Dissolution in Halite

Implications for GDF Safety

"A GDF constructed in halite would provide a **dry environment with no water** available to dissolve and transport radionuclides. Even the water in the nearest porous sedimentary rocks is likely to be a **very dense brine** with no tendency to rise and mix with shallow fresh groundwater."

- Technical Background to Generic DSSC, December 2016

Table 1 - Initial or healed permeabilities

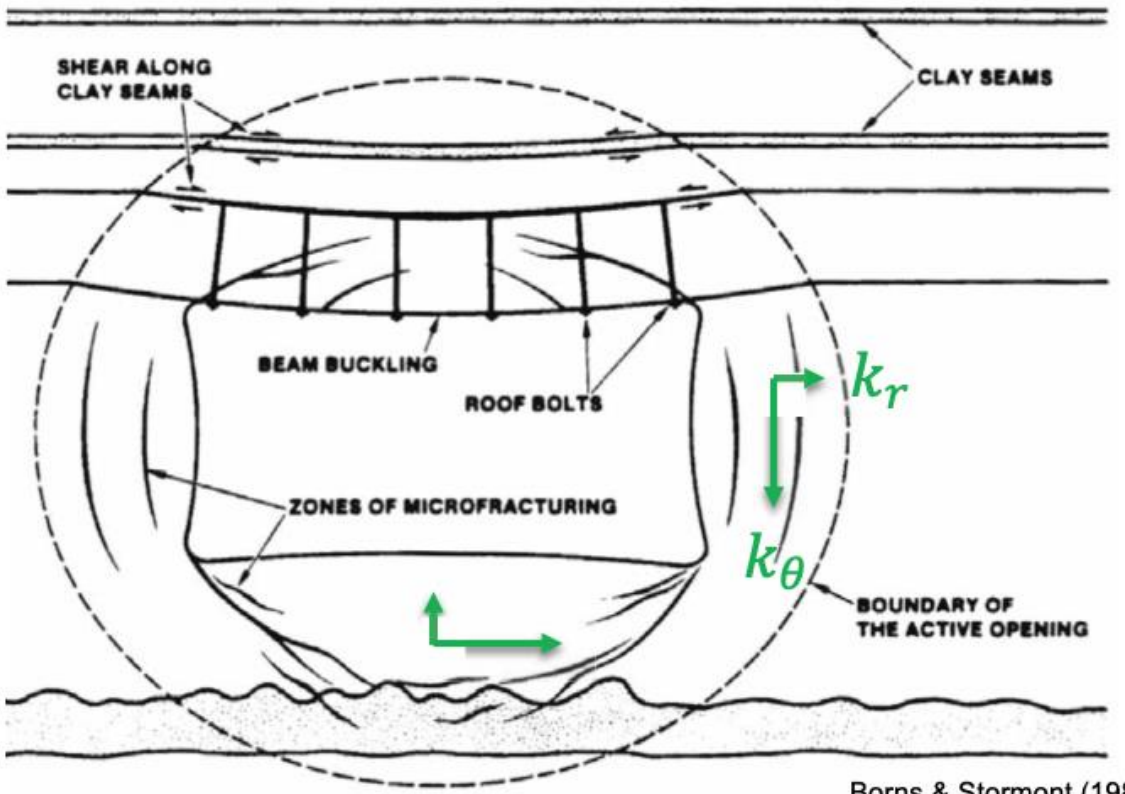
Test	Permeability (m^2)
3	2.23×10^{-20}
7	3.69×10^{-22}
13	7.73×10^{-21}
16	2.10×10^{-20}
17-1	2.19×10^{-21}
17-2	1.35×10^{-21}

(Stormont, 2001)

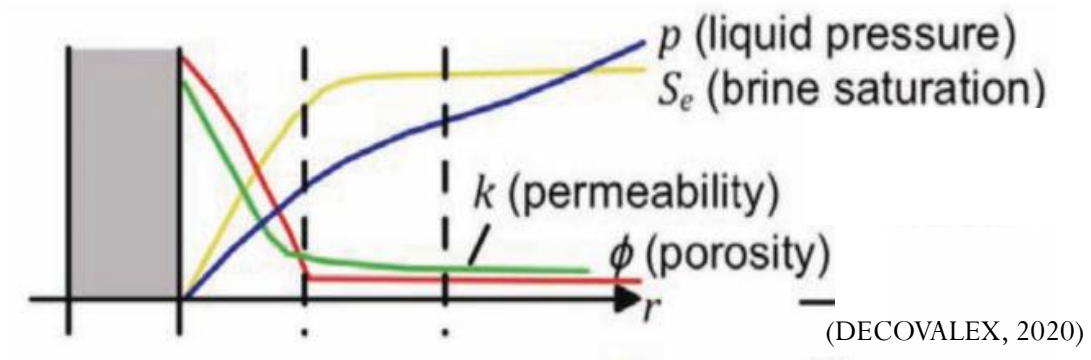
"A porosity of 0.001 is consistent with previous measurements for rock salt with with permeabilities on the order of 10^{-21} m^2" – Stormont, 1990

