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NEPHELINE FORMATION STUDY FOR SLUDGE BATCH 4 (SB4): PHASE 1 EXPERIMENTAL RESULTS

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EXECUTIVE SUMMARY

Although it is well known that the addition of Al_2O_3 to borosilicate glasses enhances the durability of the waste form (through creation of network-forming tetrahedral Na^+-$[AlO_{4/2}]^-$ pairs), the combination of high Al_2O_3 and Na_2O can lead to the formation of nepheline ($NaAlSiO_4$) – which can negatively impact durability. Given the projected high concentration of Al_2O_3 in SB4 (Lilliston 2005) and the potential use of a high Na_2O based frit to improve melt rate and a high Na_2O sludge due to settling problems, the potential formation of nepheline in various SB4 systems continues to be assessed. Twelve SB4-based glasses were fabricated and their durabilities (via the Product Consistency Test [PCT]) measured to assess the potential for nepheline formation and its potential negative impact on durability.

In terms of "acceptability," the results indicate that all of the study glasses produced are acceptable with respect to durability as defined by the PCT (normalized boron release values for all nepheline (NEPH) glasses were much lower than that of the Environmental Assessment (EA) glass (16.695 g/L)). The most durable glass is NEPH-04 (quenched) with a normalized boron release (NL [B]) of 0.61 g/L, while the least durable glass is NEPH-01 centerline canister cooled (ccc) with an NL [B] of 2.47 g/L (based on the measured composition). In terms of predictability, most of the study glasses are predictable by the ΔG_p model. Those that are not predictable (i.e., they fall outside of the prediction limits) actually fall below the prediction interval (i.e., they are over predicted by the model) suggesting the model is conservative.

The Phase 1 PCT results suggest that for those glasses prone to nepheline formation (using the 0.62 value developed by Li et al. (2003) as a guide)[1], a statistically significant difference in PCT response was observed for the two heat treatments but the impact on durability was of little or no practical concern. When one couples the PCT responses with the X-Ray Diffraction (XRD) results and/or visual observations, one could conclude that the formation of nepheline in these glasses does have a negative impact on durability. However, that impact may be of statistical significance, but the practical impact may not be sufficient to avoid a specific candidate frit for the SB4 glass system.

The results of this study not only suggest that the 0.62 value appears to be a reasonable guide to monitor sludge – frit systems with respect to potential nepheline formation, but also that the impact of nepheline, although statistically significant, has little or no practical impact in the SB4 system to durability as measured by the PCT. This latter statement must be qualified to some extent given only two glasses were selected which were actually "prone to nepheline formation" based on this general guide and the relatively volume % of nepheline formed based on XRD results (~ 0.5 vol%). If the presence of nepheline has no appreciable, adverse impact on durability for the recently revised SB4 systems, then as decisions regarding the viability of the SB4 options and the down select of candidate frits are pursued, little weight will be given to minimizing the likelihood of nepheline and the decisions will be dominated by waste throughput criteria. That is, the frit selection process will not have to consider the impact of nepheline on the ultimate durability of the product and can focus on recommending a frit that when coupled with the sludge can be processed over a waste loading (WL) interval of interest to the Defense Waste Processing Facility (DWPF) with melt rates meeting production expectations.

[1] Li et al. (2003) indicated that sodium alumino-borosilicate glasses are prone to nepheline crystallization if their compositions projected on the Na_2O-Al_2O_3-SiO_2 ternary fall within or close to the nepheline primary phase field. In particular, durable glasses with $SiO_2/(SiO_2+Na_2O+Al_2O_3) > 0.62$, where the chemical formula stand for the mass fractions in the glass, do not tend to precipitate nepheline as their primary phase.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ACRONYMS

ADS	Analytical Development Section
ANOVA	analysis of variance
ARM	Approved Reference Material
ARP	Actinide Removal Process
ASTM	American Society for Testing and Materials
bc	bias-corrected
CBU	Closure Business Unit
ccc	centerline canister cooled
DWPF	Defense Waste Processing Facility
EA	Environmental Assessment
g/L	grams per liter
HLW	high-level waste
ICP-AES	Inductively-Coupled Plasma – Atomic Emission Spectroscopy
LM	lithium-metaborate
NEPH	nepheline
NL	normalized leachate (or normalized release)
PCT	Product Consistency Test
PF	peroxide fusion
ppm	parts per million
SB4	Sludge Batch 4
SRL	Savannah River Laboratory
SRNL	Savannah River National Laboratory
SRNL-ML	Savannah River National Laboratory – Mobile Laboratory
T_L	liquidus temperature
U_{std}	uranium standard
WL	waste loading
XRD	X-ray diffraction

1.0 INTRODUCTION

Crystallization (or devitrification) in nuclear waste glasses is an important consideration in terms of processing and product performance (i.e., durability of the final waste form). With respect to the impact of crystallization on processability, DWPF uses a liquidus temperature (T_L) model (Brown et al., 2001) and an imposed T_L limit for feed acceptability to avoid bulk devitrification within the melter. In terms of product quality or the durability of the waste form, the impact of devitrification depends on the type and extent of crystallization.

As stated by Peeler et al. (2005), several studies have investigated the impacts of crystallization on DWPF-type glasses. The results of Bickford and Jantzen (1984) indicated that the formation of spinel had little or no effect on the durability of Savannah River Laboratory (SRL) 165- or SRL 131-based glasses, while the formation of acmite produced a small but noticeable increase in the rate of dissolution of the matrix glass. Cicero et al. (1993) assessed the durability of seven DWPF glass compositions and found that with respect to the impact of crystallization on durability, the type and extent of devitrification ultimately determined the durability of the glass. Kim et al. (1995) assessed the durability response of over 120 simulated high-level waste (HLW) glasses for Hanford as a function of thermal heat treatment (quenched versus ccc). The results of that study also indicated that crystallization, depending on the type and extent (or fraction), can have an adverse effect on chemical durability. Numerous other studies have assessed the devitrification potential of HLW glass and its potential impact on durability – Jantzen et al. (1984), Bickford and Jantzen (1986), Spilman et al. (1986), Marra and Jantzen (1993), Li et al. (1997), and Riley et al. (2001). In general, these studies agree that the impact of devitrification on durability is dependent upon the type and extent of crystallization.

The formation of nepheline and/or other aluminum/silicon-containing crystals is a potential in the SB4 system due to the projected compositional views recently evaluated coupled with the frit development strategy (Peeler and Edwards 2005). Compositional projections of SB4 by Lilliston (2005) indicated the sludge will be enriched in Al_2O_3 (relative to the Al_2O_3 concentrations of previous sludge batches processed through the DWPF).[2] Peeler and Edwards (2005) have identified candidate frits (ranging in Na_2O concentration from 8 – 13% by mass) for the SB4 compositional projections, which produce relatively large projected operating windows. The combination of high Al_2O_3 and Na_2O concentrations, coupled with lower SiO_2 concentrations as waste loadings increase, can lead to the formation of nepheline ($NaAlSiO_4$). Li et al. (2003) indicated that sodium alumino-borosilicate glasses are prone to nepheline crystallization if their compositions projected on the Na_2O-Al_2O_3-SiO_2 ternary fall within or close to the nepheline primary phase field. In particular, durable glasses with $SiO_2/(SiO_2+Na_2O+Al_2O_3) > 0.62$, where the chemical formula stands for the mass fractions in the glass, do not tend to precipitate nepheline as their primary phase.

Forty-eight SB4 glass compositions were screened using the nepheline discriminator to assess the potential formation of nepheline (Peeler et al., 2005). The 48 glasses were based on four specific blending scenarios as defined by Lilliston (2005), which based on theory increased the likelihood of nepheline formation. The four sludge options were: (1) 1100 Can Baseline, (2) 1100 Can Max

[2] It is noted that prior to the issuance of this report, Elder (2005a and 2005b) issued revised SB4 compositions based on a decision not to include Tank 4 in SB4. In general, all of the projected SB4 options have relatively high Al_2O_3 and/or Na_2O concentrations regardless of the Tank 4 decision. Although differences do exist between the two sets of compositional projections, use of these preliminary sludge compositions from Lilliston (2005) will provide insight into the potential effects of nepheline formation on durability for SB4-based glasses.

Al, Na; Min Mn, Ni, (3) 1100 Can Max Mg, and (4) 1100 Can Max Ni; these were coupled with Frit 418 and Frit 320. Only two (NEPH-01 and NEPH-02) of the 48 glasses were classified as "prone to nepheline formation" using the guideline or discriminator value of 0.62 (from Li et al., 2003). These two glasses were based on Frit 320 and the 1100 Canister Max Al, Na case (with and without Actinide Removal Process (ARP)) and target 40% WL, which agreed with theory regarding the potential for nepheline formation.[3] Although Li et al. (2003) defined the "line of demarcation" between glasses that are prone to nepheline formation from those that are not based on a value of 0.62, that line may be somewhat ill-defined (e.g., does the classification take into account potential kinetic effects such as slow cooling?). Therefore, to provide a higher probability of observing the formation of nepheline and the potential negative impact on durability, a value of 0.65 was used to establish the glasses to be tested in this study. Twelve glasses were identified or classified as "prone to nepheline formation" using this "less conservative" value. The objectives of this study were to fabricate these 12 glasses and assess the potential for nepheline formation and its impact on durability (as defined by the PCT).

The results of this study will provide valuable input to SB4 frit development efforts and subsequent feedback to the DWPF and Closure Business Unit (CBU) regarding the relative viability of the various SB4 options under consideration. Specifically, if the formation of nepheline for SB4 glasses is found through this study (or subsequent studies) to have an impact on durability that is overly detrimental, then candidate frits that lessen the likelihood of the formation of nepheline over an interval of waste loadings of interest to DWPF would move up the list of preferred frits. On the other hand, if the presence of nepheline has no appreciable, adverse impact on durability, then as decisions regarding the viability of the SB4 options and the down select of candidate frits are pursued, little weight will be given to minimizing the likelihood of nepheline and the decisions will be dominated by waste throughput criteria.

The experimental approach is summarized in Section 2.0. In Section 3.0, the results of the study are presented and discussed. More specifically, an assessment of the target versus measured compositions is provided to ensure the objectives of the task can be met. In addition, the PCT results for both quenched and centerline canister cooled glasses are presented for each study glass. The PCT results are discussed in terms of acceptability and model predictability. The result of both visual and XRD analyses are also presented and discussed in relation to the objectives of the task. Section 4.0 and Section 5.0 provide the summary and recommendations, respectively.

[3] Both Al_2O_3 and Na_2O concentrations in these glass systems increase as waste loadings are increased for the 1100 Can Max Al, Na case. In addition, knowing that the primary source of SiO_2 stems from the frit, as WLs increase the SiO_2 content of the glass decreases – again increasing the probability of nepheline formation according to the discriminator developed by Li et al. (2003). Based on that theory, the probability of nepheline formation should increase as high-alkali frits are used and should further increase with higher WLs for SB4.

2.0 EXPERIMENTAL

2.1 Glass Fabrication

Each glass fabricated for this study, NEPH-01 through NEPH-12, was prepared from the proper proportions of reagent-grade metal oxides, carbonates, H_3BO_3, and salts in 150-g batches. Once batched (SRNL 2002a), the glasses were melted using Savannah River National Laboratory (SRNL) technical procedure "Glass Melting" (SRNL 2002b). In general, the raw materials were thoroughly mixed and placed into a 95% Platinum/5% Gold 250-mL crucible. The batch was placed into a high-temperature furnace at the target melt temperature of 1150°C. After an isothermal hold at 1150°C for 1.0 h, the crucible was removed, and the glass was poured onto a clean stainless steel plate and allowed to air cool (quench). The glass pour patty was used as a sampling stock for the various property measurements (i.e., chemical composition and durability).

In order to bound the effects of thermal history on the product performance, approximately 25 g of each glass was heat-treated to simulate cooling along the centerline of a DWPF-type canister (Marra and Jantzen, 1993). This cooling regime is commonly referred to as the ccc curve.

2.2 Property Measurements

This section provides a general discussion of the chemical composition analyses, the PCTs, and the XRD analyses of the nepheline study glasses.

2.2.1 Compositional Analysis

To confirm that the "as-fabricated" glasses corresponded to the defined target compositions, a representative sample from each glass was submitted to the SRNL Mobile Laboratory (SRNL-ML) for chemical analysis under the auspices of an analytical plan. The plan (see Appendix A) identified the cations to be analyzed and the dissolution techniques (i.e., sodium peroxide fusion [PF] and lithium-metaborate [LM]) used. Samples prepared by LM dissolution were used to measure elemental concentrations of barium (Ba), calcium (Ca), cerium (Ce), chromium (Cr), copper (Cu), potassium (K), lanthanum (La), magnesium (Mg), sodium (Na), lead (Pb), sulfur (S), thorium (Th), titanium (Ti), zinc (Zn), and zirconium (Zr), while samples from glasses prepared by PF dissolution were used to measure elemental concentrations of aluminum (Al), boron (B), iron (Fe), lithium (Li), manganese (Mn), nickel (Ni), silicon (Si), and uranium (U). Each glass was prepared in duplicate for each cation dissolution technique (PF and LM). All of the prepared samples were analyzed (twice for each element of interest) by Inductively Coupled Plasma – Atomic Emission Spectroscopy (ICP-AES) (with the instrumentation being re-calibrated between the duplicate analyses). The analytical plan was developed in such a way as to provide the opportunity to evaluate potential sources of error. Glass standards were also intermittently run to assess the performance of the ICP – AES over the course of these analyses.

2.2.2 Product Consistency Test (PCT)

The PCT was performed in triplicate on each quenched and each ccc "NEPH" glass to assess chemical durability using technical procedure "Standard Test Methods for Determining Chemical Durability of Nuclear Waste Glasses: The Product Consistency Test (PCT)" (ASTM, 2002). Also included in this experimental test matrix was the EA glass (Jantzen et al., 1993), the Approved Reference Material (ARM) glass, and blanks from the sample cleaning batch. Samples were ground, washed, and prepared according to procedure (ASTM, 2002). Fifteen milliliters of Type I American Society for Testing and Materials (ASTM) water were added to 1.5 g of glass in stainless steel vessels. The vessels were closed, sealed, and placed in an oven at 90 ± 2°C where the samples were maintained for 7 days. The resulting solutions (once cooled) were sampled (filtered and acidified), labeled (according to the analytical plan), and analyzed under the auspices of the analytical plan (see Appendix B). The overall philosophy of the plan was to provide an opportunity to assess the consistency (repeatability) of the PCT and analytical procedures in an effort to evaluate chemical durability of the "NEPH" glasses. Normalized release rates were calculated based on targeted, measured, and bias-corrected compositions using the average of the logs of the leachate concentrations.

2.2.3 X-Ray Diffraction (XRD) Analysis

Although visual observations for crystallization were performed and documented, representative samples for all "as-fabricated" (or quenched) and ccc SB4 glasses were submitted to the SRNL Analytical Development Section (ADS) for XRD analysis.[4] Samples were run under conditions allowing an approximately 0.5 vol% detection limit. That is, if crystals (or undissolved solids) are present at 0.5 vol% (or greater), the diffractometer will not only be capable of detecting these crystals but will also allow a qualitative measure (i.e., determine the type of crystal[s] present). Otherwise, a characteristically high background devoid of crystalline spectral lines indicates that the glass product is amorphous (suggesting either a completely amorphous product or that the degree of crystallization is below the detection limit).

[4] Select glasses were initially submitted for XRD analysis based on a significant difference in the PCT response due to heat treatment, which may be indicative of nepheline or other crystalline formation and of the "negative" impact on the durability response in the ccc versions of these glasses. These included both quenched and ccc versions of NEPH-01, NEPH-02, NEPH-03, NEPH-04, and NEPH-09 (10 glasses total). That decision was made based solely on the PCT response and not visual observations of possible surface crystallization. To assess if the surface crystallization was nepheline or spinel (as presumed based on historical comparisons), all 24 glasses (both quenched and ccc of all 12 NEPH glasses) were submitted fro XRD analyses. Therefore, duplicate analyses are shown for select glasses.

3.0 RESULTS

In this section, the results of the compositional assessment (target versus measured), the durability response, and the XRD results are presented. Initially the compositional results are presented to indicate that the measured compositions are in-line with the targeted compositions – no significant batching errors were evident. The durability information for both quenched and ccc versions of each NEPH glass is then presented and discussed given it is the primary response variable of interest. The PCT results should provide a marker for those systems in which nepheline formation is likely. This section will flag or highlight significant differences observed between quenched and ccc versions of each glass. In addition, the acceptability of the NEPH glasses (measured releases compared to the EA glass benchmark) as well as the predictability of the glasses are also presented. Finally, visual and XRD results are presented which should support or provide a technical basis from which the impact (or lack thereof) of crystallization on durability can be assessed.

In this section, the measured versus targeted compositions of the twelve SB4 nepheline study glasses (NEPH-01 through NEPH-12) are presented and compared. The targeted compositions for these glasses are provided in Table C.1 of Appendix C. A sum of oxides column is provided in Table C.1 as well.

Table C.2 in Appendix C provides the elemental concentration measurements derived from the samples prepared using LM, and Table C.3 in Appendix C provides the measurements derived from the samples prepared using PF. Measurements for standards (Batch 1 and a uranium standard, U_{std}) that were included in the SRNL-ML analytical plans along with the study glasses are also provided in these two tables. Also, note that the initial sodium values provided by the SRNL-ML appeared to be consistently higher than expected which led to the samples being re-measured for sodium by the SRNL-ML. The sodium values in Table C.2 are the re-measurements generated by the SRNL-ML.

The elemental concentrations were converted to oxide concentrations by multiplying the values for each element by the gravimetric factor for the corresponding oxide. During this process, an elemental concentration that was determined to be below the detection limit of the analytical procedures used by the SRNL-ML was reduced to half of that detection limit as the oxide concentration was determined.

In the sections that follow, the analytical sequences of the measurements are explored, the measurements of the standards are investigated and used for bias correction, the measurements for each glass are reviewed, the average chemical compositions (measured and bias-corrected) for each glass are determined, and comparisons are made between the measurements and the targeted compositions for the glasses.

3.1 Measurements in Analytical Sequence

Exhibit C.1 in Appendix C provides plots of the measurements generated by the SRNL-ML for samples prepared using the LM method. The plots are in analytical sequence with different symbols and colors being used to represent each of the study and standard glasses. Similar plots for the samples prepared using the PF method are provided in Exhibit C.2 in Appendix C. These plots include all of the measurement data from Tables C.2 and C.3. A review of these plots indicates no significant patterns or trends in the analytical process over the course of these measurements, and there appear to be no obvious outliers in these chemical composition measurements.

3.1.1 Batch 1 and Uranium Standard Results

In this section, the SRNL-ML measurements of the chemical compositions of the Batch 1 and U_{std} glasses are reviewed. These measurements are investigated across the ICP-AES analytical blocks, and the results are used to bias correct the measurements for the study glasses.

Exhibit C.3 in Appendix C provides statistical analyses of the Batch 1 and U_{std} results generated by the LM prep method by block for each oxide of interest. The results include analysis of variance (ANOVA) investigations looking for statistically significant differences between the block means for each of the oxides for each of the standards. The results from the statistical tests for the Batch 1 standard may be summarized as follows: only ZrO_2 has measurements that indicate a significant ICP-AES calibration effect on the block averages at the 5% significance level. For the U_{std}, only ThO_2 has measurements that indicate a significant ICP-AES calibration effect on the block averages at the 5% significance level. This is probably an artifact of the detection limit for ThO_2. The reference values for the oxide concentrations of the standards are given in the header for each set of measurements in the exhibit.

Exhibit C.4 in Appendix C provides a similar set of analyses for the measurements derived from samples prepared via the PF method. In this exhibit, none of the measurements for Batch 1 or for U_{std} indicate a significant ICP-AES calibration effect on these averages at the 5% significance level. The reference values for the oxide concentrations of the standards are given in the headers for each set of measurements in the exhibit.

The results provide little incentive for adjusting the measurements by the effect of the ICP-AES calibration; however, the average measurements do differ from the reference values for some of the oxides. See for example the analysis for Na_2O. In keeping with the analyses that have been conducted previously, the oxide measurements of the study glasses were bias-corrected (bc) for the effect of the ICP-AES calibration on each of the analytical blocks. The basis for this bias correction is presented as part of Exhibits C.3 and C.4 – the average measurement for Batch 1 for each ICP-AES set/block for Al_2O_3, B_2O_3, BaO, CaO, Cr_2O_3, CuO, Fe_2O_3, Li_2O, MgO, MnO, Na_2O, NiO, SiO_2, and TiO_2 and the average measurement for U_{std} for each ICP-AES set/block for U_3O_8. The Batch 1 results served as the basis for bias correcting all of the oxides (that were bias corrected) except uranium. The U_{std} results were used to bias correct for uranium. For the other oxides, the Batch 1 results were used to conduct the bias correction as long as the reference value for the oxide concentration in the Batch 1 glass was greater than or equal to 0.1 wt%. Thus, applying this approach and based upon the information in the exhibits, the Batch 1 results were used to bias correct the Al_2O_3, B_2O_3, BaO, CaO, Cr_2O_3, CuO, Fe_2O_3, K_2O, Li_2O, MgO, MnO, Na_2O, NiO, SiO_2, and TiO_2 measurements. No bias correction was conducted for Ce_2O_3, La_2O_3, PbO, SO_4, ThO_2, ZnO, or ZrO_2.

The bias correction was conducted as follows. For each oxide, let $\bar{a}_{ij}$ be the average measurement for the i^{th} oxide at analytical block j for Batch 1 (or U_{std} for uranium), and let t_i be the reference value for the i^{th} oxide for Batch 1 (or for U_{std} if uranium). (The averages and reference values are provided in Exhibits C.3 and C.4.) Let $\bar{c}_{ijk}$ be the average measurement for the i^{th} oxide at analytical block j for the k^{th} glass. The bias adjustment was conducted as follows:

$$\bar{c}_{ijk} \bullet \left(1 - \frac{\bar{a}_{ij} - t_i}{\bar{a}_{ij}}\right) = \bar{c}_{ijk} \bullet \frac{t_i}{\bar{a}_{ij}}$$

Bias-corrected measurements are indicated by a "bc" suffix, and such adjustments were performed for all of the oxides of this study except for Ce_2O_3, La_2O_3, PbO, SO_4, ThO_2, ZnO, and ZrO_2. Both measured and measured "bc" values are included in the discussion that follows. In these discussions bias-corrected values for Ce_2O_3, La_2O_3, PbO, SO_4, ThO_2, ZnO, and ZrO_2 are included for completeness (e.g., to allow a sum of oxides to be computed for the bias-corrected results). These bias-corrected values are the same as the original Ce_2O_3, La_2O_3, PbO, SO_4, ThO_2, ZnO, and ZrO_2 values (i.e., once again, no bias correction was performed for this group of oxides).

3.1.2 Composition Measurements by Glass Number

Exhibits C.5 and C.6 in Appendix C provide plots of the oxide concentration measurements by Glass ID # (including both Batch 1, labeled as glass numbered 100 and U_{std}, labeled as glass numbered 200) for the measured and bias-corrected values for the LM and PF preparation methods, respectively. Different symbols and colors are used to represent the different glasses. These plots show the individual measurements across the duplicates of each preparation method and the two ICP-AES calibrations. A review of the plots presented in these exhibits reveals the repeatability of the four individual, oxide values for each glass. There appears to be a good bit of scatter in the $Fe_2O_{3,}$ MnO, and SiO_2 values. No other problems are evident in these plots.

More detailed discussions of the average, measured chemical compositions of the study glasses are provided in the sections that follow.

3.1.3 Measured versus Targeted Compositions

The four measurements for each oxide for each glass (over both preparation methods) were averaged to determine a representative chemical composition for each glass. These determinations were conducted both for the measured and for the bias-corrected data. Table 3-1 provides a summary of the target versus measured composition for the study glasses. Exhibit C.7 in Appendix C provides similar information (including the measured-bc compositional view) and highlights some of the oxides for which comparisons can be based.

Some general observations from Table 3-1 and the plots of Exhibit C.7 are offered. Considering the major oxides (i.e., > 0.5 wt%) in glass, for nearly every nepheline study glass, the measured Fe_2O_3, Li_2O, MnO, NiO, and SiO_2 values are less than their respective targeted concentrations (see shaded rows in Table 3-1). For Na_2O the measured values for most of the study glasses fall above their respective targets for this oxide. The bias corrected values for most of these oxides fall nearer the targeted values.

Table C.4 in Appendix C provides a summary of the average compositions as well as the targeted compositions and some associated differences and relative differences. Notice that the targeted sums of oxides for the standard glasses do not sum to 100% due to an incomplete coverage of the oxides in the Batch 1 (glass # 100) and U_{std} (glass # 200) glasses. All of the sums of oxides (both measured and bias-corrected) for the study glasses fall within the interval of 95 to 105 wt%.

Overall, these comparisons between the measured and targeted compositions suggest that there were some difficulties in hitting the targeted compositions for some of the oxides for some of the glasses. However, these differences were not seen as being of practical concern.

Table 3-1. Targeted and Measured Compositions (wt%) of the NEPH Study Glasses.

	NEPH-01		NEPH-02		NEPH-03		NEPH-04		NEPH-05		NEPH-06	
	Target (wt%)	Meas. (wt%)	Target (wt%)	Meas. (wt%)	Target (wt%)	Meas. (wt%)	Target (wt%)	Meas. (wt%)	Target (wt%)	Meas. (wt%)	Target (wt%)	Meas. (wt%)
Al_2O_3	12.612	12.584	11.683	11.894	8.467	8.578	12.612	12.791	9.070	9.220	8.375	8.554
B_2O_3	4.800	4.676	4.800	4.572	4.800	4.749	4.800	4.749	4.800	4.741	4.800	4.636
BaO	0.043	0.039	0.042	0.037	0.062	0.057	0.043	0.036	0.065	0.058	0.076	0.063
CaO	0.884	0.890	0.839	0.810	0.848	0.853	0.884	0.867	0.893	0.899	0.723	0.735
Ce_2O_3	0.082	0.058	0.081	0.060	0.082	0.058	0.082	0.063	0.083	0.068	0.077	0.059
Cr_2O_3	0.092	0.102	0.087	0.089	0.096	0.103	0.092	0.091	0.101	0.099	0.105	0.103
CuO	0.029	0.029	0.028	0.026	0.032	0.031	0.029	0.030	0.034	0.034	0.032	0.033
Fe_2O_3	9.087	8.442	8.701	7.909	9.897	9.243	9.087	8.367	10.404	9.671	9.240	8.392
K_2O	0.682	0.727	0.624	0.709	0.377	0.425	0.682	0.768	0.410	0.475	0.416	0.476
La_2O_3	0.034	0.027	0.034	0.026	0.036	0.026	0.034	0.025	0.037	0.029	0.034	0.024
Li_2O	4.800	4.596	4.800	4.655	4.800	4.687	4.800	4.693	4.800	4.698	4.800	4.698
MgO	0.732	0.693	0.669	0.613	0.710	0.670	0.732	0.676	0.777	0.705	0.424	0.394
MnO	1.913	1.791	1.905	1.723	2.289	2.172	1.913	1.785	2.335	2.220	2.352	2.188
Na_2O	16.348	17.085	16.987	17.456	16.682	17.085	13.948	14.423	16.011	16.546	16.504	17.018
NiO	0.583	0.501	0.579	0.460	1.400	1.220	0.583	0.491	1.486	1.301	2.254	1.918
PbO	0.081	0.071	0.078	0.063	0.065	0.056	0.081	0.068	0.066	0.059	0.063	0.055
SO_4	0.442	0.393	0.508	0.423	0.506	0.462	0.442	0.391	0.439	0.394	0.504	0.446
SiO_2	44.482	43.106	44.38	42.893	44.218	43.263	46.882	46.109	44.293	43.428	44.055	43.267
ThO_2	0.020	0.092	0.018	0.087	0.013	0.132	0.020	0.091	0.014	0.136	0.011	0.146
TiO_2	0.010	0.010	0.979	0.967	0.977	0.909	0.010	0.007	0.009	0.007	0.975	0.910
U_3O_8	2.111	2.001	2.036	1.998	3.489	3.351	2.111	2.001	3.711	3.455	4.013	3.723
ZnO	0.040	0.042	0.039	0.038	0.049	0.067	0.040	0.039	0.051	0.053	0.050	0.055
ZrO_2	0.095	0.090	0.094	0.083	0.109	0.100	0.095	0.084	0.112	0.101	0.120	0.109

Table 3-1. Targeted and Measured Compositions (wt%) of the Nepheline Study Glasses.
(cont'd)

	NEPH-07		NEPH-08		NEPH-09		NEPH-10		NEPH-11		NEPH-12	
	Target (wt%)	Meas. (wt%)	Target (wt%)	Meas. (wt%)	Target (wt%)	Meas. (wt%)	Target (wt%)	Meas. (wt%)	Target (wt%)	Meas. (wt%)	Target (wt%)	Meas. (wt%)
Al_2O_3	8.969	9.343	11.683	12.012	11.035	11.228	8.097	8.257	8.664	8.885	10.222	10.430
B_2O_3	4.800	4.717	4.800	4.668	5.200	5.087	4.800	4.725	4.800	4.741	5.200	5.031
BaO	0.080	0.077	0.042	0.036	0.038	0.031	0.062	0.056	0.065	0.061	0.037	0.033
CaO	0.756	0.737	0.839	0.816	0.774	0.760	0.859	0.861	0.905	0.893	0.734	0.729
Ce_2O_3	0.078	0.060	0.081	0.056	0.072	0.048	0.081	0.066	0.083	0.061	0.071	0.055
Cr_2O_3	0.111	0.102	0.087	0.089	0.080	0.081	0.094	0.100	0.100	0.096	0.076	0.087
CuO	0.034	0.036	0.028	0.028	0.025	0.024	0.032	0.031	0.033	0.035	0.024	0.023
Fe_2O_3	9.680	8.867	8.701	7.859	7.951	7.616	10.080	9.414	10.613	9.743	7.613	6.912
K_2O	0.454	0.494	0.624	0.724	0.597	0.673	0.334	0.380	0.363	0.384	0.546	0.604
La_2O_3	0.035	0.025	0.034	0.025	0.030	0.021	0.036	0.027	0.037	0.029	0.029	0.023
Li_2O	4.800	4.752	4.800	4.720	5.200	5.080	4.800	4.693	4.800	4.704	5.200	5.064
MgO	0.462	0.444	0.669	0.622	0.641	0.580	0.784	0.720	0.859	0.818	0.585	0.556
MnO	2.404	2.259	1.905	1.720	1.674	1.568	2.387	2.266	2.443	2.314	1.667	1.507
Na_2O	15.816	16.344	14.587	15.165	15.805	16.209	16.659	17.220	15.987	16.344	16.364	16.816
NiO	2.426	2.053	0.579	0.481	0.510	0.436	1.425	1.251	1.514	1.313	0.507	0.414
PbO	0.064	0.061	0.078	0.064	0.071	0.061	0.062	0.056	0.063	0.061	0.068	0.058
SO_4	0.438	0.392	0.508	0.433	0.386	0.333	0.506	0.460	0.439	0.380	0.444	0.388
SiO_2	44.114	43.641	46.789	45.888	47.921	47.111	44.225	43.267	44.301	43.588	47.840	46.315
ThO_2	0.012	0.167	0.018	0.085	0.017	0.079	0.012	0.132	0.014	0.151	0.016	0.076
TiO_2	0.006	0.014	0.979	0.917	0.009	0.007	0.978	0.932	0.009	0.017	0.856	0.808
U_3O_8	4.287	4.206	2.036	1.948	1.847	1.807	3.528	3.404	3.753	3.687	1.781	1.724
ZnO	0.052	0.058	0.039	0.042	0.035	0.035	0.048	0.054	0.050	0.053	0.035	0.035
ZrO_2	0.124	0.114	0.094	0.086	0.083	0.074	0.105	0.096	0.107	0.102	0.082	0.078

Given slight differences between the measured and targeted compositions (in particular differences among the oxides contained in the nepheline discriminator function), one may question the impact of these differences on the classification of nepheline formation potential. The nepheline discriminator values were originally based on the targeted compositions, but the values were also assessed on the measured and measured-bias corrected compositions as well (see Table 3-2) to see if differences in classification would exist. That is, based on the measured or measure-bc values would any of the NEPH glasses be reclassified as being prone to nepheline formation or vice-versa? Based on the measured and measured-bias corrected compositions, only NEPH-01 and -02 are prone to the formation of nepheline, using the 0.62 discriminator value – consistent with the targeted compositional views.

Table 3-2. Nepheline Discriminator Values based on Compositional View.[5]

Glass ID	Comp. view	Nepheline Value	Comp. view	Nepheline Value	Comp. view	Nepheline Value
NEPH-01	target	0.606	measured	0.592	measured-bc	0.602
NEPH-02	target	0.608	measured	0.594	measured-bc	0.604
NEPH-03	target	0.637	measured	0.628	measured-bc	0.639
NEPH-04	target	0.638	measured	0.629	measured-bc	0.638
NEPH-05	target	0.638	measured	0.628	measured-bc	0.638
NEPH-06	target	0.639	measured	0.629	measured-bc	0.639
NEPH-07	target	0.64	measured	0.629	measured-bc	0.64
NEPH-08	target	0.64	measured	0.628	measured-bc	0.638
NEPH-09	target	0.641	measured	0.632	measured-bc	0.642
NEPH-10	target	0.641	measured	0.629	measured-bc	0.64
NEPH-11	target	0.642	measured	0.633	measured-bc	0.644
NEPH-12	target	0.643	measured	0.63	measured-bc	0.64

Shaded cells indicate "prone to nepheline" formation based on the 0.62 value.

3.2 A Statistical Review of the PCT Measurements

Table D.1 in Appendix D provides the elemental leachate concentration measurements determined by the SRNL-ML for the solution samples generated by the PCTs. One of the quality control checkpoints for the PCT procedure is solution-weight loss over the course of the 7-day test. None of these PCT results indicated a solution-weight loss problem. However, one sample (x33)[6] was inadvertently spilled and lost (as indicated in Table D.1). No measurements were possible for this sample. Any measurement in Table D.1 below the detection limit of the analytical procedure (indicated by a "<") was replaced by ½ of the detection limit in subsequent analyses. In addition to adjustments for detection limits, the values were adjusted for the acid dilution factors: the values for the study glasses, the blanks, and the ARM glass in Table D.1 were multiplied by 1.6667 to determine the values in parts per million (ppm) and the values for EA were multiplied by 16.6667 due to a greater dilution factor. Table D.2 in Appendix D provides the resulting measurements.

One of the important objectives of this study is the investigation of the effects of the heat treatment on the PCTs. In the sections that follow, the analytical sequence of the measurements is explored, the measurements of the standards are investigated and used to assess the overall accuracy of the ICP-AES measurement process, the measurements for each glass are reviewed, plots are provided that explore the effects of heat treatment on the PCTs for these glasses, the PCTs are normalized using the compositions (targeted, measured, and bias-corrected) presented in Table C.4, and the normalized PCTs are compared to durability predictions for these compositions generated from the current DWPF models (Jantzen et al., 1995).

3.2.1 Measurements in Analytical Sequence

Exhibits D.1 and D.2 in Appendix D provide plots of the leachate (ppm) concentrations in analytical sequence as generated by the SRNL-ML for all of the data and excluding EA, respectively. A different color and symbol is used for each study glass or standard. No problems are seen in these plots.

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[5] Nepheline discriminator values for the quenched and ccc heat treatments are the same.
[6] "x33" was one of the triplicate PCT samples from NEPH-11ccc (see Appendix B).

3.2.2 Results for the Samples of the Multi-Element Solution Standard

Exhibit D.3 in Appendix D provides analyses of the SRNL-ML measurements of the samples of the multi-element solution standard by ICP-AES analytical (or calibration) block. An ANOVA investigating for statistically significant differences among the block averages for these samples for each element of interest is included in these exhibits. These results indicate a statistically significant (at the 5% level) difference among the Fe, Li, and Si average measurements over these blocks. However, no bias correction of the PCT results for the study glasses was conducted. This approach was taken since the triplicate PCTs for a single study glass were placed in different ICP-AES blocks. Averaging the ppm's for each set of triplicates helps to minimize the impact of the ICP-AES effects.

Table 3-3 summarizes the average measurements and the reference values for the 4 primary elements of interest. The results indicate consistent and accurate measurements from the SRNL-ML processes used to conduct these analyses.

Table 3-3. Results from samples of the multi-element solution standard

Analytical Block	Avg B (ppm)	Avg Li (ppm)	Avg Na (ppm)	Avg Si (ppm)
1	20.10	9.66	80.97	51.30
2	20.03	9.60	80.80	51.33
3	19.90	9.60	82.03	52.13
4	20.40	9.71	80.90	52.30
5	20.67	9.81	81.57	52.77
6	20.33	9.69	81.50	52.37
Grand Average	20.24	9.68	81.29	52.03
Reference Value	20.00	10.00	81.00	50.00
% difference	1.2%	-3.2%	0.4%	4.1%

3.2.3 Measurements by Glass Number

Exhibits D.4 and D.5 in Appendix D provide plots of the leachate concentrations for each type of submitted sample: the study glasses and the standards (EA, ARM, the multi-element solution standard, and blanks) with and without EA, respectively. These plots allow for the assessment of the repeatability of the measurements, which suggests some scatter in the triplicate values for some analytes for some of the glasses. Also, note that the results from the two heat treatments are shown for each study glass and that some differences between the two sets of values are evident.

3.2.4 Normalized PCT Results

PCT leachate concentrations are typically normalized using the cation composition (expressed as a weight percent) in the glass to obtain a grams per liter (g/L) leachate concentration (see Table 3-4). The normalization of the PCTs is usually conducted using the measured compositions of the glasses. This is the preferred normalization process for the PCTs. For completeness, the targeted cation and the bias-corrected cation compositions were also used to conduct this normalization.

As is the usual convention, the common logarithm of the normalized PCT (normalized leachate, NL) for each element of interest was determined and used for comparison. To accomplish this computation, one must:

1. Determine the common logarithm of the elemental parts per million (ppm) leachate concentration for each of the triplicates and each of the elements of interest (these values are provided in Table D.2 of Appendix D),

2. Average the common logarithms over the triplicates for each element of interest, and then

3. Normalizing using measured composition (preferred method) – Subtract a quantity equal to 1 plus the common logarithm of the average cation measured concentration (expressed as a weight percent of the glass) from the average computed in step 2; ***OR***

3. Normalizing using target composition – Subtract a quantity equal to 1 plus the common logarithm of the target cation concentration (expressed as a weight percent of the glass) from the average computed in step 2; ***OR***

3. Normalizing using measured bias-corrected composition – Subtract a quantity equal to 1 plus the common logarithm of the measured bias-corrected cation concentration (expressed as a weight percent of the glass) from the average computed in step 2.

Exhibit D.7 in Appendix D provides scatter plots for these results and offers an opportunity to investigate the consistency in the leaching across the elements for the glasses of this study. All normalizations of the PCTs (i.e., those generated using the targeted, measured, and bias-corrected compositional views) and both heat treatments are represented in these plots.

Consistency in the leaching across the elements is typically demonstrated by a high degree of linear correlation among the values for pairs of these elements. A high degree of correlation is seen for most of these data for most of the pairs of the elements; the smallest correlation (76.62%) is for the Li and Na ccc data for the measured and measured bc compositional views.

Table 3-4. Normalized PCTs by Glass ID/Heat Treatment/Compositional View.

Glass ID	Heat Treatment	Composition	log NL [B(g/L)]	Log NL [Li(g/L)]	log NL [Na(g/L)]	log NL [Si(g/L)]	NL B(g/L)	NL Li(g/L)	NL Na(g/L)	NL Si(g/L)
ARM	-	reference	-0.223	-0.189	-0.247	-0.489	0.60	0.65	0.57	0.32
EA	-	reference	1.257	0.973	1.149	0.638	18.06	9.41	14.09	4.34
NEPH-01	quenched	measured	-0.124	-0.128	-0.004	-0.238	0.75	0.74	0.99	0.58
NEPH-01	quenched	measured bc	-0.128	-0.126	0.019	-0.244	0.75	0.75	1.05	0.57
NEPH-01	quenched	target	-0.135	-0.147	0.015	-0.252	0.73	0.71	1.04	0.56
NEPH-01ccc	ccc	measured	0.392	0.436	0.168	0.019	2.47	2.73	1.47	1.04
NEPH-01ccc	ccc	measured bc	0.388	0.438	0.191	0.014	2.44	2.74	1.55	1.03
NEPH-01ccc	ccc	target	0.381	0.417	0.187	0.005	2.40	2.61	1.54	1.01
NEPH-02	quenched	measured	-0.075	-0.093	0.072	-0.187	0.84	0.81	1.18	0.65
NEPH-02	quenched	measured bc	-0.079	-0.091	0.095	-0.193	0.83	0.81	1.25	0.64
NEPH-02	quenched	target	-0.096	-0.107	0.084	-0.202	0.80	0.78	1.21	0.63
NEPH-02ccc	ccc	measured	0.171	0.131	0.115	-0.092	1.48	1.35	1.30	0.81
NEPH-02ccc	ccc	measured bc	0.167	0.134	0.139	-0.098	1.47	1.36	1.38	0.80
NEPH-02ccc	ccc	target	0.150	0.118	0.127	-0.107	1.41	1.31	1.34	0.78
NEPH-03	quenched	measured	0.076	0.033	0.155	-0.084	1.19	1.08	1.43	0.82
NEPH-03	quenched	measured bc	0.072	0.035	0.178	-0.089	1.18	1.08	1.51	0.81
NEPH-03	quenched	target	0.071	0.023	0.165	-0.093	1.18	1.05	1.46	0.81
NEPH-03ccc	ccc	measured	0.047	0.050	0.122	-0.097	1.12	1.12	1.32	0.80
NEPH-03ccc	ccc	measured bc	0.043	0.053	0.145	-0.102	1.11	1.13	1.40	0.79
NEPH-03ccc	ccc	target	0.043	0.040	0.132	-0.106	1.10	1.10	1.36	0.78
NEPH-04	quenched	measured	-0.213	-0.173	-0.144	-0.317	0.61	0.67	0.72	0.48

Glass ID	Heat Treatment	Composition	log NL [B(g/L)]	Log NL [Li(g/L)]	log NL [Na(g/L)]	log NL [Si(g/L)]	NL B(g/L)	NL Li(g/L)	NL Na(g/L)	NL Si(g/L)
NEPH-04	quenched	measured bc	-0.217	-0.171	-0.120	-0.322	0.61	0.68	0.76	0.48
NEPH-04	quenched	target	-0.217	-0.183	-0.129	-0.324	0.61	0.66	0.74	0.47
NEPH-04ccc	ccc	measured	-0.151	-0.126	-0.150	-0.303	0.71	0.75	0.71	0.50
NEPH-04ccc	ccc	measured bc	-0.155	-0.124	-0.126	-0.308	0.70	0.75	0.75	0.49
NEPH-04ccc	ccc	target	-0.155	-0.136	-0.135	-0.310	0.70	0.73	0.73	0.49
NEPH-05	quenched	measured	0.036	0.008	0.116	-0.138	1.09	1.02	1.31	0.73
NEPH-05	quenched	measured bc	0.032	0.010	0.139	-0.143	1.08	1.02	1.38	0.72
NEPH-05	quenched	target	0.031	-0.001	0.130	-0.146	1.07	1.00	1.35	0.71
NEPH-05ccc	ccc	measured	0.027	0.030	0.087	-0.130	1.06	1.07	1.22	0.74
NEPH-05ccc	ccc	measured bc	0.023	0.032	0.111	-0.135	1.05	1.08	1.29	0.73
NEPH-05ccc	ccc	target	0.021	0.021	0.101	-0.139	1.05	1.05	1.26	0.73
NEPH-06	quenched	measured	0.077	0.044	0.168	-0.090	1.19	1.11	1.47	0.81
NEPH-06	quenched	measured bc	0.073	0.047	0.192	-0.095	1.18	1.11	1.56	0.80
NEPH-06	quenched	target	0.062	0.035	0.182	-0.098	1.15	1.08	1.52	0.80
NEPH-06ccc	ccc	measured	0.017	0.084	0.140	-0.062	1.04	1.21	1.38	0.87
NEPH-06ccc	ccc	measured bc	0.013	0.087	0.164	-0.067	1.03	1.22	1.46	0.86
NEPH-06ccc	ccc	target	0.002	0.075	0.154	-0.069	1.00	1.19	1.42	0.85
NEPH-07	quenched	measured	0.038	0.005	0.116	-0.141	1.09	1.01	1.31	0.72
NEPH-07	quenched	measured bc	0.034	0.007	0.140	-0.146	1.08	1.02	1.38	0.71
NEPH-07	quenched	target	0.030	0.001	0.130	-0.145	1.07	1.00	1.35	0.72
NEPH-07ccc	ccc	measured	-0.017	0.053	0.097	-0.116	0.96	1.13	1.25	0.77
NEPH-07ccc	ccc	measured bc	-0.021	0.055	0.121	-0.121	0.95	1.14	1.32	0.76
NEPH-07ccc	ccc	target	-0.025	0.049	0.112	-0.121	0.94	1.12	1.29	0.76
NEPH-08	quenched	measured	-0.161	-0.135	-0.077	-0.264	0.69	0.73	0.84	0.54
NEPH-08	quenched	measured bc	-0.165	-0.133	-0.053	-0.269	0.68	0.74	0.88	0.54
NEPH-08	quenched	target	-0.174	-0.142	-0.060	-0.272	0.67	0.72	0.87	0.53
NEPH-08ccc	ccc	measured	-0.182	-0.138	-0.120	-0.278	0.66	0.73	0.76	0.53
NEPH-08ccc	ccc	measured bc	-0.186	-0.136	-0.097	-0.283	0.65	0.73	0.80	0.52
NEPH-08ccc	ccc	target	-0.194	-0.145	-0.103	-0.286	0.64	0.72	0.79	0.52
NEPH-09	quenched	measured	-0.135	-0.062	0.032	-0.201	0.73	0.87	1.08	0.63
NEPH-09	quenched	measured bc	-0.139	-0.060	0.056	-0.207	0.73	0.87	1.14	0.62
NEPH-09	quenched	target	-0.145	-0.072	0.043	-0.209	0.72	0.85	1.10	0.62
NEPH-09ccc	ccc	measured	-0.056	0.038	0.010	-0.155	0.88	1.09	1.02	0.70
NEPH-09ccc	ccc	measured bc	-0.060	0.041	0.034	-0.161	0.87	1.10	1.08	0.69
NEPH-09ccc	ccc	target	-0.065	0.028	0.021	-0.163	0.86	1.07	1.05	0.69
SNEPH-10	quenched	measured	0.094	0.058	0.170	-0.082	1.24	1.14	1.48	0.83
NEPH-10	quenched	measured bc	0.090	0.060	0.193	-0.087	1.23	1.15	1.56	0.82
NEPH-10	quenched	target	0.087	0.048	0.184	-0.092	1.22	1.12	1.53	0.81
NEPH-10ccc	ccc	measured	0.060	0.068	0.128	-0.087	1.15	1.17	1.34	0.82
NEPH-10ccc	ccc	measured bc	0.056	0.070	0.152	-0.092	1.14	1.18	1.42	0.81
NEPH-10ccc	ccc	target	0.053	0.058	0.143	-0.096	1.13	1.14	1.39	0.80
NEPH-11	quenched	measured	0.058	0.030	0.133	-0.127	1.14	1.07	1.36	0.75
NEPH-11	quenched	measured bc	0.054	0.032	0.156	-0.132	1.13	1.08	1.43	0.74
NEPH-11	quenched	target	0.052	0.021	0.143	-0.134	1.13	1.05	1.39	0.73
NEPH-11ccc	ccc	measured	0.046	0.045	0.095	-0.129	1.11	1.11	1.24	0.74
NEPH-11ccc	ccc	measured bc	0.042	0.048	0.118	-0.135	1.10	1.12	1.31	0.73
NEPH-11ccc	ccc	target	0.041	0.037	0.105	-0.136	1.10	1.09	1.27	0.73
NEPH-12	quenched	measured	-0.088	-0.041	0.077	-0.141	0.82	0.91	1.19	0.72
NEPH-12	quenched	measured bc	-0.092	-0.039	0.100	-0.146	0.81	0.91	1.26	0.71
NEPH-12	quenched	target	-0.103	-0.053	0.088	-0.155	0.79	0.89	1.23	0.70
NEPH-12ccc	ccc	measured	-0.093	-0.037	0.026	-0.151	0.81	0.92	1.06	0.71
NEPH-12ccc	ccc	measured bc	-0.097	-0.035	0.050	-0.157	0.80	0.92	1.12	0.70
NEPH-12ccc	ccc	target	-0.107	-0.048	0.038	-0.165	0.78	0.89	1.09	0.68

reference – see Jantzen et al. (1995)

3.2.5 Acceptability of the Nepheline Study Glasses and Predictability of the ΔGP Model

As seen in Table 3-4, the durabilities for the nepheline study glasses are much better than those of EA (this is indicated for a glass by its normalized leachate being smaller than that of EA). The most durable glass is NEPH-04 (quenched) with a NL [B] of 0.61 g/L (based on target, measured, and measured-bc compositions), while the least durable glass is NEPH-01 (ccc) with a NL [B] of 2.47 g/L (based on the measured composition). Therefore, in terms of "acceptability", the results indicate that all NEPH glasses are acceptable with respect to durability as compared to the EA glass with a NL [B] of 16.695 g/L (value from Jantzen et al., 1993), regardless of the presence of nepheline or any other crystalline phases (see Section 3.4 for more information).

Exhibit D.8 in Appendix D provides plots of the DWPF models that relate the logarithm of the normalized PCT (for each element of interest) to a linear function of a free energy of hydration term (ΔG_p, kcal/100g glass) derived from each of the glass compositional views (Jantzen et al., 1995) – the plot for the boron durability predictions is shown in Figure 3-1. Prediction limits, at a 95% confidence, for an individual PCT result are plotted along with the linear fit. The EA and ARM results are also indicated on all plots (see Figure 3-1 and Exhibit D.8). As shown in Figure 3-1, most of the study glasses are predictable by the ΔG_p model. Those that are not predictable (i.e., outside of the prediction limits) actually fall below the prediction interval (i.e., they are over predicted by the model) suggesting the model is conservative.

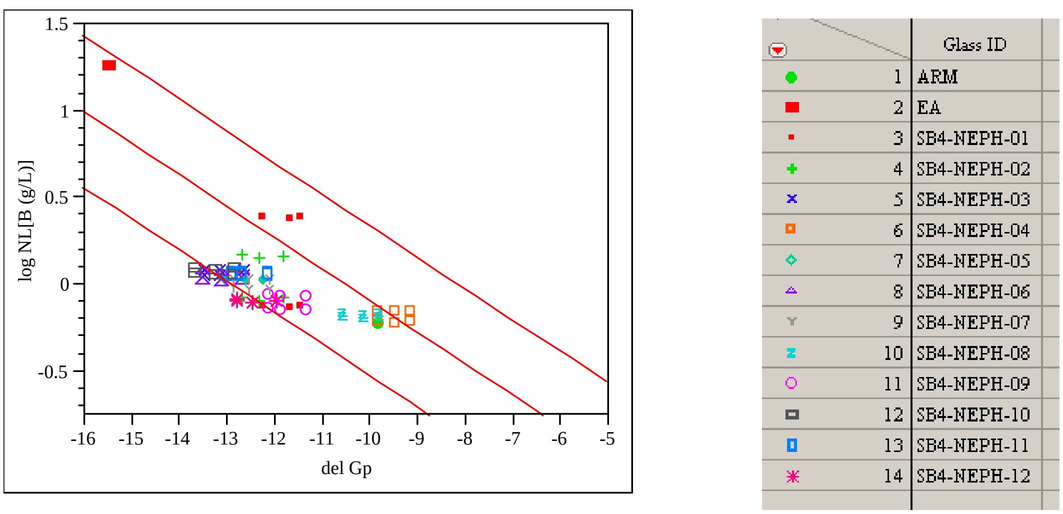

Figure 3-1. Boron Durability Predictions for the Phase 1 Nepheline Study Glasses (all compositional views and heat treatments)

3.2.6 Heat Treatment Effects on PCTs

Figure 3-2 provides an analysis of the effect of heat treatment on the PCTs for the nepheline study glasses. Figure 3-2 plots the common log of boron release versus heat treatment for each study glass. Glasses lying above the 45° red line (NEPH-01, -02, -04, and -09) indicate that the release of B from the ccc glasses was greater than the quenched version. As previously discussed, NEPH-01 and NEPH-02 were the only two glasses that the 0.62 discriminator value suggested a high potential for nepheline formation. Glasses falling below the 45° red line suggest that the NL [B] from the ccc glasses was lower (i.e., the ccc glasses are more durable) than their quenched counterparts. Although general statements regarding the differences between the quenched and ccc version of each glass could be made based on visual inspection of Figure 3-2, a more detailed assessment is warranted to provide a sound technical basis for the potential differences and to determine if the differences are of practical concern. Of particular interest are NEPH-01, -02, -04, and -09 given they appear to have a significant difference in PCT response between the two different heat treatments (especially given the ccc versions appear to be less durable than their quenched counterparts suggesting potential impacts due to nepheline).

Exhibit D.6 in Appendix D provides a closer look at the effect of heat treatment on the PCTs for each nepheline study glass by analyses of the common log of the measurements of the four primary analytes (B, Li, Na, and Si) versus heat treatment. The analyses investigate for a statistically significant difference in the mean of the common logarithm of the PCT leachate concentrations due to heat treatment. At a 5% significance level, the B, Li, Na, and Si values for NEPH-01 and for NEPH-02 indicate a statistically significant difference in the PCT response due to heat treatment with the ccc versions being statistically higher than the quenched versions. For NEPH-04 and NEPH-09, the release of B and Li for the ccc versions was significantly higher than the quenched versions (at a 5% significance level).

Although the discussion regarding differences in PCT response from a statistical point of view is informative, one must also evaluate the practical impact of the measured differences and ultimately assess the usefulness of the nepheline screening tool to guide frit development efforts for SB4.

The measured NL [B] for NEPH-01 quenched and ccc are 0.73 g/L and 2.40 g/L (normalized to the target composition) – a three-fold decrease in durability as a result of heat treatment alone. To yield such a dramatic difference in PCT response just from heat treatment either the glass composition changed (unlikely) or crystallization occurred resulting in a significant measurable impact. The most likely candidate is the formation of nepheline given its classification by the discriminator value. It should be noted that although the PCT durability response for the ccc glasses was significantly decreased, the practical impact in terms of acceptance is minimal as the release is still much lower than the EA benchmark glass (i.e., 2.40 g/L versus 16.695 g/L).

The PCT results for NEPH-02 quenched and ccc, 0.8 g/L and 1.41 g/L respectively, were also determined to be statistically significant. This glass was also classified as being prone to nepheline formation and the measured results suggest that nepheline formation was likely. However, the practical impact is of minimal concern regardless of the formation of nepheline or other possible crystalline phases that may deteriorate durability.

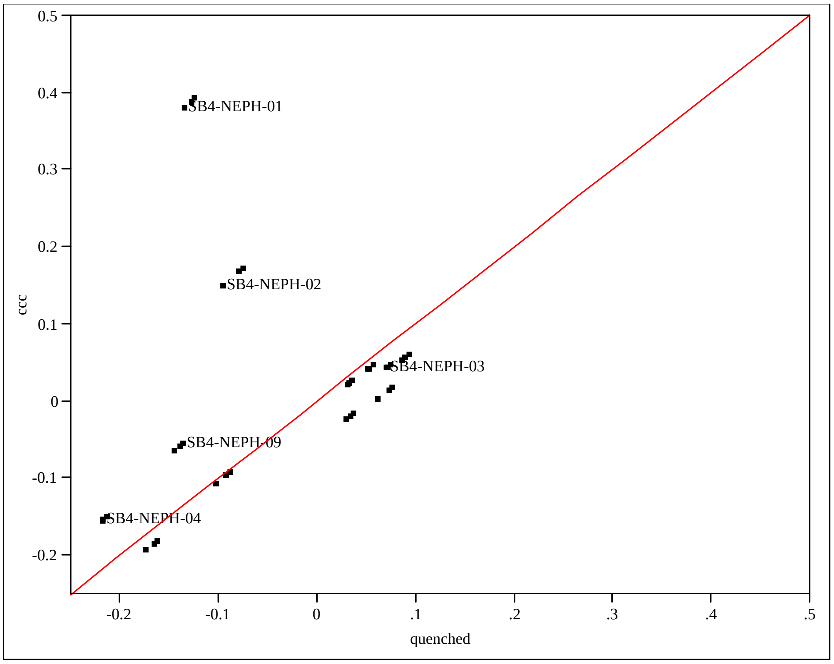

Figure 3-2. **Normalized Release of Boron for NEPH Phase 1 Glasses – ccc versus quenched**. (units are log NL [B])

The measured durability of NEPH-03 is also of interest given it was the first glass which was not classified as being prone to nepheline formation based on the 0.62 value. The measured NL [B] values for the quenched and ccc versions of this glass were 1.18 g/L and 1.12 g/L, respectively. The results suggest that the ccc version is more durable than the quenched suggesting nepheline formation is not likely or the vol% is extremely low – regardless, there is no practical difference between the two heat treatments for this glass.

NEPH-04 is also of interest given it was one of the four glasses lying above the 45° line in Figure 3-2. The NL [B] values for the quenched and ccc versions of this glass were 0.61 g/L and 0.70 g/L. Although statistically significant, the difference is of no practical concern and may be within the random error of the PCT test itself.

NEPH-09 was the last glass whose measured durability response suggested that nepheline formation may have occurred as presented in Figure 3-2. The NL [B] values for the quenched and ccc versions of this glass were 0.85 g/L and 1.07 g/L. The results suggest that, if nepheline is present, the impact on the durability of the product is minimal and of no practical concern.

The PCT response for all other NEPH glasses suggest that if devitrification occurred during the slower cooling, it had a positive impact on durability (i.e., the remaining glasses fall below the 45° line in Figure 3-1). Therefore, the presence of nepheline (at least at concentrations extensive enough to affect the durability response) in these glasses is highly unlikely.

3.3 Homogeneity

Table 3-5 summarizes the visual and XRD results for the quenched and ccc “NEPH” study glasses. The use of “homogeneous” (for both visual and XRD results) indicates that the sample was classified as a single-phase system (i.e., no evidence of crystallization at the associated detection limit). The term “surface crystals” (used as a descriptor for visual observations) implies that the surface of the glass was characterized by the presence of crystallization while the cross-section of bulk glass appeared homogeneous (i.e., single-phased, black and shiny).[7]

3.3.1 Visual Observations

In general, visual observations indicate that devitrification (via surface crystallization only) is more prevalent in the ccc glasses than in the quenched glasses, as expected, given kinetics are more favorable during the slower cooling cycle. The surface crystallization is consistent with historical visual observations of DWPF-based glasses especially those targeting higher waste loadings. More specifically, use of descriptions such as a dull or matte texture and/or metallic-like surface is common for DWPF-type glasses targeting higher WLs and/or having undergone a slow cooling schedule. Previous XRD analyses have typically indicated that the textured or metallic-like surfaces are a result of spinels which precipitate during the cooling process. This is in-line with glass theory which suggests that as WL increases, the concentrations of Fe_2O_3, NiO, Cr_2O_3 and/or MnO also increase, thus enhancing the likelihood of spinel devitrification. The results for NEPH-09 and NEPH-12 support this concept as they are the only two study glasses that targeted a lower WL (35% instead of 40%) and that were classified as homogeneous by both visual and XRD analyses. All other study glasses targeted 40% WL and were classified as having surface crystallization via visual observations suggesting the possibility of spinel formation.

Although predominantly associated with the ccc glasses, surface devitrification was also observed in the quenched versions of NEPH-05, -06, -07, -10, and -11. Peeler et al. (2005) indicate that these glasses target high WLs (all 40%) and are based on the 1100 can baseline (NEPH-05), the maximum NiO sludge option (NEPH-06 and NEPH-07), or the maximum MgO sludge option (NEPH-10 and NEPH-11). With the exception of NEPH-03, all other glasses are based on the maximum Al_2O_3 sludge option (with minimum concentrations of MnO and NiO), which suggests that the presence of higher MnO and/or NiO concentrations in the sludge led to surface crystallization in both the quenched and ccc heat treated glasses. Again, from a glass science perspective, higher concentrations of NiO and/or MnO in the glass should lead to higher T_L values as well as more rapid devitrification – all other things being equal.

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7 Surface crystallization in the “NEPH” glasses was apparent through the presence of a “textured” surface that ranged in appearance from a “dull or matte” surface to a “highly metallic-like” surface. For select glasses, “islands or spots” of devitrification were also noted on the glass surface. For a more detailed description of the visual observations and XRD results of both the quenched and ccc glasses, see WSRC-NB-2005-00054.

Table 3-5. Visual and XRD Results for the SB4 Nepheline Phase 1 Glasses.

Glass	Frit ID	Target WL	Heat Treatment	Visual	XRD
SB4-NEPH-01	320	40	quenched	Homogeneous	Homogeneous/ Homogeneous
SB4-NEPH-01	320	40	ccc	Surface crystals	Nepheline/Homogeneous
SB4-NEPH-02	320	40	quenched	Homogeneous	Homogeneous/ Homogeneous
SB4-NEPH-02	320	40	ccc	Surface crystals	Homogeneous/ Homogeneous
SB4-NEPH-03	320	40	quenched	Homogeneous	Homogeneous/ Homogeneous
SB4-NEPH-03	320	40	ccc	Surface crystals	Trevorite/Homogeneous
SB4-NEPH-04	418	40	quenched	Homogeneous	Homogeneous/ Homogeneous
SB4-NEPH-04	418	40	ccc	Surface crystals	Carnegeite/Homogeneous
SB4-NEPH-05	320	40	quenched	Surface crystals	Homogeneous
SB4-NEPH-05	320	40	ccc	Surface crystals	Homogeneous
SB4-NEPH-06	320	40	quenched	Surface crystals	Homogeneous
SB4-NEPH-06	320	40	ccc	Surface crystals	Homogeneous
SB4-NEPH-07	320	40	quenched	Surface crystals	Homogeneous
SB4-NEPH-07	320	40	ccc	Surface crystals	Homogeneous
SB4-NEPH-08	418	40	quenched	Homogeneous	Homogeneous
SB4-NEPH-08	418	40	ccc	Surface crystals	Homogeneous
SB4-NEPH-09	320	35	quenched	Homogeneous	Homogeneous/Homogeneous
SB4-NEPH-09	320	35	ccc	Homogeneous	Homogeneous/Homogeneous
SB4-NEPH-10	320	40	quenched	Surface crystals	Homogeneous
SB4-NEPH-10	320	40	ccc	Surface crystals	Homogeneous
SB4-NEPH-11	320	40	quenched	Surface crystals	Homogeneous
SB4-NEPH-11	320	40	ccc	Surface crystals	Homogeneous
SB4-NEPH-12	320	35	quenched	Homogeneous	Homogeneous
SB4-NEPH-12	320	35	ccc	Homogeneous	Homogeneous

3.3.2 XRD Results

Initially, NEPH-01, NEPH-02, NEPH-03, NEPH-04, and NEPH-09 (both quenched and ccc versions) were submitted for XRD analysis based on a potentially significant difference in PCT response between the quenched and ccc versions of each glass (see Figure 3-2). With the exception of NEPH-09, visual observations indicated the presence of surface devitrification on all ccc versions of these glasses while the quenched versions were homogeneous. The initial XRD analysis confirmed that the quenched versions of these glasses were void of crystallization (at the estimated 0.5 vol% detection limit). In addition, the ccc versions of NEPH-02 and NEPH-09 (both based on the maximum Al_2O_3 sludge option) were also determined to be homogeneous based on XRD results. These latter results were confirmed through the second set of XRD results.

For the ccc versions of NEPH-01, NEPH-03, and NEPH-04, the initial XRD results indicated the presence of nepheline ($NaAlSiO_4$), trevorite ($(Ni,Fe)Fe_2O_4$), and carnegeite ($NaAlSiO_4$),[8] respectively. Figure 3-3 and Figure 3-4 show the XRD patterns for NEPH-01 (quenched) and

[8] Nepheline and carnegeite have the same chemical formula, but differ in structure. Nepheline is the more stable of the two and is hexagonal in structure, while carnegeite is cubic. Also, carnegeite is the high-temperature version of $NaAlSiO_4$, which means if it is present here then it formed metastabally.

NEPH-01 (ccc), respectively.[9] The presence of nepheline in NEPH-01ccc (Figure 3-4) is not surprising given it was one of two glasses (the other being NEPH-02) predicted to be prone to nepheline formation through the use of the 0.62 screening value. However, NEPH-02 quenched and NEPH-02 ccc were XRD amorphous (single phased) for both sets of analyses. Trevorite in NEPH-03ccc (see Figure 3-5) is also reasonable given visual observations of surface devitrification and the high targeted WL (although it was not based on a sludge targeting maximum MnO and/or NiO).

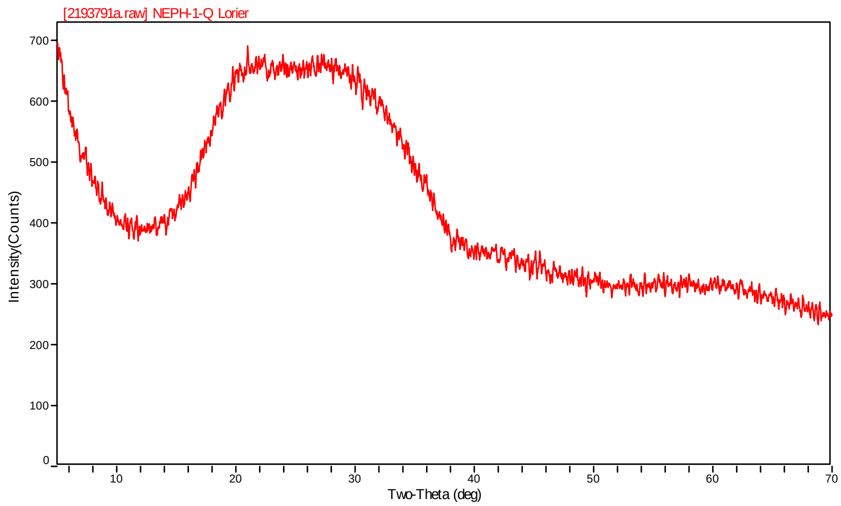

Figure 3-3. XRD Results of NEPH-01 quenched.

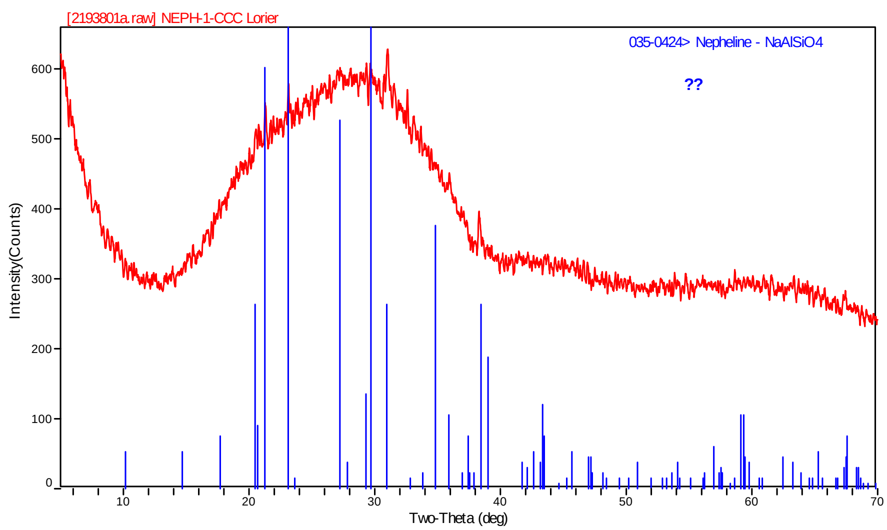

Figure 3-4. XRD Results of NEPH-01 ccc.

[9] All of the XRD results can be found in WSRC-NB-2005-00054.

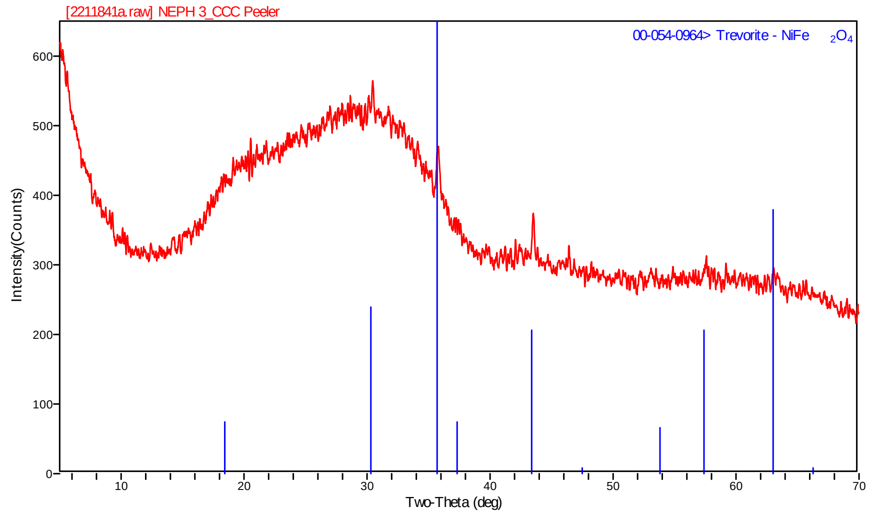

Figure 3-5. XRD Results of NEPH-03 ccc.

Although these results are consistent with expectations or historical data, other results are not as simple to explain. For example, why is NEPH-02ccc classified as homogeneous via XRD results when visual observations suggest surface devitrification? In addition, given NEPH-02 was classified as being prone to nepheline formation, why is nepheline not observed in the XRD results when a significant difference (statistically) in PCT response was measured? Why does NEPH-04ccc contain $NaAlSiO_4$ (carnegeite) when it was not prone to nepheline formation via the 0.62 value as reported by Li et al. (2003) – even though the difference in PCT response was minimal for the quenched and ccc version at 0.66 g/L and 0.73 g/L, respectively (no practical difference)? Why are there so many study glasses that were classified as homogeneous via XRD but visually have some degree of surface devitrification? Why are the XRD results "inconsistent" for NEPH-01ccc, NEPH-03ccc, and NEPH-04ccc for the duplicate analysis? Each of these questions or concerns is discussed below in more detail.

First consider the XRD results for NEPH-02ccc. Although predicted to be nepheline prone, XRD results did not detect nepheline in either the quenched or ccc glass. As noted in Section 3.3.6, the PCT results for NEPH-02 quenched and ccc were 0.8 g/L and 1.41 g/L respectively, which were determined to be statistically significant. The decrease in durability (by almost a factor of 2) does suggest a microstructure change in the glass upon slow cooling which negatively impacted durability. This result coupled with the fact that the 0.62 value indicated nepheline would form suggests that the presence of nepheline is likely but at a concentration below the detection limits of the diffractometer.

The "repeatability" (or lack thereof) associated with the duplicate XRD analyses for NEPH-01ccc NEPH-03ccc, and NEPH-04ccc suggests that the vol% of each phase present is near the detection limit of the X-ray diffractometer. For example, initial XRD results suggested that carnegeite was present in NEPH-04ccc, while the second set of XRD results suggested this glass was homogeneous (which would agree with the 0.62 screening value). Conflicting XRD results for NEPH-02ccc also were obtained as the second result did not indicate the presence of nepheline while the initial result did. The XRD results for NEPH-03ccc were also conflicting. What does all this information mean? The crystallization vol% appears to be near the detection limit of the instrument which is reflected in the “random nature” of the XRD results which could be influenced the sample taken for XRD analysis. The detection limit issue also appears to have played a significant role in identifying spinels related to surface crystallization for most ccc glasses.

Regardless of the questions or uncertainties associated with XRD results, the practical implication of the impact of devitrification on durability is measured directly by the PCT response. Based on the original nepheline discriminator value of 0.62, it was postulated that NEPH-01 (0.606 nepheline value) and NEPH-02 (0.608 nepheline value) would form nepheline and could show a difference in PCT response between the ccc and quenched versions and/or show the presence of nepheline in the XRD analysis. Glass NEPH-01 showed both. Glass NEPH-02 only showed the PCT response difference, but no nepheline in the XRD analysis, indicating that if nepheline was present it was below the XRD detection limit. It should be noted that the presence of spinels would not have this dramatic of an impact in terms of the PCT response.

NEPH-03 (0.637 nepheline value) was the first study glass anticipated to be void of nepheline formation based on the 0.62 value. Although trevorite was observed in the ccc version, the PCT response showed no significant or practical difference between the two different heat treatments (1.18 g/L for the quenched versus a 1.12 g/L for ccc). The XRD results coupled with the PCT response (see Sections 3.3.4 and 3.36) suggest that nepheline is not present in this glass – as predicted by the 0.62 value.

NEPH-04 which has a nepheline discriminator value of 0.638 and showed the presence of carnegeite (a sodium aluminosilicate very similar to nepheline) in one of the two samples submitted for XRD analysis (the second sample was X-ray amorphous suggesting that the sample was homogeneous at the detection limit). NEPH-04 also showed a slight difference in PCT response between the quenched and ccc versions – 0.61 g/L (q) and 0.71 g/L (ccc) for NL [B] release. The responses may potentially be statistically different, but are not of practical concern (as the values may be within the random error of the test and/or analytical measurement uncertainties).

All other NEPH glasses (i.e., NEPH-05 through NEPH-12) were predicted to be “nepheline-free (based on the 0.62 value), classified as homogeneous by XRD analyses (for both quenched and ccc version), and showed no significant and/or practical difference in PCT response for the two heat treatments. Although circumstantial evidence (i.e., higher WLs and similar visual observations as compared to historical glasses) suggests that the surface crystallization is likely spinel formation, XRD results can not confirm its presence presumably due to detection limit issues. However, additional circumstantial evidence can be used to support this theory in the fact that the PCT response showed no significant or practical difference for these glasses which is consistent with the known impacts (or lack thereof) for spinel formation in high-level waste glasses.

These combined results suggest that the 0.62 value appears to be a reasonable guide to monitor SB4 – frit systems with respect to potential nepheline formation. In addition, the PCT results suggest that for those glasses prone to nepheline formation, a statistically significant difference in PCT response was observed for the two heat treatments but the impact on durability was of little or no practical concern. When one couples the PCT responses with the XRD results and/or visual observations, one could conclude that the formation of nepheline in these glasses does have a negative impact on durability. That impact may be of statistical significance but the practical impact may not be sufficient to avoid a specific frit candidate for SB4.

4.0 SUMMARY

The formation of nepheline and/or other aluminum/silicon-containing crystals is potentially significant to the SB4 system due to the preliminary projected compositional views provided by Lilliston (2005) coupled with the frit development strategy. Li et al. (2003) indicated that sodium alumino-borosilicate glasses are prone to nepheline crystallization if their compositions projected on the Na_2O-Al_2O_3-SiO_2 ternary fall within or close to the nepheline primary phase field. In particular, durable glasses with $SiO_2/(SiO_2+Na_2O+Al_2O_3) > 0.62$, where the chemical formula stands for the mass fractions in the glass, do not precipitate nepheline as their primary phase. In order to provide insight into the applicability of the 0.62 value as a discriminator for observing the formation of nepheline and into its potential negative impact on durability, a value of 0.65 was used to establish the twelve "prone to nepheline formation" SB4 glasses tested in this study. The objectives of this study were to fabricate and test the durability (via the PCT) of the twelve SB4-based glasses to assess the potential for and/or the negative impact of nepheline formation.

In terms of "acceptability", the results indicate that all of the NEPH glasses produced are acceptable with respect to durability as defined by the PCT (NL [B] values of all "NEPH" glasses were much lower than that of the EA glass (16.695 g/L)). The most durable glass is NEPH-04 (quenched) with a NL [B] of 0.61 g/L (based on target, measured, and measured-bc compositions), while the least durable glass is NEPH-01 (ccc) with a NL [B] of 2.47 g/L (based on the measured composition). In terms of predictability, most of the study glasses are predictable by the ΔG_p model. Those that are not predictable (i.e., they fall outside of the prediction limits) actually fall below the prediction interval (i.e., they are over predicted by the model) suggesting the model is conservative.

Although conflicting XRD data were obtained for some glasses leading to questions or uncertainties, the practical implication of the impact of devitrification on durability is measured directly by the PCT response. Based on the original nepheline discriminator value of 0.62, it was postulated that NEPH-01 (with a 0.606 nepheline value) and NEPH-02 (with a 0.608 nepheline value) would form nepheline and could show a difference in PCT response between the ccc and quenched versions and/or show the presence of nepheline in the XRD analysis. Glass NEPH-01 showed both. Glass NEPH-02 only showed the PCT response difference, but no nepheline in the XRD analyses, indicating that if nepheline was present it was below the XRD detection limit. It should be noted that the presence of spinels would not have this dramatic of an impact in terms of the PCT response.

All other NEPH glasses (i.e., NEPH-05 through NEPH-12) were predicted to be "nepheline-free (based on the 0.62 value), classified as homogeneous by XRD analyses (for both quenched and ccc version), and showed no significant and/or practical difference in PCT response for the two heat treatments. Although circumstantial evidence (i.e., higher WLs and similar visual observations as compared to historical glasses) suggests that the surface crystallization is likely spinel formation, XRD results were not capable of confirming its presence presumably due to detection limit issues. However, additional circumstantial evidence can be used to support this theory in the fact that the PCT response showed no significant or practical difference for these glasses which is consistent with the known impact (or lack thereof) for spinel formation in high-level waste glasses.

These combined results suggest that the 0.62 value appears to be a reasonable guide to monitor SB4 – frit systems with respect to potential nepheline formation. In addition, the PCT results suggest that for those glasses prone to nepheline formation, a statistically significant difference in

PCT response was observed for the two heat treatments but the impact on durability was of little or no practical concern. When one couples the PCT responses with the XRD results and/or visual observations, one could conclude that the formation of nepheline in these glasses does have a negative impact on durability. That impact may be of statistical significance but the practical impact may not be sufficient to avoid a specific candidate frit for the SB4 glass system.

The results of this study not only suggest that the 0.62 value appears to be a reasonable guide to monitor sludge – frit systems with respect to potential nepheline formation, but also that the impact of nepheline, although statistically significant, has little or no practical impact in the SB4 system to durability as measured by the PCT. This latter statement must be qualified to some extent given only two glasses were selected which were actually "prone to nepheline formation" based on this general guide and the vol% of nepheline present (if detected) was near the detection limit of the X-ray diffractometer (i.e., ~ 0.5 vol%). If the presence of nepheline has no appreciable, adverse impact on durability for the recently revised SB4 systems, then as decisions regarding the viability of the SB4 options and the down select of candidate frits are pursued, little weight will be given to minimizing the likelihood of nepheline and the decisions will be dominated by waste throughput criteria. That is, the frit selection process will not have to consider the impact of nepheline on the ultimate durability of the product and can focus on recommending a frit that when coupled with the sludge can be processed over a WL interval of interest to DWPF with melt rates meeting production expectations. On the other hand, if the revised SB4 compositions lead to system where nepheline formation is a concern and it is demonstrated that the impact on durability is of practical significance or overly detrimental, then candidate frits, that lessen the likelihood of the formation of nepheline over an interval of waste loadings of interest to DWPF would move up the list of preferred frits.

5.0 PATH FORWARD

Based on the results and observations of this study, the following recommendations are made:

- Utilize the nepheline discriminator value of 0.62 to assess the revised SB4 systems (based on Elder (2005a and 2005b)) for potential nepheline formation.
- Determine the incentive (e.g., waste loading being limited by nepheline predictions) for challenging the nepheline predictions. The current data suggest that even though nepheline does form (or is likely) the impact on durability is of little or no practical concern. If true for the revised SB4 systems, the data could form the technical basis for increasing WLs without compromising product quality.
- If frit – sludge systems are identified which are prone to nepheline formation, consideration should be given to conduct a second experimental study. If a study is performed, glasses should be selected to “challenge” the nepheline formation potential over WLs which are within the acceptable operating window for DWPF.

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APPENDIX A

Analytical Plan Supporting the Chemical Composition Measurements

(SRNL-SCS-2005-00018)

SRNL-SCS-2005-00018

April 11, 2005

To: D. K. Peeler, 999-W

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From: T. B. Edwards, 773-42A (5-5148)
Statistical Consulting Section

wo – without glass identifiers
es – executive summary only

______________________________ ________________________
R. A. Baker, Technical Reviewer Date

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An Analytical Plan for Measuring the Chemical Compositions of the Nepheline Study Glasses (U)

1.0 EXECUTIVE SUMMARY

A study is being conducted by the Savannah River National Laboratory (SRNL) for the Defense Waste Processing Facility (DWPF) that involves investigating the potential impact of nepheline formation on the durability of high level waste glasses. To address this issue, several glass compositions were identified for their potential for the formation of nepheline as part of the frit development activities for Sludge Batch 4 (SB4).

The chemical compositions of 12 of these glasses are to be determined by the Savannah River National Laboratory – Mobile Laboratory (SRNL-ML). This memorandum provides an analytical plan to direct and support these measurements at the SRNL-ML.

