KANSAS GEOLOGICAL SURVEY
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MINERAL RESOURCES AND GROUND WATER SUPPLIES OF THE HARPER AREA AVAILABLE FOR NATIONAL DEFENSE INDUSTRIES

Prepared By

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Oil and gas

Salt

Volcanic ash

Gypsum

Clays and shales

Sand, gravel and stone

Oil field brines as a potential source of magnesium

Ground-water supplies

Report prepared by members of the staff of the Geological Survey, University of Kansas, Lawrence.

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OIL AND GAS

Harper County is well situated with respect to an abundance of Kansas produced oil and gas suitable for fuel, refining, or extraction of essential refinery by-products. Although it is not yet numbered among those counties which produce oil or gas in commercial amounts, there are in Kansas, within a radius of 50 miles of the city of Harper, twenty-four commercial oil pools and six commercial gas pools. In addition, two new gas pools were discovered during 1941 for which annual production statistics are not available. Pertinent information regarding the production from these oil and gas pools is included in the accompanying tables.

The data contained in the tables are taken from the most recent information available. They are not complete for some oil pools because 1941 production data for a few smaller unprorated pools have not been published separately. In those cases the annual production for 1940 has been substituted.

Reference to the tables will show that even under the present strict method of proration these pools have produced in excess of five million barrels of oil per year. This figure could have been appreciably exceeded had there been sufficient demand for oil.

Two of the gas pools, the Medicine Lodge pool and the Cairo pool, are numbered among the most prolific producers in Kansas. Production in these pools during 1940 was 7,675,958,000 cubic feet and 11,934,153,000 cubic feet of gas respectively.

In addition to the above important local sources of fuel there are also an interstate gas pipe line and two interstate gasoline lines crossing Harper County. The gas line crosses the county diagonally in a northeast direction. One of the gasoline lines extends in a northeast direction through the northwestern corner of the county. The other crosses the county in a north-south direction near the eastern edge.

OIL POOLS

Pool and Location	Area Acres	Cumulative Prod to 1940	Added 1941	End 1941 Total	Average Daily Prod	No. Wells Prod.	Producing Zone	Depth	Gravity (degrees Baume)
Barber County									
Lake City Sec. 7, T. 31 S., R. 13W	160	44,150	11,515	55,665	37	1 1	Viola Arbuckle	4,435 4,657	43
Medicine Lodge Sec. 15, T. 33 S., R. 13 W.	80	43,000	2,063	45,043	41		Misener	4,845	34
Whelan Sec. 32, T. 31 S., R. 11 W.	1,000	340,800	217,247	558,047	198	18	"Chat"	4,355	36
Kingman-Pratt Counties									
Cairo Sec. 7, T. 28 S., R. 11 W.	160	9,500	31,638	41,138	25	4	Viola	4,267	25
Iuka Sec. 11, T. 27 S., R. 13 W.	200	78,300	56,317	134,617	95	6 1	Simpson Arbuckle	4,292 4,354	38
Cunningham Sec. 30, T. 27 S., R. 10 W.		2,204,689	508,184	2,712,873	790	76	Lansing Viola Simpson Arbuckle	3,390 3,925 4,055 4,094	36
Reno County									
Abbeyville Sec. 24, T. 24 S., R. 8 W.	150	372,817	35,891	408,708	70	8	Lansing		37

OIL POOLS page 2

Pool and Location	Area Acres	Cumulative Prod. to 1940	Added 1941	Total End 1941	Average Daily prod	No. Wells Prod.	Producing Zone	Depth	Gravity (degrees Baume
<u>Reno County</u> (continued)									
Burrton Sec. 23, T. 23 S., R. 4 W.	7,140	30,575,715	2,523,135	33,098,850	7,153	475	Mississippian Hunton Simpson Arbuckle	3,266 3,583 3,723 3,775	42
Hilger Sec. 16, T. 26 S., R. 4 W.,	340	1,763,432	274,208	1,977,640	693	32	Viola	4,062	38
Lerado Sec. 11, T. 26 S., R. 9 W.	530	2,088,056	257,368	2,345,424	724	32	Lansing Viola	3,535 4,128	36
Yoder Sec. 34, T. 24 S., R. 5 W.	500	69,100	3,100**	72,200		6	Mississippian	3,450	36
<u>Sedgwick County</u>									
Oatville Sec. 18, T. 28 S., R. 1E.	40	10,000	1,400**			1	Simpson	3,489	45
Robbins Sec. 20, T 28 S., R. 1 E.	560	2,889,469	77,700**	2,967,169	298	55	Mississippian	3,090	44
<u>Sumner County</u>									
Anness Sec. 2, T. 30 S.,	40	36,700	7,109	43,809		1	Simpson	4,394	

