



Perspective

Natural organic carbon in groundwater

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Batiot, Emblanch and Blavoux [3] present some of the main results from Batiot's PhD dissertation [2] concerning the information on flow conditions in karst aquifers provided by the total organic carbon (TOC) as a natural tracer. Investigations of natural organic matter in groundwater are scarce and very recent. Organic matter is, however, abundant in surface and soil water and plays a geochemical part in complex formation; moreover, it has an obvious micro-biochemical role as primary nutrient. Studies of organic carbon in groundwater are essentially related to organic pollution and their purpose is to assess self-remediation or to propose remediation solutions.

The two most commonly measured parameters for organic matter in water are the Total Organic Carbon (TOC) and the Dissolved Organic Carbon (DOC). Batiot [2] showed that there is generally no significant difference between TOC and DOC in the studied carbonate aquifers.

The TOC content in soil water may reach 300 mg l^{-1} , whereas it rarely exceeds 100 mg l^{-1} in river water. According to [7], TOC in groundwater is lower than 1 mg l^{-1} : the long residence time is assumed to favour the oxidation into CO_2 by the bacterial activity in the aquifers. Most of the rare investigations of natural organic carbon in groundwater, made during the last decade, are related to karst aquifers. Karst aquifers are particularly well suited to such investigations, because their recharge occurs under various conditions: diffuse and slow infiltration through fissures and matrix, dispersed but concentrated and fast infiltration in fractures, highly concentrated and

rapid recharge through swallow holes and directly injected into the phreatic conduit network [1]. Each type of infiltration is characterised by its own flow conditions and residence time, and consequently by its geochemical characteristics. Therefore, the TOC in karst aquifers may indicate the travel time of the recharge water.

As previously shown by Emblanch in his PhD dissertation [4], TOC is an interesting natural tracer. Following his footsteps, Batiot [2] demonstrated that TOC is an excellent tracer of the residence time and flow conditions in karst systems. Her work is easily generalised, because she explored several karst systems, characterised by different recharge and flow conditions, in various temperate climates. Moreover, she monitored the aquifers in order to describe the time variation, so that the wide range of natural TOC variations in karst groundwater is now known and can be compared to well-known inorganic tracers.

TOC is relatively abundant below the soil and in rapid infiltration water (up to 10 mg l^{-1}). Its transport by infiltration and in the phreatic zone occurs mainly in rapid flow conditions. During storage in the phreatic zone, the groundwater progressively loses organics so that the TOC is oxidised into CO_2 and its content may fall to values lower than 0.5 mg l^{-1} .

In a previous approach, James [5] explored the possibility of CO_2 production inside karst aquifers by organic oxidation; she then tried to prove the existence of an internal production of CO_2 favouring the development of karst in carbonate formation at depth. However, her results could not be generalised.

The question is now: is TOC a useful and efficient tool in (karst) hydrogeology?

Inorganic natural tracers as well as environmental isotopes are now well researched and commonly

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used for defining groundwater flow conditions. The aquifer functioning is analysed by deciphering the tracer variations at the outlet of a karst system. This analysis requires the use of a large number of independent tracers typical of the input and of the different compartments or flow pathways. The geochemical characteristics of karst groundwater are highly variable in time and space. Because some tracers [6] may originate either at the surface or inside the aquifer, like magnesium, or be changed by human activities, like chloride, other natural tracers such as TOC should be looked for.

Recent progress particularly in analytical performances makes possible easy and rapid low-level analyses of organic carbon content in groundwater. Moreover, Batiot [2] explored the possibility of studying the nature of TOC in water by spectrofluorimetry. Although it requires some improvements, the method is presently very attractive and may give new information about karst aquifer functioning and its self-purification capacity. Organic carbon should also be an interesting natural tracer in alluvial aquifers, where it can be used to quantify the exchange between groundwater and river.

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