KONSULT AB

May 7, 1991

INTRAVAL KU(91)34

To: All INTRAVAL Project Participants

Dear Participant,

Please find enclosed the Test Case Descriptions of Phase 2 Test Cases Twin Lake and Mol.

Best regards,

Magdalena Ericsson

Magdalena Ericsson
Kemakta Consultants Co.
INTRAVAL Project Secretariat

Pipersgatan 27
S-112 28 Stockholm
SWEDEN

Telephone
Nat 08-654 06 80
Int +46 8 6540680

Telefax
Nat 08-652 16 07
Int +46 8 6521607

Telex
15660 KEMAKTA S

Teletex
+24018106328

INTRAVAL Phase II Test Case

TWIN LAKE TESTS

I. INTRODUCTION

Since the early 1950's AECL has been engaged in field testing and validation of conceptual and mathematical models of radionuclide transport in the subsurface environment. A great deal of aquifer testing, ranging from large number of small scale field experiments to very large scale radio-tracer migration tests have been performed at one of AECL research facilities, the Chalk River Laboratories (CRL).

The largest experimental program conducted at the CRL included 20-, 40- and 260-m natural gradient radio-tracer experiments performed in a sandy aquifer at the Twin Lake site. The experiments were performed in 1982, 1983, 1987-1988, and 1990-1991. In the 1982, 1983 and 1990-1991 experiments the use of radioiodine as a groundwater tracer resulted in unprecedented resolution of the concentration distribution in the aquifer; almost half-a-million data points were collected in the 1983 experiment. A very large amount of hydrogeological and geophysical data has also been collected at the site over the last decade. Data accumulated at the Twin Lake research site are available now for distribution to the working group members on a magnetic tape in the form of an ASCII file.

A. Pilot Group

The Pilot Group is comprised of the AECL Research Company, Ontario Hydro, U.S. Nuclear Regulatory Commission, Sandia National Laboratories, University of California at Berkeley, Commissiariat L'Energie Atomique, Institute de Mechanique des Fluids (Strasbourg), Japan Atomic Energy Research Institute.

B. Experimental Location and Brief Description

The CRL is located 200 km northwest of Ottawa, Canada in the Valley of the Ottawa River. The 37 km² property lies on the Canadian shield, with a Precambrian bedrock consisting primarily of granitic gneiss. Bedrock is exposed or is buried beneath less than 1 m of overburden over 10% of the site. The remainder of the CRL property is covered by unconsolidated sediments of late Wisconsin age to modern. For the most part, overburden consists of bouldery sandy till, fluvial sands laid down during high stages of Ottawa River, aeolian sands reworked from the fluvial deposits, and organic soils currently accumulating in wetlands. Climate is temperate-humid, with an annual average precipitation of 73 cm, of which 22 cm is available for infiltration or runoff. Most of the site is forested with a mixed coniferous-deciduous cover.

The Twin Lake site was selected in 1982, after preliminary drilling in three areas on the CRNL property, as a site with the highest natural groundwater flow velocity. The water table in the Twin Lake aquifer lies 6 to 20 m below grade; the saturated thickness of this unconfined aquifer ranges from 6 to 10 m. Total groundwater flowpath length from the tracer injection well to the groundwater discharge area is 270 m, and at present there are 170 monitoring installations in the aquifer around and downgradient of the injection well. Each installation consists of 0.64 cm ID polyethylene piezometers with short screens located at 1 m depth increments through the zone of saturation and 3.2 cm ID PVC dry pipe that fully penetrates the aquifer. Multilevel piezometers were used for water sampling and dry pipes were used for gamma scanning. The groundwater discharge area, a wetland at the toe of the dune ridge, currently contains 36 of the monitoring installations mostly at the base of the hill where there is a line of springs and seepage areas (for more details see publications on Twin Lake Tracer Tests).

C. Original Purpose of the Performed Experiments and Time Scales

Three locally-non-reactive radiotracer injections have been performed at the Twin Lake site in 1982, 1983, 1987-88 and one, with labelled pesticides, in 1990-1991. The main objective of experimental program is to understand and to quantify the dispersion process at different spatial and time scales relevant to actual cases of groundwater contamination. Mapping of the tracer distribution downgradient of the injection well extended for 20, 40 and 270 m. In the 1982 and 1983 experiments ^{131}I was used so that the tracer distribution could be mapped by gamma scanning. In the 1983 experiment, a small amount of tritiated water was also injected and groundwater samples were collected to verify that no retardation of the radioiodine took place. Tritiated water was used in the 1987 injection.

D. Objectives of the Test Case in INTRAVAL Phase II

Aquifer Heterogeneities, Their Characteristic Scales and Scales of Measurements

Results from the experiments are presented and discussed in several papers and reports given in the attached list of publications. Briefly, the results showed the presence of a number of sub-horizontal strata with seemingly uniform intralayer hydraulic properties but with up to a two-fold difference in hydraulic conductivities between layers. Local-scale (with the characteristic length of about 10 cm) longitudinal and transverse dispersivities within these strata were found to be similar to laboratory measured values, with no apparent trend toward increasing dispersivity with transport distance and transport time. At the integral scale (with the characteristic dimensions of about 0.4 m transverse-vertically, 1.5 m transverse-horizontally and 16 m longitudinally), only the one-dimensional Fickian model of dispersion seems to have a physical significance. The integral-scale longitudinal dispersivity is an order of magnitude larger than the local-scale longitudinal dispersivity. Analysis of experimental results indicates also that if the scales of measurement associated with experimental methods are not accounted for in the dispersion model, than the estimated model parameters are of little practical consequence.

E. Validation Process

The unique database is used to address the basic question: to what extent the currently available conceptual and mathematical models of transport processes predict results of the tracer tests? As the first step towards the answer to this question, intensive numerical experiments with a 2-D finite element model of the dispersion process have been performed at CRL. Analysis of results obtained from numerical experiments has indicated that the conventional finite-element model may be used for the predictive purposes provided that an appropriate space-time grid is employed. A very-fine-mesh finite element model in vertical section along the tracer flow path has provided good agreement (local and global) between simulated and observed tracer distributions. A methodology for model validation against the Twin Lake data is being developed. We also attempted to quantify advantages and disadvantages of public domain computer codes, based on finite element-, finite difference-, random walk- and method-of-characteristics models, in simulating the tracer plume behaviour. Work on the use of 3-D finite-element and random-walk models has been initiated.

We plan to validate the available codes in a blind type of numerical experiment by calibrating flow and transport models against the 1983 data first and then by predicting the tracer behaviour in 1987-88 experiment.

II. DESCRIPTION OF EXPERIMENTS

A. Parameters Measured

The Twin Lake natural gradient radiotracer test strategy provides a means for evaluating in situ local-scale dispersive properties of the sedimentary materials and local-scale flow velocity field. Information needed to characterize the groundwater velocity and dispersivity is acquired by measuring in situ changes that flowing water and sedimentary materials jointly impose on the electromagnetic field generated by radioiodine. The information is sufficient to characterize the local-scale velocity and dispersivity on a point-to-point basis. The local-scale parameters are used as input for testing the local-scale three-dimensional dispersion model of radioiodine migration. The integral-scale dispersion parameters are derived by averaging the observed concentration along the cross-section orthogonal to the mean direction of flow. The parameter estimation procedure on the specified hierarchical scales of motion is described in Moltyaner [1987], Moltyaner and Killey [1988 a,b] and Moltyaner [1989]. The estimates of dispersion parameters and velocities can be found in the cited papers and in Killey and Moltyaner [1988]. The value of 1cm can be used for the local-scale longitudinal dispersivity and the value of 0.1cm can be used for the transverse dispersivity. The integral-scale longitudinal dispersivity that can be used in the one-dimensional modelling is 38cm. Hydraulic conductivities can also be taken from these papers.

