, which is to be compared with estimated potential crude oil resources of 8.4 billion tons in the southwestern oil region of the US comprising the 6 states of Texas, New Mexico, Louisiana, Arkansas, Mississippi, and Alabama. (Off-shore resources are not included in this estimate.) These two areas are of comparable size (475,000 square miles in the Ural-Volga area and 580,000 square miles in the US southwest), and they are somewhat similar geologically, so that significant comparisons can be made.

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* The estimates and conclusions contained in this report represent the best judgment of ORR as of 1 February 1955.

** Following p. 4.

*** The term region in this report refers to the economic regions defined [redacted] 50X1-HUM
USSR: Economic Regions.

**** Tonnages throughout this report are given in metric tons.

***** Following p. 6.

It is estimated that petroleum exploration and development in the Ural-Volga since discovery in 1929 have found and proved 12.6 percent of the potential petroleum resources in that area. In the US southwest, since discovery in 1889, 66.6 percent of the potential petroleum resources have been discovered and proved. Cumulative production to date in the two areas, in percent of potential resources, is only 1.9 percent for the Ural-Volga as compared with 35.7 percent for the US southwest.

It is clear that a great era of petroleum exploration and development lies ahead for the Ural-Volga area of the USSR. Forecasts for the period 1955-70 shown in Figure 2* indicate that by 1970 about 35 percent of the total petroleum resources of the area will have been developed and about 14 percent of the total resources will have been produced. These forecasts are based on the data revealed in a geologic report on the Ural-Volga area 1/** -- a petroleum resource study -- and on the assumption that the 1955-70 period of development in the Ural-Volga area will follow the trend in the US southwest during its comparable period of development, which was from about 1925 to 1940.

The rock strata penetrated in Ural-Volga wells are similar to those of West Texas. They are much harder and more difficult to drill than the strata in the Caspian and Caucasus oil areas of the USSR, and the oil yield per acre is lower than in the Baku fields. Most of the Ural-Volga oil has a fairly high sulfur content, which adds to the refining problem.

In order to reveal the future impact of the Ural-Volga area on the Soviet petroleum industry, tentative 1955-70 forecasts of annual crude oil production have been developed for the entire USSR, for the USSR excepting the Ural-Volga area, and for the Ural-Volga area alone (see Figure 2). These forecasts indicate that by 1970 the Ural-Volga area will be producing about 61 percent of the petroleum production of the USSR compared with 41 percent in 1954. The basis for the forecasts covering the remainder of the USSR outside the Ural-Volga area is comparatively less adequate. Additional petroleum resource studies when completed will provide a basis for more dependable production forecasts together with estimates of the economic effort required for exploitation.

* Following p. 6.

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Studies of regional petroleum resources provide a basis for specific forecasts of petroleum production and resulting capabilities. Such forecasts are, of course, dependent on the economic capabilities to find and develop the resources, but the required levels of economic effort can be determined on the basis of such resource studies. With respect to vulnerabilities, regional petroleum resource studies can be of some value in indicating probable location and trends of future development.

A petroleum resource study of a single region is also of some value as an indicator of intentions. Combined with other regional petroleum resource studies covering the important petroleum areas of the country, a concise evaluation of long-term intentions should be feasible. For example, if the total internal petroleum resources and their availability are adequate for the long-term economic needs of the country, then indicated intentions to acquire or control external petroleum resources should be negative. If, on the other hand, such potential resources appear to be either inadequate or too difficult to exploit, attempts to obtain external resources might be expected. The degree of adequacy of petroleum resources will also indicate intentions concerning plans for international trade in petroleum.

I. Geologic Summary. 2/

The Ural-Volga oil-producing area, also known as the "Second Baku region," is a large triangular area in the lowland of eastern European USSR as shown in Figure 1.* It adjoins the west side of the Ural Mountains and extends westward across the Volga River. Molotov, Ufa, and Sterlitamak are along the east side of the triangular area next to the Urals, Stalingrad is at the southwest corner of the area, and Kuybyshev and Buguruslan are at its center.

The area here described lies between 40° and 58° east longitude and between 48° and 60° north latitude and includes about 475,000 square miles.

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* Following p. 4.

The Moscow basin which adjoins the west margin of the Ural-Volga area received some study as a part of the present investigation. Because this study indicated that the Ural-Volga area offers much greater promise for future potential oil resources than the Moscow basin, most of the effort was concentrated on the Ural-Volga area.

The surface of the area lies for the most part less than 1,000 feet above sea level, but it reaches an altitude of 1,217 feet in the Samara Bend of the Volga, 1,702 feet on the Ufa Plateau, and 1,800 feet at a point south of Sterlitamak. The Ural Mountains east of the region rise to an altitude of 5,377 feet. The lowest altitude, 65 feet below sea level, is on the Volga near Stalingrad.

The Ural-Volga oil-producing area is centrally located in eastern European USSR. As shown in Figure 1,* other oil-producing regions in the USSR are the Ukhta fields to the north; the Emba fields to the south, adjacent to the north end of the Caspian Sea near Gur'yev; the Baku, Groznyy, Krasnodar, and other fields to the south and southwest adjacent to the Caucasus Mountains west of the Caspian Sea; and the Nebit-Dag fields east of the Caspian Sea, opposite the Baku oil district.

The rocks of the Ural-Volga area -- chiefly sandstone, shale, limestone, dolomite, anhydrite, and gypsum -- are exposed in some places at the surface and have been penetrated in other places by the many wells of the oil and gas fields. These sedimentary rocks occur in nearly horizontal beds, or strata, and contain the petroleum deposits of the area. These rock strata, as shown by the oil and gas wells, extend from the surface to depths of 1,500 meters in much of the Ural-Volga area and to 3,000 meters in the eastern part of the area. Furthermore, exposures of the rock strata near the Ural Mountains show that their thickness there exceeds 7,000 meters.

Exploration for oil and gas in the Ural-Volga area involves not only a search for favorable structures but also the drilling of test wells. Exploration for, and the development and exploitation of, petroleum resources in this area have witnessed the application of a long and probably complete list of known techniques employed by the petroleum industry.

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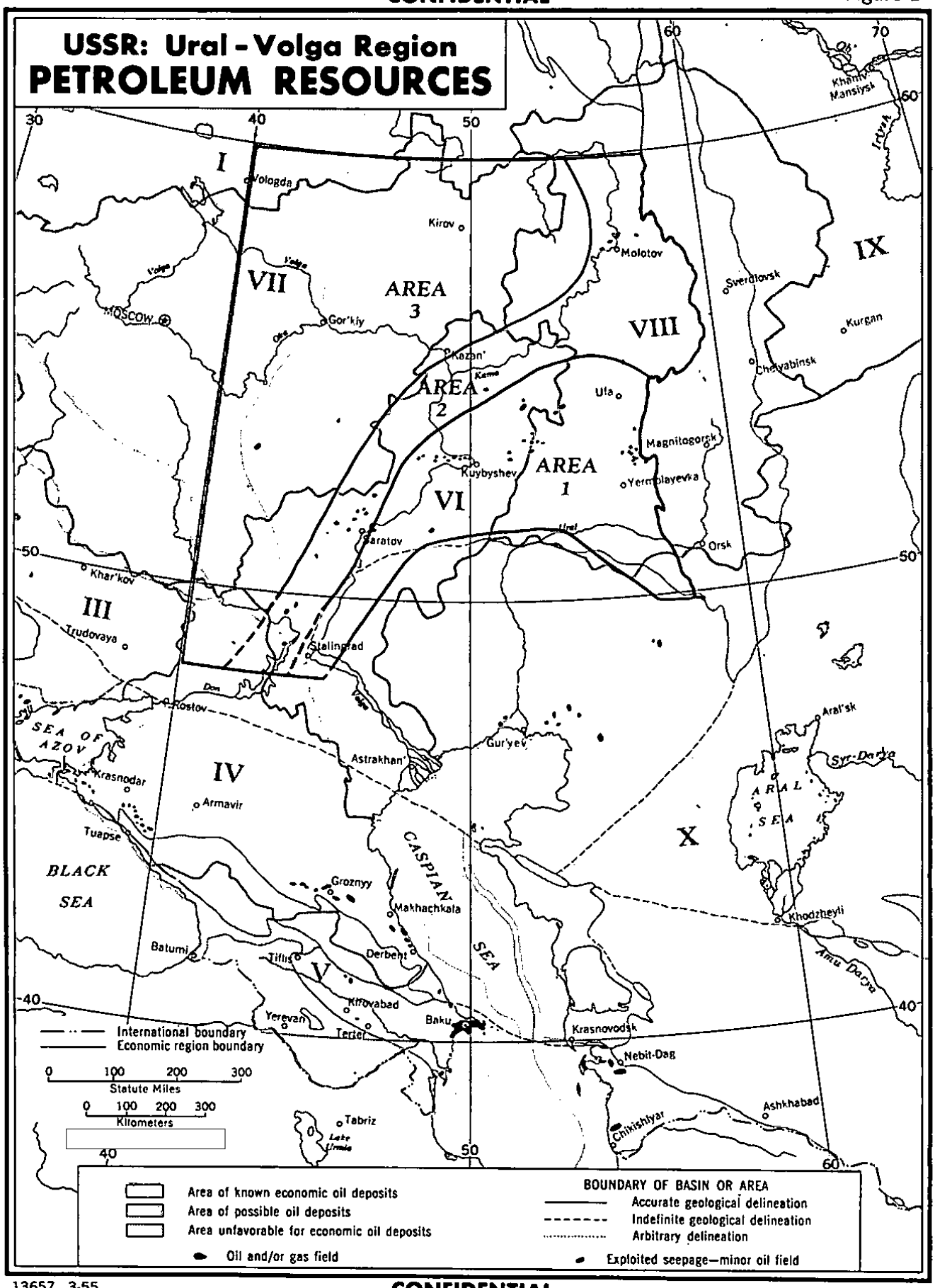
* Following p. 4.

Figure 1



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The rock strata that are drilled for oil and gas in the Ural-Volga area are much older in their geologic age than the oil-producing rocks of the Baku and the many other fields adjacent to the Caucasus Mountains and the Caspian Sea. Also, they are much harder and therefore more costly to drill.

II. Petroleum Resources.

A. Geographic Distribution. 3/

Petroleum is now being produced from 50 or more oil and gas fields in the Ural-Volga. As shown in Figure 1,* these fields are grouped in districts extending from Molotov in the northeast to Stalingrad in the southwest. The production of crude oil in these groups is given in Appendix A, Table 5.** For administrative purposes each group may contain more than one trust, and each trust includes a number of individual fields. Thus Bashneft', which in 1954 yielded 68 percent of the total crude oil produced in the Ural-Volga area, included the Tuymazyneft' fields west of Ufa and the Ishimbayneft' fields south of Ufa. The next most important group is Kuybyshevneft' in the Samara bend of the Volga River. This group accounted for 23 percent of the 1954 crude oil production of the area. The remaining 9 percent of the 1954 production is distributed to the remaining groups as indicated in Table 5. In addition, Saratovneft' is an important producer of natural gas, which is shipped by pipeline to Moscow, a distance of about 800 kilometers.

B. Geologic Distribution. 4/

Petroleum in the Ural-Volga area is produced from 7 zones of different geologic age ranging in depth from 40 to 3,000 meters. The first 3 zones are of minor actual and potential significance, producing only about 2 percent of the current crude oil production.

Zone 4 is estimated to be yielding about 16 percent of the current crude oil production in the Ural-Volga area. It produces in the Molotovneft' and Bashneft' groups. Some of the fields of this zone have produced since the early 1930's and are approaching exhaustion. The potential for future production from Zone 4 is good,

* Following p. 4.
** P. 24, below.

with emphasis on the eastern part of the Ural-Volga area from Molotov south to Ufa and beyond.

