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**Technical Note: Updated
Durability/Composition
Relationships for Hanford
High-Level Waste Glasses**

**G. F. Piepel
S. A. Hartley
P. E. Redgate**

March 1996

**Prepared for the U.S. Department of Energy
under Contract DE-AC06-76RLO 1830**

**Pacific Northwest National Laboratory
Operated for the U.S. Department of Energy
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MASTER

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Richland, Washington 99352

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1.0 INTRODUCTION

This technical note^(a) presents empirical models developed in FY1995 to predict durability as functions of glass composition. Models are presented for normalized releases of B, Li, Na, and Si from the 7-day Product Consistency Test (PCT) applied to quenched and canister centerline cooled (CCC) glasses as well as from the 28-day Materials Characterization Center-1 (MCC-1) test applied to quenched glasses. Models are presented for Composition Variation Study (CVS) data from low temperature melter (LTM) studies (Hrma, Piepel, et al. 1994) and high temperature melter (HTM) studies (Vienna et al. 1995). The data used for modeling in this technical note are listed in Appendix A.

The models presented in this technical note are first-order and reduced second-order Scheffé mixture models. The first-order Scheffé model form is

$$y = \sum_{i=1}^{10} b_i x_i \quad (1.1)$$

and the full second-order Scheffé model form is

$$y = \sum_{i=1}^{10} b_i x_i + \sum_{i=1}^9 \sum_{j=i+1}^{10} b_{ij} x_i x_j \quad (1.2)$$

where x_i is the mass fraction of i -th oxide component, b_i is the coefficient corresponding to the first-order term involving x_i , b_{ij} is the coefficient corresponding to the second-order term involving x_i and x_j , and y is a glass property value (possibly mathematically transformed). In this report we consider reduced forms of the second-order model (1.2). Reduced forms have nonzero b_{ij} values only when statistically significant. Further, reduced forms can have squared terms ($b_{ii} x_i^2$) when $i = j$. The book by Cornell (1990) discusses these and many other empirical mixture model forms.

Hrma, Piepel, et al. (1994, Section 6) discuss how the models (1.1) and (1.2) are fitted and their goodness-of-fits are evaluated. Several methods were applied for adding second-order terms to first-order models, and different candidate models resulted. The techniques used to select second-order model terms are discussed in Chapter 6 of Hrma, Piepel, et al. (1994). In this report, two candidate second-order models are presented for each case where second-order modeling was performed. In each case, Model #2 always contains more terms than Model #1. The models designated Model #2 may tend to overfit the data because of the techniques used to build the models. Hence, the models designated Model #1 may be preferable to those designated

^(a) A "technical note" presents results quickly without a lot of effort spent writing explanatory or discussion text or producing a polished document. This approach for reporting FY1995 durability modeling results was necessary due to funding cuts and work scope adjustments.

Model #2 (although the best strategy is to apply both models to validation data and determine which model predicts the best).

The first- and second-order modeling results are presented (in Sections 2, 3, and 4 of this technical note) in tables constructed by patching together and editing output from SAS (1990) PROC REG software runs. Appendix B briefly describes the contents of the patched and edited SAS outputs.

Although plots of model-predicted durability values versus measured durability values are highly useful for evaluating and visualizing the quality of fitted models, there was not sufficient time to produce report-quality versions of such plots for use in this technical note. However, line-printer-quality versions of predicted versus measured plots were produced (although not included in this note) and are referred to in the discussion where appropriate.

All models presented in this technical note were developed using mass fractions of the glass components as the representation of glass composition. Unless otherwise stated, natural logarithms of averaged normalized releases were modeled. That is, usually two PCT or MCC-1 tests were performed on each glass, and the normalized releases were averaged before taking the natural logarithm. An exception to the use of averaged normalized releases occurs for the models fit to the PCT releases from canister-centerline-cooled (CCC) glasses, since not all glasses had PCT tests performed in duplicate.

Due to scope and funding reductions later in FY1995, it was necessary to abandon certain model development activities prior to completion. The results reported in this technical note were advanced enough to report, although desirable final steps were not taken in some cases. These are documented later in the text as necessary. Efforts to investigate nonparametric forms of regression were not advanced enough to report. Nonparametric regression techniques do not assume a form of the model between the predictor variables (glass composition in this case) and the response variable (normalized elemental release from PCT or MCC-1 in this case). Tree regression, Gaussian stochastic process, and other nonparametric regression techniques had only just begun to be investigated when it was necessary to stop. Such modeling approaches have the ability to account for complicated nonlinear/interactive effects of glass components on PCT and MCC-1 releases, and any future modeling efforts should seriously consider such approaches to see if they can improve on the performance of the empirical mixture models reported here.

Models for 7-day PCT releases from quenched glasses are given in Section 2.0. Models for 7-day PCT releases from CCC glasses are given in Section 3.0. Models for 28-day MCC-1 releases from quenched glasses are given in Section 4.0. The data used to develop the models are given in Appendix A. A brief summary is given in Section 5.0. References are given in Section 6.0.

2.0 MODELS FOR PCT RELEASES FROM QUENCHED GLASS

First-order and reduced second-order mixture models fitted to PCT data from quenched CVS-I and CVS-II Phase 1, 2, 3, and 4 glasses are presented in Sections 2.1 and 2.2, respectively. First-order mixture models fitted to PCT data from quenched CVS-III Phase 1 (HTM) glasses are presented in Section 2.3. Second-order mixture models fitted to PCT data from quenched CVS-III Phase 1 (HTM) glasses are presented in Section 2.4. A first-order mixture model fitted to PCT normalized Na release data from a subset of quenched CVS-I, CVS-II Phase 1, 2, 3, and 4, and CVS-III Phase 1 glasses is presented in Section 2.5.

2.1 First-Order Mixture Models for PCT Data on Quenched CVS-I and CVS-II Phase 1, 2, 3, and 4 Glasses

Tables 2.1 to 2.4 contain the results of fitting first-order mixture models to natural logarithms of averaged PCT normalized B, Li, Na, and Si releases (g/m^2) for the 147 CVS-I and CVS-II Phases 1, 2, 3, and 4 quenched glasses. The 10-component compositions of these 147 glasses and the corresponding averaged normalized releases are given in Table A.1 of Appendix A. The models in Tables 2.1 to 2.4 update the models in Table 12.10a of Hrma, Piepel, et al. (1994), which were developed using data up through CVS-II Phase 3.

2.2 Second-Order Mixture Models for PCT Data on Quenched CVS-I and CVS-II Phase 1, 2, 3, and 4 Glasses

Tables 2.5 to 2.8 contain the results of fitting reduced second-order mixture models to natural logarithms of averaged PCT normalized B, Li, Na, and Si releases (g/m^2) for the 147 CVS-I and CVS-II Phases 1, 2, 3, and 4 quenched glasses. The data are the same as used for the first-order models, as given in Table A.1 of Appendix A. Two candidate models developed using different statistical methods to select the second-order terms (see Hrma, Piepel, et al. 1994, Section 6.1.4) are presented for each normalized elemental release. These models update the models in Tables 12.11 to 12.14 of Hrma, Piepel, et al. (1994), which were developed using data up through CVS-II Phase 3.

2.3 First-Order Mixture Models for PCT Data on Quenched CVS-III Phase 1 (HTM) Glasses

Tables 2.9 to 2.11 contain the results of fitting first-order mixture models to natural logarithms of averaged PCT normalized Li, Na, and Si releases (g/m^2) for the 40 CVS-III Phase 1 HTM quenched glasses. The 10-component compositions of these 40 glasses and the corresponding averaged normalized releases are given in Table A.2 of Appendix A.

The models in Tables 2.9 to 2.11 were obtained by ordinary least squares regression applied to the set of CVS-III Phase 1 glasses (i.e., CVS3-1 to CVS3-40). With the exception of an internal standard glass (CVS3-26) used in CVS-II, all CVS-III Phase 1 compositions are single-component variations of either CVS3-1 or CVS3-32. The single component variations were offset by variations in the remaining components, keeping them in the same relative proportions

Table 2.1. First-Order Mixture Model for Natural Logarithm of PCT Normalized Boron Release (g/m²) Fitted to Data from CVS-I and CVS-II Phase 1, 2, 3, 4 Quenched GlassesAnalysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	9	270.41848	30.04650	68.531	0.0001
Error	137	60.06552	0.43843		
C Total	146	330.48399			

Root MSE	0.66214	R-square	0.8182
Dep Mean	0.20594	R-sq ADJ	0.8063
C.V.	321.52253	R-sq PRESS	0.7853

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
SiO2	1	-4.303169	0.56796694	-7.576	0.0001
B2O3	1	11.830556	1.10128803	10.742	0.0001
Na2O	1	17.826018	1.18174399	15.085	0.0001
Li2O	1	22.969710	2.66497292	8.619	0.0001
CaO	1	-9.046127	2.01492298	-4.490	0.0001
MgO	1	10.582084	2.21575511	4.776	0.0001
Fe2O3	1	-3.100945	1.55438996	-1.995	0.0480
Al2O3	1	-25.442554	1.39494540	-18.239	0.0001
ZrO2	1	-10.629893	1.77307151	-5.995	0.0001
Others	1	0.164390	1.91908976	0.086	0.9319

Table 2.2. First-Order Mixture Model for Natural Logarithm of PCT Normalized Lithium Release (g/m²) Fitted to Data from CVS-I and CVS-II Phase 1, 2, 3, 4 Quenched GlassesAnalysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	9	179.40957	19.93440	58.256	0.0001
Error	137	46.87962	0.34219		
C Total	146	226.28919			

Root MSE	0.58497	R-square	0.7928
Dep Mean	0.10317	R-sq ADJ	0.7792
C.V.	567.00336	R-sq PRESS	0.7557

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
SiO2	1	-3.315741	0.50176749	-6.608	0.0001
B2O3	1	10.043524	0.97292728	10.323	0.0001
Na2O3	1	14.057382	1.04400568	13.465	0.0001
LiO2	1	18.556879	2.35435669	7.882	0.0001
CaO	1	-5.642665	1.78007340	-3.170	0.0019
MgO	1	6.917686	1.95749752	3.534	0.0006
Fe2O3	1	-4.161385	1.37321785	-3.030	0.0029
Al2O3	1	-21.828263	1.23235738	-17.713	0.0001
ZrO2	1	-9.725721	1.56641096	-6.209	0.0001
Others	1	0.907026	1.69541003	0.535	0.5935

Table 2.3. First-Order Mixture Model for Natural Logarithm of PCT Normalized Sodium Release (g/m²) Fitted to Data from CVS-I and CVS-II Phase 1, 2, 3, 4 Quenched GlassesAnalysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	9	258.88280	28.76476	87.128	0.0001
Error	137	45.22950	0.33014		
C Total	146	304.11230			

Root MSE	0.57458	R-square	0.8513
Dep Mean	-0.04994	R-sq ADJ	0.8415
C.V.	-1150.43908	R-sq PRESS	0.8260

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
SiO2	1	-4.470717	0.49285790	-9.071	0.0001
B2O3	1	9.373460	0.95565159	9.808	0.0001
Na2O	1	19.708318	1.02546789	19.219	0.0001
Li2O	1	19.832678	2.31255177	8.576	0.0001
CaO	1	-2.036778	1.74846569	-1.165	0.2461
MgO	1	11.750673	1.92273940	6.111	0.0001
Fe2O3	1	-4.112573	1.34883444	-3.049	0.0028
Al2O3	1	-25.622587	1.21047514	-21.167	0.0001
ZrO2	1	-11.605361	1.53859713	-7.543	0.0001
Others	1	-0.802060	1.66530564	-0.482	0.6308

Table 2.4. First-Order Mixture Model for Natural Logarithm of PCT Normalized Silicon Release (g/m²) Fitted to Data from CVS-I and CVS-II Phase 1, 2, 3, 4 Quenched GlassesAnalysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	9	106.60515	11.84502	41.984	0.0001
Error	137	38.65245	0.28213		
C Total	146	145.25760			

Root MSE	0.53116	R-square	0.7339
Dep Mean	-1.12163	R-sq ADJ	0.7164
C.V.	-47.35654	R-sq PRESS	0.6847

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
SiO2	1	-2.899486	0.45561760	-6.364	0.0001
B2O3	1	-0.762687	0.88344265	-0.863	0.3895
Na2O	1	10.565940	0.94798363	11.146	0.0001
Li2	1	19.860165	2.13781558	9.290	0.0001
CaO	1	-6.494595	1.61635179	-4.018	0.0001
MgO	1	2.470776	1.77745739	1.390	0.1668
Fe2O3	1	-3.887507	1.24691664	-3.118	0.0022
Al2O3	1	-17.162929	1.11901176	-15.338	0.0001
ZrO2	1	-10.732612	1.42234088	-7.546	0.0001
Others	1	-0.541829	1.53947531	-0.352	0.7254

Table 2.5. Reduced Second-Order Mixture Models for Natural Logarithm of PCT Normalized Boron Release (g/m²) Fitted to Data from CVS-I and CVS-II Phase 1, 2, 3, 4 Quenched Glasses**Model # 1****Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	13	292.97566	22.53659	79.912	0.0001
Error	133	37.50833	0.28202		
C Total	146	330.48399			

Root MSE	0.53105	R-square	0.8865
Dep Mean	0.20594	R-sq ADJ	0.8754
C.V.	257.86781	R-sq PRESS	0.8538

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
SiO2	1	-5.179703	0.61872072	-8.372	0.0001
B2O3	1	13.811460	1.13937328	12.122	0.0001
Na2O	1	20.851426	1.19155470	17.499	0.0001
Li2O	1	23.453585	2.18819932	10.718	0.0001
CaO	1	14.111198	5.56231577	2.537	0.0123
MgO	1	-36.637606	14.98241121	-2.445	0.0158
Fe2O3	1	-1.941573	1.34054865	-1.448	0.1499
Al2O3	1	-44.502392	3.18433856	-13.975	0.0001
ZrO2	1	-10.588991	1.52299979	-6.953	0.0001
Others	1	2.770533	1.61631972	1.714	0.0888
SiO2_MgO	1	97.566373	30.29282836	3.221	0.0016
B2O3_CaO	1	-90.151951	29.71369068	-3.034	0.0029
Na2O_CaO	1	-121.921298	34.36531047	-3.548	0.0005
Al2O3_Al2O3	1	126.553815	17.68821073	7.155	0.0001

Model # 2**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	16	297.43262	18.58954	73.118	0.0001
Error	130	33.05138	0.25424		
C Total	146	330.48399			

Root MSE	0.50422	R-square	0.9000
Dep Mean	0.20594	R-sq ADJ	0.8877
C.V.	244.83989	R-sq PRESS	0.8534

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
SiO2	1	-5.658845	0.67626775	-8.368	0.0001
B2O3	1	19.210807	2.42878356	7.910	0.0001
Na2O	1	25.973439	2.40813601	10.786	0.0001
Li2O	1	23.953430	2.11067363	11.349	0.0001
CaO	1	18.310176	5.38271930	3.402	0.0009
MgO	1	-57.972406	15.62069873	-3.711	0.0003
Fe2O3	1	-5.675079	1.69043393	-3.357	0.0010
Al2O3	1	-53.182235	4.30020588	-12.367	0.0001
ZrO2	1	-14.006619	1.70356516	-8.222	0.0001
Others	1	2.580701	1.57204396	1.642	0.1031
SiO2_MgO	1	129.969075	30.57174734	4.251	0.0001
B2O3_Na2O	1	-43.642180	20.48049962	-2.131	0.0350
B2O3_CaO	1	-109.830545	28.79040731	-3.815	0.0002
Na2O_CaO	1	-147.080548	33.27445016	-4.420	0.0001
MgO_ZrO2	1	153.523942	46.73470057	3.285	0.0013
Fe2O3_Al2O3	1	101.686407	35.47133952	2.867	0.0048
Al2O3_Al2O3	1	158.062344	20.87682605	7.571	0.0001

Table 2.6. Reduced Second-Order Mixture Models for Natural Logarithm of PCT Normalized Lithium Release (g/m²) Fitted to Data from CVS-I and CVS-II Phase 1, 2, 3, 4 Quenched Glasses**Model # 1****Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>
Model	12	194.18073	16.18173	67.532	0.000
Error	134	32.10846	0.23962		
C Total	146	226.28919			

Root MSE	0.48951	R-square	0.8581
Dep Mean	0.10317	R-sq ADJ	0.8454
C.V.	474.47264	R-sq PRESS	0.8243

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
SiO2	1	-3.244298	0.45948749	-7.061	0.0001
B2O3	1	11.840779	1.01736312	11.639	0.0001
Na2O	1	15.703559	1.06472475	14.749	0.0001
Li2O	1	18.018725	1.99238318	9.044	0.0001
CaO	1	14.756961	5.00884760	2.946	0.0038
MgO	1	7.602606	1.64231417	4.629	0.0001
Fe2O3	1	-4.630368	1.15624659	-4.005	0.0001
Al2O3	1	-38.973107	2.84987058	-13.675	0.0001
ZrO2	1	-10.948229	1.32577639	-8.258	0.0001
Others	1	1.733222	1.42625014	1.215	0.2264
B2O3_CaO	1	-101.298874	27.02743919	-3.748	0.0003
Na2O_CaO	1	-88.502106	31.30393155	-2.827	0.0054
Al2O3_Al2O3	1	104.318491	16.24088607	6.423	0.0001

Model # 2**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	14	198.37221	14.16944	66.997	0.0001
Error	132	27.91698	0.21149		
C Total	146	226.28919			

Root MSE	0.45988	R-square	0.8766
Dep Mean	0.10317	R-sq ADJ	0.8635
C.V.	445.75999	R-sq PRESS	0.8406

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
SiO2	1	-1.650361	0.53243723	-3.100	0.0024
B2O3	1	11.775583	1.13671008	10.359	0.0001
Na2O	1	12.407191	0.90390413	13.726	0.0001
Li2O	1	16.628621	1.93949911	8.574	0.0001
CaO	1	-13.172930	5.76841679	-2.284	0.0240
MgO	1	5.214627	1.64508738	3.170	0.0019
Fe2O3	1	-5.734116	1.10318515	-5.198	0.0001
Al2O3	1	-36.973215	2.88502422	-12.816	0.0001
ZrO2	1	52.389003	12.96043182	4.042	0.0001
Others	1	-0.447349	1.41771632	-0.316	0.7528
SiO2_ZrO2	1	-113.993944	23.81630529	-4.786	0.0001
B2O3_CaO	1	-86.562629	24.85618105	-3.483	0.0007
B2O3_ZrO2	1	-69.256086	22.53274197	-3.074	0.0026
CaO_CaO	1	188.029715	59.90664881	3.139	0.0021
Al2O3_Al2O3	1	84.884987	16.88905382	5.026	0.0001

Table 2.7. Reduced Second-Order Mixture Models for Natural Logarithm of PCT Normalized Sodium Release (g/m²) Fitted to Data from CVS-I and CVS-II Phase 1, 2, 3, 4 Quenched Glasses**Model # 1****Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	13	273.74088	21.05699	92.211	0.0001
Error	133	30.37142	0.22836		
C Total	146	304.11230			

Root MSE	0.47787	R-square	0.9001
Dep Mean	-0.04994	R-sq ADJ	0.8904
C.V.	-956.79692	R-sq PRESS	0.8739

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
SiO2	1	-3.260418	0.51047357	-6.387	0.0001
B2O3	1	-2.507631	4.85956244	-0.516	0.6067
Na2O	1	19.682700	0.93907576	20.960	0.0001
Li2O	1	22.974555	2.74085352	8.382	0.0001
CaO	1	5.373967	3.18499358	1.687	0.0939
MgO	1	11.719256	1.62322659	7.220	0.0001
Fe2O3	1	-3.933412	1.19826168	-3.283	0.0013
Al2O3	1	-39.139383	3.15743343	-12.396	0.0001
ZrO2	1	-12.087929	1.32800585	-9.102	0.0001
Others	1	0.610106	1.49344090	0.409	0.6835
B2O3_CaO	1	-71.984449	27.13682888	-2.653	0.0090
Li2O_Al2O3	1	-44.950328	37.91495813	-1.186	0.2379
B2O3_B2O3	1	58.099415	20.48928604	2.836	0.0053
Al2O3_Al2O3	1	99.495708	16.52554323	6.021	0.0001

Model # 2**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	14	276.34101	19.73864	93.820	0.0001
Error	132	27.77129	0.21039		
C Total	146	304.11230			

Root MSE	0.45868	R-square	0.9087
Dep Mean	-0.04994	R-sq ADJ	0.8990
C.V.	-918.38361	R-sq PRESS	0.8833

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
SiO2	1	-1.733107	0.64174838	-2.701	0.0078
B2O3	1	-3.864263	4.69156173	-0.824	0.4116
Na2O	1	14.836580	1.79326382	8.274	0.0001
Li2O	1	6.875094	4.72395364	1.455	0.1479
CaO	1	5.391841	3.08526522	1.748	0.0829
MgO	1	11.145934	1.60548477	6.942	0.0001
Fe2O3	1	-3.650992	1.14007558	-3.202	0.0017
Al2O3	1	-40.020774	2.94383324	-13.595	0.0001
ZrO2	1	15.203315	10.29160906	1.477	0.1420
Others	1	0.042729	1.48147630	0.029	0.9770
SiO2_ZrO2	1	-54.323519	20.94722871	-2.593	0.0106
B2O3_CaO	1	-66.632000	24.94669070	-2.671	0.0085
Na2O_Li2O	1	115.231573	39.55813095	2.913	0.0042
B2O3_B2O3	1	60.808186	19.99783790	3.041	0.0028
Al2O3_Al2O3	1	97.667995	15.90600132	6.140	0.0001

Table 2.8. Reduced Second-Order Mixture Models for Natural Logarithm of PCT Normalized Silicon Release (g/m^2) Fitted to Data from CVS-I and CVS-II Phase 1, 2, 3, 4 Quenched Glasses**Model # 1****Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	11	117.00254	10.63659	50.821	0.0001
Error	135	28.25506	0.20930		
C Total	146	145.25760			

Root MSE	0.45749	R-square	0.8055
Dep Mean	-1.12163	R-sq ADJ	0.7896
C.V.	-40.78805	R-sq PRESS	0.7578

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
SiO2	1	-2.594316	0.42798382	-6.062	0.0001
B2O3	1	-1.255000	0.76979187	-1.630	0.1054
Na2O	1	13.296561	1.27684334	10.414	0.0001
Li2O	1	18.884728	1.90327910	9.922	0.0001
CaO	1	-6.039152	1.39366509	-4.333	0.0001
MgO	1	2.987784	1.53270340	1.949	0.0533
Fe2O3	1	-3.977993	1.07504244	-3.700	0.0003
Al2O3	1	-28.679590	3.20035151	-8.961	0.0001
ZrO2	1	-11.757430	1.23392784	-9.528	0.0001
Others	1	-0.095678	1.33430082	-0.072	0.9429
Na2O_Al2O3	1	-44.585370	16.97620171	-2.626	0.0096
Al2O3_Al2O3	1	101.227886	15.12895164	6.691	0.0001

Model # 2**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	12	117.66496	9.80541	47.619	0.0001
Error	134	27.59265	0.20592		
C Total	146	145.25760			

Root MSE	0.45378	R-square	0.8100
Dep Mean	-1.12163	R-sq ADJ	0.7930
C.V.	-40.45721	R-sq PRESS	0.7584

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
SiO2	1	-2.491484	0.42836706	-5.816	0.0001
B2O3	1	-1.079761	0.76977460	-1.403	0.1630
Na2O	1	13.341378	1.26673413	10.532	0.0001
Li2O	1	18.906911	1.88788327	10.015	0.0001
CaO	1	-6.211588	1.38570130	-4.483	0.0001
MgO	1	1.125257	1.84110115	0.611	0.5421
Fe2O3	1	-4.369174	1.08840081	-4.014	0.0001
Al2O3	1	-28.821803	3.17538556	-9.077	0.0001
ZrO2	1	-13.041495	1.41794108	-9.197	0.0001
Others	1	-0.202241	1.32481214	-0.153	0.8789
Na2O_Al2O3	1	-43.457430	16.85025815	-2.579	0.0110
MgO_ZrO2	1	71.309196	39.75921234	1.794	0.0751
Al2O3_Al2O3	1	99.728699	15.02951251	6.636	0.0001

Table 2.9. First-Order Mixture Model for Natural Logarithm of PCT Normalized Lithium Release (g/m^2) Fitted to Data from CVS-III Phase 1 Quenched GlassesAnalysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	10	4.42581	0.44258	3.569	0.0038
Error	28	3.47238	0.12401		
C Total	38	7.89819			

Root MSE	0.35216	R-square	0.5604
Dep Mean	-0.86531	R-sq ADJ	0.4033
C.V.	-40.69709	R-sq PRESS	0.0034

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
SiO2	1	-1.953676	0.65843979	-2.967	0.0061
B2O3	1	0.661766	2.79674073	0.237	0.8147
Na2O	1	6.735840	2.22463428	3.028	0.0052
Li2O	1	13.155301	7.01819545	1.874	0.0713
Fe2O3	1	-3.403237	2.31201002	-1.472	0.1522
Al2O3	1	-2.056286	1.34052379	-1.534	0.1363
ZrO2	1	-4.540972	2.29496479	-1.979	0.0578
Bi2O3	1	-1.443090	1.95973338	-0.736	0.4676
P2O5	1	-11.825846	3.34073035	-3.540	0.0014
UO2	1	-2.986413	2.15857477	-1.384	0.1774
Others	1	-2.514953	2.57642207	-0.976	0.3374

Table 2.10. First-Order Mixture Model for Natural Logarithm of PCT Normalized Sodium Release (g/m^2) Fitted to Data from CVS-III Phase 1 Quenched GlassesAnalysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	10	18.61695	1.86169	19.986	0.0001
Error	29	2.70140	0.09315		
C Total	39	21.31835			

Root MSE	0.30521	R-square	0.8733
Dep Mean	-0.96981	R-sq ADJ	0.8296
C.V.	-31.47096	R-sq PRESS	0.6718

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
Si2O3	1	-3.833957	0.55241570	-6.940	0.0001
B2O3	1	0.105772	2.42325942	0.044	0.9655
Na2O	1	19.054028	1.92419250	9.902	0.0001
Li2O	1	13.394676	5.11747658	2.617	0.0139
Fe2O3	1	-4.069140	2.00288027	-2.032	0.0514
Al2O3	1	-9.802978	1.15762459	-8.468	0.0001
ZrO2	1	-5.420834	1.98457665	-2.731	0.0106
Bi2O3	1	-0.391317	1.68538283	-0.232	0.8180
P2O5	1	-7.463500	2.86936845	-2.601	0.0145
UO2	1	-4.032147	1.87077841	-2.155	0.0396
Others	1	-3.966323	2.20258300	-1.801	0.0821

Table 2.11. First-Order Mixture Model for Natural Logarithm of PCT Normalized Silicon Release (g/m²) Fitted to Data from CVS-III Phase 1 Quenched Glasses**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	10	4.95248	0.49525	5.493	0.0001
Error	29	2.61471	0.09016		
C Total	39	7.56719			

Root MSE	0.30027	R-square	0.6545
Dep Mean	-1.75293	R-sq ADJ	0.5353
C.V.	-17.12958	R-sq PRESS	0.3231

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
SiO2	1	-3.023796	0.54347948	-5.564	0.0001
B2O3	1	-0.605420	2.38405928	-0.254	0.8013
Na2O	1	6.851169	1.89306558	3.619	0.0011
Li2O	1	12.193124	5.03469312	2.422	0.0219
Fe2O3	1	-3.203404	1.97048045	-1.626	0.1148
Al2O3	1	-5.479606	1.13889814	-4.811	0.0001
ZrO2	1	-7.471155	1.95247291	-3.827	0.0006
Bi2O3	1	-1.416935	1.65811904	-0.855	0.3998
P2O5	1	-6.439513	2.82295177	-2.281	0.0301
UO2	1	-3.338404	1.84051554	-1.814	0.0801
Others	1	-3.048304	2.16695266	-1.407	0.1701

as in the baseline glass from which the single-component changes were made. CVS3-1 was the baseline composition for single-component variations in SiO₂, B₂O₃, Na₂O, Li₂O, Fe₂O₃, Al₂O₃, ZrO₂, Bi₂O₃, P₂O₅, and Others (before Bi₂O₃, P₂O₅, and UO₂ were removed from Others). CVS3-32 was the baseline composition for the single-component variations of UO₂.

Least squares regression was applied to the whole set of CVS3-1 to CVS3-40 to obtain the models in Tables 2.9 to 2.11. An alternative and possibly better way to fit models to single-component-variation data is to use only those data points corresponding to variations of a specific component to estimate the first-order mixture model term for that component. One way to do this is to get a slope for each component x_i by separately fitting a line $a_i + b_i x_i$ for each component using only the single-component variation points for x_i , and then developing a first-order mixture model from the slopes b_i . Unfortunately, the formula for converting slopes to first-order mixture model coefficients requires using the value of the response at the baseline composition(s). If one uses the predicted response values from the lines $a_i + b_i x_i$, these will be different for each component. If one uses the measured response value at the baseline composition(s), it will be different from the predicted values from the lines $a_i + b_i x_i$. Either approach creates an inconsistency which is bothersome from a mathematical/statistical standpoint, although the consequence is unknown from a practical standpoint. Fortunately, it is possible to simultaneously and consistently estimate the predicted value at the baseline point(s) and the slopes for each component using only the applicable single-component variation data

points for each component. However, the statistical approach for this requires specialized application of least squares software. It is also complicated by the existence of two baseline compositions, the CVS-II internal standard glass that is not a single-component-variation of one of the baseline glasses, and the fact that Others was varied singly while still containing Bi_2O_3 , P_2O_5 , and UO_2 . There was not time to apply this alternative approach for use in this report.

The fits of the Li and Si models in Tables 2.9 and 2.11, respectively, are not as good as the fit of the Na model in Table 2.10. Fits of models for PCT normalized Si release typically are not as good as for Li and Na releases. However, the reason(s) for the difference in fits of the models for PCT Li and Na releases is not clear. Past experience with low melting temperature glasses has shown that PCT normalized Li and Na releases are usually highly correlated, so that similar R^2 values are obtained when modeling these releases. One potential reason is that the Li_2O values of CVS-III Phase 1 glasses are relatively low compared to the Na_2O values. Other potential reasons could be the single-component-variation nature of the data set, the different composition region explored in CVS-III Phase 1, or the higher melting temperatures used.

2.4 Second-Order Mixture Models for PCT Data on Quenched CVS-III Phase 1 (HTM) Glasses

Tables 2.12 to 2.14 contain the results of fitting reduced second-order mixture models to natural logarithms of averaged PCT normalized Li, Na, and Si releases (g/m^2) for the 40 CVS-III Phase 1 HTM quenched glasses. The 10-component compositions of these 40 glasses and the corresponding averaged normalized releases are the same as used for the first-order mixture models, as given in Table A.2 of Appendix A.

Only squared-terms may appear in second-order models for these data, which consist of single-component variations of several components. The second-order models in Tables 2.12 to 2.14 were formed by "forcing" the first-order terms into the model, and then considering all possible additions of one, two, three, etc. squared terms. There were slight variations in the squared terms selected for the Li, Na, and Si releases, but adding Al_2O_3 , Na_2O , and B_2O_3 squared terms was suggested by the statistical model building method for all three releases. The results in Tables 2.12 and 2.14 suggest that only the Al_2O_3 squared term is highly statistically significant for PCT normalized Li and Si releases. However, the results in Table 2.13 indicate that all three of the Al_2O_3 , Na_2O , and B_2O_3 squared terms are highly statistically significant for PCT normalized Na releases. Refitting the Li and Si release models without one or both of the Na_2O and B_2O_3 squared terms is advisable so that only clearly significant second-order terms remain, but there was not time to do this given the scope and budget cut.

