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*Supplement of*

## **On the temperature in a final disposal site for high-level radioactive waste**

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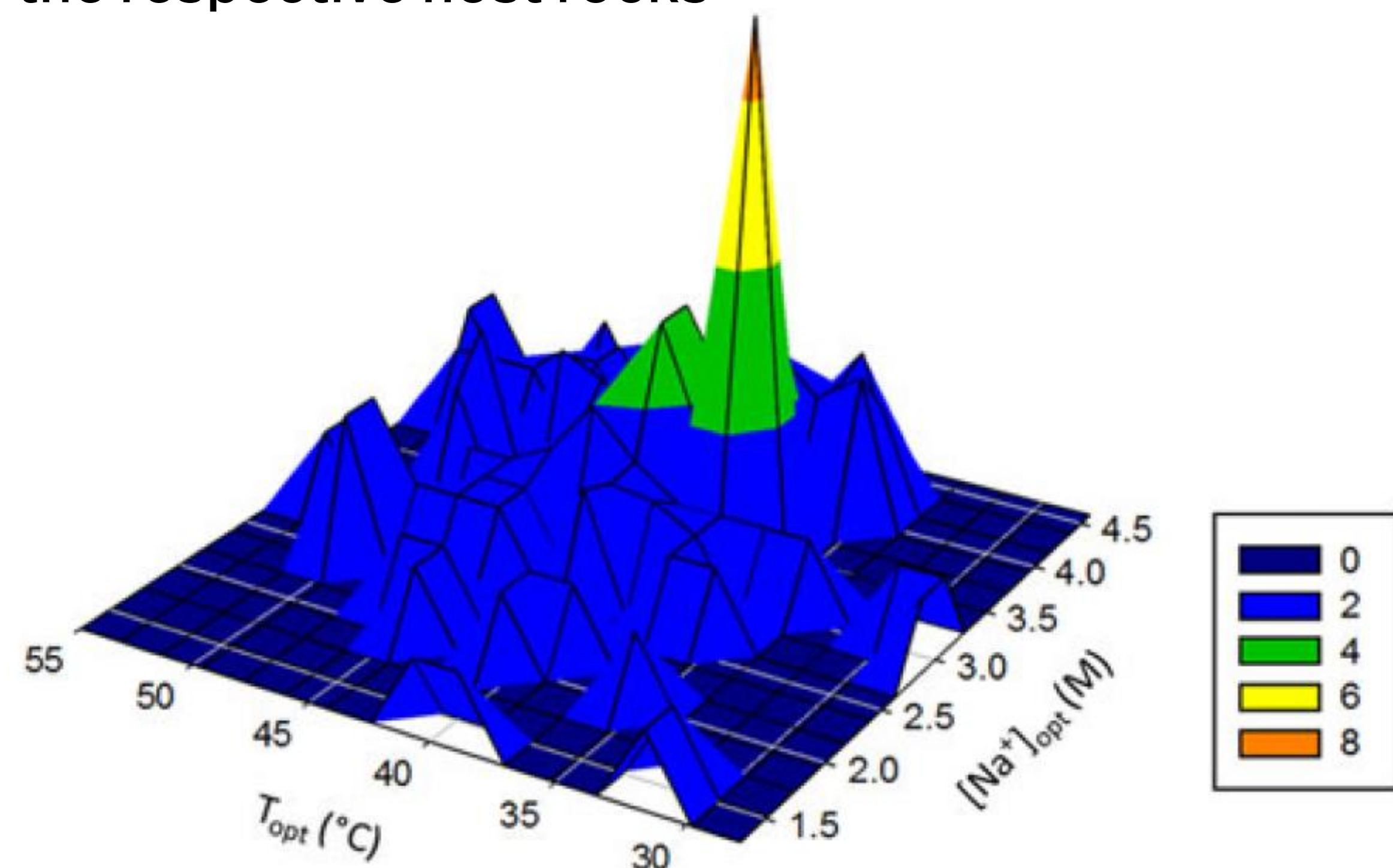
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## 1. Introduction

- The Site Selection Act (2017) stipulates in §27 (4) a precautionary temperature limit of 100 °C on the outer surface of the containers with HLRW in the final disposal site. This precautionary temperature limit shall be applied in preliminary safety analyses provided that the “maximum physically possible temperatures” in the respective host rocks have not yet been determined due to pending research.
- The prevailing temperature in the deep geological underground can trigger thermo-hydraulical, mechanical, chemical and biological processes (THMCB processes) in the respective host rocks (salt, clay, crystalline rock), which may be relevant for safety.

