*Sorption and Desorption of Cesium and
Strontium on TA-2 and TA-41
Soils and Sediments*

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SORPTION AND DESORPTION OF CESIUM AND STRONTIUM ON TA-2 AND TA-41 SOILS AND SEDIMENTS

by

K. Stephen Kung, Benjamin W. Li, Patrick A. Longmire,
and Malcolm M. Fowler

ABSTRACT

The experiments to determine the sorptivity of cesium and strontium onto TA-2 and TA-41 soils under controlled laboratory conditions were conducted. Twenty surface soil samples and seventeen transect sediment samples which were collected by the OU1098 Baseline Characterization Field Team during summer 1994 were studied. All soil and sediment samples were air-dried and passed through a 2-mm sieve before the experiments were performed. The water and organic content of these samples were determined.

Batch sorption isotherms were utilized to quantify the chemical reactivity of each soil sample toward cesium and strontium ions. Cesium-137 and strontium-85 were used as radionuclides tracers. Gamma counting was used to determine the amount of radionuclide sorption. The sorption coefficient, K_d , for each soil sample was quantified from the sorption isotherms. Batch desorption isotherms were studied after the sorption experiments to quantify the desorption of presorbed radionuclides from these surface and sediment transect soil samples.

Results show that the sorptivity of cesium is much higher than the sorptivity of strontium on all soil samples. Cesium sorption coefficient (in ml/g) is about 160-1400 for surface soils and 80-1000 for transect sediment samples. Strontium sorption coefficient (in ml/g) is about 15-70 for surface soils and 10-40 for transect sediments. A fairly good correlation between sorption of cesium and strontium was observed for transect sediment samples. Conversely, poor correlation was found between sorption of cesium and strontium on surface soils. Surface soils and sediments of stream sides showed higher sorptivity for radionuclides than those of stream sediment samples. Less than 4% and 9% of presorbed cesium was desorbed from surface soils and transect sediments, respectively. However, desorption of presorbed strontium was much higher than that of cesium for all soil and sediment samples. Rates of desorption of strontium in stream sediment samples were found to be as high as 30%. It is observed that the percentages of the radionuclides desorption are inversely related to the radionuclides sorption K_d for all soil and sediment samples. For the transect samples which were located within or near the TA-2 and TA-41 site boundaries, the sorptivity of cesium follows the order: north-side soil > south-side soils > stream sediment soils. Strontium sorption is strongly dependent on soil organic matter for all soil samples. From the relationship between soil water content and cesium sorption, it is suggested that the sorption of cesium is correlated to the clay content of the soil samples.

1.0 INTRODUCTION

1.1 Overview

TA-2 and TA-41 are located at the north central edge of Los Alamos National Laboratory, in the Los Alamos Canyon, Los Alamos County, New Mexico. Within TA-2 and TA-41, Los Alamos Canyon is bounded to the north by DP Mesa and to the south by Los Alamos Mesa. The canyon is approximately 1300 to 1400 feet wide between the two mesa tops and about 300 to 350 feet in depth. The canyon walls are generally steep and rocky, and the bottom is relatively flat and forested. A shallow intermittent stream flows along the canyon bottom. Since its establishment in 1944, TA-2 had historically been the site of different nuclear research reactors. TA-41 is used in developing and conducting studies of weapon subsystems. Current environmental monitoring has detected radioactive contaminants (primarily tritium, cesium, and strontium) in alluvial groundwater downgradient of TA-2 and TA-41 (Ref. 1)

Radioisotopes of strontium and cesium are the fission products of greatest concern because of their high yields and biological toxicity. Cesium-137 has a half-life of 30 years, and strontium-90 has a half-life of 28.5 years. The presence of these elements in soil and sediments is due to above-ground nuclear tests, nuclear accidents, and/or improper waste disposal. To study the migration of these radionuclides in surface soil is important to environmental assessment since surface soils have a close relation to human life. In order to conduct a risk assessment and remediation strategy, the distribution coefficient must be measured experimentally.

Both cesium and strontium are very soluble in water. However, their mobility in natural environments is believed to be retarded by their strong interaction with soil organic materials and clay minerals. The goal of this work is to develop specific laboratory experiments to characterize the cesium and strontium sorptivity onto TA-2 and TA-41 sites soil samples. This study will emphasize the quantification of the reactivity of specific site surface soils under controlled laboratory conditions. Batch sorption and desorption isotherms were used to quantify the amount of cesium and strontium that was retained onto the soils.

Strontium-85 was used as a surrogate for the strontium-90 sorption and desorption experiment. This isotope has a relative short half-life (65 days) and it emits a strong gamma ray at 514 KeV that can be quantified by gamma detector. Little, if any, isotope effect should be expected for using strontium-85 to represent the chemical reactivities of strontium-90.

1.2 Objective

The objective of this study is to quantify the sorptivity of cesium and strontium onto TA-2 and TA-41 site specific soil samples under a controlled environment in the laboratory. The purposes of this work are to determine cesium and strontium sorption coefficient for these site specific soils and to evaluate the potential transport of cesium and strontium. Based on this information, a risk assessment and remediation strategy can be developed.

2.0 SOIL SAMPLE

2.1 Soil Sample Source

Soil samples were collected by the OU1098 Baseline Characterization Field Sampling Team during the summer of 1994 from TA-2 and TA-41 of Los Alamos National Laboratory, New Mexico. A total of 36 soil samples, which were stored in sealed plastic bags, were received for this study from Mr. Daniel Newell in March 1995. Detail discussion of soil sample source and field activities was presented in Ref. 2. Soil sample identification codes were listed as follow:

Sample Location	Soil Code	Sample Location	Soil Code
Soil 1	AAB 1328	Tran. 1 stream	AAB 0125
Soil 2	AAB 1319	Tran. 1N	AAB 1402
Soil 4	AAB 1318	Tran. 1S	AAB 1403
Soil 5	AAB 1320	Tran. 2 stream	AAB 0124
Soil 7	AAA 9033	Tran. 2N	AAB 0093
Soil 8	AAA 6016	Tran. 2S	AAB 0094
Soil 9	AAA 6014	Tran. 3 stream	AAB 0121
Soil 10	AAB 0090	Tran. 3N	AAB 6015
Soil 11	AAB 1316	Tran. 3S	AAB 0092
Soil 12	AAA 6012	Tran. 4 stream	AAB 0123
Soil 13	AAA 9034	Tran. 4Na	AAB 0098
Soil 14	AAB 0096	Tran. 4Nb	AAB 0099
Soil 15	AAB 0091	Tran. 4S	AAA 6006
Soil 16	AAA 6009	Trans. 5 stream	AAB 0122
Soil 17	AAB 0089	Tran. 5N	AAA 6013
Soil 18	AAA 6008	Tran. 5S	AAA 8577
Soil 19	AAA 9035		
Soil 20	AAA 9036		
Soil 21	AAA 8578		
Soil 22	AAA 6005		

2.2 Soil Sample Site Description and Locations

TA-2 and TA-41 are located within Los Alamos Canyon near the north central boundary of the Los Alamos National Laboratory. TA-2 had installed and operated several different nuclear research reactors. TA-41 is used in developing and conducting studies of weapon subsystems. Wastes at TA-2 include fission products, transuranic elements, and organics. Materials used or stored in TA-41 include tritium, transuranic elements, metals, organics, and explosives. These areas have been continuously used by the Lab since early 1940 (Ref. 1).