2.0 INTRODUCTION

A study is being conducted by the Savannah River National Laboratory (SRNL) for the Defense Waste Processing Facility (DWPF) that involves investigating the potential impact of nepheline formation on the durability of high level waste glasses [1]. To address this issue, several glass compositions were selected for their potential for the formation of nepheline as part of the frit development activities for Sludge Batch 4 (SB4).

The chemical compositions of 12 glasses are to be determined by the Savannah River National Laboratory – Mobile Laboratory (SRNL-ML). This memorandum provides an analytical plan to direct and support these measurements at the SRNL-ML.

3.0 ANALYTICAL PLAN

The analytical procedures used by the SRNL-ML to determine cation concentrations for a glass sample include steps for sample preparation and for instrument calibration. Each glass is to be prepared in duplicate by each of two dissolution methods: lithium metaborate (LM) fusion and sodium peroxide fusion (PF).

The primary measurements of interest are to be acquired as follows. The samples prepared by LM are to be measured for barium (Ba), calcium (Ca), cerium (Ce), chromium (Cr), copper (Cu), potassium (K), lanthanum (La), magnesium (Mg), sodium (Na), lead (Pb), sulfur (S), thorium (Th), titanium (Ti), zinc (Zn), and zirconium (Zr) concentrations. Samples prepared by PF are to be measured for aluminum (Al), boron (B), iron (Fe), lithium (Li), manganese (Mn), nickel (Ni), silicon (Si), and uranium (U). Samples dissolved by both preparation methods are to be measured using Inductively Coupled Plasma – Atomic Emission Spectrometry (ICP-AES). It should be noted that some of these elements are minor components that may be near detection limits for most, if not all, of the study glasses.

Randomizing the preparation steps and blocking and randomizing the measurements for the ICP-AES are of primary concern in the development of this analytical plan. The sources of uncertainty for the analytical procedure used by the SRNL-ML to determine the cation concentrations for the submitted glass samples are dominated by the dissolution step in the preparation of the sample and by the calibrations of the ICP-AES.

Samples of glass standards will be included in the analytical plan to provide an opportunity for checking the performance of the instrumentation over the course of the analyses and for potential bias correction. Specifically, several samples of Waste Compliance Plan (WCP) Batch 1 (BCH) [2] and a uranium standard glass (U_{std}) are included in this analytical plan. The reference compositions of these glasses are provided in Table 1.

Table 1: Oxide Compositions of WCP Batch 1 (BCH) (wt%)

Oxide/ Anion	BCH (wt %)	Ustd (wt %)
Al_2O_3	4.877	4.1
B_2O_3	7.777	9.209
BaO	0.151	0
CaO	1.22	1.301
Cr_2O_3	0.107	0
Cs_2O	0.06	0
CuO	0.399	0
Fe_2O_3	12.839	13.196
K_2O	3.327	2.999
Li_2O	4.429	3.057
MgO	1.419	1.21
MnO	1.726	2.892
Na_2O	9.003	11.795
Nd_2O_3	0.147	0
NiO	0.751	1.12
RuO_2	0.0214	0
SiO_2	50.22	45.353
SO_3	0	0
TiO_2	0.677	1.049
U_3O_8	0	2.406
ZrO_2	0.098	0

Each glass sample submitted to the SRNL-ML will be prepared in duplicate by the LM and PF dissolution methods. Every prepared sample will be read twice by ICP-AES, with the instrument being calibrated before each of these two sets of readings. This will lead to four measurements for each cation of interest for each submitted glass.

Table 2 presents identifying codes, n01 through n12, for the 12 glasses fabricated for this nepheline study. The table provides a naming convention that is to be used in analyzing the glasses and reporting the measurements of their compositions.[10]

Table 2: Glass Identifiers to Establish Blind Samples for the SRNL-ML

Glass ID	Sample ID	Glass ID	Sample ID
SB4-NEPH-01	n05	SB4-NEPH-07	n09
SB4-NEPH-02	n10	SB4-NEPH-08	n08
SB4-NEPH-03	n03	SB4-NEPH-09	n12
SB4-NEPH-04	n02	SB4-NEPH-10	n04
SB4-NEPH-05	n01	SB4-NEPH-11	n07
SB4-NEPH-06	n11	SB4-NEPH-12	n06

10 Renaming these samples helps to ensure that they will be processed as blind samples within the SRNL-ML. Table 2 is not shown in its entirety in the copy going to the SRNL-ML.

3.1 PREPARATION OF THE SAMPLES

Each of the 12 glasses included in this analytical plan is to be prepared in duplicate by the LM and PF dissolution methods. Thus, the total number of prepared glass samples is determined by $12 \cdot 2 \cdot 2 = 48$, not including the samples of the BCH and Ustd glass standards that are to be prepared.

Tables 3a and 3b provide blocking and (random) sequencing schema for conducting the preparation steps of the analytical procedures. One block of preparation work is provided for each preparation method to facilitate the scheduling of activities by work shift. The identifier for each of the prepared samples indicates the sample identifier (ID), preparation method, and duplicate number.

Tables 3a and 3b: Preparation Blocks by Method

Table 3a: LM (Lithium Metaborate) Preparation Block

LM Block
n03LM1
n04LM1
n03LM2
n05LM1
n07LM1
n05LM2
n08LM1
n01LM1
n09LM1
n10LM1
n01LM2
n02LM1
n12LM1
n09LM2
n02LM2
n07LM2
n04LM2
n11LM1
n06LM1
n12LM2
n06LM2
n08LM2
n10LM2
n11LM2

Table 3b: PF (PEROXIDE FUSION) PREPARATION BLOCK

n07PF1
n06PF1
n10PF1
n11PF1
n10PF2
n09PF1
n08PF1
n03PF1
n12PF1
n02PF1
n09PF2
n01PF1
n04PF1
n05PF1
n06PF2
n07PF2
n11PF2
n03PF2
n08PF2
n04PF2
n01PF2
n12PF2
n02PF2
n05PF2

3.2 ICP-AES Calibration Blocks

The glass samples prepared by the LM and PF dissolution methods are to be analyzed using ICP-AES instrumentation calibrated for the particular preparation method. After the initial set of cation concentration measurements, the ICP-AES instrumentation is to be recalibrated and a second set of concentration measurements for the cations determined.

Randomized plans for measuring cation concentrations in the LM-prepared and PF-prepared samples are provided in Tables 4a and 4b, respectively. The cations to be measured are specified in the header of each table. In the tables, the sample identifiers for the 12 study glasses have been modified by the addition of a suffix (a "1" or a "2") to indicate whether the measurement was made during the first or second (respectively) ICP-AES calibration group. The identifiers for the BCH and Ustd samples have been further modified to indicate that each of these prepared samples is to be read 3 times (mirrored in the corresponding suffix of 1, 2, or 3) per calibration block.

Tables 4a and 4b:
ICP-AES Blocks & Calibration Groups
for the Glass Samples By Preparation Method

Table 4a: LM Preparation Method
(Used to Measure Elemental Ba, Ca, Ce, Cr, Cu, K, La, Mg, Na, Pb, S, Th, Ti, Zn, & Zr)

Calibration 1	Calibration 2
BCHLM11	BCHLM21
UstdLM11	UstdLM21
n09LM21	n12LM22
n11LM21	n03LM12
n01LM21	n10LM12
n12LM21	n01LM22
n12LM11	n07LM22
n01LM11	n01LM12
n07LM11	n03LM22
n03LM21	n07LM12
n04LM11	n11LM22
n02LM11	n05LM12
n05LM11	n06LM12
n05LM21	n11LM12
BCHLM12	BCHLM22
UstdLM12	UstdLM22
n09LM11	n08LM12
n08LM11	n09LM22
n06LM21	n02LM12
n04LM21	n09LM12
n10LM11	n04LM12
n10LM21	n12LM12
n07LM21	n02LM22
n02LM21	n04LM22
n06LM11	n10LM22
n11LM11	n05LM22
n08LM21	n06LM22
n03LM11	n08LM22
UstdLM13	UstdLM23
BCHLM13	BCHLM23

Table 4b: PF Preparation Method
(Used to Measure Elemental Al, B, Fe, Li, Mn, Ni, Si, & U)

Calibration 1	**Calibration 2**
BCHPF11	BCHPF21
UstdPF11	UstdPF21
n03PF11	n05PF12
n04PF21	n01PF12
n05PF11	n07PF22
n12PF11	n09PF22
n02PF11	n12PF22
n08PF21	n03PF12
n09PF21	n02PF22
n12PF21	n11PF22
n11PF11	n01PF22
n02PF21	n11PF12
n10PF11	n06PF12
n01PF11	n04PF12
BCHPF12	BCHPF22
UstdPF12	UstdPF22
n07PF21	n06PF22
n11PF21	n09PF12
n07PF11	n08PF12
n03PF21	n08PF22
n09PF11	n05PF22
n01PF21	n04PF22
n06PF21	n12PF12
n05PF21	n02PF12
n06PF11	n03PF22
n04PF11	n10PF22
n10PF21	n10PF12
n08PF11	n07PF12
UstdPF13	UstdPF23
BCHPF13	BCHPF23

4.0 CONCLUDING COMMENTS

In summary, this analytical plan identifies two preparation blocks in Tables 3a and 3b and four ICP-AES calibration blocks in Tables 4a and 4b for use by the SRNL-ML. The sequencing of the activities associated with each of the steps in the analytical procedures has been randomized. The size of each of the blocks was selected so that it could be completed in a single work shift.

If a problem is discovered while measuring samples in a calibration block, the instrument should be calibrated and the block of samples re-measured in its entirety. If for some reason the measurements are not conducted in the sequences presented in this report, a record should be made of the actual order used along with any explanative comments.

The analytical plan indicated in the preceding tables should be modified by the personnel of SRNL-ML to include any calibration check standards and/or other standards that are part of their routine operating procedures. It is also recommended that the solutions resulting from each of the prepared samples be archived for some period, considering the "shelf-life" of the solutions, in case questions arise during data analysis. This would allow for the solutions to be rerun without additional preparations, thus minimizing cost.

5.0 REFERENCES

[1] Peeler, D.K. and T.B. Edwards, "Nepheline Formation Potential in SB4 Glasses," WSRC-TR-2005-00153, Revision 0, 2005.

[2] Jantzen, C.M., J.B. Pickett, K.G. Brown, T.B. Edwards, and D.C. Beam, "Process/ Product Models for the Defense Waste Processing Facility (DWPF): Part I. Predicting Glass Durability from Composition Using a Thermodynamic Hydration Energy Reaction Model (THERMO^{TM}) (U)," WSRC-TR-93-673, Rev. 1, Volume 2, Table B.1, pp. B.9, 1995.

APPENDIX B

PCT Analytical Plan

(SRNL-SCS-2005-000122)

SRNL-SCS-2005-00022

April 25, 2005

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From: T. B. Edwards, 773-42A (5-5148)
Statistical Consulting Section

wo – without glass identifiers
es – executive summary only

______________________________ _______________________
R. A. Baker, Technical Reviewer Date

______________________________ _______________________
R. C. Tuckfield, Manager Date
Statistical Consulting Section

An Analytical Plan for Measuring PCT Solutions from the Nepheline Study Glasses (U)

1.0 EXECUTIVE SUMMARY

A study is being conducted by the Savannah River National Laboratory (SRNL) for the Defense Waste Processing Facility (DWPF) that involves investigating the potential impact of nepheline formation on the durability of high level waste glasses. To address this issue, several glass compositions were identified for their potential for the formation of nepheline as part of the frit development activities for Sludge Batch 4 (SB4). Twelve of these glasses were selected to be batched and fabricated; the durability of glasses is to be measured using the Product Consistency Test (PCT) as defined in ASTM C-1285-2002. Two heat treatments were utilized during the fabrication of each of these glasses. All 12 glasses were quenched (i.e., rapidly cooled) and cooled in accordance with the centerline-canister-cooling (ccc) regime.

The Savannah River National Laboratory-Mobile Laboratory (SRNL-ML) is to be used to measure elemental concentrations of the resulting leachate solutions from the PCTs. This memorandum provides an analytical plan for the SRNL-ML to follow in measuring the compositions of the leachate solutions resulting from the PCT procedures for the nepheline study glasses.

2.0 INTRODUCTION

A study is being conducted by the Savannah River National Laboratory (SRNL) for the Defense Waste Processing Facility (DWPF) that involves investigating the potential impact of nepheline formation on the durability of high level waste glasses [1]. To address this issue, 12 glass compositions were selected for their potential for the formation of nepheline as part of the frit development activities for Sludge Batch 4 (SB4). The durability of glasses is to be measured using the Product Consistency Test (PCT) as defined in ASTM C-1285-2002 [2]. The glasses were cooled using two heat treatments: all 12 glasses were quenched (i.e., rapidly cooled); and all 12 were then re-melted and cooled in accordance with the centerline-canister-cooling (ccc) regime. This yielded 24 study glasses to be tested by PCT.

The Savannah River National Laboratory-Mobile Laboratory (SRNL-ML) is to be used to measure elemental concentrations of the resulting leachate solutions from the PCTs. This memorandum provides an analytical plan for the SRNL-ML to follow in measuring the compositions of the leachate solutions resulting from the PCT procedures for the nepheline study glasses listed in Table 1.

Table 1: Identifiers for the Nepheline Study Glasses

SB4-NEPH-01	SB4-NEPH-09	SB4-NEPH-05ccc
SB4-NEPH-02	SB4-NEPH-10	SB4-NEPH-06ccc
SB4-NEPH-03	SB4-NEPH-11	SB4-NEPH-07ccc
SB4-NEPH-04	SB4-NEPH-12	SB4-NEPH-08ccc
SB4-NEPH-05	SB4-NEPH-01ccc	SB4-NEPH-09ccc
SB4-NEPH-06	SB4-NEPH-02ccc	SB4-NEPH-10ccc
SB4-NEPH-07	SB4-NEPH-03ccc	SB4-NEPH-11ccc
SB4-NEPH-08	SB4-NEPH-04ccc	SB4-NEPH-12ccc

3.0 DISCUSSION

Each of the study glasses of Table 1 is to be subjected to the PCT in triplicate. In addition to those for the 24 study glasses, triplicate PCTs are to be conducted on a sample of the Approved Reference Material (ARM-1) glass and a sample of the Environmental Assessment (EA) glass. Two reagent blank samples are also to be included in these tests. This results in 80 sample solutions being required to complete these PCTs.

The leachates from these tests will be diluted by adding 4 mL of 0.4 M HNO_3 to 6 mL of the leachate (a 6:10 volume to volume, v:v, dilution) before being submitted to the SRNL-ML. The EA leachates will be further diluted (1:10 v:v) with deionized water prior to submission to the SRNL-ML in order to prevent problems with the nebulizer.

Table 2 presents identifying codes, x01 through x80, for the individual solutions required for the PCTs of the study glasses and of the standards (EA, ARM-1, and blanks). This provides a naming convention that is to be used by the SRNL-ML in analyzing the solutions and reporting the relevant concentration measurements.[11]

[11] Renaming these samples ensures that they will be processed as blind samples by the SRNL-ML. This table does not contain the solution identifiers for those on the distribution list with a “wo” following their names.

Table 2: Identifiers for the PCT Solutions

Original Sample	Solution Identifier	Original Sample	Solution Identifier	Original Sample	Solution Identifier
SB4-NEPH-01	x07	SB4-NEPH-05ccc	x27	SB4-NEPH-10	x48
SB4-NEPH-01	x14	SB4-NEPH-05ccc	x16	SB4-NEPH-10	x52
SB4-NEPH-01	x79	SB4-NEPH-05ccc	x12	SB4-NEPH-10	x72
SB4-NEPH-01ccc	x05	SB4-NEPH-06	x29	SB4-NEPH-10ccc	x54
SB4-NEPH-01ccc	x45	SB4-NEPH-06	x78	SB4-NEPH-10ccc	x51
SB4-NEPH-01ccc	x22	SB4-NEPH-06	x25	SB4-NEPH-10ccc	x57
SB4-NEPH-02	x76	SB4-NEPH-06ccc	x34	SB4-NEPH-11	x69
SB4-NEPH-02	x75	SB4-NEPH-06ccc	x41	SB4-NEPH-11	x35
SB4-NEPH-02	x15	SB4-NEPH-06ccc	x74	SB4-NEPH-11	x64
SB4-NEPH-02ccc	x23	SB4-NEPH-07	x61	SB4-NEPH-11ccc	x33
SB4-NEPH-02ccc	x67	SB4-NEPH-07	x71	SB4-NEPH-11ccc	x60
SB4-NEPH-02ccc	x02	SB4-NEPH-07	x68	SB4-NEPH-11ccc	x62
SB4-NEPH-03	x36	SB4-NEPH-07ccc	x10	SB4-NEPH-12	x26
SB4-NEPH-03	x42	SB4-NEPH-07ccc	x47	SB4-NEPH-12	x03
SB4-NEPH-03	x58	SB4-NEPH-07ccc	x21	SB4-NEPH-12	x53
SB4-NEPH-03ccc	x49	SB4-NEPH-08	x32	SB4-NEPH-12ccc	x19
SB4-NEPH-03ccc	x59	SB4-NEPH-08	x13	SB4-NEPH-12ccc	x28
SB4-NEPH-03ccc	x77	SB4-NEPH-08	x17	SB4-NEPH-12ccc	x24
SB4-NEPH-04	x80	SB4-NEPH-08ccc	x04	EA	x70
SB4-NEPH-04	x73	SB4-NEPH-08ccc	x20	EA	x01
SB4-NEPH-04	x38	SB4-NEPH-08ccc	x65	EA	x06
SB4-NEPH-04ccc	x08	SB4-NEPH-09	x55	ARM-1	x63
SB4-NEPH-04ccc	x50	SB4-NEPH-09	x44	ARM-1	x37
SB4-NEPH-04ccc	x46	SB4-NEPH-09	x11	ARM-1	x39
SB4-NEPH-05	x09	SB4-NEPH-09ccc	x30	Blank	x56
SB4-NEPH-05	x18	SB4-NEPH-09ccc	x66	Blank	x31
SB4-NEPH-05	x43	SB4-NEPH-09ccc	x40		

4.0 ANALYTICAL PLAN

The analytical plan for the SRNL-ML is provided in this section. Each of the solution samples submitted to the SRNL-ML is to be analyzed only once for each of the following: boron (B), barium (Ba), cadmium (Cd), chromium (Cr), iron (Fe), lithium (Li) , sodium (Na), lead (Pb), silicon (Si), thorium (Th), and uranium (U). B, Li, Na, and Si are the elements that are to be used in the assessment of glass durability; the other elements are being monitored to address solution disposal issues in SRNL upon termination of the PCTs. The measurements are to be made in parts per million (ppm). The analytical procedure used by the SRNL-ML to determine the concentrations utilizes an Inductively Coupled Plasma – Atomic Emission Spectrometer (ICP-AES). The PCT solutions (as identified in Table 2) are grouped in six ICP-AES blocks for processing by the SRNL-ML in Table 3. Each block requires a different calibration of the ICP-AES.

Table 3: ICP-AES Calibration Blocks for Leachate Measurements

Block 1	Block 2	Block 3	Block 4	Block 5	Block 6
std-b1-1	std-b2-1	std-b3-1	std-b4-1	std-b5-1	std-b6-1
x76	x66	x72	x31	x16	x17
x26	x28	x38	x49	x18	x77
x56	x67	x62	x32	x45	x58
x69	x73	x11	x10	x01	x12
x54	x35	x15	x29	x47	x25
x23	x03	x02	x07	x78	x68
x08	x52	x40	x34	x13	x65
std-b1-2	std-b2-2	std-b3-2	std-b4-2	std-b5-2	std-b6-2
x63	x37	x24	x70	x42	x06
x33	x60	x64	x61	x14	x79
x30	x50	x46	x36	x71	x74
x48	x51	x53	x09	x59	x43
x19	x75	x39	x05	x41	x22
x80	x44	x57	x27	x20	x21
x55	std-b2-3	std-b3-3	x04	std-b5-3	std-b6-3
std-b1-3			std-b4-3		

A multi-element solution standard (denoted by "std-bi-j" where i=1 to 6 represents the block number and j=1, 2, and 3 represents the position in the block) was added at the beginning, middle, and end of each of the three blocks. This standard may be useful in checking and correcting for bias in the concentration measurements arising from the ICP calibrations.

5.0 SUMMARY

In summary, this analytical plan provides identifiers for the PCT solutions in Table 2 and six ICP-AES calibration blocks in Table 3 for the SRNL-ML to use in conducting the boron (B), barium (Ba), cadmium (Cd), chromium (Cr), iron (Fe), lithium (Li) , sodium (Na), lead (Pb), silicon (Si), thorium (Th), and uranium (U) concentration measurements for this PCT study. The sequencing of the activities associated with each of the steps in the analytical procedure has been randomized. The size of the blocks was selected so that the block could be completed in a single work shift. If for some reason the measurements are not conducted in the sequence presented in this memorandum, the actual order should be recorded along with any explanative comments.

The analytical plan indicated in the preceding tables should be modified by the personnel of the SRNL-ML to include any calibration check standards and/or other standards that are part of their standard operating procedures.

6.0 REFERENCES

[1] Peeler, D.K. and T.B. Edwards, "Nepheline Formation Potential in SB4 Glasses," WSRC-TR-2005-00153, Revision 0, 2005.

[2] ASTM C-1285-2002, "Standard Test Methods for Determining Chemical Durability of Nuclear Waste Glasses: The Product Consistency Test (PCT)," ASTM, 2002.

APPENDIX C

Tables and Exhibits Supporting the Analysis of the Chemical Composition Measurements of the Nepheline Study Glasses

Table C.1: Targeted Oxide Concentrations (as wt%'s) for the Nepheline Study Glasses

Glass #	Al2O3	B2O3	BaO	CaO	Ce2O3	Cr2O3	CuO	Fe2O3	K2O	La2O3	Li2O	MgO	MnO	Na2O	NiO	PbO	SO4	SiO2	ThO2	TiO2	U3O8	ZnO	ZrO2	Sum
SB4-NEPH-01	12.612	4.8	0.043	0.884	0.082	0.092	0.029	9.087	0.682	0.034	4.8	0.732	1.913	16.348	0.583	0.081	0.442	44.482	0.02	0.01	2.111	0.04	0.095	100.002
SB4-NEPH-02	11.683	4.8	0.042	0.839	0.081	0.087	0.028	8.701	0.624	0.034	4.8	0.669	1.905	16.987	0.579	0.078	0.508	44.389	0.018	0.979	2.036	0.039	0.094	100
SB4-NEPH-03	8.467	4.8	0.062	0.848	0.082	0.096	0.032	9.897	0.377	0.036	4.8	0.71	2.289	16.682	1.4	0.065	0.506	44.218	0.013	0.977	3.489	0.049	0.109	100.004
SB4-NEPH-04	12.612	4.8	0.043	0.884	0.082	0.092	0.029	9.087	0.682	0.034	4.8	0.732	1.913	13.948	0.583	0.081	0.442	46.882	0.02	0.01	2.111	0.04	0.095	100.002
SB4-NEPH-05	9.07	4.8	0.065	0.893	0.083	0.101	0.034	10.404	0.41	0.037	4.8	0.777	2.335	16.011	1.486	0.066	0.439	44.293	0.014	0.009	3.711	0.051	0.112	100.001
SB4-NEPH-06	8.375	4.8	0.076	0.723	0.077	0.105	0.032	9.24	0.416	0.034	4.8	0.424	2.352	16.504	2.254	0.063	0.504	44.055	0.011	0.975	4.013	0.05	0.12	100.003
SB4-NEPH-07	8.969	4.8	0.08	0.756	0.078	0.111	0.034	9.68	0.454	0.035	4.8	0.462	2.404	15.816	2.426	0.064	0.438	44.114	0.012	0.006	4.287	0.052	0.124	100.002
SB4-NEPH-08	11.683	4.8	0.042	0.839	0.081	0.087	0.028	8.701	0.624	0.034	4.8	0.669	1.905	14.587	0.579	0.078	0.508	46.789	0.018	0.979	2.036	0.039	0.094	100
SB4-NEPH-09	11.035	5.2	0.038	0.774	0.072	0.08	0.025	7.951	0.597	0.03	5.2	0.641	1.674	15.805	0.51	0.071	0.386	47.921	0.017	0.009	1.847	0.035	0.083	100.001
SB4-NEPH-10	8.097	4.8	0.062	0.859	0.081	0.094	0.032	10.088	0.334	0.036	4.8	0.784	2.387	16.659	1.425	0.062	0.506	44.225	0.012	0.978	3.528	0.048	0.105	100.002
SB4-NEPH-11	8.664	4.8	0.065	0.905	0.083	0.1	0.033	10.613	0.363	0.037	4.8	0.859	2.443	15.987	1.514	0.063	0.439	44.301	0.014	0.009	3.753	0.05	0.107	100.002
SB4-NEPH-12	10.222	5.2	0.037	0.734	0.071	0.076	0.024	7.613	0.546	0.029	5.2	0.585	1.667	16.364	0.507	0.068	0.444	47.84	0.016	0.856	1.781	0.035	0.082	99.997

Table C.2: Measured Elemental Concentrations (wt%) for Samples Prepared Using Lithium Metaborate

Glass ID	SRNL-ML ID	Block	Analytical Sequence	Ba	Ca	Ce	Cr	Cu	K	La	Mg	Na	Pb	S	Th	Ti	Zn	Zr
Batch 1	BCHLM11	1	1	0.120	0.861	<0.010	0.076	0.307	2.86	<0.010	0.756	6.96	<0.010	<0.100	<0.010	0.367	<0.010	0.061
Ustd	UstdLM11	1	2	<0.010	0.905	<0.010	0.163	0.004	2.34	<0.010	0.665	8.82	<0.010	<0.100	0.076	0.555	<0.010	<0.010
SB4-NEPH-07	N09LM21	1	3	0.066	0.529	0.050	0.068	0.028	0.417	0.021	0.260	12.0	0.052	0.124	0.144	0.007	0.045	0.082
SB4-NEPH-06	N11LM21	1	4	0.055	0.537	0.050	0.069	0.027	0.392	0.020	0.236	12.6	0.053	0.141	0.130	0.550	0.044	0.080
SB4-NEPH-05	N01LM21	1	5	0.050	0.645	0.057	0.064	0.027	0.402	0.023	0.415	12.3	0.053	0.126	0.117	0.003	0.042	0.073
SB4-NEPH-09	N12LM21	1	6	0.027	0.542	0.041	0.055	0.019	0.545	0.017	0.348	12.1	0.059	0.113	0.070	0.003	0.028	0.054
SB4-NEPH-09	N12LM11	1	7	0.027	0.544	0.040	0.052	0.019	0.578	0.017	0.334	12.0	0.051	0.097	0.067	0.002	0.027	0.053
SB4-NEPH-05	N01LM11	1	8	0.051	0.635	0.058	0.068	0.027	0.390	0.024	0.426	12.4	0.054	0.138	0.119	0.003	0.042	0.074
SB4-NEPH-11	N07LM11	1	9	0.054	0.628	0.052	0.065	0.027	0.311	0.024	0.494	12.3	0.059	0.132	0.130	0.008	0.042	0.074
SB4-NEPH-03	N03LM21	1	10	0.050	0.585	0.048	0.068	0.024	0.350	0.021	0.397	12.5	0.051	0.155	0.112	0.529	0.065	0.071
SB4-NEPH-10	N04LM11	1	11	0.051	0.609	0.056	0.069	0.025	0.322	0.022	0.433	12.8	0.051	0.153	0.114	0.554	0.043	0.069
SB4-NEPH-04	N02LM11	1	12	0.031	0.606	0.052	0.058	0.023	0.641	0.020	0.398	10.8	0.064	0.121	0.078	0.003	0.031	0.062
SB4-NEPH-01	N05LM11	1	13	0.034	0.645	0.048	0.070	0.023	0.602	0.022	0.418	12.6	0.063	0.127	0.080	0.004	0.033	0.065
SB4-NEPH-01	N05LM21	1	14	0.034	0.620	0.048	0.069	0.023	0.599	0.023	0.417	12.7	0.068	0.141	0.079	0.004	0.033	0.066
Batch 1	BCHLM12	1	15	0.121	0.828	<0.010	0.077	0.299	2.81	<0.010	0.761	7.15	<0.010	<0.100	<0.010	0.367	<0.010	0.060
Ustd	UstdLM12	1	16	<0.010	0.886	<0.010	0.164	0.004	2.32	<0.010	0.672	9.04	<0.010	<0.100	0.073	0.554	<0.010	<0.010
SB4-NEPH-07	N09LM11	1	17	0.069	0.521	0.050	0.071	0.030	0.409	0.021	0.269	12.1	0.056	0.124	0.145	0.007	0.046	0.083
SB4-NEPH-08	N08LM11	1	18	0.031	0.582	0.046	0.058	0.022	0.643	0.021	0.363	11.3	0.057	0.140	0.071	0.529	0.037	0.061
SB4-NEPH-12	N06LM21	1	19	0.029	0.510	0.047	0.059	0.018	0.497	0.019	0.338	12.4	0.057	0.126	0.065	0.487	0.027	0.057
SB4-NEPH-10	N04LM21	1	20	0.050	0.591	0.055	0.068	0.025	0.306	0.022	0.435	12.6	0.052	0.154	0.114	0.555	0.043	0.070
SB4-NEPH-02	N10LM11	1	21	0.033	0.567	0.050	0.063	0.022	0.566	0.022	0.378	13.0	0.059	0.146	0.078	0.588	0.031	0.061
SB4-NEPH-02	N10LM21	1	22	0.033	0.577	0.049	0.060	0.019	0.606	0.021	0.364	12.7	0.057	0.130	0.074	0.569	0.030	0.060
SB4-NEPH-11	N07LM21	1	23	0.055	0.637	0.051	0.067	0.028	0.329	0.024	0.495	12.1	0.056	0.121	0.132	0.009	0.043	0.074
SB4-NEPH-04	N02LM21	1	24	0.033	0.608	0.053	0.066	0.024	0.625	0.021	0.417	10.6	0.064	0.135	0.079	0.003	0.032	0.060
SB4-NEPH-12	N06LM11	1	25	0.029	0.514	0.046	0.059	0.018	0.499	0.019	0.336	12.5	0.050	0.136	0.065	0.479	0.028	0.057
SB4-NEPH-06	N11LM11	1	26	0.057	0.504	0.049	0.072	0.026	0.398	0.020	0.239	12.7	0.051	0.151	0.126	0.542	0.044	0.079
SB4-NEPH-08	N08LM21	1	27	0.033	0.557	0.047	0.063	0.023	0.551	0.021	0.387	11.2	0.062	0.151	0.076	0.560	0.030	0.064
SB4-NEPH-03	N03LM11	1	28	0.052	0.599	0.049	0.070	0.024	0.348	0.022	0.409	12.7	0.055	0.154	0.115	0.549	0.042	0.074
Ustd	UstdLM13	1	29	<0.010	0.860	<0.010	0.168	0.004	2.27	<0.010	0.682	9.19	<0.010	<0.100	0.073	0.552	<0.010	<0.010
Batch 1	BCHLM13	1	30	0.123	0.819	<0.010	0.078	0.298	2.78	<0.010	0.770	7.07	<0.010	<0.100	<0.010	0.365	<0.010	0.060
Batch 1	BCHLM21	2	1	0.124	0.857	<0.010	0.079	0.308	2.81	<0.010	0.770	6.97	<0.010	<0.100	<0.010	0.372	<0.010	0.062
Ustd	UstdLM21	2	2	<0.010	0.902	<0.010	0.166	0.004	2.29	<0.010	0.678	8.89	<0.010	<0.100	0.077	0.563	<0.010	<0.010
SB4-NEPH-09	N12LM22	2	3	0.030	0.532	0.043	0.060	0.020	0.532	0.020	0.371	11.9	0.061	0.116	0.073	0.007	0.030	0.057
SB4-NEPH-03	N03LM12	2	4	0.053	0.636	0.052	0.072	0.026	0.352	0.024	0.407	12.7	0.054	0.149	0.120	0.558	0.043	0.077
SB4-NEPH-02	N10LM12	2	5	0.034	0.576	0.053	0.061	0.023	0.567	0.023	0.375	13.0	0.063	0.135	0.080	0.591	0.031	0.064
SB4-NEPH-05	N01LM22	2	6	0.053	0.658	0.058	0.068	0.027	0.397	0.026	0.427	12.0	0.056	0.131	0.120	0.006	0.044	0.076
SB4-NEPH-11	N07LM22	2	7	0.054	0.638	0.054	0.066	0.029	0.327	0.026	0.483	11.9	0.057	0.121	0.131	0.012	0.044	0.076
SB4-NEPH-05	N01LM12	2	8	0.054	0.633	0.060	0.072	0.028	0.389	0.026	0.435	12.4	0.056	0.131	0.123	0.007	0.044	0.078
SB4-NEPH-03	N03LM22	2	9	0.052	0.620	0.051	0.072	0.026	0.363	0.024	0.405	12.8	0.051	0.160	0.117	0.544	0.067	0.076
SB4-NEPH-11	N07LM12	2	10	0.056	0.651	0.054	0.067	0.029	0.308	0.027	0.503	12.2	0.057	0.134	0.138	0.012	0.044	0.078
SB4-NEPH-06	N11LM22	2	11	0.058	0.533	0.052	0.072	0.028	0.386	0.022	0.243	12.6	0.051	0.152	0.129	0.552	0.047	0.083

Table C.2: Measured Elemental Concentrations (wt%) for Samples Prepared Using Lithium Metaborate

Glass ID	SRNL-ML ID	Block	Analytical Sequence	Ba	Ca	Ce	Cr	Cu	K	La	Mg	Na	Pb	S	Th	Ti	Zn	Zr
SB4-NEPH-01	N05LM12	2	12	0.036	0.636	0.051	0.071	0.024	0.605	0.024	0.418	12.6	0.068	0.122	0.084	0.008	0.034	0.069
SB4-NEPH-12	N06LM12	2	13	0.030	0.527	0.048	0.059	0.019	0.509	0.020	0.327	12.4	0.054	0.130	0.067	0.475	0.029	0.058
SB4-NEPH-06	N11LM12	2	14	0.057	0.529	0.052	0.070	0.027	0.407	0.021	0.233	12.6	0.051	0.152	0.129	0.539	0.044	0.081
Batch 1	BCHLM22	2	15	0.118	0.855	<0.010	0.076	0.307	2.81	<0.010	0.739	6.98	<0.010	<0.100	<0.010	0.362	<0.010	0.062
Ustd	UstdLM22	2	16	<0.010	0.895	<0.010	0.163	0.004	2.29	<0.010	0.662	9.22	<0.010	<0.100	0.077	0.551	<0.010	<0.010
SB4-NEPH-08	N08LM12	2	17	0.032	0.609	0.048	0.058	0.023	0.649	0.022	0.357	11.2	0.055	0.131	0.073	0.529	0.038	0.063
SB4-NEPH-07	N09LM22	2	18	0.069	0.532	0.052	0.070	0.029	0.412	0.023	0.269	12.2	0.060	0.135	0.149	0.010	0.049	0.086
SB4-NEPH-04	N02LN12	2	19	0.033	0.627	0.055	0.060	0.024	0.647	0.023	0.403	10.9	0.060	0.136	0.081	0.006	0.032	0.065
SB4-NEPH-07	N09LM12	2	20	0.072	0.527	0.053	0.072	0.031	0.405	0.023	0.274	12.2	0.060	0.141	0.150	0.010	0.048	0.087
SB4-NEPH-10	N04LM12	2	21	0.052	0.633	0.059	0.070	0.026	0.326	0.025	0.436	12.9	0.052	0.151	0.118	0.563	0.045	0.075
SB4-NEPH-09	N12LM12	2	22	0.029	0.555	0.043	0.055	0.020	0.582	0.019	0.347	12.1	0.058	0.119	0.070	0.006	0.029	0.056
SB4-NEPH-04	N02LM22	2	23	0.034	0.640	0.056	0.065	0.025	0.640	0.023	0.413	10.5	0.066	0.131	0.083	0.006	0.033	0.063
SB4-NEPH-10	N04LM22	2	24	0.051	0.629	0.058	0.068	0.026	0.308	0.024	0.433	12.8	0.053	0.157	0.118	0.563	0.044	0.073
SB4-NEPH-02	N10LM22	2	25	0.033	0.596	0.053	0.060	0.021	0.617	0.023	0.362	13.1	0.058	0.155	0.077	0.573	0.032	0.063
SB4-NEPH-01	N05LM22	2	26	0.036	0.645	0.051	0.070	0.024	0.609	0.025	0.420	12.8	0.066	0.135	0.083	0.008	0.035	0.069
SB4-NEPH-12	N06LM22	2	27	0.031	0.535	0.050	0.062	0.019	0.502	0.021	0.342	12.6	0.056	0.127	0.070	0.497	0.029	0.061
SB4-NEPH-08	N08LM22	2	28	0.035	0.585	0.051	0.066	0.024	0.562	0.024	0.395	11.3	0.065	0.157	0.080	0.581	0.033	0.068
Ustd	UstdLM23	2	29	<0.010	0.917	<0.010	0.166	0.004	2.33	<0.010	0.677	9.24	<0.010	<0.100	0.079	0.562	<0.010	<0.010
Batch 1	BCHLM23	2	30	0.116	0.877	<0.010	0.072	0.309	2.75	<0.010	0.736	7.16	<0.010	<0.100	<0.010	0.357	<0.010	0.062

Table C.3: Measured Elemental Concentrations (wt%) for Samples Prepared Using Peroxide Fusion

Glass	SRNL-ML		Analytical								
ID	**ID**	**Block**	**Sequence**	**Al**	**B**	**Fe**	**Li**	**Mn**	**Ni**	**Si**	**U**
Batch 1	BCHPF11	1	1	2.56	2.50	8.63	2.07	1.25	0.527	23.4	<0.100
Ustd	UstdPF11	1	2	2.13	2.85	8.89	1.42	2.07	0.764	20.5	1.98
SB4-NEPH-03	N03PF11	1	3	4.57	1.52	6.51	2.18	1.68	0.968	20.4	2.87
SB4-NEPH-10	N04PF21	1	4	4.43	1.52	6.73	2.20	1.78	1.00	20.6	2.91
SB4-NEPH-01	N05PF11	1	5	6.60	1.46	6.01	2.12	1.40	0.402	20.3	1.71
SB4-NEPH-09	N12PF11	1	6	6.00	1.59	5.09	2.36	1.19	0.329	22.1	1.53
SB4-NEPH-04	N02PF11	1	7	6.86	1.47	5.73	2.19	1.35	0.365	21.7	1.67
SB4-NEPH-08	N08PF21	1	8	6.39	1.47	5.62	2.20	1.32	0.385	21.9	1.63
SB4-NEPH-07	N09PF21	1	9	4.97	1.46	6.25	2.22	1.75	1.63	20.7	3.56
SB4-NEPH-09	N12PF21	1	10	5.93	1.59	5.56	2.35	1.22	0.338	22.2	1.54
SB4-NEPH-06	N11PF11	1	11	4.54	1.44	5.92	2.19	1.70	1.51	20.4	3.17
SB4-NEPH-04	N02PF21	1	12	6.71	1.49	5.96	2.16	1.39	0.396	21.6	1.73
SB4-NEPH-02	N10PF11	1	13	6.36	1.47	5.76	2.18	1.37	0.371	20.6	1.74
SB4-NEPH-05	N01PF11	1	14	4.92	1.47	6.73	2.19	1.70	1.01	20.5	2.95
Batch 1	BCHPF12	1	15	2.59	2.35	8.41	2.06	1.22	0.505	23.2	<0.100
Ustd	UstdPF12	1	16	2.11	2.73	8.55	1.41	2.01	0.741	20.2	1.96
SB4-NEPH-11	N07PF21	1	17	4.65	1.51	6.82	2.16	1.78	1.04	20.3	3.17
SB4-NEPH-06	N11PF21	1	18	4.54	1.45	5.73	2.17	1.65	1.48	20.1	3.19
SB4-NEPH-11	N07PF11	1	19	4.75	1.44	6.59	2.19	1.73	0.988	20.3	3.10
SB4-NEPH-03	N03PF21	1	20	4.55	1.46	6.35	2.17	1.65	0.944	20.2	2.87
SB4-NEPH-07	N09PF11	1	21	4.93	1.44	6.09	2.18	1.71	1.59	20.2	3.57
SB4-NEPH-05	N01PF21	1	22	4.86	1.45	6.58	2.16	1.66	0.992	20.1	2.94
SB4-NEPH-12	N06PF21	1	23	5.56	1.53	4.76	2.35	1.12	0.302	21.6	1.46
SB4-NEPH-01	N05PF21	1	24	6.76	1.42	5.64	2.13	1.32	0.375	19.9	1.71
SB4-NEPH-12	N06PF11	1	25	5.51	1.54	4.71	2.34	1.14	0.322	21.6	1.45
SB4-NEPH-10	N04PF11	1	26	4.34	1.42	6.34	2.15	1.68	0.944	19.9	2.89
SB4-NEPH-02	N10PF21	1	27	6.31	1.38	5.24	2.14	1.26	0.337	19.7	1.67
SB4-NEPH-08	N08PF11	1	28	6.40	1.42	5.35	2.18	1.32	0.358	21.3	1.68
Ustd	UstdPF13	1	29	2.15	2.65	8.33	1.40	1.97	0.735	19.9	1.95
Batch 1	BCHPF13	1	30	2.56	2.29	8.10	2.04	1.17	0.509	22.7	<0.100
Batch 1	BCHPF21	2	1	2.58	2.49	8.68	2.08	1.29	0.527	23.5	<0.100
Ustd	UstdPF21	2	2	2.11	2.81	8.81	1.43	2.09	0.762	20.4	1.98
SB4-NEPH-01	N05PF12	2	3	6.60	1.50	6.09	2.14	1.44	0.410	20.3	1.69
SB4-NEPH-05	N01PF12	2	4	4.88	1.50	6.90	2.19	1.77	1.05	20.4	2.92
SB4-NEPH-11	N07PF22	2	5	4.68	1.50	7.12	2.18	1.88	1.07	20.4	3.17
SB4-NEPH-07	N09PF22	2	6	4.95	1.49	6.28	2.23	1.79	1.63	20.5	3.55
Batch 1	BCHPF11	1	1	2.56	2.50	8.63	2.07	1.25	0.527	23.4	<0.100
Ustd	UstdPF11	1	2	2.13	2.85	8.89	1.42	2.07	0.764	20.5	1.98
SB4-NEPH-03	N03PF11	1	3	4.57	1.52	6.51	2.18	1.68	0.968	20.4	2.87
SB4-NEPH-10	N04PF21	1	4	4.43	1.52	6.73	2.20	1.78	1.00	20.6	2.91
SB4-NEPH-01	N05PF11	1	5	6.60	1.46	6.01	2.12	1.40	0.402	20.3	1.71
SB4-NEPH-09	N12PF11	1	6	6.00	1.59	5.09	2.36	1.19	0.329	22.1	1.53
SB4-NEPH-04	N02PF11	1	7	6.86	1.47	5.73	2.19	1.35	0.365	21.7	1.67
SB4-NEPH-08	N08PF21	1	8	6.39	1.47	5.62	2.20	1.32	0.385	21.9	1.63
SB4-NEPH-07	N09PF21	1	9	4.97	1.46	6.25	2.22	1.75	1.63	20.7	3.56
SB4-NEPH-09	N12PF21	1	10	5.93	1.59	5.56	2.35	1.22	0.338	22.2	1.54
SB4-NEPH-06	N11PF11	1	11	4.54	1.44	5.92	2.19	1.70	1.51	20.4	3.17
SB4-NEPH-04	N02PF21	1	12	6.71	1.49	5.96	2.16	1.39	0.396	21.6	1.73
SB4-NEPH-02	N10PF11	1	13	6.36	1.47	5.76	2.18	1.37	0.371	20.6	1.74
SB4-NEPH-05	N01PF11	1	14	4.92	1.47	6.73	2.19	1.70	1.01	20.5	2.95
Batch 1	BCHPF12	1	15	2.59	2.35	8.41	2.06	1.22	0.505	23.2	<0.100
Ustd	UstdPF12	1	16	2.11	2.73	8.55	1.41	2.01	0.741	20.2	1.96
SB4-NEPH-11	N07PF21	1	17	4.65	1.51	6.82	2.16	1.78	1.04	20.3	3.17
SB4-NEPH-06	N11PF21	1	18	4.54	1.45	5.73	2.17	1.65	1.48	20.1	3.19
SB4-NEPH-11	N07PF11	1	19	4.75	1.44	6.59	2.19	1.73	0.988	20.3	3.10
SB4-NEPH-03	N03PF21	1	20	4.55	1.46	6.35	2.17	1.65	0.944	20.2	2.87
SB4-NEPH-07	N09PF11	1	21	4.93	1.44	6.09	2.18	1.71	1.59	20.2	3.57
SB4-NEPH-05	N01PF21	1	22	4.86	1.45	6.58	2.16	1.66	0.992	20.1	2.94
SB4-NEPH-09	N12PF22	2	7	5.91	1.60	5.63	2.37	1.25	0.359	22.0	1.54
SB4-NEPH-03	N03PF12	2	8	4.56	1.48	6.52	2.20	1.70	0.968	20.2	2.83

Table C.3: Measured Elemental Concentrations (wt%) for Samples Prepared Using Peroxide Fusion

Glass ID	SRNL-ML ID	Block	Analytical Sequence	Al	B	Fe	Li	Mn	Ni	Si	U
SB4-NEPH-04	N02PF22	2	9	6.63	1.49	6.04	2.17	1.43	0.405	21.4	1.71
SB4-NEPH-06	N11PF22	2	10	4.52	1.43	5.93	2.19	1.72	1.52	20.3	3.14
SB4-NEPH-05	N01PF22	2	11	4.86	1.47	6.85	2.19	1.75	1.04	20.2	2.91
SB4-NEPH-06	N11PF12	2	12	4.51	1.44	5.90	2.18	1.71	1.52	20.1	3.13
SB4-NEPH-12	N06PF12	2	13	5.50	1.58	4.93	2.36	1.22	0.347	21.7	1.44
SB4-NEPH-10	N04PF12	2	14	4.34	1.47	6.65	2.18	1.78	0.990	20.2	2.87
Batch 1	BCHPF22	2	15	2.61	2.40	8.66	2.11	1.28	0.526	23.5	<0.100
Ustd	UstdPF22	2	16	2.16	2.77	8.81	1.43	2.08	0.776	20.3	1.96
SB4-NEPH-12	N06PF22	2	17	5.51	1.60	4.94	2.36	1.19	0.333	21.7	1.50
SB4-NEPH-07	N09PF12	2	18	4.93	1.47	6.19	2.20	1.75	1.604	20.2	3.59
SB4-NEPH-08	N08PF12	2	19	6.31	1.45	5.47	2.19	1.36	0.384	21.3	1.65
SB4-NEPH-08	N08PF22	2	20	6.33	1.46	5.55	2.20	1.33	0.385	21.3	1.65
SB4-NEPH-01	N05PF22	2	21	6.68	1.43	5.88	2.15	1.39	0.388	20.1	1.68
SB4-NEPH-10	N04PF22	2	22	4.37	1.46	6.62	2.19	1.78	1.00	20.2	2.88
SB4-NEPH-09	N12PF12	2	23	5.93	1.54	5.03	2.36	1.20	0.345	21.8	1.52
SB4-NEPH-04	N02PF12	2	24	6.88	1.45	5.68	2.20	1.36	0.380	21.5	1.68
SB4-NEPH-03	N03PF22	2	25	4.48	1.44	6.48	2.16	1.70	0.957	20.1	2.80
SB4-NEPH-02	N10PF22	2	26	6.27	1.40	5.43	2.16	1.33	0.364	19.8	1.66
SB4-NEPH-02	N10PF12	2	27	6.24	1.43	5.70	2.17	1.38	0.375	20.1	1.71
SB4-NEPH-11	N07PF12	2	28	4.73	1.44	6.73	2.21	1.78	1.03	20.5	3.07
Ustd	UstdPF23	2	29	2.13	2.72	8.64	1.41	2.05	0.763	20.1	1.95
Batch 1	BCHPF23	2	30	2.56	2.33	8.43	2.05	1.25	0.516	22.9	<0.100

Table C.4: Average Measured and Bias-Corrected Chemical Compositions Versus Targeted Compositions by Oxide by Nepheline Study Glass

(100 -Batch 1; 200 -U std)

Glass ID	Glass #	Oxide	Measured (wt%)	Measured Bias-Corrected (wt%)	Targeted (wt%)	Diff of Measured	Diff of Meas. bc	% Diff of Measured	% Diff Meas. of bc
SB4-NEPH-01	1	Al2O3 (wt%)	12.5841	12.6059	12.6120	-0.0279	-0.0061	-0.2%	0.0%
SB4-NEPH-01	1	B2O3 (wt%)	4.6769	4.7197	4.8000	-0.1231	-0.0803	-2.6%	-1.7%
SB4-NEPH-01	1	BaO (wt%)	0.0391	0.0439	0.0430	-0.0039	0.0009	-9.1%	2.2%
SB4-NEPH-01	1	CaO (wt%)	0.8906	0.9142	0.8840	0.0066	0.0302	0.7%	3.4%
SB4-NEPH-01	1	Ce2O3 (wt%)	0.0580	0.0580	0.0820	-0.0240	-0.0240	-29.3%	-29.3%
SB4-NEPH-01	1	Cr2O3 (wt%)	0.1023	0.0981	0.0920	0.0103	0.0061	11.2%	6.7%
SB4-NEPH-01	1	CuO (wt%)	0.0294	0.0308	0.0290	0.0004	0.0018	1.4%	6.1%
SB4-NEPH-01	1	Fe2O3 (wt%)	8.4424	8.9350	9.0870	-0.6446	-0.1520	-7.1%	-1.7%
SB4-NEPH-01	1	K2O (wt%)	0.7273	0.7166	0.6820	0.0453	0.0346	6.6%	5.1%
SB4-NEPH-01	1	La2O3 (wt%)	0.0276	0.0276	0.0340	-0.0064	-0.0064	-18.9%	-18.9%
SB4-NEPH-01	1	Li2O (wt%)	4.5964	4.5718	4.8000	-0.2036	-0.2282	-4.2%	-4.8%
SB4-NEPH-01	1	MgO (wt%)	0.6935	0.7858	0.7320	-0.0385	0.0538	-5.3%	7.4%
SB4-NEPH-01	1	MnO (wt%)	1.7915	1.9263	1.9130	-0.1215	0.0133	-6.3%	0.7%
SB4-NEPH-01	1	Na2O (wt%)	17.0859	16.1902	16.3480	0.7379	-0.1578	4.5%	-1.0%
SB4-NEPH-01	1	NiO (wt%)	0.5010	0.5705	0.5830	-0.0820	-0.0125	-14.1%	-2.1%
SB4-NEPH-01	1	PbO (wt%)	0.0714	0.0714	0.0810	-0.0096	-0.0096	-11.9%	-11.9%
SB4-NEPH-01	1	SO4 (wt%)	0.3932	0.3932	0.4420	-0.0488	-0.0488	-11.0%	-11.0%
SB4-NEPH-01	1	SiO2 (wt%)	43.1069	43.6181	44.4820	-1.3751	-0.8639	-3.1%	-1.9%
SB4-NEPH-01	1	ThO2 (wt%)	0.0927	0.0927	0.0200	0.0727	0.0727	363.7%	363.7%
SB4-NEPH-01	1	TiO2 (wt%)	0.0100	0.0111	0.0100	0.0000	0.0011	0.1%	11.4%
SB4-NEPH-01	1	U3O8 (wt%)	2.0017	2.0802	2.1110	-0.1093	-0.0308	-5.2%	-1.5%
SB4-NEPH-01	1	ZnO (wt%)	0.0420	0.0420	0.0400	0.0020	0.0020	5.0%	5.0%
SB4-NEPH-01	1	ZrO2 (wt%)	0.0908	0.0908	0.0950	-0.0042	-0.0042	-4.4%	-4.4%
SB4-NEPH-01	1	Sum of Oxides	98.0548	97.9011	100.0020	-1.9472	-2.1009	-1.9%	-2.1%
SB4-NEPH-02	2	Al2O3 (wt%)	11.8944	11.9152	11.6830	0.2114	0.2322	1.8%	2.0%
SB4-NEPH-02	2	B2O3 (wt%)	4.5723	4.6144	4.8000	-0.2277	-0.1856	-4.7%	-3.9%
SB4-NEPH-02	2	BaO (wt%)	0.0371	0.0417	0.0420	-0.0049	-0.0003	-11.6%	-0.6%
SB4-NEPH-02	2	CaO (wt%)	0.8101	0.8316	0.8390	-0.0289	-0.0074	-3.4%	-0.9%
SB4-NEPH-02	2	Ce2O3 (wt%)	0.0600	0.0600	0.0810	-0.0210	-0.0210	-25.9%	-25.9%
SB4-NEPH-02	2	Cr2O3 (wt%)	0.0892	0.0855	0.0870	0.0022	-0.0015	2.5%	-1.7%
SB4-NEPH-02	2	CuO (wt%)	0.0266	0.0278	0.0280	-0.0014	-0.0002	-5.0%	-0.6%
SB4-NEPH-02	2	Fe2O3 (wt%)	7.9098	8.3721	8.7010	-0.7912	-0.3289	-9.1%	-3.8%
SB4-NEPH-02	2	K2O (wt%)	0.7095	0.6991	0.6240	0.0855	0.0751	13.7%	12.0%
SB4-NEPH-02	2	La2O3 (wt%)	0.0261	0.0261	0.0340	-0.0079	-0.0079	-23.3%	-23.3%
SB4-NEPH-02	2	Li2O (wt%)	4.6556	4.6308	4.8000	-0.1444	-0.1692	-3.0%	-3.5%
SB4-NEPH-02	2	MgO (wt%)	0.6131	0.6947	0.6690	-0.0559	0.0257	-8.4%	3.8%
SB4-NEPH-02	2	MnO (wt%)	1.7238	1.8537	1.9050	-0.1812	-0.0513	-9.5%	-2.7%
SB4-NEPH-02	2	Na2O (wt%)	17.4566	16.5416	16.9870	0.4696	-0.4454	2.8%	-2.6%
SB4-NEPH-02	2	NiO (wt%)	0.4603	0.5241	0.5790	-0.1187	-0.0549	-20.5%	-9.5%
SB4-NEPH-02	2	PbO (wt%)	0.0638	0.0638	0.0780	-0.0142	-0.0142	-18.2%	-18.2%
SB4-NEPH-02	2	SO4 (wt%)	0.4239	0.4239	0.5080	-0.0841	-0.0841	-16.6%	-16.6%

Table C.4: Average Measured and Bias-Corrected Chemical Compositions Versus Targeted Compositions by Oxide by Nepheline Study Glass

(100 -Batch 1; 200 -U std)

Glass ID	Glass #	Oxide	Measured (wt%)	Measured Bias-Corrected (wt%)	Targeted (wt%)	Diff of Measured	Diff of Meas. bc	% Diff of Measured	% Diff Meas. of bc
SB4-NEPH-02	2	SiO2 (wt%)	42.8930	43.4031	44.3890	-1.4960	-0.9859	-3.4%	-2.2%
SB4-NEPH-02	2	ThO2 (wt%)	0.0879	0.0879	0.0180	0.0699	0.0699	388.3%	388.3%
SB4-NEPH-02	2	TiO2 (wt%)	0.9679	1.0763	0.9790	-0.0111	0.0973	-1.1%	9.9%
SB4-NEPH-02	2	U3O8 (wt%)	1.9987	2.0772	2.0360	-0.0373	0.0412	-1.8%	2.0%
SB4-NEPH-02	2	ZnO (wt%)	0.0386	0.0386	0.0390	-0.0004	-0.0004	-1.1%	-1.1%
SB4-NEPH-02	2	ZrO2 (wt%)	0.0837	0.0837	0.0940	-0.0103	-0.0103	-10.9%	-10.9%
SB4-NEPH-02	2	Sum of Oxides	97.9728	97.8010	100.0000	-2.0272	-2.1990	-2.0%	-2.2%
SB4-NEPH-03	3	Al2O3 (wt%)	8.5783	8.5933	8.4670	0.1113	0.1263	1.3%	1.5%
SB4-NEPH-03	3	B2O3 (wt%)	4.7494	4.7933	4.8000	-0.0506	-0.0067	-1.1%	-0.1%
SB4-NEPH-03	3	BaO (wt%)	0.0578	0.0650	0.0620	-0.0042	0.0030	-6.8%	4.8%
SB4-NEPH-03	3	CaO (wt%)	0.8535	0.8759	0.8480	0.0055	0.0279	0.7%	3.3%
SB4-NEPH-03	3	Ce2O3 (wt%)	0.0586	0.0586	0.0820	-0.0234	-0.0234	-28.6%	-28.6%
SB4-NEPH-03	3	Cr2O3 (wt%)	0.1030	0.0988	0.0960	0.0070	0.0028	7.3%	3.0%
SB4-NEPH-03	3	CuO (wt%)	0.0313	0.0327	0.0320	-0.0007	0.0007	-2.2%	2.3%
SB4-NEPH-03	3	Fe2O3 (wt%)	9.2430	9.7833	9.8970	-0.6540	-0.1137	-6.6%	-1.1%
SB4-NEPH-03	3	K2O (wt%)	0.4255	0.4193	0.3770	0.0485	0.0423	12.9%	11.2%
SB4-NEPH-03	3	La2O3 (wt%)	0.0267	0.0267	0.0360	-0.0093	-0.0093	-25.9%	-25.9%
SB4-NEPH-03	3	Li2O (wt%)	4.6879	4.6629	4.8000	-0.1121	-0.1371	-2.3%	-2.9%
SB4-NEPH-03	3	MgO (wt%)	0.6707	0.7600	0.7100	-0.0393	0.0500	-5.5%	7.0%
SB4-NEPH-03	3	MnO (wt%)	2.1724	2.3364	2.2890	-0.1166	0.0474	-5.1%	2.1%
SB4-NEPH-03	3	Na2O (wt%)	17.0859	16.1903	16.6820	0.4039	-0.4917	2.4%	-2.9%
SB4-NEPH-03	3	NiO (wt%)	1.2206	1.3899	1.4000	-0.1794	-0.0101	-12.8%	-0.7%
SB4-NEPH-03	3	PbO (wt%)	0.0568	0.0568	0.0650	-0.0082	-0.0082	-12.6%	-12.6%
SB4-NEPH-03	3	SO4 (wt%)	0.4629	0.4629	0.5060	-0.0431	-0.0431	-8.5%	-8.5%
SB4-NEPH-03	3	SiO2 (wt%)	43.2673	43.7817	44.2180	-0.9507	-0.4363	-2.1%	-1.0%
SB4-NEPH-03	3	ThO2 (wt%)	0.1320	0.1320	0.0130	0.1190	0.1190	915.4%	915.4%
SB4-NEPH-03	3	TiO2 (wt%)	0.9091	1.0109	0.9770	-0.0679	0.0339	-7.0%	3.5%
SB4-NEPH-03	3	U3O8 (wt%)	3.3519	3.4834	3.4890	-0.1371	-0.0056	-3.9%	-0.2%
SB4-NEPH-03	3	ZnO (wt%)	0.0675	0.0675	0.0490	0.0185	0.0185	37.8%	37.8%
SB4-NEPH-03	3	ZrO2 (wt%)	0.1006	0.1006	0.1090	-0.0084	-0.0084	-7.7%	-7.7%
SB4-NEPH-03	3	Sum of Oxides	98.4477	98.6113	100.0040	-1.5563	-1.3927	-1.6%	-1.4%
SB4-NEPH-04	4	Al2O3 (wt%)	12.7919	12.8141	12.6120	0.1799	0.2021	1.4%	1.6%
SB4-NEPH-04	4	B2O3 (wt%)	4.7494	4.7932	4.8000	-0.0506	-0.0068	-1.1%	-0.1%
SB4-NEPH-04	4	BaO (wt%)	0.0366	0.0411	0.0430	-0.0064	-0.0019	-15.0%	-4.4%
SB4-NEPH-04	4	CaO (wt%)	0.8679	0.8907	0.8840	-0.0161	0.0067	-1.8%	0.8%
SB4-NEPH-04	4	Ce2O3 (wt%)	0.0633	0.0633	0.0820	-0.0187	-0.0187	-22.9%	-22.9%
SB4-NEPH-04	4	Cr2O3 (wt%)	0.0910	0.0873	0.0920	-0.0010	-0.0047	-1.1%	-5.1%
SB4-NEPH-04	4	CuO (wt%)	0.0300	0.0314	0.0290	0.0010	0.0024	3.6%	8.4%
SB4-NEPH-04	4	Fe2O3 (wt%)	8.3673	8.8569	9.0870	-0.7197	-0.2301	-7.9%	-2.5%
SB4-NEPH-04	4	K2O (wt%)	0.7688	0.7575	0.6820	0.0868	0.0755	12.7%	11.1%
SB4-NEPH-04	4	La2O3 (wt%)	0.0255	0.0255	0.0340	-0.0085	-0.0085	-25.0%	-25.0%

Table C.4: Average Measured and Bias-Corrected Chemical Compositions Versus Targeted Compositions by Oxide by Nepheline Study Glass

(100 -Batch 1; 200 -U std)

Glass ID	Glass #	Oxide	Measured (wt%)	Measured Bias-Corrected (wt%)	Targeted (wt%)	Diff of Measured	Diff of Meas. bc	% Diff of Measured	% Diff Meas. of bc
SB4-NEPH-04	4	Li2O (wt%)	4.6933	4.6682	4.8000	-0.1067	-0.1318	-2.2%	-2.7%
SB4-NEPH-04	4	MgO (wt%)	0.6761	0.7661	0.7320	-0.0559	0.0341	-7.6%	4.7%
SB4-NEPH-04	4	MnO (wt%)	1.7851	1.9199	1.9130	-0.1279	0.0069	-6.7%	0.4%
SB4-NEPH-04	4	Na2O (wt%)	14.4236	13.6674	13.9480	0.4756	-0.2806	3.4%	-2.0%
SB4-NEPH-04	4	NiO (wt%)	0.4918	0.5600	0.5830	-0.0912	-0.0230	-15.6%	-4.0%
SB4-NEPH-04	4	PbO (wt%)	0.0684	0.0684	0.0810	-0.0126	-0.0126	-15.6%	-15.6%
SB4-NEPH-04	4	SO4 (wt%)	0.3917	0.3917	0.4420	-0.0503	-0.0503	-11.4%	-11.4%
SB4-NEPH-04	4	SiO2 (wt%)	46.1019	46.6501	46.8820	-0.7801	-0.2319	-1.7%	-0.5%
SB4-NEPH-04	4	ThO2 (wt%)	0.0913	0.0913	0.0200	0.0713	0.0713	356.6%	356.6%
SB4-NEPH-04	4	TiO2 (wt%)	0.0075	0.0084	0.0100	-0.0025	-0.0016	-24.9%	-16.4%
SB4-NEPH-04	4	U3O8 (wt%)	2.0017	2.0802	2.1110	-0.1093	-0.0308	-5.2%	-1.5%
SB4-NEPH-04	4	ZnO (wt%)	0.0398	0.0398	0.0400	-0.0002	-0.0002	-0.4%	-0.4%
SB4-NEPH-04	4	ZrO2 (wt%)	0.0844	0.0844	0.0950	-0.0106	-0.0106	-11.1%	-11.1%
SB4-NEPH-04	4	Sum of Oxides	99.0191	99.1080	100.0020	-0.9830	-0.8940	-1.0%	-0.9%
SB4-NEPH-05	5	Al2O3 (wt%)	9.2208	9.2368	9.0700	0.1508	0.1668	1.7%	1.8%
SB4-NEPH-05	5	B2O3 (wt%)	4.7413	4.7847	4.8000	-0.0587	-0.0153	-1.2%	-0.3%
SB4-NEPH-05	5	BaO (wt%)	0.0581	0.0653	0.0650	-0.0069	0.0003	-10.7%	0.4%
SB4-NEPH-05	5	CaO (wt%)	0.8993	0.9232	0.8930	0.0063	0.0302	0.7%	3.4%
SB4-NEPH-05	5	Ce2O3 (wt%)	0.0682	0.0682	0.0830	-0.0148	-0.0148	-17.8%	-17.8%
SB4-NEPH-05	5	Cr2O3 (wt%)	0.0994	0.0954	0.1010	-0.0016	-0.0056	-1.6%	-5.6%
SB4-NEPH-05	5	CuO (wt%)	0.0341	0.0357	0.0340	0.0001	0.0017	0.3%	5.0%
SB4-NEPH-05	5	Fe2O3 (wt%)	9.6719	10.2359	10.4040	-0.7321	-0.1681	-7.0%	-1.6%
SB4-NEPH-05	5	K2O (wt%)	0.4752	0.4682	0.4100	0.0652	0.0582	15.9%	14.2%
SB4-NEPH-05	5	La2O3 (wt%)	0.0290	0.0290	0.0370	-0.0080	-0.0080	-21.5%	-21.5%
SB4-NEPH-05	5	Li2O (wt%)	4.6987	4.6735	4.8000	-0.1013	-0.1265	-2.1%	-2.6%
SB4-NEPH-05	5	MgO (wt%)	0.7059	0.8000	0.7770	-0.0711	0.0230	-9.1%	3.0%
SB4-NEPH-05	5	MnO (wt%)	2.2209	2.3878	2.3350	-0.1141	0.0528	-4.9%	2.3%
SB4-NEPH-05	5	Na2O (wt%)	16.5467	15.6790	16.0110	0.5357	-0.3320	3.3%	-2.1%
SB4-NEPH-05	5	NiO (wt%)	1.3018	1.4820	1.4860	-0.1842	-0.0040	-12.4%	-0.3%
SB4-NEPH-05	5	PbO (wt%)	0.0590	0.0590	0.0660	-0.0070	-0.0070	-10.6%	-10.6%
SB4-NEPH-05	5	SO4 (wt%)	0.3940	0.3940	0.4390	-0.0450	-0.0450	-10.3%	-10.3%
SB4-NEPH-05	5	SiO2 (wt%)	43.4278	43.9433	44.2930	-0.8652	-0.3497	-2.0%	-0.8%
SB4-NEPH-05	5	ThO2 (wt%)	0.1363	0.1363	0.0140	0.1223	0.1223	873.3%	873.3%
SB4-NEPH-05	5	TiO2 (wt%)	0.0079	0.0088	0.0090	-0.0011	-0.0002	-12.0%	-2.0%
SB4-NEPH-05	5	U3O8 (wt%)	3.4551	3.5906	3.7110	-0.2559	-0.1204	-6.9%	-3.2%
SB4-NEPH-05	5	ZnO (wt%)	0.0535	0.0535	0.0510	0.0025	0.0025	5.0%	5.0%
SB4-NEPH-05	5	ZrO2 (wt%)	0.1016	0.1016	0.1120	-0.0104	-0.0104	-9.2%	-9.2%
SB4-NEPH-05	5	Sum of Oxides	98.6761	98.8253	100.0010	-1.3249	-1.1757	-1.3%	-1.2%
SB4-NEPH-06	6	Al2O3 (wt%)	8.5547	8.5696	8.3750	0.1797	0.1946	2.1%	2.3%
SB4-NEPH-06	6	B2O3 (wt%)	4.6367	4.6794	4.8000	-0.1633	-0.1206	-3.4%	-2.5%
SB4-NEPH-06	6	BaO (wt%)	0.0634	0.0712	0.0760	-0.0126	-0.0048	-16.6%	-6.3%

Table C.4: Average Measured and Bias-Corrected Chemical Compositions Versus Targeted Compositions by Oxide by Nepheline Study Glass

(100 -Batch 1; 200 -U std)

Glass ID	Glass #	Oxide	Measured (wt%)	Measured Bias-Corrected (wt%)	Targeted (wt%)	Diff of Measured	Diff of Meas. bc	% Diff of Measured	% Diff Meas. of bc
SB4-NEPH-06	6	CaO (wt%)	0.7356	0.7551	0.7230	0.0126	0.0321	1.7%	4.4%
SB4-NEPH-06	6	Ce2O3 (wt%)	0.0594	0.0594	0.0770	-0.0176	-0.0176	-22.8%	-22.8%
SB4-NEPH-06	6	Cr2O3 (wt%)	0.1034	0.0992	0.1050	-0.0016	-0.0058	-1.5%	-5.5%
SB4-NEPH-06	6	CuO (wt%)	0.0338	0.0354	0.0320	0.0018	0.0034	5.6%	10.5%
SB4-NEPH-06	6	Fe2O3 (wt%)	8.3923	8.8827	9.2400	-0.8477	-0.3573	-9.2%	-3.9%
SB4-NEPH-06	6	K2O (wt%)	0.4767	0.4697	0.4160	0.0607	0.0537	14.6%	12.9%
SB4-NEPH-06	6	La2O3 (wt%)	0.0243	0.0243	0.0340	-0.0097	-0.0097	-28.4%	-28.4%
SB4-NEPH-06	6	Li2O (wt%)	4.6987	4.6736	4.8000	-0.1013	-0.1264	-2.1%	-2.6%
SB4-NEPH-06	6	MgO (wt%)	0.3942	0.4467	0.4240	-0.0298	0.0227	-7.0%	5.4%
SB4-NEPH-06	6	MnO (wt%)	2.1886	2.3537	2.3520	-0.1634	0.0017	-6.9%	0.1%
SB4-NEPH-06	6	Na2O (wt%)	17.0185	16.1262	16.5040	0.5145	-0.3778	3.1%	-2.3%
SB4-NEPH-06	6	NiO (wt%)	1.9183	2.1842	2.2540	-0.3357	-0.0698	-14.9%	-3.1%
SB4-NEPH-06	6	PbO (wt%)	0.0555	0.0555	0.0630	-0.0075	-0.0075	-11.9%	-11.9%
SB4-NEPH-06	6	SO4 (wt%)	0.4464	0.4464	0.5040	-0.0576	-0.0576	-11.4%	-11.4%
SB4-NEPH-06	6	SiO2 (wt%)	43.2673	43.7812	44.0550	-0.7877	-0.2738	-1.8%	-0.6%
SB4-NEPH-06	6	ThO2 (wt%)	0.1462	0.1462	0.0110	0.1352	0.1352	1229.3%	1229.3%
SB4-NEPH-06	6	TiO2 (wt%)	0.9103	1.0123	0.9750	-0.0647	0.0373	-6.6%	3.8%
SB4-NEPH-06	6	U3O8 (wt%)	3.7233	3.8694	4.0130	-0.2897	-0.1436	-7.2%	-3.6%
SB4-NEPH-06	6	ZnO (wt%)	0.0557	0.0557	0.0500	0.0057	0.0057	11.4%	11.4%
SB4-NEPH-06	6	ZrO2 (wt%)	0.1091	0.1091	0.1200	-0.0109	-0.0109	-9.1%	-9.1%
SB4-NEPH-06	6	Sum of Oxides	98.1810	98.3685	100.0030	-1.8220	-1.6345	-1.8%	-1.6%
SB4-NEPH-07	7	Al2O3 (wt%)	9.3436	9.3598	8.9690	0.3746	0.3908	4.2%	4.4%
SB4-NEPH-07	7	B2O3 (wt%)	4.7172	4.7603	4.8000	-0.0828	-0.0397	-1.7%	-0.8%
SB4-NEPH-07	7	BaO (wt%)	0.0770	0.0866	0.0800	-0.0030	0.0066	-3.7%	8.3%
SB4-NEPH-07	7	CaO (wt%)	0.7377	0.7573	0.7560	-0.0183	0.0013	-2.4%	0.2%
SB4-NEPH-07	7	Ce2O3 (wt%)	0.0600	0.0600	0.0780	-0.0180	-0.0180	-23.0%	-23.0%
SB4-NEPH-07	7	Cr2O3 (wt%)	0.1027	0.0985	0.1110	-0.0083	-0.0125	-7.5%	-11.3%
SB4-NEPH-07	7	CuO (wt%)	0.0369	0.0386	0.0340	0.0029	0.0046	8.6%	13.6%
SB4-NEPH-07	7	Fe2O3 (wt%)	8.8677	9.3861	9.6800	-0.8123	-0.2939	-8.4%	-3.0%
SB4-NEPH-07	7	K2O (wt%)	0.4948	0.4875	0.4540	0.0408	0.0335	9.0%	7.4%
SB4-NEPH-07	7	La2O3 (wt%)	0.0258	0.0258	0.0350	-0.0092	-0.0092	-26.3%	-26.3%
SB4-NEPH-07	7	Li2O (wt%)	4.7525	4.7271	4.8000	-0.0475	-0.0729	-1.0%	-1.5%
SB4-NEPH-07	7	MgO (wt%)	0.4444	0.5036	0.4620	-0.0176	0.0416	-3.8%	9.0%
SB4-NEPH-07	7	MnO (wt%)	2.2596	2.4301	2.4040	-0.1444	0.0261	-6.0%	1.1%
SB4-NEPH-07	7	Na2O (wt%)	16.3445	15.4877	15.8160	0.5285	-0.3283	3.3%	-2.1%
SB4-NEPH-07	7	NiO (wt%)	2.0532	2.3379	2.4260	-0.3728	-0.0881	-15.4%	-3.6%
SB4-NEPH-07	7	PbO (wt%)	0.0614	0.0614	0.0640	-0.0026	-0.0026	-4.1%	-4.1%
SB4-NEPH-07	7	SO4 (wt%)	0.3925	0.3925	0.4380	-0.0455	-0.0455	-10.4%	-10.4%
SB4-NEPH-07	7	SiO2 (wt%)	43.6417	44.1603	44.1140	-0.4723	0.0463	-1.1%	0.1%
SB4-NEPH-07	7	ThO2 (wt%)	0.1673	0.1673	0.0120	0.1553	0.1553	1293.9%	1293.9%
SB4-NEPH-07	7	TiO2 (wt%)	0.0142	0.0158	0.0060	0.0082	0.0098	136.3%	162.9%

Table C.4: Average Measured and Bias-Corrected Chemical Compositions Versus Targeted Compositions by Oxide by Nepheline Study Glass

(100 -Batch 1; 200 -U std)

Glass ID	Glass #	Oxide	Measured (wt%)	Measured Bias-Corrected (wt%)	Targeted (wt%)	Diff of Measured	Diff of Meas. bc	% Diff of Measured	% Diff Meas. of bc
SB4-NEPH-07	7	U3O8 (wt%)	4.2068	4.3719	4.2870	-0.0802	0.0849	-1.9%	2.0%
SB4-NEPH-07	7	ZnO (wt%)	0.0585	0.0585	0.0520	0.0065	0.0065	12.5%	12.5%
SB4-NEPH-07	7	ZrO2 (wt%)	0.1141	0.1141	0.1240	-0.0099	-0.0099	-7.9%	-7.9%
SB4-NEPH-07	7	Sum of Oxides	99.2774	99.5009	100.0020	-0.7246	-0.5011	-0.7%	-0.5%
SB4-NEPH-08	8	Al2O3 (wt%)	12.0125	12.0335	11.6830	0.3295	0.3505	2.8%	3.0%
SB4-NEPH-08	8	B2O3 (wt%)	4.6689	4.7117	4.8000	-0.1311	-0.0883	-2.7%	-1.8%
SB4-NEPH-08	8	BaO (wt%)	0.0366	0.0411	0.0420	-0.0054	-0.0009	-12.9%	-2.1%
SB4-NEPH-08	8	CaO (wt%)	0.8161	0.8375	0.8390	-0.0229	-0.0015	-2.7%	-0.2%
SB4-NEPH-08	8	Ce2O3 (wt%)	0.0562	0.0562	0.0810	-0.0248	-0.0248	-30.6%	-30.6%
SB4-NEPH-08	8	Cr2O3 (wt%)	0.0895	0.0859	0.0870	0.0025	-0.0011	2.9%	-1.3%
SB4-NEPH-08	8	CuO (wt%)	0.0288	0.0301	0.0280	0.0008	0.0021	2.8%	7.6%
SB4-NEPH-08	8	Fe2O3 (wt%)	7.8598	8.3195	8.7010	-0.8412	-0.3815	-9.7%	-4.4%
SB4-NEPH-08	8	K2O (wt%)	0.7243	0.7136	0.6240	0.1003	0.0896	16.1%	14.4%
SB4-NEPH-08	8	La2O3 (wt%)	0.0258	0.0258	0.0340	-0.0082	-0.0082	-24.1%	-24.1%
SB4-NEPH-08	8	Li2O (wt%)	4.7202	4.6950	4.8000	-0.0798	-0.1050	-1.7%	-2.2%
SB4-NEPH-08	8	MgO (wt%)	0.6226	0.7055	0.6690	-0.0464	0.0365	-6.9%	5.5%
SB4-NEPH-08	8	MnO (wt%)	1.7205	1.8504	1.9050	-0.1845	-0.0546	-9.7%	-2.9%
SB4-NEPH-08	8	Na2O (wt%)	15.1650	14.3699	14.5870	0.5780	-0.2171	4.0%	-1.5%
SB4-NEPH-08	8	NiO (wt%)	0.4810	0.5476	0.5790	-0.0980	-0.0314	-16.9%	-5.4%
SB4-NEPH-08	8	PbO (wt%)	0.0644	0.0644	0.0780	-0.0136	-0.0136	-17.5%	-17.5%
SB4-NEPH-08	8	SO4 (wt%)	0.4337	0.4337	0.5080	-0.0743	-0.0743	-14.6%	-14.6%
SB4-NEPH-08	8	SiO2 (wt%)	45.8880	46.4341	46.7890	-0.9010	-0.3549	-1.9%	-0.8%
SB4-NEPH-08	8	ThO2 (wt%)	0.0853	0.0853	0.0180	0.0673	0.0673	374.1%	374.1%
SB4-NEPH-08	8	TiO2 (wt%)	0.9170	1.0197	0.9790	-0.0620	0.0407	-6.3%	4.2%
SB4-NEPH-08	8	U3O8 (wt%)	1.9486	2.0251	2.0360	-0.0874	-0.0109	-4.3%	-0.5%
SB4-NEPH-08	8	ZnO (wt%)	0.0429	0.0429	0.0390	0.0039	0.0039	10.1%	10.1%
SB4-NEPH-08	8	ZrO2 (wt%)	0.0865	0.0865	0.0940	-0.0075	-0.0075	-8.0%	-8.0%
SB4-NEPH-08	8	Sum of Oxides	98.8648	98.9361	100.0000	-1.1352	-1.0639	-1.1%	-1.1%
SB4-NEPH-09	9	Al2O3 (wt%)	11.2284	11.2479	11.0350	0.1934	0.2129	1.8%	1.9%
SB4-NEPH-09	9	B2O3 (wt%)	5.0874	5.1345	5.2000	-0.1126	-0.0655	-2.2%	-1.3%
SB4-NEPH-09	9	BaO (wt%)	0.0315	0.0355	0.0380	-0.0065	-0.0025	-17.0%	-6.7%
SB4-NEPH-09	9	CaO (wt%)	0.7601	0.7804	0.7740	-0.0139	0.0064	-1.8%	0.8%
SB4-NEPH-09	9	Ce2O3 (wt%)	0.0489	0.0489	0.0720	-0.0231	-0.0231	-32.1%	-32.1%
SB4-NEPH-09	9	Cr2O3 (wt%)	0.0811	0.0778	0.0800	0.0011	-0.0022	1.4%	-2.7%
SB4-NEPH-09	9	CuO (wt%)	0.0244	0.0255	0.0250	-0.0006	0.0005	-2.4%	2.1%
SB4-NEPH-09	9	Fe2O3 (wt%)	7.6167	8.0624	7.9510	-0.3343	0.1114	-4.2%	1.4%
SB4-NEPH-09	9	K2O (wt%)	0.6737	0.6637	0.5970	0.0767	0.0667	12.8%	11.2%
SB4-NEPH-09	9	La2O3 (wt%)	0.0214	0.0214	0.0300	-0.0086	-0.0086	-28.7%	-28.7%
SB4-NEPH-09	9	Li2O (wt%)	5.0808	5.0537	5.2000	-0.1192	-0.1463	-2.3%	-2.8%
SB4-NEPH-09	9	MgO (wt%)	0.5803	0.6577	0.6410	-0.0607	0.0167	-9.5%	2.6%
SB4-NEPH-09	9	MnO (wt%)	1.5688	1.6873	1.6740	-0.1052	0.0133	-6.3%	0.8%

Table C.4: Average Measured and Bias-Corrected Chemical Compositions Versus Targeted Compositions by Oxide by Nepheline Study Glass
(100 -Batch 1; 200 -U std)

