UNIVERSITÉ
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FACULTÉ DES SCIENCES
Département des sciences
de la Terre

Special Seminar of the Department of Earth Sciences, UNIGE
Thursday, April 2, 14h15 in Room 001
Rue des Maraîchers 13, CH-1205 Genève or via Zoom

Organic-Rich volatile worlds: linking stellar composition, thermochemical evolution, and atmospheric signatures.

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Organic matter is expected to be a key component of bodies formed in the outer regions of planetary systems. In the Solar System, measured moments of inertia, interpreted with equations of state for ices, silicates, and carbonaceous materials, suggest that organics may constitute a major fraction of the refractory interiors of several icy bodies (e.g., Reynard & Sotin, 2023; Delarue et al., 2026). Organics may therefore exert a first-order control on thermochemical evolution and volatile production—an idea that is particularly timely given the growing population of low-density exoplanets.

The presentation will summarize recent work aiming at (i) predicting the occurrence of organic-rich volatile worlds from host-star elemental abundances, and (ii) quantifying the impact of carbon/organics on thermochemical evolution. On the occurrence side, stellar abundance patterns are used to identify systems in which the available refractory and volatile budgets favor carbon-rich/organic-rich condensates beyond the relevant condensation fronts. On the interior side, evolution is modeled by combining equations of state for ices, silicates and carbonaceous materials with kinetic descriptions of the transformation of a representative organic compound as a function of time and temperature. The kinetic scheme tracks the progressive loss of H and heteroatoms from the carbonaceous phase, the associated increase in residual carbon density toward graphite-like values, and the production of mobile volatiles. These processes feed back on the thermal history and set the time-dependent inventories of potentially releasable species.

Model outputs are used to quantify expected volatile release for Titan-like bodies and carbon-rich exoplanets, and to contrast these outcomes with classical telluric and ice–silicate evolution pathways. Implications for JWST-era characterization of low-density planets, and for joint constraints from mass–radius measurements, stellar abundances, and interior evolution models, are discussed.