IAEA
International Atomic Energy Agency

Marine Environment News

A newsletter of the IAEA Marine Environment Laboratory, Monaco
Vol. 2, No. 1, March 2004
ISSN 1810–1372

In This Issue

- Director's Introduction (p.1)
- Guest Article: Radiotracers as new barometers of ocean-climate coupling (p.1)
- MEL's Underground Counting Laboratory dramatically improves the detection of marine radioactivity (p.2)
- Discovering bio-indicator species for heavy metals in the lagoon of New Caledonia (p.3)
- Carbon isotope ratios ($\delta^{13}C$) for tracking ocean carbon cycling (p.4)
- Scott Fowler: Pioneer of marine radioecology (p.5)
- Experience of a Postgraduate student (p.5)
- MEL assisting UNDP in IRAQ (p.6)
- MEDPOL sponsored training course at MEL (p.6)
- Selected recent publications (p.6)
- Training Courses (p.7)
- Current Intercomparison exercises (p.7)
- International Conference on Isotopes in Environmental Studies - Aquatic Forum 2004, 25-29 October 2004, Monte-Carlo, Monaco (p.8)

Director's Introduction

Thank you to our Member States and readers for their enthusiastic comments on our first issue which have fed into this our 2nd issue of Marine Environment News. There are two new features: the Guest Article (below) and Postgraduate Student Column (page 5). These will include views of International Marine Experts and of Postgraduates and Fellows visiting MEL. Thanks to IAEA Staff and colleagues for their contribution, and to all our readers, please do send us your comments. R Fauzi C Mantoura. F.Mantoura@iaea.org

Guest Article: Radiotracers as new barometers of ocean-climate coupling

Marine radioecology, to a great extent, was born out of concerns about the impact of atmospheric weapons testing in the 1950s and 1960s, was refined in response to the increasing civil nuclear programme and the challenges of waste management, and was tested by a number of inadvertent releases. In monitoring the results of our successful efforts over the past 20 years to reduce radiological impact on the environment, we have discovered the exquisite sensitivity and chronological power of these radioelements. Radiotracers have helped us understand water circulation, measure biological productivity and track the flux and fate of dissolved and particulate matter in the ocean. We could make more effort to exploit and promote the multidisciplinary advantages of radionuclides as marine environmental tracers and clocks. The NE Atlantic is a good example: increased discharges of some radionuclides (e.g., ^{99}Tc and ^{129}I) from fuel reprocessing during the 1990s have stimulated new and improved descriptions of radonuclide distributions over a range of space- and time-scales, in particular, in relation to the sign and strength of the North Atlantic Oscillation (NAO).

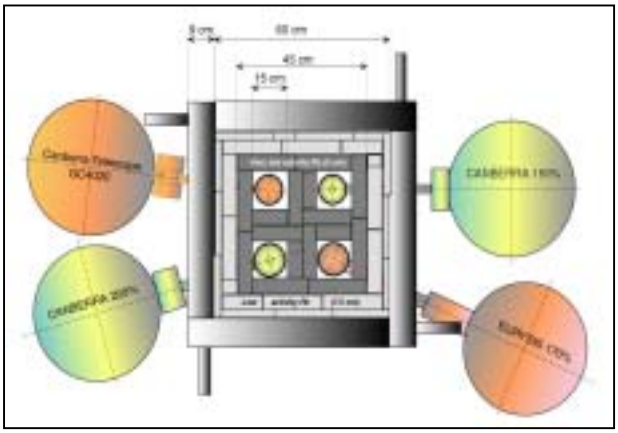
A combination of long-term oceanographic observations, new tracer measurements and more realistic models is making clearer the linkages between basin-scale processes and the response of shelf and coastal circulation, and may provide insights into the response of the ocean circulation to climate change. Increasingly complex coupled ocean-ice models are able to spatially and temporally resolve seasonally-varying circulation, in response to realistic wind forcing. A topic of current interest in western Europe is the possibility that the 'Atlantic Conveyor', carrying relatively warm Atlantic water northwards, will close down, and profoundly affect Europe's climate. This could happen if the 'normal' process of freezing and deep-water formation were to cease, due to Global warming of the Arctic. By measuring the internal oceanic distribution of a variety of radioactive and non-radioactive isotopes, and the incoming and outflowing waters of the Arctic Basin and Nordic Seas, we will gain an insight into the rate at which these changes are occurring. There are many other opportunities to use radiotracers to understand variability and change in natural systems and those impacted by human activities. One such is the forthcoming GEOTRACES programme on global trace element biogeochemistry of the ocean(www.jhu.edu/~scor/2003-EC-Meeting.htm). Perhaps such initiatives represent the most fruitful future direction for the marine radioecology research. Dr. P. Kershaw

