ammrf NEWS

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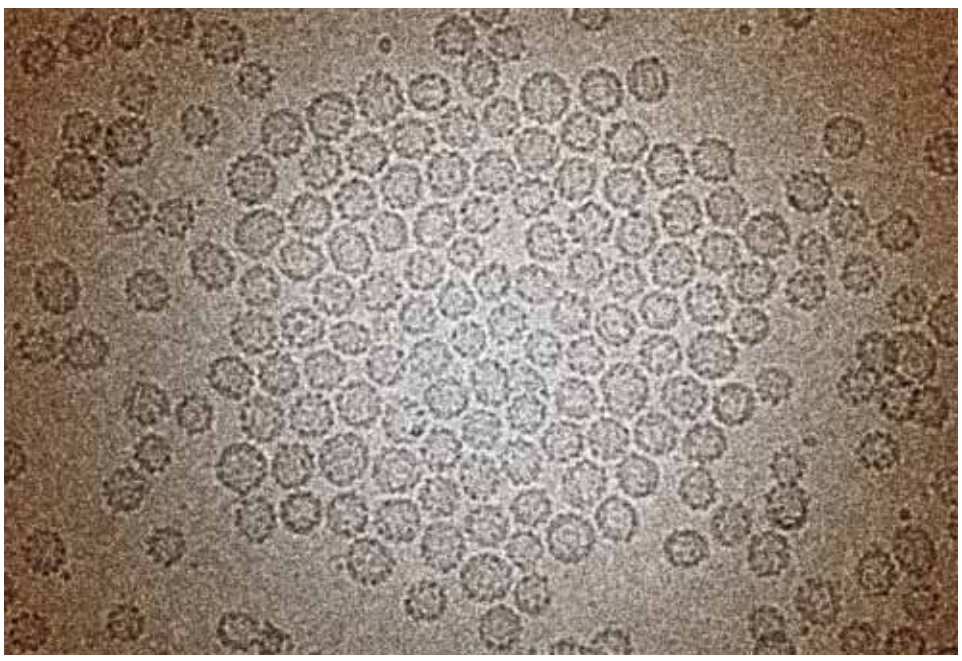
AUSTRALIAN MICROSCOPY & MICROANALYSIS RESEARCH FACILITY

- Advancing Australia's swine flu vaccine program
- National Characterisation Roadshow spreads the word
- Visualisation takes centre stage
- Nanotoxicology in the first AMMRF Linked Centre

FOCUS

Microscopy crucial to swine flu vaccine



Transmission electron micrograph of the virus-like vaccine particles produced using the new self-assembly method.

AMMRF @ UQ

Swine flu is something that has probably been on the minds of most Australians at some stage over the last six months, and the arrival of an effective vaccine is eagerly awaited by many. Keeping up with the twists and turns of the influenza virus's distinctive outer coats is a constant challenge. This means that we are always lagging behind the particular strain of flu that causes each year's new onslaught. When pandemics develop, the challenge becomes even more pressing. Speed is therefore of the essence in delivering new vaccines to quickly halt the spread of the virus and prevent it from striking down the vulnerable.

New techniques for the rapid production of swine flu vaccines are currently being developed, and Prof. Anton Middelberg's team at the University of Queensland (UQ) are using highly advanced in-vitro self-assembly techniques to produce large quantities of vaccine particles in a fraction of the time required for the more traditional methods using chicken eggs. It took only two weeks from the time that the H1N1 genetic construct arrived in their lab for the team to have produced the first batch of vaccine.

These techniques don't require the use of whole virus, making the production process far safer and easier. They make use of wonderfully efficient, cell-free bioreactors to produce just those proteins required to induce a specific immune response. Once produced, the proteins are able to self-assemble into the virus-like vaccine particles. Prof. Middelberg's team is working closely with the cryo-electron microscopists at the Centre for Microscopy and Microanalysis (CMM) at UQ to visualise their vaccine particles. High-resolution images created on the CMM flagship cryo-transmission electron microscope allow the team to monitor the structure and assembly of the particles, ensuring all is correct with the process.

