The ICTP capacity building programs in geophysics for developing countries

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ABSTRACT

Founded in 1964 by "Abdus Salam" (Nobel Laureate), the International Centre for Theoretical Physics (ICTP) operates under a tripartite agreement among the Italian Government and two United Nations Agencies, UNESCO and IAEA. Its mission is to foster advanced studies and research, especially in developing countries. While the name of the Centre reflects its beginnings, its activities today encompass most areas of physical sciences including applications.

The ICTP is undertaking a number of capacity building programs in geophysics.

The Associate Scheme is one of ICTP's oldest programs, established to provide support for distinguished scientists in developing countries in an effort to lessen the brain-drain. The Federation Scheme was established with the aim of giving the opportunity to junior representatives of scientific institutes in developing countries to participate in the ICTP's activities.

ICTP has set a program to support graduate work. This is the so-called SANDWICH Program. Here, a student registered for a Ph.D. in a University in a developing country is chosen for three visits to ICTP for a total of about 18 months, having usually a co-advisor in ICTP. The students receive their Ph.D. from their home institutions. The hope is that this mechanism will keep the students at their home universities, yet allow them access to international community and first-class research facilities through ICTP.

ICTP runs also a one year pre-PhD intensive course called the ICTP Diploma course. The program initially had three streams: High Energy Physics, Condensed Matter Physics and Mathematics. We have recently added a new stream on Earth System Physics and started in the fall of 2007 an additional program in Basic Physics without specialization. Our goal in these programs is to take good students from the least developed countries generally – and for the Basic Physics Program students from only sub-Saharan Africa – and educate them so they can compete favorably for graduate studies in any centre of learning in the world.

Under the ICTP External Activities Program, support is given to activities initiated by scientists in developing countries and carried out within their regions through: Affiliated Centres, Networks, Visiting Scholars/Consultants and Scientific Meetings.

The ICTP "Training and Research in Italian Laboratories" (TRIL) Program gives scientists from developing countries the opportunity to spend periods ranging from a few months to one year at Italian research laboratories or universities. This Program is a valuable component of the action ICTP is pursing with the strong support of the Italian Government to strengthen the communities of scientists and technologists in the developing world.

Key words: education, advanced training, geophysics, developing countries

PRESENTER'S BIOGRAPHY

Born in Algeria, I earned an engineering degree in geomechanics and a Ph.D. degree from the University of Trieste (Italy) in solid-Earth geophysics and geodynamics. I have been involved with ICTP since 1994, and have been a long-term visiting fellow until my recent appointment as a UN staff scientist. My major fields of interest are the mechanics of earthquakes and faulting and rheology of the lithosphere. My research is broadly concerned with both steady-state and transient deformation processes in the Earth, as they relate to tectonophysics and, particularly, to the physics of earthquake prediction. Since 2006 I am also serving as the coordinator of the ICTP Earth System Physics Diploma Program, a one year intensive pre-PhD course.

The DIAS Seismology in Schools (Seismeolaíocht sa Scoil) Programme

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ABSTRACT

Ireland has technology to thank for the "Celtic Tiger" Revolution, yet over the last half decade fewer and fewer Irish school students are completing high school with a science focus. To try to counter this trend, and to hopefully ensure a supply of Irish geophysicists for the future, it is important to engage and fascinate young minds with the wonders of physics and of the Earth we live on from a very early age. The Geophysics Section of the School of Cosmic Physics in the Dublin Institute for Advanced Studies (DIAS) has been running a public Outreach programme for some years, but there was a more general public orientation to the programme. In an effort to bring DIAS's science directly to the schools, we have launched a pilot programme, coincidentally and fortuitously during the International Year of Planet Earth (IYPE), called Seismology in Schools (Seismeolaíocht sa Scoil) that introduces young students to the world of geophysics through seismology and earthquake research.

The launch of DIAS's Seismology in Schools programme has been aided considerably through IRIS's (The Incorporated Institutes for Research Seismology) contributions of their AMASEIS software, that is used to display the data output from the seismometer, and educational posters and demonstration software used to teach Earth Science to students, and through the British Geological Survey's design and development of the educational seismometer; a Lehman pattern horizontal motion seismometer using a garden-gate offset suspension pendulum.

Initially, we planned for a very tentative pilot with just two seismometers rotating around local schools, but the Directors of the Educational Centres across Ireland (ATECI, Association of Teachers/Education Centres in Ireland) have become key partners in this pilot by purchasing a further 34 seismometers and promoting this initiative among their schools. In addition, the Geological Survey of Ireland (GSI) has purchased a further four seismometers as part of their contribution to IYPE.

