Mineralogy model of the deep interior of Triton

Camilla Cioria[1] and Giuseppe Mitri[1]

[1](1) International Research School of Planetary Sciences, Pescara, Italy. (2) Dipartimento di Ingegneria e Geologia, Università d'Annunzio, Pescara, Italy.

November 21, 2022

Abstract

The orbital history of Triton, coupled to its thermal evolution, and the role played from obliquity tides [1, 2], together with the ongoing geological activity [3] suggest a differentiated interior, with an outer ice shell, a possible sub-surface ocean, and a deep-rocky interior. Triton's deep interior could be hydrated, as suggested for other icy satellites, such as Titan [4, 5]. Antigorite (density: 2.5-2.6 g/cm3) is the most evocated mineral to explain the low estimated average density of the deep interior of icy moons [5]. Nevertheless, a model of a hydrated deep interior must consider the chemical environment, the lithostatic pressure, and the internal temperature, which define by their own the resulting mineral assemblages. Methods We adopt the algorithm Perple_X [6] to produce a pseudosection (Fig.1), modelling the stability fields of several mineral phases at thermodynamical equilibrium, in the function of pressure (P) and temperature (T). We select as the initial bulk composition of a proto-Triton a chondritic material. Results Figure 1 shows an Orgueil-like bulk composition simulating the rocky deep interior composition in a hydrated scenario. In addition to antigorite, we found that the mineralogy of hydrated deep interior should be characterized by the primary phases: amphibole, chlorite, antigorite, and talc, for the expected temperature and pressure of Triton's deep interior and at a temperature lower than 980 K. For higher temperature we found that hydrated phases dehydrate in olivine and pyroxenes, as main phases. We plan to investigate the role of volatiles and ices in modelling the mineralogy of the deep interior. Acknowledgments G.M. and C.C., acknowledge support from the Italian Space Agency (2020-13-HH.0). References [1] McKinnon, W. B. (1984). Nature, 311(5984), 355-358. [2] Nimmo, F., & Spencer, J. R. (2015). Icarus, 246, 2-10. [3] Hansen C.J., & Kirk R. (2015), 46th LPSC, 2423. [4] Fortes, A. D., et al. (2007). Icarus, 188(1), 139-153. [5] Castillo-Rogez J.C., Lunine J.I. (2010). Geophys. Res. Lett.37(20). [6] Connolly, J. A. D. (2005). Earth Planet Sci Lett, 236.1-2:524-541.

Mineralogy model of the deep interior of Triton

Camilla Cioria, Giuseppe Mitri

International Research School of Planetary Sciences, Italy

Dipartimento di Ingegneria e Geologia, Università d'Annunzio, Italy

AGU FALL MEETING
New Orleans, LA & Online Everywhere
13–17 December 2021

C.Cioria*, G. Mitri *camilla.cioria@unich.it

Objective:

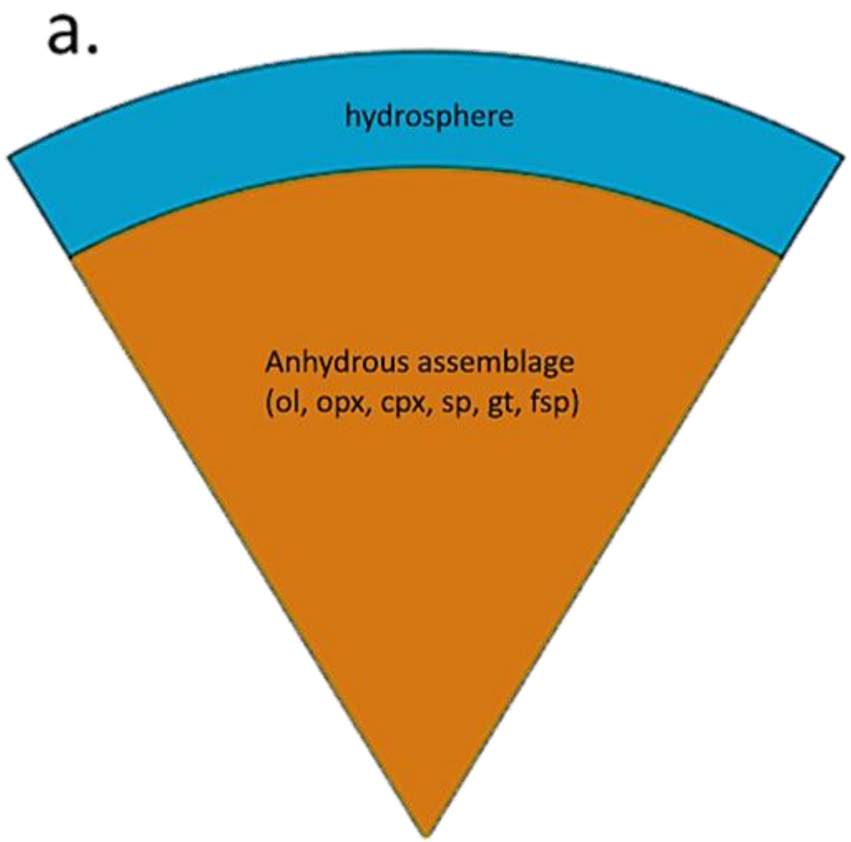
- Describe the mineralogy of the deep interior of Triton as a function of temperature, pressure, and the chemical variables.