The $R^2(\text{PRESS})$ statistics^(a) in Tables 2.12 and 2.14 are negative, indicating that there are one or more data points whose individual removal from the data set causes a considerable change

^(a) $R^2(\text{PRESS})$ is an indication of the proportion of variation in the data accounted for by the model, when each data point in turn is left out of the fit to assess the predictive performance of the model for that data point (see Chapter 6 of Hrma, Piepel, et al. 1994 for more information).

Table 2.12. Reduced Second-Order Mixture Model for Natural Logarithm of PCT Normalized Lithium Release (g/m^2) Fitted to Data from CVS-III Phase 1 Quenched Glasses**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	13	6.71607	0.51662	10.926	0.0001
Error	25	1.18212	0.04728		
C Total	38	7.89819			

Root MSE	0.21745	R-square	0.8503
Dep Mean	-0.86531	R-sq ADJ	0.7725
C.V.	-25.12980	R-sq PRESS	-0.0395

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
SiO2	1	-2.262578	0.49020610	-4.616	0.0001
B2O3	1	-11.975431	7.35060831	-1.629	0.1153
Na2O	1	2.350274	5.18566773	0.453	0.6541
Li2O	1	13.366909	3.28220629	4.073	0.0004
Fe2O3	1	-2.296670	1.32164081	-1.738	0.0941
Al2O3	1	-24.199644	3.14669046	-7.691	0.0001
ZrO2	1	-6.566902	1.30369232	-5.037	0.0001
Bi2O3	1	-0.652479	1.12015298	-0.582	0.5653
P2O5	1	-5.388044	1.86385646	-2.891	0.0077
UO2	1	-1.490992	1.25202124	-1.191	0.2445
Others	1	-0.116078	1.47986332	-0.078	0.9381
Al2O3_Al2O3	1	77.207868	12.31931430	6.267	0.0001
B2O3_B2O3	1	120.073292	78.14344586	1.537	0.1365
Na2O_Na2O	1	20.356804	19.07930769	1.067	0.2958

Table 2.13. Reduced Second-Order Mixture Model for Natural Logarithm of PCT Normalized Sodium Release (g/m^2) Fitted to Data from CVS-III Phase 1 Quenched Glasses**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	13	20.62393	1.58646	59.399	0.0001
Error	26	0.69442	0.02671		
C Total	39	21.31835			

Root MSE	0.16343	R-square	0.9674
Dep Mean	-0.96981	R-sq ADJ	0.9511
C.V.	-16.85151	R-sq PRESS	0.7195

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
SiO2	1	-5.306250	0.42090826	-12.607	0.0001
B2O3	1	-24.559011	6.31149176	-3.891	0.0006
Na2O	1	45.021471	4.45259735	10.111	0.0001
Li2O	1	10.093112	2.81821818	3.581	0.0014
Fe2O3	1	-5.959294	1.13480745	-5.251	0.0001
Al2O3	1	-24.873056	2.70185950	-9.206	0.0001
ZrO2	1	-7.172064	1.11939625	-6.407	0.0001
Bi2O3	1	-2.107048	0.96180289	-2.191	0.0376
P2O5	1	-9.772372	1.60037295	-6.106	0.0001
UO2	1	-4.837650	1.07502963	-4.500	0.0001
Others	1	-3.339205	1.27066288	-2.628	0.0142
Al2O3_Al2O3	1	54.581995	10.57779810	5.160	0.0001
Na2O_Na2O	1	-96.310338	16.38216704	-5.879	0.0001
B2O3_B2O3	1	238.436814	67.09672090	3.554	0.0015

Table 2.14. Reduced Second-Order Mixture Model for Natural Logarithm of PCT Normalized Silicon Release (g/m^2) Fitted to Data from CVS-III Phase 1 Quenched Glasses**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	13	6.62529	0.50964	14.068	0.0001
Error	26	0.94190	0.03623		
C Total	39	7.56719			

Root MSE	0.19033	R-square	0.8755
Dep Mean	-1.75293	R-sq ADJ	0.8133
C.V.	-10.85800	R-sq PRESS	-0.0277

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
SiO2	1	-2.262578	0.49020610	-4.616	0.0001
B2O3	1	-11.975431	7.35060831	-1.629	0.1153
Na2O	1	2.350274	5.18566773	0.453	0.6541
Li2O	1	13.366909	3.28220629	4.073	0.0004
Fe2O3	1	-2.296670	1.32164081	-1.738	0.0941
Al2O3	1	-24.199644	3.14669046	-7.691	0.0001
ZrO2	1	-6.566902	1.30369232	-5.037	0.0001
Bi2O3	1	-0.652479	1.12015298	-0.582	0.5653
P2O5	1	-5.388044	1.86385646	-2.891	0.0077
UO2	1	-1.490992	1.25202124	-1.191	0.2445
Others	1	-0.116078	1.47986332	-0.078	0.9381
Al2O3_Al2O3	1	77.207868	12.31931430	6.267	0.0001
B2O3_B2O3	1	120.073292	78.14344586	1.537	0.1365
Na2O_Na2O	1	20.356804	19.07930769	1.067	0.2958

in the fitted model. Given that there are only three or four single-component-variations per component in the CVS-III Phase 1 data set, it is not surprising that deletion of such points [such as occurs in computing $R^2(\text{PRESS})$] might have a considerable impact on fitted models. Hence, the negative $R^2(\text{PRESS})$ values are not necessarily a sign of questionable model quality.

Comparing R^2 values for the second-order models in Tables 2.12 to 2.14 to R^2 values for the corresponding first-order models in Tables 2.9 to 2.11 indicates that the performances of the first-order models are improved markedly by incorporating second-order terms in the model. Plots of the PCT quenched durability data confirm the presence of nonlinear effects of some components (see Vienna et al. 1995). Some of the plots there even suggest that third-order effects may exist for some components. There was not sufficient time to explore such possibilities in the modeling work reported here.

2.5 First-Order Mixture Models for PCT Data on Combined LTM and HTM Quenched Glasses

Table 2.15 contains the results of fitting first-order mixture models to natural logarithms of averaged PCT normalized Na releases (g/m^2) for a combined data set of 92 LTM (CVS-I and CVS-II Phase 1, 2, 3, 4) and HTM (CVS-III Phase 1) quenched glasses. The combined data set

Table 2.15. First-Order Mixture Model for Natural Logarithm of PCT Normalized Sodium Release (g/m^2) Fitted to a Subset of Data from CVS-I, CVS-II Phases 1, 2, 3, and 4, and CVS-III Phase 1 Quenched Glasses

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	9	111.35664	12.37296	42.878	0.0001
Error	82	23.66190	0.28856		
C Total	91	135.01854			

Root MSE	0.53718	R-square	0.8248
Dep Mean	-0.55471	R-sq ADJ	0.8055
C.V.	-96.83974	R-sq PRESS	0.7523

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
SiO2	1	-4.157807	0.55526712	-7.488	0.0001
B2O3	1	-4.813322	2.56173560	-1.879	0.0638
Na2O	1	16.952118	1.30284607	13.012	0.0001
Li2O	1	20.056655	2.96932337	6.755	0.0001
MgO	1	13.761517	2.50708590	5.489	0.0001
CaO	1	3.847059	2.42178917	1.589	0.1160
Fe2O3	1	-2.030984	1.52564259	-1.331	0.1868
Al2O3	1	-16.696474	1.35309038	-12.340	0.0001
ZrO2	1	-5.045736	1.85575587	-2.719	0.0080
Bi2O3	1	-0.008752	0.00000000	.	.
UO2	1	-1.840636	0.00000000	.	.
P2O5	1	-7.470012	0.00000000	.	.
Others	1	-0.705314	1.45849669	-0.484	0.6300
RESTRICT	-1	-0.054994	0.10076621	-0.546	0.5867
RESTRICT	-1	-0.025718	0.05937319	-0.433	0.6660
RESTRICT	-1	-0.059643	0.11027934	-0.541	0.5901

includes 54 LTM glasses and 38 of the CVS-III Phase 1 HTM glasses. The 10-component compositions of these 92 glasses and the corresponding averaged normalized releases are given in Table A.3 of Appendix A.

Most of the CVS-III Phase 1 glasses contain negligible B_2O_3 , so it is not appropriate to model normalized B releases. Normalized Li and Si releases could be modeled, but this was not done due to the funding and work scope reduction. The normalized Na release model was developed for use in constructing the CVS-III Phase 2 test matrix (Piepel, Vienna, Redgate, and Li 1995), and so it was available for inclusion in this report. The composition region to be explored by the test matrix did not include several of the CVS-I and CVS-II glasses, and did not contain two CVS-III Phase 1 glasses. For the PCT normalized Na release model to be of good quality for constructing the test matrix over the desired composition region, data for compositions outside the region were not used. Glasses with $\text{SiO}_2 < .37$, $\text{SiO}_2 > .60$, $\text{B}_2\text{O}_3 > .09$, alkalis $< .05$, alkalis $> .27$, $\text{Fe}_2\text{O}_3 > .15$, $\text{Al}_2\text{O}_3 < 0.05$, $\text{Al}_2\text{O}_3 > .17$, and $\text{ZrO}_2 > .14$ were deleted.

See Tables 2 and 4 of Piepel, Vienna, Redgate, and Li (1995) for description of the composition region to be explored by the CVS-III Phase 2 test matrix.

The model in Table 2.15 was obtained in two stages. In the first stage, separate lines

$$\ln(\text{PCT Na release}) = A + Bx \quad (2.1)$$

were fit to the single-component variations of Bi_2O_3 (CVS3-1, CVS3-28 to CVS3-31), P_2O_5 (CVS3-1, CVS3-37 to CVS3-40), and UO_2 (CVS3-32 to CVS3-36). These lines were used to compute a first-order mixture model coefficient b_i via the formula

$$b_i = p_0 + B(1 - x_0) \quad (2.2)$$

where $p_0 = A + Bx_0$ is the predicted value from (1) at the baseline composition (CVS3-1 for Bi_2O_3 and P_2O_5 single-component variations, CVS3-32 for UO_2 single-component variations), B is the slope from (1), and x_0 is the baseline value of the component varied. In the second stage, the coefficients for Bi_2O_3 , P_2O_5 , and UO_2 were forced to take those values, with the remaining component coefficients of the first-order mixture model determined from the 92 data points using least squares regression. This two-stage coefficient estimation approach was required to address the problem described in the following paragraph. It is not a completely consistent solution, as discussed in Section 2.3, but was all that could be done in the time available.

Conflicting aspects of the LTM and HTM data sets did not permit modeling PCT normalized releases using the complete combined data set over all LTM and HTM glasses. Least squares regression was used to attempt this, but very strange results were obtained. The reason for the strange results was that certain components in each of the LTM and HTM subsets of data are highly correlated. For example, most LTM glasses contained B_2O_3 , but did not contain (or did not contain appreciable amounts of) Bi_2O_3 , P_2O_5 , and UO_2 . Conversely, most HTM (CVS-III Phase 1) glasses did not contain appreciable amounts of B_2O_3 , but selected glasses did contain considerable ranges of Bi_2O_3 , P_2O_5 , and UO_2 . This leads to the confounding of the effects of B_2O_3 with the effects of Bi_2O_3 , P_2O_5 , and UO_2 when the combined data set is supplied to least squares regression. This problem could be overcome using the two-stage regression approach described in the preceding paragraph. However, initial modeling efforts indicated that the effects of some components were different in the HTM composition region compared to the LTM composition region. This suggests that first-order mixture models fit to the combined data set (even using the two-stage estimation approach) may not be appropriate. Second-order or more advanced regression modeling techniques may have the ability to fit such a combined data set, but there was not time to investigate such models.

3.0 MODELS FOR PCT RELEASES FROM CCC GLASS

First-order and reduced second-order mixture models fitted to PCT data from canister-centerline-cooled (CCC) CVS-I and CVS-II Phase 1, 2, 3, and 4 glasses are presented in Sections 3.1 and 3.2, respectively. Note that unaveraged PCT releases results were modeled, because only selected glasses had replicate PCTs conducted. Hence, two kinds of "replicate data" appear in the data set given in Table A.4 of Appendix A: (1) PCT results for samples of a given CVS glass tested at the same time, and (2) PCT results for samples of CVS glasses with different names but the same compositions, tested at different times. Variation due to replicates in (2) is expected to be larger than variation due to replicates in (1), since nominally variation in (2) includes variation in (1). Neither kind of variation can be accounted for by fitted models, so R^2 model statistics cannot achieve the theoretical maximum of 1.0. Compared to models in Sections 2.0 and 4.0 where averages of duplicate PCT releases are modeled, models in this section can be expected to have somewhat lower R^2 values due to the larger variation in unaveraged releases.

For the selected glasses that did have duplicate PCTs performed, the results differed noticeably in several cases. To resolve the differences, a third PCT was performed on some glasses. Study of the duplicate and triplicate data for which differences occurred led to assessing five data points as "bad". These five data points are identified with ID = 1 in Table A.4 of Appendix A. The occurrence of five such "bad" replicate PCT data raises questions whether data for glasses for which replicate PCTs were not performed might also be "bad" and not detected. The decision not to perform replicate PCTs of all CVS-I and CVS-II glasses was made for budget and time reasons in years past, when differences between replicate PCTs of quenched glasses were very rare. However, PCT testing of CCC glasses may be inherently more variable and prone to large differences, especially if some CCC glasses tested are phase separated or contain crystals. To test this hypothesis, the natural logarithms of the duplicate PCT normalized elemental releases were used to calculate short-term experimental standard deviation estimates resulting from duplicate PCT testing (and chemical analyses) of CCC glasses. The resulting standard deviations were: 0.13 for $\ln(\text{Si})$, 0.13 for $\ln(\text{B})$, 0.08 for $\ln(\text{Li})$, and 0.12 for $\ln(\text{Na})$. These values are two to four times as large as corresponding values reported by Hrma, Piepel, et al. (1994, Table D.3) for PCT testing of quenched glasses. Removing the duplicate data for glasses prone to phase separation and glasses containing crystals and recomputing the standard deviations yielded: 0.08 for $\ln(\text{Si})$, 0.13 for $\ln(\text{B})$, 0.08 for $\ln(\text{Li})$, and 0.11 for $\ln(\text{Na})$. These values are similar to the values above. This suggests that short-term variability of PCT results is similar for homogeneous and nonhomogeneous glasses.

Given that PCT results are more uncertain for CCC glasses, modeling may be more difficult than for quenched glasses. It may also be more difficult to model PCT results from CCC glasses due to the effects of phase separation and crystallinity on PCT releases.

3.1 First-Order Mixture Models for PCT Data on CCC CVS-I and CVS-II Phase 1, 2, 3, and 4 Glasses

Tables 3.1 to 3.4 contain the results of fitting first-order mixture models to natural logarithms of unaveraged PCT normalized B, Li, Na, and Si releases (g/m^2) for the 147 CVS-I and CVS-II Phases 1, 2, 3, and 4 CCC glasses. The 10-component compositions of these 147 glasses and the corresponding unaveraged normalized releases are given in Table A.4 of Appendix A. The two replicate results for CVS1-2 ($\# = 2.2$ and 2.3 in Table A.4) had very large residuals (difference between predicted and measured values) for the B, Li, and Na first-order models, and affected the estimates of the CaO coefficient. There was no indication these two values are "bad" in the sense described in Section 3.0, but the points are somewhat influential. Because the CVS1-2 composition is somewhat extreme compared to CVS-II glasses, it was decided to delete its two replicate data points. Hence, the models in Tables 3.1 to 3.4 and all subsequent models discussed in the remainder of Section 3 were fitted without these two data points.

The R^2 values for the models in Tables 3.1 to 3.4 are relatively low (0.44 to 0.57), indicating the first-order models do not fit the data extremely well. Plots of model-predicted versus measured values of $\ln(\text{PCT normalized release})$ for B, Li, and Na releases (not included here) show that the relatively poor fits are due to the model overpredicting lower releases and underpredicting higher releases. This sort of biased prediction behavior does not occur for PCT Si release, but the fit is still relatively poor, evidenced by large scatter about the 45° line in the predicted versus measured plot (not included here).

A potential explanation for the relatively poor fit of the models in Tables 3.1 to 3.4 to the full data set is the presence of glasses with crystallinity or glasses prone to phase separation after CCC. All glasses with larger than 7% (by volume) crystallinity or identified as prone to phase separation after CCC were eliminated from the data set and the first-order mixture models were refitted. The resulting models are given in Tables 3.5 to 3.8. The model R^2 values are markedly improved (0.70 to 0.79) compared to those in Tables 3.1 to 3.4 (0.44 to 0.57). However, they still are not quite as large as the R^2 values for the models in Tables 2.1 to 2.4 for the PCT results from quenched CVS-I and CVS-II glasses (0.79 to 0.85). This could be because crystallinity below 7 vol% still affects the PCT releases of glasses enough to affect the performance of first-order mixture models. The lower R^2 values for CCC data compared to those for quenched data could also be due to the larger uncertainty in PCT results on CCC glasses compared to quenched glasses (discussed in Section 3.0) and/or the differences of modeling averages of duplicate PCT releases (for quenched) versus modeling single PCT releases (for CCC).

Predicted versus measured plots (not included here) for the B, Li, and Na models in Tables 3.5 to 3.7 still show a slight tendency to overpredict lower releases and underpredict higher releases, although not nearly as bad as for the models in Tables 3.1 to 3.3. Deleting the glasses prone to phase separation and those with greater than 7 vol% crystallinity improved the models in this regard. It may be the models could be improved further by deleting additional data corresponding to glasses with crystallinity below the 7 vol% threshold used here. Additional

Table 3.1. First-Order Mixture Model for Natural Logarithm of PCT Normalized Boron Release (g/m²) Fitted to Data from CVS-I and CVS-II Phase 1, 2, 3, 4 CCC Glasses**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	9	212.18550	23.57617	16.976	0.0001
Error	173	240.26043	1.38879		
C Total	182	452.44593			

Root MSE	1.17847	R-square	0.4690
Dep Mean	0.68193	R-sq ADJ	0.4413
C.V.	172.81359	R-sq PRESS	0.4015

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
SiO2	1	-5.035591	0.90752926	-5.549	0.0001
B2O3	1	11.328429	1.80423685	6.279	0.0001
Na2O	1	16.236052	1.94445798	8.350	0.0001
Li2O	1	17.786078	4.32391563	4.113	0.0001
CaO	1	-12.546103	3.37560284	-3.717	0.0003
MgO	1	16.270648	3.57068358	4.557	0.0001
Fe2O3	1	3.668393	2.50989887	1.462	0.1457
Al2O3	1	-12.575423	2.24693811	-5.597	0.0001
ZrO2	1	-7.778692	2.98141587	-2.609	0.0099
Others	1	0.114164	3.16709492	0.036	0.9713

Table 3.2. First-Order Mixture Model for Natural Logarithm of PCT Normalized Lithium Release (g/m²) Fitted to Data from CVS-I and CVS-II Phase 1, 2, 3, 4 CCC Glasses**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	9	145.40909	16.15657	15.096	0.0001
Error	173	185.15440	1.07026		
C Total	182	330.56349			

Root MSE	1.03453	R-square	0.4399
Dep Mean	0.55433	R-sq ADJ	0.4107
C.V.	186.62671	R-sq PRESS	0.3676

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
SiO2	1	-4.007764	0.79668367	-5.031	0.0001
B2O3	1	11.304361	1.58386744	7.137	0.0001
Na2O	1	12.469785	1.70696196	7.305	0.0001
Li2O	1	12.716228	3.79579275	3.350	0.0010
CaO	1	-9.136948	2.96330684	-3.083	0.0024
MgO	1	11.575820	3.13456043	3.693	0.0003
Fe2O3	1	3.277678	2.20333993	1.488	0.1387
Al2O3	1	-11.439757	1.97249718	-5.800	0.0001
ZrO2	1	-7.466985	2.61726585	-2.853	0.0049
Others	1	-0.393880	2.78026608	-0.142	0.8875

Table 3.3. of PCT Normalized Sodium Release (g/m²) Fitted to Data from CVS-I and CVS-II Phase 1, 2, 3, 4 CCC GlassesAnalysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	9	226.22463	25.13607	23.535	0.0001
Error	173	184.76914	1.06803		
C Total	182	410.99376			

Root MSE	1.03346	R-square	0.5504
Dep Mean	0.34531	R-sq ADJ	0.5270
C.V.	299.28214	R-sq PRESS	0.4935

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
SiO2	1	-4.800071	0.79585204	-6.031	0.0001
B2O3	1	11.339632	1.58221410	7.167	0.0001
Na2O	1	16.583653	1.70518012	9.725	0.0001
Li2O	1	15.431567	3.79183047	4.070	0.0001
CaO	1	-8.384991	2.96021356	-2.833	0.0052
MgO	1	16.442147	3.13128838	5.251	0.0001
Fe2O3	1	1.721580	2.20103994	0.782	0.4352
Al2O3	1	-16.471572	1.97043816	-8.359	0.0001
ZrO2	1	-9.927814	2.61453379	-3.797	0.0002
Others	1	-1.564807	2.77736387	-0.563	0.5739

Table 3.4. First-Order Mixture Model for Natural Logarithm of PCT Normalized Silicon Release (g/m²) Fitted to Data from CVS-I and CVS-II Phase 1, 2, 3, 4 CCC GlassesAnalysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	9	105.58065	11.73118	25.930	0.0001
Error	173	78.26831	0.45242		
C Total	182	183.84896			

Root MSE	0.67262	R-square	0.5743
Dep Mean	-0.89134	R-sq ADJ	0.5521
C.V.	-75.46172	R-sq PRESS	0.5107

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
SiO2	1	-2.777989	0.51798329	-5.363	0.0001
B2O3	1	-1.491699	1.02978998	-1.449	0.1493
Na2O	1	10.464110	1.10982288	9.429	0.0001
Li2O	1	19.192275	2.46792709	7.777	0.0001
CaO	1	-7.078627	1.92666610	-3.674	0.0003
MgO	1	4.369483	2.03801079	2.144	0.0334
Fe2O3	1	-1.354582	1.43255510	-0.946	0.3457
Al2O3	1	-13.345625	1.28246707	-10.406	0.0001
ZrO2	1	-10.557311	1.70167913	-6.204	0.0001
Others	1	-3.396646	1.80765769	-1.879	0.0619

Table 3.5. First-Order Mixture Model for Natural Logarithm of PCT Normalized Boron Release (g/m^2) Fitted to Data from CVS-I and CVS-II Phase 1, 2, 3, 4 CCC Glasses, After Removing Glasses with Greater than 7 vol% Crystallinity and Glasses Prone to Phase Separation

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	9	199.00445	22.11161	36.469	0.0001
Error	129	78.21527	0.60632		
C Total	138	277.21973			

Root MSE	0.77867	R-square	0.7179
Dep Mean	0.32342	R-sq ADJ	0.6982
C.V.	240.75710	R-sq PRESS	0.6672

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
SiO2	1	-4.729473	0.73493165	-6.435	0.0001
B2O3	1	10.543595	1.51703664	6.950	0.0001
Na2O	1	17.504083	1.57521016	11.112	0.0001
Li2O	1	27.160735	3.69240992	7.356	0.0001
CaO	1	-11.720019	2.67332508	-4.384	0.0001
MgO	1	3.271651	4.07641803	0.803	0.4237
Fe2O3	1	-4.556372	2.25695712	-2.019	0.0456
Al2O3	1	-20.671488	1.80960611	-11.423	0.0001
ZrO2	1	-10.823278	2.45296848	-4.412	0.0001
Others	1	4.510822	2.70866575	1.665	0.0983

Table 3.6. First-Order Mixture Model for Natural Logarithm of PCT Normalized Lithium Release (g/m^2) Fitted to Data from CVS-I and CVS-II Phase 1, 2, 3, 4 CCC Glasses, After Removing Glasses with Greater than 7 vol% Crystallinity and Glasses Prone to Phase Separation

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	9	144.07606	16.00845	36.352	0.0001
Error	129	56.80835	0.44037		
C Total	138	200.88442			

Root MSE	0.66361	R-square	0.7172
Dep Mean	0.25620	R-sq ADJ	0.6975
C.V.	259.02076	R-sq PRESS	0.6619

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
SiO2	1	-4.436977	0.62633719	-7.084	0.0001
B2O3	1	9.145401	1.29287733	7.074	0.0001
Na2O	1	15.724090	1.34245506	11.713	0.0001
Li2O	1	24.072487	3.14681462	7.650	0.0001
CaO	1	-8.611992	2.27831109	-3.780	0.0002
MgO	1	0.452491	3.47408120	0.130	0.8966
Fe2O3	1	-4.390745	1.92346620	-2.283	0.0241
Al2O3	1	-17.090101	1.54221636	-11.082	0.0001
ZrO2	1	-8.620854	2.09051467	-4.124	0.0001
Others	1	4.162898	2.30842978	1.803	0.0737

Table 3.7. First-Order Mixture Model for Natural Logarithm of PCT Normalized Sodium Release (g/m^2) Fitted to Data from CVS-I and CVS-II Phase 1, 2, 3, 4 CCC Glasses, After Removing Glasses with Greater than 7 vol% Crystallinity and Glasses Prone to Phase Separation

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	9	203.10294	22.56699	55.064	0.0001
Error	129	52.86787	0.40983		
C Total	138	255.97081			

Root MSE	0.64018	R-square	0.7935
Dep Mean	0.02603	R-sq ADJ	0.7791
C.V.	2459.14798	R-sq PRESS	0.7568

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
SiO2	1	-4.556784	0.60421649	-7.542	0.0001
B2O3	1	9.498114	1.24721606	7.615	0.0001
Na2O	1	18.355657	1.29504283	14.174	0.0001
Li2O	1	24.705463	3.03567682	8.138	0.0001
CaO	1	-6.852813	2.19784671	-3.118	0.0022
MgO	1	5.378146	3.35138514	1.605	0.1110
Fe2O3	1	-4.894687	1.85553407	-2.638	0.0094
Al2O3	1	-22.802564	1.48774904	-15.327	0.0001
ZrO2	1	-12.256678	2.01668280	-6.078	0.0001
Others	1	0.621302	2.22690167	0.279	0.7807

Table 3.8. First-Order Mixture Model for Natural Logarithm of PCT Normalized Silicon Release (g/m^2) Fitted to Data from CVS-I and CVS-II Phase 1, 2, 3, 4 CCC Glasses, After Removing Glasses with Greater than 7 vol% Crystallinity and Glasses Prone to Phase Separation

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	9	94.07655	10.45295	33.828	0.0001
Error	129	39.86118	0.30900		
C Total	138	133.93773			

Root MSE	0.55588	R-square	0.7024
Dep Mean	-0.98387	R-sq ADJ	0.6816
C.V.	-56.49911	R-sq PRESS	0.6323

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
SiO2	1	-2.987485	0.52466198	-5.694	0.0001
B2O3	1	-0.661856	1.08300063	-0.611	0.5422
Na2O	1	11.236233	1.12453026	9.992	0.0001
Li2O	1	23.312473	2.63598266	8.844	0.0001
CaO	1	-7.805378	1.90846594	-4.090	0.0001
MgO	1	-1.008831	2.91012306	-0.347	0.7294
Fe2O3	1	-3.433094	1.61122410	-2.131	0.0350
Al2O3	1	-16.476287	1.29186370	-12.754	0.0001
ZrO2	1	-11.752298	1.75115508	-6.711	0.0001
Others	1	-2.580012	1.93369537	-1.334	0.1845

work is needed to determine how crystallinity type and volume percent affect PCT releases and the goodness-of-fit of PCT release models for CCC glasses.

Models for PCT releases from CCC glasses were not included by Hrma, Piepel, et al. (1994), so the models in Tables 3.1 to 3.8 are "new" models rather than "updated" models.

3.2 Second-Order Mixture Models for PCT Data on CCC CVS-I and CVS-II Phase 1, 2, 3, and 4 Glasses

Tables 3.9 to 3.12 contain the results of fitting reduced second-order mixture models to natural logarithms of unaveraged PCT normalized B, Li, Na, and Si releases (g/m^2) for the 147 CVS-I and CVS-II Phases 1, 2, 3, and 4 CCC glasses. The data are the same as used for the first-order models in Tables 3.1 to 3.4, as given in Table A.4 of Appendix A. Two candidate models developed using different statistical methods to select the second-order terms (see Hrma, Piepel, et al. 1994, Section 6.1.4) are presented for each normalized elemental release.

The R^2 values for the reduced second-order models in Tables 3.9 to 3.12 are considerably higher than the R^2 values for the first-order models fit to the same data (in Tables 3.1 to 3.4). Although not given here, predicted versus measured plots for the models in Tables 3.9 to 3.12 do not show the tendency to overpredict lower releases and underpredict higher releases as was seen for the first-order models fit to the same data. There is still some scatter around the 45° lines in the predicted versus measured plots as would be expected for models with R^2 values in the range 0.69 - 0.80. Still, it is encouraging that reduced second-order models can reasonably well fit without bias PCT releases for a data set containing homogeneous glasses as well as glasses with crystals and glasses that may be phase separated. This should be confirmed by validating the models with data not used to develop them, where such data should contain PCT results from both homogeneous and nonhomogeneous glasses within the CVS composition region.

A possible reason for the failure of the second-order models in Tables 3.9 to 3.12 to perform any better than they did is the presence in the data set of glasses with crystals and glasses prone to phase separation. All glasses with larger than 7% (by volume) crystallinity or identified as prone to phase separation after CCC were eliminated from the data set and reduced second-order mixture models were developed. The data used to fit the models are the same as used for the first-order models in Tables 3.5 to 3.8. Tables 3.13 to 3.16 contain the results of fitting these reduced second-order mixture models. The R^2 values in Tables 3.13 to 3.16 are somewhat higher than the R^2 values for the first-order models fit to the same data (in Tables 3.5 to 3.8), so it appears some components have nonlinear effects even when the glasses prone to phase separation and glasses with crystals are deleted from the data set. The R^2 values in Tables 3.13 to 3.16 are also larger than the R^2 values in Tables 3.9 to 3.12. This indicates that deleting the glasses prone to phase separation and glasses with crystals after CCC improves the fit of second-order models.

Models for PCT releases from CCC glasses were not included by Hrma, Piepel, et al. (1994), so the models in Tables 3.9 to 3.12 are "new" models rather than "updated" models.

