2.0 PRODUCING

2.1 SUMMARY

The production of crude oil in Germany, reported at the rate of 711,445 metric tons (4,980,115 barrels) in 1944 (see table on pages 82 and 83), is at a high level in consequence of war pressure for maximum supplies and as a result of a well-organized program of geological and geophysical exploration begun in 1933 as part of Germany's preparation for war. The cumulative total of crude oil production from German fields, from 1873 through 1944, amounts to approximately 9,963,500 metric tons (69,744,500 barrels).

Although German crude oil reserves must have increased in some ratio to the increase in oil production during the years 1939 to 1945, adequate data are lacking for an estimate of present reserves. Owing to the complex faulting and irregular sand conditions characterizing the salt dome fields from which nearly all German crude oil was produced prior to the war, estimates of reserves even for this period are highly speculative. The available data suggest that German reserves at the end of 1938 amounted to approximately 8,000,000 metric tons (56,000,000 barrels), and, with allowance for subsequent production, this figure may have increased to 10,000,000 metric tons (70,000,000 barrels) by the end of 1944.

From the data presented hereafter it is concluded that in the future, as in the past, the bulk of German oil will come from salt dome structures of the North German Basin. Little is known regarding favorable structures in the Bavarian Basin but it is probable that development in this area will proceed slowly, although important oil production may eventually result. The Rhine Valley Graben may continue to yield relatively small quantities of oil.

Up to the beginning of the war, in 1939, drilling in the North German Basin was confined largely to shallow salt domes. These bear closer resemblance to the shallow salt domes of East Texas, Northern Louisiana and Southern Arkansas, than to the shallow domes of the Gulf Coast proper in Texas and Louisiana. The Boggy Creek oil field in East Texas is an example of production from a shallow interior salt dome and is comparable to the similarly situated fields of Nienhagen or Wietze, in Germany. In contrast to the modest production from Boggy Creek or Nienhagen, the deep-seated domes of East Texas, Northern Louisiana and Southern Arkansas, such as Van, Eldorado, Haynesville, Lisbon, etc., have yielded prolific production. All those Gulf Coast oil fields having an estimated total production greater than 200,000,000 barrels are deep-seated domes, whereas the largest estimated ultimate production from a shallow dome is about 135,000,000 barrels. There is thus some suggestion that if future exploration in Germany is directed toward the testing of the numerous deep-seated salt domes, oil fields of considerably greater magnitude than those known in Germany to the present may be discovered. This hypothesis derives some support from the fact that the greatest oil discovery in Germany in recent years, the Reitbrook field, is associated with a moderately deep-seated salt dome.

2.1.1 Character of German Crude Oils

The chief characteristics of German crude oils are shown in the table (a) on the following page. Additional analyses of crudes and products may be found in Appendices 2 to 6 inclusive.

(a) Taken from the American Association of Petroleum Geologists Bulletin, No. 12 (1928), page 482.

Analyses of German Crude Oils

Name of Field	Wietze	Wietze	Nienhagen	Nienhagen
Geological Formation	Upper Triassic (Rhaet)	Lower Cretaceous (Wealden)	Middle Jurassic (Dogger)	Lower Cretaceous (Neokom)
Color	Olive Green	Dark Brown	Olive Green	Coffee Brown
Flash Point (Open Tests) 0°C.	27	121	82	81
Specific Gravity at 20° C.	0.882	0.946	0.901	0.914
Viscosity at 20° C (Engler)	5.63	183.6	18.1	24.0
Cold-Test (Schultze)	5 mm. at -3°	1 mm. at -15°		17 mm. at 20°
Asphalt	0.28%	1.42%		0.05%
Distillation Commenced at °C	118	245	220	130
Distilling below 150° C	2.0%			0.5%
150° - 250°	17.5%		5.0%	9.5%
250° - 275°	23.5%	1.5%	10.5%	13.8%
275° - 300°	31.5%	6.0%	15.0%	19.5%
300° - 325°	38.5%	12.5%		25.2%
325° - 350°	51.0%	26.0%	35.5%	39.2%

2.2 STRATEGIC CONSIDERATIONS

Importance in normal times.- In 1938 the German production of crude oil provided somewhat less than 10% of the country's requirements for petroleum products. The value of the indigenous natural oil was greatly enhanced, however, by the very high import duties levied on foreign oil to protect the expensive domestic production of synthetic oil from coal.

The German oil fields are conveniently located close to the waterways of the Elbe and Weser Rivers and the Mitteland Canal, and are in proximity to the major refining centers at Hamburg, Hannover and Bremen. Nevertheless, because of the relatively small yields per well, and other factors contributing to high production costs, a considerable percentage of German crude oil production would prove uneconomic if the country were freely accessible to oil imports from abroad. Crude oil can be brought to Germany much more cheaply from the Caribbean area or the Middle East than it can be produced in many of the country's present fields.

For a considerable period following the close of the present war, when it may be presumed that Germany must depend largely upon her own resources for raw materials, and when the country will be desperately short of free exchange, all of the indigenous crude oil production will be an invaluable asset.

Wartime use.- Germany's crude oil production amounted to less than 1/16 of her maximum rate of oil consumption in 1944, but as the control of foreign supplies was lost, and as the war closed in on the borders of the Altreich, the importance of the domestic crude oil production was greatly enhanced. This became even more marked as the synthetic oil plants were destroyed by bombing, for oil fields are not attractive targets, and refineries are more readily reconstructed, or relocated in small dispersed units, than are synthetic plants. Throughout the war, German domestic crude oil has been additionally valuable because it supplies an excellent base for the production of high-grade lubricants.

Enemy denial operations.- The important oil fields of Germany are so located that their conquest and capture has closely coincided with the termination of the war. Also, the enemy is here dealing with his own vital resources. So far as can be ascertained up to the present, the Germans have made little or no effort toward the destruction of oil field installations.

2.3 HISTORY OF DEVELOPMENT

As early as 1546 George Agricola, the classical writer on mining and geology, stated that oil was found near Hänigsen in the free state of Brunswick, in northern Germany. He and other ancient writers report that the oil was skimmed by the inhabitants from pits and used for painting door posts and for axle grease. These tar pits were the starting point for the development of oil fields by wells.

The first oil well in Germany was drilled in the tar pit of Wietze in 1859 for the government of Hannover, but this well, like others drilled by English, French and Belgian companies in the early 1860's, was a failure. These holes were drilled only near the seepages and outcrops containing oil, and reached depths of 100 to 200 meters (330 to 660 feet); they were located without reference to geological conditions and operated with inadequate equipment.

A favorable change in the German oil industry took place in 1881 when a Bremen firm brought in several flowing wells near Ölheim, also in the immediate vicinity of tar pits, and production was further increased shortly thereafter. An "oil boom" occurred at this time and many companies formed, but the wells they drilled were improperly located in a small area and were technically defective, so that the oil horizons were soon flooded by water and production decreased rapidly.

Also at this time additional wells were completed in the Wietze field which sufficed to maintain the total output of oil in northern Germany at an approximately even level. In 1900 a new oil horizon was encountered at Wietze, between 200 to 300 meters (660 and 1,000 feet) in depth, which yielded a very valuable light oil. This discovery led to renewed activity; production was greatly increased; new companies were formed and the banks became interested in the oil industry.

In 1904 legislation was passed regarding water shut-off and the operation of oil wells. In 1907 all of the small operating companies at Wietze were incorporated under the leadership of several German banks. Several successful wells were drilled in the Hänigsen area, which had been neglected up to this time, and German oil production in 1909 reached an annual output of 113,824 tons (796,768 barrels).

During the First World War the oil industry in Germany was adversely affected by the lack of workers and materials and no new field was opened despite an increase in the number of oil companies from 33 in 1913 to 156 in 1918. In 1919 oil recovery by mining methods was introduced in the Wietze field, which had practically depleted its gas, and by this means production from the field was maintained during the following years.

An important event in the development of the North German oil industry occurred in 1922, when a comparatively large gusher was successfully completed in the northern part of the Hänigsen-Nienhagen field, yielding initially from 200 to 300 tons (1,500 to 2,250 barrels) of oil daily. This well was followed by several others which were equally productive, and soon thereafter the output of this field surpassed that of Wietze. These Nienhagen wells were extremely important for the German oil industry, as their production greatly exceeded the previous German yield.

Also, they had not been drilled close to the flank of the Nienhagen salt dome, as were the earlier wells, but farther down dip, and accordingly they struck the oil-bearing horizons at greater depths--ranging from 700 to 800 meters (2,320 to 2,640 feet) instead of 200 to 300 meters (660 to 990 feet) as formerly. It was therefore proved that by drilling holes deeper than before it would be possible to discover considerable new production. Shortly after the war another field was developed near Oberg, which steadily yielded greater production. All these events not only resulted in a continuous increase of the oil production since 1920 but also stimulated additional exploratory work and wildcat drilling.

In 1928 a deep well drilled at some distance from the salt plug on the Ödesse-Ölheim dome was completed as a producer, and shortly afterwards other wells were brought in near it. Production in this field rose from 97 tons (679 barrels) in 1928 to 14,388 tons (100,716 barrels) in 1930.

Small amounts of oil were obtained in the 1880's in shallow wells at Heide in Holstein, and Linden, near Hannover. Active development of the Heide field was not undertaken until 1935, and early in 1938 a well was brought in on the west flank of the structure and flowed at the rate of 200 tons (1,400 barrels) of oil daily from a depth of 1,100 meters (3,608 feet). Soon thereafter similar production was obtained 5 kilometers (3 miles) farther north on the same west flank. By April 1939 the output from this field was in excess of 3,500 tons per month (24,500 barrels).

The most important recent discovery in Germany occurred at Reitbrook late in 1937. About 280 hectares (692 acres) of the field had been proven productive in 1939, with wells yielding initially in excess of 42 tons (300 barrels) daily. Peak production for the field was probably reached in 1940, with an annual output reported at 357,421 tons (2,501,947 barrels).

Other discoveries in the North German Basin between 1934 and the outbreak of the Second World War, were Rodewald (Steimbke) and the Feldbergen (Moelme extension field). Aerial photographs taken in 1943 showed the old Moelme field to be abandoned and a new pool developed about a mile to the southwest, just northwest of Feldbergen. During this period production was also encountered at Broistedt, Fallstein, Gifhorn, Lindwedel (Adolfsglueck), Meckelfeld, and Sottorf, but judging from available information on their geological characteristics and production records most of these pools appear to be of little importance, either real or potential.

During the Second World War, and especially in 1943 and 1944, aerial reconnaissance has revealed the existence of a number of new oil fields in the North German Basin. These are: the Dalum field, located near the Dutch-German frontier immediately west of Dalum and northwest of Lingen; Coevorden just across the German border in Holland, about 20 kilometers (12 miles) northwest of Dalum and 6 kilometers (4 miles) east of Coevorden; Emlicheim, 10 kilometers (6 miles) southeast of Coevorden; a discovery well near Bentheim some distance southwest of Dalum; Schöningen, located near Braunschweig in northwest Germany; Eicheloh, near Hannover, Hemmingstedt and Hemmingstedt-Kanzlei in Holstein; Epenwöhrden-North, several kilometers south-southwest of Hemmingstedt; Epenwöhrden-south, immediately south of the village of Epenwöhrden; Meldorferhafen, just west of the town of Meldorf; Etzel, south of Wilhelmshafen, near the North Sea coast; Eichlingen, about a kilometer east of Kleine Eichlingen in the Nienhagen area; Westerholz, some 12 kilometers (7 miles) west of Nienhagen; and Alte Piccardie, near the German-Dutch border.

Since 1930 production has been obtained in the Thuringian Basin of Central Germany between the massive of the Harz Mountains and the Thuringian Hills from the Volkenroda Potash Mine, but it is now depleted. Although there are other possibilities for oil in this basin no new field is known to have been discovered.

In the Rhine Valley Graben of southwest Germany, the Baden area (Bruchsal-Forst-Weingarten) and the Hessen area have yielded relatively small quantities of oil, most of it coming from Baden in what is considered to be the eastward prolongation of the Pechelbronn (France) producing horizons. The Baden-Hessen output has steadily increased from an initial annual yield of about 1,500 tons (10,500 barrels) in 1935 to a reported 10,003 tons (70,021 barrels) in 1943. Aerial reconnaissance in 1944 has shown a new field near Weiher, about 5 kilometers (3 miles) northeast of Bruchsal.

In the Bavarian Basin of southern Germany, between the northern Alps and the ancient Bohemian massive, only about 4,000 tons (28,000 barrels) of oil are reported to have been produced up to 1937, practically all of it coming from the Tegernsee area where production was first obtained in 1883 with an annual output of 62 tons (434 barrels).

The annual production of the German oil fields from 1873 to 1944, inclusive, is shown in the table on pages 82 and 83. The oil fields and known oil prospects of Germany will be individually described hereafter.

The marked increase in the number of oil field discoveries after 1934 may be attributed to the German government's efforts to aid explorational drilling as part of its plan for achieving national self-sufficiency in raw materials. The main measures taken by the government for this purpose were a campaign of geophysical mapping of those parts of the country most promising for oil discoveries and the subsidization of exploratory drilling to insure private enterprise against undue risk.

The work of geophysical exploration was carried out by the Reichs Geophysicalische Komission (National Geophysical Survey) at government expense, using chiefly the seismograph and gravity meter. Results were made public by piecemeal, and were available to qualified oil exploration companies for their guidance in making application for concessions. A representative example of such a governmental geophysical map is shown on pages 38 and 39.

The government drilling subsidy (Reichs-bohrzuschuss) was available, upon approval of application, to all companies of more than 50 per cent German capital. It consisted in a pre-determined money contribution by the government to off-set drilling costs of explorational wells, and was on a sliding scale, so that the amount of subsidy per meter drilled increased with the depth of the well. In the event that a subsidized well discovered commercial quantities of oil, the subsidy was repayable from the well's subsequent production; in the event of an unsuccessful well, the subsidy was, for all practical purposes, written off.

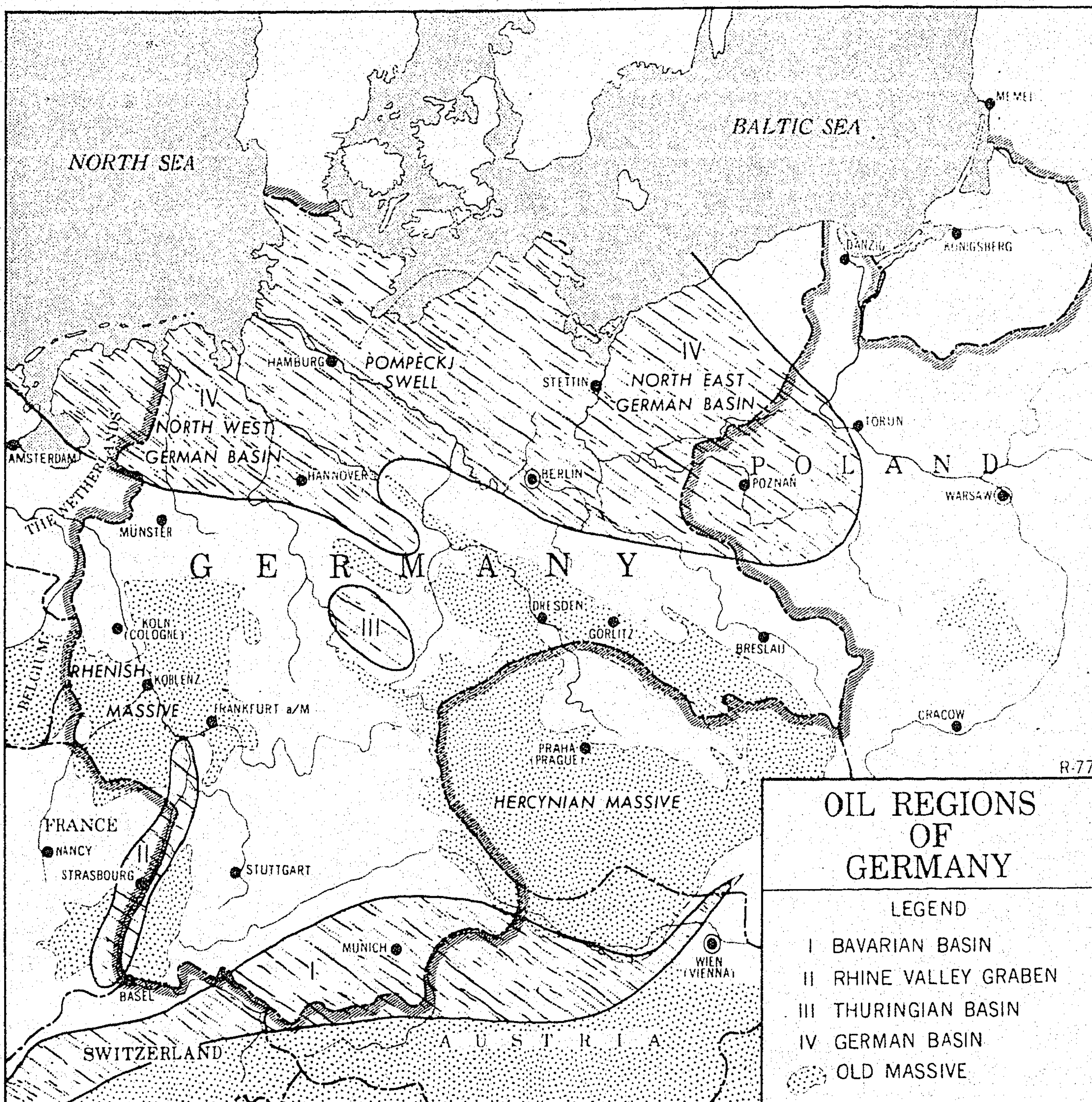
2.4 GEOLOGY OF GERMANY

2.4.1 Petroliferous Districts

Petroleum occurs in Germany in four districts, namely: (1) The North German Basin, (2) The Thuringian Basin, (3) The Rhine Valley Graben, and (4) The Bavarian Basin. The relative size and position of these districts are indicated on the map on page 26.

All but a small percentage of the oil produced in Germany comes from salt dome structures in the North German Basin, which covers an area of approximately 160,000 square kilometers (61,760 square miles) in northern and northwestern Germany. The most prolific production in this basin comes from the Prussian province of Hannover. Oil occurs here mainly on the flanks of salt domes, in horizons of Triassic, Jurassic and Cretaceous age.

The other petroliferous basins of Germany are of relatively little importance. In the Thuringian Basin, an area of less than 10,000 square kilometers (3,860 square miles), oil occurs in regular anticlines in dolomite of Upper Permian age. The Rhine Valley Graben consists chiefly of a sunken block between two tilted fault blocks and is approximately 13,000 square kilometers (5,018 square miles) in extent. It includes areas on both sides of the Rhine, with the Alsatian oil occurrence at Pechelbronn belonging to France. In this valley oil comes from beds in the Oligocene in gently dipping monoclines which are cut by faults. The Bavarian Basin comprises some 30,000 square kilometers (11,580 square miles) lying between the north-



ern Alps and the old Bohemian basement massive; this area has yielded only very small quantities of oil, the main operation being located at Tegernsee, where oil is found as seepages from beds of Upper Cretaceous and Tertiary age.

The topography of the four petroliferous provinces of Germany--the North German Basin, Thuringian Basin, Rhine Valley Graben, and Bavarian Basin-- is generally flat to gently rolling but in places becomes hilly. The surface formations outcropping in these provinces range in age from Mesozoic in the Thuringian Basin to Quarternary which covers most of the areas of the other basins. A large part of Germany lies outside these provinces and contains widespread areas of Precambrian and folded Paleozoic rocks in places overlain by less disturbed Mesozoic beds, as well as relatively small patches of Tertiary sediments.

Of the four petroliferous provinces, the North German Basin produced about 99 per cent of the oil of Germany up to 1940 and is therefore of far greater importance than all the other petroliferous districts combined. The geologic structure of this basin and its embayment in central Germany (Thuringian Basin) can best be understood by summarizing the geologic history of this part of Germany from the end of Carboniferous time, as is done in the following paragraphs.

2.4.2 Historical Geology

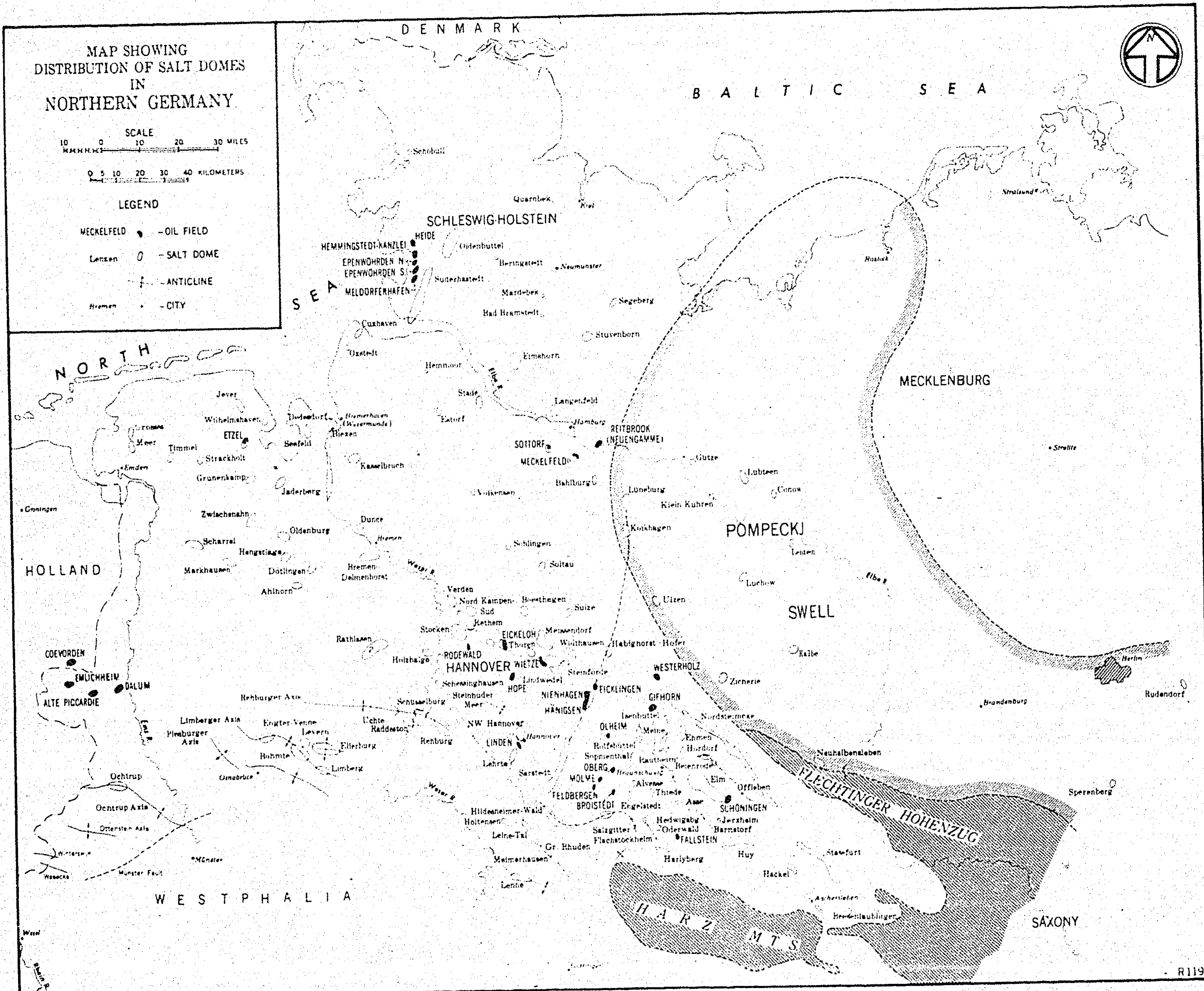
Permian.- The period represented by the Upper Carboniferous and Lower Permian rocks was one of great regional earth movements and local volcanic activity. The Carboniferous rocks were bent into vast folds, the arches of which were then eroded; large areas were cut off from the ocean and inland seas formed comparable to that of the modern Caspian. One of these stretched over most of northern and central Germany and in it were laid down the Rothliegendes and Zechstein formations of the Permian, the latter containing massive beds of rock salt with bands of potash. The land to the south and west of this inland sea was probably steep and rugged, and perhaps contained glaciers.

Triassic.- Lying upon the rocks of the Permian system of central Germany are the formations of the Triassic, the lowest beds sometimes following conformably upon the Permian and sometimes transgressing unconformably over older rocks. The Triassic is divided into (1) an Upper or Keuper series of red marl and beds of gypsum and rock salt, overlying sandstones, marls, and clays, with thin coals; (2) a Middle or Muschelkalk (shell limestone) containing thick beds of limestone and dolomite sometimes filled with crinoid stems and generally showing a middle zone of dolomites with gypsum and rock salt; (3) a Lower or Bunter (variegated) series with thick beds of coarse red sandstones, with local layers of rock-salt and gypsum, and shales with occasional red and green marls. The German Triassic appears to have been laid down in an irregular basin of great extent and diversified surface. The Muschelkalk was unquestionably deposited when there was communication with the open sea.

Jurassic.- Overlying the Triassic are the formations of the Jurassic which occur in two main areas, namely, from the southern extremity of the Black Forest through Würtemburg and Bavaria to the boundary of Bohemia, and, in the northwest German area where the Harz Mountains and its branches decline in elevation and disappear in the surrounding plain. The Jurassic system is divided into: (1) the Upper or White Jura (malm); (2) the Middle or Brown Jura (dogger); (3) Lower or Black Jura (lias). From their character it is obvious that the Jurassic rocks were deposited in waters connected with the open sea.

Cretaceous.- At the close of Jurassic time much of northern Germany was above sea level, and the Wealden formation of the Cretaceous was laid down in a large lake or estuary. During Lower Cretaceous time the land, which was more or less elevated and varied in character to the west, was undergoing slow subsidence interrupted by many oscillations so that the deposits are local and intermittent. However, in Upper Cretaceous time the region was greatly depressed. The Gault and Upper Greensand deposits were laid down on subsiding land to the west while the area to the east sank deeply below the invading waters of a continuous expanse of open sea. This period is referred to as the "Cenomanian Transgression".

Tertiary to recent.- Overlying the Cretaceous are the formations of the Tertiary system, which were deposited in comparatively shallow water. The beds are varied sandy and calcareous strata, lying in isolated basins uncomformably upon the chalk, and contain distinctive faunae. Overlying the Tertiary beds and covering most of the area of the basins are recent and Pleistocene deposits.


MAP SHOWING
DISTRIBUTION OF SALT DOMES
IN
NORTHERN GERMANY
SCALE
10 0 10 20 30 MILES
0 5 10 20 30 40 KILOMETERS
LEGEND
MECKELFELD – OIL FIELD
Lenzen – SALT DOME
– ANTICLINE
Bremen – CITY
DENMARK
BALTIC SEA
NORTH SEA
SCHLESWIG-HOLSTEIN
MECKLENBURG
HOLLAND
WESTPHALIA
HANNOVER
POMPECKJ
SWELL
FLECHTINGER HÖHENZUG
HARZ MTS
SAXONY
HEMMINGSTEDT-KANZLEI
HEIDE
EPENWÖHRDEN N.
EPENWÖHRDEN S.
MELDORFERHAFEN
ETZEL
SOTTORF
MECKELFELD
REITBROOK (NEUENGAMME)
COEVORDEN
EMLICHHEIM
DALUM
ALTE PICCARDIE
EICKELOH
RODEWALD
WIETZE
HOPE
NIENHAGEN
HÄNIGSEN
FICKLINGEN
WESTERHOLZ
GIFHORN
OLHEIM
LINDEN
OBERG
MOLME
FELDBERGEN
BROISTEDT
SCHÖNINGEN
FALLSTEIN
Cuxhaven
Stade
Oldenburg
Lüneburg
Uelzen
Verden
Limberg
Ochtrup
Salzgitter
Asse
Elm
Huy
Hackel
Sperenberg
Rüdersdorf
R119

OIL PROSPECTS IN GERMANY

NORTH GERMAN BASIN (Map on page 28)

Name	Remarks
Ahlften	Same as Soltau Dome
Alhorn	Salt dome prospect, little or no development
Alvesse	Near Brunswick. Salt dome; top of salt 650 feet; asphaltic Tertiary sands found in canal dredging. No deep wells.
Aschersleben	Near northeast end of Harz Mountains. Salt anticline; top of salt 500 feet. One of the oldest potash mines in Germany.
Asse	Southeast of Brunswick. Salt anticline. Depth to top of salt 500 feet. Potash mined. No shows of oil or gas.
Bad Bramstedt	South of Neumünster. A prospect. Based on salt water wells, probably in Tertiary formation.
Bahlburg-Pattenson	Southeast of Hamburg near Wissen. Salt dome; top of salt 1,200 feet. No oil or gas shows.
Barneberg	Between Brunswick and Magdeburg. Same as Offleben.
Barnstorf-Brunswick	Salt anticline. Gypsum at surface. Salt shallow depth. No shows of oil or gas.
Bechtsbüttel	North of Brunswick. Believed identical with Meine. Salt dome. Torsion balance discovery 1932. Top of salt 1,100 feet. Oil shows in Lower Cretaceous.
Beesen-Laublingen	Near northeast edge of Harz Mountains. Salt anticline. Top of salt 500 feet. Potash mined.
Beienrode (Dorm)	Northeast of Brunswick. Salt dome. Top of salt 700 feet. No shows of oil or gas. Potash mined.
Blexen	West of Wesermunde. A prospect--probable salt dome; the Senonian formation is unusually high. No oil shows reported in wells drilled.
Böstlingen	A prospect. No development and no information available.
Böhmte	A prospect. No development and no information available.
Bremen-Delmenhorst	Salt dome located south of Bremen. Top of salt 2,400 feet. Slight shows of oil in Upper Cretaceous.
Conow	Located on Pompeckj Swell. Salt dome. Top of salt 500 feet. Abandoned potash mine. No shows of oil or gas.
Cuxhaven	Located near seacoast. A supposed salt dome prospect. Three wells to Upper Cretaceous which is high; one reported to have oil shows.
Dedesdorf	Located west of Wesermunde, believed to be identical with Blexen.
Didderse	Located northwest of Brunswick. Believed to be identical with Rolfsbüttel.
Dötlingen	Supposed salt dome on which there is little or no development.
Dunge (Lesum)	Located northwest of Bremen. Salt dome; top of salt 500 feet. No shows of oil or gas.
Ehmen	Located northeast of Brunswick. A salt dome; top of salt 500 feet. Oil snow on southwest flank of dome. Potash mined.
Eilte	Salt dome. Top of salt 750 feet. No oil or gas shows.
Ellerburg	Anticline found by seismograph. Well drilled on top penetrated through Malm and Dogger into salt with negative results.
Elm	Large broad gentle anticline located southeast of Brunswick. Structure is asymmetrical, southeast flank dipping 10-20 degrees and northeast flank about 5 degrees. Believed to have possibilities in the Zechstein at about 1,200 meters in depth.
Elvesse	Identical with Neistadt-Elvesse anticline.
Elzel	A supposed dome located southwest of Wilhelmshaven
Engter-Venne	Located near Venne. Mapped by surface geology. Well drilled on top of structure passed through Cornbrash and was abandoned at 948 meters in Lias before reaching Rhaet. No oil shows. Salt water flow at 528 meters. Results appear to condemn structure.
Fallersleben	North end of Ehmen structure northeast of Brunswick. Salt dome. Top of salt 750 feet. No oil or gas shows.
Flachstöckheim	Salt dome. Top of salt 700 feet. Small asphaltic deposit in Lower Cretaceous. No oil.
Gross Rhuden	Located near northwest end of Harz Mountains. Salt anticline. Top of salt at 1,000 feet. Potash mined.

Name	Remarks
Grethem	Near town of Schwarmstedt. Salt dome. Top of salt 1,000 feet. Oil shows in the Lower Cretaceous on the southeast flank of dome. Potash mined.
Grünenkamp	A supposed salt dome with little or no development.
Grosses Meer	Located near northeast border of Germany. A supposed salt dome with two highs. Little or no development.
Habighorst (Hofer)	Located near Celle. Salt dome. Top of salt 1,000 feet. No shows of oil or gas. Potash mined.
Hackel	Located near Halberstadt, north of Harz Mountains. Salt anticline. Top of salt at 1,800 feet. Oil shows in the potash beds and one potash well at Hausneindorf produced a small quantity of light oil.
Hademsdorf-Büchten	Adjoining dome or possibly east extension of Grethem. Wells drilled in 1939 reported to have penetrated salt overhang into Jurassic with only shows of oil. Base of salt overhang about 770 meters.
Hambühren	West continuation of same salt stock on which Wietze field is located. No oil production.
Hannover (northwest)	Geophysical prospect; a salt dome or anticline; coredrilled prior to the war.
Hardebek	Located southwest of Neumunster. Prospect with salt water in Senonian formation at shallow depth.
Harlyberg	Located north of Harz Mountains, Near Goslar. Salt anticline. Asymmetric. Potash mined.
Hedwigsberg	Located south of Brunswick. Salt dome. Top of salt at 700 ft. No shows of oil or gas.
[illegible]moor	Near Stade. Probably a salt dome. Upper Cretaceous and Eocene at surface. Unconfirmed report states that one well drilled into salt.
Heligoland	Island in the North Sea. Structure probably deep dome with Buntsandstein of the Triassic exposed at the surface. No shows of oil or gas.
Hengstlage	West of Bremen. Deep plug found by refraction seismograph. One well drilled to 1,596 meters in Triassic with no oil shows.
Hildesheimer Wald	Northwest of Harz Mountains, near Hildesheim. Salt anticline with Lower Buntsandstein exposed at surface. Potash mined.
Hillerse	Prospect on northwest flank of Rolfsbüttel dome (see latter).
Holtensen	Anticline with Triassic exposed at surface. Contains 2 highs and is gently folded and faulted. Southern high believed to have best possibilities.
Holzbalge	Salt dome prospect with little or no development.
Hordorf	Located northeast of Brunswick. Salt dome. Oil seeps on southwest flank and some oil produced from hand dug pits. Several wells drilled without commercial production. Oil from Lower Dogger formation.
Husum	Near Nienburg. Salt dome. Top of salt 325 feet. Probable extension of the Steinhuder-Meer salt anticline. Some gas found in Lower Cretaceous.
Huy	Located near Balberstadt, north of Harz Mountains. Salt anticline. Top of salt 2,600 feet. No gas or oil shows.
Isenbüttel	North of Brunswick near Gifhorn. Geophysical prospect, probable dome. Little or no development.
Jaderberg	North of Oldenburg. Salt dome. Top of salt at 3,400 feet. Torsion balance discovery 1929. Several wells drilled. No oil or gas shows reported.
Jerxheim	Located north of Harz Mountains. Salt anticline. Top of salt at 700 feet. No oil or gas shows.

