15. SALT

THE HISTORY OF common salt—sodium chloride, with a chemical formula of NaCl—parallels the history of human civilization. So valued is salt, so needed and so important, that it has been a major player not only in global trade but in economic sanctions and monopolies, wars, the growth of cities, systems of social and political control, industrial advances, and the migration of populations. Today salt is something of an enigma. It is absolutely essential to life—we die without it—but we are told to watch our salt intake as salt can kill. Salt is cheap; we produce and use enormous quantities of it. Yet for almost all of recorded history and probably for centuries before any history was recorded, salt was a precious commodity and often very expensive. The average person at the beginning of the nineteenth century would have had great difficulty in believing that we now routinely throw mounds of salt on roads to eliminate ice.

The price of many other molecules has dropped through the efforts of chemists, either because we can now synthesize the compound in laboratories and factories (ascorbic acid, rubber, indigo, penicillin) or because we can make artificial substitutes, compounds whose properties are so similar that the natural product is less important (textiles, plastics, aniline dyes). Today we rely on newer chemicals (refrigerants) for the preservation of food, so spice molecules no longer command the price they once did. Other chemicals—pesticides and fertilizers—have increased crop yields and hence the supply of such molecules as glucose, cellulose, nicotine, caffeine, and oleic acid. But of all compounds, salt has probably had the largest increase in production coupled with the most precipitous drop in price.

GETTING SALT

Throughout history humans have collected or produced salt. Three main methods of salt production—evaporating seawater, boiling down salt solutions from brine springs, and mining rock salt—were all used in ancient times and are still in use today. Solar evaporation of seawater was (and still is) the most common method of salt production in tropical coastal regions. The process is slow but cheap. Originally seawater was thrown onto burning coals, and the salts were scraped off when the fire was extinguished. Larger quantities could be harvested from the sides of coastal rock pools. It would not have taken much imagination to realize that artificial shallow lakes or "pans," constructed in areas where tidal flow could be used to fill the pans as needed, could provide much greater quantities of salt.

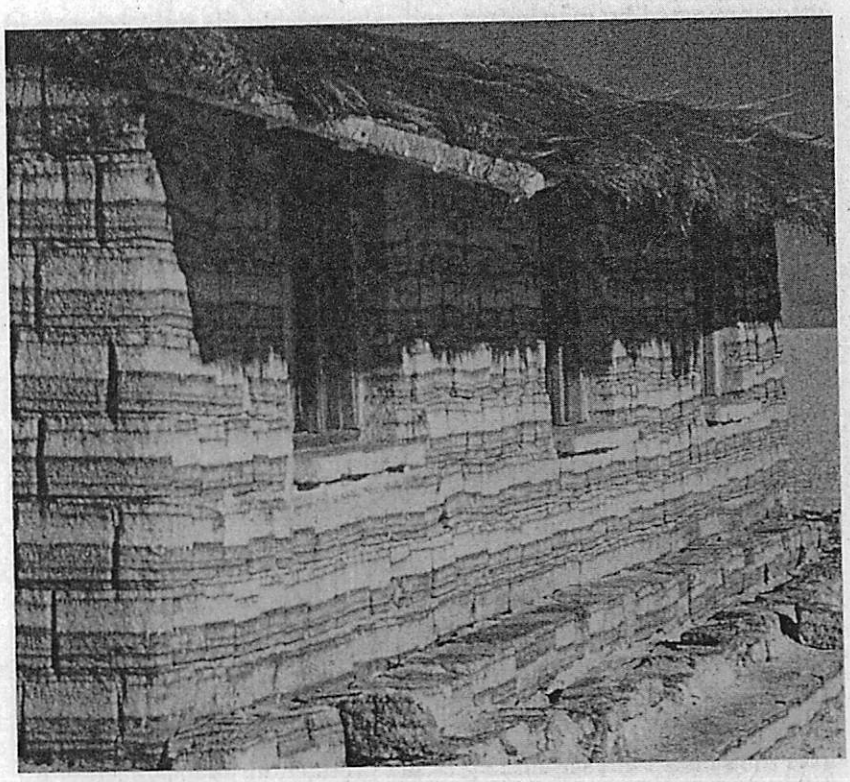
Raw sea salt is of much lower quality than either brine salt or rock salt. Although seawater is about 3.5 percent dissolved salts, only about two-thirds of this is sodium chloride; the rest is a mixture of magnesium chloride ($MgCl_2$) and calcium chloride ($CaCl_2$). As these latter two chlorides are both more soluble and less abundant than sodium chloride, NaCl crystallizes out of solution first, so it is possible to remove most of the $MgCl_2$ and $CaCl_2$ by draining them away in the residual brine. But enough remains to give sea salt a sharper taste, which is attributable to these impurities. Both magnesium and calcium chloride are deliquescent, meaning they absorb water from the air, and when this happens, salt containing these additional chlorides clumps and is difficult to pour.

