# WATER RESOURCES OF THE SODA SPRINGS AREA, IDAHO

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## INTRODUCTION

The Soda Springs area is drained by the Bear River which eventually terminates in the Great Salt Lake, and to a lesser extent by the Portneuf and Blackfoot Rivers which are tributary to the Snake River. The flows of these surface streams are closely related to the movement and occurrence of ground water in the area, but the details of the inter-relationships are not yet known. To date, investigations by the U.S. Geological Survey, the U.S. Bureau of Reclamation, and state and local agencies have been mostly surface-water oriented. It is known that lava flows have changed the course of some of the surface streams in the past but the effect of this alteration of surface-stream drainage on the ground-water system is not known. Due to the lack of ground-water data in the area and the incomplete understanding of the total hydrologic system, the U.S. Geological Survey, in financial cooperation with the Idaho State Department of Reclamation, has begun an investigation of the water resources of the entire Bear River drainage in Idaho. This investigation was not initiated until July 1, 1967; hence, the results are not yet available for publication.

## SURFACE WATER

Bear River.—The Bear River is the largest of the three major rivers near Soda Springs and it is very important to the economy of the area. Waters from the river have been used since early settlement time for irrigation and power purposes. The Bear River near Soda Springs has an average flow of 341,000 acre-feet of water per year. The main stream originates in Utah and flows through parts of Wyoming and Idaho before re-entering Utah and terminating in the Great Salt Lake. Because of this three state interest in the waters of the Bear River, disputes have been frequent and complicated. The uses of the surface waters of the Bear River in Idaho, Utah, and Wyoming are covered by the provisions of the Bear River Compact and several state-federal decrees. Basically, the compact provides for the allocation among the states of new storage rights above Bear Lake and for distribution of water within various river divisions. There are no provisions in the compact for the allocation between Utah and Idaho for the rights to increase present consumptive use between Bear Lake and the Great Salt Lake. In addition, there are no provisions governing the development of ground water.

Several proposals have been made for construction of additional water storage reservoirs in Idaho and Utah. Dams on Soda Creek and on Montpelier Creek have been built or are in the final planning. A group has proposed construction of a 40,000 acre-foot reservoir on the Bear River neap Soda Springs. The Ovid East Liberty Irrigation Company plans to store water on Ovid Creek. The U.S. Bureau of Reclamation has proposed a Bear River Project and the construction of a major dam at the Oneida Narrows. This last proposal has become the subject of a good deal of controversy in the area. Some of the objections that have been raised include:

1. There is no water available for storage due to rights of the power company for non-consumptive power purposes.
2. The reservoir would inundate much valuable farm ground.
3. Unequal division of the benefit between Idaho and Utah.
4. Proposed exportation of the water to areas outside of the Bear River drainage.

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The major storage of Bear River water in the Soda Springs area is accomplished within the Soda Point Reservoir just west of Soda Springs. The dam was built in about 1924 and the reservoir has a capacity of about 11,000 acre-feet.

PORTNEUF RIVER.—The Portneuf River flows through the northwestern part of the area. It has an average annual flow near Lava Hot Springs of 137,600 acre-feet. The waters from the Portneuf River are used in Gem Valley and further downstream for irrigation purposes. Some of this irrigation water is stored in the Chesterfield Reservoir which was built in about 1912 and has a capacity of 23,695 acre-feet.

BLACKFOOT RIVER.—The Blackfoot River flows through the northern part of the area of study. Up to 350,000 acre-feet of the water can be stored in the Blackfoot River Reservoir which was built by the U.S. Indian Service in about 1910. The stored water is later used for irrigation purposes near Blackfoot.

## GROUND WATER

On a geographic basis, the ground water of the area can be considered to be located in four areas or basins: the Gem Valley north of the Bear River drainage and generally including the Portneuf River drainage, the Gentile Valley near Grace, the valley area north of Soda Springs, and the valley of the Bear River from Montpelier to Soda Springs. There is not a complete well inventory of any of these regions; the information that is available at this time has been taken almost entirely from the well driller reports and the water rights on file in the Office of the Idaho State Reclamation Engineer.

GEM VALLEY.—There has been a significant amount of recent well development to secure irrigation water, particularly in northern Gem Valley. Some of these wells have been quite successful. There are 55 valid permits or licenses and well driller reports of 41 irrigation wells on file in the State Reclamation Engineer's Office. The irrigation wells range in depth from 55 to 355 feet. Some of the wells produce water from the alluvial material but most of the more successful wells obtain the water from the basalts. Reports on 18 wells indicate production of more than 1,000 gallons per minute and one well has a reported production of 3,380 gallons per minute. Large fractures in the basalt are encountered in some wells and the specific capacities (gallons per minute per foot of drawdown) are very high. The driller's report on the well that produced 3,380 gallons per minute reported only 18 feet of drawdown or a specific capacity of 188 gallons per minute per foot of drawdown. Some of the down stream users of the Portneuf River water in the McCammon-Downey area have recently expressed concern over the pumping of these wells and their possible effect on the natural flow of the Portneuf River.

