Contract No:

This document was prepared in conjunction with work accomplished under Contract No. 89303321CEM000080 with the U.S. Department of Energy (DOE) Office of Environmental Management (EM).

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Evaluation of a Sulfate Solubility Limit Greater Than 0.65 Weight Percent in Sludge Batch 10 Glasses

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June 2023

SRNL-STI-2023-00207, Revision 0

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Printed in the United States of America

Prepared for
U.S. Department of Energy

SRNL-STI-2023-00207
Revision 0

Keywords: *SB10, sulfate solubility, Frit 625, Frit 473*

Retention: *Lifetime*

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Savannah River National Laboratory is operated by Battelle Savannah River Alliance for the U.S. Department of Energy under Contract No. 89303321CEM000080.

ACKNOWLEDGEMENTS

I would like to thank Madison Hsieh, Anna Stanfield and Matthew Page for fabricating the glasses and personnel at the Process Science Analytical Laboratory for conducting the compositional analysis (Whitney Riley, Matthew Alexander, Daniel Jones and Joshua Kitchings).

EXECUTIVE SUMMARY

Previous laboratory-scale crucible testing with batch chemicals confirmed that the sulfate (SO_4^{2-}) limit for Sludge Batch 10 (SB10) was 0.65 weight percent (wt.%) in glass. This limit signifies that 0.65 wt.% SO_4^{2-} can be retained in the glass without the formation of a sulfate phase. The Defense Waste Processing Facility imposes this constraint in the Material Tracking Program. Based on preliminary calculations to support the Material Tracking Program, it was anticipated that transfer volumes of the monosodium titanate/sludge solids (MST/SS) stream from the Salt Waste Processing Facility (SWPF) may need to be reduced to maintain projected sulfate concentrations below 0.65 wt.% in glass. Savannah River Mission Completion requested that the Savannah River National Laboratory perform additional sulfate testing to determine whether a sulfate solubility limit greater than 0.65 wt.% is feasible for SB10, which could allow for higher transfer volumes of the MST/SS stream. This report documents the results of the testing at higher sulfate concentrations for the glass composition region defined by the most recent SB10 projection (November 2022) and Frits 473 and 625. Frit 473 was recommended for SB10 and Frit 625 was used during SB9 processing and the SB9 to SB10 transition.

A total of twenty-one glass compositions were developed based on the expected compositional variables, which include sludge-only (SO) and coupled processing with the SWPF, waste loading (WL), and frit composition. The target sulfate concentrations were varied from 0.65-0.85 wt.% at 32 and 40% WL. Each glass was prepared from reagent grade chemicals and melted at 1150 °C. Visual observations were used to confirm the presence of a sulfate salt phase on the cooled glass surfaces. Representative samples of each glass were submitted for chemical composition analysis by inductively coupled plasma-optical emission spectroscopy and Cs analysis by inductively coupled plasma-mass spectrometry. Overall the majority of mean measured values are consistent with the target values for each major oxide of interest with less than 5% error. The percent errors for the measured SO_4^{2-} concentrations are generally less than 10%, which is comparable with previous sulfate solubility study measurements and acceptable.

Only the SO glasses based on Frit 625 formed a sulfate phase at a 0.80 wt.% SO_4^{2-} target concentration at both 32 and 40% WL. The remainder of the glasses did not form a sulfate layer. Due to the formation of the sulfate phase, the limit is conservatively set at 0.70 wt.% based on the measured sulfate concentrations of 0.71 wt.% and 0.75 wt.% for these two glasses. None of the SO or coupled operation glasses based on Frit 473 formed a sulfate salt phase, which supports a sulfate limit of 0.80 wt.%.

The following SO_4^{2-} concentration limits are recommended during SO and coupled SB10 processing:

- 0.70 wt.% during processing with Frit 625
- 0.80 wt.% during processing with Frit 473

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LIST OF ABBREVIATIONS

%RSD	percent relative standard deviation
DWPF	Defense Waste Processing Facility
ICP-MS	inductively coupled plasma-mass spectrometry
ICP-OES	inductively coupled plasma-optical emission spectroscopy
LM	lithium metaborate fusion
LRM	low activity test reference material
MST/SS	monosodium titanate/sludge solids
PCCS	Product Composition Control System
PF	peroxide fusion
PSAL	Process Science Analytical Laboratory
SB10	Sludge Batch 10
SB3	Sludge Batch 3
SB4	Sludge Batch 4
SB7b	Sludge Batch 7b
SB8	Sludge Batch 8
SB9	Sludge Batch 9
SE	strip effluent
SME	Slurry Mix Evaporator
SO	sludge-only
SRAT	Sludge Receipt and Adjustment Tank
SRMC	Savannah River Mission Completion
SRNL	Savannah River National Laboratory
SSRT	Sludge Solids Receipt Tank
SWPF	Salt Waste Processing Facility
WCP	Waste Compliance Plan
WL	waste loading
wt.%	weight percent

1.0 Introduction

To support initial operations at the Defense Waste Processing Facility (DWPF), the original sulfate (SO_4^{2-}) solubility limit for Product Composition Control System (PCCS) Slurry Mix Evaporator (SME) acceptability was defined at 0.4 weight percent (wt.%) in glass based on pilot-scale melter testing.[1,2] This limit signified that 0.4 wt.% SO_4^{2-} could be retained in the glass without the formation of a sulfate phase. The utilization of a 0.4 wt.% SO_4^{2-} limit in glass for SME acceptability was challenged for Sludge Batch 3 (SB3), which included a neptunium (Np)-based stream projected to contain a significant fraction of ferrous sulfamate.[3] Laboratory-scale crucible testing with both batch chemicals and simulated Sludge Receipt and Adjustment Tank (SRAT) product was performed, and a new PCCS SME acceptability limit for SO_4^{2-} was established at 0.6 wt.% for SB3, which was confirmed by supplementary Slurry-Fed Melt Rate Furnace testing with simulated SME product.[3] While 0.6 wt.% SO_4^{2-} was allowed in the melter feed, it was anticipated that less than 0.6 wt.% would be retained in the glass based on SO_4^{2-} volatility during DWPF melter processing, which provides some conservatism with respect to the formation of a sulfate phase. PCCS was not revised to reflect the updated SO_4^{2-} limit and DWPF now imposes this constraint outside of PCCS in the Material Tracking Program.[2,4,5] The 0.6 wt.% SO_4^{2-} limit was confirmed for Sludge Batch 4 (SB4) through Sludge Batch 7b (SB7b) by laboratory-scale crucible testing with batch chemicals.[6-11] For Sludge Batch 8 (SB8) and Sludge Batch 9 (SB9), the limit was defined at 0.65 wt.%.[12-15]

In preparation for Sludge Batch 10 (SB10) processing, two sets of glasses were initially fabricated, which confirmed the 0.65 wt.% limit in glass.[16-19] Based on preliminary SB10 calculations to support the Material Tracking Program, it was anticipated that transfer volumes of the monosodium titanate/sludge solids (MST/SS) stream from the Salt Waste Processing Facility (SWPF) may need to be reduced to maintain projected sulfate concentrations below 0.65 wt.% in glass. Savannah River Mission Completion (SRMC) requested that the Savannah River National Laboratory (SRNL) perform additional sulfate testing to determine whether a sulfate solubility limit greater than 0.65 wt.% is feasible for SB10, which could allow for higher transfer volumes of the MST/SS stream.[20] This report documents the results of the testing at higher sulfate concentrations for the glass composition region defined by the most recent SB10 projection (November 2022) and Frits 473 and 625. Frit 473 was recommended for SB10 and Frit 625 was used during SB9 processing and the SB9 to SB10 transition.[21,22]

2.0 Quality Assurance

This work was requested via a Technical Task Request and directed by a Task Technical and Quality Assurance Plan.[20,23] The functional classification of this task is Safety Class. Microsoft Excel and JMP Version 16.0.0 were used to support this work.[24,25] Requirements for performing reviews of technical reports and the extent of review are established in Manual E7, Procedure 2.60.[26] This document, including calculations, was reviewed by a Design Verification. The SRNL documents the Design Verification using the SRNL Technical Report Design Checklist contained in WSRC-IM-2002-00011, Rev. 2.[27] Experimental data and design checklists for this report are stored in electronic laboratory notebook experiment C7592-00311-48.

3.0 Inputs and Assumptions

The specific inputs listed in the following sections were used to generate the glass compositions for the sulfate solubility study.

3.1 Tank 40H Blend Projection

1. Two updated SB10 Tank 40H blend projections based on the addition of 7,000 gallons of caustic were provided by SRMC System Planning in November 2022; one with a Tank 51H heel of 10 inches and the other with a heel of 30 inches.[28] Discussion and evaluation of these projections is documented in SRNL-STI-2022-00647.[21]

2. The elemental concentrations of each sludge-only (SO) Tank 40H blend projection provided by SRMC System Planning (on a calcine basis) were converted to oxides with gravimetric factors and normalized to 100 weight percent (wt.%) as shown in Appendix A Table A-1.[28]
3. Gravimetric factors were calculated using the atomic weights of the element and its corresponding oxide.[29]

Due to the similarities between the two projections, only the 10 inch projection was necessary for the experimental study. It was selected due to the slightly higher Al_2O_3 concentration, which has been previously shown to decrease sulfate solubility.[30,31]

3.2 Coupled Operation Projection

The methodology used for these calculations was originally developed for SB9.[32-35] SRNL performed subsequent calculations with the SO projection in Appendix A Table A-1 to estimate the composition in the SRAT during coupled operation with SWPF. These calculations involved developing compositions for strip effluent (SE) and the Sludge Solids Receipt Tank (SSRT) effluent stream, which consists of MST/SS. This evaluation focused on single strike operation with no entrained insoluble sludge solids (Case 1), which represents the baseline for coupled operation with SWPF.

1. DWPF receives 5700 gallons of sludge slurry from Tank 40H per SRAT batch.[36]
2. Nominal single strike operation results in 2800 gallons of the SSRT effluent stream per SRAT batch[32]; however, a transfer volume of 4500 gallons was selected to represent processing upsets,[37] which maximizes the TiO_2 concentration.
3. The concentration of MST for a single strike is 0.4 g/L.[32]
4. DWPF receives 15,000 of SE based on Next Generation Solvent per SRAT batch.[a,32,36]
5. The Cs-137 concentration in SE is 66 Ci/gallon.[38]
6. The nominal SRAT composition representing the coupled operation scenario for Case 1 is shown in Appendix A Table A-2.

3.3 Glass Compositions

1. The nominal SO and coupled Case 1 compositions projected in the SRAT are shown in Appendix A Table A-1 and Table A-2.
2. The target waste loading (WL) for SB10 is 36%; thus, 32% and 40% WL were selected to account for compositional uncertainty.[21]
3. Frit 625[b] was used for SB9 processing and during the transition to SB10.[21]
4. Frit 473[c] is the recommended frit for SB10.[21]
5. The current sulfate limit in glass for SB10 is 0.65 wt.%;[39] thus, sulfate loadings greater than 0.65 wt.% were selected.

Using the SO and Case 1 compositions, the SO_4^{2-} concentrations were fixed such that the resulting SO_4^{2-} concentrations in glass would be 0.65-0.85 wt.% at 32% and 40% WL. Similar to previous sulfate solubility studies,[6,9-12,15] the SRAT compositions were renormalized without U_3O_8 and ThO_2 since these components are not expected to have an impact on the sulfate solubility behavior. Glass compositions were developed by combining the renormalized SRAT compositions for SO and Case 1 with Frit 473 or Frit 625 at 32% and 40% WL to account for compositional uncertainty around the desired target of 36% WL.

[a] Next Generation Solvent contains the extractant MaxCalix (1,3-alt-25,27-bis(3,7- dimethyloctyl-1-oxy) calix[4]arene-benzocrown-6), which uses a boric acid strip solution.
[b] Frit 625 composition (wt.%): $1Al_2O_3$-$8B_2O_3$-$7Li_2O$-$6Na_2O$-$78SiO_2$
[c] Frit 473 composition (wt.%): $8B_2O_3$-$8Li_2O$-$5Na_2O$-$79SiO_2$

The experimental testing was divided into iterative sets to reduce the overall number of glasses necessary to meet the task objective. Set 1 focused on coupled operation with Frit 473 at increased sulfate loadings. These results were used to determine sulfate loadings for Set 2, which focused on SO with Frit 473 and both coupled and SO with Frit 625. Sets 3 and 4 included additional sulfate loadings for Frit 473 and Frit 625. Target glass compositions for each set are shown in Appendix A Table A-3. These compositions provide supplementary compositional variation and increased sulfate loadings compared to the previously evaluated SB10 glass compositions.[16-19]

4.0 Experimental Procedure

4.1 Glass Fabrication

The glasses were prepared from the proper proportions of reagent-grade oxides, carbonates, boric acid, and salts in 30 g batches. The raw materials were thoroughly mixed, placed into 95% platinum/5% gold, 100 mL crucibles and covered with a loose fitting platinum alloy lid. The crucibles were placed into an electrically heated, high-temperature furnace at the target melt temperature of 1150 °C. After an isothermal hold at 1150 °C for 1 hour, the crucibles were removed from the furnace and allowed to air cool (quench).

4.2 Visual Observations

The exposed top surface of each glass in the crucible was examined for evidence of a sulfur salt layer. A visible yellow and/or white sulfate salt layer on the surface of the glass indicated that the SO_4^{2-} solubility limit for that particular composition was exceeded. The absence of a sulfate salt layer indicated that the SO_4^{2-} was retained in the glass, which was confirmed by chemical composition measurements.

4.3 Chemical Composition Analysis

Representative samples of each glass were submitted for chemical analysis. A lithium-metaborate fusion (LM) and peroxide fusion (PF) were used to fully dissolve the glass samples for measurement.[40,41] Each glass was prepared in duplicate and all of the prepared samples were analyzed by inductively coupled plasma – optical emission spectroscopy (ICP-OES).[42] The instrument was re-calibrated between the duplicate analyses. Note that the PF duplicates of SB10S-35, -41 and -42 were measured under the same calibration. Standards were measured at the beginning and end of each calibration set to assess the performance of the instrument over the course of the analyses, which included the following:

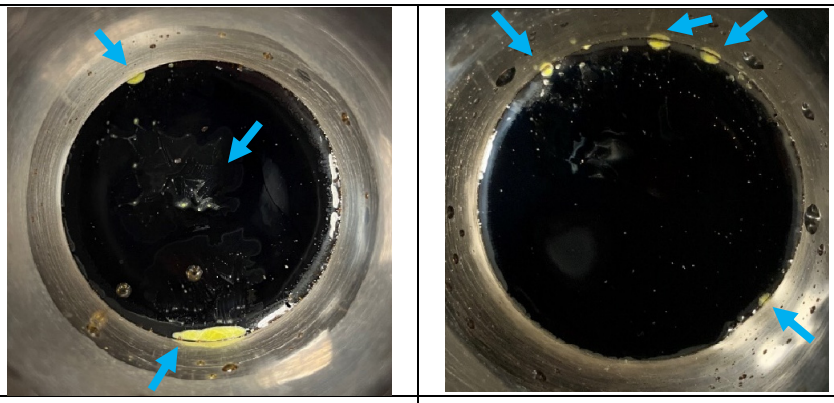
- Waste Compliance Plan (WCP) Batch 1 glass[43]
- low activity test reference material (LRM)[44]
- multi-element standard solution[45]

The peroxide fusions of the “Coupled Case 1” samples were also submitted for Cs analysis by inductively coupled plasma – mass spectrometry (ICP-MS). The SO samples were not submitted as there is no Cs in the target compositions.