The evaporation of seawater was most effective in hot, dry climates, but brine springs, underground sources of highly concentrated solutions of salt—sometimes ten times more concentrated than seawater—were also an excellent source of salt in any climate, if there was wood for the fires necessary to boil off the water in the brine solutions. Wood demand for salt production helped deforest parts of Europe. Brine salt, uncontaminated by magnesium and calcium chloride, which lessened the effectiveness of food preservation, was more desirable than sea salt but also more expensive.

Deposits of rock salt or halite—the mineral name of the NaCl found in the ground—are found in many parts of the world. Halite is the dried remains of old oceans or seas and has been mined for centuries, particularly where such deposits occur near the earth's surface. But salt was so valuable that as early as the Iron Age people in Europe turned to underground mining, creating deep shafts, miles of tunnels, and large caverns hollowed out by the removal of salt. Settlements grew up around these mines, and the continued extraction of salt led to the establishment of towns and cities, which grew wealthy from the salt economy.

Salt making or mining was important in many places in Europe throughout the Middle Ages; so valued was salt that it was known as "white gold." Venice, center of the spice trade for centuries, started as a community that obtained a living by extracting salt from the brines of the marshy lagoons in the area. Names of rivers, towns and cities in Europe—Salzburg, Halle, Hallstatt, Hallein, La Salle, Moselle—commemorate their links with salt mining or salt production, as the Greek word for salt is *hals* and the Latin is *sal. Tuz,* the Turkish name for salt, shows up in Tuzla, a town in a salt-producing region of Bosnia-Herzegovina, as well as in coastal communities in Turkey with the same or similar names.

Today, through tourism, salt is still the source of wealth for some of these old salt towns. In Salzburg, Austria, salt mines are a major tourist attraction, as they are at Wieliczka, near Cracow in Poland, where, in the great caverns hollowed out by salt removal, a dance hall, a chapel with an altar, religious statues carved from salt, and an underground lake now enchant thousands of visitors. The largest *salar,* or saltpan, in the world is the Salar de Uyuni in Bolivia, where tourists can stay at a nearby hotel made entirely from salt.



The salt hotel near Salar de Uyuni in Bolivia. (Photo by Peter Le Couteur)

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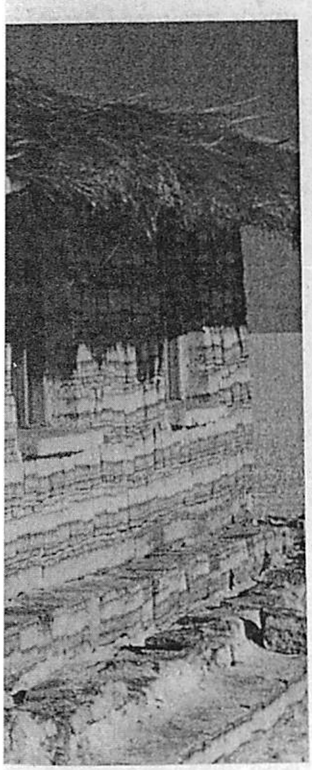