- Water types in bedded salt
  1. Disseminated clay (< 5 vol-% total; ~25 vol-% brine)
  2. Intragranular brine (fluid inclusions; 1 – 2 vol-%)
  3. Hydrous minerals (e.g., polyhalite, bischofite, epsomite)
  4. Intergranular brine (between salt crystals; << 1 vol-%)

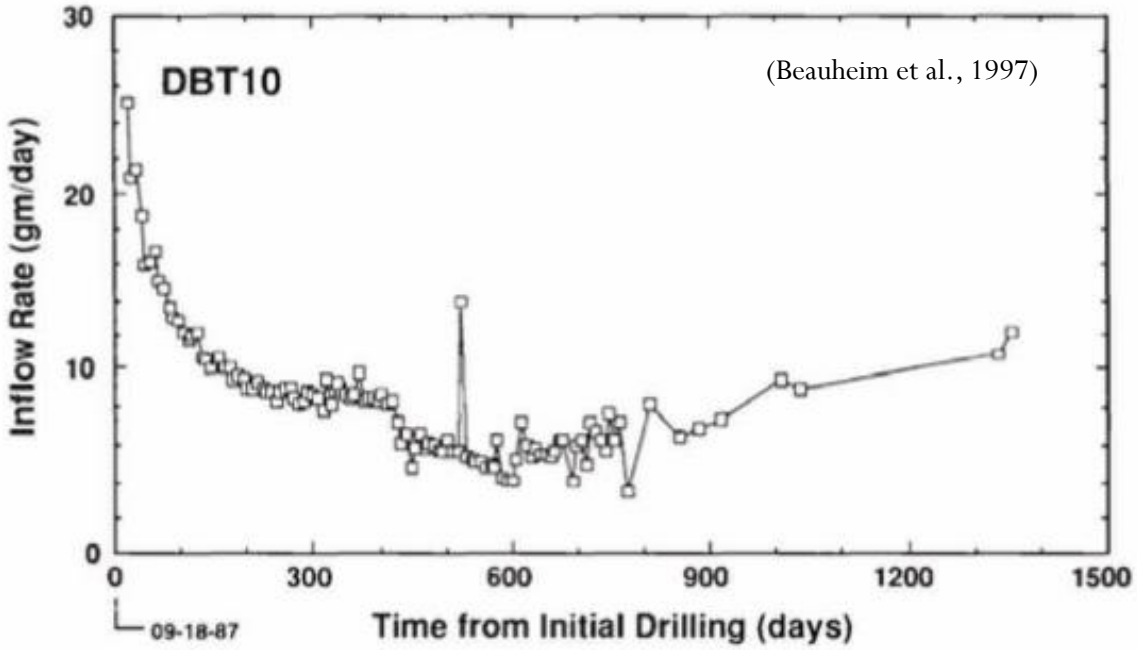
(DECOVALEX, 2020)



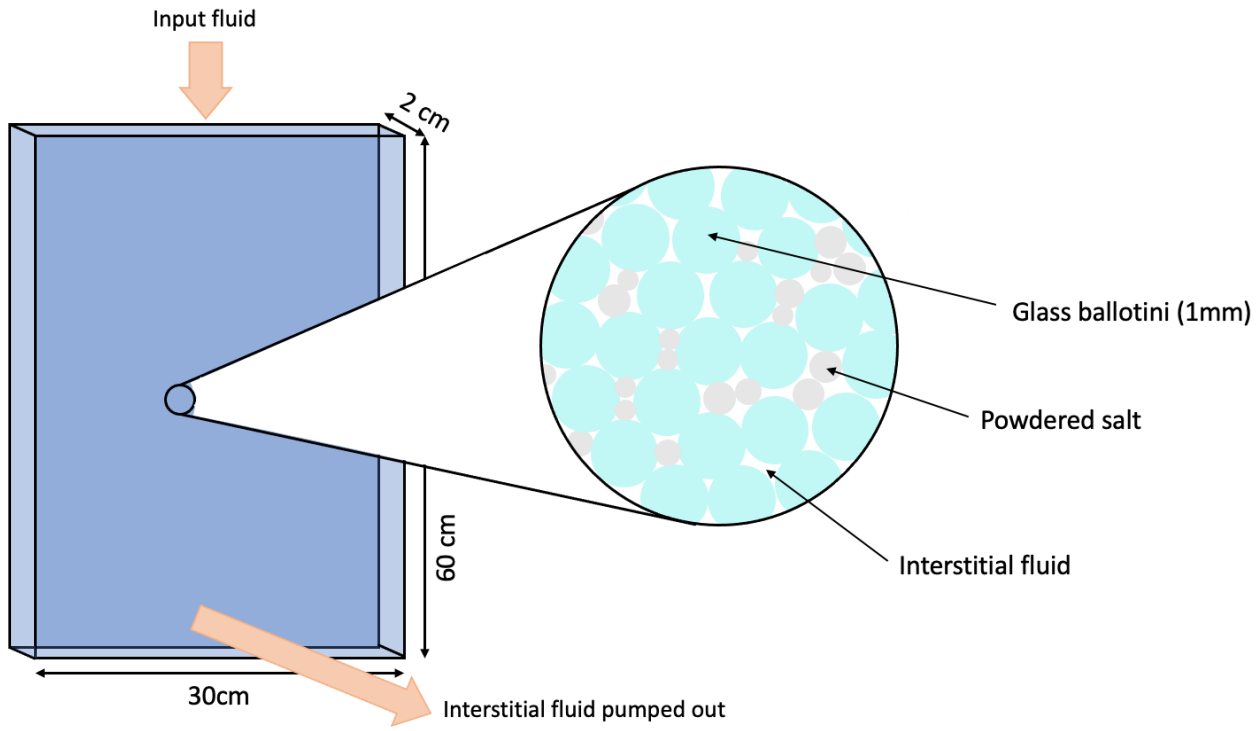
Borns & Stormont (1988)