**Added in 1940

Pool and Location	Area Acres	Cumulative Prod to 1940	Added 1941	Total End 1941	Average Daily Prod	No. Wells Prod.	Producing Zone	Depth	Gravity (degrees Baume)
Sumner County (continued)									
Caldwell Sec. 17, T. 35 S., R. 3 W.	160	1,817,950	66,600	1,884,550		4	Simpson	4,765	46
Churchill Sec. 25, T. 31 S., R. 2 E.	1,000	18,321,600	156,200	18,477,800		63	Stalnaker	1,820	37
Latta Sec. 9, T. 30 S., R. 2 W.	200	62,250	96,582	158,832		15	Lansing Kansas City	3,042 3,200	40
Oxford Sec. 23, T. 32 S., R. 2 E.	800	14,283,200	56,010	1,433,210		40	Stalnaker Layton Arbuckle	2,020 2,890	37
Oxford, West Sec. 17, T. 32 S., R. 2 E.	160	488,400	12,600**			3	Arbuckle	.....	..
Padgett Sec. 23, T. 34 S., R. 2 W.	1,800	1,903,700	69,000	1,972,700		20	Mississippian	3,474	..
Rutter Sec. 21, T. 33 S., R. 2 E.	40	46,425	11,464	57,889		2	Mississippian	3,315	..
Vernon, North Sec. 15, T. 35 S., R. 2 E.	200	217,150	33,855	251,005		5	Mississippian	3,443	..

**Added 1940

Pool and Location	Area Acres	Cumulative Prod to 1940	Added 1941	Total End 1941	Average Daily Prod	No. Wells Prod.	Producing Zone	Depth	Gravity (degrees Baume)
Sumner County (continued)									
Wellington Sec. 33, T. 31 S., R. 1 W.	1,160	4,474,793	334,900	4,809,693	1,351	97	Mississippian	3,655	41
Zyba Sec. 7, T 30 S., R. 1 E.	40	11,800	6,129	17,929		1	Simpson	3,866	41

COMMERCIAL GAS POOLS WITHIN A RADIUM OS FIFTY MILES OF HARPER, KANSAS

Pool and Location	Area Acres	Cumulative Prod to 1940 (M. cu ft)	(M. cu. ft) Added 1940	No. Wells Prod.	Producing Zone	Depth
Barber County						
Medicine Lodge Sec. 13, T. 33 S., R. 13 W.	6,400	44,113,080	7,675,958	34	Mississippian	4,455
Kingman-Pratt Counties						
Cairo Sec. 7, T. 28 S., R. 11 W.	12,000	20,459,515	11,934,153	44	Viola	4,278
Ward Sec. 11, T. 26 S., R. 12 W.	Discovered in 1941.		Daily potential 2,500,000 cubic feet gas.	1	Viola	4,320
Preston Sec. 18, T. 26 S., R. 11 W.	Discovered in 1941.		Daily potential 12,000,000 cubic feet gas.	2	Viola	4,339
Reno County						
Burrton Sec. 23, T. 23, S. R. 4 W.	5,000	41,597,964	4,674,845	52	Mississippian	3,298
Yoder Sec. 34, T. 24 S., R. 5 W.	500	....	471,285	4	Mississippian	3,402
Sedgwick County						
Derby Sec. 32, T. 28 S., R. 2 E.	160	(Abandoned)		3	Stalnaker	2,215

Pool and Location	Area Acres	Cumulative Prod to 1940 (M. cu. ft.)	Added 1940 (M. cu. ft.)	No. Wells Prod.	Producing Zone	Depth
Sumner County						
Wellington Sec. 33, T. 31 S., R. 1 W.	1,200	....	639,809	47	Mississippian	3,655
Padgett Sec. 23, T. 34 S., R. 2 E.	1,000	....	....	..	Mississippian	3,474

r County						
Wellington Sec. 33, T. 31 S., R. 1 W.	1,200	....	639,809	47	Mississippian	3,655
Padgett Sec. 23, T. 34 S., R. 2 E.	1,000	....	....	..	Mississippian	3,474

SALT

Salt beds ranging in total thickness from 0 to 500 feet underlie the Harper area. The depth to the top of the salt ranges from 200 feet in central Sumner county to 1,500 feet in eastern Barber county. The depth to the top of the salt in the immediate vicinity of Harper is approximately 800 feet.

