# Environmental impacts of nanomaterials: physico-chemical evolution, exposure mechanisms and mechanisms disturbing the biological activity in aqueous environment

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The new properties of materials at the nanoscale are at the heart of current scientific advances such as drug vectorization, cancerous tumor targeting, replacement of silicon in microelectronics by carbon, or the manufacture of more resistant materials... The main cause for this change in properties is the very high surface to volume ratio of nanoparticles and stronger reactivity. It is therefore impossible to simply transfer the physical, chemical, and thermodynamic knowledges on reactions occurring at the solution/microparticles interface to those occurring at the solution/nanoparticles interface (<20-30 nm). Thanks to the unique properties of nanoparticles, nanotechnologies will considerably grow in the near future. However, this growth stirs up awareness that we cannot ignore. In particular, people wonder about the impact of mass-produced nanoparticles that could spread into the environment.

To date, scientists master the manufacture and use of nanomaterials, however we do not know what are the risks for humans and ecosystems. No database exists regarding the amounts released within the ecosystems. However, nanoparticles due to their reactivity, their surface atoms are labile, their redox states can change easily, they are highly reactive towards aqueous compounds and can change from hydrophobic to hydrophilic. Before contacting biota they interact with many objects such as natural organic matter, clays, oxides…. It is impossible to study and understand the environmental biological effects of nanomaterials without a good knowledge of the exposure, their physico-chemical properties changes. The properties of nanoparticles able to disturb the biological activity depend on their size, on their mineralogy, their crystallinity, and their surface reactivity. All these parameters affect the toxicity via their oxido-reductive potential, the generation of Reactive Oxygen Species (ROS), their dissolution into toxic or non ions (*e.g.* $Cd^{2+}$, $Zn^{2+}$, $Ag^{+}$), or also the retention of toxic molecules on their surface (*e.g.* As, Cd, Co). The exposure i.e interactions with components , transfer within the water column or/and sediments is a crucial problem which can be resolved through experiments in mesocosms, search and analysis of Nps in media and analysis of the transformation after alteration of "nano products".

# Dating drinking water in eskers from Amos, Abitibi, Canada

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In Abitibi-Témiscamingue (Québec), eskers, glaciofluvial landforms formed by accumulations of sand and gravel, were deposited during the last deglaciation. 8000 years BP, peatlands developed around the esker flanks by drainage of the Lake Barlow-Ojibway. The eskers are known to be aquifers containing drinking water of exceptional quality, yet little is known about their hydrologic regime. A better understanding of these systems is necessary to assess the vulnerability of these aquifers to potential contaminants and to implement a suitable management plan for water resources. With a such goal, a multi-isotopic study was initiated in eskers of Amos region (Saint-Mathieu-Berry, Baraute and Harricana Moraine) using stable noble gases and $^{222}Rn$ to date these waters and trace fluid flow within the eskers and into surrounding peatlands. $^{3}He/^{4}He$ ratios have been preliminarily used to identify water mixing and to estimate groundwater residence times through the $^{3}H$-$^{3}He$ method and, when possible, U-Th-$^{4}He$ age model [1].

First results point to the occurrence of tritiogenic $^{3}He$ in groundwater flowing in the Saint-Mathieu-Berry esker that provide drinking water to the town of Amos and the bottled water Eska. Using tritium contents measured in 2004 [2] and in 2011, this study yields an age of 21-23 years. Groundwater from two deep wells (40 and 70 m) from the Harricana moraine gives $^{3}H$-$^{3}He$ ages of 7-9 yrs.

Interestingly, the Barraute esker, which is buried under Quaternary clay and the well of Landriennne which taps water at the interface with the Proterozoic basement show $^{3}He/^{4}He$ ratios (R) (normalized to that of atmosphere or Ra) of 0.930±0.022 Ra and 0.946±0.024 Ra, respectively. R/Ra below atmospheric ratio suggests a possible contribution of radiogenic $^{4}He$ and thus, older water ages. This finding is in agreement with the higher salinity measured in these two wells compared to the regional background.

Rocks samples from the Harricana Moraine were selected for measurements of U and Th contents and to estimate the $^{4}He$ release rate from the protoliths composing this aquifer [1] in order to calculate meaningful U-Th-$^{4}He$ ages for Barraute and Landrienne groundwaters.

[1] Solomon (1996) *Water Resou. Res.* **32**, 1805-1813. [2] Riverin (2006) Msc Thesis, University Laval, pp.