M/037/0088
cc: Mike
Peter
April

United States Department of the Interior

BUREAU OF LAND MANAGEMENT
Moab Field Office
82 East Dogwood
Moab, Utah 84532
http://www.blm.gov/ut/st/en/fo/moab.html

RECEIVED
SEP 26 2013
DIV. OF OIL, GAS & MINING

IN REPLY REFER TO:
3809
UTU-72499
(UTY012)

SEP 24 2013

CERTIFIED MAIL # 7012 3460 0002 5528 2520
RETURN RECEIPT REQUESTED

Lantz Indergard
Lisbon Valley Mining Company LLC
755 North Main Street, Suite B
Moab, Utah 84532

Dear Mr. Indergard:

The BLM received your Mine Plan Modification to backfill the Centennial Pit on July 2, 2013. The BLM and the United States Geological Survey (USGS) reviewed the Adrian Brown, Whetstone Associates, Inc. and Arcadis groundwater models and groundwater geochmical data for the mine area and for the pit backfill proposal. Based on these reviews the BLM has determined that the Arcadis report, submitted as part of the Mine Plan Modification, cannot be used to predict groundwater conditions that will exist at the mine site in the future and that static methods (i.e. Meteoric Water Mobility Procedure (MWMP) are not suitable methods to use to predict long-term post-mining groundwater quality.

Before the BLM can take further action on processing Lisbon Valley Mining Company's proposed Mine Plan Modification to backfill the Centennial Pit, we request: (1) responses to the summary comments below and (2) when appropriate, the additional information and (or) data that has been requested. If this information is not provided or does not adequately address deficiencies outlined in this letter, the BLM will not be able to process the proposed Mine Plan Modification to backfill the Centennial Pit. Your application to modify your Mining Plan of Operations may be denied.

A. Hydrogeologic Model

Deficiency 1:
The construction of the three models supplied by Arcadis is generally in agreement with observed lithology in the Centennial Pit area of the copper mine, however, the geometry of the lithology is not uniform from model to model and is not presented numerically the same in all three models. Conceptual assumptions made during model construction need to be supported or referenced.

a. The Arcadis report does not reference in its text as to why the assumption that a no-flow boundary completely surrounds the upper (Burro Canyon) aquifer. The argument used is that faulting has offset a portion of the Burro Canyon aquifer and juxtaposed it with either lower permeable lithologies or well developed fault gouge. The same argument should apply to lower (Navajo) aquifer as it is likely bounded by the same fault conditions. However, no explanation is given as to why these same conditions would not exist at depth.

b. No explanation is provided to support the assumption used in simulating the lower aquifer as a constant head boundary and as the only point of discharge for this "Hydrogeologic Conceptual Model".

c. In the Arcadis report, reference is made to previous aquifer tests that were completed to characterize the hydrologic system near the Lisbon Valley Mine. A range of values of aquifer storage from theses test would be useful in making a comparison to the values used in the model. In addition, if there is any analysis associated with the aquifer test that suggests a no-flow boundary is encountered, this would be useful to include in strengthening an argument for simulating the no-flow boundary in the upper aquifer model.

Remedy 1:

a. Provide references and document in a discussion as to why the assumption of the no flow boundary is made for the Burro Canyon aquifer and explain with supporting references and documentation in a discussion as to whether or not the same conditions exist for the Navajo aquifer.

b. Provide an explanation with references and a supporting documentation regarding the simulation of the lower aquifer as a constant head boundary and why it is the only point of discharge for the "Hydrogeologic Conceptual Model".

c. Include in the report the range of values of aquifer storage from the aquifer tests to compare with the values used in the model. Also include any analyses associated with the aquifer tests to strengthen the argument for simulating the no-flow boundary in the upper aquifer.

Deficiency 2:

Regarding the water budget outputs for the steady state and the transient models, there is a difference in the thickness of Layer 11. In the steady state model (LV-1), the thickness of Layer 11 is 490 feet, while in the transient model (LV-TR3) the thickness of Layer 11 is 330 feet. This difference leads to an elevated flux through the Layer 11 transient model. This change is seen in the relationship between recharge and the constant head boundary in the Navajo aquifer in the transient model (see Figure 1 below). If the hydraulic properties and geometry were the same in the two models, the transient model would begin with recharge equal to constant head discharge (steady-state conditions), well pumpage (stress on the system) would then decrease the amount of discharge from the constant head boundary. In its current form, the transient model does not illustrate this relationship. The transient model begins with 5,400 ft^3/day discharging through the constant head boundary with a steady recharge rate of 4,137 ft^3/day. The discharge rate at the end of the transient model is still well above the recharge rate of 4,900 ft^3/day. This shows that

some of the drawdown simulated by the model is attributed to the increased flux across Layer 11, due to a change in aquifer geometry. If this is a mistake, calibration would be impossible if the geometry of the model is incorrect, due to the fact that water levels are changing in response to different hydraulic properties than were calibrated to in the steady state model and not withdrawal stress alone. If this is not a mistake, there is no narrative that describes why this was done.

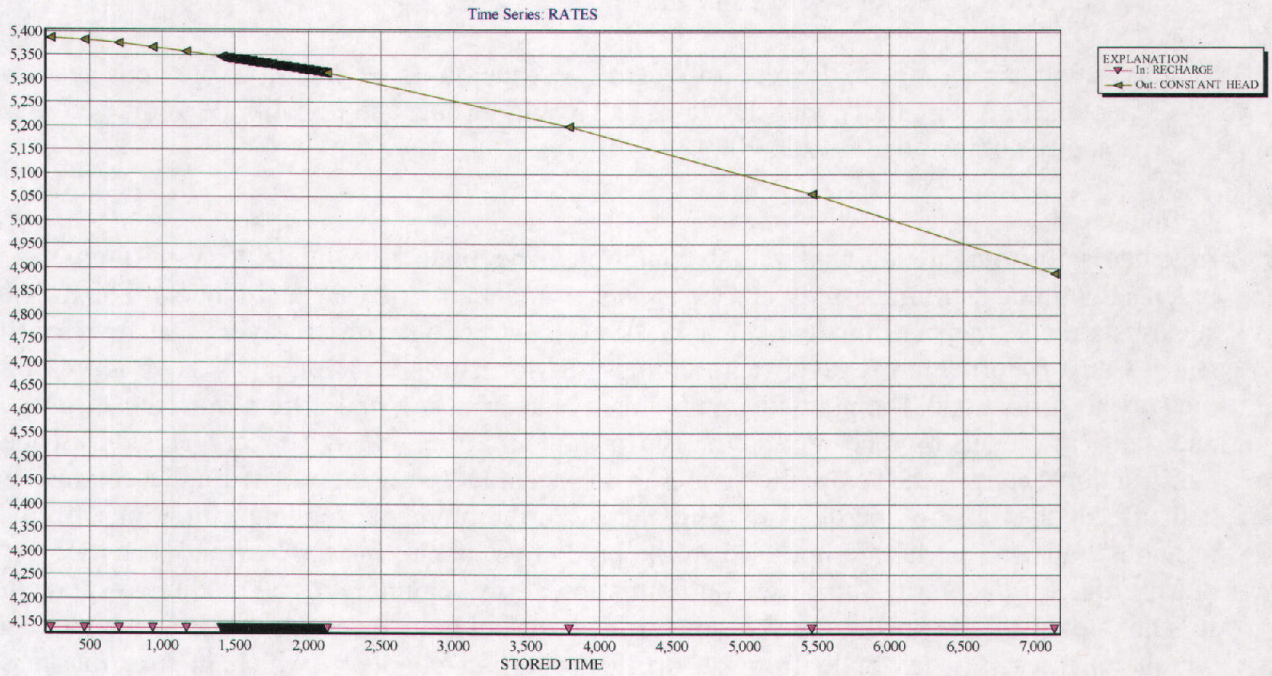

Figure 1: Rates of recharge and constant head discharge for the transient model LV-TR3.

Remedy 2:
Provide a narrative and supporting documentation stating why the same thickness for Layer 11 was not used in the steady state and transient models and account for the increased flux across Layer 11. If this is a mistake, correct the model and provide supporting narrative.

Deficiency 3:
Only one well (well MW96-7A) was used to calibrate the model. The observed data from this well used to assess the calibration of the model is limited to data from 2008 and 2009, while data is available from late 2004 through 2009. If this is the only observed data that was used during model calibration the case for having a calibrated model is weak for the following reasons:

a. As shown in the 2009 Annual Update of the Lisbon Valley Hydrogeologic System Evaluation (Whetstone, 2010), several observation wells are available to use to calibrate the model.

b. The time period 2008 and 2009 correlates to the observed data in well MW96-7A represents a less-stressed system in comparison to pumping that occurred from 2004 through 2007, which would be useful in assessing the match of observed drawdown and recovery in the wells. Using non-approximated pumpage and water levels from nearby

monitoring wells for the entire period of record (2004 through 2009) is essential for calibration of hydraulic conductivity, specific yield, and specific storage. No reasons are stated for non-use of the observed data from previous years.

