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GEOTHERMAL TRAINING PROGRAMME
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APPENDIX II TO THE REPORT:

AQUIFER FLUID COMPOSITIONS AT THE BERLÍN GEOTHERMAL FIELD, EL SALVADOR IN 2012

by

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This is Appendix II to the report *"Aquifer fluid compositions at the Berlín geothermal field, El Salvador in 2012*." by Carlos Baltazar Hernández Murga at the UNU Geothermal Training Programme in 2012. Appendix II shows the calculation of the WATCH program for the aquifer fluid compositions and the concentrations of individual aqueous species for 10 selected wells in the Berlín geothermal field, El Salvador.

APENDIX II: WATCH results for the calculated aquifer fluid compositions and the concentrations of individual aqueous species for 10 selected wells

ICELAND WATER CHEMISTRY GROUP Program WATCH, version 2.4 / 2010

TR4 BERLÍN

Water sample (mg/kg)		Steam sample			
pH/deg.C	6.66/ 20.0	Gas (volume %)		Reference temperature deg.C :	283.0 (Arbitrary)
CO2	6.49	CO2	0.00		
H2S	0.49	H2S	0.00	Sampling pressure bar abs. :	11.0
NH3	2.01	NH3	0.00	Discharge enthalpy kJ/kg :	1253. (Calculated)
B	0.0000	H2	31.98	Discharge kg/s :	0.0
SiO2	761.88	O2	1.05	Steam fraction at collection :	0.2359
Na	2857.90	CH4	5.34		
K	583.11	N2	61.63	Measured temperature deg.C :	26.3
Mg	0.103				
Ca	48.38	Liters gas per kg			
F	0.000	condensate/deg.C	0.07/25.0	Condensate (mg/kg)	
Cl	5106.30			pH/deg.C	0.00/ 0.0
SO4	19.85	Total steam (mg/kg)		CO2	0.00
Al	0.2270	CO2	2990.70	H2S	0.00
Fe	0.2200	H2S	486.90	NH3	0.00
TDS	0.00	NH3	0.00	Na	0.00

Ionic strength = 0.14429

Ionic balance : Cations (mol.eq.) = 0.14148135 Anions (mol.eq.) = 0.14429304 Difference (%) = -1.97

Liquid phase components (mg/kg)								Vapor phase (mg/kg)		Gas pressures (bar-abs.)	
B	0.0000	CO2	710.41					CO2	0.00	CO2	0.111E+01
SiO2	582.17	H2S	115.22					H2S	0.00	H2S	0.100E+00
Na	2183.78	NH3	1.53	NH3	0.00	NH3	0.330E-03				
K	445.57	H2	0.45					H2	0.00	H2	0.621E-01
Mg	0.079	O2	0.23					O2	0.00	O2	0.227E-02
Ca	36.96	CH4	0.60					CH4	0.00	CH4	0.101E-01
F	0.000	N2	12.06					N2	0.00	N2	0.147E+00
Cl	3901.83									H2O	0.672E+02
SO4	15.17									Total	0.686E+02
Al	0.1735										
Fe	0.1681										

TDS 0.00 Aquifer steam fraction = 0.0000

Ionic strength = 0.09782 1000/T (Kelvin) = 1.80

Ionic balance : Cations (mol.eq.) = 0.09578708 Anions (mol.eq.) = 0.09794049 Difference (%) = -2.22

Oxidation potential (volts) : Eh H2S= -0.445 Eh CH4= -0.519 Eh H2= -0.512 Eh NH3= -0.504

Chemical geothermometers (degrees C)

Quartz	276.8	(Fournier & Potter, GRC Bulletin, pp. 3-12, Nov. 1982)
Chalcedony	262.9	(Fournier, Geothermics, vol. 5, pp. 41-50, 1977)
Na/K	281.7	(Arnorsson et al., Geochim. Cosmochim. Acta, vol. 47, pp. 567-577, 1983)

Activity coefficients in water TR4

H+	0.677	K+	0.549	FeSO4+	0.602		
OH-	0.564	Ca++	0.151	FeCl++	0.131		
H3SiO4-	0.577	Mg++	0.191	FeCl2+	0.602		
H2SiO4--	0.139	CaHCO3+	0.624	FeCl4-	0.577		
H2BO3-	0.534	MgHCO3+	0.577	FeCl+	0.577		
HCO3-	0.577	CaOH+	0.624	Al+++	0.030		
CO3--	0.121	MgOH+	0.634	AlOH++	0.139		
HS-	0.564	NH4+	0.534	Al(OH)2+	0.611		
S--	0.131	Fe++	0.151	Al(OH)4-	0.590		
HSO4-	0.590	Fe+++	0.030	AlSO4+	0.590		
SO4--	0.111	FeOH+	0.602	Al(SO4)2-	0.590		
NaSO4-	0.611	Fe(OH)3-	0.602	AlF++	0.139		
KSO4-	0.611	Fe(OH)4--	0.131	AlF2+	0.611		
F-	0.564	Fe(OH)++	0.131	AlF4-	0.590		
Cl-	0.549	Fe(OH)2+	0.611	AlF5--	0.121		
Na+	0.577	Fe(OH)4-	0.611	AlF6---	0.009		

Chemical species in water - ppm and log mole Water pH is 5.246

H+	0.01	-5.077	Mg++	0.08	-5.507	Fe(OH)3	0.21	-5.710			
OH-	0.05	-5.520	NaCl	680.03	-1.934	Fe(OH)4-	0.00	-8.154			
H4SiO4	931.03	-2.014	KCl	56.06	-3.124	FeCl+	0.00	-7.391			
H3SiO4-	0.13	-5.864	NaSO4-	2.90	-4.613	FeCl2	0.00	-9.308			
H2SiO4--	0.00	-11.722	KSO4-	4.23	-4.505	FeCl++	0.00	-15.934			
NaH3SiO4	0.09	-6.096	CaSO4	1.64	-4.919	FeCl2+	0.00	-16.918			
H3BO3	0.00	0.000	MgSO4	0.01	-7.137	FeCl3	0.00	-18.345			
H2BO3-	0.00	0.000	CaCO3	0.00	-7.597	FeCl4-	0.00	-19.806			
H2CO3	998.68	-1.793	MgCO3	0.00	-11.447	FeSO4	0.00	-10.452			
HCO3-	1.79	-4.532	CaHCO3+	1.26	-4.903	FeSO4+	0.00	-17.901			
CO3--	0.00	-9.726	MgHCO3+	0.00	-8.517	Al+++	0.00	-17.434			
H2S	114.37	-2.474	CaOH+	0.01	-6.641	AlOH++	0.00	-12.434			
HS-	0.83	-4.600	MgOH+	0.00	-7.289	Al(OH)2+	0.00	-8.781			
S--	0.00	-13.496	NH4OH	2.29	-4.185	Al(OH)3	0.13	-5.790			
H2SO4	0.00	-10.429	NH4+	0.44	-4.608	Al(OH)4-	0.46	-5.318			
HSO4-	3.53	-4.439	Fe++	0.00	-7.835	AlSO4+	0.00	-18.311			
SO4--	5.16	-4.270	Fe+++	0.00	-21.053	Al(SO4)2-	0.00	-20.424			
HF	0.00	0.000	FeOH+	0.00	-9.360	AlF++	0.00	0.000			
F-	0.00	0.000	Fe(OH)2	0.00	-10.443	AlF2+	0.00	0.000			
Cl-	3462.66	-1.010	Fe(OH)3-	0.00	-17.127	AlF3	0.00	0.000			
Na+	1915.68	-1.079	Fe(OH)4--	0.00	-20.190	AlF4-	0.00	0.000			
K+	414.94	-1.974	Fe(OH)++	0.00	-13.137	AlF5--	0.00	0.000			
Ca++	35.97	-3.047	Fe(OH)2+	0.09	-6.001	AlF6---	0.00	0.000			

Logarithms of mineral solubility product constants (K) and ion activity products (Q) in water

	log K	log Q		log K	log Q		log K	log Q
Adularia	-14.382	-13.824	Albite, low	-13.958	-12.907	Analcime	-11.627	-10.893
Anhydrite	-8.724	-9.093	Calcite	-13.642	-14.511	Chalcedony	-1.870	-2.014
Mg-Chlorite	-87.732	-94.417	Fluorite	-11.144	99.999	Goethite	4.156	-2.599
Laumontite	-24.894	-23.018	Microcline	-14.972	-13.824	Magnetite	-13.671	-25.392
Ca-Montmor.	-72.568	-56.616	K-Montmor.	-33.777	-28.609	Mg-Montmor.	-74.073	-58.975
Na-Montmor.	-34.062	-27.692	Muscovite	-17.844	-13.382	Prehnite	-38.561	-36.409
Pyrrhotite	-2.107	-49.374	Pyrite	-17.504	-51.595	Quartz	-1.993	-2.014
Wairakite	-25.264	-23.018	Wollastonite	6.953	4.611	Zoisite	-39.581	-36.188
Epidote	-39.629	-39.008	Marcasite	-1.750	-51.595	Talc	7.546	4.743
Chrysotile	13.576	8.770	Sil. amorph.	-1.573	-2.014			

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TR4B              BERLÍN
Water sample (mg/kg)          Steam sample
pH/deg.C          7.05/ 22.0  Gas (volume %)              Reference temperature    deg.C :  289.0  (Arbitrary)
CO2              15.55        CO2               0.00
H2S               2.05        H2S               0.00     Sampling pressure     bar abs. :   10.8
NH3               0.25        NH3               0.00     Discharge enthalpy       kJ/kg :  1285.  (Calculated)
B              91.8000        H2               33.06     Discharge                 kg/s :    0.0
SiO2            755.00        O2                0.63     Steam fraction at collection   : 0.2533
Na             2291.00        CH4               4.03
K               502.00        N2               62.29     Measured temperature     deg.C :   40.0
Mg                0.059
Ca               32.10        Liters gas per kg
F                 0.000        condensate/deg.C  0.11/25.0   Condensate (mg/kg)
Cl             4151.00                                     pH/deg.C          0.00/ 0.0
SO4              14.00        Total steam (mg/kg)          CO2               0.00
Al              0.3340        CO2            5003.94       H2S               0.00
Fe              0.0370        H2S             422.59       NH3               0.00
TDS               0.00        NH3               1.07       Na                0.00
Ionic strength =  0.11669
Ionic balance :   Cations (mol.eq.) = 0.11389568    Anions (mol.eq.) = 0.11761919    Difference (%) = -3.22

