# Nano-porous Crystals the zeolites

Zeolites seen by
using electron microscopy
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There are a multitude of zeolites. Zeolites are widely used in industry for water purification, as catalysts, for the preparation of advanced materials and in nuclear reprocessing. They are used to extract nitrogen from air to increase oxygen content for both industrial and medical purposes. Their biggest use is in the production of laundry detergents. They are also used in medicine, in agriculture and in the oil industry. They have become indispensable in our daily lives: used as a softener for household appliances and essential for the petrochemical and even trap odours in the cat's litter tray!

To understand natural crystals, to duplicate them, and to try to do better… the art of synthesis!

## The stone that boils: an amazing crystal

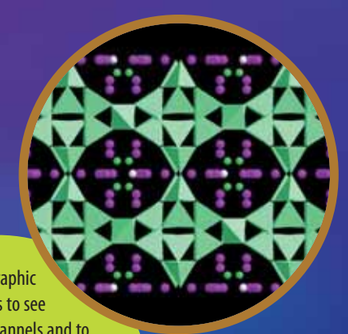
In 1756, **Cronstedt** made an astonishing discovery: while heating a sample of the mineral stilbite, it became covered in bubbles at around 150°C, as if the stone were boiling. Hence the name given to this mineral: "**zeolite**", from the Greek *zeo* (to boil) and *lithos* (stone).

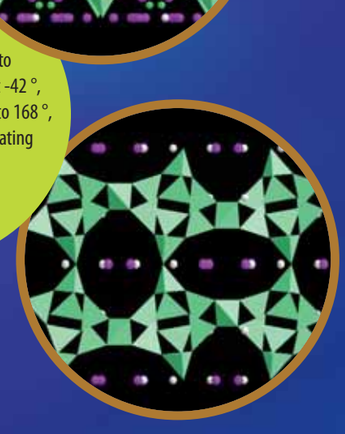
## X-rays show the nano-porous structure of this crystal

In 1930, **Taylor** and **Pauling** used X-ray diffraction to study the first zeolite crystals and revealed that, at an atomic level, these minerals are made up of a nano-porous matrix. Stilbite is a sodium calcium aluminium silicate that can hydrate or dehydrate in a reversible manner, according to the temperature. **Water is trapped** within the cavities of the structure.

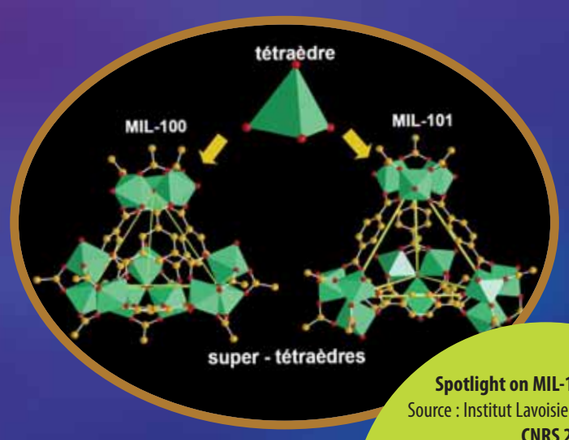
## There are around 50 natural zeolites and more than 500 artificial zeolites have been synthesized …

… by using this crystallographic approach, scientists were able to "visualize" the different atomic arrangements and cavities , enabling them to understand and then to create new zeolites.



