

THE CHESHIRE SALT REGION

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At some period before history began, but from which faint wafts of tradition come to us, a vast sea occupied the centre of Asia, probably connected with the ocean between the Ural and the mouth of the Olensk. It extended westward to the mouths of the Danube.

Then the land in central Asia and in Siberia rose, and the waters burst forth through the Bosphorus, leaving a recollection of the cataclysm in the fable of the deluge of Deucalion. The Black Sea, the Caspian, and the Seas of Azof and of Aral are the remains of this inland ocean. The Caspian and the Sea of Aral are without vents, and receive the drainage of vast tracts of country. The bed of the Caspian forms one of the deepest depressions of large extent on the surface of the earth, and into it flows the Volga, bringing in not only enormous volumes of fresh water but also vast deposits of mud. These deposits are gradually cutting off arms of the great sea from the main bulk of salt water, and when such arms, or bays, are not fed by rivers, they evaporate, and as they evaporate become annually more salt. Van Baer says : " In the neighbourhood of Novo Petrovsk, on the eastern coast, where was once a bay, is now a large number of basins, presenting every degree of saline concentration. One of these still occasionally receives water from the sea, and has deposited on its banks only a very thin layer of salt. A second, likewise full of water, has its bottom hidden by a thick crust of rose-coloured crystals, like a pavement of marble. A third exhibits a compact mass of salt, in which are pools of water whose surface is more than a yard below the level of the sea. And a fourth has lost all its water by evaporation, and the stratum of salt left behind is now covered by sand." On the same coast of the Caspian is the Kara Boshaz. This is almost cut off from the sea, but there still exists a mouth through which the salt water of the Caspian flows in, but there is no return current, the waters are exhausted by evaporation. The result is that they are becoming more saline, and a salt deposit is forming. Eventually, when the mouth chokes, the whole gulf will dry up and leave behind a bed of salt, over which the sand will blow, and which in time will be buried.

On the north-west of the Caspian, at a distance of some 200 miles from it, are the remains of what was at one time a portion of the same great sea. It is called on the maps Lake Elton. In 1805 Gobel bored at a distance of 11 miles from its then shore. " He found forty-two distinct layers of rock salt, the uppermost 1 ft. 4 in. thick, the lowermost 9 in. thick. The deeper he went the more solid the rock salt was, and the purer. At the hundredth layer (a foot thick) the salt was so hard that the iron tool broke." In process of time Lake Elton will disappear, as have thousands of other lakes and meres, the remains of the ancient sea, and leave behind it only beds of salt. Thus we have actually in progress in Asia a picture of what took place to a large

Sandstone.

The great rock salt deposits in Europe are nine in number. First of all is that vast basin which extends from Galicia through Transylvania and Wallachia, and is cut into three by the Carpathians. The second is the district of the Austrian and Bavarian Alps the third is the district of Western Germany, extending from Holstein to Würtemberg. Then come the two districts of the Vosges and of the Jura. We have next the slightly worked district of the Swiss Alps. Then comes a large Pyrenean deposit of rock salt in the basin of the Adour. In Spain is an important but not extensively worked region of salt deposit. Finally we arrive at the Cheshire and Worcestershire region, which is specially the subject of this paper.¹

The Permian period at which the salt beds of this last region were formed was one of great lakes and inland seas, some perhaps fresh, but the majority salt. These tracts of water were studded with islands and were fed with streams. Some were like the Mediterranean, in connection with the ocean; others, like the Caspian, were cut off from it. Now salt is not deposited in the ocean. Water will take up salt to the extent of 2 lb. 10 oz. a gallon, but no more. That is to say, 27 per cent. is the proportion of the strongest brine. The average saltiness of the sea is about 3½ per cent. The Caspian has but 1 per cent. of salt.

No crystallization takes place till the balance is disturbed and the water reduced by evaporation. The salt then begins to form on the surface of the water, and after a while sinks to the bottom.

