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Supplement of

Micromechanisms leading to shear failure of Opalinus Clay in a triaxial test: a high-resolution BIB–SEM study

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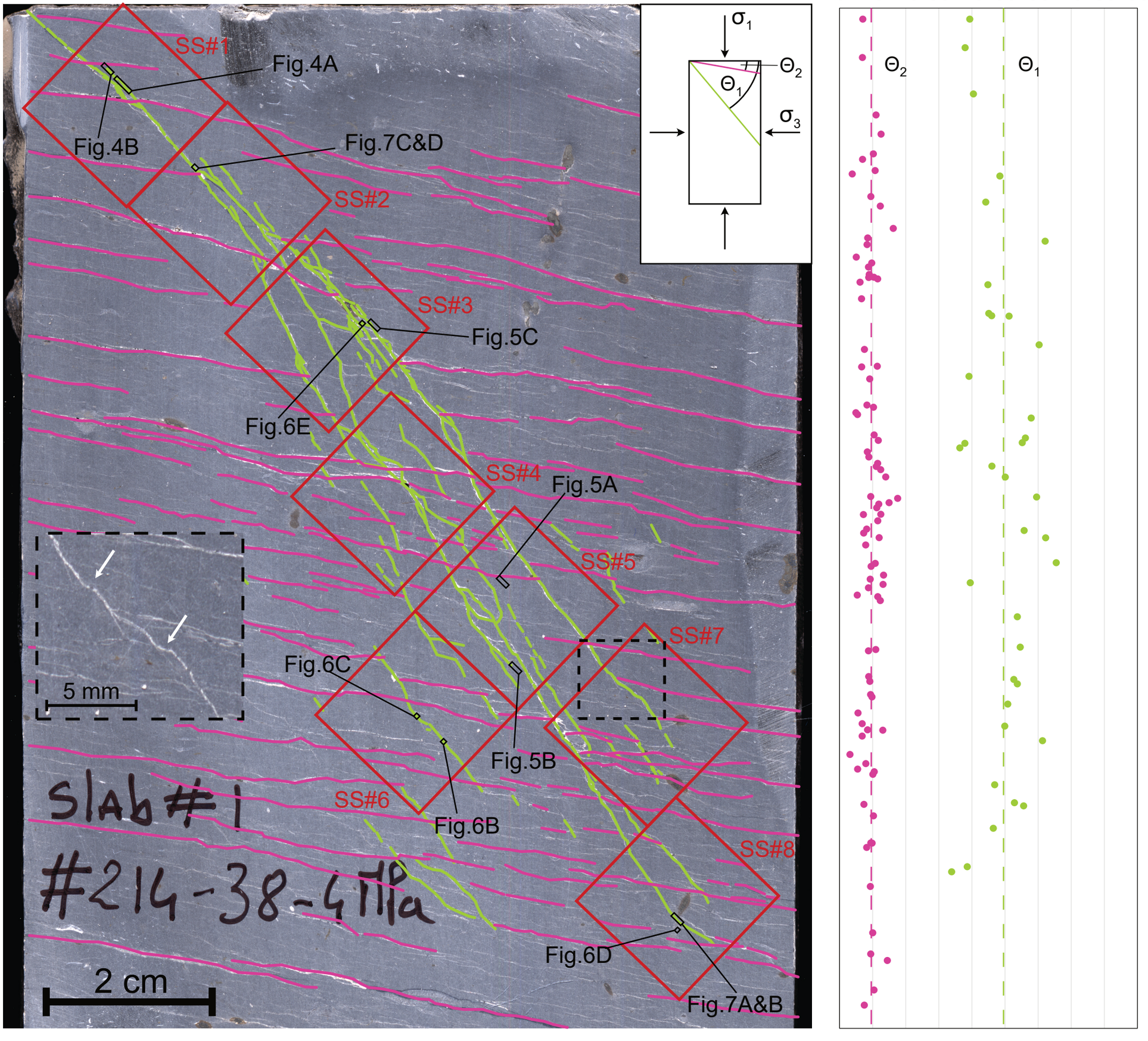