Remedy 3:

a. Provide a narrative in the report as to why data from all observation wells were not used to calibrate the model. The model should use all available data and re-calibrate to the period of record, not just to 2008 and 2009.

b. Provide a narrative in the report to justify why the observed data from previous years was not used. Again, the model should use all available data and re-calibrate to the period of record, not just to 2008 and 2009.

Deficiency 4:

In regards to construction and initial conditions, the predictive model (LV-TR9-5%) is an independent model from the previous steady state model and the transient models. The previous steady state and transient models use a 12 layer construction with 10 layers that represent the Burro Canyon Formation, 1 layer representing the Morrison Formation and 1 layer representing the Navajo formation. The predictive model is a 3 layer model, and differs from the steady state and transient models by representing the Burro Canyon Formation as 1 layer. This difference in construction changes the hydraulic properties, especially in regards to hydraulic conductance, and affects the flow properties of the model. Furthermore, the ending conditions from the previous transient model are not used in the predictive model, instead starting heads are set to one altitude for the entire Burro Canyon Formation at the beginning of the predictive simulation. It is not clear why the post-stressed heads for the transient model were not used, as the predictive simulation must re-equilibrate from an artificial starting condition which in turn masks any process that is occurring in the initial period of the predictive model.

Remedy 4:

The predictive model is different from the steady state and transient models in terms of construction and initial conditions. The accuracy of this model cannot be determined. Provide a narrative and supporting documentation to justify the differences in the construction and initial conditions used among the models.

Deficiency 5:

In General, the wording in the report is confusing. Clearly, there are three separate models: a steady-state, a transient and a predictive. The report blends pieces of construction, calibration, and results for all three models into one discussion. Each model is different from the other in terms of construction, starting conditions and discretization.

Remedy 5:

The accuracy with which the steady state model represents the actual system is undetermined as the assumptions (correlation of Layer 11 vertical hydraulic conductivity, areal recharge, no-flow boundaries, constant head in Layer 12) stated to produce the water-levels are not clearly represented. The transient model is discretized differently (representation of the system using different layer thicknesses) resulting in simulated changes in storage and water levels that are not the result of simulated stresses alone. See requests for information under Remedies 1-4.

B. Geochemical Characteristics of the Backfill Material and Resulting Post-Mining Water Quality

Deficiencies:

a. The static methods (e.g. Meteoric Water Mobility Procedure (MWMP)), provides little information on long-term water quality and should only be used to simulate short term water-rock interactions with rain or snowmelt. The unsuitability of static testing methods is supported by the comparison of water quality between water samples from the Burro Canyon aquifer and the static test results using material from Beds 14 and 15. The chemical constituents in the Burro Canyon aquifer are, on average, significantly lower in concentration than water samples from the corresponding static tests (most static test concentrations are below the lower analytical reporting limits).

b. The results of the PHREEQC model (Attachment 1) indicate that the water from the Burro Canyon aquifer is at or close to thermodynamic equilibrium with a number of minerals. The results of the Burro Canyon aquifer simulations are an estimate because no redox information is provided. A disparity exists between the simulated post-mining water quality from the laboratory simulations and the current water-quality samples from the Burro Canyon aquifer.

c. Only one sample from each bed was tested using the MWMP test, yet 75 million tons of this material will potentially be backfilled after mining. Aside from the static testing as being unsuitable to predict long-term post-mining groundwater quality, testing one sample form each bed does not adequately represent the range of materials (e.g. grain size, post mining weathering conditions, and mineralogy). A statistical sampling design is needed to insure that an adequate number of samples have been collected and properly analyzed to determine the full range of geologic materials.

d. The degree of weathering associated with the materials used in the MWMP tests is not clearly described in the supporting information. The weathered state of the backfill material should be identified because the purpose of the MWMP tests is to represent rapid release of soluble salts from weathered surfaces. Also, 97.1% of the material used from Bed 15 had a particle size greater than 5 cm. The significant proportion of large particles coupled with the exposure of non-weathered surfaces from the hand breaking of particles invalidates the MWMP results by exposing non-weathered surfaces; resulting in an underestimation of the mass of solutes then would be expected.

e. The Arcadis report does not include a Quality Assurance/Quality Control (QA/QC) Plan or the QA/QC results associated with the laboratory tests. This information, for example, should include, but not be limited to noting the standard reference material, laboratory accreditation, method blanks and sample replicates. This information is necessary to validate the results.

Remedy:

To address the deficiencies of the static tests, kinetic tests should be conducted on representative and well characterized backfill material to provide scientifically and statistically defensible predictions of long-term, post mining groundwater quality. The BLM requires Lisbon Valley

Mining Company submit a workplan outlining the kinetic tests, analytical procedures, and statistical sampling design for BLM to review and accept before executing the tests.

Before the BLM can begin an environmental analysis on Lisbon Mining Company's Mine Plan Modification proposal to backfill the Centennial Pit, we require the information requested under each remedy as described above. If this information does not meet the BLM's approval, your application to modify your Mining Plan of Operations will not be processed or may be denied.

If you have any questions please contact Rebecca Doolittle at (435) 259-2141.

Sincerely,

/s/ Jeffrey R. Smith

for

Beth Ransel
Field Manager

Enclosure:
Attachment 1

cc: Utah State Office, UT-923
UDGOM, M/037/0088

Attachment 1

```
Input file: D:\Lisbon Valley project\PHREEQC\Burro-Canyon-APR13.pqi
Output file: D:\Lisbon Valley project\PHREEQC\Burro-Canyon-APR13.pqo
Database file: C:\Program Files (x86)\USGS\Phreeqc Interactive
2.18.5570\database\wateq4f.dat

------------------
Reading data base.
------------------

      SOLUTION_MASTER_SPECIES
      SOLUTION_SPECIES
      PHASES
      EXCHANGE_MASTER_SPECIES
      EXCHANGE_SPECIES
      SURFACE_MASTER_SPECIES
      SURFACE_SPECIES
      RATES
      END
-------------------------------------
Reading input data for simulation 1.
-------------------------------------

      DATABASE C:\Program Files (x86)\USGS\Phreeqc Interactive
2.18.5570\database\wateq4f.dat
      SOLUTION 1 Burro Canyon median concentrations--oxidizing
          temp      15
          pH        7.1
          pe        -5
          redox     pe
          units     mg/l
          density   1
          Ba        0.055
          Al        0.062
          Sb        0.002
          As        0.004
          Be        0.001
          Cd        0.003
          Ca        334
          Cr        0.003
          Cu        0.043
          Fe        3.1
          Pb        0.002
          Mg        127
          Mn        0.9
          Mo        0.016
          Ni        0.015
          K         15
          Se        0.003
          Si        7.1
          Na        91
          V         0.006
          Zn        0.51
          U         0.092
          Cl        40
```

```
        F          0.4
        S(6)       1111
        Alkalinity 457 gfw 50.04
        water    1 # kg
    END
WARNING: Could not find element in database, Be.
    Concentration is set to zero.
WARNING: Could not find element in database, Cr.
    Concentration is set to zero.
WARNING: Could not find element in database, Mo.
    Concentration is set to zero.
WARNING: Could not find element in database, Sb.
    Concentration is set to zero.
WARNING: Could not find element in database, V.
    Concentration is set to zero.
-------------------------------------------
Beginning of initial solution calculations.
-------------------------------------------

Initial solution 1.     Burro Canyon median concentrations--oxidizing

-----------------------------Solution composition------------------------------

    Elements            Molality       Moles

    Al                 2.303e-006  2.303e-006
    Alkalinity         9.153e-003  9.153e-003
    As                 5.351e-008  5.351e-008
    Ba                 4.013e-007  4.013e-007
    Ca                 8.352e-003  8.352e-003
    Cd                 2.675e-008  2.675e-008
    Cl                 1.131e-003  1.131e-003
    Cu                 6.782e-007  6.782e-007
    F                  2.110e-005  2.110e-005
    Fe                 5.563e-005  5.563e-005
    K                  3.845e-004  3.845e-004
    Mg                 5.235e-003  5.235e-003
    Mn                 1.642e-005  1.642e-005
    Na                 3.967e-003  3.967e-003
    Ni                 2.561e-007  2.561e-007
    Pb                 9.674e-009  9.674e-009
    S(6)               1.159e-002  1.159e-002
    Se                 3.808e-008  3.808e-008
    Si                 1.184e-004  1.184e-004
    U                  3.874e-007  3.874e-007
    Zn                 7.819e-006  7.819e-006

----------------------------Description of solution----------------------------

                                    pH  =   7.100
                                    pe  =  -5.000
                     Activity of water  =   0.999
                        Ionic strength  =  4.291e-002
                    Mass of water (kg)  =  1.000e+000
                 Total carbon (mol/kg)  =  1.060e-002
                    Total CO2 (mol/kg)  =  1.060e-002
                  Temperature (deg C)   =  15.000
```

```
                 Electrical balance (eq)   = -1.791e-003
 Percent error, 100*(Cat-|An|)/(Cat+|An|)  =  -3.57
                              Iterations   =  10
                                 Total H   = 1.110220e+002
                                 Total O   = 5.558338e+001
```