B. Spatial and Temporal Scales

Three hierarchical scales of motion can be identified in the radioiodine transport studies, microscopic, local and integral. The microscopic scale is the scale of a fluid continuum with the characteristic dimension of 10^{-4} cm, the local scale is the scale of the porous medium with a characteristic dimensions of 10 cm, and the integral scale has longitudinal and transverse to flow characteristic lengths of 16 m and 44 cm respectively. The microscopic scale is not used in analysis because measurements of the tracer concentration are performed at the local scale. A simulation of tracer plume migration at the local scale may be done within the real time of experiment; at the integral scale the simulation should start at approximately 15 days. In the 1983 tracer test tritium and radioiodine migration was observed over 40m of subsurface flow path for 20 days. In the 1987-1988 test the evolution of the tritium plume was observed over 260 m for almost a year.

C. Experimental Setup

The experimental setup is described in detail by Killey and Moltyaner [1988]. A series of maps related to the 1987-1988 test are also attached to this description. Figure 1 shows the entire Twin Lake monitoring grid and a cross section along the axis of 1987 plume. Figure 2 shows the existing monitors over the first 80m from the injection well. Note that the injection period is 7.5 hours in the 1983 test and 3 days in the 1987-88 test.

D. Sampling Strategy

Our sampling strategy is tracer dependent. The tritium samples were collected at multilevel samplers spaced at 1 m in the transverse to flow direction with high frequency during the injection period and immediately after injection. At later times tritium samples were collected once a day. The data are in a form of the "concentration versus time". The longitudinal spacing between transverse arrays of boreholes varies from 2 to 150m (Figure 1). The radioiodine evolution in time and space was monitored by scanning dry boreholes on average three times a day. The vertical resolution of collected data is 1 cm. The spacing between boreholes is 5m in the longitudinal direction.

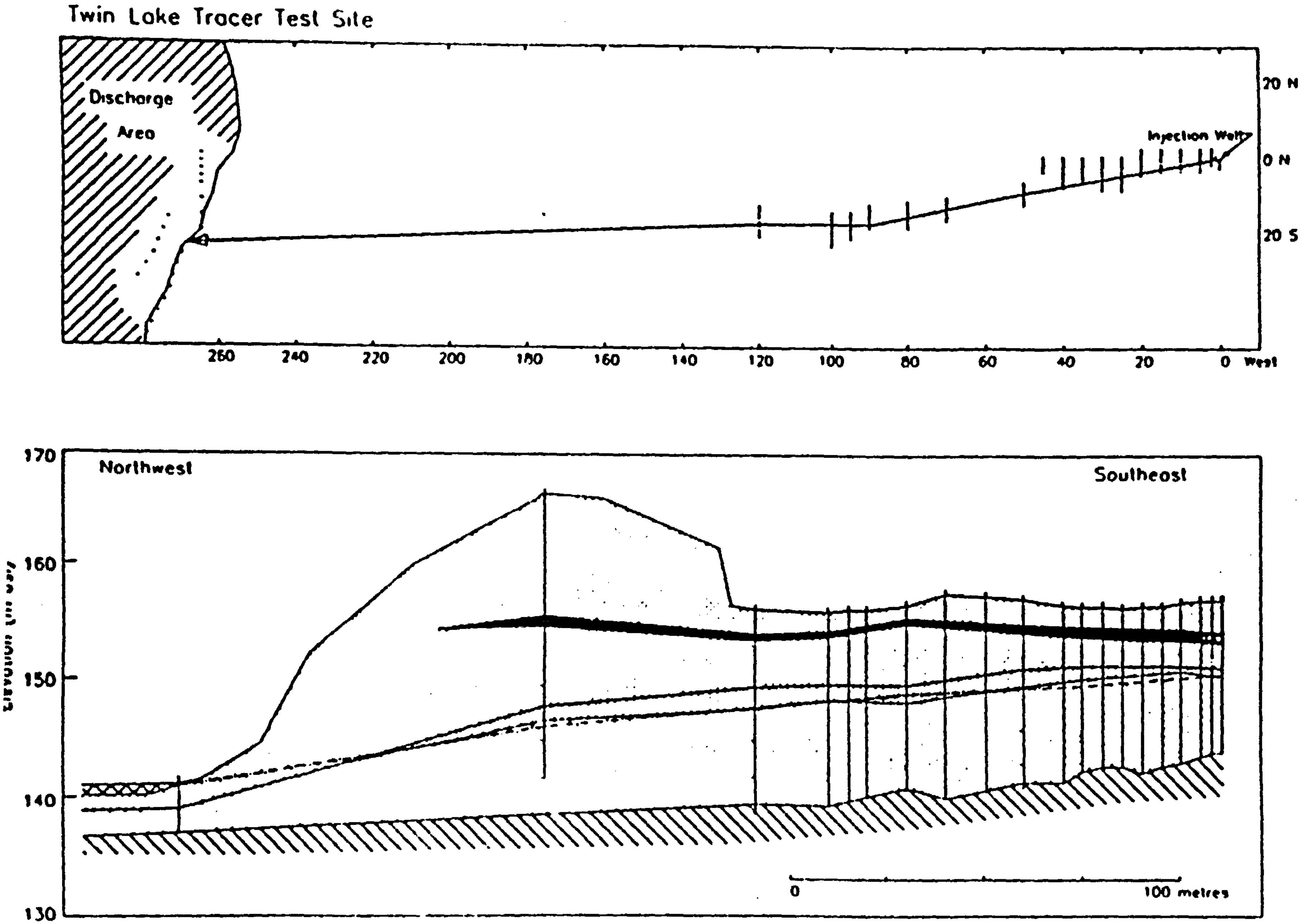
E. Independence Between Data Sets

The two data set from 1983 and 1987 tests are completely independent.