Glass ID	Glass #	Oxide	Measured (wt%)	Measured Bias-Corrected (wt%)	Targeted (wt%)	Diff of Measured	Diff of Meas. bc	% Diff of Measured	% Diff Meas. of bc
SB4-NEPH-09	9	Na2O (wt%)	16.2097	15.3598	15.8050	0.4047	-0.4452	2.6%	-2.8%
SB4-NEPH-09	9	NiO (wt%)	0.4361	0.4965	0.5100	-0.0739	-0.0135	-14.5%	-2.6%
SB4-NEPH-09	9	PbO (wt%)	0.0617	0.0617	0.0710	-0.0093	-0.0093	-13.1%	-13.1%
SB4-NEPH-09	9	SO4 (wt%)	0.3333	0.3333	0.3860	-0.0527	-0.0527	-13.7%	-13.7%
SB4-NEPH-09	9	SiO2 (wt%)	47.1181	47.6786	47.9210	-0.8029	-0.2424	-1.7%	-0.5%
SB4-NEPH-09	9	ThO2 (wt%)	0.0797	0.0797	0.0170	0.0627	0.0627	368.5%	368.5%
SB4-NEPH-09	9	TiO2 (wt%)	0.0075	0.0084	0.0090	-0.0015	-0.0006	-16.6%	-7.1%
SB4-NEPH-09	9	U3O8 (wt%)	1.8071	1.8780	1.8470	-0.0399	0.0310	-2.2%	1.7%
SB4-NEPH-09	9	ZnO (wt%)	0.0355	0.0355	0.0350	0.0005	0.0005	1.4%	1.4%
SB4-NEPH-09	9	ZrO2 (wt%)	0.0743	0.0743	0.0830	-0.0087	-0.0087	-10.5%	-10.5%
SB4-NEPH-09	9	Sum of Oxides	99.2699	99.1202	100.0010	-0.7311	-0.8808	-0.7%	-0.9%
SB4-NEPH-10	10	Al2O3 (wt%)	8.2571	8.2715	8.0970	0.1601	0.1745	2.0%	2.2%
SB4-NEPH-10	10	B2O3 (wt%)	4.7252	4.7688	4.8000	-0.0748	-0.0312	-1.6%	-0.7%
SB4-NEPH-10	10	BaO (wt%)	0.0569	0.0640	0.0620	-0.0051	0.0020	-8.2%	3.2%
SB4-NEPH-10	10	CaO (wt%)	0.8612	0.8838	0.8590	0.0022	0.0248	0.3%	2.9%
SB4-NEPH-10	10	Ce2O3 (wt%)	0.0668	0.0668	0.0810	-0.0142	-0.0142	-17.6%	-17.6%
SB4-NEPH-10	10	Cr2O3 (wt%)	0.1005	0.0964	0.0940	0.0065	0.0024	6.9%	2.5%
SB4-NEPH-10	10	CuO (wt%)	0.0319	0.0334	0.0320	-0.0001	0.0014	-0.2%	4.4%
SB4-NEPH-10	10	Fe2O3 (wt%)	9.4146	9.9646	10.0880	-0.6734	-0.1234	-6.7%	-1.2%
SB4-NEPH-10	10	K2O (wt%)	0.3801	0.3745	0.3340	0.0461	0.0405	13.8%	12.1%
SB4-NEPH-10	10	La2O3 (wt%)	0.0273	0.0273	0.0360	-0.0087	-0.0087	-24.3%	-24.3%
SB4-NEPH-10	10	Li2O (wt%)	4.6933	4.6682	4.8000	-0.1067	-0.1318	-2.2%	-2.7%
SB4-NEPH-10	10	MgO (wt%)	0.7200	0.8159	0.7840	-0.0640	0.0319	-8.2%	4.1%
SB4-NEPH-10	10	MnO (wt%)	2.2661	2.4369	2.3870	-0.1209	0.0499	-5.1%	2.1%
SB4-NEPH-10	10	Na2O (wt%)	17.2207	16.3180	16.6590	0.5617	-0.3410	3.4%	-2.0%
SB4-NEPH-10	10	NiO (wt%)	1.2515	1.4249	1.4250	-0.1735	-0.0001	-12.2%	0.0%
SB4-NEPH-10	10	PbO (wt%)	0.0560	0.0560	0.0620	-0.0060	-0.0060	-9.7%	-9.7%
SB4-NEPH-10	10	SO4 (wt%)	0.4606	0.4606	0.5060	-0.0454	-0.0454	-9.0%	-9.0%
SB4-NEPH-10	10	SiO2 (wt%)	43.2673	43.7812	44.2250	-0.9577	-0.4438	-2.2%	-1.0%
SB4-NEPH-10	10	ThO2 (wt%)	0.1320	0.1320	0.0120	0.1200	0.1200	1000.0%	1000.0%
SB4-NEPH-10	10	TiO2 (wt%)	0.9320	1.0364	0.9780	-0.0460	0.0584	-4.7%	6.0%
SB4-NEPH-10	10	U3O8 (wt%)	3.4049	3.5385	3.5280	-0.1231	0.0105	-3.5%	0.3%
SB4-NEPH-10	10	ZnO (wt%)	0.0545	0.0545	0.0480	0.0065	0.0065	13.5%	13.5%
SB4-NEPH-10	10	ZrO2 (wt%)	0.0969	0.0969	0.1050	-0.0081	-0.0081	-7.7%	-7.7%
SB4-NEPH-10	10	Sum of Oxides	98.8144	98.9779	100.0020	-1.1876	-1.0241	-1.2%	-1.0%
SB4-NEPH-11	11	Al2O3 (wt%)	8.8854	8.9007	8.6640	0.2214	0.2367	2.6%	2.7%
SB4-NEPH-11	11	B2O3 (wt%)	4.7413	4.7850	4.8000	-0.0587	-0.0150	-1.2%	-0.3%
SB4-NEPH-11	11	BaO (wt%)	0.0611	0.0687	0.0650	-0.0039	0.0037	-6.0%	5.7%
SB4-NEPH-11	11	CaO (wt%)	0.8934	0.9171	0.9050	-0.0116	0.0121	-1.3%	1.3%
SB4-NEPH-11	11	Ce2O3 (wt%)	0.0618	0.0618	0.0830	-0.0212	-0.0212	-25.6%	-25.6%
SB4-NEPH-11	11	Cr2O3 (wt%)	0.0968	0.0929	0.1000	-0.0032	-0.0071	-3.2%	-7.1%

Table C.4: Average Measured and Bias-Corrected Chemical Compositions Versus Targeted Compositions by Oxide by Nepheline Study Glass
(100 -Batch 1; 200 -U std)

Glass ID	Glass #	Oxide	Measured (wt%)	Measured Bias-Corrected (wt%)	Targeted (wt%)	Diff of Measured	Diff of Meas. bc	% Diff of Measured	% Diff Meas. of bc
SB4-NEPH-11	11	CuO (wt%)	0.0354	0.0370	0.0330	0.0024	0.0040	7.2%	12.1%
SB4-NEPH-11	11	Fe2O3 (wt%)	9.7434	10.3116	10.6130	-0.8696	-0.3014	-8.2%	-2.8%
SB4-NEPH-11	11	K2O (wt%)	0.3840	0.3783	0.3630	0.0210	0.0153	5.8%	4.2%
SB4-NEPH-11	11	La2O3 (wt%)	0.0296	0.0296	0.0370	-0.0074	-0.0074	-20.0%	-20.0%
SB4-NEPH-11	11	Li2O (wt%)	4.7041	4.6789	4.8000	-0.0959	-0.1211	-2.0%	-2.5%
SB4-NEPH-11	11	MgO (wt%)	0.8187	0.9276	0.8590	-0.0403	0.0686	-4.7%	8.0%
SB4-NEPH-11	11	MnO (wt%)	2.3145	2.4885	2.4430	-0.1285	0.0455	-5.3%	1.9%
SB4-NEPH-11	11	Na2O (wt%)	16.3445	15.4874	15.9870	0.3575	-0.4996	2.2%	-3.1%
SB4-NEPH-11	11	NiO (wt%)	1.3132	1.4951	1.5140	-0.2008	-0.0189	-13.3%	-1.2%
SB4-NEPH-11	11	PbO (wt%)	0.0617	0.0617	0.0630	-0.0013	-0.0013	-2.1%	-2.1%
SB4-NEPH-11	11	SO4 (wt%)	0.3805	0.3805	0.4390	-0.0585	-0.0585	-13.3%	-13.3%
SB4-NEPH-11	11	SiO2 (wt%)	43.5882	44.1050	44.3010	-0.7128	-0.1960	-1.6%	-0.4%
SB4-NEPH-11	11	ThO2 (wt%)	0.1511	0.1511	0.0140	0.1371	0.1371	979.0%	979.0%
SB4-NEPH-11	11	TiO2 (wt%)	0.0171	0.0190	0.0090	0.0081	0.0100	90.0%	111.4%
SB4-NEPH-11	11	U3O8 (wt%)	3.6879	3.8326	3.7530	-0.0651	0.0796	-1.7%	2.1%
SB4-NEPH-11	11	ZnO (wt%)	0.0538	0.0538	0.0500	0.0038	0.0038	7.7%	7.7%
SB4-NEPH-11	11	ZrO2 (wt%)	0.1020	0.1020	0.1070	-0.0050	-0.0050	-4.7%	-4.7%
SB4-NEPH-11	11	Sum of Oxides	98.5705	98.7949	100.0020	-1.4315	-1.2071	-1.4%	-1.2%
SB4-NEPH-12	12	Al2O3 (wt%)	10.4300	10.4482	10.2220	0.2080	0.2262	2.0%	2.2%
SB4-NEPH-12	12	B2O3 (wt%)	5.0311	5.0769	5.2000	-0.1689	-0.1231	-3.2%	-2.4%
SB4-NEPH-12	12	BaO (wt%)	0.0332	0.0373	0.0370	-0.0038	0.0003	-10.2%	0.9%
SB4-NEPH-12	12	CaO (wt%)	0.7297	0.7489	0.7340	-0.0043	0.0149	-0.6%	2.0%
SB4-NEPH-12	12	Ce2O3 (wt%)	0.0559	0.0559	0.0710	-0.0151	-0.0151	-21.2%	-21.2%
SB4-NEPH-12	12	Cr2O3 (wt%)	0.0873	0.0838	0.0760	0.0113	0.0078	14.9%	10.2%
SB4-NEPH-12	12	CuO (wt%)	0.0232	0.0242	0.0240	-0.0008	0.0002	-3.5%	0.9%
SB4-NEPH-12	12	Fe2O3 (wt%)	6.9126	7.3153	7.6130	-0.7004	-0.2977	-9.2%	-3.9%
SB4-NEPH-12	12	K2O (wt%)	0.6044	0.5955	0.5460	0.0584	0.0495	10.7%	9.1%
SB4-NEPH-12	12	La2O3 (wt%)	0.0232	0.0232	0.0290	-0.0058	-0.0058	-20.1%	-20.1%
SB4-NEPH-12	12	Li2O (wt%)	5.0647	5.0376	5.2000	-0.1353	-0.1624	-2.6%	-3.1%
SB4-NEPH-12	12	MgO (wt%)	0.5567	0.6308	0.5850	-0.0283	0.0458	-4.8%	7.8%
SB4-NEPH-12	12	MnO (wt%)	1.5075	1.6204	1.6670	-0.1595	-0.0466	-9.6%	-2.8%
SB4-NEPH-12	12	Na2O (wt%)	16.8163	15.9347	16.3640	0.4523	-0.4293	2.8%	-2.6%
SB4-NEPH-12	12	NiO (wt%)	0.4148	0.4722	0.5070	-0.0922	-0.0348	-18.2%	-6.9%
SB4-NEPH-12	12	PbO (wt%)	0.0584	0.0584	0.0680	-0.0096	-0.0096	-14.1%	-14.1%
SB4-NEPH-12	12	SO4 (wt%)	0.3887	0.3887	0.4440	-0.0553	-0.0553	-12.5%	-12.5%
SB4-NEPH-12	12	SiO2 (wt%)	46.3158	46.8652	47.8400	-1.5242	-0.9748	-3.2%	-2.0%
SB4-NEPH-12	12	ThO2 (wt%)	0.0760	0.0760	0.0160	0.0600	0.0600	374.7%	374.7%
SB4-NEPH-12	12	TiO2 (wt%)	0.8081	0.8987	0.8560	-0.0479	0.0427	-5.6%	5.0%
SB4-NEPH-12	12	U3O8 (wt%)	1.7246	1.7922	1.7810	-0.0564	0.0112	-3.2%	0.6%
SB4-NEPH-12	12	ZnO (wt%)	0.0352	0.0352	0.0350	0.0002	0.0002	0.5%	0.5%
SB4-NEPH-12	12	ZrO2 (wt%)	0.0787	0.0787	0.0820	-0.0033	-0.0033	-4.0%	-4.0%

Table C.4: Average Measured and Bias-Corrected Chemical Compositions Versus Targeted Compositions by Oxide by Nepheline Study Glass
(100 -Batch 1; 200 -U std)

Glass ID	Glass #	Oxide	Measured (wt%)	Measured Bias-Corrected (wt%)	Targeted (wt%)	Diff of Measured	Diff of Meas. bc	% Diff of Measured	% Diff Meas. of bc
SB4-NEPH-12	12	Sum of Oxides	98.0121	97.8301	99.9970	-1.9849	-2.1669	-2.0%	-2.2%
Batch 1	100	Al2O3 (wt%)	4.8686	4.8770	4.8770	-0.0084	0.0000	-0.2%	0.0%
Batch 1	100	B2O3 (wt%)	7.7063	7.7770	7.7770	-0.0707	0.0000	-0.9%	0.0%
Batch 1	100	BaO (wt%)	0.1344	0.1510	0.1510	-0.0166	0.0000	-11.0%	0.0%
Batch 1	100	CaO (wt%)	1.1886	1.2200	1.2200	-0.0314	0.0000	-2.6%	0.0%
Batch 1	100	Ce2O3 (wt%)	0.0059	0.0059	0.0000	0.0059	0.0059		
Batch 1	100	Cr2O3 (wt%)	0.1116	0.1070	0.1070	0.0046	0.0000	4.3%	0.0%
Batch 1	100	CuO (wt%)	0.3814	0.3990	0.3990	-0.0176	0.0000	-4.4%	0.0%
Batch 1	100	Fe2O3 (wt%)	12.1310	12.8390	12.8390	-0.7080	0.0000	-5.5%	0.0%
Batch 1	100	K2O (wt%)	3.3769	3.3270	3.3270	0.0499	0.0000	1.5%	0.0%
Batch 1	100	La2O3 (wt%)	0.0059	0.0059	0.0000	0.0059	0.0059		
Batch 1	100	Li2O (wt%)	4.4529	4.4290	4.4290	0.0239	0.0000	0.5%	0.0%
Batch 1	100	MgO (wt%)	1.2524	1.4190	1.4190	-0.1666	0.0000	-11.7%	0.0%
Batch 1	100	MnO (wt%)	1.6054	1.7260	1.7260	-0.1206	0.0000	-7.0%	0.0%
Batch 1	100	Na2O (wt%)	9.5012	9.0030	9.0030	0.4982	0.0000	5.5%	0.0%
Batch 1	100	NiO (wt%)	0.6596	0.7510	0.7510	-0.0914	0.0000	-12.2%	0.0%
Batch 1	100	PbO (wt%)	0.0054	0.0054	0.0000	0.0054	0.0054		
Batch 1	100	SO4 (wt%)	0.1498	0.1498	0.0000	0.1498	0.1498		
Batch 1	100	SiO2 (wt%)	49.6318	50.2200	50.2200	-0.5882	0.0000	-1.2%	0.0%
Batch 1	100	ThO2 (wt%)	0.0057	0.0057	0.0000	0.0057	0.0057		
Batch 1	100	TiO2 (wt%)	0.6088	0.6770	0.6770	-0.0682	0.0000	-10.1%	0.0%
Batch 1	100	U3O8 (wt%)	0.0590	0.0613	0.0000	0.0590	0.0613		
Batch 1	100	ZnO (wt%)	0.0062	0.0062	0.0000	0.0062	0.0062		
Batch 1	100	ZrO2 (wt%)	0.0826	0.0826	0.0980	-0.0154	-0.0154	-15.7%	-15.7%
Batch 1	100	Sum of Oxides	98.3558	99.2447	99.0200	-0.6642	0.2247	-0.7%	0.2%
U std	200	Al2O3 (wt%)	4.0278	4.0347	4.1000	-0.0722	-0.0653	-1.8%	-1.6%
U std	200	B2O3 (wt%)	8.8708	8.9523	9.2090	-0.3382	-0.2567	-3.7%	-2.8%
U std	200	BaO (wt%)	0.0056	0.0063	0.0000	0.0056	0.0063		
U std	200	CaO (wt%)	1.2511	1.2842	1.3010	-0.0499	-0.0168	-3.8%	-1.3%
U std	200	Ce2O3 (wt%)	0.0059	0.0059	0.0000	0.0059	0.0059		
U std	200	Cr2O3 (wt%)	0.2412	0.2313	0.0000	0.2412	0.2313		
U std	200	CuO (wt%)	0.0050	0.0052	0.0000	0.0050	0.0052		
U std	200	Fe2O3 (wt%)	12.3979	13.1219	13.1960	-0.7981	-0.0741	-6.0%	-0.6%
U std	200	K2O (wt%)	2.7786	2.7376	2.9990	-0.2204	-0.2614	-7.3%	-8.7%
U std	200	La2O3 (wt%)	0.0059	0.0059	0.0000	0.0059	0.0059		
U std	200	Li2O (wt%)	3.0499	3.0336	3.0570	-0.0071	-0.0234	-0.2%	-0.8%
U std	200	MgO (wt%)	1.1153	1.2638	1.2100	-0.0947	0.0538	-7.8%	4.4%
U std	200	MnO (wt%)	2.6405	2.8396	2.8920	-0.2515	-0.0524	-8.7%	-1.8%
U std	200	Na2O (wt%)	12.2219	11.5812	11.7950	0.4269	-0.2138	3.6%	-1.8%
U std	200	NiO (wt%)	0.9631	1.0965	1.1200	-0.1569	-0.0235	-14.0%	-2.1%
U std	200	PbO (wt%)	0.0054	0.0054	0.0000	0.0054	0.0054		

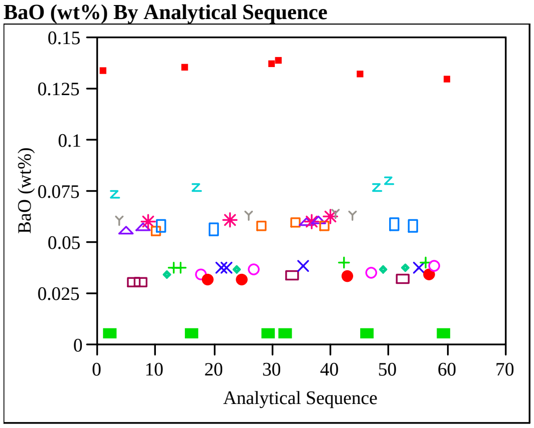
Table C.4: Average Measured and Bias-Corrected Chemical Compositions Versus Targeted Compositions by Oxide by Nepheline Study Glass

(100 -Batch 1; 200 -U std)

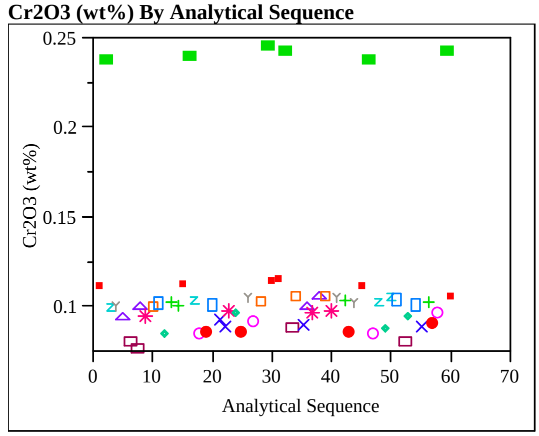
Glass ID	Glass #	Oxide	Measured (wt%)	Measured Bias-Corrected (wt%)	Targeted (wt%)	Diff of Measured	Diff of Meas. bc	% Diff of Measured	% Diff Meas. of bc
U std	200	SO4 (wt%)	0.1498	0.1498	0.0000	0.1498	0.1498		
U std	200	SiO2 (wt%)	43.2852	43.7987	45.3530	-2.0678	-1.5543	-4.6%	-3.4%
U std	200	ThO2 (wt%)	0.0863	0.0863	0.0000	0.0863	0.0863		
U std	200	TiO2 (wt%)	0.9277	1.0316	1.0490	-0.1213	-0.0174	-11.6%	-1.7%
U std	200	U3O8 (wt%)	2.3152	2.4060	2.4060	-0.0908	0.0000	-3.8%	0.0%
U std	200	ZnO (wt%)	0.0062	0.0062	0.0000	0.0062	0.0062		
U std	200	ZrO2 (wt%)	0.0068	0.0068	0.0000	0.0068	0.0068		
U std	200	Sum of Oxides	96.3651	97.1979	99.6870	-3.3219	-2.4891	-3.3%	-2.5%

Exhibit C.1: Oxide Measurements in Analytical Sequence for Samples Prepared Using the LM Method

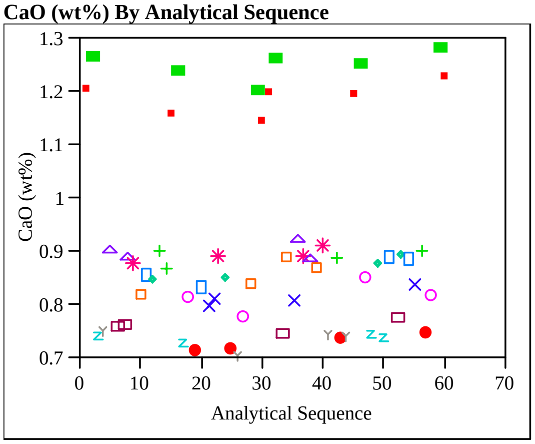
BaO (wt%) By Analytical Sequence



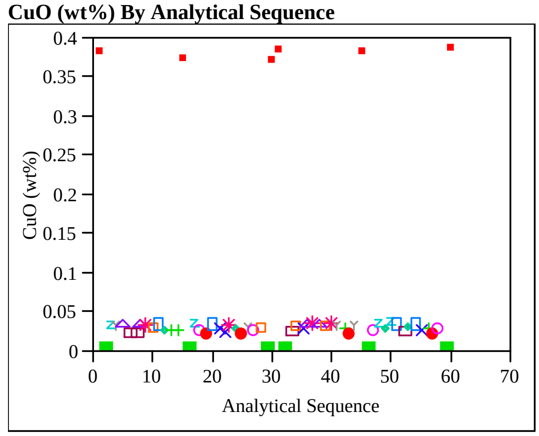
Cr2O3 (wt%) By Analytical Sequence



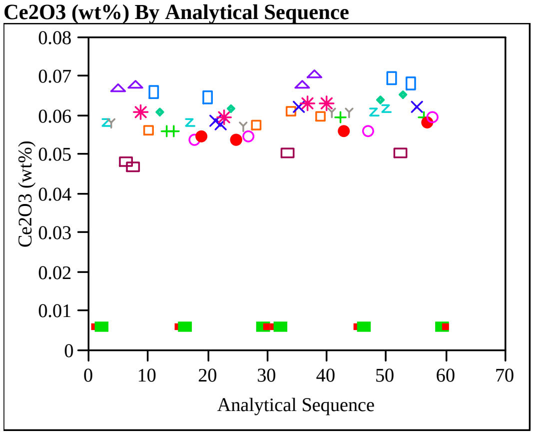
CaO (wt%) By Analytical Sequence



CuO (wt%) By Analytical Sequence



Ce2O3 (wt%) By Analytical Sequence



K2O (wt%) By Analytical Sequence

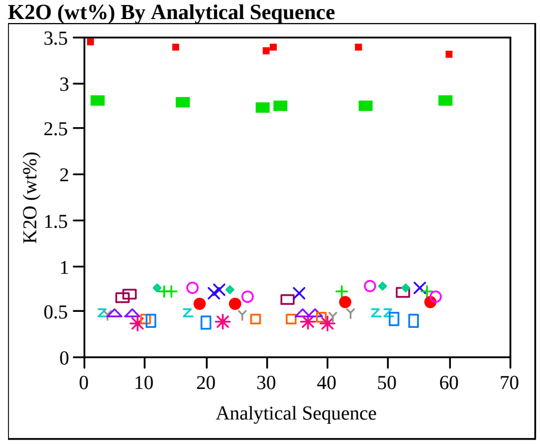
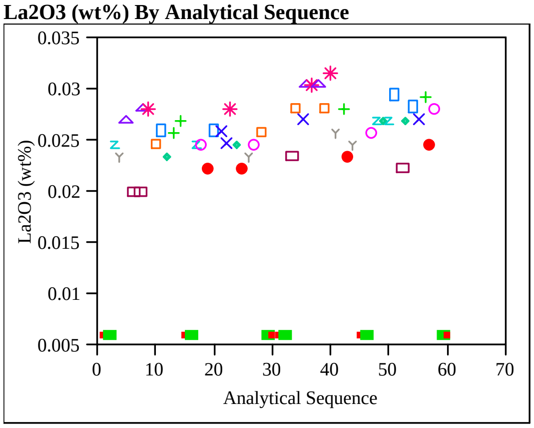
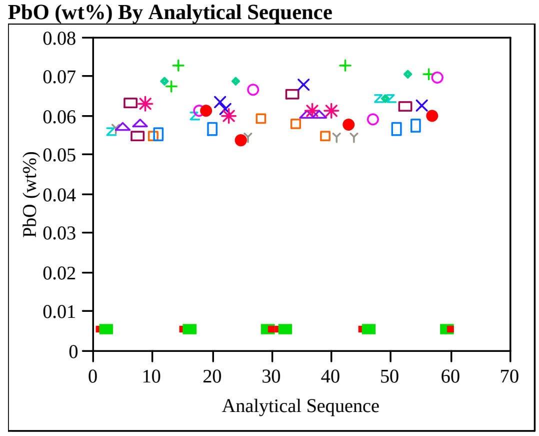


Exhibit C.1: Oxide Measurements in Analytical Sequence for Samples Prepared Using the LM Method

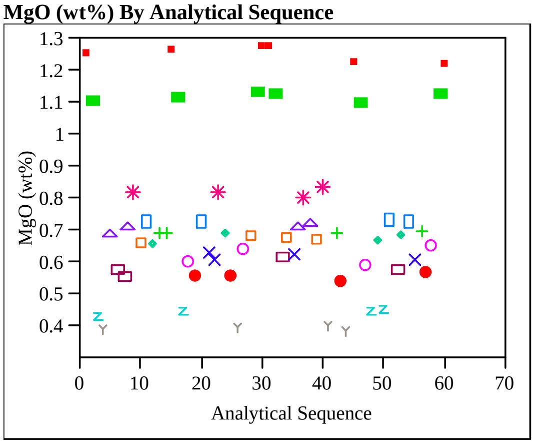
La2O3 (wt%) By Analytical Sequence



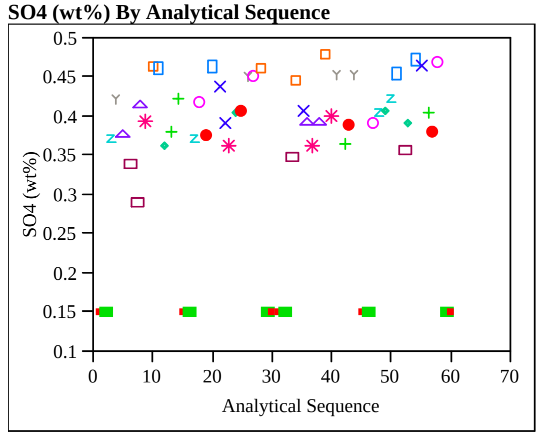
PbO (wt%) By Analytical Sequence



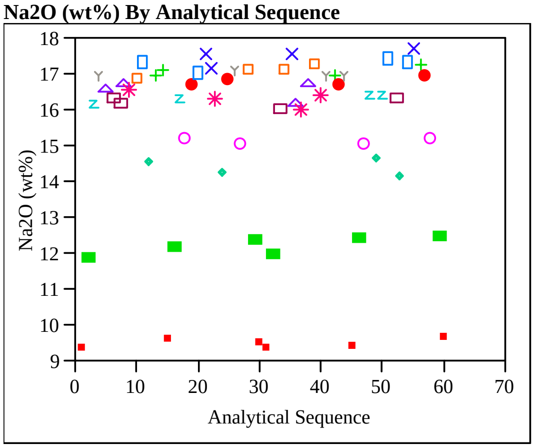
MgO (wt%) By Analytical Sequence



SO4 (wt%) By Analytical Sequence



Na2O (wt%) By Analytical Sequence



ThO2 (wt%) By Analytical Sequence

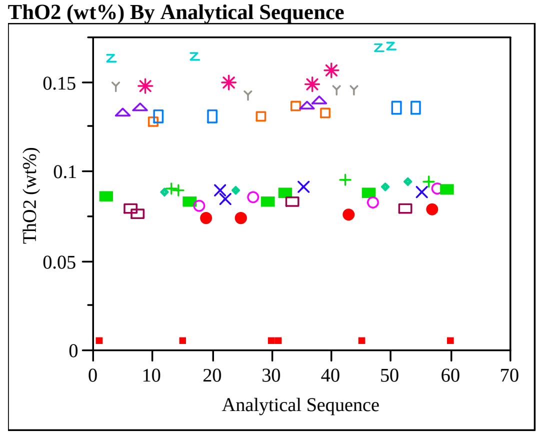
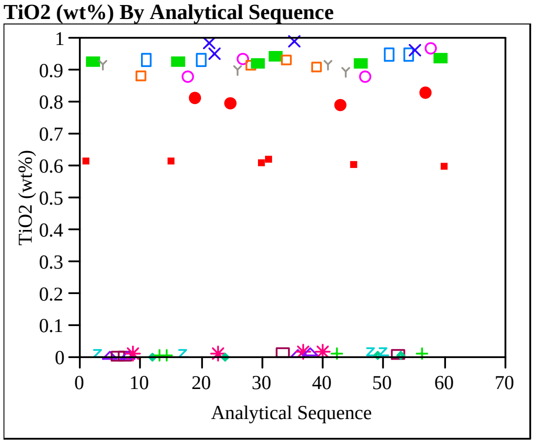
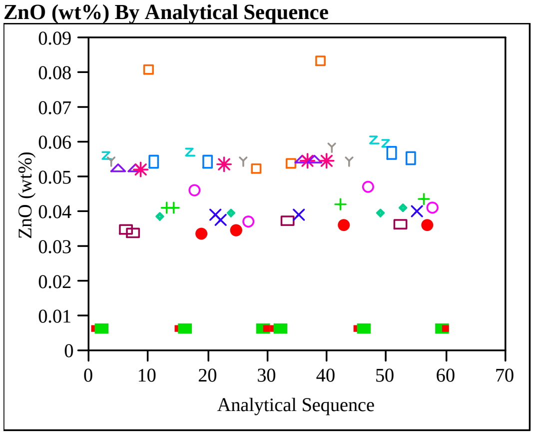


Exhibit C.1: Oxide Measurements in Analytical Sequence for Samples Prepared Using the LM Method

TiO2 (wt%) By Analytical Sequence



ZnO (wt%) By Analytical Sequence



ZrO2 (wt%) By Analytical Sequence

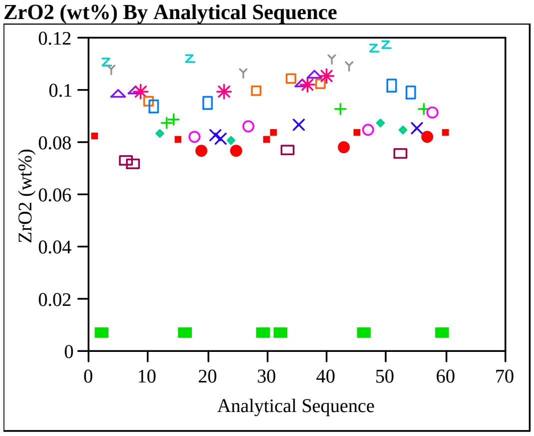
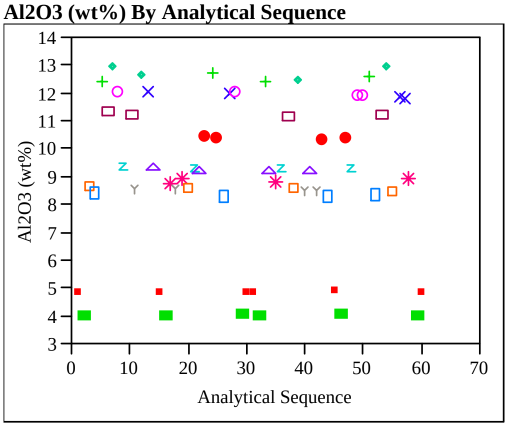
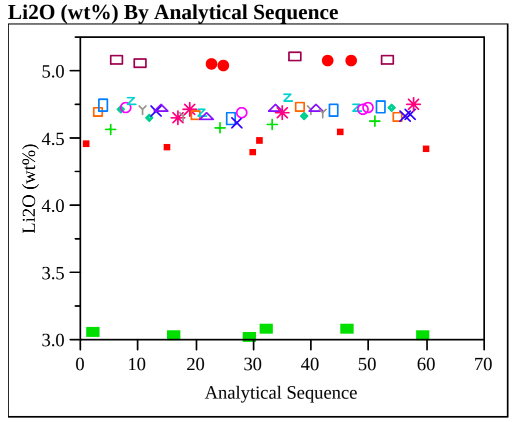


Exhibit C.2: Oxide Measurements in Analytical Sequence for Samples Prepared Using the PF Method

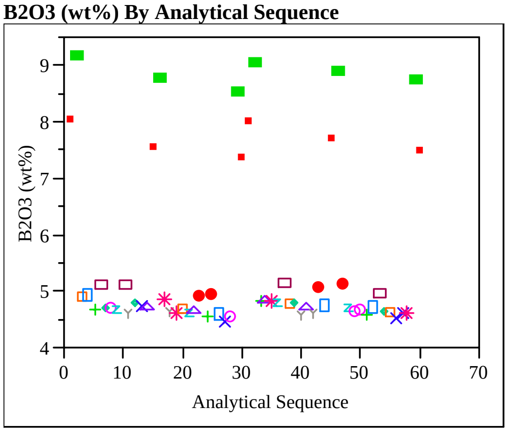
Al2O3 (wt%) By Analytical Sequence



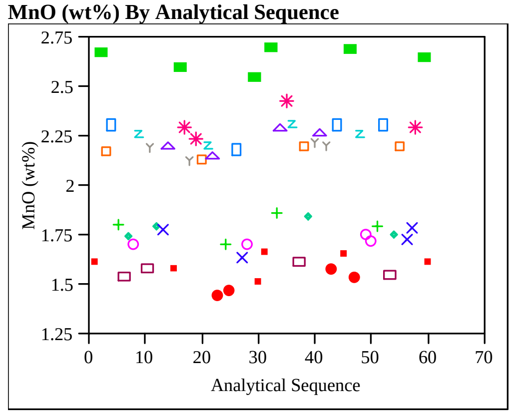
Li2O (wt%) By Analytical Sequence



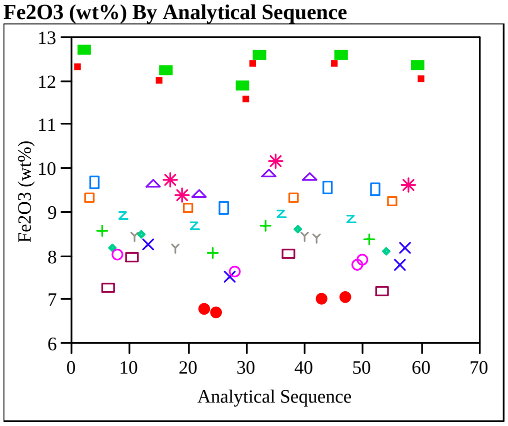
B2O3 (wt%) By Analytical Sequence



MnO (wt%) By Analytical Sequence



Fe2O3 (wt%) By Analytical Sequence



NiO (wt%) By Analytical Sequence

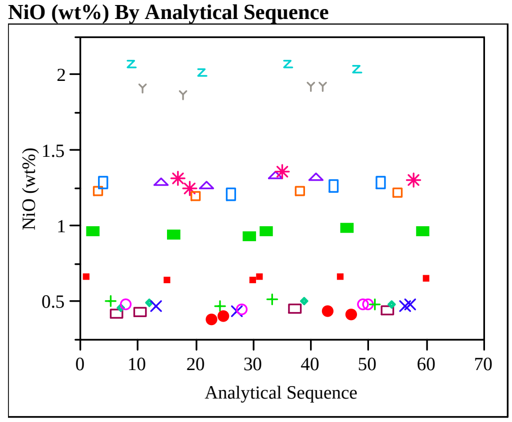
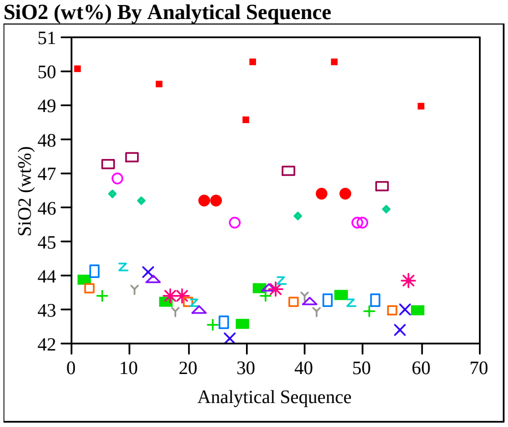


Exhibit C.2: Oxide Measurements in Analytical Sequence for Samples Prepared Using the PF Method

SiO2 (wt%) By Analytical Sequence



U3O8 (wt%) By Analytical Sequence

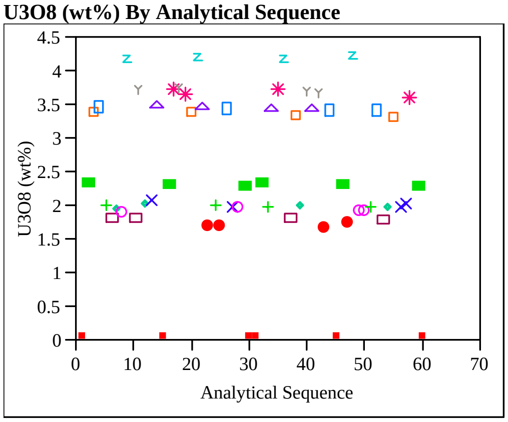
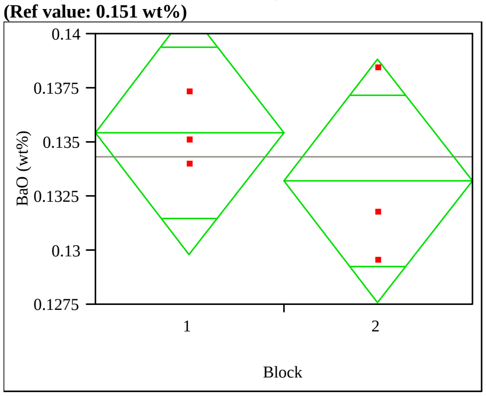


Exhibit C.3: SRNL-ML Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the LM Method

Glass ID=Batch 1

Oneway Analysis of BaO (wt%) By Block
(Ref value: 0.151 wt%)

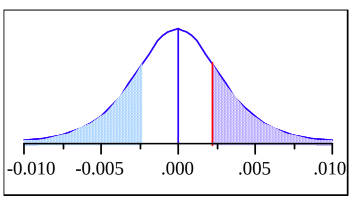


Oneway Anova
Summary of Fit

Rsquare	0.132353
Adj Rsquare	-0.08456
Root Mean Square Error	0.003501
Mean of Response	0.134352
Observations (or Sum Wgts)	6

t Test
1-2
Assuming equal variances

Difference	0.00223	t Ratio	0.781133
Std Err Dif	0.00286	DF	4
Upper CL Dif	0.01017	Prob > |t|	0.4784
Lower CL Dif	-0.00570	Prob > t	0.2392
Confidence	0.95	Prob < t	0.7608



Analysis of Variance

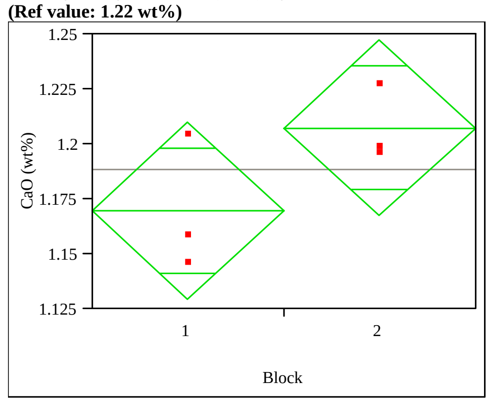
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	1	0.00000748	0.000007	0.6102	0.4784
Error	4	0.00004903	0.000012		
C. Total	5	0.00005651			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	0.135469	0.00202	0.12986	0.14108
2	3	0.133236	0.00202	0.12762	0.13885

Std Error uses a pooled estimate of error variance

Oneway Analysis of CaO (wt%) By Block
(Ref value: 1.22 wt%)

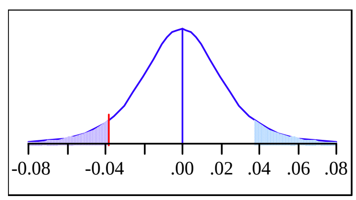


Oneway Anova
Summary of Fit

Rsquare	0.46188
Adj Rsquare	0.32735
Root Mean Square Error	0.024971
Mean of Response	1.18862
Observations (or Sum Wgts)	6

t Test
1-2
Assuming equal variances

Difference	-0.03778	t Ratio	-1.85291
Std Err Dif	0.02039	DF	4
Upper CL Dif	0.01883	Prob > |t|	0.1375
Lower CL Dif	-0.09439	Prob > t	0.9312
Confidence	0.95	Prob < t	0.0688



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	1	0.00214081	0.002141	3.4333	0.1375
Error	4	0.00249419	0.000624		
C. Total	5	0.00463500			

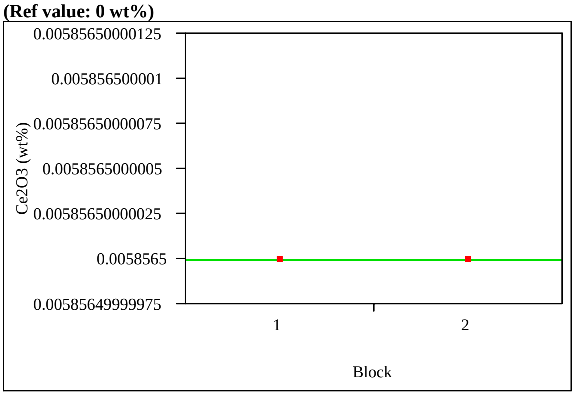
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	1.16973	0.01442	1.1297	1.2098
2	3	1.20751	0.01442	1.1675	1.2475

Std Error uses a pooled estimate of error variance

Exhibit C.3: SRNL-ML Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the LM Method

Oneway Analysis of Ce2O3 (wt%) By Block
(Ref value: 0 wt%)

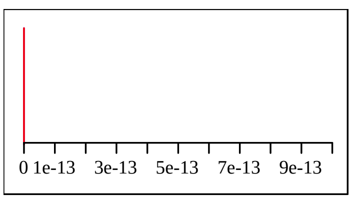


Oneway Anova
Summary of Fit

Rsquare	.
Adj Rsquare	.
Root Mean Square Error	0
Mean of Response	0.005857
Observations (or Sum Wgts)	6

t Test
1-2
Assuming equal variances

Difference	0	t Ratio	.
Std Err Dif	0	DF	4
Upper CL Dif	0	Prob > |t|	1.0000
Lower CL Dif	0	Prob > t	0.5000
Confidence	0.95	Prob < t	0.5000



Analysis of Variance

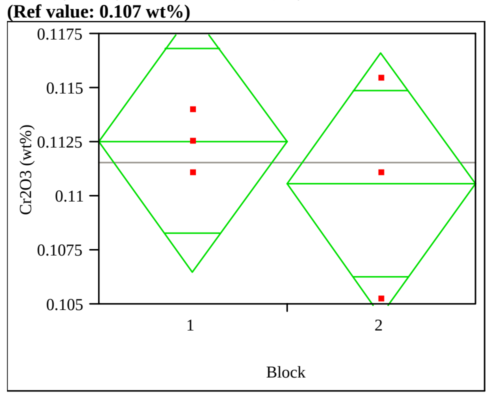
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	1	0	0	.	.
Error	4	0	0		
C. Total	5	0			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	0.005857	0	0.00586	0.00586
2	3	0.005857	0	0.00586	0.00586

Std Error uses a pooled estimate of error variance

Oneway Analysis of Cr2O3 (wt%) By Block
(Ref value: 0.107 wt%)

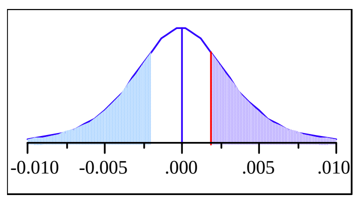


Oneway Anova
Summary of Fit

Rsquare	0.090909
Adj Rsquare	-0.13636
Root Mean Square Error	0.003774
Mean of Response	0.111569
Observations (or Sum Wgts)	6

t Test
1-2
Assuming equal variances

Difference	0.00195	t Ratio	0.632456
Std Err Dif	0.00308	DF	4
Upper CL Dif	0.01050	Prob > |t|	0.5614
Lower CL Dif	-0.00661	Prob > t	0.2807
Confidence	0.95	Prob < t	0.7193



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	1	0.00000570	0.000006	0.4000	0.5614
Error	4	0.00005697	0.000014		
C. Total	5	0.00006266			

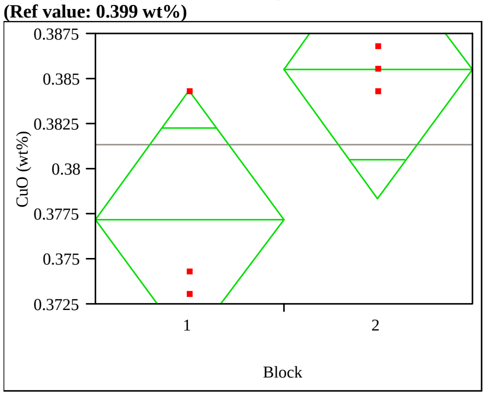
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	0.112543	0.00218	0.10649	0.11859
2	3	0.110594	0.00218	0.10455	0.11664

Std Error uses a pooled estimate of error variance

Exhibit C.3: SRNL-ML Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the LM Method

Oneway Analysis of CuO (wt%) By Block
(Ref value: 0.399 wt%)

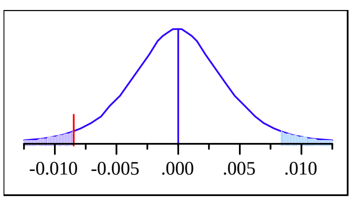


Oneway Anova
Summary of Fit

Rsquare	0.568182
Adj Rsquare	0.460227
Root Mean Square Error	0.004455
Mean of Response	0.381382
Observations (or Sum Wgts)	6

t Test
1-2
Assuming equal variances

Difference	-0.00835	t Ratio	-2.29416
Std Err Dif	0.00364	DF	4
Upper CL Dif	0.00175	Prob > |t|	0.0835
Lower CL Dif	-0.01845	Prob > t	0.9583
Confidence	0.95	Prob < t	0.0417



Analysis of Variance

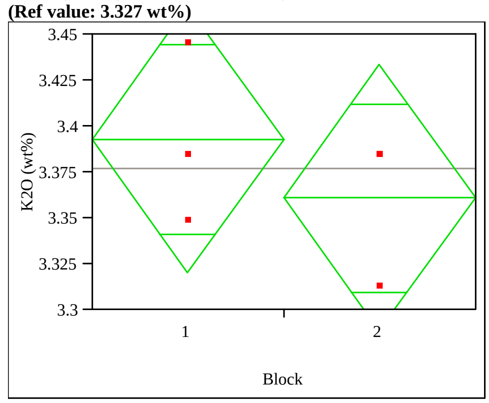
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	1	0.00010447	0.000104	5.2632	0.0835
Error	4	0.00007939	0.000020		
C. Total	5	0.00018386			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	0.377209	0.00257	0.37007	0.38435
2	3	0.385554	0.00257	0.37841	0.39270

Std Error uses a pooled estimate of error variance

Oneway Analysis of K2O (wt%) By Block
(Ref value: 3.327 wt%)

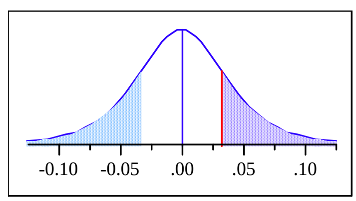


Oneway Anova
Summary of Fit

Rsquare	0.158416
Adj Rsquare	-0.05198
Root Mean Square Error	0.045339
Mean of Response	3.376895
Observations (or Sum Wgts)	6

t Test
1-2
Assuming equal variances

Difference	0.03212	t Ratio	0.867722
Std Err Dif	0.03702	DF	4
Upper CL Dif	0.13491	Prob > |t|	0.4345
Lower CL Dif	-0.07066	Prob > t	0.2173
Confidence	0.95	Prob < t	0.7827



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	1	0.00154780	0.001548	0.7529	0.4345
Error	4	0.00822268	0.002056		
C. Total	5	0.00977048			

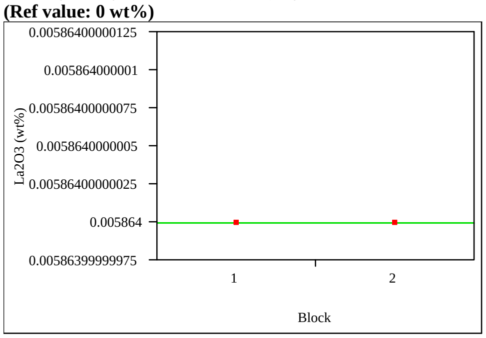
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	3.39296	0.02618	3.3203	3.4656
2	3	3.36083	0.02618	3.2882	3.4335

Std Error uses a pooled estimate of error variance

Exhibit C.3: SRNL-ML Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the LM Method

Oneway Analysis of La2O3 (wt%) By Block
(Ref value: 0 wt%)

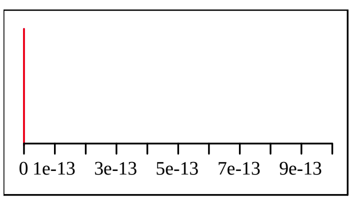


Oneway Anova
Summary of Fit

Rsquare	.
Adj Rsquare	.
Root Mean Square Error	0
Mean of Response	0.005864
Observations (or Sum Wgts)	6

t Test
1-2
Assuming equal variances

Difference	0	t Ratio	.
Std Err Dif	0	DF	4
Upper CL Dif	0	Prob > |t|	1.0000
Lower CL Dif	0	Prob > t	0.5000
Confidence	0.95	Prob < t	0.5000



Analysis of Variance

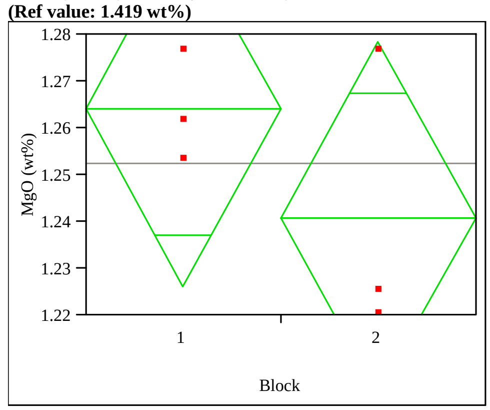
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	1	0	0	.	.
Error	4	0	0		
C. Total	5	0			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	0.005864	0	0.00586	0.00586
2	3	0.005864	0	0.00586	0.00586

Std Error uses a pooled estimate of error variance

Oneway Analysis of MgO (wt%) By Block
(Ref value: 1.419 wt%)

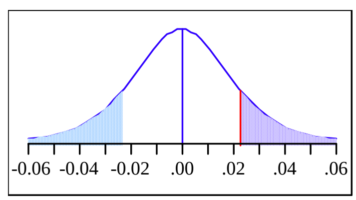


Oneway Anova
Summary of Fit

Rsquare	0.266465
Adj Rsquare	0.083082
Root Mean Square Error	0.023585
Mean of Response	1.252418
Observations (or Sum Wgts)	6

t Test
1-2
Assuming equal variances

Difference	0.02321	t Ratio	1.205424
Std Err Dif	0.01926	DF	4
Upper CL Dif	0.07668	Prob > |t|	0.2945
Lower CL Dif	-0.03025	Prob > t	0.1472
Confidence	0.95	Prob < t	0.8528



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	1	0.00080829	0.000808	1.4530	0.2945
Error	4	0.00222510	0.000556		
C. Total	5	0.00303339			

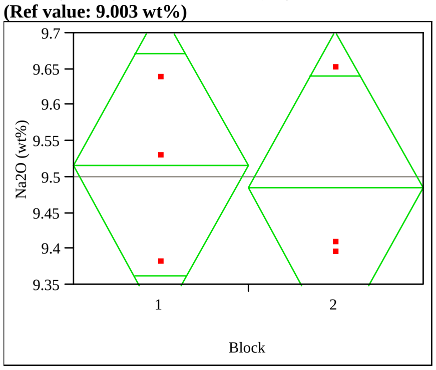
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	1.26402	0.01362	1.2262	1.3018
2	3	1.24081	0.01362	1.2030	1.2786

Std Error uses a pooled estimate of error variance

Exhibit C.3: SRNL-ML Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the LM Method

Oneway Analysis of Na2O (wt%) By Block
(Ref value: 9.003 wt%)

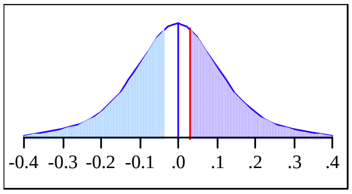


Oneway Anova
Summary of Fit

Rsquare	0.019499
Adj Rsquare	-0.22563
Root Mean Square Error	0.136586
Mean of Response	9.501153
Observations (or Sum Wgts)	6

t Test
1-2
Assuming equal variances

Difference	0.03145	t Ratio	0.282038
Std Err Dif	0.11152	DF	4
Upper CL Dif	0.34109	Prob > |t|	0.7919
Lower CL Dif	-0.27818	Prob > t	0.3960
Confidence	0.95	Prob < t	0.6040



Analysis of Variance

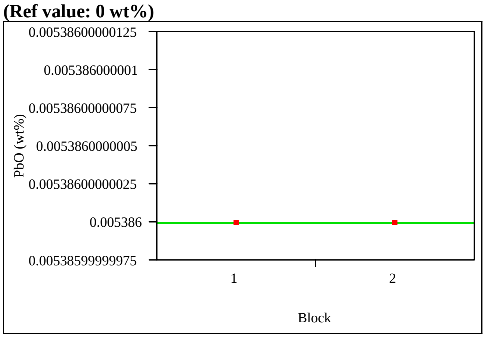
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	1	0.00148397	0.001484	0.0795	0.7919
Error	4	0.07462240	0.018656		
C. Total	5	0.07610637			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	9.51688	0.07886	9.2979	9.7358
2	3	9.48543	0.07886	9.2665	9.7044

Std Error uses a pooled estimate of error variance

Oneway Analysis of PbO (wt%) By Block
(Ref value: 0 wt%)

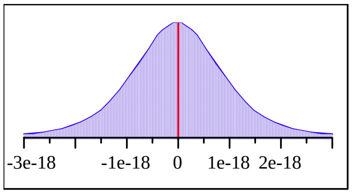


Oneway Anova
Summary of Fit

Rsquare	0
Adj Rsquare	-0.25
Root Mean Square Error	1.06e-18
Mean of Response	0.005386
Observations (or Sum Wgts)	6

t Test
1-2
Assuming equal variances

Difference	0	t Ratio	0
Std Err Dif	8.674e-19	DF	4
Upper CL Dif	2.408e-18	Prob > |t|	1.0000
Lower CL Dif	-2.41e-18	Prob > t	0.5000
Confidence	0.95	Prob < t	0.5000



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	1	0	0	0.0000	1.0000
Error	4	4.5139e-36	1.128e-36		
C. Total	5	4.5139e-36			

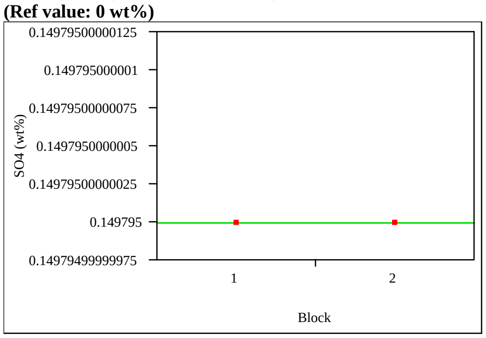
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	0.005386	6.133e-19	0.00539	0.00539
2	3	0.005386	6.133e-19	0.00539	0.00539

Std Error uses a pooled estimate of error variance

Exhibit C.3: SRNL-ML Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the LM Method

Oneway Analysis of SO4 (wt%) By Block
(Ref value: 0 wt%)

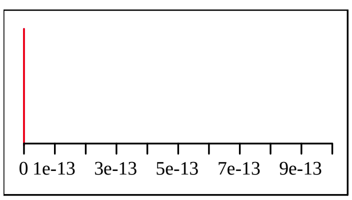


Oneway Anova
Summary of Fit

Rsquare	.
Adj Rsquare	.
Root Mean Square Error	0
Mean of Response	0.149795
Observations (or Sum Wgts)	6

t Test
1-2
Assuming equal variances

Difference	0	t Ratio	.
Std Err Dif	0	DF	4
Upper CL Dif	0	Prob > |t|	1.0000
Lower CL Dif	0	Prob > t	0.5000
Confidence	0.95	Prob < t	0.5000



Analysis of Variance

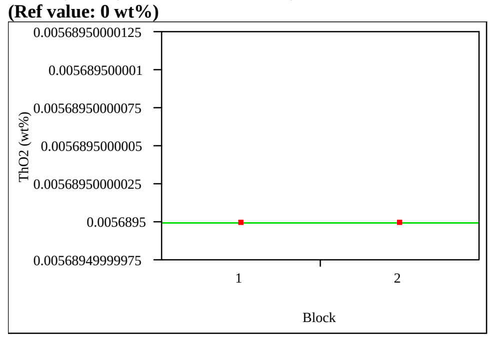
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	1	0	0	.	.
Error	4	0	0		
C. Total	5	0			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	0.149795	0	0.14979	0.14979
2	3	0.149795	0	0.14979	0.14979

Std Error uses a pooled estimate of error variance

Oneway Analysis of ThO2 (wt%) By Block
(Ref value: 0 wt%)

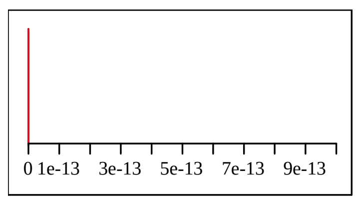


Oneway Anova
Summary of Fit

Rsquare	.
Adj Rsquare	.
Root Mean Square Error	0
Mean of Response	0.005689
Observations (or Sum Wgts)	6

t Test
1-2
Assuming equal variances

Difference	0	t Ratio	.
Std Err Dif	0	DF	4
Upper CL Dif	0	Prob > |t|	1.0000
Lower CL Dif	0	Prob > t	0.5000
Confidence	0.95	Prob < t	0.5000



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	1	0	0	.	.
Error	4	0	0		
C. Total	5	0			

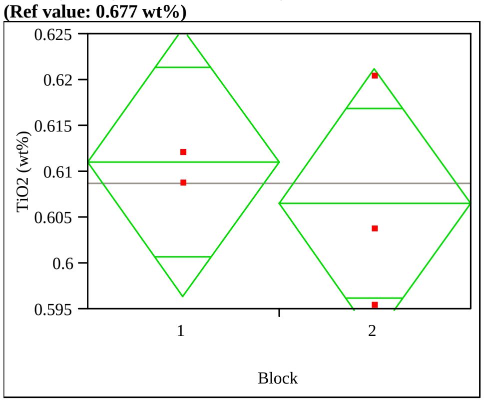
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	0.005689	0	0.00569	0.00569
2	3	0.005689	0	0.00569	0.00569

Std Error uses a pooled estimate of error variance

Exhibit C.3: SRNL-ML Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the LM Method

Oneway Analysis of TiO2 (wt%) By Block
(Ref value: 0.677 wt%)

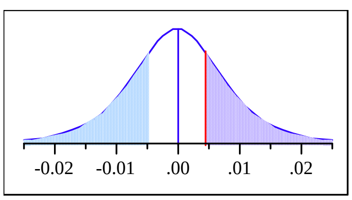


Oneway Anova
Summary of Fit

Rsquare	0.082051
Adj Rsquare	-0.14744
Root Mean Square Error	0.009111
Mean of Response	0.60882
Observations (or Sum Wgts)	6

t Test
1-2
Assuming equal variances

Difference	0.00445	t Ratio	0.597948
Std Err Dif	0.00744	DF	4
Upper CL Dif	0.02510	Prob > |t|	0.5821
Lower CL Dif	-0.01621	Prob > t	0.2910
Confidence	0.95	Prob < t	0.7090



Analysis of Variance

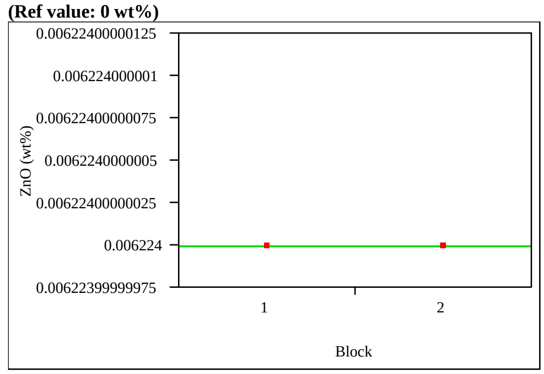
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	1	0.00002968	0.000030	0.3575	0.5821
Error	4	0.00033201	0.000083		
C. Total	5	0.00036169			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	0.611044	0.00526	0.59644	0.62565
2	3	0.606596	0.00526	0.59199	0.62120

Std Error uses a pooled estimate of error variance

Oneway Analysis of ZnO (wt%) By Block
(Ref value: 0 wt%)

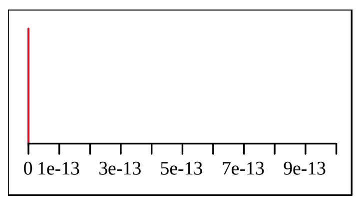


Oneway Anova
Summary of Fit

Rsquare	.
Adj Rsquare	.
Root Mean Square Error	0
Mean of Response	0.006224
Observations (or Sum Wgts)	6

t Test
1-2
Assuming equal variances

Difference	0	t Ratio	.
Std Err Dif	0	DF	4
Upper CL Dif	0	Prob > |t|	1.0000
Lower CL Dif	0	Prob > t	0.5000
Confidence	0.95	Prob < t	0.5000



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	1	0	0	.	.
Error	4	0	0		
C. Total	5	0			

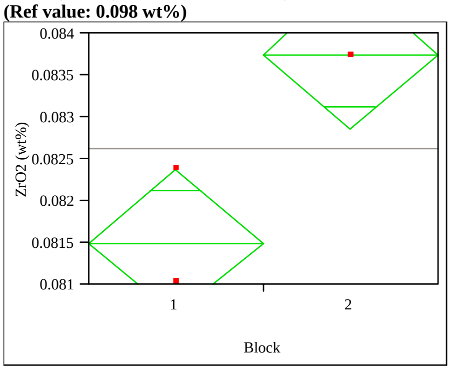
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	0.006224	0	0.00622	0.00622
2	3	0.006224	0	0.00622	0.00622

Std Error uses a pooled estimate of error variance

Exhibit C.3: SRNL-ML Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the LM Method

Oneway Analysis of ZrO2 (wt%) By Block
(Ref value: 0.098 wt%)

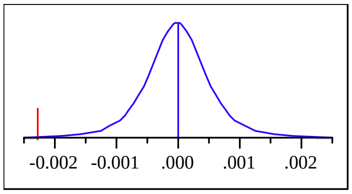


Oneway Anova
Summary of Fit

Rsquare	0.862069
Adj Rsquare	0.827586
Root Mean Square Error	0.000551
Mean of Response	0.082624
Observations (or Sum Wgts)	6

t Test
1-2
Assuming equal variances

Difference	-0.00225	t Ratio	-5
Std Err Dif	0.00045	DF	4
Upper CL Dif	-0.00100	Prob > |t|	0.0075
Lower CL Dif	-0.00350	Prob > t	0.9963
Confidence	0.95	Prob < t	0.0037



Analysis of Variance

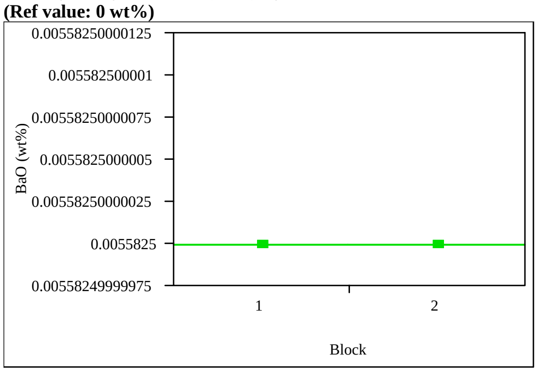
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	1	0.0000076	0.0000076	25.0000	0.0075
Error	4	0.00000122	3.0411e-7		
C. Total	5	0.00000882			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	0.081498	0.00032	0.08061	0.08238
2	3	0.083750	0.00032	0.08287	0.08463

Std Error uses a pooled estimate of error variance

Glass ID=Ustd
Oneway Analysis of BaO (wt%) By Block
(Ref value: 0 wt%)

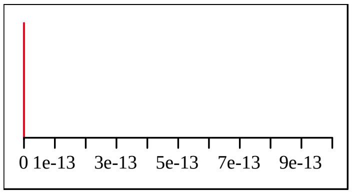


Oneway Anova
Summary of Fit

Rsquare	.
Adj Rsquare	.
Root Mean Square Error	0
Mean of Response	0.005583
Observations (or Sum Wgts)	6

t Test
1-2
Assuming equal variances

Difference	0	t Ratio	.
Std Err Dif	0	DF	4
Upper CL Dif	0	Prob > |t|	1.0000
Lower CL Dif	0	Prob > t	0.5000
Confidence	0.95	Prob < t	0.5000



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	1	0	0	.	.
Error	4	0	0		
C. Total	5	0			

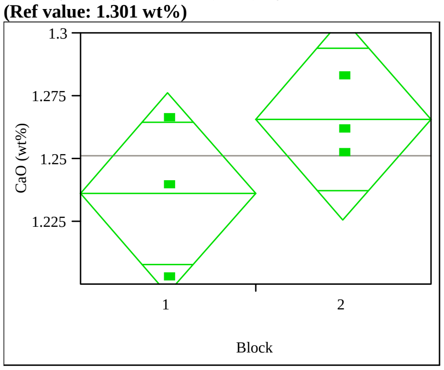
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	0.005583	0	0.00558	0.00558
2	3	0.005583	0	0.00558	0.00558

Std Error uses a pooled estimate of error variance

Exhibit C.3: SRNL-ML Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the LM Method

Oneway Analysis of CaO (wt%) By Block
(Ref value: 1.301 wt%)

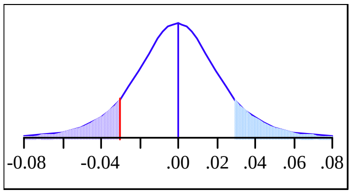


Oneway Anova
Summary of Fit

Rsquare	0.34189
Adj Rsquare	0.177362
Root Mean Square Error	0.024964
Mean of Response	1.251118
Observations (or Sum Wgts)	6

t Test
1-2
Assuming equal variances

Difference	-0.02938	t Ratio	-1.44153
Std Err Dif	0.02038	DF	4
Upper CL Dif	0.02721	Prob > |t|	0.2229
Lower CL Dif	-0.08598	Prob > t	0.8886
Confidence	0.95	Prob < t	0.1114



Analysis of Variance

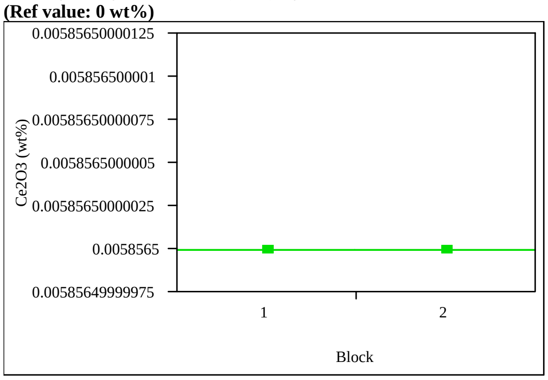
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	1	0.00129506	0.001295	2.0780	0.2229
Error	4	0.00249288	0.000623		
C. Total	5	0.00378794			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	1.23643	0.01441	1.1964	1.2764
2	3	1.26581	0.01441	1.2258	1.3058

Std Error uses a pooled estimate of error variance

Oneway Analysis of Ce2O3 (wt%) By Block
(Ref value: 0 wt%)

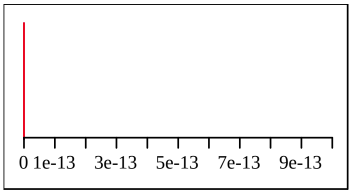


Oneway Anova
Summary of Fit

Rsquare	.
Adj Rsquare	.
Root Mean Square Error	0
Mean of Response	0.005857
Observations (or Sum Wgts)	6

t Test
1-2
Assuming equal variances

Difference	0	t Ratio	.
Std Err Dif	0	DF	4
Upper CL Dif	0	Prob > |t|	1.0000
Lower CL Dif	0	Prob > t	0.5000
Confidence	0.95	Prob < t	0.5000



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	1	0	0	.	.
Error	4	0	0		
C. Total	5	0			

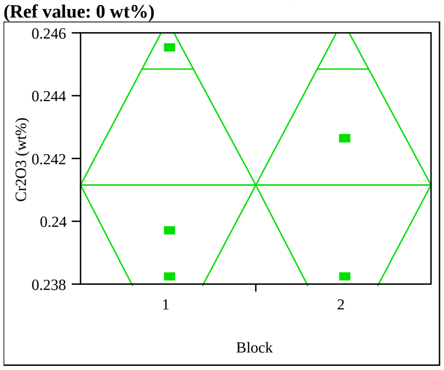
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	0.005857	0	0.00586	0.00586
2	3	0.005857	0	0.00586	0.00586

Std Error uses a pooled estimate of error variance

Exhibit C.3: SRNL-ML Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the LM Method

Oneway Analysis of Cr2O3 (wt%) By Block
(Ref value: 0 wt%)

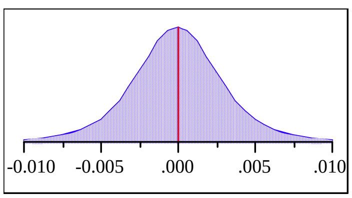


Oneway Anova
Summary of Fit

Rsquare	0
Adj Rsquare	-0.25
Root Mean Square Error	0.003268
Mean of Response	0.241164
Observations (or Sum Wgts)	6

t Test
1-2
Assuming equal variances

Difference	0.00000	t Ratio	0
Std Err Dif	0.00267	DF	4
Upper CL Dif	0.00741	Prob > |t|	1.0000
Lower CL Dif	-0.00741	Prob > t	0.5000
Confidence	0.95	Prob < t	0.5000



Analysis of Variance

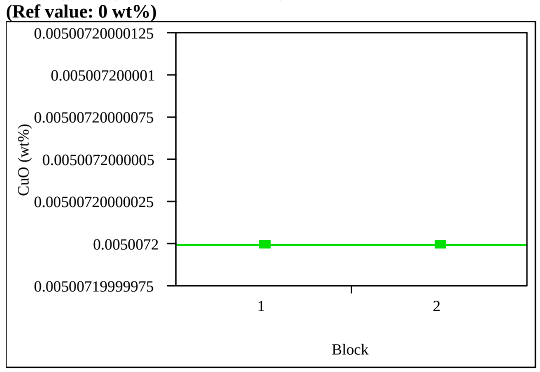
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	1	0.00000000	0.000000	0.0000	1.0000
Error	4	0.00004273	0.000011		
C. Total	5	0.00004273			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	0.241164	0.00189	0.23593	0.24640
2	3	0.241164	0.00189	0.23593	0.24640

Std Error uses a pooled estimate of error variance

Oneway Analysis of CuO (wt%) By Block
(Ref value: 0 wt%)

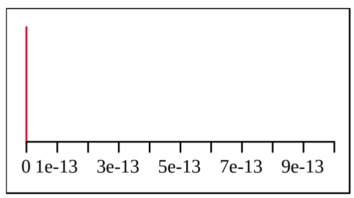


Oneway Anova
Summary of Fit

Rsquare	.
Adj Rsquare	.
Root Mean Square Error	0
Mean of Response	0.005007
Observations (or Sum Wgts)	6

t Test
1-2
Assuming equal variances

Difference	0	t Ratio	.
Std Err Dif	0	DF	4
Upper CL Dif	0	Prob > |t|	1.0000
Lower CL Dif	0	Prob > t	0.5000
Confidence	0.95	Prob < t	0.5000



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	1	0	0	.	.
Error	4	0	0		
C. Total	5	0			

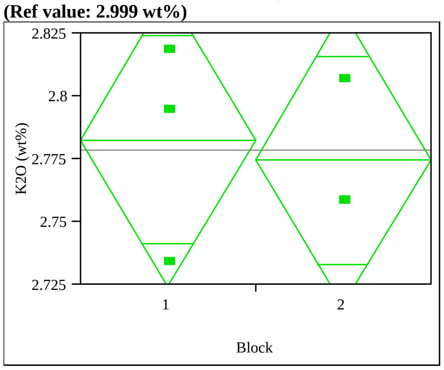
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	0.005007	0	0.00501	0.00501
2	3	0.005007	0	0.00501	0.00501

Std Error uses a pooled estimate of error variance

Exhibit C.3: SRNL-ML Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the LM Method

Oneway Analysis of K2O (wt%) By Block
(Ref value: 2.999 wt%)

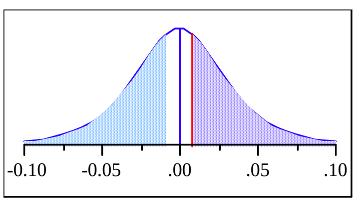


Oneway Anova
Summary of Fit

Rsquare	0.017857
Adj Rsquare	-0.22768
Root Mean Square Error	0.036471
Mean of Response	2.778611
Observations (or Sum Wgts)	6

t Test
1-2
Assuming equal variances

Difference	0.00803	t Ratio	0.26968
Std Err Dif	0.02978	DF	4
Upper CL Dif	0.09071	Prob > |t|	0.8007
Lower CL Dif	-0.07465	Prob > t	0.4004
Confidence	0.95	Prob < t	0.5996



Analysis of Variance

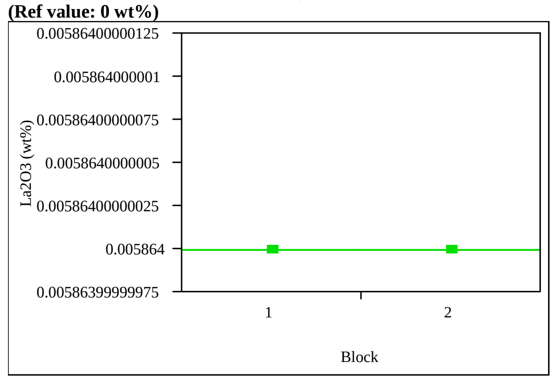
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	1	0.00009674	0.000097	0.0727	0.8007
Error	4	0.00532056	0.001330		
C. Total	5	0.00541729			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	2.78263	0.02106	2.7242	2.8411
2	3	2.77460	0.02106	2.7161	2.8331

Std Error uses a pooled estimate of error variance

Oneway Analysis of La2O3 (wt%) By Block
(Ref value: 0 wt%)

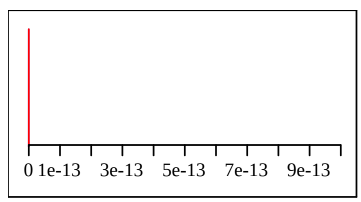


Oneway Anova
Summary of Fit

Rsquare	.
Adj Rsquare	.
Root Mean Square Error	0
Mean of Response	0.005864
Observations (or Sum Wgts)	6

t Test
1-2
Assuming equal variances

Difference	0	t Ratio	.
Std Err Dif	0	DF	4
Upper CL Dif	0	Prob > |t|	1.0000
Lower CL Dif	0	Prob > t	0.5000
Confidence	0.95	Prob < t	0.5000



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	1	0	0	.	.
Error	4	0	0		
C. Total	5	0			

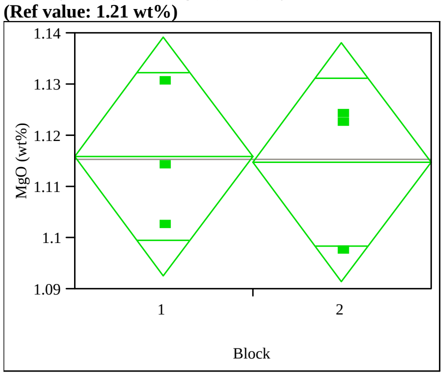
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	0.005864	0	0.00586	0.00586
2	3	0.005864	0	0.00586	0.00586

Std Error uses a pooled estimate of error variance

Exhibit C.3: SRNL-ML Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the LM Method

Oneway Analysis of MgO (wt%) By Block
(Ref value: 1.21 wt%)

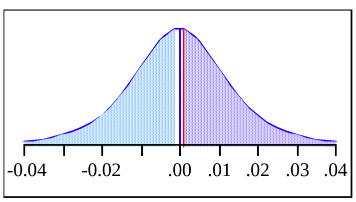


Oneway Anova
Summary of Fit

Rsquare	0.002169
Adj Rsquare	-0.24729
Root Mean Square Error	0.014518
Mean of Response	1.115349
Observations (or Sum Wgts)	6

t Test
1-2
Assuming equal variances

Difference	0.00111	t Ratio	0.09325
Std Err Dif	0.01185	DF	4
Upper CL Dif	0.03402	Prob > |t|	0.9302
Lower CL Dif	-0.03181	Prob > t	0.4651
Confidence	0.95	Prob < t	0.5349



Analysis of Variance

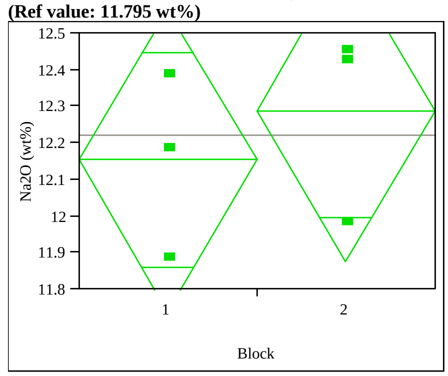
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	1	0.00000183	0.000002	0.0087	0.9302
Error	4	0.00084312	0.000211		
C. Total	5	0.00084495			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	1.11590	0.00838	1.0926	1.1392
2	3	1.11480	0.00838	1.0915	1.1381

Std Error uses a pooled estimate of error variance

Oneway Analysis of Na2O (wt%) By Block
(Ref value: 11.795 wt%)

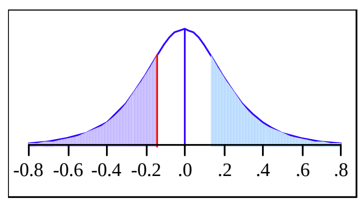


Oneway Anova
Summary of Fit

Rsquare	0.09286
Adj Rsquare	-0.13392
Root Mean Square Error	0.258005
Mean of Response	12.22187
Observations (or Sum Wgts)	6

t Test
1-2
Assuming equal variances

Difference	-0.13480	t Ratio	-0.63989
Std Err Dif	0.21066	DF	4
Upper CL Dif	0.45009	Prob > |t|	0.5571
Lower CL Dif	-0.71969	Prob > t	0.7215
Confidence	0.95	Prob < t	0.2785



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	1	0.02725656	0.027257	0.4095	0.5571
Error	4	0.26626631	0.066567		
C. Total	5	0.29352287			

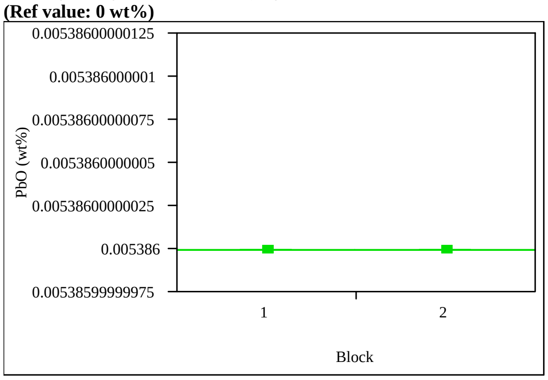
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	12.1545	0.14896	11.741	12.568
2	3	12.2893	0.14896	11.876	12.703

Std Error uses a pooled estimate of error variance

Exhibit C.3: SRNL-ML Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the LM Method

Oneway Analysis of PbO (wt%) By Block
(Ref value: 0 wt%)

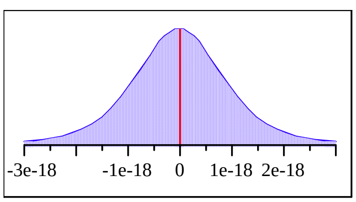


Oneway Anova
Summary of Fit

Rsquare	0
Adj Rsquare	-0.25
Root Mean Square Error	1.06e-18
Mean of Response	0.005386
Observations (or Sum Wgts)	6

t Test
1-2
Assuming equal variances

Difference	0	t Ratio	0
Std Err Dif	8.674e-19	DF	4
Upper CL Dif	2.408e-18	Prob > |t|	1.0000
Lower CL Dif	-2.41e-18	Prob > t	0.5000
Confidence	0.95	Prob < t	0.5000