This represents a personal view and does not necessarily reflect the views of CEFAS or the IAEA. For further information please contact P.J.Kershaw@cefas.co.uk

MEL's Underground Counting Laboratory Dramatically Improves the Detection of Marine Radioactivity

MEL has been heavily engaged in marine radioactivity studies for radioprotection purposes, as well as in the applications of natural and anthropogenic radionuclides as tracers for studying oceanic processes. There has been a constant need for analyses of radionuclides in many marine samples at very low levels, therefore an Underground Counting Laboratory (CAVE) was constructed to meet growing requirements. The main objectives were: (i) To decrease background levels and improve the sensitivity and precision of gamma- and beta-spectrometric measurements; (ii) To decrease the size of marine samples needed for analysis by at least a factor of 10; (iii) To decrease measuring time and analyse more samples per week; (iv) To stabilize the characteristics of gamma- and beta-spectrometers against temperature and humidity changes, but also against changes in the radon content of air and variations in cosmic-ray flux.

The use of underground laboratories for low-level gamma-ray spectrometry of environmental radionuclides is, together with the availability of large volume HPGe detectors (up to 200% relative efficiency compared to 75 mm diameter and 75 mm long NaI(Tl) detectors), the most important breakthrough in low-level counting. Why are underground laboratories needed for environmental radionuclide analysis? There are several reasons: (i) Highly accurate and precise data on natural and anthropogenic radionuclides often used as tracers in the marine and terrestrial environments are required for environmental and climate change studies; (ii) Forty years after the main introduction of anthropogenic radionuclides into the environment as a result of large-scale atmospheric nuclear weapons tests (global fallout) their concentrations in the environment have decreased considerably; (iii) With the development of highly accurate and precise mass spectrometry techniques such as Inductively Coupled Plasma Mass Spectrometry (ICPMS), Thermal Ionisation Mass Spectrometry (TIMS) and Accelerator Mass Spectrometry (AMS) the required sample size for analysis has decreased considerably (at least by a factor of 10). This poses limits on radiometrics analyses as well, as only smaller sample volumes are available for analysis, e.g., from oceanographic expeditions.



View of the lead shield with anti-cosmic plastic shielding and the HPGe detectors.

The decrease in sample volume has also important economic aspects, e.g., for marine sampling where previously large volume seawater samples were needed (up to 500 L), taken at different water layers down to several thousands of meters, which required several days of sampling at one station (ship time is very costly - several tens of thousands Euros/day). With the present state of the art technique using a Rosette system equipped with Niskin bottles of 20-30 L, the complete water column can be sampled in only two casts and within a few hours.

IAEA-MEL's Underground Counting Laboratory

As an extension of existing facilities, the CAVE provides an environment which significantly reduces background radiation around the germanium and liquid scintillation detectors thanks to the discrimination of penetrating cosmic ray particles, thus improving the detection limits for analysis of various radionuclides by about a factor of ten. This in turn allows measurement using smaller amounts of seawater or other marine samples thereby reducing sampling costs significantly. The CAVE has opened doors for investigations which previously were not possible because too large samples were required, or were not possible because of the lack of sensitivity and precision.