Currently 36 schools are participating in the enlarged pilot programme; 18 primary schools, 17 secondary schools and one vocational training scheme. In primary schools the focus is with 5th and 6th year class projects. In the secondary school system, the pilot programme is seen as an excellent Transition Year (aged 16) project. During the academic year 2008-2009 the students at these 36 schools will work with earthquake data, use the educational software and generally becoming more aware of the Earth as a dynamic planet. Teachers and students will implement a programme of reporting on the earthquakes they record throughout the year to DIAS and initiate the exchange of earthquake data between participating schools in Ireland by use of the internet.

The pilot will continue until April 2009 when a final report will be written to evaluate the success and future direction of the initiative. Based on the overwhelming interest shown to date, we envisage enlarging the programme further and working towards twinning the Schools with counterparts around the world.

This pilot programme is funded by internal DIAS funds and also by a grant from the Irish government agency DSE (Discover Science & Engineering).

Key words: Public outreach, Education, Seismology.

PRESENTER'S BIOGRAPHY

After earning his Ph.D. (Edinburgh), Alan G. Jones spent four years in Germany, then 22 years in Canada, before moving to his present position of Senior Professor and Head of Geophysics at the Dublin Institute for Advanced Studies. He has been involved in all aspects of developing the magnetotelluric method to its current state, and now works on formally combining electrical information of the Earth with other information from seismology and other geoscientific data.

UK school seismology project

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ABSTRACT

The UK school seismology project (UKSSP) is an education and outreach project targeting students aged 11-18 in secondary schools and is hosted by the British Geological Survey (BGS). The UK is suffering from a long term decline in the number of students wishing to study physical sciences beyond the age of 16 when they are able to choose which subjects to study. Research in 2006 showed that one of the key barriers to students studying geosciences at university was a lack of exposure to geoscience as a numerate scientific discipline at school. This project aims to improve the overall retention rates for students of all physical sciences by making science lessons in school more interesting and relating them to real world events. The project also has a specific aim of increasing the number of students taking geoscience courses at university or considering geoscience as a career.

School seismology projects have been running successfully in the USA for a number of years and have started in a lot of countries. This project borrowed heavily the resources that had been developed in the USA, specifically resources written by Larry Braile at Purdue university. Two separate sets of resources were developed for the UK project; 1) a set of simple classroom activities with seismology as a unifying theme, 2) a school seismometer system capable of detecting teleseismic events. Initial meetings with teachers in 2005 showed they required classroom activities to be written up in a familiar style and contain relevant links to the UK curriculum. In developing the resources for the project the UKSSP worked closely with educational experts from the Science Learning Centre at Leicester University (a government initiative to provide CPD courses for science teachers), the Science Enhancement Programme (a charitable foundation dedicated to providing innovative resources for science education in schools) and a focus group of keen secondary school teachers. The UKSSP developed its own design of school seismometer based on a "garden gate" horizontal pendulum. The final design has a natural period of 20seconds, adjustable eddy current damping and an amplifier/digitizer system giving a 20sps 16bit output. The UK seismometer system uses the well established Amaseis software (by Alan Jones and IRIS) for datalogging and analysis, enabling simple transfer of data between schools in the UK and elsewhere.

In order to deliver the project into schools the UKSSP developed a 1 day training course covering the setup and use of the seismometer system and the interpretation of the results obtained. A website at www.bgs.ac.uk/schoolseismology allows teachers to get information about recent earthquakes and exchange data files. Partnerships were developed with UK university earth science departments to deliver the project into schools, with each university department using the project as a part of its own outreach activities with clusters of local schools. In this way over 100 schools were trained in the first year of the project, with a projection that schools can be added to the project at the rate of 100 per year (10 for each university partner).

The success of the UK school seismology projects rests on three factors

1) developing a usable set of resources suitable for the local education system
2) developing strong links with established education support providers at an early stage
3) developing partnerships with universities to deliver the project and provide regional support

Key words: school seismology education outreach university

PRESENTER'S BIOGRAPHY

Paul Denton set up and now manages the UK school seismology project, based at the British Geological Survey (BGS) offices in Keyworth, Nottingham. Prior to joining the BGS in 2006 Paul Denton worked for 18 years in the Geology Department at the University of Leicester where he provided support for teaching and research projects in all areas of geophysics, including support for the KRISP seismic projects in Kenya and the EAGLE seismic project in Ethiopia. While at the University of Leicester between 2000 and 2006 he set up and managed SEIS-UK a national facility for provision of seismometers and dataloggers to UK academic researchers. Paul obtained a degree in Physics with Geophysics from the University of Bath and then spent two years working in the western desert of Egypt for the seismic contractor Seismograph Services Limited.

