6.3.3. Results of the Vipava Area

6.3.3.1. The Second Tracing Experiment in Spring 1994

(H. BEHRENS, R. BENISCHKE, W. KÄSS, M. ZUPAN)

From the individual sampling stations at the Vipava springs the samples have been delivered in different packages (Tab. 6.5). After analysis of a first series of samples some promising results showed a steep but smooth increase of the concentrations. So it could be expected for the first moment that this was a beginning of a rather classical breakthrough curve. But in the samples of the following series the pattern of breakthrough was quite different and brought concentrations for all sampling stations that could be interpreted in many different ways (influence of biological, chemical or photochemical decay, hydrological events, analytical errors and so on).

The most likely interpretation is, that the samples have been influenced by some decay or adsorption processes. During evaluation and comparison of the results from the different outlets it became apparent, that a component separation based on the data of the artificial tracer would lead to unreliable results, especially for those, where the concentration values of Vipava 4/8 (the total runoff) were higher then those of the individual springs. This is impossible, because any mixing can result at the best in the same concentration as it can be observed in the springs (Fig. 6.20).

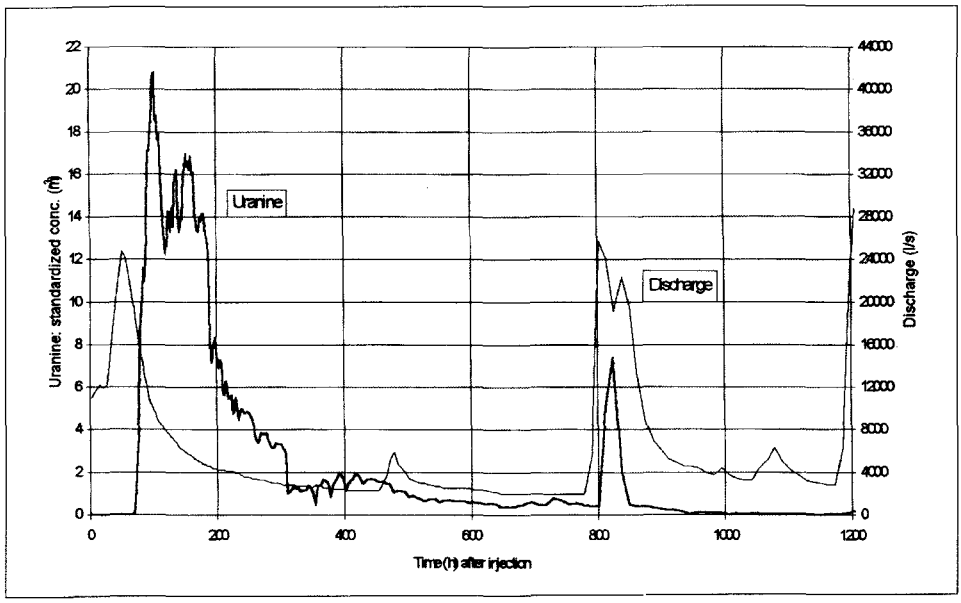

Fig. 6.20: Second experiment, April 1994: Breakthrough of Uranine at the gauging station Vipava 4/8 in comparison with the discharge.

The breakthrough-curve shows in the beginning a normal increase and is not influenced by secondary discharge peaks, also the discharge peak at approx. 500 h after injection had no influence on the concentration. The strong discharge pulse on 19th of May caused a new concentration peak, showing that the tracer which remained obviously in the system until that time has been washed out. From this time on only a decrease in concentration could be observed until the end of the sampling program.

The shape of the first concentration peak cannot be explained by special hydraulic influences from subsystems of the Vipava aquifer, because there is no indication in the discharge curve. Irregular changes or fluctuations in the time-concentration graph a short time after the main peak and a significant concentration dropdown (approx. 300 h after injection) may be a hint on other than hydraulic influences. Possible explanations will be given later in this section.