The CAVE was inaugurated by Prince Héréditaire Albert of Monaco in November 2002. The construction of the CAVE was supported by extrabudgetary contributions from the Governments of Monaco and Japan. *For further information, please contact* P.Povinec@iaea.org

Discovering bio-indicator species for heavy metals in the lagoon of New Caledonia

Nowadays, the tropical countries and small islands are among the most active in terms of urbanization and industrialization. Development inevitably leads to increasing waste production. Hence, numerous tropical ecosystems are more and more often considered as threatened zones. This is quite worrying if one takes into account that tropical ecosystems are fragile and generally have limited capacities to adapt to environmental changes. Aware of these facts and perspectives, MEL has recently become involved in studying marine pollution in tropical environments in order to build an increased knowledge database. Its objective is to help decision makers to establish criteria for a rational and sustainable marine coastal zone management scheme for protecting the marine environment.

For nearly two years, MEL's Radioecology Laboratory has been studying metal contamination in the lagoon of New Caledonia. These studies are conducted within the framework of the multidisciplinary " New Caledonia Project " (NCP) of the French national PNEC programme. In 2003, NCP involved more than 100 researchers mainly from France, but also from Australia, Monaco and USA. In particular, MEL is now coordinating the NCP bioaccumulation-related research studies.

The so-called "most beautiful lagoon of the World" is an excellent model for studying metal pollution in tropical marine ecosystems because it is subjected to input of large amounts of contaminants from land-based mining activities. Indeed, the very first economic resource of this small South Pacific Island is nickel mining exploitation. Metal contamination resulting from the nickel industry and related activities constitutes long lasting threats for marine ecosystems sheltered by the second largest reef system in the world. And, as unfortunately almost a rule when it concerns tropical ecotoxicology, available information on metal contamination in New Caledonia is extremely scarce. Due to increasing industrial development, demand for information regarding the contamination status of the lagoon is becoming greater, not only from decision makers but also from the mining industries themselves.

The expertise and state-of-the-art facilities at MEL are particularly suited to help answering some of these questions, especially those concerning the development of a biomonitoring programme for local coastal zone management. In this context, we have developed very close and fruitful scientific collaborations with colleagues from the IRD-Noumea Centre (the French Research Institute for Development, *i.e.* ex-ORSTOM).

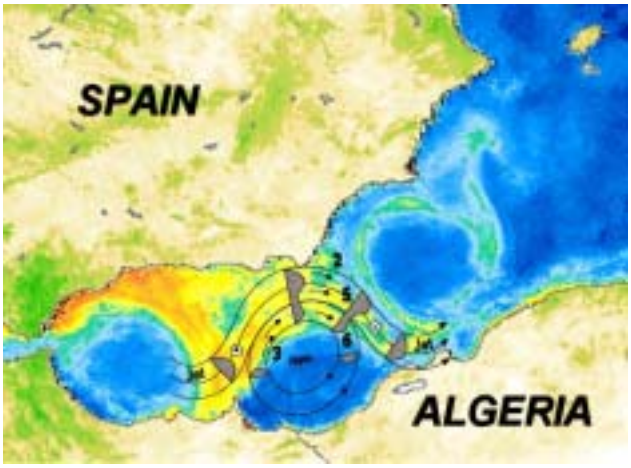
The main theme of the joint work is to characterize and validate the bioindicative value of local marine species to be used in coastal monitoring programmes. Therefore, four species commonly found in the lagoon were investigated to assess their usefulness as bioindicators: an edible clam, a brown alga and two oysters. The way the organisms accumulate and retain metals was determined considering three exposure pathways : seawater, sediment and food. Seven metals that are directly or indirectly discharged by mining industries were more studied : Ni, Co, Cr, Mn, Cd, Zn, Ag, using their radiotracers. Indeed, tracking heavy metal behaviour through their radiotracers allows rapid and sensitive detection, running multi-elemental experiments, and a reduced number of organism to sacrifice (except for ^{63}Ni, all radiotracers used are gamma-emitters which may be quantified in live organisms).