Prof. Middelberg acknowledged the crucial role of microscopy in the project, saying that, "without access to the state-of-the-art microscopes and microscopists at the CMM, progress at the international leading edge of virus assembly research would be difficult, if not impossible. Seeing these self-assembled nanostructures makes them real, and gives us confidence that we've developed robust vaccine methods".

The team intend to work on improving the technology even further to ensure a rapid response to future influenza threats.

"The world-first here is that we're engaging very early with a breakthrough technology, to try and speed up and facilitate its transfer to Australia," Prof. Middelberg said. ■

A night in the museum – in Denver with Dr Judith Field

AMMRF @ USYD

Dr Judith Field from the Australian Key Centre for Microscopy and Microanalysis at the University of Sydney recently presented the prestigious Marie Wormington Memorial Lecture at the Denver Museum of Science & Nature in the USA. To a packed house, she revealed the fascinating findings from Cuddie Springs in northern NSW where she has found archaeological evidence of Australian megafauna and other extinct creatures living side by side with humans around 36 000 years ago. This site, where animal bones have been found intimately associated with flaked stone tools, is the only known site in Australia showing evidence of co-existence. Not only that, but grinding stones have been recovered from layers dating to 30 000 years ago, 20 000 years earlier than any similar find from anywhere in the world. These grinding stones retain microscopic traces of starch granules and other plant microfossils, indicating that they were used for processing grass seeds.

Microscopy has played an important role in the investigation of all aspects of this site, for example, analysis of cut and tooth marks on the bones has shown that stone tools were used for butchering the animals. Microanalytical techniques have also been applied to dating the finds at the site and to pinpoint the origins of both the stone tools and the animal bones. This work contributes significantly to the debate over megafauna extinction, suggesting a period of sustained co-existence of humans and the megafauna.

As well as her hugely successful public lecture, Dr Field attended two conferences and presented talks at Harvard University, and the University of Oregon, Eugene, on her research at Cuddie Springs and its implications for the megafauna-extinction debate. ■

LAB NEWS

AMMRF welcomes AIBN as first Linked Centre

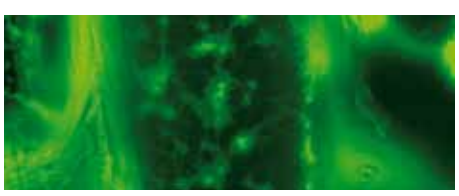
AMMRF @ UQ

The AMMRF has partnered with the Australian Institute of Bioengineering and Nanotechnology (AIBN) to form the first AMMRF Linked Centre.

