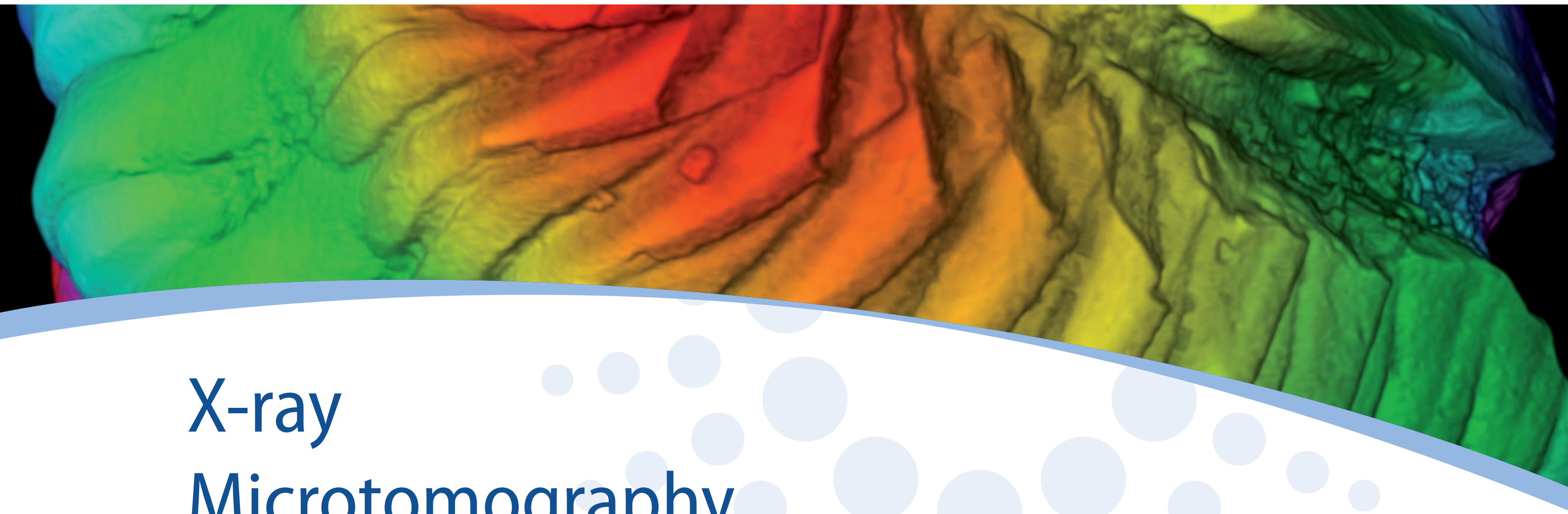


X-ray Microtomography

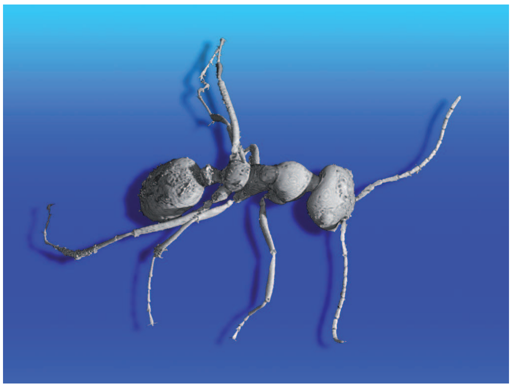
The technology at a glance

X-ray microtomography extends the capacities of X-ray imaging to produce pictures of ultra-high resolution and contrast. Using the same principles as medical scanners, coupled to synchrotron radiation and phase-contrast imaging, scientists can produce 2D and 3D representations with micrometre resolution. Often, samples can be studied where classical techniques do not provide any useful image at all.

The added value of the ESRF X-ray microtomography system

The ESRF X-ray microtomography beamlines offer state-of-the-art technology generating an extremely bright light source and high spatial resolution below 1 micron, as well as the ability to follow phenomena as they develop, therefore enabling the production of dynamic 3D images. Microtomography is one of the major imaging techniques at the ESRF, and has been used for industrial applications for over a decade. The ESRF therefore has at its disposal a unique know-how in the use of the different aspects of microtomography, allowing us to reply rapidly and efficiently to requests from industry, and so obtain optimum results. Furthermore, the ESRF provides a unique sample environment, with temperature ranges from -60° to 1600°C, as well as tension, compression and fatigue stress devices. ESRF staff are dedicated to producing the highest quality images in response to user specifications.

> “X-ray microtomography has the magnifying power to find the proverbial needle in a haystack the size of a building.”
>
> - Elodie Boller, Engineer in charge of industrial experiments on ID19



Fields of application

X-ray microtomography offers vast possibilities and some quite unexpected applications:

Polymers: structure of fibres, polyurethane, polystyrene foams (opened/closed cells).