The salt in this area is a continuation of the deposit that underlies most of the central part of Kansas. Salt is extracted both by mining methods and by solution methods at several places in the central part of the state. Undoubtedly salt of workable thickness and equal in quality to that now mined at Hutchinson and other places to the north exists in the vicinity of Harper. The thickness of the salt deposits throughtout Kansas is shown on the accompanying map.

VOLCANIC ASH

The only volcanic ash known to occur in commercial quantities in the Harper area is in two deposits about two miles east of Anthony. The larger of these deposits was at one time mined by the Pumicite Company, but no production is reported from this mine for 1941. The second deposit is a short distance east of the other, and is very much smaller.

The greater part of the volcanic ash mined in Kansas goes into various types of abrasives, particularly in cleansing and polishing agents such as mechanics' soaps and kitchen scouring powders. There are other important uses for volcanic ash, but most of these uses have been but slightly developed. One very practical application is the partial substitution of volcanic ash for cement in concrete mixtures. As much as fifty percent of the cement may be replaced by the ash without decreasing the ultimate strength. The density and resistance to the penetration of water is increased by the use of volcanic ash in the correct proportions. Volcanic ash was successfully used in the construction of a dam across the Niobrara river at Valentine, Nebraska.

GYPSUM

The most important area of gypsum deposits in Kansas lies in Barber, Comanche and Kiowa counties. Its eastern margin is about 40 miles west of Harper. The map, that accompanies this report, shows its location.

Gypsum is hydrous calcium sulfate ($CaSO_4 \cdot 2H_2O$). The mineral calcium sulfate without water is called anhydrite. Gypsum occurs as a sedimentary rock, as stringers or in veins, or as disseminated crystals in other rocks chiefly shales. In the Southern Kansas gypsum area, in Barber and neighboring counties, there are three important beds of "rock gypsum" much of which is sufficiently pure and dense to be known as alabaster. The lower bed is the Medicine Lodge gypsum. It is 30 feet thick in the mines near Sun City and this thickness is fairly constant along a line extending from Sun City to southwestern Woods county, Oklahoma. About 20 feet higher is another bed, thin in Barber county but about 20 feet thick in eastern Comanche county. This upper bed is the Shimer gypsum. About half way between these two massive gypsum deposits, in southeastern Comanche county, is a thinner deposit called Nescatunga gypsum.

Gypsum both in the raw and calcined states is useful. Raw gypsum is used as a retarder in Portland cement, as fertilizer, as filler in paints and papers, as a base for insecticides, and as a mild abrasive in tooth pastes and powders. Calcined gypsum is used in making cements and plasters and in making fabricated building materials.

Plaster of Paris is made by calcining gypsum until only a part of the water content is driven off. Gypsum cements are calcined products to which fillers and extenders are added. Fabricated gypsum products include wallboard, tiles, blocks, etc. Both gypsum plasters and fabricated forms are excellent heat and sound insulators. Keene's cement is made by calcining gypsum to red heat and recalcining after alum solution is added. The product sets slowly into a hard material that resembles marble. Plaster of Paris is used in making molds in pottery and metal plants, relief work on walls and ceilings, making beds for polishing plate glass, and in surgical and dental work.

A gypsum mill has been operating at Medicine Lodge for many years. Raw gypsum is mined near Sun City and shipped by rail to the Medicine Lodge mill where it is processed into high grade materials. Keene's cement is one of the products made at Medicine Lodge. The Medicine Lodge gypsum bed is probably the source of the best material in the United States for making Keene's cement.

Although it is known that some distance below the surface of the land these gypsum beds are represented by beds of anhydrite, a material that can not be used readily for the purposed mentioned above, the supply of readily workable gypsum in the Medicine Lodge area is so great that it is virtually inexhaustable.

