Some Early Geological and Production Problems in the Industry Beginning 100 Years Ago

by
Paul Weaver
Houston, Texas

ABSTRACT

New localities are under development in presently producing countries and in ones not previously producing evaporite minerals from underground, particularly sodium chloride (common salt) and potassium-rich evaporites.

Deposits of these minerals fall into one of three classes. Exploitation of them in Germany has a history of a century, during which threats to profitable mining have recurred in one of two forms:

To an individual mine, from later mines where the latter are of a different class of deposit with more favorable cost situations.

To a group of mines, due to an overbuilt aggregate capacity to deliver more than the demand in their territory, resulting in cut-back to part-time operations.

The presentation of the record in Germany in this paper therefore should help planning by the developers in new areas so as to minimize the two threats to success discussed in this paper.

SCOPE OF THIS PRESENTATION

One hundred years ago in 1862, the first reported production of ores of sodium, magnesium and potassium evaporite minerals was treated in a plant adjoining a mine at Stassfurt, Germany. Production of sodium chloride in Germany is of course much older, and in fact the objective in drilling and later shaft-sinking at Stassfurt was sodium chloride.

In very recent years discoveries of ore-beds of the evaporites have continued to be made. In Europe itself, Denmark and Holland are recent additions to evaporite discoveries underground. Note also that these two countries have their discovery localities almost at tidewater, therefore favorable not alone for domestic sale, but also export. Elsewhere similar recent discoveries, not alone of common salt but also some potash, promise further plants, and in the development of them I hope many of the attendants at this symposium will find application for their present knowledge in this realm of the evaporites.

In the past hundred years, to our credit is more knowledge of phase diagrams of the evaporite minerals, more mining skills, and a variety of recovery methods for specific chemical compounds.

On the debit side, we see sale price problems for a plant as to competition with neighboring ones for domestic markets, and with foreign producers for an export market for itself, with continuing threat to some area of producers as to lower cost ones which might be opened nearby, and of loss of markets further away, partly due to difference in ore, partly due to increased shipping costs, partly to government fiats.

Since Germany has a longer history of facing many problems, and larger industry effort over many years than other countries, this article will trace significant effects on the alkali industry in Germany during the last century, and principally as to the potash salts.

All countries and individual mines within them, are likely to have similar problems, and therefore all should study Germany's experience lest they exemplify the dictum: "He who will not study history shall be condemned to repeat its mistakes."

Localities mentioned are all in Europe, and appear on Figure 1.

INDEX MAP OF PART OF NORTHERN EUROPE

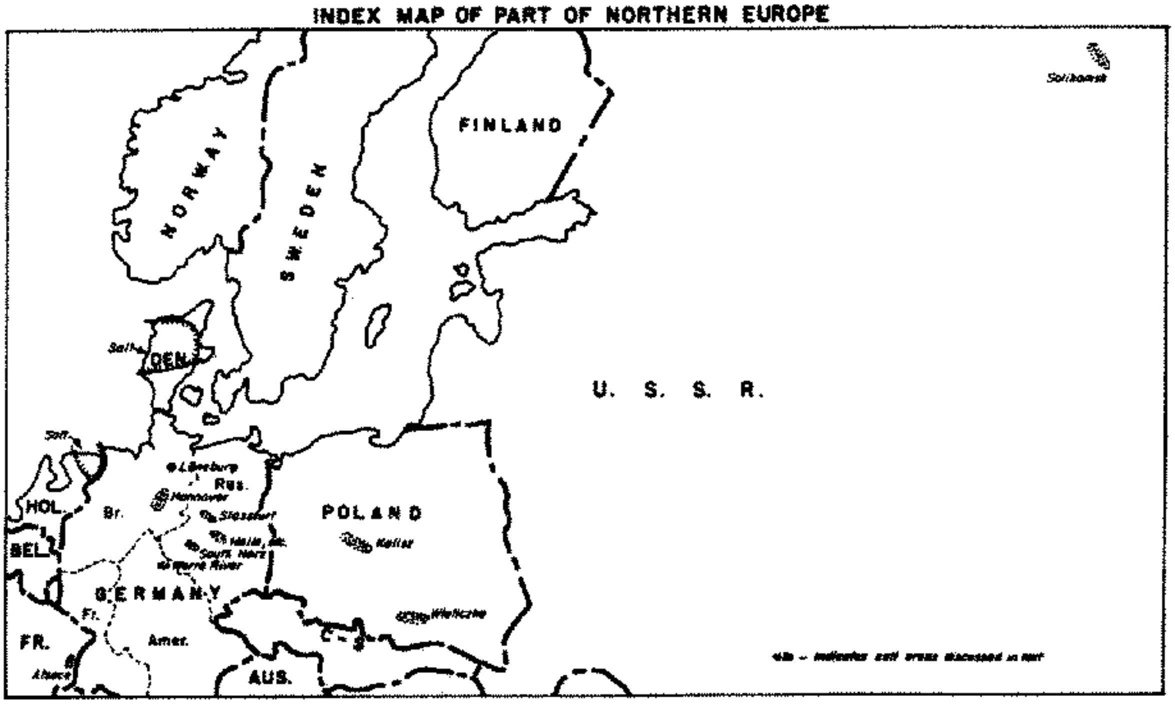


Figure 1.

