Australian Academy of Science

East Asia and Pacific Summer Institutes for US Graduate Students

2006

NSF

Australian Government

Department of Education, Science and Training

East Asia and Pacific Summer Institutes for US Graduate Students

2006

Preface

The Australian Academy of Science was delighted to welcome the group of twenty outstanding students from the United States of America who participated in the third *Summer Program in Australia for US graduate students in science and engineering*.

The program has been developed in collaboration with the US National Science Foundation and aims to introduce the students to Australian science and engineering in the context of a research laboratory and to initiate personal relationships that will better enable them to collaborate with their Australian counterparts in the future. The 2006 program commenced in mid June and lasted for eight weeks.

The Academy recognises the importance of research collaboration that goes beyond national borders and academic disciplines, and places great emphasis on strengthening exchanges that are both competitive and cooperative among talented young researchers.

The enthusiastic participants of this year's program achieved their immediate research goals, and from their reports I note that they have achieved much more. Some students have established strong collaborative links that will provide the foundation for lifetime cooperative research. Others have gained a wider perspective of the nature of research in Australia, while others have been enriched by understanding another culture. I know that these graduate students and the young Australians with whom they shared their research will play a key part in advancing cooperative research between Australia and the United States in years to come.

I would like to thank the Australian Department of Education, Science and Training for their continued support in funding this Program and of course to our colleagues at the National Science Foundation. Without their kind assistance and cooperation, this program could not have been achieved.

The Academy looks forward to welcoming a new group of students in 2007.

Professor Kurt Lambeck FAA, FRS
President
Australian Academy of Science

Contents

Orientation program

Wednesday 14th June

10.05 Participants arrive in Canberra

11.15 Administrative procedures and check–in at Liversidge Apartments

12.30 BBQ lunch at Ian Potter House (Australian Academy of Science)

14.00 Administrative details for NSF Summer Program

15.00 Commonwealth Bank, living allowances, banking and internet cafes

17.30 Dinner at the Liversidge Apartments

Thursday 15th June

8.00 Breakfast in Liversidge Apartments

8.45 Arrive at the Shine Dome, Australian Academy of Science

9.00 Official Opening of the NSF–AAS 2006 Summer Orientation Program

Professor Jenny Graves, FAA, Australian Academy of Science Foreign Secretary

Professor Graves is internationally renowned for her work in mammalian genetics and comparative genomics on Australian marsupials and monotremes. She has made extensive ground-breaking discoveries relating to the cell cycle, control of DNA replication, evolution of the mammalian genome and the function and evolution of sex chromosomes. She is Research Director at the Australian Research Council Centre for Kangaroo Genomics.

9.15 Lecture – 'Australian mammals: exceeding strange and highly worth observing.'

Dr Hugh Tyndale-Biscoe, FAA

For more than 40 years Dr Tyndale-Biscoe has been employed in marsupial research, from brushtail possums in New Zealand, to quokkas in Western Australia, and from tammar wallabies in New South Wales to opossums in South America.

10.15 Lecture – 'Science Policy in Australia.'

Dr Neil T M Hamilton, Executive Director, The Forum for European–Australian Science and Technology Co-operation (FEAST)

Dr Neil Hamilton is a geographer by training, initially studying beaches and coastal barrier systems around the world, then moving into the filed of Global Change: the study of the big, systemic (and usually human-induced) changes to the Earth System. He spent several years running large international research projects in the USA and Europe, culminating is his appointment as Deputy Executive Director of the International Human Dimensions Programme on Global Environmental Change (IHDP). He now works at the Australia National University.