O I L P R O S P E C T S I N G E R M A N Y (Continued)

NORTH GERMAN BASIN (Continued)

Name	Remarks
Jever	Northwest of Wilhelmshaven, near Jever. Salt dome prospect. Torsion balance discovery 1931. Well drilled, nor oil or gas shows reported.
Kalbe	Situated on Pompeckj Swell, near town of Gardelegen. Salt dome. Top of salt at 600 feet. Triassic outcropping. No oil or gas shows known.
Klein Kuhran	Near Lüneburg on Pompeckj Swell. Salt dome:Top of salt at 1,400 feet. No oil or gas shows.
Kolkhagen	Located in same general area as preceding. Salt dome. Top of salt 350 feet. No oil or gas shows. Potash mined.
Langenfelde (Bahrenfeld)	Northwest of Hamburg. Salt dome or horst(?).Cap rock at depth of 75 feet. Permian near surface, covered only by alluvium. No oil or gas shows.
Lehrte-Sarstedt	See Sarstedt-Lehrte-Sehnde prospect.
Leine-tal	Northwest of Harz Mountains, near Alfeld. Salt anticline. Top of salt at 1,000 ft. Mining for potash showing exceedingly faulted beds. One potash shaft struck oil and some few tons were produced. Several wells were drilled for oil in potash shaft without commercial production being obtained.
Lenne	West of Harz Mountains, near Stadtoldendorf.Salt anticline. Top of salt 2,000 feet. No oil or gas shows. Well drilled.
Lenzen	Near Lenzen on Pompeckj Swell. Salt dome. Top of salt about 1,000 feet.No oil or gas shows.
Levern	Salt dome prospect; little or no development.
Lichtenhorst	Believed to be identical with Stocken.
Limberg	East of Osnabrück. Believed to be salt dome prospect; little or no development.
Lubtheen	Near Boizenburg on Pompeckj Swell. Salt dome. Top of salt 800 feet. Potash mined.
Luchow	Located on Pompeckj Swell near Luchow. Salt dome. Top of salt 700 feet. Potash mined. No oil or gas shows.
Lüneburg	Near town of same name on Pompeckj Swell. Salt dome, gypsum cap exposed above surface. Top of salt less than 350 feet. Salt mined here since 950 A.D. Triassic rocks exposed around edges of dome.
Lydschenaher-Meer	See Zwischenahner Meer.
Markhausen	West of Bremen. Believed to be a salt dome but little or no development done.
Meimerhausen	Located northwest of Harz Mountains, near Alfeld. Salt anticline. Gypsum at surface. Salt at shallow depth. No oil or gas shows.
Meissendorf	Near Celle. Salt dome. Top of salt 350 feet. Well drilled had shows of oil in Lower Wealden at about 1,500 meters.
Neuhaldensleben	Located near town of same name north of Magdeburg. Salt dome. Drilled for oil but no shows of oil or gas reported.
Neustadt-Elvisse	Northwest of Hannover. Geophysical prospect with closure reported at 600 meters. Before war development consisted of core drilling.
Nordkampen Sud	Believed to be salt dome prospect. Little or no development done.
Nordsteimbke	Located near Fallersleben. Salt anticline with top of salt about 1,600 feet. Potash mined. No oil or gas shows reported. This prospect lies on the Oberes Allertal axis.
Oberes Allertal	Southward extension of preceding structure. A long faulted salt anticline. Top of salt 700 feet. Well drilled in bottom of potash shaft near Wefensleben. Had oil shows in anhydrite. Some few barrels produced. No commercial production established.
Ochtrup	Near Bentheim. A salt anticline. Top of salt about 1,400 feet. Structure long anticline overturned to north with Lower Buntsandstein exposed at surface. Three wells on south flank prior to 1935. One of these had oil shows in Lower Zechstein at 2,800 feet.
Oderwald	Salt anticline. Top of salt 700 feet. No oil or gas shows in wells drilled.
Offleben (Barneburg)	Salt anticline. Top of salt 350 feet. No oil or gas shows.
Oldenbüttel	East of Heide field. Prospect is an elongated salt ridge trending approximately north-south. It is believed to have oil possibilities similar to Heide at depths around 1,000 meters. Many wells will probably be required to test structure before its value is ascertained.
Oldenburg	The town of Oldenburg situated on prospect which is reported to have been discovered by torsion balance. Area is in initial stage of development without commercial production.
Oxtedt	North of Bremmerhaven near coast. This is a questionable prospect. One well shows Upper Cretacious chalk unusually high.
Raddestorf	Found with Seismograph. Two wells drilled by end of 1937, deepest to 354 meters, had gas shows. Structure was in exploratory stage of development prior to the war.
Rautheim	Immediately southeast of Brunswick. Salt dome. Top of salt 700 feet. Some oil produced from the Dogger formation at 2,600 feet on the east flank. No deep wells drilled. Potash mined.
Rehburg	Prospect is plunging nose of salt dome. Salt reported found at 124 meters. Two wells drilled before war encountered no shows of oil or gas.
Rethem	Near Verden. Salt dome. Top of salt 600 feet. No oil or gas shows. Potash mined.
Rolfsbüttel	Near Peine. Prospect on the northwest flank called Hillerse "play" where number of gas and oil shows were encountered in Middle Kimmeridge formation. Rolfsbüttel is a salt dome with the top of the salt at 700 feet. Oil shows and slight production from the Lower Cretacecus about 5-1/3 miles west of dome near Horst-Wipshausen. Small dike of basalt intrudes salt. This is furthermost occurrence northward of basalt in Germany. Basalt is Miocene or younger in age.
Rüdersdorf	East of Berlin on Pompeckj Swell. Salt dome or anticline. Top of salt 1,800 feet with uplifted Triassic at surface. No oil or gas shows are reported.
Salzdahlum	Either identical with or close to Asse. Two wells were drilled prior to the war, the deepest to 433 meters. No gas or oil shows.
Salzgitter	North of northwest end of Harz Mountains, near town of same name. Salt anticline with Triassic exposed at surface. No oil or gas shows.
Sarstedt-Lehrte-Sehnde	Near Lehrte. A salt anticline with top of salt at 600 feet. Some light oil produced from Rhaet formation in Upper Triassic and from Lower Cretaceous on east flank. Asphalt mined since 1860. No commercial production of oil.
Scharrel	Oil prospect on which there is little or no development.
Schessinghausen	Northwest of Hannover, near Nienburg. Torsion balance prospect. Several wells drilled, three or four of which had oil shows in Oligocene at about 1,000 feet. Probable salt dome though salt is not known to have been encountered by wells drilled.
Schlüsselburg	Located by seismograph and coredrilled before war. Anticline not very pronounced and may not have sufficient closure to be productive. Oil shows in Rhaet and failure to produce from this horizon reported due to low porosity.
Schöbull	North of Husum. Probable dome. Devonian formation exposed at surface. No drilling known. No oil or gas shows.
Seefeld	Southwest of Bremmerhaven. Salt dome prospect on which there has been little or no development.
Segeberg	Near Lübeck. Salt dome. Gypsum cap rock exposed at surface with Upper Permian Zechstein dolomite uplifted. Caves in gypsum cap. No oil or gas shows.
Solingen	Near Rotenberg. Salt dome. Torsion balance and seismograph discovery. Now being drilled. First well found 80 degree dip in Eocene formation at depth of about 1,500 feet.
Soltau	Near town of same name. Salt dome. Top of salt about 1,000 feet. No oil or gas shows reported. Ahlften No. 1 well on this structure found horizons of Hannover area absent.

OIL PROSPECTS IN GERMANY (Continued)

NORTH GERMAN BASIN (Continued)

Name	Remarks
Sophientel	Northwest of Brunswick. Salt dome. Top of salt about 700 feet. Torsion balance discovery. No oil or gas shows reported.
Sperenberg	South of Berlin on Pompeckj Swell. Salt dome or anticline. Surface indications of structure with Permian Zechstein at 2,000 feet. No oil or gas shows known.
Stade	West of Hamburg near town of same name. Structure is horst. Salt is interbedded with red beds. Uppermost Rotliegendes, Lower and Middle Zechstein overlain by red beds of Upper Permian. No oil or gas shows.
Stassfurt	North of east end of Harz Mountains, near town of same name. Salt anticline. Top of salt 600 feet. Oldest potash mines in Germany. No oil or gas shows.
Steinhuder-Meer	Salt dome. Top of salt 1,000 feet. Some oil and gas shows. Potash mined.
Stocken (Lichtenhorst)	Near Verden. Salt dome. Top of salt about 1,000 feet. No oil or gas shows. Structure not adequately tested before war.
Strackholt	Geophysical salt dome prospect, deep seated type with anhydrite reported at 1,270 meters. One well drilled to 1,314 meters with no shows of oil or gas.
Stuvenborn	Reported to be piercement type dome with oil possibilities on flanks. Nahe No. 1 well abandoned at 479 meters in Miocene due to mechanical difficulties. To test the structure from 5 to 10 wells will be drilled between 1,200 and 1,500 meters in depth.
Süderhastedt	Structure is believed to be salt ridge similar to Oldenbüttel and Heide field. Two dry holes have been drilled, the deepest being 948 meters. No shows of oil or gas encountered.
Sulze	Salt dome prospect with little or no development.
Theide	North end of Oderwald prospect, particularly the northwest flank. Top of the salt in this locality approximately 700 feet. Potash mined. No oil or gas shows reported.
Thüren	Salt dome prospect with little or no development.
Timmel	Salt dome prospect with little or no development.
Uchte	Geophysical high probably anticline. First well drilled in 1937 encountered no oil or gas shows and is reported to have otherwise been discouraging for future drilling.
Venne	See Engter-Venne.
Verden	Salt dome. Oil shows in Tertiary at 650 feet.
Volkensen	Near Zeven. Dome prospect. Geophysical discovery. No report of oil or gas shows in well drilled.
Wesendorf	Near Gifhorn. Torsion balance prospect not known to have been drilled.
Wilhelmshaven	Near town of same name. Torsion balance prospect not known to have been drilled.
Wolthausen	Salt dome. Discovered by torsion balance, checked with seismography. Drilling proved the presence of the dome, but no oil or gas shows were encountered.
Zichorie	On Pompeckj Swell northeast of Gifhorn. Salt dome. Top of salt 1,700 feet. No oil or gas shows reported.
Zwischenahner Meer	Salt dome. Top of salt at 1,750 feet. Torsion balance discovery. Proved existence of dome by drilling. No oil or gas shows.

THURINGIAN BASIN

Name	Remarks
Bienstedt	Situated 40 kilometers southeast of Menteroda and 17 kilometers northeast of Gotha in Province of Thuringen. The structure is an elongated dome in which upper Muschelkalk (Middle Triassic) crops out in an area 14 kilometers long and 3 kilometers wide surrounded by Keuper (Upper Triassic). Closure is possibly 150 meters. Depth to Middle Zechstein is approximately 1,000 meters.
Dieterode	Located about 30 kilometers west of Volkenroda field. The structure is a faulted anticline. It is not considered as good a prospect as other known structures in the Thuringian Basin, but is believed to have possibilities for oil northeast of the fault at depths around 800 meters in the Zechstein.
Ettersberg	Situated approximately 60 km. southeast of Menteroda and 40 km. northeast of Gotha. The structure is an elliptical shaped dome, 10 km. by 4 km., in which the Upper Muschelkalk (Middle Triassic) crops out surrounded by Keuper (Upper Triassic). Closure is about 200 meters. Depth to the Middle Zechstein is around 1,000 meters.
Kraula	About 30 km. southwest of Menteroda and 16 km. south of Muehlhausen in the province of Thuringen. Structure is a dome in which Lower Muschelkalk (Middle Triassic) is exposed over an area 6 km. by 2 km., surrounded by Middle and Upper Muschelkalk (Middle Triassic). Closure is believed to be about 200 meters. Depth to the Middle Zechstein is around 900 meters.
Schlotheim	Located about 10 km. southeast of Menteroda in the provinces of Thuringen and Sachsen. The structure contains slightly southward dipping strata tilted and offset by minor faults with northwest strike. Outcropping strata are Upper Muschelkalk (Middle Triassic). Depth to the Middle Zechstein 1,000 meters approximately.

RHINE VALLEY GRABEN

The drawings on pages 71 and 73 show prospects along the faults bounding the graben, at Weingarten, Rott, Stettfield and in other localities. On some of these excellent showings of oil have already been encountered in the wells drilled and indicated on the maps. There are also possibilities for oil in the central part of the basin along faults and on a horst or fold mentioned elsewhere in the report.

BAVARIAN BASIN

Little is known regarding the structures in this basin. The drawings on page 77 show the overthrust fault and the magnetic axes along which they probably occur. The most favorable oil prospects should be found in the deepest part of the basin just north of the overthrust fault in southeastern Bavaria.


MAP SHOWING
OIL FIELDS OF
NORTHWESTERN EUROPE
SCALE
0 20 40 60 80 100 MILES
0 20 40 60 80 100 120 140 160 KILOMETERS
D E N M A R K
NORTH SEA
N E T H E R L A N D S
G E R M A N Y
B E L G I U M
LUXEMBOURG
F R A N C E
HEIDE
HEMMINGSTEDT
EPENWOHRDEN
MELDORF
Kiel
Lubeck
Elmshorn
Cuxhaven
Stade
Hamburg
Schwerin
Bremerhaven
Wilhelmshaven
ETZEL
Emden
Harburg
REITBROOK
SOTTORF
MECKELFELD
Luneburg
Oldenburg
Bremen
Ulzen
FUHRBERG-HAMBÜHREN
WIENHAUSEN
EICKELOH
THÖREN
RODEWALD
WIETZE
WESTERHOLZ
Stendal
HOPE
EICKLINGEN
EHRA
Gardelegen
NIENHAGEN
GIFHORN
HÄNIGSEN
Hannover
ÖDESSE-ÖLHEIM
LINDEN
OBERG
Braunschweig
Burg
MÖLME
Magdeburg
FELDBERGEN
BROISTEDT
HOHENASSEL
FALLSTEIN
SCHÖNINGEN
Halberstadt
Minden
Bielefeld
Herford
COEVORDEN
ALTE PICCARDIE
EMLICHHEIM
DALUM
Ijssel Meer
Amsterdam
Bentheim
Osnabruck
's-Gravenhage
Rotterdam
Rhein River
Maas (Meuse) River
Munster
Paderborn
Gladbeck
Dortmund
Duisberg
Essen
Krefeld
Dusseldorf
Hagen
Kassel
VOLKENRODA
Muhlhausen
Antwerpen
Remscheld
Munchen-Gladbach
Eisenach
Erfurt
Koln
Bruxelles
Aachen
Marburg
Bonn
Liege
Meuse River
Koblenz
Frankfurt a/m
Mainz
Main River
WEIHER
WEINGARTEN
FORST (BRUCHSAL)
Metz
Moselle River
PECHELBRONN
Karlsruhe
LEGEND
Oil field = OBERG
Other locality = Bremen
R-101

2.5 NORTH GERMAN OIL FIELDS

2.5.1 General

In the North German Basin oil is generally trapped on salt dome structures which have frequently been compared with the fields of the Gulf Coast, Texas and Louisiana, and particularly with the interior salt domes of these states. However, attempts to explore for oil in the North German Basin, by applying Gulf Coast methods, namely, drilling around the edges of the domes near the salt, have not resulted in outstanding successes. For example, at Nienhagen drilling was started at the edge of the salt because of the presence of oil seeps. Only gradually was exploration extended some distance from these seepages and eventually the best production was developed on a nose about 3,000 meters distant from the salt plug. This characteristic of many of the German salt domes has been attributed to two main periods of uplift separated by an erosion interval--the first uplift during the Jurassic, and the second at the end of the Upper Cretaceous. When the domes first appeared during the Jurassic they were apparently of considerable extent with relatively gentle slopes; a comparatively thin section was involved in the uplift and some faulting occurred. As the salt moved in to form the stock, beds over the salt area, instead of bending, were faulted down. Some of the oil trapped under these conditions was not removed by erosion when the domes were truncated during the Cretaceous. In the next general movement, at the end of the Cretaceous, the salt rose rapidly, affecting relatively small areas but with greater intensity than during the previous uplift. This movement appears to have been too abrupt to influence greatly the accumulation of oil, although together with the regional movements it served to add to the halo of faults and grabens ranging out from the salt core. In such relatively shallow domes oil may be found in about the areas where it was trapped originally; that is, in faults at some distance from the salt core. There are, however, in the North German Basin, domes which have retained their deep seated characteristics acquired in Jurassic time; these structures yield more production than the shallow domes and the productive zone is in closer proximity to the salt. The testing of such deep-seated salt domes appears to form the most promising means of developing large oil production in Germany in the future. However, drilling on even the most favorable prospects in the North German Basin represents a highly speculative venture, as each dome presents entirely different problems not only as to the complexity of the structure but also in the up-dip pinch-out of oil horizons.

2.5.2 Geology

Stratigraphy.- The geologic section from Permian to Pleistocene, inclusive, is much the same over northwest Germany and is summarized in the stratigraphic section shown on pages 34 and 35, which also shows the producing horizons of various German oil fields.

On the map showing the oil regions of Germany (page 26) in about the center of the North German Basin there is outlined an area of uplift called the Pompeckj Swell. This uplift evidently lies along a northward continuation of the Hercynian-Bohemian massive of central Germany. It has no surface expression but was a land area from Upper Triassic to Middle Cretaceous (Albian) time. The principal oil producing horizons of Germany--the Wealden, Malm, Dogger, Lias--were, therefore, not deposited on this arch, nor are these horizons known to occur in that part of the basin east of the Pompeckj ridge. They are present in the northwest portion of the basin and in the vicinity of Braunschweig (Brunswick) and Hannover, where this stratigraphic section reaches its maximum development.

Structure.- In the northwestern part of the North German Basin there is folding in the Hercynian direction, from southeast to northwest, which started at the end of the Jurassic and received an impetus at the end of the Eocene, at the end of the Oligocene, at the end of the Miocene and a weak final phase as late as Quaternary. These movements are referred to as the Saxonian orogeny. The folding took place between old massives and decreases in intensity from south to north.

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GENERALIZED STRATIGRAPHIC SECTION OF NORTHWESTERN GERMANY

1934

● GOOD PRODUCTION O MINOR PRODUCTION G GOOD SHOW T TRACE

AGE AND FORMATION		PRINCIPAL LITHOLOGIC CHARACTER (thicknesses are relative only)	OIL FIELDS: NIENHAGEN-HÄNIGSEN	OIL FIELDS: WIETZE-STEINFÖRDE	OIL FIELDS: OBERG	OIL FIELDS: ÖLHEIM-BERKHÖPEN	OIL FIELDS: VOLKENRODA	OTHER OIL OCCURRENCES: WEFENSLEBEN	THÖREN	SOTTORF	SEHNDE	MANSFELD BASIN	KL. SCHÖPPENSTEDT	HORST-WIPSHAUSEN.	HORDORF	HOPE-LINDWEDEL	HOHENEGGELSEN	HEIDE	HADEMSTORF	DUTCH BORDER	DOLLBERGEN	DOBRILUGK	DESDEMONA POTASH MINE	GAS: NEUENGAMME	NUMEROUS POTASH MINES	MUNSTER BASIN	ASPHALT: LIMMER	VORWOHLE	MÜNSTER BASIN	BENTHEIM (VEINS)
QUATERNARY	RECENT	SAND AND GRAVEL																												
QUATERNARY	PLEISTOCENE	BOULDERS, GLACIAL TILL	O	O										T				O			T									
TERTIARY – LATE TERTIARY	PLIOCENE 0'-1300'	SAND, CLAY																												
TERTIARY – LATE TERTIARY	MIOCENE 150'-950'	SAND, CLAY, LIGNITE																												
TERTIARY – EARLY TERTIARY	OLIGOCENE 800'	SAND, CLAY, LIGNITE							G															●						
TERTIARY – EARLY TERTIARY	EOCENE 160'-330'	SAND, LIGNITE																												
TERTIARY – EARLY TERTIARY	PALEOCENE 250'-600'	MARL, SHALE, CHALK																												
CRETACEOUS – UPPER CRETACEOUS	SENONIAN 500'-660'	CHALK	O	● SEE NOTE 1						G				T				O						●						
CRETACEOUS – UPPER CRETACEOUS	EMSCHERIAN 600'-900'	MARL																												
CRETACEOUS – UPPER CRETACEOUS	TURONIAN 950'	LIMESTONE																											T	
CRETACEOUS – UPPER CRETACEOUS	CENOMANIAN 200'	MARL																											T	
CRETACEOUS – LOWER CRETACEOUS – GAULT 660'-1300'	ALBIAN – UPPER	SHALE												G																
CRETACEOUS – LOWER CRETACEOUS – GAULT 660'-1300'	ALBIAN – LOWER	SHALE																												
CRETACEOUS – LOWER CRETACEOUS – GAULT 660'-1300'	APTIAN	SHALE														T														
CRETACEOUS – LOWER CRETACEOUS – NEOKOM 660'-1300'	BARREMIAN	SHALE											O								G									
CRETACEOUS – LOWER CRETACEOUS – NEOKOM 660'-1300'	HAUTERIVIAN	SHALE																												O
CRETACEOUS – LOWER CRETACEOUS – NEOKOM 660'-1300'	VALENGINIAN	SHALE AND SANDSTONE	●	●		●								G																
CRETACEOUS – LOWER CRETACEOUS – WEALDEN		SHALE, SANDSTONE	●	●	G	●					G			G			O		G		T									
JURASSIC – MALM 600'-1640' – PORTLAND	SERPULIT	LIMESTONE																												
JURASSIC – MALM 600'-1640' – PORTLAND	MUNDER MERGEL	MARL, GYPSUM		O																										
JURASSIC – MALM 600'-1640' – PORTLAND	EIMBECKHAUSER																											●		
JURASSIC – MALM 600'-1640' – PORTLAND	GIGAS	LIMESTONE																									●	●		
JURASSIC – MALM 600'-1640' – KIMM	KIMMERIDGE	LIMESTONE																									●	●		
JURASSIC – MALM 600'-1640' – OXFORD	KORALLENOOLITH	LIMESTONE																									●			
JURASSIC – MALM 600'-1640' – OXFORD	HEERSUMER	LIMESTONE		●																										

CONTINUED ON FOLLOWING PAGE

GENERALIZED STRATIGRAPHIC SECTION OF NORTHWESTERN GERMANY (continued)

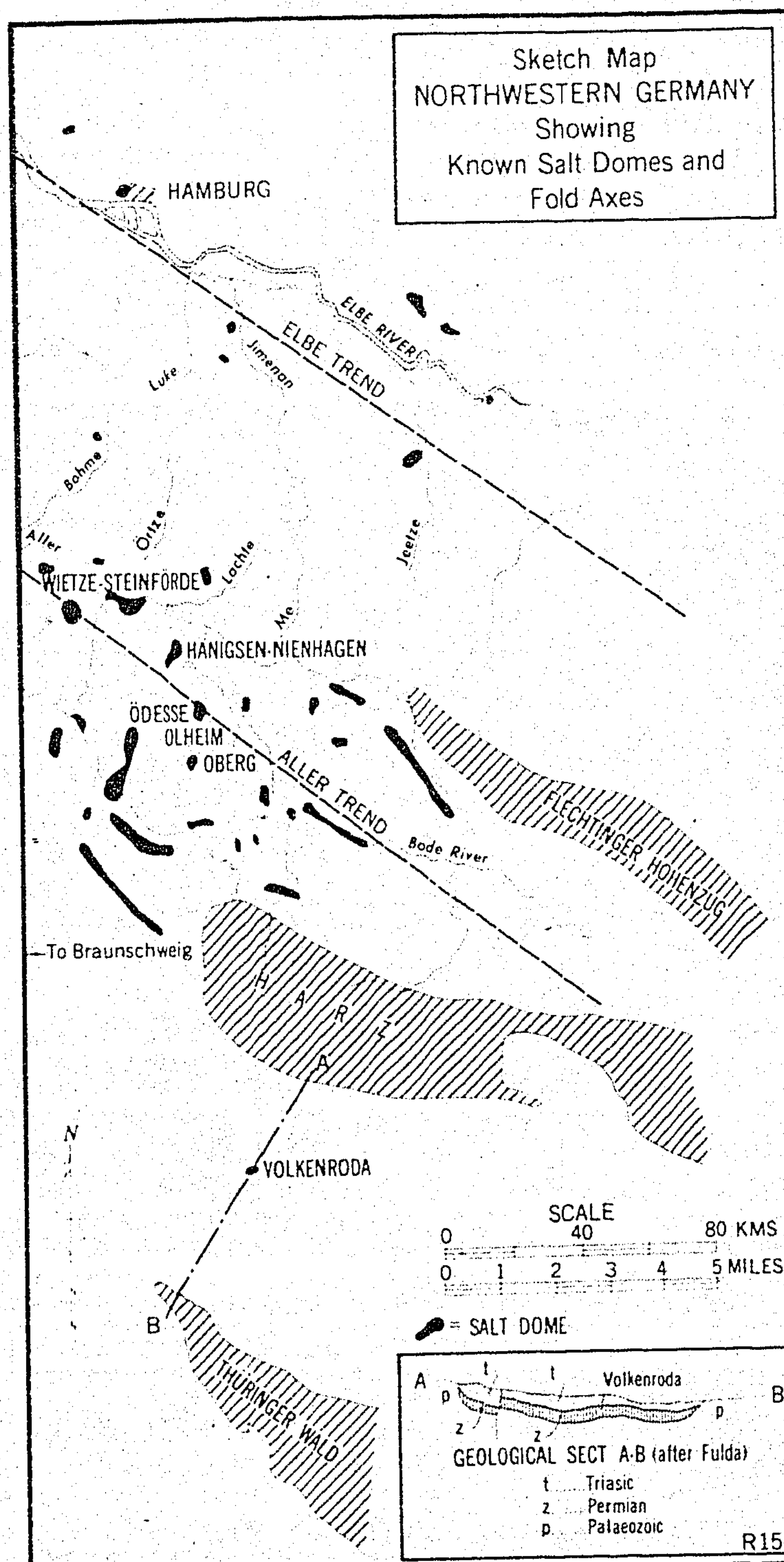
AGE AND FORMATION				PRINCIPAL LITHOLOGIC CHARACTER (thicknesses are relative only)	OIL FIELDS					OTHER OIL OCCURRENCES																GAS			ASPHALT			
					NIENHAGEN-HÄNIGSEN	WIETZE-STEINFÖRDE	OBERG	OLHEIM-BERKHOPEN	VOLKENRODA	WEFENSLEBEN	THOREN	SOTTORF	SEHNDE	MANSFELD BASIN	KL. SCHOPPENSTEDT	HORST-WIPSHAUSEN	HORDORF	HOPE-LINDWEDEL	HOHENEGGELSEN	HEIDE	HADEMSTORF	DUTCH BORDER	DOLLBERGEN	DOBRILUGK	DESDEMONA POTASH MINE	NEUENGAMME	NUMEROUS POTASH MINES	MUNSTER BASIN	LIMMER	VORWOHLE	MUNSTER BASIN	BENTHEIM (VEINS)
JURASSIC (continued)	DOGGER 500-800'	UPPER	ORNATEN	SHALE																												
			MACROCEPHALEN		●	●	G																									
			CORNBRASH	SANDSTONE, SHALE																												
			PARKINSONI				G																									
		MIDDLE	CORONATUS																													
		LOWER	POLYPLOCUS	SHALE, SANDSTONE	●		●	O									O															
			OPALINUS																													
	LIAS 600-980'	UPPER	JURENSIS																													
			POSIDONIEN	BITUMINOUS SHALE																												
		MIDDLE	AMALTHEUS																													
			CAPRICORNU	SHALE																												
		LOWER	ARIETITES																													
			ANGULATUS																													
			PSILONOTUS	SANDSTONE, SHALE																												
TRIASSIC	RHAET				●	●		●					O					G														
	KEUPER 500-1300'		GIPSKEUPER	MARL, SANDSTONE, GYPSUM																												
			KOHLENKEUPER	DOLOMITE, SANDSTONE				T																								
	MUSCHELKALK 600-980'	UPPER		LIMESTONE																												
		MIDDLE		DOLOMITE, GYPSUM																												
		LOWER		LIMESTONE																												
	BUNTSANDSTEIN 2300-5500'	UPPER		MARL, GYPSUM, ROCK SALT																												
		MIDDLE	BAUSANDSTEIN																													
			ROGENSTEIN	SANDSTONE, SHALE																												
		LOWER																														
PERMIAN	ZECHSTEIN 660-4300'	UPPER		ROCK SALT, POTASH SALT, GYPSUM, ANHYDRITE, SHALE										T				G							G		G					
		MIDDLE	STINKSCHIEFER																													
			HAUPTDOLOMIT	DOLOMITE					●	G				T																		
			ANHYDRIT	ANHYDRITE																												
			ZECHSTEINKALK	LIMESTONE																												
		LOWER	KUPFERSCHIEFER	BITUM. SHALE										T																		
			KONGLOMERAT	CONGLOMERATE																												
	ROTLIEGENDES 1600-3300'			SANDSTONE																												
				PORPHYRY																												
				SANDSTONE																												
				PORPHYRY																												
				SANDSTONE, SHALE																												
				SANDSTONE																												
CARBONIFEROUS	UPPER CARBONIFEROUS			COAL, SANDSTONE, SHALE																	G			G				G			G	

NOTE 1 SENONIAN PRODUCTION AT WIETZE-STEINFÖRDE IS SECONDARY ACCUMULATION IN BASAL TRANGRESSION SAND

NOTE 2 OMITTED IN TABLE IS GOOD OIL SHOW IN ZECHSTEIN SALT ON MAKEL STRUCTURE

R94A

The folds developed were not of the continuous undulatory type but are more in the form of horsts and grabens (called fault-folding). Along the edge of the massive, south of the North German Basin, these folds are found in the Harz range and its two branches, the Flechtinger-Höhenzug, parallel to and northeast of the Harz and the Thüringer Wald, parallel to and southwest of the Harz. In these ranges Paleozoic rocks have been brought to the surface. There are two minor folds running parallel to the Harz flexure affecting the North German Basin, one extending along the Aller River through Celle and Bremen, the other along the lower Elbe River near Hamburg. These trends of folding are indicated in the drawing below.

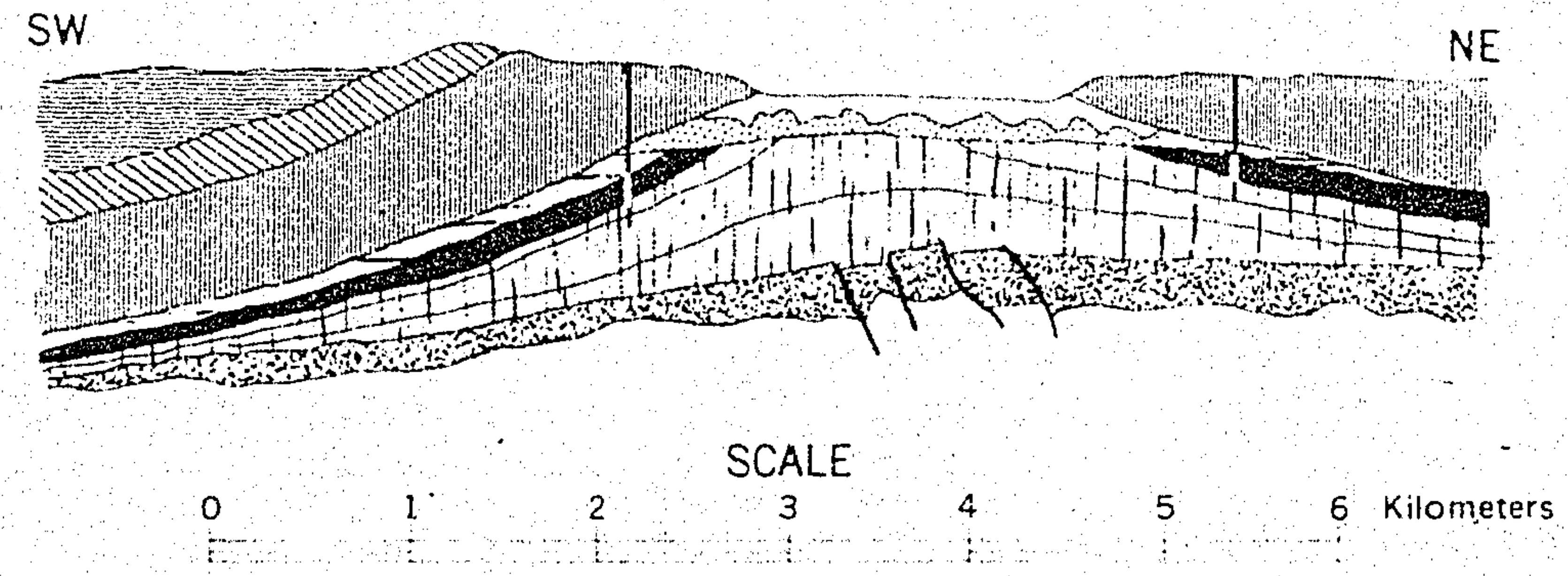


There is also another less pronounced anticlinal trend affecting the North German Basin, called the Rhenish trend, the direction of which is roughly north and south. It is strongly in evidence in a broad zone east of the Rhenish mass of Paleozoic schists and extends far to the north past Hannover and Lüneburg, into the area of the lower Elbe.

In the North German Basin oil is trapped in salt domes and salt anticlines situated along the Hercynian and Rhenish trends. Where these axes intersect, up-lifts are especially strong and salt stocks are found at the intersections. The origin of the salt is the rock-salt of the Permian Zechstein formation. Due to the pressure of thousands of feet of overlying sediments in the North German Basin the Zechstein salt became plastic and flowed upward along lines of least resistance. Generally, the salt pierced overlying strata and burst its way upward sometimes through great thicknesses of younger beds. However, there are five general types of structures in which the Zechstein salt is found, namely: (1) Sedimentary beds showing the effect of only slight deformation; (2) Stassfurt type salt dome ridge--low broad anticlines with low broad salt core tapering gently to each side and with the overlying sedimentary beds gently arched concordantly with the top of the salt; (3) Asse type salt dome ridge--a narrow, sharp anticlinal ridge with a narrow, steep-sided, sharply upthrust core of salt and overlying sedimentary beds sharply arched concordantly with the upper surface of the salt; (4) Lower Aller type salt dome ridge--an anticline with a salt core that projects into or through the overlying sedimentary beds and is in diapir relations to them; (5) Hannoverian type salt stock--a circular or elliptical dome with a core of salt which has been intruded into or through the overlying sedimentary beds. Typical examples of the Stassfurt, Asse and Hannoverian types of salt domes are shown in the drawing on page 37.