Photo by Peter Le Couteur)

TRADING SALT

That salt has been a trade commodity from earliest times is shown in records from ancient civilizations. The ancient Egyptians traded for salt, an essential ingredient in the mummification process. The Greek historian Herodotus reported visiting a salt mine in the Libyan desert in 425 B.C. Salt from the great salt plain at Danakil in Ethiopia was traded to the Romans and Arabs and exported as far as India. The Romans established a large coastal saltworks at Ostia, which was then at the mouth of the River Tiber, and around 600 B.C. built a road, the Via Salaria, to transport salt from the coast to Rome. One of the main thoroughfares in present-day Rome is still known as Via Salaria—the salt road. Forests were felled to provide fuel for the saltworks at Ostia, and subsequent soil erosion washed increasing amounts of sediment into the Tiber. Extra sediment hastened the expansion of the delta at the river mouth. Centuries later Ostia was no longer on the coast, and the saltworks had to be moved out to the shoreline again. This has been cited as one of the first examples of the impact of human industrial activity on the environment.

Salt was the basis for one of the world's great trade triangles and coincidently for the spread of Islam to the west coast of Africa. The extremely arid and inhospitable Sahara Desert was for centuries a barrier between the northern African countries bordering the Mediterranean and the rest of the continent to the south. Though there were enormous deposits of salt in the desert, south of the Sahara salt was in great demand. In the eighth century Berber merchants from North Africa began to trade grains and dried fruit, textiles and utensils, for slabs of halite mined from the great salt deposits of the Sahara (in present-day Mali and Mauritania). So abundant was salt at these sites that entire cities such as Teghaza (city of salt), built from blocks of salt, grew up around the mines. The Berber caravans, often comprising thousands of camels at a time, now laden with slabs of salt, would continue across the desert to Timbuktu, originally a small camp on the southern edge of the Sahara on a tributary of the Niger River.

By the fourteenth century, Timbuktu had become a major trading post, exchanging gold from West Africa for salt from the Sahara. It also became a center for the expansion of Islam, which was brought to the region by the Berber traders. At the height of its power—most of the sixteenth century—Timbuktu boasted an influential Koranic university, great mosques and towers, and impressive royal palaces. Caravans leaving Timbuktu carried gold, and sometimes slaves and ivory, back to the Mediterranean coast of Morocco and thence to Europe. Over the centuries many tons of gold were shipped to Europe through the Saharan gold/salt trade route.

Saharan salt was also shipped to Europe as the demand there for salt increased. Freshly caught fish must be preserved quickly, and while smoking and drying were rarely possible at sea, salting was. The Baltic and North Seas teemed with herring, cod, and haddock, and from the fourteenth century onward millions of tons of these fish, salted at sea or in nearby ports, were sold throughout Europe. In the fourteenth and fifteenth centuries the Hanseatic League, an organization of north German towns, controlled the trade in salt fish (and almost everything else) in the countries bordering the Baltic Sea.

The North Sea trade was centered in Holland and the east coast of England. But with salt available to preserve the catch, it became possible to fish even farther afield. By the end of the fifteenth century fishing boats from England, France, Holland, the Basque region of Spain, Portugal, and other European countries were regularly sailing to fish the Grand Banks off Newfoundland. For four centuries fishing fleets plundered the vast schools of cod in this region of the North Atlantic, cleaning and salting the fish as they were caught and returning to port with millions of tons of what seemed an inexhaustible supply. Sadly this was not the case; Grand Banks cod were brought to the brink of extinction in the 1990s. Today a moratorium on cod fishing, introduced by Canada in 1992, is being observed by many, but not all, of the traditional fishing nations.