----------Distribution of species----------

Species	Molality	Activity	Log Molality	Log Activity	Log Gamma
H+	9.215e-008	7.943e-008	-7.035	-7.100	-0.065
OH-	6.811e-008	5.671e-008	-7.167	-7.246	-0.080
H2O	5.551e+001	9.994e-001	1.744	-0.000	0.000
Al	2.303e-006				
Al(OH)4-	2.037e-006	1.696e-006	-5.691	-5.771	-0.080
Al(OH)2+	1.134e-007	9.439e-008	-6.946	-7.025	-0.080
Al(OH)3	7.878e-008	7.957e-008	-7.104	-7.099	0.004
AlF2+	4.852e-008	4.040e-008	-7.314	-7.394	-0.080
AlF+2	1.141e-008	5.485e-009	-7.943	-8.261	-0.318
AlF3	7.729e-009	7.806e-009	-8.112	-8.108	0.004
AlOH+2	5.034e-009	2.419e-009	-8.298	-8.616	-0.318
AlSO4+	4.921e-010	4.098e-010	-9.308	-9.387	-0.080
Al+3	1.957e-010	3.763e-011	-9.708	-10.424	-0.716
Al(SO4)2-	5.841e-011	4.863e-011	-10.234	-10.313	-0.080
AlF4-	5.775e-011	4.809e-011	-10.238	-10.318	-0.080
AlHSO4+2	5.572e-018	2.678e-018	-17.254	-17.572	-0.318
As(3)	5.351e-008				
H3AsO3	5.312e-008	5.364e-008	-7.275	-7.270	0.004
H2AsO3-	3.905e-010	3.251e-010	-9.408	-9.488	-0.080
H4AsO3+	2.536e-015	2.111e-015	-14.596	-14.675	-0.080
HAsO3-2	1.088e-017	5.228e-018	-16.963	-17.282	-0.318
AsO3-3	4.790e-026	9.213e-027	-25.320	-26.036	-0.716
As(5)	1.351e-018				
HAsO4-2	7.977e-019	3.834e-019	-18.098	-18.416	-0.318
H2AsO4-	5.530e-019	4.605e-019	-18.257	-18.337	-0.080
AsO4-3	4.355e-023	8.375e-024	-22.361	-23.077	-0.716
H3AsO4	6.546e-024	6.611e-024	-23.184	-23.180	0.004
Ba	4.013e-007				
Ba+2	2.038e-007	9.796e-008	-6.691	-7.009	-0.318
BaSO4	1.914e-007	1.933e-007	-6.718	-6.714	0.004
BaHCO3+	5.938e-009	4.944e-009	-8.226	-8.306	-0.080
BaCO3	1.388e-010	1.402e-010	-9.858	-9.853	0.004
BaOH+	5.016e-014	4.176e-014	-13.300	-13.379	-0.080
C(4)	1.060e-002				
HCO3-	8.593e-003	7.213e-003	-2.066	-2.142	-0.076
CO2	1.489e-003	1.504e-003	-2.827	-2.823	0.004
CaHCO3+	2.715e-004	2.260e-004	-3.566	-3.646	-0.080
MgHCO3+	1.852e-004	1.542e-004	-3.732	-3.812	-0.080
CaCO3	1.420e-005	1.434e-005	-4.848	-4.843	0.004
FeHCO3+	1.337e-005	1.113e-005	-4.874	-4.953	-0.080
NaHCO3	1.301e-005	1.314e-005	-4.886	-4.881	0.004
CO3-2	6.821e-006	3.386e-006	-5.166	-5.470	-0.304
MgCO3	5.186e-006	5.237e-006	-5.285	-5.281	0.004
MnHCO3+	3.432e-006	2.858e-006	-5.464	-5.544	-0.080
ZnHCO3+	1.755e-006	1.461e-006	-5.756	-5.835	-0.080
FeCO3	1.241e-006	1.253e-006	-5.906	-5.902	0.004

	MnCO3	1.184e-006	1.196e-006	-5.927	-5.922	0.004
	ZnCO3	1.076e-006	1.087e-006	-5.968	-5.964	0.004
	NiCO3	2.184e-007	2.206e-007	-6.661	-6.656	0.004
	Zn(CO3)2-2	1.637e-007	7.869e-008	-6.786	-7.104	-0.318
	NaCO3-	1.456e-007	1.212e-007	-6.837	-6.916	-0.080
	NiHCO3+	1.051e-008	8.750e-009	-7.978	-8.058	-0.080
	PbCO3	7.952e-009	8.031e-009	-8.100	-8.095	0.004
	BaHCO3+	5.938e-009	4.944e-009	-8.226	-8.306	-0.080
	Ni(CO3)2-2	2.701e-009	1.298e-009	-8.569	-8.887	-0.318
	CdHCO3+	2.024e-009	1.686e-009	-8.694	-8.773	-0.080
	PbHCO3+	9.391e-010	7.819e-010	-9.027	-9.107	-0.080
	Pb(CO3)2-2	1.421e-010	6.830e-011	-9.847	-10.166	-0.318
	BaCO3	1.388e-010	1.402e-010	-9.858	-9.853	0.004
	UO2(CO3)3-4	3.380e-011	1.803e-012	-10.471	-11.744	-1.273
	CdCO3	1.968e-011	1.988e-011	-10.706	-10.702	0.004
	UO2(CO3)2-2	1.175e-011	5.645e-012	-10.930	-11.248	-0.318
	Cd(CO3)2-2	4.428e-013	2.128e-013	-12.354	-12.672	-0.318
	CuCO3	1.663e-013	1.680e-013	-12.779	-12.775	0.004
	UO2CO3	8.503e-014	8.588e-014	-13.070	-13.066	0.004
	U(CO3)4-4	4.100e-014	2.187e-015	-13.387	-14.660	-1.273
	CuHCO3+	4.011e-014	3.340e-014	-13.397	-13.476	-0.080
	Cu(CO3)2-2	1.490e-015	7.161e-016	-14.827	-15.145	-0.318
	U(CO3)5-6	2.112e-017	2.890e-020	-16.675	-19.539	-2.864
	UO2(CO3)3-5	2.004e-018	2.056e-020	-17.698	-19.687	-1.989
	(UO2)3(CO3)6-6	2.859e-028	3.911e-031	-27.544	-30.408	-2.864
Ca	8.352e-003					
	Ca+2	5.968e-003	2.969e-003	-2.224	-2.527	-0.303
	CaSO4	2.097e-003	2.118e-003	-2.678	-2.674	0.004
	CaHCO3+	2.715e-004	2.260e-004	-3.566	-3.646	-0.080
	CaCO3	1.420e-005	1.434e-005	-4.848	-4.843	0.004
	CaF+	3.785e-007	3.151e-007	-6.422	-6.502	-0.080
	CaOH+	7.446e-009	6.200e-009	-8.128	-8.208	-0.080
	CaHSO4+	1.058e-009	8.809e-010	-8.975	-9.055	-0.080
Cd	2.675e-008					
	Cd+2	1.538e-008	7.390e-009	-7.813	-8.131	-0.318
	CdSO4	7.800e-009	7.877e-009	-8.108	-8.104	0.004
	CdHCO3+	2.024e-009	1.686e-009	-8.694	-8.773	-0.080
	CdCl+	7.640e-010	6.361e-010	-9.117	-9.196	-0.080
	Cd(SO4)2-2	7.539e-010	3.623e-010	-9.123	-9.441	-0.318
	CdCO3	1.968e-011	1.988e-011	-10.706	-10.702	0.004
	CdOH+	4.312e-012	3.590e-012	-11.365	-11.445	-0.080
	CdOHCl	2.625e-012	2.651e-012	-11.581	-11.577	0.004
	CdCl2	2.359e-012	2.382e-012	-11.627	-11.623	0.004
	CdF+	1.733e-012	1.443e-012	-11.761	-11.841	-0.080
	Cd(CO3)2-2	4.428e-013	2.128e-013	-12.354	-12.672	-0.318
	Cd(OH)2	5.173e-015	5.225e-015	-14.286	-14.282	0.004
	CdCl3-	1.441e-015	1.200e-015	-14.841	-14.921	-0.080
	CdF2	5.566e-017	5.621e-017	-16.254	-16.250	0.004
	Cd2OH+3	7.685e-019	1.478e-019	-18.114	-18.830	-0.716
	Cd(OH)3-	8.858e-021	7.375e-021	-20.053	-20.132	-0.080
	Cd(OH)4-2	1.721e-027	8.270e-028	-26.764	-27.082	-0.318
Cl	1.131e-003					
	Cl-	1.130e-003	9.331e-004	-2.947	-3.030	-0.083
	CuCl2-	1.492e-007	1.242e-007	-6.826	-6.906	-0.080
	FeCl+	2.387e-008	1.988e-008	-7.622	-7.702	-0.080
	MnCl+	2.030e-008	1.690e-008	-7.693	-7.772	-0.080
	ZnCl+	3.075e-009	2.560e-009	-8.512	-8.592	-0.080

