Saline Minerals

J. Wallace Gwynn

Utah's saline industry is one of the oldest in the state, beginning with the commercial harvesting of salt from Great Salt Lake by the Mormon pioneers in 1847. The salt industry on the lake has continued from that time to the present, marked by the appearance and disappearance of many companies. Today three companies extract salt from the lake. Other products harvested from the lake include magnesium metal, chlorine gas, potassium sulfate, magnesium chloride, and nutritional supplements. A few of the by-products and potential products include ferrous and ferric chloride, calcium chloride, sodium sulfate, lithium carbonate, bromine, and boron.

Crystalline or rock salt has been mined from the Jurassic Arapien shale in central Utah since 1854, from salt outcrops east of Nephi, and since the 1870s, from the vicinity of Redmond. Today one company is mining salt underground in the Redmond area. Potash mining began on the Salduro Salt Marsh (Bonneville Salt Flats) about 1916. Today the company is producing both potash (KCl) and common salt (NaCl) from subsurface brines. Potash and salt are also produced by a solution-mining operation near Moab in southeastern Utah from the Pennsylvanian Paradox formation of the Hermosa group. Assessment and development were done at Sevier Lake, Millard County, aimed at producing salt and eventually potassium sulfate from subsurface brines, but financial problems curtailed the operation. There are several other areas where deep crystalline salts occur in the state but have not been developed. These areas include the Sevier Desert near Delta, the Preuss salt zone in the Wyoming/Utah/Idaho thrust belt, and small deep deposits of shortite \( [\text{Na}_2\text{Ca}_2(\text{CO}_3)_6] \) and nahcolite \( [\text{NaHCO}_3] \) in the Uinta Basin.

Use of Utah's saline resources began many years before the Mormon settlers entered the Salt Lake Valley in 1847; Native Americans probably used salt from Great Salt Lake, salt springs and seeps, salt outcrops, and possibly other sources such as Sevier Lake. The first nonnatives known to use salt from Great Salt Lake were the mountain men from Ashley's Rocky Mountain Fur Company during the fall of 1825, followed by John C. Fremont during his 1843 exploration of the West. The first commercial development of the state's saline resources was the production of
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common salt from Great Salt Lake by the Mormon pioneers. Since then, the lake has produced common salt (sodium chloride), potassium chloride, potassium sulfate, sodium sulfate, magnesium chloride, magnesium metal, and chlorine gas.

This chapter reviews the development of Utah’s saline resources at Great Salt Lake and the Salduro Salt Marsh (Bonneville Salt Flats), and in northern and central Utah and the Paradox Basin. It also discusses other salt occurrences in the state that are known but have not been tapped or developed. In 2002 the value of the state’s saline-mineral production exceeded $148 million and accounted for more than 25 percent of the state's total industrial-minerals production value.

Salt Mining at the Great Salt Lake

Great Salt Lake, a remnant of the freshwater Pleistocene Lake Bonneville, occupies an area of up to 1,472,000 acres (2,300 square miles) at an elevation of 4,212 feet (lake’s historic high) in northwestern Utah (figure 1). At an average surface elevation of 4,200 feet above sea level, the lake has an area of 1,034,000 acres (1,616 square miles) and a volume of 15,390,000 acre-feet. The lake contains approximately 4.5 billion tons of dissolved salts with the following approximate composition (on a dry-weight-percentage basis): Na = 32.0, Mg = 2.5, K = 1.8, Ca = 0.2, Cl = 57.4, SO$_4$ = 6.1. The main body of the lake is divided into two parts, a southern and a northern arm, by the Southern Pacific Railroad’s rock-fill causeway. Because the causeway restricts circulation and mixing between the two arms, the southern arm, which receives nearly all of the freshwater inflow, is much less saline than the northern arm.

The Beginnings of an Industry

Within days of their arrival in the Salt Lake Valley on 24 July 1847, the Mormon leader Brigham Young and a group of his associates traveled to Great Salt Lake.1 They found an abundance of white, coarsely crystalline salt deposited on its shore. A few days later a group of the pioneers traveled to the lake and gathered 125 bushels of coarse white salt. They also boiled four barrels of salt water that yielded one barrel of fine, white, crystalline salt. It is uncertain when the first commercial salt-boiling operations began, but Charley White built and operated a permanent salt-boiling facility (at an unknown location) from the spring of 1850 until about 1860.

