APPENDIX E

FUGACITIES OF HCL^o AND HF^o IN HYDROTHERMAL FLUIDS AT MOUNT DORE

Introduction

The fugacities of volatiles components such as HF and HCl in a hydrothermal fluid may be calculated using experimentally calibrated fluid-mineral equilibria. Apatite-fluid equilibria are particularly useful, as apatite is widespread in geologic systems, re-equilibrates only sluggishly or not at all as conditions change from those of formation (Tacker and Stormer, 1989), and the thermochemistry of the relevant equilibria are moderately well constrained (Korzhinskiy, 1981).

Apatite is commonly developed as part of the alteration assemblage at Mount Dore. Its position in the paragenesis is interpreted to be during or after quartz and tourmaline, and before the dolomitization which apparently triggered sulphide mineralization. It can be a useful indicator of the abundances of F and Cl in the hydrothermal fluid responsible for its formation (*e.g.* Korzhinskiy, 1981; Sisson, 1987; Yardley, 1985), and in this instance could provide valuable information on the chemistry of the fluid immediately preceding mineralization. Apatite has therefore been extensively analysed. Ninety-seven EDS and WDS microprobe measurements of Cl and F were made from nine grains or aggregates of apatite, in seven samples representing the major lithologies.

More than half of these analyses (18 out of 24 from the granite; 26 out of 58 from the carbonaceous slates; and 1 out of 5 from calcareous metasediments) had apparently greater than the stoichiometric requirements of Cl and F per unit cell. It is impossible to estimate the proportion of hydroxylapatite in these specimens, since this component is assumed to make up the remainder of any unit cell after fluor- and chlorapatite components have been calculated. "Hyper-stoichiometric" analyses cannot be included in fluid geochemical calculations. Fortunately, many such analyses are from apatites in the granite, which are not as important as those from other lithologies for calculating fluid geochemical parameters, because mineralization is absent or of very low grade in the granite. Forty-seven "normal" analyses remain from host rocks where all three end-member components are present in non-zero proportions (Table E1). Fluorapatite is dominant, and hydroxylapatite is usually more abundant than chlorapatite, commonly by a factor of three or greater.

Thermochemistry

The technique used to calculate the fugacities of HCl and HF in the hydrothermal fluid producing the alteration and mineralization at Mount Dore follows that developed by Korzhinskiy (1981), and which was applied to metamorphic fluids by Yardley (1985). The necessary calculations were performed on an IBM-compatible computer, using the programme MINFILE (Afifi and Essene, 1989), an interactive programme for the storage and manipulation of chemical data on minerals.

The equilibria between end-members of the apatite OH-Cl-F series and a homogeneous gas phase can be represented by several equations relating pairs of end-members:

$$Ca_5(PO_4)_3Cl + H_2O(g) \;===\; Ca_5(PO_4)_3OH + HCl^o(g) \qquad \text{...(E1a)}$$

$$Ca_5(PO_4)_3F + H_2O(g) \;===\; Ca_5(PO_4)_3OH + HF^o(g) \qquad \text{...(E1b)}$$

$$Ca_5(PO_4)_3Cl + HF^o(g) \;===\; Ca_5(PO_4)_3F + HCl^o(g) \qquad \text{...(E1c)}$$

The equilibrium constants (K_e) for these exchange reactions are:

$$K_e^{Cl/OH} = \frac{f_{HCl^o}.a_{OH\text{-}ap}}{f_{H_2O}.a_{Cl\text{-}ap}} \qquad \text{...(E2a)} \qquad\qquad K_e^{F/OH} = \frac{f_{HF^o}.a_{OH\text{-}ap}}{f_{H_2O}.a_{F\text{-}ap}} \qquad \text{...(E2b)}$$

$$K_e^{Cl/F} = \frac{f_{HCl^o}.a_{F\text{-}ap}}{f_{HF^o}.a_{Cl\text{-}ap}} \qquad \text{...(E2c)}$$

where f_{HClo}, f_{HFo} and f_{H_2O} are the fugacities of HCl^o, HF^o and H_2O in the gas phase, and $a_{Cl\text{-}ap}$, $a_{F\text{-}ap}$ and $a_{OH\text{-}ap}$ are the activities of the chlorian, fluorian and hydroxylian end-member components in the apatite, respectively. Since the aim is to calculate the fugacities of the components in the gaseous (fluid) phase, equations E2a, b and c may be rewritten:

$$\frac{f_{HCl^o}}{f_{H_2O}} = K_e^{Cl/OH} \frac{a_{Cl\text{-}ap}}{a_{OH\text{-}ap}} \qquad \text{...(E3a)}$$

$$\frac{f_{HF^o}}{f_{H_2O}} = K_e^{F/OH} \frac{a_{F\text{-}ap}}{a_{OH\text{-}ap}} \qquad \text{...(E3b)}$$

$$\frac{f_{HCl^o}}{f_{HF^o}} = K_e^{Cl/F} \frac{a_{Cl\text{-}ap}}{a_{F\text{-}ap}} \qquad \text{...(3c)}$$

Fugacity ratios in the hydrothermal fluid may therefore be calculated knowing the ratios of activities of the apatite end-member components, and the exchange equilibrium constants. Korzhinskiy (1981) empirically determined the variation of the equilibrium constants with temperature and pressure, using halogen buffers on the HF-H_2O-apatite and HCl-H_2O-apatite systems at 1-4 kilobars and 500-700^{o}C, and assumed ideal solution between the apatite end-members; *i.e.*:

$$a_{Cl\text{-}ap} = X_{Cl\text{-}ap} \qquad a_{F\text{-}ap} = X_{F\text{-}ap} \qquad a_{OH\text{-}ap} = X_{OH\text{-}ap}$$

This assumption is the subject of some controversy. Hughes *et al.* (1989) studied structural variations in natural, near-end-member apatites, and determined from their atomic arrangements that they would be immiscible in solid solution, and would not mix ideally. They therefore advocated caution when using apatite in thermodynamic studies. Tacker and Stormer (1989) agreed that at 25^{o}C there is significant interaction between neighbouring Cl, F and OH ions, thus affecting their mixing relationships. They concluded, however, that at temperatures above 200^{o}C the crystal lattice expands sufficiently to relieve much of the stress relating to this interaction, and that for temperatures between 500 and 700^{o}C, apatite solid solution behaviour is nearly ideal.

The variations in equilibrium constants with temperature (in Kelvin) for a pressure of 1 kilobar were determined by Korzhinskiy (1981) to be:

$$\log K_{e\,P=1\,kbar}^{Cl/OH} = (0.00276 \times T) - 6.00 \quad \text{(E4a)}$$

$$\log K_{e}^{F/OH} = (0.00850 \times T) - 13.25 \quad \text{(E4b)}$$

$$\log K_{e\,P=1\,kbar}^{Cl/F} = (-0.00574 \times T) + 7.25 \quad \text{(E4c)}$$

Therefore, by measuring the mole fractions of the apatite end-member components, and by obtaining independent estimates of pressure and temperature, a value for K_e may be found, and the ratios of the volatile fugacities in the fluid calculated for the time of equilibration with apatite. Examples of the use of Kozhinskiy's equations in the studies of metamorphic fluids are those of Yardley (1985) and Sisson (1987).

Results

Calculations of approximate volatile fugacity ratios based on Mount Dore apatites are presented in Table E2. A pressure of one kilobar is assumed, mainly because the equations of Korzhinskiy are explicitly staed for this pressure.

One should bear in mind, however, that petrographic evidence from Mount Dore indicates that lithostatic pressures may have been up to or exceeding 200 MPa during hydrothermal activity (Chapters 3 and 6). Temperatures of 350, 450 and 550^{o}C are used, to bracket that likely for apatite formation (deduced from fluid inclusion thermometric studies; Chapter 6).

Table E2 indicates that the fugacity of HCl was tens to hundreds of times in excess of that of HF, and that both werer very low relative to that of H_2O. In order to estimate the absolute fugacities of HCl^{o} and HF^{o}, the fugacity of H_2O must be known. In the studies of Yardley (1985) and Sisson (1987), where absolute fugacities were calculated, relatively dilute metamorphic solutions were considered, where the activity of water approaches 1.0. The fluid at Mount Dore was, however, a concentrated brine (Chapter 6), and the activity of H_2O was considerably less than 1.0. Unfortunately, the activity of water in such fluids is poorly constrained, and absolute ratios of volatile fugacities must await the determination of such thermochemical information. The data are archived herein, however, in anticipation of this day.

TABLE E1: Apatite microprobe data where mole fractions of chlor- and fluor-apatite end-member components sum to less than 1.0, and hence an hydroxl-apatite component can be calculated (as 1 - $X_{F\text{-}apatite}$ - $X_{Cl\text{-}apatite}$). Only these analyses can be used in the volatile fugacity calculations recorded in Table E2. Structural formulae have been calculated assuming eight cations per unit cell.

	27121 /2/1	**27121 /2/2**	**27121 /2/3**	**27121 /2/4**	**27121 /2/5**	**27121 /2/6**	**27121 /2/7**	**27121 /2/8**	**27145 /3/1**	**27145 /3/2**	**27145 /3/3**	**27145 /3/5**	**27202 /5/1**	**27202 /5/2**	**27202 /5/3**	**27202 /5/4**	**27202 /5/5**	**27202 /5/6**	**27202 /5/7**
FeO	-	-	0.17	0.09	-	-	-	-	-	0.21	-	-	0.12	-	-	-	-	0.17	-
MgO	0.07	-	-	-	-	-	0.1	0.06	-	-	-	0.11	0.1	0.07	0.09	0.08	-	0.21	0.11
CaO	56.02	58.03	57.93	56.38	56.31	56.19	56.39	56.48	56.42	56.25	55.99	56.48	55.03	55.26	54.99	55.79	55.71	55.83	56.24
Na_2O	-	-	0.11	0.21	-	0.1	0.16	0.21	-	-	0.15	0.15	-	0.12	-	-	0.17	0.12	-
P_2O_5	43.21	43.51	43.62	42.3	43.42	43.03	43.07	43.09	43.08	42.95	43.03	42.78	42.38	42.34	42.76	42.62	42.72	43.23	42.45
Cl	0.2	0.14	0.14	0.21	0.18	0.23	0.1	0.19	-	0.79	0.96	0.9	0.36	0.41	0.36	0.31	0.29	0.33	0.29
F	2.82	1.98	1.66	2.81	2.65	3.48	3.02	2.75	2.32	2.98	2.06	2.06	3.28	3.44	3.43	2.65	3.27	2.9	2.82
SUBTOTAL	102.32	103.66	103.63	102	102.56	103.03	102.84	102.78	101.82	103.18	102.19	102.48	101.27	101.64	101.63	101.45	102.16	102.79	101.91
O=Cl,F	-1.233	-0.865	-0.731	-1.231	-1.157	-1.517	-1.294	-1.201	-0.977	-1.433	-1.084	-1.071	-1.462	-1.541	-1.526	-1.186	-1.442	-1.296	-1.253
TOTAL	**101.087**	**102.795**	**102.899**	**100.769**	**101.404**	**101.513**	**101.546**	**101.579**	**100.843**	**101.747**	**101.106**	**101.409**	**99.808**	**100.099**	**100.104**	**100.264**	**100.718**	**101.494**	**100.657**
#Fe+2	-	-	0.011	0.006	-	-	-	-	-	0.015	-	-	0.008	-	-	-	-	0.012	-
#Mg+2	0.009	-	-	-	-	-	0.012	0.007	-	-	-	0.013	0.013	0.009	0.011	0.01	-	0.026	0.014
#Ca+2	4.965	5.024	4.998	4.997	4.971	4.974	4.966	4.966	4.99	4.981	4.962	4.981	4.96	4.966	4.948	4.982	4.965	4.928	5.003
#Na+1	-	-	0.017	0.034	-	0.016	0.025	0.033	-	-	0.024	0.024	-	0.02	-	-	0.027	0.019	-
#P+5	3.026	2.976	2.974	2.963	3.029	3.01	2.997	2.994	3.01	3.005	3.013	2.981	3.019	3.006	3.04	3.008	3.008	3.015	2.984
# cations	**8.000**	**8.000**	**8.000**	**8.000**	**8.000**	**8.000**	**8.000**	**8.000**	**8.000**	**8.000**	**8.000**	**8.000**	**8.000**	**8.000**	**8.000**	**8.000**	**8.000**	**8.000**	**8.000**
#Cl	0.028	0.019	0.019	0.029	0.025	0.032	0.014	0.026	-	0.111	0.135	0.126	0.051	0.058	0.051	0.044	0.041	0.046	0.041
#F	0.738	0.506	0.423	0.735	0.691	0.909	0.785	0.714	0.606	0.779	0.539	0.536	0.873	0.912	0.911	0.699	0.86	0.756	0.74
#OH	0.234	0.475	0.558	0.235	0.284	0.058	0.201	0.26	0.394	0.11	0.326	0.338	0.076	0.029	0.038	0.258	0.099	0.198	0.219
X(Cl-ap)	0.028	0.019	0.019	0.029	0.025	0.032	0.014	0.026	-	0.111	0.135	0.126	0.051	0.058	0.051	0.044	0.041	0.046	0.041
X(F-ap)	0.738	0.506	0.423	0.736	0.691	0.91	0.785	0.714	0.606	0.779	0.539	0.536	0.873	0.913	0.911	0.698	0.86	0.756	0.74
X(OH-ap)	0.234	0.475	0.558	0.235	0.284	0.058	0.201	0.26	0.394	0.11	0.326	0.338	0.076	0.029	0.038	0.258	0.099	0.198	0.219

TABLE E1 (continued)

	27202 /5/8	**27202 /5/9**	**27202 /5/10**	**27202 /5/12**	**27238 /2/3**	**27238 /2/4**	**27238 /2/10**	**27238 /2/11**	**27238 /2/12**	**27238 /2/13**	**27238 /2/16**	**27277 /3/15**	**27277 /3/16**	**27278 /2/1**	**27278 /2/3**	**27278 /2/4**	**27278 /2/5**	**27278 /2/7**	**27278 /2/8**
FeO	0.21	-	-	0.15	0.16	-	-	-	-	-	-	-	-	-	-	0.11	0.19	0.27	-
MgO	0.15	-	-	-	-	-	0.11	-	-	-	-	-	-	0.08	0.1	-	-	-	0.06
CaO	56.39	56.1	56.38	55.72	56.63	56.38	57.33	57.5	56.27	57.31	57.43	55.67	56.72	54.21	54.46	54.12	54.2	55.24	54.81
Na_2O	-	0.11	-	-	-	0.1	-	0.13	-	-	-	-	0.14	-	0.09	-	0.13	-	-
P_2O_5	42.51	42.44	43.15	42.85	42.25	42.55	43.08	43.12	42	43.07	43.03	41.17	40.99	41.6	41.9	41.45	41.24	41.64	42.04
Cl	0.34	0.33	0.29	0.28	0.06	0.03	0.04	0.03	0.08	0.05	0.05	0.23	0.22	0.64	0.57	0.5	0.56	0.3	0.49
F	2.43	3.11	2.75	2.9	3.24	3	3.02	3.14	3.06	3.14	3.38	3.29	2.95	3.26	3.09	3.04	3.37	3.13	3.13
SUBTOTAL	102.03	102.09	102.57	101.9	102.34	102.06	103.58	103.92	101.41	103.57	103.89	100.36	101.02	99.79	100.21	99.22	99.69	100.58	100.53
O=Cl,F	-1.1	-1.384	-1.223	-1.284	-1.378	-1.27	-1.281	-1.329	-1.307	-1.334	-1.435	-1.437	-1.292	-1.517	-1.43	-1.393	-1.545	-1.386	-1.429
TOTAL	**100.93**	**100.706**	**101.346**	**100.616**	**100.962**	**100.79**	**102.299**	**102.591**	**100.103**	**102.237**	**102.455**	**98.923**	**99.728**	**98.273**	**98.78**	**97.827**	**98.145**	**99.194**	**99.101**
#Fe+2	0.015	-	-	0.01	0.011	-	-	-	-	-	-	-	-	-	-	0.008	0.014	0.019	-
#Mg+2	0.018	-	-	-	-	-	0.013	-	-	-	-	-	-	0.01	0.013	-	-	-	0.008
#Ca+2	4.993	4.996	4.985	4.97	5.026	5.001	5.011	5.011	5.032	5.019	5.025	5.049	5.078	4.974	4.958	4.979	4.974	5.002	4.976
#Na+1	-	0.018	-	-	-	0.016	-	0.02	-	-	-	-	0.023	-	0.015	-	0.022	-	-
#P+5	2.974	2.986	3.015	3.02	2.963	2.983	2.975	2.969	2.968	2.981	2.975	2.951	2.9	3.016	3.014	3.013	2.991	2.979	3.016
# cations	**8.000**	**8.000**	**8.000**	**8.000**	**8.000**	**8.000**	**8.000**	**8.000**	**8.000**	**8.000**	**8.000**	**8.000**	**8.000**	**8.000**	**8.000**	**8.000**	**8.000**	**8.000**	**8.000**
#Cl	0.048	0.046	0.041	0.04	0.008	0.004	0.006	0.004	0.011	0.007	0.007	0.033	0.031	0.093	0.082	0.073	0.081	0.043	0.07
#F	0.635	0.818	0.718	0.763	0.849	0.786	0.779	0.808	0.808	0.812	0.873	0.881	0.78	0.883	0.83	0.826	0.913	0.837	0.839
#OH	0.317	0.136	0.242	0.197	0.143	0.21	0.215	0.188	0.181	0.181	0.12	0.086	0.189	0.024	0.087	0.102	0.006	0.12	0.091
X(Cl-ap)	0.048	0.046	0.041	0.04	0.008	0.004	0.006	0.004	0.011	0.007	0.007	0.033	0.031	0.093	0.082	0.073	0.081	0.043	0.07
X(F-ap)	0.635	0.818	0.717	0.763	0.849	0.786	0.779	0.808	0.808	0.812	0.873	0.881	0.78	0.883	0.831	0.825	0.913	0.837	0.839
X(OH-ap)	0.317	0.136	0.242	0.197	0.143	0.21	0.215	0.188	0.181	0.181	0.12	0.086	0.189	0.024	0.087	0.102	0.006	0.12	0.091

TABLE E1 (continued)

	27278 /2/9	**27278 /3/1**	**27278 /3/2**	**27278 /3/3**	**27278 /3/6**	**27284 /1/1**	**27284 /1/2**	**27284 /1/6**	**27284 /1/7**
FeO	0.11	-	0.15	-	-	-	0.13	0.14	0.16
MgO	0.17	-	0.09	-	-	-	-	-	-
CaO	54.66	55.7	53	55.04	54.6	55.4	55.55	55.17	55.09
Na_2O	-	-	0.09	-	-	-	0.16	-	-
P_2O_5	42.12	42.54	40.14	42.42	42.36	42.13	42.6	41.8	42.96
Cl	0.52	0.49	0.49	0.57	0.54	0.18	0.06	0.09	0.06
F	2.94	2.49	2.45	2.66	2.62	3.52	3.68	3.36	3.12
SUBTOTAL	100.52	101.22	96.41	100.69	100.12	101.23	102.18	100.56	101.39
O=Cl,F	-1.355	-1.159	-1.142	-1.249	-1.225	-1.523	-1.563	-1.435	-1.327
TOTAL	**99.165**	**100.061**	**95.268**	**99.441**	**98.895**	**99.707**	**100.617**	**99.125**	**100.063**
#Fe+2	0.008	-	0.011	-	-	-	0.009	0.01	0.011
#Mg+2	0.021	-	0.012	-	-	-	-	-	-
#Ca+2	4.954	4.989	4.981	4.972	4.96	4.997	4.96	4.998	4.943
#Na+1	-	-	0.015	-	-	-	0.026	-	-
#P+5	3.017	3.011	2.981	3.028	3.04	3.003	3.005	2.992	3.046
# cations	**8.000**	**8.000**	**8.000**	**8.000**	**8.000**	**8.000**	**8.000**	**8.000**	**8.000**
#Cl	0.075	0.069	0.073	0.081	0.078	0.026	0.008	0.013	0.009
#F	0.787	0.658	0.68	0.709	0.702	0.937	0.97	0.898	0.826
#OH	0.139	0.272	0.247	0.209	0.22	0.037	0.022	0.089	0.165
X(Cl-ap)	0.075	0.069	0.073	0.081	0.078	0.026	0.008	0.013	0.009
X(F-ap)	0.786	0.659	0.68	0.71	0.702	0.937	0.97	0.898	0.826
X(OH-ap)	0.139	0.272	0.247	0.209	0.22	0.037	0.022	0.089	0.165

TABLE E2: Calculated ratios of fugacities of volatile components HCl, HF and H_2O in the hydrothermal fluid just prior to mineralization. Calculated using the mole fractions of chlorian, fluorian and hydroxylian end-member components of apatite. Equilibrium constants and their logarithms are determined for P = 1 kbar and T = 350°C, 450°C and 550°C, using the calibrations of Korzhinskiy (1981).