Zone 5 is producing in many fields in the southwestern part of the Ural-Volga area. Currently it is estimated to be producing about 8 percent of the total crude oil in the area, and it is the major zone producing natural gas in the Stalingrad district. Future discoveries in this zone are probable throughout the area in which it now produces.

Zone 6 is producing an estimated 18 percent of the current crude oil production in the Ural-Volga area. It is the second most important petroliferous zone in the area and is productive in fields throughout the central part of the area from Saratov to Ufa. It is an important gas producer at Saratov and one of the major producing zones in the Samara bend of the Volga River. It is also an important oil producer at Tuymazy, west of Ufa. In the future, many new deposits yet to be discovered throughout the central part of the Ural-Volga area may be expected to yield important quantities of oil from Zone 6.

Zone 7, the famous "Devonian" discovered at Tuymazy in 1944, is by far the most important petroleum-producing zone in the Ural-Volga area. It is estimated to be producing 56 percent of the current crude oil production, and it has been the principal contributor to the rapid increase in petroleum production in the Ural-Volga area during the past 10 years. The producing deposits are sandstone 7 to 30 meters thick with good porosity and permeability. They are found at depths ranging from 1,450 to 3,000 meters, increasing in depth from west to east. Zone 7 will be the principal source of future petroleum production in the Ural-Volga area. These Devonian strata underlie the entire area, and they may eventually prove to contain petroleum deposits throughout the entire area. The greatest potential for future petroleum production, however, lies in the eastern part of the area between the Volga River and the Ural Mountains.

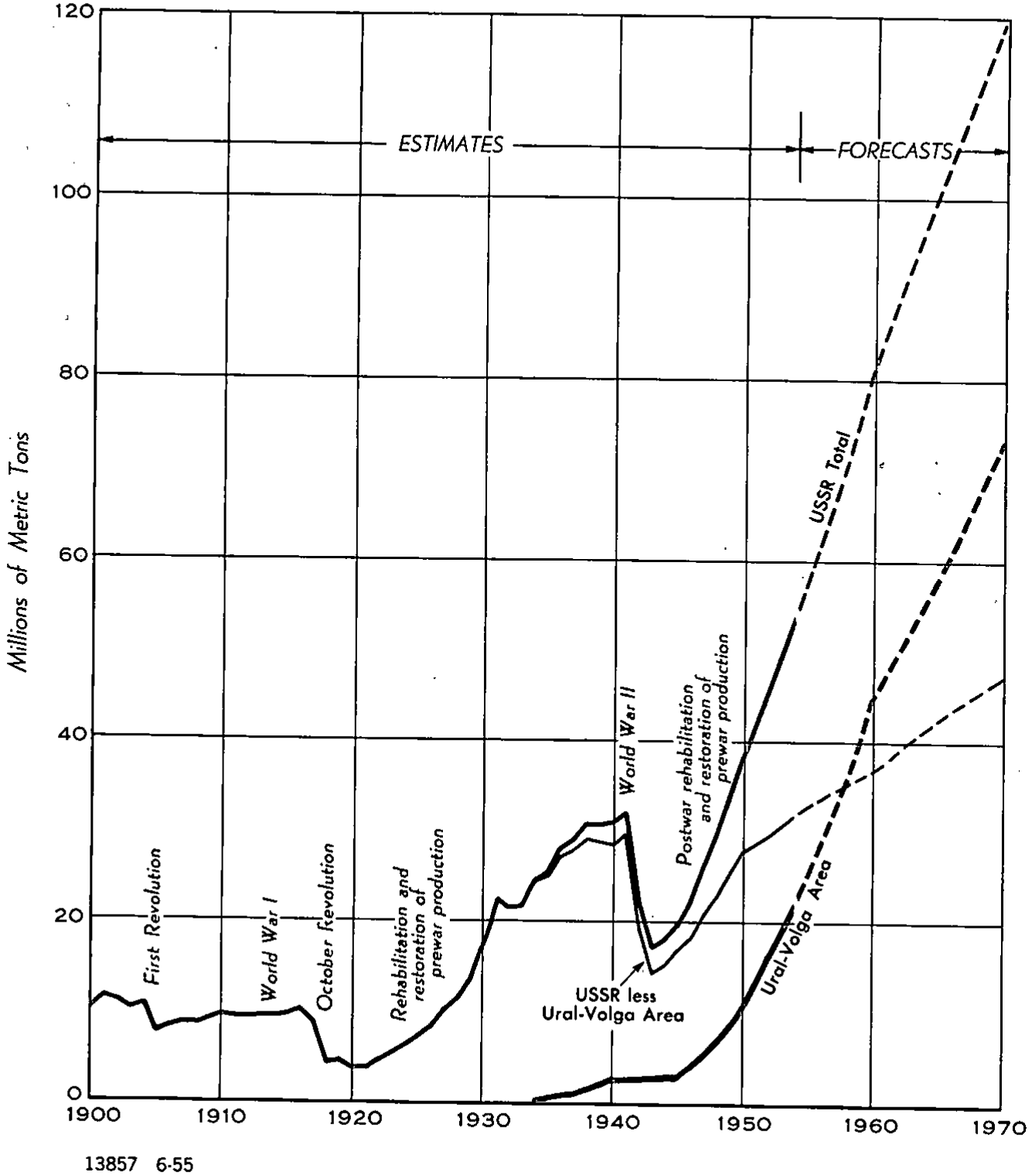
C. Character of Oil. 5/

The oil produced in the Ural-Volga area is, in general, quite heavy and is therefore low in gasoline content. It also has a fairly high sulfur content, thus adding to the refining problems. Oil from the deeper zones, however, tends to be lighter and has a lesser sulfur content than the shallow oils. Oil from the eastern fields is, in general, lighter than oil from the same zone in fields farther to the west.

Figure 2

USSR

Annual Crude Oil Production, 1900-70



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D. Quantitative Evaluation of Petroleum Resources.

The petroleum resources of any given region depend upon the geologic conditions which control the occurrence of petroleum deposits in that region. Until recent years, petroleum geologists were limited to qualitative evaluations of undiscovered regional petroleum resources, but many years of analytical study of the geologic factors controlling the occurrence of petroleum deposits throughout the world has led to a basis for quantitative evaluation of undiscovered petroleum resources. Such a quantitative evaluation depends first upon a complete geologic study of the selected region. The actual quantitative evaluation of the petroleum resources of the region is then made by the application of comprehensive knowledge and experience in petroleum exploration and development throughout the world to the geological conditions of the region.

In recent years the quantitative evaluation of petroleum resources throughout the world has been the subject of comprehensive study by at least one major company operating world wide. In 1948 this company released estimates of the petroleum resources of the world by major countries or regions. 6/ Since that time, two papers on the subject have been published, one in 1950 7/ and another in 1952. 8/ The 1954 geologic report on which the present study is based contains the most recent quantitative evaluation. 9/

Estimated petroleum resources of the Ural-Volga area of the USSR in 1954 are shown in Table 1.* The probable range of these estimates is from 40 billion to 55 billion barrels, or from 5.5 billion to 7.6 billion tons. Figure 1** shows the area to which the estimates apply.

III. Forecasts of Petroleum Production.

A. Basis for Forecasts.

The primary value of a regional estimate of petroleum resources such as that given in II, above, for the Ural-Volga area is for forecasting the probable petroleum production from the region under any given or assumed program of exploration and development. Where no specific program has been proposed, production forecasts can be made

* Table 1 follows on p. 8.
** Following p. 4.

by analogy with a similar region which has been wholly or partially developed. Such an analogy necessarily assumes equivalent or somewhat similar conditions in the two regions during the particular stage of development covered by the forecasts.

Table 1

Estimated Petroleum Resources of the Ural-Volga Area of the USSR a/
1954

Area Shown in Figure 1	Square Miles	Barrels per Square Mile	Total Ultimate Potential	
			Million Barrels	Million Metric Tons b/
1	124,000	225,000	27,900	3,828.9
2	120,000	100,000	12,000	1,646.8
3	231,000	40,000	9,240	1,268.0
Total	475,000		49,140	6,743.7

a. The estimates are for crude oil. Natural gas and natural gas liquids are not included.
b. The conversion factor is 0.137235 tons per barrel.

Three basic variables are used in order to provide a convenient basis for analogy or for comparison of various oil-producing regions, as follows:

1. Cumulative production annually, expressed as a percentage of the estimated ultimate petroleum resources of the region.

2. Cumulative gross additions to reserves (also called cumulative discoveries) annually, expressed as a percentage of the estimated ultimate petroleum resources of the region. For any given year the cumulative gross additions to reserves minus the cumulative production equals the proved reserves for that year.

3. The annual ratio of proved reserves to the current annual production.

It will be noted that the three basic variables are dimensionless: that is, they are expressed in percentages and ratios. Therefore, direct comparison can be made between different petroleum-producing regions. This is done most conveniently by graphic representation, as in Figures 3 to 7.* Usually these variables are computed and forecasts made in terms of crude oil. Natural gas and natural gas liquids are components of petroleum production which may be wasted during the early development of a region because of lack of conservation facilities or markets. Therefore, these components are usually the subject of separate and subsidiary studies.

B. Forecasts for the Ural-Volga Area.

Careful consideration of petroleum regions on which data are available led to the conclusion that the best available region for comparison with the Ural-Volga area is Petroleum Administration for War (PAW) District 3 in the US. During World War II the PAW divided the US into five districts known as PAW Districts, and production and reserve data were developed for each district and are still reported on that basis. PAW District 3 is the most important petroleum-producing district in the US, containing the six states of Alabama, Mississippi, Louisiana, Arkansas, Texas, and New Mexico. This comprises the so-called southwest oil region of the US. A comparison of the current status of petroleum development in the Ural-Volga area and PAW District 3 is shown in Table 2.**

Figures 3 and 4*** provide a graphic comparison of the three basic variables previously described between the Ural-Volga area and PAW District 3. The forecasts shown in Figure 3 for the Ural-Volga area are based on direct analogy with the same period of relative development in PAW District 3. For the cumulative gross additions to reserves, the forecast period 1955-70 for the Ural-Volga area corresponds to the period 1927-41 in PAW District 3. For the cumulative production, the forecast period 1955-70 for the Ural-Volga area corresponds to the period 1923-40 in PAW District 3. The assumed correspondence of these

* Figures 3 and 4 follow p. 10; Figures 5 and 6 follow p. 12; Figure 7 follows p. 14.
** Table 2 follows on p. 10.
*** Following p. 10.

two factors gives the ratio of proved reserves to annual production for the forecast period 1955-70 for the Ural-Volga area, as shown in Figure 3.* This ratio follows the same general pattern shown for PAW District 3 in Figure 4* and for other areas shown in Figures 5, 6, and 7.** The typical pattern of this ratio, which shows a steep initial decline followed by a much flatter decline, is explained by the period of primary development during which more reserves are proved up than can be utilized, followed by the period of secondary development during which the relationship between reserves and utilization becomes stabilized.