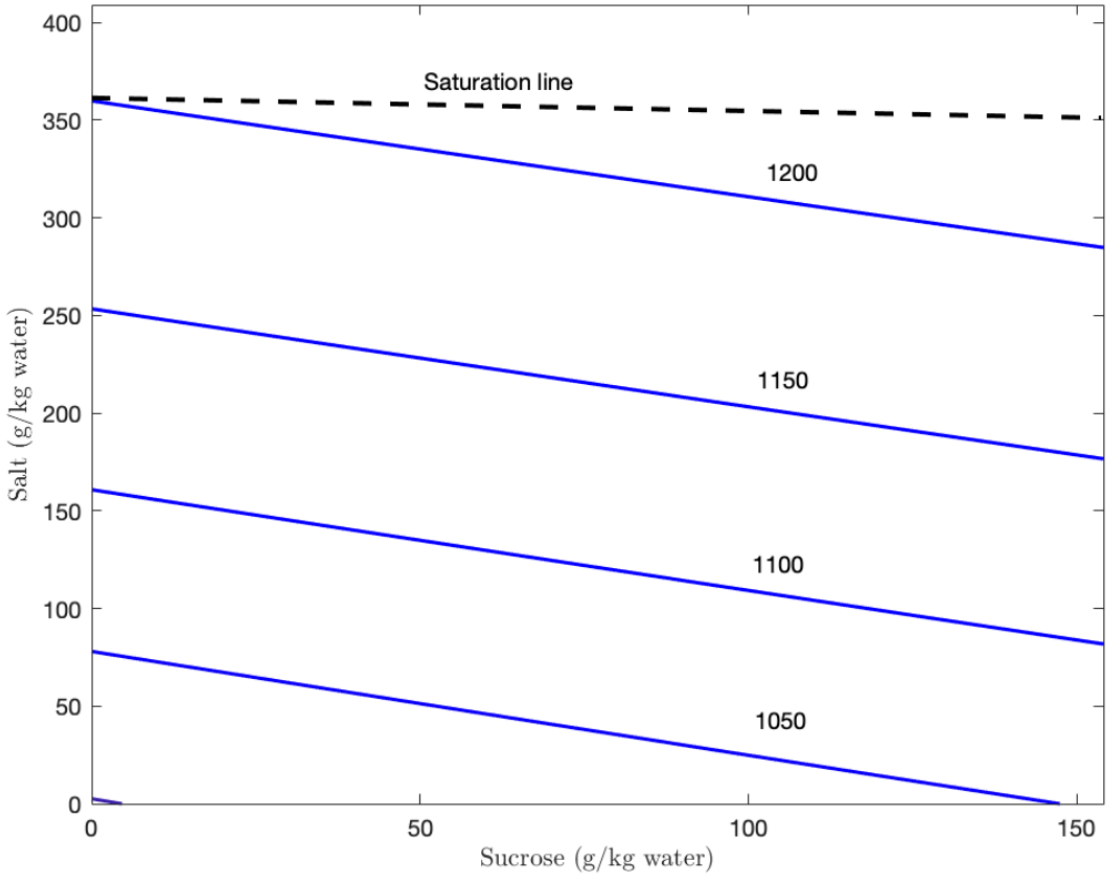


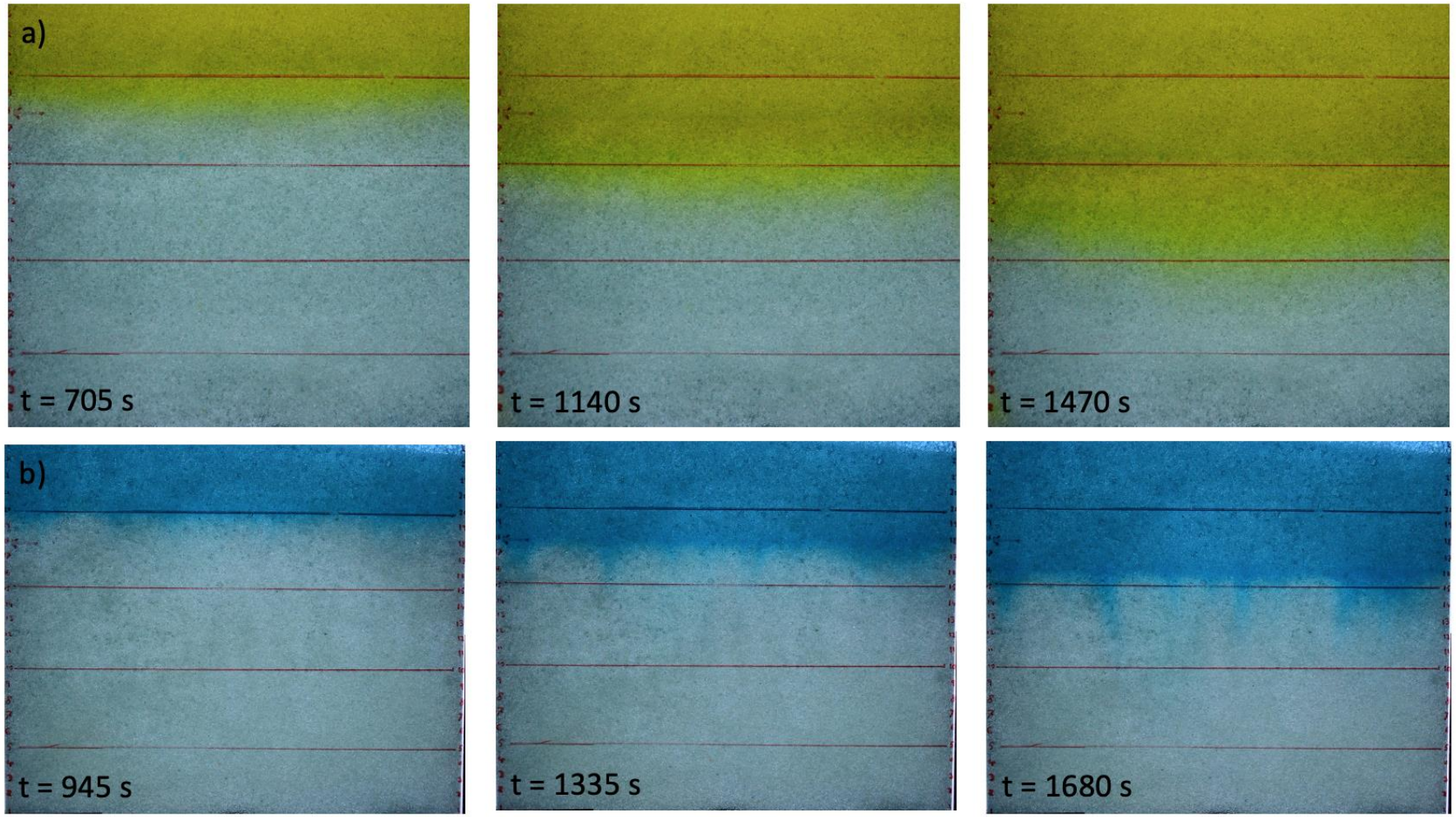
(DECOVALEX, 2020)



(Beauheim et al., 1997)