5.0 Results and Discussion

5.1 Visual Examination

SB10S-35 and SB10S-36 exhibited a sulfate salt layer on the surface as indicated by the blue arrows in Figure 5-1. Small flecks are broken pieces of glass. Both compositions had a target SO_4^{2-} concentration of 0.80 wt.% for SO processing with Frit 625 at 32 and 40% WL.



SB10S-35	SB10S-36

Figure 5-1. Images of the two test glasses that exhibited a sulfate salt layer on the surface.

5.2 Chemical Composition

Table A-4 through Table A-11 in Appendix A provide the as-measured elemental concentrations for each replicate.

5.2.1 Multi-Element Standard Solution

Table 5-1 and Table 5-2 provide a comparison of the measured and reference concentrations for the multi-element standard solution.[45] Each measured concentration is the average of six replicates. Note that Na is not measured during the analysis of PF dissolution sets. The measured concentrations of each analyte were within 6% of the reference values and each of the percent relative standard deviations (% RSD) for all elements were less than or equal to 5%. These data indicate that the ICP-OES analyses are of sufficient accuracy and within the analytical uncertainty.

Table 5-1. Multi-element Standard Solution Results with PF Glass Dissolutions

Analyte	Reference (mg/L)	Average Measured (mg/L)	% Error	%RSD
Al	50	50.6	1	4
Fe	50	52.6	5	2
Mn	20	21.1	6	2
Ni	10	10.5	5	3
S	10	10.3	3	1

Table 5-2. Multi-element Standard Solution Results with LM Glass Dissolutions

Analyte	Reference (mg/L)	Average Measured (mg/L)	% Error	%RSD
Al	50	49.9	0	4
Fe	50	49.1	-2	2
Mn	20	19.6	-2	3
Na	150	148	-1	3
Ni	10	9.51	-5	2
S	10	10.4	4	5

5.2.2 Glass Standards

Table 5-3 and Table 5-4 provide a comparison of the published and measured compositions of the WCP Batch 1 glass and LRM for major components (> 0.5 wt.%).[43,44] SO_4^{2-} was also included with the LRM results despite a concentration of less than 0.5 wt.%. The average measured values for each element were calculated based on the following criteria:

- B_2O_3, Li_2O and Na_2O can only be measured from one dissolution method and are the average of six replicates for the dissolution method noted in the table.
- Per guidance from the Process Science Analytical Laboratory (PSAL), elements having a concentration less than ~1 wt.% are the average of the replicates from the LM dissolution. Values below 1 wt.% from the PF dissolutions could result in values below the calibration curve due to additional dilutions performed on these dissolutions and are excluded.
- Except for B, Li and Na, elements having a concentration of greater than ~1 wt.% are the average of twelve replicates (six from each dissolution method).

Table 5-3. Comparison of the Published and Measured Composition of WCP Batch 1

Oxide	Dissolution Method	Published (wt.%)	Average Measured (wt.%)	% Error	%RSD
Al_2O_3	PF, LM	4.88	4.86	-0.4	3.3
B_2O_3	PF	7.78	7.62	-2.1	2.9
CaO	PF, LM	1.22	1.22	0.3	10.8
Fe_2O_3	PF, LM	12.84	12.83	-0.1	3.4
K_2O	PF, LM	3.33	3.29	-1.1	3.2
Li_2O	PF	4.43	4.38	-1.2	4.4
MgO	PF, LM	1.42	1.40	-1.4	6.2
MnO	PF, LM	1.72	1.74	1.2	4.1
Na_2O	LM	9.00	8.96	-0.5	3.5
NiO	LM	0.75	0.69	-8.0	2.3
SiO_2	PF, LM	50.2	49.69	-1.0	1.7
TiO_2	LM	0.68	0.65	-4.5	3.3

Table 5-4. Comparison of the Published and Measured Composition of LRM

Oxide	Dissolution Method	Published (wt.%)	Average Measured (wt.%)	% Error	% RSD
Al_2O_3	PF, LM	9.51	9.87	3.8	4.6
B_2O_3	PF	7.85	7.68	-2.2	3.0
CaO	LM	0.54	0.46	-15.2	3.9
Fe_2O_3	PF, LM	1.38	1.46	5.6	4.5
K_2O	PF, LM	1.48	1.45	-2.3	3.6
Na_2O	LM	20.03	20.35	1.6	2.6
SO_4^{2-}	LM	0.36	0.28	-23.6	8.9
SiO_2	PF, LM	54.2	53.06	-2.1	2.1
ZrO_2	LM	0.93	0.90	-3.7	5.4

The measured concentrations for the major glass components (> 0.5 wt.%) values are consistent with the published values and the % RSD values for these components are generally less than 5%, indicating good precision in the results. Higher error and variability is noted for the CaO results; however, CaO is usually

a minor component in the SB10 glasses (< 0.5 wt.%) and has no impact on the conclusions of this study. All of the LRM replicates had measured S concentrations that were lower than the published value, but are still within 0.1 wt.% of the published value. Overall these data indicate proper performance of the glass dissolutions and the ICP-OES analyses are of sufficient accuracy and within the analytical uncertainty.

5.2.3 SB10 Test Glasses

Table A-12 in Appendix A provides a summary of the mean measured compositions and the target compositions. The same criteria listed in Section 5.2.2 were used to calculate the mean compositions; however, the number of replicates were two for one dissolution or four for both dissolutions. Elemental values that were reported as being below the instrument detection limit were conservatively taken as the detection limit for the calculation of the mean values. All of the sums of oxides for the study glasses fall between 97.06 to 100.49 wt.%, which satisfies the DWPF PCCS requirement of 95-105 wt.%. Included in Table A-12 are the wt.% differences and percent error between the mean measured and target concentrations. Differences were calculated using more decimal places than shown in this table, which may result in slight variation due to rounding. For the major oxides with targeted or mean measured concentrations of ≥ 0.5 wt.%, the wt.% difference is shaded if the value is ≥ 0.5 wt.% and the percent error is shaded if the value is ≥ 5%.[d] Some observations are as follows:

- The average measured Al_2O_3 values are up to 0.8 wt.% lower than the target concentrations
- The average measured Cs_2O values are 0.1 wt.% lower than the target concentrations
- The average measured SiO_2 values are up to 2.6 wt.% lower than the target concentrations

Of the major oxides, Al_2O_3 and SiO_2 are consistently low compared to the target concentrations, which is attributed to variability during the dissolution and measurement process rather than during batching. Overall, the majority of mean measured values are consistent with the target values for each major oxide of interest with less than 5% error.

Table 5-5 provides a summary of the mean measured and target SO_4^{2-} concentrations along with the percent error. The percent error is generally less than 10% for all of the glasses, which is comparable with previous sulfate solubility study measurements and acceptable.[9,11,15] SB10S-35 formed a sulfate salt phase on the surface, so a percent error that exceeds 10% is expected since the SO_4^{2-} concentration in the bulk should be less than 0.80 wt.%. SB10S-42 also exceeds 10%; however, the difference is negligible and will not impact the conclusions of this report.

Table 5-5. Summary of Measured SO_4^{2-} Concentrations

Glass ID	Frit	%WL	Case	Target SO_4^{2-} (wt.%)	Mean Measured SO_4^{2-} (wt.%)	% Error
SB10S-22	473	32	Coupled Case 1	0.65	0.67	3.5
SB10S-23	473	40	Coupled Case 1	0.65	0.64	-1.4
SB10S-24	473	32	Coupled Case 1	0.70	0.66	-5.6
SB10S-25	473	40	Coupled Case 1	0.70	0.72	3.1
SB10S-26	473	32	Coupled Case 1	0.75	0.70	-6.5
SB10S-27	473	40	Coupled Case 1	0.75	0.75	-0.5
SB10S-28	473	32	Coupled Case 1	0.80	0.77	-3.6
SB10S-29	473	40	Coupled Case 1	0.80	0.74	-7.7
SB10S-30	625	40	SO	0.65	0.64	-1.1
SB10S-31	473	32	SO	0.80	0.74	-7.1

[d] The 5% value was selected arbitrarily and does not necessarily indicate a difference of practical concern.

Glass ID	Frit	%WL	Case	Target SO_4^{2-} (wt.%)	Mean Measured SO_4^{2-} (wt.%)	% Error
SB10S-32	473	40	SO	0.80	0.82	2.2
SB10S-33	625	32	Coupled Case 1	0.80	0.81	1.1
SB10S-34	625	40	Coupled Case 1	0.80	0.78	-2.3
SB10S-35	625	32	SO	0.80	0.71	-11.6
SB10S-36	625	40	SO	0.80	0.75	-6.4
SB10S-37	625	40	SO	0.70	0.72	3.4
SB10S-38	625	40	SO	0.75	0.71	-5.7
SB10S-39	473	40	SO	0.85	0.83	-1.8
SB10S-40	473	40	Coupled Case 1	0.85	0.80	-6.2
SB10S-41	625	32	SO	0.75	0.68	-8.7
SB10S-42	625	32	SO	0.70	0.62	-11.6

5.3 Sulfate Retention

The results of the sulfate study glasses for Frits 625 and 473 are shown graphically in Figure 5-2 and Figure 5-3 as a function of the measured SO_4^{2-} concentration and %WL. Data points representing glasses with a clean surface are shaded blue and those that formed a sulfate layer are shaded yellow. Only the SO glasses based on Frit 625 formed a sulfate phase at a 0.80 wt.% SO_4^{2-} target concentration at both 32 and 40% WL. The remainder of the glasses did not form a sulfate layer. Due to the formation of the sulfate phase, the limit is conservatively set at 0.70 wt.% based on the measured sulfate concentrations of 0.71 wt.% and 0.75 wt.% for these two glasses. None of the SO or Coupled Case 1 glasses based on Frit 473 formed a sulfate salt phase, which supports a sulfate limit of 0.80 wt.%.

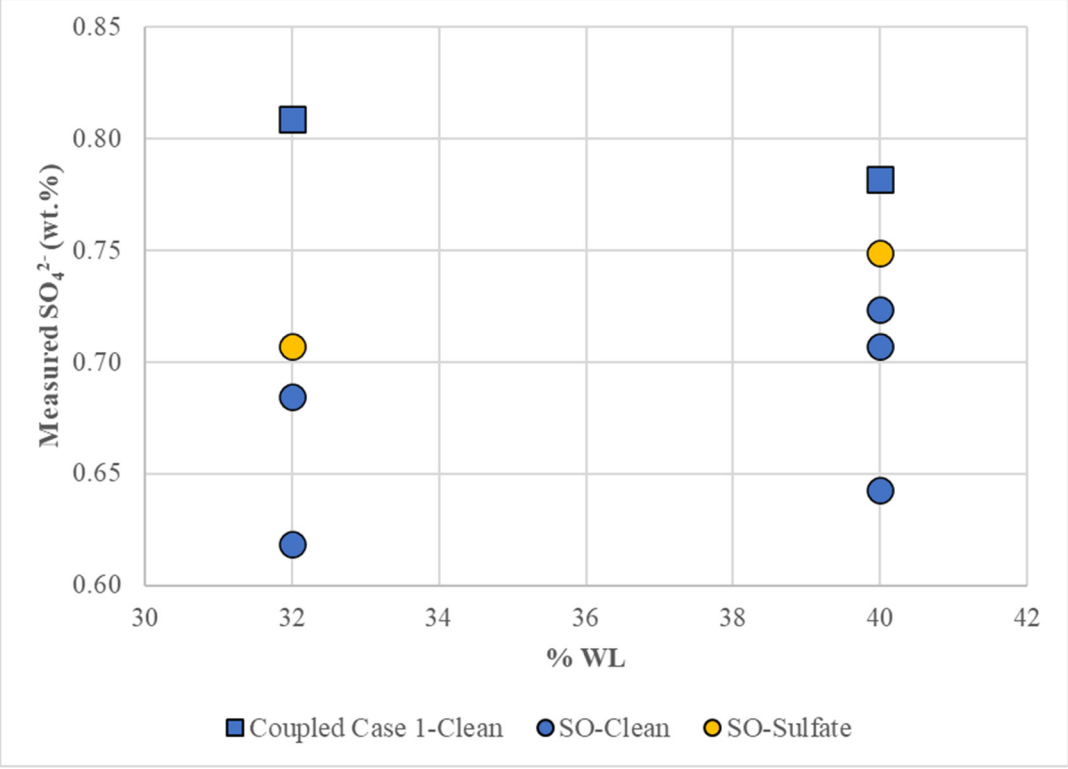


Figure 5-2. Results of the sulfate study glasses with Frit 625.

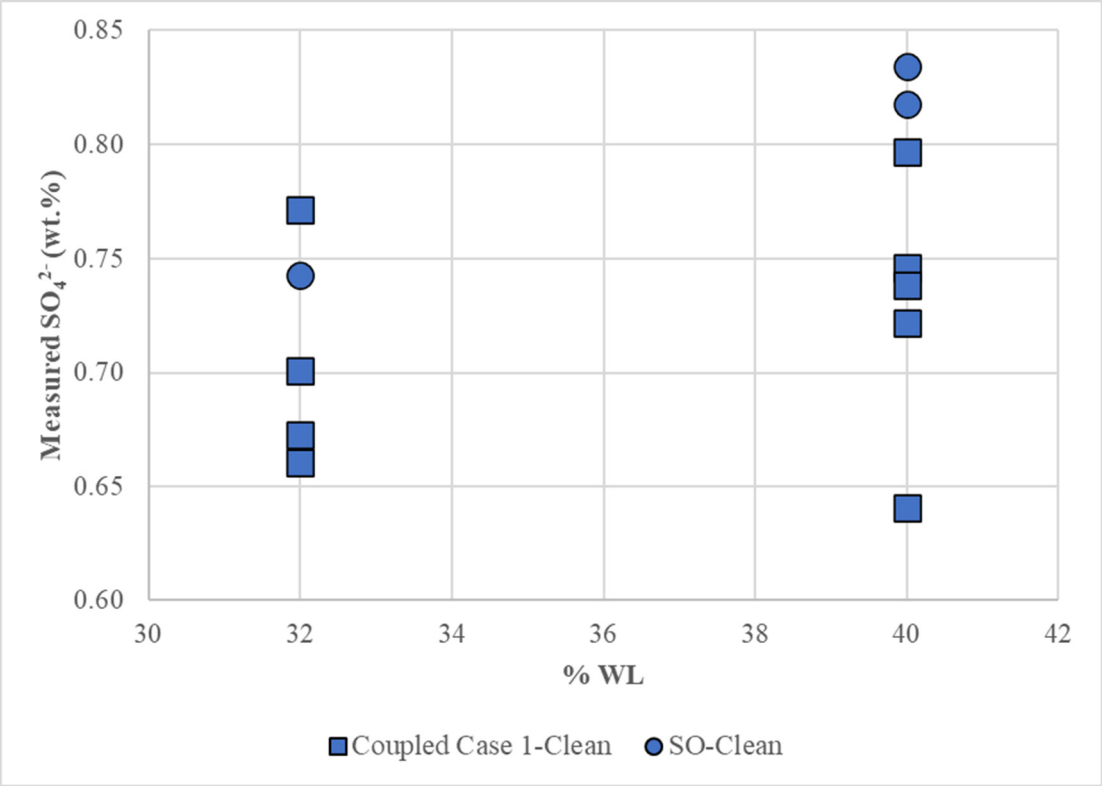


Figure 5-3. Results of the sulfate study glasses with Frit 473.