Table 3.9. Reduced Second-Order Mixture Models for Natural Logarithm of PCT Normalized Boron Release (g/m²) Fitted to Data from CVS-I and CVS-II Phase 1, 2, 3, 4 CCC Glasses**Model # 1****Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	14	332.15259	23.72518	33.134	0.0001
Error	168	120.29334	0.71603		
C Total	182	452.44593			
Root MSE		0.84619	R-square	0.7341	
Dep Mean		0.68193	R-sq ADJ	0.7120	
C.V.		124.08691	R-sq PRESS	0.6685	

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
SiO2	1	-6.755657	1.98265386	-3.407	0.0008
B2O3	1	-42.780881	11.47790189	-3.727	0.0003
Na2O	1	-39.444965	9.80175670	-4.024	0.0001
Li2O	1	0.318161	8.90402931	0.036	0.9715
CaO	1	-0.545034	2.90234274	-0.188	0.8513
MgO	1	24.927672	2.91810208	8.542	0.0001
Fe2O3	1	16.515069	2.54619891	6.486	0.0001
Al2O3	1	-27.111431	5.96152106	-4.548	0.0001
ZrO2	1	10.447908	3.44017887	3.037	0.0028
Others	1	14.679195	2.98973766	4.910	0.0001
SiO2_B2O3	1	128.280064	26.11404895	4.912	0.0001
Na2O_Li2O	1	261.434881	71.75311924	3.644	0.0004
Al2O3_ZrO2	1	-259.772284	76.03629051	-3.416	0.0008
Na2O_Na2O	1	221.445732	36.03572997	6.145	0.0001
Al2O3_Al2O3	1	184.312930	30.06609915	6.130	0.0001

Model # 2**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	17	343.83956	20.22586	30.728	0.0001
Error	165	108.60637	0.65822		
C Total	182	452.44593			
Root MSE		0.81131	R-square	0.7600	
Dep Mean		0.68193	R-sq ADJ	0.7352	
C.V.		118.97221	R-sq PRESS	0.6792	

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
SiO2	1	-7.723269	2.01353192	-3.836	0.0002
B2O3	1	-47.102833	11.52804466	-4.086	0.0001
Na2O	1	-35.998069	9.68224745	-3.718	0.0003
Li2O	1	11.260386	9.04511932	1.245	0.2149
CaO	1	0.976878	2.90030780	0.337	0.7367
MgO	1	-37.591288	20.96656991	-1.793	0.0748
Fe2O3	1	8.499593	4.03628222	2.106	0.0367
Al2O3	1	-26.392880	5.93717904	-4.445	0.0001
ZrO2	1	10.661334	3.91931285	2.720	0.0072
Others	1	16.246749	2.96121838	5.487	0.0001
SiO2_B2O3	1	129.134924	25.60600295	5.043	0.0001
SiO2_MgO	1	121.769148	42.27245436	2.881	0.0045
B2O3_Fe2O3	1	96.321209	31.44679655	3.063	0.0026
Na2O_Li2O	1	187.846198	71.79469280	2.616	0.0097
MgO_ZrO2	1	134.115516	70.28168283	1.908	0.0581
Al2O3_ZrO2	1	-273.291095	74.98488993	-3.645	0.0004
Na2O_Na2O	1	225.389991	35.37642501	6.371	0.0001
Al2O3_Al2O3	1	191.766496	29.18307375	6.571	0.0001

Table 3.10. Reduced Second-Order Mixture Models for Natural Logarithm of PCT Normalized Lithium Release (g/m²) Fitted to Data from CVS-I and CVS-II Phase 1, 2, 3, 4 CCC Glasses

Model # 1

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	16	236.13061	14.75816	25.943	0.0001
Error	166	94.43289	0.56887		
C Total	182	330.56349			
Root MSE		0.75424	R-square	0.7143	
Dep Mean		0.55433	R-sq ADJ	0.6868	
C.V.		136.06218	R-sq PRESS	0.6344	

Parameter Estimates					
Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
SiO2	1	1.513727	1.10043572	1.376	0.1708
B2O3	1	15.750586	1.49374736	10.544	0.0001
Na2O	1	-42.895300	9.83366796	-4.362	0.0001
Li2O3	1	-17.069195	7.40843440	-2.304	0.0225
CaO	1	8.306005	4.78655752	1.735	0.0845
MgO	1	13.448190	2.31424944	5.811	0.0001
Fe2O3	1	8.654273	4.04492043	2.140	0.0339
Al2O3	1	-48.537469	6.59807667	-7.356	0.0001
ZrO2	1	-2.586309	2.51214878	-1.030	0.3047
Others	1	5.644576	2.19389754	2.573	0.0110
B2O3_CaO	1	-111.251325	39.17124680	-2.840	0.0051
Na2O_Li2O	1	315.952474	63.73672282	4.957	0.0001
Na2O3_Fe2O3	1	-76.738563	37.46204272	-2.048	0.0421
Fe2O3_Al2O3	1	178.685321	44.90685965	3.979	0.0001
Al2O3_ZrO2R	1	-131.451995	67.75209843	-1.940	0.0541
Na2O_Na2O	1	197.727610	33.97046994	5.821	0.0001
Al2O3_Al2O3	1	225.874649	31.85261977	7.091	0.0001

Model # 2

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	20	252.17159	12.60858	26.056	0.0001
Error	162	78.39191	0.48390		
C Total	182	330.56349			
Root MSE		0.69563	R-square	0.7629	
Dep Mean		0.55433	R-sq ADJ	0.7336	
C.V.		125.48965	R-sq PRESS	0.6825	

Parameter Estimates					
Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
SiO2	1	-5.794430	2.09592406	-2.765	0.0064
B2O3	1	-28.070113	10.86097816	-2.584	0.0106
Na2O	1	-26.419756	9.73966380	-2.713	0.0074
Li2O	1	-26.360794	15.29882734	-1.723	0.0868
CaO	1	12.233333	4.48965731	2.725	0.0071
MgO	1	-37.994714	17.83295612	-2.131	0.0346
Fe2O3	1	13.227606	6.23865266	2.120	0.0355
Al2O3	1	-34.631911	6.79504056	-5.097	0.0001
ZrO2	1	7.920501	3.10269200	2.553	0.0116
Others	1	13.430662	2.62952798	5.108	0.0001
SiO2_B2O3	1	92.839266	23.90418223	3.884	0.0001
SiO2_MgO	1	113.364753	36.33210001	3.120	0.0021
B2O3_CaO	1	-91.432810	36.99113701	-2.472	0.0145
B2O3_Fe2O3	1	69.720171	27.93329149	2.496	0.0136
Na2O_Li2O	1	217.175929	64.02827599	3.392	0.0009
Na2O_Fe2O3	1	-100.780920	38.16738804	-2.640	0.0091
Fe2O3_Al2O3	1	156.391915	42.37585267	3.691	0.0003
Al2O3_ZrO2	1	-191.562478	64.14273567	-2.987	0.0033
Na2O_Na2O	1	175.675759	31.98130418	5.493	0.0001
Li2O_Li2O	1	345.841455	147.50918361	2.345	0.0203
Al2O3_Al2O3	1	196.029020	30.81697906	6.361	0.0001

Table 3.11. Reduced Second-Order Mixture Models for Natural Logarithm of PCT Normalized Sodium Release (g/m²) Fitted to Data from CVS-I and CVS-II Phase 1, 2, 3, 4 CCC Data**Model # 1****Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	14	313.52074	22.39434	38.598	0.0001
Error	168	97.47302	0.58020		
C Total	182	410.99376			

Root MSE	0.76171	R-square	0.7628
Dep Mean	0.34531	R-sq ADJ	0.7431
C.V.	220.58537	R-sq PRESS	0.7009

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
SiO2	1	1.938727	0.93330429	2.077	0.0393
B2O3	1	8.742031	1.99270564	4.387	0.0001
Na2O	1	-44.013051	8.86354767	-4.966	0.0001
Li2O	1	-14.939088	7.61812304	-1.961	0.0515
CaO	1	-2.195351	2.30886300	-0.951	0.3431
MgO	1	18.622154	2.32319852	8.016	0.0001
Fe2O3	1	-2.754487	3.48274668	-0.791	0.4301
Al2O3	1	-39.656433	5.10694047	-7.765	0.0001
ZrO2	1	-2.877117	2.51169978	-1.145	0.2536
Others	1	3.817269	2.20050135	1.735	0.0846
B2O3_Fe2O3	1	87.462682	28.99131972	3.017	0.0030
Na2O_Li2O	1	311.556994	64.69965416	4.815	0.0001
Al2O3_ZrO2	1	-133.593966	68.21929020	-1.958	0.0519
Na2O_Na2O	1	209.324927	32.76202381	6.389	0.0001
Al2O3_Al2O3	1	184.155879	27.22023456	6.765	0.0001

Model # 2**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	17	327.88247	19.28720	38.291	0.0001
Error	165	83.11129	0.50370		
C Total	182	410.99376			

Root MSE	0.70972	R-square	0.7978
Dep Mean	0.34531	R-sq ADJ	0.7769
C.V.	205.53092	R-sq PRESS	0.7374

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
SiO2	1	-3.621689	1.79327921	-2.020	0.0450
B2O3	1	-28.807339	10.25846124	-2.808	0.0056
Na2O	1	-36.606996	8.51675968	-4.298	0.0001
Li2O	1	0.667369	7.99668420	0.083	0.9336
CaO	1	3.944893	2.51157003	1.571	0.1182
MgO	1	22.848962	2.46978969	9.251	0.0001
Fe2O3	1	-3.308025	3.90818629	-0.846	0.3985
Al2O3	1	-46.425248	6.80016664	-6.827	0.0001
ZrO2	1	7.426579	3.79861086	1.955	0.0523
Others	1	13.107878	3.00279262	4.365	0.0001
SiO2_B2O3	1	86.594918	22.83566493	3.792	0.0002
B2O3_Fe2O3	1	101.519945	27.15396350	3.739	0.0003
Na2O_Li2O	1	251.761660	63.00320442	3.996	0.0001
Fe2O3_Al2O3	1	134.906412	44.72830296	3.016	0.0030
Al2O3_ZrO2	1	-187.153946	65.18874075	-2.871	0.0046
ZrO2_Others	1	-105.744755	50.71781629	-2.085	0.0386
Na2O_Na2O	1	205.920118	30.65063384	6.718	0.0001
Al2O3_Al2O3	1	231.679156	30.88110540	7.502	0.0001

Table 3.12. Reduced Second-Order Mixture Models for Natural Logarithm of PCT Normalized Silicon Release (g/m²) Fitted to Data from CVS-I and CVS-II Phase 1, 2, 3, 4 CCC Glasses**Model # 1****Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	12	126.39919	10.53327	31.169	0.0001
Error	170	57.44977	0.33794		
C Total	182	183.84896			

Root MSE	0.58133	R-square	0.6875
Dep Mean	-0.89134	R-sq ADJ	0.6655
C.V.	-65.21934	R-sq PRESS	0.6246

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
SiO2	1	-1.804316	0.48345279	-3.732	0.0003
B2O3	1	-1.270596	0.90329929	-1.407	0.1614
Na2O	1	10.442920	0.96580882	10.813	0.0001
Li2O	1	20.982744	2.17871278	9.631	0.0001
CaO	1	-5.279892	1.69031812	-3.124	0.0021
MgO	1	4.680635	1.76381553	2.654	0.0087
Fe2O3	1	-5.936842	1.65527513	-3.587	0.0004
Al2O3	1	-38.904283	5.03434918	-7.728	0.0001
ZrO2	1	-9.335453	1.89393574	-4.929	0.0001
Others	1	-2.455712	1.57300103	-1.561	0.1203
Fe2O3_Al2O3	1	151.028445	33.86138508	4.460	0.0001
Al2O3_ZrO2	1	-139.722912	50.00565907	-2.794	0.0058
Al2O3_Al2O3	1	133.784698	24.24921435	5.517	0.0001

Model # 2**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	14	131.53494	9.39535	30.172	0.0001
Error	168	52.31402	0.31139		
C Total	182	183.84896			

Root MSE	0.55803	R-square	0.7155
Dep Mean	-0.89134	R-sq ADJ	0.6917
C.V.	-62.60531	R-sq PRESS	0.6467

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
SiO2	1	-4.948481	1.20014132	-4.123	0.0001
B2O3	1	-28.117819	7.49953054	-3.749	0.0002
Na2O	1	2.250329	5.48245924	0.410	0.6820
Li2O	1	25.577532	2.40264661	10.646	0.0001
CaO	1	-1.505190	1.90727737	-0.789	0.4311
MgO	1	8.064921	1.93489256	4.168	0.0001
Fe2O3	1	-0.331672	2.11724618	-0.157	0.8757
Al2O3	1	-32.026903	5.27094150	-6.076	0.0001
ZrO2	1	-3.795634	2.34314787	-1.620	0.1071
Others	1	2.695003	1.97267385	1.366	0.1737
SiO2_B2O3	1	62.355419	17.10788633	3.645	0.0004
Fe2O3_Al2O3	1	126.281334	33.24411937	3.799	0.0002
Al2O3_ZrO2	1	-144.111068	50.20805285	-2.870	0.0046
Na2O_Na2O	1	47.901654	23.00243663	2.082	0.0388
Al2O3_Al2O3	1	125.271403	23.82943743	5.257	0.0001

Table 3.13. Reduced Second-Order Mixture Models for Natural Logarithm of PCT Normalized Boron Release (g/m²) Fitted to Data from CVS-I and CVS-II Phase 1, 2, 3, 4 CCC Glasses, After Removing Glasses with Greater than 7 vol% Crystallinity and Glasses Prone to Phase Separation

Model # 1

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	12	226.20147	18.85012	46.554	0.0001
Error	126	51.01825	0.40491		
C Total	138	277.21973			

Root MSE	0.63632	R-square	0.8160
Dep Mean	0.32342	R-sq ADJ	0.7984
C.V.	196.74590	R-sq PRESS	0.7492

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
SiO2	1	-4.417856	0.65002479	-6.796	0.0001
B2O3	1	10.382054	1.27434182	8.147	0.0001
Na2O	1	20.713860	1.98784032	10.420	0.0001
Li2O	1	24.764615	3.10757620	7.969	0.0001
CaO	1	-10.039076	2.21239448	-4.538	0.0001
MgO	1	21.421889	6.63978651	3.226	0.0016
Fe2O3	1	-3.192890	1.90692112	-1.674	0.0965
Al2O3	1	-38.357837	6.12323497	-6.264	0.0001
ZrO2	1	-11.113592	2.04785744	-5.427	0.0001
Others	1	2.798598	2.37618528	1.178	0.2411
Na2O_Al2O3	1	-68.140624	31.14513912	-2.188	0.0305
MgO_Al2O3	1	-183.209411	72.25572242	-2.536	0.0124
Al2O3_Al2O3	1	165.890813	24.67036814	6.724	0.0001

Model # 2

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	16	238.54433	14.90902	47.030	0.0001
Error	122	38.67539	0.31701		
C Total	138	277.21973			

Root MSE	0.56304	R-square	0.8605
Dep Mean	0.32342	R-sq ADJ	0.8422
C.V.	174.08671	R-sq PRESS	0.8019

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
SiO2	1	-3.554928	0.69467323	-5.117	0.0001
B2O3	1	11.818168	1.18076574	10.009	0.0001
Na2O	1	0.255663	7.47089792	0.034	0.9728
Li2O	1	17.073489	4.15311140	4.111	0.0001
CaO	1	-12.483030	2.51892209	-4.956	0.0001
MgO	1	53.295111	10.71000898	4.976	0.0001
Fe2O3	1	-8.288142	3.91563461	-2.117	0.0363
Al2O3	1	-35.217439	5.48956007	-6.415	0.0001
ZrO2	1	-10.853250	2.27665387	-4.767	0.0001
Others	1	10.760252	2.53043180	4.252	0.0001
Na2O_Al2O3	1	-94.863293	28.38985411	-3.341	0.0011
Li2O_Fe2O3	1	178.776061	69.84659483	2.560	0.0117
CaO_ZrO2	1	137.814339	47.56971158	2.897	0.0045
MgO_Al2O3	1	-409.633459	87.02170186	-4.707	0.0001
MgO_Others	1	-381.836487	121.49364298	-3.143	0.0021
Na2O_Na2O	1	93.915998	30.17459594	3.112	0.0023
Al2O3_Al2O3	1	185.627649	22.39310837	8.289	0.0001

Table 3.14. Reduced Second-Order Mixture Models for Natural Logarithm of PCT Normalized Lithium Release (g/m²) Fitted to Data from CVS-I and CVS-II Phase 1, 2, 3, 4 CCC Glasses, After Removing Glasses with Greater than 7 vol% Crystallinity and Glasses Prone to Phase Separation

Model # 1

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	13	166.82056	12.83235	47.089	0.0001
Error	125	34.06386	0.27251		
C Total	138	200.88442			
Root MSE		0.52203	R-square	0.8304	
Dep Mean		0.25620	R-sq ADJ	0.8128	
C.V.		203.75826	R-sq PRESS	0.7729	

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
SiO2	1	1.817566	1.09883766	1.654	0.1006
B2O3	1	10.451205	1.30624695	8.001	0.0001
Na2O	1	-30.076329	9.26894338	-3.245	0.0015
Li2O	1	-7.281000	8.20160824	-0.888	0.3764
CaO	1	-5.846645	1.87763243	-3.114	0.0023
MgO	1	5.615421	2.93369256	1.914	0.0579
Fe2O3	1	-0.220432	1.83663678	-0.120	0.9047
Al2O3	1	-41.523141	3.60884945	-11.506	0.0001
ZrO2	1	46.358957	14.28227010	3.246	0.0015
Others	1	6.668046	2.17194428	3.070	0.0026
SiO2_ZrO2	1	-105.602762	28.75203790	-3.673	0.0004
Na2O_Li2O	1	245.618039	65.56426877	3.746	0.0003
Na2O_Na2O	1	141.223240	31.15052850	4.534	0.0001
Al2O3_Al2O3	1	168.786684	20.48329138	8.240	0.0001

Model # 2

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	15	168.89740	11.25983	43.298	0.0001
Error	123	31.98702	0.26006		
C Total	138	200.88442			
Root MSE		0.50996	R-square	0.8408	
Dep Mean		0.25620	R-sq ADJ	0.8214	
C.V.		199.04792	R-sq PRESS	0.7798	

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
SiO2	1	3.836443	1.35746536	2.826	0.0055
B2O3	1	9.975414	1.70743070	5.842	0.0001
Na2O	1	-36.079419	9.30104198	-3.879	0.0002
Li2O	1	-11.092229	8.13585444	-1.363	0.1753
CaO	1	-3.879581	4.63961272	-0.836	0.4047
MgO	1	4.277641	2.90800446	1.471	0.1438
Fe2O3	1	-1.742228	1.91994649	-0.907	0.3660
Al2O3	1	-42.828736	3.66649471	-11.681	0.0001
ZrO2	1	46.131593	14.05722568	3.282	0.0013
Others	1	40.080794	14.99506065	2.673	0.0085
SiO2_ZrO2	1	-108.425903	28.21922203	-3.842	0.0002
SiO2_Others	1	-70.081198	30.68410155	-2.284	0.0241
B2O3_CaO	1	-39.907166	37.73655246	-1.058	0.2923
Na2O_Li2O	1	262.127216	65.32203740	4.013	0.0001
Na2O_Na2O	1	153.892565	30.75141317	5.004	0.0001
Al2O3_Al2O3	1	168.552548	20.37133875	8.274	0.0001

Table 3.15. Reduced Second-Order Mixture Models for Natural Logarithm of PCT Normalized Sodium Release (g/m^2) Fitted to Data from CVS-I and CVS-II Phase 1, 2, 3, 4 CCC Data, After Removing Glasses with Greater than 7 vol% Crystallinity and Glasses Prone to Phase Separation

Model # 1

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	11	221.06570	20.09688	73.121	0.0001
Error	127	34.90511	0.27484		
C Total	138	255.97081			

Root MSE	0.52426	R-square	0.8636
Dep Mean	0.02603	R-sq ADJ	0.8518
C.V.	2013.84608	R-sq PRESS	0.8275

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
SiO2	1	-3.958730	0.50766187	-7.798	0.0001
B2O3	1	9.724146	1.02199718	9.515	0.0001
Na2O	1	19.288792	1.08246731	17.819	0.0001
Li2O	1	24.974679	2.49073225	10.027	0.0001
CaO	1	-9.764965	2.25410399	-4.332	0.0001
MgO	1	8.577779	2.80291590	3.060	0.0027
Fe2O3	1	-3.649961	1.54071882	-2.369	0.0193
Al2O3	1	-46.043225	3.42700659	-13.435	0.0001
ZrO2	1	-16.263200	1.94340499	-8.368	0.0001
Others	1	1.839576	1.83382479	1.003	0.3177
CaO_ZrO2	1	141.814277	43.55999422	3.256	0.0015
Al2O3_Al2O3	1	143.158457	19.76008558	7.245	0.0001

Model # 2

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	14	226.85261	16.20376	69.004	0.0001
Error	124	29.11820	0.23482		
C Total	138	255.97081			

Root MSE	0.48459	R-square	0.8862
Dep Mean	0.02603	R-sq ADJ	0.8734
C.V.	1861.46578	R-sq PRESS	0.8458

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
SiO2	1	1.159566	1.00347437	1.156	0.2501
B2O3	1	6.134869	1.75756266	3.491	0.0007
Na2O	1	-17.771121	8.23935651	-2.157	0.0330
Li2O	1	3.904768	7.41639131	0.527	0.5995
CaO	1	-6.709021	2.09795691	-3.198	0.0018
MgO	1	10.736943	2.62096823	4.097	0.0001
Fe2O3	1	-0.342500	1.65096199	-0.207	0.8360
Al2O3	1	-50.173301	3.30467048	-15.183	0.0001
ZrO2	1	31.826243	12.98009149	2.452	0.0156
Others	1	-9.093726	4.02591147	-2.259	0.0257
SiO2_ZrO2	1	-91.292852	25.91243421	-3.523	0.0006
B2O3_Others	1	120.941665	33.92068974	3.565	0.0005
Na2O_Li2O	1	166.963713	59.19289365	2.821	0.0056
CaO_ZrO2	1	122.873655	38.86554547	3.162	0.0020
Na2O_Na2O	1	121.048482	27.74394817	4.363	0.0001
Al2O3_Al2O3	1	184.250948	18.87951999	9.759	0.0001

Table 3.16. Reduced Second-Order Mixture Models for Natural Logarithm of PCT Normalized Silicon Release (g/m^2) Fitted to Data from CVS-I and CVS-II Phase 1, 2, 3, 4 CCC Glasses, After Removing Glasses with Greater than 7 vol% Crystallinity and Glasses Prone to Phase Separation

Model # 1

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	15	110.57760	7.37184	38.816	0.0001
Error	123	23.36013	0.18992		
C Total	138	133.93773			
Root MSE		0.43580	R-square	0.8256	
Dep Mean		-0.98387	R-sq ADJ	0.8043	
C.V.		-44.29416	R-sq PRESS	0.7216	

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
SiO2	1	-1.779187	0.45322973	-3.926	0.0001
B2O3	1	0.692198	0.88500095	0.782	0.4356
Na2O	1	13.435374	0.97111912	13.835	0.0001
Li2O	1	26.317275	2.28071862	11.539	0.0001
CaO	1	-8.570588	2.21031748	-3.878	0.0002
MgO	1	13.513630	3.40954250	3.963	0.0001
Fe2O3	1	-19.831176	4.52945246	-4.378	0.0001
Al2O3	1	-54.836405	5.64201437	-9.719	0.0001
ZrO2	1	-15.241247	1.65590597	-9.204	0.0001
Others	1	-1.114247	2.69499208	-0.413	0.6800
CaO_ZrO2	1	93.438086	37.71599077	2.477	0.0146
MgO_Others	1	-313.356009	71.48757672	-4.383	0.0001
Fe2O3_Al2O3	1	171.186401	43.07004341	3.975	0.0001
Al2O3_Others	1	91.766260	37.42730223	2.452	0.0156
Fe2O3_Fe2O3	1	80.955214	31.90730239	2.537	0.0124
Al2O3_Al2O3	1	175.134059	25.22696138	6.942	0.0001

Model # 2

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	16	112.65887	7.04118	40.370	0.0001
Error	122	21.27886	0.17442		
C Total	138	133.93773			
Root MSE		0.41763	R-square	0.8411	
Dep Mean		-0.98387	R-sq ADJ	0.8203	
C.V.		-42.44784	R-sq PRESS	0.7383	

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
SiO2	1	-0.618841	0.54907691	-1.127	0.2619
B2O3	1	1.723018	0.89908038	1.916	0.0577
Na2O	1	6.750766	2.14728841	3.144	0.0021
Li2O	1	6.972215	6.01162707	1.160	0.2484
CaO	1	-8.473198	2.11837492	-4.000	0.0001
MgO	1	16.066139	3.34993910	4.796	0.0001
Fe2O3	1	-21.435367	4.36542836	-4.910	0.0001
Al2O3	1	-50.965134	5.52176940	-9.230	0.0001
ZrO2	1	-14.206871	1.61488985	-8.797	0.0001
Others	1	-1.182246	2.58273477	-0.458	0.6479
Na2O_Li2O	1	160.211008	46.37971992	3.454	0.0008
CaO_ZrO2	1	96.016650	36.15162499	2.656	0.0090
MgO_Others	1	-335.652836	68.81124806	-4.878	0.0001
Fe2O3_Al2O3	1	144.798936	41.97574141	3.450	0.0008
Al2O3_Others	1	94.960446	35.87917966	2.647	0.0092
Fe2O3_Fe2O3	1	106.150016	31.43520109	3.377	0.0010
Al2O3_Al2O3	1	161.465164	24.49715625	6.591	0.0001

4.0 MODELS FOR MCC-1 RELEASES FROM QUENCHED GLASS

First-order mixture models fitted to MCC-1 data from quenched CVS-I and CVS-II Phase 1, 2, 3, and 4 glasses are presented in Section 4.1. Reduced second-order mixture models fitted to MCC-1 data from quenched CVS-I and CVS-II Phase 1, 2, 3, and 4 glasses are presented in Section 4.2.

4.1 First-Order Mixture Models for MCC-1 Data on Quenched CVS-I and CVS-II Phase 1, 2, 3, and 4 Glasses

Tables 4.1 to 4.4 contain the results of fitting first-order mixture models to natural logarithms of averaged MCC-1 normalized B, Li, Na, and Si releases (g/m^2) for the CVS-I and CVS-II Phase 1, 2, 3, and 4 quenched glasses. MCC-1 data were available for only 144 of the 147 glasses. MCC-1 testing was not performed for the two radioactive glasses (CVS2-53 and CVS2-54), and CVS2-124. The 10-component compositions of the CVS-I and CVS-II glasses and the corresponding averaged normalized releases are given in Table A.5 of Appendix A. The models in Tables 4.1 to 4.4 update the models in Table 12.2a of Hrma, Piepel, et al. (1994), which were developed using data up through CVS-II Phase 3. The R^2 values are somewhat low, and predicted versus measured plots (not given here) show a curved pattern. This is potentially due to the presence of a few very high release data points in the data set, and also potentially due to the need for nonlinear blending terms in the mixture models.

Tables 4.5 to 4.8 contain the results of fitting first-order mixture models to natural logarithms of averaged MCC-1 normalized B, Li, Na, and Si releases (g/m^2) for 137 CVS-I and CVS-II Phase 1, 2, 3, and 4 quenched glasses after deleting the data corresponding to glasses CVS1-4, CVS1-6, CVS1-9, CVS1-13, CVS1-15, CVS1-21, and CVS2-82. These seven data points had the highest normalized B releases. Hrma, Piepel, et al. (1994) found that model predictions of normalized B, Li, Na, and Si releases at lower release values made with models developed using these data were adversely affected. Hence, first-order mixture models were refit without these seven data points. The models in Tables 4.5 to 4.8 update the models in Table 12.3a of Hrma, Piepel, et al. (1994), which were developed using data up through CVS-II Phase 3 (and also eliminating the seven points). The R^2 values in Tables 4.5 to 4.8 did not improve much compared to those in Tables 4.1 to 4.4. However, this is misleading in that the R^2 values are for different data sets. The models in Tables 4.5 to 4.8 fit/predict the data without the seven deleted points better than the models in Tables 4.1 to 4.4, which is not reflected in comparing the R^2 values for models with and without the seven data points. As an example, for the subset of data without the seven deleted points, the R^2 for the normalized B release model in Table 4.1 is 0.5891, whereas the model in Table 4.5 has a larger R^2 of 0.6747. Hence, the models in Tables 4.5 to 4.8 do fit this subset of the data noticeably better. However, the R^2 values for this subset of the data are still rather low. This could be due to the need for nonlinear blending terms in the mixture models.