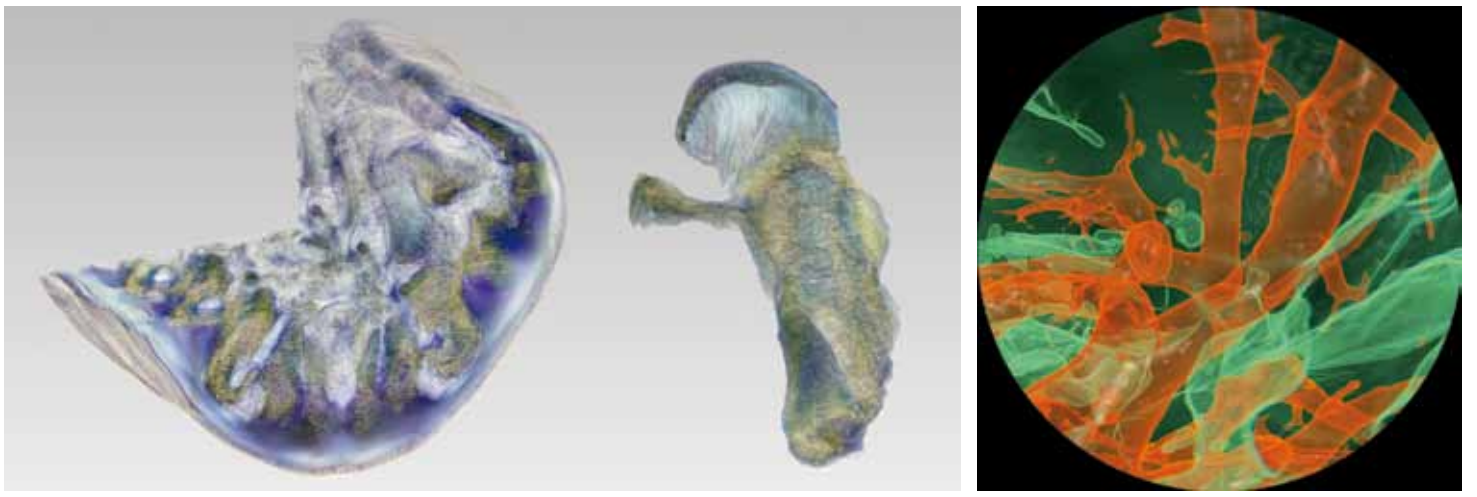
An AMMRF Linked Centre is a concentration of specialist researchers supported by a dedicated microscopist who can advise on the most appropriate techniques for their work. At the AIBN, Dr Margaret Butler, the specialist microscopist, is supporting research led by A/Prof. Darren Martin on the biological responses to a range of currently used nanoparticles. The AMMRF can make a significant contribution to this work through innovative specimen preparation techniques and state-of-the-art transmission electron microscopy and electron tomography. Providing reliable techniques to analyse the effects of nanoparticles will help the whole field of nanotechnology to move forward safely and productively.

"The specialist microscopist is an important link between the AMMRF and the AIBN, enabling world-class outcomes for the researchers" said Prof. Simon Ringer, Executive Director of the AMMRF.

AIBN Director Prof. Peter Gray welcomed the linkage saying that it "provides Institute researchers with leading-edge microscopy facilities at their fingertips." ■



RESEARCH



Left: Volumetric 3-D reconstruction of iron mineralisation in the teeth of marine chitons from data obtained by Dr Jeremy Shaw, with visualisation by Derek Gerstmann. Right: Frame from an animated visualisation of a rabbit liver based on micro-CT data from Ajay Limaye at Vizlab, ANU, processed using the freely available Drishti software.

Visualisation – the next frontier

AMMRF @ UWA

Visualisation and analysis of tomographic data has become one of the latest advances in microscopy. By combining the sophisticated instrumentation of traditional light, confocal, X-ray and electron microscopes with high-end computing, scientists are able to ask new questions and explore new ideas in ways that they have never been able to do before.

The Centre for Microscopy, Characterisation and Analysis (CMCA) at the University of Western Australia (UWA) has recognised this as a key part of their Bioimaging Initiative, which aims to increase the scale and impact of research at the interfaces of medicine, engineering and biology.

Visualisation expert Derek Gerstmann is a new breed of researcher – he has worked for Apple and AMD as well as Weta Digital and Industrial Light & Magic who create stunning visual effects for the film industry. Among his many and diverse achievements Derek has developed a sophisticated interactive lighting tool for controlling visual effects in film scenes, and software to manage a supercomputer needed to generate the images for films. Derek now joins the CMCA and the Western Australian Supercomputer Program (WASP), to marry WASP's expertise in visualisation and scalability with CMCA's expertise in microscopy. WASP has wide-ranging visualisation collaborations around Australia including with Vizlab at the Australian National University (ANU). They enable scientists to take full advantage of all the emerging technologies to best analyse, visualise and interpret their data.

Derek wants to move his research from fiction to non-fiction, and says, "My main reason for going back to academia was my desire to do research, and not be limited by the bounds of driving a commercial product, or being pushed to make the next financial market milestone. For me, being able to publish, share knowledge, and work with other scientists surpasses the novelty of the consumer-driven tech industry."

