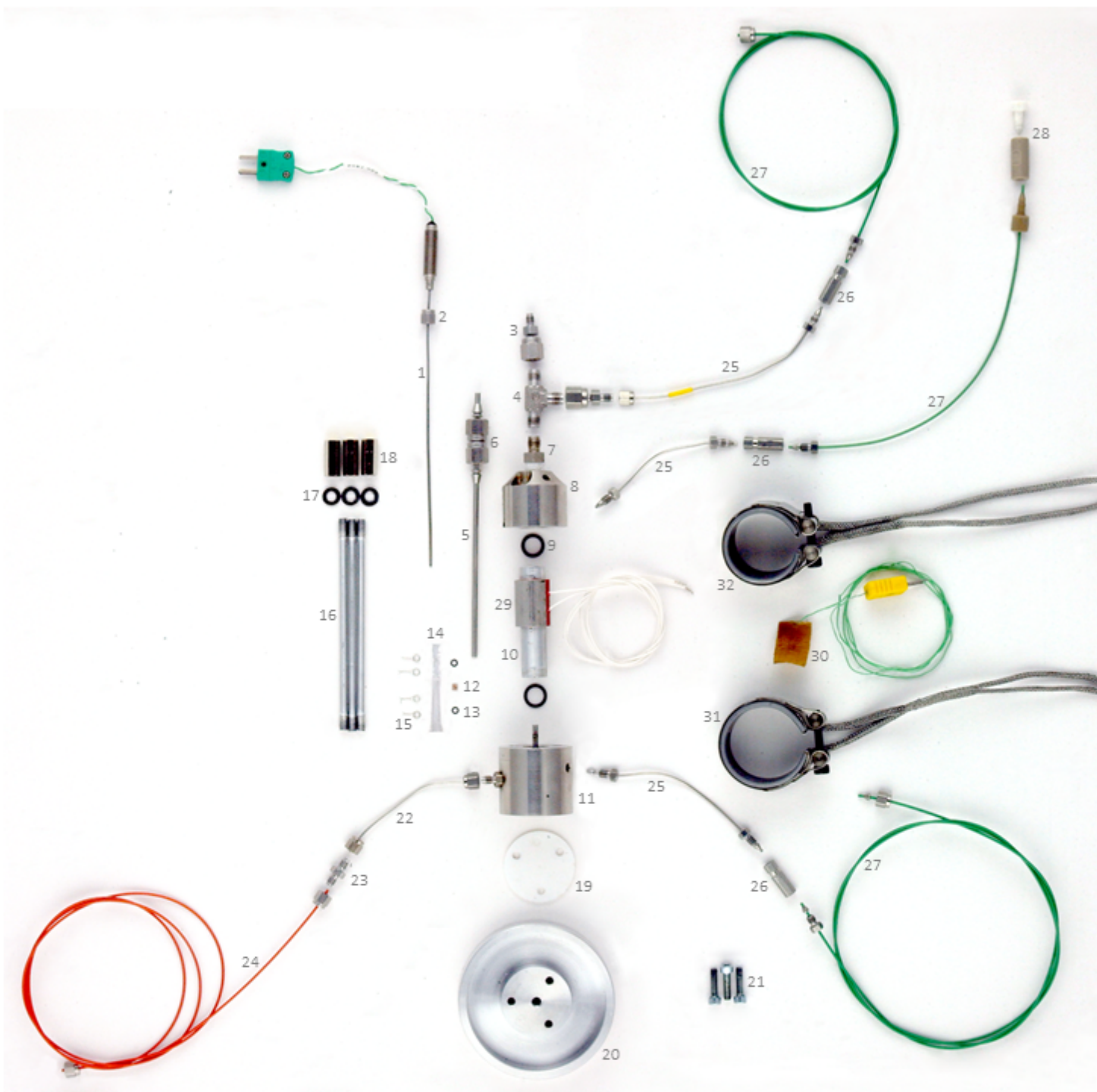