Table 4.1. First-Order Mixture Model for Natural Logarithm of MCC-1 Normalized Boron Release (g/m²) Fitted to Data from 144 CVS-I and CVS-II Phase 1, 2, 3, 4 Quenched GlassesAnalysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	9	78.19276	8.68808	30.673	0.0001
Error	134	37.95547	0.28325		
C Total	143	116.14823			

Root MSE	0.53221	R-square	0.6732
Dep Mean	2.99079	R-sq ADJ	0.6513
C.V.	17.79503	R-sq PRESS	0.6012

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
SiO2	1	0.549159	0.47138662	1.165	0.2461
B2O3	1	11.836172	0.89394131	13.240	0.0001
Na2O	1	11.471367	0.96213517	11.923	0.0001
Li2O	1	12.841357	2.15286769	5.965	0.0001
CaO	1	2.610110	1.62199349	1.609	0.1099
MgO	1	8.184703	1.79134191	4.569	0.0001
Fe2O3	1	1.672974	1.26538303	1.322	0.1884
Al2O3	1	-11.340423	1.12319790	-10.097	0.0001
ZrO2	1	-5.061814	1.42897255	-3.542	0.0005
Others	1	1.399442	1.56394096	0.895	0.3725

Table 4.2. First-Order Mixture Model for Natural Logarithm of MCC-1 Normalized Lithium Release (g/m²) Fitted to Data from 144 CVS-I and CVS-II Phase 1, 2, 3, 4 Quenched GlassesAnalysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	9	74.53603	8.28178	29.923	0.0001
Error	134	37.08653	0.27677		
C Total	143	111.62256			

Root MSE	0.52608	R-square	0.6678
Dep Mean	2.91013	R-sq ADJ	0.6454
C.V.	18.07768	R-sq PRESS	0.5946

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
SiO2	1	0.426386	0.46596064	0.915	0.3618
B2O3	1	11.681913	0.88365143	13.220	0.0001
Na2O	1	11.188983	0.95106033	11.765	0.0001
Li2O	1	11.634959	2.12808670	5.467	0.0001
CaO	1	3.551466	1.60332323	2.215	0.0284
MgO	1	7.929976	1.77072233	4.478	0.0001
Fe2O3	1	1.950696	1.25081760	1.560	0.1212
Al2O3	1	-10.885474	1.11026911	-9.804	0.0001
ZrO2	1	-4.755123	1.41252409	-3.366	0.0010
Others	1	1.783140	1.54593892	1.153	0.2508

Table 4.3. First-Order Mixture Model for Natural Logarithm of MCC-1 Normalized Sodium Release (g/m²) Fitted to Data from 144 CVS-I and CVS-II Phase 1, 2, 3, 4 Quenched Glasses**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	9	73.98272	8.22030	31.204	0.0001
Error	134	35.30031	0.26344		
C Total	143	109.28304			

Root MSE	0.51326	R-square	0.6770
Dep Mean	2.94958	R-sq ADJ	0.6553
C.V.	17.40109	R-sq PRESS	0.6041

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
SiO2	1	0.608592	0.45459884	1.339	0.1829
B2O3	1	11.756698	0.86210483	13.637	0.0001
Na2O	1	10.858304	0.92787006	11.702	0.0001
Li2O	1	13.183343	2.07619630	6.350	0.0001
CaO	1	2.637247	1.56422845	1.686	0.0941
MgO	1	8.131637	1.72754576	4.707	0.0001
Fe2O3	1	1.709431	1.22031817	1.401	0.1636
Al2O3	1	-11.032660	1.08319676	-10.185	0.0001
ZrO2	1	-5.275624	1.37808168	-3.828	0.0002
Others	1	0.902447	1.50824337	0.598	0.5506

Table 4.4. First-Order Mixture Model for Natural Logarithm of MCC-1 Normalized Silicon Release (g/m²) Fitted to Data from 144 CVS-I and CVS-II Phase 1, 2, 3, 4 Quenched Glasses**Analysis of Variance**

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	9	43.19237	4.79915	26.803	0.0001
Error	134	23.99319	0.17905		
C Total	143	67.18556			

Root MSE	0.42315	R-square	0.6429
Dep Mean	2.63308	R-sq ADJ	0.6189
C.V.	16.07041	R-sq PRESS	0.5623

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
SiO2	1	1.371112	0.37478456	3.658	0.0004
B2O3	1	8.505892	0.71074439	11.968	0.0001
Na2O	1	8.917194	0.76496317	11.657	0.0001
Li2O	1	11.005842	1.71167686	6.430	0.0001
CaO	1	0.809119	1.28959561	0.627	0.5315
MgO	1	3.655072	1.42423917	2.566	0.0114
Fe2O3	1	1.610364	1.00606593	1.601	0.1118
Al2O3	1	-8.722465	0.89301904	-9.767	0.0001
ZrO2	1	-5.569678	1.13613078	-4.902	0.0001
Others	1	0.318520	1.24343988	0.256	0.7982

Table 4.5. First-Order Mixture Model for Natural Logarithm of MCC-1 Normalized Boron Release (g/m²) Fitted to Data from 137 CVS-I and CVS-II Phase 1, 2, 3, 4 Quenched GlassesAnalysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	9	44.18410	4.90934	29.269	0.0001
Error	127	21.30177	0.16773		
C Total	136	65.48587			

Root MSE	0.40955	R-square	0.6747
Dep Mean	2.86047	R-sq ADJ	0.6517
C.V.	14.31756	R-sq PRESS	0.6121

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
SiO2	1	-0.223326	0.39497136	-0.565	0.5728
B2O3	1	10.038974	0.74702752	13.439	0.0001
Na2O	1	10.139310	0.76638969	13.230	0.0001
Li2O	1	12.067466	1.71919296	7.019	0.0001
CaO	1	3.481477	1.25781956	2.768	0.0065
MgO	1	4.987455	1.51418203	3.294	0.0013
Fe2O3	1	5.808865	1.11576085	5.206	0.0001
Al2O3	1	-6.614150	1.01427110	-6.521	0.0001
ZrO2	1	-0.962881	1.23824624	-0.778	0.4382
Others	1	3.484265	1.33560277	2.609	0.0102

Table 4.6. First-Order Mixture Model for Natural Logarithm of MCC-1 Normalized Lithium Release (g/m²) Fitted to Data from 137 CVS-I and CVS-II Phase 1, 2, 3, 4 Quenched GlassesAnalysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	9	42.77502	4.75278	29.552	0.0001
Error	127	20.42533	0.16083		
C Total	136	63.20035			

Root MSE	0.40104	R-square	0.6768
Dep Mean	2.78280	R-sq ADJ	0.6539
C.V.	14.41119	R-sq PRESS	0.6161

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
SiO2	1	-0.353647	0.38676239	-0.914	0.3623
B2O3	1	9.869879	0.73150152	13.493	0.0001
Na2O	1	9.837509	0.75046127	13.109	0.0001
Li2O	1	10.909885	1.68346176	6.481	0.0001
CaO	1	4.455194	1.23167741	3.617	0.0004
MgO	1	4.841599	1.48271171	3.265	0.0014
Fe2O3	1	6.090148	1.09257121	5.574	0.0001
Al2O3	1	-6.152094	0.99319078	-6.194	0.0001
ZrO2	1	-0.649254	1.21251089	-0.535	0.5933
Others	1	3.916399	1.30784399	2.995	0.0033

Table 4.7. First-Order Mixture Model for Natural Logarithm of MCC-1 Normalized Sodium Release (g/m^2) Fitted to Data from 137 CVS-I and CVS-II Phase 1, 2, 3, 4 Quenched GlassesAnalysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	9	41.35857	4.59540	29.696	0.0001
Error	127	19.65331	0.15475		
C Total	136	61.01188			

Root MSE	0.39338	R-square	0.6779
Dep Mean	2.82299	R-sq ADJ	0.6550
C.V.	13.93500	R-sq PRESS	0.6138

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
SiO2	1	-0.174781	0.37937963	-0.461	0.6458
B2O3	1	10.015191	0.71753817	13.958	0.0001
Na2O	1	9.523290	0.73613600	12.937	0.0001
Li2O	1	12.557126	1.65132679	7.604	0.0001
CaO	1	3.488144	1.20816639	2.887	0.0046
MgO	1	5.038917	1.45440879	3.465	0.0007
Fe2O3	1	5.740575	1.07171553	5.356	0.0001
Al2O3	1	-6.398596	0.97423214	-6.568	0.0001
ZrO2	1	-1.155690	1.18936573	-0.972	0.3331
Others	1	3.102401	1.28287905	2.418	0.0170

Table 4.8. First-Order Mixture Model for Natural Logarithm of MCC-1 Normalized Silicon Release (g/m^2) Fitted to Data from 137 CVS-I and CVS-II Phases 1, 2, 3, 4 Quenched GlassesAnalysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	9	24.55905	2.72878	24.974	0.0001
Error	127	13.87675	0.10927		
C Total	136	38.43581			

Root MSE	0.33055	R-square	0.6390
Dep Mean	2.53881	R-sq ADJ	0.6134
C.V.	13.02003	R-sq PRESS	0.5649

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
SiO2	1	0.811947	0.31878290	2.547	0.0121
B2O3	1	7.317351	0.60292878	12.136	0.0001
Na2O	1	7.808902	0.61855606	12.624	0.0001
Li2O	1	9.918587	1.38756724	7.148	0.0001
CaO	1	1.457660	1.01519100	1.436	0.1535
MgO	1	1.447854	1.22210213	1.185	0.2383
Fe2O3	1	4.773720	0.90053487	5.301	0.0001
Al2O3	1	-5.179665	0.81862210	-6.327	0.0001
ZrO2	1	-2.545399	0.99939330	-2.547	0.0121
Others	1	1.966713	1.07797012	1.824	0.0704

4.2 Second-Order Mixture Models for MCC-1 Data on Quenched CVS-I and CVS-II Phase 1, 2, 3, and 4 Glasses

Tables 4.9 to 4.12 contain the results of fitting reduced second-order mixture models to natural logarithms of averaged MCC-1 normalized B, Li, Na, and Si releases (g/m^2) for the CVS-I and CVS-II Phases 1, 2, 3, and 4 quenched glasses. MCC-1 data were available for only 144 of the 147 glasses. MCC-1 testing was not performed for the two radioactive glasses (CVS2-53 and CVS2-54), and CVS2-124. The data, given in Table A.5 of Appendix A, are the same as used for developing the first-order models in Tables 4.1 to 4.4. Two candidate models developed using different statistical methods to select the second-order terms (see Hrma, Piepel, et al. 1994, Section 6.1.4) are presented for each normalized elemental release. Second-order models fitted to the CVS-I and CVS-II data without the seven high B release glasses were not presented by Hrma, Piepel, et al. (1994), so the models in Tables 4.9 to 4.12 have no counterparts in that report. Predicted versus measured plots (not provided here) show that the second-order models in Tables 4.9 to 4.12, similar to the first-order models in Tables 4.1 to 4.4, tend to underpredict the larger normalized releases.

Tables 4.13 to 4.16 contain the results of fitting reduced second-order mixture models to natural logarithms of averaged MCC-1 normalized B, Li, Na, and Si releases (g/m^2) for 137 CVS-I and CVS-II Phase 1, 2, 3, and 4 quenched glasses after deleting the data corresponding to glasses CVS1-4, CVS1-6, CVS1-9, CVS1-13, CVS1-15, CVS1-21, and CVS2-82. These seven data points had the highest normalized B releases. The models in Tables 4.13 to 4.16 update the models in Tables 12.4 to 12.7 of Hrma, Piepel, et al. (1994), which were developed using data up through CVS-II Phase 3. Predicted versus measured plots (not provided here) show that the second-order models in Tables 4.13 to 4.16 tend to underpredict normalized releases B, Li, and Na releases of about 50 g/m^2 or larger. This tendency to underpredict larger releases was helped somewhat when seven data points with the largest releases were deleted and the model refitted. However, the results indicate that if interest is only on glasses with MCC-1 B, Li, and Na releases below 50 g/m^2 , it may be possible to further improve the models by refitting them after deleting data points with B, Li, and Na MCC-1 releases greater than approximately 50 g/m^2 . There was not time to do this and include the results in this report.

Table 4.9. Reduced Second-Order Mixture Model for Natural Logarithm of MCC-1 Normalized Boron Release (g/m²) Fitted to Data from 144 CVS-I and CVS-II Phase 1, 2, 3, 4 Quenched Glasses

Model # 1

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	11	92.59846	8.41804	47.184	0.0001
Error	132	23.54977	0.17841		
C Total	143	116.14823			

Root MSE	0.42238	R-square	0.7972
Dep Mean	2.99079	R-sq ADJ	0.7803
C.V.	14.12279	R-sq PRESS	0.7465

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
SiO2	1	0.443339	0.41226017	1.075	0.2842
B2O3	1	15.683482	1.01226882	15.493	0.0001
Na2O	1	11.223246	0.76707232	14.631	0.0001
Li2O	1	14.370767	1.72515926	8.330	0.0001
CaO	1	2.663479	1.29039824	2.064	0.0410
MgO	1	8.358950	1.42316045	5.874	0.0001
Fe2O3	1	1.621863	1.00538416	1.613	0.1091
Al2O3	1	-20.160467	2.79226944	-7.220	0.0001
ZrO2	1	-6.092297	1.14235889	-5.333	0.0001
Others	1	1.528347	1.24649675	1.226	0.2223
B2O3_Al2O3	1	-79.935432	14.21419100	-5.624	0.0001
Al2O3_Al2O3	1	108.636332	14.13324498	7.687	0.0001

Model # 2

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	12	93.45194	7.78766	44.949	0.0001
Error	131	22.69629	0.17325		
C Total	143	116.14823			

Root MSE	0.41624	R-square	0.8046
Dep Mean	2.99079	R-sq ADJ	0.7867
C.V.	13.91732	R-sq PRESS	0.7508

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
SiO2	1	0.719042	0.42483998	1.693	0.0929
B2O3	1	12.606293	1.70826169	7.380	0.0001
Na2O	1	7.825372	1.70767870	4.582	0.0001
Li2O	1	15.001715	1.72368886	8.703	0.0001
CaO	1	3.424949	1.31712362	2.600	0.0104
MgO	1	9.650710	1.51848442	6.355	0.0001
Fe2O3	1	1.932202	1.00058780	1.931	0.0556
Al2O3	1	-19.039613	2.79764629	-6.806	0.0001
ZrO2	1	-5.564850	1.15056909	-4.837	0.0001
Others	1	2.308114	1.27764748	1.807	0.0731
B2O3_Na2O	1	35.543479	16.01773921	2.219	0.0282
B2O3_Al2O3	1	-86.305575	14.29865222	-6.036	0.0001
Al2O3_Al2O3	1	109.134783	13.92955577	7.835	0.0001

Table 4.10. Reduced Second-Order Mixture Model for Natural Logarithm of MCC-1 Normalized Lithium Release (g/m²) Fitted to Data from 144 CVS-I and CVS-II Phase 1, 2, 3, 4 Quenched Glasses

Model # 1

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	11	87.97842	7.99804	44.651	0.0001
Error	132	23.64414	0.17912		
C Total	143	111.62256			

Root MSE	0.42323	R-square	0.7882
Dep Mean	2.91013	R-sq ADJ	0.7705
C.V.	14.54326	R-sq PRESS	0.7355

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
SiO2	1	0.314957	0.41308694	0.762	0.4472
B2O3	1	15.429277	1.01429888	15.212	0.0001
Na2O	1	10.945704	0.76861064	14.241	0.0001
Li2O	1	13.121217	1.72861898	7.591	0.0001
CaO	1	3.598252	1.29298607	2.783	0.0062
MgO	1	8.094997	1.42601452	5.677	0.0001
Fe2O3	1	1.903839	1.00740041	1.890	0.0610
Al2O3	1	-19.274377	2.79786919	-6.889	0.0001
ZrO2	1	-5.746524	1.14464983	-5.020	0.0001
Others	1	1.901593	1.24899654	1.522	0.1303
B2O3_A12O3	1	-77.805915	14.24269683	-5.463	0.0001
Al2O3_A12O3	1	104.549026	14.16158847	7.383	0.0001

Model # 2

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	13	90.17861	6.93682	42.053	0.0001
Error	130	21.44395	0.16495		
C Total	143	111.62256			

Root MSE	0.40614	R-square	0.8079
Dep Mean	2.91013	R-sq ADJ	0.7887
C.V.	13.95622	R-sq PRESS	0.7530

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
SiO2	1	0.188713	0.44585637	0.423	0.6728
B2O3	1	11.956156	1.66697358	7.172	0.0001
Na2O	1	9.167387	1.83058955	5.008	0.0001
Li2O	1	12.921804	1.71626177	7.529	0.0001
CaO	1	4.521425	1.28552587	3.517	0.0006
MgO	1	9.697625	1.48302875	6.539	0.0001
Fe2O3	1	2.431088	0.97878031	2.484	0.0143
Al2O3	1	-12.483764	3.44640001	-3.622	0.0004
ZrO2	1	-5.170221	1.12268387	-4.605	0.0001
Others	1	2.575405	1.24881911	2.062	0.0412
B2O3_Na2O	1	43.472205	15.70189178	2.769	0.0065
B2O3_Al2O3	1	-96.485493	14.62971225	-6.595	0.0001
Na2O_Al2O3	1	-41.770802	15.84771505	-2.636	0.0094
Al2O3_A12O3	1	108.715987	13.66083025	7.958	0.0001

Table 4.11. Reduced Second-Order Mixture Model for Natural Logarithm of MCC-1 Normalized Sodium Release (g/m^2) Fitted to Data from 144 CVS-I and CVS-II Phase 1, 2, 3, 4 Quenched Glasses

Model # 1

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	13	89.81068	6.90851	46.122	0.0001
Error	130	19.47235	0.14979		
C Total	143	109.28304			
Root MSE		0.38702	R-square	0.8218	
Dep Mean		2.94958	R-sq ADJ	0.8040	
C.V.		13.12131	R-sq PRESS	0.7696	

Parameter Estimates					
Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
SiO2	1	0.224819	0.41648862	0.540	0.5903
B2O3	1	16.089223	0.94277638	17.066	0.0001
Na2O	1	13.162640	1.11265575	11.830	0.0001
Li2O	1	8.581223	2.54609534	3.370	0.0010
CaO	1	3.194589	1.19784127	2.667	0.0086
MgO	1	7.966878	1.31124257	6.076	0.0001
Fe2O3	1	2.324673	0.94446535	2.461	0.0152
Al2O3	1	-13.178204	3.27125460	-4.028	0.0001
ZrO2	1	-6.252061	1.04769093	-5.967	0.0001
Others	1	-4.125496	2.18922955	-1.884	0.0617
B2O3_Al2O3	1	-91.213085	13.67569113	-6.670	0.0001
Na2O_Al2O3	1	-45.560684	15.20343483	-2.997	0.0033
Li2O_Others	1	119.333992	45.42979390	2.627	0.0097
Al2O3_Al2O3	1	110.926383	13.01559131	8.523	0.0001

Model # 2

Analysis of Variance					
Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	18	94.00820	5.22268	42.739	0.0001
Error	125	15.27484	0.12220		
C Total	143	109.28304			
Root MSE		0.34957	R-square	0.8602	
Dep Mean		2.94958	R-sq ADJ	0.8401	
C.V.		11.85149	R-sq PRESS	0.7947	

Parameter Estimates					
Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
SiO2	1	0.533508	0.81254888	0.657	0.5127
B2O3	1	13.213752	1.52299464	8.676	0.0001
Na2O	1	-39.413309	11.20259679	-3.518	0.0006
Li2O	1	-2.308824	4.50272405	-0.513	0.6090
CaO	1	9.349349	1.70136008	5.495	0.0001
MgO	1	13.778669	1.75989880	7.829	0.0001
Fe2O3	1	6.171893	1.71517009	3.598	0.0005
Al2O3	1	-13.124114	4.08241156	-3.215	0.0017
ZrO2	1	-0.725326	1.58165813	-0.459	0.6473
Others	1	2.113888	2.43910680	0.867	0.3878
SiO2_Na2O	1	46.187657	15.26530367	3.026	0.0030
B2O3_Na2O	1	68.668923	17.04621348	4.028	0.0001
B2O3_Al2O3	1	-88.176093	13.09137656	-6.735	0.0001
Na2O_Li2O	1	144.133139	33.30837201	4.327	0.0001
Na2O_Al2O3	1	-34.946215	15.45581796	-2.261	0.0255
Li2O_Others	1	125.184011	44.07795491	2.840	0.0053
Fe2O3_Al2O3	1	59.659675	25.47059369	2.342	0.0207
Na2O_Na2O	1	83.512740	19.17235255	4.356	0.0001
Al2O3_Al2O3	1	129.655392	14.61146192	8.874	0.0001

Table 4.12. Reduced Second-Order Mixture Model for Natural Logarithm of MCC-1 Normalized Silicon Release (g/m^2) Fitted to Data from 144 CVS-I and CVS-II Phases 1, 2, 3, 4 Quenched Glasses

Model # 1

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	14	54.15671	3.86834	38.301	0.0001
Error	129	13.02885	0.10100		
C Total	143	67.18556			
Root MSE		0.31780	R-square	0.8061	
Dep Mean		2.63308	R-sq ADJ	0.7850	
C.V.		12.06962	R-sq PRESS	0.7413	

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
SiO2	1	0.981373	0.33970240	2.889	0.0045
B2O3	1	11.379440	0.77019750	14.775	0.0001
Na2O	1	10.869517	0.90929423	11.954	0.0001
Li2O	1	10.971127	1.33225440	8.235	0.0001
CaO	1	1.918296	1.04442182	1.837	0.0686
MgO	1	22.830922	5.14871955	4.434	0.0001
Fe2O3	1	1.138094	0.77969952	1.460	0.1468
Al2O3	1	-13.163142	2.74062622	-4.803	0.0001
ZrO2	1	-6.493960	0.86734421	-7.487	0.0001
Others	1	-0.357970	0.95299739	-0.376	0.7078
B2O3_Al2O3	1	-63.081952	11.23894009	-5.613	0.0001
Na2O_Al2O3	1	-39.584704	12.37318610	-3.199	0.0017
CaO_MgO	1	-250.062298	93.48911406	-2.675	0.0084
MgO_MgO	1	-225.313669	61.32042432	-3.674	0.0003
Al2O3_Al2O3	1	97.944634	11.26959090	8.691	0.0001

Model # 2

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	15	54.82172	3.65478	37.837	0.0001
Error	128	12.36384	0.09659		
C Total	143	67.18556			
Root MSE		0.31079	R-square	0.8160	
Dep Mean		2.63308	R-sq ADJ	0.7944	
C.V.		11.80340	R-sq PRESS	0.7509	

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
SiO2	1	1.218067	0.34424168	3.538	0.0006
B2O3	1	11.173254	0.75730008	14.754	0.0001
Na2O	1	10.876825	0.88924506	12.232	0.0001
Li2O	1	11.403645	1.31326059	8.683	0.0001
CaO	1	2.465431	1.04245895	2.365	0.0195
MgO	1	24.195706	5.06196773	4.780	0.0001
Fe2O3	1	-0.679462	1.03019716	-0.660	0.5107
Al2O3	1	-19.105833	3.50907473	-5.445	0.0001
ZrO2	1	-6.758699	0.85419636	-7.912	0.0001
Others	1	-0.092398	0.93746056	-0.099	0.9216
B2O3_Al2O3	1	-55.515446	11.36312662	-4.886	0.0001
Na2O_Al2O3	1	-38.588269	12.10626692	-3.187	0.0018
CaO_MgO	1	-275.006172	91.92028131	-2.992	0.0033
Fe2O3_Al2O3	1	58.097462	22.14327296	2.624	0.0098
MgO_MgO	1	-239.496786	60.21122155	-3.978	0.0001
Al2O3_Al2O3	1	118.039168	13.42092785	8.795	0.0001

Table 4.13. Reduced Second-Order Mixture Model for Natural Logarithm of MCC-1 Normalized Boron Release (g/m²) Fitted to Data from 137 CVS-I and CVS-II Phase 1, 2, 3, 4 Quenched Glasses

Model # 1

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	12	52.01596	4.33466	39.904	0.0001
Error	124	13.46991	0.10863		
C Total	136	65.48587			

Root MSE	0.32959	R-square	0.7943
Dep Mean	2.86047	R-sq ADJ	0.7744
C.V.	11.52218	R-sq PRESS	0.7472

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
SiO2	1	-1.119371	0.42524449	-2.632	0.0096
B2O3	1	15.430267	0.98473425	15.669	0.0001
Na2O	1	10.698117	0.64927079	16.477	0.0001
Li2O	1	13.123722	1.39234882	9.426	0.0001
CaO	1	-24.717305	7.63306745	-3.238	0.0015
MgO	1	7.128924	1.25036257	5.701	0.0001
Fe2O3	1	6.122329	0.98102356	6.241	0.0001
Al2O3	1	-12.546463	2.40619532	-5.214	0.0001
ZrO2	1	-1.819981	1.06475308	-1.709	0.0899
Others	1	4.513437	1.14679156	3.936	0.0001
SiO2_CaO	1	58.519498	15.84310302	3.694	0.0003
B2O3_Al2O3	1	-70.215774	12.26968489	-5.723	0.0001
Al2O3_Al2O3	1	83.074173	12.39293432	6.703	0.0001

Model # 2

No Model #2 was developed because the statistical methods employed yielded the same model as Model #1.

Table 4.14. Reduced Second-Order Mixture Model for Natural Logarithm of MCC-1 Normalized Lithium Release (g/m²) Fitted to Data from 137 CVS-I and CVS-II Phase 1, 2, 3, 4 Quenched Glasses

Model # 1

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	12	49.76111	4.14676	38.261	0.0001
Error	124	13.43924	0.10838		
C Total	136	63.20035			

Root MSE	0.32921	R-square	0.7874
Dep Mean	2.78280	R-sq ADJ	0.7668
C.V.	11.83025	R-sq PRESS	0.7398

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
SiO2	1	-1.223405	0.42476302	-2.880	0.0047
B2O3	1	15.000277	0.98361932	15.250	0.0001
Na2O	1	10.367149	0.64853568	15.985	0.0001
Li2O	1	11.916760	1.39077238	8.568	0.0001
CaO	1	-22.502788	7.62442515	-2.951	0.0038
MgO	1	6.856999	1.24894689	5.490	0.0001
Fe2O3	1	6.413042	0.97991283	6.545	0.0001
Al2O3	1	-11.548505	2.40347098	-4.805	0.0001
ZrO2	1	-1.430259	1.06354755	-1.345	0.1811
Others	1	4.900496	1.14549315	4.278	0.0001
SiO2_CaO	1	55.937762	15.82516518	3.535	0.0006
B2O3_Al2O3	1	-66.838792	12.25579294	-5.454	0.0001
Al2O3_Al2O3	1	77.695559	12.37890283	6.276	0.0001

Model # 2

No Model #2 was developed because the statistical methods employed yielded the same model as Model #1.

Table 4.15. Reduced Second-Order Mixture Model for Natural Logarithm of MCC-1 Normalized Sodium Release (g/m²) Fitted to Data from 137 CVS-I and CVS-II Phase 1, 2, 3, 4 Quenched Glasses

Model # 1

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	12	48.87169	4.07264	41.598	0.0001
Error	124	12.14018	0.09790		
C Total	136	61.01188			

Root MSE	0.31290	R-square	0.8010
Dep Mean	2.82299	R-sq ADJ	0.7818
C.V.	11.08391	R-sq PRESS	0.7550

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
SiO2	1	-1.008253	0.40370678	-2.497	0.0138
B2O3	1	15.242114	0.93485959	16.304	0.0001
Na2O	1	10.058111	0.61638663	16.318	0.0001
Li2O	1	13.576455	1.32182936	10.271	0.0001
CaO	1	-23.301761	7.24646905	-3.216	0.0017
MgO	1	7.142461	1.18703441	6.017	0.0001
Fe2O3	1	5.989764	0.93133683	6.431	0.0001
Al2O3	1	-12.514031	2.28432672	-5.478	0.0001
ZrO2	1	-2.052172	1.01082563	-2.030	0.0445
Others	1	4.072845	1.08870905	3.741	0.0003
SiO2_CaO	1	55.596239	15.04068404	3.696	0.0003
B2O3_Al2O3	1	-68.252814	11.64825183	-5.859	0.0001
Al2O3_Al2O3	1	82.566909	11.76525894	7.018	0.0001

Model # 2

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	13	49.07134	3.77472	38.884	0.0001
Error	123	11.94053	0.09708		
C Total	136	61.01188			

Root MSE	0.31157	R-square	0.8043
Dep Mean	2.82299	R-sq ADJ	0.7836
C.V.	11.03698	R-sq PRESS	0.7536

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
SiO2	1	-1.339161	0.46352540	-2.889	0.0046
B2O3	1	15.249363	0.93091706	16.381	0.0001
Na2O	1	10.638338	0.73515527	14.471	0.0001
Li2O3	1	13.546742	1.31639858	10.291	0.0001
CaO	1	-19.077929	7.79386353	-2.448	0.0158
MgO	1	7.801438	1.26820333	6.152	0.0001
Fe2O3	1	6.449235	0.98118961	6.573	0.0001
Al2O3	1	-22.147901	7.09303239	-3.122	0.0022
ZrO2	1	-1.590426	1.05680134	-1.505	0.1349
Others	1	4.330343	1.09887345	3.941	0.0001
SiO2_CaO	1	48.184285	15.84389732	3.041	0.0029
SiO2_Al2O3	1	17.859588	12.45481076	1.434	0.1541
B2O3_Al2O3	1	-59.004944	13.27133332	-4.446	0.0001
Al2O3_Al2O3	1	85.285672	11.86789856	7.186	0.0001

Table 4.16. Reduced Second-Order Mixture Model for Natural Logarithm of MCC-1 Normalized Silicon Release (g/m²) Fitted to Data from 137 CVS-I and CVS-II Phase 1, 2, 3, 4 Quenched Glasses

Model # 1

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	14	30.62436	2.18745	34.164	0.0001
Error	122	7.81144	0.06403		
C Total	136	38.43581			
Root MSE		0.25304	R-square	0.7968	
Dep Mean		2.53881	R-sq ADJ	0.7734	
C.V.		9.96680	R-sq PRESS	0.7373	

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
SiO2	1	0.535880	0.28918301	1.853	0.0663
B2O3	1	10.063619	0.77307361	13.018	0.0001
Na2O	1	9.643890	0.77535785	12.438	0.0001
Li2O	1	9.879769	1.10461361	8.944	0.0001
CaO	1	2.451845	0.86639372	2.830	0.0054
MgO	1	21.626678	4.74237221	4.560	0.0001
Fe2O3	1	3.632560	0.70348141	5.164	0.0001
Al2O3	1	-8.190725	2.29070061	-3.576	0.0005
ZrO2	1	-3.877570	0.82685553	-4.690	0.0001
Others	1	0.915014	0.85045341	1.076	0.2841
B2O3_Al2O3	1	-49.807216	10.32265838	-4.825	0.0001
Na2O_Al2O3	1	-32.899392	10.24012593	-3.213	0.0017
CaO_MgO	1	-293.100287	91.75154950	-3.194	0.0018
MgO_MgO	1	-228.777586	57.42617159	-3.984	0.0001
Al2O3_Al2O3	1	70.421389	9.95838098	7.072	0.0001

Model # 2

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	15	30.81573	2.05438	32.622	0.0001
Error	121	7.62007	0.06298		
C Total	136	38.43581			
Root MSE		0.25095	R-square	0.8017	
Dep Mean		2.53881	R-sq ADJ	0.7772	
C.V.		9.88455	R-sq PRESS	0.7363	

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
SiO2	1	0.574302	0.28763500	1.997	0.0481
B2O3	1	10.288360	0.77742468	13.234	0.0001
Na2O	1	9.637988	0.76895102	12.534	0.0001
Li2O	1	9.943712	1.09608846	9.072	0.0001
CaO	1	2.470773	0.85929484	2.875	0.0048
MgO	1	21.433087	4.70444902	4.556	0.0001
Fe2O3	1	2.412012	0.98800669	2.441	0.0161
Al2O3	1	-7.744489	2.28610350	-3.388	0.0010
ZrO2	1	-3.787418	0.82164172	-4.610	0.0001
Others	1	-0.638745	1.22657354	-0.521	0.6035
B2O3_Al2O3	1	-52.694562	10.37017030	-5.081	0.0001
Na2O_Al2O3	1	-32.772987	10.15567140	-3.227	0.0016
CaO_MgO	1	-294.120251	90.99439906	-3.232	0.0016
Fe2O3_Others	1	32.732739	18.76162538	1.745	0.0836
MgO_MgO	1	-219.182969	57.21601014	-3.831	0.0002
Al2O3_Al2O3	1	69.692098	9.88484123	7.050	0.0001

5.0 SUMMARY

This technical note provides the results from FY 1995 work to develop first- and reduced second-order empirical mixture models relating 7-day PCT and 28-day MCC-1 normalized elemental releases to glass composition. Models for PCT and MCC-1 releases from quenched glasses and PCT releases from CCC glasses are presented. The data sets used in developing the models are documented in Appendix A.

The normalized release versus composition models for PCT and MCC-1 tests performed on quenched glasses presented in this technical note update the models contained in Chapter 12 of Hrma, Piepel, et al. (1994). The models in that report used data up through CVS-II Phase 3, whereas the models in this technical note use data up through CVS-II Phase 4. Also included in this technical note are new models for PCT and MCC-1 normalized elemental releases on quenched glasses from CVS-III Phase 1 high-temperature-melter (HTM) glasses. Separate models for the CVS-III Phase 1 data alone and for this data combined with a subset of the CVS-I and CVS-II Phase 1, 2, 3, and 4 data are presented.

This technical note presents for the first time models developed for PCT results on canister-centerline-cooled (CCC) CVS-I and CVS-II glasses. The first- and second-order models do not fit the PCT results on CCC glasses as well as the corresponding first- and second-order models fit the PCT results on quenched glasses. This is due in large measure to several CCC CVS-I and CVS-II glasses being prone to phase separation, and many more glasses containing crystals. Models fitted after deleting the data for glasses prone to phase separation and glasses with greater than 7 vol% crystallinity fit better, but still not as well as the models for PCT data on quenched glasses. This is partially due to the fact that single PCT normalized releases were modeled for the CCC data instead of averages of duplicate PCT normalized releases for the quenched data. Additional work is needed to determine how crystallinity type and volume percent affect PCT releases and the goodness-of-fit of PCT release models for CCC glasses.

Ideally the models presented in this technical note should first have been validated by applying them to data not used to develop them. However, this was not possible with the reduced scope and budget. Lack of validation of the PCT and MCC-1 models for quenched CVS-I and CVS-II (Phase 1 through Phase 4) glasses (Sections 2.1 and 2.2) is not of much concern, since the models did not change much compared to those reported by Hrma, Piepel, et al. (1994). However, "new models" such as those for CVS-III Phase 1 data (Section 2.3 and 2.4), CVS-III Phase 1 data combined with CVS-I and CVS-II data (Section 2.5), and all PCT CCC models (Section 3.0) should be used with caution until the quality of their predictive performance is confirmed using data not used to develop them. Of particular concern are the models developed using only the HTM CVS-III Phase 1 data, which provides information only about single component changes from a single base composition. Also, Vienna et al. (1995) used a different approach to develop first-order models for the CVS-III Phase 1 data, and those models show some differences compared to those presented in this report. Such differences need further study prior to deciding which models to use for HTM glasses.

6.0 REFERENCES

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APPENDIX A**GLASS COMPOSITION AND PCT AND MCC-1
NORMALIZED RELEASE LISTINGS**

This appendix contains listings of the glass compositions and normalized elemental releases used to develop composition/release models in this report. Glass compositions are listed in terms of mass fractions of the oxide components in the glass, where the mass fractions of the components listed sum to 1.0000. Normalized elemental releases from 7-day PCT and 28-day MCC-1 dissolution tests are given in units of g/m^2 . The normalized elemental release values reported are generally averages of two results from duplicate PCT tests performed, and resulting solutions analyzed, at the same time. The exception is the PCT CCC data in Table A.4, where duplicate PCT tests were only performed on some of the CVS glasses. In Table A.4, results of single PCT tests are reported and were used for modeling.