With salt in such demand, it is hardly surprising that it was often considered a prize of war rather than a commodity of trade. In ancient times settlements around the Dead Sea were conquered specifically for their precious supplies of salt. In the Middle Ages the Venetians waged war against neighboring coastal communities who threatened their all-important salt monopoly. Capturing an enemy's supply of salt was long considered a sound wartime tactic. During the American Revolution salt shortages resulted from a British embargo of imports from Europe and the West Indies into the former colony. The British destroyed salt works along the New Jersey coast to maintain the hardship affecting the colonists as a result of the high prices for imported salt. The 1864 capture of Saltville, Virginia, by Union forces during the American Civil War was seen as a vital step in reducing civilian morale and defeating the Confederate army.

It has even been suggested that a lack of dietary salt might have prevented wartime wounds from healing and was thus responsible for the death of thousands of Napoleon's soldiers during the 1812 retreat from Moscow. Lack of ascorbic acid (and the subsequent onset of scurvy) seems as likely a culprit as lack of salt under these circumstances, so both these compounds could join tin and lysergic acid derivatives as chemicals that thwarted Napoleon's dreams.

THE STRUCTURE OF SALT

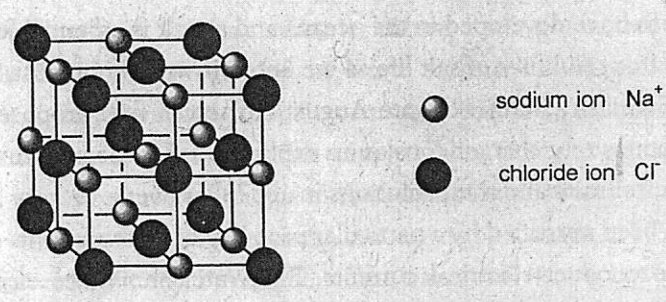
Halite, with a solubility of about 36 grams in every 100 grams of cold water, is far more soluble in water than are other minerals. As life is thought to have developed in the oceans and as salt is essential for life, without this solubility of salt life as we know it would not exist.

The Swedish chemist Svante August Arrhenius first proposed the idea of oppositely charged ions as an explanation for the structure and properties of salts and their solutions in 1887. For over a century scientists had been mystified by a particular property of salt solutions—their ability to conduct electrical currents. Rainwater shows no electrical conductivity, yet saline solutions and solutions of other salts are excellent conductors. Arrhenius's theory accounted for this conductivity; his experiments showed that the more salt dissolves into solution, the greater the concentration of the charged species—the ions—needed to carry the electrical current.

The concept of ions, as proposed by Arrhenius, also explained why acids, despite seemingly different structures, have similar properties. In water all acids produce hydrogen ions (H^+) which are responsible for the sour taste and chemical reactivity of acid solutions. Although Arrhenius's ideas were not accepted by many conservative chemists of the time, he displayed a commendable degree of perseverance and diplomacy in campaigning determinedly for the soundness of the ionic model. His critics were eventually convinced, and Arrhenius received the 1903 Nobel Prize in chemistry for his electrolytic dissociation theory.

By this time there was both a theory and practical evidence for how ions form. British physicist Joseph John Thomson in 1897 had demonstrated that all atoms contain *electrons,* the negatively charged fundamental particle of electricity that had been first proposed in 1833 by Michael Faraday. Thus if one atom lost an electron or electrons, it became a positively charged ion; if another atom gained an electron or electrons, a negatively charged ion was formed.

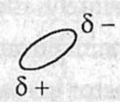
Solid sodium chloride is composed of a regular array of two different ions—positively charged sodium ions and negatively charged chloride ions—held together by strong attractive forces between the negative and positive charges.



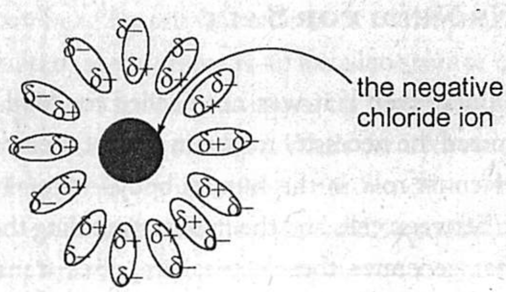
The three-dimensional structure of solid sodium chloride. The lines joining the ions are nonexistent—they are included here to show the cubic arrangement of the ions.