Analysis of Variance

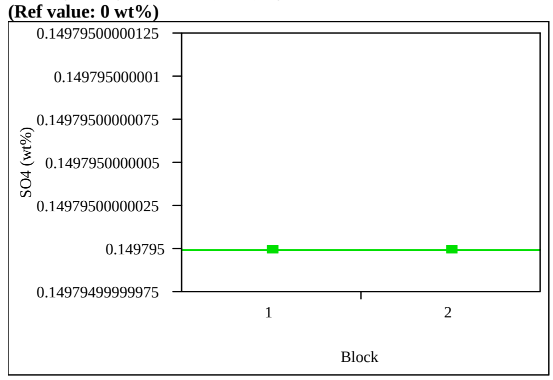
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	1	0	0	0.0000	1.0000
Error	4	4.5139e-36	1.128e-36		
C. Total	5	4.5139e-36			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	0.005386	6.133e-19	0.00539	0.00539
2	3	0.005386	6.133e-19	0.00539	0.00539

Std Error uses a pooled estimate of error variance

Oneway Analysis of SO4 (wt%) By Block
(Ref value: 0 wt%)

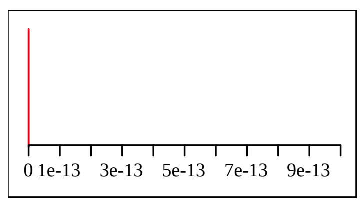


Oneway Anova
Summary of Fit

Rsquare	.
Adj Rsquare	.
Root Mean Square Error	0
Mean of Response	0.149795
Observations (or Sum Wgts)	6

t Test
1-2
Assuming equal variances

Difference	0	t Ratio	.
Std Err Dif	0	DF	4
Upper CL Dif	0	Prob > |t|	1.0000
Lower CL Dif	0	Prob > t	0.5000
Confidence	0.95	Prob < t	0.5000



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	1	0	0	.	.
Error	4	0	0		
C. Total	5	0			

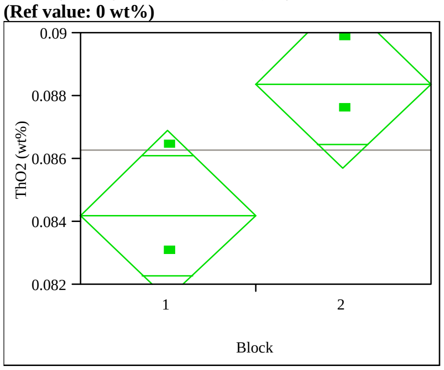
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	0.149795	0	0.14979	0.14979
2	3	0.149795	0	0.14979	0.14979

Std Error uses a pooled estimate of error variance

Exhibit C.3: SRNL-ML Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the LM Method

Oneway Analysis of ThO2 (wt%) By Block
(Ref value: 0 wt%)

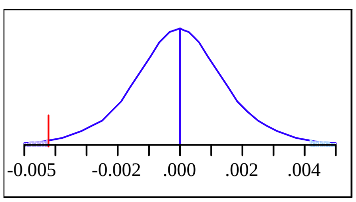


Oneway Anova
Summary of Fit

Rsquare	0.699422
Adj Rsquare	0.624277
Root Mean Square Error	0.001675
Mean of Response	0.086291
Observations (or Sum Wgts)	6

t Test
1-2
Assuming equal variances

Difference	-0.00417	t Ratio	-3.05085
Std Err Dif	0.00137	DF	4
Upper CL Dif	-0.00038	Prob > |t|	0.0380
Lower CL Dif	-0.00797	Prob > t	0.9810
Confidence	0.95	Prob < t	0.0190



Analysis of Variance

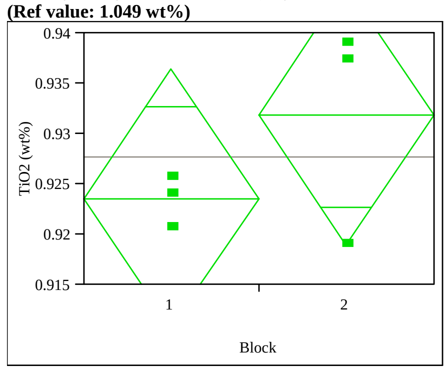
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	1	0.00002611	0.000026	9.3077	0.0380
Error	4	0.00001122	0.000003		
C. Total	5	0.00003733			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	0.084205	0.00097	0.08152	0.08689
2	3	0.088377	0.00097	0.08569	0.09106

Std Error uses a pooled estimate of error variance

Oneway Analysis of TiO2 (wt%) By Block
(Ref value: 1.049 wt%)

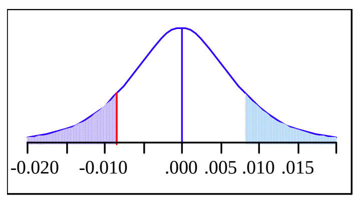


Oneway Anova
Summary of Fit

Rsquare	0.286624
Adj Rsquare	0.10828
Root Mean Square Error	0.008057
Mean of Response	0.927686
Observations (or Sum Wgts)	6

t Test
1-2
Assuming equal variances

Difference	-0.00834	t Ratio	-1.26773
Std Err Dif	0.00658	DF	4
Upper CL Dif	0.00993	Prob > |t|	0.2737
Lower CL Dif	-0.02661	Prob > t	0.8632
Confidence	0.95	Prob < t	0.1368



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	1	0.00010433	0.000104	1.6071	0.2737
Error	4	0.00025967	0.000065		
C. Total	5	0.00036401			

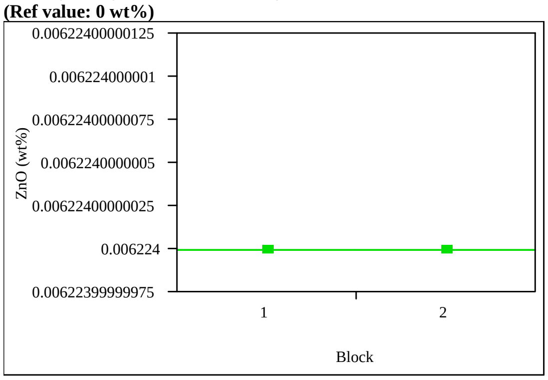
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	0.923516	0.00465	0.91060	0.93643
2	3	0.931856	0.00465	0.91894	0.94477

Std Error uses a pooled estimate of error variance

Exhibit C.3: SRNL-ML Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the LM Method

Oneway Analysis of ZnO (wt%) By Block
(Ref value: 0 wt%)

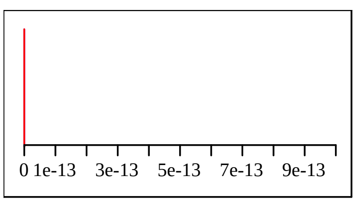


Oneway Anova
Summary of Fit

Rsquare	.
Adj Rsquare	.
Root Mean Square Error	0
Mean of Response	0.006224
Observations (or Sum Wgts)	6

t Test
1-2
Assuming equal variances

Difference	0	t Ratio	.
Std Err Dif	0	DF	4
Upper CL Dif	0	Prob > |t|	1.0000
Lower CL Dif	0	Prob > t	0.5000
Confidence	0.95	Prob < t	0.5000



Analysis of Variance

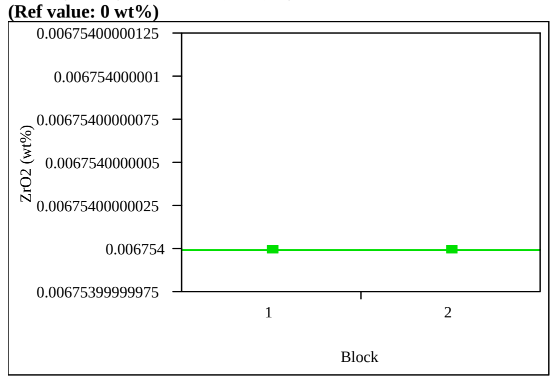
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	1	0	0	.	.
Error	4	0	0		
C. Total	5	0			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	0.006224	0	0.00622	0.00622
2	3	0.006224	0	0.00622	0.00622

Std Error uses a pooled estimate of error variance

Oneway Analysis of ZrO2 (wt%) By Block
(Ref value: 0 wt%)

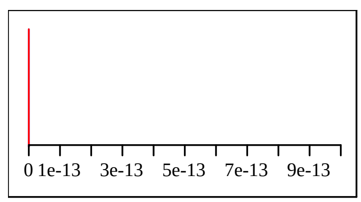


Oneway Anova
Summary of Fit

Rsquare	.
Adj Rsquare	.
Root Mean Square Error	0
Mean of Response	0.006754
Observations (or Sum Wgts)	6

t Test
1-2
Assuming equal variances

Difference	0	t Ratio	.
Std Err Dif	0	DF	4
Upper CL Dif	0	Prob > |t|	1.0000
Lower CL Dif	0	Prob > t	0.5000
Confidence	0.95	Prob < t	0.5000



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	1	0	0	.	.
Error	4	0	0		
C. Total	5	0			

Means for Oneway Anova

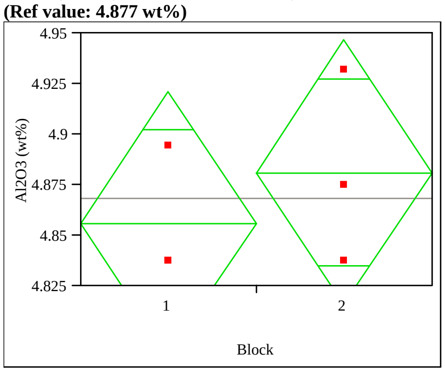
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	0.006754	0	0.00675	0.00675
2	3	0.006754	0	0.00675	0.00675

Std Error uses a pooled estimate of error variance

Exhibit C.4: SRNL-ML Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the PF Method

Glass ID=Batch 1

Oneway Analysis of Al2O3 (wt%) By Block
(Ref value: 4.877 wt%)

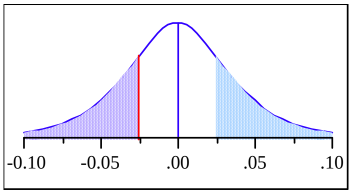


Oneway Anova
Summary of Fit

Rsquare	0.125
Adj Rsquare	-0.09375
Root Mean Square Error	0.040818
Mean of Response	4.868612
Observations (or Sum Wgts)	6

t Test
1-2
Assuming equal variances

Difference	-0.02519	t Ratio	-0.75593
Std Err Dif	0.03333	DF	4
Upper CL Dif	0.06734	Prob > |t|	0.4918
Lower CL Dif	-0.11773	Prob > t	0.7541
Confidence	0.95	Prob < t	0.2459



Analysis of Variance

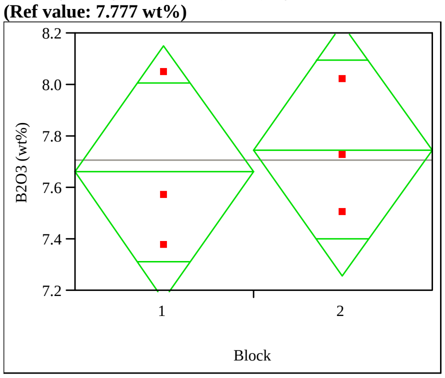
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	1	0.00095206	0.000952	0.5714	0.4918
Error	4	0.00666439	0.001666		
C. Total	5	0.00761645			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	4.85601	0.02357	4.7906	4.9214
2	3	4.88121	0.02357	4.8158	4.9466

Std Error uses a pooled estimate of error variance

Oneway Analysis of B2O3 (wt%) By Block
(Ref value: 7.777 wt%)

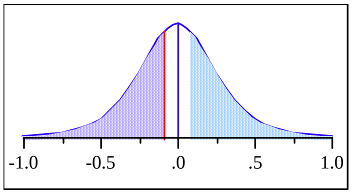


Oneway Anova
Summary of Fit

Rsquare	0.028571
Adj Rsquare	-0.21429
Root Mean Square Error	0.306596
Mean of Response	7.706294
Observations (or Sum Wgts)	6

t Test
1-2
Assuming equal variances

Difference	-0.08586	t Ratio	-0.343
Std Err Dif	0.25033	DF	4
Upper CL Dif	0.60918	Prob > |t|	0.7489
Lower CL Dif	-0.78090	Prob > t	0.6256
Confidence	0.95	Prob < t	0.3744



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	1	0.01105894	0.011059	0.1176	0.7489
Error	4	0.37600395	0.094001		
C. Total	5	0.38706289			

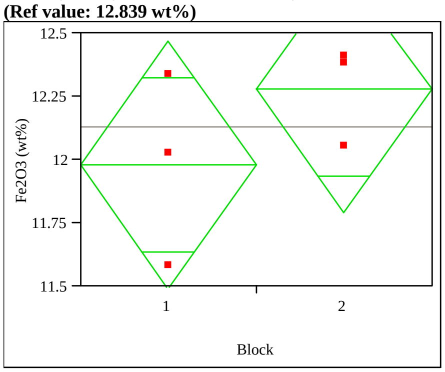
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	7.66336	0.17701	7.1719	8.1548
2	3	7.74923	0.17701	7.2578	8.2407

Std Error uses a pooled estimate of error variance

Exhibit C.4: SRNL-ML Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the PF Method

Oneway Analysis of Fe2O3 (wt%) By Block
(Ref value: 12.839 wt%)

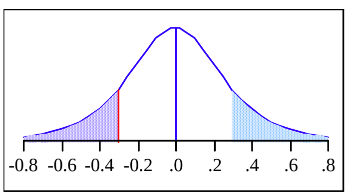


Oneway Anova
Summary of Fit

Rsquare	0.268303
Adj Rsquare	0.085378
Root Mean Square Error	0.303622
Mean of Response	12.131
Observations (or Sum Wgts)	6

t Test
1-2
Assuming equal variances

Difference	-0.30024	t Ratio	-1.21109
Std Err Dif	0.24791	DF	4
Upper CL Dif	0.38806	Prob > |t|	0.2925
Lower CL Dif	-0.98854	Prob > t	0.8537
Confidence	0.95	Prob < t	0.1463



Analysis of Variance

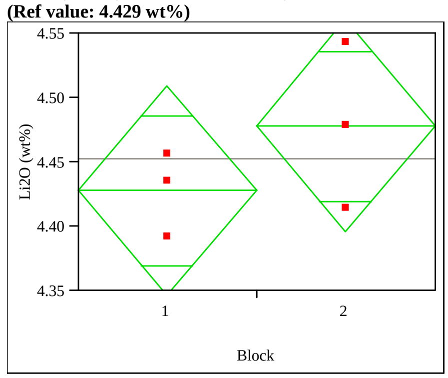
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	1	0.13521338	0.135213	1.4667	0.2925
Error	4	0.36874519	0.092186		
C. Total	5	0.50395858			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	11.9809	0.17530	11.494	12.468
2	3	12.2811	0.17530	11.794	12.768

Std Error uses a pooled estimate of error variance

Oneway Analysis of Li2O (wt%) By Block
(Ref value: 4.429 wt%)

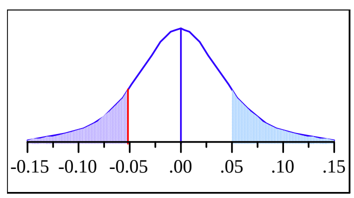


Oneway Anova
Summary of Fit

Rsquare	0.264865
Adj Rsquare	0.081081
Root Mean Square Error	0.051249
Mean of Response	4.452915
Observations (or Sum Wgts)	6

t Test
1-2
Assuming equal variances

Difference	-0.05023	t Ratio	-1.20049
Std Err Dif	0.04184	DF	4
Upper CL Dif	0.06595	Prob > |t|	0.2962
Lower CL Dif	-0.16641	Prob > t	0.8519
Confidence	0.95	Prob < t	0.1481



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	1	0.00378523	0.003785	1.4412	0.2962
Error	4	0.01050595	0.002626		
C. Total	5	0.01429118			

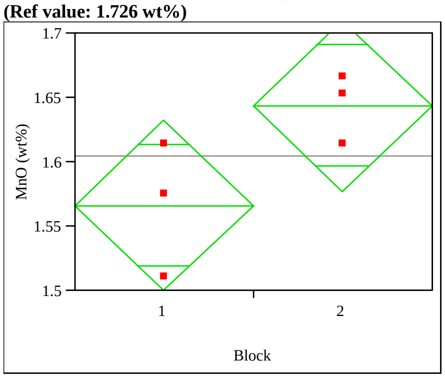
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	4.42780	0.02959	4.3456	4.5099
2	3	4.47803	0.02959	4.3959	4.5602

Std Error uses a pooled estimate of error variance

Exhibit C.4: SRNL-ML Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the PF Method

Oneway Analysis of MnO (wt%) By Block
(Ref value: 1.726 wt%)

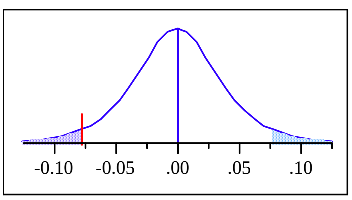


Oneway Anova
Summary of Fit

Rsquare	0.566434
Adj Rsquare	0.458042
Root Mean Square Error	0.041506
Mean of Response	1.605392
Observations (or Sum Wgts)	6

t Test
1-2
Assuming equal variances

Difference	-0.07747	t Ratio	-2.286
Std Err Dif	0.03389	DF	4
Upper CL Dif	0.01662	Prob > |t|	0.0842
Lower CL Dif	-0.17156	Prob > t	0.9579
Confidence	0.95	Prob < t	0.0421



Analysis of Variance

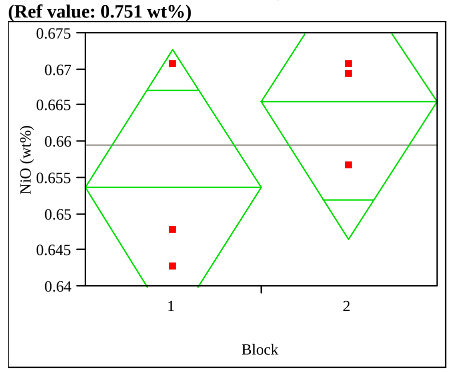
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	1	0.00900287	0.009003	5.2258	0.0842
Error	4	0.00689108	0.001723		
C. Total	5	0.01589395			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	1.56666	0.02396	1.5001	1.6332
2	3	1.64413	0.02396	1.5776	1.7107

Std Error uses a pooled estimate of error variance

Oneway Analysis of NiO (wt%) By Block
(Ref value: 0.751 wt%)

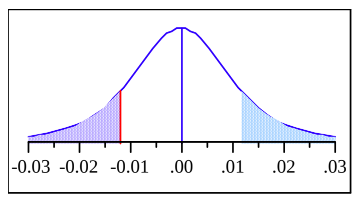


Oneway Anova
Summary of Fit

Rsquare	0.272601
Adj Rsquare	0.090751
Root Mean Square Error	0.01188
Mean of Response	0.659579
Observations (or Sum Wgts)	6

t Test
1-2
Assuming equal variances

Difference	-0.01188	t Ratio	-1.22435
Std Err Dif	0.00970	DF	4
Upper CL Dif	0.01506	Prob > |t|	0.2880
Lower CL Dif	-0.03881	Prob > t	0.8560
Confidence	0.95	Prob < t	0.1440



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	1	0.00021158	0.000212	1.4990	0.2880
Error	4	0.00056458	0.000141		
C. Total	5	0.00077616			

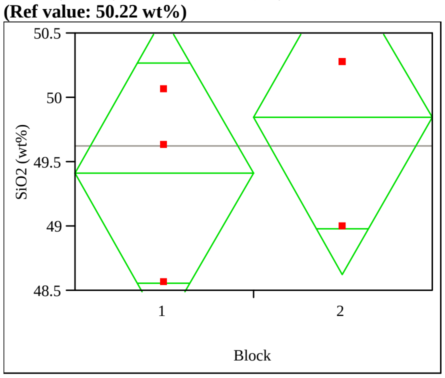
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	0.653641	0.00686	0.63460	0.67268
2	3	0.665517	0.00686	0.64647	0.68456

Std Error uses a pooled estimate of error variance

Exhibit C.4: SRNL-ML Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the PF Method

Oneway Analysis of SiO2 (wt%) By Block
(Ref value: 50.22 wt%)

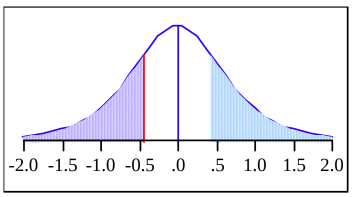


Oneway Anova
Summary of Fit

Rsquare	0.107143
Adj Rsquare	-0.11607
Root Mean Square Error	0.756357
Mean of Response	49.63176
Observations (or Sum Wgts)	6

t Test
1-2
Assuming equal variances

Difference	-0.4279	t Ratio	-0.69282
Std Err Dif	0.6176	DF	4
Upper CL Dif	1.2868	Prob > |t|	0.5265
Lower CL Dif	-2.1425	Prob > t	0.7367
Confidence	0.95	Prob < t	0.2633



Analysis of Variance

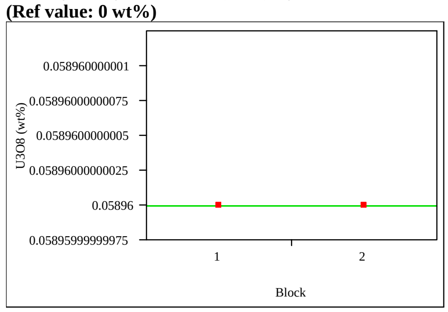
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	1	0.2745963	0.274596	0.4800	0.5265
Error	4	2.2883022	0.572076		
C. Total	5	2.5628985			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	49.4178	0.43668	48.205	50.630
2	3	49.8457	0.43668	48.633	51.058

Std Error uses a pooled estimate of error variance

Oneway Analysis of U3O8 (wt%) By Block
(Ref value: 0 wt%)

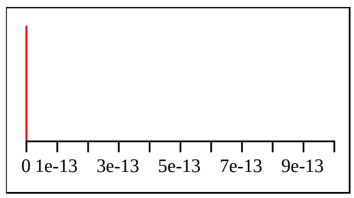


Oneway Anova
Summary of Fit

Rsquare	.
Adj Rsquare	.
Root Mean Square Error	0
Mean of Response	0.05896
Observations (or Sum Wgts)	6

t Test
1-2
Assuming equal variances

Difference	0	t Ratio	.
Std Err Dif	0	DF	4
Upper CL Dif	0	Prob > |t|	1.0000
Lower CL Dif	0	Prob > t	0.5000
Confidence	0.95	Prob < t	0.5000



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	1	0	0	.	.
Error	4	0	0		
C. Total	5	0			

Means for Oneway Anova

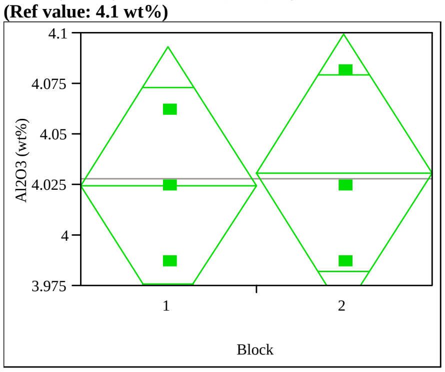
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	0.058960	0	0.05896	0.05896
2	3	0.058960	0	0.05896	0.05896

Std Error uses a pooled estimate of error variance

Exhibit C.4: SRNL-ML Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the PF Method

Glass ID=Ustd

Oneway Analysis of Al2O3 (wt%) By Block
(Ref value: 4.1 wt%)

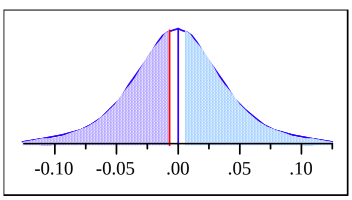


Oneway Anova
Summary of Fit

Rsquare	0.008
Adj Rsquare	-0.24
Root Mean Square Error	0.042949
Mean of Response	4.027784
Observations (or Sum Wgts)	6

t Test
1-2
Assuming equal variances

Difference	-0.00630	t Ratio	-0.17961
Std Err Dif	0.03507	DF	4
Upper CL Dif	0.09107	Prob > |t|	0.8662
Lower CL Dif	-0.10366	Prob > t	0.5669
Confidence	0.95	Prob < t	0.4331



Analysis of Variance

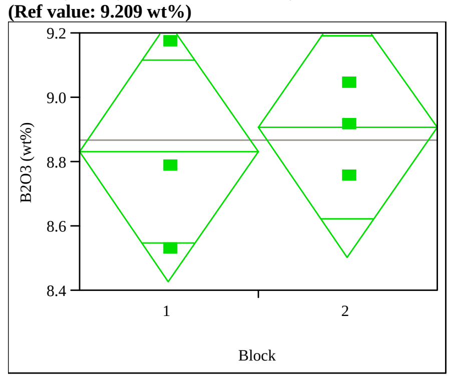
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	1	0.00005950	0.000060	0.0323	0.8662
Error	4	0.00737843	0.001845		
C. Total	5	0.00743794			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	4.02464	0.02480	3.9558	4.0935
2	3	4.03093	0.02480	3.9621	4.0998

Std Error uses a pooled estimate of error variance

Oneway Analysis of B2O3 (wt%) By Block
(Ref value: 9.209 wt%)

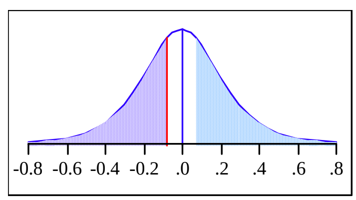


Oneway Anova
Summary of Fit

Rsquare	0.032472
Adj Rsquare	-0.20941
Root Mean Square Error	0.251138
Mean of Response	8.870824
Observations (or Sum Wgts)	6

t Test
1-2
Assuming equal variances

Difference	-0.07513	t Ratio	-0.3664
Std Err Dif	0.20505	DF	4
Upper CL Dif	0.49419	Prob > |t|	0.7326
Lower CL Dif	-0.64445	Prob > t	0.6337
Confidence	0.95	Prob < t	0.3663



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	1	0.00846700	0.008467	0.1342	0.7326
Error	4	0.25228206	0.063071		
C. Total	5	0.26074906			

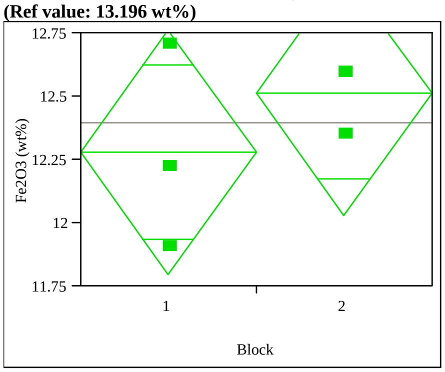
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	8.83326	0.14499	8.4307	9.2358
2	3	8.90839	0.14499	8.5058	9.3110

Std Error uses a pooled estimate of error variance

Exhibit C.4: SRNL-ML Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the PF Method

Oneway Analysis of Fe2O3 (wt%) By Block
(Ref value: 13.196 wt%)

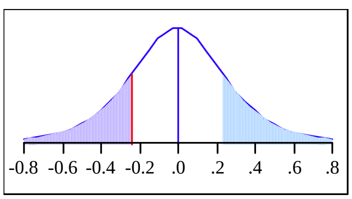


Oneway Anova
Summary of Fit

Rsquare	0.183157
Adj Rsquare	-0.02105
Root Mean Square Error	0.301991
Mean of Response	12.39788
Observations (or Sum Wgts)	6

t Test
1-2
Assuming equal variances

Difference	-0.23352	t Ratio	-0.94705
Std Err Dif	0.24657	DF	4
Upper CL Dif	0.45108	Prob > |t|	0.3972
Lower CL Dif	-0.91812	Prob > t	0.8014
Confidence	0.95	Prob < t	0.1986



Analysis of Variance

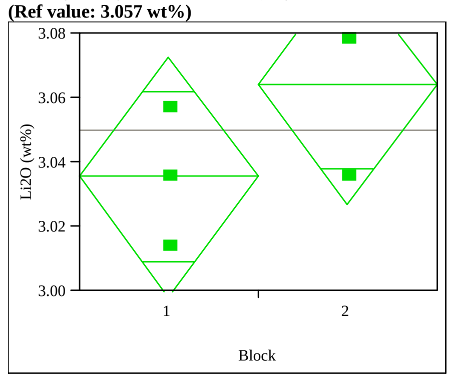
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	1	0.08179575	0.081796	0.8969	0.3972
Error	4	0.36479338	0.091198		
C. Total	5	0.44658913			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	12.2811	0.17435	11.797	12.765
2	3	12.5146	0.17435	12.031	12.999

Std Error uses a pooled estimate of error variance

Oneway Analysis of Li2O (wt%) By Block
(Ref value: 3.057 wt%)

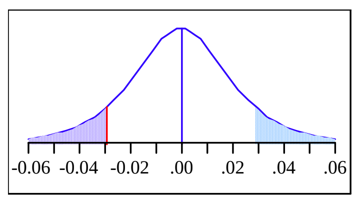


Oneway Anova
Summary of Fit

Rsquare	0.363636
Adj Rsquare	0.204545
Root Mean Square Error	0.023254
Mean of Response	3.049942
Observations (or Sum Wgts)	6

t Test
1-2
Assuming equal variances

Difference	-0.02871	t Ratio	-1.51186
Std Err Dif	0.01899	DF	4
Upper CL Dif	0.02401	Prob > |t|	0.2051
Lower CL Dif	-0.08142	Prob > t	0.8974
Confidence	0.95	Prob < t	0.1026



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	1	0.00123599	0.001236	2.2857	0.2051
Error	4	0.00216299	0.000541		
C. Total	5	0.00339898			

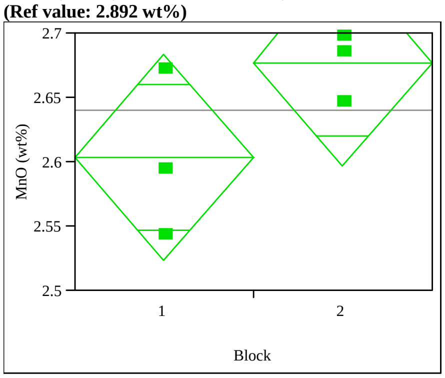
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	3.03559	0.01343	2.9983	3.0729
2	3	3.06429	0.01343	3.0270	3.1016

Std Error uses a pooled estimate of error variance

Exhibit C.4: SRNL-ML Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the PF Method

Oneway Analysis of MnO (wt%) By Block
(Ref value: 2.892 wt%)

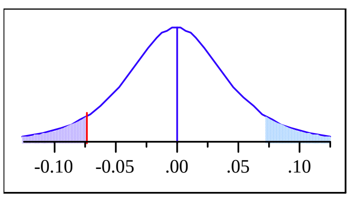


Oneway Anova
Summary of Fit

Rsquare	0.448062
Adj Rsquare	0.310078
Root Mean Square Error	0.049729
Mean of Response	2.640504
Observations (or Sum Wgts)	6

t Test
1-2
Assuming equal variances

Difference	-0.07317	t Ratio	-1.802
Std Err Dif	0.04060	DF	4
Upper CL Dif	0.03957	Prob > |t|	0.1459
Lower CL Dif	-0.18590	Prob > t	0.9271
Confidence	0.95	Prob < t	0.0729



Analysis of Variance

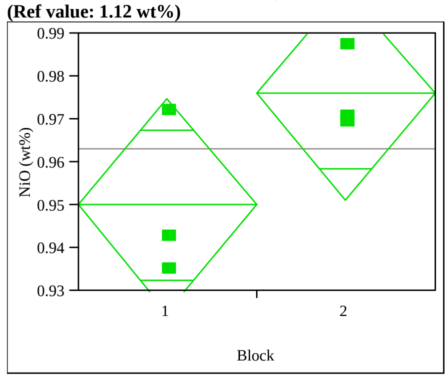
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	1	0.00803033	0.008030	3.2472	0.1459
Error	4	0.00989204	0.002473		
C. Total	5	0.01792237			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	2.60392	0.02871	2.5242	2.6836
2	3	2.67709	0.02871	2.5974	2.7568

Std Error uses a pooled estimate of error variance

Oneway Analysis of NiO (wt%) By Block
(Ref value: 1.12 wt%)

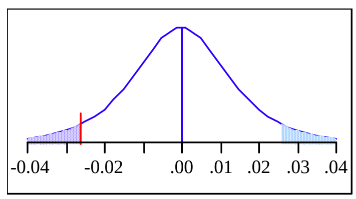


Oneway Anova
Summary of Fit

Rsquare	0.512182
Adj Rsquare	0.390227
Root Mean Square Error	0.015463
Mean of Response	0.96307
Observations (or Sum Wgts)	6

t Test
1-2
Assuming equal variances

Difference	-0.02587	t Ratio	-2.04934
Std Err Dif	0.01263	DF	4
Upper CL Dif	0.00918	Prob > |t|	0.1098
Lower CL Dif	-0.06093	Prob > t	0.9451
Confidence	0.95	Prob < t	0.0549



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	1	0.00100421	0.001004	4.1998	0.1098
Error	4	0.00095644	0.000239		
C. Total	5	0.00196065			

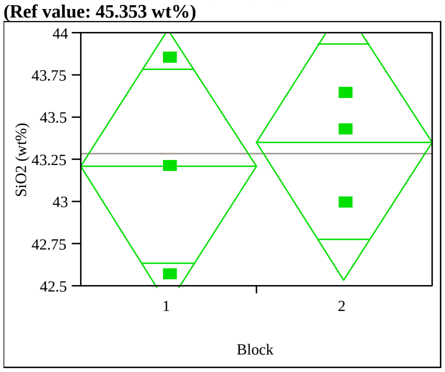
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	0.950133	0.00893	0.92535	0.9749
2	3	0.976008	0.00893	0.95122	1.0008

Std Error uses a pooled estimate of error variance

Exhibit C.4: SRNL-ML Measurements by Analytical Block for Samples of the Standard Glasses Prepared Using the PF Method

Oneway Analysis of SiO2 (wt%) By Block
(Ref value: 45.353 wt%)

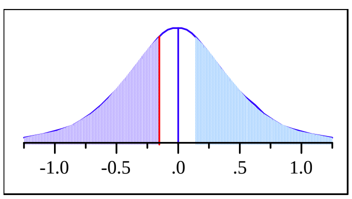


Oneway Anova
Summary of Fit

Rsquare	0.028571
Adj Rsquare	-0.21429
Root Mean Square Error	0.509255
Mean of Response	43.28517
Observations (or Sum Wgts)	6

t Test
1-2
Assuming equal variances

Difference	-0.1426	t Ratio	-0.343
Std Err Dif	0.4158	DF	4
Upper CL Dif	1.0118	Prob > |t|	0.7489
Lower CL Dif	-1.2971	Prob > t	0.6256
Confidence	0.95	Prob < t	0.3744



Analysis of Variance

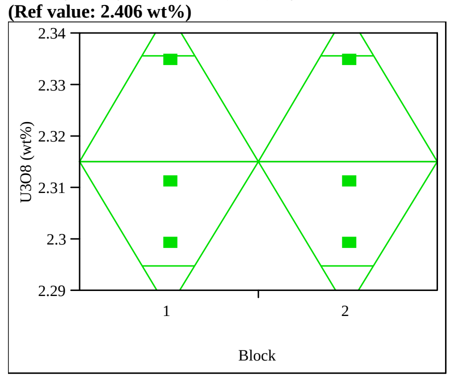
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	1	0.0305107	0.030511	0.1176	0.7489
Error	4	1.0373637	0.259341		
C. Total	5	1.0678744			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	43.2139	0.29402	42.398	44.030
2	3	43.3565	0.29402	42.540	44.173

Std Error uses a pooled estimate of error variance

Oneway Analysis of U3O8 (wt%) By Block
(Ref value: 2.406 wt%)

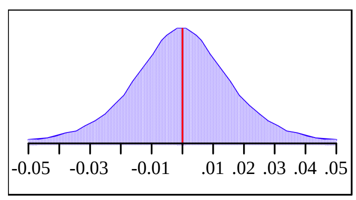


Oneway Anova
Summary of Fit

Rsquare	0
Adj Rsquare	-0.25
Root Mean Square Error	0.018013
Mean of Response	2.315163
Observations (or Sum Wgts)	6

t Test
1-2
Assuming equal variances

Difference	0.00000	t Ratio	0
Std Err Dif	0.01471	DF	4
Upper CL Dif	0.04083	Prob > |t|	1.0000
Lower CL Dif	-0.04083	Prob > t	0.5000
Confidence	0.95	Prob < t	0.5000



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	1	0.00000000	0.000000	0.0000	1.0000
Error	4	0.00129781	0.000324		
C. Total	5	0.00129781			

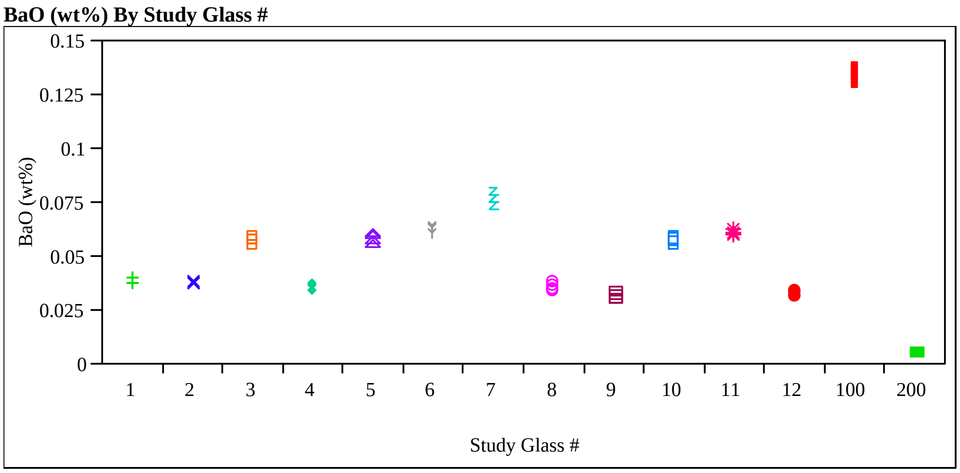
Means for Oneway Anova

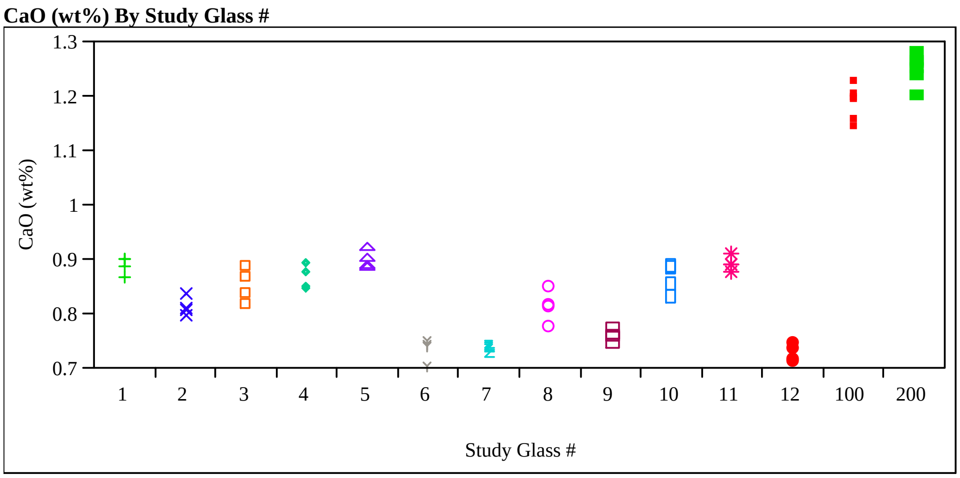
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	2.31516	0.01040	2.2863	2.3440
2	3	2.31516	0.01040	2.2863	2.3440

Std Error uses a pooled estimate of error variance

Exhibit C.5: Measured and Measured Bias-Corrected Oxide Weight Percents by Glass # for the Glasses Prepared Using the LM Method

(100 – Batch 1; 200 – Ustd)





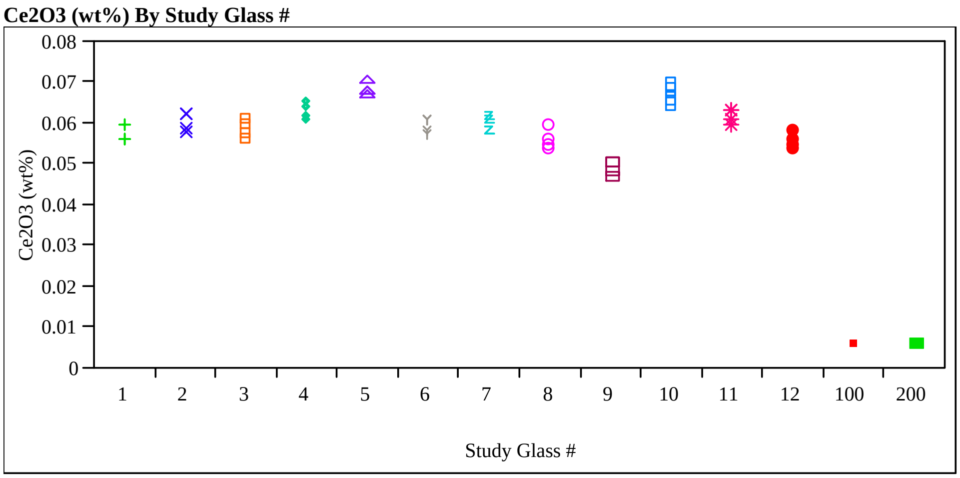
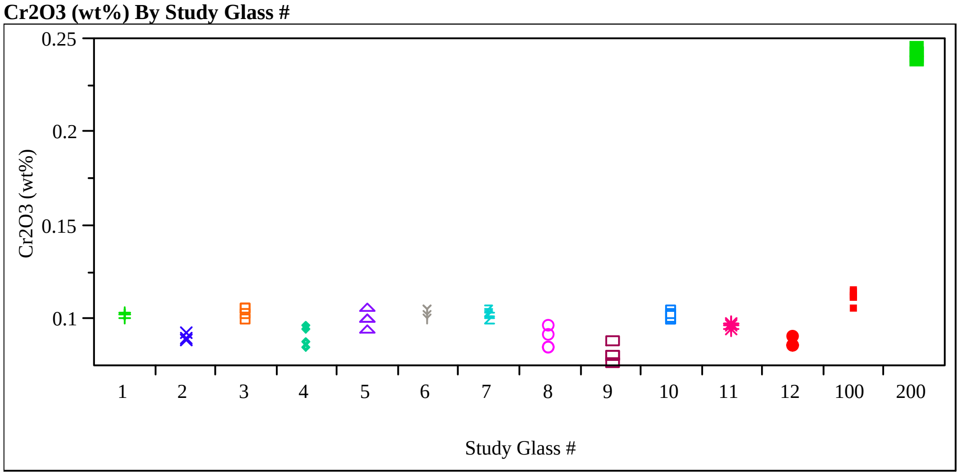
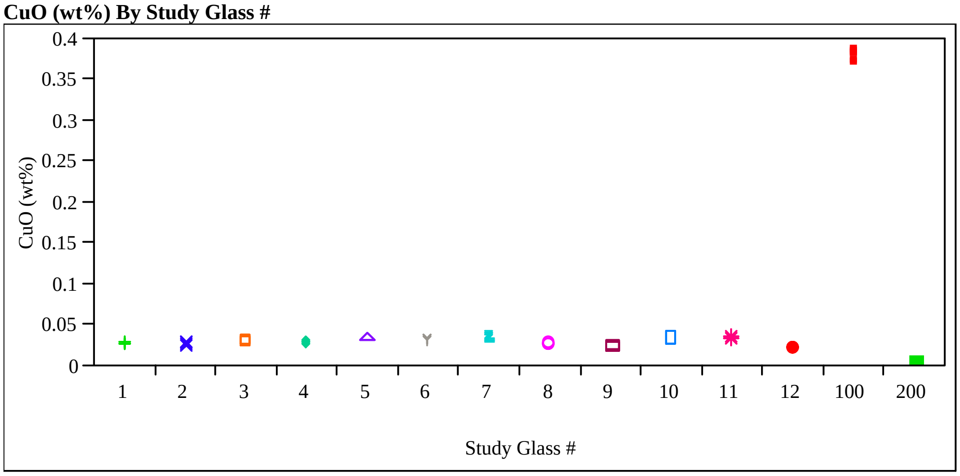


Exhibit C.5: Measured and Measured Bias-Corrected Oxide Weight Percents by Glass # for the Glasses Prepared Using the LM Method

(100 – Batch 1; 200 – Ustd)





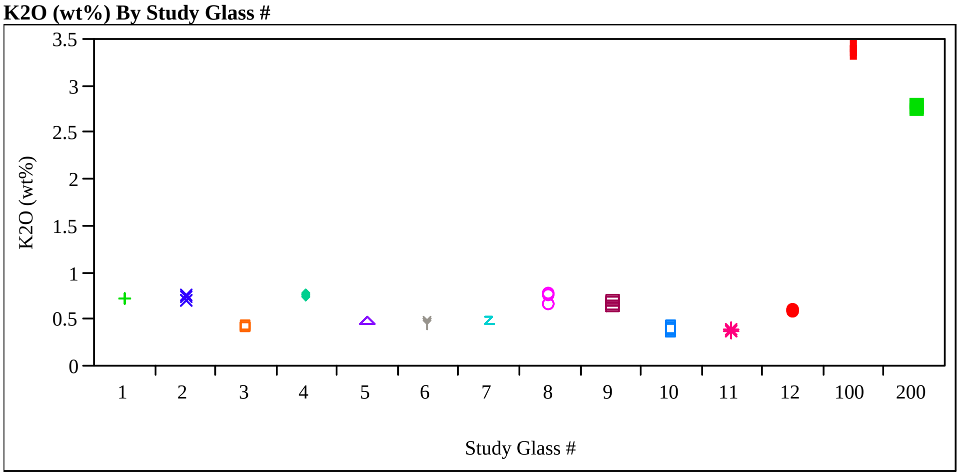
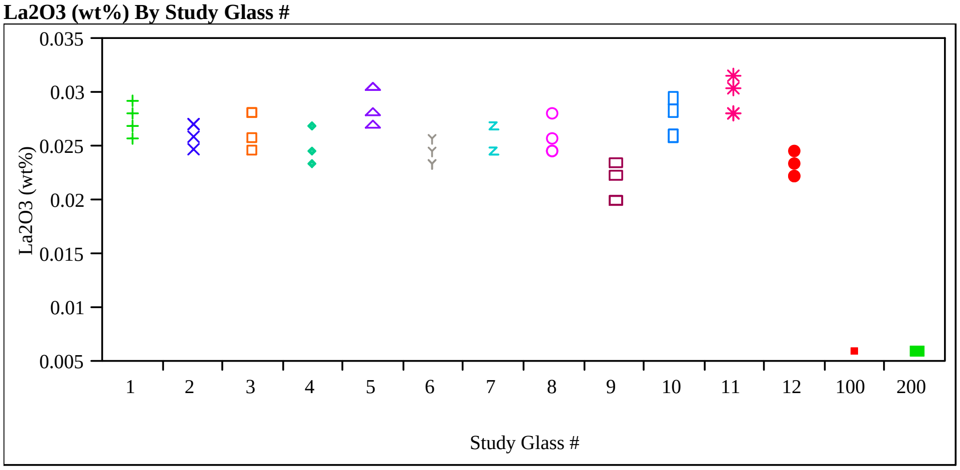
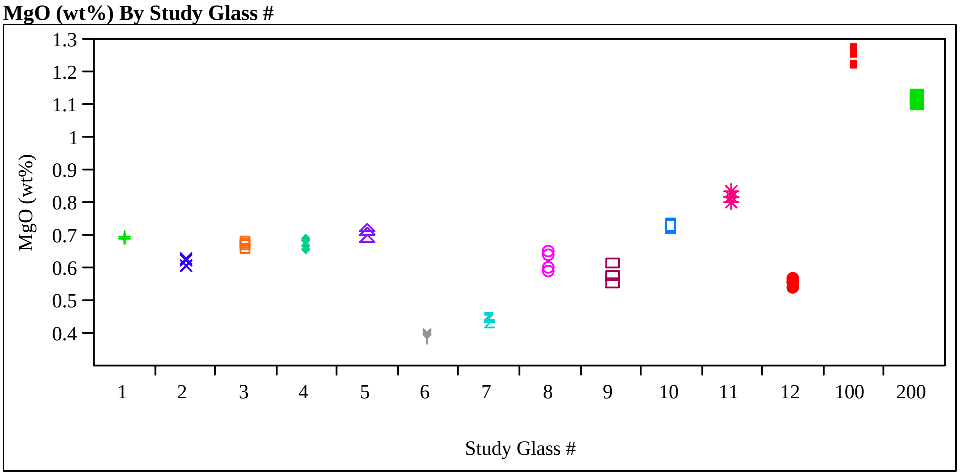


Exhibit C.5: Measured and Measured Bias-Corrected Oxide Weight Percents by Glass # for the Glasses Prepared Using the LM Method

(100 – Batch 1; 200 – Ustd)





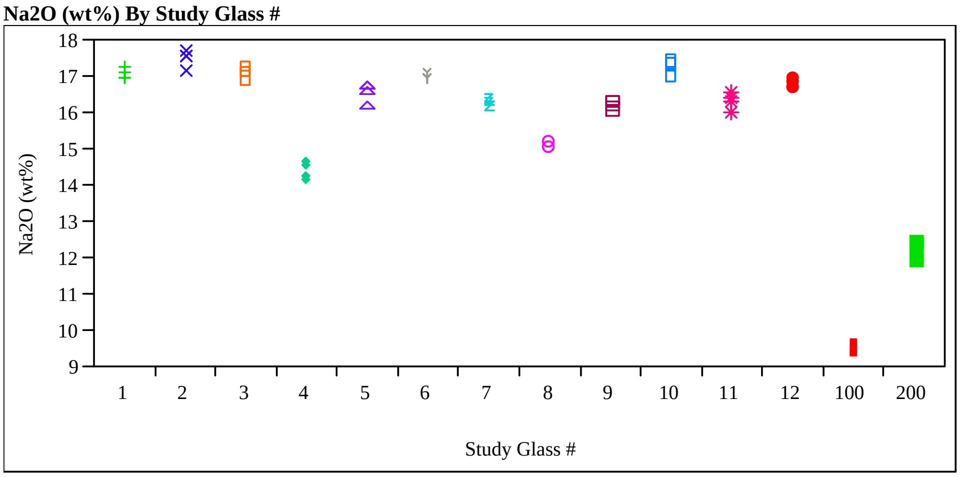
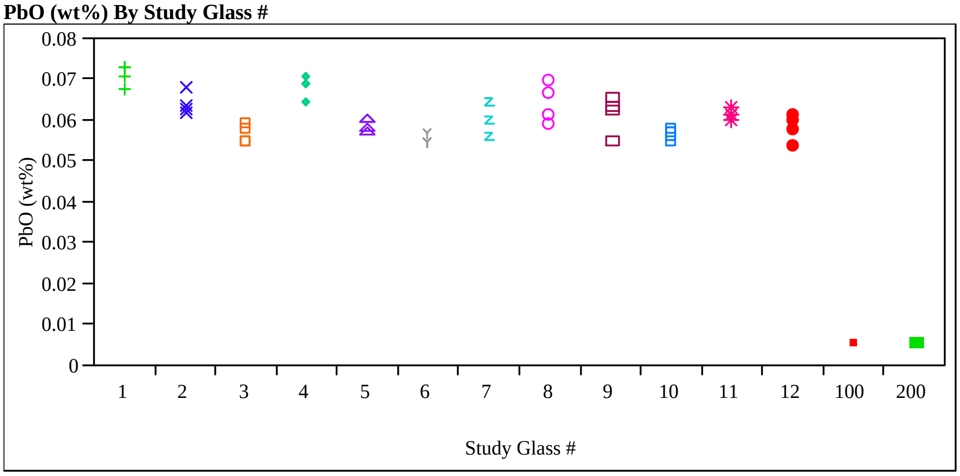


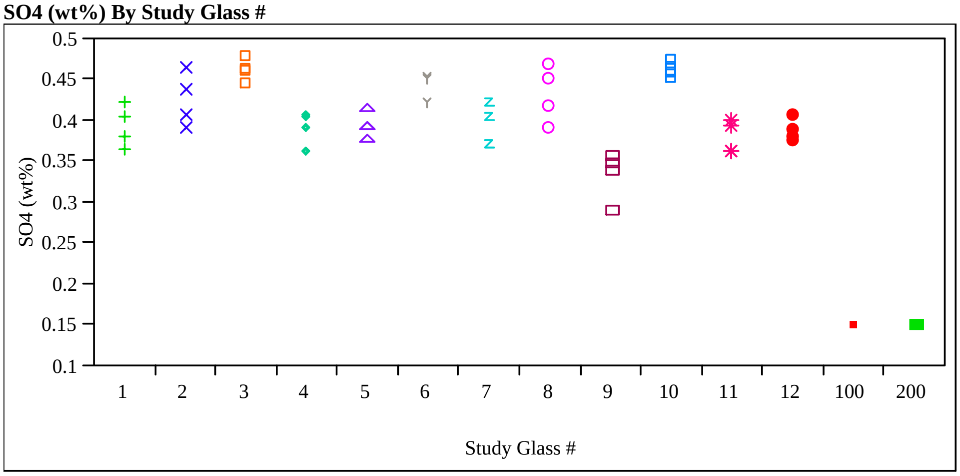
Exhibit C.5: Measured and Measured Bias-Corrected Oxide Weight Percents by Glass # for the Glasses Prepared Using the LM Method

(100 – Batch 1; 200 – Ustd)

PbO (wt%) By Study Glass #



SO4 (wt%) By Study Glass #



ThO2 (wt%) By Study Glass #

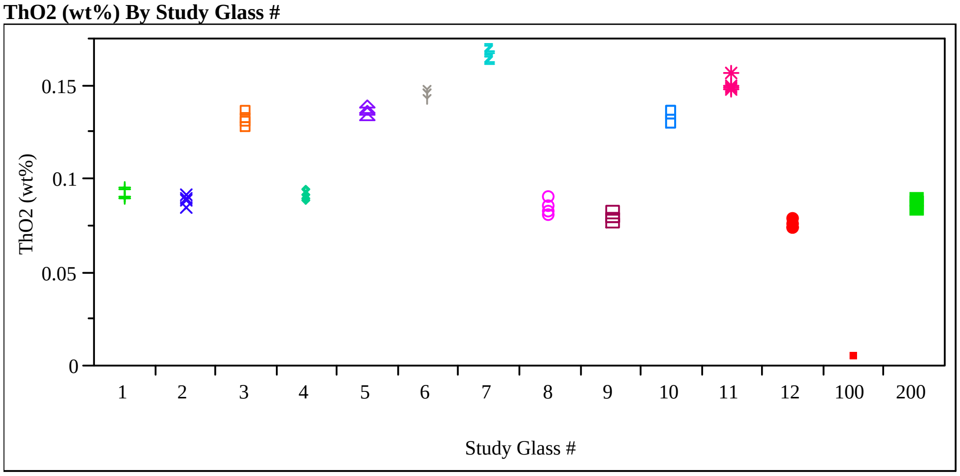
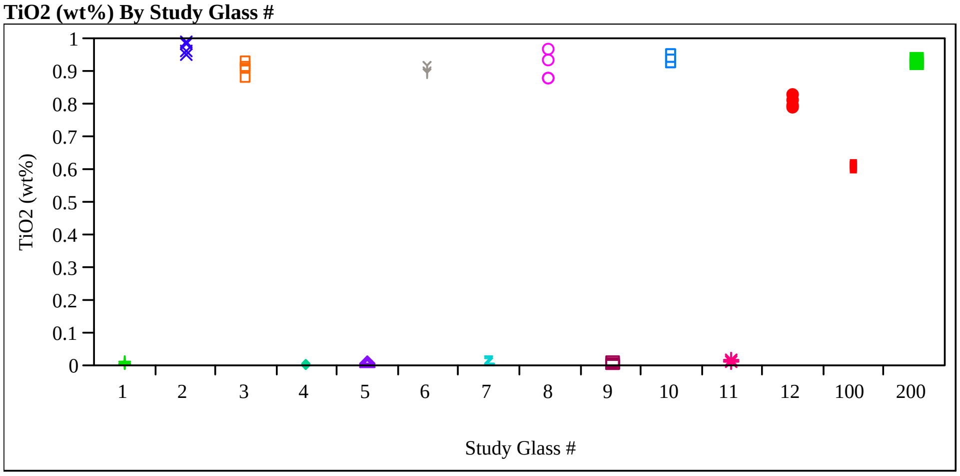


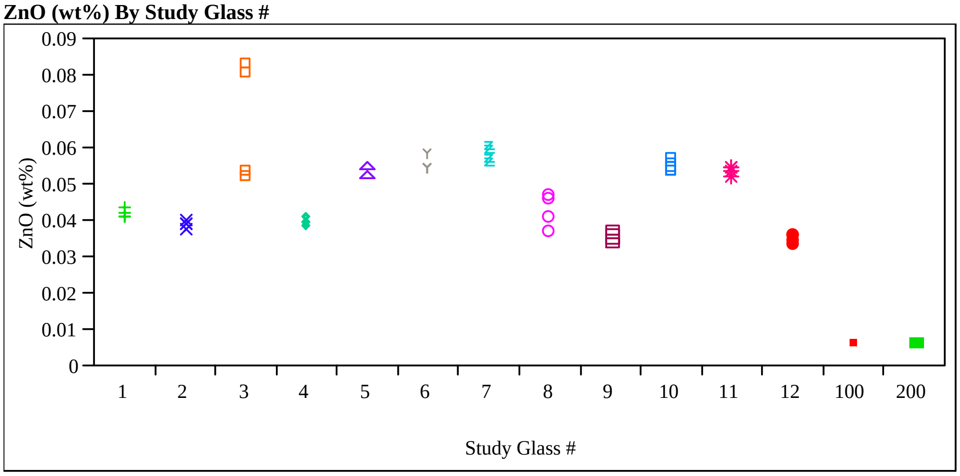
Exhibit C.5: Measured and Measured Bias-Corrected Oxide Weight Percents by Glass # for the Glasses Prepared Using the LM Method

(100 – Batch 1; 200 – Ustd)

TiO2 (wt%) By Study Glass #



ZnO (wt%) By Study Glass #



ZrO2 (wt%) By Study Glass #

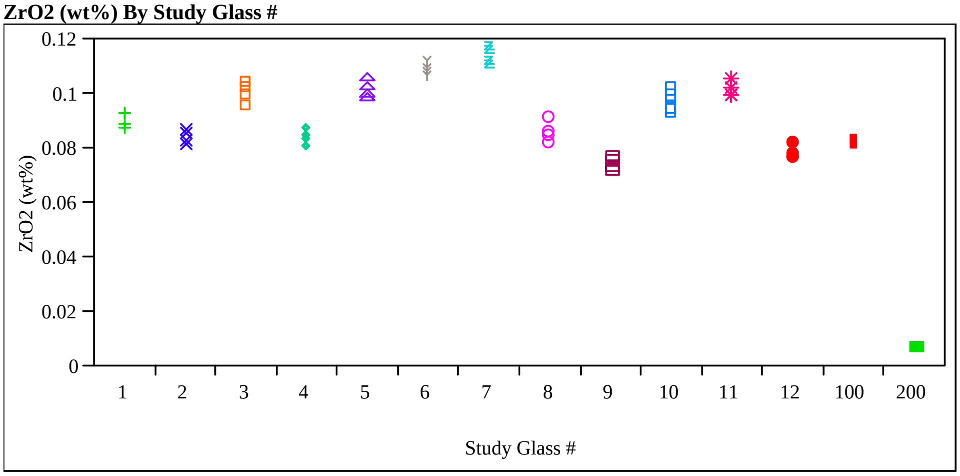
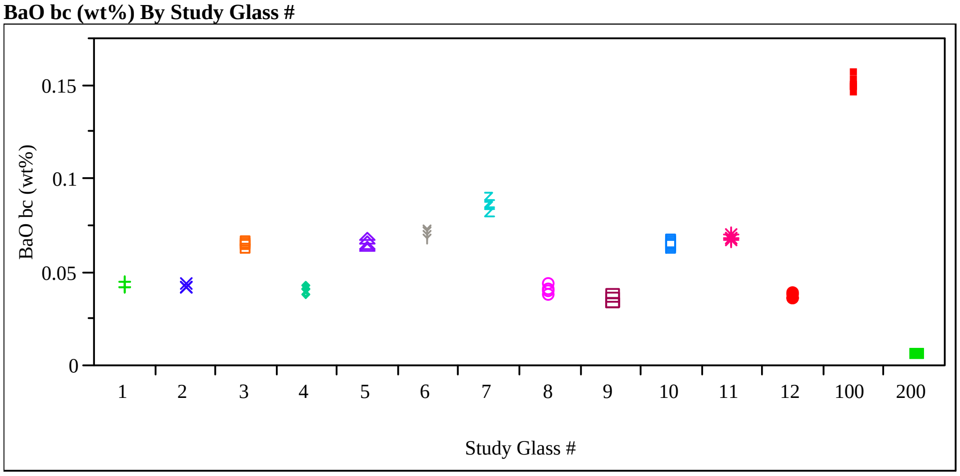


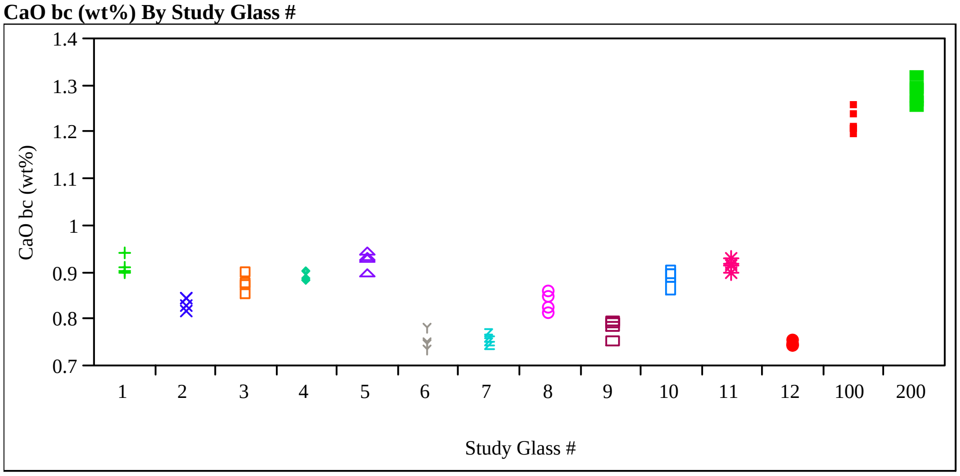
Exhibit C.5: Measured and Measured Bias-Corrected Oxide Weight Percents by Glass # for the Glasses Prepared Using the LM Method

(100 – Batch 1; 200 – Ustd)

BaO bc (wt%) By Study Glass #



CaO bc (wt%) By Study Glass #



Ce2O3 bc (wt%) By Study Glass #

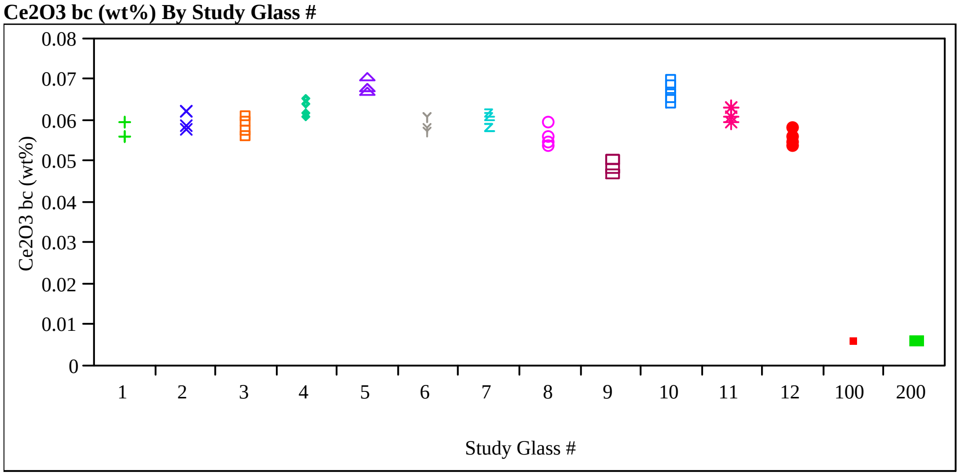
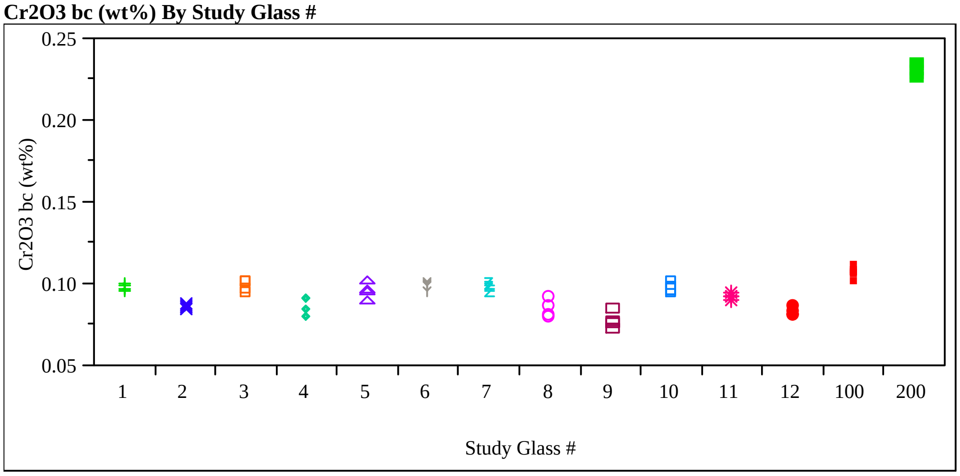


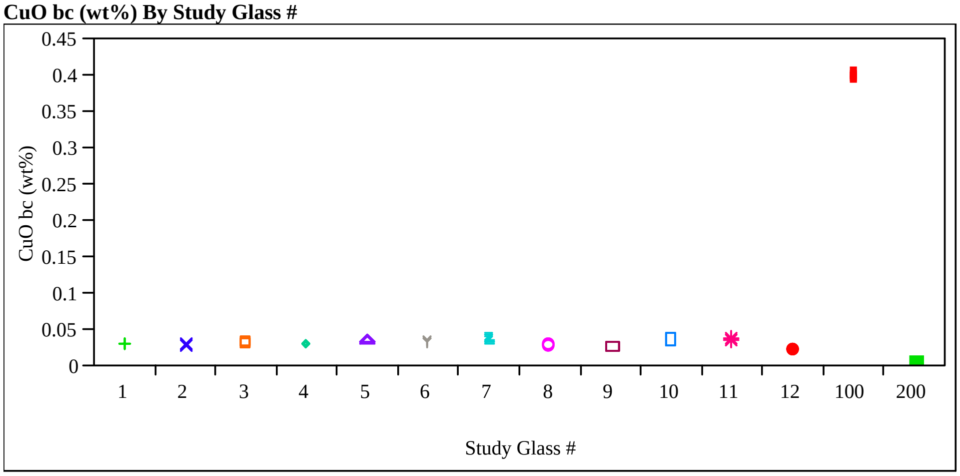
Exhibit C.5: Measured and Measured Bias-Corrected Oxide Weight Percents by Glass # for the Glasses Prepared Using the LM Method

(100 – Batch 1; 200 – Ustd)

Cr2O3 bc (wt%) By Study Glass #



CuO bc (wt%) By Study Glass #



K2O bc (wt%) By Study Glass #

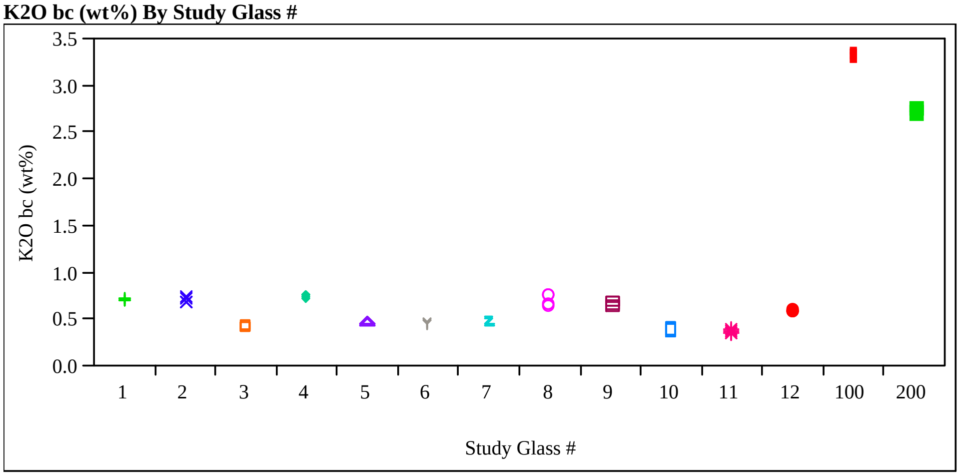
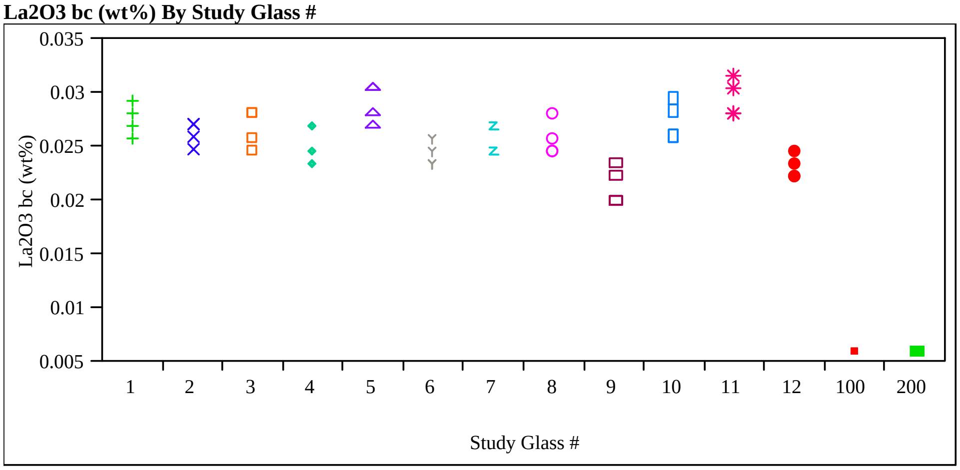


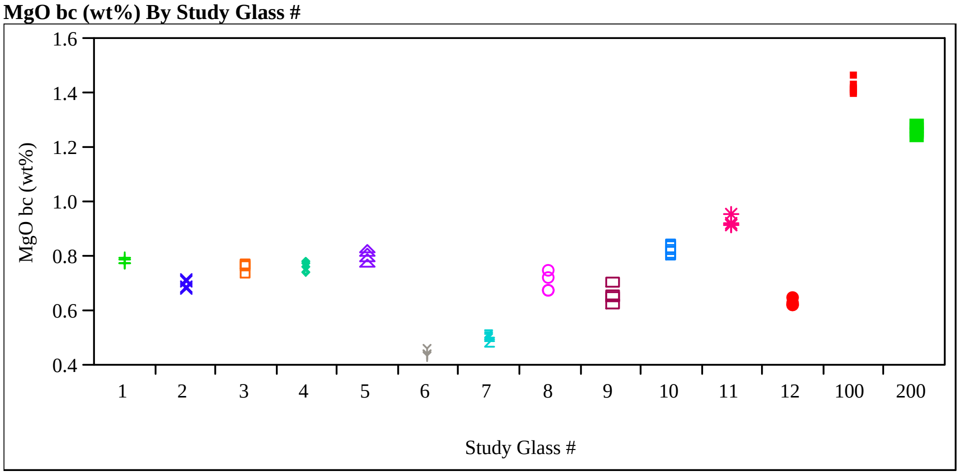
Exhibit C.5: Measured and Measured Bias-Corrected Oxide Weight Percents by Glass # for the Glasses Prepared Using the LM Method

(100 – Batch 1; 200 – Ustd)

La2O3 bc (wt%) By Study Glass #



MgO bc (wt%) By Study Glass #



Na2O bc (wt%) By Study Glass #

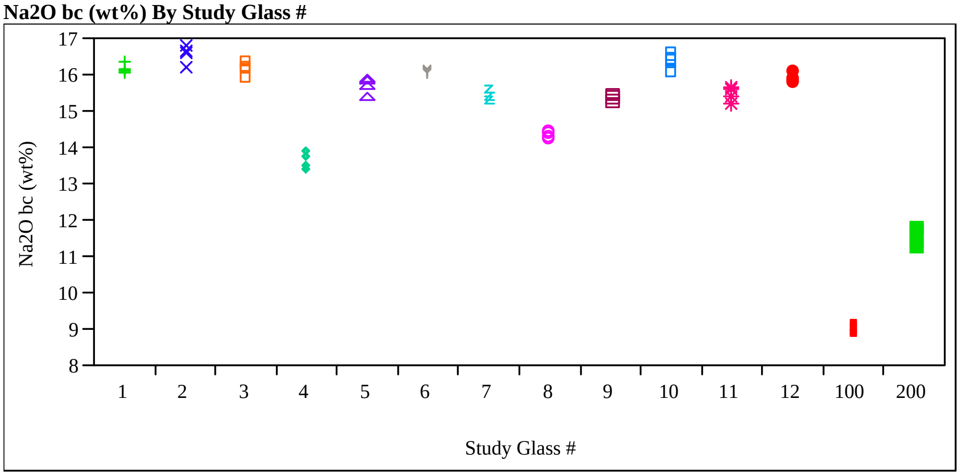
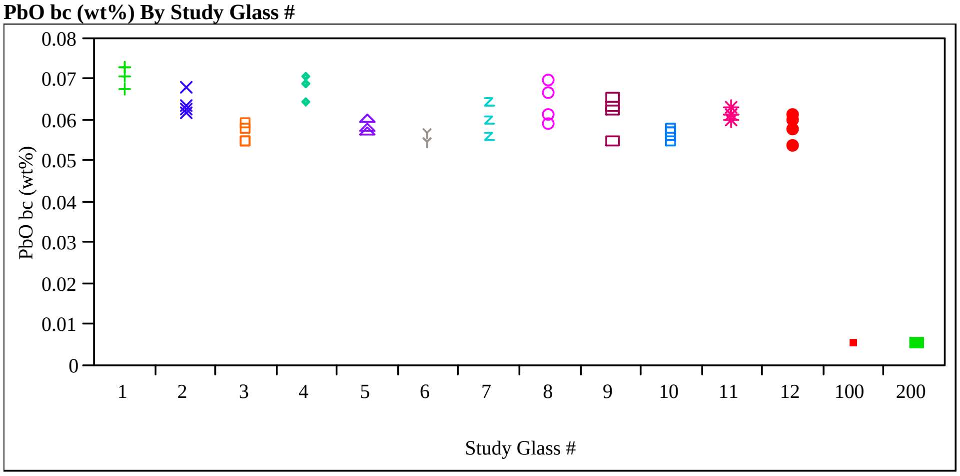


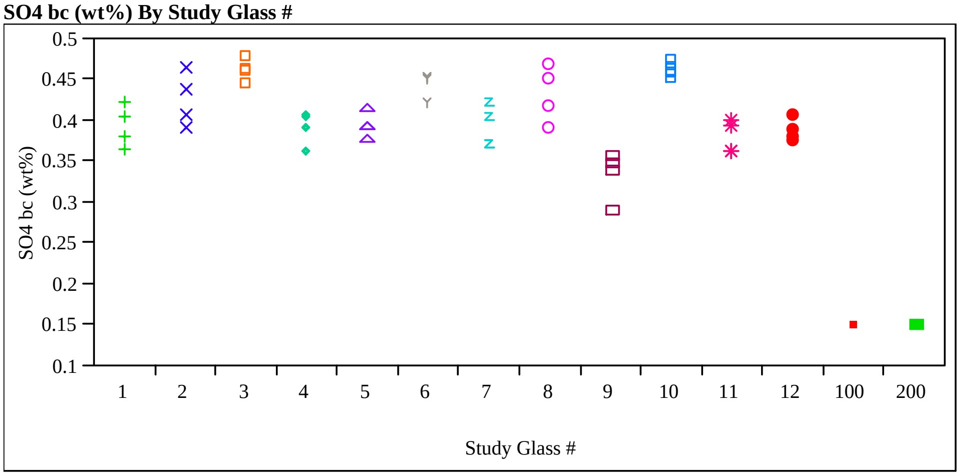
Exhibit C.5: Measured and Measured Bias-Corrected Oxide Weight Percents by Glass # for the Glasses Prepared Using the LM Method

(100 – Batch 1; 200 – Ustd)

PbO bc (wt%) By Study Glass #



SO4 bc (wt%) By Study Glass #



ThO2 bc (wt%) By Study Glass #

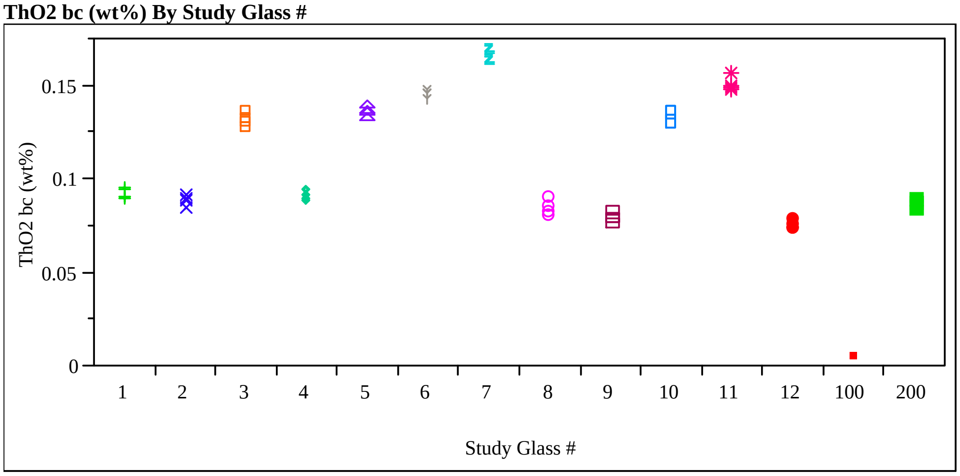
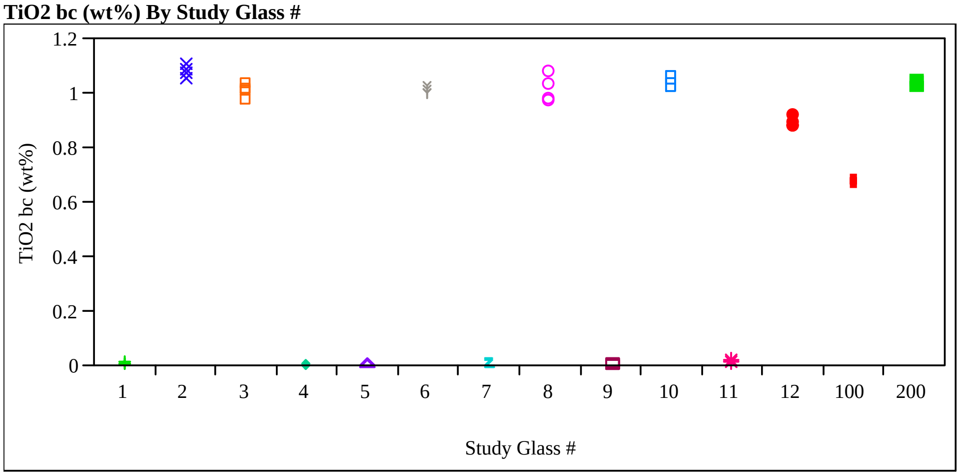


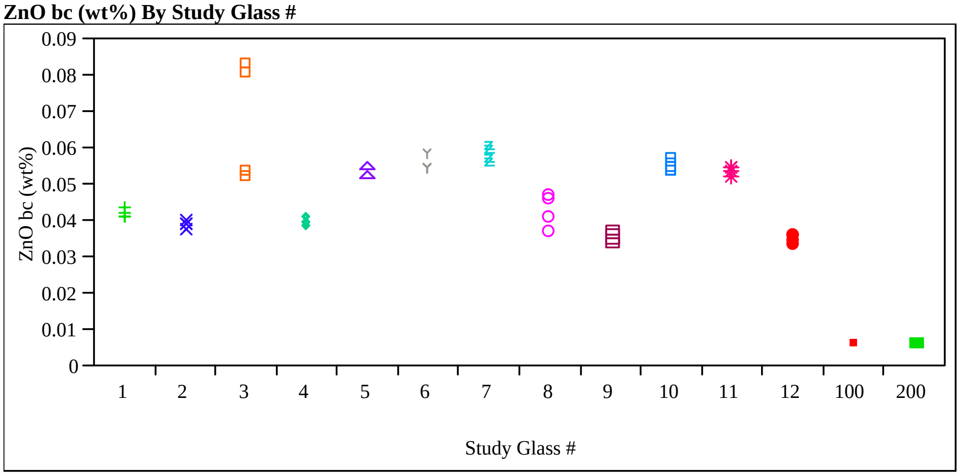
Exhibit C.5: Measured and Measured Bias-Corrected Oxide Weight Percents by Glass # for the Glasses Prepared Using the LM Method

(100 – Batch 1; 200 – Ustd)