Table A.1. Compositions, Normalized PCT Releases, and pH for CVS-I and CVS-II Phase 1, 2, 3, and 4 Quenched Glasses

#	Glass	Phase	SiO2	B2O3	Na2O	Li2O	CaO	MgO	Fe2O3	Al2O3	ZrO2	Others	Si	B	Li	Na	pH
1	CVS1-1	1	.4801	.1142	.1003	.0376	.0275	.0363	.0568	.0636	.0429	.0407	0.167	0.521	0.529	0.403	10.92
2	CVS1-2	1	.5500	.0500	.0500	.0700	.1000	.0000	.0200	.1500	.0000	.0100	0.054	0.066	0.154	0.064	11.42
3	CVS1-3	1	.4200	.2000	.0500	.0700	.0000	.0800	.0200	.1400	.0100	.0100	0.172	0.864	0.791	0.580	9.85
4	CVS1-4	1	.5700	.2000	.0900	.0100	.0200	.0800	.0200	.0000	.0000	.0100	0.540	20.639	16.935	17.034	9.67
5	CVS1-5	1	.5700	.0500	.0700	.0700	.0000	.0000	.1500	.0800	.0000	.0100	0.318	0.355	0.462	0.191	11.22
6	CVS1-6	1	.4400	.2000	.0500	.0700	.0000	.0000	.0200	.0000	.1200	.1000	0.312	6.113	4.892	3.046	10.07
7	CVS1-7	1	.5700	.0500	.0964	.0100	.1000	.0000	.0336	.0000	.1300	.0100	0.114	0.287	0.331	0.339	10.91
8	CVS1-8	1	.5363	.0500	.0837	.0100	.0000	.0800	.1500	.0000	.0800	.0100	0.265	1.238	0.744	0.805	10.42
9	CVS1-9	1	.4200	.1962	.0538	.0100	.0000	.0800	.1400	.0000	.0000	.1000	0.345	10.993	8.602	7.897	8.69
10	CVS1-10	1	.5700	.0851	.0949	.0100	.0000	.0000	.0200	.1200	.0000	.1000	0.104	0.127	0.386	0.095	9.76
11	CVS1-11	1	.4200	.1549	.0751	.0100	.1000	.0000	.0200	.1400	.0000	.0800	0.041	0.099	0.187	0.099	9.99
12	CVS1-12	1	.4200	.1764	.0736	.0700	.1000	.0000	.1500	.0000	.0000	.0100	0.825	4.662	4.171	4.395	11.12
13	CVS1-13	1	.5700	.2000	.1862	.0100	.0000	.0000	.0200	.0038	.0000	.0100	0.786	14.072	12.903	12.413	10.37
14	CVS1-14	1	.4200	.2000	.1862	.0100	.0000	.0000	.0200	.0238	.1300	.0100	0.149	9.847	8.011	5.790	9.63
15	CVS1-15	1	.5589	.0500	.1211	.0700	.0000	.0800	.0200	.0000	.0000	.1000	0.967	18.778	11.198	13.995	13.03
16	CVS1-16	1	.4327	.0500	.1873	.0100	.0000	.0800	.0858	.1442	.0000	.0100	0.241	0.523	0.266	0.540	12.01
17	CVS1-17	1	.4545	.0500	.1455	.0100	.1000	.0000	.1400	.0000	.0000	.1000	0.663	2.235	2.075	2.304	11.57
18	CVS1-18	1	.4214	.0500	.1186	.0700	.0200	.0800	.0200	.0000	.1300	.0900	1.531	11.238	8.065	8.040	12.25
19	CVS1-19	1	.4801	.1142	.1003	.0376	.0275	.0363	.0568	.0636	.0429	.0407	0.166	0.523	0.533	0.433	10.29
20	CVS1-20	1	.4801	.1142	.1003	.0376	.0275	.0363	.0568	.0636	.0429	.0407	0.156	0.455	0.468	0.396	10.16
21	CVS1-21	1	.5700	.2000	.0900	.0100	.0200	.0800	.0200	.0000	.0000	.0100	0.459	18.850	15.591	15.536	9.68
22	CVS1-22	1	.5363	.0500	.0837	.0100	.0000	.0800	.1500	.0000	.0800	.0100	0.259	1.119	0.704	0.760	9.81
23	CVS1-23	1	.5153	.0956	.1052	.0375	.0289	.0084	.1179	.0456	.0063	.0393	0.229	0.525	0.535	0.487	10.29
24	CVS2-1	2	.5226	.0874	.0700	.0600	.0000	.0500	.0400	.0800	.0100	.0800	0.170	0.312	0.369	0.208	10.21
25	CVS2-2	2	.5017	.0700	.0883	.0600	.0700	.0000	.0450	.1100	.0300	.0250	0.075	0.128	0.276	0.188	10.92
26	CVS2-3	2	.4645	.1320	.0700	.0435	.0700	.0100	.0450	.1032	.0368	.0250	0.064	0.137	0.222	0.125	10.08
27	CVS2-4	2	.5600	.1095	.0700	.0536	.0700	.0000	.0400	.0619	.0100	.0250	0.101	0.158	0.300	0.182	10.40
28	CVS2-5	2	.4752	.1590	.1010	.0200	.0348	.0000	.0400	.0800	.0100	.0800	0.106	0.284	0.382	0.284	9.58
29	CVS2-6	2	.5372	.0700	.0700	.0382	.0700	.0046	.1200	.0159	.0100	.0641	0.421	1.185	1.303	1.284	10.48
30	CVS2-7	2	.4814	.1700	.0700	.0591	.0094	.0000	.0400	.0953	.0100	.0648	0.164	0.740	0.812	0.343	9.89
31	CVS2-8	2	.5115	.0700	.0985	.0600	.0000	.0500	.1140	.0610	.0100	.0250	0.263	0.484	0.523	0.445	10.75
32	CVS2-9	2	.5432	.0944	.0924	.0600	.0000	.0000	.0712	.0138	.1000	.0250	0.241	0.560	0.620	0.374	10.34
33	CVS2-10	2	.4694	.1700	.1306	.0200	.0000	.0000	.0669	.1043	.0100	.0288	0.115	1.332	1.322*	0.828	9.46
34	CVS2-11	2	.4916	.0751	.0833	.0600	.0700	.0100	.0400	.0100	.0935	.0665	0.510	1.587	1.564	1.370	11.46
35	CVS2-12	2	.4683	.1700	.0700	.0466	.0700	.0100	.0400	.0901	.0100	.0250	0.075	0.194	0.262	0.184	9.90
36	CVS2-13	2	.4937	.0700	.1692	.0225	.0300	.0500	.0400	.0896	.0100	.0250	0.182	0.360	0.362	0.478	11.14
37	CVS2-14	2	.4600	.1313	.0802	.0486	.0500	.0200	.0400	.0243	.1000	.0457	0.261	1.656	1.468	1.268	10.46
38	CVS2-15	2	.4729	.0700	.1700	.0214	.0601	.0000	.0400	.0756	.0100	.0800	0.180	0.331	0.451	0.608	11.30
39	CVS2-16	2	.5353	.1053	.1125	.0375	.0083	.0084	.0719	.0231	.0385	.0592	0.558	2.937	2.349	2.182	10.36
40	CVS2-17	2	.4801	.1142	.1003	.0376	.0275	.0363	.0568	.0636	.0429	.0407	0.167	0.495	0.572	0.474	10.27

* A typo in a data file caused an erroneous value of 1.332 to be used in fitting PCT Li release models. However, the impact on the resulting models should be negligible.

Table A.1. Compositions, Normalized PCT Releases, and pH for CVS-I and CVS-II Phase 1, 2, 3, and 4 Quenched Glasses (continued)

#	Glass	Phase	SiO2	B2O3	Na2O	Li2O	CaO	MgO	Fe2O3	Al2O3	ZrO2	Others	Si	B	Li	Na	pH
41	CVS2-18	2	.5353	.1053	.1125	.0375	.0083	.0084	.0719	.0231	.0385	.0592	0.546	2.578	2.094	1.886	10.34
42	CVS2-19	2	.5328	.1048	.1129	.0373	.0082	.0084	.0733	.0235	.0392	.0596	0.450	1.990	1.654	1.481	10.35
43	CVS2-20	3	.5700	.0500	.1031	.0669	.0000	.0000	.0600	.0100	.1300	.0100	0.187	0.347	0.386	0.279	10.89
44	CVS2-21	3	.5700	.1314	.0500	.0700	.0000	.0800	.0200	.0686	.0000	.0100	0.506	3.854	2.534	2.089	10.26
45	CVS2-22	3	.5700	.0500	.0735	.0700	.0000	.0800	.0200	.0365	.0000	.1000	2.249	9.646	5.453	6.097	11.72
46	CVS2-23	3	.5700	.0522	.2000	.0100	.0800	.0000	.0200	.0578	.0000	.0100	0.144	0.173	0.604	0.809	11.81
47	CVS2-24	3	.4464	.2000	.0736	.0700	.0000	.0000	.0200	.0961	.0000	.0939	0.179	4.522	3.226	2.060	9.80
48	CVS2-25	3	.5059	.0500	.0841	.0700	.0800	.0000	.1500	.0033	.0000	.0567	1.214	4.662	2.765	3.526	11.91
49	CVS2-26	3	.4431	.2000	.0512	.0700	.0800	.0000	.0200	.0257	.1000	.0100	0.275	1.628	1.436	1.349	10.11
50	CVS2-27	3	.5463	.0500	.2000	.0155	.0000	.0800	.0200	.0782	.0000	.0100	0.890	3.270	1.835	2.342	11.87
51	CVS2-28	3	.5619	.0500	.2000	.0126	.0000	.0000	.0200	.0555	.0000	.1000	1.654	5.144	3.682	3.538	11.54
52	CVS2-29	3	.4391	.2000	.0675	.0100	.0800	.0000	.0200	.0000	.0834	.1000	0.192	1.286	1.355	1.273	9.11
53	CVS2-30	3	.5190	.2000	.0832	.0100	.0000	.0000	.1320	.0458	.0000	.0100	0.174	6.512	4.194	2.552	8.74
54	CVS2-31	3	.5700	.1843	.0500	.0331	.0800	.0000	.0200	.0526	.0000	.0100	0.121	0.411	0.460	0.318	9.54
55	CVS2-32	3	.5445	.0500	.2000	.0428	.0000	.0000	.0200	.0027	.1300	.0100	2.747	9.646	5.527	5.896	12.31
56	CVS2-33	3	.4200	.0544	.2000	.0364	.0000	.0800	.0200	.0892	.0000	.1000	0.516	1.723	1.438	1.608	11.94
57	CVS2-34	3	.4200	.1743	.2000	.0369	.0000	.0000	.0200	.1388	.0000	.0100	0.265	4.340	3.468	2.700	11.55
58	CVS2-35	3	.4200	.0500	.2000	.0428	.0800	.0000	.0632	.1340	.0000	.0100	0.204	0.320	0.580	0.910	11.90
59	CVS2-36	3	.5421	.0500	.0891	.0700	.0800	.0000	.1500	.0088	.0000	.0100	0.276	0.480	0.630	0.654	11.34
60	CVS2-37	3	.5700	.0839	.1061	.0700	.0000	.0000	.0200	.1400	.0000	.0100	0.206	0.246	0.300	0.177	10.45
61	CVS2-38	3	.5147	.1109	.1044	.0100	.0000	.0800	.1428	.0272	.0000	.0100	0.280	1.119	0.728	0.807	9.56
62	CVS2-39	3	.4838	.0500	.1362	.0700	.0000	.0800	.0742	.0258	.0700	.0100	1.612	12.701	6.528	7.668	12.50
63	CVS2-40	3	.5040	.0639	.1500	.0421	.0200	.0500	.0200	.1000	.0200	.0300	0.172	0.337	0.328	0.399	11.13
64	CVS2-41	3	.5325	.0694	.0781	.0700	.0500	.0200	.0300	.1000	.0200	.0300	0.104	0.177	0.260	0.188	10.89
65	CVS2-42	3	.5675	.0500	.0625	.0700	.0320	.0380	.1000	.0300	.0200	.0300	0.574	1.694	1.220	1.337	11.19
66	CVS2-43	3	.5070	.1477	.0500	.0653	.0200	.0300	.0300	.0500	.0700	.0300	0.196	0.767	0.697	0.451	9.97
67	CVS2-44	3	.5700	.1078	.0500	.0699	.0500	.0200	.0200	.0623	.0200	.0300	0.128	0.255	0.294	0.194	10.31
68	CVS2-45	3	.5299	.1106	.0500	.0595	.0200	.0500	.0308	.0592	.0200	.0700	0.186	0.500	0.478	0.374	10.05
69	CVS2-46	3	.5264	.1259	.0577	.0700	.0200	.0200	.0200	.0746	.0200	.0654	0.148	0.317	0.346	0.188	10.19
70	CVS2-47	3	.5294	.0500	.1277	.0429	.0500	.0200	.0200	.0400	.0500	.0700	0.434	1.159	1.124	1.055	11.39
71	CVS2-48	3	.4700	.1442	.0968	.0390	.0500	.0200	.0200	.0854	.0200	.0546	0.102	0.307	0.318	0.284	10.09
72	CVS2-49	3	.5073	.1357	.0957	.0413	.0200	.0200	.0515	.0785	.0200	.0300	0.136	0.303	0.334	0.217	9.97
73	CVS2-50	3	.4801	.1142	.1003	.0376	.0275	.0363	.0568	.0636	.0429	.0407	0.150	0.442	0.426	0.368	10.23
74	CVS2-51	3	.5328	.1048	.1129	.0373	.0082	.0084	.0733	.0235	.0392	.0596	0.411	1.764	1.496	1.283	10.30
75	CVS2-52	3	.6000	.0817	.0450	.0788	.0008	.0009	.0720	.0233	.0385	.0590	0.294	0.557	0.554	0.260	10.16
76	CVS2-53	3	.5226	.0874	.0700	.0600	.0000	.0500	.0400	.0800	.0100	.0800	0.176	0.304	0.305	0.202	10.02
77	CVS2-54	3	.5328	.1048	.1129	.0373	.0082	.0084	.0733	.0235	.0392	.0596	0.571	2.761	1.715	1.612	10.23
78	CVS2-55	3	.5328	.1048	.1129	.0373	.0082	.0084	.0733	.0235	.0392	.0596	0.352	1.342	1.127	0.880	10.19
79	CVS2-56	3	.5328	.1048	.1129	.0373	.0082	.0084	.0733	.0235	.0392	.0596	0.368	1.419	1.218	0.946	10.20
80	CVS2-57	3	.5328	.1048	.1129	.0373	.0082	.0084	.0733	.0235	.0392	.0596	0.346	1.164	1.081	0.842	10.26
81	CVS2-58	3	.3900	.2000	.0500	.0700	.0200	.0800	.0200	.1500	.0100	.0100	0.138	0.778	0.636	0.620	9.87

A.3

Table A.1. Compositions, Normalized PCT Releases, and pH for CVS-I and CVS-II Phase 1, 2, 3, and 4 Quenched Glasses (continued)

#	Glass	Phase	SiO2	B2O3	Na2O	Li2O	CaO	MgO	Fe2O3	Al2O3	ZrO2	Others	Si	B	Li	Na	pH
82	CVS2-59	4	.4380	.1718	.1268	.0727	.0375	.0005	.0200	.1150	.0075	.0102	0.268	1.591	1.287	1.222	11.47
83	CVS2-60	4	.5281	.0876	.1725	.0743	.0063	.0005	.0200	.0925	.0075	.0107	0.415	1.624	1.158	1.523	11.96
84	CVS2-61	4	.5281	.0664	.1200	.0730	.0000	.0000	.0200	.1625	.0175	.0125	0.195	0.222	0.280	0.230	10.89
85	CVS2-62	4	.5579	.1765	.1125	.0156	.0500	.0005	.0200	.0500	.0075	.0095	0.268	1.002	0.862	0.928	9.56
86	CVS2-63	4	.3232	.1717	.1900	.0051	.1000	.0000	.0200	.1800	.0000	.0100	0.079	0.332	0.222	0.390	10.59
87	CVS2-64	4	.5697	.0509	.0925	.0642	.0025	.0008	.0812	.0288	.0431	.0663	0.234	0.379	0.376	0.342	10.62
88	CVS2-65	4	.5344	.1128	.0860	.0697	.0007	.0004	.0013	.0196	.1548	.0203	0.148	0.335	0.355	0.200	10.62
89	CVS2-66	4	.5175	.0917	.1211	.0523	.0097	.0061	.0388	.1180	.0026	.0422	0.164	0.210	0.247	0.223	10.54
90	CVS2-67	4	.4596	.1587	.1086	.0583	.0024	.0001	.0004	.2043	.0000	.0076	0.230	0.512	0.480	0.214	9.73
91	CVS2-68	4	.5040	.1355	.0797	.0696	.0007	.0002	.0046	.1640	.0001	.0416	0.254	0.308	0.340	0.127	9.84
92	CVS2-69	4	.5660	.0781	.0664	.0713	.0079	.0032	.0334	.0816	.0005	.0916	0.186	0.226	0.302	0.112	10.18
93	CVS2-70	4	.4854	.1418	.0812	.0691	.0008	.0008	.0080	.1819	.0005	.0305	0.286	0.312	0.381	0.128	9.89
94	CVS2-71	4	.5697	.0509	.0925	.0642	.0025	.0008	.0812	.0288	.0431	.0663	0.244	0.411	0.427	0.350	10.78
95	CVS2-72	4	.5175	.0917	.1211	.0523	.0097	.0061	.0388	.1180	.0026	.0422	0.153	0.210	0.226	0.228	10.48
96	CVS2-73	4	.5040	.1355	.0797	.0696	.0007	.0002	.0046	.1640	.0001	.0416	0.179	0.244	0.301	0.074	9.96
97	CVS2-74	4	.5660	.0781	.0664	.0713	.0079	.0032	.0334	.0816	.0005	.0916	0.163	0.226	0.279	0.147	10.41
98	CVS2-75	4	.4854	.1418	.0812	.0691	.0008	.0008	.0080	.1819	.0005	.0305	0.220	0.278	0.334	0.100	9.88
99	CVS2-76	4	.5018	.0600	.1800	.0632	.0400	.0050	.1050	.0200	.0050	.0200	4.045	14.871	7.571	12.541	12.46
100	CVS2-77	4	.4550	.0600	.1800	.0700	.0050	.0050	.1050	.0200	.1100	.0900	2.290	9.512	6.221	6.552	12.26
101	CVS2-78	4	.5600	.1600	.0500	.0254	.0050	.0400	.0699	.0200	.0497	.0200	0.191	0.934	0.698	0.593	9.21
102	CVS2-79	4	.5479	.1600	.0500	.0121	.0050	.0050	.1050	.0200	.0050	.0900	0.190	0.744	0.684	0.660	8.96
103	CVS2-80	4	.5074	.1600	.0500	.0176	.0050	.0400	.1050	.0200	.0750	.0200	0.195	0.764	0.672	0.600	9.15
104	CVS2-81	4	.4400	.0600	.1734	.0700	.0050	.0400	.1050	.0200	.0050	.0816	3.036	16.613	8.064	12.824	12.51
105	CVS2-82	4	.5600	.0950	.1800	.0700	.0050	.0400	.1050	.0200	.0050	.0200	16.884	44.000	19.969	35.377	12.18
106	CVS2-83	4	.4900	.0951	.1800	.0699	.0400	.0050	.1050	.0200	.0050	.0900	11.447	34.656	19.228	27.890	12.33
107	CVS2-84	4	.4550	.0600	.1800	.0700	.0050	.0050	.1050	.0200	.0800	.0200	0.493	12.460	6.682	8.236	12.42
108	CVS2-85	4	.4400	.0600	.1800	.0700	.0050	.0200	.0050	.1700	.0050	.0450	0.291	0.456	0.422	0.749	11.68
109	CVS2-86	4	.4764	.0600	.1800	.0136	.0400	.0050	.0050	.1700	.0050	.0450	0.082	0.115	0.091	0.254	10.98
110	CVS2-87	4	.4983	.0800	.1800	.0180	.0137	.0050	.0250	.0987	.0613	.0200	0.114	0.178	0.131	0.286	10.90
111	CVS2-88	4	.4597	.0600	.1403	.0700	.0400	.0050	.0250	.1050	.0750	.0200	0.162	0.308	0.376	0.473	11.52
112	CVS2-89	4	.4400	.1171	.1800	.0100	.0400	.0050	.1050	.0200	.0629	.0200	0.364	1.716	1.236	1.348	11.04
113	CVS2-90	4	.5600	.1600	.0542	.0700	.0050	.0050	.1008	.0200	.0050	.0200	0.716	5.577	3.764	3.481	9.98
114	CVS2-91	4	.5600	.1600	.1050	.0100	.0050	.0400	.0050	.0200	.0050	.0900	0.468	8.642	6.774	6.738	9.38
115	CVS2-92	4	.4400	.1600	.1000	.0700	.0050	.0400	.0050	.0200	.0700	.0900	1.214	18.590	12.442	11.792	11.12
116	CVS2-93	4	.4400	.1337	.1279	.0700	.0098	.0050	.0986	.0200	.0050	.0900	1.967	13.227	7.757	10.010	11.76
117	CVS2-94	4	.4400	.1600	.1800	.0526	.0400	.0050	.0271	.0703	.0050	.0200	0.935	4.070	3.066	3.350	11.84
118a	CVS2-95	4	.4895	.1112	.1671	.0428	.0113	.0166	.0897	.0367	.0041	.0310	2.008	9.976	4.271	7.259	11.81
118b	CVS2-95	4	.4879	.1108	.1666	.0427	.0113	.0165	.0926	.0366	.0041	.0310	2.008	9.976	4.271	7.259	11.81
119	CVS2-96	4	.4801	.1142	.1003	.0376	.0275	.0363	.0568	.0636	.0429	.0407	0.159	0.493	0.429	0.410	10.24

Note: Point 118a is the nominal composition of the DWPf EA glass, with the mass fractions of Fe₂O₃ and FeO added together and listed as Fe₂O₃. Point 118b is an erroneous reexpression of the composition that was used in modeling but not detected until after completion of modeling. The impact of this should be negligible due to the minor differences in the 118a and 118b compositions.

Table A.1. Compositions, Normalized PCT Releases, and pH for CVS-I and CVS-II Phase 1, 2, 3, and 4 Quenched Glasses (continued)

#	Glass	Phase	SiO2	B2O3	Na2O	Li2O	CaO	MgO	Fe2O3	Al2O3	ZrO2	Others	Si	B	Li	Na	pH
120	CVS2-97	4	.5328	.1048	.1129	.0373	.0082	.0084	.0733	.0235	.0392	.0596	0.391	1.434	1.052	1.134	10.25
121	CVS2-98	4	.4200	.1743	.2000	.0369	.0000	.0000	.0200	.1388	.0000	.0100	0.267	4.520	3.497	2.796	11.58
122	CVS2-99	4	.5203	.0969	.0980	.0356	.0097	.0077	.1019	.0523	.0199	.0577	0.131	0.232	0.246	0.199	10.10
123	CVS2-100	4	.5329	.0740	.0626	.0596	.0035	.0012	.1229	.0286	.0443	.0704	0.170	0.326	0.343	0.226	10.34
124	CVS2-101	4	.4895	.1112	.1671	.0428	.0113	.0166	.0897	.0367	.0041	.0310	1.819	8.644	3.831	6.586	11.92
125	CVS2-102	5	.5353	.1053	.1125	.0375	.0083	.0084	.0719	.0231	.0385	.0592	0.559	2.672	1.921	1.677	10.28
126	CVS2-103	5	.4100	.1337	.1428	.0476	.0105	.0107	.0913	.0293	.0489	.0752	0.691	6.073	4.066	4.082	11.61
127	CVS2-104	5	.4500	.1246	.1332	.0444	.0098	.0099	.0851	.0273	.0456	.0701	0.712	5.548	3.633	3.668	11.29
128	CVS2-105	5	.4900	.1156	.1235	.0412	.0091	.0092	.0789	.0254	.0423	.0650	0.687	4.590	3.132	2.974	10.82
129	CVS2-106	5	.5700	.0974	.1041	.0347	.0077	.0078	.0665	.0214	.0356	.0548	0.447	1.651	1.348	1.165	10.18
130	CVS2-107	5	.5684	.0500	.1195	.0398	.0088	.0089	.0763	.0245	.0409	.0629	0.348	0.788	0.662	0.620	10.68
131	CVS2-108	5	.5086	.1500	.1069	.0356	.0079	.0080	.0683	.0220	.0366	.0562	0.357	2.144	1.646	1.387	9.79
132	CVS2-109	5	.4786	.2000	.1006	.0335	.0074	.0075	.0643	.0207	.0344	.0529	0.313	5.707	4.494	3.584	9.54
133	CVS2-110	5	.5730	.1127	.0500	.0401	.0089	.0090	.0770	.0247	.0412	.0634	0.160	0.314	0.402	0.118	9.61
134	CVS2-111	5	.5127	.1009	.1500	.0359	.0080	.0081	.0689	.0221	.0369	.0567	1.199	6.135	3.894	4.043	11.35
135	CVS2-112	5	.4825	.0949	.2000	.0338	.0075	.0076	.0648	.0208	.0347	.0534	0.454	14.400	7.794	9.603	12.04
136	CVS2-113	5	.5506	.1083	.1157	.0100	.0085	.0086	.0740	.0238	.0396	.0609	0.216	0.612	0.630	0.510	9.63
137	CVS2-114	5	.5228	.1028	.1099	.0600	.0081	.0082	.0702	.0226	.0376	.0578	1.838	7.116	4.928	4.599	11.41
138	CVS2-115	5	.5172	.1017	.1087	.0700	.0080	.0081	.0695	.0223	.0372	.0572	1.942	9.406	5.837	5.765	11.55
139	CVS2-116	5	.5290	.1041	.1112	.0371	.0200	.0083	.0711	.0228	.0381	.0585	0.606	3.012	2.203	2.030	10.43
140	CVS2-117	5	.5398	.1062	.1135	.0378	.0084	.0000	.0725	.0233	.0388	.0597	0.445	1.590	1.337	1.099	10.19
141	CVS2-118	5	.5290	.1041	.1112	.0371	.0082	.0200	.0711	.0228	.0381	.0585	0.606	3.630	2.609	2.394	10.40
142	CVS2-119	5	.5480	.1078	.1152	.0384	.0085	.0086	.0736	.0000	.0394	.0606	0.829	3.803	2.688	2.574	10.32
143	CVS2-120	5	.5206	.1024	.1094	.0365	.0081	.0082	.0699	.0500	.0374	.0576	0.154	0.291	0.324	0.231	10.09
144	CVS2-121	5	.4932	.0970	.1036	.0346	.0077	.0077	.0662	.1000	.0355	.0545	0.129	0.199	0.311	0.137	10.06
145	CVS2-122	5	.4658	.0916	.0979	.0326	.0072	.0073	.0626	.1500	.0335	.0515	0.128	0.193	0.363	0.089	9.91
146	CVS2-123	5	.5328	.1048	.1129	.0373	.0082	.0084	.0733	.0235	.0392	.0596	0.391	1.473	1.125	1.075	10.22
147	CVS2-124	5	.3700	.1428	.1525	.0508	.0113	.0114	.0975	.0313	.0522	.0803	0.692	5.567	4.424	4.293	11.78

A.5

Table A.2. Compositions, Normalized PCT Releases, and pH for CVS-III Phase 1 Quenched Glasses

Glass	SiO2	B2O3	Na2O	Li2O	Fe2O3	Al2O3	ZrO2	B12O3	P2O5	UO2	Others	Si	Li	Na	pH
CVS3-1	0.5333	0.0005	0.1234	0.0286	0.0680	0.0487	0.0438	0.0137	0.0079	0.0000	0.1321	0.160	0.383	0.400	11.20
CVS3-2	0.6000	0.0004	0.1057	0.0245	0.0583	0.0417	0.0375	0.0118	0.0068	0.0000	0.1133	0.132	0.360	0.306	10.80
CVS3-3	0.4500	0.0005	0.1454	0.0337	0.0801	0.0574	0.0516	0.0162	0.0094	0.0000	0.1557	0.202	0.447	0.609	11.61
CVS3-4	0.4000	0.0006	0.1586	0.0367	0.0874	0.0626	0.0563	0.0176	0.0102	0.0000	0.1700	0.254	0.595	0.907	11.88
CVS3-5	0.3700	0.0006	0.1665	0.0386	0.0918	0.0657	0.0591	0.0185	0.0107	0.0000	0.1785	0.271	0.620	1.174	12.03
CVS3-6	0.4889	0.0837	0.1131	0.0262	0.0623	0.0446	0.0401	0.0126	0.0073	0.0000	0.1212	0.151	0.346	0.296	10.23
CVS3-7	0.5122	0.0400	0.1185	0.0274	0.0653	0.0468	0.0420	0.0132	0.0076	0.0000	0.1270	0.150	0.326	0.307	10.72
CVS3-8	0.4710	0.0004	0.2258	0.0252	0.0600	0.0430	0.0387	0.0121	0.0070	0.0000	0.1168	0.585	1.643	2.625	12.44
CVS3-9	0.5779	0.0005	0.0500	0.0309	0.0737	0.0527	0.0474	0.0149	0.0086	0.0000	0.1434	0.100	0.355	0.034	10.24
CVS3-10	0.5097	0.0004	0.1179	0.0716	0.0650	0.0465	0.0418	0.0131	0.0076	0.0000	0.1284	0.334	0.865	0.824	11.84
CVS3-11	0.5215	0.0005	0.1206	0.0500	0.0665	0.0476	0.0428	0.0134	0.0078	0.0000	0.1293	0.224	0.540	0.567	11.58
CVS3-12	0.5490	0.0005	0.1270	0.0000	0.0700	0.0501	0.0451	0.0141	0.0082	0.0000	0.1360	0.113	(a)	0.314	10.78
CVS3-13	0.4864	0.0004	0.1125	0.0260	0.1500	0.0444	0.0399	0.0125	0.0072	0.0000	0.1207	0.162	0.380	0.336	11.02
CVS3-14	0.5093	0.0004	0.1178	0.0273	0.1100	0.0465	0.0418	0.0131	0.0076	0.0000	0.1262	0.155	0.356	0.346	11.06
CVS3-15	0.5722	0.0005	0.1324	0.0306	0.0000	0.0522	0.0470	0.0147	0.0085	0.0000	0.1419	0.187	0.529	0.585	11.54
CVS3-16	0.4202	0.0004	0.0972	0.0225	0.0536	0.2500	0.0345	0.0108	0.0063	0.0000	0.1045	0.120	0.511	0.079	10.34
CVS3-17	0.4597	0.0004	0.1063	0.0246	0.0586	0.1800	0.0377	0.0118	0.0068	0.0000	0.1141	0.118	0.422	0.129	10.64
CVS3-18	0.4877	0.0004	0.1128	0.0261	0.0622	0.1300	0.0400	0.0126	0.0073	0.0000	0.1209	0.111	0.304	0.199	10.74
CVS3-19	0.5606	0.0005	0.1297	0.0300	0.0715	0.0000	0.0460	0.0144	0.0084	0.0000	0.1389	0.842	1.640	1.717	11.43
CVS3-20	0.4685	0.0004	0.1084	0.0251	0.0597	0.0428	0.1600	0.0121	0.0070	0.0000	0.1160	0.110	0.331	0.289	11.04
CVS3-21	0.4908	0.0004	0.1135	0.0263	0.0626	0.0448	0.1200	0.0126	0.0073	0.0000	0.1217	0.097	0.301	0.254	11.02
CVS3-22	0.5131	0.0004	0.1187	0.0275	0.0654	0.0468	0.0800	0.0132	0.0076	0.0000	0.1273	0.119	0.310	0.303	11.07
CVS3-23	0.5577	0.0005	0.1290	0.0299	0.0711	0.0509	0.0000	0.0144	0.0083	0.0000	0.1382	0.232	0.502	0.562	11.28
CVS3-24	0.4966	0.0004	0.1149	0.0266	0.0633	0.0453	0.0408	0.0195	0.0113	0.0000	0.1813	0.151	0.355	0.380	11.07
CVS3-25	0.5742	0.0005	0.1328	0.0307	0.0732	0.0524	0.0471	0.0073	0.0042	0.0000	0.0776	0.161	0.384	0.420	11.26
CVS3-26	0.5328	0.1048	0.1129	0.0373	0.0733	0.0235	0.0392	0.0000	0.0010	0.0000	0.0752	0.358	1.041	1.024	10.26
CVS3-27	0.4864	0.0004	0.1125	0.0260	0.1500	0.0444	0.0399	0.0125	0.0072	0.0000	0.1207	0.157	0.358	0.329	10.98
CVS3-28	0.5170	0.0005	0.1196	0.0277	0.0659	0.0472	0.0424	0.0437	0.0077	0.0000	0.1283	0.160	0.382	0.400	11.20
CVS3-29	0.5062	0.0005	0.1171	0.0271	0.0645	0.0462	0.0416	0.0637	0.0075	0.0000	0.1256	0.189	0.411	0.432	11.22
CVS3-30	0.4792	0.0005	0.1109	0.0257	0.0611	0.0437	0.0393	0.1137	0.0071	0.0000	0.1188	0.183	0.397	0.420	11.23
CVS3-31	0.4522	0.0004	0.1046	0.0242	0.0576	0.0413	0.0371	0.1637	0.0067	0.0000	0.1122	0.202	0.451	0.465	11.26
CVS3-32	0.5306	0.0004	0.1146	0.0287	0.0631	0.0452	0.0407	0.0127	0.0074	0.0900	0.0666	0.159	0.370	0.327	10.88
CVS3-33	0.5644	0.0005	0.1219	0.0305	0.0672	0.0481	0.0432	0.0135	0.0078	0.0320	0.0709	0.149	0.339	0.335	10.95
CVS3-34	0.5475	0.0004	0.1182	0.0296	0.0652	0.0467	0.0420	0.0131	0.0076	0.0610	0.0687	0.154	0.358	0.332	10.89
CVS3-35	0.5136	0.0004	0.1109	0.0277	0.0611	0.0438	0.0394	0.0123	0.0071	0.1190	0.0647	0.164	0.397	0.326	10.78
CVS3-36	0.4966	0.0004	0.1072	0.0268	0.0591	0.0423	0.0381	0.0119	0.0069	0.1480	0.0627	0.166	0.395	0.306	10.80
CVS3-37	0.5214	0.0005	0.1206	0.0279	0.0665	0.0476	0.0428	0.0134	0.0300	0.0000	0.1293	0.151	0.188	0.370	10.52
CVS3-38	0.5107	0.0005	0.1181	0.0274	0.0651	0.0466	0.0419	0.0131	0.0500	0.0000	0.1266	0.145	0.292	0.323	11.03
CVS3-39	0.4999	0.0005	0.1156	0.0268	0.0637	0.0456	0.0410	0.0129	0.0700	0.0000	0.1240	0.137	0.234	0.275	10.81
CVS3-40	0.4892	0.0005	0.1132	0.0262	0.0624	0.0447	0.0402	0.0126	0.0900	0.0000	0.1210	0.129	0.205	0.235	10.59

(a) Glass did not contain this element, so it cannot be released.

