

GEOLOGICAL SURVEY CIRCULAR 235



SODIUM CARBONATE BRINE AND
TRONA DEPOSITS IN SWEETWATER
COUNTY, WYOMING

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GEOLOGICAL SURVEY

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SWEETWATER COUNTY, WYOMING**

By H. B. Lindeman

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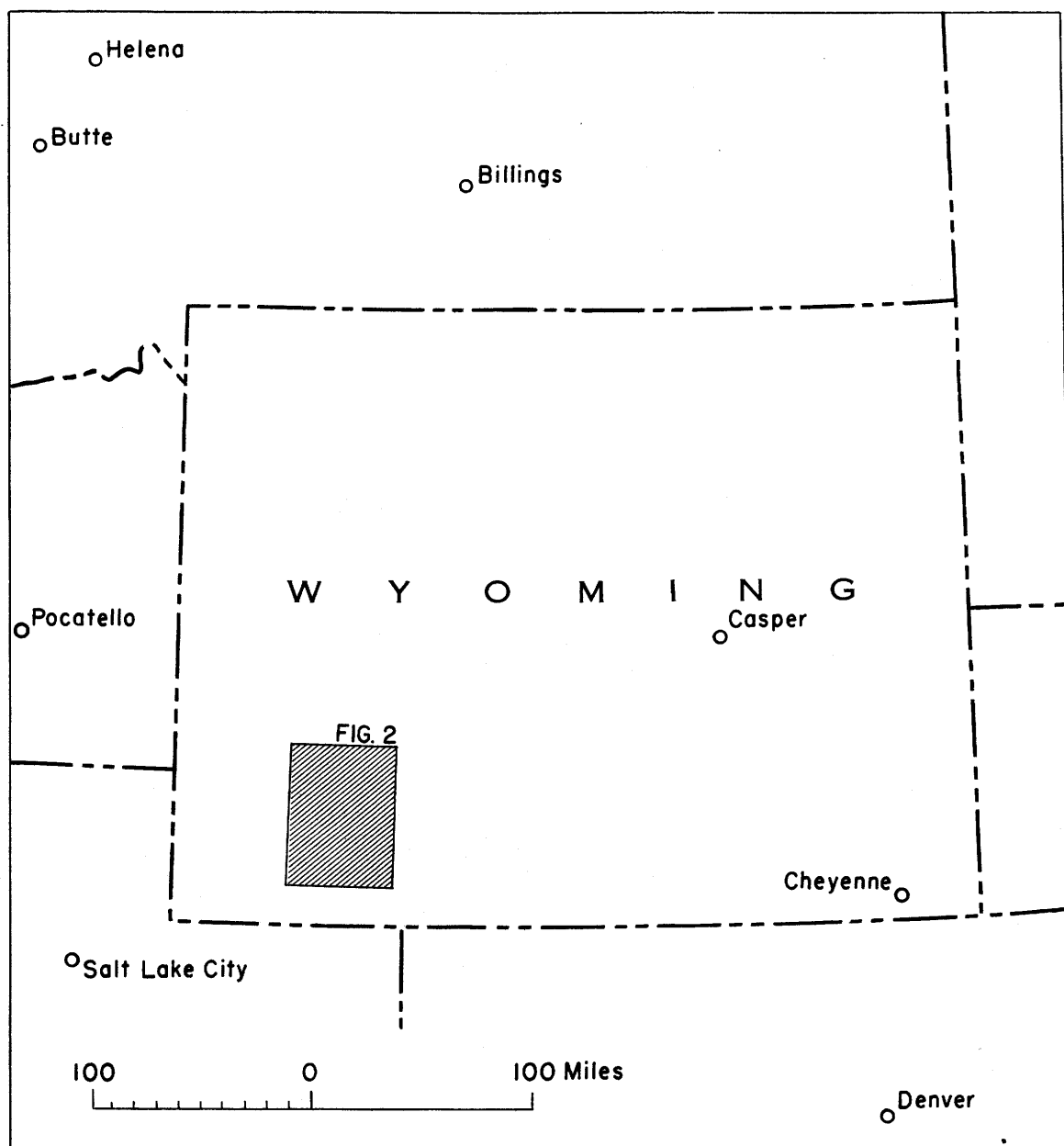


Figure 1. --Index map showing location of area of sodium carbonate brine and trona deposits, Sweetwater County, Wyo.

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INTRODUCTION

This report presents a short review of the historical background, the more important physical and chemical aspects, and some of the factors which may affect development of the sodium carbonate brines and trona deposits known to exist underground in Sweetwater County, Wyo. The area (fig. 1) lies in the southwestern part of the State and extends westward from the town of Green River for a distance of 20 miles and northward for 35 miles. By highway, the area is about 175 miles northeast of Salt Lake City, Utah; about 310 miles west of Cheyenne, Wyo.; and about 225 miles southeast of Pocatello, Idaho. Not all of the area is known to be underlain by brines or trona deposits, but to the date of this report they had been found at the locations shown on figure 2.