GEOLOGICAL SETTING AND SHAPE OF EVAPORITE ORES

Before we can appreciate the shifts in tonnage produced during the century in Germany, we shall recall what kind of ore bodies there are present in that country, and why one kind basically is more promising for tonnage cost at the shaft collar. There is no evidence that future ore bodies of large size of potash and other evaporites will be of an unfamiliar kind, but rather that all will fall in one of the three types we have exploited already in Germany and elsewhere, and which are:

Type 1. Ore bodies nearly horizontal, of low porosity and permeability, as are the beds above and below them. Such a condition encourages the miner to hope neither for large water flows nor gas mine bursts. This is the geological setting of salt near Cleveland, and is the one of the potash and salt section at Solikamsk in European U. S. S. R. (Figure 2).

Type 2. Evaporite beds maintaining uniform thickness for some distance, as in Type 1, but arched or tilted instead of horizontal. The top of the ore has frequently been eroded, and younger beds which may be of considerable porosity and permeability deposited on the truncated salt. This was the situation at Stassfurt. For its historical interest, rather than its adequate coverage, a geologic section of the first two mines and their cross-cuts, as of about 1880 are shown in Figure 3.

PROFILE ACROSS A TYPE I SALT DEPOSIT
SOLIKAMSK, U.S.S.R.

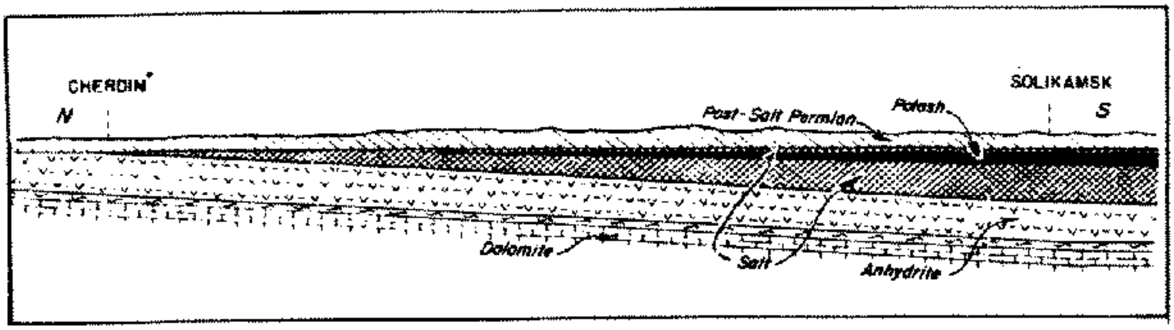
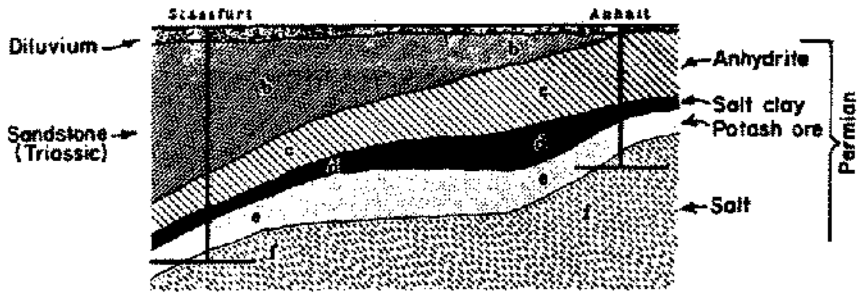


Figure 2.

PROFILE ACROSS A TYPE 2 SALT SECTION
ORIGINAL MINES AT STASSFURT, GERMANY



Furer: 1900, p.105

Figure 3.

Type 3. Tilting and dislocations of individual layers of evaporites have gone so strenuously that they occupy a diapir structure, frequently a mass, cylindrical in cross section, and with major axis tending to the vertical. This is present in the Gulf Coast as salt domes.