Liquid phase components (mg/kg)                     Vapor phase (mg/kg)        Gas pressures (bar-abs.)
B          68.5491        CO2        1279.00        CO2           0.00        CO2       0.189E+01
SiO2        563.77        H2S         108.56        H2S           0.00        H2S       0.891E-01
Na        1710.74         NH3           0.46        NH3           0.00        NH3       0.122E-03
K          374.85         H2            0.75        H2            0.00        H2        0.953E-01
Mg           0.044        O2            0.23        O2            0.00        O2        0.206E-02
Ca          23.97         CH4           0.73        CH4           0.00        CH4       0.113E-01
F            0.000        N2           19.65        N2            0.00        N2        0.218E+00
Cl        3099.64                                                             H2O       0.734E+02
SO4         10.45                                                             Total     0.757E+02
Al          0.2494
Fe          0.0276
TDS          0.00         Aquifer steam fraction =  0.0000

Ionic strength =  0.07684                                                 1000/T (Kelvin) =   1.78
Ionic balance :   Cations (mol.eq.) = 0.07486586    Anions (mol.eq.) = 0.07764724    Difference (%) = -3.65
Oxidation potential (volts) :     Eh H2S= -0.538   Eh CH4= -0.595   Eh H2= -0.597   Eh NH3= -0.561

Chemical geothermometers (degrees C)
Quartz      272.3   (Fournier & Potter, GRC Bulletin, pp. 3-12, Nov. 1982)
Chalcedony  259.0   (Fournier, Geothermics, vol. 5, pp. 41-50, 1977)
Na/K        290.8   (Arnorsson et al., Geochim. Cosmochim. Acta, vol. 47, pp. 567-577, 1983)
Activity coefficients in water                                          TR4B
H+                    0.684     K+                    0.568     FeSO4+                    0.615
OH-                       0.580     Ca++                  0.162     FeCl++                    0.143
H3SiO4-                   0.593     Mg++                  0.201     FeCl2+                    0.615
H2SiO4--                  0.151     CaHCO3+               0.635     FeCl4-                    0.593
H2BO3-                    0.554     MgHCO3+               0.593     FeCl+                     0.593
HCO3-                     0.593     CaOH+                 0.635     Al+++                     0.033
CO3--                 0.133     MgOH+                 0.644     AlOH++                    0.151
HS-                       0.580     NH4+                  0.554     Al(OH)2+                  0.623
S--                       0.143     Fe++                  0.162     Al(OH)4-                  0.604
HSO4-                     0.604     Fe+++                 0.033     AlSO4+                    0.604
SO4--                     0.123     FeOH+                 0.615     Al(SO4)2-                 0.604
NaSO4-                    0.623     Fe(OH)3-              0.615     AlF++                     0.151
KSO4-                     0.623     Fe(OH)4--             0.143     AlF2+                     0.623
F-                        0.580     Fe(OH)++              0.143     AlF4-                     0.604
Cl-                       0.568     Fe(OH)2+              0.623     AlF5--                    0.133
Na+                       0.593     Fe(OH)4-              0.623     AlF6---                   0.011

Chemical species in water - ppm and log mole                                  Water pH is  5.865
H+              0.00   -5.701     Mg++            0.04   -5.791     Fe(OH)3         0.05   -6.359
OH-             0.21   -4.917     NaCl          559.97   -2.019     Fe(OH)4-        0.00   -8.221
H4SiO4        901.13   -2.028     KCl            47.26   -3.198     FeCl+           0.00   -9.501
H3SiO4-         0.45   -5.324     NaSO4-          2.24   -4.726     FeCl2           0.00  -11.272
H2SiO4--        0.00  -10.643     KSO4-           3.91   -4.538     FeCl++          0.00  -18.700
NaH3SiO4        0.28   -5.630     CaSO4           1.09   -5.097     FeCl2+          0.00  -19.731
H3BO3         391.76   -2.198     MgSO4           0.00   -7.415     FeCl3           0.00  -21.216
H2BO3-          0.32   -5.281     CaCO3           0.05   -6.340     FeCl4-          0.00  -22.750
H2CO3        1788.49   -1.540     MgCO3           0.00  -10.294     FeSO4           0.00  -12.500
HCO3-          10.68   -3.757     CaHCO3+         5.40   -4.273     FeSO4+          0.00  -20.580
CO3--           0.00   -8.433     MgHCO3+         0.00   -7.967     Al+++           0.00  -19.922
H2S           105.97   -2.507     CaOH+           0.04   -6.178     AlOH++          0.00  -14.192
HS-             2.52   -4.119     MgOH+           0.01   -6.835     Al(OH)2+        0.00   -9.822
S--             0.00  -12.392     NH4OH           0.88   -4.600     Al(OH)3         0.06   -6.139
H2SO4           0.00  -11.584     NH4+            0.03   -5.751     Al(OH)4-        0.81   -5.070
HSO4-           0.93   -5.017     Fe++            0.00   -9.913     AlSO4+          0.00  -20.728
SO4--           4.17   -4.362     Fe+++           0.00  -23.885     Al(SO4)2-       0.00  -22.845
HF              0.00    0.000     FeOH+           0.00  -10.724     AlF++           0.00    0.000
F-              0.00    0.000     Fe(OH)2         0.00  -11.149     AlF2+           0.00    0.000
Cl-          2737.49   -1.112     Fe(OH)3-        0.00  -17.248     AlF3            0.00    0.000
Na+          1489.96   -1.188     Fe(OH)4--       0.00  -19.663     AlF4-           0.00    0.000
K+            348.94   -2.049     Fe(OH)++        0.00  -15.213     AlF5--          0.00    0.000
Ca++           21.46   -3.271     Fe(OH)2+        0.00   -7.291     AlF6---         0.00    0.000

Logarithms of mineral solubility product constants (K) and ion activity products (Q) in water
                log K     log Q                 log K     log Q                 log K     log Q
Adularia      -14.395  -13.668     Albite, low   -13.975  -12.788     Analcime      -11.658  -10.760
Anhydrite      -8.838   -9.332     Calcite       -13.804  -13.369     Chalcedony     -1.849   -2.028
Mg-Chlorite   -88.306  -90.333     Fluorite      -11.180   99.999     Goethite        4.510   -3.273
Laumontite    -24.978  -22.750     Microcline    -14.973  -13.668     Magnetite     -13.061  -27.556
Ca-Montmor.   -72.552  -60.874     K-Montmor.    -33.739  -30.702     Mg-Montmor.   -74.057  -63.302
Na-Montmor.   -34.023  -29.822     Muscovite     -17.847  -13.938     Prehnite      -38.818  -35.089
Pyrrhotite      1.403  -53.786     Pyrite        -13.110  -58.758     Quartz         -1.976   -2.028
Wairakite     -25.416  -22.750     Wollastonite    6.861    5.642     Zoisite       -39.911  -35.224
Epidote       -40.212  -38.362     Marcasite       2.471  -58.758     Talc            7.345    7.614
Chrysotile     13.332   11.670     Sil. amorph.   -1.559   -2.028
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ICELAND WATER CHEMISTRY GROUP                                                    Program WATCH, version 2.4 / 2010

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TR4C              BERLÍN
Water sample (mg/kg)          Steam sample
pH/deg.C          6.76/ 22.0  Gas (volume %)              Reference temperature    deg.C :  280.0  (Arbitrary)
CO2                9.49       CO2               0.00
H2S                0.36       H2S               0.00     Sampling pressure     bar abs. :   10.3
NH3                0.26       NH3               0.00     Discharge enthalpy       kJ/kg :  1237.  (Calculated)
B              117.1000       H2               25.41     Discharge                 kg/s :    0.0
SiO2             722.00       O2                0.48     Steam fraction at collection   : 0.2331
Na              3224.00       CH4               4.11
K                658.00       N2               69.99     Measured temperature     deg.C :   45.0
Mg                 0.143
Ca                80.60       Liters gas per kg
F                  0.000      condensate/deg.C  0.12/25.0  Condensate (mg/kg)
Cl              5834.00                                   pH/deg.C          0.00/ 0.0
SO4               17.00       Total steam (mg/kg)        CO2               0.00
Al                0.1820      CO2            4647.46     H2S               0.00
Fe                0.0280      H2S             388.51     NH3               0.00
TDS               0.00        NH3               1.09     Na                0.00
Ionic strength =  0.16494
Ionic balance :   Cations (mol.eq.) = 0.16074227    Anions (mol.eq.) = 0.16479256    Difference (%) = -2.49

Liquid phase components (mg/kg)                    Vapor phase (mg/kg)        Gas pressures (bar-abs.)
B          89.7996         CO2        1090.77      CO2           0.00         CO2       0.174E+01
SiO2        553.67         H2S          90.85      H2S           0.00         H2S       0.798E-01
Na        2472.36          NH3           0.45      NH3           0.00         NH3       0.109E-03
K          504.60          H2             0.59     H2            0.00         H2        0.851E-01
Mg           0.110         O2             0.18     O2            0.00         O2        0.180E-02
Ca          61.81          CH4            0.76     CH4           0.00         CH4       0.134E-01
F            0.000         N2            22.66     N2            0.00         N2        0.290E+00
Cl        4473.88                                                             H2O       0.642E+02
SO4         13.04                                                             Total     0.664E+02
Al           0.1396
Fe           0.0215
TDS          0.00          Aquifer steam fraction =  0.0000

Ionic strength =  0.11257                                                  1000/T (Kelvin) =   1.81
Ionic balance :   Cations (mol.eq.) = 0.10948934    Anions (mol.eq.) = 0.11259617    Difference (%) = -2.80
Oxidation potential (volts) :     Eh H2S= -0.475   Eh CH4= -0.540   Eh H2= -0.543   Eh NH3= -0.504

Chemical geothermometers (degrees C)
Quartz      270.0   (Fournier & Potter, GRC Bulletin, pp. 3-12, Nov. 1982)
Chalcedony  256.9   (Fournier, Geothermics, vol. 5, pp. 41-50, 1977)
Na/K        281.1   (Arnorsson et al., Geochim. Cosmochim. Acta, vol. 47, pp. 567-577, 1983)
Activity coefficients in water                                          TR4C
H+                      0.672     K+                      0.538     FeSO4+                  0.593
OH-                         0.553     Ca++                    0.144     FeCl++                  0.124
H3SiO4-                     0.567     Mg++                    0.185     FeCl2+                  0.593
H2SiO4--                    0.132     CaHCO3+                 0.616     FeCl4-                  0.567
H2BO3-                      0.521     MgHCO3+                 0.567     FeCl+                   0.567
HCO3-                       0.567     CaOH+                   0.616     Al+++                   0.028
CO3--                   0.114     MgOH+                   0.627     AlOH++                  0.132
HS-                         0.553     NH4+                    0.521     Al(OH)2+                0.603
S--                         0.124     Fe++                    0.144     Al(OH)4-                0.581
HSO4-                       0.581     Fe+++                   0.028     AlSO4+                  0.581
SO4--                       0.103     FeOH+                   0.593     Al(SO4)2-               0.581
NaSO4-                      0.603     Fe(OH)3-                0.593     AlF++                   0.132
KSO4-                       0.603     Fe(OH)4--               0.124     AlF2+                   0.603
F-                          0.553     Fe(OH)++                0.124     AlF4-                   0.581
Cl-                         0.538     Fe(OH)2+                0.603     AlF5--                  0.114
Na+                         0.567     Fe(OH)4-                0.603     AlF6---                 0.007

