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Summary of baseline experiments for generic repository engineered barriers

Fuel Cycle Research & Development

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SUMMARY

This document summarizes the last four years of experiments and attempts to compile pertinent 1) SEM images, 2) electron microprobe data for major mineral phases, and 3) aqueous geochemistry data from both starting materials and the 17 major experiments conducted so far into one source. There is also a discussion of more recent characterization results and interpretation of copper corrosion rates.

This database, along with summary conclusions will be of use to other experimental teams on the DOE complex, nuclear repository system modelers, and the international repository science community.

Major concepts developed so far include:

1) illitization of smectites may be restricted due to the bulk chemistry of the overall system,

2) pyrite within bentonite that may be used as backfill reacts readily in groundwater and the resulting H_2S(aq,g) reacts in a minor fashion with steel and aggressively with copper,

3) bentonite heated to 300°C in a dry environment has very restricted reactivity,

4) Experiments held at 300°C for 4 months and then stepped down in temperature over two more months exhibit no discernable retrograde reactions. This may well be due to kinetic effects of metastable phases.

5) the interface between bentonite and steel develops a well characterized new mineral phase, Fe-saponite (especially at 300°C), that grows perpendicular to the steel surface,

6) Another Fe layered phyllosilicate, stilpnomelane, grows in the presence on native iron (one of our solid buffer materials), is consistent with the idea that oxygen fugacity may be quite variable, depending on scale,

7) Zeolites transform as temperature increases. Mine run bentonite contains clinoptilolite, and transforms to analcime at higher temperature, releasing both SiO_2 and water. Opalinus Clay upon heating develops wairakite along cracks and edges. The location of these new growth zeolites is due to the impermeable nature of the shale. Mixtures of Opalinus Clay and Colony bentonite produce an intermediate composition Analcime-Wairakite solid solution phase, indicating ease of cation exchange for this zeolite.

8) Pit corrosion is the driving force in copper degradation. The copper reacts with H_2S(aq,g) to produce chalcocite and covellite. At latter times in the reaction pathway Cl may combine with copper to produce atacamite.

9) Systematic measurements (850+) of copper corrosion cross sections have determined corrosion reaction rates at experimental temperatures and pressures. At 6 week duration, corrosion rates ranged from 0.12 to 0.39 micron/day, depending on heating profiles and bulk composition. However, in the 6 month experiment, the corrosion rate dropped by an order of magnitude, to 0.024 micron/day. We believe that complete coverage by the reaction product chalcocite pacifies the corrosion reaction.

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ACRONYMS

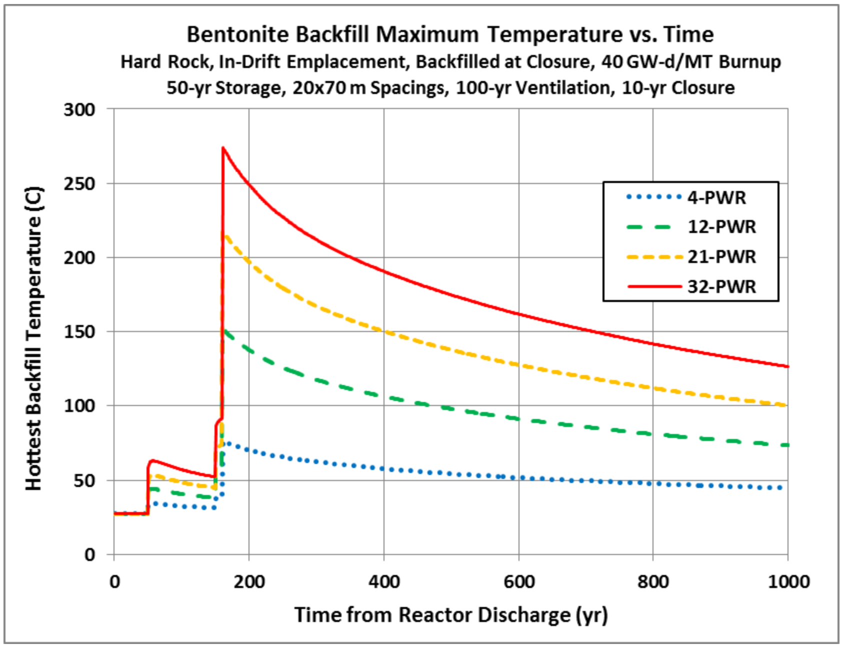
CEC – cation exchange capacity
DI – deionized
EBS – Engineered Barrier Systems
EDX – energy dispersive X-ray
EMP - electron microprobe
FY – fiscal year
GW- Giga Watt
IAEA – International Atomic Energy Association
IC - ion chromatography
I-S - illite-smectite
MT – metric ton
NIST –National Institute of Standards and Technology
PWR – pressurized water reactor
SEM - scanning electron microscope
TEM – transmission electron microscope
XRD - X-ray diffraction
XRF - X-ray florescence

ARGILLITE DISPOSAL R&D - LANL 2015 SUMMARY OF BASELINE EXPERIMENTS FOR GENERIC REPOSITORY ENGINEERED BARRIERS

1. INTRODUCTION

The U.S. Department of Energy has designed the Used Fuel Disposition Campaign to investigate the design and safety function of generic nuclear geologic repositories in a variety of geologic settings. The evaluation of engineered barrier system (EBS) concepts and interaction with the wall rock (i.e., natural barriers), waste canisters, or other EBS interfaces are important to the long term performance and safety of geologic repositories (Nutt et al., 2011, Jove-Colon et al., 2011). The European community, especially the French, have investigated bentonite stability in contact with steel under a variety of experimental conditions in an attempt to replicate repository conditions (Pusch 1979; Madsen 1998; Meunier et al. 1998; Guillaume et al. 2003; Wersin et al. 2007; Mosser-Ruck et al. 2010; Ferrage et al. 2011). The majority of their research was focused on lower temperature environments and atmospheric pressures. With the US considering the possibility of either dense packing or the use of dual purpose canisters, the differences in heat load associated with dual purpose canisters were summarized by Caporuscio et al. (2014) and described as follows. “At present, dual purpose canister designs vary greatly, but, in most cases, canisters will be constructed from steel or stainless steel with a steel reinforced concrete overpack (IAEA 2000). In some designs, copper cladding can be added on to the steel canister (Pusch 2008). These canisters can have up to 32 spent fuel assemblies (32 pressurized water reactors or 32-PWR), while many of the European concepts are limited to four spent fuel assemblies (4-PWR) (Pusch 2008; Greenburg and Wen 2013). This increased number of

Figure 1: Bounding backfill temperature histories at the waste package surface, for in-drift emplacement in crystalline rock (2.5 W/m-K) with a compacted bentonite backfill (0.6 W/m-K). Backfill rehydration is neglected as a bounding approximation. Waste packages with various capacities are plotted, for fuel with 40 GW-d/MT burnup. For this comparative calculation all packages would be stored at the surface 50 years, then ventilated in the repository 100 years, and finally backfilled over a period of 10 years before permanent closure (personal communication from Ernest Hardin).(From Caporuscio, et al., 2014)



spent fuel assemblies will generate a greater amount of heat radiating into the host rock. High-level modeling suggests a 32-PWR waste package (at 60 gigawatt-days per metric ton burnup) disposed in a clay/shale host rock, has the potential to reach 299°C after 85 years within 1 meter from the waste package (25 years ventilation; 15 m package spacing; Greenberg and Wen 2013). These results are just one of many models or designs for a U.S. nuclear repository, but, this particular model provides one possible high temperature scenario (Figure 1)". Our experimental program aims to characterize how EBS components react and change at reasonable high temperature in-situ repository conditions.

2. BACKGROUND

One of the more accepted ideas for high-level nuclear waste disposal is to emplace the steel waste canister in a geological repository with a bentonite barrier between the canister and host rock (Pusch 1979; Meunier et al. 1998). Bentonite is used to provide 1) a physical barrier to prevent fluid seeping in from natural surroundings and interacting with the waste package, 2) a chemical barrier by attenuating actinide migration if a release occurs. Furthermore, the bentonite's swelling capacity has the capability of self-sealing if cracks develop within the bentonite due to shrink-swell phenomena. However, there remain large uncertainties regarding the long-term stability of bentonite at potential repository conditions, particularly, under prolonged periods of high thermal loads. There have been numerous investigations on the stability of bentonites under various repository conditions and in contact with various metals replicating possible canister compositions (Pusch 1979; Madsen 1998; Meunier et al. 1998; Guillaume et al. 2003; Wersin et al. 2007; Mosser-Ruck et al. 2010; Ferrage et al. 2011).

This report summarizes the various authigenic minerals occurring within hydrothermal experiments replicating a high temperature repository environment. Various reactions include unprocessed Wyoming bentonite, the clay/metal interface, and the metal/clay/host rock components. Much of the characterization and discussion on the early EBS (1-12) results have been published in Cheshire et al. (2013; 2014). Characterization of both the pre-run materials and post experiment phases of experiments EBS-1 through -17 (experiment conditions are listed in Table 1) have been included to better describe the processes that progress during the hydrothermal reactions. In addition to expanded analyses of the earlier reactions, experiments on host-rock interaction and post-heat cooling were conducted to further our understanding of this complex system. The synthetic brine chemistry had slight variation between different batches, with all 4 Stripa brines listed in Table 2, and the initial Opalinus clay synthetic groundwater depicted in Table 3.

Table 1 Initial components and reaction conditions for EBS experiments. EBS-8 developed a leak during experiment. This experiment was discarded and repeated as EBS-11.

Experiment	**Clay, g**	**Brine, g**	**EBS Component**	**Run temp, °C**	**Run time**
EBS-1	7.4	79	**Bentonite only**	25/100/200/300/25	4 weeks
EBS-2	7.2	62	304SS	25/100/200/300/25	4 weeks
EBS-3	6.79	59.4	316SS	25/100/200/300/25	5 weeks
EBS-4	16.21	145	Cu	25/100/200/300/25	5 weeks
EBS-5	15.77	135.9	304SS	300	6 weeks
EBS-6	12.11	104.2	Low-C Steel	25/100/200/300/25	5 weeks
EBS-7	14.63	157.9	Graphite	25/100/200/300/25	5 weeks
EBS-8	15.28	131.9	**Cu (FAILED)**	300	6 weeks
EBS-9	15.52	167.6	Quartz sand	25/100/200/300/25	5 weeks
EBS-10	21.11	182.3	316SS	300	6 weeks
EBS-11	15.04	129.8	Cu	300	6 weeks
EBS-12	208.5	41.7	**Run for LBNL**	300	7 weeks

Table 1 cont.

6 MONTH EXPERIMENTS

EBS-13	29.62	245.3	316 SS	300 to 120	6 months
EBS-16	29.62	248.3	Cu	300 to 120	6 months

OPALINUS CLAY EXPERIMENTS

EBS-14	14.86	128.1	**Opalinus Clay**	300	6 weeks
EBS-15	14.72	158.5	Opal - 316SS	300	6 weeks
EBS-17	14.44	155.2	Opal - Cu	300	6 weeks

Table 2 Synthetic groundwater chemistries used in the hydrothermal experiments. All values were measured at 25°C.

Species	Stripa V2.1 mg/L	Stripa V2.2 mg/L	Stripa V2.3 mg/L	Stripa V2.4 mg/L
Ca^{2+}	93	95	43	61
Cl^{-}	931	455	686	882
K^{+}	583	9	299	559
Na^{+}	171	166	162	201
Si	1	2	2	1
SO_4^{2-}	46	48	31	53
Sr^{2+}	0.05	<0.05	<0.05	0.06
TDS	1863	773	1226	1759
pH	7.35	9.48	6.93	11.2
Experiment Used	EBS 1-5	EBS 6-9	EBS 10-12	EBS 13, 16

Table 3 Synthetic groundwater chemistry used in the Opalinus Clay experiments. All values were measured at 25°C. n.m. = not measured

	Type Solution	**Actual Solution**
Species	mg/L	mg/L
Ca^{2+}	421	426
Cl^{-}	5672	6470
CO_3^{2-}	162	n.m.
K^{+}	221	225
Na^{+}	3885	3846
Si	5	1
SO_4^{2-}	2305	998
Sr^{2+}	27	0.16
TDS	11502	12153
pH	7.24	7.50
Experiment Used		EBS 14, 15, 17

3. METHODS

All three of the following descriptions (Experimental Setup, Mineral characterization, and Aqueous geochemical analyses) are included here for completeness in this summary document. The three sections are taken verbatim from Caporuscio, et al. (2014).

3.1 Experimental Setup

The bentonite used in this experimental work is mined from a reducing horizon in Colony, Wyoming. The bentonite was pulverized and sieved to < 3 mm and used with a free moisture of ~15.5 wt. %. The synthetic groundwater solution was chosen to replicate a deep groundwater composition (Table 1, Stripa sample V2 (69-4), Frape et al. 2003). The groundwater solution was prepared using reagent grade materials dissolved in double deionised water. NaOH and HCl were added to adjust the initial solution pH. This solution was then filtered through a 0.45 µm filter and sparged with He before each experiment. The salt solution was added at 9:1 water: bentonite ratio. Initial components for all experiments have been summarized in Table 3.

A second series of experiments were performed to examine the bentonite system with host rock inclusion. Host-rock experiments focused on Opalinus Clay from the Swiss Underground Research Laboratory located at Mont Terri. The core was collected from BFE-A10 drillcore (interval from 11 to 12 m and interval from 33 to 34 m from the borehole head). A portion of the Opalinus Clay was crushed and sieved with 10 mesh (~2 mm). Opalinus Clay to be used in experiments was reconstituted at 80 wt.% -10 mesh and 20 wt.% +10 mesh. Synthetic groundwater was chosen to replicate the groundwater composition that represents Opalinus Clay porewater (Table 2, Pearson et al., 2003). The salt solution was added at 9:1 water: rock ratio.

The redox conditions for each system were buffered using a 1:1 mixture (by mass) of Fe_3O_4 and Fe° added at 0.07 wt. % of the bentonite mass. Approximately 7 wt. % (of total solids mass) 304 stainless steel (NIST SRM 101g), 316 stainless steel (NIST SRM 160b), Cu-foil, and low-carbon steel (provided by Sandia National Laboratory) were added to the experiments to mimic the presence of a waste canister.

Reactants were loaded into either a flexible gold or titanium bag and fixed into a 500 mL Gasket Confined Closure reactor (Seyfried et al. 1987). Experiments were pressurized to 150 - 160 bar and were heated following three different temperature profiles: 1) 120°C for 2 weeks, 210°C for 2 weeks, and then 300°C for 1 week, 2) isothermal at 300 °C for 6 weeks and 3) 300°C for 4 months, 210°C for 1 month, and 120°C for 1 month. Reaction liquids were extracted during the experiments and analyzed to investigate the aqueous geochemical evolution in relationship to mineralogical alterations. The sampled reaction liquids were split three-ways producing aliquots for unfiltered anion, unfiltered cation, and filtered (0.45 µm syringe filter) cation determination. All aliquots were stored in a refrigerator at 1°C until analysis.

3.2 Mineral Characterization

X-ray diffraction (XRD) analyses of experimental materials determined mineral compositions. Each sample was ground with 20 wt. % corundum (Al_2O_3) for quantitative XRD analysis of the bulk rock (Chung 1974). XRD measurements were conducted with a Siemens D500 diffractometer using Cu-Kα radiation. Data were collected from 2 to 70 °2θ with a 0.02 º2θ step-size and count times of 8 to 12 seconds per step. To better analyze the non-clay and clay fractions, the < 2 μm particles were separated via sedimentation in DI H_2O. An aliquot of the < 2 μm suspension was dropped on a zero-background quartz plate and dried. This oriented mount was X-rayed from 2 to 40 °2θ at 8 to 12 s per step. The oriented mount was then saturated with ethylene glycol in a 60 °C oven for 24 hours and XRD analysis was repeated. A portion of the > 2 μm particles was ground with a mortar/pestle, deposited on a zero-background quartz plate, and X-rayed under the same parameters as the bulk powder material. The remaining > 2 μm portion was used for electron microscopy. Mineral identification and unit-cell parameters analysis was performed using Jade© 9.5 X-ray data evaluation program with ICDD PDF-4 database. Quantitative phase analysis (QXRD) was performed using FULLPAT (Chipera and Bish 2002). Illite-smectite composition of higher-ordered (R1-3) illite-smectites were modeled via ClayStrat+ (developed by Hongji Yuan and David Bish). Expandable component abundances for the disordered illite-smectites were calculated via the Δ°2Θ method (Środoń 1980; Eberl et al. 1993; Moore and Reynolds 1997). A regression from calculated data were used to calculate the % expandable (%Exp) component in each untreated and reacted bentonite. The equations are:

$$\%Exp = 973.76 - 323.45\Delta + 38.43\Delta^2 - 1.62\Delta^3$$ (Eberl et al. 1993, Eq. 3, R^2=0.99),

with Δ corresponding to Δ°2Θ between the 002 and 003 peak positions for the oriented, ethylene glycol saturated samples.

Analytical electron microscopy was performed using a FEI™ Inspect F scanning electron microscope (SEM). All samples were Au/Pd-coated prior to SEM analysis. Imaging with the SEM was performed using a 5.0 kV accelerating voltage and 1.5 spot size. Energy dispersive X-ray spectroscopy (EDX) was performed at 30 kV and a 3.0 spot size.

Electron microprobe (EMP) analyses were performed at the University of Oklahoma using a Cameca SX50 electron microprobe equipped with five wavelength-dispersive spectrometers and PGT PRISM 2000 energy-dispersive X-ray detector. Petrographic characterization was performed by backscattered electron imaging coupled with energy-dispersive X-ray analysis, using beam conditions of 20 kV acceleration and 20 nA sample current. Quantitative analysis was performed by wavelength-dispersive spectrometry using 20 kV accelerating voltage, 20 nA beam current, and 2 µm spot size. Matrix corrections employed the PAP algorithm (Pouchou and Pichoir 1985), with oxygen content calculated by stoichiometry. Counting times were 30 seconds on peak for all elements, yielding minimum levels of detection (calculated at 3-σ above mean background) in the range of 0.01 to 0.03 wt. % of the oxides for all components except F (0.16 wt. %). All standards for elements in the silicates were analyzed using 30 second count times on peak, using K-alpha emissions. The standards and oxide detection limits are presented in Appendix A, with analytical data presented in Appendix B.

3.3 Aqueous Geochemical Analyses

Major cations and trace metals were analyzed via inductively coupled plasma-optical emission spectrometry (Perkin Elmer Optima 2100 DV) and inductively coupled plasma-mass spectrometry (Elan 6100) utilizing EPA methods 200.7 and 200.8. Ultra-high purity nitric acid was used in sample and calibration preparation prior to sample analysis. Internal standards (Sc, Ge, Bi, and In) were added to samples and standards to correct for matrix effects. Standard Reference Material (SRM) 1643e Trace Elements in Water was used to check the accuracy of the multi-element calibrations. Inorganic anion samples were analyzed by ion chromatography (IC) following EPA method 300 on a Dionex DX-600 system. Aqueous geochemical results are presented in Appendix C.

4. RESULTS/DISCUSSION

4.1 Summary of Previous Work

Caporuscio, et al. (2014) and Cheshire et.al. (2014) have written extensively on the results of most of the experiments produced for the Argillite EBS research program. To that effect, I will first summarize our findings from FY-14 and then provide updates on experimental characterization results from 2015.

4.1.1 Layer Charge

A series of 45 capsule experiments were designed to interrogate if any layer charge increase took place during the EBS experiments (Caporuscio, et al., 2014). Smectite swelling is the competing effects between the interlayer cation hydration energy (hydration-repulsion) and the Coulombic attractive forces between negatively-charged 2:1 layers and positively-charged interlayer cations (Laird, 1996; 2006). When Coulombic attractive forces dominate over hydration-repulsion collapse of the interlayer spaces occurs. Collapse can be cause by several possible scenarios, increased layer charge (i.e., illitization), increased interlayer cation charges (i.e., interlayer exchange reactions), or decreased interlayer cation hydration energy (i.e., interlayer exchange reactions). Alternatively, swelling occurs when the hydration-repulsion dominates over the Coulombic attractive forces. . It is evident (Caporuscio etal, 2014) that there is variation in the layer charge within the starting montmorillonite, but the current EBS reaction conditions do not significantly alter the layer charges or charge distribution. This is also confirmed by the CEC measurement showing no change in CEC values between all reaction products and the starting montmorillonite.

4.1.2 Illitization

There was no evidence of illite-smectite mixed-layering during the six-month cooling experiment where montmorillonite was heated to 300°C for four months, consistent with the other EBS experiments in our Na-dominated hydrothermal systems. The following description from Caporuscio etal (2014) summarizes the smectite-illite transformation complexity and explains why our experiments do not generate illite. *"Smectite-to-illite transformation is not well understood and probably follows several different reaction pathways, i.e. solid-state* *transformation and dissolution-precipitation (Güven 2001; Dong 2005; Zhang et al. 2007). These different reaction mechanisms may be due to different geological or experimental conditions, including variables such as water/rock ratio, fluid composition, redox state, occurrence of microbial organisms, and presence or absence of organic matter (Small et al. 1992; Small 1993; Güven 2001; Dong 2005; Zhang et al. 2007). Solid-state transformation may be operative in closed systems with a low water/rock ratio, whereas, dissolution-precipitation may be the dominant mechanism in open systems with high water/rock ratios (Zhang et al. 2007). In our experiments, it appears that two major parameters are preventing smectite-to-illite alteration: alkali and silica solution compositions.*

Current experimental results are consistent with other experimental data showing that a limited supply of K^+ along with a relatively high Na^+ activity significantly decreases dioctahedral smectite illitization rates (Eberl and Hower 1977; Eberl 1978, Eberl et al. 1978; Roberson and Lahann 1981; Mosser-Ruck et al. 1999). Their studies also show that, in general, dioctahedral smectites with low hydration-energy interlayer-cations (e.g., K^+, Rb^+, Cs^+) are more susceptible to smectite-to-illite alteration reaction compared to dioctahedral smectites with higher hydration-energy interlayer-cations (e.g., Na^+, Ca^{2+}, Mg^{2+}). These results are consistent with capsule experiments from the current work. However, the presence of a Na-rich system does not preclude smectite illitization. There have been numerous occurrences of illite and illite/smectite occurring in natural or experimental systems that are Na-dominated (Bannister 1943; Frey 1969; Eberl and Hower 1977; Eberl et al. 1978; Whitney and Velde 1993; Mosser-Ruck et al. 1999; Środoń 1999). But, in all these cases, either the temperatures exceeded 300°C or there was a significant potassium source from groundwater or coexisting minerals. Temperatures beyond 300°C exceed the upper temperature limits expected for a repository environment and the experimental temperature from this investigation (Greenburg and Wen 2013). Additionally, Na-bentonites are currently the bentonite of choice for a repository backfill, thereby, providing a K-depleted and Na-enrich system. Even though the aqueous solutions in the experiments were K-rich, the overall system (bentonite + water) was Na^+ dominant (~ 2,400 mg Na/L) and K^+ poor (~ 1,000 mg K/L). Include Ca^{2+} (~750 mg/L, bentonite + water) in the discussion, the overall $(Na^+ + Ca^{2+})/K^+$ ratio is greater than 3.0. It is evident that the dominance of Na^+ and Ca^{2+} along with the low abundance of K^+ does not facilitate illite-smectite formation after 45 days at 300°C.

Silica activities in these experiments appear to be controlled partially by silicate mineral dissolution and precipitation, in addition to clinoptilolite to analcime alteration. Solutions saturated with respect to cristobalite probably contributed to illitization retardation in these current experiments. Systems with silica concentrations higher than quartz saturation have been shown to significantly retard illitization rates (Eberl et al. 1978; Lahann and Roberson 1980; Abercrombie et al. 1994). Abercrombie et al. (1994) has shown that a K-smectite to be the stable phase, potentially up to 200°C, provided silica activity is higher than ~10^{-2}. It was noted by

Abercrombie et al. (1994) that as silica levels decreased, due to quartz precipitation, illitization progressed within the system. Therefore, an environment with silica concentrations saturated with respect to cristobalite at temperatures less than 300°C, such as the current experiments, smectite-to-illite alteration should further be inhibited. However, it is important to consider differences between closed, experimental systems versus geological or repository environments that open to the surrounding environment. Many processes that are observed in a closed, experimental system might be mitigated in an open system where solutes can freely move in and out of the environment.

We have shown that at higher silica activities (i.e., cristobalite saturation) clinoptilolite is altered to a high-silicon analcime under the current experimental conditions. Again, these reactions were observed in the other EBS experiments with extended periods at 300°C. Previous studies (Smyth 1982; Wilkin and Barnes 1998; 2000; Cheshire et al., 2014) have linked changes in Na, Al, and Si activities with the alteration of clinoptilolite by analcime. However, experimental work (T < 300°C) from Wilkin and Barnes (1998) indicate silica activity influences clinoptilolite alteration by affecting the reaction affinity rather than controlling the reaction equilibrium. Wilkin and Barnes (1998) also show that analcime can form in an environment saturated with respect to cristobalite provided there is a sufficient change in the Na and/or Al activities.

The effect on the repository due the changes in the system's silica phases and concentrations appears to be a significant issue regarding the repository stability and physical properties. Cementation via silica precipitation is believed to pose the greatest risks to the repository stability and isolation capability compared other mineral reaction (Pusch et al. 1998). Silica precipitation has the potential to weld the smectite lamellae together and reduce the smectite expandability (Pusch et al. 1998; Pusch 2002). The primary mechanism for silica liberation includes smectite illitization, silica/silicate dissolution/saturation, and zeolite alteration."

4.1.3 $H_2S_{(aq,g)}$ Generation

All experiments generated $H_2S(_{aq,g})$, with the 300 oC isothermal reactions producing the gas faster and in greater quantities. The $H_2S_{(aq,g)}$ is most likely related to pyrite solubility in a chloride-bearing solution (Crerar et al. 1978; Ohmoto et al. 1994). The reducing nature of the experimental system easily preserved the $H_2S_{(aq,g)}$ species. Pyrite contents obtained by QXRD analyses for the Colony Wyoming bentonite (0.4 wt%) and Opalinus Clay (1.1 wt%) are listed in Table 4. Sulfide-induced corrosion of the waste canisters is the primary concern for the Swedish repository systems (Börjesson et al. 2010), therefore the Swedish Nuclear Fuel and Waste Management Company (SKB) have emplaced fairly strict sulfur specifications (sulfide content < 0.5 wt. %; total sulfur < 1 wt. %) for the bentonite buffer used in their repositories (Börjesson et al. 2010).

Table 4 Quantitative X-Ray Diffraction (QXRD) analyses of the buffer clay (Wyoming Bentonite) the wall rock (Opalinus Clay) and end product results of all seventeen experiments. Values are in weight percent.
b.d.l. = below detection limit, n.s. = not sampled

	Wyoming Bentonite	Opalinus Clay Switzerland	EBS-1 --	EBS-2 304 SS	EBS-3 316 SS	EBS-4 Cu	EBS-6 LC Steel	EBS-7 Graphite	EBS -9 Quartz	EBS-5 304 SS	EBS-10 316 SS	EBS-11 Cu	EBS-12 20% H_2O
			Stepped Heating from 25/100/200/300/25							Isothermal 300°C			
Smectite	72	24.1	81	75	79	79	81	75	73	79	79	80	71
Chlorite	b.d.l.	9.1	n.s.-	n.s.	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s
Kaolinite	b.d.l.	16.9	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s
Clinoptilolite	13	0.0	8	9	6	6	7	5	6	2	6	8	4
Analcime / Wairakite	b.d.l.	0.0	b.d.l.	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	3	1	1	1
Quartz	1	13.8	2	1	2	1	2	3	16	2	3	2	3
Cristobalite/ Opal-C	2	0.0	2	3	2	1	4	5	6	2	6	8	4
Biotite	3	7.4	2	4	1	2	1	+	+	2	1	+	+
Pyrite	0.4	1.1	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l	+
Plagioclase	9	3	4	6	7	6	3	2	2	5	6	5	7
K-Feldspar	b.d.l.	5.9	2	3	3	3	1	1	1	2	2	2	3
Calcite	6	16.4	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s
Dolomite	+	0.7	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s
Siderite	2	0.1	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s
Magnetite		0.0	b.d.l.	b.d.l	2	1	+	+	1	1	b.d.l	b.d.l	b.d.l
Graphite		0.0	b.d.l.	b.d.l	b.d.l	b.d.l	b.d.l	12	b.d.l	b.d.l	b.d.l	b.d.l	b.d.l
Gypsum		0.0	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s
Total:	100.4	100	101	101	100	99	99	99	101	100	100	100	99

Table 4 cont. b.d.l. = below detection limit, n.s. = not sampled

	Wyoming Bentonite	Opalinus Clay Switzerland	EBS-13 316 SS	EBS-16 Cu	EBS-14 Opalinus Clay	EBS-15 Opal -316 SS	EBS-17 Opal -Cu
			6 month 300°C to 120°C		6 weeks Isothermal 300°C		
Smectite	72	24.1	69.8	65.2	39.8	51.6	63.8
Chlorite	b.d.l.	9.1	0.0	0.0	11.1	1.3	1.1
Kaolinite	b.d.l.	16.9	0.0	0.0	1.8	0.2	0.0
Clinoptilolite	13	0.0	0.0	1.8	0.0	15.0	11.7
Analcime / Wairakite	b.d.l.	0.0	3.4	4.4	5.5	1.3	3.0
Quartz	1	13.8	2.6	3.2	8.4	5.5	3.3
Cristobalite/ Opal-C	2	0.0	5.1	6.9	0.0	0.0	0.0
Biotite	3	7.4	1.5	2.6	11.9	9.7	2.0
Pyrite	0.4	1.1	0.0	0.0	0.7	0.0	0.2
Plagioclase	9	3	10.3	10.6	3.5	11.8	11.3
K-Feldspar	b.d.l.	5.9	4.7	3.7	4.3	2.3	3.1
Calcite	6	16.4	0.0	0.2	9.4	0.0	0.0
Dolomite	+	0.7	0.0	0.0	0.0	0.0	0.0
Siderite	2	0.1	0.0	0.0	0.0	0.0	0.0
Magnetite		0.0	2.8	1.4	3.1	1.1	0.5
Graphite		0.0	n.s	n.s	n.s	n.s	n.s
Gypsum		0.0	0.0	0.0	0.5	0.3	0.1
Total:	100.4	100	100	100	100	100	100

4.1.4 Dry Clay Experiment for LBNL

At the request of Lawrence Berkley National Laboratory an experiment was run using a bentonite water (15 wt %) mix and held at 300°C for seven weeks. It turns out that dry system kinetics and mineral solubility are highly restricted. Many of the chemical reactions observed in the wet system (9:1 water: rock systems) either do not take place or are restricted in the dry (~ 15 wt. %) system. Pyrite does not undergo decomposition and clinoptilolite undergoes limited dissolution with limited analcime formation. It is evident that reaction kinetics are accelerated under water saturation due to increased ion mobility and minerals' saturation limits.

4.1.5 Mineral Reactions

Caporuscio et al. (2014) provided a succinct and explicit discussion of mineral phase changes during various heating profiles, corrosion effects in bentonite backfill, and reactions with Opalinus Clay (zeolite formation, clay mineralogy, and pH effects). To make this summary document fully usable, that discussion is repeated here:

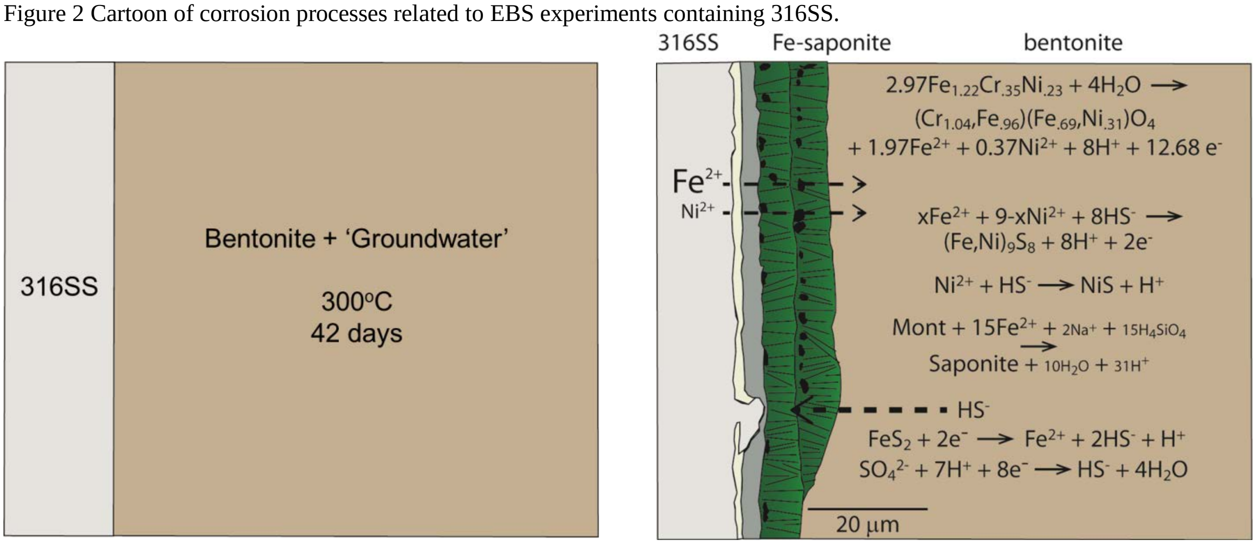
Heating profile. *The mineral evolution and geochemical processes are consistent between all three reactions with differing heating profiles. These profiles were designed to mimic the maximum heating profile during a repository's lifetime, with exception to the duration of each stage: (1) heating from 120°C (2 weeks); 220°C (2 weeks); 300°C (1 week); (2) isothermal, 300°C (6 weeks); (3) cooling from 300°C (16 weeks), 220°C (4 weeks); 120°C (4 weeks). There were no retrograde reactions observed during the cooling phase. Essentially EBS-10 and EBS-13 show no significant differences between the two reaction products.*

It would be expected during the early emplacement of the waste canister that silica saturation, exchange reaction will take place under limited conditions. The relatively dry environment of the early bentonite would significantly restrict the mineral reactions due to the limited ion mobility and early saturation. It is possible that sulfide gas could be generated, but as shown in the 15 wt. % free moisture experiment (EBS-12) pyrite decomposition was not readily observed due to the restricted solubility. As temperatures increase to peak temperature (currently unknown and will be determine during repository design), various possible zeolite reactions (mordenite, laumontite, analcime, wairakite formation) will occur due to the precursor clinoptilolite and volcanic glasses. These zeolite reactions, along with silica saturation reactions, will control the porewater solution chemistry and determine any further mineral alteration. Illite formation can still progress, if a K-source is available, but, K-source stability with respect to the repository conditions will determine the illitization rates. As shown in the capsule experiments, adding K-bearing minerals does not necessarily force illitization; dissolution of those mineral phases has to take place. Illitization thermodynamics and kinetics are strongly tied to the alkali, alkaline earth, silica, and hydrogen (pH) activities; therefore, it is difficult to predict whether illitization will occur in a repository. After the high temperature pulse passes and temperatures begin to decrease, retrograde reaction have the potential to further *change the high temperature mineralogy. As observed in current work, no significant retrograde reactions took place, but as with any experimental work slow kinetics of such reactions make them difficult to show experimentally. It would be expected silica saturation is maintained at continuing lower temperatures by releasing silica from solution. This in turn should partially cement and fill pores in the bentonite. Retrograde zeolite reactions are expected, but currently the extent of such reaction and types are unknown.*

Corrosion in bentonite. *Results from these experiments have shown the more dynamic environment associated with this system is at the bentonite-metal interface. Trioctahedral, Fe-rich saponite crystallized on steel surfaces forming a reactive substrate with a high surface area compared to the original steel surfaces. Partial dissolution of the steel plates contributes ferrous iron into the fluid phase while silica and aluminum facilitates Fe-saponite (smectite) crystallization (Figure 2). Liberated Ni , from the steel, partitions into the sulfide phases forming pentlandite ($(Fe,Ni)_9S_8$) and millerite (NiS). Oxidative leaching of Fe and Ni forms a chromite ($(Cr_{1.04},Fe_{0.96})(Fe_{0.69},Ni_{0.31})O_4$ passivation layer on the outer surface of the 316SS plates, restricting corrosion rates (0.1 $\mu m \cdot d^{-1}$ stainless steel) compared to non-alloyed metals (0.6 $\mu m \cdot d^{-1}$ low-carbon steel and 0.8 $\mu m \cdot d^{-1}$ copper). Formation mechanism for Fe-saponite is not completely understood for this system. There are two possible scenarios for Fe-saponite formation: 1) direct crystallization in a Fe- and Si-rich solution as a result from bulk mineralogy influences or 2) Fe + montmorillonite interactions breaking down montmorillonite and producing Fe-saponite. The latter mechanism would be a deleterious reaction to the overall repository as montmorillonite is primary mineral in the barrier.*

Fe-phyllosilicates tend to have strong sorption properties towards actinides and other radioactive materials; therefore, they have the potential to provide added barrier properties for actinide containment. The dynamics and reactivity of actinide adsorption need to be incorporated into the long term repository performance evaluation models. However, this work

Figure 2 Cartoon of corrosion processes related to EBS experiments containing 316SS.



has never been addressed in repository studies. Inclusion of a reactive, high surface-area canister into used-fuel repositories performance assessments should help provide a viable repository evaluation.

Opalinus Clay

There are very limited cation exchange reactions associated with the Opalinus Clay and solution chemistry due to no significant amount of smectite. Opalinus Clay is dominated with clay phases (i.e., illite, I-S, kaolinite, and chlorite) that typically do not freely exchange cations.

Zeolite formation. *The primary authigenic zeolite in experiments with Opalinus Clay alone differs from the Opalinus Clay experiments with bentonite. These differences appear to be strongly related to the solution chemistry. Bentonite-bearing experiments most likely exchanged Ca into the montmorillonite interlayer producing a Ca depleted solution compared to the Opalinus Clay experiments. Solution chemistry associated with the Opalinus clay will remain fairly unchanged unless mineral alteration occurs. The changing of solution chemistry as function of the types of clays in the system appears to indirectly control zeolite stability.*

The analcime-wairakite series typically forms through dissolution-precipitation mechanisms through an intermediate mineral or glass phase. In the other EBS experiments, it appears that analcime formed from a direct dissolution-precipitation at the expense of precursor clinoptilolite and volcanic glass. This paragenetic sequence has been previously observed by many other researchers (Smyth, 1982; Masuda et al., 1996; Wilkin and Barnes, 1998). Natural paragenetic sequences suggest that clinoptilolite to analcime may progress at temperatures as low as 75 - 90° C (Smyth 1982; Masuda et al. 1996). Alternatively, work from Wilkin and Barnes (1998; 2000) shows analcime formation kinetics are significantly increased at alkaline pH's (9 - 10), whereas, experiments with circum-neutral pH's showed limited to no analcime formation even at with temperatures > 100° C lasting up to 26 days. It is evident that onset temperatures associated with mineral alterations that pH, along with many other solution chemistry parameters, are important to understand.

Wairakite primarily forms when excess silica is present and typically crystallizes through either an intermediate Ca-mordenite ($CaAl_2Si_{10}O_{24}\cdot 7H_2O$) or laumontite ($CaAl_2Si_4O_{12}\cdot 4H_2O$) phase (Ames and Sands, 1958; Jové and Hacker, 1997). In their experimental works, wairakite was observed to be stable between 315°C and 450°C. However, the inclusion of small amount of Na-substitution lowers the formational conditions for wairakite. Additionally, there are limited isomorphous substitutions between analcime and wairakite making Na- or Ca-enriched end members, as opposed of a true intermediate analcime-wairakite (Steiner, 1955; Coombs, 1955; Ames and Sands, 1958). Na-mordenite has an experimental stability range between 190 to 300°C, whereas, Ca-mordenite ranges from 340 to 380°C (Ames and Sand, 1958).

The possible presence of mordenite and laumontite combined with information from Ames and Sand (1958) and Jové and Hacker (1997) strongly suggests that wairakite in this system is probably from the decomposition of mordenite and/or laumontite. Mordenite and laumontite, therefore, appears to have crystallized from the decomposition of kaolinite in the silica and Na/Ca-rich fluids. This reaction would have progressed either until the reaction was quenched or when one of the reactants was depleted and in this case, kaolinite appears to be the limiting resource as it has been completely removed. The presence of Na in our system appears to have lowered the formation temperatures to below 300°C for Na-enriched wairakite.

However, when bentonite is included into Opalinus Clay experiments, the solution chemistry changes significantly forcing the formation of a high-silicon, Ca-enriched analcime. The analcime composition from this experiment is similar to analcime from EBS experiments with bentonite as the only clay. However, it is evident that the reaction mechanisms are very different. In bentonite only reactions, high-silicon analcime crystallized from clinoptilolite and unaltered glass with in the high Na and $SiO_{2(aq)}$ *fluids. EBS experiments with 20 wt. % Opalinus Clay much of the original clinoptilolite is preserved, but kaolinite is completely removed. When kaolinite and clinoptilolite are present in a Na/Ca-rich fluid, kaolinite is preferentially recrystallized into either Na/Ca-mordenite and laumontite or analcime.*

Clay mineralogy. *Following the clay mineral evolution within Opalinus materials is complicated due to the variety of clay minerals present in the Opalinus experimental systems. Two systems were tested: (1) Opalinus Clay and (2) bentonite with 20 wt. % Opalinus Clay. The latter experiment was setup to represent mixing between a repository host rock with a bentonite backfill to determine what effects (if any) the host rock has on the backfill material. After thermal processing in brine, the Opalinus Clay appears to have an increase in the I-S distribution. The original Opalinus material appeared to have an R3 illite (0.8-0.9)-smectite, but after 300°C for 6 week in an Opalinus brine an R3 illite (0.9)/smectite and a R1 illite (0.7)/smectite was produced. However, illitization in the host rock may not be a major concern as Opalinus Clay is primarily a low-permeable barrier with very limited swelling capacity due to the low amounts of swelling smectite within the Opalinus Clay. The major concern is the reactivity of Opalinus Clay with the bentonite causing alteration to the bentonite constituents. There was negligible illitization within the bentonite fraction in the mixed reaction (EBS-15). This is consistent with the capsule experiments containing a bentonite with a secondary rock phase. It is important to note that these experiments do not preclude the possibility of host rock – bentonite interaction at these temperatures because kinetics may not allow the observation of mineral alterations under the current experimental duration. With any of these experiments representing repository system, kinetics is always an issue that has to be taken into account when interpreting data.*

pH effects. *Many of the reactions described above are strongly influence by the pH of the system. Most mineral reaction rates that are of concern to a repository are increased under high pH systems. Chermak (1992) showed that under pH conditions of 11-13, Na-rectorite was* *formed at 150 – 200°C within 17 days. Fully formed Na-mica (paragonite) developed after 32 days. Work from Eberl and Hower (1977) and Eberl (1978) do not show illitization until 260 – 400°C at quenched pH's ranging from 4 – 5. These observations are consistent with the current research. The Opalinus Clay experiment starts with a 7.5 – 7.8 solution pH, but during the reaction the pH drops to 4 – 5. The reactions experience significant zeolite reactions, but it appears illitization does not occur under the Na-dominated environment. These high pH dependent reactions will play a major factor within the bentonite backfill near the concrete liners, especially if the concrete used contains significant K^+ concentrations. However, these same reactions should have a minor impact on the bentonite backfill near the waste package because steel and copper corrosion tend to lower the pH.*

5. NEW INFORMATION AND INTERPRETATION FROM CHARACTERIZATION OF EXPERIMENTS IN FY-15

5.1 Illite formation in experimental runs

As discussed in Caporuscio et al. (2014) the bulk composition of the experimental material dominates the formation of illite in a closed system. The experiments with Colony bentonite, Stripa synthetic brine, and metal never generated any measurable illite. It was determined that a combination of silica and Na saturation, along with low K concentrations precluded illitization of the smectites at 300°C. Clay mineral evolution with Opalinus Clay material is more diverse. The starting Opalinus Clay is dominated with illite-smectite (I-S) mixed-layers and discrete illite with minor amounts of smectite. The resultant clay reaction products of EBS-14, EBS-15 and EBS-17 have a bimodal clay composition. The montmorillonite from the bentonite component has not significantly reacted to illite, while the post reaction Opalinus Clay fraction has a clay characteristic similar to the starting Opalinus Clay. Caporuscio et al. (2014) describes the post reaction Opalinus Clay material as a well-crystalline illite and a poorly-crystalline illite displaying a low, broad reflection superimposed on a sharp 10 Å illite reflection. The I-S appears to be a R0 illite (0.1)/smectite and expands to 16.8 Å with a $\Delta 2\theta$ (002/003) values of 5.44°, corresponding to 91% expandability. R1-3 ordered I-S were not detected. In summary, the starting material, maximum pressure / temperature attained, and the overall bulk chemistry of a specific EBS system will dictate whether secondary illite will form.

5.2 Zeolite phase transformations at elevated temperatures

Cheshire et al. (2014) noted that clinoptilolite (Figure 3a) was the precursor zeolite that transformed to analcime (Figure 3b) at high temperature. The reaction was listed as:

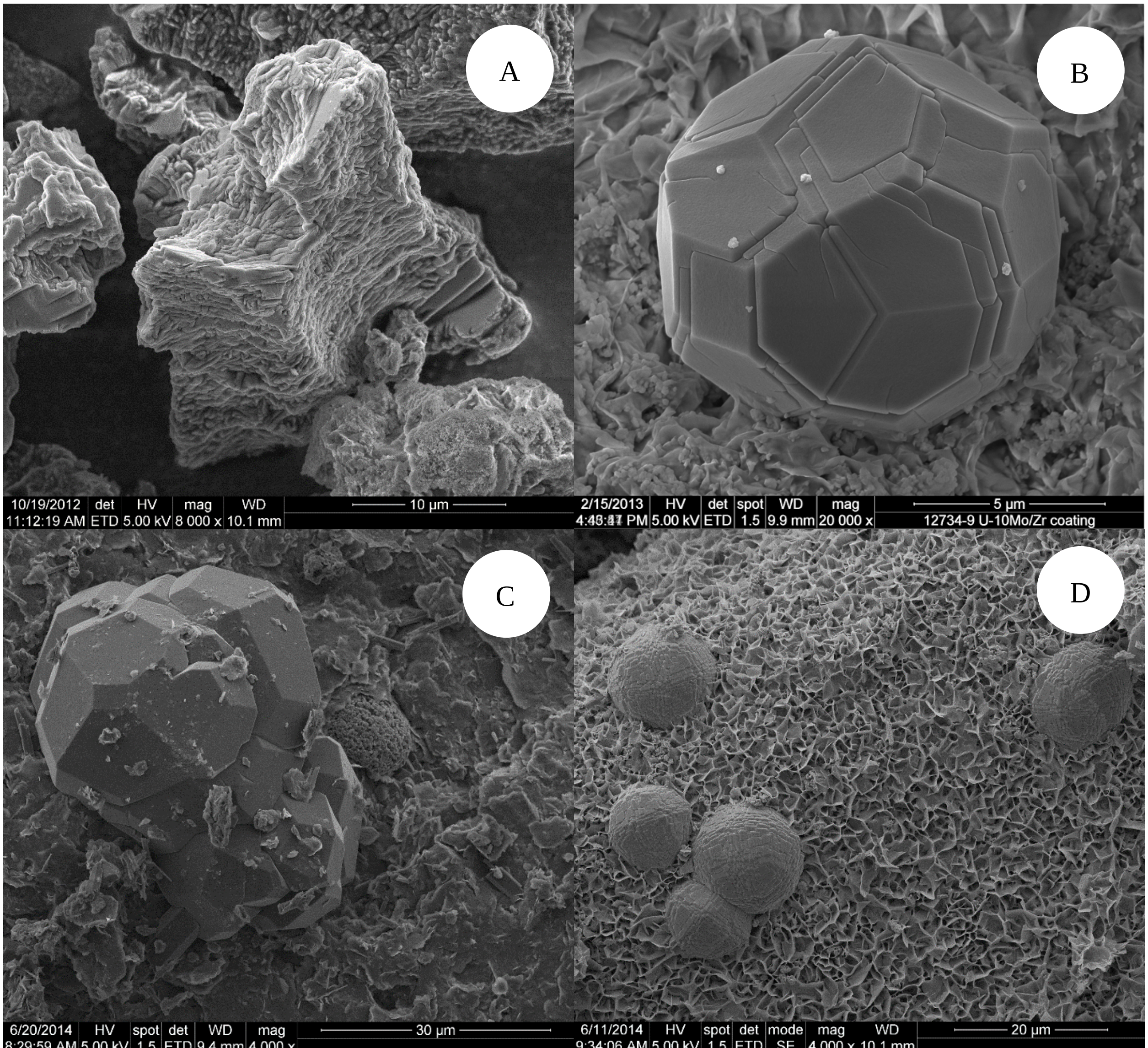
Clinoptilolite + Na + Ca → Analcime + SiO_2 + H_2O + K + Fe + Mg:

$$(Na_{4.30},Ca_{0.39},K_{0.14},Mg_{0.20})(Si_{29.82},A_{16.28},Fe_{0.03})O_{72}\cdot 21H_2O + 0.92Na^+ + 0.02Ca^{2+} \rightarrow 8.16(Na_{0.64},Ca_{0.05})(Si_{2.23},A_{10.77})O_6\cdot 1H_2O + 0.14K^+ \; 0.20Mg^{2+} + 11.62SiO_{2(aq)} + 12.64H_2O + 0.03Fe^{2+} + 0.40H$$

Table 5 presents data on the high temperature zeolite phase in all EBS experiments to date. Note that the experiments with bentonite only produce analcime (Na-rich, monoclinic) phases (Figure 3b). The experiment with Opalinus Clay only (EBS-14) indicates the zeolite wairakite (Ca-rich, triclinic, Figure 3c) has grown at high temperature. Of great interest are experiments EBS-15 and EBS-17, which contain a mixture on Wyoming bentonite as backfill and Opalinus Clay as the wall rock. The resultant zeolite produced (Figure 3d) is intermediate between analcime and wairakite in composition (Table 5). This is in agreement with Seki (1971) and expands the solid solution fields that he described. The generalized reaction between the two zeolite phases with complete exchange of Na and Ca is shown below

Wairakite → Analcime

$$\mathbf{CaAl_2Si_4O_{12}\ 2(H_2O) \rightarrow Na_2Al_2Si_4O_{12}\ 2(H_2O)}$$



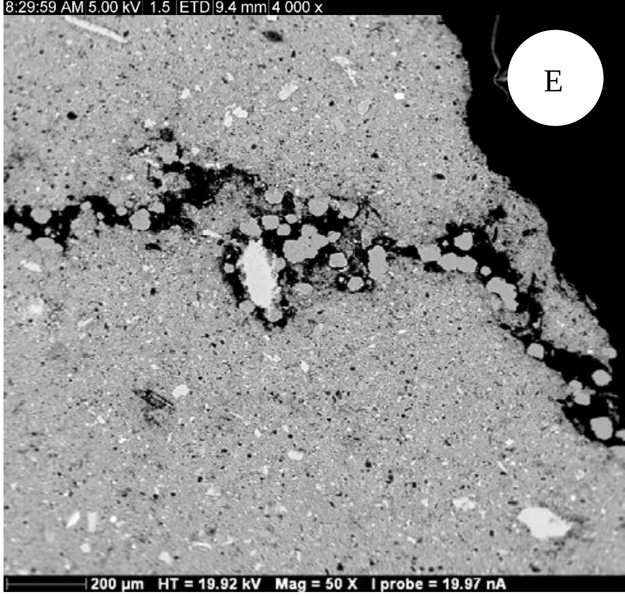


Figure 3 **A**) Colony Wyoming Bentonite starting material- Image of clinoptilolite pseudomorping glass shard.**B**) EBS 5 post reaction material. Euhedral analcime crystal in bed of smectite clay. **C**) EBS 14 post reaction material. Image of wairakite crystals in platy smectite bed. Morphology of this Ca-rich zeolite is slightly different from the Na-rich analcime above. **D**) EBS 15 post reaction material. These zeolites are part of the Analcime – Wairakite solid solution series, specifically $Analcime_{64}$--$Wairakite_{36.}$ Although surface morphology is striking different from the previous two zeolite images, these crystals may not be fully developed. **E**) EBS 14 Back Scattered Electron (BSE) image. Euhedral crystals in crack are wairakite with composition $Analcime_{22}$—$Wairakite_{78.}$ Note that the zeolite mineral is confined to the region where the Opalinus Clay synthetic brine interacted with the Opalinus Clay wall rock. The shale itself is non-porous and did not allow zeolites to form within the rock.