The salt formation of the Triassic period is by no means continuous. The salt lies in pans or beds of various extent, and between these pans there are but traces of salt. At one place is rock salt; this thins away, becomes more and more mixed with marl, and finally is represented by a trace only. When that is the case we know that we have come to the margin of an ancient Permian mere. In the Triassic period there extended a chain of salt lakes from the mouth of the Mersey to the Severn, and the great Cheshire deposit occupies the bed of one of these, which in all probability formerly communicated with the ocean somewhere where now stands the great port of Liverpool.

It may be said to occupy the depression through which now runs the river Weaver. The rock salt lies above the New Red Sandstone. The lowest bed is at Northwich, 87 ft. thick, and lies 213 ft. below the surface. Above that is a layer of impervious marl, locally termed "stone," 30 ft. thick. Above that again is the first deposit of rock salt reached in boring or mining; it is 63 ft. thick, and that lies 120 ft. below the surface. Between the surface and the first rock salt are gravels and gypsum beds, and immediately over the salt is "beany-metal," or "flag." Very generally as soon as this flag is pierced brine rises and rushes up the shaft. Water percolates through the porous beds to the topmost rock salt and takes up from it as much as it can hold, and there lies in subterranean lakes of brine. When this brine is pumped to the surface fresh water takes its place and is in turn converted into brine, to be again removed by pumping. Thus in the proximity to the salt works the salt rock is being incessantly corroded and removed in the

form of brine. The result is the formation of a vast reservoir or cavern underground, in the place where was the rock salt, and as the water which does all the mining leaves no pillars to sustain the roof, the land above it sinks, and eventually must go down, not indeed 63 ft., but considerably more than half that amount. If the salt rock were perfectly pure it would be wholly removed in the form of brine, but it is not pure. It was formed in lakes into which streams flowed, carrying deposits of mud, and this muddy deposit remains.

Now the river Weaver at Northwich is 32 ft. 6 in. above the sea-level, and the level of the lower part of the town is 40 ft. Consequently, if only a little over half the subjacent salt rock be removed, the river and town will sink to the sea-level, and become a vast lake. Already, in the neighbourhood, something of the kind is taking place. What was at one time a brook is transformed into a mere, which in places is deeper than 40 ft., and which is gradually increasing, and would increase much more rapidly were not all kinds of rubbish and the dredgings of the canal and river thrown into it, to the amount of 100,000 to 150,000 tons annually. At Winsford the land has gone down to such an extent that two great lakes have been formed, locally termed "flashes," and rows of houses, shops, a church and chapels have had to be removed because sliding down into the gulf that was forming and is continually increasing.

In Northwich the greater portion of the town is sinking, and as it goes down, the inhabitants are obliged to rebuild or adapt their houses to the changed conditions of level. What was a ground floor becomes a cellar. What was first floor becomes ground floor. The houses and churches crack, stagger, and go to pieces. A new police station of brick showed such rents that it had to be banded about with iron to hold it together. In May, 1892, a house lurched over, and its foundations sank on one side, and water came up over them. The appearance was extraordinary, and the angle of subsidence was so great that it was no longer possible to occupy the house. It had to be taken to pieces. A horse in its stable disappeared into the bowels of the earth. Another horse went down in a field. In the middle of a large cornfield suddenly the land sank, the hedge and great trees went down, and disappeared, and now there stands a crater-like hole with a tarn covering $5\frac{1}{2}$ acres in its bottom. In 1890 over 2,000,000 tons of salt were exported from the Cheshire salt district. That signifies over 2,000,000 tons of rock drawn out from under the feet of the inhabitants and the foundations of their houses. It is, or was, a favourite joke among schoolboys to remove surreptitiously the laths from a bed, when he who slept on the mattress above sank, mattress and bedding and all, to the floor. Something of the same sort of thing is being done to the inhabitants of the Weaver valley in Cheshire. An entire mattress, or the major part of one, 63 ft. thick, is being pulled away from under them, and as it is plucked away, clown they go deeper and deeper.

The rock salt is quarried or mined out of the lowest bed, but brine is pumped from the upper bed. Enormous damage has been caused by water getting into the old salt mines. These mines were opened in 1781, but some out-crops of the upper salt were worked from 1670. When the lower run of salt was discovered those worked in the upper deposit were abandoned. Water got in, and these mines have fallen in and formed great funnel-shaped craters. But such subsidences

upper bed.