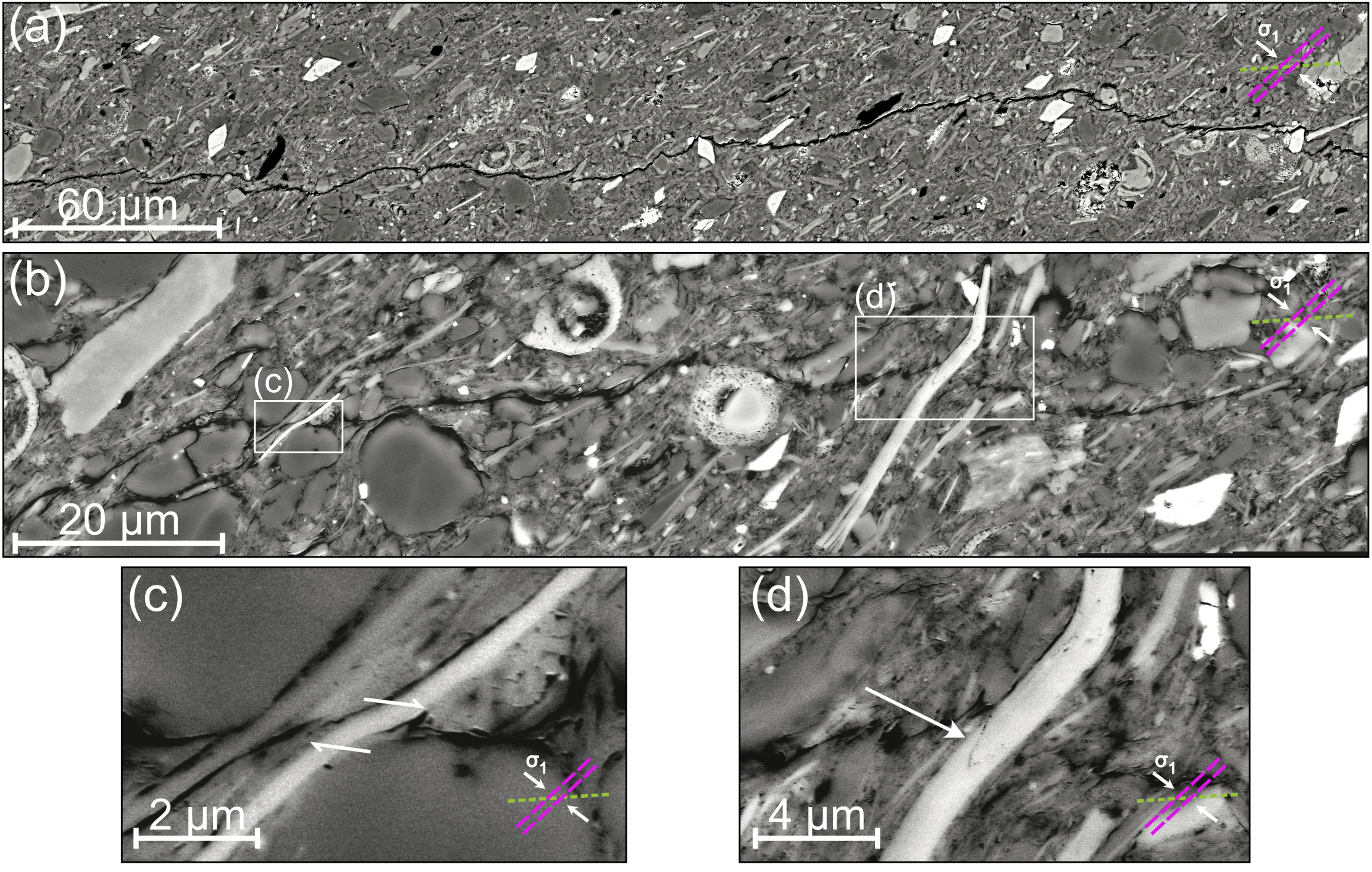
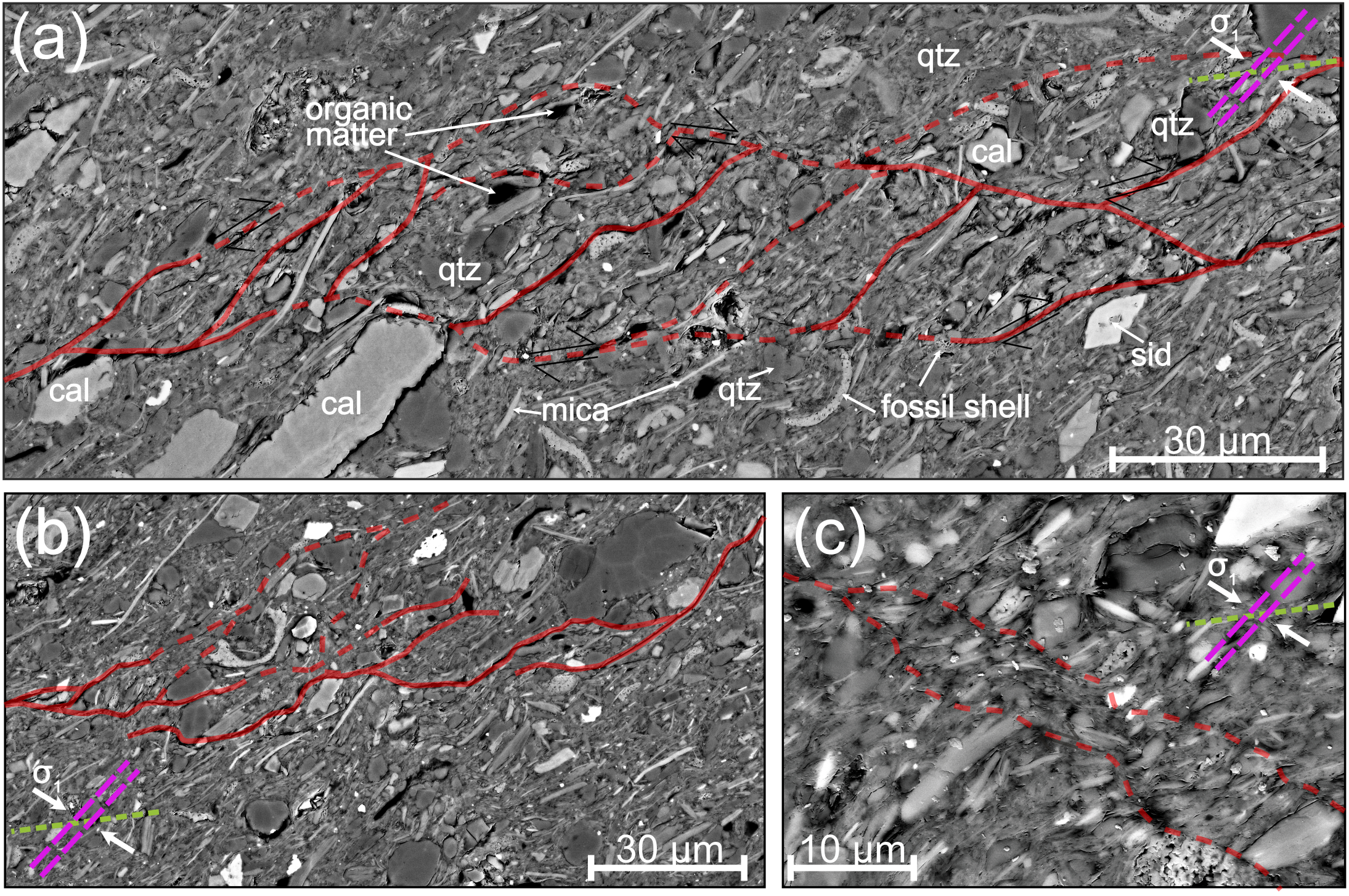
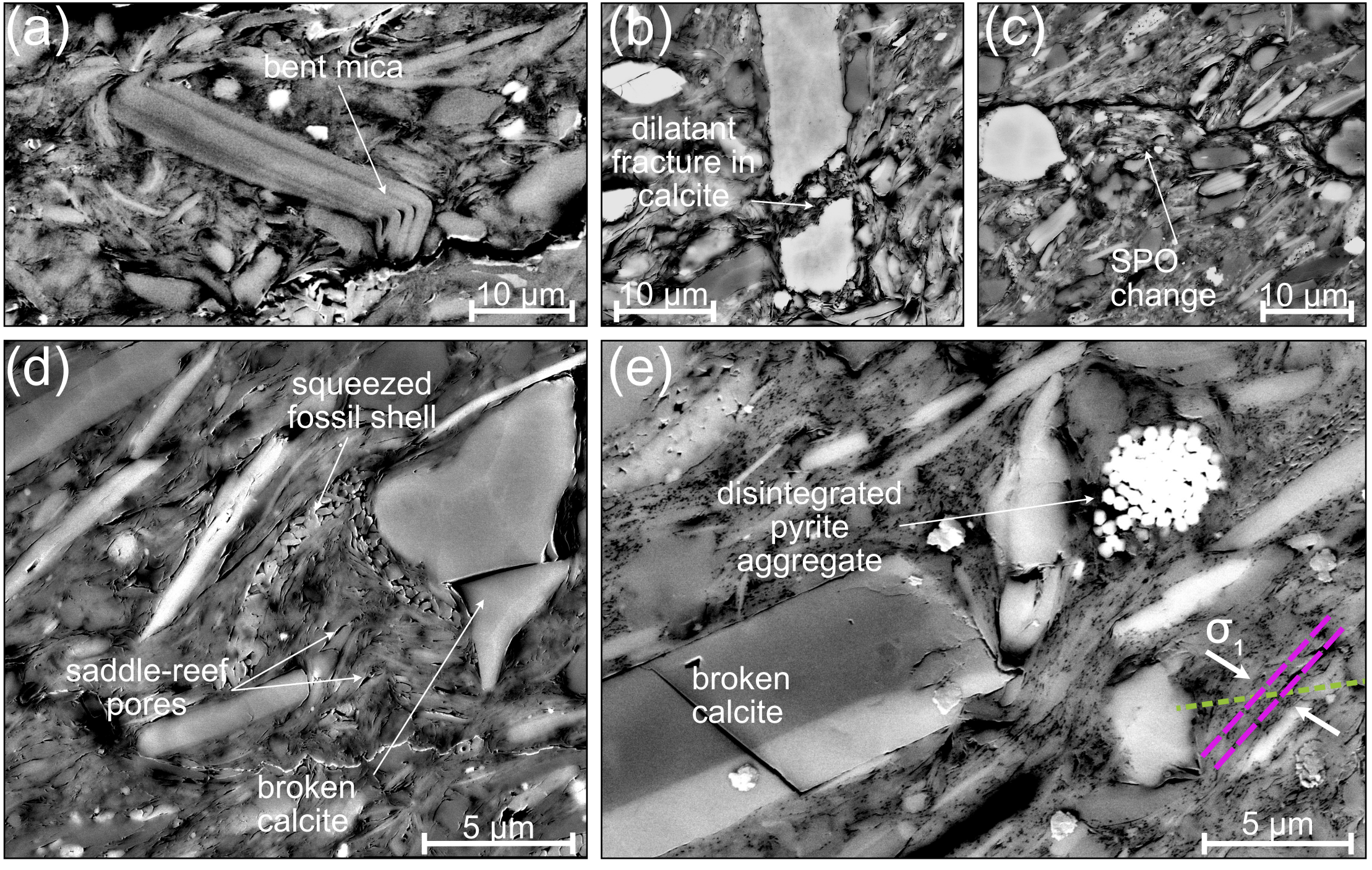
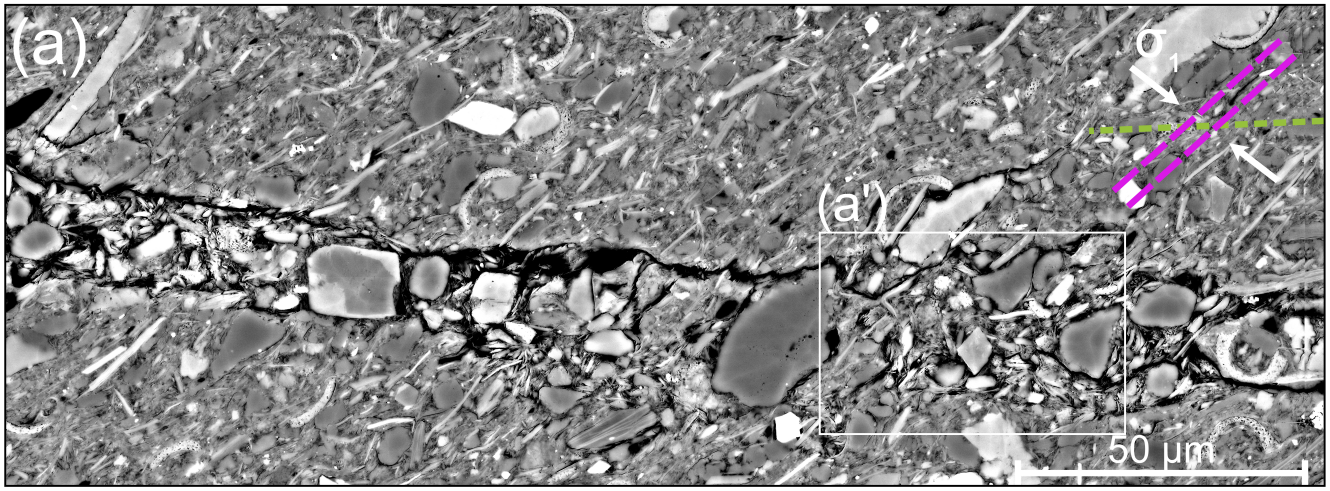