Chemical species in water - ppm and log mole                                        Water pH is  5.487
H+              0.00   -5.314     Mg++            0.10   -5.366     Fe(OH)3          0.03   -6.538
OH-             0.09   -5.270     NaCl          762.97   -1.884     Fe(OH)4-         0.00   -8.722
H4SiO4        885.28   -2.036     KCl            64.38   -3.064     FeCl+            0.00   -8.448
H3SiO4-         0.23   -5.611     NaSO4-          2.78   -4.631     FeCl2            0.00  -10.435
H2SiO4--        0.00  -11.186     KSO4-           3.86   -4.545     FeCl++           0.00  -17.339
NaH3SiO4        0.18   -5.811     CaSO4           2.12   -4.807     FeCl2+           0.00  -18.296
H3BO3         513.43   -2.081     MgSO4           0.01   -7.076     FeCl3            0.00  -19.688
H2BO3-          0.20   -5.488     CaCO3           0.02   -6.718     FeCl4-           0.00  -21.104
H2CO3        1528.52   -1.608     MgCO3           0.00  -10.618     FeSO4            0.00  -11.623
HCO3-           5.35   -4.057     CaHCO3+         5.58   -4.258     FeSO4+           0.00  -19.434
CO3--           0.00   -8.956     MgHCO3+         0.00   -7.933     Al+++            0.00  -18.301
H2S            89.54   -2.580     CaOH+           0.03   -6.224     AlOH++           0.00  -13.117
HS-             1.28   -4.414     MgOH+           0.00   -6.969     Al(OH)2+         0.00   -9.277
S--             0.00  -13.067     NH4OH           0.75   -4.670     Al(OH)3          0.06   -6.085
H2SO4           0.00  -11.025     NH4+            0.10   -5.278     Al(OH)4-         0.41   -5.362
HSO4-           1.64   -4.772     Fe++            0.00   -8.913     AlSO4+           0.00  -19.291
SO4--           4.92   -4.291     Fe+++           0.00  -22.431     Al(SO4)2-        0.00  -21.477
HF              0.00    0.000     FeOH+           0.00  -10.249     AlF++            0.00    0.000
F-              0.00    0.000     Fe(OH)2         0.00  -11.114     AlF2+            0.00    0.000
Cl-          3980.44   -0.950     Fe(OH)3-        0.00  -17.540     AlF3             0.00    0.000
Na+          2171.64   -1.025     Fe(OH)4--       0.00  -20.373     AlF4-            0.00    0.000
K+            469.72   -1.920     Fe(OH)++        0.00  -14.344     AlF5--           0.00    0.000
Ca++           58.94   -2.833     Fe(OH)2+        0.01   -7.056     AlF6---          0.00    0.000

Logarithms of mineral solubility product constants (K) and ion activity products (Q) in water
                log K     log Q                 log K     log Q                 log K     log Q
Adularia      -14.378  -13.895     Albite, low   -13.952  -12.976     Analcime      -11.613  -10.940
Anhydrite      -8.667   -8.949     Calcite       -13.561  -13.575     Chalcedony     -1.880   -2.036
Mg-Chlorite   -87.452  -92.018     Fluorite      -11.126   99.999     Goethite        3.980   -3.414
Laumontite    -24.855  -23.012     Microcline    -14.974  -13.895     Magnetite     -13.974  -27.638
Ca-Montmor.   -72.573  -60.498     K-Montmor.    -33.795  -30.602     Mg-Montmor.   -74.078  -62.923
Na-Montmor.   -34.080  -29.683     Muscovite     -17.843  -14.035     Prehnite      -38.436  -35.704
Pyrrhotite     -3.855  -56.319     Pyrite        -19.694  -60.244     Quartz         -2.003   -2.036
Wairakite     -25.191  -23.012     Wollastonite    7.000    5.264     Zoisite       -39.420  -35.775
Epidote       -39.361  -39.119     Marcasite      -3.852  -60.244     Talc            7.647    6.480
Chrysotile     13.699   10.551     Sil. amorph.   -1.580   -2.036
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ICELAND WATER CHEMISTRY GROUP                                                    Program WATCH, version 2.4 / 2010

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TR5               BERLÍN
Water sample (mg/kg)          Steam sample
pH/deg.C          6.30/ 20.0  Gas (volume %)              Reference temperature    deg.C :  297.0  (Arbitrary)
CO2               2.56        CO2               0.00
H2S               0.87        H2S               0.00      Sampling pressure     bar abs. :   11.7
NH3               0.24        NH3               0.00      Discharge enthalpy       kJ/kg :  1328.  (Calculated)
B              115.3030       H2               36.56      Discharge                 kg/s :    0.0
SiO2             791.81       O2                0.70      Steam fraction at collection   : 0.2689
Na              3157.11       CH4               7.22
K                690.33       N2               55.51      Measured temperature     deg.C :   39.0
Mg                 0.051
Ca                46.19       Liters gas per kg
F                  0.000       condensate/deg.C  0.06/25.0  Condensate (mg/kg)
Cl              5696.31                                     pH/deg.C          0.00/ 0.0
SO4               12.08        Total steam (mg/kg)         CO2               0.00
Al                0.2310       CO2            2574.15      H2S               0.00
Fe                0.0480       H2S             453.64      NH3               0.00
TDS               0.00         NH3               0.00      Na                0.00
Ionic strength =  0.16009
Ionic balance :   Cations (mol.eq.) = 0.15697509    Anions (mol.eq.) = 0.16066114    Difference (%) = -2.32

Liquid phase components (mg/kg)                     Vapor phase (mg/kg)        Gas pressures (bar-abs.)
B          84.2929         CO2         694.17       CO2           0.00         CO2       0.965E+00
SiO2        578.85         H2S         122.64       H2S           0.00         H2S       0.968E-01
Na        2308.02          NH3           0.17       NH3           0.00         NH3       0.382E-04
K           504.67         H2            0.45       H2            0.00         H2        0.510E-01
Mg           0.037         O2            0.14       O2            0.00         O2        0.114E-02
Ca           33.77         CH4           0.71       CH4           0.00         CH4       0.979E-02
F             0.000        N2            9.49       N2            0.00         N2        0.926E-01
Cl         4164.31                                                             H2O       0.824E+02
SO4           8.83                                                             Total     0.836E+02
Al          0.1689
Fe          0.0351
TDS           0.00          Aquifer steam fraction =  0.0000

Ionic strength =  0.09764                                                1000/T (Kelvin) =   1.75
Ionic balance :   Cations (mol.eq.) = 0.09544021    Anions (mol.eq.) = 0.09813601    Difference (%) = -2.79
Oxidation potential (volts) :     Eh H2S= -0.474   Eh CH4= -0.548   Eh H2= -0.527   Eh NH3= -0.496

Chemical geothermometers (degrees C)
Quartz      276.0   (Fournier & Potter, GRC Bulletin, pp. 3-12, Nov. 1982)
Chalcedony  262.3   (Fournier, Geothermics, vol. 5, pp. 41-50, 1977)
Na/K        293.8   (Arnorsson et al., Geochim. Cosmochim. Acta, vol. 47, pp. 567-577, 1983)
Activity coefficients in water                                          TR5
H+                    0.657     K+                    0.523     FeSO4+                  0.577
OH-                       0.537     Ca++                  0.130     FeCl++                  0.111
H3SiO4-                   0.551     Mg++                  0.167     FeCl2+                  0.577
H2SiO4--                  0.118     CaHCO3+               0.600     FeCl4-                  0.551
H2BO3-                    0.507     MgHCO3+               0.551     FeCl+                   0.551
HCO3-                     0.551     CaOH+                 0.600     Al+++                   0.023
CO3--                 0.102     MgOH+                 0.611     AlOH++                  0.118
HS-                       0.537     NH4+                  0.507     Al(OH)2+                0.587
S--                       0.111     Fe++                  0.130     Al(OH)4-                0.565
HSO4-                     0.565     Fe+++                 0.023     AlSO4+                  0.565
SO4--                     0.092     FeOH+                 0.577     Al(SO4)2-               0.565
NaSO4-                    0.587     Fe(OH)3-              0.577     AlF++                   0.118
KSO4-                     0.587     Fe(OH)4--             0.111     AlF2+                   0.587
F-                        0.537     Fe(OH)++              0.111     AlF4-                   0.565
Cl-                       0.523     Fe(OH)2+              0.587     AlF5--                  0.102
Na+                       0.551     Fe(OH)4-              0.587     AlF6---                 0.006

Chemical species in water - ppm and log mole                                  Water pH is  5.305
H+                0.01   -5.122     Mg++              0.04   -5.832     Fe(OH)3           0.05   -6.363
OH-               0.06   -5.456     NaCl           1072.53   -1.736     Fe(OH)4-          0.00   -8.802
H4SiO4          925.75   -2.016     KCl              85.54   -2.940     FeCl+             0.00   -8.753
H3SiO4-           0.12   -5.917     NaSO4-            1.48   -4.904     FeCl2             0.00  -10.198
H2SiO4--          0.00  -11.800     KSO4-             3.11   -4.638     FeCl++            0.00  -17.012
NaH3SiO4          0.08   -6.165     CaSO4             0.76   -5.252     FeCl2+            0.00  -18.043
H3BO3           482.02   -2.108     MgSO4             0.00   -7.824     FeCl3             0.00  -19.459
H2BO3-            0.11   -5.737     CaCO3             0.00   -7.693     FeCl4-            0.00  -20.859
H2CO3           976.49   -1.803     MgCO3             0.00  -11.906     FeSO4             0.00  -12.165
HCO3-             1.32   -4.664     CaHCO3+           0.93   -5.037     FeSO4+            0.00  -19.348
CO3--             0.00   -9.917     MgHCO3+           0.00   -8.944     Al+++             0.00  -18.087
H2S             121.98   -2.446     CaOH+             0.02   -6.570     AlOH++            0.00  -12.840
HS-               0.64   -4.713     MgOH+             0.00   -7.355     Al(OH)2+          0.00   -9.017
S--               0.00  -13.432     NH4OH             0.30   -5.073     Al(OH)3           0.11   -5.838
H2SO4             0.00  -10.621     NH4+              0.03   -5.752     Al(OH)4-          0.46   -5.318
HSO4-             2.30   -4.626     Fe++              0.00   -9.214     AlSO4+            0.00  -19.238
SO4--             2.61   -4.566     Fe+++             0.00  -22.416     Al(SO4)2-         0.00  -21.625
HF                0.00    0.000     FeOH+             0.00  -10.562     AlF++             0.00    0.000
F-                0.00    0.000     Fe(OH)2           0.00  -11.540     AlF2+             0.00    0.000
Cl-            3473.04   -1.009     Fe(OH)3-          0.00  -18.213     AlF3              0.00    0.000
Na+            1885.79   -1.086     Fe(OH)4--         0.00  -21.035     AlF4-             0.00    0.000
K+              458.91   -1.930     Fe(OH)++          0.00  -14.181     AlF5--            0.00    0.000
Ca++             33.16   -3.082     Fe(OH)2+          0.02   -6.721     AlF6---           0.00    0.000