Water molecules, although not consisting of ions, are partially charged. One side of a water molecule (the hydrogen side) is slightly positive, and the other side (the oxygen side) is slightly negative. This is what allows sodium chloride to dissolve in water. Although the attraction between a positive sodium ion and the negative end of water molecules (and the attraction between negative chloride ions and the positive end of water molecules) are similar to the attractive force between Na^+ ions and Cl^- ions, what ultimately accounts for the solubility of salt is the tendency for these ions to disperse randomly. If ionic salts do not dissolve to any extent in water, it is because the attractive forces between the ions are greater than the water-to-ion attractions.

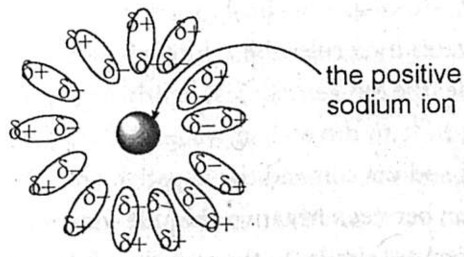
Representing the water molecule as:



with δ– indicating the partial negative end of the molecule and δ+ the partial positive end of the molecule, we can show the negative chloride ions in aqueous solution as surrounded by the slightly positive end of water molecules:



and the positive sodium ion in aqueous solution as surrounded by the slightly negative end of water molecules:



It is this solubility of sodium chloride that makes salt—by attracting water molecules—such a good preservative. Salt preserves meat and fish by removing water from the tissues; in conditions of much-reduced water levels and a high salt content, the bacteria that cause decay are unable to survive. A lot more salt was used in this manner to keep food from decaying than was deliberately added to enhance flavors. In regions where dietary salt came mainly from meat, additional salt for food preservation was an essential factor in maintaining life. The other traditional methods of food preservation, smoking and drying, very often required the use of salt as part of the process. Food would be soaked in a brine solution prior to the actual smoking or drying. Communities without a local source of salt were dependent on supplies obtained by trade.

THE BODY'S NEED FOR SALT

From earliest times, even if it was not needed for food preservation, humans recognized the necessity to obtain salt for their diet. Ions from salt play an essential role in the human body, maintaining the electrolyte balance between cells and the fluid surrounding the cells. Part of the process that generates the electrical impulses transmitted along neurons in the nervous system involves what is called the sodium-potassium pump. More Na^+ (sodium) ions are forced out of a cell than K^+ (potassium) ions are pumped into it, resulting in a net negative charge of the cytoplasm inside the cell compared with the outside of the cell membrane. Thus a difference in charge—known as a membrane potential—is generated, which powers electrical impulses. Salt is therefore vital for the functioning of nerves and ultimately muscle movement.

Cardiac glycoside molecules, such as the digoxin and digitoxin found in foxglove, inhibit the sodium-potassium pump, giving a higher level of Na^+ ions inside the cell. This ultimately increases the contractive force of the heart muscles and accounts for the activity of these molecules as heart stimulants. The chloride ion from salt is also needed in the body to produce hydrochloric acid, an essential component of the digestive juices in the stomach.

Salt concentration in a healthy person varies within a very narrow range. Lost salt must be replaced; excess salt must be excreted. Salt deprivation causes loss of weight and appetite, cramps, nausea, and inertia and can, in extreme cases of depletion of body salt—such as in marathon runners—lead to vascular collapse and death. Excess sodium ion intake, however, is known to contribute to high blood pressure, a significant factor for cardiovascular disease, and to kidney and liver disorders.

