TECHNICAL REPORT

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Diffusion in the matrix of granitic rock. Field test in the Stripa mine. Final report

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FIELD·TEST IN THE STRIPA MINE
FINAL REPORT

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SUMMARY

Three similar migration experiments in the matrix of granitic rock have been performed and are presented. The experiments have been carried out in "undisturbed" rock, that is rock under its natural stress environment. Since the experiments were performed at the 360 m level in the Stripa Mine (Stripa, Sweden), the rock was subjected to nearly the same conditions as the rock surrounding a nuclear waste repository as proposed in the Swedish concept (SKB) where the nuclear waste is to be stored in canisters at approximately 500 m depth in crystalline rock.

A mixture of three nonsorbing (conservative) tracers, Uranine, Cr–EDTA, and I^-, were injected into the granitic rock matrix for three different time periods: about 3 months, about 6 months, and about 3.5 years. The subsequent overcorings of the injection holes showed that the tracers had in some cases migrated at least about 400 mm (measuring limit) into the rock matrix for the experiment with the longest injection time. It could also be seen that there were large differences in migration distance into the rock matrix for samples taken fairly close to each other.

The results from all three experiments showed that all three tracers had migrated through the disturbed zone close to the injection hole, through the fissure coating material, and a distance into the "undisturbed" rock matrix.

These results therefore indicate that it is possible for dissolved compounds to migrate into the rock matrix. This migration into the rock matrix will permit the uptake of dissolved species in water flowing in fractures and will increase the area available for sorption of sorbing radionuclides significantly and therefore retard the radionuclides by order(s) of magnitude.

Diffusivities and hydraulic conductivities obtained in this in–situ experiment compare well with those obtained in laboratory experiments.

1. BACKGROUND

Our present concept of the micro structure of granite is illustrated in Figure 1.1 (Neretnieks, 1980).

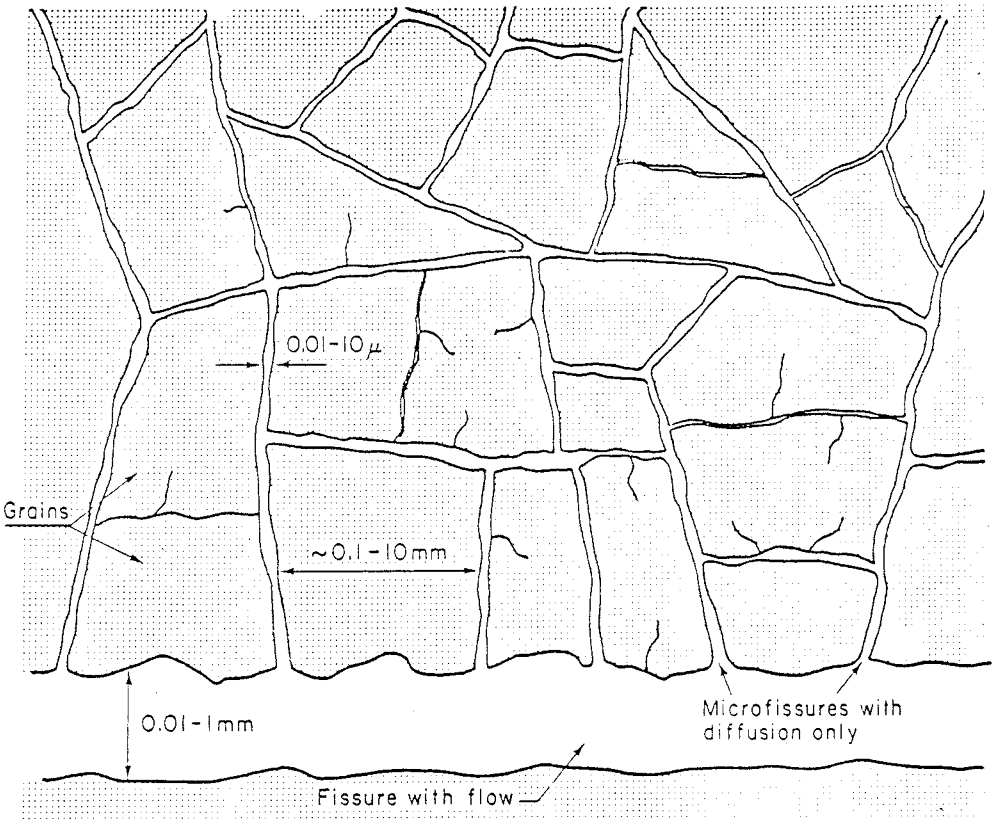


Figure 1.1. A two-dimensional view of the micro structure of granite showing "typical" sizes of grains, microfissures, and fissures.

The granite is intersected by a number of fissures in which water flows. In the rock matrix, a connected pore system (microfissure system) exists where molecules can move by diffusion. The fissures are sometimes coated with a thin layer of fissure coating material, which the molecules must diffuse through before they can penetrate the pore system within the rock matrix.

In the Swedish repository concept it is proposed that the nuclear waste is to be stored in canisters at approximately 500 m depth in crystalline rock. The canisters may eventually degrade in time and the radionuclides may then be transported away by the seeping water in the fissures. The radionuclides migrating with the seeping water may be considerably retarded if they diffuse into the rock and sorb on the surfaces of the microfissures in the rock matrix (Neretnieks, 1980).

The importance of matrix diffusion is illustrated in Figure 1.2 where projected breakthrough curves for some radionuclides in a decay chain at a long distance from the waste storage are shown for surface sorption and surface sorption + matrix diffusion (Rasmuson et al, 1982).

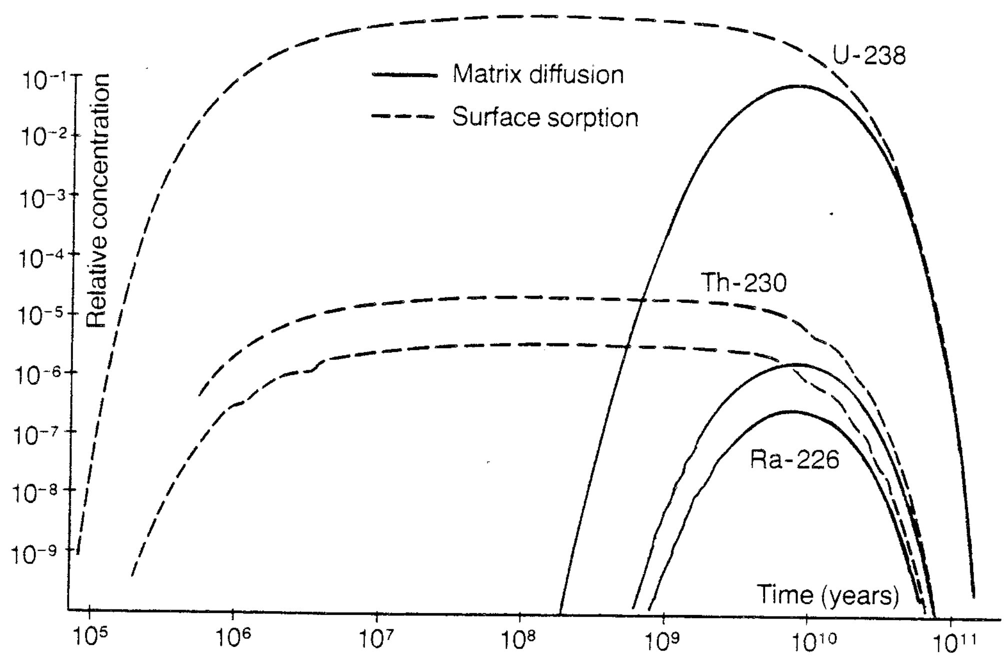


Figure 1.2. The influence of matrix diffusion. $D_p \epsilon_p = 10^{-12}$ m^2/s.

From Figure 1.2 and the discussion above it is obvious that diffusion into the rock matrix is a very important mechanism for radionuclide retardation. It is therefore important to ensure that this connected pore system exists under natural stress conditions and can be utilized for diffusion.

In a migration experiment performed in the Stripa Mine at the 360 m level, sorbing as well as nonsorbing tracers were injected into a natural fracture (Abelin et al, 1985). The subsequent excavation of the fracture plane and analysis of the rock matrix close to the fracture plane indicated that some of the sorbing tracers had migrated a short distance into the rock matrix.

Furthermore, a series of laboratory experiments have been performed with the purpose to determine diffusion coefficients for various tracers in granite and other crystalline rocks (Skagius, 1986; Bradbury et al, 1982). These laboratory experiments show that it is possible for sorbing as well as nonsorbing tracers to migrate in the rock matrix by diffusion, but these experiments were not carried out in "undisturbed" rock. It can not be ruled out that the reduction in the rock stresses which occur when samples are taken out have induced the microfissures. It is thus necessary to make in–situ experiments in rock in the natural stress environment before a first stress release, since a recompression will not necessarily close irreversibly induced microfissures.

The in–situ diffusion experiments were performed in the Stripa mine at the 360 m level. At this level, it will give nearly the same stress conditions as in the planned nuclear waste repository.

2. INFLUENCE OF THE STRESS FIELD AND EXPERIMENTAL DESIGN

2.1 Experimental considerations

Performing an in-situ experiment where the tracers are to be subjected to natural conditions requires some experimental considerations. In the Swedish repository concept it is presumed that the nuclear waste is to be stored in canisters at 500 m depth in the bedrock. Because of these conditions, the experiments need to be performed at a large depth under natural conditions. To obtain such a working environment, the experiments were performed at the 360 m level in the Stripa mine.

Even at large depths the rock stresses might be disturbed by excavations and boreholes and the experiments performed in this disturbed rock might not be representative for the adjacent undisturbed rock. The disturbance in the stress field is, however, limited to a close vicinity of the excavation and borehole and the undisturbed rock can be reached by using a proper drilling arrangement.

The main aim of this experiment was to investigate if diffusion into the porous rock matrix takes place under natural conditions. The most satisfactory way of doing this kind of experiment is to perform a migration experiment with only diffusion. This was however considered as almost impossible (see Chapter 2.3), so the performed experiments included advection as well as diffusion. However, if these experiments can show that it is possible for tracers to migrate within the connected pore system by advection and diffusion, then the pore system would also be available for only diffusion.

2.2 Influence of the stress field

Close to a drift or a borehole, the rock stresses will be changed compared to "undisturbed" rock. This change is dependent on the values and directions of the rock stresses, but as a general rule one can say that the rock stresses are changed approximately 2 hole diameters out from and below the hole, see Figure 2.1. At distances larger than the 2 hole diameters essentially "undisturbed" rock exists (Stephansson, 1981).

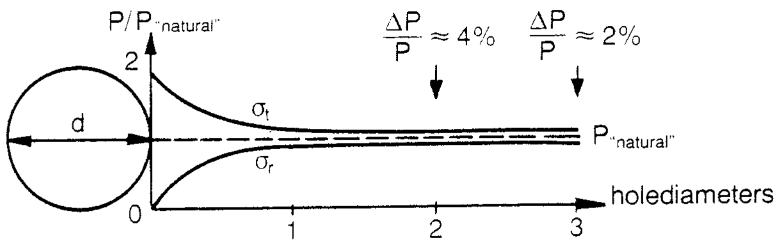


Figure 2.1. One example of the deviation from natural stress vs distance from a hole.

Since the objective with these experiments is to do migration experiments in "undisturbed" rock, the experiments had to take place more than 2 drift diameters away from the drift at the 360 m level. This ensured that the experiments were made in rock where the stresses were only marginally influenced by the drift.

The diameter of the drift where the experiments took place was approximately 5 m. Holes with a diameter of 146 mm were drilled downwards from the drift. The depths of the holes were between 11 and 18 m. At these distances from the drift, the changes in rock stresses due to the drift can be neglected and essentially "undisturbed" rock is reached. In one of the holes a rock stress measurement was performed at the depth of 15.5 – 17.5 m which confirmed that "undisturbed" rock was reached (see Appendix 1). Since these experiments took place in holes separated by just a few meters, it was assumed that "undisturbed" rock was reached also in the other experiments.

However, even if the changes due to the drift can be neglected, the existence of the 146 mm hole will cause a change in the rock stresses approximately 0.3 m (2 hole diameters) outward and below the bottom of the hole. To reduce the change in the rock stresses, a 20 mm hole (approximately 3 m long) was drilled in the bottom of the 146 mm hole. The 20 mm hole caused a change in the rock stresses approximately 40 mm outward. Outside this disturbed zone and about 0.3 m below the 146 mm hole essentially "undisturbed" rock was reached.

With the 146 mm packer positioned just above the little hole, see Figure 2.2, this hole will serve as injection hole in the experiments. The experimental layout was identical for the three experiments.

If tracers can migrate from the little injection hole, past the disturbed zone and into "undisturbed" rock, then these experiments will indicate the existence of a connected pore system in "undisturbed" rock.

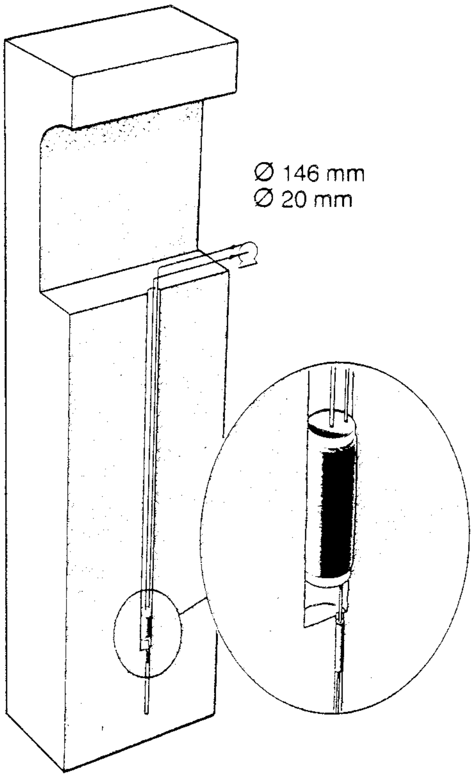


Figure 2.2 Drilling dimensions and packer positions.

2.3 Experimental alternatives : Diffusion / Diffusion + Advection

2.3.1 Pressure gradients

The most satisfactory way of doing this kind of experiment is to do a diffusion experiment without any overpressure in the injection hole. But considering the pressure measurements done by Lawrence Berkely Laboratories (Wilson, 1981) at the same level (360 m level) and only about 100 m away from the drift where these experiments have taken place, it was found that the pressure gradients for the water (tracer solution) in the injection hole and the pore water in the surrounding rock were different, see Appendix 2.

The pressure gradient in the water (tracer solution) in the injection hole is 1 m/m if the hole is drilled straight downward and < 1 m/m if the hole is drilled in any other direction. But according to the above mentioned pressure measurements, the pressure gradient in the rock should be between 3 and 4.5 m/m at reasonable distances (10−20 m) from the drift independent of direction from the drift. The differences in pressure gradients will give pressure differences between the injection hole and the rock, and since a pressure difference is the driving force for advection in a permeable medium, advection will occur simultaneously with diffusion unless the experiment is performed at an "infinite" distance from the drift. Figure 2.3 illustrates the pressure gradients for the injection hole and the surrounding rock.

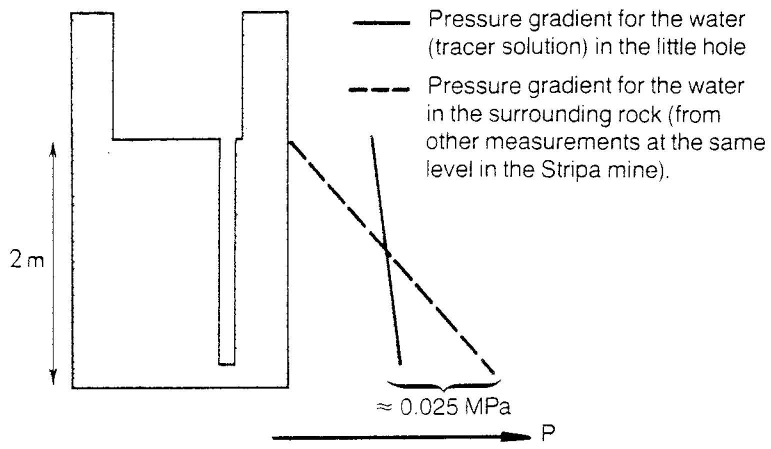


Figure 2.3. Pressure gradients for injection hole and surrounding rock.

If the pressure gradients looks like what is illustrated in Figure 2.3, it means that simultaneously with diffusion, advection will occur out from the injection hole in the top and into the injection hole in the bottom. Since there is no pressure difference in the central part of the injection hole, no advection will occur there.

The discussion above indicates that the diffusion profile from a "pure" diffusion experiment might be more or less displaced because of advection. Since diffusion and advection may be of the same order of magnitude, it may not be possible to separate the concentration profile due to diffusion from that due to advection.

2.3.2 Diffusion : Expected migration distances

The diffusion coefficients for Uranine, I^-, and Cr−EDTA have been determined in laboratory experiments (Skagius, 1986). The diffusivities, D_p, were found to be between $0.1 \cdot 10^{-13}$ – $5 \cdot 10^{-13}$ m^2/s in those experiments. The diffusivities are expected to be approximately a factor 2 lower in an in-situ experiment due to the existence of rock stresses and somewhat lower temperature. In the following discussion the diffusivity, D_p, is assumed to be $1*10^{-10}$ m^2/s.

The concentration for radial diffusion from a cylindrical source is only a function of radius r and time t. For a nonsorbing component the equation becomes:

$$\text{Diffusion equation :} \quad \frac{\partial c}{\partial t} = D_p \frac{1}{r} \frac{\partial}{\partial r} \left(r \frac{\partial c}{\partial r} \right) \qquad (1)$$

Solving this equation with the appropriate initial and boundary conditions gives concentration profiles as a function of r and t, see Figure 2.4.

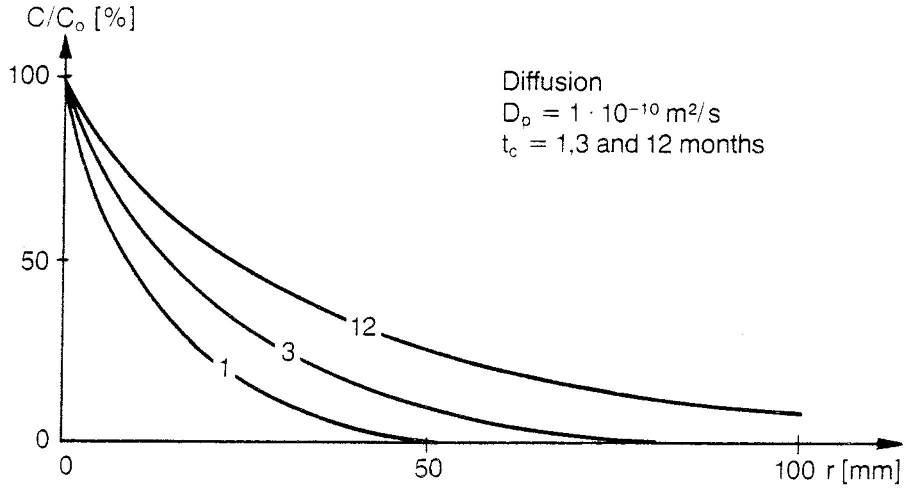


Figure 2.4. DIFFUSION. C/C_0 vs r for various migration times.

2.3.3 Advection : Expected migration distances

A pressure gradient will induce advection in a permeable medium. What significance this pressure gradient will have on the flowrate into the rock matrix is mainly determined by the hydraulic conductivity (K_p) of the rock matrix. At the time when this experiment started there had not been any work done in determining the hydraulic conductivity in the rock matrix for Stripa granite. But according to measurements in other granitic rocks (Brace, 1968: Heard, 1979; Freeze, 1979), the hydraulic conductivity in granitic rock is expected to be between 10^{-13} – 10^{-12} m/s.

The equation that predicts the radial flowrate (v_r) and the radial flow distance (r_f) for a nonsorbing component is :

Radial flow equation : $v_r = \frac{\text{const.}}{r_f}$ (2)

This equation can be solved to obtain the radius of a moving front at time t. Assuming that Darcy's law is valid, we obtain for stationary flow:

$$r_f = \sqrt{\frac{2*t*K_p*(P_1-P_2)}{\epsilon_p*\ln(r_2/r_1)} + r_1^2} \qquad (3)$$

The parameters and their expected values are:

K_p — hydraulic conductivity for the rock matrix , 10^{-12} – 10^{-13} m/s

P_1-P_2 — pressure difference between injection hole and surrounding rock

ϵ_p — porosity in the rock matrix , assumed to be 0.345 % (Müller–Vonmoos, 1981)

r_1 — radius of injection hole (0.01 m)

r_2 — distance for pressure difference (assumed to be 4 m => $\ln r_2/r_1 = 6$)

The radial flow distance can be calculated by Equation (3) with the expected values of the parameters. Figure 2.5 illustrates the flow distance for the largest pressure difference that would occur between a 2 m long injection hole and the surrounding rock if the experiment was carried out as a diffusion experiment.

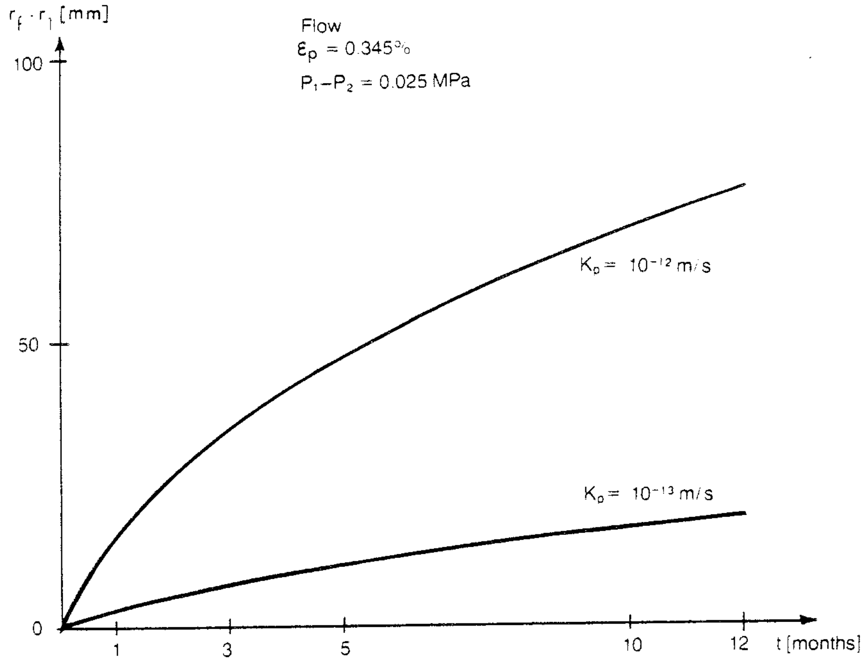


Figure 2.5. ADVECTION. Advective distance into the rock matrix vs time for different values on K_p. P_1-P_2 = 0.025 MPa.

In Figure 2.5 it is shown how far into the rock matrix the tracers will migrate as a function of time and K_p. It is difficult to predict the effect of dispersion when the flowrates are as low as those in Figure 2.5 , therefore, dispersion is not included.

2.3.4 Experimental considerations

Comparing Figures 2.4 and 2.5, it is obvious that if the experiment is carried out as a diffusion experiment then the radial flow distance due to the pressure difference is of the same order of magnitude as the expected diffusion distance, assuming a hydraulic conductivity $K_p \geq 10^{-13}$ m/s. Another effect that would disturb the concentration profile from a diffusion experiment is the dispersion connected with the radial advection. Furthermore, Figure 2.5 also shows how sensitive a diffusion experiment is for leakage. If there is some leakage in the system, then the injection pressure will be lower than the water pressure in the surrounding rock. That would lead to flow from the surrounding rock into the injection hole.

Because of the difficulties indicated above it was decided to carry out the experiment with an overpressure of approximately 1 MPa in Part I and approximately 0.5 MPa in Parts II and III. The chosen overpressures were large enough to eliminate the problem with the different pressure gradients and small enough to avoid influencing the micro structure of the rock (Stephansson, 1981).

The advective distances due to an overpressure of 1 MPa calculated with Equation (3) are illustrated in Figure 2.6.

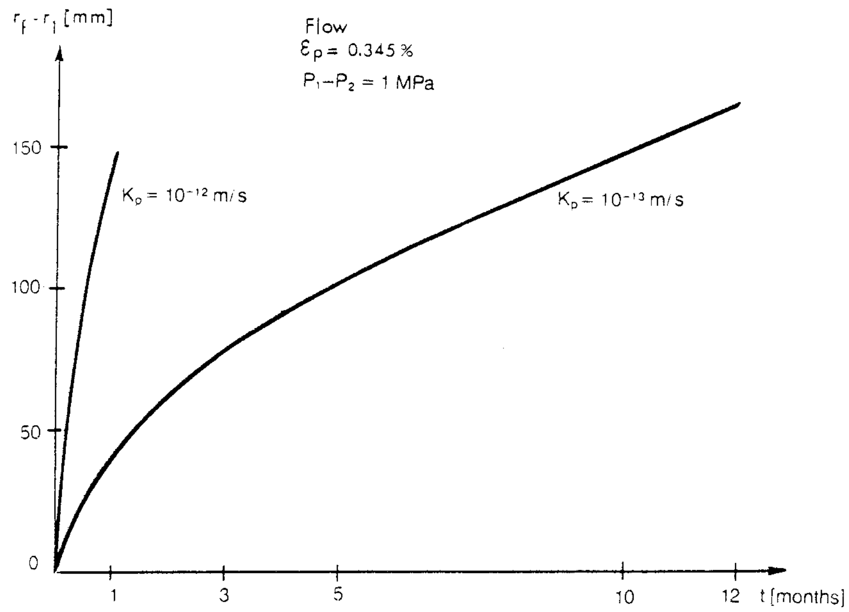


Figure 2.6. ADVECTION. Advective distance into the rock matrix vs time, for different values on K_p. $P_1 - P_2 = 1$ MPa.

Based on the calculations illustrated in Figure 2.6 it was decided to use an injection time of 3 months for Part I of the experiment.

2.3.5 Diffusion + advection : Expected migration distances

The equations that predict the migration distance when radial diffusion and advection occur simultaneously are:

Diffusion equation : $$\frac{\partial c}{\partial t} + v_r \frac{\partial c}{\partial r} = D_p \frac{1}{r} \frac{\partial}{\partial r} \left(r \frac{\partial c}{\partial r}\right) \qquad (4)$$

Radial advection equation : $$v_r = \frac{\text{const.}}{r} \qquad (2)$$

The initial and boundary conditions imply that there are no tracers in the rock at the start and a constant concentration in the injection hole all times thereafter.

To solve this advection – diffusion problem for radial symmetry, the numerical code TRUMP (Edwards, 1972) was used. The results for some calculations with different K_p and D_p are illustrated in Figure 2.7. The flow calculation is based on an overpressure of 0.9 MPa, which is the actual overpressure used in Part I of the experiment. The dispersion due to the advection is neglected in the calculations.

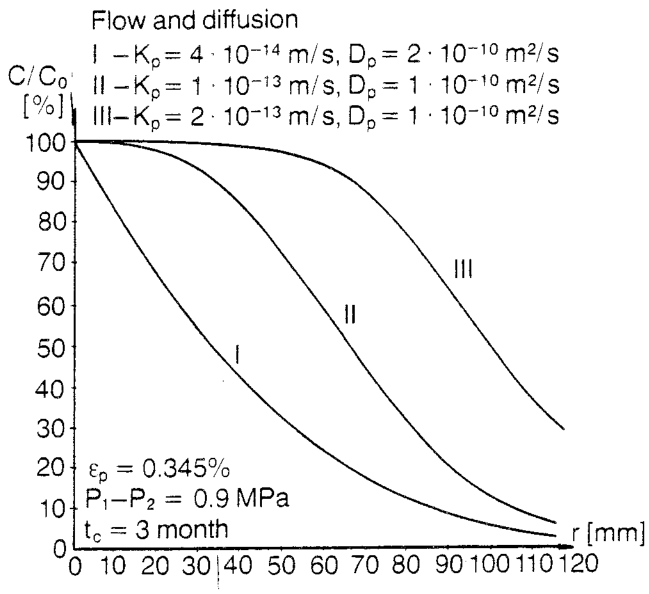


Figure 2.7. ADVECTION AND DIFFUSION. Concentration profiles in the rock matrix vs time for different values on K_p and D_p. $P_1 - P_2 = 0.9$ MPa.

It can be seen in Figure 2.7 that if the values of K_p and D_p are of the same order as expected, then the tracers would migrate beyond the disturbed zone (approximately 40 mm) and a distance into the rock matrix within an injection time of 3 months.

2.4 Experimental design

After drilling the holes (Ø 146 mm and Ø 20 mm), one small packer was installed in the little hole and one big packer was placed close to the bottom of the large hole, see Figure 2.2. Both packers were mechanically operated.

The small packer was used to get a nylon tube to the bottom of the small hole in order to get a good circulation of the tracers before starting the tracer injection. The large packer was used to close off the injection compartment from the rest of the hole. In this way the lower approximately 100 mm of the large hole and all of the small hole were used for the tracer injection.

After the installations of the packers, the water flowrate into the the injection compartment as well as the water pressure were monitored. However, no reliable values on the natural water pressure were found due to the very low water inflow rates.

According to other measurements in the Stripa mine at the same level and only about 100 m from the drift were these experiments have been performed the water pressures at the distances from the drift were the experiments took place is expected to be between 1.0 – 1.4 MPa (see Appendix 2).

A constant overpressure was used for the injection of the tracer solution. This overpressure ensured that the tracers would migrate by advection and diffusion out from the injection hole and into the pore system of the rock matrix. The overpressure was supplied by using compressed nitrogen.

2.5 Part I

Part I of the in–situ experiment was a preparatory experiment with a tracer injection time of about 3 months where the main purpose was to answer the following questions:

- Can holes be drilled in the way shown in Figure 2.2 ?
- Does the injection system work well ?
- Does the suggested sampling arrangement for tracers work ?
- Can the experiment give any indication about if there exists a connected pore system or not in the rock matrix, and if there seems to exist a connected pore system, can any rough values on the hydraulic conductivity and the diffusivity be obtained ?

2.6 Part II and Part III

Part II and Part III of the field experiment were started simultaneously. The aims were to obtain more evidence over longer times on the existence of matrix diffusion.

The method of drilling a 20 mm hole in the bottom of the 146 mm hole, injecting tracers in the small hole and later overcore the hole worked well. The packer system and injection system also worked well. The sampling arrangement for tracers, i.e.

overcoring, cutting, drilling sampling cores, leaching these sampling cores, and analysing the tracer content, also worked well.

Based on the results from Part I it was decided to use almost the same drilling arrangement, injection system, sampling arrangement, and tracers.

Parts I and II of this field experiment have been reported earlier (Birgersson and Neretnieks, 1982; 1983).

3. OVERCORING AND SAMPLING

The injection of tracers were terminated after 3 months (Part I), 6 months (Part II) and 3.5 years (Part III). The packers were retrieved and the little hole was overcored. The core from the overcoring had a diameter of 132 mm and length of approximately 3.5 m, see Figure 3.1. The core was cut into approximately 50 mm long cylinders.

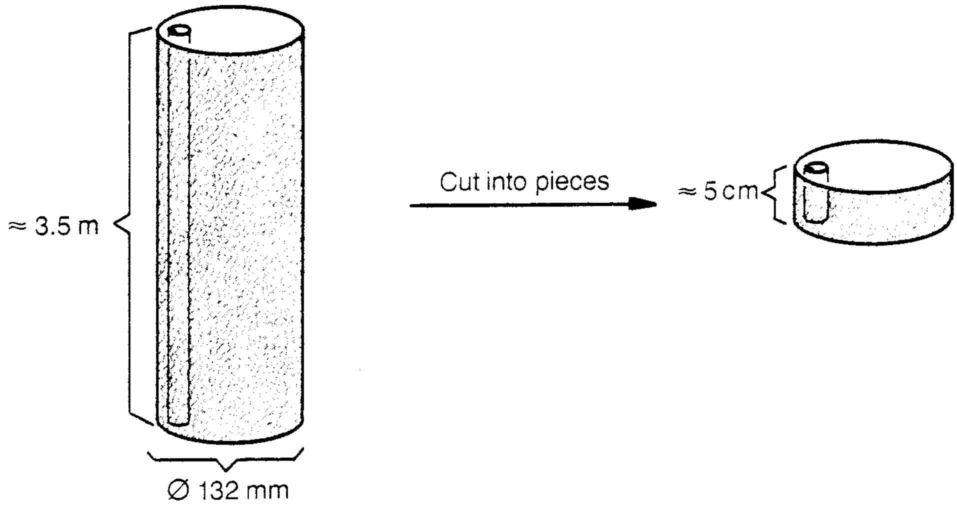


Figure 3.1. Sampling, step 1.

From these cylinders, a number of sampling cores (Ø 10 mm) were drilled at different distances from the injection hole, see Figure 3.2. The number of sampling cores obtained were about 200 in Part I, about 650 in Part II, and about 1800 in Part III. The sampling cores were leached in distilled water.

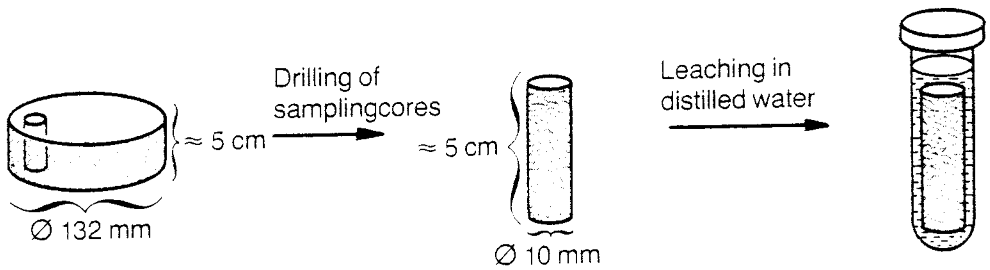


Figure 3.2. Sampling, step 2.

The tracer concentration in the distilled water was determined and recalculated for the concentration in the pore water. The recalculated concentrations in Parts II and III were based on the porosity that was obtained for every individual sampling core from the weight difference between a wet and dry core. In Part I, all concentrations were based on an assumed uniform porosity of 0.345 % (Müller–Vonmoos, 1981).

In Parts II and III of the experiment, additional holes were drilled adjacent to the injection hole. This was done in order to study the concentration profile further out than the approximately 110 mm that was obtained from the overcoring of the injection hole. For more information about the drilling arrangements in Parts II and III, see Chapter 5.

4. TRACERS AND ANALYTICAL METHODS

4.1 Tracers

The objective of this tracer experiment was to investigate the existence of a connected pore system in "undisturbed" rock. This was accomplish by injecting mixtures of nonsorbing tracers. Since nonsorbing tracers do not sorb on the surfaces in the micropores, the migration rate into the matrix is "high", which means penetration into "undisturbed" rock occurs in a "short" time.

The method of finding suitable nonsorbing tracers has been:

- Test on stability
- Test on sorption on the materials used in the equipment
- Test on sorption on crushed granite.

These tests showed that Cr−EDTA, Uranine, and I^- were stable and did not sorb on either the construction materials or crushed granite. Since a mixture of these tracers did not show any chemical reaction, it was decided to use them in the experiments (Birgersson and Neretnieks, 1982).

4.2 Analytical methods

The tracers were analysed using three different methods. This analyzing procedure will decrease the risk in obtaining a systematic error due to the analysis equipment.

Table 4.1. Tracers used

Tracer	Molecular weight	Analytical method	Injection concentration
Cr–EDTA	344	Atomic absorption	5 000 – 10 000 ppm
Uranine (Na–fluorescein)	376	UV–VIS spectrophotometer	20 000 – 80 000 ppm
I^-	127	Ion selective electrode	100 000 – 150 000 ppm

After the leaching in distilled water, the Cr–EDTA concentration could be analysed directly in the leached water. Since the absorbance for Uranine is very pH–dependent in the region pH 4–8, the pH was increased to pH 8.5 – 9.5 by addition of a solid buffer (a mixture of H_3BO_3, KCl, and NaOH) before Uranine was analysed. Before the I^- concentration could be analysed, the ionic strength had to be increased by addition of a small amount 5 M $NaNO_3$

The analysis sequence was as follows:

$$\text{Cr-EDTA} \xrightarrow{\text{Solid buffer}} \text{Uranine} \xrightarrow{\text{5M } NaNO_3} I^-$$

The addition of the solid buffer did not influence the I^- measurements.

As can be seen in Table 4.1 above, the injection concentrations of the tracers were high. This was because the tracer concentrations were diluted 500 – 1000 times from leaching the sampling cores. The concentrations were chosen in such a way that the dynamic range of the tracer concentrations in the distilled water should be approximately 4 orders of magnitude so it would be possible to detect the tracers down to a relative concentration C/C_0 of 0.01. The accuracy was about ± 10 % for all tracers at the lowest concentration.

5. CORE DESCRIPTIONS

5.1 Part I

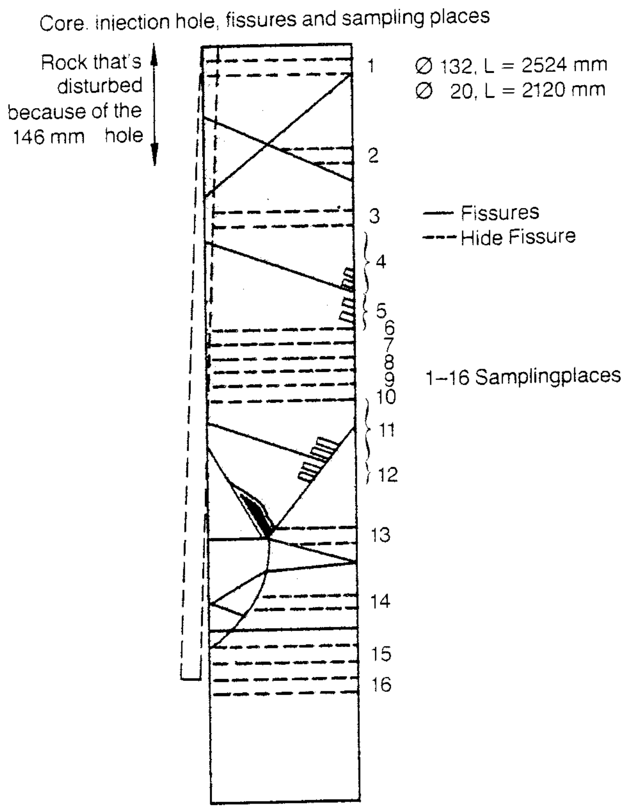


Figure 5.1. Core description, Part I.

The injection of tracers continued for approximately 3 months in Part I of the field experiment. Because of this "short" injection time only the injection hole was overcored, i.e. no additional holes were drilled. This drilling arrangement made it possible to study the concentration profile approximately 110 mm outward from the injection hole, i.e. considerably further out than the 40 mm (2 hole diameters) that have a changed stress field compared to "undisturbed" rock.

The core from the overcoring of the injection hole was intersected by a number of fissures. The water inflow rate into the injection compartment was approximately 7 ml/h which means that at least one of the fissures must have been water bearing. Therefore, a number of samples were taken close to the fissures in order to see if there was any indication of tracers having migrated first into the fissure by water flow and then through the fissure coating material and into the rock matrix by diffusion.

Comments on the sampling pieces:

3, 6–10, 15, and 16	–	Investigation of the concentration profile in the rock matrix.
4, 5, 11, and 12	–	Samples taken far from the injection hole and close to a fissure. Could indicate diffusion through the fissure coating material.
13 and 14	–	Samples taken behind a fissure. If tracers are found here they must have passed through the fissure coating material.

Since a lot of fissures intersected the core and that the length of the injection hole was just 2 m, only a few samples were obtained where the migration into the "undisturbed" rock could be studied.

5.2 Part II

The injection of tracers continued for about 6 months in this experiment. Because of this "long" injection time and the results from Part I regarding obtained values on D_p and K_p it was decided to drill another Ø 146 mm hole, see Figure 5.2.

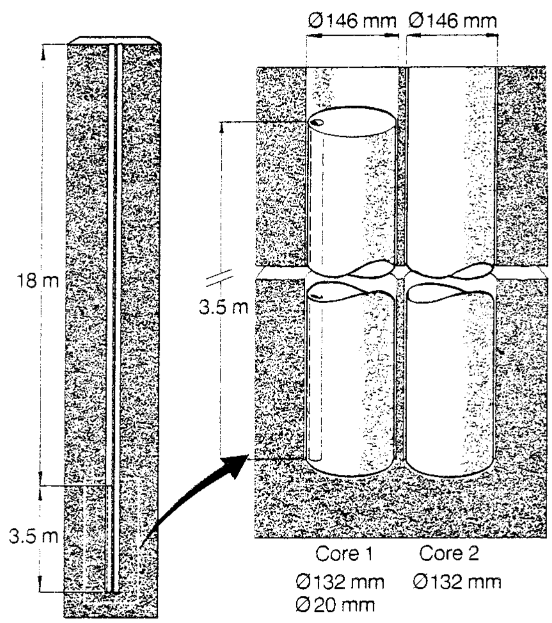


Figure 5.2. Drilling arrangement, Part II.

The description of the cores are given in Figure 5.3.

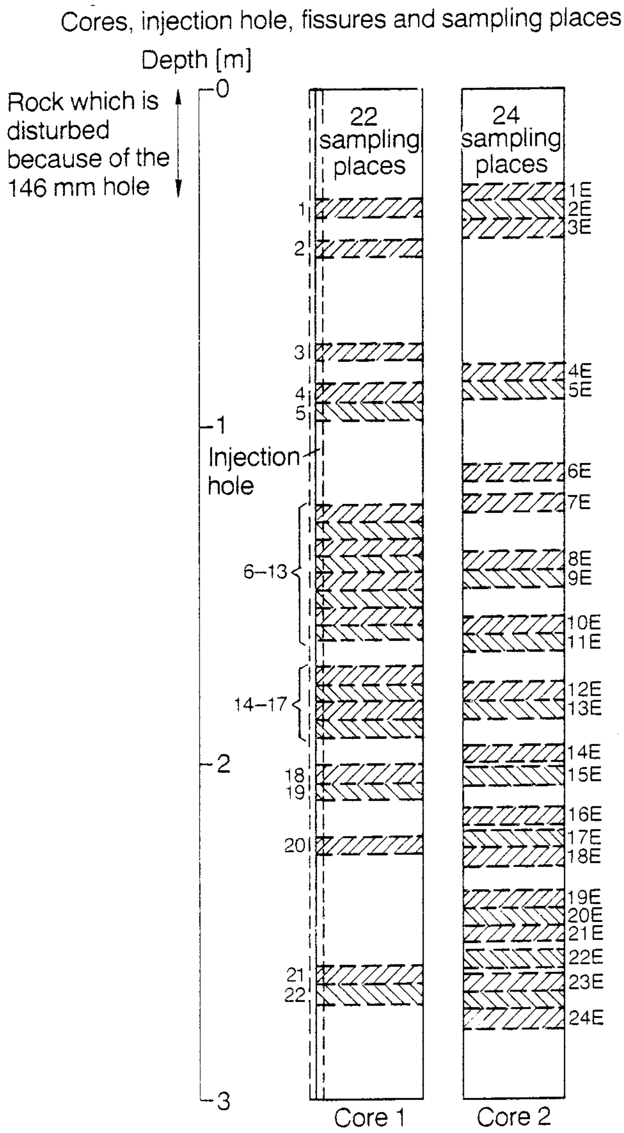


Figure 5.3. Core description, Part II.