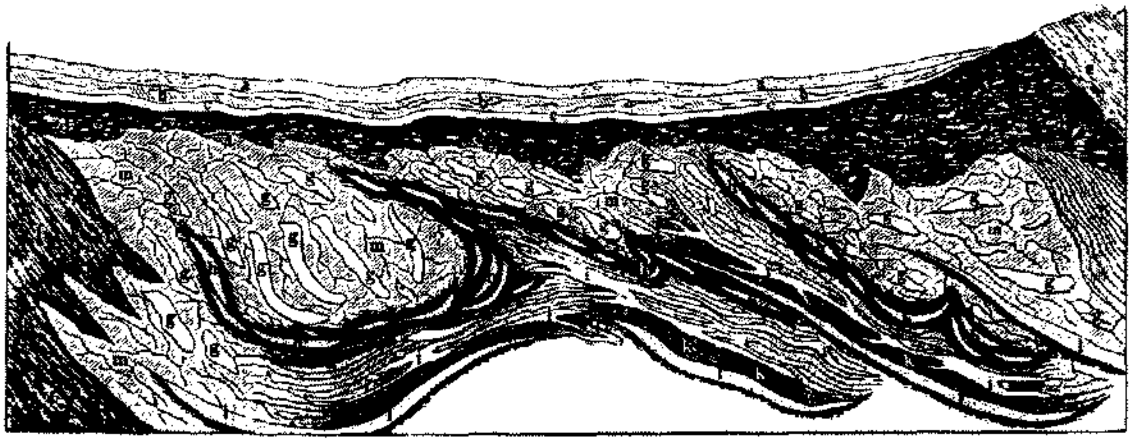
In this diapir movement, the more plastic evaporite layers are more affected, and are disconnected to form what are called "ravelled shards," so for such evaporite ores there are many bodies in a single mine, each of small tonnage, separated by the more persistent, and frequently non-ore, salt and anhydrite. (Figure 4)

It is obvious that the total footage of development underground, and generally the shaft depth, in any one region will be least for Type 1, more for Type 2, and most for Type 3; also as ore is mined near the top and flank beds, which bound the ore, and which usually are of greater permeability and porosity, there is greater hazard of fluid infiltration into the workings.

SALT MINING HISTORY IN GERMANY, AND PARTICULARLY FOR POTASH

Salt mining in Germany started at Lüneburg -- a Type 3 deposit which is a salt dome with gypsum caprock on the surface forming a surface hill, like some of the U. S. salt domes. This salt supply, carried on under church management around a thousand years ago, dominated the supply situation, and was only 20 miles from tidewater at Hamburg and the North Sea fisherman.

PROFILE ACROSS A TYPE 3 SALT SECTION
WIELICZKA, POLAND



Beds g, h, i and m are salt
Bed l is sandstone
Bed k is gypsum-clay

Furer: 1900, p. 257

Figure 4.

The importance of Lüneburg in the expansion of salt production and to geologists looking for ore was like the Five Islands in Louisiana. Lüneburg's surface topography and geology guided wildcatters. It is to be noted that those geologists and drillers worked not for private capital but for one of the somewhat or completely autonomous states of what was pre-World War II Germany. This was also the case in Poland and Galicia.

The first discovery of potash, recognized as such, in this wildcatting was a well started at Stassfurt by the State of Prussia which was spudded in 1839, and reached 1851 feet in 1851, with salt from 800 feet down. The manager inferred the magnesium and potassium chlorides in the bailings were from up the hole, and recommended a shaft be sunk to shut off the upper part of the salt, and produce the pure sodium chloride at the total depth.

In accordance with safety considerations, two shafts were completed to 1100 feet in 1856, but a surface plant to treat the ore was not completed until 1862; in the meantime the adjoining state of Anhalt also completed two shafts and commenced mining in 1862. Figure 3 shows the early development in their two mines.

It is intriguing to figure what might have happened if potash mining in Germany remained in the hand of the states and later of the German Federal Government. It did remain in the hand of the government in Poland, where the mine at Kalisz opened in the 15th century and never reached a production of annually more than 10,000 tons K_2O up to 1915.

But in Germany in 1865, private wildcatting was allowed in Prussia and later in other states, and the boom quickly developed.

By 1888, there were the two states and eight private plants marketing potash and salt, with the private plants alone having 75 small evaporator competitions from brine wells.

Discrepancies in production costs between mines began to show up unfavorably to some Type 3 mines. Productive capacity was way over demand, so the government could dominate sale prices and allocate allowables; furthermore, a graduated delivered price helped domestic purchasers, particularly those nearest to the refineries.

To aggravate these woes of private operators, during the nineties, there was discovered a province containing salt of Type 1 at shallow depths near Fulda along the Werra River.

By 1904 a roster showed 544 operations in the alkali business in Germany, but there was considerable concentration in a few major "groups," so-called, of ownership.