TiO2 bc (wt%) By Study Glass #



ZnO bc (wt%) By Study Glass #



ZrO2 bc (wt%) By Study Glass #

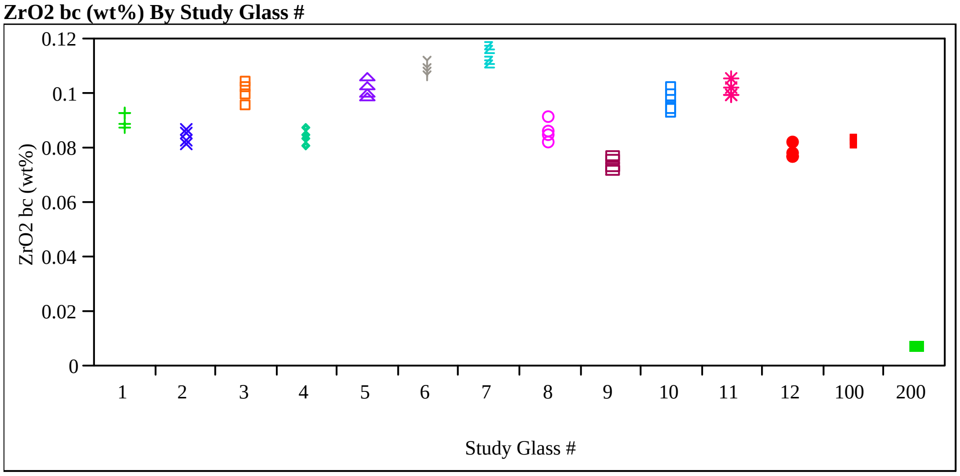
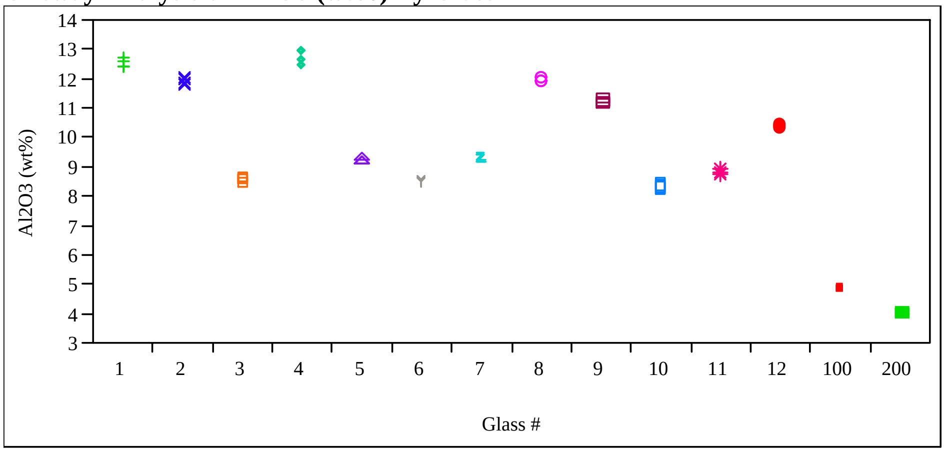


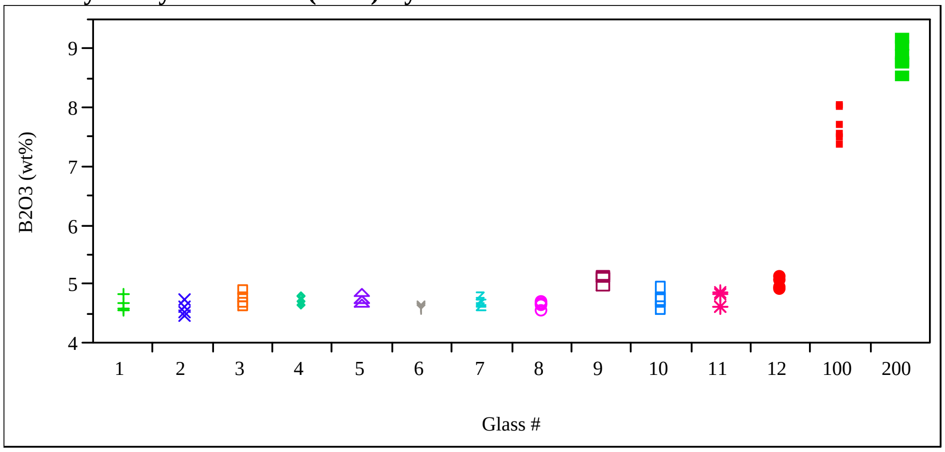
Exhibit C.6: Measured and Measured Bias-Corrected Oxide Weight Percents by Glass # for the Glasses Prepared Using the PF Method

(100 – Batch 1; 200 – Ustd)

Oneway Analysis of Al2O3 (wt%) By Glass #



Oneway Analysis of B2O3 (wt%) By Glass #



Oneway Analysis of Fe2O3 (wt%) By Glass #

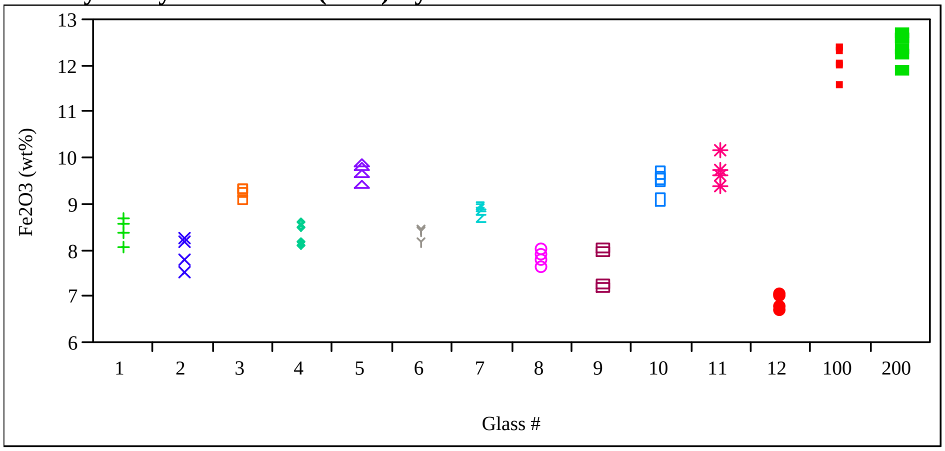
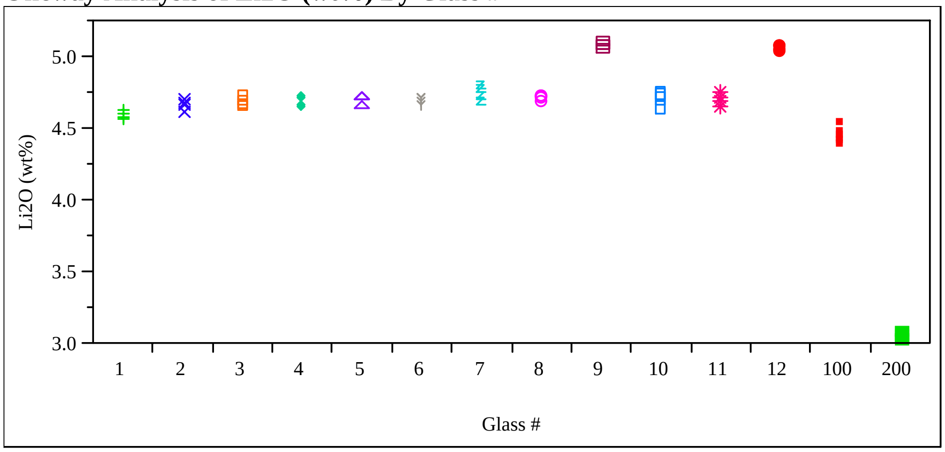


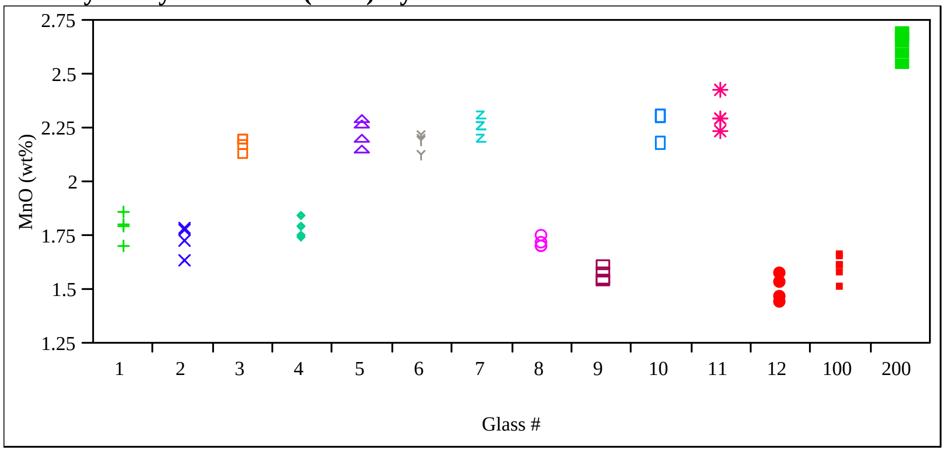
Exhibit C.6: Measured and Measured Bias-Corrected Oxide Weight Percents by Glass # for the Glasses Prepared Using the PF Method

(100 – Batch 1; 200 – Ustd)

Oneway Analysis of Li2O (wt%) By Glass #



Oneway Analysis of MnO (wt%) By Glass #



Oneway Analysis of NiO (wt%) By Glass #

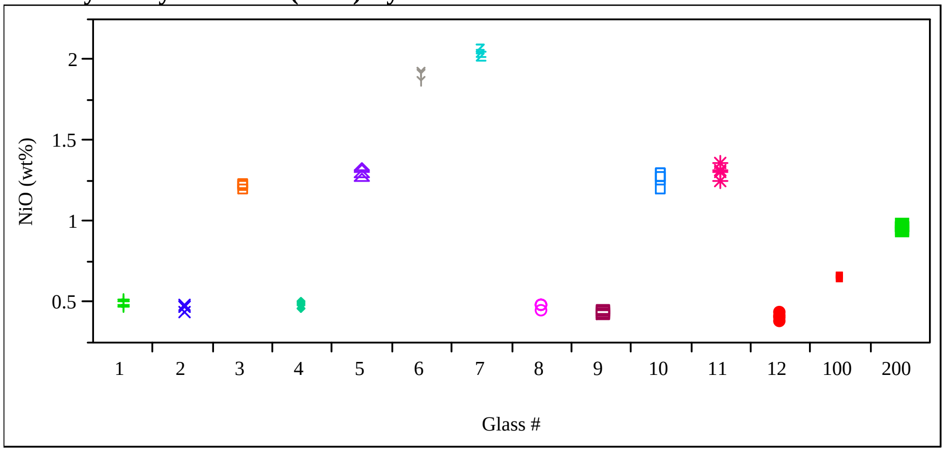
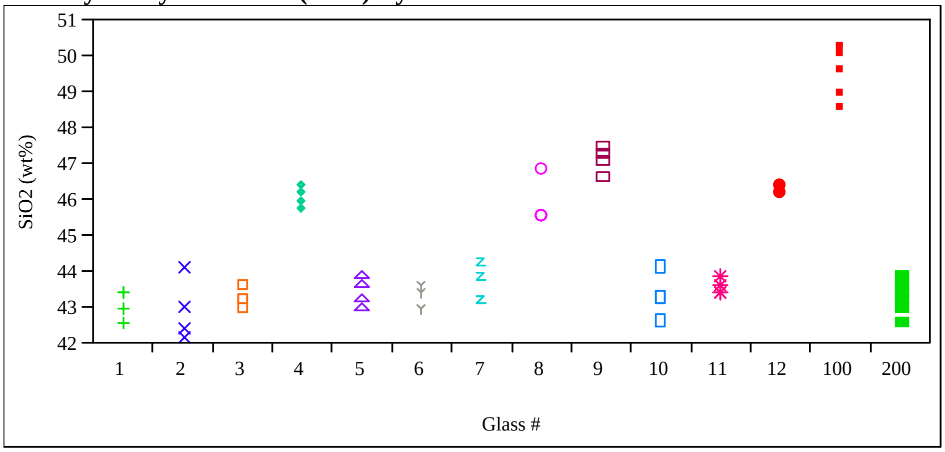


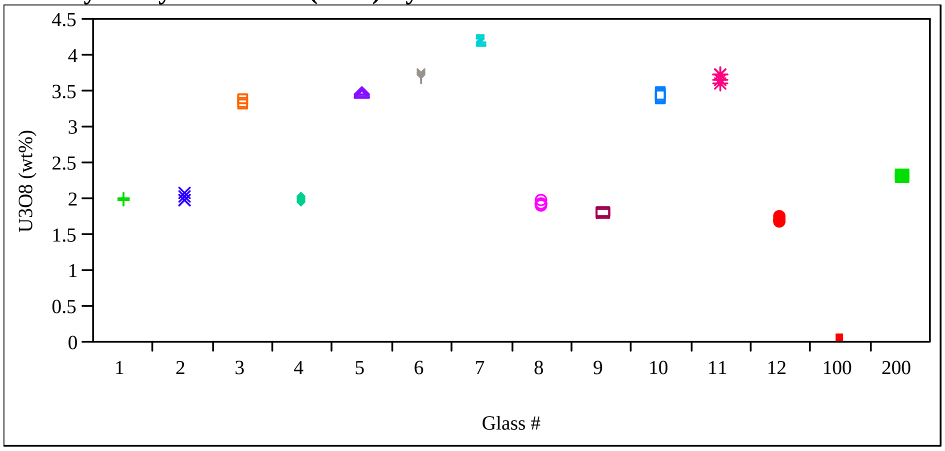
Exhibit C.6: Measured and Measured Bias-Corrected Oxide Weight Percents by Glass # for the Glasses Prepared Using the PF Method

(100 – Batch 1; 200 – Ustd)

Oneway Analysis of SiO2 (wt%) By Glass #



Oneway Analysis of U3O8 (wt%) By Glass #



Oneway Analysis of Al2O3 bc (wt%) By Glass #

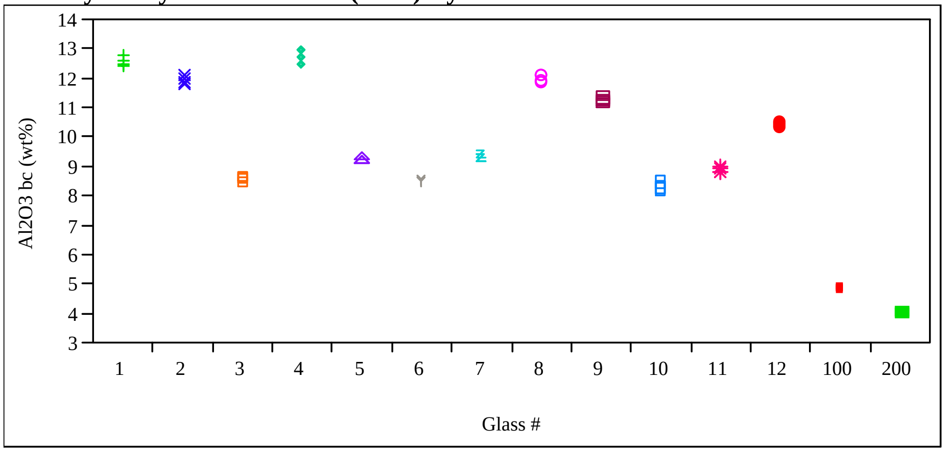
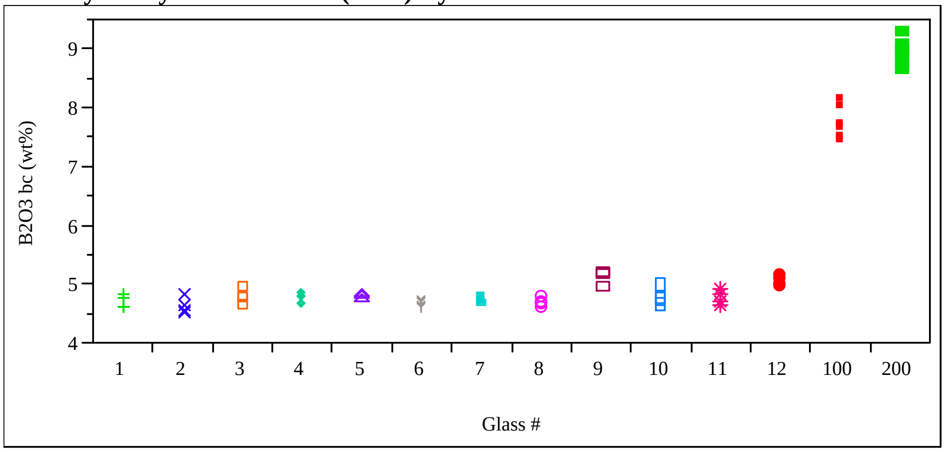


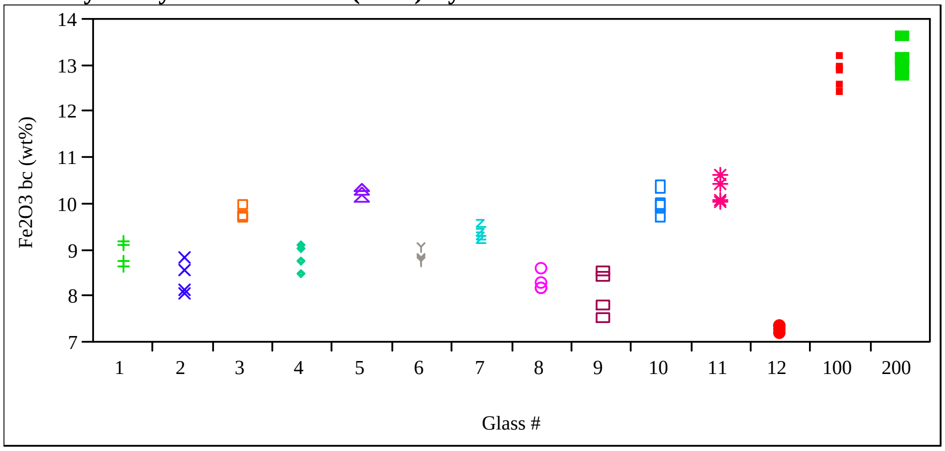
Exhibit C.6: Measured and Measured Bias-Corrected Oxide Weight Percents by Glass # for the Glasses Prepared Using the PF Method

(100 – Batch 1; 200 – Ustd)

Oneway Analysis of B2O3 bc (wt%) By Glass #



Oneway Analysis of Fe2O3 bc (wt%) By Glass #



Oneway Analysis of Li2O bc (wt%) By Glass #

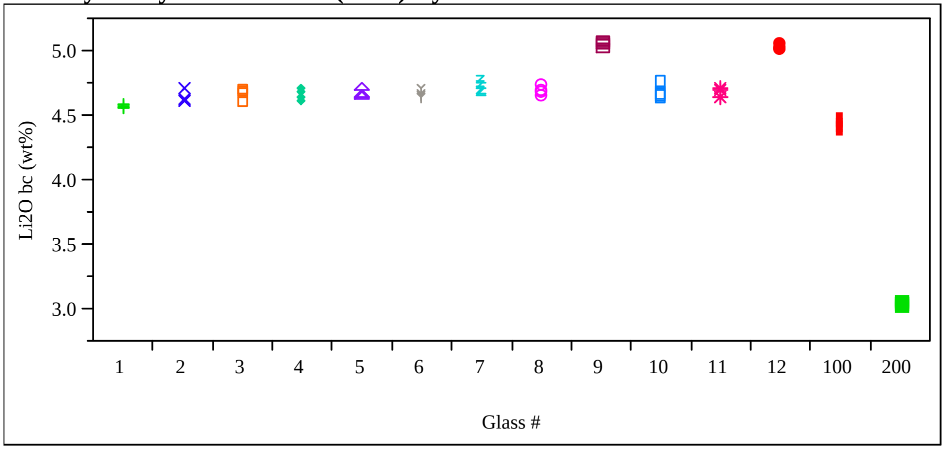
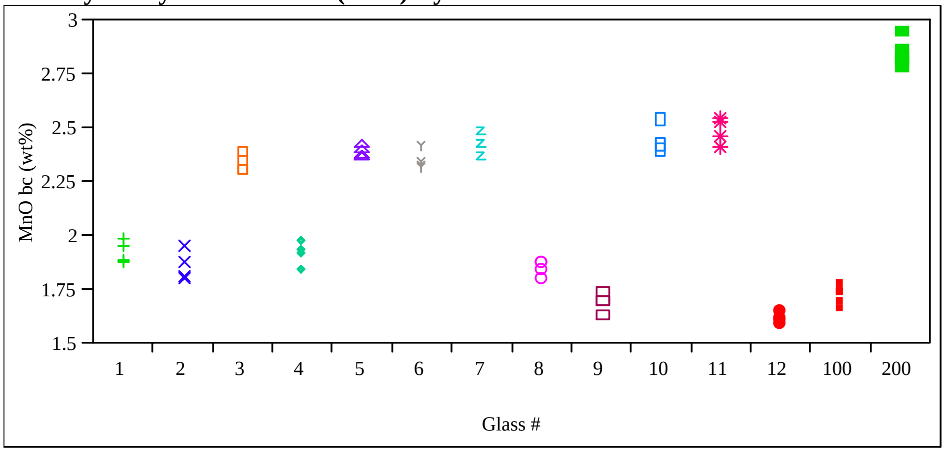


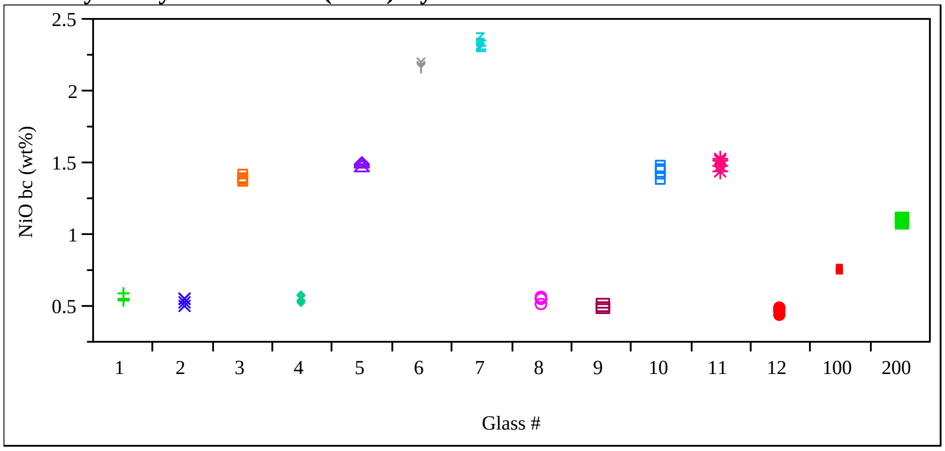
Exhibit C.6: Measured and Measured Bias-Corrected Oxide Weight Percents by Glass # for the Glasses Prepared Using the PF Method

(100 – Batch 1; 200 – Ustd)

Oneway Analysis of MnO bc (wt%) By Glass



Oneway Analysis of NiO bc (wt%) By Glass



Oneway Analysis of SiO2 bc (wt%) By Glass

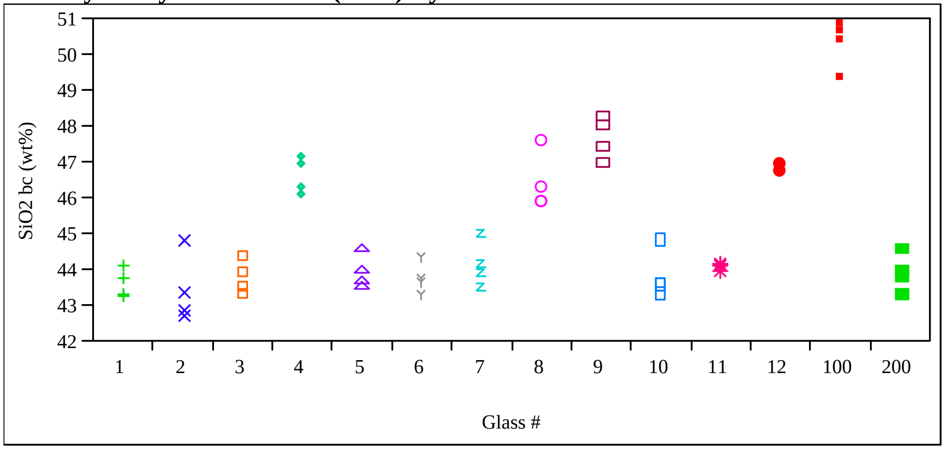


Exhibit C.6: Measured and Measured Bias-Corrected Oxide Weight Percents by Glass # for the Glasses Prepared Using the PF Method

(100 – Batch 1; 200 – Ustd)

Oneway Analysis of U3O8 bc (wt%) By Glass #

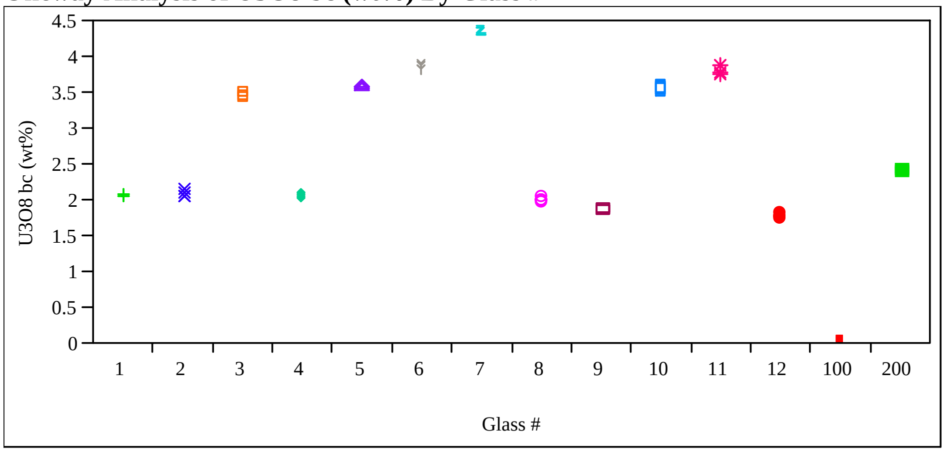
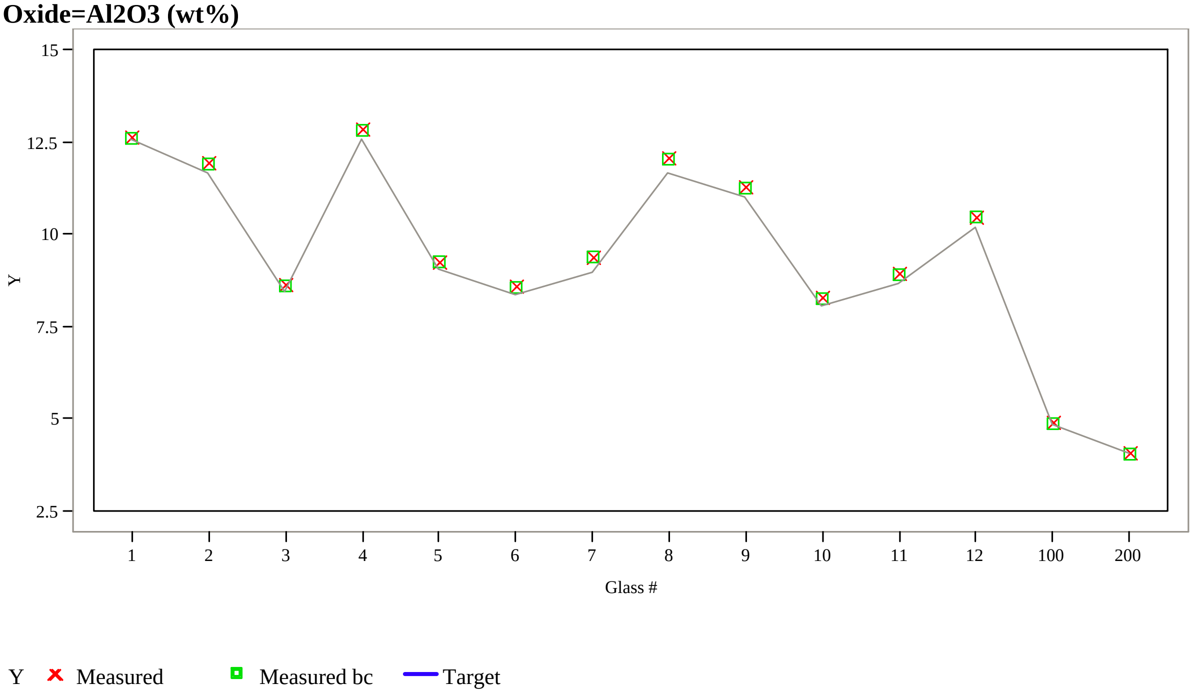


Exhibit C.7: Average Measured and Bias-Corrected (bc) Versus Targeted Compositions by Glass # by Oxide

(100 – Batch 1; 200 – Ustd)

Oxide=Al2O3 (wt%)



Oxide=B2O3 (wt%)

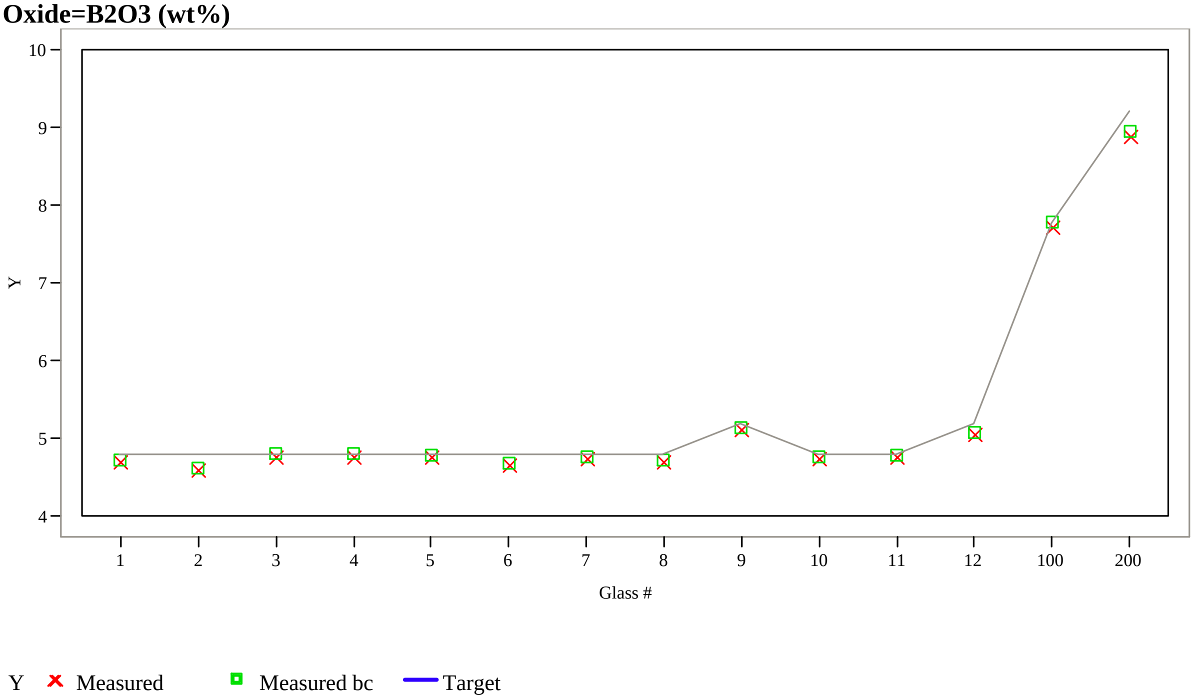
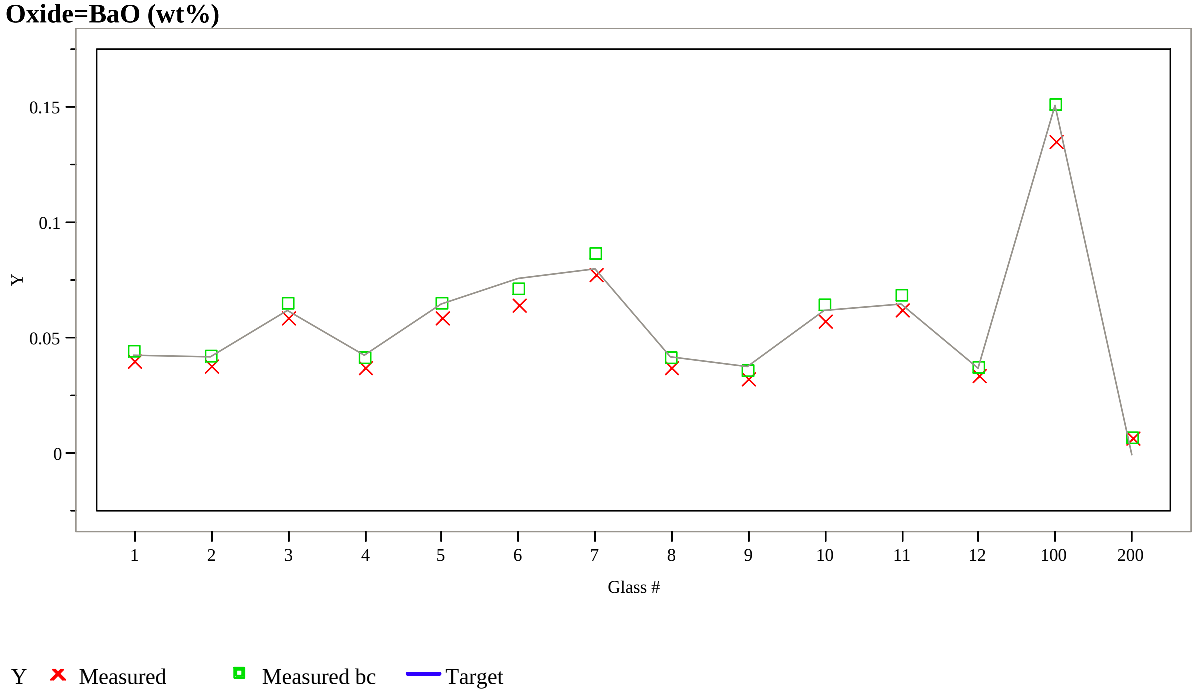


Exhibit C.7: Average Measured and Bias-Corrected (bc) Versus Targeted Compositions by Glass # by Oxide

(100 – Batch 1; 200 – Ustd)

Oxide=BaO (wt%)



Oxide=CaO (wt%)

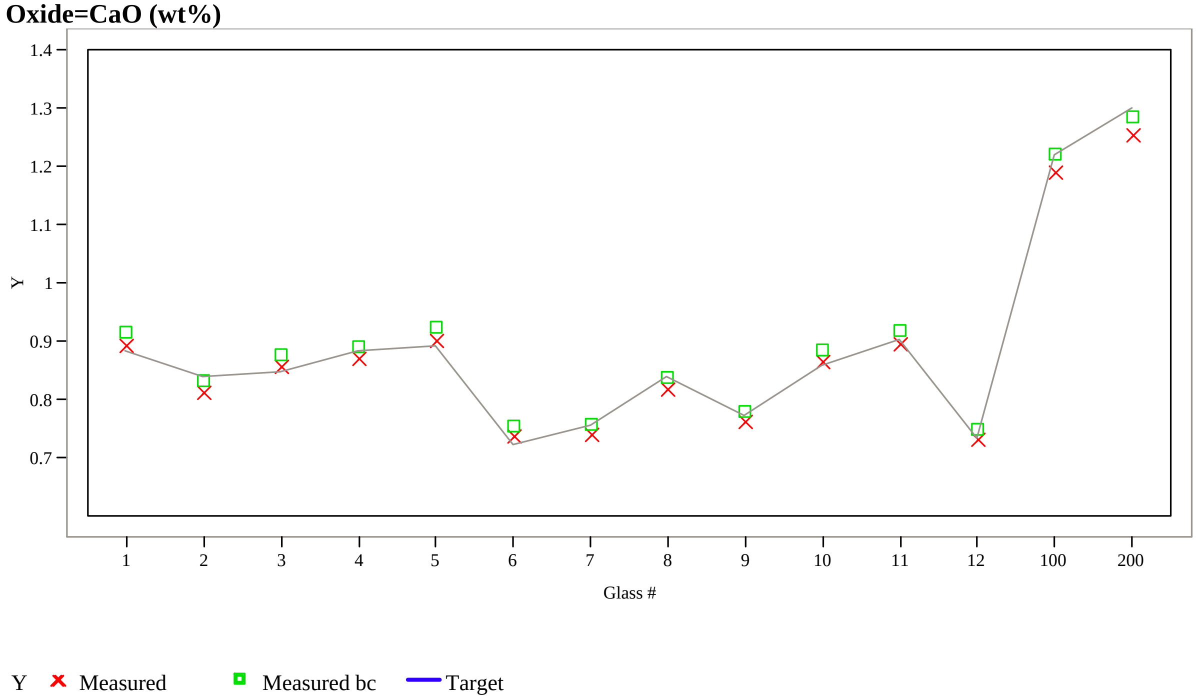
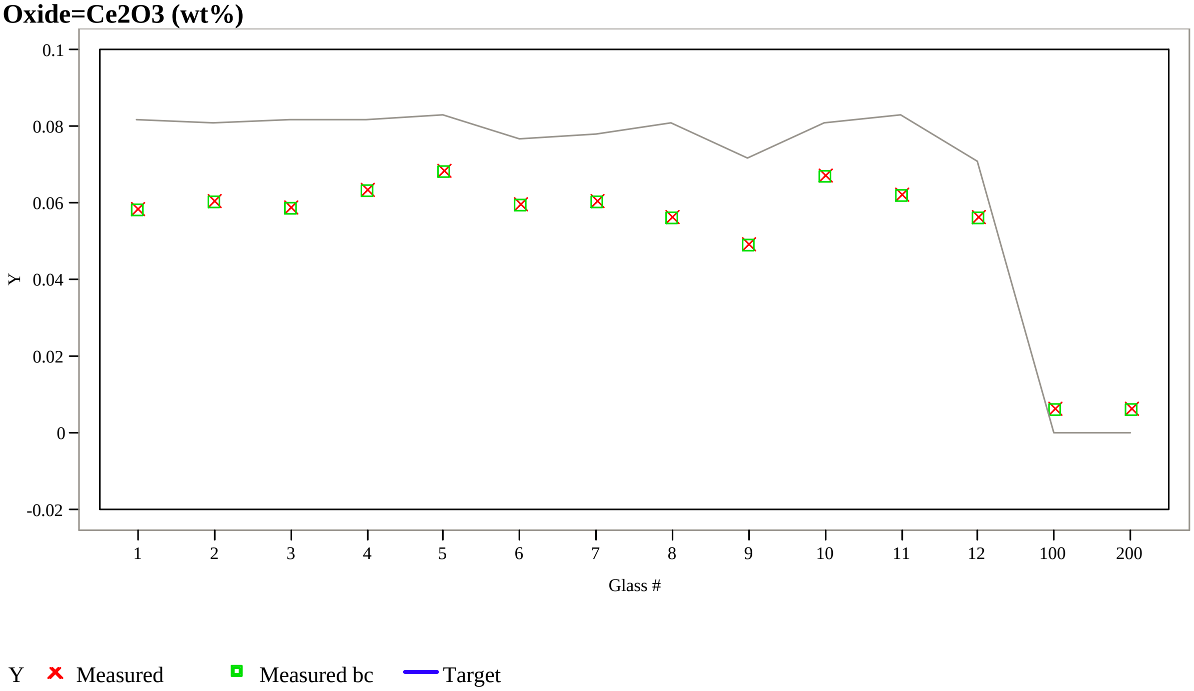


Exhibit C.7: Average Measured and Bias-Corrected (bc) Versus Targeted Compositions by Glass # by Oxide

(100 – Batch 1; 200 – Ustd)

Oxide=Ce2O3 (wt%)



Oxide=Cr2O3 (wt%)

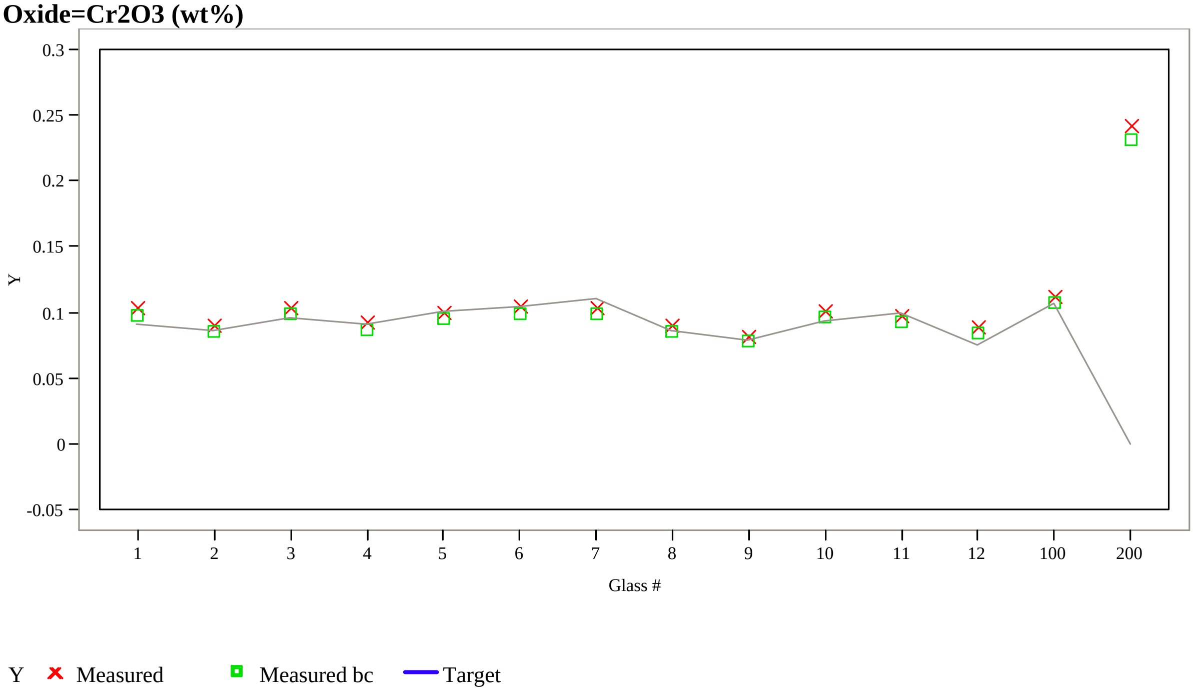
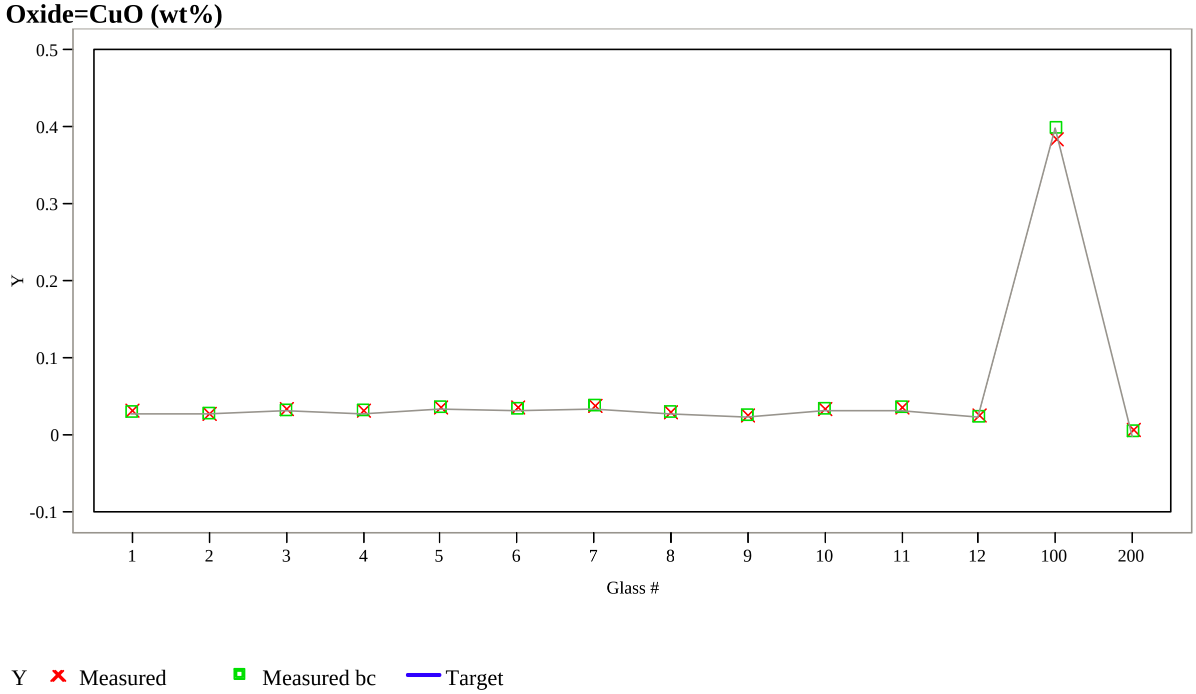


Exhibit C.7: Average Measured and Bias-Corrected (bc) Versus Targeted Compositions by Glass # by Oxide

(100 – Batch 1; 200 – Ustd)

Oxide=CuO (wt%)



Oxide=Fe2O3 (wt%)

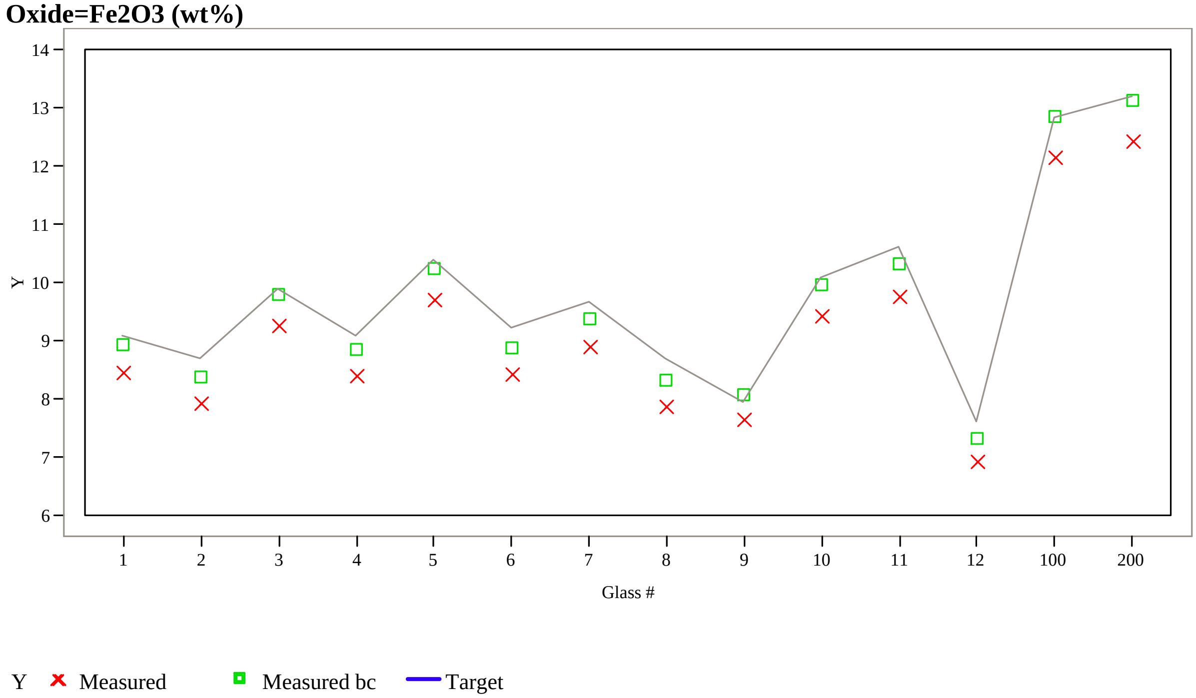
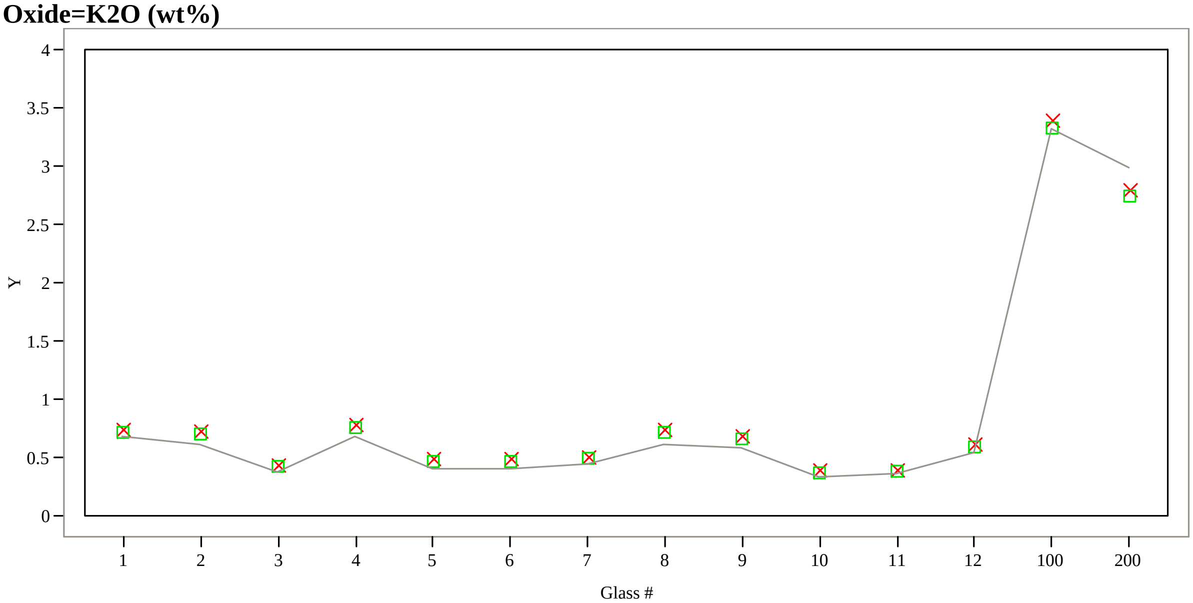


Exhibit C.7: Average Measured and Bias-Corrected (bc) Versus Targeted Compositions by Glass # by Oxide

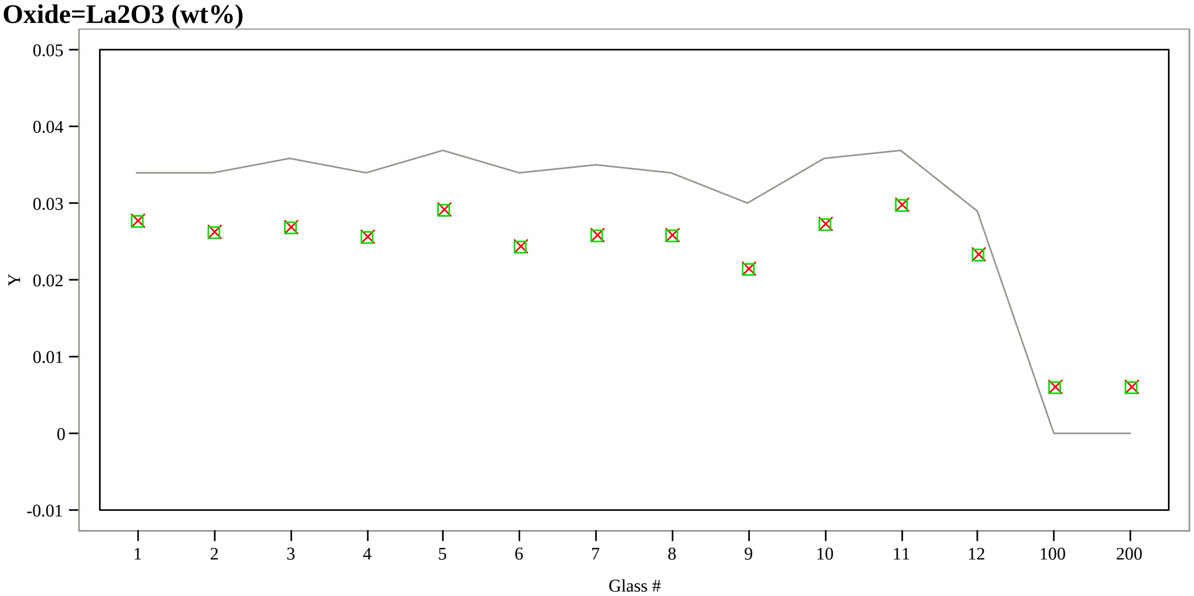
(100 – Batch 1; 200 – Ustd)

Oxide=K2O (wt%)



Y ✕ Measured ▫ Measured bc — Target

Oxide=La2O3 (wt%)

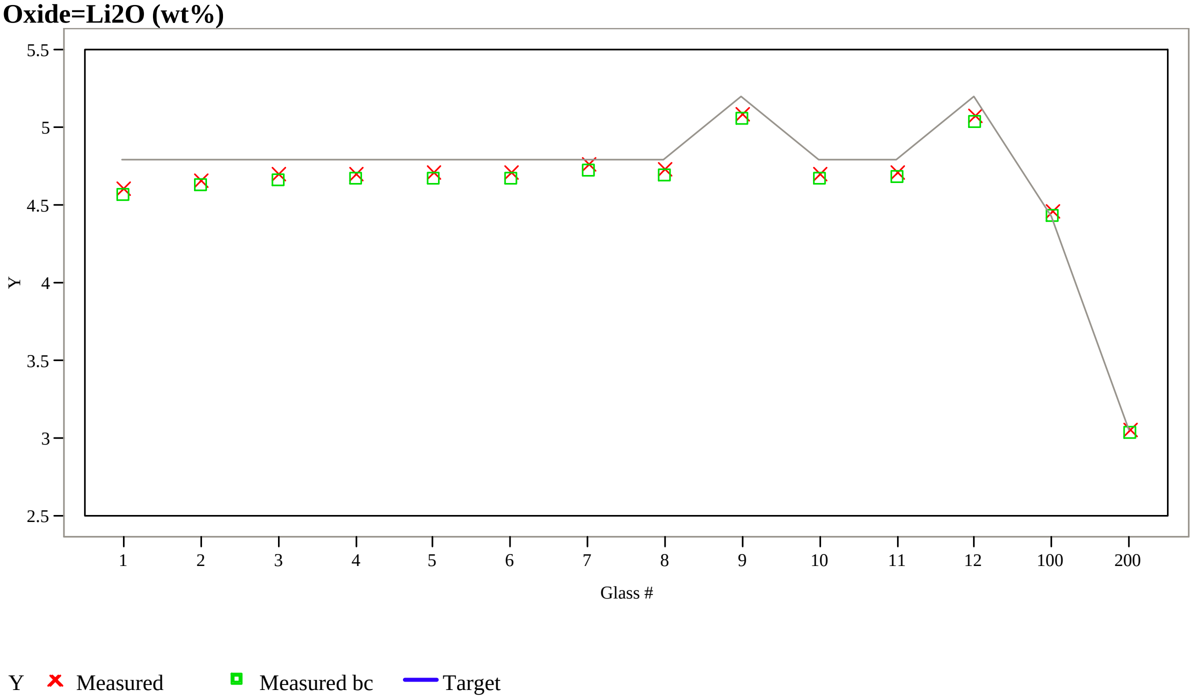


Y ✕ Measured ▫ Measured bc — Target

Exhibit C.7: Average Measured and Bias-Corrected (bc) Versus Targeted Compositions by Glass # by Oxide

(100 – Batch 1; 200 – Ustd)

Oxide=Li2O (wt%)



Oxide=MgO (wt%)

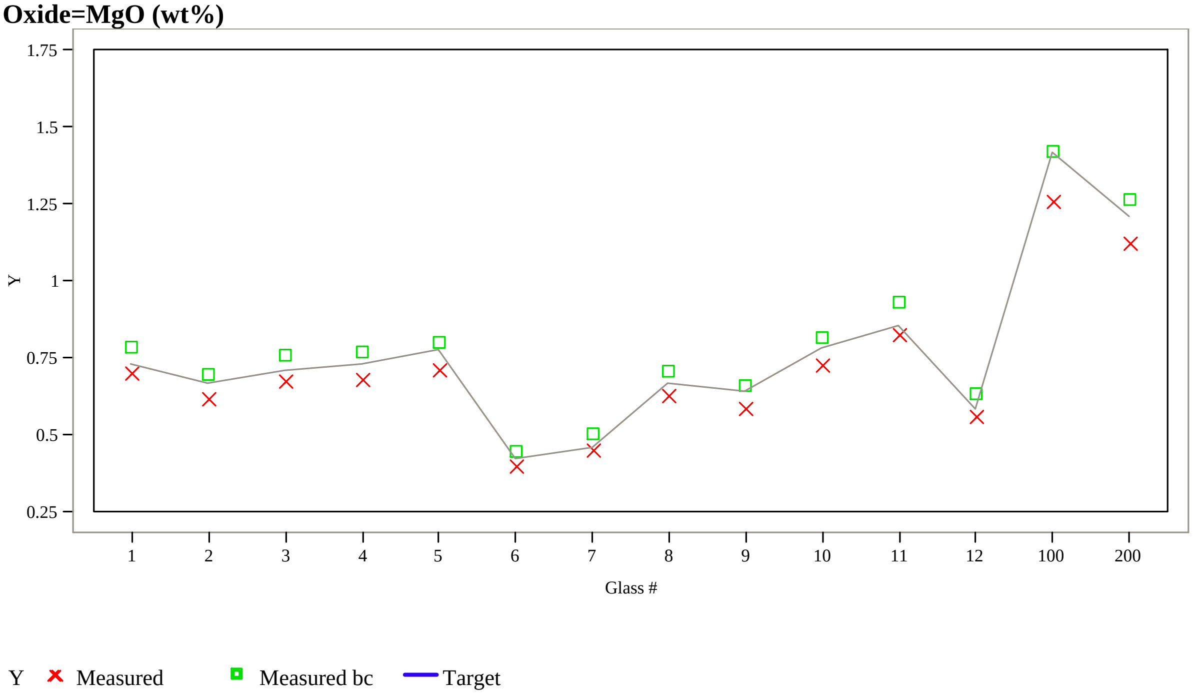
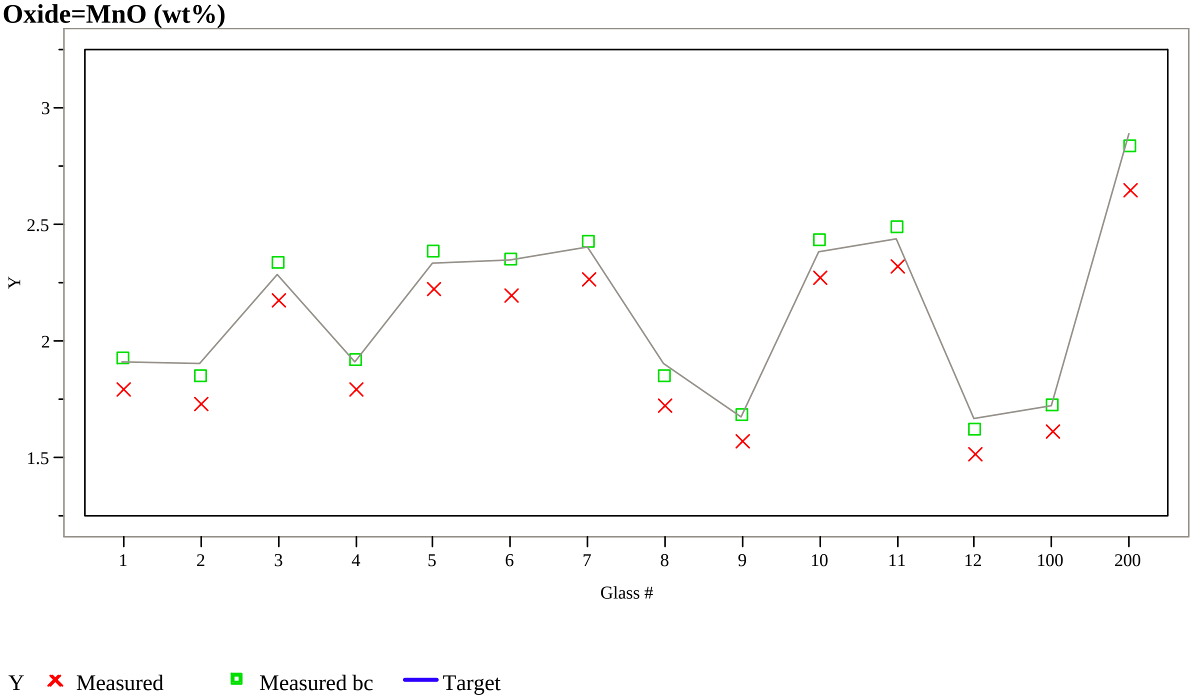


Exhibit C.7: Average Measured and Bias-Corrected (bc) Versus Targeted Compositions by Glass # by Oxide

(100 – Batch 1; 200 – Ustd)

Oxide=MnO (wt%)



Oxide=Na2O (wt%)

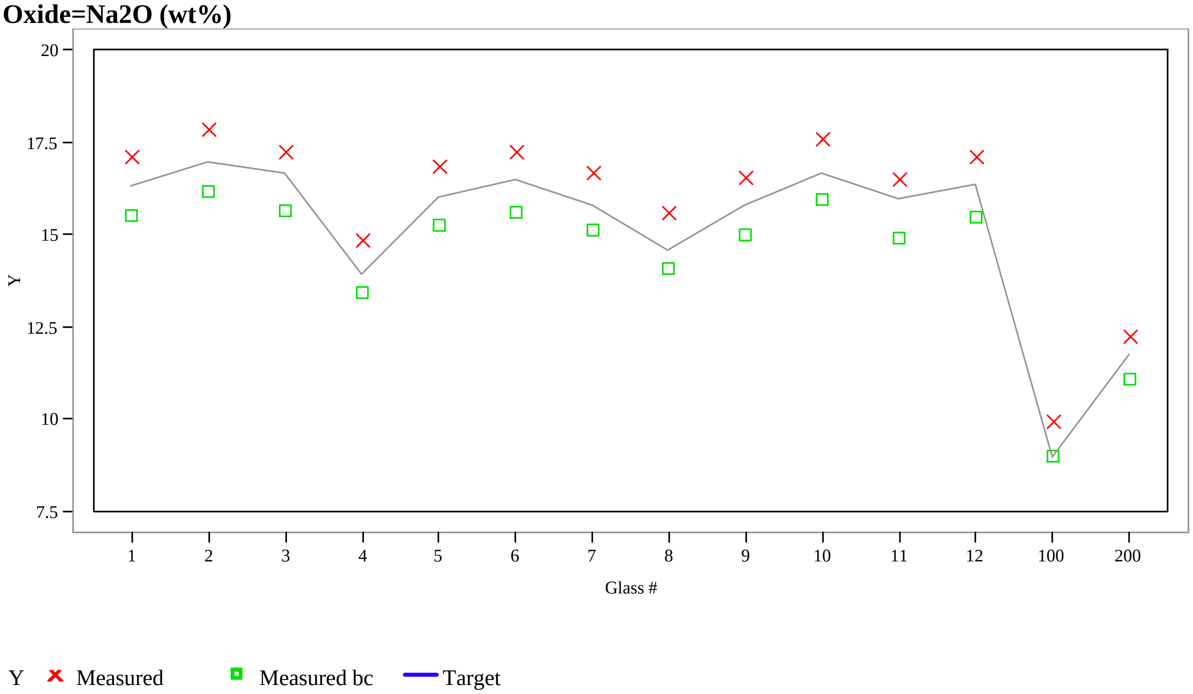
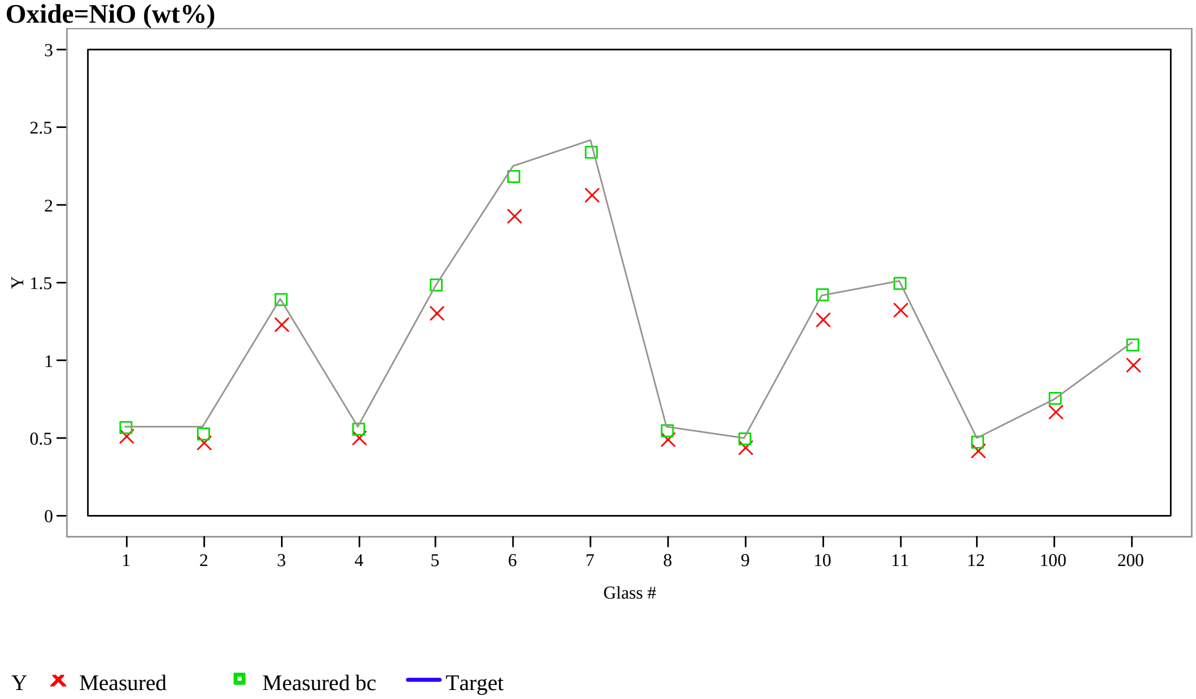


Exhibit C.7: Average Measured and Bias-Corrected (bc) Versus Targeted Compositions by Glass # by Oxide

(100 – Batch 1; 200 – Ustd)

Oxide=NiO (wt%)



Oxide=PbO (wt%)

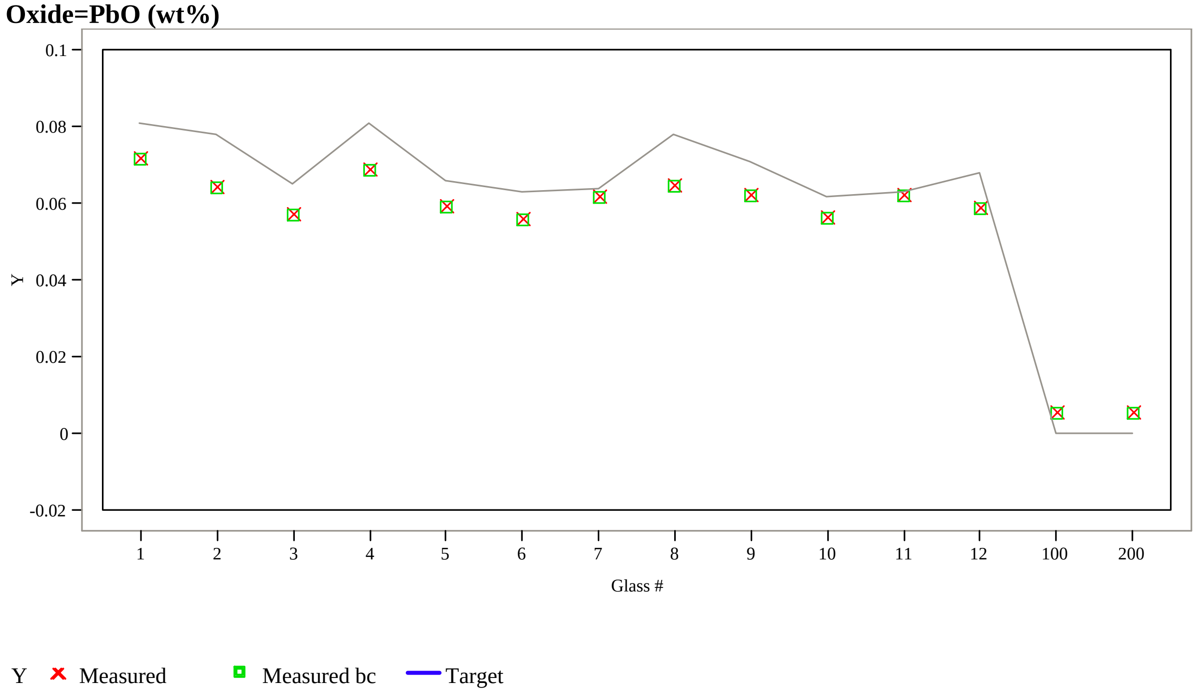
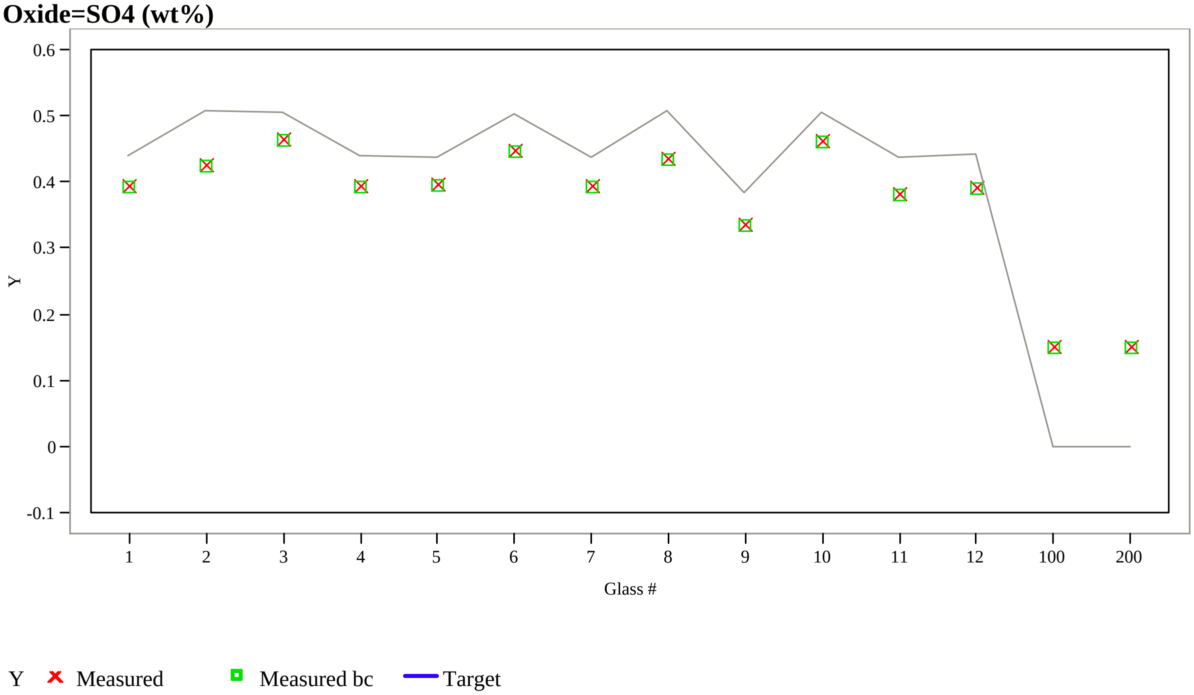


Exhibit C.7: Average Measured and Bias-Corrected (bc) Versus Targeted Compositions by Glass # by Oxide

(100 – Batch 1; 200 – Ustd)

Oxide=SO4 (wt%)



Oxide=SiO2 (wt%)

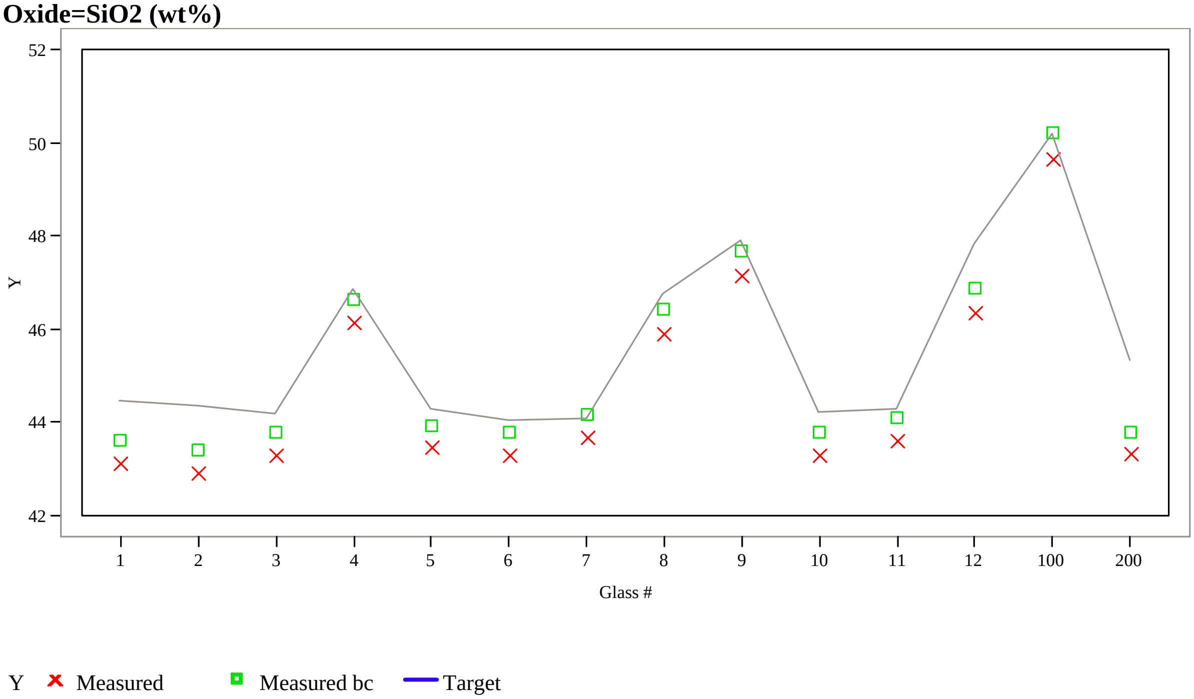
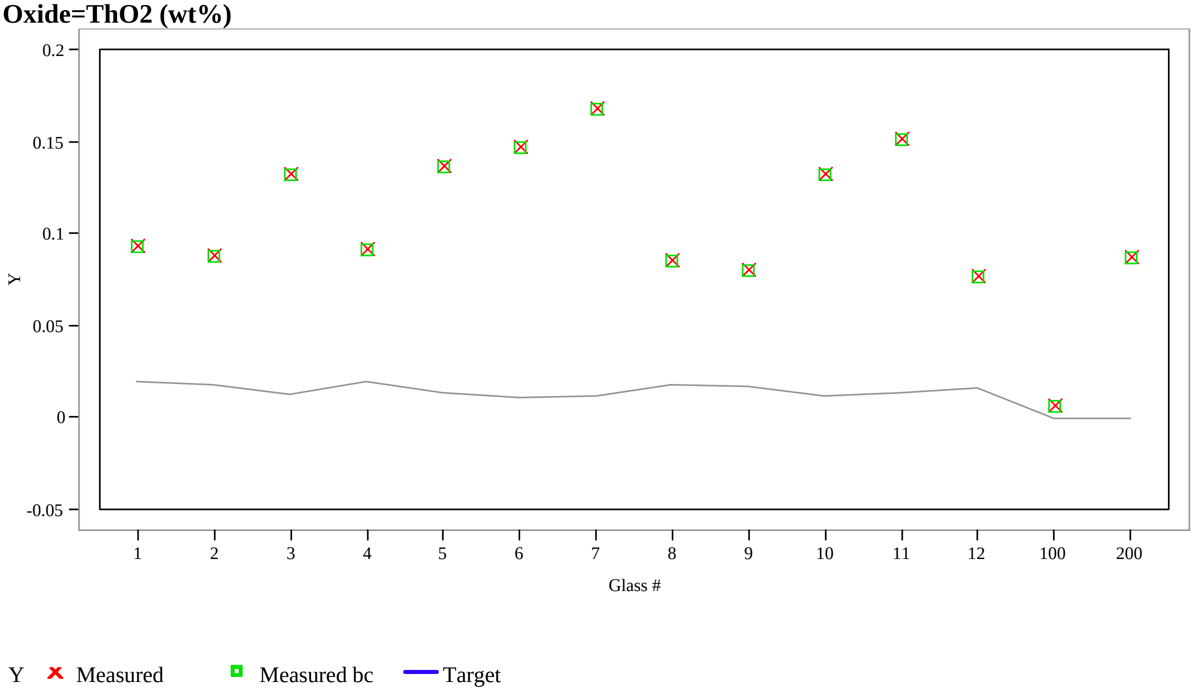


Exhibit C.7: Average Measured and Bias-Corrected (bc) Versus Targeted Compositions by Glass # by Oxide

(100 – Batch 1; 200 – Ustd)

Oxide=ThO2 (wt%)



Oxide=TiO2 (wt%)

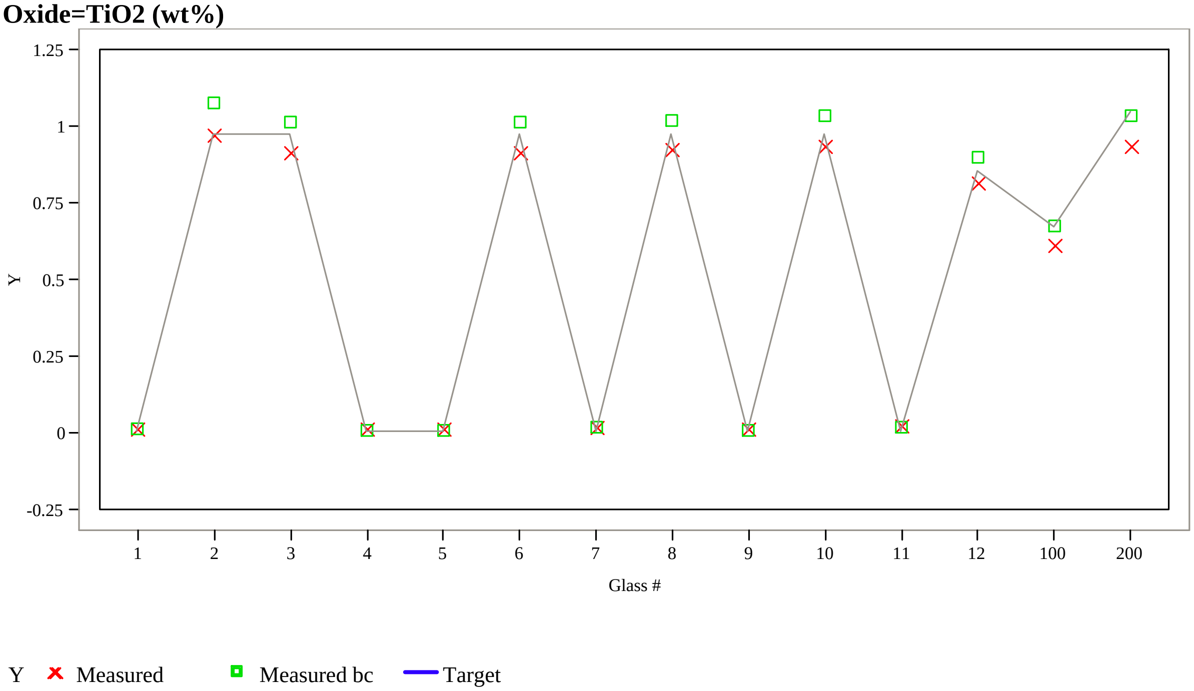
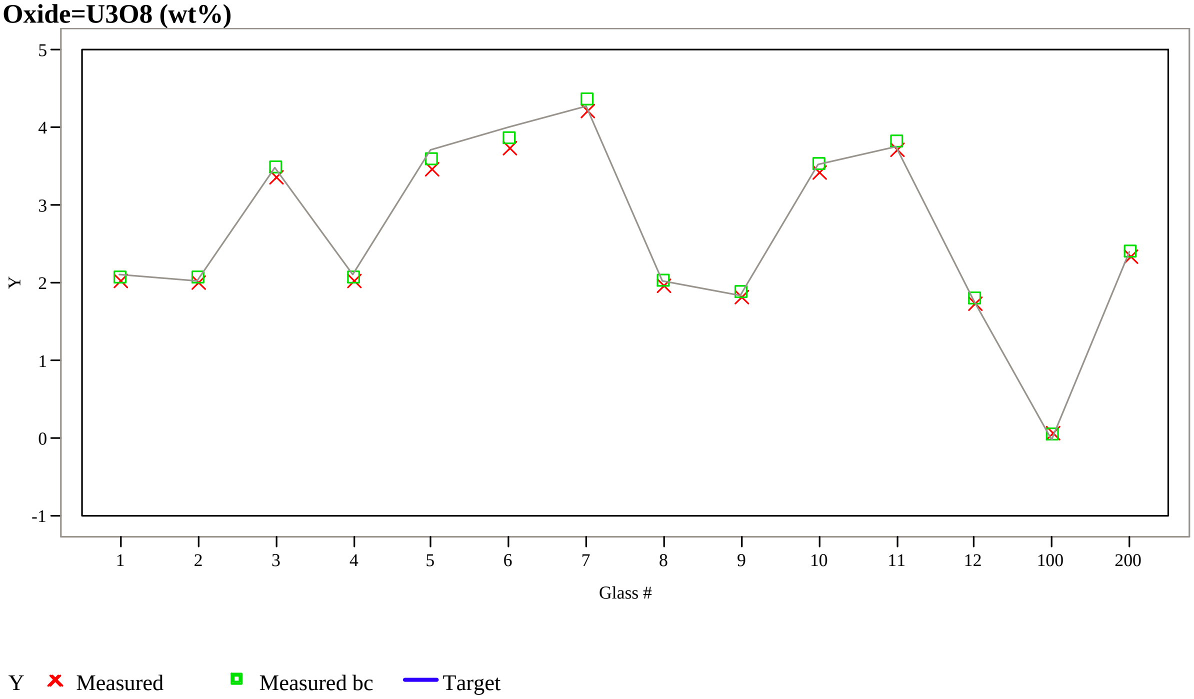


