U.S. DEPARTMENT OF ENERGY
OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT

PRESENTATION TO THE NUCLEAR WASTE TECHNICAL REVIEW BOARD

SUBJECT: NATURAL ANALOGUES FOR NUCLEAR WASTE GLASS

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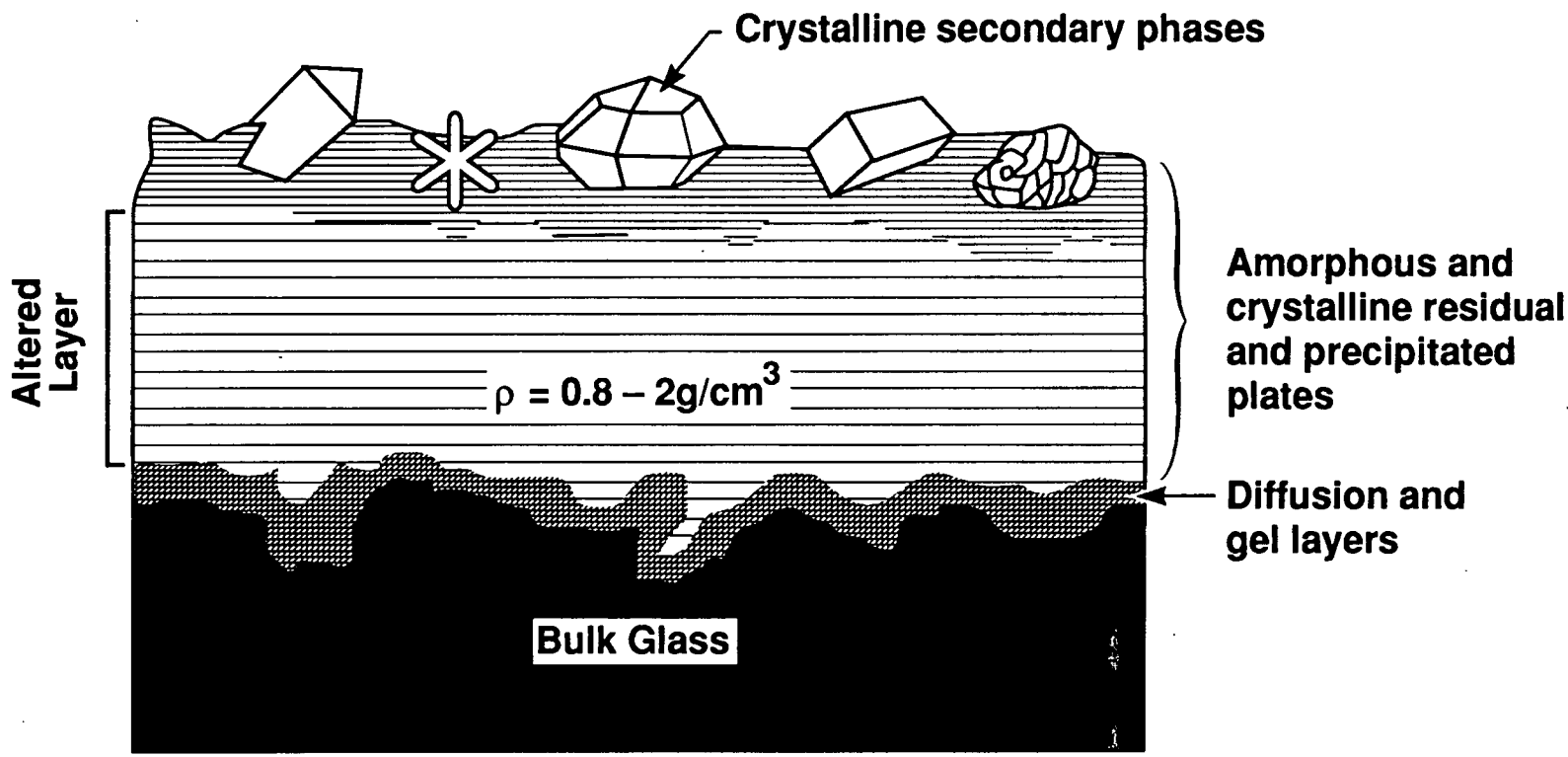
Reacted glass surface features