Logarithms of mineral solubility product constants (K) and ion activity products (Q) in water
                  log K     log Q                  log K     log Q                  log K     log Q
Adularia        -14.420  -13.828     Albite, low   -14.003  -12.960     Analcime      -11.705  -10.944
Anhydrite        -8.991   -9.569     Calcite       -14.021  -14.879     Chalcedony     -1.821   -2.016
Mg-Chlorite     -89.098  -96.028     Fluorite      -11.228   99.999     Goethite        4.988   -3.308
Laumontite      -25.102  -23.167     Microcline    -14.982  -13.828     Magnetite     -12.240  -28.168
Ca-Montmor.     -72.516  -57.551     K-Montmor.    -33.682  -29.003     Mg-Montmor.   -74.018  -60.189
Na-Montmor.     -33.964  -28.135     Muscovite     -17.849  -13.509     Prehnite      -39.175  -36.572
Pyrrhotite        6.118  -54.329     Pyrite         -7.222  -57.303     Quartz         -1.955   -2.016
Wairakite       -25.628  -23.167     Wollastonite    6.740    4.625     Zoisite       -40.366  -36.412
Epidote         -41.087  -39.879     Marcasite       8.134  -57.303     Talc            7.079    3.941
Chrysotile       13.009    7.974     Sil. amorph.   -1.541   -2.016
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ICELAND WATER CHEMISTRY GROUP Program WATCH, version 2.4 / 2010

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TR5B BERLÍN

Water sample (mg/kg) Steam sample

pH/deg.C	6.29/ 20.0	Gas (volume %)		Reference temperature deg.C :	291.0 (Arbitrary)
CO2	3.92	CO2	0.00		
H2S	0.59	H2S	0.00	Sampling pressure bar abs. :	11.5
NH3	0.17	NH3	0.00	Discharge enthalpy kJ/kg :	1295. (Calculated)
B	123.5850	H2	35.38	Discharge kg/s :	0.0
SiO2	747.50	O2	0.69	Steam fraction at collection :	0.2539
Na	3569.34	CH4	6.62		
K	726.11	N2	57.31	Measured temperature deg.C :	37.8
Mg	0.071				
Ca	90.09	Liters gas per kg			
F	0.000	condensate/deg.C	0.06/25.0	Condensate (mg/kg)	
Cl	6450.48			pH/deg.C	0.00/ 0.0
SO4	10.98	Total steam (mg/kg)		CO2	0.00
Al	0.2530	CO2	2604.64	H2S	0.00
Fe	0.1700	H2S	352.66	NH3	0.00
TDS	0.00	NH3	0.00	Na	0.00

Ionic strength = 0.18225

Ionic balance : Cations (mol.eq.) = 0.17794055 Anions (mol.eq.) = 0.18185452 Difference (%) = -2.18

Liquid phase components (mg/kg) Vapor phase (mg/kg) Gas pressures (bar-abs.)

B	92.2016	CO2	664.35			CO2	0.00			CO2	0.972E+00
SiO2	557.68	H2S	90.00			H2S	0.00			H2S	0.742E-01
Na	2662.93	NH3	0.13	NH3	0.00			NH3		0.284E-04	
K	541.72	H2	0.42			H2	0.00			H2	0.520E-01
Mg	0.053	O2	0.13			O2	0.00			O2	0.115E-02
Ca	67.21	CH4	0.63			CH4	0.00			CH4	0.945E-02
F	0.000	N2	9.48			N2	0.00			N2	0.102E+00
Cl	4812.43									H2O	0.756E+02
SO4	8.19									Total	0.768E+02
Al	0.1888										
Fe	0.1268										
TDS	0.00	Aquifer steam fraction = 0.0000									

Ionic strength = 0.11572 1000/T (Kelvin) = 1.77

Ionic balance : Cations (mol.eq.) = 0.11257656 Anions (mol.eq.) = 0.11550042 Difference (%) = -2.56

Oxidation potential (volts) : Eh H2S= -0.463 Eh CH4= -0.536 Eh H2= -0.519 Eh NH3= -0.481

Chemical geothermometers (degrees C)

Quartz	270.9	(Fournier & Potter, GRC Bulletin, pp. 3-12, Nov. 1982)
Chalcedony	257.8	(Fournier, Geothermics, vol. 5, pp. 41-50, 1977)
Na/K	283.9	(Arnorsson et al., Geochim. Cosmochim. Acta, vol. 47, pp. 567-577, 1983)

Activity coefficients in water TR5B

H+	0.655	K+	0.514	FeSO4+	0.572		
OH-	0.530	Ca++	0.126	FeCl++	0.107		
H3SiO4-	0.545	Mg++	0.165	FeCl2+	0.572		
H2SiO4--	0.115	CaHCO3+	0.596	FeCl4-	0.545		
H2BO3-	0.497	MgHCO3+	0.545	FeCl+	0.545		
HCO3-	0.545	CaOH+	0.596	Al+++	0.022		
CO3--	0.097	MgOH+	0.607	AlOH++	0.115		
HS-	0.530	NH4+	0.497	Al(OH)2+	0.582		
S--	0.107	Fe++	0.126	Al(OH)4-	0.559		
HSO4-	0.559	Fe+++	0.022	AlSO4+	0.559		
SO4--	0.088	FeOH+	0.572	Al(SO4)2-	0.559		
NaSO4-	0.582	Fe(OH)3-	0.572	AlF++	0.115		
KSO4-	0.582	Fe(OH)4--	0.107	AlF2+	0.582		
F-	0.530	Fe(OH)++	0.107	AlF4-	0.559		
Cl-	0.514	Fe(OH)2+	0.582	AlF5--	0.097		
Na+	0.545	Fe(OH)4-	0.582	AlF6---	0.005		

Chemical species in water - ppm and log mole Water pH is 5.282

H+	0.01	-5.098	Mg++	0.05	-5.675	Fe(OH)3	0.16	-5.818			
OH-	0.06	-5.464	NaCl	1124.36	-1.716	Fe(OH)4-	0.00	-8.244			
H4SiO4	891.87	-2.033	KCl	87.19	-2.932	FeCl+	0.00	-7.828			
H3SiO4-	0.12	-5.894	NaSO4-	1.48	-4.906	FeCl2	0.00	-9.432			
H2SiO4--	0.00	-11.734	KSO4-	2.52	-4.730	FeCl++	0.00	-16.193			
NaH3SiO4	0.09	-6.096	CaSO4	1.20	-5.056	FeCl2+	0.00	-17.184			
H3BO3	527.24	-2.069	MgSO4	0.00	-7.733	FeCl3	0.00	-18.562			
H2BO3-	0.12	-5.694	CaCO3	0.00	-7.424	FeCl4-	0.00	-19.919			
H2CO3	933.75	-1.822	MgCO3	0.00	-11.739	FeSO4	0.00	-11.351			
HCO3-	1.48	-4.615	CaHCO3+	1.81	-4.746	FeSO4+	0.00	-18.653			
CO3--	0.00	-9.801	MgHCO3+	0.00	-8.781	Al+++	0.00	-17.726			
H2S	89.41	-2.581	CaOH+	0.03	-6.342	AlOH++	0.00	-12.598			
HS-	0.56	-4.768	MgOH+	0.00	-7.328	Al(OH)2+	0.00	-8.877			
S--	0.00	-13.529	NH4OH	0.21	-5.228	Al(OH)3	0.13	-5.787			
H2SO4	0.00	-10.733	NH4+	0.03	-5.780	Al(OH)4-	0.51	-5.271			
HSO4-	1.82	-4.726	Fe++	0.00	-8.311	AlSO4+	0.00	-18.999			
SO4--	2.56	-4.575	Fe+++	0.00	-21.516	Al(SO4)2-	0.00	-21.460			
HF	0.00	0.000	FeOH+	0.00	-9.759	AlF++	0.00	0.000			
F-	0.00	0.000	Fe(OH)2	0.00	-10.790	AlF2+	0.00	0.000			
Cl-	4088.94	-0.938	Fe(OH)3-	0.00	-17.452	AlF3	0.00	0.000			
Na+	2220.31	-1.015	Fe(OH)4--	0.00	-20.337	AlF4-	0.00	0.000			
K+	495.27	-1.897	Fe(OH)++	0.00	-13.428	AlF5--	0.00	0.000			
Ca++	66.12	-2.783	Fe(OH)2+	0.07	-6.140	AlF6---	0.00	0.000			

Logarithms of mineral solubility product constants (K) and ion activity products (Q) in water

	log K	log Q		log K	log Q		log K	log Q
Adularia	-14.401	-13.808	Albite, low	-13.981	-12.900	Analcime	-11.669	-10.868
Anhydrite	-8.876	-9.311	Calcite	-13.858	-14.493	Chalcedony	-1.842	-2.033
Mg-Chlorite	-88.501	-95.349	Fluorite	-11.192	99.999	Goethite	4.629	-2.740
Laumontite	-25.008	-22.858	Microcline	-14.974	-13.808	Magnetite	-12.857	-26.168
Ca-Montmor.	-72.545	-56.853	K-Montmor.	-33.726	-28.773	Mg-Montmor.	-74.049	-59.630
Na-Montmor.	-34.009	-27.865	Muscovite	-17.847	-13.376	Prehnite	-38.906	-35.986
Pyrrhotite	2.579	-50.996	Pyrite	-11.641	-54.785	Quartz	-1.971	-2.033
Wairakite	-25.468	-22.858	Wollastonite	6.831	4.850	Zoisite	-40.023	-35.770
Epidote	-40.420	-38.726	Marcasite	3.883	-54.785	Talc	7.278	4.187
Chrysotile	13.251	8.252	Sil. amorph.	-1.555	-2.033			