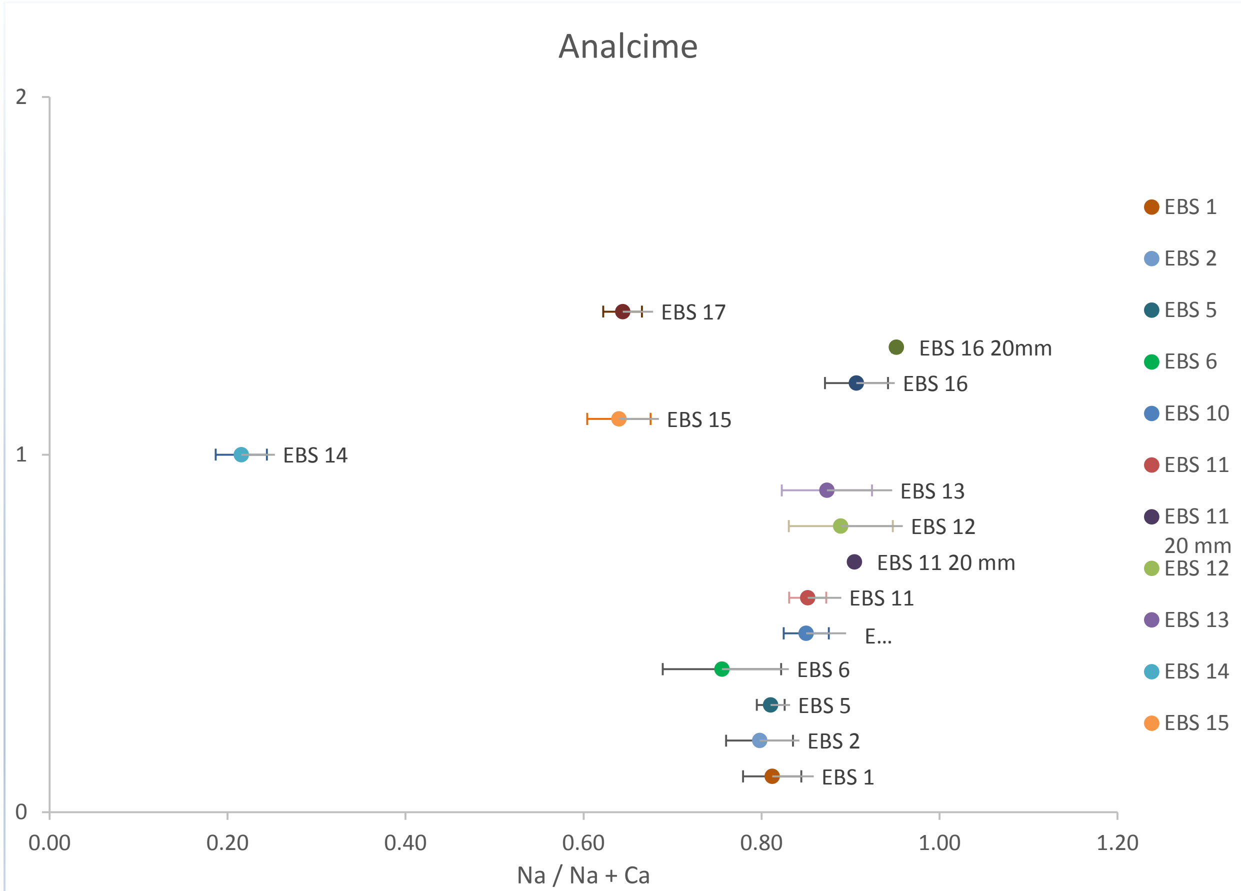


Figure 4 Plot of Analcime—Wairakite Solid Solution compositions . The average compositions (and standard deviations) were obtained from the electron microprobe values in Appendix B. High Na dominated zeolites (Analcime) were typically generated in Colony Wyoming bentonite. The highest Ca zeolite ($Wairakite_{78}$— $Analcime_{22}$) was observed in in the Opalinus Clay only reaction product. Two experiments (EBS-15 and EBS-17) with both Colony Wyoming bentonite and Opalinus Clay result in intermediate composition Analcime—Wairakite Solid Solution minerals.

Table 5 Average composition of post reaction zeolite compositions.

Sample	Analcime--Wairakite Solid solution
EBS 1	An_{81}--Wrk_{19}
EBS 2	An_{80}--Wrk_{20}
EBS 5	An_{81}--Wrk_{19}
EBS 6	An_{75}--Wrk_{25}
EBS 10	An_{85}--Wrk_{15}
EBS 11	An_{85}--Wrk_{15}
EBS 11 spot	An_{91}--Wrk_{9}
EBS 12	An_{88}--Wrk_{12}
EBS 13	An_{87}--Wrk_{13}
EBS 14	An_{22}--Wrk_{78}
EBS 15	An_{64}--Wrk_{36}
EBS 16	An_{91}--Wrk_{9}
EBS 16 spot	An_{95}--Wrk_{5}
EBS 17	An_{64}--Wrk_{36}

Figure 5 Pentlandite (white) sitting on a bed of Fe-saponite, all of which form as a mantling material on 316 stainless steel.

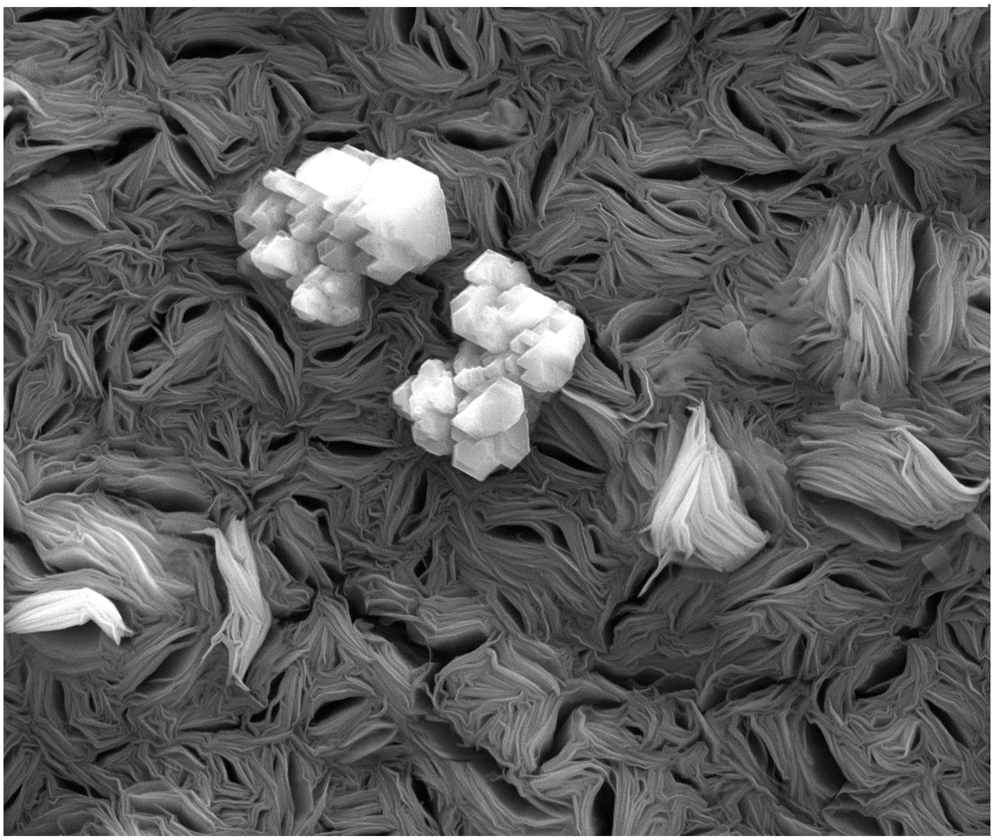


Figure 3e, which is a reflected light image of the reacted Opalinus Clay, depicts wairakite crystals that formed within a crack in the wall rock material. This is indicative of the complete sample, in that the zeolite forms only on the edges or within cracks of the Opalinus Clay. All petrographic evidence indicates that the Opalinus Clay shale has such limited porosity and permeability that the resultant wairakite crystals can not grow in the matrix. They are relegated to leaching aluminum and silica from the wall rock and nucleating at the rock surface.

5.3 Steel corrosion during elevated pressure/temperature EBS experiments

The following mineral phases have been previously identified (Caporuscio et al., 2014) as growing at the interface between bentonite backfill and various steels: Fe-saponite ((Ca/2,Na),3(Fe^{++})3$(Si,Al)_4O_{10}(OH)_2$, pentlandite ($(Fe,Ni)_9S_8$) (Figure 5), chromite ($Fe^{++}Cr_2O_4$), pyrrhotite (FeS) (Figure 7), millerite (NiS). Figure 6 depicts the growth of the interface assemblage perpendicular to the steel. We have just recently identified another interface material: stilpnomelane (Appendix B.1 and Figure 8.). This Fe-bearing phase seems to only occur when mantling iron metal (one of our solid buffer materials).

Although stilpnomelane is a common metamorphic mineral and occurs over a wide P, T spectra (Winkler, 1976) there is a darth of occurrences reported in experimental literature. Similar experimental work by Ferrage (2011), Mosser-Ruck et al. (2010), Guillaume, et al. (2003) and Munier (1998) do not report this mineral phase in their reaction products. The chemical formula of stilpnomelane [K (Fe^{++},Mg, Fe^{+++})$_8$$(Si,Al)_{12}(O,OH)_{27}$] indicates that iron occurs in both

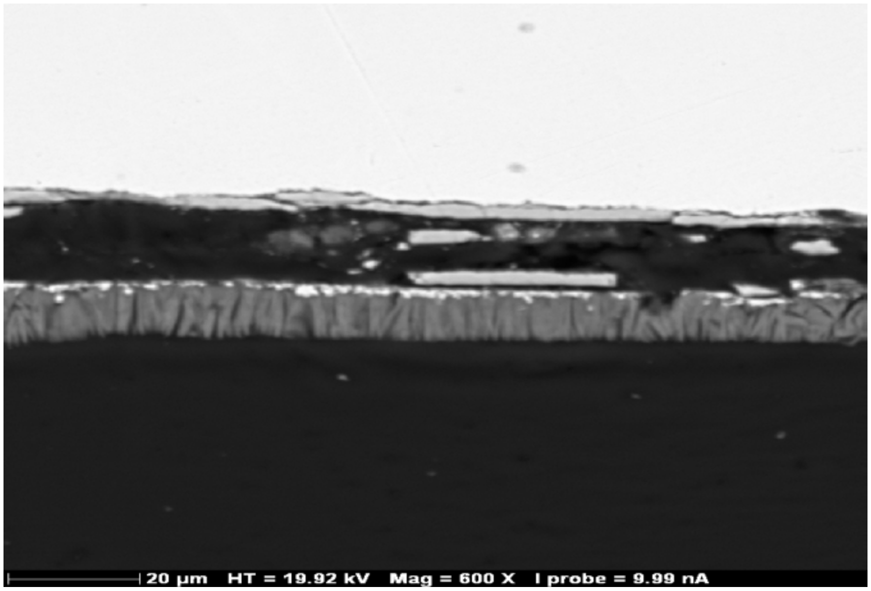


Figure 6 BSE image of steel and Fe-saponite interface from experiment EBS-13. Note the perpendicular growth pattern of the Fe-saponite with respect to the steel (white material at top). This interface material has be forcibly removed from the steel during preparation of the sample by vacuum injected epoxy.

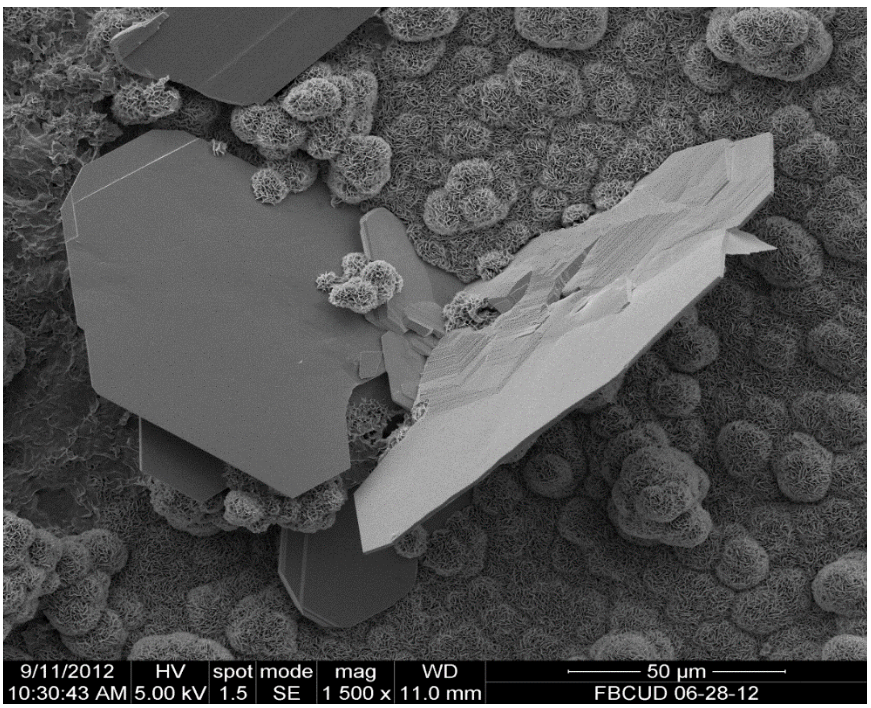


Figure 7 SEM image of pyrrhotite nested in bed of Fe-saponite rosettes. Sample EBS-6 : the growth substrate is low carbon steel.

oxidation states. Given that the iron metal in our experiments (Figure 8) is mantled first by an iron oxide (magnetite?), followed by an Fe sulfide (pyrrhotite) and finally by stilpnomelane,

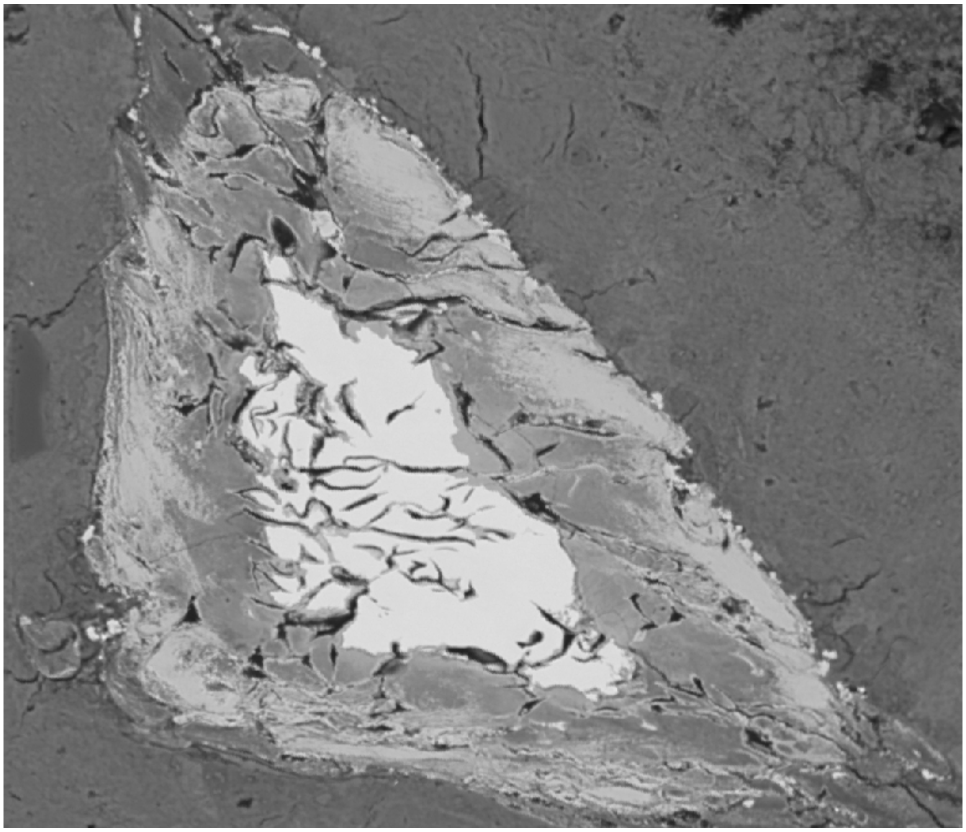


Figure 8 BSE image of iron metal with concentric alteration zones. Bright white core is remnant iron metal, dark grey is iron oxide, light grey is an iron sulfide (probably pyrrhotite) remaining mottled intermediate grey is stilpnomelane. Sample is EBS 15.

there is a potential that micro-domains of differing oxygen fugacity may be at play. This phenomena and mineral genesis deserves further investigation concerning iron corrosion.

5.4 Copper corrosion

Caporuscio et al (2014) discussed copper corrosion in the high P,T EBS experiments in some detail. We have since performed two further experiments (EBS-16 – 6 month, EBS-17- 6 week, Opalinus clay). The primary reaction associated with sulfide-induced copper corrosion is reaction to chalcocite

$$\mathbf{Cu^{\circ} + H_2S \rightarrow Cu_2S_{(s)} + 2e^- + 2H^+.}$$

Copper → Chalcocite

And is well illustrated in an image from EBS-4 (Figure 9). The type of corrosion encountered in all four experiments is pit corrosion (Figure 10). Chalcocite formed a hexagonal morphology ranging from discrete plates to completely coalesced patches on the copper surface (Figures 11 and 12). Chalcocite crystallized on the copper surfaces due to available H_2S from the

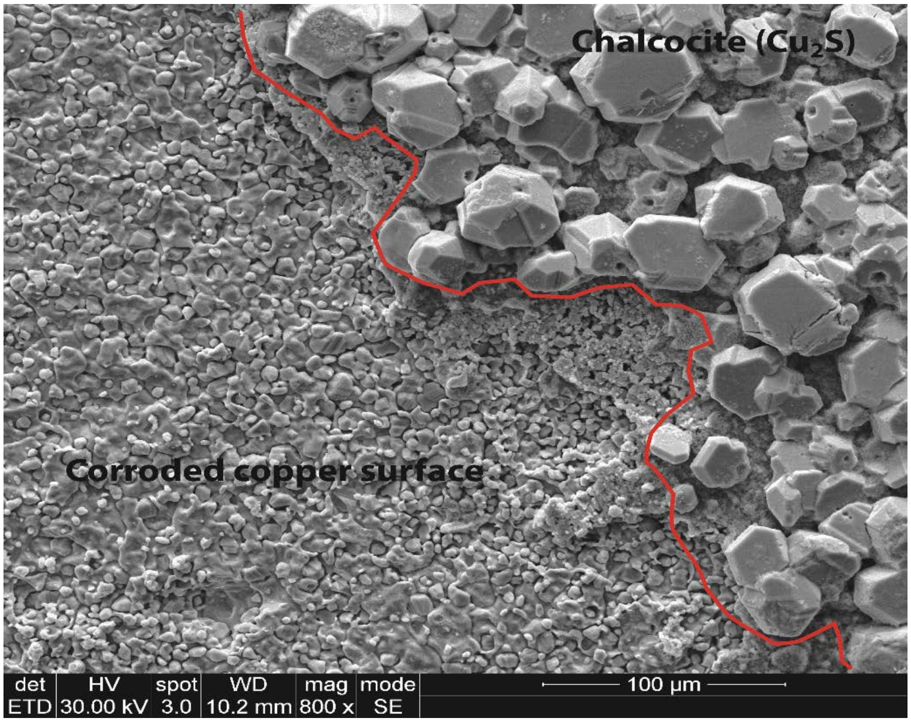


Figure 9 Corroded copper surface (lower left) and the covering chalcocite secondary growth (upper right). Sample EBS-4.

decomposition of pyrite in the hydrothermal environment. It is evident that the formation of these surface bound minerals was from the direct crystallization from solution in the localized environments surrounding the metal plates.

The corrosion and growth of chalcocite typically begins as individual crystals and / or aligned stringers of crystals (Figure 12). This growth of chalcocite in a linear fashion may be due to nucleation along striations and defects in the copper foil. Eventually the copper corrodes further and the surface is totally mantled by chalcocite (Figure 12). Other mineral phases have recently been identified, namely covellite (CuS) and atacamite ($Cu_2Cl(OH)_3$). Covellite was recognized in reflected light microscopy during corrosion thickness measurements, while atacamite was identified by morphologic characteristics (Figure 13). The very late stage atacamite growth is most likely due to late stage scavenging of Cl form solution.

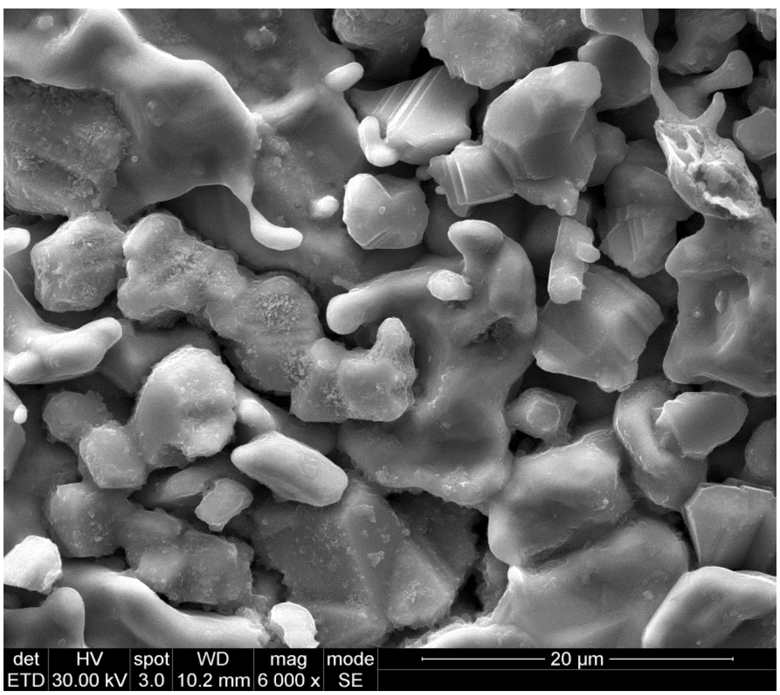


Figure 10 Plan view of pit corrosion in Sample EBS-4

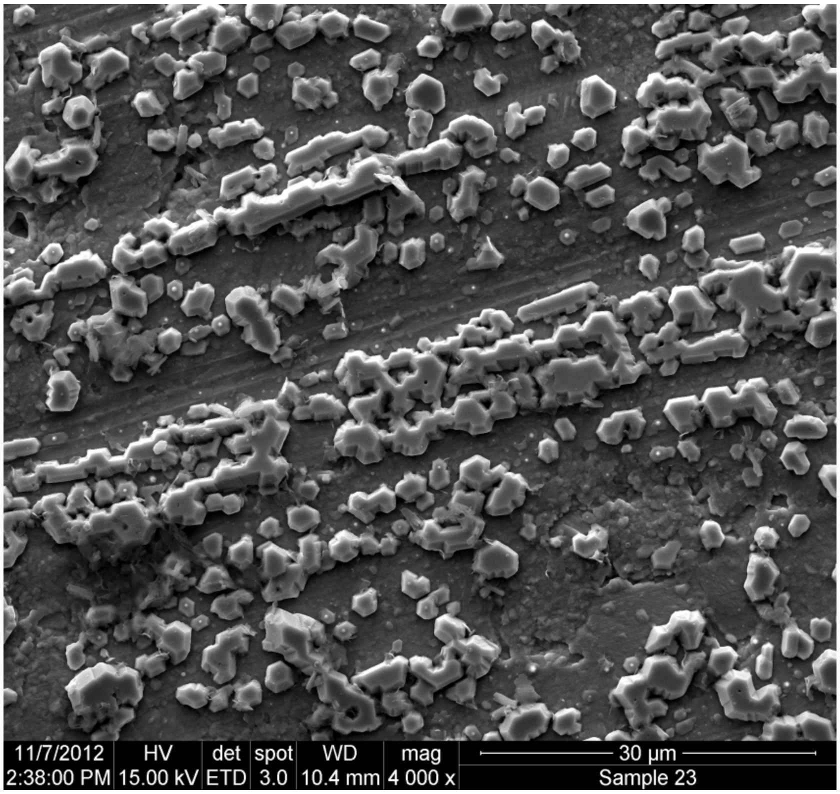


Figure 11 Sample EBS-8. Initial growth of chalcocite on copper

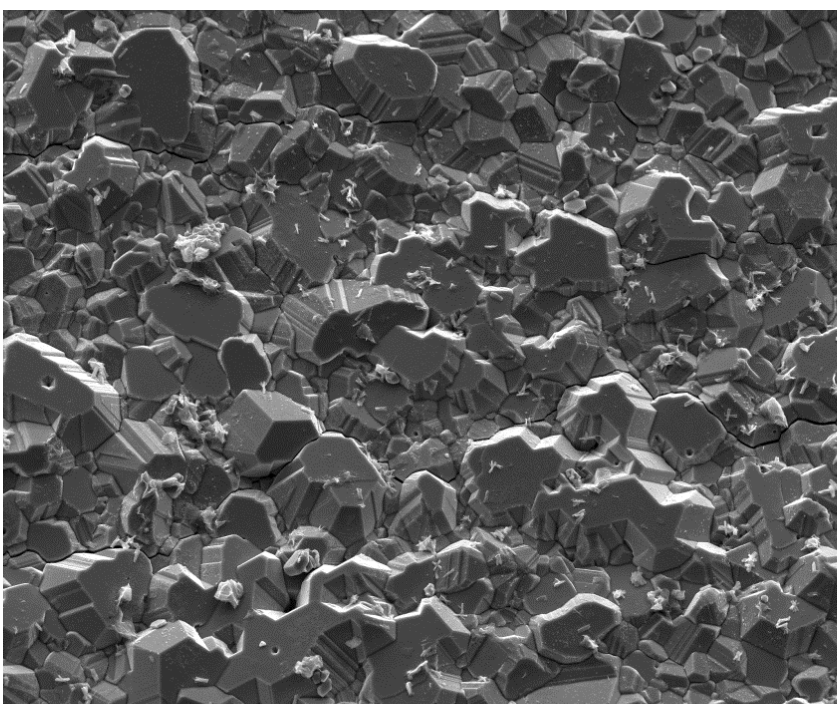


Figure 12 Total coverage of copper by chalcocite. Sample EBS-8.

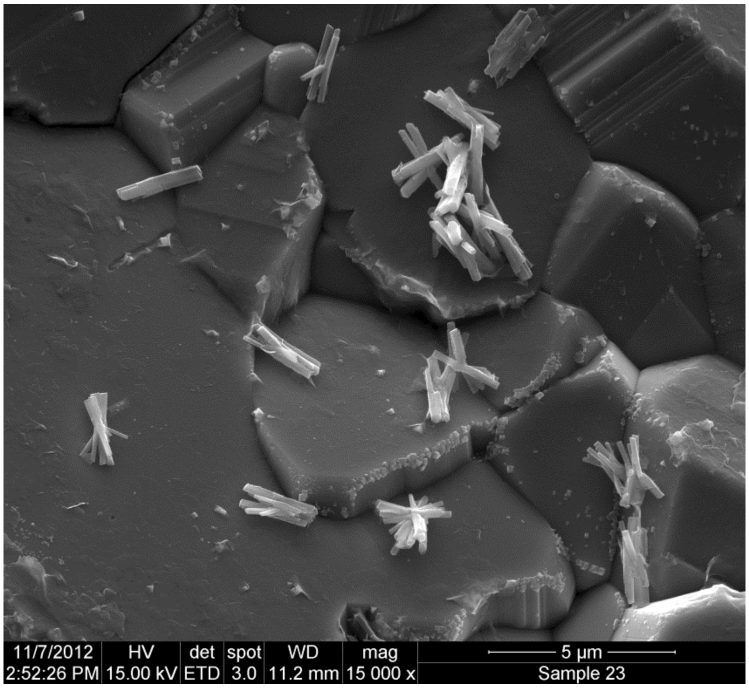


Figure 13 Atacamite (orthorhombic laths) resting on top of chalcocite crystals. Their growth is due to late stage scavenging of Cl from the brine. Sample EBS-8

5.5 Copper corrosion rate determination

The thickness of the chalcocite layer and the depth of the corrosion pitting varied with both temperature profile and experiment duration. In most of the experiments the chalcocite forms a thick layer over a corroded/pitted layer. A notable exception to this is the Opalinus Clay run, EBS-17, where the chalcocite layer was found to be either absent or extremely thick. For the ramped temperature experiment, EBS-4, the average chalcocite thickness was 3.0(13) µm. In the isothermal experiments in both bentonite (EBS-11) and opalinus (EBS-17) clay, the layer was notably thicker, 8.2(42) µm and 5.6(40) µm respectively. The chalcocite layer was dramatically thinner in the six month long-term cooling run (EBS-16) with a depth of only 2.6(13) µm.

The thickness of the chalcocite layer generally correlated with the amount of pitting corrosion the Cu foil had undergone. The initial overall thicknesses of the copper foils is ~ 63 µm. The short term isothermal experiments in both bentonite and opalinus clay yielded similar average pit corrosion, 13.5(63) µm and 13.1(58) µm respectively. The ramped experiment (EBS-4) incurred less corrosion, having an average pit depth of only 5.7(22) µm. The most significant result comes from the six month experiment. The average pit depth of EBS-16 was 4.3(14) µm, which is similar to that of EBS-4, but sustained over a much longer period of time. These average corrosion depths were determined from corrosion pitting occurring on the exterior surfaces of the rolled copper foil. The surfaces within the rolled copper foil were protected from the brine and thus did not suffer significantly from either chloride or sulfide attack.

Table 6 Copper corrosion rate data. Note that the EBS-16 (6 month experiment) corrosion rate is an order of magnitude lower than the other 3 experiments (5-6 week run time). The longer run time experiment likely formed complete coverage of chalcocite over the copper and passivated the reaction.

Experiment	Components	Temperature (K)	Duration (days)	Average Chalcocite Thickness (Microns)	Average Corrosion Pit Depth (Microns)	Average Corrosion rate (Microns/day)
EBS4 RLM	Cu + Bentonite	25/100/200/300/25	5 weeks/35 days	2.5(10)	4.2(16)	0.12(4)
EBS4 SEM	Cu + Bentonite	25/100/200/300/25	5 weeks/35 days	3.5(15)	6.7(20)	0.19(6)
EBS4 All	Cu + Bentonite	25/100/200/300/25	5 weeks/35 days	3.0(13)	5.7(22)	0.16(6)
EBS11 RLM	Cu + Bentonite	300	6 weeks/42 days	6.1(37)	10.0(38)	0.24(9)
EBS11 SEM	Cu + Bentonite	300	6 weeks/42 days	9.8(38)	16.3(65)	0.39(15)
EBS11 All	Cu + Bentonite	300	6 weeks/42 days	8.2(42)	13.5(63)	0.32(15)
EBS16 RLM	Cu + Bentonite	300 to 120	6 months/180 days	2.0(7)	4.3(13)	0.024(7)
EBS16 SEM	Cu + Bentonite	301 to 120	6 months/180 days	2.9(14)	4.2(15)	0.023(9)
EBS 16 All	Cu + Bentonite	302 to 120	6 months/180 days	2.6(13)	4.3(14)	0.024(8)
EBS17 RLM	Cu + Opalinus	300	6 weeks/42 days	4.0(26)	12.0(54)	0.29(13)
EBS17 SEM	Cu + Opalinus	300	6 weeks/42 days	7.3(45)	13.8(59)	0.32(14)
EBS17 All	Cu + Opalinus	300	6 weeks/42 days	5.6(40)	13.1(58)	0.31(14)

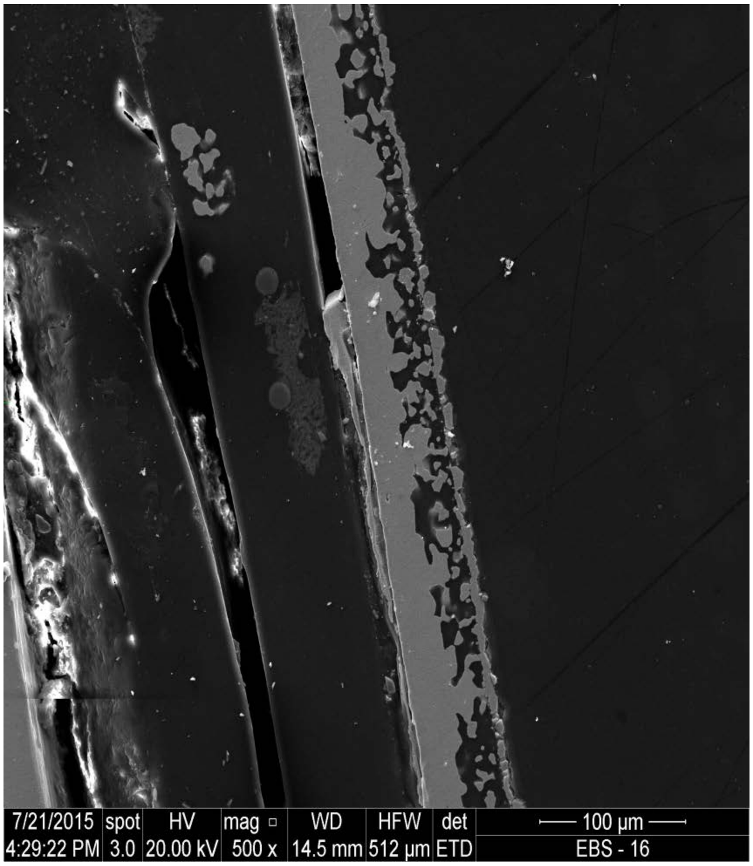


Figure 14 Experiment EBS-17. Note that pit corrosion of this copper foil has progressed to nearly 50% of the total thickness of the sample.

The corrosion rates listed in Table 6 were determined by dividing the average corrosion pit depth by the number of days in the run. Table 6 was compiled from over 850 data points. The corrosion rates from the two isothermal experiments on bentonite and Opalinus Clay were within experimental error of each other and the highest measured. The corrosion of the Cu mixed with Opalinus Clay exhibited several regions of extreme corrosion (Figure14). These parts of the copper foil were corroded fifty percent or more and show deep channeling in the Cu foil. The corrosion rate for the five week ramped experiment (EBS-4) was half that of the isothermal experiments, 0.16(6) µm/day for the ramped versus ~ 0.31 µm/day for the isothermal experiments. The six month long-term cooling experiment had a much smaller average corrosion rate of 0.024(8) µm/day. This is consistent with the reduced corrosion found in the long term experiment.

The nature of corrosion pitting in the copper foils was similar for all experiments. The average aspect ratio of the width to the depth of the corrosion pits found in the experiment with the least corrosion, the six month extended cooling run, was 1.4(9). The run with the most corrosion, the six week Opalinus Clay run, had a nearly identical aspect ratio of 1.3(8). The similarity of these aspect ratios indicates that although more rapid corrosion is occurring during the six week experiment, the pit shapes are unaffected by rate and retain the same nature regardless of the amount of corrosion the copper foil has undergone. A wide variety of corrosion pit structures exist, but extremely deep corrosion pits are just as common as shallow wide ones.

6. CONCLUSIONS

This document summarizes the last four years of experiments and attempts to compile pertinent 1) SEM images, 2) electron microprobe data for major mineral phases, and 3) aqueous geochemistry data from both starting materials and the 17 major experiments conducted so far into one source. There is also a discussion of more recent characterization results and interpretation of copper corrosion rates.

6.1 Major concepts developed so far include:

1) illitization of smectites may be restricted due to the bulk chemistry of the overall system,

2) pyrite within bentonite that may be used as backfill reacts readily in groundwater and the resulting H_2S(aq,g) reacts in a minor fashion with steel and aggressively with copper,

3) bentonite heated to 300°C in a dry environment has very restricted reactivity,

4) Experiments held at 300°C for 4 months and then stepped down in temperature over two more months exhibit no discernable retrograde reactions. This may well be due to kinetic effects of metastable phases.

5) the interface between bentonite and steel develops a well characterized new mineral phase, Fe-saponite (especially at 300°C), that grows perpendicular to the steel surface,

6) Another Fe layered phyllosilicate, stilpnomelane, grows in the presence on native iron (one of our solid buffer materials), which alludes to the idea that oxygen fugacity may be quite variable, depending on scale,

7) Zeolites transform as temperature increases. Mine run bentonite contains clinoptilolite, and transforms to analcime at higher temperature, releasing both SiO_2 and water. Opalinus Clay upon heating develops wairakite along cracks and edges. The location of these new growth zeolites is due to the impermeable nature of the shale. Mixtures of Opalinus Clay and Colony bentonite produce an intermediate composition Analcime-Wairakite solid solution phase, indicating ease of cation exchange for this zeolite.

8) Pit corrosion is the driving force in copper degradation. The copper reacts with H_2S(aq,g) to produce chalcocite and covellite. At latter times in the reaction pathway Cl may combine with copper to produce atacamite.

9) Systematic measurements (N>850) of copper corrosion cross sections have determined corrosion reaction rates at experimental temperatures and pressures. At 6 week duration, corrosion rates ranged from 0.12 to 0.39 micron/day, depending on heating profiles and bulk composition. However, in the 6 month experiment, the corrosion rate dropped by an order of magnitude, to 0.024 micron/day. We believe that complete coverage by the reaction product chalcocite pacifies the corrosion reaction.

This database, along with summary conclusions will be of use to other experimental teams on the DOE complex, system modeler, and the international repository science community.

Further research is needed in the following areas:

- Corrosion of steels and copper must be the focus of the upcoming year

- Provide further information on complete repository thermal pulse event, using long term (6 month) experiments with and without host rocks.
- Performed detailed geochemical modeling of F13-FY15 experimental reactions
- International FEBEX-DP – hydrothermal treatment of FEBEX samples expanding the thermal range in addition to routine mineral/geochemical interrogations.
- Perform transmission electron microscope (TEM) investigation looking at very local chemical changes in at a single metal surface.
- Purify mineral phases for thermodynamic investigations using solution calorimetry

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APPENDIX A:

SEM/BSE Images
Separate Document

APPENDIX B:

Electron Microprobe Standards and Detection Limits

EMP standards and oxide detection limits for silicate analyses

Element	Standard Material	Minimum Detection Limit[a]
Mg	Synthetic Phlogopite	0.02
F	Synthetic Phlogopite	0.11
Na	Albite (Amelia, NC, U.S.A, Rutherford Mine)	0.02
Al	Labradorite (Chihuahua, Mexico)	0.02
Si	Labradorite (Chihuahua, Mexico)	0.02
Ca	Labradorite (Chihuahua, Mexico)	0.01
Cl	Tugtupite (Greenland)	0.01
K	Adularia (St. Gotthard, Switzerland)	0.01
Ti	Titanite glass (Penn State)	0.02
Cr	Synthetic Magnesio-chromite	0.04
Mn	Rhodonite (unknown locality)	0.02
Fe	Augite (unknown locality)	0.02
Ni	Synthetic Liebenbergite	0.06
Zn	Gahnite	0.05

[a] Minimum Detection Limit (MDL) values for oxides of respective elements

APPENDIX B:
Electron Microprobe Mineral Chemistry

Biotite

	Weight Percent Components														
Label	**SiO_2**	**TiO_2**	**Al_2O_3**	**Cr_2O_3**	**FeO***	**MnO**	**MgO**	**NiO**	**ZnO**	**CaO**	**Na_2O**	**K_2O**	**F**	**Cl**	**Total**
	Atoms per Formula Unit (sum excludes F&Cl)														
	Si	**Ti**	**Al**	**Cr**	**Fe**	**Mn**	**Mg**	**Ni**	**Zn**	**Ca**	**Na**	**K**	**F**	**Cl**	**Sum**
Biotite															
MR-Bentonite															
MRBENT-Bt1-1	36.26	4.38	13.06	0.00	25.87	0.25	7.44	0.00	0.07	0.03	0.41	8.47	0.53	0.22	97.00
MRBENT-Bt1-2	36.40	4.38	12.91	0.02	25.41	0.24	7.48	0.00	0.07	0.04	0.44	8.26	0.82	0.22	96.70
MRBENT-Bt1-3	36.29	4.48	12.87	0.00	25.65	0.25	7.70	0.00	0.04	0.02	0.40	8.46	0.39	0.23	96.80
Ave.	**36.32**	**4.41**	**12.95**	**0.01**	**25.65**	**0.25**	**7.54**	**0.00**	**0.06**	**0.03**	**0.42**	**8.40**	**0.58**	**0.22**	**96.83**
Std Dev	**0.06**	**0.05**	**0.08**	**0.01**	**0.19**	**0.00**	**0.11**	**0.00**	**0.01**	**0.01**	**0.02**	**0.10**	**0.18**	**0.01**	**0.13**
10 Oxygen + 2(OH,F,CL) Basis															
MRBENT-Bt1-1	3.11	0.28	1.32	0.00	1.85	0.02	0.95	0.00	0.00	0.00	0.07	0.93	0.14	0.03	8.54
MRBENT-Bt1-2	3.14	0.28	1.31	0.00	1.83	0.02	0.96	0.00	0.00	0.00	0.07	0.91	0.22	0.03	8.54
MRBENT-Bt1-3	3.11	0.29	1.30	0.00	1.84	0.02	0.98	0.00	0.00	0.00	0.07	0.92	0.10	0.03	8.52
Ave.	**3.12**	**0.28**	**1.31**	**0.00**	**1.84**	**0.02**	**0.97**	**0.00**	**0.00**	**0.00**	**0.07**	**0.92**	**0.16**	**0.03**	**8.53**
Std Dev	**0.02**	**0.00**	**0.01**	**0.00**	**0.01**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.05**	**0.00**	**0.01**
EBS-1															
EBS1-F1-Bt1-1	35.25	4.15	13.81	0.00	26.62	0.33	6.89	0.01	0.05	0.00	0.37	8.64	0.54	0.28	96.96
EBS1-F1-Bt1-2	35.08	4.26	13.95	0.00	26.63	0.33	6.86	0.01	0.06	0.01	0.32	8.59	0.41	0.30	96.83
EBS1-F1-Bt1-3	35.31	4.37	13.83	0.00	26.42	0.29	7.04	0.00	0.05	0.00	0.29	8.73	0.59	0.31	97.23
Ave.	**35.21**	**4.26**	**13.87**	**0.00**	**26.56**	**0.32**	**6.93**	**0.01**	**0.05**	**0.00**	**0.33**	**8.66**	**0.51**	**0.30**	**97.00**
Std Dev	**0.09**	**0.09**	**0.06**	**0.00**	**0.10**	**0.02**	**0.08**	**0.00**	**0.01**	**0.00**	**0.03**	**0.06**	**0.08**	**0.01**	**0.17**
10 Oxygen + 2(OH,F,CL) Basis															
EBS1-F1-Bt1-1	3.05	0.27	1.41	0.00	1.92	0.02	0.89	0.00	0.00	0.00	0.06	0.95	0.15	0.04	8.58
EBS1-F1-Bt1-2	3.03	0.28	1.42	0.00	1.92	0.02	0.88	0.00	0.00	0.00	0.05	0.95	0.11	0.04	8.56
EBS1-F1-Bt1-3	3.04	0.28	1.41	0.00	1.91	0.02	0.91	0.00	0.00	0.00	0.05	0.96	0.16	0.05	8.58
Ave.	**3.04**	**0.28**	**1.41**	**0.00**	**1.92**	**0.02**	**0.89**	**0.00**	**0.00**	**0.00**	**0.05**	**0.95**	**0.14**	**0.04**	**8.57**
Std Dev	**0.01**	**0.01**	**0.01**	**0.00**	**0.01**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.01**	**0.01**	**0.02**	**0.00**	**0.01**
EBS-2															
EBS2-F3-Bt1-1	36.30	4.68	13.17	0.00	25.32	0.30	7.81	0.03	0.08	0.03	0.41	7.95	0.55	0.21	96.83
EBS2-F3-Bt1-2	35.75	4.91	13.27	0.00	24.98	0.26	7.91	0.00	0.07	0.04	0.47	7.73	0.75	0.18	96.32
Ave.	**36.02**	**4.79**	**13.22**	**0.00**	**25.15**	**0.28**	**7.86**	**0.01**	**0.08**	**0.04**	**0.44**	**7.84**	**0.65**	**0.20**	**96.58**
Std Dev	**0.28**	**0.11**	**0.05**	**0.00**	**0.17**	**0.02**	**0.05**	**0.01**	**0.01**	**0.00**	**0.03**	**0.11**	**0.10**	**0.01**	**0.26**
10 Oxygen + 2(OH,F,CL) Basis															
EBS2-F3-Bt1-1	3.10	0.30	1.33	0.00	1.81	0.02	0.99	0.00	0.01	0.00	0.07	0.87	0.15	0.03	8.49
EBS2-F3-Bt1-2	3.08	0.32	1.35	0.00	1.80	0.02	1.01	0.00	0.00	0.00	0.08	0.85	0.21	0.03	8.51
Ave.	**3.09**	**0.31**	**1.34**	**0.00**	**1.80**	**0.02**	**1.00**	**0.00**	**0.00**	**0.00**	**0.07**	**0.86**	**0.18**	**0.03**	**8.50**
Std Dev	**0.01**	**0.01**	**0.01**	**0.00**	**0.00**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.03**	**0.00**	**0.01**
EBS-4															