Production quotas, etc., had been the subject of "syndicates," as follows:

Date Founded	Period of Agreement (Years)
1879	5
1883	5
1888	10
1898	3
1901	3

Finally in 1910, after "syndicate" setting of price and production quotas broke down as a voluntary association of operators, the German government assumed control of all sale prices, but as soon as the potash mines of Alsace became French property after World War I, German price structure was threatened by the new owner's competition, so in 1919, an overall study was ordered of the relative reserves and relative mining costs, resulting in the Act of October 22, 1921,[1] under which three categories were set up: (a) Mines deemed unable to justify retention even in stand by condition; (b) Mines with cost and reserve situation favorable, if demand and prices increased; and (c) Mines justifying continuance of operation.

At first, the blow was softened by offering an override to the losers out of the winner's profits, if and when, until 1953, but this became burdensome.

As a result, in 1922 of a former 211 potash shafts, only 124 were still in production, as follows:

POTASH PRODUCTION FOR 1922 BY TYPE ORE BODY

Mining District	Type Ore Body	No. Shafts	Metric Tons Gross Ore	Metric Tons K_2O	Annual Avg. Per Shaft
Hannover	3	54	3,800,000	446,000	8,300
South Harz	2	24	2,300,000	300,000	12,500
Stassfurt	2	24	2,000,000	216,000	9,000
Halle-Mans., etc.	2	12	1,300,000	131,000	10,900
Werra River	1	14	2,400,000	273,000	18,000
Totals		124	11,800,000	1,366,000	10,700

In 1924 with only 70 shafts in production, improvement resulted from an outside source: By contract of August, that year, France agreed to a partition of the American market: 62 1/2 % to Germany, 37 1/2% to France.

Here endeth the control of world markets by Germany, but after World War II there was another -- loss not only of land, but production capacity and customers within the former territory. Also the Poles and the Russians woke up to increase total world -- available potash.

There seems no excuse for starting now a repetition of the German history outlined above inside a new potash region inside another country. Geological and geophysical surveys with subsurface data from such other source as oil tests should enable us to class as Type 1, 2, or 3 new prospects in advance of shaft sinking; and test wells should determine grade of ore, probable mining hazards, etc.

[1] Note: For those who wish to study this law, it is "Stillegungsverordnung."

What is not quite so easy to evaluate is the consumer demand in what might be considered the trade territory, and a failure in this regard was evident in the German case in this way: Liebig in two books, one dated 1840, the other 1855, clearly showed enough potassium was necessary to efficient crop yields, and his findings were arguments to build plants to supply potassium. What the potash people did not understand was how to get the customers -- that is, the farmers -- to buy it as fast as they were ready to sell.

Further proof of how little influence Liebig had for many years is the story of the slow development of potash in Poland and Russia. Today there is an enormous Type 1 ore body producing at Solikamsk in Russia (see Figure 1). Although the existence of some potash there was known in the last century, it was practically unused. In 1900, the top expert on salt, etc., was Furer. He stated that although Russian evaporite mineral production was then only a very small volume compared to Germany, the probable reserves were very large and widely distributed.

In a similar way in 1962, we can see substantial favorable reserves in other countries, so we must consider: Will they overbuild for their domestic demands, and will they then get into export markets, even into our own domestic ones?

The pace of selling customers has stepped up since Liebig's time; even so, is it not now necessary to create another break-through as to new fields for uses like his was?

One might be found by study of the partition coefficient in salt deposition, and probably the discovery of trace elements of importance, perhaps in the salt, perhaps in the salt clays, dolomites, etc., of the evaporites.

Another might be to jump way out as Libbey is reported to have done in a recent speech, where he mused that perhaps by atomic energy the silicon ion in sand might be upgraded to a useful new metallic element. Fantasy, you say. So they must have said about Liebig.

As to the technicians at this symposium, there is a special lesson not yet mentioned as to German history. It is the need for foreign experience in new provience in new provinces developed abroad. Two cases of foreign contributions to German efficiency are: (a) the British introduced the diamond drill-crown and core-drill to Germany; (b) they suggested using saturated magnesium chloride brine in well-drilling to prevent solution of potash beds.

SUMMARY

As shown by the history of the potash industry's growth in Germany since 1862, disaster to individual mines was caused by their location in geological settings where they were not in the low-cost class. Disaster several times overtook the whole German industry because increased total mine capacity was created without considering the lag in increase of demand in the logical trade territory.

As in the past, a successful industry and single operators within that industry must build at low cost locations relative to neighbors and within adequate trade territory for the productive capacity. Evaluation of each factor requires study of similar past history.

ACKNOWLEDGEMENTS

Industry surveys of this scope are based on many question and answer periods. Of two protagonists of mine at such sessions, I wish to thank two who are still active: Harold B. Foxhall and Karl Hasselmann.