The sodium carbonate brines occur at the town of Green River and near Eden, north of Green River, and sodium carbonate brines

and thick beds of the mineral trona ($\text{Na}_2\text{CO}_3 \cdot \text{NaHCO}_3 \cdot 2\text{H}_2\text{O}$) occur northwest of Green River.

Deposits of sodium salts, whose existence in Wyoming was known in pioneer times, have been described by Chatard (1890), whose bulletin also contains an excerpt from a paper (Weeks, 1886) on glass-making materials and related soda deposits. The deposits discussed are dry or partly dry surface lakes and can, for the most part, be considered as sodium sulphate. A bulletin by Schultz (1909) on these and other deposits also contains a description of sodium brines from wells drilled at the town of Green River. The geology has been further described by Sears and Bradley (1924).

In the past 16 years brine deposits, in addition to those mentioned in the preceding paragraph, have been found, and

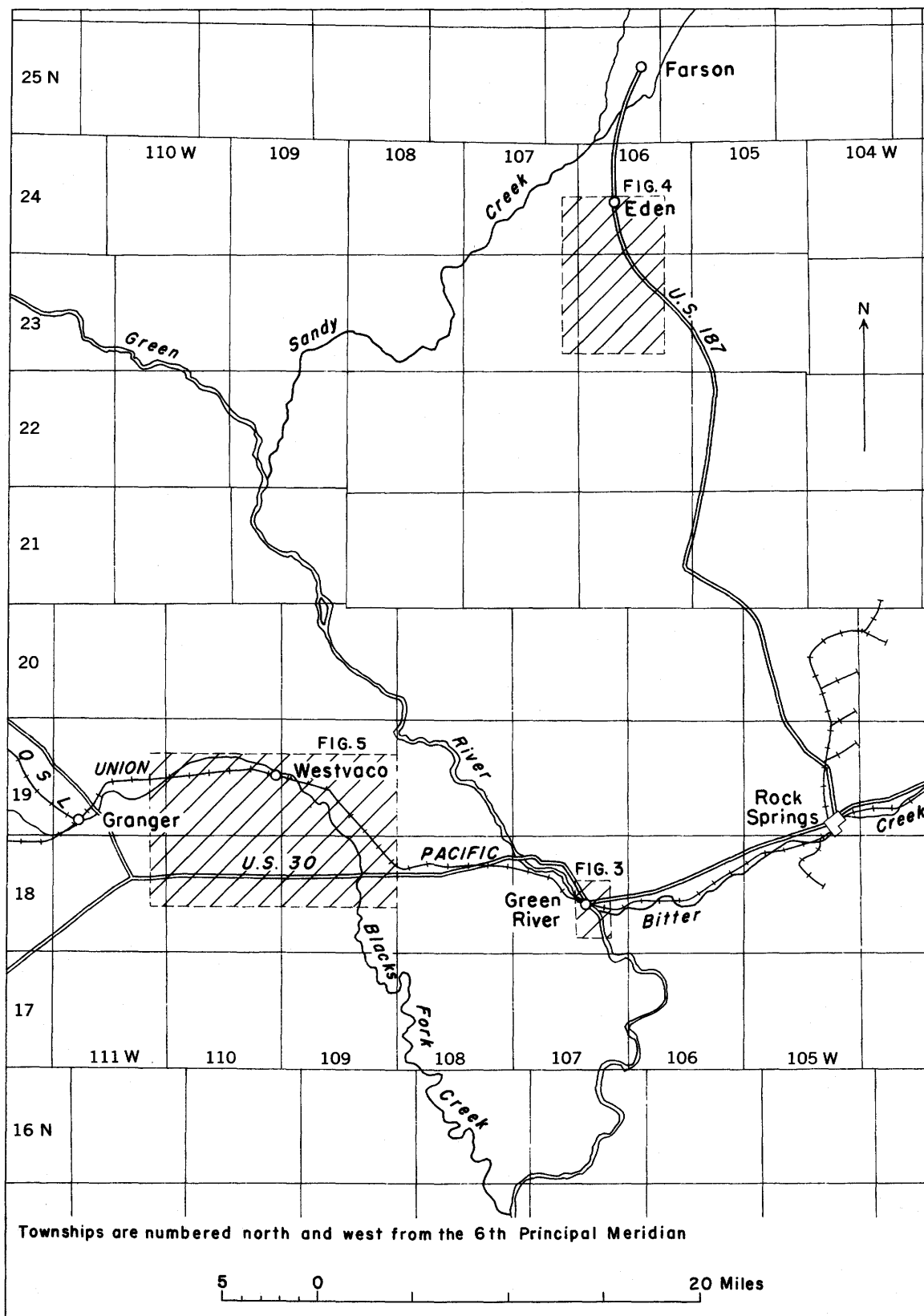


Figure 2. --General map showing relationship of prospected or developed sodium carbonate brine and trona areas, Sweetwater County, Wyo.

trona deposits have been discovered, partly prospected, and partly developed in the area (Romano, 1952). Prospecting and development have proved the trona deposits to be of such remarkable quality, thickness, and extent as to constitute a major commercial mineral resource. Further prospecting and development of the brines will be necessary to establish their degree of economic importance.