Reference 2 describes in detail the location and soil sampling site. In brief, the surface soil sample sites were located within or near TA-2 and TA-41 boundaries. Sample points were selected relative to area facilities and other potential sources of contamination. Five sediment transects along the stream within the area were sampled. Transacts 1 to 4 are within or near the boundaries of TA-2 and TA-41, transect 5 is located about 1100 feet downstream of TA 2. Each transect consisted of three points: one within the active stream bed (the stream sediment) and one point on each side (north and south) of the stream. An additional sediment sample (code:AAB0099, Tran. 4Nb), located on the north side of the stream at transect 4, was added.

3.0 EXPERIMENTAL DESIGN AND PROCEDURES

3.1 Soil Preparation and Characterization

A total of 36 soil samples stored in sealed plastic bags were received from Mr. Daniel Newell, in March 1995. Among these soil samples, 20 samples were surface soils and 16 samples were transect sediment soils. It should be noted that two soil samples were not labeled on the plastic bag with any code. However, from the soil properties that were identified later in this study, these two unidentified samples were possibly the transect sediment soils (sample ID:AAB 0092, Transact 3 S and AAB 0122, Transact 5 Stream). Thus, these two soil samples were assigned as transect sediments in this report.

All soil samples were received in sealed plastic bags. The soils were first transferred to clean plastic trays and then air-dried in room temperature for 24 hours. The soils were sieved through a 2-mm sieve. The fraction that passed through the sieve was collected and stored in high-density polyethylene bottles for the experiments.

The water content of these air-dried soil samples was determined by the weight difference for 10-g air-dried soil before and after being treated at 120°C for 24 hours. Soil organic matter content was determined by using the Walkley-Black wet oxidation method on the air-dried soil samples. Soil pH was determined in both water and 0.01 M CaCl₂ by using a 1:2 solid to solution ratio.

3.2 Metal Ions

Radioisotope strontium-85 and cesium-137 were used as sorbents in the sorption and desorption experiments. Strontium-85 was obtained from Dr. K. Abney of CST-11. This material was produced by the radioisotope team of the Los Alamos National Laboratory. The cesium-137 that was used in this work was a product from DuPont. These radionuclides were used with no further purification. No nonradioactive strontium and cesium appeared in the stock solutions as carrier. Desired concentration of the material was diluted and prepared in a 0.01 mole/liter KCl solution. Cesium stock solution concentrations were about 4 to 25×10^{-10} mole/liter. Strontium stock solution concentrations were about 2 to 23×10^{-13} mole/liter. All the stock solutions were adjusted to pH 6.8 ± 0.1 by NaOH or HCl solution.

3.3 General Procedure

Batch sorption isotherm was used to quantify the chemical reactivity of surface and transact sediment soil samples collected from TA-2 and TA-41 to cesium and strontium under controlled experimental conditions. Batch sorption experiments involve preparing the soil sample, adding a solution containing a known metal concentration, mixing the solution and the soil in a container, separating the soil from the suspension, and determining the amount of tracer in the solution phase. At least four initial solution concentrations were used to generate a sorption isotherm. For all the solutions, 0.01 M KCl was used as a background electrolyte to remain at essentially constant ionic strength.

3.4 Detailed Experimental Procedures

3.4.1 Batch Sorption Experiment.

Sorption experiments were conducted as follows:

1. Determine the weight of a clean centrifuge tube.
2. Weigh two grams of the air-dried soil sample into a clean centrifuge tube.
3. Weigh the tube with the soil sample.
4. Add 20 ml of solution which contains a known concentration of the radionuclide ions.
5. Weigh the tube after addition of the solution.
6. Seal the tube and mix the phases on a shaker for at least 72 hours.
7. Centrifuge the mixture for 10 minutes at a speed of 5,000 rpm. Swirl the tube in an upright position to remove the solid from the tube side walls. Centrifuge again for 30 minutes at a speed of 10,000 rpm. Swirl the tube again. Centrifuge the final suspension for 60 minutes at a minimum speed of 12,000 rpm.
8. Separate the phases by carefully pouring all of the solution out to a clean tube.
9. Centrifuge again for 60 minutes at a minimum speed of 12,000 rpm. Separate the phases by carefully pouring all of the solution out to a clean tube.
10. Centrifuge again for 60 minutes at a minimum speed of 12,000 rpm. Pipette at least 10 ml of the supernatant solution to a clean tube. Centrifuge again for

60 minutes at a minimum speed of 12,000 rpm.

11. Transfer 5 ml of the supernatant solution, obtained from step 10, to a scintillation vial to analyze the radionuclide concentration left in the solution phase by gamma spectrometry.
12. Determine the amount of sorption by subtracting the final solution concentration out of the initial concentration.
13. Plot the sorption isotherms.
14. Determine the sorption coefficient.

3.4.2 Batch Desorption Experiment.

Desorption experiments were conducted as follows:

1. Add 20 ml of 0.01 M KCl solution into the centrifuge tube left from step 9, the second run of separation, in the sorption experiment.
2. Swirl the tube and carefully pour all of the solution out to the centrifuge tube left from step 7, the first run, in sorption experiment.
3. Seal the tube and mix the phases on a shaker for at least 72 hours.
4. Centrifuge the mixture for 10 minutes at a speed of 5,000 rpm. Swirl the tube at upright position to remove solid from the tube side walls. Centrifuge again for 30 minutes at speed of 10,000 rpm. Swirl the tube again. Centrifuge the final suspension for 60 minutes at a minimum speed of 12, 000 rpm.
5. Separate the phases by carefully pouring all the solution out to a clean tube.
6. Centrifuge again for 60 minutes at a minimum speed of 12, 000 rpm. Separate the phases by carefully pouring the all solution out to a clean tube.
7. Centrifuge again for 60 minutes at a minimum speed of 12, 000 rpm. Pipette at least 10 ml of the supernatant solution to a clean tube. Centrifuge again for 60 minutes at a minimum speed of 12,000 rpm.
8. Transfer 5 ml of the solution, obtained from step 7, to a scintillation vial to analyze the radionuclide concentration left in the solution phase by gamma spectrometry.
9. Determine the amount of desorption from the final solution concentration.
10. Plot the desorption isotherms.
11. Determine the desorption coefficient.

3.5 Radiochemical Analysis Method

Radionuclides were analyzed by gamma spectrometry. Measurements were performed at the counting room of the nuclear chemistry facility (TA-48, RC-1) with sodium iodide and/or the germanium detector. Cesium-137 was analyzed by using 661 keV energy and strontium -85 was analyzed by using 514 keV energy.

4.0 RESULTS

4.1 Soil Sample Characterization

Results of soil characterization are summarized in Table 4.1.

