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APPENDIX A - Microthermometry Data

Data is interpreted and discussed in Chapter 2.

Teu	Eutectic temperature / first melting temperature
Tm (aq)	Final melting temperature of ice
Tm (CO_2)	Final melting temperature of CO_2
Th V (CO_2)	Homogenisation temperature of CO_2 ($L \rightarrow V$)
ThV	Homogenisation temperature of vapour phase
Td_{Syl}	Dissolution temperature of Sylvite daughter mineral
Td_{Hal}	Dissolution temperature of Halite daughter mineral
Td_{FPS}	Dissolution temperature of Ferropyrosmalite daughter mineral
Td_{Cal}	Dissolution temperature of Calcite daughter mineral
Td_{Ukn}	Dissolution temperature of unknown daughter mineral/s
TD	Decrepitation temperature
Th	Final homogenisation temperature

MS INCLUSIONS

DATA APPENDICES HAVE BEEN REMOVED

LVD INCLUSIONS

DATA APPENDICES HAVE BEEN REMOVED

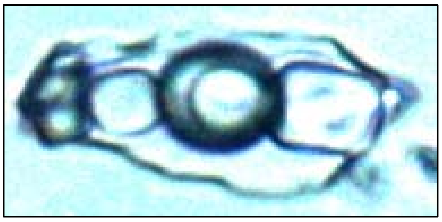
CB INCLUSIONS

DATA APPENDICES HAVE BEEN REMOVED

CO_2 INCLUSIONS

DATA APPENDICES HAVE BEEN REMOVED

40_M12: CB Inclusion



Inclusion Volume:	754 μm^3		
Vapour Volume:	127.8 μm^3		
Vapour Volume %:	16.95		
CO_2 : 95%	CO_2 mass (x10^{-12}g):	103.2	
N_2 : 5%	N_2 mass (x10^{-12}g):	5.4	

Daughter Phases:

Species	**Density (g/cm^3)**	**Volume (μm^3)**	**Mass (x10-^{12}g)**
Halite	2.17	125.0	271.3
Sylvite	1.99	44.7	89.0
$CaCO_3$	2.72	54.6	148.5
	Total	224.3	
	Daughter Vol %:	29.7	

Liquid Volume:	401.9 μm^3	**Liquid Mass (x10-^{12}g):**	602.9
Liquid Volume %:	62.4		(for ρ = 1.5 g/cm^3)

Solute and solvent masses

		(x10^{-12}g)	wt%
mass NaCl	=271.3 + (0.0062 x 602.9)	308.63	30.81
mass KCl	=89 + (0.0322 x 602.9)	126.33	12.61
mass $FeCl_2$	=(0.1 x 602.9)	60.29	6.02
mass $CaCO_3$	=148.5	148.51	14.83
mass H_20	=(0.4134 x 602.9)	249.22	24.88
mass CO_2	=103.2	103.20	10.30
mass N_2	=5.4	5.43	0.54
TOTAL		1001.60	100.00

Fluid Composition:

	(x10^{-12}g)		(x10^{-12}g)
mass Na^+	121.41	mass Cl^-	187.22
mass K^+	66.26	mass Cl^-	60.07
mass Fe^{2+}	26.56	mass Cl^-	33.72
mass Ca^{2+}	59.47		
		TOTAL Cl^-	281.02
mass CO_3^-	89.04		
mass CO_2	103.20		
mass N_2	5.43		
mass H_20	2057.73		
TOTAL	2810.11		

	Molarity
m Na^+	**2.83**
m K^+	**0.95**
m Fe^{2+}	**0.44**
m Ca^{2+}	**2.97**
m Cl^-	**12.67**
m CO_3^-	**0.46**
m CO_2	**5.7**
m N_2	**0.24**
m H_20	**16.16**

45.77 Wt % Salts

852_1_1: MS Inclusion

Inclusion Volume:	584.95	μm^3
Vapour Volume:	53.2	μm^3
Vapour Volume %:	9.09	

Daughter Phases:

Species	Density (g/cm^3)	Volume (μm^3)	Mass ($x10^{-12}g$)
Halite	2.17	296.3	643.0
Sylvite	1.99	64.0	127.4
Ferropyrosmalite	3.12	34.7	108.3
	Total	395.0	
	Daughter Vol %:	67.5	

Liquid Volume:	136.8 μm^3	**Liquid Mass ($x10^{-12}g$):**	205.1
Liquid Volume %:	23.38		(for ρ = 1.5 g/cm^3)