MECHANISTIC MODELING APPROACH

- IDENTIFY CHEMICAL PROCESSES OF GLASS DISSOLUTION
- GENERATE MODEL OF GLASS DISSOLUTION
- PERFORM EXPERIMENTS THAT ISOLATE AND QUANTIFY IMPORTANT PROCESSES
- VALIDATE MODEL WITH SITE-SPECIFIC EXPERIMENTS AND NATURAL ANALOGS

KEY QUESTIONS TO BE ADDRESSED WITH NATURAL ANALOGUES

- DOES RATE DETERMINIG MECHANISM CHANGE OVER LONG TIME PERIODS?
- DOES STEADY STATE-TYPE REACTION CONTINUE?
- DO ALTERATION LAYERS EVENTUALLY RESTRICT TRANSPORT AND SLOW REACTION RATE?

COMPOSITIONS IN WEIGHT PERCENT OF SEVERAL NUCLEAR WASTE GLASSES AND BASALT GLASS

	SRL-165-U	JSS-A	PNL 76-68	SRL-131	BASALTIC GLASS
Al_2O_3	4.08	4.9	0.7	3.1	14
B_2O_3	6.76	14.4	9.3	9.9	-
BaO	0.06	-	0.5	0.1	-
CaO	1.62	4.0	2.4	1.0	11
CeO_2	-	0.9	0.9	0.2	-
Cs_2O	0.07	1.4	0.9	0.3	-
Fe_2O_3	11.3	2.9	9.3	14.3	4
FeO	0.35	-	-	-	8
K_2O	n.a.	-	-	0.1	0.2
La_2O_3	-	0.9	4.1	0.3	-
Li_2O	4.18	2.0	-	3.9	-
MgO	0.70	-	-	1.2	7
MnO	2.27	-	.04	4.2	.2
MnO_3	-	1.7	1.9	-	-
Na_2O	10.8	9.8	13.9	14.8	2.5
NiO	0.85	-	-	1.5	-
SiO_2	52.8	45.2	41.5	38.6	51
SrO	.11	-	0.4	0.1	-
TiO_2	0.14	-	3.0	0.8	2
ZnO	0.04	2.5	4.6	-	-
ZrO_2	0.66	2.6	1.8	0.3	-
U_3O_8	0.96	0.5	-	1.6	-
P_2O_5	0.29	-	0.7	0.1	0.1

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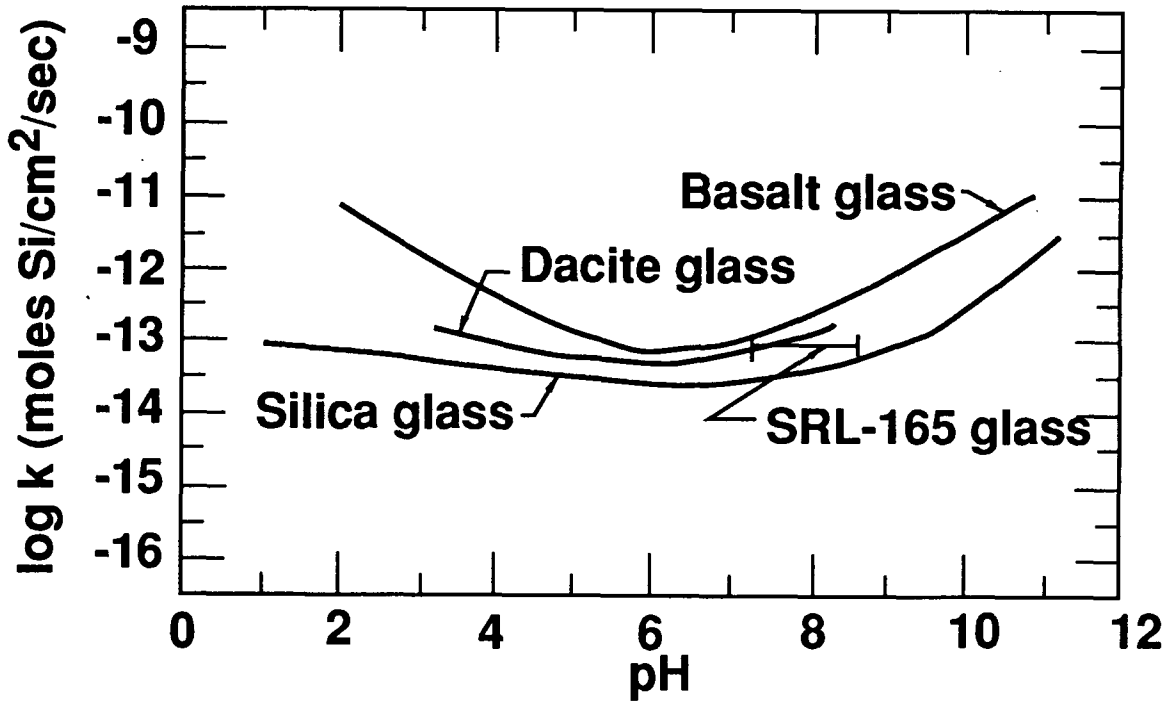
RATE CONSTANTS FOR GLASS DISSOLUTION AT 65° C