ICELAND WATER CHEMISTRY GROUP Program WATCH, version 2.4 / 2010

TR5C BERLÍN

Water sample (mg/kg) / Steam sample

pH/deg.C	6.12/ 22.0	Gas (volume %)		Reference temperature deg.C :	283.0 (Arbitrary)
CO2	3.20	CO2	0.00		
H2S	0.31	H2S	0.00	Sampling pressure bar abs. :	12.0
NH3	0.51	NH3	0.00	Discharge enthalpy kJ/kg :	1253. (Calculated)
B	129.0000	H2	24.60	Discharge kg/s :	0.0
SiO2	729.00	O2	0.42	Steam fraction at collection :	0.2288
Na	3740.00	CH4	4.93		
K	734.00	N2	70.06	Measured temperature deg.C :	46.0
Mg	0.148				
Ca	126.70	Liters gas per kg			
F	0.000	condensate/deg.C	0.08/25.0	Condensate (mg/kg)	
Cl	6794.00			pH/deg.C	0.00/ 0.0
SO4	11.50	Total steam (mg/kg)		CO2	0.00
Al	0.2190	CO2	2418.79	H2S	0.00
Fe	0.0940	H2S	358.86	NH3	0.00
TDS	0.00	NH3	0.97	Na	0.00

Ionic strength = 0.19270

Ionic balance : Cations (mol.eq.) = 0.18736831 Anions (mol.eq.) = 0.19148303 Difference (%) = -2.17

Liquid phase components (mg/kg) / Vapor phase (mg/kg) / Gas pressures (bar-abs.)

B	99.4830	CO2	555.92	CO2	0.00	CO2	0.868E+00		
SiO2	562.19	H2S	82.35	H2S	0.00	H2S	0.716E-01		
Na	2884.24	NH3	0.62	NH3	0.00	NH3	0.117E-03		
K	566.05	H2	0.36	H2	0.00	H2	0.499E-01		
Mg	0.114	O2	0.10	O2	0.00	O2	0.945E-03		
Ca	97.71	CH4	0.58	CH4	0.00	CH4	0.969E-02		
F	0.000	N2	14.31	N2	0.00	N2	0.175E+00		
Cl	5239.44					H2O	0.672E+02		
SO4	8.87					Total	0.683E+02		
Al	0.1689								
Fe	0.0725								
TDS	0.00	Aquifer steam fraction = 0.0000							

Ionic strength = 0.13004 1000/T (Kelvin) = 1.80

Ionic balance : Cations (mol.eq.) = 0.12600679 Anions (mol.eq.) = 0.12918199 Difference (%) = -2.49

Oxidation potential (volts) : Eh H2S= -0.429 Eh CH4= -0.505 Eh H2= -0.492 Eh NH3= -0.471

Chemical geothermometers (degrees C)

Quartz	272.0	(Fournier & Potter, GRC Bulletin, pp. 3-12, Nov. 1982)
Chalcedony	258.8	(Fournier, Geothermics, vol. 5, pp. 41-50, 1977)
Na/K	277.6	(Arnorsson et al., Geochim. Cosmochim. Acta, vol. 47, pp. 567-577, 1983)

Activity coefficients in water — TR5C

H+	0.660	K+	0.515	FeSO4+	0.575		
OH-	0.531	Ca++	0.129	FeCl++	0.109		
H3SiO4-	0.547	Mg++	0.170	FeCl2+	0.575		
H2SiO4--	0.117	CaHCO3+	0.600	FeCl4-	0.547		
H2BO3-	0.497	MgHCO3+	0.547	FeCl+	0.547		
HCO3-	0.547	CaOH+	0.600	Al+++	0.024		
CO3--	0.099	MgOH+	0.611	AlOH++	0.117		
HS-	0.531	NH4+	0.497	Al(OH)2+	0.585		
S--	0.109	Fe++	0.129	Al(OH)4-	0.561		
HSO4-	0.561	Fe+++	0.024	AlSO4+	0.561		
SO4--	0.089	FeOH+	0.575	Al(SO4)2-	0.561		
NaSO4-	0.585	Fe(OH)3-	0.575	AlF++	0.117		
KSO4-	0.585	Fe(OH)4--	0.109	AlF2+	0.585		
F-	0.531	Fe(OH)++	0.109	AlF4-	0.561		
Cl-	0.515	Fe(OH)2+	0.585	AlF5--	0.099		
Na+	0.547	Fe(OH)4-	0.585	AlF6---	0.006		

Chemical species in water - ppm and log mole — Water pH is 5.106

H+	0.01	-4.926	Mg++	0.11	-5.337	Fe(OH)3	0.08	-6.144				
OH-	0.04	-5.634	NaCl	1032.41	-1.753	Fe(OH)4-	0.00	-8.709				
H4SiO4	899.12	-2.029	KCl	81.97	-2.959	FeCl+	0.00	-7.435				
H3SiO4-	0.10	-5.995	NaSO4-	1.58	-4.877	FeCl2	0.00	-9.283				
H2SiO4--	0.00	-11.943	KSO4-	2.22	-4.785	FeCl++	0.00	-15.776				
NaH3SiO4	0.08	-6.163	CaSO4	1.60	-4.929	FeCl2+	0.00	-16.727				
H3BO3	568.92	-2.036	MgSO4	0.00	-7.389	FeCl3	0.00	-18.081				
H2BO3-	0.09	-5.812	CaCO3	0.00	-7.623	FeCl4-	0.00	-19.425				
H2CO3	781.40	-1.900	MgCO3	0.00	-11.715	FeSO4	0.00	-10.984				
HCO3-	1.07	-4.755	CaHCO3+	1.71	-4.771	FeSO4+	0.00	-18.266				
CO3--	0.00	-10.026	MgHCO3+	0.00	-8.621	Al+++	0.00	-16.838				
H2S	81.88	-2.619	CaOH+	0.02	-6.403	AlOH++	0.00	-12.006				
HS-	0.46	-4.860	MgOH+	0.00	-7.295	Al(OH)2+	0.00	-8.548				
S--	0.00	-13.842	NH4OH	0.81	-4.635	Al(OH)3	0.15	-5.716				
H2SO4	0.00	-10.520	NH4+	0.23	-4.888	Al(OH)4-	0.41	-5.363				
HSO4-	2.18	-4.648	Fe++	0.00	-7.928	AlSO4+	0.00	-18.166				
SO4--	2.72	-4.547	Fe+++	0.00	-20.964	Al(SO4)2-	0.00	-20.651				
HF	0.00	0.000	FeOH+	0.00	-9.641	AlF++	0.00	0.000				
F-	0.00	0.000	Fe(OH)2	0.00	-10.884	AlF2+	0.00	0.000				
Cl-	4574.20	-0.889	Fe(OH)3-	0.00	-17.688	AlF3	0.00	0.000				
Na+	2477.77	-0.967	Fe(OH)4--	0.00	-20.831	AlF4-	0.00	0.000				
K+	522.42	-1.874	Fe(OH)++	0.00	-13.212	AlF5--	0.00	0.000				
Ca++	96.54	-2.618	Fe(OH)2+	0.05	-6.276	AlF6---	0.00	0.000				

Logarithms of mineral solubility product constants (K) and ion activity products (Q) in water

	log K	log Q		log K	log Q		log K	log Q
Adularia	-14.382	-13.863	Albite, low	-13.958	-12.931	Analcime	-11.627	-10.902
Anhydrite	-8.724	-9.103	Calcite	-13.642	-14.536	Chalcedony	-1.870	-2.029
Mg-Chlorite	-87.732	-95.122	Fluorite	-11.144	99.999	Goethite	4.156	-3.033
Laumontite	-24.894	-22.850	Microcline	-14.972	-13.863	Magnetite	-13.671	-26.700
Ca-Montmor.	-72.568	-55.836	K-Montmor.	-33.777	-28.327	Mg-Montmor.	-74.073	-58.437
Na-Montmor.	-34.062	-27.394	Muscovite	-17.844	-13.274	Prehnite	-38.561	-36.145
Pyrrhotite	-2.107	-54.060	Pyrite	-17.504	-57.334	Quartz	-1.993	-2.029
Wairakite	-25.264	-22.850	Wollastonite	6.953	4.677	Zoisite	-39.581	-35.850
Epidote	-39.629	-39.178	Marcasite	-1.750	-57.334	Talc	7.546	4.198
Chrysotile	13.576	8.256	Sil. amorph.	-1.573	-2.029			

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ICELAND WATER CHEMISTRY GROUP                                                    Program WATCH, version 2.4 / 2010

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TR9                BERLÍN
Water sample (mg/kg)          Steam sample
pH/deg.C          6.88/ 22.0  Gas (volume %)                Reference temperature    deg.C :  281.0  (Arbitrary)
CO2                12.00      CO2                0.00
H2S                 0.14      H2S                0.00       Sampling pressure     bar abs. :   12.0
NH3                 0.44      NH3                0.00       Discharge enthalpy       kJ/kg :  1242.  (Calculated)
B                127.2000     H2                39.00       Discharge                 kg/s :    0.0
SiO2               677.00      O2                 0.48       Steam fraction at collection   : 0.2235
Na                3653.00      CH4                7.06
K                  707.00      N2                53.46       Measured temperature     deg.C :   99.0
Mg                   0.060
Ca                 134.00      Liters gas per kg
F                    0.000     condensate/deg.C  0.06/25.0   Condensate (mg/kg)
Cl                6585.00                                    pH/deg.C          0.00/ 0.0
SO4                 12.80      Total steam (mg/kg)          CO2               0.00
Al                 0.3130      CO2            3129.11       H2S               0.00
Fe                 0.0290      H2S             310.13       NH3               0.00
TDS                  0.00      NH3               1.96       Na                0.00
Ionic strength =  0.18803
Ionic balance :   Cations (mol.eq.) = 0.18324377    Anions (mol.eq.) = 0.18589514    Difference (%) = -1.44