CLAYS AND SHALES

Clays and shales are the raw materials from which a variety of products are manufactured. These products include building materials such as bricks and hollow tiles; pottery, stoneware, and refractories. There are very few areas as large as the one included in this report which do not have some type of clay which can be made into common bricks, and clays capable of being fired to hard red facing bricks are not at all uncommon. However, white to buff firing clays which can be manufactured into pottery or firebricks are rather rare, and are likely to be found only in thin beds in restricted areas.

The value of raw materials for the manufacture of clay products cannot be certainly determined without making the standard ceramic tests which simulate the actual manufacturing processes of drying and firing in a kiln. No such tests have been made for samples taken in the Harper area. However, samples from the Ninnescah shale, which crops out in Harper county, have been taken from these same beds where they extend northward into McPherson county, near Johnstown. Several of these shales proved to be satisfactory for the manufacture of common bricks and a few thin beds fire to cream and buff colors, and can be made into light-colored face bricks if sufficient care were taken not to overfire them.

In general, the forming and drying properties of the shales tested were excellent. However, most of them contained a high percentage of fluxing materials such as calcium carbonate and magnesium carbonate. For this reason the temperature of fusion of the shales is far below that required for fireclays, and the vitrification range is abnormally short. Clays or shales with a short range of vitrification require very closely controlled temperatures for firing, inasmuch as they remain open and porous in texture to near their melting point. A brick which is to withstand exposure to the weather must be fired to a temperature high enough to reduce the porosity, yet below the fusion point. If the lowp porosity temperature and the melting temperature are very close together the danger of overfiring or underfiring is great.

It is not safe to assume that the Ninnescah shale of McPherson county is identical in quality to the Ninnescah shale in Harper county. Also it is possible that the rather limited vertical range which was sampled in McPherson is not completely representative of the whole formation. It is possible that these shales in Harper county are of somewhat poorer quality than those in McPherson county, but they may be much better, and it seems certain that some of the shales in Harper or adjacent counties are suitable for some of the more widely used ceramic materials such as building tile and red brick.

SAND, GRAVEL, AND OTHER STONE

As indicated on the accompanying map, sand and gravel are available in widely scattered areas in the region surrounding Harper. Deposits are present, and many are being worked along most of the streams in the area. Several commercial sand boats are in operation along Arkansas and Ninnescaw rivers in southeastern Sedgwick and in northeastern Sumner county. Sand and gravel suitable for all their common uses are present in practically unlimited amounts within a short distance from any point in the area discussed in this report.

Limestone is not plentiful in this area. However, according to Mr. Rufus Kirk, county engineer of Sumner county, limestone quarries that are worked intermittently are located in sec. 36, T. 31 S., R. 2 E, secs. 5 and 15, T. 32 S., R. 3 W., and in sec. 14, T. 35 S., R. 3 W.

OIL FIELD BRINES AS A POTENTIAL SOURCE OF MAGNESIUM

Attention is called to the strategic position of magnesium among essential war materials. This metal is used in making tracer bullets and shells and various types of signal flares, photographic flash bombs, etc., but its greatest usefulness is, no doubt, as an ingredient in alloys with aluminum. It is reported that if sufficient magnesium can be obtained it will be extensively used in airplane manufacture. Captured German planes show that it is being used by the enemy.

Magnesium is one of the most abundant metals. It is a part of many rocks. Its compounds occur in sea water, in many mineral springs, and in deep brines. The metal, however, does not occur native. That is, it is not found in the free or metallic state. Ocean water contains about 0.14 per cent magnesium.

Analyses of various Kansas oil-field brines show that the magnesium content of several oil filled waters in several times that of ordinary ocean water. In one case, in a water sample from the Cunningham field in Kingman county, the magnesium content is 0.869 per cent. This is, however, an unusually high magnesium content, although many examples ranging from 0.3 to 0.5 per cent are not unusual.

Magnesium is being produced in two places in the United States. It is being extracted from well waters in Michigan and from sea water at Freeport, Texas. It is reported that the Freeport plant treats daily 500,000,000 gallons of water and annually produces 75,000 tons of magnesium.