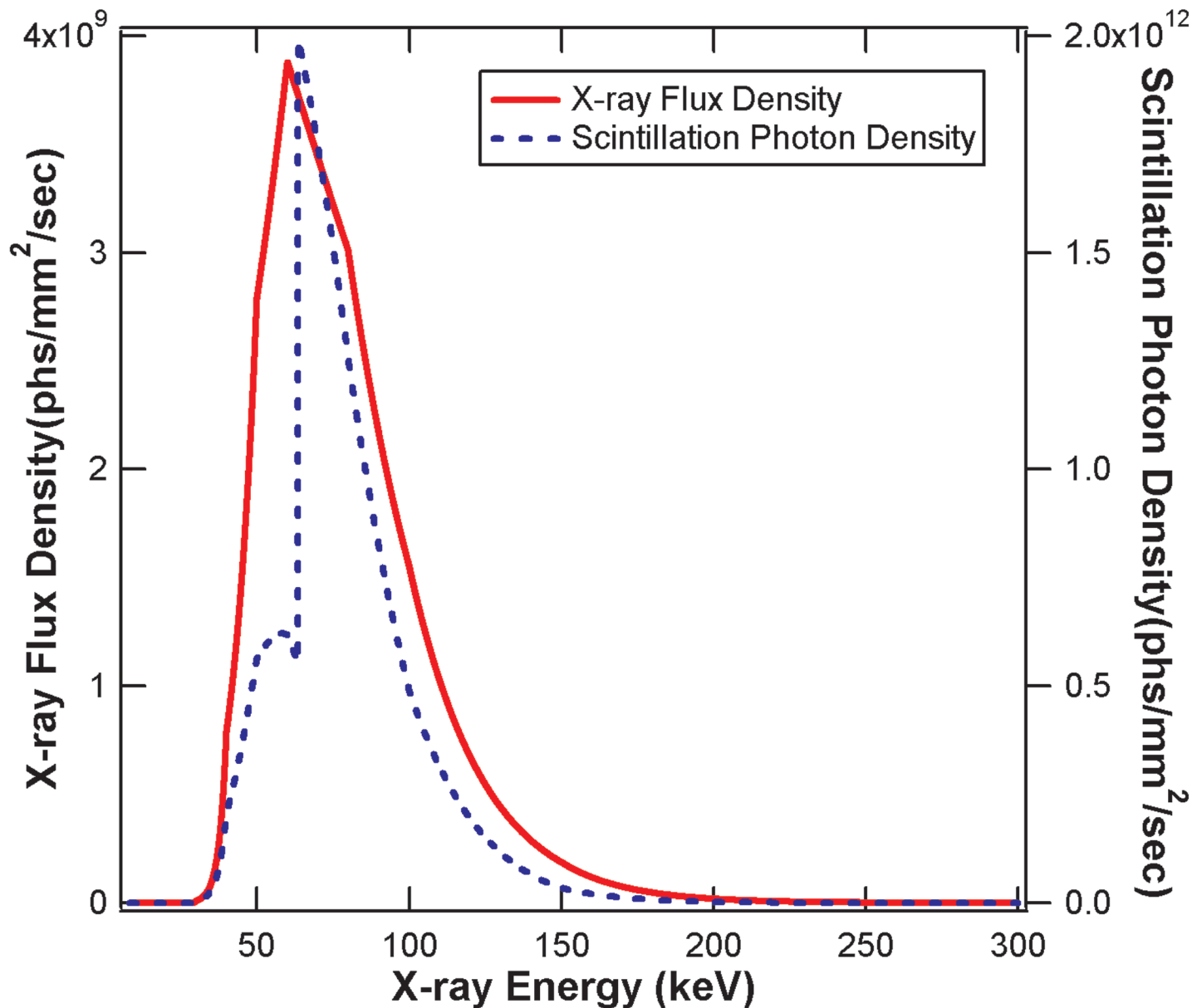