6.0 Conclusions

The results of this study demonstrate that for SO and coupled processing at 32 and 40% WL, glasses based on Frit 625 retain up to 0.70 wt.% SO_4^{2-} and glasses based on Frit 473 retain up to 0.80 wt.% SO_4^{2-}.

7.0 Recommendations

The following SO_4^{2-} concentration limits are recommended during SO and coupled SB10 processing:

- 0.70 wt.% during processing with Frit 625
- 0.80 wt.% during processing with Frit 473

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Appendix A. Projections and Supplementary Data

Table A-1. Normalized SB10 Confirmation Sample Tank 40H Blend Projections (wt.%)

Projection	7000 gal Caustic 10" Heel November 2022	7000 gal Caustic 30" Heel November 2022
Al_2O_3	28.10	27.42
B_2O_3	0.05	0.05
BaO	0.09	0.09
CaO	1.33	1.35
Ce_2O_3	0.24	0.24
Cr_2O_3	0.23	0.23
CuO	0.07	0.07
Fe_2O_3	22.03	22.27
Gd_2O_3	0.09	0.09
K_2O	0.17	0.17
La_2O_3	0.06	0.06
Li_2O	0.09	0.09
MgO	0.49	0.48
MnO	6.20	6.29
Na_2O	30.43	30.74
NiO	0.90	0.93
PbO	0.05	0.05
SO_4^{2-}	0.88	0.88
SiO_2	2.00	2.06
ThO_2	2.26	2.21
TiO_2	0.04	0.04
U_3O_8	4.08	4.08
ZnO	0.04	0.04
ZrO_2	0.09	0.09

Table A-2. SRNL-Developed SRAT Compositions for Coupled Operation

Case	Coupled Case 1 Single Strike
Tank 40H Volume (gal)	5700
SSRT Volume (gal)	4500
SE Volume (gal)	15,000
Al_2O_3	22.10
B_2O_3	0.72
BaO	0.07
CaO	1.00
Ce_2O_3	0.18
Cr_2O_3	0.17
Cs_2O	1.68
CuO	0.05
Fe_2O_3	16.51
Gd_2O_3	0.07
K_2O	0.35
La_2O_3	0.05
Li_2O	0.07
MgO	0.37
MnO	4.65
Na_2O	33.57
NiO	0.67
PbO	0.04
SO_4^{2-}	0.71
SiO_2	1.50
ThO_2	1.70
TiO_2	10.64
U_3O_8	3.06
ZnO	0.03
ZrO_2	0.07

Table A-3. Target Glass Compositions

Frit	**473**	**473**	**473**	**473**	**473**	**473**	**473**
% WL	32	40	32	40	32	40	32
Case	Coupled Case 1	Coupled Case 1	Coupled Case 1	Coupled Case 1	Coupled Case 1	Coupled Case 1	Coupled Case 1
SO_4^{2-} (wt.%)	0.65	0.65	0.70	0.70	0.75	0.75	0.80
Glass ID	**SB10S-22**	**SB10S-23**	**SB10S-24**	**SB10S-25**	**SB10S-26**	**SB10S-27**	**SB10S-28**
Al_2O_3	7.33	9.20	7.32	9.19	7.31	9.18	7.29
B_2O_3	5.68	5.10	5.68	5.10	5.68	5.10	5.68
BaO	0.02	0.03	0.02	0.03	0.02	0.03	0.02
CaO	0.33	0.42	0.33	0.41	0.33	0.41	0.33
Ce_2O_3	0.06	0.07	0.06	0.07	0.06	0.07	0.06
Cr_2O_3	0.06	0.07	0.06	0.07	0.06	0.07	0.06
Cs_2O	0.56	0.70	0.55	0.70	0.55	0.70	0.55
CuO	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Fe_2O_3	5.47	6.87	5.47	6.86	5.46	6.85	5.45
Gd_2O_3	0.02	0.03	0.02	0.03	0.02	0.03	0.02
K_2O	0.12	0.15	0.12	0.15	0.12	0.15	0.12
La_2O_3	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Li_2O	5.46	4.83	5.46	4.83	5.46	4.83	5.46
MgO	0.12	0.15	0.12	0.15	0.12	0.15	0.12
MnO	1.54	1.93	1.54	1.93	1.54	1.93	1.53
Na_2O	14.53	16.97	14.51	16.95	14.50	16.94	14.48
NiO	0.22	0.28	0.22	0.28	0.22	0.28	0.22
PbO	0.01	0.02	0.01	0.02	0.01	0.02	0.01
SO_4^{2-}	0.65	0.65	0.70	0.70	0.75	0.75	0.80
SiO_2	54.22	48.02	54.22	48.02	54.22	48.02	54.21
TiO_2	3.53	4.43	3.52	4.43	3.52	4.42	3.51
ZnO	0.01	0.01	0.01	0.01	0.01	0.01	0.01
ZrO_2	0.02	0.03	0.02	0.03	0.02	0.03	0.02

Table A-3. Target Glass Compositions (continued)

Frit	**473**	**625**	**473**	**473**	**625**	**625**	**625**
% WL	40	40	32	40	32	40	32
Case	Coupled Case 1	SO	SO	SO	Coupled Case 1	Coupled Case 1	SO
SO_4^{2-} (wt.%)	0.80	0.65	0.80	0.80	0.80	0.80	0.80
Glass ID	**SB10S-29**	**SB10S-30**	**SB10S-31**	**SB10S-32**	**SB10S-33**	**SB10S-34**	**SB10S-35**
Al_2O_3	9.17	12.52	9.45	11.87	7.97	9.77	10.13
B_2O_3	5.10	4.82	5.46	4.82	5.68	5.10	5.46
BaO	0.03	0.04	0.03	0.04	0.02	0.03	0.03
CaO	0.41	0.56	0.45	0.56	0.33	0.41	0.45
Ce_2O_3	0.07	0.10	0.08	0.10	0.06	0.07	0.08
Cr_2O_3	0.07	0.10	0.08	0.10	0.06	0.07	0.08
Cs_2O	0.69	0.00	0.00	0.00	0.55	0.69	0.00
CuO	0.02	0.03	0.02	0.03	0.02	0.02	0.02
Fe_2O_3	6.84	9.34	7.41	9.31	5.45	6.84	7.41
Gd_2O_3	0.03	0.04	0.03	0.04	0.02	0.03	0.03
K_2O	0.15	0.07	0.06	0.07	0.12	0.15	0.06
La_2O_3	0.02	0.03	0.02	0.03	0.02	0.02	0.02
Li_2O	4.83	4.24	5.47	4.84	4.78	4.23	4.79
MgO	0.15	0.21	0.16	0.21	0.12	0.15	0.16
MnO	1.93	2.63	2.09	2.62	1.53	1.93	2.09
Na_2O	16.92	16.51	13.63	15.86	15.16	17.52	14.31
NiO	0.28	0.38	0.30	0.38	0.22	0.28	0.30
PbO	0.02	0.02	0.02	0.02	0.01	0.02	0.02
SO_4^{2-}	0.80	0.65	0.80	0.80	0.80	0.80	0.80
SiO_2	48.02	47.65	54.39	48.25	53.53	47.42	53.71
TiO_2	4.41	0.02	0.01	0.02	3.51	4.41	0.01
ZnO	0.01	0.02	0.01	0.02	0.01	0.01	0.01
ZrO_2	0.03	0.04	0.03	0.04	0.02	0.03	0.03

Table A-3. Target Glass Compositions (continued)

Frit	**625**	**625**	**625**	**473**	**473**	**625**	**625**
% WL	40	40	40	40	40	32	32
Case	SO	SO	SO	SO	Coupled Case 1	SO	SO
SO_4^{2-} (wt.%)	0.80	0.70	0.75	0.85	0.85	0.75	0.70
Glass ID	**SB10S-36**	**SB10S-37**	**SB10S-38**	**SB10S-39**	**SB10S-40**	**SB10S-41**	**SB10S-42**
Al_2O_3	12.47	12.50	12.49	11.86	9.15	10.15	10.16
B_2O_3	4.82	4.82	4.82	4.82	5.10	5.46	5.46
BaO	0.04	0.04	0.04	0.04	0.03	0.03	0.03
CaO	0.56	0.56	0.56	0.56	0.41	0.45	0.45
Ce_2O_3	0.10	0.10	0.10	0.10	0.07	0.08	0.08
Cr_2O_3	0.10	0.10	0.10	0.10	0.07	0.08	0.08
Cs_2O	0.00	0.00	0.00	0.00	0.69	0.00	0.00
CuO	0.03	0.03	0.03	0.03	0.02	0.02	0.02
Fe_2O_3	9.31	9.33	9.32	9.30	6.84	7.42	7.43
Gd_2O_3	0.04	0.04	0.04	0.04	0.03	0.03	0.03
K_2O	0.07	0.07	0.07	0.07	0.15	0.06	0.06
La_2O_3	0.03	0.03	0.03	0.03	0.02	0.02	0.02
Li_2O	4.24	4.24	4.24	4.84	4.83	4.79	4.79
MgO	0.21	0.21	0.21	0.21	0.15	0.16	0.16
MnO	2.62	2.63	2.62	2.62	1.93	2.09	2.09
Na_2O	16.46	16.49	16.47	15.84	16.90	14.33	14.35
NiO	0.38	0.38	0.38	0.38	0.28	0.30	0.30
PbO	0.02	0.02	0.02	0.02	0.02	0.02	0.02
SO_4^{2-}	0.80	0.70	0.75	0.85	0.85	0.75	0.70
SiO_2	47.65	47.65	47.65	48.24	48.02	53.71	53.71
TiO_2	0.02	0.02	0.02	0.02	4.41	0.01	0.01
ZnO	0.02	0.02	0.02	0.02	0.01	0.01	0.01
ZrO_2	0.04	0.04	0.04	0.04	0.03	0.03	0.03

Table A-4. Multi-Element Standard Solution Concentrations Measured by ICP-OES

Lab ID	Set	Al (ppm)	Fe (ppm)	Mn (ppm)	Na (ppm)	Ni (ppm)	S (ppm)
Sulfur Standard	PF1	51.5	52.2	21.2	not measured	10.5	10.2
Sulfur Standard	PF1	53.4	53.2	21.6	not measured	10.6	10.3
Sulfur Standard	PF2	52.1	51.9	20.7	not measured	10.3	10.3
Sulfur Standard	PF2	50.2	51.2	20.4	not measured	10.1	10.4
Sulfur Standard	PF3	48.9	54.3	21.7	not measured	10.9	10.1
Sulfur Standard	PF3	47.2	53.0	21.2	not measured	10.7	10.3
Sulfur Standard	LM1	49.7	49.5	19.8	150	9.52	10.7
Sulfur Standard	LM1	51.8	50.2	20.2	149	9.72	10.7
Sulfur Standard	LM2	49.4	49.1	19.4	147	9.53	10.8
Sulfur Standard	LM2	51.6	48.8	19.5	152	9.48	9.98
Sulfur Standard	LM3	46.3	47.6	18.7	141	9.22	9.63
Sulfur Standard	LM3	50.4	49.1	20.0	148	9.60	10.7

Table A-5. PF Set 1 Elemental Concentrations Measured by ICP-OES

Sample ID	Lab ID	Set	Al (wt.%)	B (wt.%)	Ba (wt.%)	Ca (wt.%)	Ce (wt.%)	Cr (wt.%)	Cu (wt.%)	Fe (wt.%)	Gd (wt.%)	K (wt.%)	La (wt.%)
WCP Batch 1	Batch standard	PF1	2.68	2.45	0.14	1.04	<0.100	<0.100	0.33	9.45	<0.100	2.80	<0.100
LRM	LRM	PF1	5.52	2.48	<0.100	0.43	<0.100	0.13	<0.100	1.07	<0.100	1.26	<0.100
SB10S-22	S-15803	PF1	3.55	1.69	<0.100	0.30	<0.100	<0.100	<0.100	3.96	<0.100	0.12	<0.100
SB10S-23	S-15804	PF1	4.68	1.54	<0.100	0.37	<0.100	<0.100	<0.100	5.05	<0.100	0.23	<0.100
SB10S-24	S-15805	PF1	4.09	1.78	<0.100	0.30	<0.100	<0.100	<0.100	4.04	<0.100	0.13	<0.100
SB10S-25	S-15806	PF1	4.84	1.59	<0.100	0.36	<0.100	<0.100	<0.100	5.13	<0.100	0.20	<0.100
SB10S-26	S-15807	PF1	3.83	1.79	<0.100	0.31	<0.100	<0.100	<0.100	4.03	<0.100	0.15	<0.100
SB10S-27	S-15808	PF1	4.78	1.55	<0.100	0.36	<0.100	<0.100	<0.100	4.97	<0.100	0.20	<0.100
SB10S-28	S-15809	PF1	3.73	1.65	<0.100	1.01	<0.100	<0.100	<0.100	4.00	<0.100	0.13	<0.100
SB10S-29	S-15810	PF1	4.71	1.58	<0.100	0.36	<0.100	<0.100	<0.100	5.05	<0.100	0.15	<0.100
SB10S-30	S-15811	PF1	6.53	1.53	<0.100	0.49	<0.100	<0.100	<0.100	6.89	<0.100	0.14	<0.100
SB10S-31	S-15851	PF1	5.03	1.76	<0.100	0.41	<0.100	<0.100	<0.100	5.52	<0.100	0.15	<0.100
SB10S-32	S-15852	PF1	6.35	1.51	<0.100	0.52	<0.100	<0.100	<0.100	6.94	<0.100	0.13	<0.100
SB10S-33	S-15853	PF1	4.25	1.76	<0.100	0.31	<0.100	<0.100	<0.100	4.05	<0.100	0.11	<0.100
SB10S-34	S-15854	PF1	5.21	1.58	<0.100	0.41	<0.100	<0.100	<0.100	5.09	<0.100	0.17	<0.100
SB10S-36	S-15856	PF1	6.78	1.54	<0.100	0.55	<0.100	<0.100	<0.100	7.05	<0.100	0.12	<0.100
SB10S-37	S-15866	PF1	6.74	1.55	<0.100	0.51	<0.100	<0.100	<0.100	7.04	<0.100	0.12	<0.100
SB10S-38	S-15867	PF1	6.85	1.56	<0.100	0.50	<0.100	<0.100	<0.100	6.89	<0.100	0.11	<0.100
SB10S-39	S-15881	PF1	6.11	1.54	<0.100	0.47	<0.100	<0.100	<0.100	6.88	<0.100	0.12	<0.100
SB10S-40	S-15882	PF1	4.75	1.62	<0.100	0.35	<0.100	<0.100	<0.100	5.08	<0.100	0.18	<0.100
WCP Batch 1	Batch standard	PF1	2.66	2.42	0.14	1.01	<0.100	<0.100	0.33	9.45	<0.100	2.80	<0.100
LRM	LRM	PF1	5.40	2.43	<0.100	0.41	<0.100	0.13	<0.100	1.08	<0.100	1.24	<0.100