So far, results indicate that metals are readily incorporated and strongly retained in the tissues when organisms are exposed via seawater or food. They also indicate a very low bioavailability of sediment-bound metals : metal uptake from sediments is 3 to 5 orders of magnitude less efficient than from seawater. Modelisation of the results showed that food represents the main source of intake (> 80%) for most metals in the bivalves. The alga and the two oysters appear to be excellent bioindicators showing a rapid response time in metal uptake and a suitable potential to furnish necessary information on ambient contamination levels. Presently, work is conducted to validate these findings, both in the laboratory at MEL and under real environmental conditions in the lagoon of New Caledonia.

For further information, contact M.Warnau@iaea.org

Carbon Isotopes ratios ($\delta^{13}C$) for tracking ocean carbon cycling

Oceanic fronts, analogous to atmospheric fronts, form where different water masses meet. They are characterised as zones of enhanced biological activity. Thus, waters tend to be rich in organic matter, with implications at all scales of the food chain, including fisheries. One such example, the Almeria-Oran front, is found in the south-western Mediterranean Sea where surface waters of Atlantic origin meet more saline Mediterranean water. This front exhibits complex permanent hydrological structures, essentially represented at the surface by a main current along the front (a jet) that is associated with an anticyclonic gyre of Atlantic waters.



Study area of Almofront project and schematic representation of the different hydrodynamic structures of the Almeria-Oran front (Mediterranean Sea). SeaWIFS satellite imagery of surface chlorophyll a, adapted from JRC of E.C., IMW Unit, IES Institute, Frédéric Mélin (blue to red: low to high chlorophyll a concentrations).

Marine biogeochemical studies of particulate matter are fundamental for understanding carbon cycling, and assessing the sources and fate of the organic matter. The lipid biogeochemistry of suspended and sinking particles collected in the Almeria-Oran frontal zone was investigated in the IAEA Marine Environmental Studies Laboratory to determine the sources and transformation processes of organic matter in relation to the physical forcing of the front. This was a joint project with French colleagues from the Laboratoire d'Océanographie de Villefranche-sur-mer.

Techniques used included the recently developed Gas Chromatography-Combustion-Isotope Ratio Mass Spectrometry (GC-C-IRMS) for the determination of the $\delta^{13}C$ of specific lipid biomarkers. The results can be used to distinguish different sources of carbon (e.g., marine, terrestrial, bacterial), and elucidate the transport and degradation processes of organic material through the water column. In this case, data illustrated the influence of the currents on the composition and transport of particles. A minor terrestrial contribution was also observed, which remained after degradation of the more labile marine organic matter.

The GC-C-IRMS instrument to measure the stable carbon isotope ratios ($\delta^{13}C$) of individual organic compounds.

The molecular abundance and carbon isotopic composition of lipid biomarkers allowed the characterization of three different areas in the Almeria-Oran front:

i. The Mediterranean zone dominated by moderately degraded phytoplanktonic communities exhibited low zooplanktonic biomass and comparatively high bacterial activity.

ii. The upstream side of the gyre and the jet were characterized by relatively degraded phytoplankton material with high bacterial activity and an enhanced zooplankton biomass.

iii. The downstream side of the gyre was characterized by a phytoplanktonic bloom subject to rather low zooplankton grazing and low bacterial activity.

This study contributed to better understanding the cycling of carbon in complex marine ecosystems, showing the fertilising effect that the frontal zones exhibit compared with its adjacent waters. *For further information, please contact* *I.Tolosa@iaea.org*

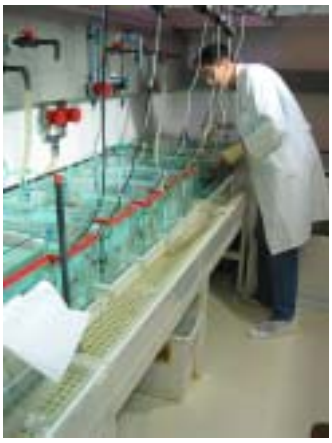
***Full articles**: (1) *Distribution of sterol and fatty alcohol biomarkers in particulate matter from the frontal structure of the Alboran Sea (SW Mediterranean Sea) by I. Tolosa, N. LeBlond, C.Copin-Montegut, J.-C. Marty, S. de Mora, L. Prieur, Mar. Chem., 82 (2003) pp 161-183.*
(2) Distribution of pigments and fatty acid biomarkers in particulate matter from the frontal structure of the Alboran Sea (SW Mediterranean Sea) by I. Tolosa et al. Marine Chemistry, in revision.