The Geological Survey expects soon to have figures showing the approximate amounts of water of high magnesium content that is available in various oil fields. From data at hand it is clear that brines with magnesium content from 4 to more than 6 times that of ocean water are available in various parts of Kansas.

Slaked lime is used in an early step in the process of extracting magnesium from brines. Treatment with lime brings about the precipitation of magnesium hydroxide. Treatment of magnesium hydroxide produces magnesium chloride. These steps precede electrolysing. Kansas limestone and chalk deposits are readily available for making lime, and salt for making hydrochloric acid is abundant in central and southwestern Kansas. There is an abundance of natural gas, in southwestern Kansas, that can be used as fuel for processing.

It has been suggested that several small plants, for the partial completion of the magnesium extracting process, might be made in Kansas and other Mid-Continent states, and that the process be completed in a central plant located at a place where cheap electricity is available. The possible extraction of magnesium from oil-field brines is of special interest because it may be a means of converting into a valuable mineral resource a by-product of the petroleum industry that heretofore has been regarded only as an expensive, deletarious waste.

The stone corral dolomite, which crop out in northeastern Kingman county may prove to be a workable low grade magnesium ore. The Geological Survey is now making analyses of this rock to determine its magnesium content.

MEMORANDUM IN REGARD TO GROUND-WATER SUPPLIES AVAILABLE WITHIN A RADIUS OF 25 MILES OF THE CITY OF HARPER, KANSAS

By Stanley W. Lohman*

SOURCE OF DATA

In July and August of 1941, an investigation was made of the geology and ground-water resources of Barber county, Kansas, by the State Geological Survey of Kansas and the United States Geological Survey, with the cooperation of the Division of Sanitation of the Kansas State Board of Health and the Division of Water Resources of the Kansas State Board of Agriculture. Information on water supplies in Barber county given below was supplied by Frank Byrne, the geologist who made the investigation. No ground-water studies have been made in Harper, Sumner, or Kingman counties by the cooperating State and Federal agencies. Information on ground-water supplies in the vicinities of Harper, Anthony, Corwin, Norwick, and Mayfield was kindly supplied by H. O. Joslyn, president of the Layne-Western Co., Kansas City, Mo. Information on public water supplies at Harper, Anthony, Kingman, Hazleton, Attica, Conway Springs, Argonia, and Sharon, was obtained by Bruce Latta and Thad McLaughlin, from data in the files of the Division of Sanitation of the Kansas State Board of Health, at Lawrence.

WATER-BEARING FORMATIONS

The geology of the area surrounding Harper is shown on the accompanying Geologic Map of Kansas, issued by the State Geological Survey in 1937.

The area colored blue and labled Pce is underlain by relatively

* Federal Geologist in charge of ground-water investigations in Kansas

impermeable red shale and associated rocks. These rocks yield only small supplies of very hard water to wells, and do not supply sufficient water for industrial use.

The area covered by horizontal orange lines and labeled Tó is underlain by older stream deposits of silt, sand, and gravel. In western Kansas these deposits are thick and yield large supplies of water. In Barber, Kingman, and Harper counties, however, these deposits are relatively thin, and most of the ground water drains out through springs and seeps along the eastward and southward facing escarpment. In these counties, therefore, the deposits under consideration in general cannot be counted on to supply quantities of ground water large enough for use by defense plants.

The areas stippled in orange and labeled Qt, Qal, or Qds, are underlain by thin stream and wind-laid deposits of clay, silt, sand, and gravel. These deposits are younger and lie topographically lower than those described in the preceding paragraph. The deposits contain beds of water-bearing sand and gravel, and range in thickness from less than 30 feet to about 80 feet. Wells in these deposits supply most of the cities in the area, as described below.

LOCAL WATER SUPPLIES

Anthony -- The city of Anthony derives its water supply from several shallow dug and drilled wells in the alluvium of Bluff creek. The alluvium is less than 30 feet thick in most places, and individual wells yield only about 50 gallons a minute. The water contains 254 parts per million of hardness (most of which is carbonate hardness), 49 parts of chloride, and less than 0.1 part of iron.

Argonia -- The city of Argonia is supplied from 2 drilled wells situated about a quarter of a mile north of the city. The wells are 50 feet deep and 8 inches in diameter. Each well yields 75 gallons a minute (draw-down not known). The water has a hardness of 175 parts per million, and contains practically no chloride or iron.

