Challenges associated with the behaviour of radioactive particles in the environment - DTU Orbit (30/01/2019)

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A series of different nuclear sources associated with the nuclear weapon and fuel cycles have contributed to the release of radioactive particles to the environment. Following nuclear weapon tests, safety tests, conventional destruction of weapons, reactor explosions and fires, a major fraction of released refractory radionuclides such as uranium (U) and plutonium (Pu) were present as entities ranging from sub microns to fragments. Furthermore, radioactive particles and colloids have been released from reprocessing facilities and civil reactors, from radioactive waste dumped at sea, and from NORM sites. Thus, whenever refractory radionuclides are released to the environment following nuclear events, radioactive particles should be expected. Results from many years of research have shown that particle characteristics such as elemental composition depend on the source, while characteristics such as particle size distribution, structure, and oxidation state influencing ecosystem transfer depend also on the release scenarios. When radioactive particles are deposited in the environment, weathering processes occur and associated radionuclides are subsequently mobilized, changing the apparent Kd. Thus, particles retained in soils or sediments are unevenly distributed, and dissolution of radionuclides from particles may be partial. For areas affected by particle contamination, the inventories can therefore be underestimated, and impact and risk assessments may suffer from unacceptable large uncertainties if radioactive particles are ignored. To integrate radioactive particles into environmental impact assessments, key challenges include the linking of particle characteristics to specific sources, to ecosystem transfer, and to uptake and retention in biological systems. To elucidate these issues, the EC-funded COMET and RATE projects and the IAEA Coordinated Research Program on particles have revisited selected contaminated sites and archive samples. This COMET position paper summarizes new knowledge on key sources that have contributed to particle releases, including particle characteristics based on advanced techniques, with emphasis on particle weathering processes as well as on heterogeneities in biological samples to evaluate potential uptake and retention of radioactive particles.