The length of the injection hole was 3 m in Part II. This made it possible to study the differences in penetration depth into the rock matrix in many sampling pieces located at different depths.

Samples were taken at 22 different levels from core 1. This made it possible to study the variation in migration distance into the rock matrix versus depth in core. Because of core 2, the concentration profile could in some cases be followed approximately 250 mm outward from the injection hole at approximately the same depth. Chapter 7 contains information on the concentration profiles.

5.3 Part III

The injection of tracers continued for about 3.5 years in Part III. This long injection time and the results from Parts I and II led to 5 additional holes being drilled, see Figure 5.4.

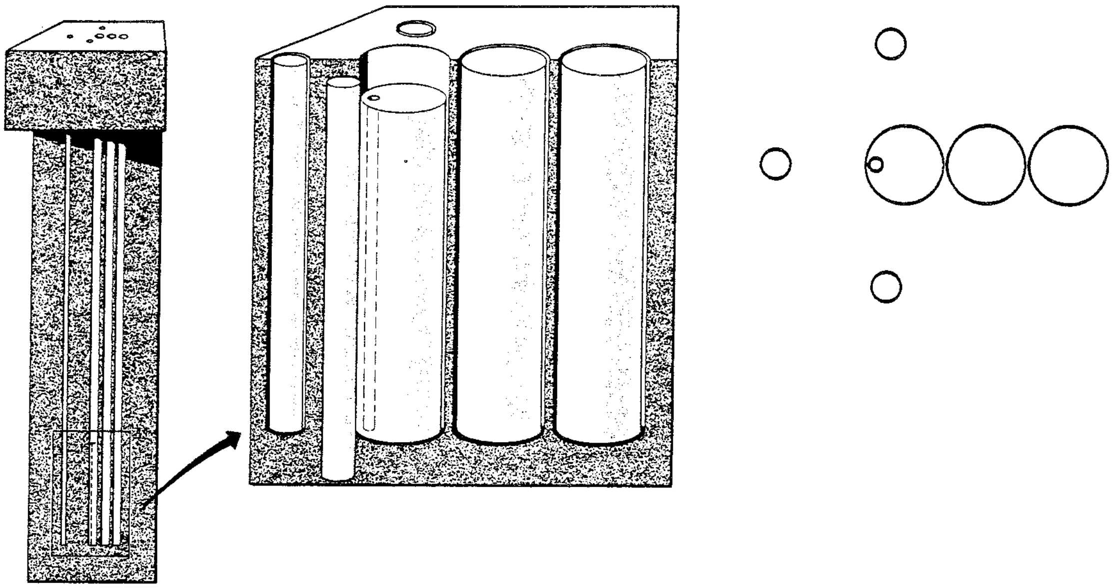


Figure 5.4. Drilling arrangement, Part III.

This drilling arrangement made it possible to study the concentration profile approximately 400 mm outward from the injection hole in one direction. In order to study the concentration profiles in other directions, three smaller (Ø 76 mm) holes were drilled approximately 250 mm from the injection hole. Only minor parts of the cores were crushed during the drilling and samples could be taken from the major parts of the cores. Examples of concentration profiles are found in Chapter 8.

6. RESULTS, PART I

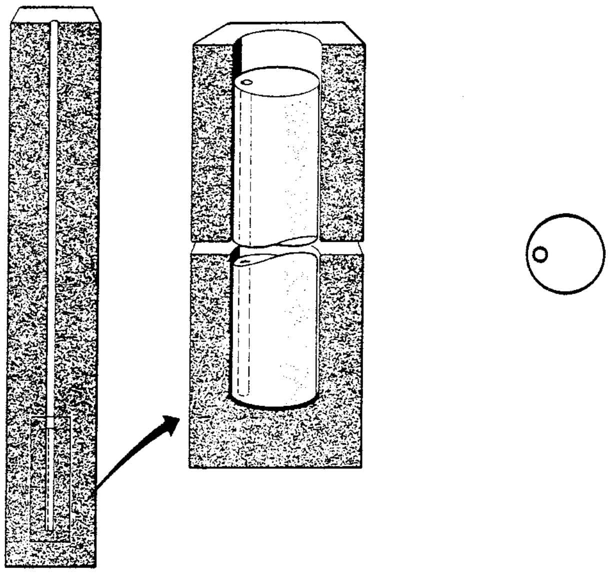


Figure 6.1. Drilling arrangement, Part I.

6.1 Concentration profiles

The concentration profiles in the pieces where migration had taken place in the rock matrix, i.e. "far" from any fissures, all showed the same results. All the tracers had passed the disturbed zone (approximately 40 mm) and had migrated a distance into "undisturbed" rock.

As an example, the concentration profile for the sample taken approximately 1.2 m below the bottom of the 146 mm hole and a theoretical curve is shown in Figure 6.2. Note that all experimental points in Part I are calculated with a uniform porosity of 0.345 % in the rock matrix (see Chapter 2.3.3).

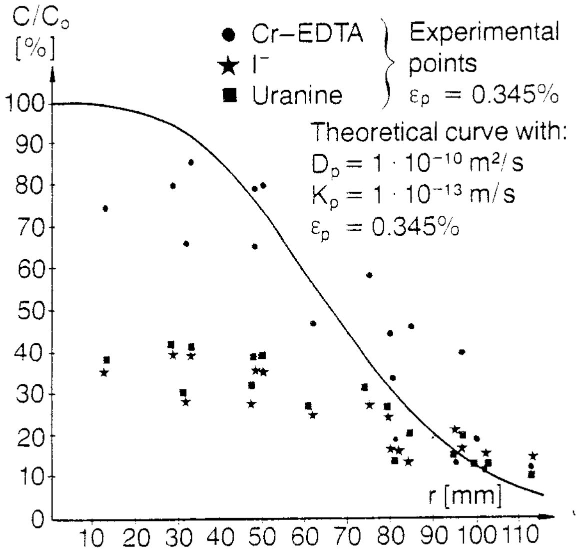


Figure 6.2. PART I. Tracer concentration vs distance from injection hole.

The tracer concentrations for the individual sampling cores are presented in Appendix 3.

6.1.1 Influence of fissures

The granite is intersected by a number of fissures where water flows. Figure 6.2 indicates that tracers can migrate by advection and diffusion within the pore system in the rock matrix. If this pore system should be available for tracers (and radionuclides), then the sometimes present thin layer of fissure coating material between the fissure and the rock matrix must be possible to pass through.

The water inflow rate into the injection hole was approximately 7 ml/h in Part I. Therefore, at least one of the fissures intersecting the injection hole must have been water bearing. The investigation of points No. 4, 5, 11, and 12 in Figure 5.1 could have indicated migration through the fissure coating material if the concentrations of tracers had been increased close to the fissure compared with sampling points a little way out. Unfortunately there was not enough data to show this.

From the two pieces taken behind a fissure the samples from piece No. 13 showed no or very low concentrations ($C/C_0 < 2$ % for all tracers). Samples from piece No. 14, however, showed that tracers had migrated into a piece surrounded by fractures, see Figure 6.3. The distance from the injection hole to the fissure coating material was approximately 70 mm, i.e. the fissure was located in "undisturbed" rock. There were three ways for tracers to reach piece No. 14, see Figure 6.4.

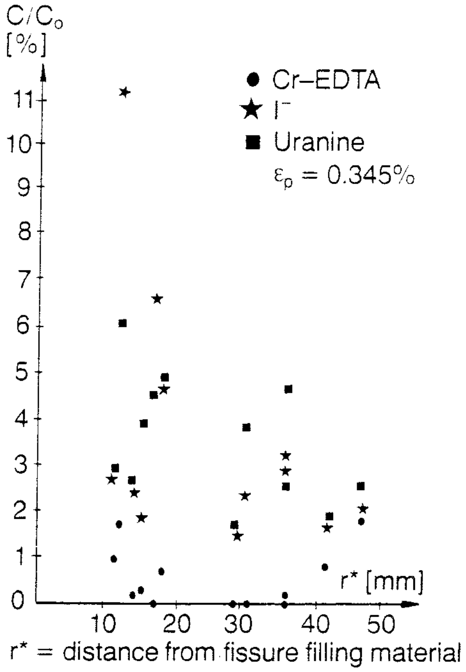


Figure 6.3. Part I. Tracer concentration vs distance from fissure coating material for piece No. 14.

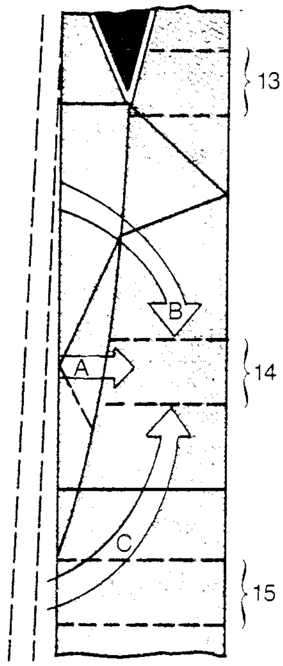


Figure 6.4. Part I. Possible migration path ways to piece No. 14.

A and B — Migration through the rock matrix (and/or in the fissure) and through the fissure coating material.

C — Migration outside the fissure. But this alternative can be excluded since no (or very little) tracers were found in piece No. 15. That is probably because the bottom of the injection hole was filled with granite particles that remained from the drilling.

The discussion above shows that the existence of tracers in piece No. 14 indicates migration through fissure coating material located in a natural stress environment.

It can be seen from Figure 6.3 that the relative concentration (C/C_0) behind the fissure is low compared to the relative concentration at the same distance for migration in the rock matrix as shown in Figure 6.2. This could, however, be explained by a number of factors, for example:

- The tracers migrated through the rock matrix and to the fissure where dilution occurred due to the natural water content within the fissure.

- The tracers reached the fissures and were then transported away by the water flow.

- The fissure is connected to a fissure system that is under lower pressure. Then the whole (or at least the major) pressure drop occurs between the injection hole and the fissure. In this case the tracers would migrate from the injection hole to the fissure by advection and diffusion, and into the rock matrix of piece No. 14 by just diffusion.

- The fissure coating material decreases the migration rate.

Although the tracer concentration was relatively low in piece No. 14, which can be explained by either one or a combination of the factors above, the fact remains that tracers were found in the rock matrix behind fissure coating material in its natural stress environment.

6.2 Conclusions

All three tracers passed the disturbed zone and migrated a distance into the "undisturbed" rock matrix. At least one of the concentration profiles (Cr−EDTA) can be explained by simple advection − diffusion migration without chemical interaction. Also the tracers migrated through fissure coating material located in the "undisturbed" rock.

The concentration profile for Cr−EDTA seemed to differ from those for Uranine and I^- in such a way that Cr−EDTA reached concentrations close to $C/C_0=1$ near the injection hole. Some fraction of the tracer content within the sampling core could have leached out during the cutting of the core into slices and the subsequent drilling of sampling cores. Therefore, the differences between the concentration profiles for Cr−EDTA and for Uranine and I^- can be explained if Cr−EDTA is slightly sorbing. If this is the case, then Cr−EDTA would have an increased concentration close to the injection hole and would not be affected by the leaching in the same way as Uranine and I^-. One explanation to the with distance from the injection hole decreasing concentrations and the low concentrations of Uranine and I^- even closer to the injection hole might be that just a part of the measured porosity is available for the tracers, i.e. a lot of dead end pores within the rock matrix. If that is the case then only a minor part of the area within the pore system in the rock matrix would be available for sorption of radionuclides. This will be discussed further in Chapters 7 and 8.

6.3 Decisions based on the results

The decisions that were based on the experiences from Part I regarding the equipment are described in Chapter 2.6. Since the core from Part I was intersected with a great number of fissures, the migration into the rock matrix could be followed through the whole sampling piece at only 6 different locations. The concentration profiles in these 6 sampling pieces showed almost the same result, i.e. the difference in depth ($\leqslant$ 0.5 m) did not seem to affect the shape of the concentration profile. In order to study the concentration profiles over a longer distance, it was decided to increase the length of the injection hole from 2 m in Part I to 3 m in Parts II and III.

Furthermore, all three tracers seemed to have migrated further out into the rock matrix than the approximately 110 mm that could be followed in the core from the overcoring. Due to that it was decided to use a lower overpressure when injecting the tracers in Parts II and III and to drill out some additional cores in order to study the concentration profile further out than the approximately 110 mm that is possible if one only overcores the injection hole.

7. RESULTS, PART II

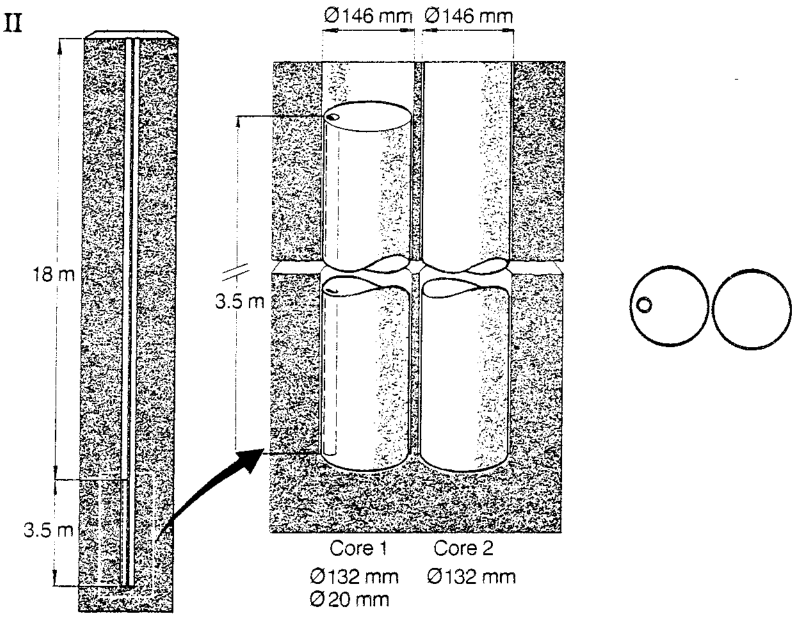


Figure 7.1. Drilling arrangement, Part II.

7.1 Concentration profiles

The length of the injection hole was 3 m in Part II and just a few parts of the core was intersected by fissures or crushed during the drilling. Therefore it was possible to study the concentration profiles into the rock matrix at several locations separated in distance from the bottom of the large (Ø 146 mm) hole.

No observations of migration through the fissure coating material could be done in this experiment for the following reasons: (1) The water inflow rate into the injection hole was below the detection limit (< 0.1 ml/h), which implies that the fissures intersecting the injection hole do not carry water in measurable rates; (2) no fissure was located as nicely as the fissure in Part I described in Chapter 6.1.1.

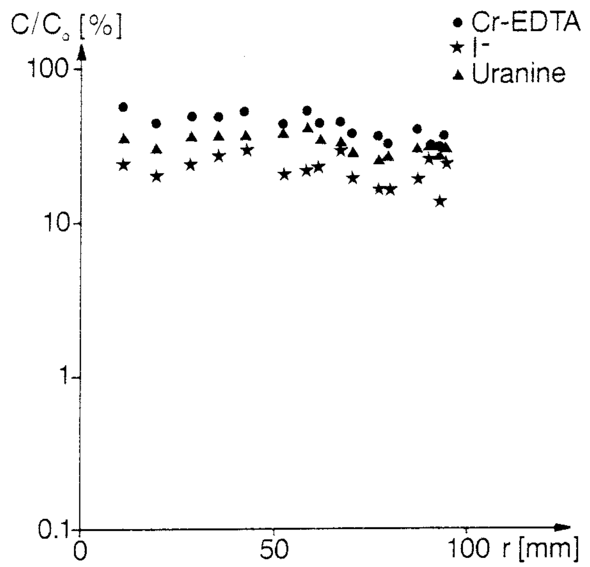
All tracer concentrations in Part II are based on the porosity obtained from the weight difference between wet and dry sampling core. The porosities and tracer concentrations for the individual sampling cores are presented in Appendix 4.

7.1.1 Concentration profiles in core 1

Compared to Part I, the results in Part II showed a considerable variation in migration distance with depth in the core. The penetration depth could in some cases vary by a factor 3 or more in sampling pieces that were separated by just a few tens of centimeters in depth.

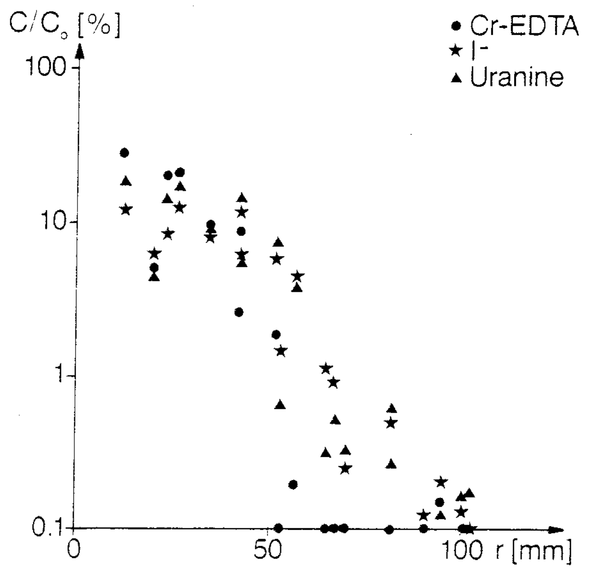
The prevailing trend is that all three tracers have migrated a long distance into the rock matrix at the top and the bottom of the injection hole, while the migration distance is rather short in the middle section of the hole.

The variation in migration distance with depth in the core located closest to the injection hole (core 1) is illustrated in the Figures 7.2–7.7.



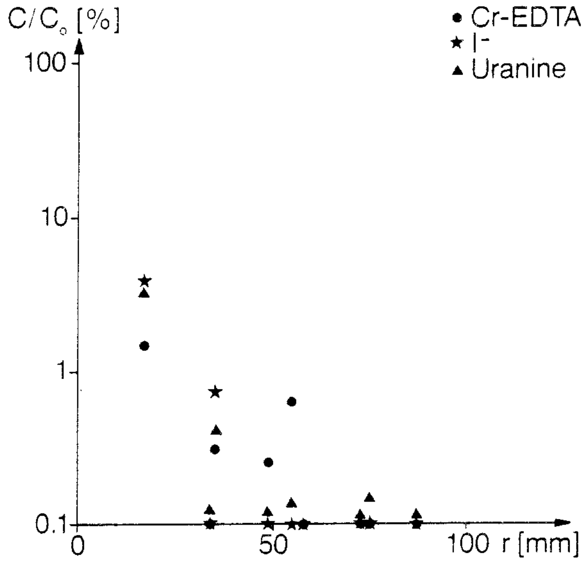
There is almost no decline in tracer concentration with distance in this sampling piece for at least the first 100 mm that could be studied from core 1. Sampling piece 1 at depth 0.36 m has the same tendency.

Figure 7.2. Part II. Tracer concentration vs distance from injection hole for sampling piece 2, depth 0.48 m.



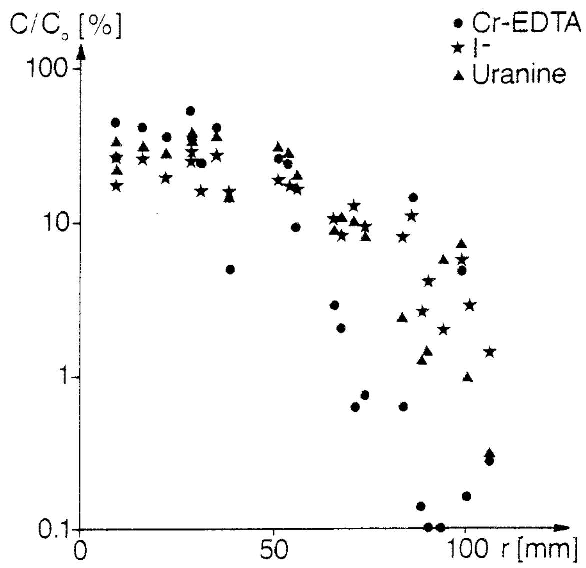
The concentration profiles for sampling pieces 3 to 9 were quite similar. It can be seen that the concentration decreases rapidly between 40 and 70 mm outward from the injection hole and that the penetration depth (i.e. concentrations above the detection limit) is at least 80 mm.

Figure 7.3. Part II. Tracer concentration vs distance from injection hole for sampling piece 6, depth 1.27 m.



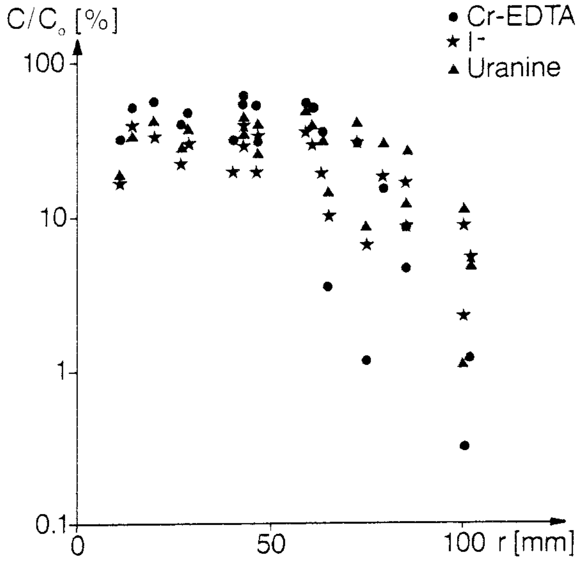
Sampling pieces 10 to 13 (depth 1.46 – 1.59 m) showed the shortest penetration depths. The concentration in these sampling pieces was low even close to the injection hole and the penetration depth was just about 50 mm.

Figure 7.4. Part II. Tracer concentration vs distance from injection hole for sampling piece 12, depth 1.55 m.



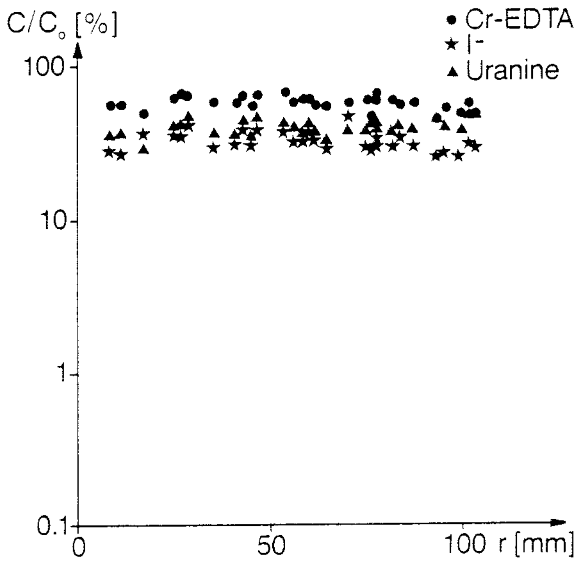
In sampling pieces 14–19 (depth 1.74 – 2.08 m) somewhat higher concentrations were found. Uranine and I^- migrated at least 110 mm, while the Cr–EDTA concentration became very low approximately 90 mm from the injection hole.

Figure 7.5. Part II. Tracer concentration vs distance from injection hole for sampling piece 19, depth 2.08 m.



In sampling piece 20 the concentration had increased a little further. For Uranine and I^- the concentration tends to decrease at approximately 90 mm from the injection hole, while the decrease occurs approximately 20 mm earlier for Cr–EDTA.

Figure 7.6. Part II. Tracer concentration vs distance from injection hole for sampling piece 20, depth 2.24 m.



For sampling pieces 21 and 22 (depth 2.62 – 2.67 m) none of the three tracers showed any decrease in concentration for at least the 110 mm that could be followed from core 1.

Figure 7.7. Part II. Tracer concentration vs distance from injection hole for sampling piece 21, depth 2.62 m.

From looking at the figures above, it is obvious that the migration distance into the rock matrix varies considerably between samples taken at different depths in the core.

The same concentration differences between the tracers are seen in Part II as in Part I. In the cases of a high tracer concentration it seems that Cr–EDTA has an increased concentration compared to Uranine and I^-, while these tracers have migrated further out into the rock matrix when the concentration is low.

7.1.2 Concentration profiles in core 2

The distance between the injection hole and the sampling cores from core 2 was between 150 and 250 mm.

Tracers were found in 8 of the 24 sampling pieces from core 2. These 8 sampling pieces were 1E–3E (depth 0.31 – 0.42 m) and 19E–23E (depth 2.41 – 2.64 m), see Figure 5.3. The fact that tracers were found just in the top and the bottom of core 2 agrees with the results from core 1 presented in the previous chapter.

Since some of the sampling pieces from cores 1 and 2 were located at approximately the same depth, it was in some cases possible to study the concentration profile at the same depth all the way from the injection hole and approximately 250 mm outward.

The Figures 7.8–7.11 show some examples from different depths in the cores where the concentrations could be followed in the two cores.

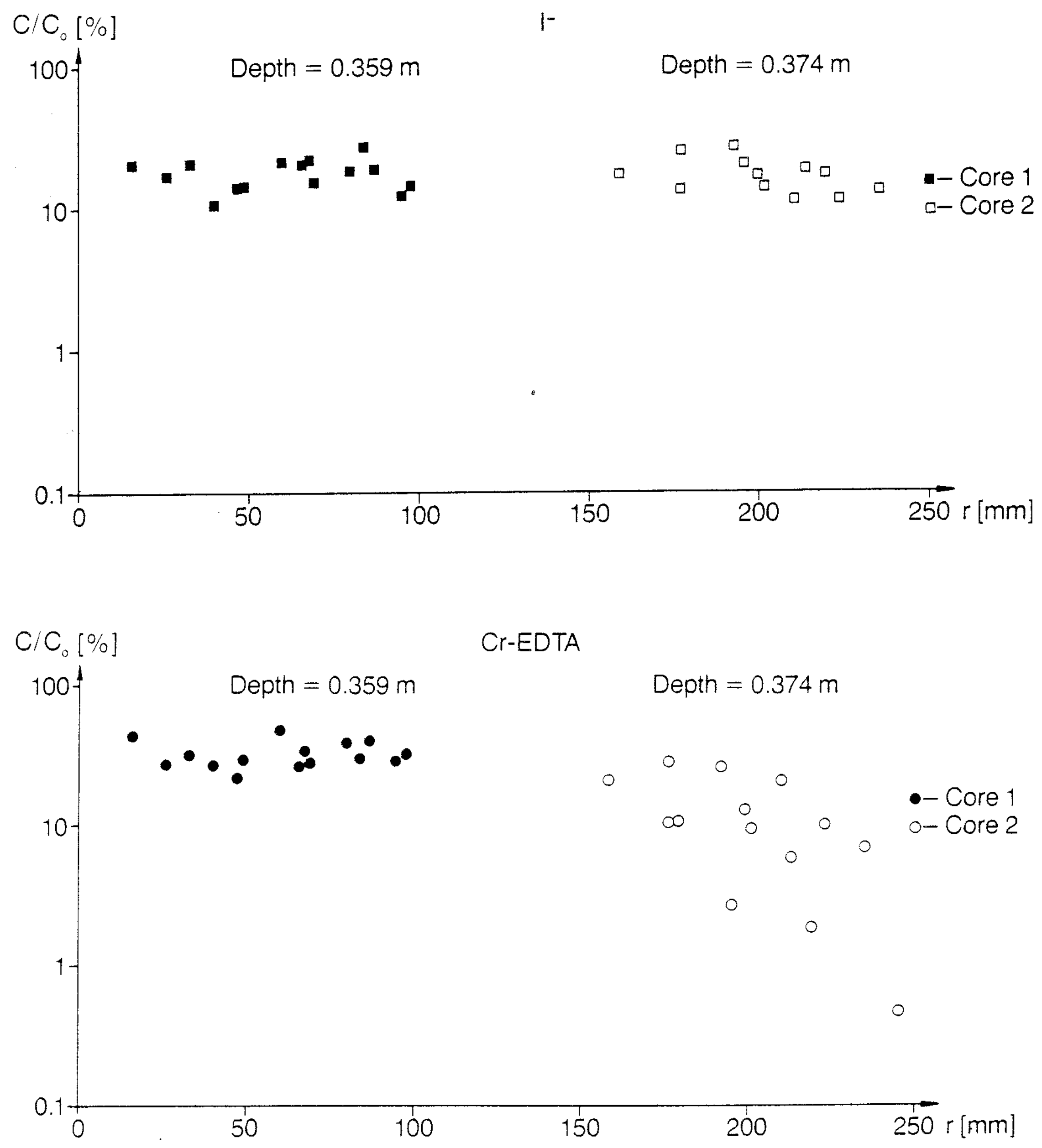


Figure 7.8. Part II. Tracer concentration vs distance from injection hole for sampling pieces 1 and 2E.
Difference in depth is 15 mm.

Figure 7.8 indicates that the I^- concentration does not decrease with distance from the injection hole for at least 250 mm. However, the Cr–EDTA concentration shows a significant decrease 200–250 mm from the injection hole.

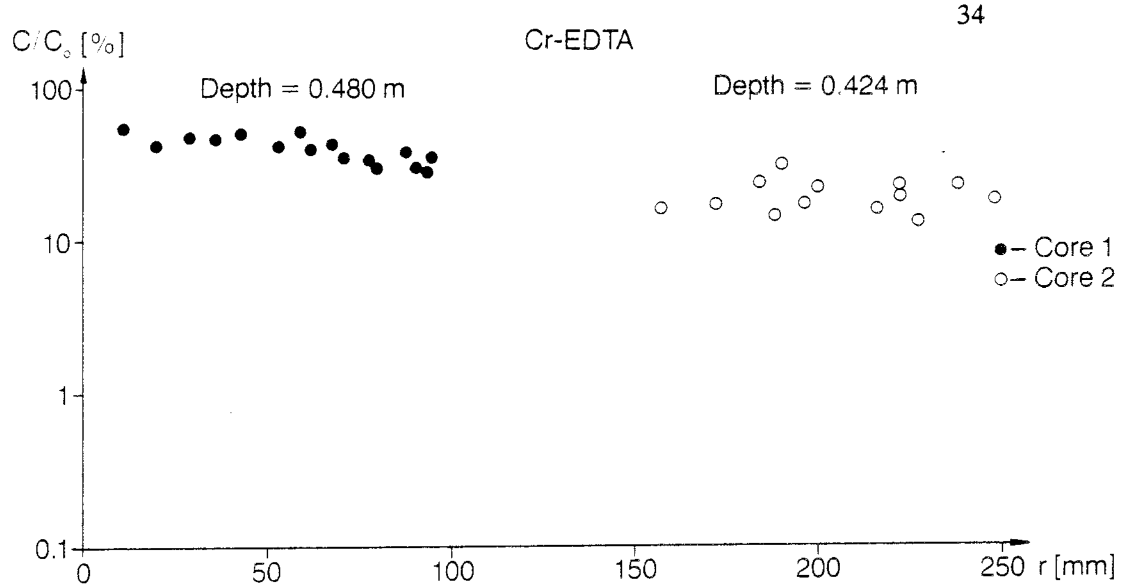


Figure 7.9. Part II. Cr–EDTA concentration vs distance from injection hole for sampling pieces 2 and 3E. Difference in depth is 56 mm.

Figure 7.9 illustrates the depth in core 2 where the highest Cr–EDTA concentrations were found. There is no significant decrease in concentration for Cr–EDTA (or the other traces) for at least 250 mm.

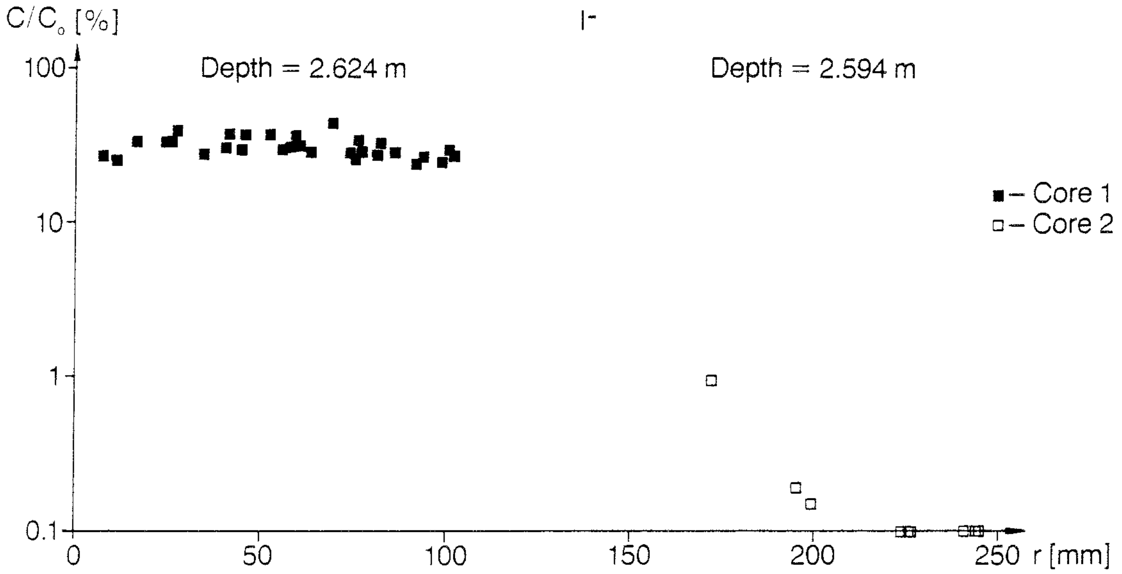


Figure 7.10. Part II. I^- concentration vs distance from injection hole for sampling pieces 21 and 22E. Difference in depth is 30 mm.

Figure 7.10 shows that neither Cr–EDTA nor Uranine were found in sampling piece 22E, but that I^- had penetrated this sampling piece. It can also be seen that there is a drastic decrease in concentration between core 1 and core 2, i.e. between 110–170 mm outward from the injection hole.

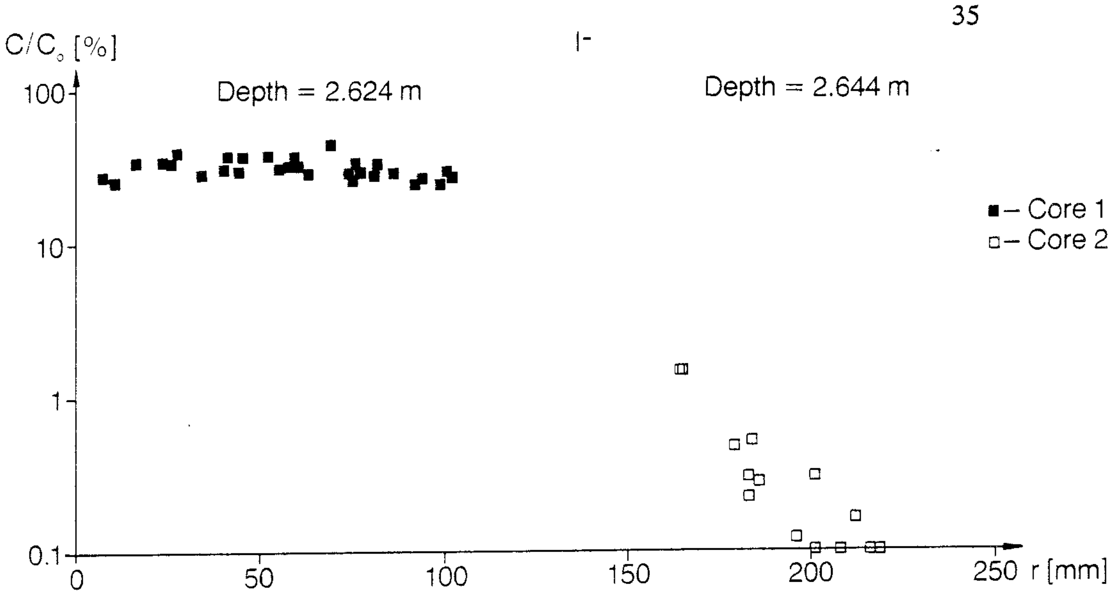


Figure 7.11. Part II. I^- concentration vs distance from injection hole for sampling piece 21 and 23E.
Difference in depth is 20 mm.

The results from sampling pieces 22E and 23E (Figures 7.10 and 7.11) both show that only I^- had penetrated core 2 at these depths and that the I^- concentration decreased rapidly between core 1 and core 2.

The concentration profiles for sampling pieces 19E–21E (depth 2.41 – 2.51 m) could not be followed all the way from the injection hole since core 1 was crushed at the corresponding depth. Howevèr, sampling pieces 19E–21E showed high concentrations of all three tracers.

7.1.3 Penetration depth for a fixed concentration

The difference in migration distance with depth can be illustrated very clearly by the penetration depth for a fixed concentration plotted versus the depth in core.

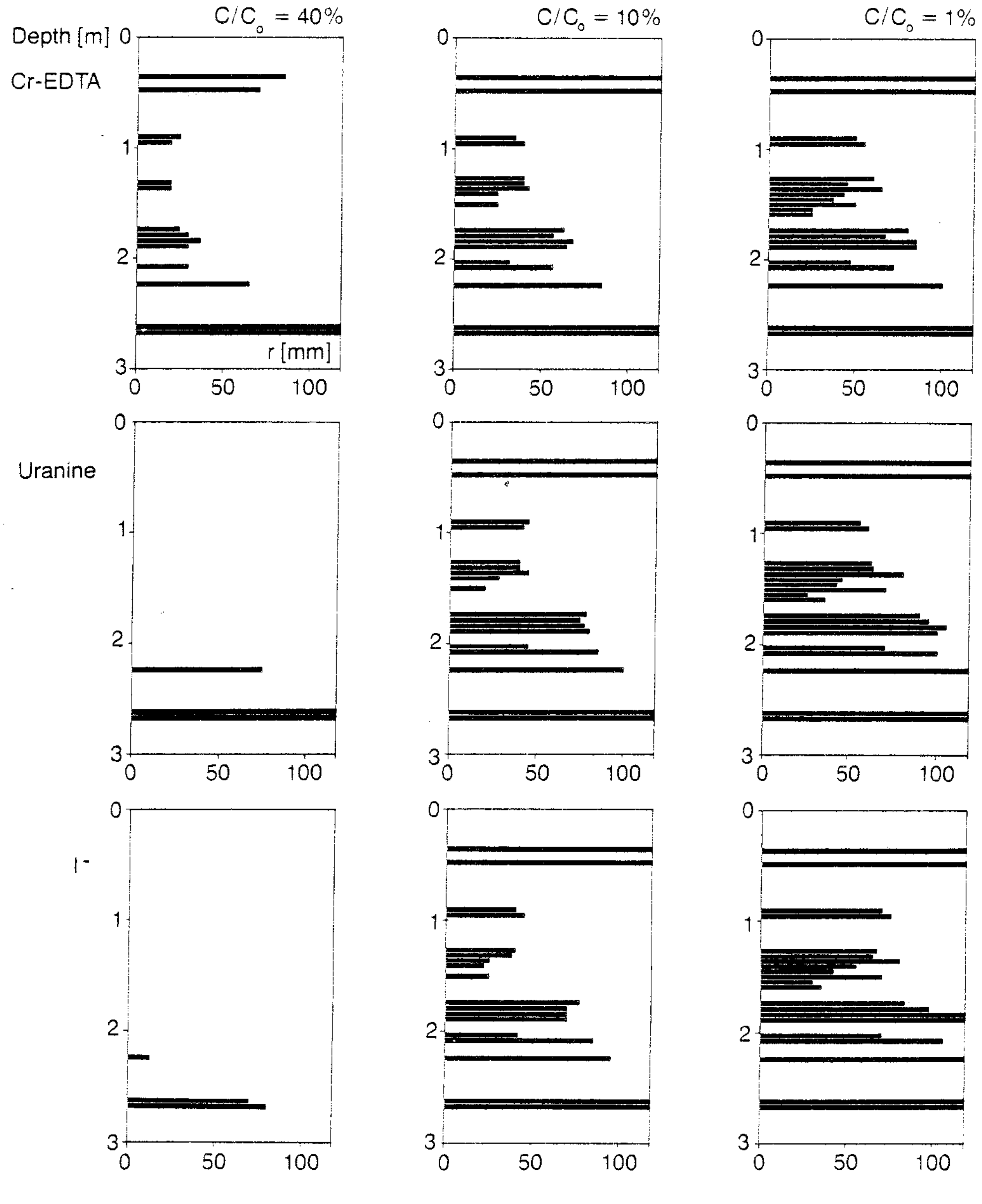


Figure 7.12. Part II. Core 1. Penetration depth for different concentrations for Cr−EDTA, Uranine and I^- vs depth in core.

It can be seen in Figure 7.12 that only 3 of the 22 sampling pieces from core 1 had Uranine and I^- concentrations C/C_0 of 40 % or higher, while this concentration for Cr−EDTA was found in 14 sampling pieces. The diagrams for C/C_0 = 10 % indicate that the penetration distance for this concentration is approximately the same for all three tracers. The diagrams clearly shows for the concentration C/C_0 = 1 % that I^- has the longest and Cr−EDTA the shortest penetration distances.