The five types of structures enumerated above represent different reactions of the Zechstein salt series to variations in tectonic conditions. In the Magdeburg-

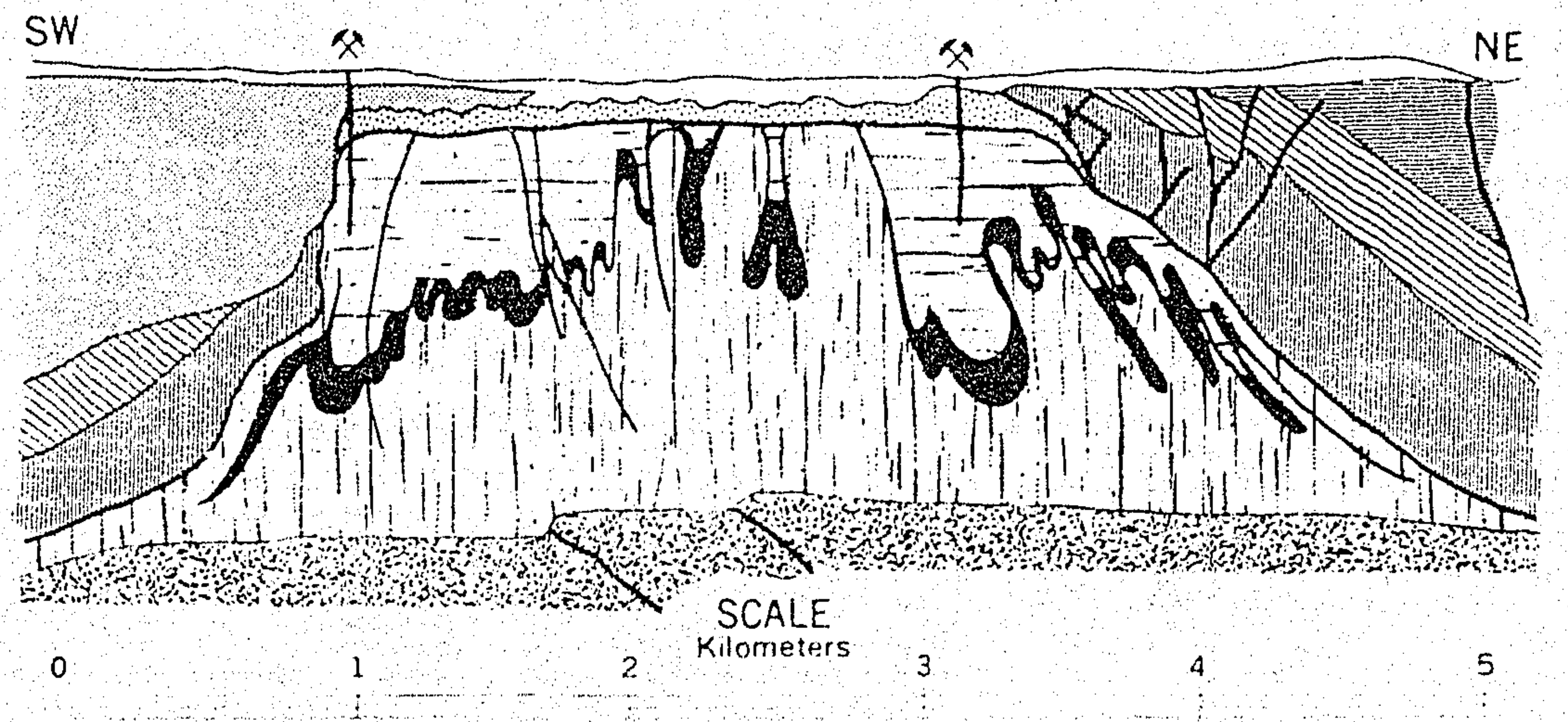
TYPES OF GERMAN SALT DOMES



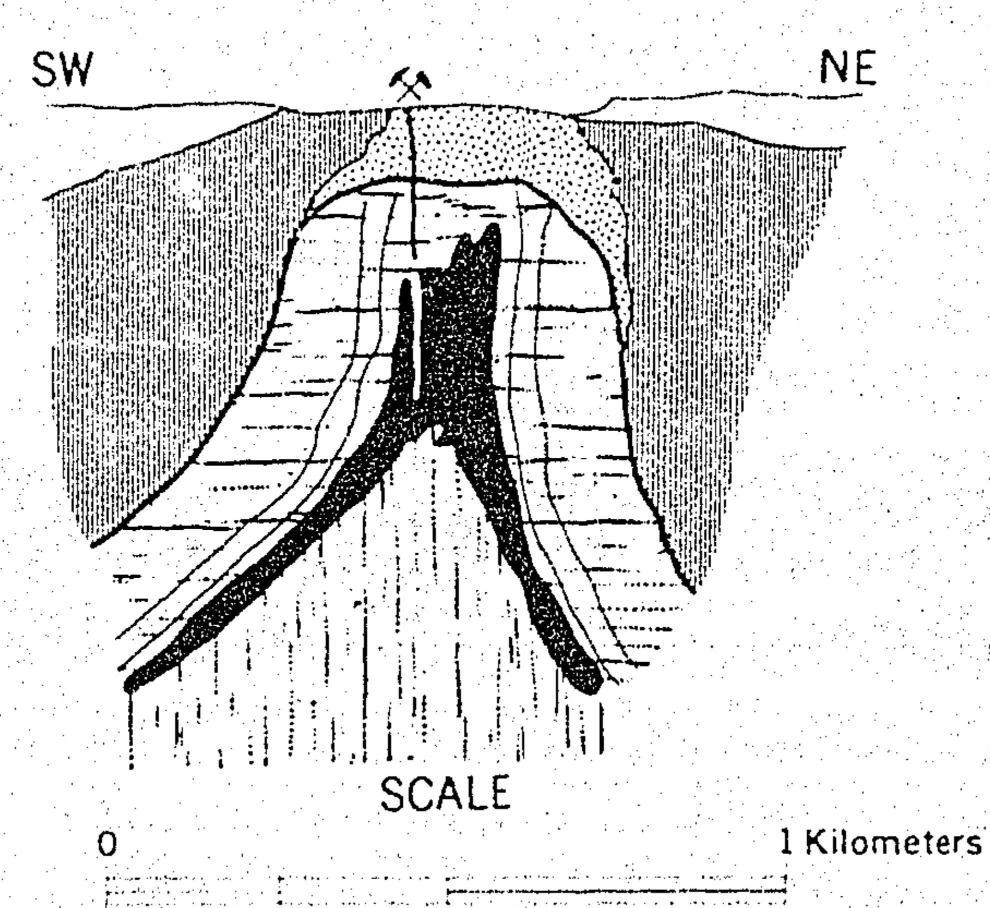
"STASSFURT" TYPE SALT DOME RIDGE
Cross-section of the Schmücke-Finne Ridge
(after Schlafke)

LEGEND

- Lower Cretaceous
- Keuper
- Muschlekalk
- Buntsandstein
- Gypsum cap
- "Younger" salt series
- "Older" salt series
- Undifferentiated Zechstein
- ⚒ Potash shaft



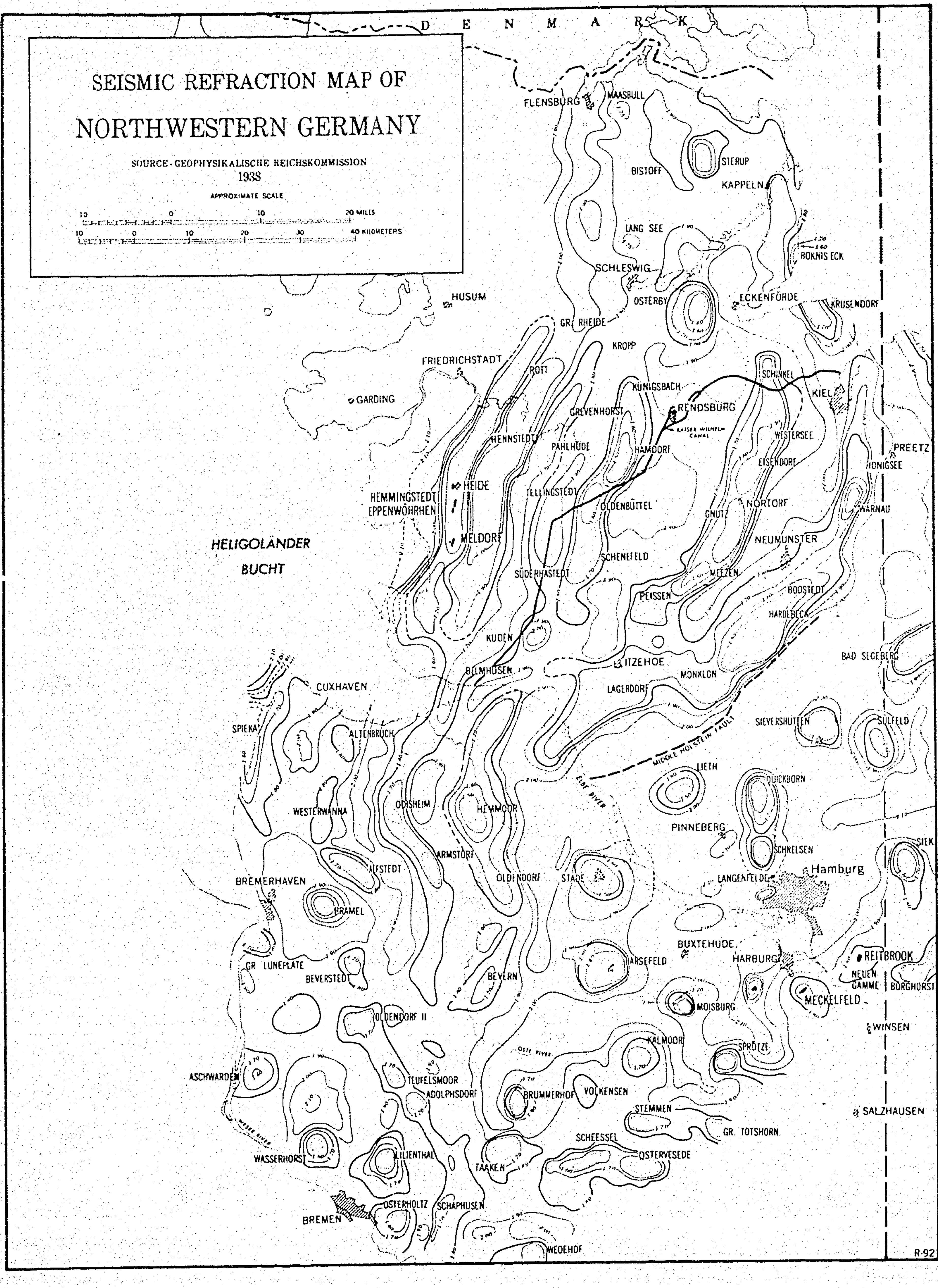
"HANNOVERIAN" OR "STOCK" TYPE OF SALT DOME
Cross-section of the Benthe Stock (after Stille and Seidl)



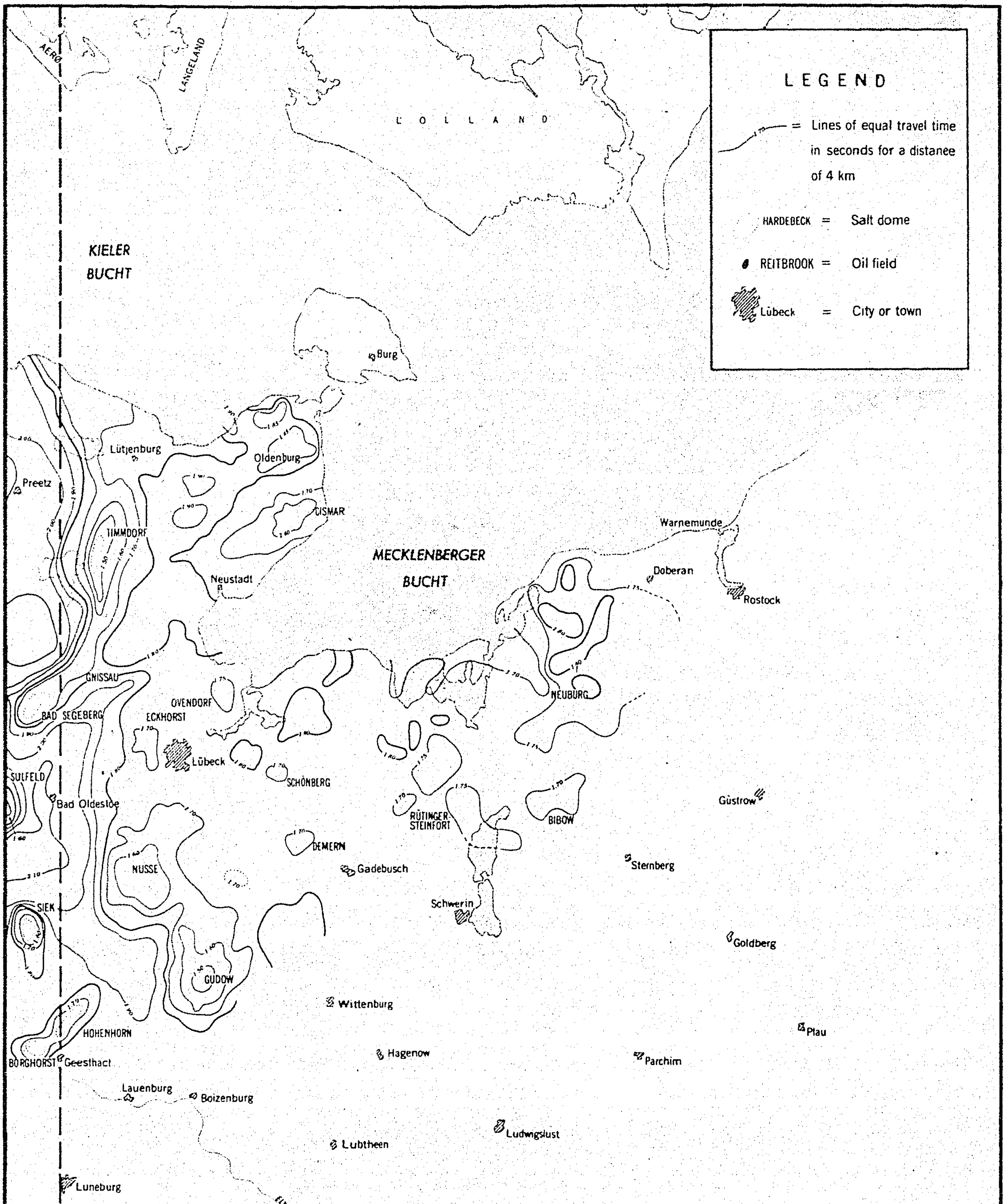
"ASSE" TYPE OF SALT DOME
Cross-section of the Stassfurt Ridge
at Wester-Egeln (älter Schunemann)

R139

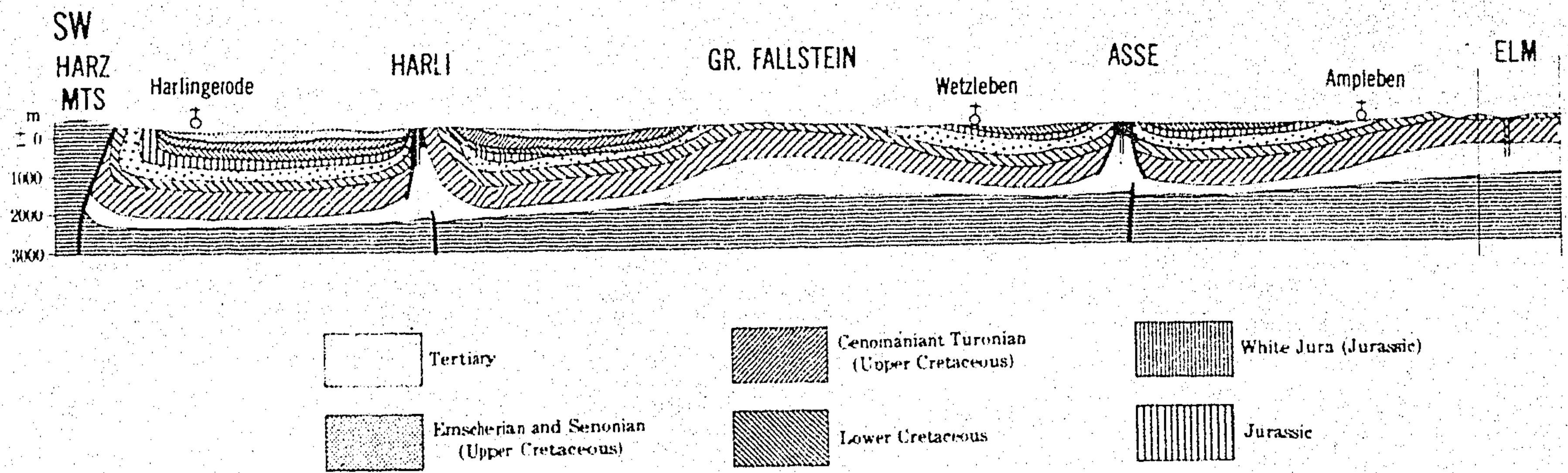
Seismic refraction map



Seismic refraction map



GEOLOGICAL CROSS-SECTION THROUGH



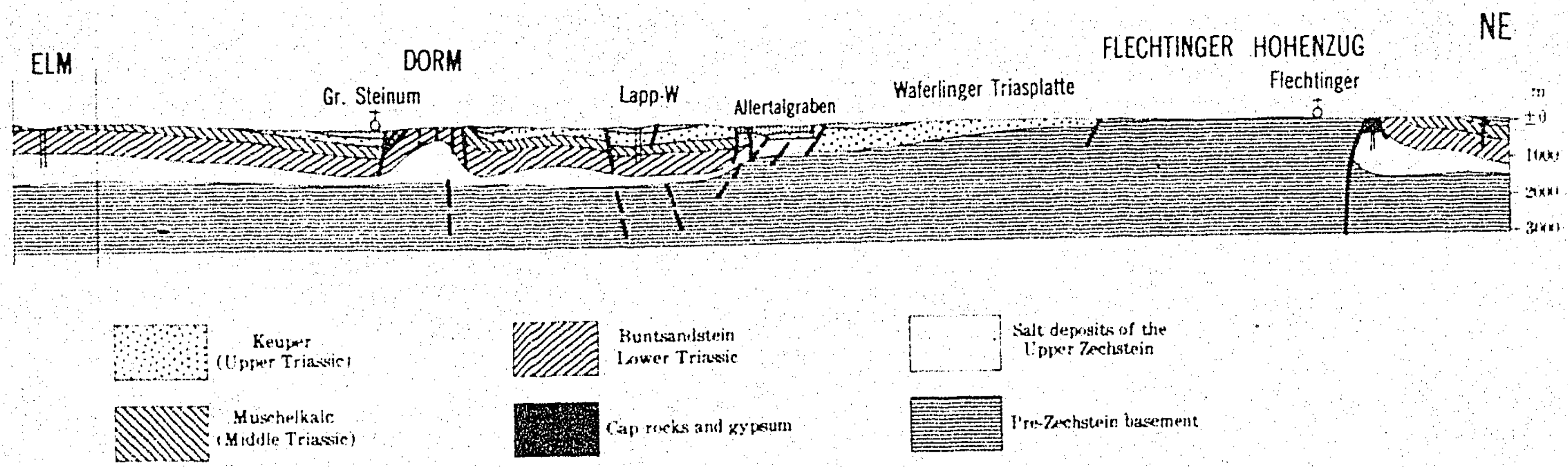
Halberstadt area, which lies as if crushed between the Flectinger-Höhenzug and the Harz Pre-Permian massives, the salt domes take the form of ridges with the same Hercynian strike that characterizes the two massives. In the south Hannover district the structures reflect a Rhenish influence and the salt domes take the form of salt stocks at the intersections of Hercynian and Rhenish anticlinal axes. In the northwestward continuation of the Harz and in the Lower Aller district, the Rhenish influence is not so strongly manifest and the salt domes tend to take the form of salt dome ridges striking with the Hercynian axes. Farther north in the North German plain, the salt domes take the form of salt stocks. A general law seems to hold in regard to the form of the cross-section, that where the sedimentary cover is relatively thin, as in the Magdeburg-Halberstadt Basin, the Stassfurt and Asse types with cover concordant with the upper surface of the salt prevail, and that where the cover is thick, the Hannoverian type prevails with the salt core in diapir relation to the cover. The abundance of exposures in potash mines and data from borings made in exploration for potash has resulted in the differentiation of the salt series into recognizable members and made it possible to work out the structure of the domes in great detail, as well as to show the great plasticity of the salt.

Generally the oil is found around the flanks of the salt masses, where the oil-bearing formations abut against faults or against the salt stock, or at unconformities. Oil sometimes occurs on the crest of a dome above the salt mass, but there has been no production from the cap rocks such as occurs in many of the American salt dome oil fields. About 40 salt structures, many of which were discovered in the course of exploration for potash, were known in 1928. By 1933 the number had increased to 70 and just prior to the war there were at least 100 known domes, of which relatively few had been tested by drilling.

Oil found in the Zechstein beds of the Permian is generally considered to have originated within the formation. Crude produced from the various Mesozoic formations is believed to have come mainly from source beds within the Mesozoic, although there is also a possibility that some oil may have migrated upward from older beds along faults and fractures at the edge of the salt intrusive.

Although salt domes are the only structures in the North German Basin known to be productive, it is possible that oil fields may yet be found along the elevated portions of the Hercynian-Bohemian massive extending out into the basin. The Pompeckj ridge is believed to be one such extension. This type of ridge may prove analogous to the buried granite ridge in the Texas Panhandle, where oil reservoirs have been found above the crest and in the talus and sands along the flank. There is also the possibility of oil accumulation in anticlinal folds without associated salt tectonics. A probable fault is reported extending approximately southwest-northeast through Stade up to Segeberg, along which Cretaceous strata are said to be 5,000 feet higher on the northwestern side than on the southeastern side and this line of disturbance may have some relation to the North Schleswig part of the Pompeckj massive.

THE SUBHERZYNIAN BASIN



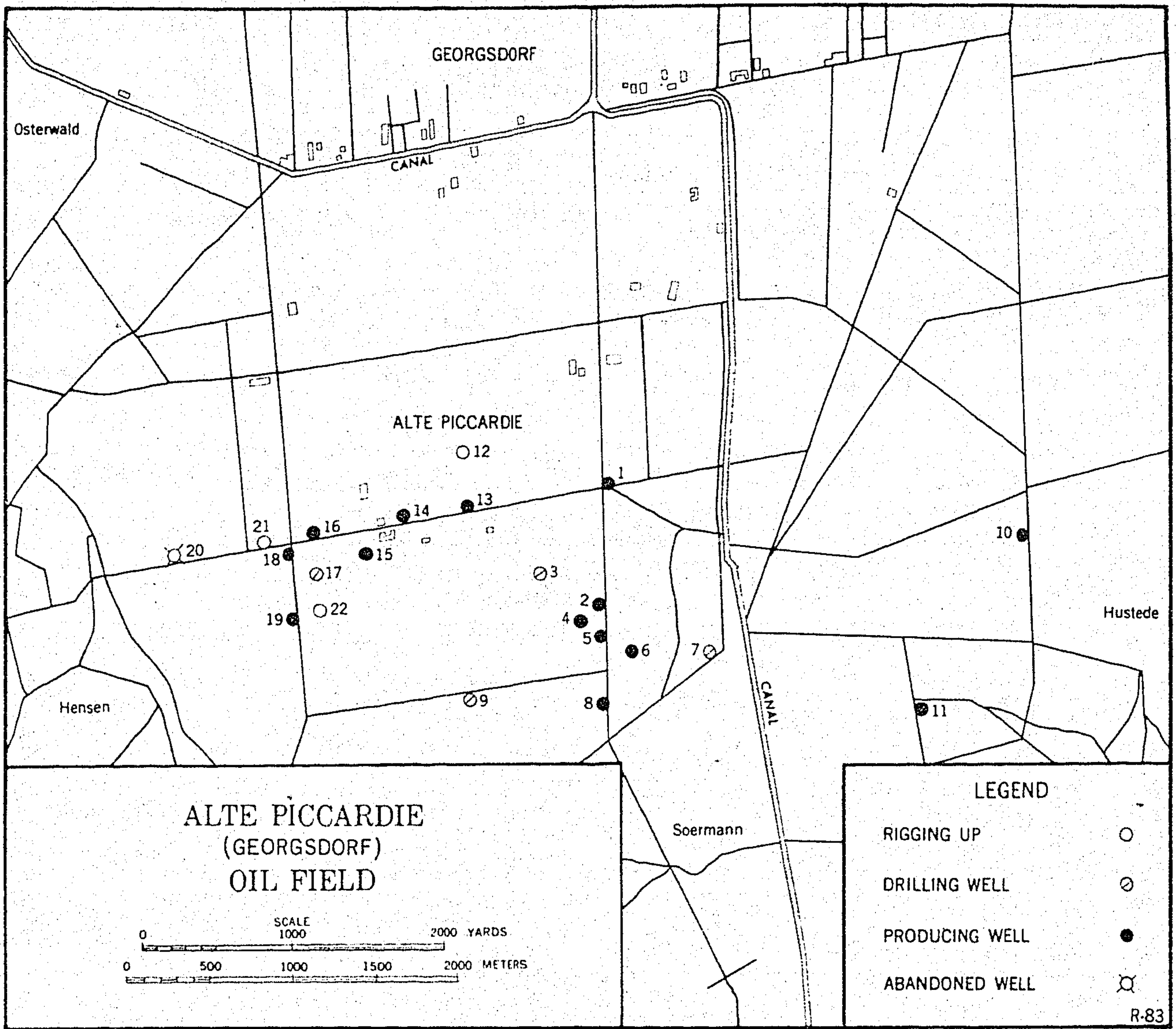
Varying subdivisions of the North German Basin have been proposed by several geologists and will be mentioned in connection with the description of the individual fields and prospects. No representative cross-section of the basin is available but a section through its southern portion between the Harz Mountains and Flechtinger-Höhenzug, shown in the drawing on pages 40 and 41, indicates the structural conditions that exist when the sedimentary series overlying the Zechstein is comparatively thin.

Exploratory methods.- Due to the widespread mantle of Quaternary deposits which covers most of the North German Basin, comparatively few domes can be found in the course of geologic mapping and the search for new structures is based primarily on geophysical methods supplemented by data obtained from wells drilled. As previously indicated, the German government made a seismic refraction survey of northwest Germany several years prior to the outbreak of World War II. The results of this work are shown on seismic refraction map on pages 38 and 39, which provide a general structural picture of the area covered.

To supplement work of this type, the gravitymeter and torsion balance are frequently used. The latter is well adapted for locating exactly the edge of the salt mass. The magnetometer also indicates the presence of salt and principally that of cap rock but is effective only to very shallow depths and, therefore, cannot compete with the torsion balance or gravitymeter. The structure of the formations adjacent to the salt is generally hard to determine; resistivity measurements are used to obtain evidence as to their character and structure, especially when this work can be done in conjunction with electric logging of wells in the vicinity. Generally one geophysical method is supplemented by others in order that the structural picture may be as definite as possible before a well is drilled. Subsurface mapping by means of well logs and paleontological data obtained from the examination of well cuttings and cores is also methodically carried out, and after a few holes have been drilled on the salt dome this type of map serves as the basis for subsequent development of the structure. The oil fields of the North German Basin are described hereafter in alphabetical order.

2.5.3 Alte Piccardie (Georgsdorf) Field

Aerial reconnaissance revealed the presence of a new oil field at Alte Piccardie, near the Germany-Netherlands border. No development was observed in this field during previous aerial reconnaissance on June 13, 1943. Aerial cover of August 3, 1944 showed two drilling wells and three others drilling or already on production. From aerial photographs taken November 29, 1944, the following deductions were made: The field consisted of three wells rigging up, four wells drilling, fourteen wells probably producing and one well possibly abandoned. Wells are drilled by rotary and after completion the original derricks are left for some time and later replaced by light, small production derricks. A very small storage yard was observed but for tool dressing and servicing the small nearby field of Dalum is probably used.



The absence of any large tanks probably indicates that the tanks at Dalum are utilized for main storage but no pipe line connecting the two fields has been observed in the photographs. The extent of the field at the end of November, 1944, is indicated in the accompanying map.

From this map it is evident that the new field extends for about three miles in an east-west direction and has a width of about a mile. From the arrangement of the wells it appears probable that the structure is an anticline or elongated salt dome. The oil bearing strata are probably Cretaceous and the structure may be closed in Tertiary sediments.

Production records recently obtained in Germany indicate that this field is known to the Germans as Georgsdorf, and that it began producing in 1944, yielding 2,454 metric tons (17,178 barrels) of oil during that year. The field appears to be in an early stage of development, and the yield for 1945 may be at a considerably higher rate.

2.5.4 Broistedt Field

The Broistedt field was discovered in 1937 and in 1939 was believed to be nearing depletion. It lies southwest of Braunschweig (Brunswick) and production is obtained on the faulted flank of a salt dome structure. Aerial reconnaissance in October 1943 revealed that six new oil wells had been completed in a southern extension of the field, the linear arrangement suggesting location along a fault. Figures for the output at Broistedt are given in the table on page 83.

Information obtained from aerial photographs taken in October 1943, referred to above, may be summarized as follows. The field extended three-quarters of a mile from the southern edge of Broistedt to about one-quarter mile northeast of Reppmier. It contained nine wells, the easternmost of which was abandoned, indicating that the producing limits had been reached in that direction. Five wells in the eastern part of the field showed stripped derricks and were evidently producing. Cooling stations resembling water separators were observed near the west end of this line of producing wells. Farther west there was a drilling site which apparently was abandoned, and beyond it a well with a stripped derrick, engine house, black-out equipment, etc. and was apparently an exploratory well in which slow progress was being made due to repeated tests, as this well had been observed in aerial coverage of June 1943. A new location in preparation for drilling was observed a little south of the above mentioned wells near Broistedt. Three-quarters of a mile to the north there is a railroad siding but the only indication of a pipe line trench is a fresh trace extending southward away from the field.

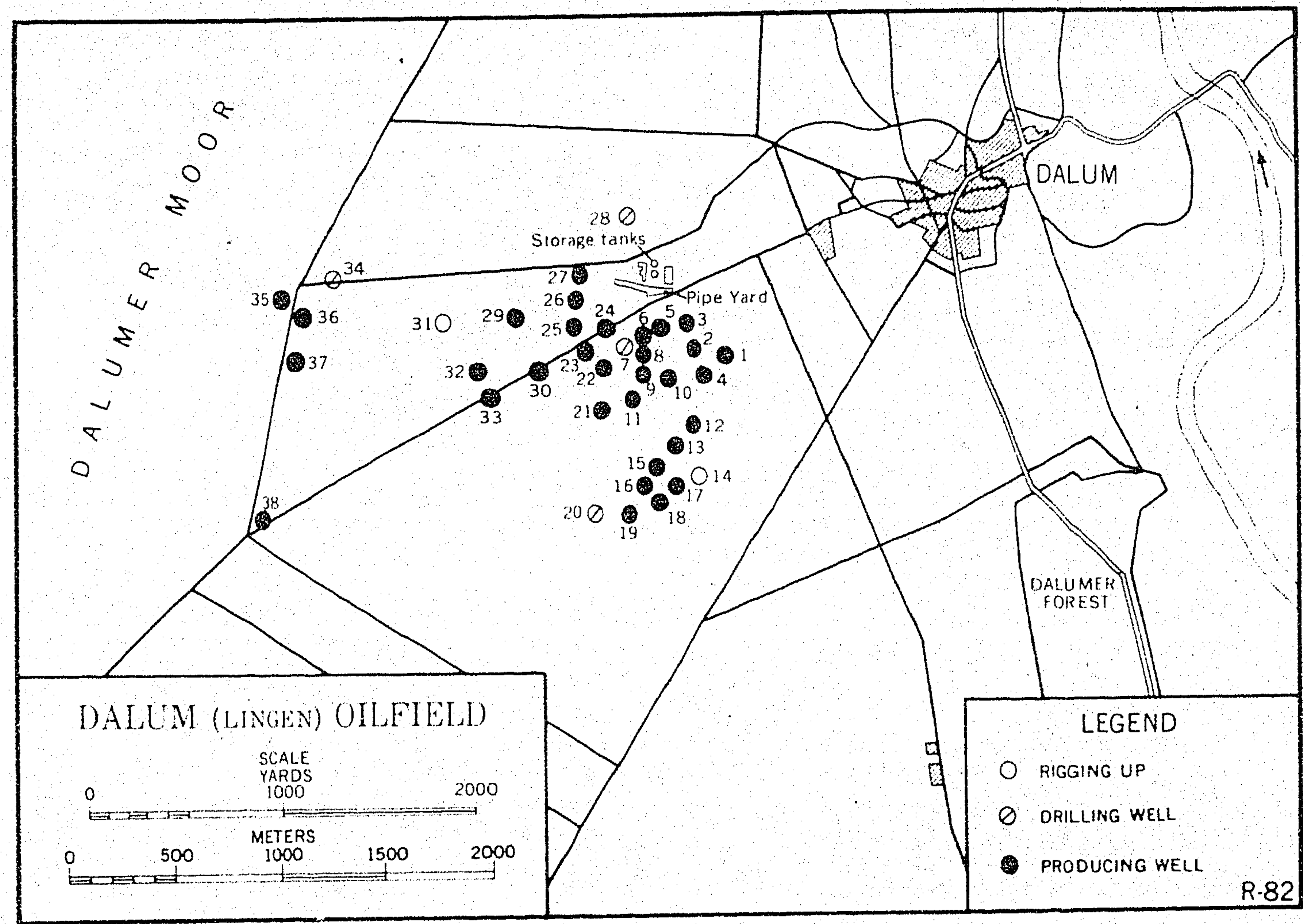
2.5.5 Coevorden Field

The Coevorden field is located in Holland close to the German border. It is a new field and is mentioned briefly in the present report in view of its proximity to the Alte Piccardie and Dalum fields of Germany. The Coevorden field is situated at Oud Schoonebeck, six kilometers east of Coevorden. Recent aerial reconnaissance showed eight locations, four of which were one-quarter to one and one-half miles north of Oud Schoonebeck, spaced at intervals of one-half to one mile, and four more were grouped in an area one mile south of the village with a spacing of about 800 feet. At the time of reconnaissance it appeared that two wells south of Oud Schoonebeck and one well to the north were in production and the others were in various stages of drilling or rigging up. The oil is reported to have been encountered at a depth of 750 meters or more and to be of black, viscous type.

2.5.6 Dalum (Lingen) Field

The Dalum field is near the Netherlands-Germany frontier, three-quarters of a mile west of the village of Dalum and northwest of the town of Lingen. Development in this area was observed by aerial reconnaissance as early as September 1943, when the field contained five producing and two drilling wells with three others rigging up. Aerial photographs taken at the end of November 1944 were not sufficiently clear to be certain of details but the following deductions made from them appear reasonably certain. There were thirty-one producing wells, four drilling wells and three others rigging up as shown in the map on page 44. Production is believed to come from the Lower Cretaceous (Wealden or Valendis).

Twenty-six new wells have been brought into production in this field with four drilling rigs in a little more than a year. There are no production figures available for individual wells but captured records show that the Dalum field, officially listed as Lingen, began producing in 1942, and yielded 19,148 metric tons (134,036 barrels) of oil in 1944.



2.5.7 Eickeloh (Hademstorf) Field

This new field, the existence of which was noted in aerial reconnaissance of August 1944, is located about one mile south of Eickeloh on what appears to be the Hademstorf structure, approximately 30 kilometers north and slightly west of Hannover. At that time the field consisted of three completed wells, two others in the last stages of completion and three wells in process of drilling. The wells appear to be deep, flowing and adequately spaced. The three large rotary rigs in operation suggest that the completed wells are yielding good production and the field will become of importance. German production records show that the Eickeloh (Hademstorf) field produced 4,671 metric tons (32,697 barrels) of oil in 1943, and 10,134 metric tons (70,938 barrels) in 1944.

2.5.8 Emlichheim

It had been reported that a well producing heavy crude was brought in at Emlichheim, 10 kilometers southeast of the Coevorden field in Holland, in the direction of Bentheim. A discovery in this area appeared highly probable in view of the exploratory drilling in 1944 and the recent oil discoveries at Coevorden, Alte Piccardie and Dalum. It has now been verified that 3,017 metric tons (21,119 barrels) of oil were obtained from Emlichheim in 1944.

A discovery well is reported to have been completed near Bentheim, and aerial reconnaissance early in 1944 showed an exploratory test drilling at Gut Gildehaus, near Bentheim and 19 miles southwest of the Dalum field. The report has not been substantiated and there is no basis for assuming that production has been obtained in this area.

2.5.9 Epenwöhrden North Field

This field, observed during aerial reconnaissance in April 1944, lies about two miles south-southwest of Hemmingstedt in Holstein and at that time occupied an area 2,000 yards long and about 300 yards wide, trending north and south. Aerial photographs at the beginning of August 1944 showed the field to consist of eight producing wells (one doubtful), three drilling and five abandoned wells. A row of four 50-ton tanks were situated just west of the northernmost producing well and another group of eight 50-ton tanks was erected immediately north of the southernmost oil well. Production from this field is included in the figures for the Heide district in the table on page 83. The position of the field with respect to neighboring pools is shown in the map on page 50.

2.5.10 Epenwöhrden South Field

Epenwöhrden South was also observed during the aerial reconnaissance of April 1944. The field lies immediately south of the village of Epenwöhrden and two miles north-northwest of the town of Meldorf as shown on the map on page 50. At the time of the reconnaissance the development consisted of fourteen producing and four abandoned wells and it was inferred that the field was more than 2-1/2 years old with flush production gone. Aerial photographs taken at the beginning of August 1944, showed twelve producing wells, three doubtful and six abandoned wells. The figures for production are included in those for the Heide district.

2.5.11 Etzel Oil Field

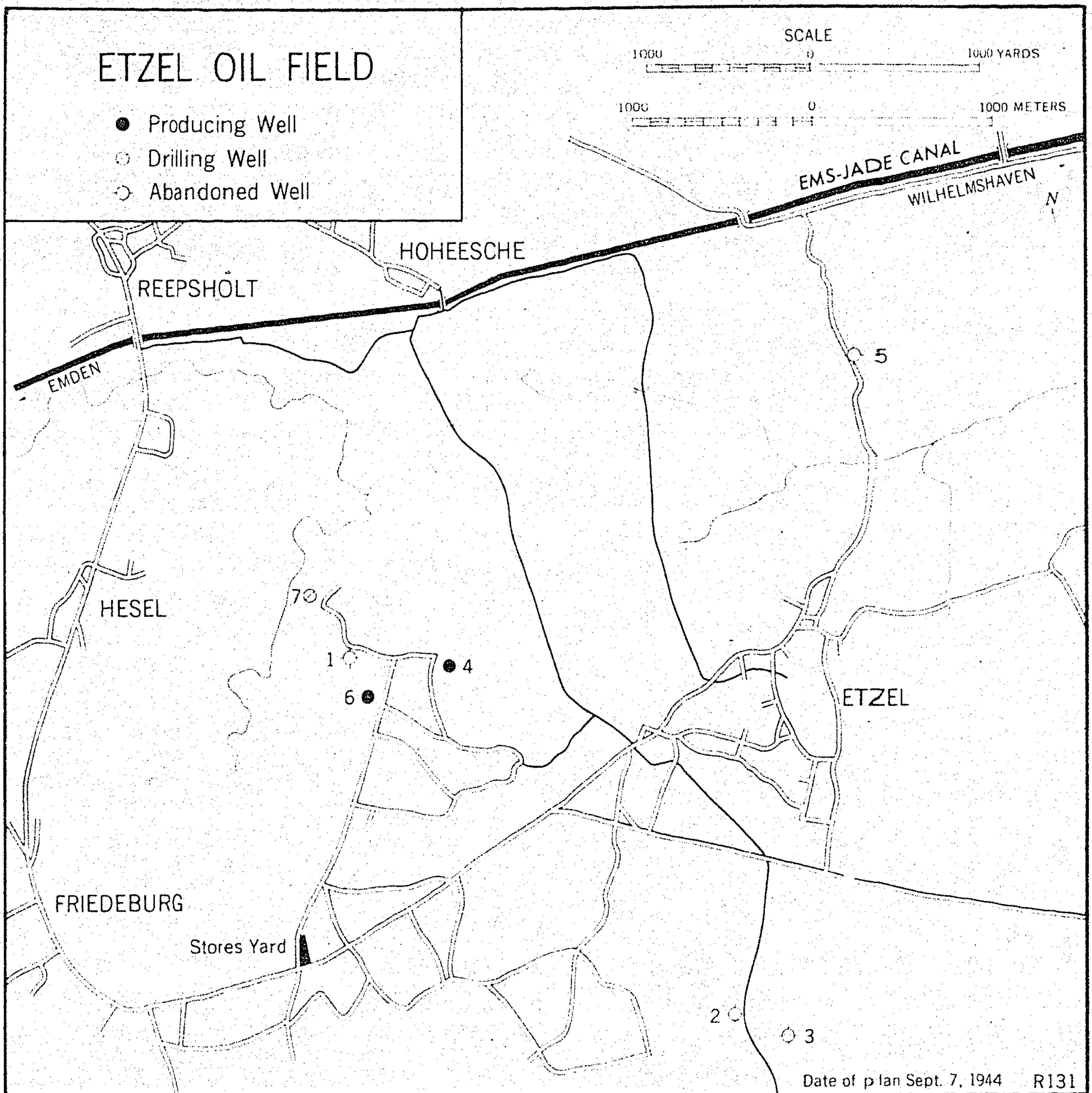
Aerial reconnaissance in the latter part of February 1945, evinced the presence of a small oil field near the village of Etzel about nine miles west-southwest of Wilhelmshaven, near the North Sea coast. See map on page 46.