Exhibit C.7: Average Measured and Bias-Corrected (bc) Versus Targeted Compositions by Glass # by Oxide

(100 – Batch 1; 200 – Ustd)

Oxide=U3O8 (wt%)



Oxide=ZnO (wt%)

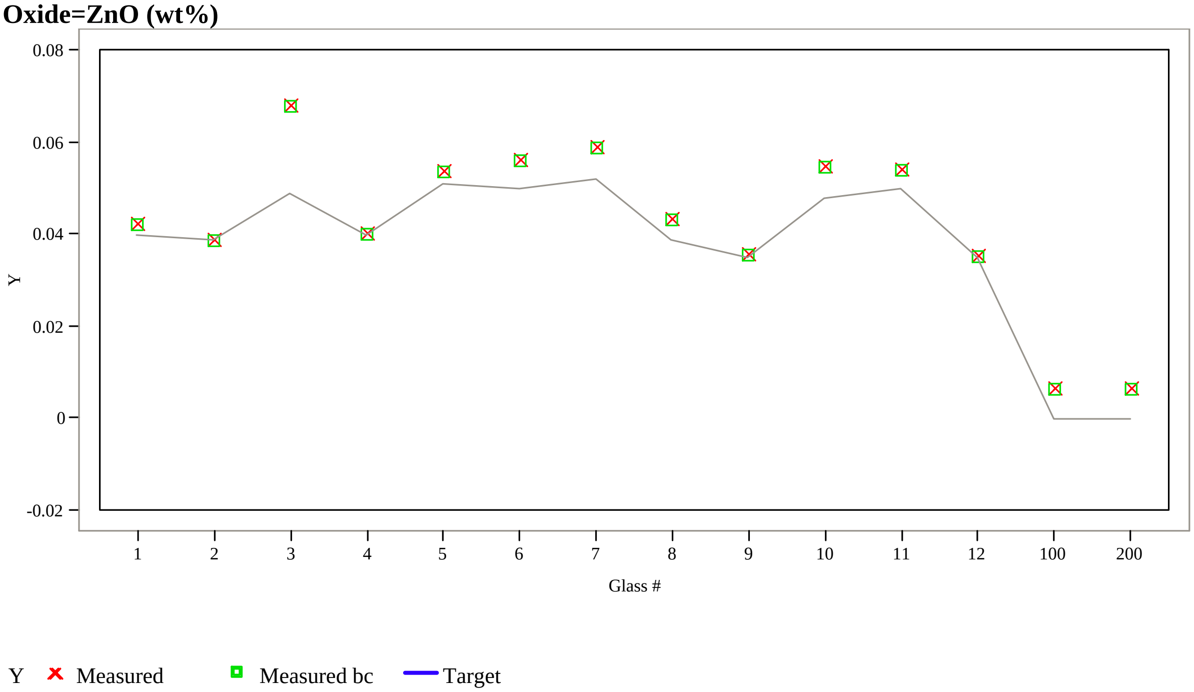
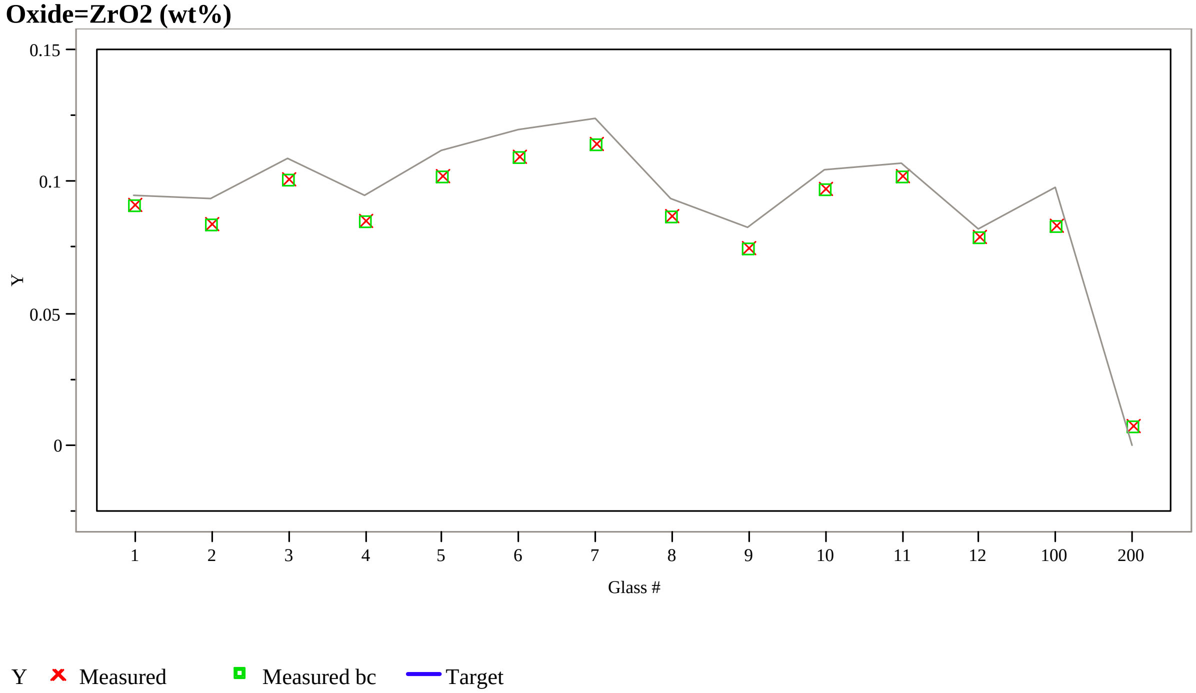


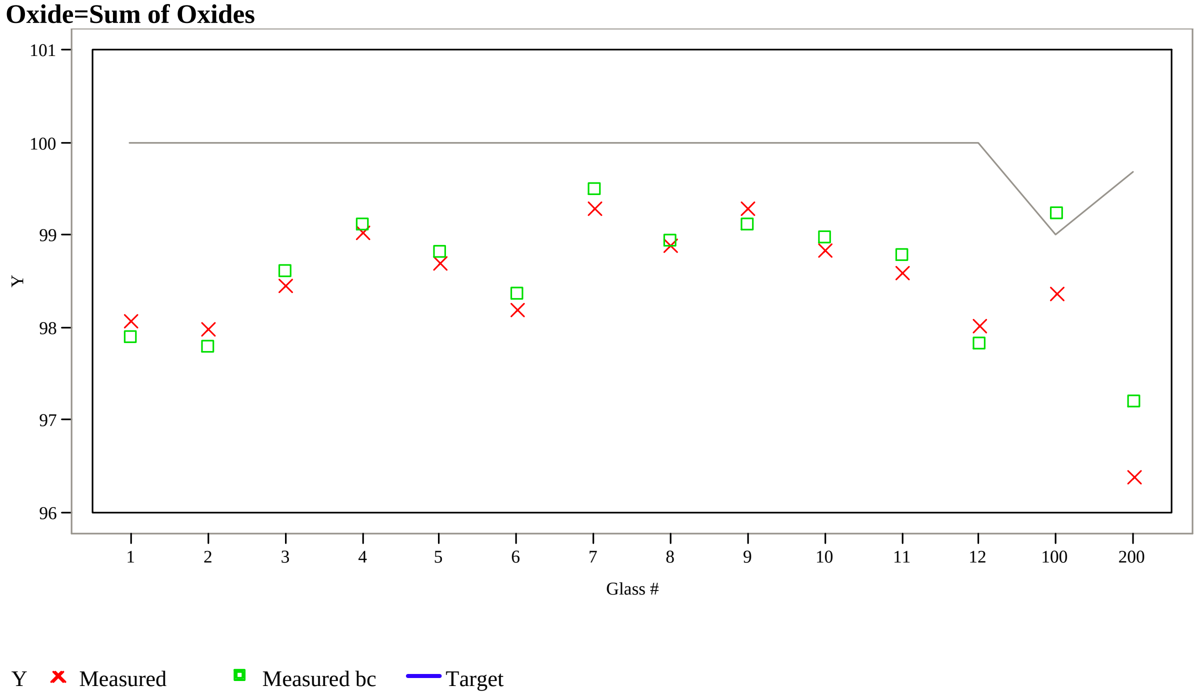
Exhibit C.7: Average Measured and Bias-Corrected (bc) Versus Targeted Compositions by Glass # by Oxide

(100 – Batch 1; 200 – Ustd)

Oxide=ZrO2 (wt%)



Oxide=Sum of Oxides



APPENDIX D

Tables and Exhibits Supporting the Analysis of the PCT Results for the Nepheline Study Glasses

Table D.1: SRNL-ML Measurements of the PCT Solutions for the Nepheline Study Glasses

					Elemental Concentrations as received (ar) from the SRNL-ML (in ppm)										
Glass ID	Heat Treatment	Block	Seq	SRNL-ML ID	B (ar)	Ba ar	Cd ar	Cr ar	Fe ar	Li ar	Na ar	Pb ar	Si ar	Th ar	U ar
Soln Std		1	1	STD-B1-1	20.5	<0.010	<0.080	<0.050	4.02	9.68	79.9	<0.200	51.8	<0.100	<0.100
SB4-NEPH-02	quenched	1	2	X76	7.05	<0.010	<0.080	<0.050	8.61	10.4	90	<0.200	77.3	<0.100	1.2
SB4-NEPH-12	quenched	1	3	X26	7.48	<0.010	<0.080	<0.050	14	12.7	88.2	<0.200	92	<0.100	2.53
Blank		1	4	X56	<0.040	<0.010	<0.080	<0.050	<0.040	<0.500	<0.100	<0.200	<0.200	<0.100	<0.100
SB4-NEPH-11	quenched	1	5	X69	9.96	<0.010	<0.080	<0.050	5.51	14.1	99.2	<0.200	90.4	<0.100	1.95
SB4-NEPH-10ccc	ccc	1	6	X54	10.2	<0.010	<0.080	<0.050	6.71	15.3	103	<0.200	98.6	<0.100	1.59
SB4-NEPH-02ccc	ccc	1	7	X23	12.4	<0.010	<0.080	<0.050	8.65	17	101	<0.200	93.6	<0.100	1.24
SB4-NEPH-04ccc	ccc	1	8	X08	6.04	<0.010	<0.080	<0.050	4.15	9.79	44.7	<0.200	63.2	<0.100	3.47
Soln Std		1	9	STD-B1-2	19.8	<0.010	<0.080	<0.050	4.03	9.63	80.8	<0.200	50.9	<0.100	<0.100
ARM-1		1	10	X63	12.7	<0.010	<0.080	<0.050	0.252	9.22	24.4	<0.200	42.1	<0.100	<0.100
SB4-NEPH-11ccc	ccc	1	11	X33	This sample was inadvertently spilled and lost.										
SB4-NEPH-09ccc	ccc	1	12	X30	8.13	<0.010	<0.080	<0.050	12.3	15.2	73.1	<0.200	90	<0.100	4.79
SB4-NEPH-10	quenched	1	13	X48	10.9	<0.010	<0.080	<0.050	5.79	14.9	114	<0.200	98.2	<0.100	1.24
SB4-NEPH-12ccc	ccc	1	14	X19	7.41	<0.010	<0.080	<0.050	13.6	12.9	79.7	<0.200	90.3	<0.100	2.62
SB4-NEPH-04	quenched	1	15	X80	5.27	<0.010	<0.080	<0.050	4.86	8.47	45.3	<0.200	59.5	<0.100	2.35
SB4-NEPH-09	quenched	1	16	X55	6.9	<0.010	<0.080	<0.050	11.5	11.7	77.7	<0.200	82.2	<0.100	4.31
Soln Std		1	17	STD-B1-3	20	<0.010	<0.080	<0.050	4.06	9.67	82.2	<0.200	51.2	<0.100	<0.100
Soln Std		2	1	STD-B2-1	20.5	<0.010	<0.080	<0.050	4.17	9.62	80	<0.200	51.6	<0.100	<0.100
SB4-NEPH-09ccc	ccc	2	2	X66	8.62	<0.010	<0.080	<0.050	12.6	15.5	73.2	<0.200	92.2	<0.100	4.8
SB4-NEPH-12ccc	ccc	2	3	X28	7.63	<0.010	<0.080	<0.050	13.7	13	78.6	<0.200	91.5	<0.100	2.5
SB4-NEPH-02ccc	ccc	2	4	X67	12.9	<0.010	<0.080	<0.050	8.69	17.8	100	<0.200	99.2	<0.100	1.35
SB4-NEPH-04	quenched	2	5	X73	5.51	<0.010	<0.080	<0.050	5.2	8.87	46.3	<0.200	63	<0.100	3.3
SB4-NEPH-11	quenched	2	6	X35	10.2	<0.010	<0.080	<0.050	5.77	14	98.3	<0.200	90.8	<0.100	1.96
SB4-NEPH-12	quenched	2	7	X03	7.76	<0.010	<0.080	<0.050	14.1	12.8	89	<0.200	93.8	<0.100	2.78
SB4-NEPH-10	quenched	2	8	X52	10.8	<0.010	<0.080	<0.050	6.09	14.8	112	<0.200	99.3	<0.100	1.28
Soln Std		2	9	STD-B2-2	19.8	<0.010	<0.080	<0.050	4.08	9.57	80.6	<0.200	51.2	<0.100	<0.100
ARM-1		2	10	X37	12.6	<0.010	<0.080	<0.050	0.197	9.08	24.8	<0.200	41.9	<0.100	<0.100
SB4-NEPH-11ccc	ccc	2	11	X60	9.87	<0.010	<0.080	<0.050	5.93	14.5	90.7	<0.200	90	<0.100	1.75
SB4-NEPH-04ccc	ccc	2	12	X50	6.49	<0.010	<0.080	<0.050	4.53	10	47	<0.200	65.8	<0.100	2.98
SB4-NEPH-10ccc	ccc	2	13	X51	10.2	<0.010	<0.080	<0.050	7.06	15.3	103	<0.200	99.4	<0.100	1.84
SB4-NEPH-02	quenched	2	14	X75	7.3	<0.010	<0.080	<0.050	8.85	10.5	94.9	<0.200	78.1	<0.100	1.21
SB4-NEPH-09	quenched	2	15	X44	7.02	<0.010	<0.080	<0.050	11.2	13.6	78.8	<0.200	83.3	<0.100	4.33

Table D.1: SRNL-ML Measurements of the PCT Solutions for the Nepheline Study Glasses

					Elemental Concentrations as received (ar) from the SRNL-ML (in ppm)										
Glass ID	**Heat Treatment**	**Block**	**Seq**	**SRNL-ML ID**	**B (ar)**	**Ba ar**	**Cd ar**	**Cr ar**	**Fe ar**	**Li ar**	**Na ar**	**Pb ar**	**Si ar**	**Th ar**	**U ar**
Soln Std		2	16	STD-B2-3	19.8	<0.010	<0.080	<0.050	3.98	9.6	81.8	<0.200	51.2	<0.100	<0.100
Soln Std		3	1	STD-B3-1	20.3	<0.010	<0.080	<0.050	3.94	9.56	81.8	<0.200	52.1	<0.100	<0.100
SB4-NEPH-10	quenched	3	2	X72	11.1	<0.010	<0.080	<0.050	6.84	15.1	114	<0.200	104	<0.100	1.58
SB4-NEPH-04	quenched	3	3	X38	5.49	<0.010	<0.080	<0.050	4.86	9.02	46.8	<0.200	64.6	<0.100	3.26
SB4-NEPH-11ccc	ccc	3	4	X62	9.78	<0.010	<0.080	<0.050	5.91	14.6	90.4	<0.200	91.5	<0.100	1.51
SB4-NEPH-09	quenched	3	5	X11	6.9	<0.010	<0.080	<0.050	11.6	11.6	76.7	<0.200	83.8	<0.100	4.32
SB4-NEPH-02	quenched	3	6	X15	7.18	<0.010	<0.080	<0.050	8.72	10.5	90.2	<0.200	79	<0.100	1.06
SB4-NEPH-02ccc	ccc	3	7	X02	12.6	<0.010	<0.080	<0.050	9.53	17.9	103	<0.200	99	<0.100	1.13
SB4-NEPH-09ccc	ccc	3	8	X40	8.28	<0.010	<0.080	<0.050	13.1	15.7	75.3	<0.200	95	<0.100	4.74
Soln Std		3	9	STD-B3-2	19.8	<0.010	<0.080	<0.050	4	9.64	80.9	<0.200	52.3	<0.100	<0.100
SB4-NEPH-12ccc	ccc	3	10	X24	7.66	<0.010	<0.080	<0.050	13.4	13	80.2	<0.200	93.2	<0.100	2.79
SB4-NEPH-11	quenched	3	11	X64	10.1	<0.010	<0.080	<0.050	5.48	14	98.9	<0.200	92.4	<0.100	1.9
SB4-NEPH-04ccc	ccc	3	12	X46	6.24	<0.010	<0.080	<0.050	4.51	9.57	44.8	<0.200	64.3	<0.100	2.38
SB4-NEPH-12	quenched	3	13	X53	7.72	<0.010	<0.080	<0.050	14.1	13	90.7	<0.200	95.7	<0.100	2.66
ARM-1		3	14	X39	12.5	<0.010	<0.080	<0.050	<0.040	9.21	23.9	<0.200	43	<0.100	<0.100
SB4-NEPH-10ccc	ccc	3	15	X57	9.94	<0.010	<0.080	<0.050	8.09	15.3	103	<0.200	100	<0.100	2.11
Soln Std		3	16	STD-B3-3	19.6	<0.010	<0.080	<0.050	4.07	9.6	83.4	<0.200	52	<0.100	<0.100
Soln Std		4	1	STD-B4-1	20.6	<0.010	<0.080	<0.050	4.07	9.73	80.6	<0.200	52.3	<0.100	<0.100
Blank		4	2	X31	<0.040	<0.010	<0.080	<0.050	<0.040	<0.500	<0.100	<0.200	<0.200	<0.100	<0.100
SB4-NEPH-03ccc	ccc	4	3	X49	9.66	<0.010	<0.080	<0.050	6.47	14.8	97.7	<0.200	95.2	<0.100	1.23
SB4-NEPH-08	quenched	4	4	X32	5.81	<0.010	<0.080	<0.050	6.25	9.68	57.6	<0.200	70.2	<0.100	0.286
SB4-NEPH-07ccc	ccc	4	5	X10	8.21	<0.010	<0.080	<0.050	9.32	14.9	90.2	<0.200	93.4	<0.100	1.96
SB4-NEPH-06	quenched	4	6	X29	9.95	<0.010	<0.080	<0.050	5.8	14.3	109	<0.200	96.4	<0.100	1.36
SB4-NEPH-01	quenched	4	7	X07	6.15	<0.010	<0.080	<0.050	7.36	9.4	73.6	<0.200	68	<0.100	2.31
SB4-NEPH-06ccc	ccc	4	8	X34	8.72	<0.010	<0.080	<0.050	13.8	15.8	103	<0.200	104	<0.100	5.05
Soln Std		4	9	STD-B4-2	20.1	<0.010	<0.080	<0.050	3.99	9.68	80.8	<0.200	52.2	<0.100	<0.100
EA		4	10	X70	38.3	<0.010	<0.080	<0.050	<0.040	11.3	106	<0.200	59.7	<0.100	<0.100
SB4-NEPH-07	quenched	4	11	X61	9.73	<0.010	<0.080	<0.050	5.81	13.6	95.8	<0.200	89.4	<0.100	1.54
SB4-NEPH-03	quenched	4	12	X36	10.3	<0.010	<0.080	<0.050	9.11	13.9	108	<0.200	98.2	<0.100	1.39
SB4-NEPH-05	quenched	4	13	X09	9.48	<0.010	<0.080	<0.050	8	13.1	96.3	<0.200	87.8	<0.100	1.94
SB4-NEPH-01ccc	ccc	4	14	X05	21.7	<0.010	<0.080	<0.050	13.2	35.7	113	<0.200	128	<0.100	5.7
SB4-NEPH-05ccc	ccc	4	15	X27	9.16	<0.010	<0.080	<0.050	6.2	14	89.1	<0.200	88.1	<0.100	1.3

Table D.1: SRNL-ML Measurements of the PCT Solutions for the Nepheline Study Glasses

					Elemental Concentrations as received (ar) from the SRNL-ML (in ppm)										
Glass ID	Heat Treatment	Block	Seq	SRNL-ML ID	B (ar)	Ba ar	Cd ar	Cr ar	Fe ar	Li ar	Na ar	Pb ar	Si ar	Th ar	U ar
SB4-NEPH-08ccc	ccc	4	16	X04	5.55	<0.010	<0.080	<0.050	5.27	9.53	50.4	<0.200	67.7	<0.100	0.178
Soln Std		4	17	STD-B4-3	20.5	<0.010	<0.080	<0.050	3.98	9.73	81.3	<0.200	52.4	<0.100	<0.100
Soln Std		5	1	STD-B5-1	20.8	<0.010	<0.080	<0.050	3.87	9.79	81.8	<0.200	52.6	<0.100	<0.100
SB4-NEPH-05ccc	ccc	5	2	X16	9.92	<0.010	<0.080	<0.050	9.08	14.6	92.8	<0.200	95	<0.100	2.01
SB4-NEPH-05	quenched	5	3	X18	9.85	<0.010	<0.080	<0.050	7.38	13.6	95.6	<0.200	91.5	<0.100	1.75
SB4-NEPH-01ccc	ccc	5	4	X45	21.5	<0.010	<0.080	<0.050	12	34.7	110	<0.200	127	<0.100	5.39
EA		5	5	X01	37.9	<0.010	<0.080	<0.050	<0.040	11.2	105	<0.200	59.5	<0.100	<0.100
SB4-NEPH-07ccc	ccc	5	6	X47	8.85	<0.010	<0.080	<0.050	9.82	15.3	90.7	<0.200	95.3	<0.100	2.18
SB4-NEPH-06	quenched	5	7	X78	10.6	<0.010	<0.080	<0.050	6.26	14.6	112	<0.200	99.3	<0.100	1.69
SB4-NEPH-08	quenched	5	8	X13	6.11	<0.010	<0.080	<0.050	5.8	9.56	55.6	<0.200	69.7	<0.100	0.445
Soln Std		5	9	STD-B5-2	20.5	<0.010	<0.080	<0.050	3.89	9.77	81.2	<0.200	52.9	<0.100	<0.100
SB4-NEPH-03	quenched	5	10	X42	10.8	<0.010	<0.080	<0.050	9.05	14.3	110	<0.200	101	<0.100	1.79
SB4-NEPH-01	quenched	5	11	X14	6.82	<0.010	<0.080	<0.050	6.79	9.63	75.9	<0.200	71	<0.100	2.6
SB4-NEPH-07	quenched	5	12	X71	9.74	<0.010	<0.080	<0.050	5.13	13.5	95.8	<0.200	89	<0.100	1.62
SB4-NEPH-03ccc	ccc	5	13	X59	9.86	<0.010	<0.080	<0.050	6.62	14.6	99.3	<0.200	96.5	<0.100	1.52
SB4-NEPH-06ccc	ccc	5	14	X41	9.13	<0.010	<0.080	<0.050	13.4	15.7	105	<0.200	105	<0.100	5.39
SB4-NEPH-08ccc	ccc	5	15	X20	5.94	<0.010	<0.080	<0.050	4.77	9.63	51.6	<0.200	68.1	<0.100	0.274
Soln Std		5	16	STD-B5-3	20.7	<0.010	<0.080	<0.050	3.77	9.87	81.7	<0.200	52.8	<0.100	<0.100
Soln Std		6	1	STD-B6-1	20.8	<0.010	<0.080	<0.050	3.98	9.74	80.7	<0.200	52.6	<0.100	<0.100
SB4-NEPH-08	quenched	6	2	X17	6.08	<0.010	<0.080	<0.050	6.15	9.67	56.5	<0.200	70.5	<0.100	0.487
SB4-NEPH-03ccc	ccc	6	3	X77	10.1	<0.010	<0.080	<0.050	9.59	14.6	105	<0.200	99.6	<0.100	2.25
SB4-NEPH-03	quenched	6	4	X58	10.5	<0.010	<0.080	<0.050	9.91	14.1	108	<0.200	101	<0.100	1.52
SB4-NEPH-05ccc	ccc	6	5	X12	9.13	<0.010	<0.080	<0.050	9.04	13.5	88.2	<0.200	87.9	<0.100	1.94
SB4-NEPH-06	quenched	6	6	X25	10.4	<0.010	<0.080	<0.050	6.04	14.6	114	<0.200	100	<0.100	1.57
SB4-NEPH-07	quenched	6	7	X68	9.3	<0.010	<0.080	<0.050	5.61	13.1	93.6	<0.200	87.2	<0.100	1.47
SB4-NEPH-08ccc	ccc	6	8	X65	5.7	<0.010	<0.080	<0.050	5.71	9.57	51.6	<0.200	67.8	<0.100	0.291
Soln Std		6	9	STD-B6-2	20	<0.010	<0.080	<0.050	4.04	9.65	80.7	<0.200	52.1	<0.100	<0.100
EA		6	10	X06	37.9	<0.010	<0.080	<0.050	0.312	11	105	<0.200	58.9	<0.100	<0.100
SB4-NEPH-01	quenched	6	11	X79	6.71	<0.010	<0.080	<0.050	6.76	9.56	76.6	<0.200	70.5	<0.100	2.36
SB4-NEPH-06ccc	ccc	6	12	X74	9.1	<0.010	<0.080	<0.050	12.5	16.2	106	<0.200	107	<0.100	5.12
SB4-NEPH-05	quenched	6	13	X43	9.47	<0.010	<0.080	<0.050	6.86	13.3	96.7	<0.200	86.9	<0.100	2
SB4-NEPH-01ccc	ccc	6	14	X22	21.3	<0.010	<0.080	<0.050	11.6	34.4	113	<0.200	124	<0.100	6.01

Table D.1: SRNL-ML Measurements of the PCT Solutions for the Nepheline Study Glasses

					Elemental Concentrations as received (ar) from the SRNL-ML (in ppm)										
Glass ID	Heat Treatment	Block	Seq	SRNL-ML ID	B (ar)	Ba ar	Cd ar	Cr ar	Fe ar	Li ar	Na ar	Pb ar	Si ar	Th ar	U ar
SB4-NEPH-07ccc	ccc	6	15	X21	8.31	<0.010	<0.080	<0.050	8.94	14.7	92.2	<0.200	92.4	<0.100	2.07
Soln Std		6	16	STD-B6-3	20.2	<0.010	<0.080	<0.050	3.95	9.67	83.1	<0.200	52.4	<0.100	<0.100

Table D.2: SRNL-ML Measurements of the PCT Solutions for the Study Glasses After Appropriate Adjustments

					Elemental Concentrations Adjusted for Dilution Effects (in ppm)										
Glass ID	Heat Treatment	Block	Seq	SRNL-ML ID	B	Ba	Cd	Cr	Fe	Li	Na	Pb	Si	Th	U
Soln Std		1	1	STD-B1-1	20.5000	0.0050	0.0400	0.0250	4.0200	9.6800	79.9000	0.1000	51.8000	0.0500	0.0500
SB4-NEPH-02	quenched	1	2	X76	11.7502	0.0083	0.0667	0.0417	14.3503	17.3337	150.0030	0.1667	128.8359	0.0833	2.0000
SB4-NEPH-12	quenched	1	3	X26	12.4669	0.0083	0.0667	0.0417	23.3338	21.1671	147.0029	0.1667	153.3364	0.0833	4.2168
Blank		1	4	X56	0.0333	0.0083	0.0667	0.0417	0.0333	0.4167	0.0833	0.1667	0.1667	0.0833	0.0833
SB4-NEPH-11	quenched	1	5	X69	16.6003	0.0083	0.0667	0.0417	9.1835	23.5005	165.3366	0.1667	150.6697	0.0833	3.2501
SB4-NEPH-10ccc	ccc	1	6	X54	17.0003	0.0083	0.0667	0.0417	11.1836	25.5005	171.6701	0.1667	164.3366	0.0833	2.6501
SB4-NEPH-02ccc	ccc	1	7	X23	20.6671	0.0083	0.0667	0.0417	14.4170	28.3339	168.3367	0.1667	156.0031	0.0833	2.0667
SB4-NEPH-04ccc	ccc	1	8	X08	10.0669	0.0083	0.0667	0.0417	6.9168	16.3170	74.5015	0.1667	105.3354	0.0833	5.7834
Soln Std		1	9	STD-B1-2	19.8000	0.0050	0.0400	0.0250	4.0300	9.6300	80.8000	0.1000	50.9000	0.0500	0.0500
ARM-1		1	10	X63	21.1671	0.0083	0.0667	0.0417	0.4200	15.3670	40.6675	0.1667	70.1681	0.0833	0.0833
SB4-NEPH-11ccc	ccc	1	11	X33	This sample was inadvertently spilled and lost.										
SB4-NEPH-09ccc	ccc	1	12	X30	13.5503	0.0083	0.0667	0.0417	20.5004	25.3338	121.8358	0.1667	150.0030	0.0833	7.9835
SB4-NEPH-10	quenched	1	13	X48	18.1670	0.0083	0.0667	0.0417	9.6502	24.8338	190.0038	0.1667	163.6699	0.0833	2.0667
SB4-NEPH-12ccc	ccc	1	14	X19	12.3502	0.0083	0.0667	0.0417	22.6671	21.5004	132.8360	0.1667	150.5030	0.0833	4.3668
SB4-NEPH-04	quenched	1	15	X80	8.7835	0.0083	0.0667	0.0417	8.1002	14.1169	75.5015	0.1667	99.1687	0.0833	3.9167
SB4-NEPH-09	quenched	1	16	X55	11.5002	0.0083	0.0667	0.0417	19.1671	19.5004	129.5026	0.1667	137.0027	0.0833	7.1835
Soln Std		1	17	STD-B1-3	20.0000	0.0050	0.0400	0.0250	4.0600	9.6700	82.2000	0.1000	51.2000	0.0500	0.0500
Soln Std		2	1	STD-B2-1	20.5000	0.0050	0.0400	0.0250	4.1700	9.6200	80.0000	0.1000	51.6000	0.0500	0.0500
SB4-NEPH-09ccc	ccc	2	2	X66	14.3670	0.0083	0.0667	0.0417	21.0004	25.8339	122.0024	0.1667	153.6697	0.0833	8.0002
SB4-NEPH-12ccc	ccc	2	3	X28	12.7169	0.0083	0.0667	0.0417	22.8338	21.6671	131.0026	0.1667	152.5031	0.0833	4.1668
SB4-NEPH-02ccc	ccc	2	4	X67	21.5004	0.0083	0.0667	0.0417	14.4836	29.6673	166.6700	0.1667	165.3366	0.0833	2.2500
SB4-NEPH-04	quenched	2	5	X73	9.1835	0.0083	0.0667	0.0417	8.6668	14.7836	77.1682	0.1667	105.0021	0.0833	5.5001
SB4-NEPH-11	quenched	2	6	X35	17.0003	0.0083	0.0667	0.0417	9.6169	23.3338	163.8366	0.1667	151.3364	0.0833	3.2667
SB4-NEPH-12	quenched	2	7	X03	12.9336	0.0083	0.0667	0.0417	23.5005	21.3338	148.3363	0.1667	156.3365	0.0833	4.6334
SB4-NEPH-10	quenched	2	8	X52	18.0004	0.0083	0.0667	0.0417	10.1502	24.6672	186.6704	0.1667	165.5033	0.0833	2.1334
Soln Std		2	9	STD-B2-2	19.8000	0.0050	0.0400	0.0250	4.0800	9.5700	80.6000	0.1000	51.2000	0.0500	0.0500
ARM-1		2	10	X37	21.0004	0.0083	0.0667	0.0417	0.3283	15.1336	41.3342	0.1667	69.8347	0.0833	0.0833
SB4-NEPH-11ccc	ccc	2	11	X60	16.4503	0.0083	0.0667	0.0417	9.8835	24.1672	151.1697	0.1667	150.0030	0.0833	2.9167
SB4-NEPH-04ccc	ccc	2	12	X50	10.8169	0.0083	0.0667	0.0417	7.5502	16.6670	78.3349	0.1667	109.6689	0.0833	4.9668
SB4-NEPH-10ccc	ccc	2	13	X51	17.0003	0.0083	0.0667	0.0417	11.7669	25.5005	171.6701	0.1667	165.6700	0.0833	3.0667
SB4-NEPH-02	quenched	2	14	X75	12.1669	0.0083	0.0667	0.0417	14.7503	17.5004	158.1698	0.1667	130.1693	0.0833	2.0167
SB4-NEPH-09	quenched	2	15	X44	11.7002	0.0083	0.0667	0.0417	18.6670	22.6671	131.3360	0.1667	138.8361	0.0833	7.2168

Table D.2: SRNL-ML Measurements of the PCT Solutions for the Study Glasses After Appropriate Adjustments

					Elemental Concentrations Adjusted for Dilution Effects (in ppm)										
Glass ID	Heat Treatment	Block	Seq	SRNL-ML ID	B	Ba	Cd	Cr	Fe	Li	Na	Pb	Si	Th	U
Soln Std		2	16	STD-B2-3	19.8000	0.0050	0.0400	0.0250	3.9800	9.6000	81.8000	0.1000	51.2000	0.0500	0.0500
Soln Std		3	1	STD-B3-1	20.3000	0.0050	0.0400	0.0250	3.9400	9.5600	81.8000	0.1000	52.1000	0.0500	0.0500
SB4-NEPH-10	quenched	3	2	X72	18.5004	0.0083	0.0667	0.0417	11.4002	25.1672	190.0038	0.1667	173.3368	0.0833	2.6334
SB4-NEPH-04	quenched	3	3	X38	9.1502	0.0083	0.0667	0.0417	8.1002	15.0336	78.0016	0.1667	107.6688	0.0833	5.4334
SB4-NEPH-11ccc	ccc	3	4	X62	16.3003	0.0083	0.0667	0.0417	9.8502	24.3338	150.6697	0.1667	152.5031	0.0833	2.5167
SB4-NEPH-09	quenched	3	5	X11	11.5002	0.0083	0.0667	0.0417	19.3337	19.3337	127.8359	0.1667	139.6695	0.0833	7.2001
SB4-NEPH-02	quenched	3	6	X15	11.9669	0.0083	0.0667	0.0417	14.5336	17.5004	150.3363	0.1667	131.6693	0.0833	1.7667
SB4-NEPH-02ccc	ccc	3	7	X02	21.0004	0.0083	0.0667	0.0417	15.8837	29.8339	171.6701	0.1667	165.0033	0.0833	1.8834
SB4-NEPH-09ccc	ccc	3	8	X40	13.8003	0.0083	0.0667	0.0417	21.8338	26.1672	125.5025	0.1667	158.3365	0.0833	7.9002
Soln Std		3	9	STD-B3-2	19.8000	0.0050	0.0400	0.0250	4.0000	9.6400	80.9000	0.1000	52.3000	0.0500	0.0500
SB4-NEPH-12ccc	ccc	3	10	X24	12.7669	0.0083	0.0667	0.0417	22.3338	21.6671	133.6693	0.1667	155.3364	0.0833	4.6501
SB4-NEPH-11	quenched	3	11	X64	16.8337	0.0083	0.0667	0.0417	9.1335	23.3338	164.8366	0.1667	154.0031	0.0833	3.1667
SB4-NEPH-04ccc	ccc	3	12	X46	10.4002	0.0083	0.0667	0.0417	7.5168	15.9503	74.6682	0.1667	107.1688	0.0833	3.9667
SB4-NEPH-12	quenched	3	13	X53	12.8669	0.0083	0.0667	0.0417	23.5005	21.6671	151.1697	0.1667	159.5032	0.0833	4.4334
ARM-1		3	14	X39	20.8338	0.0083	0.0667	0.0417	0.0333	15.3503	39.8341	0.1667	71.6681	0.0833	0.0833
SB4-NEPH-10ccc	ccc	3	15	X57	16.5670	0.0083	0.0667	0.0417	13.4836	25.5005	171.6701	0.1667	166.6700	0.0833	3.5167
Soln Std		3	16	STD-B3-3	19.6000	0.0050	0.0400	0.0250	4.0700	9.6000	83.4000	0.1000	52.0000	0.0500	0.0500
Soln Std		4	1	STD-B4-1	20.6000	0.0050	0.0400	0.0250	4.0700	9.7300	80.6000	0.1000	52.3000	0.0500	0.0500
Blank		4	2	X31	0.0333	0.0083	0.0667	0.0417	0.0333	0.4167	0.0833	0.1667	0.1667	0.0833	0.0833
SB4-NEPH-03ccc	ccc	4	3	X49	16.1003	0.0083	0.0667	0.0417	10.7835	24.6672	162.8366	0.1667	158.6698	0.0833	2.0500
SB4-NEPH-08	quenched	4	4	X32	9.6835	0.0083	0.0667	0.0417	10.4169	16.1337	96.0019	0.1667	117.0023	0.0833	0.4767
SB4-NEPH-07ccc	ccc	4	5	X10	13.6836	0.0083	0.0667	0.0417	15.5336	24.8338	150.3363	0.1667	155.6698	0.0833	3.2667
SB4-NEPH-06	quenched	4	6	X29	16.5837	0.0083	0.0667	0.0417	9.6669	23.8338	181.6703	0.1667	160.6699	0.0833	2.2667
SB4-NEPH-01	quenched	4	7	X07	10.2502	0.0083	0.0667	0.0417	12.2669	15.6670	122.6691	0.1667	113.3356	0.0833	3.8501
SB4-NEPH-06ccc	ccc	4	8	X34	14.5336	0.0083	0.0667	0.0417	23.0005	26.3339	171.6701	0.1667	173.3368	0.0833	8.4168
Soln Std		4	9	STD-B4-2	20.1000	0.0050	0.0400	0.0250	3.9900	9.6800	80.8000	0.1000	52.2000	0.0500	0.0500
EA		4	10	X70	638.3346	0.0833	0.6667	0.4167	0.3333	188.3337	1766.6702	1.6667	995.0020	0.8333	0.8333
SB4-NEPH-07	quenched	4	11	X61	16.2170	0.0083	0.0667	0.0417	9.6835	22.6671	159.6699	0.1667	149.0030	0.0833	2.5667
SB4-NEPH-03	quenched	4	12	X36	17.1670	0.0083	0.0667	0.0417	15.1836	23.1671	180.0036	0.1667	163.6699	0.0833	2.3167
SB4-NEPH-05	quenched	4	13	X09	15.8003	0.0083	0.0667	0.0417	13.3336	21.8338	160.5032	0.1667	146.3363	0.0833	3.2334
SB4-NEPH-01ccc	ccc	4	14	X05	36.1674	0.0083	0.0667	0.0417	22.0004	59.5012	188.3371	0.1667	213.3376	0.0833	9.5002
SB4-NEPH-05ccc	ccc	4	15	X27	15.2670	0.0083	0.0667	0.0417	10.3335	23.3338	148.5030	0.1667	146.8363	0.0833	2.1667

Table D.2: SRNL-ML Measurements of the PCT Solutions for the Study Glasses After Appropriate Adjustments

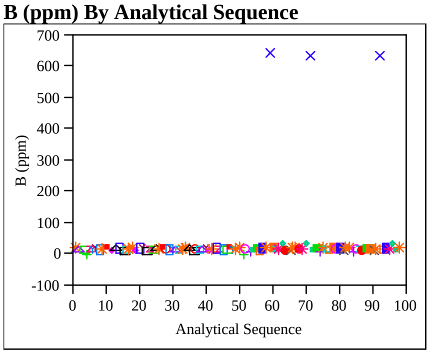
					Elemental Concentrations Adjusted for Dilution Effects (in ppm)										
Glass ID	Heat Treatment	Block	Seq	SRNL-ML ID	B	Ba	Cd	Cr	Fe	Li	Na	Pb	Si	Th	U
SB4-NEPH-08ccc	ccc	4	16	X04	9.2502	0.0083	0.0667	0.0417	8.7835	15.8837	84.0017	0.1667	112.8356	0.0833	0.2967
Soln Std		4	17	STD-B4-3	20.5000	0.0050	0.0400	0.0250	3.9800	9.7300	81.3000	0.1000	52.4000	0.0500	0.0500
Soln Std		5	1	STD-B5-1	20.8000	0.0050	0.0400	0.0250	3.8700	9.7900	81.8000	0.1000	52.6000	0.0500	0.0500
SB4-NEPH-05ccc	ccc	5	2	X16	16.5337	0.0083	0.0667	0.0417	15.1336	24.3338	154.6698	0.1667	158.3365	0.0833	3.3501
SB4-NEPH-05	quenched	5	3	X18	16.4170	0.0083	0.0667	0.0417	12.3002	22.6671	159.3365	0.1667	152.5031	0.0833	2.9167
SB4-NEPH-01ccc	ccc	5	4	X45	35.8341	0.0083	0.0667	0.0417	20.0004	57.8345	183.3370	0.1667	211.6709	0.0833	8.9835
EA		5	5	X01	631.6679	0.0833	0.6667	0.4167	0.3333	186.6670	1750.0035	1.6667	991.6687	0.8333	0.8333
SB4-NEPH-07ccc	ccc	5	6	X47	14.7503	0.0083	0.0667	0.0417	16.3670	25.5005	151.1697	0.1667	158.8365	0.0833	3.6334
SB4-NEPH-06	quenched	5	7	X78	17.6670	0.0083	0.0667	0.0417	10.4335	24.3338	186.6704	0.1667	165.5033	0.0833	2.8167
SB4-NEPH-08	quenched	5	8	X13	10.1835	0.0083	0.0667	0.0417	9.6669	15.9337	92.6685	0.1667	116.1690	0.0833	0.7417
Soln Std		5	9	STD-B5-2	20.5000	0.0050	0.0400	0.0250	3.8900	9.7700	81.2000	0.1000	52.9000	0.0500	0.0500
SB4-NEPH-03	quenched	5	10	X42	18.0004	0.0083	0.0667	0.0417	15.0836	23.8338	183.3370	0.1667	168.3367	0.0833	2.9834
SB4-NEPH-01	quenched	5	11	X14	11.3669	0.0083	0.0667	0.0417	11.3169	16.0503	126.5025	0.1667	118.3357	0.0833	4.3334
SB4-NEPH-07	quenched	5	12	X71	16.2337	0.0083	0.0667	0.0417	8.5502	22.5005	159.6699	0.1667	148.3363	0.0833	2.7001
SB4-NEPH-03ccc	ccc	5	13	X59	16.4337	0.0083	0.0667	0.0417	11.0336	24.3338	165.5033	0.1667	160.8366	0.0833	2.5334
SB4-NEPH-06ccc	ccc	5	14	X41	15.2170	0.0083	0.0667	0.0417	22.3338	26.1672	175.0035	0.1667	175.0035	0.0833	8.9835
SB4-NEPH-08ccc	ccc	5	15	X20	9.9002	0.0083	0.0667	0.0417	7.9502	16.0503	86.0017	0.1667	113.5023	0.0833	0.4567
Soln Std		5	16	STD-B5-3	20.7000	0.0050	0.0400	0.0250	3.7700	9.8700	81.7000	0.1000	52.8000	0.0500	0.0500
Soln Std		6	1	STD-B6-1	20.8000	0.0050	0.0400	0.0250	3.9800	9.7400	80.7000	0.1000	52.6000	0.0500	0.0500
SB4-NEPH-08	quenched	6	2	X17	10.1335	0.0083	0.0667	0.0417	10.2502	16.1170	94.1686	0.1667	117.5024	0.0833	0.8117
SB4-NEPH-03ccc	ccc	6	3	X77	16.8337	0.0083	0.0667	0.0417	15.9837	24.3338	175.0035	0.1667	166.0033	0.0833	3.7501
SB4-NEPH-03	quenched	6	4	X58	17.5004	0.0083	0.0667	0.0417	16.5170	23.5005	180.0036	0.1667	168.3367	0.0833	2.5334
SB4-NEPH-05ccc	ccc	6	5	X12	15.2170	0.0083	0.0667	0.0417	15.0670	22.5005	147.0029	0.1667	146.5029	0.0833	3.2334
SB4-NEPH-06	quenched	6	6	X25	17.3337	0.0083	0.0667	0.0417	10.0669	24.3338	190.0038	0.1667	166.6700	0.0833	2.6167
SB4-NEPH-07	quenched	6	7	X68	15.5003	0.0083	0.0667	0.0417	9.3502	21.8338	156.0031	0.1667	145.3362	0.0833	2.4500
SB4-NEPH-08ccc	ccc	6	8	X65	9.5002	0.0083	0.0667	0.0417	9.5169	15.9503	86.0017	0.1667	113.0023	0.0833	0.4850
Soln Std		6	9	STD-B6-2	20.0000	0.0050	0.0400	0.0250	4.0400	9.6500	80.7000	0.1000	52.1000	0.0500	0.0500
EA		6	10	X06	631.6679	0.0833	0.6667	0.4167	5.2000	183.3337	1750.0035	1.6667	981.6686	0.8333	0.8333
SB4-NEPH-01	quenched	6	11	X79	11.1836	0.0083	0.0667	0.0417	11.2669	15.9337	127.6692	0.1667	117.5024	0.0833	3.9334
SB4-NEPH-06ccc	ccc	6	12	X74	15.1670	0.0083	0.0667	0.0417	20.8338	27.0005	176.6702	0.1667	178.3369	0.0833	8.5335
SB4-NEPH-05	quenched	6	13	X43	15.7836	0.0083	0.0667	0.0417	11.4336	22.1671	161.1699	0.1667	144.8362	0.0833	3.3334
SB4-NEPH-01ccc	ccc	6	14	X22	35.5007	0.0083	0.0667	0.0417	19.3337	57.3345	188.3371	0.1667	206.6708	0.0833	10.0169

Table D.2: SRNL-ML Measurements of the PCT Solutions for the Study Glasses After Appropriate Adjustments

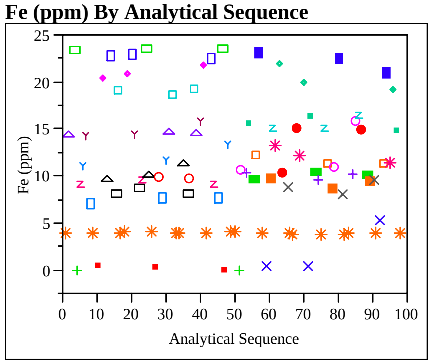
					Elemental Concentrations Adjusted for Dilution Effects (in ppm)										
Glass ID	**Heat Treatment**	**Block**	**Seq**	**SRNL-ML ID**	**B**	**Ba**	**Cd**	**Cr**	**Fe**	**Li**	**Na**	**Pb**	**Si**	**Th**	**U**
SB4-NEPH-07ccc	ccc	6	15	X21	13.8503	0.0083	0.0667	0.0417	14.9003	24.5005	153.6697	0.1667	154.0031	0.0833	3.4501
Soln Std		6	16	STD-B6-3	20.2000	0.0050	0.0400	0.0250	3.9500	9.6700	83.1000	0.1000	52.4000	0.0500	0.0500

Exhibit D.1: SRNL-ML PCT Measurements in Analytical Sequence for Study Glasses, EA, ARM, Blanks, and Solution Standards

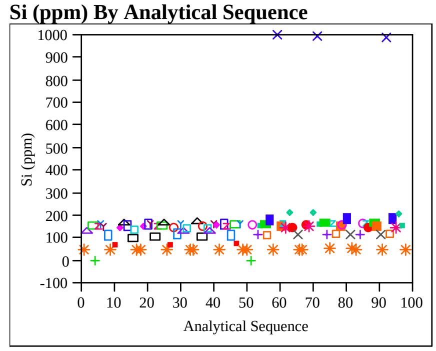
B (ppm) By Analytical Sequence



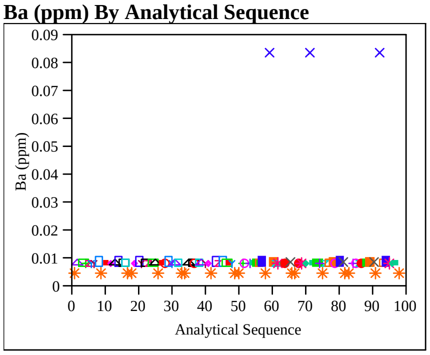
Fe (ppm) By Analytical Sequence



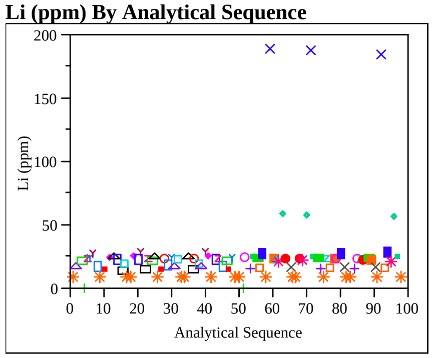
Si (ppm) By Analytical Sequence



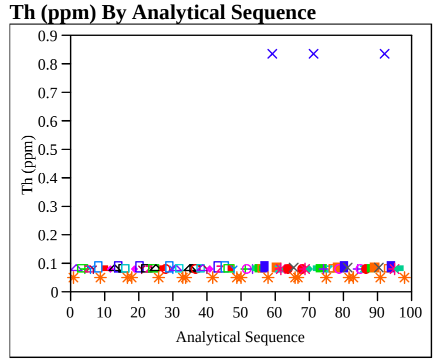
Ba (ppm) By Analytical Sequence



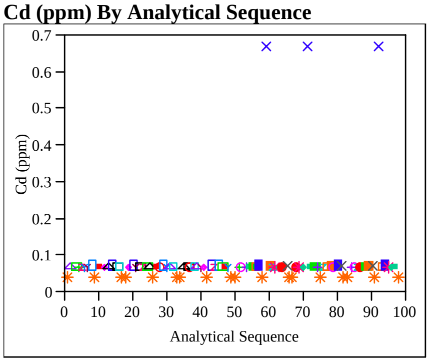
Li (ppm) By Analytical Sequence



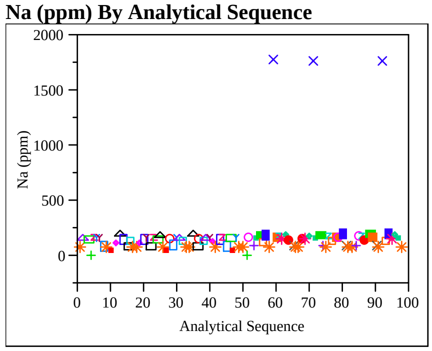
Th (ppm) By Analytical Sequence



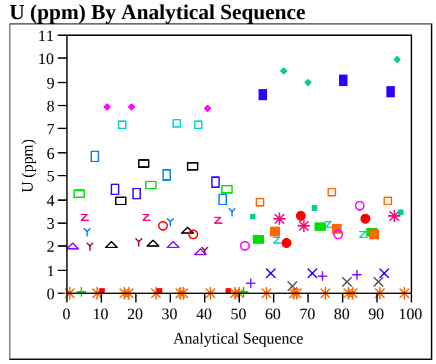
Cd (ppm) By Analytical Sequence



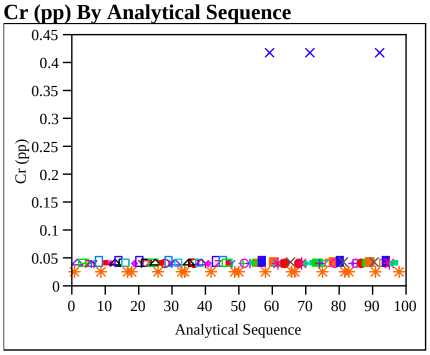
Na (ppm) By Analytical Sequence



U (ppm) By Analytical Sequence



Cr (pp) By Analytical Sequence



Pb (ppm) By Analytical Sequence

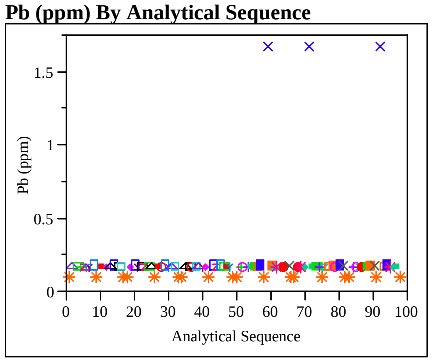
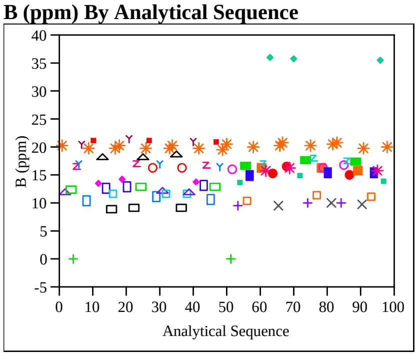
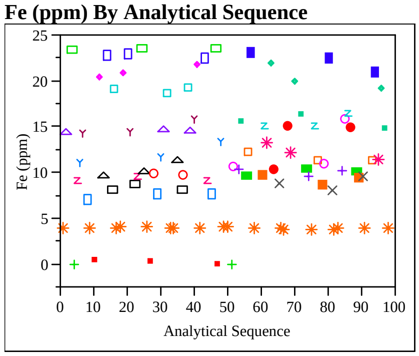


Exhibit D.2: SRNL-ML PCT Measurements in Analytical Sequence for Study Glasses, ARM, Blanks, and Standards Solutions

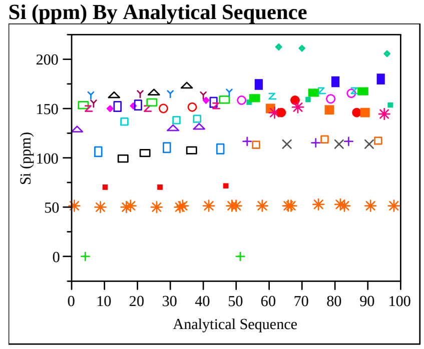
B (ppm) By Analytical Sequence



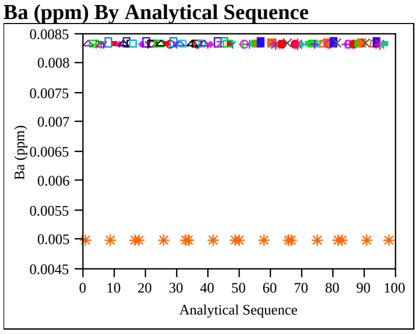
Fe (ppm) By Analytical Sequence



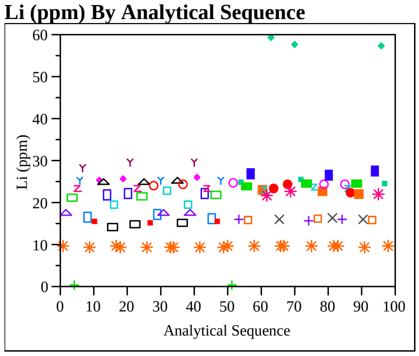
Si (ppm) By Analytical Sequence



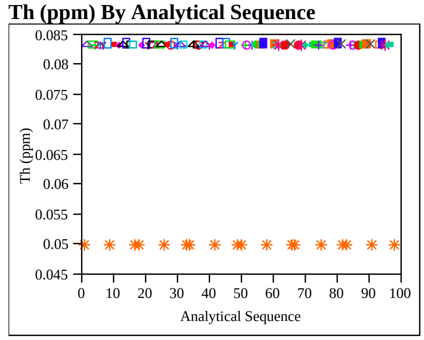
Ba (ppm) By Analytical Sequence



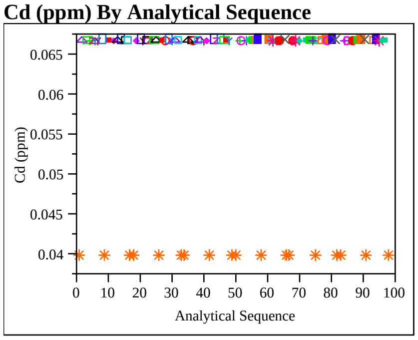
Li (ppm) By Analytical Sequence



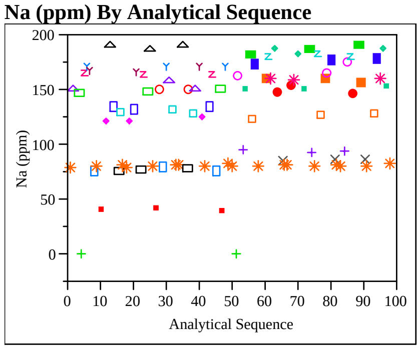
Th (ppm) By Analytical Sequence



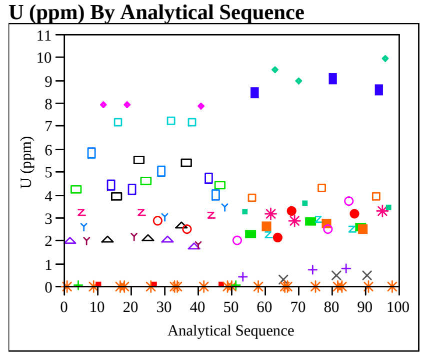
Cd (ppm) By Analytical Sequence



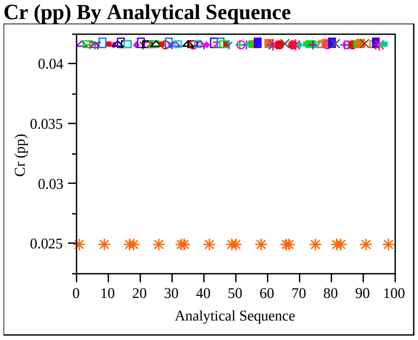
Na (ppm) By Analytical Sequence



U (ppm) By Analytical Sequence



Cr (pp) By Analytical Sequence



Pb (ppm) By Analytical Sequence

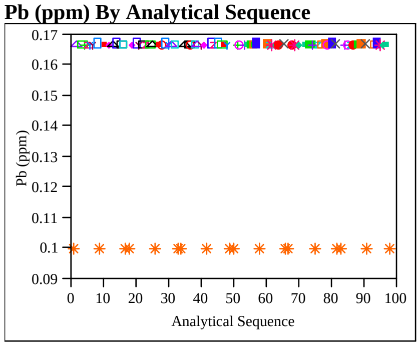
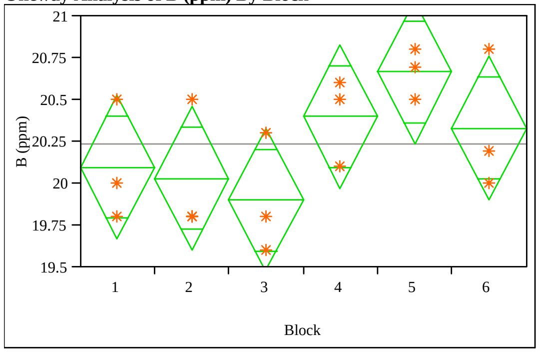


Exhibit D.3: Measurements of the Multi-Element Solution Standard by Set and ICP Block

Oneway Analysis of B (ppm) By Block



Oneway Anova
Summary of Fit

Rsquare	0.461522
Adj Rsquare	0.237156
Root Mean Square Error	0.339116
Mean of Response	20.23889
Observations (or Sum Wgts)	18

Analysis of Variance

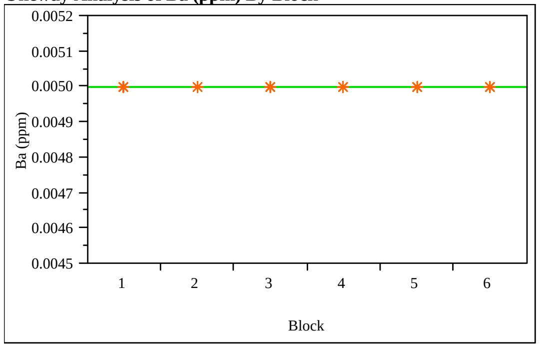
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	5	1.1827778	0.236556	2.0570	0.1420
Error	12	1.3800000	0.115000		
C. Total	17	2.5627778			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	20.1000	0.19579	19.673	20.527
2	3	20.0333	0.19579	19.607	20.460
3	3	19.9000	0.19579	19.473	20.327
4	3	20.4000	0.19579	19.973	20.827
5	3	20.6667	0.19579	20.240	21.093
6	3	20.3333	0.19579	19.907	20.760

Std Error uses a pooled estimate of error variance

Oneway Analysis of Ba (ppm) By Block



Oneway Anova
Summary of Fit

Rsquare	.
Adj Rsquare	.
Root Mean Square Error	0
Mean of Response	0.005
Observations (or Sum Wgts)	18

Analysis of Variance

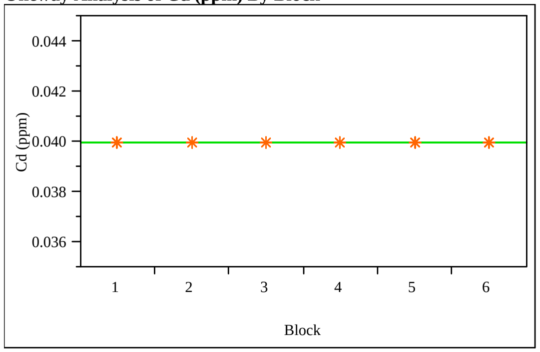
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	5	0	0	.	.
Error	12	0	0		
C. Total	17	0			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	0.005000	0	0.00500	0.00500
2	3	0.005000	0	0.00500	0.00500
3	3	0.005000	0	0.00500	0.00500
4	3	0.005000	0	0.00500	0.00500
5	3	0.005000	0	0.00500	0.00500
6	3	0.005000	0	0.00500	0.00500

Std Error uses a pooled estimate of error variance

Oneway Analysis of Cd (ppm) By Block



Oneway Anova
Summary of Fit

Rsquare	.
Adj Rsquare	.
Root Mean Square Error	0
Mean of Response	0.04
Observations (or Sum Wgts)	18

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	5	0	0	.	.
Error	12	0	0		
C. Total	17	0			

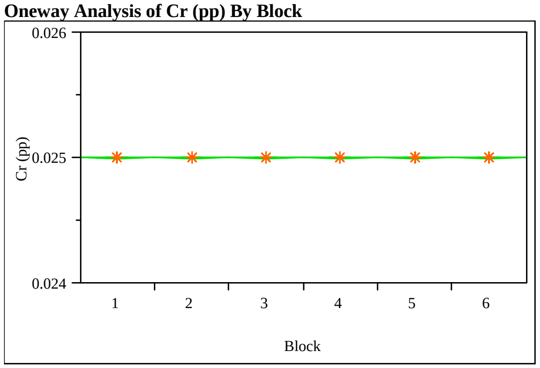
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	0.040000	0	0.04000	0.04000
2	3	0.040000	0	0.04000	0.04000
3	3	0.040000	0	0.04000	0.04000
4	3	0.040000	0	0.04000	0.04000
5	3	0.040000	0	0.04000	0.04000
6	3	0.040000	0	0.04000	0.04000

Std Error uses a pooled estimate of error variance

Exhibit D.3: Measurements of the Multi-Element Solution Standard by Set and ICP Block

Oneway Analysis of Cr (pp) By Block



Oneway Anova
Summary of Fit

Rsquare	0
Adj Rsquare	-0.41667
Root Mean Square Error	4.25e-18
Mean of Response	0.025
Observations (or Sum Wgts)	18

Analysis of Variance

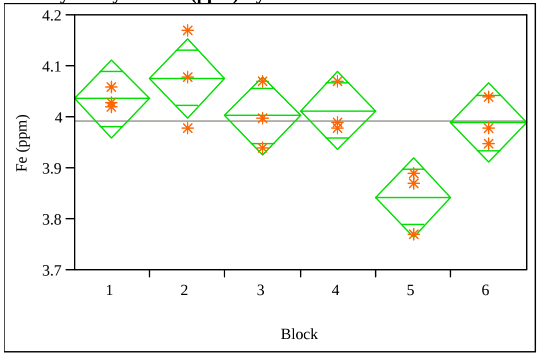
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	5	0	0	0.0000	1.0000
Error	12	2.1667e-34	1.806e-35		
C. Total	17	2.1667e-34			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	0.025000	2.453e-18	0.02500	0.02500
2	3	0.025000	2.453e-18	0.02500	0.02500
3	3	0.025000	2.453e-18	0.02500	0.02500
4	3	0.025000	2.453e-18	0.02500	0.02500
5	3	0.025000	2.453e-18	0.02500	0.02500
6	3	0.025000	2.453e-18	0.02500	0.02500

Std Error uses a pooled estimate of error variance

Oneway Analysis of Fe (ppm) By Block



Oneway Anova
Summary of Fit

Rsquare	0.680995
Adj Rsquare	0.548077
Root Mean Square Error	0.061056
Mean of Response	3.993889
Observations (or Sum Wgts)	18

Analysis of Variance

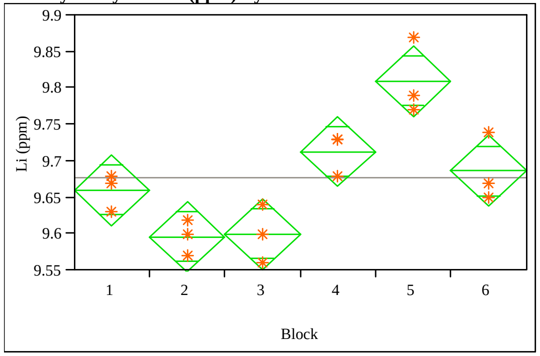
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	5	0.09549444	0.019099	5.1234	0.0096
Error	12	0.04473333	0.003728		
C. Total	17	0.14022778			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	4.03667	0.03525	3.9599	4.1135
2	3	4.07667	0.03525	3.9999	4.1535
3	3	4.00333	0.03525	3.9265	4.0801
4	3	4.01333	0.03525	3.9365	4.0901
5	3	3.84333	0.03525	3.7665	3.9201
6	3	3.99000	0.03525	3.9132	4.0668

Std Error uses a pooled estimate of error variance

Oneway Analysis of Li (ppm) By Block



Oneway Anova
Summary of Fit

Rsquare	0.844125
Adj Rsquare	0.779177
Root Mean Square Error	0.038297
Mean of Response	9.677778
Observations (or Sum Wgts)	18

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	5	0.09531111	0.019062	12.9970	0.0002
Error	12	0.01760000	0.001467		
C. Total	17	0.11291111			

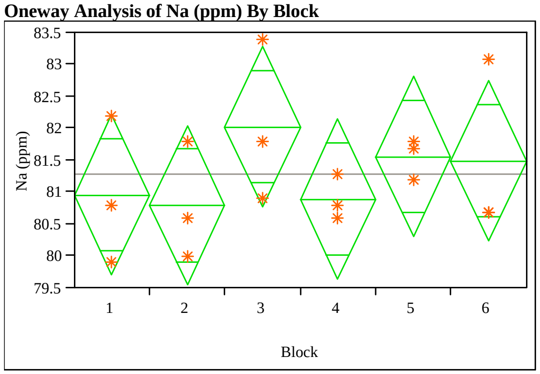
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	9.66000	0.02211	9.6118	9.7082
2	3	9.59667	0.02211	9.5485	9.6448
3	3	9.60000	0.02211	9.5518	9.6482
4	3	9.71333	0.02211	9.6652	9.7615
5	3	9.81000	0.02211	9.7618	9.8582
6	3	9.68667	0.02211	9.6385	9.7348

Std Error uses a pooled estimate of error variance

Exhibit D.3: Measurements of the Multi-Element Solution Standard by Set and ICP Block

Oneway Analysis of Na (ppm) By Block



Oneway Anova
Summary of Fit

Rsquare	0.228042
Adj Rsquare	-0.09361
Root Mean Square Error	0.994987
Mean of Response	81.29444
Observations (or Sum Wgts)	18

Analysis of Variance

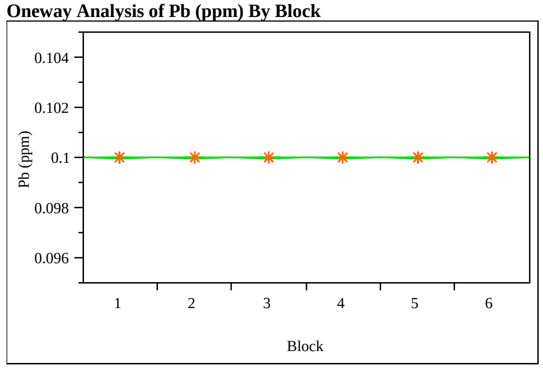
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	5	3.509444	0.701889	0.7090	0.6281
Error	12	11.880000	0.990000		
C. Total	17	15.389444			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	80.9667	0.57446	79.715	82.218
2	3	80.8000	0.57446	79.548	82.052
3	3	82.0333	0.57446	80.782	83.285
4	3	80.9000	0.57446	79.648	82.152
5	3	81.5667	0.57446	80.315	82.818
6	3	81.5000	0.57446	80.248	82.752

Std Error uses a pooled estimate of error variance

Oneway Analysis of Pb (ppm) By Block



Oneway Anova
Summary of Fit

Rsquare	0
Adj Rsquare	-0.41667
Root Mean Square Error	1.7e-17
Mean of Response	0.1
Observations (or Sum Wgts)	18

Analysis of Variance

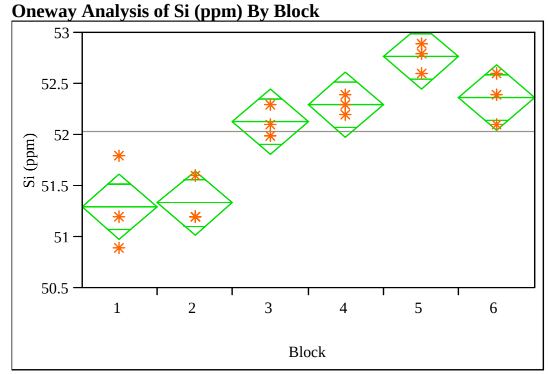
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	5	0	0	0.0000	1.0000
Error	12	3.4667e-33	2.889e-34		
C. Total	17	3.4667e-33			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	0.100000	9.813e-18	0.10000	0.10000
2	3	0.100000	9.813e-18	0.10000	0.10000
3	3	0.100000	9.813e-18	0.10000	0.10000
4	3	0.100000	9.813e-18	0.10000	0.10000
5	3	0.100000	9.813e-18	0.10000	0.10000
6	3	0.100000	9.813e-18	0.10000	0.10000

Std Error uses a pooled estimate of error variance

Oneway Analysis of Si (ppm) By Block



Oneway Anova
Summary of Fit

Rsquare	0.873068
Adj Rsquare	0.82018
Root Mean Square Error	0.252763
Mean of Response	52.03333
Observations (or Sum Wgts)	18

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	5	5.2733333	1.05467	16.5078	<.0001
Error	12	0.7666667	0.06389		
C. Total	17	6.0400000			

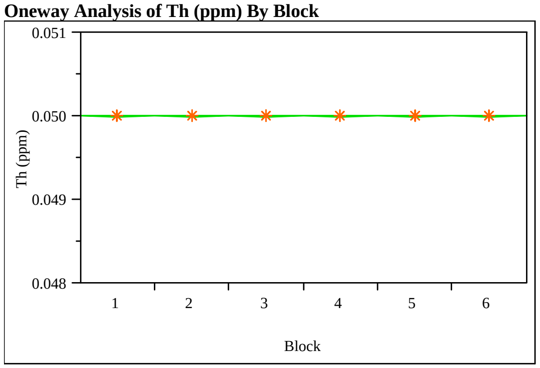
Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	51.3000	0.14593	50.982	51.618
2	3	51.3333	0.14593	51.015	51.651
3	3	52.1333	0.14593	51.815	52.451
4	3	52.3000	0.14593	51.982	52.618
5	3	52.7667	0.14593	52.449	53.085
6	3	52.3667	0.14593	52.049	52.685

Std Error uses a pooled estimate of error variance

Exhibit D.3: Measurements of the Multi-Element Solution Standard by Set and ICP Block

Oneway Analysis of Th (ppm) By Block



Oneway Anova
Summary of Fit

Rsquare	0
Adj Rsquare	-0.41667
Root Mean Square Error	8.5e-18
Mean of Response	0.05
Observations (or Sum Wgts)	18

Analysis of Variance

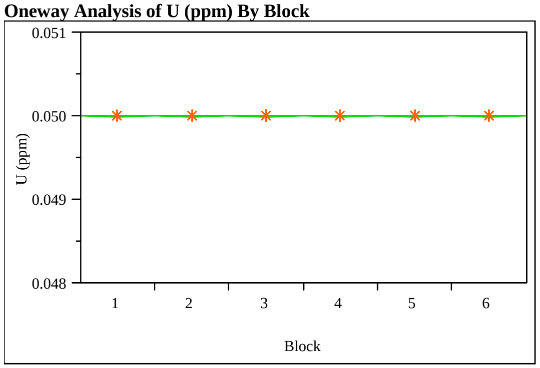
Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	5	0	0	0.0000	1.0000
Error	12	8.6667e-34	7.222e-35		
C. Total	17	8.6667e-34			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	0.050000	4.907e-18	0.05000	0.05000
2	3	0.050000	4.907e-18	0.05000	0.05000
3	3	0.050000	4.907e-18	0.05000	0.05000
4	3	0.050000	4.907e-18	0.05000	0.05000
5	3	0.050000	4.907e-18	0.05000	0.05000
6	3	0.050000	4.907e-18	0.05000	0.05000

Std Error uses a pooled estimate of error variance

Oneway Analysis of U (ppm) By Block



Oneway Anova
Summary of Fit

Rsquare	0
Adj Rsquare	-0.41667
Root Mean Square Error	8.5e-18
Mean of Response	0.05
Observations (or Sum Wgts)	18

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Block	5	0	0	0.0000	1.0000
Error	12	8.6667e-34	7.222e-35		
C. Total	17	8.6667e-34			

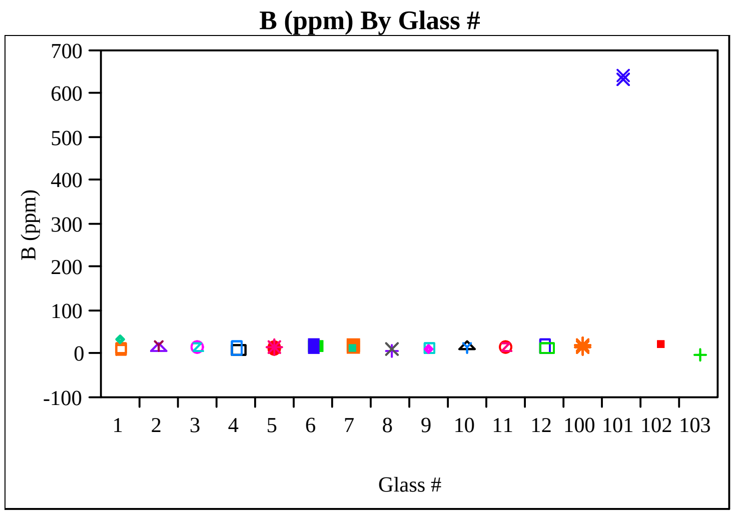
Means for Oneway Anova

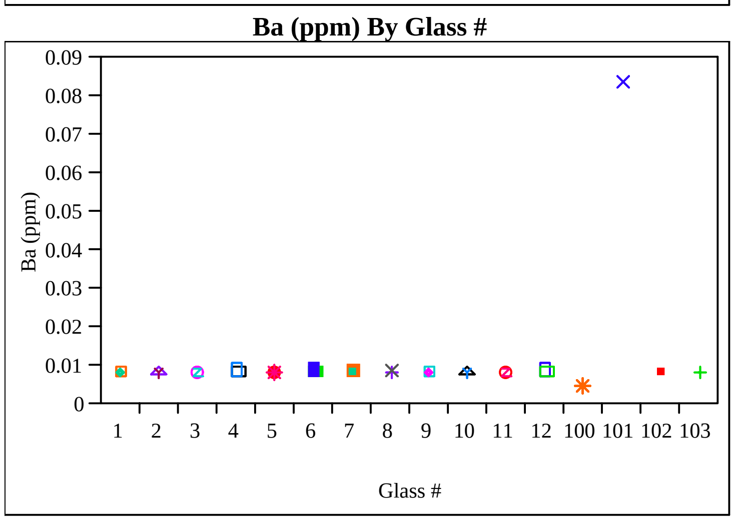
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	3	0.050000	4.907e-18	0.05000	0.05000
2	3	0.050000	4.907e-18	0.05000	0.05000
3	3	0.050000	4.907e-18	0.05000	0.05000
4	3	0.050000	4.907e-18	0.05000	0.05000
5	3	0.050000	4.907e-18	0.05000	0.05000
6	3	0.050000	4.907e-18	0.05000	0.05000

Std Error uses a pooled estimate of error variance

Exhibit D.4: SRNL-ML PCT Measurements by Glass Number for Study Glasses and Standards

(100 – Solution Standard; 101 – EA; 102 – ARM; 103 – Blanks)





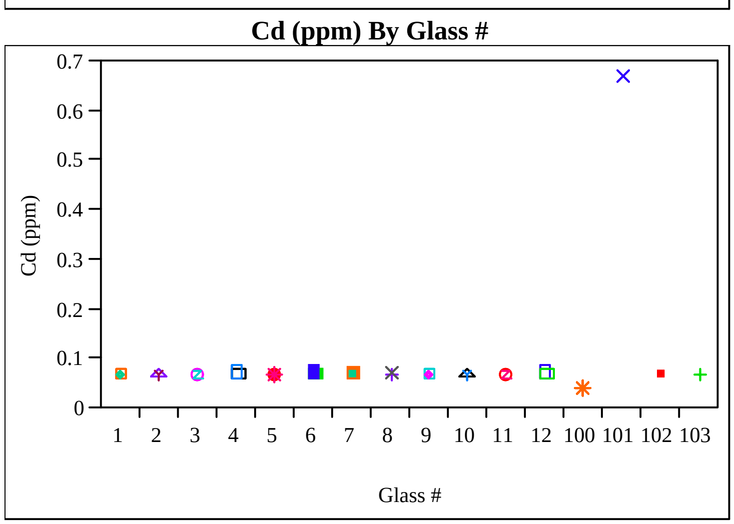
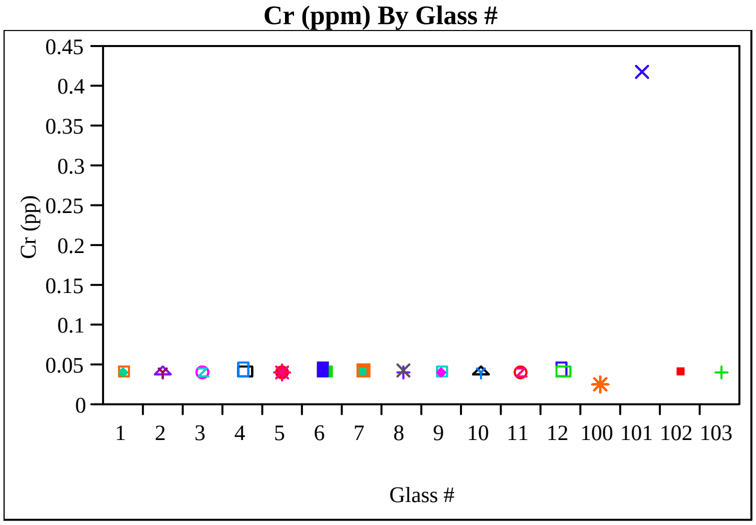
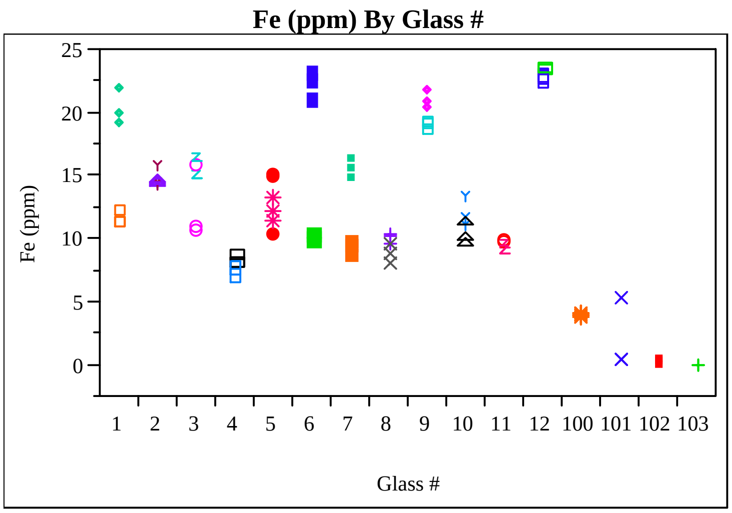


Exhibit D.4: SRNL-ML PCT Measurements by Glass Number for Study Glasses and Standards

(100 – Solution Standard; 101 – EA; 102 – ARM; 103 – Blanks)