Table A-5. PF Set 1 Elemental Concentrations Measured by ICP-OES (continued)

Sample ID	Lab Id	Set	Li (wt.%)	Mg (wt.%)	Mn (wt.%)	Ni (wt.%)	Pb (wt.%)	S (wt.%)	Si (wt.%)	Ti (wt.%)	Zn (wt.%)	Zr (wt.%)
WCP Batch 1	Batch standard	PF1	2.13	0.91	1.44	0.61	<0.100	<0.100	23.70	0.42	<0.100	<0.100
LRM	LRM	PF1	<0.100	<0.100	<0.100	0.15	0.14	<0.100	25.50	<0.100	<0.100	0.72
SB10S-22	S-15803	PF1	2.45	<0.100	1.25	0.17	<0.100	0.25	24.30	2.12	<0.100	<0.100
SB10S-23	S-15804	PF1	2.27	<0.100	1.59	0.24	<0.100	0.19	22.60	2.74	<0.100	<0.100
SB10S-24	S-15805	PF1	2.55	<0.100	1.31	0.18	<0.100	0.22	25.20	2.17	<0.100	<0.100
SB10S-25	S-15806	PF1	2.23	<0.100	1.62	0.24	<0.100	0.26	22.80	2.74	<0.100	<0.100
SB10S-26	S-15807	PF1	2.51	<0.100	1.29	0.19	<0.100	0.31	25.50	2.18	<0.100	<0.100
SB10S-27	S-15808	PF1	2.18	<0.100	1.56	0.22	<0.100	0.27	22.10	2.66	<0.100	<0.100
SB10S-28	S-15809	PF1	2.46	<0.100	1.22	0.18	<0.100	0.31	24.50	2.15	<0.100	<0.100
SB10S-29	S-15810	PF1	2.22	<0.100	1.57	0.21	<0.100	0.30	22.60	2.75	<0.100	<0.100
SB10S-30	S-15811	PF1	1.96	0.11	2.14	0.31	<0.100	0.26	23.00	<0.100	<0.100	<0.100
SB10S-31	S-15851	PF1	2.58	<0.100	1.70	0.25	<0.100	0.25	25.90	<0.100	<0.100	<0.100
SB10S-32	S-15852	PF1	2.33	0.12	2.22	0.31	<0.100	0.27	23.30	<0.100	<0.100	<0.100
SB10S-33	S-15853	PF1	2.25	<0.100	1.27	0.18	<0.100	0.34	25.20	2.20	<0.100	<0.100
SB10S-34	S-15854	PF1	1.93	<0.100	1.58	0.23	<0.100	0.33	21.90	2.77	<0.100	<0.100
SB10S-36	S-15856	PF1	2.03	0.13	2.24	0.31	<0.100	0.29	23.20	<0.100	<0.100	<0.100
SB10S-37	S-15866	PF1	2.03	0.12	2.21	0.31	<0.100	0.27	22.70	<0.100	<0.100	<0.100
SB10S-38	S-15867	PF1	1.99	0.11	2.16	0.30	<0.100	0.21	22.90	<0.100	<0.100	<0.100
SB10S-39	S-15881	PF1	2.26	0.11	2.19	0.30	<0.100	0.31	22.50	<0.100	<0.100	<0.100
SB10S-40	S-15882	PF1	2.25	<0.100	1.60	0.23	<0.100	0.27	22.70	2.76	<0.100	<0.100
WCP Batch 1	Batch standard	PF1	2.11	0.90	1.44	0.61	<0.100	<0.100	23.40	0.42	<0.100	<0.100
LRM	LRM	PF1	<0.100	<0.100	<0.100	0.15	0.13	<0.100	25.10	<0.100	<0.100	0.72

Table A-6. PF Set 2 Elemental Concentrations Measured by ICP-OES

Sample ID	Lab Id	Set	Al (wt.%)	B (wt.%)	Ba (wt.%)	Ca (wt.%)	Ce (wt.%)	Cr (wt.%)	Cu (wt.%)	Fe (wt.%)	Gd (wt.%)	K (wt.%)	La (wt.%)
WCP Batch 1	Batch standard	PF2	2.65	2.40	0.14	0.96	<0.100	<0.100	0.32	9.34	<0.100	2.81	<0.100
LRM	LRM	PF2	5.38	2.41	<0.100	0.38	<0.100	0.13	<0.100	1.06	<0.100	1.20	<0.100
SB10S-22	S-15803	PF2	3.59	1.68	<0.100	0.24	<0.100	<0.100	<0.100	3.97	<0.100	0.10	<0.100
SB10S-23	S-15804	PF2	4.41	1.46	<0.100	0.29	<0.100	<0.100	<0.100	4.87	<0.100	0.18	<0.100
SB10S-24	S-15805	PF2	3.96	1.71	<0.100	0.25	<0.100	<0.100	<0.100	3.95	<0.100	0.11	<0.100
SB10S-25	S-15806	PF2	4.50	1.48	<0.100	0.29	<0.100	<0.100	<0.100	4.90	<0.100	0.16	<0.100
SB10S-26	S-15807	PF2	3.50	1.65	<0.100	0.23	<0.100	<0.100	<0.100	3.86	<0.100	0.12	<0.100
SB10S-27	S-15808	PF2	4.83	1.53	<0.100	0.33	<0.100	<0.100	<0.100	5.03	<0.100	0.18	<0.100
SB10S-28	S-15809	PF2	3.62	1.59	<0.100	0.23	<0.100	<0.100	<0.100	3.95	<0.100	0.14	<0.100
SB10S-29	S-15810	PF2	4.44	1.49	<0.100	0.29	<0.100	<0.100	<0.100	4.90	<0.100	0.13	<0.100
SB10S-30	S-15811	PF2	6.14	1.45	<0.100	0.42	<0.100	<0.100	<0.100	6.70	<0.100	0.11	<0.100
SB10S-31	S-15851	PF2	4.83	1.66	<0.100	0.34	<0.100	<0.100	<0.100	5.33	<0.100	<0.100	<0.100
SB10S-32	S-15852	PF2	6.18	1.44	<0.100	0.46	<0.100	<0.100	<0.100	6.90	<0.100	<0.100	<0.100
SB10S-33	S-15853	PF2	3.97	1.64	<0.100	0.24	<0.100	<0.100	<0.100	3.86	<0.100	<0.100	<0.100
SB10S-34	S-15854	PF2	4.96	1.52	<0.100	0.31	<0.100	<0.100	<0.100	5.07	<0.100	0.12	<0.100
SB10S-36	S-15856	PF2	6.66	1.49	<0.100	0.45	<0.100	<0.100	<0.100	6.94	<0.100	<0.100	<0.100
SB10S-37	S-15866	PF2	6.22	1.45	<0.100	0.44	<0.100	<0.100	<0.100	6.77	<0.100	0.12	<0.100
SB10S-38	S-15867	PF2	6.32	1.44	<0.100	0.39	<0.100	<0.100	<0.100	6.62	<0.100	<0.100	<0.100
SB10S-39	S-15881	PF2	6.09	1.50	<0.100	0.44	<0.100	<0.100	<0.100	6.79	<0.100	<0.100	<0.100
SB10S-40	S-15882	PF2	4.75	1.56	<0.100	0.33	<0.100	<0.100	<0.100	4.98	<0.100	0.19	<0.100
WCP Batch 1	Batch standard	PF2	2.51	2.29	0.14	0.88	<0.100	<0.100	0.31	9.10	<0.100	2.59	<0.100
LRM	LRM	PF2	5.34	2.38	<0.100	0.38	<0.100	0.13	<0.100	1.06	<0.100	1.18	<0.100

Table A-6. PF Set 2 Elemental Concentrations Measured by ICP-OES (continued)

Sample ID	Lab Id	Set	Li (wt.%)	Mg (wt.%)	Mn (wt.%)	Ni (wt.%)	Pb (wt.%)	S (wt.%)	Si (wt.%)	Ti (wt.%)	Zn (wt.%)	Zr (wt.%)
WCP Batch 1	Batch standard	PF2	2.03	0.88	1.40	0.60	<0.100	<0.100	24.00	0.41	<0.100	<0.100
LRM	LRM	PF2	<0.100	<0.100	<0.100	0.14	<0.100	<0.100	25.10	<0.100	<0.100	0.71
SB10S-22	S-15803	PF2	2.41	<0.100	1.24	0.17	<0.100	0.29	23.60	2.15	<0.100	<0.100
SB10S-23	S-15804	PF2	2.08	<0.100	1.51	0.23	<0.100	0.25	22.20	2.65	<0.100	<0.100
SB10S-24	S-15805	PF2	2.47	<0.100	1.26	0.17	<0.100	0.25	24.70	2.14	<0.100	<0.100
SB10S-25	S-15806	PF2	2.08	<0.100	1.52	0.22	<0.100	0.29	21.90	2.64	<0.100	<0.100
SB10S-26	S-15807	PF2	2.37	<0.100	1.21	0.18	<0.100	0.29	24.10	2.10	<0.100	<0.100
SB10S-27	S-15808	PF2	2.09	<0.100	1.55	0.22	<0.100	0.27	22.80	2.74	<0.100	<0.100
SB10S-28	S-15809	PF2	2.36	<0.100	1.18	0.18	<0.100	0.24	24.70	2.13	<0.100	<0.100
SB10S-29	S-15810	PF2	2.05	<0.100	1.49	0.21	<0.100	0.24	22.00	2.66	<0.100	<0.100
SB10S-30	S-15811	PF2	1.83	<0.100	2.04	0.30	<0.100	0.18	22.40	<0.100	<0.100	<0.100
SB10S-31	S-15851	PF2	2.39	<0.100	1.62	0.24	<0.100	0.25	25.20	<0.100	<0.100	<0.100
SB10S-32	S-15852	PF2	2.18	0.11	2.18	0.31	<0.100	0.30	23.30	<0.100	<0.100	<0.100
SB10S-33	S-15853	PF2	2.04	<0.100	1.18	0.17	<0.100	0.26	24.70	2.12	<0.100	<0.100
SB10S-34	S-15854	PF2	1.83	<0.100	1.54	0.22	<0.100	0.30	22.70	2.76	<0.100	<0.100
SB10S-36	S-15856	PF2	1.91	0.11	2.17	0.30	<0.100	0.33	23.40	<0.100	<0.100	<0.100
SB10S-37	S-15866	PF2	1.88	0.11	2.08	0.30	<0.100	0.23	22.40	<0.100	<0.100	<0.100
SB10S-38	S-15867	PF2	1.78	<0.100	2.03	0.28	<0.100	0.28	22.20	<0.100	<0.100	<0.100
SB10S-39	S-15881	PF2	2.15	0.11	2.15	0.30	<0.100	0.29	23.30	<0.100	<0.100	<0.100
SB10S-40	S-15882	PF2	2.10	<0.100	1.55	0.22	<0.100	0.24	23.00	2.74	<0.100	<0.100
WCP Batch 1	Batch standard	PF2	1.90	0.84	1.36	0.58	<0.100	<0.100	23.20	0.40	<0.100	<0.100
LRM	LRM	PF2	<0.100	<0.100	<0.100	0.15	<0.100	0.11	24.90	<0.100	<0.100	0.71

Table A-7. PF Set 3 Elemental Concentrations Measured by ICP-OES

Sample ID	Lab ID	Set	Al (wt.%)	B (wt.%)	Ba (wt.%)	Ca (wt.%)	Ce (wt.%)	Cr (wt.%)	Cu (wt.%)	Fe (wt.%)	Gd (wt.%)	K (wt.%)	La (wt.%)
WCP Batch 1	Batch standard	PF3	2.64	2.34	0.138	0.930	<0.100	<0.100	0.313	8.95	<0.100	2.89	<0.100
LRM	LRM	PF3	5.29	2.29	<0.100	0.377	<0.100	0.133	<0.100	0.996	<0.100	1.28	<0.100
SB10S-35	S-16208	PF3	4.96	1.58	<0.100	0.342	<0.100	<0.100	<0.100	5.00	<0.100	0.112	<0.100
SB10S-35	S-16208	PF3	5.22	1.64	<0.100	0.366	<0.100	<0.100	<0.100	5.15	<0.100	0.120	<0.100
SB10S-41	S-16221	PF3	5.00	1.54	<0.100	0.350	<0.100	<0.100	<0.100	5.08	<0.100	0.105	<0.100
SB10S-41	S-16221	PF3	4.98	1.54	<0.100	0.344	<0.100	<0.100	<0.100	5.09	<0.100	<0.100	<0.100
SB10S-42	S-16222	PF3	5.01	1.55	<0.100	0.345	<0.100	<0.100	<0.100	4.99	<0.100	0.100	<0.100
SB10S-42	S-16222	PF3	5.08	1.58	<0.100	0.339	<0.100	<0.100	<0.100	5.07	<0.100	0.131	<0.100
WCP Batch 1	Batch standard	PF3	2.61	2.29	0.139	0.920	<0.100	<0.100	0.311	8.86	<0.100	2.71	<0.100
LRM	LRM	PF3	5.34	2.32	<0.100	0.383	<0.100	0.134	<0.100	1.00	<0.100	1.22	<0.100

Table A-7. PF Set 3 Elemental Concentrations Measured by ICP-OES (continued)