GENTILE VALLEY.—In the Gentile Valley there are 20 valid permits or licenses on file and 8 well driller reports on irrigation wells. All of the reports, except for one, indicate the wells produce more than 1,000 gallons per minute. All of the wells are producing water from basalt and in some cases also from cinders and alluvial material.

BEAR RIVER VALLEY.—In the Bear River Valley, between Montpelier and Soda Springs, there are 11 valid permits or licenses on file, but there is not a single well driller's report on file in the State Reclamation Engineer's Office. The ground-water development in this area has not been extensive, perhaps in part due to a more abundant supply of surface water.

SODA SPRINGS VALLEY.—In the valley north of Soda Springs, most of the well development has occurred within a few miles of Soda Springs. In that immediate area, there are 20 valid permits or licenses on file in the State Reclamation Engineer's Office and there are 11 well driller reports. All of the well driller reports, except one, indicate that the wells were drilled for industrial purposes for companies associated with the phosphate development in the valley. Most of the wells obtain water from the basalt, but in some cases only alluvial material is described in the well driller reports. The production of water as reported by the well drillers, ranges from 35 gallons per minute to 3,405 gallons per minute.

UNDERGROUND FLOW.—Of worthwhile mention is the movement of water from the Blackfoot River drainage by ground-water channels into the Bear River drainage. After the Blackfoot Dam was constructed and the reservoir filled in the early 1910's, whirlpools were noted in the fingers of the reservoir located in the northeast portion of Township 7 south, Range 41 East and the northwest portion of Township 7 South, Range 42 East. The flow of Soda Creek and other associated streams increased significantly shortly thereafter. The flow from springs was also reported to increase and the Five Mile Meadow area became more marshy. It has been documented that there is a loss of Blackfoot River Reservoir water into the basalt of the region (Mansfield 1927). This water is reappearing in the valley north of Soda Springs. The amount of water that is transported annually in this manner is not known.

Preliminary information indicates that the water levels in the northern part of the valley north of Soda Springs are significantly higher than the water levels in Gem Valley (Norman P. Dion, personal communication, 1967). This would lead one to speculate as to the possibility of water moving westward through the mountain mass between these two valleys or perhaps through a low pass locally known as "Ten Mile" and contributing to the ground waters of Gem Valley. If water were to move in sufficient quantities to recharge Gem Valley in this manner, it would also be possible for this water to continue to move westward into the Portneuf River drainage and hence become a part of the Portneuf River supply. At this point, however, this movement of water is speculative as only preliminary water level data are available and the transmissibility of the material between the two valleys has not been investigated.

*Soda Water.*—Of special interest in the area around Soda Springs is the occurrence of "soda water" or water saturated with carbon dioxide gas. Within the city limits of Soda Springs a well has been drilled that encountered water under high pressure due to the high carbon dioxide gas content. It is now claimed that Soda Springs has the largest carbon dioxide gas "geyser" in the world. This well is controlled at the surface and when the valves are opened, water shoots 175 feet into the air.

There are many soda springs reported in the region; not only at the city of Soda Springs but as far north as the Blackfoot Reservoir (Mansfield 1927). Perhaps the most famous of the springs is Hooper Springs which is visited by thousands of people each year and the soda water issuing from it is used in the preparation of beverages by the visitors of the small park at the site of the springs.

North of Hooper Springs less than one mile, the Soda Creek Dam has been constructed and water was first stored in this reservoir during the 1967 water year. The reservoir has a capacity of 2,500 acre-feet. During the construction of the dam, soda water was encountered in the foundation at the deeper levels of the cutoff trench. This soda water has created a significant problem in the construction of dam and continues to flow out of the base of the dam through drains constructed to carry the water away. Its flow initially was $2\frac{1}{2}$ second feet of water, but since the filling of the reservoir this flow has increased. The exact reason for the increase of flow is not known. It is possible that reservoir water is leaking into the drain. It is also possible that the pressures in the artesian soda-water system have increased from the weight of the water stored in the reservoir and thereby increased the flow of the drain.

