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Rocking Fluid Flow: High-Speed X-ray Imaging of Natural Rocks at ESRF

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Understanding fluid dynamics within natural rock formations is crucial for optimising porous fluid flow with direct applications for CO_2 mineral trapping and hydrogen production. At the European Synchrotron Radiation Facility (ESRF), technological advancements have significantly enhanced our ability to observe these phenomena in real time and under in situ conditions.

ESRF's beamline ID19 has been at the forefront of developing ultra-fast X-ray imaging techniques. Notably, high-resolution volumetric imaging enables capturing dynamic processes with remarkable temporal resolution. These methods involve quickly acquiring systems under high Peclect numbers under stationary conditions. Promising advancements now also allow the exploration of non-stationary processes. In addition, ESRF has pioneered megahertz projection imaging capable of recording volumetric information at MHz rates and micrometre resolution without necessitating sample rotation, facilitating the study of rapid, non-reproducible processes in four dimensions (3D + time).

The Block Allocation Group (BAG) initiative CHRONOS, on beamlines BM18 and BM05, extends the value of these imaging techniques by supporting long-term experimental projects. This framework is particularly beneficial for studying CO_2 mineral trapping and hydrogen production under prolonged and natural conditions, providing unprecedented insights into fluid-rock interactions over time.

The combination of ultra-fast imaging techniques and the CHRONOS BAG framework at ESRF offers a powerful platform for advancing our understanding of fluid flow in natural rocks. We encourage exploring the complexities of fluid-rock interactions with the present capabilities and developing them to advance our knowledge in geosciences continually.

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References

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