ACKNOWLEDGMENTS

The writer is indebted to officials of the Union Pacific Railroad Co., Intermountain Chemical Corp., and the Wyoming Trona Corp. for making available certain information contained in this report.

BRINE

Brine is found at three localities (fig. 2) and further prospecting may prove its presence in adjacent areas. The three areas known to have potential producing characteristics are Green River (figs. 2, 3), Eden (figs. 2, 4), and Westvaco (figs. 2, 5). The Westvaco area also contains beds of the mineral trona.

Green River area

Before World War I, brine was discovered near the town of Green River (fig. 3). Brine pumped from 13 wells drilled in the vicinity by the Western Alkali Corporation and Associates yielded sodium carbonate which was used in a local plant (Schultz, 1909). None of these wells was drilled to a depth greater than 300 feet.

In December 1935 a well (MFS 1, fig. 3) was drilled to a depth of 439 feet (fig. 6) in the Green River area by the Mountain Fuel Supply Co. A sample of brine (sp gr 1.046) from a depth of 162 feet was analyzed by the U. S. Geological Survey as follows:

	Grams per liter	Percent
Constituents:		
CO ₃ -----	17.76	31.00
HCO ₃ -----	5.09	8.90
Cl-----	10.59	18.50
SO ₄ -----	.78	1.38
Ca-----	0	----
Mg-----	.02	.03
K-----	.16	.28
Na-----	22.72	39.91
B-----	-----	Trace
Total-----	57.12	100.00

	Grams per liter	Percent
Conventional combinations:		
Na ₂ CO ₃ -----	31.35	54.95
NaHCO ₃ -----	6.97	12.20
NaCl-----	17.45	30.54
Na ₂ SO ₄ -----	.85	1.49
MgSO ₄ -----	.12	.21
K ₂ SO ₄ -----	.35	.61
Total---	57.09	100.00

Eden area

In 1938 soda brine was found at a depth of 450 to 500 feet in a well (John Hay, fig. 4) being drilled for water near Eden. The brine was cased off and the well was deepened to a fresh-water producing aquifer. As a result of the information thus obtained, the Wyoming Trona Corp. drilled a well in 1949 (no. 1, fig. 4) for the purpose of testing the quality and quantity of the brine. At 477 feet the brine had sufficient artesian pressure to force it from a 4-inch pipe for a distance of approximately 3 feet. After about 30 minutes the flow diminished to an estimated 40 gallons per minute. The following analyses (in percent) of brine from this well were made by the U. S. Geological Survey:

	Sample	
	1	2
Na ₂ CO ₃ -----	3.68	4.20
NaHCO ₃ -----	1.44	.73
Cl-----	.017	.018
SO ₄ -----	.003	.002
Ca-----	.000	.008
Mg-----	.001	.003
K ₂ O-----	.023	.050
Time taken (a.m.) --	9.35 ^{a/}	9.35
Date -----	Sept. 1, 1949	Sept. 1, 1949
Depth (feet) -----	477	477
Color -----	Brown	Amber
Specific gravity at		
25° C -----	1.0480	1.0485

^{a/} Taken immediately after opening valve for testing.