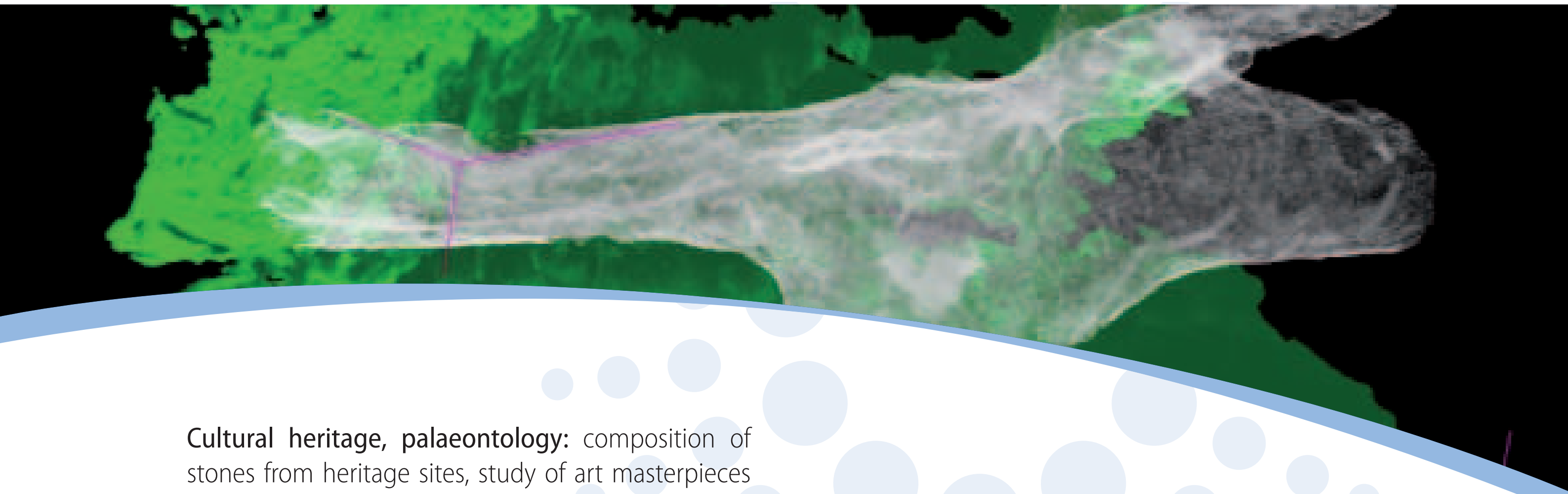
Mining, oil: permeability and determination of microstructure of rocks, hardening of cement.

Cosmetics: lipsticks, structure of hair, shaving foams.

Food: cooking conditions of bread, structure of chocolate mousse, seeds, sugar, salt, fruit, ice-cream, etc.

Processing: structural and process validation, quality control support.

Environment: structure of snow, soil analysis.



Cultural heritage, palaeontology: composition of stones from heritage sites, study of art masterpieces (e.g. Rembrandt, Monet, Van Gogh) and fossils.

"The quality of the experiments at the ESRF is way above my expectations – *fantastique!* I really appreciate not only the scientific results, but also the contact with the staff and their very high level of expertise. I fully recommend the ESRF as a state-of-the-art facility."
- Rhodia (France)

Corporate clients include CEA, AREVA, Lafarge, L'Oréal, Rhodia, Schneider Electric, Unilever

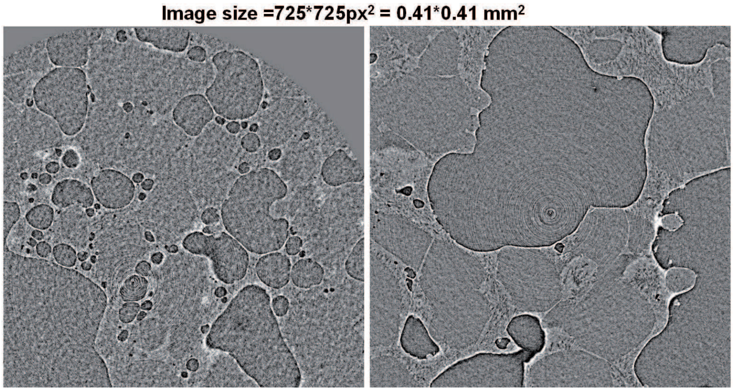
"What I appreciate most when using the ESRF facility is the easy working relationship we have with their staff. Things always go very smoothly. We get some pretty serious work done, but in a very pleasant and friendly environment. Even though we're a small company, we get first-class treatment at the ESRF."
- ERM SARL (France - 14 employees)

CASE STUDY

Unilever used high-resolution tomography imaging to characterise the microstructure of ice-cream.

The challenge: To understand how the microstructure of ice-cream changes after temperature abuse.
Background: The microstructure of ice crystals and air bubbles is critical to ice-cream's quality and sensory properties. Ice cream is of course inherently unstable, and temperature increases during transport, storage or even on exit from the customer's freezer can all play a factor in destroying the microstructure of small ice crystals, leading to recrystallisation and a coarser structure.
Results: Using the X-ray tomography setup of ID19 at low temperature, the microscopic structure of the ice-cream became very clear, showing the change in structure on several samples previously prepared.
How did the synchrotron help? The Unilever research was a challenge for the ID19 team, requiring a specialised *in situ* sample environment and highly-reduced acquisition times. The ID19 intensity, its detector system and the low temperature device compatible with high resolution (sample rotation over 180°) led to the high-quality 3D images with a voxel size of just 0.56 micron.

Image size =725*725px^2 = 0.41*0.41 mm^2



Comparison between fresh (left) ice-cream and "temperature-abused" ice cream (right), clearly showing the large ice crystals and air bubbles after the temperature cycling.