Sample ID	Lab ID	Set	Li (wt.%)	Mg (wt.%)	Mn (wt.%)	Ni (wt.%)	Pb (wt.%)	S (wt.%)	Si (wt.%)	Ti (wt.%)	Zn (wt.%)	Zr (wt.%)
WCP Batch 1	Batch standard	PF3	2.07	0.892	1.33	0.572	<0.100	<0.100	23.0	0.403	<0.100	<0.100
LRM	LRM	PF3	<0.100	<0.100	<0.100	0.138	<0.100	0.131	24.4	<0.100	<0.100	0.695
SB10S-35	S-16208	PF3	2.07	0.105	1.58	0.227	<0.100	0.340	23.3	<0.100	<0.100	<0.100
SB10S-35	S-16208	PF3	2.14	0.109	1.63	0.234	<0.100	0.351	24.9	<0.100	<0.100	<0.100
SB10S-41	S-16221	PF3	2.15	<0.100	1.56	0.226	<0.100	0.380	24.0	<0.100	<0.100	<0.100
SB10S-41	S-16221	PF3	2.11	<0.100	1.57	0.226	<0.100	0.380	24.1	<0.100	<0.100	<0.100
SB10S-42	S-16222	PF3	2.11	<0.100	1.53	0.222	<0.100	0.316	23.6	<0.100	<0.100	<0.100
SB10S-42	S-16222	PF3	2.09	<0.100	1.56	0.226	<0.100	0.346	24.0	<0.100	<0.100	<0.100
WCP Batch 1	Batch standard	PF3	1.96	0.887	1.32	0.576	<0.100	0.169	22.7	0.397	<0.100	<0.100
LRM	LRM	PF3	<0.100	<0.100	<0.100	0.142	<0.100	<0.100	24.8	<0.100	<0.100	0.710

Table A-8. LM Set 1 Elemental Concentrations Measured by ICP-OES

Sample ID	Lab Id	Set	Al (wt.%)	Ba (wt.%)	Ca (wt.%)	Ce (wt.%)	Cr (wt.%)	Cu (wt.%)	Fe (wt.%)	Gd (wt.%)	K (wt.%)	La (wt.%%)
WCP Batch 1	Batch standard	LM1	2.52	0.13	0.77	<0.100	<0.100	0.32	8.87	<0.100	2.67	<0.100
LRM	LRM	LM1	5.17	<0.100	0.31	<0.100	0.13	<0.100	1.02	<0.100	1.18	<0.100
SB10S-22	S-15803	LM1	3.44	<0.100	0.23	<0.100	<0.100	<0.100	3.75	<0.100	0.11	<0.100
SB10S-23	S-15804	LM1	4.47	<0.100	0.29	<0.100	<0.100	<0.100	4.70	<0.100	0.17	<0.100
SB10S-24	S-15805	LM1	3.79	<0.100	0.24	<0.100	<0.100	<0.100	3.73	<0.100	<0.100	<0.100
SB10S-25	S-15806	LM1	4.54	<0.100	0.29	<0.100	<0.100	<0.100	4.70	<0.100	0.14	<0.100
SB10S-26	S-15807	LM1	3.57	<0.100	0.25	<0.100	<0.100	<0.100	3.79	<0.100	0.11	<0.100
SB10S-27	S-15808	LM1	4.55	<0.100	0.29	<0.100	<0.100	<0.100	4.68	<0.100	0.14	<0.100
SB10S-28	S-15809	LM1	3.59	<0.100	0.23	<0.100	<0.100	<0.100	3.78	<0.100	0.11	<0.100
SB10S-29	S-15810	LM1	4.53	<0.100	0.29	<0.100	<0.100	<0.100	4.75	<0.100	0.12	<0.100
SB10S-30	S-15811	LM1	6.12	<0.100	0.39	<0.100	<0.100	<0.100	6.43	<0.100	<0.100	<0.100
SB10S-31	S-15851	LM1	4.60	<0.100	0.32	<0.100	<0.100	<0.100	5.04	<0.100	<0.100	<0.100
SB10S-32	S-15852	LM1	5.74	<0.100	0.39	<0.100	<0.100	<0.100	6.32	<0.100	<0.100	<0.100
SB10S-33	S-15853	LM1	3.90	<0.100	0.23	<0.100	<0.100	<0.100	3.68	<0.100	<0.100	<0.100
SB10S-34	S-15854	LM1	4.82	<0.100	0.29	<0.100	<0.100	<0.100	4.76	<0.100	0.13	<0.100
SB10S-36	S-15856	LM1	6.17	<0.100	0.36	<0.100	<0.100	<0.100	6.33	<0.100	<0.100	<0.100
SB10S-37	S-15866	LM1	6.11	<0.100	0.38	<0.100	<0.100	<0.100	6.42	<0.100	<0.100	<0.100
SB10S-38	S-15867	LM1	6.35	<0.100	0.38	<0.100	<0.100	<0.100	6.30	<0.100	<0.100	<0.100
SB10S-39	S-15881	LM1	5.88	<0.100	0.38	<0.100	<0.100	<0.100	6.41	<0.100	<0.100	<0.100
SB10S-40	S-15882	LM1	4.55	<0.100	0.28	<0.100	<0.100	<0.100	4.71	<0.100	0.13	<0.100
WCP Batch 1	Batch standard	LM1	2.63	0.14	0.81	<0.100	<0.100	0.32	8.99	<0.100	2.80	<0.100
LRM	LRM	LM1	5.26	<0.100	0.33	<0.100	0.13	<0.100	1.05	<0.100	1.21	<0.100

Table A-8. LM Set 1 Elemental Concentrations Measured by ICP-OES (continued)

Sample ID	Lab Id	Set	Mg (wt.%)	Mn (wt.%)	Na (wt.%)	Ni (wt.%)	Pb (wt.%)	S (wt.%)	Si (wt.%)	Ti (wt.%)	Zn (wt.%)	Zr (wt.%)
WCP Batch 1	Batch standard	LM1	0.82	1.33	6.91	0.55	<0.100	<0.0500	23.00	0.40	<0.100	<0.100
LRM	LRM	LM1	<0.100	<0.100	15.60	0.14	<0.100	0.102	24.60	<0.100	<0.100	0.69
SB10S-22	S-15803	LM1	<0.100	1.17	10.80	0.16	<0.100	0.228	23.90	2.08	<0.100	<0.100
SB10S-23	S-15804	LM1	<0.100	1.46	12.80	0.22	<0.100	0.218	21.60	2.63	<0.100	<0.100
SB10S-24	S-15805	LM1	<0.100	1.19	11.10	0.16	<0.100	0.230	24.20	2.08	<0.100	<0.100
SB10S-25	S-15806	LM1	<0.100	1.47	12.60	0.21	<0.100	0.251	21.70	2.59	<0.100	<0.100
SB10S-26	S-15807	LM1	<0.100	1.20	10.80	0.17	<0.100	0.248	24.40	2.11	<0.100	<0.100
SB10S-27	S-15808	LM1	<0.100	1.45	12.30	0.20	<0.100	0.255	21.20	2.58	<0.100	<0.100
SB10S-28	S-15809	LM1	<0.100	1.13	10.80	0.17	<0.100	0.266	24.40	2.10	<0.100	<0.100
SB10S-29	S-15810	LM1	<0.100	1.46	12.60	0.19	<0.100	0.257	21.70	2.62	<0.100	<0.100
SB10S-30	S-15811	LM1	<0.100	1.98	12.00	0.28	<0.100	0.229	21.60	<0.100	<0.100	<0.100
SB10S-31	S-15851	LM1	<0.100	1.54	9.92	0.22	<0.100	0.254	24.20	<0.100	<0.100	<0.100
SB10S-32	S-15852	LM1	0.11	2.01	11.30	0.28	<0.100	0.283	21.30	<0.100	<0.100	<0.100
SB10S-33	S-15853	LM1	<0.100	1.13	11.00	0.16	<0.100	0.275	23.70	2.05	<0.100	<0.100
SB10S-34	S-15854	LM1	<0.100	1.45	12.90	0.20	<0.100	0.258	21.20	2.64	<0.100	<0.100
SB10S-36	S-15856	LM1	0.11	1.98	11.90	0.27	<0.100	0.257	21.30	<0.100	<0.100	<0.100
SB10S-37	S-15866	LM1	0.11	2.00	11.90	0.28	<0.100	0.246	21.20	<0.100	<0.100	<0.100
SB10S-38	S-15867	LM1	<0.100	1.95	12.10	0.27	<0.100	0.247	21.30	<0.100	<0.100	<0.100
SB10S-39	S-15881	LM1	0.11	2.02	11.80	0.28	<0.100	0.290	21.80	<0.100	<0.100	<0.100
SB10S-40	S-15882	LM1	<0.100	1.47	12.40	0.20	<0.100	0.270	21.60	2.63	<0.100	<0.100
WCP Batch 1	Batch standard	LM1	0.84	1.36	6.79	0.56	<0.100	<0.0500	23.20	0.40	<0.100	<0.100
LRM	LRM	LM1	<0.100	<0.100	15.20	0.14	<0.100	0.102	24.80	<0.100	<0.100	0.70

Table A-9. LM Set 2 Elemental Concentration Measured by ICP-OES

Sample ID	Lab Id	Set	Al (wt.%)	B (wt.%)	Ba (wt.%)	Ca (wt.%)	Ce (wt.%)	Cr (wt.%)	Cu (wt.%)	Fe (wt.%)	Gd (wt.%)	K (wt.%)	La (wt.%)
WCP Batch 1	Batch standard	LM2	2.52	0.13	0.78	<0.100	<0.100	0.31	8.83	<0.100	2.73	<0.100	<0.100
LRM	LRM	LM2	5.11	<0.100	0.32	<0.100	0.13	<0.100	1.01	<0.100	1.17	<0.100	<0.100
SB10S-22	S-15803	LM2	3.49	<0.100	0.23	<0.100	<0.100	<0.100	3.75	<0.100	0.11	<0.100	<0.100
SB10S-23	S-15804	LM2	4.37	<0.100	0.28	<0.100	<0.100	<0.100	4.58	<0.100	0.15	<0.100	<0.100
SB10S-24	S-15805	LM2	3.77	<0.100	0.22	<0.100	<0.100	<0.100	3.67	<0.100	<0.100	<0.100	<0.100
SB10S-25	S-15806	LM2	4.47	<0.100	0.27	<0.100	<0.100	<0.100	4.63	<0.100	0.13	<0.100	<0.100
SB10S-26	S-15807	LM2	3.45	<0.100	0.24	<0.100	<0.100	<0.100	3.66	<0.100	0.10	<0.100	<0.100
SB10S-27	S-15808	LM2	4.43	<0.100	0.28	<0.100	<0.100	<0.100	4.56	<0.100	0.13	<0.100	<0.100
SB10S-28	S-15809	LM2	3.52	<0.100	0.23	<0.100	<0.100	<0.100	3.69	<0.100	0.10	<0.100	<0.100
SB10S-29	S-15810	LM2	4.38	<0.100	0.27	<0.100	<0.100	<0.100	4.59	<0.100	0.11	<0.100	<0.100
SB10S-30	S-15811	LM2	6.06	<0.100	0.36	<0.100	<0.100	<0.100	6.27	<0.100	<0.100	<0.100	<0.100
SB10S-31	S-15851	LM2	4.63	<0.100	0.29	<0.100	<0.100	<0.100	4.95	<0.100	<0.100	<0.100	<0.100
SB10S-32	S-15852	LM2	5.79	<0.100	0.36	<0.100	<0.100	<0.100	6.23	<0.100	<0.100	<0.100	<0.100
SB10S-33	S-15853	LM2	3.86	<0.100	0.23	<0.100	<0.100	<0.100	3.59	<0.100	<0.100	<0.100	<0.100
SB10S-34	S-15854	LM2	4.77	<0.100	0.29	<0.100	<0.100	<0.100	4.66	<0.100	0.12	<0.100	<0.100
SB10S-36	S-15856	LM2	6.10	<0.100	0.36	<0.100	<0.100	<0.100	6.18	<0.100	<0.100	<0.100	<0.100
SB10S-37	S-15866	LM2	6.03	<0.100	0.37	<0.100	0.41	<0.100	6.30	<0.100	<0.100	<0.100	<0.100
SB10S-38	S-15867	LM2	6.51	<0.100	0.36	<0.100	<0.100	<0.100	6.28	<0.100	<0.100	<0.100	<0.100
SB10S-39	S-15881	LM2	5.91	<0.100	0.37	<0.100	<0.100	<0.100	6.32	<0.100	<0.100	<0.100	<0.100
SB10S-40	S-15882	LM2	4.58	<0.100	0.28	<0.100	<0.100	<0.100	4.62	<0.100	0.12	<0.100	<0.100
WCP Batch 1	Batch standard	LM2	2.57	0.13	0.78	<0.100	<0.100	0.31	8.67	<0.100	2.66	<0.100	<0.100
LRM	LRM	LM2	5.20	<0.100	0.33	<0.100	0.13	<0.100	1.00	<0.100	1.17	<0.100	<0.100

Table A-9. LM Set 2 Elemental Concentration Measured by ICP-OES

Sample ID	Lab Id	Set	Mg (wt.%)	Mn (wt.%)	Na (wt.%)	Ni (wt.%)	Pb (wt.%)	S (wt.%)	Si (wt.%)	Ti (wt.%)	Zn (wt.%)	Zr (wt.%)
WCP Batch 1	Batch standard	LM2	0.81	1.32	6.71	0.55	<0.100	<0.0500	23.50	0.39	<0.100	<0.100
LRM	LRM	LM2	<0.100	<0.100	15.10	0.14	<0.100	0.0844	25.00	<0.100	<0.100	0.67
SB10S-22	S-15803	LM2	<0.100	1.16	10.60	0.15	<0.100	0.221	24.80	2.09	<0.100	<0.100
SB10S-23	S-15804	LM2	<0.100	1.41	12.40	0.20	<0.100	0.210	21.80	2.59	<0.100	<0.100
SB10S-24	S-15805	LM2	<0.100	1.16	10.90	0.15	<0.100	0.211	24.20	2.07	<0.100	<0.100
SB10S-25	S-15806	LM2	<0.100	1.43	12.50	0.20	<0.100	0.231	21.70	2.60	<0.100	<0.100
SB10S-26	S-15807	LM2	<0.100	1.15	10.60	0.16	<0.100	0.220	24.30	2.06	<0.100	<0.100
SB10S-27	S-15808	LM2	<0.100	1.40	12.20	0.19	<0.100	0.243	21.50	2.56	<0.100	<0.100
SB10S-28	S-15809	LM2	<0.100	1.10	10.60	0.16	<0.100	0.249	24.70	2.07	<0.100	<0.100
SB10S-29	S-15810	LM2	<0.100	1.39	12.40	0.19	<0.100	0.236	21.50	2.62	<0.100	<0.100
SB10S-30	S-15811	LM2	<0.100	1.91	12.30	0.26	<0.100	0.200	22.10	<0.100	<0.100	<0.100
SB10S-31	S-15851	LM2	<0.100	1.50	10.30	0.21	<0.100	0.242	25.10	<0.100	<0.100	<0.100
SB10S-32	S-15852	LM2	<0.100	1.96	11.60	0.27	<0.100	0.263	22.20	<0.100	<0.100	<0.100
SB10S-33	S-15853	LM2	<0.100	1.09	11.10	0.15	<0.100	0.265	24.20	2.04	<0.100	<0.100
SB10S-34	S-15854	LM2	<0.100	1.41	12.90	0.20	<0.100	0.264	21.70	2.64	<0.100	<0.100
SB10S-36	S-15856	LM2	<0.100	1.92	12.00	0.26	<0.100	0.243	21.50	<0.100	<0.100	<0.100
SB10S-37	S-15866	LM2	0.11	1.93	12.20	0.27	<0.100	0.237	21.20	<0.100	<0.100	<0.100
SB10S-38	S-15867	LM2	<0.100	1.92	12.50	0.26	<0.100	0.225	22.00	<0.100	<0.100	<0.100
SB10S-39	S-15881	LM2	0.10	1.97	12.00	0.27	<0.100	0.267	22.10	<0.100	<0.100	<0.100
SB10S-40	S-15882	LM2	<0.100	1.43	12.40	0.20	<0.100	0.262	22.10	2.63	<0.100	<0.100
WCP Batch 1	Batch standard	LM2	0.81	1.29	6.51	0.54	<0.100	<0.0500	23.40	0.39	<0.100	<0.100
LRM	LRM	LM2	<0.100	<0.100	15.20	0.13	<0.100	0.0875	25.10	<0.100	<0.100	0.68