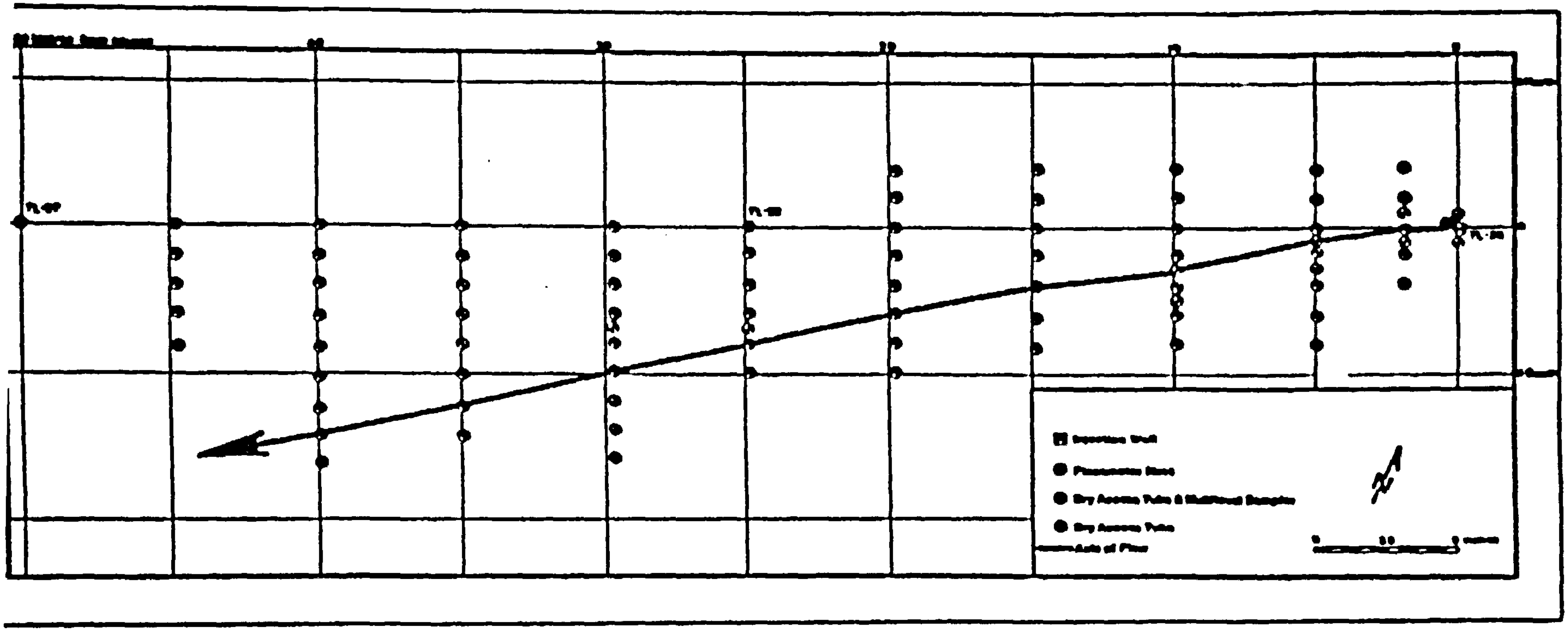
F. Biases Inherent in the Design

The tracer tests were designed for collecting concentration data versus time. This strategy requires to lay a grid of monitors in arrays perpendicular to the mean direction of flow.

INJECTION WELL AND MONITOR LOCATIONS



INJECTION WELL AND MONITOR LOCATIONS



G. Complementary Experiments

A 20 m natural gradient tracer test was performed at the same site in the 1982 and 260 m test is performed in 1990-1991.

F. Background Information

The information on geological and hydrological conditions at the tracer test site is given in Killey and Moltyaner [1988]. The geophysical information was used to develop the hydrostratigraphic scale model of the aquifer (see the same paper).

III. AVAILABLE EXPERIMENTAL RESULTS

A. Raw Data

Raw data (on a magnetic tape) and associated documentation are available through the INTRAVAL secretariat from G. Moltyaner, Environmental Research Branch, CRL.

B. Processed Data

Cross sectionally averaged data for the one-dimensional analysis are also available upon request.

IV. PREVIOUS MODELLING

The two-dimensional modelling of the 1983 plume along the mean direction of flow by the finite elements method is described by Moltyaner and Poisson [1988] and Moltyaner [1988].

V. CURRENT STATUS AND EXPERIMENTAL SCHEDULE

There is an ongoing effort to simulate 1983 and 1987 data in two and three dimensions by various organizations in North America, Japan and Europe.

VI. INFORMATION EXCHANGE

Dr. Greg Moltyaner
Environmental Research Branch
Chalk River Laboratories
AECL Research Company
Chalk River, Ontario, Canada K0J 1J0

VII. EXPECTED OUTPUT FROM PROJECT TEAMS

It is expected that Project Teams will make available results of simulations, methods and models used to get the results, criteria and methods used for model validations.

VIII. REFERENCES

LIST OF PUBLICATIONS ON TWIN LAKE TRACER TESTS

STOCHASTIC VERSUS DETERMINISTIC: A CASE STUDY
G.L. Moltyaner
Hydrogeology 2 (1986) 183-196

MIXING CUP AND THROUGH-THE-WALL MEASUREMENTS IN THE FIELD-SCALE TRACER TESTS AND THEIR RELATED SCALES OF AVERAGING
G.L. Moltyaner
J. of Hydrology 89 (1987) 281-302

A COMPARISON OF FIELD AND LABORATORY METHODS FOR DETERMINING CONTAMINANT FLOW PARAMETERS
S.R. Taylor, G.L. Moltyaner, K.W.F. Howard, and R.W.D. Killey
Ground Water 25(3) (1987) 321-330 AECL-9370

METHOD OF MOMENTS ANALYSIS OF THE TWIN LAKE TRACER TEST DATA
G.L. Moltyaner and C.A. Wills
Atomic Energy of Canada Limited Report (1987) AECL-9521

THE TWIN LAKE TRACER TESTS: SETTING METHODOLOGY, AND HYDRAULIC CONDUCTIVITY DISTRIBUTION
R.W.D. Killey and G.L. Moltyaner
Water Resources Res. 24(10) (1988) 1585-1612

ESTIMATION OF LOCAL AND INTEGRAL DISPERSION PARAMETERS
G.L. Moltyaner
Proc. of the Sixth Confress, the Asian and Pacific Region Division of the International Association for Hydraulic Res., Kyoto, Japan, (1988) July 20-22

DISPERSION OF CONTAMINANTS IN SATURATED POROUS MEDIA: VALIDATION OF A FINITE-ELEMENT MODEL
G.L. Moltyaner
Proc. of the 7th Int. Conf. on Computational Methods in Water Resources, Computational Mechanics Publications, Elsevier, Editors: M.A. Celia et al. 36 (1988) 201-205

THE TWIN LAKE TRACER TESTS: LONGITUDINAL DISPERSION
G.L. Moltyaner and R.W.D. Killey
Water Resources Res. 24(10) (1988) 1613-1627 AECL-9770

THE TWIN LAKE TRACER TESTS: TRANSVERSE DISPERSION
G.L. Moltyaner and R.W.D. Killey
Water Resources Res. 24(10) (1988) 1628-1637 AECL-9771

DISPERSION OF CONTAMINANTS IN SATURATED POROUS MEDIA: VALIDATION OF NUMERICAL MODELS
G.L. Moltyaner and J.M. Poisson
Atomic Energy of Canada Limited Report (1988) AECL-9520

LOCAL- AND PLUME-SCALE DISPERSION IN THE 40- AND 260-m NATURAL-GRADIENT TRACER TESTS
G.L. Moltyaner and C.A. Wills
Water Resources Res. (1989) (Submitted)

HYDRODYNAMIC DISPERSION AT THE LOCAL SCALE OF CONTINUUM REPRESENTATION
G.L. Moltyaner
Water Resources Res. 25(5) (1989) 1041-1048

FIELD STUDIES OF DISPERSION: RADIOACTIVE TRACER EXPERIMENTS ON SCALES OF 20, 40, AND 260 METERS
G.L. Moltyaner
"Dyanmics of Fluids in Hierarchial Porous Formations", Academic Press Limited, Ed. J. Cushman, Chapter 11 (1990) 7-35.

