Oral presentation | S3: Rheology and Material Transfer in Mantle and Crust (Special Session)

Thu. Sep 11, 2025 2:00 PM - 6:00 PM JST | Thu. Sep 11, 2025 5:00 AM - 9:00 AM UTC Oral Presentation C(Room No. 28)

S3: Rheology and Material Transfer in Mantle and Crust (Special Session)

Chairperson:Ikuo Katayama(Hiroshima University), Miki Tasaka(Shizuoka University), Tomoaki Kubo(Kyushu University)

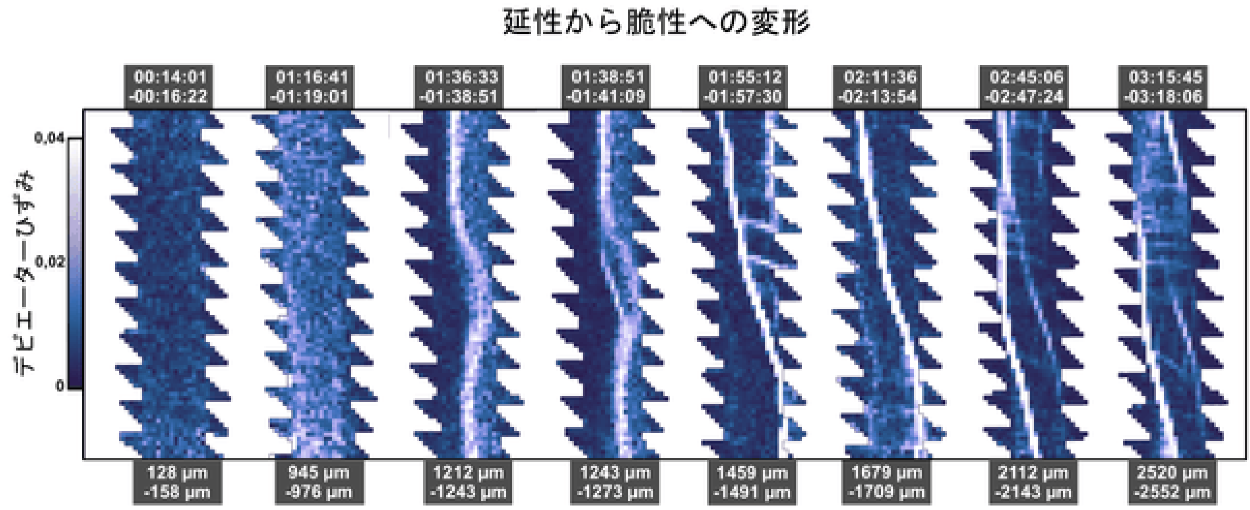
Invited Lecture

4:00 PM - 4:25 PM JST | 7:00 AM - 7:25 AM UTC

[S3-07] Seeing fault failure in real time: s4DμCT of gypsum dehydration

Nick Harpers[1], Florian Fusseis[1], *Eranga Gayanath Jayawickrama[1] (1. RWTH Aachen Univ.)
Keywords：s4DμCT、Dehydration、Shear

Synchrotron-based 4D microtomography (s4DμCT), the time-resolved extension of three-dimensional X-ray computed microtomography, offers a non-invasive way to visualize and quantify internal microstructural changes during dynamic processes. Utilizing the progression in synchrotron radiation, fast detectors, and digital volume correlation (DVC), this technique enables high-resolution imaging and quantification of evolving systems under controlled mechanical, thermal, and chemical conditions. In this study, we apply s4DμCT to investigate the syn-deformational dehydration of gypsum in a direct-shear experiment. This experiment can be considered an analogue for serpentine dehydration in subduction zones. The process involves complex hydraulic, mechanical, and chemical (HMC) interactions that remain poorly understood, especially under shear stress. We conducted a series of operando direct shear experiments on high-purity gypsum powders using the x-ray transparent Heitt Mjölnir rig at the ID19 beamline of the European Synchrotron Radiation Facility (ESRF). These experiments captured the real-time evolution of microstructures during dehydration, under conditions of 10 MPa confining pressure, 2 MPa fluid pressure, and heating from 60 °C to 125 °C, with concurrent shear strain applied at a constant displacement rate. s4DμCT imaging allowed us to discriminate between gypsum, hemihydrate, and pore space with high fidelity, providing insights into the spatial and temporal evolution of deformation structures such as Riedel shears, compaction bands, and boundary shears. Our analyses use DVC to resolve grain-scale deformation and reaction rate during coupled deformation and dehydration in the s4DμCT data. The initial results demonstrate a clear link between microstructural changes and variations in frictional and transport properties. These findings underscore the power of s4DμCT in capturing the feedback between chemical reactions and hydro-mechanical behavior during shear, with broader implications for understanding fault zone processes. Future work will extend to other lithologies and focus on quantifying rate-and-state friction to better characterize sliding stability in deforming systems.


延性から脆性への変形
00:14:01 -00:16:22
01:16:41 -01:19:01
01:36:33 -01:38:51
01:38:51 -01:41:09
01:55:12 -01:57:30
02:11:36 -02:13:54
02:45:06 -02:47:24
03:15:45 -03:18:06
デビエーターひずみ
0,04
0,02
0
128 µm -158 µm
945 µm -976 µm
1212 µm -1243 µm
1243 µm -1273 µm
1459 µm -1491 µm
1679 µm -1709 µm
2112 µm -2143 µm
2520 µm -2552 µm