Label	Weight Percent Components													
Label	SiO_2	TiO_2	Al_2O_3	Cr_2O_3	FeO*	MnO	MgO	NiO	ZnO	CaO	Na_2O	K_2O	F	Cl	Total
	Atoms per Formula Unit (sum excludes F&Cl)														
	Si	Ti	Al	Cr	Fe	Mn	Mg	Ni	Zn	Ca	Na	K	F	Cl	Sum
EBS4-Bt1-1	35.21	5.25	12.93	0.00	28.20	0.21	6.41	0.02	0.09	0.00	0.45	8.48	0.63	0.30	97.84
EBS4-Bt1-2	34.88	5.15	12.91	0.00	28.21	0.20	6.42	0.01	0.08	0.03	0.55	8.39	0.71	0.26	97.46
Ave.	**35.05**	**5.20**	**12.92**	**0.00**	**28.21**	**0.20**	**6.41**	**0.02**	**0.08**	**0.02**	**0.50**	**8.44**	**0.67**	**0.28**	**97.65**
Std Dev	**0.16**	**0.05**	**0.01**	**0.00**	**0.01**	**0.00**	**0.01**	**0.00**	**0.00**	**0.01**	**0.05**	**0.05**	**0.04**	**0.02**	**0.19**
10 Oxygen + 2(OH,F,CL) Basis															
EBS4-Bt1-1	2.78	0.31	1.20	0.00	1.86	0.01	0.75	0.00	0.01	0.00	0.07	0.86	0.16	0.04	7.86
EBS4-Bt1-2	2.77	0.31	1.21	0.00	1.88	0.01	0.76	0.00	0.00	0.00	0.09	0.85	0.18	0.03	7.89
Ave.	**2.78**	**0.31**	**1.21**	**0.00**	**1.87**	**0.01**	**0.76**	**0.00**	**0.00**	**0.00**	**0.08**	**0.85**	**0.17**	**0.04**	**7.88**
Std Dev	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.00**	**0.01**	**0.00**	**0.01**
EBS-5															
EBS5-F1-Bt1-1	35.75	5.19	12.42	0.01	28.54	0.22	5.08	0.01	0.06	0.00	0.38	8.55	0.55	0.30	97.05
EBS5-F1-Bt1-2	35.00	5.07	12.44	0.00	28.50	0.22	5.08	0.00	0.03	0.03	0.35	8.47	0.53	0.31	96.03
EBS5-F1-Bt1-3	35.52	5.22	12.57	0.00	28.70	0.22	5.16	0.00	0.06	0.00	0.41	8.49	0.60	0.30	97.25
EBS5-F2-Bt-1	34.74	5.19	12.92	0.00	27.06	0.22	6.21	0.01	0.05	0.01	0.32	8.48	0.55	0.28	96.03
EBS5-F2-Bt-2	35.33	5.06	12.99	0.00	27.17	0.23	6.25	0.01	0.08	0.03	0.37	8.54	0.51	0.28	96.85
Ave.	**35.27**	**5.15**	**12.67**	**0.00**	**27.99**	**0.22**	**5.55**	**0.01**	**0.06**	**0.01**	**0.37**	**8.50**	**0.55**	**0.30**	**96.64**
Std Dev	**0.36**	**0.07**	**0.24**	**0.00**	**0.72**	**0.00**	**0.55**	**0.00**	**0.02**	**0.01**	**0.03**	**0.03**	**0.03**	**0.01**	**0.52**
10 Oxygen + 2(OH,F,CL) Basis															
EBS5-F1-Bt1-1	3.12	0.34	1.28	0.00	2.08	0.02	0.66	0.00	0.00	0.00	0.06	0.95	0.15	0.05	8.51
EBS5-F1-Bt1-2	3.09	0.34	1.29	0.00	2.10	0.02	0.67	0.00	0.00	0.00	0.06	0.95	0.15	0.05	8.53
EBS5-F1-Bt1-3	3.10	0.34	1.29	0.00	2.09	0.02	0.67	0.00	0.00	0.00	0.07	0.94	0.17	0.04	8.53
EBS5-F2-Bt-1	3.05	0.34	1.34	0.00	1.98	0.02	0.81	0.00	0.00	0.00	0.05	0.95	0.15	0.04	8.54
EBS5-F2-Bt-2	3.06	0.33	1.33	0.00	1.97	0.02	0.81	0.00	0.01	0.00	0.06	0.94	0.14	0.04	8.54
Ave.	**3.08**	**0.34**	**1.31**	**0.00**	**2.05**	**0.02**	**0.72**	**0.00**	**0.00**	**0.00**	**0.06**	**0.95**	**0.15**	**0.04**	**8.53**
Std Dev	**0.02**	**0.00**	**0.02**	**0.00**	**0.06**	**0.00**	**0.07**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.00**	**0.01**
EBS-6															
EBS6-F1-Bt1	35.69	5.35	13.27	0.01	27.21	0.21	6.27	0.02	0.10	0.01	0.47	8.35	0.69	0.26	97.89
EBS6-F1-Bt1-2	35.37	5.35	13.43	0.00	27.02	0.20	6.38	0.00	0.02	0.02	0.45	8.06	0.72	0.30	97.32
EBS6-F2-Bt2-1	35.07	5.45	13.21	0.00	27.35	0.20	6.23	0.00	0.07	0.02	0.36	8.42	0.75	0.25	97.38
EBS6-F2-Bt2-2	35.32	5.47	12.98	0.00	27.05	0.21	6.03	0.00	0.03	0.03	0.35	8.32	0.59	0.25	96.65
Ave.	**35.36**	**5.41**	**13.22**	**0.00**	**27.16**	**0.20**	**6.23**	**0.01**	**0.06**	**0.02**	**0.41**	**8.29**	**0.69**	**0.27**	**97.31**
Std Dev	**0.22**	**0.06**	**0.16**	**0.00**	**0.13**	**0.01**	**0.13**	**0.01**	**0.03**	**0.01**	**0.05**	**0.13**	**0.06**	**0.02**	**0.44**
10 Oxygen + 2(OH,F,CL) Basis															
EBS6-F1-Bt1	3.07	0.35	1.34	0.00	1.95	0.02	0.80	0.00	0.01	0.00	0.08	0.91	0.19	0.04	8.53
EBS6-F1-Bt1-2	3.05	0.35	1.37	0.00	1.95	0.01	0.82	0.00	0.00	0.00	0.07	0.89	0.20	0.04	8.52
EBS6-F2-Bt2-1	3.04	0.36	1.35	0.00	1.98	0.01	0.81	0.00	0.00	0.00	0.06	0.93	0.20	0.04	8.55
EBS6-F2-Bt2-2	3.07	0.36	1.33	0.00	1.97	0.02	0.78	0.00	0.00	0.00	0.06	0.92	0.16	0.04	8.50
Ave.	**3.06**	**0.35**	**1.35**	**0.00**	**1.96**	**0.01**	**0.80**	**0.00**	**0.00**	**0.00**	**0.07**	**0.91**	**0.19**	**0.04**	**8.52**
Std Dev	**0.01**	**0.01**	**0.01**	**0.00**	**0.01**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.01**	**0.02**	**0.02**	**0.00**	**0.02**

	Weight Percent Components														
Label	**SiO_2**	**TiO_2**	**Al_2O_3**	**Cr_2O_3**	**FeO***	**MnO**	**MgO**	**NiO**	**ZnO**	**CaO**	**Na_2O**	**K_2O**	**F**	**Cl**	**Total**
	Atoms per Formula Unit (sum excludes F&Cl)														
	Si	**Ti**	**Al**	**Cr**	**Fe**	**Mn**	**Mg**	**Ni**	**Zn**	**Ca**	**Na**	**K**	**F**	**Cl**	**Sum**
EBS-7															
EBS7-Bt1-1	35.36	5.10	13.26	0.00	27.84	0.19	6.38	0.02	0.02	0.03	0.57	8.40	0.82	0.27	97.85
EBS7-Bt1-2	36.03	4.89	13.21	0.01	27.31	0.20	6.24	0.00	0.06	0.02	0.65	8.16	0.82	0.27	97.47
Ave.	**35.69**	**4.99**	**13.23**	**0.00**	**27.58**	**0.20**	**6.31**	**0.01**	**0.04**	**0.03**	**0.61**	**8.28**	**0.82**	**0.27**	**97.66**
Std Dev	**0.33**	**0.10**	**0.02**	**0.00**	**0.26**	**0.00**	**0.07**	**0.01**	**0.02**	**0.00**	**0.04**	**0.12**	**0.00**	**0.00**	**0.19**
10 Oxygen + 2(OH,F,CL) Basis															
EBS7-Bt1-1	2.79	0.30	1.23	0.00	1.84	0.01	0.75	0.00	0.00	0.00	0.09	0.85	0.20	0.04	7.87
EBS7-Bt1-2	2.84	0.29	1.23	0.00	1.80	0.01	0.73	0.00	0.00	0.00	0.10	0.82	0.21	0.04	7.83
Ave.	**2.82**	**0.30**	**1.23**	**0.00**	**1.82**	**0.01**	**0.74**	**0.00**	**0.00**	**0.00**	**0.09**	**0.83**	**0.21**	**0.04**	**7.85**
Std Dev	**0.02**	**0.01**	**0.00**	**0.00**	**0.02**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.01**	**0.01**	**0.00**	**0.00**	**0.02**
EBS-9															
EBS9-Bt1-1	38.58	3.92	14.64	0.00	22.65	0.19	7.50	0.00	0.04	0.07	0.59	7.12	0.49	0.23	95.77
EBS9-Bt1-2	37.07	4.22	13.78	0.01	23.81	0.22	7.44	0.01	0.10	0.13	0.38	7.54	0.45	0.23	95.15
Ave.	**37.82**	**4.07**	**14.21**	**0.00**	**23.23**	**0.21**	**7.47**	**0.00**	**0.07**	**0.10**	**0.49**	**7.33**	**0.47**	**0.23**	**95.46**
Std Dev	**0.75**	**0.15**	**0.43**	**0.00**	**0.58**	**0.02**	**0.03**	**0.00**	**0.03**	**0.03**	**0.10**	**0.21**	**0.02**	**0.00**	**0.31**
10 Oxygen + 2(OH,F,CL) Basis															
EBS9-Bt1-1	2.96	0.23	1.32	0.00	1.45	0.01	0.86	0.00	0.00	0.01	0.09	0.70	0.12	0.03	7.62
EBS9-Bt1-2	2.90	0.25	1.27	0.00	1.56	0.01	0.87	0.00	0.01	0.01	0.06	0.75	0.11	0.03	7.69
Ave.	**2.93**	**0.24**	**1.30**	**0.00**	**1.51**	**0.01**	**0.86**	**0.00**	**0.00**	**0.01**	**0.07**	**0.72**	**0.12**	**0.03**	**7.66**
Std Dev	**0.03**	**0.01**	**0.03**	**0.00**	**0.05**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.01**	**0.03**	**0.00**	**0.00**	**0.03**
EBS-10															
EBS10-Bt-1	34.81	5.20	12.85	0.00	28.07	0.20	6.46	0.00	0.07	0.03	0.57	8.47	0.68	0.26	97.33
EBS10-Bt-2	34.99	5.06	12.97	0.00	28.08	0.21	6.51	0.00	0.05	0.03	0.61	8.43	0.60	0.27	97.49
EBS10-Bt2-1	35.60	5.03	12.92	0.00	27.56	0.21	6.48	0.01	0.07	0.01	0.48	8.47	0.61	0.25	97.38
EBS10-Bt2-2	34.69	4.93	12.82	0.01	27.01	0.18	6.43	0.00	0.07	0.04	0.57	8.08	0.60	0.25	95.36
Ave.	**35.02**	**5.05**	**12.89**	**0.00**	**27.68**	**0.20**	**6.47**	**0.00**	**0.06**	**0.03**	**0.56**	**8.36**	**0.62**	**0.26**	**96.89**
Std Dev	**0.35**	**0.10**	**0.06**	**0.01**	**0.44**	**0.01**	**0.03**	**0.01**	**0.01**	**0.01**	**0.05**	**0.16**	**0.03**	**0.01**	**0.89**
10 Oxygen + 2(OH,F,CL) Basis															
EBS10-Bt-1	2.77	0.31	1.21	0.00	1.87	0.01	0.77	0.00	0.00	0.00	0.09	0.86	0.17	0.03	7.89
EBS10-Bt-2	2.77	0.30	1.21	0.00	1.86	0.01	0.77	0.00	0.00	0.00	0.09	0.85	0.15	0.04	7.89
EBS10-Bt2-1	2.81	0.30	1.20	0.00	1.82	0.01	0.76	0.00	0.00	0.00	0.07	0.85	0.15	0.03	7.84
EBS10-Bt2-2	2.80	0.30	1.22	0.00	1.82	0.01	0.77	0.00	0.00	0.00	0.09	0.83	0.15	0.03	7.85
Ave.	**2.79**	**0.30**	**1.21**	**0.00**	**1.84**	**0.01**	**0.77**	**0.00**	**0.00**	**0.00**	**0.09**	**0.85**	**0.16**	**0.03**	**7.87**
Std Dev	**0.02**	**0.01**	**0.01**	**0.00**	**0.02**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.01**	**0.01**	**0.00**	**0.02**
EBS-11															
EBS11-Bt-1	36.65	4.17	13.43	0.00	25.16	0.22	7.36	0.01	0.10	0.04	0.49	8.17	0.70	0.23	96.38
EBS11-Bt-2	36.52	4.24	13.52	0.00	25.63	0.26	7.40	0.01	0.05	0.03	0.56	8.25	0.60	0.24	97.01

	Weight Percent Components														
Label	SiO_2	TiO_2	Al_2O_3	Cr_2O_3	FeO*	MnO	MgO	NiO	ZnO	CaO	Na_2O	K_2O	F	Cl	Total
	Atoms per Formula Unit (sum excludes F&Cl)														
	Si	Ti	Al	Cr	Fe	Mn	Mg	Ni	Zn	Ca	Na	K	F	Cl	Sum
Average	36.59	4.20	13.47	0.00	25.39	0.24	7.38	0.01	0.07	0.04	0.52	8.21	0.65	0.23	96.70
Std Dev	0.06	0.03	0.05	0.00	0.23	0.02	0.02	0.00	0.02	0.00	0.04	0.04	0.05	0.01	0.32
10 Oxygen + 2(OH,F,CL) Basis															
EBS11-Bt-1	3.96	0.01	1.65	0.00	2.70	0.01	0.52	0.00	0.00	0.13	0.46	0.02	0.00	0.00	9.45
EBS11-Bt-2	3.99	0.00	1.60	0.00	2.71	0.01	0.54	0.00	0.00	0.12	0.47	0.02	0.00	0.02	9.46
Average	3.97	0.00	1.62	0.00	2.71	0.01	0.53	0.00	0.00	0.13	0.46	0.02	0.00	0.01	9.46
Std Dev	0.02	0.00	0.02	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
EBS-12															
EBS12-Bt1-1	35.65	4.44	12.72	0.01	25.85	0.29	7.99	0.00	0.06	0.04	0.39	8.57	0.71	0.22	96.58
EBS12-Bt1-2	35.56	4.38	13.12	0.00	25.35	0.28	8.14	0.00	0.07	0.06	0.38	8.29	0.74	0.24	96.24
Average	35.61	4.41	12.92	0.01	25.60	0.28	8.06	0.00	0.07	0.05	0.38	8.43	0.72	0.23	96.41
Std Dev	0.04	0.03	0.20	0.01	0.25	0.01	0.07	0.00	0.00	0.01	0.01	0.14	0.02	0.01	0.17
10 Oxygen + 2(OH,F,CL) Basis															
EBS12-Bt1-1	2.82	0.26	1.19	0.00	1.71	0.02	0.94	0.00	0.00	0.00	0.06	0.87	0.18	0.02	7.88
EBS12-Bt1-2	2.82	0.26	1.23	0.00	1.68	0.02	0.96	0.00	0.00	0.00	0.06	0.84	0.19	0.02	7.87
Average	2.82	0.26	1.21	0.00	1.70	0.02	0.95	0.00	0.00	0.00	0.06	0.85	0.18	0.02	7.87
Std Dev	0.00	0.00	0.02	0.00	0.02	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01
EBS-13															
EB13-Bt-1	35.02	4.09	13.61	0.01	26.29	0.33	7.56	0.00	0.08	0.04	0.30	8.58	0.72	0.22	96.50
EB13-Bt-2	35.41	5.02	13.34	0.00	27.78	0.21	6.24	0.03	0.08	0.00	0.45	8.57	0.77	0.30	97.81
EB13-Bt-3	35.44	4.87	13.49	0.00	27.81	0.20	6.31	0.02	0.09	0.00	0.43	8.61	0.70	0.29	97.90
Average	**35.29**	**4.66**	**13.48**	**0.00**	**27.29**	**0.25**	**6.70**	**0.01**	**0.08**	**0.02**	**0.39**	**8.59**	**0.73**	**0.27**	**97.41**
Std Dev	**0.24**	**0.50**	**0.14**	**0.00**	**0.87**	**0.07**	**0.74**	**0.01**	**0.00**	**0.02**	**0.08**	**0.02**	**0.04**	**0.04**	**0.78**
10 Oxygen + 2(OH,F,CL) Basis															
EB13-Bt-1	2.78	0.24	1.28	0.00	1.75	0.02	0.90	0.00	0.00	0.00	0.05	0.87	0.18	0.03	7.90
EB13-Bt-2	2.80	0.30	1.24	0.00	1.84	0.01	0.74	0.00	0.00	0.00	0.07	0.86	0.19	0.04	7.86
EB13-Bt-3	2.79	0.29	1.25	0.00	1.83	0.01	0.74	0.00	0.01	0.00	0.06	0.87	0.18	0.04	7.86
Average	**2.79**	**0.28**	**1.26**	**0.00**	**1.81**	**0.02**	**0.79**	**0.00**	**0.00**	**0.00**	**0.06**	**0.87**	**0.18**	**0.04**	**7.87**
Std Dev	**0.01**	**0.03**	**0.02**	**0.00**	**0.05**	**0.00**	**0.09**	**0.00**	**0.00**	**0.00**	**0.01**	**0.00**	**0.01**	**0.01**	**0.02**
EBS-15															
EB15-Bt-1	34.71	4.08	13.27	0.02	25.60	0.27	7.40	0.00	0.02	0.02	0.29	8.53	0.44	0.23	94.66
EB15-Bt-2	35.06	4.13	13.56	0.01	25.48	0.28	7.51	0.00	0.08	0.02	0.32	8.56	0.31	0.24	95.39
EB15-Bt-3	35.07	3.70	13.48	0.00	26.87	0.41	6.88	0.02	0.10	0.04	0.29	8.54	0.82	0.29	96.08
Average	**34.94**	**3.97**	**13.44**	**0.01**	**25.99**	**0.32**	**7.26**	**0.01**	**0.07**	**0.03**	**0.30**	**8.54**	**0.53**	**0.25**	**95.38**
Std Dev	**0.21**	**0.24**	**0.15**	**0.01**	**0.77**	**0.08**	**0.34**	**0.01**	**0.04**	**0.01**	**0.02**	**0.01**	**0.27**	**0.03**	**0.71**
10 Oxygen + 2(OH,F,CL) Basis															
EB15-Bt-1	2.80	0.25	1.26	0.00	1.72	0.02	0.89	0.00	0.00	0.00	0.05	0.88	0.11	0.03	7.86

	Weight Percent Components														
Label	**SiO_2**	**TiO_2**	**Al_2O_3**	**Cr_2O_3**	**FeO***	**MnO**	**MgO**	**NiO**	**ZnO**	**CaO**	**Na_2O**	**K_2O**	**F**	**Cl**	**Total**
	Atoms per Formula Unit (sum excludes F&Cl)														
	Si	**Ti**	**Al**	**Cr**	**Fe**	**Mn**	**Mg**	**Ni**	**Zn**	**Ca**	**Na**	**K**	**F**	**Cl**	**Sum**
EB15-Bt-2	2.79	0.25	1.27	0.00	1.70	0.02	0.89	0.00	0.00	0.00	0.05	0.87	0.08	0.03	7.84
EB15-Bt-3	2.82	0.22	1.28	0.00	1.81	0.03	0.82	0.00	0.01	0.00	0.04	0.88	0.21	0.04	7.90
Average	**2.80**	**0.24**	**1.27**	**0.00**	**1.74**	**0.02**	**0.87**	**0.00**	**0.00**	**0.00**	**0.05**	**0.87**	**0.13**	**0.03**	**7.87**
Std Dev	**0.01**	**0.01**	**0.01**	**0.00**	**0.06**	**0.01**	**0.04**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.07**	**0.00**	**0.03**
EB-16															
EB16-Bt-1	35.43	3.99	13.47	0.02	25.67	0.28	7.73	0.02	0.10	0.04	0.30	8.77	0.49	0.23	96.29
EB16-Bt-2	34.25	4.45	13.96	0.00	25.11	0.27	7.78	0.02	0.05	0.00	0.24	8.46	0.58	0.24	95.11
Average	**34.84**	**4.22**	**13.72**	**0.01**	**25.39**	**0.27**	**7.76**	**0.02**	**0.08**	**0.02**	**0.27**	**8.61**	**0.53**	**0.24**	**95.70**
Std Dev	**0.83**	**0.32**	**0.35**	**0.01**	**0.40**	**0.01**	**0.03**	**0.00**	**0.03**	**0.03**	**0.05**	**0.22**	**0.06**	**0.01**	**0.83**
10 Oxygen + 2(OH,F,CL) Basis															
EB16-Bt-1	2.80	0.24	1.26	0.00	1.70	0.02	0.91	0.00	0.01	0.00	0.05	0.89	0.12	0.03	7.87
EB16-Bt-2	2.74	0.27	1.32	0.00	1.68	0.02	0.93	0.00	0.00	0.00	0.04	0.86	0.15	0.03	7.87
Average	**2.77**	**0.25**	**1.29**	**0.00**	**1.69**	**0.02**	**0.92**	**0.00**	**0.00**	**0.00**	**0.04**	**0.87**	**0.13**	**0.03**	**7.87**
Std Dev	**0.04**	**0.02**	**0.04**	**0.00**	**0.01**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.01**	**0.01**	**0.02**	**0.00**	**0.00**
EB-17															
EB17-Bt-1	34.46	4.62	13.30	0.01	26.89	0.24	7.23	0.00	0.08	0.03	0.31	8.51	0.78	0.22	96.30
EB17-Bt-2	34.87	4.88	13.05	0.00	27.36	0.21	6.20	0.00	0.05	0.03	0.33	8.49	0.57	0.30	96.03
Average	**34.66**	**4.75**	**13.17**	**0.01**	**27.12**	**0.23**	**6.72**	**0.00**	**0.07**	**0.03**	**0.32**	**8.50**	**0.67**	**0.26**	**96.17**
Std Dev	**0.29**	**0.18**	**0.17**	**0.01**	**0.33**	**0.02**	**0.72**	**0.00**	**0.02**	**0.00**	**0.02**	**0.01**	**0.15**	**0.05**	**0.19**
10 Oxygen + 2(OH,F,CL) Basis															
EB17-Bt-1	2.76	0.28	1.26	0.00	1.80	0.02	0.86	0.00	0.00	0.00	0.05	0.87	0.20	0.02	7.90
EB17-Bt-2	2.80	0.29	1.23	0.00	1.84	0.01	0.74	0.00	0.00	0.00	0.05	0.87	0.14	0.02	7.84
Average	**2.78**	**0.29**	**1.25**	**0.00**	**1.82**	**0.02**	**0.80**	**0.00**	**0.00**	**0.00**	**0.05**	**0.87**	**0.17**	**0.02**	**7.87**
Std Dev	**0.03**	**0.01**	**0.02**	**0.00**	**0.02**	**0.00**	**0.09**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.04**	**0.00**	**0.04**

APPENDIX B:
Electron Microprobe Mineral Chemistry

Chlorite/Saponite
Stipnomelane

CHLORITE / SAPONITE														
	Weight Percent Components													
Label	**SiO_2**	**TiO_2**	**Al_2O_3**	**Cr_2O_3**	**FeO***	**MnO**	**MgO**	**NiO**	**ZnO**	**CaO**	**Na_2O**	**K_2O**	**F**	**Cl**	**Total**
	Atoms per Formula Unit (sum excludes F&Cl)														
	Si	**Ti**	**Al**	**Cr**	**Fe**	**Mn**	**Mg**	**Ni**	**Zn**	**Ca**	**Na**	**K**	**F**	**Cl**	**Sum**
Chlorites (03/12/13)															
EBS-2															
EBS2 Chl-2	32.53	0.08	13.68	2.74	27.98	0.30	2.16	2.16	0.04	1.90	1.46	0.79	0.28	0.41	86.51
EBS2 Chl-4	30.66	0.00	12.22	0.48	35.91	0.37	2.19	0.86	0.03	1.24	1.47	0.67	0.09	0.95	87.16
EBS2 Chl-7	29.58	0.01	11.64	3.48	34.91	0.68	1.57	2.60	0.01	0.03	1.26	0.07	0.12	0.37	86.34
EBS2 Chl-8	37.59	0.01	12.03	0.28	29.34	0.29	2.39	0.33	0.03	1.66	1.93	0.63	0.00	0.36	86.88
EBS2 Chl-10	37.07	0.03	13.87	0.44	29.33	0.31	1.75	0.49	0.00	1.67	1.72	0.91	0.12	0.20	87.90
EBS2 Chl-11	36.35	0.00	13.51	0.68	28.16	0.35	1.65	1.60	0.05	1.40	1.88	0.57	0.18	0.16	86.54
Average EBS-2	33.96	0.02	12.83	1.35	30.94	0.38	1.95	1.34	0.03	1.32	1.62	0.61	0.13	0.41	86.89
Std Dev	**3.48**	**0.03**	**0.97**	**1.39**	**3.53**	**0.15**	**0.34**	**0.93**	**0.02**	**0.67**	**0.27**	**0.29**	**0.09**	**0.29**	**0.58**
28 Oxygen Basis (10 oxygen + 8(OH)) (sum excludes F & Cl)															
EBS2 Chl-2	3.66	0.01	1.81	0.24	2.63	0.03	0.36	0.20	0.00	0.23	0.32	0.11	0.10	0.08	9.61
EBS2 Chl-4	3.58	0.00	1.68	0.04	3.50	0.04	0.38	0.08	0.00	0.16	0.33	0.10	0.03	0.19	9.89
EBS2 Chl-7	3.48	0.00	1.62	0.32	3.44	0.07	0.28	0.25	0.00	0.00	0.29	0.01	0.05	0.07	9.75
EBS2 Chl-8	4.07	0.00	1.54	0.02	2.66	0.03	0.39	0.03	0.00	0.19	0.40	0.09	0.00	0.07	9.42
EBS2 Chl-10	3.97	0.00	1.75	0.04	2.63	0.03	0.28	0.04	0.00	0.19	0.36	0.12	0.04	0.04	9.41
EBS2 Chl-11	3.97	0.00	1.74	0.06	2.57	0.03	0.27	0.14	0.00	0.16	0.40	0.08	0.06	0.03	9.42
Average EBS-2	**3.79**	**0.00**	**1.69**	**0.12**	**2.90**	**0.04**	**0.33**	**0.12**	**0.00**	**0.16**	**0.35**	**0.09**	**0.05**	**0.08**	**9.58**
Std Dev	**0.22**	**0.00**	**0.09**	**0.12**	**0.40**	**0.01**	**0.05**	**0.08**	**0.00**	**0.07**	**0.04**	**0.04**	**0.03**	**0.05**	**0.19**
Chl 18 Oxygen	4.87	0.00	2.17	0.16	3.74	0.05	0.42	0.16	0.00	0.20	0.45	0.11	0.06	0.10	12.32
EBS-5															
Good Points: Low-Iron Phase															
EBS5-Sil-1	53.24	0.12	16.53	0.09	5.64	0.04	2.00	0.14	0.01	1.11	0.34	0.59	0.13	0.04	80.02
EBS5-Sil-2	52.91	0.13	17.43	0.07	3.66	0.04	1.62	0.15	0.00	0.77	0.29	0.59	0.27	0.04	77.95
EBS5-Sil-3	54.33	0.08	17.14	0.09	3.63	0.03	1.68	0.15	0.03	0.68	0.36	0.61	0.02	0.04	78.86
EBS5-Sil-4	57.69	0.13	16.16	0.13	4.12	0.01	1.62	0.06	0.01	0.62	0.63	0.63	0.18	0.05	82.04
EBS5-Sil-5	60.13	0.12	14.90	0.12	3.25	0.02	1.45	0.06	0.00	0.69	0.71	0.82	0.05	0.05	82.35
EBS5-Sil-7	58.44	0.11	13.70	0.13	3.67	0.05	1.49	0.14	0.00	0.65	0.56	0.68	0.26	0.04	79.92
EBS5-Sil-8	63.84	0.00	7.32	0.54	7.70	0.12	1.48	0.33	0.02	0.66	0.33	0.15	0.19	0.03	82.71
EBS5-Sil-12	52.70	0.08	14.94	0.09	5.38	0.06	2.19	0.10	0.00	0.96	0.40	0.33	0.24	0.10	77.56
EBS5-Sil-13	46.83	0.11	21.19	0.31	7.13	0.04	2.61	0.11	0.00	0.97	0.61	0.52	0.18	0.13	80.74
EBS5-Sil-14	62.14	0.08	14.63	0.38	5.85	0.03	2.11	0.12	0.00	0.84	0.63	0.40	0.25	0.14	87.60

	Weight Percent Components														
Label	**SiO_2**	**TiO_2**	**Al_2O_3**	**Cr_2O_3**	**FeO***	**MnO**	**MgO**	**NiO**	**ZnO**	**CaO**	**Na_2O**	**K_2O**	**F**	**Cl**	**Total**
	Atoms per Formula Unit (sum excludes F&Cl)														
	Si	**Ti**	**Al**	**Cr**	**Fe**	**Mn**	**Mg**	**Ni**	**Zn**	**Ca**	**Na**	**K**	**F**	**Cl**	**Sum**
EBS5-Sil-15	46.05	0.09	20.53	0.35	9.61	0.07	3.21	0.16	0.00	1.60	0.73	0.29	0.14	0.26	83.07
EBS5-Sil-18	59.26	0.06	14.23	0.13	4.44	0.03	1.88	0.10	0.01	0.84	0.49	0.35	0.12	0.11	82.03
EBS5-Sil-19	62.40	0.06	12.58	0.16	3.19	0.02	1.39	0.10	0.03	0.71	0.42	0.42	0.08	0.08	81.66
EBS5-Sil-20	58.20	0.08	15.70	0.13	4.21	0.02	1.87	0.07	0.03	0.81	0.49	0.35	0.13	0.07	82.17
EBS5-Sil-22	63.02	0.05	14.42	0.20	4.75	0.04	1.35	0.11	0.00	0.64	0.76	1.21	0.12	0.03	86.71
EBS5-Sil-26	57.53	0.08	19.43	0.24	5.29	0.02	1.92	0.16	0.00	0.97	0.51	0.44	0.24	0.06	86.88
EBS5-Sil-30	65.94	0.05	10.02	0.07	2.34	0.00	1.21	0.05	0.00	0.54	0.53	0.33	0.19	0.11	81.37
EBS5-Sil-31	61.28	0.08	11.95	0.05	2.64	0.01	1.38	0.05	0.00	0.52	0.89	0.39	0.00	0.12	79.37
EBS5-Sil-32	62.01	0.08	10.80	0.07	2.37	0.03	1.27	0.04	0.01	0.54	0.39	0.36	0.25	0.10	78.31
EBS5-Sil-33	59.18	0.03	13.61	0.05	3.10	0.00	1.72	0.08	0.00	0.63	0.43	0.55	0.00	0.10	79.47
EBS5-Sil-34	62.16	0.04	11.12	0.08	2.44	0.00	1.32	0.07	0.01	0.53	0.41	0.46	0.12	0.09	78.85
EBS5-Sil-36	59.16	0.06	14.19	0.20	5.86	0.03	1.81	0.12	0.01	0.73	0.58	0.27	0.23	0.06	83.30
EBS5-Sil-38	56.78	0.11	12.81	0.13	5.36	0.04	1.56	0.10	0.00	0.74	0.58	0.31	0.08	0.09	78.68
Average	**58.05**	**0.08**	**14.58**	**0.17**	**4.59**	**0.03**	**1.75**	**0.11**	**0.01**	**0.77**	**0.52**	**0.48**	**0.15**	**0.08**	**81.38**
Std Dev	**5.10**	**0.03**	**3.31**	**0.12**	**1.84**	**0.03**	**0.47**	**0.06**	**0.01**	**0.24**	**0.15**	**0.22**	**0.09**	**0.05**	**2.83**
28 Oxygen Basis (10 oxygen + 8(OH)) (sum excludes F & Cl)															
EBS5-Sil-1	4.02	0.01	1.47	0.01	0.36	0.00	0.23	0.01	0.00	0.09	0.05	0.06	0.03	0.00	6.30
EBS5-Sil-2	4.05	0.01	1.57	0.00	0.23	0.00	0.18	0.01	0.00	0.06	0.04	0.06	0.06	0.01	6.23
EBS5-Sil-3	4.08	0.00	1.52	0.01	0.23	0.00	0.19	0.01	0.00	0.06	0.05	0.06	0.00	0.01	6.21
EBS5-Sil-4	4.19	0.01	1.38	0.01	0.25	0.00	0.18	0.00	0.00	0.05	0.09	0.06	0.04	0.01	6.21
EBS5-Sil-5	4.30	0.01	1.26	0.01	0.19	0.00	0.15	0.00	0.00	0.05	0.10	0.07	0.01	0.01	6.15
EBS5-Sil-7	4.34	0.01	1.20	0.01	0.23	0.00	0.17	0.01	0.00	0.05	0.08	0.06	0.06	0.00	6.16
EBS5-Sil-8	4.65	0.00	0.63	0.03	0.47	0.01	0.16	0.02	0.00	0.05	0.05	0.01	0.04	0.00	6.08
EBS5-Sil-12	4.11	0.00	1.37	0.01	0.35	0.00	0.25	0.01	0.00	0.08	0.06	0.03	0.06	0.01	6.28
EBS5-Sil-13	3.60	0.01	1.92	0.02	0.46	0.00	0.30	0.01	0.00	0.08	0.09	0.05	0.04	0.02	6.53
EBS5-Sil-14	4.27	0.00	1.18	0.02	0.34	0.00	0.22	0.01	0.00	0.06	0.08	0.03	0.05	0.02	6.22
EBS5-Sil-15	3.52	0.01	1.85	0.02	0.61	0.00	0.36	0.01	0.00	0.13	0.11	0.03	0.03	0.03	6.65
EBS5-Sil-18	4.29	0.00	1.21	0.01	0.27	0.00	0.20	0.01	0.00	0.06	0.07	0.03	0.03	0.01	6.16
EBS5-Sil-19	4.47	0.00	1.06	0.01	0.19	0.00	0.15	0.01	0.00	0.05	0.06	0.04	0.02	0.01	6.05
EBS5-Sil-20	4.21	0.00	1.34	0.01	0.25	0.00	0.20	0.00	0.00	0.06	0.07	0.03	0.03	0.01	6.19
EBS5-Sil-22	4.33	0.00	1.17	0.01	0.27	0.00	0.14	0.01	0.00	0.05	0.10	0.11	0.03	0.00	6.19
EBS5-Sil-26	3.99	0.00	1.59	0.01	0.31	0.00	0.20	0.01	0.00	0.07	0.07	0.04	0.05	0.01	6.29
EBS5-Sil-30	4.70	0.00	0.84	0.00	0.14	0.00	0.13	0.00	0.00	0.04	0.07	0.03	0.04	0.01	5.96
EBS5-Sil-31	4.50	0.00	1.03	0.00	0.16	0.00	0.15	0.00	0.00	0.04	0.13	0.04	0.00	0.02	6.06
EBS5-Sil-32	4.61	0.00	0.95	0.00	0.15	0.00	0.14	0.00	0.00	0.04	0.06	0.03	0.06	0.01	5.99

	Weight Percent Components														
Label	**SiO_2**	**TiO_2**	**Al_2O_3**	**Cr_2O_3**	**FeO***	**MnO**	**MgO**	**NiO**	**ZnO**	**CaO**	**Na_2O**	**K_2O**	**F**	**Cl**	**Total**
	Atoms per Formula Unit (sum excludes F&Cl)														
	Si	**Ti**	**Al**	**Cr**	**Fe**	**Mn**	**Mg**	**Ni**	**Zn**	**Ca**	**Na**	**K**	**F**	**Cl**	**Sum**
EBS5-Sil-33	4.37	0.00	1.18	0.00	0.19	0.00	0.19	0.00	0.00	0.05	0.06	0.05	0.00	0.01	6.10
EBS5-Sil-34	4.58	0.00	0.97	0.00	0.15	0.00	0.15	0.00	0.00	0.04	0.06	0.04	0.03	0.01	6.00
EBS5-Sil-36	4.27	0.00	1.21	0.01	0.35	0.00	0.19	0.01	0.00	0.06	0.08	0.02	0.05	0.01	6.21
EBS5-Sil-38	4.31	0.01	1.15	0.01	0.34	0.00	0.18	0.01	0.00	0.06	0.09	0.03	0.02	0.01	6.18
Average	**4.25**	**0.00**	**1.26**	**0.01**	**0.28**	**0.00**	**0.19**	**0.01**	**0.00**	**0.06**	**0.07**	**0.04**	**0.03**	**0.01**	**6.19**
Std Dev	**0.30**	**0.00**	**0.30**	**0.01**	**0.12**	**0.00**	**0.05**	**0.00**	**0.00**	**0.02**	**0.02**	**0.02**	**0.02**	**0.01**	**0.16**
EBS-6															
EBS6 Chl-4	36.90	0.00	11.97	0.02	33.99	0.22	0.81	0.01	0.00	0.53	1.12	0.43	0.05	0.09	86.13
EBS6 Chl-5	37.24	0.01	11.72	0.01	33.18	0.23	0.78	0.02	0.02	0.48	1.46	0.46	0.03	0.07	85.72
EBS6 Chl-6	35.18	0.01	12.26	0.03	33.11	0.22	0.84	0.00	0.02	0.50	1.53	0.34	0.00	0.01	84.04
EBS6 Chl-7	35.23	0.03	12.62	0.04	33.43	0.23	0.93	0.01	0.00	0.51	1.15	0.62	0.03	0.08	84.91
EBS6 Chl-9	35.83	0.00	13.42	0.00	33.26	0.20	0.83	0.00	0.00	0.84	0.64	0.15	0.00	0.01	85.18
EBS6 Chl-10	36.78	0.00	14.11	0.03	34.52	0.23	0.85	0.00	0.00	0.89	0.56	0.17	0.07	0.01	88.21
EBS6 Chl-11	35.67	0.00	13.31	0.00	35.10	0.21	0.81	0.01	0.00	0.85	0.72	0.17	0.00	0.02	86.87
EBS6 Chl-12	36.76	0.02	14.18	0.02	35.31	0.22	0.84	0.00	0.03	0.76	0.63	0.23	0.08	0.02	89.11
Average EBS-6	**36.20**	**0.01**	**12.95**	**0.02**	**33.99**	**0.22**	**0.83**	**0.01**	**0.01**	**0.67**	**0.98**	**0.32**	**0.03**	**0.04**	**86.27**
Std Dev	**0.81**	**0.01**	**0.95**	**0.01**	**0.89**	**0.01**	**0.04**	**0.01**	**0.01**	**0.18**	**0.39**	**0.17**	**0.03**	**0.03**	**1.71**
28 Oxygen Basis (10 oxygen + 8(OH)) (sum excludes F & Cl)															
EBS6 Chl-4	4.08	0.00	1.56	0.00	3.14	0.02	0.13	0.00	0.00	0.06	0.24	0.06	0.02	0.02	9.31
EBS6 Chl-5	4.12	0.00	1.53	0.00	3.07	0.02	0.13	0.00	0.00	0.06	0.31	0.06	0.01	0.01	9.31
EBS6 Chl-6	3.99	0.00	1.64	0.00	3.14	0.02	0.14	0.00	0.00	0.06	0.34	0.05	0.00	0.00	9.38
EBS6 Chl-7	3.97	0.00	1.68	0.00	3.15	0.02	0.16	0.00	0.00	0.06	0.25	0.09	0.01	0.02	9.37
EBS6 Chl-9	3.97	0.00	1.75	0.00	3.09	0.02	0.14	0.00	0.00	0.10	0.14	0.02	0.00	0.00	9.23
EBS6 Chl-10	3.95	0.00	1.79	0.00	3.10	0.02	0.14	0.00	0.00	0.10	0.12	0.02	0.02	0.00	9.24
EBS6 Chl-11	3.92	0.00	1.73	0.00	3.23	0.02	0.13	0.00	0.00	0.10	0.15	0.02	0.00	0.00	9.31
EBS6 Chl-12	3.93	0.00	1.79	0.00	3.15	0.02	0.13	0.00	0.00	0.09	0.13	0.03	0.03	0.00	9.28
Average EBS-6	**3.99**	**0.00**	**1.68**	**0.00**	**3.13**	**0.02**	**0.14**	**0.00**	**0.00**	**0.08**	**0.21**	**0.05**	**0.01**	**0.01**	**9.30**
Std Dev	**0.07**	**0.00**	**0.10**	**0.00**	**0.05**	**0.00**	**0.01**	**0.00**	**0.00**	**0.02**	**0.09**	**0.02**	**0.01**	**0.01**	0.06
EBS-7															
EBS7-Chl1-1	34.88	0.05	15.55	0.00	33.78	0.12	1.62	0.01	0.05	0.08	0.82	0.02	0.00	0.06	87.02
EBS7-Chl1-2	34.32	0.07	15.08	0.02	33.58	0.11	1.64	0.00	0.00	0.07	0.50	0.01	0.00	0.11	85.48

	Weight Percent Components														
Label	**SiO_2**	**TiO_2**	**Al_2O_3**	**Cr_2O_3**	**FeO***	**MnO**	**MgO**	**NiO**	**ZnO**	**CaO**	**Na_2O**	**K_2O**	**F**	**Cl**	**Total**
	Atoms per Formula Unit (sum excludes F&Cl)														
	Si	**Ti**	**Al**	**Cr**	**Fe**	**Mn**	**Mg**	**Ni**	**Zn**	**Ca**	**Na**	**K**	**F**	**Cl**	**Sum**
EBS7-Chl1-3	32.39	0.05	14.80	0.00	37.47	0.13	1.60	0.00	0.01	0.07	1.01	0.04	0.00	0.05	87.60
Average	**33.86**	**0.05**	**15.14**	**0.01**	**34.94**	**0.12**	**1.62**	**0.01**	**0.02**	**0.07**	**0.77**	**0.02**	**0.00**	**0.07**	**86.70**
Std Dev	**1.30**	**0.01**	**0.38**	**0.01**	**2.19**	**0.01**	**0.02**	**0.01**	**0.03**	**0.00**	**0.26**	**0.02**	**0.00**	**0.03**	**1.09**
28 Oxygen Basis (10 oxygen + 8(OH)) (sum excludes F & Cl)															
EBS7-Chl1-1	3.79	0.00	1.99	0.00	3.07	0.01	0.26	0.00	0.00	0.01	0.17	0.00	0.00	0.01	9.31
EBS7-Chl1-2	3.80	0.01	1.97	0.00	3.11	0.01	0.27	0.00	0.00	0.01	0.11	0.00	0.00	0.02	9.28
EBS7-Chl1-3	3.60	0.00	1.94	0.00	3.48	0.01	0.27	0.00	0.00	0.01	0.22	0.01	0.00	0.01	9.54
Average	**3.73**	**0.00**	**1.97**	**0.00**	**3.22**	**0.01**	**0.27**	**0.00**	**0.00**	**0.01**	**0.17**	**0.00**	**0.00**	**0.01**	**9.38**
Std Dev	**0.11**	**0.00**	**0.02**	**0.00**	**0.23**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.06**	**0.00**	**0.00**	**0.01**	**0.14**
EBS-9															
EBS9-Chl1-1	35.06	0.05	14.06	0.00	32.78	0.08	1.73	0.00	0.00	0.55	3.14	0.09	0.00	0.01	87.56
EBS9-Chl2-1	37.02	0.06	15.10	0.00	33.26	0.13	1.78	0.00	0.01	0.64	1.50	0.13	0.00	0.00	89.62
EBS9-Chl2-2	36.83	0.02	15.08	0.00	33.31	0.10	1.84	0.00	0.06	0.69	0.98	0.08	0.04	0.00	89.01
Average	**36.30**	**0.04**	**14.75**	**0.00**	**33.11**	**0.10**	**1.78**	**0.00**	**0.02**	**0.63**	**1.87**	**0.10**	**0.01**	**0.01**	**88.73**
Std Dev	**1.08**	**0.02**	**0.59**	**0.00**	**0.29**	**0.02**	**0.05**	**0.00**	**0.03**	**0.07**	**1.12**	**0.03**	**0.02**	**0.00**	**1.06**
28 Oxygen Basis (10 oxygen + 8(OH)) (sum excludes F & Cl)															
EBS9-Chl1-1	3.81	0.00	1.80	0.00	2.98	0.01	0.28	0.00	0.00	0.06	0.66	0.01	0.00	0.00	9.62
EBS9-Chl2-1	3.88	0.00	1.86	0.00	2.91	0.01	0.28	0.00	0.00	0.07	0.30	0.02	0.00	0.00	9.35
EBS9-Chl2-2	3.88	0.00	1.87	0.00	2.94	0.01	0.29	0.00	0.00	0.08	0.20	0.01	0.01	0.00	9.29
Average	**3.86**	**0.00**	**1.85**	**0.00**	**2.94**	**0.01**	**0.28**	**0.00**	**0.00**	**0.07**	**0.39**	**0.01**	**0.00**	**0.00**	**9.42**
Std Dev	**0.04**	**0.00**	**0.04**	**0.00**	**0.03**	**0.00**	**0.01**	**0.00**	**0.00**	**0.01**	**0.24**	**0.00**	**0.01**	**0.00**	**0.18**
EBS-10															
Good Points: High-Iron Phase															
EBS10-Sil-7	28.30	0.07	17.74	1.08	28.06	0.37	3.45	0.38	0.02	1.08	0.70	0.04	0.12	0.27	81.69
EBS10-Sil-8	22.52	0.08	18.01	1.20	26.78	0.35	3.18	1.42	0.00	0.84	0.47	0.06	0.11	0.22	75.24
EBS10-Sil-9	28.14	0.08	17.39	1.06	27.03	0.40	3.22	0.37	0.02	1.17	0.82	0.06	0.23	0.32	80.29
EBS10-Sil-10	28.50	0.07	17.73	0.98	27.89	0.38	3.18	1.25	0.00	1.17	0.85	0.05	0.08	0.25	82.40
EBS10-Sil-11	27.97	0.08	15.26	0.94	27.38	0.35	2.67	0.99	0.00	1.11	0.92	0.07	0.00	0.29	78.04
EBS10-Sil-12	27.07	0.06	17.20	1.24	28.48	0.41	3.09	0.66	0.01	1.01	0.69	0.04	0.15	0.19	80.31
EBS10-Sil-13	31.92	0.09	16.29	1.15	28.96	0.37	3.20	0.61	0.00	1.24	1.05	0.06	0.08	0.27	85.29