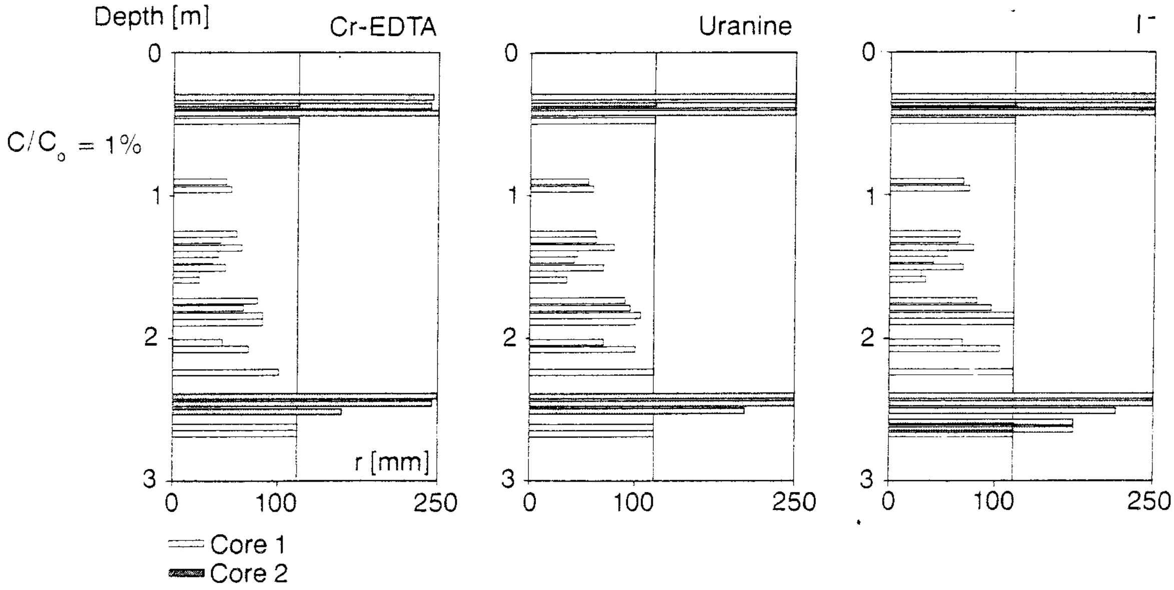


Figure 7.13. Part II. Cores 1 and 2. Penetration distance for C/C_0 = 1 % for Cr−EDTA, Uranine, and I^- vs depth in the cores.

Figure 7.13 shows that the concentration profiles for all three tracers could be followed at the same depth in core 1 and core 2 at the top of the cores. This was also possible at the bottom of the cores for I^-.

7.2 Causes of the differences in penetration depth

The fact that the migration distance is different at different depths can be caused by

- Differences in porosity (ϵ_p)
- Differences in the migration parameters (K_p and D_p).

The possibility of the tracers migrating within a fracture intersecting the injection hole has been excluded in this part of the field experiment since the water inflow rate and injection flowrate are so small that the existence of water bearing fractures intersecting the injection hole can be excluded.

7.2.1 Porosity

The porosity was measured for every individual sampling core (about 650 sampling cores) by comparing the weight difference between a wet and dry core. Figure 7.14 illustrates the mean value of the porosity (± the standard deviation) for each sampling piece from core 1 and core 2.

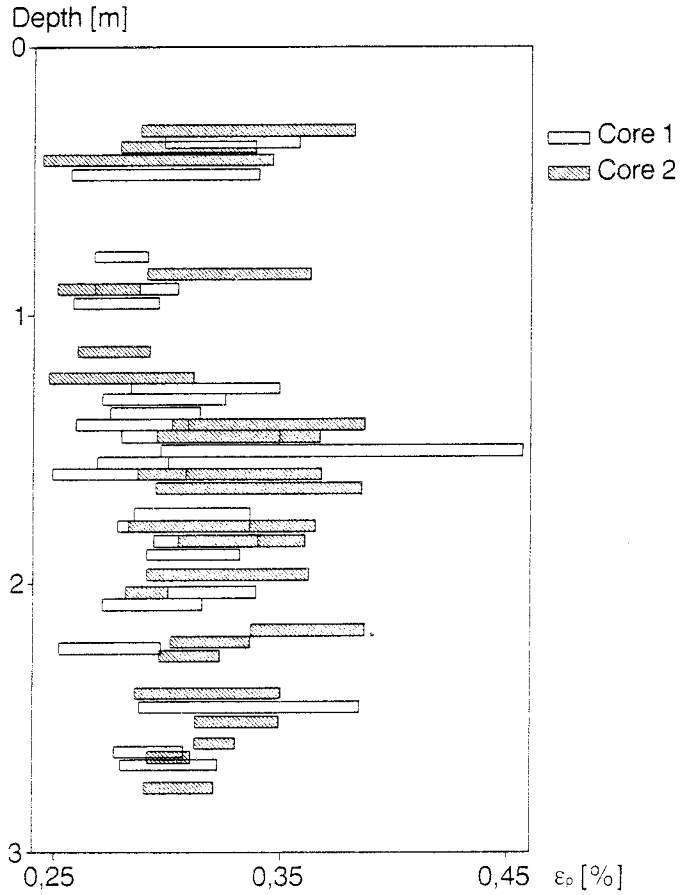


Figure 7.14. Part II. Core 1 and core 2. The porosity (± the standard deviation) vs depth.

From the observations in the figure the difference in migration distance with depth can not be explained by the porosity, since the porosity is almost the same for all sampling pieces.

7.2.2 Hydraulic conductivity and diffusivity

The reason for the considerable difference in migration distance for sampling pieces separated by just a few tens of centimeters seems to be caused by the variation in the migration parameters (K_p and D_p) with location due to inhomogeneities.

The values of the migration parameters have been evaluated by comparing the experimentally obtained concentration profiles with theoretical concentration profiles obtained by using Equations (2) and (4) and the TRUMP (Edwards, 1972) computer code. These approximative values of D_p and K_p are summarized in Table 7.1.

Table 7.1. Approximate values on D_p and K_p for different depths.

Sampling piece	Depth (m)	D_p (m^2/s)	K_p (m/s)
1-2	0.36-0.48	$\geqslant 1*10^{-10}$	$\geqslant 2-5*10^{-13}$
3-9	0.78-1.41	$\approx 0.5*10^{-10}$	$\approx 0.1*10^{-13}$
10-13	1.46-1.59	$\approx 0.05*10^{-10}$	$\leqslant 0.1*10^{-13}$
14-20	1.74-2.24	$\approx 1*10^{-10}$	$\approx 1*10^{-13}$
21-22	2.62-2.67	$\geqslant 1*10^{-10}$	$\geqslant 2-5*10^{-13}$

Table 7.1 shows that D_p and K_p can vary with an order of magnitude for sampling pieces separated by just a few tens of centimeters. There was no obvious decline in concentration for the approximately 250 mm that could be studied in some pieces in the top and bottom of the core. In these cases no value of D_p or K_p (except for a lower limit) could be obtained.

7.3 Conclusions

All three tracers migrated through the zone disturbed by the presence of the injection hole and a distance into the "undisturbed" rock.

The same difference between Cr-EDTA and the tracers Uranine and I^- that was found in Part I was also found in Part II. Both Uranine and I^- migrated a longer distance into the rock matrix, even though the two had lower concentrations compared to Cr–EDTA close to the injection hole.

In some cases there was no obvious decrease at all in the tracer concentrations for at least the first 250 mm that could be studied from core 1 and 2. Therefore, the possibility about dead end pores can be excluded (Chapter 6.2). If part of the migration had taken place in dead end pores then the tracer concentrations would have to decrease with distance from the injection hole. The reason for this is that dead end pores have just a limited extent.

In Part I, the length of the injection hole was 2 m and large parts of the core from the overcoring were crushed. The length of the injection hole was 3 m in Part II and since only minor parts of the core were crushed during the overcoring it was possible to study the concentration profiles at different depths. It was found that the values of the hydraulic conductivity (K_p) and diffusivity (D_p) could vary with an order of magnitude for sampling pieces separated just a few tens of centimeters. The differences in migration distances could not be explained by the porosity since the porosity was almost the same for all sampling pieces.

7.4 Decisions based on the results

In Part II, the tracers were injected for about 6 months and had at some locations migrated further out than the 250 mm that could be studied from the two cores from the overcoring. In Part III, the tracers were injected for about 3.5 years and it was decided to drill out another core in order to study the concentration profile further out into the rock matrix. It was also decided to include some laboratory work in order to try to explain the differences in K_p and D_p.

8. RESULTS, PART III

It can be seen in Figure 8.1 that three large holes (Ø 146 mm) made it possible to study the concentration profile as far as about 400 mm outward from the injection hole. The three additional small holes (Ø 76 mm) made it possible to study the concentrations in other directions.

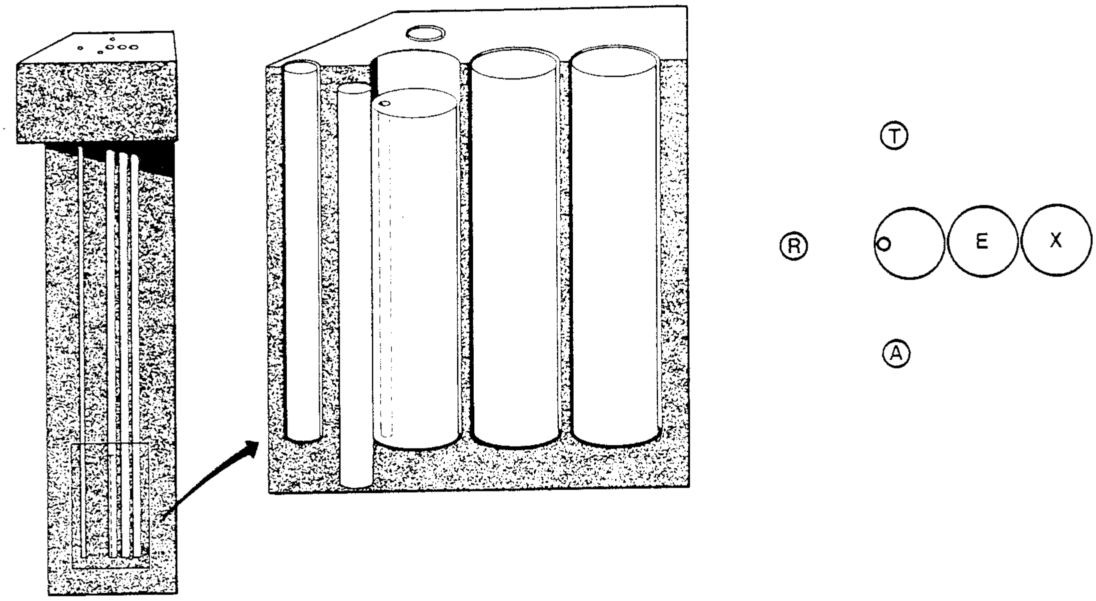


Figure 8.1 Part III. Drilling arrangement and notation of the cores.

8.1 Concentration profiles

The length of the injection hole as well as the cores from the overcoring were approximately 3 m. The cores had only minor parts that were crushed during the overcoring and between 28 and 45 sampling pieces were taken from each core. The concentration profiles could in some cases be followed about 400 mm outward from the injection hole and in different directions at the same level.

As in Part II, no water entered into the injection hole, which implies that migration within the intersecting fissures can be neglected.

All tracer concentrations in Part III are based on the porosity obtained from the weight difference between a wet and dry sampling core. The porosities and tracer concentrations for the individual cores are presented in Appendix 5.

8.1.1 Concentration profiles

The results from Part III of the experiment show that the tracer concentrations seem to vary considerably with depth along the core as well as with direction from the injection hole. The penetration depth could in some cases vary by a factor 2 or more in sampling pieces that were separated by just a few tens of centimeters in depth or located at the same depth but in different directions from the injection hole

The prevailing trend is that the tracers migrated a long distance into the rock matrix from the upper part of the injection hole.

Some examples of concentration profiles for depths where the profile could be followed in many of the cores are given in Figures 8.2−8.16.

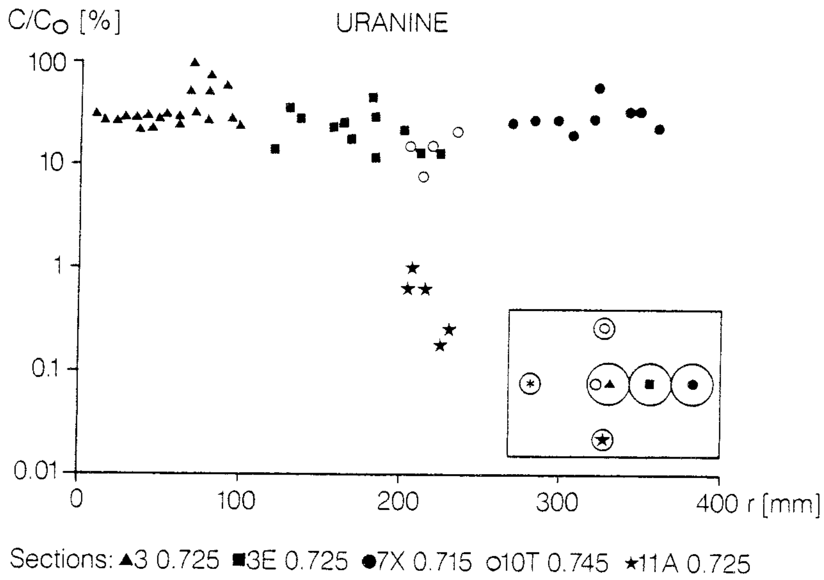


Figure 8.2 Part III. Uranine concentration vs distance at ≈ 0.725 m depth.

Figure 8.2 illustrates the concentration profile for Uranine in the sampling pieces located around 0.725 m below the 146 mm hole. The tracer concentration within the large cores is almost independent of distance from the injection hole. However, the samples from one of the cores taken in another direction, but still at the same depth in the injection hole, show concentrations that are approximately 2 orders of magnitude lower. This indicates that the transport properties can vary considerably in different directions. The concentration profiles for I^- and Cr–EDTA showed similar results.

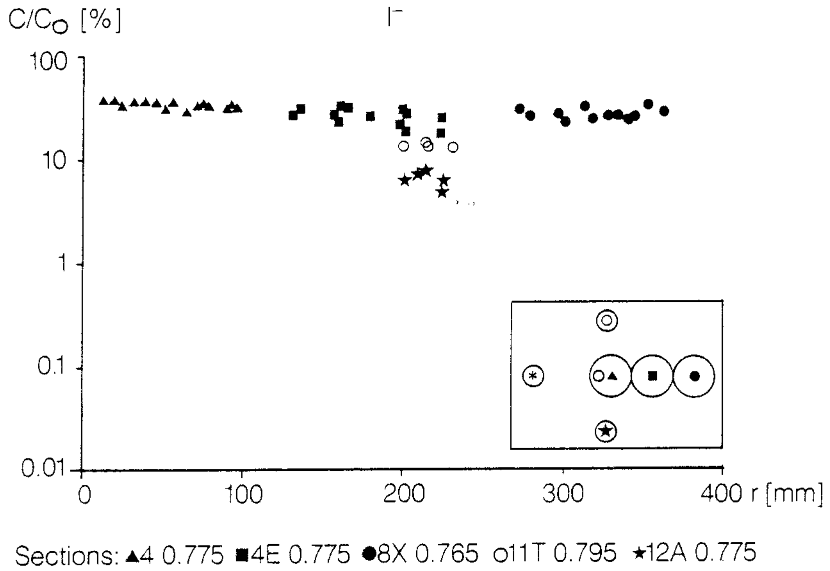


Figure 8.3 Part III. I^- concentration vs distance at ≈ 0.775 m depth.

The concentration profiles at the 0.775 m depth, illustrated with I^- in Figure 8.3, show that the concentration is almost independent of distance from the injection hole. The decrease in concentration in one of the small cores is also seen at this location, but not to the same extent as illustrated in Figure 8.2.

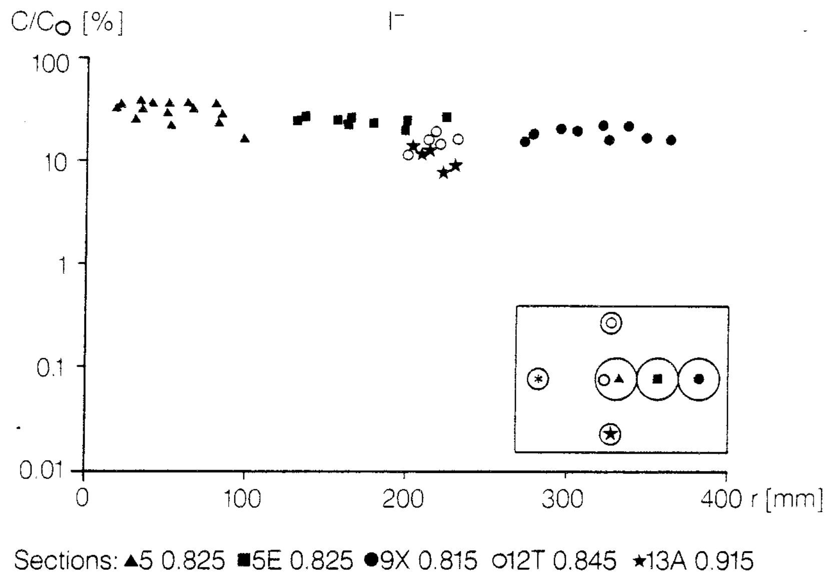


Figure 8.4 Part III. I^- concentration vs distance at ≈ 0.825 m depth.

Even at the 0.825 m depth, see Figure 8.4 for the I^- concentration, the concentration is almost independent of distance from the injection hole. In this example, the concentrations in the small cores are of the same order of magnitude as the concentration in the large core at the same distance from the injection hole.

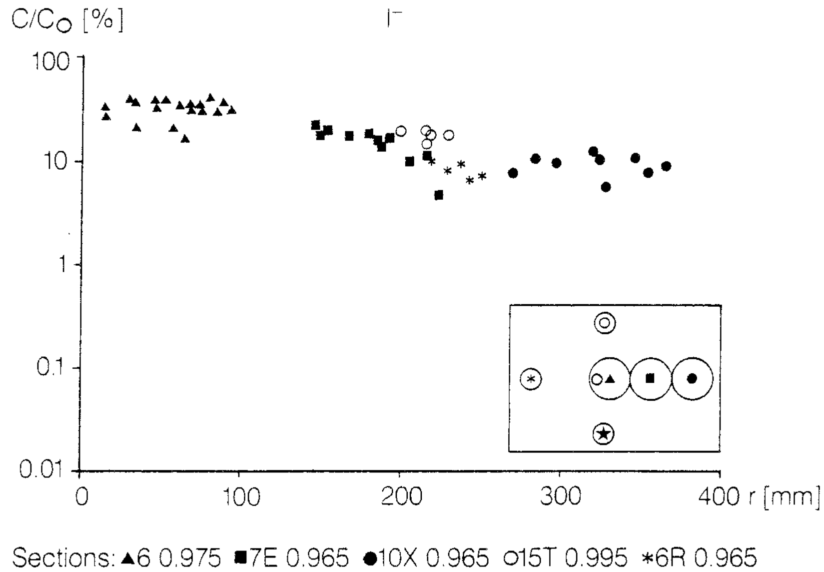


Figure 8.5 Part III. I^- concentration vs distance at ≈ 0.975 m depth.

Figure 8.5 illustrates that the I^- concentration decreases somewhat with distance from the injection hole. There does not seem to be any difference in concentration between samples taken in different directions from the injection hole.

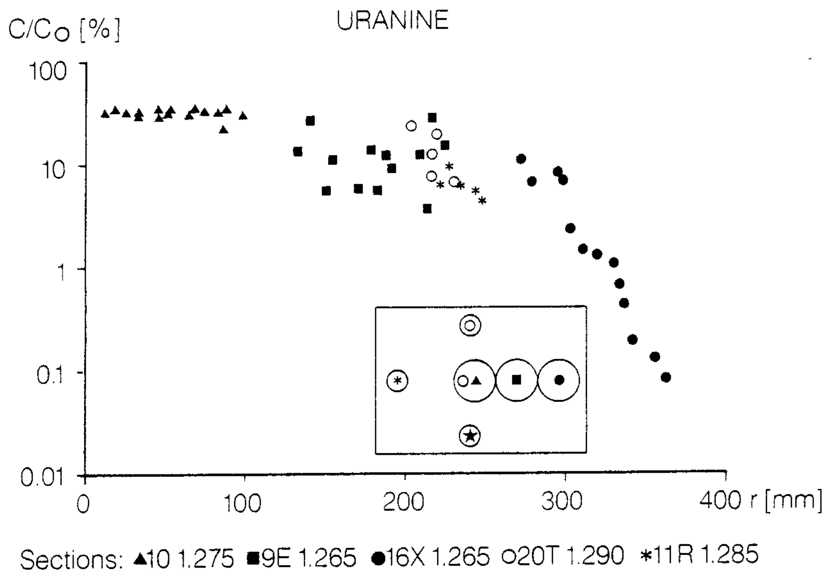


Figure 8.6 Part III. Uranine concentration vs distance at ≈ 1.275 m depth.

The concentration for Uranine decreases rapidly far out from the injection hole at the 1.275 m level as shown in Figure 8.6, but the tracers still penetrated the rock matrix at least the 370 mm that could be studied. There does not seem to be any major differences in penetration depth in the different directions from the injection hole.

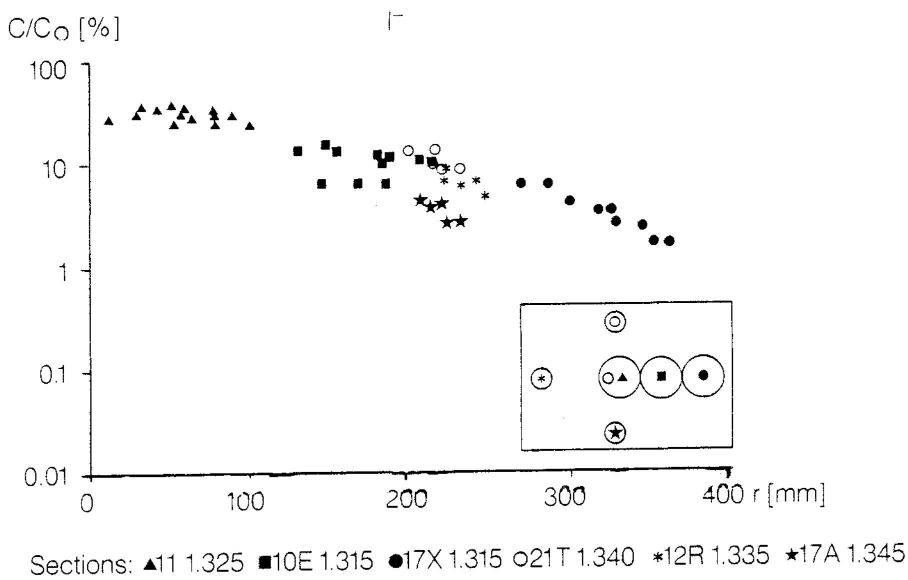


Figure 8.7 Part III. I^- concentration vs distance at ≈ 1.325 m depth.

In Figure 8.7 the concentration for I^- decreases with distance from the injection hole at the 1.325 m level, but there does not seem to be any major differences in penetration depth in different directions from the injection hole.

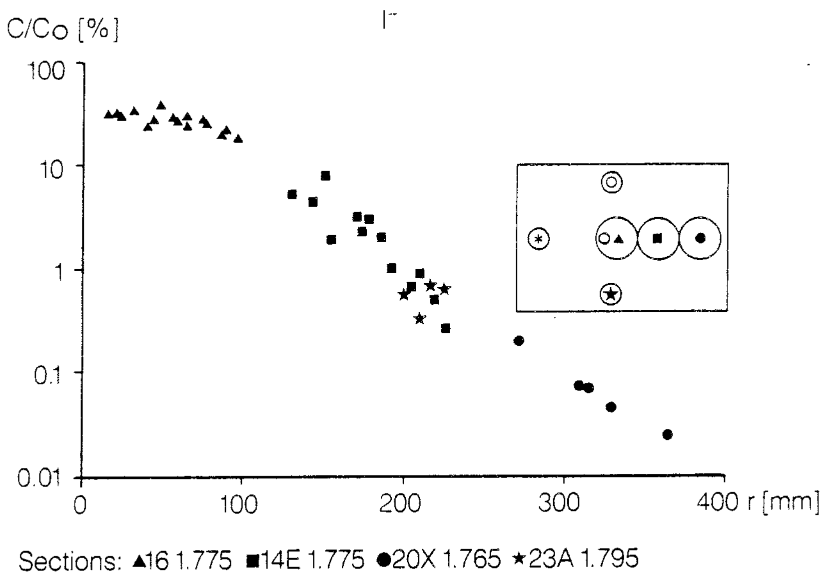


Figure 8.8 Part III. I$^-$ concentration vs distance at ≈ 1.775 m depth.

In Figure 8.8 the I$^-$ concentration decreases continuously with distance from the injection hole at the 1.775 m level. No real difference in the concentration is observed in the different directions from the injection hole. Figure 8.9 shows the Uranine concentration for the same locations.

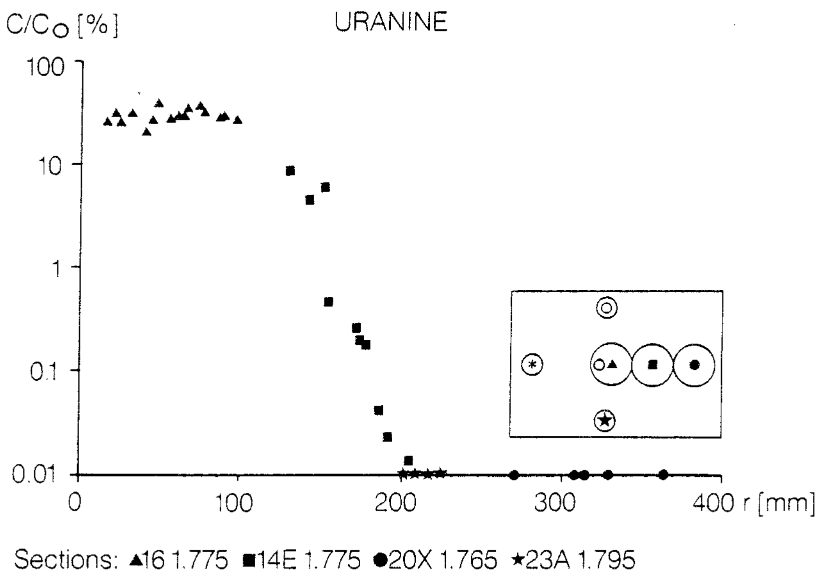


Figure 8.9 Part III. Uranine concentration vs distance at ≈ 1.775 m depth.

Figures 8.8 and 8.9 show the difference between the tracers I$^-$ and Uranine. For the tracer I$^-$, it migrated at least 370 mm into the rock matrix, while Uranine could only be found about 200 mm outward from the injection hole, see Figure 8.9. Cr–EDTA could only be found about 110 mm out from the injection hole.

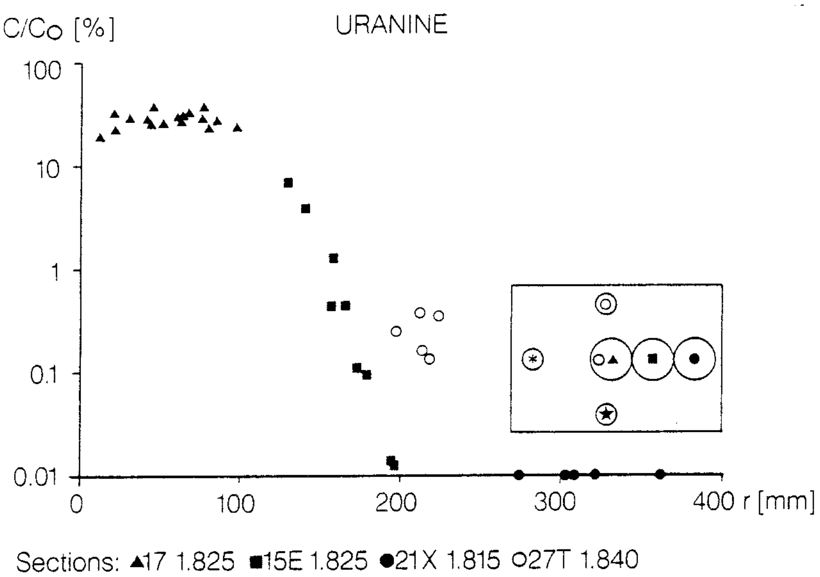


Figure 8.10 Part III. Uranine concentration vs distance at ≈ 1.825 m depth.

The concentration profile at the 1.825 m level in Figure 8.10 is very similar to the concentration profile illustrated in Figure 8.9. However, these figures shows the same tracer for injection points separated with only about 50 mm.

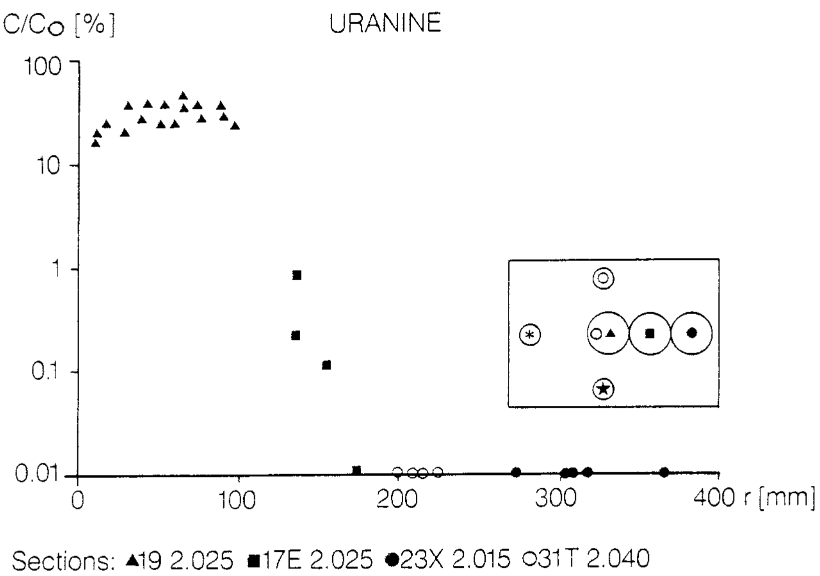


Figure 8.11 Part III. Uranine concentration vs distance at ≈ 2.025 m depth.

In Figure 8.11, Uranine migrated a slightly shorter distance into the rock matrix at the 2.025 m level than at the above presented levels. I^- and Cr–EDTA also migrated a shorter distance at this level compared to the above levels.

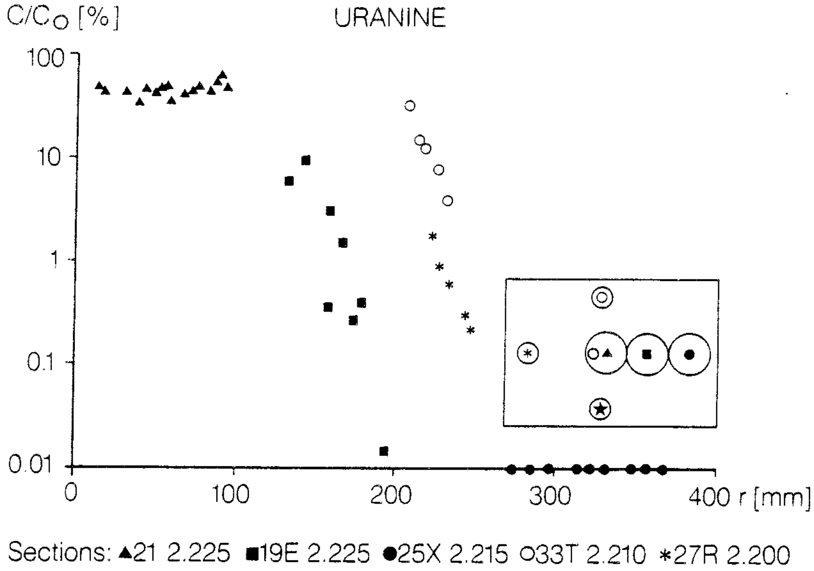


Figure 8.12. Part III. Uranine concentration vs distance at ≈ 2.225 m depth.

At the 2.225 m level shown in Figure 8.12, Uranine can be followed approximately 200 mm outward into the rock matrix in the large cores, while the small cores show high Uranine concentrations about 250 mm outward from the injection hole. This is another indication that the variation in penetration depth can be quite different in different directions.

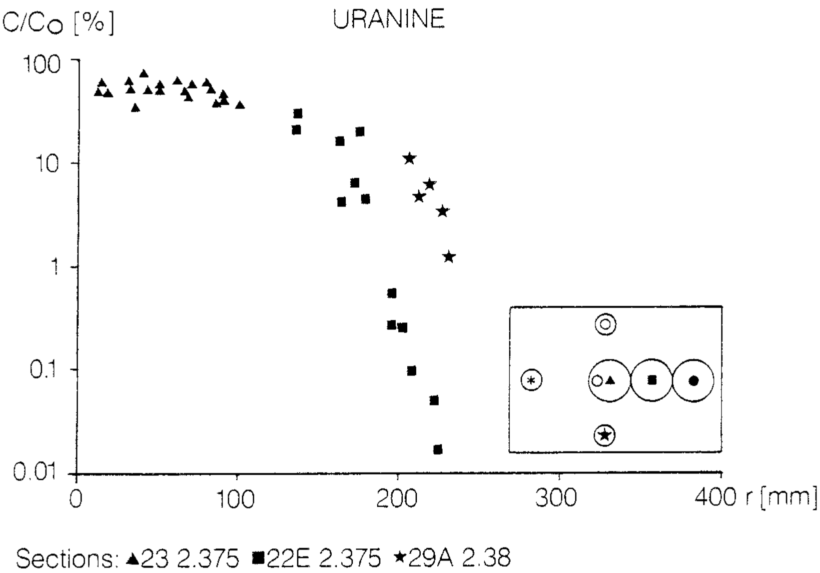


Figure 8.13. Part III. Uranine concentration vs distance at ≈ 2.375 m depth.

The concentration profiles could only be followed in two of the large cores and one of the small cores at the 2.375 m level, see Figure 8.13.

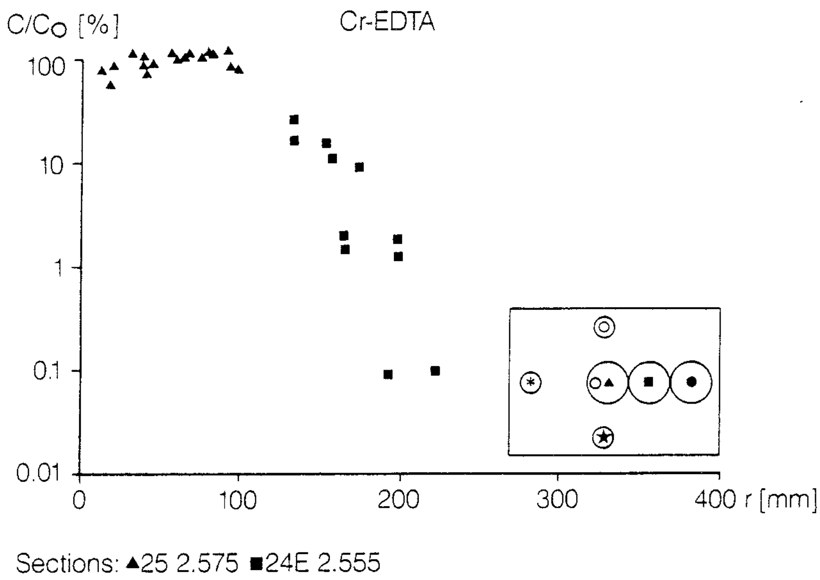


Figure 8.14. Part III. Cr–EDTA concentration vs distance at ≈ 2.575 m depth.

At the 2.575 m level, the concentration profiles could only be followed in two of the large cores. Figure 8.14 shows the Cr–EDTA concentration. The concentrations for I^- and Uranine are somewhat higher, but still decreased in the core located furthest away from the injection hole.

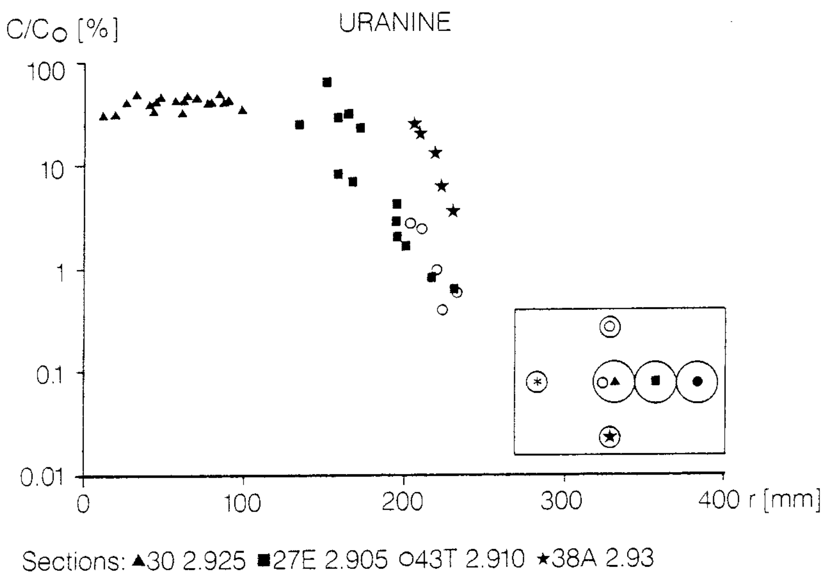


Figure 8.15. Part III. Uranine concentration vs distance at ≈ 2.925 m depth.

The tracer concentrations could be followed in two large cores and two small cores at the 2.925 m level as shown in Figure 8.15. The Uranine concentration was slightly increased in one of the small cores, 38A, compared to the samples taken in the other cores at the same distance from the injection hole.

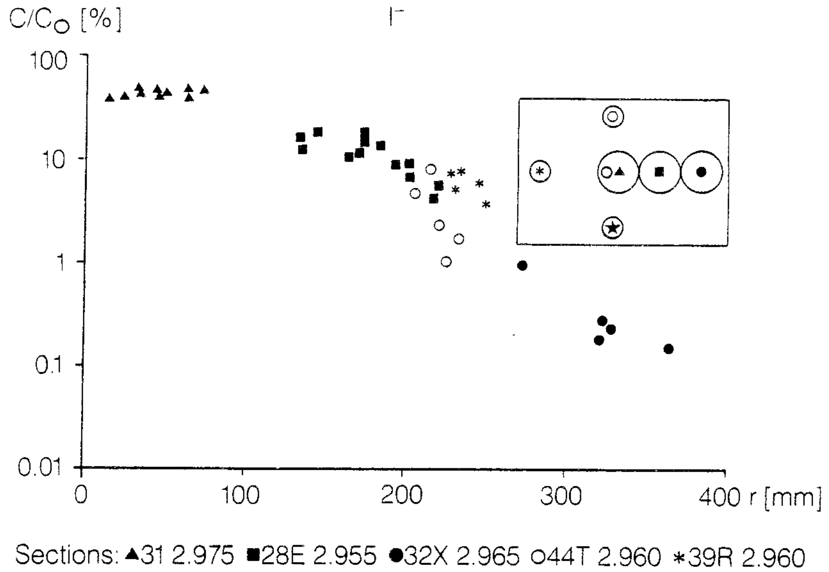


Figure 8.16. Part III. I^- concentration vs distance at ≈ 2.975 m depth.

From Figure 8.16 it can be seen that the I^- concentrations at the 2.925 m level was fairly high even as far from the injection holes as 350 mm. Also there does not seem to be any differences in concentration between the different directions.

From looking at the Figures 8.2–8.16 it is obvious that the migration distance varies considerably with the depth in the cores, the direction from the injection hole and the chosen tracer.

8.1.2 Concentration for a fixed distance from the injection hole

Since the concentration profiles can not be followed the whole distance from the injection hole to the sampling cores for the three small cores (Ø 76 mm, see Figure 8.1), it is meaningless to illustrate the penetration depth for a fixed concentration. Instead the tracer concentrations for a fixed distance from the injection hole as illustrated in Figures 8.17 to 8.19 show the differences in concentration with depth in the cores and direction from the injection hole. The distance from the injection hole to the sampling cores in the Ø 76 mm cores are 200–250 mm. Therefore, the concentrations illustrated below are mean values for sampling cores located 200–250 mm from the injection hole.

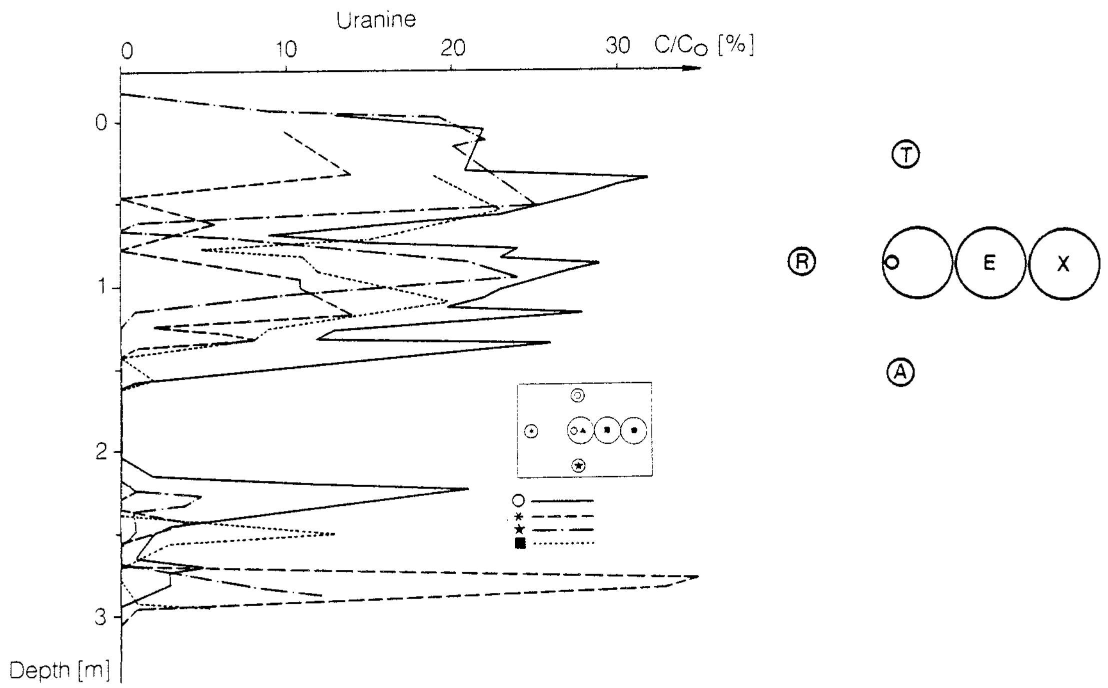


Figure 8.17. Average Uranine concentration 200−250 mm from the injection hole.