11.20 Tour CSIRO Discovery Centre with Dr Ta-Yan Leong, Senior Advisor CSIRO Global Development

12.25 Lunch at CSIRO Discovery Centre Café

14.00 Attend Question Time at the House of Representatives and tour of Parliament House

15.35 Tour of main public buildings and monuments along Lake Burley Griffin and Mt Ainslie

19.00 Dinner at Civic Café

Friday 16th June

9.00 Arrive at the Shine Dome

9.15 Site visits of Australian National University

12.45 Picnic Lunch by Lake Burley Griffin

14.30 Tour of The National Museum of Australia – A Living Culture

16.30 Free time

Research reports

Name: Emory Chan

University: University of California at Berkeley

Research advisor(s): Associate Professor Justin Cooper-White

Host institution(s): Division of Chemical Engineering, University of Queensland, St. Lucia

Research subject

Rheology of anisotropic nanoparticle solutions in microfluidic devices

Research description

Colloidal nanoparticles are increasingly being synthesised, characterised, and utilised in microfluidic devices. At UC-Berkeley, I have synthesised various materials and shapes of nanoparticles, such as four-armed cadmium telluride tetrapods, in microfluidic reactors. When modelling such reactions and flows, it is important to understand how the presence of the particles and their shape affect fluid properties such as shear viscosity. At the Tissue Engineering & Microfluidics lab at the University of Queensland, I have studied how several sizes and volume fractions of CdTe tetrapods affect the characteristic shear viscosity of aqueous solutions in microscale channels.

Research activities

In the Cooper-White lab at UQ, microfluidic channels were fabricated out of polydimethylsiloxane (PDMS), a clear silicone elastomer widely used for the rapid, inexpensive prototyping of microfluidic devices, especially in the absence of expensive clean-room fabrication facilities. I learned how to microfabricate microchannel molds for such PDMS devices with SU-8, an epoxy-based photoresist using photolithography. These molds were used to cast PDMS devices out such that the cured silicone retains the inverse shape of the SU-8 mold. The microfabricated PDMS channels were then sealed with a glass cover slip, creating an enclosed channel that was 50 x 50 μm (height x width). Pressure taps in the PDMS devices were punched 5 mm apart in between the inlet and outlet holes such that the pressure drop across this length could be measured as fluid flows through the channel. Nanoparticle solutions were flowed through this microfabricated channel at various flow rates, which correspond to specific average shear rates. Using shear rate and the pressure drop, as measured by a miniature pressure transducer connected to the pressure taps, we could then calculate the characteristic viscosity of our solutions for nanoparticles of various dimensions and volume fractions.

Before we could take our measurements, however, we had to transfer our CdTe nanoparticle solutions from their customary organic solvents to aqueous solution, since PDMS is degraded by organic solvents. The nanoparticles were coated with poly(maleic anydride tetradecane) and then the polymer was cross-linked with a difunctional alklyamine. The resulting shell coated the particles with negatively charged carboxyl groups that allowed the nanocrystals form stable

suspensions in water. Transmission electron microscopy and UV-visible absorption measurements demonstrated that the nanoparticles' original structural and optical properties were retained, even in water. While this solubilization technique has been previously published by others for spherical nanoparticles, we found that it was quite reproducible for the water solubilisation of large CdTe tetrapods, which has not been reported before.

Rheological measurements with these aqueous nanoparticle solutions were performed with large CdTe tetrapods (110 x 8 nm arm length x diameter, volume fraction = 0.0025%, 0.00125%) and small CdTe tetrapods (35 x 6 nm l x d, volume fraction = 0.01 %). Pressure measurements showed traces very similar to that of pure water, as one would expect at such low volume fractions. Viscosity vs. shear rate plots showed fairly constant viscosity at high shear rates (>2000 s^{-1}), as one would expect for a Newtonian fluid. The nanoparticle data may have exhibited slight shear-thinning behaviour at lower shear rates, but the error at such low pressures is considerable, and so such data is inconclusive. More sensitive and accurate pressure transducers and more data points, especially at lower shear rates and higher volume fractions would shed more light on the effects of nanoparticles on microscale fluid rheology. Unfortunately, synthesising and solubilising enough nanoparticles for stable, high volume fraction solutions is quite tedious.