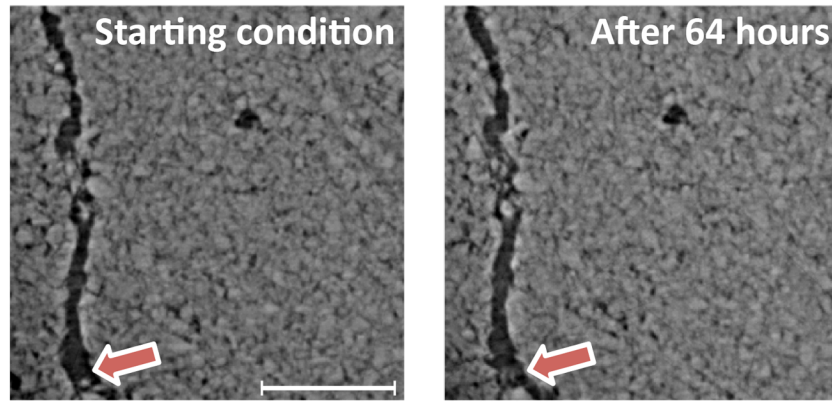
**Figure S1** Sketch of the sample jacket.



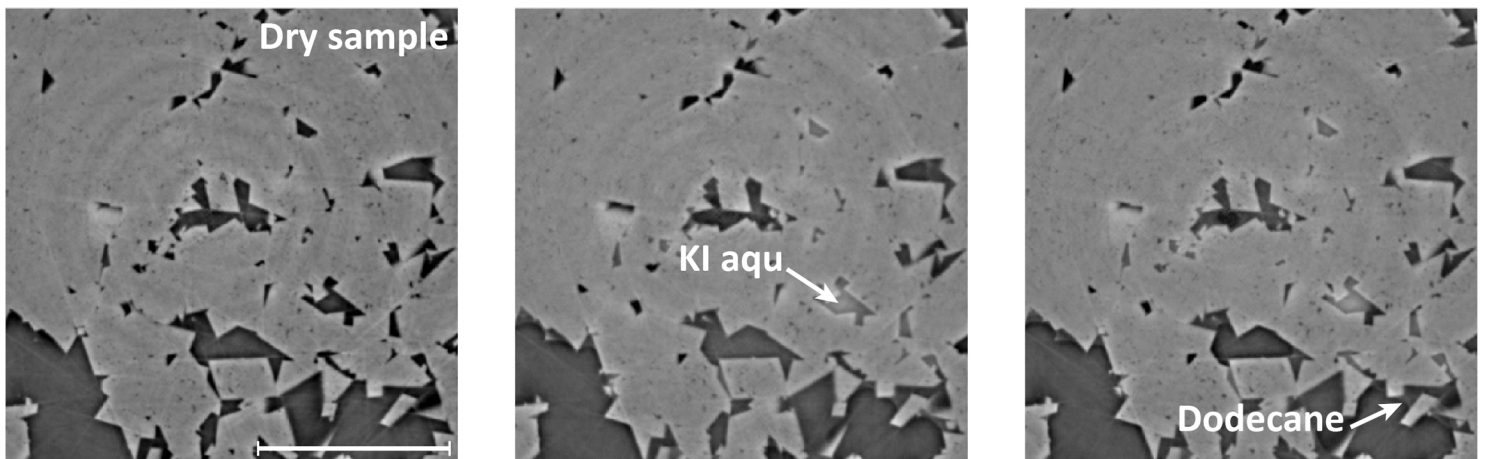
**Figure S2** The components of the cell. The labels correspond to the positions in Supporting Table 1.



**Figure S3** Calculated energy of the polychromatic beam used in the experiments at beamline 2BM at APS. The calculation is based on an APS banding magnet source. The flux from the source is confined in a solid angle of 0.088 mrad in both horizontal and vertical directions. The flux density is calculated on a plane located 25m from the source. The calculation assumes a 1-mm Al, 15-mm Si and 8-mm borosilicate glass filter plus 8 mm aluminum from the pressure vessel. The scintillator is a 100  $\mu$ m thick LuAG:Ce single crystal.



(a)



(b)

**Figure S4** (a) Visualization of the same vertical slice in tomographic datasets collected during the carbonation experiment, arrows indicate newly grown minerals. As these data were collected, the sample was at 473 K and 15 MPa confining pressure. The scale bar in the left image is 250  $\mu\text{m}$  long. See text for details of experiment 1. (b) The same vertical slice through a dolomite sample, with the data having been collected at three different time steps during the imbibition experiment. The slices show different fluid phases (dodecane, KI-doped H<sub>2</sub>O, gas) in the pores. The scale bar in the first image is 500  $\mu\text{m}$  long. See text for details of experiment 2.