TABLE 4.1 Result of Soil Characterization

Soil Code	Sample Location	% Water Content	pH (1:2 water)	pH (1:2 CaCl ₂)	% Organic Material
AAB 1328	Soil 1	0.7	5.9	5.3	2.4
AAB 1319	Soil 2	0.4	6.2	5.6	0.7
AAB 1318	Soil 4	1.3	5.7	5.2	1.4
AAB 1320	Soil 5	0.8	7.8	7.2	1.4
AAA 9033	Soil 7	0.5	6.2	5.6	1.3
AAA 6016	Soil 8	0.5	6.8	6.1	1.0
AAA 6014	Soil 9	0.5	6.8	6.3	0.8
AAB 0090	Soil 10	0.9	6.5	6.0	2.7
AAB 1316	Soil 11	0.3	6.6	6.1	0.6
AAA 6012	Soil 12	0.4	6.6	5.9	0.8
AAA 9034	Soil 13	0.9	5.9	5.6	2.9
AAB 0096	Soil 14	0.6	6.1	5.6	1.5
AAB 0091	Soil 15	0.7	6.3	5.9	0.9
AAA 6009	Soil 16	0.8	6.0	5.4	2.5
AAB 0089	Soil 17	1.8	6.3	6.0	5.6
AAA 6008	Soil 18	1.3	6.2	5.8	5.5
AAA 9035	Soil 19	1.2	6.0	5.4	4.0
AAA 9036	Soil 20	0.5	5.6	5.0	1.9
AAA 8578	Soil 21	0.5	5.9	5.4	1.0
AAA 6005	Soil 22	0.5	6.3	5.7	1.6
AAB 0125	Tran. 1 stream	0.2	7.5	6.8	0.1
AAB 1402	Tran. 1N	0.7	6.8	6.4	1.8
AAB 1403	Tran. 1S	0.4	6.8	6.4	0.8
AAB 0124	Tran. 2 stream	0.1	7.7	7.2	0.1
AAB 0093	Tran. 2N	0.7	7.0	6.7	1.7
AAB 0094	Tran. 2S	0.7	6.6	6.3	1.8
AAB 0121	Tran. 3 stream	0.2	7.9	7.3	0.3
AAB 6015	Tran. 3N	0.6	6.7	6.4	1.5
AAB 0092	Tran. 3S	0.6	6.0	5.3	2.1
AAB 0123	Tran. 4 stream	0.2	7.1	7.0	0.1
AAB 0098	Tran. 4Na	0.7	6.4	5.9	2.1
AAB 0099	Tran. 4Nb	1.2	6.3	5.9	2.7
AAA 6006	Tran. 4S	0.3	7.1	6.4	0.4
AAB 0122	Trans. 5 stream	0.2	7.0	6.6	0.3
AAA 6013	Tran. 5N	0.5	6.4	5.9	1.3
AAA 8577	Tran. 5S	0.6	6.5	6.2	2.0

4.2 Metal Sorption and Desorption

4.2.1 Cesium Sorption by Surface and Transact Sediment Soil Samples

The sorption isotherms of cesium onto the surface soils and transact sediment samples are plotted in Figures 4.2.1.1 through 4.2.1.36. Results of cesium sorption coefficients (Kd), which were calculated from the slope of the isotherm, are listed in Table 4.2.1.

TABLE 4.2.1 The sorption coefficient, Kd, of cesium onto TA-2/TA-41 site soils.

Soil Code	Sample Location	Cs Sorption Kd (ml/g)	Soil Code	Sample Location	Cs Sorption Kd (ml/g)
AAB 1328	Soil 1	462.4	AAB 0125	Tran. 1 stream	77.5
AAB 1319	Soil 2	352.3	AAB 1402	Tran. 1N	831.9
AAB 1318	Soil 4	1444.3	AAB 1403	Tran. 1S	269.3
AAB 1320	Soil 5	414.8	AAB 0124	Tran. 2 stream	110.4
AAA 9033	Soil 7	220.2	AAB 0093	Tran. 2N	496.1
AAA 6016	Soil 8	435.8	AAB 0094	Tran. 2S	468.9
AAA 6014	Soil 9	276.3	AAB 0121	Tran. 3 stream	247.2
AAB 0090	Soil 10	305.7	AAB 6015	Tran. 3N	505.9
AAB 1316	Soil 11	287.8	AAB 0092	Tran. 3S	397.0
AAA 6012	Soil 12	353.3	AAB 0123	Tran. 4 stream	209.9
AAA 9034	Soil 13	459.5	AAB 0098	Tran. 4Na	735.8
AAB 0096	Soil 14	162.3	AAB 0099	Tran. 4Nb	1034.1
AAB 0091	Soil 15	392.7	AAA 6006	Tran. 4S	299.9
AAA 6009	Soil 16	337.7	AAB 0122	Tran. 5 stream	226.5
AAB 0089	Soil 17	663.4	AAA 6013	Tran. 5N	412.4
AAA 6008	Soil 18	423.9	AAA 8577	Tran. 5S	557.9
AAA 9035	Soil 19	630.7			
AAA 9036	Soil 20	360.0			
AAA 8578	Soil 21	485.2			
AAA 6005	Soil 22	309.1

Cesium-137 Sorption Isotherm for Soil 1 AAB 1328

Figure 4.2.1.1 Sorption isotherm of cesium on surface soil #1 (AAB1328). Cesium sorption coefficient is calculated as 462.4 (in ml/g) for this sample.

Figure 4.2.1.2 Sorption isotherm of cesium on surface soil #2 (AAB1319). Cesium sorption coefficient is calculated as 352.3 (in ml/g) for this sample.

Cesium-137 Sorption Isotherm for Soil 4 AAB 1318

Figure 4.2.1.3 Sorption isotherm of cesium on surface soil #4 (AAB1318). Cesium sorption coefficient is calculated as 1444 (in ml/g) for this sample.

Cesium-137 Sorption Isotherm for Soil 5 AAB 1320

Figure 4.2.1.4 Sorption isotherm of cesium on surface soil #5 (AAB1320). Cesium sorption coefficient is calculated as 414.8 (in ml/g) for this sample.

Cesium-137 Sorption Isotherm for Soil 7 AAA 9033

Figure 4.2.1.5 Sorption isotherm of cesium on surface soil #7 (AAA9033). Cesium sorption coefficient is calculated as 220.2 (in ml/g) for this sample.

Cesium-137 Sorption Isotherm for Soil 8 AAA 6016

Figure 4.2.1.6 Sorption isotherm of cesium on surface soil #8 (AAA6016). Cesium sorption coefficient is calculated as 435.8 (in ml/g) for this sample.

Figure 4.2.1.7 Sorption isotherm of cesium on surface soil #9 (AAB6014). Cesium sorption coefficient is calculated as 276.3 (in ml/g) for this sample.

Cesium-137 Sorption Isotherm for Soil 10 AAB 0090

Figure 4.2.1.8 Sorption isotherm of cesium on surface soil #10 (AAB0090). Cesium sorption coefficient is calculated as 305.6 (in ml/g) for this sample.

Cesium-137 Sorption Isotherm for Soil 11 AAB 1316

Figure 4.2.1.9 Sorption isotherm of cesium on surface soil #11 (AAB1316). Cesium sorption coefficient is calculated as 287.8 (in ml/g) for this sample.

Cesium-137 Sorption Isotherm for Soil 12 AAA 6012

Figure 4.2.1.10 Sorption isotherm of cesium on surface soil #12 (AAA6012). Cesium sorption coefficient is calculated as 353.3 (in ml/g) for this sample.

Cesium-137 Sorption Isotherm for Soil 13 AAA 9034

Figure 4.2.1.11 Sorption isotherm of cesium on surface soil #13 (AAA9034). Cesium sorption coefficient is calculated as 459.5 (in ml/g) for this sample.

Cesium-137 Sorption Isotherm for Soil 14 AAB 0096

Figure 4.2.1.12 Sorption isotherm of cesium on surface soil #14 (AAB0096). Cesium sorption coefficient is calculated as 162.3 (in ml/g) for this sample.

Cesium-137 Sorption Isotherm for Soil 15 AAB 0091

Figure 4.2.1.13 Sorption isotherm of cesium on surface soil #15 (AAB0091). Cesium sorption coefficient is calculated as 392.7 (in ml/g) for this sample.

Cesium-137 Sorption Isotherm for Soil 16 AAA 6009

Figure 4.2.1.14 Sorption isotherm of cesium on surface soil #16 (AAA6009). Cesium sorption coefficient is calculated as 337.7 (in ml/g) for this sample.