TRITIUM MIGRATION IN THE TWIN LAKE 260-m NATURAL GRADIENT DISPERSION TEST
R.W.D. Killey, C.A. Wills, and G.L. Moltyaner
Proc. of Transport and Mass Exchange Processes in Sand and Gravel Aquifers, AECL-10308; Ed. G.L. Moltyaner (1991) (in press)

DISPERSION IN GEOLOGICAL MEDIA
G.L. Moltyaner and C.A. Wills
Proc. of Transport and Mass Exchange Processes in Sand and Gravel Aquifers, AECL-10308; Ed. G.L. Moltyaner (1991) (in press)

METHODS FOR CALCULATING THE INTEGRAL-SCALE DISPERSION CO-EFFICIENT WITH APPLICATIONS TO THE TWIN LAKE AQUIFER
G.L. Moltyaner and C.A. Wills
Proc. of Transport and Mass Exchange Processes in Sand and Gravel Aquifers, AECL-10308; Ed. G.L. Moltyaner (1991) (in press)

STUDIECENTRUM VOOR KERNENERGIE

CENTRE D'ETUDE DE L'ENERGIE NUCLEAIRE

INTRAVAL
(phase 2)

(Test case description and data)

Three Dimensional In-Situ Migration Experiment in the Boom Clay Formation at the MOL Site in Belgium

April 15, 1991

1. INTRODUCTION

Since 1974 a Belgian research and development programme is carried out by SCK/CEN on the geological disposal of radioactive waste. Its main objectives are to develop the concept and the techniques, to demonstrate the feasibility and to assess the safety and performance of the geological disposal of conditioned radioactive waste in a deep argillaceous formation (the Boom clay formation).

The parameters required in safety assessment studies are determined in the laboratory on clay samples taken from the underground. Different types of migration experiments are performed on the samples. Reshaped and reconsolidated clay plugs are used for Flow Through type diffusion experiments (1,2). Clay cores drilled parallel with and perpendicular to the stratification of the formation are used for percolation experiments (3). The values of the migration parameters obtained from the small scale laboratory experiments are used for long term safety assessment calculations (PAGIS and PACOMA studies).

Despite the precautions taken during sample collection and the preparation of the diffusion experiments, parameters determined in the laboratory are subject to uncertainty. To improve the confidence in the laboratory data and to validate the safety assessment model, a large scale in-situ experiment has been set up.

In 1982 SCK/CEN has build an underground research laboratory (URL) in the Boom clay formation underlying the Belgian nuclear research facilities at Mol at a depth of 220 meters. Figure 1 shows the underground facility as build up to date. In 1985 a multiple purpose piezometernest has been installed in the clay formation through access hole No. 1 in the concrete plug at the right end of the URL (see CP1 on figure 1).

The aim of this piezometernest was to get a good estimation of the in-situ hydraulic parameters of the Boom clay formation and to start a large scale in-situ migration test. The purpose of the large scale migration test is to validate the safety assessment model and the migration parameters used for the long time predictive calculations.

The described experiment is a joint effort between SCK/CEN and the Power Reactor and Nuclear Fuel Development Corporation (PNC) of Japan. SCK/CEN is financially supported for this experiment by NIRAS/ONDRAF (Brussels).

2. DESCRIPTION OF THE EXPERIMENT

Figure 2 gives a conceptual view of the piezometernest installed in the URL. The all stainless steel system contains 9 piezometers, interspaced by 0.9 m long tubes, and numbered from 1 to 9. Each piezometer consists of two concentric tubes, the outer one being made of sintered stainless steel. Figure 3 gives an outline of a filter (piezometer) of the piezometernest.

The distance between the filters from center to center is 1 meter. A stand pipe with an internal diameter of 2 mm is connected to the space separating the concentric tubes. The stand pipe makes the connection between the filter and the URL. The internal volume of the stand pipe is 3.14 ml per meter pipe. The volume of the space separating the concentric tubes is 75.4 ml, and the pore volume of the filter is 13.0 ml. The whole system is assembled in the gallery before it is mounted in the bore hole.

A horizontal hole with a diameter of 50 mm and a depth of 10 m in the clay is drilled in the clay formation by rotary drilling. The cuttings are removed by compressed air. Immediately after drilling, the completely assembled piezometernest is pushed in the drilled hole. An inert gas is flushed through the filters to prevent oxidation of the clay. After about 2 days the small gap separating the tubing and the wall of the hole in the clay is completely sealed by convergence creep of the clay, and the gas flow stops. The clay formation acts as a packer and isolates each of the 9 piezometers from each other. The total internal volume of the stand pipes for the different filters are given in the table I.

Table I: Total internal volume of the stand pipes for the different filters

Filter number	Total volume stand pipe (ml)
1	37.68
2	34.54
3	31.40
4	29.83
5	26.69
6	23.56
7	23.55
8	20.41
9	17.27

3. PRESSURE DISTRIBUTION

The presence of the vertical experimental shaft at the end of the URL (see figure 1) at atmospheric pressure and lined with concrete bricks creates a hydraulic pressure gradient in the neighborhood of the piezometernest. The interstitial water pressure build-up in the piezometers is measured by Bourdon manometers coupled with snaptite connections to the stand pipes. The steady state pressure distribution as a function of the depth in the clay is given in table II.

Figure 4 shows the pressure distribution in the piezometers as a function of the depth in the clay formation. The numbering of the filters is also indicated together with an indication of the injection filter.

Table II Steady state pore water pressure distrbution around piezometernest CP1 as a function of the depth in the clay formation

Filter Nr	Depth in clay (m)	Pore water pressure (MPa)
9	2	0.36
8	3	0.69
7	4	0.92
6	5	1.12
5	6	1.29
4	7	1.43
3	8	1.55
2	9	1.68
1	10	1.78

4. INJECTION OF THE HTO TRACER

About 2.5 years after the installation of the piezometernest the clay formation was supposed to be settled. The injection of the HTO tracer could be done. A stainless steel vessel containing 925 MBq of HTO was connected between filters CP1/ and CP1/5 from 20/01/88 to 10/03/88. The pressure difference of 0.39 MPa between the two filters drove the HTO tracer into filter CP1/5 with a flowrate of 5.61 ml/day. The volume of the stand pipe from filter CP1/5 amounts to 26.69 ml. The total amount of liquid injected in filter CP1/5 is 280.5 ml or 2.4 times the dead volume of the piezometer. Then the vessel was disconnected an the stand pipes were closed. Now all the filters are closed and there is no water flow in the filters. The system is left alone and the HTO migration is 3-dimensional.

Utmost care was taken not to contaminate the other filters with HTO during loading and injection in CP1/5.

5. SAMPLING STRATEGY AND CONCENTRATION MEASUREMENTS

For the measurement of the HTO concentration in the interstitial liquid in the clay, liquid samples are collected from the filters CP1/4 and CP1/6 adjacent to the injection filter CP1/5 at a distance of 1 meter.

To avoid disturbance of the HTO concentration distribution in the clay formation due to sampling of the interstitial liquid, the sampling frequency and the total amount of sampled liquid are kept as low as possible. From previous model calculations for the design of the experiment the first sampling should be done about 3 months after starting the injection and continued at a two months interval. The collected liquid sample volume has to be at least equal to the dead volume of the sampled piezometer. The first eight samples from each filter are taken in one fraction to collect sufficient activity for the measurement. For the sampling, weighed sample containers are connected to piezometers CP1/4 and CP1/6 by means of snap-tite connections. After a sampling duration of a few days the containers are disconnected and the amount of water collected is weighed. The HTO content in the sample is measured by liquid scintillation counting.

The interstitial Boom clay water has a high content of organic material causing severe quenching for low energy beta particles of tritium (Emax = 18 KeV). For the first samples with very low activities, quenching was avoided by distillation of the liquid before the addition of the liquid scintilator. Sample 8 and higher were corrected for quenching by measuring with and without the addition of an internal standard.