With exception of station Vipava 4/8 no other spring was equipped for continuous recording of discharge or stage, only Vipava 4/6 and Vipava 4/7 were measured at a bridge of their joint runoff channel about 100 m downstream of the outlets. This was a pity insofar that there was no other possibility to compare the tracer breakthrough curves at the springs with their individual discharge. Before the tracing experiment it was known from hydrochemical analyses and conductivity measurements that the most northern spring

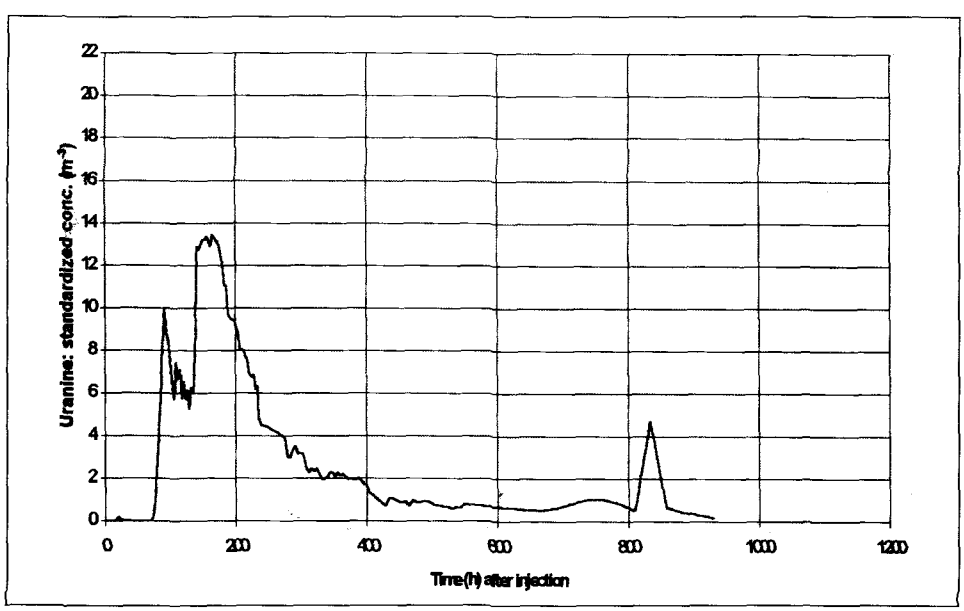

Fig. 6.21: Second experiment, April 1994: Breakthrough curve of Uranine at Vipava 4/1 (Pri Kapelici).

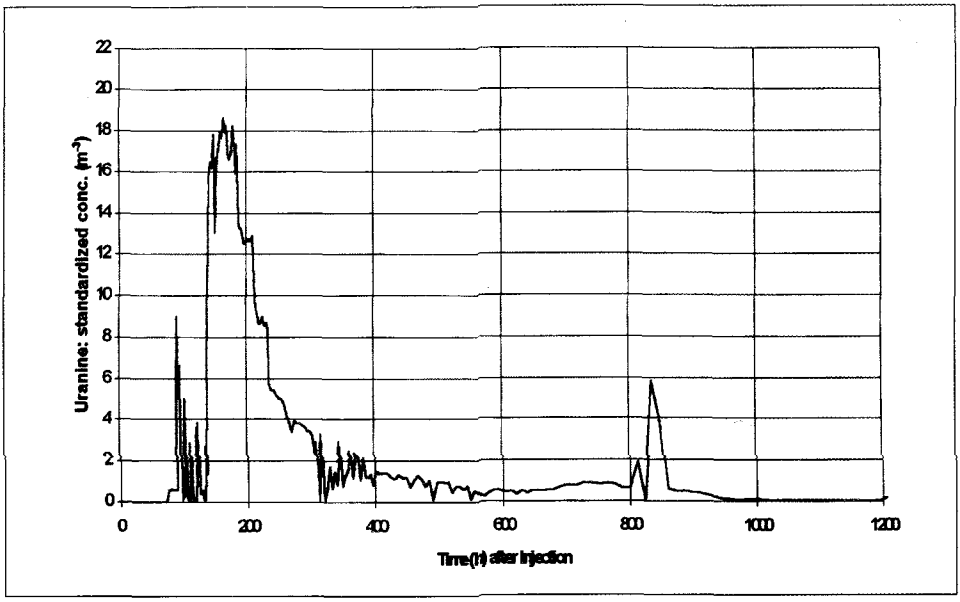

Fig. 6.22: Second experiment, April 1994: Breakthrough curve of Uranine at Vipava 4/2 (Pod Lipo).