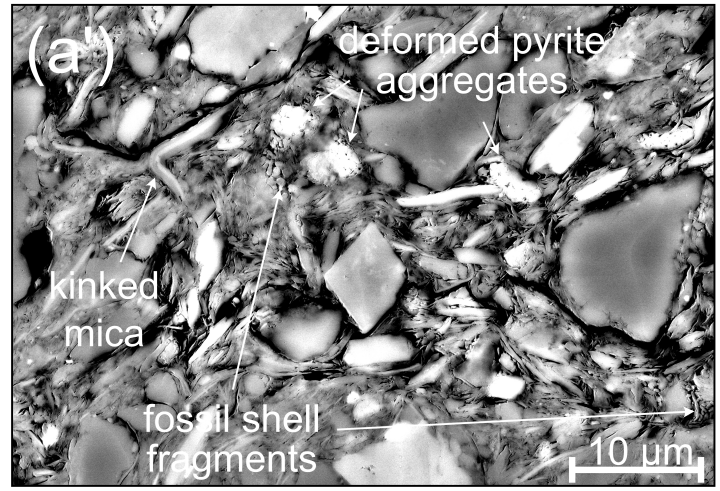
SS#1
Fig.4A
Fig.4B
Fig.7C&D
SS#2
SS#3
Fig.5C
Fig.6E
SS#4
Fig.5A
SS#5
SS#7
Fig.6C
Fig.5B
SS#6
Fig.6B
SS#8
Fig.6D
Fig.7A&B
5 mm
2 cm
Slab #1
#214-38-4 MPa
σ1
σ3
Θ1
Θ2
angle (°)
0 10 20 30 40 50 60 70 80 90