Table A-10. LM Set 3 Elemental Concentration Measured by ICP-OES

Sample ID	Lab ID	Set	Al (wt.%)	Ba (wt.%)	Ca (wt.%)	Ce (wt.%)	Cr (wt.%)	Cu (wt.%)	Fe (wt.%)	Gd (wt.%)	K (wt.%)	La (wt.%%)
WCP Batch 1	Batch standard	LM3	2.41	0.124	0.791	<0.100	<0.100	0.285	8.61	<0.100	2.66	<0.100
LRM	LRM	LM3	4.56	<0.100	0.325	<0.100	0.121	<0.100	0.936	<0.100	1.13	<0.100
SB10S-35	S-16208	LM3	4.62	<0.100	0.298	<0.100	<0.100	<0.100	4.98	<0.100	<0.100	<0.100
SB10S-35	S-16208	LM3	5.23	<0.100	0.326	<0.100	<0.100	<0.100	5.36	<0.100	<0.100	<0.100
SB10S-41	S-16221	LM3	4.87	<0.100	0.305	<0.100	<0.100	<0.100	5.26	<0.100	<0.100	<0.100
SB10S-41	S-16221	LM3	5.30	<0.100	0.331	<0.100	<0.100	<0.100	5.49	<0.100	<0.100	<0.100
SB10S-42	S-16222	LM3	4.65	<0.100	0.298	<0.100	<0.100	<0.100	4.92	<0.100	<0.100	<0.100
SB10S-42	S-16222	LM3	5.47	<0.100	0.321	<0.100	<0.100	<0.100	5.53	<0.100	<0.100	<0.100
WCP Batch 1	Batch standard	LM3	2.47	0.130	0.829	<0.100	<0.100	0.306	8.58	<0.100	2.68	<0.100
LRM	LRM	LM3	5.11	<0.100	0.347	<0.100	0.129	<0.100	0.950	<0.100	1.17	<0.100

Table A-10. LM Set 3 Elemental Concentration Measured by ICP-OES (continued)

Sample ID	Lab ID	Set	Mg (wt.%)	Mn (wt.%)	Na (wt.%)	Ni (wt.%)	Pb (wt.%)	S (wt.%)	Si (wt.%)	Ti (wt.%)	Zn (wt.%)	Zr (wt.%)
WCP Batch 1	Batch standard	LM3	0.731	1.27	6.70	0.520	<0.100	<0.0500	22.8	0.365	<0.100	<0.100
LRM	LRM	LM3	0.0588	0.0557	14.4	0.133	<0.100	0.0902	23.4	<0.100	<0.100	0.603
SB10S-35	S-16208	LM3	0.0933	1.57	10.2	0.212	<0.100	0.226	23.7	<0.100	<0.100	<0.100
SB10S-35	S-16208	LM3	0.104	1.74	11	0.225	<0.100	0.246	25.3	<0.100	<0.100	<0.100
SB10S-41	S-16221	LM3	0.0784	1.62	10.6	0.213	<0.100	0.222	23.6	<0.100	<0.100	<0.100
SB10S-41	S-16221	LM3	0.0888	1.73	11.4	0.223	<0.100	0.235	26.3	<0.100	<0.100	<0.100
SB10S-42	S-16222	LM3	0.0784	1.49	9.99	0.212	<0.100	0.204	27.3	<0.100	<0.100	<0.100
SB10S-42	S-16222	LM3	0.0880	1.72	11.2	0.223	<0.100	0.209	27.4	<0.100	<0.100	<0.100
WCP Batch 1	Batch standard	LM3	0.812	1.31	6.25	0.541	<0.100	<0.0500	22.8	0.387	<0.100	<0.100
LRM	LRM	LM3	0.0655	0.0592	15.1	0.138	<0.100	0.0849	24.9	<0.100	<0.100	0.640

Table A-11. ICP-MS Data

Sample ID	Lab ID	Cs (µg/L)	PSAL Preparation*		Cs (wt.%)
			Dilution (mL)	Sample Weight (g)	
SB10S-22	LW29367	2662	250	0.1458	0.456
SB10S-23	LW29368	3440	250	0.1507	0.571
SB10S-24	LW29369	2925	250	0.1567	0.467
SB10S-25	LW29370	3248	250	0.1458	0.557
SB10S-26	LW29371	3033	250	0.1597	0.475
SB10S-27	LW29372	3620	250	0.1480	0.611
SB10S-28	LW29373	2664	250	0.1513	0.440
SB10S-29	LW29374	3835	250	0.1492	0.643
SB10S-33	LW29375	2828	250	0.1570	0.450
SB10S-34	LW29376	3674	250	0.1547	0.594
SB10S-40	LW29377	3411	250	0.1425	0.598

*Since the PSAL PF dissolutions were submitted to the Analytical Characterization and Sample Management group, the PSAL dilution and weight data are also presented to convert the Cs concentration from µg/L measured by ICP-MS to wt.%.

Table A-12. Comparison of Target and Mean Measured Compositions[a]

Sample ID	Oxide	Target (wt.%)	Mean Measured (wt.%)	Difference (wt.%)	% Error
WCP Batch 1	Al_2O_3	4.88	4.86	0.0	-0.4
WCP Batch 1	B_2O_3	7.78	7.62	-0.2	-2.1
WCP Batch 1	BaO	0.15	0.15	0.0	
WCP Batch 1	CaO	1.22	1.22	0.0	0.4
WCP Batch 1	Cr_2O_3	0.11	0.15	0.0	
WCP Batch 1	CuO	0.20	0.39	0.2	
WCP Batch 1	Fe_2O_3	12.84	12.83	0.0	-0.1
WCP Batch 1	K_2O	3.33	3.29	0.0	-1.1
WCP Batch 1	Li_2O	4.43	4.38	-0.1	-1.2
WCP Batch 1	MgO	1.42	1.33	-0.1	-6.2
WCP Batch 1	MnO	1.72	1.74	0.0	1.2
WCP Batch 1	Na_2O	9.00	8.96	0.0	-0.5
WCP Batch 1	NiO	0.75	0.69	-0.1	-8.0
WCP Batch 1	SiO_2	50.20	49.69	-0.5	-1.0
WCP Batch 1	TiO_2	0.68	0.65	0.0	-4.5
WCP Batch 1	ZrO_2	0.10	0.14	0.0	
WCP Batch 1	**Sum**	98.81	98.80	0.0	0.0
LRM	Al_2O_3	9.51	9.87	0.4	3.8
LRM	B_2O_3	7.85	7.68	-0.2	-2.2
LRM	BaO	0.00	0.11	0.1	
LRM	CaO	0.54	0.46	-0.1	-15.2
LRM	Cr_2O_3	0.19	0.18	0.0	
LRM	Fe_2O_3	1.38	1.46	0.1	5.6
LRM	K_2O	1.48	1.45	0.0	-2.3
LRM	La_2O_3	0.02	0.12	0.1	
LRM	Li_2O	0.11	0.22	0.1	
LRM	MgO	0.10	0.14	0.0	
LRM	MnO	0.08	0.11	0.0	
LRM	Na_2O	20.03	20.35	0.3	1.6
LRM	NiO	0.19	0.17	0.0	
LRM	PbO	0.10	0.11	0.0	
LRM	SiO_2	54.20	53.05	-1.1	-2.1
LRM	SO_4^{2-}	0.36	0.28	-0.1	
LRM	TiO_2	0.10	0.17	0.1	
LRM	ZrO_2	0.93	0.90	0.0	-3.7
LRM	**Sum**	97.17	97.30	0.1	0.1
SB10S-22	Al_2O_3	7.33	6.65	-0.7	-9.3
SB10S-22	B_2O_3	5.68	5.43	-0.3	-4.5
SB10S-22	BaO	0.02	0.11	0.1	
SB10S-22	CaO	0.33	0.32	0.0	
SB10S-22	Ce_2O_3	0.06	0.12	0.1	

[a] Differences were calculated using more decimal places than shown in this table, which may result in slight variation due to rounding. For the major oxides with targeted or mean measured concentrations of ≥ 0.5 wt.%, the wt.% difference is shaded if the value is ≥ 0.5 wt.% and the percent error is shaded if the value is ≥ 5%.

Table A-12. Comparison of Target and Mean Measured Compositions (continued)

Sample ID	Oxide	Target (wt.%)	Average Measured (wt.%)	Difference (wt.%)	% Error
SB10S-22	Cr_2O_3	0.06	0.15	0.1	
SB10S-22	Cs_2O	0.56	0.48	-0.1	-13.7
SB10S-22	CuO	0.02	0.13	0.1	
SB10S-22	Fe_2O_3	5.47	5.52	0.0	0.8
SB10S-22	Gd_2O_3	0.02	0.12	0.1	
SB10S-22	K_2O	0.12	0.13	0.0	
SB10S-22	La_2O_3	0.02	0.12	0.1	
SB10S-22	Li_2O	5.46	5.23	-0.2	-4.2
SB10S-22	MgO	0.12	0.17	0.0	
SB10S-22	MnO	1.54	1.56	0.0	1.0
SB10S-22	Na_2O	14.53	14.42	-0.1	-0.7
SB10S-22	NiO	0.22	0.20	0.0	
SB10S-22	PbO	0.01	0.11	0.1	
SB10S-22	SiO_2	54.22	51.66	-2.6	-4.7
SB10S-22	SO_4^{2-}	0.65	0.67	0.0	3.5
SB10S-22	TiO_2	3.53	3.52	0.0	-0.3
SB10S-22	ZnO	0.01	0.12	0.1	
SB10S-22	ZrO_2	0.02	0.14	0.1	
SB10S-22	**Sum**	100.00	97.06	-2.9	-2.9
SB10S-23	Al_2O_3	9.20	8.47	-0.7	-7.9
SB10S-23	B_2O_3	5.10	4.83	-0.3	-5.3
SB10S-23	BaO	0.03	0.11	0.1	
SB10S-23	CaO	0.42	0.40	0.0	
SB10S-23	Ce_2O_3	0.07	0.12	0.0	
SB10S-23	Cr_2O_3	0.07	0.15	0.1	
SB10S-23	Cs_2O	0.70	0.61	-0.1	-13.5
SB10S-23	CuO	0.02	0.13	0.1	
SB10S-23	Fe_2O_3	6.87	6.86	0.0	-0.1
SB10S-23	Gd_2O_3	0.03	0.12	0.1	
SB10S-23	K_2O	0.15	0.19	0.0	
SB10S-23	La_2O_3	0.02	0.12	0.1	
SB10S-23	Li_2O	4.83	4.68	-0.1	-3.1
SB10S-23	MgO	0.15	0.17	0.0	
SB10S-23	MnO	1.93	1.93	0.0	-0.1
SB10S-23	Na_2O	16.97	16.98	0.0	0.1
SB10S-23	NiO	0.28	0.27	0.0	
SB10S-23	PbO	0.02	0.11	0.1	
SB10S-23	SiO_2	48.02	47.17	-0.8	-1.8
SB10S-23	SO_4^{2-}	0.65	0.64	0.0	-1.4
SB10S-23	TiO_2	4.43	4.43	0.0	-0.1
SB10S-23	ZnO	0.01	0.12	0.1	
SB10S-23	ZrO_2	0.03	0.14	0.1	
SB10S-23	**Sum**	100.00	98.72	-1.3	-1.3
SB10S-24	Al_2O_3	7.32	7.37	0.1	0.7

Table A-12. Comparison of Target and Mean Measured Compositions (continued)

Sample ID	Oxide	Target (wt.%)	Average Measured (wt.%)	Difference (wt.%)	% Error
SB10S-24	B_2O_3	5.68	5.62	-0.1	-1.1
SB10S-24	BaO	0.02	0.11	0.1	
SB10S-24	CaO	0.33	0.33	0.0	
SB10S-24	Ce_2O_3	0.06	0.12	0.1	
SB10S-24	Cr_2O_3	0.06	0.15	0.1	
SB10S-24	Cs_2O	0.55	0.50	-0.1	-10.0
SB10S-24	CuO	0.02	0.13	0.1	
SB10S-24	Fe_2O_3	5.47	5.50	0.0	0.6
SB10S-24	Gd_2O_3	0.02	0.12	0.1	
SB10S-24	K_2O	0.12	0.12	0.0	
SB10S-24	La_2O_3	0.02	0.12	0.1	
SB10S-24	Li_2O	5.46	5.40	-0.1	-1.0
SB10S-24	MgO	0.12	0.17	0.0	
SB10S-24	MnO	1.54	1.59	0.0	3.1
SB10S-24	Na_2O	14.51	14.83	0.3	2.2
SB10S-24	NiO	0.22	0.20	0.0	
SB10S-24	PbO	0.01	0.11	0.1	
SB10S-24	SiO_2	54.22	52.57	-1.6	-3.0
SB10S-24	SO_4^{2-}	0.70	0.66	0.0	-5.6
SB10S-24	TiO_2	3.52	3.53	0.0	0.3
SB10S-24	ZnO	0.01	0.12	0.1	
SB10S-24	ZrO_2	0.02	0.14	0.1	
SB10S-24	**Sum**	100.00	99.48	-0.5	-0.5
SB10S-25	Al_2O_3	9.19	8.67	-0.5	-5.7
SB10S-25	B_2O_3	5.10	4.94	-0.2	-3.1
SB10S-25	BaO	0.03	0.11	0.1	
SB10S-25	CaO	0.41	0.40	0.0	
SB10S-25	Ce_2O_3	0.07	0.12	0.0	
SB10S-25	Cr_2O_3	0.07	0.15	0.1	
SB10S-25	Cs_2O	0.70	0.59	-0.1	-15.6
SB10S-25	CuO	0.02	0.13	0.1	
SB10S-25	Fe_2O_3	6.86	6.92	0.1	0.9
SB10S-25	Gd_2O_3	0.03	0.12	0.1	
SB10S-25	K_2O	0.15	0.17	0.0	
SB10S-25	La_2O_3	0.02	0.12	0.1	
SB10S-25	Li_2O	4.83	4.64	-0.2	-4.0
SB10S-25	MgO	0.15	0.17	0.0	
SB10S-25	MnO	1.93	1.95	0.0	1.0
SB10S-25	Na_2O	16.95	16.92	0.0	-0.2
SB10S-25	NiO	0.28	0.26	0.0	
SB10S-25	PbO	0.02	0.11	0.1	
SB10S-25	SiO_2	48.02	47.12	-0.9	-1.9
SB10S-25	SO_4^{2-}	0.70	0.72	0.0	3.1
SB10S-25	TiO_2	4.43	4.41	0.0	-0.5

