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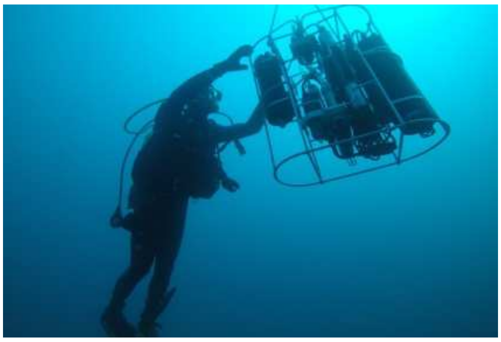
The processes that determine climate are complex. Oceans store about a quarter of the carbon dioxide emitted through human activities, and as a result mitigate some of the impacts of climate change. Yet increasing carbon emissions and rising temperatures could cause this balance to shift, with possible major consequences for global weather patterns. In order to understand and anticipate potential changes, it is key to understand the processes involved in the carbon cycle and in the oceans.

The IAEA Environment Laboratories study the global carbon cycle and have been collecting and measuring particulate matter from the deep ocean which contains this carbon for over 30 years, providing valuable information on trends.

This edition of the Environment Laboratories Newsletter will review the Laboratories' work in the area of the carbon cycle and climate change, as well as highlight some of the other projects underway from July to December 2016.

For more information on the activities of the IAEA Environment Laboratories, please visit www.iaea.org/nael.
David Osborn
Director, IAEA Environment Laboratories.

(Photo: S. Jones-Couture / IAEA)



(Photo: R. Cassi / IAEA)

The role of the oceans in carbon cycling

The flux of carbon, such as in carbon dioxide (CO_2) and methane (CH_4) - two prominent greenhouse gases - between different environmental compartments (the atmosphere, the ocean, terrestrial biosphere and sediments) is known as the global carbon cycle. Accurately quantifying these fluxes and stocks of carbon is necessary to construct the climate models used to predict the impacts of climate change.

At least a quarter of the carbon dioxide (CO_2) released into the atmosphere by anthropogenic activities such as fossil fuel burning is taken up by the ocean. The reservoir of carbon stored in the deep ocean is 50 times larger than that in the atmosphere. A small change in fluxes to the ocean carbon pool, such as those potentially caused by climate change and rising temperatures, could affect the storage capacity of the ocean, which in turn could have dramatic consequences for atmospheric CO_2 levels. If the biological pump in the ocean were to shut off, atmospheric CO_2 could rise anywhere between 200 and 400 ppm above today's levels of ~400 ppm, reached for the first time in 2015.

This regulating ecosystem service is beneficial to populations worldwide. Its economic value has been estimated at 100 to 1,500 million euro per year for the Mediterranean Sea alone.

Researchers at the IAEA Environment Laboratories in Monaco take seawater samples to measure particulate carbon. (Photo: R. Cassi / IAEA)

The IAEA Environment Laboratories use radioisotopes to understand the magnitude of this service and how it might be impacted by changing climate conditions. The flux of carbon to the deep ocean can be measured directly by collecting sinking particles in sediment traps, and indirectly using naturally-occurring radioisotopes of thorium and polonium. These radioisotopes decay at known rates and are used as "clocks" to determine how quickly sinking fluxes occur.

The application of these tools in a variety of ocean settings helps determine the extent of sinking carbon flux across different ecosystems and evaluate its sensitivity to climate change. The Environment Laboratories participate in research missions around the world to collect samples to measure particle flux, including in the Arctic Ocean, region which is sensitive to ocean warming, and to oxygen minimum zones such as off the coasts of Peru and Mauritania. Such zones are predicted to expand under future climate change scenarios.

The Environment Laboratories also examine the fate of carbon by using radioisotopes to analyse microbial processes in the deep ocean. Microbes are responsible for the remineralization of organic material from sinking particles into inorganic carbon. Understanding the rates of this recycling and the conditions that affect it is important to evaluate the deep ocean's capacity to store carbon and how that might change under a changing climate and marine environment. Both naturally-occurring radiocarbon and radioisotope-labelled tracers can be used to measure these microbial processes with regards to the cycling of carbon in the deep ocean.

How does it work?

