



Glowing clay: Real time tracing using a suite of novel clay based fluorescent tracers

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Clay is one of the most mobile fractions of soil due to its small particle size. It is also known to sorb many chemicals, such as nutrients (notably phosphorus), agrochemicals and heavy metals. The movement of clay is therefore linked with the transport and fate of these substances. A novel fluorescent clay tracing suite has been produced, together with an imaging technique. This suite consists of qualitative clay tracers, using rhodamine based fluorophores, and quantitative clay tracers, using metal based fluorophores. Efforts have also been made to allow integration of commercially available tracers, which are silt and sand sized. The clay tracers exploit the high affinity that montmorillonite has for Rhodamine B and Ru(bpy)3. This allows for an extremely thin layer of the fluorophore to be sorbed onto the clay's surface, in much the same way as materials in the natural environment will bind to clay. The tracer that is produced retains key chemical and physical properties of clay, such as size, shape and density. The retention of these micro-properties results in the retention of macro-properties, such as tendency to aggregate and cracking on drying.

Imaging techniques have been developed to analyse these tracers. The imaging system uses diffused laser light to excite the tracer and a modified DSLR camera to image the soil surface. The images have been compiled into a time lapse video showing the movement of clay over the course of a rainfall event. This is the first time that the quantitative movement of clay has been recorded over a soil surface in real time. 4D data can be extracted from the images allowing the spatial location and intensity of tracer to be monitored over time, with mm precision and on the timescale of seconds.

As the system can also work with a commercial tracer it is possible to investigate the movement of particles of almost any size and over a range of scales from soil box to hillside. This allows users to access this technique without the need to produce the tracer themselves.