Liquid phase components (mg/kg)                      Vapor phase (mg/kg)        Gas pressures (bar-abs.)
B          98.7702         CO2         708.69        CO2           0.00         CO2       0.111E+01
SiO2        525.69         H2S          69.42        H2S           0.00         H2S       0.601E-01
Na        2836.54          NH3          0.78         NH3           0.00         NH3       0.201E-03
K           548.98         H2             0.40       H2            0.00         H2        0.568E-01
Mg            0.047        O2             0.08       O2            0.00         O2        0.781E-03
Ca          104.05         CH4            0.58       CH4           0.00         CH4       0.997E-02
F             0.000        N2             7.64       N2            0.00         N2        0.963E-01
Cl         5113.22                                                              H2O       0.652E+02
SO4           9.94                                                              Total     0.665E+02
Al          0.2430
Fe          0.0225
TDS          0.00         Aquifer steam fraction =  0.0000

Ionic strength =  0.12870                                                1000/T (Kelvin) =   1.80
Ionic balance :   Cations (mol.eq.) = 0.12514066    Anions (mol.eq.) = 0.12720019    Difference (%) = -1.63
Oxidation potential (volts) :     Eh H2S= -0.502   Eh CH4= -0.564   Eh H2= -0.556   Eh NH3= -0.544

Chemical geothermometers (degrees C)
Quartz      263.5   (Fournier & Potter, GRC Bulletin, pp. 3-12, Nov. 1982)
Chalcedony  250.8   (Fournier, Geothermics, vol. 5, pp. 41-50, 1977)
Na/K        275.5   (Arnorsson et al., Geochim. Cosmochim. Acta, vol. 47, pp. 567-577, 1983)
Activity coefficients in water                                    TR9
H+                    0.663     K+                    0.520     FeSO4+                 0.579
OH-                       0.536     Ca++                  0.133     FeCl++                 0.112
H3SiO4-                   0.551     Mg++                  0.173     FeCl2+                 0.579
H2SiO4--                  0.121     CaHCO3+               0.604     FeCl4-                 0.551
H2BO3-                    0.502     MgHCO3+               0.551     FeCl+                  0.551
HCO3-                     0.551     CaOH+                 0.604     Al+++                  0.025
CO3--                 0.102     MgOH+                 0.615     AlOH++                 0.121
HS-                       0.536     NH4+                  0.502     Al(OH)2+               0.589
S--                       0.112     Fe++                  0.133     Al(OH)4-               0.566
HSO4-                     0.566     Fe+++                 0.025     AlSO4+                 0.566
SO4--                     0.092     FeOH+                 0.579     Al(SO4)2-              0.566
NaSO4-                    0.589     Fe(OH)3-              0.579     AlF++                  0.121
KSO4-                     0.589     Fe(OH)4--             0.112     AlF2+                  0.589
F-                        0.536     Fe(OH)++              0.112     AlF4-                  0.566
Cl-                       0.520     Fe(OH)2+              0.589     AlF5--                 0.102
Na+                       0.551     Fe(OH)4-              0.589     AlF6---                0.006

Chemical species in water - ppm and log mole                                  Water pH is  5.677
H+                0.00   -5.499     Mg++              0.04   -5.740     Fe(OH)3          0.04   -6.480
OH-               0.15   -5.066     NaCl            952.97   -1.788     Fe(OH)4-         0.00   -8.468
H4SiO4          840.30   -2.058     KCl              75.67   -2.994     FeCl+            0.00   -8.713
H3SiO4-           0.35   -5.440     NaSO4-            2.17   -4.740     FeCl2            0.00  -10.635
H2SiO4--          0.00  -10.807     KSO4-             2.89   -4.669     FeCl++           0.00  -17.795
NaH3SiO4          0.29   -5.608     CaSO4             2.31   -4.771     FeCl2+           0.00  -18.742
H3BO3           564.58   -2.039     MgSO4             0.00   -7.640     FeCl3            0.00  -20.103
H2BO3-            0.35   -5.243     CaCO3             0.05   -6.340     FeCl4-           0.00  -21.463
H2CO3           988.03   -1.798     MgCO3             0.00  -10.841     FeSO4            0.00  -12.105
HCO3-             5.34   -4.058     CaHCO3+           8.76   -4.062     FeSO4+           0.00  -20.124
CO3--          0.00   -8.745     MgHCO3+           0.00   -8.330     Al+++            0.00  -18.790
H2S              67.88   -2.701     CaOH+             0.09   -5.824     AlOH++           0.00  -13.415
HS-               1.49   -4.345     MgOH+             0.00   -7.155     Al(OH)2+         0.00   -9.402
S--               0.00  -12.774     NH4OH             1.38   -4.404     Al(OH)3          0.07   -6.018
H2SO4             0.00  -11.552     NH4+              0.11   -5.201     Al(OH)4-         0.76   -5.094
HSO4-             0.77   -5.102     Fe++              0.00   -9.199     AlSO4+           0.00  -19.978
SO4--             3.75   -4.409     Fe+++             0.00  -22.936     Al(SO4)2-        0.00  -22.324
HF                0.00    0.000     FeOH+             0.00  -10.357     AlF++            0.00    0.000
F-                0.00    0.000     Fe(OH)2           0.00  -11.037     AlF2+            0.00    0.000
Cl-            4499.17   -0.896     Fe(OH)3-          0.00  -17.266     AlF3             0.00    0.000
Na+            2461.17   -0.970     Fe(OH)4--         0.00  -19.867     AlF4-            0.00    0.000
K+              508.46   -1.886     Fe(OH)++          0.00  -14.650     AlF5--           0.00    0.000
Ca++             99.82   -2.604     Fe(OH)2+          0.01   -7.181     AlF6---          0.00    0.000

Logarithms of mineral solubility product constants (K) and ion activity products (Q) in water
                  log K     log Q                  log K     log Q                  log K     log Q
Adularia        -14.379  -13.687     Albite, low   -13.954  -12.746     Analcime       -11.617  -10.688
Anhydrite        -8.686   -8.924     Calcite       -13.588  -13.216     Chalcedony      -1.877   -2.058
Mg-Chlorite     -87.545  -92.063     Fluorite      -11.132   99.999     Goethite         4.039   -3.361
Laumontite      -24.868  -22.398     Microcline    -14.973  -13.687     Magnetite      -13.873  -27.471
Ca-Montmor.     -72.571  -59.503     K-Montmor.    -33.790  -30.181     Mg-Montmor.    -74.077  -62.524
Na-Montmor.     -34.074  -29.240     Muscovite     -17.843  -13.696     Prehnite       -38.477  -34.494
Pyrrhotite       -3.273  -56.422     Pyrite        -18.964  -62.165     Quartz          -2.000   -2.058
Wairakite       -25.215  -22.398     Wollastonite    6.984    5.815     Zoisite        -39.474  -34.499
Epidote         -39.449  -37.855     Marcasite      -3.152  -62.165     Talc             7.613    6.325
Chrysotile      13.658   10.442     Sil. amorph.   -1.578   -2.058
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TR17              BERLÍN
Water sample (mg/kg)          Steam sample
pH/deg.C          6.20/ 20.0  Gas (volume %)              Reference temperature    deg.C :  269.0  (Arbitrary)
CO2               2.49        CO2               0.00
H2S               0.19        H2S               0.00      Sampling pressure     bar abs. :    9.2
NH3               0.21        NH3               0.00      Discharge enthalpy       kJ/kg :  1180.  (Calculated)
B              155.4060       H2               17.10      Discharge                 kg/s :    0.0
SiO2           773.88         O2                1.83      Steam fraction at collection   : 0.2138
Na            4445.10         CH4               0.92
K              812.41         N2               80.15      Measured temperature     deg.C :   89.8
Mg               0.174
Ca             190.12         Liters gas per kg
F                0.000        condensate/deg.C  0.02/25.0  Condensate (mg/kg)
Cl            8166.35                                     pH/deg.C          0.00/ 0.0
SO4             11.60         Total steam (mg/kg)         CO2               0.00
Al             0.1333         CO2            2227.21      H2S               0.00
Fe             0.2130         H2S             305.90      NH3               0.00
TDS              0.00         NH3               0.00      Na                0.00
Ionic strength =  0.23142
Ionic balance :   Cations (mol.eq.) = 0.22305777    Anions (mol.eq.) = 0.23006244    Difference (%) = -3.09

Liquid phase components (mg/kg)                     Vapor phase (mg/kg)        Gas pressures (bar-abs.)
B         122.1779          CO2         478.17      CO2           0.00         CO2       0.826E+00
SiO2        608.42          H2S          65.56      H2S           0.00         H2S       0.616E-01
Na        3494.67           NH3           0.16      NH3           0.00         NH3       0.235E-04
K           638.70          H2             0.05     H2            0.00         H2        0.800E-02
Mg            0.137         O2             0.08     O2            0.00         O2        0.932E-03
Ca          149.47          CH4            0.02     CH4           0.00         CH4       0.415E-03
F             0.000         N2             3.14     N2            0.00         N2        0.478E-01
Cl         6420.27                                                            H2O       0.542E+02
SO4           9.12                                                            Total     0.551E+02
Al          0.1048
Fe          0.1675
TDS          0.00         Aquifer steam fraction =  0.0000

Ionic strength =  0.16434                                                1000/T (Kelvin) =   1.84
Ionic balance :   Cations (mol.eq.) = 0.15785764    Anions (mol.eq.) = 0.16336830    Difference (%) = -3.43
Oxidation potential (volts) :     Eh H2S= -0.402   Eh CH4= -0.457   Eh H2= -0.428   Eh NH3= -0.431

Chemical geothermometers (degrees C)
Quartz      283.2   (Fournier & Potter, GRC Bulletin, pp. 3-12, Nov. 1982)
Chalcedony  268.3   (Fournier, Geothermics, vol. 5, pp. 41-50, 1977)
Na/K        266.8   (Arnorsson et al., Geochim. Cosmochim. Acta, vol. 47, pp. 567-577, 1983)
Activity coefficients in water                                    TR17
H+                    0.660     K+                    0.508     FeSO4+                0.571
OH-                       0.525     Ca++                  0.130     FeCl++                    0.109
H3SiO4-                   0.542     Mg++                  0.172     FeCl2+                    0.571
H2SiO4--                  0.117     CaHCO3+               0.597     FeCl4-                    0.542
H2BO3-                    0.489     MgHCO3+               0.542     FeCl+                     0.542
HCO3-                     0.542     CaOH+                 0.597     Al+++                     0.025
CO3--                 0.098     MgOH+                 0.609     AlOH++                0.117
HS-                       0.525     NH4+                  0.489     Al(OH)2+                  0.582
S--                       0.109     Fe++                  0.130     Al(OH)4-                  0.557
HSO4-                     0.557     Fe+++                 0.025     AlSO4+                    0.557
SO4--                     0.088     FeOH+                 0.571     Al(SO4)2-                 0.557
NaSO4-                    0.582     Fe(OH)3-              0.571     AlF++                     0.117
KSO4-                     0.582     Fe(OH)4--             0.109     AlF2+                     0.582
F-                        0.525     Fe(OH)++              0.109     AlF4-                     0.557
Cl-                       0.508     Fe(OH)2+              0.582     AlF5--                    0.098
Na+                       0.542     Fe(OH)4-              0.582     AlF6---                   0.005