The ocean stores carbon primarily through two mechanisms: the solubility pump and the biological carbon pump. In the solubility pump, CO_2 is sequestered from the atmosphere into the deep ocean by physical and chemical processes such as gas exchange and dissolution reactions coupled with water mass formation and circulation. Through the biological carbon pump, phytoplankton in the surface ocean take up CO_2 during photosynthesis and convert this inorganic carbon to particulate and dissolved organic carbon. The complexity of biological processes makes estimating the magnitude and variability of carbon sequestration by the biological carbon pump more difficult than the solubility pump.

With a view to proposing new applications of radionuclides to further our understanding of the effects of climate change on carbon sequestration by the ocean's biological carbon pump (BCP), the IAEA hosted a Technical Meeting on the "Application of Radionuclides in Studies of the Carbon Cycle and the Impact of Ocean Acidification" on October 19 to 21, 2016 at the IAEA's Environment Laboratories in Monaco. The meeting consisted of seven invited scientists from institutions in the United Kingdom, the United States, Germany, France, and Australia. These scientists have a range of expertise from applying radionuclides to measure biogeochemical fluxes in the ocean to studying key players and processes in the biological pump such as zooplankton and particle aggregation. Participants discussed advances in the application of radionuclides to particle cycling in the BCP, important biological and physical processes in the BCP, and the potential impacts of climate change on this system.

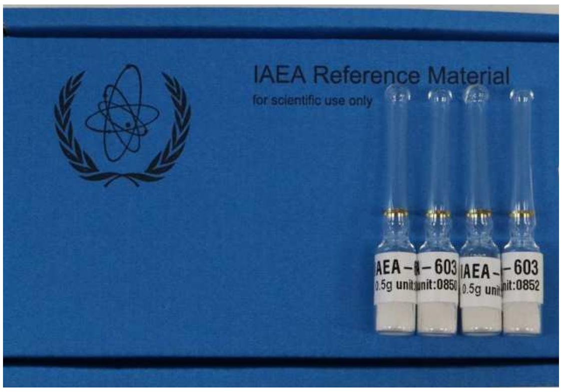
Participants gathered to discuss the application of radionuclides to further understanding climate change. (Photo: O. Anghelici / IAEA)

Participants also established priorities for radionuclide method development and how these radionuclide tracers could be applied to key research questions related to the BCP in the present and future ocean. The participants agreed that two publications produced from this meeting could be of use to the greater scientific community: 1) a brief meeting summary of key points from the meeting and 2) a perspective-style article outlining recent developments and proposing new priorities in the application of radionuclides to the study of the BCP. In addition, ideas for data synthesis and compilation efforts were proposed and initiated among the participants that may result in future publications.

New IAEA reference material for improved measurement of greenhouse gases

The IAEA Environment Laboratories have recently produced a new reference material which will contribute to improved measurements of greenhouse gases, such as carbon dioxide and methane, and provide information on their origin. Made of Carrara marble, the same marble that Michelangelo used to make his famous sculpture of David, the reference material will help gain a more precise understanding of greenhouse gases. Member States will be able to use this information to manage the sources of their emissions and work towards their Intended Nationally Determined Contributions (INDCs), as laid out in the Paris Agreement.

The new reference material, IAEA-603, will be used by laboratories worldwide to reliably calibrate instruments to measure the isotopic composition of carbon and oxygen in greenhouse gases such as carbon dioxide and methane and to perform quality assurance tests to ensure the accuracy and long-term compatibility of their results. With an ultra-low uncertainty, the carbonate reference material will allow a better estimation of the sources and sinks of these



The new IAEA reference material will contribute to improved measurements of greenhouse gases carbon dioxide and methane. (Photo: S. Assonov / IAEA)

greenhouse gases and ultimately improve the accuracy of global climate models. As climate change becomes a reality, decision-makers seek solid scientific evidence to guide their policies.

How is the new reference material used?

Carbon dioxide (CO2) released during the burning of fossil fuels has a unique isotopic signature, which is similar to the isotopic signature of the plants and other organic matter from which it originates. By studying the isotopic ratio of stable carbon isotopes in atmospheric, marine, and ice core samples, scientists can assess the sources of carbon in these materials and have been able to determine that, since the industrial revolution, the increased levels of CO_2 in the atmosphere result from fossil-fuel combustion. Isotopic

The new reference material is made of marble similar to that used to make Michelangelo's statue of David. (Photo: IAEA)

ratios also provide valuable insight into other sources of greenhouse gases in the atmosphere such as from agriculture (rice fields, livestock) and land-use changes.

