- Supporting Online Material –

Appendix JH2012

Quartz Cementation History of Sandstones Revealed by High-Resolution SIMS Oxygen Isotope Analysis

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Ion Microprobe Analysis of Quartz Overgrowths

In situ oxygen isotope data were acquired in the WiscSIMS Laboratory at the University of Wisconsin–Madison by a CAMECA ims-1280 large-radius multicollector ion microprobe (Kita et al., 2009, Valley and Kita 2009). Quartz overgrowths were analyzed during two analytical sessions in May 2008 (Table 1) and June 2009 (Table 2). In the first session, two settings of the $^{133}Cs^{+}$ primary ion beam allowed for a switch from ~ 20 μm beam spot diameter with an intensity of ~ 2.3 nA to 12 μm with ~ 1.3 nA intensity. The typical secondary $^{16}O^{-}$ ion intensity was ~ $2.8x10^{9}$ cps for the 2.3 nA primary beam and ~ $1.5x10^{9}$ for analyses using the 1.3 nA beam. Measurements were performed in multicollector Faraday Cup mode and with conditions similar to those reported by Kelly et al. (2007). In the second analytical session, a $^{133}Cs^{+}$ primary ion beam with an intensity of ~ 25 pA was focused to a size of approximately 2 μm x 3 μm. General conditions of the analyses are similar to those reported in Kozdon et al. (2009). The secondary O^{-} ions were detected by a Faraday cup ($^{16}O^{-}$) and a miniature Hamamatsu electron multiplier ($^{18}O^{-}$). The typical secondary $^{16}O^{-}$ ion intensity was ~ 3 x 10^{7} cps. Charging of the sample surface was compensated by Au-coating and an electron flood gun. Grains of the University of Wisconsin quartz standard, UWQ-1, ($\delta^{18}O$ = 12.33‰ [SMOW]; Kelly et al., 2007) were mounted in the center of each thin section. Four consecutive measurements of UWQ-1 quartz standard were performed before and after every set of 8–22 sample analyses. The precision (reproducibility) of a set of bracketing standard analyses is assigned as uncertainty of unknown samples. Detailed analytical protocols are described in Kita et al. (2009).

Table 1. Oxygen Isotope Analyses of Quartz Overgrowths at WiscSIMS 2008

Sample Mount J.H. 20 (211/27-A2). 20 µm beam, 2.3 nA intensity. May 7, 2008.

Analyses #	Sample	^{16}O cps x10^9	$\delta^{18}O$ RAW	2 SE[a)]	$\delta^{18}O$ VSMOW	2 SD[b)]
5	UWQ-1	2.95	6.93	0.22		
6	UWQ-1	2.84	6.90	0.35		
7	UWQ-1	2.95	7.03	0.13		
8	UWQ-1	2.88	6.91	0.14		
10	20_A01_02	2.86	17.13	0.18	22.49	0.40
11	20_A01_03	2.90	18.23	0.21	23.59	0.40
12	20_A01_04	2.90	16.14	0.17	21.49	0.40
13	20_A01_05	2.87	3.34	0.16	8.62	0.40
14	20_A02_01	2.86	5.14	0.22	10.43	0.40
15	20_A02_02	2.89	6.02	0.16	11.32	0.40
16	20_A03_01a	2.87	3.76	0.17	9.05	0.40
17	UWQ-1	2.78	7.07	0.25		
18	UWQ-1	2.72	7.48	0.24		
19	UWQ-1	2.75	7.06	0.28		
20	UWQ-1	2.87	6.85	0.17		
Bracket (5-7, 17-20)		**average**	**7.03**			**2 SD = 0.40**

Sample Mount J.H. 20 (211/27-A2). 12 µm beam, 1.3 nA intensity. May 7, 2008.

21	UWQ-1	1.49	6.73	0.33		
22	UWQ-1	1.47	7.06	0.37		
23	UWQ-1	1.48	6.92	0.40		
24	UWQ-1	1.51	6.78	0.33		
25	20_A02_03	1.50	16.88	0.40	22.25	0.45
30	20_A02_08	1.42	15.31	0.43	20.68	0.45
32	20_A02_010	1.49	14.67	0.35	20.04	0.45
35	20_A02_013	1.49	15.62	0.32	20.99	0.45
36	UWQ-1	1.48	7.16	0.35		
37	UWQ-1	1.47	6.94	0.28		
38	UWQ-1	1.47	7.44	0.33		
39	UWQ-1	1.45	7.00	0.35		
Bracket (21-24, 36-39)		**average**	**7.00**			**2 SD = 0.45**
40	20_A03_01	1.43	16.92	0.45	22.24	0.34
41	20_A03_02	1.44	17.44	0.56	22.75	0.34
42	20_A03_03	1.52	16.32	0.29	21.63	0.34
43	20_A03_04	1.50	15.12	0.27	20.43	0.34
45	20_A03_06	1.51	15.28	0.37	20.59	0.34
46	20_A03_07	1.50	15.09	0.29	20.40	0.34
47	20_A03_08	1.50	17.27	0.38	22.59	0.34

Analyses #	Sample	^{16}O cps x10^9	$\delta^{18}O$ RAW	2 SE[a)]	$\delta^{18}O$ VSMOW	2 SD[b)]
48	20_A03_09	1.51	16.80	0.33	22.11	0.34
49	20_A03_10	1.49	16.47	0.39	21.79	0.34
50	20_A03_11	1.49	17.41	0.32	22.73	0.34
51	20_A03_12	1.48	15.88	0.31	21.19	0.34
52	20_A03_13	1.49	17.71	0.41	23.02	0.34
53	20_A03_14	1.50	17.18	0.35	22.49	0.34
54	20_A03_15	1.50	17.16	0.45	22.48	0.34
55	UWQ-1	1.50	7.05	0.36		
56	UWQ-1	1.51	7.07	0.33		
57	UWQ-1	1.51	6.89	0.32		
58	UWQ-1	1.51	6.99	0.28		
Bracket (36-39, 55-58)		**average**	**7.07**			**2 SD = 0.34**
59	20_A03_16	1.48	5.49	0.39	10.82	0.28
60	20_A03_17	1.50	5.94	0.48	11.28	0.28
61	20_A09_01	1.53	4.03	0.28	9.36	0.28
62	20_A09_02	1.52	17.09	0.30	22.49	0.28
63	20_A09_03	1.55	16.76	0.29	22.15	0.28
64	20_A09_04	1.52	16.45	0.36	21.85	0.28
65	20_A09_05	1.55	16.15	0.33	21.55	0.28
66	20_A09_06	1.54	15.18	0.34	20.56	0.28
67	20_A09_07	1.55	14.97	0.20	20.36	0.28
68	20_A09_08	1.54	16.36	0.34	21.75	0.28
69	20_A09_09	1.55	16.49	0.43	21.88	0.28
70	20_A09_010	1.54	15.53	0.34	20.92	0.28
71	UWQ-1	1.53	7.02	0.42		
72	UWQ-1	1.53	6.76	0.37		
73	UWQ-1	1.53	6.90	0.26		
74	UWQ-1	1.54	7.22	0.35		
Bracket (55-58, 71-74)		**average**	**6.99**			**2 SD = 0.28**

Sample Mount J.H. 19 (211/27-A2). 12 µm beam. May 7, 2008.