It is inferred from the aerial cover that drilling operations have been conducted at Etzel during the past three years on a structure of apparently large size. The fact that the field contained only seven wells in early 1945, and that of these only two appeared to be producing, suggests that very little success has been achieved to date.

The status of the Etzel field is noted below from aerial reconnaissance interpretation:

<u>Well No. 1</u> was drilling on December 16, 1941 but the site was cleared and the <u>hole</u> apparently abandoned by June 11, 1943.
<u>Wells Nos. 2 and 3</u> are also apparently abandoned locations on cover of June 11, 1943. The date of drilling these wells is not known but it seems from the state of these sites that they were probably drilled not earlier than 1942.
<u>Well No. 4</u> was drilling June 11, 1943 and was probably put on the pump by August 17, 1943 at which time the stripped derrick was left at the location.
<u>Well No. 5</u> was started between June 11, 1943 and August 17, 1943 but apparently met with no success as the site was cleared before February 22, 1944.
<u>Well No. 6</u> was drilling August 17, 1943 and was probably pumping on July 7, 1944.
<u>Well No. 7</u> the most recent known venture, was drilling on July 7, 1944.

Production from the Etzel field is reported as 3,139 metric tons (21,973 barrels) during 1944.



2.5.12 Fallstein Field

The Fallstein field is situated some 30 kilometers south of the town of Brunswick and a relatively short distance north of the Harz Mountains. The structure is a broad anticline with Triassic limestone outcropping in the core. The discovery well was completed in September 1935, yielding 75 barrels of oil and considerable gas daily from the Zechstein dolomite, between 4,000 and 5,000 feet in depth. The annual production figures for the field are given in the table on page 83. The oil is of fairly light gravity and paraffin-base. The available information indicates that no production was obtained in 1938 and early 1939, which suggests that the small yield did not justify the considerable effort to obtain it and the field has been abandoned.

2.5.13 Feldbergen (Mölme Extension) Field

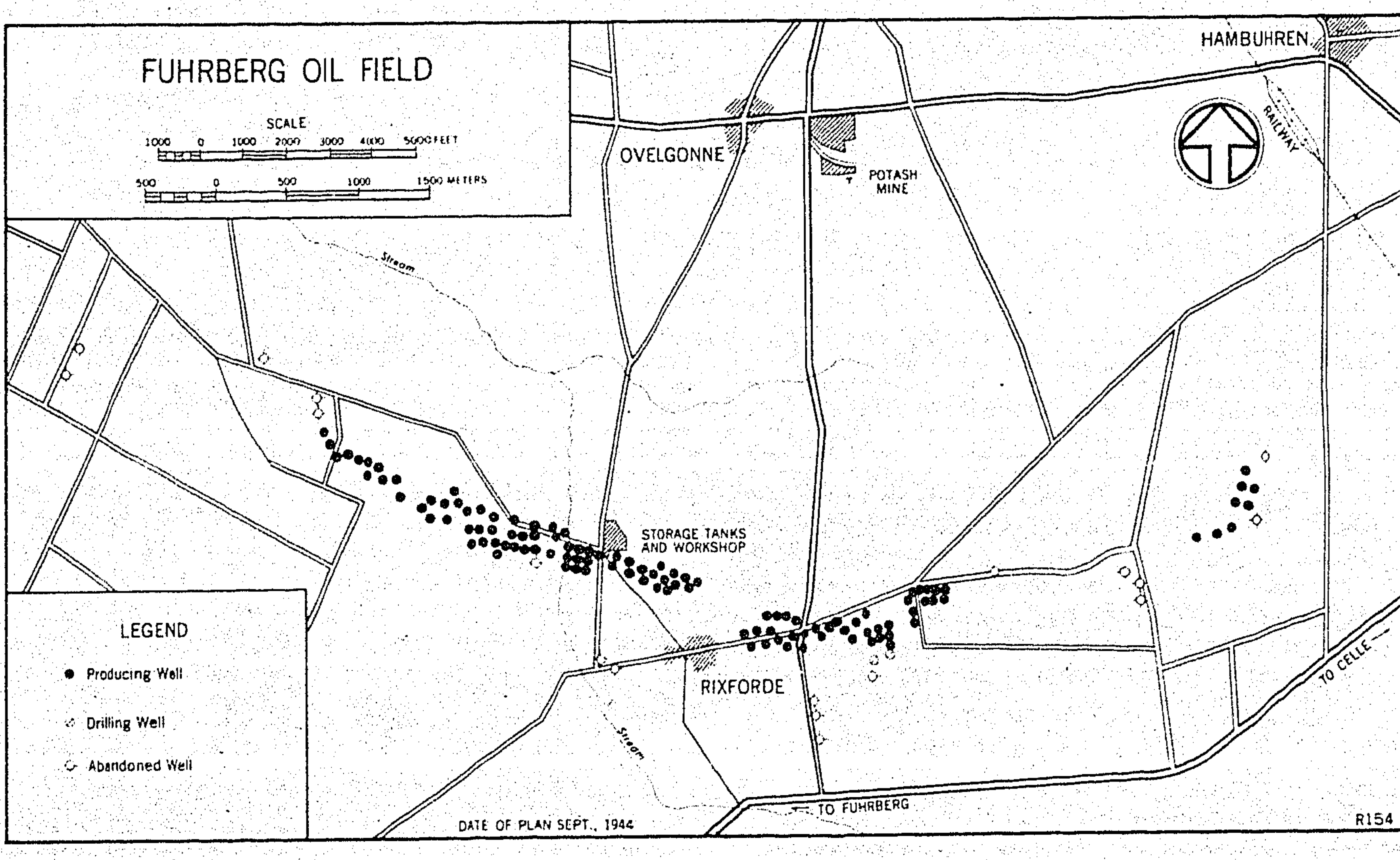
Aerial photographs taken on December 22, 1943 show a new pool developed one mile southwest of the Mölme field on the northwest side of Feldbergen. The Feldbergen field at that time comprised fourteen or fifteen producing wells, two wells being completed as producers, and two sites prepared for drilling. An abandoned location on the western edge of the field indicated the limit of production in that direction. Small water-separation tanks were observed situated near the middle of the west side of the field from which oil was probably piped to a tank and loading rack on the Hildesheim-Brunswick railroad one-quarter mile south of Feldbergen. A short siding was constructed at this point. From the aerial photographs referred to above, the field appeared to be approaching completion in December 1943 and it is likely that all of the development up to that time has been effected in the preceding eighteen months. Production from the Feldbergen extension is included in the figures for the Mölme field in the table on page 83.

2.5.14 Fuhrberg Field

Aerial reconnaissance during the summer of 1944 has revealed the existence of an extensive oil field in the Fuhrberg Forest, between the villages of Hambühren and Fuhrberg.

Some 138 wells have been identified, arranged in a narrow and gently curved crescent over five miles in length. The quality of the photographs does not permit an accurate evaluation of the state of all of these wells, but small production tripods can be seen at some wells and others are equipped with what appear to be small pumping units without any type of derrick.

A few well sites appear to be stripped of all installations and are, therefore, assumed to have been abandoned. At two new well locations in the middle of the field small 75 feet derricks were noted and those two wells were apparently drilling at the time of the reconnaissance. Of the 138 wells identified at this field it is tentatively estimated that two were drilling, 118 were pumping and 18 were abandoned.



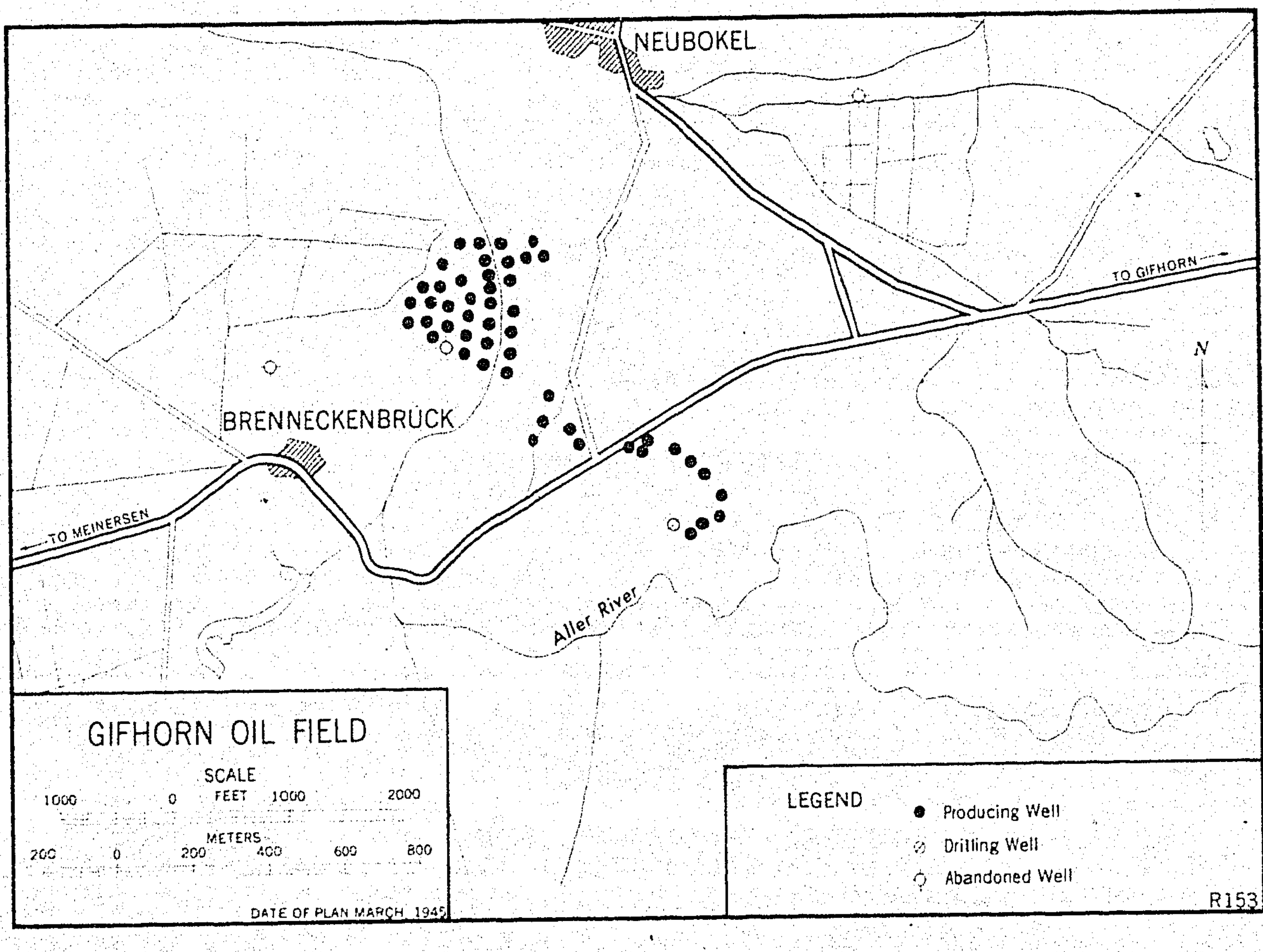
In addition to several small tanks among the wells, one 110 foot and two 35 foot storage tanks are situated in the middle of the field and have a total estimated capacity of 11,600 metric tons.

The arcuate form of the field indicates that it is situated on the edge of a very large salt uplift, in rather similar geological conditions to the Nienhagen field. This theory is supported by the presence of a potash mine in what would appear to be the center of the uplift.

Although the field probably was first drilled in prewar times, no production figures are known for this period. While the wells are similarly situated geologically and probably produce from the same geological formations as those at Nienhagen, the production per well is probably not so high as at Nienhagen as the wells are evidently much shallower (this is surmised from the lightness of the drilling rigs and pumping equipment and the close spacing which is from 220 feet to 300 ft.). Production from the Fuhrberg field is reported as 58,560 metric tons (409,920 barrels) in 1944. The Hambühren extension of this field is listed separately in production records and in 1944 produced 2,221 metric tons (15,547 barrels).

2.5.15 Gifhorn Field

The Gifhorn field lies along the highly faulted flanks of an elongated salt structure located some 25 kilometers north of Braunschweig (Brunswick). The discovery well was completed in September 1935, and yielded a heavy oil from sandstone overlying the salt in the Wealdon or Valendis formations of Lower Cretaceous age. The early wells produced initially between 50 and 100 barrels of oil daily from depths between 650 and 1,000 feet. Deep drilling was then undertaken along the west side of the Aller River and the field seems to have been fully outlined in 1937 but showed no indication of good production. There are reported to have been more than 40 oil wells in the area in 1939.



Aerial photographs taken in late March 1945 indicated a total of 53 wells in the Gifhorn field, of which 49 appeared to be producing, one drilling and three abandoned. This suggests that new wells drilled during the war years have not sufficed to compensate for the wells depleted and abandoned in that interval, as the records show that production had declined to 3,036 tons (21,252 barrels in 1944.

2.5.16 Heide Field

This field is located on a complex salt dome structure near Heide in Holstein, in which the flanks and crest are badly broken; the original producing area was situated on Liether Moor, 1-1/2 miles south of the town. The structure was discovered in 1860 in the course of drilling water wells, and asphaltic sands were also found at that time. A major feature of the uplift is a Permian horst covered by the Cretaceous. Heavy oil was encountered in fissures in the Senonian Chalk (Upper Cretaceous) and light oil found in the Turonian and Cenomanian (Upper Cretaceous) and Albian (Middle Cretaceous). The top of the salt is reported to lie 1,500 feet beneath the surface. The attempts made to develop production at shallow depth by mining and drilling methods achieved but little success and considerable water was produced along with the oil. In September 1935, oil was encountered in the course of deeper drilling at 1,312 feet in the sandy marls of the red sandstone series of the Rotliegendes formation (Permian). The well yielded initially 130 barrels (19 metric tons) per day. Other wells were completed as producers and deep exploratory tests were drilled; the deepest of these in 1938 reached 12,762 feet (Holstein No. 14). The average depth of the producing wells at the beginning of 1939 was about 3,600 feet.

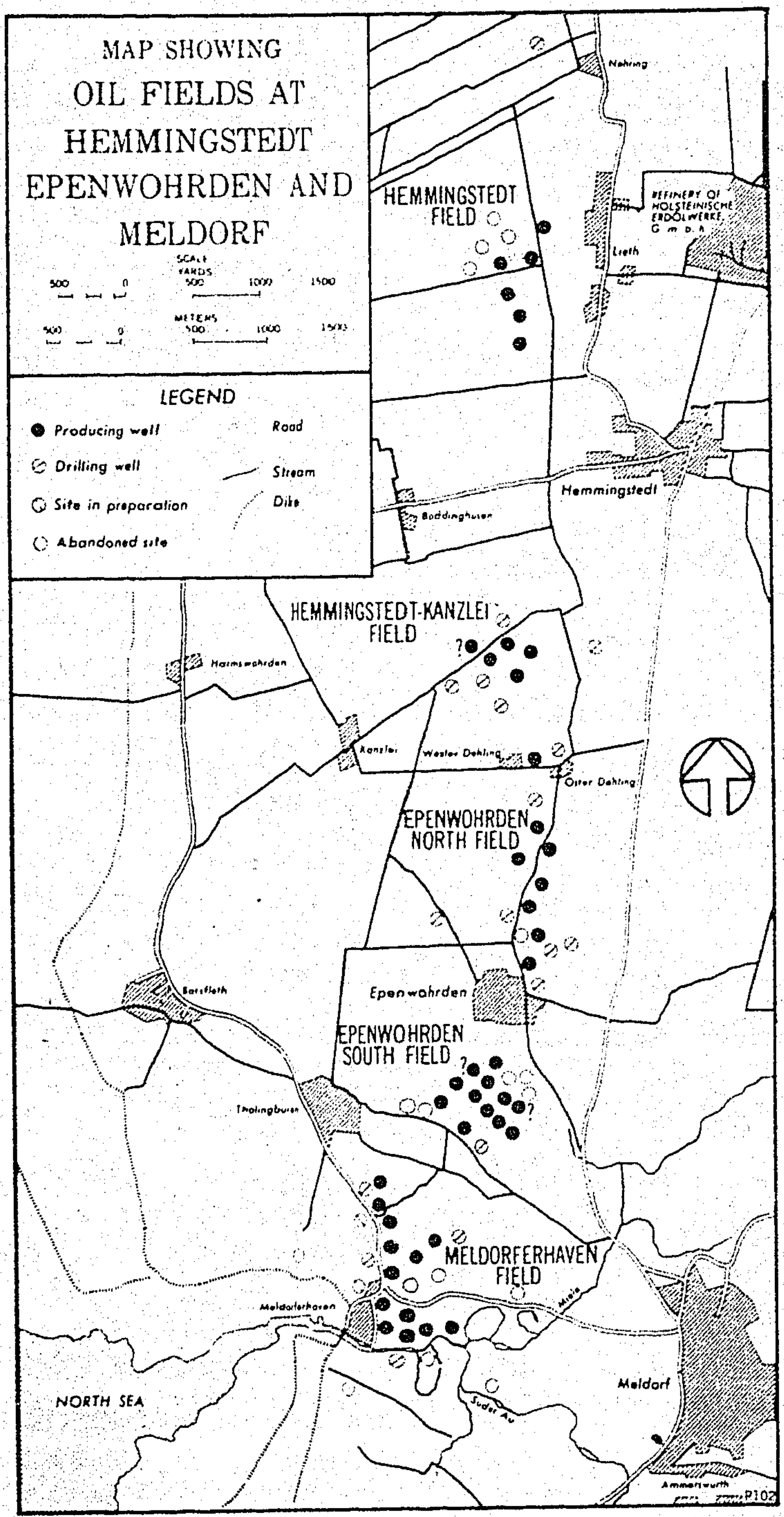
In the spring of 1939 a new area of high productivity was discovered in another segment of the structure about three kilometers north of the original producing area. A well in this extension to the field came in on March 6th, yielding 1,841 barrels (263 metric tons) of oil daily; a second well completed June 14th produced 1,624 barrels (232 tons) per day and a third on July 19th, 630 barrels (90 tons). The depths of these three holes averaged about 850 meters and the gravity of the oil was 33.5 degrees A.P.I. According to the available information this new production came from an elongated and narrow strip which could accomodate probably not more than one row of wells. The three wells were spaced 200 meters apart; therefore, little can be conjectured as to the length of the productive strip. The finding of such accumulations in a geologically complicated area such as Heide may be classed as sporadic. However, with an extensive area still largely undeveloped, recurrences of such local pools may be expected.

A major development at Heide was observed during aerial reconnaissance in February 1942, when there were seventeen locations with derricks, twelve locations apparently abandoned and three wells drilling in a new area about a mile west of Heide. In May 1943, the same area showed thirty-two locations with derricks, seventeen abandoned wells and one drilling well. Additional aerial coverage in March 1944 showed that this phase of development at Heide had passed, that all drilling outfits had been removed and the number of producing wells had been reduced from thirty-two to thirty since May 1943--indicating that the decline in production had begun. Nine mounded oil tanks and two refining units were observed in an area near the field which was connected by a branch line with the Heide-Meldorf railway.

Records obtained from Germany presumably include production from the Heide, Hemmingstedt, Hemmingstedt-Kanzlei, Epenwöhrden North and South, and the Meldorferhafen fields under the single heading of "Heide". These composite production figures are shown, by years, in the table on pages 82 and 83.

2.5.17 Hemmingstedt Field

This small oil field was detected in air cover of late February 1945. Twelve well sites can be identified as shown on the map on page 50.



Six of these wells, with stripped 75-foot derricks, are presumed to be producing. Four sites have been entirely cleared and are apparently abandoned. Two wells have recently been drilled, one about 1,200 yards north, and another about 1,000 yards south of the productive area. Drilling activities have been stopped at the first of these between 15.1.45 and 8.2.45 and most of the equipment has been removed, but the drilling derrick still remains. Whether production has been obtained or not, cannot be determined. Drilling was in progress or about to commence at the second location on November 29, 1944.

A group of 10 small oil tanks, each with a capacity of 50 tons, is situated in the center of the producing area and at the eastern end of these tanks a small pumphouse is noted. The tanks and pumphouse are surrounded by a rectangular blast wall.

The field is situated on the same tectonic lines as the Heide oil field (to the north) and the oil fields of the Meldorf District (to the south). It is, therefore, likely that production is obtained from the Zechstein limestone and that comparable production figures also apply. Production from the Hemmingstedt field is included in the figures for Heide in the German production records, page 83.

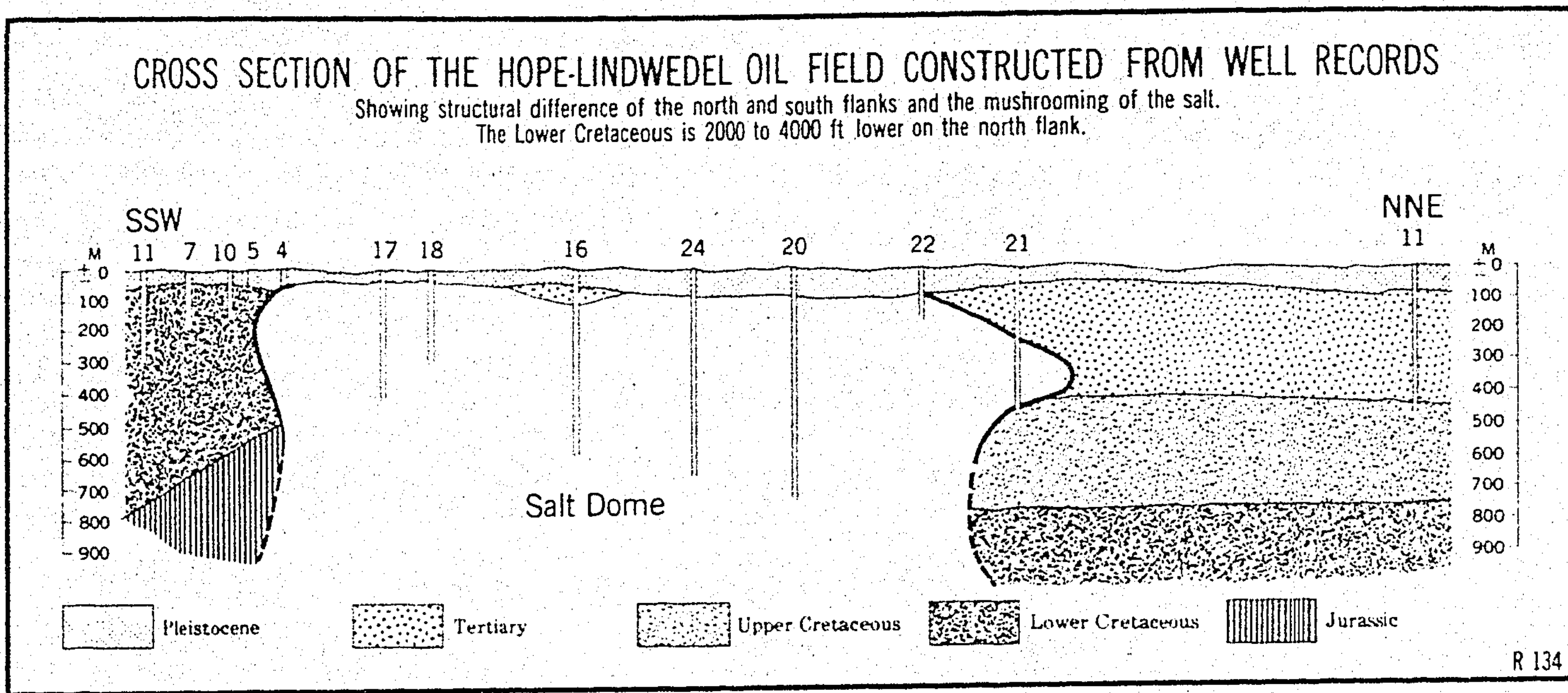
2.5.18 Hemmingstedt-Kanzlei Field

This field lies 1-1/2 miles southwest of Hemmingstedt in Holstein, due north of Epenwöhrden and not far from the Heide field. Its existence was revealed by aerial reconnaissance during March 1944 which was followed by aerial observations in April and August 1944. The location of the field is shown on the map on this page.

The air cover of April 1944 showed three completed producing wells, two drilling wells and three locations prepared for drilling. According to aerial photographs taken August 1, 1944, the field consisted of five producing and four drilling wells and one abandoned well. The annual production for 1944 is included with the statistics for the Heide district. On the basis of current information it is not possible to determine the eventual size of the field.

2.5.19 Hope-Lindwedel (Adolphsglueck) Field

The Hope-Lindwedel (Adolphsglueck) field is located about 30 kilometers north of Hannover. The structure is a salt dome, elipsoidal in shape and about six kilometers long and five kilometers wide. There is a cap of gypsum and anhydrite at shallow depth overlying the salt core, and the top of the salt is mushroomed on all sides. Several faults of considerable magnitude occur, with upthrow to the south. No Pre-Cretaceous rocks are exposed at the surface, but their presence is expected



at depths of 600 meters or more at various points along the periphery of the dome. A representative cross-section of the structure is shown in drawing above.

The early operations on the dome consisted of potash mining and these were interrupted by an explosion following which oil and gas seeped into the workings. A shaft extended to the west border of the dome encountered gas under pressure and yielded about 300 barrels of oil. A few shallow holes were later drilled on top or close to the edge of the dome, but none reached the oil horizons. Several oil shows were encountered in these tests. Up to 1930 about thirty wells had been drilled on the flanks from 100 to 900 meters in depth and with one exception none penetrated an oil horizon. The exception was a well which drilled through a part of the Wealden (Lower Cretaceous) where this formation is at or near the surface and could not be productive.

Small commercial production was developed on the structure in 1938 from what was believed to be a fault plane leakage from a source which may be of Rhaet (Upper Triassic) age. The annual production records through the year 1939 are indicated in the table on page 83. Aerial photographs taken at the end of 1943 showed most of the area of the field but no oil installations were recognizable. Accordingly, this field has probably been abandoned, as it was nearing exhaustion in the fault plane seepage at the outbreak of the war.

There appear to be excellent possibilities for oil on the Hope-Lindewedel structure, particularly on the western flank where oil was found in the shaft and at the southern end of the dome where partially eroded Wealden is encountered about 4,000 feet higher than it is on the northern flank. There is a good chance of production at comparatively shallow depths from the Dogger and Lias (Jurassic) and the Rhaet (Triassic). All flanks of the dome have possibilities of production and oil may be found trapped beneath the salt overhang.

2.5.20 Linden Field

There is little information available regarding the Linden area on the southwest outskirts of the city of Hannover, which, from 1886 to 1896, yielded between one and fifteen tons of oil annually, the total output amounting to only 62 tons. This area may lie on the northern flank of the Benthe salt dome which is still in the prospect stage of development or may be on an adjacent separate structure which is believed to underlie Hannover. The oil was obtained at shallow depth and while this production was of little importance, the Linden area is included among the producing fields in order that the list may be complete.

2.5 21 Meckelfeld Field

The Meckelfeld field lies a little more than ten kilometers south of Hamburg and about the same distance southwest of the Reitbrook field which it is reported to closely resemble in structure and producing horizon (a description of the latter field appears on pages 59 to 61). There is but little information available regarding the geology of the Meckelfeld field except that production originally came from the Upper Cretaceous at about 450 meters. However, the sand and source conditions were decidedly inferior to those at Reitbrook. Notwithstanding the less favorable production, the Meckelfeld field was being actively developed in 1939 and had at least sixteen wells in an area about a mile southeast of the town. Aerial reconnaissance in the latter part of 1942 showed all of these wells to have been abandoned and a new extension to the field developed within a mile of the Harburg-Luneburg railroad on the southeast side, between one-half and one and one-half miles southeast of the town. The new extension contained thirteen wells and one drilling well at the time of aerial coverage; also the equipment was modern and the derricks tall. This development at Meckelfeld appears of some significance, as the wells bear little relation to the old field and it appears probable that a deeper reservoir has been discovered. Production figures from 1938 to 1944, inclusive, are given in the table on page 83.

2.5.22 Meldorferhafen Field

The existence of this field, which lies along the same structural trend as Heide, in Holstein, became known through aerial reconnaissance early in 1944. The Meldorferhafen field is situated immediately west of the town of Meldorf and extends northward nearly to Thalingburen, where it is separated from the Epenwöhrden south field by a small saddle. Towards the south the field extends to the meandering rivers which enter the sea at Meldorferhafen (see map on page 50).

On March 13, 1944, when observed from the air, the field consisted of thirteen producing wells, five derricks partially or completely rigged-up for drilling and two more sites in preparation. All of these locations were arranged peripherally, stepping out from the proved producing area so that a minimum of dry holes would be drilled. Production is believed to come from the Zechstein limestone (Permian). A small tank farm was observed east of the main road junction at Meldorferhafen and a workshop center located about 300 yards to the north. Scars showing the position of pipe lines connecting the wells to the field storage were seen, but the trunk pipe lines could not be detected, although it appears probable the oil is conveyed by pipe line to the refinery located near Hemmingstedt.

Aerial photographs of the field were again taken August 1, 1944 and showed twelve producing wells, four wells drilling, three sites in preparation and three abandoned holes. The latter were situated at the east and south edges of the area and the most recent site being prepared for drilling was located on the western edge of the northern part of the field.

Production from the Meldorferhafen wells, referred to above, is believed comparable to the Heide wells; the annual output for the field is included in the Heide district as shown in the table on page 83.

2.5.23 Mölme Field

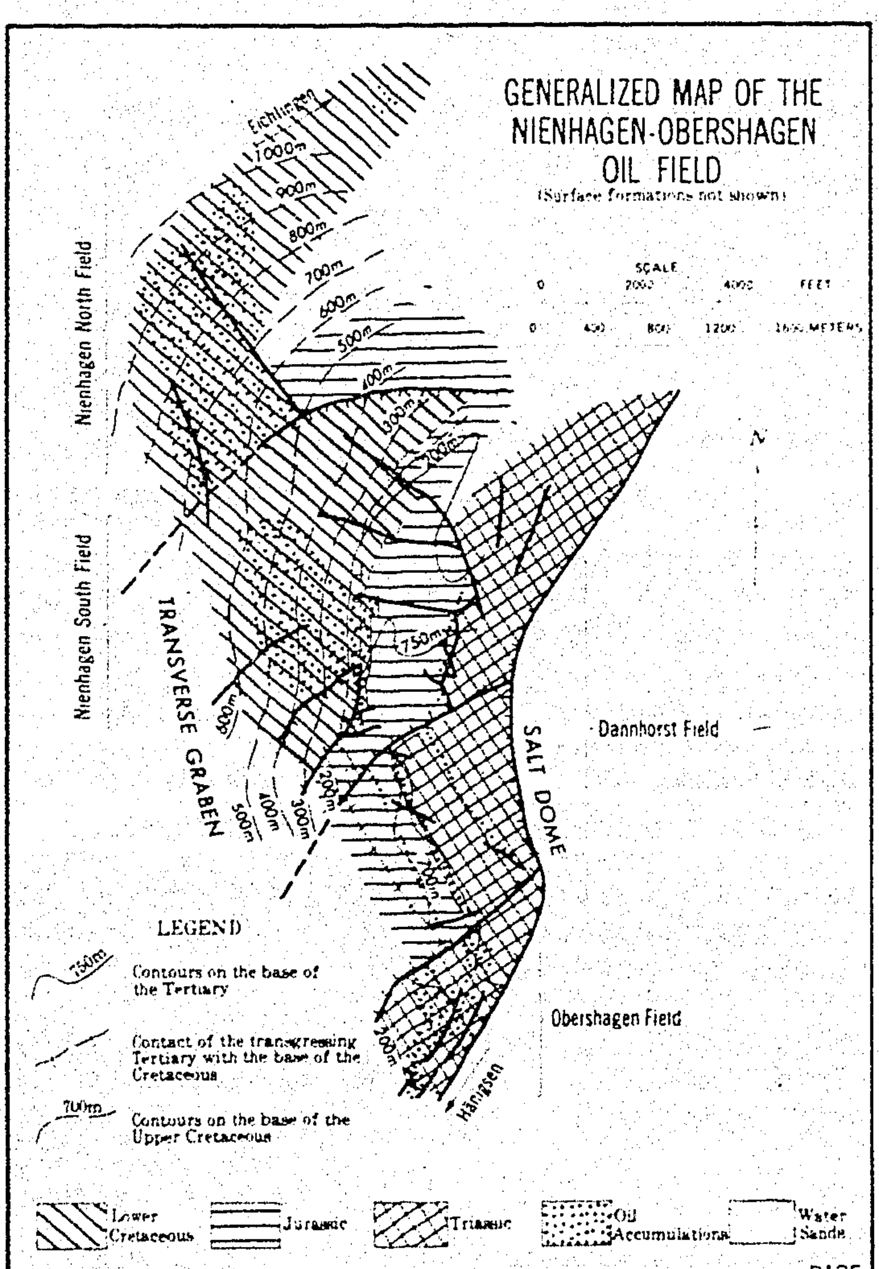
The Mölme salt dome lies approximately 35 kilometers southeast of Hannover. Wells drilled before 1935 found good shows in the Jurassic at depths of about 3,000 feet, and the top of the salt was encountered about 1,000 feet. Wachtet No. 5, the discovery well for the field, was brought into production during 1935 with an initial yield of 210 barrels (70 metric tons) of light oil per day. The well was completed at 984 feet near the western edge of the salt plug, with the oil coming from horizons in the Lower Lias (Lower Jurassic) and the Rhaet (Triassic). Production was also developed on the east side of the dome at depths between 150 and 450 feet in Lower Lias and Rhaet.

There is reported to have been 80 producing wells in the field in 1939, many of which were shut-in due to lack of refining facilities at the time. Production was obtained until 1943, as indicated in the table on page 83. However, aerial photographs taken December 22, 1943 showed the Mölme field to be completely abandoned and the Feldbergen field, previously described, developed at an interval of a mile or more towards the southwest. It is probable that further exploration and drilling at Mölme will yield new production.

The Mölme dome is somewhat similar to that of nearby Oberg, and lies east of the southwest continuation of the Ölsburg salt stock, being separated from the latter by a graben. The available structure map of the Mölme structure is shown on page 57. The dome is eroded more deeply than that of Oberg, consequently the producing horizons--the lowermost Lias (Lower Jurassic) and the Rhaet (Triassic)--were encountered near the surface. On the west flank shallow oil is reported to occur in the Wealden (Lower Cretaceous) although this formation is not known to have yielded commercial production at Mölme.

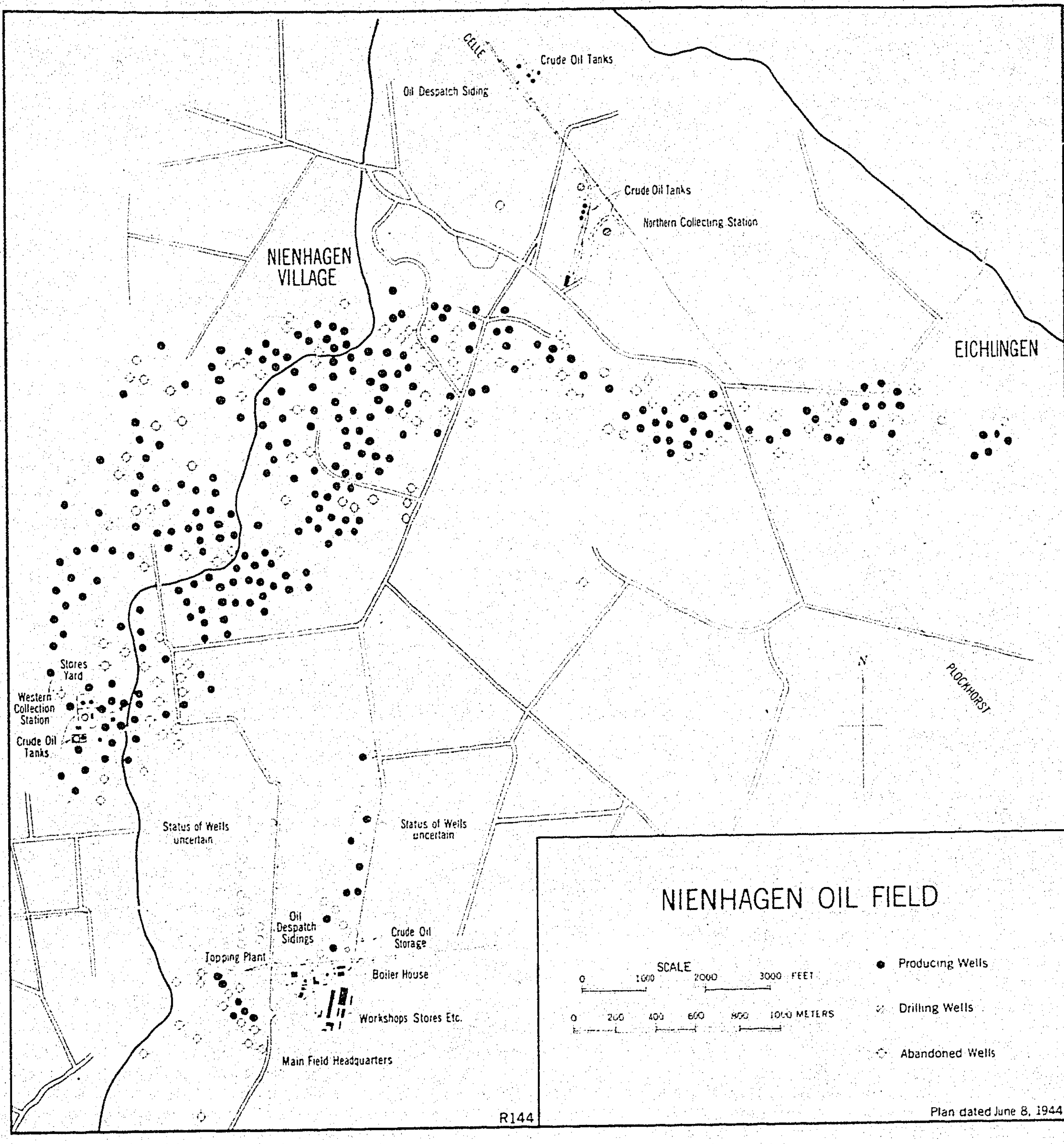
2.5.24 Nienhagen-Hänigsen-Obershagen-Eichlingen Field

This field, some eight miles northeast of the city of Hannover is situated on the west flank of a north-northeast (Rhenian) trending salt stock about five miles (eight kilometers) in length and approximately two miles (three kilometers) wide. Development started in 1860 with a well 55 meters in depth, near Teerkuhlenberg south of the present Nienhagen field. During 52 years of prospecting, from 1860 to 1912, a total of 280 wells were drilled; in 15 years, from 1912 to 1927, 360 additional wells were brought into production. In 1937, there were more than 750 wells in the field. During the course of development the proved area has been extended from Nienhagen southward to Hänigsen and northeastward towards Eichlingen. Annual production figures for the field are shown in the table on pages 82 and 83.