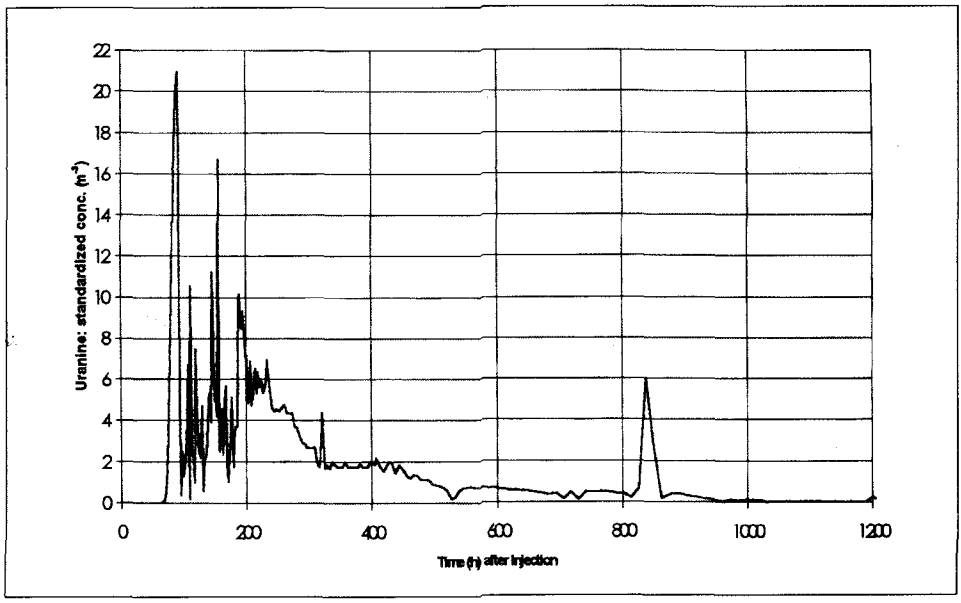

Fig. 6.23: Second experiment, April 1994: Breakthrough curve of Uranine at Vipava 4/3 (Perhavčeva Klet).

(Vipava 4/7 - Pod Farovžem) is probably influenced at certain times by the Bela river which delimits the Nanos massif in the north. The complete different breakthrough curve at this spring may serve as a respective indication.

The figures Fig. 6.21 to Fig. 6.27 show the time-concentration graphs of the individual springs.

The time-concentration graph for station Vipava 4/7 had to be drawn with a concentration scale different from all the other stations, because of rather low values. This station is the only one which showed a possible influence either from the Bela river or from another spring covered by alluvial sediments and with different behaviour. In comparison with the graphs from the other stations (including the total runoff at Vipava 4/8), which are very similar to each other, the discharge of Vipava 4/7 seems to be of no significance. Otherwise the influence on the discharge graph or on the time-concentration graph should be much stronger.

The similarity of the time-concentration graphs from Vipava 4/1-4/6 and Vipava 4/8 shows (despite of not explainable fluctuations) that they represent more or less well mixed water discharging from the springs. The differences between these springs and the station at Vipava 4/7 could originate also from waste water disposal from some houses above and therefore from enhanced biodegradation of the tracer in the samples. Another effect studied by W.