	CdCl+	7.640e-010	6.361e-010	-9.117	-9.196	-0.080
	ZnOHCl	6.193e-010	6.255e-010	-9.208	-9.204	0.004
	CuCl3-2	3.673e-010	1.765e-010	-9.435	-9.753	-0.318
	NiCl+	2.474e-011	2.060e-011	-10.607	-10.686	-0.080
	MnCl2	6.815e-012	6.883e-012	-11.167	-11.162	0.004
	PbCl+	4.711e-012	3.922e-012	-11.327	-11.406	-0.080
	CdOHCl	2.625e-012	2.651e-012	-11.581	-11.577	0.004
	ZnCl2	2.376e-012	2.400e-012	-11.624	-11.620	0.004
	CdCl2	2.359e-012	2.382e-012	-11.627	-11.623	0.004
	NiCl2	6.909e-014	6.978e-014	-13.161	-13.156	0.004
	PbCl2	6.969e-015	7.038e-015	-14.157	-14.153	0.004
	ZnCl3-	2.836e-015	2.361e-015	-14.547	-14.627	-0.080
	MnCl3-	2.125e-015	1.769e-015	-14.673	-14.752	-0.080
	CdCl3-	1.441e-015	1.200e-015	-14.841	-14.921	-0.080
	CuCl+	1.679e-017	1.398e-017	-16.775	-16.855	-0.080
	PbCl3-	5.878e-018	4.894e-018	-17.231	-17.310	-0.080
	ZnCl4-2	2.117e-018	1.017e-018	-17.674	-17.993	-0.318
	UO2Cl+	9.460e-021	7.876e-021	-20.024	-20.104	-0.080
	CuCl2	6.202e-021	6.263e-021	-20.207	-20.203	0.004
	PbCl4-2	4.199e-021	2.018e-021	-20.377	-20.695	-0.318
	UO2Cl2	3.538e-025	3.573e-025	-24.451	-24.447	0.004
	FeCl+2	3.531e-025	1.697e-025	-24.452	-24.770	-0.318
	CuCl3-	2.073e-026	1.726e-026	-25.683	-25.763	-0.080
	UCl+3	6.958e-027	1.338e-027	-26.158	-26.873	-0.716
	FeCl2+	1.179e-027	9.818e-028	-26.928	-27.008	-0.080
	CuCl4-2	1.322e-031	6.353e-032	-30.879	-31.197	-0.318
	FeCl3	9.071e-032	9.161e-032	-31.042	-31.038	0.004
Cu(1)	6.782e-007					
	Cu+	5.286e-007	4.401e-007	-6.277	-6.356	-0.080
	CuCl2-	1.492e-007	1.242e-007	-6.826	-6.906	-0.080
	CuCl3-2	3.673e-010	1.765e-010	-9.435	-9.753	-0.318
Cu(2)	2.657e-013					
	CuCO3	1.663e-013	1.680e-013	-12.779	-12.775	0.004
	CuHCO3+	4.011e-014	3.340e-014	-13.397	-13.476	-0.080
	Cu(OH)2	3.025e-014	3.055e-014	-13.519	-13.515	0.004
	Cu+2	1.922e-014	9.238e-015	-13.716	-14.034	-0.318
	CuSO4	6.847e-015	6.915e-015	-14.165	-14.160	0.004
	Cu(CO3)2-2	1.490e-015	7.161e-016	-14.827	-15.145	-0.318
	CuOH+	1.396e-015	1.162e-015	-14.855	-14.935	-0.080
	CuCl+	1.679e-017	1.398e-017	-16.775	-16.855	-0.080
	CuF+	2.848e-018	2.371e-018	-17.545	-17.625	-0.080
	Cu(OH)3-	2.782e-020	2.316e-020	-19.556	-19.635	-0.080
	CuCl2	6.202e-021	6.263e-021	-20.207	-20.203	0.004
	Cu2(OH)2+2	4.402e-025	2.116e-025	-24.356	-24.675	-0.318
	Cu(OH)4-2	1.210e-025	5.814e-026	-24.917	-25.236	-0.318
	CuCl3-	2.073e-026	1.726e-026	-25.683	-25.763	-0.080
	CuCl4-2	1.322e-031	6.353e-032	-30.879	-31.197	-0.318
F	2.110e-005					
	F-	1.863e-005	1.551e-005	-4.730	-4.809	-0.080
	MgF+	1.928e-006	1.606e-006	-5.715	-5.794	-0.080
	CaF+	3.785e-007	3.151e-007	-6.422	-6.502	-0.080
	AlF2+	4.852e-008	4.040e-008	-7.314	-7.394	-0.080
	NaF	2.863e-008	2.892e-008	-7.543	-7.539	0.004
	AlF+2	1.141e-008	5.485e-009	-7.943	-8.261	-0.318
	AlF3	7.729e-009	7.806e-009	-8.112	-8.108	0.004
	FeF+	2.874e-009	2.393e-009	-8.541	-8.621	-0.080
	HF	1.534e-009	1.549e-009	-8.814	-8.810	0.004

MnF+		5.729e-010	4.770e-010	-9.242	-9.321	-0.080
ZnF+		3.717e-010	3.095e-010	-9.430	-9.509	-0.080
AlF4-		5.775e-011	4.809e-011	-10.238	-10.318	-0.080
NiF+		3.266e-012	2.719e-012	-11.486	-11.566	-0.080
CdF+		1.733e-012	1.443e-012	-11.761	-11.841	-0.080
HF2-		1.012e-013	8.423e-014	-12.995	-13.075	-0.080
PbF+		4.521e-014	3.764e-014	-13.345	-13.424	-0.080
CdF2		5.566e-017	5.621e-017	-16.254	-16.250	0.004
UO2F+		1.427e-017	1.188e-017	-16.846	-16.925	-0.080
PbF2		1.180e-017	1.192e-017	-16.928	-16.924	0.004
H2F2		8.809e-018	8.896e-018	-17.055	-17.051	0.004
CuF+		2.848e-018	2.371e-018	-17.545	-17.625	-0.080
UO2F2		6.151e-019	6.212e-019	-18.211	-18.207	0.004
UF3+		3.715e-019	3.093e-019	-18.430	-18.510	-0.080
UF2+2		1.823e-019	8.763e-020	-18.739	-19.057	-0.318
UF4		3.994e-020	4.033e-020	-19.399	-19.394	0.004
UF+3		3.637e-021	6.995e-022	-20.439	-21.155	-0.716
UO2F3-		2.197e-021	1.829e-021	-20.658	-20.738	-0.080
PbF3-		1.609e-021	1.339e-021	-20.794	-20.873	-0.080
FeF+2		3.650e-022	1.754e-022	-21.438	-21.756	-0.318
FeF2+		1.150e-022	9.578e-023	-21.939	-22.019	-0.080
UF5-		1.739e-023	1.448e-023	-22.760	-22.839	-0.080
FeF3		2.251e-024	2.273e-024	-23.648	-23.643	0.004
UO2F4-2		3.833e-025	1.842e-025	-24.416	-24.735	-0.318
UF6-2		6.295e-026	3.025e-026	-25.201	-25.519	-0.318
PbF4-2		2.069e-026	9.942e-027	-25.684	-26.003	-0.318
SiF6-2		5.416e-031	2.603e-031	-30.266	-30.585	-0.318
Fe(2)	5.563e-005					
Fe+2		3.211e-005	1.543e-005	-4.493	-4.812	-0.318
FeHCO3+		1.337e-005	1.113e-005	-4.874	-4.953	-0.080
FeSO4		8.855e-006	8.942e-006	-5.053	-5.049	0.004
FeCO3		1.241e-006	1.253e-006	-5.906	-5.902	0.004
FeOH+		3.403e-008	2.834e-008	-7.468	-7.548	-0.080
FeCl+		2.387e-008	1.988e-008	-7.622	-7.702	-0.080
FeF+		2.874e-009	2.393e-009	-8.541	-8.621	-0.080
FeHSO4+		5.498e-012	4.578e-012	-11.260	-11.339	-0.080
Fe(OH)2		1.222e-012	1.234e-012	-11.913	-11.909	0.004
Fe(OH)3-		6.257e-016	5.209e-016	-15.204	-15.283	-0.080
Fe(3)	2.320e-015					
Fe(OH)2+		1.248e-015	1.039e-015	-14.904	-14.983	-0.080
Fe(OH)3		1.062e-015	1.073e-015	-14.974	-14.970	0.004
Fe(OH)4-		9.753e-018	8.120e-018	-17.011	-17.090	-0.080
FeOH+2		7.683e-019	3.692e-019	-18.114	-18.433	-0.318
FeF+2		3.650e-022	1.754e-022	-21.438	-21.756	-0.318
FeSO4+		3.447e-022	2.870e-022	-21.463	-21.542	-0.080
FeF2+		1.150e-022	9.578e-023	-21.939	-22.019	-0.080
Fe+3		4.346e-023	8.359e-024	-22.362	-23.078	-0.716
Fe(SO4)2-		2.852e-023	2.375e-023	-22.545	-22.624	-0.080
FeF3		2.251e-024	2.273e-024	-23.648	-23.643	0.004
FeCl+2		3.531e-025	1.697e-025	-24.452	-24.770	-0.318
FeCl2+		1.179e-027	9.818e-028	-26.928	-27.008	-0.080
FeHSO4+2		1.296e-028	6.229e-029	-27.887	-28.206	-0.318
FeCl3		9.071e-032	9.161e-032	-31.042	-31.038	0.004
Fe2(OH)2+4		1.055e-034	5.628e-036	-33.977	-35.250	-1.273
Fe3(OH)4+5		0.000e+000	0.000e+000	-45.510	-47.498	-1.989
H(0)	9.806e-008					
H2		4.903e-008	4.952e-008	-7.310	-7.305	0.004