AFRICAARRAY: Building geosciences capacity in Africa

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ABSTRACT

AfricaArray (AA) is a pan-african initiative that promotes linked research and training programs to build professional geosciences capacity in support of the mineral, water and environmental sectors in Africa. The primary goal of AfricaArray (AA) is to address the problem of limited and shrinking training and human capacity in science fields allied to natural resource utilization in Africa by establishing a unique in-situ education program initially focused on geophysics, but at later stages expanded to geosciences disciplines in general.

AA is designed to achieve this goal over 20 years, by tightly coupling education and research programs in the geosciences with scientific data gathering through observational stations spread across Africa. The observational stations are positioned to provide data that can augment water, oil, gas, and mineral exploration, and help the forecasting of natural hazards such as earthquakes and volcanic eruptions. Network capabilities are initially focused on seismic sensors, but expansions in network capabilities are planned by linking AA facilities to other networks that include hydrologic, GPS, and climate change sensors. In detail, the objectives of AA are:

1. Work with the public and private sectors in selected African countries to ensure high quality, long-term training capacity in the geosciences is developed and maintained.
2. In-situ training of a new generation of African geoscientists with BSc, MSc and PhD degrees, who will be well positioned to become leaders in government, industry and academic institutions.
3. Increase the pool of locally trained geoscientists from historically disadvantaged groups, i.e. black and female students, to take up high-level positions in Africa's natural resources industries
4. Promote the development of a sustainable scientific community within Africa through education and applied research collaborations and data exchanges.

AfricaArray was launched as a long-term initiative in July 2004 by the University of the Witwatersrand, South Africa, the Council for Geoscience of South Africa, and Penn State University, USA, and is supported by IRIS (Integrated Research Institute of Seismology) where AfricaArray datasets are stored and distributed. One of the principle research questions that AfricaArray seeks to address is to better resolve the structure of the Earth's crust and mantle below southern and central Africa. Details about AA can be found on the AA website (www.africaarray.psu.edu).

AfricaArray is built on $3M of in-kind support from universities and government agencies in South Africa (mainly the University of the Witwatersrand and the Council for Geoscience, SA) and the U.S. (mainly Penn State and IRIS), and has garnered close to $6M in new funding from industry partners and government agencies in the U.S. and South Africa. AA has grown quickly and been successful largely because of grass-roots support from many people within a variety of African institutions that are committed to AfricaArray's capacity building goals (currently 17 African countries actively participate in AfricaArray in collaboration with 11 private companies and many organizations outside of Africa).

Key words: AfricaArray, Capacity Building, Seismic Network, Africa, geosciences.

PRESENTER'S BIOGRAPHY

Paul Dirks is Head of School of the School of Geosciences at the University of the Witwatersrand, a position he has held since 2002. In 2004, together with Andy Nyblade from Penn State University, Paul founded the AfricaArray programme for which he now serves as a co-director. This project was recently highlighted in an article in "The Leading Edge". Paul holds a Ph.D. is from the University of Melbourne (1990), Australia, in the general fields of structural-metamorphic geology and tectonics. His MSc (1987) and undergraduate degrees are from the University of Utrecht the Netherlands, where he was born in 1962. Paul is a structural geologist with an interest in geodynamics and the tectonic history of cratonic terrains and adjacent mobile belts, including mineralization patterns.

Attracting and encouraging future geophysicists through IRIS undergraduate research experiences and EarthScope/USArray siting

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ABSTRACT

To meet the increasing demand for geophysicists within the US, the IRIS Consortium offers two programs. The first program, designed to retain and encourage undergraduate students interested in possibly pursuing a career in geophysics, introduces students to seismology through summer research internships. Since 1998, the IRIS E&O program has provided students with opportunities to gain experience participating in seismological research in order to attract a diverse group of students during their undergraduate education to careers in geoscience. Since its inception, 85% of the IRIS internship alumni have received or are currently pursuing advanced degrees in the geosciences, while an additional 6% are working in a geoscience career with their undergraduate degree. The potential mentor pool represented by the IRIS Consortium includes academic seismologists from across the US, representing interests and research areas that cover a broad spectrum of specialties in seismology. The program blends the spirit of a traditional Research Experiences for Undergraduate (REU) site with IRIS's successful experience hosting students at widely separated institutions. The result has been the development and refinement of a model that bonds students into a cohort, despite conducting their research at geographically distributed sites. Key to the model are: a) research projects that have a common focus of modern seismology; b) a week-long orientation where students get to know one another, share common experiences and establish a "social presence" with the other interns while receiving training in practical seismology; c) a cyberinfrastructure to maintain their connectedness with the rest of the group in a way that enables both learning and collaboration; and d) an annual alumni reception at the Fall Meeting of the American Geophysical Union to reconnect and share additional experiences.