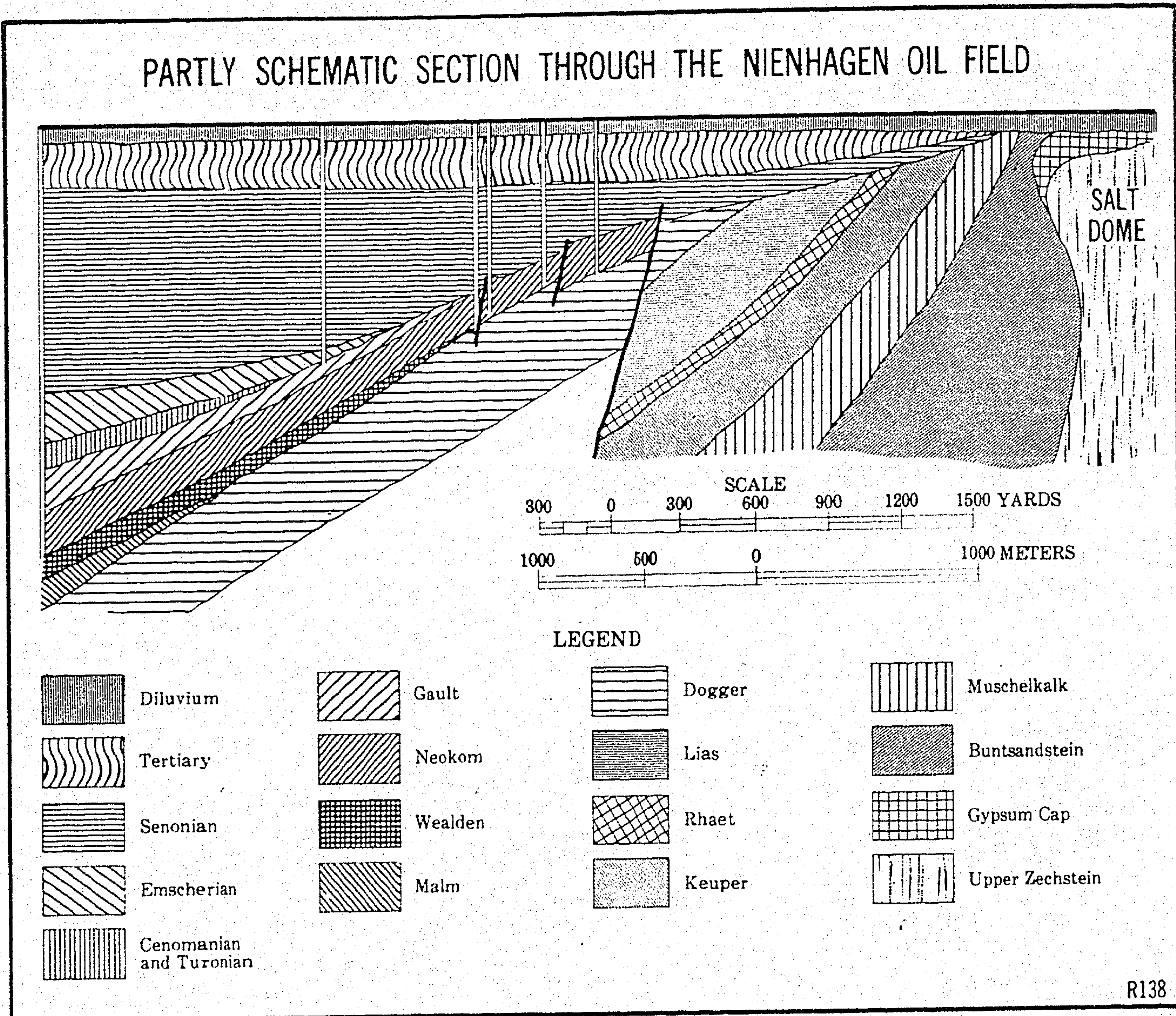
The map on this page, and the cross-section on page 55 show the chief structural and stratigraphic relations on the west flank of the dome on which production is obtained. The top of the salt is encountered at about 100 meters below the surface. The strata in proximity to the salt include a stratigraphic section from Triassic to Jurassic in age. Close to the salt the beds are overturned and faulted. Farther out they are tilted on edge and gradually to the west the dip becomes less steep. Then follows a steeply dipping fault placing the Lower Cretaceous in contact with the Middle Jurassic. Gentler dips occur in the overlying formations to the west. In the more prolific northern portion of the field the Mesozoic strata form a gentle northwest striking anticline which is cut by the west flank of the salt core. This anticline has a breadth of about a mile (1.5 kilometers).

The Middle Jurassic is overlain unconformably by the Lower Cretaceous on



which Upper Cretaceous beds rest unconformably. The Tertiary overlies all other formations, including Permian, unconformably.

Practically all of the formations from Zechstein (Permian) to Tertiary, inclusive, in this field are more or less impregnated with oil. However, oil is not yet known to occur in the Zechstein dolomite normally beneath the potash salt horizon. Oil occurs, however, in the brecciated zone about the salt mass in cavities and fissures. This is a heavy paraffinic oil. The next higher horizon is the "Schilfsandstein" of Keuper (Upper Triassic) age. This oil is rather heavy with density between 0.883 and 0.936 (28.7 and 19.7 degrees A.P.I.). The two above-mentioned horizons are only very locally productive and of little importance, due perhaps to their lenticular character and small extent. The more important horizons in the well stratified series are as follows:



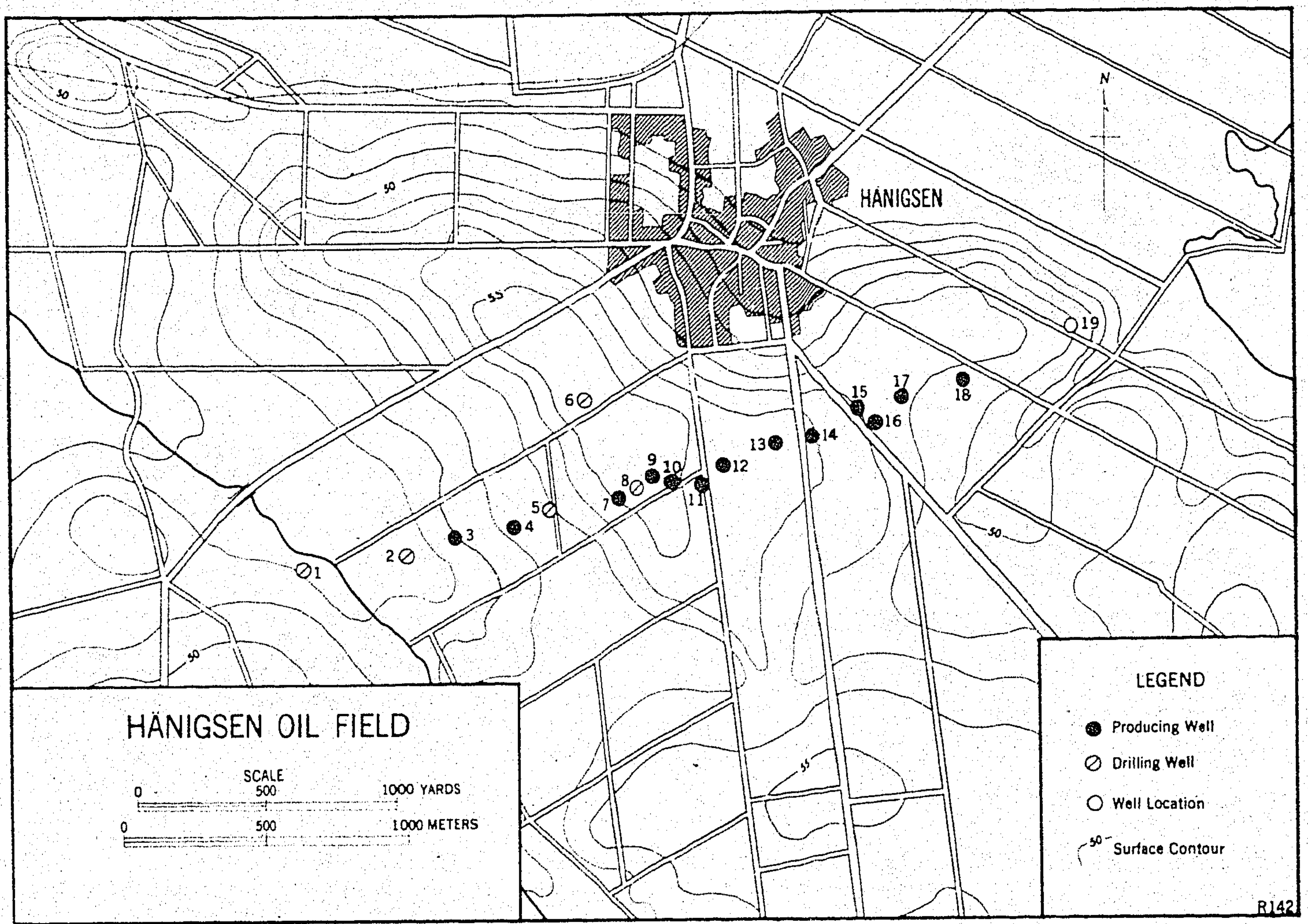
1. Sandstones of the Rhaet (Uppermost Triassic) and base of Lias (Lowermost Jurassic or possibly Uppermost Triassic) constitute an important oil horizon.

2. The Bajocian horizon of the Dogger (Middle Jurassic) containing Inoceramus polyplocus, yields small production.

3. The Bathonian horizon of the Dogger (Middle Jurassic) with Parkinsonia parkinsoni, and the Cornbrash, contain oil in small quantities.

4. Lower Callovian, with Macrocephalities macrocephalus of the Dogger (Middle Jurassic), is an important oil horizon locally where very porous calcareous sands (oölitic) are present. This formation is also much fractured with resulting increased porosity; the gravity of the oil is .897 (26.2° A.P.I.): and well E. 38 gave abnormal production from this horizon.

5. By far the most important oil horizon is the Lower Cretaceous, Wealden and Valendis. There are three producing levels, the deepest of which is the Wealden oil sand, 10 meters thick; above this are two Valendis sands comprising a total of about 50 meters. The sands are of littoral or shallow water type. The deeper horizon is only present in the extreme west and elsewhere the Valendis conglomerate and sands are transgressive. In the northern part of the field oil from this horizon has a gravity of .895 (26.5° A.P.I.) with paraffinic base and contains 8-10 per



cent of light products. The oil from farther south (at Forstort) has a gravity of .915 (23° A.P.I.).

6. Sandy and glauconitic beds in the Lower Hauterivian of the Gault (Middle Cretaceous) are also impregnated but are not important.

7. Weak indications of oil are found locally in concretions in the Albian (Middle Cretaceous) and Senonian (Upper Cretaceous) but they are of no commercial importance.

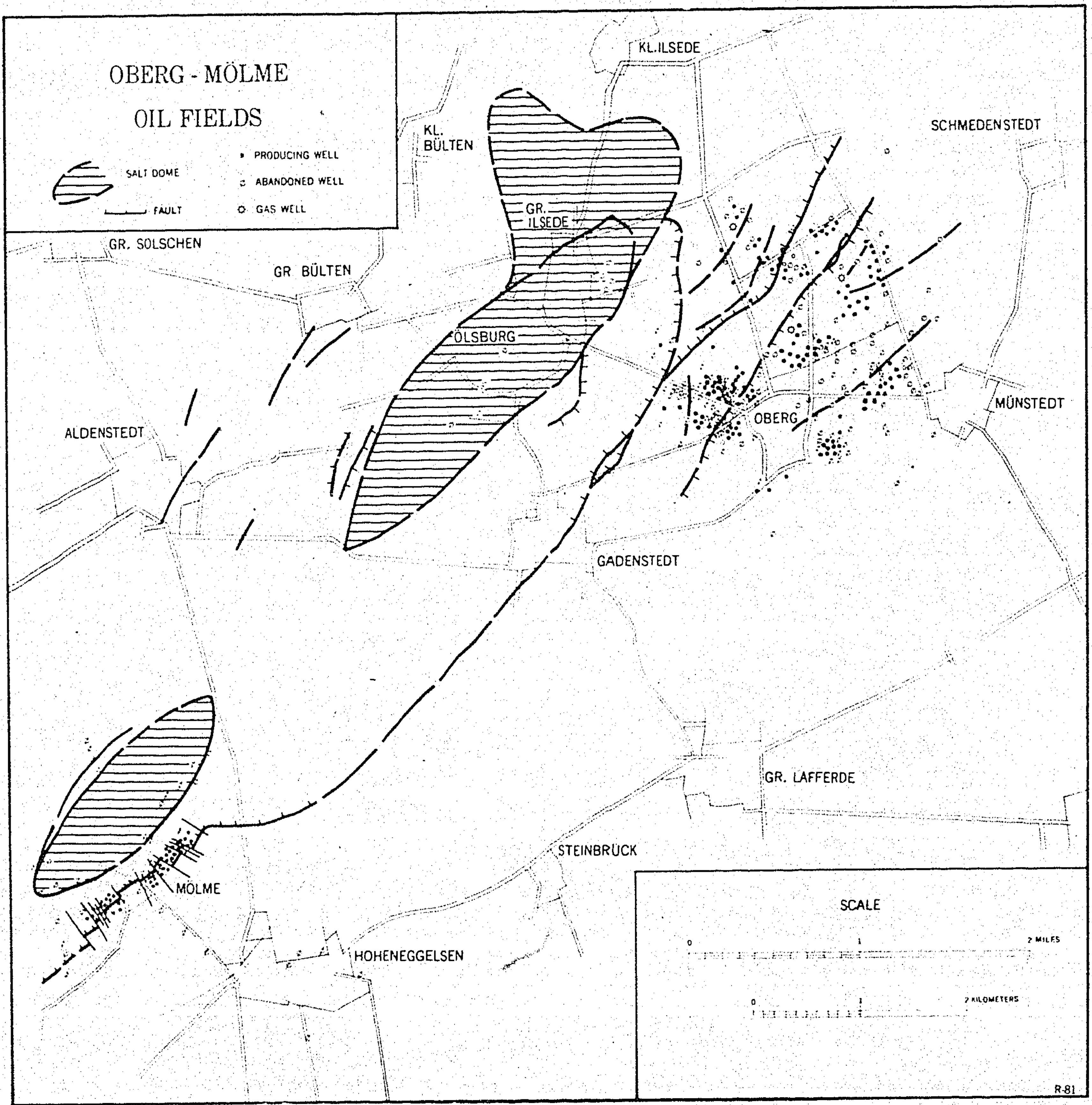
8. The Tertiary and Quaternary sometimes show weak impregnations of oil. The local farmers have dug shallow pits in Quaternary deposits where seepages occur and gather tar on the water of these local pools or "Teerkuhlen".

Prior to the outbreak of the war, the Nienhagen field was being extended northeastward in the direction of Eichlingen along the northern flank of the salt plug in an area of fault blocks with the production coming from Valendis-Wealden beds (Lower Cretaceous). The section penetrated consisted of approximately 300 meters of Tertiary and 700 to 900 meters of Upper Cretaceous, which overlaps the Valendis and Wealden in an angular unconformity. Small-scale aerial photographs taken of the Eichlingen area in the latter part of 1944 show five drilling wells in a further extension in this vicinity.

The production record of the Nienhagen group of oil fields, including the war period up to 1945, is shown in the table on pages 82 and 83.

2.5.25 Oberg Field

This oil field is situated both west and east of the town of Oberg, southeast of Hannover. It is in the form of a semi-dome and lies nearly two kilometers east of the Ölsburg (Gross Ilsede) salt stock, from which the field is separated by a graben containing mainly Upper Cretaceous beds.



The geology and structure of the Oberg field is indicated in the above drawing. The producing area is a little more than two kilometers long from northwest to southeast and more than a kilometer wide. On the surface Dogger and Malm (Jurassic) and the unconformably overlying Wealden (Lower Cretaceous) are exposed on the upthrown faulted area east of the graben. In this part of the field production comes from the Dogger and Wealden where the latter has not been exposed to erosion. On the downthrown side, in the graben, Upper Cretaceous rocks outcrop at the surface and commercial production is reported to have been obtained from the

Wealden (Lower Cretaceous). Production at Oberg is greatly controlled by the lenticularity of the Dogger sand as well as by the structure. In the wells drilled shows of oil have been encountered in various other formations from Rhaet (Upper Triassic) to the Cretaceous, and oil accumulates in tar-pits dug in the Pleistocene

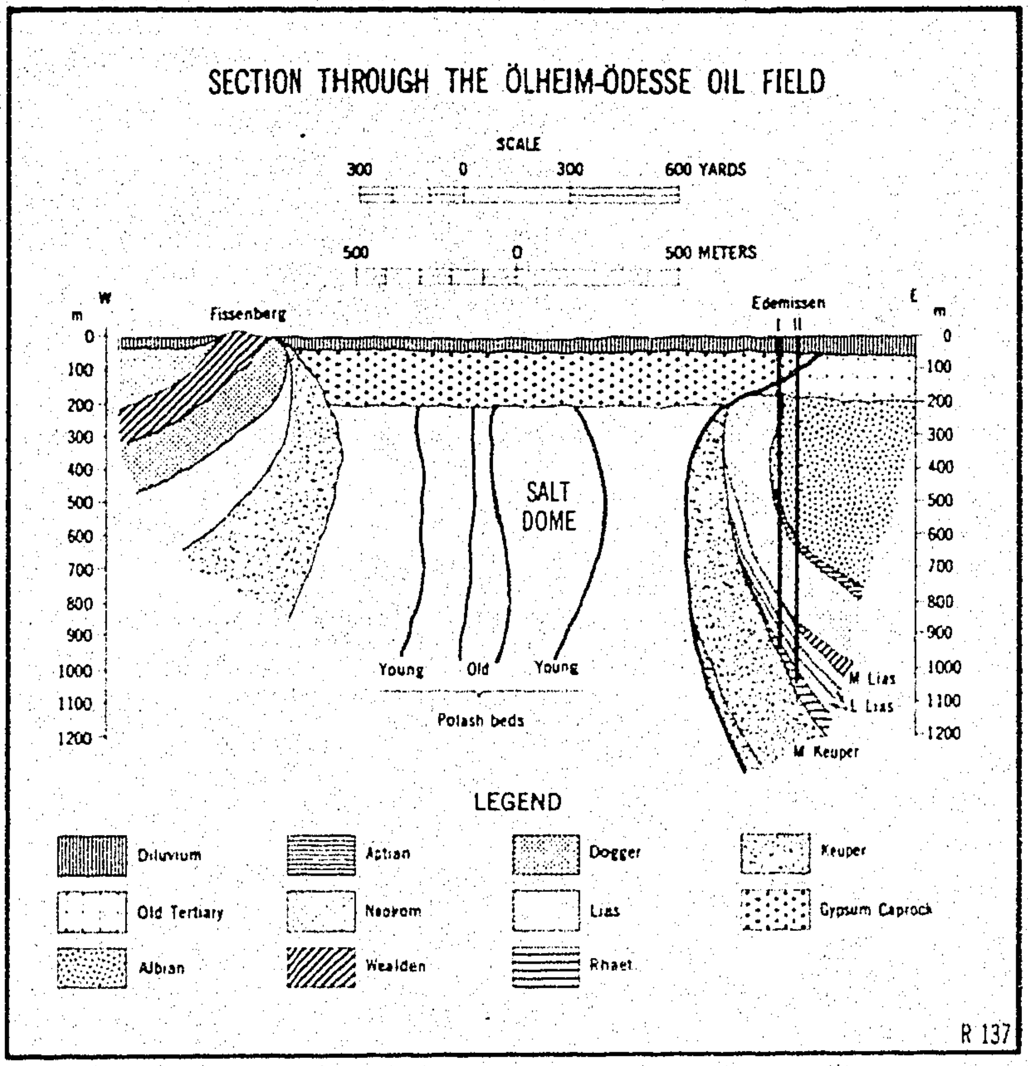
Prior to 1920, only unimportant production had been obtained from the Oberg field, at shallow depths between 50 and 450 feet and in a few deeper wells between 600 and 1,000 feet. Soon thereafter, however, production was developed at between 1,500 and 1,800 feet. Between the years 1919 and 1928, about 80 wells were completed in lenticular sands of the Dogger, the main producing horizon of the field, with the wells yielding, initially, between 50 and 250 barrels per day. The oil was of light (0.85) specific gravity, and contained about 20 per cent gasoline. By the end of 1933 there were 173 wells in the field, of which 84 were producing oil from depths ranging between 800 and 1,800 feet; some of these were flowing but the majority were being pumped or had been placed on airlift. In 1935 the field was extended northward by the completion of Lahnstein No. 3 at a depth of 777 feet in the Dogger, with an initial production of 150 barrels per day. Shortly thereafter a well drilled to 984 feet in this part of the field yielded initially 600 barrels of oil per day. From 1935 through 1939 the Oberg field seemed to be on a regular decline.

During August 1942 aerial photographs were taken on the west and northwest side of Oberg which, however, did not include the main field and showed only four or five derricks standing, out of 19 known to have been built within 1-1/2 miles northwest of the city; nearly all the old locations were obliterated. Four tanks of 100 to 200 tons capacity were observed in this sector, indicating only a small output from wells in the vicinity. However, a new area of development was noted at that time with six derricks and twelve apparently abandoned locations. This area was again observed during aerial reconnaissance on January 21, 1944, when it contained only three new producing wells. It is now known that during the war period the Oberg field maintained a nearly stable production, as indicated by the figures of the table on pages 82 and 83.

2.5.26 Ölheim-Berkhöpen-Ödesse Field

This field lies approximately 35 kilometers northwest of Brunswick and about 30 kilometers east and slightly north of Hannover. It is a salt dome structure a little more than three kilometers long and one kilometer broad, trending in a north-south direction. The beds around the salt stock have been uplifted by the salt mass and dip steeply, being broken by radial and peripheral faults. The dip of the eastern flank of the dome is very steep and the western flank less steep. The rocks exposed on the flanks are Lower Cretaceous unconformably overlying Middle Jurassic which in turn overlies Triassic beds. A cross-section of the field is shown on page 59.

The oil-bearing horizons are the Rhaet (Uppermost Triassic), Lower Dogger (Middle Jurassic), Wealden (Lower Cretaceous) and the Tertiary. The first flowing wells in Germany were drilled on the southeast flank of the salt stock in 1880 and completed in very shallow Wealden and Tertiary sands. One of these, well Mohr No. 3, came in at 210 feet from the Wealden and yielded several hundred barrels of fairly heavy oil per day. It is in this territory that the German oil industry had its origin. However, salt water encroachment in the shallow producing sands and poor well completions due chiefly to lack of technical equipment resulted in depletion by 1920. Up until 1925 the drilling in this field was all to the south of the salt dome, near Ölheim. In 1925 a deep well drilled on the northern edge of the dome encountered very complicated structure but a second well drilled in 1928 and situated farther from the salt stock found production in the Upper Dogger (Middle Jurassic). These two wells were known as Edemissen Nos. 1 and 2 and are indicated on the cross-section on page 59. A leading independent operator in Europe, Anton Raky, then leased the State Forest of Berkhöpen and sank three wells to the Rhaet-



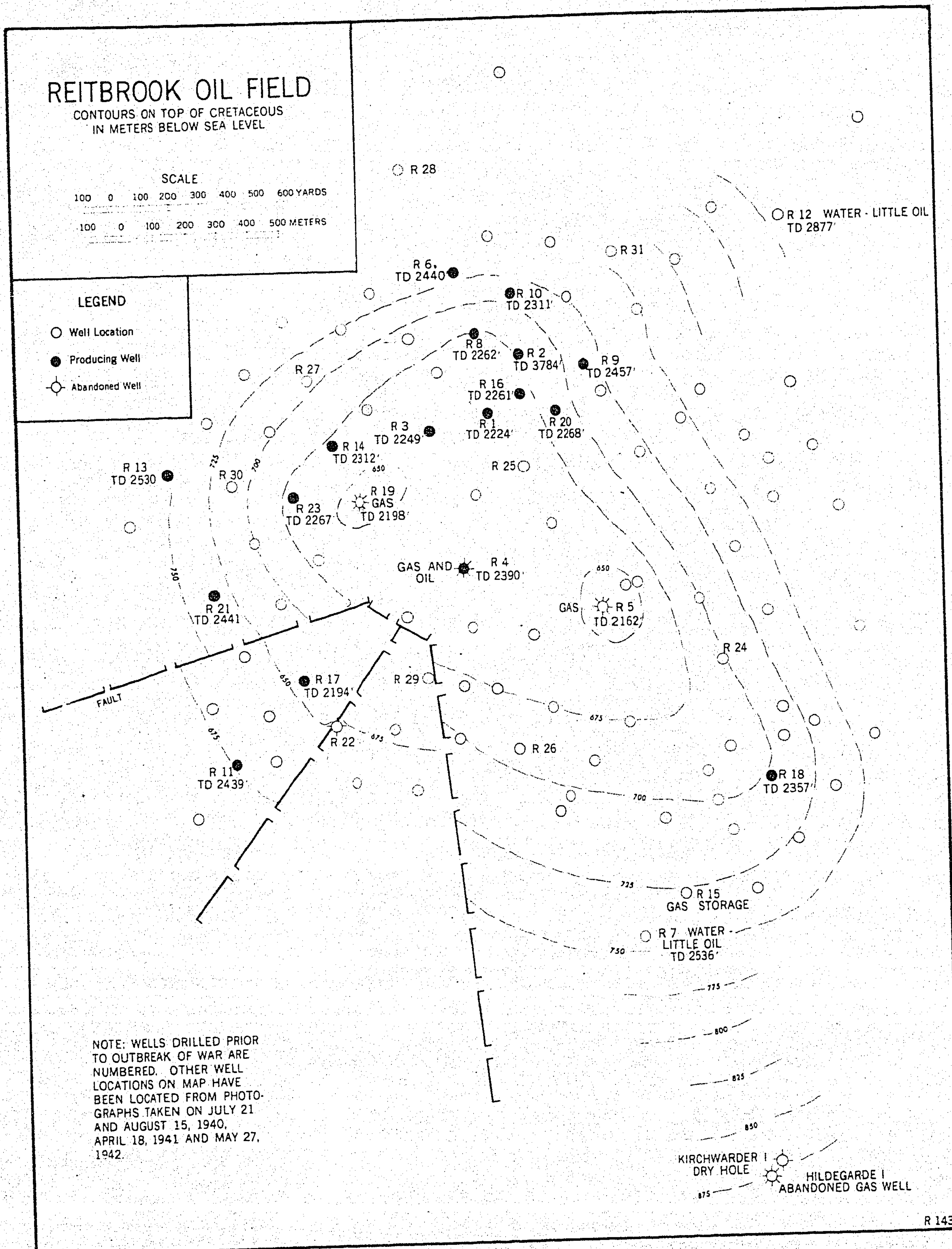
Lias (Triassic-Jurassic) contact where he struck large production. The best of these wells, Ödesse No. 4, yielded initially 120 metric tons per day and the production of the field rose from 97 metric tons (679 barrels) in 1928 to 14,388 metric tons (100,716 barrels) in 1930. The Berkhöpen concession was then purchased by a drilling company operated by the German government, (the Preussiche Bergwerks und Hütten A.G.- Preussag), who continued drilling it and obtained large yields from flowing wells. A representative well, Preussag No. 11, which was 1,000 meters deep, produced 110 to 120 metric tons of oil daily. The Lower Cretaceous oil is heavy; the main production from the Middle Jurassic is light oil of 0.850 specific gravity containing some 20 per cent gasoline.

The statistics covering annual production from this field, up to 1944, are shown in the table on pages 82 and 83. So far as was known in 1939, the field had no specific possibilities for any notable increase in production.

Aerial reconnaissance at the end of 1943 showed that there had been very little new development in the area known to have been productive prior to the war and, therefore, its output was becoming very small. However, a new area had been opened up along a northeast-southwest belt immediately east of the old Olheim field, overlapping the original area in the north only. Of the new wells seventeen had stripped steel derricks standing and were presumably in production from an estimated depth of 3,000 feet; there were four peripheral locations without derricks which were considered abandoned. There was no evidence of preparations for further drilling and it is likely that development in this segment of the field was completed.

2.5.27 Reitbrook Field

The Reitbrook oil field (sometimes referred to as the Neuengamme field) is located about 9-1/2 miles southeast of Hamburg. Prior to the discovery of oil, natural gas had been found accidently in an adjacent area when, on November 3, 1910, a water well blew out at a depth of 815 feet from a gas sand in the Middle Oligocene. After running wild for many months this well was brought under control and all the gas produced (reported to be 95 per cent methane) was used for illumination purposes in the city of Hamburg. The gas pressure declined from 410 p.s.i. in 1910 to 14 p.s.i. in 1919 when the well was nearing exhaustion. A second well was then drilled and found gas at 915 feet. Continued cleaning of these two wells was necessary. The total gas production from 1910 to 1937 amounted to seven billion cubic feet. Eighteen other wells were drilled for gas in the immediate vicinity but all were non-commercial. The gas producing area was generally known as the Neuengamme gas field.


REITBROOK OIL FIELD
CONTOURS ON TOP OF CRETACEOUS IN METERS BELOW SEA LEVEL
SCALE
100 0 100 200 300 400 500 600 YARDS
100 0 100 200 300 400 500 METERS
LEGEND
Well Location
Producing Well
Abandoned Well
R 28
R 12 WATER - LITTLE OIL TD 2877'
R 31
R 6, TD 2440'
R 10 TD 2311'
R 8 TD 2262'
R 2 TD 3784'
R 9 TD 2457'
R 27
R 16 TD 2261'
R 1 TD 2224'
R 20 TD 2268'
R 3 TD 2249'
R 14 TD 2312'
R 13 TD 2530
R 30
R 25
R 19 GAS TD 2198'
R 23 TD 2267'
GAS AND OIL
R 4 TD 2390'
GAS
R 5 TD 2162'
R 21 TD 2441
R 24
R 17 TD 2194'
R 29
FAULT
R 22
R 26
R 11 TD 2439'
R 18 TD 2357'
R 15 GAS STORAGE
R 7 WATER - LITTLE OIL TD 2536'
NOTE: WELLS DRILLED PRIOR TO OUTBREAK OF WAR ARE NUMBERED. OTHER WELL LOCATIONS ON MAP HAVE BEEN LOCATED FROM PHOTOGRAPHS TAKEN ON JULY 21 AND AUGUST 15, 1940, APRIL 18, 1941 AND MAY 27, 1942.
KIRCHWARDER I DRY HOLE
HILDEGARDE I ABANDONED GAS WELL
R 143

Oil was discovered at Reitbrook in a well completed during August 1937. The field has proved to be the most outstanding oil discovery in Germany in recent years. Production comes from depths of between 2,200 and 2,500 feet on a dome overlying a salt plug. The dome is sub-oval in shape with the long axis approximately southeast-northwest. Several radial faults have been mapped on the southwest side of the dome, resulting in two faulted segments in that area. The oil producing formation is a sandy, porous, fractured chalk marking the top of the Cretaceous at the unconformity between Cretaceous and Eocene. Gravity of the oil is 23.5° A.P.I. The producing zone varies in porosity and is believed to average around 43 feet in thickness, and to extend over about 1,000 acres. The total chalk section is about 200 feet thick.

A structure map of the Reitbrook field is shown on page 60 and on which are located wells drilled prior to the outbreak of the war and those spotted subsequently by means of aerial photographs. Of the wells drilled prior to 1940 the highest structurally, Reitbrook No. 5, encountered the top of the Cretaceous chalk at 2,162 feet. The lowest well structurally, Reitbrook No. 12, topped the chalk at 2,877 feet. Salt was found beneath the Cretaceous in Reitbrook No. 2 at 3,784 feet. The water table in the producing zone is reported to have been at 2,510 feet, and wells Nos. 5 and 19 indicate a gas cap of about 15 acres.

The yield from the field reached a peak of 357,221 metric tons (2,500,547) barrels) in 1940, but by 1944 this had sunk to 35,997 metric tons (251,979 barrels).

The total recoverable oil reserves from this field are estimated to be approximately 11,000,000 barrels.

Producing Wells, Reitbrook Field

Year	Number of Producing Wells	Average Daily Production per Well	
1938	2 to 16	125 barrels	(18 metric tons)
1939	16 to 30	165 "	(23 1/2 " ")
1940	30 to 78	152 "	(22 " ")
1941(a)	78 to 110	67 "	(9 1/2 " ")
1942(a)	110	37 "	(5 " ")
1943(a)	105	26 "	(3 3/4 " ")
1944(a)	90	20 "	(3 " ")

The present producing reservoir at Reitbrook will probably be depleted by 1948.

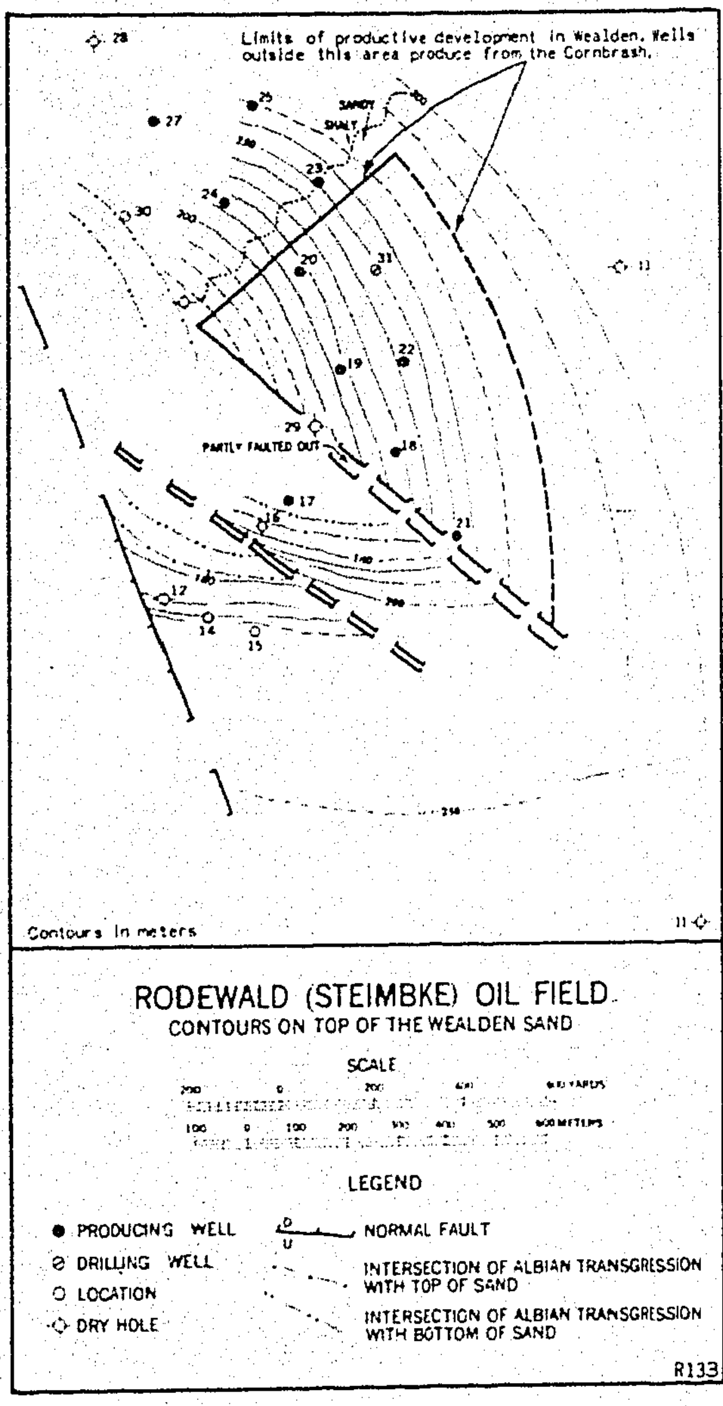
2.5.28 Rodewald (Steimbke) Field

The Rodewald (Steimbke) field is situated about 10 kilometers east and slightly north of Nienburg and approximately 45 kilometers (28 miles), north-northwest of Hannover; it lies south of the Stöcken salt stock.