Cesium-137 Sorption Isotherm for Soil 17 AAB 0089

Figure 4.2.1.15 Sorption isotherm of cesium on surface soil #17 (AAB0089). Cesium sorption coefficient is calculated as 337.7 (in ml/g) for this sample.

Cesium-137 Sorption Isotherm for Soil 18 AAA 6008

Figure 4.2.1.16 Sorption isotherm of cesium on surface soil #18 (AAA6008). Cesium sorption coefficient is calculated as 423.9 (in ml/g) for this sample.

Cesium-137 Sorption Isotherm for Soil 19 AAA 9035

Figure 4.2.1.17 Sorption isotherm of cesium on surface soil #19 (AAA9035). Cesium sorption coefficient is calculated as 630.7 (in ml/g) for this sample.

Cesium-137 Sorption Isotherm for Soil 20 AAA 9036

Figure 4.2.1.18 Sorption isotherm of cesium on surface soil #20 (AAA9036). Cesium sorption coefficient is calculated as 360.0 (in ml/g) for this sample.

Figure 4.2.1.19 Sorption isotherm of cesium on surface soil #21 (AAA5878). Cesium sorption coefficient is calculated as 337.7 (in ml/g) for this sample.

Cesium-137 Sorption Isotherm for Soil 22 AAA 6005

Figure 4.2.1.20 Sorption isotherm of cesium on surface soil #22 (AAA6005). Cesium sorption coefficient is calculated as 309.1 (in ml/g) for this sample.

Cesium-137 Sorption Isotherm for Tran. 1N AAB 1402

Figure 4.2.1.21 Sorption isotherm of cesium on transact 1 north sediment sample (AAB1402). Cesium sorption coefficient is calculated as 831.9 (in ml/g) for this sample.

Cesium-137 Sorption Isotherm for Tran. 1S AAB 1403

Figure 4.2.1.22 Sorption isotherm of cesium on transact 1 south sediment sample (AAB1403). Cesium sorption coefficient is calculated as 269.3 (in ml/g) for this sample.

Cesium-137 Sorption Isotherm for Tran. 1 stream AAB 0125

Figure 4.2.1.23 Sorption isotherm of cesium on transact 1 sediment sample (AAB0125). Cesium sorption coefficient is calculated as 77.5 (in ml/g) for this sample.

Cesium-137 Sorption Isotherm for Tran. 2N AAB 0093

Figure 4.2.1.24 Sorption isotherm of cesium on transact 2 north sediment sample (AAB0093). Cesium sorption coefficient is calculated as 496.1 (in ml/g) for this sample.

Cesium-137 Sorption Isotherm for Tran. 2S AAB 0094

Figure 4.2.1.25 Sorption isotherm of cesium on transact 2 south sediment sample (AAB0094). Cesium sorption coefficient is calculated as 468.9 (in ml/g) for this sample.

Cesium-137 Sorption Isotherm for Tran. 2 stream AAB 0124

Figure 4.2.1.26 Sorption isotherm of cesium on transact 2 sediment sample (AAB0124). Cesium sorption coefficient is calculated as 110.4 (in ml/g) for this sample.

Figure 4.2.1.27 Sorption isotherm of cesium on transact 3 north sediment sample (AAB6015). Cesium sorption coefficient is calculated as 505.9 (in ml/g) for this sample.

Cesium-137 Sorption Isotherm for Trans. 3 S

Figure 4.2.1.28 Sorption isotherm of cesium on transact 3 south sediment sample (unidentified). Cesium sorption coefficient is calculated as 397.0 (in ml/g) for this sample.

Cesium-137 Sorption Isotherm for Tran. 3 stream AAB 0121

Figure 4.2.1.29 Sorption isotherm of cesium on transact 3 sediment sample (AAB0121). Cesium sorption coefficient is calculated as 247.2 (in ml/g) for this sample.

Cesium-137 Sorption Isotherm for Tran. 4Na AAB 0098

Figure 4.2.1.30 Sorption isotherm of cesium on transact 4 north (A) sediment sample (AAB0098). Cesium sorption coefficient is calculated as 735.8 (in ml/g) for this sample.

Cesium-137 Sorption Isotherm for Tran. 4Nb AAB 0099

Figure 4.2.1.31 Sorption isotherm of cesium on transact 4 north (B) sediment sample (AAB0099). Cesium sorption coefficient is calculated as 1034 (in ml/g) for this sample.

Cesium-137 Sorption Isotherm for Tran. 4S AAA 6006

Figure 4.2.1.32 Sorption isotherm of cesium on transact 4 south sediment sample (AAA6006). Cesium sorption coefficient is calculated as 299.9 (in ml/g) for this sample.

Cesium-137 Sorption Isotherm for Tran. 4 stream AAB 0123

Figure 4.2.1.33 Sorption isotherm of cesium on transect 4 sediment sample (AAB0123). Cesium sorption coefficient is calculated as 209.9 (in ml/g) for this sample.

Cesium-137 Sorption Isotherm for Tran. 5N AAA 6013

Figure 4.2.1.34 Sorption isotherm of cesium on transact 5 north sediment sample (AAA6013). Cesium sorption coefficient is calculated as 412.4 (in ml/g) for this sample.

Cesium-137 Sorption Isotherm for Tran. 5S AAA 8577

Figure 4.2.1.35 Sorption isotherm of cesium on transect 5 south sediment sample (AAA8577). Cesium sorption coefficient is calculated as 557.9 (in ml/g) for this sample.

Cesium-137 Sorption Isotherm for Trans. 5 Stream

Figure 4.2.1.36 Sorption isotherm of cesium on transact 5 sediment sample (initially unidentified). Cesium sorption coefficient is calculated as 226.5 (in ml/g) for this sample.

4.2.2 Cesium Desorption by Surface and Transact Sediment Soil Samples

The desorption isotherms of cesium onto the surface soils and transact sediment samples are plotted in Figures 4.2.2.1 through 4.2.2.36. The percentage desorption of presorbed cesium is listed in Table 4.2.2.

TABLE 4.2.2 Desorption of cesium form TA-2/TA-41 site soils.

Soil Code	Sample Location	% Cs desorb	Soil Code	Sample Location	% Cs desorb
AAB 1328	Soil 1	2.3	AAB 0125	Tran. 1 stream	6.9
AAB 1319	Soil 2	2.5	AAB 1402	Tran. 1N	3.3
AAB 1318	Soil 4	0.9	AAB 1403	Tran. 1S	2.9
AAB 1320	Soil 5	1.4	AAB 0124	Tran. 2 stream	8.5
AAA 9033	Soil 7	3.4	AAB 0093	Tran. 2N	2.0
AAA 6016	Soil 8	2.5	AAB 0094	Tran. 2S	2.1
AAA 6014	Soil 9	3.4	AAB 0121	Tran. 3 stream	4.8
AAB 0090	Soil 10	2.8	AAB 6015	Tran. 3N	2.2
AAB 1316	Soil 11	3.3	AAB 0092	Tran. 3S	4.4
AAA 6012	Soil 12	3.0	AAB 0123	Tran. 4 stream	5.0
AAA 9034	Soil 13	2.3	AAB 0098	Tran. 4Na	1.6
AAB 0096	Soil 14	2.7	AAB 0099	Tran. 4Nb	0.8
AAB 0091	Soil 15	2.4	AAA 6006	Tran. 4S	3.8
AAA 6009	Soil 16	2.6	AAB 0122	Tran. 5 stream	6.3
AAB 0089	Soil 17	1.3	AAA 6013	Tran. 5N	2.1
AAA 6008	Soil 18	2.0	AAA 8577	Tran. 5S	1.8
AAA 9035	Soil 19	1.7			
AAA 9036	Soil 20	2.6			
AAA 8578	Soil 21	2.0			
AAA 6005	Soil 22	3.4

Cesium-137 Desorption Isotherm for Soil 1 AAB 1328

Figure 4.2.2.1 Desorption isotherm of cesium on surface soil #1 (AAB1328). Cesium desorption coefficient is calculated as 417.8 (in ml/g) for this sample.