"Scientists need an understanding of what is happening at an isotopic-level," said IAEA Stable Isotope Reference Material Specialist Sergey Assonov. "In order to get reliable observational data, scientists need reference materials with a low uncertainty which satisfy the World Meteorological Organization Data Quality Objectives for global monitoring."

In an effort to contribute to improved measurements of greenhouse gases, experts gathered at an IAEA Technical Meeting in Vienna, Austria, from 21 to 25 November 2016 to discuss the further development of IAEA stable isotope reference products.

Impact of Ocean Acidification on the calcification process of cuttlefish

The IAEA Environment Laboratories have begun a new project to study the potential impacts of ocean acidification on calcification, the process by which organisms grow their shells and bones. Studies have shown that increased acidity in the ocean may affect skeletal structure in corals, making them more fragile and susceptible to damage caused by storms or over-grazing by fish. The Environment Laboratories are examining to what extent other marine species may be affected by a decreased seawater pH as well, and have started a new project studying the impacts on cuttlefish.

As part of this project, researchers have recreated a low pH environment in a controlled aquarium, replicating the conditions of increased ocean acidification scenarios. A second aquarium with cuttlefish is set at today's seawater pH value and used as a control condition. At monthly intervals, cuttlefish bone is extracted from specimen in

The Laboratories are studying the effect of low pH environments on bone structure. (Photo: F. Oberhänsli / IAEA)

both groups (low pH versus today' pH values). In collaboration with the Scientific Centre of Monaco (CSM), the micro-structural changes are assessed with a Scanning Electron Microscope (SEM) by measuring the thickness of the lamellar and pillar walls. Studying the physiological changes in cuttlebone developed under different pH conditions provides important information on how marine biota could be impacted by ocean acidification. These can include effects on species' growth rates, buoyancy control (i.e. their ability to swim), and even resistance to predators.

Replicating the human digestive process to assess contaminant uptake

Researchers at the IAEA Environment Laboratories have developed a "cocktail" of enzymes and reagents that replicate the human digestive system and allow scientists to measure how pollutants ingested through the consumption of seafood can be absorbed by the human body.

Fish tissue and organ samples are exposed to this artificial digestive cocktail much in the same way they would naturally move through the organism during digestion. At

Researchers weigh fish samples as part of their experiments. (Photo: S. Jones-Couture / IAEA)

the end of the process, IAEA researchers measure the remaining pollutants, which provides insight into how pollutants are metabolized during digestion and what pollutants are available to be absorbed by our bodies. The "digestive cocktail" includes human saliva, digestive and gastric fluids, duodenal fluid and bile. Some of the solutions of this "gastric cocktail" are a mix of over 30 enzymes.

The experiments also examine fish samples cooked in different ways, to see if this has an impact on pollutant transfer. In some countries fish is traditionally eaten raw, while in others it is dried or cooked. It is well-known for example that lemon changes the acidity of a dish, and researchers can investigate whether this has an effect on the pollutant accumulation rate.

Using nuclear techniques, we can follow how pollutants move through coastal and marine ecosystems and organisms, but these new techniques are truly innovative in that we now are able to trace how these same pollutants are transformed and accumulated in humans.

Implications of this work are important for seafood security and safety as populations around the globe depend on fish as part of their diet: in 2013 fish was a key part of the animal protein intake for 3.1 billion people globally.

Assisting Mediterranean Member States with data quality assurance in the analysis of contaminants in marine samples

The year 2016 marks the 30th anniversary of the addition of the Marine Environmental Studies Laboratory (MESL) to the Environment Laboratories. MESL was set up by the Agency to assist Member States to monitor marine pollution as part of UNEP's Regional Seas Programmes, with an initial focus on the Mediterranean. The Laboratory acts as the Regional Analytical Centre for the MED POL Programme, which is the marine pollution and control component of the Mediterranean Action Plan. The IAEA Environment Laboratories in collaboration with UNEP/MAP – MED POL have developed a comprehensive and interactive strategy to enhance the capacities of the Mediterranean laboratories and build more effective scientific groups at the national level in order to address marine pollution issues of national and regional context. As part of this ongoing support, the Environment Laboratories organised during the second semester 2016, two Proficiency Tests and two Training Courses on the analysis of trace elements and organic contaminants in marine samples.

