

## Multi-tracer study of groundwater in a semi-arid region in Northwest India

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As a semi-arid region with mainly monsoon dominated precipitation, the Cambay Basin situated in Northern Gujarat, India, holds a groundwater aquifer system well suited for palaeoclimatic studies covering the past 30-100 kyr. Our project aims to estimate regional palaeotemperature via analyses of dissolved noble gases and stable isotopes, while using tracers such as SF<sub>6</sub>, Radon, <sup>4</sup>He, <sup>14</sup>C and <sup>3</sup>H-<sup>3</sup>He for dating. Besides temperature information, we also expect to gain new insights about changes in aridity related to monsoon.

During a first sampling campaign, water samples were collected following a transect along a flow path in the northern part of the basin. Helium data suggest a linear increase of age with flow distance. <sup>14</sup>C analyses are being performed to obtain a quantitative time scale. Existing <sup>4</sup>He/<sup>222</sup>Rn ages will be complemented and used to support and extend the <sup>14</sup>C dating. High concentrations of SF<sub>6</sub> throughout the aquifer prevent the use of this tracer for dating. A natural origin of the SF<sub>6</sub> is likely, and possible relationships to high fluoride concentrations in the groundwater, as well as <sup>222</sup>Rn and <sup>4</sup>He data will be explored.

Preliminary interpretations of the climatic signals recorded by the noble gas as well as stable isotope data can be made. Calculated noble gas temperatures (NGTs) from wells in the recharge area are close to 29°C, corresponding well to recent groundwater temperatures but significantly exceeding the mean annual air temperature (27.5°C at Ahmedabad). Older samples show up to about 3°C cooler NGTs. δ<sup>18</sup>O values show an almost linear increase along the transect, whereas the deuterium excess indicates a sharp transition.

Results of a second transect, which is currently being sampled, will also be presented.

## Implications of nanoparticle aggregation state and reactivity in toxicity testing

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Falling within the gray zone between the atomic and bulk scales, nanomaterials may be expected to exhibit properties that change due to the formation of nanoparticle clusters to an extent that is intermediate between those when atoms cluster of form molecules and when colloidal particles aggregate. In this communication, we discuss the effects of aggregation on nanoparticle fate, transport, and reactivity as well as the implications of aggregation for studies of nanoparticle toxicity.

The interplay between physical forces that bring nanoparticles in contact, the chemistry of nanoparticles surfaces and environmental factors that may transform these surfaces, play an important role in determining nanoparticle transport, fate and reactivity through their effects on aggregate structure. We discuss the role of environmental and physiological conditions in determining nanoparticle aggregation rates and aggregate structure as well as the impact of aggregate structure on removal by sedimentation. Using photosensitization by fullerene nanoparticles as an example, we show how differences in aggregate structure may affect nanoparticle reactivity. Dependence of NP fate, transport and reactivity on the structure of aggregates they form represents a clear departure from the behavior of conventional chemical compounds with major implications for the protocols required in studying exposure and hazards. We conclude with a discussion of precautions to be taken in accounting for aggregation when evaluating interactions between nanoparticles and living systems.