Chemical species in water - ppm and log mole                                  Water pH is  5.025
H+              0.01   -4.845     Mg++            0.13   -5.256     Fe(OH)3         0.13   -5.917
OH-             0.03   -5.714     NaCl          983.09   -1.774     Fe(OH)4-        0.00   -8.504
H4SiO4        973.02   -1.995     KCl            79.86   -2.970     FeCl+           0.04   -6.341
H3SiO4-         0.11   -5.920     NaSO4-          1.81   -4.819     FeCl2           0.00   -8.633
H2SiO4--        0.00  -11.826     KSO4-           1.90   -4.851     FeCl++          0.00  -14.878
NaH3SiO4        0.11   -6.027     CaSO4           2.01   -4.831     FeCl2+          0.00  -15.758
H3BO3         698.71   -1.947     MgSO4           0.01   -7.320     FeCl3           0.00  -17.068
H2BO3-          0.11   -5.755     CaCO3           0.00   -7.583     FeCl4-          0.00  -18.375
H2CO3         671.31   -1.966     MgCO3           0.00  -11.694     FeSO4           0.00   -9.953
HCO3-           1.20   -4.705     CaHCO3+         2.32   -4.640     FeSO4+          0.00  -17.446
CO3--           0.00   -9.904     MgHCO3+         0.00   -8.566     Al+++           0.00  -16.203
H2S            65.06   -2.719     CaOH+           0.02   -6.408     AlOH++          0.00  -11.679
HS-             0.48   -4.838     MgOH+           0.00   -7.529     Al(OH)2+        0.00   -8.472
S--             0.00  -13.972     NH4OH           0.16   -5.347     Al(OH)3         0.10   -5.881
H2SO4           0.00  -10.607     NH4+            0.09   -5.300     Al(OH)4-        0.24   -5.591
HSO4-           1.77   -4.738     Fe++            0.01   -6.850     AlSO4+          0.00  -17.650
SO4--           3.13   -4.487     Fe+++           0.00  -19.838     Al(SO4)2-       0.00  -20.179
HF              0.00    0.000     FeOH+           0.00   -8.819     AlF++           0.00    0.000
F-              0.00    0.000     Fe(OH)2         0.00  -10.226     AlF2+           0.00    0.000
Cl-          5785.93   -0.787     Fe(OH)3-        0.00  -17.062     AlF3            0.00    0.000
Na+          3107.55   -0.869     Fe(OH)4--       0.00  -20.433     AlF4-           0.00    0.000
K+            596.27   -1.817     Fe(OH)++        0.00  -12.455     AlF5--          0.00    0.000
Ca++          147.94   -2.433     Fe(OH)2+        0.11   -5.927     AlF6---         0.00    0.000

Logarithms of mineral solubility product constants (K) and ion activity products (Q) in water
                log K     log Q                 log K     log Q                 log K     log Q
Adularia      -14.371  -13.940     Albite, low  -13.939  -12.965     Analcime      -11.569  -10.970
Anhydrite      -8.460   -8.863     Calcite      -13.268  -14.231     Chalcedony     -1.921   -1.995
Mg-Chlorite   -86.459  -95.721     Fluorite     -11.063   99.999     Goethite        3.343   -2.746
Laumontite    -24.728  -22.988     Microcline   -14.993  -13.940     Magnetite     -15.073  -25.215
Ca-Montmor.   -72.581  -57.110     K-Montmor.   -33.858  -29.006     Mg-Montmor.   -74.086  -59.810
Na-Montmor.   -34.142  -28.031     Muscovite    -17.838  -13.643     Prehnite      -37.998  -36.300
Pyrrhotite    -10.215  -52.882     Pyrite       -27.684  -56.309     Quartz         -2.039   -1.995
Wairakite     -24.936  -22.988     Wollastonite   7.173    4.737     Zoisite       -38.851  -36.151
Epidote       -38.507  -39.046     Marcasite    -11.515  -56.309     Talc            8.020    4.115
Chrysotile     14.155    8.104     Sil. amorph.  -1.607   -1.995
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TR17A             BERLÍN
Water sample (mg/kg)          Steam sample
pH/deg.C          6.67/ 20.0  Gas (volume %)              Reference temperature    deg.C :  263.0  (Arbitrary)
CO2                 3.29      CO2               0.00
H2S                 0.70      H2S               0.00      Sampling pressure     bar abs. :    8.8
NH3                 0.25      NH3               0.00      Discharge enthalpy       kJ/kg :  1150.  (Calculated)
B                147.1261     H2                7.74      Discharge                 kg/s :    0.0
SiO2               553.99     O2                1.29      Steam fraction at collection   : 0.2023
Na                4188.30     CH4               0.97
K                  682.19     N2               90.00      Measured temperature     deg.C :   59.9
Mg                   0.278
Ca                 250.54     Liters gas per kg
F                    0.000    condensate/deg.C  0.02/25.0  Condensate (mg/kg)
Cl                7637.00                                  pH/deg.C          0.00/ 0.0
SO4                 28.08     Total steam (mg/kg)        CO2               0.00
Al                 0.3160     CO2            1510.60     H2S               0.00
Fe                 0.5355     H2S             289.24     NH3               0.00
TDS                  0.00     NH3               0.00     Na                0.00
Ionic strength =  0.22011
Ionic balance :   Cations (mol.eq.) = 0.21162386    Anions (mol.eq.) = 0.21557876    Difference (%) = -1.85

Liquid phase components (mg/kg)                    Vapor phase (mg/kg)        Gas pressures (bar-abs.)
B         117.3637         CO2         308.21      CO2           0.00         CO2       0.551E+00
SiO2        441.92         H2S          59.07      H2S           0.00         H2S       0.566E-01
Na        3341.04          NH3           0.20      NH3           0.00         NH3       0.354E-04
K           544.19         H2            0.03      H2            0.00         H2        0.524E-02
Mg            0.222        O2            0.08      O2            0.00         O2        0.942E-03
Ca          199.86         CH4           0.03      CH4           0.00         CH4       0.634E-03
F             0.000        N2            4.74      N2            0.00         N2        0.790E-01
Cl         6092.10                                                           H2O       0.493E+02
SO4          22.40                                                           Total     0.500E+02
Al           0.2521
Fe           0.4272
TDS          0.00         Aquifer steam fraction =  0.0000

Ionic strength =  0.16118                                                 1000/T (Kelvin) =   1.87
Ionic balance :   Cations (mol.eq.) = 0.15460692    Anions (mol.eq.) = 0.15777278    Difference (%) = -2.03
Oxidation potential (volts) :     Eh H2S= -0.428   Eh CH4= -0.485   Eh H2= -0.444   Eh NH3= -0.458

Chemical geothermometers (degrees C)
Quartz      244.6   (Fournier & Potter, GRC Bulletin, pp. 3-12, Nov. 1982)
Chalcedony  231.5   (Fournier, Geothermics, vol. 5, pp. 41-50, 1977)
Na/K        253.2   (Arnorsson et al., Geochim. Cosmochim. Acta, vol. 47, pp. 567-577, 1983)
Activity coefficients in water                                          TR17A
H+                    0.666     K+                    0.518     FeSO4+                0.580
OH-                       0.535     Ca++                  0.138     FeCl++                    0.116
H3SiO4-                   0.551     Mg++                  0.181     FeCl2+                    0.580
H2SiO4--                  0.125     CaHCO3+               0.605     FeCl4-                    0.551
H2BO3-                    0.499     MgHCO3+               0.551     FeCl+                     0.551
HCO3-                     0.551     CaOH+                 0.605     Al+++                     0.028
CO3--                 0.105     MgOH+                 0.617     AlOH++                0.125
HS-                       0.535     NH4+                  0.499     Al(OH)2+                  0.590
S--                       0.116     Fe++                  0.138     Al(OH)4-                  0.566
HSO4-                     0.566     Fe+++                 0.028     AlSO4+                    0.566
SO4--                     0.095     FeOH+                 0.580     Al(SO4)2-                 0.566
NaSO4-                    0.590     Fe(OH)3-              0.580     AlF++                     0.125
KSO4-                     0.590     Fe(OH)4--             0.116     AlF2+                     0.590
F-                        0.535     Fe(OH)++              0.116     AlF4-                     0.566
Cl-                       0.518     Fe(OH)2+              0.590     AlF5--                    0.105
Na+                       0.551     Fe(OH)4-              0.590     AlF6---                   0.006

Chemical species in water - ppm and log mole                                  Water pH is  5.318
H+                0.01   -5.142     Mg++             0.21   -5.054     Fe(OH)3          0.46   -5.362
OH-               0.06   -5.436     NaCl           796.13   -1.866     Fe(OH)4-         0.00   -7.643
H4SiO4          706.58   -2.134     KCl             59.51   -3.098     FeCl+            0.07   -6.104
H3SiO4-           0.18   -5.726     NaSO4-           4.73   -4.401     FeCl2            0.00   -8.635
H2SiO4--          0.00  -11.308     KSO4-            4.12   -4.516     FeCl++           0.00  -15.091
NaH3SiO4          0.17   -5.842     CaSO4            7.19   -4.277     FeCl2+           0.00  -15.967
H3BO3           671.08   -1.964     MgSO4            0.03   -6.663     FeCl3            0.00  -17.299
H2BO3-            0.21   -5.471     CaCO3            0.01   -7.015     FeCl4-           0.00  -18.647
H2CO3           429.89   -2.159     MgCO3            0.00  -11.017     FeSO4            0.00   -9.240
HCO3-             1.79   -4.532     CaHCO3+          4.38   -4.363     FeSO4+           0.00  -17.176
CO3--             0.00   -9.403     MgHCO3+          0.00   -8.205     Al+++            0.00  -16.702
H2S              58.05   -2.769     CaOH+            0.05   -6.026     AlOH++           0.00  -11.976
HS-               0.99   -4.524     MgOH+            0.00   -7.122     Al(OH)2+         0.00   -8.530
S--               0.00  -13.417     NH4OH            0.24   -5.166     Al(OH)3          0.15   -5.710
H2SO4             0.00  -10.858     NH4+             0.08   -5.331     Al(OH)4-         0.70   -5.131
HSO4-             2.08   -4.668     Fe++             0.01   -6.586     AlSO4+           0.00  -17.726
SO4--             8.50   -4.053     Fe+++            0.00  -19.913     Al(SO4)2-        0.00  -19.830
HF                0.00    0.000     FeOH+            0.00   -8.324     AlF++            0.00    0.000
F-                0.00    0.000     Fe(OH)2          0.00   -9.470     AlF2+            0.00    0.000
Cl-            5580.84   -0.803     Fe(OH)3-         0.00  -16.006     AlF3             0.00    0.000
Na+            3026.90   -0.881     Fe(OH)4--        0.00  -19.173     AlF4-            0.00    0.000
K+              511.79   -1.883     Fe(OH)++         0.00  -12.355     AlF5--           0.00    0.000
Ca++            195.96   -2.311     Fe(OH)2+         0.20   -5.652     AlF6---          0.00    0.000