Cesium-137 Desorption Isotherm for Soil 2 AAB 1319

Figure 4.2.2.2 Desorption isotherm of cesium on surface soil #2 (AAB1319). Cesium desorption coefficient is calculated as 292.5 (in ml/g) for this sample.

Cesium-137 Desorption Isotherm for Soil 4 AAB 1318

Figure 4.2.2.3 Desorption isotherm of cesium on surface soil #4 (AAB1318).
Cesium desorption coefficient is calculated as 1014.2 (in ml/g) for this sample.

Figure 4.2.2.4 Desorption isotherm of cesium on surface soil #5 (AAB1320). Cesium desorption coefficient is calculated as 984.5 (in ml/g) for this sample.

Figure 4.2.2.5 Desorption isotherm of cesium on surface soil #7 (AAA9033). Cesium desorption coefficient is calculated as 301.6 (in ml/g) for this sample.

Cesium-137 Desorption Isotherm for Soil 8 AAA 6016

Figure 4.2.2.6 Desorption isotherm of cesium on surface soil #8 (AAA6016). Cesium desorption coefficient is calculated as 395.7 (in ml/g) for this sample.

Figure 4.2.2.7 Desorption isotherm of cesium on surface soil #9 (AAB6014). Cesium desorption coefficient is calculated as 284.4 (in ml/g) for this sample.

Cesium-137 Desorption Isotherm for Soil 10 AAB 0090

Figure 4.2.2.8 Desorption isotherm of cesium on surface soil #10 (AAB0090). Cesium desorption coefficient is calculated as 362.1 (in ml/g) for this sample.

Cesium-137 Desorption Isotherm for Soil 11 AAB 1316

Figure 4.2.2.9 Desorption isotherm of cesium on surface soil #11 (AAB1316). Cesium desorption coefficient is calculated as 407.6 (in ml/g) for this sample.

Cesium-137 Desorption Isotherm for Soil 12 AAA 6012

Figure 4.2.2.10 Desorption isotherm of cesium on surface soil #12 (AAA6012). Cesium desorption coefficient is calculated as 344.7 (in ml/g) for this sample.

Cesium-137 Desorption Isotherm for Soil 13 AAA 9034

Figure 4.2.2.11 Desorption isotherm of cesium on surface soil #13 (AAA9034). Cesium desorption coefficient is calculated as 428.5 (in ml/g) for this sample.

Cesium-137 Desorption Isotherm for Soil 14 AAB 0096

Figure 4.2.2.12 Desorption isotherm of cesium on surface soil #14 (AAB0096). Cesium desorption coefficient is calculated as 317.9 (in ml/g) for this sample.

Cesium-137 Desorption Isotherm for Soil 15 AAB 0091

Figure 4.2.2.13 Desorption isotherm of cesium on surface soil #15 (AAB0091). Cesium desorption coefficient is calculated as 432.6 (in ml/g) for this sample.

Cesium-137 Desorption Isotherm for Soil 16 AAA 6009

Figure 4.2.2.14 Desorption isotherm of cesium on surface soil #16 (AAA6009). Cesium desorption coefficient is calculated as 377.2 (in ml/g) for this sample.

Cesium-137 Desorption Isotherm for Soil 17 AAB 0089

Figure 4.2.2.15 Desorption isotherm of cesium on surface soil #17 (AAB0089). Cesium desorption coefficient is calculated as 704.9 (in ml/g) for this sample.

Figure 4.2.2.16 Desorption isotherm of cesium on surface soil #18 (AAA6008). Cesium desorption coefficient is calculated as 471.5 (in ml/g) for this sample.

Figure 4.2.2.17 Desorption isotherm of cesium on surface soil #19 (AAA9035). Cesium desorption coefficient is calculated as 575.6 (in ml/g) for this sample.

Figure 4.2.2.18 Desorption isotherm of cesium on surface soil #20 (AAA9036). Cesium desorption coefficient is calculated as 395.0(in ml/g) for this sample.

Cesium-137 Desorption Isotherm for Soil 21 AAA 8578

Figure 4.2.2.19 Desorption isotherm of cesium on surface soil #21 (AAA8578). Cesium desorption coefficient is calculated as 433.9 (in ml/g) for this sample.

Cesium-137 Desorption Isotherm for Soil 22 AAA 6005

Figure 4.2.2.20 Desorption isotherm of Cesium on surface soil #22 (AAA6005). cesium desorption coefficient is calculated as 311.5 (in ml/g) for this sample.

Cesium-137 Desorption Isotherm for Tran. 1N AAB 1402

Figure 4.2.2.21 Desorption isotherm of Cesium on transact 1 north sediment sample (AAB1402). cesium desorption coefficient is calculated as 742.7 (in ml/g) for this sample.

Figure 4.2.2.22 Desorption isotherm of Cesium on transact 1 south sediment sample (AAB1403). cesium desorption coefficient is calculated as 282.2 (in ml/g) for this sample.

Cesium-137 Desorption Isotherm for Tran. 1 stream AAB 0125

Figure 4.2.2.23 Desorption isotherm of Cesium on transact 1 sediment sample (AAB0125). cesium desorption coefficient is calculated as 131.3 (in ml/g) for this sample.

Cesium-137 Desorption Isotherm for Tran. 2N AAB 0093

Figure 4.2.2.24 Desorption isotherm of Cesium on transect 2 north sediment sample (AAB0093). Cesium desorption coefficient is calculated as 468.9 (in ml/g) for this sample.

Cesium-137 Desorption Isotherm for Tran. 2S AAB 0094

Figure 4.2.2.25 Desorption isotherm of cesium on transact 2 south sediment sample (AAB0094). Cesium desorption coefficient is calculated as 510.7 (in ml/g) for this sample.

Cesium-137 Desorption Isotherm for Tran. 2 stream AAB 0124

Figure 4.2.2.26 Desorption isotherm of cesium on transact 2 sediment sample (AAB0124). Cesium desorption coefficient is calculated as 100.1 (in ml/g) for this sample.

Cesium-137 Desorption Isotherm for Tran. 3N AAB 6015

Figure 4.2.2.27 Desorption isotherm of cesium on transact 3 north sediment sample (AAB6015). Cesium desorption coefficient is calculated as 522.1 (in ml/g) for this sample.

Cesium-137 Desorption Isotherm for Trans. 3 S

Figure 4.2.2.28 Desorption isotherm of cesium on transact 3 south sediment sample (unidentified). Cesium desorption coefficient is calculated as 425.5 (in ml/g) for this sample.

Figure 4.2.2.29 Desorption isotherm of cesium on transact 3 sediment sample (AAB0121). Cesium desorption coefficient is calculated as 197.2 (in ml/g) for this sample.

Cesium-137 Desorption Isotherm for Tran. 4Na AAB 0098

Figure 4.2.2.30 Desorption isotherm of cesium on transact 4 north (A) sediment sample (AAB0098). Cesium desorption coefficient is calculated as 617.7 (in ml/g) for this sample.

Cesium-137 Desorption Isotherm for Tran. 4Nb AAB 0099

Figure 4.2.2.31 Desorption isotherm of cesium on transact 4 north (B) sediment sample (AAB0099). Cesium desorption coefficient is calculated as 1236 (in ml/g) for this sample.