75	UWQ-1	1.53	7.04	0.34		
76	UWQ-1	1.53	7.00	0.28		
77	UWQ-1	1.55	6.64	0.32		
78	UWQ-1	1.55	6.55	0.28		
79	19_A02_01	1.55	4.54	0.28	10.17	0.44
80	19_A02_02	1.55	11.83	0.29	17.50	0.44
81	19_A02_03	1.54	17.58	0.33	23.28	0.44
82	19_A02_04	1.55	17.44	0.29	23.14	0.44
83	19_A02_05	1.55	16.36	0.44	22.06	0.44
84	19_A02_06	1.52	16.47	0.24	22.16	0.44
85	19_A02_07	1.51	16.15	0.38	21.84	0.44
86	19_A02_08	1.51	20.55	0.39	26.27	0.44

Analyses #	Sample	^{16}O cps x10^9	$\delta^{18}O$ RAW	2 SE[a)]	$\delta^{18}O$ VSMOW	2 SD[b)]
87	19_A02_09	1.54	16.46	1.12	22.15	0.44
88	19_A02_010	1.55	17.24	0.34	22.94	0.44
89	19_A02_011	1.60	11.33	0.31	17.00	0.44
90	19_A02_012	1.55	4.09	0.41	9.71	0.44
91	19_A02_013	1.54	18.05	0.32	23.75	0.44
92	19_A02_014	1.53	16.33	0.27	22.03	0.44
93	19_A02_015	1.55	17.79	0.36	23.49	0.44
94	19_A02_016	1.54	16.28	0.29	21.98	0.44
95	UWQ-1	1.55	6.57	0.30		
96	UWQ-1	1.56	6.58	0.33		
97	UWQ-1	1.54	6.71	0.43		
98	UWQ-1	1.55	6.44	0.46		
Bracket (75-78, 95-98)		**average**	**6.69**			**2 SD = 0.44**
101	19_A05_01	1.52	16.90	0.32	22.73	0.32
102	19_A05_02	1.53	15.86	0.26	21.68	0.32
103	19_A05_03	1.53	4.27	0.31	10.02	0.32
104	19_A05_04	1.56	15.01	0.32	20.82	0.32
105	19_A05_05	1.55	15.42	0.32	21.24	0.32
106	19_A05_06	1.55	15.97	0.30	21.79	0.32
107	19_A05_07	1.55	16.86	0.31	22.68	0.32
108	19_A05_08	1.55	17.38	0.29	23.21	0.32
109	19_A05_09	1.55	4.90	0.34	10.66	0.32
110	19_A05_10	1.54	16.37	0.41	22.20	0.32
111	19_A07_01	1.55	15.80	0.33	21.62	0.32
112	19_A07_02	1.52	16.52	0.29	22.34	0.32
113	19_A07_03	1.54	6.66	0.26	12.42	0.32
114	19_A07_04	1.55	9.20	0.24	14.98	0.32
115	19_A07_05	1.55	6.16	0.44	11.92	0.32
116	UWQ-1	1.56	6.32	0.37		
117	UWQ-1	1.55	6.47	0.32		
118	UWQ-1	1.57	6.61	0.22		
119	UWQ-1	1.55	6.82	0.25		
Bracket (95-98, 116-119)		**average**	**6.56**	**0.32**		**2 SD = 0.32**
120	19_A02_017	1.55	10.78	0.38	16.45	0.39
121	19_A02_018	1.55	4.85	0.34	10.61	0.39
123	19_A07_06	1.56	16.52	0.37	22.23	0.39
124	19_A07_07	1.58	11.26	0.37	16.93	0.39
125	19_A07_08	1.55	6.87	0.32	12.52	0.39
126	19_A07_09	1.55	4.59	0.32	10.23	0.39
127	19_A07_10	1.55	17.29	0.38	23.00	0.39
128	19_A07_11	1.57	16.60	0.29	22.31	0.39
129	19_A07_12	1.56	16.64	0.33	22.34	0.39
130	19_A07_13	1.57	15.60	0.29	21.29	0.39
131	19_A07_14	1.57	15.86	0.36	21.56	0.39

Analyses #	Sample	^{16}O cps x10^9	$\delta^{18}O$ RAW	2 SE[a)]	$\delta^{18}O$ VSMOW	2 SD[b)]
132	19_A07_15	1.56	15.63	0.27	21.32	0.39
133	19_A07_16	1.55	16.29	0.30	21.99	0.39
134	19_A07_17	1.57	17.49	0.33	23.19	0.39
135	19_A07_18	1.57	16.93	0.32	22.64	0.39
136	19_A07_19	1.58	16.17	0.36	21.87	0.39
137	19_A07_20	1.58	15.01	0.23	20.70	0.39
138	19_A07_21	1.59	14.37	0.19	20.06	0.39
139	19_A07_22	1.52	15.11	0.40	20.80	0.39
140	19_A07_23	1.63	17.68	0.27	23.39	0.39
142	UWQ-1	1.60	6.82	0.39		
143	UWQ-1	1.59	6.78	0.28		
144	UWQ-1	1.62	6.79	0.35		
145	UWQ-1	1.59	6.85	0.30		
Bracket (116-119, 142-145)			**average**	**6.68**		**2 SD = 0.39**
146	19_A08_01	1.57	14.95	0.39	20.71	0.44
147	19_A08_02	1.58	15.46	0.25	21.22	0.44
148	19_A08_03	1.59	17.46	0.42	23.23	0.44
149	19_A08_04	1.59	7.36	0.39	13.08	0.44
150	19_A08_05	1.58	5.10	0.29	10.80	0.44
151	19_A08_06	1.59	13.66	0.31	19.41	0.44
154	19_A08_09	1.59	15.72	0.28	21.49	0.44
156	19_A08_011	1.58	15.36	0.40	21.12	0.44
157	19_A08_012	1.59	14.98	0.17	20.74	0.44
159	19_A08_014	1.58	11.93	0.34	17.68	0.44
160	19_A08_015	1.58	4.94	0.23	10.65	0.44
162	UWQ-1	1.58	6.34	0.27		
163	UWQ-1	1.58	6.37	0.40		
164	UWQ-1	1.59	6.60	0.42		
165	UWQ-1	1.58	6.41	0.39		
Bracket (142-145, 162-165)			**average**	**6.62**		**2 SD = 0.44**

Sample Mount J.H. 1 (211/11a-3). 12 µm beam. May 7, 2008.