The field is developed on a northwest-southeast trending anticlinal structure bounded by strike faults of considerable size on both the southwest and northeast flanks, so that the anticline is in effect a horst. The structure is asymmetric with the southwest flank thrown down considerably by faulting and the northwest flank downthrown with much less displacement. A cross-section at right angles to the strike of the structure is shown in the drawing on page 62, and a structural map of the field also appears on page 62.

The cross-section indicates there was already a gentle structure in this area prior to the Portland (Upper part of the Jurassic), as illustrated by the transgression of Portland on Upper Dogger (Middle Jurassic), the uppermost Dogger and the lower Malm being removed on top of the structure. A further important accentuation of the structure due to another movement took place prior to the Albian

(a) Estimated.



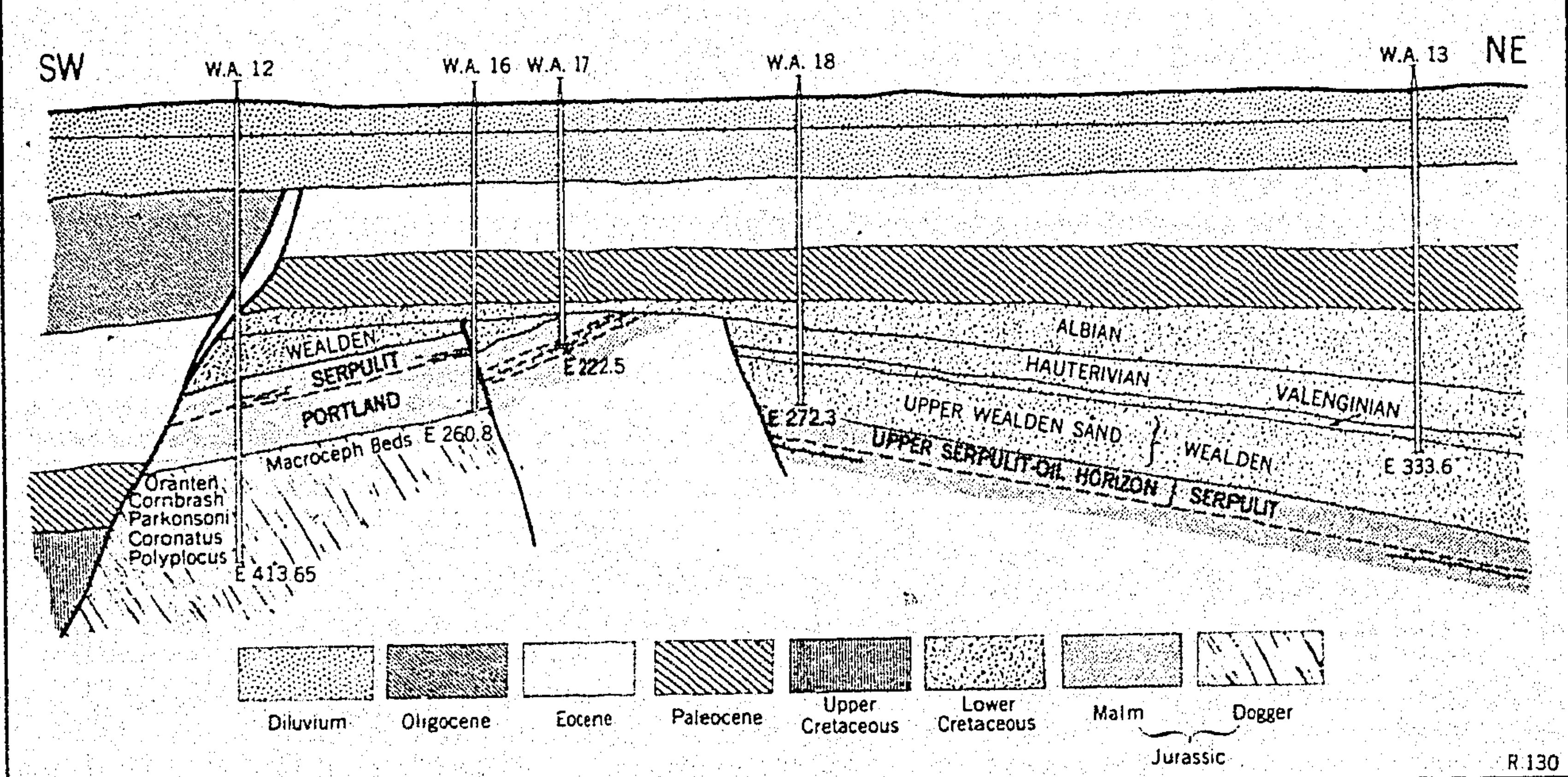
(uppermost Middle Cretaceous) as illustrated by the transgression of the Albian.

In the Rodewald (Steimbke) field production has been obtained from the Wealden (Lower Cretaceous), Serpulite (Upper Jurassic), and Cornbrash (Middle Jurassic) and there are believed to be possibilities from the Rhaet (Uppermost Triassic) which is not known to have been tested.

The discovery well for the field was drilled in 1936 but actual production did not start until May 1937. By August 1939 the proved area of the field amounted to 110 acres and contained twenty-five undrilled locations. Up to January 1st, 1937, fifteen wells had been completed of which fourteen were dry and one producing; three wells were drilled during 1937 of which one was dry and two producing; in 1938 six wells were completed, all of which yielded up to 100 barrels of oil per day initially and, in 1939 five wells were drilled, one of which was dry and four producing with maximum yields of around 310 barrels per day initially. Oil was brought to the surface by artificial lift, either bailing or pumping. The gravity of the Wealden crude was 14° A.P.I. and that of the Jurassic, 16° A.P.I. Production was encountered between 222 and 1,162 meters (730 and 3,813 feet) in depth.

The reported annual production for the field is shown in the table on page 83.

CROSS-SECTION OF THE RODEWALD OIL FIELD



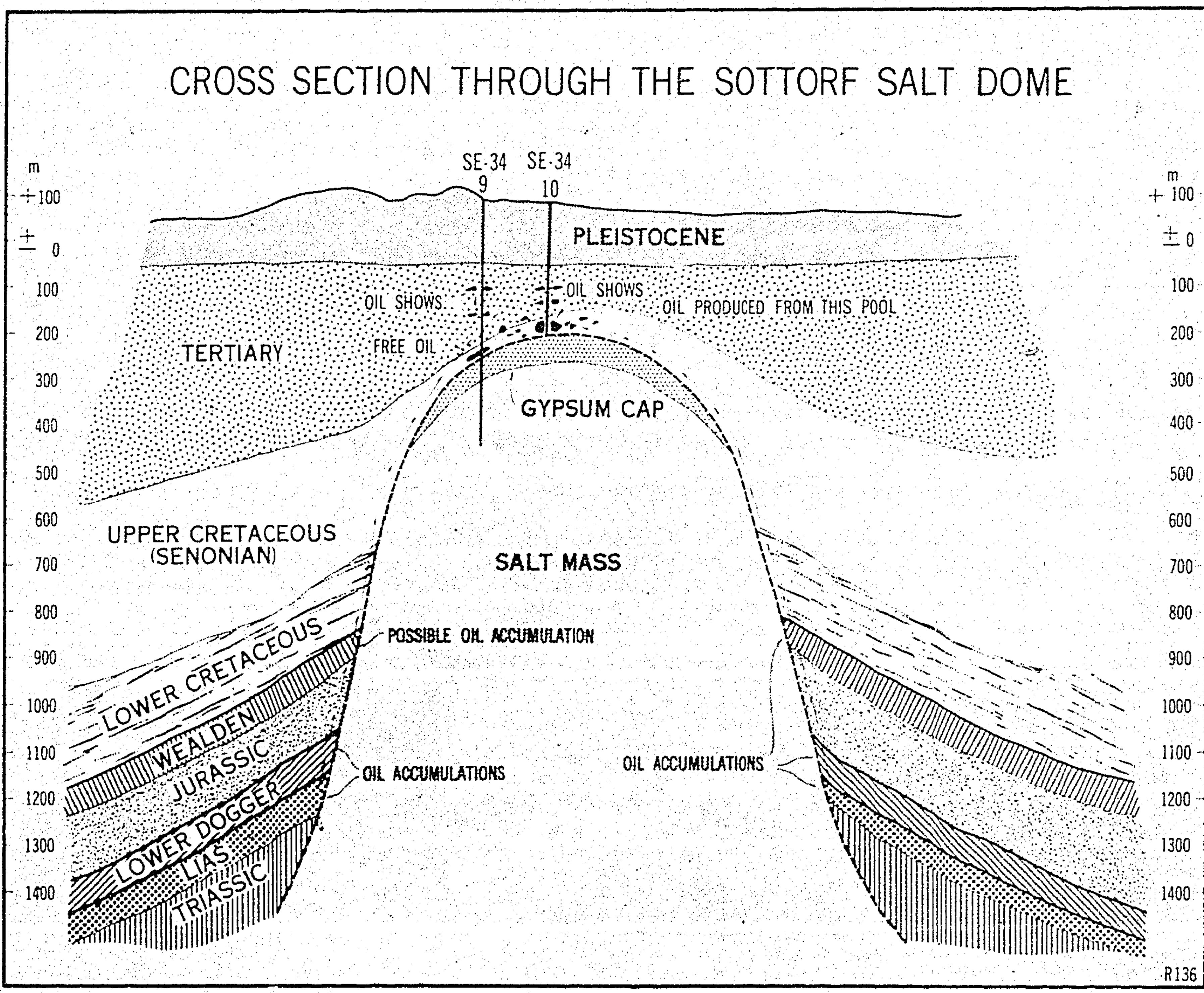
2.5.29 Schöningen Field

The Schöningen field lies some 30 kilometers (19 miles) southeast of Brunswick and approximately 45 kilometers (28 miles) west of Magdeburg. When the field was observed during the course of aerial reconnaissance in August 1942, it contained five small derricks and a single tank; no wells were being drilled. Available records contain no mention of production from this field.

2.5.30 Sottorf Field

The Sottorf field is situated approximately 17 kilometers southwest of Hamburg. The structure is that of a salt dome similar in many respects to Reitbrook. The general geology and structure are shown by the cross-section below.

Development on the Sottorf structure was started in 1920 with the drilling of a well to a depth of 561 meters (1,870 feet) which was abandoned in the salt. A second well reached a depth of 294 meters (980 feet) and encountered showings of oil in the top of the Cretaceous before being abandoned. A hole which was being drilled for water found small production in the upper part of the Cretaceous on top of the dome. In 1937 small quantities of oil were obtained at depths of about 900 feet. During 1938 and 1939 the production came from the cap rock of the salt plug but was insignificant. No oil was obtained in November and December 1938, nor in



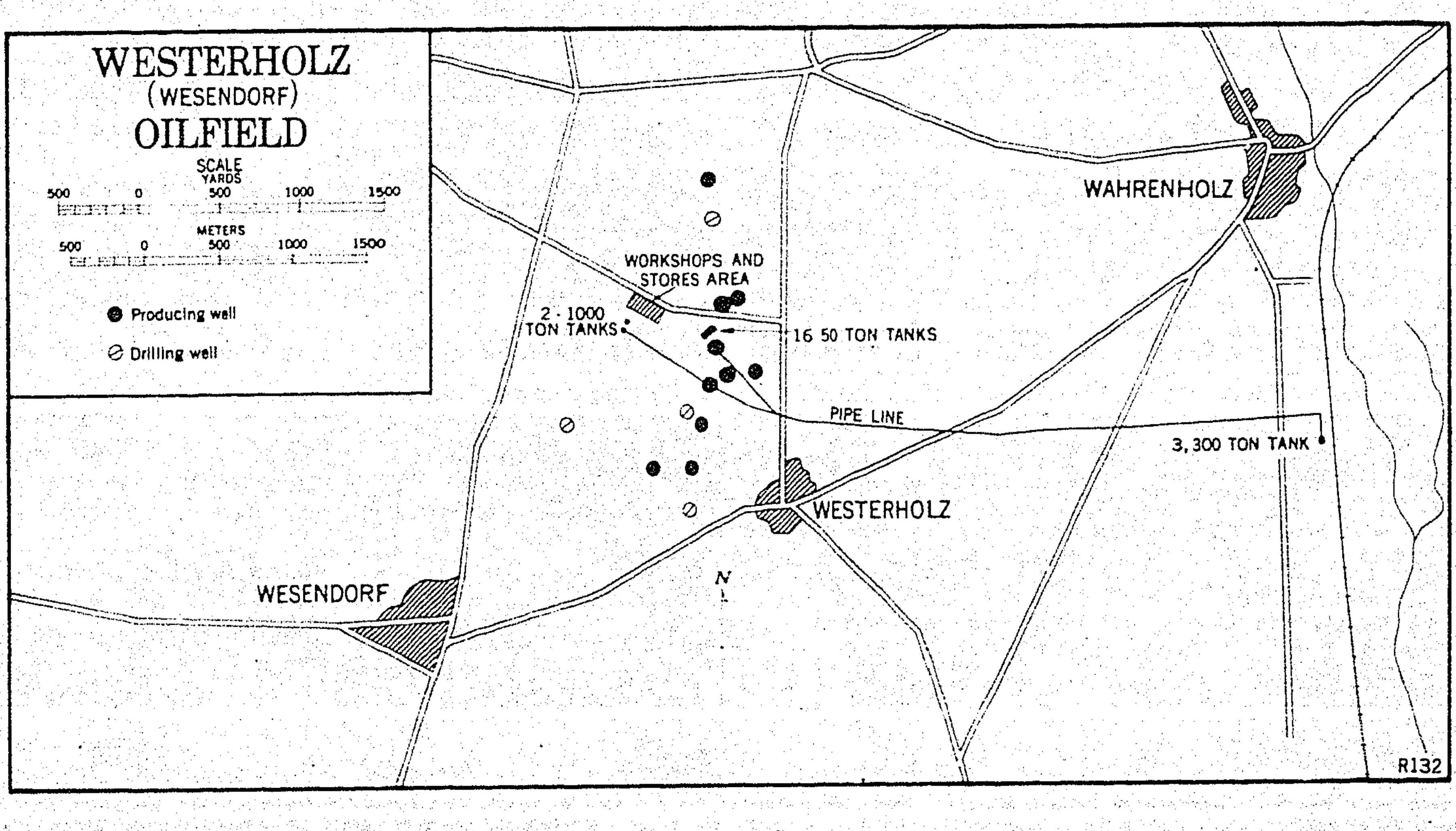
January 1939; only 56 barrels were produced in February and 201 barrels in March. The field yielded 296 barrels of oil in April, 429 barrels in May, 732 barrels in June and 1,459 barrels in July. This rapid rise is attributed to a crevice development and therefore cannot be used as a basis for estimating any considerably subsequent production. This cap rock field may be credited with a production of approximately 1,150 metric tons (8,000 barrels) in 1939, but after 1940 the yearly output declined rapidly. Aerial photographs taken in August 1943 showed all but three wells in the field to have been abandoned. Production from these is negligible and the field is regarded as depleted. See the table of oil field production on page 83.

2.5.31 Westerholz (Wesendorf) Field

The existence of a new oil field north and northwest of the village of Westerholz and about 8 miles north of Gifhorn was observed in aerial photographs taken during August and October 1944. The quality and scale of the photographs were not sufficiently good to permit accurate observation of all details but the following facts were noted.

There were 14 well sites all but one of which were arranged in an area elongated from north to south measuring about 2,000 x 700 yards; the other well (an uncompleted test) was situated about 600 yards farther west. The arrangement of the wells suggests that the pool lies along a fault on the flank of a salt dome.

The deductions from the aerial photographs are indicated by means of the map below. In October 1944 there were 10 producing and 3 drilling wells and one well rigging up or 14 wells in all. Also there were several tanks for oil storage; one battery of sixteen 50-ton tanks situated in the middle of the field and probably used for initial settling; two 1,000-ton tanks in the area of the workshops, probably used as the main storage; and one 3,300-tank located close to the railway line about 2-1/2 miles east of the oil field and about 1 mile south of Wahrenholz. The total tank capacity for the field was, therefore, about 6,000 tons. The important pipe lines are those connecting the two 1,000-ton tanks and sixteen 50-ton tanks with the 3,300-ton tank at the railway line. In addition to the foregoing several other pipe lines were noted interconnecting the wells and the tanks.



The Westerholz (Wesendorf) field appears to be a new development of expanding importance, with production in 1944 amounting to 34,271 metric tons (239,897 barrels).

2.5.32 Wietze Field

This field, sometimes called Wietze-Steinförde, is located about 32 kilometers northeast of Hannover and 17 kilometers from Celle. It has produced oil since 1873 and for many years prior to that time potash was mined in the area. The field is developed along the west end of the irregular Hambühren-Oldau salt stock which is elongated for some 12 kilometers in the Hercynian direction of folding, (northwest-southeast) and is from 1 to 3 kilometers wide. A sketch map and a cross-section of the Wietze field on page 66, show the main stratigraphic and structural features of the area.

The field lies on a long faulted nose of the salt anticline, plunging in a west-northwest direction and overthrust towards the north, with the overthrust mass reposing on the north flank. The cap rock in the Wietze field is about 150 feet deep and ranges in thickness from 80 to 160 feet.

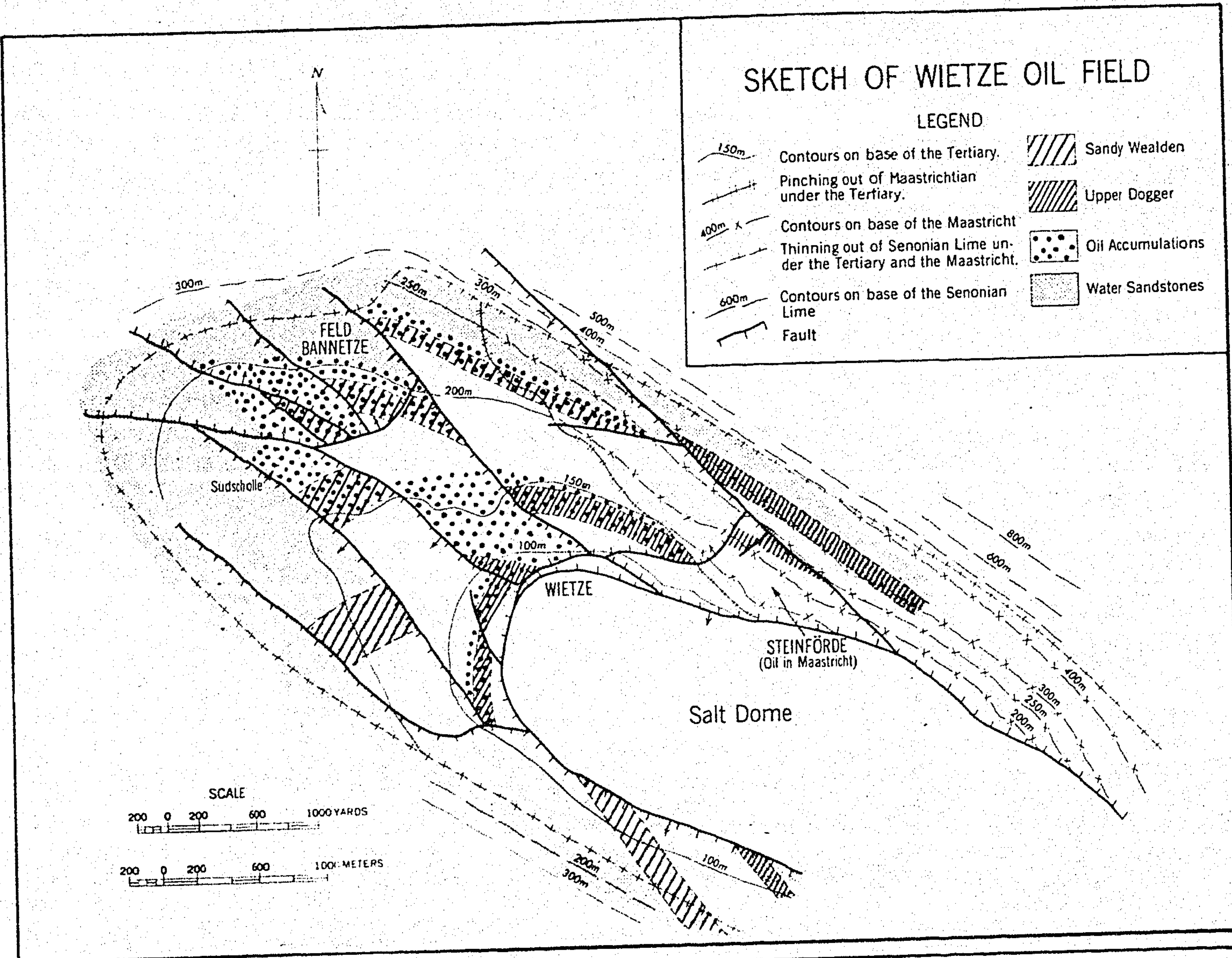
The strata on the south flank dip about 35 degrees towards the south and are of Middle Jurassic to Lower Jurassic age. The beds on the north flank dip steeply (66 to 70 degrees); they range from Keuper (Upper Jurassic) to Lower Cretaceous in age and are bevelled off at the overthrust fault-plane, which dips at an angle of from 20 to 30 degrees and lies between 200 and 400 meters in depth. The thrust-plane also cuts several smaller strike and dip faults. Above the over-thrust fault there are strata from Middle Jurassic to Lower Cretaceous in age. Some distance from the edge of the dome on the north flank, the Senonian (Uppermost Cretaceous) overlaps the lower Cretaceous. All formations on the southern as well as the northern flank, with the exception of the salt, are unconformably covered by the Tertiary over which there is a mantle of glacial "diluvium" forming the surface throughout the area. The Wietze-Steinförde structure must have originated prior to the Senonian (Late Cretaceous) time. Following the Senonian only minor orogenic movements have taken place in the Tertiary and later sediments.

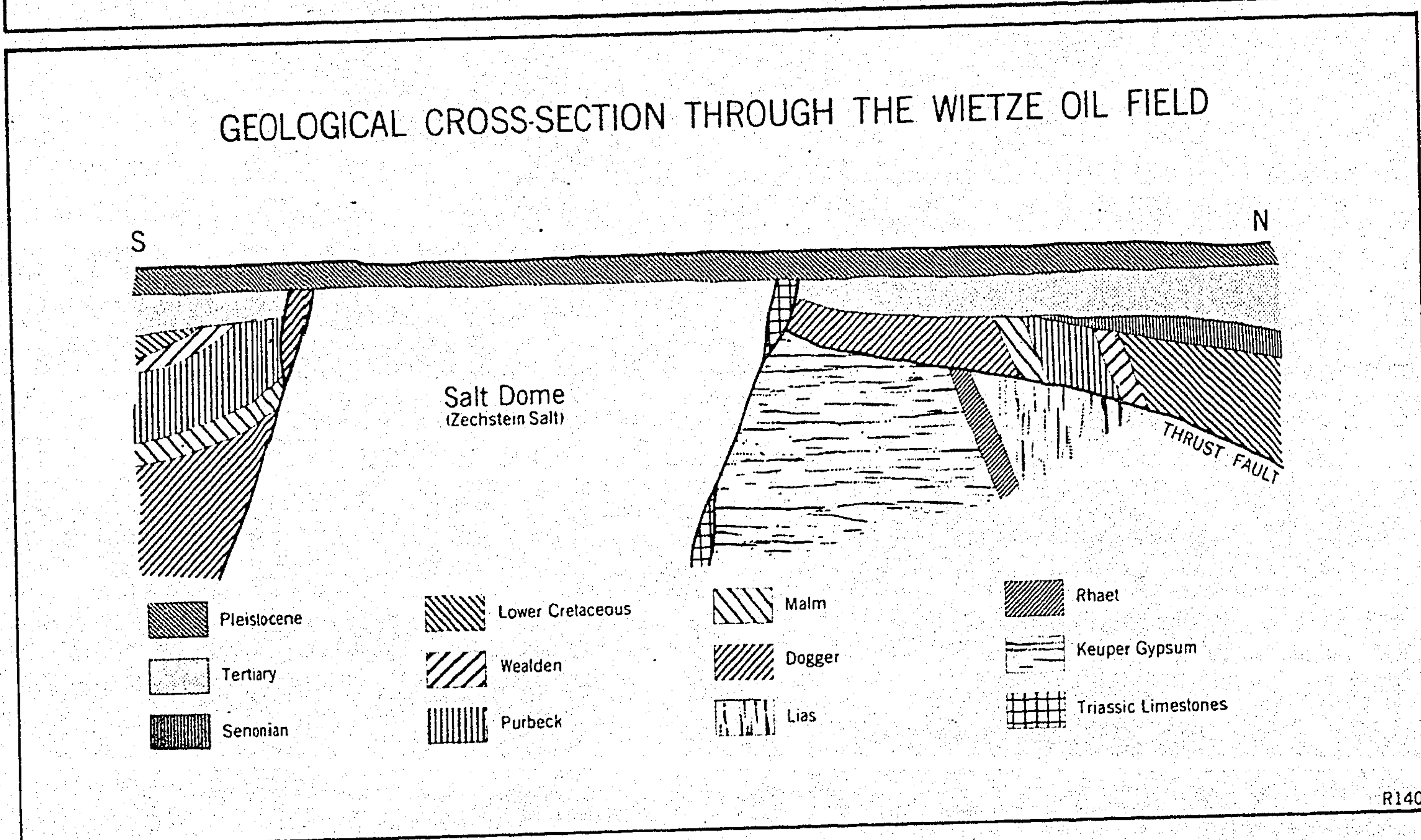
The oil field occupies an area of approximately 5 square kilometers around the north and northwest end of the salt stock and in 1937 contained more than 2,000 wells. The average depth of the wells was approximately 800 feet; the average annual output amounted to about 100 metric tons per well and the wells produce an exceptionally long time. The producing horizons are found in the Upper Triassic, Middle and Upper Jurassic, Lower Cretaceous and traces of oil have been encountered in the Tertiary and Quaternary. The oil horizons consist of coarse porous sands in the following formations.

Oil Producing Horizons in the Wietze Field

Formation	Per Cent of Wietze Production	Specific Gravity of the Crude
1. Wealden (Lower Cretaceous)	39	0.943 - 0.955
2. Callovian or Upper Dogger (Middle Jurassic)	32	0.931 - 0.958
3. Middle Rhaet (Upper Triassic)	17	0.884
4. Senonian (Uppermost Cretaceous)	9	
5. Lusitanian and Purbeck (Upper Jurassic)	3	

1. The Wealden is a brackish water and estuarine deposit at the base of the Cretaceous. The oil zone dips from 40 to 45 degrees and in places 60 degrees. The thickness of the total Wealden ranges from 200 to 260 feet (60 to 80 meters). In it may be recognized four oil horizons forming lenticular cross-bedded sands intercalated with shales. The thickness of the lenses ranges from 3.3 to 40 feet (1 to 12 meters). On the average it amounts to about 20 feet (6 meters). Oil occurs in the sands only and the interbedded shales are free from oil. Below the oil sands there are red marls of Upper Jurassic age. Wells for the exploitation of these Wealden


SKETCH OF WIETZE OIL FIELD
LEGEND
150m
Contours on base of the Tertiary.
Pinching out of Maastrichtian under the Tertiary.
400m
Contours on base of the Maastricht
Thinning out of Senonian Lime under the Tertiary and the Maastricht.
600m
Contours on base of the Senonian Lime
Fault
Sandy Wealden
Upper Dogger
Oil Accumulations
Water Sandstones
N
FELD BANNETZE
Sudscholle
WIETZE
STEINFÖRDE
(Oil in Maastricht)
Salt Dome
SCALE
200 0 200 600 1000 YARDS
200 0 200 600 1000 METERS


GEOLOGICAL CROSS-SECTION THROUGH THE WIETZE OIL FIELD
S
N
Salt Dome
(Zechstein Salt)
THRUST FAULT
Pleistocene
Tertiary
Senonian
Lower Cretaceous
Wealden
Purbeck
Malm
Dogger
Lias
Rhaet
Keuper Gypsum
Triassic Limestones
R140

horizons attain a depth ranging from 660 to 990 feet (200 to 300 meters). It is this horizon which is exploited by well known mining operations with two shafts and galleries; the oil sand is brought to the surface where it is washed free of oil and then put back into the mine as fill.

2. In the Middle Jurassic oil is found in the Upper and Lower Dogger which, however, were not yielding important production immediately prior to the war.

3. The oldest oil horizon belongs to the Middle Rhaet of the Upper Triassic. It is, also, the deepest horizon of the entire field, with the depths of wells ranging between 1,089 and 1,155 feet (330 to 350 meters) and possibly deeper. The oil is of light grade, although all other oil horizons of Wietze contain heavy oil. The reservoir rocks consist of two sandstone horizons 63 and 8 feet (19 and 2.5 meters) in thickness, separated by a bed of clay 33 feet (10 meters) thick.

4. The Senonian oil horizon in the Upper Cretaceous had proven of little importance, which is true also of the oil occurrences in the Tertiary and later sediments.

5. The Lusitanian and Purbeck beds of the Upper Jurassic contain oil sands which, however, are of but small importance.

Before 1900, the field's production was small but with the opening up of a new new horizon at 600 to 1,000 feet in depth, increased yields were obtained which gradually climbed to 773,752 barrels in 1908. Subsequently, the annual output declined and in 1920 amounted to 214,963 barrels. Since 1917, approximately half the oil was produced by underground mining operations from the Wealden in the overthrust mass, which yielded a gradually increasing production up to 1930, after which the annual output again declined. In 1938 the field was in the stripper stage of development although routine drilling of inside locations and special leads probably were still being followed. However, the results thus obtained had no material effect on the field's output immediately prior to the war other than lessen its decline. With approximately half the production coming from the oil mine, the output from this operation could be gradually increased during the war so that the field's total production would remain stationary over a period of years. For instance, during World War I, the Germans could have increased considerably their mined oil production had they operated under less stringent safety regulations and, had the war continued, probably more oil would have been mined by using prisoners of war, concerning whose fate less consideration would have been taken. It appears likely that during World War II that this means of increasing production has been utilized. The tables on pages 82 and 83, shows the annual output from 1873 to 1944, inclusive.

2.5.33 Other Fields

Production records seized in Germany at the time of that country's military collapse in 1945 indicate that several small oil fields developed during the war had not been detected by aerial reconnaissance. These are at Ehra, Hohenassel, Thören and Wienhausen, all in the Hannover district. The production records of these fields are shown in the table on page 83, and their locations indicated in the map on page 32. The Hambühren field, listed separately in the production record, is an extension of the Fuhrberg field and is shown on the map on page 47.

2.6 THURINGIAN BASIN OIL FIELDS

2.6.1 General

The Thuringian Basin, between the Harz Mountains and Thüringerwald-massif, is indicated in the lower part of illustration on page 36 which contains a small section across the basin. The latter represents in a very general way the main structural and stratigraphic conditions found there.

Oil was accidentally discovered in the Thuringian Basin during the course of mining operations at Volkenroda. For many years slight oil and gas shows in potash core holes had been disregarded, but on July 2, 1930 a small diameter core hole blew out in the Menteroda mine, from a depth of 180 feet below the 3,000 foot level and the oil caught fire. After the blaze had been extinguished it was found that this level of the mine was flooded with oil. Commercial production was developed soon thereafter. Peak production was reached the following year and the field is now depleted in the known oil horizons.

2.6.2 Geology

Stratigraphy.- The Thuringian Basin represents an embayment of the North German Basin, projecting into central Germany. The rocks exposed on the surface are for the most part Triassic in age (Keuper, Muschelkalk and Bunter formations). There is a relatively small area of Upper Permian along the north edge of the basin and small patches of Tertiary and later deposits in various localities throughout the basin.

The stratigraphic charts on page 35, show the divisions of the Triassic and Permian. In the Thuringian Basin the oil producing horizons occur in the middle and lower Zechstein formation of Permian age; also, oil and gas have been encountered in fissures and fractures. The chief characteristics of the Zechstein formation are summarized below.

Permian Zechstein (660 - 4,300 ft.)

- Upper
  - **Anhydrite and younger rock salt**
  - **Hauptanhydrit**
  - **Gray salt-clay**
  - **Older potash beds**
  - **Older rock salt**
  - **Basal anhydrite**
- Middle
  - **Stinkschiefer (Hauptdolomit) --Volkenroda main pay**
  - **Anhydrite and rock salt**
- Lower
  - **Limestones**
  - **Kupferschiefer**
  - **Conglomerate**

The Stinkschiefer (bituminous dolomitic shale) is considered by most German geologists to be the source beds of the oil. However, the thickness of Permian Underlying the Zechstein section described above, is not known for the center of the basin and may possibly contain source material. An interesting feature is a belt of maximum anhydrite deposition which is reported to extend southwestward from the Harz massive in the northern part of the basin, with the Volkenroda oil field lying just inside this thick flank deposit. Up to the outbreak of the war no oil had been encountered on other structures in the basin, although a number of wells had been drilled on them.

Structure.- The synclinal area of the Thuringian Basin has not been compressed into strong anticlinal structues nor has it has an overload sufficient to squeeze salt up into plugs and domes. The Triassic and Permian formations along the northeast edge of the basin dip gently towards the southwest. In the center of the basin there is a graben zone, containing gentle anticlines and synclines, all of which strike southeast-northwest in alignment with the Harz Mountains and the Thuringer Wald. The Volkenroda oil field lies on one of these gentle "highs" near the center of the vast synclinorium. There are other somewhat similar anticlines or elongated domes in the basin which may prove productive. All of these structures are described in detail in the discussions of the oil prospects of Germany.

2.6.3 Volkenroda Field

The Volkenroda field, in central Thuringia some 30 miles NNW of Erfurt, is believed to be located in a belt of maximum anhydrite deposition of the Zechstein (Upper Permian). Muschelkalk dolomite of the Triassic is found on the surface. The structure, a gentle anticline trending northwest-southeast, is apparently closed and is one of two such anticlines in the vicinity. A fault zone of several hundred feet displacement--the Schlotheim fault--having a northwest-southeast strike lies within a short distance of Volkenroda.

Oil is found in the Middle Zechstein, in fractured, somewhat cavernous and porous dolomite just below the salt formation of the Upper Zechstein, and also in the Lower Zechstein dolomite. The saturated reservoir rocks, while only slightly folded, vary from 110 to 210 in thickness. The oil and gas are encountered mainly in fissures and fractures.

Divisions of the Zechstein (Upper Permain) at Volkenroda

Upper Zechstein		Potash-Salt
Middle Zechstein	(Oil Production)	(Stinkschiefer) Dolomite and anhydrite with bituminous shale which is 20 to 35 feet thick.
Lower Zechstein	(Oil Production)	(Kupferschiefer) Dolomite and limestone with bituminous shales.
Lower Permian		(Dyassic)

The potash-salt Zechstein formation was mined for many years at Volkenroda prior to the discovery of oil and the slight oil and gas shows in core holes in the mine were disregarded until 1930, when one of these blew out and caught fire from a depth of 180 feet below the bottom of the 3,000-foot level in the Menteroda part of the mine. After the fire had been extinguished, many small-diameter holes (1-1/2 inches to 3-1/2 inches) were drilled from the bottom levels of the mine and yielded oil at depths between 160 and 260 feet from the Middle and Lower Zechstein. Many of these holes were 45 degrees from the vertical and directed at right angles to the strike of the fractures in order to cut and produce from several fractures.

Production commenced in 1930. By August 1931 there were 50 flowing wells; at the end of 1931 more than 100 wells had been completed and the area proved by them measures some 5,500 meters long and 1,600 meters wide. The gas-oil ratio was 1:1,500. Gas pressures varied between 1,120 p.s.i. on the anticlinal axis to 420 p.s.i. on the flanks. There probably was a gas cap, as gas was generally encountered first and oil at greater depth. The oil was drained down the lowermost tunnels, collected in pits from which it was pumped to gathering tanks at the bottom of the main shaft, brought to the surface, and loaded into railroad tank cars.