To obtain the concentration (C_i^j) of HTO in the interstitial liquid in the vicinity of the filter from the concentration measured in the collected sample (Cs) corrections have to be made for the stagnant liquid in the dead volume of the piezometer. If we assume that the concentration in the stand pipe is equal to the previous concentration in the vicinity of the filter (Ci) and the concentration in the concentric space near the filter and in the pore space of the filter does not differ to much from the concentration in the formation at that position, then the concentration at the filter position may be calculated as :

$$Cj = (Vs*Cs - Vsp*Ci)/(Vs - Vsp)$$

Vs is the total volume and Cs the concentration of the sample, Vsp is the internal volume of the stand pipe and Ci the previous concentration.

To test the hypothesis, sample number 9 is been collected in 8 fractions. Table III gives the results of the fractionated sampling of sample CPI/4-9. Figure 5 gives a plot of the percolated activity as a function of the quantity of the sampled liquid. The line on the figure shows the calculation of the correction formula and proofs the validity of the correction hypothesis.

Table III Results of the fractionated sampling of sample CPI/4-9

Fraction Nr	Total sampled liquid (ml)	Total sampled activity (Bq)
1	21.26	7.11
2	40.40	15.93
3	57.86	28.28
4	73.50	40.08
5	128.41	89.49
6	142.81	102.97
7	160.43	118.84
8	177.29	134.91

From sample number 9 on sampling is done in two fractions. A first fraction with a volume of at least two times the volume of the stand pipe of the filter. A second fraction with a volume of at least 100 ml. The concentration of the second fraction is equal to the concentration in the vicinity of the filter and no more correction is needed.

6. PROPOSED PARAMETER VALUES FOR MODEL CALCULATIONS

The proposed best values of the parameters for the calculation of the migration in the Boom clay formation based on the experiments on samples in the surface laboratory are :

- hydraulic conductivity	K	=	3.2E-12	m/s
- hydraulic gradient	dh/dx	=	-18.9	m/m
- diffusion access. porosity	n	=	0.35	-
- dispersion length	a	=	0.002	m
- retardation factor	R	=	1	-
- half live HTO	T	=	12.28	year
- Darcy velocity (x direction)	Vd	=	6.0E-11	m/s
- dispersion constant (x)	Dx	=	4.1E-10	m²/s
- dispersion constant (y)	Dy	=	4.1E-10	m²/s
- dispersion constant (z)	Dz	=	2.0E-10	m²/s

The diffusion parameters have been determined in Flow Through type diffusion experiments on reconsolidated clay plugs (2). The apparent dispersion constant and the dispersion length have been measured by percolation experiments on clay cores drilled parallel and perpendicular to the stratification of the Boom clay formation (3).

The hydraulic conductivity of the formation has been determined in-situ in the piezometernest CP1 previous to the injection of the tracer.

The value proposed for the diffusion accessible porosity is 0.35 at an estimated in-situ consolidation pressure of 2.4 MPa.

7. MEASURED CONCENTRATION DISTRIBUTION

The results of the concentration measurements in the filters CP1/4, CP1/5 and CP1/6 are given in table IV. The concentration of the sample number 4 of the filters 4 and 6 are below detection limit. The elapsed time is the time since injection of the HTO tracer. The last column in the table gives the concentration in the vicinity of the filter in Bq/l.

Table IV Data on HTO concentrations in filters number CP1/4, CP1/5 and CP1/6.

Sample number	Start sampling (d/m/y)	Sample time (day)	Sample volume (ml)	Sample activ. (Bq)	Elapsed time (day)	Concentration (Bq/l)
CP1/4-4	27/11/88	10.10	184.8	<	311	0.000E0
CP1/4-5	22/03/89	7.08	128.2	0.372	426	3.800E0
CP1/4-6	16/05/89	9.30	167.8	3.239	481	2.270E1
CP1/4-7	18/07/89	9.80	178.0	16.18	544	1.046E2
CP1/4-8	27/09/89	8.90	161.8	49.83	615	3.540E2
CP1/4-9	04/12/89	10.02	177.3	-	683	9.529E2
CP1/4-10	02/04/90	9.00	160.8	-	802	3.045E3
CP1/4-11	22/08/90	4.65	83.8	-	944	8.148E3
CP1/4-12	08/03/91	5.77	99.1	-	1143	2.410E4
CP1/5-1	08/04/91	1.00	15.8	-	1174	1.240E7
CP1/6-4	27/11/88	10.10	125.4	<	311	0.000E0
CP1/6-5	22/03/89	7.08	87.8	0.205	426	3.500E0
CP1/6-6	16/05/89	9.30	112.0	1.579	481	1.790E1
CP1/6-7	18/07/89	9.80	120.0	9.60	544	1.005E2
CP1/6-8	27/09/89	8.90	109.7	30.43	615	3.435E2
CP1/6-9	04/12/89	10.02	125.0	-	683	1.064E3
CP1/6-10	02/04/90	9.00	111.6	-	802	3.046E3
CP1/6-11	22/08/90	4.65	57.9	-	944	1.074E4
CP1/6-12	08/03/91	5.77	68.6	-	1143	2.440E4

The activity in the first four samples of filter CP1/4 are below detection limit. For filter CP1/6 HTO concentrations of 150, 33, 3.7 and 0.0 Bq/l have been measured for sampling after respectively 87, 145, 216 and 311 days. These unexpected results are supposed to be due to a slight contamination during the loading of the HTO tracer.

Figure 6 displays the measured concentration in the filters CP1/4 and CP1/6 as a function of the time since injection of the tracer. A simulation of the experiment with the MICOF program using the parameter values of chapter 7 is also given.

8. REFERENCES

(1) M. Put and P. Henrion, Radiochimica Acta, 44/45, 343-347 (1988)

(2) P. Henrion, M. Put and M. Van Gompel, The influence of compaction on the diffusion of non-sorbed species in Boom clay. Presented at "MIGRATION 89", Monterey,USA

(3) M. Put, et al., Estimation of the migration parameters for the Boom clay formation by percolation experiments on undisturbed clay cores. MRS 1990 Fall Meeting, Boston

