• STUDY OF THE QUALITY OF FLUORESCENT PRODUCTS USED IN HYDROGEOLOGICAL TRACING

• ABSTRACT

An inter-laboratory study of the quality of fluorescent products used for artificial tracing in hydrogeology was achieved. It was dealing with products currently available from professional suppliers and conducted on 36 batches of the 6 most commonly used dyes in Western Europe (uranine, eosin, sulforhodamines B and G, sodium naphthionate and amino G acid). These products were provided by 6 French retailers in 3 separate series purchased with 9 months intervals. Some older products (purchased before 2007 and stored in the laboratory) were also analyzed, as well as chemical standards of the same molecules. The studied characteristics were appearance, color, water and tracer content of the products, and, in solution (or directly for liquid uranines), appearance, color and possible odor, physico-chemical properties (electrical conductivity, pH), spectral characteristics, fluorescence yield (intensity as a function of concentration). The stability of the tracers was tested up to 6 months, with samples exposed to light, darkness, low (< 4°C) and high (+ 40°C) temperatures (for concentrations ranging between 0.1 and 25 µg/L).

The results provide reassuring conclusions about the quality of the products as hydrogeological tracers, especially regarding their fluorescence properties: presence of the fluorescent compound with its specific spectroscopic characteristics (excitation and emission wavelengths allowing its identification), absence of any other fluorescent component, or other components which might interfere, linearity of the relation concentration-fluorescence intensity (allowing quantitative analyses), and, for most of them, stability of fluorescence up to 6 months in the dark, in the range of temperatures encountered in natural waters. The only exceptions concern some products undergoing an early and sudden degradation, at low concentration, which could be due to biodegradation following microbial contamination linked to the humidification of the powder or its hygroscopic nature (by instance in the case of sodium naphthionate), as well as all solutions of amino G acid, which undergo degradation (up to 25 % loss of fluorescence intensity after 6 months) even under the most conservative conditions (darkness and cold).

However, this study has highlighted the very high variability of the dye content of commercial fluorescent products, whose origin is out control for the final user because it may be due to manufacturers' practices of adding other components in order to lower the costs, or to frequent changes of suppliers or mixing between several products by resellers, in order to keep permanent stocks of dyes. These alterations explain inaccurate data in the technical sheets provided by resellers. In addition, the proportion of products with a purity close to 100 % appears very low (only uranine and amino G acid powders being in this case, although not consistently: some uranine powders were found containing less than 50 % dye). Sulforhodamines, in particular, always contain an insoluble part (of unknown nature), limiting their dye content to a maximum of 60 % in the case of sulforhodamine B. This variability among products has never been taken into consideration until now by tracing practitioners and analysts, who implicitly consider that products are pure tracers.

This unprecedented and wide-ranging study thus provided new data about the behavior of dye solutions, which were missing until now. This is the case for amino G acid, and regarding the photodegradation kinetics of all targeted molecules. These results may suggest new practical guidelines for artificial hydrogeological tracing, including a better choice of suppliers, better estimates of mass injected, more relevant analytical laboratory practices, better conservation of products, as well as samples, or even field procedures. These improvements of tracing practices will further increase the value of this method for water resource and environmental management.

• KEY WORDS (THEMATIC AND GEOGRAPHICAL AREA)

Hydrogeological tracing technique, artificial fluorescent dyes, product quality