# SULPHUR DEPOSITS NEAR SODA SPRINGS, IDAHO*

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## LOCATION

Five miles east of the town of Soda Springs, in T. 9 S., R. 43 E., in Bannock County, Idaho, on the Oregon Short Line, is a group of sulphur springs and associated deposits of native sulphur. An attempt was made to work these deposits in the late nineties and a considerable amount of sulphur was produced in 1901 and 1902, but the attempt was finally abandoned and the plant was being dismantled during the fall of 1910. The character of the deposits is of sufficient interest, however, to warrant a brief description.

## TOPOGRAPHY

The springs are situated at the mouth of Sulphur Canyon, a short gulch formed by the junction of North, Middle, and South Sulphur canyons. The surrounding hills stand from 1,500 to 2,500 feet above the rather broad canyon bottom and the area as a whole is situated on the western flank of the Aspen Range.

## GEOLOGY

The geology of the area involves old sedimentary rocks of several formations and a minor amount of igneous rock, all of which owe their present relations to one another mainly to faulting. The springs themselves are located along a northwest-southeast fault zone with rocks of early Carboniferous age to the east and Triassic rocks to the west. The Carboniferous sediments of the area range from the Madison Limestone (Mississippian) to the Phosphoria Formation (Permian), and include an unnamed upper Missippian interval and strata of Pennsylvanian age which are believed to represent the Morgan Formation of northeastern Utah and the Weber quartzite. The Triassic(?) is represented by the Woodside Shale alone, the overlying formations to the south and east (Thaynes Limestone and Ankareh Shale) not being recognized. The igneous rocks consist of pre-Cretaceous white volcanic tuff (ash) intimately associated with the sulphur deposits and basaltic flows of probably early Quaternary age. Tertiary lake beds, travertine, hill wash, and alluvium abound and obscure the relations of the older formations. The faults associated with the sulphur deposits are normal and are presumed to extend to considerable depths and to afford passages for the sulphur-bearing gases or solutions. The waters supplying the springs are doubtless derived from the catchment areas of the Aspen Range. The nearest hot spring is Steamboat Spring, on Bear River, about 2 miles west of Soda Springs, and the nearest center of recent volcanic activity is the group of craters about 9 miles northwest of the sulphur deposits.

## DESCRIPTION OF THE SPRINGS

The springs vary in size from holes comparable to a wash basin to some that are large enough for a good-sized swimming pool. The milky or cloudy color of the water, which is cold, is due to the presence of free sulphur. The cloudiness is more intense in some of the springs than in others, and there is a noticeable variation in the amount of gas exhausted and the rate of its expulsion in bubbles through the water. These variations are not constant for any particular set of springs, but shift about from one group to another, owing to some undetermined cause. The springs are very numerous and no attempt was made to determine the actual number. Many small ones are concealed in the marsh. The following paragraphs give a description of some of the most characteristic springs examined.

On the south side of Sulphur Canyon, in the SE ¼ NW ¼ sec. 13, are two groups of springs. The largest spring of the western group has a surface area which at the time examined was estimated at about 500 square feet. The water is very milky and a large amount of gas, carbon dioxide and hydrogen sulphide, is discharged both through the water of the spring as bubbles and through the gravel and holes higher on the hillside to a distance of some 150 feet from the spring.

*In consideration of the current interest in sulfur, this paper is reprinted from U. S. Geol. Surv. Bull. 470-J (out-of-print). Local inquiries indicate no significant developments since this early report. (Editor)

The eastern group is between 300 and 400 feet northeast from this one and consists of smaller springs, in which, however, the gas is discharged with greater force, as is indicated by the greater height to which the water is lifted by the bubbles. The same gases, carbon dioxide and hydrogen sulphide, are exhausted by these springs and also through crevices and holes in the ground over an area possibly half an acre in extent. At this point the cementation of the gravel by the deposition of sulphur in the interstices can be seen in process.

The marsh group, in the SW ¼ NW ¼ sec. 13, includes a great number of springs, which occupy a zone of 150 feet or more in width between Sulphur Canyon and the group on the north side. A sample of water taken from one of these springs gave a strong acid reaction with litmus and had the bitter, repulsive taste which is characteristic of the water in all the springs.

The largest of the springs on the north side of Sulphur Canyon, in the NW ¼ NW ¼ sec. 13, has an estimated surface area of about 2,000 square feet and is probably the remnant of the lake mentioned by Peale. The water is extremely cloudy and the deposition of sulphur in the small ditch which takes the overflow can be seen at the present time. E. W. Largilliere, of Soda Springs, reports that the best quality of sulphur obtained in this vicinity was taken out of this spring.