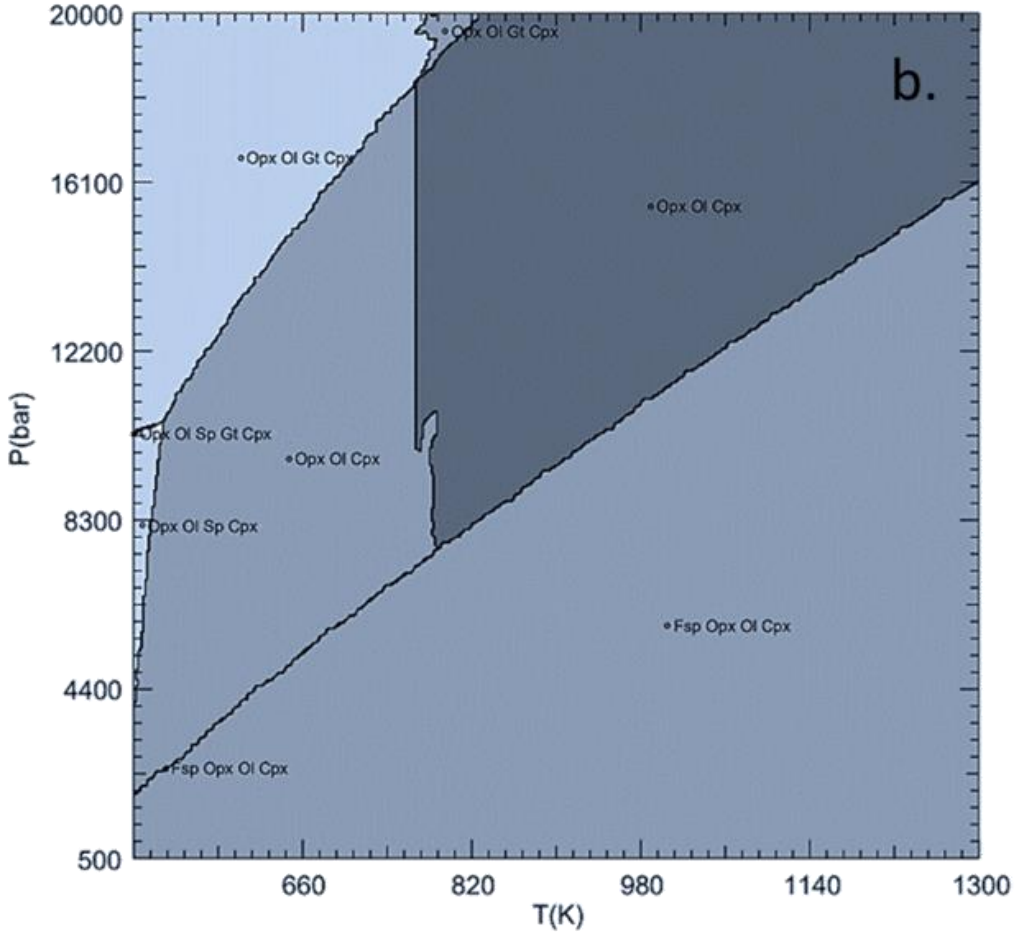
Methodology

- The Perple_X algorithm was used to model the stability fields of minerals in the deep interior of Triton.
- Chondrite (CI,CM,CV) material precursor was assumed (Orgueil, Murchison, and Allende).
- The results for the Orgueil chondrite (CI) precursor are presented here.
- We considered both an anhydrous and a hydrated evolutionary scenario.