Solute and solvent masses

		($x10^{-12}g$)	wt%
mass NaCl	=643 + (0.0062 x 205.1)	644.24	64.32
mass KCl	=127.4 + (0.0322 x 205.1)	133.97	13.38
mass $FeCl_2$	=(0.1 x 205.1)	20.51	2.05
mass $CaCl_2$	=(0.4482 x 205.1)	91.94	9.18
mass H_20	=(0.0803 x 108.3) + (0.4134 x 205.1)	93.49	9.33
mass FeO	=(0.4908 x 108.3)	53.14	5.31
mass MnO	=(0.0471 x 108.3)	5.10	0.51
mass MgO	=(0.0038 x 108.3)	0.41	0.04
mass SiO2	=(0.3421 x 108.3)	37.04	3.70
Mass Cl	=(0.0404 x 108.3)	4.37	0.44
TOTAL		1084.21	108.25

Fluid Composition:

	($x10^{-12}g$)		($x10^{-12}g$)
mass Na^+	253.43	mass Cl^-	390.82
mass K^+	70.26	mass Cl^-	63.70
mass Fe^{2+}	50.34	mass Cl^-	11.47
mass Ca^{2+}	33.21	mass Cl^-	58.73
mass Mg^{2+}	0.25		
mass Mn^{2+}	3.95		
mass Si^{4+}	17.31		
		TOTAL Cl^-	529.10
mass O	32.87		
mass H_20	93.49		
TOTAL	1084.21		

	Molarity
m Na^+	**13.27**
m K^+	**1.77**
m Fe^{2+}	**0.86**
m Ca^{2+}	**0.79**
m Mg^{2+}	**0.01**
m Mn^{2+}	**0.07**
m Si^{4+}	**0.58**
m Cl^-	**26.88**
m O	**1.95**
m H_20	**5.24**

81.07 Wt % Salts

15_1_3: MS Inclusion

Inclusion Volume:	154.6 μm^3
Vapour Volume:	4.2 μm^3
Vapour Volume %:	2.72

Daughter Phases:

Species	**Density (g/cm^3)**	**Volume (μm^3)**	**Mass ($x10^{-12}g$)**
Halite	2.17	64.0	138.9
Sylvite	1.99	9.3	18.5
Ferropyrosmalite	3.12	6.8	21.1
	Total	80.1	
	Daughter Vol %:	51.8	

Liquid Volume:	70.4 μm^3	**Liquid Mass ($x10^{-12}g$):**	105.5
Liquid Volume %:	45.5		(for ρ = 1.5 g/cm^3)

Solute and solvent masses

		($x10^{-12}g$)	wt%
mass NaCl	=138.9 + (0.0062 x 105.5)	139.53	13.93
mass KCl	=18.5 + (0.0322 x 105.5)	21.90	2.19
mass $FeCl_2$	=(0.1 x 105.5)	61.35	6.13
mass $CaCl_2$	=(0.4482 x 105.5)	47.30	4.72
mass H_20	=(0.0803 x 21.1) + (0.4134 x 105.5)	45.32	4.52
mass FeO	=(0.4908 x 105.5)	51.79	5.17
mass MnO	=(0.0471 x 105.5)	4.97	0.50
mass MgO	=(0.0038 x 105.5)	0.40	0.04
mass SiO_2	=(0.3421 x 105.5)	36.10	3.60
Mass Cl	=(0.0404 x 105.5)	4.26	0.43
TOTAL		412.93	41.23

Fluid Composition:

	($x10^{-12}g$)		($x10^{-12}g$)
mass Na^+	54.89	mass Cl^-	84.65
mass K^+	11.49	mass Cl^-	10.42
mass Fe^{2+}	67.29	mass Cl^-	34.32
mass Ca^{2+}	17.08	mass Cl^-	30.21
mass Mg^{2+}	0.24		
mass Mn^{2+}	3.85		
mass Si^{4+}	16.87		
		TOTAL Cl^-	163.86
mass O	32.04		
mass H_20	45.32		
TOTAL	412.93		

	Molarity
m Na^+	**6.67**
m K^+	**0.73**
m Fe^{2+}	**3.42**
m Ca^{2+}	**1.08**
m Mg^{2+}	**0.02**
m Mn^{2+}	**0.17**
m Si^{4+}	**1.52**
m Cl^-	**18.56**
m O	**5.26**
m H_20	**6.84**