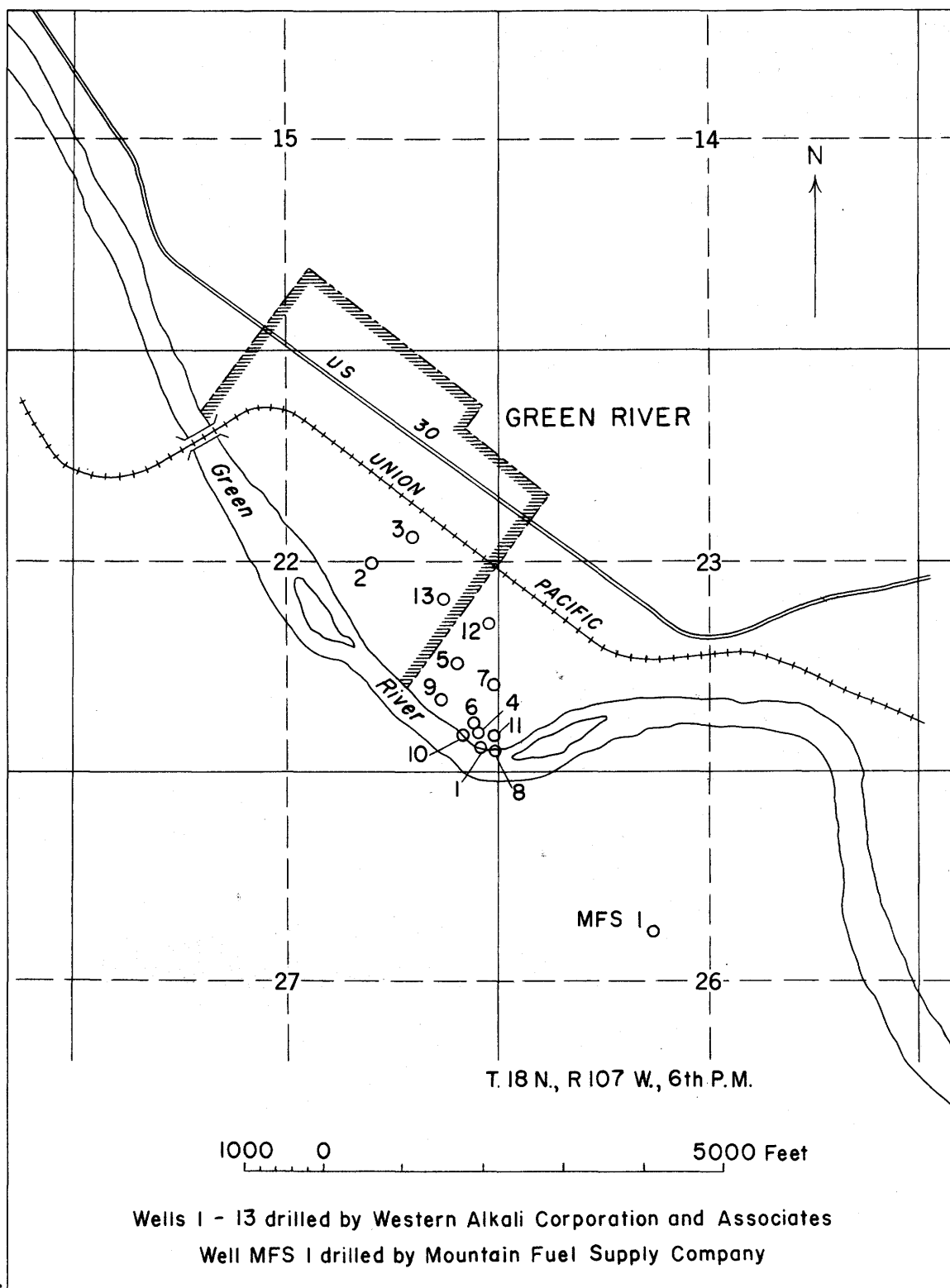


Figure 3.--Sodium carbonate brine wells, Green River area, Sweetwater County, Wyo.