He has hit the ground running, co-authoring a conference paper on visualising muscle fibre damage in muscular dystrophy with Blake Klyen and colleagues from the Optical + BioMedical Engineering Lab at UWA. He also provided Dr Jeremy Shaw from the CMCA with a beautiful 3-D reconstruction of a chiton marine mollusc, which was presented in Dr Shaw's talk describing biomineralisation at the Microscopy and Microanalysis conference in Richmond USA. ■

LAB NEWS

Change in Canberra – welcome Professor Tim White

AMMRF @ ANU

It is very exciting to welcome Prof. Tim White as Director of the Electron Microscopy Unit (EMU) at the Australian National University. It is also a great chance for us to say a big thank you to A/Prof. Tim Senden who stepped into the breach, steering the EMU into the AMMRF and preparing it for a bright future. We wish him well as he is finally able to move back into full-time research.

Our editor has been talking to Prof. White as he moves into his new role joining us from the Nanyang Technological University in Singapore.

Q: Why did you want to come back to Australia?

As we all know 'home is where the heart is', and after 13 eventful years abroad it felt like the right time to reconnect with our families and convince our son that Australia was more than a holiday destination! Just as we were looking to come back, I was delighted to have a chance to apply for this position in Canberra.

Q: What are you most looking forward to about being back in Oz?

Mainly I am just looking forward to hearing a bit of irreverent banter about politics, sport, life in general ...

Q: What will you miss most about Singapore?

Singapore is undoubtedly one of the most dynamic, multicultural and exciting places in the world for almost any profession. Things that should work, do work, and it is impossible not to find the drive for perfection infectious.

Q: I know you are passionate about teaching – do you have any specific plans for microscopy teaching?

It is a cliché, but I really do believe in research-led teaching. I also think students today are probably more impatient to learn than in the past – instant gratification is the order of the day. Rather than despair about this, the trick is to make online tools available for students to access when they ready to learn specific techniques. I am hoping that by collaborating across the AMMRF we can set up virtual microscope laboratories that can tap into these online learning preferences.

Q: What do you most want to achieve at the EMU/AMMRF?

The overall goals are very clear. First, the EMU has to reinvent itself as an academic unit, which is not only a service provider for microscopy, but offers undergraduate and postgraduate courses and immersion training in instrumentation, and develops a distinctive research profile. The generic use of microscopy means the EMU also should serve as a catalyst for interdisciplinary collaborations across ANU and beyond as it matures. Second, the EMU has to contribute to the breadth and depth of the AMMRF. One obvious area is advanced training, but there is also the need to identify a flagship instrument/capability that is unique and world-class. ■

EXECUTIVE DIRECTOR'S COLUMN

It is indeed an interesting time at this point in every year, when federal budgets and annual reports are being pored over by ministerial departments and research organisations alike. At the AMMRF, our own financial reports and forecasts must be prepared and reported on, and the next phase of the business plan implemented. It is a lot of work – sometimes referred to as the 'cost of compliance'. The various node directors and I regard this as an opportunity for planning and strategy development, and we have been busy with financial and scientific forecasting exercises in the last months.

In doing so, it is clearly evident that contemporary government policy recognises the importance of investment in major national research infrastructure to enable and accelerate research and development in Australia. This is critical for Australian science and engineering. Moreover, two aspects of this are topical just now. The first is the tension between funding only the capital expenditure part of research capability and funding the 'soft' component – the people. My colleagues and I in the AMMRF are firmly of the view that people are the secret to success in building research capability. And, it is not merely about securing salary support for people, formidable though that is. There are also the matters of recruitment, mentoring, networking, training, competency development and retaining our staff. As a result, there is now a growing cohort of expert microscopists and microanalysts, who have discipline expertise ranging from medicine to materials science, which is able to support our user base.

Another burgeoning issue at present is the level of engagement between the industrial sector and national research facilities. Quality research is not the exclusive domain of academics and publically funded researchers; there are, in fact, many truly excellent industrial research programs. The AMMRF continues to work closely with industry, providing testing services, contract research services and long-term research collaborations that enable solutions to industrial R&D questions.

