

# Scaling in Geothermal Pipelines

## Progress Report

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### Background

Tracer testing is an efficient method for the characterization of subsurface properties and to investigate the behavior of both non-reactive and reactive solutes in groundwater.

### Ongoing Research

At present investigating the interaction of common geohydrological tracers such as Amino Rhodamine G, Pyranine, Rhodamine B, Amino G Acid, Naphthionic acid and Fluorescein sodium salt with three different rocks Basalt, Rhyolite and Quartz at pH 3,6.5 and 9 respectively.

The motivation of study is to examine the common geohydrological tracers and employ the non-reactive tracer for the fluid rock interaction experiments in future.

The experiments were conducted using a PTFE flow through column loaded with porous sand. Tracers were injected for 4 pore volumes and switched back to blank solution pumped at fixed flow rates through the system continuously monitored with an aid of spectrophotometer and samples were collected for 2 minutes in every five minutes.

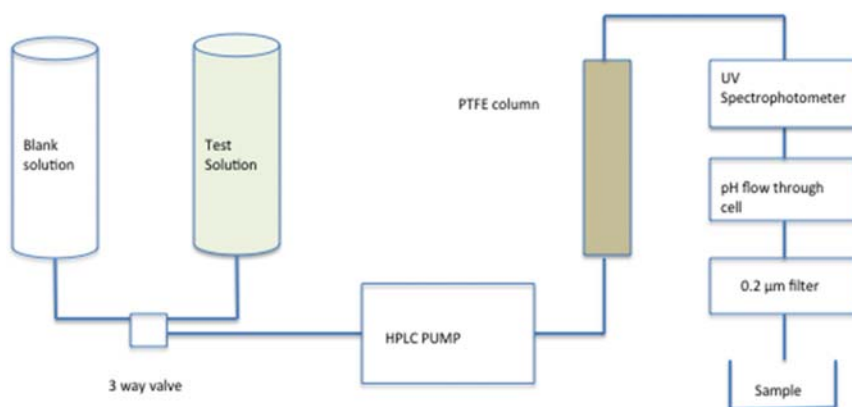


Fig 1. Schematic diagram of the system where the blank and tracers were pumped at 1ml/min flow rate and the PTFE column (16 cm length and 1cm inner diameter) is pre loaded with dry sand (45-125 $\mu$ m).

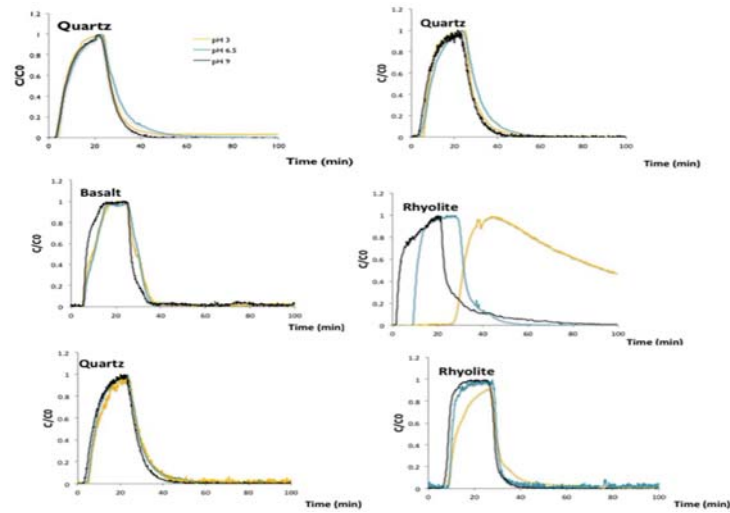


Fig 2. Break through curves of Amino G Acid, Amino Rhodamine G, Naphthionic acid, Rhodamine B, Fluroscein sodium salt and Pyranine tracers.

## Results

Tracers Fluorescein sodium salt and Rhodamine B were reactive compared to other four tracers. Could be due to adsorption in the PTFE column.

Tracer	Percent Recovery for Basalt sand at pH 3,6.5 and 9	Percent Recovery for Rhyolite sand at pH 3,6.5 and 9	Percent Recovery for Quartz sand at pH 3,6.5 and 9
Amino Rhodamine G	99%,100% & 100%	100%, 95% & 96%	98%, 100% & 100%
Pyranine	97%, 98% & 100%	99%, 100% & 100%	100%, 96% & 99%
Napthionic Acid	99%,93% & 100%	98%, 100% & 100%	100%, 100% & 100%
Rhodamine B	42%,96% & 99%	47%, 100% & 99%	69%, 100% & 96%
Fluorescein sodium salt	47%, 98% & 98%	51%, 100% & 100%	97%, 100% & 100%
Amino G Acid	94%, 100% & 100%	99%, 100% & 100%	100%, 100% & 96%

Table 1. Recovery of tracers from column experiments.

## Future work

In order to evaluate the behavior of various tracers, the results of the column flow-through experiments were simulated taken the above factors into account. The simulations were conducted with the aid of the PHREEQC program.