	Weight Percent Components													
Label	**SiO_2**	**TiO_2**	**Al_2O_3**	**Cr_2O_3**	**FeO***	**MnO**	**MgO**	**NiO**	**ZnO**	**CaO**	**Na_2O**	**K_2O**	**F**	**Cl**	**Total**
	Atoms per Formula Unit (sum excludes F&Cl)														
	Si	**Ti**	**Al**	**Cr**	**Fe**	**Mn**	**Mg**	**Ni**	**Zn**	**Ca**	**Na**	**K**	**F**	**Cl**	**Sum**
EBS10-Sil-14	29.67	0.07	16.67	0.73	27.98	0.39	3.18	0.31	0.00	1.04	0.92	0.07	0.00	0.25	81.29
EBS10-Sil-15	26.88	0.07	16.79	1.06	28.35	0.37	3.15	0.66	0.00	0.83	0.85	0.06	0.00	0.17	79.23
EBS10-Sil-17	28.70	0.06	16.82	1.17	28.65	0.40	3.09	0.40	0.01	1.08	0.77	0.06	0.01	0.20	81.42
EBS10-Sil-18	28.75	0.09	16.84	0.92	28.76	0.40	3.20	2.80	0.02	1.34	0.72	0.06	0.10	0.28	84.28
EBS10-Sil-19	29.98	0.08	17.63	0.92	27.90	0.43	3.03	0.70	0.02	1.03	0.90	0.06	0.07	0.26	83.01
EBS10-Sil-20	29.53	0.08	16.24	0.73	28.06	0.43	2.82	0.58	0.00	1.21	0.88	0.08	0.15	0.28	81.07
EBS10-Sil-25	32.89	0.09	15.65	0.38	23.31	0.30	3.23	0.23	0.00	1.28	1.10	0.23	0.14	0.40	79.25
EBS10-Sil-26	38.06	0.08	15.69	0.22	22.63	0.34	2.66	0.25	0.00	1.29	0.59	0.66	0.06	0.15	82.70
Average	**29.26**	**0.08**	**16.80**	**0.92**	**27.35**	**0.38**	**3.09**	**0.77**	**0.01**	**1.12**	**0.81**	**0.11**	**0.09**	**0.25**	**81.03**
Std Dev	**3.37**	**0.01**	**0.84**	**0.30**	**1.88**	**0.03**	**0.22**	**0.66**	**0.01**	**0.15**	**0.17**	**0.16**	**0.07**	**0.06**	**2.51**
28 Oxygen Basis (10 oxygen + 8(OH)) (sum excludes F & Cl)															
EBS10-Sil-7	2.59	0.00	1.92	0.08	2.15	0.03	0.47	0.03	0.00	0.11	0.12	0.00	0.04	0.04	7.51
EBS10-Sil-8	2.29	0.01	2.16	0.10	2.28	0.03	0.48	0.12	0.00	0.09	0.09	0.01	0.04	0.04	7.66
EBS10-Sil-9	2.63	0.01	1.91	0.08	2.11	0.03	0.45	0.03	0.00	0.12	0.15	0.01	0.07	0.05	7.51
EBS10-Sil-10	2.60	0.01	1.90	0.07	2.12	0.03	0.43	0.09	0.00	0.11	0.15	0.01	0.02	0.04	7.52
EBS10-Sil-11	2.70	0.01	1.74	0.07	2.21	0.03	0.38	0.08	0.00	0.11	0.17	0.01	0.00	0.05	7.51
EBS10-Sil-12	2.55	0.00	1.91	0.09	2.24	0.03	0.43	0.05	0.00	0.10	0.13	0.01	0.05	0.03	7.55
EBS10-Sil-13	2.79	0.01	1.68	0.08	2.11	0.03	0.42	0.04	0.00	0.12	0.18	0.01	0.02	0.04	7.45
EBS10-Sil-14	2.71	0.01	1.80	0.05	2.14	0.03	0.43	0.02	0.00	0.10	0.16	0.01	0.00	0.04	7.46
EBS10-Sil-15	2.56	0.01	1.88	0.08	2.25	0.03	0.45	0.05	0.00	0.08	0.16	0.01	0.00	0.03	7.55
EBS10-Sil-17	2.64	0.00	1.82	0.09	2.20	0.03	0.42	0.03	0.00	0.11	0.14	0.01	0.00	0.03	7.49
EBS10-Sil-18	2.60	0.01	1.79	0.07	2.17	0.03	0.43	0.20	0.00	0.13	0.13	0.01	0.03	0.04	7.57
EBS10-Sil-19	2.68	0.01	1.86	0.07	2.09	0.03	0.40	0.05	0.00	0.10	0.16	0.01	0.02	0.04	7.46
EBS10-Sil-20	2.73	0.01	1.77	0.05	2.17	0.03	0.39	0.04	0.00	0.12	0.16	0.01	0.04	0.04	7.48
EBS10-Sil-25	3.00	0.01	1.68	0.03	1.77	0.02	0.44	0.02	0.00	0.13	0.19	0.03	0.04	0.06	7.31
EBS10-Sil-26	3.23	0.01	1.57	0.01	1.60	0.02	0.34	0.02	0.00	0.12	0.10	0.07	0.02	0.02	7.08
Average	**2.69**	**0.01**	**1.83**	**0.07**	**2.11**	**0.03**	**0.42**	**0.06**	**0.00**	**0.11**	**0.15**	**0.01**	**0.03**	**0.04**	**7.47**
Std Dev	**0.21**	**0.00**	**0.14**	**0.02**	**0.18**	**0.00**	**0.04**	**0.05**	**0.00**	**0.01**	**0.03**	**0.02**	**0.02**	**0.01**	**0.13**
Good Points: Low-Iron Phase															
EBS10-Sil-29	50.80	0.08	19.64	0.11	4.21	0.04	1.17	0.05	0.00	0.60	0.36	0.52	0.09	0.18	77.86
EBS10-Sil-30	45.77	0.12	17.38	0.14	4.67	0.06	1.04	0.05	0.00	0.69	0.47	0.51	0.12	0.22	71.24
EBS10-Sil-32	61.29	0.01	11.76	0.35	3.26	0.05	0.46	0.03	0.00	1.89	0.63	0.22	0.06	0.13	80.14
EBS10-Sil-33	64.44	0.00	17.54	0.30	2.29	0.04	0.24	0.01	0.00	1.05	3.23	0.01	0.12	0.06	89.34

	Weight Percent Components														
Label	**SiO_2**	**TiO_2**	**Al_2O_3**	**Cr_2O_3**	**FeO***	**MnO**	**MgO**	**NiO**	**ZnO**	**CaO**	**Na_2O**	**K_2O**	**F**	**Cl**	**Total**
	Atoms per Formula Unit (sum excludes F&Cl)														
	Si	**Ti**	**Al**	**Cr**	**Fe**	**Mn**	**Mg**	**Ni**	**Zn**	**Ca**	**Na**	**K**	**F**	**Cl**	**Sum**
Average	**55.57**	**0.05**	**16.58**	**0.23**	**3.61**	**0.05**	**0.73**	**0.04**	**0.00**	**1.06**	**1.17**	**0.31**	**0.10**	**0.15**	**79.64**
Std Dev	**8.76**	**0.06**	**3.37**	**0.12**	**1.05**	**0.01**	**0.45**	**0.02**	**0.00**	**0.59**	**1.38**	**0.25**	**0.03**	**0.07**	**7.48**
28 Oxygen Basis (10 oxygen + 8(OH)) (sum excludes F & Cl)															
EBS10-Sil-29	3.91	0.00	1.78	0.01	0.27	0.00	0.13	0.00	0.00	0.05	0.05	0.05	0.02	0.02	6.27
EBS10-Sil-30	3.89	0.01	1.74	0.01	0.33	0.00	0.13	0.00	0.00	0.06	0.08	0.06	0.03	0.03	6.32
EBS10-Sil-32	4.50	0.00	1.02	0.02	0.20	0.00	0.05	0.00	0.00	0.15	0.09	0.02	0.01	0.02	6.05
EBS10-Sil-33	4.25	0.00	1.37	0.02	0.13	0.00	0.02	0.00	0.00	0.07	0.41	0.00	0.02	0.01	6.28
Average	**4.14**	**0.00**	**1.48**	**0.01**	**0.23**	**0.00**	**0.09**	**0.00**	**0.00**	**0.08**	**0.16**	**0.03**	**0.02**	**0.02**	**6.23**
Std Dev	**0.29**	**0.00**	**0.36**	**0.01**	**0.09**	**0.00**	**0.06**	**0.00**	**0.00**	**0.04**	**0.17**	**0.03**	**0.01**	**0.01**	**0.12**
Chlorite (analyzed with 20 mm spot)															
EBS-11															
EBS11-Chl1 20u	38.39	0.08	13.56	0.01	31.34	0.11	3.40	0.02	0.01	1.18	2.30	0.13	0.00	0.01	90.55
EBS11-Chl2 20u	36.96	0.02	12.60	0.00	30.04	0.06	3.35	0.02	0.03	1.07	2.22	0.14	0.00	0.09	86.58
Average	**37.68**	**0.05**	**13.08**	**0.01**	**30.69**	**0.09**	**3.37**	**0.02**	**0.02**	**1.13**	**2.26**	**0.13**	**0.00**	**0.05**	**88.57**
Std Dev	**1.01**	**0.04**	**0.68**	**0.01**	**0.92**	**0.04**	**0.04**	**0.00**	**0.01**	**0.08**	**0.06**	**0.01**	**0.00**	**0.05**	**2.81**
28 Oxygen Basis (10 oxygen + 8(OH)) (sum excludes F & Cl)															
EBS11-Chl1 20u	3.96	0.01	1.65	0.00	2.70	0.01	0.52	0.00	0.00	0.13	0.46	0.02	0.00	0.00	9.45
EBS11-Chl2 20u	3.99	0.00	1.60	0.00	2.71	0.01	0.54	0.00	0.00	0.12	0.47	0.02	0.00	0.02	9.46
Average	**3.97**	**0.00**	**1.62**	**0.00**	**2.71**	**0.01**	**0.53**	**0.00**	**0.00**	**0.13**	**0.46**	**0.02**	**0.00**	**0.01**	**9.46**
Std Dev	**0.02**	**0.00**	**0.03**	**0.00**	**0.01**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.00**
EBS-13															
EB13-Ch-1	33.63	0.04	15.58	0.00	34.69	0.18	3.34	0.03	0.01	0.67	0.94	0.05	0.03	0.13	89.27
EB13-Ch-2	34.40	0.04	15.80	0.01	30.58	0.12	3.60	0.00	0.01	0.63	1.16	0.16	0.11	0.24	86.74
EB13-Ch-4	30.75	0.05	16.86	0.02	34.72	0.21	3.89	0.05	0.01	0.41	0.78	0.05	0.14	0.10	87.96
EB13-Ch-5	33.10	0.06	16.46	0.02	34.66	0.18	3.46	0.03	0.00	0.77	0.84	0.05	0.01	0.05	89.68
EB13-ChLD-6	36.92	0.03	15.84	0.01	30.66	0.12	3.53	0.03	0.04	1.33	1.56	0.18	0.00	0.14	90.34
Average	**33.76**	**0.04**	**16.11**	**0.01**	**33.06**	**0.16**	**3.56**	**0.03**	**0.01**	**0.76**	**1.05**	**0.10**	**0.06**	**0.13**	**88.80**
Std Dev	**2.23**	**0.01**	**0.54**	**0.01**	**2.23**	**0.04**	**0.21**	**0.02**	**0.01**	**0.34**	**0.31**	**0.06**	**0.06**	**0.07**	**1.44**

	Weight Percent Components														
Label	**SiO_2**	**TiO_2**	**Al_2O_3**	**Cr_2O_3**	**FeO***	**MnO**	**MgO**	**NiO**	**ZnO**	**CaO**	**Na_2O**	**K_2O**	**F**	**Cl**	**Total**
	Atoms per Formula Unit (sum excludes F&Cl)														
	Si	**Ti**	**Al**	**Cr**	**Fe**	**Mn**	**Mg**	**Ni**	**Zn**	**Ca**	**Na**	**K**	**F**	**Cl**	**Sum**
28 Oxygen Basis (10 oxygen + 8(OH)) (sum excludes F & Cl)															
EB13-Ch-1	3.61	0.00	1.97	0.00	3.11	0.02	0.53	0.00	0.00	0.08	0.20	0.01	0.01	0.02	9.52
EB13-Ch-2	3.72	0.00	2.02	0.00	2.77	0.01	0.58	0.00	0.00	0.07	0.24	0.02	0.04	0.04	9.44
EB13-Ch-4	3.38	0.00	2.18	0.00	3.19	0.02	0.64	0.00	0.00	0.05	0.17	0.01	0.05	0.02	9.64
EB13-Ch-5	3.53	0.00	2.07	0.00	3.09	0.02	0.55	0.00	0.00	0.09	0.17	0.01	0.00	0.01	9.53
EB13-ChLD-6	3.80	0.00	1.92	0.00	2.64	0.01	0.54	0.00	0.00	0.15	0.31	0.02	0.00	0.02	9.41
Average	**3.61**	**0.00**	**2.03**	**0.00**	**2.96**	**0.01**	**0.57**	**0.00**	**0.00**	**0.09**	**0.22**	**0.01**	**0.02**	**0.02**	**9.51**
Std Dev	**0.17**	**0.00**	**0.10**	**0.00**	**0.24**	**0.00**	**0.04**	**0.00**	**0.00**	**0.04**	**0.06**	**0.01**	**0.02**	**0.01**	**0.09**
EBS-13 Metal Mount: Chlorite															
EB13M-Chl-1	39.13	0.02	14.94	0.05	30.85	0.15	1.37	0.26	0.04	1.04	0.53	0.21	0.00	0.06	88.63
EB13M-Chl-2	38.28	0.08	14.41	0.06	30.06	0.15	1.35	0.23	0.01	1.01	0.35	0.18	0.01	0.07	86.21
EB13M-Chl-3	38.47	0.08	14.57	0.07	29.59	0.14	1.39	0.21	0.01	0.97	0.48	0.31	0.06	0.09	86.39
EB13M-Chl-4	36.65	0.08	15.62	0.07	31.21	0.17	1.75	0.28	0.00	1.17	0.58	0.29	0.03	0.04	87.93
EB13M-Chl-5	36.85	0.11	15.93	0.03	31.75	0.21	1.79	0.26	0.01	1.26	0.38	0.22	0.03	0.05	88.85
EB13M-Chl-6	41.68	0.10	16.50	0.20	27.16	0.17	3.14	0.32	0.00	0.91	1.90	0.40	0.00	0.06	92.53
EB13M-Chl-7	32.51	0.07	15.64	0.59	30.86	0.25	2.84	0.35	0.03	0.70	1.71	0.18	0.00	0.08	85.78
EB13M-Chl-8	33.05	0.08	16.22	0.62	31.30	0.29	2.98	0.27	0.03	0.74	1.30	0.20	0.01	0.07	87.12
EB13M-Chl-9	32.32	0.12	15.83	0.55	31.24	0.25	2.87	0.36	0.02	0.69	1.25	0.23	0.00	0.08	85.79
EB13M-Chl-10	33.82	0.11	17.45	0.48	32.86	0.31	3.24	0.29	0.00	0.68	1.06	0.26	0.03	0.05	90.61
Average	**36.28**	**0.08**	**15.71**	**0.27**	**30.69**	**0.21**	**2.27**	**0.28**	**0.02**	**0.92**	**0.95**	**0.25**	**0.02**	**0.06**	**87.99**
Std Dev	**3.21**	**0.03**	**0.92**	**0.26**	**1.52**	**0.06**	**0.80**	**0.05**	**0.01**	**0.21**	**0.57**	**0.07**	**0.02**	**0.01**	**2.23**
28 Oxygen Basis (10 oxygen + 8(OH)) (sum excludes F & Cl)															
EB13M-Chl-1	4.07	0.00	1.83	0.00	2.68	0.01	0.21	0.02	0.00	0.12	0.11	0.03	0.00	0.01	9.09
EB13M-Chl-2	4.09	0.01	1.81	0.00	2.68	0.01	0.21	0.02	0.00	0.12	0.07	0.02	0.00	0.01	9.05
EB13M-Chl-3	4.09	0.01	1.83	0.01	2.63	0.01	0.22	0.02	0.00	0.11	0.10	0.04	0.02	0.02	9.07
EB13M-Chl-4	3.88	0.01	1.95	0.01	2.77	0.02	0.28	0.02	0.00	0.13	0.12	0.04	0.01	0.01	9.22
EB13M-Chl-5	3.87	0.01	1.97	0.00	2.79	0.02	0.28	0.02	0.00	0.14	0.08	0.03	0.01	0.01	9.20
EB13M-Chl-6	4.06	0.01	1.89	0.02	2.21	0.01	0.46	0.03	0.00	0.09	0.36	0.05	0.00	0.01	9.19
EB13M-Chl-7	3.60	0.01	2.04	0.05	2.86	0.02	0.47	0.03	0.00	0.08	0.37	0.03	0.00	0.01	9.55
EB13M-Chl-8	3.59	0.01	2.08	0.05	2.84	0.03	0.48	0.02	0.00	0.09	0.27	0.03	0.00	0.01	9.50
EB13M-Chl-9	3.58	0.01	2.07	0.05	2.89	0.02	0.47	0.03	0.00	0.08	0.27	0.03	0.00	0.01	9.51
EB13M-Chl-10	3.54	0.01	2.15	0.04	2.87	0.03	0.50	0.02	0.00	0.08	0.22	0.03	0.01	0.01	9.49
Average	**3.84**	**0.01**	**1.96**	**0.02**	**2.72**	**0.02**	**0.36**	**0.02**	**0.00**	**0.10**	**0.20**	**0.03**	**0.01**	**0.01**	**9.29**

	Weight Percent Components													
Label	**SiO_2**	**TiO_2**	**Al_2O_3**	**Cr_2O_3**	**FeO***	**MnO**	**MgO**	**NiO**	**ZnO**	**CaO**	**Na_2O**	**K_2O**	**F**	**Cl**	**Total**
	Atoms per Formula Unit (sum excludes F&Cl)														
	Si	**Ti**	**Al**	**Cr**	**Fe**	**Mn**	**Mg**	**Ni**	**Zn**	**Ca**	**Na**	**K**	**F**	**Cl**	**Sum**
Std Dev	**0.24**	**0.00**	**0.12**	**0.02**	**0.20**	**0.01**	**0.13**	**0.00**	**0.00**	**0.02**	**0.12**	**0.01**	**0.01**	**0.00**	**0.20**
EBS-15															
Mantle around metal (stilpnomelane or aluminous glauconite?)															
EB15-Mantle-1	33.93	0.00	14.00	0.00	31.80	0.12	2.21	0.00	0.00	6.12	0.05	0.02	0.07	0.36	88.68
EB15-Mantle-2	34.28	0.02	13.21	0.00	31.49	0.11	2.50	0.00	0.01	6.63	0.12	0.01	0.08	0.33	88.79
EB15-Mantle-3	29.55	0.00	16.05	0.00	36.29	0.21	3.07	0.00	0.00	2.80	0.01	0.01	0.00	0.26	88.26
Average	**32.59**	**0.01**	**14.42**	**0.00**	**33.19**	**0.15**	**2.59**	**0.00**	**0.00**	**5.18**	**0.06**	**0.01**	**0.05**	**0.32**	**88.58**
Std Dev	**2.64**	**0.01**	**1.47**	**0.00**	**2.69**	**0.06**	**0.44**	**0.00**	**0.00**	**2.08**	**0.06**	**0.00**	**0.04**	**0.05**	**0.28**
28 Oxygen + 6(OH) (~8Si) Basis (sum excludes F & Cl)															
EB15-Mantle-1	8.035	0.000	3.908	0.000	6.298	0.024	0.780	0.000	0.001	1.552	0.022	0.005	0.055	0.144	20.62
EB15-Mantle-2	8.110	0.004	3.684	0.001	6.231	0.022	0.880	0.000	0.001	1.680	0.054	0.004	0.060	0.134	20.67
EB15-Mantle-3	7.306	0.000	4.677	0.000	7.504	0.044	1.132	0.000	0.001	0.742	0.003	0.003	0.000	0.109	21.41
Average	**7.817**	**0.001**	**4.090**	**0.000**	**6.677**	**0.030**	**0.931**	**0.000**	**0.001**	**1.325**	**0.026**	**0.004**	**0.039**	**0.129**	**20.90**
Std Dev	**0.444**	**0.002**	**0.521**	**0.000**	**0.716**	**0.012**	**0.181**	**0.000**	**0.000**	**0.509**	**0.026**	**0.001**	**0.034**	**0.018**	**0.44**
EB-15 Metal Mount: Chlorite															
EB15M-Chl-1	34.62	0.07	13.35	0.15	19.01	0.16	2.40	0.29	0.00	1.72	0.43	0.14	0.00	0.30	72.62
EB15M-Chl-2	44.45	0.06	14.53	0.15	15.09	0.12	2.23	0.20	0.00	1.70	0.85	0.41	0.12	0.28	80.18
EB15M-Chl-3	37.17	0.04	14.30	0.32	23.07	0.16	3.86	0.33	0.01	2.08	1.11	0.17	0.00	0.13	82.76
EB15M-Chl-4	35.05	0.01	13.26	0.70	29.37	0.21	3.79	0.21	0.00	1.29	2.78	0.04	0.09	0.04	86.83
EB15M-Chl-5	34.20	0.00	13.02	0.64	28.92	0.20	3.85	0.21	0.01	1.23	3.59	0.04	0.00	0.02	85.93
EB15M-Chl-6	29.92	0.07	12.40	0.45	17.86	0.15	2.99	0.34	0.02	1.72	0.47	0.05	0.06	0.32	66.83
EB15M-Chl-7	33.08	0.02	14.24	0.76	29.22	0.20	3.85	0.27	0.03	1.49	1.94	0.12	0.12	0.01	85.36
EB15M-Chl-8	32.38	0.08	14.10	0.48	20.64	0.20	3.12	0.62	0.03	1.96	0.69	0.06	0.00	0.19	74.54
EB15M-Chl-9	27.61	0.02	11.05	0.10	18.60	0.17	1.87	0.47	0.00	1.46	1.16	0.07	0.01	0.29	62.89
Average	**34.27**	**0.04**	**13.36**	**0.42**	**22.42**	**0.17**	**3.11**	**0.33**	**0.01**	**1.63**	**1.45**	**0.12**	**0.05**	**0.18**	**77.55**
Std Dev	**4.48**	**0.03**	**1.05**	**0.24**	**5.18**	**0.03**	**0.74**	**0.13**	**0.01**	**0.27**	**1.04**	**0.11**	**0.05**	**0.12**	**8.26**
28 Oxygen Basis (10 oxygen + 8(OH)) (sum excludes F & Cl)															
EB15M-Chl-1	4.21	0.01	1.91	0.01	1.94	0.02	0.44	0.03	0.00	0.22	0.10	0.02	0.00	0.06	8.91
EB15M-Chl-2	4.66	0.00	1.80	0.01	1.32	0.01	0.35	0.02	0.00	0.19	0.17	0.05	0.04	0.05	8.59
EB15M-Chl-3	4.04	0.00	1.83	0.03	2.10	0.01	0.62	0.03	0.00	0.24	0.23	0.02	0.00	0.02	9.17

	Weight Percent Components														
Label	**SiO_2**	**TiO_2**	**Al_2O_3**	**Cr_2O_3**	**FeO***	**MnO**	**MgO**	**NiO**	**ZnO**	**CaO**	**Na_2O**	**K_2O**	**F**	**Cl**	**Total**
	Atoms per Formula Unit (sum excludes F&Cl)														
	Si	**Ti**	**Al**	**Cr**	**Fe**	**Mn**	**Mg**	**Ni**	**Zn**	**Ca**	**Na**	**K**	**F**	**Cl**	**Sum**
EB15M-Chl-4	3.81	0.00	1.70	0.06	2.67	0.02	0.61	0.02	0.00	0.15	0.59	0.01	0.03	0.01	9.63
EB15M-Chl-5	3.76	0.00	1.69	0.06	2.66	0.02	0.63	0.02	0.00	0.15	0.76	0.01	0.00	0.00	9.75
EB15M-Chl-6	4.02	0.01	1.96	0.05	2.01	0.02	0.60	0.04	0.00	0.25	0.12	0.01	0.02	0.07	9.08
EB15M-Chl-7	3.67	0.00	1.86	0.07	2.71	0.02	0.64	0.02	0.00	0.18	0.42	0.02	0.04	0.00	9.60
EB15M-Chl-8	3.92	0.01	2.01	0.05	2.09	0.02	0.56	0.06	0.00	0.25	0.16	0.01	0.00	0.04	9.15
EB15M-Chl-9	4.02	0.00	1.89	0.01	2.26	0.02	0.40	0.06	0.00	0.23	0.33	0.01	0.01	0.07	9.24
Average	**4.01**	**0.00**	**1.85**	**0.04**	**2.19**	**0.02**	**0.54**	**0.03**	**0.00**	**0.21**	**0.32**	**0.02**	**0.02**	**0.04**	**9.24**
Std Dev	**0.28**	**0.00**	**0.10**	**0.02**	**0.42**	**0.00**	**0.11**	**0.01**	**0.00**	**0.04**	**0.22**	**0.01**	**0.02**	**0.03**	**0.35**

APPENDIX B:
Electron Microprobe Mineral Chemistry

Feldspar

Sanidine	(Low totals due to Ba content)			Kfs = Kspar		San = Sanidine		Afs = Alkali feldspar							
	Weight Percent Components														
Label	**SiO2**	**TiO2**	**Al2O3**	**Cr2O3**	**FeO***	**MnO**	**MgO**	**NiO**	**ZnO**	**CaO**	**Na2O**	**K2O**	**F**	**Cl**	**Total**
MRBentontite															
MRBENT-F3Kfs1	63.50	0.00	19.70	0.01	0.15	0.01	0.00	0.01	0.00	0.18	3.13	11.29	0.03	0.00	97.98
MRBENT-F3Kfs1-2	64.15	0.01	19.31	0.00	0.16	0.00	0.00	0.00	0.00	0.17	3.13	11.19	0.00	0.00	98.12
MRBENT-F3-Kf2-1	65.81	0.01	19.25	0.00	0.15	0.00	0.00	0.00	0.02	0.17	3.36	11.47	0.00	0.00	100.25
AVE	**64.49**	**0.01**	**19.42**	**0.00**	**0.15**	**0.00**	**0.00**	**0.00**	**0.01**	**0.17**	**3.21**	**11.32**	**0.01**	**0.00**	**98.78**
STD DEV	**0.97**	**0.01**	**0.20**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.01**	**0.11**	**0.11**	**0.01**	**0.00**	**1.04**
8 Oxygen Basis (sum excludes F&Cl)															
MRBENT-F3Kfs1	2.95	0.00	1.08	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.28	0.67	0.00	0.00	4.99
MRBENT-F3Kfs1-2	2.97	0.00	1.05	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.28	0.66	0.00	0.00	4.98
MRBENT-F3-Kf2-1	2.98	0.00	1.03	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.29	0.66	0.00	0.00	4.98
AVE	**2.97**	**0.00**	**1.05**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.29**	**0.66**	**0.00**	**0.00**	**4.98**
STD DEV	**0.01**	**0.00**	**0.02**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.01**
EBS-1															
EBS1-F1-Kfs1-1	65.33	0.00	19.06	0.01	0.11	0.00	0.00	0.01	0.04	0.19	2.56	12.50	0.00	0.01	99.82
EBS1-F1-Kfs1-2	65.12	0.01	18.96	0.00	0.10	0.02	0.00	0.00	0.00	0.18	2.56	12.42	0.02	0.00	99.38
EBS1-F1-Kfs1-3	65.45	0.00	18.70	0.00	0.12	0.00	0.00	0.00	0.00	0.18	2.58	12.40	0.00	0.00	99.45
EBS1-F3-Kfs2-1	66.34	0.01	18.80	0.01	0.12	0.02	0.00	0.00	0.03	0.17	3.52	11.33	0.00	0.00	100.35
EBS1-F3-Kfs2-2	66.42	0.02	18.71	0.00	0.11	0.00	0.00	0.00	0.00	0.16	3.50	11.36	0.00	0.00	100.30
AVE	**65.73**	**0.01**	**18.85**	**0.01**	**0.11**	**0.01**	**0.00**	**0.00**	**0.02**	**0.17**	**2.94**	**12.00**	**0.00**	**0.00**	**99.86**
STD DEV	**0.60**	**0.01**	**0.16**	**0.01**	**0.01**	**0.01**	**0.00**	**0.00**	**0.02**	**0.01**	**0.52**	**0.60**	**0.01**	**0.00**	**0.46**
8 Oxygen Basis (sum excludes F&Cl)															
EBS1-F1-Kfs1-1	2.98	0.00	1.03	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.23	0.73	0.00	0.00	4.98
EBS1-F1-Kfs1-2	2.99	0.00	1.02	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.23	0.73	0.00	0.00	4.98
EBS1-F1-Kfs1-3	3.00	0.00	1.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.23	0.72	0.00	0.00	4.97
EBS1-F3-Kfs2-1	3.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.31	0.65	0.00	0.00	4.98
EBS1-F3-Kfs2-2	3.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.31	0.66	0.00	0.00	4.98
AVE	**2.99**	**0.00**	**1.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.26**	**0.70**	**0.00**	**0.00**	**4.98**
STD DEV	**0.01**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.04**	**0.04**	**0.00**	**0.00**	**0.00**
EBS 2															
EBS2-F1-Kfs1-1	65.04	0.00	18.79	0.00	0.15	0.01	0.01	0.00	0.02	0.17	3.51	10.65	0.00	0.01	98.37
EBS2-F1-Kfs1-2	65.10	0.00	18.77	0.00	0.14	0.00	0.00	0.01	0.01	0.18	3.60	10.61	0.00	0.01	98.43
EBS2-F2-Kfs2-1	65.72	0.00	18.92	0.01	0.08	0.00	0.00	0.00	0.02	0.18	3.39	11.44	0.00	0.00	99.77
EBS2-F2-Kfs2-2	66.22	0.00	18.85	0.02	0.07	0.00	0.00	0.00	0.02	0.19	3.38	11.40	0.01	0.00	100.15

	Weight Percent Components														
Label	**SiO2**	**TiO2**	**Al2O3**	**Cr2O3**	**FeO***	**MnO**	**MgO**	**NiO**	**ZnO**	**CaO**	**Na2O**	**K2O**	**F**	**Cl**	**Total**
EBS2-F2-Kfs3-1	65.98	0.01	18.85	0.01	0.09	0.00	0.00	0.00	0.00	0.18	3.39	11.51	0.03	0.00	100.03
EBS2-F2-Kfs3-2	66.47	0.00	18.60	0.00	0.10	0.02	0.00	0.01	0.01	0.18	3.40	11.46	0.00	0.00	100.25
AVE	**65.75**	**0.00**	**18.80**	**0.01**	**0.11**	**0.01**	**0.00**	**0.00**	**0.01**	**0.18**	**3.45**	**11.18**	**0.01**	**0.00**	**99.50**
STD DEV	**0.59**	**0.00**	**0.11**	**0.01**	**0.03**	**0.01**	**0.01**	**0.00**	**0.01**	**0.01**	**0.09**	**0.43**	**0.01**	**0.00**	**0.87**
8 Oxygen Basis (sum excludes F&Cl)															
EBS2-F1-Kfs1-1	2.99	0.00	1.02	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.31	0.63	0.00	0.00	4.97
EBS2-F1-Kfs1-2	2.99	0.00	1.02	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.32	0.62	0.00	0.00	4.97
EBS2-F2-Kfs2-1	2.99	0.00	1.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.30	0.66	0.00	0.00	4.98
EBS2-F2-Kfs2-2	3.00	0.00	1.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.30	0.66	0.00	0.00	4.97
EBS2-F2-Kfs3-1	3.00	0.00	1.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.30	0.67	0.00	0.00	4.98
EBS2-F2-Kfs3-2	3.01	0.00	0.99	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.30	0.66	0.00	0.00	4.97
AVE	**3.00**	**0.00**	**1.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.30**	**0.65**	**0.00**	**0.00**	**4.98**
STD DEV	**0.01**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.02**	**0.00**	**0.00**	**0.01**
EBS-6															
EBS6-F2-Kf1-1	64.78	0.01	18.74	0.00	0.12	0.02	0.00	0.00	0.02	0.17	3.03	11.30	0.08	0.00	98.28
EBS6-F2-Kf1-2	65.14	0.00	18.59	0.01	0.14	0.01	0.01	0.00	0.02	0.18	3.09	11.30	0.00	0.00	98.48
8 Oxygen Basis (sum excludes F&Cl)															
EBS6-F2-Kf1-1	2.99	0.00	1.02	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.27	0.67	0.01	0.00	4.98
EBS6-F2-Kf1-2	3.00	0.00	1.01	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.28	0.66	0.00	0.00	4.96
EBS-7															
EBS7-Afs1-1	65.63	0.01	18.84	0.01	0.16	0.00	0.00	0.02	0.05	0.16	3.39	11.58	0.10	0.00	99.90
8 Oxygen Basis (sum excludes F&Cl)															
EBS7-Afs1-1	2.99	0.00	1.01	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.30	0.67	0.01	0.00	5.00
EBS-9															
EBS9-Afs1-1	65.39	0.01	18.74	0.00	0.18	0.02	0.01	0.01	0.00	0.17	3.46	11.56	0.12	0.00	99.62
8 Oxygen Basis (sum excludes F&Cl)															
EBS9-Afs1-1	2.99	0.00	1.01	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.31	0.67	0.02	0.00	5.00
EBS-10															
EBS10-Afs-1	63.28	0.02	18.43	0.00	0.17	0.00	0.02	0.01	0.00	0.25	2.99	11.19	0.06	0.00	96.40
EBS10-Afs-2	63.71	0.00	18.58	0.00	0.19	0.00	0.00	0.00	0.00	0.27	3.68	10.38	0.00	0.00	96.80

	Weight Percent Components													
Label	**SiO2**	**TiO2**	**Al2O3**	**Cr2O3**	**FeO***	**MnO**	**MgO**	**NiO**	**ZnO**	**CaO**	**Na2O**	**K2O**	**F**	**Cl**	**Total**
EBS10-Afs3-1	64.91	0.02	18.82	0.01	0.15	0.00	0.00	0.01	0.00	0.19	3.22	11.39	0.03	0.00	98.74
EBS10-Afs-4	65.49	0.00	18.99	0.00	0.18	0.00	0.00	0.03	0.02	0.19	3.24	11.22	0.07	0.00	99.40
AVE	**64.35**	**0.01**	**18.70**	**0.00**	**0.17**	**0.00**	**0.00**	**0.01**	**0.01**	**0.23**	**3.28**	**11.04**	**0.04**	**0.00**	**97.83**
STD DEV	**1.03**	**0.01**	**0.25**	**0.00**	**0.02**	**0.00**	**0.00**	**0.01**	**0.01**	**0.04**	**0.29**	**0.45**	**0.03**	**0.00**	**1.46**
8 Oxygen Basis (sum excludes F&Cl)															
EBS10-Afs-1	2.99	0.00	1.02	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.27	0.67	0.01	0.00	4.98
EBS10-Afs-2	2.98	0.00	1.03	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.33	0.62	0.00	0.00	4.98
EBS10-Afs3-1	2.99	0.00	1.02	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.29	0.67	0.00	0.00	4.98
EBS10-Afs-4	2.99	0.00	1.02	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.29	0.65	0.01	0.00	4.97
AVE	**2.99**	**0.00**	**1.02**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.30**	**0.65**	**0.01**	**0.00**	**4.98**
STD DEV	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.03**	**0.02**	**0.00**	**0.00**	**0.00**
EBS-11															
EBS11-Afs-1	65.58	0.01	18.37	0.00	0.14	0.00	0.00	0.00	0.01	0.24	3.71	10.40	0.20	0.00	98.58
EBS11-Afs-2	65.36	0.00	18.52	0.01	0.11	0.01	0.01	0.00	0.00	0.17	3.41	11.39	0.00	0.00	98.97
EBS11-Afs-4	66.72	0.00	18.76	0.00	0.18	0.00	0.01	0.00	0.01	0.17	4.18	10.34	0.03	0.00	100.39
AVE	**65.89**	**0.00**	**18.55**	**0.00**	**0.14**	**0.00**	**0.00**	**0.00**	**0.01**	**0.20**	**3.77**	**10.71**	**0.08**	**0.00**	**99.31**
STD DEV	**0.73**	**0.01**	**0.20**	**0.00**	**0.04**	**0.00**	**0.00**	**0.00**	**0.01**	**0.04**	**0.39**	**0.59**	**0.11**	**0.00**	**0.95**
8 Oxygen Basis (sum excludes F&Cl)															
EBS11-Afs-1	3.02	0.00	1.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.33	0.61	0.03	0.00	4.97
EBS11-Afs-2	3.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.30	0.67	0.00	0.00	4.98
EBS11-Afs-4	3.01	0.00	1.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.37	0.59	0.00	0.00	4.98
AVE	**3.01**	**0.00**	**1.00**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.33**	**0.62**	**0.01**	**0.00**	**4.98**
STD DEV	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.03**	**0.04**	**0.02**	**0.00**	**0.01**
EBS-12															
EBS12-Afs-1	62.89	0.02	18.55	0.02	0.17	0.00	0.00	0.00	0.00	0.17	3.28	11.07	0.00	0.00	96.17
EBS12-Afs-1	63.58	0.01	18.66	0.00	0.19	0.00	0.00	0.00	0.00	0.18	3.26	10.96	0.00	0.01	96.87
EBS12-Afs-2	61.36	0.00	18.67	0.00	0.18	0.00	0.00	0.02	0.00	0.20	3.19	10.03	0.00	0.00	93.64
EBS12-Afs-3	64.53	0.03	18.48	0.01	0.11	0.00	0.00	0.00	0.00	0.15	3.27	11.42	0.00	0.00	98.01
AVE	**63.09**	**0.01**	**18.59**	**0.01**	**0.16**	**0.00**	**0.00**	**0.00**	**0.00**	**0.18**	**3.25**	**10.87**	**0.00**	**0.00**	**96.17**
STD DEV	**1.34**	**0.01**	**0.09**	**0.01**	**0.04**	**0.00**	**0.00**	**0.01**	**0.00**	**0.02**	**0.04**	**0.59**	**0.00**	**0.00**	**1.85**
8 Oxygen Basis (sum excludes F&Cl)															
EBS12-Afs-1	2.97	0.00	1.03	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.30	0.67	0.00	0.00	4.99
EBS12-Afs-1	2.98	0.00	1.03	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.30	0.66	0.00	0.00	4.98
EBS12-Afs-2	2.96	0.00	1.06	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.30	0.62	0.00	0.00	4.96
EBS12-Afs-3	2.99	0.00	1.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.29	0.68	0.00	0.00	4.99

	Weight Percent Components													
Label	**SiO2**	**TiO2**	**Al2O3**	**Cr2O3**	**FeO***	**MnO**	**MgO**	**NiO**	**ZnO**	**CaO**	**Na2O**	**K2O**	**F**	**Cl**	**Total**
AVE	**2.98**	**0.00**	**1.03**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.30**	**0.65**	**0.00**	**0.00**	**4.98**
STD DEV	**0.01**	**0.00**	**0.02**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.03**	**0.00**	**0.00**	**0.01**
EB-13															
EB13-San-1	66.07	0.00	18.92	0.00	0.21	0.00	0.00	0.02	0.03	0.24	3.68	10.97	0.00	0.00	100.14
EB13-San-2	65.48	0.00	18.75	0.00	0.19	0.00	0.01	0.00	0.01	0.15	3.35	11.50	0.11	0.00	99.51
EB13-San-3	64.79	0.00	18.97	0.00	0.24	0.00	0.00	0.00	0.02	0.18	3.17	11.37	0.00	0.00	98.74
EB13-San-4	65.48	0.00	19.14	0.01	0.19	0.01	0.00	0.00	0.00	0.21	3.46	11.27	0.06	0.00	99.80
Average	**65.46**	**0.00**	**18.94**	**0.00**	**0.21**	**0.00**	**0.00**	**0.00**	**0.01**	**0.19**	**3.42**	**11.28**	**0.04**	**0.00**	**99.55**
Std Dev	**0.52**	**0.00**	**0.16**	**0.00**	**0.02**	**0.01**	**0.00**	**0.01**	**0.01**	**0.04**	**0.21**	**0.23**	**0.05**	**0.00**	**0.60**
8 Oxygen Basis (sum excludes F&Cl)															
EB13-San-1	2.99	0.00	1.01	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.32	0.63	0.00	0.00	4.98
EB13-San-2	3.00	0.00	1.01	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.30	0.67	0.02	0.00	4.99
EB13-San-3	2.98	0.00	1.03	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.28	0.67	0.00	0.00	4.98
EB13-San-4	2.98	0.00	1.03	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.31	0.65	0.01	0.00	4.99
Average	**2.99**	**0.00**	**1.02**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.30**	**0.66**	**0.01**	**0.00**	**4.98**
Std Dev	**0.01**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.02**	**0.02**	**0.01**	**0.00**	**0.01**
EB-15															
Sanidine															
EB15-San-1	66.40	0.01	19.14	0.01	0.12	0.01	0.00	0.00	0.00	0.15	3.45	11.70	0.00	0.00	100.97
EB15-San-2	64.91	0.01	19.00	0.00	0.11	0.00	0.00	0.02	0.00	0.19	2.47	12.71	0.00	0.00	99.43
EB15-San-3	64.80	0.00	18.70	0.01	0.24	0.00	0.00	0.00	0.01	0.18	2.49	12.78	0.01	0.00	99.21
Average	**65.37**	**0.00**	**18.95**	**0.01**	**0.16**	**0.00**	**0.00**	**0.01**	**0.00**	**0.17**	**2.81**	**12.40**	**0.00**	**0.00**	**99.87**
Std Dev	**0.89**	**0.00**	**0.22**	**0.01**	**0.07**	**0.01**	**0.00**	**0.01**	**0.01**	**0.02**	**0.56**	**0.60**	**0.01**	**0.00**	**0.96**
8 Oxygen Basis (sum excludes F&Cl)															
EB15-San-1	2.99	0.00	1.02	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.30	0.67	0.00	0.00	4.99
EB15-San-2	2.98	0.00	1.03	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.22	0.74	0.00	0.00	4.99
EB15-San-3	2.99	0.00	1.02	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.22	0.75	0.00	0.00	4.99
Average	**2.99**	**0.00**	**1.02**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.25**	**0.72**	**0.00**	**0.00**	**4.99**
Std Dev	**0.00**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.05**	**0.04**	**0.00**	**0.00**	**0.00**
EB-16															
Sanidine															
EB16-San-1	65.12	0.01	18.61	0.00	0.10	0.01	0.01	0.02	0.00	0.16	2.64	12.64	0.00	0.01	99.33
EB16-San-2	64.68	0.02	19.03	0.00	0.13	0.00	0.00	0.00	0.00	0.16	2.51	12.72	0.05	0.00	99.28

	Weight Percent Components														
Label	**SiO2**	**TiO2**	**Al2O3**	**Cr2O3**	**FeO***	**MnO**	**MgO**	**NiO**	**ZnO**	**CaO**	**Na2O**	**K2O**	**F**	**Cl**	**Total**
EB16-San-3	62.43	0.00	18.49	0.00	0.11	0.00	0.00	0.00	0.00	0.21	2.28	12.19	0.00	0.00	95.72
EB16-San-4	62.49	0.00	18.62	0.00	0.16	0.00	0.00	0.00	0.02	0.23	2.33	12.06	0.00	0.00	95.90
Average	**63.68**	**0.01**	**18.69**	**0.00**	**0.12**	**0.00**	**0.00**	**0.01**	**0.00**	**0.19**	**2.44**	**12.40**	**0.01**	**0.00**	**97.56**
Std Dev	**1.42**	**0.01**	**0.24**	**0.00**	**0.03**	**0.00**	**0.01**	**0.01**	**0.01**	**0.03**	**0.16**	**0.33**	**0.03**	**0.00**	**2.02**
8 Oxygen Basis (sum excludes F&Cl)															
EB16-San-1	2.99	0.00	1.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.23	0.74	0.00	0.00	4.99
EB16-San-2	2.98	0.00	1.03	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.22	0.75	0.01	0.00	4.99
EB16-San-3	2.98	0.00	1.04	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.21	0.74	0.00	0.00	4.98
EB16-San-4	2.97	0.00	1.04	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.21	0.73	0.00	0.00	4.98
Average	**2.98**	**0.00**	**1.03**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.22**	**0.74**	**0.00**	**0.00**	**4.99**
Std Dev	**0.01**	**0.00**	**0.02**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.01**	**0.00**	**0.00**	**0.01**
EB-17															
Sanidine															
EB17-San-1	65.51	0.01	18.83	0.00	0.19	0.00	0.00	0.00	0.00	0.18	3.46	11.49	0.00	0.01	99.69
EB17-San-2	65.12	0.00	18.66	0.00	0.13	0.02	0.00	0.00	0.00	0.17	3.43	11.50	0.00	0.00	99.03
Average	**65.32**	**0.01**	**18.74**	**0.00**	**0.16**	**0.01**	**0.00**	**0.00**	**0.00**	**0.18**	**3.45**	**11.49**	**0.00**	**0.01**	**99.36**
Std Dev	**0.27**	**0.01**	**0.12**	**0.00**	**0.05**	**0.01**	**0.00**	**0.00**	**0.00**	**0.01**	**0.02**	**0.01**	**0.00**	**0.01**	**0.47**
8 Oxygen Basis (sum excludes F&Cl)															
EB17-San-1	2.99	0.00	1.01	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.31	0.67	0.00	0.00	4.99
EB17-San-2	2.99	0.00	1.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.31	0.67	0.00	0.00	4.99
Average	**2.99**	**0.00**	**1.01**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.31**	**0.67**	**0.00**	**0.00**	**4.99**
Std Dev	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

Plagioclase														
	Weight Percent Components													
Label	**SiO_2**	**TiO_2**	**Al_2O_3**	**Cr_2O_3**	**FeO***	**MnO**	**MgO**	**NiO**	**ZnO**	**CaO**	**Na_2O**	**K_2O**	**F**	**Cl**	**Total**
MRBentontite															
MRBENT-F3-Plg1-1	63.29	0.02	23.21	0.00	0.20	0.00	0.00	0.01	0.01	4.10	8.32	1.09	0.00	0.00	100.26
MRBENT-F3-Plg1-2	63.12	0.00	23.19	0.01	0.21	0.00	0.00	0.00	0.03	4.10	8.05	1.24	0.02	0.01	99.95
MRBENT-F3-Plg1-3	64.10	0.00	23.18	0.00	0.20	0.00	0.00	0.04	0.02	4.14	8.55	1.13	0.00	0.00	101.36
AVE	**63.50**	**0.01**	**23.19**	**0.01**	**0.20**	**0.00**	**0.00**	**0.02**	**0.02**	**4.11**	**8.31**	**1.16**	**0.01**	**0.00**	**100.52**
STD DEV	**0.43**	**0.01**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.02**	**0.01**	**0.02**	**0.21**	**0.06**	**0.01**	**0.00**	**0.61**
8 Oxygen Basis (sum excludes F&Cl)															
MRBENT-F3-Plg1-1	2.80	0.00	1.21	0.00	0.01	0.00	0.00	0.00	0.00	0.19	0.71	0.06	0.00	0.00	4.98
MRBENT-F3-Plg1-2	2.80	0.00	1.21	0.00	0.01	0.00	0.00	0.00	0.00	0.19	0.69	0.07	0.00	0.00	4.98
MRBENT-F3-Plg1-3	2.80	0.00	1.20	0.00	0.01	0.00	0.00	0.00	0.00	0.19	0.73	0.06	0.00	0.00	4.99
AVE	**2.80**	**0.00**	**1.21**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.19**	**0.71**	**0.07**	**0.00**	**0.00**	**4.98**
STD DEV	**0.00**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.01**
EBS-1															
EBS1-F1-Pl1-1	61.60	0.00	23.81	0.01	0.19	0.00	0.00	0.00	0.03	5.93	7.47	1.00	0.00	0.00	100.05
EBS1-F1-Pl1-2	60.71	0.00	25.07	0.00	0.21	0.00	0.00	0.02	0.02	6.66	7.17	0.79	0.10	0.00	100.71
AVE	**61.16**	**0.00**	**24.44**	**0.00**	**0.20**	**0.00**	**0.00**	**0.01**	**0.02**	**6.30**	**7.32**	**0.89**	**0.05**	**0.00**	**100.38**
STD DEV	**0.63**	**0.00**	**0.89**	**0.00**	**0.01**	**0.00**	**0.00**	**0.01**	**0.01**	**0.52**	**0.21**	**0.14**	**0.00**	**0.00**	**0.47**
8 Oxygen Basis (sum excludes F&Cl)															
EBS1-F1-Pl1-1	2.74	0.00	1.25	0.00	0.01	0.00	0.00	0.00	0.00	0.28	0.64	0.06	0.00	0.00	4.98
EBS1-F1-Pl1-2	2.69	0.00	1.31	0.00	0.01	0.00	0.00	0.00	0.00	0.32	0.62	0.04	0.01	0.00	4.99
AVE	**2.72**	**0.00**	**1.28**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.30**	**0.63**	**0.05**	**0.01**	**0.00**	**4.99**
STD DEV	**0.04**	**0.00**	**0.04**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.02**	**0.02**	**0.01**	**0.00**	**0.00**	**0.00**
EBS-2															
EBS2-F3-Plg1-1	63.55	0.01	23.36	0.00	0.21	0.00	0.00	0.01	0.01	4.57	8.54	0.91	0.00	0.01	101.19
EBS2-F3-Plg1-2	62.98	0.02	23.45	0.00	0.23	0.00	0.00	0.00	0.00	4.80	8.49	0.89	0.16	0.01	100.97
AVE	**63.27**	**0.02**	**23.41**	**0.00**	**0.22**	**0.00**	**0.00**	**0.01**	**0.00**	**4.68**	**8.51**	**0.90**	**0.08**	**0.01**	**101.08**
STD DEV	**0.40**	**0.00**	**0.06**	**0.00**	**0.01**	**0.00**	**0.00**	**0.01**	**0.00**	**0.16**	**0.03**	**0.01**	**0.00**	**0.00**	**0.16**
8 Oxygen Basis (sum excludes F&Cl)															
EBS2-F3-Plg1-1	2.79	0.00	1.21	0.00	0.01	0.00	0.00	0.00	0.00	0.21	0.73	0.05	0.00	0.00	5.00
EBS2-F3-Plg1-2	2.78	0.00	1.22	0.00	0.01	0.00	0.00	0.00	0.00	0.23	0.73	0.05	0.02	0.00	5.01
AVE	**2.78**	**0.00**	**1.21**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.22**	**0.73**	**0.05**	**0.01**	**0.00**	**5.00**