For the Proficiency Test on organic contaminants, a sample of marine sediment was sent to 32 Mediterranean laboratories in 13 Member States, which were asked to provide results for compounds from three groups: i) chlorinated pesticides, ii) PCBs and iii) petroleum hydrocarbons, using the measurement procedures usually applied for MEDPOL monitoring studies. For the Proficiency Test on trace elements, a marine biota proficiency sample was sent to 38 Mediterranean laboratories in 14 Members States to determine trace elements of the following: silver, aluminium, arsenic, calcium, cadmium, cobalt, chromium, copper, iron, mercury, magnesium, manganese, sodium, nickel, lead, selenium, tin, strontium, vanadium and zinc. Reports on the measurement performances will help participants identify possible areas for progress and initiate actions to improve the data quality assurance of the laboratories.

Furthermore, two training courses on the analysis of trace elements and organic contaminants in marine samples were organised by MESL in Monaco from 24 October to 4 November 2016. Attended by 10 scientists from 8 Mediterranean countries, the courses aimed at strengthening the skills of scientists involved in national marine pollution monitoring programmes, regionally coordinated by UNEP/MAP – MED POL.

The training courses included theoretical lectures and practical laboratory exercises on sample preparation, appropriate analytical techniques used in marine pollution monitoring and data quality assurance. Important concepts of measurement science – known as metrology in chemistry – such as the validation of measurement procedures, the use of certified reference materials, as well as traceability and uncertainty of measurement results were also presented.

Trainees do a practical exercise on sample preparation. (Photo: R. Cassi / IAEA)

The trainees of both courses participated in a sampling field trip at sea for a hands-on training on marine sediment and seawater sampling techniques. This included procedures for surface sediment (grab sampler), surface water and under-water sampling (Niskin bottle).
The Environment Laboratories will continue to organise similar training courses in close collaboration with UNEP/MAP.

Pollution trends in coastal areas

The IAEA Environment Laboratories have begun a new Coordinated Research Project to study the temporal trends of pollution in coastal areas. Isotopic and nuclear techniques will be used to determine and date pollutants such as radionuclides (both naturally-occurring and anthropogenic), trace elements, rare earth elements, organic pollutants and microplastics in sediment cores.

14 Member States from diverse geographical regions facing different pollution problems will participate in this project. Institutions will collaborate to establish a scientific platform to improve the dating methods for the study of pollution trends, to harmonize and verify the approach in areas with high sedimentation rates and to assess pollution sources using stable and radio- isotopes.

The first Research Coordination Meeting (RCM) was hosted by the Pontifical Catholic University of Rio de Janeiro (PUC- Rio), Brazil in November 2016 and was attended by 15 representatives from 12 Member States who presented their projects and agreed on a road map for the research. The main objective of the meeting was to prepare the Coordinated Research Project work plan and establish the content of a sediment-dating protocol and action plan for its preparation.

Researchers collect sediment samples in Brazil. (Photo: M. Rozmaric / IAEA)

The meeting included a field exercise on a sampling boat provided by the Brazilian Navy to collect sediment core samples which will be used to validate a lead-210 (Pb-210) dating methodology through an inter-laboratory comparison amongst project participants.

IAEA Collaborating Centre enhances the reliability and comparability of environmental radioactivity measurement results

IAEA Deputy Director General Aldo Malavasi officially redesignated the Korea Institute of Nuclear Safety as an IAEA Collaborating Centre to enhance the reliability and comparability of environmental radioactivity measurement results. The Korea Institute of Nuclear Safety was previously an IAEA collaborating centre for one term in 2011. With its large experience and expertise in environmental radioactivity measurements, it has provided valuable support to IAEA activities in the fields of preparation and characterization of environmental reference materials and development of analytical procedures for environmental radioactivity monitoring.

The redesignation of the Korea Institute of Nuclear Safety as an IAEA Collaborating Centre recognises both its significant achievements in these fields, as well as the close and valuable cooperation between the two organisations. During their previous designation period, the Korea Institute of Nuclear Safety contributed to the production and characterization of reference materials and proficiency test materials, provided its expertise for the development and validation of several IAEA recommended analytical procedures for environmental radioactivity monitoring, and organized practical training courses on those analytical procedures.