Scott Fowler: Pioneer of Marine Radioecology

After three decades of scientific excellence in marine radioecology and exemplary international service to our Member States, Scott has just retired from the IAEA's Marine Environment Laboratory, Monaco.

Scott completed his PhD in 1969 in Biological Oceanography. He was awarded a Fullbright Scholarship to teach Marine Ecology in Mexico before joining the IAEA Marine Laboratory in 1970 as marine biologist. With the global concern about the fate and impacts of radionulides in the ocean, he built up a unique, world-class, radio-experimental aquaria laboratory to investigate bioaccumulation and fate of over 46 radionuclides by a wide range of marine organisms. Scott has published over 300 Scientific papers in Internationally Peer Reviewed Journals including the premier journal Nature. He has been Senior Scientist in several EU, International and InterAgency Programmes on the cycling and fate of trace metals, radionuclides and carbon in the ocean.

Scott has recently gained entry into the Top 5000 personalities in Who's Who and the IAEA has presented him with its Distinguished Service Award. It gives me great pleasure to pay tribute to Scott, as an outstanding International marine radioecologist, who believed and practiced by example the IAEA's values of international technical excellence, credibility, objectivity and cooperation with our Member States. I am very pleased that Scott remains under a special contract to write up outstanding reports and provide advice to MEL. *R. Fauzi C. Mantoura*



Experiences of a Postgraduate Student

I have been living in Nice for 15 years and had never heard about MEL until I graduated in Applied Marine Biology last June from Heriot-Watt University, Edinburgh. I am 24. I am today an intern at MEL in the Radioecology Group, and am currently working on bioaccumulation of heavy metals in bivalves and algae from New Caledonian lagoons. O.K. So what?

So I feel lucky because one day 'someone' I did not know answered the phone, put his confidence in the willing student that I was, and appointed me the week after. I thought this was impossible in the little world of marine biology, especially in an international organization like the IAEA. I have to admit, I expected rigidity. I expected closed doors, and when you are a student, you do not have a lot in your key ring. You can only pray to knock on the right door at the right time and catch the eye of a good Lord.

So I feel lucky because this 'someone' was not alone, and they all together form a team that one is proud to join, and as diversified and passionate as you could hope for. During my first three months however, my presence in MEL has been concentrated in the radioecology group so it would be inappropriate to share my deep feelings on anything else. There, I have been introduced to radioecological subtleties, I have been taught the lab-specific do's and don'ts, I have been used to late and accelerated lunch breaks as well as somewhat irregular working hours. To picture it, I would see the radioecology group as a human body. You look at it and you wonder how it works. But it sure works! I am in gestation in this body, and everyone else has a vital function. But it would not be challenging if positions were rigid, and fortunately individuals are definitely not inhibited in a hierarchic organization. From my own experience, the dual strength of the group is certainly the interactivity of its staff and its ability to integrate students under excellent conditions (salary issues put aside!). These two points should anyway be essential in any dynamic scientific activity.

By the way, let's deal with science. As soon as I had a first look at the brand new, specially designed laboratory facilities, I was astonished. Glass everywhere, large aquaria, and the cream of detectors. As for my contribution, the topic does not necessarily speak for itself and people- I mean my family, my friends and others unfamiliar to radioecological issues- usually ask me the ins and outs of my work in Monaco- 'No, not the Museum!!'. I often find it difficult to make them realize why environmental studies also need to be undertaken in a laboratory, or how 'disgusting' oysters can faithfully indicate a level of contamination. Not only does it remind me of my misunderstood-scientist complex, but it also points out a need for communication. This page was a sort of an open window. I took this opportunity to express my happiness and offer an insight on my debut work at MEL.