These results, although negative or inconclusive, do answer two major questions pertaining to my thesis research. First, the near-identical rheology of the nanoparticle solutions compared to their host solvent is quite convenient, because this allows us to accurately model fluid behaviour using the known properties of the pure solvent. Because my thesis project involves the growth of nanoparticles over time in channels, this result allows me to avoid the complex situation in which the fluid properties are changing over time and space. Second, this research highlights the advantage of studying the physical properties of nanoparticle solutions with microfluidic devices. Microfluidics not only require less material than macroscale methods, but they can also access much lower shear rates, which is the regime where nanoparticles are most likely to have a rheological effect. In the future, such techniques may allow us to understand how nanoparticles with complex shapes can affect the shear viscosity and elasticity of solutions.

Perspective of research after this program

This research allowed me to study microfluidic flows from an engineering/fluid mechanics perspective and also introduced me to the issues and advantages of alternative fabrication methods. I have a new appreciation for the rigor that engineering research requires, and I will no doubt call upon my hosts again if I ever need to perform such measurements again.

Advisor's remarks

Emory has performed well in the lab during his short visit and achieved results which are at least useful to his thesis. These preliminary results and the ensuing discussions have encouraged my laboratory (in collaboration with Emory) to pursue the investigation of nanoparticle flow in microdevices into higher volume fraction domains, where interesting rheological phenomena are likely to be observed. Emory was a pleasure to deal with and the group have benefited from his significant expertise in nanoparticle synthesis and microreactor design and his insight into alternative microfabrication methods currently not available within my laboratory. I have certainly found this a worthwhile experience and would be more than happy to host future students of Emory's calibre in my laboratory.

Name: Timothy Davidson

University: University of Oregon

Research advisor(s): Professor Chad Hewitt

Host institution(s): National Centre for Marine and Coastal Conservation, Australian Maritime College

Research subject

Invasion ecology, marine biology

Research description

The Australasian burrowing isopod (*Sphaeroma quoianum*) is introduced to numerous estuaries along the Pacific Coast of North America (PCNA). In some estuaries, the invasive isopod can achieve prolific densities (thousands/0.25m^3) within select intertidal substrata (marsh banks, wood, friable rock) and can exacerbate the rate of shoreline erosion. The most pronounced effects occur within salt marsh banks, which can experience up to a meter of lateral erosion in one year in *S. quoianum* infested areas. Despite the prevalence of this species along the PCNA, the distribution and density of *S. quoianum* within its native range of Australia and New Zealand remains largely unknown. Interestingly, there are no reports of *S. quoianum* achieving prolific densities or exacerbating shoreline erosion in Australia despite extensive research in Australian saltmarshes. The rarity of *S. quoianum* in Australian marsh studies suggest population densities are lower than on the PCNA. My research compared the population densities, distribution, habitat use, and identified the possible factors that may be limiting *S. quoianum* populations within Port Phillip Bay, Tamar estuary (Tasmania), and Coos Bay, Oregon (USA).

Preliminary results indicate *S. quoianum* lives within brackish water between 5-31‰ and exhibits very similar distributional patterns within all embayments. Densities vary significantly between substrata type and embayment. Within marsh bank substrata, mean isopod densities were approximately 400 times greater in Coos Bay than in the Tamar Estuary and Port Phillip Bay. Similarly, densities within friable rock were about 3.6 times greater in Coos Bay than the Tamar Estuary and Port Phillip Bay. Within wood substrata, however, the mean densities were not statistically different. These results indicate *S. quoianum* is primarily a wood boring species within their native range but utilises a greater variety of substrata within their non-native range. It is unclear what factors may be limiting the isopod populations within their native range. *S. quoianum* is mostly a sedentary burrow dweller, therefore, competition and predation likely do not explain density differences. Other factors that may limit isopod densities include differing habitat characteristics and availability, disease, or parasites. Future work will attempt to further elucidate the role of these factors in limiting *S. quoianum* densities.