Table 2

Comparison of Petroleum Development in the Ural-Volga Area in the USSR and in PAW District 3 in the US

Item for Comparison	Ural-Volga Area a/	US PAW District 3 b/
Area (thousand square miles)	475	580
Petroleum resources (billion metric tons, crude oil)	6.7	8.4
First oil production (year)	1929	1889
Percent of resources discovered and proved (to 1953-54)	12.6	66.6
Percent of resources produced (to 1953-54)	1.9	35.7
Number of oil and gas fields (1954)	50	3,358
Total wells drilled (to 1954)		427,262
Producing oil wells (1953)		172,064
1953 production (million metric tons)	19.2	190.3
Cumulative production (to 1953-55) (million metric tons)	126.1	2,983.5
Cumulative gross additions to reserves (to 1953-55) (million metric tons)	850	5,600
1953 ratio of proved reserves to current annual production	33.1	13.8

a. Data from Table 4, p. 22, below, and sources cited therein.
b. Data derived from Table 6, p. 27, below, and sources cited therein.

* Following p. 10.
** Figures 5 and 6 follow p. 12; Figure 7 follows p. 14.

Figure 3

URAL-VOLGA AREA, USSR

Cumulative Gross Additions to Crude Oil Reserves, and Cumulative Production, 1900-70

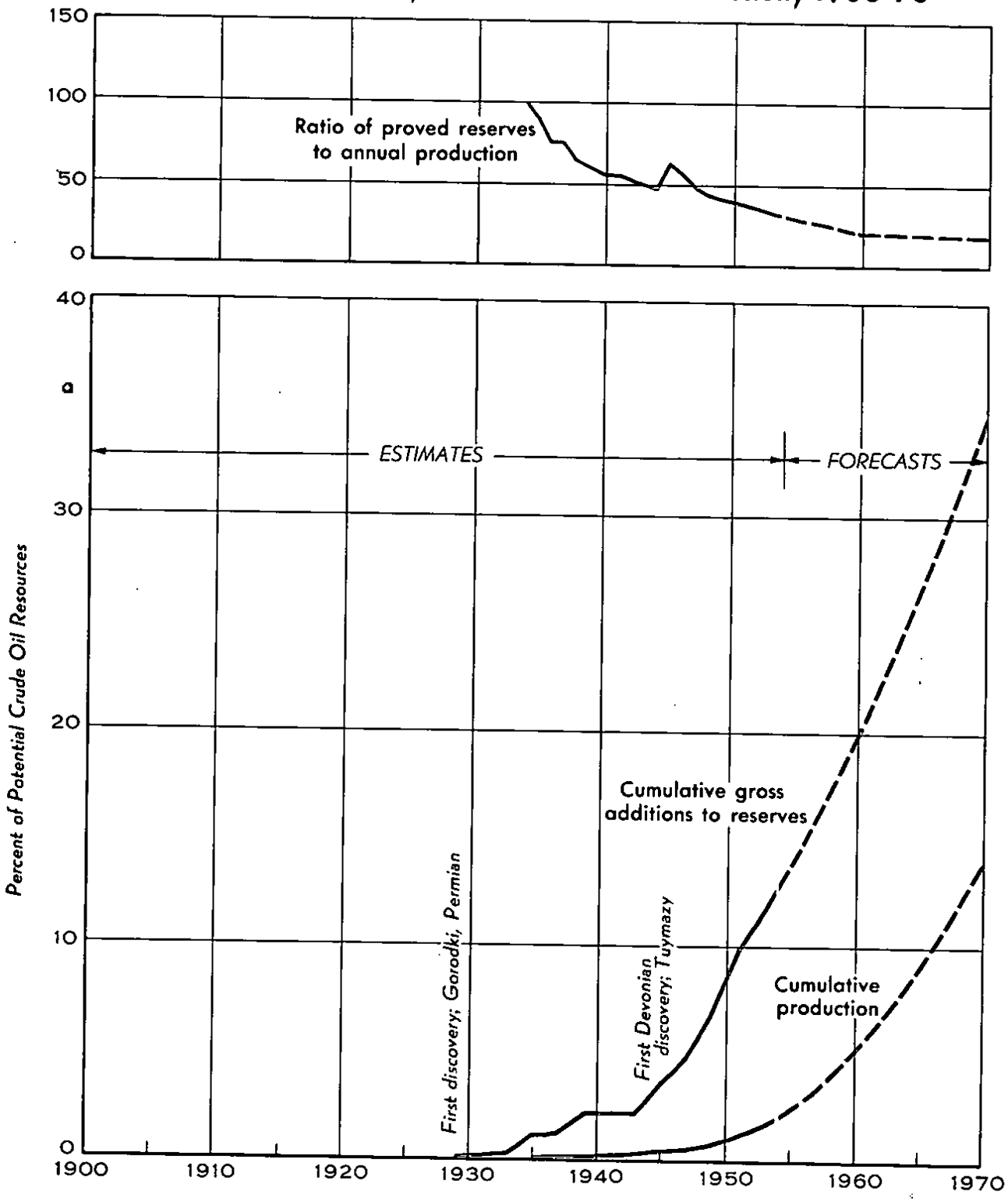

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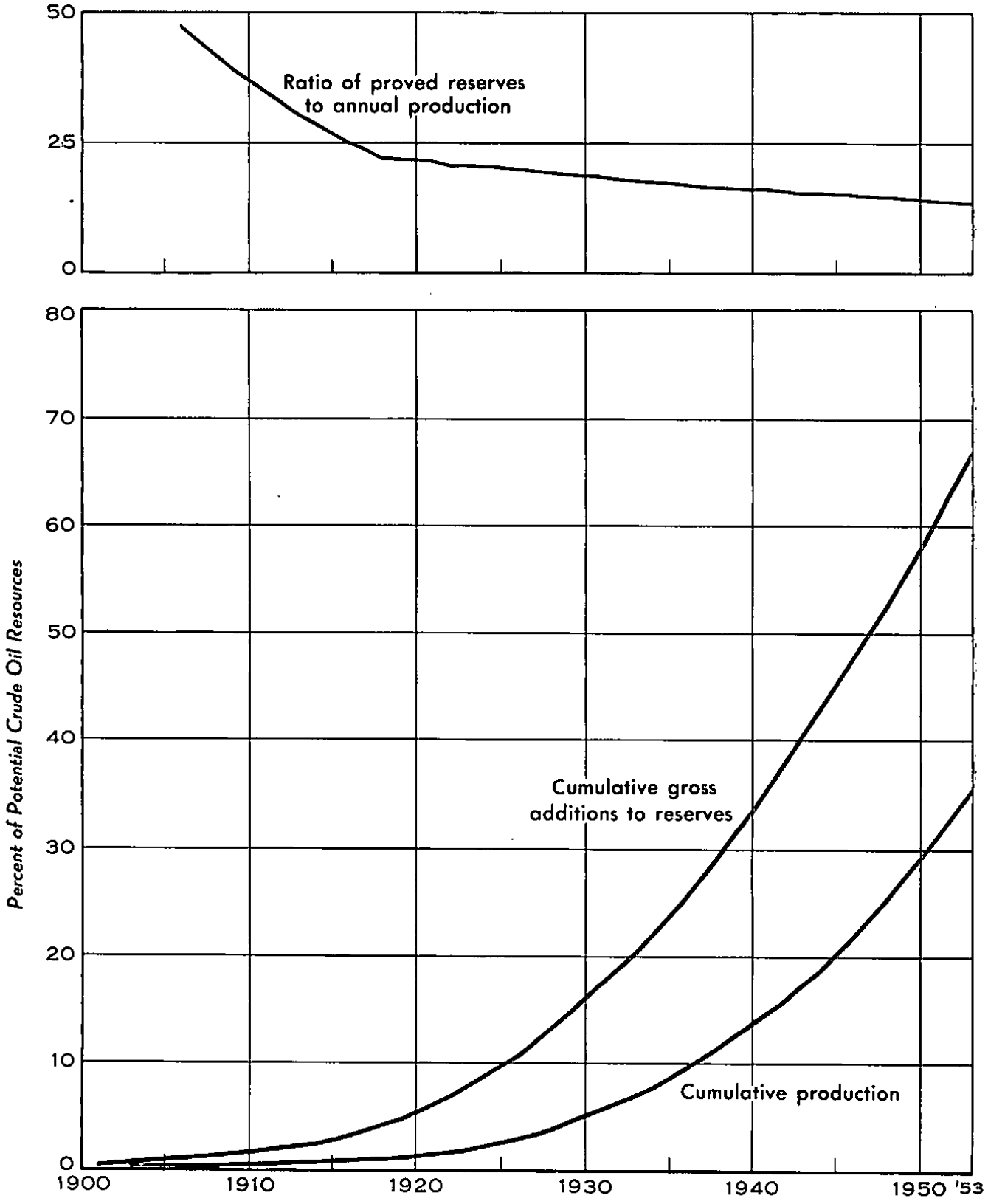
Figure 4

PAW DISTRICT 3, US

Cumulative Gross Additions to Crude Oil Reserves, and Cumulative Production, 1900-53



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On the basis of the foregoing analogy, the forecasts 1955-70 for the Ural-Volga area call for gross additions to reserves during this period of 1.5 billion tons (see Table 2*). During the corresponding period 1927-41 in PAW District 3, gross additions to reserves amounted to 2 billion tons (see Table 4**).

C. Forecasts as a Basis for Estimating Inputs.

As the gross additions to petroleum reserves in any region are a direct result of the total input of materials and labor into the exploration and development of the petroleum resources in that region, the foregoing type of analogy can be used as a basis for estimating inputs into the petroleum industry of the region. The data given in Table 2 for the Ural-Volga area combined with input data on PAW District 3 can therefore be used as a basis for estimates and forecasts of inputs into the petroleum industry in that area, with appropriate modifications for the differences in specific conditions between the Ural-Volga area and PAW District 3.

D. Forecasts for the USSR Less Ural-Volga Area.

In order to derive the maximum immediate value from the geologic report and the evaluation and forecasts of petroleum resources in the Ural-Volga area, 10/ tentative evaluations and forecasts are presented on the remainder of the USSR. The bases for these latter evaluations and forecasts are as follows:

1. Estimated petroleum resources of the USSR, published in 1948. 11/ This estimate, amounting to 20.6 billion tons (150 billion barrels), covers all of the USSR except the off-shore areas.

2. Estimated gross additions to reserves in the USSR during the 20-year period 1952-72, published in 1952. 12/ This estimate, amounting to 3 billion tons, took into account both the geologic potential and the economic capabilities to explore and develop petroleum resources.

Figure 3*** shows the results of the analysis of the USSR less the Ural-Volga area. For comparison, Figure 6**** shows the US less PAW District 3. It will be noted that in the USSR the indicated

* P. 10, above.
** P. 22, below.
*** Following p. 10.
**** Following p. 12.

development rate is very much slower than in the US. This difference indicates the need for additional regional studies on the US similar to that of the geologic report on the Ural-Volga area. 13/ Until this is done, the evaluations and forecasts shown herein of the USSR less the Ural-Volga area should be considered tentative.

E. Middle East and Over-All Comparisons.

Figure 7* illustrates the extreme range in the basic variables depicting the development of petroleum resources, showing the values of these variables for the Middle East. In this phenomenal oil-producing area of 2,716,000 square miles, current cumulative gross additions to reserves amount to 11.8 billion tons. This vast quantity of proved oil, equal to over twice that in US PAW District 3, has been found and developed with the drilling of only 1,272 wells. This is equal to 9.3 million tons added to reserves for each well drilled, compared with about 13,000 tons per well drilled in PAW District 3, or more than 700 times greater return per well drilled. 14/

The remarkably high rate of development in the Middle East can be attributed to the three following factors, which dominate petroleum resource development:

1. Productivity.

The exceptional productivity of Middle East petroleum deposits is reflected in the foregoing comparison of Middle East wells with those in US PAW District 3.

2. Access to Markets.

There is ready access to world markets in the Middle East. Most of the fields are close to tidewater.

