The origin of the magnesium chloride under Veendam

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Nedmag mines magnesium chloride from the subsurface beneath Veendam. Zechstein Minerals selects a special quality from this production that is fit for topical applications in the cosmetic and the health markets. Prof. dr. Janos L. Urai, of the geological facility of RWTH University in Aachen. explains how this salt was formed under Veendam and what makes it so unique.

There's a thick layer of salt deep below the surface of the Northern Netherlands. It is mostly made up of rock salt (halite). This is sodium chloride, which is the same stuff as table salt and the salt used to de-ice roads. In most places there is also a thin layer of potassium salt (carnalite), which is used to make fertilizer. But it's only under Veendam that you will find a rich deposit of magnesium chloride (bischofite, after the German geologist Gustav Bischof). It's one of a few places in Europe where this salt can be mined.

To understand what makes this location so special, we have to go back to the Permian era, about 200 million years ago. The climate then was warm and dry, and Northern Europa was covered by an enormous inland sea. This Zechstein sea (fig. 1) had only a narrow connection to the ocean. Sunlight and heat, caused the water to evaporate. Eventually, this made the water so salty that salts started to crystallize on the sea floor, forming thick layers of rock salt.

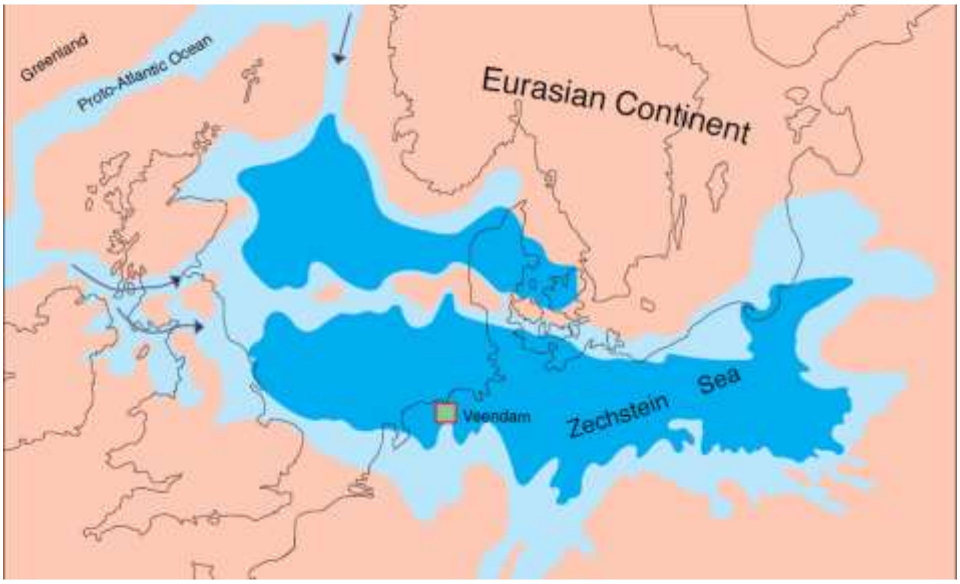

Figure 1: the location of the Zechstein sea

Now and then the ocean would flow into the Zechstein sea, adding new salt and new water. Due to the difference in height between the two bodies of water, the Zechtein water never flowed back into the ocean. The new water evaporated and the new salt remained. Because the water couldn't get any more saline, this salt sunk to the bottom, where layer upon layer of salt was formed. It's through a similar process that the Dead Sea became so salty, although that sea is about a thousand times smaller than the Zechstein sea was. Inland seas of that size don't exist in our geological era.

The cycle of evaporation and new water flowing in went on for about ten million years, until the new water couldn't compensate for the level of evaporation anymore, and the sea started to dry up. The ocean floor, which was covered by layers of salt miles thick, started breaking through the surface of water, like little islands. Slowly, a salt desert was formed, which stretched from London to Warsaw. These kind of deserts can now be found on all continents, where race car drivers sometimes use them to set new speed records, because they are so flat and empty (see fig. 2).

Figure 2: a modern-day salt desert in Oman

There was still a bit of salt water remaining, though, although it didn't much resemble water anymore: the amount of dissolved salt had made it gooey and thick as honey. This water flowed to the lowest places on the dried out bottom of the sea – depressions that were formed by subterranean geological activity – where it collected into little lakes. One of the largest of these lakes formed underneath the place where Veendam is today, due to a unique geological quirk in the terrain. If you would have taken a drive through this desert at the time, you would have seen a seemingly endless white flat, with small lakes here and there. Almost like an oasis, but filled with undrinkable liquid.

Eventually, this water in which only the magnesium chloride remained also started to evaporate. Magnesium chloride is extremely soluble, which also means that it's almost impossible to get out of water to crystallize. During the many centuries in which the Zechstein sea rose and fell, it has never crystallized, meaning that those gooey lakes contained almost all the magnesium chloride that had ever passed into the Zechstein sea. Eventually, though, the last bit of water evaporated as well, leaving a layer of magnesium chloride, thirty meters thick, where the lake had been.