Table A-12. Comparison of Target and Mean Measured Compositions (continued)

Sample ID	Oxide	Target (wt.%)	Average Measured (wt.%)	Difference (wt.%)	% Error
SB10S-25	ZnO	0.01	0.12	0.1	
SB10S-25	ZrO_2	0.03	0.14	0.1	
SB10S-25	**Sum**	100.00	98.96	-1.0	-1.0
SB10S-26	Al_2O_3	7.31	6.78	-0.5	-7.3
SB10S-26	B_2O_3	5.68	5.54	-0.1	-2.5
SB10S-26	BaO	0.02	0.11	0.1	
SB10S-26	CaO	0.33	0.34	0.0	
SB10S-26	Ce_2O_3	0.06	0.12	0.1	
SB10S-26	Cr_2O_3	0.06	0.15	0.1	
SB10S-26	Cs_2O	0.55	0.50	0.0	-8.4
SB10S-26	CuO	0.02	0.13	0.1	
SB10S-26	Fe_2O_3	5.46	5.48	0.0	0.4
SB10S-26	Gd_2O_3	0.02	0.12	0.1	
SB10S-26	K_2O	0.12	0.13	0.0	
SB10S-26	La_2O_3	0.02	0.12	0.1	
SB10S-26	Li_2O	5.46	5.25	-0.2	-3.8
SB10S-26	MgO	0.12	0.17	0.0	
SB10S-26	MnO	1.54	1.57	0.0	1.7
SB10S-26	Na_2O	14.50	14.42	-0.1	-0.5
SB10S-26	NiO	0.22	0.21	0.0	
SB10S-26	PbO	0.01	0.11	0.1	
SB10S-26	SiO_2	54.22	52.57	-1.6	-3.0
SB10S-26	SO_4^{2-}	0.75	0.70	0.0	-6.5
SB10S-26	TiO_2	3.52	3.52	0.0	0.1
SB10S-26	ZnO	0.01	0.12	0.1	
SB10S-26	ZrO_2	0.02	0.14	0.1	
SB10S-26	**Sum**	100.02	98.29	-1.7	-1.7
SB10S-27	Al_2O_3	9.18	8.78	-0.4	-4.3
SB10S-27	B_2O_3	5.10	4.96	-0.1	-2.8
SB10S-27	BaO	0.03	0.11	0.1	
SB10S-27	CaO	0.41	0.40	0.0	
SB10S-27	Ce_2O_3	0.07	0.12	0.0	
SB10S-27	Cr_2O_3	0.07	0.15	0.1	
SB10S-27	Cs_2O	0.70	0.65	-0.1	-7.5
SB10S-27	CuO	0.02	0.13	0.1	
SB10S-27	Fe_2O_3	6.85	6.88	0.0	0.4
SB10S-27	Gd_2O_3	0.03	0.12	0.1	
SB10S-27	K_2O	0.15	0.16	0.0	
SB10S-27	La_2O_3	0.02	0.12	0.1	
SB10S-27	Li_2O	4.83	4.60	-0.2	-4.9
SB10S-27	MgO	0.15	0.17	0.0	
SB10S-27	MnO	1.93	1.92	0.0	-0.3
SB10S-27	Na_2O	16.94	16.51	-0.4	-2.5
SB10S-27	NiO	0.28	0.25	0.0	

Table A-12. Comparison of Target and Mean Measured Compositions (continued)

Sample ID	Oxide	Target (wt.%)	Average Measured (wt.%)	Difference (wt.%)	% Error
SB10S-27	PbO	0.02	0.11	0.1	
SB10S-27	SiO_2	48.02	46.85	-1.2	-2.4
SB10S-27	SO_4^{2-}	0.75	0.75	0.0	-0.5
SB10S-27	TiO_2	4.42	4.40	0.0	-0.5
SB10S-27	ZnO	0.01	0.12	0.1	
SB10S-27	ZrO_2	0.03	0.14	0.1	
SB10S-27	**Sum**	100.01	98.37	-1.6	-1.6
SB10S-28	Al_2O_3	7.29	6.83	-0.5	-6.3
SB10S-28	B_2O_3	5.68	5.22	-0.5	-8.2
SB10S-28	BaO	0.02	0.11	0.1	
SB10S-28	CaO	0.33	0.33	0.0	
SB10S-28	Ce_2O_3	0.06	0.12	0.1	
SB10S-28	Cr_2O_3	0.06	0.15	0.1	
SB10S-28	Cs_2O	0.55	0.47	-0.1	-15.2
SB10S-28	CuO	0.02	0.13	0.1	
SB10S-28	Fe_2O_3	5.45	5.51	0.1	1.1
SB10S-28	Gd_2O_3	0.02	0.12	0.1	
SB10S-28	K_2O	0.12	0.13	0.0	
SB10S-28	La_2O_3	0.02	0.12	0.1	
SB10S-28	Li_2O	5.46	5.19	-0.3	-5.0
SB10S-28	MgO	0.12	0.17	0.0	
SB10S-28	MnO	1.53	1.49	0.0	-2.3
SB10S-28	Na_2O	14.48	14.42	-0.1	-0.4
SB10S-28	NiO	0.22	0.21	0.0	
SB10S-28	PbO	0.01	0.11	0.1	
SB10S-28	SiO_2	54.21	52.57	-1.6	-3.0
SB10S-28	SO_4^{2-}	0.80	0.77	0.0	-3.6
SB10S-28	TiO_2	3.51	3.52	0.0	0.4
SB10S-28	ZnO	0.01	0.12	0.1	
SB10S-28	ZrO_2	0.02	0.14	0.1	
SB10S-28	**Sum**	99.99	97.93	-2.1	-2.1
SB10S-29	Al_2O_3	9.17	8.53	-0.6	-7.0
SB10S-29	B_2O_3	5.10	4.94	-0.2	-3.1
SB10S-29	BaO	0.03	0.11	0.1	
SB10S-29	CaO	0.41	0.39	0.0	
SB10S-29	Ce_2O_3	0.07	0.12	0.0	
SB10S-29	Cr_2O_3	0.07	0.15	0.1	
SB10S-29	Cs_2O	0.69	0.68	0.0	-1.2
SB10S-29	CuO	0.02	0.13	0.1	
SB10S-29	Fe_2O_3	6.84	6.89	0.1	0.8
SB10S-29	Gd_2O_3	0.03	0.12	0.1	
SB10S-29	K_2O	0.15	0.13	0.0	
SB10S-29	La_2O_3	0.02	0.12	0.1	
SB10S-29	Li_2O	4.83	4.60	-0.2	-4.9

Table A-12. Comparison of Target and Mean Measured Compositions (continued)

Sample ID	Oxide	Target (wt.%)	Average Measured (wt.%)	Difference (wt.%)	% Error
SB10S-29	MgO	0.15	0.17	0.0	
SB10S-29	MnO	1.93	1.91	0.0	-1.2
SB10S-29	Na_2O	16.92	16.85	-0.1	-0.4
SB10S-29	NiO	0.28	0.24	0.0	
SB10S-29	PbO	0.02	0.11	0.1	
SB10S-29	SiO_2	48.02	46.96	-1.1	-2.2
SB10S-29	SO_4^{2-}	0.80	0.74	-0.1	-7.7
SB10S-29	TiO_2	4.41	4.44	0.0	0.7
SB10S-29	ZnO	0.01	0.12	0.1	
SB10S-29	ZrO_2	0.03	0.14	0.1	
SB10S-29	**Sum**	100.00	98.58	-1.4	-1.4
SB10S-30	Al_2O_3	12.52	11.74	-0.8	-6.2
SB10S-30	B_2O_3	4.82	4.80	0.0	-0.5
SB10S-30	BaO	0.04	0.11	0.1	
SB10S-30	CaO	0.56	0.52	0.0	-6.7
SB10S-30	Ce_2O_3	0.10	0.12	0.0	
SB10S-30	Cr_2O_3	0.10	0.15	0.0	
SB10S-30	CuO	0.03	0.13	0.1	
SB10S-30	Fe_2O_3	9.34	9.40	0.1	0.6
SB10S-30	Gd_2O_3	0.04	0.12	0.1	
SB10S-30	K_2O	0.07	0.12	0.1	
SB10S-30	La_2O_3	0.03	0.12	0.1	
SB10S-30	Li_2O	4.24	4.08	-0.2	-3.8
SB10S-30	MgO	0.21	0.17	0.0	
SB10S-30	MnO	2.63	2.60	0.0	-1.0
SB10S-30	Na_2O	16.51	16.38	-0.1	-0.8
SB10S-30	NiO	0.38	0.35	0.0	
SB10S-30	PbO	0.02	0.11	0.1	
SB10S-30	SiO_2	47.65	47.65	0.0	0.0
SB10S-30	SO_4^{2-}	0.65	0.64	0.0	-1.1
SB10S-30	TiO_2	0.02	0.17	0.1	
SB10S-30	ZnO	0.02	0.12	0.1	
SB10S-30	ZrO_2	0.04	0.14	0.1	
SB10S-30	**Sum**	100.02	99.71	-0.3	-0.3
SB10S-31	Al_2O_3	9.45	9.02	-0.4	-4.6
SB10S-31	B_2O_3	5.46	5.51	0.0	0.8
SB10S-31	BaO	0.03	0.11	0.1	
SB10S-31	CaO	0.45	0.43	0.0	
SB10S-31	Ce_2O_3	0.08	0.12	0.0	
SB10S-31	Cr_2O_3	0.08	0.15	0.1	
SB10S-31	CuO	0.02	0.13	0.1	
SB10S-31	Fe_2O_3	7.41	7.45	0.0	0.5
SB10S-31	Gd_2O_3	0.03	0.12	0.1	
SB10S-31	K_2O	0.06	0.12	0.1	

Table A-12. Comparison of Target and Mean Measured Compositions (continued)

Sample ID	Oxide	Target (wt.%)	Average Measured (wt.%)	Difference (wt.%)	% Error
SB10S-31	La_2O_3	0.02	0.12	0.1	
SB10S-31	Li_2O	5.47	5.35	-0.1	-2.2
SB10S-31	MgO	0.16	0.17	0.0	
SB10S-31	MnO	2.09	2.05	0.0	-1.8
SB10S-31	Na_2O	13.63	13.63	0.0	0.0
SB10S-31	NiO	0.30	0.28	0.0	
SB10S-31	PbO	0.02	0.11	0.1	
SB10S-31	SiO_2	54.39	53.70	-0.7	-1.3
SB10S-31	SO_4^{2-}	0.80	0.74	-0.1	-7.1
SB10S-31	TiO_2	0.01	0.17	0.2	
SB10S-31	ZnO	0.01	0.12	0.1	
SB10S-31	ZrO_2	0.03	0.14	0.1	
SB10S-31	**Sum**	100.00	99.70	-0.3	-0.3
SB10S-32	Al_2O_3	11.87	11.37	-0.5	-4.3
SB10S-32	B_2O_3	4.82	4.75	-0.1	-1.5
SB10S-32	BaO	0.04	0.11	0.1	
SB10S-32	CaO	0.56	0.52	0.0	-6.8
SB10S-32	Ce_2O_3	0.10	0.12	0.0	
SB10S-32	Cr_2O_3	0.10	0.15	0.0	
SB10S-32	CuO	0.03	0.13	0.1	
SB10S-32	Fe_2O_3	9.31	9.43	0.1	1.3
SB10S-32	Gd_2O_3	0.04	0.12	0.1	
SB10S-32	K_2O	0.07	0.12	0.1	
SB10S-32	La_2O_3	0.03	0.12	0.1	
SB10S-32	Li_2O	4.84	4.85	0.0	0.3
SB10S-32	MgO	0.21	0.17	0.0	
SB10S-32	MnO	2.62	2.70	0.1	3.1
SB10S-32	Na_2O	15.86	15.43	-0.4	-2.7
SB10S-32	NiO	0.38	0.35	0.0	
SB10S-32	PbO	0.02	0.11	0.1	
SB10S-32	SiO_2	48.25	48.19	-0.1	-0.1
SB10S-32	SO_4^{2-}	0.80	0.82	0.0	2.2
SB10S-32	TiO_2	0.02	0.17	0.1	
SB10S-32	ZnO	0.02	0.12	0.1	
SB10S-32	ZrO_2	0.04	0.14	0.1	
SB10S-32	**Sum**	100.03	99.97	-0.1	-0.1
SB10S-33	Al_2O_3	7.97	7.55	-0.4	-5.3
SB10S-33	B_2O_3	5.68	5.47	-0.2	-3.6
SB10S-33	BaO	0.02	0.11	0.1	
SB10S-33	CaO	0.33	0.32	0.0	
SB10S-33	Ce_2O_3	0.06	0.12	0.1	
SB10S-33	Cr_2O_3	0.06	0.15	0.1	
SB10S-33	Cs_2O	0.55	0.48	-0.1	-13.3
SB10S-33	CuO	0.02	0.13	0.1	

Table A-12. Comparison of Target and Mean Measured Compositions (continued)

