HOW TO MAKE A ROCK 101: SILICA GEL FORMATION

Sandy Iligan[1], Sofiyah Shariff[1], Daniela Gutierrez Rueda[1], Dr. Kurt Konhauser[1]
[1]Dept. of Earth and Atmospheric Sciences, University of Alberta

Background

- 2.5 billion years ago, the oxygen levels before the Proterozoic were nowhere near as modern atmospheric oxygen levels today.
- Banded iron formations (BIFs) serve as evidence for the influx of oxygen accumulation in the atmosphere, essentially known as the **Great Oxidation Event (GOE)**. BIFs (fig. 1) include layers of iron-rich minerals and chert. **Chert** is a type of sedimentary rock with a silicon dioxide chemical structure (SiO_2).

Fig. 1 *Banded iron formations. Photograph: Graeme Churchard (1)*

- There are two approaches on rock formation:
  - the classic approach requires extremely high temperatures and high pressure environments to generate enough energy to transform clusters into rocks.
  - The non-classical approach is that there are **different stages during rock formation** when dealing with lower temperature and pressure environments. The result is dependent on how much energy is exerted onto the clusters before fully transforming into a rock.
- **The purpose of this experiment is to support that non-classical approach by achieving the first stage of rock formation in the silica cycle which is amorphous silica in the form of silica gel (the final stage being the formation of chert).**

Methods

Fig. 2 *Sodium metasilicate solutions before adding acid*

- Six 0.5 M sodium metasilicate solutions were created and poured into petri dishes to make two types of solution (real seawater (RS) and synthetic seawater (SS)) and three variations for each type (control, leaf, and mushroom).
- 0.5 M of sodium metasilicate solution is acidified using 6ml of 35% hydrochloric acid (HCl) to precipitate a silica gel.
- Visual tests are conducted for 10 days and 5 samples are taken every other day within the 10 days. pH tests are also conducted to test acidity.
- A subjective scale is used to conduct the visual and viscosity test which ranged from 1 to 5, 1 being liquid (homogenous) and 5 being solid (fully gelled). A 6 would mean crystallization.

Results

Initial Results after adding 35% HCl:

Final Results after 10 days since adding 35% HCl:

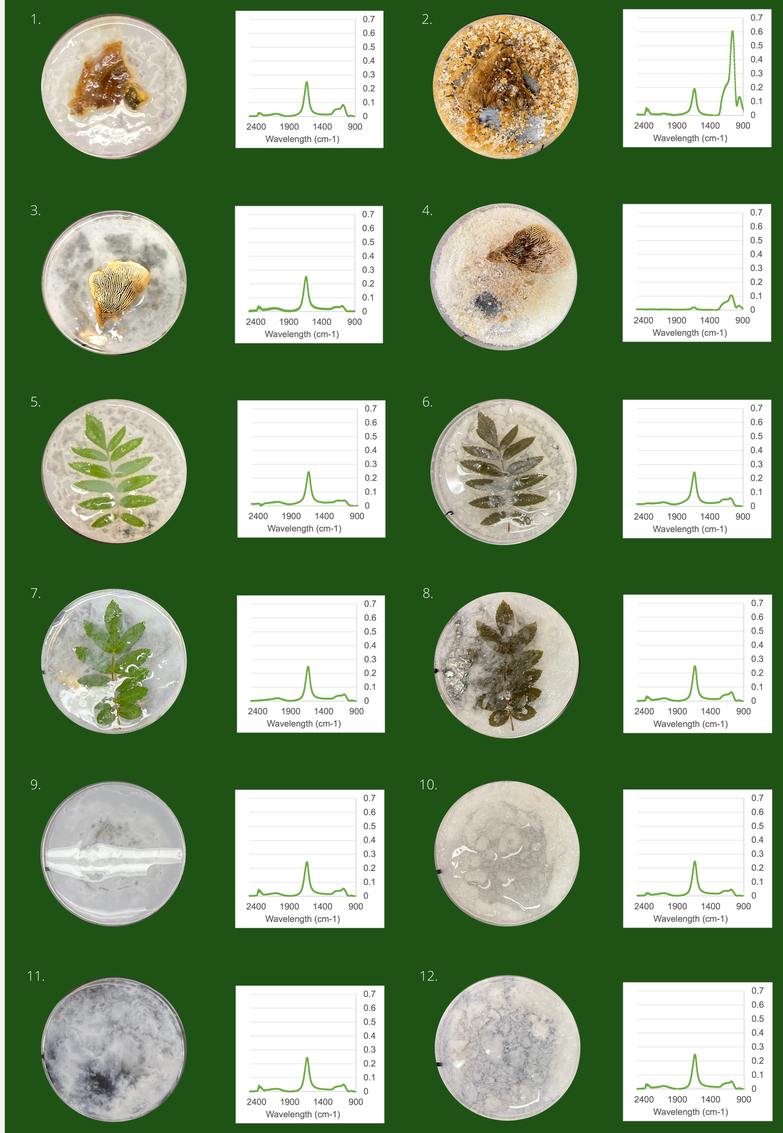

Fig. 3 ***1.*** *Initial RS mushroom* ***2.*** *Final RS mushroom* ***3.*** *Initial SS mushroom* ***4.*** *Final SS mushroom* ***5.*** *Initial RS leaf* ***6.*** *Final RS leaf* ***7.*** *Initial SS leaf* ***8.*** *Final SS leaf* ***9.*** *Initial RS control* ***10.*** *Final RS control* ***11.*** *Initial SS control* ***12.*** *Final SS control. On the right side of each petri dish are FTIR results from samples taken.*

Results

	pH	Viscosity
RS mushroom	2 and 12	1
SS mushroom	2 and 12	1
RS leaf	2 and 12	1
SS leaf	2 and 12	1
RS control	2 and 12	1
SS control	2 and 12	1

Fig. 4 *The initial solution characteristics after adding 35% HCl*

	pH	Viscosity
RS mushroom	2	6
SS mushroom	2	6
RS leaf	2	2
SS leaf	2	5
RS control	2	3
SS control	2	2

Fig. 5 *The final solution characteristics 10 days after since adding 35% HCl*

Discussions and Conclusions

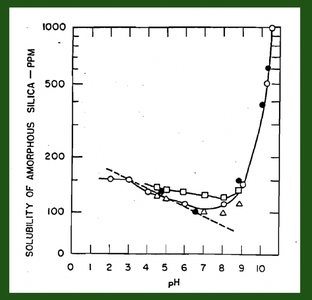

Fig. 6 *Solubility chart of silica gel (2)*

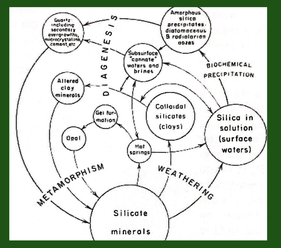

Fig. 7 *The silica cycle (3)*

- As seen from fig. 3 and fig. 5, major observations include:
  - The RS and SS mushroom crystallizing completely; this is due to carbon dioxide being released during decomposition causing the solution to be more acidic.
  - RS control gelled faster than SS control. However, SS leaf gelled faster than RS leaf.
- By acidifying the sodium metasilicate solutions, the solubility of silica decreases (fig. 6). This causes the solution to be supersaturated with respect to silica leading to the precipitation of silica gel.
- Next steps include a process called diagenesis (fig. 7) which involves pressurizing the silica gel and increasing the temperature to successfully form chert.

Acknowledgements and References

Acknowledgements

A special thanks to the WISEST staff, Brette Harris, Kelly Rozanitis, Weiduo Hao, Daniela Gutierrez Rueda, and Dr. Kurt Konhauser for supporting me throughout the program.

References