3. Competitive versus Noncompetitive Conditions.

The effect of competitive conditions began to appear in the Middle East about 1940, as shown in Figure 7.*

* Following p. 14.

Figure 5

USSR, LESS URAL-VOLGA AREA
Cumulative Gross Additions to Crude Oil Reserves, and Cumulative Production, 1900-70

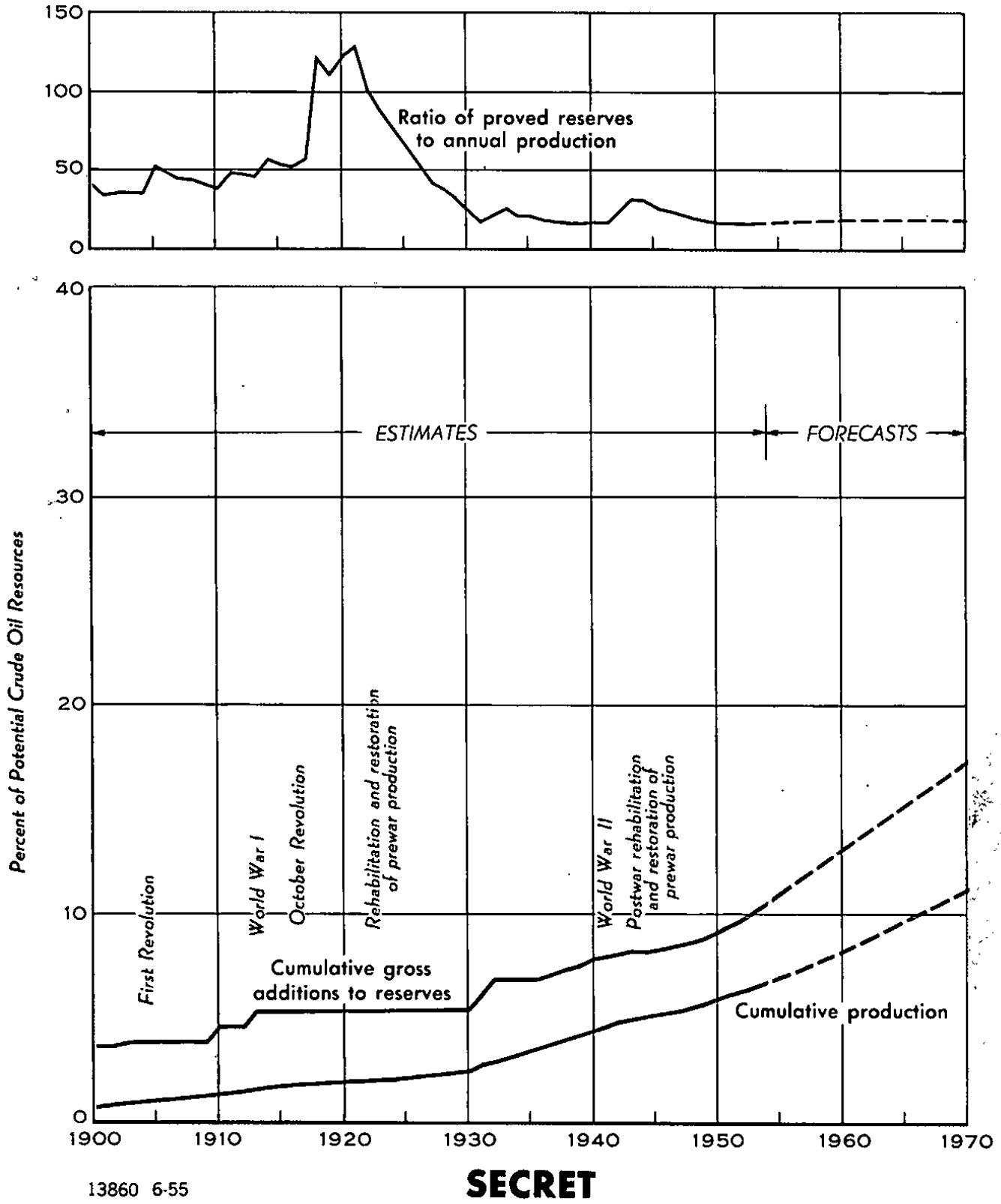

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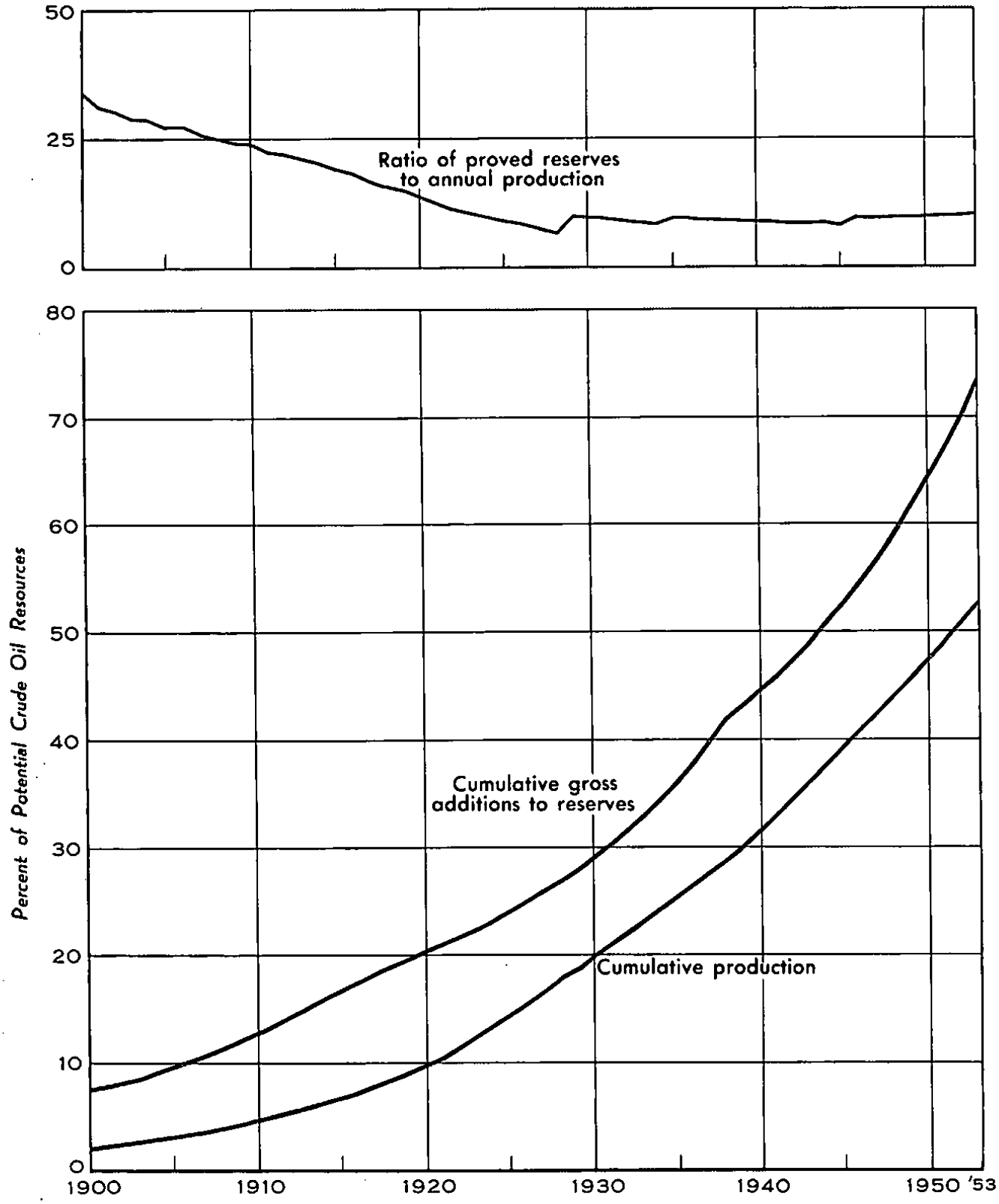
Figure 6

US, LESS PAW DISTRICT 3
Cumulative Gross Additions to Crude Oil Reserves, and Cumulative Production, 1900-53



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Further study of the data in the geologic report on the Ural-Volga area will define more accurately the relative productivity of the Ural-Volga deposits. It is known, however, that the productivity is much closer to that of US PAW District 3 than it is to that of the Middle East. As shown in Figure 8,* the actual rate of development in the Ural-Volga for 1943-54 is somewhat greater than that in US PAW District 3 during the corresponding period of its development -- that is, from 1913 to 1924. This higher rate may be attributed, at least in part, to the discovery in 1944 of prolific Devonian deposits in the Ural-Volga area. As indicated in Figure 8, the forecasts for the Ural-Volga area assume that by 1972 the relative development (cumulative gross additions to reserves as percent of potential resources) will equal that of US PAW District 3 in 1942.

Transportation in the Ural-Volga area is a dominant retarding factor and will so continue. Studies based on the data in the geologic report on the Ural-Volga area will provide the basis for estimating the annual inputs needed for transportation facilities for consistency with the petroleum production forecasts. Therefore, the factor of accessibility of markets with respect to Ural-Volga oil can be resolved in quantitative terms.

The factor of competitive versus noncompetitive conditions, in determining the rate of development of petroleum resources, has been the subject of worldwide study by one major oil company. An official of that company has submitted a chart showing the results of these studies. The data shown on that chart are reproduced in Figure 8. It will be noted that the estimated development rate in the Ural-Volga area since 1943 parallels roughly the average competitive trend and that forecasts to 1972 follow this trend. Conversely, the USSR less the Ural-Volga area parallels approximately the average noncompetitive trend, and the tentative forecasts to 1972 follow this latter trend. This whole subject of competitive versus noncompetitive conditions, as applied to Communist economic systems, requires further study.

F. Strategic Significance of Forecasts.

Petroleum resource studies, such as that on the Ural-Volga area, together with evaluations and forecasts developed therefrom, have the following strategic significance:

* Following p. 14.

1. Capabilities.

Combined with input studies based on them, regional petroleum resource studies will provide specific data on economic capabilities to find, develop, transport, and process petroleum.

2. Vulnerabilities.

Regional petroleum resource studies indicate the present and probable future locations and trends of petroleum development. Such information is of value in indicating probable vulnerabilities in such regions.

3. Intentions.

The significance of regional resource studies with regard to intentions is of considerable value if all important potential petroleum-producing regions are covered. Such studies should indicate clearly the availability of internal petroleum resources for the long term in comparison with the availability of external petroleum resources -- for example, the availability to the USSR of oil from the Middle East. Such studies will also provide a basis for estimating long-term intentions with respect to economic penetration of Free World petroleum markets.