62.84 Wt % Salts

15_1_15: MS Inclusion

Inclusion Volume:	703.6 μm^3
Vapour Volume:	68.6 μm^3
Vapour Volume %:	9.75

Daughter Phases:

Species	Density (g/cm^3)	Volume (μm^3)	Mass ($x10^{-12}g$)
Halite	2.17	179.7	389.9
Sylvite	1.99	49.3	98.1
Ferropyrosmalite	3.12	65.5	204.4
	Total	294.5	
	Daughter Vol %:	41.9	

Liquid Volume:	340.5 μm^3	**Liquid Mass ($x10^{-12}g$):**	510.8
Liquid Volume %:	48.4		(for ρ = 1.5 g/cm^3)

Solute and solvent masses

		($x10^{-12}g$)	wt%
mass NaCl	=389.9 + (0.0062 x510.8)	393.12	39.25
mass KCl	=98.1 + (0.0322 x 510.8)	114.55	11.44
mass $FeCl_2$	=(0.1 x 510.8)	51.08	5.10
mass $CaCl_2$	=(0.4482 x 510.8)	228.92	22.86
mass H_20	=(0.0803 x 204.4) + (0.4134 x 510.8)	227.55	22.72
mass FeO	=(0.4908 x 204.4)	250.68	25.03
mass MnO	=(0.0471 x 204.4)	24.06	2.40
mass MgO	=(0.0038 x 204.4)	1.94	0.19
mass SiO2	=(0.3421 x 204.4)	174.73	17.44
Mass Cl	=(0.0404 x 204.4)	20.63	2.06
TOTAL		1487.25	148.49

Fluid Composition:

	($x10^{-12}g$)		($x10^{-12}g$)
mass Na^+	154.64	mass Cl^-	238.47
mass K^+	60.08	mass Cl^-	54.47
mass Fe^{2+}	217.36	mass Cl^-	28.57
mass Ca^{2+}	82.68	mass Cl^-	146.24
mass Mg^{2+}	1.17		
mass Mn^{2+}	18.63		
mass Si^{4+}	81.67		
		TOTAL Cl^-	488.39
mass O	155.07		
mass H_20	227.55		
TOTAL	1487.25		

	Molarity
M Na^+	**5.05**
M K^+	**1.08**
M Fe^{2+}	**3.01**
M Ca^{2+}	**1.47**
M Mg^{2+}	**0.03**
M Mn^{2+}	**0.23**
M Si^{4+}	**2.07**
M Cl^-	**13.79**
M O	**7.28**
M H_20	**10.03**

57.55 Wt % Salts

36B_51: MS Inclusion

Inclusion Volume: 1082.8 μm^3

Vapour Volume: 67.7 μm^3
Vapour Volume %: 6.25

Daughter Phases:

Species	Density (g/cm^3)	Volume (μm^3)	Mass ($x10^{-12}g$)
Halite	2.17	583.7	1266.6
Sylvite	1.99	103.5	206.0
Ferropyrosmalite	3.12	101.7	317.3
	Total	788.9	
	Daughter Vol %:	72.9	

Liquid Volume: 226.2 μm^3 **Liquid Mass ($x10^{-12}g$):** 339.3
Liquid Volume %: 20.89 (for ρ = 1.5 g/cm^3)

Solute and solvent masses

		($x10^{-12}g$)	wt%
mass NaCl	=1266.6 + (0.0062 x 339.3)	1268.73	126.67
mass KCl	=206.0 + (0.0322 x 339.3)	216.89	21.65
mass $FeCl_2$	=(0.1 x 339.3)	61.35	6.13
mass $CaCl_2$	=(0.4482 x 339.3)	152.07	15.18
mass H_20	=(0.0803 x 317.3) + (0.4134 x 339.3)	165.75	16.55
mass FeO	=(0.4908 x 317.3)	166.53	16.63
mass MnO	=(0.0471 x 317.3)	15.98	1.60
mass MgO	=(0.0038 x 317.3)	1.29	0.13
mass SiO2	=(0.3421 x 317.3)	116.07	11.59
Mass Cl	=(0.0404 x 317.3)	13.71	1.37
TOTAL		2178.37	217.49

Fluid Composition:

	($x10^{-12}g$)		($x10^{-12}g$)
mass Na^+	499.08	mass Cl^-	769.65
mass K^+	113.75	mass Cl^-	103.14
mass Fe^{2+}	156.48	mass Cl^-	34.32
mass Ca^{2+}	54.93	mass Cl^-	97.15
mass Mg^{2+}	0.78		
mass Mn^{2+}	12.38		
mass Si^{4+}	54.26		
		TOTAL Cl^-	1017.96
mass O	103.02		
mass H_20	165.75		
TOTAL	2178.37		