Temperature (°C)	$K_e^{Cl/OH}$	**log** $K_e^{Cl/OH}$	$K_e^{F/OH}$	**log** $K_e^{F/OH}$	$K_e^{Cl/F}$	**log** $K_e^{Cl/F}$
350	$5.25x10^{-5}$	-4.280	$1.1x10^{-8}$	-7.95	4711.06	3.673
450	$9.9x10^{-5}$	-4.004	$7.8x10^{-8}$	-7.103	1256.37	3.099
550	$1.87x10^{-4}$	-3.728	$5.58x10^{-7}$	-6.253	335.057	2.525

SAMPLE	$\log \frac{X_{Cl-ap}}{X_{OH-ap}}$	$\log \frac{X_{F-ap}}{X_{OH-ap}}$	$\log \frac{X_{Cl-ap}}{X_{F-ap}}$	$\frac{f_{HCl}}{f_{H2O}}$ ($x10^{-5}$) 350°C	450°C	550°C	$\log \frac{f_{HCl}}{f_{H2O}}$ 350°C	450°C	550°C	$\frac{f_{HF}}{f_{H2O}}$ ($x10^{-7}$) 350°C	450°C	550°C	$\log \frac{f_{HF}}{f_{H2O}}$ 350°C	450°C	550°C	$\frac{f_{HCl}}{f_{HF}}$ 350°C	450°C	550°C	$\log \frac{f_{HCl}}{f_{HF}}$ 350°C	450°C	550°C
27121/2/1	-0.928	0.493	-1.42	0.62	1.17	2.209	-5.207	-4.932	-4.656	0.342	2.425	17.35	-7.466	-6.615	-5.761	179.05	47.748	12.734	2.253	1.679	1.105
27121/2/2	-1.391	0.03	-1.421	0.213	0.402	0.76	-5.671	-5.396	-5.119	0.118	0.836	5.981	-7.928	-7.078	-6.223	178.5	47.604	12.695	2.252	1.678	1.104
27121/2/3	-1.463	-0.118	-1.345	0.181	0.341	0.645	-5.742	-5.467	-5.191	0.084	0.595	4.256	-8.076	-7.226	-6.371	212.91	56.781	15.143	2.328	1.754	1.18
27121/2/4	-0.892	0.506	-1.397	0.674	1.27	2.399	-5.172	-4.896	-4.62	0.352	2.499	17.88	-7.453	-6.602	-5.748	188.67	50.315	13.418	2.276	1.702	1.128
27121/2/5	-1.059	0.38	-1.439	0.459	0.865	1.633	-5.339	-5.063	-4.787	0.264	1.872	13.39	-7.578	-6.728	-5.873	171.48	45.731	12.196	2.234	1.66	1.086
27121/2/6	-0.263	1.188	-1.451	2.866	5.404	10.21	-4.543	-4.267	-3.991	1.695	12.02	86	-6.771	-5.92	-5.065	166.85	44.497	11.867	2.222	1.648	1.074
27121/2/7	-1.156	0.594	-1.751	0.366	0.691	1.304	-5.436	-5.161	-4.885	0.432	3.066	21.93	-7.364	-6.513	-5.659	83.59	22.293	5.945	1.922	1.348	0.774
27121/2/8	-0.989	0.442	-1.432	0.538	1.015	1.917	-5.269	-4.994	-4.717	0.305	2.16	15.45	-7.516	-6.666	-5.811	174.42	46.516	12.405	2.242	1.668	1.094
27145/3/1	-	0.185	-	-	-	-	-	-	-	0.168	1.194	8.542	-7.774	-6.923	-6.068	-	-	-	-	-	-
27145/3/2	-0.0017	0.846	-0.848	5.229	9.861	18.63	-4.282	-4.006	-3.73	0.771	5.469	39.12	-7.113	-6.262	-5.406	669.26	178.48	47.599	2.826	2.252	1.678
27145/3/3	-0.386	0.217	-0.603	2.16	4.073	7.694	-4.666	-4.39	-4.114	0.181	1.285	9.193	-7.742	-6.891	-6.037	1176.49	313.75	83.673	3.071	2.497	1.923
27145/3/5	-0.426	0.204	-0.631	1.968	3.711	7.01	-4.706	-4.431	-4.154	0.176	1.249	8.934	-7.754	-6.903	-6.049	1102.96	294.14	78.444	3.043	2.469	1.895
27202/5/1	-0.183	1.048	-1.231	3.448	6.502	12.28	-4.462	-4.187	-3.911	1.228	8.71	62.31	-6.911	-6.06	-5.205	277.08	73.894	19.707	2.443	1.869	1.295
27202/5/2	0.299	1.494	-1.195	0.875	1.649	3.116	-5.058	-4.783	-4.506	0.324	2.3	16.45	-7.489	-6.638	-5.784	266.23	70.998	18.934	2.425	1.851	1.277
27202/5/3	0.081	1.331	-1.25	1.04	1.961	3.705	-4.983	-4.707	-4.431	0.421	2.987	21.37	-7.376	-6.525	-5.67	243.75	65.004	17.336	2.387	1.813	1.239
27202/5/4	-0.771	0.432	-1.203	10.46	19.72	37.24	-3.981	-3.705	-3.429	3.43	24.32	174	-6.465	-5.614	-4.759	300.89	80.243	21.4	2.478	1.904	1.33
27202/5/5	-0.383	0.94	-1.323	6.326	11.93	22.53	-4.199	-3.923	-3.647	2.357	16.71	119.6	-6.628	-5.777	-4.922	264.97	70.663	18.845	2.423	1.849	1.275
27202/5/6	-0.636	0.579	-1.215	0.889	1.677	3.168	-5.051	-4.775	-4.499	0.297	2.108	15.08	-7.527	-6.676	-5.822	295.32	78.759	21.004	2.47	1.896	1.322
27202/5/7	-0.725	0.533	-1.259	2.171	4.094	7.734	-4.663	-4.388	-4.112	0.957	6.788	48.56	-7.019	-6.168	-5.314	223.89	59.708	15.923	2.35	1.776	1.202
27202/5/8	-0.819	0.306	-1.125	1.213	2.288	4.322	-4.916	-4.641	-4.364	0.417	2.956	21.15	-7.38	-6.529	-5.675	287.28	76.612	20.431	2.458	1.884	1.31
27202/5/9	-0.459	0.787	-1.245	0.988	1.863	3.52	-5.005	-4.73	-4.453	0.376	2.664	19.06	-7.425	-6.574	-5.72	259.62	69.236	18.464	2.414	1.84	1.266
27202/5/10	-0.778	0.47	-1.248	0.796	1.501	2.834	-5.099	-4.824	-4.548	0.222	1.577	11.28	-7.653	-6.802	-5.948	353.23	94.201	25.122	2.548	1.974	1.4
27202/5/12	-0.703	0.583	-1.286	1.826	3.443	6.504	-4.738	-4.463	-4.187	0.67	4.771	34.13	-7.172	-6.321	-5.467	267.88	71.439	19.052	2.428	1.854	1.28
27238/2/3	-1.215	0.788	-2.003	0.137	0.258	0.487	-5.864	-5.589	-5.312	0.404	2.863	20.48	-7.394	-6.543	-5.689	33.438	8.917	2.378	1.524	0.95	0.376
27238/2/4	-1.693	0.578	-2.271	0.118	0.223	0.421	-5.927	-5.652	-5.376	0.484	3.43	24.54	-7.315	-6.465	-5.61	24.12	6.432	1.715	1.382	0.808	0.234
27238/2/10	-1.584	0.565	-2.149	0.336	0.633	1.195	-5.474	-5.199	-4.923	0.502	3.558	25.46	-7.299	-6.449	-5.594	66.001	17.602	4.694	1.82	1.246	0.672
27238/2/11	-1.648	0.643	-2.291	0.203	0.383	0.724	-5.692	-5.417	-5.14	0.499	3.538	25.31	-7.302	-6.451	-5.597	40.2	10.721	2.859	1.604	1.03	0.456
27238/2/12	-1.194	0.659	-1.854	0.31	0.585	1.105	-5.508	-5.233	-4.957	0.82	5.815	41.6	-7.086	-6.235	-5.381	37.345	9.959	2.656	1.572	0.998	0.424
27238/2/13	-1.412	0.657	-2.069	0.32	0.603	1.139	-5.495	-5.22	-4.944	0.675	4.786	34.24	-7.171	-6.32	-5.465	46.751	12.468	3.325	1.67	1.096	0.522
27238/2/16	-1.228	0.872	-2.101	0.107	0.201	0.379	-5.973	-5.697	-5.421	0.416	2.953	21.13	-7.38	-6.53	-5.675	25.245	6.733	1.795	1.402	0.828	0.254

TABLE E2 (continued)

SAMPLE	log X_{Cl-ap}/X_{OH-ap}	log X_{F-ap}/X_{OH-ap}	log X_{Cl-ap}/X_{F-ap}	f_{HCl}/f_{H2O} ($x10^{-3}$)			log f_{HCl}/f_{H2O}			f_{HF}/f_{H2O} ($x10^{-7}$)			log f_{HF}/f_{H2O}			f_{HCl}/f_{HF}			log f_{HCl}/f_{HF}		
				350°C	450°C	550°C	350°C	450°C	550°C	350°C	450°C	550°C	350°C	450°C	550°C	350°C	450°C	550°C	350°C	450°C	550°C
27277/3/15	-0.386	1.041	-1.426	2.159	4.072	7.691	-4.666	-4.39	-4.114	1.208	8.564	61.26	-6.918	-6.067	-5.213	176.49	47.067	12.552	2.247	1.673	1.099
27277/3/16	-0.753	0.646	-1.398	0.928	1.749	3.304	-5.033	-4.757	-4.481	0.486	3.448	24.67	-7.313	-6.462	-5.608	188.27	50.209	13.39	2.275	1.701	1.127
27278/2/1	0.551	1.529	-0.978	18.67	35.21	66.51	-3.729	-3.453	-3.177	3.719	26.37	188.7	-6.43	-5.579	-4.724	495.62	132.17	35.249	2.695	2.121	1.547
27278/2/3	-0.033	0.972	-1.005	4.863	9.171	17.32	-4.313	-4.038	-3.761	1.031	7.31	52.29	-6.987	-6.136	-5.282	465.69	124.19	33.121	2.668	2.094	1.52
27278/2/4	-0.152	0.903	-1.055	3.699	6.975	13.18	-4.432	-4.156	-3.88	0.879	6.235	44.61	-7.056	-6.205	-5.351	415.22	110.73	29.531	2.618	2.044	1.47
27278/2/5	1.333	2.383	-1.05	113	213.1	402.5	-2.947	-2.671	-2.395	26.59	188.5	1349	-5.575	-4.725	-3.87	419.51	111.88	29.836	2.623	2.049	1.475
27278/2/7	-0.439	0.851	-1.289	1.912	3.606	6.811	-4.718	-4.443	-4.167	0.78	5.531	39.57	-7.108	-6.257	-5.403	241.97	64.53	17.209	2.384	1.81	1.236
27278/2/8	-0.12	0.957	-1.076	3.986	7.516	14.2	-4.399	-4.124	-3.848	0.996	7.059	50.5	-7.002	-6.151	-5.297	395.22	105.4	28.108	2.597	2.023	1.449
27278/2/9	-0.276	0.747	-1.023	2.777	5.24	9.897	-4.556	-4.281	-4.004	0.614	4.356	31.16	-7.212	-6.361	-5.506	446.52	119.08	31.757	2.65	2.076	1.502
27278/3/1	-0.595	0.381	-0.977	1.333	2.513	4.746	-4.875	-4.6	-4.324	0.265	1.877	13.43	-7.577	-6.726	-5.872	496.8	132.49	35.333	2.696	2.122	1.548
27278/3/2	-0.526	0.444	-0.97	1.564	2.949	5.57	-4.806	-4.53	-4.254	0.306	2.168	15.51	-7.515	-6.664	-5.809	504.91	134.65	35.91	2.703	2.129	1.555
27278/3/3	-0.417	0.523	-0.94	2.011	3.793	7.164	-4.697	-4.421	-4.145	0.367	2.602	18.62	-7.435	-6.585	-5.73	540.97	144.27	38.475	2.733	2.159	1.585
27278/3/6	-0.462	0.495	-0.957	1.812	3.418	6.455	-4.742	-4.466	-4.19	0.344	2.438	17.44	-7.464	-6.613	-5.758	520.33	138.76	37.006	2.716	2.142	1.568
27284/1/1	-0.163	1.399	-1.562	3.603	6.795	12.83	-4.443	-4.168	-3.892	2.755	19.54	139.8	-6.56	-5.709	-4.855	129.1	34.428	9.181	2.111	1.537	0.963
27284/1/2	-0.4	1.659	-2.059	2.091	3.942	7.446	-4.68	-4.404	-4.128	5.013	35.55	254.3	-6.3	-5.449	-4.595	41.161	10.977	2.927	1.614	1.04	0.466
27284/1/6	-0.832	1.011	-1.843	0.772	1.456	2.751	-5.112	-4.837	-4.56	1.127	7.994	57.19	-6.948	-6.097	-5.243	67.622	18.034	4.809	1.83	1.256	0.682
27284/1/7	-1.302	0.685	-1.987	0.262	0.494	0.933	-5.582	-5.306	-5.03	0.533	3.777	27.02	-7.274	-6.423	-5.568	48.549	12.947	3.453	1.686	1.112	0.538

APPENDIX F1

TABULATED AQUEOUS FLUID INCLUSION THERMOMETRIC DATA

Inclusion type abbreviations: Type I MS - Type I multiphase solid; Type II MS - Type II multiphase solid; Type I L2P -Type I liquid-rich two-phase; V-rich 2P - vapour-rich two-phase. **Phase transition temperature abbreviations:** T_e - first melting (eutectic); T_m(ice) - final ice melting; T_{hL}(vapour) - vapour into liquid homogenization (except where marked by a "V", in which case homogenization was to vapour); T_m(syl) - sylvite dissolution; T_m(hal) - halite dissolution; T_m(Fe-chl) - Fe-chloride dissolution; T_d/(T_l) - decrepitation/(first significant leakage). Hyphen - heating run performed and transition occurred, but temperature not recorded. Blank space ( ) - subzero heating runs not performed (in the case of Type I MS inclusions), or for hyperzero heating runs, the indicated transition did not occur, or was not relevant to the inclusion system.

Sample number/ inclusion type	T_e (°C)	T_m(ice) (°C)	T_{hL}(vap) (°C)	T_m(syl) (°C)	T_m(hal) (°C)	T_m(Fe-chl) (°C)	T_d/(T_l) (°C)	Degree of fill
27085								
Type I L2P	-54±2	-15.5±0.1	133.0±0.5					>0.95
"	-55.7±0.3	-19.0±0.2	195±1					0.9
V-rich 2P	-	-	290±5(V)					<0.01
"	-45	-	392±1					0.5
"	-	-	290±5(V)					<0.4
"	-	-	363±2					<0.4
"	-	-	208±1					0.85-0.9
"	-	-	358±2					0.6
"	-	-	356.5±0.5					0.55-0.6
"	-	-	295±1					0.75-0.8
"	-	-	270±2					0.7
27086								
Type I MS	-	-	-	270±5			-/(>195)	
"	-	-	-	239±1				
"	-	-	350	203±1			-/(>350)	
"	-50±2	-	-	<200			410±5/(-)	
"	-	-	-	<200			410±5/(30	
"	-	-	<300	<200			0)	
"	-	-	340±2	<200			410±5	
27093								
Type I L2P	<-40	-5.4±0.1	253.2±0.3					0.9
"	<-59	0.0	96.8±0.2					0.97
"	<-38	-7.3±0.1	174±0.2				200	0.95
"	-	-1.5±0.1	171.5±0.2					0.95
"	-	-5.9±0.1	192.9±0.2					0.92
"	<-56	-	129±1					0.98
"	<-56	-7±0.5	129.5±0.3					0.98
"	-	-	118±2					0.98
"	-	-	116±1					0.96
"	-	-	132±0.2					0.97
"	-	-	132±0.5					0.97

Sample number/ inclusion type	T_e (°C)	T_m(ice) (°C)	T_{hL}(vap) (°C)	T_m(syl) (°C)	T_m(hal) (°C)	T_m(Fe-chl) (°C)	T_d/(T_l) (°C)	Degree of fill
27163-1								
Type II MS	-	-	118.5±1	188±1				
27163-2								
Type I MS	<-45	-	144.7±0.1	-			438	
"	<-45	-	208.8±0.2	-	470±5		>530	
"	<-45	-	133±1	-	456±3	495±5	495	
Type II MS	-	-25±2	137.7±0.2		159.5±0.2			
"	-	-25±2	134.5±0.5		145±5			
"	-	-24.0±0.1	126.8±0.2		164.5±0.5			
Type I L2P	-51±1	-25±2	191.7±0.3					0.95
"	-43±2	-23.7±0.1	137.8±0.5				368	>0.98
"	-	-5.8±0.2	166.5±0.2					0.95
"	-	-7±2	121.0±0.2					>0.98
"	-	0.0±0.1	-					0.98
"	-	-	161±1					0.85
"	-	-	177.3±0.1					0.85
"	-	-	201.5±0.5					0.9
"	-	-20±1	113.1±0.2					0.9
"	-	-	148.3±0.2					-
27195								
Type I MS	-	-	350±2	-	465±5	455±5	-	
"	-	-	175±5	-		<420	-/(220)	
"	-	-	175±5	-	465±5	455	-/(175)	
"	-	-	330±10	-	450±10		-/(220)	
"	-	-	<120	-			-	
"	-	-	<120	-	430±20	430±20	-	
"	-	-	<125	-			-	
"	-	-	130	-			-	
"	-	-	330±5	-			-/(>330)	
"	-	-	170±5	-			-	
"	-	-	177±5	-	<450	450±10	-/(>180)	
"	-	-	137±1	-	490±10		-	
Type I L2P	-	-23.0±0.1	126.5±1					>0.95
"	-	-	121.0±1					>0.95
"	-52±2	-22.7±0.1	122.6±0.2					>0.95
"	-	-22.8±0.1	122.5±2					>0.95
V-rich 2P	-	-	285±2					0.70
"	-	-	295±5					0.65-0.7
"	-	-	240±10					0.80
27263								
Type I MS	-	-	-	-	445±3	>500	-/(-)	
"	-	-	352±5	-		>500	-/(<400)	
"	-	-	-	175±0.2	482±2	490±1	-/(>300)	
"	-	-	-	-			-	
"	-	-	-	-		483±3	-	
"	-	-	-	-	470±5	480?	-	
"	-	-	<350	-			430/(-)	
"	-	-	<370	-	465±5		-	

Sample number/ inclusion type	**T_e (°C)**	**T_m(ice) (°C)**	**T_{hL}(vap) (°C)**	**T_m(syl) (°C)**	**T_m(hal) (°C)**	**T_m(Fe-chl) (°C)**	**T_d/(T_l) (°C)**	**Degree of fill**
27263 (cont/d)								
Type I L2P	<40	-4.9±0.1						0.98
"	<40	-4.9±0.1						0.98
"	-52±2	<-2						>0.98
"	<40	-6.6±0.1						0.9-0.95
"	<40	-5±0.2						>0.97
"	<40	-0.5±0.5						>0.95
"	<40	-5.6±0.1						0.95
"	<40	-5.6±0.1						0.95
"	<40	-5.6±0.1						0.93
"	<40	-0.8±0.1						0.97
"	<40	0.0±0.1						0.98
"	-	-1.4±0.1						0.95
27271								
Type I MS			?	217.5±1	515±2		550±2	
"				<250			400±10	
"				210±5			-	
"				224±2			480±3	
"				<210			550	
"				<210			-	
"				210±10			<450	
"				211±2			270±2	
27273-4								
Type I MS			-	180			342±2	
"			-	-			-	
"			-	205±1			292±1	
"			-	195			340±5	
"			287.5±1	190±10			-	
"			345	201±1			360	
"			-	195			<350	
"			-	196±2			335±2	
"			-	190±10			229	
"			-	195±10			-	
27273-6								
Type I L2P	-59±0.5	-13.6±0.2	139.0±0.1					>0.95
"	-	-13.6±0.2	141.4±0.1					>0.95
"	-	-13.6±0.2	138.4±0.1					>0.95
"	-	-13.6±0.2	134.1±0.1					>0.95
"	-59±0.5	-13.6±0.2	134.1±0.1					>0.95
"	-	-13.6±0.2	133.4±0.1					>0.95
"	-	-13.6±0.2	-					>0.95
"	-	-13.6±0.2	132±1					>0.95
"	-	-13.6±0.2	131±1					>0.95
"	-	-13.6±0.2	-					>0.95
"	-	-0.7±0.2	168.3±0.2					>0.95
"	-	-	162±5					>0.95
"	-	-	164.0±0.5					>0.95

APPENDIX F2

CALCULATION OF FLUID COMPOSITION FROM VOLUMETRIC DATA

The concentrations of different solute species in the original homogeneous hydrothermal fluid trapped in Type I multiphase solid inclusions have been estimated using the phase volume method (Kwak *et al.*, 1986). At room temperature, each inclusion contains a number of daughter phases (salts), a saline liquid phase, and a vapour phase, which was produced by shrinking of the liquid during cooling. Volumes were obtained for each of these phases, and the masses of each of solute and solvent species estimated. The vapour phase was assumed to contain negligible amounts of both solutes and solvent. The total mass of each solute in the inclusion was therefore taken as the sum of its mass in the daughter phase and in the solution.

The mass of each each daughter species was calculated using known volume and density data (halite: ρ = 2.17 g.cm^{-3}; sylvite: ρ = 1.99 g.cm^{-3}; $FeCl_2.2H_2O$; ρ = 2.39 g.cm^{-3}; antarcticite: ρ = 1.68 g.cm^{-3}; calcite: ρ = 2.72 g.cm^{-3}). Haematite is considered to be an accidentally trapped solid contributing little to the overall fluid composition, and is consequently disregarded in the calculations. For antarcticite and $FeCl_2.2H_2O$ the masses of $CaCl_2$, $FeCl_2$ and water of hydration were also calculated; *viz.*

mass of $FeCl_2$ in $FeCl_2.2H_2O$ = 0.7788 x mass $FeCl_2.2H_2O$
mass of H_2O in $FeCl_2.2H_2O$ = 0.2212 x mass $FeCl_2.2H_2O$

mass of $CaCl_2$ in antarcticite = 0.5068 x mass $CaCl_2.6H_2O$
mass of H_2O in antarcticite = 0.4932 x mass $CaCl_2.6H_2O$

The mass of the liquid at room temperature was determined from its measured volume and its assumed density of 1.5 g.cm^{-3}. The mass of each of the major dissolved salts was calculated assuming negligible solubility of calcite, and a solution composition at 25^{o}C of:

$CaCl_2$ 44.82wt% : KCl 3.22wt% : NaCl 0.62wt% : $FeCl_2$ 10.0wt% : H_2O 41.34wt%

(see Section 6.3.2 for discussion). Masses of solutes in solution are thus:

NaCl mass in solution = 0.0062 x liquid mass
KCl mass in solution = 0.0322 x liquid mass
$FeCl_2$ mass in solution = 0.10 x liquid mass
$CaCl_2$ mass in solution = 0.4482 x liquid mass
H_2O mass in liquid = 0.4134 x liquid mass

The total mass of each cationic and anionic species and of the solvent in the original homogeneous solution was then calculated:

Na^+ mass = 0.3934 x total NaCl mass
K^+ mass = 0.5245 x total KCl mass
Fe^{2+} mass = 0.4406 x ($FeCl_2$ mass in $FeCl_2.2H_2O$ and solution)
Ca^{2+} mass = 0.3611 x ($CaCl_2$ mass in $CaCl_2.6H_2O$ + liquid) + (0.4004 x mass $CaCO_3$)
Cl^- mass = (0.6066 x NaCl) + (0.4755 x KCl) + (0.5594 x $FeCl_2$) + (0.6389 x $CaCl_2$)
H_2O mass = H_2O mass in $FeCl_2.2H_2O$ and $CaCl_2.6H_2O$ + H_2O mass in liquid

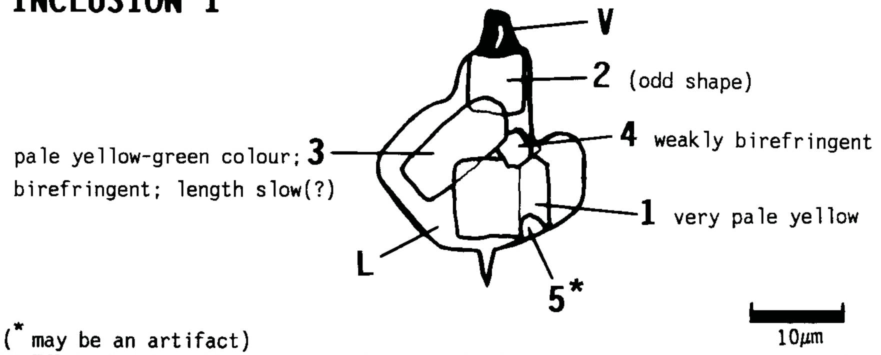
Having calculated the masses of solutes and solvent, the concentrations of the former in the original homogeneous hydrothermal fluid were determined, as molarities (mole of solute per litre of solution) and molalities (mole of solute per kilogram of solvent)(Table 6.9). When calculating molarities, the volume of the solution used is equal to the volume of the entire inclusion.

Systematic errors in measurement are comparatively small ($\pm$ 0.25 to 0.5 μm), but are proportionately larger for smaller inclusions or daughters. Only inclusions larger than 10 to 15 μm in diameter were used. Very small daughters will not significantly contribute to the total volume of such inclusions. Systematic error is therefore considered to be relatively minor. Greater error arises from the estimation of shapes of inclusions and daughter phases, where these were indeterminate or irregular. Volumetric errors are quoted in the tabulated calcuations in this appendix as ± 10%, but this is systematic error only, and quoted total inclusion volumes should not be considered more accurate than ± 20-30%.

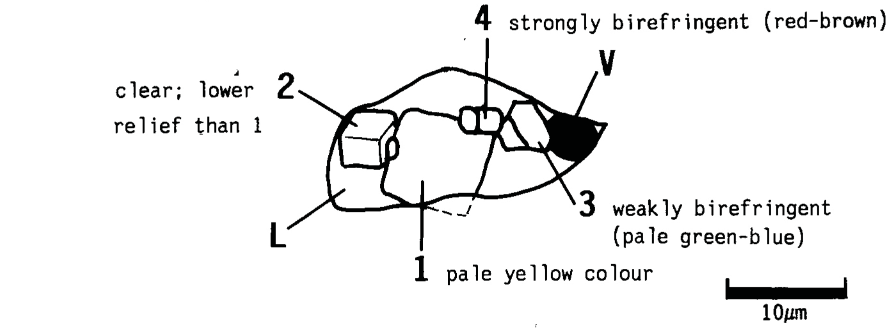
Far greater, and unknown, inaccuracies arise in the fluid composition calculations because of the necessary simplifications required in order to use existing experimental phase solubility data (Section 6.3.2). Final solute concentrations are therefore likely to be accurate only to within an order of magnitude.