Attica -- The city of Attica is supplied from 4 drilled wells situated northeast of the city. The wells penetrate from 40 to 50 feet of alluvium. Each well yields 125 to 170 gallons a minute. The city uses about 2,000,000 gallons a month and also supplies 3,000,000 gallons a month to the railroad. The wells do not supply sufficient water at all times, however, and the city has considered developing a surface-water supply. The well water has a hardness of 261 parts per million (most of which is carbonate hardness), contains 45 parts of chloride, and 0.13 parts of iron.

Conway Springs -- Conway Springs is supplied from 9 wells situated at the western edge of the city. The wells are about 40 feet deep. Generally only 5 of the wells are used. The supply is rated at 300,000 gallons a day. The water has a hardness of only 71 parts per million, and contains very little iron or chloride.

Corwin -- Several wells at Corwin owned by the Empire Company are about 30 feet deep. Each well yields about 100 gallons a minute from the shallow alluvium.

Harper -- The city of Harper derives its supply from 3 drilled wells near the power plant west of the city. Two of the wells are 45 and 54 feet deep, are 24 inches in diameter, and yield 250 and 300 gallons a minute, respectively. The new well drilled in 1940 is 81 feet deep, and when tested it yielded 450 gallons a minute with a draw-down of only 9 feet after pumping 24 hours. The screen and casing have a diameter of 24 inches, and are gravel-packed to a diameter of 48 inches. The static water level in this well is 30 feet. The well penetrates 35 feet of water-bearing gravel and sand, but owing to the discontinuous nature of the beds, it was necessary to put down 10 test holes before selecting the site for the well. According to R. O. Joslyn, the new well would yield 700 gallons a minute or about 1,000,000 gallons a day. The water has a hardness of about 250 parts per million, contains 26 parts of chloride, and only 0.02 parts of iron.

Hazleton -- The city of Hazleton is supplied from one dug well about 23 feet deep. The well has a static water level of about 15 feet, and delivers 55 gallons a minute. The rate capacity of the system is 70,000 gallons a day. A test well drilled near Hazleton penetrated sand and gravel between the depths of 7 and 43½ feet. The water contains 385 parts per million of hardness (mostly carbonate hardness), 47 parts of chloride, and 0.19 parts of iron.

Kingman -- The city of Kingman is supplied from springs, but also has 5 drilled wells for emergency use. The wells are 50 feet deep. In 1933 the aggregate yield of the 5 wells was only 300 gallons a minute. The geologic source and chemical quality of the well water is not known.

Norwich -- The city of Norwich is supplied from 2 gravel-walled wells situated northeast of the city. Each well is about 92 feet deep and is pumped at the rate of 100 gallons a minute. According to R. O. Joslyn, one of the wells was tested at 150 gallons a minute with a draw-down of 8 feet, and probably would yield as much as 400 gallons a minute. The water has a hardness of only 75 parts per million, and contains negligible amounts of chloride and iron.

Sharon -- The city of Sharon is supplied from one gravel-walled well situated east of the city. It is 41 feet deep and yields 100 gallons a minute. Pumping at rates higher than this causes sand to enter the well. The water has a hardness of 293 parts per million (chiefly carbonate hardness), contains 42 parts of chloride, and 0.12 part of iron.

CONCLUSIONS

According to the available data, the area in the vicinity of Harper and areas north and east of Harper appear to be the most promising localities for the development of ground-water supplies for national defense plants. In these areas it should be possible to develop as much as 5,000,000 gallons a day continuously, and possible somewhat larger supplies would be available for a period of a few years during the present emergency. It might be possible to develop comparable supplies elsewhere within a radium of 25 miles from Harper, but confirmatory data are lacking.

Supplies of from 100,000 to possibly 1,000,000 gallons a day probably could be developed at favorable localities underlain by thick beds of pervious alluvium. A continuous supply of 100,000 gallons a day or more probably could be developed along the Barber-Harper county line, about a mile north of U. S. Highway 160.

Considerable test drilling should precede any attempt to develop large supplies of ground water in this general area. If favorable areas are found in test drilling, one or more properly constructed wells should be put down in each area and pumped continuously for from one week to a month, in order to determine the adequacy of the supply under conditions of heavy pumping.