Cesium-137 Desorption Isotherm for Tran. 4S AAA 6006

Figure 4.2.2.32 Desorption isotherm of cesium on transact 4 south sediment sample (AAA6006). Cesium desorption coefficient is calculated as 290.7 (in ml/g) for this sample.

Cesium-137 Desorption Isotherm for Tran. 4 stream AAB 0123

Figure 4.2.2.33 Desorption isotherm of cesium on transact 4 sediment sample (AAB0123). Cesium desorption coefficient is calculated as 197.4 (in ml/g) for this sample.

Cesium-137 Desorption Isotherm for Tran. 5N AAA 6013

Figure 4.2.2.34 Desorption isotherm of cesium on transact 5 north sediment sample (AAA6013). Cesium desorption coefficient is calculated as 511.1 (in ml/g) for this sample.

Cesium-137 Desorption Isotherm for Tran. 5S AAA 8577

Figure 4.2.2.35 Desorption isotherm of cesium on transact 5 south sediment sample (AAA8577). Cesium desorption coefficient is calculated as 534.7 (in ml/g) for this sample.

Cesium-137 Desorption Isotherm for Trans. 5 Stream

Figure 4.2.2.36 Desorption isotherm of cesium on transact 5 sediment sample (initially unidentified). Cesium desorption coefficient is calculated as 220.6 (in ml/g) for this sample.

4.2.3 Strontium Sorption by Surface and Transact Sediment Soil Samples

The sorption isotherms of strontium onto the surface soils and transact sediment samples are plotted in Figures 4.2.3.1 through 4.2.3.36. Results of strontium sorption coefficients (K_d), which were calculated from the slope of the isotherm, are listed in Table 4.2.3.

TABLE 4.2.1 The sorption coefficient of strontium on to TA-2/TA-41 site soils.

Soil Code	Sample Location	Sr Sorption K_d (ml/g)	Soil Code	Sample Location	Sr Sorption K_d (ml/g)
AAB 1328	Soil 1	40.1	AAB 0125	Tran. 1 stream	8.8
AAB 1319	Soil 2	22.3	AAB 1402	Tran. 1N	34.0
AAB 1318	Soil 4	30.3	AAB 1403	Tran. 1S	20.3
AAB 1320	Soil 5	24.1	AAB 0124	Tran. 2 stream	9.2
AAA 9033	Soil 7	28.2	AAB 0093	Tran. 2N	24.7
AAA 6016	Soil 8	25.2	AAB 0094	Tran. 2S	26.0
AAA 6014	Soil 9	24.4	AAB 0121	Tran. 3 stream	10.4
AAB 0090	Soil 10	54.4	AAB 6015	Tran. 3N	28.1
AAB 1316	Soil 11	17.9	AAB 0092	Tran. 3S	41.3
AAA 6012	Soil 12	15.8	AAB 0123	Tran. 4 stream	9.7
AAA 9034	Soil 13	48.4	AAB 0098	Tran. 4Na	28.6
AAB 0096	Soil 14	35.1	AAB 0099	Tran. 4Nb	38.9
AAB 0091	Soil 15	20.9	AAA 6006	Tran. 4S	10.7
AAA 6009	Soil 16	47.5	AAB 0122	Tran. 5 stream	12.1
AAB 0089	Soil 17	67.7	AAA 6013	Tran. 5N	20.2
AAA 6008	Soil 18	67.5	AAA 8577	Tran. 5S	19.3
AAA 9035	Soil 19	61.8			
AAA 9036	Soil 20	25.1			
AAA 8578	Soil 21	21.5			
AAA 6005	Soil 22	35.9

Figure 4.2.3.1 Sorption isotherm of strontium on surface soil #1 (AAB1328). Strontium sorption coefficient is calculated as 40.1 (in ml/g) for this sample.

Figure 4.2.3.2 Sorption isotherm of strontium on surface soil #2 (AAB1319). Strontium sorption coefficient is calculated as 22.3 (in ml/g) for this sample.

Figure 4.2.3.3 Sorption isotherm of strontium on surface soil #4 (AAB1318). Strontium sorption coefficient is calculated as 30.3 (in ml/g) for this sample.

Figure 4.2.3.4 Sorption isotherm of strontium on surface soil #5 (AAB1320). Strontium sorption coefficient is calculated as 24.1 (in ml/g) for this sample.

Figure 4.2.3.5 Sorption isotherm of strontium on surface soil #7 (AAA9033). Strontium sorption coefficient is calculated as 28.2 (in ml/g) for this sample.

Figure 4.2.3.6 Sorption isotherm of strontium on surface soil #8 (AAA6016). Strontium sorption coefficient is calculated as 25.2 (in ml/g) for this sample.

Figure 4.2.3.7 Sorption isotherm of strontium on surface soil #9 (AAB6014). Strontium sorption coefficient is calculated as 24.4 (in ml/g) for this sample.

Figure 4.2.3.8 Sorption isotherm of strontium on surface soil #10 (AAB0090). Strontium sorption coefficient is calculated as 54.4 (in ml/g) for this sample.

Figure 4.2.3.9 Sorption isotherm of strontium on surface soil #11 (AAB1316). Strontium sorption coefficient is calculated as 17.9 (in ml/g) for this sample.

Figure 4.2.3.10 Sorption isotherm of strontium on surface soil #12 (AAA6012). Strontium sorption coefficient is calculated as 353.3 (in ml/g) for this sample.

Figure 4.2.3.11 Sorption isotherm of strontium on surface soil #13 (AAA9034). Strontium sorption coefficient is calculated as 48.4(in ml/g) for this sample.

Figure 4.2.3.12 Sorption isotherm of strontium on surface soil #14 (AAB0096). Strontium sorption coefficient is calculated as 35.1 (in ml/g) for this sample.

Figure 4.2.3.13 Sorption isotherm of strontium on surface soil #15 (AAB0091). Strontium sorption coefficient is calculated as 392.7 (in ml/g) for this sample.

Figure 4.2.3.14 Sorption isotherm of strontium on surface soil #16 (AAA6009). Strontium sorption coefficient is calculated as 47.5 (in ml/g) for this sample.

Figure 4.2.3.15 Sorption isotherm of strontium on surface soil #17 (AAB0089). Strontium sorption coefficient is calculated as 67.7 (in ml/g) for this sample.

Figure 4.2.3.16 Sorption isotherm of strontium on surface soil #18 (AAA6008). Strontium sorption coefficient is calculated as 67.5 (in ml/g) for this sample.

Figure 4.2.3.17 Sorption isotherm of strontium on surface soil #19 (AAA9035). Strontium sorption coefficient is calculated as 61.8 (in ml/g) for this sample.

Figure 4.2.3.18 Sorption isotherm of strontium on surface soil #20 (AAA9036). Strontium sorption coefficient is calculated as 360.0 (in ml/g) for this sample.

Figure 4.2.3.19 Sorption isotherm of strontium on surface soil #21 (AAA8578). Strontium sorption coefficient is calculated as 21.5 (in ml/g) for this sample.

Figure 4.2.3.20 Sorption isotherm of strontium on surface soil #22 (AAA6005). Strontium sorption coefficient is calculated as 35.9 (in ml/g) for this sample.

Figure 4.2.3.21 Sorption isotherm of strontium on transact 1 north sediment sample (AAB1402). Strontium sorption coefficient is calculated as 34.0 (in ml/g) for this sample.