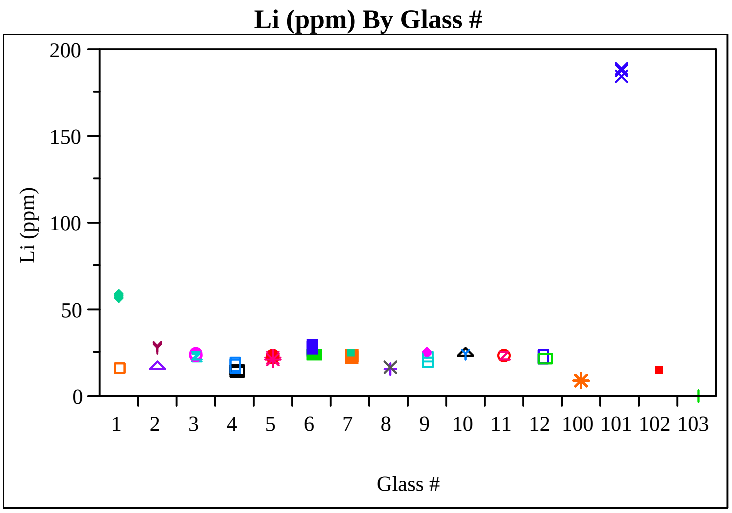
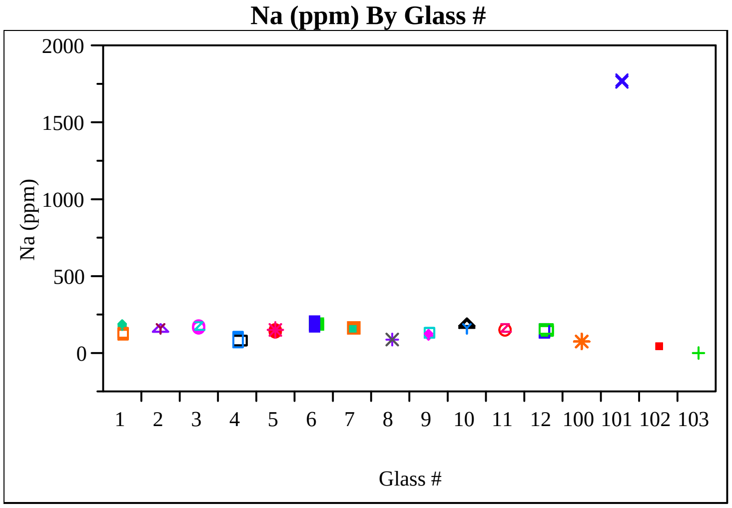
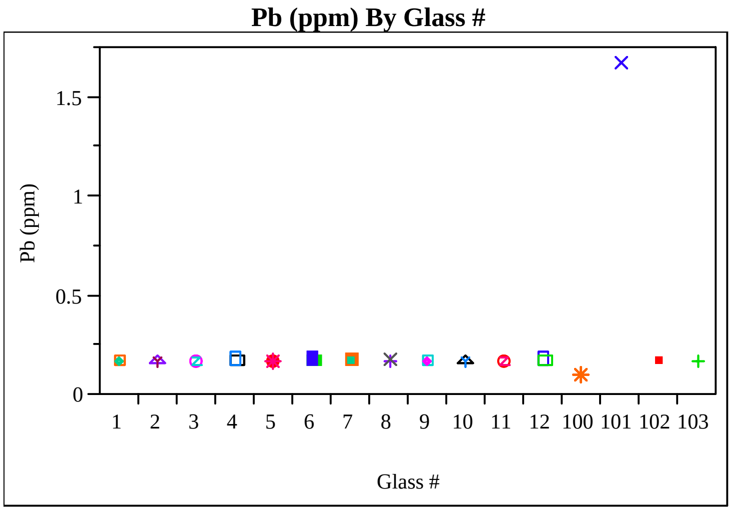


Exhibit D.4: SRNL-ML PCT Measurements by Glass Number for Study Glasses and Standards

(100 – Solution Standard; 101 – EA; 102 – ARM; 103 – Blanks)





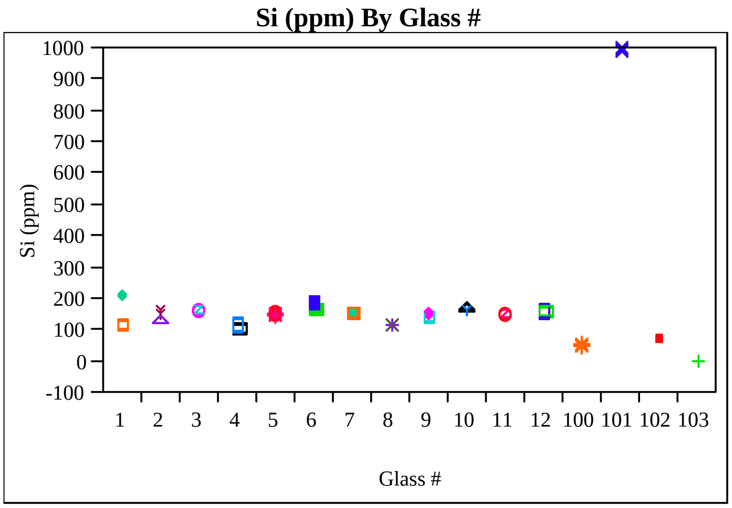
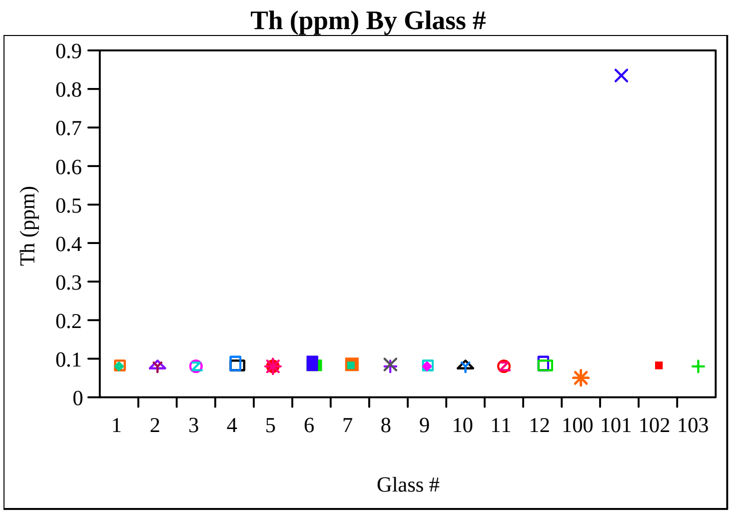


Exhibit D.4: SRNL-ML PCT Measurements by Glass Number for Study Glasses and Standards

(100 – Solution Standard; 101 – EA; 102 – ARM; 103 – Blanks)



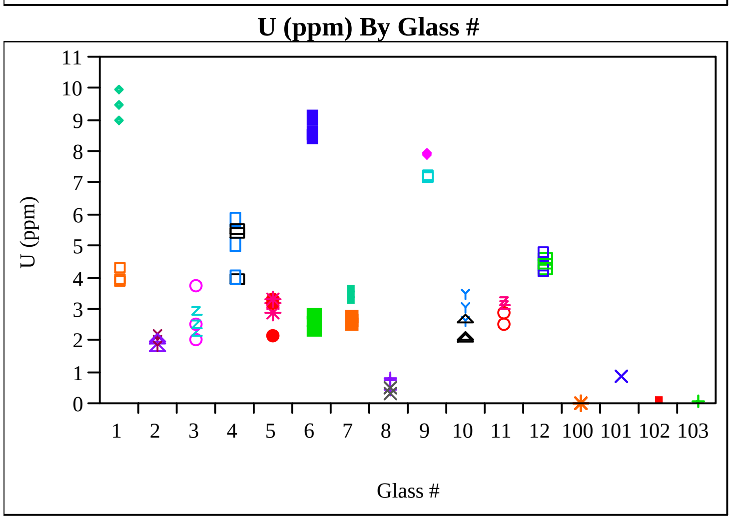
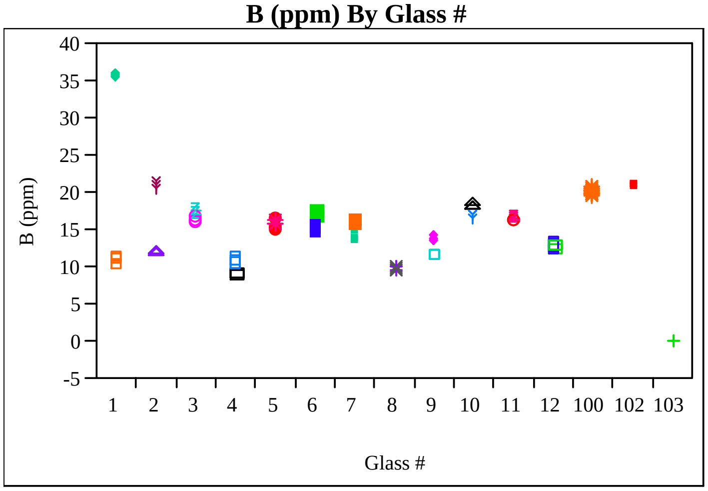


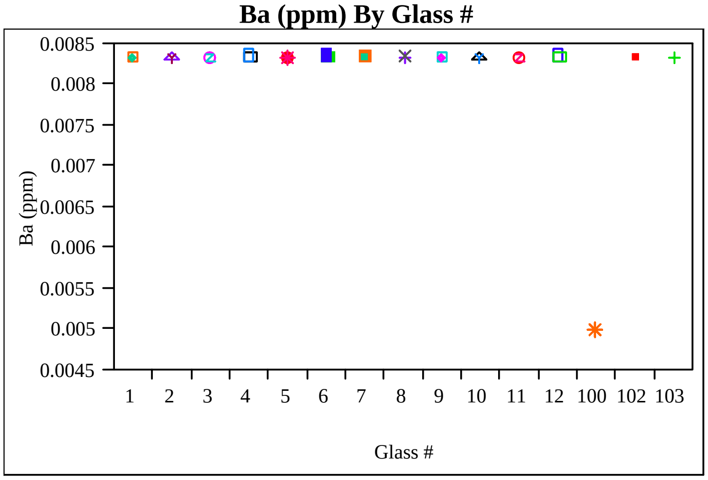
Exhibit D.5: SRNL-ML PCT Measurements by Glass Number for Study Glasses and Standards Except EA

(100 – Solution Standard; 102 – ARM; 103 – Blanks)

B (ppm) By Glass #



Ba (ppm) By Glass #



Cd (ppm) By Glass #

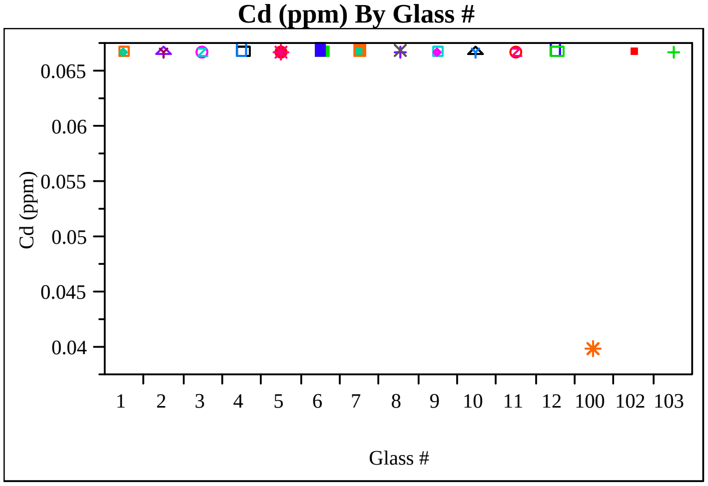
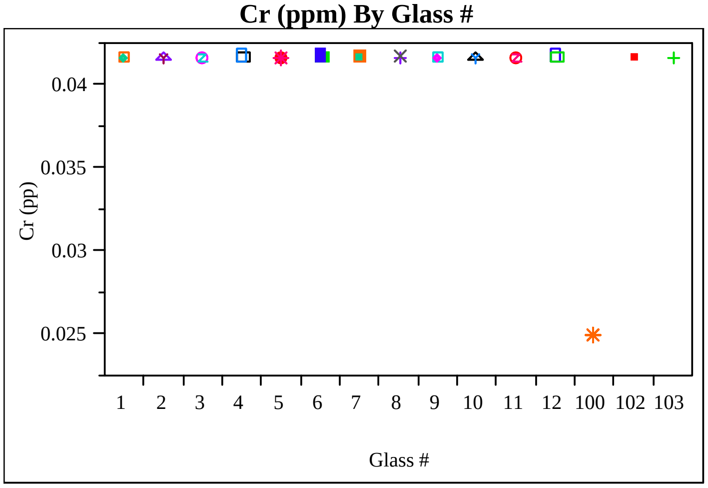
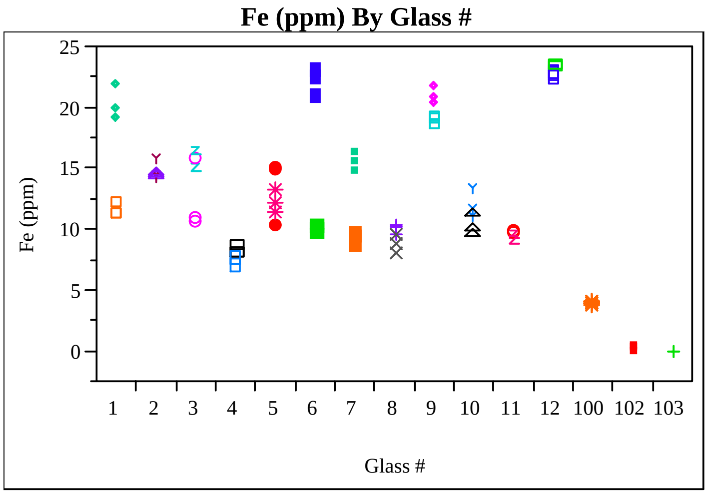


Exhibit D.5: SRNL-ML PCT Measurements by Glass Number for Study Glasses and Standards Except EA

(100 – Solution Standard; 102 – ARM; 103 – Blanks)





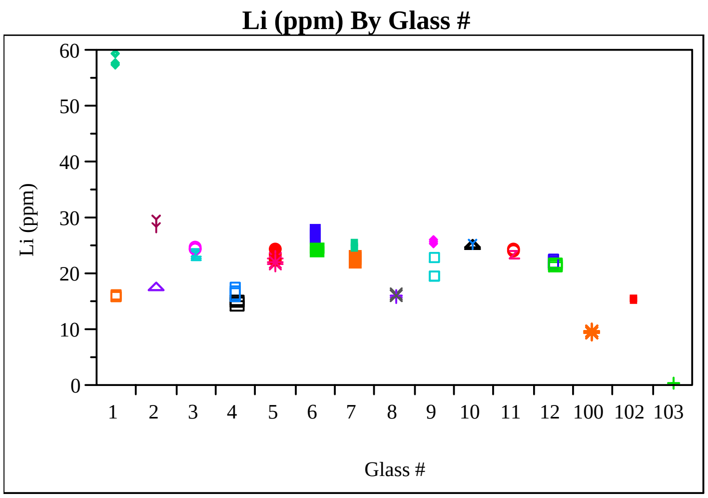
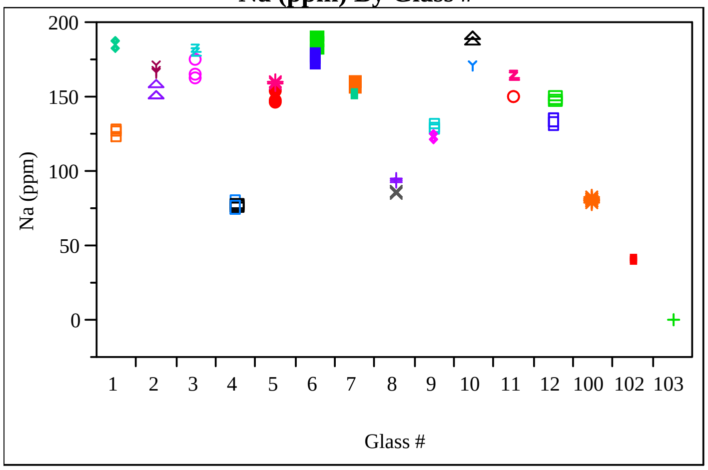


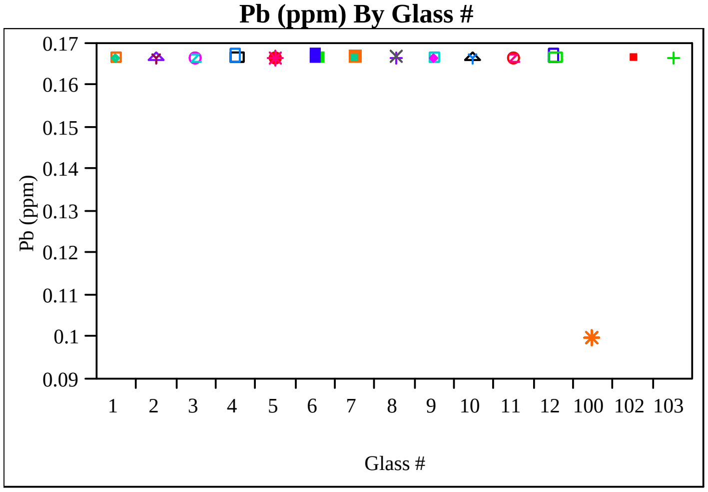
Exhibit D.5: SRNL-ML PCT Measurements by Glass Number for Study Glasses and Standards Except EA

(100 – Solution Standard; 102 – ARM; 103 – Blanks)

Na (ppm) By Glass #



Pb (ppm) By Glass #



Si (ppm) By Glass #

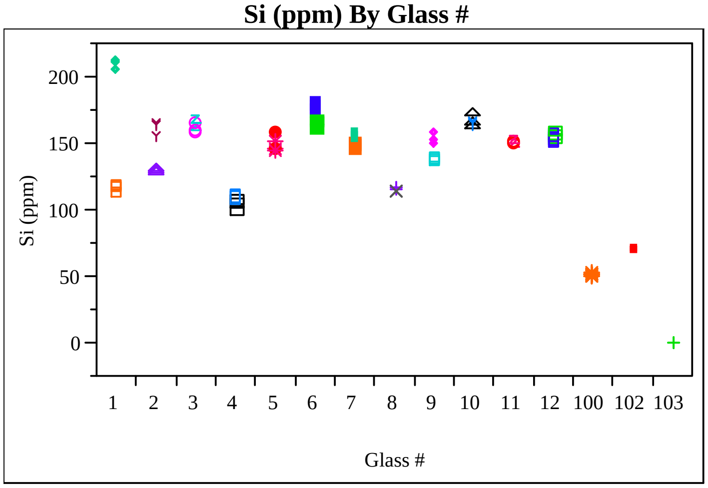
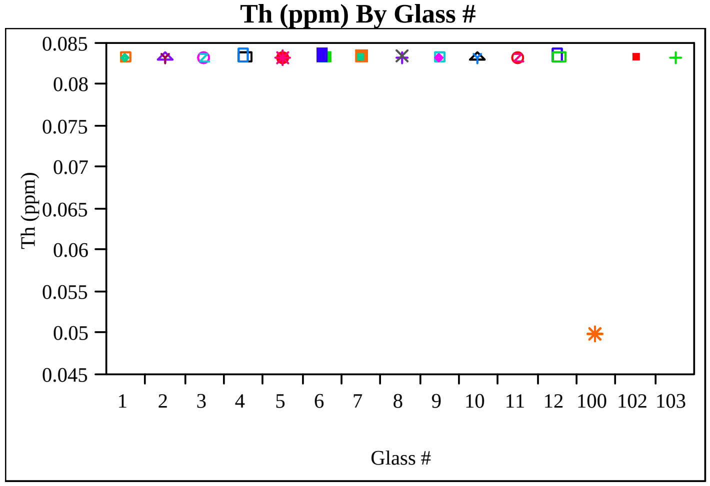


Exhibit D.5: SRNL-ML PCT Measurements by Glass Number for Study Glasses and Standards Except EA

(100 – Solution Standard; 102 – ARM; 103 – Blanks)



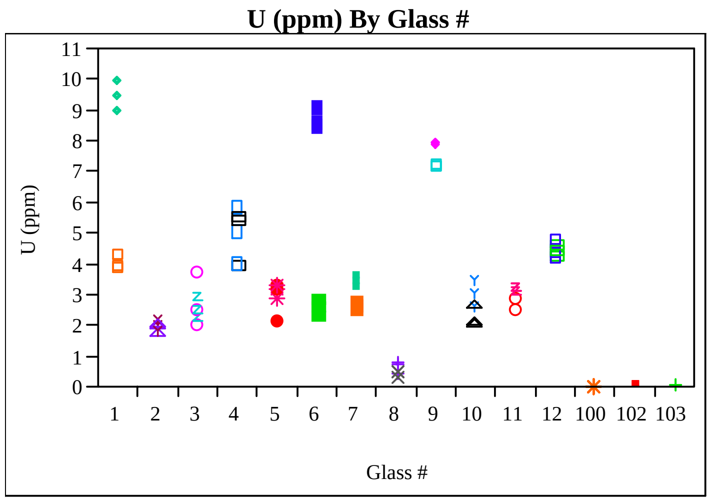
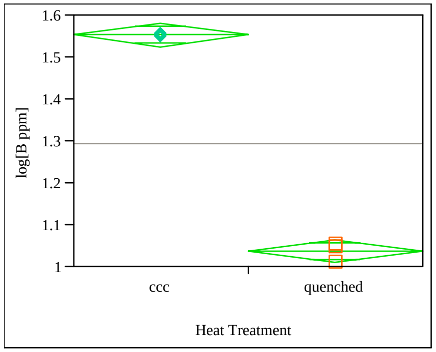


Exhibit D.6: Effects of Heat Treatment on PCT Response by Study Glass

Glass #=1

Oneway Analysis of log[B ppm] By Heat Treatment



Oneway Anova
Summary of Fit

Rsquare	0.997006
Adj Rsquare	0.996258
Root Mean Square Error	0.017313
Mean of Response	1.296301
Observations (or Sum Wgts)	6

t Test
ccc-quenched
Assuming equal variances

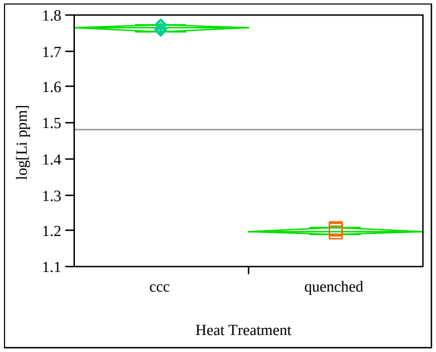
Difference	0.515965	t Ratio	36.49911
Std Err Dif	0.014136	DF	4
Upper CL Dif	0.555214	Prob > |t|	<.0001
Lower CL Dif	0.476716	Prob > t	<.0001
Confidence	0.95	Prob < t	1.0000

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
ccc	3	1.55428	0.01000	1.5265	1.5820
quenched	3	1.03832	0.01000	1.0106	1.0661

Std Error uses a pooled estimate of error variance

Oneway Analysis of log[Li ppm] By Heat Treatment



Oneway Anova
Summary of Fit

Rsquare	0.999581
Adj Rsquare	0.999477
Root Mean Square Error	0.007071
Mean of Response	1.482985
Observations (or Sum Wgts)	6

t Test
ccc-quenched
Assuming equal variances

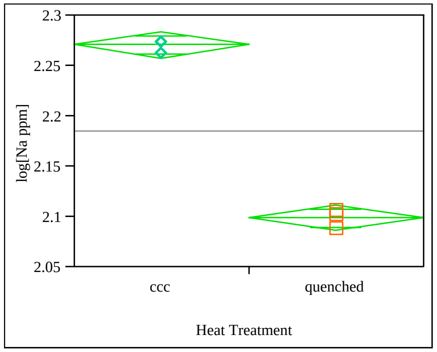
Difference	0.564115	t Ratio	97.70954
Std Err Dif	0.005773	DF	4
Upper CL Dif	0.580144	Prob > |t|	<.0001
Lower CL Dif	0.548085	Prob > t	<.0001
Confidence	0.95	Prob < t	1.0000

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
ccc	3	1.76504	0.00408	1.7537	1.7764
quenched	3	1.20093	0.00408	1.1896	1.2123

Std Error uses a pooled estimate of error variance

Oneway Analysis of log[Na ppm] By Heat Treatment



Oneway Anova
Summary of Fit

Rsquare	0.994264
Adj Rsquare	0.99283
Root Mean Square Error	0.008003
Mean of Response	2.185007
Observations (or Sum Wgts)	6

t Test
ccc-quenched
Assuming equal variances

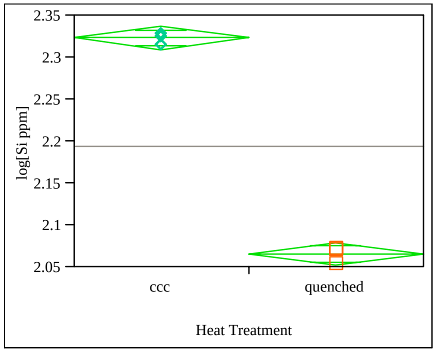
Difference	0.172067	t Ratio	26.33095
Std Err Dif	0.006535	DF	4
Upper CL Dif	0.190211	Prob > |t|	<.0001
Lower CL Dif	0.153924	Prob > t	<.0001
Confidence	0.95	Prob < t	1.0000

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
ccc	3	2.27104	0.00462	2.2582	2.2839
quenched	3	2.09897	0.00462	2.0861	2.1118

Std Error uses a pooled estimate of error variance

Oneway Analysis of log[Si ppm] By Heat Treatment



Oneway Anova
Summary of Fit

Rsquare	0.996938
Adj Rsquare	0.996173
Root Mean Square Error	0.008738
Mean of Response	2.194589
Observations (or Sum Wgts)	6

t Test
ccc-quenched
Assuming equal variances

Difference	0.257493	t Ratio	36.08895
Std Err Dif	0.007135	DF	4
Upper CL Dif	0.277303	Prob > |t|	<.0001
Lower CL Dif	0.237683	Prob > t	<.0001
Confidence	0.95	Prob < t	1.0000

Means for Oneway Anova

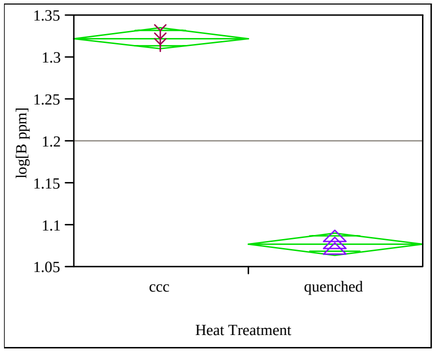
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
ccc	3	2.32334	0.00505	2.3093	2.3373
quenched	3	2.06584	0.00505	2.0518	2.0799

Std Error uses a pooled estimate of error variance

Exhibit D.6: Effects of Heat Treatment on PCT Response by Study Glass *(continued)*

Glass #=2

Oneway Analysis of log[B ppm] By Heat Treatment



Oneway Anova
Summary of Fit

Rsquare	0.997093
Adj Rsquare	0.996366
Root Mean Square Error	0.00812
Mean of Response	1.200527
Observations (or Sum Wgts)	6

t Test
ccc-quenched
Assuming equal variances

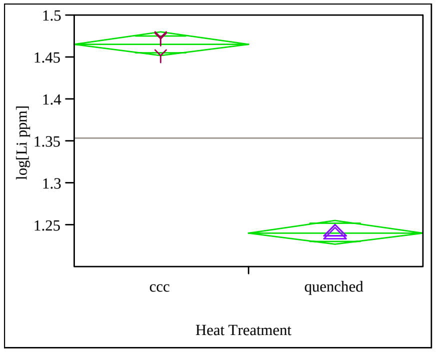
Difference	0.245582	t Ratio	37.03979
Std Err Dif	0.006630	DF	4
Upper CL Dif	0.263990	Prob > |t|	<.0001
Lower CL Dif	0.227173	Prob > t	<.0001
Confidence	0.95	Prob < t	1.0000

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
ccc	3	1.32332	0.00469	1.3103	1.3363
quenched	3	1.07774	0.00469	1.0647	1.0908

Std Error uses a pooled estimate of error variance

Oneway Analysis of log[Li ppm] By Heat Treatment



Oneway Anova
Summary of Fit

Rsquare	0.995877
Adj Rsquare	0.994846
Root Mean Square Error	0.008857
Mean of Response	1.354046
Observations (or Sum Wgts)	6

t Test
ccc-quenched
Assuming equal variances

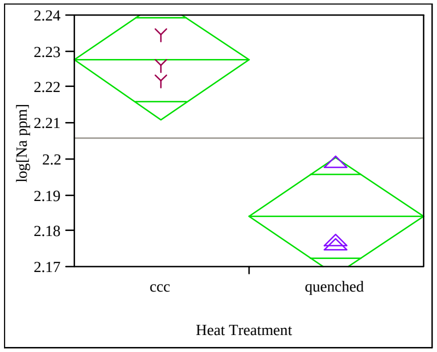
Difference	0.224770	t Ratio	31.08291
Std Err Dif	0.007231	DF	4
Upper CL Dif	0.244847	Prob > |t|	<.0001
Lower CL Dif	0.204693	Prob > t	<.0001
Confidence	0.95	Prob < t	1.0000

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
ccc	3	1.46643	0.00511	1.4522	1.4806
quenched	3	1.24166	0.00511	1.2275	1.2559

Std Error uses a pooled estimate of error variance

Oneway Analysis of log[Na ppm] By Heat Treatment



Oneway Anova
Summary of Fit

Rsquare	0.869789
Adj Rsquare	0.837237
Root Mean Square Error	0.010302
Mean of Response	2.205836
Observations (or Sum Wgts)	6

t Test
ccc-quenched
Assuming equal variances

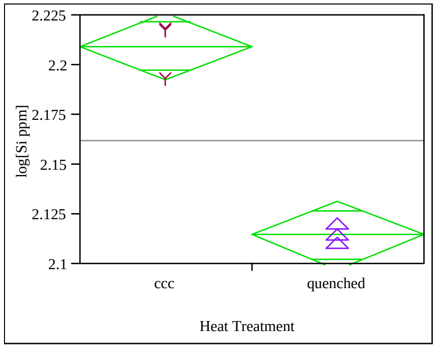
Difference	0.043481	t Ratio	5.169088
Std Err Dif	0.008412	DF	4
Upper CL Dif	0.066836	Prob > |t|	0.0067
Lower CL Dif	0.020126	Prob > t	0.0033
Confidence	0.95	Prob < t	0.9967

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
ccc	3	2.22758	0.00595	2.2111	2.2441
quenched	3	2.18410	0.00595	2.1676	2.2006

Std Error uses a pooled estimate of error variance

Oneway Analysis of log[Si ppm] By Heat Treatment



Oneway Anova
Summary of Fit

Rsquare	0.967475
Adj Rsquare	0.959343
Root Mean Square Error	0.010665
Mean of Response	2.162171
Observations (or Sum Wgts)	6

t Test
ccc-quenched
Assuming equal variances

Difference	0.094988	t Ratio	10.90786
Std Err Dif	0.008708	DF	4
Upper CL Dif	0.119166	Prob > |t|	0.0004
Lower CL Dif	0.070810	Prob > t	0.0002
Confidence	0.95	Prob < t	0.9998

Means for Oneway Anova

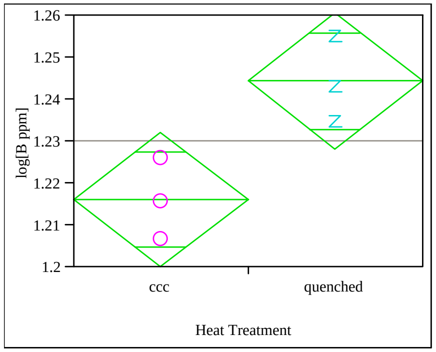
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
ccc	3	2.20967	0.00616	2.1926	2.2268
quenched	3	2.11468	0.00616	2.0976	2.1318

Std Error uses a pooled estimate of error variance

Exhibit D.6: Effects of Heat Treatment on PCT Response by Study Glass *(continued)*

Glass #=3

Oneway Analysis of log[B ppm] By Heat Treatment



Oneway Anova
Summary of Fit

Rsquare	0.746527
Adj Rsquare	0.683159
Root Mean Square Error	0.010024
Mean of Response	1.230295
Observations (or Sum Wgts)	6

t Test
ccc-quenched
Assuming equal variances

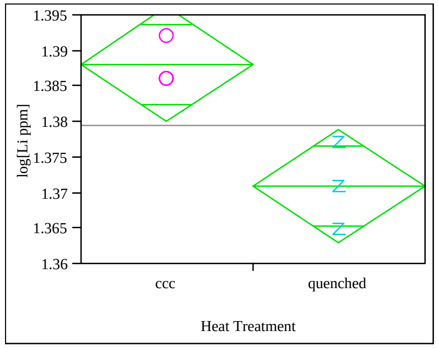
Difference	-0.02809	t Ratio	-3.43231
Std Err Dif	0.00818	DF	4
Upper CL Dif	-0.00537	Prob > |t|	0.0265
Lower CL Dif	-0.05082	Prob > t	0.9868
Confidence	0.95	Prob < t	0.0132

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
ccc	3	1.21625	0.00579	1.2002	1.2323
quenched	3	1.24434	0.00579	1.2283	1.2604

Std Error uses a pooled estimate of error variance

Oneway Analysis of log[Li ppm] By Heat Treatment



Oneway Anova
Summary of Fit

Rsquare	0.816144
Adj Rsquare	0.770181
Root Mean Square Error	0.00498
Mean of Response	1.379614
Observations (or Sum Wgts)	6

t Test
ccc-quenched
Assuming equal variances

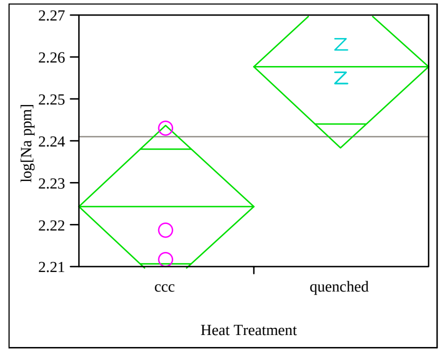
Difference	0.017132	t Ratio	4.213811
Std Err Dif	0.004066	DF	4
Upper CL Dif	0.028421	Prob > |t|	0.0135
Lower CL Dif	0.005844	Prob > t	0.0068
Confidence	0.95	Prob < t	0.9932

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
ccc	3	1.38818	0.00287	1.3802	1.3962
quenched	3	1.37105	0.00287	1.3631	1.3790

Std Error uses a pooled estimate of error variance

Oneway Analysis of log[Na ppm] By Heat Treatment



Oneway Anova
Summary of Fit

Rsquare	0.742223
Adj Rsquare	0.677779
Root Mean Square Error	0.012054
Mean of Response	2.241236
Observations (or Sum Wgts)	6

t Test
ccc-quenched
Assuming equal variances

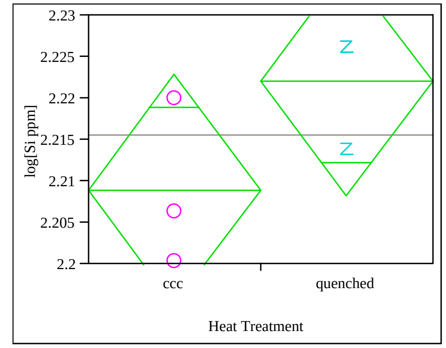
Difference	-0.03340	t Ratio	-3.39372
Std Err Dif	0.00984	DF	4
Upper CL Dif	-0.00608	Prob > |t|	0.0274
Lower CL Dif	-0.06073	Prob > t	0.9863
Confidence	0.95	Prob < t	0.0137

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
ccc	3	2.22454	0.00696	2.2052	2.2439
quenched	3	2.25794	0.00696	2.2386	2.2773

Std Error uses a pooled estimate of error variance

Oneway Analysis of log[Si ppm] By Heat Treatment



Oneway Anova
Summary of Fit

Rsquare	0.46041
Adj Rsquare	0.325512
Root Mean Square Error	0.008691
Mean of Response	2.215554
Observations (or Sum Wgts)	6

t Test
ccc-quenched
Assuming equal variances

Difference	-0.01311	t Ratio	-1.84744
Std Err Dif	0.00710	DF	4
Upper CL Dif	0.00659	Prob > |t|	0.1384
Lower CL Dif	-0.03281	Prob > t	0.9308
Confidence	0.95	Prob < t	0.0692

Means for Oneway Anova

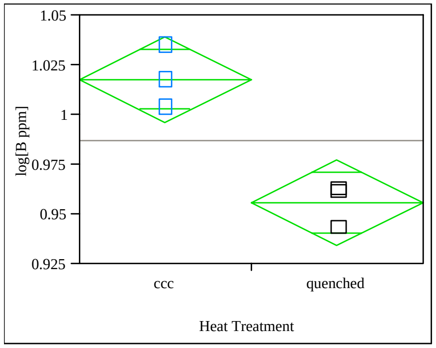
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
ccc	3	2.20900	0.00502	2.1951	2.2229
quenched	3	2.22211	0.00502	2.2082	2.2360

Std Error uses a pooled estimate of error variance

Exhibit D.6: Effects of Heat Treatment on PCT Response by Study Glass *(continued)*

Glass #=4

Oneway Analysis of log[B ppm] By Heat Treatment



Oneway Anova

Summary of Fit

Rsquare	0.889048
Adj Rsquare	0.86131
Root Mean Square Error	0.013408
Mean of Response	0.987024
Observations (or Sum Wgts)	6

t Test

ccc-quenched

Assuming equal variances

Difference	0.061977	t Ratio	5.661425
Std Err Dif	0.010947	DF	4
Upper CL Dif	0.092372	Prob > |t|	0.0048
Lower CL Dif	0.031583	Prob > t	0.0024
Confidence	0.95	Prob < t	0.9976

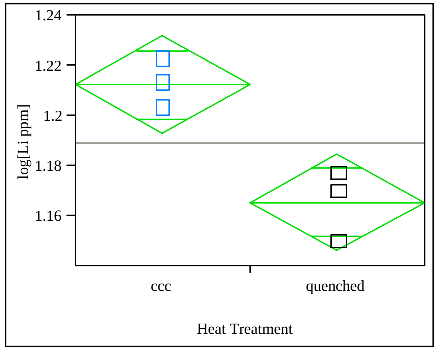
Analysis of Variance

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
ccc	3	1.01801	0.00774	0.99652	1.0395
quenched	3	0.95604	0.00774	0.93454	0.9775

Std Error uses a pooled estimate of error variance

Oneway Analysis of log[Li ppm] By Heat Treatment



Oneway Anova

Summary of Fit

Rsquare	0.849878
Adj Rsquare	0.812348
Root Mean Square Error	0.012069
Mean of Response	1.188975
Observations (or Sum Wgts)	6

t Test

ccc-quenched

Assuming equal variances

Difference	0.046894	t Ratio	4.758678
Std Err Dif	0.009854	DF	4
Upper CL Dif	0.074254	Prob > |t|	0.0089
Lower CL Dif	0.019534	Prob > t	0.0045
Confidence	0.95	Prob < t	0.9955

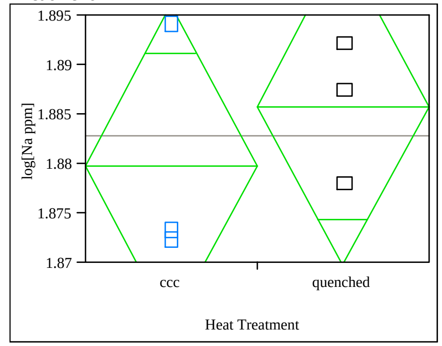
Analysis of Variance

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
ccc	3	1.21242	0.00697	1.1931	1.2318
quenched	3	1.16553	0.00697	1.1462	1.1849

Std Error uses a pooled estimate of error variance

Oneway Analysis of log[Na ppm] By Heat Treatment



Oneway Anova

Summary of Fit

Rsquare	0.119917
Adj Rsquare	-0.1001
Root Mean Square Error	0.010087
Mean of Response	1.882792
Observations (or Sum Wgts)	6

t Test

ccc-quenched

Assuming equal variances

Difference	-0.00608	t Ratio	-0.73826
Std Err Dif	0.00824	DF	4
Upper CL Dif	0.01679	Prob > |t|	0.5013
Lower CL Dif	-0.02895	Prob > t	0.7493
Confidence	0.95	Prob < t	0.2507

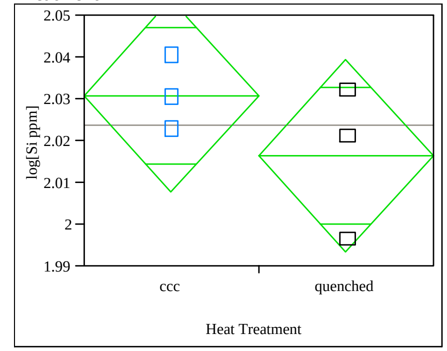
Analysis of Variance

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
ccc	3	1.87975	0.00582	1.8636	1.8959
quenched	3	1.88583	0.00582	1.8697	1.9020

Std Error uses a pooled estimate of error variance

Oneway Analysis of log[Si ppm] By Heat Treatment



Oneway Anova

Summary of Fit

Rsquare	0.272664
Adj Rsquare	0.090829
Root Mean Square Error	0.014357
Mean of Response	2.023731
Observations (or Sum Wgts)	6

t Test

ccc-quenched

Assuming equal variances

Difference	0.01435	t Ratio	1.224548
Std Err Dif	0.01172	DF	4
Upper CL Dif	0.04690	Prob > |t|	0.2879
Lower CL Dif	-0.01819	Prob > t	0.1440
Confidence	0.95	Prob < t	0.8560

Analysis of Variance

Means for Oneway Anova

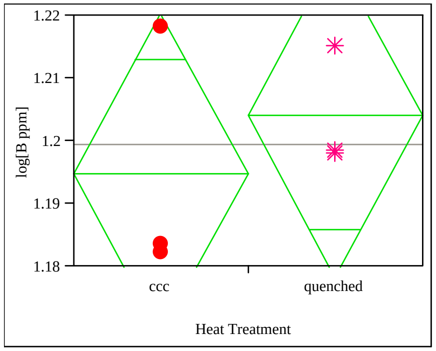
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
ccc	3	2.03091	0.00829	2.0079	2.0539
quenched	3	2.01655	0.00829	1.9935	2.0396

Std Error uses a pooled estimate of error variance

Exhibit D.6: Effects of Heat Treatment on PCT Response by Study Glass *(continued)*

Glass #=5

Oneway Analysis of log[B ppm] By Heat Treatment



Oneway Anova
Summary of Fit

Rsquare	0.11127
Adj Rsquare	-0.11091
Root Mean Square Error	0.015989
Mean of Response	1.199436
Observations (or Sum Wgts)	6

t Test
ccc-quenched
Assuming equal variances

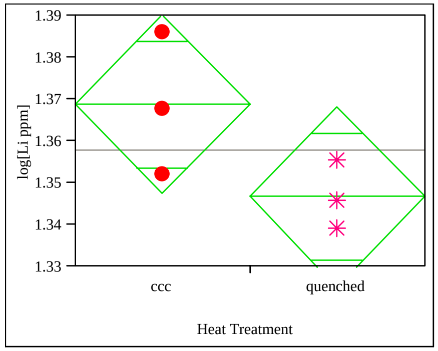
Difference	-0.00924	t Ratio	-0.70768
Std Err Dif	0.01306	DF	4
Upper CL Dif	0.02701	Prob > |t|	0.5182
Lower CL Dif	-0.04549	Prob > t	0.7409
Confidence	0.95	Prob < t	0.2591

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
ccc	3	1.19482	0.00923	1.1692	1.2204
quenched	3	1.20406	0.00923	1.1784	1.2297

Std Error uses a pooled estimate of error variance

Oneway Analysis of log[Li ppm] By Heat Treatment



Oneway Anova
Summary of Fit

Rsquare	0.505477
Adj Rsquare	0.381846
Root Mean Square Error	0.013356
Mean of Response	1.35777
Observations (or Sum Wgts)	6

t Test
ccc-quenched
Assuming equal variances

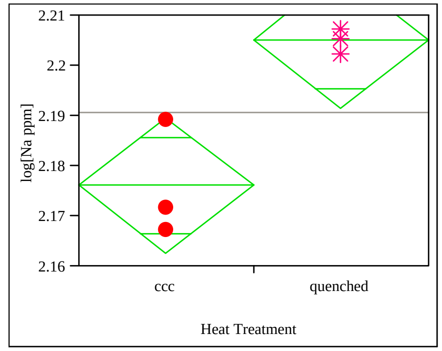
Difference	0.02205	t Ratio	2.022029
Std Err Dif	0.01091	DF	4
Upper CL Dif	0.05233	Prob > |t|	0.1132
Lower CL Dif	-0.00823	Prob > t	0.0566
Confidence	0.95	Prob < t	0.9434

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
ccc	3	1.36880	0.00771	1.3474	1.3902
quenched	3	1.34674	0.00771	1.3253	1.3682

Std Error uses a pooled estimate of error variance

Oneway Analysis of log[Na ppm] By Heat Treatment



Oneway Anova
Summary of Fit

Rsquare	0.814002
Adj Rsquare	0.767502
Root Mean Square Error	0.008452
Mean of Response	2.190592
Observations (or Sum Wgts)	6

t Test
ccc-quenched
Assuming equal variances

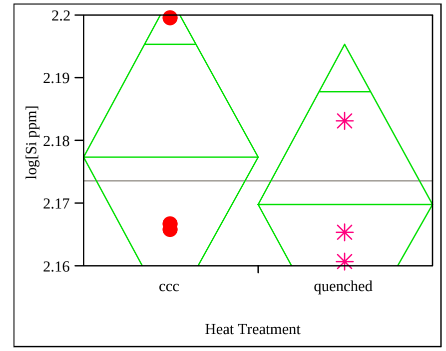
Difference	-0.02887	t Ratio	-4.18396
Std Err Dif	0.00690	DF	4
Upper CL Dif	-0.00971	Prob > |t|	0.0139
Lower CL Dif	-0.04803	Prob > t	0.9931
Confidence	0.95	Prob < t	0.0069

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
ccc	3	2.17616	0.00488	2.1626	2.1897
quenched	3	2.20503	0.00488	2.1915	2.2186

Std Error uses a pooled estimate of error variance

Oneway Analysis of log[Si ppm] By Heat Treatment



Oneway Anova
Summary of Fit

Rsquare	0.07812
Adj Rsquare	-0.15235
Root Mean Square Error	0.015955
Mean of Response	2.173628
Observations (or Sum Wgts)	6

t Test
ccc-quenched
Assuming equal variances

Difference	0.00758	t Ratio	0.582204
Std Err Dif	0.01303	DF	4
Upper CL Dif	0.04375	Prob > |t|	0.5917
Lower CL Dif	-0.02858	Prob > t	0.2958
Confidence	0.95	Prob < t	0.7042

Means for Oneway Anova

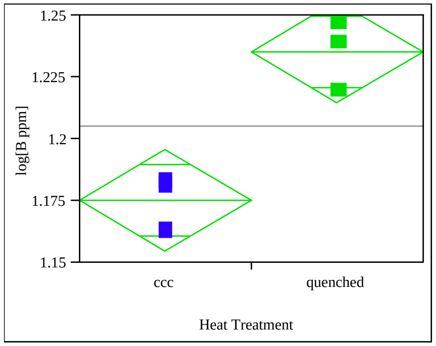
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
ccc	3	2.17742	0.00921	2.1518	2.2030
quenched	3	2.16984	0.00921	2.1443	2.1954

Std Error uses a pooled estimate of error variance

Exhibit D.6: Effects of Heat Treatment on PCT Response by Study Glass *(continued)*

Glass #=6

Oneway Analysis of log[B ppm] By Heat Treatment



Oneway Anova
Summary of Fit

Rsquare	0.893385
Adj Rsquare	0.866731
Root Mean Square Error	0.012702
Mean of Response	1.205223
Observations (or Sum Wgts)	6

t Test
ccc-quenched
Assuming equal variances

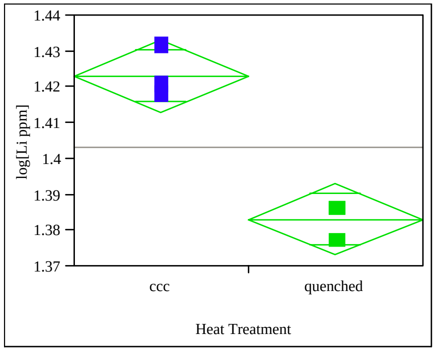
Difference	-0.06004	t Ratio	-5.78947
Std Err Dif	0.01037	DF	4
Upper CL Dif	-0.03125	Prob > |t|	0.0044
Lower CL Dif	-0.08884	Prob > t	0.9978
Confidence	0.95	Prob < t	0.0022

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
ccc	3	1.17520	0.00733	1.1548	1.1956
quenched	3	1.23524	0.00733	1.2149	1.2556

Std Error uses a pooled estimate of error variance

Oneway Analysis of log[Li ppm] By Heat Treatment



Oneway Anova
Summary of Fit

Rsquare	0.938325
Adj Rsquare	0.922907
Root Mean Square Error	0.006281
Mean of Response	1.40321
Observations (or Sum Wgts)	6

t Test
ccc-quenched
Assuming equal variances

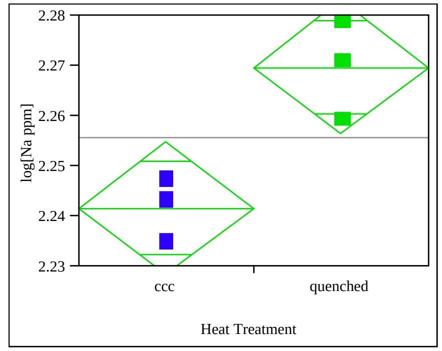
Difference	0.040010	t Ratio	7.801049
Std Err Dif	0.005129	DF	4
Upper CL Dif	0.054250	Prob > |t|	0.0015
Lower CL Dif	0.025770	Prob > t	0.0007
Confidence	0.95	Prob < t	0.9993

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
ccc	3	1.42321	0.00363	1.4131	1.4333
quenched	3	1.38320	0.00363	1.3731	1.3933

Std Error uses a pooled estimate of error variance

Oneway Analysis of log[Na ppm] By Heat Treatment



Oneway Anova
Summary of Fit

Rsquare	0.812251
Adj Rsquare	0.765314
Root Mean Square Error	0.008265
Mean of Response	2.255671
Observations (or Sum Wgts)	6

t Test
ccc-quenched
Assuming equal variances

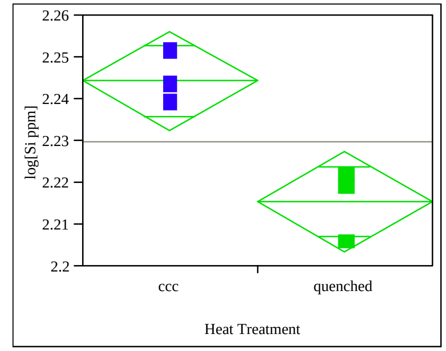
Difference	-0.02807	t Ratio	-4.15993
Std Err Dif	0.00675	DF	4
Upper CL Dif	-0.00934	Prob > |t|	0.0141
Lower CL Dif	-0.04681	Prob > t	0.9929
Confidence	0.95	Prob < t	0.0071

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
ccc	3	2.24163	0.00477	2.2284	2.2549
quenched	3	2.26971	0.00477	2.2565	2.2830

Std Error uses a pooled estimate of error variance

Oneway Analysis of log[Si ppm] By Heat Treatment



Oneway Anova
Summary of Fit

Rsquare	0.849215
Adj Rsquare	0.811519
Root Mean Square Error	0.007447
Mean of Response	2.229963
Observations (or Sum Wgts)	6

t Test
ccc-quenched
Assuming equal variances

Difference	0.028860	t Ratio	4.746356
Std Err Dif	0.006080	DF	4
Upper CL Dif	0.045742	Prob > |t|	0.0090
Lower CL Dif	0.011978	Prob > t	0.0045
Confidence	0.95	Prob < t	0.9955

Means for Oneway Anova

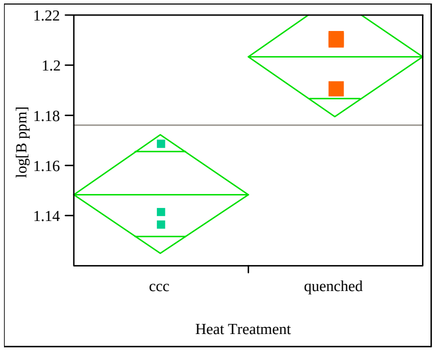
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
ccc	3	2.24439	0.00430	2.2325	2.2563
quenched	3	2.21553	0.00430	2.2036	2.2275

Std Error uses a pooled estimate of error variance

Exhibit D.6: Effects of Heat Treatment on PCT Response by Study Glass *(continued)*

Glass #=7

Oneway Analysis of log[B ppm] By Heat Treatment



Oneway Anova

Summary of Fit

Rsquare	0.837045
Adj Rsquare	0.796306
Root Mean Square Error	0.014795
Mean of Response	1.176198
Observations (or Sum Wgts)	6

t Test

ccc-quenched

Assuming equal variances

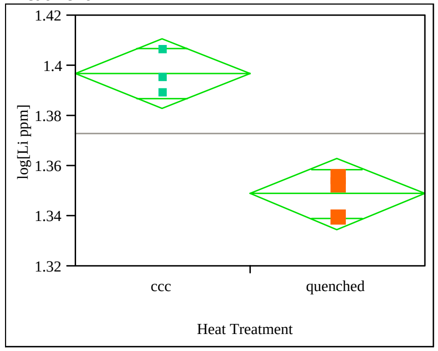
Difference	-0.05476	t Ratio	-4.53284
Std Err Dif	0.01208	DF	4
Upper CL Dif	-0.02122	Prob > |t|	0.0106
Lower CL Dif	-0.08829	Prob > t	0.9947
Confidence	0.95	Prob < t	0.0053

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
ccc	3	1.14882	0.00854	1.1251	1.1725
quenched	3	1.20358	0.00854	1.1799	1.2273

Std Error uses a pooled estimate of error variance

Oneway Analysis of log[Li ppm] By Heat Treatment



Oneway Anova

Summary of Fit

Rsquare	0.919022
Adj Rsquare	0.898777
Root Mean Square Error	0.008728
Mean of Response	1.372914
Observations (or Sum Wgts)	6

t Test

ccc-quenched

Assuming equal variances

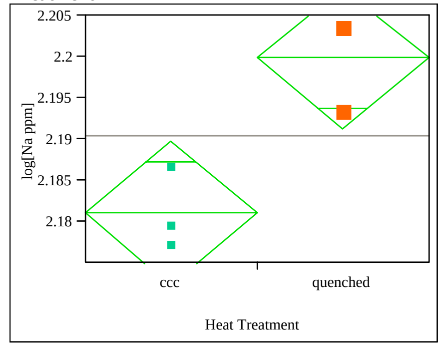
Difference	0.048017	t Ratio	6.737655
Std Err Dif	0.007127	DF	4
Upper CL Dif	0.067804	Prob > |t|	0.0025
Lower CL Dif	0.028230	Prob > t	0.0013
Confidence	0.95	Prob < t	0.9987

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
ccc	3	1.39692	0.00504	1.3829	1.4109
quenched	3	1.34891	0.00504	1.3349	1.3629

Std Error uses a pooled estimate of error variance

Oneway Analysis of log[Na ppm] By Heat Treatment



Oneway Anova

Summary of Fit

Rsquare	0.819609
Adj Rsquare	0.774512
Root Mean Square Error	0.005407
Mean of Response	2.190449
Observations (or Sum Wgts)	6

t Test

ccc-quenched

Assuming equal variances

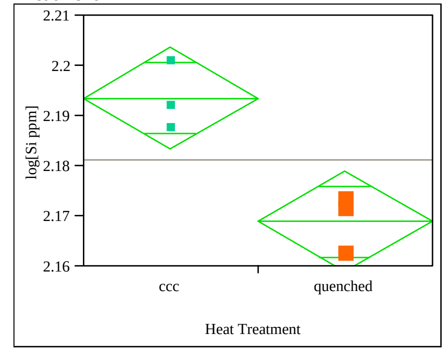
Difference	-0.01882	t Ratio	-4.26311
Std Err Dif	0.00441	DF	4
Upper CL Dif	-0.00656	Prob > |t|	0.0130
Lower CL Dif	-0.03108	Prob > t	0.9935
Confidence	0.95	Prob < t	0.0065

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
ccc	3	2.18104	0.00312	2.1724	2.1897
quenched	3	2.19986	0.00312	2.1912	2.2085

Std Error uses a pooled estimate of error variance

Oneway Analysis of log[Si ppm] By Heat Treatment



Oneway Anova

Summary of Fit

Rsquare	0.850889
Adj Rsquare	0.813612
Root Mean Square Error	0.006312
Mean of Response	2.18125
Observations (or Sum Wgts)	6

t Test

ccc-quenched

Assuming equal variances

Difference	0.024623	t Ratio	4.777627
Std Err Dif	0.005154	DF	4
Upper CL Dif	0.038932	Prob > |t|	0.0088
Lower CL Dif	0.010314	Prob > t	0.0044
Confidence	0.95	Prob < t	0.9956

Means for Oneway Anova

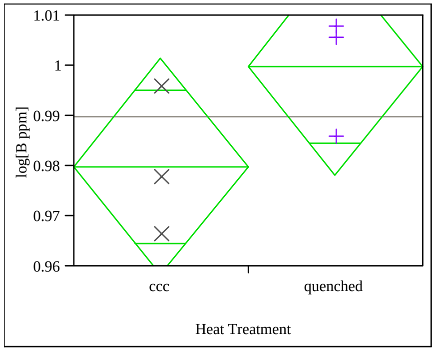
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
ccc	3	2.19356	0.00364	2.1834	2.2037
quenched	3	2.16894	0.00364	2.1588	2.1791

Std Error uses a pooled estimate of error variance

Exhibit D.6: Effects of Heat Treatment on PCT Response by Study Glass *(continued)*

Glass #=8

Oneway Analysis of log[B ppm] By Heat Treatment



Oneway Anova
Summary of Fit

Rsquare	0.45175
Adj Rsquare	0.314688
Root Mean Square Error	0.01353
Mean of Response	0.98987
Observations (or Sum Wgts)	6

t Test
ccc-quenched
Assuming equal variances

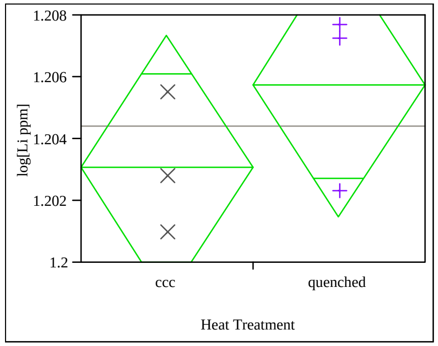
Difference	-0.02006	t Ratio	-1.81547
Std Err Dif	0.01105	DF	4
Upper CL Dif	0.01062	Prob > |t|	0.1436
Lower CL Dif	-0.05073	Prob > t	0.9282
Confidence	0.95	Prob < t	0.0718

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
ccc	3	0.979842	0.00781	0.95815	1.0015
quenched	3	0.999898	0.00781	0.97821	1.0216

Std Error uses a pooled estimate of error variance

Oneway Analysis of log[Li ppm] By Heat Treatment



Oneway Anova
Summary of Fit

Rsquare	0.278788
Adj Rsquare	0.098485
Root Mean Square Error	0.002669
Mean of Response	1.204423
Observations (or Sum Wgts)	6

t Test
ccc-quenched
Assuming equal variances

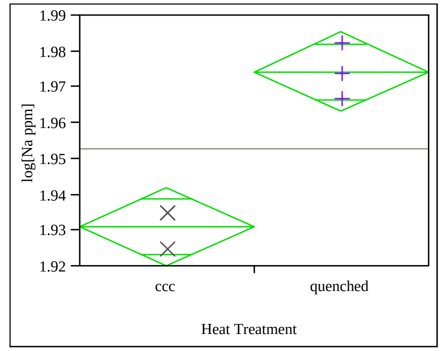
Difference	-0.00271	t Ratio	-1.24347
Std Err Dif	0.00218	DF	4
Upper CL Dif	0.00334	Prob > |t|	0.2816
Lower CL Dif	-0.00876	Prob > t	0.8592
Confidence	0.95	Prob < t	0.1408

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
ccc	3	1.20307	0.00154	1.1988	1.2073
quenched	3	1.20578	0.00154	1.2015	1.2101

Std Error uses a pooled estimate of error variance

Oneway Analysis of log[Na ppm] By Heat Treatment



Oneway Anova
Summary of Fit

Rsquare	0.937351
Adj Rsquare	0.921688
Root Mean Square Error	0.006851
Mean of Response	1.952737
Observations (or Sum Wgts)	6

t Test
ccc-quenched
Assuming equal variances

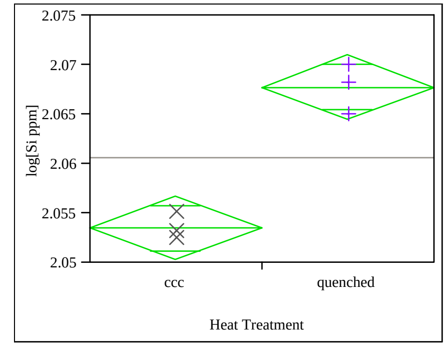
Difference	-0.04327	t Ratio	-7.73611
Std Err Dif	0.00559	DF	4
Upper CL Dif	-0.02774	Prob > |t|	0.0015
Lower CL Dif	-0.05880	Prob > t	0.9992
Confidence	0.95	Prob < t	0.0008

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
ccc	3	1.93110	0.00396	1.9201	1.9421
quenched	3	1.97437	0.00396	1.9634	1.9854

Std Error uses a pooled estimate of error variance

Oneway Analysis of log[Si ppm] By Heat Treatment



Oneway Anova
Summary of Fit

Rsquare	0.949928
Adj Rsquare	0.93741
Root Mean Square Error	0.002006
Mean of Response	2.060645
Observations (or Sum Wgts)	6

t Test
ccc-quenched
Assuming equal variances

Difference	-0.01426	t Ratio	-8.71117
Std Err Dif	0.00164	DF	4
Upper CL Dif	-0.00972	Prob > |t|	0.0010
Lower CL Dif	-0.01881	Prob > t	0.9995
Confidence	0.95	Prob < t	0.0005

Means for Oneway Anova

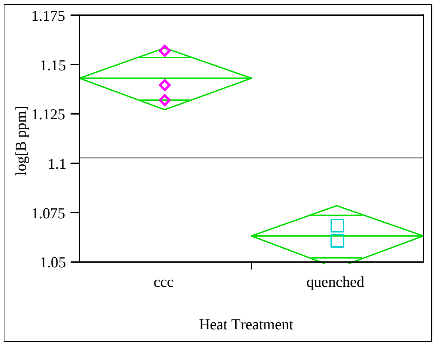
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
ccc	3	2.05351	0.00116	2.0503	2.0567
quenched	3	2.06778	0.00116	2.0646	2.0710

Std Error uses a pooled estimate of error variance

Exhibit D.6: Effects of Heat Treatment on PCT Response by Study Glass *(continued)*

Glass #=9

Oneway Analysis of log[B ppm] By Heat Treatment



Oneway Anova
Summary of Fit

Rsquare	0.96223
Adj Rsquare	0.952788
Root Mean Square Error	0.009689
Mean of Response	1.103135
Observations (or Sum Wgts)	6

t Test
ccc-quenched
Assuming equal variances

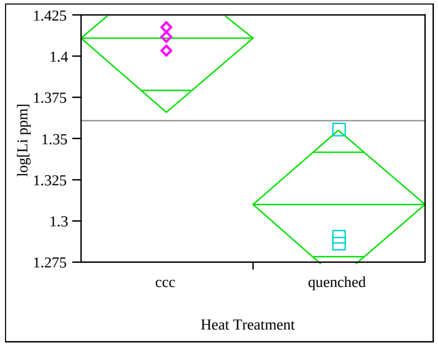
Difference	0.079864	t Ratio	10.09479
Std Err Dif	0.007911	DF	4
Upper CL Dif	0.101830	Prob > |t|	0.0005
Lower CL Dif	0.057899	Prob > t	0.0003
Confidence	0.95	Prob < t	0.9997

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
ccc	3	1.14307	0.00559	1.1275	1.1586
quenched	3	1.06320	0.00559	1.0477	1.0787

Std Error uses a pooled estimate of error variance

Oneway Analysis of log[Li ppm] By Heat Treatment



Oneway Anova
Summary of Fit

Rsquare	0.829634
Adj Rsquare	0.787043
Root Mean Square Error	0.027925
Mean of Response	1.3609
Observations (or Sum Wgts)	6

t Test
ccc-quenched
Assuming equal variances

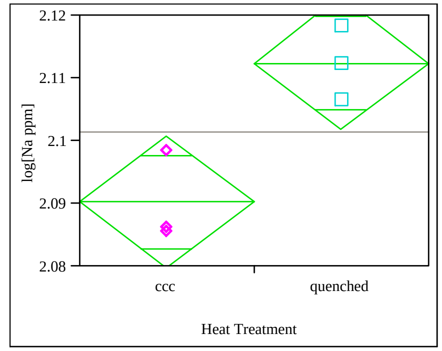
Difference	0.100631	t Ratio	4.413488
Std Err Dif	0.022801	DF	4
Upper CL Dif	0.163936	Prob > |t|	0.0116
Lower CL Dif	0.037326	Prob > t	0.0058
Confidence	0.95	Prob < t	0.9942

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
ccc	3	1.41122	0.01612	1.3665	1.4560
quenched	3	1.31059	0.01612	1.2658	1.3553

Std Error uses a pooled estimate of error variance

Oneway Analysis of log[Na ppm] By Heat Treatment



Oneway Anova
Summary of Fit

Rsquare	0.808622
Adj Rsquare	0.760777
Root Mean Square Error	0.006606
Mean of Response	2.101352
Observations (or Sum Wgts)	6

t Test
ccc-quenched
Assuming equal variances

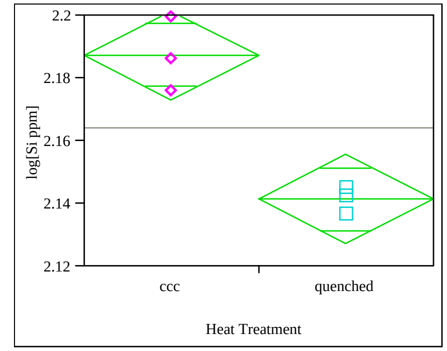
Difference	-0.02217	t Ratio	-4.11108
Std Err Dif	0.00539	DF	4
Upper CL Dif	-0.00720	Prob > |t|	0.0147
Lower CL Dif	-0.03715	Prob > t	0.9926
Confidence	0.95	Prob < t	0.0074

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
ccc	3	2.09027	0.00381	2.0797	2.1009
quenched	3	2.11244	0.00381	2.1018	2.1230

Std Error uses a pooled estimate of error variance

Oneway Analysis of log[Si ppm] By Heat Treatment



Oneway Anova
Summary of Fit

Rsquare	0.910044
Adj Rsquare	0.887555
Root Mean Square Error	0.008852
Mean of Response	2.164434
Observations (or Sum Wgts)	6

t Test
ccc-quenched
Assuming equal variances

Difference	0.045979	t Ratio	6.361315
Std Err Dif	0.007228	DF	4
Upper CL Dif	0.066047	Prob > |t|	0.0031
Lower CL Dif	0.025911	Prob > t	0.0016
Confidence	0.95	Prob < t	0.9984

Means for Oneway Anova

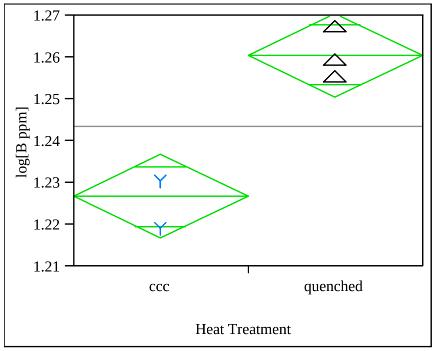
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
ccc	3	2.18742	0.00511	2.1732	2.2016
quenched	3	2.14144	0.00511	2.1273	2.1556

Std Error uses a pooled estimate of error variance

Exhibit D.6: Effects of Heat Treatment on PCT Response by Study Glass *(continued)*

Glass #=10

Oneway Analysis of log[B ppm] By Heat Treatment



Oneway Anova
Summary of Fit

Rsquare	0.916279
Adj Rsquare	0.895348
Root Mean Square Error	0.006268
Mean of Response	1.243651
Observations (or Sum Wgts)	6

t Test
ccc-quenched
Assuming equal variances

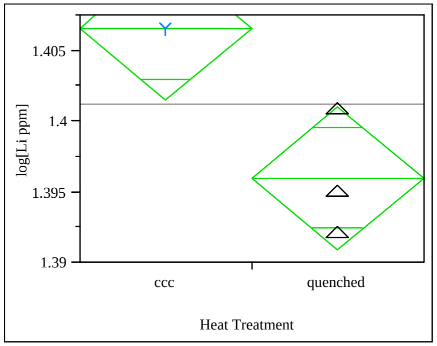
Difference	-0.03386	t Ratio	-6.61646
Std Err Dif	0.00512	DF	4
Upper CL Dif	-0.01965	Prob > |t|	0.0027
Lower CL Dif	-0.04807	Prob > t	0.9986
Confidence	0.95	Prob < t	0.0014

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
ccc	3	1.22672	0.00362	1.2167	1.2368
quenched	3	1.26058	0.00362	1.2505	1.2706

Std Error uses a pooled estimate of error variance

Oneway Analysis of log[Li ppm] By Heat Treatment



Oneway Anova
Summary of Fit

Rsquare	0.809268
Adj Rsquare	0.761585
Root Mean Square Error	0.003136
Mean of Response	1.401274
Observations (or Sum Wgts)	6

t Test
ccc-quenched
Assuming equal variances

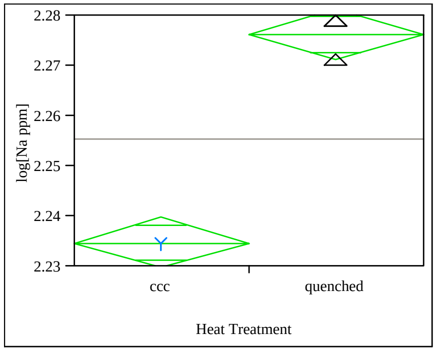
Difference	0.010550	t Ratio	4.119694
Std Err Dif	0.002561	DF	4
Upper CL Dif	0.017660	Prob > |t|	0.0146
Lower CL Dif	0.003440	Prob > t	0.0073
Confidence	0.95	Prob < t	0.9927

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
ccc	3	1.40655	0.00181	1.4015	1.4116
quenched	3	1.39600	0.00181	1.3910	1.4010

Std Error uses a pooled estimate of error variance

Oneway Analysis of log[Na ppm] By Heat Treatment



Oneway Anova
Summary of Fit

Rsquare	0.984985
Adj Rsquare	0.981231
Root Mean Square Error	0.003138
Mean of Response	2.255447
Observations (or Sum Wgts)	6

t Test
ccc-quenched
Assuming equal variances

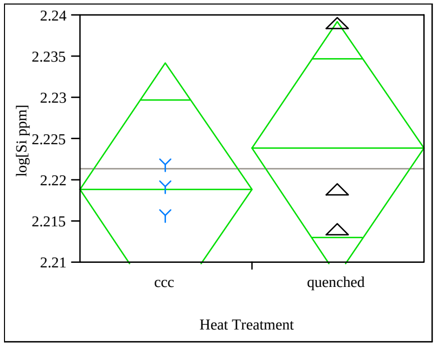
Difference	-0.04151	t Ratio	-16.1986
Std Err Dif	0.00256	DF	4
Upper CL Dif	-0.03439	Prob > |t|	<.0001
Lower CL Dif	-0.04862	Prob > t	1.0000
Confidence	0.95	Prob < t	<.0001

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
ccc	3	2.23469	0.00181	2.2297	2.2397
quenched	3	2.27620	0.00181	2.2712	2.2812

Std Error uses a pooled estimate of error variance

Oneway Analysis of log[Si ppm] By Heat Treatment



Oneway Anova
Summary of Fit

Rsquare	0.090553
Adj Rsquare	-0.13681
Root Mean Square Error	0.009594
Mean of Response	2.221417
Observations (or Sum Wgts)	6

t Test
ccc-quenched
Assuming equal variances

Difference	-0.00494	t Ratio	-0.63109
Std Err Dif	0.00783	DF	4
Upper CL Dif	0.01681	Prob > |t|	0.5622
Lower CL Dif	-0.02669	Prob > t	0.7189
Confidence	0.95	Prob < t	0.2811

Means for Oneway Anova

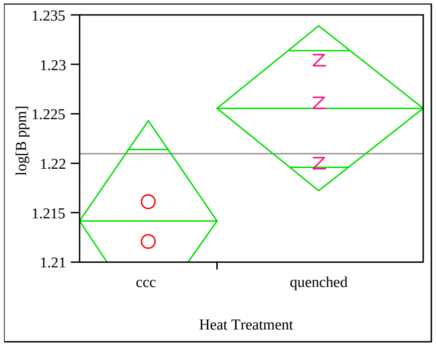
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
ccc	3	2.21895	0.00554	2.2036	2.2343
quenched	3	2.22389	0.00554	2.2085	2.2393

Std Error uses a pooled estimate of error variance

Exhibit D.6: Effects of Heat Treatment on PCT Response by Study Glass *(continued)*

Glass #=11

Oneway Analysis of log[B ppm] By Heat Treatment



Oneway Anova
Summary of Fit

Rsquare	0.715793
Adj Rsquare	0.621057
Root Mean Square Error	0.004543
Mean of Response	1.221025
Observations (or Sum Wgts)	5

t Test
ccc-quenched
Assuming equal variances

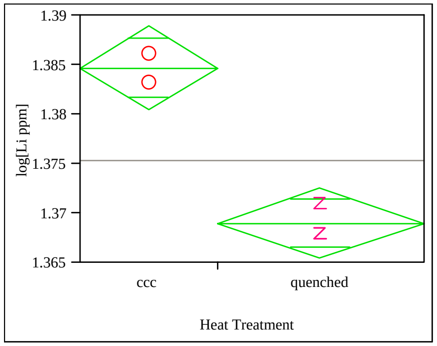
Difference	-0.01140	t Ratio	-2.74876
Std Err Dif	0.00415	DF	3
Upper CL Dif	0.00180	Prob > |t|	0.0708
Lower CL Dif	-0.02460	Prob > t	0.9646
Confidence	0.95	Prob < t	0.0354

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
ccc	2	1.21419	0.00321	1.2040	1.2244
quenched	3	1.22558	0.00262	1.2172	1.2339

Std Error uses a pooled estimate of error variance

Oneway Analysis of log[Li ppm] By Heat Treatment



Oneway Anova
Summary of Fit

Rsquare	0.964705
Adj Rsquare	0.95294
Root Mean Square Error	0.0019
Mean of Response	1.375297
Observations (or Sum Wgts)	5

t Test
ccc-quenched
Assuming equal variances

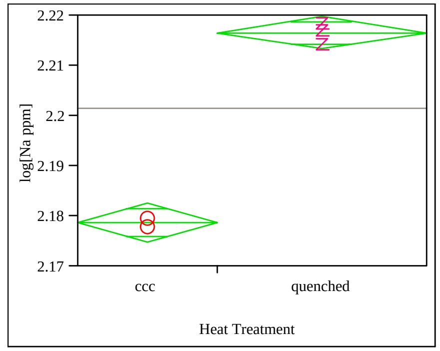
Difference	0.015702	t Ratio	9.055303
Std Err Dif	0.001734	DF	3
Upper CL Dif	0.021220	Prob > |t|	0.0028
Lower CL Dif	0.010184	Prob > t	0.0014
Confidence	0.95	Prob < t	0.9986

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
ccc	2	1.38472	0.00134	1.3804	1.3890
quenched	3	1.36902	0.00110	1.3655	1.3725

Std Error uses a pooled estimate of error variance

Oneway Analysis of log[Na ppm] By Heat Treatment



Oneway Anova
Summary of Fit

Rsquare	0.994703
Adj Rsquare	0.992938
Root Mean Square Error	0.001748
Mean of Response	2.201465
Observations (or Sum Wgts)	5

t Test
ccc-quenched
Assuming equal variances

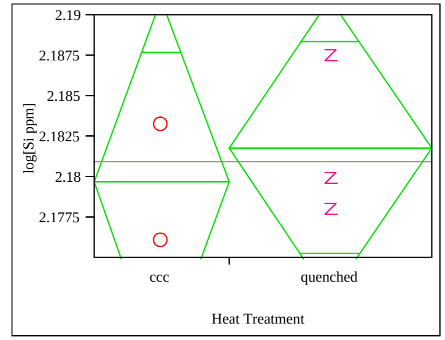
Difference	-0.03787	t Ratio	-23.7355
Std Err Dif	0.00160	DF	3
Upper CL Dif	-0.03279	Prob > |t|	0.0002
Lower CL Dif	-0.04294	Prob > t	0.9999
Confidence	0.95	Prob < t	<.0001

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
ccc	2	2.17875	0.00124	2.1748	2.1827
quenched	3	2.21661	0.00101	2.2134	2.2198

Std Error uses a pooled estimate of error variance

Oneway Analysis of log[Si ppm] By Heat Treatment



Oneway Anova
Summary of Fit

Rsquare	0.067414
Adj Rsquare	-0.24345
Root Mean Square Error	0.005042
Mean of Response	2.180975
Observations (or Sum Wgts)	5

t Test
ccc-quenched
Assuming equal variances

Difference	-0.00214	t Ratio	-0.46568
Std Err Dif	0.00460	DF	3
Upper CL Dif	0.01251	Prob > |t|	0.6732
Lower CL Dif	-0.01679	Prob > t	0.6634
Confidence	0.95	Prob < t	0.3366

Means for Oneway Anova

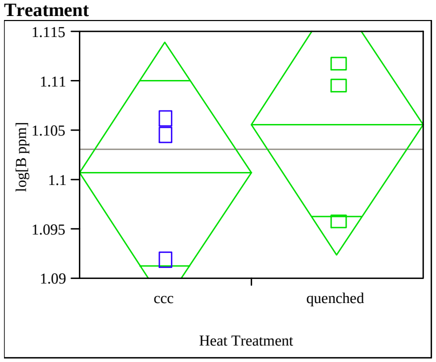
Level	Number	Mean	Std Error	Lower 95%	Upper 95%
ccc	2	2.17969	0.00357	2.1683	2.1910
quenched	3	2.18183	0.00291	2.1726	2.1911

Std Error uses a pooled estimate of error variance

Exhibit D.6: Effects of Heat Treatment on PCT Response by Study Glass *(continued)*

Glass #=12

Oneway Analysis of log[B ppm] By Heat Treatment



Oneway Anova
Summary of Fit

Rsquare	0.117964
Adj Rsquare	-0.10254
Root Mean Square Error	0.008266
Mean of Response	1.103183
Observations (or Sum Wgts)	6

t Test
ccc-quenched
Assuming equal variances

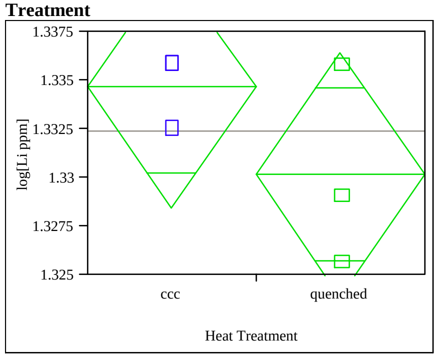
Difference	-0.00494	t Ratio	-0.73141
Std Err Dif	0.00675	DF	4
Upper CL Dif	0.01380	Prob > |t|	0.5051
Lower CL Dif	-0.02367	Prob > t	0.7475
Confidence	0.95	Prob < t	0.2525

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
ccc	3	1.10071	0.00477	1.0875	1.1140
quenched	3	1.10565	0.00477	1.0924	1.1189

Std Error uses a pooled estimate of error variance

Oneway Analysis of log[Li ppm] By Heat Treatment



Oneway Anova
Summary of Fit

Rsquare	0.333975
Adj Rsquare	0.167468
Root Mean Square Error	0.003897
Mean of Response	1.33243
Observations (or Sum Wgts)	6

t Test
ccc-quenched
Assuming equal variances

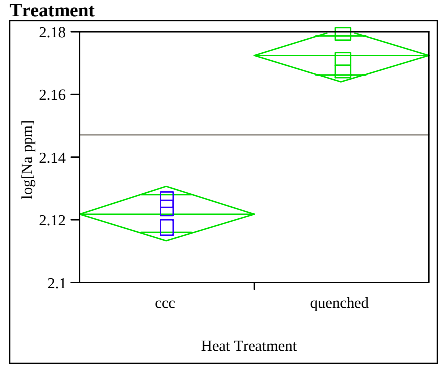
Difference	0.00451	t Ratio	1.416255
Std Err Dif	0.00318	DF	4
Upper CL Dif	0.01334	Prob > |t|	0.2296
Lower CL Dif	-0.00433	Prob > t	0.1148
Confidence	0.95	Prob < t	0.8852