In this context, the AMMRF was invited to address the issue of industrial use of NCRIS-funded research infrastructure at the annual conference of the Australasian Industrial Research Group (AIRG) held in Parliament House, Canberra, 20 August 2009. Key government officials and industry leaders were in attendance to explore the use of research infrastructure by industry and, through this, its contribution to Australia's economy. A very interesting conversation all around! ■

Regards,
Simon Ringer, Executive Director & CEO

COMMUNITY

‘Delivering Capability’ – Fremantle 2009

In June, AMMRF staff from around the nation gathered in Fremantle, Western Australia for the 3rd Strategic Planning Workshop. The theme was ‘Delivering Capability’ and this was addressed throughout the sessions and breakout groups.

The groups focused on particular techniques, and they discussed plans for technique-based workshops along with other aspects of user training, by asking questions such as:

- What works and what doesn’t?
- How does a particular technique influence the way users are trained?
- Is there a common training model?
- What can be done to improve outcomes?

The various operational committees got in some important planning while other staff were able to go for a tour the UWA node.

A clear highlight was a talk by Prof. Tim White on the potential of online tools to train users. Tim is the new director of the AMMRF node at the Australian National University (see page 2).

Another highlight in a very packed program was the User Feedback Forum in which three AMMRF users talked about their experiences in accessing our facilities. Mahvash Khan, a PhD student from the University of Sydney, and Dr Swaminathan Iyer and Dr Jeremy Shaw, researchers from the University of Western Australia, have had experience in working in a variety of AMMRF laboratories. Their talks were very well received and were invaluable in helping us to improve what we do.

Many thanks to everyone for all the work they put in to make it a very successful event. ■

Roadshow spreads the word on world-class research infrastructure

The results of last year’s survey conducted by the National Characterisation Council revealed that researchers need to use characterisation in their research, but many are not aware of the breadth of capability available to them. In response to this, the four NCRIS-funded characterisation facilities: the Australian Synchrotron, the Australian Microscopy & Microanalysis Research Facility, the National Imaging Facility and the National Deuteration Facility got together to organise two roadshows to spread the word amongst the research community.

Perth and Adelaide were chosen as the initial venues, and in the first week of August the AMMRF presented their capabilities as part of an intensive afternoon of seminars and discussion sessions in each location, helping researchers to become better informed and able to incorporate the most appropriate techniques into their future research strategies.

The audiences came from across the research spectrum with interests ranging from nanoscale materials science to large-animal imaging. The presentations covered introductions to each facility and case studies that highlighted how the techniques available can be applied to diverse research areas, often crossing facility boundaries in a highly complementary fashion. Opportunities were provided for the delegates to discuss their particular research questions with staff from all the facilities so they could develop a plan of action to take their research forward.

The collaborative nature of the facilities in supporting and enabling world-class research and innovation in Australia was extremely attractive to the researchers present. The travel and access arrangements were also very well received, proving highly significant in allowing researchers to make that all-important initial visit to get their projects underway.

The feedback from the two events was generally very positive with most respondents saying that they would recommend the roadshows to their colleagues and students. It will be interesting to see how many new users result from the process and longer-term evaluation of the events will continue. ■

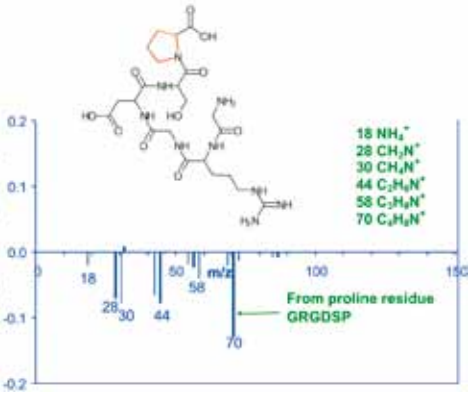
Prof. Tanya Monro opening the National Characterisation Roadshow at the University of Adelaide on 6 August 2009.