In the mid-1860s Great Salt Lake’s salt industry received its first real stimulus due to the discovery of silver in the mining camps around Butte, Montana. The chlorination process used to reduce the silver ores required large quantities of salt. Utah had the salt, and by 1870 the railroads provided the transportation; thus, a substantial salt market was born.

Early Process Developments (1860 to 1895)

Two factors played an important role in changing the way the budding salt industries produced salt. First, the lake began a sustained rise from its 4,200-foot
Figure 1. Past and present solar-pond locations and other cultural features around Great Salt Lake, Utah.
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elevation in 1860 to its high of nearly 4,212 feet in 1872, and second, there was an increasing demand for better-tasting, higher-purity salt. As the lake level began to rise, the beds of white crystalline salt the pioneers had found along the shore were covered and dissolved, and the lake brine was too diluted to produce salt without additional evaporation. So the salt producers had to build solar-evaporation ponds to produce the salt. They accomplished this by building dikes across the entrances of coves. At first, the dikes were simply constructed of earth taken from the bottom of the ponds. These dikes, however, soon washed away. More durable dikes were then built, consisting of two parallel rows of cottonwood stakes driven into the ground every two feet with a latticework of willows woven between them and backed by bulrushes. The space between the two rows was then filled with earth.

The salt producers depended on the periodic rise of the lake’s level to fill their ponds. The periodic rise was due to north-wind-induced tides that raised the water elevation on the south end of the lake as much as 1.5 feet. Since this method of filling the ponds was not reliable, they soon resorted to horse-powered pumps.

The early salt producers found that evaporating a pond of lake water to dryness produced bitter-tasting salt due to its high potassium, magnesium, and sulfate content. The salt also contained mud, sticks, and other debris. To produce a cleaner and better-tasting salt, they developed a process called fractional crystallization that used a series of ponds. The first pond settled mud and other debris from the brine. The brine was then moved to a second pond, where solar evaporation concentrated it to the point of sodium-chloride saturation. The concentrated brine was then moved to a third pond, where crystalline salt was precipitated from it onto the pond floor. Precipitation was allowed to continue until the brine concentration reached a density of about 29 degrees Baumé. At that point the remaining brine, called the bittern, was drained from the pond back into the lake. This process produced cleaner and better-tasting salt.

Utah salt makers also developed the split or a cleavage-plane procedure to assist in harvesting salt. At the beginning of each evaporation season, about May or June, a thin layer of very small salt crystals was deposited on the floor of the salt ponds, forming a split between the floor and the large crystals of the annual crop. Two methods were used to make the split, resulting in either a sun split or a mechanical split. A sun split was created by draining the pond until only a small amount of highly concentrated brine covered the floor. A layer of very fine crystals—up to one-eighth inch in size—was precipitated over the large, jagged crystals below. Fresh, highly concentrated brine was then brought into the ponds. The larger crystals of the annual crop grew upon the fine salt layer. A mechanical split resulted from dragging a heavy object, such as a length of rail, across the floor of the pond. This process knocked the edges off the crystals and formed a fine layer of salt that separated the floor from the new crop.
Early Companies on the South Shores of Great Salt Lake

More than 20 companies produced salt on the shores of Great Salt Lake between 1880 and 1915. The following 6 companies developed into major enterprises on the southern shores.

Jeremy and Company was organized about 1870. The ponds were located at North Point, a portion of the lakeshore three miles north and east of the site of the old Saltair resort. It was one of the first companies to construct artificial evaporation ponds rather than depend on the deposition of salt in small, diked-off bays and inlets. Ponds from 5 to one 100 acres were filled using the natural rise and fall of the lake level that accompanied changes in wind direction and seasons. Government records show that Jeremy and Company harvested more than half of the salt produced in Utah during 1880. With a constant annual production of 10,000 tons, it accounted for only one-sixth of the total lake production in 1890, however. In the spring of 1891, Jeremy and Company reincorporated as Jeremy Salt Company and produced 13,000 tons of salt. The next year, production fell to 5,000 tons. In 1896 the company was sold to Inland Crystal Salt Company.