	Weight Percent Components													
Label	**SiO_2**	**TiO_2**	**Al_2O_3**	**Cr_2O_3**	**FeO***	**MnO**	**MgO**	**NiO**	**ZnO**	**CaO**	**Na_2O**	**K_2O**	**F**	**Cl**	**Total**
STD DEV	**0.01**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**
EBS-4															
EBS4-AltPlag1-1	68.44	0.22	19.26	0.00	1.22	0.02	0.35	0.02	0.00	1.64	3.98	6.92	0.02	0.02	102.10
EBS4-AltPlag1-2	61.37	0.34	24.68	0.00	1.18	0.01	0.40	0.00	0.02	3.49	4.31	3.94	0.00	0.03	99.78
AVE	**64.90**	**0.28**	**21.97**	**0.00**	**1.20**	**0.01**	**0.37**	**0.01**	**0.01**	**2.57**	**4.15**	**5.43**	**0.01**	**0.03**	**100.94**
STD DEV	**5.00**	**0.08**	**3.84**	**0.00**	**0.03**	**0.00**	**0.04**	**0.02**	**0.02**	**1.31**	**0.23**	**2.10**	**0.00**	**0.00**	**1.64**
8 Oxygen Basis (sum excludes F&Cl)															
EBS4-AltPlag1-1	2.99	0.01	0.99	0.00	0.04	0.00	0.02	0.00	0.00	0.08	0.34	0.39	0.00	0.00	4.87
EBS4-AltPlag1-2	2.74	0.01	1.30	0.00	0.04	0.00	0.03	0.00	0.00	0.17	0.37	0.22	0.00	0.00	4.89
AVE	**2.87**	**0.01**	**1.15**	**0.00**	**0.04**	**0.00**	**0.02**	**0.00**	**0.00**	**0.12**	**0.36**	**0.31**	**0.00**	**0.00**	**4.88**
STD DEV	**0.18**	**0.00**	**0.22**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.06**	**0.03**	**0.11**	**0.00**	**0.00**	**0.02**
EBS-9															
EBS9-Ab1 (vfg)	68.43	0.05	20.33	0.00	0.36	0.00	0.06	0.00	0.00	0.11	11.19	0.11	0.06	0.01	100.68
EBS9-Pl1-1	61.98	0.00	23.57	0.00	0.28	0.00	0.01	0.00	0.00	5.27	8.01	0.99	0.00	0.00	100.12
AVE	**65.20**	**0.03**	**21.95**	**0.00**	**0.32**	**0.00**	**0.04**	**0.00**	**0.00**	**2.69**	**9.60**	**0.55**	**0.03**	**0.01**	**100.40**
STD DEV	**4.56**	**0.04**	**2.29**	**0.00**	**0.05**	**0.00**	**0.04**	**0.00**	**0.00**	**3.65**	**2.25**	**0.62**	**0.04**	**0.00**	**0.40**
8 Oxygen Basis (sum excludes F&Cl)															
EBS9-Ab1 (vfg)	3.01	0.00	1.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.98	0.01	0.01	0.00	5.02
EBS9-Pl1-1	2.76	0.00	1.24	0.00	0.01	0.00	0.00	0.00	0.00	0.25	0.69	0.06	0.00	0.00	5.00
AVE	**2.89**	**0.00**	**1.12**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.13**	**0.84**	**0.03**	**0.00**	**0.00**	**5.01**
STD DEV	**0.18**	**0.00**	**0.17**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.17**	**0.21**	**0.04**	**0.00**	**0.00**	**0.02**
EBS-10															
EBS10-Pl-1	63.53	0.02	22.85	0.00	0.26	0.02	0.00	0.00	0.01	4.46	8.36	1.00	0.00	0.00	100.51
EBS10-Pl-2	60.50	0.00	24.31	0.00	0.30	0.02	0.00	0.00	0.00	6.22	7.41	0.77	0.00	0.00	99.53
EBS10-Pl2-1	60.52	0.03	24.57	0.01	0.26	0.00	0.01	0.02	0.02	6.00	7.44	0.86	0.00	0.00	99.74
EBS10-Pl-4	64.03	0.00	22.66	0.01	0.27	0.02	0.00	0.00	0.00	3.53	7.95	1.17	0.09	0.00	99.70
AVE	**62.15**	**0.01**	**23.60**	**0.00**	**0.27**	**0.02**	**0.01**	**0.00**	**0.01**	**5.05**	**7.79**	**0.95**	**0.02**	**0.00**	**99.87**
STD DEV	**1.90**	**0.01**	**0.98**	**0.01**	**0.02**	**0.01**	**0.00**	**0.01**	**0.01**	**1.28**	**0.46**	**0.18**	**0.04**	**0.00**	**0.44**
8 Oxygen Basis (sum excludes F&Cl)															
EBS10-Pl-1	2.80	0.00	1.19	0.00	0.01	0.00	0.00	0.00	0.00	0.21	0.72	0.06	0.00	0.00	4.99
EBS10-Pl-2	2.71	0.00	1.28	0.00	0.01	0.00	0.00	0.00	0.00	0.30	0.64	0.04	0.00	0.00	4.99
EBS10-Pl2-1	2.71	0.00	1.29	0.00	0.01	0.00	0.00	0.00	0.00	0.29	0.64	0.05	0.00	0.00	4.99

	Weight Percent Components													
Label	**SiO_2**	**TiO_2**	**Al_2O_3**	**Cr_2O_3**	**FeO***	**MnO**	**MgO**	**NiO**	**ZnO**	**CaO**	**Na_2O**	**K_2O**	**F**	**Cl**	**Total**
EBS10-Pl-4	2.84	0.00	1.18	0.00	0.01	0.00	0.00	0.00	0.00	0.17	0.68	0.07	0.01	0.00	4.95
AVE	**2.76**	**0.00**	**1.24**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.24**	**0.67**	**0.05**	**0.00**	**0.00**	**4.98**
STD DEV	**0.07**	**0.00**	**0.06**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.06**	**0.03**	**0.01**	**0.01**	**0.00**	**0.02**
EBS-11															
EBS11-Pl-1	60.70	0.02	24.40	0.00	0.23	0.00	0.01	0.00	0.02	6.79	7.44	0.74	0.00	0.00	100.35
EBS11-Pl-2	62.65	0.02	22.87	0.00	0.22	0.01	0.00	0.01	0.02	4.45	8.37	1.00	0.00	0.00	99.62
AVE	**61.68**	**0.02**	**23.63**	**0.00**	**0.23**	**0.00**	**0.01**	**0.01**	**0.02**	**5.62**	**7.90**	**0.87**	**0.00**	**0.00**	**99.98**
STD DEV	**1.38**	**0.00**	**1.08**	**0.00**	**0.01**	**0.00**	**0.00**	**0.01**	**0.01**	**1.65**	**0.66**	**0.18**	**0.00**	**0.00**	**0.51**
8 Oxygen Basis (sum excludes F&Cl)															
EBS11-Pl-1	2.70	0.00	1.28	0.00	0.01	0.00	0.00	0.00	0.00	0.32	0.64	0.04	0.00	0.00	5.00
EBS11-Pl-2	2.79	0.00	1.20	0.00	0.01	0.00	0.00	0.00	0.00	0.21	0.72	0.06	0.00	0.00	5.00
AVE	**2.75**	**0.00**	**1.24**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.27**	**0.68**	**0.05**	**0.00**	**0.00**	**5.00**
STD DEV	**0.06**	**0.00**	**0.06**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.08**	**0.06**	**0.01**	**0.00**	**0.00**	**0.00**
EBS-12															
EBS12-Pl-1	59.53	0.00	26.09	0.00	0.24	0.00	0.00	0.00	0.03	8.05	6.90	0.57	0.01	0.00	101.42
EBS12-Pl-1	60.59	0.00	26.57	0.00	0.27	0.00	0.01	0.02	0.00	7.92	7.16	0.59	0.07	0.01	103.18
EBS12-Pl-2	62.17	0.00	23.18	0.02	0.23	0.00	0.00	0.01	0.01	4.88	8.04	1.01	0.02	0.01	99.57
AVE	**60.76**	**0.00**	**25.28**	**0.01**	**0.25**	**0.00**	**0.00**	**0.01**	**0.01**	**6.95**	**7.37**	**0.72**	**0.03**	**0.00**	**101.39**
STD DEV	**1.33**	**0.00**	**1.83**	**0.01**	**0.02**	**0.00**	**0.00**	**0.01**	**0.02**	**1.79**	**0.60**	**0.25**	**0.03**	**0.00**	**1.80**
8 Oxygen Basis (sum excludes F&Cl)															
EBS12-Pl-1	1.97	0.00	1.02	0.00	0.01	0.00	0.00	0.00	0.00	0.29	0.44	0.02	0.00	0.00	3.75
EBS12-Pl-1	1.97	0.00	1.02	0.00	0.01	0.00	0.00	0.00	0.00	0.28	0.45	0.02	0.01	0.00	3.76
EBS12-Pl-2	2.08	0.00	0.91	0.00	0.01	0.00	0.00	0.00	0.00	0.18	0.52	0.04	0.00	0.00	3.74
AVE	**2.01**	**0.00**	**0.98**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.25**	**0.47**	**0.03**	**0.00**	**0.00**	**3.75**
STD DEV	**0.06**	**0.00**	**0.06**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.06**	**0.04**	**0.01**	**0.00**	**0.00**	**0.01**
EB-15															
EB15-Plg-1	59.60	0.01	25.86	0.00	0.20	0.00	0.00	0.00	0.00	7.22	7.00	0.73	0.00	0.01	100.63
EB15-Plg-2	59.55	0.00	26.03	0.00	0.18	0.02	0.01	0.00	0.00	7.30	6.88	0.72	0.04	0.00	100.71
EB15-Plg-3	61.96	0.03	23.89	0.00	0.26	0.00	0.00	0.00	0.01	5.48	7.94	0.86	0.14	0.00	100.52
Average	**60.37**	**0.01**	**25.26**	**0.00**	**0.21**	**0.01**	**0.00**	**0.00**	**0.00**	**6.67**	**7.27**	**0.77**	**0.06**	**0.00**	**100.62**
Std Dev	**1.38**	**0.01**	**1.19**	**0.00**	**0.04**	**0.01**	**0.00**	**0.00**	**0.01**	**1.03**	**0.58**	**0.08**	**0.07**	**0.00**	**0.10**
8 Oxygen Basis (sum excludes F&Cl)															

	Weight Percent Components													
Label	**SiO_2**	**TiO_2**	**Al_2O_3**	**Cr_2O_3**	**FeO***	**MnO**	**MgO**	**NiO**	**ZnO**	**CaO**	**Na_2O**	**K_2O**	**F**	**Cl**	**Total**
EB15-Plg-1	2.65	0.00	1.35	0.00	0.01	0.00	0.00	0.00	0.00	0.34	0.60	0.04	0.00	0.00	5.00
EB15-Plg-2	2.64	0.00	1.36	0.00	0.01	0.00	0.00	0.00	0.00	0.35	0.59	0.04	0.01	0.00	4.99
EB15-Plg-3	2.75	0.00	1.25	0.00	0.01	0.00	0.00	0.00	0.00	0.26	0.68	0.05	0.02	0.00	5.00
Average	**2.68**	**0.00**	**1.32**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.32**	**0.63**	**0.04**	**0.01**	**0.00**	**5.00**
Std Dev	**0.06**	**0.00**	**0.06**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.05**	**0.05**	**0.00**	**0.01**	**0.00**	**0.00**
EB-16															
EB16-Pl-1	61.59	0.01	23.61	0.02	0.26	0.00	0.00	0.00	0.03	5.31	7.85	0.91	0.00	0.00	99.59
EB16-Pl-2	59.36	0.01	25.39	0.00	0.33	0.02	0.00	0.00	0.00	6.77	7.15	0.69	0.04	0.00	99.75
Average	**60.48**	**0.01**	**24.50**	**0.01**	**0.29**	**0.01**	**0.00**	**0.00**	**0.02**	**6.04**	**7.50**	**0.80**	**0.02**	**0.00**	**99.67**
Std Dev	**1.58**	**0.00**	**1.25**	**0.01**	**0.05**	**0.02**	**0.00**	**0.00**	**0.02**	**1.03**	**0.49**	**0.16**	**0.03**	**0.00**	**0.11**
8 Oxygen Basis (sum excludes F&Cl)															
EB16-Pl-1	2.75	0.00	1.24	0.00	0.01	0.00	0.00	0.00	0.00	0.25	0.68	0.05	0.00	0.00	4.99
EB16-Pl-2	2.66	0.00	1.34	0.00	0.01	0.00	0.00	0.00	0.00	0.33	0.62	0.04	0.01	0.00	5.00
Average	**2.71**	**0.00**	**1.29**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.29**	**0.65**	**0.05**	**0.00**	**0.00**	**5.00**
Std Dev	**0.06**	**0.00**	**0.07**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.05**	**0.04**	**0.01**	**0.00**	**0.00**	**0.01**
EB-17															
EB17-Pl-1	63.37	0.03	23.41	0.01	0.21	0.00	0.00	0.00	0.00	4.44	8.44	0.95	0.02	0.00	100.88
EB17-Pl-2	61.48	0.01	24.62	0.01	0.29	0.02	0.00	0.01	0.00	6.08	7.63	0.81	0.00	0.00	100.95
EB17-Pl-3	61.73	0.03	24.10	0.01	0.40	0.00	0.00	0.00	0.03	5.39	7.73	0.98	0.07	0.00	100.43
Average	**62.19**	**0.02**	**24.04**	**0.01**	**0.30**	**0.01**	**0.00**	**0.00**	**0.01**	**5.30**	**7.93**	**0.91**	**0.03**	**0.00**	**100.75**
Std Dev	**1.02**	**0.01**	**0.61**	**0.00**	**0.09**	**0.01**	**0.00**	**0.00**	**0.01**	**0.82**	**0.44**	**0.09**	**0.04**	**0.00**	**0.28**
8 Oxygen Basis (sum excludes F&Cl)															
EB17-Pl-1	2.79	0.00	1.21	0.00	0.01	0.00	0.00	0.00	0.00	0.21	0.72	0.05	0.00	0.00	4.99
EB17-Pl-2	2.71	0.00	1.28	0.00	0.01	0.00	0.00	0.00	0.00	0.29	0.65	0.05	0.00	0.00	4.99
EB17-Pl-3	2.74	0.00	1.26	0.00	0.01	0.00	0.00	0.00	0.00	0.26	0.66	0.06	0.01	0.00	4.99
Average	**2.75**	**0.00**	**1.25**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.25**	**0.68**	**0.05**	**0.00**	**0.00**	**4.99**
Std Dev	**0.04**	**0.00**	**0.03**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.04**	**0.04**	**0.01**	**0.01**	**0.00**	**0.00**

APPENDIX B:
Electron Microprobe Mineral Chemistry

Zeolites

Zeolites															
	Weight Percent Components														
Label	**SiO_2**	**TiO_2**	**Al_2O_3**	**Cr_2O_3**	**FeO***	**MnO**	**MgO**	**NiO**	**ZnO**	**CaO**	**Na_2O**	**K_2O**	**F**	**Cl**	**Total**
	Cations														
	Si	**Ti**	**Al**	**Cr**	**Fe**	**Mn**	**Mg**	**Ni**	**Zn**	**Ca**	**Na**	**K**	**F**	**Cl**	**Sum**
MR-Bentonite															
zeoltilized shards															
MRBENT-Shard1	69.70	0.02	12.93	0.02	0.09	0.00	0.10	0.01	0.00	0.53	5.70	0.21	0.00	0.00	89.30
MRBENT-Shard2	69.87	0.00	12.37	0.00	0.07	0.01	0.10	0.02	0.00	0.58	5.99	0.37	0.00	0.00	89.39
MRBENT-Shard3	70.79	0.02	12.20	0.01	0.08	0.00	0.11	0.00	0.00	0.56	5.62	0.22	0.10	0.00	89.71
MRBENT-F2Sh4	69.54	0.00	12.10	0.00	0.08	0.01	0.86	0.00	0.00	1.64	2.58	0.42	0.01	0.00	87.24
MRBENT-F2Sh5	68.75	0.00	12.48	0.00	0.06	0.00	0.93	0.00	0.00	1.74	3.45	0.22	0.00	0.01	87.65
MRBENT-F2Sh6	70.78	0.00	12.55	0.01	0.06	0.00	0.31	0.00	0.01	1.96	2.80	0.21	0.07	0.01	88.78
MRBENT-F3Sh7	73.87	0.01	12.87	0.03	0.10	0.00	0.07	0.00	0.00	0.54	4.70	0.05	0.00	0.00	92.24
MRBENT-F3-Sh8	73.22	0.00	12.93	0.00	0.09	0.01	0.11	0.02	0.01	0.55	5.56	0.06	0.00	0.00	92.55
MRBENT-F3Sh9	74.98	0.00	12.93	0.01	0.14	0.02	0.13	0.00	0.03	0.45	4.72	0.06	0.00	0.01	93.47
Average	**71.28**	**0.01**	**12.60**	**0.01**	**0.09**	**0.00**	**0.30**	**0.01**	**0.01**	**0.95**	**4.57**	**0.20**	**0.02**	**0.00**	**90.04**
Std Dev	**2.19**	**0.01**	**0.33**	**0.01**	**0.02**	**0.01**	**0.34**	**0.01**	**0.01**	**0.63**	**1.31**	**0.13**	**0.04**	**0.00**	**2.21**
6 Oxygen Basis															
MRBENT-Shard1	2.48	0.00	0.54	0.00	0.00	0.00	0.01	0.00	0.00	0.02	0.39	0.01	0.00	0.00	3.45
MRBENT-Shard2	2.49	0.00	0.52	0.00	0.00	0.00	0.01	0.00	0.00	0.02	0.41	0.02	0.00	0.00	3.47
MRBENT-Shard3	2.51	0.00	0.51	0.00	0.00	0.00	0.01	0.00	0.00	0.02	0.39	0.01	0.01	0.00	3.45
MRBENT-F2Sh4	2.51	0.00	0.51	0.00	0.00	0.00	0.05	0.00	0.00	0.06	0.18	0.02	0.00	0.00	3.34
MRBENT-F2Sh5	2.48	0.00	0.53	0.00	0.00	0.00	0.05	0.00	0.00	0.07	0.24	0.01	0.00	0.00	3.38
MRBENT-F2Sh6	2.51	0.00	0.52	0.00	0.00	0.00	0.02	0.00	0.00	0.07	0.19	0.01	0.01	0.00	3.34
MRBENT-F3Sh7	2.52	0.00	0.52	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.31	0.00	0.00	0.00	3.38
MRBENT-F3-Sh8	2.50	0.00	0.52	0.00	0.00	0.00	0.01	0.00	0.00	0.02	0.37	0.00	0.00	0.00	3.42
MRBENT-F3Sh9	2.52	0.00	0.51	0.00	0.00	0.00	0.01	0.00	0.00	0.02	0.31	0.00	0.00	0.00	3.38
Average	**2.50**	**0.00**	**0.52**	**0.00**	**0.00**	**0.00**	**0.02**	**0.00**	**0.00**	**0.04**	**0.31**	**0.01**	**0.00**	**0.00**	**3.40**
Std Dev	**0.02**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.02**	**0.00**	**0.00**	**0.02**	**0.09**	**0.01**	**0.00**	**0.00**	**0.05**
EBS-1															
zeoltilized shards															
EBS1-F1-Sh1	73.23	0.01	12.37	0.01	0.10	0.00	0.15	0.00	0.00	1.30	4.40	1.06	0.01	0.01	92.65
EBS1-F1-Sh2	70.17	0.00	12.55	0.00	0.05	0.00	0.17	0.01	0.00	1.35	4.23	1.08	0.04	0.01	89.67
EBS1-F1-Sh3	70.10	0.00	12.91	0.00	0.06	0.00	0.15	0.00	0.00	1.72	3.58	1.09	0.00	0.00	89.61
EBS1-F2-Sh4	71.52	0.03	13.24	0.00	0.07	0.01	0.13	0.02	0.01	1.97	3.86	0.91	0.00	0.01	91.79
EBS1-F2-Sh5	70.68	0.01	13.29	0.00	0.08	0.00	0.14	0.00	0.00	2.05	4.30	0.92	0.00	0.00	91.47
EBS1-F2-Sh6	71.13	0.00	12.79	0.00	0.20	0.01	0.13	0.00	0.00	1.34	4.29	1.18	0.00	0.01	91.08
EBS1-F3-Sh7	71.23	0.00	12.49	0.00	0.07	0.00	0.10	0.00	0.01	1.59	3.84	1.53	0.00	0.00	90.87
EBS1-F3-Sh8	71.23	0.00	12.97	0.00	0.15	0.00	0.21	0.02	0.00	1.27	3.66	1.78	0.04	0.00	91.33
EBS1-F3-Sh9	71.99	0.00	12.96	0.00	0.05	0.00	0.13	0.03	0.00	1.96	3.38	1.44	0.09	0.00	92.03
EBS1-F3-Sh10	70.06	0.00	13.11	0.01	0.06	0.01	0.13	0.00	0.00	1.71	3.44	1.58	0.00	0.00	90.10
Average	**71.13**	**0.01**	**12.87**	**0.00**	**0.09**	**0.00**	**0.14**	**0.01**	**0.00**	**1.63**	**3.90**	**1.26**	**0.02**	**0.00**	**91.06**
Std Dev	**0.98**	**0.01**	**0.32**	**0.00**	**0.05**	**0.00**	**0.03**	**0.01**	**0.01**	**0.30**	**0.38**	**0.30**	**0.03**	**0.00**	**1.01**

	Weight Percent Components														
Label	**SiO_2**	**TiO_2**	**Al_2O_3**	**Cr_2O_3**	**FeO***	**MnO**	**MgO**	**NiO**	**ZnO**	**CaO**	**Na_2O**	**K_2O**	**F**	**Cl**	**Total**
	Cations														
	Si	**Ti**	**Al**	**Cr**	**Fe**	**Mn**	**Mg**	**Ni**	**Zn**	**Ca**	**Na**	**K**	**F**	**Cl**	**Sum**
6 Oxygen Basis															
EBS1-F1-Sh1	2.51	0.00	0.50	0.00	0.00	0.00	0.01	0.00	0.00	0.05	0.29	0.05	0.00	0.00	3.41
EBS1-F1-Sh2	2.49	0.00	0.52	0.00	0.00	0.00	0.01	0.00	0.00	0.05	0.29	0.05	0.00	0.00	3.42
EBS1-F1-Sh3	2.48	0.00	0.54	0.00	0.00	0.00	0.01	0.00	0.00	0.07	0.25	0.05	0.00	0.00	3.39
EBS1-F2-Sh4	2.48	0.00	0.54	0.00	0.00	0.00	0.01	0.00	0.00	0.07	0.26	0.04	0.00	0.00	3.40
EBS1-F2-Sh5	2.46	0.00	0.55	0.00	0.00	0.00	0.01	0.00	0.00	0.08	0.29	0.04	0.00	0.00	3.43
EBS1-F2-Sh6	2.49	0.00	0.53	0.00	0.01	0.00	0.01	0.00	0.00	0.05	0.29	0.05	0.00	0.00	3.42
EBS1-F3-Sh7	2.50	0.00	0.52	0.00	0.00	0.00	0.01	0.00	0.00	0.06	0.26	0.07	0.00	0.00	3.41
EBS1-F3-Sh8	2.49	0.00	0.53	0.00	0.00	0.00	0.01	0.00	0.00	0.05	0.25	0.08	0.00	0.00	3.42
EBS1-F3-Sh9	2.49	0.00	0.53	0.00	0.00	0.00	0.01	0.00	0.00	0.07	0.23	0.06	0.01	0.00	3.40
EBS1-F3-Sh10	2.48	0.00	0.55	0.00	0.00	0.00	0.01	0.00	0.00	0.06	0.24	0.07	0.00	0.00	3.40
Average	**2.49**	**0.00**	**0.53**	**0.00**	**0.00**	**0.00**	**0.01**	**0.00**	**0.00**	**0.06**	**0.26**	**0.06**	**0.00**	**0.00**	**3.41**
Std Dev	**0.01**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.03**	**0.01**	**0.00**	**0.00**	**0.01**
EBS-2															
zeoltilized shards															
EBS2-F1-Sh1	72.20	0.00	12.39	0.00	0.08	0.01	0.12	0.00	0.01	1.63	3.57	1.02	0.11	0.01	91.15
EBS2-F1-Sh2	70.52	0.00	12.90	0.00	0.09	0.01	0.13	0.00	0.01	1.68	3.31	0.96	0.17	0.00	89.76
EBS2-F1-Sh3	72.31	0.01	12.32	0.00	0.05	0.00	0.14	0.00	0.01	1.66	3.88	0.98	0.00	0.00	91.35
EBS2-F2-Sh4	72.50	0.00	11.99	0.00	0.11	0.00	0.11	0.00	0.01	1.76	3.10	0.91	0.00	0.01	90.50
EBS2-F2-Sh5	71.73	0.03	12.09	0.02	0.07	0.00	0.12	0.00	0.01	1.69	4.06	1.24	0.02	0.00	91.07
EBS2-F2-Sh6	70.28	0.02	12.69	0.00	0.07	0.00	0.13	0.00	0.00	1.83	4.22	1.04	0.02	0.00	90.30
EBS2-F3-Sh7	71.85	0.00	12.81	0.00	0.08	0.01	0.11	0.01	0.01	2.12	3.81	1.00	0.12	0.01	91.94
EBS2-F3-Sh8	70.52	0.00	12.67	0.00	0.10	0.00	0.11	0.00	0.00	2.02	3.38	1.12	0.19	0.01	90.12
EBS2-F3-Sh9	69.81	0.00	12.33	0.02	0.37	0.00	0.17	0.00	0.01	0.87	4.01	1.30	0.00	0.03	88.93
Average	**71.30**	**0.01**	**12.47**	**0.00**	**0.11**	**0.00**	**0.13**	**0.00**	**0.01**	**1.69**	**3.70**	**1.06**	**0.07**	**0.01**	**90.57**
Std Dev	**1.01**	**0.01**	**0.32**	**0.01**	**0.10**	**0.00**	**0.02**	**0.00**	**0.01**	**0.35**	**0.38**	**0.13**	**0.08**	**0.01**	**0.92**
6 Oxygen Basis															
EBS2-F1-Sh1	2.51	0.00	0.51	0.00	0.00	0.00	0.01	0.00	0.00	0.06	0.24	0.05	0.01	0.00	3.39
EBS2-F1-Sh2	2.50	0.00	0.54	0.00	0.00	0.00	0.01	0.00	0.00	0.06	0.23	0.04	0.02	0.00	3.40
EBS2-F1-Sh3	2.51	0.00	0.50	0.00	0.00	0.00	0.01	0.00	0.00	0.06	0.26	0.04	0.00	0.00	3.39
EBS2-F2-Sh4	2.53	0.00	0.49	0.00	0.00	0.00	0.01	0.00	0.00	0.07	0.21	0.04	0.00	0.00	3.35
EBS2-F2-Sh5	2.51	0.00	0.50	0.00	0.00	0.00	0.01	0.00	0.00	0.06	0.27	0.06	0.00	0.00	3.41
EBS2-F2-Sh6	2.48	0.00	0.53	0.00	0.00	0.00	0.01	0.00	0.00	0.07	0.29	0.05	0.00	0.00	3.43
EBS2-F3-Sh7	2.49	0.00	0.52	0.00	0.00	0.00	0.01	0.00	0.00	0.08	0.26	0.04	0.01	0.00	3.42
EBS2-F3-Sh8	2.50	0.00	0.53	0.00	0.00	0.00	0.01	0.00	0.00	0.08	0.23	0.05	0.02	0.00	3.41
EBS2-F3-Sh9	2.50	0.00	0.52	0.00	0.01	0.00	0.01	0.00	0.00	0.03	0.28	0.06	0.00	0.00	3.41
Average	**2.50**	**0.00**	**0.52**	**0.00**	**0.00**	**0.00**	**0.01**	**0.00**	**0.00**	**0.06**	**0.25**	**0.05**	**0.01**	**0.00**	**3.40**
Std Dev	**0.01**	**0.00**	**0.02**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.03**	**0.01**	**0.01**	**0.00**	**0.02**
EBS-4															

	Weight Percent Components													
Label	**SiO_2**	**TiO_2**	**Al_2O_3**	**Cr_2O_3**	**FeO***	**MnO**	**MgO**	**NiO**	**ZnO**	**CaO**	**Na_2O**	**K_2O**	**F**	**Cl**	**Total**
	Cations														
	Si	**Ti**	**Al**	**Cr**	**Fe**	**Mn**	**Mg**	**Ni**	**Zn**	**Ca**	**Na**	**K**	**F**	**Cl**	**Sum**
EBS4-Cpt1-1	69.54	0.06	14.91	0.02	2.68	0.00	0.85	0.00	0.00	0.68	1.60	0.84	0.00	0.04	91.21
EBS4-Cpt2-1	74.50	0.00	13.08	0.00	0.16	0.00	0.13	0.00	0.00	1.55	0.32	0.48	0.00	0.01	90.24
AVERAGE	72.02	0.03	13.99	0.01	1.42	0.00	0.49	0.00	0.00	1.12	0.96	0.66	0.00	0.03	90.73
St Dev	2.48	0.03	0.92	0.01	1.26	0.00	0.36	0.00	0.00	0.44	0.64	0.18	0.00	0.01	0.49
24 oxygen Atoms per Formula Unit (sum excludes F & Cl)															
EBS4-Cpt1-1	9.71	0.01	2.45	0.00	0.31	0.00	0.18	0.00	0.00	0.10	0.43	0.15	0.00	0.01	13.35
EBS4-Cpt2-1	10.23	0.00	2.12	0.00	0.02	0.00	0.03	0.00	0.00	0.23	0.09	0.08	0.00	0.00	12.79
AVERAGE	9.97	0.00	2.29	0.00	0.17	0.00	0.10	0.00	0.00	0.17	0.26	0.12	0.00	0.01	13.07
St Dev	0.26	0.00	0.17	0.00	0.15	0.00	0.08	0.00	0.00	0.06	0.17	0.03	0.00	0.00	0.28
EBS-5															
zeoltilized shards															
EBS5-F1-Sh1	74.57	0.03	11.88	0.00	0.11	0.01	0.11	0.00	0.00	1.46	2.44	0.06	0.00	0.01	90.69
EBS5-F1-Sh2	71.46	0.00	15.91	0.00	0.09	0.01	0.00	0.02	0.04	0.59	3.21	8.03	0.00	0.01	99.37
Average	**73.01**	**0.01**	**13.90**	**0.00**	**0.10**	**0.01**	**0.06**	**0.01**	**0.02**	**1.03**	**2.83**	**4.05**	**0.00**	**0.01**	**95.03**
Std Dev	**2.20**	**0.02**	**2.85**	**0.00**	**0.01**	**0.00**	**0.08**	**0.01**	**0.03**	**0.61**	**0.54**	**5.64**	**0.00**	**0.00**	**6.14**
6 Oxygen Basis															
EBS5-F1-Sh1	2.57	0.00	0.48	0.00	0.00	0.00	0.01	0.00	0.00	0.05	0.16	0.00	0.00	0.00	3.28
EBS5-F1-Sh2	2.38	0.00	0.62	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.21	0.34	0.00	0.00	3.58
Average	**2.47**	**0.00**	**0.55**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.04**	**0.19**	**0.17**	**0.00**	**0.00**	**3.43**
Std Dev	**0.13**	**0.00**	**0.10**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.02**	**0.03**	**0.24**	**0.00**	**0.00**	**0.22**
Analcime/New Zeolite															
EBS5-F1-An1	71.70	0.00	19.14	0.00	0.24	0.01	0.08	0.00	0.02	1.60	4.32	0.07	0.05	0.01	97.21
EBS5-F1-An2	69.73	0.00	19.44	0.00	0.12	0.02	0.04	0.00	0.00	2.05	3.98	0.04	0.13	0.01	95.50
EBS5-F1-An3	70.24	0.00	19.34	0.00	0.13	0.01	0.04	0.00	0.00	1.72	4.67	0.03	0.06	0.01	96.23
EBS5-F1-An4	70.27	0.01	19.28	0.00	0.17	0.00	0.07	0.00	0.00	1.83	4.35	0.04	0.12	0.01	96.10
EBS5-F2-Anl5	69.08	0.00	19.81	0.02	0.23	0.01	0.05	0.02	0.01	1.85	4.30	0.03	0.04	0.02	95.44
EBS5-F2-Anl6	69.92	0.01	19.35	0.00	0.18	0.01	0.05	0.00	0.00	1.91	4.62	0.03	0.04	0.02	96.11
EBS5-F2-Anl7	70.09	0.00	19.35	0.01	0.20	0.02	0.08	0.00	0.00	1.81	4.67	0.04	0.05	0.01	96.31
EBS5-F2-Anl8	69.91	0.01	18.95	0.02	0.16	0.01	0.04	0.00	0.00	1.87	4.69	0.02	0.03	0.01	95.70
EBS5-F3-Anl9	69.74	0.01	18.96	0.00	0.11	0.00	0.02	0.01	0.00	2.13	4.54	0.07	0.08	0.01	95.64
EBS5-F3-Anl10	68.88	0.00	19.33	0.01	0.13	0.00	0.03	0.00	0.00	2.16	4.56	0.06	0.07	0.08	95.25
Average	**69.96**	**0.00**	**19.29**	**0.01**	**0.17**	**0.01**	**0.05**	**0.00**	**0.00**	**1.89**	**4.47**	**0.04**	**0.07**	**0.02**	**95.95**
Std Dev	**0.76**	**0.01**	**0.25**	**0.01**	**0.04**	**0.01**	**0.02**	**0.01**	**0.01**	**0.18**	**0.23**	**0.02**	**0.04**	**0.02**	**0.57**
6 Oxygen Basis															
EBS5-F1-An1	2.35	0.00	0.74	0.00	0.01	0.00	0.00	0.00	0.00	0.06	0.27	0.00	0.01	0.00	3.43
EBS5-F1-An2	2.33	0.00	0.76	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.26	0.00	0.01	0.00	3.44
EBS5-F1-An3	2.33	0.00	0.75	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.30	0.00	0.01	0.00	3.46
EBS5-F1-An4	2.33	0.00	0.75	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.28	0.00	0.01	0.00	3.45

	Weight Percent Components														
Label	**SiO_2**	**TiO_2**	**Al_2O_3**	**Cr_2O_3**	**FeO***	**MnO**	**MgO**	**NiO**	**ZnO**	**CaO**	**Na_2O**	**K_2O**	**F**	**Cl**	**Total**
	Cations														
	Si	**Ti**	**Al**	**Cr**	**Fe**	**Mn**	**Mg**	**Ni**	**Zn**	**Ca**	**Na**	**K**	**F**	**Cl**	**Sum**
EBS5-F2-Anl5	2.31	0.00	0.78	0.00	0.01	0.00	0.00	0.00	0.00	0.07	0.28	0.00	0.00	0.00	3.45
EBS5-F2-Anl6	2.32	0.00	0.76	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.30	0.00	0.00	0.00	3.46
EBS5-F2-Anl7	2.32	0.00	0.76	0.00	0.01	0.00	0.00	0.00	0.00	0.06	0.30	0.00	0.01	0.00	3.46
EBS5-F2-Anl8	2.33	0.00	0.74	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.30	0.00	0.00	0.00	3.45
EBS5-F3-Anl9	2.33	0.00	0.75	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.29	0.00	0.01	0.00	3.46
EBS5-F3-Anl10	2.31	0.00	0.76	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.30	0.00	0.01	0.00	3.47
Average	**2.32**	**0.00**	**0.76**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.07**	**0.29**	**0.00**	**0.01**	**0.00**	**3.45**
Std Dev	**0.01**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.01**	**0.00**	**0.00**	**0.00**	**0.01**
EBS-6															
zeoltilized shards															
EBS6-F1Sh1	69.51	0.00	12.66	0.00	0.09	0.01	0.18	0.01	0.01	2.82	3.14	0.02	0.00	0.01	88.43
EBS6-F1Sh2	69.80	0.00	12.32	0.00	0.08	0.01	0.16	0.00	0.01	2.52	3.06	0.01	0.00	0.01	87.98
EBS6-F1Sh3	70.74	0.01	13.00	0.01	0.07	0.03	0.17	0.00	0.00	2.42	3.28	0.02	0.13	0.00	89.89
EBS6-F2-Sh4(fine)	74.58	0.00	12.20	0.00	0.10	0.01	0.18	0.00	0.00	1.95	3.47	0.02	0.09	0.01	92.60
EBS6-F2-Sh5	73.53	0.00	12.50	0.01	0.09	0.03	0.16	0.00	0.01	1.98	3.29	0.02	0.00	0.00	91.61
EBS6-F2-Sh6	71.57	0.03	11.92	0.00	0.08	0.00	0.15	0.01	0.03	1.93	3.57	0.01	0.04	0.00	89.34
EBS6-F3-Sh7	70.60	0.04	11.48	0.02	0.07	0.01	0.15	0.01	0.00	1.81	4.00	0.01	0.03	0.01	88.23
EBS6-F3-Sh8	76.41	0.05	13.41	0.01	0.21	0.00	0.00	0.00	0.01	0.68	3.34	5.99	0.00	0.01	100.12
EBS6-F3-Sh8-2	76.73	0.13	13.92	0.00	0.34	0.00	0.00	0.01	0.00	1.22	4.05	4.50	0.08	0.01	100.98
EBS6-F3-Sh9	72.34	0.00	12.94	0.00	0.12	0.01	0.18	0.00	0.00	1.92	2.47	0.01	0.00	0.02	90.02
EBS6-F3-Sh10	72.19	0.00	12.69	0.01	0.10	0.00	0.17	0.00	0.00	2.19	2.88	0.00	0.00	0.01	90.23
Average	**72.55**	**0.02**	**12.64**	**0.01**	**0.12**	**0.01**	**0.14**	**0.00**	**0.01**	**1.95**	**3.32**	**0.97**	**0.03**	**0.01**	**91.77**
Std Dev	**2.50**	**0.04**	**0.68**	**0.01**	**0.08**	**0.01**	**0.07**	**0.00**	**0.01**	**0.59**	**0.46**	**2.14**	**0.05**	**0.00**	**4.56**
6 Oxygen Basis															
EBS6-F1Sh1	2.49	0.00	0.53	0.00	0.00	0.00	0.01	0.00	0.00	0.11	0.22	0.00	0.00	0.00	3.36
EBS6-F1Sh2	2.50	0.00	0.52	0.00	0.00	0.00	0.01	0.00	0.00	0.10	0.21	0.00	0.00	0.00	3.34
EBS6-F1Sh3	2.49	0.00	0.54	0.00	0.00	0.00	0.01	0.00	0.00	0.09	0.22	0.00	0.01	0.00	3.37
EBS6-F2-Sh4(fine)	2.54	0.00	0.49	0.00	0.00	0.00	0.01	0.00	0.00	0.07	0.23	0.00	0.01	0.00	3.35
EBS6-F2-Sh5	2.52	0.00	0.51	0.00	0.00	0.00	0.01	0.00	0.00	0.07	0.22	0.00	0.00	0.00	3.33
EBS6-F2-Sh6	2.53	0.00	0.50	0.00	0.00	0.00	0.01	0.00	0.00	0.07	0.24	0.00	0.00	0.00	3.35
EBS6-F3-Sh7	2.53	0.00	0.48	0.00	0.00	0.00	0.01	0.00	0.00	0.07	0.28	0.00	0.00	0.00	3.37
EBS6-F3-Sh8	2.48	0.00	0.51	0.00	0.01	0.00	0.00	0.00	0.00	0.02	0.21	0.25	0.00	0.00	3.49
EBS6-F3-Sh8-2	2.47	0.00	0.53	0.00	0.01	0.00	0.00	0.00	0.00	0.04	0.25	0.18	0.01	0.00	3.50
EBS6-F3-Sh9	2.52	0.00	0.53	0.00	0.00	0.00	0.01	0.00	0.00	0.07	0.17	0.00	0.00	0.00	3.30
EBS6-F3-Sh10	2.51	0.00	0.52	0.00	0.00	0.00	0.01	0.00	0.00	0.08	0.19	0.00	0.00	0.00	3.32
Average	**2.51**	**0.00**	**0.51**	**0.00**	**0.00**	**0.00**	**0.01**	**0.00**	**0.00**	**0.07**	**0.22**	**0.04**	**0.00**	**0.00**	**3.37**
Std Dev	**0.02**	**0.00**	**0.02**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.02**	**0.03**	**0.09**	**0.01**	**0.00**	**0.06**
EBS-7															
Clinoptilolite															
EBS7-Cpt1-1	59.65	0.11	15.71	0.00	3.52	0.03	1.58	0.02	0.01	4.26	1.54	0.17	0.13	0.03	86.74

	Weight Percent Components														
Label	**SiO_2**	**TiO_2**	**Al_2O_3**	**Cr_2O_3**	**FeO***	**MnO**	**MgO**	**NiO**	**ZnO**	**CaO**	**Na_2O**	**K_2O**	**F**	**Cl**	**Total**
	Cations														
	Si	**Ti**	**Al**	**Cr**	**Fe**	**Mn**	**Mg**	**Ni**	**Zn**	**Ca**	**Na**	**K**	**F**	**Cl**	**Sum**
24 oxygen Atoms per Formula Unit (sum excludes F & Cl)															
EBS7-Cpt1-1	9.03	0.01	2.80	0.00	0.45	0.00	0.36	0.00	0.00	0.69	0.45	0.03	0.06	0.01	13.831
EBS-9															
EBS9-Cpt1-1	70.04	0.05	15.11	0.00	0.99	0.01	0.57	0.00	0.01	1.94	1.11	0.31	0.00	0.03	90.17
24 oxygen Atoms per Formula Unit (sum excludes F & Cl)															
EBS9-Cpt1-1	9.78	0.00	2.49	0.00	0.12	0.00	0.12	0.00	0.00	0.29	0.30	0.05	0.00	0.01	13.15
EBS-10															
Analcime															
EBS10-Anl1-1	69.67	0.00	19.12	0.00	0.18	0.00	0.03	0.02	0.00	1.53	4.44	0.06	0.00	0.00	95.05
EBS10-Anl-2	69.83	0.03	18.98	0.00	0.21	0.01	0.05	0.01	0.02	1.13	4.04	0.02	0.03	0.00	94.36
EBS10-Anl-3	69.08	0.01	18.98	0.01	0.23	0.02	0.10	0.00	0.00	1.37	4.37	0.06	0.00	0.00	94.22
EBS10-Anl-4	68.65	0.01	18.89	0.00	0.18	0.03	0.04	0.00	0.01	1.14	5.29	0.01	0.09	0.00	94.32
EBS10-Anl-5	69.37	0.00	18.92	0.00	0.23	0.00	0.05	0.00	0.00	1.15	3.17	0.01	0.00	0.00	92.91
EBS10-Anl-6	68.03	0.01	18.72	0.00	0.16	0.01	0.02	0.01	0.00	1.64	4.07	0.03	0.00	0.01	92.71
EBS10-Anl-7	69.74	0.00	18.54	0.00	0.16	0.00	0.04	0.00	0.00	1.44	4.56	0.02	0.08	0.02	94.62
EBS10-Anl-8	69.81	0.01	19.96	0.00	0.20	0.00	0.05	0.01	0.00	1.06	3.57	0.02	0.00	0.01	94.69
EBS10-Anl-9	70.03	0.00	19.77	0.00	0.20	0.00	0.04	0.00	0.00	1.35	4.04	0.02	0.12	0.00	95.57
EBS10-Anl-10	71.44	0.13	19.86	0.00	0.60	0.02	0.22	0.01	0.01	0.88	4.42	0.20	0.03	0.01	97.84
EBS10-Anl-11	68.93	0.00	18.98	0.00	0.20	0.00	0.04	0.00	0.00	1.55	3.58	0.05	0.00	0.01	93.34
EBS10-Anl-12	68.22	0.01	19.68	0.00	0.24	0.01	0.09	0.02	0.02	0.96	3.27	0.01	0.00	0.02	92.54
EBS10-Anl-13	68.49	0.00	19.52	0.01	0.14	0.01	0.04	0.00	0.00	1.43	3.72	0.05	0.17	0.00	93.58
Average	**69.33**	**0.01**	**19.23**	**0.00**	**0.23**	**0.01**	**0.06**	**0.01**	**0.00**	**1.28**	**4.04**	**0.04**	**0.04**	**0.01**	**94.29**
Std	**0.88**	**0.03**	**0.45**	**0.00**	**0.11**	**0.01**	**0.05**	**0.01**	**0.01**	**0.23**	**0.56**	**0.05**	**0.06**	**0.01**	**1.36**
6 Oxygen Basis															
EBS10-Anl1-1	2.33	0.00	0.75	0.00	0.01	0.00	0.00	0.00	0.00	0.06	0.29	0.00	0.00	0.00	3.44
EBS10-Anl-2	2.35	0.00	0.75	0.00	0.01	0.00	0.00	0.00	0.00	0.04	0.26	0.00	0.00	0.00	3.41
EBS10-Anl-3	2.33	0.00	0.75	0.00	0.01	0.00	0.00	0.00	0.00	0.05	0.29	0.00	0.00	0.00	3.44
EBS10-Anl-4	2.33	0.00	0.75	0.00	0.01	0.00	0.00	0.00	0.00	0.04	0.35	0.00	0.01	0.00	3.48
EBS10-Anl-5	2.35	0.00	0.76	0.00	0.01	0.00	0.00	0.00	0.00	0.04	0.21	0.00	0.00	0.00	3.37
EBS10-Anl-6	2.33	0.00	0.76	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.27	0.00	0.00	0.00	3.43
EBS10-Anl-7	2.35	0.00	0.74	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.30	0.00	0.01	0.00	3.44
EBS10-Anl-8	2.33	0.00	0.79	0.00	0.01	0.00	0.00	0.00	0.00	0.04	0.23	0.00	0.00	0.00	3.39
EBS10-Anl-9	2.33	0.00	0.77	0.00	0.01	0.00	0.00	0.00	0.00	0.05	0.26	0.00	0.01	0.00	3.42
EBS10-Anl-10	2.33	0.00	0.76	0.00	0.02	0.00	0.01	0.00	0.00	0.03	0.28	0.01	0.00	0.00	3.44
EBS10-Anl-11	2.34	0.00	0.76	0.00	0.01	0.00	0.00	0.00	0.00	0.06	0.24	0.00	0.00	0.00	3.40
EBS10-Anl-12	2.33	0.00	0.79	0.00	0.01	0.00	0.00	0.00	0.00	0.04	0.22	0.00	0.00	0.00	3.39
EBS10-Anl-13	2.33	0.00	0.78	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.25	0.00	0.02	0.00	3.41
Average	**2.33**	**0.00**	**0.76**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.05**	**0.26**	**0.00**	**0.00**	**0.00**	**3.42**