	Molarity
m Na^+	**12.93**
m K^+	**1.41**
m Fe^{2+}	**1.36**
m Ca^{2+}	**0.65**
m Mg^{2+}	**0.01**
m Mn^{2+}	**0.10**
m Si^{4+}	**0.91**
m Cl^-	**24.74**
m O	**3.10**
m H_20	**4.57**

84.06 Wt % Salts

APPENDIX C - Laser Raman Data

Methodology is detailed in Chapter 2, section 2.3.2
Data is discussed in and intepreted in Chapter 2, section 2.4.3

DATA APPENDICES HAVE BEEN REMOVED

APPENDIX D - NOBLE GAS AND HALOGEN DATA

Methodology is detailed in Chapter 3, section3.2
Data is discussed and interpreted in Chapter 3, section 3.4

DATA APPENDICES HAVE BEEN REMOVED

APPENDIX E - PIXE DATA

DATA APPENDICES HAVE BEEN REMOVED

APPENDIX F - LA-ICP-MS DATA

Methodology is detailed in Chapter 4, section 4.2.2
Data is discussed in and intepreted in Chapter 4, sections 4.3 & 4.4

DATA APPENDICES HAVE BEEN REMOVED

APPENDIX G - HCh control file algorithms

Model results are presented and discussed in Chapter 5.

Symbol	Variable
T	Current temperature (^{o}C)
P	Current pressure (bars)
I	Current step number
N	Current wave number
[1]	Input composition (1 = first, 2 = second, etc)
[A]	Bulk composition of aqueous phase in system from current wave, previous step
[S]	Bulk composition of solid phase in system from current wave, previous step
[*]	Current total system bulk composition (all phases)

[1] = rock
[2] = fluid1
[3] = fluid2

Unless otherwise specified all models are isothermal and isobaric at 600 ^{o}C and 3000 bars.

Basic Model Algorithms (after Cleverley and Oliver, 2005)

- ***Fluid Mixing model - rock buffered (Figure 5.1A)***

Initial Step:
[*] = [2] + (0.1*[1])
General Step:
[*] = ([2]*(i/50)) + ([3]*(1-(i/50))) + (0.1*[1])
Stop when: i=50

- ***Batch Reaction model for variable fluid rock ratios (Figure 5.1B)***

Initial Step:
[*] = [1] + ([2]*10^-6)
General Step:
[*] = [1] + ([2]*(10^(i-6))
Stop when: i=10

- ***Fluid Mixing model - Isobaric Cooling (Figure 5.1C)***

Step Series 0, Initial Step:
T= 600
P= 3000
[*] = [1] + (0.1*[2])
Step Series 0, General Step:

T=600
P=3000
[*] = ([1]*(i/50)) + ([3]*(1-(i/50))) + (0.1*[2])
Stop when: i=50
Step Series N, Initial Step
T = T-(10*N)
P = 3000
[*] = [1] + (0.1*[2])
Step Series N, General Step
T = T-(10*N)
P = 3000
[*] = ([1]*(i/50)) + ([3]*(1-(i/50))) + (0.1*[2])
Stop when: N=30

- ***Flow-through model (Figure 5.1D)***

Initial Step:
[*] = [2]
General Step:
[*] = [A] + ([1]*(0.015*i)
Stop when: i=20

- ***Flush model (Figure 5.1E)***

Initial Step:
[*] = [1]
General Step:
[*] = [S] + (0.1*[2])
Stop when i=20

Specific fluid mixing models (Section 5.4.3.1)

- ***Model 1 (Figure 5.6)***

Initial Step:
T=400
P=2000
[*] = [2] + [3]
General Step:
T=400
P=2000
[*] = [A] + (0.1*[1])
Stop when: i=20

- ***Model 2 (Figure 5.7)***

Initial Step:
T=400
P=2000

[*] = [2] + [3]

General Step:

T=400

P=2000

[*] = [A] + (0.1*[1]) + ([3]*(i/20))

Stop when: i=20

- ***Model 3 (Figure 5.8)***

Initial Step:

T=400

P=2000

[*] = [1] + [2]

General Step:

T=400

P=2000

[*] = [S] + [A] + ([3]*(i/20))

Stop when: i=20

DATA APPENDICES HAVE BEEN REMOVED