Challenges at the entry into the ecological age

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There can be no viable future for humanity without a healthy planet. Humanity now moves an order of magnitude more material per year than all of nature´s forces. In the past 30 years we have used up 1/3 of the Earth´s resoures, including 30% of of the world´s forest, 25% of the Earth´s soil and 50% of oil. Using the Earth´s atmpsphere for waste disposal for fossil fuel is significantly altering its composition and heating up the planet. Concordingly the globalising growth economic system is destabilising the planet´s life-supporting systems. The direct impacts on human development as well as rising food and resouce costs mean that current economic growth is rapidly becoming unsustainable and a global transition is needed to the ecological age of human civilisation. The transition to the this new age needs to occur before the middle of this century [1].

The way forward is for developing nations to contract their consumption to allow developing nations to increase their consumption and that we converge at an equitable amount of consumption of Earth´s resources as soon as possible. The world economic system needs to move from growth economics to balanced green economics [2] where we live withing the ecological boundaries of the Earth. By 2050 our western CO_2 emissions need to be decreased by at least 80%, the ecological fooprint reduced to 1.4 gha/capita (75% decudtion for EU) and the human development index to rise substantially. This includes raising overall wellbeing, life expectancy, and eduation. Development needs to move from growth to focusing on environmental protection and stabilising the human population as well as sustainable resource use (water, soil, materials), transport, energy, food, communication and urban design. Geochemists have a role to play at every stage of the process in making the ecological age a success.

[1] Head (2008) *Entering the Ecological Age.* The Institution of Civil Engineers Brunel Lecture Series. [2] Cato (2009) *Green Economics.* Earthscan.

Rhenium in Indian Estuaries and high Re in the Gulf of Cambay

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To understand the behaviour of Re in the tropical estuaries, water and sediment samples were collected from the Narmada Tapi, Mandovi and Mahi estuaries of the Arabian Sea. Samples collected during pre-monsoon and monsoon according to the salinity gradient from river water to open ocean were analysed for their Re contents by isotope dilution using ICP-MS. Re in river waters analysed in this study vary from 1 to 41 pM. In the Narmada, Tapi, and Mahi rivers, it is higher compared to the earlier estimates of the average global riverine Re concentration, 2.1 pM [1, 2]. An annual global flux of riverine Re is estimated to be ~350×10^3 moles with an average concentration of ~9.3 pM based on Re content of this study and those from literature. Re behaves conservatively in all the estuaries in the Arabian Sea. Its concentration in the water of the Arabian Sea, estimated based on the Mandovi estuaries, is ~40 pM, similar to the open ocean Re content of the Arabian Sea measured in this study and to its open ocean value in the other regions of the world. However, the seawater Re content in the Gulf of Cambay estimated based on Re data in the Narmada and the Tapi estuaries is 2 to 5 times higher compared to the open ocean. This is further confirmed by high Re concentration in the Mahi estuary and in coastal waters of the Gulf of Cambay. Higher concentration of dissolved Re in the Gulf of Cambay is probably of anthropogenic origin. Preliminary estimate indicates that polluted rivers and industrial waste waters supply ~2350 moles of Re annually directly to the Gulf of Cambay. Anthropogenic Re supply coupled with high residence time of water in the Gulf are the probable factors responsible for its high Re concentration. Petroleum, Chemical and pharmaceutical industries and coal, lignite and diesel burning in the power plants seems to be the major sources of anthropogenic Re to the rivers and to the Gulf of Cambay. Global riverine Re supply to the oceans, estimated in this study, is ~8 times higher compared to its sink in the reducing sediments [3], indicating non-steady state of ocean for Re. This study highlights the need for a detail study of Re in the various global rivers and in oceans particularly in coastal regions and semi enclosed basins of the world to understand its behaviour in various reservoirs and to constrain the residence time of Re in the oceans.

[1] Colodner *et al*. (1993) *Earth and Planetary Science Letters* **117**, 205-221. [2] Anbar *et al*. (1992) *Geochimica et Cosmochimica Acta* **56**, 4099-4103. [3] Ravizza *et al.* (1991) *Geochimica et Cosmochimica Acta* **55**, 3741-3752.