The average human body contains about four ounces of salt; we are continuously losing salt, mainly through perspiration and excretion in urine, and so we have to replace it on a daily basis. Prehistoric man filled his dietary need for salt from the meat of the largely herbivorous animals he hunted, as raw meat is an excellent source of salt. As agriculture developed and grains and vegetables became a larger part of the diet, supplementary salt was needed. While carnivorous animals do not seek out salt licks, herbivorous animals need to do so. Humans in parts of the world where little meat is eaten and vegetarians require additional salt. Supplemental salt, a necessity as soon as humans adopted a settled agrarian way of life, must be obtained locally or through trade.

TAXING SALT

The human need for salt, together with its specific methods of production, have historically made this mineral peculiarly fitted for political control, monopoly, and taxation. For a government, a tax on salt would produce a reliable income. There was no substitute for salt, and everyone needed it, so everyone would have to pay. Salt sources were known; the production of salt is difficult to hide, salt itself is bulky and hard to conceal, and its transportation can be easily regulated and taxed. From 2000 B.C. in China, where the Emperor Hsia Yu ordered that the imperial court would be supplied by salt from Shantung Province, down through the ages, salt has been profitable for governments through taxes, tolls, and tariffs. In biblical times salt, considered a spice and taxed as such, was subject to customs duty at the many stopping places along caravan routes. After the death of Alexander the Great in 323 B.C., officials in Syria and Egypt continued to collect a salt tax that had originally been imposed by the Greek administration.

Throughout all these centuries the process of gathering taxes required tax collectors, many of whom became wealthy by increasing tax rates, adding extra duties, and selling exemptions. Rome was no exception. Originally the Ostia saltworks on the Tiber delta were taken over by the Roman state, so that salt could be supplied at reasonable rates to everyone. Such largesse did not last. The revenues from taxing salt offered too great a temptation, and a salt tariff was imposed. As the Roman Empire expanded, so did salt monopolies and salt taxes. Tax gatherers, independent agents supervised by the governor of each Roman province, levied taxes wherever they could. For those who lived far from salt-producing areas, the high cost of salt not only reflected transportation costs but tariffs, taxes, and duties at every step of the way.

Throughout the Middle Ages in Europe the taxation of salt continued, often in the form of tolls imposed on barges or carts carrying salt from salt mines or coastal production plants. It reached its height in

France with the infamous, oppressive, and much-hated salt tax known as the *gabelle.* Reports on the origin of the gabelle vary. Some accounts say Charles of Anjou in Provence imposed it in 1259, others that it started as a general tax applied to commodities like wheat, wine, and salt in the late thirteenth century to help maintain a permanent army. Whatever its true origin, by the fifteenth century the gabelle had become one of France's main national levies, and the name referred only to the tax on salt.

But the gabelle was not just a tax on salt. It also carried the requirement that every man, woman, and child over the age of eight purchase a weekly amount of salt, at a price set by the king. Not only could the salt tax itself be raised, but the obligatory ration could also be increased at the monarch's whim. What was once intended as a uniform tax on the population soon extracted higher penalties on some regions of France than others. In general, those provinces that obtained their salt from Atlantic salt works were subject to the *grande gabelle,* more than twice what was paid in regions—known as Les Provinces des Petites Gabelles—where salt was supplied from Mediterranean saltworks. Through political influence or treaty arrangements some areas were exempt from the gabelle or paid only a fraction; at times there was no gabelle in Brittany and a special low rate in Normandy. At its height the gabelle increased the price of salt more than twenty times its real cost for those citizens in Les Provinces des Grandes Gabelles.

Salt tax collectors—referred to as gabelle farmers, as they harvested the taxes from the people—would monitor the per capita use of salt to ensure consumption obligations were met. Attempts to smuggle salt were rife despite severe penalties for being discovered with contraband salt; a common punishment in such cases was a sentence to the galleys. Peasant farmers and poor city dwellers were the most severely affected by the harsh and unfairly applied gabelle. Appeals to the king for relief from this onerous tax fell on deaf ears, and it has been suggested that the gabelle was one of the main grievances responsible for the French Revolution. It was abolished at the height of the revolution in 1790, and more than thirty gabelle collectors were executed. But the abolition did not last. In 1805 Napoleon reintroduced the gabelle, a measure he claimed was necessary to pay for his war against Italy. It was not finally eliminated until after World War II.