Figure 7

MIDDLE EAST
Cumulative Gross Additions to Crude Oil Reserves, and Cumulative Production, 1911-53

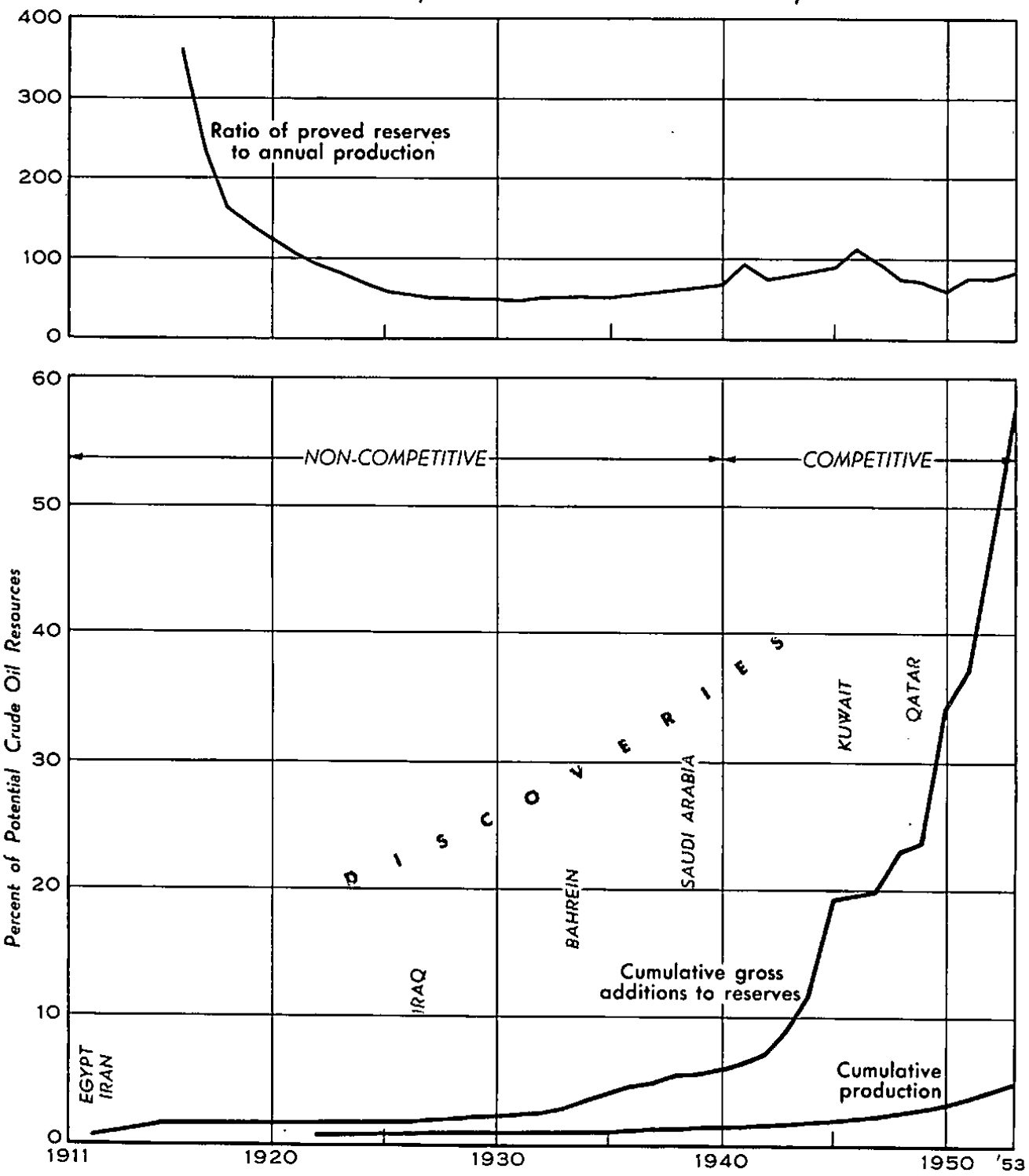

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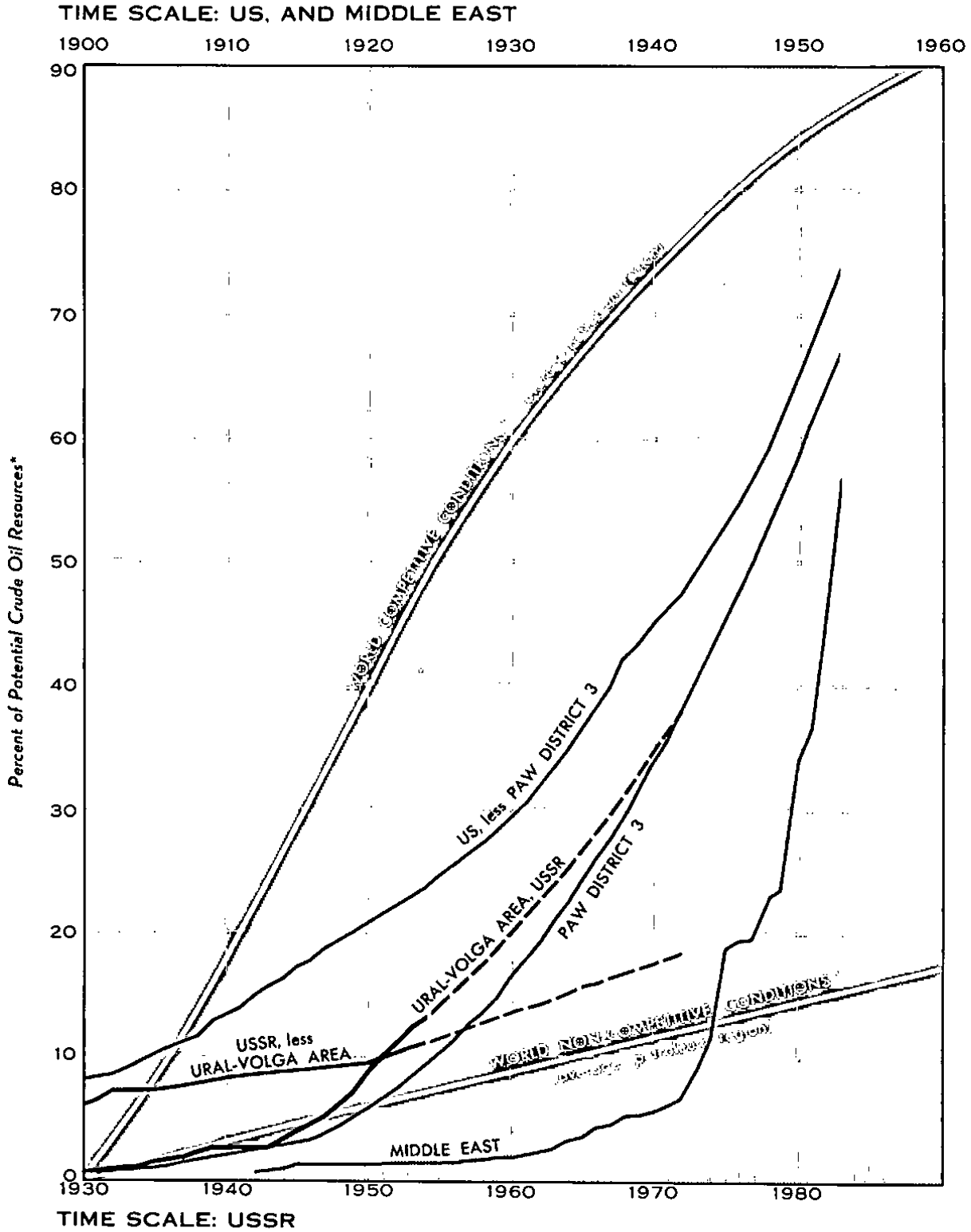
Figure 8

US, USSR, AND MIDDLE EAST

Comparative Petroleum Resource Development Rates, 1900-80



†No actual time scale; referred to year of discovery.

*Estimates and forecasts of cumulative gross additions to reserves as percent of potential crude oil resources.

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APPENDIX A

STATISTICAL DATA ON PETROLEUM PRODUCTION AND RESERVES SHOWING RELATIONSHIP OF US PAW DISTRICT 3 TO POTENTIAL PETROLEUM RESOURCES IN THE URAL-VOLGA AREA, USSR, AND ON OTHER REGIONS FOR ANALOGY AND COMPARISON

Table 3* provides the basic data to support the graphic data shown in Figure 2. It also provides certain percentage distribution figures cited in the text.

Tables 4 and 5** provide the data to support graphic data shown in Figures 3 and 4. These tables also provide quantitative estimates and forecasts needed for proposed input studies.

Table 6*** provides the data to support the graphic data shown in Figures 5, 6, and 7.

Table 7**** provides data on crude oil production by groups in the Ural-Volga area. These data have not been previously published. They are the basis for certain percentage distribution figures cited in the text.

Tables 4, 5, and 6 also provide the data to support certain graphic data shown in Figure 8.

All quantities tabulated in this appendix are in million tons expressed to the nearest one-tenth million. This degree of significance is warranted with respect to Soviet data on production of crude oil, particularly for prewar years. It is not warranted on reserve data for crude oil. A significant value of the order of 10 million to 100 million tons reflects the relative accuracy of reserve data. The continuous balance between production and reserves shown in Tables 4 and 5, however, requires that reserve data be carried to the nearest one-tenth million tons in order to provide a statistical check on the data. For

* Table 3 follows on p. 17, below.
** Tables 4 and 5 follow on pp. 22 and 24, respectively, below.
*** Table 6 follows on p. 27, below.
**** Table 7 follows on p. 30, below.

example, in checking Table 4, the cumulative production, column (5), for any year equals the cumulative production of the previous year plus the annual production, column (3), of the given year. Likewise, for cumulative gross additions to reserves, column (6), any given year equals the previous year plus current gross additions to reserves, column (2). Net change in reserves during year, column (4), equals current gross additions to reserves, column (2), minus current production, column (3). Then the proved reserves at the first of any given year, column (1), equals the proved reserves at the first of the previous year plus or minus the net change in reserves, column (4), during the previous year. Finally, and for checking purposes, the proved reserves at the first of any given year, column (1), plus the cumulative production at the end of the previous year, column (5), equal the cumulative gross additions to reserves at the end of the previous year, column (6).

Table 3

Estimates of Annual Crude Oil Production in the USSR, 1900-54, and Forecasts, 1955-72, with the Ural-Volga Area Shown Separately a/*

Million Metric Tons

Year	Remarks	USSR Less Ural-Volga		Ural-Volga Only		Total USSR
		Quantity	Percent of Total USSR	Quantity	Percent of Total USSR	Quantity
1821-99		80.2	100	0	0	80.2
1900		10.4	100	0	0	10.4
1901		11.6	100	0	0	11.5
1902		11.1	100	0	0	11.1
1903		10.4	100	0	0	10.4
1904		10.9	100	0	0	10.9
1905	First Revolution	7.6	100	0	0	7.6
1906		8.2	100	0	0	8.2
1907		8.7	100	0	0	8.7
1908		8.7	100	0	0	8.7
1909		9.3	100	0	0	9.3
1910		9.6	100	0	0	9.6
1911		9.2	100	0	0	9.2
1912		9.3	100	0	0	9.3
1913		9.2	100	0	0	9.2
1914	World War I	9.2	100	0	0	9.2
1915		9.5	100	0	0	9.5
1916		10.0	100	0	0	10.0

* Footnotes for Table 3 follow on p. 21.