TECHNOLOGY

Making bioactive surfaces – ToF-SIMS can help

AMMRF @ SARF

A central theme in biomaterials research is the design and fabrication of ‘bioactive’ surfaces. These comprise synthetic materials whose surfaces are coated with biologically active molecules in order to induce a desirable biological response from the surrounding environment. One example is the covalent binding of proteins that support cell attachment and proliferation, onto polypropylene surfaces, for purposes such as tissue engineering. Another example is the functionalisation of surfaces through the attachment of short synthetic peptides that replicate an active region of a larger protein.



Structure of the GRGDSP hexapeptide with a PCA analysis from the ToF-SIMS spectra showing the distinguishing species originating from the hexapeptide.

Covalently attached large proteins can often be detected on surfaces by X-ray photoelectron spectroscopy (XPS). However, XPS encounters sensitivity limits in many common situations: when the underlying material is a polymer with a similar composition to the substance being bound; when small synthetic oligopeptides are bound; or when only small amounts of bioactive molecules are attached to the surface.

ToF-SIMS, on the other hand, can detect extremely small amounts of surface-attached biomolecules. For instance, where oligopeptides are bound, it detects distinctive ions generated from the amino acids, which allows even low concentrations of the attached molecules to be distinguished from the substrates. An example is the binding of the hexapeptide GRGDSP, onto polypropylene via covalent immobilisation. Here, the polypropylene was functionalised with aldehyde and epoxy groups by the plasma polymerisation of allyl glycidyl ether, followed by the anchoring of the GRGDSP hexapeptide by covalent reaction. The coated surface was characterised by ToF-SIMS, with principal component analysis (PCA) to enhance spectral differences. A number of nitrogen-containing fragments were detected, for example the distinct immonium fingerprint ion derived from the proline residue. ■

LAB NEWS

Sharing expertise

AMMRF Linked Laboratory

During May, Elishia Mackay and Diane Green from the CSIRO’s Australian Animal Health Laboratory (AAHL) in Geelong headed north for training at the Centre for Microscopy and Microanalysis (CMM) at the University of Queensland. The training visit, coordinated by Dr Charles Ferguson, Prof. John Drennan and Dr Matthias Floetenmeyer, allowed the pair to hone their skills in cryo-ultramicrotomy.

The training covered preparation, sectioning and staining of samples and Diane and Elishia said they enjoyed getting hands-on experience at the CMM’s cryo-transmission electron microscopy facility; a purpose-built laboratory for advanced cryo-electron microscopy and 3-D electron tomography.

They will be putting their newly acquired skills into practice within the AAHL Biosecurity Microscopy Facility (ABMF), a Linked Laboratory of the AMMRF. The pair will now be on hand to assist researchers in using the specialised CSIRO facility. Offering a live-cell and cryo-transmission electron microscopy capability, all within a high bio-containment environment, the ABMF enables fundamental research with infectious disease agents that require the highest level of containment. ■

STAFF NEWS

The University of Queensland

Dr Margaret Butler has recently taken up a position as a postdoctoral research fellow and microscopist in the new AMMRF Linked Centre in the Australian Institute for Bioengineering and Nanotechnology (AIBN) at the University of Queensland (UQ). She obtained her PhD in microbiology at UQ and is now providing expertise in biological electron microscopy to a nanomaterials group working on nanotoxicology within the AIBN. She will also spread the good word about the capabilities of the AMMRF to other researchers of the AIBN. ■

The University of Western Australia

Jay Chinnery is the new Centre Manager at the Centre for Microscopy, Characterisation and Analysis at the University of Western Australia. He has a BCom specialising in Commerce and Business Information Systems and is currently completing both an MBA and a BA in Psychology. Jay brings over ten years business administration experience, about half of which was gained in higher education sector (UWA and Curtin University of Technology) while the other half was from the banking industry. He has skills in strategic planning, project management, risk management, business intelligence and financial management. ■

AAHL Biosecurity Microscopy Facility (ABMF), CSIRO

Dr Paul Monaghan has recently become the Leader of Advanced Light Microscopy at the ABMF. Paul has a PhD in Zoology from the University of Birmingham, UK, and set up the electron microscopy laboratory at the Ludwig Institute for Cancer Research in London. He then worked in cancer research for 21 years. Ten years ago he joined the Institute for Animal Health at Pirbright to regenerate microscopy at the Institute. Paul ran the Bioimaging Laboratory, researching a number of viruses including FMD, Bluetongue virus and African swine fever virus. He has been closely associated with the Royal Microscopical Society for many years and is currently vice-president and president-elect of the Society. ■