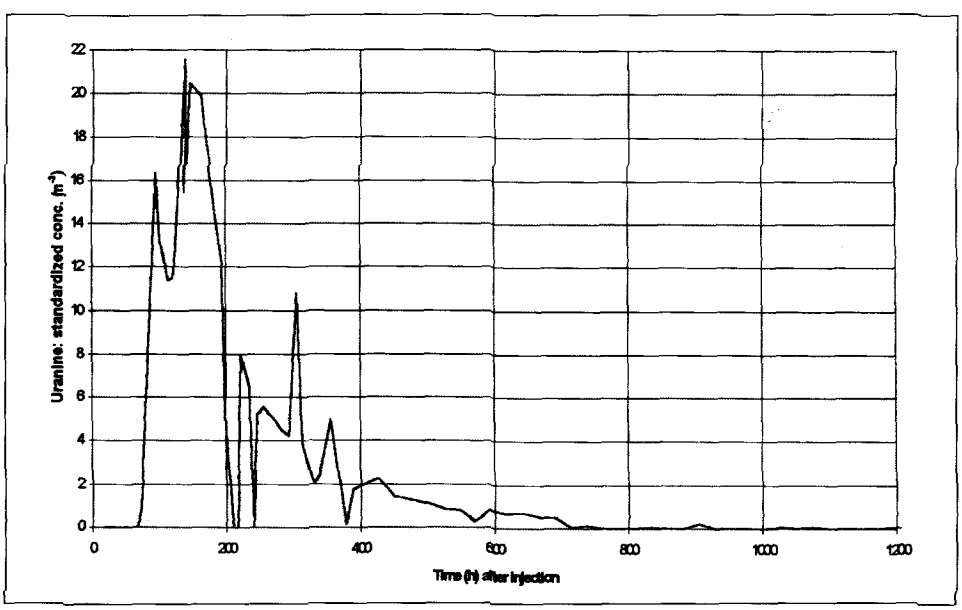

Fig. 6.24: Second experiment, April 1994: Breakthrough curve of Uranine at Vipava 4/4 (Vipavska Jama).

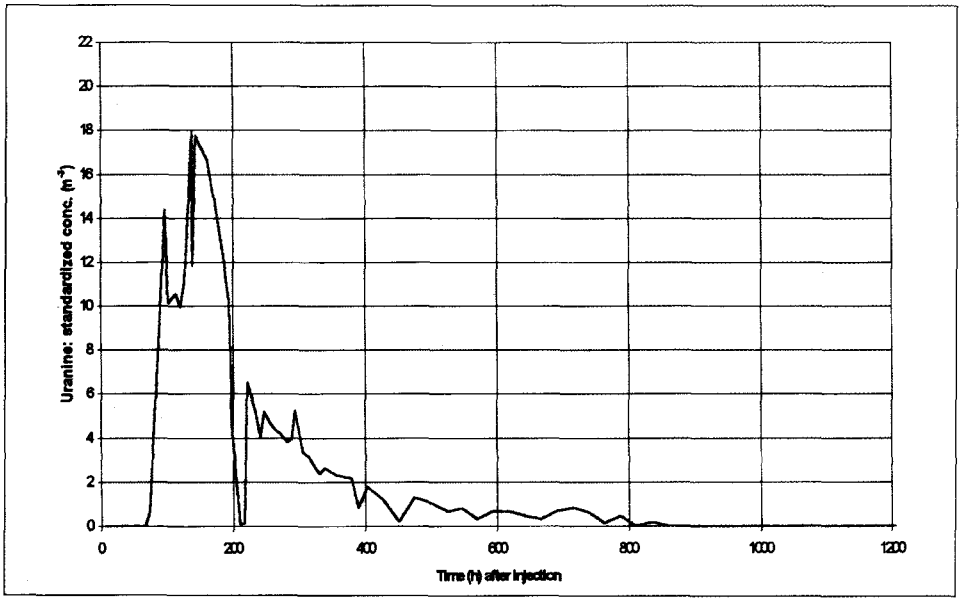

Fig. 6.25: Second experiment, April 1994: Breakthrough curve of Uranine at Vipava 4/5 (Pod Skalo).