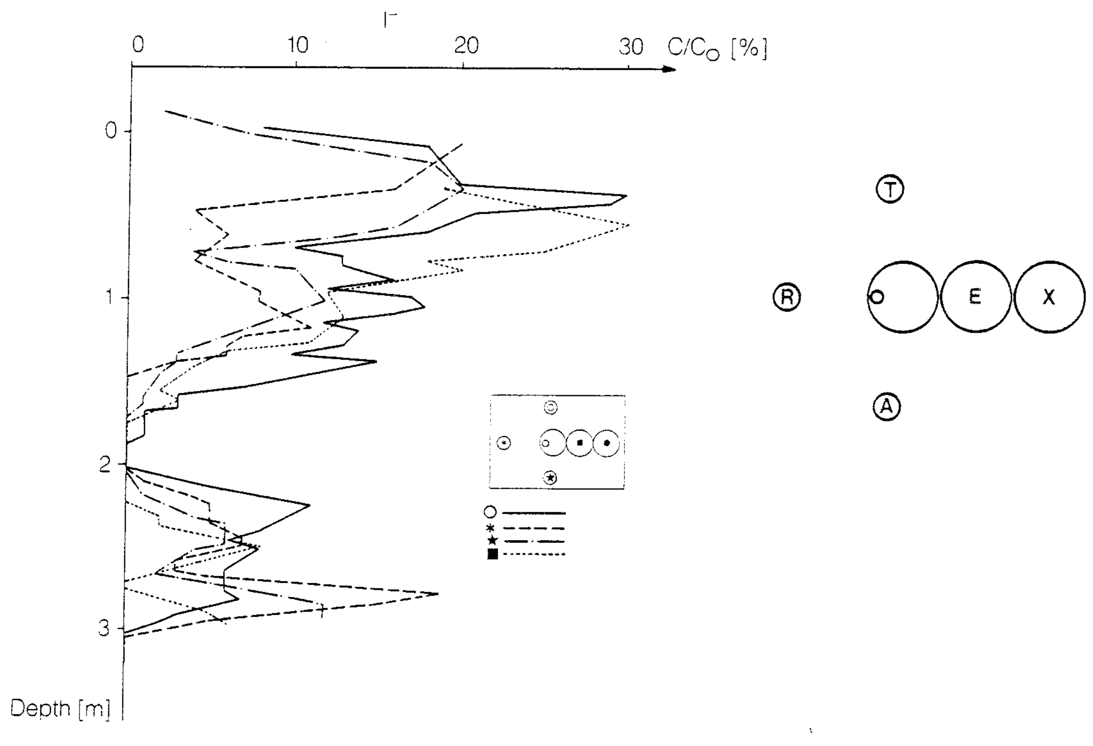


Figure 8.18. Average Iodide concentration 200−250 mm from the injection hole.

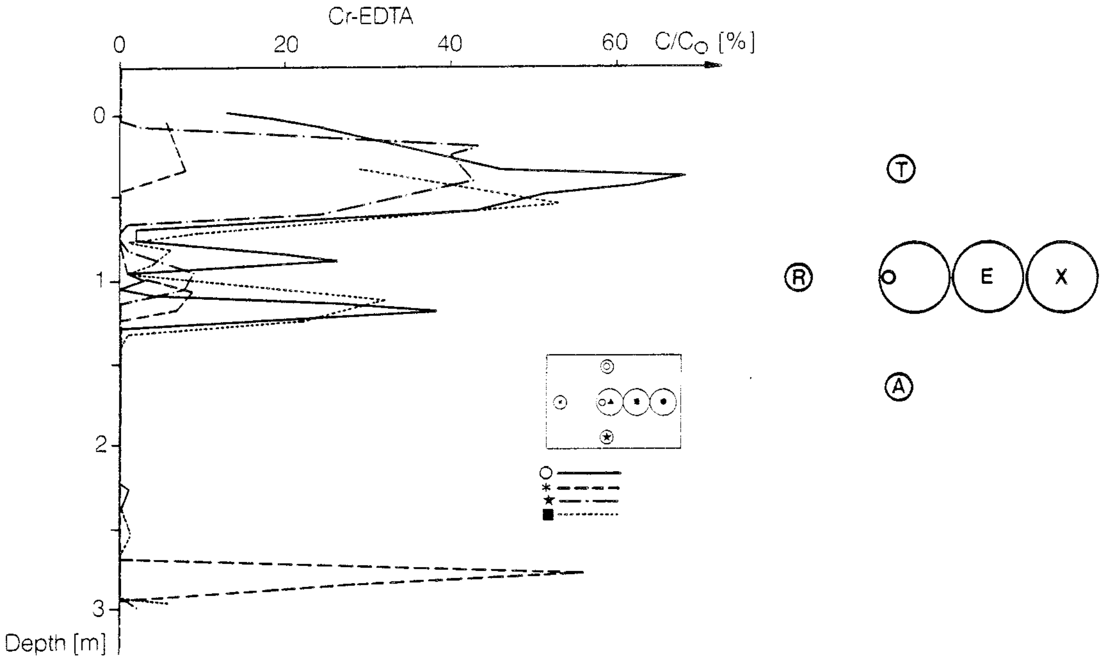


Figure 8.19. Average Cr−EDTA concentration 200−250 mm from the injection hole.

Figures 8.17 to 8.19 show that there are large differences in the concentration at different depths in the cores. The concentrations are fairly high in the upper meter and then decreases to 0 at approximately 2 m depth. The concentrations around 2.5−3 m depth are quite different in the different directions. Samples taken from the cores denoted E,T, and A have concentrations that are well above 0 but still lower than those found in the upper part of the cores. However, samples taken from the core denoted by R have concentrations that are well above any concentration found at any other level in that core.

It can also be seen that there is a large difference in behaviour between the tracers. I^- has penetrated a larger number of sampling pieces than Uranine which was found in a larger number of sampling pieces than Cr−EDTA. However, the Cr−EDTA concentrations are in many cases well above those for I^- and Uranine.

8.2 Causes of the differences in penetration depth

It was observed also in Part III of this experiment that the migration distances were different at different depths and directions from the injection hole. One explanation for these differences could be differences in the porosity (ϵ_p). But even if the porosity is the same, the pore size distribution could be different. That is, assuming the same porosity, a large number of small pores would give different migration properties compared to a few large pores. Another explanation for the difference in the concentration in pieces located at the same depth but in different directions could be if the pores (microfissures) had specific directions.

The following laboratory investigations were performed in order to determine the reason for the differences in penetration depth:

- Determination of the porosity (ϵ_p)
- Determination of the pore size distribution
- Determination of the directions for the microfissures

8.2.1 Porosity

The porosity was measured for every individual sampling core (about 1800 sampling cores in Part III) by comparing the weight difference between a wet and dry core. This measurement gave the same result as presented for Part II, i.e. no significant differences in porosities were found between the sampling pieces. The porosity was found to be between 0.12–0.51 % with an average close to 0.3 %, see Appendix 5. Therefore, the difference in migration distance with depth and direction from the injection hole can not be explained by the porosity, since the porosity is almost the same for all sampling pieces.

8.2.2 Pore size distribution

The pore size distributions were measured using three different methods. The methods used were a Hg–method, BET–method and a surface investigation via an electron–microscope.

First the method with mercury penetrometry was tried. But due to the low porosity of approximately 0.3 %, the amount of mercury that penetrated the rock matrix was to small to give any reliable results about the pore size distribution.

The second method that was tried was the BET−method using N_2 gas. But as with the Hg−method, the porosity was to low for the method to give any results on the pore size distribution.

The third method tried was to investigate the surface with electron microscope. From these pictures it was possible to count the number of pores and determine the size of the pores. One must however keep in mind that the investigated rock surface was just a few mm^2, so the obtained pore size distributions must be considered as very local and might therefore not at all represent the rock matrix around the location for the sample. The pore size distribution for 5 samples were determined by this method. Figure 8.20 shows an example of the obtained results.

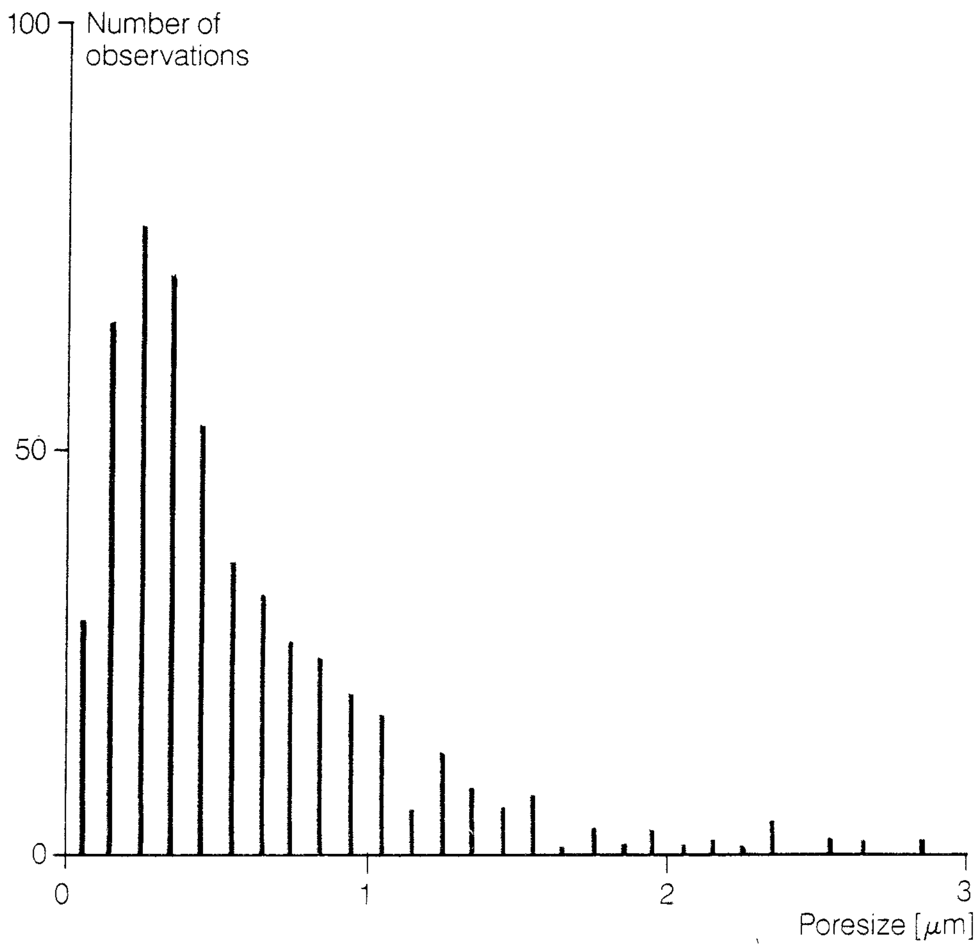


Figure 8.20. Pore size distribution for sample 25:9.
Results obtained by electron microscope.

It can be seen in Figure 8.20 that the major part of the pores in this specific sample have a opening of less than 0.5 μm. Almost no pores have a opening above 2 μm.

Some small variations in pore size distribution was found when comparing the samples. The samples are arranged in increasing frequency of large pores in Table 8.1.

Table 8.1. Pore size distribution.
Samples arranged in increasing frequency of large pores.

No	Sample	Depth (m)	ϵ_p (%)	
1	25:9	2.575	0.212	Increased frequency of large pores ↓
2	2E:12	0.555	0.468	
3	15E:9	1.825	0.415	
4	5E:1	0.825	0.422	
5	10E:13	1.315	0.362	

The pore size distributions were determined in sampling cores from the core obtained when overcoring the injection hole and the core denoted E, see Figure 8.1.

As the porosity is almost the same for the samples in Table 8.1, it should be that the sample with the highest frequency of large pores should have the largest hydraulic conductivity and thereby the highest tracer concentration at a distance from the injection hole. Figure 8.21 shows the average Uranine concentration 200−250 mm from the injection hole and the locations of the samples analysed for pore size distribution.

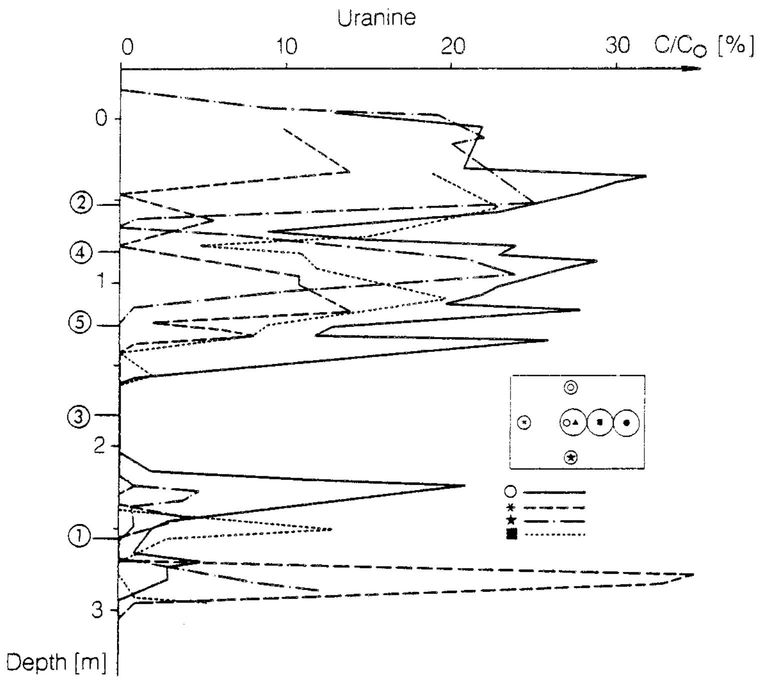


Figure 8.21. Average Uranine concentration 200−250 mm from the injection hole and location of samples analysed for pore size distribution.

It can be seen in Figure 8.21 that the samples denoted 2, 4, and 5 are located in areas with a high concentration at a distance from the injection hole. Sample No. 1 is located in an area with somewhat lower concentration and sample No. 3 in an area where the concentration is below the detection limit. The number of samples taken are few, but Figure 8.21 indicates that there might be a correlation between the pore size and the ability for tracers to penetrate the rock matrix. A sample with an increased frequency of large pores would then have an increased tracer concentration at a distance from the source.

8.2.3 Direction of microfissures

The direction of the microfissures was determined in three samples (Jaktlund, 1986). The method used was the DSA−method (Differential Strain Analysis). A small rock sample with a size of a few centimeters, was subjected to a surrounding stress whereby a portion of the fissures was closed. By subjecting the samples to a number of different stresses, the compression in different directions could be evaluated. The compression will be proportional to the number of fissures that are perpendicular to the compression direction. However, no specific microfissure direction could be found in any of the three samples.

8.2.4 Hydraulic conductivity and diffusivity

The reason for the considerable differences in migration distance for sampling pieces separated by just a few tens of centimeters in depth or at the same depth but in different directions seems to be caused by variations in the migration parameters, K_p and D_p due to inhomogeneities in the rock matrix.

Values on the diffusivity and the hydraulic conductivity were obtained when evaluating the concentration profiles shown in Chapter 8.1.1. Laboratory measurements were performed in order to compare laboratory and in-situ values for the hydraulic conductivity and the diffusivity. It should, however, be noted that the laboratory measurements were performed on fairly small samples so that these values should be considered as more or less local values for the specific sample and therefore maybe not representative for the rock matrix around the sample.

8.2.4.1 In-situ measurements

The values of the migration parameters, K_p and D_p, have been evaluated by comparing the experimentally obtained concentration profiles with theoretical concentration profiles obtained by using Equations (2) and (4) and the TRUMP program (Edwards, 1972).

If it should be possible to evaluate K_p and D_p from the concentration profiles one must be able to follow the concentration not only in the core from the overcoring of the injection hole but also in the cores denoted E and X, see Figure 8.1. There must also be a decrease in the concentration over the studied length, otherwise just a lower limit of K_p would be obtained. This is the case for the samples taken around 0.7 m depth from which just a lower limit of K_p can be obtained, see Figures 8.2 to 8.4. In these cases K_p is greater than or equal to $2*10^{-13}$ m/s.

It is not possible to obtain any values on K_p or D_p from the cores denoted T, R, and A since just a part of the concentration profile can be seen in these directions. The approximative values for D_p and K_p from the evaluation of the concentration profiles into the rock matrix are illustrated in Figures 8.22 and 8.23.

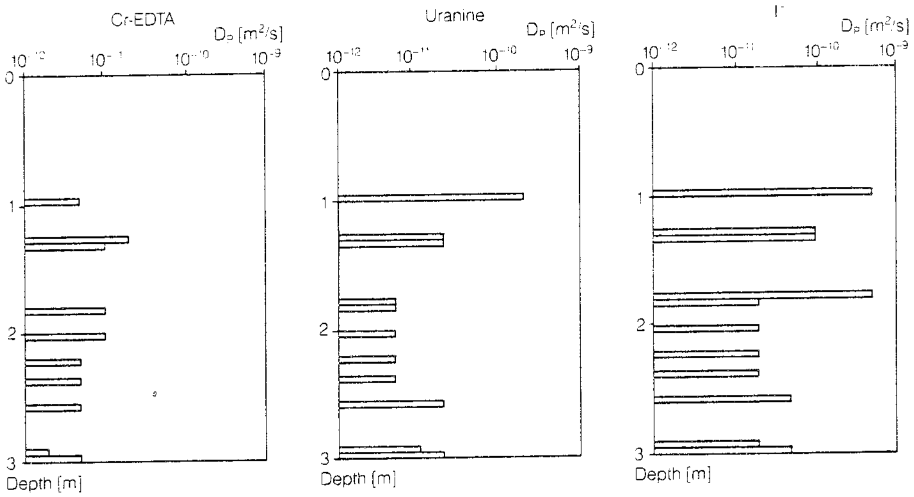


Figure 8.22. Part III. D_p vs depth in the cores for the three tracers.

The diffusivity were evaluated at the locations illustrated in Figure 8.22. It was not possible to follow the concentration profile as far out into the rock matrix as needed for the evaluation of D_p and K_p at the other locations. The difference in behaviour between the tracers is also clearly illustrated. Iodide has diffusivity values that are one to two orders of magnitude larger than Cr–EDTA, while the diffusivity for Uranine is somewhere between these two tracers. The diffusivities vary between $2*10^{-12}$ to $5*10^{-10}$ m^2/s.

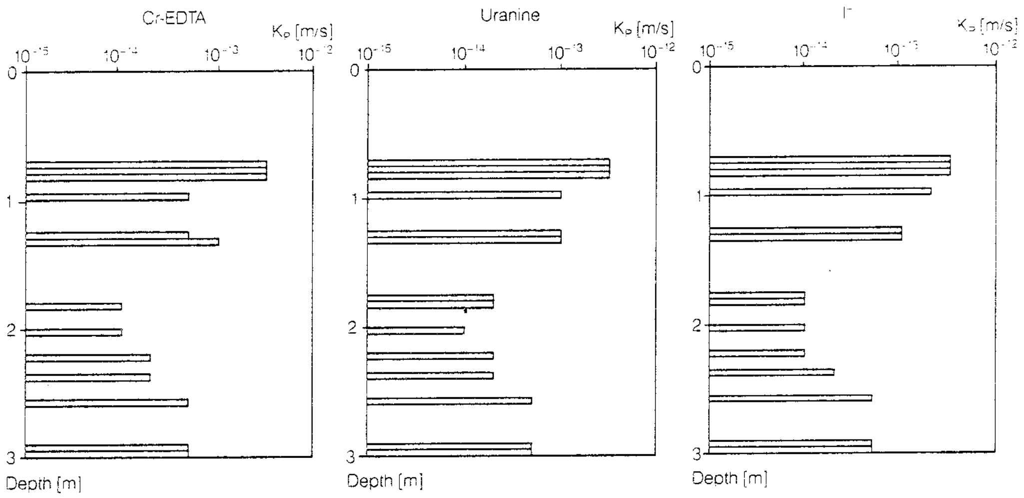


Figure 8.23. Part III. K_p vs depths in the cores for the three tracers.

In contrast to the diffusivity, the evaluation of the hydraulic conductivity is not dependent on the tracer but just on the properties of the rock matrix. Therefore, the hydraulic conductivity should be the same whether evaluated from the concentration profile for I^-, Uranine, or Cr–EDTA. The conductivities were evaluated individually for the different tracers and it can be seen from Figure 8.23 that the difference between the tracers is not above a factor of 2. The hydraulic conductivity was found to vary between $1*10^{-14}$ to $\geq 2*10^{-13}$ m/s.

8.2.4.2 Laboratory measurements

The diffusivity in the rock matrix for a tracer can be measured in the laboratory. By using a diffusion cell in which a piece of rock is located between a volume of tracer solution and pure water, the increase in tracer concentration in the volume with "pure" water gives the value of $D_p \epsilon_p$, see Figure 8.24. For more information about through diffusion experiments, see Skagius (1986).

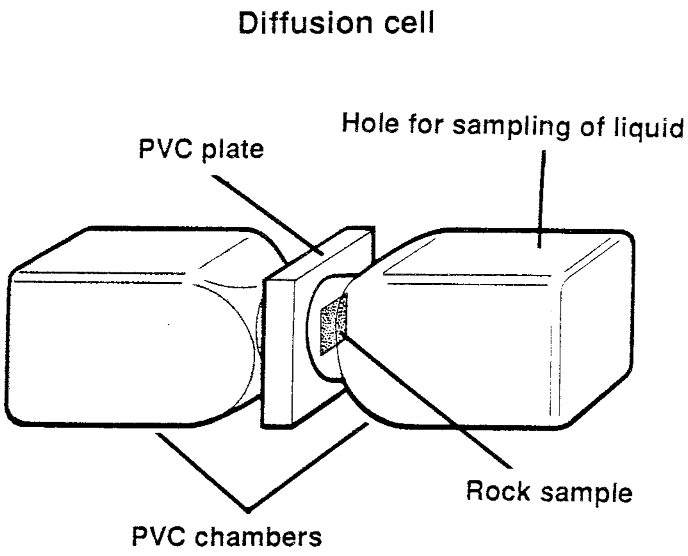


Figure 8.24. Equipment for the through diffusion experiment.

The rock piece used in the experiment had a diameter of 42 mm and a thickness of 10 mm. So the $D_p \epsilon_p$ value obtained from the through diffusion experiment would be considered as a very local value for the investigated rock. Plotting the amount of tracers that have diffused through the rock piece as a function of time gives a straight line which has a slope that is proportional to $D_p \epsilon_p$, see Figure 8.25.

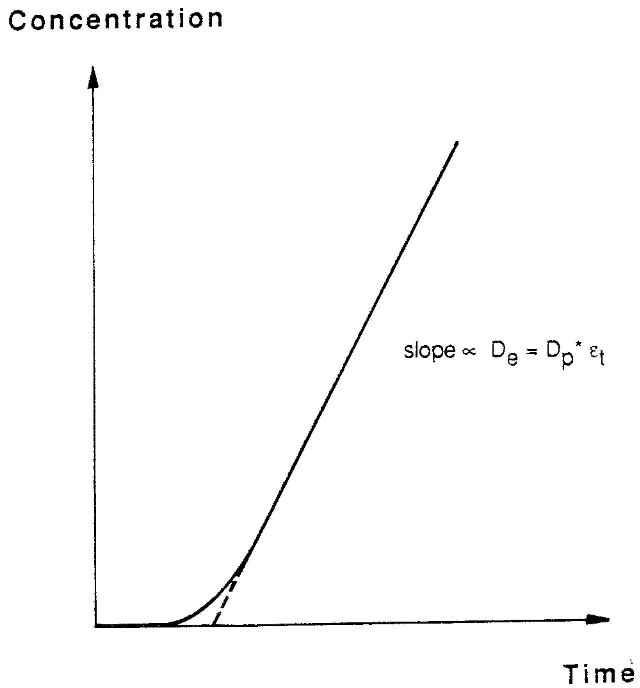


Figure 8.25. Evaluation of a through diffusion experiment.

The diffusivity was measured on four different rock samples all from core E, see Figure 8.1. The measurements were performed for approximately 6 months. The diffusivities from the laboratory experiments are listed in Table 8.2.

Table 8.2. Diffusivities obtained from laboratory experiments.

Depth in core (m)	Diffusivity * 10^{-12} (m^2/s) Iodide	Uranine
1.490	90	8
2.630	200	9
2.830	200	3
2.830	200	10

It can be seen in Table 8.2 that the diffusivity for I^- is at least one order of magnitude larger than for Uranine. This was also seen in the in-situ experiment. The two samples taken for laboratory experiments at the same level of 2.830 m were separated by just a few millimeters, but the difference in diffusivity for Uranine is a factor of three! However, these values are of the same order of magnitude as those obtained in-situ and are illustrated in Figure 8.26.

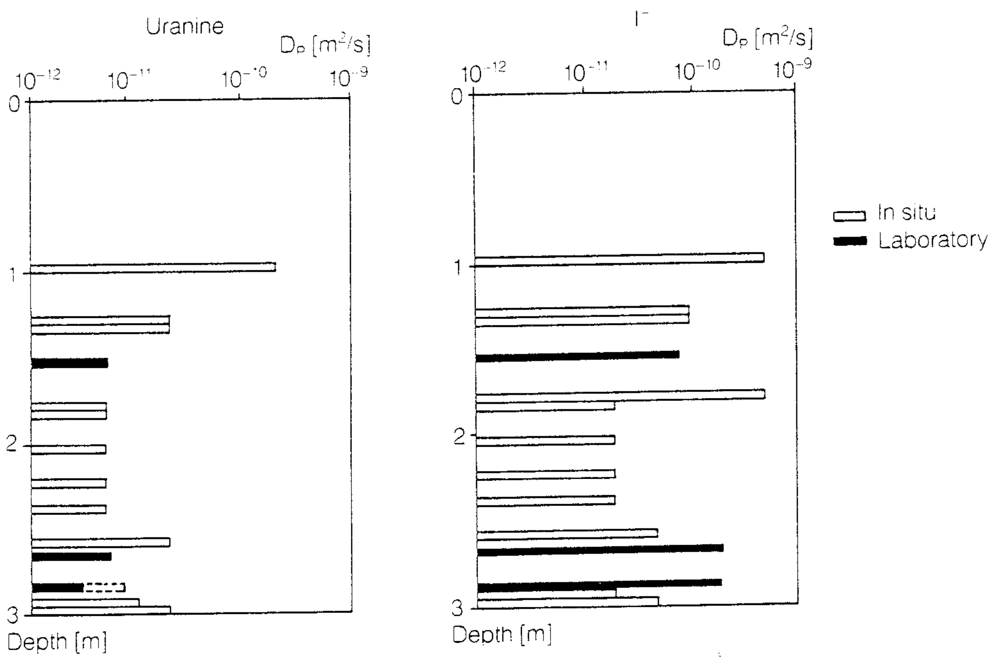


Figure 8.26. Comparison between diffusivities obtained in the laboratory and in-situ.

Factors that will increase the diffusivity obtained from laboratory experiments compared to in–situ experiments are the temperature and surrounding stress. In this case the temperature was higher (≈ 20°) and the surrounding stress was lower (= 0) in the laboratory experiment than in the in–situ experiment (≈ 10°, ≈ 15 MPa). These findings compare well with the results shown in Figure 8.26 where it can be seen that the diffusivities obtained in the laboratory are slightly higher than those obtained in–situ. This result is important since it indicates that the diffusivities found in laboratory experiments also seem to be valid for in–situ conditions under natural stress conditions.

The hydraulic conductivity was determined by laboratory experiments for five different samples (Forsberg, 1987). The equipment used is illustrated in Figure 8.27.

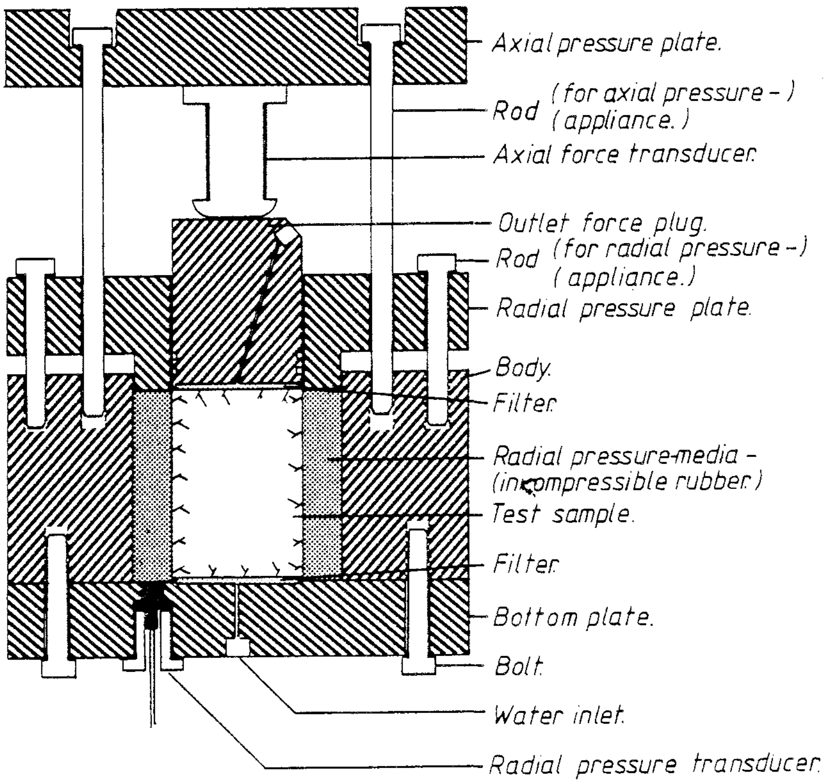


Figure 8.27. Laboratory equipment used for determination of the hydraulic conductivity.

By monitoring the water flowrate through the rock sample and the water pressure gradient it is possible to evaluate the hydraulic conductivity. With the equipment illustrated in Figure 8.27 it is possible to simulate in–situ conditions by subjecting the rocksample to suitable radial and axial stresses.

The length of the rock sample was approximately 100 mm and the diameter approximately 66 mm why the obtained values on the hydraulic conductivity must be considered to be local values that do not have to be valid for the rock around the sample. It should however be noted that the five samples, all taken from core X, were drilled out in such a way that the water flow in this laboratory measurement was in the same direction as during the in–situ test.

The natural rock stress at the location where these experiments were performed was around 15 MPa, see Appendix 1. Therefore, the hydraulic conductivity was evaluated for all five rock samples using a uniform confining stress of 15 MPa. The hydraulic conductivity was also determined in some of the rock samples using other confining stresses in order to evaluate the effect of the confining stress on the hydraulic conductivity.

The procedure was performed using different pressure gradients. First, a water pressure difference of 51 kPa was applied over the 100 mm long sample. With this fairly low gradient the water injection flowrates decreased to 0 after a short while, so the water pressure was increased to 204 kPa. Evaluating the obtained hydraulic conductivity from using a water pressure difference of 204 kPa gave the same conductivity as when using a pressure difference of 450 kPa. So, it can be stated that an increased water pressure difference will increase the water flowrate through the rock sample which is a great advantage when the conductivities are as low as in this experiment, $K_p \approx 10^{-14} - 10^{-13}$ m/s. Therefore, a water pressure difference of 450 kPa was used for all samples.

The amount of water that had been transported through the rock sample was monitored several times every week. One example of the hydraulic conductivity for one of the five tested rock samples is given for two different confining stresses in Figure 8.28.

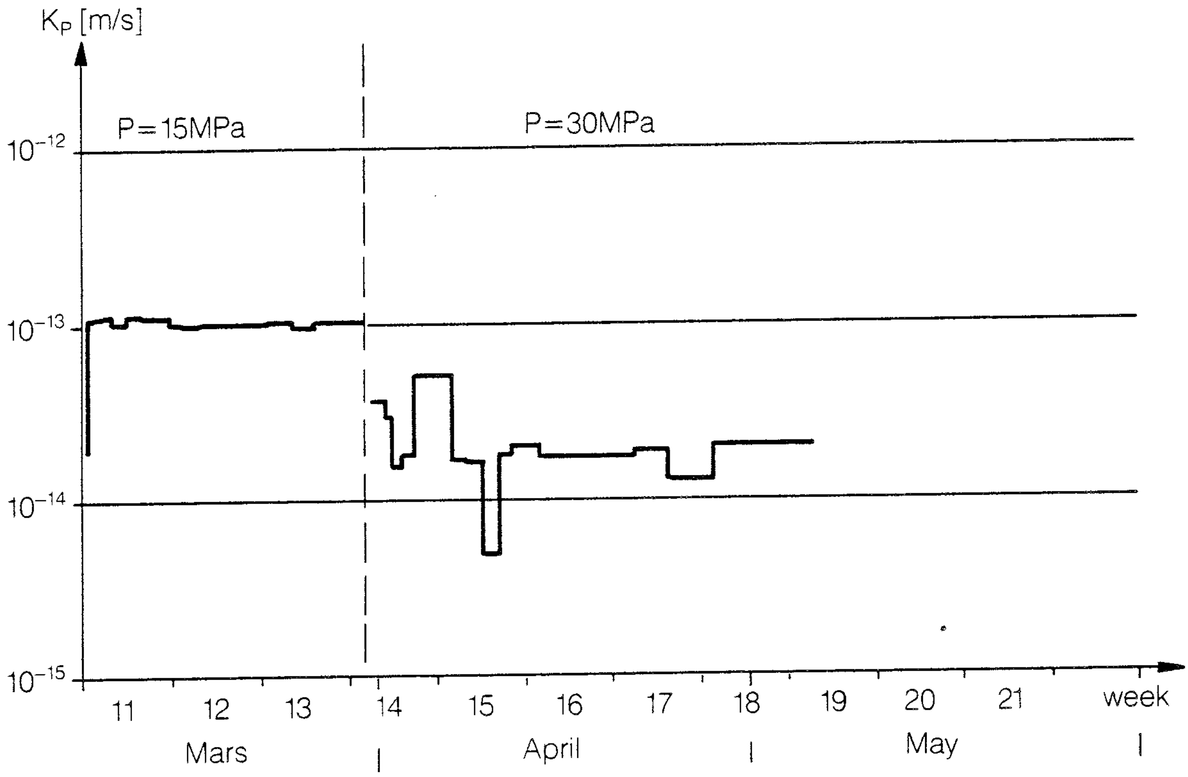


Figure 8.28. Hydraulic conductivity obtained in the laboratory test as a function of time for two different confining stresses.

It can be seen in Figure 8.28 that the conductivity decreases by a factor of three when increasing the surrounding stress from 15 MPa to 30 MPa. The hydraulic conductivities obtained from the laboratory experiments are given in Table 8.3.

Table 8.3. Hydraulic conductivity for the rock samples

Depth (m)	Conductivity (m/s)	Confining stress (MPa)
1.48	$2*10^{-14}$	15
1.89	$2*10^{-13}$	15
	$5*10^{-14}$	25
2.14	$1*10^{-13}$	15
	$3*10^{-14}$	30
2.74	$8*10^{-14}$	15
	$4*10^{-14}$	20
2.89	$2*10^{-13}$	15

It can be seen in Table 8.3 that the hydraulic conductivity, K_p, was found to be between $2*10^{-14}$ – $2*10^{-13}$ m/s for the rock samples with a confining stress of 15 MPa. It can also be seen that an increase in the confining stress reduces the conductivity. If one compares the hydraulic conductivities obtained in–situ with those obtained in this laboratory experiment it is obvious that the values are of the same order of magnitude, see Figure 8.29. It might be that the conductivities found in the laboratory experiment were slightly larger than those obtained in–situ. This could be explained if the actual in–situ stress was above the assumed 15 MPa. The increased conductivity in the laboratory experiment could also be due to that these rock samples were subjected to a decrease in the stresses from the in–situ conditions to 0 stress when the samples were taken out. This decrease in the stresses might induce fractures that were not closed when the samples were recompressed.

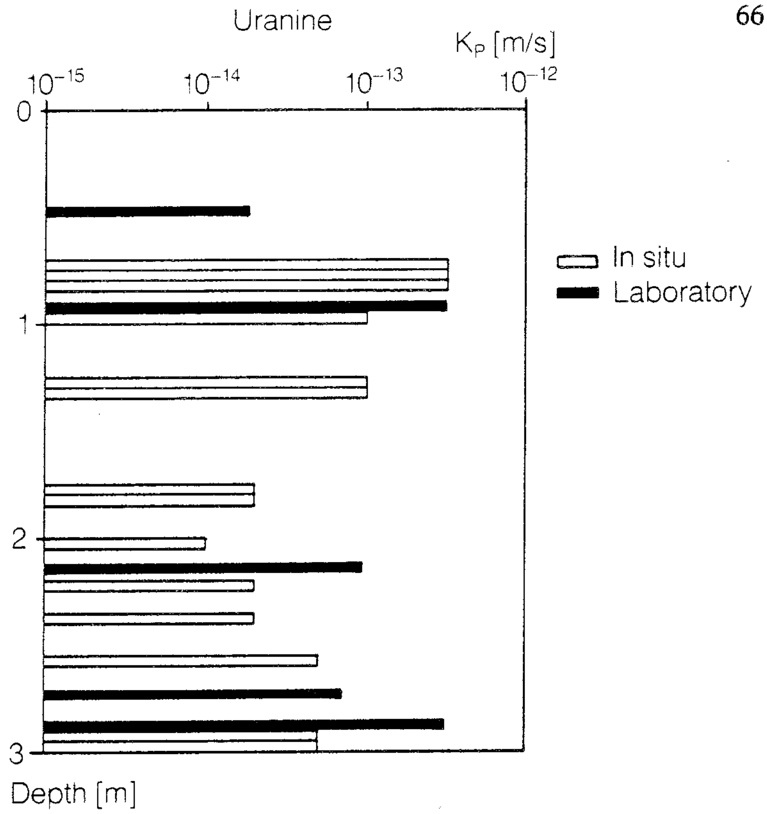


Figure 8.29. Hydraulic conductivity vs depth in core. From in−situ conditions and laboratory experiments.

8.3 Conclusions

All three tracers migrated through the zone disturbed by the presence of the injection hole and a distance into "undisturbed" rock.

The same migration difference found between Cr−EDTA and the tracers Uranine and I^- in Parts I and II was also found in Part III. Uranine and I^- both migrated a longer distance into the rock matrix and also had lower concentrations than Cr−EDTA close to the injection hole.

In some cases, no obvious decrease in tracer concentrations for at least some 400 mm could be seen.

The differences in D_p and K_p could be an order of magnitude between samples separated by just a few tens of centimeters. This was also found in Part II. The drilling arrangement in Part III made it possible to study the concentration profile in more than one direction. In some cases there were large differences between the concentrations in different directions. This is an indication that the values of D_p and K_p are dependent on location (depth) as well as direction.

The changes in migration properties at different locations and in different directions could not be explained by the laboratory experiments performed concerning porosity, pore size distribution or direction of microfissures. The diffusivities and hydraulic conductivities obtained in-situ compared well with those obtained in the laboratory experiments.

9. DISCUSSION

9.1 Sources of error

An in-situ experiment is of course more difficult to perform than a laboratory experiment so that a number of errors of course will occur. The most important errors are listed below.

I	Pressure release	Before overcoring the injection hole, the pressure was released and the packers were removed. This release in pressure allows the tracers to migrate from the surrounding rock to the non-pressurized injection hole by advection. The time between pressure release and drilling was between 1 and 4 weeks.
II	Drilling (Ø 146, 76 mm)	During the drillings, the cores were flushed with water (drilling fluid) and the tracers could migrate out from the cores by diffusion. It took about 3 hours to drill 3 m. When drilling out a core, the surrounding rock stress decreases which will increase the porosity within the core. This increased porosity means that the core "takes up" the surrounding drill fluid which will decrease the tracer concentration.

III	Sampling	The cores were flushed with water during the sampling (cutting into pieces and drilling of sampling cores). This means diffusion out from the core during about 5 minutes (cutting) respective about 2 minutes (drilling).
IV	Analysis	The errors in the analysis was about ± 10 % for concentrations down to $C/C_0 = 0.01$.
V	Porosity	The porosities were determined for every individual sampling core in Parts II and III. The error in the porosity is estimated to be about ± 10 %.

Points I, II, and III decreased the tracer concentrations in the sampling cores. Therefore, the tracer concentrations in the sampling cores may have been higher than indicated in the preceding diagrams.

When looking at the drilling arrangement for Part III it should be noted that the injection hole was overcored first, whereupon the holes denoted E, X, T, R, and A were drilled. The tracers could then migrate closer to the injection hole due to the pressure gradient induced when the injection pressure was decreased and the packers taken up. The tracers could however never migrate further away from the injection hole. Therefore, the tracers could have penetrated even further out into the rock matrix than illustrated in the foregoing diagrams.

9.2 Recommended work

The major aim with this experiment was to investigate if tracers can diffuse into the rock matrix under natural stress conditions. Since the experiment can be regarded as a demonstration experiment for matrix diffusion it is important that the experimental conditions are as close to natural conditions as possible. The following points must therefore be considered:

- Rock stresses
- Water pressure
- Diffusion through fissure coating material
- Sorbing tracers

The experiment has to take place in undisturbed rock. If the water pressure is reduced, then the risk to influence the micro structure of the rock is decreased. If the micropore system within the rock matrix should be available for sorption of radionuclides emerging from a repository, then the nuclides must first diffuse through the sometimes present thin layer of fissure coating material. In a demonstration experiment it might be useful to show that sorbing tracers as well as nonsorbing tracers can diffuse into the rock matrix.

Rock stresses

To avoid the problem with the rock stresses deep drill holes must be used, with fairly small diameter, where the last part of the hole is located in rock that is undisturbed because of the drift. This was done in the presented diffusion experiment.

Water pressure

To avoid using any overpressure when injecting the tracers, one could locate a fracture in the undisturbed part of the hole with natural water flow and close of a small section of it. That would not induce any problems with the pressure gradients. Then one could inject sorbing and nonsorbing (maybe radioactive) tracers for a long time without any overpressure into the fracture. Injection without using any overpressure requires a dilution probe. In the presented experiment a small overpressure was used for the tracer injection and only nonsorbing tracers were used.

Diffusion through fissure coating material

Injecting tracers with a dilution probe implies that the tracers would migrate with the natural water flow into the fracture and diffuse from the fracture, through the fracture coating material, and into the adjacent rock matrix. The fracture coating material as well as the rock matrix would be located in undisturbed rock just a short distance away from the injection zone. In the presented experiment, mainly diffusion in the rock matrix was observed except for one presented case where the tracers must have passed through fissure coating material located in undisturbed rock.

Sorbing tracers

In a demonstration experiment it might be useful to show that sorbing tracers as well as nonsorbing tracers can or cannot diffuse into the rock matrix. In the presented experiment just nonsorbing tracers were used.