Table 3

Estimates of Annual Crude Oil Production in the USSR, 1900-54, and Forecasts, 1955-72, with the Ural-Volga Area Shown Separately a/
(Continued)

Million Metric Tons

Year	Remarks	USSR Less Ural-Volga		Ural-Volga Only		Total USSR
		Quantity	Percent of Total USSR	Quantity	Percent of Total USSR	Quantity
1917	October Revolution	8.8	100	0	0	8.8
1918		4.1	100	0	0	4.1
1919		4.4	100	0	0	4.4
1920		3.9	100	0	0	3.9
1920-21		3.8	100	0	0	3.8
1921-22		4.7	100	0	0	4.7
1922-23		5.3	100	0	0	5.3
1923-24	Rehabilitation	6.1	100	0	0	6.1
1924-25	and restoration of	7.1	100	0	0	7.1
1925-26	prewar production	8.3	100	0	0	8.3
1926-27		10.3	100	0	0	10.3
1927-28		11.5	100	0	0	11.5
1928-29		13.5	100	b/	0	13.5
1929-30		17.3	100	b/	0	17.3
Special Quarter 1930		5.3	100	b/	0	5.3
1931		22.4	100	b/	0	22.4
1932		21.4	100	b/	0	21.4
1933		21.5	99.9	b/	0.1	21.5

Table 3

Estimates of Annual Crude Oil Production in the USSR, 1900-54, and Forecasts, 1955-72, with the Ural-Volga Area Shown Separately a/
(Continued)

Million Metric Tons

Year	Remarks	USSR Less Ural-Volga		Ural-Volga Only		Total USSR
		Quantity	Percent of Total USSR	Quantity	Percent of Total USSR	Quantity
1934		24.1	99.6	0.1	0.4	24.2
1935		24.7	98.4	0.4	1.6	25.1
1936		27.0	96.8	0.9	3.2	27.9
1937		27.6	96.8	0.9	3.2	28.5
1938		29.0	96.0	1.2	4.0	30.2
1939		28.6	94.1	1.8	5.9	30.4
1940	World War II	28.2	92.0 c/	2.4	8.0 c/	30.7 c/
1941		29.5	92.5	2.4	7.5	31.9
1942		19.6	88.7	2.5	11.3	22.1
1943		14.1	84.4	2.6	15.6	16.7
1944		15.1	84.8	2.7	15.2	17.8
1945		16.7	86.1	2.7	13.9	19.4
1946	Rehabilitation	18.0	82.9	3.7	17.1	21.7
1947	and restoration of	20.8	80.0	5.2	20.0	26.0
1948	prewar production	22.7	77.2	6.7	22.8	29.4
1949		25.2	75.0	8.4	25.0	33.6
1950		27.3	72.6	10.3	27.4	37.6
1951		28.2	67.8	13.4	32.2	41.6 d/
1952		29.1	63.8	16.5	36.2	45.6 d/

Table 3

Estimates of Annual Crude Oil Production in the USSR, 1900-54, and Forecasts, 1955-72, with the Ural-Volga Area Shown Separately a/
(Continued)

Million Metric Tons

Year	Remarks	USSR Less Ural-Volga		Ural-Volga Only		Total USSR
		Quantity	Percent of Total USSR	Quantity	Percent of Total USSR	Quantity
1953		30.4	61.3	19.2	38.7	49.6 d/
1954		31.5	58.8	22.1	41.2	53.6 d/
1955		32.8	56.9	24.8	43.1	57.6
1956		33.4	54.2	28.2	45.8	61.6
1957		34.2	51.9	31.7	48.1	65.9
1958		35.1	49.6	35.6	50.4	70.7
1959		35.9	47.4	39.9	52.6	75.8
1960		36.6	45.1	44.6	54.9	81.2
1961		37.8	44.5	47.1	55.5	84.9
1962		39.0	44.1	49.5	55.9	88.5
1963		40.1	43.4	52.3	56.6	92.4
1964		41.2	42.8	55.1	57.2	96.3
1965		42.1	42.2	57.7	57.8	99.8
1966		43.1	41.5	60.7	58.5	103.8
1967		43.9	40.8	63.7	59.2	107.6
1968		44.8	40.3	66.5	59.7	111.3
1969		45.5	39.5	69.8	60.5	115.3

Table 3

Estimates of Annual Crude Oil Production in the USSR, 1900-54, and Forecasts, 1955-72, with the Ural-Volga Area Shown Separately a/
(Continued)

Million Metric Tons

Year	Remarks	USSR Less Ural-Volga		Ural-Volga Only		Total USSR
		Quantity	Percent of Total USSR	Quantity	Percent of Total USSR	Quantity
1970		46.3	38.9	72.7	61.1	119.0
1971		47.0	38.2	76.1	61.8	123.1
1972		47.6	37.6	79.1	62.4	126.7

a. Based on production data on Ural-Volga only from Table 2 and production data on USSR less Ural-Volga from Table 3.
b. Less than 0.05 million metric tons.
c. Total and percentages are derived from unrounded figures and do not agree with rounded data shown.
d. Total liquid hydrocarbons -- crude oil plus natural gas liquids -- are as follows: 1951, 42.8; 1952, 47.7; 1953, 52.7; and 1954, 57.6. 15/

Table 4

Crude Oil Production and Reserves in the Ural-Volga Area, USSR
Annual Estimates, 1929-54, and Annual Forecasts, 1955-72

Year	Significant Discoveries a/*	(1) Proved Reserves First of Year b/ (Million Metric Tons)	(2) Gross Additions to Reserves during Year c/ (Million Metric Tons)	(3) Production during Year d/ (Million Metric Tons)	(4) Net Change in Reserves during Year b/ (Million Metric Tons)	(5) Cumulative Production (End of Year) Quantity b/ (Million Metric Tons)	(5a) Cumulative Production (End of Year) Percent of Potential e/	(6) Cumulative Gross Additions to Reserves (End of Year) Quantity b/ (Million Metric Tons)	(6a) Cumulative Gross Additions to Reserves (End of Year) Percent of Potential e/	Ratio of Proved Reserves to Annual Production b/
1929	Gorodki -- Permian	0	2.0	f/	2.0	f/	g/	2.0	0.03	h/
1930		2.0	2.0	f/	2.0	f/	g/	4.0	0.06	h/
1931		4.0	2.0	f/	2.0	f/	g/	6.0	0.09	h/
1932	Ishimbayevo -- Permian	6.0	2.0	f/	2.0	f/	g/	8.0	0.12	h/
1933		8.0	2.0	f/	2.0	f/	g/	10.0	0.15	h/
1934	Krasnokamsk -- carboniferous	10.0	26.1	0.1	26.0	0.1	g/	36.1	0.54	100.0
1935	Syzran -- carboniferous	36.0	31.9	0.4	31.5	0.5	0.01	68.0	1.01	90.0
1936	Smakayevo -- Permian	67.5	0.9	0.9	0	1.4	0.02	68.9	1.02	75.0
1937	Tuymazy -- carboniferous	67.5	9.4	0.9	8.5	2.3	0.03	78.3	1.16	75.0
1938	Buguruslan -- Permian	76.0	33.2	1.2	32.0	3.5	0.05	111.5	1.65	63.3
1939	Termen Yelga -- Permian	108.0	29.4	1.8	27.6	5.3	0.08	140.9	2.09	60.0
1940	Bugulma area	135.6	0	2.4	-2.4	7.7	0.11	140.9	2.09	56.5
1941	Allagutavo -- carboniferous	133.2	0	2.4	-2.4	10.1	0.15	140.9	2.09	55.5
1942	Saratov gas	130.8	0	2.5	-2.5	12.6	0.19	140.9	2.09	52.3
1943	Zolnÿ -- carboniferous	128.3	0	2.6	-2.6	15.2	0.23	140.9	2.09	49.3
1944	Tuymazy -- Devonian	125.7	45.0	2.7	42.3	17.9	0.27	185.9	2.76	46.6
1945	Krasnokamsk -- Devonian	168.0	45.0	2.7	42.3	20.6	0.31	230.9	3.42	62.2
1946	Archeda gas	210.3	45.0	3.7	41.3	24.3	0.36	275.9	4.09	56.8
1947		251.6	45.0	5.2	39.8	29.5	0.44	320.9	4.76	48.4
1948	Bavlÿ -- Devonian	291.4	66.4	6.7	59.7	36.2	0.54	387.3	5.74	43.5
1949	(Other Devonian	351.1	69.8	8.4	61.4	44.6	0.66	457.1	6.78	41.8
1950	discoveries probable	412.5	100.3	10.3	90.0	54.9	0.81	557.4	8.27	40.0
1951	during the period	502.5	91.7	13.4	78.3	68.3	1.01	649.1	9.63	37.5
1952	1949-53, but no	580.8	71.2	16.5	54.7	84.8	1.26	720.3	10.68	35.2
1953	data available)	635.5	68.8	19.2	49.6	104.0	1.54	789.1	11.70	33.1
1954	Shostovka	685.1	60.0	22.1	37.9	126.1	1.87	849.1	12.59	31.0
1955		723.0	70.8	24.8	46.0	150.9	2.24	919.9	13.64	29.2
1956		769.0	73.6	28.2	45.4	179.1	2.66	993.5	14.73	27.3
1957		814.4	76.4	31.7	44.7	210.8	3.13	1,069.9	15.87	25.7
1958		859.1	79.2	35.6	43.6	246.4	3.65	1,149.1	17.04	24.1
1959		902.7	82.0	39.9	42.1	286.3	4.25	1,231.1	18.26	22.6
1960		944.8	84.8	44.6	40.2	330.9	4.91	1,315.9	19.51	21.2
1961		985.0	87.6	47.1	40.5	378.0	5.61	1,403.5	20.81	20.9

* Footnotes for Table 4 follow on p. 23.

Table 4

Crude Oil Production and Reserves in the Ural-Volga Area, USSR
Annual Estimates, 1929-54, and Annual Forecasts, 1955-72
(Continued)

Year	Significant Discoveries a/	(1) Proved Reserves First of Year b/ (Million Metric Tons)	(2) Gross Additions to Reserves during Year c/ (Million Metric Tons)	(3) Production during Year d/ (Million Metric Tons)	(4) Net Change in Reserves during Year b/ (Million Metric Tons)	(5) Cumulative Production (End of Year) Quantity b/ (Million Metric Tons)	(5a) Cumulative Production (End of Year) Percent of Potential e/	(6) Cumulative Gross Additions to Reserves (End of Year) Quantity b/ (Million Metric Tons)	(6a) Cumulative Gross Additions to Reserves (End of Year) Percent of Potential e/	Ratio of Proved Reserves to Annual Production b/
1962		1,025.5	90.4	49.5	40.9	427.5	6.34	1,493.9	22.15	20.7
1963		1,066.4	93.2	52.3	40.9	479.8	7.11	1,587.1	23.53	20.4
1964		1,107.3	96.0	55.1	40.9	534.9	7.93	1,683.1	24.96	20.1
1965		1,148.2	98.8	57.7	41.1	592.6	8.79	1,781.9	26.42	19.9
1966		1,189.3	101.6	60.7	40.9	653.3	9.69	1,883.5	27.93	19.6
1967		1,230.2	104.4	63.7	40.7	717.0	10.63	1,987.9	29.48	19.3
1968		1,270.9	107.2	66.5	40.7	783.5	11.62	2,095.1	31.07	19.1
1969		1,311.6	110.0	69.8	40.2	853.3	12.65	2,205.1	32.70	18.8
1970		1,351.8	112.8	72.7	40.1	926.0	13.73	2,317.9	34.37	18.6
1971		1,391.9	115.5	76.1	39.4	1,002.1	14.86	2,433.4	36.08	18.3
1972		1,431.3	118.0	79.1	38.9	1,081.2	16.03	2,551.4	37.83	18.1

a. Compiled from source 16/.
b. Data in this column for 1929-54 compiled from columns (2) and (3). Data for 1955-72 computed directly from data in columns (5a) and (6a).
c. Estimated gross additions to reserves for 1929-50 derived from source 17/ and for 1951-54 estimated by extrapolation. Data for 1955-72 computed directly from data in columns (5a) and (6a).
d. Estimated annual production for 1929-53 from source 18/. Estimated annual production for 1954 extrapolated on basis of claimed increases cited in source 19/ modified by probable depletion throughout the Ural-Volga region.
e. The potential to which the percentages in columns (5a) and (6a) are referred is 6,743.7 million tons. This potential was derived from source 20/ under the guidance of CIA consultants. Data in columns for period 1955-72 based on analogy with similar data for US PAW District 3 during comparable development period 1924-41, as shown in Table 6, p. 27, below.
f. Less than 0.05 million tons.
g. Less than 0.005 percent.
h. Value of ratio is not relevant for 1929-33.

