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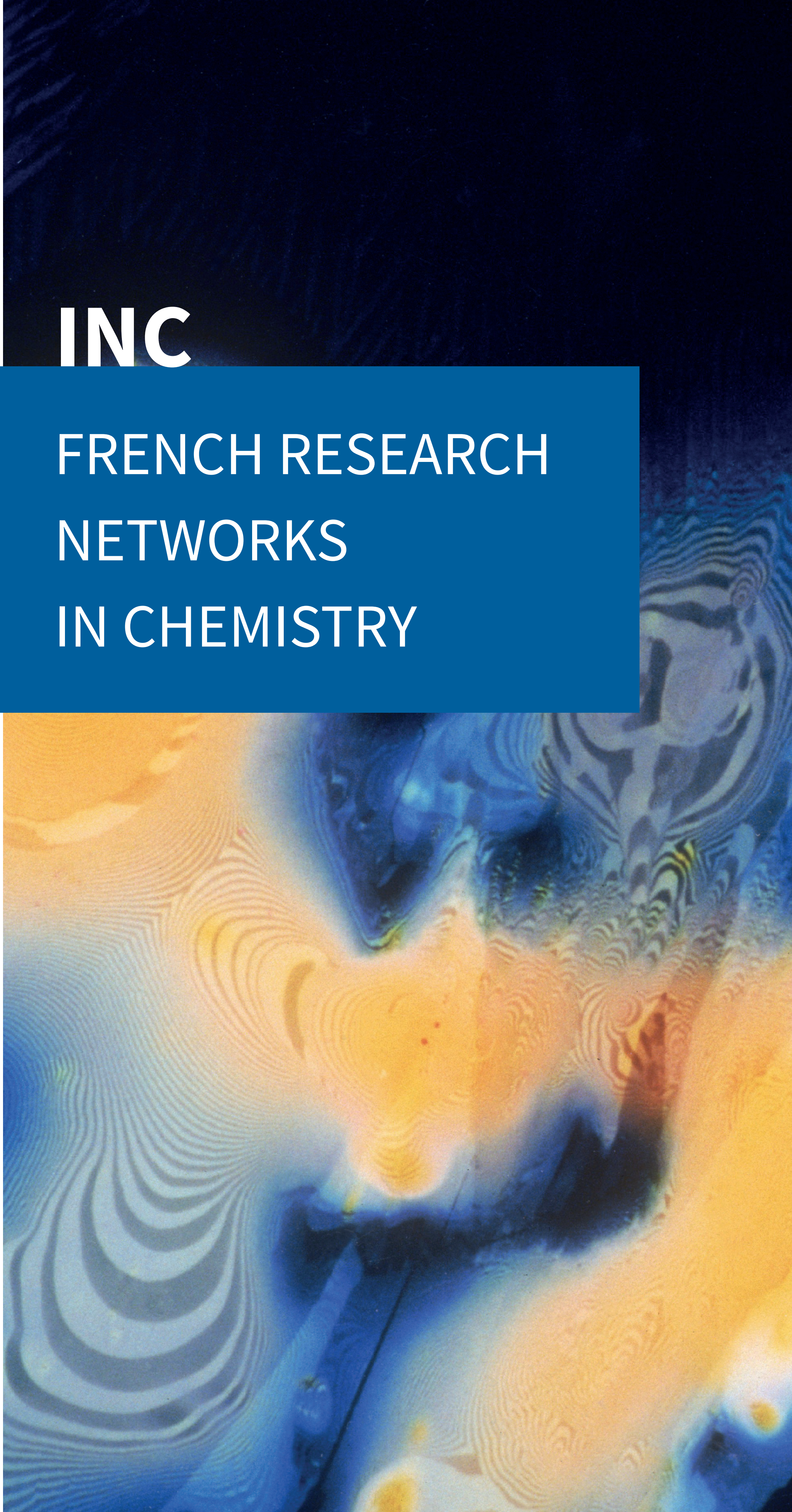
FRENCH RESEARCH NETWORKS IN CHEMISTRY