9. CONTACT PERSON

Martin PUT
SCK/CEN
Boeretang 200
B-2400 MOL
Belgium

TEL (014)33.22.30
TFX (014)31.50.21

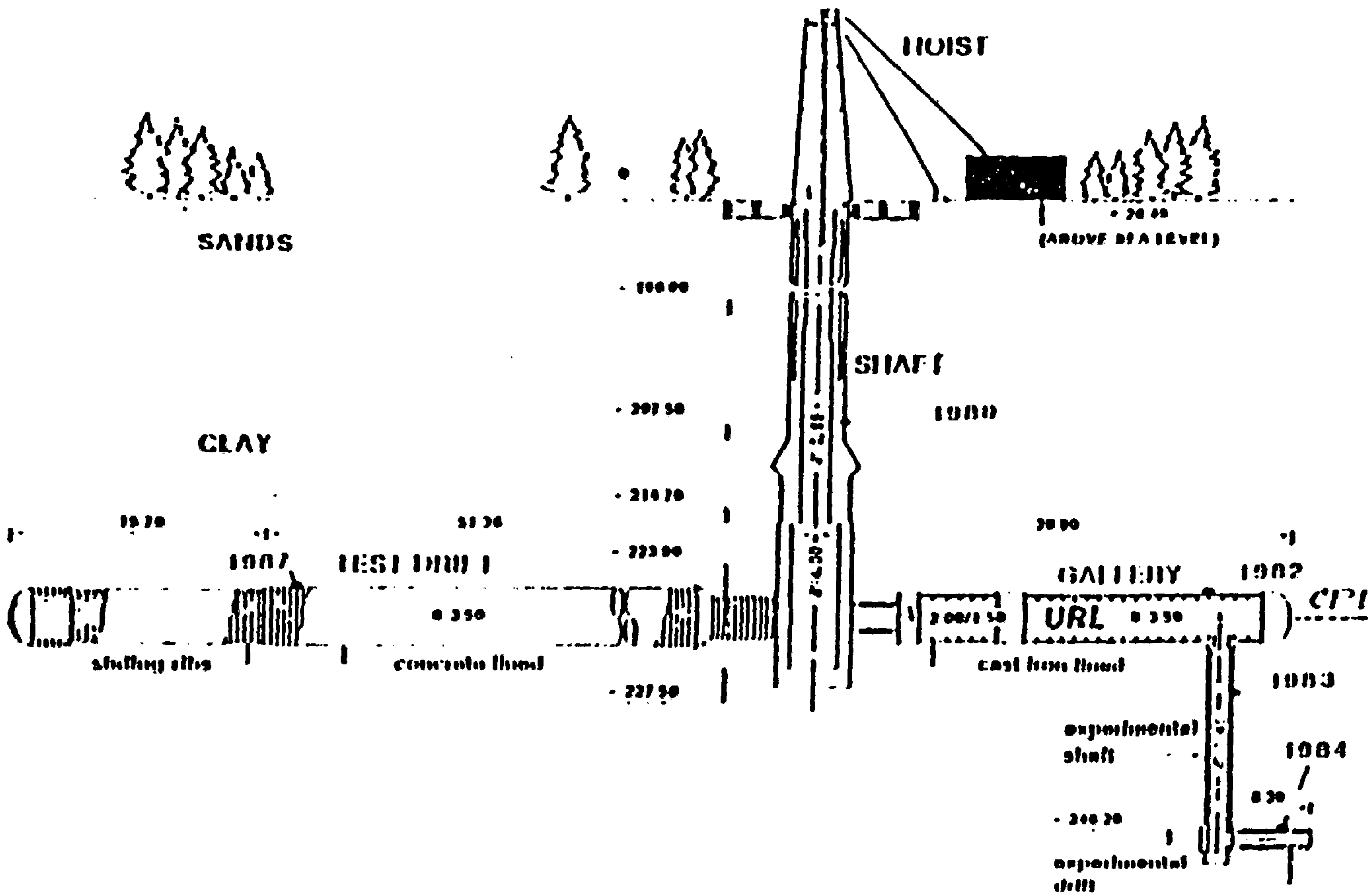


Figure 1: Scheme of the as built underground facility
at SCK/CEN MOL Belgium.

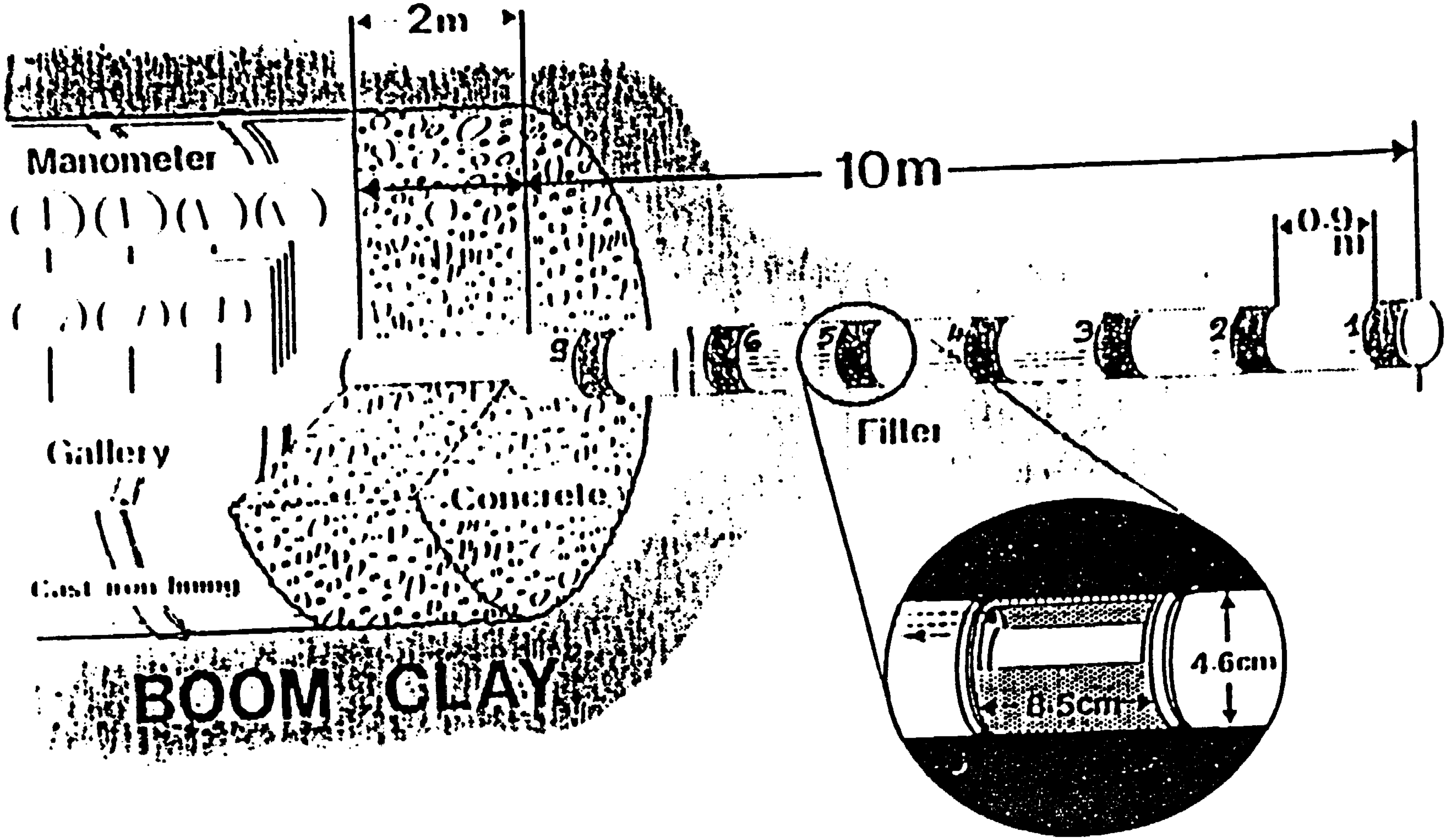


Figure 2: Conceptual view of piezometernest.