Presentation of the IAEA Collaborating Centre plaque to the representative of the Korea Institute of Nuclear Safety by the IAEA Deputy Director General Aldo Malavasi. (Photo: A. Pitois / IAEA)

New matrix reference materials of terrestrial origin and new validated analytical procedures for environmental radioactivity monitoring will be developed in cooperation with the Collaborating Centre, resulting in more internationally-recognized reference products available to Member States and contributing to quality environmental radioactivity measurement results worldwide. Reference materials for the analysis of radionuclides in matrices ranging from soil to vegetation and validated analytical procedures for environmental radioactivity monitoring are essential tools to assist Member States in enhancing the reliability and comparability of environmental measurement results and to support their environmental radioactivity monitoring and research programmes.

Radionuclide monitoring in the Marshall Islands

Atmospheric nuclear weapons tests in the Marshall Islands in the 1940s and 1950s have resulted in a legacy of radioactive contamination with consequences for health and the environment. The IAEA Environment Laboratories conducted an expert mission to the atoll in December 2016 to review existing sampling and laboratory capabilities and protocols and to define requirements to establish a national radionuclide monitoring capability. The goal was to discuss and refine the work plan with key technical counterparts in the two lead agencies, the RMI Environmental Protection Authority and Marshall Islands Marine Resources Authority. A series of meetings also took place with key stakeholders from the Marshall Islands' government and civil society. Discussion focused on objectives of the proposed monitoring, the history of the atoll's nuclear legacy and how to ensure the sustainability of the developed capacity beyond the lifetime of the project.

The Marshallese rely largely on external scientists, primarily the U.S. Department of Energy, to undertake environmental monitoring and to provide advice on radiation exposure and health consequences. The project has been designed to build capacity in the Marshall Islands to enable local scientists to perform these important functions themselves.

The focus of the initial phase of the project is on supplying basic radioanalytical equipment and on building expertise in the collection, preparation and analysis of environmental and food samples through fellowships, expert missions and training courses. A second phase will include the monitoring of selected locations in the Marshall Islands by the newly trained scientists in collaboration with international experts.

The Environment Laboratories are working with Marshall Islands to develop radionuclide monitoring capability. (Photo: P. Mc Ginnity / IAEA)

Samples to be studied will include local fruit crops like pandanus, coconut and breadfruit, livestock such as pigs, chickens, and seafood like fish and clams, and finally drinking water.

An important objective of the project is to assist local authorities in addressing concerns and the current lack of understanding by the public regarding the nuclear issues affecting their country. Therefore, there will be a strong emphasis on public engagement. The results of the surveys will be presented to community leaders (local government officials) and local members of the public using posters, presentations, radio spots and social media content tailored for each individual location.

Assessing Radioactivity in Food

With the support of the IAEA and the Canadian Nuclear Safety Commission, thirteen scientists representing laboratories from Brazil, Czech Republic, Estonia, Republic of Korea, Madagascar, Mexico, the Netherlands, Portugal, Singapore, Slovenia, Tunisia, Turkey and the United Arab Emirates, gained practical experience on a

Scientists learning a state-of-the-art method for precise assessment of radioactivity in food products at the laboratory of the Canadian Nuclear Safety Commission in Ottawa, Canada. (Photo: A. Pitois / IAEA)

state-of-the-art method that can be used to determine the presence of radionuclides in food products.

The venue was an ALMERA practical training course on the determination of organically bound tritium in food products and on the methods and procedures involved in its assessment. It was organized by the IAEA Environment Laboratories, in cooperation with the Canadian Nuclear Safety Commission (CNSC), in Ottawa, Canada, from 26 to 30 September 2016. Its goal was to lead to additional capacity building for routine environmental monitoring in ALMERA member laboratories.

The Analytical Laboratories for the Measurement of Environmental Radioactivity, or ALMERA, is a worldwide network of analytical laboratories capable of providing reliable and timely determination of radionuclides as part of both routine and emergency environmental monitoring. The scientists attending the practical training course all worked in laboratories belonging to the ALMERA network.