Table A.3. Compositions and Normalized PCT Releases for 92 CVS-I and CVS-II Phase 1, 2, 3, and 4 Quenched Glasses

Glass	SiO2	B2O3	Na2O	Li2O	CaO	MgO	Fe2O3	Al2O3	ZrO2	B12O3	P2O5	UO2	Others	Si	B	Na	Li
CVS1-2	.5500	.0500	.0500	.0700	.1000	.0000	.0200	.1500	.0000	.0000	.0000	.0000	.0100	0.054	0.066	0.064	0.154
CVS1-5	.5700	.0500	.0700	.0700	.0000	.0000	.1500	.0800	.0000	.0000	.0000	.0000	.0100	0.318	0.355	0.191	0.462
CVS1-7	.5700	.0500	.0964	.0100	.1000	.0000	.0336	.0000	.1300	.0000	.0000	.0000	.0100	0.114	0.287	0.339	0.331
CVS1-8	.5363	.0500	.0837	.0100	.0000	.0800	.1500	.0000	.0800	.0000	.0000	.0000	.0100	0.265	1.238	0.805	0.744
CVS1-10	.5700	.0851	.0949	.0100	.0000	.0000	.0200	.1200	.0000	.0000	.0000	.0000	.1000	0.104	0.127	0.095	0.386
CVS1-15	.5589	.0500	.1211	.0700	.0000	.0800	.0200	.0000	.0000	.0000	.0000	.0000	.1000	0.967	18.778	13.995	11.198
CVS1-16	.4327	.0500	.1873	.0100	.0000	.0800	.0858	.1442	.0000	.0000	.0000	.0000	.0100	0.241	0.523	0.540	0.266
CVS1-17	.4545	.0500	.1455	.0100	.1000	.0000	.1400	.0000	.0000	.0000	.0000	.0000	.1000	0.663	2.235	2.304	2.075
CVS1-18	.4214	.0500	.1186	.0700	.0200	.0800	.0200	.0000	.1300	.0000	.0000	.0000	.0900	1.531	11.238	8.040	8.065
CVS1-22	.5363	.0500	.0837	.0100	.0000	.0800	.1500	.0000	.0800	.0000	.0000	.0000	.0100	0.259	1.119	0.760	0.704
CVS2-1	.5226	.0874	.0700	.0600	.0000	.0500	.0400	.0800	.0100	.0000	.0000	.0000	.0800	0.170	0.312	0.208	0.369
CVS2-2	.5017	.0700	.0883	.0600	.0700	.0000	.0450	.1100	.0300	.0000	.0000	.0000	.0250	0.075	0.128	0.188	0.276
CVS2-6	.5372	.0700	.0700	.0382	.0700	.0046	.1200	.0159	.0100	.0000	.0000	.0000	.0641	0.421	1.185	1.284	1.303
CVS2-8	.5115	.0700	.0985	.0600	.0000	.0500	.1140	.0610	.0100	.0000	.0000	.0000	.0250	0.263	0.484	0.445	0.523
CVS2-11	.4916	.0751	.0833	.0600	.0700	.0100	.0400	.0100	.0935	.0000	.0000	.0000	.0665	0.510	1.587	1.370	1.564
CVS2-13	.4937	.0700	.1692	.0225	.0300	.0500	.0400	.0896	.0100	.0000	.0000	.0000	.0250	0.182	0.360	0.478	0.362
CVS2-15	.4729	.0700	.1700	.0214	.0601	.0000	.0400	.0756	.0100	.0000	.0000	.0000	.0800	0.180	0.331	0.608	0.451
CVS2-20	.5700	.0500	.1031	.0669	.0000	.0000	.0600	.0100	.1300	.0000	.0000	.0000	.0100	0.187	0.347	0.279	0.386
CVS2-22	.5700	.0500	.0735	.0700	.0000	.0800	.0200	.0365	.0000	.0000	.0000	.0000	.1000	2.249	9.646	6.097	5.453
CVS2-23	.5700	.0522	.2000	.0100	.0800	.0000	.0200	.0578	.0000	.0000	.0000	.0000	.0100	0.144	0.173	0.809	0.604
CVS2-25	.5059	.0500	.0841	.0700	.0800	.0000	.1500	.0033	.0000	.0000	.0000	.0000	.0567	1.214	4.662	3.526	2.765
CVS2-27	.5463	.0500	.2000	.0155	.0000	.0800	.0200	.0782	.0000	.0000	.0000	.0000	.0100	0.890	3.270	2.342	1.835
CVS2-28	.5619	.0500	.2000	.0126	.0000	.0000	.0200	.0555	.0000	.0000	.0000	.0000	.1000	1.654	5.144	3.538	3.682
CVS2-32	.5445	.0500	.2000	.0428	.0000	.0000	.0200	.0027	.1300	.0000	.0000	.0000	.0100	2.747	9.646	5.896	5.527
CVS2-33	.4200	.0544	.2000	.0364	.0000	.0800	.0200	.0892	.0000	.0000	.0000	.0000	.1000	0.516	1.723	1.608	1.438
CVS2-35	.4200	.0500	.2000	.0428	.0800	.0000	.0632	.1340	.0000	.0000	.0000	.0000	.0100	0.204	0.320	0.910	0.580
CVS2-36	.5421	.0500	.0891	.0700	.0800	.0000	.1500	.0088	.0000	.0000	.0000	.0000	.0100	0.276	0.480	0.654	0.630
CVS2-37	.5700	.0839	.1061	.0700	.0000	.0000	.0200	.1400	.0000	.0000	.0000	.0000	.0100	0.206	0.246	0.177	0.300
CVS2-39	.4838	.0500	.1362	.0700	.0000	.0800	.0742	.0258	.0700	.0000	.0000	.0000	.0100	1.612	12.701	7.668	6.528
CVS2-40	.5040	.0639	.1500	.0421	.0200	.0500	.0200	.1000	.0200	.0000	.0000	.0000	.0300	0.172	0.337	0.399	0.328
CVS2-41	.5325	.0694	.0781	.0700	.0500	.0200	.0300	.1000	.0200	.0000	.0000	.0000	.0300	0.104	0.177	0.188	0.260
CVS2-42	.5675	.0500	.0625	.0700	.0320	.0380	.1000	.0300	.0200	.0000	.0000	.0000	.0300	0.574	1.694	1.337	1.220
CVS2-47	.5294	.0500	.1277	.0429	.0500	.0200	.0200	.0400	.0500	.0000	.0000	.0000	.0700	0.434	1.159	1.055	1.124
CVS2-52	.6000	.0817	.0450	.0788	.0008	.0009	.0720	.0233	.0385	.0000	.0000	.0000	.0590	0.294	0.557	0.260	0.554
CVS2-53	.5226	.0874	.0700	.0600	.0000	.0500	.0400	.0800	.0100	.0000	.0000	.0000	.0800	0.176	0.304	0.202	0.305
CVS2-60	.5281	.0876	.1725	.0743	.0063	.0005	.0200	.0925	.0075	.0000	.0000	.0000	.0107	0.415	1.624	1.523	1.158
CVS2-61	.5281	.0664	.1200	.0730	.0000	.0000	.0200	.1625	.0175	.0000	.0000	.0000	.0125	0.195	0.222	0.230	0.280
CVS2-64	.5697	.0509	.0925	.0642	.0025	.0008	.0812	.0288	.0431	.0000	.0000	.0000	.0663	0.234	0.379	0.342	0.376
CVS2-69	.5660	.0781	.0664	.0713	.0079	.0032	.0334	.0816	.0005	.0000	.0000	.0000	.0916	0.186	0.226	0.112	0.302
CVS2-71	.5697	.0509	.0925	.0642	.0025	.0008	.0812	.0288	.0431	.0000	.0000	.0000	.0663	0.244	0.411	0.350	0.427

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Table A.3. Compositions and Normalized PCT Releases for 92 CVS-I and CVS-II Phase 1, 2, 3, and 4 Quenched Glasses (continued)

Class	SiO2	B2O3	Na2O	Li2O	CaO	MgO	Fe2O3	Al2O3	ZrO2	B2O3	P2O5	UO2	Others	SI	B	Na	LI
CVS2-74	.5660	.0781	.0664	.0713	.0079	.0032	.0034	.0816	.0005	.0000	.0000	.0000	.0000	.0916	.0163	.0226	0.147
CVS2-76	.5018	.0600	.1800	.0632	.0400	.0050	.1050	.0200	.0050	.0000	.0000	.0000	.0000	.0200	.4045	.14.871	12.541
CVS2-77	.4550	.0600	.1800	.0700	.0050	.0050	.1050	.0200	.0050	.0000	.0000	.0000	.0000	.0900	.2.290	.9.512	6.552
CVS2-81	.4400	.0600	.1734	.0700	.0050	.0050	.1050	.0200	.0050	.0000	.0000	.0000	.0000	.0816	.3.036	.16.613	12.824
CVS2-84	.4550	.0600	.1800	.0700	.0050	.0050	.1050	.0200	.0050	.0000	.0000	.0000	.0000	.0200	.0.493	.12.460	8.236
CVS2-85	.4400	.0600	.1800	.0700	.0050	.0050	.1050	.0200	.0050	.0000	.0000	.0000	.0000	.0450	.0.291	.0.456	0.749
CVS2-86	.4764	.0600	.1800	.0136	.0400	.0050	.1700	.0050	.0000	.0000	.0000	.0000	.0000	.0450	.0.082	.0.115	0.254
CVS2-87	.4983	.0800	.1800	.0180	.0137	.0050	.0250	.0987	.0613	.0000	.0000	.0000	.0000	.0200	.0.114	.0.178	0.286
CVS2-88	.4597	.0600	.1403	.0700	.0400	.0050	.0250	.0750	.0000	.0000	.0000	.0000	.0000	.0200	.0.162	.0.308	0.473
CVS2-100	.5329	.0740	.0626	.0596	.0035	.0012	.1229	.0286	.0443	.0000	.0000	.0000	.0000	.0704	.0.170	.0.326	0.226
CVS2-107	.5684	.0500	.1195	.0398	.0088	.0089	.0763	.0245	.0409	.0000	.0000	.0000	.0000	.0629	.0.348	.0.788	0.620
ECA-451	.4712	.0500	.1196	.0686	.0093	.0003	.0552	.0649	.0349	.0000	.0000	.0000	.0000	.1260	.0.257	.0.487	0.548
ECA-501	.4231	.0700	.1329	.0511	.0104	.0003	.0613	.0722	.0388	.0000	.0000	.0000	.0000	.1401	.0.209	.0.474	0.508
N508	.4603	.0000	.1666	.0000	.0039	.0010	.0451	.1407	.0754	.0000	.0000	.0000	.0000	.1071	.0.170	.0.000	0.463
CVS3-1	.5333	.0005	.1234	.0286	.0126	.0005	.0680	.0487	.0438	.0137	.0079	.0000	.0000	.1192	.0.160	.0.422	0.400
CVS3-2	.6000	.0004	.1057	.0245	.0108	.0004	.0583	.0417	.0375	.0118	.0068	.0000	.0000	.1021	.0.132	.4.803	0.306
CVS3-3	.4500	.0005	.1454	.0337	.0148	.0006	.0801	.0574	.0516	.0162	.0094	.0000	.0000	.1404	.0.202	.0.450	0.609
CVS3-4	.4000	.0006	.1586	.0367	.0162	.0006	.0874	.0626	.0563	.0176	.0102	.0000	.0000	.1532	.0.254	.0.654	0.907
CVS3-5	.3700	.0006	.1665	.0386	.0170	.0006	.0918	.0657	.0591	.0185	.0107	.0000	.0000	.1609	.0.271	.0.627	1.174
CVS3-6	.4889	.0837	.1131	.0262	.0116	.0004	.0623	.0446	.0401	.0126	.0073	.0000	.0000	.1092	.0.151	.0.309	0.296
CVS3-7	.5122	.0400	.1185	.0274	.0121	.0005	.0653	.0468	.0420	.0132	.0076	.0000	.0000	.1144	.0.150	.0.264	0.307
CVS3-8	.4710	.0004	.2258	.0252	.0111	.0004	.0430	.0387	.0121	.0070	.0000	.0000	.0000	.1053	.0.585	.1.266	2.625
CVS3-9	.5779	.0005	.0500	.0309	.0137	.0005	.0737	.0527	.0474	.0149	.0086	.0000	.0000	.1291	.0.100	.0.209	0.034
CVS3-10	.5097	.0004	.1179	.0716	.0120	.0005	.0650	.0465	.0418	.0131	.0076	.0000	.0000	.1139	.0.334	.0.703	0.824
CVS3-11	.5215	.0005	.1206	.0500	.0123	.0005	.0665	.0476	.0428	.0134	.0078	.0000	.0000	.1165	.0.224	.0.429	0.567
CVS3-12	.5490	.0005	.1270	.0000	.0130	.0005	.0700	.0501	.0451	.0141	.0082	.0000	.0000	.1227	.0.113	.0.100	0.314
CVS3-13	.4864	.0004	.1125	.0260	.0115	.0004	.1500	.0444	.0399	.0125	.0072	.0000	.0000	.1087	.0.162	.0.804	0.336
CVS3-14	.5093	.0004	.1178	.0273	.0120	.0005	.1100	.0465	.0418	.0131	.0076	.0000	.0000	.1138	.0.155	.0.301	0.346
CVS3-15	.5722	.0005	.1324	.0306	.0135	.0005	.0000	.0522	.0470	.0147	.0085	.0000	.0000	.1279	.0.187	.0.466	0.585
CVS3-16	.4202	.0004	.0972	.0225	.0099	.0004	.2500	.0536	.0345	.0108	.0063	.0000	.0000	.0939	.0.120	.0.268	0.079
CVS3-17	.4597	.0004	.1063	.0246	.0109	.0004	.0586	.0586	.0377	.0118	.0068	.0000	.0000	.1028	.0.118	.0.523	0.129
CVS3-18	.4877	.0004	.1128	.0261	.0115	.0004	.0622	.1300	.0400	.0126	.0073	.0000	.0000	.1089	.0.111	.0.643	0.199
CVS3-19	.5606	.0005	.1297	.0300	.0132	.0005	.0715	.0000	.0460	.0144	.0084	.0000	.0000	.1252	.0.842	.2.022	1.717
CVS3-21	.4908	.0004	.1135	.0263	.0116	.0004	.0626	.0448	.1200	.0126	.0073	.0000	.0000	.1097	.0.097	.0.196	0.254
CVS3-22	.5131	.0004	.1187	.0275	.0121	.0005	.0654	.0468	.0800	.0132	.0076	.0000	.0000	.1147	.0.119	.0.324	0.303
CVS3-23	.5577	.0005	.1290	.0299	.0132	.0005	.0711	.0509	.0000	.0144	.0083	.0000	.0000	.1246	.0.232	.0.402	0.562
CVS3-24	.4966	.0004	.1149	.0266	.0117	.0004	.0633	.0453	.0408	.0195	.0113	.0000	.0000	.1692	.0.151	.0.261	0.380
CVS3-25	.5742	.0005	.1328	.0307	.0136	.0005	.0732	.0524	.0471	.0073	.0042	.0000	.0000	.0635	.0.161	.0.209	0.420
CVS3-27	.4864	.0004	.1125	.0260	.0115	.0004	.1500	.0444	.0399	.0125	.0072	.0000	.0000	.1087	.0.157	.0.342	0.329

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Table A.3. Compositions and Normalized PCT Releases for 92 CVS-I and CVS-II Phase 1, 2, 3, and 4 Quenched Glasses (continued)

Glass	SiO2	B2O3	Na2O	Li2O	CaO	MgO	Fe2O3	Al2O3	ZrO2	Bi2O3	P2O5	UO2	Others	Si	B	Na	Li
CVS3-28	.5170	.0005	.1196	.0277	.0122	.0005	.0659	.0472	.0424	.0437	.0077	.0000	.1156	0.160	0.305	0.400	0.382
CVS3-29	.5062	.0005	.1171	.0271	.0120	.0005	.0645	.0462	.0416	.0637	.0075	.0000	.1132	0.189	0.241	0.432	0.411
CVS3-30	.4792	.0005	.1109	.0257	.0113	.0004	.0611	.0437	.0393	.1137	.0071	.0000	.1071	0.183	0.338	0.420	0.397
CVS3-31	.4522	.0004	.1046	.0242	.0107	.0004	.0576	.0413	.0371	.1637	.0067	.0000	.1011	0.202	0.261	0.465	0.451
CVS3-32	.5287	.0004	.1142	.0286	.0117	.0004	.0629	.0450	.0405	.0127	.0074	.0930	.0545	0.159	0.523	0.327	0.370
CVS3-33	.5637	.0005	.1217	.0304	.0124	.0005	.0671	.0480	.0432	.0135	.0078	.0330	.0582	0.149	0.370	0.335	0.339
CVS3-34	.5462	.0004	.1179	.0295	.0120	.0005	.0650	.0465	.0419	.0131	.0076	.0630	.0564	0.154	0.463	0.332	0.358
CVS3-35	.5112	.0004	.1104	.0276	.0113	.0004	.0608	.0436	.0392	.0123	.0071	.1230	.0527	0.164	0.443	0.326	0.397
CVS3-36	.4937	.0004	.1066	.0267	.0109	.0004	.0588	.0421	.0378	.0119	.0069	.1530	.0508	0.166	0.543	0.306	0.395
CVS3-37	.5214	.0005	.1206	.0279	.0123	.0005	.0665	.0476	.0428	.0134	.0300	.0000	.1165	0.151	0.546	0.370	0.188
CVS3-38	.5107	.0005	.1181	.0274	.0121	.0005	.0651	.0466	.0419	.0131	.0500	.0000	.1141	0.145	.	0.323	0.292
CVS3-39	.4999	.0005	.1156	.0268	.0118	.0004	.0637	.0456	.0410	.0129	.0700	.0000	.1117	0.137	.	0.275	0.234
CVS3-40	.4892	.0005	.1132	.0262	.0116	.0004	.0624	.0447	.0402	.0126	.0900	.0000	.1093	0.129	.	0.235	0.205

Table A.4. Compositions, Normalized PCT Releases, and pH for CVS-I and CVS-II Phase 1, 2, 3, and 4 Canister-Centerline-Cooled Glasses

#	ID	Glass	SiO2	B2O3	Na2O	Li2O	CaO	MgO	Fe2O3	Al2O3	ZrO2	Others	Si	B	Li	Na	pH
1	0	CVS1-1	0.4801	0.1142	0.1003	0.0376	0.0275	0.0363	0.0568	0.0636	0.0429	0.0407	0.149	0.386	0.498	0.358	10.20
2.1	1	CVS1-2	0.5500	0.0500	0.0500	0.0700	0.1000	0.0000	0.0200	0.1500	0.0000	0.0100	0.311	3.087	1.505	1.199	11.38
2.2	0	CVS1-2	0.5500	0.0500	0.0500	0.0700	0.1000	0.0000	0.0200	0.1500	0.0000	0.0100	0.220	1.289	1.356	0.536	11.60
2.3	0	CVS1-2	0.5500	0.0500	0.0500	0.0700	0.1000	0.0000	0.0200	0.1500	0.0000	0.0100	0.239	1.711	1.253	0.555	11.51
3	0	CVS1-3	0.4200	0.2000	0.0500	0.0700	0.0000	0.0800	0.0200	0.1400	0.0100	0.0100	0.190	0.732	0.817	0.540	9.76
4	0	CVS1-4	0.5700	0.2000	0.0900	0.0100	0.0200	0.0800	0.0200	0.0000	0.0000	0.0100	0.699	14.791	18.495	18.269	9.32
5	0	CVS1-5	0.5700	0.0500	0.0700	0.0700	0.0000	0.0000	0.1500	0.0800	0.0000	0.0100	0.956	0.878	1.859	0.496	11.50
6.1	0	CVS1-6	0.4400	0.2000	0.0500	0.0700	0.0000	0.0000	0.0200	0.0000	0.1200	0.1000	0.267	4.662	3.994	2.642	9.56
6.2	0	CVS1-6	0.4400	0.2000	0.0500	0.0700	0.0000	0.0000	0.0200	0.0000	0.1200	0.1000	0.304	5.410	3.810	2.951	9.61
7	0	CVS1-7	0.5700	0.0500	0.0964	0.0100	0.1000	0.0000	0.0336	0.0000	0.1300	0.0100	0.142	0.312	0.280	0.326	10.29
8	0	CVS1-8	0.5363	0.0500	0.0837	0.0100	0.0000	0.0800	0.1500	0.0000	0.0800	0.0100	0.438	4.180	2.151	1.658	9.59
9.1	0	CVS1-9	0.4200	0.1962	0.0538	0.0100	0.0000	0.0800	0.1400	0.0000	0.0000	0.1000	0.127	28.434	37.634	37.325	9.04
9.2	0	CVS1-9	0.4200	0.1962	0.0538	0.0100	0.0000	0.0800	0.1400	0.0000	0.0000	0.1000	0.478	33.842	38.065	37.200	9.08
10	0	CVS1-10	0.5700	0.0851	0.0949	0.0100	0.0000	0.0000	0.0200	0.1200	0.0000	0.1000	0.097	0.119	0.301	0.092	9.14
11	0	CVS1-11	0.4200	0.1549	0.0751	0.0100	0.1000	0.0000	0.0200	0.1400	0.0000	0.0800	0.043	0.197	0.280	0.126	9.55
12	0	CVS1-12	0.4200	0.1764	0.0736	0.0700	0.1000	0.0000	0.1500	0.0000	0.0000	0.0100	0.906	2.989	3.948	4.083	11.19
13	0	CVS1-13	0.5700	0.2000	0.1862	0.0100	0.0000	0.0000	0.0200	0.0038	0.0000	0.0100	2.062	12.379	12.796	12.485	10.32
14	0	CVS1-14	0.4200	0.2000	0.1862	0.0100	0.0000	0.0000	0.0200	0.0238	0.1300	0.0100	0.137	8.601	6.774	5.067	9.71
15	0	CVS1-15	0.5589	0.0500	0.1211	0.0700	0.0000	0.0800	0.0200	0.0000	0.0000	0.1000	0.650	19.614	8.571	14.022	11.99
16.1	0	CVS1-16	0.4327	0.0500	0.1873	0.0100	0.0000	0.0800	0.0858	0.1442	0.0000	0.0100	1.975	22.830	10.860	8.850	12.28
16.2	0	CVS1-16	0.4327	0.0500	0.1873	0.0100	0.0000	0.0800	0.0858	0.1442	0.0000	0.0100	1.459	20.547	9.290	7.267	12.29
17.1	0	CVS1-17	0.4545	0.0500	0.1455	0.0100	0.1000	0.0000	0.1400	0.0000	0.0000	0.1000	0.395	0.961	1.056	1.014	11.34
17.2	0	CVS1-17	0.4545	0.0500	0.1455	0.0100	0.1000	0.0000	0.1400	0.0000	0.0000	0.1000	0.472	1.283	1.344	1.426	11.56
18	0	CVS1-18	0.4214	0.0500	0.1186	0.0700	0.0200	0.0800	0.0200	0.0000	0.1300	0.0900	1.699	22.186	5.714	12.216	12.30
19	0	CVS1-19	0.4801	0.1142	0.1003	0.0376	0.0275	0.0363	0.0568	0.0636	0.0429	0.0407	0.138	0.410	0.503	0.363	10.11
20	0	CVS1-20	0.4801	0.1142	0.1003	0.0376	0.0275	0.0363	0.0568	0.0636	0.0429	0.0407	0.149	0.443	0.515	0.364	10.21
21	0	CVS1-21	0.5700	0.2000	0.0900	0.0100	0.0200	0.0800	0.0200	0.0000	0.0000	0.0100	0.694	16.881	19.355	18.718	9.32
22	0	CVS1-22	0.5363	0.0500	0.0837	0.0100	0.0000	0.0800	0.1500	0.0000	0.0800	0.0100	0.458	3.859	2.000	1.538	9.62
23	0	CVS1-23	0.5153	0.0956	0.1052	0.0375	0.0289	0.0084	0.1179	0.0456	0.0063	0.0393	0.193	0.370	0.373	0.339	9.87
24	0	CVS2-1	0.5228	0.0874	0.0700	0.0600	0.0000	0.0500	0.0400	0.0800	0.0100	0.0800	0.237	0.386	0.305	0.248	10.30
25	0	CVS2-2	0.5017	0.0700	0.0883	0.0600	0.0700	0.0000	0.0450	0.1100	0.0300	0.0250	0.077	0.136	0.215	0.160	10.77
26	0	CVS2-3	0.4645	0.1320	0.0700	0.0435	0.0700	0.0100	0.0450	0.1032	0.0368	0.0250	0.060	0.134	0.198	0.116	10.14
27	0	CVS2-4	0.5600	0.1095	0.0700	0.0536	0.0700	0.0000	0.0400	0.0619	0.0100	0.0250	0.090	0.147	0.241	0.154	10.30
28	0	CVS2-5	0.4752	0.1590	0.1010	0.0200	0.0348	0.0000	0.0400	0.0800	0.0100	0.0800	0.146	0.263	0.285	0.264	9.61
29	0	CVS2-6	0.5372	0.0700	0.0700	0.0382	0.0700	0.0046	0.1200	0.0159	0.0100	0.0641	0.418	1.240	1.064	0.934	10.26
30	0	CVS2-7	0.4814	0.1700	0.0700	0.0591	0.0094	0.0000	0.0400	0.0953	0.0100	0.0648	0.189	0.653	0.666	0.337	9.82
31	0	CVS2-8	0.5115	0.0700	0.0985	0.0600	0.0000	0.0500	0.1140	0.0610	0.0100	0.0250	0.522	0.850	1.183	0.561	11.34
32	0	CVS2-9	0.5432	0.0944	0.0924	0.0600	0.0000	0.0000	0.0712	0.0138	0.1000	0.0250	0.236	0.545	0.484	0.314	10.24
33	0	CVS2-10	0.4694	0.1700	0.1306	0.0200	0.0000	0.0000	0.0669	0.1043	0.0100	0.0288	0.162	0.965	0.968	0.645	9.51
34	0	CVS2-11	0.4916	0.0751	0.0833	0.0600	0.0700	0.0100	0.0400	0.0100	0.0935	0.0665	0.426	1.019	1.108	1.092	11.33
35	0	CVS2-12	0.4683	0.1700	0.0700	0.0466	0.0700	0.0100	0.0400	0.0901	0.0100	0.0250	0.082	0.136	0.213	0.156	9.90
36	0	CVS2-13	0.4937	0.0700	0.1692	0.0225	0.0300	0.0500	0.0400	0.0896	0.0100	0.0250	0.177	0.345	0.335	0.390	10.94
37	0	CVS2-14	0.4600	0.1312	0.0802	0.0486	0.0500	0.0200	0.0400	0.0243	0.1000	0.0457	0.258	1.580	1.254	1.210	10.50

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Table A.4. Compositions, Normalized PCT Releases, and pH for CVS-I and CVS-II Phase 1, 2, 3, and 4 Canister-Centerline-Cooled Glasses (continued)