ELEMENTAL COMPOSITION	wt (%)
MgO	15.87
SiO_2	22.69
CaO	1.36
Na_2O	0.76
Al_2O_3	1.70
FeO	4.63

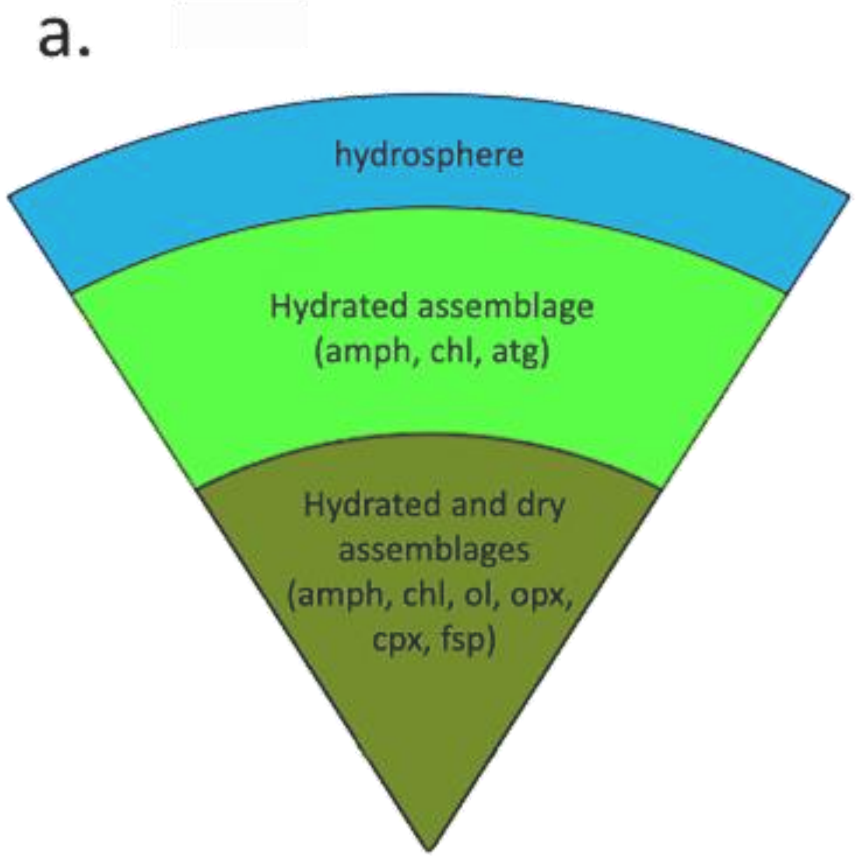
Measured mass-amounts from Orgueil chondrite (Jarosewich, 1990)