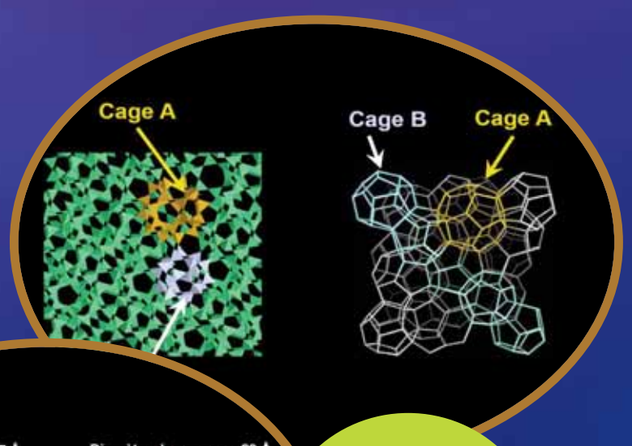


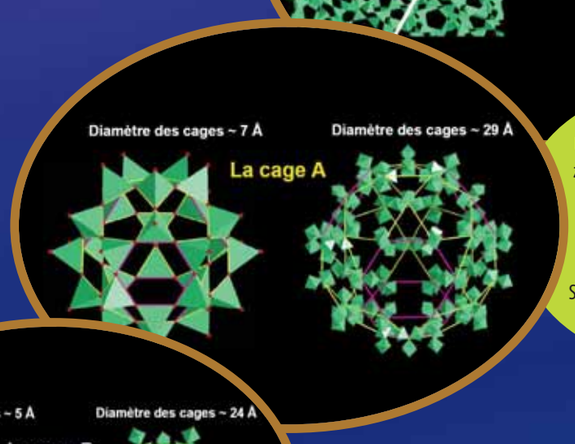
Crystallographic studies allow us to see the structure of channels and to locate water in stilbite water: at -42 °, the water enters the channels - to 168 °, the water leaves the stilbite. Heating causes a loss of water in the channels.
Source : IMN-Nantes

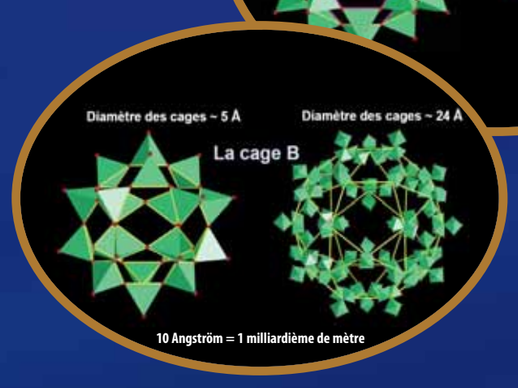



**Spotlight on MIL-100**
Source : Institut Lavoisier & Gerard Ferey
**CNRS 2010 Gold Medal**

By combining organic molecules and inorganic bricks Gerard Ferey and his team at the Institut Lavoisier de Versailles could create new porous materials like MIL-100 and MIL-101 with giant cages, ten to one hundred times larger than those of natural zeolites, which can act as a reservoir of gas, molecules and even drug molecules.

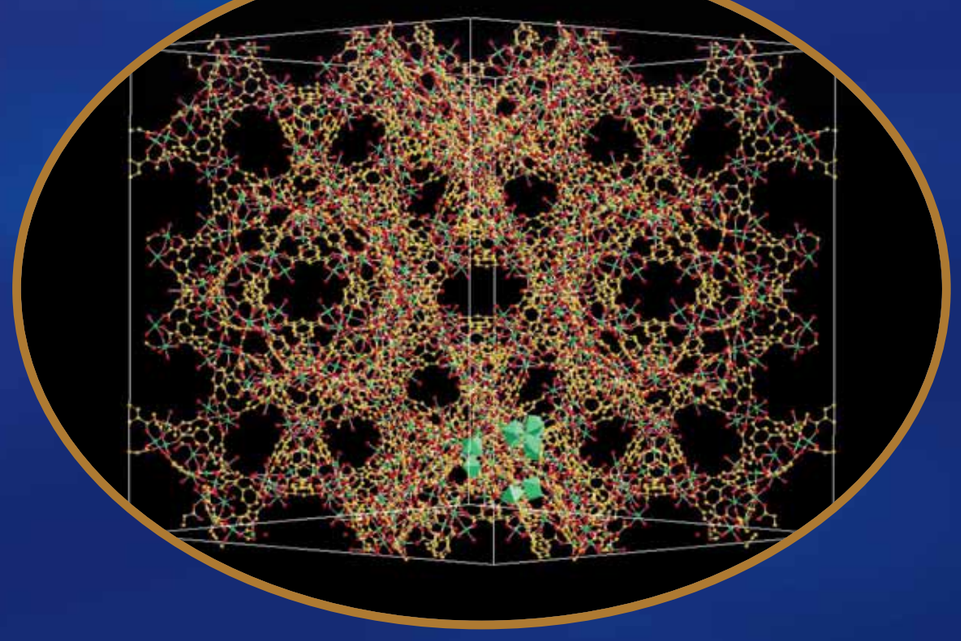



Understanding the zeolite ZSM-39 in order to create the porous MIL100 : the "super-tetrahedra" are super building blocks.

Source : Institut Lavoisier Verrsailles



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