The crude is light, 0.836 specific gravity (37.8^{o} A.P.I.), and has a paraffin content of 1.94 per cent. It contains about 25 per cent gasoline. Part of the gas was reported to have a high nitrogen content.

The annual yields for the field are shown in table on pages 82 and 83. According to the last available information on the Volkenroda field, no oil was produced between November 1938 and March 1939. It is, therefore, concluded that the known reservoir was depleted at that time.

2.7 RHINE VALLEY GRABEN OIL FIELDS

2.7.1 General

The position and approximate area of the Rhine Valley Graben is shown on the map on page 26. This basin comprises about 5,020 square miles (13,000 square kilometers) and extends on both sides of the Rhine from the town of Basel in the south to Mainz and Frankfurt in the north. It is crossed by the German-French frontier. The Alsation oil occurrences at Pechelbronn are in French territory and it is here that until recent years, almost the entire French production of crude oil was obtained. In German territory oil was discovered in the state of Baden, near the village of Forst, in 1935, and the annual yield that year amounted to 1,553 metric tons (10,871 barrels). Later, small production was obtained at Grotzingen and Bruchsal in the same vicinity and aerial reconnaissance during the past year revealed the existence of a new field at Weiher, a short distance to the north of Forst. Negligible quantities of oil have also been produced in the state of Hessen. The annual output of crude from the Rhine Valley Graben in Germany is stated in the table on pages 82 and 83.

2.7.2 Geology

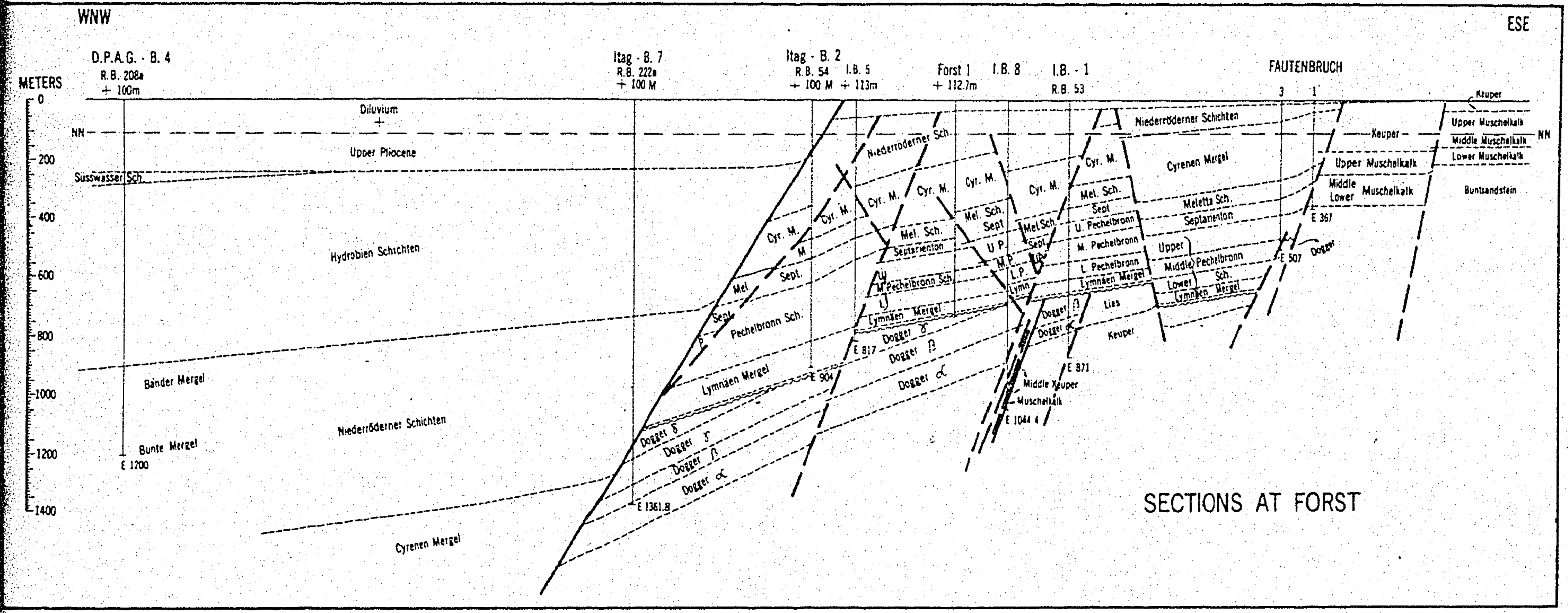
Stratigraphy.- The geologic history of the Rhine Valley Graben may be briefly summarized as follows.

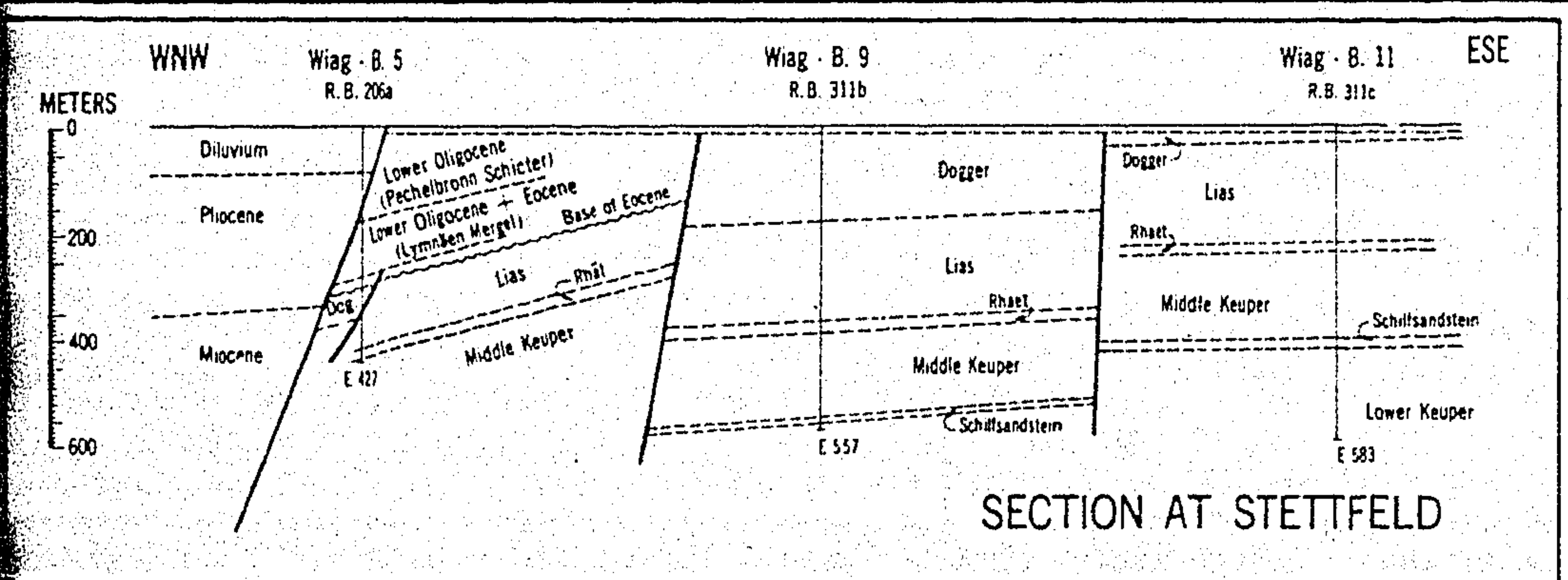
Triassic and Jurassic formations were unconformably deposited on strongly folded Paleozoic. At the beginning of the Tertiary these Mesozoic sediments began to subside by graben faulting. This subsidence during the Oligocene was of considerable magnitude, so much so that it permitted the sea to advance into this area in a tongue-like narrow belt. Apparently the sea invaded the area from both the north and south, and there may have been a connection with the Paris Tertiary basin.

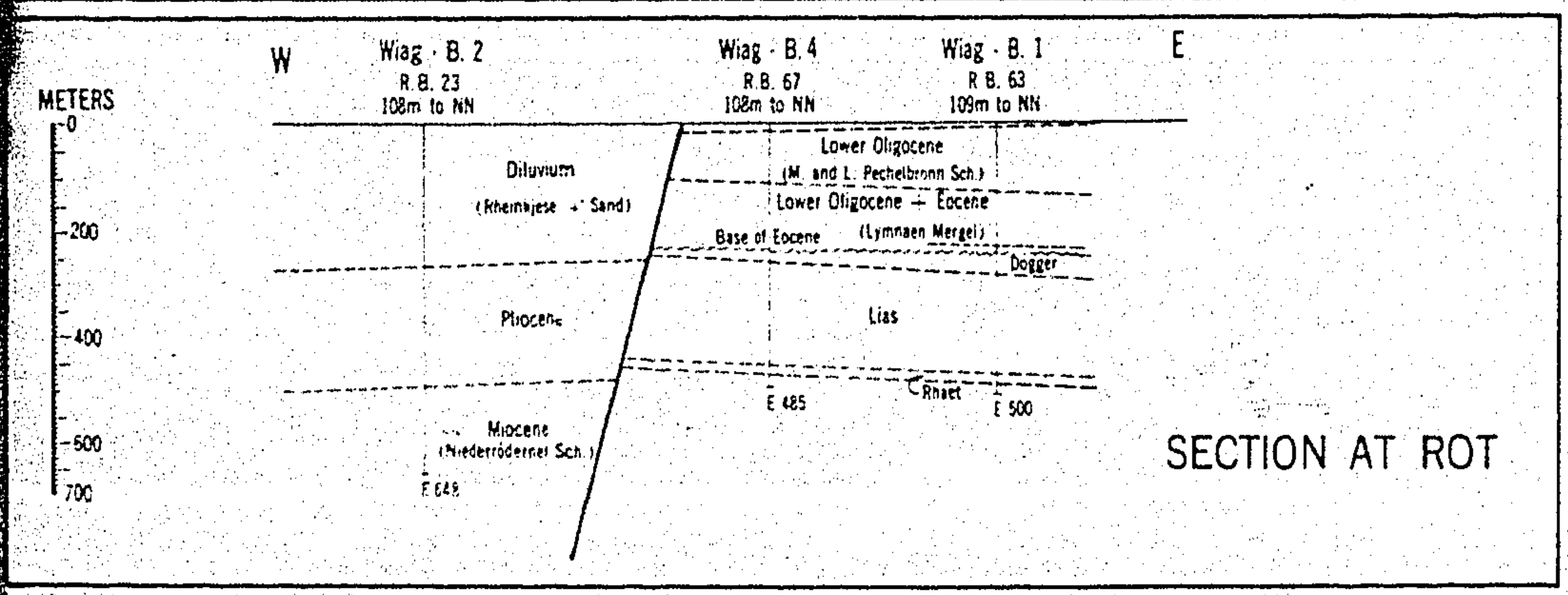
More than 4,000 feet of Oligocene sediments were deposited in the Rhine Valley Graben conformably upon a thin (33 to 66 feet) Eocene section. The Oligocene facies vary from fresh water to continental to brackish-water sediments. During the Miocene, the Paleozoic masses of the Vosges and Black Forest were uplifted and the sea between them was detached, dried up, and continental and fresh water sediments were laid down. Faulting continued throughout the Tertiary with the result that from 4,500 to more than 6,000 feet of Tertiary sediments accumulated in the graben.

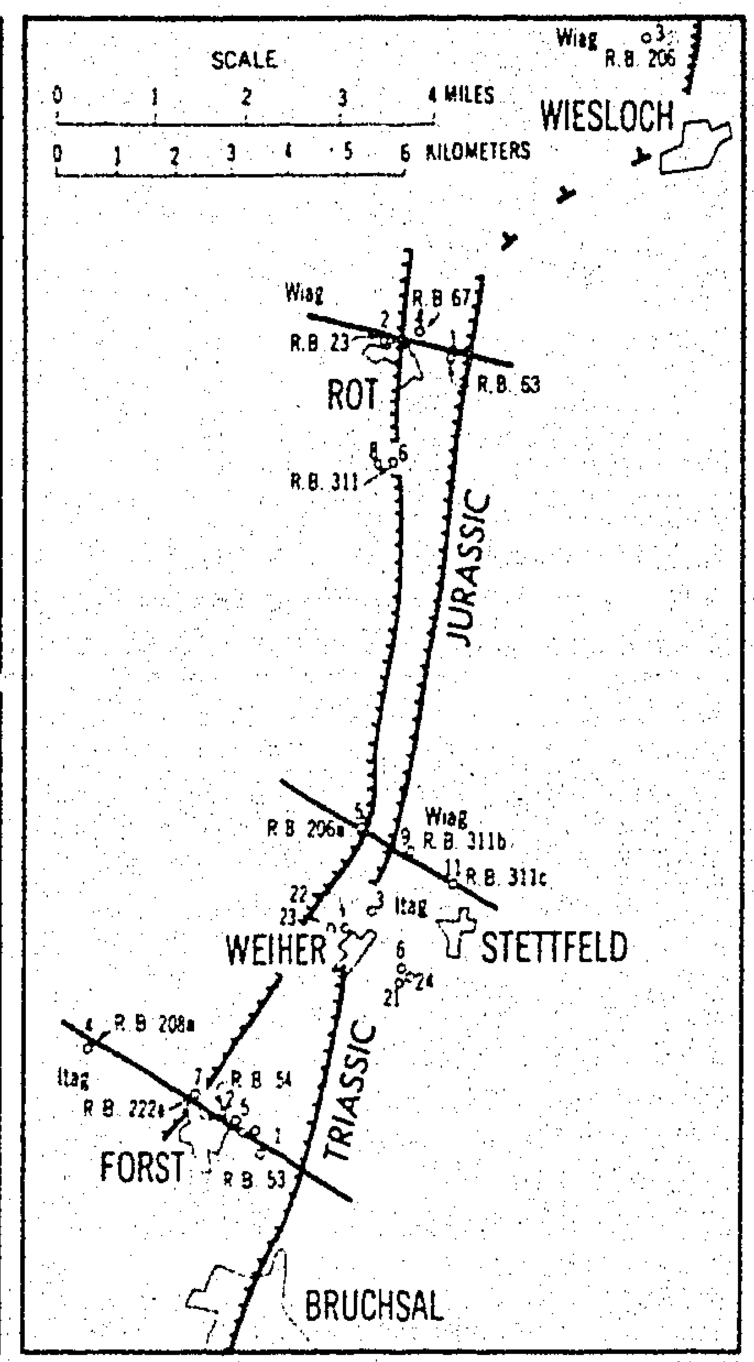
Quaternary and late Tertiary deposits cover practically the entire surface of the Rhine Valley Graben. The principal oil horizons are found in the Oligocene which is composed of marls, limestones and shales interstratified with numerous sand lenses. Oil accumulation is controlled partly by the lenticularity of the oil sands and partly by faulting. These lenticular sands average but a few feet in thickness but some are known to exceed 1,000 feet in length, 500 feet in breadth and 30 feet in thickness. The Oligocene section at Pechelbronn is given in the table on page 72.

The above mentioned table showing the Oligocene section at Pechelbronn is representative in a general way of the section at Baden in Germany, except that in the latter area the Oligocene is not as well developed and some of the sands which are productive at Pechelbronn are missing. At Baden the two principal oil sands are of lower and middle Oligocene age respectively and are less productive than the Pechelbronn sands. There are numerous lower oil horizons down to the Jurassic, both in Pechelbronn and Baden and it is interesting to note the German geologists consider that oil has migrated upward along fault planes from the Zechstein dolomite (Upper Permian) whereas French geologists advance the theory that the oil originates in the Oligocene and migrates downward along fault planes into the older beds.









SECTIONS THROUGH

RHEIN VALLEY

GRABEN

OIL FIELDS

BADEN,

GERMANY

R120

Oligocene Section at Pechelbronn, France

Upper Oligocene	Stampian	Meletta shales	1,312 ft. thick
		Fish Scale Beds	20 ft. thick
		Foraminiferal Marls	98 ft. thick
	[illegible]n	Upper Pechelbronn Beds: Northern facies; fresh water conglomerates and sandstones; 918 ft. thick. Southern facies; marine, 754 ft. thick.	
		Fossiliferous Zone: 230 ft. thick.	
		Lower Pechelbronn Beds: 328 to 426 ft. thick.	
	Red Clay Beds	164 to 394 ft. thick.	
Lower Oligocene	Dolomite Beds	771 to 886 ft. thick.	

----Unconformity----

Jurassic and Triassic ——————

Structure.- In the Rhine Valley Graben a mantle of Quarternary deposits covers the thick Tertiary series which is divided into partially eroded fault blocks arranged more or less in steps trending in a northeast-southwest direction parallel to the major faults which lie along the east and west borders of the graben. These blocks are narrower east of the Rhine, in Germany, than west of it, in France. There are also numerous cross faults striking at various angles to the major trend. Oil is trapped adjacent to faults in the gently dipping beds but the extent of the producing horizons depends not only on these structural conditions but also is determined by the lenticularity of the sands, as previously indicated.

Some of the major faults are recognizable on the surface but many are covered by the mantle of Quaternary sediments and, therefore, the structure within the graben has been mapped largely by means of information secured during the course of drilling and mining operations and through geophysical exploration.

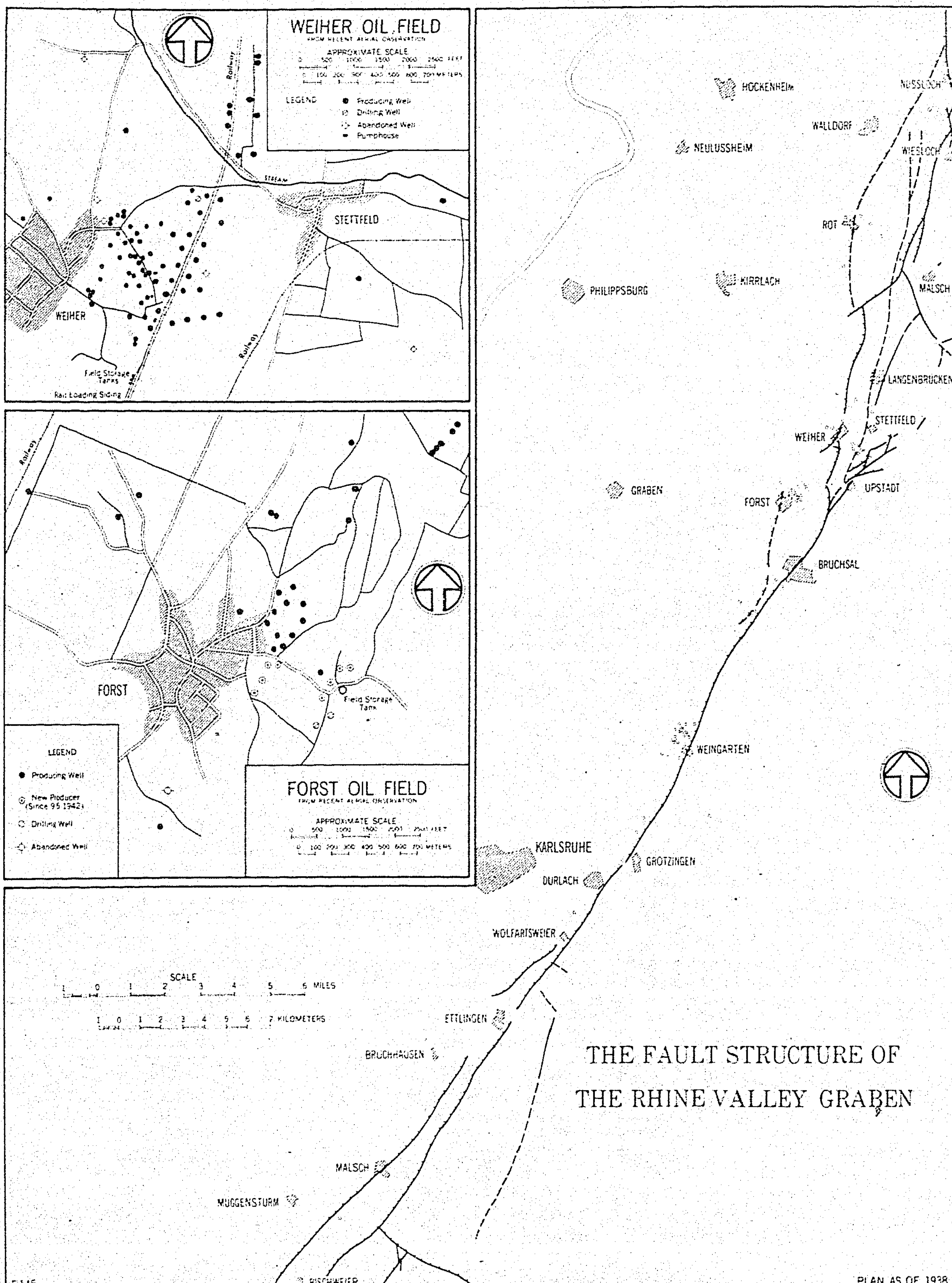
Locations of the individual fields with respect to the fault system and the general structural conditions are shown by the map and cross-sections on page 71.

2.7.3 Bruchsal-Forst Field

The Bruchsal field is situated north and west of the town of Karlsruhe, close to the main graben faulting and just within the area of the graben (see page 73). The field lies on a block faulted monoclinal structure, the details of which are shown in the drawing on page 71.

In 1921 a number of shallow wells were drilled near the town of Bruchsal, resulting in small production from Tertiary sands. By the end of 1933, the field contained 9 wells, five of which were yielding small quantities of oil and four were dry holes; in 1935 only two of the five were productive, the oil coming from Lower Oligocene sands.

Under the stimulus of subsidies offered by the German government, drilling activity increased, resulting not only in finding oil in lower and middle Oligocene horizons in a northward extension of the Bruchsal field near Forst, but also in production from sandstones in the Jurassic and Triassic (Keuper). During 1935 two wells were completed yielding 100 barrels per day each from the Jurassic. One of these (R.B. No. 53), drilled to 2,860 feet, encountered this production in a fine-grained sand at 2,760 feet and also penetrated two Oligocene oil horizons--in the Upper Melletta at 985 feet (500 liters of oil per day) and in the green Lymnaea marl of the basal dolomitic zone. The well was bottomed in Posidonia shale in which oil shows were found.


WEIHER OIL FIELD
FROM RECENT AERIAL OBSERVATION
APPROXIMATE SCALE
LEGEND
Producing Well
Drilling Well
Abandoned Well
Pumphouse
Railway
STREAM
STETTFELD
WEIHER
Field Storage Tanks
Rail Loading Siding
FORST
Field Storage Tank
LEGEND
Producing Well
New Producer (Since 9-5-1942)
Drilling Well
Abandoned Well
FORST OIL FIELD
FROM RECENT AERIAL OBSERVATION
APPROXIMATE SCALE
HOCKENHEIM
NUSSLOCH
WALLDORF
NEULUSSHEIM
WIESLOCH
ROT
PHILIPPSBURG
KIRRLACH
MALSCH
LANGENBRUCKEN
STETTFELD
WEIHER
GRABEN
FORST
UPSTADT
BRUCHSAL
WEINGARTEN
KARLSRUHE
GROTZINGEN
DURLACH
WOLFARTSWEIER
SCALE
0 1 2 3 4 5 6 MILES
0 1 2 3 4 5 6 7 KILOMETERS
ETTLINGEN
BRUCHHAUSEN
THE FAULT STRUCTURE OF
THE RHINE VALLEY GRABEN
MALSCH
MUGGENSTURM
BISCHWEIER
R145
PLAN AS OF 1938

The Bruchsal-Forst field at the beginning of 1937 contained six producing wells, averaging 35 barrels daily per well and during the year commercial production was obtained in shallow sands at about 600 feet in a southern extension of the original Bruchsal field, as well as in the Forst area. Other discoveries were reported to have extended the area in 1939. Aerial photographs, taken in May 1942, covered only a portion of the field and were of limited value.

On September 29, 1944 the field was photographed from the air and was shown to contain 35 wells. The long axis of the producing area appeared to be northeast-southwest. Of these completed wells 16 had derricks removed and pumps installed; they were located for the most part at the southeastern limits of the field and it is possible were producing only from shallow Oligocene sands. The remaining 19 wells still had small derricks in place. Of these wells eleven were old producers; the remaining eight wells were all located along the southeast edge of the field and were completed since the air coverage of May 1942. It could not be determined, due to the small scale of the photographs, if these wells were flowing or pumping. It is possible that the wells with derricks in position obtained production from a deep horizon. It appeared probable that the field was producing from two horizons (possibly Jurassic and Oligocene). In addition to the wells described, the photographs showed two drilling wells in the southeast extension of the field. East of Forst a small field storage tank, 35 feet in diameter, was observed in the photographs. The capacity was approximately 800 tons (5,600 barrels) and as there is no German refinery in the immediate area this indicates that production is on a very small scale. The development of the field at the end of September 1944, as observed from the aerial photographs, is indicated by means of the map on page 73.

Production figures are included with those of other Rhine Valley fields in the table on page 83.

2.7.4 Weiher Field

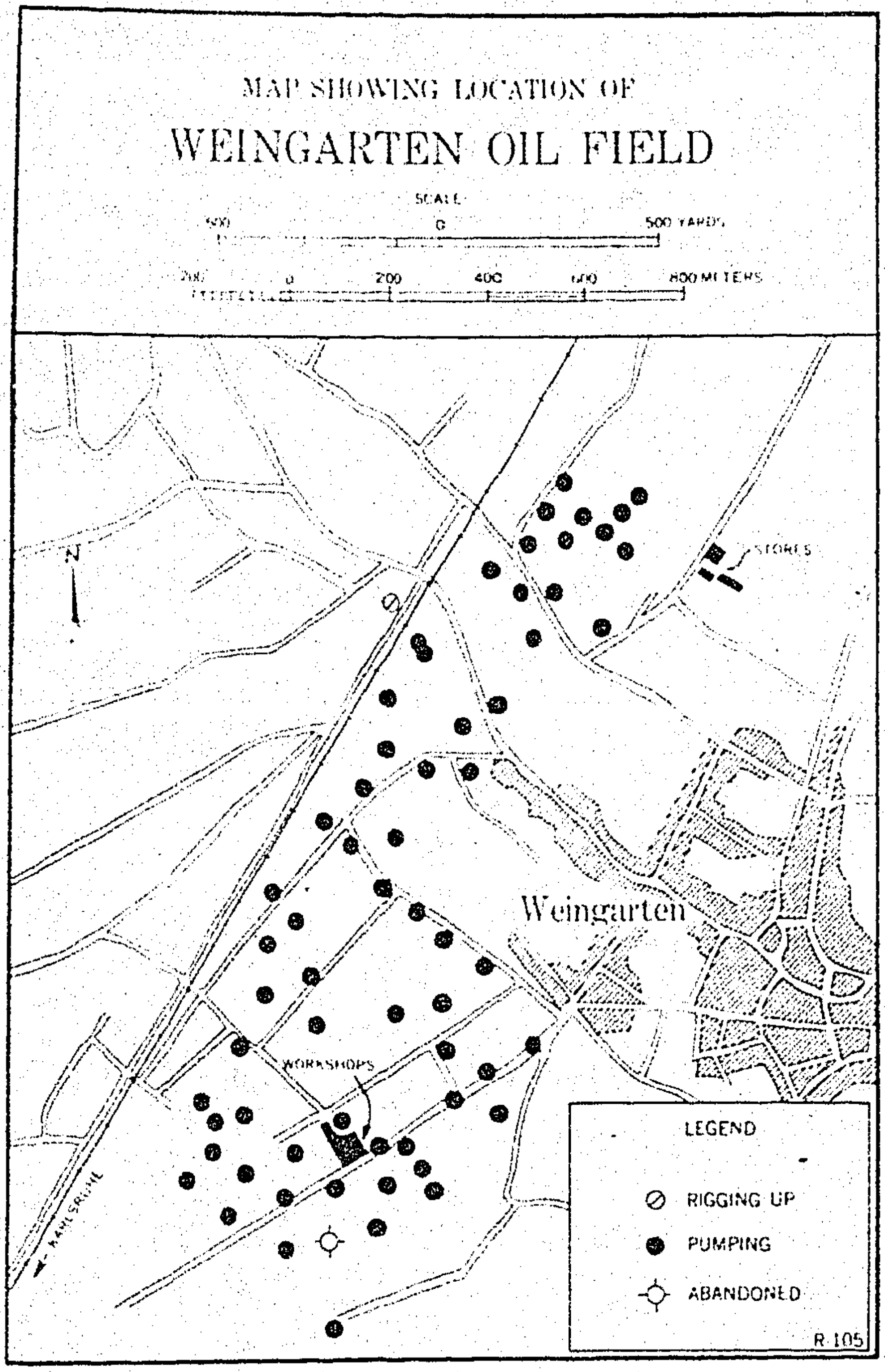
Aerial photographs taken during September 1944, showed the existence of a new oil field at Weiher, northeast of Forst as shown on the map on page 73.

The Weiher oil field appeared to extend northeast-southwest and contained 77 wells. Of these 35 had the derrick removed and pump installed. In general these wells are situated along the northern limits of the field. The remaining 42 wells still had small derricks in position. Some of these were being pumped, as three small pumphouses were observed in the southern part of the field. It could not be determined, due to the small scale of the photographs, whether the remaining wells were flowing or pumping. The presence of such a large number of pumping wells suggests that all production is by means of some mechanical lift. In addition to the above mentioned wells, one drilling well was observed in the angle formed by the Weiher-Stettfeld road and the railway. The eastern and western limits of production seem to have been determined, as indicated by the presence of four abandoned sites along the edges of the field. Alongside some of the wells there were small water separation units. A railway siding on the Bruchsal-Heidelberg railroad serves the field and on this siding were three small field storage tanks about 20 feet square, probably for gravity feed to the tank cars. The development noted in the Weiher field during September 1944 is shown on the map on page 73.

The Weiher field probably afforded most of the Rhine Valley production recorded in the table on page 83.

2.7.5 Weingarten Field

This small oil field extends north and south through the village of Weingarten, some 2½ miles northeast of Karlsruhe. Development began in early 1939 and the field has expanded slowly during the war years.



From air cover of late February 1945, the Weingarten oil field is known to have contained 65 wells, of which 63 wells appeared to be pumping. These were all equipped with 75 foot derricks or 50 foot tripods. One location in the southernmost part of the field appeared to be stripped and abandoned. One location was being rigged up for drilling at the only site west of the railway line, just southwest of the station. The average well spacing in the field is about 300 feet, and at the date of the above cover the proved area still contained several undrilled locations.

Field installations, other than derricks or tripods, appear to consist of a group of small work shops at the southern end of the area and three medium size storage sheds just east of the northern part of the field. No large capacity oil storage tanks are detected in the photographs.

By rough analogy with other fields in the Baden, it is assumed that production in the Weingarten field will average one-half metric ton per well per day, that is, a total of 30 metric tons per day or 11,000 metric tons per year.

Production figures are included with those of other Rhine Valley fields in the table on page 83.

2.8 BAVARIAN (MUNICH) BASIN OIL FIELDS

2.8.1 General

The Bavarian Basin, sometimes called the Munich Tertiary Basin of southern Bavaria, is an enlargement of part of the belt of Tertiary sediments which lie in front of the northern edge of the Alpine Mountain system and which extends from western Switzerland through northern Switzerland, southern Württemberg, southern Bavaria, into Austria to connect with the Vienna Tertiary Basin. Oil has been produced in the Bavarian Basin at Tegernsee, in very small amounts. Annual production figures for this area are included in the table on pages 82 and 83. Gas is known to occur in small quantities along the Inn River southwest of Passau.

2.8.2 Geology

The drawing on page 77 shows the basic geological features of the Bavarian Basin. On the northwest the basin is bounded by Jurassic and older rocks and on the northeast by granites, gneisses and schists. To the south are Triassic and Jurassic limestones, as well as crystalline rocks of the Alps. The basin originated near the end of the Cretaceous and developed throughout the Alpine mountain making movements. The Flysch formation was deposited in the basin from late Cretaceous throughout the Eocene and Oligocene and was folded and faulted by the movements occurring during its deposition. The culmination of the Alpine movements was a northward overthrust from the Alpine area which overrode the southern part of the basin. The Schlier formation was deposited over folded and faulted Flysch during Lower Miocene time and was also involved in the last of the mountain-making movements, particularly along the northern edge of the overthrust where it is extremely folded and faulted and in places the Flysch is thrust over the Schlier. Farther north in the basin the Schlier is only gently folded. To the north of the overthrust there appears to be no evidence of folding parallel to the Mesozoic Alps. However, torsion balance and magnetometer surveys made in 1932 showed that there are uplifts in this area which are believed to be favorable prospects for oil. The magnetic axes are indicated in the drawing on page 77, and while some of these may be due to anomalies not caused by uplift, such axes as those of Dannau and Alb must reflect geologic structure in the subsurface. Near the northern edge of the basin, faults and buried ridges are found. During the course of the torsion balance survey the following approximate thicknesses of unconsolidated sediments of the basin were indicated in these localities.

Approximate Thickness of Unconsolidated Sediments, Bavarian Basin

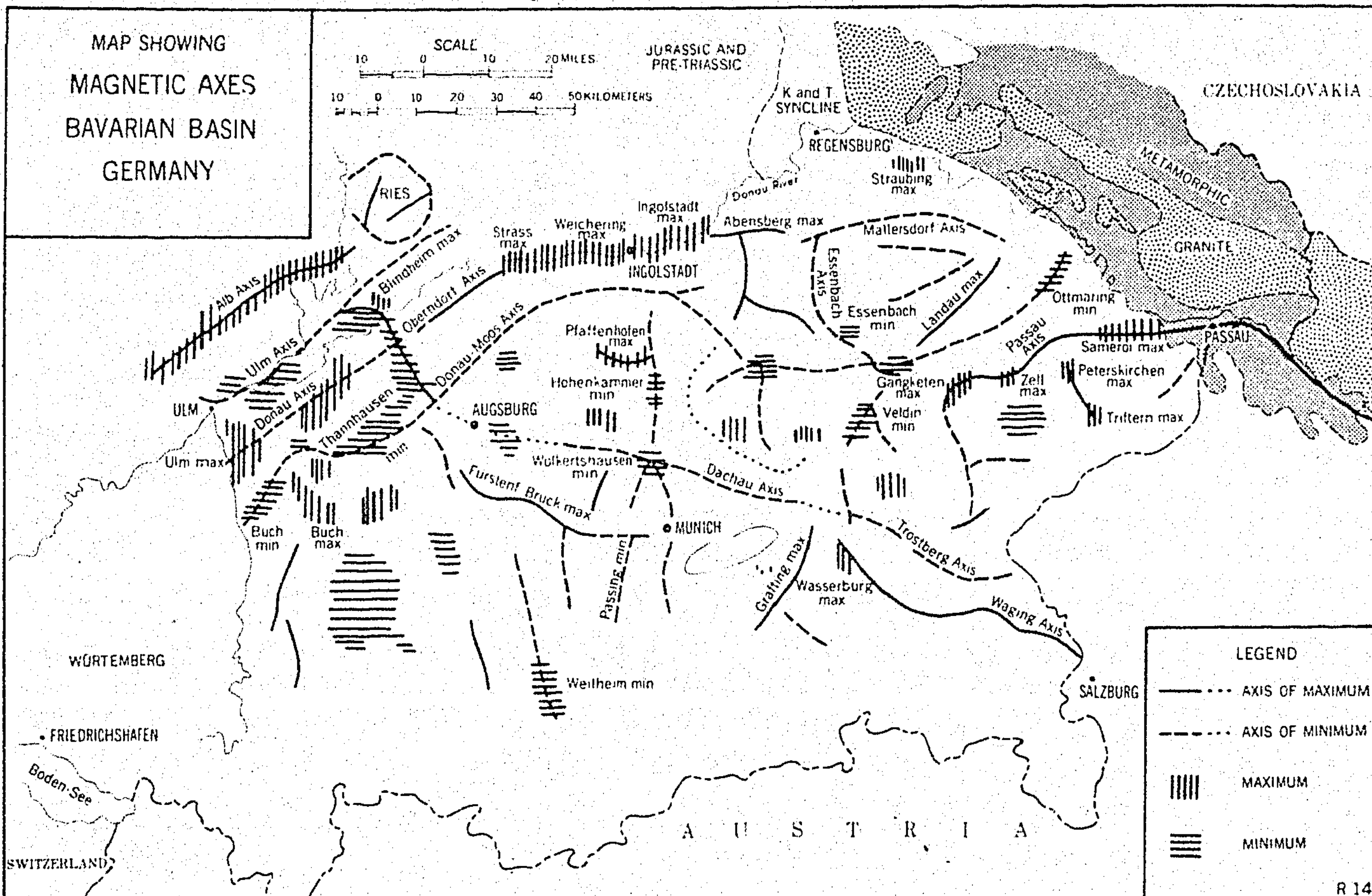
Place	Feet	Possible Error
Munich	8,000	25 per cent
Holzkirchen	13,000	"
Landshut	1,500	"
Taufkirchen Normally	6,000	"
Top of the prospective structure	5,200	"
Rosenheim	13,000	"

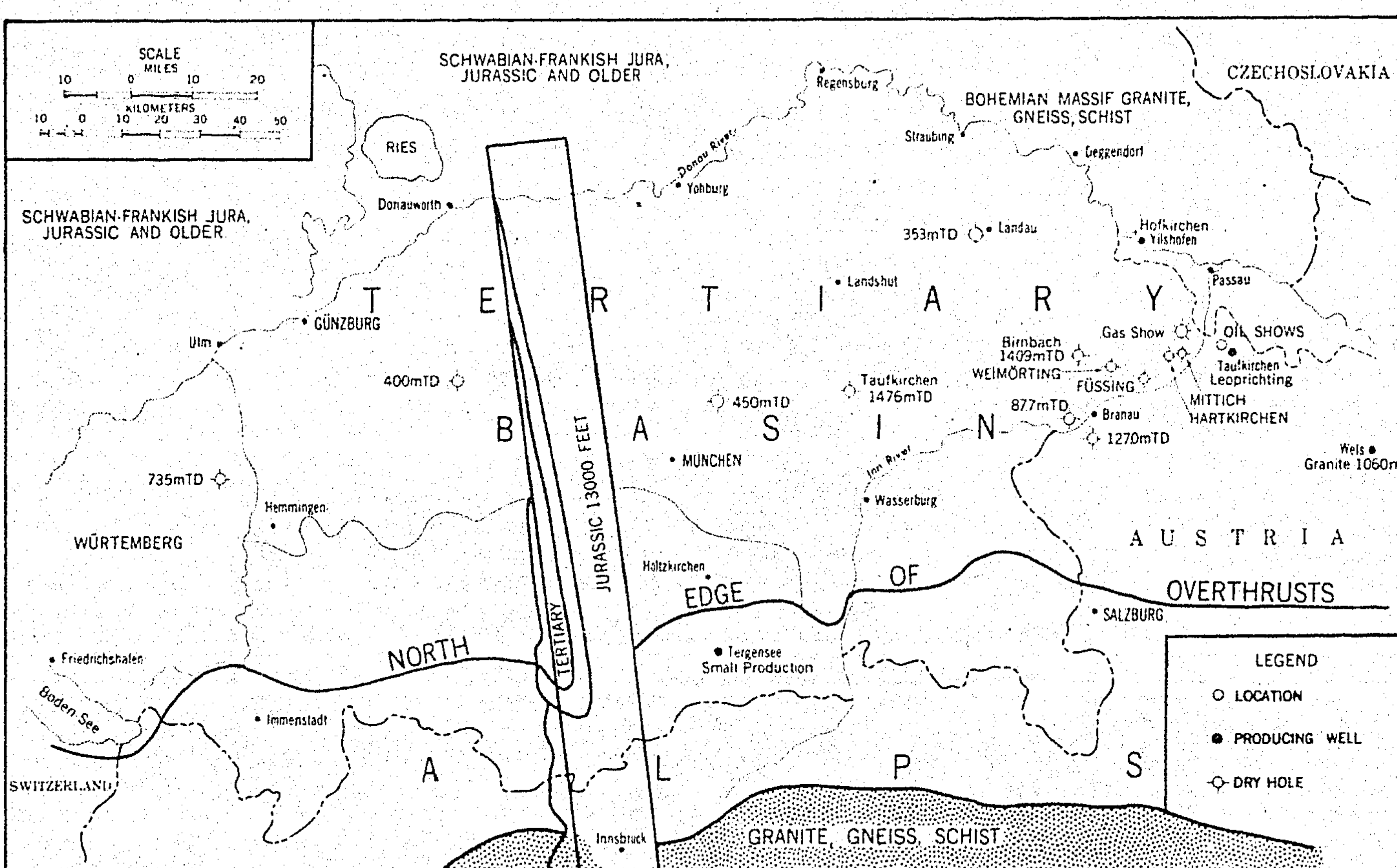
The errors will probably all be of the same relative magnitude. A deep well at Branau on the Inn River was still in the Oligocene at 4,230 feet, its total depth. At the town of Wels granite was topped at 3,477 feet. Logs of some of the holes drilled in the basin are shown graphically on page 79.