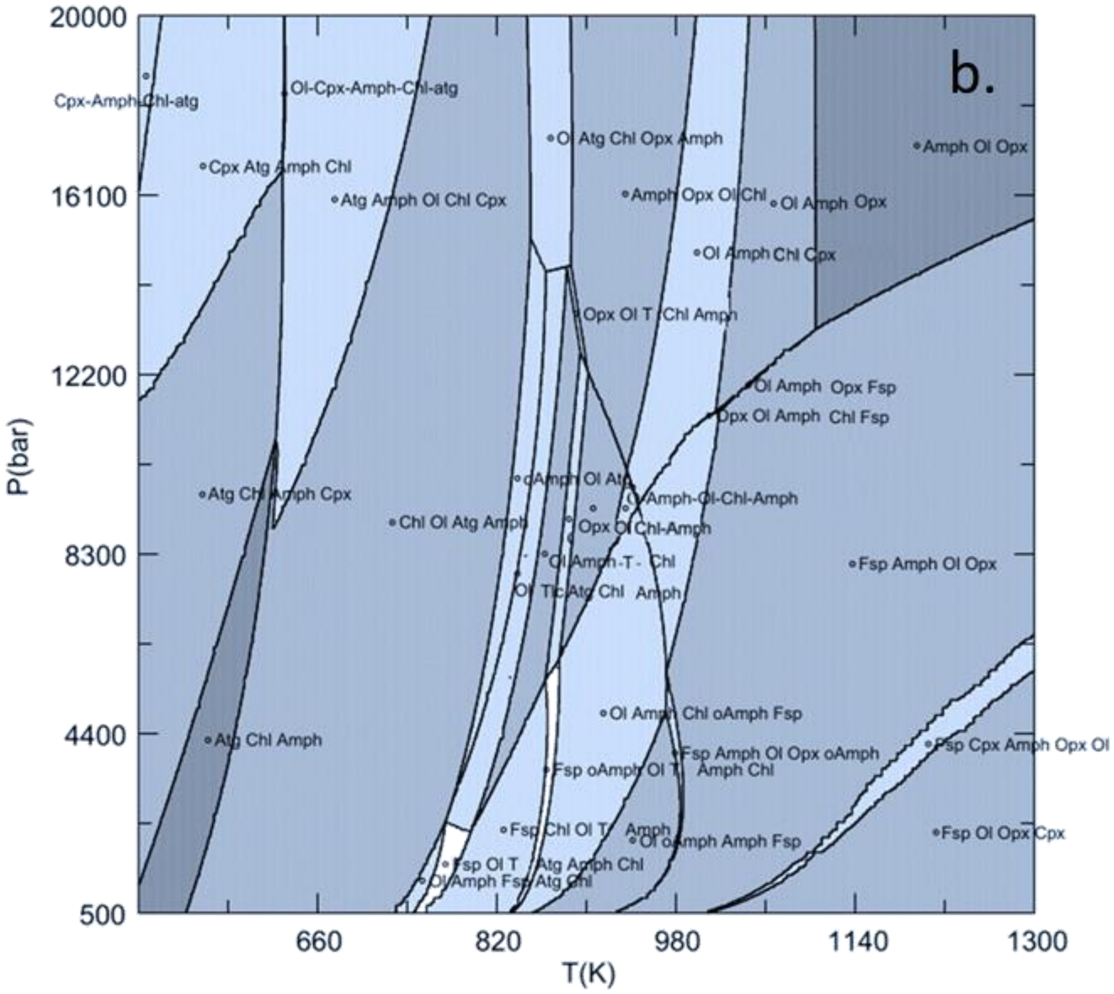




- Internal structure of an anhydrous deep interior of Triton.
- Mean density: 3309.06 kg m^{-3}.

- Pseudosection for CI precursor material with anhydrous mineralogy assemblages.
- Primary phases are olivine *(Ol),* clinopyroxenes *(Cpx),* and orthopyroxenes *(Opx)*. Accessory phases are garnet *(Gt),* spinel *(Sp),* and feldspars *(Fsp).*





- Internal structure of a hydrated deep interior of Triton.
- Mean density: 2957.65 kg m^{-3}.
- Hydrate stability with presence up to 1300 K – 20 kbar.

- Pseudosection for CI precursor material with hydrated mineralogy assemblages.
- Primary phases are amphiboles *(Amph),* chlorite *(Chl),* antigorite *(Atg)*, talc *(T)* olivine (*Ol*), clinopyroxenes *(Cpx),* orthopyroxenes *(Opx)*. Accessory phases are garnet *(Gt),* spinel *(Sp),* and feldspars *(Fsp).*

Conclusions

- We developed a mineralogy model of the deep interior of Triton assuming Orgueil chondrite (CI) as a precursor material.

- We derived two possible deep interior mineralogies:
  - Anhydrous deep interior (mean assemblage: olivine, clinopyroxenes, and orthopyroxenes). Mean density: 3309.06 kg m^{-3}.
  - Hydrated deep interior (mean assemblage: amphiboles, chlorite, antigorite, talc, feldspars, olivine, orthopyroxene, clinopyroxene). Mean density: 2957.65 kg m^{-3}.
  - The hydrated model presented a more complex assemblage. In this model, the amphiboles group contains phases that are stable in every field of the pseudo-section while the presence of antigorite demonstrates that serpentinization has occurred.

- Future radio-science experiment results can constrain the mean density and the composition of the deep interior of Triton.

C.Cioria*, G. Mitri *camilla.cioria@unich.it