ANU ceramists are helping the East Timorese build better water filters

ANU researchers are working on ways of improving ceramics that have the potential to be used in water filters in East Timor. The hope is that the work might have broader application in other developing countries.

Water-borne diseases are a major problem in East Timor, just as they are in many developing countries. The traditional solution is to boil the water, however this consumes valuable firewood and is a risk to small children when live fires are contained in small village dwellings.

World Vision in collaboration with OMT (the East Timorese women’s association) has developed a plan to assist the women of Manatuto village to produce ceramic water filters from the local Manatuto clay. The idea is to encourage the people to use filtered water and raise awareness of the diseases that can be caused by drinking the water straight from the village pump. (This practice is common as many skip the water-boiling process.) Manatuto was chosen as it has a strong village pottery tradition.

The local clay, a fine red mix, is combined with river sand or beach sand and sometimes rice husk ash. The mixture is sieved through a fly screen and formed by hand. The traditional pottery firing method involves using a bonfire made with cow manure. It’s a rough method with an uneven firing range that produces ceramics of poor structure and inconsistent density.

Sandy Lockwood, a ceramist from Balmoral Village near Mittagong, NSW, has visited East Timor for World Vision on several occasions in recent months, and has worked with the people of Manatuto village to build a wood kiln capable of firing greater numbers of water storage vessels at temperatures significantly higher than can be achieved in the bonfires that were previously used. Sandy anticipates that the new kiln will see fewer losses and achieve ceramics with a consistent range of properties.

Filtering the water involves passing the water from an upper ceramic vessel into a lower vessel through ‘candle filters’ imported from Brazil. These filters are a hollow vessel, made from a low-iron kaolinitic material, filled with charcoal. They filter out suspended silt, though how effective they are at removing bacteria is unknown. Unfortunately, each filter unit costs between $US3-5 making them too expensive for the East Timorese to purchase.

(Continued on page 2)
The hope is that the villagers can manufacture their own clay filters (and even sell them in other parts of East Timor). To help them understand what type of clay mix is needed, and how it’s best prepared, Sandy has enlisted the assistance of ceramists at ANU. Tony Flynn, a ceramicist based in the Department of Engineering, and David Goggin, an engineering undergraduate also studying ceramics, have been preparing a range of ceramic specimens and examining their structures.

With financial assistance from CSEM, the researchers have been looking at the best combination of the materials available to the East Timorese and the best firing temperature for the women to use to fire the water filter containers. The study involves an investigation of the micro-structure of the traditional ceramics and involves trialling different mixes to see if they can improve the uniformity of their structures while maximising their porosity and strength. The work has already shown that beach sand is an inappropriate component in the mix as it introduces too salt that creates too much shrinkage in the filters. River sand is a better alternative though beach sand may still have a role to play in water storage vessels.

The aim is to come up with a mixture, and a schedule for its firing, that can be easily replicated and produce water filters of the highest quality in terms of strength and filtering potential. The challenge is to ensure that this can be done using only the basic ingredients and technology available to the East Timorese.

The work has involved some collaboration with the Australian Defense Force Academy (through Bob Clark and Bill Doran) which has offered use of its furnaces in the School of Aerospace and Mechanical Engineering for test firings at different temperatures.

Because terracotta clays have approximately similar properties the world over, this research might have application in many developing countries where water quality is a problem. The UN World Health Organisation has already expressed interest in the work.

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“Words of substance
“There are children playing in the street who could solve some of my top problems in physics, because they have modes of sensory perception that I lost long ago.”

– Robert Oppenheimer
What’s on offer in the Depart. of Geology

The ANU Department of Geology (Fac of Science), owns and operates a range of analytical and experimental equipment for work in the field of geology. Students who require a facility more than occasionally are encouraged to learn how to use it.

Thin section lab
▶ Rock crushing and milling facilities (hydraulic splitter and mills): In order to get a reliable bulk average chemical analysis of a rock, it’s important to be able to mill a representative sample down to a homogeneous powder.
▶ Rock sawing, polishing and thin section making:
Much identification of phases and analysis of textures in rocks is done under the optical microscope, using either thin sections (usually 0.03mm thick) in transmitted light, or polished slices mounted in epoxy blocks and reflected light for opaque material such as ore samples.
▶ Optical microscopes:
Petrographic microscopes are equipped with polarisers in the light path before and after the sample. Change in specimen colour with polarisation direction of the light can indicate the presence of minerals that may be used to identify minerals, quantitatively analyse mixtures of phases, or refine the crystallographic unit cell and structure of a single mineral.
▶ Software for quantitative analysis of multiphase powders, structure refinement, etc.
▶ Sample preparation facilities (WC ring mill, kiln and drying oven, ultrasonic bath, centrifuge, etc)
▶ Ion-beam thinner for transmission electron microscopy.
▶ Transmission electron microscope (JEOL 200CX), providing high-magnification images and electron diffraction patterns from very thin edges of crushed-grain samples or specimens that have been milled in the ion-beam thinner.