For further information, please contact E.Buschiazzo@iaea.org

MEL assisting UNDP in IRAQ

The Marine Environment Studies Laboratory (MESL) at MEL has started collaboration with UNDP, investigating shipwrecks in the waterways of Kuwait and Iraq. The UNDP Iraq Unit is overseeing the survey, and eventual salvage and removal of over 200 shipwrecks. MESL was invited to provide a wide range of scientific and technical expertise relating to the environmental monitoring during the wreck survey and salvage / removal phases. The contaminants of interest encompass several metals, petroleum hydrocarbons, organochlorinated chemicals and various chemical munitions.

The first mission examining a set of 20 shipwrecks started on January 11, 2004. Stephen de Mora and Mekki Azzouz participated on the scientific mission aboard the survey vessel *Halul 32*. The upper picture shows them aboard the *Ain Zalah*, a wrecked tanker lying in 11 m of water on a hard substrate. The vessel still contains oil and various unexploded ordinance. The lower picture shows another adjacent tanker called the *Ramaila*.
Sediment samples are collected by divers from around the wrecks. They are freeze-dried on the *Halul 32* and retuned to Monaco for analyses of contaminants. The first survey is scheduled to end February 2004.
For further information, please contact S.J.de-Mora@iaea.org

MEDPOL sponsored training course at NAML

During 2003, two training courses on the determination of organic pollutants (Petroleum hydrocarbons and chlorinated pesticides) were organized in the ROPME Gulf area. First course from 11 to 23 January in the Water Pollution Monitoring Department of EPA in Safat, Kuwait was followed by 6 trainees from local laboratories working within the ROPME framework and another course from 15 to 26 February in the laboratory of the Supreme Council for Environment and Natural Reserves in Doha, Qatar where 12 trainees from the Supreme Council and from the University attended.
In Monaco, 2 training courses were organized on the measurement of chlorinated pesticides and PCBs in the marine environment for the MEDPOL programme. The first one from 16 June to 2 July was followed by 7 trainees from 7 Mediterranean countries (Algeria, Bosnia and Herzegovina, Israel, Slovenia, Syria, Tunisia and Turkey).

As the number of requests for training were rather important in 2003, a second training course had to be organized on the same subject of chlorinated pesticides and PCBs. This training course was organized from 3 to 18 November with 5 trainees from 5 Mediterranean countries (Albania, Croatia, Cyprus, Libya and Morocco).

SELECTED RECENT PUBLICATIONS FROM MEL

- Comparative radiotracer study on cadmium uptake, storage, detoxification and depuration in the oyster *Crassostrea gigas* - Potential adaptive mechanisms, Boisson F., Goudard F., Durand J.-P., Barbot C., Pieri J., Amiard J.-C., Fowler S.W. Marine Ecology Progress Series, 254: 177-186 (2003).
- Relative importance of food and dissolved pathways for lead contamination in shrimp, Boisson F., Cotret O., Teyssié J.-L., El-Baradeï M., Fowler S.W. Marine Pollution Bulletin, 46: 1549-1557 (2003)
- Delineation of PCB uptake pathways in a benthic sea star using a radiolabelled congener. Danis B., Cotret O., Teyssié J.-L., Fowler S.W., Bustamante P., Warnau M. Marine Ecology Progress Series, 253: 155-163 (2003).
- Distribution of plutonium and americium in the marginal seas of the northwest Pacific Ocean, Lee, S-H., Gastaud, J., Povinec, P.P., Hong G-H., Kim, H., Chung, C-S., Lee, K-W., Pettersson, H.B.L. Deep-Sea Research II, 50: 2727-2750 (2003).
- Anthropogenic radionuclides in Indian Ocean surface waters - the Indian Ocean transect 1998, Povinec, P.P., Delfanti, R., Gastaud, J., La Rosa, J., Morgenstern, U., Oregioni, B., Pham, M.K., Salvi, S., Top, A. Deep-Sea Research II, 50: 2751-2760.
- IAEA'97 expedition to the NW Pacific Ocean - results of oceanographic and radionuclide investigations of the water column, Povinec, P.P., Livingston, H.D., Shima, S., Aoyama, M., Gastaud, J., Goroncy, I., Hirose, K., Huynh-Ngoc, L., Ikeuchi, Y., Ito, T., La Rosa, J., Liong Wee Kwong, L., Lee, S-H., Moriya, H., Mulsow, S., Oregioni, B., Pettersson, H., Togawa, O. Deep-Sea Research II, 50: 2607-2637.
- Organochlorinated Compounds in Caspian Sea Sediments, Stephen de Mora, Jean-Pierre Villeneuve, Mohammad Reza Sheikholeslami, Chantal Cattini, and Imma Tolosa, *Marine Pollution Bulletin* 48, 30-43 (2004).
- Aliphatic and Aromatic Hydrocarbons in Coastal Caspian Sea Sediments, I. Tolosa, S. de Mora, M. R. Sheikholeslami, J.-P. Villeneuve, J. Bartocci & C. Cattini *Marine Pollution Bulletin* 48, 44-60 (2004).
- An Assessment of Metal Contamination in Coastal Sediments of the Caspian Sea, S. de Mora, M. R. Sheikholeslami, E. Wyse, S. Azemard & R. Cassi *Marine Pollution Bulletin* 48, 61-77 (2004).