## SULPHUR DEPOSITS

Sulphur deposits have been mined on the north side of Sulphur Canyon in the SE ¼ SW ¼ and the SW ¼ SE ¼ sec. 2 and the NE ¼ NW ¼ and the NW ¼ NE ¼ sec. 11, and on the south side of Wood Canyon in the SE ¼ SE ¼ sec. 11 and the NE ¼ NE ¼ sec. 14. A small amount of prospecting has been done in sec. 13, but apparently no sulphur has been mined. The greater part of the excavation in both groups of workings has been done 50 to 200 feet above the level of the present springs. Both quarrying and tunneling were employed in developing the deposits. About 2,000 cubic yards had been excavated in the open work. The condition of the tunnels was such that an examination of them was impossible, so that no idea was gained of the extent of the underground workings, which are reported, however, to comprise several hundred feet. The plant for the separation of the sulphur from the gangue was located on the Wood Canyon side of the divide.

The sulphur, associated with small crystals of gypsum, occurs as the cement of a fault agglomerate or breccia composed of fragments of tuff, limestone, and quartzite. The tuff is composed of angular fragments of volcanic glass and makes up the most conspicuous part of the agglomerate. It is snow white and apparently does not weather to a nourishing soil, and the barren character of its outcrop was noted by the early explorers. It is wholly probable that the gases exhausted by the rock crevices in the immediate vicinity have also the effect of stunting, retarding, or even destroying plant and animal life. Dead rabbits and birds bore ample evidence to this fact. The principal indication of the age of the tuff is gained from the age of the faulting, which is of course inferred from a broader view of the region than can be had in this particular area. The age of these particular faults is not evident more definitely than that they are post-Triassic, but by comparison with other parallel faults, of which the Cokeville fault can be taken as a type, they may be and probably are late Cretaceous. The fact that the tuff forms a prominent part of the fault agglomerate is taken to indicate that it is pre-Cretaceous in age and not to be correlated in any way with the late basaltic flows of the vicinity.

The sulphur is found in small pyramidal crystals lining cavities and in crystalline and amorphous masses in the interstices of the breccia. The crystallinity is shown by the spherical radiating figure formed upon some surfaces obtained by breaking, and the smooth to conchoidal fracture on other surfaces serves to indicate the amorphous variety. A rather spectacular form of occurrence in stalactites in vertical crevices in the breccia was noted in the south wall of the quarry on the Wood Canyon side of the divide. This variety has almost a canary-yellow color on fresh fracture, but on exposure changes rapidly to a dull submetallic gray. The gray color of much of the lower grade ore is apparently due to a thin coating of similar material. The air bubbles which are included in the stalactitic sulphur may indicate that the sulphur was exuded in a fluid state rather than deposited from solution. An unsatisfactory attempt was made to estimate the percentage of sulphur contained in the ore and the conclusion reached—that the run of the quarry face would average 10 percent native sulphur—must be accepted with caution, for it depends entirely on observation and inference.

Alum is reported by Mr. James Call, of Soda Springs, as present in the ore, but none was found by the writers.

## METHOD OF SMELTING THE ORE

The ore from these deposits was smelted by the Western Sulphur Co., of Duluth, Minn., in a plant located near the deposits, but the company failed, although the equipment appears to have been well selected and well installed. It consisted of two coal-burning boiler units, a battery of five or six cylindrical retorts, and a crushing plant. The system of smelting consisted of introducing the hand-sorted ore in perforated iron cars of about half a ton capacity into a retort which would hold one car at a time, melting the sulphur from the gangue by the introduction of steam into the retort, and drawing off the sulphur into suitable molds. The sulphur cake was then put through a crusher and grinder and reduced to a fine power and bagged. The condition of the gangue in the dump indicated that the recovery, though not perfect, was up to the standard usually set for the method used.

## ORIGIN OF THE SULPHUR

According to Clarke the deposition of the sulphur is due apparently to the imperfect oxidation of the hydrogen sulphide, which may be generated either by the action of acid waters on sulphides or through the reduction of sulphates, such as gypsum, by micro-organisms, or the gas may be of volcanic origin, as it is regarded in the view generally adopted for the origin of the deposits near Girgenti, in Sicily. Large deposits of gypsum are unknown in the geologic section of southeastern Idaho, and the small amount of that mineral associated with the sulphur appears rather to have had a common origin than to have served as a source. The proximity of these deposits to volcanic centers suggests that the volcanic origin for the hydrogen sulphide and the associated carbon dioxide is plausible.

## OUTLOOK

The failure of an apparently well-backed attempt to develop these deposits will render improbable any further attempts in the immediate future. It is extremely doubtful if the deposits can be profitably worked by a process giving a complete recovery of the values, even to supply the local demand, in competition with the relatively high-grade deposits of Wyoming and Utah.