The Legacy of Akimasa Masuda: From REE in Meteorites to REY in the Environment

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After the pioneering work of Sir Johan Gadolin and other Europeans in the 18th to early 20th century, Rare Earth Element (REE) geochemistry began to take off in the mid-1950s, strongly promoted by the works of (amongst few others) Akimasa Masuda in Japan and Larry Coryell in the US. They independently and contemporaneously developed the concept of chondrite- or shale-normalized REE patterns, a technique still used today to illustrate the REE distribution in minerals, rocks and natural waters. Better understanding of the *geo*chemistry of the REE was always triggered by major advances in analytical techniques, and hence INAA, TIMS, and ICPMS, for example, catalysed the application of REE geochemistry and significantly enlarged the geochemical toolbox. After an initial focus on cosmochemistry and igneous systems, REE geochemistry expanded into the fields of sedimentary systems and ore deposits in the late 1970s and early 1980s, before aqueous REE geochemistry started to flourish in the 1980s and '90s. Since the mid-'90s, yttrium (Ho's geochemical twin) is often included in the discussion, as Y-Ho fractionation may provide additional information, particularly on aqueous systems, and it was confirmed that, indeed, lanthanide tetrad effects can be observed in natural materials, as initially suggested by A. Masuda. In the past 15 years, strongly increasing worldwide demand for REE met with export restrictions imposed by the monopolist REE supplier China, causing commodity prices to explode. Suddenly, the REE became media darlings for a while, eventually facilitating funding for numerous studies of potential REE deposits, REE beneficiation and recycling technology, and supply chain management. However, the increased use of REE in high-tech products also increased their release into the environment. The observation of anthropogenic REE in dust, soil and, in natural waters such as coastal seawater, river and lake water, ground water, and tapwater, and the recognition of the importance of nanoparticles for REE transport caused increased interest in the *bio*geochemistry of the REE, in their bioavailability and their potential (eco)toxicological effects. On this background, this presentation will summarize the latest findings on the distribution and impact of anthropogenic REE, on their uptake by fungi, mussels and fish, and on the impact of biogenic compounds on their biogeochemical behaviour.