Injecting tracers in a fracture with unknown direction and water flow paths will induce huge problems. One way would be to drill out a large number of large cores from the drift and then drill out a large number of sampling cores. To determine the tracer concentration versus distance from the fracture surface, leaching (nonsorbing tracers) and grinding (sorbing tracers) methods could be used. Since channeling occurs in single fractures (Abelin et al., 1985), most of the samples would be obtained from the rock where the adjacent fracture plane have not been in contact with the water. Enough sampling could, however, give information about the extent of channeling. Another problem would be to take samples in the flow direction. The tracers would migrate in the natural flow direction since no overpressure would be used for injection. The natural flow direction is difficult to determine. Therefore, this proposed migration experiment would take long time, cost a lot of money, and cause large analysing problems.

Compared to the presented experiment this proposed experiment would eliminate the need of an overpressure for the tracer injection. It would also be possible to use sorbing tracers since the migration in the fracture is "quick", then the subsequent diffusion through the fissure coating material and the diffusion into the rock matrix would be located in undisturbed rock.

10. SUMMARY OF MAIN RESULTS AND CONCLUSIONS

The conclusions from these experiments are as follows :

- Nonsorbing tracers migrated through the disturbed zone and a distance into undisturbed rock.

- The tracers migrated through fissure coating/filling material located in undisturbed rock.

- Diffusivities and hydraulic conductivities found in-situ compared well with those found in laboratory experiments.

- Large differences in diffusivity and hydraulic conductivity were found in samples located just a few tens of centimeters apart.

- Laboratory measurements concerning pore size distribution, microfissure direction, and porosity could not explain the differences in migration distance between the samples.

The results indicate that it is possible for tracers (and therefore radionuclides) to migrate a considerable distance into a granitic rock matrix under natural stress conditions.

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NOTATION

C	concentration in liquid	mol/m^3
C_0	injection concentration	mol/m^3
D_p	diffusivity in water in pores	m^2/s
K_p	hydraulic conductivity in the rock matrix	m/s
L	length	m
P	pressure	Pa
$P_{\text{"natural"}}$	natural pressure in the rock	Pa
P_1-P_2	pressure difference between injection hole and surrounding rock	Pa
r	radial distance	m
r_f	radial distance for flow	m
r_1	radius of injection hole	m
r_2	radial difference for pressure difference	m
t	time	s
t_c	contact time	s
v_r	radial velocity	m/s

Δ	difference	
ϵ_p	porosity of unfractured rock, matrix porosity	m^3/m^3
σ_r	radial tension	Pa
σ_t	tangential tension	Pa
$\emptyset$	diameter	m

Rock stress measurement

A rock stress measurement was performed by the Swedish Power Board in the hole that was used for Parts I and II of the in-situ experiment. The rock stresses were measured in three points located at 15.5, 16.0, and 17.5 m depth from the floor of the drift, see Figure A1.1. The drift is located approximately 347 m below the ground level. Since the hole where Part III of the in-situ experiment was performed is located just about 5 m from the hole where the rock stress measurement took place the obtained rock stresses are assumed to be valid also for this hole.

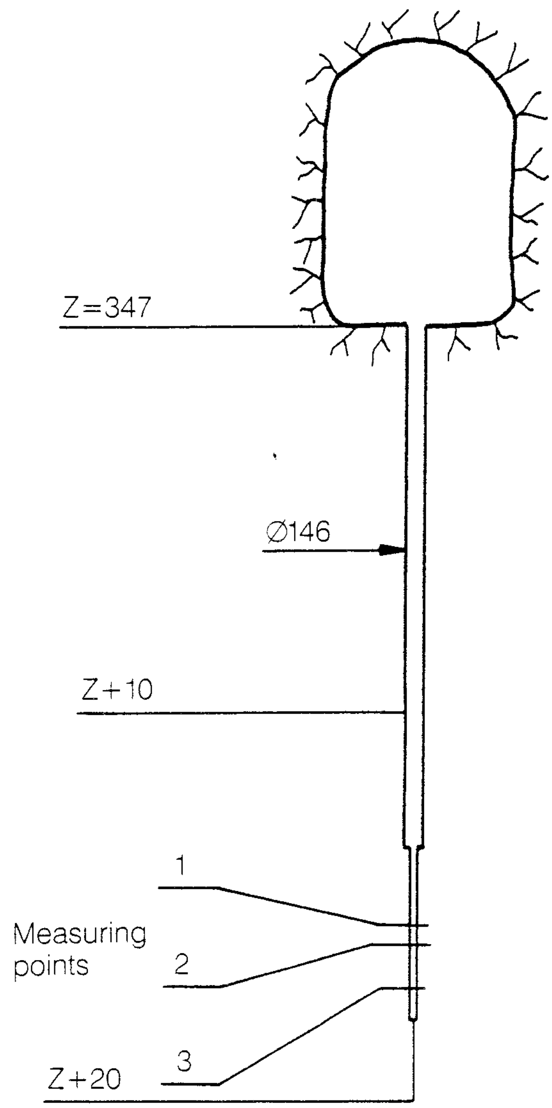


Figure A1.1. Location of the measuring points for the rock stress measurement

The rock stress can be divided into three perpendicular principal stresses. It was found that the largest principal stress was almost horizontal and the minor almost vertical. The largest principal stress was found to be ≈ 28 MPa and the minor ≈ 5 MPa. The second largest principal stress (horizontal) was ≈ 8 MPa. Figure A1.2 shows the results in the three measuring points.

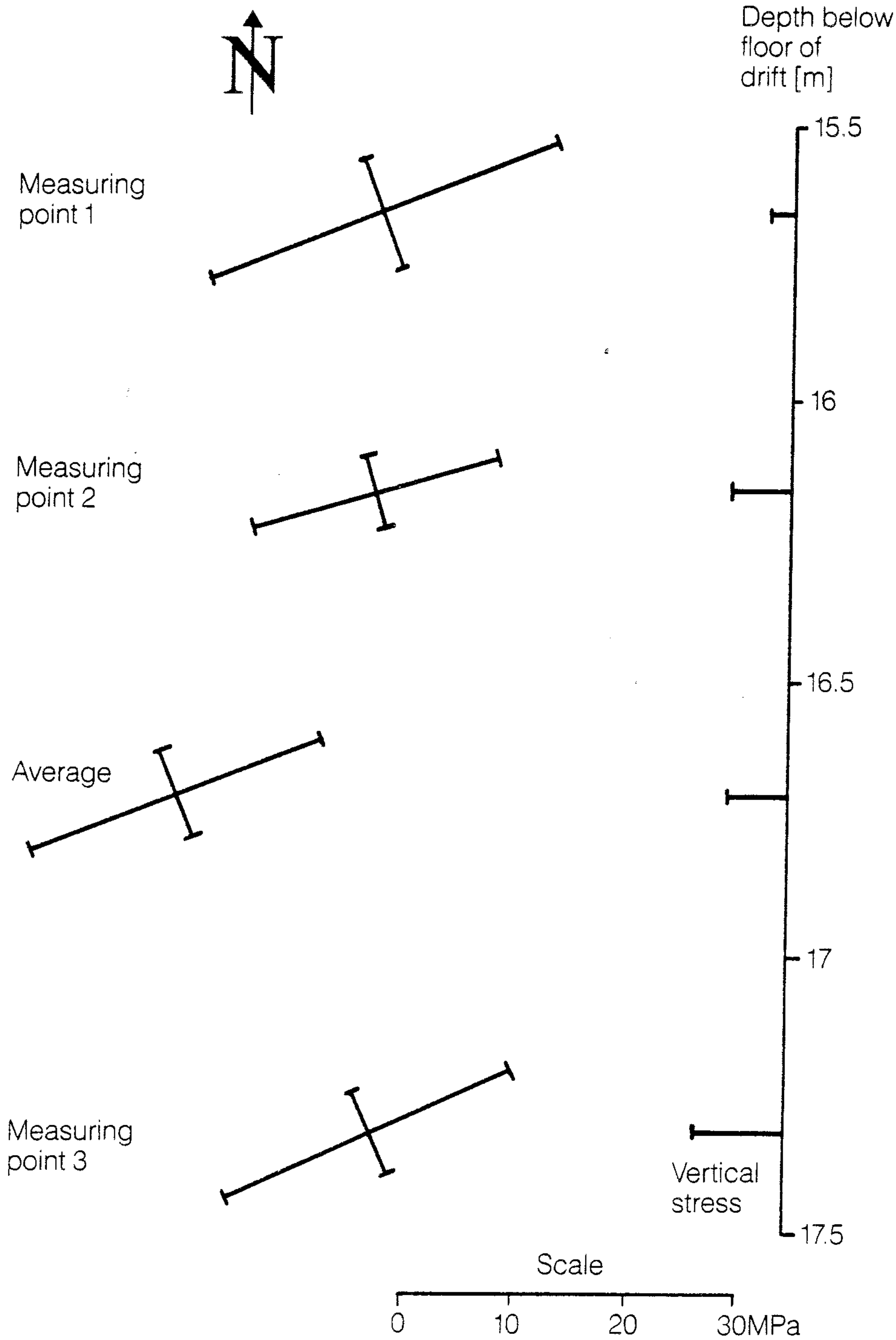


Figure A1.2. The principal stresses projected onto the horizontal plane

The above stress distribution agrees well with what is regarded as natural stress in the Stripa Mine.

Water pressure as a function of distance from a drift

A number of water pressure measurements were performed by Lawrence Berkeley Laboratory (LBL) at the ventilation drift in the Stripa Mine (Wilson, 1981). The presented diffusion experiments were carried out in the extensiometer drift which is located at the same level in the mine and just about 100 m from the ventilation drift. It is therefore assumed that the results from the ventilation drift is valid also for the extensiometer drift. The results from the water pressure measurements are illustrated in Figure A2.1.

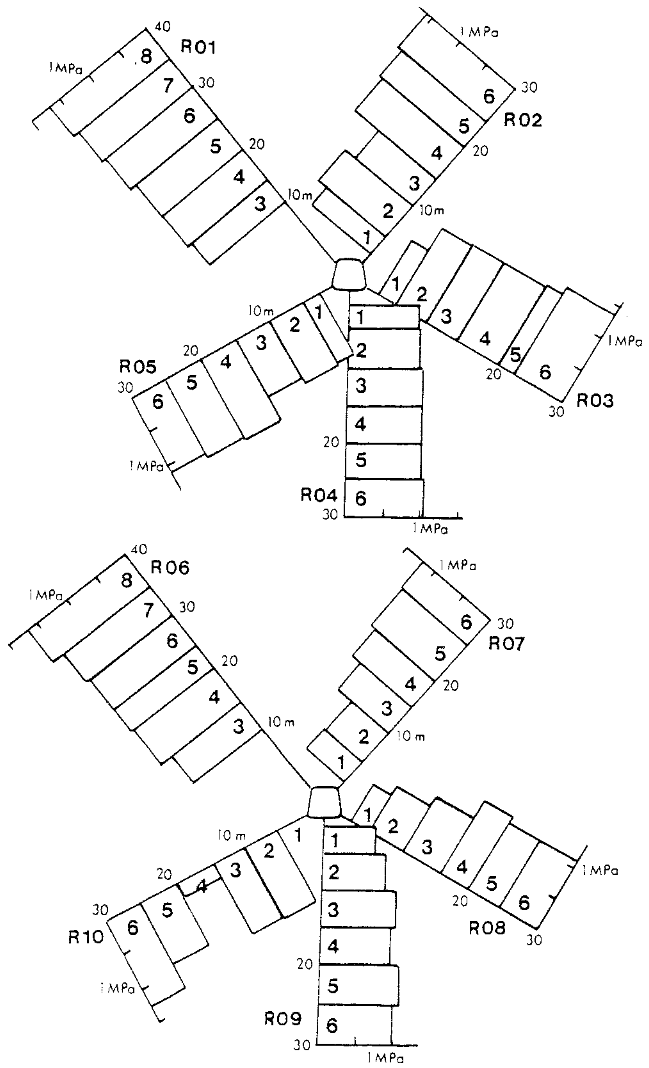


Figure A2.1. Water pressure in the R-holes in the ventilation drift

If the water head above the axis of the drift is plotted as function of radial distance in a lin−log diagram as in Figure A2.2, a number of straight lines are obtained.

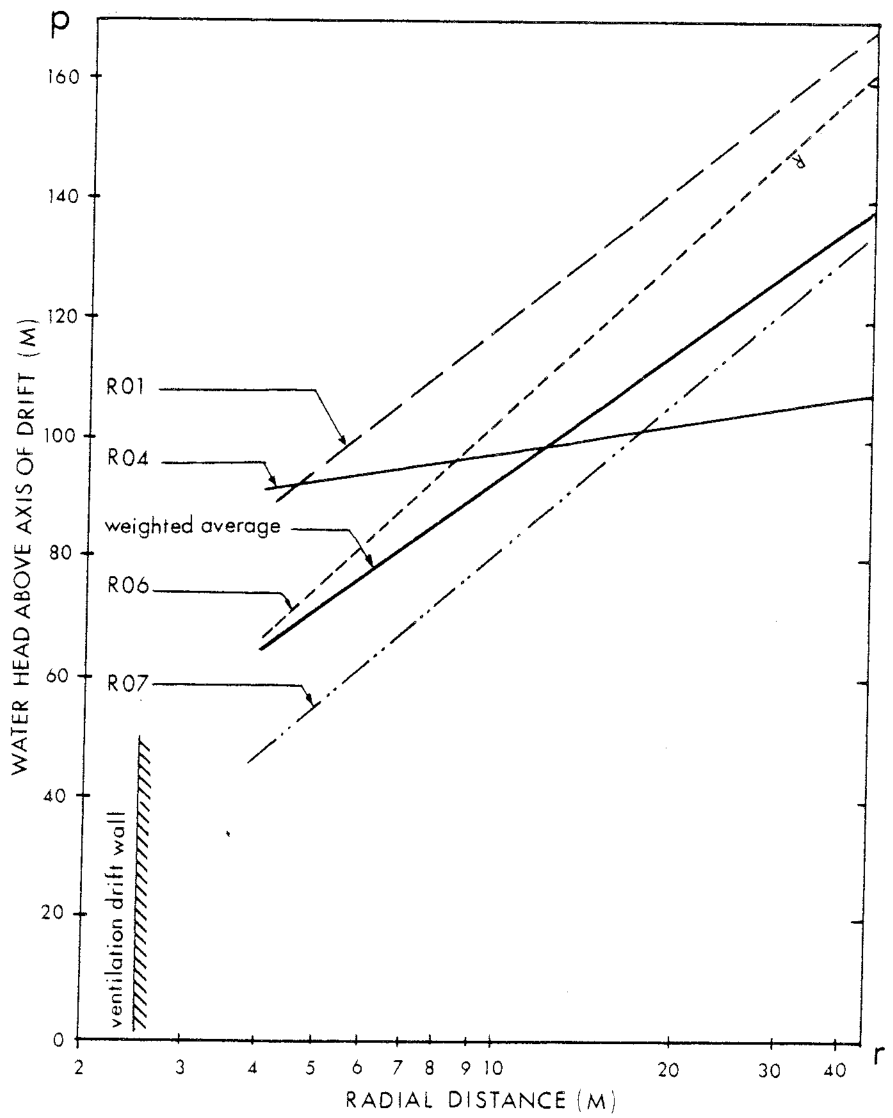


Figure A2.2. Water head above axis of the drift vs radial distance

A straight line in a lin−log diagram means that the pressure is defined as

$$P = C_1 + C_2 * \log r \qquad (A2.1)$$

where C_1 is the intercept, C_2 the slope of the line and r is the radial distance. Differentiation of Equation (A2.1) gives the pressure gradient as function of r,

$$\frac{\partial P}{\partial r} = \frac{C_2}{r * \ln 10} \qquad (A2.2)$$

The slope for the weighted average curve is $C_2 = 75$, which gives

$$\frac{\partial P}{\partial r} = \frac{33}{r} \qquad (A2.3)$$

This means that the difference between the pressure gradients for the injection hole and the surrounding rock is between 2 and 3 m/m (0.02−0.03 MPa/m) at the distance from the drift where the experiments have taken place (≈ 10−20 m) if the injection hole is drilled straight downward. The difference will be less than 2−3 m/m if the injection hole is drilled in any other direction.

The only way to avoid the difficulties with the different pressure gradients and to perform a diffusion experiment is to drill a very deep hole, so that $\partial P/\partial r \rightarrow 0$. But this is unpractical.

Tracer concentrations, Part I.

Table A3.1 gives the notation of the sampling cores, depth in the injection hole, radial distance from the injection hole as well as the relative concentrations for Uranine, Iodide and Cr−EDTA. The concentrations are based on an assumed uniform porosity of 0.345 % in the rock matrix and an assumed uniform density of 2.62 g/cm^3. The relative concentrations are calculated using the tracer concentration in the water after leaching (see Chapter 3) and the porosity. The locations of the cores are given in Figure A3.1.

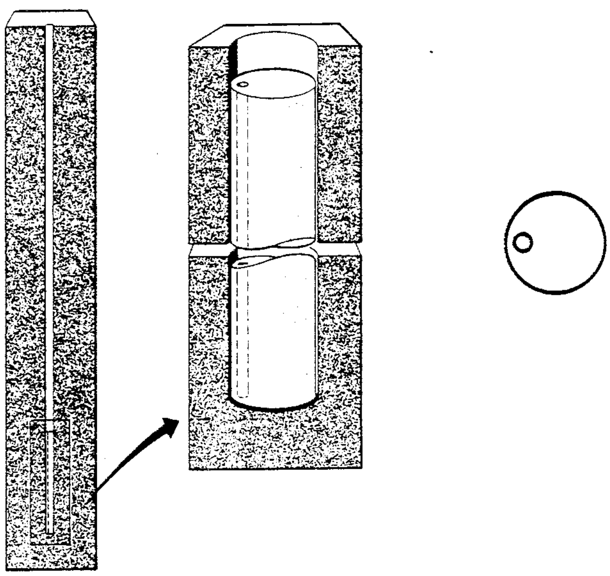


Figure A3.1. Location of core in Part I.

Table A3.1. Concentration data, Part I

Core	No.	Depth [m]	Distance [mm]	Relative concentration Uranine [%]	I⁻ [%]	Cr-EDTA [%]
1	1	0.080	61	38.5	38.7	72.5
	2		53	42.3	43.8	75.8
	3		68	32.2	34.8	63.4
	4		25	—	—	—
	5		19	38.0	36.5	64.5
	6		52	—	—	—
	7		52	35.0	36.8	64.3
	8		105	30.6	32.9	56.8
	9		90	35.5	37.1	64.9
	10		83	—	—	—
	11		37	37.2	37.0	66.7
	12		64	31.5	30.4	56.6
2	1	0.360	43	34.4	32.1	43.7
	2		23	31.0	25.7	54.5
	3		20	—	—	—
	4		37	37.0	33.6	42.7
	5		38	36.1	32.2	71.3
3	1	0.585	18	29.0	24.9	54.3
	2		43	35.2	34.4	66.3
	3		104	13.6	13.1	22.2
	4		56	23.0	18.1	42.7
	5		81	24.0	33.6	21.7
	6		70	24.1	28.5	22.2
	7		72	29.9	29.4	54.0
	8		59	35.6	35.2	64.8
	9		100	9.3	13.3	11.3
	10		40	—	—	—
4	1	≈0.645	≈110	9.0	6.1	21.6
	2		≈110	23.7	19.6	28.0
	3		≈110	18.0	17.8	15.4
	4		≈110	40.6	40.0	29.9
	5		≈110	22.8	21.1	41.5
5	1	≈0.670	≈110	33.4	26.6	50.4
	2		≈110	33.3	29.5	61.5
	3		≈110	19.6	18.0	39.8
6	1	0.925	43	39.7	37.2	72.9
	2		35	16.3	13.3	36.6
	3		64	38.0	31.6	69.3
	4		70	—	—	—
	5		80	26.6	23.4	44.3
	6		103	34.4	28.8	35.5
	7		83	46.5	37.3	69.6
	8		101	26.4	30.8	23.0
	9		81	35.9	29.6	62.4
	10		63	44.9	37.0	78.0
	11		107	32.8	26.5	48.8

Table A3.1 continued

Core	No.	Depth [m]	Distance [mm]	Relative concentration Uranine [%]	I$^-$ [%]	Cr-EDTA [%]
7	1	0.980	83	30.0	25.9	29.1
	2		99	19.0	18.2	25.0
	3		58	36.1	31.8	56.1
	4		63	25.7	23.9	43.9
	5		42	30.7	26.5	68.6
	6		104	13.8	15.5	23.8
	7		80	18.9	23.0	31.4
	8		94	22.4	25.7	37.8
	9		17	16.7	15.3	43.1
	10		33	—	—	—
	11		62	20.7	17.7	58.1
	12		21	28.7	26.6	66.9
8	1	1.035	—	—	—	—
9	1	1.085	105	—	—	—
	2		106	11.9	10.6	11.5
	3		100	13.6	12.1	24.9
	4		83	13.1	11.1	39.7
	5		69	22.2	23.5	37.5
	6		87	22.1	26.0	24.2
	7		93	20.7	21.1	42.2
	8		73	19.9	20.7	21.6
	9		73	17.3	15.7	39.0
	10		53	35.5	29.7	66.0
	11		61	23.1	24.0	49.7
	12		41	25.7	22.6	65.5
	13		31	31.3	26.6	72.8
	14		18	29.9	25.7	68.1
	15		53	37.0	28.6	72.0
10	1	1.140	113	10.8	14.2	12.2
	2		102	11.3	15.0	10.8
	3		81	14.0	14.9	18.6
	4		96	19.3	15.7	39.1
	5		79	26.2	22.8	43.4
	6		74	30.9	25.8	57.6
	7		49	38.6	33.6	78.4
	8		48	38.2	34.5	78.3
	9		28	40.3	38.0	79.0
	10		32	39.6	38.2	84.1
	11		12	37.3	34.0	73.4
	12		31	29.8	27.2	64.9
	13		95	15.0	20.3	13.4
	14		80	16.4	15.8	33.1
	15		61	26.2	24.6	45.2
	16		47	31.3	26.3	63.9
	17		100	13.5	7.2	19.2
	18		84	19.9	12.2	45.2

Table A3.1 continued

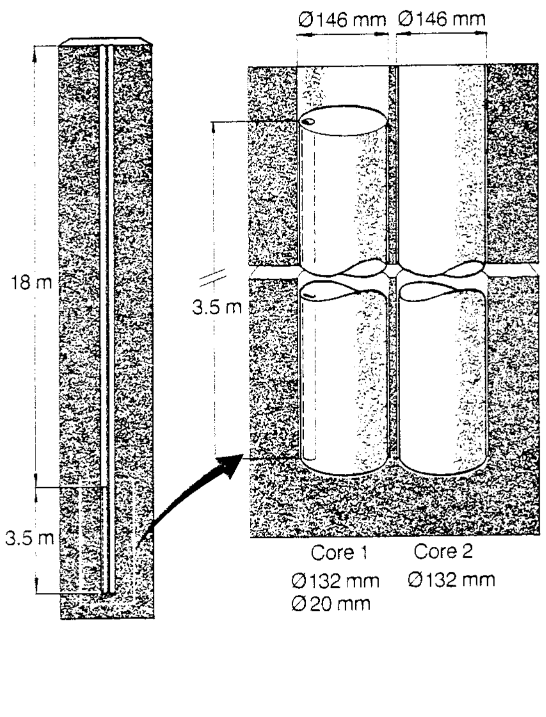
Core	No.	Depth [m]	Distance [mm]	Relative concentration Uranine [%]	I^- [%]	Cr-EDTA [%]
11	1	≈1.270	≈90	4.6	5.8	–
	2		≈90	7.9	7.8	2.1
	3		≈90	10.8	9.2	6.3
	4		≈90	10.5	7.9	12.0
	5		≈90	11.4	7.8	11.2
	6		≈90	6.7	10.7	3.5
	7		≈90	6.1	10.5	2.7
12	1	≈1.330	≈80	33.2	24.0	51.9
	2		≈80	24.7	21.3	22.9
	3		≈80	13.3	12.4	4.9
	4		≈80	2.8	4.3	0.0
	5		≈80	1.2	1.2	0.1
	6		≈80	20.0	13.1	13.4
	7		≈80	3.6	4.6	0.0
	8		≈80	1.2	0.8	0.0
	9		≈80	11.9	9.7	2.0
	10		≈80	6.9	5.2	0.2
	11		≈80	2.4	2.3	0.0
	12		≈80	2.0	0.4	0.0
	13		≈80	1.2	0.0	0.0
13	1	1.605	117	3.7	1.0	0.4
	2		95	2.0	0.6	0.7
	3		109	1.0	0.3	0.6
	4		89	1.4	0.3	0.2
	5		110	0.8	0.1	0.0
	6		90	0.7	0.1	0.2
	7		70	1.1	0.1	0.5
	8		91	0.6	0.1	0.0
	9		66	1.0	0.1	0.0
14	1	1.820	105	3.9	1.8	0.2
	2		85	2.9	2.7	0.9
	3		98	1.7	1.5	0.0
	4		114	1.9	1.7	0.8
	5		80	2.7	2.4	0.1
	6		93	3.9	2.3	0.0
	7		113	2.7	2.1	1.8
	8		73	4.8	4.7	0.7
	9		91	4.7	3.2	0.2
	10		97	2.6	2.8	0.0
	11		72	4.5	6.6	0.0
	12		74	6.1	11.1	1.7

Table A3.1 continued

Core	No.	Depth [m]	Distance [mm]	Relative concentration Uranine [%]	I^- [%]	Cr-EDTA [%]
15	1	2.025	62	0.4	0.1	0.0
	2		81	0.6	0.0	0.0
	3		62	0.3	0.0	0.0
	4		95	0.7	0.0	0.0
	5		78	0.6	0.0	0.0
	6		106	0.7	0.1	0.0
	7		92	1.0	0.1	0.0
	8		116	0.4	0.4	0.0
	9		98	0.7	0.6	0.0
	10		103	1.9	2.1	0.0
	11		108	–	–	–
	12		87	0.6	–	0.0
	13		98	–	–	–
	14		81	0.9	1.1	0.0
	15		66	0.6	0.1	0.4
	16		21	2.4	2.1	0.1
	17		40	1.6	0.8	0.2
	18		71	0.8	0.2	0.0
16	1	2.125	42	1.0	0.0	0.2
	2		20	0.6	0.0	0.2
	3		40	0.9	0.0	0.2
	4		35	1.4	0.0	0.0
	5		18	1.4	0.0	0.1
	6		50	0.6	0.1	0.2
	7		58	0.7	0.0	0.2
	8		81	0.8	0.0	0.3
	9		118	0.5	0.0	0.9
	10		100	0.6	0.0	0.3
	11		100	0.4	0.0	0.0
	12		82	0.8	0.0	0.1
	13		60	0.7	0.0	0.2
	14		106	0.8	0.0	0.3

Porosities and tracer concentrations, Part II.

Table A4.1 gives the notation of the sampling cores, depth in the injection hole, radial distance from the injection hole, porosity as well as the relative concentrations for Uranine, Iodide, and Cr−EDTA. The porosity is calculated from the weight difference between a wet and dry sampling core and an assumed uniform density of 2.62 g/cm³. The relative concentrations are calculated using the tracer concentration in the water after leaching (see chapter 3) and the porosity. The locations of the cores are given in Figure A4.1.



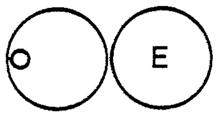


Figure A4.1. Location of cores in Part II.

Table A4.1. Porosity and concentration data, Part II

Core	No.	Depth [m]	Distance [mm]	Porosity [%]	Relative concentration Uranine [%]	I⁻ [%]	Cr-EDTA [%]
1	1	0.359	47	0.34	16.9	13.8	22.1
	2		69	0.32	19.2	15.2	27.4
	3		49	0.33	18.5	14.2	29.4
	4		87	0.28	27.5	18.9	40.4
	5		98	0.36	23.7	14.4	32.2
	6		80	0.26	27.9	18.4	39.2
	7		60	0.31	30.8	20.9	48.0
	8		95	0.47	19.1	12.4	28.7
	9		84	0.38	22.9	27.1	30.0
	10		68	0.34	24.9	21.6	33.3
	11		26	0.32	20.6	16.8	27.6
	12		40	0.34	18.6	10.6	27.0
	13		16	0.35	28.0	20.2	43.5
	14		66	0.34	22.2	20.4	26.0
	15		33	0.35	24.3	20.5	32.0
2	1	0.480	43	0.28	35.2	27.1	50.5
	2		36	0.31	34.6	25.7	46.7
	3		68	0.36	30.8	27.8	42.9
	4		91	0.43	29.6	24.0	30.2
	5		80	0.30	25.2	15.4	30.1
	6		88	0.29	27.6	17.6	37.8
	7		62	0.25	32.0	21.4	40.8
	8		78	0.31	23.9	15.2	33.8
	9		94	0.30	25.1	12.6	28.6
	10		95	0.27	28.2	22.0	34.7
	11		53	0.25	35.3	18.7	41.9
	12		59	0.30	38.1	20.1	52.0
	13		29	0.33	34.0	22.3	48.2
	14		11	0.36	33.1	22.8	54.2
	15		71	0.22	26.4	18.1	35.4
	16		—	—	—	—	—
	17		20	0.34	28.8	19.7	43.1
3	1	0.784	84	0.27	0.1	0.3	0.1
	2		67	0.28	0.1	0.1	0.2
	3		58	0.28	0.1	0.2	0.1
	4		59	0.29	0.1	0.2	0.2
	5		77	0.28	0.1	0.0	0.2
	6		77	0.27	0.1	0.0	0.2
	7		98	0.29	0.1	0.0	0.1
	8		83	0.28	0.1	0.0	0.1
	9		96	0.25	0.0	0.0	0.1
	10		110	0.29	0.1	—	0.2
	11		102	0.27	0.1	0.1	0.0

Table A4.1 continued

Core	No.	Depth [m]	Distance [mm]	Porosity [%]	Relative concentration Uranine [%]	I^- [%]	Cr-EDTA [%]
4	1	0.904	70	0.28	0.3	2.3	0.1
	2		92	0.26	0.1	0.2	0.0
	3		81	0.30	0.1	0.2	0.0
	4		59	0.31	1.0	2.8	0.1
	5		40	0.28	16.9	10.5	6.8
	6		19	0.31	24.4	13.7	36.5
	7		29	0.32	20.0	11.1	10.4
	8		52	0.28	0.9	2.8	0.1
	9		70	0.28	0.2	0.0	0.0
	10		69	0.27	0.1	0.5	0.0
	11		94	0.32	0.1	0.1	0.0
	12		91	0.26	0.0	0.1	0.2
	13		51	0.29	0.4	1.8	0.2
	14		103	0.28	0.1	0.1	0.1
	15		44	0.28	16.4	14.2	7.3
	16		62	0.27	1.7	—	0.0
	17		28	0.28	34.9	30.3	44.0
5	1	0.956	56	0.28	0.9	2.7	0.3
	2		28	0.28	1.9	18.6	12.5
	3		10	0.28	16.3	16.4	29.5
	4		75	0.26	0.1	1.0	0.2
	5		100	0.26	0.0	0.2	0.2
	6		85	0.27	0.1	0.6	0.0
	7		62	0.31	0.7	2.2	0.1
	8		39	0.29	11.9	7.8	4.5
	9		14	0.28	22.9	18.4	40.0
	10		62	0.32	0.4	0.8	0.1
	11		83	0.27	0.1	0.5	0.0
	12		19	0.27	22.3	21.9	37.8
	13		37	0.28	20.6	16.0	17.6
	14		63	0.26	1.2	4.2	0.0
	15		93	0.32	0.1	0.3	0.0
	16		83	0.29	0.1	1.0	0.0
	17		62	0.24	5.6	7.5	0.3
	18		32	0.26	24.7	17.4	22.4

Table A4.1 continued

Core	No.	Depth [m]	Distance [mm]	Porosity [%]	Relative concentration Uranine [%]	I⁻ [%]	Cr-EDTA [%]
6	1	1.271	34	0.33	9.1	8.2	9.4
	2		52	0.35	7.3	5.8	1.8
	3		26	0.34	16.5	12.6	20.5
	4		57	0.31	3.8	4.2	0.2
	5		12	0.35	17.8	12.1	27.2
	6		42	0.33	13.6	11.5	8.7
	7		42	0.33	5.2	6.0	2.6
	8		20	0.43	4.3	6.0	4.7
	9		67	0.33	0.5	0.9	0.0
	10		65	0.34	0.3	1.1	0.0
	11		53	0.22	0.6	1.4	0.0
	12		70	0.25	0.3	0.2	0.0
	13		82	0.35	0.3	0.5	0.0
	14		91	0.30	0.1	0.1	0.1
	15		102	0.34	0.2	0.0	0.0
	16		101	0.31	0.2	0.1	0.0
	17		82	0.26	0.6	0.5	0.0
	18		95	0.25	0.1	0.2	0.2
	19		23	0.31	13.5	8.2	19.6
7	1	1.315	76	0.29	0.3	0.7	0.2
	2		68	0.26	1.9	2.8	0.3
	3		31	0.32	19.3	14.8	15.6
	4		55	0.36	1.2	2.2	0.1
	5		42	0.30	15.2	8.6	10.3
	6		63	0.32	2.1	2.2	0.0
	7		86	0.41	0.1	0.2	0.1
	8		100	0.31	0.1	0.1	0.0
	9		92	0.31	0.1	0.2	0.0
	10		87	0.32	0.1	0.2	0.0
	11		69	0.27	0.5	0.9	0.0
	12		42	0.28	7.4	5.6	0.8
	13		19	0.28	23.5	12.7	37.3
	14		15	0.27	31.5	15.3	45.2
	15		19	0.29	17.9	11.0	28.2
8	1	1.365	52	0.28	9.9	4.4	3.6
	2		68	0.30	2.2	2.2	0.7
	3		75	0.29	1.3	1.2	0.2
	4		89	0.29	0.3	0.7	0.0
	5		67	0.28	3.3	3.9	0.2
	6		74	0.33	1.1	3.6	0.1
	7		89	0.29	0.2	0.5	0.2
	8		102	0.25	0.1	0.1	0.0
	9		94	0.31	0.1	0.2	0.3
	10		12	0.27	21.8	13.7	33.7
	11		16	0.26	27.2	20.0	45.6
	12		39	0.33	11.6	6.7	10.9
	13		63	0.30	2.0	1.7	0.3
	14		23	0.34	16.7	8.8	16.5
	15		46	0.30	10.3	5.7	0.6

Table A4.1 continued

Core	No.	Depth [m]	Distance [mm]	Porosity [%]	Relative concentration Uranine [%]	I^- [%]	Cr-EDTA [%]
9	1	1.409	20	0.29	19.9	11.7	20.0
	2		48	0.29	0.4	1.1	0.1
	3		70	0.28	0.0	0.2	0.0
	4		39	0.31	1.8	2.6	0.0
	5		45	0.26	3.1	2.5	0.9
	6		64	0.29	0.2	0.9	0.0
	7		81	0.28	0.0	0.1	0.0
	8		60	0.27	0.1	0.5	0.0
	9		68	0.34	0.1	0.5	0.1
	10		79	0.26	0.0	0.1	0.0
	11		105	0.25	0.1	0.0	0.0
	12		89	0.36	0.0	0.0	0.4
10	1	1.455	40	0.33	1.5	2.6	0.8
	2		65	0.36	0.1	0.0	0.0
	3		90	0.34	0.1	0.0	0.0
	4		69	0.27	0.1	0.0	0.0
	5		46	0.53	0.2	0.0	0.0
	6		36	0.33	0.1	0.1	0.0
	7		62	0.30	0.1	0.0	0.0
	8		65	0.40	0.0	0.0	0.1
	9		30	0.28	0.1	0.2	0.0
	10		65	0.60	0.1	0.0	0.0
	11		97	0.26	0.0	0.0	0.0
11	1	1.505	11	0.29	13.6	13.5	17.2
	2		10	0.56	0.7	3.5	0.5
	3		26	—	—	—	—
	4		36	0.39	4.4	5.2	4.4
	5		49	—	—	—	—
	6		58	0.34	1.9	2.0	0.7
	7		36	—	—	—	—
	8		45	0.46	0.2	0.0	0.0
	9		64	0.34	0.1	0.0	0.0
	10		82	0.32	0.2	0.0	0.1
	11		100	0.51	0.1	0.0	0.0
12	1	1.551	17	0.35	3.4	3.9	1.5
	2		35	0.28	0.4	0.8	0.3
	3		55	0.27	0.1	0.0	0.5
	4		87	0.28	0.1	0.0	0.0
	5		34	0.30	0.1	0.0	0.0
	6		49	0.31	0.1	0.0	0.2
	7		73	0.29	0.1	0.0	0.0
	8		75	0.27	0.2	0.0	0.0
	9		58	0.34	0.1	0.0	0.0

Table A4.1 continued

Core	No.	Depth [m]	Distance [mm]	Porosity [%]	Relative concentration Uranine [%]	I⁻ [%]	Cr-EDTA [%]
13	1	1.591	17	0.50	3.1	3.2	3.3
	2		29	0.29	1.5	1.4	0.3
	3		66	0.26	0.1	0.0	0.0
	4		70	0.30	0.2	0.1	0.0
	5		79	0.28	0.1	0.1	0.0
	6		85	0.31	0.1	0.0	0.0
	7		98	0.22	0.1	0.0	0.2
	8		96	0.29	0.1	0.0	0.2
	9		97	0.27	0.1	0.0	0.0
14	1	1.739	11	0.32	18.2	12.6	29.8
	2		34	0.32	24.5	13.7	35.5
	3		55	0.38	5.9	3.5	2.9
	4		74	0.28	1.2	1.0	0.2
	5		92	0.30	0.3	0.5	0.0
	6		107	0.30	0.1	0.0	0.0
	7		99	0.28	0.2	0.5	0.1
	8		82	0.29	2.5	1.2	0.0
	9		63	0.31	6.6	3.5	3.8
	10		43	0.32	25.1	13.3	30.9
	11		23	0.34	23.8	15.4	36.7
	12		100	0.27	0.6	0.5	0.0
	13		81	0.28	6.5	3.3	0.5
	14		61	0.28	23.3	12.9	16.3
	15		79	0.30	11.1	8.0	1.0
	16		42	0.36	23.1	15.7	30.2
	17		59	0.31	21.3	12.0	16.6
	18		24	0.36	24.8	18.2	29.0
	19		13	0.34	17.0	13.1	25.6
	20		33	0.30	12.0	9.6	9.6
	21		74	0.32	0.6	1.2	0.0
	22		61	0.30	1.4	1.7	0.0
	23		75	0.30	0.8	1.5	0.0
	24		90	0.34	0.2	0.5	0.0
	25		96	0.44	0.1	0.3	0.0

Table A4.1 continued

Core	No.	Depth [m]	Distance [mm]	Porosity [%]	Relative concentration Uranine [%]	I⁻ [%]	Cr-EDTA [%]
15	1	1.791	7	0.30	21.3	14.3	31.3
	2		26	0.27	27.6	16.5	42.8
	3		45	0.30	20.9	11.7	22.6
	4		62	0.33	11.3	7.4	5.6
	5		82	0.35	2.3	2.9	0.2
	6		103	0.35	0.1	0.5	0.0
	7		98	0.32	0.3	0.8	0.0
	8		79	0.32	1.4	2.4	0.2
	9		91	0.30	0.4	1.2	0.3
	10		56	0.34	6.8	5.6	1.6
	11		51	0.29	10.9	7.9	5.6
	12		38	0.32	12.0	12.0	19.2
	13		20	0.32	23.3	15.4	34.2
	14		36	0.30	24.4	12.9	33.0
	15		52	0.29	15.7	8.5	10.9
	16		95	0.37	1.1	1.4	0.0
	17		74	0.31	12.2	4.6	4.4
	18		54	0.30	14.5	7.0	16.2
	19		33	0.29	22.4	12.8	31.1
	20		19	0.26	23.3	16.3	36.6
	21		90	0.30	3.6	2.0	0.3
	22		73	0.32	10.5	4.2	0.8
	23		53	0.28	20.1	9.0	12.6
	24		36	0.29	21.3	9.3	23.3
	25		70	0.28	4.7	10.3	0.1
16	1	1.843	11	0.27	24.7	21.8	40.8
	2		30	0.33	20.5	17.0	32.6
	3		50	0.33	18.0	11.5	28.1
	4		71	0.31	13.2	8.5	9.8
	5		89	0.34	5.1	4.5	0.4
	6		105	0.37	1.3	2.2	0.3
	7		97	0.31	3.7	3.2	0.1
	8		75	0.32	16.8	9.0	6.6
	9		53	0.31	24.0	14.3	33.2
	10		36	0.32	23.4	17.9	39.2
	11		29	0.29	26.2	22.0	42.2
	12		89	0.30	7.8	4.8	0.5
	13		70	0.30	22.1	10.3	8.4
	14		56	0.30	20.2	11.9	18.7
	15		43	0.30	19.5	13.7	13.4
	16		86	0.31	4.9	3.5	0.5
	17		76	0.33	3.4	4.4	0.7
	18		90	0.33	1.6	3.2	0.6
	19		89	0.32	0.6	3.2	0.6
	20		103	0.33	0.6	1.8	0.5
	21		53	0.37	7.6	10.7	2.7
	22		35	0.30	21.3	16.0	35.7
	23		20	0.30	16.6	14.2	32.4
	24		40	0.29	21.5	13.0	26.3