K	3.845e-004					
K+		3.758e-004	3.103e-004	-3.425	-3.508	-0.083
KSO4-		8.607e-006	7.166e-006	-5.065	-5.145	-0.080
Mg	5.235e-003					
Mg+2		3.720e-003	1.890e-003	-2.430	-2.724	-0.294
MgSO4		1.323e-003	1.336e-003	-2.878	-2.874	0.004
MgHCO3+		1.852e-004	1.542e-004	-3.732	-3.812	-0.080
MgCO3		5.186e-006	5.237e-006	-5.285	-5.281	0.004
MgF+		1.928e-006	1.606e-006	-5.715	-5.794	-0.080
MgOH+		4.073e-008	3.392e-008	-7.390	-7.470	-0.080
Mn(2)	1.642e-005					
Mn+2		9.250e-006	4.446e-006	-5.034	-5.352	-0.318
MnHCO3+		3.432e-006	2.858e-006	-5.464	-5.544	-0.080
MnSO4		2.530e-006	2.555e-006	-5.597	-5.593	0.004
MnCO3		1.184e-006	1.196e-006	-5.927	-5.922	0.004
MnCl+		2.030e-008	1.690e-008	-7.693	-7.772	-0.080
MnOH+		7.428e-010	6.185e-010	-9.129	-9.209	-0.080
MnF+		5.729e-010	4.770e-010	-9.242	-9.321	-0.080
MnCl2		6.815e-012	6.883e-012	-11.167	-11.162	0.004
MnCl3-		2.125e-015	1.769e-015	-14.673	-14.752	-0.080
Mn(OH)3-		1.685e-019	1.403e-019	-18.773	-18.853	-0.080
Mn(3)	1.576e-036					
Mn+3		1.576e-036	3.031e-037	-35.802	-36.518	-0.716
Mn(6)	0.000e+000					
MnO4-2		0.000e+000	0.000e+000	-90.491	-90.809	-0.318
Mn(7)	0.000e+000					
MnO4-		0.000e+000	0.000e+000	-105.790	-105.870	-0.080
Na	3.967e-003					
Na+		3.882e-003	3.240e-003	-2.411	-2.489	-0.078
NaSO4-		7.192e-005	5.988e-005	-4.143	-4.223	-0.080
NaHCO3		1.301e-005	1.314e-005	-4.886	-4.881	0.004
NaCO3-		1.456e-007	1.212e-007	-6.837	-6.916	-0.080
NaF		2.863e-008	2.892e-008	-7.543	-7.539	0.004
Ni	2.561e-007					
NiCO3		2.184e-007	2.206e-007	-6.661	-6.656	0.004
Ni+2		1.828e-008	8.787e-009	-7.738	-8.056	-0.318
NiHCO3+		1.051e-008	8.750e-009	-7.978	-8.058	-0.080
NiSO4		6.111e-009	6.172e-009	-8.214	-8.210	0.004
Ni(CO3)2-2		2.701e-009	1.298e-009	-8.569	-8.887	-0.318
NiCl+		2.474e-011	2.060e-011	-10.607	-10.686	-0.080
NiOH+		8.855e-012	7.373e-012	-11.053	-11.132	-0.080
NiF+		3.266e-012	2.719e-012	-11.486	-11.566	-0.080
Ni(SO4)2-2		2.969e-012	1.427e-012	-11.527	-11.846	-0.318
Ni(OH)2		1.377e-013	1.391e-013	-12.861	-12.857	0.004
NiCl2		6.909e-014	6.978e-014	-13.161	-13.156	0.004
Ni(OH)3-		2.102e-017	1.750e-017	-16.677	-16.757	-0.080
O(0)	0.000e+000					
O2		0.000e+000	0.000e+000	-81.114	-81.109	0.004
Pb	9.674e-009					
PbCO3		7.952e-009	8.031e-009	-8.100	-8.095	0.004
PbHCO3+		9.391e-010	7.819e-010	-9.027	-9.107	-0.080
PbSO4		2.992e-010	3.022e-010	-9.524	-9.520	0.004
Pb+2		2.840e-010	1.365e-010	-9.547	-9.865	-0.318
Pb(CO3)2-2		1.421e-010	6.830e-011	-9.847	-10.166	-0.318
PbOH+		4.021e-011	3.348e-011	-10.396	-10.475	-0.080
Pb(SO4)2-2		1.299e-011	6.245e-012	-10.886	-11.204	-0.318
PbCl+		4.711e-012	3.922e-012	-11.327	-11.406	-0.080

Pb(OH)2		1.623e-013	1.639e-013	-12.790	-12.786	0.004
PbF+		4.521e-014	3.764e-014	-13.345	-13.424	-0.080
PbCl2		6.969e-015	7.038e-015	-14.157	-14.153	0.004
Pb(OH)3-		2.843e-017	2.367e-017	-16.546	-16.626	-0.080
PbF2		1.180e-017	1.192e-017	-16.928	-16.924	0.004
PbCl3-		5.878e-018	4.894e-018	-17.231	-17.310	-0.080
Pb2OH+3		5.319e-019	1.023e-019	-18.274	-18.990	-0.716
PbCl4-2		4.199e-021	2.018e-021	-20.377	-20.695	-0.318
PbF3-		1.609e-021	1.339e-021	-20.794	-20.873	-0.080
Pb(OH)4-2		1.420e-021	6.822e-022	-20.848	-21.166	-0.318
Pb3(OH)4+2		3.700e-026	1.778e-026	-25.432	-25.750	-0.318
PbF4-2		2.069e-026	9.942e-027	-25.684	-26.003	-0.318
S(6)	1.159e-002					
SO4-2		8.077e-003	3.938e-003	-2.093	-2.405	-0.312
CaSO4		2.097e-003	2.118e-003	-2.678	-2.674	0.004
MgSO4		1.323e-003	1.336e-003	-2.878	-2.874	0.004
NaSO4-		7.192e-005	5.988e-005	-4.143	-4.223	-0.080
FeSO4		8.855e-006	8.942e-006	-5.053	-5.049	0.004
KSO4-		8.607e-006	7.166e-006	-5.065	-5.145	-0.080
MnSO4		2.530e-006	2.555e-006	-5.597	-5.593	0.004
ZnSO4		1.358e-006	1.371e-006	-5.867	-5.863	0.004
BaSO4		1.914e-007	1.933e-007	-6.718	-6.714	0.004
Zn(SO4)2-2		9.891e-008	4.754e-008	-7.005	-7.323	-0.318
HSO4-		2.964e-008	2.468e-008	-7.528	-7.608	-0.080
CdSO4		7.800e-009	7.877e-009	-8.108	-8.104	0.004
NiSO4		6.111e-009	6.172e-009	-8.214	-8.210	0.004
CaHSO4+		1.058e-009	8.809e-010	-8.975	-9.055	-0.080
Cd(SO4)2-2		7.539e-010	3.623e-010	-9.123	-9.441	-0.318
AlSO4+		4.921e-010	4.098e-010	-9.308	-9.387	-0.080
PbSO4		2.992e-010	3.022e-010	-9.524	-9.520	0.004
Al(SO4)2-		5.841e-011	4.863e-011	-10.234	-10.313	-0.080
Pb(SO4)2-2		1.299e-011	6.245e-012	-10.886	-11.204	-0.318
FeHSO4+		5.498e-012	4.578e-012	-11.260	-11.339	-0.080
Ni(SO4)2-2		2.969e-012	1.427e-012	-11.527	-11.846	-0.318
CuSO4		6.847e-015	6.915e-015	-14.165	-14.160	0.004
UO2SO4		2.668e-017	2.694e-017	-16.574	-16.570	0.004
AlHSO4+2		5.572e-018	2.678e-018	-17.254	-17.572	-0.318
UO2(SO4)2-2		1.737e-018	8.347e-019	-17.760	-18.078	-0.318
U(SO4)2		6.440e-021	6.504e-021	-20.191	-20.187	0.004
USO4+2		5.837e-022	2.805e-022	-21.234	-21.552	-0.318
FeSO4+		3.447e-022	2.870e-022	-21.463	-21.542	-0.080
Fe(SO4)2-		2.852e-023	2.375e-023	-22.545	-22.624	-0.080
FeHSO4+2		1.296e-028	6.229e-029	-27.887	-28.206	-0.318
Se(-2)	3.808e-008					
HSe-		3.806e-008	3.169e-008	-7.420	-7.499	-0.080
H2Se		2.145e-011	2.166e-011	-10.669	-10.664	0.004
Se(4)	1.565e-029					
HSeO3-		1.464e-029	1.219e-029	-28.834	-28.914	-0.080
SeO3-2		1.010e-030	4.853e-031	-29.996	-30.314	-0.318
H2SeO3		5.392e-034	5.445e-034	-33.268	-33.264	0.004
Se(6)	0.000e+000					
SeO4-2		0.000e+000	0.000e+000	-56.052	-56.370	-0.318
HSeO4-		0.000e+000	0.000e+000	-61.856	-61.935	-0.080
Si	1.184e-004					
H4SiO4		1.182e-004	1.194e-004	-3.927	-3.923	0.004
H3SiO4-		1.836e-007	1.529e-007	-6.736	-6.816	-0.080
H2SiO4-2		1.364e-013	6.558e-014	-12.865	-13.183	-0.318