#	ID	Glass	SiO2	B2O3	Na2O	Li2O	CaO	MgO	Fe2O3	Al2O3	ZrO2	Others	Si	B	Li	Na	pH
38	0	CVS2-15	0.4729	0.0700	0.1700	0.0214	0.0601	0.0000	0.0400	0.0756	0.0100	0.0800	0.208	1.493	1.558	0.163	9.87
39.1	0	CVS2-16	0.5353	0.1053	0.1125	0.0375	0.0083	0.0084	0.0719	0.0231	0.0385	0.0592	0.523	2.718	1.892	1.755	10.31
39.2	0	CVS2-16	0.5353	0.1053	0.1125	0.0375	0.0083	0.0084	0.0719	0.0231	0.0385	0.0592	0.547	2.550	1.864	1.689	10.29
40	0	CVS2-17	0.4801	0.1142	0.1003	0.0376	0.0275	0.0363	0.0568	0.0636	0.0429	0.0407	0.156	0.676	0.629	0.423	10.30
41	0	CVS2-18	0.5353	0.1053	0.1125	0.0375	0.0083	0.0084	0.0719	0.0231	0.0385	0.0592	0.559	2.443	1.778	1.617	10.23
42.1	0	CVS2-19	0.5328	0.1048	0.1129	0.0373	0.0082	0.0084	0.0733	0.0235	0.0392	0.0596	0.401	1.457	1.153	1.074	10.28
42.2	0	CVS2-19	0.5328	0.1048	0.1129	0.0373	0.0082	0.0084	0.0733	0.0235	0.0392	0.0596	0.353	1.258	1.038	1.015	10.23
43	0	CVS2-20	0.5700	0.0500	0.1031	0.0669	0.0000	0.0000	0.0600	0.0100	0.1300	0.0100	0.206	0.322	0.402	0.268	10.90
44	0	CVS2-21	0.5700	0.1314	0.0500	0.0700	0.0000	0.0800	0.0200	0.0686	0.0000	0.0100	0.487	3.181	2.458	1.752	10.34
45.1	0	CVS2-22	0.5700	0.0500	0.0735	0.0700	0.0000	0.0800	0.0200	0.0365	0.0000	0.1000	2.718	6.431	4.301	5.143	11.44
45.2	0	CVS2-22	0.5700	0.0500	0.0735	0.0700	0.0000	0.0800	0.0200	0.0365	0.0000	0.1000	1.614	5.434	3.656	3.851	11.52
46	0	CVS2-23	0.5700	0.0522	0.2000	0.0100	0.0800	0.0000	0.0200	0.0578	0.0000	0.0100	0.140	0.203	0.559	0.708	11.76
47	0	CVS2-24	0.4464	0.2000	0.0736	0.0700	0.0000	0.0000	0.0200	0.0961	0.0000	0.0939	0.187	4.019	3.226	1.831	9.91
48.1	1	CVS2-25	0.5059	0.0500	0.0841	0.0700	0.0800	0.0000	0.1500	0.0033	0.0000	0.0567	1.246	0.868	3.610	0.673	11.81
48.2	0	CVS2-25	0.5059	0.0500	0.0841	0.0700	0.0800	0.0000	0.1500	0.0033	0.0000	0.0567	1.322	1.717	4.240	1.081	12.06
48.3	0	CVS2-25	0.5059	0.0500	0.0841	0.0700	0.0800	0.0000	0.1500	0.0033	0.0000	0.0567	1.368	1.833	4.270	1.322	12.01
49	0	CVS2-26	0.4431	0.2000	0.0512	0.0700	0.0800	0.0000	0.0200	0.0257	0.1000	0.0100	0.328	1.326	1.567	1.448	10.17
50	0	CVS2-27	0.5463	0.0500	0.2000	0.0155	0.0000	0.0800	0.0200	0.0782	0.0000	0.0100	0.860	2.572	1.734	2.096	11.84
51	0	CVS2-28	0.5619	0.0500	0.2000	0.0126	0.0000	0.0000	0.0200	0.0555	0.0000	0.1000	1.654	3.601	3.158	3.032	11.54
52	0	CVS2-29	0.4391	0.2000	0.0675	0.0100	0.0800	0.0000	0.0200	0.0000	0.0834	0.1000	0.243	0.949	1.075	1.108	9.22
53.1	0	CVS2-30	0.5190	0.2000	0.0832	0.0100	0.0000	0.0000	0.1320	0.0458	0.0000	0.0100	0.391	16.881	15.054	9.719	8.76
53.2	0	CVS2-30	0.5190	0.2000	0.0832	0.0100	0.0000	0.0000	0.1320	0.0458	0.0000	0.0100	0.210	19.132	13.871	7.646	8.76
54	0	CVS2-31	0.5700	0.1843	0.0500	0.0331	0.0800	0.0000	0.0200	0.0526	0.0000	0.0100	0.172	0.584	0.682	0.539	9.60
55	0	CVS2-32	0.5445	0.0500	0.2000	0.0428	0.0000	0.0000	0.0200	0.0027	0.1300	0.0100	2.924	7.588	6.231	5.660	12.16
56	0	CVS2-33	0.4200	0.0544	0.2000	0.0364	0.0000	0.0800	0.0200	0.0892	0.0000	0.1000	1.526	11.526	5.908	7.412	12.50
57	0	CVS2-34	0.4200	0.1743	0.2000	0.0369	0.0000	0.0000	0.0200	0.1388	0.0000	0.0100	0.280	4.520	3.497	2.594	11.42
58.1	0	CVS2-35	0.4200	0.0500	0.2000	0.0428	0.0800	0.0000	0.0632	0.1340	0.0000	0.0100	1.959	23.183	8.793	10.377	12.58
58.2	1	CVS2-35	0.4200	0.0500	0.2000	0.0428	0.0800	0.0000	0.0632	0.1340	0.0000	0.0100	3.307	41.801	13.064	17.183	12.71
58.3	0	CVS2-35	0.4200	0.0500	0.2000	0.0428	0.0800	0.0000	0.0632	0.1340	0.0000	0.0100	2.361	26.913	9.773	13.106	12.61
59	0	CVS2-36	0.5421	0.0500	0.0891	0.0700	0.0800	0.0000	0.1500	0.0088	0.0000	0.0100	0.223	0.354	0.568	0.431	11.40
60	0	CVS2-37	0.5700	0.0839	0.1061	0.0700	0.0000	0.0000	0.0200	0.1400	0.0000	0.0100	0.236	0.230	0.320	0.177	10.35
61	0	CVS2-38	0.5147	0.1109	0.1044	0.0100	0.0000	0.0800	0.1428	0.0272	0.0000	0.0100	0.270	0.725	0.602	0.574	9.84
62.1	0	CVS2-39	0.4838	0.0500	0.1362	0.0700	0.0000	0.0800	0.0742	0.0258	0.0700	0.0100	1.965	17.042	5.530	8.906	12.30
62.2	0	CVS2-39	0.4838	0.0500	0.1362	0.0700	0.0000	0.0800	0.0742	0.0258	0.0700	0.0100	1.303	13.730	4.562	7.718	12.42
63	0	CVS2-40	0.5040	0.0639	0.1500	0.0421	0.0200	0.0500	0.0200	0.1000	0.0200	0.0300	0.171	0.317	0.347	0.364	11.12
64	0	CVS2-41	0.5325	0.0694	0.0781	0.0700	0.0500	0.0200	0.0300	0.1000	0.0200	0.0300	0.124	0.199	0.307	0.199	10.91
65	0	CVS2-42	0.5675	0.0500	0.0625	0.0700	0.0320	0.0380	0.1000	0.0300	0.0200	0.0300	2.259	6.109	4.301	3.763	11.45
66	0	CVS2-43	0.5070	0.1477	0.0500	0.0653	0.0200	0.0300	0.0300	0.0500	0.0700	0.0300	0.198	0.697	0.593	0.445	9.88
67	0	CVS2-44	0.5700	0.1078	0.0500	0.0699	0.0500	0.0200	0.0200	0.0623	0.0200	0.0300	0.174	0.388	0.323	0.310	10.40
68	0	CVS2-45	0.5299	0.1106	0.0500	0.0595	0.0200	0.0500	0.0308	0.0592	0.0200	0.0700	0.169	0.397	0.439	0.240	9.97
69	0	CVS2-46	0.5264	0.1259	0.0577	0.0700	0.0200	0.0200	0.0200	0.0746	0.0200	0.0654	0.146	0.294	0.307	0.199	10.09
70	0	CVS2-47	0.5294	0.0500	0.1277	0.0429	0.0500	0.0200	0.0200	0.0400	0.0500	0.0700	0.478	1.286	0.902	0.945	11.40
71	0	CVS2-48	0.4700	0.1442	0.0968	0.0390	0.0500	0.0200	0.0200	0.0854	0.0200	0.0546	0.114	0.229	0.309	0.258	10.09

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Table A.4. Compositions, Normalized PCT Releases, and pH for CVS-I and CVS-II Phase 1, 2, 3, and 4 Canister-Centerline-Cooled Glasses (continued)

#	ID	Glass	SiO2	B2O3	Na2O	Li2O	CaO	MgO	Fe2O3	Al2O3	ZrO2	Others	Si	B	Li	Na	pH
72	0	CVS2-49	0.5073	0.1357	0.0957	0.0413	0.0200	0.0200	0.0515	0.0785	0.0200	0.0300	0.141	0.206	0.279	0.204	9.91
73	0	CVS2-50	0.4801	0.1142	0.1003	0.0376	0.0275	0.0363	0.0568	0.0636	0.0429	0.0407	0.158	0.563	0.486	0.376	10.27
74	0	CVS2-51	0.5328	0.1048	0.1129	0.0373	0.0082	0.0084	0.0733	0.0235	0.0392	0.0596	0.359	1.442	1.067	0.997	10.23
75	0	CVS2-52	0.6000	0.0817	0.0450	0.0788	0.0008	0.0009	0.0720	0.0233	0.0385	0.0590	0.285	0.551	0.478	0.270	10.08
78	0	CVS2-55	0.5328	0.1048	0.1129	0.0373	0.0082	0.0084	0.0733	0.0235	0.0392	0.0596	0.373	0.930	0.894	0.728	10.08
79	0	CVS2-56	0.5328	0.1048	0.1129	0.0373	0.0082	0.0084	0.0733	0.0235	0.0392	0.0596	0.461	1.212	1.193	1.027	10.21
80	0	CVS2-57	0.5328	0.1048	0.1129	0.0373	0.0082	0.0084	0.0733	0.0235	0.0392	0.0596	0.281	0.828	0.778	0.657	9.91
81	0	CVS2-58	0.3900	0.2000	0.0500	0.0700	0.0200	0.0800	0.0200	0.1500	0.0100	0.0100	0.156	0.820	0.829	0.768	9.81
82	0	CVS2-59	0.4380	0.1718	0.1268	0.0727	0.0375	0.0005	0.0200	0.1150	0.0075	0.0102	0.268	1.591	1.390	1.116	11.52
83	0	CVS2-60	0.5281	0.0876	0.1725	0.0743	0.0063	0.0005	0.0200	0.0925	0.0075	0.0107	0.577	1.542	1.621	1.457	11.99
84	0	CVS2-61	0.5281	0.0664	0.1200	0.0730	0.0000	0.0000	0.0200	0.1625	0.0175	0.0125	0.223	0.232	0.354	0.225	10.83
85	0	CVS2-62	0.5579	0.1765	0.1125	0.0156	0.0500	0.0005	0.0200	0.0500	0.0075	0.0095	0.287	1.093	1.034	0.958	9.54
86	0	CVS2-63	0.3232	0.1717	0.1900	0.0051	0.1000	0.0000	0.0200	0.1800	0.0000	0.0100	0.102	3.652	3.584	2.163	10.29
87	0	CVS2-64	0.5697	0.0509	0.0925	0.0642	0.0025	0.0008	0.0812	0.0288	0.0431	0.0663	0.242	0.354	0.419	0.297	10.79
88	0	CVS2-65	0.5344	0.1128	0.0860	0.0697	0.0007	0.0008	0.0013	0.0196	0.1548	0.0203	0.156	0.356	0.417	0.204	10.72
89	0	CVS2-66	0.5175	0.0917	0.1211	0.0523	0.0097	0.0061	0.0388	0.1180	0.0026	0.0422	0.194	0.210	0.267	0.195	10.39
90	0	CVS2-67	0.4596	0.1587	0.1086	0.0583	0.0024	0.0001	0.0004	0.2043	0.0000	0.0076	0.232	0.446	0.480	0.205	9.63
91.1	0	CVS2-68	0.5040	0.1355	0.0797	0.0696	0.0007	0.0002	0.0046	0.1640	0.0001	0.0416	0.721	11.189	7.740	3.221	9.91
91.2	0	CVS2-68	0.5040	0.1355	0.0797	0.0696	0.0007	0.0002	0.0046	0.1640	0.0001	0.0416	0.604	11.450	6.566	2.646	9.97
92	0	CVS2-69	0.5660	0.0781	0.0664	0.0713	0.0079	0.0032	0.0334	0.0816	0.0005	0.0916	0.223	0.391	0.317	0.406	10.17
93	0	CVS2-70	0.4854	0.1418	0.0812	0.0691	0.0008	0.0008	0.0080	0.1819	0.0005	0.0305	0.500	13.152	8.138	3.643	9.86
94	0	CVS2-71	0.5697	0.0509	0.0925	0.0642	0.0025	0.0008	0.0812	0.0288	0.0431	0.0663	0.223	0.370	0.444	0.318	10.80
95	0	CVS2-72	0.5175	0.0917	0.1211	0.0523	0.0097	0.0061	0.0388	0.1180	0.0026	0.0422	0.171	0.193	0.278	0.218	10.54
96.1	0	CVS2-73	0.5040	0.1355	0.0797	0.0696	0.0007	0.0002	0.0046	0.1640	0.0001	0.0416	0.297	2.610	1.699	0.668	10.17
96.2	0	CVS2-73	0.5040	0.1355	0.0797	0.0696	0.0007	0.0002	0.0046	0.1640	0.0001	0.0416	0.288	2.705	2.039	0.691	10.03
97	0	CVS2-74	0.5660	0.0781	0.0664	0.0713	0.0079	0.0032	0.0334	0.0816	0.0005	0.0916	0.194	0.247	0.302	0.152	10.30
98.1	0	CVS2-75	0.4854	0.1418	0.0812	0.0691	0.0008	0.0008	0.0080	0.1819	0.0005	0.0305	0.330	2.449	1.867	0.921	10.00
98.2	0	CVS2-75	0.4854	0.1418	0.0812	0.0691	0.0008	0.0008	0.0080	0.1819	0.0005	0.0305	0.218	2.404	1.371	0.486	9.91
99	0	CVS2-76	0.5018	0.0600	0.1800	0.0632	0.0400	0.0050	0.1050	0.0200	0.0050	0.0200	4.024	13.130	6.550	9.546	12.27
100	0	CVS2-77	0.4550	0.0600	0.1800	0.0700	0.0050	0.0050	0.0050	0.0200	0.1100	0.0900	1.785	8.039	41.475	4.155	12.21
101	0	CVS2-78	0.5600	0.1600	0.0500	0.0254	0.0050	0.0400	0.0699	0.0200	0.0497	0.0200	0.248	19.092	22.013	14.825	9.29
102.1	0	CVS2-79	0.5479	0.1600	0.0500	0.0121	0.0050	0.0050	0.1050	0.0200	0.0050	0.0900	1.638	40.193	43.544	38.275	8.84
102.2	1	CVS2-79	0.5479	0.1600	0.0500	0.0121	0.0050	0.0050	0.1050	0.0200	0.0050	0.0900	0.190	46.021	41.856	33.154	8.87
103.1	0	CVS2-80	0.5074	0.1600	0.0500	0.0176	0.0050	0.0400	0.1050	0.0200	0.0750	0.0200	0.379	20.096	28.715	20.755	9.26
103.2	0	CVS2-80	0.5074	0.1600	0.0500	0.0176	0.0050	0.0400	0.1050	0.0200	0.0750	0.0200	0.318	31.451	30.547	21.563	9.30
104.1	0	CVS2-81	0.4400	0.0600	0.1734	0.0700	0.0050	0.0400	0.1050	0.0200	0.0050	0.0816	1.976	20.364	4.117	15.389	12.51
104.2	0	CVS2-81	0.4400	0.0600	0.1734	0.0700	0.0050	0.0400	0.1050	0.0200	0.0050	0.0816	2.343	20.338	4.424	14.884	12.64
105	0	CVS2-82	0.5600	0.0950	0.1800	0.0700	0.0050	0.0400	0.0050	0.0200	0.0050	0.0200	21.558	50.093	20.123	37.436	12.09
106	0	CVS2-83	0.4900	0.0951	0.1800	0.0699	0.0400	0.0050	0.0050	0.0200	0.0050	0.0900	7.566	29.247	18.613	21.751	12.43
107	0	CVS2-84	0.4550	0.0600	0.1800	0.0700	0.0050	0.0050	0.1050	0.0200	0.0800	0.0200	3.287	20.364	8.848	12.728	12.48
108	0	CVS2-85	0.4400	0.0600	0.1800	0.0700	0.0050	0.0200	0.0050	0.1700	0.0050	0.0450	0.364	45.552	6.605	18.344	12.36
109	0	CVS2-86	0.4764	0.0600	0.1800	0.0136	0.0400	0.0050	0.0050	0.1700	0.0050	0.0450	0.105	0.268	0.269	0.299	11.04
110	0	CVS2-87	0.4983	0.0800	0.1800	0.0180	0.0137	0.0050	0.0250	0.0987	0.0613	0.0200	0.142	0.161	0.185	0.261	10.77

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Table A.4. Compositions, Normalized PCT Releases, and pH for CVS-I and CVS-II Phase 1, 2, 3, and 4 Canister-Centerline-Cooled Glasses (continued)

#	ID	Glass	SiO2	B2O3	Na2O	Li2O	CaO	MgO	Fe2O3	Al2O3	ZrO2	Others	Si	B	Li	Na	pH
111.1	1	CVS2-88	0.4597	0.0600	0.1403	0.0700	0.0400	0.0050	0.0250	0.1050	0.0750	0.0200	0.237	0.723	0.661	0.624	11.68
111.2	0	CVS2-88	0.4597	0.0600	0.1403	0.0700	0.0400	0.0050	0.0250	0.1050	0.0750	0.0200	0.173	0.340	0.484	0.463	11.66
112	0	CVS2-89	0.4400	0.1171	0.1800	0.0100	0.0400	0.0050	0.1050	0.0200	0.0629	0.0200	0.267	1.194	0.978	1.048	10.25
113	0	CVS2-90	0.5600	0.1600	0.0542	0.0700	0.0050	0.0050	0.1008	0.0200	0.0050	0.0200	0.763	6.129	4.670	3.916	9.96
114	0	CVS2-91	0.5600	0.1600	0.1050	0.0100	0.0050	0.0400	0.0050	0.0200	0.0050	0.0900	0.515	8.240	6.667	6.418	9.73
115	0	CVS2-92	0.4400	0.1600	0.1000	0.0700	0.0050	0.0400	0.0050	0.0200	0.0700	0.0900	1.870	16.077	12.750	10.377	11.08
116	0	CVS2-93	0.4400	0.1337	0.1279	0.0700	0.0098	0.0050	0.0986	0.0200	0.0050	0.0900	1.020	14.430	9.524	12.118	11.80
117	0	CVS2-94	0.4400	0.1600	0.1800	0.0526	0.0400	0.0050	0.0271	0.0703	0.0050	0.0200	1.020	3.195	3.700	3.594	11.89
118	0	CVS2-95	0.4879	0.1108	0.1666	0.0427	0.0113	0.0165	0.0926	0.0366	0.0041	0.0310	2.236	8.718	5.168	7.727	11.83
119	0	CVS2-96	0.4801	0.1142	0.1003	0.0376	0.0275	0.0363	0.0568	0.0636	0.0429	0.0407	0.145	0.662	0.486	0.349	10.11
120	0	CVS2-97	0.5328	0.1048	0.1129	0.0373	0.0082	0.0084	0.0733	0.0235	0.0392	0.0596	0.401	1.105	1.182	1.158	10.29
121	0	CVS2-98	0.4200	0.1743	0.2000	0.0369	0.0000	0.0000	0.0200	0.1388	0.0000	0.0100	0.282	2.970	3.730	2.763	11.62
122	0	CVS2-99	0.5203	0.0969	0.0980	0.0356	0.0097	0.0077	0.1019	0.0523	0.0199	0.0577	0.117	0.183	0.254	0.199	9.73
123	0	CVS2-100	0.5329	0.0740	0.0626	0.0598	0.0035	0.0012	0.1229	0.0286	0.0443	0.0704	0.206	0.326	0.386	0.269	10.41
124	0	CVS2-101	0.4861	0.1113	0.1683	0.0420	0.0123	0.0178	0.0932	0.0359	0.0048	0.0285	2.333	9.590	5.049	8.144	11.84
125.1	0	CVS2-102	0.5353	0.1053	0.1125	0.0375	0.0083	0.0084	0.0719	0.0231	0.0385	0.0592	0.524	2.722	1.894	1.755	10.31
125.2	0	CVS2-102	0.5353	0.1053	0.1125	0.0375	0.0083	0.0084	0.0719	0.0231	0.0385	0.0592	0.548	2.553	1.865	1.689	10.28
126.1	0	CVS2-103	0.4100	0.1337	0.1428	0.0476	0.0105	0.0107	0.0913	0.0293	0.0489	0.0752	0.780	5.732	4.363	4.247	11.49
126.2	0	CVS2-103	0.4100	0.1337	0.1428	0.0476	0.0105	0.0107	0.0913	0.0293	0.0489	0.0752	0.806	6.069	4.431	4.251	11.49
127.1	0	CVS2-104	0.4500	0.1246	0.1332	0.0444	0.0098	0.0099	0.0851	0.0273	0.0456	0.0701	0.818	6.395	4.656	4.206	11.19
127.2	0	CVS2-104	0.4500	0.1246	0.1332	0.0444	0.0098	0.0099	0.0851	0.0273	0.0456	0.0701	0.792	6.472	4.389	4.075	11.21
128.1	0	CVS2-105	0.4900	0.1156	0.1235	0.0412	0.0091	0.0092	0.0789	0.0254	0.0423	0.0650	0.640	3.594	2.981	2.735	10.67
128.2	0	CVS2-105	0.4900	0.1156	0.1235	0.0412	0.0091	0.0092	0.0789	0.0254	0.0423	0.0650	0.672	3.483	3.060	2.751	10.66
129.1	0	CVS2-106	0.5700	0.0974	0.1041	0.0347	0.0077	0.0078	0.0665	0.0214	0.0356	0.0548	0.398	1.305	1.117	0.978	10.02
129.2	0	CVS2-106	0.5700	0.0974	0.1041	0.0347	0.0077	0.0078	0.0665	0.0214	0.0356	0.0548	0.388	1.355	1.086	0.893	10.03
130.1	0	CVS2-107	0.5684	0.0500	0.1195	0.0398	0.0088	0.0089	0.0763	0.0245	0.0409	0.0629	0.263	0.708	0.508	0.468	10.46
130.2	0	CVS2-107	0.5684	0.0500	0.1195	0.0398	0.0088	0.0089	0.0763	0.0245	0.0409	0.0629	0.256	0.612	0.459	0.429	10.46
131.1	0	CVS2-108	0.5086	0.1500	0.1069	0.0356	0.0079	0.0080	0.0683	0.0220	0.0366	0.0562	0.379	2.233	1.843	1.551	9.79
131.2	0	CVS2-108	0.5086	0.1500	0.1069	0.0356	0.0079	0.0080	0.0683	0.0220	0.0366	0.0562	0.360	2.147	1.722	1.419	9.80
132.1	0	CVS2-109	0.4786	0.2000	0.1006	0.0335	0.0074	0.0075	0.0643	0.0207	0.0344	0.0529	0.326	4.250	3.820	3.002	9.44
132.2	0	CVS2-109	0.4786	0.2000	0.1006	0.0335	0.0074	0.0075	0.0643	0.0207	0.0344	0.0529	0.335	4.411	3.916	3.062	9.43
133.1	0	CVS2-110	0.5730	0.1127	0.0500	0.0401	0.0089	0.0090	0.0770	0.0247	0.0412	0.0634	0.231	2.643	2.172	1.577	9.75
133.2	0	CVS2-110	0.5730	0.1127	0.0500	0.0401	0.0089	0.0090	0.0770	0.0247	0.0412	0.0634	0.241	2.628	2.306	1.537	9.76
134.1	0	CVS2-111	0.5127	0.1009	0.1500	0.0359	0.0080	0.0081	0.0689	0.0221	0.0369	0.0567	1.456	3.017	5.004	5.032	11.22
134.2	0	CVS2-111	0.5127	0.1009	0.1500	0.0359	0.0080	0.0081	0.0689	0.0221	0.0369	0.0567	1.202	6.258	4.135	4.264	11.20
135.1	0	CVS2-112	0.4825	0.0949	0.2000	0.0338	0.0075	0.0076	0.0648	0.0208	0.0347	0.0534	0.459	15.893	8.374	10.177	12.05
135.2	0	CVS2-112	0.4825	0.0949	0.2000	0.0338	0.0075	0.0076	0.0648	0.0208	0.0347	0.0534	0.448	14.757	7.514	9.638	12.02
136.1	0	CVS2-113	0.5506	0.1083	0.1157	0.0100	0.0085	0.0086	0.0740	0.0238	0.0396	0.0609	0.194	0.520	0.484	0.419	9.62
136.2	0	CVS2-113	0.5506	0.1083	0.1157	0.0100	0.0085	0.0086	0.0740	0.0238	0.0396	0.0609	0.210	0.595	0.545	0.454	9.64
137.1	0	CVS2-114	0.5228	0.1028	0.1099	0.0600	0.0081	0.0082	0.0702	0.0226	0.0376	0.0578	1.717	6.881	4.462	4.108	11.34
137.2	0	CVS2-114	0.5228	0.1028	0.1099	0.0600	0.0081	0.0082	0.0702	0.0226	0.0376	0.0578	1.798	7.194	4.534	4.231	11.39
138.1	0	CVS2-115	0.5172	0.1017	0.1087	0.0700	0.0080	0.0081	0.0695	0.0223	0.0372	0.0572	1.826	9.605	5.827	5.735	11.55
138.2	0	CVS2-115	0.5172	0.1017	0.1087	0.0700	0.0080	0.0081	0.0695	0.0223	0.0372	0.0572	1.828	9.336	5.581	5.487	11.53

Table A.4. Compositions, Normalized PCT Releases, and pH for CVS-I and CVS-II Phase 1, 2, 3, and 4 Canister-Centerline-Cooled Glasses (continued)

#	ID	Glass	SiO2	B2O3	Na2O	Li2O	CaO	MgO	Fe2O3	Al2O3	ZrO2	Others	Si	B	Li	Na	pH
139.1	0	CVS2-116	0.5290	0.1041	0.1112	0.0371	0.0200	0.0083	0.0711	0.0228	0.0381	0.0585	0.578	2.769	2.004	1.891	10.39
139.2	0	CVS2-116	0.5290	0.1041	0.1112	0.0371	0.0200	0.0083	0.0711	0.0228	0.0381	0.0585	0.562	2.739	2.033	1.952	10.41
140.1	0	CVS2-117	0.5398	0.1062	0.1135	0.0378	0.0084	0.0000	0.0725	0.0233	0.0388	0.0597	0.440	1.622	1.423	1.152	10.19
140.2	0	CVS2-117	0.5398	0.1062	0.1135	0.0378	0.0084	0.0000	0.0725	0.0233	0.0388	0.0597	0.432	1.577	1.309	1.129	10.18
141.1	0	CVS2-118	0.5290	0.1041	0.1112	0.0371	0.0082	0.0200	0.0711	0.0228	0.0381	0.0585	0.576	2.831	2.207	2.006	10.31
141.2	0	CVS2-118	0.5290	0.1041	0.1112	0.0371	0.0082	0.0200	0.0711	0.0228	0.0381	0.0585	0.534	2.785	2.004	1.928	10.30
142.1	0	CVS2-119	0.5480	0.1078	0.1152	0.0384	0.0085	0.0086	0.0736	0.0000	0.0394	0.0606	0.826	3.600	3.028	2.821	10.33
142.2	0	CVS2-119	0.5480	0.1078	0.1152	0.0384	0.0085	0.0086	0.0736	0.0000	0.0394	0.0606	0.828	3.585	3.000	2.809	10.35
143.1	0	CVS2-120	0.5206	0.1024	0.1094	0.0365	0.0081	0.0082	0.0699	0.0500	0.0374	0.0576	0.140	0.299	0.310	0.221	10.10
143.2	0	CVS2-120	0.5206	0.1024	0.1094	0.0365	0.0081	0.0082	0.0699	0.0500	0.0374	0.0576	0.136	0.283	0.301	0.211	10.08
144.1	0	CVS2-121	0.4932	0.0970	0.1036	0.0346	0.0077	0.0077	0.0662	0.1000	0.0355	0.0545	0.121	0.166	0.269	0.132	10.02
144.2	0	CVS2-121	0.4932	0.0970	0.1036	0.0346	0.0077	0.0077	0.0662	0.1000	0.0355	0.0545	0.117	0.183	0.271	0.137	9.99
145.1	0	CVS2-122	0.4658	0.0916	0.0979	0.0326	0.0072	0.0073	0.0626	0.1500	0.0335	0.0515	0.115	0.250	0.310	0.089	9.94
145.2	0	CVS2-122	0.4658	0.0916	0.0979	0.0326	0.0072	0.0073	0.0626	0.1500	0.0335	0.0515	0.117	0.176	0.307	0.088	9.90
146.1	0	CVS2-123	0.5328	0.1048	0.1129	0.0373	0.0082	0.0084	0.0733	0.0235	0.0392	0.0596	0.359	1.444	1.068	0.997	10.23
146.2	0	CVS2-123	0.5328	0.1048	0.1129	0.0373	0.0082	0.0084	0.0733	0.0235	0.0392	0.0596	0.353	1.260	1.039	1.015	10.23
147.1	0	CVS2-124	0.3700	0.1428	0.1525	0.0508	0.0113	0.0114	0.0975	0.0313	0.0522	0.0803	0.911	9.885	6.922	6.629	11.85
147.2	0	CVS2-124	0.3700	0.1428	0.1525	0.0508	0.0113	0.0114	0.0975	0.0313	0.0522	0.0803	0.942	10.493	7.261	7.026	11.87

Note: Points with ID = 1 are replicates that were eliminated from modeling after being assessed as outliers compared to other replicates.