Table A4.1 continued

Core	No.	Depth [m]	Distance [mm]	Porosity [%]	Relative concentration Uranine [%]	I^- [%]	Cr-EDTA [%]
17	1	1.891	53	0.30	20.7	12.5	13.7
	2		74	0.29	8.2	6.1	0.0
	3		36	0.28	26.3	25.0	34.7
	4		17	0.31	23.1	19.1	31.9
	5		12	0.34	22.2	18.6	32.0
	6		30	0.32	25.5	20.7	38.2
	7		51	0.30	26.8	14.7	28.6
	8		30	0.33	20.8	13.6	28.0
	9		46	0.30	24.8	16.0	29.7
	10		68	0.31	19.8	11.1	4.8
	11		63	0.32	20.8	12.0	12.5
	12		103	0.32	0.7	1.8	0.0
	13		89	0.31	5.8	5.3	0.0
	14		79	0.33	12.8	8.2	1.6
	15		80	0.34	6.2	5.7	0.0
	16		97	0.35	3.2	3.6	0.0
	17		102	0.27	2.6	3.6	0.0
	18		13	0.32	22.7	19.2	29.1
	19		29	0.31	22.6	16.9	24.7
	20		49	0.34	14.2	9.6	4.6
	21		73	0.33	3.0	4.3	0.0
	22		92	0.32	0.7	1.9	0.0
	23		35	0.31	13.4	9.2	10.5
	24		55	0.32	4.5	5.4	0.0
	25		88	0.26	0.4	1.1	0.0
18	1	2.031	8	0.33	17.7	17.9	27.6
	2		27	0.34	27.9	17.8	32.3
	3		45	0.36	13.2	9.3	7.6
	4		64	0.35	2.4	2.9	0.1
	5		80	0.32	0.2	0.6	0.3
	6		100	0.33	0.1	0.1	0.0
	7		96	0.27	0.1	0.2	0.2
	8		74	0.32	0.3	0.8	0.0
	9		88	0.27	0.1	0.4	0.1
	10		53	0.30	3.3	5.2	0.4
	11		69	0.32	0.5	1.5	0.0
	12		33	0.33	13.0	12.5	7.4
	13		23	0.34	12.5	11.3	10.5
	14		52	0.33	2.1	3.7	0.3
	15		41	0.32	3.0	6.3	0.8
	16		68	0.31	0.2	0.3	0.1
	17		89	0.34	0.4	0.4	0.0
	18		69	0.33	1.7	1.8	0.2
	19		47	0.31	2.0	4.5	0.2
	20		28	0.32	12.3	12.1	6.8
	21		13	0.31	24.0	16.1	27.1
	22		28	0.31	8.3	7.9	3.0
	23		48	0.31	1.2	2.3	0.0
	24		64	0.29	0.6	1.2	0.1
	25		64	0.33	0.1	0.7	0.1
	26		88	0.31	0.1	0.4	0.1

Table A4.1 continued

Core	No.	Depth [m]	Distance [mm]	Porosity [%]	Relative concentration Uranine [%]	I$^-$ [%]	Cr-EDTA [%]
19	1	2.079	56	0.27	19.8	15.8	9.3
	2		74	0.27	7.5	9.0	0.7
	3		90	0.28	1.4	4.1	0.0
	4		106	0.28	0.3	1.3	0.3
	5		35	0.29	35.3	26.7	39.2
	6		16	0.32	30.2	26.0	42.7
	7		9	0.32	32.8	25.9	46.0
	8		29	0.29	33.8	24.6	34.4
	9		38	0.28	14.5	15.2	4.8
	10		66	0.30	8.7	10.2	2.9
	11		31	0.32	21.9	16.0	23.1
	12		86	0.31	14.8	11.1	14.5
	13		84	0.27	2.3	7.8	0.6
	14		101	0.26	1.0	2.8	0.2
	15		99	0.25	6.9	5.6	4.9
	16		9	0.28	21.7	14.4	25.6
	17		29	0.30	37.6	29.3	52.2
	18		22	0.32	27.6	18.9	35.9
	19		51	0.30	29.6	18.2	26.1
	20		54	0.31	27.3	16.5	24.4
	21		71	0.31	9.6	12.4	0.6
	22		94	0.32	5.6	1.9	0.0
	23		67	0.29	10.8	8.1	2.0
	24		89	0.28	1.2	2.6	0.1
20	1	2.239	86	0.25	26.8	16.8	8.8
	2		101	0.23	10.7	8.9	0.3
	3		80	0.26	29.7	17.9	15.3
	4		102	0.30	5.1	4.9	1.2
	5		86	0.30	11.8	8.7	4.5
	6		101	0.24	1.1	2.2	0.3
	7		64	0.28	30.8	19.8	35.4
	8		61	0.25	40.3	28.9	50.7
	9		75	0.29	8.4	6.7	1.2
	10		65	0.27	14.4	10.4	3.5
	11		47	0.29	26.8	19.3	32.2
	12		43	0.29	34.7	29.8	54.8
	13		27	0.28	27.9	22.5	39.1
	14		41	0.28	31.4	19.6	32.6
	15		14	0.30	34.3	40.6	52.2
	16		73	0.25	40.1	28.5	28.9
	17		47	0.29	39.2	34.3	53.0
	18		60	0.24	49.6	35.3	54.0
	19		28	0.29	36.4	29.4	47.9
	20		11	0.30	18.4	17.5	32.5
	21		43	0.26	43.5	37.8	59.3
	22		20	0.27	41.0	34.5	56.1

Table A4.1 continued

Core	No.	Depth [m]	Distance [mm]	Porosity [%]	Relative concentration Uranine [%]	I^- [%]	Cr-EDTA [%]
21	1	2.624	103	0.28	46.5	27.8	45.2
	2		87	0.29	36.5	28.8	54.3
	3		70	0.29	36.3	44.8	54.3
	4		53	0.30	40.1	37.7	64.4
	5		35	0.31	35.5	28.6	56.9
	6		17	0.31	28.5	34.3	47.4
	7		100	0.31	37.3	24.8	47.7
	8		82	0.31	35.2	28.3	58.9
	9		64	0.32	30.5	29.1	51.9
	10		45	0.30	32.4	29.9	52.9
	11		26	0.34	41.1	34.2	64.7
	12		8	0.28	34.8	27.4	57.3
	13		93	0.30	43.3	24.6	42.9
	14		77	0.29	38.2	29.6	57.9
	15		58	0.28	34.8	32.6	59.1
	16		41	0.28	34.6	30.8	55.4
	17		25	0.28	39.0	34.4	59.5
	18		76	0.29	40.4	26.8	45.3
	19		56	0.28	38.1	31.1	57.1
	20		102	0.29	47.0	29.6	54.3
	21		83	0.30	38.5	33.1	54.6
	22		61	0.28	35.6	32.3	53.2
	23		42	0.27	42.4	37.6	60.4
	24		28	0.26	45.5	40.5	62.7
	25		11	0.32	36.3	26.0	54.6
	26		95	0.30	39.9	26.7	50.1
	27		77	0.28	40.6	33.5	62.0
	28		60	0.27	41.2	35.8	58.6
	29		46	0.31	44.6	37.3	62.0
	30		75	0.26	37.7	28.9	57.6

Table A4.1 continued

Core	No.	Depth [m]	Distance [mm]	Porosity [%]	Relative concentration Uranine [%]	I$^-$ [%]	Cr-EDTA [%]
22	1	2.672	79	0.34	27.8	25.1	39.7
	2		95	0.29	41.4	31.2	50.5
	3		100	0.31	35.7	23.1	41.4
	4		94	0.29	41.8	25.4	33.0
	5		70	0.34	34.4	26.4	49.8
	6		60	0.32	26.2	37.0	40.9
	7		79	0.28	44.4	27.3	38.1
	8		73	0.30	41.6	36.5	63.1
	9		99	0.29	40.5	29.3	50.6
	10		79	0.30	38.7	33.9	59.6
	11		56	0.30	41.2	37.0	62.8
	12		59	0.31	35.4	30.1	53.1
	13		79	0.27	42.5	34.2	59.9
	14		41	0.32	35.2	31.3	52.9
	15		36	0.30	40.5	35.6	62.3
	16		42	0.29	44.7	39.3	64.3
	17		63	0.29	34.4	32.1	54.7
	18		51	0.28	49.0	38.9	73.9
	19		61	0.29	41.0	30.8	55.4
	20		41	0.25	47.2	43.1	70.7
	21		31	0.28	42.0	36.4	64.8
	22		17	0.33	33.0	30.3	51.9
	23		23	0.32	41.6	36.8	66.8
	24		19	0.32	38.8	32.9	55.4

Table A4.1 continued

Core	No.	Depth [m]	Distance [mm]	Porosity [%]	Relative concentration Uranine [%]	I⁻ [%]	Cr-EDTA [%]
1E	1	0.314	200	0.37	11.3	12.1	9.1
	2		174	0.26	30.0	28.5	39.6
	3		202	0.40	9.5	11.4	10.0
	4		197	0.31	22.3	20.2	23.8
	5		165	0.32	7.4	10.5	5.0
	6		248	0.32	2.8	5.8	0.8
	7		236	0.40	9.1	8.6	7.5
	8		167	0.32	13.4	14.7	16.5
	9		187	0.28	19.0	19.5	20.8
	10		173	0.42	17.1	15.7	21.0
	11		216	0.35	11.8	13.4	9.3
	12		215	0.32	12.2	14.7	10.4
	13		229	0.31	7.4	11.2	4.0
	14		219	0.30	14.4	12.1	12.4
2E	1	0.374	177	0.27	23.1	26.0	28.6
	2		236	0.30	12.2	14.1	7.1
	3		246	0.33	1.8	–	0.5
	4		–	–	–	–	–
	5		180	0.34	12.1	–	10.7
	6		200	0.30	14.8	17.5	13.0
	7		224	0.38	11.2	12.0	10.3
	8		214	0.32	9.6	19.7	5.9
	9		177	0.38	11.8	14.0	10.4
	10		211	0.30	12.4	11.8	20.9
	11		202	0.29	12.1	14.6	9.5
	12		193	0.29	22.0	28.1	26.1
	13		196	0.33	8.3	21.1	2.7
	14		159	0.27	15.9	17.6	21.0
	15		220	0.30	3.7	18.1	1.9
3E	1	0.424	239	0.28	20.8	21.7	22.7
	2		223	0.29	13.9	13.6	18.9
	3		191	0.43	20.4	19.6	31.3
	4		158	0.38	12.9	11.7	16.1
	5		173	0.24	16.4	16.5	17.2
	6		228	0.32	9.8	7.7	13.1
	7		197	0.21	17.5	15.4	17.2
	8		250	0.29	17.8	16.2	16.0
	9		189	0.37	7.8	7.5	14.3
	10		217	0.29	16.0	12.2	15.7
	11		223	0.40	17.8	13.3	22.8
	12		201	0.29	16.4	12.0	21.9
	13		185	0.28	14.6	13.6	23.6
4E	1	0.849	180	0.36	0.1	0.0	0.0
	2		234	0.29	0.1	0.1	0.2
	3		245	0.32	0.1	0.0	0.0
	4		166	0.33	0.0	0.0	0.1
	5		201	0.38	0.0	0.0	0.0
	6		241	0.26	0.1	0.0	0.4
	7		211	0.32	0.1	0.0	0.2
	8		163	0.34	0.2	0.0	0.0

Table A4.1 continued

Core	No.	Depth [m]	Distance [mm]	Porosity [%]	Relative concentration Uranine [%]	I⁻ [%]	Cr-EDTA [%]
5E	1	0.904	234	0.24	0.2	0.0	0.0
	2		166	0.28	0.2	0.0	0.2
	3		244	0.26	0.3	0.0	0.0
	4		137	0.28	0.2	0.0	0.0
	5		215	0.27	0.2	0.0	0.2
	6		248	0.25	0.3	0.0	0.0
	7		196	0.27	0.3	0.0	0.0
	8		154	0.29	0.2	0.0	0.0
6E	1	1.136	250	0.26	0.3	0.0	0.3
	2		153	0.25	0.2	0.0	0.1
	3		205	0.29	0.2	0.0	0.0
	4		207	0.28	0.1	0.0	0.1
	5		172	0.28	0.2	0.0	0.0
	6		233	0.29	0.2	0.0	0.0
	7		173	0.28	0.2	0.0	0.0
7E	1	1.235	250	0.32	0.0	0.0	0.0
	2		155	0.28	0.1	0.0	0.0
	3		214	0.23	0.2	0.0	0.2
	4		198	0.30	0.1	0.1	0.0
	5		226	0.27	0.1	0.0	0.4
	6		236	0.24	0.1	0.0	0.4
	7		184	0.31	0.1	0.1	0.4
	8		174	0.29	0.1	0.0	0.0
8E	1	1.409	155	0.37	0.2	0.0	0.4
	2		250	0.60	0.1	0.0	0.2
	3		200	0.32	0.2	0.1	0.5
	4		210	0.32	0.1	0.0	0.0
	5		177	0.40	0.2	0.0	0.0
	6		238	0.28	0.2	0.0	0.1
	7		235	0.39	0.1	0.0	0.0
	8		173	0.32	0.2	0.0	0.0
9E	1	1.455	250	0.50	0.1	0.0	0.0
	2		155	0.28	0.1	0.1	0.0
	3		212	0.32	0.1	0.0	0.0
	4		202	0.18	0.2	0.1	0.0
	5		172	0.34	0.3	0.0	0.0
	6		175	0.38	0.2	0.0	0.0
	7		235	0.45	0.1	0.0	0.0
	8		232	0.33	0.2	0.0	0.0
10E	1	1.596	250	0.38	0.1	0.0	0.0
	2		153	0.36	0.1	0.0	0.0
	3		202	0.30	0.1	0.0	0.0
	4		211	0.32	0.2	0.0	0.0
	5		237	0.36	0.1	0.0	0.0
	6		—	—	—	—	—
	7		232	0.29	0.2	0.0	0.0
	8		165	0.28	0.0	0.0	0.0

Table A4.1 continued

Core	No.	Depth [m]	Distance [mm]	Porosity [%]	Relative concentration Uranine [%]	I^- [%]	Cr-EDTA [%]
11E	1	1.646	252	0.31	0.1	0.0	0.1
	2		153	0.28	0.2	0.0	0.7
	3		216	0.37	0.1	0.0	0.0
	4		202	0.35	0.1	0.0	0.0
	5		176	0.34	0.1	0.0	0.5
	6		241	0.41	0.1	0.0	0.0
	7		233	0.37	0.1	0.0	0.0
	8		168	0.30	0.1	0.1	0.0
12E	1	1.786	251	0.29	0.0	0.0	0.3
	2		153	0.28	0.1	0.0	0.0
	3		215	0.27	0.1	0.0	0.0
	4		203	0.38	0.1	0.0	0.0
	5		241	0.29	0.0	0.0	0.0
	6		179	0.33	0.1	0.0	0.0
	7		173	0.38	0.0	0.0	0.0
	8		232	0.35	0.1	0.0	0.0
13E	1	1.838	248	0.32	0.0	0.0	0.0
	2		153	0.35	0.0	0.0	0.0
	3		214	0.31	0.0	0.0	0.1
	4		195	0.34	0.0	0.0	0.0
	5		180	0.36	0.0	0.0	0.0
	6		238	0.29	0.0	0.0	0.0
	7		232	0.37	0.1	0.0	0.0
	8		170	0.32	0.0	0.0	0.0
14E	1	1.966	250	0.31	0.1	0.0	0.1
	2		153	0.28	0.2	0.0	0.7
	3		201	0.30	0.2	0.0	0.4
	4		214	0.34	0.1	0.0	0.4
	5		180	0.38	0.2	0.0	0.6
	6		170	0.31	0.0	0.1	0.0
	7		240	0.36	0.1	0.0	0.4
	8		234	0.33	0.1	0.0	0.4
15E	1	2.036	252	0.30	0.1	0.0	0.5
	2		153	0.28	0.2	0.0	0.6
	3		212	0.28	0.1	0.1	0.2
	4		203	0.28	0.2	0.1	0.0
	5		240	0.36	0.2	0.0	0.0
	6		234	0.29	0.2	0.0	0.1
	7		172	0.30	0.4	0.0	0.3
	8		177	0.30	0.2	0.0	0.5
16E	1	2.174	250	0.39	0.2	0.0	0.0
	2		150	0.33	0.1	0.3	0.0
	3		212	0.38	0.2	0.0	0.0
	4		207	0.37	0.1	0.1	0.0
	5		178	0.32	0.1	0.4	0.0
	6		235	0.37	0.1	0.1	0.0
	7		173	0.37	0.2	0.2	0.0
	8		237	0.36	0.1	0.0	0.0

Table A4.1 continued

Core	No.	Depth [m]	Distance [mm]	Porosity [%]	Relative concentration Uranine [%]	I^- [%]	Cr-EDTA [%]
17E	1	2.219	250	0.33	0.3	0.0	0.2
	2		150	0.31	0.2	0.1	0.0
	3		213	0.31	0.2	0.0	0.0
	4		210	0.34	0.0	0.0	0.0
	5		171	0.33	0.1	0.0	0.0
	6		177	0.29	0.1	0.0	0.0
	7		240	0.31	0.1	0.0	0.0
	8		234	0.34	0.1	0.0	0.0
18E	1	2.269	246	0.32	0.4	0.2	0.0
	2		155	0.29	0.4	0.1	0.0
	3		206	0.32	0.2	0.2	0.0
	4		208	0.31	0.3	0.1	0.0
	5		176	0.30	0.1	0.1	0.0
	6		232	0.30	0.2	0.1	0.0
	7		232	0.37	0.2	0.2	0.0
	8		208	0.32	0.3	0.2	0.0
19E	1	2.409	156	0.29	0.8	2.9	0.1
	2		254	0.25	6.3	11.6	5.2
	3		206	0.29	7.0	6.7	9.6
	4		209	0.30	13.2	18.2	10.6
	5		166	0.34	1.6	5.1	0.0
	6		164	0.33	0.6	3.4	0.0
	7		192	0.35	4.5	10.7	5.9
	8		248	0.33	2.2	4.0	1.4
	9		229	0.32	3.1	5.0	3.1
	10		178	0.36	1.7	6.0	2.2
	11		187	0.32	4.3	6.0	4.5
	12		190	0.33	4.4	6.7	5.5
20E	1	2.459	156	–	–	–	–
	2		162	0.40	9.5	10.6	7.7
	3		186	0.39	8.9	10.7	4.3
	4		163	0.38	7.5	6.2	2.0
	5		183	0.36	7.0	9.2	4.1
	6		173	0.37	7.6	8.1	3.2
	7		197	0.39	8.8	7.2	1.9
	8		182	0.38	8.0	5.3	0.9
	9		257	0.30	0.7	2.0	0.0
	10		214	0.35	0.3	1.1	0.2
	11		209	0.29	13.9	11.8	10.1
	12		203	0.32	12.0	9.6	4.1
	13		237	0.28	8.4	10.5	6.9
	14		240	0.25	0.7	1.1	0.0
	15		187	0.33	2.4	2.4	0.4
	16		206	0.31	2.0	3.0	0.0
	17		227	0.26	10.7	9.5	6.1

Table A4.1 continued

Core	No.	Depth [m]	Distance [mm]	Porosity [%]	Relative concentration Uranine [%]	I⁻ [%]	Cr-EDTA [%]
21E	1	2.514	156	0.36	5.8	4.9	2.8
	2		253	0.35	0.1	0.1	0.0
	3		210	0.34	0.1	0.1	0.2
	4		203	0.31	4.7	2.4	0.1
	5		181	0.34	2.0	2.7	0.1
	6		203	0.33	0.4	0.9	0.0
	7		229	0.31	0.2	0.3	0.0
	8		166	0.31	1.9	4.5	0.4
	9		166	0.33	3.0	2.4	0.3
	10		185	0.32	0.3	0.9	0.0
	11		205	0.32	0.2	0.5	0.2
	12		183	0.33	1.6	3.4	0.0
	13		178	0.30	1.9	4.2	0.7
	14		208	0.31	0.5	1.6	0.0
	15		186	0.34	0.3	0.6	0.0
	16		237	0.36	0.1	0.1	0.0
	17		235	0.64	0.0	0.2	0.0
22E	1	2.594	245	0.31	0.1	0.0	0.0
	2		241	0.33	0.2	0.0	0.0
	3		226	0.32	0.2	0.0	0.0
	4		224	0.32	0.2	0.0	0.0
	5		225	0.34	0.2	0.0	0.2
	6		200	0.33	0.2	0.2	0.0
	7		196	0.31	0.0	0.2	0.1
	8		200	0.32	0.1	0.2	0.3
	9		173	0.31	0.1	1.0	0.0
	10		244	0.32	0.1	0.0	0.0
23E	1	2.644	217	0.29	0.0	0.1	0.0
	2		202	0.29	0.0	0.2	0.0
	3		166	0.30	0.2	1.5	0.0
	4		180	0.30	0.1	0.4	0.0
	5		165	0.30	0.1	1.5	0.0
	6		187	0.30	0.0	0.3	0.0
	7		209	0.30	0.0	0.1	0.0
	8		197	0.31	0.1	0.1	0.4
	9		220	0.28	0.1	0.1	0.0
	10		213	0.31	0.1	0.2	0.0
	11		185	0.30	0.2	0.5	0.0
	12		184	0.31	0.2	0.3	0.0
	13		184	0.31	0.2	0.2	0.0
	14		202	0.30	0.1	0.1	0.0

Table A4.1 continued

Core	No.	Depth [m]	Distance [mm]	Porosity [%]	Relative concentration Uranine [%]	I^- [%]	Cr-EDTA [%]
24E	1	2.759	180	0.30	0.1	0.0	0.0
	2		225	0.28	0.1	0.0	0.0
	3		193	0.29	0.2	0.0	0.0
	4		218	0.31	0.1	0.1	0.4
	5		161	0.32	0.0	0.0	0.0
	6		243	0.30	0.1	0.0	0.1
	7		160	0.31	0.1	0.0	0.0
	8		243	0.30	0.1	0.0	0.2
	9		198	0.31	0.2	0.0	0.3
	10		213	0.30	0.1	0.0	0.4
	11		220	0.34	0.1	0.0	0.1
	12		207	0.30	0.1	0.0	0.0
	13		217	0.31	0.0	0.0	0.1
	14		224	0.29	0.1	0.0	0.1

Porosities and tracer concentrations, Part III.

Table A5.1 gives the notation of the sampling cores, depth in the injection hole, radial distance from the injection hole, porosity as well as the relative concentrations for Uranine, Iodide, and Cr−EDTA. The porosity is calculated from the weight difference a between wet and dry sampling core and an assumed uniform density of 2.62 g/cm ^{3}. The relative concentrations are calculated using the tracer concentration in the water after leaching (see chapter 3) and the porosity. The locations of the cores are given in Figure A5.1.

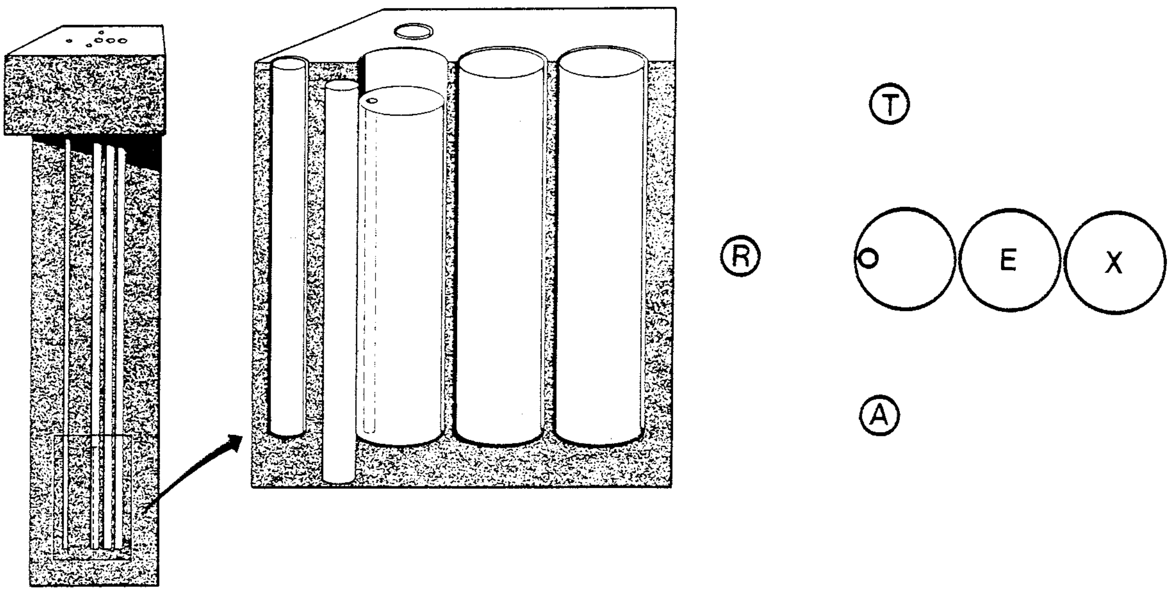


Figure A5.1. Location of cores in Part III.

Table A5.1. Porosity and concentration data, Part III

Core	No.	Depth [m]	Distance [mm]	Porosity [%]	Relative concentration Uranine [%]	I$^-$ [%]	Cr-EDTA [%]
1	1	0.275	52	0.39	21.4	20.4	43.6
	2		43	0.30	28.7	29.7	60.5
	3		79	0.32	28.2	32.5	—
	4		82	0.28	24.8	20.5	-
	5		82	0.34	17.9	15.4	—
	6		63	0.33	22.8	17.4	37.3
	7		60	0.33	19.4	20.8	43.2
	8		67	0.29	26.0	27.4	55.9
	9		56	0.33	24.6	27.5	53.0
	10		40	0.32	27.8	26.5	52.4
	11		97	—	—	—	—
	12		37	0.34	27.0	28.0	48.7
	13		73	0.31	24.0	23.9	38.3
	14		35	0.40	21.4	20.5	46.6
	15		13	0.29	23.8	24.7	56.9
	16		18	0.29	24.1	24.0	59.5
	17		18	0.29	30.6	31.8	68.0
2	1	0.485	86	0.32	28.8	34.9	66.6
	2		92	0.36	26.0	34.6	75.4
	3		80	0.38	30.0	16.6	86.2
	4		87	0.37	32.4	24.2	71.7
	5		71	0.40	26.9	36.0	90.6
	6		71	0.37	25.7	29.5	—
	7		45	0.33	34.0	34.9	73.5
	8		62	0.34	34.8	40.8	78.5
	9		46	0.36	35.3	35.1	83.4
	10		61	0.36	33.9	32.3	76.8
	11		44	0.36	33.5	32.6	76.2
	12		28	0.35	26.8	30.2	71.8
	13		10	0.38	26.2	30.3	75.9

Table A5.1 continued

Core	No.	Depth [m]	Distance [mm]	Porosity [%]	Relative concentration Uranine [%]	I$^-$ [%]	Cr-EDTA [%]
3	1	0.725	98	0.41	23.2	15.0	63.1
	2		90	0.46	57.7	30.0	73.3
	3		80	0.39	48.7	35.8	77.2
	4		69	0.41	92.0	34.5	74.7
	5		79	0.42	26.8	31.9	69.6
	6		60	0.41	24.0	28.6	70.1
	7		80	0.43	72.4	29.2	66.8
	8		67	0.43	51.8	27.5	61.2
	9		60	0.44	28.1	35.0	75.1
	10		71	0.41	30.0	36.6	75.0
	11		52	0.42	29.1	35.6	82.2
	12		53	0.44	32.4	36.2	80.5
	13		41	0.46	29.6	33.8	81.9
	14		34	0.43	28.0	35.4	79.8
	15		14	0.35	26.2	32.6	62.7
	16		25	0.38	27.8	32.6	65.9
	17		44	0.42	22.4	30.9	66.9
	18		28	0.38	28.3	34.7	67.1
	19		9	0.36	30.3	38.1	67.7
	20		48	0.39	26.8	30.4	62.6
	21		61	0.39	23.6	26.9	66.4
	22		45	0.35	21.4	26.0	58.6
	23		22	0.35	25.9	34.4	70.2
	24		36	0.36	21.5	27.1	53.6
	25		94	0.48	27.1	27.2	61.2
4	1	0.775	94	0.42	23.6	32.6	79.0
	2		78	0.42	39.0	31.9	80.2
	3		72	0.38	53.7	31.2	80.6
	4		96	0.40	106.9	31.3	71.9
	5		76	0.41	99.1	33.6	79.0
	6		73	0.43	27.8	34.4	70.8
	7		90	0.42	28.1	30.2	64.2
	8		78	0.40	29.2	34.7	68.6
	9		58	0.39	37.0	35.1	68.6
	10		65	0.40	24.1	28.6	58.0
	11		52	0.38	71.9	29.6	75.2
	12		57	0.42	30.9	35.9	79.8
	13		56	0.39	25.4	32.5	69.4
	14		40	0.37	29.3	35.0	83.2
	15		33	0.38	29.0	35.7	72.0
	16		40	0.41	31.0	36.9	81.8
	17		47	0.39	43.0	34.5	74.4
	18		25	0.40	26.4	32.4	72.2
	19		13	0.38	30.2	36.5	82.0
	20		21	0.38	29.4	36.3	78.6

Table A5.1 continued

Core	No.	Depth [m]	Distance [mm]	Porosity [%]	Relative concentration Uranine [%]	I^- [%]	Cr-EDTA [%]
5	1	0.825	84	0.44	78.5	27.6	69.0
	2		81	0.38	48.8	34.6	75.7
	3		63	0.40	30.0	36.0	80.5
	4		63	0.40	27.7	34.2	73.2
	5		35	0.35	32.1	37.2	77.0
	6		51	0.42	29.6	35.2	80.3
	7		41	0.38	30.7	35.4	77.3
	8		66	0.38	28.7	30.6	75.9
	9		52	0.37	18.4	21.2	54.9
	10		30	0.35	20.5	24.3	56.9
	11		51	0.36	24.6	28.6	62.6
	12		21	0.34	29.0	34.3	71.1
	13		19	0.36	26.8	31.3	66.2
	14		35	0.35	25.9	31.0	67.8
	15		98	0.46	11.0	16.0	55.3
	16		82	0.44	17.0	22.2	62.1
6	1	0.975	93	0.36	35.2	30.5	62.1
	2		74	0.38	30.7	33.6	64.7
	3		53	0.36	32.9	37.7	67.2
	4		33	0.37	32.8	35.8	64.5
	5		15	0.37	22.6	26.0	49.0
	6		88	0.35	34.0	35.7	69.1
	7		67	0.36	31.2	34.6	62.6
	8		46	0.36	33.0	38.0	66.0
	9		30	0.36	33.8	38.3	67.0
	10		14	0.37	29.3	32.4	57.9
	11		80	0.35	43.1	40.3	70.1
	12		61	0.35	26.5	33.9	56.8
	13		46	0.41	27.1	31.0	57.6
	14		34	0.40	31.0	35.2	64.0
	15		64	0.45	9.7	15.9	26.3
	16		84	0.40	40.5	28.7	57.7
	17		68	0.40	28.0	30.3	55.0
	18		48	0.39	26.3	31.2	54.8
	19		34	0.38	17.4	20.7	40.6
	20		57	0.41	20.4	19.8	47.0
	21		75	0.38	28.9	29.3	56.8

Table A5.1 continued

Core	No.	Depth [m]	Distance [mm]	Porosity [%]	Relative concentration Uranine [%]	I$^-$ [%]	Cr-EDTA [%]
7	1	1.025	91	0.43	26.5	28.0	56.2
	2		67	0.41	29.1	33.5	57.2
	3		49	0.42	28.5	32.9	54.8
	4		28	0.42	21.0	25.4	50.1
	5		59	0.43	30.5	34.9	62.7
	6		38	0.42	32.2	36.8	60.8
	7		23	0.44	20.1	23.8	45.2
	8		55	0.42	31.4	34.8	62.3
	9		81	0.40	29.7	34.0	60.4
	10		75	0.41	29.5	32.3	57.6
	11		47	0.41	22.8	24.1	51.3
	12		73	0.41	26.1	27.7	57.2
	13		79	0.41	36.0	34.1	65.5
	14		62	0.41	30.0	33.8	58.8
	15		17	0.41	24.5	27.6	52.8
	16		36	0.40	23.4	24.8	49.7
	17		55	0.42	23.4	23.1	49.8
8	1	1.075	100	0.45	28.1	30.0	64.8
	2		77	0.48	30.9	35.1	63.5
	3		53	0.46	27.9	32.3	61.8
	4		33	0.48	17.0	20.0	38.0
	5		15	0.44	19.9	21.7	46.6
	6		92	0.46	29.2	31.5	64.2
	7		66	0.45	30.0	34.0	60.4
	8		44	0.45	27.7	31.6	57.4
	9		66	0.44	29.2	33.3	61.1
	10		38	0.44	26.3	29.6	60.0
	11		90	0.46	41.0	32.9	66.9
	12		67	0.45	37.3	28.4	59.6
	13		43	0.44	20.9	24.6	51.1
	14		21	0.44	27.9	30.9	58.5
	15		36	0.46	12.2	15.0	34.0
9	1	1.225	100	0.43	25.4	24.1	53.4
	2		79	0.48	28.7	31.8	58.4
	3		59	0.48	28.1	31.2	54.8
	4		39	0.44	27.9	32.6	55.1
	5		19	0.43	28.8	—	57.3
	6		88	0.45	28.4	31.8	62.9
	7		62	0.44	28.2	33.7	56.7
	8		36	0.42	25.6	29.0	54.1
	9		18	0.41	27.2	30.6	57.1
	10		31	0.41	24.9	28.9	52.7
	11		57	0.40	30.0	33.7	59.6
	12		85	0.42	33.8	34.6	71.5
	13		61	0.42	25.2	29.3	54.2
	14		80	0.43	29.3	30.9	64.6
	15		40	0.43	27.8	32.0	62.3
	16		82	0.49	26.6	29.3	57.7
	17		60	0.43	30.2	33.1	64.7
	18		40	0.51	25.3	26.2	53.1
	19		19	0.47	21.2	23.6	47.6

Table A5.1 continued

Core	No.	Depth [m]	Distance [mm]	Porosity [%]	Relative concentration Uranine [%]	I⁻ [%]	Cr-EDTA [%]
10	1	1.275	98	0.37	29.6	28.9	60.4
	2		75	0.40	33.1	35.4	66.1
	3		54	0.42	33.5	35.7	65.7
	4		33	0.44	29.2	33.1	57.0
	5		12	0.43	31.1	32.4	61.9
	6		87	0.39	31.0	32.5	60.4
	7		67	0.46	31.4	34.0	63.5
	8		46	0.46	33.1	35.2	68.7
	9		26	0.46	31.6	34.2	64.7
	10		83	0.42	30.6	31.7	58.8
	11		65	0.46	28.9	32.0	62.4
	12		46	0.44	27.4	32.0	60.8
	13		88	0.41	32.6	31.0	61.6
	14		68	0.40	35.0	36.1	68.7
	15		52	0.41	29.4	34.4	60.9
	16		34	0.41	31.3	35.0	60.8
	17		19	0.42	33.9	37.2	66.9
	18		86	0.40	21.5	21.4	45.0
	19		72	0.42	33.8	34.0	66.8
	20		53	0.44	34.0	33.4	65.0
11	1	1.325	100	0.48	32.5	23.2	57.7
	2		78	0.47	32.0	32.6	67.6
	3		60	0.49	31.4	34.0	65.5
	4		33	0.48	31.2	35.6	65.2
	5		13	0.48	22.7	26.4	52.0
	6		89	0.48	27.2	29.0	61.0
	7		78	0.48	25.9	29.0	59.4
	8		64	0.46	23.9	27.6	57.3
	9		42	0.45	29.1	33.7	61.4
	10		52	0.50	32.7	36.4	69.3
	11		90	0.47	32.2	28.1	68.5
	12		79	0.51	24.8	23.4	57.7
	13		53	0.41	22.0	24.3	57.5
	14		30	0.50	25.4	29.8	61.6
	15		58	0.48	28.9	30.5	66.6

Table A5.1 continued

Core	No.	Depth [m]	Distance [mm]	Porosity [%]	Relative concentration Uranine [%]	I⁻ [%]	Cr-EDTA [%]
12	1	1.475	97	0.38	39.7	29.1	61.7
	2		75	0.34	38.4	37.8	70.7
	3		52	0.32	40.0	35.3	68.8
	4		29	0.34	36.8	32.4	69.1
	5		11	0.33	21.3	20.4	49.0
	6		88	0.36	34.0	28.4	64.7
	7		78	0.36	26.2	23.2	57.0
	8		58	0.33	28.5	27.8	58.1
	9		36	0.32	34.8	28.9	61.9
	10		64	0.34	39.4	36.0	69.0
	11		47	0.32	43.0	36.3	75.0
	12		26	0.31	36.7	34.3	67.8
	13		86	0.32	37.4	31.3	67.9
	14		76	0.34	33.4	30.1	63.3
	15		66	0.33	37.9	38.2	66.3
	16		54	0.32	32.6	31.8	66.4
	17		46	0.36	37.3	39.0	66.2
	18		29	0.33	33.1	36.0	62.6
	19		42	0.33	22.2	23.2	48.2
	20		19	0.32	23.5	25.8	53.3
13	1	1.525	100	0.33	24.5	30.2	56.1
	2		74	0.35	32.7	31.6	67.6
	3		53	0.33	36.0	50.8	68.7
	4		27	0.31	39.4	54.3	73.6
	5		85	0.34	27.5	31.1	57.8
	6		61	0.35	33.4	36.6	68.2
	7		58	0.32	34.4	37.7	70.2
	8		39	0.30	38.5	44.1	70.7
	9		38	0.30	35.8	50.8	70.5
	10		17	0.27	23.0	29.1	53.6
	11		88	0.32	35.2	33.6	68.8
	12		68	0.31	37.7	34.4	71.8
	13		47	0.28	39.6	36.2	75.3
	14		70	0.31	34.8	35.0	69.0
	15		86	0.32	31.4	28.5	62.9
	16		13	0.31	25.2	26.0	55.5
	17		30	0.30	24.1	28.1	56.2
	18		56	0.30	27.3	31.7	58.9

Table A5.1 continued

Core	No.	Depth [m]	Distance [mm]	Porosity [%]	Relative concentration Uranine [%]	I^- [%]	Cr-EDTA [%]
14	1	1.675	97	0.31	21.0	19.9	48.8
	2		77	0.30	30.3	31.1	62.8
	3		61	0.32	29.0	29.0	56.6
	4		42	0.32	33.6	32.4	62.9
	5		20	0.33	32.6	30.7	62.3
	6		84	0.32	26.1	24.1	56.9
	7		65	0.33	30.1	28.7	60.5
	8		84	0.34	24.3	24.5	50.8
	9		42	0.32	32.4	34.0	62.5
	10		63	0.32	28.5	30.7	58.5
	11		48	0.31	29.5	30.8	60.0
	12		19	0.30	30.0	34.6	58.4
	13		88	0.28	26.7	28.4	61.9
	14		66	0.30	29.9	32.5	64.8
	15		47	0.28	33.0	36.4	67.2
	16		83	0.31	27.1	27.3	58.0
	17		66	0.30	28.2	30.6	63.6
	18		32	0.30	30.5	33.5	67.1
	19		14	0.31	34.1	36.3	68.0
15	1	1.725	98	0.29	24.2	22.0	47.4
	2		76	0.39	21.1	21.5	42.4
	3		53	0.33	28.1	31.3	50.4
	4		35	0.36	28.1	31.2	49.0
	5		16	0.32	28.4	33.2	52.0
	6		88	0.33	28.1	23.8	52.2
	7		67	0.31	25.4	25.9	47.6
	8		83	0.32	26.4	24.7	53.4
	9		63	0.33	24.6	25.9	48.5
	10		41	0.34	26.8	28.8	51.7
	11		39	0.34	27.0	31.0	56.0
	12		89	0.32	30.0	24.8	55.2
	13		83	0.31	29.9	25.8	57.5
	14		68	0.29	29.7	30.7	66.2
	15		48	0.26	37.4	39.1	77.7
	16		67	0.27	44.2	31.6	66.7
	17		47	0.27	30.4	32.9	68.4
	18		27	0.27	33.4	37.7	69.4

Table A5.1 continued

Core	No.	Depth [m]	Distance [mm]	Porosity [%]	Relative concentration Uranine [%]	I⁻ [%]	Cr-EDTA [%]
16	1	1.775	97	0.34	27.0	17.7	37.8
	2		77	0.34	32.2	24.7	54.4
	3		56	0.33	27.8	28.9	53.2
	4		32	0.32	31.0	33.0	59.5
	5		16	0.33	25.4	30.9	53.6
	6		89	0.32	29.3	21.0	49.6
	7		65	0.36	28.9	25.2	53.8
	8		45	0.36	25.6	27.6	48.0
	9		24	0.33	25.3	29.3	52.7
	10		77	0.33	31.9	25.8	56.1
	11		60	0.34	26.8	25.8	53.9
	12		87	0.33	27.8	19.9	47.8
	13		75	0.30	35.7	27.6	63.2
	14		66	0.31	34.0	29.7	61.0
	15		48	0.30	37.9	37.2	70.7
	16		62	0.31	29.5	27.6	61.0
	17		40	0.33	20.0	23.2	47.0
	18		22	0.33	29.8	30.7	63.0
17	1	1.825	98	0.31	23.1	14.1	28.8
	2		77	0.28	37.1	24.9	61.6
	3		53	0.31	25.8	26.5	49.5
	4		31	0.32	28.0	29.6	53.9
	5		12	0.32	18.8	26.1	43.7
	6		80	0.34	23.3	15.6	35.3
	7		68	0.31	33.0	25.4	61.5
	8		80	0.32	21.9	17.1	41.9
	9		46	0.33	25.3	26.0	50.5
	10		63	0.32	26.0	22.9	52.0
	11		43	0.32	24.7	24.7	52.4
	12		22	0.33	21.6	26.2	49.5
	13		85	0.33	26.7	16.8	43.6
	14		65	0.33	30.9	26.4	61.4
	15		76	0.32	28.2	21.7	56.7
	16		46	0.29	36.2	35.0	66.6
	17		61	0.30	29.0	26.8	64.0
	18		42	0.30	27.7	30.1	64.9
	19		22	0.29	31.2	31.6	65.0

Table A5.1 continued

Core	No.	Depth [m]	Distance [mm]	Porosity [%]	Relative concentration Uranine [%]	I^- [%]	Cr-EDTA [%]
18	1	1.975	96	0.28	23.1	12.5	20.2
	2		74	0.27	37.6	24.0	63.3
	3		53	0.31	26.9	24.6	58.6
	4		30	0.25	25.9	27.6	58.9
	5		11	0.29	19.2	22.9	46.6
	6		90	0.24	23.5	14.3	34.1
	7		81	0.24	24.0	16.0	45.0
	8		68	0.28	24.1	18.9	52.5
	9		50	0.27	26.4	24.6	59.4
	10		27	0.27	22.3	24.3	55.6
	11		65	0.26	35.4	28.5	74.3
	12		42	0.24	30.4	29.9	68.8
	13		87	0.25	36.8	18.2	38.4
	14		69	0.26	27.4	19.7	57.2
	15		53	0.22	20.6	23.1	55.4
	16		30	0.22	22.8	29.0	59.3
	17		12	0.24	21.6	27.0	54.4
	18		67	0.27	35.5	26.4	65.4
	19		42	0.27	26.3	26.9	60.5
19	1	2.025	96	0.26	22.7	13.5	16.8
	2		74	0.26	35.7	24.9	60.0
	3		53	0.26	36.7	34.0	88.4
	4		30	0.24	36.1	37.7	77.7
	5		10	0.26	15.9	22.6	46.0
	6		90	0.26	28.0	19.1	36.0
	7		76	0.24	27.8	24.3	54.4
	8		60	0.27	24.1	26.1	54.3
	9		39	0.26	27.7	29.7	62.0
	10		17	0.23	24.2	31.0	63.6
	11		65	0.26	35.0	29.0	67.2
	12		44	0.26	36.9	36.5	76.5
	13		88	0.27	35.2	18.2	30.9
	14		73	0.25	37.2	19.3	45.3
	15		50	0.26	23.9	23.2	54.9
	16		29	0.25	20.2	24.0	49.6
	17		11	0.24	20.6	25.7	54.4
	18		65	0.25	45.4	30.9	78.7
	19		42	0.22	37.3	35.8	74.4