Host rock	Temperature dependent process (example)
Salt rock	<ul style="list-style-type: none"> <li>• Release of water from crystals</li> <li>• Formation of cracks and fractures</li> </ul>
Clay rock	<ul style="list-style-type: none"> <li>• Mineral transformations (Buffer, host rock)</li> <li>• Gas generation</li> </ul>
Crystalline rock	<ul style="list-style-type: none"> <li>• Mineral transformations (Buffer, fracture fillings)</li> </ul>

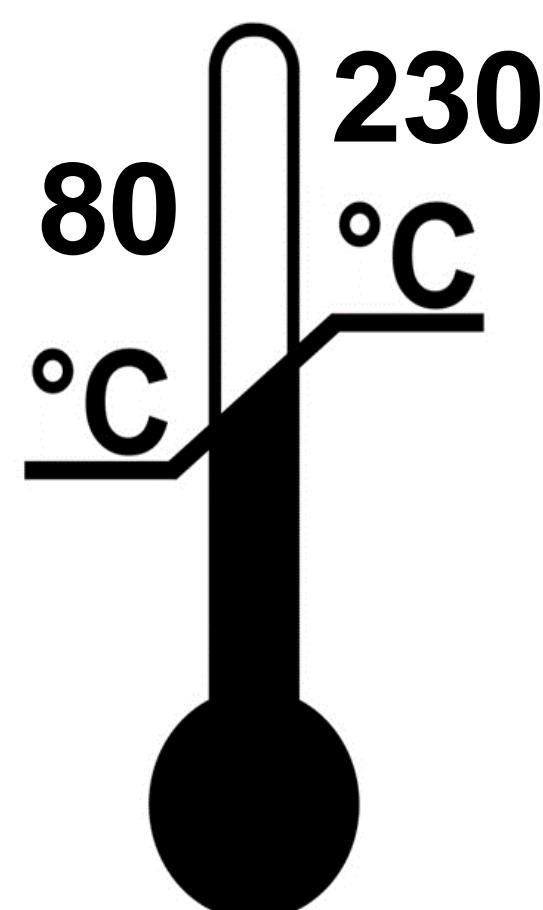
**Fig. 1** Examples for temperature-depending processes in the respective host rocks



**Fig. 2** Growth rate of microorganisms depends on temperature and salinity

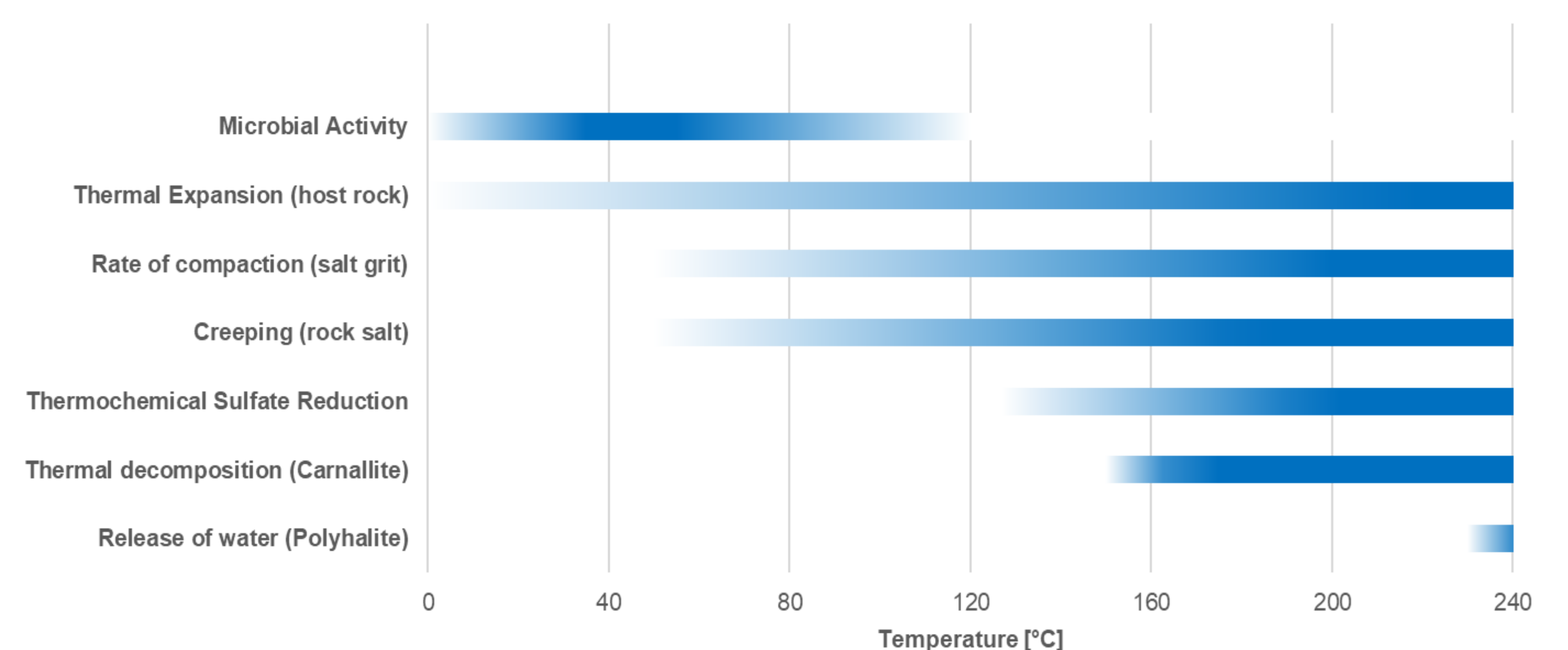
## 3. Results

- Safety relevant THMCB processes in the respective host rocks are well known (Fig. 1, 2, 3 and 4).
- To derive specific temperature limits for the outer surface of the container, the temperature compatibility of the components of the disposal concept should be considered.
- The interactions of all relevant processes of the disposal concept needs to be considered in a safety analysis.
- The maximum temperature limits for the outer surface of the container, which are considered for disposal concepts in different national concepts, can range between 80° C to 230° C.
- No explicit maximum temperature limits or requirements on the temperature for final disposal concepts were found in other national regulations. Some general requirements on design temperatures exist.