Inland Salt Company was organized on 21 November 1887 by a group of Mormon entrepreneurs and was the predecessor of the Inter-Mountain Salt Company, Inland Crystal Salt Company, Royal Crystal Salt Company, and Morton Salt Company’s Utah branch. In 1888 Inland Salt began constructing its ponds, presumably at the old Morton Salt site (figure 1), which were the first ponds specifically designed to use the fractional crystallization process. In 1888, the first year of operation, 5,000 tons of salt were produced, and by 1890 Inland Salt was producing two-thirds of the 60,000 tons of salt marketed by Utah companies. In April 1891 Inland Salt was sold to buyers from Kansas City for $200,000. In the fall of 1892 money from the sale of Inland Salt was used to develop a resort and a new salt works on the shore of Great Salt Lake. Saltair resort, the Saltair Railway, and Inter-Mountain Salt Company resulted from this investment.

Inland Crystal Salt Company was the result of the reincorporation and renaming of the Inland Salt Company on 1 July 1891. About $50,000 was invested in renovating the old facilities, including installing the world’s largest rotary-kiln dryer, coining the brand name “Royal Crystal” which appeared on the table- and dairy-grades of salt, and developing a process for making salt blocks for livestock. As a result of the growing market and renovation of the refining facilities, the total production of the company during 1891 was 90,000 tons or 50,000 tons more than Inland Salt had produced the previous year. Inland Crystal Salt and its successors, including Morton Salt Company, used the name Royal Crystal at least through 1971.

Inter-Mountain Salt Company was organized on 1 October 1892, funded in part by the sale of Inland Salt. Inter-Mountain developed its pond complex directly east
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of the property owned by Inland Crystal Salt and built a refining mill in Salt Lake City. About four-fifths of the salt sent through the refinery was sold as table salt. Inter-Mountain operated successfully until 2 March 1898, when the plant burned. Stockholders of Inter-Mountain then bought a controlling interest in Inland Crystal Salt Company.

After the merger with Inter-Mountain in 1898, Inland Crystal Salt became the only successful enterprise on the south shore of the lake. However, in 1901 two companies, Diamond Salt Company and Weir Salt Company, attempted to establish salt works in the area.

Diamond Salt Company was located west of the Inland Crystal Salt works and was incorporated on 2 February 1901 with plans of establishing a sanitarium, bathing facility, amusement park, and salt-manufacturing business. Ponds were built north of the Salt Lake and Los Angeles Railway and west of the Inland Crystal Salt works, but the other plans never materialized. The company sold its holdings to E.L. Sheets Company, which in turn was purchased by Inland Crystal Salt in 1915.

Weir Salt Company started its operations about the same time as Diamond Salt entered the industry. Its operations were located on the south shore of the lake near Lake Point, and its ponds were south of the location later occupied by the Hardy plant. Problems plagued the company, and construction of the facility was never completed. Deseret Livestock Company later purchased the property and began construction of its salt works on the same site in 1949.

The Salt Monopoly

The merger of Inter-Mountain and Inland Crystal Salt in 1898 marked the end of an era in Utah’s salt industry. Gradually the small companies around the lake failed or were purchased by the merged Inter-Mountain and Inland Crystal Salt. The role of the Church of Jesus Christ of Latter-day Saints in Utah’s salt industry grew steadily through the decade prior to 1898 until it became the dominant influence in the emerging monopoly. After the merger, the church-controlled company tried to maintain and strengthen its monopolistic position by purchasing lands suitable for salt operations or buying out competing firms. In 1901, however, Diamond Salt Company and Weir Salt Company constructed facilities on the south shore of the lake, and the Sears Utah Salt Company was established on the east shore of the lake near Syracuse in competition with the monopoly. Unfortunately, Inland Crystal Salt reportedly applied strong-arm tactics, such as intimidation and destruction of property, to control the salt market in addition to eliminating competition through its ability to control the price of salt.

During the first two decades of the twentieth century, the Inland Company maintained its position as the major salt producer in the state. Other small companies produced salt in Utah during this period, but the monopoly was not significantly threatened until Morton Salt Company moved into the area in 1918.