Over the one-week period, the participants learned the method for the determination of organically bound tritium in food samples. The method is applicable to a large range of unprocessed food products, such as potato, wheat and milk. They were also trained on the calculation and uncertainty estimation of the measured radionuclide content. The scientists were shown by experts the key components of the analytical work and the data analysis required for ensuring high quality measurement results. The training course included a half-day technical visit to selected CNSC laboratory facilities, an opportunity for the participants to learn about various nuclear applications.

Ensuring food does not exceed radioactivity levels established by national regulations is essential to protect the public from harmful ionizing radiation. Laboratories need reliable and precise analytical methods to ensure worldwide enforcement of radiation safety regulations for food products.

Mr. David Osborn, Director of the IAEA Environment Laboratories, explained that the advanced analytical methods for precise assessment of radionuclides content in food products are of vital importance. “People need to be able to trust the food they are eating is safe, that laboratories have the capability to detect contaminants, and that the information provided is reliable” he said.

Tritium, a radioactive isotope of hydrogen, is present in the environment as a result of controlled releases from specific nuclear fuel cycle facilities and from past atmospheric global fallout. Under certain conditions, it can bind to environmental organic compounds such as soil, vegetation, and food. These processes form organically bound tritium that is a biologically hazardous chemical species of tritium.

This course is part of a series of practical courses aimed at training scientists on state-of-the-art analytical methods for radionuclide content determination in environmental and food samples. It follows the successful practical ALMERA training courses on methods for the rapid determination of radiostrontium in milk (2014, Republic of Korea) and radionuclides in environmental samples (2014 and 2015, USA). Such courses are an efficient and effective way to build additional capabilities in countries interested in enhancing their environmental radioactivity monitoring programmes and emergency response preparedness.

IAEA Environment Laboratories work with Japanese authorities to ensure that information about radioactivity in seawater and seafood is reliable

The IAEA Environment Laboratories continued to assist the Government of Japan in ensuring that the Sea Area Monitoring Plan is comprehensive, credible and transparent. A sampling mission was organized in November 2016 to collect seawater and fish samples for the sixth inter-laboratory comparison (ILC) organised since the start of the project.

Like the previous five sampling missions, which took place in 2014, 2015 and early 2016 (see Environmental Laboratories Newsletters Vol 1, No 2, Vol 2, No 1 and Vol 2, No 2), this mission was carried out as part of a series of ILCs organized within the project for “Marine Monitoring: Confidence Building and Data Quality Assurance”.

Six batches of fresh fish samples caught by local fishermen at locations in the vicinity of the Fukushima Daiichi Nuclear Power Plant were collected from the fish landing port of Onahama. Two batches of chum salmon, two batches of olive flounder, one batch of John Dory and one batch of Japanese Spanish mackerel were prepared at the Marine Ecology Research Institute (MERI) in Onjuku, Japan and analysed for caesium-134and caesium-137 at MERI. After subsequent analysis at the Japan Chemical Analysis Center in Chiba and the Japan Frozen Foods Inspection Corporation (JFFIC) in Yokohama, the frozen fish samples will be shipped to the IAEA Environment Laboratories in Monaco for radioactivity measurement.

Collection of water samples offshore Fukushima. (Photo: A.V Harms / IAEA)

Seawater samples were collected from five sampling points within a 10 km radius from the Fukushima Daiichi Nuclear Power Plant. For each sampling point, three identical seawater sub-samples were prepared and distributed to the three participating laboratories (Japan Chemical Analysis Center in Chiba, Japan, KANSO Co. LTD in Osaka, Japan, and the IAEA Environment Laboratories in Monaco) for the radioactivity analysis of hydrogen-3 (tritium), strontium-90, caesium-134, and caesium-137.

The results reported by Japanese laboratories and the IAEA Environment Laboratories for this exercise will be evaluated early 2017. The results obtained so far in earlier exercises demonstrate a high level of accuracy and competence on the part of the Japanese laboratories involved in the analyses of radionuclides in marine samples for the Sea Area Monitoring programme.

13th Coordination meeting of the ALMERA Network

The 2016 coordination meeting of the IAEA's Network of Analytical Laboratories for the Measurement of Environmental Radioactivity (ALMERA) was hosted by the Australian Nuclear Science and Technology Organisation (ANSTO) in Sydney, Australia, from 26 to 28 October 2016. The meeting was attended by 50 participants from 31 Member States and provided an overview of recent ALMERA activities in the area of proficiency tests, method development and discussed plans for future activities. The meeting participants had the opportunity to visit state-of-the-art research facilities at ANSTO, such as the OPAL research reactor, the Centre for Accelerator Science and the Environmental Radioactivity Measurement Centre, which hosts ANSTO's low-level counting facility, radiochemistry laboratories and the ITRAX core scanner (http://www.ansto.gov.au/index.htm).