Logarithms of mineral solubility product constants (K) and ion activity products (Q) in water
                  log K     log Q                  log K     log Q                  log K     log Q
Adularia        -14.375  -13.949     Albite, low   -13.939  -12.919     Analcime      -11.552  -10.786
Anhydrite        -8.348   -8.248     Calcite       -13.110  -13.551     Chalcedony     -1.944   -2.134
Mg-Chlorite     -85.943  -91.802     Fluorite      -11.029   99.999     Goethite        3.001   -2.164
Laumontite      -24.669  -22.463     Microcline    -15.012  -13.949     Magnetite     -15.666  -23.190
Ca-Montmor.     -72.583  -56.922     K-Montmor.    -33.892  -29.045     Mg-Montmor.   -74.088  -59.548
Na-Montmor.     -34.174  -28.015     Muscovite     -17.838  -13.291     Prehnite      -37.773  -34.916
Pyrrhotite      -13.654  -48.568     Pyrite        -32.018  -52.504     Quartz         -2.061   -2.134
Wairakite       -24.806  -22.463     Wollastonite    7.270    5.332     Zoisite       -38.556  -34.587
Epidote         -38.125  -37.080     Marcasite     -15.665  -52.504     Talc            8.226    5.986
Chrysotile       14.406   10.254     Sil. amorph.   -1.622   -2.134
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ICELAND WATER CHEMISTRY GROUP Program WATCH, version 2.4 / 2010

TR18 BERLÍN

Water sample (mg/kg) Steam sample

pH/deg.C	7.47/ 20.0	Gas (volume %)		Reference temperature deg.C :	265.0 (Arbitrary)
CO2	15.84	CO2	0.00		
H2S	1.17	H2S	0.00	Sampling pressure bar abs. :	9.5
NH3	0.34	NH3	0.00	Discharge enthalpy kJ/kg :	1160. (Calculated)
B	86.2070	H2	6.49	Discharge kg/s :	0.0
SiO2	626.55	O2	0.84	Steam fraction at collection :	0.2016
Na	1998.31	CH4	0.64		
K	308.54	N2	92.02	Measured temperature deg.C :	66.8
Mg	0.027				
Ca	44.90	Liters gas per kg			
F	0.000	condensate/deg.C	0.05/25.0	Condensate (mg/kg)	
Cl	3441.05			pH/deg.C	0.00/ 0.0
SO4	26.76	Total steam (mg/kg)		CO2	0.00
Al	0.3250	CO2	3516.53	H2S	0.00
Fe	0.1200	H2S	417.51	NH3	0.00
TDS	0.00	NH3	0.00	Na	0.00

Ionic strength = 0.09884

Ionic balance : Cations (mol.eq.) = 0.09689300 Anions (mol.eq.) = 0.09803366 Difference (%) = -1.17

Liquid phase components (mg/kg)				Vapor phase (mg/kg)		Gas pressures (bar-abs.)	
B	68.8253	CO2	721.68	CO2	0.00	CO2	0.126E+01
SiO2	500.22	H2S	85.12	H2S	0.00	H2S	0.779E-01
Na	1595.40	NH3	0.28	NH3	0.00	NH3	0.740E-04
K	246.33	H2	0.05	H2	0.00	H2	0.927E-02
Mg	0.022	O2	0.11	O2	0.00	O2	0.130E-02
Ca	35.85	CH4	0.04	CH4	0.00	CH4	0.891E-03
F	0.000	N2	10.49	N2	0.00	N2	0.169E+00
Cl	2747.24					H2O	0.509E+02
SO4	21.37					Total	0.524E+02
Al	0.2595						
Fe	0.0958						
TDS	0.00	Aquifer steam fraction = 0.0000					

Ionic strength = 0.07395 1000/T (Kelvin) = 1.86

Ionic balance : Cations (mol.eq.) = 0.07259463 Anions (mol.eq.) = 0.07350856 Difference (%) = -1.25

Oxidation potential (volts) : Eh H2S= -0.507 Eh CH4= -0.548 Eh H2= -0.523 Eh NH3= -0.529

Chemical geothermometers (degrees C)

Quartz	257.6	(Fournier & Potter, GRC Bulletin, pp. 3-12, Nov. 1982)
Chalcedony	245.1	(Fournier, Geothermics, vol. 5, pp. 41-50, 1977)
Na/K	248.4	(Arnorsson et al., Geochim. Cosmochim. Acta, vol. 47, pp. 567-577, 1983)

Activity coefficients in water TR18

H+	0.713	K+	0.608	FeSO4+	0.651	
OH-	0.619	Ca++	0.202	FeCl++	0.181	
H3SiO4-	0.630	Mg++	0.242	FeCl2+	0.651	
H2SiO4--	0.190	CaHCO3+	0.669	FeCl4-	0.630	
H2BO3-	0.596	MgHCO3+	0.630	FeCl+	0.630	
HCO3-	0.630	CaOH+	0.669	Al+++	0.049	
CO3--	0.171	MgOH+	0.677	AlOH++	0.190	
HS-	0.619	NH4+	0.596	Al(OH)2+	0.658	
S--	0.181	Fe++	0.202	Al(OH)4-	0.641	
HSO4-	0.641	Fe+++	0.049	AlSO4+	0.641	
SO4--	0.160	FeOH+	0.651	Al(SO4)2-	0.641	
NaSO4-	0.658	Fe(OH)3-	0.651	AlF++	0.190	
KSO4-	0.658	Fe(OH)4--	0.181	AlF2+	0.658	
F-	0.619	Fe(OH)++	0.181	AlF4-	0.641	
Cl-	0.608	Fe(OH)2+	0.658	AlF5--	0.171	
Na+	0.630	Fe(OH)4-	0.658	AlF6---	0.019	

Chemical species in water - ppm and log mole Water pH is 5.910

H+	0.00	-5.763	Mg++	0.02	-6.102	Fe(OH)3	0.16	-5.824		
OH-	0.21	-4.905	NaCl	259.04	-2.353	Fe(OH)4-	0.00	-7.566		
H4SiO4	799.15	-2.080	KCl	18.30	-3.610	FeCl+	0.00	-8.038		
H3SiO4-	0.67	-5.155	NaSO4-	5.13	-4.366	FeCl2	0.00	-10.695		
H2SiO4--	0.00	-10.286	KSO4-	4.37	-4.490	FeCl++	0.00	-17.835		
NaH3SiO4	0.41	-5.457	CaSO4	3.68	-4.568	FeCl2+	0.00	-18.830		
H3BO3	393.27	-2.197	MgSO4	0.01	-7.255	FeCl3	0.00	-20.370		
H2BO3-	0.39	-5.194	CaCO3	0.08	-6.103	FeCl4-	0.00	-22.032		
H2CO3	998.48	-1.793	MgCO3	0.00	-10.409	FeSO4	0.00	-10.530		
HCO3-	13.36	-3.660	CaHCO3+	8.24	-4.089	FeSO4+	0.00	-19.190		
CO3--	0.00	-8.109	MgHCO3+	0.00	-8.242	Al+++	0.00	-19.266		
H2S	80.61	-2.626	CaOH+	0.05	-6.088	AlOH++	0.00	-13.844		
HS-	4.37	-3.879	MgOH+	0.00	-7.458	Al(OH)2+	0.00	-9.647		
S--	0.00	-12.300	NH4OH	0.50	-4.847	Al(OH)3	0.05	-6.165		
H2SO4	0.00	-11.679	NH4+	0.04	-5.710	Al(OH)4-	0.85	-5.049		
HSO4-	1.06	-4.963	Fe++	0.00	-8.375	AlSO4+	0.00	-19.749		
SO4--	10.47	-3.962	Fe+++	0.00	-22.498	Al(SO4)2-	0.00	-21.521		
HF	0.00	0.000	FeOH+	0.00	-9.378	AlF++	0.00	0.000		
F-	0.00	0.000	Fe(OH)2	0.00	-9.870	AlF2+	0.00	0.000		
Cl-	2581.41	-1.138	Fe(OH)3-	0.00	-15.868	AlF3	0.00	0.000		
Na+	1492.42	-1.188	Fe(OH)4--	0.00	-18.564	AlF4-	0.00	0.000		
K+	235.47	-2.220	Fe(OH)++	0.00	-14.247	AlF5--	0.00	0.000		
Ca++	31.43	-3.106	Fe(OH)2+	0.02	-6.759	AlF6---	0.00	0.000		

Logarithms of mineral solubility product constants (K) and ion activity products (Q) in water

	log K	log Q		log K	log Q		log K	log Q
Adularia	-14.373	-13.919	Albite, low	-13.938	-12.871	Analcime	-11.557	-10.791
Anhydrite	-8.385	-8.559	Calcite	-13.162	-12.677	Chalcedony	-1.936	-2.080
Mg-Chlorite	-86.113	-91.220	Fluorite	-11.040	99.999	Goethite	3.115	-2.635
Laumontite	-24.688	-22.605	Microcline	-15.005	-13.919	Magnetite	-15.469	-24.566
Ca-Montmor.	-72.582	-61.595	K-Montmor.	-33.881	-31.334	Mg-Montmor.	-74.087	-64.513
Na-Montmor.	-34.163	-30.286	Muscovite	-17.838	-14.177	Prehnite	-37.847	-34.552
Pyrrhotite	-12.510	-50.181	Pyrite	-30.576	-55.002	Quartz	-2.053	-2.080
Wairakite	-24.848	-22.605	Wollastonite	7.237	5.940	Zoisite	-38.653	-34.681
Epidote	-38.246	-37.186	Marcasite	-14.284	-55.002	Talc	8.157	6.987
Chrysotile	14.322	11.147	Sil. amorph.	-1.617	-2.080			