	Weight Percent Components													
Label	**SiO_2**	**TiO_2**	**Al_2O_3**	**Cr_2O_3**	**FeO***	**MnO**	**MgO**	**NiO**	**ZnO**	**CaO**	**Na_2O**	**K_2O**	**F**	**Cl**	**Total**
	Cations														
	Si	**Ti**	**Al**	**Cr**	**Fe**	**Mn**	**Mg**	**Ni**	**Zn**	**Ca**	**Na**	**K**	**F**	**Cl**	**Sum**
Std	**0.01**	**0.00**	**0.02**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.04**	**0.00**	**0.01**	**0.00**	**0.03**
EBS-11															
Analcime: analyzed with 2 um spot size															
EBS11-Anl-1	68.03	0.02	18.52	0.00	0.14	0.00	0.04	0.00	0.01	1.37	4.68	0.04	0.00	0.01	92.85
EBS11-Anl-2	68.06	0.00	18.23	0.02	0.12	0.02	0.04	0.00	0.00	1.34	4.46	0.05	0.00	0.02	92.36
EBS11-Anl-3	68.82	0.00	18.44	0.00	0.16	0.01	0.04	0.00	0.01	1.52	4.49	0.09	0.00	0.00	93.60
EBS11-Anl-4	69.10	0.02	18.79	0.01	0.17	0.00	0.04	0.00	0.00	1.38	3.79	0.04	0.00	0.02	93.36
EBS11-Anl-5	69.10	0.02	18.33	0.00	0.19	0.00	0.06	0.01	0.02	1.33	3.72	0.04	0.05	0.02	92.89
EBS11-Anl-6	70.07	0.03	18.50	0.00	0.17	0.01	0.04	0.01	0.02	1.53	4.28	0.08	0.00	0.01	94.74
EBS11-Anl-7	69.71	0.00	18.86	0.00	0.18	0.01	0.04	0.01	0.02	1.33	4.29	0.04	0.09	0.01	94.60
EBS11-Anl-10	70.21	0.00	18.40	0.00	0.15	0.00	0.02	0.01	0.00	1.55	3.77	0.08	0.00	0.00	94.21
EBS11-Anl-11	68.95	0.04	19.53	0.00	0.43	0.00	0.23	0.00	0.00	0.81	3.74	0.08	0.01	0.02	93.85
EBS11-Anl-12	65.72	0.05	18.23	0.00	0.65	0.00	0.25	0.00	0.03	0.88	3.09	0.09	0.00	0.04	89.02
EBS11-Anl-13	67.06	0.07	19.47	0.00	0.47	0.01	0.26	0.00	0.02	0.93	3.79	0.13	0.07	0.01	92.29
Average	**68.62**	**0.02**	**18.66**	**0.00**	**0.26**	**0.00**	**0.10**	**0.00**	**0.01**	**1.27**	**4.01**	**0.07**	**0.02**	**0.01**	**93.07**
Std	**1.28**	**0.02**	**0.44**	**0.01**	**0.17**	**0.01**	**0.09**	**0.00**	**0.01**	**0.26**	**0.45**	**0.03**	**0.03**	**0.01**	**1.51**
6 Oxygen Basis															
EBS11-Anl-1	2.33	0.00	0.75	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.31	0.00	0.00	0.00	3.45
EBS11-Anl-2	2.34	0.00	0.74	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.30	0.00	0.00	0.00	3.44
EBS11-Anl-3	2.34	0.00	0.74	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.30	0.00	0.00	0.00	3.44
EBS11-Anl-4	2.34	0.00	0.75	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.25	0.00	0.00	0.00	3.40
EBS11-Anl-5	2.36	0.00	0.74	0.00	0.01	0.00	0.00	0.00	0.00	0.05	0.25	0.00	0.00	0.00	3.40
EBS11-Anl-6	2.35	0.00	0.73	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.28	0.00	0.00	0.00	3.43
EBS11-Anl-7	2.34	0.00	0.75	0.00	0.01	0.00	0.00	0.00	0.00	0.05	0.28	0.00	0.01	0.00	3.43
EBS11-Anl-10	2.36	0.00	0.73	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.25	0.00	0.00	0.00	3.40
EBS11-Anl-11	2.33	0.00	0.78	0.00	0.01	0.00	0.01	0.00	0.00	0.03	0.25	0.00	0.00	0.00	3.41
EBS11-Anl-12	2.34	0.00	0.76	0.00	0.02	0.00	0.01	0.00	0.00	0.03	0.21	0.00	0.00	0.00	3.39
EBS11-Anl-13	2.31	0.00	0.79	0.00	0.01	0.00	0.01	0.00	0.00	0.03	0.25	0.01	0.01	0.00	3.43
Average	**2.34**	**0.00**	**0.75**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.05**	**0.27**	**0.00**	**0.00**	**0.00**	**3.42**
Std	**0.01**	**0.00**	**0.02**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.03**	**0.00**	**0.00**	**0.00**	**0.02**
Analcime: analyzed with 20 um spot size															
EBS11-Anl-8 20u	64.05	0.00	17.76	0.00	0.10	0.00	0.02	0.01	0.00	1.51	8.50	0.10	0.10	0.00	92.15
EBS11-Anl-9 20u	64.70	0.00	17.76	0.00	0.08	0.01	0.01	0.01	0.00	1.46	7.64	0.09	0.00	0.01	91.77
Average	**64.37**	**0.00**	**17.76**	**0.00**	**0.09**	**0.00**	**0.02**	**0.01**	**0.00**	**1.49**	**8.07**	**0.09**	**0.05**	**0.00**	**91.96**
Std Dev	**0.46**	**0.00**	**0.00**	**0.00**	**0.01**	**0.00**	**0.01**	**0.00**	**0.00**	**0.03**	**0.61**	**0.01**	**0.07**	**0.00**	**0.27**
6 Oxygen Basis															
EBS11-Anl-8 20u	2.27	0.00	0.74	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.58	0.00	0.01	0.00	3.66
EBS11-Anl-9 20u	2.28	0.00	0.74	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.52	0.00	0.00	0.00	3.61
Average	**2.28**	**0.00**	**0.74**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.06**	**0.55**	**0.00**	**0.01**	**0.00**	**3.63**
Std Dev	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.04**	**0.00**	**0.01**	**0.00**	**0.04**

	Weight Percent Components													
Label	**SiO_2**	**TiO_2**	**Al_2O_3**	**Cr_2O_3**	**FeO***	**MnO**	**MgO**	**NiO**	**ZnO**	**CaO**	**Na_2O**	**K_2O**	**F**	**Cl**	**Total**
	Cations														
	Si	**Ti**	**Al**	**Cr**	**Fe**	**Mn**	**Mg**	**Ni**	**Zn**	**Ca**	**Na**	**K**	**F**	**Cl**	**Sum**
EBS-12															
EBS12-Anl?-1	71.17	0.00	18.61	0.00	0.33	0.01	0.20	0.00	0.00	0.55	1.83	0.05	0.02	0.01	92.78
EBS12-Anl?-2	70.45	0.03	18.66	0.00	0.27	0.01	0.14	0.00	0.00	0.45	4.02	0.04	0.00	0.01	94.08
EBS12-Anl?-2	67.71	0.03	19.56	0.02	0.35	0.00	0.17	0.00	0.01	0.43	2.09	0.03	0.07	0.02	90.50
EBS12-Anl?-3	70.62	0.01	18.97	0.02	0.38	0.02	0.17	0.01	0.00	0.50	3.90	0.02	0.06	0.01	94.69
EBS12-Anl?-4	70.39	0.04	18.69	0.00	0.33	0.01	0.23	0.00	0.03	0.43	3.91	0.12	0.03	0.02	94.23
EBS12-Anl?-5	69.20	0.03	19.38	0.00	0.48	0.02	0.28	0.00	0.03	0.44	2.10	0.01	0.00	0.00	91.98
EBS12-Anl?-6	73.78	0.03	11.06	0.00	0.08	0.00	0.18	0.00	0.00	1.32	2.21	0.10	0.00	0.00	88.77
Average	**70.48**	**0.02**	**17.85**	**0.01**	**0.32**	**0.01**	**0.19**	**0.00**	**0.01**	**0.59**	**2.87**	**0.05**	**0.03**	**0.01**	**92.43**
Std	**1.72**	**0.01**	**2.79**	**0.01**	**0.11**	**0.01**	**0.04**	**0.00**	**0.01**	**0.30**	**0.94**	**0.04**	**0.03**	**0.01**	**2.02**
6 Oxygen Basis															
EBS12-Anl?-1	2.40	0.00	0.74	0.00	0.01	0.00	0.01	0.00	0.00	0.02	0.12	0.00	0.00	0.00	3.30
EBS12-Anl?-2	2.36	0.00	0.74	0.00	0.01	0.00	0.01	0.00	0.00	0.02	0.26	0.00	0.00	0.00	3.40
EBS12-Anl?-2	2.35	0.00	0.80	0.00	0.01	0.00	0.01	0.00	0.00	0.02	0.14	0.00	0.01	0.00	3.33
EBS12-Anl?-3	2.36	0.00	0.75	0.00	0.01	0.00	0.01	0.00	0.00	0.02	0.25	0.00	0.01	0.00	3.40
EBS12-Anl?-4	2.36	0.00	0.74	0.00	0.01	0.00	0.01	0.00	0.00	0.02	0.25	0.01	0.00	0.00	3.40
EBS12-Anl?-5	2.36	0.00	0.78	0.00	0.01	0.00	0.01	0.00	0.00	0.02	0.14	0.00	0.00	0.00	3.32
EBS12-Anl?-6	2.59	0.00	0.46	0.00	0.00	0.00	0.01	0.00	0.00	0.05	0.15	0.00	0.00	0.00	3.26
Average	**2.40**	**0.00**	**0.71**	**0.00**	**0.01**	**0.00**	**0.01**	**0.00**	**0.00**	**0.02**	**0.19**	**0.00**	**0.00**	**0.00**	**3.34**
Std	**0.08**	**0.00**	**0.11**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.06**	**0.00**	**0.00**	**0.00**	**0.05**
EBS-13															
EB13-Anl1-1	69.04	0.00	19.06	0.00	0.22	0.00	0.06	0.01	0.00	0.52	5.73	0.21	0.01	0.02	94.87
EB13-Anl-2	67.99	0.00	18.24	0.00	0.13	0.01	0.01	0.02	0.00	1.85	5.18	0.06	0.00	0.01	93.49
EB13-Anl-3	68.85	0.00	18.65	0.00	0.09	0.01	0.02	0.00	0.01	1.94	5.61	0.05	0.08	0.02	95.33
EB13-Anl-4	68.67	0.01	18.85	0.00	0.09	0.00	0.01	0.00	0.00	1.94	5.44	0.07	0.00	0.00	95.08
EB13-Anl-5	68.80	0.00	19.20	0.00	0.11	0.01	0.03	0.00	0.01	1.00	5.56	0.03	0.00	0.01	94.76
EB13-Anl-6	69.48	0.02	18.54	0.02	0.10	0.01	0.03	0.01	0.02	1.86	5.76	0.07	0.00	0.00	95.92
EB13-Anl-7	68.19	0.00	18.97	0.02	0.15	0.01	0.03	0.01	0.01	2.10	5.86	0.09	0.02	0.00	95.44
EB13-Anl-8	69.79	0.01	17.85	0.00	0.27	0.01	0.09	0.00	0.01	0.65	5.97	0.19	0.00	0.03	94.88
EB13-Anl-9	69.45	0.00	18.90	0.00	0.19	0.01	0.04	0.03	0.03	0.60	6.65	0.03	0.00	0.00	95.94
EB13-Anl-10	68.21	0.02	18.50	0.00	0.17	0.02	0.02	0.00	0.00	1.80	6.01	0.07	0.00	0.00	94.83
EB13-Anl-11	68.10	0.02	18.60	0.02	0.12	0.01	0.00	0.03	0.00	1.85	5.91	0.06	0.00	0.00	94.72
EB13-Anl-12	67.81	0.01	19.11	0.01	0.16	0.00	0.03	0.00	0.00	2.11	5.33	0.09	0.04	0.01	94.69
Average	**68.70**	**0.01**	**18.70**	**0.01**	**0.15**	**0.01**	**0.03**	**0.01**	**0.01**	**1.52**	**5.75**	**0.09**	**0.01**	**0.01**	**95.00**
Std Dev	**0.65**	**0.01**	**0.39**	**0.01**	**0.06**	**0.01**	**0.02**	**0.01**	**0.01**	**0.63**	**0.38**	**0.06**	**0.02**	**0.01**	**0.65**
6 Oxygen Basis															
EB13-Anl1-1	2.32	0.00	0.76	0.00	0.01	0.00	0.00	0.00	0.00	0.02	0.37	0.01	0.00	0.00	3.49
EB13-Anl-2	2.33	0.00	0.74	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.34	0.00	0.00	0.00	3.48
EB13-Anl-3	2.32	0.00	0.74	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.37	0.00	0.01	0.00	3.50

	Weight Percent Components														
Label	SiO_2	TiO_2	Al_2O_3	Cr_2O_3	FeO*	MnO	MgO	NiO	ZnO	CaO	Na_2O	K_2O	F	Cl	Total
	Cations														
	Si	Ti	Al	Cr	Fe	Mn	Mg	Ni	Zn	Ca	Na	K	F	Cl	Sum
EB13-Anl-4	2.31	0.00	0.75	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.36	0.00	0.00	0.00	3.49
EB13-Anl-5	2.32	0.00	0.76	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.36	0.00	0.00	0.00	3.48
EB13-Anl-6	2.32	0.00	0.73	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.37	0.00	0.00	0.00	3.50
EB13-Anl-7	2.30	0.00	0.75	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.38	0.00	0.00	0.00	3.52
EB13-Anl-8	2.35	0.00	0.71	0.00	0.01	0.00	0.00	0.00	0.00	0.02	0.39	0.01	0.00	0.00	3.49
EB13-Anl-9	2.32	0.00	0.74	0.00	0.01	0.00	0.00	0.00	0.00	0.02	0.43	0.00	0.00	0.00	3.53
EB13-Anl-10	2.31	0.00	0.74	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.39	0.00	0.00	0.00	3.52
EB13-Anl-11	2.31	0.00	0.74	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.39	0.00	0.00	0.00	3.52
EB13-Anl-12	2.30	0.00	0.76	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.35	0.00	0.00	0.00	3.50
Average	**2.32**	**0.00**	**0.74**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.05**	**0.38**	**0.00**	**0.00**	**0.00**	**3.50**
Std Dev	**0.01**	**0.00**	**0.02**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.02**	**0.02**	**0.00**	**0.00**	**0.00**	**0.01**
EBS-14															
Wairaikite															
EB14-Anl-0	57.60	0.01	22.39	0.00	0.10	0.02	0.00	0.00	0.00	10.64	1.66	0.07	0.00	0.01	92.48
EB14-Anl-1	57.05	0.01	21.73	0.01	0.08	0.03	0.00	0.00	0.02	10.50	1.46	0.07	0.05	0.01	90.99
EB14-Anl-2	56.05	0.01	22.01	0.00	0.12	0.01	0.00	0.00	0.01	10.76	1.36	0.05	0.00	0.01	90.39
EB14-Anl-3	57.58	0.00	22.40	0.02	0.12	0.00	0.00	0.01	0.02	10.17	1.89	0.06	0.06	0.00	92.34
EB14-Anl-4	57.45	0.02	21.70	0.01	0.10	0.01	0.00	0.01	0.00	10.57	1.48	0.06	0.00	0.01	91.42
EB14-Anl-5	56.32	0.02	21.95	0.01	0.08	0.02	0.00	0.00	0.00	10.94	1.30	0.05	0.00	0.00	90.70
EB14-Anl-6	55.41	0.00	21.94	0.00	0.07	0.00	0.00	0.01	0.00	10.47	1.74	0.05	0.06	0.00	89.77
EB14-Anl-7	57.08	0.01	21.76	0.00	0.08	0.01	0.00	0.00	0.00	10.69	1.31	0.05	0.00	0.00	90.99
EB14-Anl-8	57.78	0.00	21.52	0.01	0.10	0.00	0.00	0.00	0.00	9.73	1.96	0.08	0.00	0.00	91.18
EB14-Anl-9	57.62	0.03	21.58	0.00	0.10	0.00	0.00	0.00	0.02	10.04	1.81	0.07	0.01	0.01	91.28
EB14-Anl-10	57.84	0.02	21.48	0.00	0.11	0.00	0.00	0.01	0.01	10.24	1.67	0.06	0.04	0.00	91.47
EB14-Anl-11	59.22	0.02	21.28	0.01	0.05	0.01	0.00	0.00	0.02	10.05	1.76	0.05	0.00	0.00	92.46
EB14-Anl-12	57.32	0.03	21.90	0.00	0.08	0.00	0.00	0.00	0.01	10.34	1.61	0.05	0.02	0.01	91.38
EB14-Anl-13	57.23	0.03	21.66	0.00	0.10	0.00	0.04	0.01	0.00	10.72	1.42	0.06	0.00	0.02	91.31
EB14-Anl-14	56.18	0.00	21.89	0.01	0.11	0.00	0.00	0.00	0.01	10.83	1.40	0.06	0.00	0.01	90.51
EB14-Anl-15	56.72	0.00	21.65	0.01	0.13	0.00	0.00	0.00	0.00	10.27	1.59	0.06	0.23	0.00	90.66
EB14-Anl-16	53.71	0.00	21.21	0.01	0.06	0.00	0.00	0.02	0.00	10.45	1.36	0.07	0.00	0.01	86.90
Average	**56.95**	**0.01**	**21.77**	**0.01**	**0.09**	**0.01**	**0.00**	**0.00**	**0.01**	**10.44**	**1.57**	**0.06**	**0.03**	**0.01**	**90.96**
Std Dev	1.20	0.01	0.32	0.01	0.02	0.01	0.01	0.01	0.01	0.32	0.21	0.01	0.06	0.01	1.27
6 Oxygen Basis															
EB14-Anl-0	2.06	0.00	0.94	0.00	0.00	0.00	0.00	0.00	0.00	0.41	0.11	0.00	0.00	0.00	3.53
EB14-Anl-1	2.07	0.00	0.93	0.00	0.00	0.00	0.00	0.00	0.00	0.41	0.10	0.00	0.01	0.00	3.52
EB14-Anl-2	2.05	0.00	0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.42	0.10	0.00	0.00	0.00	3.52
EB14-Anl-3	2.06	0.00	0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.39	0.13	0.00	0.01	0.00	3.54
EB14-Anl-4	2.07	0.00	0.92	0.00	0.00	0.00	0.00	0.00	0.00	0.41	0.10	0.00	0.00	0.00	3.52
EB14-Anl-5	2.05	0.00	0.94	0.00	0.00	0.00	0.00	0.00	0.00	0.43	0.09	0.00	0.00	0.00	3.52
EB14-Anl-6	2.05	0.00	0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.41	0.12	0.00	0.01	0.00	3.54
EB14-Anl-7	2.07	0.00	0.93	0.00	0.00	0.00	0.00	0.00	0.00	0.42	0.09	0.00	0.00	0.00	3.51
EB14-Anl-8	2.09	0.00	0.92	0.00	0.00	0.00	0.00	0.00	0.00	0.38	0.14	0.00	0.00	0.00	3.52

	Weight Percent Components													
Label	**SiO_2**	**TiO_2**	**Al_2O_3**	**Cr_2O_3**	**FeO***	**MnO**	**MgO**	**NiO**	**ZnO**	**CaO**	**Na_2O**	**K_2O**	**F**	**Cl**	**Total**
	Cations														
	Si	**Ti**	**Al**	**Cr**	**Fe**	**Mn**	**Mg**	**Ni**	**Zn**	**Ca**	**Na**	**K**	**F**	**Cl**	**Sum**
EB14-Anl-9	2.08	0.00	0.92	0.00	0.00	0.00	0.00	0.00	0.00	0.39	0.13	0.00	0.00	0.00	3.52
EB14-Anl-10	2.09	0.00	0.91	0.00	0.00	0.00	0.00	0.00	0.00	0.40	0.12	0.00	0.00	0.00	3.52
EB14-Anl-11	2.11	0.00	0.89	0.00	0.00	0.00	0.00	0.00	0.00	0.38	0.12	0.00	0.00	0.00	3.51
EB14-Anl-12	2.07	0.00	0.93	0.00	0.00	0.00	0.00	0.00	0.00	0.40	0.11	0.00	0.00	0.00	3.52
EB14-Anl-13	2.07	0.00	0.92	0.00	0.00	0.00	0.00	0.00	0.00	0.42	0.10	0.00	0.00	0.00	3.52
EB14-Anl-14	2.05	0.00	0.94	0.00	0.00	0.00	0.00	0.00	0.00	0.42	0.10	0.00	0.00	0.00	3.53
EB14-Anl-15	2.07	0.00	0.93	0.00	0.00	0.00	0.00	0.00	0.00	0.40	0.11	0.00	0.03	0.00	3.53
EB14-Anl-16	2.05	0.00	0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.43	0.10	0.00	0.00	0.00	3.53
Average	**2.07**	**0.00**	**0.93**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.41**	**0.11**	**0.00**	**0.00**	**0.00**	**3.52**
Std Dev	**0.02**	**0.00**	**0.02**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.02**	**0.01**	**0.00**	**0.01**	**0.00**	**0.01**
EBS-15															
Analcime															
EB15-Anl-1	65.29	0.00	19.90	0.01	0.54	0.01	0.12	0.00	0.00	3.57	4.15	0.01	0.00	0.01	93.61
EB15-Anl-2	65.79	0.03	20.34	0.00	0.23	0.01	0.06	0.01	0.00	3.91	4.40	0.04	0.00	0.01	94.82
EB15-Anl-3	65.92	0.01	20.75	0.00	0.19	0.02	0.04	0.02	0.03	4.20	3.39	0.03	0.08	0.00	94.69
EB15-Anl-4	66.44	0.01	19.63	0.00	0.48	0.02	0.13	0.02	0.00	3.53	3.41	0.03	0.07	0.03	93.78
EB15-Anl-5	66.29	0.01	20.25	0.00	0.41	0.02	0.11	0.02	0.00	3.71	3.50	0.02	0.00	0.02	94.37
EB15-Anl-6	66.21	0.04	19.43	0.01	0.42	0.03	0.09	0.00	0.00	3.83	2.90	0.01	0.00	0.02	92.99
EB15-Anl-7	65.54	0.01	20.23	0.00	0.55	0.02	0.17	0.00	0.01	3.45	3.39	0.05	0.00	0.02	93.45
EB15-Anl-8	65.61	0.00	19.52	0.00	0.30	0.02	0.05	0.02	0.00	4.05	3.67	0.03	0.08	0.01	93.36
EB15-Anl-9	65.92	0.04	19.15	0.00	0.35	0.01	0.13	0.00	0.01	3.57	4.36	0.02	0.02	0.02	93.60
EB15-Anl-10	66.11	0.01	19.05	0.00	0.19	0.01	0.04	0.01	0.00	3.66	3.89	0.06	0.00	0.02	93.05
EB15-Anl-11	65.82	0.02	19.36	0.03	0.34	0.00	0.11	0.01	0.00	3.78	3.77	0.02	0.11	0.01	93.39
EB15-Anl-12	66.19	0.01	19.23	0.01	0.25	0.00	0.09	0.01	0.00	3.95	3.79	0.01	0.00	0.02	93.55
EB15-Anl-13	65.73	0.00	20.06	0.00	0.24	0.02	0.06	0.00	0.03	3.72	4.37	0.08	0.00	0.03	94.34
Average	**65.91**	**0.01**	**19.76**	**0.01**	**0.34**	**0.01**	**0.09**	**0.01**	**0.01**	**3.76**	**3.77**	**0.03**	**0.03**	**0.02**	**93.77**
Std Dev	0.33	0.01	0.53	0.01	0.13	0.01	0.04	0.01	0.01	0.22	0.46	0.02	0.04	0.01	0.60
6 Oxygen Basis															
EB15-Anl-1	2.25	0.00	0.81	0.00	0.02	0.00	0.01	0.00	0.00	0.13	0.28	0.00	0.00	0.00	3.49
EB15-Anl-2	2.24	0.00	0.82	0.00	0.01	0.00	0.00	0.00	0.00	0.14	0.29	0.00	0.00	0.00	3.50
EB15-Anl-3	2.24	0.00	0.83	0.00	0.01	0.00	0.00	0.00	0.00	0.15	0.22	0.00	0.01	0.00	3.46
EB15-Anl-4	2.28	0.00	0.79	0.00	0.01	0.00	0.01	0.00	0.00	0.13	0.23	0.00	0.01	0.00	3.45
EB15-Anl-5	2.26	0.00	0.81	0.00	0.01	0.00	0.01	0.00	0.00	0.14	0.23	0.00	0.00	0.00	3.45
EB15-Anl-6	2.28	0.00	0.79	0.00	0.01	0.00	0.00	0.00	0.00	0.14	0.19	0.00	0.00	0.00	3.42
EB15-Anl-7	2.25	0.00	0.82	0.00	0.02	0.00	0.01	0.00	0.00	0.13	0.23	0.00	0.00	0.00	3.45
EB15-Anl-8	2.26	0.00	0.79	0.00	0.01	0.00	0.00	0.00	0.00	0.15	0.25	0.00	0.01	0.00	3.47
EB15-Anl-9	2.27	0.00	0.78	0.00	0.01	0.00	0.01	0.00	0.00	0.13	0.29	0.00	0.00	0.00	3.49
EB15-Anl-10	2.28	0.00	0.77	0.00	0.01	0.00	0.00	0.00	0.00	0.14	0.26	0.00	0.00	0.00	3.46
EB15-Anl-11	2.27	0.00	0.79	0.00	0.01	0.00	0.01	0.00	0.00	0.14	0.25	0.00	0.01	0.00	3.47
EB15-Anl-12	2.27	0.00	0.78	0.00	0.01	0.00	0.00	0.00	0.00	0.15	0.25	0.00	0.00	0.00	3.46
EB15-Anl-13	2.25	0.00	0.81	0.00	0.01	0.00	0.00	0.00	0.00	0.14	0.29	0.00	0.00	0.00	3.50
Average	**2.26**	**0.00**	**0.80**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.14**	**0.25**	**0.00**	**0.00**	**0.00**	**3.47**
Std Dev	**0.01**	**0.00**	**0.02**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.03**	**0.00**	**0.00**	**0.00**	**0.02**

	Weight Percent Components													
Label	**SiO_2**	**TiO_2**	**Al_2O_3**	**Cr_2O_3**	**FeO***	**MnO**	**MgO**	**NiO**	**ZnO**	**CaO**	**Na_2O**	**K_2O**	**F**	**Cl**	**Total**
	Cations														
	Si	**Ti**	**Al**	**Cr**	**Fe**	**Mn**	**Mg**	**Ni**	**Zn**	**Ca**	**Na**	**K**	**F**	**Cl**	**Sum**
EBS-16															
Analcime															
EB16-Anl-1	68.93	0.00	18.54	0.00	0.11	0.02	0.02	0.00	0.00	1.20	4.75	0.04	0.00	0.00	93.63
EB16-Anl-2	69.87	0.02	18.68	0.00	0.16	0.00	0.04	0.00	0.02	0.63	5.49	0.02	0.00	0.01	94.95
EB16-Anl-3	69.42	0.00	18.69	0.00	0.11	0.01	0.02	0.00	0.00	1.16	5.21	0.04	0.18	0.00	94.84
EB16-Anl-4	68.37	0.00	18.63	0.01	0.11	0.00	0.01	0.01	0.00	1.39	5.25	0.05	0.00	0.00	93.84
EB16-Anl-5	69.27	0.02	18.37	0.00	0.48	0.00	0.02	0.01	0.00	1.40	5.09	0.06	0.12	0.01	94.84
EB16-Anl-6	68.67	0.01	18.71	0.02	0.11	0.00	0.02	0.00	0.00	0.63	5.73	0.02	0.00	0.00	93.92
EB16-Anl-7	68.66	0.00	18.42	0.00	0.07	0.00	0.03	0.00	0.00	0.82	5.86	0.02	0.05	0.00	93.94
EB16-Anl-8	68.25	0.00	18.86	0.00	0.15	0.03	0.04	0.00	0.01	0.63	5.39	0.04	0.05	0.01	93.45
EB16-Anl-9	69.79	0.02	18.60	0.00	0.13	0.01	0.04	0.00	0.00	0.55	5.31	0.05	0.00	0.01	94.52
EB16-Anl-10	68.17	0.01	18.34	0.00	0.09	0.03	0.01	0.00	0.00	1.47	5.03	0.07	0.04	0.00	93.27
Average	**68.94**	**0.01**	**18.58**	**0.00**	**0.15**	**0.01**	**0.03**	**0.00**	**0.00**	**0.99**	**5.31**	**0.04**	**0.05**	**0.00**	**94.12**
Std Dev	**0.62**	**0.01**	**0.17**	**0.01**	**0.12**	**0.01**	**0.01**	**0.00**	**0.01**	**0.37**	**0.33**	**0.02**	**0.06**	**0.00**	**0.62**
6 Oxygen Basis															
EB16-Anl-1	2.34	0.00	0.74	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.31	0.00	0.00	0.00	3.45
EB16-Anl-2	2.34	0.00	0.74	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.36	0.00	0.00	0.00	3.47
EB16-Anl-3	2.34	0.00	0.74	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.34	0.00	0.02	0.00	3.47
EB16-Anl-4	2.33	0.00	0.75	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.35	0.00	0.00	0.00	3.48
EB16-Anl-5	2.34	0.00	0.73	0.00	0.01	0.00	0.00	0.00	0.00	0.05	0.33	0.00	0.01	0.00	3.47
EB16-Anl-6	2.33	0.00	0.75	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.38	0.00	0.00	0.00	3.48
EB16-Anl-7	2.33	0.00	0.74	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.39	0.00	0.01	0.00	3.49
EB16-Anl-8	2.33	0.00	0.76	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.36	0.00	0.01	0.00	3.47
EB16-Anl-9	2.35	0.00	0.74	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.35	0.00	0.00	0.00	3.46
EB16-Anl-10	2.33	0.00	0.74	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.33	0.00	0.00	0.00	3.47
Average	**2.34**	**0.00**	**0.74**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.04**	**0.35**	**0.00**	**0.00**	**0.00**	**3.47**
Std Dev	**0.01**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.02**	**0.00**	**0.01**	**0.00**	**0.01**
EBS-17															
Analcime															
EB17-Anl-1	64.82	0.03	20.36	0.00	0.20	0.01	0.03	0.01	0.00	4.05	4.12	0.02	0.00	0.01	93.67
EB17-Anl-2	64.74	0.03	21.00	0.00	0.70	0.02	0.22	0.00	0.00	4.07	4.14	0.03	0.12	0.04	95.11
EB17-Anl-3	65.07	0.01	20.95	0.00	0.40	0.00	0.12	0.02	0.00	3.94	4.41	0.02	0.07	0.02	95.02
EB17-Anl-4	65.62	0.01	19.40	0.00	0.51	0.00	0.14	0.01	0.00	4.21	3.63	0.07	0.00	0.01	93.62
EB17-Anl-5	65.84	0.00	19.86	0.00	0.24	0.01	0.06	0.02	0.02	4.04	4.17	0.02	0.00	0.01	94.30
EB17-Anl-6	65.64	0.03	19.87	0.00	0.16	0.00	0.04	0.00	0.00	4.18	4.17	0.02	0.06	0.02	94.20
EB17-Anl-7	65.17	0.01	19.69	0.00	0.17	0.01	0.04	0.02	0.02	4.38	3.74	0.03	0.00	0.01	93.29
EB17-Anl-8	65.64	0.01	19.86	0.00	0.16	0.01	0.04	0.00	0.01	4.01	3.88	0.04	0.00	0.01	93.66
EB17-Anl-9	65.73	0.00	19.72	0.01	0.13	0.00	0.04	0.02	0.00	4.16	4.28	0.03	0.00	0.01	94.12
EB17-Anl-10	66.49	0.03	19.89	0.00	0.27	0.01	0.09	0.00	0.02	3.76	4.30	0.04	0.04	0.00	94.94

Label	Weight Percent Components														
Label	**SiO_2**	**TiO_2**	**Al_2O_3**	**Cr_2O_3**	**FeO***	**MnO**	**MgO**	**NiO**	**ZnO**	**CaO**	**Na_2O**	**K_2O**	**F**	**Cl**	**Total**
	Cations														
	Si	**Ti**	**Al**	**Cr**	**Fe**	**Mn**	**Mg**	**Ni**	**Zn**	**Ca**	**Na**	**K**	**F**	**Cl**	**Sum**
Average	**65.47**	**0.01**	**20.06**	**0.00**	**0.29**	**0.01**	**0.08**	**0.01**	**0.01**	**4.08**	**4.09**	**0.03**	**0.03**	**0.01**	**94.19**
Std Dev	**0.53**	**0.01**	**0.54**	**0.00**	**0.19**	**0.01**	**0.06**	**0.01**	**0.01**	**0.17**	**0.25**	**0.02**	**0.04**	**0.01**	**0.65**
6 Oxygen Basis															
EB17-Anl-1	2.23	0.00	0.83	0.00	0.01	0.00	0.00	0.00	0.00	0.15	0.28	0.00	0.00	0.00	3.49
EB17-Anl-2	2.21	0.00	0.85	0.00	0.02	0.00	0.01	0.00	0.00	0.15	0.27	0.00	0.01	0.00	3.51
EB17-Anl-3	2.22	0.00	0.84	0.00	0.01	0.00	0.01	0.00	0.00	0.14	0.29	0.00	0.01	0.00	3.51
EB17-Anl-4	2.26	0.00	0.79	0.00	0.01	0.00	0.01	0.00	0.00	0.16	0.24	0.00	0.00	0.00	3.47
EB17-Anl-5	2.25	0.00	0.80	0.00	0.01	0.00	0.00	0.00	0.00	0.15	0.28	0.00	0.00	0.00	3.49
EB17-Anl-6	2.25	0.00	0.80	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.28	0.00	0.01	0.00	3.49
EB17-Anl-7	2.25	0.00	0.80	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.25	0.00	0.00	0.00	3.47
EB17-Anl-8	2.25	0.00	0.80	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.26	0.00	0.00	0.00	3.47
EB17-Anl-9	2.25	0.00	0.80	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.28	0.00	0.00	0.00	3.49
EB17-Anl-10	2.26	0.00	0.80	0.00	0.01	0.00	0.00	0.00	0.00	0.14	0.28	0.00	0.00	0.00	3.49
Average	**2.24**	**0.00**	**0.81**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.15**	**0.27**	**0.00**	**0.00**	**0.00**	**3.49**
Std Dev	**0.02**	**0.00**	**0.02**	**0.00**	**0.01**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.02**	**0.00**	**0.00**	**0.00**	**0.01**

APPENDIX C1:

Aqueous Geochemical Data

EBS-1

Sample ID	Date Sampled	Al	As	Ba	Ca	Cl	F	Fe	K	Std. D.	Mo	Na	Std. D.	Se	Si	Std. D.	SiO2	Std. D.	SO4	Sr	Ti	Zn	TDS	Cation	Anion	Balance
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	+/-	ppm	ppm	+/-	ppm	ppm	+/-	calc ppm	+/-	ppm	ppm	ppm	ppm	ppm	Sum	Sum	
ESB 01/00		<0.05	<0.01	<0.05	89	1045	<0.2	<0.5	583	3	<0.05	167	2	<0.05	1	0	2	0	47	0.05	<0.05	<0.05	1934	27	30	-0.07
EBS 1/01 F	7/27/2011	0.06	0.01	0.09	33	---	---	<0.5	458	0	0.06	403	3	<0.05	46	0	98	1	---	0.25	<0.05	<0.05	992	31	0	1
EBS 1/02 F	8/1/2011	<0.05	0.03	0.10	18	---	---	<0.5	276	1	0.14	581	0	<0.05	87	1	186	2	---	0.24	<0.05	<0.05	1061	33	0	1
EBS 1/03 F	8/8/2011	<0.05	0.03	0.12	17	---	---	<0.5	207	2	0.16	687	8	<0.05	102	0	217	1	---	0.23	<0.05	0.57	1130	36	0	1
EBS 1/04 F	8/11/2011	0.39	0.04	0.10	14	---	---	<0.5	174	1	0.13	683	1	<0.05	296	2	634	5	---	0.13	0.07	0.60	1507	35	0	1
EBS 1/05 F	8/15/2011	0.15	0.04	0.09	12	---	---	1.0	155	1	0.09	690	5	<0.05	322	3	690	6		0.09	0.07	0.50	1549	35	0	1
EBS 1/06F	8/24/2011	1.46	0.34	0.08	3	---	---	<0.5	98	1	<0.05	647	4	<0.05	584	1	1250	2	---	<0.05	0.11	0.52	2000	31	0	1
EBS 1/07 Q	8/23/2011	<0.05	0.02	0.02	10	1458	1.39	<0.5	37	0	<0.005	584	2	0.01	137	1	293	2	201	0.06	0.02	0.04	2585	27	45	-0.26

EBS-2

Sample ID	Date Sampled	Al	Std. D.	As	Ba	Ca	Std. D.	Cl	Cr	Cu	F	K	Std. D.	Mo	Na	Std. D.	Se	Si	Std. D.	SiO2	Std. D.	SO4	Sr	Ti	Zn	TDS	Cation	Anion	Balance
		ppm	+/-	ppm	ppm	ppm	+/-	ppm	ppm	ppm	ppm	ppm	+/-	ppm	ppm	+/-	ppm	ppm	+/-	ppm	+/-	ppm	ppm	ppm	ppm	Ppm	Sum	Sum	
EBS 2/01 F	7/27/2011	0.07	0.01	<0.01	0.08	39	1	---	<0.05	<0.05	---	469	7	0.07	362	4	<0.05	34	0	73	1	---	0.20	<0.05	<0.05	943	30	0	1.00
EBS 2/02 F	8/1/2011	<0.05		<0.01	0.09	18	1	---	<0.05	<0.05	---	254	4	0.16	540	7	<0.05	76	1	164	2	---	0.18	<0.05	0.35	976	31	0	1.00
EBS 2/03 F	8/8/2011	<0.05		<0.01	0.09	18	0	---	<0.05	<0.05	---	170	1	0.15	575	3	<0.05	94	1	202	3	---	0.12	<0.05	0.44	966	30	0	1.00
EBS 2/04 F	8/11/2011	0.16	0.01	<0.01	0.10	18	0	---	<0.05	<0.05	---	149	0	0.09	568	12	<0.05	274	1	586	3	---	0.09	0.07	0.68	1322	29	0	1.00
EBS 2/05 F	8/15/2011	0.12	0.01	<0.01	0.10	17	0	---	<0.05	<0.05	---	119	2	<0.05	521	2	<0.05	284	3	608	7	---	0.08	0.07	0.40	1266	27	0	1.00
EBS 2/06 F	8/22/2011	0.47	0.00	0.06	0.09	5	0	---	<0.05	<0.05	---	84	0	<0.05	452	1	<0.05	546	1	1168	2	---	<0.05	0.12	0.48	1710	22	0	1.00
EBS 2/07 Q	8/24/2011	3.50	0.05	0.01	0.02	11	0	772	0.007	0.011	1.62	44	1	<0.005	407	7	0.01	129	1	276	3	114	0.08	0.03	0.01	1629	20	24	-0.10

EBS-3

Sample ID	Date analyzed	Date Sampled	Al	As	B	Std. D.	Ba	Ca	K	Std. D.	Li	Na	Std. D.	Ni	Rb	Si	Std. D.	SiO2	Std. D.	Sr	TDS	Cation	Anion	Balance
			ppm	ppm	ppm	+/-	ppm	ppm	ppm	+/-	ppm	ppm	+/-	ppm	ppm	ppm	+/-	ppm	+/-	ppm	ppm	Sum	Sum	
EBS 3/1 F	05/10/12	3/22/2012	0.04	0.017	0.61	0.01	0.08	12	202	3	0.21	422	4	0.04	0.05	47	0	100	1	0.15	737	24	0	1.00
EBS 3/2 F	05/10/12	3/28/2012	0.01	0.036	1.47	0.03	0.05	12	176	0	0.23	579	4	0.09	0.05	81	0	173	1	0.17	943	30	0	1.00
EBS 3/3 F	05/10/12	4/4/2012	<0.01	0.034	3.40	0.04	0.08	12	134	1	0.34	556	5	0.03	0.05	86	1	185	2	0.14	891	28	0	0.99
EBS 3/4 F	05/10/12	4/18/2012	0.46	0.005	9.02	0.07	0.05	8	93	1	0.31	545	6	0.02	0.05	265	4	566	8	0.05	1222	27	0	0.97
EBS 3/5 F	05/15/12	4/25/2012	1.0	0.006	8	0	0.09	4	58	1	0.28	430	3	0.09	0.05	481	3	1028	6	0.02	1530	20	0	0.96
EBS 3/6 F	05/14/12	4/27/2012	<0.01	<0.002	7	0	0.05	7	21	0	0.51	538	2	0.06	0.01	118	1	252	3	0.08	825	24	0	0.97

EBS-4

Sample ID	Date analyzed	Date Sampled	Al	As	B	Ba	Ca	Std. D.	Cu	Fe	K	Std. D.	Li	Mg	Mn	Na	Std. D.	Ni	Pb	Rb	Si	Std. D.	SiO2	Std. D.	Sr	Ti	Zn	TDS	Cation	Anion	Balance
			ppm	ppm	ppm	ppm	ppm	+/-	ppm	ppm	ppm	+/-	ppm	ppm	ppm	ppm	+/-	ppm	ppm	ppm	ppm	+/-	ppm	+/-	ppm	ppm	ppm	ppm	Sum	Sum	
EBS 4/1 F	05/10/12	4/6/2012	0.10	0.032	0.63	0.16	14	1	0.01	<0.5	245	2	0.06	<0.5	<0.01	581	7	0.04	<0.002	0.08	61	1	130	1	0.29	<0.05	<0.01	971	32	0	1.00
EBS 4/2 F	05/14/12	4/12/2012	0.01	0.013	0.25	0.13	14	0	<0.01	<0.5	180	1	0.11	<0.5	<0.01	651	4	0.05	<0.002	0.07	86	0	185	0	0.30	<0.05	<0.01	1029	34	0	1.00
EBS 4/3 F	05/14/12	4/19/2012	10	<0.002	1	0.20	16	1	0.02	5	145	2	0.15	3.0	0.02	689	6	0.05	0.028	0.07	128	1	275	2	0.38	0.09	<0.01	1145	36	0	1.00
EBS 4/4 F	05/15/12	4/26/2012	0.3	<0.002	9	0.10	9	1	<0.01	<0.5	116	1	0.22	<0.5	<0.01	717	7	0.05	<0.002	0.08	312	3	668	7	0.15	<0.05	<0.01	1521	35	0	0.98
EBS 4/5 F	05/14/12	5/3/2012	0.14	<0.002	8	0.08	9	0	<0.01	<0.5	113	2	0.25	<0.5	<0.01	681	5	0.05	<0.002	0.08	132	1	281	2	0.16	<0.05	<0.01	1094	33	0	0.98
EBS 4/6 F	05/15/12	5/10/2012	0.9	<0.002	9	0.05	4	0	<0.01	<0.5	88	1	0.28	<0.5	<0.01	606	10	0.05	<0.002	0.08	450	7	963	16	0.04	<0.05	0.11	1671	29	0	0.97
EBS 4/7 F	05/14/12	5/11/2012	13	<0.002	8	0.13	15	0	<0.01	10	49	1	0.57	2.6	0.07	751	10	0.02	0.009	0.03	227	5	487	11	0.36	0.11	<0.01	1337	37	0	0.98

EBS-5

Sample ID	Date analyzed	Date Sampled	Al	B	Ba	Ca	Std. D.	Cl	F	K	Std. D.	Li	Na	Std .D.	NO3	NO3-N	Si	Std. D.	SiO2	Std. D.	SO4	Zn	Std. D.	TDS	Cation	Anion	Balance
			ppm	ppm	ppm	ppm	+/-	ppm	ppm	ppm	+/-	ppm	ppm	+/-	ppm	ppm	ppm	+/-	ppm	+/-	ppm	ppm	+/-	ppm	Sum	Sum	
EBS 05/00 F	07/27/12	7/2/2012	<0.1	0.39	<0.1	100	5	---	---	645	13	<0.1	184	6	---	---	<1		<2.14		---	<0.1		930	29	0	1.00
EBS 05/00 F	08/01/12	7/2/2012	<0.1	<0.1	1.95	106	1		---	667	1	<0.1	191	3	---	---	<1		<2.14			<0.1		966	31	0	1.00
EBS 5/1 F	08/02/12	7/5/2012	<0.1	1.15	<0.1	107	1	---	---	706	7	<0.1	258	2	---	---	48	0	103	0	---	<0.1		1175	35	0	1.00
EBS 5/1 F	08/01/12	7/5/2012	<0.1	0.70	<0.1	107	2	---	---	704	4	<0.1	263	2	---	---	47	0	101	0	---	<0.1		1176	35	0	1.00
EBS 05/02 F	07/27/12	7/12/2012	<0.1	9.81	<0.1	<1		---	---	96	0	<0.1	693	2	---	---	553	0	1183	0	---	<0.1		1981	33	0	0.97
EBS 05/03 F	07/27/12	7/19/2012	<0.1	10.42	<0.1	<1		---	---	91	0	<0.1	740	1	---	---	584	0	1250	1	---	<0.1		2091	34	0	0.97
EBS 5/4 F	07/27/12	7/26/2012	<0.1	11.48	<0.1	12.6	0.1	---	---	94	0	<0.1	789	1	---	---	583	1	1248	1	---	<0.1		2155	37	1	0.97
EBS 5/5 F	08/07/12	8/2/2012	0.4	11	<0.1	11	1	---	---	15	0	0.14	483	5	---	---	318	3	681	6	---	0.11	0.01	1202	22	1	0.96
EBS 5/6 F	08/21/12	8/14/2012	0.9	7	<0.1	9	1	---	---	56	1	<0.1	582	9	---	---	506	5	1082	11	---	0.84	0.09	1738	27	0	0.98
EBS 5/7 F	08/21/12	8/15/2012	0.1	7	<0.1	19	1	1278	1.3	49	0	<0.1	776	6	53.1	12	81	1	173	1	362	0.72	0.02	2719	36	45	-0.11

No unfiltered cation sample delivered

EBS-6

Sample ID	Date analyzed	Date Sampled	Al	B	Ba	Ca	Std. D.	K	Li	Na	Std. D.	Si	Std. D.	SiO2	Std. D.	Zn	TDS	Cation	Anion	Balance
			ppm	ppm	ppm	ppm	+/-	ppm	ppm	ppm	+/-	ppm	+/-	ppm	+/-	ppm	ppm	Sum	Sum	
EBS 06/00 F	07/27/12	7/2/2012	<0.1	<0.1	<0.1	98	2	9	<0.1	181	3	<1		<2.14		<0.1	288	13	0	1.00
EBS 06/00 F	08/01/12	7/2/2012	<0.1	<0.1	0.92	100	2	10	<0.1	192	3	<1		<2.14		<0.1	302	14	0	1.00
EBS 6/1 F	07/27/12	7/5/2012	<0.1	2.0	<0.1	59	0	29	<0.1	258	0	13	0	27	0	<0.1	375	15	0	0.99
EBS 6/1 F	08/01/12	7/5/2012	<0.1	<0.1	<0.1	71	0	17	<0.1	302	0	20	0	43	0	<0.1	433	17	0	1.00
EBS 06/02 F	07/27/12	7/12/2012	<0.1	<0.1	<0.1	53.0	0.2	<1	<0.1	387	0	24.9	0.0	53	0	<0.1	494	19	0	1.00
EBS 06/03 F	07/27/12	7/19/2012	<0.1	5.08	<0.1	41.7	0.1	22	<0.1	518	0	43.8	0.0	94	0	<0.1	681	25	0	0.98
EBS 6/4 F	07/27/12	7/26/2012	<0.1	10.91	<0.1	16.7	0.1	12	<0.1	553	1	309	0	662	0	<0.1	1254	25	1	0.96
EBS 06/06 F	08/07/12	8/6/2012	1.5	9	<0.1	10	0	12	0.12	351	4	543	2	1161	4	0.13	1545	16	0	0.95
EBS 6/7 F	08/21/12	8/9/2012	1.6	7	<0.1	8	1	1	<0.1	239	1	414	5	885	11	0.83	1142	11	0	0.94
EBS 6/8 F	08/21/12	8/10/2012	0.1	6	<0.1	10	1	<1	<0.1	313	5	183	3	392	7	0.75	722	14	0	0.96

EBS-7

Sample ID	Date analyzed	Date Sampled	Al	B	Ca	Std. D.	Cl	K	Li	Na	Std. D.	Si	Std. D.	SiO2	Std. D.	SO4	Sr	Zn	Std. D.	TDS	Cation	Anion	Balance
			ppm	ppm	ppm	+/-	ppm	ppm	ppm	ppm	+/-	ppm	+/-	ppm	+/-	ppm	ppm	ppm	+/-	Ppm	Sum	Sum	
EBS 0700	08/21/12	8/17/2012	<0.1	<0.1	96	1	477	<1	<0.1	153	1	2	0	5	0	46	<0.1	0.28	0.37	777	11	14	-0.11
EBS 7/1 F	08/23/12	8/22/2012	0.26	0.8	35	1	---	6	<0.1	251	3	16	0	34	0	---	0.13	0.03	0.01	327	13	0	0.99
EBS 7/2 F	02/25/13	8/30/2012	0.23	1	28	0	---	12	<0.05	357	3	33	1	70	3	---	0.12	<0.05		468	17	0	0.99
EBS 7/3 F	02/25/13	9/6/2012	0.13	2	26	1	---	11	<0.05	405	6	45	2	96	4	---	0.11	<0.05		541	19	0	0.99
EBS 7/4 F	02/25/13	9/13/2012	0.73	6	9	0	---	11	0.12	365	2	185	3	396	5	---	<0.05	<0.05		788	17	0	0.97
EBS 7/5 F	02/25/13	9/20/2012	0.60	7	7	1	---	11	0.13	375	1	244	1	523	3	---	<0.05	<0.05		923	17	0	0.96
EBS 7/6 F	02/25/13	9/27/2012	2.90	7	5	1	---	11	0.15	307	1	477	3	1021	7	---	<0.05	<0.05		1354	14	0	0.95
EBS 7/7 F	02/25/13	9/28/2012	0.16	7	8	0	---	5	0.24	381	3	244	1	522	3	---	<0.05	<0.05		924	17	0	0.96