Sample ID	Oxide	Target (wt.%)	Average Measured (wt.%)	Difference (wt.%)	% Error
SB10S-33	Fe_2O_3	5.45	5.43	0.0	-0.4
SB10S-33	Gd_2O_3	0.02	0.12	0.1	
SB10S-33	K_2O	0.12	0.12	0.0	
SB10S-33	La_2O_3	0.02	0.12	0.1	
SB10S-33	Li_2O	4.78	4.62	-0.2	-3.4
SB10S-33	MgO	0.12	0.17	0.0	
SB10S-33	MnO	1.53	1.51	0.0	-1.5
SB10S-33	Na_2O	15.16	14.90	-0.3	-1.7
SB10S-33	NiO	0.22	0.20	0.0	
SB10S-33	PbO	0.01	0.11	0.1	
SB10S-33	SiO_2	53.53	52.31	-1.2	-2.3
SB10S-33	SO_4^{2-}	0.80	0.81	0.0	1.1
SB10S-33	TiO_2	3.51	3.51	0.0	-0.1
SB10S-33	ZnO	0.01	0.12	0.1	
SB10S-33	ZrO_2	0.02	0.14	0.1	
SB10S-33	**Sum**	99.99	98.48	-1.5	-1.5
SB10S-34	Al_2O_3	9.77	9.33	-0.4	-4.5
SB10S-34	B_2O_3	5.10	4.99	-0.1	-2.1
SB10S-34	BaO	0.03	0.11	0.1	
SB10S-34	CaO	0.41	0.41	0.0	
SB10S-34	Ce_2O_3	0.07	0.12	0.0	
SB10S-34	Cr_2O_3	0.07	0.15	0.1	
SB10S-34	Cs_2O	0.69	0.63	-0.1	-8.7
SB10S-34	CuO	0.02	0.13	0.1	
SB10S-34	Fe_2O_3	6.84	7.00	0.2	2.3
SB10S-34	Gd_2O_3	0.03	0.12	0.1	
SB10S-34	K_2O	0.15	0.15	0.0	
SB10S-34	La_2O_3	0.02	0.12	0.1	
SB10S-34	Li_2O	4.23	4.05	-0.2	-4.3
SB10S-34	MgO	0.15	0.17	0.0	
SB10S-34	MnO	1.93	1.93	0.0	0.0
SB10S-34	Na_2O	17.52	17.39	-0.1	-0.7
SB10S-34	NiO	0.28	0.26	0.0	
SB10S-34	PbO	0.02	0.11	0.1	
SB10S-34	SiO_2	47.42	46.80	-0.6	-1.3
SB10S-34	SO_4^{2-}	0.80	0.78	0.0	-2.3
SB10S-34	TiO_2	4.41	4.51	0.1	2.2
SB10S-34	ZnO	0.01	0.12	0.1	
SB10S-34	ZrO_2	0.03	0.14	0.1	
SB10S-34	**Sum**	100.00	99.48	-0.5	-0.5
SB10S-35	Al_2O_3	10.13	9.46	-0.7	-6.6
SB10S-35	B_2O_3	5.46	5.18	-0.3	-5.1
SB10S-35	BaO	0.03	0.11	0.1	
SB10S-35	CaO	0.45	0.44	0.0	

Table A-12. Comparison of Target and Mean Measured Compositions (continued)

Sample ID	Oxide	Target (wt.%)	Average Measured (wt.%)	Difference (wt.%)	% Error
SB10S-35	Ce_2O_3	0.08	0.12	0.0	
SB10S-35	Cr_2O_3	0.08	0.15	0.1	
SB10S-35	CuO	0.02	0.13	0.1	
SB10S-35	Fe_2O_3	7.41	7.32	-0.1	-1.2
SB10S-35	Gd_2O_3	0.03	0.12	0.1	
SB10S-35	K_2O	0.06	0.12	0.1	
SB10S-35	La_2O_3	0.02	0.12	0.1	
SB10S-35	Li_2O	4.79	4.53	-0.3	-5.4
SB10S-35	MgO	0.16	0.16	0.0	
SB10S-35	MnO	2.09	2.10	0.0	0.7
SB10S-35	Na_2O	14.31	14.29	0.0	-0.1
SB10S-35	NiO	0.30	0.28	0.0	
SB10S-35	PbO	0.02	0.11	0.1	
SB10S-35	SiO_2	53.71	51.98	-1.7	-3.2
SB10S-35	SO_4^{2-}	0.80	0.71	-0.1	-11.6
SB10S-35	TiO_2	0.01	0.17	0.2	
SB10S-35	ZnO	0.01	0.12	0.1	
SB10S-35	ZrO_2	0.03	0.14	0.1	
SB10S-35	**Sum**	100.00	97.85	-2.1	-2.1
SB10S-36	Al_2O_3	12.47	12.14	-0.3	-2.6
SB10S-36	B_2O_3	4.82	4.88	0.1	1.2
SB10S-36	BaO	0.04	0.11	0.1	
SB10S-36	CaO	0.56	0.50	-0.1	-10.2
SB10S-36	Ce_2O_3	0.10	0.12	0.0	
SB10S-36	Cr_2O_3	0.10	0.15	0.0	
SB10S-36	CuO	0.03	0.13	0.1	
SB10S-36	Fe_2O_3	9.31	9.47	0.2	1.7
SB10S-36	Gd_2O_3	0.04	0.12	0.1	
SB10S-36	K_2O	0.07	0.12	0.1	
SB10S-36	La_2O_3	0.03	0.12	0.1	
SB10S-36	Li_2O	4.24	4.24	0.0	0.0
SB10S-36	MgO	0.21	0.17	0.0	
SB10S-36	MnO	2.62	2.68	0.1	2.4
SB10S-36	Na_2O	16.46	16.11	-0.4	-2.1
SB10S-36	NiO	0.38	0.34	0.0	
SB10S-36	PbO	0.02	0.11	0.1	
SB10S-36	SiO_2	47.65	47.81	0.2	0.3
SB10S-36	SO_4^{2-}	0.80	0.75	-0.1	-6.4
SB10S-36	TiO_2	0.02	0.17	0.1	
SB10S-36	ZnO	0.02	0.12	0.1	
SB10S-36	ZrO_2	0.04	0.14	0.1	
SB10S-36	**Sum**	100.03	100.49	0.5	0.5
SB10S-37	Al_2O_3	12.50	11.86	-0.6	-5.1
SB10S-37	B_2O_3	4.82	4.83	0.0	0.2

Table A-12. Comparison of Target and Mean Measured Compositions (continued)

Sample ID	Oxide	Target (wt.%)	Average Measured (wt.%)	Difference (wt.%)	% Error
SB10S-37	BaO	0.04	0.11	0.1	
SB10S-37	CaO	0.56	0.52	0.0	-7.4
SB10S-37	Ce_2O_3	0.10	0.12	0.0	
SB10S-37	Cr_2O_3	0.10	0.37	0.3	
SB10S-37	CuO	0.03	0.13	0.1	
SB10S-37	Fe_2O_3	9.33	9.48	0.2	1.6
SB10S-37	Gd_2O_3	0.04	0.12	0.1	
SB10S-37	K_2O	0.07	0.12	0.1	
SB10S-37	La_2O_3	0.03	0.12	0.1	
SB10S-37	Li_2O	4.24	4.21	0.0	-0.8
SB10S-37	MgO	0.21	0.18	0.0	
SB10S-37	MnO	2.63	2.65	0.0	0.9
SB10S-37	Na_2O	16.49	16.24	-0.2	-1.5
SB10S-37	NiO	0.38	0.35	0.0	
SB10S-37	PbO	0.02	0.11	0.1	
SB10S-37	SiO_2	47.65	46.80	-0.9	-1.8
SB10S-37	SO_4^{2-}	0.70	0.72	0.0	3.4
SB10S-37	TiO_2	0.02	0.17	0.1	
SB10S-37	ZnO	0.02	0.12	0.1	
SB10S-37	ZrO_2	0.04	0.14	0.1	
SB10S-37	**Sum**	100.02	99.46	-0.6	-0.6
SB10S-38	Al_2O_3	12.49	12.30	-0.2	-1.6
SB10S-38	B_2O_3	4.82	4.83	0.0	0.2
SB10S-38	BaO	0.04	0.11	0.1	
SB10S-38	CaO	0.56	0.51	0.0	-8.4
SB10S-38	Ce_2O_3	0.10	0.12	0.0	
SB10S-38	Cr_2O_3	0.10	0.15	0.0	
SB10S-38	CuO	0.03	0.13	0.1	
SB10S-38	Fe_2O_3	9.32	9.33	0.0	0.1
SB10S-38	Gd_2O_3	0.04	0.12	0.1	
SB10S-38	K_2O	0.07	0.12	0.1	
SB10S-38	La_2O_3	0.03	0.12	0.1	
SB10S-38	Li_2O	4.24	4.06	-0.2	-4.3
SB10S-38	MgO	0.21	0.17	0.0	
SB10S-38	MnO	2.62	2.60	0.0	-0.7
SB10S-38	Na_2O	16.47	16.58	0.1	0.7
SB10S-38	NiO	0.38	0.33	0.0	
SB10S-38	PbO	0.02	0.11	0.1	
SB10S-38	SiO_2	47.65	47.28	-0.4	-0.8
SB10S-38	SO_4^{2-}	0.75	0.71	0.0	-5.7
SB10S-38	TiO_2	0.02	0.17	0.1	
SB10S-38	ZnO	0.02	0.12	0.1	
SB10S-38	ZrO_2	0.04	0.14	0.1	
SB10S-38	**Sum**	100.02	100.08	0.1	0.1

Table A-12. Comparison of Target and Mean Measured Compositions (continued)

Sample ID	Oxide	Target (wt.%)	Average Measured (wt.%)	Difference (wt.%)	% Error
SB10S-39	Al_2O_3	11.86	11.33	-0.5	-4.4
SB10S-39	B_2O_3	4.82	4.89	0.1	1.5
SB10S-39	BaO	0.04	0.11	0.1	
SB10S-39	CaO	0.56	0.52	0.0	-6.3
SB10S-39	Ce_2O_3	0.10	0.12	0.0	
SB10S-39	Cr_2O_3	0.10	0.15	0.0	
SB10S-39	CuO	0.03	0.13	0.1	
SB10S-39	Fe_2O_3	9.30	9.44	0.1	1.5
SB10S-39	Gd_2O_3	0.04	0.12	0.1	
SB10S-39	K_2O	0.07	0.12	0.1	
SB10S-39	La_2O_3	0.03	0.12	0.1	
SB10S-39	Li_2O	4.84	4.75	-0.1	-1.9
SB10S-39	MgO	0.21	0.18	0.0	
SB10S-39	MnO	2.62	2.69	0.1	2.6
SB10S-39	Na_2O	15.84	16.04	0.2	1.3
SB10S-39	NiO	0.38	0.34	0.0	
SB10S-39	PbO	0.02	0.11	0.1	
SB10S-39	SiO_2	48.24	47.97	-0.3	-0.6
SB10S-39	SO_4^{2-}	0.85	0.83	0.0	-1.8
SB10S-39	TiO_2	0.02	0.17	0.1	
SB10S-39	ZnO	0.02	0.12	0.1	
SB10S-39	ZrO_2	0.04	0.14	0.1	
SB10S-39	**Sum**	100.03	100.38	0.3	0.3
SB10S-40	Al_2O_3	9.15	8.80	-0.3	-3.8
SB10S-40	B_2O_3	5.10	5.12	0.0	0.4
SB10S-40	BaO	0.03	0.11	0.1	
SB10S-40	CaO	0.41	0.39	0.0	
SB10S-40	Ce_2O_3	0.07	0.12	0.0	
SB10S-40	Cr_2O_3	0.07	0.15	0.1	
SB10S-40	Cs_2O	0.69	0.63	-0.1	-8.1
SB10S-40	CuO	0.02	0.13	0.1	
SB10S-40	Fe_2O_3	6.84	6.93	0.1	1.3
SB10S-40	Gd_2O_3	0.03	0.12	0.1	
SB10S-40	K_2O	0.15	0.15	0.0	
SB10S-40	La_2O_3	0.02	0.12	0.1	
SB10S-40	Li_2O	4.83	4.68	-0.1	-3.1
SB10S-40	MgO	0.15	0.17	0.0	
SB10S-40	MnO	1.93	1.95	0.0	1.2
SB10S-40	Na_2O	16.9	16.72	-0.2	-1.1
SB10S-40	NiO	0.28	0.25	0.0	
SB10S-40	PbO	0.02	0.11	0.1	
SB10S-40	SiO_2	48.02	47.81	-0.2	-0.4
SB10S-40	SO_4^{2-}	0.85	0.80	-0.1	-6.2
SB10S-40	TiO_2	4.41	4.49	0.1	1.8

Table A-12. Comparison of Target and Mean Measured Compositions (continued)

Sample ID	Oxide	Target (wt.%)	Average Measured (wt.%)	Difference (wt.%)	% Error
SB10S-40	ZnO	0.01	0.12	0.1	
SB10S-40	ZrO_2	0.03	0.14	0.1	
SB10S-40	**Sum**	100.01	99.99	0.0	0.0
SB10S-41	Al_2O_3	10.15	9.52	-0.6	-6.2
SB10S-41	B_2O_3	5.46	4.96	-0.5	-9.2
SB10S-41	BaO	0.03	0.11	0.1	
SB10S-41	CaO	0.45	0.44	0.0	
SB10S-41	Ce_2O_3	0.08	0.12	0.0	
SB10S-41	Cr_2O_3	0.08	0.15	0.1	
SB10S-41	CuO	0.02	0.13	0.1	
SB10S-41	Fe_2O_3	7.42	7.48	0.1	0.8
SB10S-41	Gd_2O_3	0.03	0.12	0.1	
SB10S-41	K_2O	0.06	0.12	0.1	
SB10S-41	La_2O_3	0.02	0.12	0.1	
SB10S-41	Li_2O	4.79	4.58	-0.2	-4.3
SB10S-41	MgO	0.16	0.14	0.0	
SB10S-41	MnO	2.09	2.09	0.0	0.1
SB10S-41	Na_2O	14.33	14.83	0.5	3.5
SB10S-41	NiO	0.3	0.28	0.0	
SB10S-41	PbO	0.02	0.11	0.1	
SB10S-41	SiO_2	53.71	52.41	-1.3	-2.4
SB10S-41	SO_4^{2-}	0.75	0.68	-0.1	-8.7
SB10S-41	TiO_2	0.01	0.17	0.2	
SB10S-41	ZnO	0.01	0.12	0.1	
SB10S-41	ZrO_2	0.03	0.14	0.1	
SB10S-41	**Sum**	100	98.80	-1.2	-1.2
SB10S-42	Al_2O_3	10.16	9.55	-0.6	-6.0
SB10S-42	B_2O_3	5.46	5.04	-0.4	-7.7
SB10S-42	BaO	0.03	0.11	0.1	
SB10S-42	CaO	0.45	0.43	0.0	
SB10S-42	Ce_2O_3	0.08	0.12	0.0	
SB10S-42	Cr_2O_3	0.08	0.15	0.1	
SB10S-42	CuO	0.02	0.13	0.1	
SB10S-42	Fe_2O_3	7.43	7.33	-0.1	-1.3
SB10S-42	Gd_2O_3	0.03	0.12	0.1	
SB10S-42	K_2O	0.06	0.12	0.1	
SB10S-42	La_2O_3	0.02	0.12	0.1	
SB10S-42	Li_2O	4.79	4.52	-0.3	-5.6
SB10S-42	MgO	0.16	0.14	0.0	
SB10S-42	MnO	2.09	2.03	-0.1	-2.7
SB10S-42	Na_2O	14.35	14.28	-0.1	-0.5
SB10S-42	NiO	0.3	0.28	0.0	
SB10S-42	PbO	0.02	0.11	0.1	
SB10S-42	SiO_2	53.71	54.71	1.0	1.9

Table A-12. Comparison of Target and Mean Measured Compositions (continued)

Sample ID	Oxide	Target (wt.%)	Average Measured (wt.%)	Difference (wt.%)	% Error
SB10S-42	SO_4^{2-}	0.7	0.62	-0.1	-11.6
SB10S-42	TiO_2	0.01	0.17	0.2	
SB10S-42	ZnO	0.01	0.12	0.1	
SB10S-42	ZrO_2	0.03	0.14	0.1	
SB10S-42	**Sum**	99.99	100.32	0.3	0.3