ALMERA meeting participants. (Photo: K. Cubbin / ANSTO)

The objective of the ALMERA collaboration is to enhance the capability of the network laboratories to provide accurate and timely radioactivity analysis results in the event of an accidental or intentional release of radioactivity. It works toward this objective through comprehensive testing of analytical proficiency, targeted training and collaborative method development.

Staff spotlight: François Oberhänsli

Francois Oberhänsli, known as "Franky" by his colleagues, first started at the IAEA Environment Laboratories in Monaco as an intern in 2004, after studying biochemistry/biology and aquaculture at Montpellier University in France. He attended a training course on coral culture and fish breeding at the Monaco Oceanographic Museum's aquarium and then returned to the Environment Laboratories as a Laboratory Technician where he maintains the numerous laboratory aquaria and assists with experiments on sensitive species like sponges, corals and fish.

François works with his colleagues to develop research projects which directly benefit Member States and provide insight into the movement of contaminants within marine ecosystems and organisms. He was part of a team that developed and implemented an IKS CO_2 regulation system to reproduce in an aquarium an environment with increased acidity, which facilitates the study of the potential impact of ocean acidification on marine ecosystems.

François Oberhänsli showing fellows how to use the radioligand binding assay, a nuclear technique to detect biotoxins linked with harmful algal blooms. (Photo: S. Jones-Couture / IAEA)

"I am lucky to work in nuclear applications, which is an area I am passionate about. Each experiment is a new challenge with regards to acclimatisation, breeding, and experimental work on new species. Trying to find solutions to Member States' practical challenges is a real source of motivation" says François.

François is also active in Technical Cooperation projects and is one of the staff who trains visiting fellows on the use of nuclear techniques in radioecology.

Fellow's corner

Working on the measurement of ultra-low levels of long-lived radionuclides in seawater

In the framework of the collaboration with the CNA (Centro Nacional de Aceleradores) in Seville, Spain, Ms Mercedes López Lora spent 3 months in the Monaco Environment Laboratories from September to November 2016 to improve radiochemical methods for the measurement of actinides through Accelerator Mass Spectrometry (AMS).

Mercedes in the Laboratory. (Photo: I. Levy / IAEA)

While at the Environment Laboratories, Mercedes worked to develop a new radiochemical procedure for the simultaneous determination of uranium, plutonium and neptunium in seawater samples using AMS. The idea was to start with the existing method used in the IAEA's Environment Laboratories in Monaco for plutonium and americium determination in large volume seawater samples and adapt it in order to include neptunium and uranium measurement at the same time. Mercedes' objective was to establish the new procedure and perform tests to check the reproducibility of the method. Using the new method, she prepared samples from the Mediterranean Sea collected in 2001 to provide baseline figures and bring additional insight into oceanographic processes based on a multi-tracer approach. The measurement of the samples will then be performed in the CNA in Seville at the beginning of next year.

Mercedes has a Masters degree in Nuclear Physics and is currently doing her PhD on actinides measurement using AMS.

2017 Annual World Oceans Day Oceanic Photo Competition

Participants have until 12 May 2017 to submit their entries in this annual competition. Results will be announced during the UN events marking World Oceans Day, which this year will include the UN Ocean conference, to be held in New York 5-9 June 2017.