Training Courses

MEL has a long history of organising training courses for Member States, regional organisations and other UN organisations. They cover a range of topics related to the application of radionuclides in marine studies and the analysis of non-radioactive pollutants. Applications should be made up to six months in advance through Governmental official channels. Some recent courses and those planned for 2004 are listed below.
For further information, please contact S.Henry@iaea.org.

HOST/LOCATION	COURSE TITLE	DATE
Federal Environment Agency, Abu Dhabi, UAE	UAE – sponsored course for collection of marine samples	December 2003
Department of Environment, Tehran, IRAN	ROPME – sponsored course for the analysis of metals in the marine environment	December 2003
Nuclear Research Institute, Manila, Philippines	IAEA-TC – sponsored course for the assessment of sources and dispersion of pollutants	January 2004
Department of Environment, Tehran, IRAN	ROPME – sponsored course for the analysis of metals in the marine environment	February 2004
MEL Monaco	MEDPOL – sponsored course for the analysis of organic contaminants in the marine environment	June 2004
MEL Monaco	MEDPOL – sponsored course for the analysis of metals in the marine environment	October 2004

Current Intercomparison Exercises

MEL has a long experience in running programmes of intercomparison (IC) exercises and proficiency tests for the analysis of radionuclides, organic contaminants and metals in various marine media. IC exercises allow laboratories to evaluate their performance and improve the quality of their data. The IC exercises range from global scale, with typically 150 laboratories taking part, to regional scale, involving dozens of laboratories, and to project-dedicated exercises, involving in the order of 10 participants. Intercomparison materials are distributed free of charge to participating laboratories. MEL is also one of the few producers of marine reference materials in the world. *For further information,*

SAMPLE	MATRIX	STATUS
IAEA-385	Radionuclides in Irish Sea sediment	Report in 2004
IAEA-410	Radionuclides in Bikini Atoll sediment	Sample distribution in 2005
IAEA-412	Radionuclides in Pacific Ocean sediment	Sample distribution in 2005
IAEA-415	Radionuclides in North Atlantic fish	Sample distribution in 2004
IAEA-418	Iodine-129 in Mediterranean seawater	Deadline for results: November 30, 2003
IAEA-432	Petroleum hydrocarbons and organochlorinated compounds in mussels	Deadline for results: September 30, 2003
IAEA-433	Trace elements and methylmercury in marine sediment	Deadline for results: September 30, 2003
IAEA-435	Petroleum hydrocarbons and organochlorinated compounds in tuna fish muscle	Scheduled for 2nd half 2004
IAEA-436	Trace elements and methylmercury in tuna fish muscle	Scheduled for 2nd half 2004