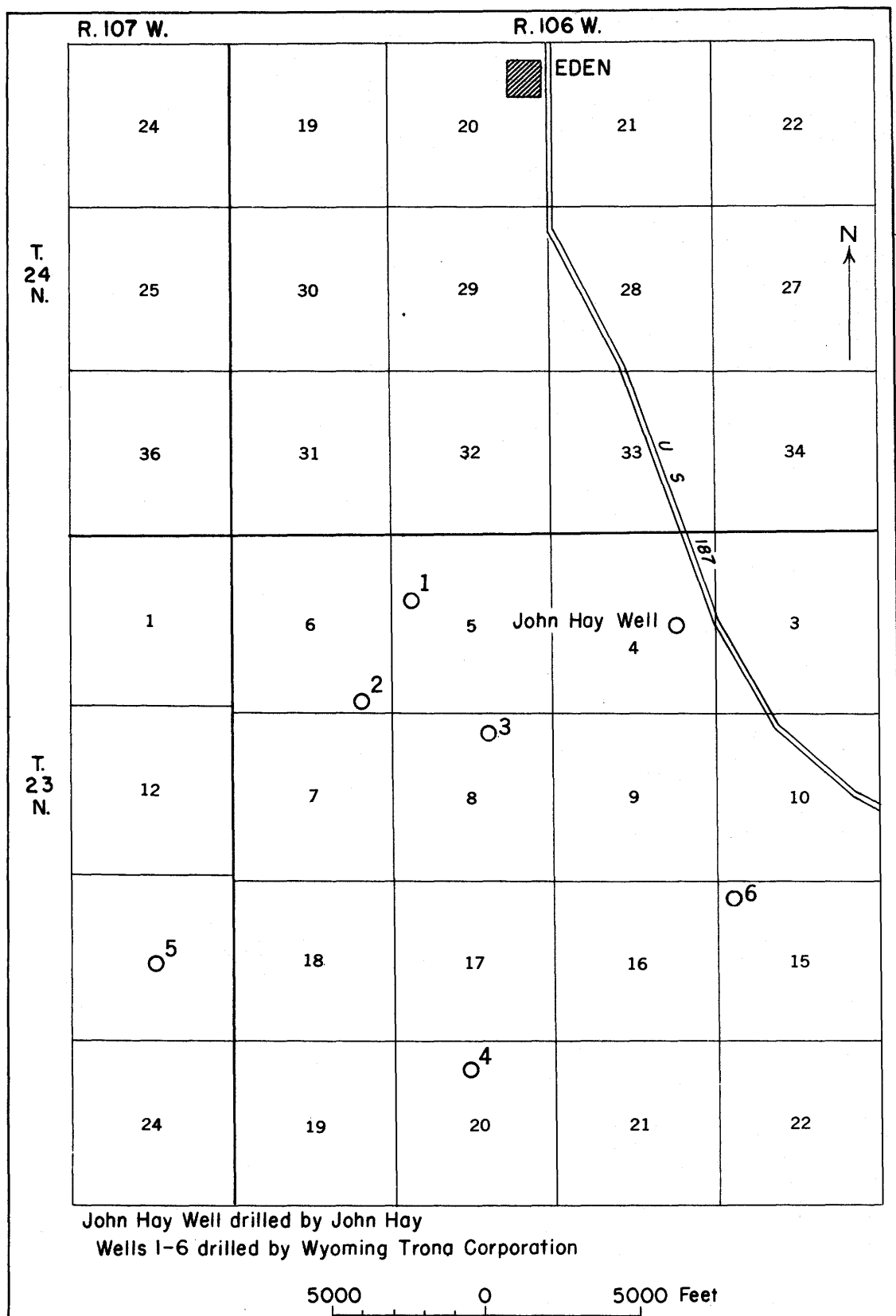


Figure 4. --Sodium carbonate brine wells, Eden area, Sweetwater County, Wyo.

Before March 1952 six wells had been drilled in the area (fig. 4) by the Wyoming Trona Corp. and brine was found in all wells at depths of 400 to 600 feet (fig. 6). There was an artesian flow of brine from several of the wells, but their productive capacity had not then been fully determined.

A dark substance found in some of the brine from these wells appears to come from a zone a few feet above the zone which contains the more abundant amber-colored brine. The exact stratigraphic location of the dark brown- and amber-brine zones has not been definitely established. An analysis of the dark-colored brine (sp gr 1.055) from the no. 1 well (fig. 4) was made by the Geological Survey with the following results:

	Grams per liter
Solids (total dissolved at 180°)---	70.01
Sodium carbonate (alkalinity)-----	47.05
Organic acids (organic matter) ^{a/} ---	7.70

Westvaco area

In 1944 the Westvaco Chlorine Products Corp., now the Intermountain Chemical Corp., drilled its nos. 1 and 2 wells in the Westvaco area (C, D, fig. 5) for the purpose of testing the commercial possibilities of the brine and also to test the trona deposits lying about 800 feet below the brine horizon (fig. 6). Neither well could be made to produce more than 10 gallons of brine a minute and further testing was abandoned in favor of mining the trona beds. In several other wells drilled to test the trona beds in the area sodium carbonate brine was found about 700 feet below the surface. Analyses of these brines are not available.

TRONA DEPOSITS

In January 1938 an oil test, John Hay no. 1 (N, fig. 5) drilled by the Mountain Fuel Supply Co. in the Westvaco area, resulted in the discovery of the first trona to be found at depth. Identification of the mineral was made by the Geological Survey in core samples, the occurrence being made public in several reports (Mendenhall, 1940; Smith, 1942; Harness and Coons, 1942). Northupite, pirssonite, and gaylussite were also found and, in addition, two new minerals, shortite ($\text{Na}_2\text{CO}_3 \cdot 2\text{CaCO}_3$) and bradleyite ($\text{Na}_3\text{PO}_4 \cdot \text{MgCO}_3$), were discovered (Fahey, 1939, 1941).

^{a/} Complex naphthenic and resin acid salts probably formed by reaction of alkaline brine with petroleum.

As a result of this trona discovery, several companies became interested in the Westvaco area. Before March 1952 these companies had drilled the following 10 test holes and obtained samples of trona from them: Mountain Fuel Supply Co., John Hay no. 1; Westvaco Chlorine Product Corp. (now Intermountain Chemical Corp.), Westvaco nos. 1, 3, and 4; Union Pacific Railroad, nos. 1, 2, 3, and 4; and Potash Company of America, nos. 1 and 2. Two other wells, Union Pacific Railroad no. 5 and Westvaco no. 2, were not drilled deep enough to penetrate the trona deposits.