166	UWQ-1	1.59	6.90	0.33		
167	UWQ-1	1.61	6.54	0.31		
168	UWQ-1	1.60	6.91	0.28		
169	UWQ-1	1.59	6.76	0.33		
170	1_A01_01	1.59	12.28	0.50	17.94	0.48
171	1_A01_02	1.59	-0.02	0.34	5.58	0.48
172	1_A01_03	1.60	17.57	0.25	23.26	0.48
176	1_A01_07	1.58	15.52	0.35	21.20	0.48
178	1_A01_09	1.60	15.38	0.19	21.06	0.48
179	1_A01_10	1.60	15.67	0.21	21.36	0.48
180	1_A01_11	1.60	15.40	0.31	21.08	0.48

Analyses #	Sample	^{16}O cps x10^9	$\delta^{18}O$ RAW	2 SE[a)]	$\delta^{18}O$ VSMOW	2 SD[b)]
181	1_A01_12	1.61	15.15	0.40	20.83	0.48
182	UWQ-1	1.61	6.66	0.37		
183	UWQ-1	1.65	6.20	0.24		
184	UWQ-1	1.63	6.89	0.36		
185	UWQ-1	1.63	6.71	0.30		
	Bracket (166-169, 182-185)		**average**	**6.70**		**2 SD = 0.48**
			May 8, 2008			
190	UWQ-1	1.44	7.34	0.44		
191	UWQ-1	1.44	7.53	0.29		
192	UWQ-1	1.43	7.39	0.38		
193	UWQ-1	1.44	7.38	0.39		
194	1_A01_13	1.44	17.13	0.37	22.18	0.23
195	1_A01_14	1.44	18.31	0.32	23.37	0.23
196	1_A01_15	1.46	8.88	0.43	13.89	0.23
197	1_A02b_01	1.44	16.39	0.32	21.43	0.23
202	UWQ-1	1.45	7.28	0.37		
203	UWQ-1	1.45	7.16	0.38		
204	UWQ-1	1.45	7.31	0.44		
205	UWQ-1	1.44	7.24	0.31		
	Bracket (190-193, 202-205)		**average**	**7.33**		**2 SD = 0.23**
206	1_A02b_06	1.45	16.14	0.35	21.22	0.15
207	1_A02b_07	1.44	16.62	0.32	21.71	0.15
208	1_A02b_08	1.45	18.33	0.23	23.43	0.15
209	1_A02b_08	1.44	8.77	0.43	13.82	0.15
210	1_A02b_09	1.45	14.85	0.42	19.93	0.15
211	1_A02b_10	1.44	17.48	0.31	22.57	0.15
212	1_A02b_11	1.45	8.15	0.38	13.2	0.15
213	1_A02b_12	1.44	15.70	0.26	20.78	0.15
214	1_A02b_13	1.44	16.27	0.32	21.36	0.15
215	1_A02b_14	1.46	16.16	0.38	21.24	0.15
216	1_A02b_15	1.46	16.49	0.35	21.57	0.15
217	1_A02b_16	1.45	5.03	0.35	10.06	0.15
218	1_A02b_17	1.47	15.39	0.49	20.47	0.15
220	1_A02b_20	1.46	16.01	0.50	21.10	0.15
221	1_A02b_21	1.44	15.18	0.41	20.26	0.15
222	UWQ-1	1.47	7.31	0.32		
223	UWQ-1	1.48	7.39	0.35		
226	UWQ-1	1.45	7.38	0.30		
227	UWQ-1	1.45	7.26	0.40		
	Bracket (202-205, 222-227)		**average**	**7.29**		**2 SD = 0.15**
228	1_A02b_21	1.47	15.21	0.37	20.26	0.40
229	1_A02b_22	1.47	14.46	0.42	19.50	0.40
230	1_A02b_23	1.47	16.58	0.38	21.63	0.40

Analyses #	Sample	^{16}O cps x10^9	$\delta^{18}O$ RAW	2 SE[a)]	$\delta^{18}O$ VSMOW	2 SD[b)]
231	1_A02b_24	1.48	15.67	0.29	20.72	0.40
233	1_A02b_25	1.47	6.39	0.43	11.39	0.40
234	1_A02c_01	1.46	4.31	0.34	9.30	0.40
235	1_A02c_02	1.48	16.33	0.34	21.38	0.40
236	1_A02c_03	1.49	16.70	0.37	21.75	0.40
237	1_A02c_04	1.46	16.53	0.41	21.58	0.40
238	1_A02c_05	1.46	5.71	0.39	10.71	0.40
239	1_A02c_06	1.45	5.88	0.32	10.88	0.40
240	1_A02c_07	1.44	19.46	0.46	24.53	0.40
241	1_A02c_08	1.45	17.08	0.40	22.13	0.40
242	1_A02c_09	1.45	4.59	0.39	9.58	0.40
243	UWQ-1	1.46	7.19	0.39		
244	UWQ-1	1.44	7.01	0.35		
245	UWQ-1	1.46	7.35	0.35		
246	UWQ-1	1.47	7.72	0.24		
Bracket (222-227, 243-246)			**average**	**7.32**		**2 SD = 0.40**

[a)] Internal error of a single analysis calculated as the standard error of the mean of 20 cycles (25 cycles in Session II) in 2σ

[b)] 2 SD of the bracketing standard analysis

Table 2. Oxygen Isotope Analyses of Quartz Overgrowths at WiscSIMS 2009

Analyses #	Sample	^{16}O cps x10^9	$\delta^{18}O$ RAW	2 SE[a)]	$\delta^{18}O$ VSMOW	2 SD[b)]
Sample Mount NS19 (211/27-A2). 2 µm beam. June 3, 2009.						
26	UWQ-1	3.44	-0.74	0.57		
27	UWQ-1	3.21	0.02	0.55		
28	UWQ-1	3.21	-0.27	0.51		
29	UWQ-1	3.17	-0.01	0.48		
30	NS19. 2_A5_1	3.12	8.69	0.63		
31	NS19. 2_A5_2	3.08	9.08	0.51	21.17	0.83
32	NS19. 2_A5_3	3.05	9.52	0.47	21.56	0.83
33	NS19. 2_A5_4	2.97	9.43	0.62	22.01	0.83
34	NS19. 2_A5_5	3.02	9.77	0.59	21.92	0.83
35	NS19. 2_A5_6	3.02	9.17	0.54	22.26	0.83
36	NS19. 2_A5_7	2.97	9.41	0.76	21.66	0.83
37	NS19. 2_A5_8	3.00	9.64	0.69	21.90	0.83
38	NS19. 2_A5_9	2.93	8.86	0.67	21.34	0.83
39	NS19. 2_A5_10	3.05	8.99	0.70	21.47	0.83
40	UWQ-1	3.17	0.26	0.73		
41	UWQ-1	3.17	-0.41	0.62		
42	UWQ-1	3.17	0.43	0.55		
43	UWQ-1	3.16	0.41	0.46		
Bracket (26-29, 40-43)		**average**	**-0.04**			**2 SD = 0.83**
44	NS19 .2_A5_11	3.18	9.27	0.67	21.42	0.65
45	NS19 .2_A5_12	3.16	9.59	0.65	21.74	0.65
46	NS19 .2_A5_13	3.14	10.20	0.56	22.37	0.65
47	NS19 .2_A5_14	3.16	10.23	0.45	22.39	0.65
48	NS19 .2_A5_15	3.12	9.65	0.45	21.81	0.65
49	NS19 .2_A5_16	3.10	9.26	0.60	21.41	0.65
50	NS19 .2_A5_17	3.10	10.12	0.45	22.28	0.65
51	NS19 .2_A5_18	3.09	9.53	0.62	21.68	0.65
52	NS19 .2_A5_19	3.10	9.86	0.54	22.02	0.65
53	NS19 .2_A5_20	3.13	10.23	0.55	22.39	0.65
54	UWQ-1	3.02	0.31	0.62		
55	UWQ-1	3.02	0.70	0.51		
56	UWQ-1	2.97	0.15	0.48		
57	UWQ-1	2.98	0.44	0.51		
Bracket (40-43, 54-57)		**average**	**0.29**			**2 SD = 0.65**
58	NS19 .2_A5_21	2.96	10.95	0.57	23.11	0.38
59	NS19 .2_A5_22	3.00	10.57	0.82	22.73	0.38
60	NS19 .2_A5_23	2.96	11.30	0.41	23.46	0.38