In the millions of years that followed, many layers of sand and clay were deposited on top of the salt. And the salt, which was now underground, started to flow. This might seem impossible: salt is, after all, tough and solid when you hold a block of it in your hands. You could easily build a house out of rock salt. But in geological time, it behaves more like a very slow-flowing liquid. Compare it to ice in a glacier: a block of ice is hard as rock, and yet the glacier slowly flows down the mountain.

Similarly, due to the enormous amount of pressure from the rocks on top of them, and the heat from the earth underneath, the salts began to flow beneath the earth. In salt mines all over the world, you can see that the layers of salt, which had crystallized on top of each other, didn't remain neatly stacked. Instead, they started to bend and to fold into each other, like the different layers of sugar in a fair lollipop.

What makes Veendam so unique is not just that it's situated on top of a former magnesium chloride lake, but what happened after the lake dried out. By pure coincidence, there was a slight dent in the layers of rock that formed on top of the place where the lake used to be. Meaning that there was slightly less weight there as well. For the salt, which was behaving like a liquid, this was enough to be pushed upwards in that exact spot. Compare it to a half-inflated air bed: if you lie down with two people, the weight of your bodies will push the air up in between you (see figure

3).

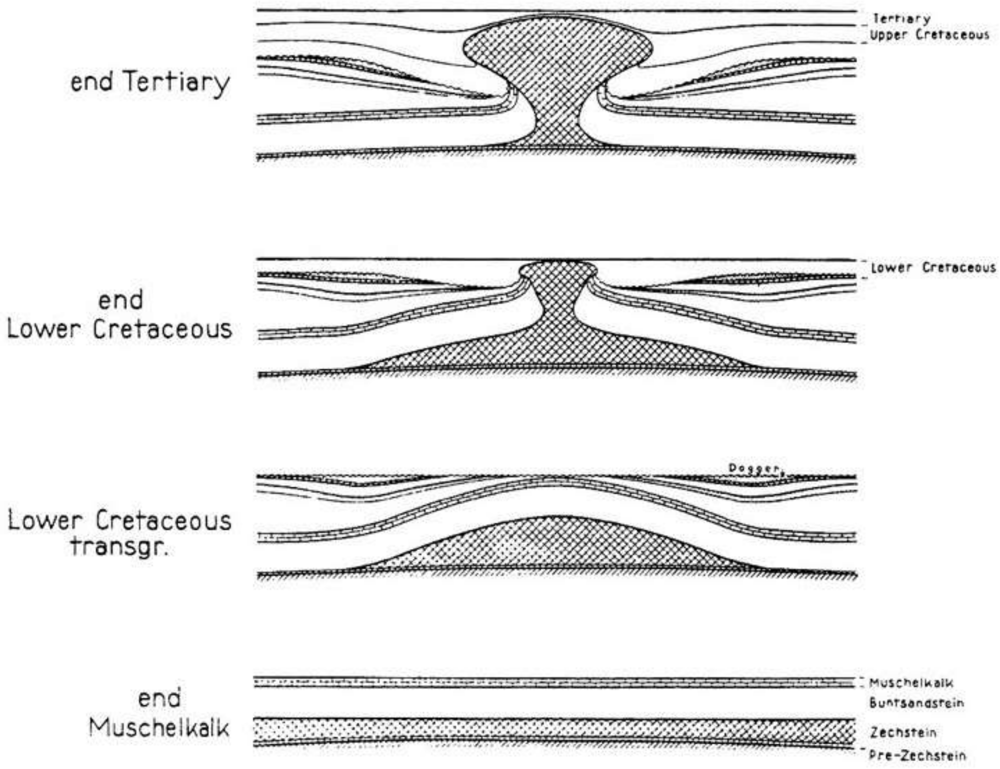

Figure 3: the salt flows upwards. The chronology in this picture is from bottom to top. Trusheim (1960)

This latter process is fairly normal, and it happened all over the place that was once the Zechstein sea. But there's only one place where it happened on the spot where a magnesium chloride lake used to be. Geologically, these two processes are completely disconnected. It was pure luck that this happened underneath Veendam, and this is what makes it such a unique mining site.

Right now, this magnesium chloride is about a mile underground. To mine it, Nedmag drills a hole in the salt hill (geologists call this a “salt pillow”) and lowers two pipes down into it. Through the first pipe, they pump water down. As you might recall, magnesium chloride is really soluble, so it almost immediately dissolves in the water. Since this whole process takes part a mile beneath the earth, there is immense pressure on the water (which also helps the magnesium salt to dissolve more easily). Because of this, Nedmag only has to open the tap on the second pipe for the water to flow back up to the surface, where it can be cooked until only the magnesium chloride remains.

If magnesium chloride was solid, this process would leave an increasingly larger cavern in the underground. But as we discussed earlier, salt flows, and magnesium chloride happens to flow faster than most salts. The pressure on the water inside the hole is lower than the pressure inside the layer of salt, which, if you'll recall the analogy of the airbed, is under the pressure of a mile of rock in all directions. Because of this, the magnesium chloride flows to the opening of the pipes, where it can be dissolved and collected.

This is how Nedmag unearths a salt that crystallized 200 million years ago, in a shallow lake bed in an enormous salt desert, where the sunlight was so bright it would have burned your eyes.