SiF6-2		5.416e-031	2.603e-031	-30.266	-30.585	-0.318
U(3)	4.172e-030					
U+3		4.172e-030	8.024e-031	-29.380	-30.096	-0.716
U(4)	3.873e-007					
U(OH)4		3.871e-007	3.910e-007	-6.412	-6.408	0.004
U(OH)3+		1.544e-010	1.286e-010	-9.811	-9.891	-0.080
U(CO3)4-4		4.100e-014	2.187e-015	-13.387	-14.660	-1.273
U(OH)2+2		1.311e-014	6.303e-015	-13.882	-14.200	-0.318
U(CO3)5-6		2.112e-017	2.890e-020	-16.675	-19.539	-2.864
UF3+		3.715e-019	3.093e-019	-18.430	-18.510	-0.080
UOH+3		2.049e-019	3.941e-020	-18.688	-19.404	-0.716
UF2+2		1.823e-019	8.763e-020	-18.739	-19.057	-0.318
UF4		3.994e-020	4.033e-020	-19.399	-19.394	0.004
U(SO4)2		6.440e-021	6.504e-021	-20.191	-20.187	0.004
UF+3		3.637e-021	6.995e-022	-20.439	-21.155	-0.716
USO4+2		5.837e-022	2.805e-022	-21.234	-21.552	-0.318
UF5-		1.739e-023	1.448e-023	-22.760	-22.839	-0.080
U+4		3.926e-025	2.095e-026	-24.406	-25.679	-1.273
UF6-2		6.295e-026	3.025e-026	-25.201	-25.519	-0.318
UCl+3		6.958e-027	1.338e-027	-26.158	-26.873	-0.716
U6(OH)15+9		0.000e+000	0.000e+000	-58.334	-64.778	-6.444
U(5)	2.872e-011					
UO2+		2.872e-011	2.391e-011	-10.542	-10.621	-0.080
UO2(CO3)3-5		2.004e-018	2.056e-020	-17.698	-19.687	-1.989
U(6)	4.563e-011					
UO2(CO3)3-4		3.380e-011	1.803e-012	-10.471	-11.744	-1.273
UO2(CO3)2-2		1.175e-011	5.645e-012	-10.930	-11.248	-0.318
UO2CO3		8.503e-014	8.588e-014	-13.070	-13.066	0.004
UO2(OH)3-		9.626e-016	8.015e-016	-15.017	-15.096	-0.080
UO2OH+		3.190e-016	2.656e-016	-15.496	-15.576	-0.080
UO2SO4		2.668e-017	2.694e-017	-16.574	-16.570	0.004
UO2F+		1.427e-017	1.188e-017	-16.846	-16.925	-0.080
UO2+2		1.327e-017	6.378e-018	-16.877	-17.195	-0.318
UO2(SO4)2-2		1.737e-018	8.347e-019	-17.760	-18.078	-0.318
UO2F2		6.151e-019	6.212e-019	-18.211	-18.207	0.004
UO2Cl+		9.460e-021	7.876e-021	-20.024	-20.104	-0.080
UO2F3-		2.197e-021	1.829e-021	-20.658	-20.738	-0.080
UO2(OH)4-2		3.325e-022	1.598e-022	-21.478	-21.796	-0.318
UO2F4-2		3.833e-025	1.842e-025	-24.416	-24.735	-0.318
UO2Cl2		3.538e-025	3.573e-025	-24.451	-24.447	0.004
(UO2)2(OH)2+2		1.765e-026	8.485e-027	-25.753	-26.071	-0.318
(UO2)3(CO3)6-6		2.859e-028	3.911e-031	-27.544	-30.408	-2.864
(UO2)2OH+3		5.311e-030	1.021e-030	-29.275	-29.991	-0.716
(UO2)3(OH)5+		6.375e-033	5.308e-033	-32.196	-32.275	-0.080
(UO2)3(OH)7-		1.555e-033	1.295e-033	-32.808	-32.888	-0.080
(UO2)3(OH)4+2		1.703e-035	8.185e-036	-34.769	-35.087	-0.318
(UO2)4(OH)7+		0.000e+000	0.000e+000	-40.904	-40.983	-0.080
Zn	7.819e-006					
Zn+2		3.348e-006	1.609e-006	-5.475	-5.793	-0.318
ZnHCO3+		1.755e-006	1.461e-006	-5.756	-5.835	-0.080
ZnSO4		1.358e-006	1.371e-006	-5.867	-5.863	0.004
ZnCO3		1.076e-006	1.087e-006	-5.968	-5.964	0.004
Zn(CO3)2-2		1.637e-007	7.869e-008	-6.786	-7.104	-0.318
Zn(SO4)2-2		9.891e-008	4.754e-008	-7.005	-7.323	-0.318
ZnOH+		1.216e-008	1.013e-008	-7.915	-7.995	-0.080
Zn(OH)2		3.175e-009	3.206e-009	-8.498	-8.494	0.004
ZnCl+		3.075e-009	2.560e-009	-8.512	-8.592	-0.080

ZnOHCl	6.193e-010	6.255e-010	-9.208	-9.204	0.004
ZnF+	3.717e-010	3.095e-010	-9.430	-9.509	-0.080
ZnCl2	2.376e-012	2.400e-012	-11.624	-11.620	0.004
Zn(OH)3-	1.532e-013	1.276e-013	-12.815	-12.894	-0.080
ZnCl3-	2.836e-015	2.361e-015	-14.547	-14.627	-0.080
ZnCl4-2	2.117e-018	1.017e-018	-17.674	-17.993	-0.318
Zn(OH)4-2	5.292e-019	2.543e-019	-18.276	-18.595	-0.318