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CONTENT

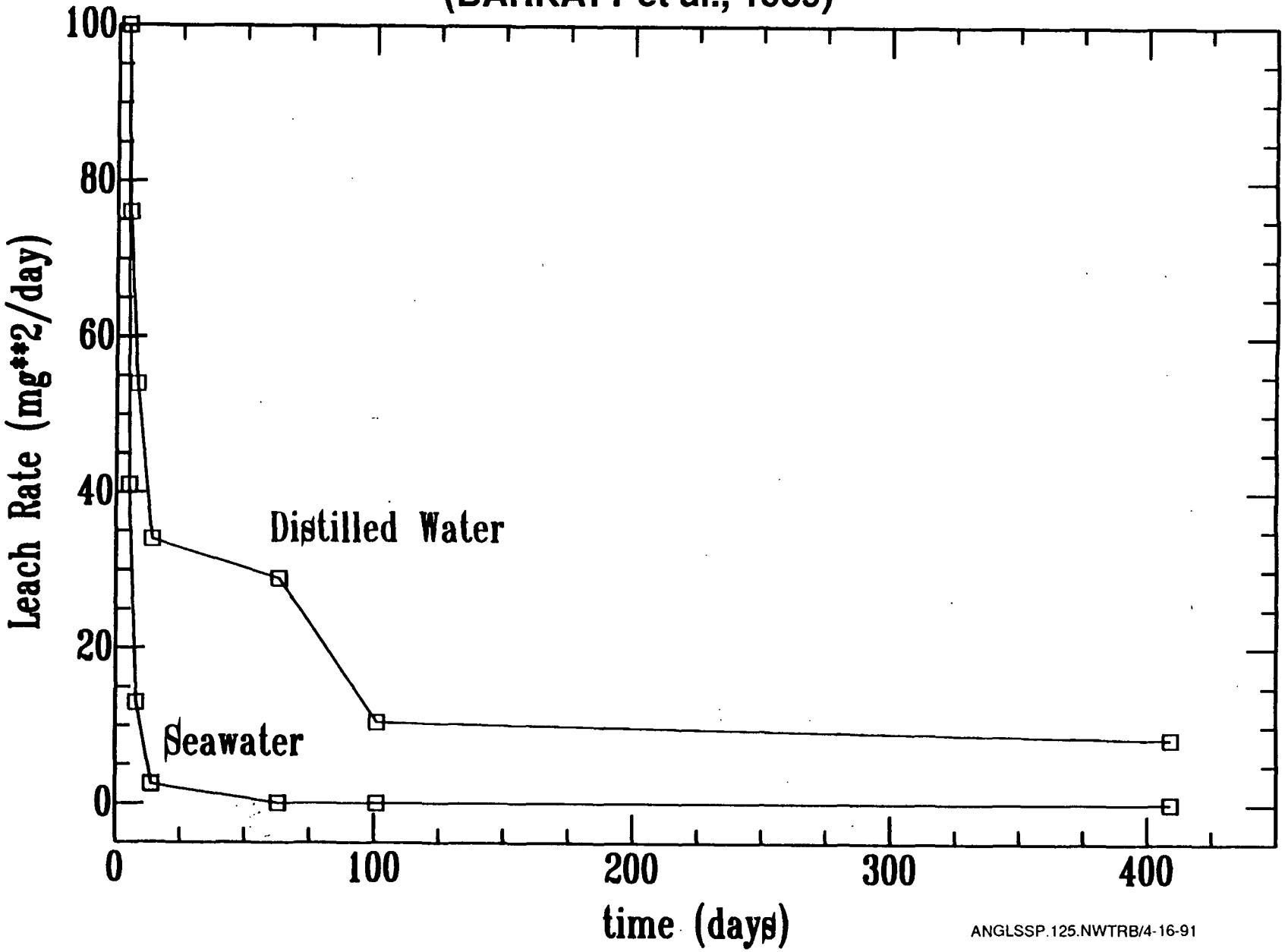
- AN INTRODUCTION DESCRIBING EACH TDB COMPONENT, ITS HARDWARE/SOFTWARE, AND TDB ADMINISTRATOR AND OTHER KEY STAFF
- ADMINISTRATIVE AND TECHNICAL GUIDELINES FOR THE IDENTIFICATION, SUBMISSION, AND RETRIEVAL OF TDB DATA
- IDENTIFIES CURRENT CONTENT OF TDB COMPONENT
- INCLUDES EXAMPLES OF SUBMITTALS, PRODUCTS, AND TYPES OF DATA IN THE DATABASE