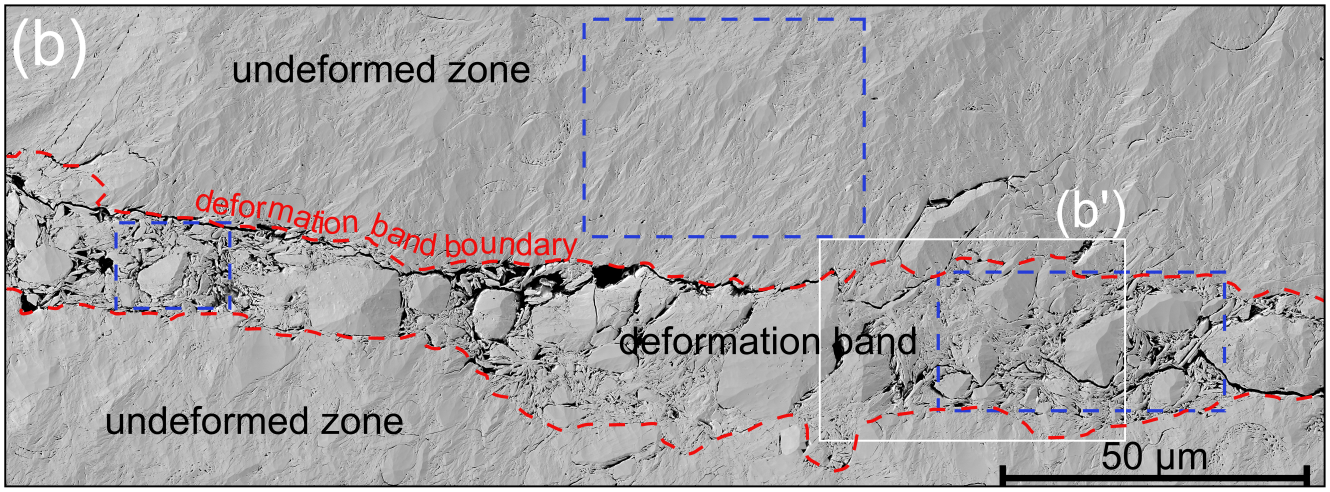

(a)
σ1
60 μm
(b)
(c)
(d)
σ1
20 μm
(c)
σ1
2 μm
(d)
σ1
4 μm

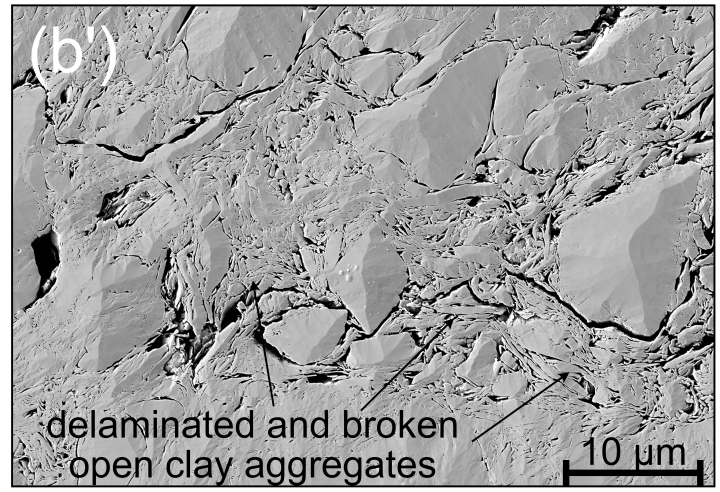

(a)
organic matter
qtz
qtz
cal
qtz
cal
cal
mica
qtz
fossil shell
sid
σ1
30 μm
(b)
σ1
30 μm
(c)
σ1
10 μm