EBS-8

Sample ID	Date analyzed	Date Sampled	Al	B	Ca	Std. D.	K	Li	Na	Std. D.	Si	Std. D.	SiO2	Std. D.	Sr	Zn	TDS	Cation	Anion	Balance
			ppm	ppm	ppm	+/-	ppm	ppm	ppm	+/-	ppm	+/-	ppm	+/-	ppm	ppm	ppm	Sum	Sum	
EBS 08/01F	08/23/12	8/23/2012	2.91	9.4	6	1	7	<0.1	258	1	461	2	986	5	<0.1	0.84	1271	12	0	0.93
EBS 08/02F	02/25/13	8/30/2012	0.64	7.6	6	0	9	0.14	259	1	350	2	750	5	<0.05	<0.05	1033	12	0	0.94
EBS 08/03F	02/25/13	9/6/2012	1.42	7.5	5	0	10	0.14	247	1	493	5	1056	11	<0.05	<0.05	1326	11	0	0.94
EBS 08/04F	02/25/13	9/13/2012	<0.05	6.8	3	0	11	0.16	231	1	43	0	91	0	<0.05	<0.05	343	10	0	0.94
EBS 08/05F	02/25/13	9/20/2012	<0.05	6.8	3	0	12	0.17	228	1	37	0	79	1	<0.05	<0.05	329	10	0	0.94
EBS 08/06F	02/25/13	9/27/2012	0.86	6.6	4	0	12	0.18	218	1	385	2	824	4	<0.05	<0.05	1066	10	0	0.94
EBS 08/07 F	02/25/13	10/4/2012	0.62	6.4	4	0	12	0.18	213	2	186	3	398	6	<0.05	<0.05	634	10	0	0.94
EBS 08/08 F	02/25/13	10/5/2012	0.47	4.7	16	1	11	0.23	200	2	336	2	719	5	0.10	<0.05	952	10	0	0.96

EBS-9

Sample ID	Date analyzed	Date Sampled	Al	B	Ca	Std. D.	K	Li	Mg	Na	Std .D.	Si	Std. D.	SiO2	Std. D.	Sr	TDS	Cation	Anion	Balance
			ppm	ppm	ppm	+/-	ppm	ppm	ppm	ppm	+/-	ppm	+/-	ppm	+/-	ppm	ppm	Sum	Sum	
EBS 9/0 F	02/25/13	11/1/2012	0.25	0.4	96	2	8	<0.05	<0.5	182	1	<0.5		<1		<0.05	287	13	0	1.00
EBS 9/1 F	02/25/13	11/1/2012	0.21	0.4	15	0	6	<0.05	<0.5	356	3	18	0	38	0	0.10	415	16	0	1.00
EBS 9/2 F	02/25/13	11/8/2012	0.47	0.8	18	0	8	<0.05	<0.5	415	4	42	1	89	1	0.10	532	19	0	1.00
EBS 9/3 F	02/25/13	11/15/2012	0.14	1.7	16	0	8	0.06	<0.5	423	3	57	0	122	1	0.07	571	19	0	0.99
EBS 9/4 F	02/25/13	11/21/2012	0.62	5.4	8	0	9	0.08	<0.5	419	4	196	1	418	1	<0.05	861	19	0	0.97
EBS 9/5 F	02/25/13	11/29/2012	0.48	7.0	8	0	11	0.08	<0.5	414	2	261	3	559	6	<0.05	999	19	0	0.97
EBS 9/6 F	02/25/13	12/4/2012	2.41	6.8	5	1	11	0.10	<0.5	328	2	468	4	1002	8	<0.05	1355	15	0	0.96
EBS 9/7 F	02/25/13	12/10/2012	2.18	6.8	4	0	10	0.11	<0.5	313	2	476	5	1019	10	<0.05	1356	14	0	0.96
EBS 9/8 F	02/25/13	12/11/2012	0.81	7.1	7	1	12	0.15	0.7	386	7	451	5	965	11	<0.05	1379	18	0	0.96

EBS-10

Sample ID	Date analyzed	Date Sampled	Al	Std. D.	B	Ca	Std. D.	K	Std. D.	Li	Na	Std. D.	Si	Std. D.	SiO2	Std. D.	Sr	Zn	TDS	Cation	Anion	Balance
			ppm	+/-	ppm	ppm	+/-	ppm	+/-	ppm	ppm	+/-	ppm	+/-	ppm	+/-	ppm	ppm	Ppm	Sum	Sum	
EBS10/1 F	03/05/13	1/18/2013	1.56	0.03	6	9	0	150	4	<0.05	376	13	310	13	663	28	<0.05	<0.05	1205	21	0	0.97
EBS 10/2 F	03/05/13	1/24/2013	0.91	0.01	10	7	0	53	0	0.07	451	4	481	4	1028	9	<0.05	<0.05	1550	21	0	0.96
EBS 10/3 F	03/05/13	1/31/2013	0.95	0.00	10	9	0	33	0	0.08	463	4	534	2	1143	5	<0.05	0.08	1659	22	0	0.96
EBS 10/4 F	03/05/13	2/7/2013	0.87	0.02	10	9	1	29	0	0.08	453	2	533	1	1140	1	<0.05	<0.05	1642	21	0	0.96
EBS 10/5 F	03/05/13	2/15/2013	0.88	0.01	12	9	1	33	0	0.08	442	1	539	1	1154	2	<0.05	0.25	1650	21	1	0.95
EBS 10/6 F	03/05/13	2/21/2013	0.83	0.00	10	9	0	29	0	0.09	431	2	533	2	1140	3	<0.05	<0.05	1620	20	0	0.95
EBS 10/7 F	04/21/2013	2/28/2013	1.33	0.02	8	7	1	41	1	0.30	442	6	598	4	1279	10	<0.05	<0.05	1778	21	0	0.96
EBS 10/8 F 2/28/13	04/21/2013	3/1/2013	0.40	0.00	5	23	0	27	0	0.07	355	1	324	4	692	9	0.18	<0.05	1104	17	0	0.97

EBS-11

Sample ID	Date analyzed	Date Sampled	Al	B	Std. D.	Ca	Std. D.	K	Std. D.	Li	Na	Std. D.	Si	Std. D.	SiO2	Std. D.	Sr	Zn	TDS	Cation	Anion	Balance
			ppm	ppm	+/-	ppm	+/-	ppm	+/-	ppm	ppm	+/-	ppm	+/-	ppm	+/-	ppm	ppm	Ppm	Sum	Sum	
EBS 11/1 F	02/26/2013	2/1/2013	3.45	7.8	0.2	5	1	71	2	0.20	425	7	491	6	1051	14	<0.05	<0.05	1563	21	0	0.97
EBS 11/2 F	02/26/2013	2/7/2013	1.98	8.1	0.0	4	0	33	0	0.21	438	11	536	2	1146	4	<0.05	0.27	1631	20	0	0.96
EBS 11/3 F	02/26/2013	2/14/2013	1.90	8.5	0.3	4	0	30	0	0.21	425	4	506	9	1082	18	<0.05	<0.05	1552	20	0	0.96
EBS 11/4 F	02/26/2013	2/21/2013	1.88	7.8	0.1	4	1	29	0	0.21	412	3	506	3	1083	6	<0.05	0.05	1538	19	0	0.96
EBS 11/5F	04/21/2013	2/28/2013	1.57	6.9	0.1	6	1	31	0	0.24	428	4	521	5	1116	11	<0.05	<0.05	1589	20	0	0.97
EBS 11/6F	04/21/2013	3/7/2013	1.63	7.2	0.0	6	1	31	0	0.22	425	2	532	1	1138	1	<0.05	<0.05	1609	20	0	0.97
EBS 11/7 F	04/21/2013	3/14/2013	1.64	7.0	0.1	6	0	30	0	0.21	408	5	473	4	1011	9	<0.05	<0.05	1464	19	0	0.97
EBS 11/8 F 3/14/13	04/21/2013	3/15/2013	0.27	7.1	0.0	35	1	34	0	0.35	499	7	388	2	830	4	0.42	<0.05	1406	24	0	0.97

EBS-13

Sample ID	Date analyzed	Date Sampled	Al	B	Ba	Ca	Std. D.	K	Std. D.	Li	Mg	Mn	Na	Std. D.	Si	Std. D.	SiO2	Std. D.	Sr	Zn	TDS	Cation	Anion	Balance
			ppm	ppm	ppm	ppm	+/-	ppm	+/-	ppm	ppm	ppm	ppm	+/-	ppm	+/-	ppm	+/-	ppm	ppm	ppm	Sum	Sum	
EBS 13/00 F	3/19/2014	9/18/2013	<0.02	<0.04	<0.02	62	1	926	3	0.04	<0.2	<0.02	234	3	<0.2		<0.4		0.08	<0.02	1222	37	0	1.00
EBS 13/01 F	3/19/2014	9/18/2013	0.18	4	0.03	2.0	0.1	281	6	0.16	0.32	<0.02	451	6	110	2	235	4	0.02	<0.02	974	27	0	0.99
EBS 13/02 F	3/19/2014	10/3/2013	<0.02	8	0.05	4.1	0.2	66	0	0.28	<0.2	<0.02	578	2	32	0	68	0	0.02	0.03	724	27	0	0.97
EBS 13/03 F	3/19/2014	10/24/2013	0.42	7	0.03	2.5	0.1	56	0	0.28	<0.2	<0.02	552	7	38	1	80	2	<0.02	0.07	698	26	0	0.97
EBS 13/04 F	3/19/2014	11/14/2013	0.45	8	<0.02	2.4	0.2	56	0	0.30	<0.2	<0.02	555	6	33	0	70	0	<0.02	<0.02	692	26	0	0.97
EBS 13/05 F	3/19/2014	12/5/2013	0.03	11	0.04	3.7	0.1	75	1	0.41	<0.2	<0.02	721	6	55	0	118	1	0.04	0.02	929	34	0	0.97
EBS 13/06 F	3/19/2014	12/18/2013	0.42	10	0.04	2.9	0.2	69	0	0.40	<0.2	<0.02	666	3	68	0	145	1	0.02	0.06	894	31	0	0.97
EBS 13/07 F	3/19/2014	1/6/2014	0.39	7	<0.02	1.8	0.0	81	1	0.59	<0.2	<0.02	638	3	78	2	166	4	0.03	<0.02	895	30	0	0.98
EBS 13/08 F	3/19/2014	2/3/2014	0.28	7	0.02	4.6	0.1	67	1	0.61	<0.2	<0.02	598	5	382	3	818	7	0.08	<0.02	1495	28	0	0.98
EBS 13/09 F	3/20/2014	2/14/2014	0.35	7	0.03	4.2	0.1	48	1	0.44	<0.2	<0.02	494	7	303	3	649	7	0.06	<0.02	1203	23	0	0.97
EBS 13/10 F	3/20/2014	2/24/2014	0.34	6	0.03	4.0	0.1	49	0	0.44	<0.2	<0.02	531	2	308	2	659	5	0.06	<0.02	1251	25	0	0.98
EBS 13/11 F	3/20/2014	3/13/2014	0.05	6	0.06	3.9	0.2	44	0	0.44	<0.2	0.02	504	5	191	1	409	3	0.08	<0.02	967	23	0	0.98
EBS 13/12 F	3/20/2014	3/20/2014	0.04	6	0.07	3.6	0.2	46	0	0.47	<0.2	0.02	510	0	179	1	383	3	0.08	<0.02	949	24	0	0.98
EBS 13/13 F	7/24/2014	3/26/2014	1.03	7	0.27	<0.1		37	0	0.27	<0.1	<0.01	472	7	150	3	321	6	0.13	0.12	839	22	0	0.97

EBS-14

Sample ID	Date analyzed	Date Sampled	Al	B	Ba	Ca	Std. D.	K	Std. D.	Li	Mg	Std. D.	Mn	Na	Std. D.	Si	Std. D.	SiO2	Std. D.	Sr	Zn	TDS	Cation	Anion	Balance
			ppm	ppm	ppm	ppm	+/-	ppm	+/-	ppm	ppm	+/-	ppm	ppm	+/-	ppm	+/-	ppm	+/-	ppm	ppm	Ppm	Sum	Sum	
EBS 14/00 F	3/20/2014	11/27/2013	<0.05	0.2	<0.05	441	4	223	2	<0.05	193	3	<0.05	3781	17	1	0	1	0	0.17	<0.05	4640	207	0	1.00
EBS 14/01 F	3/20/2014	11/27/2013	<0.05	5	0.21	319	3	176	0	2	8	0	0.09	3835	11	36	0	78	0	2.5	0.11	4426	187	0	1.00
EBS 14/02 F	3/20/2014	12/6/2013	<0.05	6	0.12	507	7	106	1	6	1	0	0.16	3581	36	41	1	87	1	1.5	0.06	4296	184	0	1.00
EBS 14/03 F	3/20/2014	12/18/2013	<0.05	6	0.23	573	5	225	4	11	1	0	0.22	4056	19	51	1	108	2	2.4	0.08	4984	212	0	1.00
EBS 14/04 F	3/20/2014	1/6/2014	<0.05	6	0.29	590	17	334	6	13	1.3	0.1	0.24	4065	28	47	1	100	3	2.8	0.15	5113	216	0	1.00
EBS 14/05 F (Quench)	7/24/2014	1/8/2014	1.28	7	0.27	1084	16	172	1	6	<0.5		<0.05	3371	30	27	1	57	1	4.5	0.58	4703	205	0	1.00

EBS-15

Sample ID	Date analyzed	Date Sampled	Al	B	Ba	Ca	Std .D.	Fe	K	Std .D.	Li	Mg	Std .D.	Na	Std .D.	Si	Std .D.	SiO2	Std. D.	Sr	Zn	Std. D.	TDS	Cation	Anion	Balance
			ppm	ppm	ppm	ppm	+/-	ppm	ppm	+/-	ppm	ppm	+/-	ppm	+/-	ppm	+/-	ppm	+/-	ppm	ppm	+/-	Ppm	Sum	Sum	
EBS15/00 F	10/31/2014	3/13/2014	<0.05	<0.1	<0.05	432	1	<0.5	215	1	<0.05	186	1	3742	24	8	0	16	0	0.15	0.83	0.01	4592	204	0	1.00
EBS15/01 F	10/31/2014	4/10/2014	0.32	3.91	0.17	46	0	<0.5	62	1	0.60	<0.5		1847	12	36	0	78	1	0.23	0.26	0.37	2039	84	0	1.00
EBS15/02 F	10/31/2014	4/17/2014	0.69	3.66	0.25	52	0	<0.5	61	0	0.70	<0.5		1625	2	88	1	189	2	0.25	0.54	0.02	1934	75	0	1.00
EBS15/03 F	10/31/2014	4/24/2014	0.50	3.39	0.30	56	1	<0.5	60	0	0.68	<0.5		1514	5	75	0	160	0	0.26	0.53	0.23	1796	70	0	1.00
EBS15/05 F	10/31/2014	5/1/2014	0.27	5.13	0.53	77	0	<0.5	90	0	1.44	<0.5		2206	10	38	0	81	1	0.41	0.83	0.02	2462	102	0	1.00
EBS15/06 F	10/31/2014	5/8/2014	0.28	4.75	0.40	72	1	<0.5	83	1	1.25	<0.5		1962	17	66	1	141	3	0.36	0.38	0.04	2266	91	0	1.00
EBS15/07 F	10/31/2014	5/14/2014	<0.05	5.00	0.27	435	2	3.42	78	0	1.48	0.9	0.0	2053	7	281	0	602	1	1.44	0.45	0.16	3181	113	0	1.00

EBS-16

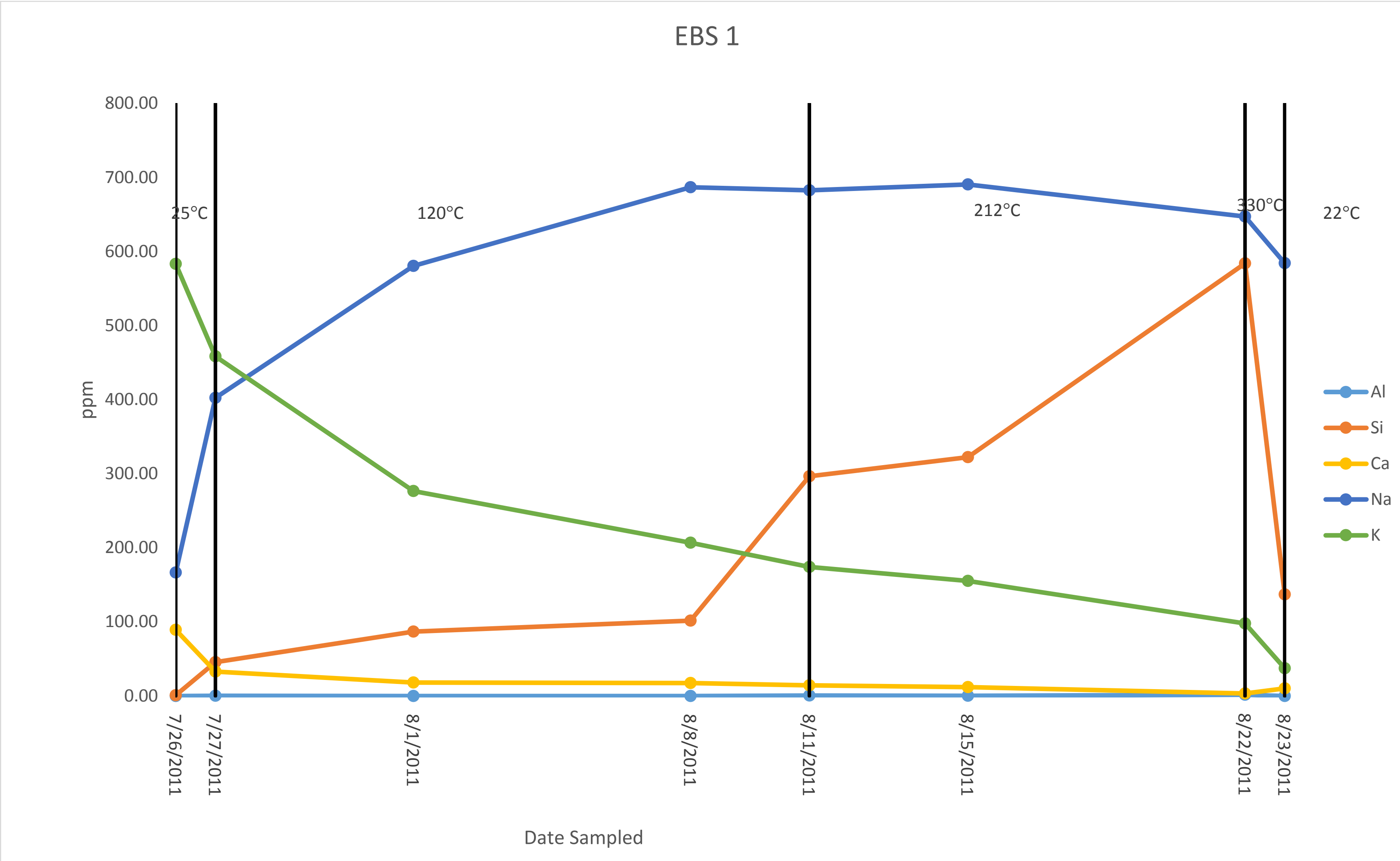
Sample ID	Date analyzed	Date Sampled	Al	B	Std. D.	Ba	Ca	Std. D.	Fe	K	Std. D.	Li	Mn	Na	Std. D.	Si	Std. D.	SiO2	Std. D.	Sr	Zn	TDS	Cation	Anion	Balance
			ppm	ppm	+/-	ppm	ppm	+/-	ppm	ppm	+/-	ppm	ppm	ppm	+/-	ppm	+/-	ppm	+/-	ppm	ppm	Ppm	Sum	Sum	
EBS 16/00 F	7/24/2014	5/15/2014	0.36	<0.02		<0.01	69	0	<0.1	540	10	<0.01	<0.01	191	2	1	0	2	0	0.05	0.14	802	26	0	1.00
EBS 16/01 F	7/24/2014	5/15/2014	2.73	6.52	0.04	<0.01	<0.1		<0.1	179	2	<0.01	<0.01	476	2	381	4	815	9	0.12	0.12	1479	26	0	0.98
EBS 16/02 F	7/24/2014	5/29/2014	1.53	8.26	0.14	<0.01	<0.1		<0.1	45	1	0.07	<0.01	553	6	465	2	995	5	0.12	0.10	1603	25	0	0.97
EBS 16/03 F	7/24/2014	6/18/2014	1.49	8.40	0.05	0.01	<0.1		<0.1	45	0	0.10	<0.01	576	8	469	2	1003	5	0.13	0.09	1634	26	0	0.97
EBS 16/4 F	11/6/2014	7/6/2014	0.79	7.75	0.05	0.04	3	0	<0.2	53	0	0.17	<0.02	565	4	484	3	1036	6	0.03	0.03	1666	26	0	0.97
EBS 16/5 F	11/6/2014	7/31/2014	0.66	8.48	0.05	0.07	5	0	<0.2	64	0	0.21	<0.02	582	3	269	39	576	84	0.04	0.07	1236	27	0	0.97
EBS 16/6 F	**11/6/2014**	**8/21/2014**	**<0.02**	**7.52**	**0.13**	**0.28**	**10**	**1**	**<0.2**	**66**	**0**	**<0.02**	**<0.02**	**650**	**6**	**14**	**1**	**29**	**1**	**<0.02**	**0.40**	**763**	**30**	**0**	**0.98**
EBS 16/7 F	11/6/2014	9/18/2014	0.52	7.76	0.03	0.11	5	0	<0.2	56	1	0.08	<0.02	559	6	229	2	489	4	0.03	0.16	1117	26	0	0.97
EBS 16/8 F	11/6/2014	9/30/2014	<0.02	7.63	0.05	0.18	8	0	<0.2	59	0	0.17	<0.02	611	4	292	2	624	4	0.09	0.22	1311	28	0	0.98
EBS 16/9 F	11/6/2014	10/9/2014	<0.02	7.72	0.03	0.17	7	0	<0.2	68	0	0.24	<0.02	653	3	311	2	666	5	0.08	0.26	1403	31	0	0.98
EBS 16/10 F	11/6/2014	10/20/2014	<0.02	7.85	0.04	0.17	8	0	<0.2	64	0	0.21	<0.02	661	6	303	1	649	2	0.08	0.24	1390	31	0	0.98
EBS 16/11 F	11/6/2014	10/30/2014	<0.02	8.39	0.06	0.20	8	0	0.3	66	0	0.37	0.04	677	2	207	1	443	2	0.15	0.20	1204	32	0	0.98
EBS 16/12 F																									
EBS 16/13 F																									
EBS 16/14 F																									

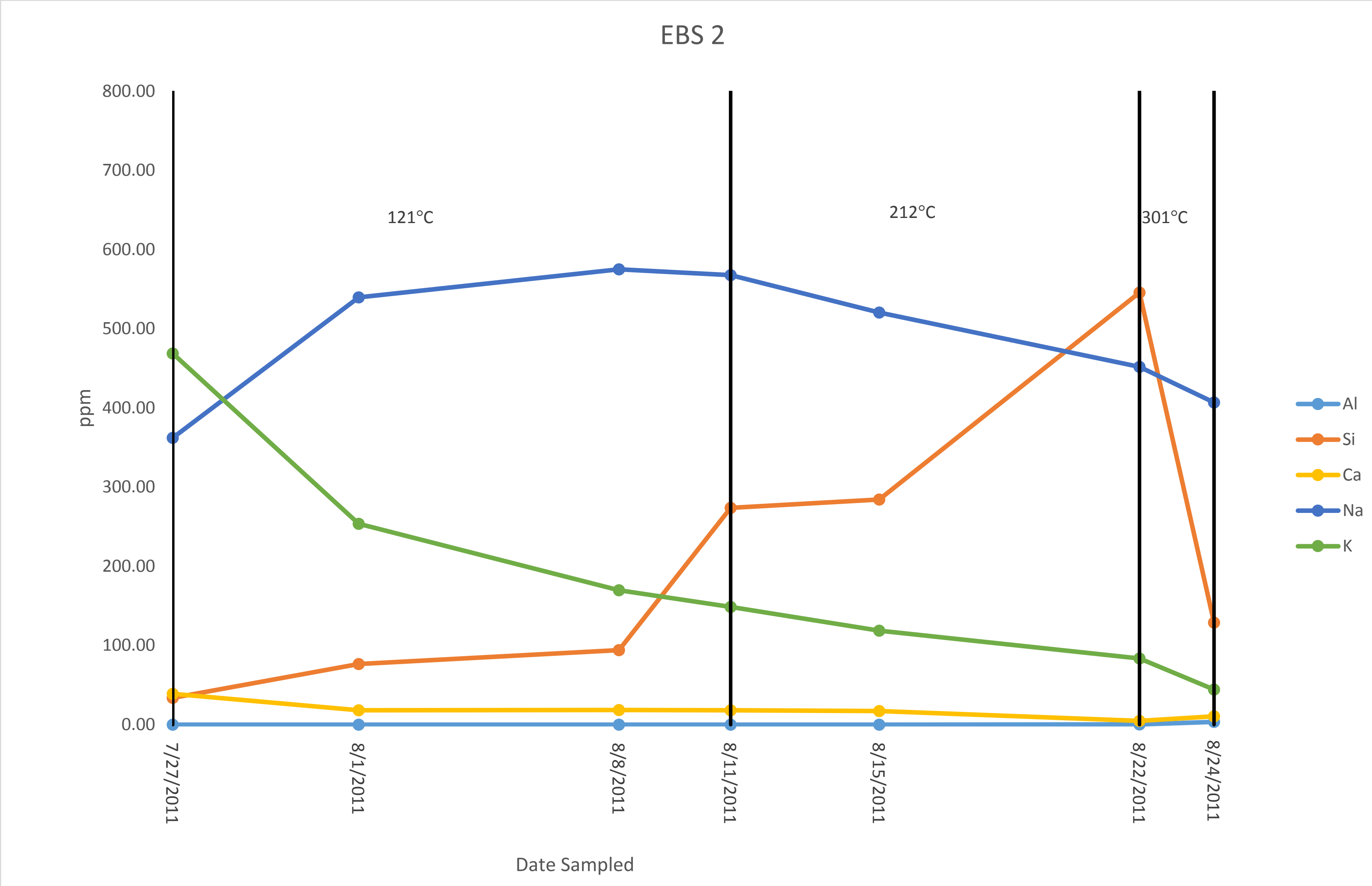
EBS-17

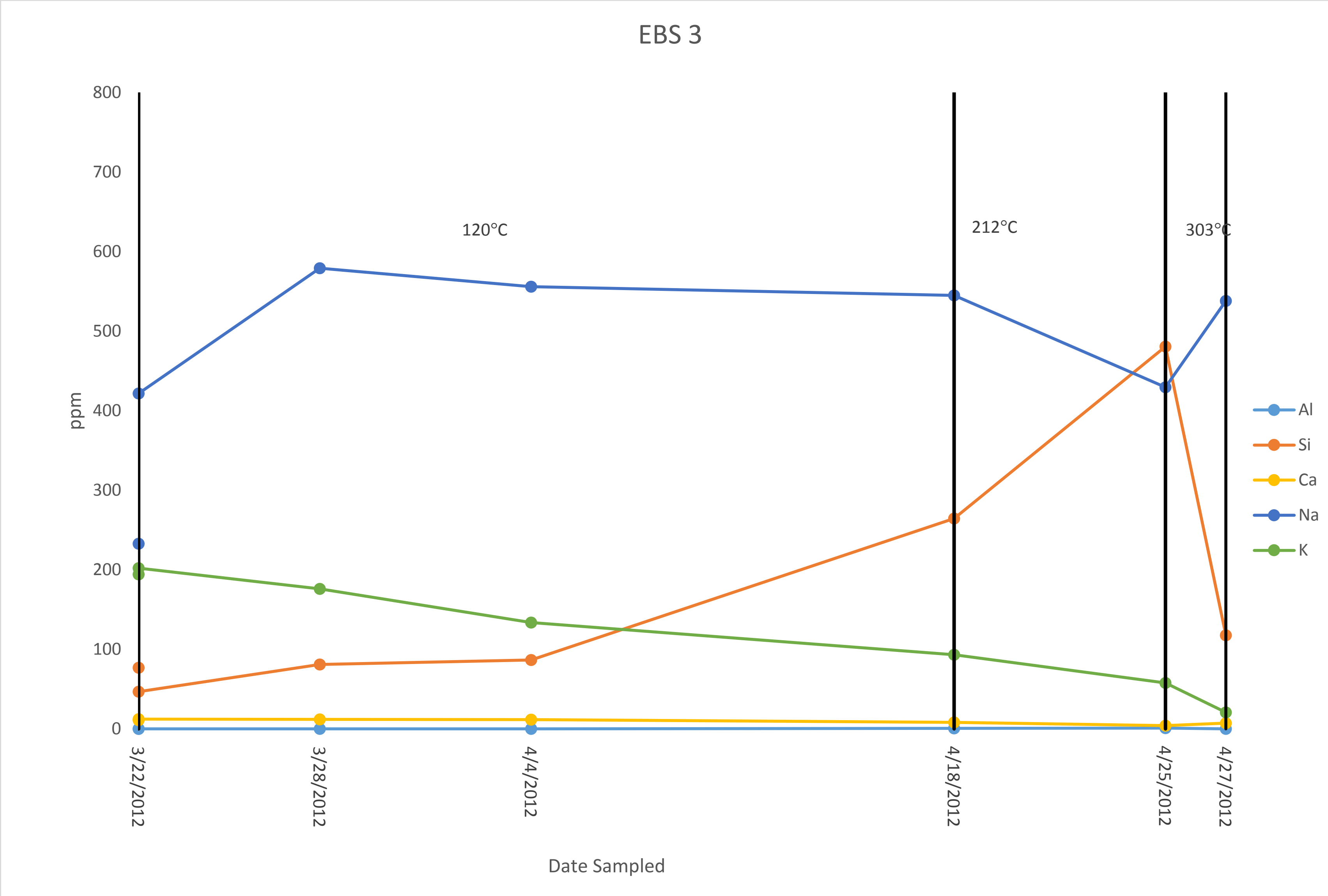
Sample ID	Date analyzed	Date Sampled	Al	B	Ba	Ca	Std. D.	Fe	K	Std. D.	Mg	Std. D.	Mn	Na	Std. D.	Si	Std. D.	SiO2	Std. D.	Sr	Zn	TDS	Cation	Anion	Balance
			ppm	ppm	ppm	ppm	+/-	ppm	ppm	+/-	ppm	+/-	ppm	ppm	+/-	ppm	+/-	ppm	+/-	ppm	ppm	Ppm	Sum	Sum	
EBS17/00 F	11/7/2014	6/27/2014	<0.05	<0.1	<0.05	420	3	<0.5	228	3	192	1	<0.05	3834	32	<0.5		<1		0.12	<0.05	4673	208	0	1.00
EBS17/01 F	11/7/2014	7/16/2014	0.47	6.18	0.50	34	1	<0.5	170	1	<0.5		0.05	3987	32	47	0	100	1	0.39	<0.05	4298	179	0	1.00
EBS17/02 F	11/7/2014	7/31/2014	0.70	7.51	0.49	132	1	0.22	138	2	<0.5		0.18	3781	32	37	1	80	1	0.89	0.15	4141	174	0	1.00
EBS17/03 F	11/7/2014	8/7/2014	0.48	6.84	0.65	141	2	0.28	141	3	<0.5		0.29	3614	23	37	4	80	8	0.94	0.21	3987	167	0	1.00
EBS17/04 F	11/7/2014	8/14/2014	0.34	6.55	0.78	142	1	0.36	141	1	<0.5		0.39	3482	11	36	0	77	1	0.97	0.22	3852	162	0	1.00
EBS17/05 F	11/7/2014	8/21/2014	0.37	7.53	0.73	157	2	0.35	150	1	<0.5		0.48	3519	50	45	1	97	1	1.06	0.32	3934	164	0	1.00
EBS17/06 F	11/7/2014	8/26/2014	0.27	6.58	0.77	148	1	0.35	142	2	<0.5		0.47	3337	14	44	1	94	3	0.99	0.31	3731	156	0	1.00
EBS17/07 F	11/7/2014	8/27/2014	<0.05	4.68	0.33	543	5	0.83	95	1	0.7	0.0	0.53	2451	15	54	0	116	1	2.12	0.20	3214	136	0	1.00

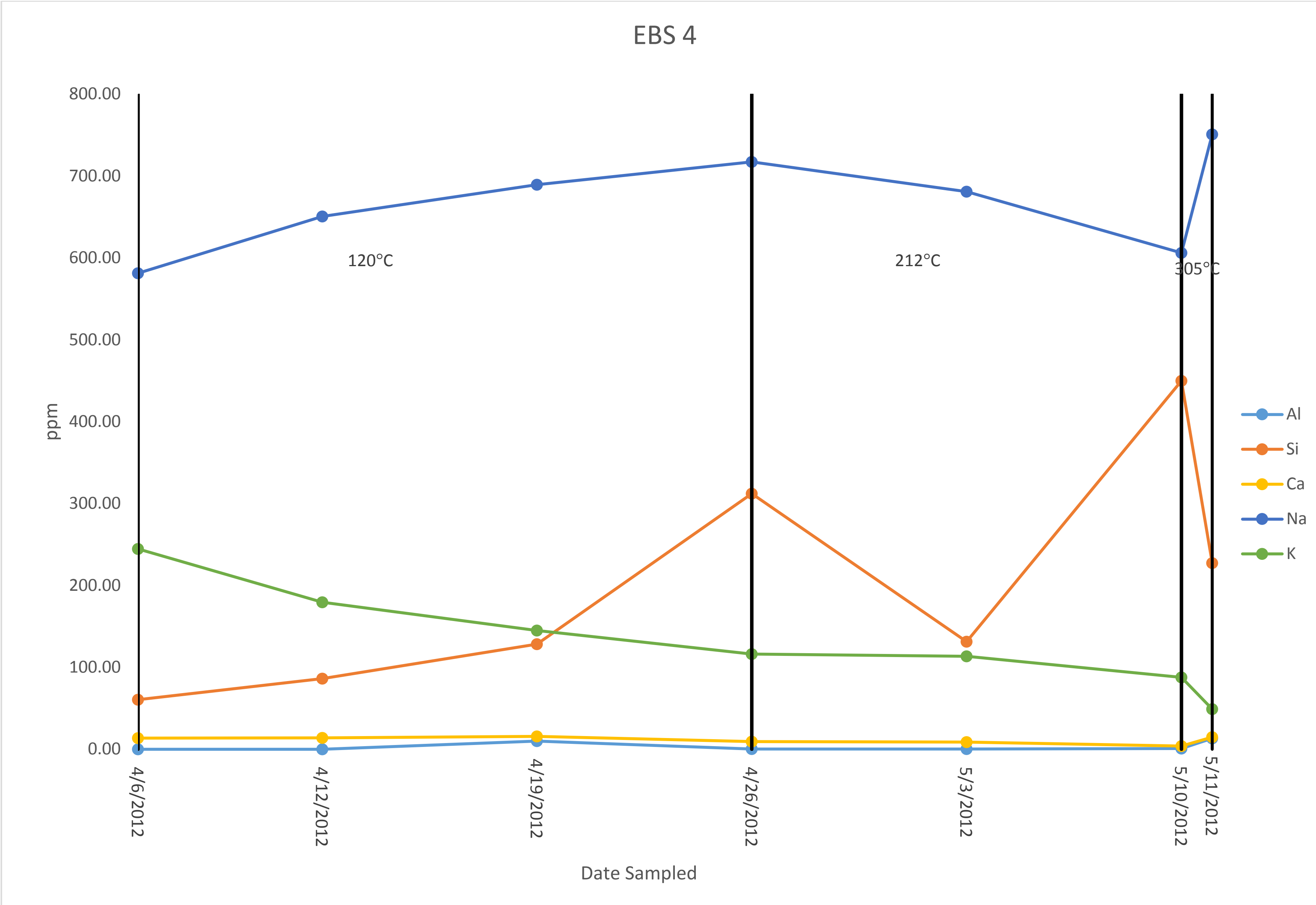
APPENDIX C2:

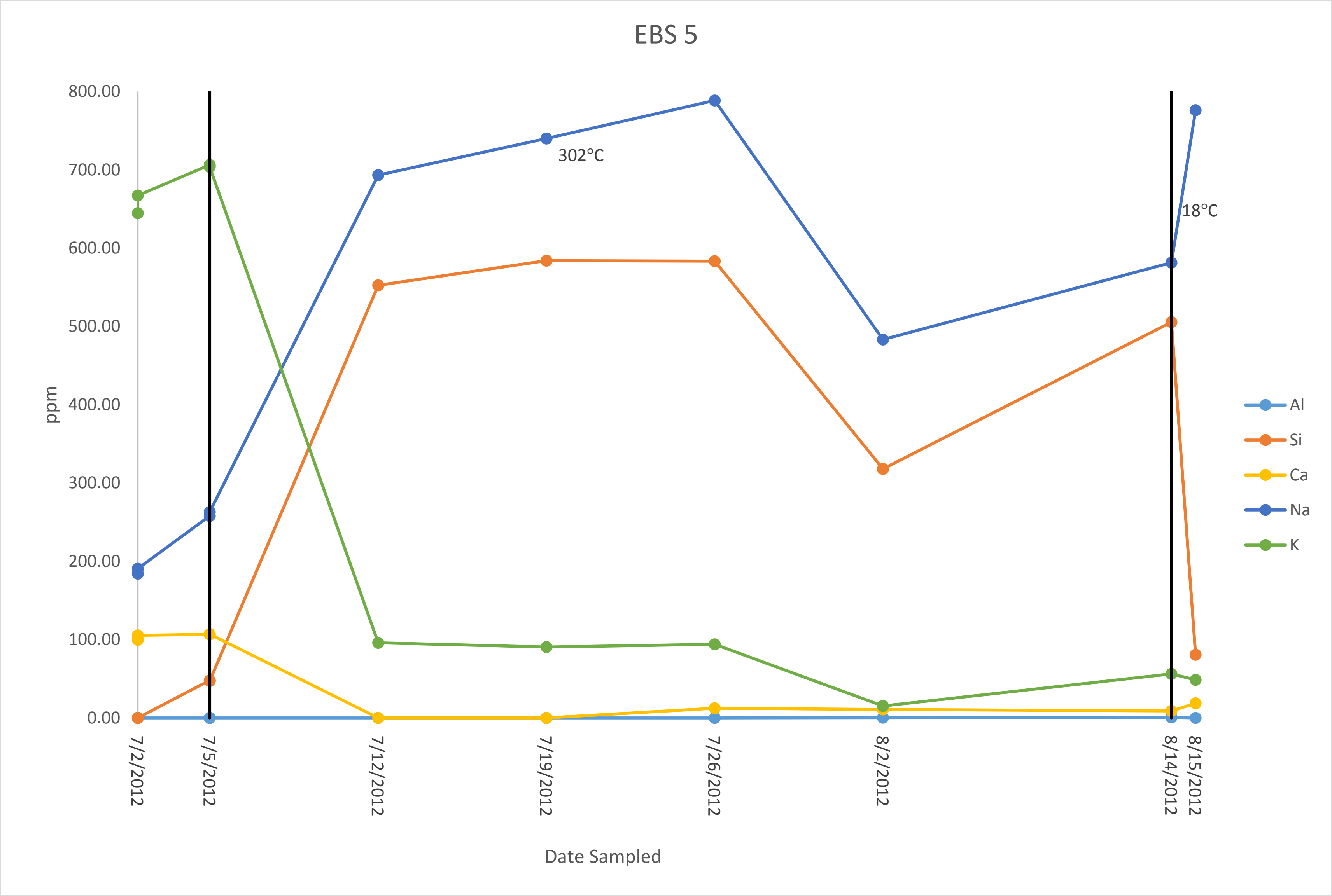
Graphs of Brine Chemistry for EBS Experiments

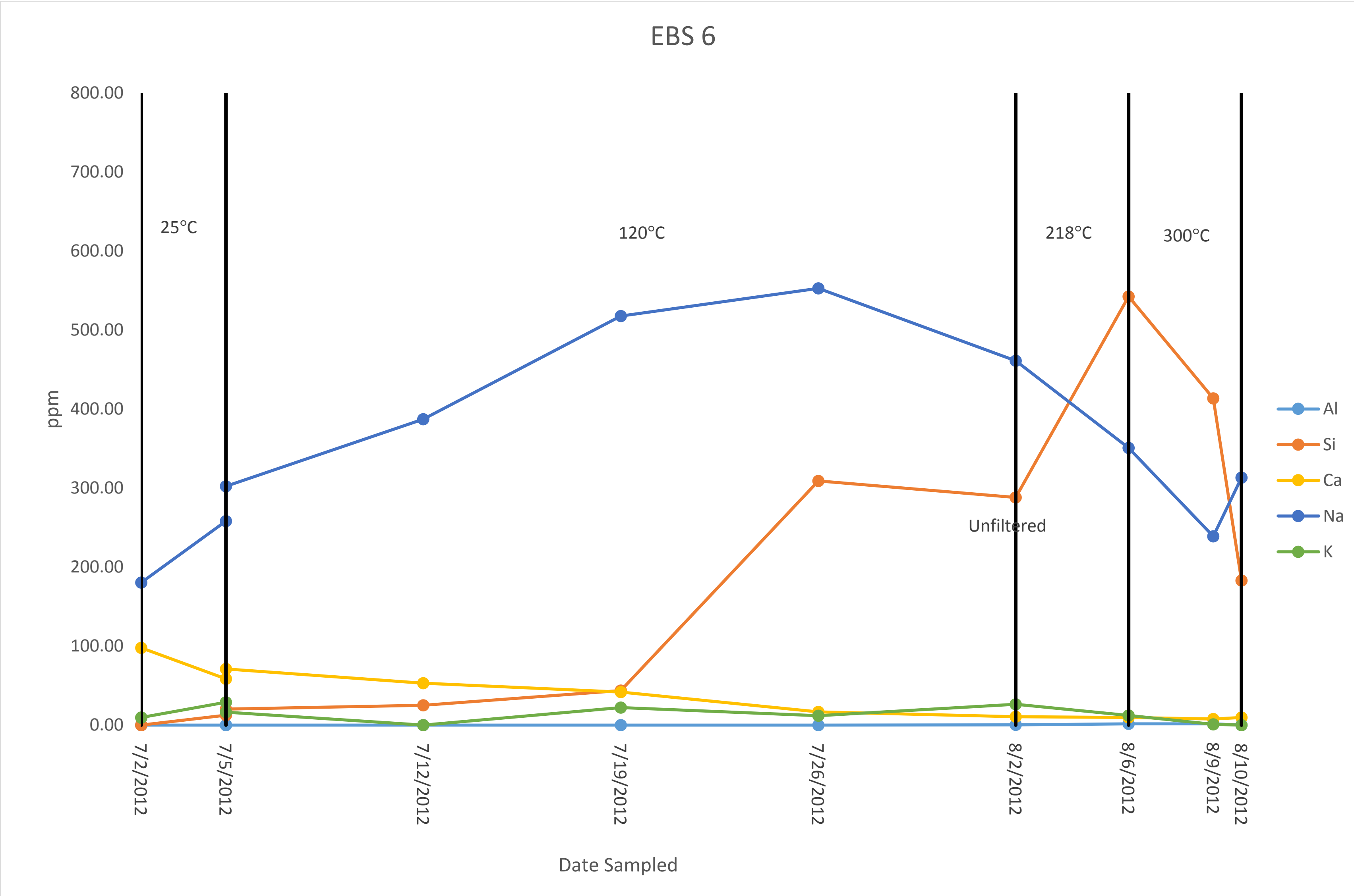

EBS 1
800.00
700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00
ppm
25°C
120°C
212°C
330°C
22°C
7/26/2011
7/27/2011
8/1/2011
8/8/2011
8/11/2011
8/15/2011
8/22/2011
8/23/2011
Date Sampled
Al
Si
Ca
Na
K

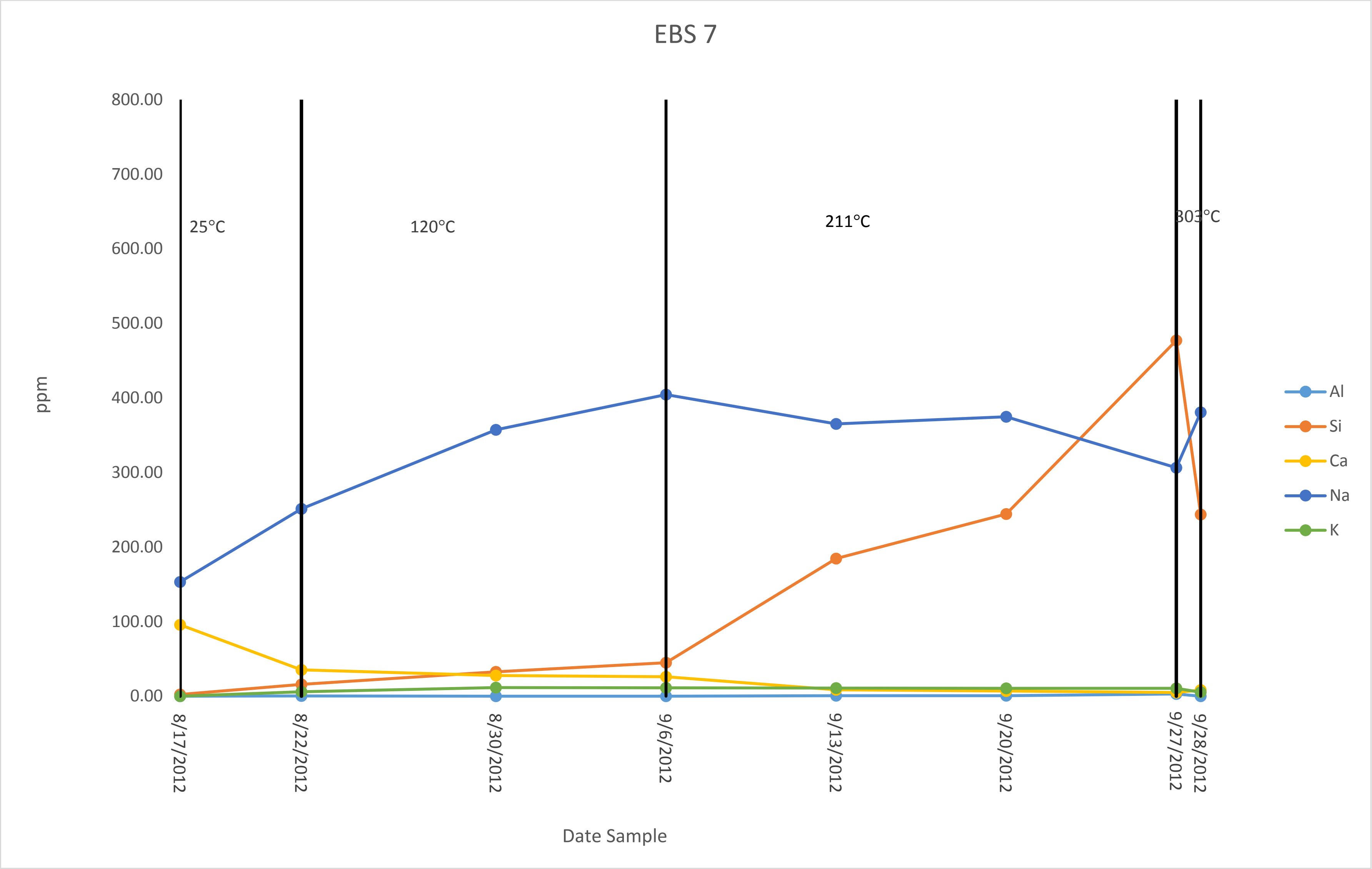

EBS 2
800.00
700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00
ppm
121°C
212°C
301°C
7/27/2011
8/1/2011
8/8/2011
8/11/2011
8/15/2011
8/22/2011
8/24/2011
Date Sampled
Al
Si
Ca
Na
K