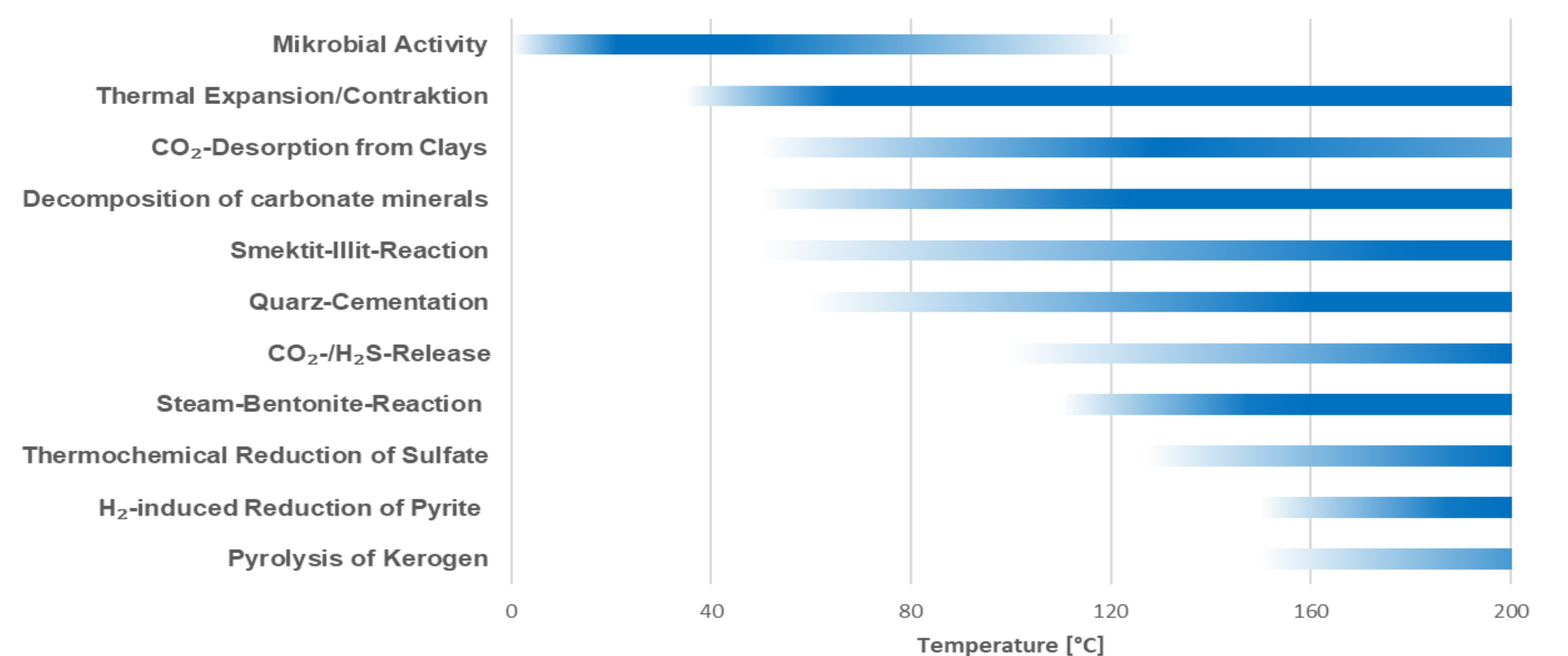


## 2. Description of the work

- The study reviewed temperature-dependent processes (THMCB) of safety and disposal concepts in the respective host rocks (Fig. 1). Many, if not all, temperature-dependent processes are described in detail in databases for features, events and processes (FEP-databases), which were used as reference.
- National regulations of thirteen countries were screened for requirements on temperature limits and/or on retrievability/recovery.



**Fig. 3** Main temperature-dependent processes for safety concepts in salt rock



**Fig. 4** Main temperature-dependent processes for safety concepts in clay rock

## 4. Conclusions

- The interactions of all relevant processes of the final disposal concept shall be considered and studied by safety analysis.
- As a result, the maximum temperature limit on the outer surface of the container depend on the safety and disposal concepts for salt, clay and crystalline rock.
- Therefore, a generic requirement for a temperature limit on the outer surface of the container can not be specified.
- Measures to ease retrievability/recovery may require an operational limit on temperatures to ensure its feasibility in reasonable time span.
- In order to justify temperature limits other than 100° C, future research – especially by the implementer - should focus on the interactions of temperature-dependent processes in different disposal concepts.

### References

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