Analyses #	Sample	^{16}O cps x10^9	$\delta^{18}O$ RAW	2 SE[a)]	$\delta^{18}O$ VSMOW	2 SD[b)]
61	NS19 .2_A5_24	2.98	10.59	0.65	22.74	0.38
62	NS19 .2_A5_25	2.90	10.95	0.47	23.11	0.38
63	NS19 .2_A5_26	2.93	10.77	0.58	22.93	0.38
64	NS19 .2_A5_27	2.88	11.01	0.64	23.16	0.38
65	NS19 .2_A5_28	2.89	10.62	0.44	22.77	0.38
66	NS19 .2_A5_29	2.80	12.22	0.76	24.39	0.38
67	NS19 .2_A5_30	2.87	14.73	0.58	26.94	0.38
68	UWQ-1	3.02	0.13	0.65		
69	UWQ-1	3.06	0.15	0.80		
70	UWQ-1	3.05	0.30	0.44		
71	UWQ-1	3.05	0.24	0.63		
	Bracket (54-57, 68-71)		**average**	**0.30**		**2 SD = 0.38**
72	NS19 .2_A5_31	3.02	-0.42	0.65	11.58	0.55
73	NS19 .2_A5_32	3.05	-0.78	0.69	11.22	0.55
74	NS19 .2_A5_33	3.02	-1.22	0.68	10.77	0.55
75	NS19 .2_A5_34	3.02	-0.95	0.53	11.05	0.55
76	NS19 .2_A5_35	2.90	-1.24	0.66	10.75	0.55
77	NS19 .2_A5_36	2.93	-1.01	0.72	10.99	0.55
78	NS19 .2_A5_37	2.96	10.68	0.52	22.82	0.55
79	NS19 .2_A5_38	2.97	10.70	0.71	22.84	0.55
80	NS19 .2_A5_39	2.97	12.39	0.51	24.54	0.55
81	NS19 .2_A5_40	2.81	15.50	0.72	27.70	0.55
82	UWQ-1	3.01	0.71	0.48		
83	UWQ-1	2.99	-0.06	0.62		
84	UWQ-1	2.95	0.71	0.58		
85	UWQ-1	2.93	0.36	0.61		
	Bracket (68-71, 82-85)		**average**	**0.32**		**2 SD = 0.55**
86	NS19 .2_A5_41	2.91	15.24	0.55	27.57	0.96
87	NS19 .2_A5_42	2.91	14.67	0.50	27.00	0.96
88	NS19 .2_A5_43	2.94	12.94	0.61	25.25	0.96
89	NS19 .2_A5_44	2.83	8.63	0.64	20.88	0.96
91	NS19 .2_A5_46	2.80	9.21	0.58	21.47	0.96
92	NS19 .2_A5_47	2.84	9.06	0.59	21.32	0.96
93	NS19 .2_A5_48	2.85	10.26	0.54	22.53	0.96
94	NS19 .2_A5_49	2.85	10.08	0.62	22.35	0.96
95	UWQ-1	3.02	0.15	0.53		
96	UWQ-1	3.01	0.33	0.55		
97	UWQ-1	3.02	-0.78	0.48		
98	UWQ-1	3.04	0.03	0.75		
	Bracket (82-85, 95-98)		**average**	**0.18**		**2 SD = 0.96**

[a)] Internal error of a single analysis calculated as the standard error of the mean of 20 cycles (25 cycles in Session II) in 2σ

[b)] 2 SD of the bracketing standard analysis

Pit Analysis

After ion microprobe analysis a combination of Scanning Electron (SE), Back Scattered (BSE) and Cathodoluminescene (SEM-CL) microscopy was used to relocate and characterizes each individual pit. Figures 1 to 11 below give a full account of how each pit has been interpreted with reasoning for each analyses inclusion or exclusion from this study.

Table 3. Key to pit interpretation

Material Type	Pit Color
Detrital	Black
Overgrowth	White
Mixed	Red
Low Yield	Yellow
Pit overlap	Green
Sample cracked	Pink
Unknown detrital host (NS20 Area 2)	Gold

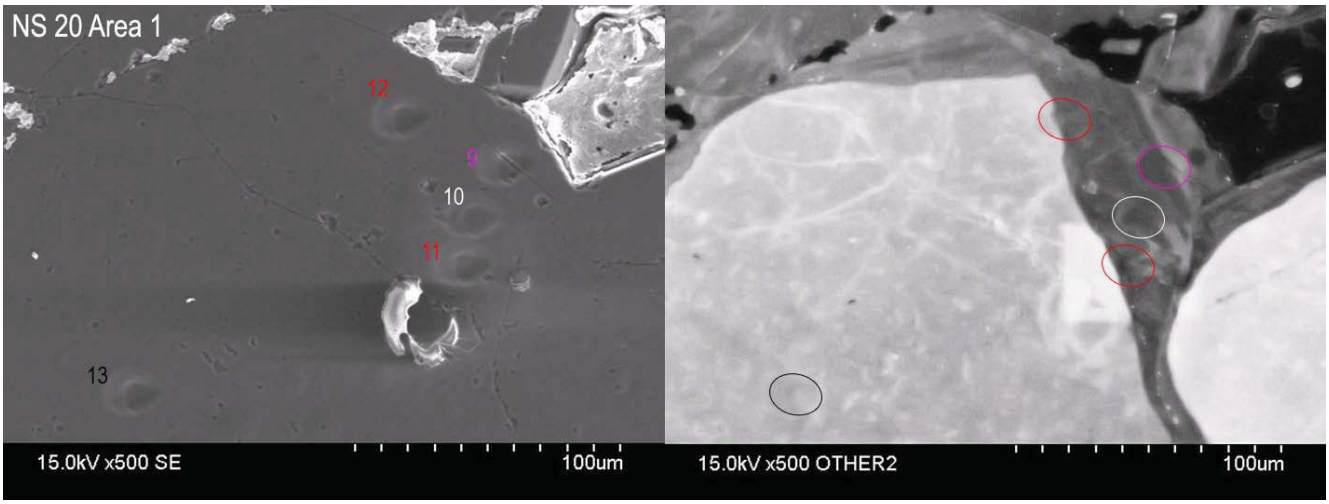

Figure 1. SE (left) and SEM-CL image (right) of sample NS20 Area 1. All analyses have been performed with a 20 µm pit.