SAMPLE JCU-27086

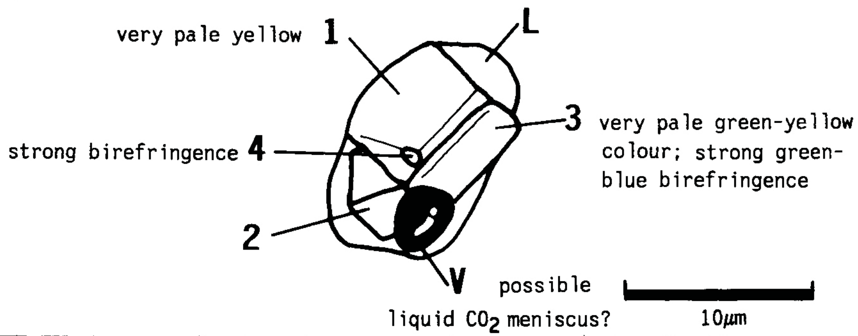
INCLUSION 1



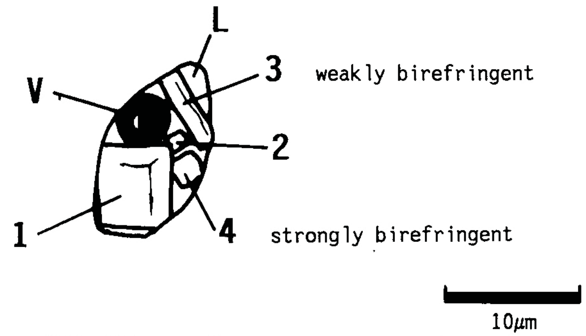
INCLUSION 5



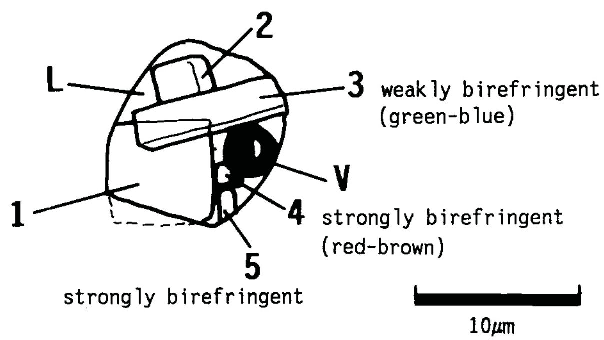
INCLUSION 9



INCLUSION 10



INCLUSION 11



KEY TO LABELS

- **V** H_2O (± (L±V) CO_2?) vapour bubble
- **L** H_2O liquid
- **1** halite
- **2** sylvite
- **3** Fe-chloride ($FeCl_2 . 2H_2O$?)
- **4** carbonate (calcite?)
- **5** unknown

SAMPLE NUMBER: JCU-27086 **INCLUSION NUMBER:** 1

Inclusion volume: 3856 $^{+520}_{-472}$ µm^3

Vapour volume: 80.4 $^{+16}_{-14}$ µm^3

Daughters:

Species	Density (g.cm^{-3})	Volume (µm^{-3})	Mass (x10^{-12}g)
halite	2.17	756.1 $^{+64}_{-61}$	1640.7 $^{+139}_{-132}$
sylvite	1.99	582 $^{+52}_{-53}$	1158.2 $^{+104}_{-106}$
$FeCl_2.2H_2O$	2.39	257.7 $^{+99}_{-87}$	615.9 $^{+237}_{-208}$
?$CaCO_3$	2.72	51 $^{+18}_{-15}$	138.7 $^{+49}_{-41}$

Liquid volume: 2121 $^{+274}_{-238}$ µm^3 **Liquid mass (x10^{-12}g)**
: 3181.5 $^{+411}_{-357}$ (for ρ = 1.5 g.cm^{-3})
: 2757.3 $^{+356}_{-309}$ (for ρ = 1.7 g.cm^{-3})
: 3605.0 $^{+466}_{-405}$ (for ρ = 1.3 g.cm^{-3})

Solute and solvent masses:

		(x10^{-12}g)	wt%
mass NaCl	= 4640.7 + (0.0062 x 3181.5)	= 1660.42	24.66
mass KCl	= 1158.2 + (0.0322 x 3181.5)	= 1260.0	18.71
mass $FeCl_2.2H_2O$	= 615.9		
mass $FeCl_2$	= (0.7788 x 615.9) + (0.10 x 3181.5)	= 797.8	11.85
mass ?$CaCO_3$	= 138.7	= 138.7	2.06
mass $CaCl_2$	= (0.4482 x 3181.5)	= 1426.0	21.17
mass H_2O	= (0.4134 x 3181.5) + (0.2212 x 615.9)	= 1451.47	21.55
TOTAL		= 6734.39	100.00

Fluid composition:

	(x10^{-12}g)		(x10^{-12}g)		
mass Na^+	= 653.21	mass Cl^-	= 1007.21	nNa^+	= 2.84x10^{-11} mol
mass K^+	= 660.87	mass Cl^-	= 599.13	nK^+	= 1.69x10^{-11} mol
mass Fe^{2+}	= 351.52	mass Cl^-	= 446.3	nFe^{2+}	= 6.29x10^{-12} mol
mass Ca^{2+}	= 570.79	mass Cl^-	= 911.07	nCa^{2+}	= 1.42x10^{-11} mol
		TOTAL Cl^-	= 2963.7	nCl^-	= 7.91x10^{-11} mol
mass H_2O	= 1451.47			nH_2O	= 8.06x10^{-11} mol

wt% salts = 78.45 wt% Cl^- = 44.01

SAMPLE NUMBER: JCU-27086 **INCLUSION NUMBER:** 5

Inclusion volume: 1702.1 $^{+213}_{-198}$ µm^3

Vapour volume: 28.7 $^{+6}_{-5}$ µm^3

Daughters:

Species	Density ($g.cm^{-3}$)	Volume (μm^{-3})	Mass ($x10^{-12}g$)
halite	2.17	355.5 $^{+42}_{-37}$	771.4 $^{+91}_{-80}$
sylvite	1.99	54.7 $^{+12}_{-10}$	108.9 $^{+24}_{-20}$
$FeCl_2.2H_2O$	2.39	104 $^{+32}_{-27}$	248.6 $^{+76.5}_{-64.5}$
?$CaCO_3$	2.72	1.8 $^{+1.1}_{-0.7}$	4.9 $^{+3.0}_{-1.9}$

Liquid volume: 1154.5 $^{+118}_{-117}$ µm^3 **Liquid mass ($x10^{-12}g$):** 1731.8 $^{+177}_{-176}$ (for ρ = 1.5 $g.cm^{-3}$)
: 1962.7 $^{+201}_{-199}$ (for ρ = 1.7 $g.cm^{-3}$)
: 1500.9 $^{+153}_{-152}$ (for ρ = 1.3 $g.cm^{-3}$)

Solute and solvent masses:

		($x10^{-12}g$)	wt%
mass NaCl	= 771.4 + (0.0062 x 1731.8)	= 782.14	27.29
mass KCl	= 108.9 + (0.0322 x 1731.8)	= 164.66	5.75
mass $FeCl_2.2H_2O$	= 248.6		
mass $FeCl_2$	= (0.7788 x 248.6) + (0.10 x 1731.8)	= 366.79	12.80
mass ?$CaCO_3$	= 4.9	= 4.9	0.17
mass $CaCl_2$	= (0.4482 x 1731.8)	= 776.19	27.09
mass H_2O	= (0.4134 x 1731.8) + (0.2212 x 248.6)	= 770.92	26.90
TOTAL		= 2865.60	100.00

Fluid composition:

	($x10^{-12}g$)		($x10^{-12}g$)		
mass Na^+	= 307.69	mass Cl^-	= 474.45	nNa^+	= $1.34x10^{-11}$ mol
mass K^+	= 86.36	mass Cl^-	= 78.30	nK^+	= $2.21x10^{-12}$ mol
mass Fe^{2+}	= 161.61	mass Cl^-	= 205.18	nFe^{2+}	= $2.89x10^{-12}$ mol
mass Ca^{2+}	= 282.25	mass Cl^-	= 495.91	nCa^{2+}	= $7.04x10^{-12}$ mol
		TOTAL Cl^-	= 1253.84	nCl^-	= $3.29x10^{-11}$ mol
mass H_2O	= 770.92			nH_2O	= $4.28x10^{-11}$ mol

wt% salts = 73.10 wt% Cl^- = 43.75

SAMPLE NUMBER: JCU-27086 **INCLUSION NUMBER:** 9

Inclusion volume: 1359 $^{+139}_{-130}$ μm^3

Vapour volume: 59 $^{+20}_{-30}$ μm^3

Daughters:

Species	Density ($g.cm^{-3}$)	Volume (μm^{-3})	Mass ($x10^{-12}g$)
halite	2.17	437.3 $^{+45}_{-32}$	948.9 $^{+98}_{-91}$
sylvite	1.99	133.0 $^{+25}_{-23}$	264.7 $^{+50}_{-46}$
$FeCl_2.2H_2O$	2.39	73.8 $^{+27}_{-23}$	176.4 $^{+65}_{-55}$
?$CaCO_3$	2.72	8.6 $^{+6}_{-4}$	24.1 $^{+17}_{-11}$

Liquid volume: 647.3 $^{+16}_{-21}$ μm^3 **Liquid mass ($x10^{-12}g$)** : 970.95 $^{+24}_{-32}$ (for ρ = 1.5 $g.cm^{-3}$)
: 1100.4 $^{+27}_{-36}$ (for ρ = 1.7 $g.cm^{-3}$)
: 841.5 $^{+21}_{-27}$ (for ρ = 1.3 $g.cm^{-3}$)

Solute and solvent masses:

		($x10^{-12}g$)	wt%
mass NaCl	= 948.9 + (0.0062 x 970.95)	= 954.9	38.54
mass KCl	= 264.7 + (0.0322 x 970.95)	= 295.97	11.95
mass $FeCl_2.2H_2O$	= 176.4		
mass $FeCl_2$	= (0.7788 x 176.4) + (0.10 x 970.95)	= 234.33	9.46
mass ?$CaCO_3$	= 24.1	= 24.1	0.97
mass $CaCl_2$	= (0.4482 x 970.95)	= 527.8	21.30
mass H_2O	= (0.4134 x 970.95) + (0.2212 x 176.4)	= 440.41	17.78
TOTAL		= 2477.51	100.00

Fluid composition:

	($x10^{-12}g$)		($x10^{-12}g$)		
mass Na^+	= 375.66	mass Cl^-	= 579.24	nNa^+	= $1.63x10^{-11}$ mol
mass K^+	= 155.24	mass Cl^-	= 140.73	nK^+	= $3.97x10^{-12}$ mol
mass Fe^{2+}	= 103.25	mass Cl^-	= 131.09	nFe^{2+}	= $1.85x10^{-12}$ mol
mass Ca^{2+}	= 166.79	mass Cl^-	= 278.04	nCa^{2+}	= $4.16x10^{-12}$ mol
		TOTAL Cl^-	= 1129.1	nCl^-	= $3.19x10^{-11}$ mol
mass H_2O	= 440.41			nH_2O	= $2.45x10^{-11}$ mol

wt% salts = 82.22(!) wt% Cl^- = 45.57

SAMPLE NUMBER: JCU-27086 **INCLUSION NUMBER:** 10

Inclusion volume: 252.5 $^{+53}_{-47}$ µm^3

Vapour volume: 8.5 $^{+3}_{-2}$ µm^3

Daughters:

Species	Density (g.cm^{-3})	Volume (µm^{-3})	Mass (x10^{-12}g)
halite	2.17	35.6 $^{+9}_{-7}$	77.25 $^{+19.5}_{-15.2}$
sylvite	1.99	1.2 $^{+0.7}_{-0.6}$	2.39 $^{+1.4}_{-1.2}$
$FeCl_2.2H_2O$	2.39	9.4 $^{+4.6}_{-3.6}$	22.5 $^{+11}_{-8.6}$
?$CaCO_3$	2.72	3.1 $^{+1.4}_{-1.2}$	8.43 $^{+3.8}_{-3.3}$

Liquid volume: 194.7 $^{+34}_{-33}$ µm^3 **Liquid mass (x10^{-12}g)** **:** 292.1 $^{+51}_{-50}$ (for ρ = 1.5 g.cm^{-3})
: 331.0 $^{+58}_{-56}$ (for ρ = 1.7 g.cm^{-3})
: 253.1 $^{+44}_{-43}$ (for ρ = 1.3 g.cm^{-3})

Solute and solvent masses:

		(x10^{-12}g)	wt%
mass NaCl	= 77.25 + (0.0062 x 292.1)	= 139.9	30.18
mass KCl	= 2.39 + (0.0322 x 292.1)	= 11.80	2.55
mass $FeCl_2.2H_2O$	= 22.5		
mass $FeCl_2$	= (0.7788 x 22.5) + (0.10 x 292.1)	= 46.73	10.08
mass ?$CaCO_3$	= 8.43	= 8.43	1.82
mass $CaCl_2$	= (0.4482 x 292.1)	= 130.92	28.25
mass H_2O	= (0.4134 x 292.1) + (0.2212 x 22.5)	= 125.73	27.13
TOTAL		= 463.51	100.00

Fluid composition:

	(x10^{-12}g)		(x10^{-12}g)		
mass Na^+	= 55.04	mass Cl^-	= 84.86	nNa^+	= 2.39x10^{-12} mol
mass K^+	= 6.19	mass Cl^-	= 5.61	nK^+	= 1.58x10^{-13} mol
mass Fe^{2+}	= 20.59	mass Cl^-	= 26.14	nFe^{2+}	= 3.69x10^{-13} mol
mass Ca^{2+}	= 50.65	mass Cl^-	= 83.65	nCa^{2+}	= 1.26x10^{-12} mol
		TOTAL Cl^-	= 200.26	nCl^-	= 5.65x10^{-12} mol
mass H_2O	= 125.73			nH_2O	= 6.99x10^{-12} mol

wt% salts = 72.87 wt% Cl^- = 43.21

SAMPLE NUMBER: JCU-27086 **INCLUSION NUMBER:** 11

Inclusion volume: 420.6 $^{+65}_{-58}$ μm^3

Vapour volume: 6.2 $^{+2.3}_{-1.8}$ μm^3

Daughters:

Species	Density ($g.cm^{-3}$)	Volume (μm^{-3})	Mass ($x10^{-12}g$)
halite	2.17	223.7 $^{+29}_{-27}$	485.43 $^{+63}_{-59}$
sylvite	1.99	16.2 $^{+5.3}_{-4.3}$	32.24 $^{+10.6}_{-4.6}$
$FeCl_2.2H_2O$	2.39	27.7 $^{+14.6}_{-11.8}$	66.2 $^{+34.9}_{-28.2}$
?$CaCO_3$	2.72	0.58 $^{+0.5}_{-0.3}$	1.58 $^{+1.4}_{-0.8}$

Liquid volume: 146.2 $^{+13}_{-12}$ μm^3 **Liquid mass ($x10^{-12}g$)** : 219.3 $^{+20}_{-18}$ (for ρ = 1.5 $g.cm^{-3}$)
: 248.5 $^{+22}_{-20}$ (for ρ = 1.7 $g.cm^{-3}$)
: 190.1 $^{+17}_{-16}$ (for ρ = 1.3 $g.cm^{-3}$)

Solute and solvent masses:

		($x10^{-12}g$)	wt%
mass NaCl	= 485.43 + (0.0062 x 219.3)	= 486.79	60.28
mass KCl	= 32.24 + (0.0322 x 219.3)	= 39.30	4.87
mass $FeCl_2.2H_2O$	= 66.2		
mass $FeCl_2$	= (0.7788 x 66.2) + (0.10 x 219.3)	= 73.49	9.10
mass ?$CaCO_3$	= 1.58	= 1.58	0.20
mass $CaCl_2$	= (0.4482 x 219.3)	= 98.29	12.17
mass H_2O	= (0.4134 x 219.3) + (0.2212 x 66.2)	= 105.30	13.04
TOTAL		= 807.59	100.00

Fluid composition:

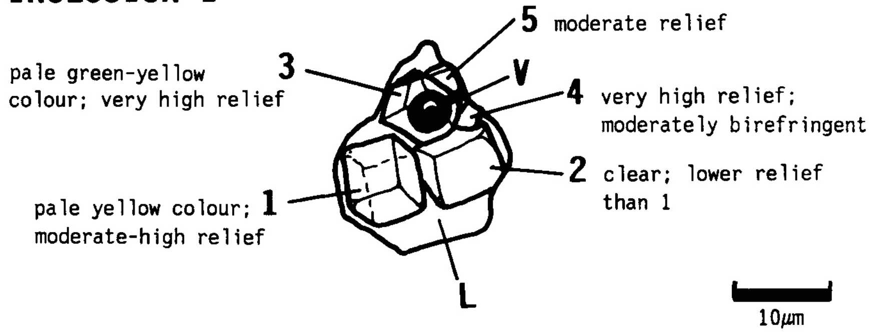
	($x10^{-12}g$)		($x10^{-12}g$)		
mass Na^+	= 191.50	mass Cl^-	= 295.29	nNa^+	= $8.33x10^{-12}$ mol
mass K^+	= 20.61	mass Cl^-	= 18.69	nK^+	= $5.27x10^{-13}$ mol
mass Fe^{2+}	= 32.38	mass Cl^-	= 41.12	nFe^{2+}	= $5.80x10^{-13}$ mol
mass Ca^{2+}	= 36.13	mass Cl^-	= 62.80	nCa^{2+}	= $9.01x10^{-13}$ mol
		TOTAL Cl^-	= 417.90	nCl^-	= $1.18x10^{-11}$ mol
mass H_2O	= 105.30			nH_2O	= $5.85x10^{-12}$ mol

wt% salts = 86.96(!) wt% Cl^- = 51.75

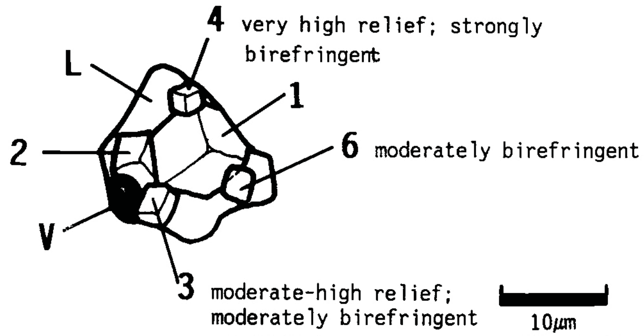
?Fe_2O_3 : present but volumetrically insignificant.

SAMPLE JCU-27094

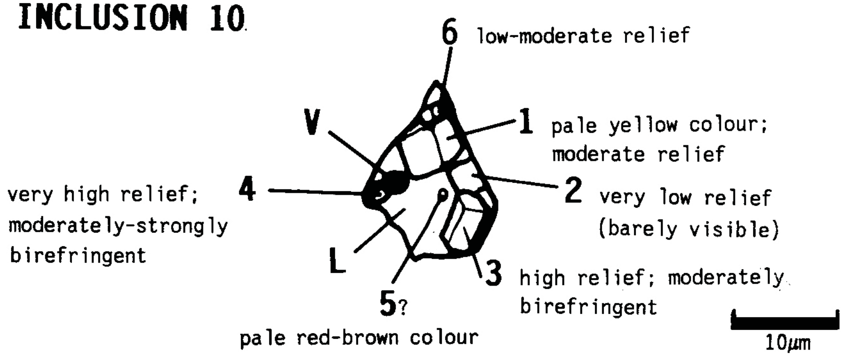
INCLUSION 1



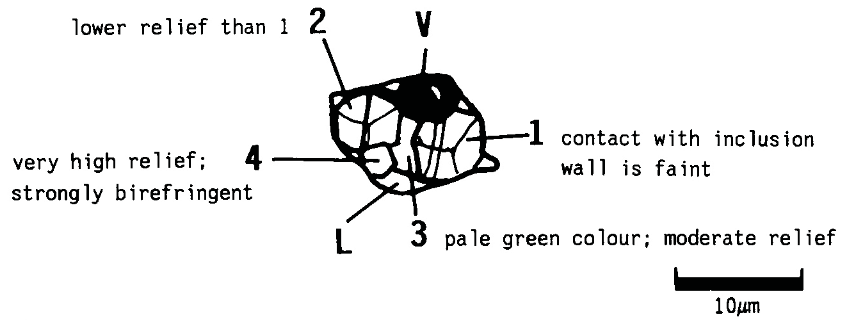
INCLUSION 7



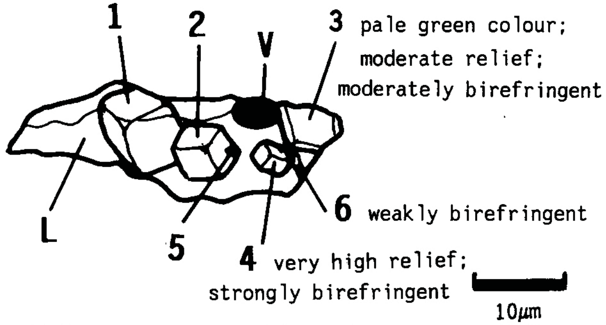
INCLUSION 10



INCLUSION 11



INCLUSION 12



KEY TO LABELS

- **V** H_2O (± (L±V) CO_2?) vapour bubble
- **L** H_2O liquid
- **1** halite
- **2** sylvite
- **3** Fe-chloride ($FeCl_2.2H_2O$?)
- **4** carbonate (calcite?)
- **5** haematite
- **6** unknown

SAMPLE NUMBER: JCU-27094 **INCLUSION NUMBER:** 1

Inclusion volume: 2022.1 $^{+115}_{-110}$ µm^3

Vapour volume: 14.7 $^{+6.6}_{-5.1}$ µm^3

Daughters:

Species	Density (g.cm^{-3})	Volume (µm^{-3})	Mass (x10^{-12}g)
halite	2.17	223.7 $^{+29}_{-27}$	485.4 $^{+63}_{-59}$
sylvite	1.99	172.4 $^{+23}_{-22}$	343.1 $^{+46}_{-44}$
$FeCl_2.2H_2O$	2.39	97.9 $^{+30}_{-26}$	234.0 $^{+72}_{-62}$
?$CaCO_3$	2.72	15.6 $^{+6.4}_{-5.0}$	42.4 $^{+17.4}_{-13.6}$
?$CaCl_2.6H_2O$	1.68	10.9 $^{+8.0}_{-6.3}$	18.3 $^{+13.4}_{-10.6}$

Liquid volume: 1486.9 $^{+150}_{-150}$ µm^3 **Liquid mass (x10^{-12}g):** 2230.4 $^{+225}_{-225}$ (for ρ = 1.5 g.cm^{-3})
: 2527.7 $^{+255}_{-255}$ (for ρ = 1.7 g.cm^{-3})
: 1933.0 $^{+195}_{-195}$ (for ρ = 1.3 g.cm^{-3})

Solute and solvent masses:

		(x10^{-12}g)	wt%
mass NaCl	= 485.4 + (0.0062 x 2230.4)	= 499.23	14.89
mass KCl	= 343.1 + (0.0322 x 2230.4)	= 414.92	12.37
mass $FeCl_2.2H_2O$	= 234.0		
mass $FeCl_2$	= (0.7788 x 234.0) + (0.10 x 2230.4)	= 405.27	12.08
mass ?$CaCO_3$	= 42.4	= 42.4	1.26
mass ?$CaCl_2.6H_2O$	= 18.3		
mass $CaCl_2$	= (0.4482 x 2230.4) + (0.5068 x 18.3)	= 1008.91	30.08
mass H_2O	= (0.4134 x 2230.4) + (0.2212 x 234.0) + (0.4932 x 18.3)	= 982.81	29.31
TOTAL		= 3353.54	100.00

Fluid composition:

	(x10^{-12}g)		(x10^{-12}g)		
mass Na^+	= 196.40	mass Cl^-	= 302.83	nNa^+	= 8.54x10^{-12} mol
mass K^+	= 217.62	mass Cl^-	= 197.29	nK^+	= 5.57x10^{-12} mol
mass Fe^{2+}	= 178.56	mass Cl^-	= 226.71	nFe^{2+}	= 3.20x10^{-12} mol
mass Ca^{2+}	= 381.29	mass Cl^-	= 644.59	nCa^{2+}	= 9.52x10^{-12} mol
		TOTAL Cl^-	= 1371.42	nCl^-	= 3.87x10^{-11} mol
mass H_2O	= 982.81			nH_2O	= 5.46x10^{-11} mol

wt% salts = 70.69 wt% Cl^- = 40.89

SAMPLE NUMBER: JCU-27094 **INCLUSION NUMBER:** 7

Inclusion volume: 1076.1 $^{+90}_{-80}$ µm^3

Vapour volume: 10.1 $^{+3.2}_{-2.5}$ µm^3

Daughters:

Species	Density (g.cm^{-3})	Volume (µm^{-3})	Mass (x10^{-12}g)
halite	2.17	185.2 $^{+25}_{-23}$	401.9 $^{+54}_{-50}$
sylvite	1.99	79.5 $^{+15}_{-13}$	158.2 $^{+30}_{-26}$
$FeCl_2.2H_2O$	2.39	17.6 $^{+8.5}_{-6.6}$	42.1 $^{+20.3}_{-15.8}$
?$CaCO_3$	2.72	27.0 $^{+8.9}_{-7.3}$	73.4 $^{+24}_{-20}$
?$CaCl_2.6H_2O$	1.68	8.6 $^{+4.7}_{-3.5}$	14.5 $^{+7.9}_{-5.9}$

Liquid volume: 748.1 $^{+25}_{-24}$ µm^3 **Liquid mass (x10^{-12}g):** 1122.2 $^{+38}_{-36}$ (for ρ = 1.5 g.cm^{-3})
: 1271.8 $^{+43}_{-41}$ (for ρ = 1.7 g.cm^{-3})
: 972.5 $^{+33}_{-31}$ (for ρ = 1.3 g.cm^{-3})

Solute and solvent masses:

		(x10^{-12}g)	wt%
mass NaCl	= 401.9 + (0.0062 x 1122.2)	= 408.86	22.56
mass KCl	= 158.2 + (0.0322 x 1122.2)	= 194.33	10.72
mass $FeCl_2.2H_2O$	= 42.1		
mass $FeCl_2$	= (0.7788 x 42.1) + (0.10 x 1122.2)	= 145.00	8.00
mass ?$CaCO_3$	= 73.4	= 73.4	4.05
mass ?$CaCl_2.6H_2O$	= 14.5		
mass $CaCl_2$	= (0.4482 x 1122.2) + (0.5068 x 14.5)	= 510.30	28.16
mass H_2O	= (0.4134 x 1122.2) + (0.2212 x 42.1) + (0.4932 x 14.5)	= 480.36	26.51
TOTAL		= 1812.25	100.00

Fluid composition:

	(x10^{-12}g)		(x10^{-12}g)		
mass Na^+	= 160.85	mass Cl^-	= 248.01	nNa^+	= 7.0x10^{-12} mol
mass K^+	= 101.93	mass Cl^-	= 92.41	nK^+	= 2.61x10^{-12} mol
mass Fe^{2+}	= 63.89	mass Cl^-	= 81.11	nFe^{2+}	= 1.14x10^{-12} mol
mass Ca^{2+}	= 213.66	mass Cl^-	= 326.03	nCa^{2+}	= 5.33x10^{-12} mol
		TOTAL Cl^-	= 747.56	nCl^-	= 2.11x10^{-11} mol
mass H_2O	= 480.36			nH_2O	= 2.67x10^{-11} mol

wt% salts = 73.49 wt% Cl^- = 41.25

SAMPLE NUMBER: JCU-27094 **INCLUSION NUMBER:** 10

Inclusion volume: 553.9^{+49}_{-47} µm^3

Vapour volume: $2.91^{+1.4}_{-1.0}$ µm^3

Daughters:

Species	Density (g.cm^{-3})	Volume (µm^{-3})	Mass (x10^{-12}g)
halite	2.17	129.6^{+20}_{-18}	281.2^{+43}_{-39}
sylvite	1.99	$16.2^{+5.3}_{-4.4}$	$32.2^{+10.5}_{-8.8}$
$FeCl_2.2H_2O$	2.39	$15.9^{+9.4}_{-7.2}$	$38.0^{+22.5}_{-17.2}$
?$CaCO_3$	2.72	$2.2^{+2.0}_{-1.3}$	$6.0^{+5.4}_{-3.5}$
?$CaCl_2.6H_2O$	1.68	$5.6^{+2.6}_{-2.1}$	$9.4^{+4.4}_{-3.5}$

Liquid volume: 381.5^{+40}_{-40}µm^3 **Liquid mass (x10^{-12}g):** 572.3^{+60}_{-60} (for ρ = 1.5 g.cm^{-3})
: 648.6^{+68}_{-68} (for ρ = 1.7 g.cm^{-3})
: 496.0^{+52}_{-52} (for ρ = 1.3 g.cm^{-3})

Solute and solvent masses:

		(x10^{-12}g)	wt%
mass NaCl	= 281.2 + (0.0062 x 572.3)	= 284.75	30.32
mass KCl	= 32.2 + (0.0322 x 572.3)	= 50.63	5.39
mass $FeCl_2.2H_2O$	= 38.0		
mass $FeCl_2$	= (0.7788 x 38.00) + (0.10 x 572.3)	= 86.82	9.25
mass ?$CaCO_3$	= 6.0	= 6.0	0.64
mass ?$CaCl_2.6H_2O$	= 9.4		
mass $CaCl_2$	= (0.4482 x 572.3) + (0.5068 x 9.4)	= 261.25	27.82
mass H_2O	= (0.4134 x 572.3) + (0.2212 x 38.0) + (0.4932 x 9.4)	= 249.61	26.58
TOTAL		= 939.06	100.00

Fluid composition:

	(x10^{-12}g)		(x10^{-12}g)		
mass Na^+	= 112.02	mass Cl^-	= 172.73	nNa^+	= 4.87x10^{-12} mol
mass K^+	= 26.55	mass Cl^-	= 24.07	nK^+	= 6.79x10^{-13} mol
mass Fe^{2+}	= 38.25	mass Cl^-	= 48.57	nFe^{2+}	= 6.85x10^{-13} mol
mass Ca^{2+}	= 96.74	mass Cl^-	= 166.91	nCa^{2+}	= 2.41x10^{-12} mol
		TOTAL Cl^-	= 1412.28	nCl^-	= 1.16x10^{-11} mol
mass H_2O	= 249.61			nH_2O	= 1.39x10^{-11} mol

wt% salts = 73.42 wt% Cl^- = 43.90

?Fe_2O_3 : present but volumetrically insignificant.

SAMPLE NUMBER: JCU-27094 **INCLUSION NUMBER:** 11

Inclusion volume: 391.6^{+69}_{-62} µm^3

Vapour volume: $23.0^{+5.1}_{-4.4}$ µm^3

Daughters:

Species	Density (g.cm^{-3})	Volume (µm^{-3})	Mass (x10^{-12}g)
halite	2.17	$61.5^{+12.6}_{-10.9}$	$133.5^{+27.3}_{-23.7}$
sylvite	1.99	$47.4^{+10.6}_{-9.1}$	$94.3^{+21.1}_{-18.1}$
$FeCl_2.2H_2O$	2.39	29.0^{+19}_{-16}	69.3^{+45}_{-38}
?$CaCO_3$	2.72	$8.6^{+2.7}_{-4.2}$	$23.4^{+7.3}_{-11.4}$

Liquid volume: 222.1^{+20}_{-20}µm^3 **Liquid mass (x10^{-12}g):** 333.2^{+30}_{-30} (for ρ = 1.5 g.cm^{-3})
: 377.6^{+34}_{-34} (for ρ = 1.7 g.cm^{-3})
: 288.7^{+26}_{-26} (for ρ = 1.3 g.cm^{-3})

Solute and solvent masses:

		(x10^{-12}g)	wt%
mass NaCl	= 133.5 + (0.0062 x 333.2)	= 135.57	20.74
mass KCl	= 94.3 + (0.0322 x 333.2)	= 105.03	16.07
mass $FeCl_2.2H_2O$	= 69.3		
mass $FeCl_2$	= (0.7788 x 69.3) + (0.10 x 333.2)	= 87.29	13.35
mass ?$CaCO_3$	= 23.4	= 23.4	3.58
mass $CaCl_2$	= (0.4482 x 333.2)	= 149.32	22.84
mass H_2O	= (0.4134 x 333.2) + (0.2212 x 69.3)	= 153.05	23.41
TOTAL		= 653.66	100.00

Fluid composition:

	(x10^{-12}g)		(x10^{-12}g)		
mass Na^+	= 55.33	mass Cl^-	= 82.23	nNa^+	= 2.32x10^{-12} mol
mass K^+	= 55.09	mass Cl^-	= 49.94	nK^+	= 1.41x10^{-12} mol
mass Fe^{2+}	= 38.46	mass Cl^-	= 48.83	nFe^{2+}	= 6.89x10^{-13} mol
mass Ca^{2+}	= 63.29	mass Cl^-	= 95.40	nCa^{2+}	= 1.58x10^{-12} mol
		TOTAL Cl^-	= 276.40	nCl^-	= 7.80x10^{-12} mol
mass H_2O	= 153.05			nH_2O	= 8.50x10^{-12} mol

wt% salts = 76.59 wt% Cl^- = 42.28

SAMPLE NUMBER: JCU-27094 **INCLUSION NUMBER:** 12

Inclusion volume: 2789.9 $^{+672}_{-581}$ µm^3

Vapour volume: 40.22 $^{+7.3}_{-6.5}$ µm^3

Daughters:

Species	Density (g.cm^{-3})	Volume (µm^{-3})	Mass (x10^{-12}g)
halite	2.17	582.0 $^{+54}_{-51}$	1262.9 $^{+117}_{-111}$
sylvite	1.99	216.0 $^{+34}_{-31}$	429.8 $^{+68}_{-62}$
$FeCl_2.2H_2O$	2.39	77.5 $^{+32}_{-26}$	185.2 $^{+77}_{-62}$
?$CaCO_3$	2.72	23.3 $^{+8.7}_{-7.1}$	63.4 $^{+23.7}_{-19.3}$
?$CaCl_2.6H_2O$	1.68	1.0 $^{+0.9}_{-0.6}$	1.68 $^{+1.5}_{-1.0}$

Liquid volume: 1849.9 $^{+535}_{-549}$ µm^3 **Liquid mass (x10^{-12}g):** 2774.9 $^{+803}_{-689}$ (for ρ = 1.5 g.cm^{-3})
: 3144.8 $^{+910}_{-780}$ (for ρ = 1.7 g.cm^{-3})
: 2404.9 $^{+696}_{-597}$ (for ρ = 1.3 g.cm^{-3})

Solute and solvent masses:

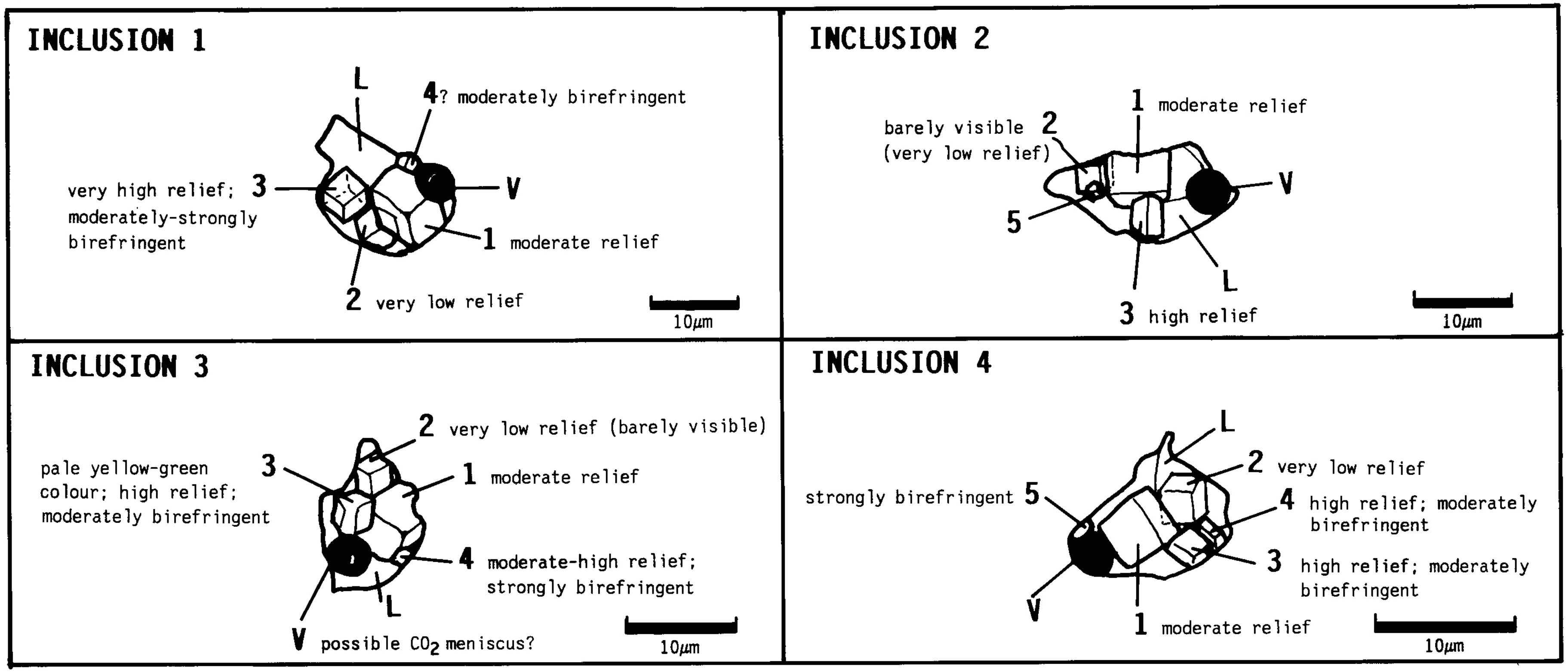
		(x10^{-12}g)	wt%
mass NaCl	= 1262.9 + (0.0062 x 2774.9)	= 1280.1	27.13
mass KCl	= 429.8 + (0.0322 x 2774.9)	= 519.5	11.00
mass $FeCl_2.2H_2O$	= 185.2		
mass $FeCl_2$	= (0.7788 x 185.2) + (0.10 x 2774.9)	= 421.72	8.94
mass ?$CaCO_3$	= 63.4	= 63.4	1.34
mass ?$CaCl_2.6H_2O$	= 1.68		
mass $CaCl_2$	= (0.4482 x 2774.9) + (0.5068 x 1.68)	= 1244.54	26.38
mass H_2O	= (0.4134 x 2774.9) + (0.2212 x 185.2) + (0.4932 x 1.68)	= 1188.92	25.20
TOTAL		= 4717.83	100.00

Fluid composition:

	(x10^{-12}g)		(x10^{-12}g)		
mass Na^+	= 503.59	mass Cl^-	= 776.51	nNa^+	= 2.19x10^{-11} mol
mass K^+	= 272.29	mass Cl^-	= 246.86	nK^+	= 6.96x10^{-12} mol
mass Fe^{2+}	= 185.81	mass Cl^-	= 235.91	nFe^{2+}	= 3.33x10^{-12} mol
mass Ca^{2+}	= 474.79	mass Cl^-	= 795.14	nCa^{2+}	= 1.19x10^{-11} mol
		TOTAL Cl^-	= 2054.42	nCl^-	= 5.80x10^{-11} mol
mass H_2O	= 1188.92			nH_2O	= 6.61x10^{-11} mol

wt% salts = 74.80 wt% Cl^- = 43.55

SAMPLE JCU-27110



KEY TO LABELS

V H_2O (± (L±V) CO_2?) vapour bubble
L H_2O liquid
1 halite
2 sylvite
3 Fe-chloride ($FeCl_2.2H_2O$?)
4 carbonate (calcite?)
5 unknown

SAMPLE NUMBER: JCU-27110 **INCLUSION NUMBER:** 1

Inclusion volume: 559.4^{+99}_{-89} µm^3

Vapour volume: $14.7^{+3.8}_{-3.2}$ µm^3

Daughters:

Species	Density (g.cm^{-3})	Volume (µm^{-3})	Mass (x10^{-12}g)
halite	2.17	66.4^{+13}_{-12}	144.1^{+28}_{-26}
sylvite	1.99	$11.9^{+4.3}_{-3.5}$	$23.7^{+8.6}_{-7.0}$
$FeCl_2.2H_2O$	2.39	$10.8^{+9.3}_{-6.6}$	$25.8^{+22.2}_{-15.8}$
?$CaCO_3$	2.72	$0.5^{+0.5}_{-0.3}$	$1.36^{+1.4}_{-0.8}$

Liquid volume: 455.1^{+68}_{-64} µm^3 **Liquid mass (x10^{-12}g):** 682.7^{+102}_{-96} (for ρ = 1.5 g.cm^{-3})
: 773.7^{+116}_{-109} (for ρ = 1.7 g.cm^{-3})
: 591.6^{+88}_{-83} (for ρ = 1.3 g.cm^{-3})

Solute and solvent masses:

		(x10^{-12}g)	wt%
mass NaCl	= 144.1 + (0.0032 x 692.7)	= 148.33	16.90
mass KCl	= 23.7 + (0.0322 x 682.7)	= 45.68	5.21
mass $FeCl_2.2H_2O$	= 25.8		
mass $FeCl_2$	= (0.7788 x 25.8) + (0.10 x 682.7)	= 88.36	10.07
mass ?$CaCO_3$	= 1.36	= 1.36	0.15
mass $CaCl_2$	= (0.4482 x 682.7)	= 305.96	34.86
mass H_2O	= (0.4134 x 682.7) + (0.2212 x 25.8)	= 287.92	32.77
TOTAL		= 877.61	100.00

Fluid composition:

	(x10^{-12}g)		(x10^{-12}g)		
mass Na^+	= 58.35	mass Cl^-	= 89.98	nNa^+	= 2.54x10^{-12} mol
mass K^+	= 23.96	mass Cl^-	= 21.72	nK^+	= 6.13x10^{-13} mol
mass Fe^{2+}	= 38.93	mass Cl^-	= 49.43	nFe^{2+}	= 6.97x10^{-13} mol
mass Ca^{2+}	= 111.03	mass Cl^-	= 195.48	nCa^{2+}	= 2.77x10^{-12} mol
		TOTAL Cl^-	= 359.61	nCl^-	= 1.01x10^{-11} mol
mass H_2O	= 287.92			nH_2O	= 1.60x12^{-11} mol

wt% salts = 67.23 wt% Cl^- = 40.63

SAMPLE NUMBER: JCU-27110 **INCLUSION NUMBER:** 2

Inclusion volume: 481.7 $^{+50}_{-46}$ μm^3

Vapour volume: 18.6 $^{+4.6}_{-4.0}$ μm^3

Daughters:

Species	Density ($g.cm^{-3}$)	Volume (μm^{-3})	Mass ($x10^{-12}g$)
halite	2.17	129.6 $^{+20}_{-18}$	281.2 $^{+43}_{-39}$
sylvite	1.99	16.2 $^{+5.3}_{-4.4}$	32.2 $^{+10.6}_{-8.8}$
$FeCl_2.2H_2O$	2.39	12.7 $^{+11.2}_{-7.9}$	30.4 $^{+27}_{-19}$
?$CaCO_3$	2.72	3.1 $^{+1.3}_{-1.1}$	8.4 $^{+3.5}_{-3.0}$

Liquid volume: 301.5 $^{+7}_{-11}$ μm^3 **Liquid mass ($x10^{-12}g$):** 452.3 $^{+11}_{-17}$ (for ρ = 1.5 $g.cm^{-3}$)
: 512.6 $^{+12}_{-19}$ (for ρ = 1.7 $g.cm^{-3}$)
: 392.0 $^{+9}_{-14}$ (for ρ = 1.3 $g.cm^{-3}$)

Solute and solvent masses:

		($x10^{-12}g$)	wt%
mass NaCl	= 281.2 + (0.0062 x 452.3)	= 284.00	35.30
mass KCl	= 32.2 + (0.0322 x 452.3)	= 46.76	5.81
mass $FeCl_2.2H_2O$	= 30.4		
mass $FeCl_2$	= (0.7788 x 30.4) + (0.10 x 452.3)	= 68.90	8.56
mass ?$CaCO_3$	= 8.4	= 8.4	1.04
mass $CaCl_2$	= (0.4482 x 452.3)	= 202.70	25.20
mass H_2O	= (0.4134 x 452.3) + (0.2212 x 30.4)	= 193.69	24.08
TOTAL		= 804.45	100.00

Fluid composition:

	($x10^{-12}g$)		($x10^{-12}g$)		
mass Na^+	= 111.73	mass Cl^-	= 172.28	nNa^+	= $4.86x10^{-12}$ mol
mass K^+	= 24.53	mass Cl^-	= 22.24	nK^+	= $6.27x10^{-13}$ mol
mass Fe^{2+}	= 30.36	mass Cl^-	= 38.54	nFe^{2+}	= $5.44x10^{-13}$ mol
mass Ca^{2+}	= 76.56	mass Cl^-	= 129.50	nCa^{2+}	= $1.91x10^{-12}$ mol
		TOTAL Cl^-	= 362.56	nCl^-	= $1.02x10^{-11}$ mol
mass H_2O	= 193.69			nH_2O	= $1.08x10^{-11}$ mol

wt% salts = 75.92 wt% Cl^- = 45.07

SAMPLE NUMBER: JCU-27110 **INCLUSION NUMBER:** 3

Inclusion volume: 330.7^{+44}_{-41} µm^3

Vapour volume: $20.9^{+8.3}_{-6.5}$ µm^3

Daughters:

Species	Density (g.cm^{-3})	Volume (µm^{-3})	Mass (x10^{-12}g)
halite	2.17	89.9^{+16}_{-14}	195.1^{+35}_{-30}
sylvite	1.99	$8.0^{+7.6}_{-4.6}$	$15.9^{+15.1}_{-9.2}$
$FeCl_2.2H_2O$	2.39	$12.9^{+8.9}_{-6.5}$	$30.8^{+21.3}_{-15.5}$
?$CaCO_3$	2.72	$0.9^{+0.7}_{-0.5}$	$2.5^{+1.9}_{-1.4}$

Liquid volume: 198.1^{+20}_{-20} µm^3 **Liquid mass (x10^{-12}g):** 297.2^{+30}_{-30} (for ρ = 1.5 g.cm^{-3})
: 336.8^{+34}_{-34} (for ρ = 1.7 g.cm^{-3})
: 257.5^{+26}_{-26} (for ρ = 1.3 g.cm^{-3})

Solute and solvent masses:

		(x10^{-12}g)	wt%
mass NaCl	= 195.1 + (0.0062 x 297.2)	= 196.94	36.37
mass KCl	= 15.9 + (0.0322 x 297.2)	= 25.47	4.70
mass $FeCl_2.2H_2O$	= 30.8		
mass $FeCl_2$	= (0.7788 x 30.8) + (0.10 x 297.2)	= 53.70	9.92
mass ?$CaCO_3$	= 2.5	= 2.5	0.46
mass $CaCl_2$	= (0.4482 x 297.2)	= 133.18	24.60
mass H_2O	= (0.4134 x 297.2) + (0.2212 x 30.8)	= 129.66	23.95
TOTAL		= 541.45	100.00

Fluid composition:

	(x10^{-12}g)		(x10^{-12}g)		
mass Na^+	= 77.48	mass Cl^-	= 119.47	nNa^+	= $3.37x10^{-12}$ mol
mass K^+	= 13.34	mass Cl^-	= 12.11	nK^+	= $3.42x10^{-13}$ mol
mass Fe^{2+}	= 23.66	mass Cl^-	= 30.04	nFe^{2+}	= $4.24x10^{-13}$ mol
mass Ca^{2+}	= 49.09	mass Cl^-	= 85.09	nCa^{2+}	= $1.23x10^{-12}$ mol
		TOTAL Cl^-	= 246.71	nCl^-	= $6.96x10^{-12}$ mol
mass H_2O	= 129.66			nH_2O	= $7.20x10^{-12}$ mol

wt% salts = 76.05 wt% Cl^- = 45.56

SAMPLE NUMBER: JCU-27110 **INCLUSION NUMBER:** 4

Inclusion volume: 127.5 $^{+13}_{-12}$ µm^3

Vapour volume: 10.3 $^{+4.2}_{-4.0}$ µm^3

Daughters:

Species	Density (g.cm^{-3})	Volume (µm^{-3})	Mass (x10^{-12}g)
halite	2.17	28.1 $^{+7.5}_{-6.4}$	61.0 $^{+16.3}_{-13.9}$
sylvite	1.99	5.8 $^{+2.8}_{-2.1}$	11.5 $^{+5.6}_{-4.2}$
$FeCl_2.2H_2O$	2.39	4.08 $^{+4.9}_{-2.3}$	9.8 $^{+11.7}_{-5.5}$
?$CaCO_3$	2.72	1.0 $^{+1.0}_{-0.6}$	2.72 $^{+2.7}_{-1.6}$

Liquid volume: 77.7 $^{+8}_{-8}$ µm^3 **Liquid mass (x10^{-12}g):** 116.6 $^{+12}_{-12}$ (for ρ = 1.5 g.cm^{-3})
: 132.1 $^{+14}_{-14}$ (for ρ = 1.7 g.cm^{-3})
: 101.0 $^{+10}_{-10}$ (for ρ = 1.3 g.cm^{-3})