All of the wells (fig. 5) which were drilled to the necessary depth penetrated beds of trona as much as 11.6 feet in thickness in the Green River formation. The thick beds usually include a few minor shale bands. Each well, with the exceptions noted previously, penetrated at least 1 trona bed of minable thickness. Since most of the wells penetrated more than 1 minable bed, it is believed that well logs which show only 1 may be inaccurate because of solution of the trona during the drilling process. For this report the use of actual well and shaft logs was not admissible and wells in the Westvaco area are represented by a generalized log (fig. 6). Four well logs show only 1 bed of trona while the other logs show from 3 to 11 beds, each 1 foot or more thick, separated by strata of shale of varying thickness. The trona beds shown in each log do not correspond to the other beds in thickness, purity, or elevation. Prospect holes are widely separated, and there has not been a sufficient number drilled to demonstrate the continuity of any one trona bed or to determine possible areas where there may be so many shale bands in the trona bed as to discourage mining.

In 1946 and 1947 visual information concerning the strata and deposits was obtained when the Westvaco Chlorine Products Corp. sank its no. 1 shaft (A, fig. 5). (See Romano, 1952). The shaft was put down to a depth of 1,550 feet, 50 feet below a 10-foot bed of trona, the thickest found at that location. Several beds of trona were found in the shaft, but only the 10-foot bed and two others within a distance of 200 feet above it are of possible commercial importance. A detailed stratigraphic section of the shaft is not available for inclusion in this report.

In the mine the upper 3 to 4 feet of the 10-foot bed is found consistently to contain several bands of shale, the thickest about 3 inches, and mining is confined to the part below the shale bands. Roof