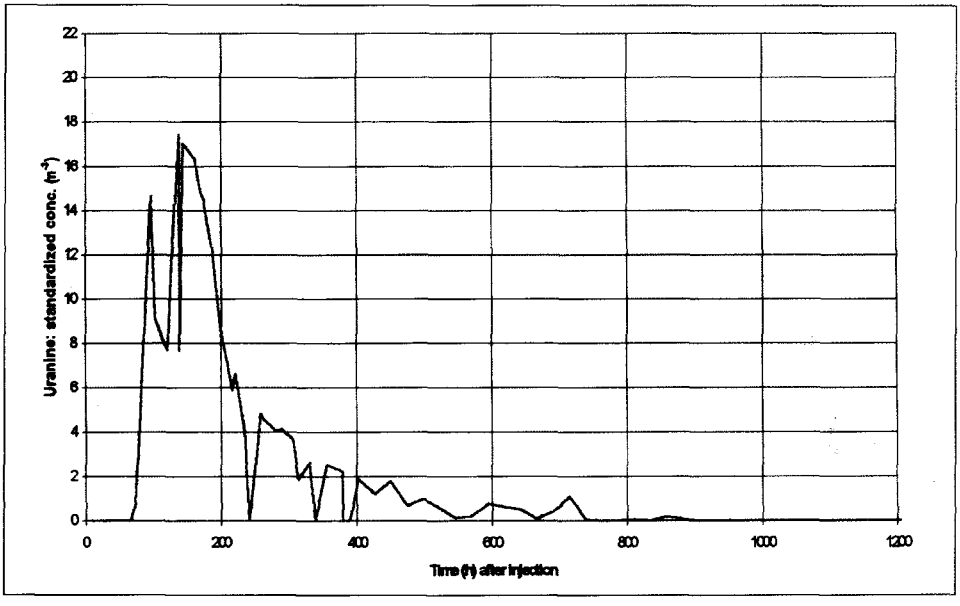

Fig. 6.26: Second experiment, April 1994: Breakthrough curve of Uranine at Vipava 4/6 (Pod Farovžem A).

KÄSS (ref. to chapter 8.1.) could be irregular adsorption at the walls in the sample flasks, or it is a combined influence of both adsorption and biodegradation.

Summarising the characteristic data from all breakthrough-curves it can be said that the first arrival and therefore the maximum flow velocity is quite similar for all stations (Tab. 6.14). The data for peak concentration and the flow velocity calculated for the concentration peak are very influenced by the above mentioned irregularities in the concentrations; they depend on the degree of possible degradation effects.

Despite these influences the calculated recovery for Vipava 4/8 (the only station where discharge data were available) is rather high. But a recovery of about 74 % means that approx. 25 % remained in the system until the end of the sampling program. But taking into account, that the measured concentration values are the result from unknown effects mentioned above, the total recovery could also be nearly 90 or 100 %.

Attempts to separate runoff components only by the uranine data failed. Corresponding concentration values could not be compared in the strong mathematical sense and for separating the discharge of Vipava 4/6 and Vipava 4/7 from Vipava 4/8 was not possible by means of the uranine data, because there was no sampling station at the gauging section for Vipava 4/6 and 4/7.

