Using high temperature gas-cooled reactors for energy neutral mineral development processes – a proposed IAEA Coordinated Research Project

N. Haneklaus[1], F. Reitsma[1], H. Tulsidas[1], B. Tyobeka[2], E. Schnug[3], H-J. Allelein[4], B. Birky[5], G. Dyck[1], T. Koshy[1]

[1] International Atomic Energy Agency, Vienna, Austria

[2] National Nuclear Regulator, PO Box 7106, Centurion, 0046, Republic of South Africa

[3] Technical University Braunschweig, Braunschweig, Germany

[4] Forschungszentrum Jülich//Institute for Reactor Safety and Reactor Technology RWTH-Aachen, Jülich/Aachen, Germany

[5] Florida Industrial and Phosphate Research Institute, Bartow, Florida, USA

E-mail address of main author: nilshaneklaus@yahoo.de

Today, uranium mined from various regions is the predominant reactor fuel of the present generation of nuclear power plants. The anticipated growth in nuclear energy may require introducing uranium/thorium from unconventional resources (e.g. phosphates, coal ash or sea water) as a future nuclear reactor fuel. The demand for mineral commodities is growing exponentially and high-grade, easily-extractable resources are being depleted rapidly. This shifts the global production to low-grade, or in certain cases unconventional mineral resources, the production of which is constrained by the availability of large amounts of energy.

Numerous mining processes can benefit from the use of so-called “thermal processing”. This is in particular beneficial for (1) low grade deposits that cannot be treated using the presently dominant chemical processing techniques; (2) the extraction of high purity end products; and (3) the separation of high value or unwanted impurities (e.g. uranium, thorium, rare earths, etc.) that could be used/sold, when extracted, which will result in cleaner final products. The considerably lower waste products also make it attractive compared to chemical processing. In the future, we may need to extract nuclear fuel and minerals from the same unconventional resources to make nuclear fuel- and low grade ore processing feasible and cost-effective. These processes could be sustainable only if low-cost, carbon free, reliable energy is available for comprehensive extraction of all valuable commodities, for the entire life of the project. Nuclear power plants and specifically High Temperature Gas-cooled Reactors (HTGRs) can produce this energy and heat in a sustainable way, especially if enough uranium/thorium can be extracted to fuel these reactors.

The proposed Coordinated Research Project (CRP) will thus conduct research and techno-economic feasibility studies on the combination of the following aspects: (1) the use of unconventional uranium (and thorium) resources as future nuclear reactor fuel; (2) the use of thermal processing to extract minerals and by-products in mining and mineral development processes and (3) the study of the sustainability of these two processes, individually or combined with the utilization of HTGRs as the electricity/heat source. The CRP further intends to generate basic data on the availability and characteristics of such low grade mineral resources and their impurities. Finally, the possibility of

“energy neutral” value addition in mineral development projects by using the recovered uranium/thorium as reactor fuel for the HTGR deployed to power the process will be evaluated.

Although the need to utilize unconventional uranium (and thorium) resources may still be far into the future, the legal requirements for beneficiation of minerals (such as the recently implemented law in Indonesia) and new cleaner regulations of end products (e.g. cleaner fertilizers, reduced impurities in end products) create an urgency to investigate the feasibility of thermal processing of minerals and removal of impurities such as uranium and thorium that are disadvantageous in the final product but beneficial if used otherwise or sold.