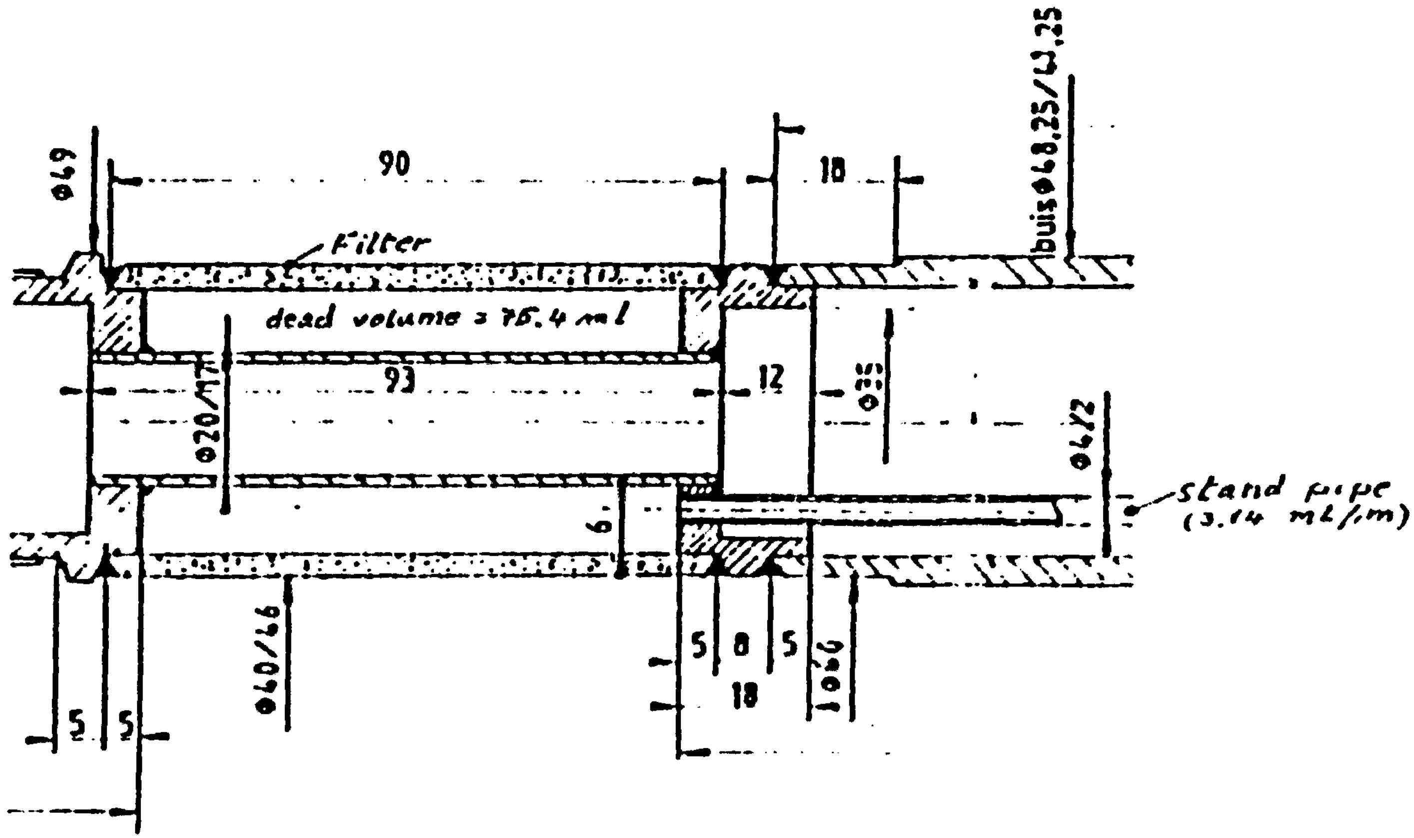


Figure 3 : Outline of a filter from piezometernest CP1.

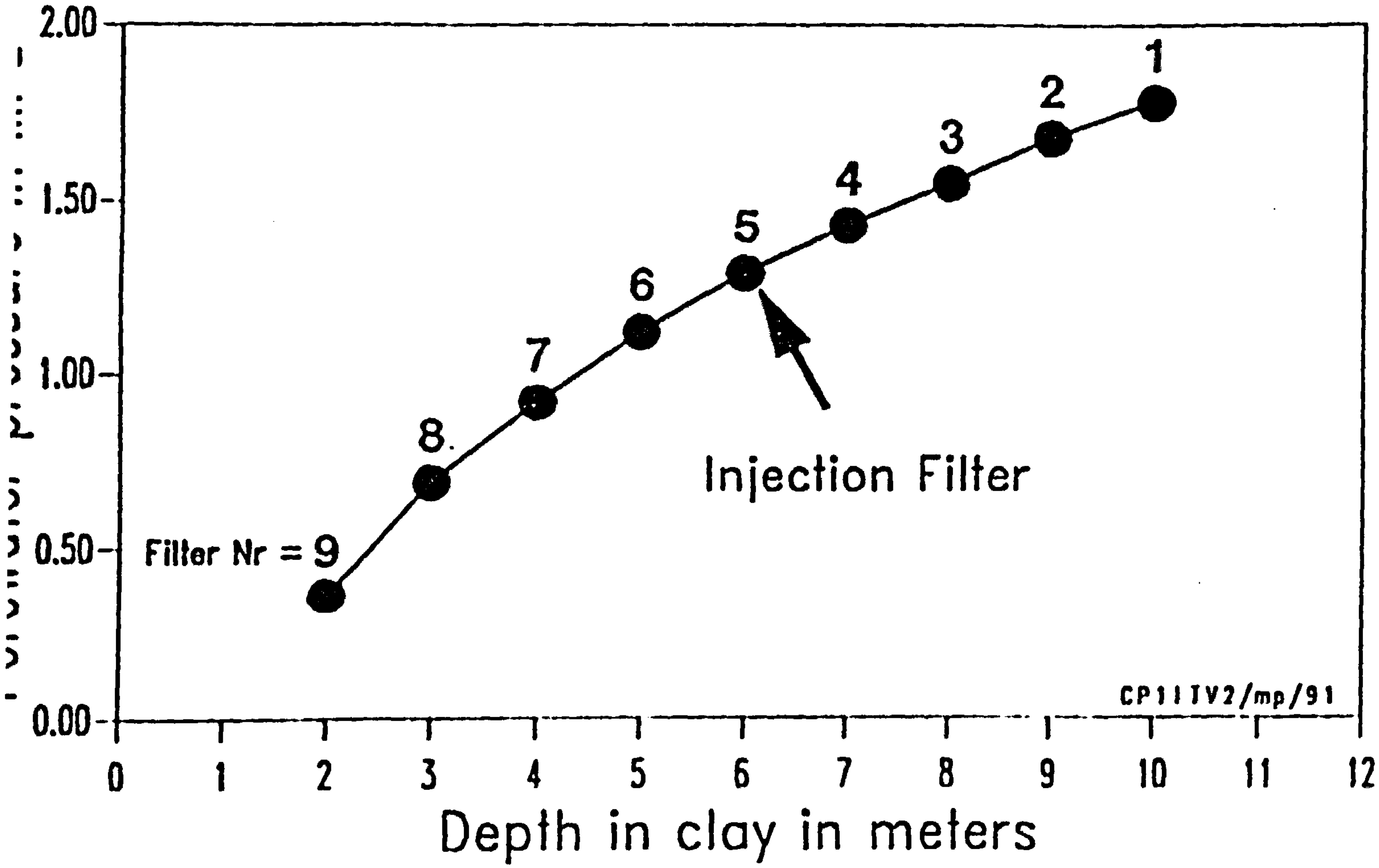


Figure 4: Pressure profile in CP1.