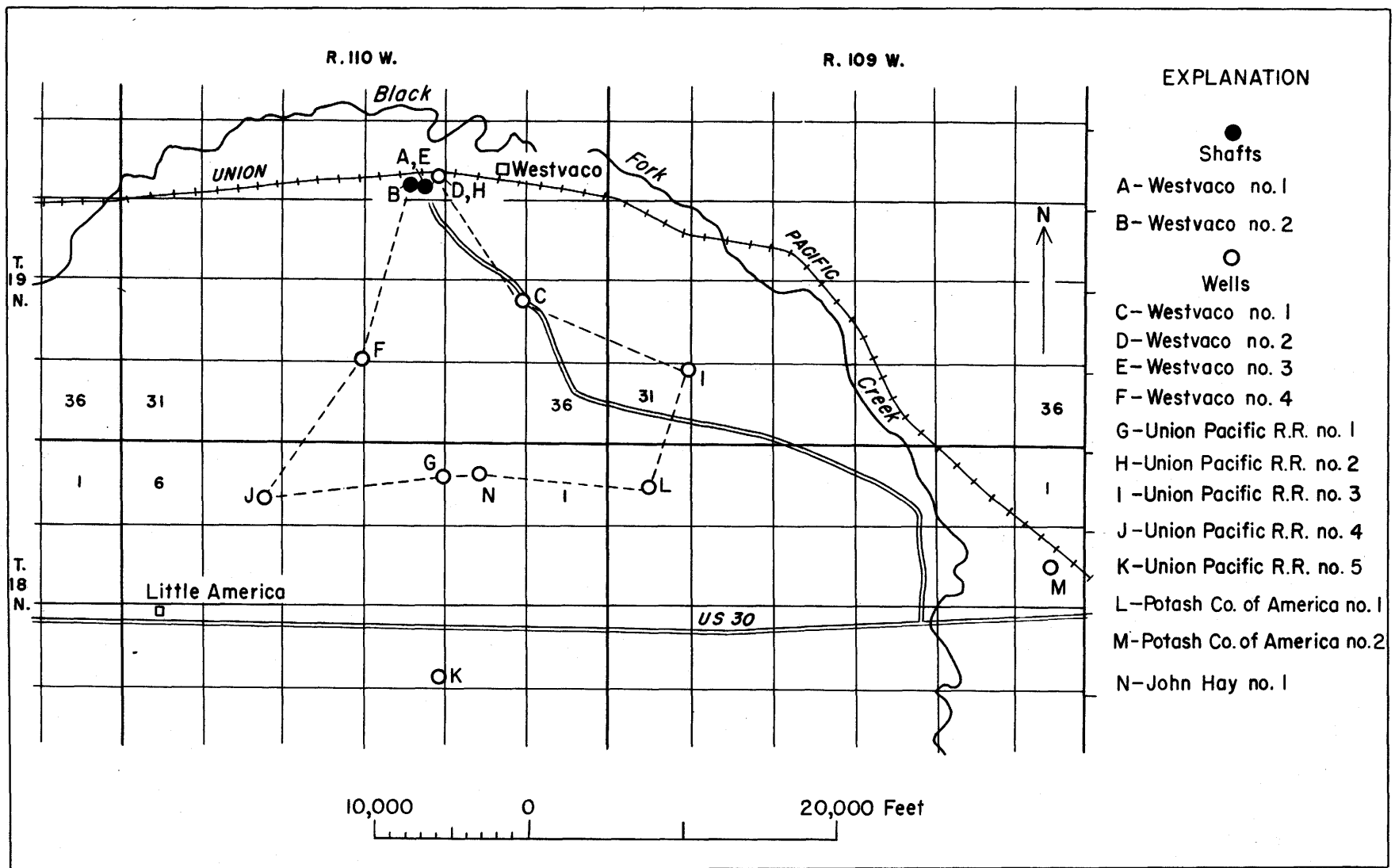


Figure 5.--Sodium carbonate brine wells and trona deposits, Westvaco area, Sweetwater County, Wyo.

support in the workings is obtained by bolting the upper 3 to 4 feet of interspersed trona and shale to the overlying stratum. The trona bed varies in thickness within narrow limits throughout the mine and lies relatively horizontal on a bed of low-grade oil shale. Water has been found in small quantities in the mine workings where crevices infrequently occur. A relatively small area has been found in the course of mine development where the bed contains so many shale bands that mining is uneconomical. Except for initial shaft development, mining has been neither difficult nor excessively costly. Shaft no. 2 (B, fig. 5) for ore-hoisting purposes was recently completed at a point 1,100 feet west of shaft no. 1 and a solution refinery for the production of soda ash has been built at the mine site.

The following approximate analysis of the trona ore was furnished by the Intermountain Chemical Corp.:

	Percent
Na ₂ CO ₃ -----	45.30
NaHCO ₃ -----	35.90
Cl-----	.09
SO ₄ -----	.03
Fe-----	.05
SiO ₂ -----	1.10
Combined water-----	15.40
Insolubles-----	a/ 3.50-15.00

The insoluble fraction in the above analysis is composed of the following compounds, with approximate percents:

	Percent
SiO ₂ -----	27.0
CaO-----	18.0
MgO-----	13.0
CO ₂ -----	25.0
R ₂ O ₃ -----	6.0
K ₂ O-----	4.5
Fe ₂ O ₃ -----	1.8
Organic-----	2.0

The crude ore generally is light amber in color.

If it is assumed that all of the area within the dotted line on figure 5 contains at least one minable bed of trona having a minimum thickness of 7 feet, then an estimated 125 million tons of ore is contained within the bounds of that line. Also, if it may be assumed that a minimum thickness of 3½ feet of minable trona is contained in a second bed in that same area, then an additional 60 million tons of ore is available. The area is bounded by test wells that show

a/ Depends on the amount of contained shale.

one or more minable trona beds which probably extend for a considerable distance outside the enclosed area. The Potash Company of America drilled its no. 2 well (M, fig. 5) at some distance east of the area first prospected, and a minable bed of trona was found.

ECONOMIC FACTORS

The deposits are favorably situated with respect to most of the factors which may influence their development: other basic mineral resources, transportation, fuel supplies, and water. Although not so near to markets as might be desired, the deposits are not unfavorably located in that respect.

The railroads, highways, main streams, land subdivisions, and wells are shown on the general map of the trona and brine region (fig. 2). The main line of the Union Pacific Railroad traverses the southern part of the area and divides near the western edge to form the Oregon Short Line Branch. U. S. Highway 30 also traverses the southern part of the area. Coal is available from the neighboring Rock Springs and Kemmerer, Wyo., coal fields, and natural gas is produced from the Baxter basin and Church Buttes fields nearby in southwestern Wyoming.

Precipitation in the area is slight, and, because of low humidity and prevailing strong winds, conditions should be favorable for concentration of brines by solar evaporation. The Green River and its tributaries Blacks Fork and Sandy Creek are within or near the area (figs. 2, 5) and the water may be made available for industrial use.

A considerable amount of oil shale, some of good quality, lies above, between, and below the trona beds. The log of the Union Pacific Railroad no. 2 well refers to a thin bed of gilsonite, and other logs show the presence of bentonitic shales. The potash-bearing rock wyomingite is abundant in surface deposits near Rock Springs, Wyo. Extensive phosphate deposits exist a short distance to the west, in western Wyoming and eastern Idaho, where the phosphate industry is now well established. Important deposits of potassium, sodium, and magnesium salts are found in Utah. Ferrous and nonferrous smelting industries using ores produced locally are established in Utah and Colorado.

A large part of the area containing the trona beds is owned by the Union Pacific Railroad. In general, the railroad owns every odd-numbered section (square mile) for 20 miles on each side of its right-of-way and the State has title to secs. 16 and 36.