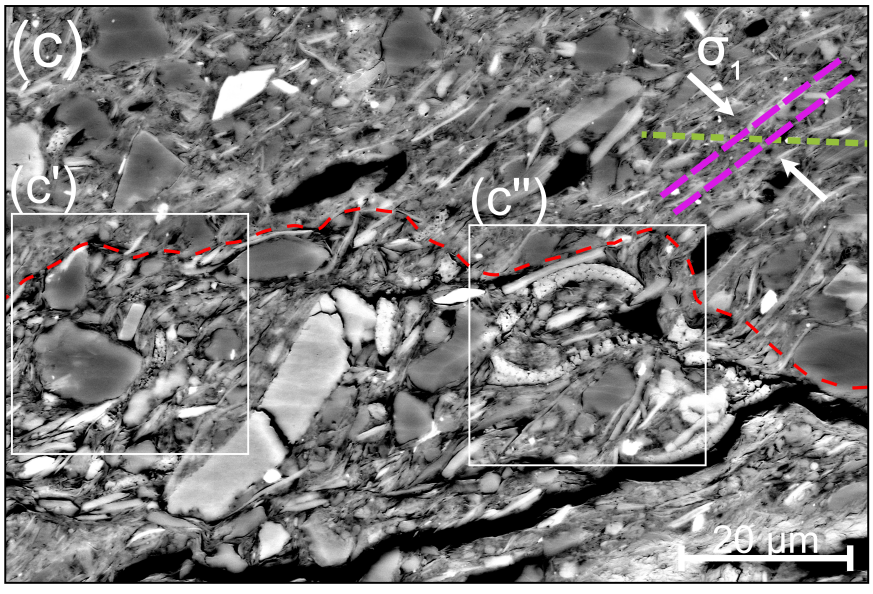

(a)
bent mica
10 μm
(b)
dilatant fracture in calcite
10 μm
(c)
SPO change
10 μm
(d)
squeezed fossil shell
saddle-reef pores
broken calcite
5 μm
(e)
disintegrated pyrite aggregate
broken calcite
σ1
5 μm

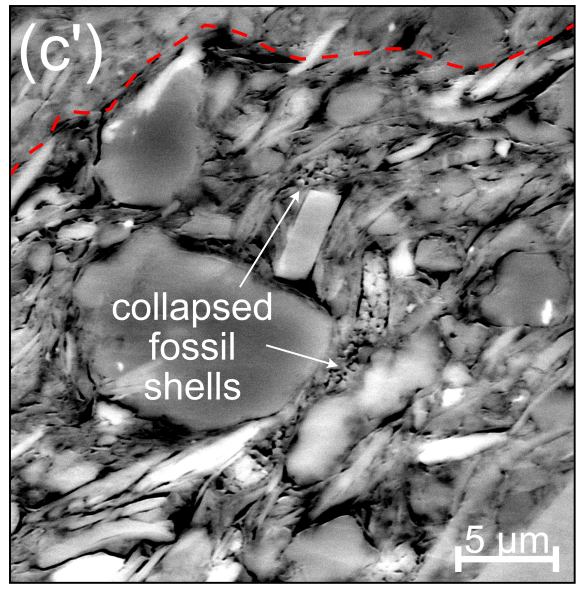

(a)
σ1
(a')
50 μm

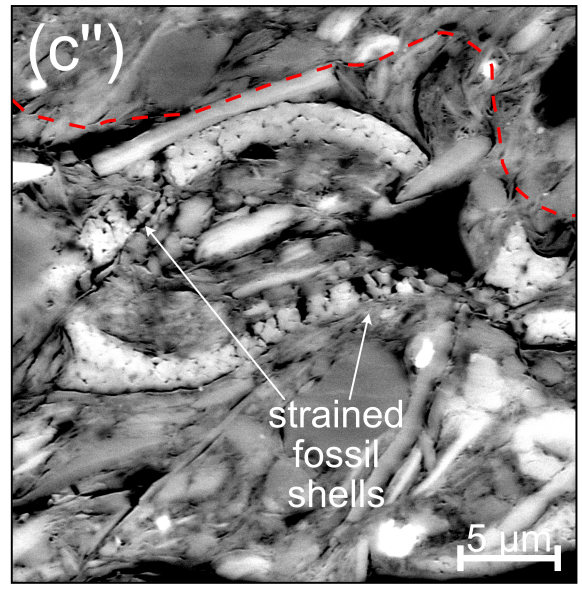

(a')
deformed pyrite aggregates
kinked mica
fossil shell fragments
10 μm

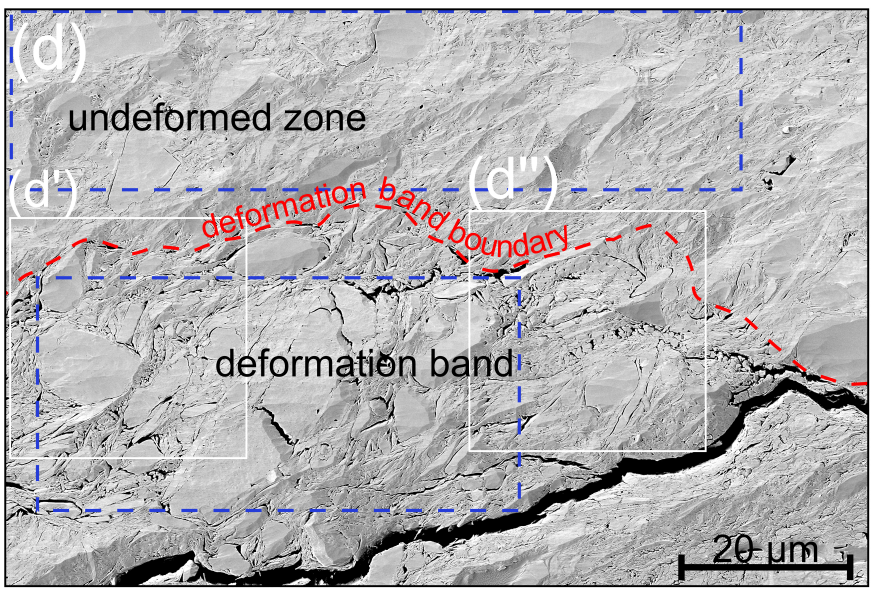

(b)
undeformed zone
deformation band boundary
(b')
deformation band
undeformed zone
50 μm

