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Using Monte Carlo Simulations and Experiments to Investigate the Activation of Heavy Metals Using 14.1 MeV Neutrons

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The area of Richards Bay is one of the industrialized areas in South Africa and, as a result, it is prone to industrial pollution. Two studies were recently conducted in the area, one of the studies focused on the chemical contamination and radiological risk of water sources in the area and it was found that heavy metals such as As, Mn and Cd were the main contaminants, with Mn being above the target water quality range (TWQR). In this study the aim was to investigate the feasibility of employing the Neutron Activation Analysis (NAA) technique to measure the levels of heavy metals and other trace elements in Richards Bay water and sediments. The technique is known to be sensitive to about 78 elements in the periodic table when employing thermal neutrons, since it decreases with an increase in neutron energy, a Monte Carlo-based code was used to simulate the activation of copper, a matrix consisting of the elements under study and a standard reference sample. Gamma energies identified in the
Cu spectrum were 1718 keV, 2097 keV and 2301 keV. The simulations showed that elements are most likely to be activated by 14.1 MeV neutrons if present in higher quantities, due to typically low fast neutron cross-sections in most elements. The simulation results for the matrix of elements were poor due to saturation, and also due to some activation products such as Mg-27, Fe-53 and Al-28 having a half life shorter than the preferred irradiation time.

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Name of supervisor: Dr. P.P. Maleka
Institution: iThemba LABS
Email address: pmaleka@tlabs.ac.za

Primary author: Mr MHLONGO, Sizwe (University of the Western Cape)

Co-authors: Dr MALEKA, Peane (iThemba LABS); Dr NTSHANGASE, Sifiso Senzo (University of Zululand)

Presenter: Mr MHLONGO, Sizwe (University of the Western Cape)

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