Salt of the earth

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We are all familiar with salt from the kitchen table, health warnings about too much salt and its use and importance for mankind, eg in gritting of roads. What else do we need to know about salt?

Everyone has a favourite rock, be it the sandstones of Petra, Portland Stone or Aberdeen Granite as a building stone or organic shale as a source of oil and gas (perhaps not the favourite at the moment!) The speaker intended to show that a rock to be admired is salt. Halite is an unusually beautiful mineral with unique physical properties that merit consideration.

Folded salt in a Sicilian mine

How is salt deposited?

Salt is dissolved by water and transported as a fluid to be reprecipitated elsewhere. It is an important rock, despite forming only 2% of the known sedimentary record. Evaporation of 1,000m of seawater yields only 16m of solid salts. First to be precipitated are the carbonates (0.1m), followed by gypsum (0.6m), halite (12m) and potassium-magnesium bittern salts (2.8m). With these yields, how do we get enough water to form the thicknesses of halite that are found. This requires replenishment of the water. For example, a lagoon adjacent to the sea may receive input from the sea by seepage or overflow of the lagoon barrier, run-off from land, rainfall, meteoric and hydrothermal seepage and will lose water by seepage into the ground and by evaporation.

This was illustrated by the Salar de Uyuni in south-west Bolivia, which has large amounts of salt enclosed within the surrounding Andean volcanic terrain. Its diameter is as great as the distance from London to Derby. The surprising feature is the rate of accumulation of salt. Clastic rocks tend to grow at a rate of mm/1,000 years but monitoring with radar shows that salt in the Salar de Uynuni is aggrading at 2cm/year. There is positive feedback, since as the salt is deposited the basin subsides. The inflow in this case is hydrothermal.

The Dead Sea is probably more familiar, lying 430m below sea level and being 300m deep with a salinity of 34% (10 times that of sea water). The inflow is from ancient Messenian salt of Miocene age from the drying up of the Mediterranean Sea, which is dissolved and carried into the Dead Sea basin. Salt is harvested from the Dead Sea.

History of salt

This essentially starts at Lake Yucheng in east central China, where salt has been extracted since 6000BC. Salt could be easily transported in water in clay pots and reprecipitated when needed. The Romans in 5000BC used steel pans rather than clay pots. Taoist monk alchemists in China were using salt in an attempt to discover the elixir of life but instead found Soduium Nitrate (NaNO3), the foundation of gunpowder.

Salt can be used to help to preserve food – fish, meat and even human bodies. The Egyptians used this by inserting salt to remove water and preserve the body for the afterlife. They also used it to preserve the huge amounts of food in tombs to provide the soul nourishment on its passage to the afterlife. The tomb of Tutankhamen contained 116 baskets of fruit, 40 jars of wine, large volumes of vegetables and preserved meats.

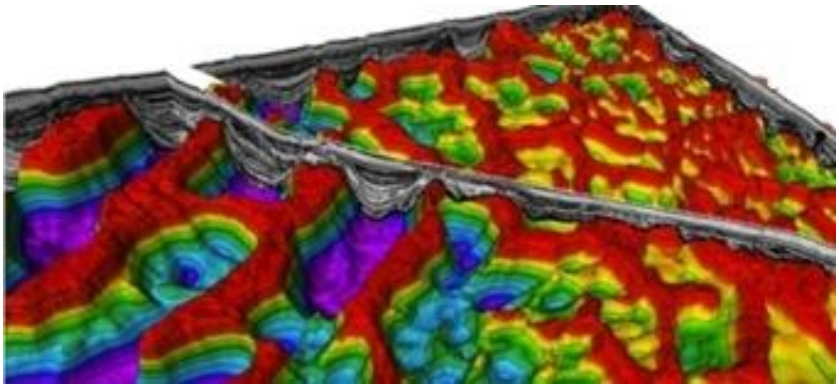
In the USA, salt played a pivotal role in the Civil War because of the importance of feeding soldiers who were far from their home resources. Salt, in fact, had more value than money and the soldiers were paid in salt, from which we derive the word salary from the Latin *sal*, meaning salt.. There were huge battles in the disputed area between the Union and the Confederacy, including 2 battles at Saltville in 1864 and 1865 for control of the salt mines there.

Salt behaving badly

Lake Peigneur, Louisiana, is a 3km diameter lake drained by a canal that heads south the the Gulf of Mexico. It is situated on top of a salt dome (diapir), which has mining for salt in its upper part. An oil company drilled from a platform in the lake attempting to hit structures in the country rock adjacent to the diaper but the borehole diverted into open mine shaft networks. The toppling rig was abandoned and fresh water flooded into the mine. Fortunately the 55 miners there escaped without harm. A whirlpool formed, which enlarged to 900m across in 2 hours. It swallowed 2 drilling platforms, a towing tug and 11 barges and drained 13Mm3 of water in 3 hours. The lake refilled within days from the salt water canal over a 50ft- high waterfall, the highest ever in Louisiana and the water formed a 400ft geyser from the mine shaft. (of the barges came back a day later.

Physical properties of salt

Salt is a very weak rock. Most rocks increase in strength with depth of burial but salt does not so it forms a weak layer in a pile of sediments. Density in sandstones and mudstones also increases with depth but salt becomes a little less dense so it is buoyant and under load will flow up fractures in the overlying rocks to form a diaper, which can be very large. Some of the North Sea diapirs in the Zechstein salt are up to 2km high and 1km across.



Giant ancient salt structures buried offshore Brazil

Salt is important because of its function in hydrocarbon exploration. Hydrocarbon plays require an organic-rich source rock, a porous reservoir rock and an impermeable or low permeability seal rock. 60% of the giant hydrocarbon fields containing >0.5 billion barrels of oil are associated with salt, typically as the seal. For example, the Auger field in the Gulf of Mexico has about 250M barrels of oil recoverable and is being developed at a cost of $1 billion (£640M). The Tupi/Lula discovery in Brazil has 5 billion barrels of oil recoverable and is intended to produce c0.5M barrels/day from 300 wells, with development costs of $100 billion (£63 billion).

Conclusion

The speaker concluded by expressing the hope that his demonstration of the fascination and beauty of salt had turned the audience into halophiles – salt-loving organisms.