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
ccc	3	1.33468	0.00225	1.3284	1.3409
quenched	3	1.33018	0.00225	1.3239	1.3364

Std Error uses a pooled estimate of error variance

Oneway Analysis of log[Na ppm] By Heat Treatment



Oneway Anova
Summary of Fit

Rsquare	0.970317
Adj Rsquare	0.962896
Root Mean Square Error	0.005406
Mean of Response	2.147444
Observations (or Sum Wgts)	6

t Test
ccc-quenched
Assuming equal variances

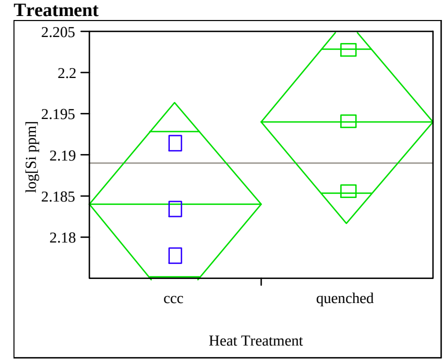
Difference	-0.05047	t Ratio	-11.4349
Std Err Dif	0.00441	DF	4
Upper CL Dif	-0.03822	Prob > |t|	0.0003
Lower CL Dif	-0.06272	Prob > t	0.9998
Confidence	0.95	Prob < t	0.0002

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
ccc	3	2.12221	0.00312	2.1135	2.1309
quenched	3	2.17268	0.00312	2.1640	2.1813

Std Error uses a pooled estimate of error variance

Oneway Analysis of log[Si ppm] By Heat Treatment



Oneway Anova
Summary of Fit

Rsquare	0.388863
Adj Rsquare	0.236079
Root Mean Square Error	0.007774
Mean of Response	2.189095
Observations (or Sum Wgts)	6

t Test
ccc-quenched
Assuming equal variances

Difference	-0.01013	t Ratio	-1.59536
Std Err Dif	0.00635	DF	4
Upper CL Dif	0.00750	Prob > |t|	0.1859
Lower CL Dif	-0.02775	Prob > t	0.9071
Confidence	0.95	Prob < t	0.0929

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
ccc	3	2.18403	0.00449	2.1716	2.1965
quenched	3	2.19416	0.00449	2.1817	2.2066

Std Error uses a pooled estimate of error variance

Exhibit D.7: Correlations and Scatter Plots of Normalized PCTs by Compositional View and Heat Treatment

Comp View/Heat Treatment=measured bc-ccc

Correlations

	log NL[B (g/L)]	log NL[Li(g/L)]	log NL[Na (g/L)]	log NL[Si (g/L)]
log NL[B (g/L)]	1.0000	0.9683	0.7799	0.8666
log NL[Li(g/L)]	0.9683	1.0000	0.7662	0.8896
log NL[Na (g/L)]	0.7799	0.7662	1.0000	0.9638
log NL[Si (g/L)]	0.8666	0.8896	0.9638	1.0000

Scatterplot Matrix

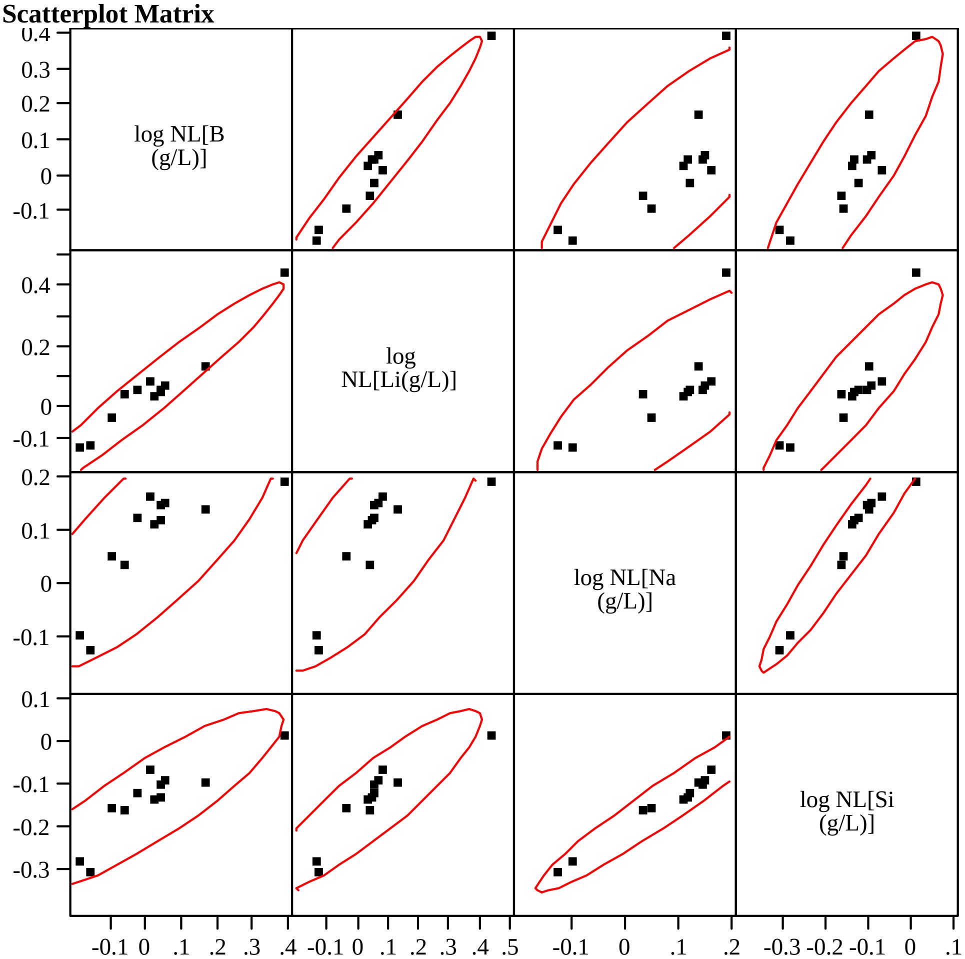


Exhibit D.7: Correlations and Scatter Plots of Normalized PCTs by Compositional View and Heat Treatment

Comp View/Heat Treatment=measured bc-quenched

Correlations

	log NL[B (g/L)]	log NL[Li(g/L)]	log NL[Na (g/L)]	log NL[Si (g/L)]
log NL[B (g/L)]	1.0000	0.9617	0.9411	0.9382
log NL[Li(g/L)]	0.9617	1.0000	0.9521	0.9680
log NL[Na (g/L)]	0.9411	0.9521	1.0000	0.9829
log NL[Si (g/L)]	0.9382	0.9680	0.9829	1.0000

Scatterplot Matrix

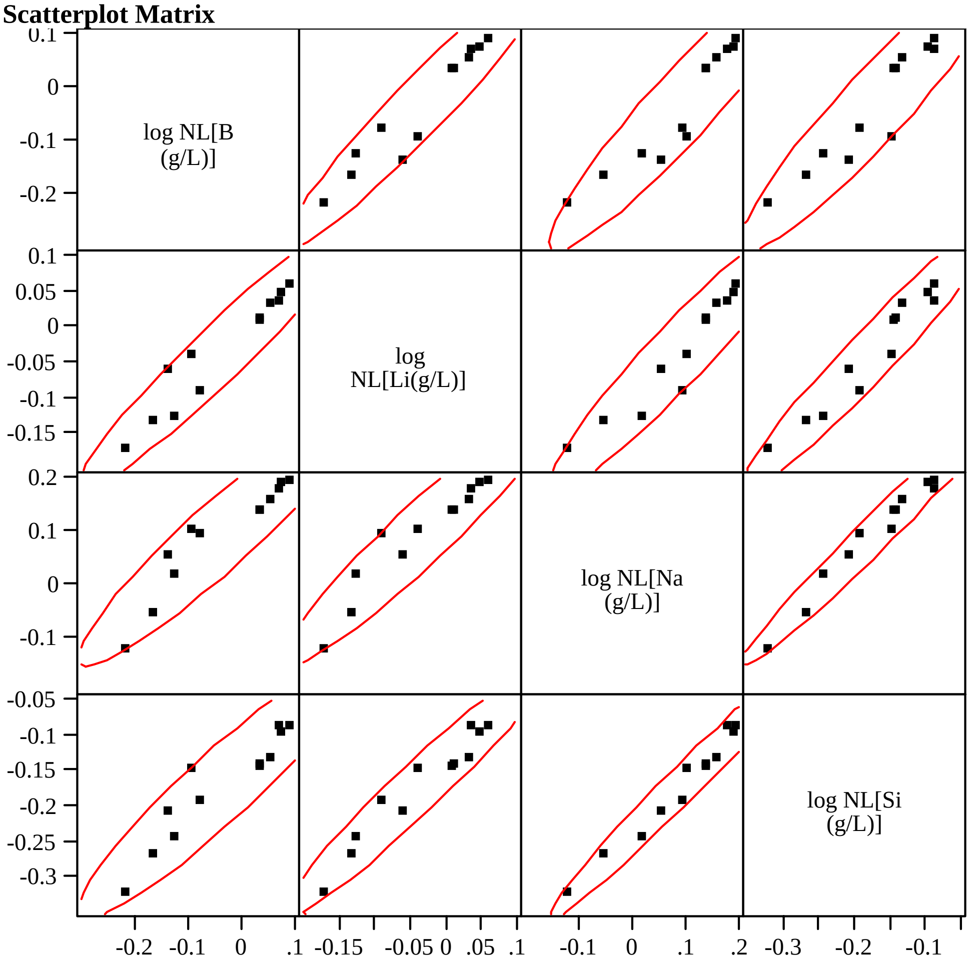


Exhibit D.7: Correlations and Scatter Plots of Normalized PCTs by Compositional View and Heat Treatment

Comp View/Heat Treatment=measured-ccc

Correlations

	log NL[B (g/L)]	log NL[Li(g/L)]	log NL[Na (g/L)]	log NL[Si (g/L)]
log NL[B (g/L)]	1.0000	0.9683	0.7799	0.8666
log NL[Li(g/L)]	0.9683	1.0000	0.7662	0.8896
log NL[Na (g/L)]	0.7799	0.7662	1.0000	0.9638
log NL[Si (g/L)]	0.8666	0.8896	0.9638	1.0000

Scatterplot Matrix

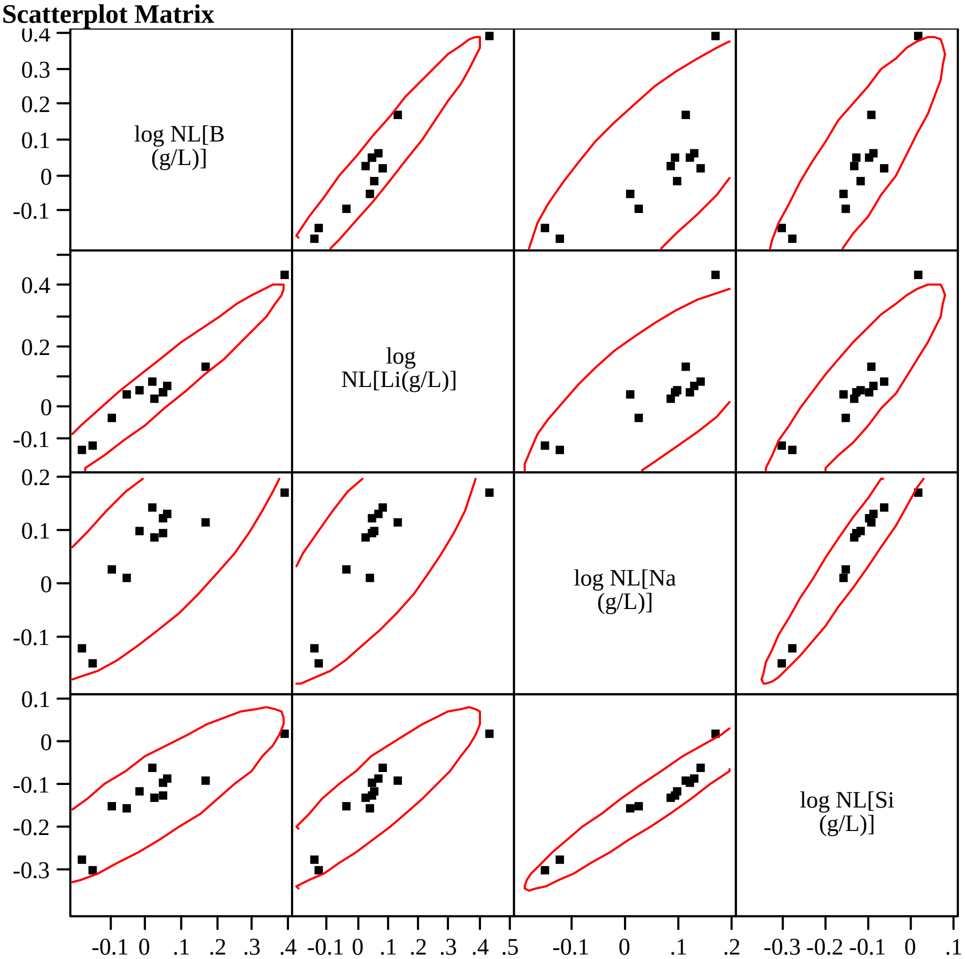


Exhibit D.7: Correlations and Scatter Plots of Normalized PCTs by Compositional View and Heat Treatment

Comp View/Heat Treatment=measured-quenched

Correlations

	log NL[B (g/L)]	log NL[Li(g/L)]	log NL[Na (g/L)]	log NL[Si (g/L)]
log NL[B (g/L)]	1.0000	0.9617	0.9411	0.9382
log NL[Li(g/L)]	0.9617	1.0000	0.9520	0.9680
log NL[Na (g/L)]	0.9411	0.9520	1.0000	0.9829
log NL[Si (g/L)]	0.9382	0.9680	0.9829	1.0000

Scatterplot Matrix

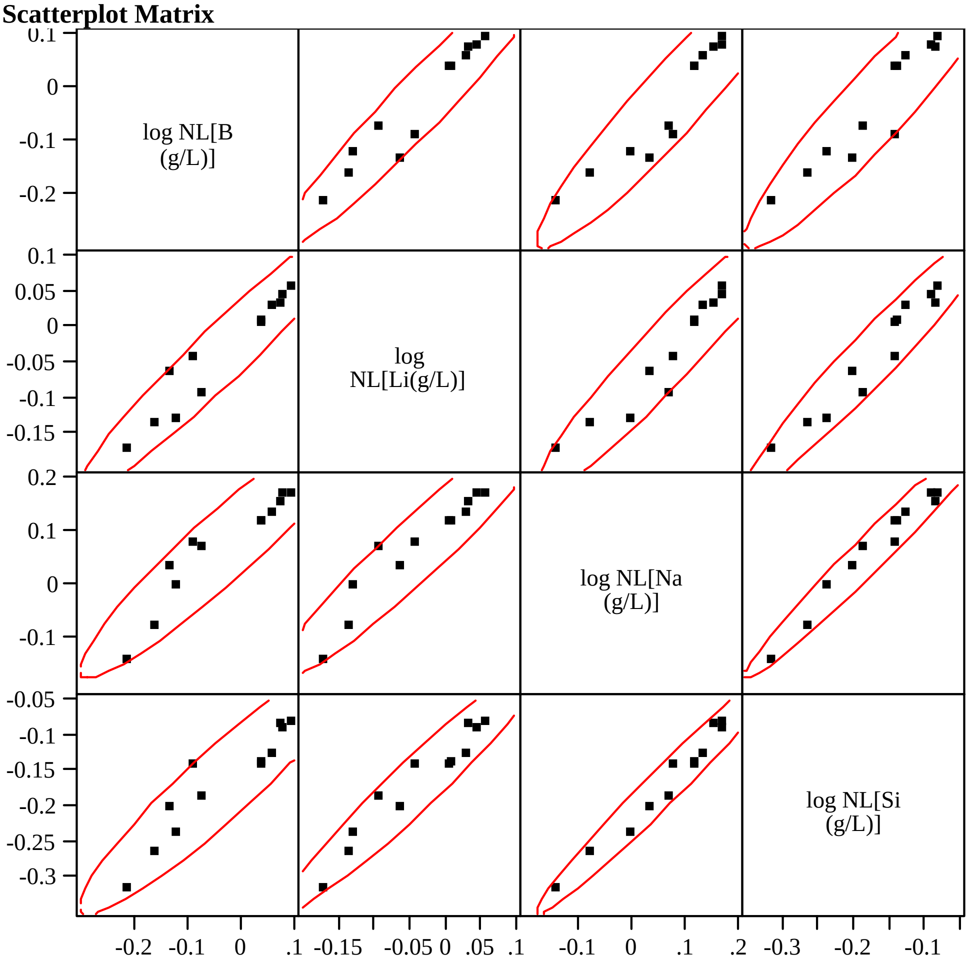


Exhibit D.7: Correlations and Scatter Plots of Normalized PCTs by Compositional View and Heat Treatment

Comp View/Heat Treatment=target-ccc

Correlations

	log NL[B (g/L)]	log NL[Li(g/L)]	log NL[Na (g/L)]	log NL[Si (g/L)]
log NL[B (g/L)]	1.0000	0.9663	0.7894	0.8578
log NL[Li(g/L)]	0.9663	1.0000	0.7826	0.8888
log NL[Na (g/L)]	0.7894	0.7826	1.0000	0.9707
log NL[Si (g/L)]	0.8578	0.8888	0.9707	1.0000

Scatterplot Matrix

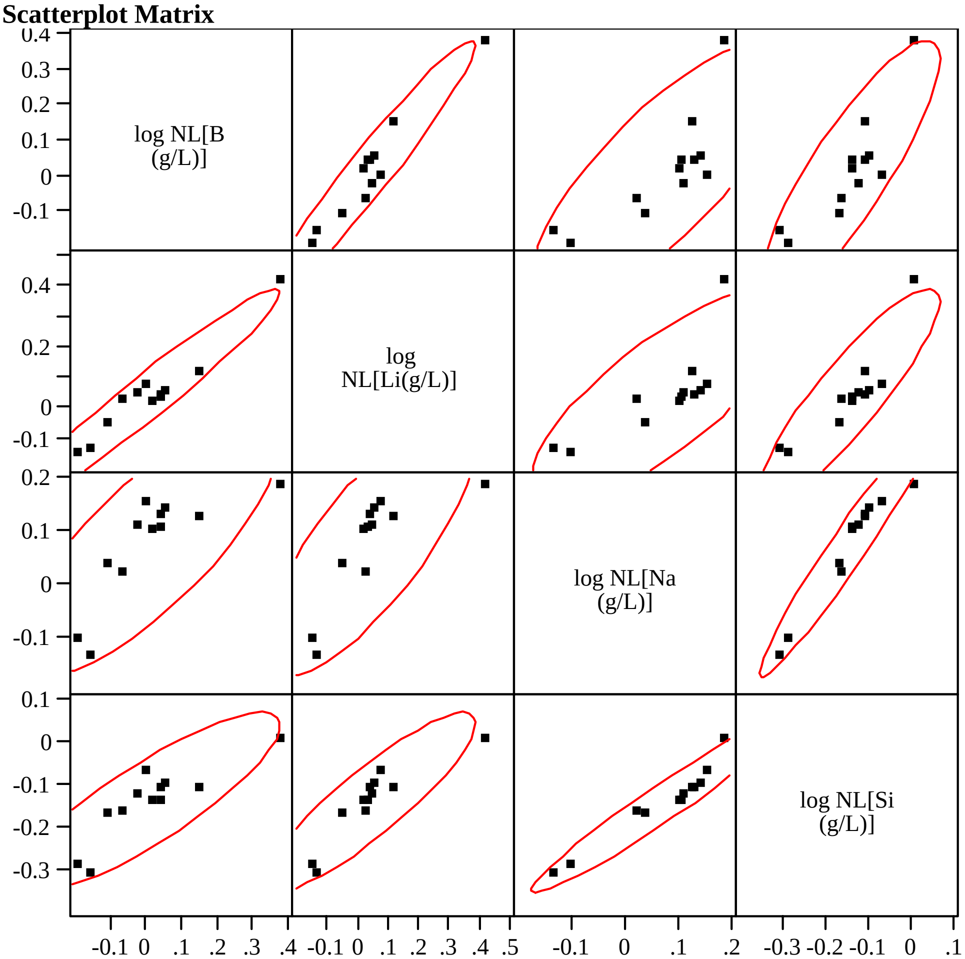


Exhibit D.7: Correlations and Scatter Plots of Normalized PCTs by Compositional View and Heat Treatment

Comp View/Heat Treatment=target-quenched

Correlations

	log NL[B (g/L)]	log NL[Li(g/L)]	log NL[Na (g/L)]	log NL[Si (g/L)]
log NL[B (g/L)]	1.0000	0.9597	0.9325	0.9384
log NL[Li(g/L)]	0.9597	1.0000	0.9417	0.9713
log NL[Na (g/L)]	0.9325	0.9417	1.0000	0.9801
log NL[Si (g/L)]	0.9384	0.9713	0.9801	1.0000

Scatterplot Matrix

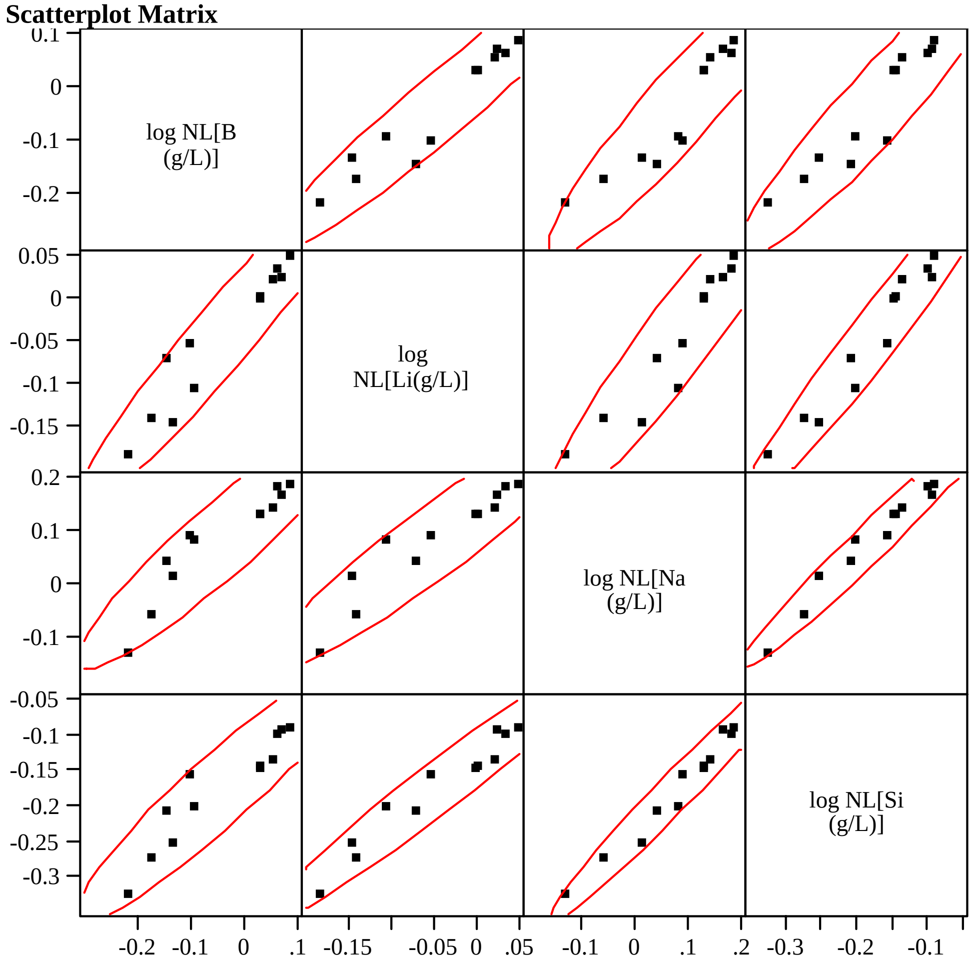
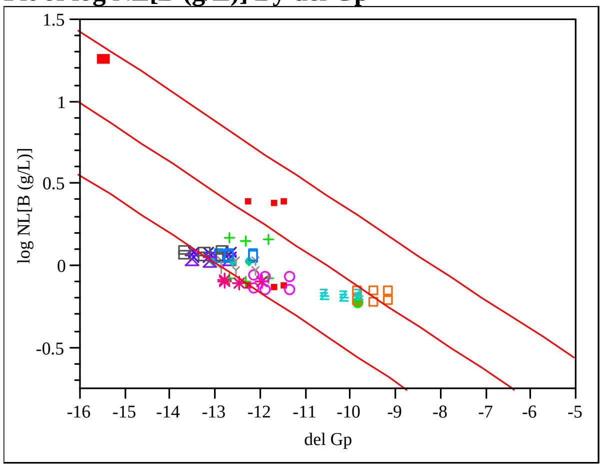
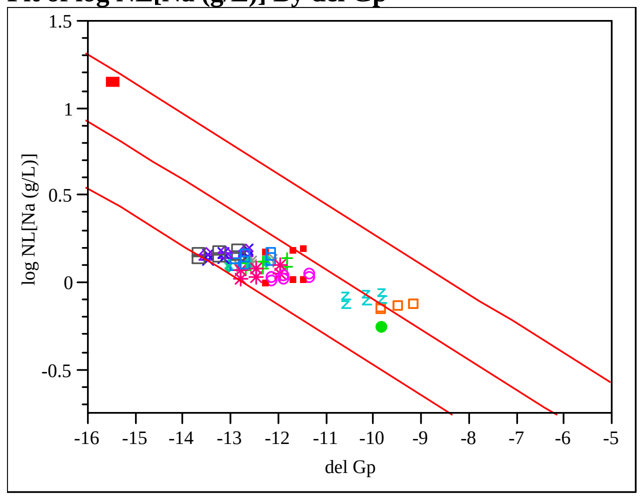


Exhibit D.8: del Gp (ΔG_p) Predictions versus Common Logarithm Normalized Leachate (log NL[.]) for B, Li, Na, and Si Over All Compositional Views and Heat Treatments

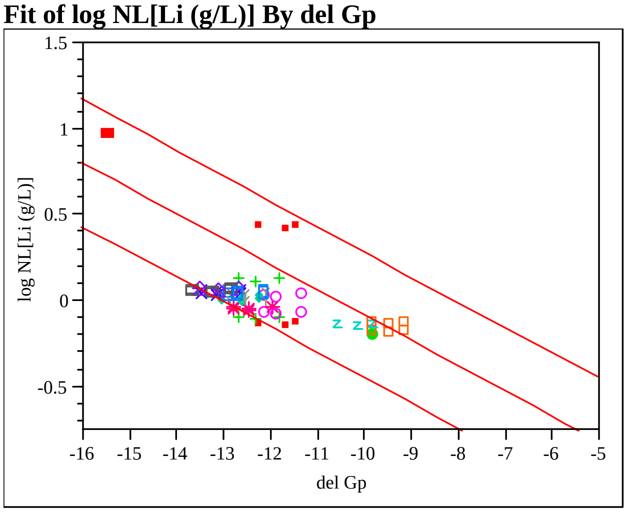
Fit of log NL[B (g/L)] By del Gp



Fit of log NL[Na (g/L)] By del Gp



Fit of log NL[Li (g/L)] By del Gp



Fit of log NL[Si (g/L)] By del Gp

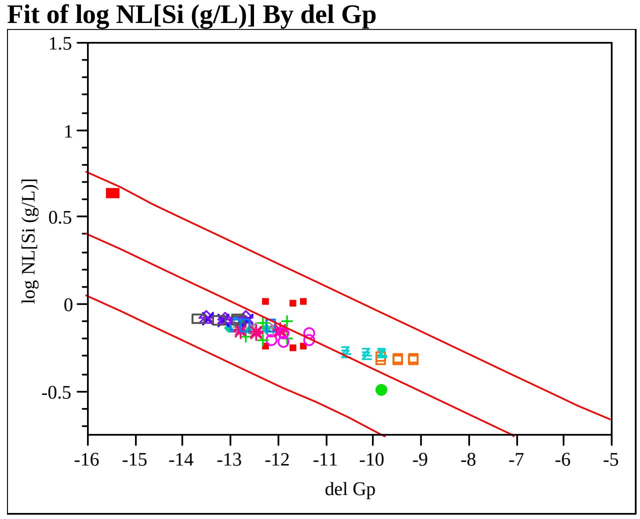
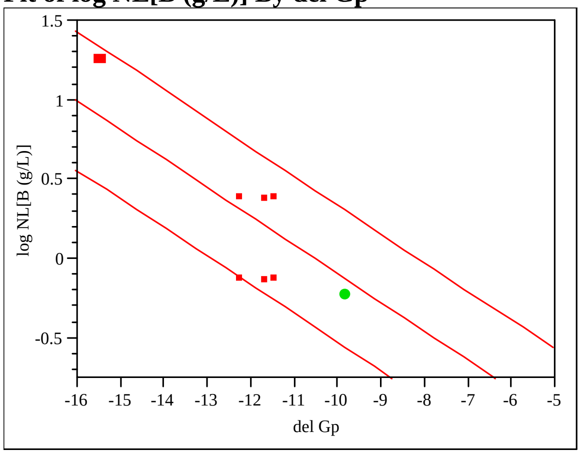


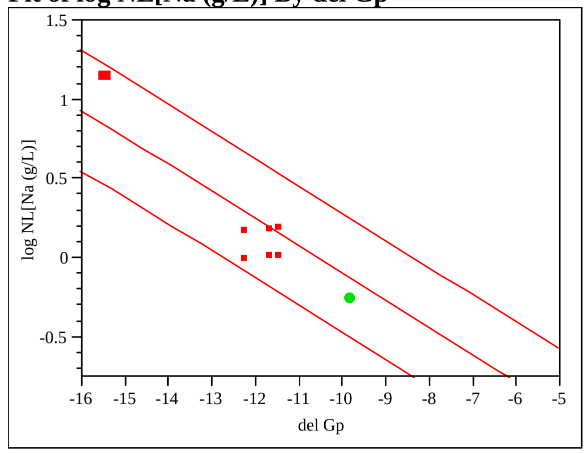
Exhibit D.9: del Gp (ΔG_p) Predictions versus Common Logarithm Normalized Leachate (log NL[.]) for B, Li, Na, and Si by Study Glass Over All Compositional Views and Heat Treattment

Study Glass # 1 with EA and ARM

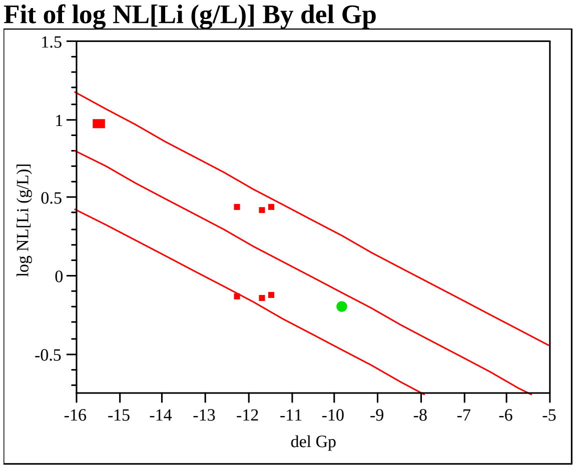
Fit of log NL[B (g/L)] By del Gp



Fit of log NL[Na (g/L)] By del Gp



Fit of log NL[Li (g/L)] By del Gp



Fit of log NL[Si (g/L)] By del Gp

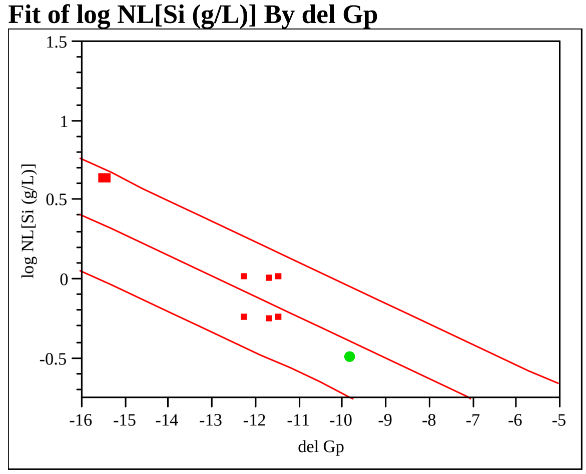
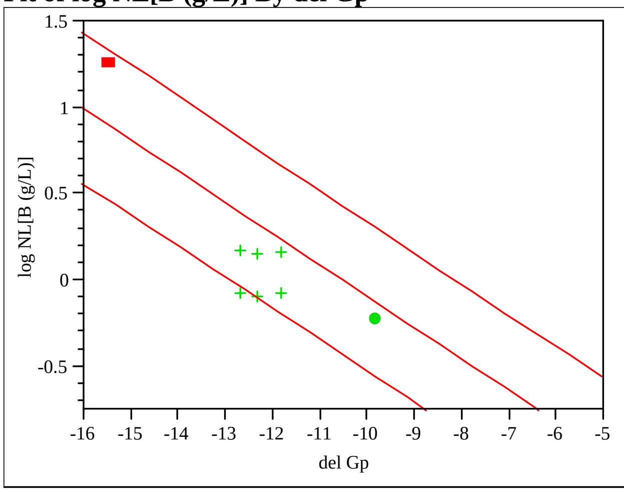


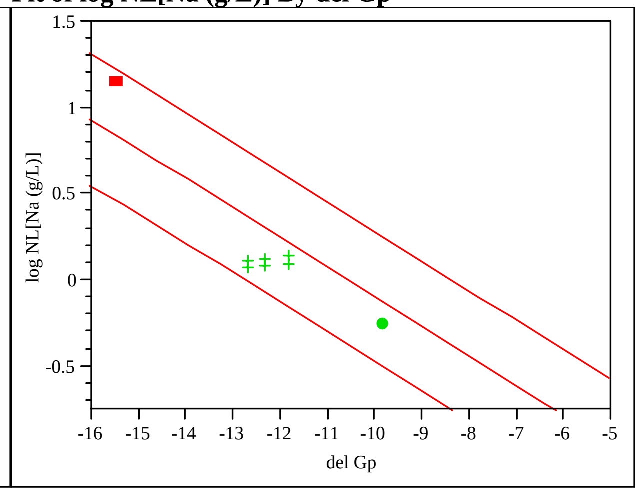
Exhibit D.9: del Gp (ΔG_p) Predictions versus Common Logarithm Normalized Leachate (log NL[.]) for B, Li, Na, and Si by Study Glass Over All Compositional Views and Heat Treatment

Study Glass # 2 with EA and ARM

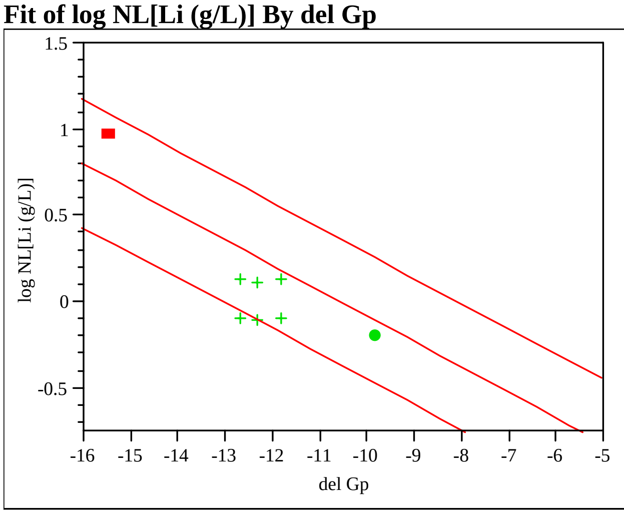
Fit of log NL[B (g/L)] By del Gp



Fit of log NL[Na (g/L)] By del Gp



Fit of log NL[Li (g/L)] By del Gp



Fit of log NL[Si (g/L)] By del Gp

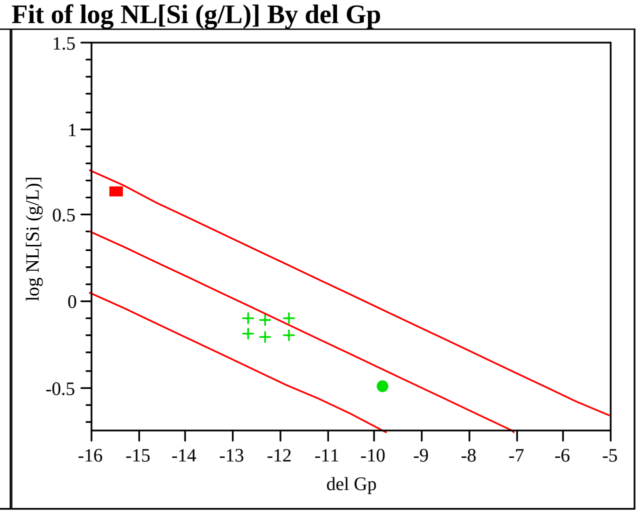
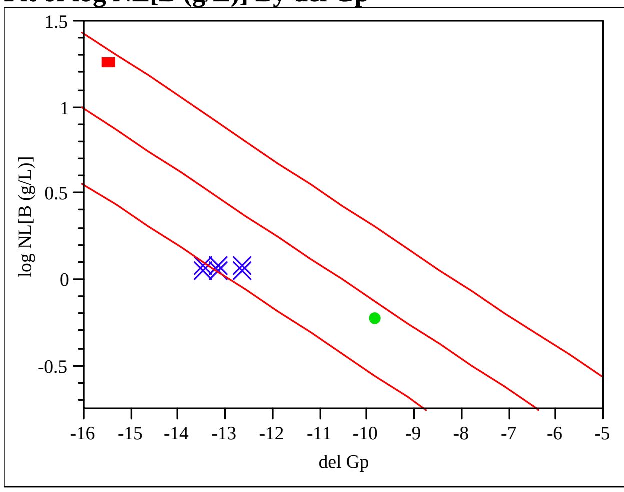


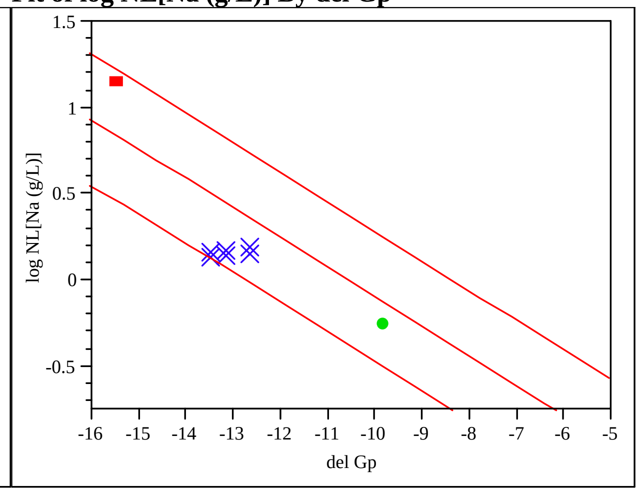
Exhibit D.9: del Gp (ΔG_p) Predictions versus Common Logarithm Normalized Leachate (log NL[.]) for B, Li, Na, and Si by Study Glass Over All Compositional Views and Heat Treatments

Study Glass # 3 with EA and ARM

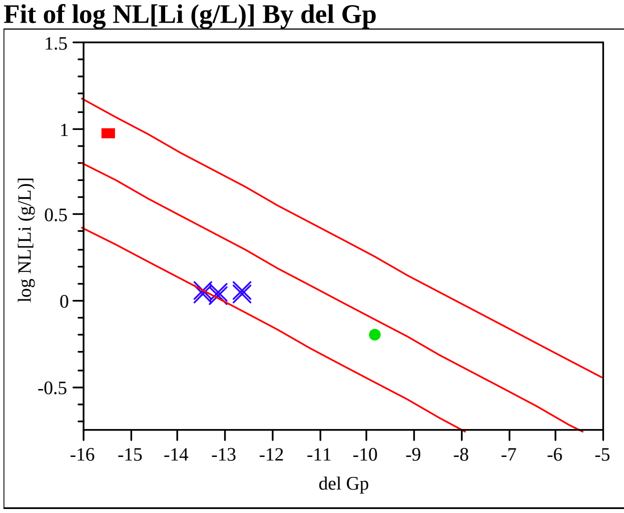
Fit of log NL[B (g/L)] By del Gp



Fit of log NL[Na (g/L)] By del Gp



Fit of log NL[Li (g/L)] By del Gp



Fit of log NL[Si (g/L)] By del Gp

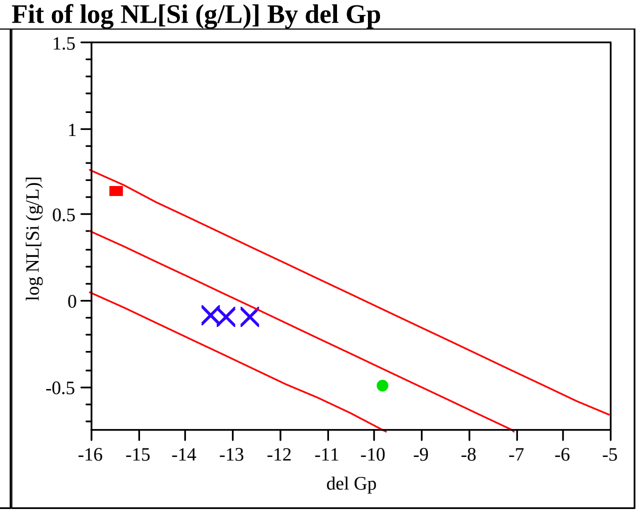
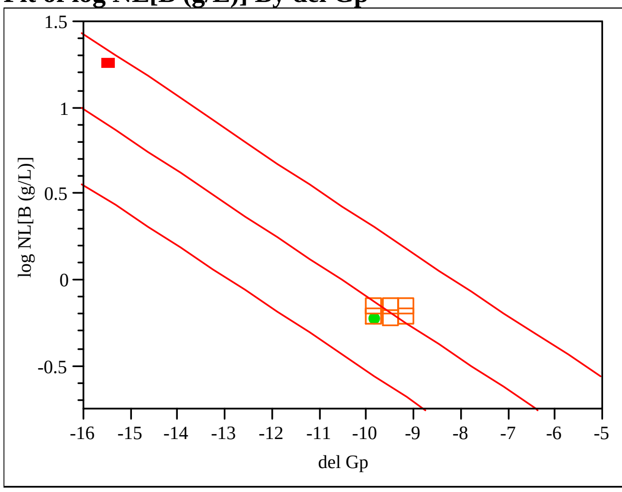


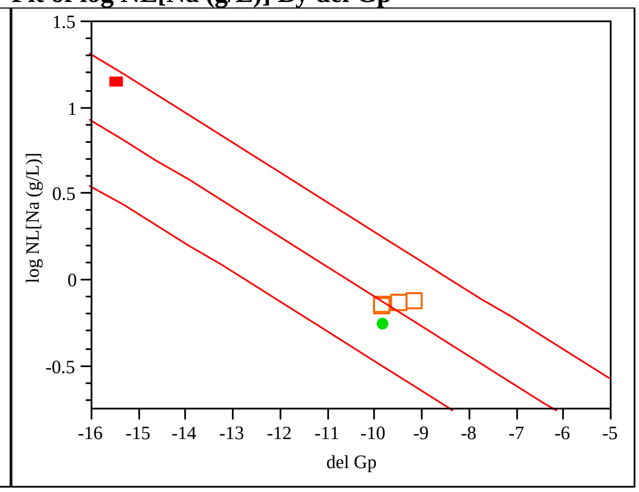
Exhibit D.9: del Gp (ΔG_p) Predictions versus Common Logarithm Normalized Leachate (log NL[.]) for B, Li, Na, and Si by Study Glass Over All Compositional Views and Heat Treatments

Study Glass # 4 with EA and ARM

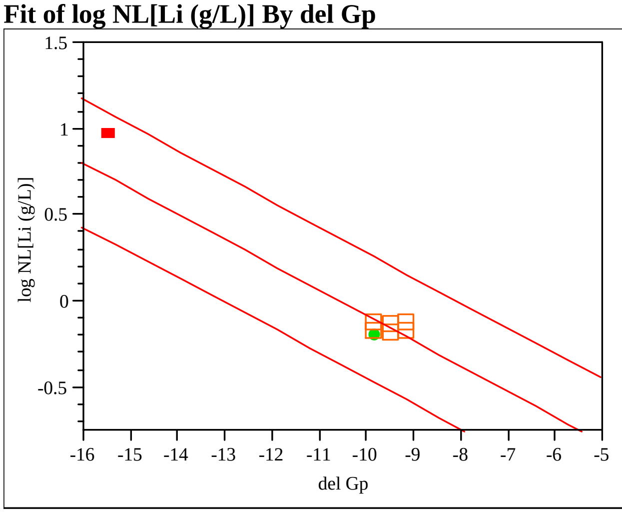
Fit of log NL[B (g/L)] By del Gp



Fit of log NL[Na (g/L)] By del Gp



Fit of log NL[Li (g/L)] By del Gp



Fit of log NL[Si (g/L)] By del Gp

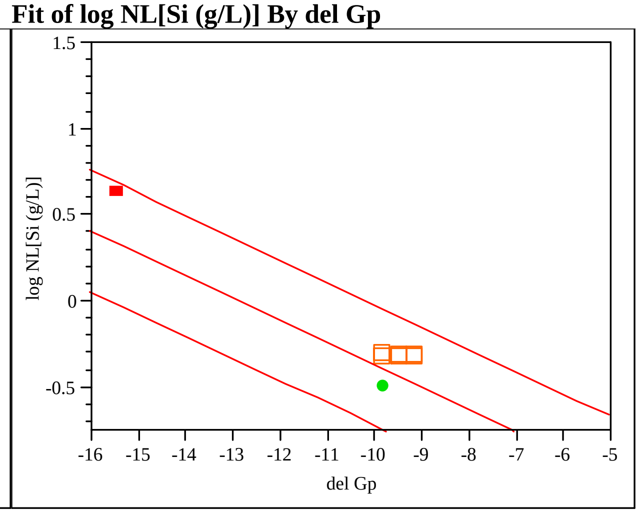
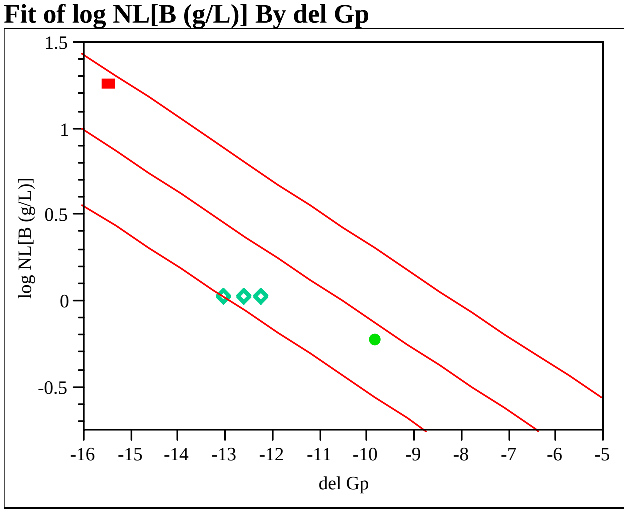


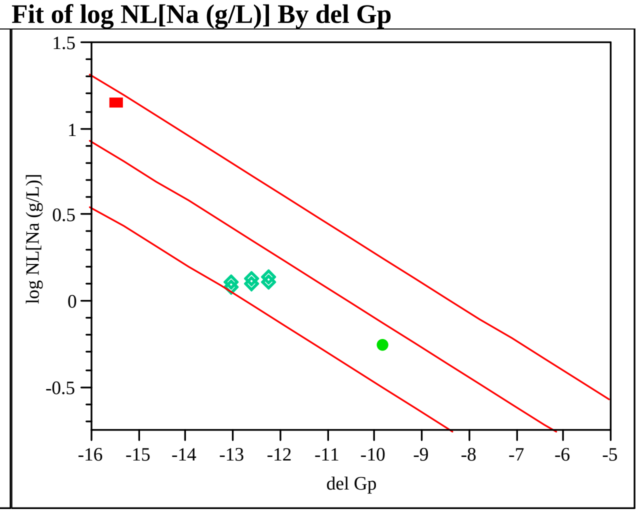
Exhibit D.9: del Gp (ΔG_p) Predictions versus Common Logarithm Normalized Leachate (log NL[.]) for B, Li, Na, and Si by Study Glass Over All Compositional Views and Heat Treatments

Study Glass # 5 with EA and ARM

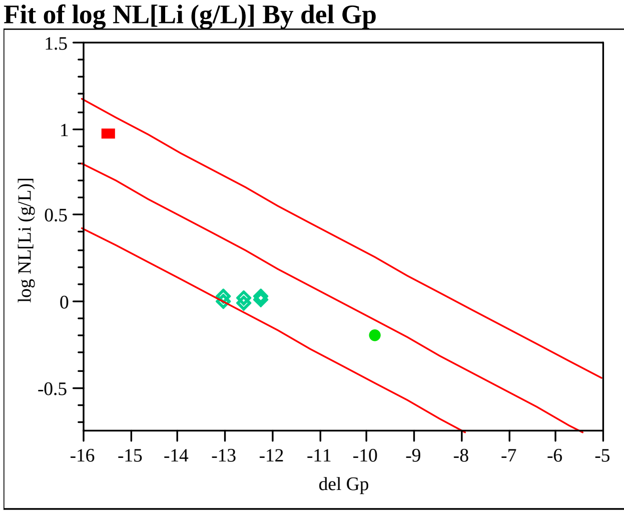
Fit of log NL[B (g/L)] By del Gp



Fit of log NL[Na (g/L)] By del Gp



Fit of log NL[Li (g/L)] By del Gp



Fit of log NL[Si (g/L)] By del Gp

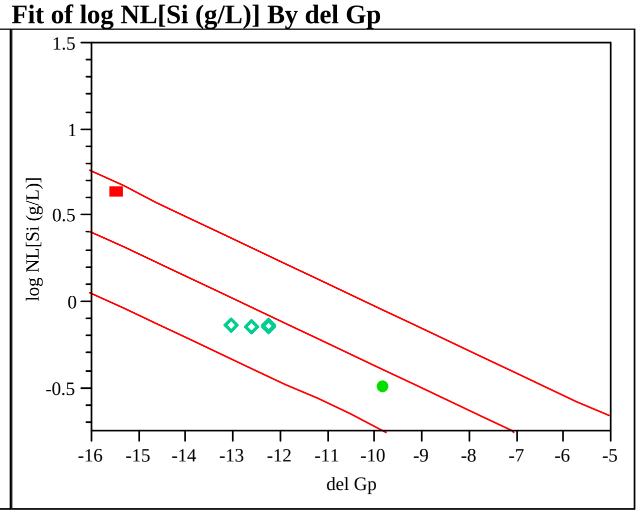
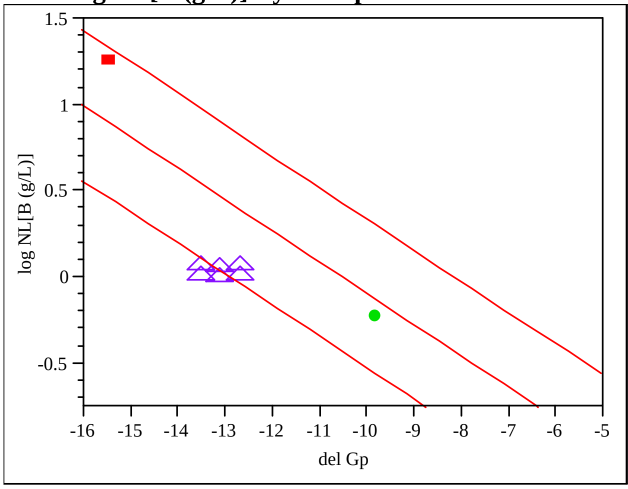


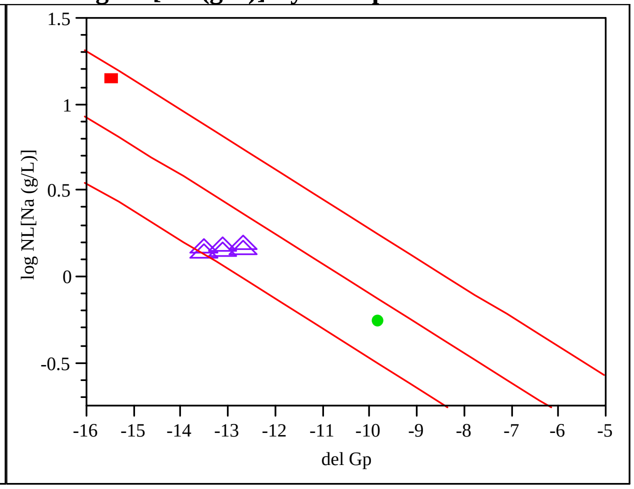
Exhibit D.9: del Gp (ΔG_p) Predictions versus Common Logarithm Normalized Leachate (log NL[.]) for B, Li, Na, and Si by Study Glass Over All Compositional Views and Heat Treatments

Study Glass # 6 with EA and ARM

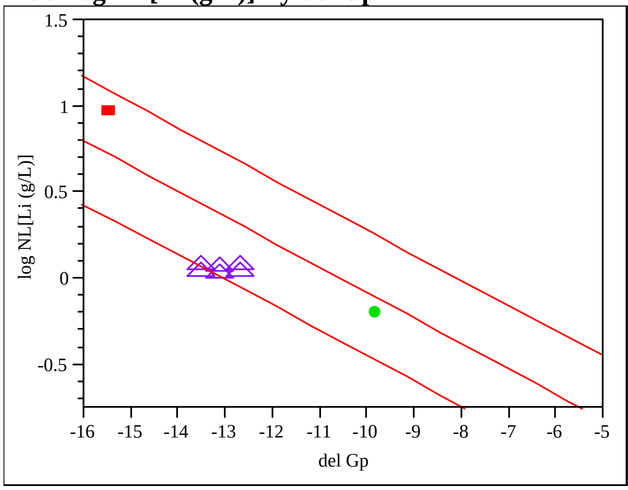
Fit of log NL[B (g/L)] By del Gp



Fit of log NL[Na (g/L)] By del Gp



Fit of log NL[Li (g/L)] By del Gp



Fit of log NL[Si (g/L)] By del Gp

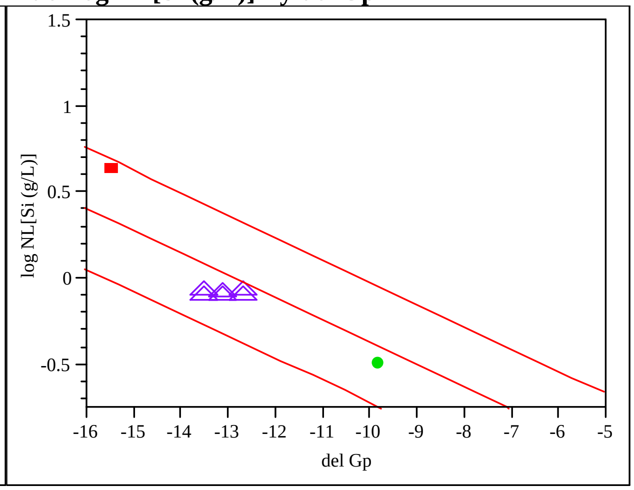
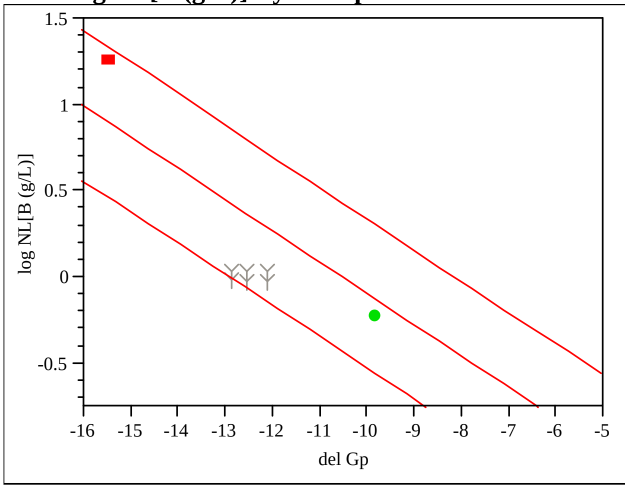


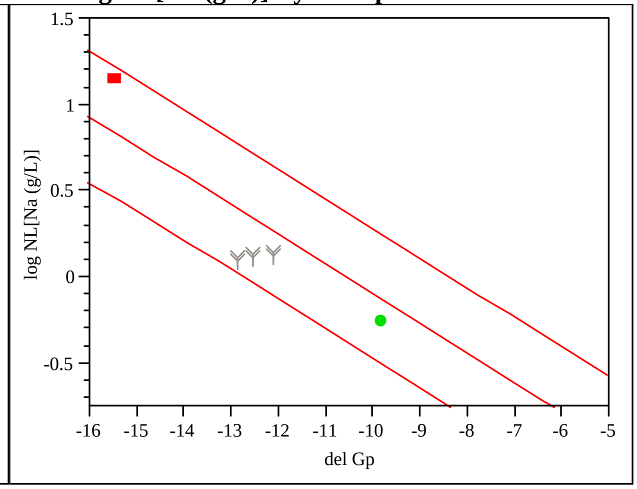
Exhibit D.9: del Gp (ΔG_p) Predictions versus Common Logarithm Normalized Leachate (log NL[.]) for B, Li, Na, and Si by Study Glass Over All Compositional Views and Heat Treatments

Study Glass # 7 with EA and ARM

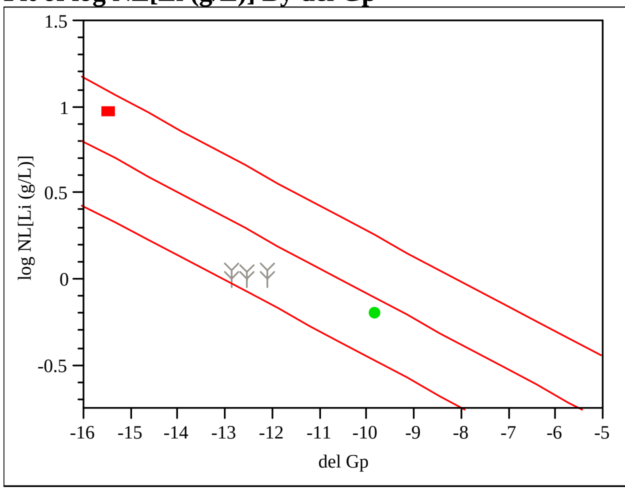
Fit of log NL[B (g/L)] By del Gp



Fit of log NL[Na (g/L)] By del Gp



Fit of log NL[Li (g/L)] By del Gp



Fit of log NL[Si (g/L)] By del Gp

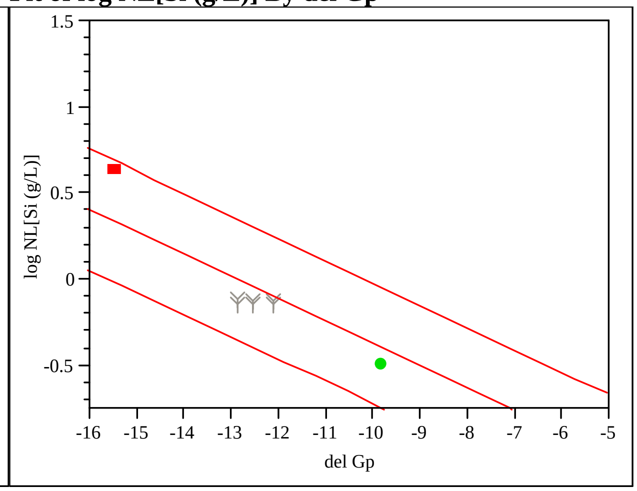
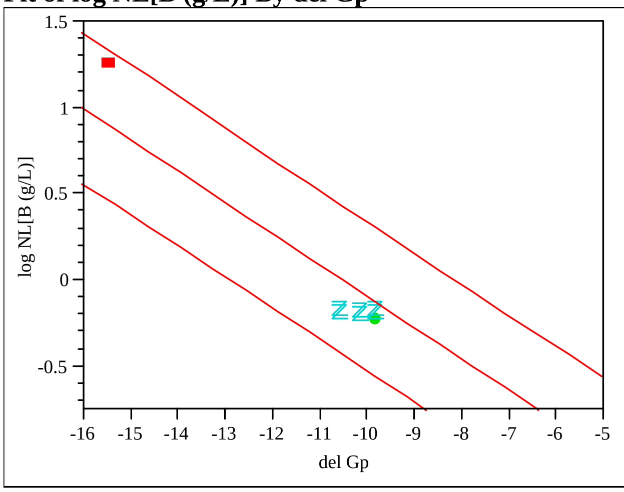


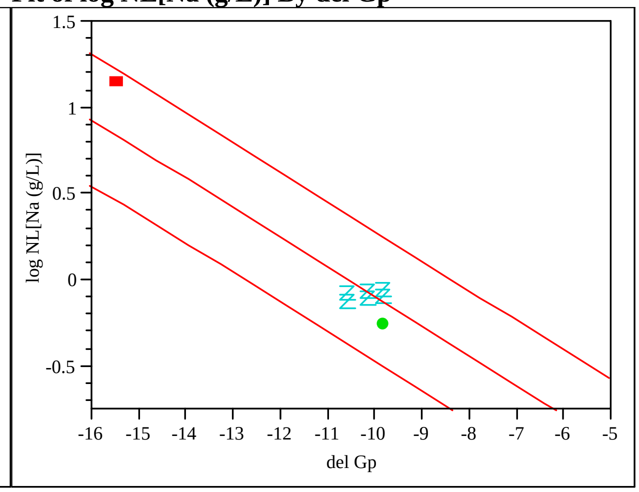
Exhibit D.9: del Gp (ΔG_p) Predictions versus Common Logarithm Normalized Leachate (log NL[.]) for B, Li, Na, and Si by Study Glass Over All Compositional Views and Heat Treatments

Study Glass # 8 with EA and ARM

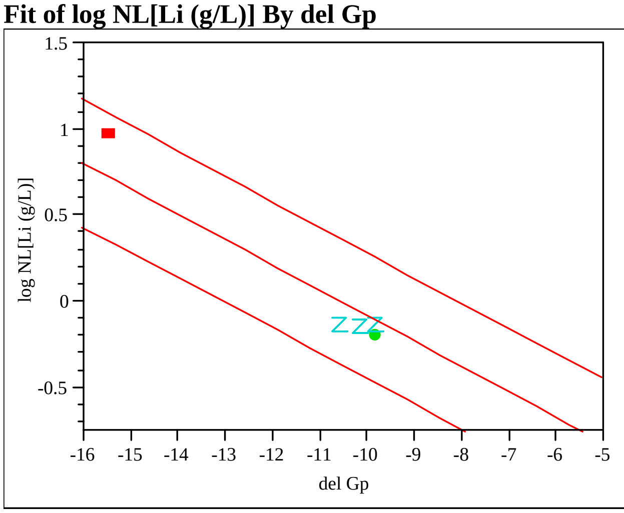
Fit of log NL[B (g/L)] By del Gp



Fit of log NL[Na (g/L)] By del Gp



Fit of log NL[Li (g/L)] By del Gp



Fit of log NL[Si (g/L)] By del Gp

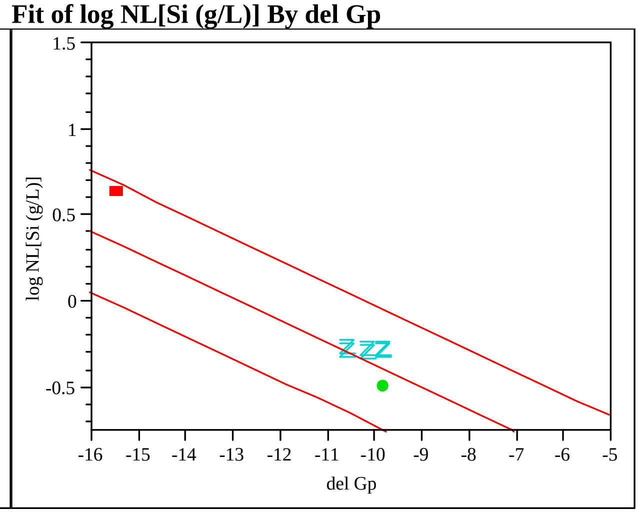
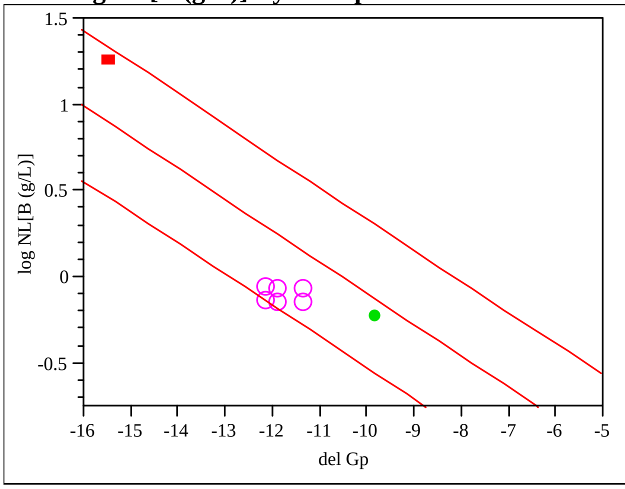


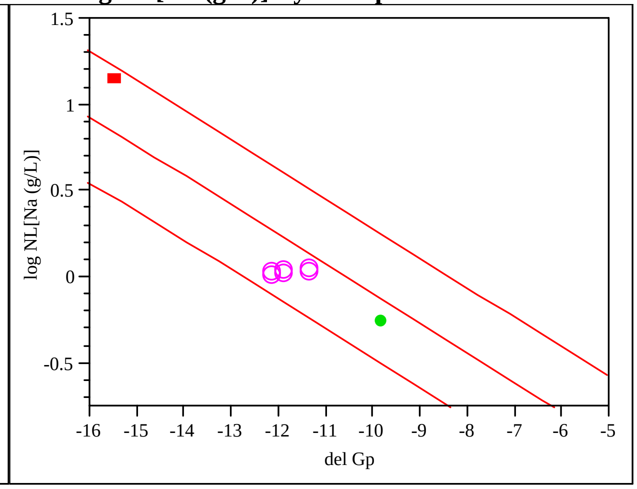
Exhibit D.9: del Gp (ΔG_p) Predictions versus Common Logarithm Normalized Leachate (log NL[.]) for B, Li, Na, and Si by Study Glass Over All Compositional Views and Heat Treatments

Study Glass # 9 with EA and ARM

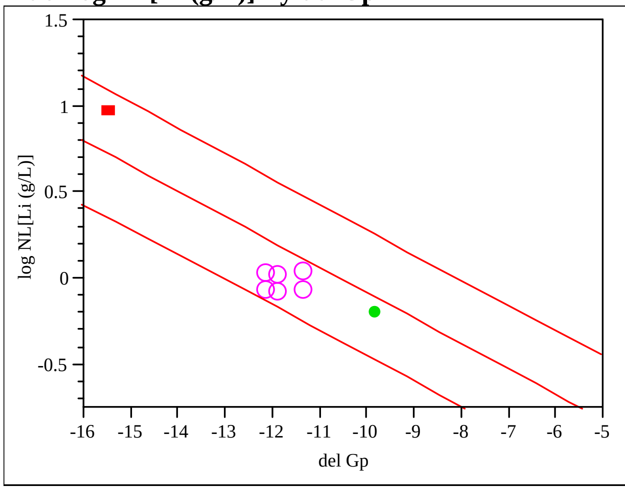
Fit of log NL[B (g/L)] By del Gp



Fit of log NL[Na (g/L)] By del Gp



Fit of log NL[Li (g/L)] By del Gp



Fit of log NL[Si (g/L)] By del Gp

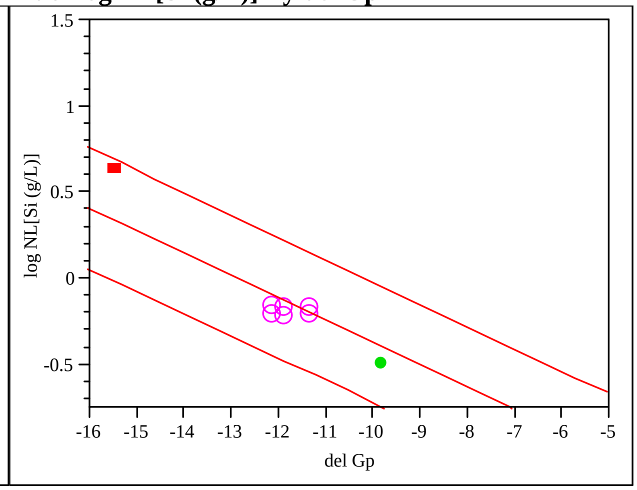
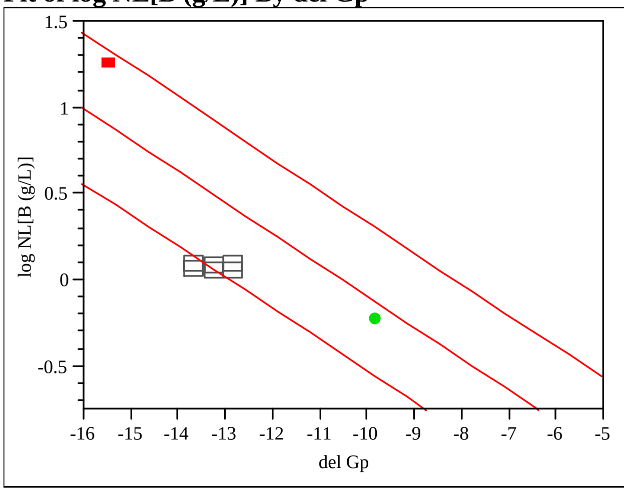


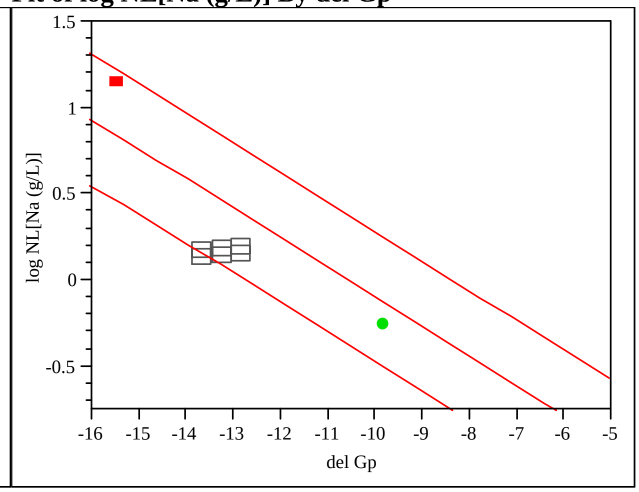
Exhibit D.9: del Gp (ΔG_p) Predictions versus Common Logarithm Normalized Leachate (log NL[.]) for B, Li, Na, and Si by Study Glass Over All Compositional Views and Heat Treatments

Study Glass # 10 with EA and ARM

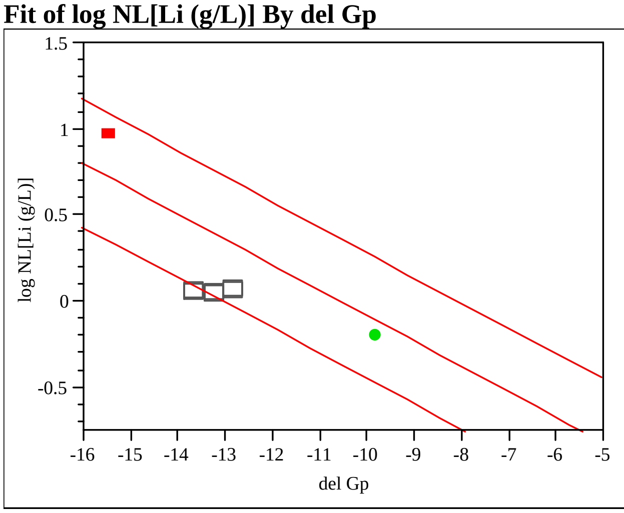
Fit of log NL[B (g/L)] By del Gp



Fit of log NL[Na (g/L)] By del Gp



Fit of log NL[Li (g/L)] By del Gp



Fit of log NL[Si (g/L)] By del Gp

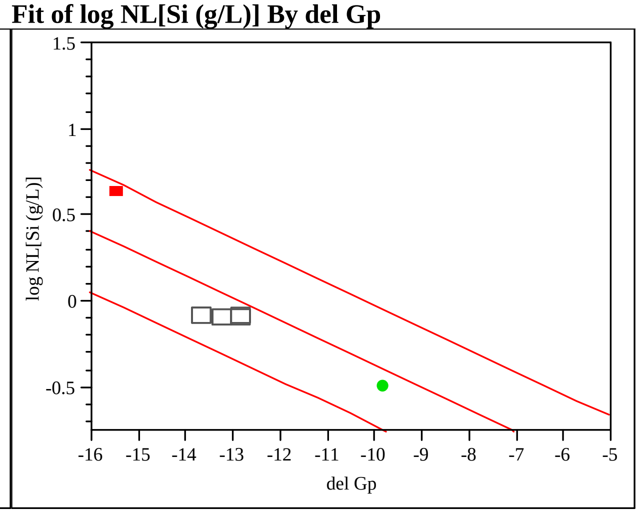
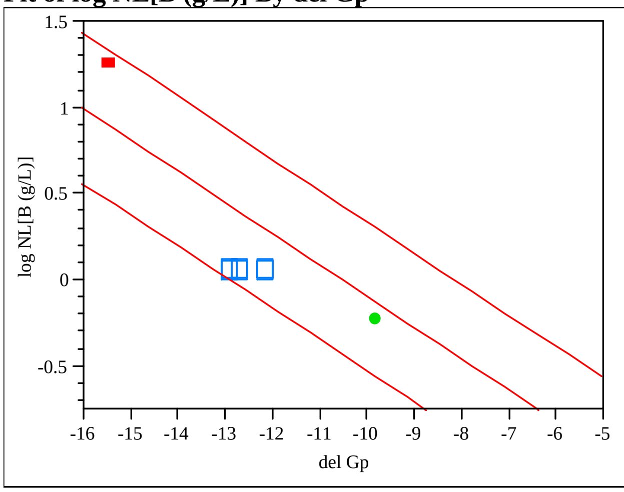


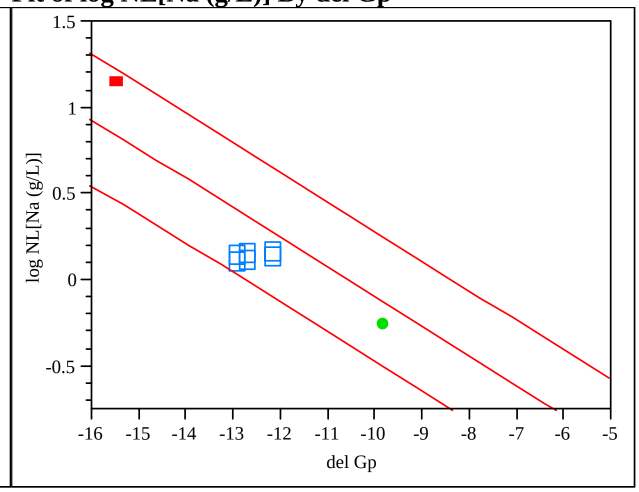
Exhibit D.9: del Gp (ΔG_p) Predictions versus Common Logarithm Normalized Leachate (log NL[.]) for B, Li, Na, and Si by Study Glass Over All Compositional Views and Heat Treatments

Study Glass # 11 with EA and ARM

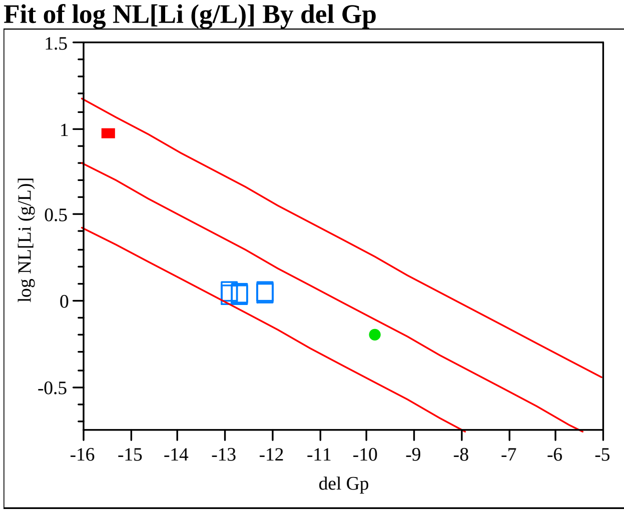
Fit of log NL[B (g/L)] By del Gp



Fit of log NL[Na (g/L)] By del Gp



Fit of log NL[Li (g/L)] By del Gp



Fit of log NL[Si (g/L)] By del Gp

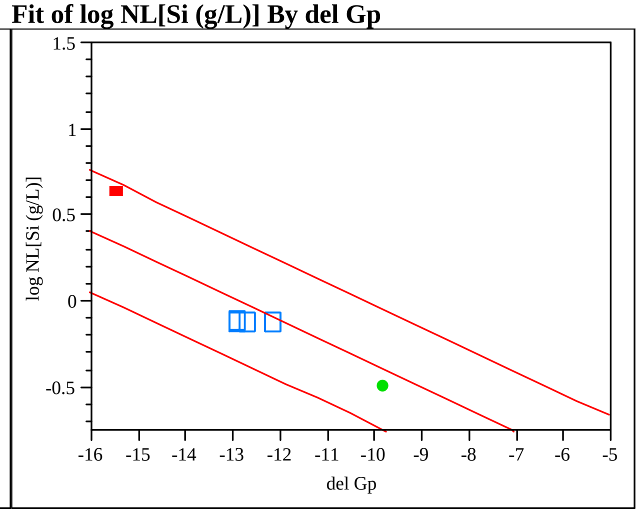
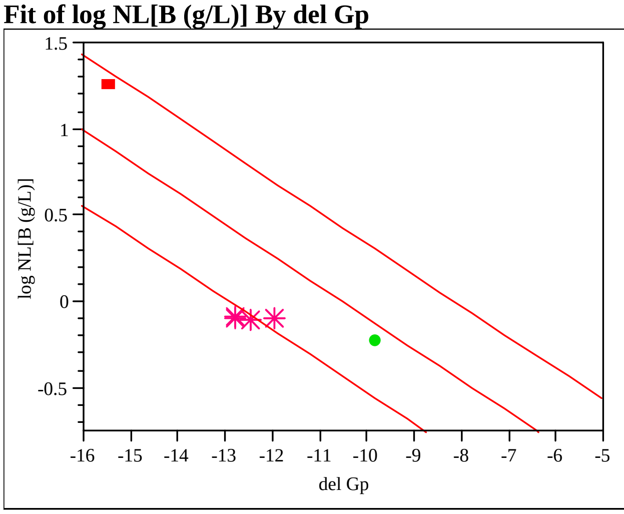


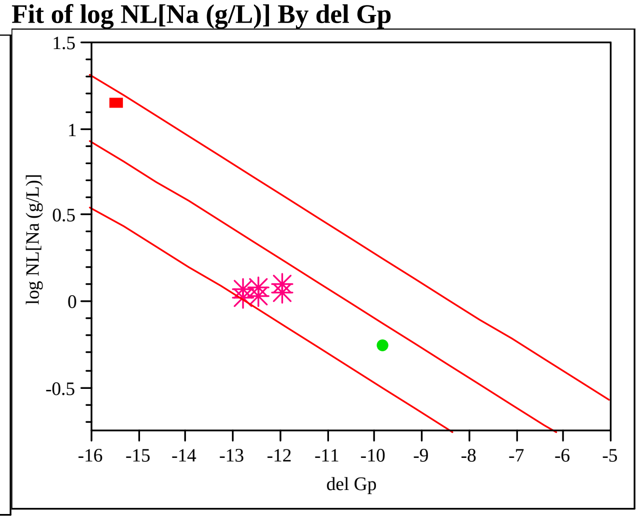
Exhibit D.9: del Gp (ΔG_p) Predictions versus Common Logarithm Normalized Leachate (log NL[.]) for B, Li, Na, and Si by Study Glass Over All Compositional Views and Heat Treatments

Study Glass # 12 with EA and ARM

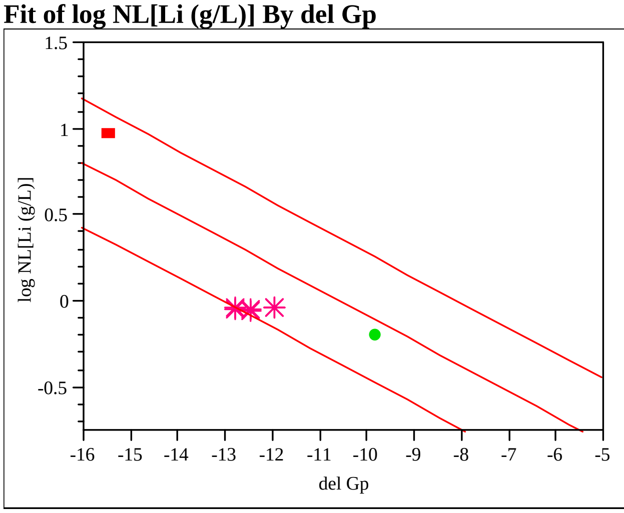
Fit of log NL[B (g/L)] By del Gp



Fit of log NL[Na (g/L)] By del Gp



Fit of log NL[Li (g/L)] By del Gp



Fit of log NL[Si (g/L)] By del Gp