Solute and solvent masses:

		(x10^{-12}g)	wt%
mass NaCl	= 61.0 + (0.0062 x 116.6)	= 61.72	26.90
mass KCl	= 11.5 + (0.0322 x 116.6)	= 43.16	18.81
mass $FeCl_2.2H_2O$	= 9.8		
mass $FeCl_2$	= (0.7788 x 9.8) + (0.10 x 116.6)	= 19.29	8.41
mass ?$CaCO_3$	= 2.72	= 2.72	1.19
mass $CaCl_2$	= (0.4482 x 116.6)	= 52.24	22.76
mass H_2O	= (0.4134 x 116.6) + (0.2212 x 9.8)	= 50.35	21.94
TOTAL		= 229.48	100.00

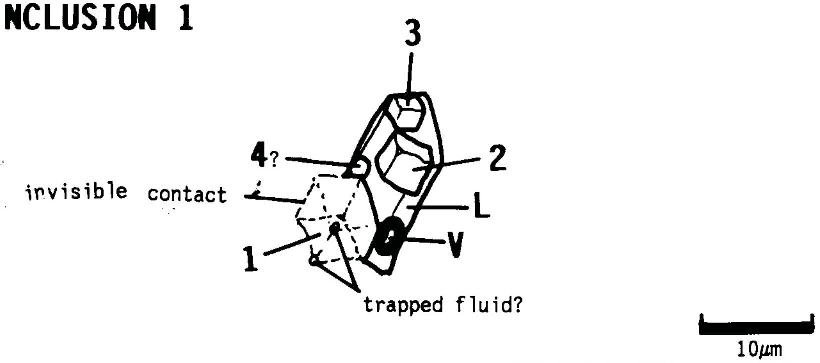
Fluid composition:

	(x10^{-12}g)		(x10^{-12}g)		
mass Na^+	= 24.28	mass Cl^-	= 37.44	nNa^+	= 1.06x10^{-12} mol
mass K^+	= 22.64	mass Cl^-	= 20.52	nK^+	= 5.79x10^{-13} mol
mass Fe^{2+}	= 8.50	mass Cl^-	= 10.79	nFe^{2+}	= 1.52x10^{-13} mol
mass Ca^{2+}	= 19.95	mass Cl^-	= 33.38	nCa^{2+}	= 4.98x10^{-13} mol
		TOTAL Cl^-	= 102.13	nCl^-	= 2.88x10^{-12} mol
mass H_2O	= 50.53			nH_2O	= 2.80x10^{-12} mol

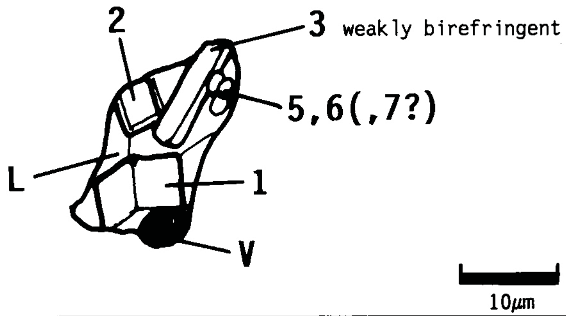
wt% salts = 78.06 wt% Cl^- = 44.50

SAMPLE JCU-27199

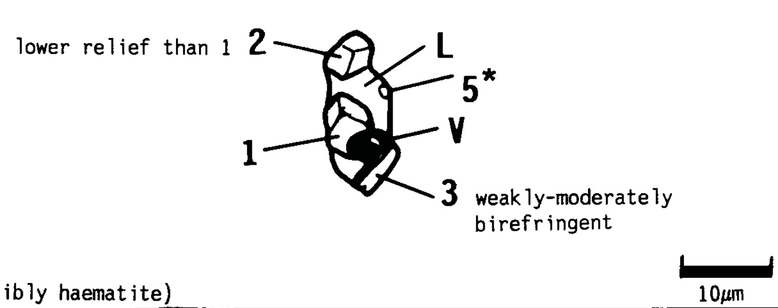
INCLUSION 1



INCLUSION 2

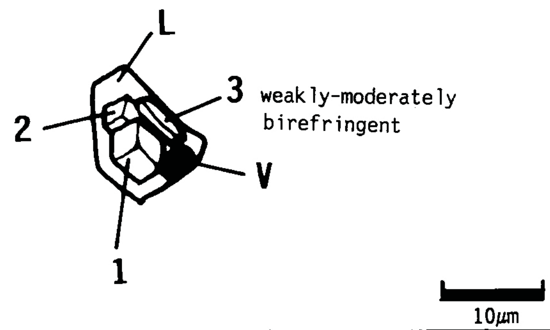


INCLUSION 3

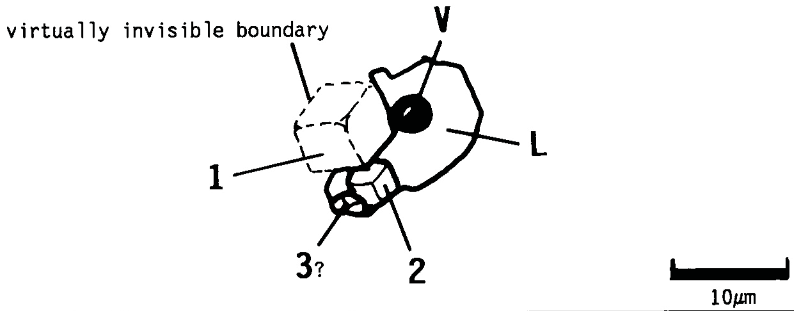


(* possibly haematite)

INCLUSION 6



INCLUSION 9



KEY TO LABELS

V	H_2O (± (L±V) CO_2?) vapour bubble
L	H_2O liquid
1	halite
2	sylvite
3	Fe-chloride ($FeCl_2.2H_2O$?)
4	carbonate (calcite?)
5,6,7	unknowns

SAMPLE NUMBER: JCU-27199 **INCLUSION NUMBER:** 1

Inclusion volume: 792.9 $^{+80}_{-80}$ µm^3

Vapour volume: 13.3 $^{+3.6}_{-3.0}$ µm^3

Daughters:

Species	Density (g.cm^{-3})	Volume (µm^{-3})	Mass (x10^{-12}g)
halite	2.17	129.6 $^{+24}_{-22}$	281.2 $^{+52}_{-48}$
sylvite	1.99	35.6 $^{+9}_{-8}$	70.8 $^{+18}_{-16}$
$FeCl_2.2H_2O$	2.39	11.9 $^{+4.3}_{-3.4}$	28.4 $^{+10.3}_{-8.1}$
?$CaCO_3$	2.72	4.2 $^{+2.8}_{-2.0}$	11.4 $^{+7.6}_{-5.4}$

Liquid volume: 598.3 $^{+36}_{-42}$µm^3 **Liquid mass (x10^{-12}g):** 897.5 $^{+54}_{-63}$ (for ρ = 1.5 g.cm^{-3})
: 1017.1 $^{+38}_{-71}$ (for ρ = 1.7 g.cm^{-3})
: 777.8 $^{+47}_{-55}$ (for ρ = 1.3 g.cm^{-3})

Solute and solvent masses:

		(x10^{-12}g)	wt%
mass NaCl	= 281.2 + (0.0062 x 897.5)	= 286.77	22.24
mass KCl	= 70.8 + (0.0322 x 897.5)	= 99.70	7.73
mass $FeCl_2.2H_2O$	= 28.4		
mass $FeCl_2$	= (0.7788 x 28.4) + (0.10 x 897.5)	= 111.87	8.68
mass ?$CaCO_3$	= 11.4	= 11.4	0.88
mass $CaCl_2$	= (0.4482 x 897.5)	= 402.26	31.20
mass H_2O	= (0.4134 x 897.5) + (0.2212 x 28.4)	= 377.31	29.26
TOTAL		= 1289.31	100.00

Fluid composition:

	(x10^{-12}g)		(x10^{-12}g)		
mass Na^+	= 112.81	mass Cl^-	= 173.95	nNa^+	= 4.91x10^{-12} mol
mass K^+	= 52.29	mass Cl^-	= 47.41	nK^+	= 1.34x10^{-12} mol
mass Fe^{2+}	= 49.29	mass Cl^-	= 62.58	nFe^{2+}	= 8.83x10^{-13} mol
mass Ca^{2+}	= 149.82	mass Cl^-	= 257.00	nCa^{2+}	= 3.74x10^{-12} mol
		TOTAL Cl^-	= 540.94	nCl^-	= 1.53x10^{-11} mol
mass H_2O	= 377.31			nH_2O	= 2.10x10^{-11} mol

wt% salts = 70.74 wt% Cl^- = 41.96

SAMPLE NUMBER: JCU-27199 **INCLUSION NUMBER:** 2

Inclusion volume: 1788.8 $^{+129}_{-124}$ µm^3

Vapour volume: 48.9 $^{+13.5}_{-11.1}$ µm^3

Daughters:

Species	Density (g.cm^{-3})	Volume (µm^{-3})	Mass (x10^{-12}g)
halite	2.17	284.9 $^{+34}_{-31}$	618.2 $^{+74}_{-67}$
sylvite	1.99	111.3 $^{+18}_{-17}$	221.5 $^{+36}_{-34}$
$FeCl_2.2H_2O$	2.39	42.1 $^{+21}_{-17}$	100.6 $^{+50}_{-41}$

Liquid volume: 1300.6 $^{+41}_{-47}$ µm^3 **Liquid mass (x10^{-12}g):** 1950.9 $^{+62}_{-71}$ (for ρ = 1.5 g.cm^{-3})
: 2211.0 $^{+70}_{-80}$ (for ρ = 1.7 g.cm^{-3})
: 1690.8 $^{+53}_{-61}$ (for ρ = 1.3 g.cm^{-3})

Solute and solvent masses:

		(x10^{-12}g)	wt%
mass NaCl	= 618.2 + (0.0062 x 1950.9)	= 630.30	21.80
mass KCl	= 221.5 + (0.0322 x 1950.9)	= 284.32	9.83
mass $FeCl_2.2H_2O$	= 100.6		
mass $FeCl_2$	= (0.7788 x 100.6) + (0.10 x 1950.9)	= 273.44	9.46
mass $CaCl_2$	= (0.4482 x 1950.9)	= 874.39	30.24
mass H_2O	= (0.4134 x 1950.9) + (0.2212 x 100.6)	= 828.76	28.66
TOTAL		= 2891.21	100.00

Fluid composition:

	(x10^{-12}g)		(x10^{-12}g)		
mass Na^+	= 247.96	mass Cl^-	= 382.34	nNa^+	= 1.08x10^{-11} mol
mass K^+	= 149.13	mass Cl^-	= 135.19	nK^+	= 3.81x10^{-12} mol
mass Fe^{2+}	= 120.48	mass Cl^-	= 152.96	nFe^{2+}	= 2.16x10^{-12} mol
mass Ca^{2+}	= 315.74	mass Cl^-	= 558.65	nCa^{2+}	= 7.88x10^{-12} mol
		TOTAL Cl^-	= 1229.14	nCl^-	= 3.47x10^{-11} mol
mass H_2O	= 828.76			nH_2O	= 4.60x10^{-11} mol

wt% salts = 71.34 wt% Cl^- = 42.51

SAMPLE NUMBER: JCU-27199 **INCLUSION NUMBER:** 3

Inclusion volume: 311.7 $^{+41}_{-37}$ μm^3

Vapour volume: 12.8 $^{+3.6}_{-2.9}$ μm^3

Daughters:

Species	Density ($g.cm^{-3}$)	Volume (μm^{-3})	Mass ($x10^{-12}g$)
halite	2.17	59.3 $^{+12}_{-11}$	128.7 $^{+26}_{-24}$
sylvite	1.99	16.2 $^{+5.3}_{-4.4}$	32.2 $^{+10.5}_{-8.8}$
$FeCl_2.2H_2O$	2.39	4.5 $^{+5.3}_{-3.5}$	10.8 $^{+12.7}_{-8.4}$

Liquid volume: 218.9 $^{+14}_{-15}$ μm^3

Liquid mass ($x10^{-12}g$): 328.4 $^{+21}_{-23}$ (for ρ = 1.5 $g.cm^{-3}$)
: 372.1 $^{+24}_{-26}$ (for ρ = 1.7 $g.cm^{-3}$)
: 284.6 $^{+18}_{-20}$ (for ρ = 1.3 $g.cm^{-3}$)

Solute and solvent masses:

		($x10^{-12}g$)	wt%
mass NaCl	= 128.7 + (0.0062 x 328.4)	= 130.74	26.14
mass KCl	= 32.2 + (0.0322 x 328.4)	= 42.77	8.55
mass $FeCl_2.2H_2O$	= 10.8		
mass $FeCl_2$	= (0.7788 x 10.8) + (0.10 x 328.4)	= 41.25	8.25
mass $CaCl_2$	= (0.4482 x 328.4)	= 147.17	29.43
mass H_2O	= (0.4134 x 328.4) + (0.2212 x 10.8)	= 138.13	27.62
TOTAL		= 500.06	100.00

Fluid composition:

	($x10^{-12}g$)		($x10^{-12}g$)		
mass Na^+	= 51.43	mass Cl^-	= 79.30	nNa^+	= $2.24x10^{-12}$ mol
mass K^+	= 22.43	mass Cl^-	= 20.34	nK^+	= $5.74x10^{-13}$ mol
mass Fe^{2+}	= 18.17	mass Cl^-	= 23.07	nFe^{2+}	= $3.25x10^{-13}$ mol
mass Ca^{2+}	= 53.14	mass Cl^-	= 94.03	nCa^{2+}	= $1.33x10^{-12}$ mol
		TOTAL Cl^-	= 216.74	nCl^-	= $6.11x10^{-12}$ mol
mass H_2O	= 138.13			nH_2O	= $7.67x10^{-12}$ mol

wt% salts = 72.38 wt% Cl^- = = 43.34

SAMPLE NUMBER: JCU-27199 **INCLUSION NUMBER:** 6

Inclusion volume: 450.6 $^{+35}_{-34}$ μm^3

Vapour volume: 16.7 $^{+4.1}_{-3.6}$ μm^3

Daughters:

Species	Density ($g.cm^{-3}$)	Volume (μm^{-3})	Mass ($x10^{-12}g$)
halite	2.17	54.9 $^{+12}_{-6}$	119.13 $^{+26}_{-13}$
sylvite	1.99	11.9 $^{+4.3}_{-3.5}$	23.7 $^{+8.6}_{-7.0}$
$FeCl_2.2H_2O$	2.39	5.9 $^{+6.9}_{-4.6}$	14.1 $^{+16.5}_{-11.0}$

Liquid volume: 361.2 $^{+8}_{-16}$ μm^3 **Liquid mass ($x10^{-12}g$):** 541.8 $^{+12}_{-24}$ (for ρ = 1.5 $g.cm^{-3}$)
: 614.0 $^{+14}_{-27}$ (for ρ = 1.7 $g.cm^{-3}$)
: 469.6 $^{+10}_{-21}$ (for ρ = 1.3 $g.cm^{-3}$)

Solute and solvent masses:

		($x10^{-12}g$)	wt%
mass NaCl	= 119.1 + (0.0062 x (41.8)	= 122.46	17.53
mass KCl	= 23.7 + (0.0322 x 541.8)	= 41.15	5.89
mass $FeCl_2.2H_2O$	= 14.1		
mass $FeCl_2$	= (0.7788 x 14.1) + (0.10 x 541.8)	= 65.16	9.33
mass $CaCl_2$	= (0.4482 x 541.8)	= 242.84	34.76
mass H_2O	= (0.4134 x 541.8) + 0.2212 x 14.1)	= 227.10	32.50
TOTAL		= 698.71	100.00

Fluid composition:

	($x10^{-12}g$)		($x10^{-12}g$)		
mass Na^+	= 48.18	mass Cl^-	= 74.28	nNa^+	= $2.10x10^{-12}$ mol
mass K^+	= 21.58	mass Cl^-	= 19.57	nK^+	= $5.52x10^{-13}$ mol
mass Fe^{2+}	= 28.71	mass Cl^-	= 36.45	nFe^{2+}	= $5.14x10^{-13}$ mol
mass Ca^{2+}	= 87.69	mass Cl^-	= 155.15	nCa^{2+}	= $2.19x10^{-12}$ mol
		TOTAL Cl^-	= 285.45	nCl^-	= $8.05x10^{-12}$ mol
mass H_2O	= 227.10			nH_2O	= $1.26x10^{-11}$ mol

wt% salts = 67.5 wt% Cl^- = 40.85

SAMPLE NUMBER: JCU-27199 **INCLUSION NUMBER:** 9

Inclusion volume: 624.8 $^{+62}_{-59}$ μm^3

Vapour volume: 11.3 $^{+3.1}_{-2.7}$ μm^3

Daughters:

Species	Density ($g.cm^{-3}$)	Volume (μm^{-3})	Mass ($x10^{-12}g$)
halite	2.17	174.8 $^{+30}_{-27}$	379.3 $^{+65}_{-59}$
sylvite	1.99	35.6 $^{+9}_{-8}$	70.8 $^{+18}_{-16}$
$FeCl_2.2H_2O$	2.39	3.0 $^{+1.3}_{-1.1}$	7.17 $^{+3.1}_{-2.6}$

Liquid volume: 400.1 $^{+19}_{-20}$ μm^3 **Liquid mass ($x10^{-12}g$):** 600.2 $^{+29}_{-30}$ (for ρ = 1.5 $g.cm^{-3}$)
: 680.2 $^{+32}_{-34}$ (for ρ = 1.7 $g.cm^{-3}$)
: 520.1 $^{+25}_{-26}$ (for ρ = 1.3 $g.cm^{-3}$)

Solute and solvent masses:

		($x10^{-12}g$)	wt%
mass NaCl	= 379.3 + (0.0062 x 600.2)	= 383.02	36.22
mass KCl	= 70.8 + (0.0322 x 600.2)	= 90.13	8.52
mass $FeCl_2.2H_2O$	= 7.17		
mass $FeCl_2$	= (0.7788 x 7.17) + (0.10 x 600.2)	= 65.60	6.20
mass $CaCl_2$	= (0.4482 x 600.2)	= 268.99	25.44
mass H_2O	= (0.4134 x 600.2) + (0.2212 x 7.17)	= 249.69	23.61
TOTAL		= 1057.43	100.00

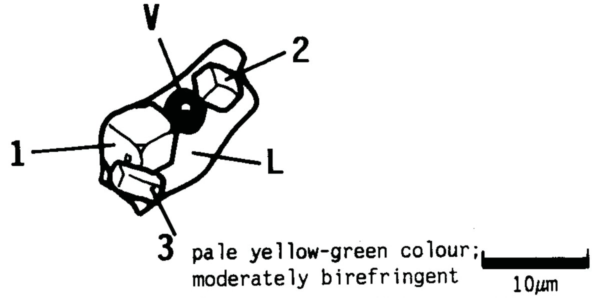
Fluid composition:

	($x10^{-12}g$)		($x10^{-12}g$)		
mass Na^+	= 150.68	mass Cl^-	= 232.34	nNa^+	= $6.55x10^{-12}$ mol
mass K^+	= 47.27	mass Cl^-	= 42.86	nK^+	= $1.21x10^{-12}$ mol
mass Fe^{2+}	= 28.90	mass Cl^-	= 36.70	nFe^{2+}	= $5.18x10^{-13}$ mol
mass Ca^{2+}	= 97.13	mass Cl^-	= 171.86	nCa^{2+}	= $2.42x10^{-12}$ mol
		TOTAL Cl^-	= 483.76	nCl^-	= $1.37x10^{-11}$ mol
mass H_2O	= 249.69			nH_2O	= $1.39x10^{-11}$ mol

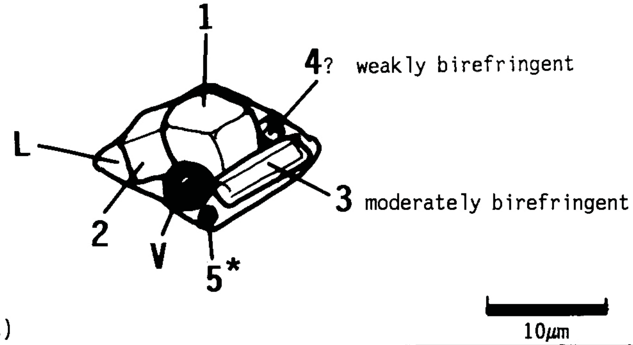
wt% salts = 76.39 wt% Cl^- = 45.75

SAMPLE JCU-27271

INCLUSION 1

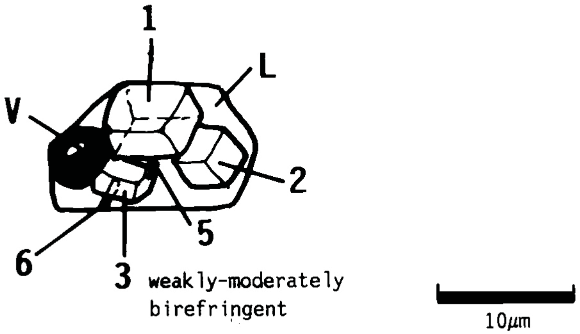


INCLUSION 4



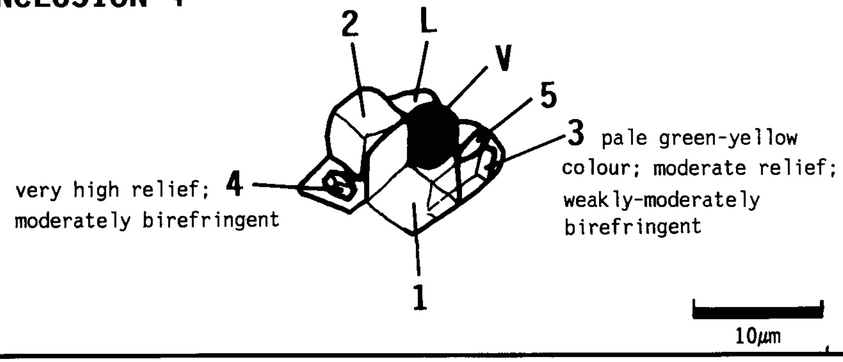
(* may be an artifact)

INCLUSION 9



SAMPLE JCU-27068

INCLUSION 4



KEY TO LABELS

- **V** H_2O (± (L±V) CO_2?) vapour bubble
- **L** H_2O liquid
- **1** halite
- **2** sylvite
- **3** Fe-chloride ($FeCl_2.2H_2O$?)
- **4** carbonate (calcite?)
- **5,6** unknowns

SAMPLE NUMBER: JCU-27271 **INCLUSION NUMBER:** 1

Inclusion volume: 744.8 $^{+72}_{-68}$ μm^3

Vapour volume: 18.6 $^{+4.6}_{-4.0}$ μm^3

Daughters:

Species	Density ($g.cm^{-3}$)	Volume (μm^{-3})	Mass ($x10^{-12}g$)
halite	2.17	129.6 $^{+20}_{-18}$	281.2 $^{+43}_{-39}$
sylvite	1.99	28.0 $^{+8}_{-6}$	55.7 $^{+16}_{-12}$
$FeCl_2.2H_2O$	2.39	11.0 $^{+8}_{-6}$	26.3 $^{+19}_{-14}$

Liquid volume: 557.6 $^{+31}_{-34}$ μm^3

Liquid mass ($x10^{-12}g$): 836.4 $^{+47}_{-51}$ (for $\rho = 1.5\ g.cm^{-3}$)
: 947.9 $^{+53}_{-58}$ (for $\rho = 1.7\ g.cm^{-3}$)
: 724.9 $^{+40}_{-44}$ (for $\rho = 1.3\ g.cm^{-3}$)

Solute and solvent masses:

		($x10^{-12}g$)	wt%
mass NaCl	= 281.2 + (0.0062 x 836.4)	= 286.39	23.87
mass KCl	= 55.7 + (0.0322 x 836.4)	= 82.63	6.89
mass $FeCl_2.2H_2O$	= 26.3		
mass $FeCl_2$	= (0.7788 x 26.3) + (0.10 x 836.4)	= 104.12	8.68
mass $CaCl_2$	= (0.4482 x 836.4)	= 374.88	31.25
mass H_2O	= (0.4134 x 836.4) + (0.2212 x 26.3)	= 351.58	29.31
TOTAL		= 1199.61	100.00

Fluid composition:

	($x10^{-12}g$)		($x10^{-12}g$)		
mass Na^+	= 112.66	mass Cl^-	= 173.72	nNa^+	= $4.90x10^{-12}$ mol
mass K^+	= 43.34	mass Cl^-	= 39.29	nK^+	= $1.12x10^{-12}$ mol
mass Fe^{2+}	= 45.88	mass Cl^-	= 58.25	nFe^{2+}	= $8.22x10^{-13}$ mol
mass Ca^{2+}	= 135.37	mass Cl^-	= 239.51	nCa^{2+}	= $3.38x10^{-12}$ mol
		TOTAL Cl^-	= 510.77	nCl^-	= $1.44x10^{-11}$ mol
mass H_2O	= 351.58			nH_2O	= $1.95x10^{-11}$ mol

wt% salts = 70.69 wt% Cl^- = 42.58

SAMPLE NUMBER: JCU-27271 **INCLUSION NUMBER:** 4

Inclusion volume: 498.4 $^{+40}_{-42}$ μm^3

Vapour volume: 14.7 $^{+4.0}_{-3.3}$ μm^3

Daughters:

Species	Density ($g.cm^{-3}$)	Volume (μm^{-3})	Mass ($x10^{-12}g$)
halite	2.17	145.4 $^{+22}_{-20}$	315.5 $^{+48}_{-43}$
sylvite	1.99	21.6 $^{+6}_{-5}$	43.0 $^{+12}_{-10}$
$FeCl_2.2H_2O$	2.39	17.3 $^{+12.5}_{-7.5}$	41.35 $^{+30}_{-18}$
?$CaCO_3$	2.72	1.6 $^{+1.5}_{-0.9}$	4.4 $^{+4.1}_{-2.5}$

Liquid volume: 297.8 $^{+30}_{-30}$ μm^3

Liquid mass ($x10^{-12}g$): 446.7 $^{+45}_{-45}$ (for ρ = 1.5 $g.cm^{-3}$)
: 506.3 $^{+51}_{-51}$ (for ρ = 1.7 $g.cm^{-3}$)
: 387.1 $^{+39}_{-39}$ (for ρ = 1.3 $g.cm^{-3}$)

Solute and solvent masses:

		($x10^{-12}g$)	wt%
mass NaCl	= 315.5 + (0.0062 x 446.7)	= 318.27	37.40
mass KCl	= 43.0 + (0.0322 x 446.7)	= 57.38	6.74
mass $FeCl_2.2H_2O$	= 41.35		
mass $FeCl_2$	= (0.7788 x 41.35) + (0.10 x 446.7)	= 76.87	9.03
mass ?$CaCO_3$	= 4.4	= 4.4	0.52
mass $CaCl_2$	= (0.4482 x 446.7)	= 200.21	= 23.53
mass H_2O	= (0.4134 x 446.7) + (0.2212 x 41.35)	193.81	22.78
TOTAL		= 850.95	100.00

Fluid composition:

	($x10^{-12}g$)		($x10^{-12}g$)		
mass Na^+	= 125.21	mass Cl^-	= 193.06	nNa^+	= $5.45x10^{-12}$ mol
mass K^+	= 30.1	mass Cl^-	= 27.28	nK^+	= $7.70x10^{-13}$ mol
mass Fe^{2+}	= 33.87	mass Cl^-	= 43.00	nFe^{2+}	= $6.07x10^{-13}$ mol
mass Ca^{2+}	= 74.06	mass Cl^-	= 127.91	nCa^{2+}	= $1.85x10^{-12}$ mol
		TOTAL Cl^-	= 391.25	nCl^-	= $1.10x10^{-11}$ mol
mass H_2O	= 193.81			nH_2O	= $1.08x10^{-11}$ mol

wt% salts = 77.22 wt% Cl^- = 45.98

SAMPLE NUMBER: JCU-27271 **INCLUSION NUMBER:** 9

Inclusion volume: 816.8 $^{+78}_{-73}$ μm^3

Vapour volume: 38.3 $^{+7}_{-6.3}$ μm^3

Daughters:

Species	Density ($g.cm^{-3}$)	Volume (μm^{-3})	Mass ($x10^{-12}g$)
halite	2.17	144.7 $^{+22}_{-20}$	314.0 $^{+48}_{-43}$
sylvite	1.99	27.0 $^{+7.3}_{-6.2}$	53.7 $^{+14.5}_{-12.3}$
$FeCl_2.2H_2O$	2.39	16.6 $^{+8.7}_{-6.6}$	39.7 $^{+21}_{-16}$
?$CaCl_2.6H_2O$[1]	1.68	-	-

Liquid volume: 590.2 $^{+33}_{-34}$ μm^3 **Liquid mass ($x10^{-12}g$):** 885.3 $^{+50}_{-51}$ (for ρ = 1.5 $g.cm^{-3}$)
: 1003.3 $^{+56}_{-58}$ (for ρ = 1.7 $g.cm^{-3}$)
: 767.3 $^{+43}_{-44}$ (for ρ = 1.3 $g.cm^{-3}$)

Solute and solvent masses:

		($x10^{-12}g$)	wt%
mass NaCl	= 314.0 + (0.0062 x 885.3)	= 319.49	24.71
mass KCl	= 53.7 + (0.0322 x 885.3)	= 82.21	6.36
mass $FeCl_2.2H_2O$	= 39.7		
mass $FeCl_2$	= (0.7788 x 39.7) + (0.10 x 885.3)	= 119.45	9.24
mass ?$CaCl_2.6H_2O$	(assume negligible)		
mass $CaCl_2$	= (0.4482 x 885.3)	= 396.79	30.69
mass H_2O	= (0.4134 x 885.3) + (0.2212 x 39.7)	= 374.77	28.99
TOTAL		= 1292.70	100.00

Fluid composition:

	($x10^{-12}g$)		($x10^{-12}g$)		
mass Na^+	= 125.69	mass Cl^-	= 193.80	nNa^+	= $5.47x10^{-12}$ mol
mass K^+	= 43.12	mass Cl^-	= 39.09	nK^+	= $1.10x10^{-12}$ mol
mass Fe^{2+}	= 52.63	mass Cl^-	= 66.82	nFe^{2+}	= $9.42x10^{-13}$ mol
mass Ca^{2+}	= 143.28	mass Cl^-	= 253.51	nCa^{2+}	= $3.58x10^{-12}$ mol
		TOTAL Cl^-	= 553.22	nCl^-	= $1.56x10^{-11}$ mol
mass H_2O	= 374.77			nH_2O	= $2.08x10^{-11}$ mol

wt% salts = 71.01 wt% Cl^- = 42.8

[1] $CaCl_2.6H_2O$ was tentatively identified, but volumetrically insignificant; it indicates probable $CaCl_2$ saturation in the liquid.

SAMPLE NUMBER: JCU-27068 **INCLUSION NUMBER:** 4

Inclusion volume: 814.0 $^{+234}_{-197}$ µm^3

Vapour volume: 33.2 $^{+6.5}_{-5.7}$ µm^3

Daughters:

Species	Density (g.cm^{-3})	Volume (µm^{-3})	Mass (x10^{-12}g)
halite	2.17	163.2 $^{+24}_{-21}$	354.1 $^{+52}_{-46}$
sylvite	1.99	114.6 $^{+19}_{-17}$	228.1 $^{+38}_{-34}$
$FeCl_2.2H_2O$	2.39	15.6 $^{+8.9}_{-6.7}$	37.3 $^{+21.3}_{-16.0}$
?$CaCO_3$	2.72	3.5 $^{+2.1}_{-1.5}$	9.5 $^{+5.7}_{-4.1}$
?$CaCl_2.6H_2O$	1.68	2.1 $^{+1.2}_{-0.9}$	3.5 $^{+2.0}_{-1.5}$

Liquid volume: 481.8 $^{+172}_{-144}$ µm^3

Liquid mass (x10^{-12}g): 722.7 $^{+258}_{-216}$ (for ρ = 1.5 g.cm^{-3})
: 819.1 $^{+292}_{-245}$ (for ρ = 1.7 g.cm^{-3})
: 626.3 $^{+224}_{-187}$ (for ρ = 1.3 g.cm^{-3})

Solute and solvent masses:

		(x10^{-12}g)	wt%
mass NaCl	= 354.1 + (0.0062 x 722.7)	= 358.58	26.46
mass KCl	= 228.1 + (0.0322 x 722.7)	= 251.37	18.55
mass $FeCl_2.2H_2O$	= 37.3		
mass $FeCl_2$	= (0.7788 x 37.3) + (0.10 x 722.7)	= 101.32	7.48
mass ?$CaCO_3$	= 9.5	= 9.5	0.70
mass ?$CaCl_2.6H_2O$	= 3.5		
mass $CaCl_2$	= (0.4482 x 722.7) + (0.5068 x 3.5)	= 325.69	24.03
mass H_2O	= (0.4134 x 722.7) + (0.2212 x 37.3) + (0.4932 x 3.5)	= 308.74	22.78
TOTAL		= 1355.20	100.00

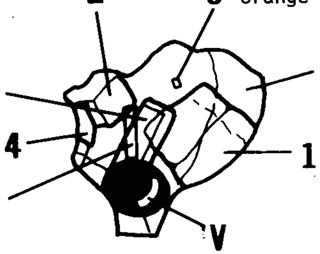
Fluid composition:

	(x10^{-12}g)		(x10^{-12}g)		
mass Na^+	= 141.07	mass Cl^-	= 217.52	nNa^+	= 6.14x10^{-12} mol
mass K^+	= 131.84	mass Cl^-	= 119.53	nK^+	= 3.37x10^{-12} mol
mass Fe^{2+}	= 44.64	mass Cl^-	= 56.68	nFe^{2+}	= 7.99x10^{-13} mol
mass Ca^{2+}	= 121.41	mass Cl^-	= 208.08	nCa^{2+}	= 3.03x10^{-12} mol
		TOTAL Cl^-	= 601.81	nCl^-	= 1.70x10^{-11} mol
mass H_2O	= 308.74			nH_2O	= 1.72x10^{-11} mol

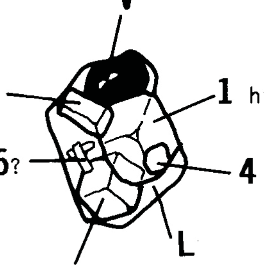
wt% salts = 77.22 wt% Cl^- = 44.41

SAMPLE JCU-27273

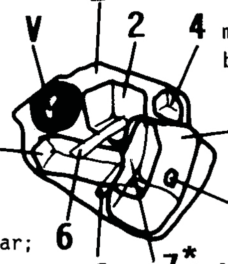
INCLUSION 1



INCLUSION 4

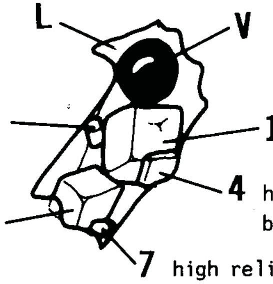


INCLUSION 5

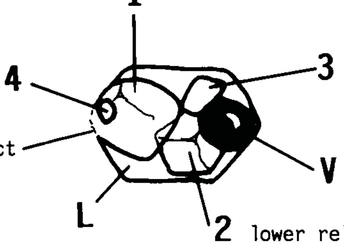


(* may also be Fe-chloride)

INCLUSION 8



INCLUSION 10



negative crystal shape (// to host quartz C-axis)

KEY TO LABELS

- **V** H_2O (± (L±V) CO_2?) vapour bubble
- **L** H_2O liquid
- **1** halite
- **2** sylvite
- **3** Fe-chloride ($FeCl_2.2H_2O$?)
- **4** carbonate (calcite?)
- **5** haematite?
- **6** unknown (possibly $CaCl_2.6H_2O$)
- **7,8** unknown

SAMPLE NUMBER: JCU-27273 **INCLUSION NUMBER:** 1

Inclusion volume: 3914.0 $^{+395}_{-371}$ µm^3

Vapour volume: 339.0 $^{+49}_{-45}$ µm^3

Daughters:

Species	Density (g.cm^{-3})	Volume (µm^{-3})	Mass (x10^{-12}g)
halite	2.17	1036.4 $^{+95}_{-89}$	2249.0 $^{+206}_{-193}$
sylvite	1.99	355.5 $^{+38}_{-37}$	707.5 $^{+76}_{-74}$
$FeCl_2.2H_2O$	2.39	182.4 $^{+52}_{-46}$	435.9 $^{+124}_{-110}$
Fe_2O_3	5.26	0.23 $^{+0.4}_{-0.2}$	1.21 $^{+2.1}_{-1.1}$
?$CaCO_3$	2.72	15.6 $^{+6}_{-5}$	42.4 $^{+16}_{-14}$
?$CaCl_2.6H_2O$	1.68	12.8 $^{+6}_{-5}$	21.5 $^{+10.1}_{-8.4}$

Liquid volume: 1972.1 $^{+149}_{-144}$ µm^3 **Liquid mass (x10^{-12}g):** 2958.2 $^{+224}_{-216}$ (for ρ = 1.5 g.cm^{-3})
: 3352.6 $^{+253}_{-245}$ (for ρ = 1.7 g.cm^{-3})
: 2563.7 $^{+194}_{-187}$ (for ρ = 1.3 g.cm^{-3})

Solute and solvent masses:

		(x10^{-12}g)	wt%
mass NaCl	= 2249.0 + (0.0062 x 2958.2)	= 2267.34	35.34
mass KCl	= 707.5 + (0.0322 x 2958.2)	= 802.75	12.51
mass $FeCl_2.2H_2O$	= 435.9		
mass $FeCl_2$	= (0.7788 x 435.9) + (0.10 x 2958.2)	= 635.30	9.90
mass ?Fe_2O_3	= 1.21	= 1.21	0.02
mass ?$CaCO_3$	= 42.4	= 42.4	0.66
mass ?$CaCl_2.6H_2O$	= 21.5		
mass $CaCl_2$	= (0.5068 x 21.5) + (0.4482 x 2958.2)	= 1336.76	20.84
mass H_2O	= (0.4134 x 2958.2) + (0.2212 x 435.9) + (0.4932 x 21.5)	= 1329.95	20.73
TOTAL		= 6415.71	100.00

Fluid composition:

	(x10^{-12}g)		(x10^{-12}g)		
mass Na^+	= 891.97	mass Cl^-	= 1375.37	nNa^+	= 3.88x10^{-11} mol
mass K^+	= 421.05	mass Cl^-	= 381.71	nK^+	= 1.08x10^{-11} mol
mass Fe^{2+}	= 279.91	mass Cl^-	= 355.39	nFe^{2+}	= 5.01x10^{-12} mol
mass Fe^{3+}	= 0.85			nFe^{3+}	= 1.52x10^{-14} mol
mass Ca^{2+}	= 491.31	mass Cl^-	= 854.06	nCa^{2+}	= 1.23x10^{-11} mol
		TOTAL Cl^-	= 2966.53	nCl^-	= 8.37x10^{-11} mol
mass H_2O	= 1329.95			nH_2O	= 7.39x10^{-11} mol

wt% salts = 79.27 wt% Cl^- = 46.2

Assuming all Fe^{3+} is in Fe_2O_3 then Fe^{2+}/Fe^{3+} = 329.6 and $Fe^{3+}/(Fe^{2+}+Fe^{3+})$ = 0.0030

SAMPLE NUMBER: JCU-27273 **INCLUSION NUMBER:** 4

Inclusion volume: 1700.8 $^{+326}_{-293}$ µm^3

Vapour volume: 103.4 $^{+23}_{-20}$ µm^3

Daughters:

Species	Density (g.cm^{-3})	Volume (µm^{-3})	Mass (x10^{-12}g)
halite	2.17	223.9 $^{+29}_{-27}$	485.9 $^{+63}_{-59}$
sylvite	1.99	66.3 $^{+13}_{-11}$	131.9 $^{+26}_{-22}$
$FeCl_2.2H_2O$	2.39	33.7 $^{+14}_{-12}$	80.5 $^{+34}_{-29}$
?$CaCO_3$	2.72	7.2 $^{+3.2}_{-2.9}$	19.6 $^{+8.7}_{-6.8}$
?$CaCl_2.6H_2O$	1.68	1.34 $^{+0.8}_{-1.0}$	2.25 $^{+1.3}_{-1.7}$

Liquid volume: 1265.0 $^{+243}_{-219}$ µm^3 **Liquid mass (x10^{-12}g):** 1897.5 $^{+365}_{-329}$ (for ρ = 1.5 g.cm^{-3})
: 2150.5 $^{+413}_{-372}$ (for ρ = 1.7 g.cm^{-3})
: 1644.5 $^{+316}_{-285}$ (for ρ = 1.3 g.cm^{-3})

Solute and solvent masses:

		(x10^{-12}g)	wt%
mass NaCl	= 485.9 + (0.0062 x 1895.7)	= 497.67	19.01
mass KCl	= 131.9 + (0.0322 x 1897.5)	= 193.0	7.37
mass $FeCl_2.2H_2O$	= 80.5		
mass $FeCl_2$	= (0.7788 x 80.5) + (0.10 x 1897.5)	= 252.44	9.64
mass ?$CaCO_3$	= 19.6	= 19.6	0.75
mass ?$CaCl_2.6H_2O$	= 2.25		
mass $CaCl_2$	= (0.5068 x 2.25) + (0.4482 x 1897.5)	= 851.60	32.53
mass H_2O	= (0.4134 x 1897.5) + (0.2212 x 80.5) + (0.4932 x 2.25)	= 803.34	30.69
TOTAL		= 2617.66	100.00

Fluid composition:

	(x10^{-12}g)		(x10^{-12}g)		
mass Na^+	= 195.78	mass Cl^-	= 301.89	nNa^+	= 8.52x10^{-12} mol
mass K^+	= 101.23	mass Cl^-	= 91.77	nK^+	= 2.59x10^{-12} mol
mass Fe^{2+}	= 111.23	mass Cl^-	= 141.22	nFe^{2+}	= 1.99x10^{-12} mol
mass Ca^{2+}	= 315.36	mass Cl^-	= 544.09	nCa^{2+}	= 7.87x10^{-12} mol
		TOTAL Cl^-	= 1078.97	nCl^-	= 3.04x10^{-11} mol
mass H_2O	= 803.34			nH_2O	= 4.46x10^{-11} mol

wt% salts = 69.31 wt% Cl^- = 41.22

SAMPLE NUMBER: JCU-27273 **INCLUSION NUMBER:** 5

Inclusion volume: 1107.8 $^{+462}_{-413}$ μm^3

Vapour volume: 132.5 $^{+14}_{-15}$ μm^3

Daughters:

Species	Density ($g.cm^{-3}$)	Volume (μm^{-3})	Mass ($x10^{-12}g$)
halite	2.17	129.6 $^{+24}_{-22}$	281.2 $^{+52}_{-48}$
sylvite	1.99	28.1 $^{+7.5}_{-6.4}$	55.9 $^{+15}_{-12.7}$
$FeCl_2.2H_2O$	2.39	39.7 $^{+12}_{-10}$	94.9 $^{+29}_{-24}$
?Fe_2O_3	5.26	0.014 $^{+0.05}_{-0.02}$	0.074 $^{+0.26}_{-0.11}$
?$CaCO_3$	2.72	5.6 $^{+3}_{-2}$	15.2 $^{+7.2}_{-5.4}$
?$CaCl_2.6H_2O$	1.68	4.9 $^{+3.6}_{-2.5}$	8.2 $^{+6.1}_{-4.2}$

Liquid volume: 758.6 $^{+388}_{-348}$ μm^3 **Liquid mass ($x10^{-12}g$):** 1137.9 $^{+582}_{-522}$ (for ρ = 1.5 $g.cm^{-3}$)
: 1289.6 $^{+660}_{-592}$ (for ρ = 1.7 $g.cm^{-3}$)
: 986.2 $^{+504}_{-452}$ (for ρ = 1.3 $g.cm^{-3}$)

Solute and solvent masses:

		($x10^{-12}g$)	wt%
mass NaCl	= 281.2 + (0.0062 x 1137.9)	= 288.25	18.09
mass KCl	= 55.9 + (0.0322 x 1137.9)	= 92.54	5.81
mass $FeCl_2.2H_2O$	= 94.9		
mass $FeCl_2$	= (0.7788 x 94.9) + (0.10 x 1137.9)	= 187.70	11.78
mass ?Fe_2O_3	= 0.074	= 0.074	$4.64x10^{-3}$
mass ?$CaCO_3$	= 15.2	= 15.2	0.95
mass ?$CaCl_2.6H_2O$	= 8.2		
mass $CaCl_2$	= (0.5068 x 8.2) + (0.4482 x 1137.9)	= 514.16	32.27
mass H_2O	= (0.4134 x 1137.9) + (0.2212 x 94.9) + (0.4932 x 8.2)	= 495.44	31.09
TOTAL		= 1593.4	100.00

Fluid composition:

	($x10^{-12}g$)		($x10^{-12}g$)		
mass Na^+	= 113.40	mass Cl^-	= 174.85	nNa^+	= $4.93x10^{-12}$ mol
mass K^+	= 48.50	mass Cl^-	= 44.0	nK^+	= $1.24x10^{-12}$ mol
mass Fe^{2+}	= 82.70	mass Cl^-	= 105.00	nFe^{2+}	= $1.48x10^{-12}$ mol
mass Fe^{3+}	= 0.052			nFe^{3+}	= $9.27x10^{-16}$ mol
mass Ca^{2+}	= 191.75	mass Cl^-	= 328.50	nCa^{2+}	= $4.78x10^{-12}$ mol
		TOTAL Cl^-	= 652.35	nCl^-	= $1.84x10^{-11}$ mol
mass H_2O	= 495.44			nH_2O	= $2.75x10^{-11}$ mol

wt% salts = 68.91 wt% Cl^- = 40.94

Assuming all Fe^{3+} is in Fe_2O_3 Fe^{2+}/Fe^{3+} = 1596.55 and $Fe^{3+}/(^{2+}+Fe^{3+})$ = 0.0006

SAMPLE NUMBER: JCU-27273 **INCLUSION NUMBER:** 8

Inclusion volume: 3440.0^{+229}_{-218} µm^3

Vapour volume: 333.3^{+30}_{-29} µm^3

Daughters:

Species	Density (g.cm^{-3})	Volume (µm^{-3})	Mass (x10^{-12}g)
halite	2.17	439.0^{+45}_{-42}	952.6^{+98}_{-91}
sylvite	1.99	148.9^{+22}_{-20}	296.3^{+44}_{-40}
$FeCl_2.2H_2O$	2.39	8.0^{+8}_{-5}	19.1^{+19}_{-12}
?$CaCO_3$	2.72	86.8^{+16}_{-14}	236.1^{+44}_{-38}

Liquid volume: 2415.5^{+105}_{-106} µm^3 **Liquid mass (x10^{-12}g):** 3623.3^{+158}_{-159} (for ρ = 1.5 g.cm^{-3})
: 4106.4^{+179}_{-180} (for ρ = 1.7 g.cm^{-3})
: 3140.2^{+137}_{-138} (for ρ = 1.3 g.cm^{-3})

Solute and solvent masses:

		(x10^{-12}g)	wt%
mass NaCl	= 952.6 + (0.0062 x 3623.3)	= 975.1	19.02
mass KCl	= 296.3 + (0.0322 x 3623.3)	= 412.97	8.05
mass $FeCl_2.2H_2O$	= 19.1		
mass $FeCl_2$	= (0.7788 x 19.1) + (0.10 x 3623.3)	= 377.21	7.36
mass ?$CaCO_3$	= 236.1	= 236.1	4.60
mass $CaCl_2$	= (0.4482 x 3623.3)	= 1623.96	31.67
mass H_2O	= (0.4134 x 3623.3) + (0.2212 x 19.1)	= 1502.10	29.3
TOTAL		= 5127.45	100.00

Fluid composition:

	(x10^{-12}g)		(x10^{-12}g)		
mass Na^+	= 383.6	mass Cl^-	= 591.5	nNa^+	= $1.67x10^{-11}$ mol
mass K^+	= 216.6	mass Cl^-	= 196.4	nK^+	= $5.54x10^{-12}$ mol
mass Fe^{2+}	= 166.20	mass Cl^-	= 211.01	nFe^{2+}	= $2.98x10^{-12}$ mol
mass Ca^{2+}	= 680.95	mass Cl^-	= 1037.6	nCa^{2+}	= $1.69x10^{-11}$ mol
		TOTAL Cl^-	= 2036.51	nCl^-	= $5.74x10^{-11}$ mol
mass H_2O	= 1502.10			nH_2O	= $8.35x10^{-11}$ mol

wt% salts = 70.7 wt% Cl^- = 39.72

SAMPLE NUMBER: JCU-27273 **INCLUSION NUMBER:** 10

Inclusion volume: 839.3^{+75}_{-71} µm^3

Vapour volume: $67.8^{+10.6}_{-9.5}$ µm^3

Daughters:

Species	Density ($g.cm^{-3}$)	Volume (μm^{-3})	Mass ($x10^{-12}g$)
halite	2.17	172.4^{+25}_{-22}	374.1^{+54}_{-48}
sylvite	1.99	54.7^{+12}_{-10}	108.9^{+24}_{-20}
$FeCl_2.2H_2O$	2.39	$8.5^{+6.7}_{-5.0}$	20.3^{+16}_{-12}
?$CaCO_3$	2.72	$2.7^{+1.7}_{-1.2}$	$7.3^{+4.6}_{-3.3}$

Liquid volume: 533.2^{+19}_{-23} µm^3 **Liquid mass ($x10^{-12}g$):** 799.8^{+29}_{-35} (for ρ = 1.5 $g.cm^{-3}$)
: 906.4^{+32}_{-39} (for ρ = 1.7 $g.cm^{-3}$)
: 693.2^{+25}_{-30} (for ρ = 1.3 $g.cm^{-3}$)

Solute and solvent masses:

		($x10^{-12}g$)	wt%
mass NaCl	= 374.1 + (0.0062 x 799.8)	= 379.06	28.93
mass KCl	= 108.9 + (0.0322 x 799.8)	= 134.65	10.28
mass $FeCl_2.2H_2O$	= 20.3		
mass $FeCl_2$	= (0.7788 x 20.3) + (0.10 x 799.8)	= 95.79	7.31
mass ?$CaCO_3$	= 7.3	= 7.3	0.56
mass $CaCl_2$	= (0.4482 x 799.8)	= 358.47	27.36
mass H_2O	= (0.4134 x 799.8) + (0.2212 x 20.3)	= 335.13	25.57
TOTAL		= 1310.40	100.00

Fluid composition:

	($x10^{-12}g$)		($x10^{-12}g$)		
mass Na^+	= 149.12	mass Cl^-	= 229.94	nNa^+	= $6.49x10^{-12}$ mol
mass K^+	= 70.63	mass Cl^-	= 64.03	nK^+	= $1.81x10^{-12}$ mol
mass Fe^{2+}	= 42.21	mass Cl^-	= 53.59	nFe^{2+}	= $7.56x10^{-13}$ mol
mass Ca^{2+}	= 132.37	mass Cl^-	= 229.03	nCa^{2+}	= $3.30x10^{-12}$ mol
		TOTAL Cl^-	= 576.59	nCl^-	= $1.63x10^{-11}$ mol
mass H_2O	= 335.13			nH_2O	= $1.86x10^{-11}$ mol

wt% salts = 74.43 wt% Cl^- = 44.0

APPENDIX G

LISTING FOR THE PROGRAM "ISOTOPE.BAS"

```
10 CLS
20 PRINT "Welcome to ISODELTA, a QUICKBASIC programme for calculating"
30 PRINT " delta-values for 18O, 13C and D in fluid coexisting with"
40 PRINT "  a range of minerals, for a range of temperatures,"
45 PRINT "          in the system of your choice"
50 CLS : PRINT
60 PRINT "Please select the isotopic system you wish to use: "
70 PRINT
80 PRINT "1   delta-18O"
90 PRINT "2   delta-13C"
100 PRINT "3   delta-D"
110 PRINT "4   QUIT"
120 PRINT
160 INPUT "Enter the number of your choice: "; DTA
170 PRINT
171 IF DTA < 1 OR DTA > 4 GOTO 160
175 IF DTA = 1 THEN 200
180 IF DTA = 2 THEN 400
185 IF DTA = 3 THEN 600
190 IF DTA = 4 THEN 999
200 ' ------------------------------------------------------------------
201 ' Base routine for calculation of delta-18O values
202 ' ------------------------------------------------------------------
205 CLS : PRINT
210 PRINT "Excellent choice! Together we can calculate fluid delta-18O"
220 PRINT "using information from the following mineral-fluid pairs"
230 PRINT
240 PRINT "1  biotite-H2O                    6  paragonite-H2O"
250 PRINT "2  calcite-H2O                    7  plagioclase-H2O"
260 PRINT "3  dolomite-H2O                   8  quartz-H2O"
270 PRINT "4  K-feldspar-H2O                 9  PREVIOUS MENU"
271 PRINT "5  muscovite-H2O                  10 QUIT"
280 PRINT
290 PRINT "Please enter the number of the mineral for which"
300 INPUT "you have delta-18O isotopic data: "; MIN
305 IF MIN < 1 OR MIN > 10 THEN 306 ELSE 308
306 PRINT "Whoops! Your finger must have slipped. Please try again.": GOTO 290
308 PRINT
309 INPUT "Please enter the sample number: "; NUM$
310 IF MIN = 1 THEN GOSUB 1000
320 IF MIN = 2 THEN GOSUB 2000
330 IF MIN = 3 THEN GOSUB 3000
340 IF MIN = 4 THEN GOSUB 4000
350 IF MIN = 5 THEN GOSUB 5000
355 IF MIN = 6 THEN GOSUB 5000
360 IF MIN = 7 THEN GOSUB 6000
370 IF MIN = 8 THEN GOSUB 7000
380 IF MIN = 9 THEN GOTO 50
390 IF MIN = 10 THEN 999
```

```
400 ' -----------------------------------------------------------------
405 ' Base routine for calculation of delta-13C values
410 ' -----------------------------------------------------------------
420 CLS : PRINT
430 PRINT "Excellent choice! Together we can calculate fluid delta-13C"
440 PRINT "using information from the following mineral-fluid pairs"
450 PRINT
460 PRINT "1  calcite-CO2                3  PREVIOUS MENU"
470 PRINT "2  dolomite-CO2               4  QUIT"
480 PRINT
490 PRINT "Please enter the number of the mineral for which"
500 INPUT "you have delta-18O isotopic data: "; MIN
510 IF MIN < 1 OR MIN > 4 THEN 520 ELSE 530
520 PRINT "Whoops! Your finger must have slipped. Please try again.": GOTO 490
530 INPUT "Please enter the sample number: "; NUM$
540 IF MIN = 1 OR MIN = 2 THEN GOSUB 8000
550 IF MIN = 3 THEN GOTO 50
560 IF MIN = 4 THEN 999
600 ' -----------------------------------------------------------------
601 ' Base routine for calculation of delta-D values
602 ' -----------------------------------------------------------------
605 : PRINT
610 PRINT "Excellent choice! Together we can calculate fluid delta-D"
620 PRINT "using information from the following mineral-fluid pairs"
630 PRINT
640 PRINT "1  biotite-H2O                 4  phlogopite-H2O"
650 PRINT "2  muscovite-H2O               5  PREVIOUS MENU"
660 PRINT "3  amphibole-H2O               6  QUIT "
680 PRINT
690 PRINT "Please enter the number of the mineral for which"
700 INPUT "you have delta-D isotopic data: "; MIN
705 IF MIN < 1 OR MIN > 6 THEN 706 ELSE 708
706 PRINT "Whoops! Your finger must have slipped. Please try again.": GOTO 690
708 PRINT
709 INPUT "Please enter the sample number: "; NUM$
710 IF MIN = 1 OR MIN = 2 OR MIN = 3 OR MIN = 4 THEN GOSUB 9000
720 IF MIN = 5 THEN GOTO 50
730 IF MIN = 6 THEN 999
999 END
1000 ' -----------------------------------------------------------------
1005 ' Calculate delta-18O of water coexisting with BIOTITE"
1010 ' -----------------------------------------------------------------
1015 CLS
1020 PRINT "OK! Let's calculate the delta-18O of water coexisting"
1025 PRINT "with BIOTITE, for the temperature range you specify."
1030 PRINT
1035 PRINT "Oh dear, I am sorry, but I don't yet have the necessary"
1040 PRINT "equations. Please try another mineral."
1045 CLS : GOTO 230
1050 RETURN
```

```
2000 ' ---------------------------------------------------------------
2005 ' Calculate delta-18O of water coexisting with CALCITE"
2010 ' ---------------------------------------------------------------
2011 MINAM$ = "CALCITE"
2012 CLS : PRINT
2015 PRINT "OK! Let's calculate the delta-18O of water coexisting"
2020 PRINT "with CALCITE, for the temperature range you specify."
2030 PRINT
2040 PRINT "We will use the empirical calibration of O'Neil et al., 1969."
2050 PRINT "(Journal of Chemical Physics, v.51, p.5547-5558), which is valid"
2060 PRINT "in the temperature range 0 to 500 degrees Celcius."
2070 PRINT
2075 LOLIM = 273.15: UPLIM = 773.15
2080 CALIB$ = "Using calibration of O'Neil et al. (1969)"
2085 GOSUB 15000
2086 GOSUB 15500
2090 FOR TEMK = STEMK TO FTEMK STEP INC
2120 DEL2 = 2.89 - (2.78 * 10 ^ 6 * TEMK ^ (-2)) + DEL1
2130 IF YEP$ = "Y" OR YEP$ = "y" THEN GOSUB 18000 ELSE GOSUB 18500
2140 NEXT TEMK
2150 GOSUB 14000
2160 RETURN
3000 ' ---------------------------------------------------------------
3005 ' Calculate delta-18O of water coexisting with DOLOMITE"
3010 ' ---------------------------------------------------------------
3011 MINAM$ = "DOLOMITE"
3012 CLS : PRINT
3015 PRINT "OK! Let's calculate the delta-18O of water coexisting"
3020 PRINT "with DOLOMITE, for the temperature range you specify."
3030 CLS
3040 PRINT "We have the option of using one of several different calibrations"
3050 PRINT "for this delta-18O calculation."
3060 PRINT
3090 PRINT "1. Friedman and O'Neil compilation, 1977."
3100 PRINT "      Temperature range 300 to 510 degrees Celcius"
3110 PRINT "2. Sheppard and Schwarcz, 1970."
3120 PRINT "      Temperature range   to  degrees Celcius"
3130 PRINT "3. Mathews and Katz, 1977."
3140 PRINT "      Temperature range 252 to 295 degrees Celcius"
3150 PRINT
3160 INPUT "Please select the one you wish to use: "; CAL
3165 IF CAL < 1 OR CAL > 3 THEN 3166 ELSE 3170
3166 PRINT "Slippery fingers! Please try again.": GOTO 3160
3170 IF CAL = 1 THEN 3200
3180 IF CAL = 2 THEN 3400
3190 IF CAL = 3 THEN 3600
3200 CLS : PRINT
3210 PRINT "You've chosen the Friedman and O'Neil (1977) compilation. Let's go!"
3220 PRINT
3230 LOLIM = 523.15: UPLIM = 773.15
3235 CALIB$ = "Using the compilation of Friedman and O'Neil (1977)"
3237 GOSUB 15000
3240 GOSUB 15500
```

```
3250 FOR TEMK = STEMK TO FTEMK STEP INC
3260 DEL2 = 1.5 - 3.2 * (10 ^ 6 * TEMK ^ (-2)) + DEL1
3270 IF YEP$ = "Y" OR YEP$ = "y" THEN GOSUB 18000 ELSE GOSUB 18500
3280 NEXT TEMK
3290 GOSUB 14000
3400 CLS : PRINT
3410 PRINT "You've chosen the calibration of Sheppard and Schwarcz (1970). Let's go!"
3420 PRINT
3430 LOLIM = 523.15: UPLIM = 773.15
3435 CALIB$ = "Using the calibration of Sheppard and Schwarcz (1970)"
3437 GOSUB 15000
3440 GOSUB 15500
3450 FOR TEMK = STEMK TO FTEMK STEP INC
3480 DEL2 = 3.29 - 3.23 * (10 ^ 6 * TEMK ^ (-2)) + DEL1
3490 IF YEP$ = "Y" OR YEP$ = "y" THEN GOSUB 18000 ELSE GOSUB 18500
3500 NEXT TEMK
3510 GOSUB 14000
3600 CLS : PRINT
3610 PRINT "You've chosen the calibration of Mathew and Katz (1977). Let's go!"
3620 PRINT
3630 LOLIM = 523.15: UPLIM = 573.15
3635 CALIB$ = "Using the calibration of Mathews and Katz (1977)"
3637 GOSUB 15000
3640 GOSUB 15500
3650 FOR TEMK = STEMK TO FTEMK STEP INC
3680 DEL2 = 3.24 - 3.06 * (10 ^ 6 * TEMK ^ (-2)) + DEL1
3690 IF YEP$ = "Y" OR YEP$ = "y" THEN GOSUB 18000 ELSE GOSUB 18500
3700 NEXT TEMK
3710 GOSUB 14000
3720 RETURN
4000 ' --------------------------------------------------------------
4005 ' Calculate delta-18O of water coexisting with K-FELDSPAR"
4010 ' --------------------------------------------------------------
4011 MINAM$ = "K-FELDSPAR"
4012 CLS : PRINT
4015 PRINT "OK! Let's calculate the delta-18O of water coexisting"
4020 PRINT "with K-FELDSPAR, for the temperature range you specify."
4030 CLS
4040 PRINT "We have the option of using one of several different calibrations"
4050 PRINT "for this delta-18O calculation."
4060 PRINT
4070 PRINT "1. Friedman and O'Neil compilation, 1977."
4080 PRINT "     Temperature range 500 to 800 degrees Celcius"
4090 PRINT "2. O'Neil and Taylor, 1967. Am. Mineral., v.52, p.1414-1437."
4100 PRINT "     Temperature range 350 to 800 degrees Celcius"
4110 PRINT "3. Matsuhisa et al., 1979. Geochim. Cosmochim. Acta, v.43, pp.1131-1140."
4120 PRINT "     Temperature range 400 to 800 degrees Celcius"
4130 PRINT
4140 INPUT "Please select the one you wish to use: "; CAL
4165 IF CAL < 1 OR CAL > 3 THEN 4166 ELSE 4170
4166 PRINT "Slippery fingers! Please try again.": GOTO 4140
4170 IF CAL = 1 THEN 4200
4180 IF CAL = 2 THEN 4400
4190 IF CAL = 3 THEN 4600
```

```
4200 CLS : PRINT
4210 PRINT "You've chosen the Friedman and O'Neil (1977) compilation. Let's go!"
4230 LOLIM = 723.15: UPLIM = 1073.15
4235 CALIB$ = "Using the compilation of Friedman and O'Neil (1977)"
4237 GOSUB 15000
4240 GOSUB 15500
4250 FOR TEMK = STEMK TO FTEMK STEP INC
4280 DEL2 = 3.7 - 3.13 * (10 ^ 6 * TEMK ^ (-2)) + DEL1
4290 IF YEP$ = "Y" OR YEP$ = "y" THEN GOSUB 18000 ELSE GOSUB 18500
4300 NEXT TEMK
4310 GOSUB 14000
4400 CLS : PRINT
4410 PRINT "You've chosen the O'Neil and Taylor (1967) calibration. Let's go!"
4420 LOLIM = 623.15: UPLIM = 1073.15
4425 CALIB$ = "Using the calibration of O'Neil and Taylor (1967)"
4427 GOSUB 15000
4430 GOSUB 15500
4440 FOR TEMK = STEMK TO FTEMK STEP INC
4470 DEL2 = 3.41 - 2.91 * (10 ^ 6 * TEMK ^ (-2)) + DEL1
4480 IF YEP$ = "Y" OR YEP$ = "y" THEN GOSUB 18000 ELSE GOSUB 18500
4490 NEXT TEMK
4500 GOSUB 14000
4600 CLS : PRINT
4610 PRINT "You've chosen the Matsuhisa et al. (1979) calibration. Let's go!"
4620 LOLIM = 673.15: UPLIM = 1073.15
4625 CALIB$ = "Using the calibration of Matsuhisa et al. (1979)"
4627 GOSUB 15000
4630 GOSUB 15500
4650 FOR TEMK = STEMK TO FTEMK STEP INC
4660 IF TEMK >= 673.15 AND TEMK < 773.15 THEN DEL2 = 2.51 - (2.39 * 10 ^ 6 * TEMK
        ^ (-2)) + DEL1
4700 IF TEMK >= 773.15 AND TEMK <= 773.15 THEN DEL2 = 1.16 - (1.59 * 10 ^ 6 * TEMK
        ^ (-2)) + DEL1
4720 IF YEP$ = "Y" OR YEP$ = "y" THEN GOSUB 18000 ELSE GOSUB 18500
4730 NEXT TEMK
4740 GOSUB 14000
4800 RETURN
5000 ' ----------------------------------------------------------------------
5005 ' Calculate delta-18O of water coexisting with MUSCOVITE or PARAGONITE"
5010 ' ----------------------------------------------------------------------
5020 CLS : PRINT
5022 IF MIN = 5 THEN MINAM$ = "MUSCOVITE"
5024 IF MIN = 6 THEN MINAM$ = "PARAGONITE"
5030 PRINT "OK! Let's calculate the delta-18O of water coexisting"
5040 PRINT "with", MINAM$, "for the temperature range you specify"
5050 PRINT
5060 PRINT "We have the option of using one of several different calibrations"
5070 PRINT "for this delta-18O calculation."
5080 PRINT
5090 PRINT "1. Friedman and O'Neil compilation, 1977."
5100 PRINT "     Temperature range 500 to 800 degrees Celcius"
5110 PRINT "2. O'Neil and Taylor, 1969. J. Geophys. Res., v.74, pp. 6012-6022."
5120 PRINT "     Temperature range 400 to 650 degrees Celcius"
5130 PRINT
```

```
5140 INPUT "Please select the one you wish to use: "; CAL
5145 PRINT
5150 IF CAL < 1 OR CAL > 2 THEN 5155 ELSE 5170
5155 PRINT "Slippery fingers! Please try again.": GOTO 5140
5170 IF CAL = 1 THEN 5200
5180 IF CAL = 2 THEN 5400
5200 PRINT "You've chosen the Friedman and O'Neil (1977) compilation. Let's go!"
5210 PRINT
5220 LOLIM = 773.15: UPLIM = 1073.15
5230 CALIB$ = "Using the compilation of Friedman and O'Neil (1977)"
5237 GOSUB 15000
5240 GOSUB 15500
5250 FOR TEMK = STEMK TO FTEMK STEP INC
5280 DEL2 = 3.1 - (1.9 * 10 ^ 6 * TEMK ^ (-2)) + DEL1
5290 IF YEP$ = "Y" OR YEP$ = "y" THEN GOSUB 18000 ELSE GOSUB 18500
5300 NEXT TEMK
5310 GOSUB 14000
5400 CLS : PRINT
5410 PRINT "You've chosen the O'Neil and Taylor (1969) calibration. Let's go!"
5420 PRINT
5430 LOLIM = 673.15: UPLIM = 723.15
5435 CALIB$ = "Using the calibration of O'Neil and Taylor (1969)"
5437 GOSUB 15000
5440 GOSUB 15500
5450 FOR TEMK = STEMK TO FTEMK STEP INC
5480 DEL2 = 3.89 - (2.38 * 10 ^ 6 * TEMK ^ (-2)) + DEL1
5490 IF YEP$ = "Y" OR YEP$ = "y" THEN GOSUB 18000 ELSE GOSUB 18500
5500 NEXT TEMK
5510 GOSUB 14000
5800 RETURN
6000 ' ----------------------------------------------------------------
6010 ' Subroutine for calculating the delta-18O of water in equilibrium
6020 ' with plagioclase.
6030 ' ----------------------------------------------------------------
6031 MINAM$ = "PLAGIOCLASE"
6032 CLS : PRINT
6034 PRINT "OK! Let's calculate the delta-18O of water coexisting"
6036 PRINT "with PLAGIOCLASE, for the temperature range you specify"
6038 PRINT
6040 PRINT "We have the option of using one of several different calibrations"
6050 PRINT "for this delta-18O calculation."
6060 PRINT
6070 PRINT "1. Friedman and O'Neil compilation, 1977."
6080 PRINT "     Temperature range 500 to 800 degrees Celcius"
6090 PRINT "2. O'Neil and Taylor, 1967. Am. Mineral., v.52, p.1414-1437."
6100 PRINT "     Temperature range 350 to 800 degrees Celcius"
6110 PRINT "3. Matsuhisa et al., 1979. Geochim. Cosmochim. Acta, v.43, pp.1131-1140."
6120 PRINT "     Temperature range 400 to 800 degrees Celcius"
6130 PRINT
6140 INPUT "Please select the one you wish to use: "; CAL
6145 PRINT
6146 IF CAL < 1 OR CAL > 3 THEN 6147 ELSE 6150
6147 PRINT "Slippery fingers! Please try again.": GOTO 6140
6150 PRINT "All these calculations require the mole proportion of anorthite"
6155 PRINT "in the plagioclase."
```

```
6156 PRINT
6157 INPUT "Please enter this value (between 0 and 1.0): "; XAN
6170 IF CAL = 1 THEN 6200
6180 IF CAL = 2 THEN 6400
6190 IF CAL = 3 THEN 6600
6200 PRINT "You've chosen the Friedman and O'Neil (1977) compilation. Let's go!"
6210 PRINT
6220 LOLIM = 773.15: UPLIM = 1073.15
6230 CALIB$ = "Using the compilation of Friedman and O'Neil (1977)"
6237 GOSUB 15000
6240 GOSUB 15500
6250 FOR TEMK = STEMK TO FTEMK STEP INC
6280 DEL2 = 3.7 - (3.13 - 1.04 * XAN) * (10 ^ 6 * TEMK ^ (-2)) + DEL1
6290 IF YEP$ = "Y" OR YEP$ = "y" THEN GOSUB 18000 ELSE GOSUB 18500
6300 NEXT TEMK
6310 GOSUB 14000
6400 CLS : PRINT
6410 PRINT "You've chosen the O'Neil and Taylor (1967) calibration. Let's go!"
6420 PRINT
6430 LOLIM = 623.15: UPLIM = 1073.15
6435 CALIB$ = "Using the calibration of O'Neil and Taylor (1967)"
6437 GOSUB 15000
6440 GOSUB 15500
6450 FOR TEMK = STEMK TO FTEMK STEP INC
6480 DEL2 = (3.41 + .41 * XAN) - (2.91 - .76 * XAN) * (10 ^ 6 * TEMK ^ (-2)) + DEL1
6490 IF YEP$ = "Y" OR YEP$ = "y" THEN GOSUB 18000 ELSE GOSUB 18500
6500 NEXT TEMK
6510 GOSUB 14000
6600 CLS : PRINT
6610 PRINT "You've chosen the Matsuhisa et al. (1979) calibration. Let's go!"
6620 PRINT
6630 LOLIM = 673.15: UPLIM = 1073.15
6635 CALIB$ = "Using the calibration of Matsuhisa et al. (1979)"
6637 GOSUB 15000
6640 GOSUB 15500
6650 FOR TEMK = STEMK TO FTEMK STEP INC
6680 IF TEMK >= 673.15 AND TEMK < 773.15 THEN DEL2 = (2.51 + .3 * XAN) - (2.39 - .9 *
        XAN) * (10 ^ 6 * TEMK ^ (-2)) + DEL1
6700 IF TEMK >= 773.15 AND TEMK <= 773.15 THEN DEL2 = (1.16 + .85 * XAN) - (1.59 - .55
        * XAN) * (10 ^ 6 * TEMK ^ (-2)) + DEL1
6720 IF YEP$ = "Y" OR YEP$ = "y" THEN GOSUB 18000 ELSE GOSUB 18500
6730 NEXT TEMK
6740 GOSUB 14000
6800 RETURN
7000 ' ----------------------------------------------------------------
7005 ' Calculate delta-18O of water coexisting with QUARTZ"
7010 ' ----------------------------------------------------------------
7011 MINAM$ = "QUARTZ"
7012 CLS : PRINT
7015 PRINT "OK! Let's calculate the delta-18O of water coexisting"
7020 PRINT "with QUARTZ, for the temperature range you specify."
7030 PRINT
7040 PRINT "We have the option of using one of several different calibrations"
7050 PRINT "for this delta-18O calculation."
7060 PRINT
```

```
7070 PRINT "1. Friedman and O'Neil compilation, 1977."
7080 PRINT "     Temperature range 200 to 750 degrees Celcius"
7090 PRINT "2. Ligang et al., 1989. Economic Geology, v.84, pp.1643-1650."
7100 PRINT "     Temperature range 180 to 550 degrees Celcius, and saline fluid."
7110 PRINT "3. Matsuhisa et al., 1979. Geochim. Cosmochim. Acta, v.43, pp.1131-1140."
7120 PRINT "     Temperature range 200 to 800 degrees Celcius"
7130 PRINT
7140 INPUT "Please select the one you wish to use: "; CAL
7145 PRINT
7146 IF CAL < 1 OR CAL > 3 THEN 7147 ELSE 7150
7147 PRINT "Slippery fingers! Please try again.": GOTO 7140
7150 IF CAL = 1 THEN 7200
7160 IF CAL = 2 THEN 7400
7170 IF CAL = 3 THEN 7600
7200 PRINT
7205 PRINT "You've chosen the Friedman and O'Neil (1977) compilation. Let's go!"
7210 PRINT
7230 LOLIM = 473.15: UPLIM = 1023.15
7235 CALIB$ = "Using the compilation of Friedman and O'Neil (1977)"
7237 GOSUB 15000
7240 GOSUB 15500
7250 FOR TEMK = STEMK TO FTEMK STEP INC
7280 IF TEMK >= 473.15 AND TEMK < 773.15 THEN DEL2 = 2.9 - (3.38 * 10 ^ 6 * TEMK
        ^ (-2)) + DEL1
7300 IF TEMK >= 773.15 AND TEMK <= 1023.15 THEN DEL2 = 1.46 - (2.51 * 10 ^ 6 * TEMK
        ^ (-2)) + DEL1
7320 IF YEP$ = "Y" OR YEP$ = "y" THEN GOSUB 18000 ELSE GOSUB 18500
7330 NEXT TEMK
7340 GOSUB 14000
7400 PRINT
7405 PRINT "You've chosen the Ligang et al. (1989) calibration. Let's go!"
7410 PRINT
7420 LOLIM = 453.15: UPLIM = 823.15
7425 CALIB$ = "Using the calibration of Ligang et al. (1989)"
7427 GOSUB 15000
7430 GOSUB 15500
7440 FOR TEMK = STEMK TO FTEMK STEP INC
7470 DEL2 = 2.72 - (3.306 * 10 ^ 6 * TEMK ^ (-2)) + DEL1
7480 IF YEP$ = "Y" OR YEP$ = "y" THEN GOSUB 18000 ELSE GOSUB 18500
7490 NEXT TEMK
7500 GOSUB 14000
7600 PRINT
7610 PRINT "You've chosen the Matsuhisa et al. (1979) calibration. Let's go!"
7620 PRINT
7630 LOLIM = 473.15: UPLIM = 1073.15
7635 CALIB$ = "Using the calibration of Matsuhisa et al. (1979)"
7637 GOSUB 15000
7640 GOSUB 19000
7650 FOR TEMK = STEMK TO FTEMK STEP INC
7680 IF TEMK >= 473.15 AND TEMK < 673.15 THEN DEL2 = 3.31 - (3.34 * 10 ^ 6 * TEMK
        ^ (-2)) + DEL1
7700 IF TEMK >= 673.15 AND TEMK < 773.15 THEN DEL2 = 2.94 - (3.13 * 10 ^ 6 * TEMK
        ^ (-2)) + DEL1
```

```
7720 IF TEMK >= 773.15 AND TEMK <= 1073.15 THEN DEL2 = 1.14 - (2.05 * 10 ^ 6 * TEMK
        ^ (-2)) + DEL1
7740 IF YEP$ = "Y" OR YEP$ = "y" THEN GOSUB 18000 ELSE GOSUB 18500
7750 NEXT TEMK
7760 GOSUB 14000
7800 RETURN
8000 ' ----------------------------------------------------------------
8005 ' Calculate the delta-13C of CO2 coexisting with C-bearing minerals
8010 ' ----------------------------------------------------------------
8020 IF MIN = 1 THEN MINAM$ = "CALCITE"
8030 IF MIN = 2 THEN MINAM$ = "DOLOMITE"
8040 LOLIM = 273.15: UPLIM = 873.15
8050 CALIB$ = "Using the empirical fractionation factors of Sheppard and
        Schwarcz (1970)"
8060 CLS : PRINT
8070 PRINT "OK! Let's calculate the delta-D of water coexisting"
8080 PRINT "with", MINAM$, "for the temperature range you specify"
8090 PRINT
8100 PRINT "The calibration used for the calcite-CO2 system is based on a polynomial fit"
8110 PRINT "of values calculated by Bottinga (1969)(Geochim. Cosmochim. Acta, v.33,"
8120 PRINT "pp.49-64)."
8130 PRINT "The calibration for dolomite-CO2 is based on empirical fractionation"
8140 PRINT "factors between dolomite and calcite, detrmined by Sheppard and Schwarcz"
8150 PRINT "(1970)(Contr. Mineral. Petrol., v.26, 161-198)."
8160 PRINT "Both are applicable between 0 and 600 degrees Celcius."
8170 PRINT
8180 PRINT "You have chosen", MINAM$, ", so let's go!"
8190 GOSUB 15000
8200 GOSUB 19000
8210 FOR TEMK = STEMK TO FTEMK STEP INC
8220 IF MINAM$ = "CALCITE" THEN DEL2 = (8.914 * 10 ^ 8 * TEMK ^ (-3)) - (8.557 * 10
        ^ 6 * TEMK ^ (-2)) + (18.11 * 10 ^ 3 * TEMK ^ (-1)) - 8.27 + DEL1
8230 IF MINAM$ = "DOLOMITE" THEN DEL2 = (8.914 * 10 ^ 8 * TEMK ^ (-3)) - (8.737 * 10
        ^ 6 * TEMK ^ (-2)) + (18.11 * 10 ^ 3 * TEMK ^ (-1)) - 8.44 + DEL1
8240 IF YEP$ = "Y" OR YEP$ = "y" THEN GOSUB 18000 ELSE GOSUB 18500
8250 NEXT TEMK
8260 GOSUB 14000
8270 RETURN
9000 ' ----------------------------------------------------------------
9005 ' Calculate the delta-D of water coexisting with OH-bearing minerals
9010 ' ----------------------------------------------------------------
9020 IF MIN = 1 THEN MINAM$ = "BIOTITE"
9030 IF MIN = 2 THEN MINAM$ = "HORNBLENDE"
9040 IF MIN = 3 THEN MINAM$ = "MUSCOVITE"
9050 IF MIN = 4 THEN MINAM$ = "PHLOGOPITE"
9255 LOLIM = 673.15: UPLIM = 1123.15
9256 CALIB$ = "Using the calibration of Suzuoki and Epstein (1976)"
9060 CLS : PRINT
9070 PRINT "OK! Let's calculate the delta-D of water coexisting"
9080 PRINT "with", MINAM$, "for the temperature range you specify"
9090 PRINT
9100 PRINT "The one calibration available is that of Suzuoki and Epstein (1976)"
9110 PRINT "(Geochim. Cosmochim. Acta, v.40, pp.1229-1240)."
9120 PRINT "This is applicable for all minerals listed, for a temperature range"
9125 PRINT "between 400 and 850 degreec Celcius, but requires knowledge of the"
```

```
9130 PRINT "mole fractions of Al3+, Fe2+ and Mg2+ in the octahedral sites."
9140 PRINT
9150 INPUT "Do you have this information (Y or N)?: "; GOT$
9160 IF GOT$ = "Y" OR GOT$ = "y" THEN 9400 ELSE 9200
9200 CLS : PRINT
9205 PRINT "Even without mineral compositional data, you could still use the"
9210 PRINT "empirical calibrations of Suzuoki and Epstein (1976) for 'average'"
9215 PRINT "muscovite, biotite and hornblende, bearing in mind the greater"
9220 PRINT "inaccuracies associated with these approximations."
9225 PRINT
9230 INPUT "Do you wish to use these calibrations (Y or N)?: "; USE$
9235 IF USE$ <> "Y" OR USE$ <> "y" THEN 9237 ELSE 50
9237 GOSUB 15000
9240 GOSUB 17700
9245 FOR TEMK = STEMK TO FTEMK STEP INC
9250 IF MINAM$ = "MUSCOVITE" THEN DEL2 = (22.1 * 10 ^ 6 * TEMK ^ (-2)) - 19.1 + DEL1
9260 IF MINAM$ = "BIOTITE" THEN DEL2 = (21.3 * 10 ^ 6 * TEMK ^ (-2)) + 2.8 + DEL1
9270 IF MINAM$ = "HORNBLENDE" THEN DEL2 = (23.9 * 10 ^ 6 * TEMK ^ (-2)) - 7.9 + DEL1
9280 IF YEP$ = "Y" OR YEP$ = "y" THEN GOSUB 18000 ELSE GOSUB 18500
9290 NEXT TEMK
9300 GOSUB 14000
9400 CLS : PRINT
9410 PRINT "OK! You can - 1. Calculate mole fractions from mineral formulae; or"
9420 PRINT "                        2. Enter pre-calculated mole fractions"
9430 PRINT
9450 INPUT "Enter your preferred option (1 or 2): "; OPT
9460 IF OPT < 1 OR OPT > 2 THEN 9465 ELSE 9470
9465 PRINT "Slippery fingers! Please try again.": GOTO 9450
9470 IF OPT = 1 THEN GOSUB 9700
9480 IF OPT = 2 THEN GOSUB 9800
9490 PRINT
9510 CALIB$ = "Using the calibration of Suzuoki and Epstein (1976)"
9515 GOSUB 15000
9520 GOSUB 17700
9530 FOR TEMK = STEMK TO FTEMK STEP INC
9540 DEL2 = (22.4 * 10 ^ 6 * TEMK ^ (-2)) - (2 * XAL - 4 * XMG - 68 * XFE) - 28.2 + DEL1
9550 IF YEP$ = "Y" OR YEP$ = "y" THEN GOSUB 18000 ELSE GOSUB 18500
9560 NEXT TEMK
9570 GOSUB 14000
9700 ' --------------------------------------------------------------
9705 ' Calculate mole fractions for octahedral cations
9710 ' --------------------------------------------------------------
9720 PRINT
9730 INPUT "Enter the number of Al3+ cations: "; AL
9740 INPUT "Enter the number of Fe2+ cations: "; FE
9750 INPUT "Enter the number of Mg2+ cations: "; MG
9760 XAL = AL / (AL + FE + MG)
9770 XFE = FE / (AL + FE + MG)
9780 XMG = MG / (AL + FE + MG)
9790 RETURN
9800 ' --------------------------------------------------------------
9805 ' Input precalculated octahedral cation mole fractions
9810 ' --------------------------------------------------------------
9820 PRINT
9840 INPUT "Enter the octahedral Al3+ mole fraction: "; XAL
```

```
9850 INPUT "Enter the octahedral Fe2+ mole fraction: "; XFE
9860 INPUT "Enter the octahedral Mg2+ mole fraction: "; XMG
9870 RETURN
14000 ' ------------------------------------------------------------
14010 ' "Out of temperature range" error handling
14020 ' ------------------------------------------------------------
14030 PRINT "Out of experimental range - end of calculation!"
14040 GOTO 60
14050 RETURN
15000 ' ------------------------------------------------------------
15005 ' Subroutine for deciding whether SMOW or PDB calculations are
15010 ' required, and what the temperature range will be.
15015 ' ------------------------------------------------------------
15020 IF DTA = 1 THEN 15060
15025 IF DTA = 2 THEN 15040
15030 IF DTA = 3 THEN 15045
15035 IF DTA = 4 THEN 15050
15040 PRINT : INPUT "Enter the delta-13C (PDB) value for the mineral: "; DEL1: GOTO 15100
15045 PRINT : INPUT "Enter the delta-D (SMOW) value for the mineral: "; DEL1: GOTO 15100
15050 PRINT : INPUT "Enter the delta-34S value for the mineral: "; DEL1: GOTO 15100
15055 PRINT
15060 INPUT "Enter the delta-18O value for the mineral: "; DEL1
15065 PRINT
15070 PRINT "What is this value measured relative to?"
15075 PRINT
15080 INPUT "(1) SMOW or (2) PDB; Please enter the number: "; REL
15085 PRINT
15090 IF REL < 1 OR REL > 2 THEN 15095 ELSE 15100
15095 PRINT "Slippery fingers! Please try again.": GOTO 15050
15100 PRINT
15110 INPUT "Enter the starting temperature (in Celcius): "; STEMC
15115 STEMK = STEMC + 273.15
15116 IF STEMK < LOLIM THEN 15117 ELSE 15120
15117 PRINT "Sorry, this is outside the experimental range.": GOTO 15110
15120 INPUT "Enter the finishing temperature (in Celcius): "; FTEMC
15125 FTEMK = FTEMC + 273.15
15126 IF FTEMK > UPLIM THEN 15127 ELSE 15130
15127 PRINT "Sorry, this is outside the experimental range.": GOTO 15120
15130 INPUT "Enter the temperature increment to use: "; INC
15140 PRINT
15150 IF INC = 0 THEN INC = 1000
15160 RETURN
15500 ' ------------------------------------------------------------
15510 ' Decide on data printing options for delta-18O calculations
15520 ' ------------------------------------------------------------
15540 INPUT "Do you wish to output your results to printer (enter Y or N)?: "; YEP$
15550 IF YEP$ = "Y" OR YEP$ = "y" AND REL = 1 THEN GOSUB 16000
15560 IF YEP$ = "Y" OR YEP$ = "y" AND REL = 2 THEN GOSUB 16500
15570 IF YEP$ = "N" OR YEP$ = "n" AND REL = 1 THEN GOSUB 17000
15580 IF YEP$ = "N" OR YEP$ = "n" AND REL = 2 THEN GOSUB 17500
15590 RETURN
```

```
16000 ' ------------------------------------------------------------
16010 ' Print headings for delta-18O (SMOW) calculations to printer
16020 ' ------------------------------------------------------------
16025 LPRINT CHR$(15)
16026 LPRINT "-----------------------------------------------------------------------------"
16027 LPRINT CALIB$
16030 LPRINT "JCUNQ", "MINERAL", "TEMPERATURE", "DEL-18O", "DEL-18O"
16040 LPRINT "NUMBER", "SPECIES", "(KELVIN)", "MINERAL", "WATER"
16050 LPRINT , , , "(SMOW)", "(SMOW)"
16060 LPRINT
16070 RETURN
16500 ' ------------------------------------------------------------
16510 ' Print headings for delta-18O (PDB) calculations to printer
16520 ' ------------------------------------------------------------
16525 LPRINT CHR$(15)
16526 LPRINT "-----------------------------------------------------------------------------"
16527 LPRINT CALIB$
16530 LPRINT "JCUNQ", "MINERAL", "TEMPERATURE", "DEL-18O", "DEL-18O"
16540 LPRINT "NUMBER", "SPECIES", "(KELVIN)", "MINERAL", "WATER"
16550 LPRINT , , , "(PDB)", "(PDB)"
16560 LPRINT
16570 RETURN
17000 ' ------------------------------------------------------------
17010 ' Print headings for delta-18O (SMOW) calculations to screen
17020 ' ------------------------------------------------------------
17025 PRINT CHR$(15)
17026 PRINT "-----------------------------------------------------------------------------"
17027 PRINT CALIB$
17030 PRINT "JCUNQ", "MINERAL", "TEMPERATURE", "DEL-18O", "DEL-18O"
17040 PRINT "NUMBER", "SPECIES", "(KELVIN)", "MINERAL", "WATER"
17050 PRINT , , , "(SMOW)", "(SMOW)"
17060 PRINT
17070 RETURN
17500 ' ------------------------------------------------------------
17510 ' Print headings for delta-18O (PDB) calculations to screen
17520 ' ------------------------------------------------------------
17525 PRINT CHR$(15)
17526 PRINT "-----------------------------------------------------------------------------"
17527 PRINT CALIB$
17530 PRINT "JCUNQ", "MINERAL", "TEMPERATURE", "DEL-18O", "DEL-18O"
17540 PRINT "NUMBER", "SPECIES", "(KELVIN)", "MINERAL", "WATER"
17550 PRINT , , , "(PDB)", "(PDB)"
17560 PRINT
17570 RETURN
17700 ' ------------------------------------------------------------
17710 ' Decide on data printing options for delta-D calculations
17720 ' ------------------------------------------------------------
17740 INPUT "Do you wish to output your results to printer (enter Y or N)?: "; YEP$
17750 IF YEP$ = "Y" OR YEP$ = "y" THEN GOSUB 17800
17760 IF YEP$ = "N" OR YEP$ = "n" THEN GOSUB 17900
17770 RETURN
```

```
17800 ' ------------------------------------------------------------
17810 ' Print headings for delta-D (SMOW) calculations to printer
17820 ' ------------------------------------------------------------
17825 LPRINT CHR$(15)
17826 LPRINT "----------------------------------------------------------------------------"
17827 LPRINT CALIB$
17830 LPRINT "JCUNQ", "MINERAL", "TEMPERATURE", "DEL-D", "DEL-D"
17840 LPRINT "NUMBER", "SPECIES", "(KELVIN)", "MINERAL", "WATER"
17850 LPRINT , , , "(SMOW)", "(SMOW)"
17860 LPRINT
17870 RETURN
17900 ' ------------------------------------------------------------
17910 ' Print headings for delta-D (SMOW) calculations to screen
17920 ' ------------------------------------------------------------
17925 PRINT CHR$(15)
17926 PRINT "----------------------------------------------------------------------------"
17927 PRINT CALIB$
17930 PRINT "JCUNQ", "MINERAL", "TEMPERATURE", "DEL-D", "DEL-D"
17940 PRINT "NUMBER", "SPECIES", "(KELVIN)", "MINERAL", "WATER"
17950 PRINT , , , "(SMOW)", "(SMOW)"
17960 PRINT
17970 RETURN
18000 ' ------------------------------------------------------------
18010 ' Print data for each pass, to printer
18020 ' ------------------------------------------------------------
18030 LPRINT NUM$, MINAM$, TEMK, DEL1, DEL2
18040 RETURN
18500 ' ------------------------------------------------------------
18510 ' Print data for each pass, to screen
18520 ' ------------------------------------------------------------
18530 PRINT NUM$, MINAM$, TEMK, DEL1, DEL2
18540 RETURN
19000 ' ------------------------------------------------------------
19010 ' Decide on data printing options for delta-13C calculations
19020 ' ------------------------------------------------------------
19040 INPUT "Do you wish to output your results to printer (enter Y or N)?: "; YEP$
19050 IF YEP$ = "Y" OR YEP$ = "y" THEN GOSUB 19100
19060 IF YEP$ = "N" OR YEP$ = "n" THEN GOSUB 19200
19070 RETURN
19100 ' ------------------------------------------------------------
19110 ' Print headings for delta-13C (PDB) calculations to printer
19120 ' ------------------------------------------------------------
19125 LPRINT CHR$(15)
19126 LPRINT "----------------------------------------------------------------------------"
19127 LPRINT CALIB$
19130 LPRINT "JCUNQ", "MINERAL", "TEMPERATURE", "DEL-13C", "DEL-13C"
19140 LPRINT "NUMBER", "SPECIES", "(KELVIN)", "MINERAL", "CO2"
19150 LPRINT , , , "(PDB)", "(PDB)"
19160 LPRINT
19170 RETURN
```

```
19200 ' ------------------------------------------------------------
19210 ' Print headings for delta-13C (PDB) calculations to screen
19220 ' ------------------------------------------------------------
19225 PRINT CHR$(15)
19226 PRINT "------------------------------------------------------------------------------"
19227 PRINT CALIB$
19230 PRINT "JCUNQ", "MINERAL", "TEMPERATURE", "DEL-13C", "DEL-13C"
19240 PRINT "NUMBER", "SPECIES", "(KELVIN)", "MINERAL", "CO2"
19250 PRINT , , , "(PDB)", "(PDB)"
19260 PRINT
19270 RETURN
```