Research activities

I conducted distributional surveys of the Tamar Estuary, Port Phillip Bay, and Coos Bay via boat, car, and on foot. At each accessible point, all intertidal substrata was noted and examined for the presence of *S. quoianum* and burrows. Each surveyed point was marked using GPS and salinity was measured. Up to 5-10 minutes of search effort was devoted to each point. To estimate the densities of *S. quoianum*, I sampled marsh bank, wood, and friable rock substrata in eight representative sites per embayment. Samples were physically sorted in the lab and organisms were identified to the lowest taxonomic level.

Perspective of research after this program

After participating in the EAPSI program I better understand the importance and benefits of international collaboration. The Australian scientists I worked with provided unique ideas and insight into my research. Their unique insight expanded my abilities and skills (especially in statistical analysis) and imparted knowledge that will be crucial to my future work in marine biology. Not only will I maintain the professional relationships established through the EAPSI program, but I will also actively pursue additional collaborators within Australia and elsewhere.

Advisor's remarks

I found the research interactions with Tim to be excellent and aligned with the education and research orientation of the National Centre for Marine and Coastal Conservation. Tim is a very motivated and self-confident student, with a keen interest in the natural history of the systems he is studying and the role of biological invasions in changing the native ecological interactions. The opportunity to provide support to Tim in evaluating a species, introduced to his home system in Coos Bay, in its native habitat was extremely satisfying. We were able to provide Tim with the opportunity to evaluate the Tamar Estuary in Tasmania, a system very similar to Coos Bay, and Port Phillip Bay, a system very different from Coos Bay. In so doing, Tim worked with several other academics here at AMC. Tim also interacted with the undergraduate students here at the National Centre and provided a visiting lecture that was very well received.

I found the EAPSI program to be well organised and satisfying from a personal and professional perspective. I would look forward to being directly or indirectly involved in future opportunities through the EAPSI program.

Name: Boonsri Dickinson

University: The University of Colorado at Boulder

Research advisor(s): Dr Christine Hreyna

Host institution(s): The University of New South Wales

Research subject

A continuum model describing binary and continuous size distributions: Kinetic theory for rapid, granular flows and discrete element modelling

Research description

Louis Pasteur ~ 'Science belongs to no one country'.

From sand dunes emerging on Florida beaches to snow covering Colorado mountains to the cliffs overlooking Sydney shores, granular materials are what most people would find beautiful. The importance of granular matter is evident in how the flow of particles colors our lives in profound and divergent manners – from the quotidian formation of clouds to the monumental onrush of avalanches. Although particulate flows play critical roles in the phenomena that constitute our daily lives, the behavior of granular materials remains poorly understood.

Granular materials can behave as a gas, liquid or solid, depending on the stresses on the system. However, a governing equation describing the different behaviors does not exist to the extent that the Navier-Stokes equation can describe fluid flow. Two centuries ago, the kinetic theory was applied to predict the temperature and pressure of ideal gases. A similar approach can be used when describing granular materials in a 'gaseous' state. However, when applied to granular materials, the kinetic theory must incorporate a key difference in the nature of collisions: gas molecules do not lose kinetic energy in their perfectly elastic collisions while solid particles do lose kinetic energy in their inelastic collisions. It is worthwhile to note that kinetic theory, when applied to granular materials, cannot be used to predict how a pile of sand behaves because a pile of sand is not in a 'gaseous' state – i.e., a pile of sand involves enduring, multi-particle contacts rather than nearly-instantaneous contacts between particles in continual motion.

Currently, the existing kinetic theories for granular materials are restricted to spherical particles in monodisperse (identical particles) systems and binary systems. Although the governing equations of those kinetic theories can describe multiple species, no one has determined how many species are necessary to model a continuous size distribution. Since continuous size distributions play important roles in nature as well as industry, MD simulations will be used in conjunction with kinetic theory to obtain constitutive quantities to overcome the shortcomings of current models. Therefore, using continuum theories (kinetic theory) combined with MD simulations will help further the understanding of how granular materials with a continuous size distribution behave.