Analogue Deformation Lab
▶ Deformation stage for studying textural changes as a function of strain, strain rate and temperature in softer, lower-melting analogues of rocks.
▶ High-quality optical microscopy with digital video capture.

Micropaleontology & limnology
▶ Micropaleontological lab and microfossil collection from The Australian region.
▶ Low-temperature room for growing micro-organisms in marine waters for geochemical analysis.
▶ Equipment for limnological investigations of inland waters.

Coral Reef and Marine Carbonate Geochemistry
▶ 18Hp hydraulic drill for shallow (5-15m) drilling of soft rocks, used for taking core samples from coral reefs in order to investigate their growth histories.
▶ Portable Mtrom auto-titrator for analysing carbonate chemistry of marine waters.

X-ray Laboratory / Electron Microscopy
▶ 2 X-ray powder diffractometers (?-? with Cu tube, ?-2? with Cu tube). The X-ray diffraction patterns from a flat powder sample contain distinctive “fingerprint” spectra for each mineral that may be used to identify minerals, quantitatively analyse mixtures of phases, or refine the crystallographic unit cell and structure of a single mineral.
▶ Software for quantitative analysis of multiphase powders, structure refinement, etc.
▶ Sample preparation facilities (WC ring mill, kiln and drying oven, ultrasonic bath, centrifuge, etc)
▶ Ion-beam thinner for transmission electron microscopy.
▶ Transmission electron microscope (JEOL 200CX), providing high-magnification images and electron diffraction patterns from very thin edges of crushed-grain samples or specimens that have been milled in the ion-beam thinner.

Geochemical Lab
▶ Wet chemical laboratory
▶ XRF pressed-pellet and fused-disk making facilities.
X-ray fluorescence spectroscopy requires a few grams of sample, either a pressed pellet of fine, homogeneous rock powder, or a glass disk made by dissolving the rock powder in molten lithium borate.
▶ XRF spectrometer for major and trace elements in whole rocks. XRF cannot be used for very light elements (below Na in atomic number, usually) but can quantitatively determine heavier elements down to ppm levels.
▶ ICP-Mass Spectrometer with Laser Ablation Unit. A UV laser is focused onto a small spot (tens – hundreds of mm) in a flat sample such as a thin section of rock. The atomised spot is then sucked into the argon plasma torch of the Mass Spectrometer, which allows chemical analysis (including light elements and others that are difficult to measure by other techniques) down to parts per billion levels.
▶ ICP-Atomic Emission Spectrometer for simultaneous analysis of multiple trace elements in liquid samples.
▶ Volatile Analyser for water and carbon content determination, and quantitative analysis of volatile-rich minerals.

Fluid Inclusion Lab
▶ Heating-cooling stage for measuring freezing and homogenisation temperatures of fluid inclusions (bubbles of liquid + gas + salts) trapped in mineral crystals. This can allow determination of the density and composition of the fluids in which the crystal grew.

High-Pressure Lab
▶ Two Piston-cylinder uniaxial presses. In these, very small samples can be compressed to pressures of over 2 GPa (20,000 atmospheres) and temperatures of 1500°C, allowing syntheses and reactions to be performed at conditions approximating those of the deep crust.
▶ Cold-seal bombs. For larger-volume experiments at high pressure and temperature incorporating fluids.
▶ 1-atmosphere furnace

ASRP Research Fellowships 2003

Synchrotron radiation research in Australia is entering a new era. The Australian Synchrotron Research Program (ASRP), a Major National Research Facility supported by the Australian government, invites applications for up to six ASRP Research Fellowships.

The call is out for outstanding and enthusiastic scientists who have recently completed, or are about to complete, a doctorate in any relevant discipline to undertake research in areas of science and technology requiring the use of synchrotron radiation. Opportunities exist in a wide range of disciplines including chemistry, physics, molecular biology, biochemistry, medicine, materials science, environmental science and chemical engineering. At present the synchrotron facilities accessed through the ASRP are the Advanced Photon Source in Chicago, USA, the National Synchrotron Radiation Research Center in Hsinchu, Taiwan, and the Photon Factory in Tsukuba, Japan.

The salary of ASRP Research Fellows is equivalent to the Lecturer Grade A scale of the sponsoring institution. In addition, ASRP Research Fellows receive an annual allowance to support research expenses such as the travel and subsistence costs associated with the visits to a synchrotron research facility.


Where do ya get it?

It's a perennial problem: who's got that piece of equipment that you need? ANU can be such a labyrinth and it sometimes seems the only way to find anything is to be lucky and stumble over it yourself. Well, Sally Stowe (from the ANU Electron Microscope Unit) and Karen Edwards (from the Biomolecular Resource Facility, JCSMR) are establishing a resource that might go some way to change this. They've set up a web page that serves as a guide to 'shared research resources'. It contains a list of existing (and planned-for) equipment and services available for research on campus.