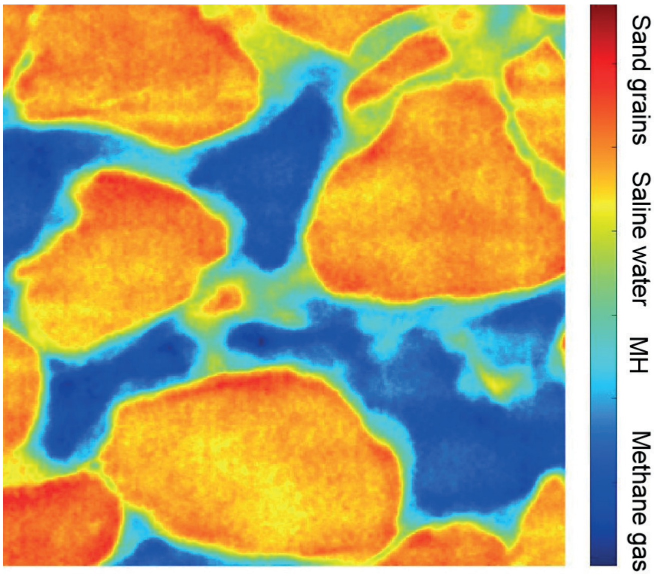
GDR HYDRATES

Gas hydrates

OBJECTIVES

The topic of gas hydrates crosses various disciplinary fields, ranging from astrophysics to geosciences, chemical engineering and molecular sciences. Long considered and examined mainly as an industrial nuisance (plugging of "hydrocarbon pipelines", instability of the ocean floor), these "nanoporous ices" now open up new application prospects (*e.g.* gas storage / separation / capture, secondary refrigeration, water purification, etc.) and new fundamental questions (formation mechanism, natural occurrence in the solar system, impact on planetary atmospheres and climates, etc.). Tackling these challenges requires concerted and multi-disciplinary actions, which are addressed by the GDR.

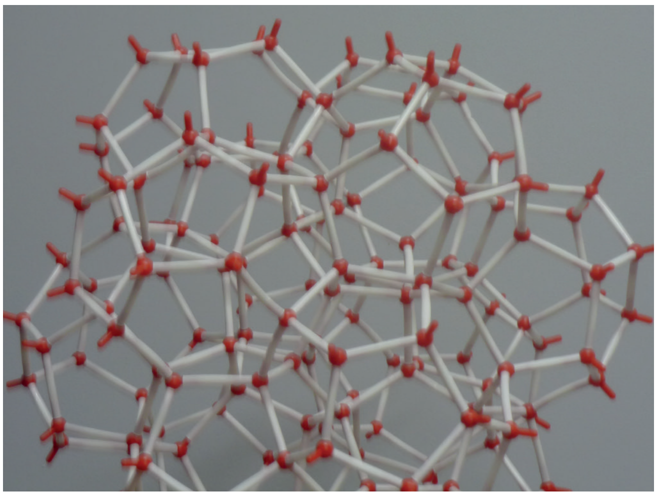
Do gas hydrates occur elsewhere than on Earth?



X-ray tomography image (500µm x 500 µm) of an artificial gas hydrate sediment.

THEMATICS

- Molecular sciences and thermodynamics
- Chemical engineering
- Geosciences
- Astrophysics and planetology



Representation of the water nanocages of gas hydrates.

103 RESEARCHERS INVOLVED IN 29 LABORATORIES

PROSPECTS

The GDR HYDRATES is based on a transversal axis dedicated to molecular sciences, aiming at providing an in-depth understanding of phenomena at the molecular scale (physico-chemistry, spectroscopy, crystallography, etc.), with the purpose of improving and infering macro-scale behavior (thermodynamic and kinetic poperties, etc.). Such studies are key to the research axis dedicated to chemical engineering and technology, geosciences and astrophysics. Among the major scientific challenges in the field of hydrates (non-exhaustive list), cross-cutting axes have been identified as priorities for their contribution both in terms of fundamental knowledge and impacts for innovation in the energy and environmental fields:

HYDRATE-SUBSTRATE SOLID INTERACTIONS

Under natural or industrial conditions, gas hydrates have strong interactions with substrates (inorganic, organic, (meso)porous, etc.). These interactions control the distribution of gas hydrates in the pore space of gas-hydrate-bearing sediments and in other kinds of porous or mesoporous media. They have an impact on the promoter / inhibitor character of specific solid substrates empirically observed, but poorly understood.

OUT-OF-EQUILIBRIUM THERMODYNAMICS AND METASTABILITY

Hydrates can form with compositions not predicted by classical thermodynamic models. The kinetic properties of crystallization and metastability must be taken into account. To date, the identification of thermo-kinetic couplings is an open question that interests molecular sciences as much as industrial applications, earth sciences or astrophysics.

OCCUPANCY RATE OF GAS HYDRATE CAGES

Hydrates are known for their large capacity to store and selectively capture gas molecules. Our current knowledge of the parameters controlling the occupancy rate of the cages is very limited. However, it is a key parameter for estimating the storage capacity of gases in specific materials, with obvious applications in process engineering, geosciences and astrophysics.

FORMATION UNDER EXTREME CONDITIONS

The conditions encountered in the core of planets or on the surface of comets differ from those encountered in Earth oceans or industrial environments. The formation of gas hydrates under ultra-low or very high-pressures (from the Pa to a few GPa) has been studied very little so far. In addition to their fundamental interest in molecular sciences, geosciences and astrophysics, such studies under boundary conditions open up new prospects for gas storage issues.

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HYDRATES Gas hydrates