Research activities

I continued my research thesis by expanding the kinetic theories to assess how binary mixtures behave. Kinetic theory is a continuum model for particulate flows. It requires closure for the constitutive quantities that arise from the averaging process, which can be calculated by solving the equations in Matlab.

Broadening my knowledge of simulation work and particle technology was a big part of my visit. I learned more about discrete element modelling by talking with more than ten of Aibing Yu's graduate students about their projects. I also visited other chemical engineering departments at the University of Queensland, Monash University and the University of Melbourne. CISRO also hosted a visit that showed me how my discrete modelling research can be applied to a multi-million dollar film project, which excited me about all of the possible applications of the work.

Perspective of research after this program

I realised that the project I was working on was too fundamental for me. The experience broadened by view of science research and made me appreciate it more. There are so many incredible things that graduate students invent or discover everyday. While I was in Australia, I discovered my dream job as a science journalist. I do not believe I would have realized otherwise. Now I get to learn about everything from cancer to Mars. Going to Australia for EAPSI changed my life – and I couldn't be any happier.

Advisor's remarks

Boonsri is very special. This was the case when I was contacted re her visit to Australia. Her coming proved my feeling. In Australia, she tried hard to solve the problem assigned by her supervisor in the USA, and at the same time developed interest in other areas. It is from the later that she realised that she has talent at science writing. She shifted her interest and career quickly. She is brave and determined. This shift proves to be right: she has made excellent progress in this 'new' area quickly. She will be a good science journalist, and will have a very bright future there.

Her shift in career might be a loss to her supervisor in the USA, and me too in terms of scientific research. But we are pleased to see Boonsri has found something she loves and can develop her career herself. For a supervisor/educator, it could not be better.

Name: John Eme

University: University of California, Irvine

Research advisor(s): Dr Peter Frappell (La Trobe University) and Dr James Hicks (University of California, Irvine)

Host institution(s): La Trobe University, Victoria, Australia

Research subject

Factorial aerobic scope of hyperoxic-cultured Murray cod (*Maccullochella peelii peelii*)

Research description

Artificially induced hyperoxia is occasionally used to increase growth and promote disease resistance during commercial aquaculture of fishes. However, chronic exposure to supersaturated oxygen levels can result in oxidative stress and the development of gas bubbles in integument near the gills. In addition to oxidative damage, exposure to hyperoxic water induces marked changes in cardiovascular and hematological parameters in fish, including depressed ventilation (V_W) and heart rate (f_H), increased venous and arterial PO_2, and increased arterial PCO_2. Studies on hyperoxic-cultured fishes practically focus on growth and mortality. We investigated the effect of acute (24-hour) normoxic exposure on hyperoxic-cultured Murray cod (*Maccullochella peelii peelii*) metabolism and cardiovascular system.

Research activities

We transported hyperoxic-cultured cod from Alexandra to La Trobe and maintained all fish at 150% oxygen saturation until experimentation. Fishes were anesthetised with Oxafalone and platinum leads attached ventrally in order to record heart rate and ventilation. Measurements of heart rate, ventilation and metabolism commenced for 24 hours in hyperoxic water in a purpose-built, 139 L swim flume (Figure 1). At the end of 24 hours, fishes were swum to exhaustion by stepwise increase in water speed (~0.7 m/s). Fishes were allowed to recover from exercise for 2 hours, and then oxygen levels were brought to normal levels (i.e., normoxia) and baseline and exercise measures repeated. A separate group of fish were instrumented with a Doppler flow probe around the ventral aorta and a cannula was placed in the dorsal aorta for serial arterial blood sampling (Figure 2). Instrumented fishes were held for 24 hours in hyperoxic water in the swim flume, and then swam to exhaustion, and measures repeated following a 24 hour acute exposure to normoxia. A Radiometer BMS3 was used to determine Pa_{O2} and Pa_{CO2}, a Hemoscan to monitor hemoglobin concentrations ($g \cdot L^{-1}$) and a Lactate kit to monitor lactate levels ($g \cdot L^{-1}$).