Visitors to the website can search the site for the machine or service they're after and from here they can visit the home page of any specific machine.

Of course, it's impossible to compile a comprehensive list of every piece of research technology (and service) available on campus but this is a great start. If you're responsible for shared research resource, make sure it appears on the list.

And if you're wondering what are some of the fantastic facilities available on campus, check out the new website. Keep in mind that the site is still under development. Indeed, Sally Stowe (STOWE@rsbs.anu.edu.au) would be very interested in hearing any suggestions you might have on how it might be improved.


Diary: conferences and seminars

15 International Symposium on Radiopharmaceutical Chemistry
10-14 August

ICRR 2003
12th International Congress of Radiation Research
17-22 August

WC 2003
World Congress on medical physics and biomedical engineering
24-29 August

X-ray Coherence 2003
X-ray science with coherent radiation (satellite meeting of SRI 2003, see below)
22-23 August

8th SRI 2003
8th International Conference on Synchrotron Radiation Instrumentation
25-29 August

electronicAsia
Hong Kong, http://www.electronicasia.com/
13-16 October

13th AINSE Conference on Nuclear Techniques of Analysis
includes the 8th Vacuum Society of Australia Congress
Lucas Heights, Sydney
26-28 November
Materials Grab Bag

Synchrotron workshop a huge success

The "Australian Synchrotron: A Workshop for Potential Users" was a three-day workshop held from 29-31 January 2003 at the University of Melbourne. Around 350 delegates attended the workshop - a tremendous turnout showing the growing interest in this project. Delegates representing 13 countries and all Australian states were present.

The workshop was part of the process for developing the first group of Australian Synchrotron beamlines to meet the needs of Australian Science and industry. It featured keynote presentations from Australian and international figures in synchrotron research and management, and workshops dedicated to discussion of individual beamlines.

For excellent background reports on the different beamlines and for pdfs of each presenters notes, see http://www.synchrotron.vic.gov.au/whats_new/user_workshops.asp

This is a great reference for anyone wanting a detailed picture of the many applications of synchrotron radiation, and the pros and cons of the various beamlines being proposed for the Australian Synchrotron.

Nanotech web presentations

The International Engineering Consortium has just launched a website containing webcasts of presentations given at the Nanotech DesignCon 2003 conference held recently in Santa Clara, California.

There are six 45-minute presentations, filmed in their entirety, and all of them can be accessed free of charge at http://nano.iec.org/event. If you haven’t got broadband access to the net you can view the presentations in slide form.

Presented with support from the American National Science Foundation, the NanoEngineering TecForum and NanoEngineering Education Workshop offered attendees a chance to hear from some of the leading thinkers in nanotechnology from academia, industry, and government. The TecForum focused on the current state of nanotechnology and its impact on university curricula. Current and future applications of nanoscale research and their implications for practicing engineers were also discussed.

In addition to being a fascinating discussion on nanotech, the website is also an example of how conferences can now be archived for posterity (or at least for as long as there’s funding to maintain the website).

Outstanding Fellows

Two ANU scientists with materials connections have recently been honoured with prestigious ARC Federation Fellowships for their fine achievements, and though you’ve probably heard this through other channels it’s worth repeating here:

Professor Hans Bachor (Department of Physics, Fac of Science) has been made a Fellow to develop the area of quantum and atom optics.

Professor Barry Luther-Davies (Laser Physics Centre, RSPhysSE) has been made a Fellow to create novel photonic and nanostructured materials by ablation of solids with ultra-fast lasers.

What’s more, there were several other materials researchers awarded Federation Fellowships around Australia. These include Prof Marcela Bilek, Syd Uni, functional surfaces for biodevices; Dr Calum Drummond, CSIRO, manipulation of nano-scale assembly; Prof Andrew Holmes, Melb Uni, polymeric photonic materials; and Prof Max Lu, Qld Uni, nanomaterials for advanced fuel cells.

Each Federation Fellow receives around $230,000 each year for five years making the Fellowships the most valuable publicly funded support offered in Australia. What’s more, each Fellow also receives a limited edition Federation Fellow lapel pin.

For more information see http://www.arc.gov.au/pdf/min_pr_fed_fellows.pdf
**the backpage**

**MM webspotting**

**Cermics**

- Australasian Ceramic Society
- The American Ceramic Society
- Ceramic Fuel Cells Limited
- Australian Fused Materials
- Advanced Ceramics in Australia
- ANSTO Ceramics Powder Characterisation

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**CSEM**

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Research School of Chemistry  
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Department of Engineering (Faculty of Engineering and Information Technology)  
Department of Geology (Faculty of Science)  
Department of Physics (Faculty of Science)

National Institute of the Arts  
Materials Workshops

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Please let us know if you wish to be added to our electronic or postal mailing lists.  
Electronic copies of *Materials Monthly*, useful links and additional information about CSEM can be found at our website.


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*The above images, and many more stunning cross sections of ceramics, can be found in the DoITPoMS Micrograph Library run by the University of Cambridge.*