In the news

Toenails reveal exposure to environmental arsenic

Tests on toenail clippings can reveal exposure to environmental arsenic (As), according to scientists from Leicester and Nottingham, UK [1].

Doctoral research at the British Geological Survey by Mark Button of the University of Leicester used toenail clippings to find fresh evidence of exposure to environmental As within a UK population living close to a former As mine. He carried out the research with Gawen Jenkin (Department of Geology, University of Leicester), Chris Harrington (School of Science and Technology, Nottingham Trent University) and Michael Watts (British Geological Survey, which funded it).

"We initially identified high levels of As in earthworms living in contaminated soils surrounding the former mine," said Button. "That got us thinking about potential exposure in people living close to the site."

The researchers collected toenails from eight residents living near a former As mine in Devon, UK, who formed the exposed group, and nine residents from Nottinghamshire, UK, with no anticipated As exposure, who comprised the control group. The researchers washed and acid digested the samples under microwave irradiation. They then analyzed the samples using inductively coupled plasma mass spectrometry (ICP-MS).

Concentrations of total As in the toenails of the exposed group were in the range 858–25,981 µg/kg (geometric mean, 5406 µg/kg), compared to those of the control group of 73–273 µg/kg (geometric mean, 122 µg/kg).

Total As concentrations in toenail samples were positively correlated to environmental As levels (Fig. 1).

High-performance liquid chromatography (HPLC)-ICP-MS analysis of aqueous toenail extracts revealed inorganic arsenite (As\textsuperscript{III}) to be the dominant species extracted (~83%) with lower amounts of inorganic arsenate (As\textsuperscript{V}) and organic dimethylarsinate (DMA\textsuperscript{V}) (~13% and ~8.5%, respectively). The only notable difference between groups in terms of AS species was the presence of small amounts (<1%) of organic methylarsonate (MA\textsuperscript{V}) in two toenail samples from the exposed group.

**Preliminary research**

"This preliminary research indicates that people living close to a former As mine have elevated levels of As in their toenails," claimed Button. "However, the potential health risks in this case, if any, are not yet clear and no As-related health issues have been reported. A large-scale and more detailed bio-monitoring study is required to confirm these initial results."

"This is the first time that the chemical form of the As in toenails has been measured," said Jenkin. "That can tell us something about how it got in there and possible risk factors.

"There is definitely more research needed to look at, amongst other things, a larger sample of volunteers, to see if the values change with time (it is quite possible the high values recorded are a one-off for that person, or due to slow toenail growth concentrating harmless quantities of As), and to look at the possible pathways by which the As is ingested," he said.

"Coupling our analyses with regular blood measurements would be very revealing."

Long-term exposure to As is associated with increases in lung, liver, bladder and kidney cancers and skin growths. Previous studies using hair
suggested high levels of As in the bodies of King George III and Napoleon Bonaparte.

Contact:
Mark Button
British Geological Survey
Nottingham, UK
Tel.: +44 (0)115 9363100
E-mail: mbutton@bgs.ac.uk

Reference
(DOI: 10.1039/b817097e).

Nano-hydrogels detect cancer

Nano-hydrogels can detect where cancer cells are and then attack them from the inside, according to the New Materials and Supramolecular Spectroscopy research team at the University of the Basque Country (UBC), Bilbao, Spain (Fig. 2).

Led by Issa Katime, they have developed intelligent nano-hydrogels capable of detecting changes in pH. While blood generally has a pH of 7.4, where cancer is located, pH drops to 4.7–5.2. To detect such changes in pH, the researchers functionalized hydrogels with folic acid, which can detect and “trick” cancer cells to permit penetration of their membranes and, under these conditions, the hydrogel acts like a “Trojan horse”. Once the inside the cancer cell, the change in pH favors swelling of the nano-hydrogel to release the pharmaceutical drug.

The use of nanoparticles posed a number of difficulties:
• interweaving them into a net in a controlled manner to create nano-hydrogels;
• the spaces created within the structure of the net need to be the right size to transport the right amount of the pharmaceutical drug; and,
• all the particles need to be a similar size.

On synthesizing polymers, particles of very different sizes were obtained. If they were to be injected into the human body, these particles could not be much greater than 15–30 nm.

The UBC research team therefore perfected a technique that enabled