France was not the only country where such taxes on a necessity of life were burdensome. In coastal Scotland, particularly around the Firth of Forth, salt had been produced for centuries before it was ever taxed. Solar evaporation was not feasible in the cool, damp climate; seawater was boiled in large vessels, which were originally wood-fired and later coal-fired. By the 1700s there were more than 150 such saltworks in Scotland, plus numerous others that were peat-fired. The salt industry was so important to the Scots that the Eighth Article of the 1707 Treaty of Union between Scotland and England guaranteed Scotland a seven-year exemption from English salt taxes and after that a reduced rate forever. England's salt industry was based on the extraction of salt from brine as well as the mining of rock salt. Both methods were a great deal more efficient and profitable than the coal-fired seawater method of Scottish production. The industry in Scotland needed relief from English salt taxes in order to survive.

In 1825 the United Kingdom became the first country to abolish its salt tax, not so much because of the resentment this tax had generated among the working class throughout the centuries as because of the recognition of the changing role of salt. The Industrial Revolution is usually thought of as a mechanical revolution—the development of the flying shuttle, the spinning jenny, the water frame, the steam engine, the power loom—but it was also a chemical revolution. Large-scale production of chemicals was required for the textile industry, for bleaching, soap making, glassmaking, potteries, the steel industry, tanneries, paper manufacturing, and the brewing and distilling industries. Manufacturers and factory owners pushed for the repeal of the salt tax because salt was becoming vastly more important as a starting material in manufacturing processes than as a preservative and food culinary supplement. Removal of the salt tax, sought by generations of the poor, became a reality only when salt was recognized as a key raw material for industrial prosperity in Britain.

Britain's enlightened stance on salt taxes did not extend to her colonies. In India a British-imposed salt tax became a symbol of colonial oppression seized upon by Mahatma Gandhi as he led the struggle for Indian independence. The salt tax in India was more than a tax. As many conquerors had found over the centuries, control of salt supplies meant political and economic control. Government regulations in British India made the nongovernmental sale or production of salt a criminal offense. Even collecting salt formed through natural evaporation around rock pools at the seacoast was outlawed. Salt, sometimes imported from England, had to be purchased from government agents at prices established by the British. In India, where the diet is mainly vegetarian and the often intensely hot climate promotes salt loss through sweating, it was especially important that salt be added to food. Under colonial rule the population was forced to pay for a mineral that millions had traditionally been able to gather or produce themselves at little or no cost.

In 1923, almost a century after Britain had eliminated the salt tax on its own citizens, the salt tax in India was doubled. In March 1930, Gandhi and a handful of supporters started a 240-mile march to the small village of Dandi, on the northwest coast of India. Thousands joined his pilgrimage, and once they reached the shoreline, they began to collect salt incrustations from the beach, to boil seawater, and to sell the salt they produced. Thousands more joined in breaking the salt laws; illegal salt was sold in villages and cities all over India and was frequently confiscated by the police. Gandhi's supporters were often brutalized by the police, and thousands were imprisoned. Thousands more took their places making salt. Strikes, boycotts, and demonstrations followed. By the following March the draconian salt laws of India had been modified: local people were permitted to collect salt or make it from local sources and sell it to others in their villages. Although a commercial tax still applied, the British government's salt monopoly was broken. Gandhi's ideals of nonviolent civil disobedience had proven effective, and the days of the British Raj were numbered.