Publications

- **Method Validation for HR ICP-SFMS Determination of the Emerging Contaminants in the Open Ocean: Rare Earth Elements as a Case Study.** WYSOCKA, I., VASILEVA, E. in Spectrochimica Acta Part B.
- **Development of procedure for determination of lead isotope ratios in seawater by application of seaFAST sample pre-treatment system and HR SF ICP-MS.** VASILEVA, E., WYSOCKA, I. in Spectrochimica Acta Part B.
- **Radiological aspects of transition of Russian areas affected by the Chernobyl accident to normal activities**. Sanzharova, N.I., Fesenko, S.V., Romanovic, I.K., Marchenko, T.A., Razdaivodin, A.N., Panov, A.V., Shubina, O.A., Prudnikov, P.V., Isamov, N.N., Radin, A.I., Bruk, G.Ya. Radiation biology. Radioecology, 56(3) 2016.
- **Remediation of areas contaminated by caesium: basic mechanisms behind remedial options and experience in application.** Fesenko, S., Howard, B.J., Sanzharova, N., Vidal, M., In: Impact of cesium on plants and the Environment, Gupta, D.K. and Walther, C. (Eds.) Springer, Berlin (2016) 265-310.
- **Calculation spreadsheet for uncertainty estimation of measurement results in gamma-ray spectrometry and its validation for quality assurance purpose.** A. Ceccatelli, A. Pitois.
- **Atomic Weights of the Elements 2013**. J. Meija, T.B. Coplen, M. Berglund, W.A. Brand, P. De Bièvre, M. Gröning, N.E. Holden, J. Irrgeher, R.D. Loss, T. Walczyk, T. Prohaska. Pure and Applied Chemistry, 88(3), 2016, 265-291.
- **Isotopic Composition of the Elements 2013.** J. Meija, T.B. Coplen, M. Berglund, W.A. Brand, P. De Bièvre, M. Gröning, N.E. Holden, J. Irrgeher, R.D. Loss, T. Walczyk, T. Prohaska. Pure and Applied Chemistry, 88(3), 2016, 293-306.
- **A comparison of remediation after the Chernobyl and Fukushima Daiichi accidents**. S. Fesenko, M. Balonov, G. Pröhl, S. Nakayama, B.J. Howard. Radiation Protection Dosimetry, 171 (3) (2016) 1–7.
- **INPRO Methodology for Sustainability Assessment of Nuclear Energy Systems: Environmental Impact of Stressors.** IAEA (A. Korinny, J. Phillips, S. Fesenko): STI/PUB/1733, IAEA Nuclear Energy Series No. NG-T-3.15 (2016), 94 pp.
- **Prawn biomonitors of nutrient and trace metal pollution along Asia-Pacific coastlines**. FRY, B., CARTER, J.F., KAMAL, M., METIAN, M., TINGGI, U., WADUGE, V.A., BIN YACCUP, R. Isotopes in Environmental & Health Studies, Vol. 52, N°6 (2016) pp. 619-632.
- **First description of the neuro-anatomy of a larval coral reef fish, Amphiprion ocellaris.** JACOB, H., METIAN, M., BROOKER, R.M., DURAN, E., NAKAMURA, N., ROUX, MASANET, P., SOULAT, O., LECCHINI, D. Journal of Fish Biology, 89 (2016) pp. 1583-1591.
- **IAEA's ALMERA network: Supporting the quality of environmental radioactivity measurements.** OSVATH, I., TARJAN, S., PITOIS, A., GROENING, M., OSBORN, D. Applied Radiation and Isotopes, 109 (2016) pp. 90-95.

Upcoming and recent events

Dates	Description	Location
30 March 2017	Presentation of the OA-ICC as part of Monaco Ocean Week	Monaco
10-12 April 2017	Coordination Meeting to support the Global Ocean Acidification Observing Network	IAEA, Vienna, Austria
10-12 April 2017	"The Oceans Solutions Initiative" Expert workshop	IAEA Environment Laboratories, Monaco.
25 April – 27 April 2017	Thirteenth Expert Meeting of Bonn-OSINet (Oil Spill Identification Network).	IAEA Environment Laboratories, Monaco.
6-9 June 2017	Participation in Monacology: the annual Monaco ecology awareness week.	Monaco
3-7 July 2017	ALMERA Workshop on the Measurement of Natural Radionuclides in Environmental Samples and NORM	Karlsruhe, Germany
September 2017 TBC	ALMERA Workshop on In-Situ Methods for Contaminated Site Characterisation	Kurchatov City, Kazakhstan
23-25 October 2017	14th ALMERA Coordination Meeting	Stockholm, Sweden
30 – 10 November 2017	MED POL Training Course on the Analysis of Organochlorinated Pesticides and Polychlorinated Biphenyls in Environmental Samples	IAEA Environment Laboratories, Monaco
30 – 10 November 2017	MED POL Training Course on Analytical Techniques for the Determination of Trace Elements in Environmental Samples.	IAEA Environment Laboratories, Monaco

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