Stratigraphy.- In Upper Cretaceous time the Alps were folded and a depression existed to the north of these folds in which sediments, called the Flysch, were deposited, consisting mostly of sandstones, siliceous limestones, marls and shales. In Bavaria the thickness of the Flysch is estimated at 1,000 meters or more. Deposition of the Flysch series continued during Eocene and Oligocene times when folding was also taking place in the basin and its deeper portions wandered gradually to the north. After maximum uplift had occurred detritial sediments were deposited upon the Flysch unconformably in lower Miocene times and the sedimentary series thus formed is referred to as the Schlier or molasse. It is composed of marls and sands with marls predominating towards the center of its basin. Slight folding continued during the deposition of the Schlier and the Flysch, which was already strongly folded, was faulted and thrust over the Schlier along the southern edge of the Schlier basin. The deepest part of the latter is near the Flysch overthrust and the maximum thickness of Schlier deposits is believed to be between 2,000 and 3,000 meters. The Tertiary section younger than the Schlier is comparatively thin or missing entirely in the Bavarian Basin. There is, however, a widespread mantle of Quaternary deposits which cover considerable areas throughout the basin.

A generalized stratigraphic section is given below.

Formation	Age	Average Thickness
Schlier (molasse)	Lower Miocene	2,000 - 3,000 meters
	--Unconformity--	
Flysch	Oligocene Eocene	1,000 meters
	--Unconformity--	
Cretaceous		





SKETCH MAP SHOWING THE GEOLOGICAL SETTING OF THE MUNICH BASIN, DEEP WELLS AND SHOWS OF OIL AND GAS.

R 147A

The small quantities of oil produced in the basin have come from beds in the Flysch and this oil is believed to be indigenous to the formation.

Structure.- The petroliferous region is found along the Bavarian overthrust where Eocene Flysch is thrust over lower Miocene Schlier. Near Tegernsee there is a seepage of light paraffinous oil from fractures, and the production from this area is from beds in the Flysch. This folded belt involving the Schlier is from 10 to 20 miles wide and north of it the Schlier is found lying nearly horizontal beneath the Quaternary.

There are believed to be more favorable structures for oil in the basin than Tegernsee, particularly in southeastern Bavaria in the deeper part of the Schlier basin, where there is the greatest thickness of Oligocene and Miocene sediments. Source beds for oil as well as favorable reservoir rocks should occur in the stratigraphic section and no doubt deep wells will eventually be drilled on folds in this area. There is also a possibility that high areas may be found along the buried ridge of basement rocks in the northern part of the basin which will afford traps for oil. The oil possibilities of the area may be considerably greater than the development to date would indicate.

2.8.3 Tegernsee Field

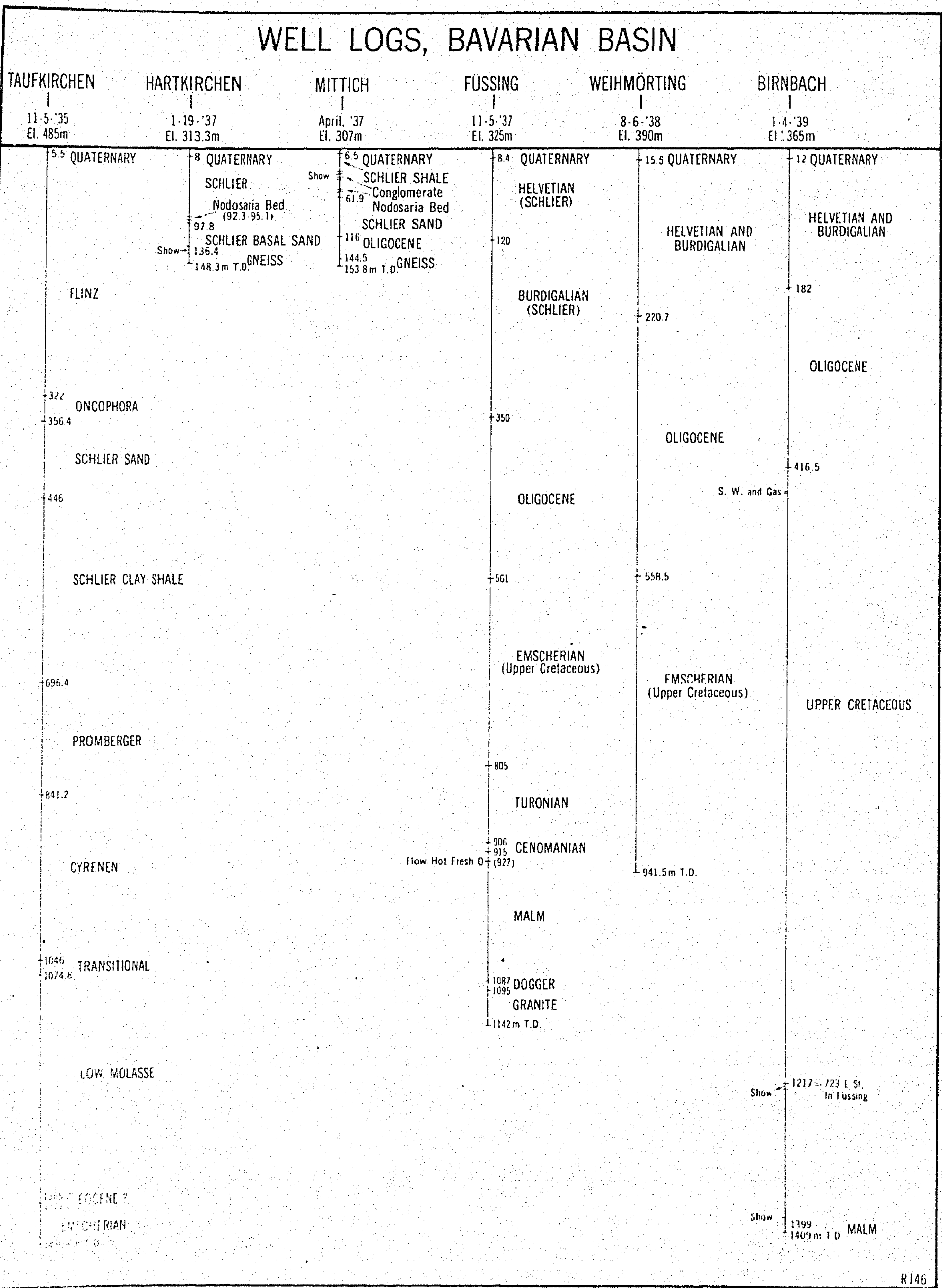
Figures covering the small production known to have been obtained up to 1926 at Tegernsee are included on page 82; the total production from this field is reported to be in the neighborhood of 4,000 metric tons (28,000 barrels). This area lies in the southern part of the basin, as shown on the map on page 77, where the Flysch has been overthrust upon the molasse and Schlier. Oil shows at Tegernsee Lake have been known since the 15 century, coming from fissures in the Flysch sandstone in isoclinal anticlines which dip southward at high angles. Drilling in seepage area commenced in 1881 and up to 1932 about 30 wells had been drilled, the average depth being about 3,750 feet. The productive area in 1928 was 124 acres. The crude is paraffin base and light, of specific gravity from 0.790 to 0.835 (47.5 - 38 A.P.I.). In 1937 the field yielded a small quantity of light oil from a 600 foot horizon. The oil is believed to be indigenous to the Flysch formation.

2.8.4 Salsburg, etc.

At Salsburg insignificant quantities of oil have been obtained from ancient seepages in the Flysch. Not far from the German border in Austria oil has been produced in the Taufkirchen-Leoprechting area near Schärding, where it is trapped in granite wash against a buried granite hill overlaid by the Schlier. Nine wells were drilled from 1917 to 1919 and of these seven encountered oil sands up to 7 meters thick. About 150 tons of heavy viscous oil were produced by bailing from a depth of 120 meters. The oil was under hydrostatic pressure. Due to the viscous character of the crude and absence of gas, the water relationships impose great difficulties to recovery of oil by mining methods. An attempt was made to mine the sands, which had an oil content of about 40 per cent by volume, but such efforts were abandoned.

At Wels, natural gas has been produced from more than 150 wells in and around the city, the maximum depth being about 350 meters (1,148 feet). The gas is reported to occur in lenticular sands and production was short lived.

Although the Bavarian Basin is believed to have good oil possibilities, little is known regarding the favorable structures or prospects. It is probable that considerable exploration and drilling will be required before an important discovery is made. Reference has been made to these prospects in the description of the oil prospects of Germany.


WELL LOGS, BAVARIAN BASIN
TAUFKIRCHEN
11-5-'35
El. 485m
5.5 QUATERNARY
FLINZ
322
ONCOPHORA
356.4
SCHLIER SAND
446
SCHLIER CLAY SHALE
696.4
PROMBERGER
841.2
CYRENEN
1046
1074.8
TRANSITIONAL
LOW MOLASSE
HARTKIRCHEN
1-19-'37
El. 313.3m
8 QUATERNARY
SCHLIER
Nodosaria Bed
(92.3-95.1)
97.8
SCHLIER BASAL SAND
Show
136.4
148.3m T.D.
GNEISS
MITTICH
April, '37
El. 307m
6.5 QUATERNARY
Show
SCHLIER SHALE
Conglomerate
61.9
Nodosaria Bed
SCHLIER SAND
116 OLIGOCENE
144.5
153.8m T.D.
GNEISS
FÜSSING
11-5-'37
El. 325m
8.4 QUATERNARY
HELVETIAN
(SCHLIER)
120
BURDIGALIAN
(SCHLIER)
350
OLIGOCENE
561
EMSCHERIAN
(Upper Cretaceous)
805
TURONIAN
906
915
CENOMANIAN
Flow Hot Fresh O (927)
MALM
1087
1095
DOGGER
GRANITE
1142m T.D.
WEIHMÖRTING
8-6-'38
El. 390m
15.5 QUATERNARY
HELVETIAN AND
BURDIGALIAN
220.7
OLIGOCENE
558.5
EMSCHERIAN
(Upper Cretaceous)
941.5m T.D.
BIRNBACH
1-4-'39
El. 365m
12 QUATERNARY
HELVETIAN AND
BURDIGALIAN
182
OLIGOCENE
416.5
S. W. and Gas
UPPER CRETACEOUS
Show
1217 = 723 L. St.
In Fussing
Show
1399
1409m T.D.
MALM
R146

2.9 OIL SHALE EXPLOITATION

Development of production from oil shales outcropping over a wide area in the Baden district of southwestern Germany was contemplated prior to the war, and began on a small scale during the early war years. The oil-bearing shales occur in the Lower Jurassic (Lias epsilon) Posidonia beds, and have a reported thickness of four meters at Aalen, 7.5 meters in Holzmaden and 13.4 meters at Boll. The oil shales are in general "lean", and their extensive development could only reflect urgent need for increased indigenous oil production, or marked technological advances in shale oil recovery methods.

Under pressure of wartime necessity exploitation of the Baden oil shale deposits appears to have been undertaken on a larger scale, and development is reported to have been taken over in 1944 by the Geilenberg war emergency organization, with the S.S. (Schutzstaffel) evincing a strong and direct interest. These factors are reflected in the very rapid progress which has been made in construction work since August 1944.

A total of 17 plants has been detected by aerial reconnaissance; all of these are situated along an outcrop of an oil shale bed at points where this is known to be thickest and most easily exploited. Of the identified shale oil plants, five are apparently in operation and the remainder in various stages of completion. The majority of the plants appear to employ a distillation process of a novel and so far unexplained type.

The potential oil production from the known sites is tentatively estimated as of the order of 350,000 tons year of crude oil. In the absence of any information concerning the nature of the crude oil obtained, it is not possible to do more than hazard a guess that a ten per cent yield of gasoline and thirty per cent of diesel oil might be obtained.

The status of individual plants, as of the date of latest air cover, is summarized on page 81.

SHALE OIL PLANTS

Plant	Method of Burning Shale	Type of Plant	Location: Latitude N	Location: Longitude E	Date of Last Cover	Remarks
Düsslingen	In heaps.	Engstlatt	48° 27' 00"	09° 04' 25"	23.3.45	Nearly ready for operation.
Bisingen	In heaps.	Engstlatt	48° 19' 05"	08° 55' 40"	24.3.45	Working. Three heaps of shale burnt.
Engstlatt	In heaps.	Engstlatt	48° 18' 10"	08° 53' 00"	24.3.45	Unlikely to be ready for two months.
Erzingen I	In heaps.	Engstlatt	48° 15' 30"	08° 48' 40"	24.3.45	Working. One heap of shale burnt.
Erzingen II	In heaps.	Engstlatt	48° 15' 15"	08° 48' 10"	15.2.45	Not likely to be operable for another month.
Dautmergen	In heaps.	Engstlatt	48° 14' 25"	08° 45' 15"	25.12.44	Least advanced site on 25.12.44.
Dormettingen I	In heaps.	Engstlatt	48° 14' 15"	08° 45' 55"	15.2.45	May be working by now appeared nearly ready on 15.2.45.
Dormettingen II	In heaps.	Engstlatt	48° 14' 00"	08° 46' 05"	15.2.45	Construction moderately advanced, not likely to be operating.
Zimmern	In heaps.	Engstlatt	48° 13' 10"	08° 44' 15"	15.2.45	May be working by now, well advanced 15.2.45.
Schörzingen I	In heaps.	Engstlatt	48° 10' 50"	08° 43' 15"	25.12.44	Moderately advanced 25.12.44. May be working by now.
Schömberg	In heaps.	Prototype of Engstlatt	48° 12' 00"	08° 45' 10"	15.2.45	Working. Considerable amount of shale treated since 25.12.44.
Frommern	In retorts.		48° 15' 00"	08° 51' 25"	15.3.45	Construction not complete but possibly nearly operable.
Schörzingen II	In underground galleries.	Largely experimental	48° 10' 20"	08° 44' 30"	30.9.44	Known to have been used but not obviously active.
Dotternhausen	In retorts.	Experimental	48° 13' 40"	08° 46' 50"	15.2.45	Active. Associated with cement works.
Metzingen	In heaps.? Underground.	Experimental. Small.	48° 32' 05"	09° 16' 05"	16.2.45	Known to have been used, but not obviously active. Identification uncertain.
Holzheim	Underground	Experimental	48° 40' 40"	09° 41' 25"	13.3.45	Probably active. Associated with sawmill.
Eislingen		Refinery for experimental plants.	48° 41' 45"	09° 42' 45"	13.3.45	Active. No evidence of recent extensions.

PRODUCTION OF THE GERMAN OIL FIELDS (a)

	1873		1874		1875		1876		1877 & 1878		1879		1880		1881		1882		1883		1884		1885		1886		1887	
	Tons	Barrels	Tons	Barrels	Tons	Barrels	Tons	Barrels	Tons	Barrels	Tons	Barrels	Tons	Barrels	Tons	Barrels	Tons	Barrels	Tons	Barrels	Tons	Barrels	Tons	Barrels	Tons	Barrels	Tons	Barrels
Heide																	4	28										
Linden near Hannover																									12	84	15	105
Ölheim-Berkhoepen-Ödesse															2,990	20,930	5,100	35,700	1,036	7,252	1,404	9,828	2,620	18,340	2,382	16,674	2,078	14,546
Tegernsee (Bavaria)																			62	434	82	574	33	231	24	168		
Wietze	39	270	39	270	39	270	45	315	x	x	47	329	256	1,792	2,871	20,097	5,985	41,895	2,495	17,465	3,631	25,417	75	525	277	1,939	459	4,613
TOTAL	39	270	39	270	39	270	45	315	x	x	47	329	256	1,792	5,861	41,027	11,089	77,623	3,593	25,151	5,117	35,819	2,728	19,096	2,695	18,865	2,552	17,864

	1888		1889		1890		1891		1892		1893		1894		1895		1896		1897		1898		1899		1900	
	Tons	Barrels	Tons	Barrels	Tons	Barrels	Tons	Barrels	Tons	Barrels	Tons	Barrels	Tons	Barrels	Tons	Barrels	Tons	Barrels	Tons	Barrels	Tons	Barrels	Tons	Barrels	Tons	Barrels
Heide																										
Linden near Hannover	8	56	6	42	3	21	5	35	1	7	4	28	3	21	3	21	2	14								
Ölheim-Berkhoepen-Ödesse	1,650	11,550	1,486	10,402	1,413	9,891	1,182	8,274	759	5,306	494	3,458	509	3,563	723	5,061	701	4,905	1,054	7,378	805	5,635	869	6,083	689	4,823
Tegernsee (Bavaria)																										
Wietze	1,113	7,791	1,567	10,969	833	5,831	1,311	9,177	826	5,782	897	6,279	1,088	7,616	886	6,202	809	5,663	1,546	10,822	1,740	12,180	2,536	17,752	27,042	189,294
TOTAL	2,771	19,397	3,059	21,413	2,249	15,743	2,498	17,486	1,585	11,095	1,395	9,765	1,600	11,200	1,612	11,284	1,512	10,584	2,600	18,200	2,545	17,815	3,405	23,835	27,731	194,117

	1901		1902		1903		1904		1905		1906		1907		1908		1909		1910		1911		1912	
	Tons	Barrels	Tons	Barrels	Tons	Barrels	Tons	Barrels	Tons	Barrels	Tons	Barrels	Tons	Barrels	Tons	Barrels	Tons	Barrels	Tons	Barrels	Tons	Barrels	Tons	Barrels
Heide							79	553					85	595							5	35	5	35
Linden near Hannover																								
Nienhagen-Hänigsen Obershagen-Eichlingen							117	819	499	3,493	502	3,514	347	2,429	812	5,684	6,114	42,798	18,666	130,662	8,032	56,224	5,191	36,337
Ölheim-Berkhoepen-Ödesse	832	5,824	723	5,061	987	6,909	1,329	9,303	1,663	11,641	1,315	9,205	1,446	10,122	1,654	11,578	1,654	11,578	1,047	7,329	826	5,782	661	4,627
Tegernsee (Bavaria)											131	917	130	910	168	1,176	304	2,128						
Wietze	23,266	162,862	28,797	201,579	40,746	285,222	66,079	462,553	55,579	389,053	57,379	401,653	78,377	548,639	110,536	773,752	105,752	740,264	91,283	638,981	89,786	628,502	81,621	571,347
TOTAL	24,098	168,686	29,520	206,640	41,733	292,131	67,604	473,228	57,741	404,187	59,327	415,289	80,385	562,695	113,170	792,190	113,824	796,768	110,996	776,972	98,649	690,543	87,478	612,346

	1913		1914		1915		1916		1917		1918		1919		1920		1921		1922		1923		1924	
	Tons	Barrels	Tons	Barrels	Tons	Barrels	Tons	Barrels	Tons	Barrels	Tons	Barrels	Tons	Barrels	Tons	Barrels	Tons	Barrels	Tons	Barrels	Tons	Barrels	Tons	Barrels
Heide	4	28	4	28	4	28	2	14	6	42	2	14	4	28										
Linden near Hannover																								
Nienhagen-Hänigsen Obershagen-Eichlingen	7,146	50,022	7,771	54,397	7,061	49,427	6,734	47,138	5,844	40,908	5,600	39,200	4,025	28,175	3,596	25,172	3,116	21,812	9,751	68,257	15,208	106,456	20,230	141,610
Oberg															631	4,417	965	6,755	901	6,307	1,452	10,164	1,024	7,168
Ölheim-Berkhoepen-Ödesse	510	3,570	515	3,605	478	3,346	486	3,402	411	2,877	388	2,716	442	3,094										
Tegernsee (Bavaria)															90	630	86	602	73	511	52	364	53	371
Wietze	63,522	444,654	52,836	369,852	48,358	338,506	44,023	308,161	37,361	261,527	32,039	224,273	32,758	229,306	30,709	214,963	34,221	239,547	31,266	218,862	34,058	238,406	38,045	266,315
TOTAL	71,182	498,274	61,126	427,882	55,901	391,307	51,245	358,715	43,622	305,354	38,029	266,203	37,229	260,603	35,026	245,182	38,388	268,716	41,991	293,937	50,770	355,390	59,352	415,464

	1925		1926		1927		1928		1929		1930		1931		1932		1933		1934	
	Tons	Barrels	Tons	Barrels	Tons	Barrels	Tons	Barrels	Tons	Barrels	Tons	Barrels	Tons	Barrels	Tons	Barrels	Tons	Barrels	Tons	Barrels
Heide																				
Linden near Hannover																				
Nienhagen-Hänigsen Obershagen-Eichlingen	37,289	261,023	47,776	334,432	48,375	338,625	39,189	274,323	44,413	310,891	72,343	506,404	72,364	506,548	109,915	769,405	144,979	1,014,853	240,732	1,685,124
Oberg	1,053	7,371	3,344	23,408	5,215	36,502	6,617	46,319	9,654	67,578	10,355	72,485	16,584	116,088	18,673	130,711	15,733	110,131	12,705	88,935
Ölheim-Berkhoepen-Ödesse							97	679	1,505	10,535	14,388	100,716	30,507	213,549	32,997	230,979	18,173	127,211	7,429	52,001
Tegernsee (Bavaria)	20	140	29	203																
Volkenroda (Thuringia)											4,258	29,806	51,555	360,885	15,783	110,481	5,814	40,698	1,750	12,250
Wietze	40,762	285,334	44,218	309,526	50,213	351,495	46,106	322,742	48,226	337,582	61,077	427,539	57,661	403,634	52,426	366,982	53,804	376,628	51,874	363,118
TOTAL	79,124	553,868	95,367	667,569	103,803	726,622	92,009	644,063	103,798	726,586	162,421	1,136,950	228,671	1,600,704	229,794	1,608,558	238,503	1,669,521	314,490	2,201,428

	1935		1936		1937		1938		1939		1940		1941		1942		1943		1944	
	Tons	Barrels	Tons	Barrels	Tons	Barrels	Tons	Barrels	Tons (Estimated)	Barrels	Tons (Estimated)	Barrels	Tons (Estimated)	Barrels	Tons (Estimated)	Barrels	Tons (Estimated)	Barrels	Tons (Estimated)	Barrels
Alte Piccardie (Georgsdorf)																			2,456	17,178
Broistedt					1,490	10,430(c)	855	5,985(c)	930	6,510	768	5,376	983	6,881	4,505	31,535	3,731	25,907	2,551	17,857
Coevorden (b)																	5,000	35,000	15,000	105,000
Dalum (Lingen)															194	1,358	6,052	42,364	19,148	134,036
Emra									54	378	3,120	21,840	1,710	11,970	1,088	7,616	809	5,663	387	2,709
Eickeloh (Hademstorf)															400	2,800	4,671	32,697	10,134	70,938
Ehlichheim																			3,017	21,119
Epenwöhrden North							Production included under Heide													
Epenwöhrden South								"	"		"									
Etzel																	1,502	12,514	3,129	21,973
Fallstein	1,308	9,156	65	455(c)	490	3,430(c)			Depleted											
Feldbergen							Production included under Mölme													
Fuhrberg									1,906	13,342	12,759	89,313	28,263	197,841	45,966	321,762	51,451	360,157	58,560	409,920
Gifhorn	694	4,858	5,397	37,780(c)	4,523	31,663(c)	3,552	24,864(c)	3,102	21,714	4,150	29,050	3,610	25,270	2,948	20,636	3,241	22,687	3,036	21,252
Hambühren																	1,137	7,959	2,221	15,547
Heide	1,564	10,948	8,278	57,942(c)	4,514	31,600(c)	25,993	181,950(c)	83,643	585,901	230,142	1,610,994	206,703	1,446,921	141,450	990,150	115,692	809,844	120,420	842,940
Hemmingstedt (d)							Production included under Heide													
Hemmingstedt-Kanzlei								"	"		"	"					1,148	8,036	14,873	104,111
Hohenassel																				
Hope-Lindwedel (Adolphsglueck)							143	1,000(c)	71	500	Depleted									
Linden (near Hannover)									Depleted											
Meckelfeld							1,830	12,810(c)	4,586	32,102	6,077	42,539	6,180	43,2..	7,030	49,210	5,085	35,595	4,573	32,011
Meldorfhafen							Production included under Heide													
Mölme	6,814	47,698	12,957	90,700(c)	9,829	68,800(c)	9,993	69,950(c)	9,341	65,387	8,866	62,062	7,040	49,280	10,709	74,963	13,159	92,113	14,383	100,681
Nienhagen-Hänigsen Oberehagen-Eichlingen	331,211	2,318,477	333,266	2,332,862	348,161	2,437,127	..0,452	2,523,165	359,946	2,519,622	317,136	2,219,952	313,692	2,195,844	292,947	2,050,629	298,885	2,092,195	250,243	1,751,701
Oberg	27,879	195,153	23,125	161,875	21,410	149,870	16,903	118,321	14,501	101,507	17,004	119,028	16,514	115,598	15,982	111,874	15,156	106,092	11,325	79,275
Ölheim-Berkhoepen-Odesse	7,638	53,466	8,700	60,900(c)	9,364	65,550(c)	9,136	63,950(c)	6,588	46,116	5,716	40,012	4,415	30,905	6,048	42,336	4,261	29,827	3,987	27,909
Reitbrook					1,024	7,165	57,143	400,000(c)	191,613	1,341,291	357,221	2,500,547	210,475	1,473,325	104,024	728,168	52,712	368,984	35,997	251,979
Rhine Valley (Baden, Weingarten, Forst)	1,553	10,871	5,243	36,700(c)	6,433	45,033(c)	12,561	87,925(c)	14,878	104,146	9,825	68,775	8,590	60,130	9,523	66,661	10,233	71,631	8,393	58,751
Rodewald					673	4,712	3,806	26,645	21,536	150,752	40,187	281,309	51,290	359,030	47,780	334,460	53,214	372,498	53,533	374,731
Schöningen									Depleted											
Sottorf					386	2,699	411	2,879	1,171	8,197	1,578	11,046	772	5,404	322	2,254	124	868	92	644
Tegernsee (Bavaria)									Depleted						12,602	88,214	24,619	172,333	22,397	156,779
Thören																				
Volkenroda (Thuringia)	747	5,229	776	5,435(c)	385	2,695(c)	50	350(c)	Depleted											
Westerholz (Wesendorf)																	11,333	79,331	34,271	239,897
Wienhausen															13,324(e)	93,268	1,222	8,556	112	784
Wietze	50,265	351,855	46,833	327,845	44,759	313,383	43,448	304,136	40,988	286,916	37,765	264,355	37,330	261,310	36,172	253,204	35,404	247,828	32,199	225,393
TOTAL	429,673	3,007,711	444,642	3,112,494	453,451	3,174,157	546,276	3,823,930	755,054	5,285,381	1,052,314	7,366,198	897,587	6,282,969	753,016	5,271,112	715,117	5,005,819	712,445	4,986,115

(a) The annual production statistics in this table were derived from the following sources: (1) for the years 1873 to 1926, inclusive, from the American Association of Petroleum Geologists Bulletin, No. 12 (1925), pages 474 to 479;
(2) 1927 to 1939, inclusive, from the American Institute of Mining and Metallurgical Engineers' annual volumes, Petroleum Division's "Transactions", modified by statistics from the files of Socony-Vacuum Oil Company;
(3) 1940 to 1944, inclusive, from captured German production records.
In all cases the figures in metric tons represent the original statistical data and a uniform factor of seven barrels per metric ton has been used in converting to barrels.
(b) Estimated production. Not included in total for Germany.
(c) Approximate.
(d) This is additional to the "Hemmingstedt-Kanzlei" field.
(e) Includes various other fields.

	1935		1936		1937		1938		1939		1940		1941		1942		1943		1944	
	Tons	Barrels	Tons	Barrels	Tons	Barrels	Tons	Barrels	Tons (Estimated)	Barrels (Estimated)	Tons (Estimated)	Barrels (Estimated)	Tons (Estimated)	Barrels (Estimated)	Tons (Estimated)	Barrels (Estimated)	Tons (Estimated)	Barrels (Estimated)	Tons (Estimated)	Barrels (Estimated)
Alte Piccardie (Georgsdorf)																			2,454	17,178
Broistedt					1,490	10,430(c)	855	5,985(c)	930	6,510	768	5,376	983	6,881	4,505	31,535	3,701	25,907	2,551	17,857
Coevorden (b)																	5,000	35,000	15,000	105,000
Dalum (Lingen)															194	1,358	6,052	42,364	19,148	134,036
Ehra									54	378	3,120	21,840	1,710	12,970	1,088	7,616	809	5,663	387	2,709
Eickeloh (Hademstorf)															400	2,800	4,671	32,697	10,134	70,935
Emlichheim																			3,017	21,119
Epenwöhrden North							Production included under Heide													
Epenwöhrden South								"	"		"									
Etzel																	1,602	12,614	3,139	21,973
Fallstein	1,308	9,156	65	455(c)	490	3,430(c)			Depleted											
Feldbergen							Production included under Mölme													
Fuhrberg									1,906	13,342	12,759	89,313	28,263	197,841	45,966	321,762	51,451	360,157	58,560	409,920
Gifhorn	694	4,858	5,397	37,780(c)	4,523	31,663(c)	3,552	24,864(c)	3,102	21,714	4,150	29,050	3,610	25,270	2,948	20,636	3,241	22,687	3,036	21,252
Hambühren																	1,137	7,959	2,221	15,547
Heide	1,564	10,948	8,278	57,942(c)	4,514	31,600(c)	25,993	181,951(c)	83,843	586,901	230,142	1,610,994	206,703	1,446,921	141,450	990,150	115,692	809,844	120,420	842,940
Hemmingstedt (d)							Production included under Heide													
Hemmingstedt-Kanzlei								"	"		"	"								
Hohenassel																	1,148	8,036	14,873	104,111
Hope-Lindwedel (Adolphsglueck)							143	1,000(c)	71	500		Depleted								
Linden (near Hannover)									Depleted											
Meckelfeld							1,830	12,810(c)	4,586	32,102	6,077	42,539	6,180	43,2..	7,030	49,210	5,085	35,595	4,573	32,011
Meldorfhafen							Production included under Heide													
Mölme	6,814	47,698	12,957	90,700(c)	9,829	68,800(c)	9,993	69,950(c)	9,341	65,387	6,866	62,062	7,040	49,280	10,709	74,963	13,159	92,113	14,383	100,681
Nienhagen-Hänigsen Obershagen-Eicklingen	331,211	2,318,477	333,266	2,332,862	348,161	2,437,127	360,452	2,523,165	359,946	2,519,622	317,136	2,219,952	313,692	2,195,844	292,947	2,050,629	298,885	2,092,195	250,243	1,751,701
Oberg	27,879	195,153	23,125	161,875	21,410	149,870	16,903	118,321	14,501	101,507	17,004	119,028	16,514	115,598	15,982	111,874	15,156	106,092	11,325	79,275
Ölheim-Berkhoepen-Odesse	7,638	53,466	8,700	60,900(c)	9,364	65,550(c)	9,136	63,950(c)	6,588	46,116	5,716	40,012	4,415	30,905	6,048	42,336	4,261	29,827	3,987	27,909
Reitbrook					1,024	7,165	57,143	400,000(c)	191,613	1,341,291	357,221	2,500,547	210,475	1,473,325	104,026	728,182	52,712	368,984	35,997	251,979
Rhine Valley (Baden, Weingarten, & Forst)	1,553	10,871	5,243	36,700(c)	6,433	45,033(c)	12,561	87,925(c)	14,878	104,146	9,825	68,775	8,590	60,130	9,523	66,661	10,233	71,631	8,393	58,751
Rodewald					673	4,712	3,806	26,645	21,536	150,752	40,187	281,309	51,290	359,030	47,780	334,460	53,214	372,498	53,533	374,731
Schöningen									Depleted											
Sottorf					386	2,699	411	2,879	1,171	8,197	1,578	11,046	772	5,404	322	2,254	124	868	92	644
Tegernsee (Bavaria)									Depleted											
Thören															12,602	88,214	24,619	172,333	22,397	156,779
Volkenroda (Thuringia)	747	5,229	776	5,435(c)	385	2,695(c)	50	350(c)	Depleted											
Westerholz (Wesendorf)																	11,333	79,331	34,271	239,897
Wienhausen															13,324(e)	93,268	1,228	8,596	112	784
Wietze	50,265	351,855	46,835	327,845	44,769	313,383	43,448	304,136	40,988	286,916	37,765	264,355	37,330	261,310	36,172	253,204	35,404	247,828	32,199	225,393
T O T A L	429,673	3,007,711	444,642	3,112,494	453,451	3,174,157	546,278	3,823,930	755,054	5,285,381	1,052,314	7,366,198	897,567	6,282,969	753,016	5,271,112	715,117	5,005,819	711,445	4,980,115

(a) The annual production statistics in this table were derived from the following sources: (1) for the years 1873 to 1926, inclusive, from the American Association of Petroleum Geologists Bulletin, No. 12 (1925), pages 476 to 479;
(2) 1927 to 1939, inclusive, from the American Institute of Mining and Metallurgical Engineers' annual volumes, Petroleum Division's "Transactions", modified by statistics from the files of Socony-Vacuum Oil Company;
(3) 1940 to 1944, inclusive, from captured German production records.
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