Table A5.1 continued

Core	No.	Depth [m]	Distance [mm]	Porosity [%]	Relative concentration Uranine [%]	I^- [%]	Cr-EDTA [%]
20	1	2.175	100	0.20	16.5	14.4	40.0
	2		78	0.20	42.8	33.9	86.8
	3		58	0.20	54.8	50.2	109.25
	4		33	0.20	50.4	48.2	98.2
	5		12	0.21	32.1	38.0	67.3
	6		86	0.20	29.2	24.3	67.5
	7		76	0.20	27.4	26.0	63.0
	8		57	0.19	34.5	31.8	76.8
	9		26	0.18	43.0	39.6	92.0
	10		16	0.19	35.0	40.1	77.4
	11		64	0.19	46.2	43.1	95.0
	12		45	0.18	54.4	50.2	113.0
	13		94	0.18	40.4	25.9	75.9
	14		80	0.19	44.2	30.8	86.2
	15		63	0.18	37.2	35.2	77.6
	16		41	0.19	31.2	34.3	66.7
	17		18	0.18	40.6	41.9	83.5
	18		69	0.18	59.0	46.9	109.9
	19		42	0.19	50.2	49.7	100.5
21	1	2.225	93	0.18	46.0	29.5	90.0
	2		71	0.20	43.2	36.5	95.0
	3		49	0.20	41.8	42.2	87.4
	4		29	0.20	41.2	42.0	87.0
	5		12	0.18	47.4	51.2	100.3
	6		92	0.18	49.6	31.5	92.5
	7		82	0.18	45.1	35.8	92.9
	8		68	0.19	39.8	34.9	82.5
	9		55	0.17	47.5	43.2	96.8
	10		30	0.18	44.8	43.3	91.0
	11		88	0.15	62.2	48.7	124.6
	12		52	0.19	48.0	43.6	93.8
	13		86	0.19	52.9	34.0	96.0
	14		74	0.21	46.2	35.3	95.3
	15		74	-	-	-	-
	16		38	0.19	34.3	38.6	72.7
	17		16	0.19	42.2	42.5	84.9
	18		65	0.23	40.7	35.0	83.5
	19		42	0.20	45.6	43.8	93.9

Table A5.1 continued

Core	No.	Depth [m]	Distance [mm]	Porosity [%]	Relative concentration Uranine [%]	I^- [%]	Cr-EDTA [%]
22	1	2.275	97	0.28	26.7	19.0	52.0
	2		75	0.32	26.6	24.3	53.7
	3		30	0.26	30.9	35.3	62.4
	4		71	0.30	39.8	36.8	79.0
	5		73	0.25	43.8	38.2	81.1
	6		90	0.29	30.9	27.4	62.4
	7		50	0.29	34.1	34.8	68.4
	8		68	0.27	31.9	28.9	64.1
	9		31	0.26	33.7	34.9	66.1
	10		92	0.28	29.5	22.0	59.0
	11		50	0.29	35.6	34.5	74.6
	12		14	0.25	33.5	36.0	56.4
	13		63	0.27	26.5	23.5	57.8
	14		38	0.28	26.0	27.3	56.1
	15		40	0.26	24.2	26.5	53.6
	16		63	0.28	31.5	25.9	59.0
	17		83	0.30	31.9	21.0	52.6
23	1	2.375	99	0.17	35.3	30.9	87.1
	2		79	0.18	57.4	49.3	112.9
	3		61	0.20	60.1	57.1	116.8
	4		40	0.20	70.9	68.5	129.9
	5		15	0.22	57.7	50.4	106.8
	6		90	0.17	37.7	36.4	90.0
	7		69	0.20	56.2	51.4	113.6
	8		86	0.18	35.7	36.1	83.5
	9		66	0.19	45.6	43.4	100.8
	10		49	0.21	53.7	55.9	108.0
	11		32	0.22	49.0	50.8	97.1
	12		51	0.17	53.9	53.4	111.3
	13		13	0.23	47.4	47.4	89.3
	14		35	0.22	32.9	38.3	75.2
	15		90	0.25	41.7	35.6	86.4
	16		69	0.24	52.0	49.5	102.9
	17		82	0.24	48.8	41.8	96.3
	18		67	0.27	41.3	41.1	82.8
	19		18	0.26	45.4	45.5	88.8
	20		43	0.27	46.7	48.7	94.6
	21		30	0.25	57.9	57.1	109.7
	22		50	0.26	47.9	49.5	90.6

Table A5.1 continued

Core	No.	Depth [m]	Distance [mm]	Porosity [%]	Relative concentration Uranine [%]	I$^-$ [%]	Cr-EDTA [%]
24	1	2.425	94	0.30	18.3	18.7	46.8
	2		70	0.29	17.8	23.9	44.4
	3		48	0.32	15.6	22.8	39.1
	4		27	0.28	17.1	22.5	43.5
	5		11	0.30	20.8	25.0	49.4
	6		92	0.32	28.2	23.8	60.9
	7		77	0.30	23.9	23.3	52.2
	8		58	0.31	23.4	24.1	52.2
	9		24	0.30	22.6	23.4	50.0
	10		63	0.30	22.2	26.1	54.2
	11		89	0.30	40.7	26.5	63.8
	12		72	0.29	35.1	33.4	69.5
	13		45	0.32	30.4	31.2	62.7
	14		20	0.28	28.7	29.6	60.5
	15		61	0.30	25.5	27.5	60.0
25	1	2.575	98	-	-	-	-
	2		80	0.18	47.2	47.4	117.2
	3		56	0.22	49.6	49.6	116.1
	4		32	0.20	46.0	47.1	111.4
	5		12	0.21	32.4	33.0	77.8
	6		92	0.16	42.0	37.1	116.9
	7		81	0.17	42.5	39.2	111.4
	8		60	0.22	43.6	37.1	101.0
	9		39	0.21	35.8	32.7	85.5
	10		18	0.19	20.8	24.0	56.4
	11		76	0.20	43.1	40.7	105.7
	12		41	0.20	27.1	37.6	72.0
	13		94	0.21	39.6	28.8	83.5
	14		83	0.21	44.4	38.9	111.6
	15		66	0.20	47.5	42.2	105.9
	16		46	0.22	37.2	38.3	88.3
	17		20	0.19	37.1	36.4	84.9
	18		68	0.22	49.3	47.7	112.4
	19		40	0.20	47.2	46.6	104.1
26	1	2.625	97	0.18	38.6	30.4	92.0
	2		76	0.17	57.1	52.7	126.2
	3		51	0.17	65.7	63.3	128.0
	4		29	0.16	62.9	63.4	126.8
	5		10	0.21	29.4	37.1	79.4
	6		92	0.14	95.4	32.6	93.1
	7		83	0.14	39.2	39.6	102.9
	8		67	0.16	52.1	51.5	113.3
	9		45	0.13	72.3	68.5	147.3
	10		22	0.14	57.9	51.1	122.4
	11		67	0.16	59.4	52.5	126.3
	12		40	0.13	78.1	74.2	160.0
	13		91	0.18	40.3	32.1	82.5
	14		75	0.17	51.7	47.2	110.0
	15		52	0.18	38.8	40.3	91.0
	16		25	0.12	45.6	53.0	120.0
	17		66	0.18	59.8	53.7	129.5

Table A5.1 continued

Core	No.	Depth [m]	Distance [mm]	Porosity [%]	Relative concentration Uranine [%]	I^- [%]	Cr-EDTA [%]
27	1	2.675	98	0.14	75.3	27.9	65.2
	2		79	0.14	66.4	69.1	139.0
	3		58	0.12	88.5	81.9	164.6
	4		33	0.18	62.0	61.0	118.2
	5		12	—	—	—	—
	6		91	—	—	—	—
	7		83	0.13	71.6	47.1	104.0
	8		67	0.16	54.4	55.3	118.1
	9		49	0.19	56.7	56.4	111.7
	10		27	0.20	52.7	47.9	104.4
	11		67	0.16	57.9	55.9	112.3
	12		40	0.19	59.6	57.2	111.8
	13		86	0.20	46.0	36.3	93.2
	14		78	0.21	42.0	44.2	89.3
	15		58	0.24	26.9	30.4	63.3
	16		35	0.21	26.6	29.7	67.5
	17		16	0.21	25.3	26.8	60.0
	18		67	0.20	59.6	53.3	112.0
	19		43	0.17	66.3	61.3	127.5
28	1	2.825	100	0.19	0.8	4.9	0.7
	2		80	0.19	3.2	9.6	0.7
	3		60	0.21	12.6	15.4	7.2
	4		38	0.22	52.2	46.2	82.3
	5		19	0.18	45.0	48.2	99.7
	6		93	0.18	1.8	7.0	0.3
	7		86	0.19	3.0	8.3	1.3
	8		70	0.17	6.8	12.2	2.2
	9		75	0.18	2.4	7.7	1.7
	10		62	0.18	8.0	13.6	5.2
	11		50	0.21	20.1	19.9	20.2
	12		25	0.21	44.0	41.3	80.0
	13		18	0.19	30.0	35.0	73.6
	14		61	0.24	24.9	22.3	26.5
	15		63	0.19	8.9	13.0	4.2
	16		36	0.20	45.2	42.4	99.7
	17		50	0.26	27.9	25.1	47.3
	18		33	0.20	31.0	33.2	74.4
	19		17	0.19	23.3	25.8	60.8
	20		94	0.22	1.1	5.1	1.0
	21		74	0.20	3.2	10.8	1.0
	22		91	0.19	1.5	7.0	1.4
	23		52	0.25	30.2	30.5	50.5
	24		68	0.28	10.8	15.6	17.6
	25		84	0.20	3.4	11.5	6.4
	26		36	0.22	48.0	42.4	87.5
	27		56	0.25	41.5	39.9	78.3
	28		74	0.20	38.7	38.2	77.5
	29		60	0.20	39.6	38.1	89.2
	30		41	0.18	55.2	52.3	108.4
	31		21	0.18	60.5	50.0	121.8
	32		35	0.17	41.0	42.1	89.5
	33		15	0.14	51.3	48.4	114.2

Table A5.1 continued

Core	No.	Depth [m]	Distance [mm]	Porosity [%]	Relative concentration Uranine [%]	I^- [%]	Cr-EDTA [%]
29	1	2.875	100	0.29	21.0	15.0	34.4
	2		78	0.30	41.7	21.8	49.2
	3		56	0.28	45.7	29.2	63.7
	4		32	0.29	36.8	27.1	65.2
	5		10	0.32	27.6	27.1	46.1
	6		90	0.30	36.8	21.4	55.9
	7		80	0.34	26.4	17.0	41.8
	8		70	0.31	37.8	22.5	50.2
	9		47	0.31	38.8	26.8	64.5
	10		66	0.33	23.4	17.1	43.1
	11		45	0.32	25.7	20.0	54.2
	12		20	0.34	29.9	24.7	53.7
	13		89	0.30	25.9	17.7	35.3
	14		77	0.33	30.6	17.9	32.1
	15		60	0.37	23.2	19.6	38.9
	16		40	0.33	27.2	25.5	57.3
	17		18	0.32	34.1	29.4	65.1
	18		66	0.32	43.6	24.4	55.3
	19		48	0.34	34.3	23.2	58.7
30	1	2.925	98	0.28	33.4	26.9	70.3
	2		78	0.28	39.3	33.6	80.4
	3		57	0.29	41.2	35.3	78.2
	4		33	0.27	46.2	43.1	100.4
	5		12	0.28	29.7	31.0	63.3
	6		88	0.28	39.0	30.7	75.6
	7		65	0.25	46.0	38.2	84.1
	8		81	0.26	39.0	33.1	78.8
	9		43	0.27	31.9	36.5	71.8
	10		61	0.26	30.7	34.5	68.8
	11		20	0.27	29.8	32.4	70.1
	12		41	0.27	37.1	35.0	88.8
	13		91	0.27	40.4	31.4	77.0
	14		85	0.25	47.5	38.9	94.7
	15		71	0.26	43.2	38.0	82.0
	16		48	0.27	45.0	41.9	86.2
	17		63	0.27	42.0	38.4	83.5
	18		26	0.29	38.9	36.7	71.8
	19		45	0.29	41.1	38.3	83.2
31	1	2.975	63	0.26	34.9	37.2	74.7
	2		63	0.26	45.0	46.0	82.8
	3		65	0.26	42.2	43.8	80.4
	4		73	0.25	55.1	45.8	91.2
	5		48	0.28	40.0	42.8	81.1
	6		45	0.26	36.0	38.8	79.2
	7		44	0.26	44.1	45.3	86.9
	8		51	0.27	42.4	44.5	83.2
	9		50	0.28	39.5	40.8	83.9
	10		32	0.30	45.8	46.8	93.8
	11		23	0.27	39.2	38.9	78.8
	12		32	0.28	40.5	41.2	84.7
	13		14	0.28	35.5	37.4	76.0

Table A5.1 continued

Core	No.	Depth [m]	Distance [mm]	Porosity [%]	Relative concentration Uranine [%]	I^- [%]	Cr-EDTA [%]
1E	1	0.345	162	0.36	27.2	29.1	56.4
	2		203	0.33	23.9	22.7	45.8
	3		140	0.35	20.3	20.8	43.2
	4		217	0.41	12.0	16.3	16.6
	5		128	0.36	20.2	26.9	39.4
	6		196	0.36	18.5	16.2	33.3
	7		220	0.35	21.6	20.3	30.5
	8		169	0.36	15.7	15.4	36.8
	9		173	0.39	20.8	25.3	28.9
	10		180	0.36	22.0	22.7	43.2
	11		177	0.36	22.8	22.3	42.9
	12		148	0.38	15.0	26.7	33.4
	13		199	0.42	17.2	17.9	24.0
2E	1	0.555	159	0.48	27.0	34.4	80.8
	2		206	0.41	24.0	29.8	35.1
	3		141	0.48	21.2	24.5	59.3
	4		214	0.42	22.7	30.9	66.8
	5		132	0.45	26.0	34.0	75.6
	6		193	0.54	21.9	31.2	79.1
	7		174	0.49	23.4	29.0	36.4
	8		232	0.44	23.0	30.0	55.0
	9		176	0.47	24.1	32.1	66.4
	10		157	0.48	24.0	31.0	71.5
	11		191	0.48	24.3	29.8	70.6
	12		166	0.47	30.8	34.6	49.5
	13		197	0.40	26.4	34.0	51.4
3E	1	0.725	222	0.43	11.9	26.5	0.3
	2		127	0.46	35.3	28.6	65.4
	3		200	0.45	22.0	23.8	30.3
	4		168	0.47	17.5	34.4	12.1
	5		120	0.50	14.0	29.9	1.2
	6		255	0.49	13.1	22.9	12.7
	7		165	0.41	25.2	26.2	50.0
	8		140	0.43	27.2	32.3	17.9
	9		186	0.39	29.0	29.5	48.5
	10		213	0.45	12.9	27.8	6.6
	11		185	0.42	43.8	26.5	55.2
	12		186	0.46	11.4	31.4	1.7
	13		161	0.44	22.9	32.0	44.5

Table A5.1 continued

Core	No.	Depth [m]	Distance [mm]	Porosity [%]	Relative concentration Uranine [%]	I⁻ [%]	Cr-EDTA [%]
4E	1	0.775	226	0.48	9.0	23.7	0.3
	2		134	0.42	16.8	26.1	16.4
	3		202	0.43	7.2	20.5	1.8
	4		170	0.42	13.4	32.0	17.9
	5		201	0.46	7.2	28.9	1.3
	6		135	0.38	15.0	29.9	13.1
	7		225	0.48	3.5	17.2	0.0
	8		162	0.42	14.5	22.7	8.7
	9		181	0.43	6.1	25.5	1.8
	10		203	0.43	4.8	27.0	0.0
	11		202	0.52	4.0	17.6	1.6
	12		162	0.40	9.4	33.1	2.3
	13		157	0.40	14.2	26.7	7.7
5E	1	0.825	224	0.42	23.4	25.7	5.6
	2		132	0.44	21.3	23.3	51.9
	3		200	0.42	11.5	19.9	14.9
	4		166	0.44	19.0	25.5	34.1
	5		201	0.44	18.7	24.3	18.5
	6		220	0.44	7.6	19.6	0.7
	7		138	0.49	17.8	25.8	38.9
	8		165	0.44	15.6	21.8	26.3
	9		181	0.47	7.7	22.0	14.6
	10		200	0.44	7.3	20.2	7.2
	11		200	0.49	10.3	24.4	1.4
	12		156	0.41	11.1	24.9	16.8
	13		157	0.42	16.4	24.3	26.7
6E	1	0.915	215	0.38	5.9	12.4	0.4
	2		146	0.40	17.2	19.3	13.7
	3		221	0.38	14.5	13.7	5.4
	4		179	0.39	7.9	18.9	1.0
	5		227	0.42	2.4	5.2	0.8
	6		186	0.38	16.3	17.3	5.7
	7		206	0.41	7.1	14.1	2.0
	8		169	0.40	12.1	16.7	4.3
	9		143	0.40	17.6	19.6	24.3
	10		161	0.39	8.2	14.7	5.1
	11		190	0.40	4.6	12.4	0.4
7E	1	0.965	215	0.43	6.6	13.8	0.3
	2		146	0.40	18.1	22.2	20.7
	3		215	0.41	5.2	10.7	0.3
	4		223	0.43	1.3	4.6	0.1
	5		185	0.40	11.0	14.9	4.4
	6		179	0.39	8.8	18.2	3.4
	7		205	0.41	2.5	9.6	0.0
	8		193	0.39	9.4	16.4	1.5
	9		153	0.37	15.8	19.2	13.8
	10		187	0.39	11.8	13.4	0.2
	11		144	0.36	24.9	22.4	11.4
	12		149	0.41	18.5	17.2	12.4
	13		167	0.40	24.1	17.0	14.9

Table A5.1 continued

Core	No.	Depth [m]	Distance [mm]	Porosity [%]	Relative concentration Uranine [%]	I^- [%]	Cr-EDTA [%]
8E	1	1.115	215	0.40	9.1	6.6	5.2
	2		139	0.44	19.0	22.0	32.8
	3		146	0.48	27.5	19.7	54.0
	4		130	0.44	23.2	23.3	9.3
	5		182	0.46	23.9	16.6	15.6
	6		156	0.44	18.8	24.3	24.4
	7		179	0.43	17.8	19.5	8.4
	8		173	0.42	23.1	17.8	56.7
	9		215	0.42	19.2	11.6	16.0
	10		223	0.44	13.2	10.3	9.6
	11		182	0.42	20.0	14.9	42.6
	12		199	0.45	15.9	13.2	24.4
	13		196	0.43	21.8	14.3	37.6
9E	1	1.265	213	0.33	3.7	13.6	1.2
	2		150	0.41	5.4	8.7	0.0
	3		216	0.38	28.0	14.7	55.2
	4		140	0.36	26.6	16.3	15.0
	5		224	0.35	15.0	11.6	33.2
	6		178	0.30	13.4	17.9	0.5
	7		187	0.38	11.7	9.7	27.6
	8		132	0.36	13.1	11.9	3.3
	9		182	0.35	5.4	13.0	0.9
	10		208	0.35	12.1	14.0	27.2
	11		191	0.33	9.1	11.2	8.0
	12		171	0.32	5.7	12.7	2.5
	13		154	0.36	10.9	13.2	0.9
10E	1	1.315	213	0.46	6.2	9.0	4.0
	2		146	0.38	0.6	6.4	0.1
	3		214	0.40	21.6	10.4	46.9
	4		148	0.42	23.0	15.5	2.0
	5		225	0.44	5.4	8.9	12.9
	6		181	0.48	14.6	11.7	1.0
	7		185	0.43	7.8	6.2	19.9
	8		131	0.39	4.3	13.1	0.0
	9		183	0.43	2.9	9.8	0.0
	10		207	0.38	6.2	10.5	11.8
	11		168	0.41	1.1	6.3	0.7
	12		188	0.41	8.9	11.4	0.5
	13		155	0.36	3.6	12.9	0.0

Table A5.1 continued

Core	No.	Depth [m]	Distance [mm]	Porosity [%]	Relative concentration Uranine [%]	Relative concentration I^- [%]	Relative concentration Cr-EDTA [%]
11E	1	1.415	159	0.42	0.4	3.6	0.0
	2		204	0.38	26.4	13.9	20.6
	3		137	0.41	27.6	15.0	20.1
	4		221	0.38	0.9	4.6	0.0
	5		134	0.43	5.3	8.0	0.0
	6		195	0.39	0.4	4.1	0.2
	7		224	0.37	8.6	7.4	0.2
	8		168	0.39	33.8	20.0	43.8
	9		170	0.41	10.7	11.2	0.4
	10		146	0.41	20.0	13.3	0.7
	11		176	0.40	1.1	5.7	0.1
	12		201	0.39	5.0	9.5	0.1
	13		198	0.39	24.9	18.4	8.0
12E	1	1.565	161	0.38	1.2	2.5	0.0
	2		206	0.38	16.1	11.3	1.4
	3		135	0.38	20.3	13.0	0.2
	4		215	0.38	1.6	2.9	0.2
	5		194	0.41	0.7	1.6	0.0
	6		130	0.37	1.1	5.7	0.0
	7		167	0.39	33.0	16.7	8.9
	8		222	0.38	3.1	5.2	0.2
	9		173	0.39	10.0	6.9	8.0
	10		151	0.38	4.0	5.2	1.7
	11		158	0.42	8.6	11.0	0.4
	12		191	0.45	3.5	3.4	0.3
	13		197	0.43	11.4	10.2	7.3
13E	1	1.615	221	0.41	0.4	2.9	0.0
	2		131	0.40	9.4	7.8	0.0
	3		203	0.42	17.6	12.1	0.8
	4		169	0.42	0.2	2.1	0.0
	5		222	0.44	2.5	5.8	0.1
	6		200	0.37	0.6	2.4	0.1
	7		164	0.36	26.9	18.1	5.3
	8		178	0.36	3.6	8.9	0.2
	9		181	0.37	0.8	4.3	0.0
	10		208	0.37	1.5	6.4	0.1
	11		179	0.35	18.4	16.0	0.3
	12		158	0.36	10.6	11.8	0.3
14E	1	1.775	205	0.35	0.0	0.7	0.0
	2		155	0.36	0.5	1.9	0.1
	3		219	0.37	0.0	0.5	0.2
	4		143	0.36	4.6	4.5	0.1
	5		178	0.35	0.2	3.0	0.1
	6		174	0.32	0.2	2.4	0.2
	7		226	0.34	0.0	0.3	0.2
	8		130	0.34	8.6	5.3	0.1
	9		192	0.36	0.0	1.0	0.2
	10		186	0.36	0.0	2.0	0.4
	11		151	0.35	6.0	8.0	0.1
	12		210	0.38	0.0	0.9	0.2

Table A5.1 continued

Core	No.	Depth [m]	Distance [mm]	Porosity [%]	Relative concentration Uranine [%]	I⁻ [%]	Cr-EDTA [%]
15E	1	1.825	205	0.37	0.0	0.4	0.2
	2		157	0.39	0.4	2.0	0.0
	3		140	0.40	3.8	3.8	0.1
	4		221	0.40	0.0	0.3	0.1
	5		173	0.38	0.1	1.5	0.1
	6		221	0.47	0.0	0.2	0.1
	7		195	0.42	0.0	0.8	0.2
	8		130	0.38	6.8	4.2	0.2
	9		178	0.42	0.1	1.4	0.2
	10		166	0.41	0.4	2.5	0.2
	11		202	0.43	0.0	0.5	0.2
	12		194	0.39	0.0	0.8	0.2
	13		158	0.36	1.2	3.3	0.2
16E	1	1.875	215	0.41	0.0	0.2	0.0
	2		146	0.39	0.2	1.4	0.0
	3		214	0.39	2.5	3.3	0.1
	4		147	0.43	0.0	0.3	0.0
	5		179	0.42	0.0	1.4	0.0
	6		183	0.41	0.0	0.1	0.0
	7		227	0.44	0.0	0.7	0.1
	8		184	0.41	3.5	3.3	0.0
	9		131	0.39	0.0	0.6	0.0
	10		193	0.42	0.0	0.3	0.0
	11		205	0.40	0.5	3.5	0.0
	12		168	0.41	0.9	3.5	0.1
	13		151	0.43	0.0	0.8	0.0
17E	1	2.025	206	0.32	0.0	0.1	0.0
	2		161	0.36	0.0	0.3	0.0
	3		220	0.35	0.0	0.0	0.0
	4		135	0.34	0.9	2.6	0.2
	5		179	0.38	0.0	0.5	0.0
	6		174	0.35	0.0	0.5	0.0
	7		225	0.36	0.0	0.0	0.0
	8		194	0.36	0.0	0.1	0.0
	9		135	0.33	0.2	2.1	0.0
	10		186	0.36	0.0	0.4	0.1
	11		154	0.36	0.1	2.1	0.0
	12		206	0.36	0.1	0.0	0.0
	13		174	0.36	0.0	0.5	0.0

Table A5.1 continued

Core	No.	Depth [m]	Distance [mm]	Porosity [%]	Relative concentration Uranine [%]	I^- [%]	Cr-EDTA [%]
18E	1	2.075	212	0.35	0.0	0.1	0.1
	2		151	0.38	0.0	0.6	0.0
	3		145	0.38	0.0	0.0	0.0
	4		216	0.34	0.5	2.7	0.0
	5		186	0.36	0.0	0.1	0.0
	6		225	0.34	0.0	0.7	0.3
	7		133	0.38	0.0	0.2	0.0
	8		186	0.35	0.5	2.7	0.1
	9		181	0.34	0.0	0.7	0.0
	10		192	0.33	0.0	0.2	0.2
	11		207	0.34	0.0	1.7	0.1
	12		152	0.35	0.0	0.2	0.0
	13		171	–	–	–	–
19E	1	2.225	205	0.38	0.0	0.5	0.0
	2		157	0.36	0.3	1.9	0.0
	3		141	0.36	9.1	7.3	0.0
	4		220	0.33	0.0	0.6	0.0
	5		225	0.35	0.0	0.3	0.0
	6		172	0.38	0.3	2.3	0.0
	7		131	0.33	6.0	5.2	0.2
	8		191	0.32	0.0	0.9	0.0
	9		177	0.35	0.4	4.2	0.0
	10		204	0.36	0.0	1.0	0.0
	11		165	0.37	1.6	6.1	0.0
	12		192	0.32	0.0	1.9	0.0
	13		158	0.33	3.1	7.3	0.0
20E	1	2.275	207	0.50	0.0	1.0	0.0
	2		158	0.31	1.8	4.5	0.0
	3		140	0.30	17.6	9.0	1.5
	4		216	0.33	0.0	1.5	0.2
	5		172	0.33	0.5	4.2	0.1
	6		222	0.32	0.0	0.9	0.1
	7		192	0.33	0.0	1.7	0.1
	8		123	0.32	17.2	9.4	2.1
	9		177	0.32	0.3	3.1	0.0
	10		146	0.31	4.3	7.6	0.2
	11		186	0.34	0.3	4.7	0.1
	12		201	0.32	0.0	1.8	0.0
	13		173	0.33	0.4	4.1	0.0

Table A5.1 continued

Core	No.	Depth [m]	Distance [mm]	Porosity [%]	Relative concentration Uranine [%]	I^- [%]	Cr-EDTA [%]
21E	1	2.325	157	0.34	0.0	2.1	0.0
	2		203	0.31	2.0	4.5	0.0
	3		133	0.32	22.7	10.7	0.8
	4		220	0.33	0.0	3.1	0.0
	5		171	0.35	1.2	6.1	0.0
	6		131	0.34	1.9	5.8	0.1
	7		194	0.32	0.0	2.0	0.1
	8		164	0.34	27.8	2.8	0.4
	9		223	0.35	0.0	2.0	0.0
	10		144	0.35	4.7	8.0	0.0
	11		179	0.36	5.8	10.3	0.0
	12		172	0.34	0.1	4.0	0.0
	13		204	0.31	0.1	2.9	0.0
22E	1	2.375	208	0.33	0.1	2.2	0.0
	2		163	0.34	4.0	4.8	0.0
	3		136	0.34	28.6	13.8	12.8
	4		222	0.32	0.0	2.0	0.0
	5		178	0.33	4.3	9.0	0.0
	6		171	0.34	6.1	6.8	0.0
	7		225	0.35	0.0	1.0	0.0
	8		135	0.34	20.5	11.2	11.9
	9		195	0.34	0.2	2.5	0.0
	10		162	0.32	15.8	14.1	0.0
	11		201	0.32	0.2	4.0	0.0
	12		195	0.32	0.5	4.8	0.1
	13		174	—	—	—	—
23E	1	2.505	221	0.37	24.0	10.8	37.7
	2		130	0.35	7.2	7.9	0.0
	3		203	0.34	23.6	16.3	41.0
	4		165	0.34	10.4	7.2	0.0
	5		222	0.38	14.8	12.9	48.0
	6		202	0.38	17.5	8.0	10.2
	7		164	0.34	21.0	10.8	2.9
	8		135	0.35	4.6	5.6	0.0
	9		180	0.34	30.3	14.8	18.1
	10		211	0.39	28.1	14.2	57.3
	11		182	0.36	26.2	11.7	4.8
	12		182	0.34	34.3	17.6	23.1
	13		148	0.33	11.0	10.1	0.0

Table A5.1 continued

Core	No.	Depth [m]	Distance [mm]	Porosity [%]	Relative concentration Uranine [%]	I⁻ [%]	Cr-EDTA [%]
24E	1	2.555	166	0.36	19.6	12.9	1.5
	2		201	0.36	3.9	4.5	0.0
	3		133	0.34	12.1	7.7	25.4
	4		222	0.34	2.3	4.2	0.1
	5		198	0.35	4.0	7.6	1.8
	6		135	0.35	13.6	11.1	16.7
	7		164	0.36	27.5	11.0	2.0
	8		217	0.35	2.4	4.4	0.0
	9		174	0.34	18.1	11.5	9.1
	10		157	0.36	12.7	10.4	11.1
	11		153	0.34	17.4	10.6	15.2
	12		199	0.33	7.9	9.6	1.2
	13		193	0.37	8.8	7.8	0.1
25E	1	2.705	220	0.36	0.0	0.4	0.0
	2		129	0.35	0.2	2.7	0.1
	3		200	0.38	16.1	8.1	15.1
	4		165	0.32	0.0	0.1	0.0
	5		222	0.36	14.7	6.4	14.8
	6		202	0.34	0.0	0.1	0.1
	7		158	0.36	4.8	7.1	0.0
	8		140	0.40	0.0	0.5	0.0
	9		180	0.35	9.3	10.4	0.0
	10		207	0.38	12.5	7.4	1.2
	11		182	0.32	0.0	0.3	0.0
	12		178	0.38	17.4	12.8	1.7
	13		150	0.35	1.5	5.9	0.0
26E	1	2.755	216	0.32	0.0	0.6	0.2
	2		146	0.38	2.0	4.9	0.1
	3		146	0.36	0.0	0.2	0.0
	4		215	0.34	8.9	10.2	33.8
	5		182	0.36	0.0	0.4	0.0
	6		225	0.37	0.1	0.9	0.0
	7		133	0.36	0.0	0.3	0.0
	8		184	0.38	18.0	9.6	3.2
	9		183	0.32	0.2	2.0	0.0
	10		192	0.34	0.0	0.7	0.0
	11		209	0.36	14.8	7.6	13.6
	12		156	0.34	0.0	0.5	0.1
	13		171	0.37	8.0	12.4	0.5

Table A5.1 continued

Core	No.	Depth [m]	Distance [mm]	Porosity [%]	Relative concentration Uranine [%]	I⁻ [%]	Cr-EDTA [%]
27E	1	2.905	164	0.31	30.3	10.3	17.1
	2		201	0.30	1.6	4.1	0.4
	3		231	0.31	0.6	3.4	0.1
	4		159	0.29	8.1	5.0	20.6
	5		196	0.31	4.0	6.9	0.1
	6		134	0.32	25.0	9.0	50.3
	7		218	0.34	0.8	2.6	0.6
	8		167	0.29	6.9	5.2	1.9
	9		172	0.31	22.3	13.6	3.4
	10		152	0.32	63.0	16.1	53.0
	11		195	0.32	2.8	7.2	0.0
	12		197	0.32	2.0	5.9	0.0
	13		158	0.31	28.5	10.3	12.6
28E	1	2.955	164	0.36	24.5	10.6	27.3
	2		201	0.37	13.1	9.0	4.8
	3		134	0.36	22.3	12.5	47.7
	4		216	0.39	5.6	4.2	4.3
	5		133	0.36	43.5	16.6	79.2
	6		193	0.36	14.7	8.7	11.1
	7		219	0.34	3.7	5.5	3.8
	8		171	0.36	22.6	11.4	24.0
	9		174	0.34	33.0	17.1	23.4
	10		144	0.35	40.3	18.4	67.2
	11		173	0.36	34.6	15.0	18.0
	12		201	0.34	5.4	6.7	7.4
	13		183	0.35	23.3	13.6	14.1

Table A5.1 continued

Core	No.	Depth [m]	Distance [mm]	Porosity [%]	Relative concentration Uranine [%]	I^- [%]	Cr-EDTA [%]
1R	1	0.075	236	0.35	15.0	22.0	8.1
	2		246	0.34	9.3	19.2	4.7
	3		230	0.34	8.9	22.0	3.5
	4		247	0.34	13.9	20.1	9.8
	5		225	0.43	8.9	16.2	5.6
2R	1	0.345	236	0.28	14.3	19.6	2.9
	2		223	0.31	11.9	13.3	9.4
	3		228	0.30	18.5	16.4	14.4
	4		246	0.27	14.0	15.5	7.2
3R	1	0.475	236	0.31	0.2	4.7	0.0
	2		244	0.33	0.3	3.0	0.0
	3		230	0.31	1.4	7.4	0.2
	4		249	0.35	0.2	2.7	0.5
	5		220	0.32	1.4	9.0	0.5
4R	1	0.625	236	0.36	6.5	6.4	0.4
	2		245	0.34	3.0	5.5	0.3
	3		232	0.36	8.8	6.7	0.3
	4		248	0.34	3.5	5.0	0.6
	5		223	0.38	14.4	9.6	0.4
5R	1	0.775	237	0.32	0.5	4.2	0.1
	2		243	0.34	0.3	3.2	0.2
	3		231	0.32	1.1	5.4	0.3
	4		253	0.34	0.1	2.6	0.4
	5		223	0.33	1.9	6.5	0.6
6R	1	0.965	237	0.37	13.1	9.2	0.4
	2		245	0.52	7.1	6.5	0.0
	3		230	0.38	10.6	7.9	3.9
	4		252	0.41	9.0	7.1	0.9
	5		220	0.34	16.3	9.9	3.1
7R	1	1.015	236	0.44	10.6	8.7	7.7
	2		244	0.42	11.6	7.5	6.6
	3		230	0.44	11.2	9.8	2.7
	4		248	0.41	7.6	6.7	3.1
	5		221	0.44	15.6	9.8	16.8
8R	1	1.065	236	0.42	12.5	9.7	8.9
	2		247	0.42	14.2	9.2	17.4
	3		231	0.40	11.1	11.0	0.6
	4		250	0.42	7.8	8.0	2.1
	5		223	0.43	15.5	10.0	16.6
9R	1	1.185	234	0.35	15.2	11.6	7.1
	2		227	0.36	15.6	13.8	9.1
	3		243	0.38	13.4	10.8	4.6
	4		247	0.38	11.8	9.9	2.8
	5		220	0.36	17.9	13.9	17.0

Table A5.1 continued

Core	No.	Depth [m]	Distance [mm]	Porosity [%]	Relative concentration Uranine [%]	I⁻ [%]	Cr-EDTA [%]
10R	1	1.235	235	0.39	3.3	4.5	0.0
	2		231	0.39	5.2	9.4	0.0
	3		245	0.40	1.2	7.0	0.0
	4		250	0.38	2.0	7.4	0.0
	5		223	0.40	2.5	6.1	0.0
11R	1	1.285	234	0.35	6.4	6.0	0.0
	2		228	0.34	8.9	7.3	0.1
	3		244	0.38	5.2	5.4	0.1
	4		247	0.35	4.5	5.5	0.0
	5		223	0.37	6.5	6.0	1.0
12R	1	1.335	234	0.36	7.8	5.9	0.0
	2		222	0.38	10.9	6.9	0.1
	3		242	0.34	7.8	6.6	0.1
	4		247	0.36	4.6	5.0	0.0
	5		223	0.34	14.3	8.7	0.3
13R	1	1.385	235	0.34	1.8	3.9	0.0
	2		244	0.32	3.0	4.0	0.0
	3		236	0.32	0.9	3.4	0.1
	4		248	0.29	1.2	3.6	0.0
	5		222	0.34	6.6	6.9	0.0
14R	1	1.435	237	0.31	0.1	1.4	0.1
	2		231	0.32	1.2	4.3	0.0
	3		221	0.32	0.1	2.0	0.1
	4		251	0.28	0.0	1.6	0.0
15R	1	1.485	236	0.32	0.0	0.9	0.0
	2		247	0.35	0.0	0.9	0.0
	3		231	0.31	0.0	0.6	0.0
	4		250	0.32	0.0	0.6	0.0
	5		221	0.31	0.2	3.5	0.0
16R	1	1.535	235	0.31	0.0	1.1	0.0
	2		243	0.33	0.0	1.0	0.0
	3		231	0.32	0.0	0.6	0.0
	4		251	0.33	0.0	0.4	0.0
	5		222	0.31	0.0	2.0	0.0
17R	1	1.585	235	0.30	0.0	0.8	0.0
	2		246	0.29	0.0	0.8	0.0
	3		231	0.31	0.0	0.5	0.0
	4		247	0.31	0.0	0.4	0.0
	5		220	0.27	0.0	1.6	0.0
18R	1	1.635	236	0.28	0.0	0.7	0.0
	2		241	0.31	0.0	0.8	0.0
	3		231	0.26	0.0	0.5	0.0
	4		249	0.29	0.0	0.3	0.0
	5		222	0.27	0.0	1.1	0.0

Table A5.1 continued

Core	No.	Depth [m]	Distance [mm]	Porosity [%]	Relative concentration Uranine [%]	I^- [%]	Cr-EDTA [%]
19R	1	1.685	235	0.30	0.0	0.5	0.0
	2		229	0.30	0.0	0.6	0.0
	3		244	0.28	0.0	0.4	0.0
	4		247	0.30	0.0	0.3	0.0
	5		223	0.30	0.0	0.7	0.0
20R	1	1.735	236	0.29	0.0	0.2	0.0
	2		233	0.29	0.0	0.2	0.0
	3		242	0.29	0.0	0.2	0.0
	4		249	0.29	0.0	0.1	0.0
	5		219	0.29	0.0	0.4	0.0
21R	1	1.850	238	0.33	0.0	0.6	0.0
	2		247	0.29	0.0	0.5	0.0
	3		229	0.31	0.0	0.4	0.0
	4		250	0.29	0.0	0.2	0.0
	5		224	0.33	0.1	1.2	0.0
22R	1	1.900	235	0.34	0.0	0.9	0.0
	2		227	0.32	0.0	0.8	0.0
	3		242	0.33	0.0	0.8	0.0
	4		251	0.33	0.0	0.4	0.0
	5		224	0.35	0.1	1.5	0.0
23R	1	1.950	237	0.32	0.0	1.0	0.0
	2		246	0.33	0.0	0.7	0.0
	3		230	0.32	0.0	0.7	0.0
	4		223	0.30	0.1	1.7	0.0
	5		250	0.33	0.0	0.5	0.0
24R	1	2.000	237	0.31	0.0	0.8	0.0
	2		244	0.30	0.0	0.7	0.0
	3		229	0.29	0.0	0.6	0.0
	4		250	0.33	0.0	0.3	0.0
	5		221	0.31	0.0	1.2	0.0
25R	1	2.050	237	0.30	0.0	1.1	0.0
	2		245	0.31	0.0	0.8	0.0
	3		231	0.29	0.0	1.0	0.0
	4		250	0.29	0.0	0.6	0.0
	5		223	0.29	0.0	1.6	0.0
26R	1	2.100	236	0.28	0.0	1.4	0.0
	2		247	0.27	0.0	1.1	0.0
	3		229	0.30	0.0	1.0	0.0
	4		250	0.26	0.0	0.8	0.0
	5		224	0.30	0.0	1.8	0.0
27R	1	2.200	233	0.29	0.6	4.3	0.1
	2		226	0.30	0.9	4.0	0.0
	3		243	0.29	0.3	3.0	0.0
	4		247	0.32	0.2	2.9	0.0
	5		221	0.30	1.8	5.3	0.0