IRIS has a second program that engages students in EarthScope/USArray site reconnaissance. From 2005 to 2008, 70 students from 20 universities have conducted site reconnaissance for nearly 700 EarthScope Transportable Array stations. As the array moves across the US, this program provides both undergraduate and graduate students with the opportunity to take part in a major continental-scale research project and exposes students from other science disciplines to geophysics. The 10-week summer involvement begins with a multi-day workshop to introduce students and their faculty sponsors to seismic station requirements and a variety of mapping tools. The training includes a day in the field to provide students an opportunity to evaluate actual sites and to gain experience using field equipment and techniques. Once assigned a geographic working area, each 2-person team uses GIS-based suitability maps to identify potential locations for further investigation and then they travel to these sites to determine the best location for the seismic station. The students interact with landowners and prepare detailed reconnaissance reports for each site to document their findings and recommendations. This program has proven to be an efficient way to locate a large number of sites for Transportable Array stations while also providing an exciting learning opportunity for students.

Key words: undergraduate research students

PRESENTER'S BIOGRAPHY

Dr. John Taber is the Education and Outreach Program Manager at IRIS (Incorporated Research Institutions for Seismology) and has been in that role since 2001. He received his PhD in geophysics from the University of Washington and then worked as a research scientist at Lamont-Doherty Earth Observatory of Columbia University, monitoring Aleutian seismicity. Later while at Victoria University of Wellington in New Zealand, he was involved in seismic hazards research, earthquake education and public outreach. He is co-author of a general interest book on earthquakes and volcanoes in New Zealand.

AfricaArray international geophysics field school – a hands on approach to learning geophysics

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ABSTRACT

Geophysics is a science that studies the Earth and geophysicists need to learn how to collect accurate data under real field conditions. The AfricaArray international geophysics field school provides students with an opportunity to design, undertake and interpret real geophysical surveys while investigating important geological problems.

The field school has three distinct components. In the first week students attend lectures about the various methods, geology of the field site and interpretation software. They then design a survey for a particular geophysical problem that will be encountered, such as using the seismic refraction method to determine overburden thickness. Students must determine the resolution, limits and cost of their proposed survey by producing forward models that predict the outcome of their design. This planning and costing component is crucial as understanding the interplay between survey design, cost and resolution is crucial to conducting any type of successful geophysical survey.

The second week is devoted to the collection, quality control and processing of data at the field site. Students spend time on each geophysical method including gravity, differential GPS, magnetic, resistivity, ground penetrating radar (GPR), EM31 and refraction seismic. This ensures that students are exposed to a wide variety of modern equipment. The third week is spent on processing, interpreting and integrating the results from the different surveys into a comprehensive company style report and culminates with presentations from the students.

The field school also functions as a two tier training system. While the main objective is to train Honours level (4th year) students to plan, conduct and interpret a geophysical survey, a secondary objective is to provide graduate students with teaching and supervision experience. Thus several graduate student instructors participate by supervising a method in the field and provide lectures in the classroom both before and after the field work. This gives graduate students valuable exposure to lecturing and project management experience.

Because the field school is taught as a distinct module within the Geophysics Honours program, it is possible to promote the field school to a wider audience and include additional participants from within and outside of South Africa. This has allowed us to build an international profile for the course, which we hope will translate into a more diverse and higher quality course. Through the AfricaArray initiative, funding from the NSF (PIRE) program and the Society of Exploration Geophysicists (SEG) Foundation grants, we have been able to attract additional international students and expert staff to the field school. These participants have included professionals from universities, geological surveys and mining companies interested in upgrading their field skills. In addition, through the AfricaArray collaboration with Penn State University, African-American students from the USA participate in the field school in the hope that a geophysics experience in Africa will attract more US minority students to a geosciences career.

These additional students add an important dynamic to the field school. Many of these students are older and very focused on career objectives and provide excellent role models for the Honours students at Wits. The value of the cultural exchange is enormous as most of our students have not had the opportunity to travel outside of South Africa. The contacts and bonds that the students make are important and long lasting.

Key words: geophysics, field work, field school

PRESENTER'S BIOGRAPHY

Susan Webb originates from upstate New York and received her B.Sc. in Geophysics from State University of New York at Binghamton, USA. She then moved to Newfoundland, Canada, where she received her M.Sc. in geophysics from Memorial University. Currently she is a lecturer in potential field methods in the School of Geosciences at the University of the Witwatersrand and conducts research on the interpretation and modeling of gravity and magnetic data. She also runs the AfricaArray international geophysics field school and is active on several committees of the SEG.