----------Saturation indices----------

Phase	SI	log IAP	log KT	
Adularia	0.31	-21.05	-21.36	KAlSi3O8
Al(OH)3(a)	-0.60	10.87	11.47	Al(OH)3
AlAsO4:2H2O	-17.67	-33.50	-15.84	AlAsO4:2H2O
Albite	-1.37	-20.03	-18.66	NaAlSi3O8
AlumK	-13.39	-18.75	-5.35	KAl(SO4)2:12H2O
Alunite	3.13	3.01	-0.12	KAl3(SO4)2(OH)6
Analcime	-2.94	-16.10	-13.16	NaAlSi2O6:H2O
Anglesite	-4.43	-12.27	-7.84	PbSO4
Anhydrite	-0.60	-4.93	-4.34	CaSO4
Annite	8.28	-78.96	-87.23	KFe3AlSi3O10(OH)2
Anorthite	-1.90	-21.91	-20.01	CaAl2Si2O8
Antlerite	-24.40	-16.11	8.29	Cu3(OH)4SO4
Aragonite	0.28	-8.00	-8.28	CaCO3
Arsenolite	-12.98	-14.54	-1.56	As2O3
Artinite	-7.05	3.28	10.33	MgCO3:Mg(OH)2:3H2O
As2O5(cr)	-54.78	-46.36	8.42	As2O5
As_native	-0.34	-13.57	-13.23	As
Atacamite	-17.62	-9.80	7.82	Cu2(OH)3Cl
Azurite	-22.52	-17.99	4.54	Cu3(OH)2(CO3)2
B-UO2(OH)2	-8.89	-3.00	5.89	UO2(OH)2
Ba3(AsO4)2	-16.83	-67.18	-50.35	Ba3(AsO4)2
BaF2	-10.84	-16.63	-5.79	BaF2
Barite	0.73	-9.41	-10.14	BaSO4
Basaluminite	4.19	26.89	22.70	Al4(OH)10SO4
BaSeO3	-30.93	-37.32	-6.39	BaSeO3
Beidellite	3.96	-42.85	-46.81	(NaKMg0.5)0.11Al2.33Si3.67O10(OH)2
Bianchite	-6.44	-8.20	-1.76	ZnSO4:6H2O
Birnessite	-30.55	13.05	43.60	MnO2
Bixbyite	-30.21	-30.44	-0.22	Mn2O3
Boehmite	1.57	10.87	9.30	AlOOH
Brochantite	-31.28	-15.94	15.34	Cu4(OH)6SO4
Brucite	-6.05	11.48	17.53	Mg(OH)2
Bunsenite	-6.91	6.14	13.06	NiO
Ca3(AsO4)2:4w	-34.83	-53.74	-18.91	Ca3(AsO4)2:4H2O
Calcite	0.43	-8.00	-8.43	CaCO3
CaSeO3	-27.24	-32.84	-5.60	CaSeO3
Cd(gamma)	-12.18	1.87	14.05	Cd
Cd(OH)2	-7.58	6.07	13.65	Cd(OH)2
Cd(OH)2(a)	-8.19	6.07	14.26	Cd(OH)2
Cd3(OH)2(SO4)2	-21.71	-15.00	6.71	Cd3(OH)2(SO4)2
Cd3(OH)4SO4	-20.96	1.60	22.56	Cd3(OH)4SO4
Cd4(OH)6SO4	-20.73	7.67	28.40	Cd4(OH)6SO4
CdCl2	-13.63	-14.19	-0.57	CdCl2
CdCl2:2.5H2O	-12.21	-14.19	-1.98	CdCl2:2.5H2O
CdCl2:H2O	-12.53	-14.19	-1.66	CdCl2:H2O

CdF2	-15.02	-17.75	-2.73	CdF2
CdMetal	-12.08	1.87	13.95	Cd
CdOHCl	-7.77	-4.06	3.71	CdOHCl
CdSiO3	-7.34	2.15	9.48	CdSiO3
CdSO4	-10.81	-10.54	0.27	CdSO4
CdSO4:2.7H2O	-8.77	-10.54	-1.76	CdSO4:2.67H2O
CdSO4:H2O	-9.07	-10.54	-1.47	CdSO4:H2O
Cerrusite	-2.08	-15.34	-13.25	PbCO3
Chalcanthite	-13.76	-16.44	-2.68	CuSO4:5H2O
Chalcedony	-0.25	-3.92	-3.67	SiO2
Chlorite14A	-4.87	67.36	72.23	Mg5Al2Si3O10(OH)8
Chlorite7A	-8.34	67.36	75.70	Mg5Al2Si3O10(OH)8
Chrysotile	-6.90	26.58	33.48	Mg3Si2O5(OH)4
Claudetite	-13.03	-14.54	-1.51	As2O3
Clinoenstatite	-4.30	7.55	11.85	MgSiO3
CO2(g)	-1.48	-2.82	-1.34	CO2
Coffinite	6.17	-1.20	-7.37	USiO4
Cotunnite	-11.01	-15.93	-4.91	PbCl2
Cristobalite	-0.20	-3.92	-3.73	SiO2
Cu(OH)2	-8.86	0.17	9.03	Cu(OH)2
Cu2SO4	-13.28	-15.12	-1.83	Cu2SO4
Cu3(AsO4)2:6w	-53.14	-88.26	-35.12	Cu3(AsO4)2:6H2O
CuCO3	-9.87	-19.50	-9.63	CuCO3
CuF	-18.56	-11.17	7.39	CuF
CuF2	-23.37	-23.65	-0.28	CuF2
CuF2:2H2O	-19.20	-23.65	-4.46	CuF2:2H2O
CuMetal	7.84	-1.36	-9.20	Cu
CuOCuSO4	-28.71	-16.27	12.43	CuO:CuSO4
CupricFerrite	-10.26	-3.39	6.86	CuFe2O4
Cuprite	3.20	1.49	-1.71	Cu2O
CuprousFerrite	7.79	-1.03	-8.82	CuFeO2
CuSO4	-19.91	-16.44	3.47	CuSO4
Diaspore	3.37	10.87	7.51	AlOOH
Diopside	-5.41	15.30	20.72	CaMgSi2O6
Dioptase	-10.49	-3.76	6.73	CuSiO3:H2O
Dolomite	0.66	-16.19	-16.85	CaMg(CO3)2
Dolomite(d)	0.07	-16.19	-16.26	CaMg(CO3)2
Epsomite	-2.92	-5.13	-2.21	MgSO4:7H2O
Fe(OH)2.7Cl.3	-1.78	-4.82	-3.04	Fe(OH)2.7Cl0.3
Fe(OH)3(a)	-6.67	-1.78	4.89	Fe(OH)3
Fe2(SeO3)3	-101.67	-137.10	-35.43	Fe2(SeO3)3
Fe3(OH)8	-14.39	5.83	20.22	Fe3(OH)8
FeSe2	2.97	-15.61	-18.58	FeSe2
Fluorite	-1.42	-12.15	-10.73	CaF2
Forsterite	-10.51	19.03	29.54	Mg2SiO4
Gibbsite	2.18	10.87	8.69	Al(OH)3
Goethite	-1.15	-1.78	-0.63	FeOOH
Goslarite	-6.16	-8.20	-2.04	ZnSO4:7H2O
Greenalite	-0.49	20.32	20.81	Fe3Si2O5(OH)4
Gummite	-13.98	-3.00	10.99	UO3
Gypsum	-0.35	-4.93	-4.58	CaSO4:2H2O
H2(g)	-4.20	-7.31	-3.11	H2
H2O(g)	-1.78	-0.00	1.78	H2O
Halite	-7.08	-5.52	1.56	NaCl
Halloysite	0.39	13.90	13.51	Al2Si2O5(OH)4
Hausmannite	-32.85	30.74	63.59	Mn3O4
Hematite	-0.33	-3.56	-3.22	Fe2O3