Table A.5. Compositions, Normalized MCC-1 Releases, and pH for CVS-I and CVS-II Phase 1, 2, 3, and 4 Quenched Glasses

#	Glass	SiO2	B2O3	Na2O	Li2O	CaO	MgO	Fe2O3	Al2O3	ZrO2	Others	Si	B	Li	Na	pH
1	CVS1-1	0.4801	0.1142	0.1003	0.0376	0.0275	0.0363	0.0568	0.0636	0.0429	0.0407	8.990	12.470	11.950	12.365	9.950
2	CVS1-2	0.5500	0.0500	0.0500	0.0700	0.1000	0.0000	0.0200	0.1500	0.0000	0.0100	6.820	7.460	7.190	7.410	10.040
3	CVS1-3	0.4200	0.2000	0.0500	0.0700	0.0000	0.0800	0.0200	0.1400	0.0100	0.0100	10.840	15.570	15.560	15.620	9.575
4	CVS1-4	0.5700	0.2000	0.0900	0.0100	0.0200	0.0800	0.0200	0.0000	0.0000	0.0100	64.850	189.710	161.935	180.445	9.650
5	CVS1-5	0.5700	0.0500	0.0700	0.0700	0.0000	0.0000	0.1500	0.0800	0.0000	0.0100	10.420	11.480	10.460	10.830	10.065
6	CVS1-6	0.4400	0.2000	0.0500	0.0700	0.0000	0.0000	0.0200	0.0000	0.1200	0.1000	45.380	121.300	108.600	92.995	9.910
7	CVS1-7	0.5700	0.0500	0.0964	0.0100	0.1000	0.0000	0.0336	0.0000	0.1300	0.0100	7.495	10.995	10.505	10.750	9.850
8	CVS1-8	0.5363	0.0500	0.0837	0.0100	0.0000	0.0800	0.1500	0.0000	0.0800	0.0100	11.730	17.875	16.730	17.310	9.715
9	CVS1-9	0.4200	0.1962	0.0538	0.0100	0.0000	0.0800	0.1400	0.0000	0.0000	0.1000	45.790	158.720	148.820	150.300	9.240
10	CVS1-10	0.5700	0.0851	0.0949	0.0100	0.0000	0.0000	0.0200	0.1200	0.0000	0.1000	2.695	2.745	3.330	2.805	8.510
11	CVS1-11	0.4200	0.1549	0.0751	0.0100	0.1000	0.0000	0.0200	0.1400	0.0000	0.0800	6.770	8.250	8.170	8.320	9.165
12	CVS1-12	0.4200	0.1764	0.0736	0.0700	0.1000	0.0000	0.1500	0.0000	0.0000	0.0100	49.350	118.480	122.580	122.680	10.865
13	CVS1-13	0.5700	0.2000	0.1862	0.0100	0.0000	0.0000	0.0200	0.0038	0.0000	0.0100	187.620	690.515	652.690	637.305	10.590
14	CVS1-14	0.4200	0.2000	0.1862	0.0100	0.0000	0.0000	0.0200	0.0238	0.1300	0.0100	23.935	73.635	68.065	57.690	10.090
15	CVS1-15	0.5589	0.0500	0.1211	0.0700	0.0000	0.0800	0.0200	0.0000	0.0000	0.1000	73.405	210.285	172.040	172.495	12.370
16	CVS1-16	0.4327	0.0500	0.1873	0.0100	0.0000	0.0800	0.0858	0.1442	0.0000	0.0100	11.380	16.850	15.375	16.010	10.480
17	CVS1-17	0.4545	0.0500	0.1455	0.0100	0.1000	0.0000	0.1400	0.0000	0.0000	0.1000	20.240	39.100	40.860	40.850	10.960
18	CVS1-18	0.4214	0.0500	0.1186	0.0700	0.0200	0.0800	0.0200	0.0000	0.1300	0.0900	5.905	24.055	23.655	23.240	11.030
19	CVS1-19	0.4801	0.1142	0.1003	0.0376	0.0275	0.0363	0.0568	0.0636	0.0429	0.0407	8.945	13.025	13.185	13.050	9.880
20	CVS1-20	0.4801	0.1142	0.1003	0.0376	0.0275	0.0363	0.0568	0.0636	0.0429	0.0407	8.835	12.505	12.495	12.490	9.880
21	CVS1-21	0.5700	0.2000	0.0900	0.0100	0.0200	0.0800	0.0200	0.0000	0.0000	0.0100	61.105	205.790	177.740	192.425	9.650
22	CVS1-22	0.5363	0.0500	0.0837	0.0100	0.0000	0.0800	0.1500	0.0000	0.0800	0.0100	11.615	17.360	17.095	16.990	9.765
23	CVS1-23	0.5153	0.0956	0.1052	0.0375	0.0289	0.0084	0.1179	0.0456	0.0063	0.0393	12.020	15.370	15.710	15.630	9.960
24	CVS2-1	0.5226	0.0874	0.0700	0.0600	0.0000	0.0500	0.0400	0.0800	0.0100	0.0800	9.370	12.240	12.610	11.840	9.460
25	CVS2-2	0.5017	0.0700	0.0883	0.0600	0.0700	0.0000	0.0450	0.1100	0.0300	0.0250	7.295	8.440	9.535	9.155	9.610
26	CVS2-3	0.4645	0.1320	0.0700	0.0435	0.0700	0.0100	0.0450	0.1032	0.0368	0.0250	7.365	8.870	9.560	9.120	9.295
27	CVS2-4	0.5600	0.1095	0.0700	0.0536	0.0700	0.0000	0.0400	0.0619	0.0100	0.0250	9.550	9.730	10.870	10.375	9.525
28	CVS2-5	0.4751	0.1590	0.1010	0.0200	0.0348	0.0000	0.0400	0.0800	0.0100	0.0800	9.220	10.405	11.825	10.975	9.045
29	CVS2-6	0.5373	0.0700	0.0700	0.0382	0.0700	0.0046	0.1200	0.0159	0.0100	0.0641	13.565	17.475	18.740	18.825	9.665
30	CVS2-7	0.4814	0.1700	0.0700	0.0591	0.0094	0.0000	0.0400	0.0953	0.0100	0.0648	9.485	5.020	4.780	24.240	9.760
31	CVS2-8	0.5115	0.0700	0.0985	0.0600	0.0000	0.0500	0.1140	0.0610	0.0100	0.0250	15.030	18.505	19.915	19.170	9.815
32	CVS2-9	0.5431	0.0944	0.0924	0.0600	0.0000	0.0000	0.0712	0.0138	0.1000	0.0250	11.420	13.200	14.405	13.165	9.515
33	CVS2-10	0.4694	0.1700	0.1306	0.0200	0.0000	0.0000	0.0669	0.1043	0.0100	0.0288	10.990	12.275	12.790	11.025	8.925
34	CVS2-11	0.4915	0.0751	0.0833	0.0600	0.0700	0.0100	0.0400	0.0100	0.0935	0.0665	11.660	19.850	21.700	17.920	9.945
35	CVS2-12	0.4683	0.1700	0.0700	0.0466	0.0700	0.0100	0.0400	0.0901	0.0100	0.0250	8.435	9.860	10.275	9.670	9.250
36	CVS2-13	0.4937	0.0700	0.1692	0.0225	0.0300	0.0500	0.0400	0.0896	0.0100	0.0250	10.630	13.360	14.000	16.595	9.735
37	CVS2-14	0.4600	0.1313	0.0802	0.0486	0.0500	0.0200	0.0400	0.0243	0.1000	0.0457	8.240	15.095	15.525	14.965	9.475
38	CVS2-15	0.4729	0.0700	0.1700	0.0214	0.0601	0.0000	0.0400	0.0756	0.0100	0.0800	11.105	25.100	33.045	5.380	9.030
39	CVS2-16	0.5353	0.1053	0.1125	0.0375	0.0083	0.0084	0.0719	0.0231	0.0385	0.0592	14.410	18.085	18.220	18.225	9.460
40	CVS2-17	0.4801	0.1142	0.1003	0.0376	0.0275	0.0363	0.0568	0.0636	0.0429	0.0407	9.230	12.325	14.015	13.475	9.315

Table A.5. Compositions, Normalized MCC-1 Releases, and pH for CVS-I and CVS-II Phase 1, 2, 3, and 4 Quenched Glasses (continued)

#	Glass	SiO2	B2O3	Na2O	Li2O	CaO	MgO	Fe2O3	Al2O3	ZrO2	Others	Si	B	Li	Na	pH
41	CVS2-18	0.5353	0.1053	0.1125	0.0375	0.0083	0.0084	0.0719	0.0231	0.0385	0.0592	15.740	19.720	20.325	23.370	9.380
42	CVS2-19	0.5328	0.1048	0.1129	0.0373	0.0082	0.0084	0.0733	0.0235	0.0392	0.0596	11.185	13.690	13.755	13.070	9.340
43	CVS2-20	0.5700	0.0500	0.1031	0.0669	0.0000	0.0000	0.0600	0.0100	0.1300	0.0100	7.215	8.425	7.280	7.685	9.545
44	CVS2-21	0.5700	0.1314	0.0500	0.0700	0.0000	0.0800	0.0200	0.0686	0.0000	0.0100	9.390	11.805	10.305	11.250	9.365
45	CVS2-22	0.5700	0.0500	0.0735	0.0700	0.0000	0.0800	0.0200	0.0365	0.0000	0.1000	11.435	15.595	13.500	14.560	9.740
46	CVS2-23	0.5700	0.0522	0.2000	0.0100	0.0800	0.0000	0.0200	0.0578	0.0000	0.0100	10.270	11.210	10.485	11.625	9.855
47	CVS2-24	0.4464	0.2000	0.0736	0.0700	0.0000	0.0000	0.0200	0.0961	0.0000	0.0939	10.100	19.855	17.370	15.920	9.375
48	CVS2-25	0.5059	0.0500	0.0841	0.0700	0.0800	0.0000	0.1500	0.0033	0.0000	0.0567	21.265	34.500	31.490	33.650	10.270
49	CVS2-26	0.4431	0.2000	0.0512	0.0700	0.0800	0.0000	0.0200	0.0257	0.1000	0.0100	17.795	39.145	35.020	37.245	9.750
50	CVS2-27	0.5463	0.0500	0.2000	0.0155	0.0000	0.0800	0.0200	0.0782	0.0000	0.0100	8.780	11.220	9.895	10.980	9.635
51	CVS2-28	0.5619	0.0500	0.2000	0.0126	0.0000	0.0000	0.0200	0.0555	0.0000	0.1000	8.860	9.835	8.870	9.975	9.510
52	CVS2-29	0.4391	0.2000	0.0675	0.0100	0.0800	0.0000	0.0200	0.0000	0.0834	0.1000	20.755	42.285	37.740	40.630	9.140
53	CVS2-30	0.5190	0.2000	0.0832	0.0100	0.0000	0.0000	0.1320	0.0458	0.0000	0.0100	8.110	24.435	21.075	18.305	8.755
54	CVS2-31	0.5700	0.1843	0.0500	0.0331	0.0800	0.0000	0.0200	0.0526	0.0000	0.0100	22.395	47.020	42.690	44.200	9.405
55	CVS2-32	0.5445	0.0500	0.2000	0.0428	0.0000	0.0000	0.0200	0.0027	0.1300	0.0100	13.615	16.620	14.120	16.040	10.070
56	CVS2-33	0.4200	0.0544	0.2000	0.0364	0.0000	0.0800	0.0200	0.0892	0.0000	0.1000	9.230	14.510	12.705	13.950	10.255
57	CVS2-34	0.4200	0.1743	0.2000	0.0369	0.0000	0.0000	0.0200	0.1388	0.0000	0.0100	12.795	29.240	26.170	22.810	9.980
58	CVS2-35	0.4200	0.0500	0.2000	0.0428	0.0800	0.0000	0.0632	0.1340	0.0000	0.0100	9.645	11.610	10.825	12.030	10.215
59	CVS2-36	0.5421	0.0500	0.0891	0.0700	0.0800	0.0000	0.1500	0.0088	0.0000	0.0100	15.490	21.090	19.005	20.345	10.125
60	CVS2-37	0.5700	0.0839	0.1061	0.0700	0.0000	0.0000	0.0200	0.1400	0.0000	0.0100	9.295	9.635	8.400	9.050	9.325
61	CVS2-38	0.5147	0.1109	0.1044	0.0100	0.0000	0.0800	0.1428	0.0272	0.0000	0.0100	16.935	23.645	20.355	22.330	9.270
62	CVS2-39	0.4838	0.0500	0.1362	0.0700	0.0000	0.0800	0.0742	0.0258	0.0700	0.0100	10.490	16.300	14.205	15.335	10.170
63	CVS2-40	0.5040	0.0639	0.1500	0.0421	0.0200	0.0500	0.0200	0.1000	0.0200	0.0300	9.450	12.205	10.650	11.680	9.790
64	CVS2-41	0.5325	0.0694	0.0781	0.0700	0.0500	0.0200	0.0300	0.1000	0.0200	0.0300	7.925	9.425	8.095	8.930	9.595
65	CVS2-42	0.5675	0.0500	0.0625	0.0700	0.0320	0.0380	0.1000	0.0300	0.0200	0.0300	10.990	14.310	12.200	13.405	9.860
66	CVS2-43	0.5070	0.1477	0.0500	0.0653	0.0200	0.0300	0.0300	0.0500	0.0700	0.0300	8.620	11.330	9.915	10.865	9.225
67	CVS2-44	0.5700	0.1078	0.0500	0.0699	0.0500	0.0200	0.0200	0.0623	0.0200	0.0300	8.790	10.275	8.845	9.875	9.560
68	CVS2-45	0.5299	0.1106	0.0500	0.0595	0.0200	0.0500	0.0308	0.0592	0.0200	0.0700	8.790	11.600	9.845	10.905	9.425
69	CVS2-46	0.5264	0.1259	0.0577	0.0700	0.0200	0.0200	0.0200	0.0746	0.0200	0.0654	9.070	10.985	9.585	10.355	9.315
70	CVS2-47	0.5294	0.0500	0.1277	0.0429	0.0500	0.0200	0.0200	0.0400	0.0500	0.0700	8.760	11.555	10.005	10.925	9.830
71	CVS2-48	0.4700	0.1442	0.0968	0.0390	0.0500	0.0200	0.0200	0.0854	0.0200	0.0546	8.410	10.625	9.205	10.105	9.415
72	CVS2-49	0.5073	0.1357	0.0957	0.0413	0.0200	0.0200	0.0515	0.0785	0.0200	0.0300	9.475	11.350	9.790	10.710	9.010
73	CVS2-50	0.4801	0.1142	0.1003	0.0376	0.0275	0.0363	0.0568	0.0636	0.0429	0.0407	8.365	11.430	9.835	10.810	9.445
74	CVS2-51	0.5328	0.1048	0.1129	0.0373	0.0082	0.0084	0.0733	0.0235	0.0392	0.0596	10.230	12.350	10.320	12.180	9.480
75	CVS2-52	0.6000	0.0817	0.0450	0.0788	0.0008	0.0009	0.0720	0.0233	0.0385	0.0590	8.990	10.075	8.705	9.550	9.465
76	CVS2-53	0.5226	0.0874	0.0700	0.0600	0.0000	0.0500	0.0400	0.0800	0.0100	0.0800	.	.	.	.	.
77	CVS2-54	0.5328	0.1048	0.1129	0.0373	0.0082	0.0084	0.0733	0.0235	0.0392	0.0596	.	.	.	.	.
78	CVS2-55	0.5328	0.1048	0.1129	0.0373	0.0082	0.0084	0.0733	0.0235	0.0392	0.0596	13.110	15.905	13.725	14.920	9.515
79	CVS2-56	0.5328	0.1048	0.1129	0.0373	0.0082	0.0084	0.0733	0.0235	0.0392	0.0596	14.360	17.230	14.990	16.295	9.565
80	CVS2-57	0.5328	0.1048	0.1129	0.0373	0.0082	0.0084	0.0733	0.0235	0.0392	0.0596	12.130	15.280	13.320	14.385	9.545
81	CVS2-58	0.3900	0.2000	0.0500	0.0700	0.0200	0.0800	0.0200	0.1500	0.0100	0.0100	8.655	13.150	11.445	12.720	9.355

Table A.5. Compositions, Normalized MCC-1 Releases, and pH for CVS-I and CVS-II Phase 1, 2, 3, and 4 Quenched Glasses (continued)

#	Glass	SiO2	B2O3	Na2O	Li2O	CaO	MgO	Fe2O3	Al2O3	ZrO2	Others	Si	B	Li	Na	pH
82	CVS2-59	0.4380	0.1718	0.1268	0.0727	0.0375	0.0005	0.0200	0.1150	0.0075	0.0102	9.760	11.975	10.205	11.690	9.850
83	CVS2-60	0.5281	0.0876	0.1725	0.0743	0.0063	0.0005	0.0200	0.0925	0.0075	0.0107	10.720	16.520	14.615	16.410	10.435
84	CVS2-61	0.5281	0.0664	0.1200	0.0730	0.0000	0.0000	0.0200	0.1625	0.0175	0.0125	10.320	10.895	9.575	10.725	9.750
85	CVS2-62	0.5579	0.1765	0.1125	0.0156	0.0500	0.0005	0.0200	0.0500	0.0075	0.0095	9.960	12.390	11.580	12.580	9.325
86	CVS2-63	0.3232	0.1717	0.1900	0.0051	0.1000	0.0000	0.0200	0.1800	0.0000	0.0100	7.930	9.645	10.540	9.575	9.610
87	CVS2-64	0.5697	0.0509	0.0925	0.0642	0.0025	0.0008	0.0812	0.0288	0.0431	0.0663	10.690	12.315	10.720	12.310	9.850
88	CVS2-65	0.5344	0.1128	0.0860	0.0697	0.0007	0.0004	0.0013	0.0196	0.1548	0.0203	7.800	9.405	8.330	9.015	9.590
89	CVS2-66	0.5175	0.0917	0.1211	0.0523	0.0097	0.0061	0.0388	0.1180	0.0026	0.0422	10.320	11.745	10.485	11.685	9.610
90	CVS2-67	0.4596	0.1587	0.1086	0.0583	0.0024	0.0001	0.0004	0.2043	0.0000	0.0076	10.925	11.145	9.960	11.230	9.110
91	CVS2-68	0.5040	0.1355	0.0797	0.0696	0.0007	0.0002	0.0046	0.1640	0.0001	0.0416	10.180	10.560	9.425	10.565	9.210
92	CVS2-69	0.5660	0.0781	0.0664	0.0713	0.0079	0.0032	0.0334	0.0816	0.0005	0.0916	9.440	9.880	8.750	9.845	9.450
93	CVS2-70	0.4854	0.1418	0.0812	0.0691	0.0008	0.0008	0.0080	0.1819	0.0005	0.0305	11.010	11.560	10.425	11.780	9.220
94	CVS2-71	0.5697	0.0509	0.0925	0.0642	0.0025	0.0008	0.0812	0.0288	0.0431	0.0663	10.130	12.000	10.550	11.800	9.785
95	CVS2-72	0.5175	0.0917	0.1211	0.0523	0.0097	0.0061	0.0388	0.1180	0.0026	0.0422	10.320	11.745	10.485	12.240	9.710
96	CVS2-73	0.5040	0.1355	0.0797	0.0696	0.0007	0.0002	0.0046	0.1640	0.0001	0.0416	6.150	6.645	5.870	6.340	9.100
97	CVS2-74	0.5660	0.0781	0.0664	0.0713	0.0079	0.0032	0.0334	0.0816	0.0005	0.0916	8.680	9.880	8.750	9.845	9.490
98	CVS2-75	0.4854	0.1418	0.0812	0.0691	0.0008	0.0008	0.0080	0.1819	0.0005	0.0305	7.920	8.620	7.780	8.630	9.120
99	CVS2-76	0.5018	0.0600	0.1800	0.0632	0.0400	0.0050	0.1050	0.0200	0.0050	0.0200	20.225	26.530	23.650	27.325	10.705
100	CVS2-77	0.4550	0.0600	0.1800	0.0700	0.0050	0.0050	0.0050	0.0200	0.1100	0.0900	26.535	49.575	43.010	45.295	11.170
101	CVS2-78	0.5600	0.1600	0.0500	0.0254	0.0050	0.0400	0.0699	0.0200	0.0497	0.0200	20.410	32.150	27.940	31.000	9.150
102	CVS2-79	0.5479	0.1600	0.0500	0.0121	0.0050	0.0050	0.1050	0.0200	0.0050	0.0900	23.400	32.150	29.325	31.000	8.845
103	CVS2-80	0.5074	0.1600	0.0500	0.0176	0.0050	0.0400	0.1050	0.0200	0.0750	0.0200	26.105	45.215	39.100	43.125	9.100
104	CVS2-81	0.4400	0.0600	0.1734	0.0700	0.0050	0.0400	0.1050	0.0200	0.0050	0.0816	48.560	107.180	89.090	97.155	11.600
105	CVS2-82	0.5600	0.0950	0.1800	0.0700	0.0050	0.0400	0.0050	0.0200	0.0050	0.0200	362.485	643.090	506.910	591.490	11.790
106	CVS2-83	0.4900	0.0951	0.1800	0.0699	0.0400	0.0050	0.0050	0.0200	0.0050	0.0900	29.000	37.190	33.840	37.810	10.720
107	CVS2-84	0.4550	0.0600	0.1800	0.0700	0.0050	0.0050	0.1050	0.0200	0.0800	0.0200	22.775	30.010	26.110	29.950	10.755
108	CVS2-85	0.4400	0.0600	0.1800	0.0700	0.0050	0.0200	0.0050	0.1700	0.0050	0.0450	15.295	18.490	15.980	19.095	10.450
109	CVS2-86	0.4764	0.0600	0.1800	0.0136	0.0400	0.0050	0.0050	0.1700	0.0050	0.0450	7.180	8.305	7.905	8.610	9.530
110	CVS2-87	0.4983	0.0800	0.1800	0.0180	0.0137	0.0050	0.0250	0.0987	0.0613	0.0200	7.720	9.445	8.660	9.730	9.580
111	CVS2-88	0.4597	0.0600	0.1403	0.0700	0.0400	0.0050	0.0250	0.1050	0.0750	0.0200	6.970	9.110	8.290	9.510	10.060
112	CVS2-89	0.4400	0.1171	0.1800	0.0100	0.0400	0.0050	0.1050	0.0200	0.0629	0.0200	21.125	38.440	34.410	37.815	10.035
113	CVS2-90	0.5600	0.1600	0.0542	0.0700	0.0050	0.0050	0.1008	0.0200	0.0050	0.0200	26.135	29.140	25.960	29.840	9.560
114	CVS2-91	0.5600	0.1600	0.1050	0.0100	0.0050	0.0400	0.0050	0.0200	0.0050	0.0900	26.330	44.210	38.710	43.640	9.125
115	CVS2-92	0.4400	0.1600	0.1000	0.0700	0.0050	0.0400	0.0050	0.0200	0.0700	0.0900	20.640	86.415	70.660	72.775	10.560
116	CVS2-93	0.4400	0.1337	0.1279	0.0700	0.0098	0.0050	0.0986	0.0200	0.0050	0.0900	97.130	216.450	176.655	194.940	10.890
117	CVS2-94	0.4400	0.1600	0.1800	0.0526	0.0400	0.0050	0.0271	0.0703	0.0050	0.0200	44.680	87.420	77.680	84.230	10.740
118	CVS2-95	0.4895	0.1112	0.1671	0.0428	0.0113	0.0166	0.0897	0.0367	0.0041	0.0310	34.485	49.160	40.950	46.780	10.260
119	CVS2-96	0.4801	0.1142	0.1003	0.0376	0.0275	0.0363	0.0568	0.0636	0.0429	0.0407	8.900	12.530	11.155	12.630	9.570

Table A.5. Compositions, Normalized MCC-1 Releases, and pH for CVS-I and CVS-II Phase 1, 2, 3, and 4 Quenched Glasses (continued)

#	Glass	SiO2	B2O3	Na2O	Li2O	CaO	MgO	Fe2O3	Al2O3	ZrO2	Others	Si	B	Li	Na	pH
120	CVS2-97	0.5328	0.1048	0.1129	0.0373	0.0082	0.0084	0.0733	0.0235	0.0392	0.0596	10.430	12.890	10.950	13.130	9.490
121	CVS2-98	0.4200	0.1743	0.2000	0.0369	0.0000	0.0000	0.0200	0.1388	0.0000	0.0100	13.230	30.440	27.680	25.945	10.075
122	CVS2-99	0.5203	0.0969	0.0980	0.0356	0.0097	0.0077	0.1019	0.0523	0.0199	0.0577	10.065	13.940	11.780	12.445	9.485
123	CVS2-100	0.5329	0.0740	0.0626	0.0596	0.0035	0.0012	0.1229	0.0286	0.0443	0.0704	10.030	14.125	11.910	12.490	9.620
124	CVS2-101	0.4895	0.1112	0.1671	0.0428	0.0113	0.0166	0.0897	0.0367	0.0041	0.0310	48.200	90.760	76.620	79.440	10.635
125	CVS2-102	0.5353	0.1053	0.1125	0.0375	0.0083	0.0084	0.0719	0.0231	0.0385	0.0592	15.368	19.238	17.491	17.370	9.540
126	CVS2-103	0.4100	0.1337	0.1428	0.0476	0.0105	0.0107	0.0913	0.0293	0.0489	0.0752	25.797	52.909	49.697	45.773	10.220
127	CVS2-104	0.4500	0.1246	0.1332	0.0444	0.0098	0.0099	0.0851	0.0273	0.0456	0.0701	20.180	30.967	28.335	27.824	9.870
128	CVS2-105	0.4900	0.1156	0.1235	0.0412	0.0091	0.0092	0.0789	0.0254	0.0423	0.0650	17.007	22.669	20.879	20.734	9.680
129	CVS2-106	0.5700	0.0974	0.1041	0.0347	0.0077	0.0078	0.0665	0.0214	0.0356	0.0548	11.059	13.370	12.705	12.428	9.370
130	CVS2-107	0.5684	0.0500	0.1195	0.0398	0.0088	0.0089	0.0763	0.0245	0.0409	0.0629	10.150	12.540	11.887	11.278	9.560
131	CVS2-108	0.5086	0.1500	0.1069	0.0356	0.0079	0.0080	0.0683	0.0220	0.0366	0.0562	23.737	22.722	27.788	28.051	9.470
132	CVS2-109	0.4786	0.2000	0.1006	0.0335	0.0074	0.0075	0.0643	0.0207	0.0344	0.0529	46.878	90.836	83.454	76.361	9.400
133	CVS2-110	0.5730	0.1127	0.0500	0.0401	0.0089	0.0090	0.0770	0.0247	0.0412	0.0634	8.577	10.128	9.385	9.299	9.080
134	CVS2-111	0.5127	0.1009	0.1500	0.0359	0.0080	0.0081	0.0689	0.0221	0.0369	0.0567	20.213	25.972	24.261	23.810	9.870
135	CVS2-112	0.4825	0.0949	0.2000	0.0338	0.0075	0.0076	0.0648	0.0208	0.0347	0.0534	53.142	98.259	89.076	80.863	10.760
136	CVS2-113	0.5506	0.1083	0.1157	0.0100	0.0085	0.0086	0.0740	0.0238	0.0396	0.0609	10.478	12.767	11.075	11.532	9.180
137	CVS2-114	0.5228	0.1028	0.1099	0.0600	0.0081	0.0082	0.0702	0.0226	0.0376	0.0578	21.049	20.331	20.072	19.744	9.860
138	CVS2-115	0.5172	0.1017	0.1087	0.0700	0.0080	0.0081	0.0695	0.0223	0.0372	0.0572	22.309	29.404	26.267	26.037	10.050
139	CVS2-116	0.5290	0.1041	0.1112	0.0371	0.0200	0.0083	0.0711	0.0228	0.0381	0.0585	14.743	19.768	17.680	17.574	9.570
140	CVS2-117	0.5398	0.1062	0.1135	0.0378	0.0084	0.0000	0.0725	0.0233	0.0388	0.0597	16.229	19.983	18.206	18.405	9.560
141	CVS2-118	0.5290	0.1041	0.1112	0.0371	0.0082	0.0200	0.0711	0.0228	0.0381	0.0585	15.551	20.386	18.549	18.786	9.590
142	CVS2-119	0.5480	0.1078	0.1152	0.0384	0.0085	0.0086	0.0736	0.0000	0.0394	0.0606	38.602	56.673	50.123	49.135	9.760
143	CVS2-120	0.5206	0.1024	0.1094	0.0365	0.0081	0.0082	0.0699	0.0500	0.0374	0.0576	11.082	13.502	12.373	12.257	9.450
144	CVS2-121	0.4932	0.0970	0.1036	0.0346	0.0077	0.0077	0.0662	0.1000	0.0355	0.0545	8.448	10.110	9.012	9.171	9.240
145	CVS2-122	0.4658	0.0916	0.0979	0.0326	0.0072	0.0073	0.0626	0.1500	0.0335	0.0515	7.798	9.302	8.576	8.191	8.930
146	CVS2-123	0.5328	0.1048	0.1129	0.0373	0.0082	0.0084	0.0733	0.0235	0.0392	0.0596	12.432	15.648	13.549	14.921	9.500
147	CVS2-124	0.3700	0.1428	0.1525	0.0508	0.0113	0.0114	0.0975	0.0313	0.0522	0.0803					

APPENDIX B

EXPLANATION OF SAS OUTPUT IN TABLES
CONTAINING MODEL RESULTS.

This appendix briefly explains the relevant portions of the contents of the tables in this report that contain the results of fitting first- and second-order mixture models to PCT and MCC-1 normalized release data from quenched and CCC glasses. The tables were constructed from patched and edited portions of SAS (1990) output. To facilitate the explanations, the Model #2 portion of Table 2.7 (which contains a reduced second-order mixture model for natural log of PCT normalized Na release) is reproduced here.

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	14	276.34101	19.73864	93.820	0.0001
Error	132	27.77129	0.21039		
C Total	146	304.11230			

Root MSE	0.45868	R-square	0.9087
Dep Mean	-0.04994	R-sq ADJ	0.8990
C.V.	-918.38361	R-sq PRESS	0.8833

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0	Prob > T
SiO2	1	-1.733107	0.64174838	-2.701	0.0078
B2O3	1	-3.864263	4.69156173	-0.824	0.4116
Na2O	1	14.836580	1.79326382	8.274	0.0001
Li2O	1	6.875094	4.72395364	1.455	0.1479
CaO	1	5.391841	3.08526522	1.748	0.0829
MgO	1	11.145934	1.60548477	6.942	0.0001
Fe2O3	1	-3.650992	1.14007558	-3.202	0.0017
Al2O3	1	-40.020774	2.94383324	-13.595	0.0001
ZrO2	1	15.203315	10.29160906	1.477	0.1420
Others	1	0.042729	1.48147630	0.029	0.9770
SiO2_ZrO2	1	-54.323519	20.94722871	-2.593	0.0106
B2O3_CaO	1	-66.632000	24.94669070	-2.671	0.0085
Na2O_Li2O	1	115.231573	39.55813095	2.913	0.0042
B2O3_B2O3	1	60.808186	19.99783790	3.041	0.0028
Al2O3_Al2O3	1	97.667995	15.90600132	6.140	0.0001

The table is divided into two parts. The Analysis of Variance part gives a statistical summary of how much of the variation in the natural log normalized Na release values is accounted for by the model. It is not necessary for most readers/users of this material to understand every term and number in this part of the output. The most important values for readers of this report are the R^2 , $R^2(\text{ADJ})$, and $R^2(\text{PRESS})$ statistics, which generally summarize the proportion of variation in natural log normalized release values accounted for by the model. The closer the values are to one, the better the model. For definitions and more discussion of these three R^2 statistics, see Chapter 6 of Hirma, Piepel, et al. (1994). The reader interested in understanding the balance of the Analysis of Variance part of the output is referred to the SAS (1990) documentation or a discussion in a statistics book of analysis of variance in the regression context.

The Parameter Estimates portion of the output contains the fitted model coefficients (parameter estimates) and standard errors of the coefficients. For example, the coefficient for SiO_2 is -1.733107, which has standard error 0.64174838. Similarly, the second-order term $\text{B}_2\text{O}_3 * \text{B}_2\text{O}_3$ has coefficient 60.808186 and standard error 19.99783790. For practical application of the models, it is sufficient to round the coefficients and standard errors to two or three decimal places.

The Parameter Estimates portion of the output also has the results for statistical t-tests to ascertain whether each coefficient (parameter estimate) is statistically different from zero. The "T for HO: parameter=0" column is obtained by dividing the "Parameter Estimate" column by the "Standard Error" column, which yields the T test statistic. The "Prob > |T|" column contains what is referred to as the significance level of the t-test. The significance level is merely the probability of incorrectly declaring that a coefficient is statistically different from zero. Generally, significance levels below 0.05 or even 0.10 are sufficient to conclude that the corresponding coefficients are statistically different from zero. **The t-test portion of the outputs for the first-order mixture models and first-order portions of reduced second-order mixture models should be ignored.** This is because a component coefficient in a first-order mixture model equaling zero does not correspond to the component having no effect on the response. Hence, the t-test of whether a first-order mixture model coefficient equals or is significantly different from zero is of no interest. The t-test results are of interest for second-order models, however. To illustrate, consider the t-test for the $\text{B}_2\text{O}_3 * \text{B}_2\text{O}_3$ second-order term. To two decimals, the coefficient 60.81 divided by its standard error 20.00 yields $T = 3.04$, which has a significance level of 0.0028. This means there is only a 0.0028 probability (0.28 percent) of being wrong in declaring the coefficient statistically different from zero.