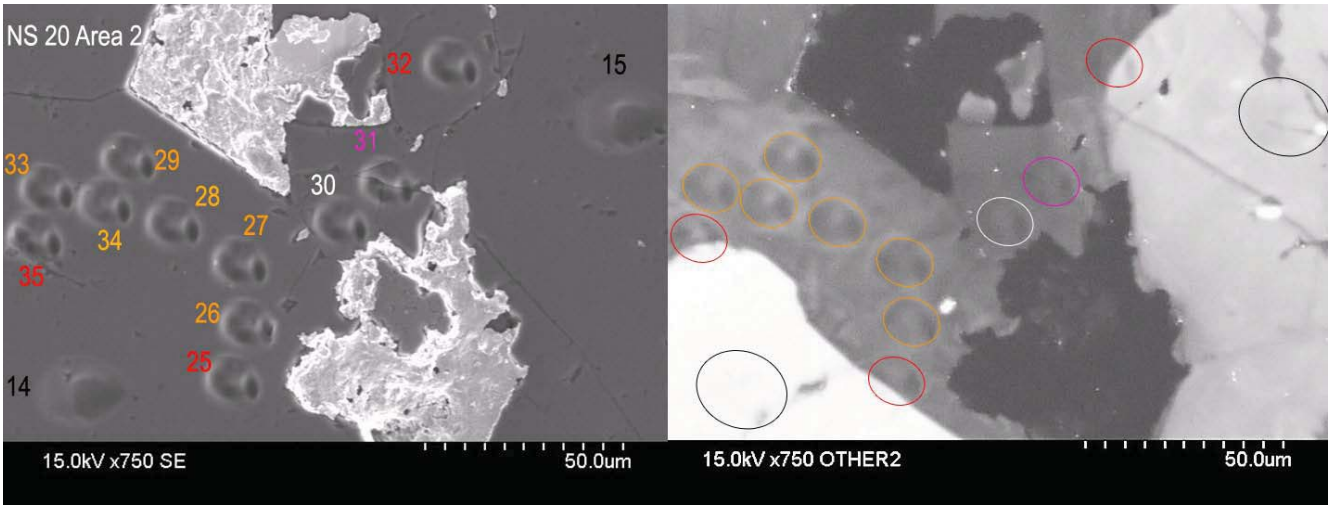

Figure 2a. SE (left) and SEM-CL image (right) of sample NS20 Area 2. Pits 14 and 15 are 20 µm all other analyses have been performed at 12 µm.

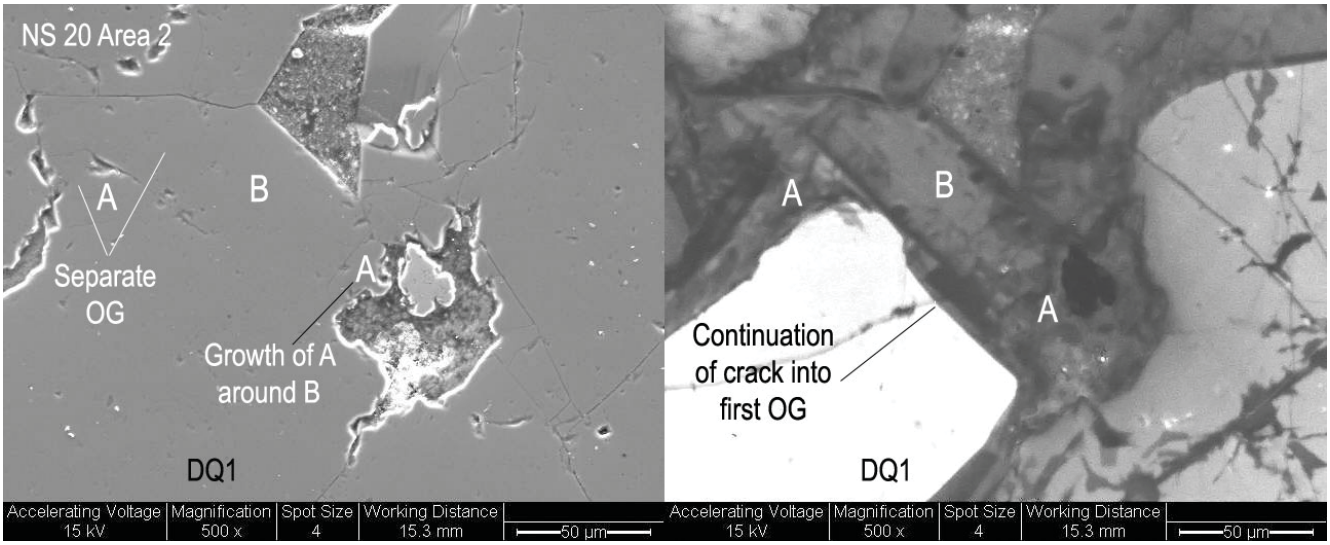

Figure 2b. BSE (left) and SEM-CL image (right) of sample NS20 Area 2 before isotope analysis.

Around detrital quartz 1 (DQ1) appear two distinct CL regions (Fig 2a, clearer in 2b). Close to DQ1 appears a thin overgrowth layer (A), further into the pore space is a much thicker region of overgrowth material (B). Although this overgrowth appears fairly continuous in both the SE (Fig. 2a) and the BSE (Fig. 2b) images a small separation line can be seen within the authigenic material. When imposed on the SEM-CL images this line appears to separate region A from B. A two phase precipitation is unlikely in this instance as area A appears to precipitate around B. The distinct lack of relationship between the two regions is highlighted by the continuation of a small crack that runs through DQ1 and area A but is not seen in area B. We have interpreted area B as originating from an unseen detrital grain that lies below DQ1. During diagenesis the quartz cement has precipitated up into the pore space from this unseen grain forming area B, with the overgrowth material related to DQ1 (A) precipitating independently. As it is unclear which detrital grain is hosting overgrowth B data from this area has been disregarded as indicated by the gold circles.