Dr Andrew Leis joined ABMF as Leader of Electron Tomography. Andrew will focus on 3-D reconstruction of viruses to aid in the determination of structure, for use as a novel tool in diagnostics. He will be using correlative light and electron microscopy for studying the structural dynamics of viruses. Andrew has a BAppSc (Hons) from the University of Southern Queensland and a PhD from the School of Microbiology and Immunology, University of New South Wales. Prior to joining the ABMF, he gained postdoctoral experience at the Max Planck Institute of Biochemistry in Martinsried, Germany. ■

RESEARCH

Calibration collaboration

AMMRF @ USYD

Nanoscale materials and structures pose some tough challenges for those who have an interest in measuring their dimensions with a high degree of accuracy.

Increasingly, scanning electron microscopy (SEM) and transmission electron microscopy (TEM) are the methods of choice, because they enable the nanostructure or particle to be imaged and therefore measured directly. Obtaining good precision and accuracy in such measurement necessitates careful instrument calibration against standards of known dimension. A number of these are available from commercial sources. Published standards exist for SEM calibration, but are only in draft form for TEM.

Potentially, there are a large number of experimental and environmental variables that may affect the validity of such calibrations over a sustained period. To address these concerns, the Australian Key Centre for Microscopy and Microanalysis (AKCMM) at the University of Sydney has recently embarked on a joint program of research with the National Measurement Institute (NMI). This particular project will look at the stability of SEM and TEM calibrations over a twelve-month period, under real working conditions, such as those found in a busy multi-user environment. It is hoped that the work will provide some insights into the influence of instrument and environmental variables on the quality and reliability of calibrations. The work should also enable a realistic determination of the frequency with which instruments should be calibrated, and

One of the standards to be used in the calibration of a scanning electron microscope.

the impact of any instrument maintenance or other configurational changes that might occur. Further it will help to ensure that the AKCMM's instruments are providing its users with the most accurate data possible. It will be intriguing to see the results and we will keep you posted. ■

Micro-pump drives massive movements

AMMRF @ UWA

Microscopy carried out at the Centre for Microscopy, Characterisation and Analysis at the University of Western Australia (UWA) has revealed exciting new evidence that enables scientists to model the mechanisms of fluid movements known to be behind earthquakes, mineral deposition, and other large-scale geological events. The work, by Dr Florian Fusseis and colleagues from UWA and Dr Rob Hough from CSIRO Exploration and Mining, was published recently in *Nature* and focussed on rock that had been deformed in the depths of the crust 320 million years ago.

The new microscopic evidence shows that a simple, small-scale pumping mechanism can occur when rock is squeezed, with fluid being slowly pushed from one microscopic pore to the next as the deformation of the rock progresses. This accounts for large-scale fluid

Scanning electron micrograph showing grain-boundary pores in the deformed rock.

movement through the mid-crust regions without the need for the high fluid pressures that were previously thought to be required. ■

OUT OF THE FRAME

Crate outcome for recycling

AMMRF @ SARF

So you just received your new million-dollar instrument, and presumably you know what to do with it. But what do you do with the crate it came in? Here's a suggestion: build a chicken house. You will get instant satisfaction and loads of eggs.

From just two instrument crates, SARF Director Prof. Hans Griesser created an apartment complex of four chicken houses. He just bought corner posts, roof beams, and nails. The interior walls, doors, and some exterior panels came from the crates, and a few old corrugated iron sheets completed the structure. He had a lot of fun building it, and even if he can't saw straight, the chickens don't seem to mind.

First-class chicken accommodation.

And if you're wondering why he built four chicken houses – he was instructed to do so by his wife – an idea that seemed good at the time. Ask him more over a beer sometime. ■

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