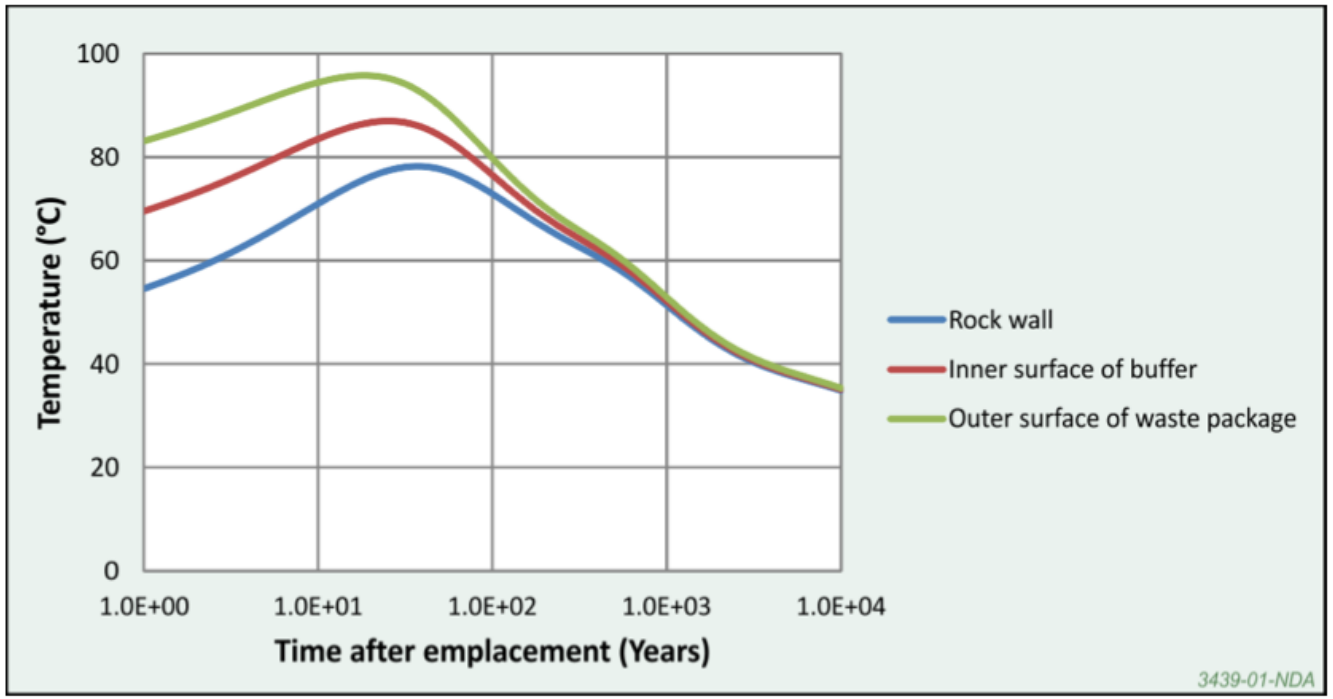

Input fluid
2 cm
Glass ballotini (1mm)
Powdered salt
Interstitial fluid
60 cm
30cm
Interstitial fluid pumped out


Saturation line
1200
1150
1100
1050
Salt (g/kg water)
Sucrose (g/kg water)
0
50
100
150
200
250
300
350
400

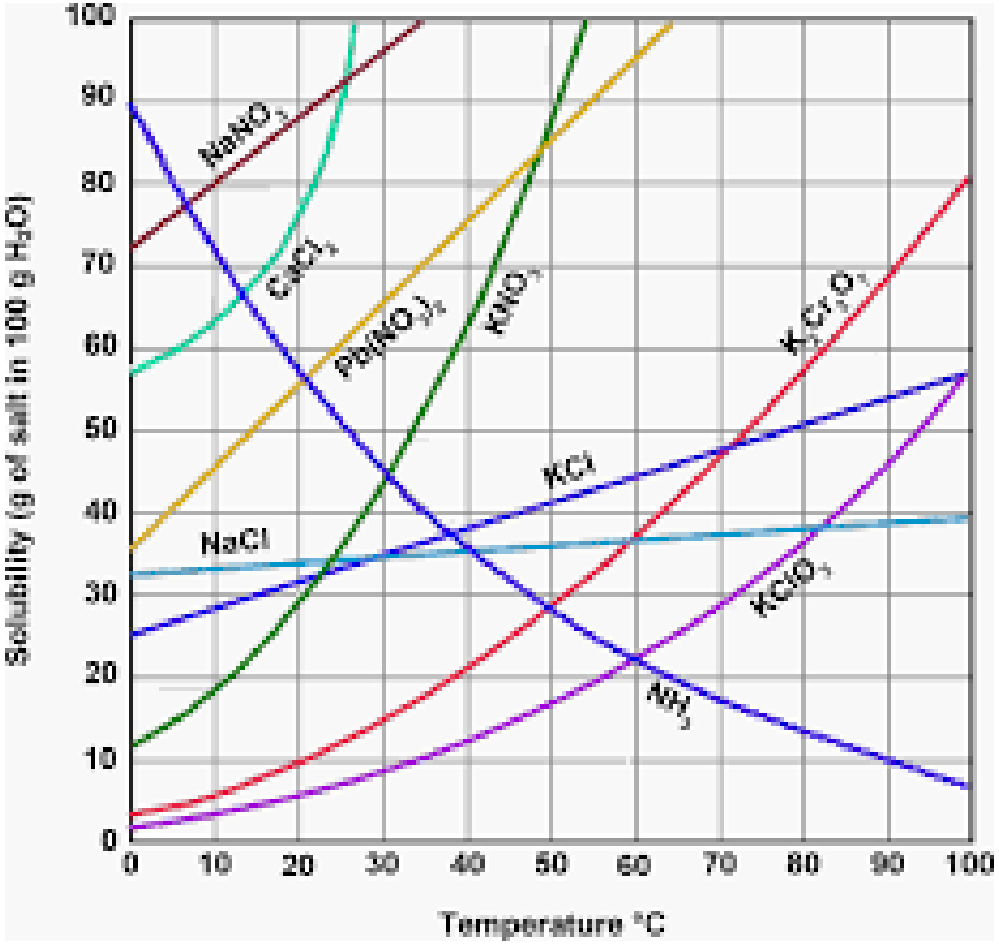

a)
t = 705 s
t = 1140 s
t = 1470 s
b)
t = 945 s
t = 1335 s
t = 1680 s
c)
21.7cm
1100s
d)
31.3cm
1100s

