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Moldovan police examine suspected radioactive uranium-238 in August 2010.

Expand nuclear forensics

Characterizing nuclear materials deters illicit trafficking and terrorism, but more scientists, techniques and collaborations are needed, says **Klaus Mayer**.

Since the International Atomic Energy Agency (IAEA) implemented its Incident and Trafficking Database in 1995, around 2,300 events involving illicit nuclear or other radioactive materials have been reported. Although most cases involve lost or orphan radioactive sources containing, for example, cobalt-60 or iridium-192 for medical or industrial applications, 10–15 incidents per year concern nuclear materials turning up out of regulatory control.

Uranium and plutonium are most worrying because, as well as posing a radiological hazard, they may be indicative of proliferation or nuclear terrorism. The sorts of things seized are scrap metal contaminated with grams of enriched uranium or kilograms of natural uranium, gram-sized samples of uranium metal, and uranium fuel pellets. In 1994, 300 grams of plutonium oxide powder were intercepted at Munich airport in Germany.

Officials detect unlawful nuclear materials at borders, seaports and airports or in state territories by measuring radiation directly or acting on tip-offs from police or intelligence work. Whenever such a sample is intercepted, agencies want to know: which laws have been broken? When and where was the material produced? What was the intended use? Where was the material stolen or diverted? Is more of it at large? Nuclear-forensic scientists try to answer these questions.

The chemical and physical signatures of a radioactive material — from its appearance and microstructure to its elemental and isotopic composition — shed light on its origin and history. For example, the isotope ratios of strontium impurities in a sample of natural uranium may indicate whether it was mined in Australia or Namibia. The presence of daughter products from nuclear decays reveal the production date of the material, and products, such as uranium-236, of neutron reactions indicate that it was irradiated in a power plant.

Nuclear forensics is a small and specialized field that has matured since the early 1990s. But progress is still too slow. Although the number of scientific publications in the discipline has risen from a handful in 2001, it still numbers only a few dozen a year.

States worldwide need to implement nuclear-forensic capabilities — both nationally and internationally — through greater collaboration. To boost the robustness of the methods, and thence their credibility, new forms of analysis and signatures for nuclear materials need to be developed. Nuclear-forensic data need to be archived securely and more experts must be trained. Otherwise smugglers and terrorists might evade prosecution.

A few years ago in a European country, a radiation detector at a scrap-metal recycling facility triggered an alarm. A piece of steel in a shipment from south Asia had ▶