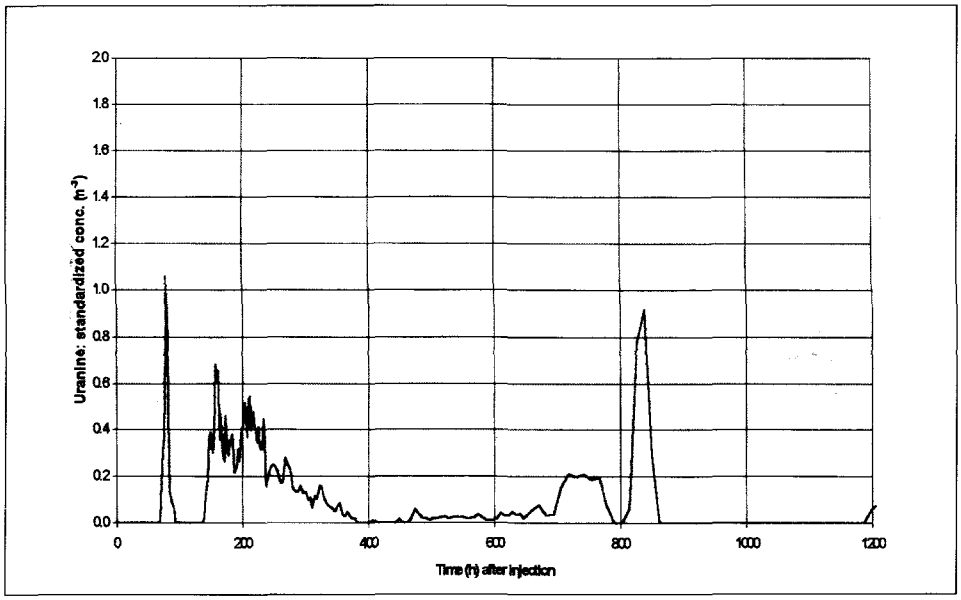

Fig. 6.27: Second experiment, April 1994: Breakthrough curve of Uranine at Vipava 4/7 (Pod Farovžem B).

Tab. 6.14: Summary of tracer data from all sampling stations.

Injection Start	1994.04.16 / 12:45	Tracer:	Uranine
Injection End	1994.04.16 / 12:50	Amount (gross;kg):	7.000000
		Reference (net;kg):	0.004228
Hor. Distance	12990	Amount (net;kg):	6.995772
Vert. Difference	365		

Spring	Date/Time	Flow time after inj. start (h)	Flow velocity (m/h)	Conc. (mg/m^3)	Std. Conc. (m^{-3})	Load (mg/s)	
Vipava 4/1 (Pri Kapelici)							
1. Arrival	1994.04.19 14:00	73.25	177.3	0.013	0.186		
Peak	1994.04.23 10:00	165.25	78.6	0.939	13.429		
Vipava 4/2 (Pod Lipo)							
1. Arrival	1994.04.19 15:00	74.25	174.9	0.013	0.187		
Peak	1994.04.23 11:00	166.25	78.1	1.305	18.654		
Vipava 4/3 (Perhavčeva Klet)							
1. Arrival	1994.04.19 11:00	70.25	184.9	0.008	0.119		
Peak	1994.04.20 09:00	92.25	140.8	1.467	20.975		
Vipava 4/4 (Vipavska Jama)							
1. Arrival	1994.04.19 14:30	73.75	176.1	0.065	0.929		
Peak	1994.04.22 08:00	139.25	93.3	1.512	21.614		
Vipava 4/5 (Pod Skalo)							
1. Arrival	1994.04.19 14:30	73.75	176.1	0.048	0.686		
Peak	1994.04.22 08:00	139.25	93.3	1.258	17.986		
Vipava 4/6 (Pod Farovžem A)							
1. Arrival	1994.04.19 14:30	73.75	176.1	0.054	0.771		
Peak	1994.04.22 08:00	139.25	93.3	1.219	17.429		
Vipava 4/7 (Pod Farovžem B)							
1. Arrival	1994.04.19 11:00	70.25	184.9	0.001	0.014		
Peak	1994.04.19 21:00	80.25	161.9	0.074	1.059		
Vipava 4/8							
1. Arrival	1994.04.19 10:00	69.25	187.6	0.005	0.067	0.091	
Peak	1994.04.20 20:00	103.25	125.8	1.455	20.796	13.963	
Load - peak conc.	1994.04.20 20:00					13.963	
Peak load at:	1994.04.20 18:00					14.121	
Recovery until:	1994.07.28 09:00						5.14 kg
Recovery until:	1994.07.28 09:00						73.46 %