- A density difference appears to promote dispersion of a reacted infiltrating fluid
- Fluid migrating in a damage zone may dissolve other accessory minerals and become dense compared to the formation fluid
- Beds of accessory minerals should be considered when modelling pathways for radionuclide dispersion

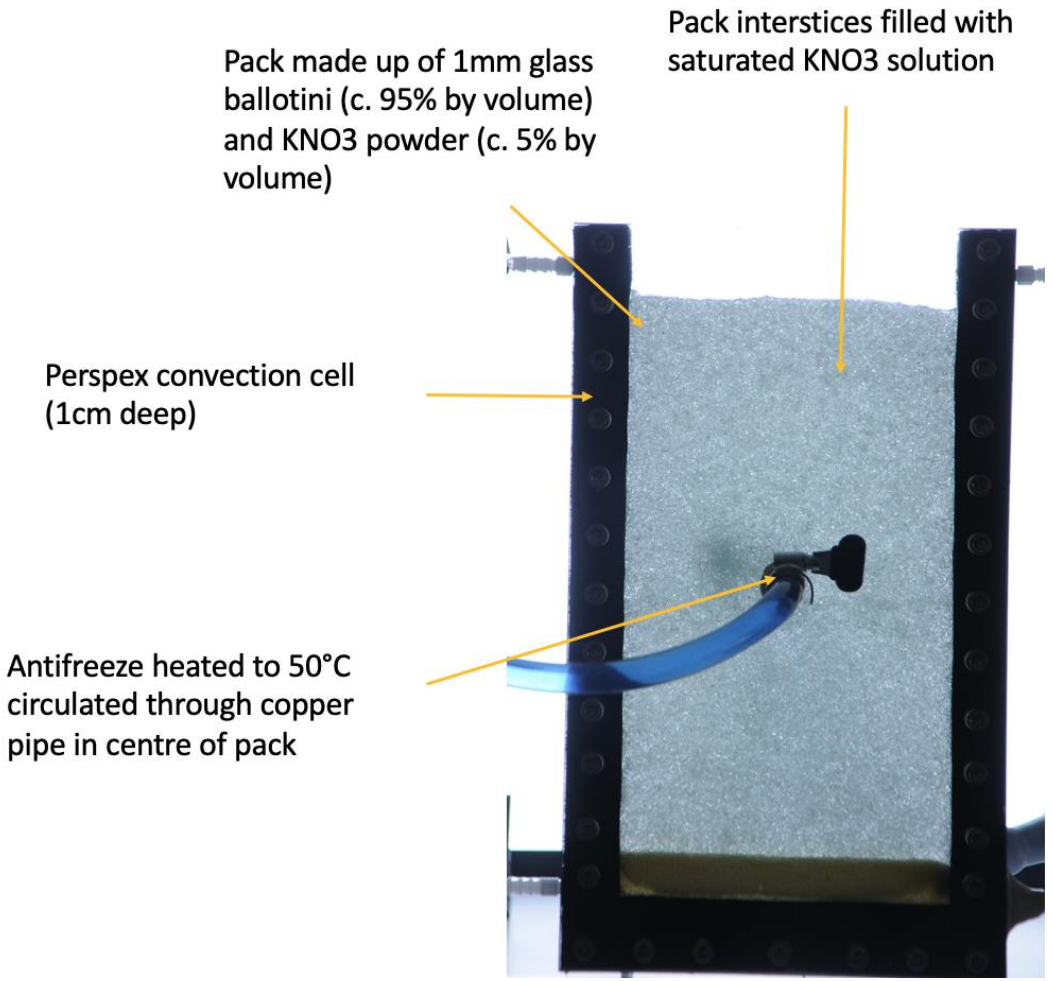
British Geological Survey

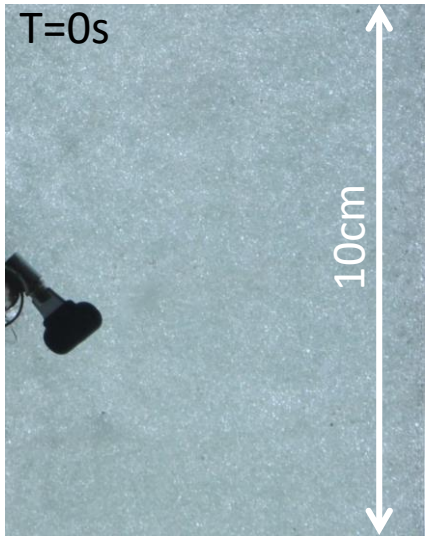


(RWM Ltd., 2016)