SALT AS A STARTING MATERIAL

The removal of the salt tax in Britain was important not only to those industries that used salt as part of their manufacturing processes but also to companies that made inorganic chemicals, where salt was a major starting material. It was particularly significant for another sodium compound, sodium carbonate (Na_2CO_3), known as soda ash or washing soda. Soda ash, used in soap making and needed in large quantities as the demand for soap increased, came mainly from naturally occurring deposits, often incrustations around drying alkaline lakes or from residues from burning kelp and other seaweeds. Soda ash from these sources was impure and supplies were limited, so the possibility of producing sodium carbonate from the plentiful supplies of sodium chloride attracted attention. In the 1790s Archibald Cochrane, the ninth earl of Dundonald—now considered one of the leaders of Britain's chemical revolution and a founder of the chemical alkali industry—whose modest family estate on Scotland's Firth of Forth bordered on numerous coal-fired saltpans, took out a patent for converting salt to "artificial alkali," but his process was never a commercial success. In France in 1791, Nicolas Leblanc developed a method of making sodium carbonate from salt, sulfuric acid, coal, and limestone. The onset of the French Revolution delayed establishment of Leblanc's process, and it was in England where the profitable manufacture of soda ash began.

In Belgium in the early 1860s, the brothers Ernest and Alfred Solvay developed an improved method of converting sodium chloride to sodium carbonate using limestone ($CaCO_3$) and ammonia gas (NH_3). The key steps were the formation of a precipitate of sodium bicarbonate ($NaHCO_3$) from a concentrated solution of brine, infused with ammonia gas and carbon dioxide (from limestone):

$$NaCl_{(aq)} + NH_{3(g)} + CO_{2(g)} + H_2O_{(l)} \longrightarrow NaHCO_{3(s)} + NH_4Cl_{(aq)}$$

sodium chloride | ammonia | carbon dioxide | water | sodium bicarbonate | ammonium chloride

and then production of sodium carbonate by heating the sodium bicarbonate:

$$2\,NaHCO_{3(s)} \longrightarrow Na_2CO_{3(s)} + CO_{2(g)}$$

sodium bicarbonate | sodium carbonate | carbon dioxide

Today the Solvay process remains the main method of preparing synthetic soda ash, but discoveries of massive deposits of natural soda ash—the Green River basin of Wyoming, for example, has soda ash resources estimated at over ten billion tons—have decreased the demand for its preparation from salt.

Another sodium compound, caustic soda (NaOH), has also long been in demand. Industrially, caustic soda or sodium hydroxide is made by passing an electric current through a solution of sodium chloride—a process known as *electrolysis*. Caustic soda, one of the ten most produced chemicals in the United States, is essential in extracting aluminum metal from its ore and in the manufacture of rayon, cellophane, soaps, detergents, petroleum products, paper, and pulp. Chlorine gas, also produced in the electrolysis of brine, was originally considered a by-product of the process, but it was soon discovered that chlorine was an excellent bleaching agent and a potent disinfectant. Today the production of chlorine is as much a reason for commercial electrolysis of NaCl solutions as the production of NaOH. Chlorine is now used in the manufacture of many organic products, such as pesticides, polymers, and pharmaceuticals.

From fairy tales to biblical parables, from Swedish folk myths to North American Indian legends, different societies around the world tell stories of salt. Salt is used in ceremonies and rites, it symbolizes hospitality and good fortune, and it protects against evil spirits and ill luck. The important role of salt in shaping human culture is also seen in language. We earn a salary—the derivation of the word comes from the fact that Roman soldiers were often paid in salt. Our words for salad (originally dressed only with salt), sauce and salsa, sausage and salami all come from the same Latin root. As in other languages, our everday speech is "salted" with metaphors: "salt of the earth," "old salt," "worth his salt," "below the salt," "with a grain of salt," "back to the salt mine."

The ultimate irony in the story of salt is that despite all the wars fought over it, despite the battles and protests over taxation and tolls imposed on it, despite migrations in search of it and the despair of hundreds of thousands imprisoned for smuggling it, by the time the discovery of new underground salt deposits and modern technology had vastly decreased its price, the need for salt in food preservation was already greatly diminished—refrigeration had become the standard method of preventing decomposition of food. This compound that throughout history has been honored and revered, desired and fought over, and sometimes been valued more highly than gold, is nowadays not only cheap and readily available but is considered commonplace.