



## Pattern formation in confined chemical gardens

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Chemical gardens are plant-like mineral structures first described in the seventeenth century and popularly known from chemistry sets for children. They are classically grown in three-dimensional containers by placing a solid metal-salt seed into a silicate solution. When the metal salt starts dissolving in the silicate solution, a semi-permeable membrane forms by precipitation across which water is pumped by osmosis from the silicate solution into the metal salt solution, further dissolving the salt. Above a given pressure, the membrane breaks. The dissolved metal salt solution being generally less dense than the reservoir silicate solution, it rises as a buoyant jet through the broken membrane and further precipitates in contact with the silicate solution, producing a collection of mineral forms that resemble a garden.

Such gardens are the subject of increased interest as a model system to understand pattern formation in sea-ice brinicles and hydrothermal vents on the seafloor, among others. All these self-organized precipitation structures at the interface between chemistry, fluid dynamics and mechanics share indeed common chemical, mechanical and electrical properties.

In this framework, we study experimentally spatial patterns resulting from the growth of chemical gardens in confined quasi-two-dimensional (2D) geometries upon radial injection of a metallic salt solution into a silicate solution in a horizontal Hele-Shaw cell. We find a large variety of patterns including spirals, fingers, worms, filiform tubes, and flower-like patterns. By exploring the phase space of reactant concentrations and injection flow rates, we observe transitions between these spatio-temporal structures resulting from a coupling between the precipitation reaction, mechanical effects and hydrodynamic instabilities.