(SFScience.net., 2022)

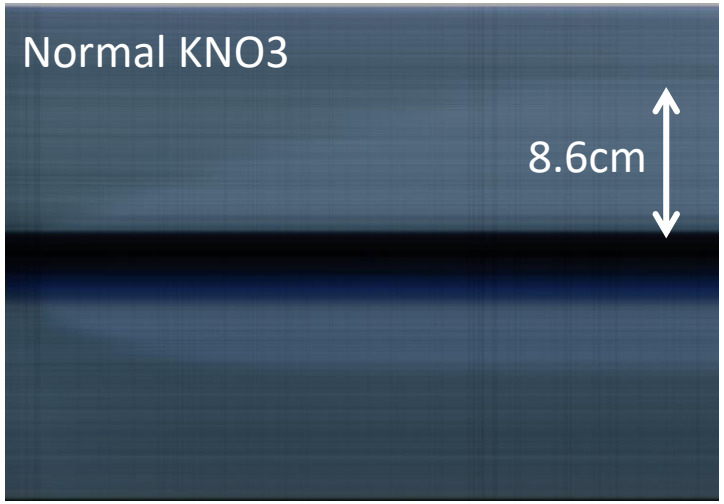

Pack made up of 1mm glass ballotini (c. 95% by volume) and KNO3 powder (c. 5% by volume)
Pack interstices filled with saturated KNO3 solution
Perspex convection cell (1cm deep)
Antifreeze heated to 50°C circulated through copper pipe in centre of pack