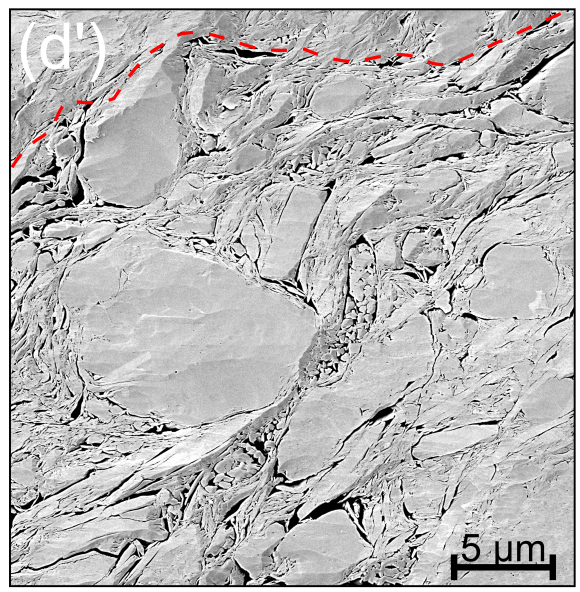

(b')
delaminated and broken open clay aggregates
10 μm

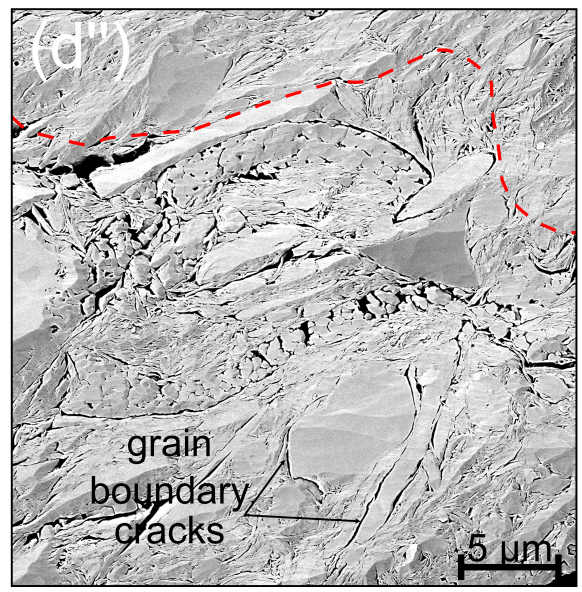

(c)
σ1
(c')
(c'')
20 μm


(c')
collapsed fossil shells
5 μm


(c'')
strained fossil shells
5 μm


(d)
undeformed zone
(d')
(d'')
deformation band boundary
deformation band
20 μm


(d')
5 μm


(d'')
grain boundary cracks
5 μm

Pore size analysis

Fig. 8(b)

SS2 Map 17

intact rock

size total image[µm²]	2797.05			
size total image[nm²]	2797045200			
Count		Total Area µn	Average Size	%Area
	33757	79.38	0.002352	2.93
porosity (%)	**2.84**			

undeformed bin [µm²]	*frequ.*	*cum. (%)*	*classes*
0.0004	0	0.00	
0.0006	13485	39.95	39.95
0.001	19368	57.37	17.43
0.002	24586	72.83	15.46
0.004	29271	86.71	13.88
0.006	30992	91.81	5.10
0.008	31915	94.54	2.73
0.01	32401	95.98	1.44
0.02	33288	98.61	2.63
0.04	33609	99.56	0.95
0.06	33695	99.82	0.25
0.08	33720	99.89	0.07
0.1	33733	99.93	0.04
0.2	33753	99.99	0.06
0.4	33757	100.00	0.01

SS2 Map 17

deformation zone

size total image [µm²]	1427.85			
size total image[nm²]	1427851900			
Count		Total Area	Average Size	%Area
	20528	125.44	0.006111	8.79
porosity (%)	**8.79**			

deformed1 bin [µm²]	frequ.	cum. (%)	classes
0.0006	7805	38.02	38.02
0.001	11128	54.21	16.19
0.002	14166	69.01	14.80
0.004	16848	82.07	13.07
0.006	17927	87.33	5.26
0.008	18539	90.31	2.98
0.01	18864	91.89	1.58
0.02	19598	95.47	3.58
0.04	20067	97.75	2.28
0.06	20214	98.47	0.72
0.08	20285	98.82	0.35
0.1	20343	99.10	0.28
0.2	20442	99.58	0.48
0.4	20500	99.86	0.28
0.6	20511	99.92	0.05
0.8	20514	99.93	0.01
1	20521	99.97	0.03
2	20526	99.99	0.02
4	20528	100.00	0.01

