

## Transparent liner use

Several FLUTE methods are enhanced with a transparent liner. A liner material has been developed which is essentially transparent (to be explained), strong, and relatively immune to oxidizers like potassium permanganate.

The transparent liner does not appear to be transparent until it is submerged in water. In that state, one can read clearly 12 point print if it is in direct contact with the opposite side of the liner. The water greatly reduces the index of refraction difference from that between the air and the liner where one cannot read print easily through the liner. Therefore, the liner under water is relatively transparent for objects in contact with the liner. NAPL FLUTE stains on the NAPL cover are an excellent example of what can be observed on the outside of the liner from inside the liner with a camera. Since those stains develop in time after exposure to a NAPL, it is useful to see how they grow and from where they originate. Since the NAPL FLUTE normally must be removed from the borehole, one only observes the state of staining at the time of removal. Another nice aspect of the transparent liner use is that the liner can be filled with clean water for good visibility whereas clay and silt can drastically reduce the visibility in some boreholes.

Other interesting applications for this proprietary method\* are to map in time the arrival of very staining fluids like potassium permanganate, a bright purple remediation fluid for TCE, at the wall of a borehole while the borehole is sealed with a liner. The sealed borehole is not perturbing the flow of the permanganate in the formation so the arrivals are essentially those that would occur in the natural state before the hole was drilled. The permanganate may be injected into a nearby hole and the timing of the arrival and the development of stains in observation wells would be very useful to the understanding of subsurface flows and the distribution of the injected remediation fluid. The stains can be observed in time since a camera can be lowered through the hole at many later times to determine the location and growth rate (i.e., the effective flow rate) of the stains. Other staining fluids can also be used which may not be so reactive as permanganate. It is expected that fluorescent dyes would react to a UV camera and light source inside the liner.

The transparent liner is another technique which seals the borehole against a perturbation of the flow field, but still allows access for a variety of possible measurements. For example, the presence of coal tar in the fractures of the formation should be quite visible if the transparent liner were covered with a thin hydrophobic white sheeting which wicks the coal tar from the fracture. Other kinds of reactive coverings can be used which respond to components in the formation such as special kinds of minerals and ores. The liner can always be withdrawn to examine potential reactions, but then the test is ended. With a transparent liner, the exposure can continue so as to avoid the concern that the liner was not left in place long enough, a common opinion when a NAPL FLUTE cover shows no staining.

It remains to be seen if there is a useful view of the hole wall to allow geologic identification of the formation structure.

- FLUTE has a patent pending on this technique