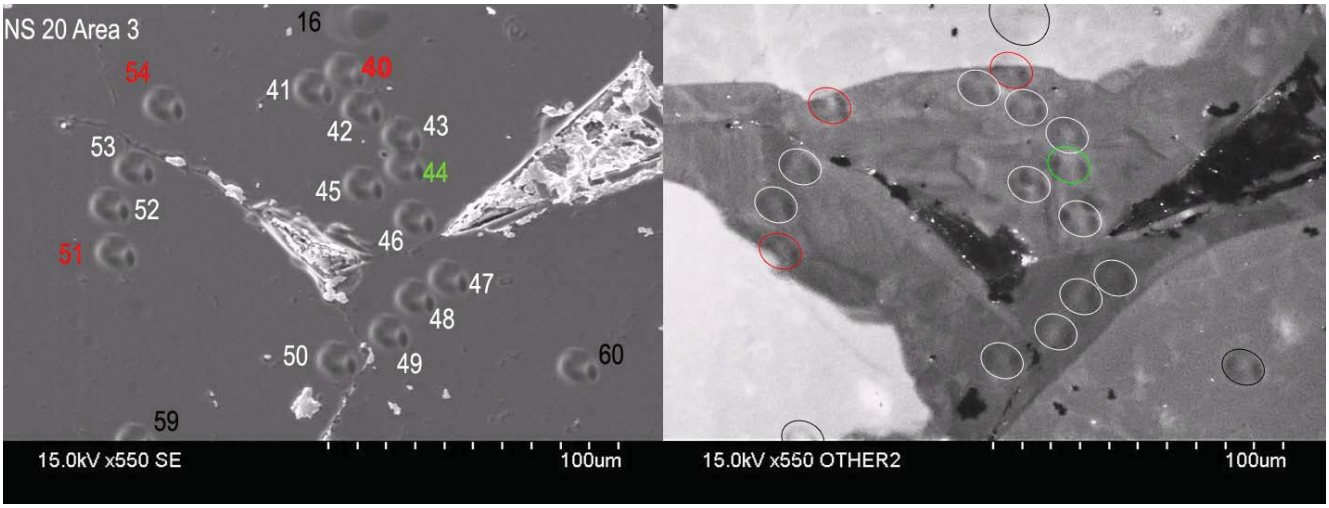

Figure 3. SE (left) and SEM-CL image (right) of sample NS20 Area 3. Pit 16 = 20 µm all other analyses have been performed at 12 µm.

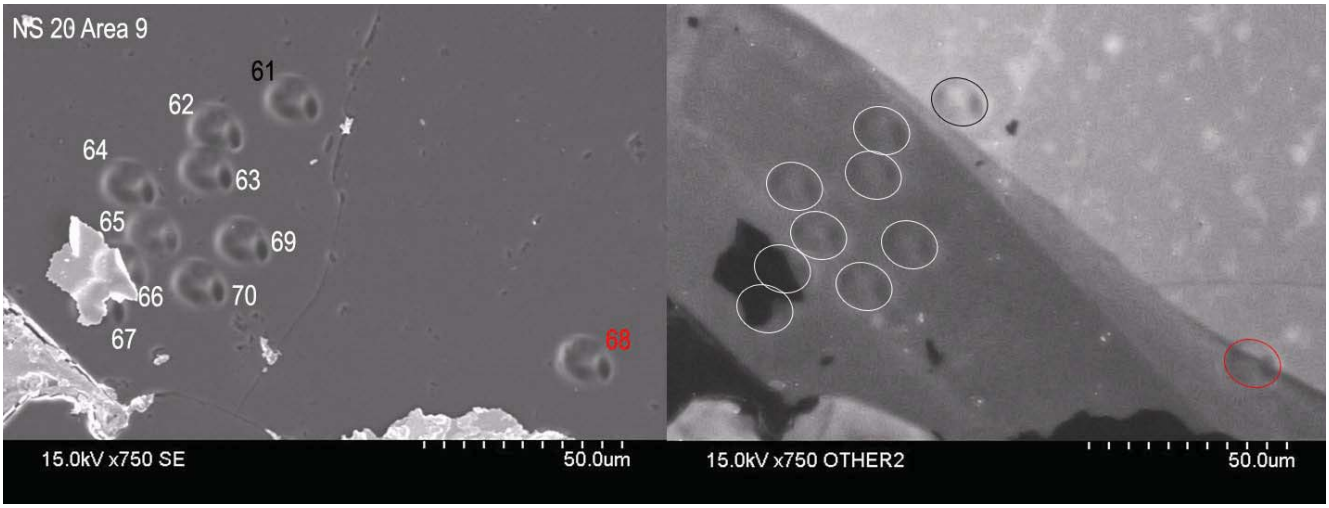

Figure 4. SE (left) and SEM-CL image (right) of sample NS20 Area 9. All analyses have been performed with a 12 µm pit.

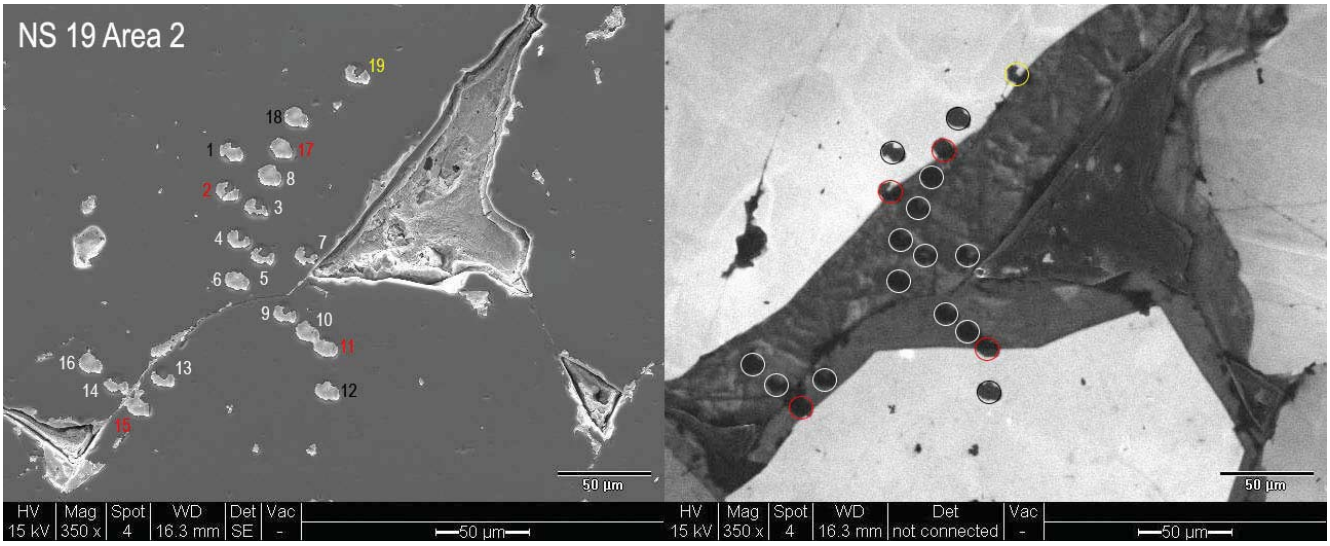

Figure 5. SE (left) and SEM-CL image (right) of sample NS19 Area 2. All analyses have been performed with a 12 µm pit.