INTERPRETIVE GEOLOGY OF THE
SELWYN-MOUNT DORE-STUART REGION
KEY TO LITHOLOGICAL UNITS
Granite
dl metadolerite/metabasalt
MARY KATHLEEN GROUP
STAVELEY FORMATION
Pks₂ Poorly bedded, internally massive, quartz pebble-to-cobble conglomerate; clasts poorly-sorted, sub-angular to sub-rounded, generally matrix-supported in red-brown, calcareous, quartzofeldspathic arenite.
Pks₁ Pale yellow-brown, dark grey-green, and dark green-brown, variably calcareous and ferruginous metalutites and phyllites; numerous interbeds of brown, siliceous arenite; thin- to medium-bedded; syn- and post-sedimentary structures common (graded beds, low-angle cross-laminations, symmetrical ripples, convolute (slumped) bedding, ball-and-pillow structures, halite hoppers); calcsilicates adjacent to Mount Dore Granite.
MARONAN SUPERGROUP
SOLDIERS CAP GROUP
qtzt Finely banded to massive, mylonitic (recrystallized) quartzite; belongs to Toole Creek Volcanics or Staveley Formation)
TOOLE CREEK VOLCANICS
Pot₂ Grey to black, variably silicified (± mylonitized) carbonaceous slate
Pot₁ Grey to pale green, variably silicified quartz-muscovite schist
MOUNT NORNA QUARTZITE
Pon₂ Clean, thick-bedded quartz meta-arenite.
Pon₁ Clean, even-grained meta-arenites, and variably carbonaceous pelitic schists; meta-arenites are laterally continuous, internally massive, in isolated beds a few metres thick, or in packages up to 80 metres thick; carbonaceous schists increasingly abundant up-sequence, and commonly staurolite-bearing; sedimentary structures rare.
FULLARTON RIVER GROUP
LLEWELLYN CREEK FORMATION
Pol Well-bedded, siliciclastic metagreywackes, meta-arenites and meta-argillites, in varying relative proportions; thin- to thick-bedded; good sedimentary structures (e.g. graded bedding, partial to complete Bouma sequences).
NEW HOPE ARKOSE
Poh Medium- to thick-bedded, massive, medium- to coarse-grained, quartz-rich meta-arkose; minor thin-bedded staurolite schist.
DOUBLE CROSSING METAMORPHICS
Plm Quartzofeldspathic schists, gneisses, minor amphibolite
LOCATION OF FIELD STATIONS
CLONCURRY
KEY TO GEOLOGICAL SYMBOLS
S₀ orientation: dipping, vertical, overturned
S₁ orientation: dipping, vertical
S₂ orientation: dipping, vertical
S₃ orientation: dipping, vertical
S₄ orientation: dipping, vertical
L₁¹ mineral lineation
L₂⁰ intersection lineation
L₂² mineral lineation
L₃⁰·² intersection lineation
younging direction
F₂ axial trace: antiform, synform
F₃ axial trace: antiform, synform
F₂⁰ fold vergence
F₃⁰ or ² fold vergence
shear zone boundary
late tectonic fault: well-defined, approximate or inferred
geological boundary: observed, inferred
form lines (from aerial photo interp.)
ironstone
quartz vein
pegmatite dyke
KEY TO GEOGRAPHICAL SYMBOLS
river, creek
tributary
road (unsealed)
track (4WD accessibility)
railway embankment
mine or prospect
township
bore
SELWYN
SELWYN SHEAR
MOUNT ELLIOTT Cu,Au
SWAN Cu,Au
BELGIUM SYNCLINE
LADY ELLA Cu
BELGIUM
GIN CREEK
FLORA Cu
STARRA SHEAR
SELWYN SHEAR ZONE
MOUNT DORE FAULT
MOUNT DORE GRANITE
MOUNT DORE Cu,Ag
MARILYN Cu
OLD AMOCO CAMP
MORT RIVER
STARRA Au,Cu
MARIPOSA Cu
MOUNT COBALT GRANITE
MORT RIVER BORE
MARIPOSA ANTICLINE
PYRAMID SYNCLINE
NEW HOPE ANTICLINE
MORT RIVER SYNCLINE
NEW HOPE W
MOUNT COBALT Cu,W
ABANDONED AIRSTRIP
SELWYN SHEAR ZONE
MOUNT DORE FAULT
STUART Cu
MOUNT THOMAS Pb,Zn
YELLOW WATERHOLE GRANITE
TN MN
6°
0 1000 2000
METRES
21°30'
21°35'
21°40'
21°45'
140°30'
MAP TO ACCOMPANY BEARDSMORE PH.D. THESIS, 1992. Petrogenesis of Mount Dore-style mineralization. JCUNQ GEOLOGY DEPT.