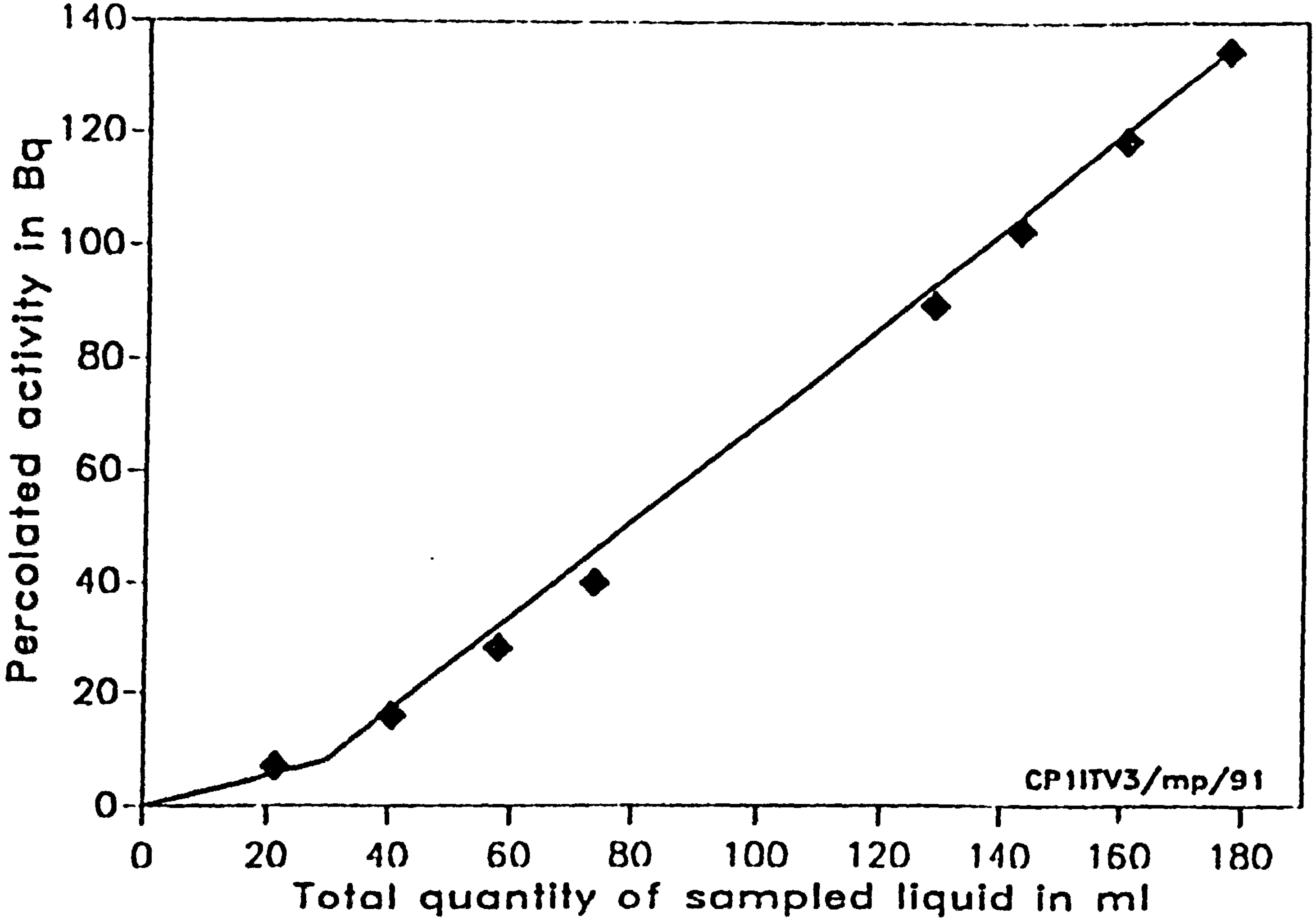


Figure 5 : Percolated HTO activity (Bq) as a function of the quantity of the sampled liquid for sample CP1/4-9.

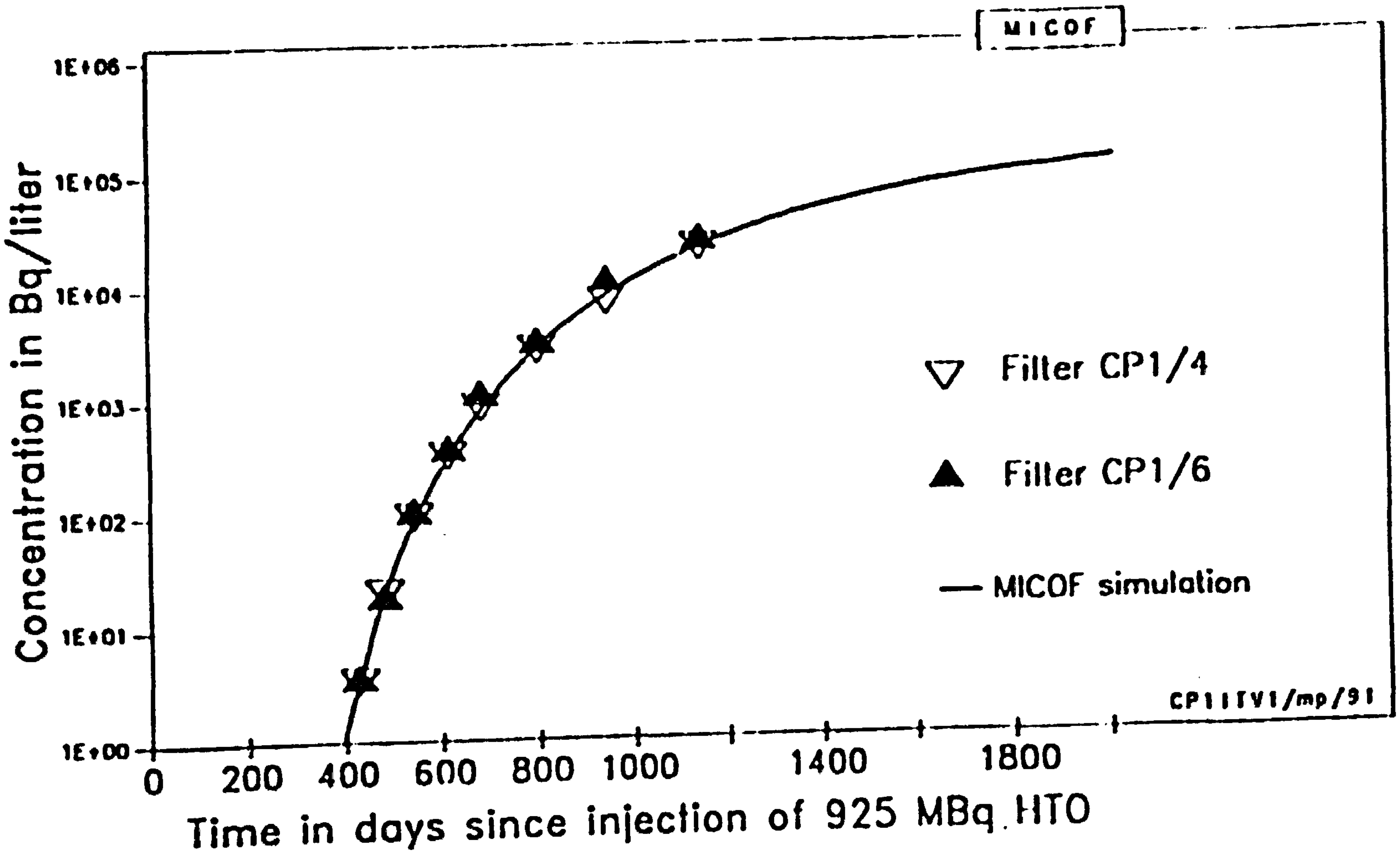


Figure 6 : Concentration in the liquid for the filters CP1/4 and CP1/6.