Tracer testing from Chalk karst features in the Pang and Lambourn Catchments, Berkshire

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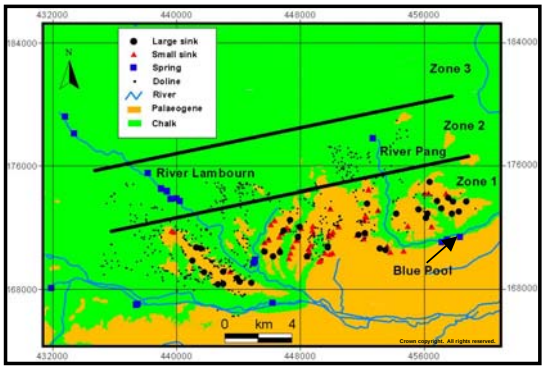
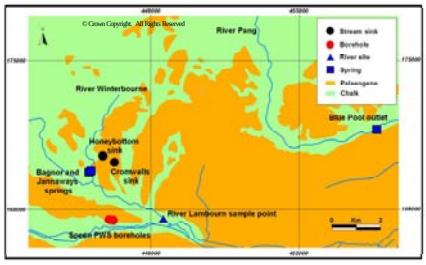
Introduction

Surface karst features in the Pang and Lambourn catchments decrease in density with distance from the Palaeogene cover. Ephemerally active stream sinks are commonly found where Palaeogene cover is present (Zone 1). Tracer testing was undertaken from stream sinks in Zone 1 to investigate the nature of groundwater flow.



Bacteriophage tracer testing in the Lambourn catchment



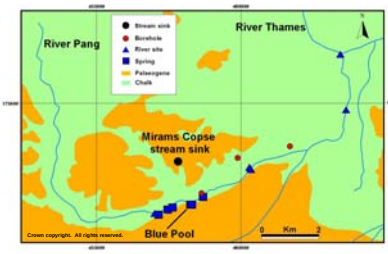
Tracer was injected into Honeybottom and Cromwells stream sinks. 7 spring, borehole and river sites were monitored

Tracer from **Cromwells stream sink** was detected at **Bagnor spring** in 9 samples between 2 and 13 days after injection, indicating a groundwater velocity (based on time to 1st arrival of tracer) of **0.64 km/day.** Tracer was also detected at **Jannaways spring** in one sample 9 days after injection. The tracer was at the detection threshold indicating **high attenuation.** No tracer was detected at the Speen PWS or the Blue Pool spring.

Tracer was injected into **Honeybottom stream sink** under very low flow conditions. No conclusive positive results were obtained. Results from the River Lambourn, Bagnor spring, and the Blue Pool spring were inconclusive.

Tracer test from Mirams Copse stream sink, Pang catchment

Optical brightener Photine C was injected into Mirams Copse stream sink. 11 spring, borehole and river sites were monitored. 7 injections were made with progressively increased amounts of tracer from 25 g to 1000 g under variable flow conditions. **No tracer was detected** at any of the monitoring sites.



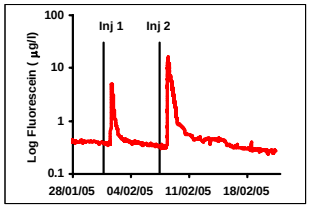
Location of monitoring sites during Mirams Copse Photine test

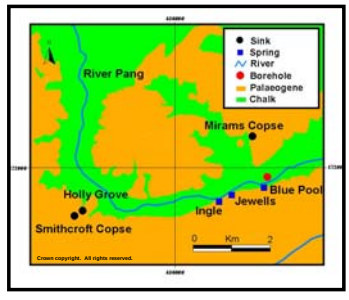
Variable flow in Mirams Copse stream sink

A subsequent tracer test in which bacteriophage was injected into the stream sink under high flow conditions produced **positive results at the Blue Pool.** Results indicate a **very rapid groundwater velocity of 4.3 km/day** combined with **very high tracer attenuation** (~ 0.00005 % of the injected bacteriophage was measured at the Blue Pool).

Dye tracer test at Smithcroft Copse sink, Pang catchment

Two injections of Sodium Fluorescein tracer were made. Three springs and one borehole were monitored. Tracer was only detected at the Blue Pool spring, 5.1 km from Smithcroft Copse. Tracer breakthrough was very rapid (groundwater velocities were **6 km/day** based on 1st arrival of tracer), and narrow peaks indicate **low attenuation** but recovery ~ 25% suggests some loss of tracer.





Conclusions

- Groundwater flow from stream sinks (point recharge) associated with Palaeogene cover may show **very rapid flow** (~ 5 km/day) combined with **low tracer attenuation. Example:** Smithcroft Copse to Blue Pool
- Rapid groundwater flow can also be associated with **very high tracer attenuation. Example:** Mirams Copse to the Blue Pool
- Causes of attenuation vary with type of tracer:

Bacteriophage are affected by sorption and die-off, and slow flow through sediment at the stream sink may be important.

Fluorescent dyes are probably not severely sorbed, so attenuation is likely to be dominated by hydrodynamic dispersion and/or double porosity diffusion during passage through the Chalk.

- **Implications for groundwater management:** Runoff entering stream sinks may reach rivers via rapid groundwater flow with low attenuation, transporting solutes, pathogens, and soil- derived sediment that may have an impact on water quality in springs, rivers and boreholes.

Find out more…

Maurice, L.D., Atkinson, T.C., Barker, J.A., Bloomfield, J.P., Farrant, A.R., and Williams, A.T., 2006. Karstic behaviour of groundwater in the English Chalk. *Journal of Hydrology* 330 (1-2). pages 63-70.

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