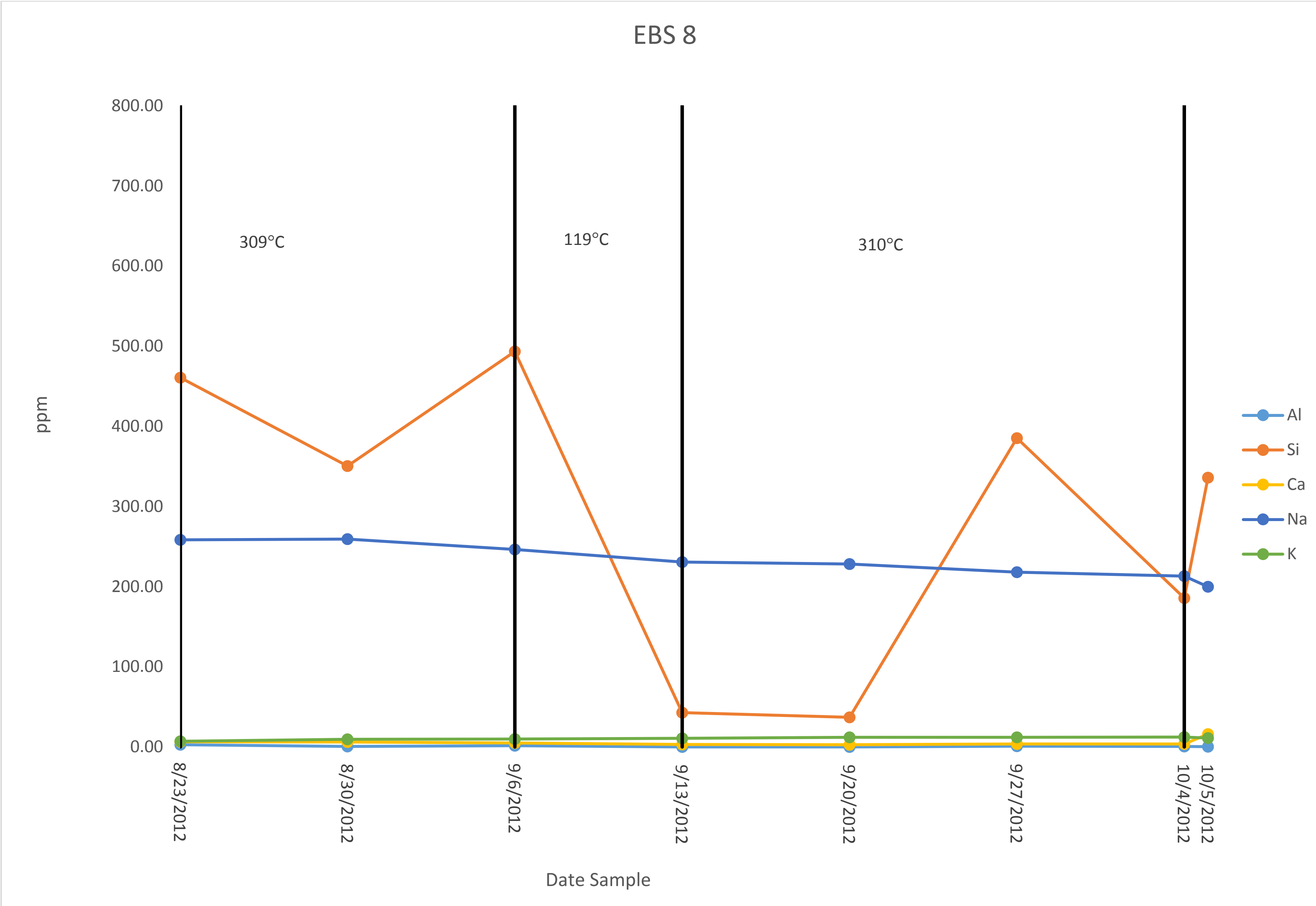

EBS 3
800
700
600
500
400
300
200
100
0
ppm
120°C
212°C
303°C
3/22/2012
3/28/2012
4/4/2012
4/18/2012
4/25/2012
4/27/2012
Date Sampled
Al
Si
Ca
Na
K

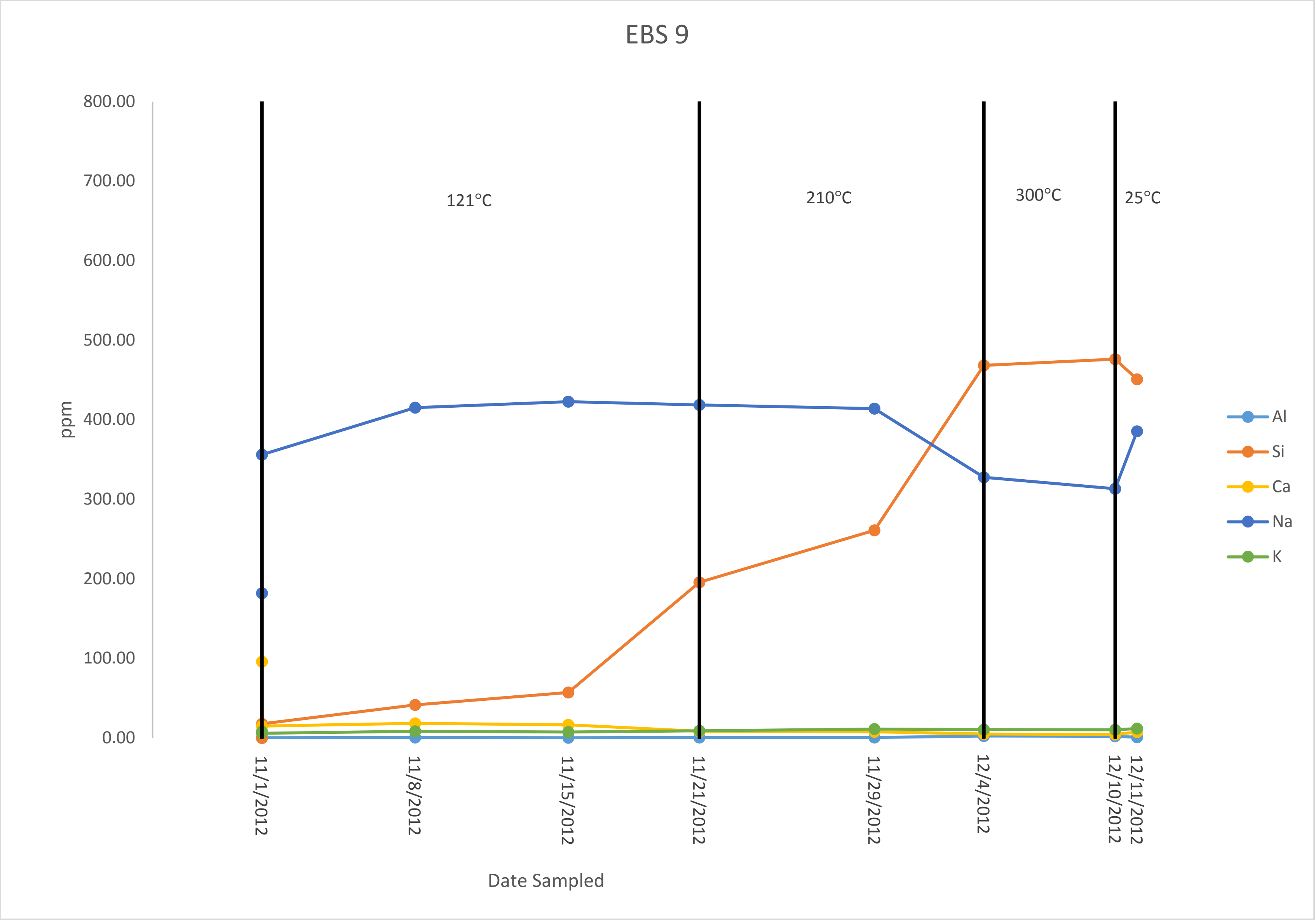

EBS 4
800.00
700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00
ppm
120°C
212°C
305°C
4/6/2012
4/12/2012
4/19/2012
4/26/2012
5/3/2012
5/10/2012
5/11/2012
Date Sampled
Al
Si
Ca
Na
K

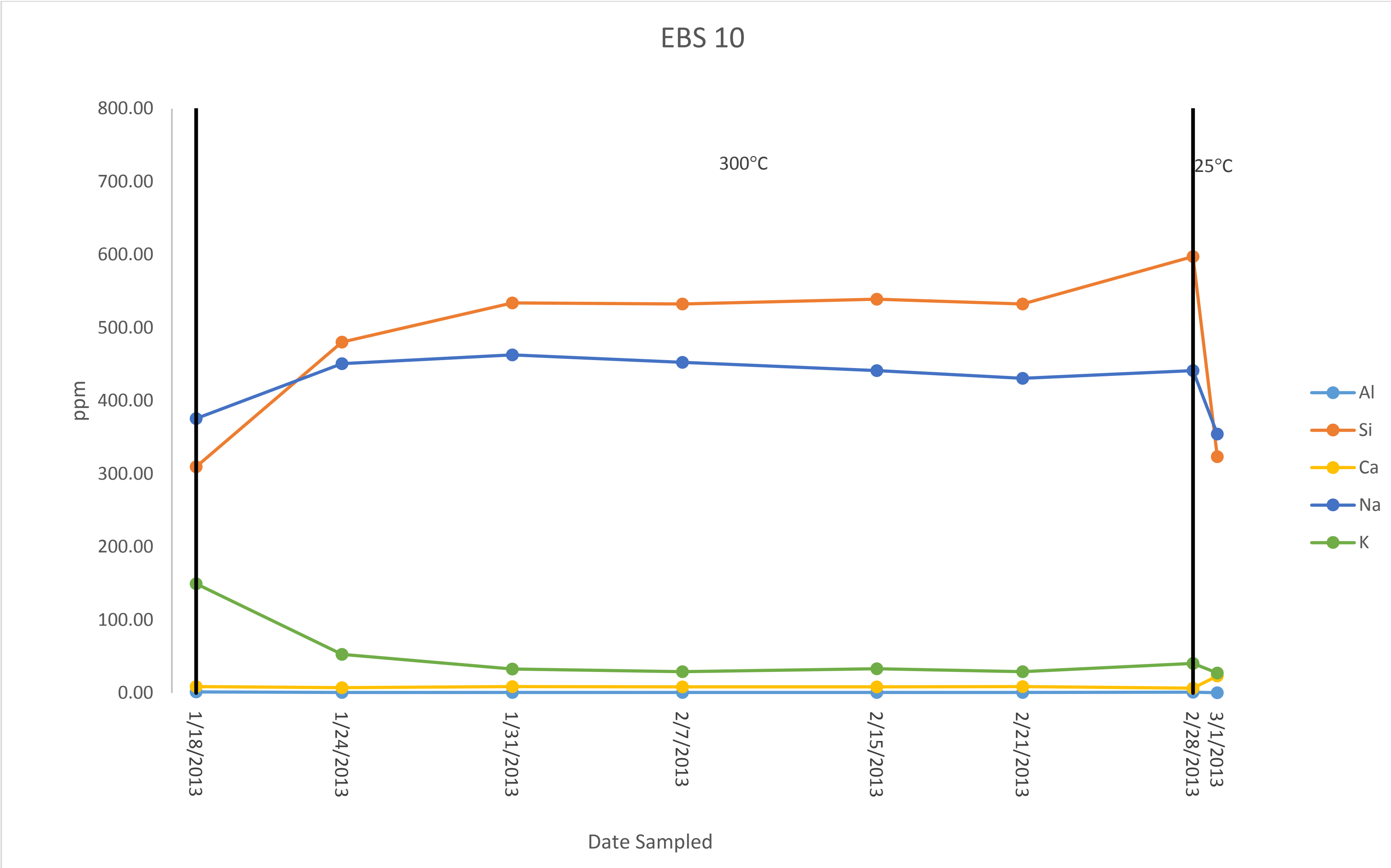

EBS 5
800.00
700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00
ppm
302°C
18°C
7/2/2012
7/5/2012
7/12/2012
7/19/2012
7/26/2012
8/2/2012
8/14/2012
8/15/2012
Date Sampled
Al
Si
Ca
Na
K

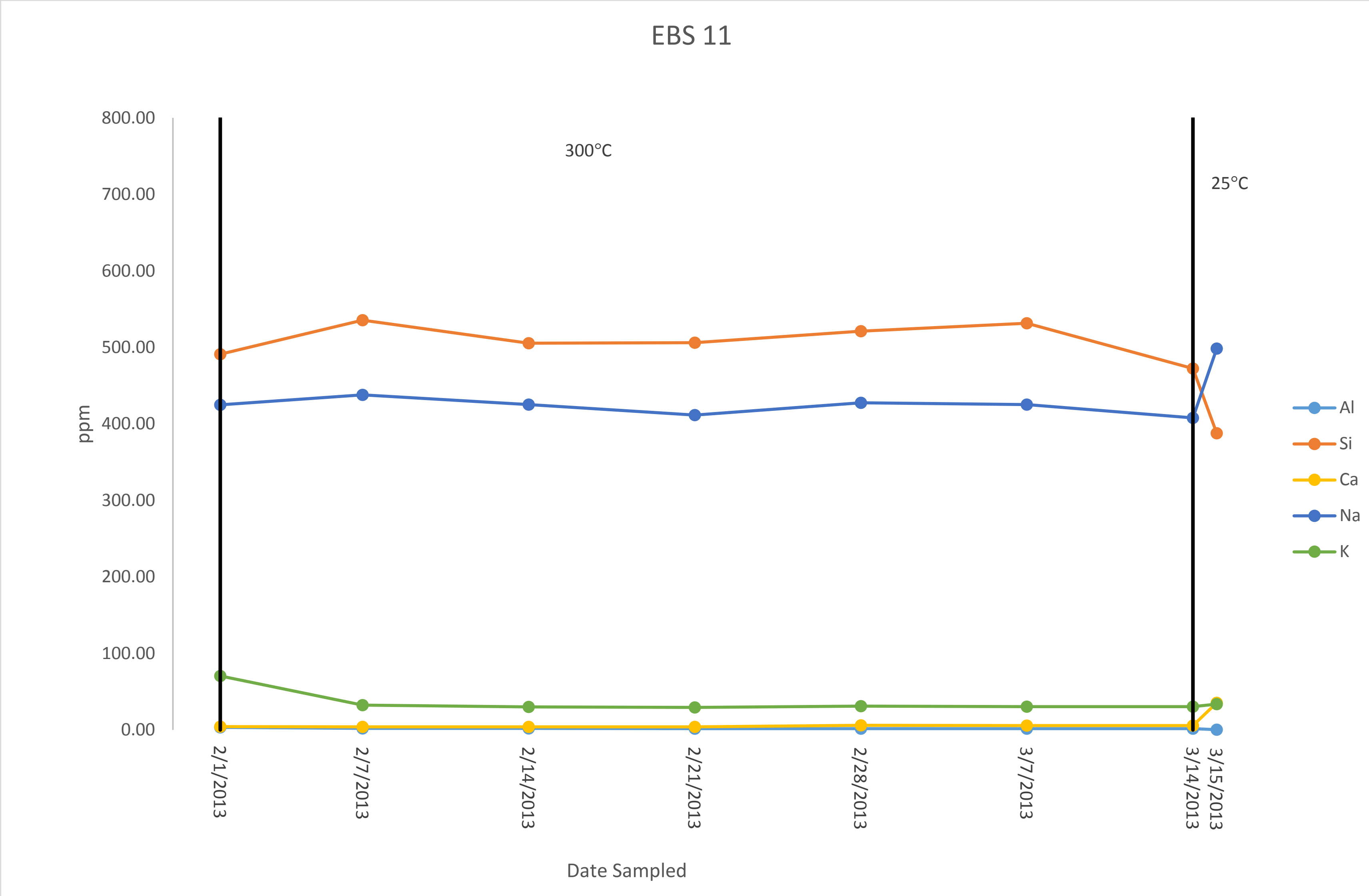

EBS 6
800.00
700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00
ppm
25°C
120°C
218°C
300°C
Unfiltered
Al
Si
Ca
Na
K
7/2/2012
7/5/2012
7/12/2012
7/19/2012
7/26/2012
8/2/2012
8/6/2012
8/9/2012
8/10/2012
Date Sampled

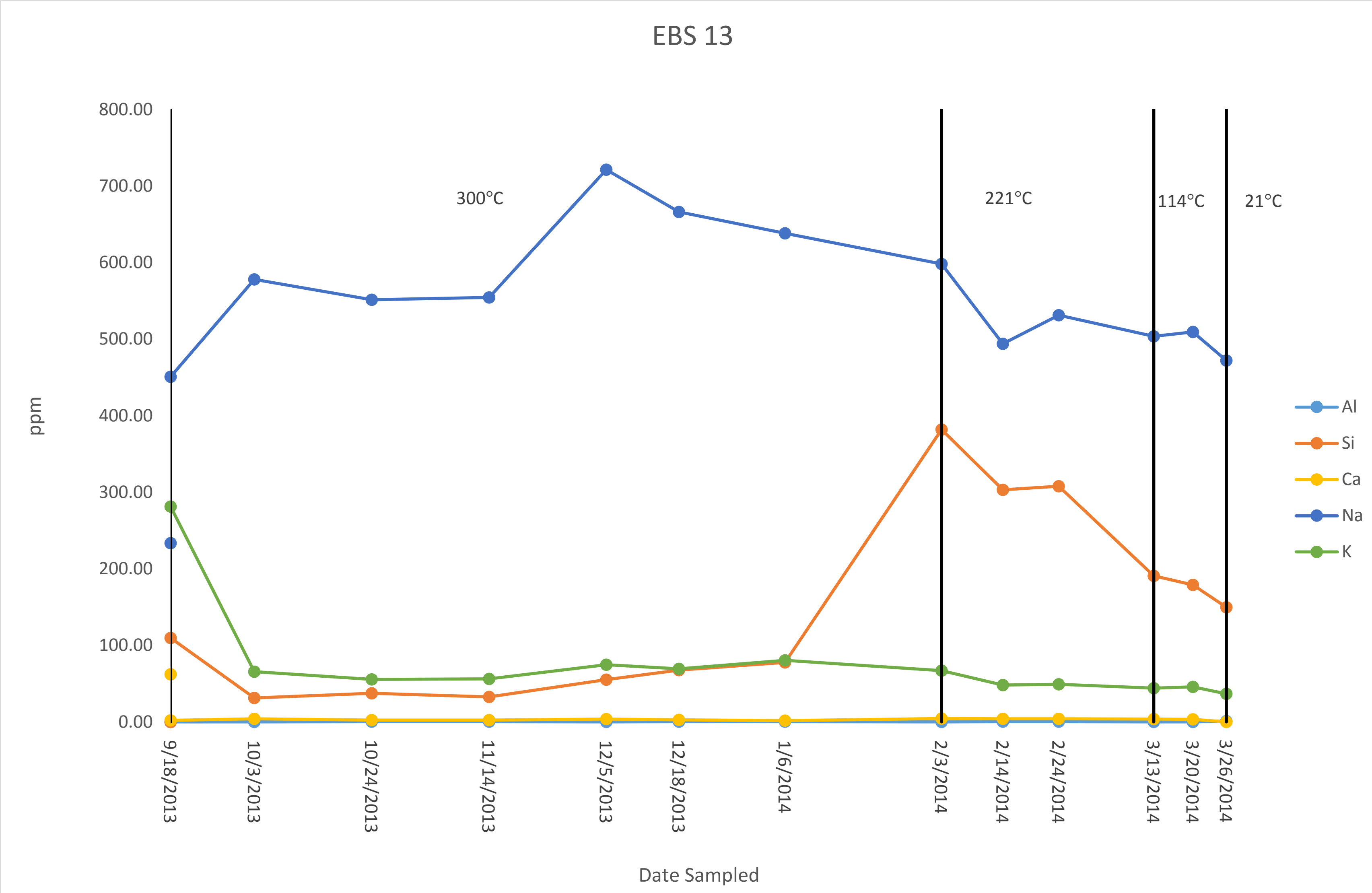

EBS 7
800.00
700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00
ppm
25°C
120°C
211°C
303°C
8/17/2012
8/22/2012
8/30/2012
9/6/2012
9/13/2012
9/20/2012
9/27/2012
9/28/2012
Date Sample
Al
Si
Ca
Na
K

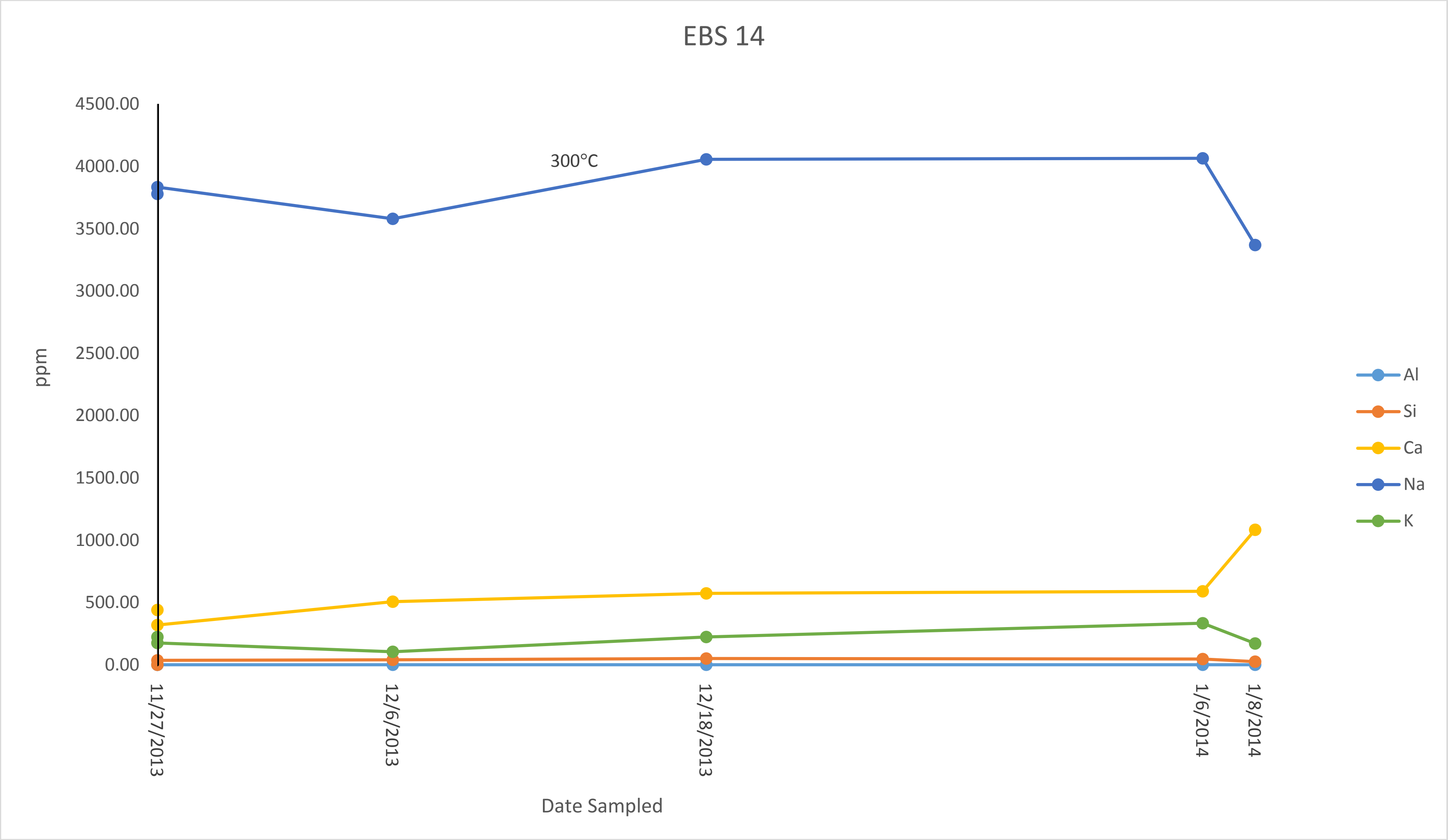

EBS 8
800.00
700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00
ppm
309°C
119°C
310°C
8/23/2012
8/30/2012
9/6/2012
9/13/2012
9/20/2012
9/27/2012
10/4/2012
10/5/2012
Date Sample
Al
Si
Ca
Na
K

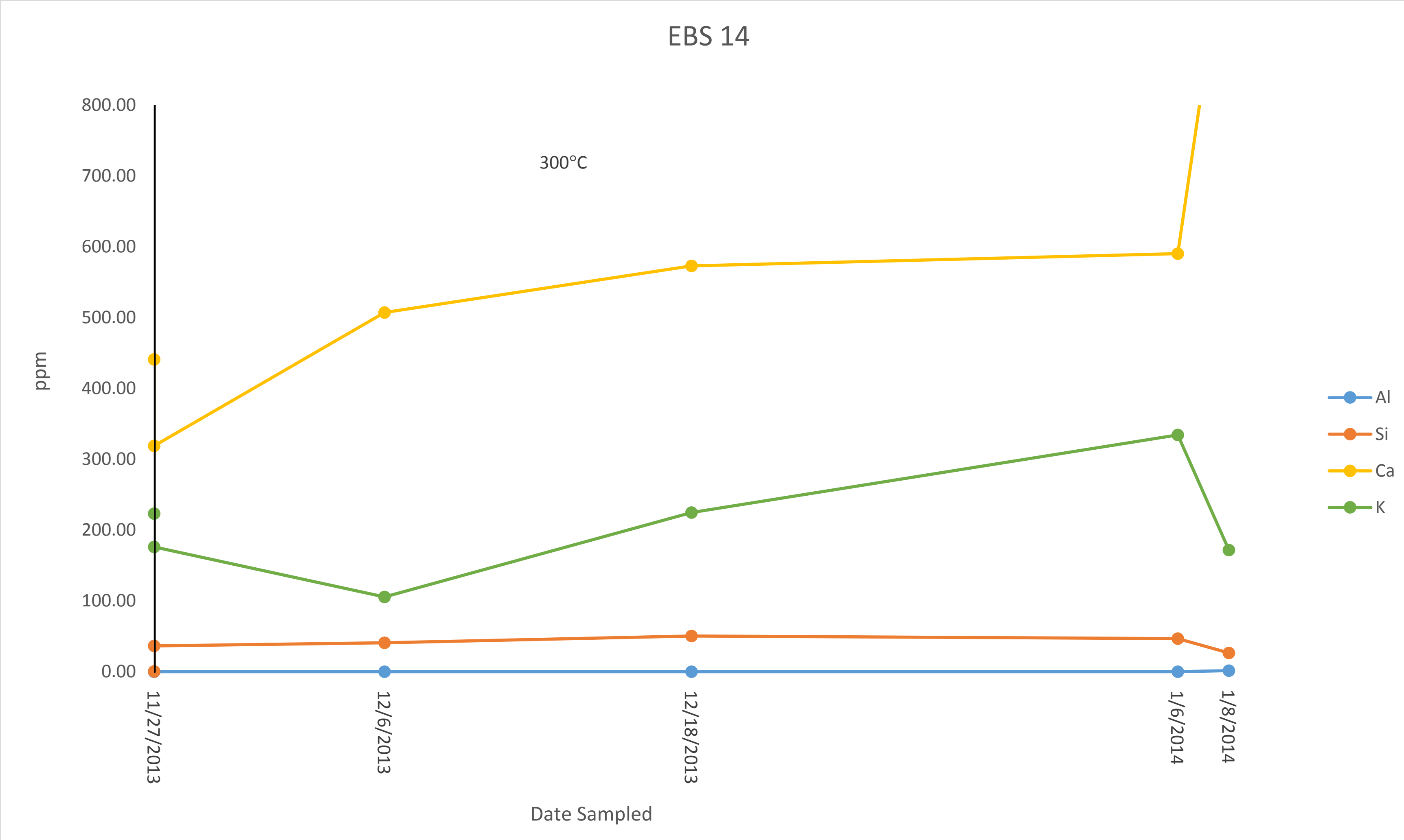

EBS 9
800.00
700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00
ppm
121°C
210°C
300°C
25°C
11/1/2012
11/8/2012
11/15/2012
11/21/2012
11/29/2012
12/4/2012
12/10/2012
12/11/2012
Date Sampled
Al
Si
Ca
Na
K

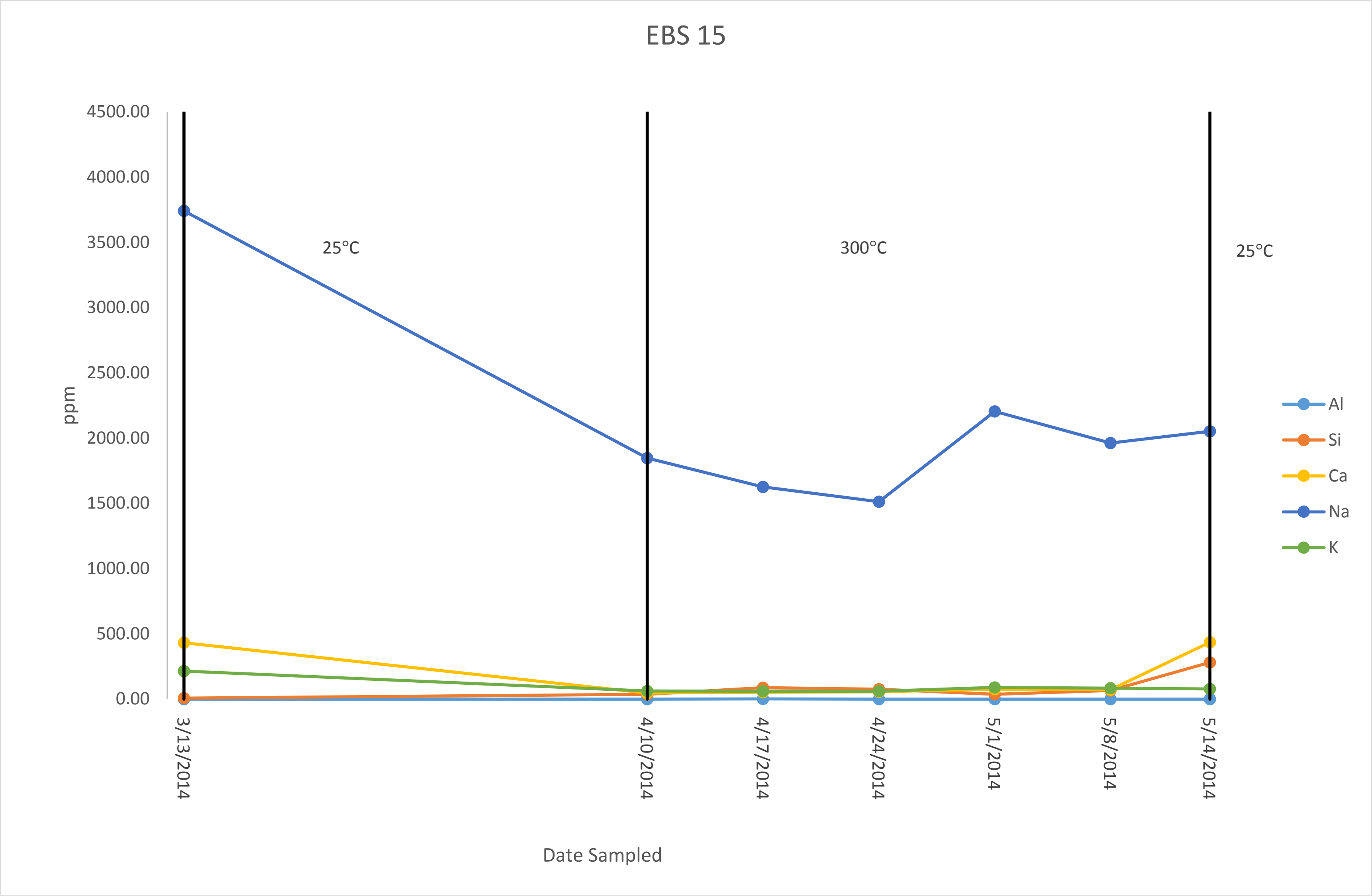

EBS 10
300°C
25°C
ppm
800.00
700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00
1/18/2013
1/24/2013
1/31/2013
2/7/2013
2/15/2013
2/21/2013
2/28/2013
3/1/2013
Date Sampled
Al
Si
Ca
Na
K

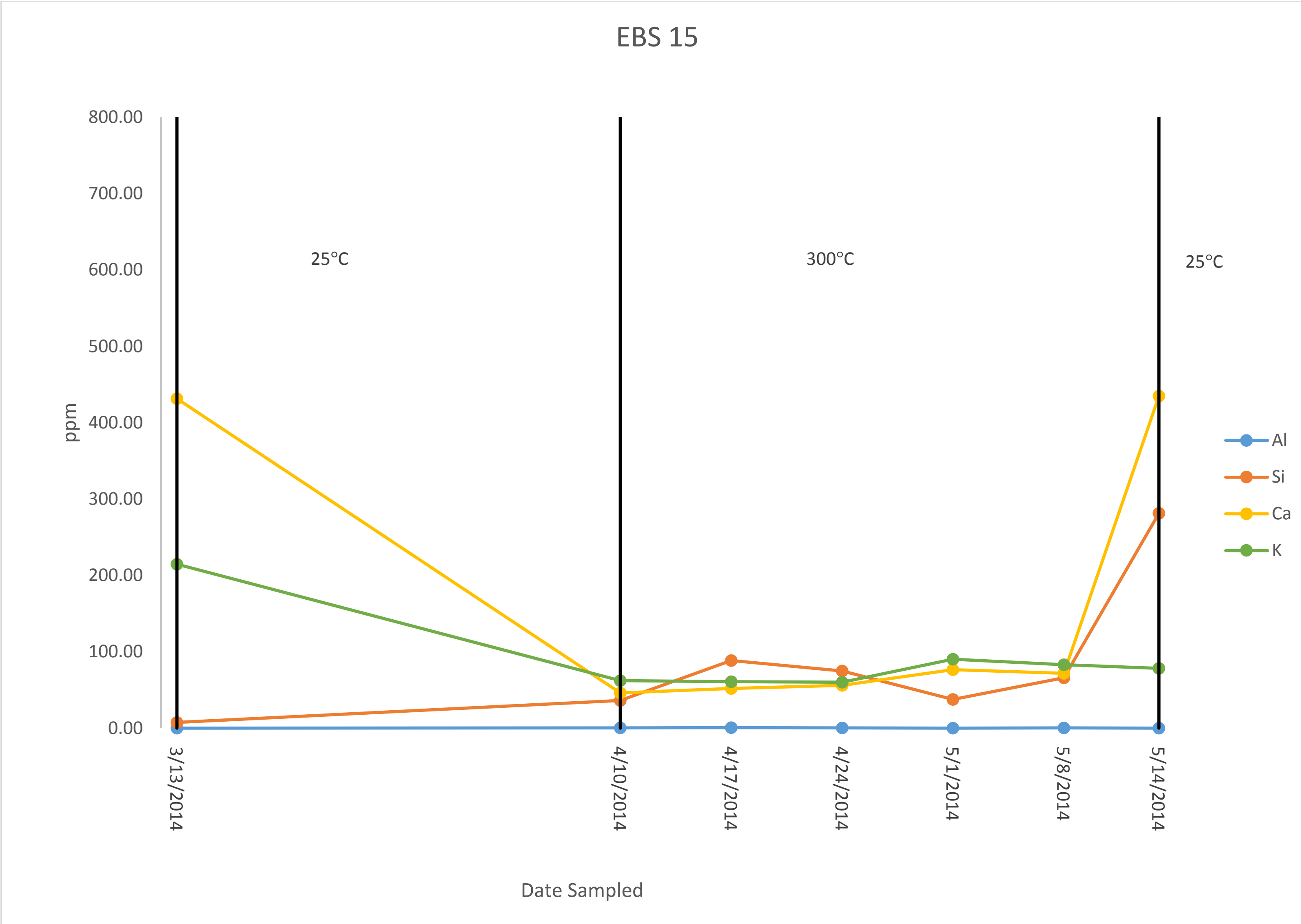

EBS 11
800.00
700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00
ppm
300°C
25°C
2/1/2013
2/7/2013
2/14/2013
2/21/2013
2/28/2013
3/7/2013
3/14/2013
3/15/2013
Date Sampled
Al
Si
Ca
Na
K

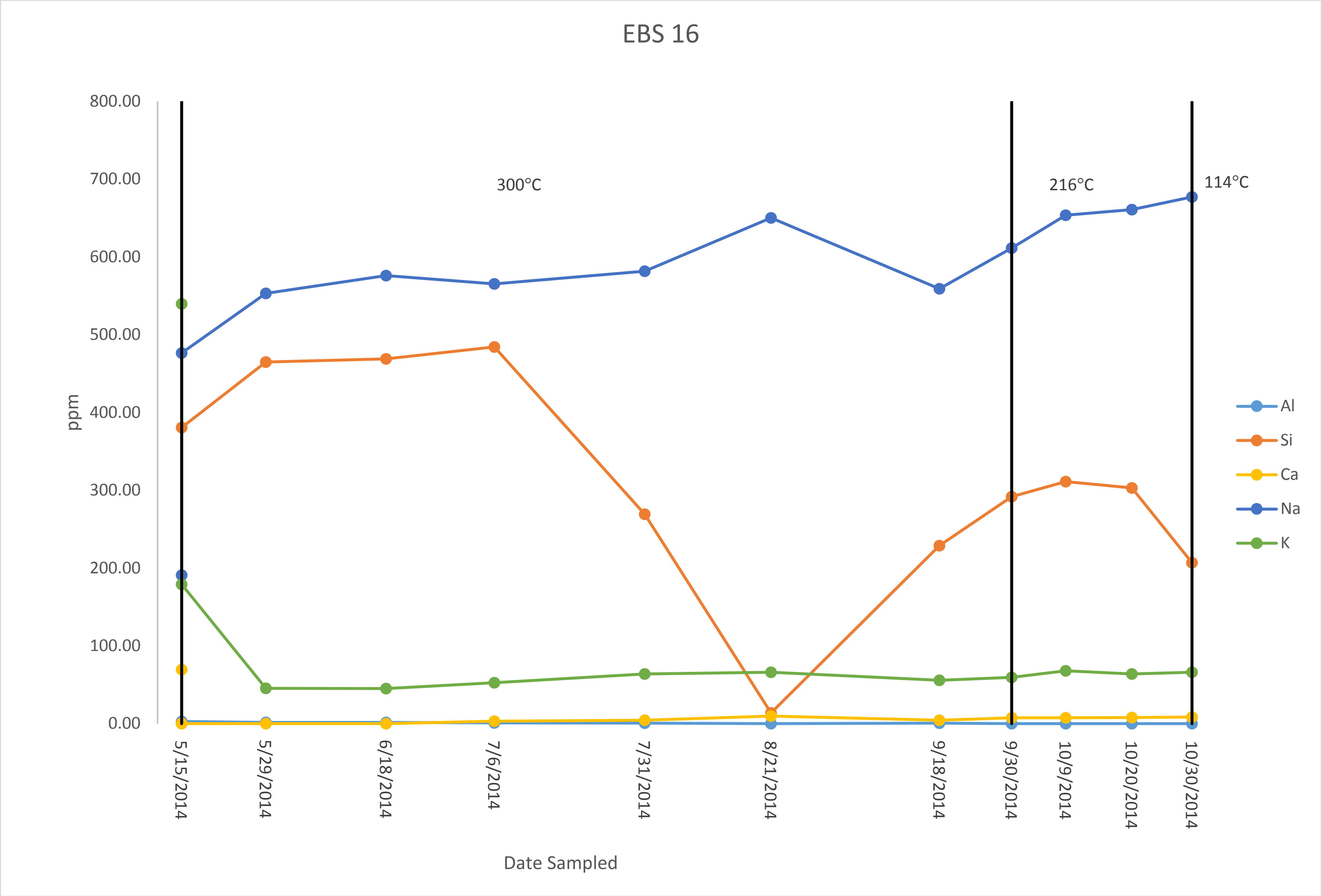

EBS 13
800.00
700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00
ppm
300°C
221°C
114°C
21°C
9/18/2013
10/3/2013
10/24/2013
11/14/2013
12/5/2013
12/18/2013
1/6/2014
2/3/2014
2/14/2014
2/24/2014
3/13/2014
3/20/2014
3/26/2014
Date Sampled
Al
Si
Ca
Na
K


EBS 14
4500.00
4000.00
3500.00
3000.00
2500.00
2000.00
1500.00
1000.00
500.00
0.00
ppm
300°C
11/27/2013
12/6/2013
12/18/2013
1/6/2014
1/8/2014
Date Sampled
Al
Si
Ca
Na
K


EBS 14
300°C
ppm
800.00
700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00
11/27/2013
12/6/2013
12/18/2013
1/6/2014
1/8/2014
Date Sampled
Al
Si
Ca
K


EBS 15
4500.00
4000.00
3500.00
3000.00
2500.00
2000.00
1500.00
1000.00
500.00
0.00
ppm
25°C
300°C
25°C
3/13/2014
4/10/2014
4/17/2014
4/24/2014
5/1/2014
5/8/2014
5/14/2014
Date Sampled
Al
Si
Ca
Na
K


EBS 15
800.00
700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00
ppm
25°C
300°C
25°C
3/13/2014
4/10/2014
4/17/2014
4/24/2014
5/1/2014
5/8/2014
5/14/2014
Date Sampled
Al
Si
Ca
K


EBS 16
ppm
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700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00
300°C
216°C
114°C
5/15/2014
5/29/2014
6/18/2014
7/6/2014
7/31/2014
8/21/2014
9/18/2014
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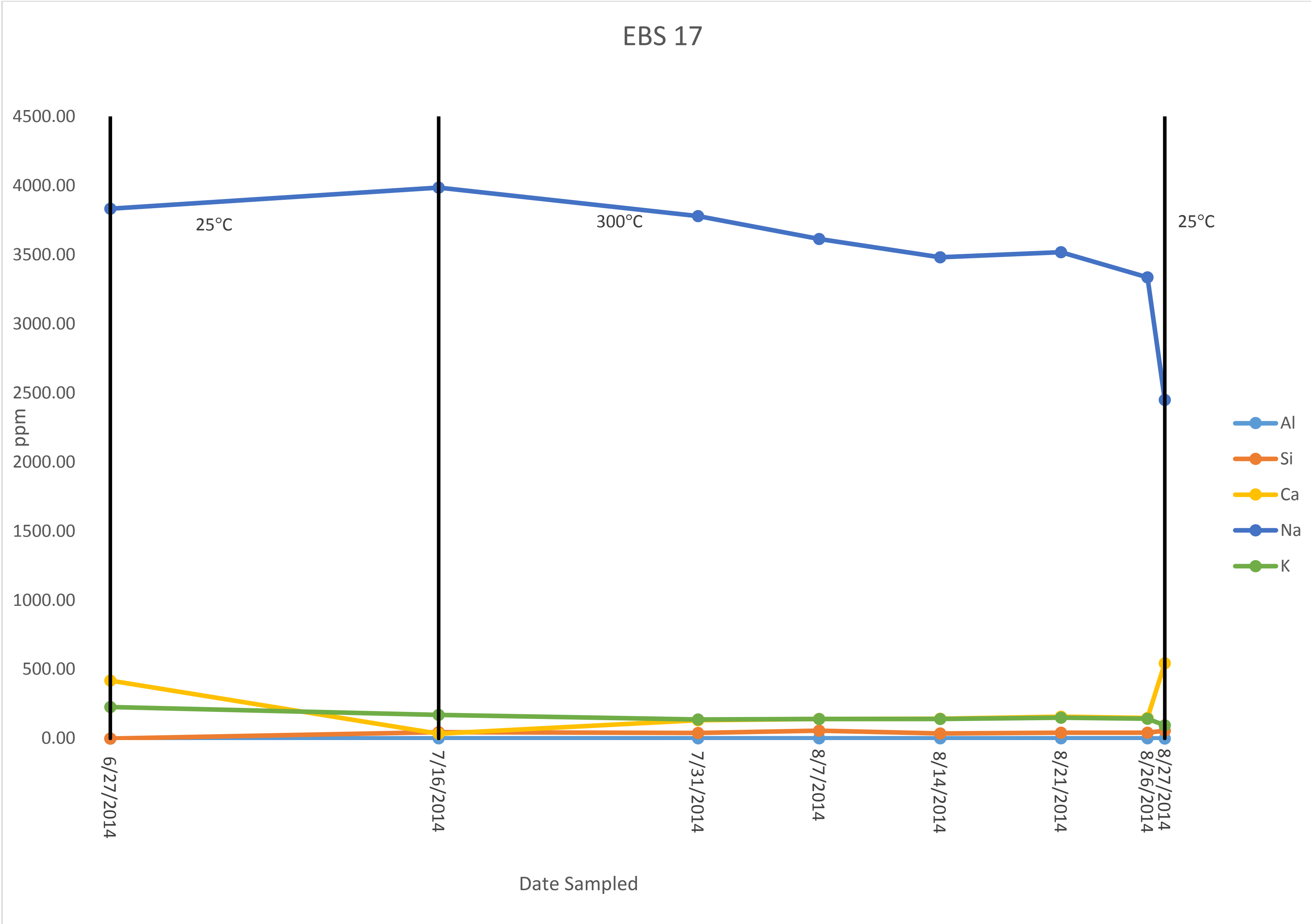
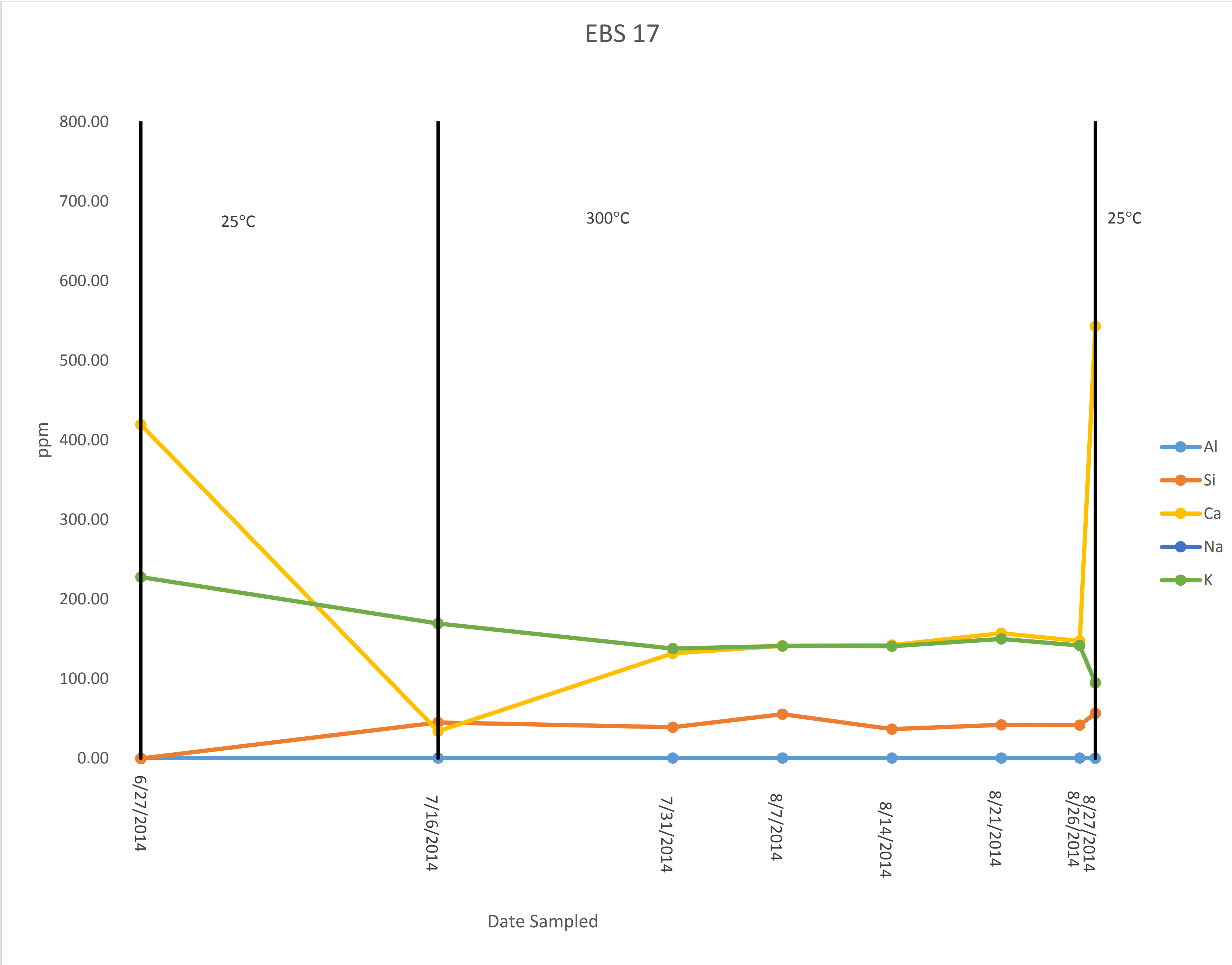
10/30/2014
Date Sampled
Al
Si
Ca
Na
K


EBS 17
4500.00
4000.00
3500.00
3000.00
2500.00
2000.00
1500.00
1000.00
500.00
0.00
ppm
25°C
300°C
25°C
6/27/2014
7/16/2014
7/31/2014
8/7/2014
8/14/2014
8/21/2014
8/26/2014
8/27/2014
Date Sampled
Al
Si
Ca
Na
K


EBS 17
800.00
700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00
ppm
25°C
300°C
25°C
6/27/2014
7/16/2014
7/31/2014
8/7/2014
8/14/2014
8/21/2014
8/26/2014
8/27/2014
Date Sampled
Al
Si
Ca
Na
K