SS2 Map 17

deformation zone

size total image [µm²]	235.54			
size total image[nm²]	235537200			
Count		Total Area	Average Size	%Area
	4435	23.18	0.005226	9.85
porosity (%)	**9.84**			

deformed2 bin [µm²]	frequ.	cum. (%)	classes
0.0006	1525	34.39	34.39
0.001	2300	51.86	17.47
0.002	2968	66.92	15.06
0.004	3615	81.51	14.59
0.006	3854	86.90	5.39
0.008	4005	90.30	3.40
0.01	4091	92.24	1.94
0.02	4258	96.01	3.77
0.04	4351	98.11	2.10
0.06	4382	98.80	0.70
0.08	4395	99.10	0.29
0.1	4406	99.35	0.25
0.2	4423	99.73	0.38
0.4	4430	99.89	0.16
0.6	4433	99.95	0.07
0.8	4433	99.95	0.00
1	4434	99.98	0.02
2	4435	100.00	0.02
4	4435	100.00	0.00

Pore size analysis

Fig. 8(a)

SS7 Map 2

intact rock

size total image[µm²]	1698.2795
size total image[nm²]	1698279500

Count	Total Area	Average Size	%Area
28766	69.08	0.002402	4.07

porosity (%)	**4.07**

undeformed

bin [µm²]	*frequ.*	*cum. (%)*	*classes*
0.0001	0	0.00	
0.0002	6322	21.98	21.98
0.0004	11244	39.09	17.11
0.0006	14040	48.81	9.72
0.0008	15942	55.42	6.61
0.001	17407	60.51	5.09
0.002	21643	75.24	14.73
0.004	24808	86.24	11.00
0.006	26192	91.05	4.81
0.008	26912	93.55	2.50
0.02	28233	98.15	4.59
0.04	28613	99.47	1.32
0.06	28698	99.76	0.30
0.08	28732	99.88	0.12
0.1	28745	99.93	0.05
0.2	28762	99.99	0.06
0.4	28766	100.00	0.01

SS7 Map 2

deformation zone 1

size total image [µm²]	259.84
size total image [nm²]	259836000

Count	Total Area	Average Size	%Area
2766	54.99	0.019882	21.16

porosity (%)	**21.16**

deformed 1

bin [µm²]	frequ.	cum. (%)	classes
0.0001	0	0	
0.0002	519	18.76	18.76
0.0004	936	33.84	15.08
0.0006	1176	42.52	8.68
0.0008	1355	48.99	6.47
0.001	1491	53.90	4.92
0.002	1888	68.26	14.35
0.004	2178	78.74	10.48
0.006	2309	83.48	4.74
0.008	2394	86.55	3.07
0.02	2572	92.99	6.44
0.04	2639	95.41	2.42
0.06	2675	96.71	1.30
0.08	2700	97.61	0.90
0.1	2709	97.94	0.33
0.2	2726	98.55	0.61
0.4	2742	99.13	0.58
0.6	2751	99.46	0.33
0.8	2756	99.64	0.18
1	2758	99.71	0.07
2	2762	99.86	0.14
4	2764	99.93	0.07
6	2764	99.93	0.00
8	2765	99.96	0.04
10	2766	100.00	0.04

SS7 Map 2

deformation zone 2

size total image [µm²]	1108.6642
size total image [nm²]	1108664200

Count	Total Area	Average Size	%Area
10711	178.82	0.016695	16.13

porosity (%)	**16.13**

deformed 2

bin [µm²]	frequ.	cum. (%)	classes
0.0001	0	0	
0.0002	2059	19.22	19.22
0.0004	3583	33.45	14.23
0.0006	4448	41.53	8.08
0.0008	5074	47.37	5.84
0.001	5582	52.11	4.74
0.002	7028	65.61	13.50
0.004	8242	76.95	11.33
0.006	8797	82.13	5.18
0.008	9113	85.08	2.95
0.02	9850	91.96	6.88
0.04	10226	95.47	3.51
0.06	10355	96.68	1.20
0.08	10431	97.39	0.71
0.1	10477	97.82	0.43
0.2	10589	98.86	1.05
0.4	10641	99.35	0.49
0.6	10666	99.58	0.23
0.8	10677	99.68	0.10
1	10684	99.75	0.07
2	10701	99.91	0.16
4	10705	99.94	0.04
6	10708	99.97	0.03
8	10710	99.99	0.02
10	10710	99.99	0.00
20	10711	100.00	0.01