Thermal stability of metalorganic compounds on volcanic olivine

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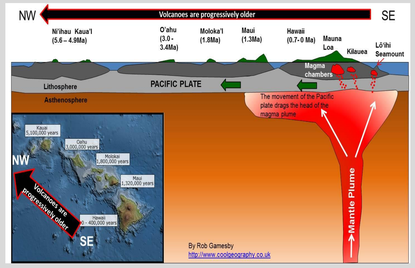
Context of the project

A previously unknown class of metalorganic compounds has been revealed in meteorites [1] and surfaces of silicate phases. The reaction of organic molecules with minerals lead to metal organic structures. They are stable under high temperature and pressure, and may have been involved in the emergence of life, since metals play an important role in living systems.

Aim of the project

- **Profiling** metalorganic compounds **thermal signature**, and understand their **formation**
- Investigate the **mineral-molecular interaction**
- Early Earth conditions

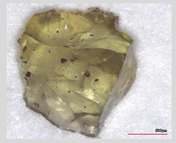
Hot spot: Iki lava lake Kilauea (1959)

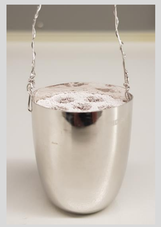


The Hawaiian archipelago is the result of upwelling magma coming up from deep mantle. Kilauea volcano, youngest island produces tholeiitic and alkali basalt. This eruption is olivine rich and a good study case because of a high Mg olivine content [2].

Sample

- Olivine (**87% Fo**)
- Inclusions: fluid and spinels

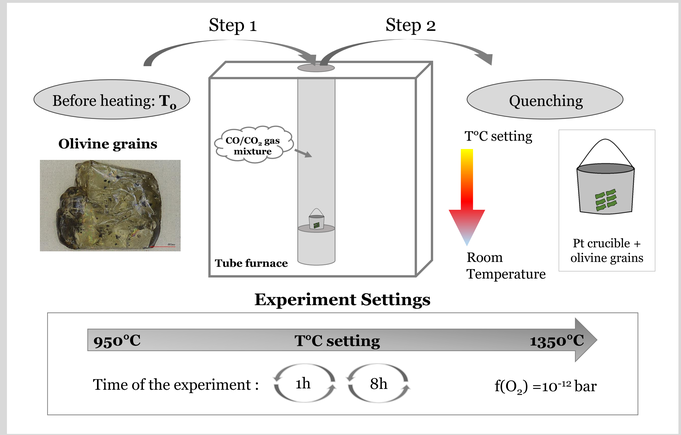




The olivine grains are handpicked and as basalt free as possible and put individually in Pt crucibles contained in a Pt basket.

Experimental approach

We use a high temperature gas-mixing tube furnace, and perform experiments within the stability field of olivine [3] between 950 and 1350°C. A reduced atmosphere is created using a CO/CO2 gas mixture. The olivine grains were held for dwell times of 1 to 8h, and quenched by vertical lifting out of the furnace and cooling down in air to room temperature.

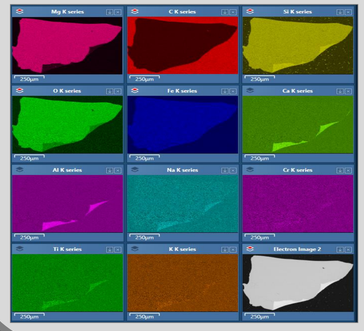


Stability of Olivines

EPMA measurements

- **Similar composition** of major elements after heating

wt%	MgO	SiO2	FeO
T0	**45,760**	**40,774**	**12,379**
Stdv T0	0,988	0,386	1,030
HT 1h	**46,823**	**39,508**	**12,618**
Stdv 1h	0,571	0,719	0,586
HT 8h	**47,201**	**40,477**	**12,481**
Stdv 8h	0,560	0,535	0,607



SEM mapping

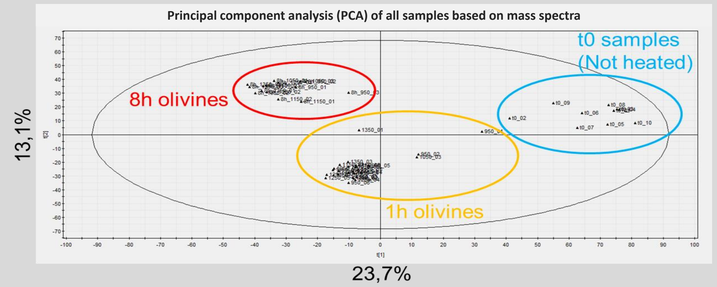
- **No diffusion** of elements in olivine grains
- **Melt phase** different from olivine, composition associated to **melted basalt attached**

Preliminary results

The organic cargo was analysed using FT-ICR-MS. The olivines were crushed and the soluble organic matter was extracted with methanol.

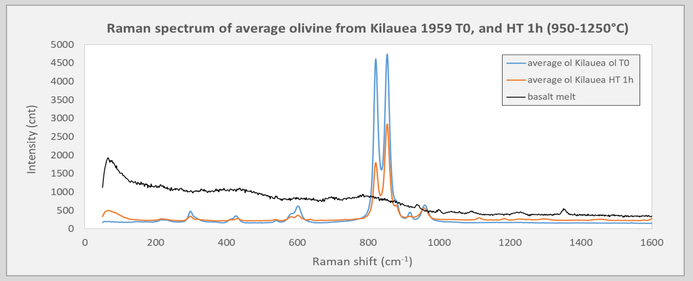
FT-ICR-MS

- Systematic **changes of organic molecular composition** due to temperature and time of exposure (cf M. Matzka)



Raman spectroscopy

- Confirm **thermal stability of olivines** and composition
- Confirm the non crystal chemical structure of the melt phase and be taken into account in the rest of our study.



Conclusion

The preliminary results of this study show that under a reduced atmosphere and high temperatures (950-1350°C) :

- **Homogeneity** and thermal stability of **olivines** from 1959 Kilauea eruption stay constant
- **Metalorganic compound** contents are **influenced by heat**
- **Olivine** phase appears to allow metalorganic compounds to evolve

References

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