Origin and Occurrence of Commercial Potash Deposits

ROBERT C. FITE, Oklahoma A. and M. College, Stillwater

Potash has been an important item of commerce for centuries. Until recently, its use was restricted to the manufacture of soap, glass, and black gunpowder. The salt was obtained by leaching ashes of wood and other vegetative wastes in large iron pots—hence, the name "potash." It became the principal product of the chemical industries in America before 1850 as a byproduct of clearing the virgin forest lands for agriculture. The total annual supply for these chemical uses, however, never amounted to more than a few thousand tons for the entire world.

After the discovery of natural subterranean potash salts near Strassfurt, Germany, in 1851, a supply became available for other uses. German scientists soon proved it to be valuable as a fertilizer on the agricultural lands of Germany. The first experimental use of potash as a fertilizer in America occurred in 1873. This was followed by increased and more widespread consumption with each passing decade.

American agricultural production, as well as that of many other countries, has become dependent on the use of potash. Critical shortages in farm crops would inevitably result if a supply of this salt should suddenly cease to be available. It assumes far greater importance in the American economy that its monetary value would indicate. Extensive potash deposits are not widespread, but rather, restricted to only a few countries of the world. This paper attempts to describe the manner of origin and extent of these deposits, to present an inventory of potash resources of the world, and to evaluate the reliability of this new stimulus to agricultural productive capacity.

Compounds of potassium are frequent in the earth's crust, comprising about 2.4 percent of all terrestrial matter. An average cubic mile of sea water contains almost two million tons of pure potash (potassium oxide). The top six inches of the soil contain a great store of potash. Usually, however, most of the potash in the soil is combined with silicates and other insoluble compounds. They are not broken down into soluble components with sufficient rapidity to supply growing plants with optimum requirements. No method has been devised to speed up the release of this store of unavailable potash in the soil for immediate plant use. Maximum crop production frequently requires the regular addition of soluble potash, even on relatively rich and virgin soils.

It is fortunate, therefore, that nature has provided several concentrated deposits of potash salts which are readily available for man's use. These deposits, of sufficient concentration and suitable chemical composition to have commercial significance, are the result of a rare combination of situations and events in geologic history. The origin of natural potash deposits has been explained by many different theories, most of which agree except for minor details.

The salts were laid down in the distant past by the evaporation of saline water from seas and lakes. The complete deposition required hundreds or even thousands of years. The salts were precipitated by the desiccant process and later were manteled by sedimentary clays, limestones, sands, and gravels. Arms of the sea were cut off from the parent ocean by sand bars, or other obstructions in hot and arid regions of the world. Evaporation exceeded inflow and the residual bitterns of the lakes became more and more concentrated. Eventually, the least soluble salts were precipitated on the bottoms of the lakes. Succeeding layers of other salts followed, according to their lack of ability to remain in solution. Since most potash salts are relatively soluble, they were among the last to be

deposited. The highly concentrated bitterns were then contained in the deeper but smaller basins within the major depressions. In this manner, potash deposits were usually concentrated in relatively small areas with respect to the size of the original seas.

Variations from this simplified sequence of events would occur if water should enter the basin at intermittent intervals to interrupt the desiccant process. Judging from the stratification and order of deposition of salts in some of the larger deposits of the world, the process was interrupted and repeated several times. Finally, the salts became protected from further weathering by a sedimentary stratum of impervious materials. During succeeding geologic ages, the salt beds were subjected to considerable folding and faulting in the case of German deposits, or they remained more or less undisturbed in the case of potash deposits in France and the United States.

Some inland lakes have followed this process of salt deposition. Their potash deposits are not great, however, unless tributary waters have flowed from areas with a high potash content. Potash is now produced from three such water bodies in the world: Searles Lake in California, Salduro Marsh in Utah, and the Dead Sea in Palestine.

The first natural potash deposit in the world was discovered in Germany, by accident, while sinking a mine shaft in search of common salt. Prior to this discovery in 1851, the principal source of potash had been wood ashes. A bitter salt, later identified as potash, was discovered by a well boring in eastern Galacia in 1854. Potash was discovered near Wittelsheim in Alsace in 1904, and in Suria, Spain, in 1912. Five years later, a discovery was made near the eastern foothills of the Ural Mountains at Solikamsk, Russia. With the exception of Germany, none of the countries made serious attempts to exploit their potash resources until the close of World War I.

America was suddenly awakened, by the First World War, to the fact that this country had developed a great dependence on potash for normal agricultural production. The single foreign source of supply was completely cut off by the Allied blockade of German ports in January, 1915. Domestic potash prices soared from $35 to $500 per ton of K_2O, but auxiliary sources of production were unable to supply the demand, even under this great price stimulus. Feverish exploration by governmental agencies and private concerns was unable to alleviate the hardships of a potash famine during the war years. It was not until 1926 that commercially valuable potash salts were discovered in the Permian Basin of the United States near Carlsbad, New Mexico. First production from these deposits was accomplished in 1931. Ten years later, production exceeded domestic consumption for the first time. Domestic production has remained adequate for domestic needs although the annual rate of consumption has continued to increase through the war and post-war years. More than 1.5 million tons of K_2O were consumed domestically during the year ending May 31, 1951.

Although known potash reserves of the world are adequate to supply anticipated needs for many centuries, the deposits are limited and restricted to only a few countries. The extent of proven reserves in the principal potash producing countries of the world is shown in the accompanying table.

POTASH RESERVES OF THE WORLD

COUNTRY	MILLION METRIC TONS OF K_2O
United States	120
France	300
Spain	300
Palestine	1,300
Germany (Western Zones)	1,200
Germany (Soviet Zone)	1,800
Soviet Union	25,000
World Total	30,020

These figures have significance only in the light of current consumption and probable future demands for potash. The rate of current world consumption is certainly small, in comparison to reserves, totaling less than 3.5 million metric tons of K_2O annually during recent year. Prospects for an adequate supply in the United States, however, is not so bright. This country produces and consumes more than one-fourth of the total world's production. The limited reserves in the United States will be adequate for less than one hundred years at the present rate of consumption.

On the other hand, the use of potash as a fertilizer is new and, in many parts of the world, untried. Only a few countries of northwestern Europe and the United States have used potash extensively. Even these countries continue to increase potash consumption by more intensive and extensive uses of fertilizers. To illustrate, the average annual potash consumption in Illinois during the period of 1935-1939 was less than 3,000 tons of K_2O, whereas 129,030 tons were delivered for use in that state during the year ending May 31, 1951. It has been estimated that the soils of China, alone, would profitably respond to annual applications of fertilizer potash in excess of the total world's production. In 1950, only 24,000 metric tons of K_2O were consumed in South America, 34,000 metric tons in Africa, and 147,000 tons in all of Asia outside of the "Iron Curtain." Illinois consumed more than half as much potash in 1950 as the combined total of three continents. It thus becomes apparent that the world's potential demand for potash is hundreds of times greater than the current rate of consumption.

Proved reserves of high-grade potash salts in the United States are quite limited with respect to domestic consumption and probable future demands. Considerable care is justified to protect existing resources against unwise use. Additional research is urgent to discover new potash deposits or to advance technical skills to recover potash from known low-grade sources, such as polyhalite, alunite, leucite, or sea water.