IMPACTS OF BASALTIC GLASS ANALOGUE

- DEMONSTRATES THAT GLASS CAN REMAIN STABLE IN UPPER CRUST FOR MILLIONS OF YEARS
- CAN BE USED TO DETERMINE WHETHER ALTERATION LAYERS PROVIDE TRANSPORT BARRIER TO GLASS REACTION
- WILL PROVIDE VALIDATION SUPPORT OF KINETIC MODEL

MICROTEKTITE DISSOLUTION RATES AT 90°C

(BARKATT et al., 1989)



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IMPACTS OF TEKTITE ANALOGUE

- MAGNESIUM IS THE COMPONENT OF SEAWATER THAT DECREASES DISSOLUTION RATES
- EXPERIMENTS ARE PLANNED TO FURTHER UNDERSTAND AND QUANTIFY THE EFFECT
- SURFACE EXAMINATION WILL TELL WHETHER EFFECT IS DUE TO SURFACE CHEMISTRY OR SECONDARY PHASE FORMATION

SUMMARY OF IMPACT OF NATURAL ANALOGUE INFORMATION ON GLASS TASK

- IDENTIFIED IMPORTANT EFFECTS ON GLASS DISSOLUTION
- INFLUENCED EXPERIMENTAL PLANS
- WILL PROVIDE VALIDATION SUPPORT OF KINETIC MODEL

COMPOSITIONS IN WEIGHT PERCENT OF SEVERAL NUCLEAR WASTE GLASSES AND BASALT GLASS.

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CeO_2	–	0.9	0.9	0.2	–
Cs_2O	0.07	1.4	0.9	0.3	–
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FeO	0.35	–	–	–	8
K_2O	n.a.†	–	–	0.1	0.2
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MgO	0.70	–	–	1.2	7
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MoO_3	–	1.7	1.9	–	–
Na_2O	10.8	9.8	13.9	14.8	2.5
NiO	0.85	–	–	1.5	–
SiO_2	52.8	45.2	41.5	38.6	51
SrO	.11	–	0.4	0.1	–
TiO_2	0.14	–	3.0	0.8	2
ZnO	0.04	2.5	4.6	–	–
ZrO_2	0.66	2.6	1.8	0.3	–
U_3O_8	0.96	0.5	–	1.6	–
P_2O_5	0.29	–	0.7	0.1	0.1