At Middlesborough, in Durham, salt had been discovered by boring at the depth of 2,000 ft. There two shafts are opened ; fresh water is injected by one, and is drawn out in the form of brine from the other. In Cheshire water is sometimes pumped down, but usually it descends naturally through cracks in the subsiding surface and through the gravelly soil that lies above the " rock."

Naturally the brine does not run away in springs. In ancient times it was brought up from shafts in leather buckets, and was then steamed in "wych-houses." Various Cheshire noblemen and gentry had their "wych-houses" and brine wells in the salt district. In and about Northwich the land is literally honeycombed with old salt mines. When the fresh water in its course passes over the rock salt forming the roof of the mine it dissolves it completely, and then the upper earths fall in, leaving an enormous hole. There are over 80 acres of standing water in Dunkirk and Marston thus formed.

At the latter is a mere, covering 15 acres, that has come into existence within the last fifteen years. The ground is rapidly sinking in both these districts, and the area of lakes is rapidly increasing. When there are buildings on the sinking ground they present fissures, and literally fall to pieces. The amount of injury to property is enormous. In 1881 evidence was produced before a Committee in Parliament that 644 acres of land had been damaged by subsidence, 295 houses, 12 warehouses, and 62 shops. The depreciation on this property was estimated at £40,037 10s., and the annual loss to the owners £1,579 18s. The rateable value of property affected by subsidence was as follows : Wincham, £882; Leftwich, £728; Winnington, £1,382; Anderton, £1,878 ; Castle Northwich, £319; Witten, £6,710; Northwich, £4, 938.

The injury done in the early days, when the manufacture of salt was small, was infinitesimal. Then the brine was brought up in buckets by hand. After that, windmills were employed to pump up the brine. Now we have steam-engines, and the trade in salt is greatly increased. As it increases so does the action of the subterranean water, and the state of quietude which existed by nature is disturbed. First a few sinkings took place, then they became more numerous, and now go on irregularly in some places, regularly in others, and will so continue till a whole district is submerged, and the towns of Winsford, Middlesville, Northwich, Sandbach, lie at the bottom of an inland lake, much as do the cities of the plain under the briny waters of the Dead Sea.

Rock salt is indeed mined chiefly at Northwich, but the rock salt is extracted from the lowest bed, one which the water does not reach, as it is separated from the upper flooded bed by impervious marl. Where man works, there he leaves pillars sustaining the roof, or at all events would build up supports, but where the mining agency is water no such provision is or can be made, and as the rock salt is dissolved and removed, the surface must sink over the void artificially formed. If the whole surface will not sink as much as sixty-three feet it is because the salt rock, as already said, is not pure, it contains much grit and mud that was washed into

hardly allow for it more than fifteen feet, and the surface will sink eventually some forty-eight feet, that is to say some eight feet below sea-level. In some of the meres or "flashes " formed, the bottom is considerably below sea-level, and inevitably these "flashes" will extend till the entire surface over the salt-runs is submerged.

One might perhaps have thought that these "flashes" and the wells in the craters would be briny; such, however, is not the case, for fresh water, being of less gravity than brine, floats on the surface. Taken on the whole, the salt district of Cheshire is one of the most interesting in England that could be visited, and it is interesting not only on account of the process of the manufacture of salt, but also because there we can see a whole tract of country being let down under water, whilst teeming with life, by the activity of the salt trade.

In 1890 a bill was brought into parliament to enable a company to pump out brine at Wincham, and convey it by pipes to Widnes, in Lancashire, for the manufacture of alkali. This was, with a vengeance, to despoil the district without bringing in a corresponding gain. It was successfully defeated. A bill for compensation to land and house-owners, introduced in 1881, was thrown out, through the determined resistance of the salt and alkali manufacturers.

No doubt the inhabitants of the towns live on that trade, but no doubt also that they are subjected to very extraordinary risks and very great disadvantages.

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