Table 5

Crude Oil Production and Reserves in the USSR Less Ural-Volga Area
Annual Estimates, 1900-54, and Annual Forecasts, 1955-72

Year	Significant Events and New Discoveries by Oil Regions a/*	Proved Reserves First of Year (Million Metric Tons)	Gross Additions to Reserves during Year (Million Metric Tons)	Production during Year (Million Metric Tons)	Net Change in Reserves during Year (Million Metric Tons)	Cumulative Production (End of Year)		Cumulative Gross Additions to Reserves (End of Year)		Ratio of Proved Reserves to Annual Production
						Quantity (Million Metric Tons)	Percent of Potential b/	Quantity (Million Metric Tons)	Percent of Potential b/	
1821-99						80.2	0.58	491.8	3.54	
1900		411.6	0	10.4	-10.4	90.6	0.65	491.8	3.54	39.6
1901		401.2	0	11.6	-11.6	102.2	0.74	491.8	3.54	34.6
1902		389.6	0	11.1	-11.1	113.3	0.82	491.8	3.54	35.1
1903	New discoveries in Baku	378.5	25.0	10.4	14.6	123.7	0.89	516.8	3.72	36.4
1904	oil region	393.1	20.0	10.9	9.1	134.6	0.97	536.8	3.86	36.1
1905	First Revolution	402.2	0	7.6	-7.6	142.2	1.02	536.8	3.86	52.9
1906		394.6	0	8.2	-8.2	150.4	1.08	536.8	3.86	48.1
1907		386.4	0	8.7	-8.7	159.1	1.14	536.8	3.86	44.4
1908		377.7	0	8.7	-8.7	167.8	1.21	536.8	3.86	43.4
1909	Discoveries in Central	369.0	1.0	9.3	-8.3	177.1	1.27	537.8	3.87	39.7
1910	Asia, Emba, and Baku	360.7	100.0	9.6	90.4	186.7	1.34	637.8	4.59	37.6
1911		451.1	0.0	9.2	-9.2	195.9	1.41	637.8	4.59	49.0
1912		441.9	0.0	9.3	-9.3	205.2	1.48	637.8	4.59	47.5
1913	Groznyy discoveries	432.6	100.0	9.2	90.8	214.4	1.54	737.8	5.31	47.0
1914	World War I	523.4	0	9.2	-9.2	223.6	1.61	737.8	5.31	56.9
1915	New Emba discovery	514.2	5.0	9.5	-4.5	233.1	1.68	742.8	5.34	54.1
1916		509.7	0	10.0	-10.0	243.1	1.75	742.8	5.34	51.0
1917	October Revolution	499.7	0	8.8	-8.8	251.9	1.81	742.8	5.34	56.8
1918		490.9	0	4.1	-4.1	256.0	1.84	742.8	5.34	119.7
1919		486.8	0	4.4	-4.4	260.4	1.87	742.8	5.34	110.6
1920		482.4	0	3.9	-3.9	264.3	1.90	742.8	5.34	123.7
1920-21		478.5	0	3.8	-3.8	268.1	1.93	742.8	5.34	125.9
1921-22		474.7	0	4.7	-4.7	272.8	1.96	742.8	5.34	101.0
1922-23	Rehabilitation and	470.0	0	5.3	-5.3	278.1	2.00	742.8	5.34	88.7
1923-24	restoration	464.7	0	6.1	-6.1	284.2	2.04	742.8	5.34	76.2
1924-25	of prewar	458.6	0	7.1	-7.1	291.3	2.10	742.8	5.34	64.6
1925-26	production	451.5	2.0	8.3	-6.3	299.6	2.15	744.8	5.36	54.4
1926-27		445.2	0	10.3	-10.3	309.9	2.23	744.8	5.36	43.2
1927-28		434.9	0	11.5	-11.5	321.4	2.31	744.8	5.36	37.8
1928-29	New Groznyy discoveries	423.4	0.7	13.5	-12.8	334.9	2.41	745.5	5.36	31.4
1929-30		410.6	0.8	17.3	-16.5	352.2	2.53	746.3	5.37	23.7
Special Quarters of 1/4 1930		394.1	0	5.3	- 5.3	357.5	2:57	746.3	5.37	c/

* Footnotes for Table 5 follow on p. 26.

Table 5

Crude Oil Production and Reserves in the USSR Less Ural-Volga Area
Annual Estimates, 1900-54, and Annual Forecasts, 1955-72
(Continued)

Year	Significant Events and New Discoveries by Oil Regions a/	Proved Reserves First of Year (Million Metric Tons)	Gross Additions to Reserves during Year (Million Metric Tons)	Production during Year (Million Metric Tons))	Net Change in Reserves during Year (Million Metric Tons)	Cumulative Production (End of Year)		Cumulative Gross Additions to Reserves (End of Year)		Ratio of Proved Reserves to Annual Production
						Quantity (Million Metric Tons)	Percent of Potential b/	Quantity (Million Metric Tons)	Percent of Potential b/	
1931	New discoveries	388.8	99.0	22.4	76.6	379.9	2.73	845.3	6.08	17.4
1932	in Central Asia, Baku,	464.4	98.6	21.4	77.2	401.3	2.89	943.9	6.79	21.7
1933	and Daghestan	542.6	0	21.5	-21.5	422.8	3.04	943.9	6.79	25.2
1934		521.1	0	24.1	-24.1	446.9	3.22	943.9	6.79	21.6
1935	New Emba discovery	497.0	0	24.7	-24.7	471.6	3.39	943.9	6.79	20.1
1936		472.3	18.4	27.0	-8.6	498.6	3.59	962.3	6.92	17.5
1937		464.7	26.1	27.6	-1.5	526.2	3.79	988.4	7.11	16.8
1938		462.2	22.7	29.0	-6.3	555.2	3.99	1,011.1	7.27	15.9
1939		455.9	30.2	28.6	1.6	583.8	4.20	1,041.3	7.49	15.9
1940		457.5	43.6	28.2	15.4	612.0	4.40	1,084.9	7.80	16.2
1941	World War II	472.9	13.6	29.5	-15.9	641.5	4.61	1,098.5	7.90	16.0
1942		457.0	13.5	19.6	-6.1	661.1	4.76	1,112.0	8.00	23.3
1943		450.9	13.4	14.1	-0.7	675.2	4.86	1,125.4	8.10	32.0
1944		450.2	0	15.1	-15.1	690.3	4.97	1,125.4	8.10	29.8
1945		435.1	16.7	16.7	0	707.0	5.09	1,142.1	8.22	26.1
1946	Postwar rehabilitation	435.1	18.0	18.0	0	725.0	5.22	1,160.1	8.35	24.2
1947	and restoration of	435.1	20.8	20.8	0	745.8	5.37	1,180.9	8.50	20.9
1948	prewar production	435.1	22.7	22.7	0	768.5	5.53	1,203.6	8.66	19.2
1949	Caspian Sea	435.1	28.9	25.2	3.7	793.7	5.71	1,232.5	8.87	17.3
1950	off-shore discoveries	438.8	35.1	27.3	7.8	821.0	5.91	1,267.6	9.12	16.1
1951	and	446.6	41.3	28.2	13.1	849.2	6.11	1,308.9	9.42	15.8
1952	development	459.7	47.5	29.1	18.4	878.3	6.32	1,356.4	9.76	15.8
1953		478.1	53.6	30.4	23.2	908.7	6.54	1,410.0	10.14	15.7
1954 d/		501.3	59.8	31.5	28.3	940.2	6.76	1,469.8	10.57	15.9
1955		529.6	58.6	32.8	25.8	973.0	7.00	1,528.4	11.00	16.1
1956		555.4	58.7	33.4	25.3	1,006.4	7.24	1,587.1	11.42	16.6
1957		580.7	58.6	34.2	24.4	1,040.6	7.49	1,645.7	11.84	17.0
1958		605.1	58.7	35.1	23.6	1,075.7	7.74	1,704.4	12.26	17.2
1959		628.7	58.6	35.9	22.7	1,111.6	8.00	1,763.0	12.68	17.5
1960		651.4	58.6	36.6	22.0	1,148.2	8.26	1,821.6	13.10	17.8
1961		673.4	58.7	37.8	20.9	1,186.0	8.53	1,880.3	13.53	17.8
1962		694.3	58.6	39.0	19.6	1,225.0	8.81	1,938.9	13.95	17.8
1963		713.9	58.7	40.1	18.6	1,265.1	9.10	1,997.6	14.37	17.8
1964		732.5	58.6	41.2	17.4	1,306.3	9.40	2,056.2	14.79	17.8

Table 5

Crude Oil Production and Reserves in the USSR Less Ural-Volga Area
Annual Estimates, 1900-54, and Annual Forecasts, 1955-72
(Continued)

Year	Significant Events and New Discoveries by Oil Regions a/	Proved Reserves First of Year (Million Metric Tons)	Gross Additions to Reserves during Year (Million Metric Tons)	Production during Year (Million Metric Tons)	Net Change in Reserves during Year (Million Metric Tons)	Cumulative Production (End of Year)		Cumulative Gross Additions to Reserves (End of Year)		Ratio of Proved Reserves to Annual Production
						Quantity (Million Metric Tons)	Percent of Potential b/	Quantity (Million Metric Tons)	Percent of Potential b/	
1965		749.9	58.6	42.1	16.5	1,348.4	9.70	2,114.8	15.21	17.8
1966		766.4	58.7	43.1	15.6	1,391.5	10.01	2,173.5	15.64	17.8
1967		782.0	58.6	43.9	14.7	1,435.4	10.33	2,232.1	16.06	17.8
1968		796.7	58.6	44.8	13.8	1,480.2	10.65	2,290.7	16.48	17.8
1969		810.5	58.7	45.5	13.2	1,525.7	10.98	2,349.4	16.90	17.8
1970		823.7	58.6	46.3	12.3	1,572.0	11.31	2,408.0	17.32	17.8
1971		836.0	58.7	47.0	11.7	1,619.0	11.65	2,466.7	17.75	17.8
1972		847.7	58.6	47.6	11.0	1,666.6	11.99	2,525.3	18.17	17.8

a. Estimated annual production for 1900-53 derived from source 21/, less values shown in Table 4 for the period 1929-53. Estimated gross additions to reserves derived from source 22/ (modified by values in Table 4) for selected years, with interpolated and extrapolated values of ratios of proved reserves to annual production for remaining years, used for the period 1900-54. Remaining data for the period 1900-54 are calculated directly from annual production and annual gross additions to reserves.

b. The potential to which the percentages cumulative production and percentages gross additions to reserves are referred is 13,900.4 million tons. This is the difference between estimate for USSR published in 1948 23/, and that derived for the Ural-Volga area. This potential is the only one available. It should be independently determined on a regional basis by additional studies similar to the study on the Ural-Volga area. 24/

c. No basis for a ratio involving annual production.

d. Forecasts for 1954 to 1972 based on 25/ estimate of geologic potential and economic capabilities for 1952-1972 period supplemented by the assumption of an increase in the ratio of proved reserves to annual production from 15.9 in 1954 to 17.8 in 1960 and extrapolation of this latter ratio to 1972. Justification for this assumption is by analogy with US experience. However, this assumption and the entire forecast shown should be checked by additional regional studies on the USSR similar to that completed on the Ural-Volga area. 26/

Table 6

Significant Relationships between Crude Oil Production, Reserves, and Potential Resources in Two Selected Regions of the US and in the Middle East 1900-53