Table A5.1 continued

Core	No.	Depth [m]	Distance [mm]	Porosity [%]	Relative concentration Uranine [%]	I⁻ [%]	Cr-EDTA [%]
28R	1	2.250	236	0.29	1.2	5.9	0.0
	2		245	0.30	1.2	6.0	0.0
	3		230	0.29	0.7	4.2	0.0
	4		250	0.31	0.3	3.7	0.0
	5		224	0.29	4.5	7.1	0.2
29R	1	2.300	233	0.30	0.6	6.1	0.0
	2		227	0.34	0.6	5.4	0.2
	3		242	0.31	0.3	5.1	0.0
	4		245	0.34	0.1	3.3	0.0
	5		222	0.34	2.0	7.8	0.2
30R	1	2.350	233	0.32	0.6	5.2	0.1
	2		228	0.34	0.9	6.5	0.0
	3		241	0.31	0.3	3.3	0.1
	4		246	0.29	0.5	4.2	0.2
	5		222	0.32	1.9	6.1	0.1
31R	1	2.450	236	0.32	4.7	7.6	0.1
	2		244	0.32	4.2	7.1	0.0
	3		229	0.31	5.2	6.4	0.1
	4		250	0.33	1.4	4.4	0.1
	5		223	0.34	11.9	10.1	0.2
32R	1	2.500	238	0.33	2.8	8.0	0.1
	2		246	0.30	2.3	7.2	0.0
	3		232	0.31	3.5	8.4	0.0
	4		249	0.42	0.8	4.6	0.0
	5		225	0.34	7.8	11.1	0.0
33R	1	2.550	238	0.28	0.7	5.4	0.1
	2		248	0.28	0.7	5.4	0.0
	3		231	0.28	0.5	5.6	0.0
	4		250	0.28	0.2	4.0	0.0
	5		224	0.28	3.2	9.2	0.0
34R	1	2.600	238	0.29	0.3	4.6	0.0
	2		245	0.30	0.3	3.8	0.0
	3		229	0.30	0.1	3.2	0.0
	4		251	0.28	0.0	2.3	0.0
	5		224	0.29	2.0	6.9	0.1
35R	1	2.650	237	0.31	0.5	4.3	0.0
	2		245	0.30	0.4	3.4	0.0
	3		229	0.32	0.2	2.8	0.0
	4		250	0.31	0.1	2.4	0.1
	5		224	0.33	1.8	5.0	0.0
36R	1	2.700	237	0.32	0.6	4.9	0.0
	2		249	0.30	0.8	5.6	0.0
	3		232	0.28	0.4	6.1	0.0
	4		250	0.34	0.1	3.1	0.1
	5		222	0.30	2.4	7.6	0.2

Table A5.1 continued

Core	No.	Depth [m]	Distance [mm]	Porosity [%]	Relative concentration Uranine [%]	I^- [%]	Cr-EDTA [%]
37R	1	2.800	237	0.31	37.8	20.9	60.0
	2		245	0.31	33.7	19.0	54.9
	3		230	0.35	39.2	20.3	55.4
	4		253	0.33	28.2	12.9	34.6
	5		226	0.33	34.6	21.1	58.0
38R	1	2.850	236	0.31	36.5	17.8	32.2
	2		243	0.30	29.3	13.7	29.2
	3		228	0.32	35.9	15.2	27.9
	4		252	0.31	20.4	11.1	13.7
	5		223	0.32	38.7	17.2	42.3
39R	1	2.960	234	0.31	2.0	7.0	0.0
	2		228	0.30	1.1	5.1	0.3
	3		246	0.29	1.3	5.7	0.2
	4		250	0.30	0.3	3.6	0.0
	5		229	0.32	3.2	6.8	0.0
40R	1	3.010	235	0.30	0.1	2.5	0.0
	2		230	0.29	0.0	2.3	0.0
	3		243	0.29	0.0	2.3	0.0
	4		248	0.28	0.0	1.6	0.0
	5		223	0.30	0.1	2.7	0.0
41R	1	3.060	234	0.29	0.0	0.7	0.0
	2		231	0.28	0.0	0.6	0.0
	3		245	0.29	0.0	0.5	0.0
	4		247	0.26	0.0	0.4	0.0
	5		223	0.33	0.0	0.5	0.0
42R	1	3.110	236	0.30	0.0	0.1	0.0
	2		242	0.30	0.0	0.1	0.0
	3		227	0.30	0.0	0.1	0.0
	4		247	0.30	0.0	0.1	0.0
	5		221	0.31	0.0	0.1	0.0
43R	1	3.220	238	0.33	0.0	0.0	0.0
	2		247	0.34	0.0	0.0	0.0
	3		232	0.29	0.0	0.0	0.0
	4		250	0.30	0.0	0.0	0.0
	5		222	0.32	0.0	0.0	0.0

Table A5.1 continued

Core	No.	Depth [m]	Distance [mm]	Porosity [%]	Relative concentration Uranine [%]	I⁻ [%]	Cr-EDTA [%]
1A	1	-0.125	217	0.40	0.1	2.8	0.0
	2		209	0.43	0.1	3.2	0.0
2A	1	-0.005	215	0.39	11.9	8.4	0.0
	2		210	0.35	9.0	7.7	0.1
	3		225	0.36	9.6	7.0	0.1
	4		228	0.36	6.3	6.3	0.0
	5		202	0.38	13.2	6.8	0.0
3A	1	0.045	217	0.34	19.3	13.6	4.5
	2		208	0.35	20.2	12.7	5.3
	3		227	0.38	19.4	11.5	1.6
	4		229	0.35	28.2	9.8	0.6
	5		202	0.39	16.3	10.5	22.2
4A	1	0.175	216	0.34	25.1	24.8	48.0
	2		207	0.33	21.4	19.6	42.6
	3		224	0.33	22.6	19.7	42.6
	4		229	0.34	21.8	18.0	42.3
	5		200	0.32	24.4	14.1	44.1
5A	1	0.225	214	0.36	19.6	19.4	37.9
	2		207	0.38	23.3	21.1	44.9
	3		223	0.33	20.3	19.4	39.5
	4		226	0.35	22.0	20.4	40.9
	5		199	0.32	20.0	17.5	40.0
6A	1	0.355	214	0.31	22.7	22.6	44.2
	2		206	0.36	23.3	22.2	41.2
	3		220	0.33	22.9	20.9	46.3
	4		227	0.34	20.4	18.4	43.9
	5		202	0.36	21.7	19.8	38.9
7A	–	0.405	–	–	–	–	–
8A	1	0.575	216	0.40	23.1	18.3	18.0
	2		207	0.38	15.3	14.3	37.3
	3		224	0.38	18.0	17.0	16.5
	4		229	0.39	32.4	16.1	7.5
	5		205	0.40	43.0	15.5	39.7
9A	1	0.625	214	0.40	10.0	14.4	0.3
	2		207	0.39	12.8	12.8	2.4
	3		223	0.40	9.3	13.7	0.2
	4		228	0.42	9.2	12.2	0.2
	5		201	0.40	15.4	15.3	3.3
10A	1	0.675	215	0.37	1.6	8.6	0.3
	2		210	0.37	1.6	7.9	0.2
	3		222	0.38	1.2	7.4	0.2
	4		228	0.38	0.5	5.3	0.4
	5		202	0.39	2.4	6.9	0.4

Table A5.1 continued

Core	No.	Depth [m]	Distance [mm]	Porosity [%]	Relative concentration Uranine [%]	I$^-$ [%]	Cr-EDTA [%]
11A	1	0.725	215	0.40	0.6	5.1	0.0
	2		207	0.38	1.0	4.7	0.0
	3		226	0.38	0.2	3.5	0.0
	4		231	0.39	0.2	3.3	0.0
	5		205	0.38	0.6	5.4	0.0
12A	1	0.775	214	0.37	7.0	7.4	1.2
	2		209	0.38	11.4	6.9	9.0
	3		223	0.37	3.4	4.9	0.1
	4		225	0.40	6.4	6.1	1.2
	5		201	0.40	7.1	6.1	1.6
13A	1	0.915	214	0.36	20.7	11.7	9.4
	2		209	0.38	23.4	11.3	19.4
	3		222	0.37	15.8	7.6	1.5
	4		229	0.36	20.2	9.0	10.1
	5		203	0.38	26.0	13.1	9.2
14A	1	1.015	216	0.38	23.9	14.2	11.1
	2		206	0.38	29.6	12.9	29.6
	3		224	0.39	11.8	8.2	0.4
	4		227	0.42	21.4	10.4	9.4
	5		203	0.39	29.1	14.1	3.1
15A	1	1.115	213	0.41	9.7	10.2	0.1
	2		206	0.41	16.8	10.9	0.1
	3		221	0.42	3.6	7.6	0.0
	4		225	0.42	6.4	8.3	0.1
	5		200	0.38	19.9	12.5	0.4
16A	1	1.215	214	0.40	1.0	7.4	0.0
	2		207	0.39	4.1	8.4	0.2
	3		224	0.38	0.3	4.1	0.0
	4		227	0.38	1.0	5.4	0.1
	5		203	0.39	1.3	6.7	0.1
17A	1	1.345	220	0.37	0.8	3.8	0.2
	2		233	0.33	0.2	2.5	0.0
	3		207	0.37	1.7	4.1	0.3
	4		224	0.39	0.2	2.7	0.1
	5		214	0.32	1.8	3.8	0.0
18A	1	1.395	215	0.32	0.6	4.1	0.0
	2		208	0.33	0.1	2.4	0.1
	3		224	0.33	1.6	4.3	0.1
	4		229	0.32	0.2	2.8	0.1
	5		204	0.32	0.8	3.6	0.0
19A	1	1.445	215	0.30	0.0	2.9	0.0
	2		210	0.31	0.0	1.7	0.0
	3		222	0.31	0.2	3.7	0.0
	4		228	0.30	0.0	2.5	0.0
	5		205	0.29	0.0	2.3	0.0

Table A5.1 continued

Core	No.	Depth [m]	Distance [mm]	Porosity [%]	Relative concentration Uranine [%]	I$^-$ [%]	Cr-EDTA [%]
20A	1	1.595	218	0.30	0.0	1.6	0.0
	2		230	0.29	0.0	0.7	0.0
	3		206	0.30	0.1	1.8	0.0
	4		225	0.29	0.0	1.2	0.0
	5		210	0.30	0.0	1.3	0.0
21A	1	1.645	218	0.32	0.0	1.8	0.0
	2		207	0.30	0.0	0.8	0.0
	3		223	0.31	0.1	1.8	0.0
	4		231	0.31	0.0	1.0	0.0
	5		200	0.31	0.0	1.4	0.0
22A	1	1.745	214	0.35	0.0	1.0	0.0
	2		207	0.35	0.0	0.5	0.0
	3		226	0.36	0.1	1.2	0.0
	4		227	0.35	0.0	0.8	0.0
	5		203	0.34	0.0	1.1	0.0
23A	1	1.795	216	0.36	0.0	0.7	0.0
	2		208	0.37	0.0	0.3	0.0
	3		227	0.35	0.0	0.6	0.0
	4		227	0.32	0.0	0.6	0.0
	5		201	0.35	0.0	0.6	0.0
24A	1	1.895	216	0.31	0.0	0.3	0.0
	2		211	0.30	0.0	0.1	0.0
	3		226	0.32	0.0	0.4	0.0
	4		227	0.31	0.0	0.2	0.0
	5		202	0.31	0.0	0.3	0.0
25A	1	1.945	217	0.29	0.0	0.3	0.0
	2		211	0.30	0.0	0.1	0.0
	3		226	0.32	0.0	0.3	0.0
	4		229	0.29	0.0	0.2	0.0
	5		205	0.30	0.0	0.2	0.0
26A	1	2.195	217	0.29	0.1	1.4	0.0
	2		210	0.28	0.0	0.7	0.0
	3		226	0.29	0.1	1.4	0.0
	4		228	0.29	0.0	1.0	0.0
	5		204	0.30	0.1	1.3	0.0
27A	1	2.280	217	0.30	2.3	4.4	0.1
	2		208	0.32	0.7	2.3	0.0
	3		224	0.32	3.7	4.3	0.0
	4		229	0.30	1.1	2.7	0.1
	5		204	0.32	1.1	3.5	0.0
28A	1	2.330	215	0.34	6.7	5.9	0.0
	2		212	0.32	1.1	2.9	0.0
	3		224	0.34	17.4	5.7	0.3
	4		230	0.33	2.6	3.7	0.0
	5		203	0.33	6.7	5.4	0.0

Table A5.1 continued

Core	No.	Depth [m]	Distance [mm]	Porosity [%]	Relative concentration Uranine [%]	I^- [%]	Cr-EDTA [%]
29A	1	2.380	218	0.32	5.7	7.9	0.0
	2		231	0.30	1.2	4.8	0.1
	3		206	0.33	10.3	6.5	0.2
	4		226	0.28	3.4	6.8	0.1
	5		212	0.32	4.5	6.5	0.0
30A	1	2.430	219	0.30	2.0	8.2	0.3
	2		231	0.32	0.3	4.2	0.2
	3		205	0.30	7.7	9.1	0.0
	4		227	0.28	0.9	6.0	0.0
	5		210	0.31	2.8	6.7	0.0
31A	1	2.480	213	0.27	1.9	7.7	0.2
	2		210	0.32	0.3	4.5	0.0
	3		224	0.28	4.0	8.2	0.2
	4		228	0.31	0.9	5.6	0.0
	5		202	0.31	3.7	7.0	0.1
32A	1	2.530	215	0.32	1.0	5.0	0.0
	2		209	0.30	0.4	2.5	0.1
	3		226	0.32	2.6	5.6	0.0
	4		228	0.29	0.4	3.3	0.0
	5		206	0.28	2.3	6.1	0.0
33A	1	2.680	216	0.32	0.1	2.8	0.0
	2		209	0.35	0.0	1.9	0.0
	3		226	0.36	0.3	3.0	0.0
	4		228	0.34	0.0	1.8	0.0
	5		206	0.32	0.5	3.9	0.0
34A	1	2.730	217	0.32	0.6	6.4	0.2
	2		212	0.32	0.1	3.6	0.0
	3		225	0.32	2.5	7.9	0.0
	4		231	0.31	0.2	4.7	0.0
	5		204	0.31	1.7	7.9	0.0
35A	1	2.780	214	0.33	3.5	11.1	0.0
	2		208	0.33	1.0	6.7	0.0
	3		225	0.32	9.3	10.6	0.0
	4		227	0.34	1.0	6.1	0.0
36A	1	2.830	215	0.33	4.4	12.8	0.0
	2		210	0.29	2.6	10.3	0.0
	3		226	0.32	8.2	11.6	0.1
	4		228	0.31	1.6	9.4	0.0
	5		203	0.31	13.3	17.1	0.2
37A	1	2.880	217	0.31	8.6	13.8	0.1
	2		211	0.32	4.4	11.3	0.2
	3		224	0.31	12.7	12.0	0.8
	4		229	0.31	4.5	10.1	0.1
	5		203	0.31	22.5	14.9	1.2

Table A5.1 continued

Core	No.	Depth [m]	Distance [mm]	Porosity [%]	Relative concentration Uranine [%]	I^- [%]	Cr-EDTA [%]
38A	1	2.930	220	0.31	12.5	14.8	2.1
	2		231	0.32	3.5	10.9	0.2
	3		206	0.32	24.9	12.4	16.4
	4		224	0.32	6.0	8.8	5.0
	5		208	0.34	19.8	13.4	0.0

Table A5.1 continued

Core	No.	Depth [m]	Distance [mm]	Porosity [%]	Relative concentration Uranine [%]	I⁻ [%]	Cr-EDTA [%]
1X	1	-0.325	358	0.39	0.0	0.2	0.0
	2		272	0.42	3.0	1.4	0.1
	3		327	0.39	0.0	0.3	0.1
	4		258	0.41	0.6	1.0	0.0
	5		317	0.40	0.2	0.6	0.1
	6		343	0.41	0.0	0.2	0.0
	7		295	0.40	0.3	0.6	0.1
	8		282	0.43	2.7	1.7	2.8
	9		340	0.42	0.0	0.4	0.0
2X	1	-0.115	357	0.34	0.7	1.1	0.1
	2		273	0.31	20.8	9.3	0.6
	3		328	0.32	0.8	2.4	0.0
	4		304	0.36	8.7	6.7	0.1
	5		311	0.31	10.9	5.6	0.1
	6		352	0.33	0.3	1.2	0.1
	7		294	0.37	3.6	4.4	0.1
	8		334	0.36	3.3	2.8	0.3
	9		285	0.33	25.5	11.0	0.8
3X	1	0.035	357	0.37	0.0	0.4	0.0
	2		274	0.35	22.8	8.8	2.3
	3		325	0.37	0.6	1.8	0.1
	4		309	0.34	0.4	1.4	0.2
	5		320	0.35	1.3	2.1	0.3
	6		348	0.28	0.0	1.1	0.0
	7		337	0.34	0.0	0.4	0.0
	8		293	0.35	8.2	5.8	0.0
	9		278	0.34	14.4	8.9	5.5
	10		296	0.33	19.1	9.0	1.2
4X	1	0.235	358	0.35	0.0	0.2	0.0
	2		273	0.36	15.4	8.8	0.1
	3		311	0.32	0.5	1.3	0.1
	4		324	0.35	0.6	2.6	0.2
	5		319	0.32	0.9	3.7	0.3
	6		345	0.39	0.0	0.7	0.0
	7		344	0.36	0.0	0.3	0.1
	8		299	0.35	4.2	4.6	0.2
	9		285	0.32	12.2	9.6	0.3
5X	1	0.435	357	0.32	0.2	7.1	0.1
	2		278	0.32	20.6	16.9	9.9
	3		313	0.32	2.7	10.6	0.2
	4		327	0.32	2.1	9.2	0.3
	5		322	0.31	1.8	11.1	0.3
	6		341	0.35	0.3	6.7	0.0
	7		349	0.31	0.3	6.9	0.1
	8		294	0.31	9.4	13.2	0.1
	9		288	0.34	11.9	15.6	0.1

Table A5.1 continued

Core	No.	Depth [m]	Distance [mm]	Porosity [%]	Relative concentration Uranine [%]	Relative concentration I^- [%]	Relative concentration Cr-EDTA [%]
6X	1	0.545	356	0.36	18.5	19.8	13.1
	2		270	0.40	10.6	21.3	0.4
	3		330	0.38	9.5	20.0	2.8
	4		304	0.43	11.9	23.1	10.7
	5		321	0.42	9.8	24.1	6.5
	6		304	0.46	5.2	20.3	0.2
	7		354	0.51	15.3	22.5	8.3
	8		334	0.43	13.3	21.4	13.2
	9		256	0.41	9.1	24.5	2.4
7X	1	0.715	360	0.44	22.6	24.8	79.7
	2		268	0.45	24.5	20.6	77.7
	3		322	0.44	57.3	30.1	83.8
	4		306	0.43	19.4	27.2	44.4
	5		346	0.42	33.1	26.6	75.5
	6		296	0.45	27.6	28.9	77.4
	7		281	0.41	27.2	30.9	76.9
	8		341	0.38	33.3	—	—
	9		318	0.43	27.8	30.7	79.7
8X	1	0.765	362	0.39	30.7	27.6	98.0
	2		273	0.38	33.4	29.7	66.2
	3		328	0.35	25.3	25.6	46.9
	4		313	0.41	28.4	30.8	108.6
	5		352	0.35	56.0	33.1	89.2
	6		301	0.35	28.1	22.3	47.8
	7		279	0.37	30.9	25.6	68.9
	8		341	0.39	27.2	23.3	80.3
	9		318	0.39	29.4	23.9	71.0
	10		344	0.41	31.3	25.5	87.1
	11		334	0.36	29.9	25.8	60.4
	12		297	0.36	31.8	26.5	60.0
	13		298	0.43	42.9	27.2	75.1
9X	1	0.815	363	0.38	24.4	16.0	43.8
	2		272	0.41	14.8	15.0	20.3
	3		325	0.33	22.2	15.5	4.6
	4		305	0.37	25.4	19.3	52.0
	5		321	0.40	23.5	21.5	28.6
	6		348	0.43	20.2	16.6	31.7
	7		294	0.44	17.7	20.2	7.2
	8		337	0.38	26.5	21.8	54.0
	9		278	0.37	19.7	18.0	35.7
10X	1	0.965	363	0.35	6.3	8.9	0.9
	2		268	0.40	10.3	7.7	2.3
	3		326	0.42	4.6	5.4	0.1
	4		318	0.37	7.0	12.2	0.1
	5		322	0.38	6.1	10.3	0.0
	6		352	0.37	5.6	7.6	0.2
	7		295	0.37	10.4	9.5	1.0
	8		344	0.40	6.0	10.3	0.8
	9		282	0.38	7.6	10.4	0.2

Table A5.1 continued

Core	No.	Depth [m]	Distance [mm]	Porosity [%]	Relative concentration Uranine [%]	I^- [%]	Cr-EDTA [%]
11X	1	1.015	364	0.38	9.7	10.0	9.2
	2		271	0.39	3.4	9.3	0.2
	3		326	0.38	1.0	4.8	0.1
	4		311	0.40	5.0	12.7	0.7
	5		320	0.40	2.1	8.8	0.1
	6		351	0.42	2.9	7.8	0.3
	7		290	0.42	1.7	6.9	0.1
	8		346	0.39	9.1	10.6	11.6
	9		282	0.38	4.7	12.2	0.4
12X	1	1.065	365	0.41	11.4	9.4	10.6
	2		269	0.38	5.5	8.2	0.1
	3		327	0.42	0.6	4.2	0.1
	4		310	0.43	10.0	10.1	6.2
	5		318	0.41	3.2	8.6	0.2
	6		351	0.40	4.2	7.2	0.5
	7		299	0.42	0.7	5.4	0.0
	8		341	0.44	10.0	11.5	2.1
	9		283	0.40	9.6	10.7	0.3
	10		332	0.39	1.5	6.0	0.0
	11		342	0.42	7.4	10.1	0.3
	12		292	0.42	2.0	7.6	0.1
	13		305	0.41	6.3	10.0	0.3
13X	1	1.115	362	0.41	10.6	7.8	1.4
	2		269	0.42	10.4	7.4	0.0
	3		330	0.41	1.2	4.3	0.0
	4		306	0.39	14.1	9.8	0.4
	5		345	0.38	12.7	8.4	5.7
	6		353	0.44	5.3	6.8	0.2
	7		300	0.42	1.5	5.2	0.1
	8		280	0.39	16.3	10.5	2.2
	9		322	0.40	6.0	8.0	0.1
14X	1	1.165	360	0.36	7.6	5.3	0.0
	2		270	0.41	15.1	8.4	1.7
	3		330	0.42	1.6	4.2	0.1
	4		310	0.43	8.1	7.8	0.1
	5		349	0.42	3.9	4.7	0.3
	6		343	0.42	6.0	4.4	0.1
	7		299	0.42	3.5	5.8	0.1
	8		282	0.43	13.9	8.5	4.4
	9		319	0.42	4.0	5.6	0.2
15X	1	1.215	362	0.43	1.0	2.9	0.0
	2		272	0.43	13.4	5.1	7.4
	3		329	0.41	1.6	2.5	0.0
	4		303	0.44	3.2	5.6	0.1
	5		352	0.51	0.6	2.0	0.1
	6		299	0.44	6.0	3.5	0.1
	7		281	0.48	12.0	6.1	3.3
	8		339	0.42	0.9	3.8	0.2
	9		321	0.46	1.8	3.6	0.2

Table A5.1 continued

Core	No.	Depth [m]	Distance [mm]	Porosity [%]	Relative concentration Uranine [%]	I^- [%]	Cr-EDTA [%]
16X	1	1.265	362	0.44	0.1	2.0	0.0
	2		271	0.41	11.7	6.3	0.6
	3		329	0.39	1.0	2.9	0.1
	4		310	0.44	1.5	4.6	0.0
	5		356	0.43	0.1	2.0	0.0
	6		298	0.41	6.9	4.3	0.1
	7		342	0.41	0.2	2.8	0.1
	8		278	0.43	7.0	6.8	0.1
	9		319	0.42	1.3	3.9	0.0
	10		295	0.42	8.1	6.0	0.4
	11		333	0.42	0.6	2.6	0.2
	12		303	0.40	2.2	5.0	0.1
	13		335	0.42	0.4	3.0	0.1
17X	1	1.315	361	0.45	0.4	1.6	0.0
	2		269	0.40	16.5	6.2	20.6
	3		328	0.37	4.3	2.5	0.3
	4		317	0.41	1.8	3.4	0.0
	5		325	0.40	3.3	3.4	0.0
	6		352	0.39	1.0	1.7	0.0
	7		299	0.35	10.0	4.1	5.9
	8		344	0.40	0.8	2.3	0.1
	9		286	0.38	7.6	6.3	2.3
18X	1	1.405	364	0.40	0.1	0.4	0.2
	2		275	0.42	3.6	1.8	1.3
	3		330	0.39	0.4	0.7	0.2
	4		318	0.42	1.2	1.3	0.0
	5		317	0.45	1.0	1.2	0.1
	6		352	0.44	0.1	0.5	0.2
	7		296	0.37	1.5	1.3	0.1
	8		346	0.44	0.2	0.6	0.0
	9		288	0.40	2.1	1.7	0.0
	10		296	0.40	2.1	1.4	0.1
19X	1	1.555	364	0.37	0.0	0.1	0.0
	2		271	0.34	0.0	0.3	0.0
	3		319	0.34	0.0	0.2	0.0
	4		300	0.36	0.0	0.2	0.0
	5		302	0.29	0.0	0.2	0.0
20X	1	1.765	364	0.33	0.0	0.0	0.0
	2		271	0.27	0.0	0.2	0.0
	3		329	0.30	0.0	0.0	0.0
	4		309	0.31	0.0	0.1	0.0
	5		314	0.27	0.0	0.1	0.0
21X	1	1.815	361	0.32	0.0	0.0	0.0
	2		273	0.35	0.0	0.1	0.0
	3		321	0.34	0.0	0.0	0.0
	4		302	0.34	0.0	0.0	0.0
	5		307	0.40	0.0	0.0	0.0

Table A5.1 continued

Core	No.	Depth [m]	Distance [mm]	Porosity [%]	Relative concentration Uranine [%]	I⁻ [%]	Cr-EDTA [%]
22X	1	1.965	366	0.32	0.0	0.0	0.0
	2		274	0.32	0.0	0.0	0.0
	3		299	0.32	0.0	0.0	0.0
	4		312	0.33	0.0	0.0	0.0
	5		299	0.31	0.0	0.0	0.0
23X	1	2.015	365	0.33	0.0	0.0	0.0
	2		272	0.32	0.0	0.0	0.0
	3		307	0.32	0.0	0.0	0.0
	4		318	0.33	0.0	0.0	0.0
	5		303	0.35	0.0	0.0	0.0
24X	1	2.065	364	0.36	0.0	0.0	0.0
	2		273	0.35	0.0	0.0	0.0
	3		328	0.36	0.0	0.0	0.0
	4		317	0.35	0.0	0.0	0.0
	5		295	0.40	0.0	0.0	0.0
	6		356	0.37	0.0	0.0	0.0
	7		351	0.39	0.0	0.0	0.0
	8		285	0.38	0.0	0.0	0.0
	9		325	0.34	0.0	0.0	0.0
25X	1	2.215	366	0.39	0.0	0.1	0.0
	2		272	0.37	0.0	0.0	0.0
	3		330	0.42	0.0	0.0	0.0
	4		313	0.38	0.0	0.0	0.0
	5		296	0.40	0.0	0.0	0.0
	6		356	0.37	0.0	0.0	0.0
	7		347	0.35	0.0	0.0	0.0
	8		284	0.36	0.0	0.0	0.0
	9		321	0.38	0.0	0.0	0.0
26X	1	2.265	367	0.37	0.0	0.0	0.0
	2		272	0.37	0.0	0.0	0.0
	3		331	0.40	0.0	0.0	0.0
	4		311	0.37	0.0	0.0	0.0
	5		354	0.44	0.0	0.0	0.0
	6		302	0.37	0.0	0.0	0.0
	7		345	0.37	0.0	0.0	0.0
	8		285	0.37	0.0	0.0	0.0
	9		321	0.39	0.0	0.0	0.0
27X	1	2.315	365	0.37	0.0	0.0	0.0
	2		272	0.36	0.0	0.0	0.0
	3		330	0.36	0.0	0.0	0.0
	4		324	0.36	0.0	0.0	0.0
	5		355	0.37	0.0	0.0	0.0
	6		283	0.36	0.0	0.0	0.0
	7		313	0.39	0.0	0.0	0.0
	8		346	0.41	0.0	0.0	0.0
	9		285	0.35	0.0	0.0	0.0

Table A5.1 continued

Core	No.	Depth [m]	Distance [mm]	Porosity [%]	Relative concentration Uranine [%]	I^- [%]	Cr-EDTA [%]
28X	1	2.415	361	0.32	0.0	0.0	0.0
	2		274	0.32	0.0	0.1	0.0
	3		331	0.28	0.0	0.0	0.0
	4		317	0.30	0.1	0.1	0.0
	5		323	0.33	0.0	0.0	0.0
29X	1	2.625	344	0.28	0.0	0.1	0.0
	2		277	0.28	0.0	0.6	0.0
	3		312	0.28	0.0	0.2	0.0
	4		361	0.41	0.0	0.0	0.0
	5		331	0.38	0.0	0.0	0.0
30X	1	2.675	359	0.39	0.0	0.1	0.0
	2		274	0.30	0.0	0.2	0.0
	3		324	0.33	0.0	0.1	0.0
	4		314	0.34	0.0	0.0	0.0
	5		323	0.47	0.0	0.0	0.0
31X	1	2.815	364	0.33	0.0	0.0	0.0
	2		274	0.35	0.0	0.0	0.0
	3		330	0.33	0.0	0.0	0.0
	4		314	0.33	0.0	0.0	0.0
	5		323	0.32	0.0	0.0	0.0
32X	1	2.965	364	0.28	0.0	0.2	0.0
	2		272	0.26	0.1	1.0	0.0
	3		328	0.28	0.0	0.2	0.0
	4		320	0.29	0.0	0.2	0.0
	5		322	0.28	0.1	0.3	0.0
33X	1	3.015	364	0.30	0.1	0.4	0.0
	2		273	0.27	1.0	1.0	0.0
	3		333	0.32	0.2	0.4	0.0
	4		312	0.30	0.2	0.9	0.0
	5		357	0.24	0.3	0.8	0.0
	6		301	0.27	0.6	0.8	0.0
	7		346	0.34	0.0	0.5	0.0
	8		336	0.30	0.0	0.7	0.0
	9		307	0.29	0.6	1.6	0.0
34X	1	3.065	271	0.28	6.2	4.1	0.4
	2		324	0.28	0.6	1.4	0.1
	3		331	0.34	0.7	0.9	0.0
	4		363	0.32	0.1	0.4	0.3
	5		302	0.31	1.9	1.8	0.0
	6		318	0.28	0.2	1.4	0.0
	7		284	0.28	3.0	3.3	0.3
	8		354	0.31	0.2	0.6	0.1
	9		346	0.31	0.1	0.4	0.1
	10		289	0.30	2.5	3.1	0.1
	11		320	0.29	0.6	1.6	0.0
	12		298	0.30	1.3	2.6	0.0
	13		311	0.29	0.8	2.0	0.1

Table A5.1 continued

Core	No.	Depth [m]	Distance [mm]	Porosity [%]	Relative concentration Uranine [%]	I^- [%]	Cr-EDTA [%]
1T	1	-0.025	216	0.37	19.2	9.6	18.9
	2		200	0.39	16.3	10.0	20.1
	3		233	0.37	2.5	3.4	5.4
	4		219	0.36	9.2	8.4	4.7
	5		214	0.38	13.3	8.9	23.6
2T	1	0.025	214	0.37	21.9	14.8	24.0
	2		199	0.35	22.0	14.5	25.6
	3		232	0.38	11.8	10.4	11.8
	4		213	0.35	15.8	12.4	22.6
	5		218	0.36	14.2	10.8	12.1
3T	1	0.075	217	0.32	25.1	21.9	24.2
	2		201	0.35	25.3	19.9	26.2
	3		232	0.32	18.4	14.7	18.1
	4		216	0.35	19.3	17.2	27.7
4T	1	0.325	214	0.33	32.1	30.0	68.6
	2		195	0.32	19.6	18.4	47.0
	3		213	0.30	18.3	16.9	40.0
	4		220	0.27	23.8	22.4	46.7
5T	1	0.375	215	0.36	32.3	32.8	70.7
	2		210	0.31	33.2	27.3	62.6
	3		199	0.30	30.8	30.9	68.4
6T	1	0.425	214	0.30	24.4	28.1	52.8
	2		198	0.26	35.4	32.7	65.9
	3		207	0.34	36.2	31.0	77.0
	4		226	0.32	24.0	22.8	59.0
7T	1	0.475	217	0.34	27.3	21.5	52.8
	2		201	0.28	18.5	18.4	43.6
	3		217	0.34	28.8	24.3	65.4
8T	1	0.595	215	0.33	25.1	20.4	54.7
	2		226	0.33	21.3	15.6	44.3
	3		208	0.31	20.4	16.6	21.2
	4		198	0.33	26.0	19.9	41.0
9T	1	0.695	218	0.41	10.8	9.7	11.1
	2		203	0.43	8.2	10.1	2.4
	3		209	0.37	9.7	10.9	1.0
10T	1	0.745	219	0.35	15.5	13.9	2.5
	2		205	0.36	15.0	13.4	1.3
	3		234	0.34	21.3	15.1	2.1
	4		213	0.35	7.5	10.5	—
11T	1	0.795	216	0.41	24.6	14.2	1.8
	2		200	0.39	23.4	13.2	3.2
	3		231	0.36	25.0	12.7	2.4
	4		214	0.40	28.2	14.6	8.6

Table A5.1 continued

Core	No.	Depth [m]	Distance [mm]	Porosity [%]	Relative concentration Uranine [%]	I$^-$ [%]	Cr-EDTA [%]
12T	1	0.845	216	0.36	40.6	18.2	25.2
	2		200	0.39	21.4	11.6	20.7
	3		231	0.37	21.9	15.7	16.6
	4		214	0.37	25.2	16.3	40.6
	5		220	0.39	22.0	14.4	6.1
13T	1	0.895	215	0.35	31.3	18.2	33.2
	2		201	0.36	27.2	14.6	26.8
	3		230	0.39	31.6	14.9	19.0
	4		214	0.35	23.3	13.8	41.2
	5		218	0.36	30.6	14.0	6.0
14T	1	0.945	216	0.39	32.6	13.4	—
	2		200	0.37	27.9	14.2	8.0
	3		232	0.40	37.7	9.6	0.3
	4		213	0.38	23.7	12.8	0.1
	5		219	0.39	16.9	10.4	4.7
15T	1	0.995	215	0.34	29.4	19.0	1.1
	2		200	0.34	43.8	19.5	15.4
	3		229	0.33	26.7	17.2	—
	4		216	0.36	31.2	14.3	7.6
	5		219	0.33	24.0	16.8	—
16T	1	1.045	217	0.39	19.2	22.3	0.7
	2		204	0.36	37.7	21.3	0.0
	3		233	0.39	24.7	14.3	0.0
	4		219	0.40	23.1	16.3	0.3
	5		213	0.40	24.0	17.0	0.1
17T	1	1.095	217	0.41	21.7	18.1	6.4
	2		204	0.42	17.0	16.3	5.4
	3		231	0.42	26.3	15.3	2.5
	4		215	0.43	22.3	17.9	4.2
	5		223	0.42	23.3	15.4	2.6
18T	1	1.145	214	0.45	15.0	12.9	36.5
	2		198	0.44	16.4	10.9	33.8
	3		207	0.44	22.3	12.6	26.8
	4		226	0.47	42.8	11.9	20.3
	5		230	0.44	19.9	13.4	30.2
	6		218	0.42	21.4	14.6	—
19T	1	1.195	214	0.37	30.9	17.8	37.0
	2		198	0.38	28.5	14.1	40.0
	3		230	0.36	27.3	15.5	38.8
	4		215	0.41	22.5	14.4	46.6
	5		218	0.40	28.8	14.7	10.1
20T	1	1.290	216	0.32	12.6	15.7	0.0
	2		203	0.32	23.2	17.0	0.3
	3		230	0.33	6.7	10.4	0.1
	4		219	0.31	19.3	13.0	1.0

Table A5.1 continued

Core	No.	Depth [m]	Distance [mm]	Porosity [%]	Relative concentration Uranine [%]	I⁻ [%]	Cr-EDTA [%]
21T	1	1.340	216	0.35	14.0	13.8	0.1
	2		199	0.37	21.8	13.0	0.1
	3		231	0.40	5.8	8.8	0.0
	4		214	0.38	18.0	11.4	0.3
	5		219	0.34	4.5	8.7	0.1
22T	1	1.390	215	0.30	24.2	16.7	0.0
	2		203	0.27	30.8	20.7	0.0
	3		229	0.29	25.4	16.1	0.0
	4		215	0.29	29.6	13.4	0.3
	5		220	0.31	11.3	11.0	0.1
23T	1	1.540	216	0.27	10.1	10.7	0.0
	2		200	0.30	10.7	8.1	0.1
	3		229	0.26	4.7	8.8	0.2
	4		216	0.27	4.8	6.8	0.4
	5		216	0.27	3.7	6.5	0.1
24T	1	1.590	217	0.32	1.5	5.8	0.0
	2		201	0.36	2.8	5.0	0.0
	3		232	0.26	0.5	3.7	0.0
	4		214	0.33	1.0	3.7	0.0
	5		219	0.33	1.7	3.1	0.0
25T	1	1.640	216	0.27	0.4	4.1	0.0
	2		202	0.27	0.6	3.6	0.0
	3		228	0.27	0.2	3.9	0.0
	4		216	0.28	0.5	2.9	0.0
	5		219	0.28	0.1	2.9	0.0
26T	1	1.690	209	0.26	0.1	1.9	0.0
	2		196	0.24	0.1	1.5	0.0
	3		225	0.25	0.1	1.8	0.0
	4		218	0.28	0.0	1.8	0.0
27T	1	1.840	212	0.25	0.4	1.2	0.0
	2		198	0.22	0.2	0.9	0.0
	3		224	0.24	0.4	1.5	0.0
	4		215	0.25	0.2	0.7	0.0
	5		218	0.26	0.1	1.3	0.0
28T	1	1.890	216	0.35	0.0	0.6	0.0
	2		203	0.34	0.0	0.6	0.0
	3		232	0.41	0.0	0.4	0.0
	4		216	0.37	0.0	0.3	0.0
	5		222	0.34	0.0	0.9	0.0
29T	1	1.940	215	0.32	0.0	0.5	0.0
	2		200	0.30	0.0	0.4	0.0
	3		229	0.31	0.0	0.3	0.0
	4		217	0.30	0.0	0.2	0.0
	5		217	0.30	0.0	0.4	0.0

Table A5.1 continued

Core	No.	Depth [m]	Distance [mm]	Porosity [%]	Relative concentration Uranine [%]	I^- [%]	Cr-EDTA [%]
30T	1	1.990	215	0.35	0.0	0.3	0.0
	2		200	0.36	0.0	0.3	0.0
	3		229	0.39	0.0	0.3	0.0
	4		217	0.35	0.0	0.4	0.0
	5		218	0.40	0.0	0.2	0.0
31T	1	2.040	211	0.29	0.0	0.4	0.0
	2		198	0.28	0.0	0.4	0.0
	3		225	0.31	0.0	0.3	0.0
	4		206	0.28	0.0	0.5	0.0
	5		214	0.30	0.0	0.2	0.0
32T	1	2.160	215	0.34	3.2	7.7	0.0
	2		200	0.36	0.7	4.0	0.0
	3		229	0.33	8.8	8.6	0.0
	4		209	0.36	1.8	4.5	0.2
	5		213	0.34	1.0	4.7	0.0
33T	1	2.210	217	0.40	12.1	10.8	0.2
	2		231	0.38	4.1	8.0	0.0
	3		206	0.38	33.2	11.9	6.9
	4		213	0.40	15.0	9.7	0.3
	5		225	0.38	7.7	8.3	0.0
34T	1	2.260	213	0.35	20.9	12.7	0.3
	2		199	0.37	10.1	8.8	0.2
	3		230	0.35	41.3	13.6	11.2
	4		215	0.36	29.0	10.8	3.6
	5		219	0.35	16.4	10.5	0.3
35T	1	2.410	217	0.30	6.2	6.8	0.2
	2		202	0.27	4.5	5.5	0.2
	3		231	0.26	29.0	12.5	1.0
	4		217	0.21	20.2	10.2	0.5
36T	1	2.460	214	0.30	3.5	5.8	0.2
	2		199	0.30	2.1	4.1	0.0
	3		230	0.30	5.4	8.2	0.2
	4		216	0.30	4.5	8.6	0.2
	5		216	0.29	2.0	3.6	0.2
37T	1	2.510	213	0.30	3.0	7.6	0.0
	2		199	0.35	0.8	4.7	0.0
	3		228	0.33	5.0	13.1	0.0
	4		215	0.36	2.9	13.7	0.2
	5		217	0.33	2.0	5.8	0.1
38T	1	2.660	215	0.31	1.9	6.4	0.0
	2		201	0.30	0.6	5.3	0.0
	3		230	0.32	5.1	6.6	0.0
	4		219	0.33	2.7	7.7	0.0
	5		220	0.32	0.6	3.6	0.1

Table A5.1 continued

Core	No.	Depth [m]	Distance [mm]	Porosity [%]	Relative concentration Uranine [%]	I⁻ [%]	Cr-EDTA [%]
39T	1	2.710	214	0.32	5.8	7.0	0.1
	2		200	0.30	1.4	5.3	0.1
	3		229	0.31	11.4	6.6	0.2
	4		216	0.31	8.9	12.3	0.2
	5		216	0.29	2.2	4.9	0.4
40T	1	2.760	219	0.32	3.0	6.0	0.1
	2		232	0.33	1.4	6.3	0.0
	3		207	0.30	8.6	6.0	0.1
	4		212	0.31	5.0	7.8	0.2
	5		225	0.30	2.8	7.2	0.3
41T	1	2.810	215	0.27	3.9	8.0	0.1
	2		200	0.26	1.4	6.3	0.2
	3		230	0.26	6.5	6.7	0.2
	4		215	0.26	4.0	7.7	0.4
	5		218	0.25	2.2	7.2	0.3
42T	1	2.860	215	0.27	3.5	5.9	0.1
	2		200	0.30	1.2	4.6	0.2
	3		230	0.30	7.3	5.3	0.1
	4		212	0.29	3.6	5.9	0.2
	5		219	0.31	1.0	2.8	0.2
43T	1	2.910	221	0.33	1.0	3.0	0.0
	2		234	0.31	0.6	3.6	0.1
	3		206	0.30	2.8	4.7	0.1
	4		212	0.26	2.4	6.4	0.2
	5		226	0.34	0.4	1.7	0.1
44T	1	2.960	220	0.34	0.3	2.2	0.0
	2		233	0.30	0.1	1.7	0.0
	3		205	0.23	1.5	4.6	0.1
	4		214	0.25	0.8	7.8	0.1
	5		224	0.28	0.1	1.0	0.2
45T	1	3.010	215	0.31	0.0	0.8	0.0
	2		200	0.32	0.0	0.5	0.0
	3		229	0.32	0.0	1.3	0.1
	4		217	0.33	0.0	3.4	0.2
	5		218	0.30	0.0	0.3	0.2

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[1] Chalmers University of Technology
[2] University of Linköping
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[1] Royal Institute of Technology, Stockholm, Sweden
[2] Lawrence Berkeley Laboratory, Berkeley, CA, USA
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US Geological Survey, Lakewood, CA, USA
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