Figure 4.2.3.22 Sorption isotherm of strontium on transect 1 south sediment sample (AAB1403). Strontium sorption coefficient is calculated as 20.2 (in ml/g) for this sample.

Figure 4.2.3.23 Sorption isotherm of strontium on transact 1 sediment sample (AAB0125). Strontium sorption coefficient is calculated as 77.5 (in ml/g) for this sample.

Figure 4.2.3.24 Sorption isotherm of strontium on transect 2 north sediment sample (AAB0093). Strontium sorption coefficient is calculated as 24.7 (in ml/g) for this sample.

Figure 4.2.3.25 Sorption isotherm of strontium on transact 2 south sediment sample (AAB0094). Strontium sorption coefficient is calculated as 26.0 (in ml/g) for this sample.

Figure 4.2.3.26 Sorption isotherm of strontium on transact 2 sediment sample (AAB0124). Strontium sorption coefficient is calculated as 110.4 (in ml/g) for this sample.

Figure 4.2.3.27 Sorption isotherm of strontium on transact 3 north sediment sample (AAB6015). Strontium sorption coefficient is calculated as 28.1 (in ml/g) for this sample.

Figure 4.2.3.28 Sorption isotherm of strontium on transact 3 south sediment sample (unidentified). Strontium sorption coefficient is calculated as 41.3 (in ml/g) for this sample.

Figure 4.2.3.29 Sorption isotherm of strontium on transact 3 sediment sample (AAB0121). Strontium sorption coefficient is calculated as 247.2 (in ml/g) for this sample.

Figure 4.2.3.30 Sorption isotherm of strontium on transact 4 north (A) sediment sample (AAB0098). Strontium sorption coefficient is calculated as 28.6 (in ml/g) for this sample.

Figure 4.2.3.31 Sorption isotherm of strontium on transact 4 north (B) sediment sample (AAB0099). Strontium sorption coefficient is calculated as 38.9 (in ml/g) for this sample.

Figure 4.2.3.32 Sorption isotherm of strontium on transact 4 south sediment sample (AAA6006). Strontium sorption coefficient is calculated as 10.7 (in ml/g) for this sample.

Cesium-137 Sorption Isotherm for Tran. 4 stream AAB 0123

Figure 4.2.3.33 Sorption isotherm of strontium on transact 4 sediment sample (AAB0123). Strontium sorption coefficient is calculated as 21.0 (in ml/g) for this sample.

Figure 4.2.3.34 Sorption isotherm of strontium on transect 5 north sediment sample (AAA6013). Strontium sorption coefficient is calculated as 20.2 (in ml/g) for this sample.

Figure 4.2.3.35 Sorption isotherm of strontium on transect 5 south sediment sample (AAA8577). Strontium sorption coefficient is calculated as 19.3 (in ml/g) for this sample.

Figure 4.2.3.36 Sorption isotherm of strontium on transact 5 sediment sample (initially unidentified). Strontium sorption coefficient is calculated as 12.1 (in ml/g) for this sample.

4.2.4 Strontium Desorption by Surface and Transact Sediment Soil Sample

The desorption isotherms of strontium onto the surface soils and transact sediment samples are plotted in Figures 4.2.4.1 through 4.2.4.36. The percentage desorption of presorbed cesium is listed in Table 4.2.4

TABLE 4.2.4 Strontium desorption from TA-2/TA-41 soil samples.

Soil Code	Sample Location	% Sr desorb	Soil Code	Sample Location	% Sr desorb
AAB 1328	Soil 1	11.7	AAB 0125	Tran. 1 stream	32.4
AAB 1319	Soil 2	16.3	AAB 1402	Tran. 1N	13.9
AAB 1318	Soil 4	13.9	AAB 1403	Tran. 1S	18.9
AAB 1320	Soil 5	16.1	AAB 0124	Tran. 2 stream	34.4
AAA 9033	Soil 7	15.5	AAB 0093	Tran. 2N	16.8
AAA 6016	Soil 8	14.3	AAB 0094	Tran. 2S	15.1
AAA 6014	Soil 9	16.6	AAB 0121	Tran. 3 stream	30.6
AAB 0090	Soil 10	9.3	AAB 6015	Tran. 3N	15.1
AAB 1316	Soil 11	19.2	AAB 0092	Tran. 3S	10.9
AAA 6012	Soil 12	21.9	AAB 0123	Tran. 4 stream	31.6
AAA 9034	Soil 13	9.6	AAB 0098	Tran. 4Na	15.1
AAB 0096	Soil 14	11.4	AAB 0099	Tran. 4Nb	13.0
AAB 0091	Soil 15	17.7	AAA 6006	Tran. 4S	25.6
AAA 6009	Soil 16	10.1	AAB 0122	Tran. 5 stream	24.8
AAB 0089	Soil 17	8.8	AAA 6013	Tran. 5N	19.0
AAA 6008	Soil 18	8.3	AAA 8577	Tran. 5S	17.7
AAA 9035	Soil 19	10.0			
AAA 9036	Soil 20	14.6			
AAA 8578	Soil 21	17.0			
AAA 6005	Soil 22	10.9

Figure 4.2.4.1 Desorption isotherm of strontium on surface soil #1 (AAB1328). Strontium desorption coefficient is calculated as 105.6 (in ml/g) for this sample.

Figure 4.2.4.2 Desorption isotherm of strontium on surface soil #2 (AAB1319). Strontium desorption coefficient is calculated as 61.4 (in ml/g) for this sample.

Figure 4.2.4.3 Desorption isotherm of strontium on surface soil #4 (AAB1318). Strontium desorption coefficient is calculated as 80.7 (in ml/g) for this sample.

Figure 4.2.4.4 Desorption isotherm of strontium on surface soil #5 (AAB1320). Strontium desorption coefficient is calculated as 66.9 (in ml/g) for this sample.

Figure 4.2.4.5 Desorption isotherm of strontium on surface soil #7 (AAA9033). Strontium desorption coefficient is calculated as 73.9 (in ml/g) for this sample.

Figure 4.2.4.6 Desorption isotherm of strontium on surface soil #8 (AAA6016). Strontium desorption coefficient is calculated as 70.6 (in ml/g) for this sample.

Figure 4.2.4.7 Desorption isotherm of strontium on surface soil #9 (AAB6014). Strontium desorption coefficient is calculated as 65.6 (in ml/g) for this sample.

Figure 4.2.4.8 Desorption isotherm of strontium on surface soil #10 (AAB0090). Strontium desorption coefficient is calculated as 142.4 (in ml/g) for this sample.

Figure 4.2.4.9 Desorption isotherm of strontium on surface soil #11 (AAB1316). Strontium desorption coefficient is calculated as 50.6 (in ml/g) for this sample.

Figure 4.2.4.10 Desorption isotherm of strontium on surface soil #12 (AAA6012). Strontium desorption coefficient is calculated as 44.7 (in ml/g) for this sample.

Figure 4.2.4.11 Desorption isotherm of strontium on surface soil #13 (AAA9034). Strontium desorption coefficient is calculated as 150.5 (in ml/g) for this sample.

Figure 4.2.4.12 Desorption isotherm of strontium on surface soil #14 (AAB0096). Strontium desorption coefficient is calculated as 101.3 (in ml/g) for this sample.

Figure 4.2.4.13 Desorption isotherm of strontium on surface soil #15 (AAB0091). Strontium desorption coefficient is calculated as 54.3 (in ml/g) for this sample.

Figure 4.2.4.14 Desorption isotherm of strontium on surface soil #16 (AAA6009). Strontium desorption coefficient is calculated as 134.5 (in ml/g) for this sample.