**Table S1** Components and materials used for the cell, as well as suppliers.

	<b>Parts list</b>	material/ specification	manufacturer/ supplier	comment
#	<b>Cell</b>			
1	Sheathed thermocouple, 150mm long, 1/16" OD	type K	Omega	temperature monitored through the beamline controls
2	1/16" nut with front and back ferrules		Swagelok	
3	Reducing connection 1/8" port to 1/16" tube w/ 1/8" nut with front and back ferrules	SS 316	Swagelok	
4	1/8" Union Tee, 1/8" Tube OD	SS 316	Swagelok	
5	1/8" OD, 1/16" ID tube, variable length	SS 316	Swagelok	
6	1/8" nuts with front and back ferrules	SS 316	Swagelok	
7	Male connector, 1/8" tube to 1/8" NPT	SS 316	Swagelok	
8	Upper end cap with feed-in/out for flow-through and confining oil	SS 316	custom built	dimensions see technical drawing
9	O-rings, 7 mm ID, 1.5 mm cross section	Viton	RS components	
10	Central tube, 60 x 14 mm (OD, 6 mm ID)	Al 99.99%	Goodfellow	6082T6 alloy is cheaper and can be used with the described beamline configuration. Due to the higher yield strength of the material and the substantially increased safety margin, we recommend using it to machine this component.
11	Lower end cap with tube stub, 1/8" OD, with feed-in/out for flow-through and confining oil	SS 316	custom built	dimensions see technical drawing
12	<b>Sample</b> , 3 mm diameter	rock	God	
13	O-rings, 3 mm ID, .9 mm cross section	Viton	RS components	
14	High-temp heat shrink tubing 6.4/1.6 mm (sleeve/shrunk diameter)	Viton	RS components	
15	0.3 mm thick wire	steel	RS components	
16	Support rods, 114 mm long, central diameter 4 mm with M5 threads at the thicker ends	Al 99.99%	Goodfellow	6082T6 alloy is cheaper and can be used with the described beamline configuration. Due to the higher yield strength of the material and the substantially increased safety margin, we

recommend using it to machine this component.

17	Discs springs, 0.6x10 mm (OD, 5.2 mm ID)	steel	Belleville Springs	
18	M5 nuts, 20 mm long	SS 316	RS components	
19	Insulation disc, 39 x 1.7 mm	Viton	custom built	
20	Drip tray/stage connector, 84 mm diameter	Al alloy	custom built	dimensions see technical drawing
21	M3 bolts	steel	RS components	
22	1/16" OD, 1/32" ID tube, variable length w/ 1/16" nut with front and back ferrules	SS 316	Swagelok	
23	1/16" union	SS 316	Swagelok	
24	1/16" OD, 0.02" ID tubing w/ w/ 1/16" nut with front and back ferrules	PEEK/SS 316	IDEX Health and Science/ Swagelok	PEEK Polyether ether ketone
25	1/16" OD, 1/32" ID tube, variable length w/ 1/16" chromatography fitting	SS 316	Swagelok	
26	1/16" low dead volume chromatography union	SS 316	Swagelok	
27	1/16" OD, 0.03" ID tubing w/ w/ 1/16" chromatography fitting	PEEK/SS 316	IDEX Health and Science/ Swagelok	PEEK Polyether ether ketone
28	Connector for 1/16" tubing with plug	PEEK	IDEX Health and Science	PEEK Polyether ether ketone

### Heating

29	Heater mat 1.25 W, 12 V w/ bracket	Silicon/Al alloy	RS components/ custom made	
30	Adhesive thermocouples	type K	Omega	mounted beneath each of the bracket heaters
31	Bracket heater 40 mm ID, 250W, 240V	mica nozzle	RS components	
32	Bracket heater 35 mm ID, 150W, 240V	mica nozzle	RS components	
33	On-off heater controllers	TC4800	Tempatron, RS components	

### Pressurization (shown in Suppl. Figure 1b)

34	Silicon oil	Syltherm 800	Dow Chemicals	
35	Syringe pumps, manually adjustable or motor-driven		custom built	One for flow-through and confining pressure, respectively

36	Miniature Industrial Pressure Gauge, 6mm Swagelok tube adapter, 0 to 25 Mpa	SS 316	Swagelok	Two for flow through (before and after cell), one for confining pressure
37	Severe-Service Union-Bonnet Needle Valve	SS 316	Swagelok	Two for flow through (before and after cell), one for confining pressure
38	High-pressure adjustable back pressure regulator W/ fittings for 1/6" tubing	PEEK/perfluoro-elastomer, PTFE	IDEX Health and Science	adjustable from 13.8-34.5 Mpa, PTFE Polytetrafluoroethylene
39	Reducing connection 6mm port to 1/16" tube	SS 316	Swagelok	Two for flow through (before and after cell), one for confining pressure
40	6mm Union Tee, 6mm Tube OD	SS 316	Swagelok	Two for flow through (before and after cell), one for confining pressure
41	6mm OD 4mm ID tube	SS 316	Swagelok	
<b>low-T/low-P cell (components not shown in Fig. 1)</b>				
42	Cell top and base parts with feed-in/out for flow-through and confining oil	PEEK 30% GF		
43	Central tube, 60x14 mm (OD, 6 mm ID)	Quartz glass, Herasil 102	Heraeus	

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