Year	US PAW District 3 a/*			US Less PAW District 3 b/			Middle East c/		
	Cumulative Production as Percent of Potential	Cumulative Gross Additions to Reserves as Percent of Potential	Ratio of Proved Reserves to Annual Production	Cumulative Production as Percent of Potential	Cumulative Gross Additions to Reserves as Percent of Potential	Ratio of Proved Reserves to Annual Production	Cumulative Production as Percent of Potential	Cumulative Gross Additions to Reserves as Percent of Potential	Ratio of Proved Reserves to Annual Production
1900	d/	d/	e/	2.0	7.5	34.1			
1901	d/	0.2	e/	2.2	7.8	31.2			
1902	d/	0.3	e/	2.4	8.2	30.8			
1903	0.1	0.4	e/	2.6	8.6	29.2			
1904	0.1	0.6	e/	2.8	9.1	29.0			
1905	0.1	0.7	e/	3.1	9.6	27.8			
1906	0.1	0.9	47.1	3.3	10.1	27.9			
1907	0.1	1.0	44.2	3.6	10.7	26.0		(No petroleum production in Middle East before 1911)	
1908	0.1	1.2	41.5	3.9	11.4	25.3			
1909	0.2	1.3	38.9	4.2	12.1	24.7			
1910	0.2	1.5	36.5	4.6	12.8	24.4			
1911	0.2	1.7	34.3	5.0	13.6	22.7	d/	d/	e/
1912	0.3	1.9	32.2	5.3	14.4	22.4	d/	0.1	e/
1913	0.3	2.0	30.2	5.8	15.2	21.8	d/	0.3	e/
1914	0.4	2.3	28.4	6.2	16.0	20.8	d/	0.5	e/
1915	0.5	2.7	26.6	6.7	16.7	19.4	d/	0.9	e/
1916	0.6	3.1	25.0	7.2	17.4	18.6	d/	0.9	352
1917	0.7	3.5	23.5	7.8	18.2	17.2	d/	0.9	227
1918	0.8	4.1	22.0	8.4	18.9	16.0	d/	0.9	154
1919	0.9	4.7	21.7	9.0	19.6	15.2	d/	0.9	132
1920	1.1	5.4	21.4	9.7	20.3	14.0	d/	0.9	114
1921	1.3	6.1	21.2	10.5	21.0	13.0	d/	1.0	98
1922	1.5	6.9	20.9	11.4	21.7	12.0	0.1	1.1	84
1923	1.8	7.8	20.6	12.3	22.5	11.2	0.1	1.1	72
1924	2.1	8.8	20.3	13.3	23.2	10.2	0.1	1.1	58
1925	2.5	9.8	20.1	14.4	24.1	9.7	0.1	1.1	49
1926	2.9	10.9	19.8	15.6	24.9	9.0	0.1	1.1	46
1927	3.3	12.1	19.5	16.8	25.9	8.1	0.2	1.3	41
1928	3.9	13.3	19.3	18.0	26.8	7.4	0.2	1.3	40
1929	4.6	14.6	19.0	18.8	27.9	10.3	0.2	1.5	40
1930	5.1	16.0	18.8	19.9	29.0	10.0	0.2	1.5	41
1931	5.7	17.4	18.5	20.9	30.2	9.6	0.3	1.6	41
1932	6.3	18.9	18.3	22.1	31.5	9.4	0.3	1.8	42

* Footnotes for Table 6 follow on p. 28.

Table 6

Significant Relationships between Crude Oil Production, Reserves, and Potential Resources
in Two Selected Regions of the US and in the Middle East
1900-53
(Continued)

Year	US PAW District 3 a/			US Less PAW District 3 b/			Middle East c/		
	Cumulative Production as Percent of Potential	Cumulative Gross Additions to Reserves as Percent of Potential	Ratio of Proved Reserves to Annual Production	Cumulative Production as Percent of Potential	Cumulative Gross Additions to Reserves as Percent of Potential	Ratio of Proved Reserves to Annual Production	Cumulative Production as Percent of Potential	Cumulative Gross Additions to Reserves as Percent of Potential	Ratio of Proved Reserves to Annual Production
1933	7.0	20.5	18.0	23.2	32.9	9.0	0.3	2.2	42
1934	7.7	22.2	17.8	24.3	34.4	8.7	0.4	2.8	43
1935	8.5	23.9	17.6	25.4	36.1	9.7	0.4	3.3	43
1936	9.4	25.7	17.3	26.5	37.8	9.6	0.5	3.9	46
1937	10.3	27.5	17.1	27.7	39.8	9.4	0.6	4.2	49
1938	11.3	29.4	16.9	28.9	42.0	9.4	0.6	4.8	52
1939	12.5	31.4	16.7	30.1	43.2	9.2	0.7	4.8	55
1940	13.5	33.5	16.4	31.6	44.5	9.1	0.8	5.2	61
1941	14.6	35.6	16.2	33.2	45.8	8.9	0.8	5.7	84
1942	15.8	37.8	16.0	34.6	47.3	8.8	0.9	6.4	66
1943	17.1	40.1	15.8	36.1	48.9	8.7	1.0	8.4	70
1944	18.5	42.4	15.6	37.6	50.7	8.6	1.1	11.2	75
1945	20.0	44.9	15.4	39.2	52.5	8.4	1.2	18.6	80
1946	21.7	47.3	15.2	40.7	54.5	9.7	1.4	19.0	104
1947	23.5	49.9	15.0	42.4	56.6	9.7	1.6	19.3	88
1948	25.4	52.5	14.8	44.0	58.9	9.8	1.9	22.6	65
1949	27.2	55.2	14.6	45.7	61.4	9.9	2.2	23.1	62
1950	29.1	57.9	14.4	47.4	64.1	10.0	2.6	33.6	50
1951	31.1	60.8	14.2	49.2	67.0	10.0	3.1	36.5	67
1952	33.3	63.7	14.0	50.9	70.0	10.1	3.6	45.4	67
1953	35.7	66.6	13.8	52.8	73.3	10.1	4.1	56.5	73

a. The significant data shown were derived from basic data on crude oil production and reserves published in the following sources:
Crude oil production, 1900-30 from 27/; 1931-53 from 28/.
Crude oil reserves, 1900-36 from 29/, modified by prorating PAW District data against API (American Petroleum Institute) US data from source 30/ for consistency with data after 1936 which are API rather than PAW; 1937-46 from 31/; 1947-53 from 32/.
The initial computations from the original data were smoothed by simple analytic and graphic methods in order to use them for forecasting by analogy in Table 4.
The potential crude oil resources of PAW District 3 used for the calculations are 8,368.6 million tons. This was derived from Weeks estimate in 33/ for the US and reserve data in 34/ to obtain the remaining potential resources in the US as of 31 December 1953, amounting to 4,505.7 million tons. These remaining resources were prorated to PAW Districts on the basis of gross additions to reserves for the period 1937-54. This proration gave 2,794 million tons, or 62 percent of remaining potential crude oil resources in the US as of 31 December 1953, in PAW District 3. Adding these remaining potential resources in District 3 to the cumulative gross additions to reserves in this District as of 31 December 1953, amounting to 5,574.6 million tons, gives the total potential crude oil resources of District 3 of 8,368.6 million tons.
b. Data for the US less District 3 are derived from the same sources and by the same statistical methods as those described under a, above, for the US total and for the US less District 3 by difference.

Table 6

Significant Relationships between Crude Oil Production, Reserves, and Potential Resources in Two Selected Regions of the US and in the Middle East 1900-53
(Continued)

c. The significant data shown were derived from basic data on crude oil production and reserves in the Middle East given in the following sources:
Crude oil production 1911-52 from source 35/ and 1953 from 36/.
Crude oil reserve data for the end of 1953 from source 37/ and reserve data for previous years are from previous annual International Operations issues of this same publication, World Oil, insofar as the data are available. Reserve data for remaining years were interpolated or extrapolated on the basis of historical records of petroleum discovery and development in the Middle East given in 38/.
The data shown are the initial computations from the original data in the sources cited. They are not smoothed as were the US data, because these Middle East data are not used in this study for forecasting by analogy, but are included simply for comparative purposes.
The potential crude oil resources of the Middle East used for the calculations are 20,909.2 million tons, as published by Weeks in 1948. 39/
d. Less than 0.05 percent.
e. Value of ratio is not relevant for initial period.

Table 7

Estimated Annual Crude Oil Production in the Ural-Volga Area, USSR
by Groups a/*
1929-54

Million Metric Tons

Year	Molotovneft'	Bashneft'	Kuybyshevneft'	Buguruslanneft'	Tatneft'	Saratovneft'	Stalingrad	Other Areas	Total Ural-Volga
1929	b/								b/
1930	b/								b/
1931	b/								b/
1932	b/	b/							b/
1933	b/	b/							b/
1934	b/	0.1							0.1
1935	b/	0.4							0.4
1936	b/	0.9							0.9
1937	b/	0.9	b/						0.9
1938	b/	1.1	0.1	b/					1.2
1939	0.1	1.6	0.1	b/					1.8
1940	0.1	2.0	0.2	0.1					2.4
1941	0.1	2.0	0.2	0.1					2.4
1942	0.1	2.0	0.3	0.1					2.5
1943	0.1	2.0	0.4	0.1					2.6
1944	0.1	1.9	0.6	0.1					2.7
1945	0.1	1.9	0.6	0.1					2.7
1946	0.2	2.6	0.8	0.1	b/				3.7
1947	0.3	3.5	1.2	0.2	b/				5.2

* Footnotes for Table 7 follow on p. 31.

Table 7

Estimated Annual Crude Oil Production in the Ural-Volga Area, USSR by Groups a/ 1929-54 (Continued)

Million Metric Tons

Year	Molotovneft'	Bashneft'	Kuybyshevneft'	Buguruslanneft'	Tatneft'	Saratovneft'	Stalingrad	Other Areas	Total Ural-Volga
1948	0.3	4.4	1.7	0.2	0.1	b/			6.7
1949	0.4	5.6	2.0	0.2	0.2	b/			8.4
1950	0.5	6.3	2.9	0.3	0.2	0.1			10.3
1951	0.5	8.8	3.4	0.3	0.3	0.1			13.4
1952	0.6	11.2	3.9	0.4	0.3	0.1			16.5
1953	0.7	12.6	4.8	0.5	0.4	0.2			19.2
1954	0.7	15.0	5.2	0.5	0.4	0.2	0.1	b/	22.1
Total to 1 Jan 1955	4.9	86.8	28.4	3.3	1.9	0.7	0.1	b/	126.1

a. Data for total Ural-Volga from Table 3. Distribution to groups prorated from data in source 40/ for period 1929-52 except for years 1941-44 which are interpolated. The data by groups for 1950-52 are adjusted slightly to conform to recent information on Bashneft'. 41/ Data for Bashneft' for 1953-54 from 42/ and remaining groups prorated on basis of 1952 production.
b. Less than 0.05 million tons.

APPENDIX B

METHODOLOGY

Two general types of data are presented in this report: (1) estimates of the potential petroleum resources of the Ural-Volga area of the USSR and (2) forecasts of future production based primarily on the above estimate.

The methods used in developing the estimate of potential petroleum resources are briefly summarized in Section II, D, of this report. [redacted] for a more complete exposition of the methods and to the geologic report on the Ural-Volga area 44/ for a more detailed understanding of the application of these methods to the region covered. 50X1

The methods used for developing the forecasts of production of crude oil in the Ural-Volga region are explained in Section III of this report. They are widely used in the petroleum industry for forecasting, although their detailed application varies somewhat to fit specific requirements.

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