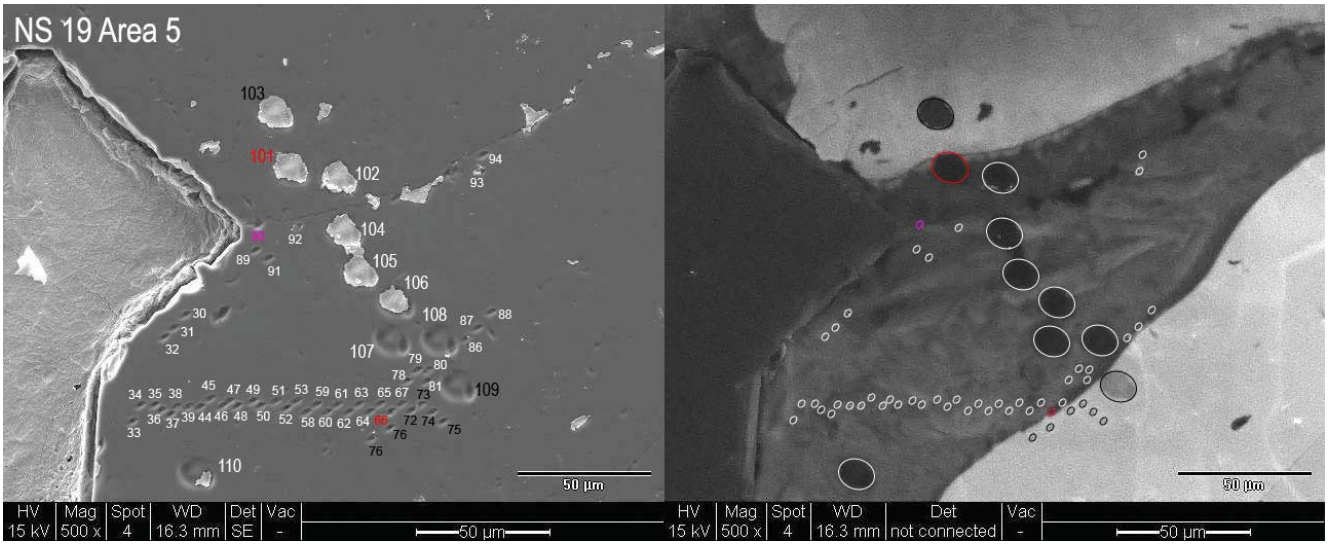

Figure 6. SE (left) and SEM-CL image (right) of sample NS19 Area 5. The larger 12 µm pits were performed in 2008 (pits, 101-110). A second analysis session was performed in 2009 using the smaller 2 µm pit (smaller numbers 30-94).

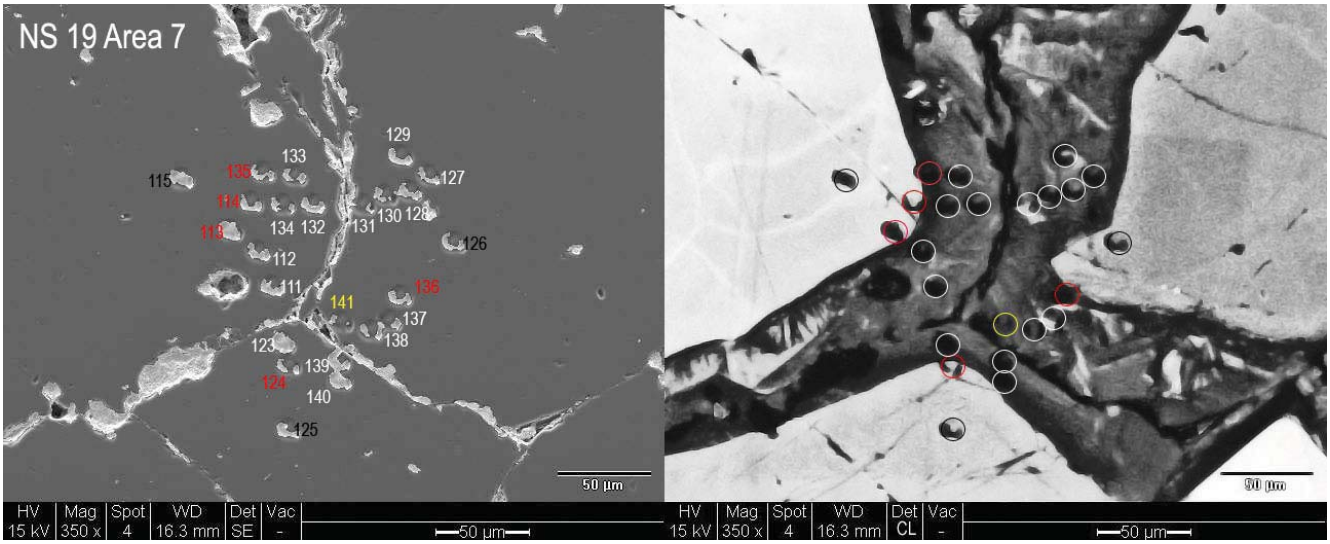

Figure 7. SE (left) and SEM-CL image (right) of sample NS19 Area 7. All analyses have been performed with a 12 µm pit.

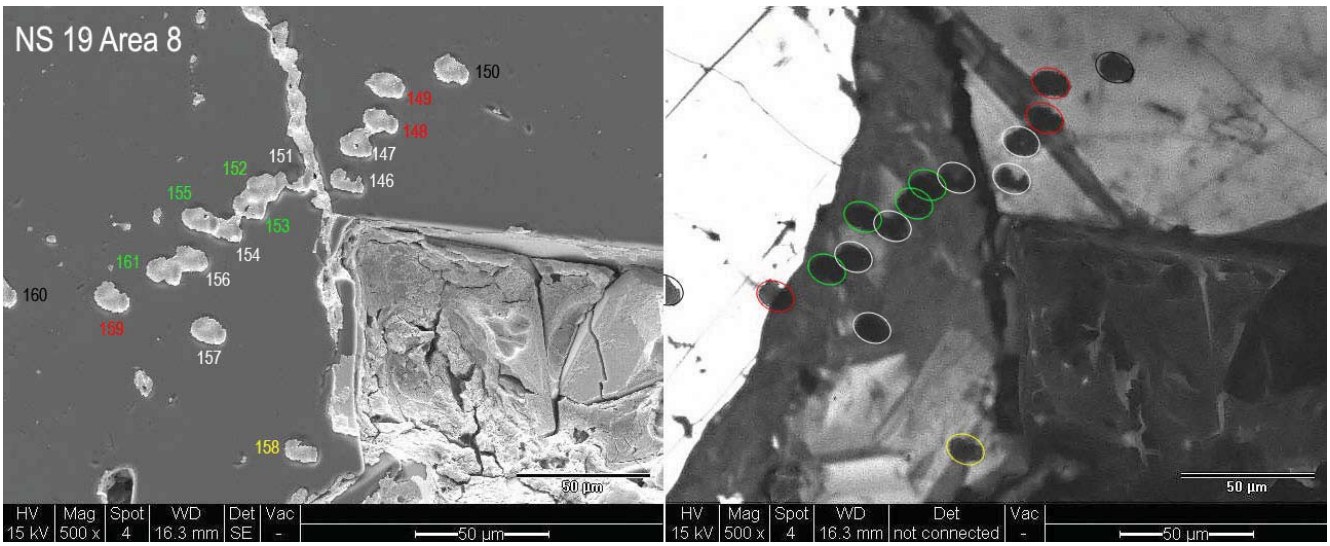

Figure 8. SE (left) and SEM-CL image (right) of sample NS19 Area 8. All analyses have been performed with a 12 µm pit.