Figure 4.2.4.15 Desorption isotherm of strontium on surface soil #17 (AAB0089). Strontium desorption coefficient is calculated as 170.4 (in ml/g) for this sample.

Figure 4.2.4.16 Desorption isotherm of strontium on surface soil #18 (AAA6008). Strontium desorption coefficient is calculated as 169.5 (in ml/g) for this sample.

Figure 4.2.4.17 Desorption isotherm of strontium on surface soil #19 (AAA9035). Strontium desorption coefficient is calculated as 195.1 (in ml/g) for this sample.

Figure 4.2.4.18 Desorption isotherm of strontium on surface soil #20 (AAA9036). Strontium desorption coefficient is calculated as 70.8 (in ml/g) for this sample.

Figure 4.2.4.19 Desorption isotherm of strontium on surface soil #21 (AAA8578). Strontium desorption coefficient is calculated as 62.9 (in ml/g) for this sample.

Figure 4.2.4.20 Desorption isotherm of strontium on surface soil #22 (AAA6005). Strontium desorption coefficient is calculated as 135.2 (in ml/g) for this sample.

Figure 4.2.4.21 Desorption isotherm of strontium on transect 1 north sediment sample (AAB1402). Strontium desorption coefficient is calculated as 93.2 (in ml/g) for this sample.

Figure 4.2.4.22 Desorption isotherm of strontium on transact 1 south sediment sample (AAB1403). Strontium desorption coefficient is calculated as 56.4 (in ml/g) for this sample.

Figure 4.2.4.23 Desorption isotherm of strontium on transact 1 sediment sample (AAB0125). Strontium desorption coefficient is calculated as 23.3 (in ml/g) for this sample.

Figure 4.2.4.24 Desorption isotherm of strontium on transact 2 north sediment sample (AAB0093). Strontium desorption coefficient is calculated as 64.5 (in ml/g) for this sample.

Figure 4.2.4.25 Desorption isotherm of strontium on transect 2 south sediment sample (AAB0094). Strontium desorption coefficient is calculated as 68.9 (in ml/g) for this sample.

Figure 4.2.4.26 Desorption isotherm of strontium on transact 2 sediment sample (AAB0124). Strontium desorption coefficient is calculated as 25.0 (in ml/g) for this sample.

Figure 4.2.4.27 Desorption isotherm of strontium on transact 3 north sediment sample (AAB6015). Strontium desorption coefficient is calculated as 74.0 (in ml/g) for this sample.

Figure 4.2.4.28 Desorption isotherm of strontium on transact 3 south sediment sample (unidentified). Strontium desorption coefficient is calculated as 118.6 (in ml/g) for this sample.

Figure 4.2.4.29 Desorption isotherm of strontium on transact 3 sediment sample (AAB0121). Strontium desorption coefficient is calculated as 32.5 (in ml/g) for this sample.

Figure 4.2.4.30 Desorption isotherm of strontium on transact 4 north (A) sediment sample (AAB0098). Strontium desorption coefficient is calculated as 75.6 (in ml/g) for this sample.

Figure 4.2.4.31 Desorption isotherm of strontium on transact 4 north (B) sediment sample (AAB0099). Strontium desorption coefficient is calculated as 96.6 (in ml/g) for this sample.

Figure 4.2.4.32 Desorption isotherm of strontium on transact 4 south sediment sample (AAA6006). Strontium desorption coefficient is calculated as 30.0 (in ml/g) for this sample.

Figure 4.2.4.33 Desorption isotherm of strontium on transact 4 sediment sample (AAB0123). Strontium desorption coefficient is calculated as 28.3 (in ml/g) for this sample.

Figure 4.2.4.34 Desorption isotherm of strontium on transect 5 north sediment sample (AAA6013). Strontium desorption coefficient is calculated as 52.8 (in ml/g) for this sample.

Figure 4.2.4.35 Desorption isotherm of strontium on transact 5 south sediment sample (AAA8577). Strontium desorption coefficient is calculated as 57.7 (in ml/g) for this sample.

Figure 4.2.4.36 Desorption isotherm of strontium on transact 5 sediment sample (initially unidentified). Strontium desorption coefficient is calculated as 36.6 (in ml/g) for this sample.

5.0 Discussion

5.1 Relationship Between Cesium and Strontium Sorption

Figure 5.1.1 shows the relationship between cesium and strontium sorption onto surface and transact sediment soil samples. A fairly good correlation between the sorption of cesium and strontium was observed for transact sediment samples. However, poor correlation was found for surface soils. Results suggested that cesium and strontium may not sorb by the same sorption mechanism on these two sets of soil samples.

Figure 5.1.1. The relationship between sorption coefficients of cesium and strontium on TA-2 and TA-41 soil samples.

5.2 Relationship Between Sorption Kd and Percentage Desorption

The relationship between sorption coefficients and percentage desorption of presorbed metal ions for TA-2 and TA-41 soil samples are shown in Figures 5.2.1 and 5.2.2. An inverse correlation between the sorptivity and degree of desorption clearly appeared for both metals. From this data, it is concluded that when sorption is stronger, fewer presorbed metal ions are desorbed from both surface soil and transact sediment samples.

Figure. 5.2.1. Correlation between cesium sorption coefficients and percentage of desorption for transact sediment soils and surface soils that were collected from TA-2 and TA-41.

Figure. 5.2.2. Correlation between strontium sorption coefficients and percentage of strontium desorption for transact sediment soils and surface soils that were collected from TA-2 and TA-41.

5.3 Effect of Soil Organic Matter Content on Cesium and Strontium Sorption

The relationship between soil organic matter content and the sorption coefficient for cesium and strontium ions is presented in Figures 5.3.1 and 5.3.2. A strong correlation was found for the sorption of strontium onto both surface and transect sediment soils (Fig. 5.3.2). A fairly good effect of organic matter on the sorption of cesium was found only for transect sediment soils but not for surface soils (Fig. 5.3.1). Apparently, cesium sorption does not depend totally on organic content. Strontium sorption, however, is strongly dependent on soil organic matter.

Figure. 5.3.1. Correlation between cesium sorption coefficients and percentage of soil organic matter content for transect sediment soils and surface soils that were collected from TA-2 and TA-41.

Figure. 5.3.2. Correlation between strontium sorption coefficients and percentage of soil organic matter content for transact sediment soils and surface soils that were collected from TA-2 and TA-41.

5.4 Effect of Soil Water Content on Cesium and Strontium Sorption

There are two major factors that may affect the water content of the air-dried soil samples. One is the organic material content and the other factor is soil clay content. The relationship between soil organic content and soil water content is plotted in Figure 5.4.1. A better correlation between water content and organic content is found in transact sediment soils than that is in surface soils. Obviously, clay content is higher in surface soil than it is in transact sediment soils. Since cesium sorption was not strongly affected by soil organic content, a relatively good relationship between cesium sorption coefficient and water content (Fig. 5.4.2) suggests that clay content is significant for the cesium sorption. Soil clay materials, such as layer silicates, should affect the sorption of cesium ions through a cation exchange mechanism. Strontium sorption is affected by both organic and clay content. Thus, a strong relationship was found between strontium sorption and water content for both surface and transact sediment soils (Figure 5.4.3).

Figure 5.4.1 Correlation between soil organic content and soil water content for TA-2 and TA-41 soil samples.

Figure. 5.4.2. Correlation between cesium sorption coefficients and soil water content for transact sediment soils and surface soils that were collected from TA-2 and TA-41.

Figure. 5.4.3. Correlation between strontium sorption coefficients and soil water content for transact sediment soils and surface soils that were collected from TA-2 and TA-41.

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