Serpentinization does not build up salt formations

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The classical theory on the formation of enormous rock salt deposits (salt giants) is that of the evaporation of seawater in shallow basins over millions of years.[1] In 2018, this view was challenged by suggesting that salt giants are caused by salt magmas that solidified in between muddy Flood sediments.[2] Then, in 2019, an alternative mechanism was published by Debure *et al.*[3] in which the metamorphic serpentinization process (see below) was claimed to have formed brines that ultimately resulted in the formation of salt giants.

Debure *et al.* state:

"... evaporation alone cannot explain salt deposits several kilometres thick (salt giants) or deposits of highly soluble evaporites (bischofite, carnallite and tachyhydrite)."

On this we agree. They give several powerful reasons why; for instance, contradictions between the amount of soluble salt, the assumed paleoclimate and the absence of fossils in the salt deposits. If salt deposits formed due to evaporation, one would expect to find the fossils of plants and animals embedded in the rock salt. Nonetheless, we object to their solution that serpentinization itself is a sufficient mechanism to explain salt giants. Furthermore, this process does not appear to fit within the framework of the biblical timescale.

From serpentinization to salt giant

Serpentinization is a process in which the sub-seafloor mantle rock peridotite transforms into serpentine. The process is expected to occur underneath the five- to ten-kilometre-thick oceanic crust (figure 1). Debure *et al.* state:

"The associated geochemical processes involve the consumption of massive amounts of pure water, leading to the production of concentrated brines."

During the serpentinization process the volume and temperature of the rock increase. The ocean supplies the water that penetrates the rock. Assuming this is regular seawater, the unused salt becomes concentrated in a brine. For the salt to be deposited as solid structures, the brine needs to become supercritical (> 407°C and > 300 bars),[4] evaporated by solar power, or precipitated by any other process. Debure *et al.* opt for:

"The temperature decrease that accompanies the ascent of the brine in the crust and/or the sediments lowers the salt solubility and allows salt deposition."

So, they suggest that the hot, dense brine rises up through the crust until it reaches the sea floor. The cooling down to 4°C will decrease solubility, which causes partial precipitation. Somehow this salt layer at the ocean floor will not dissolve into the ocean but form a salt giant.

Discussion

The transformation of 1 m^3 of peridotite into serpentine by seawater yields about 5 dm^3 of salt.[4] This sea salt is concentrated into a brine, whereafter the brine flows up through the earth's crust. This mechanism has to overcome several problems:

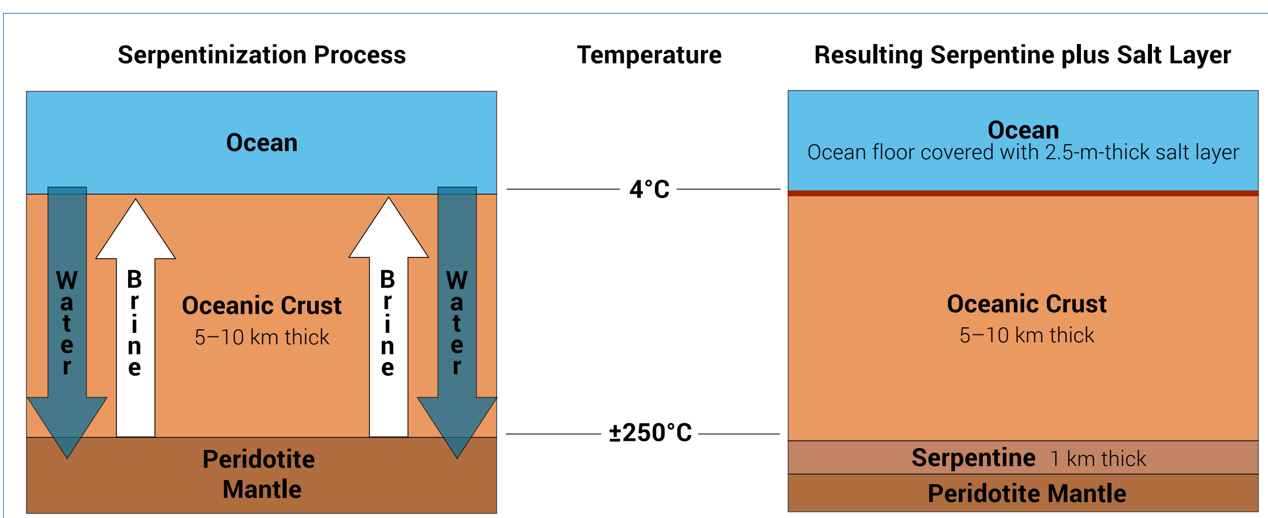

Figure 1. The serpentinization process as described by Debure *et al.*[3] Peridotite is assumed to have consumed massive amounts of water from the oceans to serpentinize. The remaining salt became concentrated in a hot brine, which rose and cooled, thus delivering the salt at the ocean floor.

- The brine is denser than the seawater that is assumed to seep down through the 5–10-km-thick crust. So, the brine will stay where it originated underneath the crust and/or will mix with the seawater that flows down. It is improbable that the downward and upward flows become separated. Debure *et al.* did not suggest a mechanism to solve this problem.
- The amount of peridotite that must be altered is beyond description. 1 km^3 of rock salt requires serpentinization of at least 200 km^3 of peridotite; that is, if *all* salt is eventually deposited in a salt giant. However, that is likely impossible, as a significant part of the salt will stay in solution (if not all, which is more likely). If a generous 50% of the formed brine will be deposited, then 400 km^3 of peridotite is required for 1 km^3 of salt. However, serpentinite (including partially serpentinized peridotite) is not abundant in the oceanic crust.[5]
- A single salt giant can contain a million km^3 of salt.[6] This requires 400 million km^3 of peridotite to be serpentinized under the favourable conditions mentioned above. Assuming a pure peridotite 1-km-thick top layer of the mantle, an area of 400 million km^2 (80% of the total global surface) had to be serpentinized for a single salt giant. That caused a 2.5-m-thick layer of pure salt spread out on the ocean floor. But how will that be accumulated into a salt giant, situated in a continental basin?
- If such large parts of the ocean floor were poisoned by such a brine, fossils should be abundantly present in the salt. But a remarkable feature of salt giants is the lack of fossils.
- In the serpentinization model, seawater seeps slowly down to the mantle, whereafter a brine plumes upward. Each 1 km^3 of salt requires 130 km^3 of seawater[7] to seep down through the solid crust. Given the salt volume required, this process will take a long time. That might not be a problem in the secular view of Debure *et al.* However, the duration of the proposed mechanism is impossible to fit in a biblical timescale.
- After the seawater slowly seeps down through the crust the actual serpentinization can start. Therefore, the water needs to diffuse into the mantle rock. Debure *et al.* state:

  > "The low water diffusion coefficient (10^{-7}–10^{-8} cm^{2}s^{-1} at 34°C) can limit the rate of serpentinization below 100°C, whereas serpentinization is more efficient at 300°C (1 km formed in 1 Ma)."[8,9]

  Again, that shows the process will not fit in a young-earth timescale.
- The seawater used in the serpentinization process likely contained the same salt concentration as today to allow for the serpentinization process to form brines. However, calculations show that year by year the seas' salt content is increasing as salts are transported to the seas via rivers but remain when water evaporates.[10] Extrapolating to the past would yield oceans of a lower salinity. This could greatly alter the time and volume for the serpentinization process.
- The formation of kilometres-high uprising salt pillars buried in sedimentary basins remains unexplained in the serpentinization model.

Conclusion

Even from a secular point of view, it seems a stretch to try and use serpentinization to explain salt giants. Given the higher density of the resulting brine, it is highly unlikely that it ever was able to pass through the crust to reach the ocean floor above. In the unlikely event that salt layers were formed in the depths of the oceans, they should have contained fossils, which the salt giants do not. Moreover, the serpentinization process only addresses the existence of salt layers, whereas salt tectonics needs to be explained as well.

From a biblical perspective it is even more improbable to form salt giants solely through the serpentinization process. The oceans likely could not provide the necessary salt, and the process takes too long to fit a biblical timescale.

Biblical creationists would be better served by exploring other models, such as a primary igneous origin for salt,[11] which provide better fits for the geological evidence and the biblical timescale.

References

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