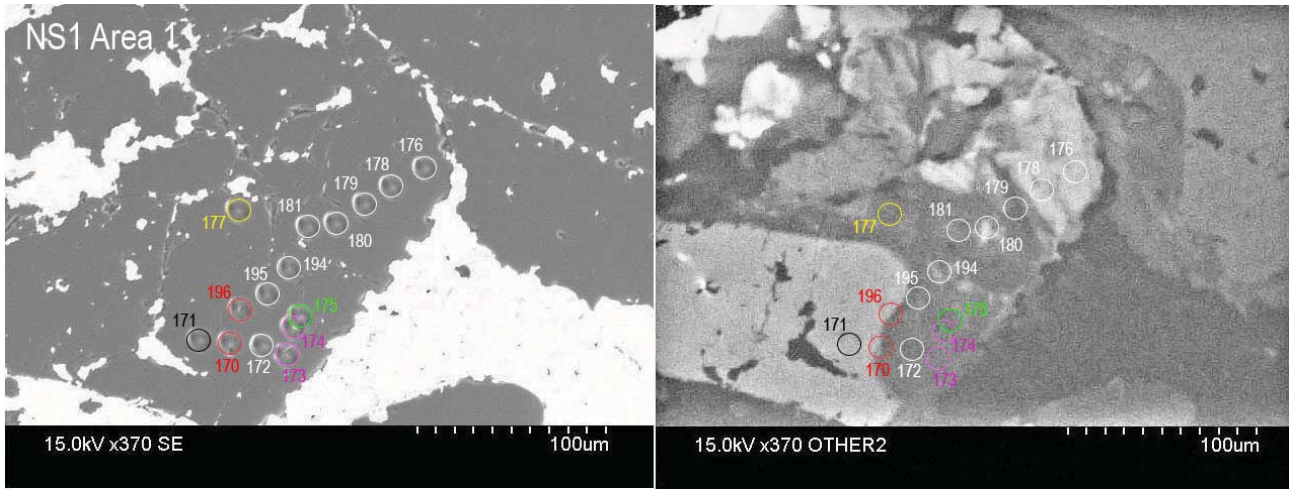

Figure 9. SE (left) and SEM-CL image (right) of sample NS1 Area 1. All analyses have been performed with a 12 µm pit.

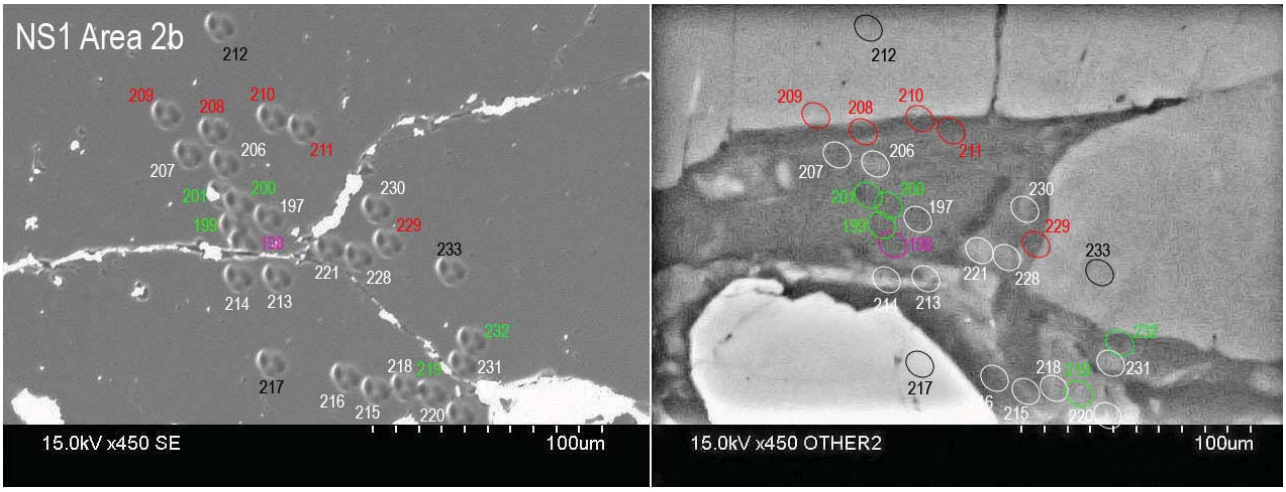

Figure 10. SE (left) and SEM-CL image (right) of sample NS1 Area 2b. All analyses have been performed with a 12 µm pit.

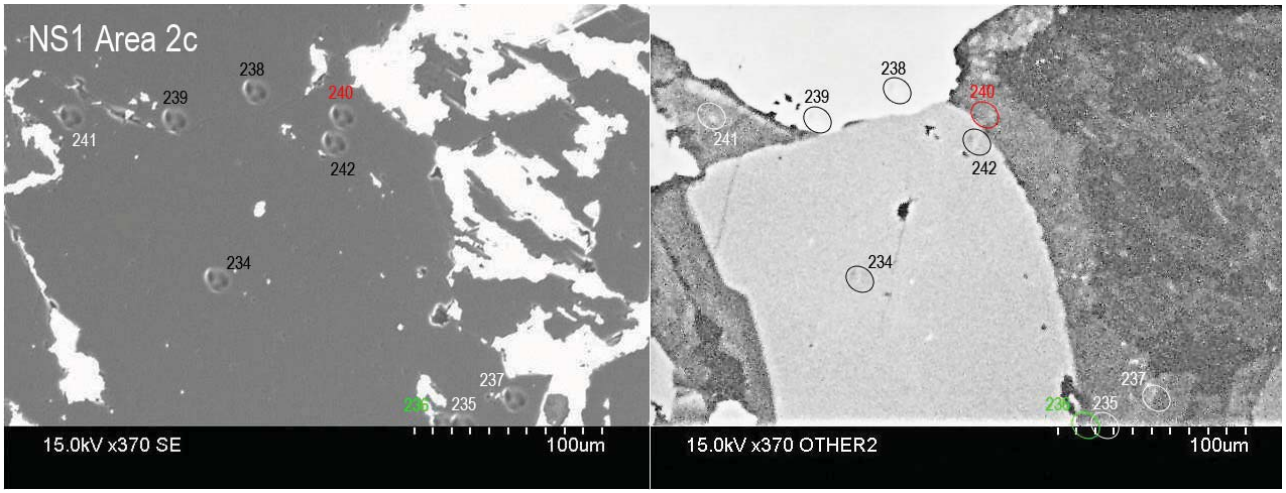

Figure 11. SE (left) and SEM-CL image (right) of sample NS1 Area 2c. All analyses have been performed with a 12 µm pit.

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