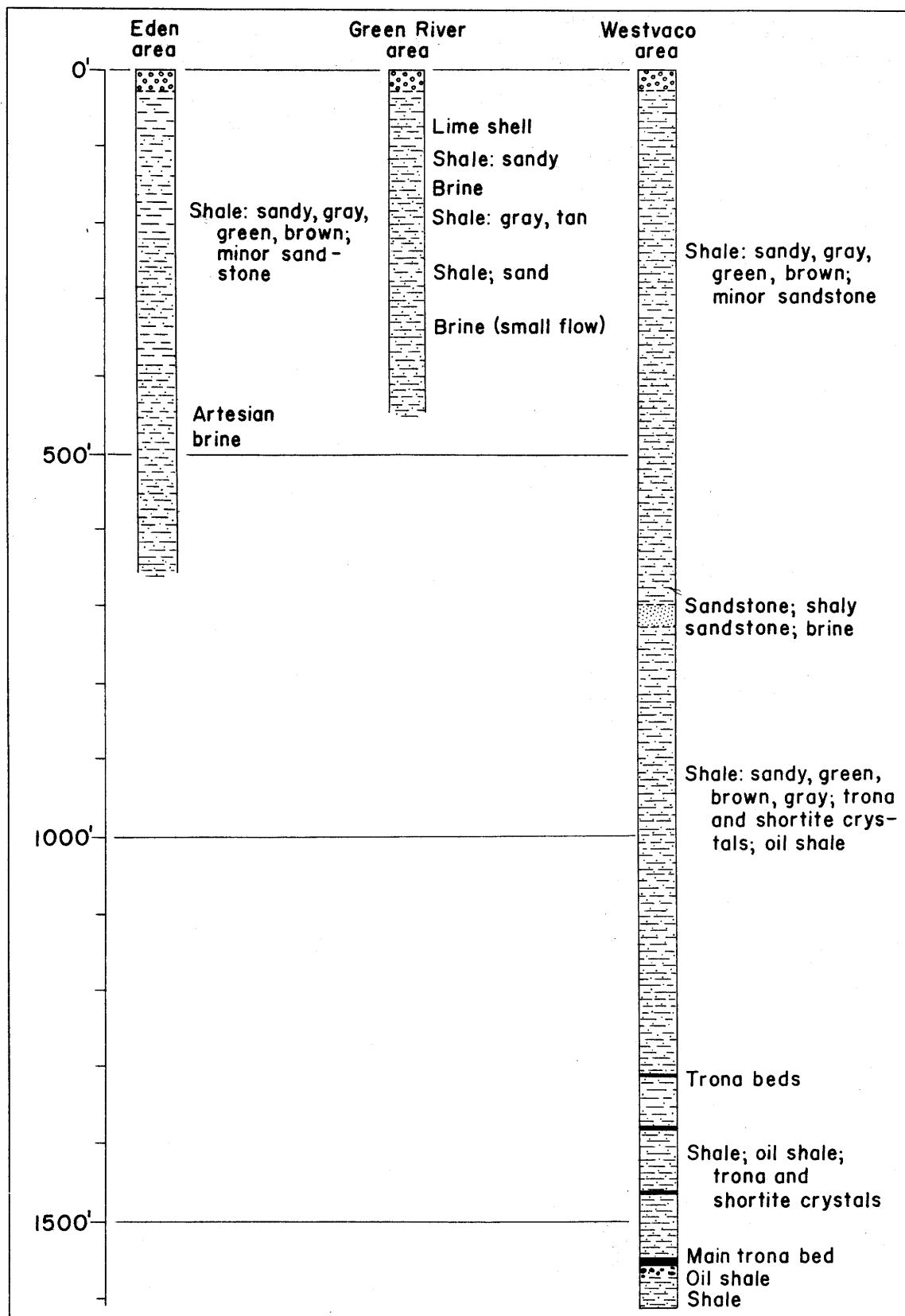


Figure 6. --Generalized sections from well-log data, sodium carbonate brine and trona deposits, Sweetwater County, Wyo.

Some of the land in the remaining 16 sections in each township has passed from Federal ownership. Leasing of Federal land has already yielded a substantial income from rentals and royalties.

Mineable trona was found in the easternmost well (M, fig. 5) several hundred feet above the elevation at which it was found in the other wells in the area. This fact gives rise to the speculation that further geologic investigation or drilling may indicate that trona beds can be reached at a shallower depth in the vicinity of the town of Green River.

Sodium carbonate, or its chief manufactured product, soda ash, is a basic chemical having wide application in industry. If the deposits are considered in relationship to the other minerals found in the surrounding territory it may be inferred that resources exist which could result in the growth of an extensive chemical industry in this part of the United States.

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