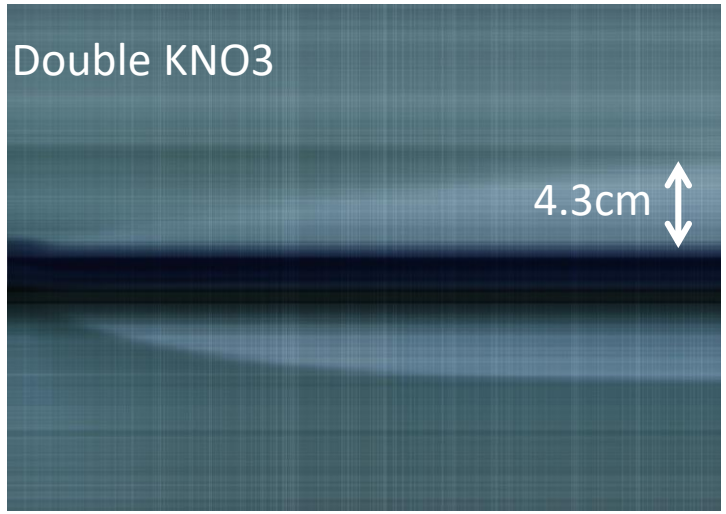

T=0s
10cm

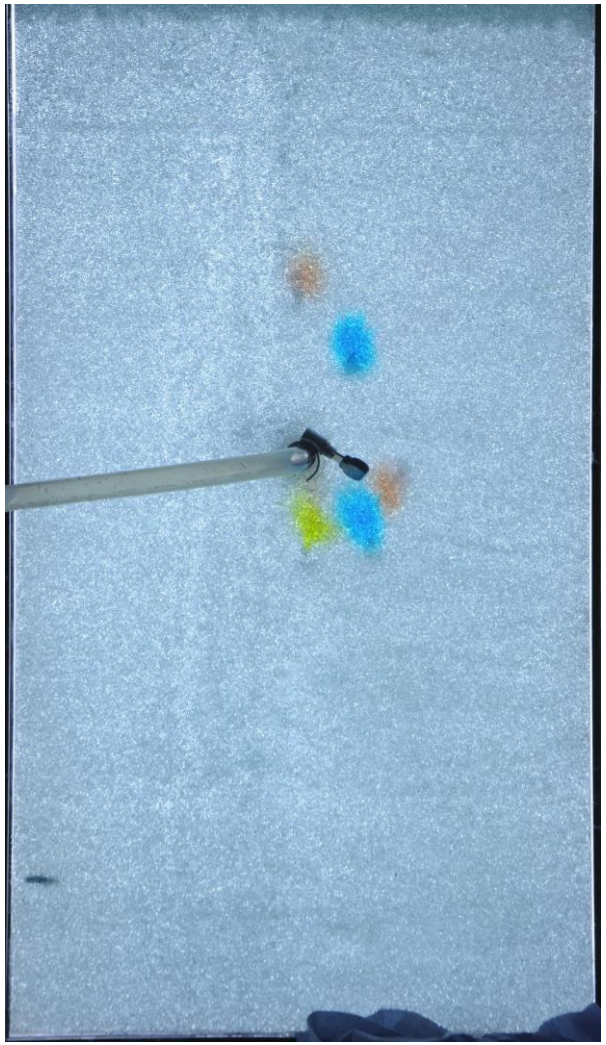

T=2000s


T=4000s

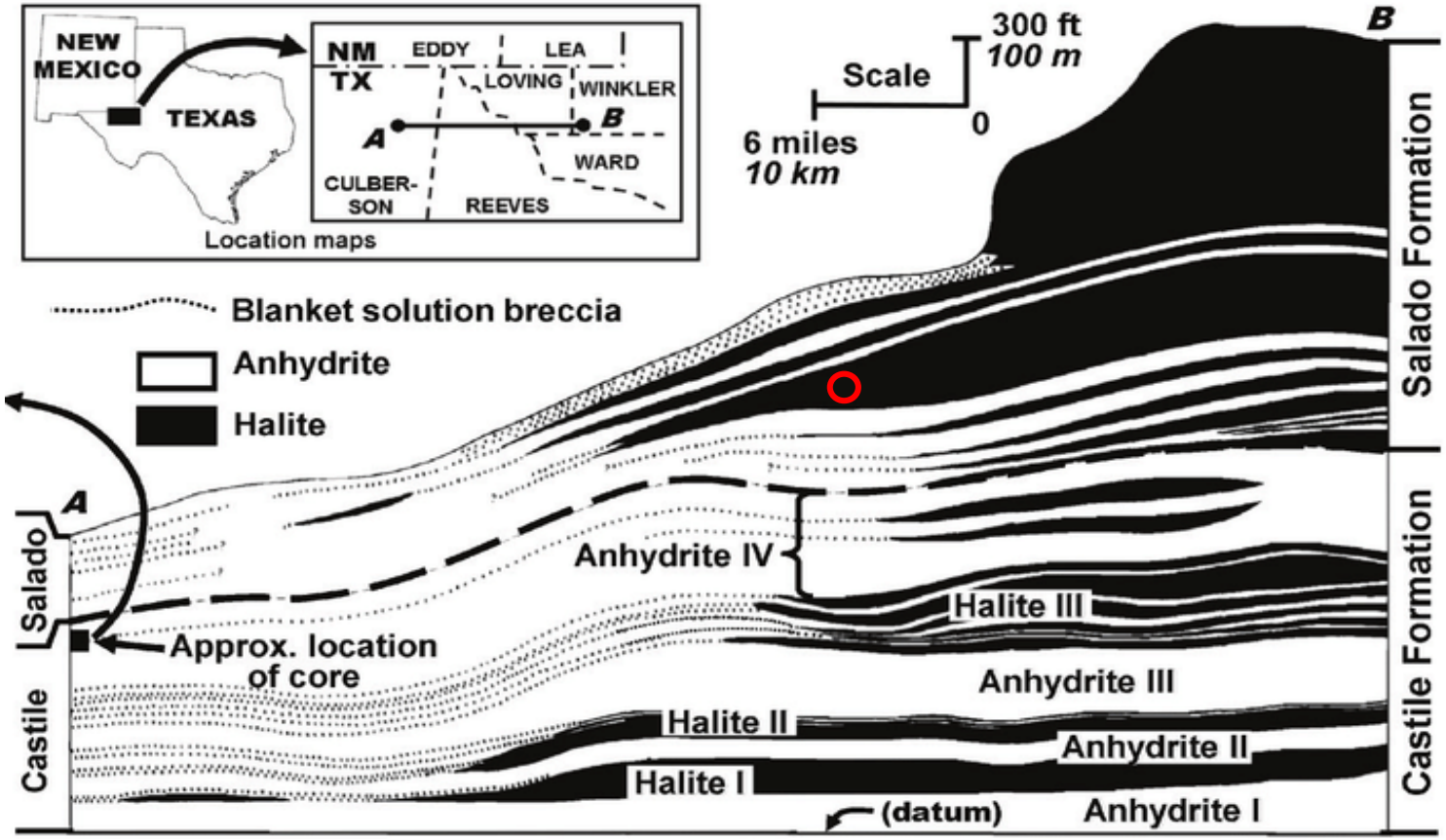

T=6000s


Normal KNO3
8.6cm


Double KNO3
4.3cm



- Minerals which are more soluble in hotter water may be dissolved more in the area around a GDF
- This may promote increased permeability around a drift, allowing a pathway for contaminated water to escape
- Changing permeability also affects the ability of the GDF to contain gasses
- The exact mechanics of this system are poorly understood



(Anderson, 1972)