APPENDIX D

IV. RESULTS OF γ-SPECTRAL AND ^{90}Sr ANALYSES OF D SERIES WATER SAMPLES

A. LASL RESULTS

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D-Series Sample Number	Total Volume Pumped (m^3)	dpm/ml at t_o			
		^{90}Sr	^{106}Ru	^{125}Sb	^{137}Cs
1	0.587	10.60	4770	41	2.74
2	1.136		5130	42	6.75
3	1.635	6.98	5620	19	15.53
(2 wks. later)			(5890)	(22)	(13.55)
4	2.434		5020	20	12.47
5	4.054	6.87	4240	23	3.81
6	5.311		3890	24	2.35
7	6.556	6.78	3740	25	2.56
8	7.798		3670	27	2.07
9	9.036	6.92	3300	28	1.77
10	10.274		3560	29	1.75
11	11.508	7.01	3680	27	1.77
12	12.742		3730	30	1.83
13	13.980	6.79	3560	28	1.72
14	15.210		3470	23	1.64
15	16.444		3950	31	1.73
16	17.674	6.87	3700	28	1.64
17	18.908		3430	27	1.67
3 filter			280[a]	11[a]	10.8[a]
3 filtrate			5620	16	1.7
3 Total Activity			5900	27	12.5

[a]Activity on filter was co-rected to equivalent dpm/ml to permit comparison with the filtrate.

matrix, and complex flow fields in the fracture. Nonetheless, the results of this simple model are useful because matrix diffusion will be a dominant mechanism affecting radionuclide transport in tuff by fracture flow. For several years matrix diffusion has been considered an important factor in element transport through fractures in crystalline rock.[62,69,70] The effect will be much more dramatic in tuff, even over relatively short distances, because tuff porosity is several orders of magnitude higher than that of granite.

The physical properties of G-Tunnel tuff have been determined in previous measurements. Table LVII contains a list of the nominal parameter values chosen for matrix diffusion calculations. The ionic diffusion coefficient corresponds to that of strontium and is an intermediate value compared to the ionic diffusivities of most monovalent and divalent ions. Fissure apertures from 10 to 100 μm and flow velocities U_f from 1 to 100 m/day were used in the calculations.

Figure 86 shows the activity profile for a nonsorbing tracer, $K_d' = 0$, with a flow rate of 1 m/day after 300 days. Although the water has traveled 300 m, activity has traveled only 9 cm. This result is caused by loss of tracer to the rock matrix; Fig. 87 shows that tracer has penetrated far beyond 1 cm. This apparent retardation occurs because the concentration gradient at the tracer front is the highest and, therefore, diffusion there is the fastest; activity in the leading edge is lost to the matrix until the concentration in the matrix builds up. These results clearly indicate that in the G-Tunnel field experiment a flow rate of 1 m/day would be too slow because the planned duration of the experiment is 30 to 60 days for both sorbing and nonsorbing tracers.

TABLE LVII

PHYSICAL PARAMETERS USED FOR MATRIX DIFFUSION CALCULATIONS WITH G-TUNNEL TUFF

Parameter	Symbol	Value
Density	ρ	1.6 g/cm^2
Matrix porosity	ε	0.30
Constrictivity/tortuosity	α/τ^2	0.10
Ionic diffusion coefficient	D^i	7.74×10^{-10} m^2/second
Effective diffusion coefficient	D_{eff}	2.71×10^{-11} m^2/second

Table 11. (continued)

Sampling Location	Date	Sample Type[c]	Radio-nuclide	Radioactivity Conc. (10^{-9} μCi/ml)	% of Conc. Guide
Frenchman, NV Flowing Well	2/20	23	^{3}H	<9	<0.01
			^{89}Sr	<5	<0.2
			^{90}Sr	<4	<1
			^{226}Ra	0.26	0.9
			^{234}U	0.36	<0.01
			^{235}U	<0.02	<0.01
			^{238}U	0.23	<0.01
			^{238}Pu	<0.2	<0.01
			^{239}Pu	<0.09	<0.01
Frenchman, NV Hunts Station	2/20	23	^{3}H	<8	<0.01
			^{89}Sr	<6	<0.2
			^{90}Sr	<4	<1
			^{234}U	0.73	<0.01
			^{235}U	0.035	<0.01
			^{238}U	0.41	<0.01
			^{238}Pu	<0.05	<0.01
			^{239}Pu	<0.02	<0.01
Frenchman, NV Frenchman Station	2/19	23	^{3}H	<7	<0.01
			^{89}Sr	<6	<0.2
			^{90}Sr	<4	<1
			^{226}Ra	0.17	0.6
			^{234}U	23	0.08
			^{235}U	0.55	<0.01
			^{238}U	11	0.03
			^{238}Pu	<0.05	<0.01
			^{239}Pu	<0.05	<0.01
Frenchman, NV Well HS-1	2/19	23	^{3}H	<7	<0.01
			^{89}Sr	<6	<0.2
			^{90}Sr	<4	<2
			^{226}Ra	0.067	0.2
			^{234}U	3.3	0.01
			^{235}U	0.098	<0.01
			^{238}U	2.2	<0.01
			^{238}Pu	<0.04	<0.01
			^{239}Pu	<0.02	<0.01