Huntite	-3.27	-32.58	-29.31	CaMg3(CO3)4
Hydrocerrusite	-8.88	-26.34	-17.46	Pb(OH)2:2PbCO3
Hydromagnesite	-13.87	-21.30	-7.43	Mg5(CO3)4(OH)2:4H2O
Illite	3.35	-38.31	-41.66	K0.6Mg0.25Al2.3Si3.5O10(OH)2
Jarosite(ss)	-25.81	-35.64	-9.83	(K0.77Na0.03H0.2)Fe3(SO4)2(OH)6
Jarosite-K	-26.54	-34.95	-8.41	KFe3(SO4)2(OH)6
Jarosite-Na	-29.57	-33.93	-4.36	NaFe3(SO4)2(OH)6
JarositeH	-34.56	-38.55	-3.99	(H3O)Fe3(SO4)2(OH)6
Jurbanite	-2.50	-5.73	-3.23	AlOHSO4
Kaolinite	5.57	13.90	8.33	Al2Si2O5(OH)4
Kmica	10.24	24.45	14.21	KAl3Si3O10(OH)2
Langite	-33.74	-15.94	17.80	Cu4(OH)6SO4:H2O
Larnakite	-7.82	-7.93	-0.12	PbO:PbSO4
Laumontite	2.21	-29.76	-31.97	CaAl2Si4O12:4H2O
Laurionite	-6.42	-5.80	0.62	PbOHCl
Leonhardite	12.53	-59.52	-72.05	Ca2Al4Si8O24:7H2O
Litharge	-8.80	4.33	13.14	PbO
Magadiite	-8.55	-22.85	-14.30	NaSi7O13(OH)3:3H2O
Maghemite	-9.94	-3.56	6.39	Fe2O3
Magnesite	-0.32	-8.19	-7.87	MgCO3
Magnetite	0.81	5.83	5.02	Fe3O4
Malachite	-14.56	-8.91	5.65	Cu2(OH)2CO3
Manganite	-14.39	10.95	25.34	MnOOH
Massicot	-9.00	4.33	13.34	PbO
Matlockite	-8.07	-17.70	-9.63	PbClF
Melanothallite	-24.14	-20.09	4.04	CuCl2
Melanterite	-4.88	-7.22	-2.34	FeSO4:7H2O
Minium	-59.10	17.20	76.30	Pb3O4
Mirabilite	-5.79	-7.39	-1.60	Na2SO4:10H2O
Mn2(SO4)3	-75.53	-80.25	-4.72	Mn2(SO4)3
Mn3(AsO4)2:8H2O	-33.51	-62.21	-28.71	Mn3(AsO4)2:8H2O
MnCl2:4H2O	-13.68	-11.41	2.27	MnCl2:4H2O
MnSO4	-10.82	-7.76	3.06	MnSO4
Monteponite	-8.33	6.07	14.40	CdO
Montmorillonite-Aberdeen	1.51	-28.18	-29.69	(HNaK)0.14Mg0.45Fe0.33Al1.47Si3.82O10(OH)2
Montmorillonite-BelleFourche	2.93	-31.98	-34.91	(HNaK)0.09Mg0.29Fe0.24Al1.57Si3.93O10(OH)2
Montmorillonite-Ca	4.06	-42.46	-46.51	Ca0.165Al2.33Si3.67O10(OH)2
Morenosite	-8.03	-10.46	-2.43	NiSO4:7H2O
Na4UO2(CO3)3	-27.27	-43.56	-16.29	Na4UO2(CO3)3
Nahcolite	-3.99	-4.63	-0.64	NaHCO3
Nantokite	-2.37	-9.39	-7.01	CuCl
Natron	-8.74	-10.45	-1.71	Na2CO3:10H2O
Nesquehonite	-2.72	-8.19	-5.47	MgCO3:3H2O
Ni(OH)2	-3.88	6.14	10.03	Ni(OH)2
Ni2SiO4	-7.02	8.36	15.39	Ni2SiO4
Ni3(AsO4)2:8H2O	-44.81	-70.32	-25.51	Ni3(AsO4)2:8H2O
Ni4(OH)6SO4	-24.03	7.97	32.00	Ni4(OH)6SO4
NiCO3	-6.94	-13.53	-6.59	NiCO3
Nsutite	-29.52	13.05	42.56	MnO2
O2(g)	-78.30	-81.11	-2.81	O2
Otavite	-1.50	-13.60	-12.10	CdCO3
Pb(OH)2	-4.17	4.33	8.51	Pb(OH)2
Pb2(OH)3Cl	-10.25	-1.46	8.79	Pb2(OH)3Cl
Pb2O(OH)2	-17.53	8.67	26.20	PbO:Pb(OH)2
Pb2O3	-48.17	12.87	61.04	Pb2O3

Pb2OCO3	-10.79	-11.00	-0.21	PbO:PbCO3
Pb2SiO4	-15.67	4.75	20.42	Pb2SiO4
Pb3(AsO4)2	-40.35	-75.75	-35.40	Pb3(AsO4)2
Pb3O2CO3	-18.36	-6.67	11.69	PbCO3:2PbO
Pb3O2SO4	-14.53	-3.60	10.93	PbSO4:2PbO
Pb4(OH)6SO4	-20.37	0.73	21.10	Pb4(OH)6SO4
Pb4O3SO4	-22.26	0.73	22.99	PbSO4:3PbO
PbF2	-12.06	-19.48	-7.42	PbF2
PbMetal	-4.12	0.14	4.26	Pb
PbO:0.3H2O	-8.65	4.33	12.98	PbO:0.33H2O
PbSiO3	-7.14	0.41	7.56	PbSiO3
Phillipsite	-0.66	-20.54	-19.87	Na0.5K0.5AlSi3O8:H2O
Phlogopite	-7.25	37.13	44.38	KMg3AlSi3O10(OH)2
Phosgenite	-11.45	-31.26	-19.81	PbCl2:PbCO3
Plattnerite	-42.56	8.53	51.10	PbO2
Portlandite	-11.92	11.67	23.59	Ca(OH)2
Prehnite	-2.20	-14.16	-11.96	Ca2Al2Si3O10(OH)2
Pyrochroite	-6.35	8.85	15.20	Mn(OH)2
Pyrolusite	-29.99	13.05	43.04	MnO2
Pyrophyllite	6.88	-41.43	-48.31	Al2Si4O10(OH)2
Quartz	0.21	-3.92	-4.13	SiO2
Retgersite	-8.39	-10.46	-2.07	NiSO4:6H2O
Rhodochrosite	0.27	-10.82	-11.09	MnCO3
Rhodochrosite(d)	-0.43	-10.82	-10.39	MnCO3
Rutherfordine	-8.25	-22.67	-14.41	UO2CO3
Schoepite	-8.71	-3.00	5.71	UO2(OH)2:H2O
Scorodite	-25.91	-46.16	-20.25	FeAsO4:2H2O
Se(s)	6.92	-10.40	-17.32	Se
SeO2	-36.13	-44.51	-8.38	SeO2
Sepiolite	-4.85	11.18	16.03	Mg2Si3O7.5OH:3H2O
Sepiolite(d)	-7.48	11.18	18.66	Mg2Si3O7.5OH:3H2O
Siderite	0.54	-10.28	-10.83	FeCO3
Siderite(d)(3)	0.17	-10.28	-10.45	FeCO3
Silicagel	-0.79	-3.92	-3.13	SiO2
SiO2(a)	-1.13	-3.92	-2.80	SiO2
Smithsonite	-1.37	-11.26	-9.89	ZnCO3
Talc	-3.84	18.74	22.58	Mg3Si4O10(OH)2
Tenorite	-7.84	0.17	8.01	CuO
Thenardite	-7.22	-7.38	-0.16	Na2SO4
Thermonatrite	-10.65	-10.45	0.20	Na2CO3:H2O
Tremolite	-9.69	49.35	59.04	Ca2Mg5Si8O22(OH)2
Trona	-14.74	-15.08	-0.34	NaHCO3:Na2CO3:2H2O
U(OH)2SO4	-10.68	-13.88	-3.20	U(OH)2SO4
U3O8(c)	-6.92	16.56	23.48	U3O8
U4O9(c)	15.89	15.08	-0.81	U4O9
UF4(c)	-26.79	-44.92	-18.13	UF4
UF4:2.5H2O	-17.36	-44.92	-27.56	UF4:2.5H2O
UO2(a)	2.62	2.72	0.10	UO2
UO3(gamma)	-11.21	-3.00	8.21	UO3
Uraninite(c)	7.05	2.72	-4.33	UO2
Uranophane	-19.65	-2.16	17.49	Ca(UO2)2(SiO3OH)2
Wairakite	-2.38	-29.76	-27.37	CaAl2Si4O12:2H2O
Willemite	-3.29	12.89	16.18	Zn2SiO4
Witherite	-3.88	-12.48	-8.60	BaCO3
Zincite(c)	-3.29	8.41	11.70	ZnO
Zincosite	-11.70	-8.20	3.50	ZnSO4
Zn(OH)2-a	-4.04	8.41	12.45	Zn(OH)2

```
      Zn(OH)2-b          -3.34    8.41   11.75  Zn(OH)2
      Zn(OH)2-c          -3.79    8.41   12.20  Zn(OH)2
      Zn(OH)2-e          -3.09    8.41   11.50  Zn(OH)2
      Zn(OH)2-g          -3.30    8.41   11.71  Zn(OH)2
      Zn2(OH)2SO4        -7.29    0.21    7.50  Zn2(OH)2SO4
      Zn2(OH)3Cl         -8.52    6.68   15.20  Zn2(OH)3Cl
      Zn3(AsO4)2:2.5w -35.99  -63.54  -27.55  Zn3(AsO4)2:2.5H2O
      Zn3O(SO4)2        -28.59   -7.99   20.60  ZnO:2ZnSO4
      Zn4(OH)6SO4       -11.38   17.02   28.40  Zn4(OH)6SO4
      Zn5(OH)8Cl2       -16.73   21.77   38.50  Zn5(OH)8Cl2
      ZnCl2             -19.33  -11.85    7.47  ZnCl2
      ZnCO3:H2O          -1.00  -11.26  -10.26  ZnCO3:H2O
      ZnF2              -14.22  -15.41   -1.19  ZnF2
      ZnMetal           -22.49    4.21   26.69  Zn
      ZnO(a)             -2.90    8.41   11.31  ZnO
      ZnSiO3              1.09    4.48    3.39  ZnSiO3
      ZnSO4:H2O          -7.90   -8.20   -0.30  ZnSO4:H2O

------------------
End of simulation.
------------------

-------------------------------------
Reading input data for simulation 2.
-------------------------------------

-----------
End of run.
-----------
```