Preliminary analysis of metabolic rate data indicates that hyperoxic-cultured Murray cod show a reduced factorial aerobic scope during acute exposure to normoxia. During exercise to exhaustion in hyperoxic water, Murray cod display a factorial scope of 1.93 (±0.34). Conversely, following a 24-hour acute exposure to normoxia, Murray cod display a significantly lower (paired t-test = 0.047,

N = 6) scope of 1.60 (±0.25). No difference exists between resting metabolic rate at hyperoxia and normoxia, indicating that the difference in scope is likely due primarily amount of oxygen in the blood (i.e., PO_2). Analysis of heart rate, ventilation, blood flow, and partial pressures of oxygen and carbon dioxide will be completed by year's end.

Figure 1. Murray cod in swim flume

Figure 2. Murray cod with flow probe and cannula

Perspective of research after this program

I have a very positive view of Australian research after working in Dr Frappell's lab. He, his post-docs, graduate students and the staff were very kind to me and assisted me in getting settled quickly and beginning and executing my research. I became familiar with the differences between American and Australian graduate careers, post-doctoral careers, and funding opportunities, as well as the structure and functioning of an Australian university. Most importantly, I made great personal research contacts and completed a publishable piece of scientific research.

Advisor's remarks

Firstly, can I offer my sincere thank you to the program for allowing us the opportunity to forge collaboration between out two laboratories.

John Eme was an excellent ambassador for the program and his Institute. John seamlessly integrated into my laboratory and very quickly established himself in the proposed series of experiments on hyperoxia and its effect on oxygen transport during exercise in the Murray Cod. In the time available, John made good inroads in to the project and together we will complete analysis and prepare a manuscript over the following months. To this end, we maintain regular contact and the two labs are keen to foster further collaboration.

During his time here John developed new skills while imparting detailed knowledge of physiology that was of benefit to other members in the lab. There can be little doubt that John enjoyed the experience and he eagerly participated in other aspects of lab life, while at the same time mixing with the greater community in the Department.

In sum, this was a successful placement of an upcoming scientist.

Name: Dawn Feltus

University: North Dakota State University

Research advisor(s): Dr Una Ryan

Host institution(s): Murdoch University

Research subject

The development of *Cryptosporidium parvum* life cycle stages using a host cell-free culture method

Research description

Cryptosporidium has historically been considered an obligate intracellular parasite; however the research group at Murdoch University has developed a method to propagate *C. parvum* in a host cell-free culture system that allows the parasite to complete its entire life cycle without the need of host cells. My research plan was to learn how to set up the cell-free culture in regards to handling the oocysts, the makeup of the media used to maintain the oocysts and most of all learning how to differentiate the different life cycle stages with microscopy.

Research activities

In the limited amount of time, I set up plates of oocysts and spent the majority of the time viewing the different life cycle stages with microscopy. Viewing the different stages of the life cycle with microscopy was difficult. Not all stages of the life cycle are easily visible and it was difficult to take clear images. However, by the end of the 7 weeks, I had compiled numerous images from all stages of the life cycle and managed to set up successful cell-free cultures of oocysts.

Perspective of research after this program

Learning the cell-free culture method has given me opportunities for new research here in the US. Establishing the cell-free method has yet to be successful in any research lab outside of Murdoch University; however, I have now been able to set up the method here in the US and have successfully viewed the beginning stages of the *Cryptosporidium* life cycle. I have only just begun working with the method here in the States, but if successful, I will continue the work started in Australia and will hopefully be able to present it at the next *Cryptosporidium* conference. The method is so new, that there are endless opportunities for research projects. I am grateful to the assistance Annika Boxell gave me in regards to setting up the culture and viewing the life cycle. Without her help, I would be lost in a sea of crypto!

Advisor's remarks

Dawn Feltus recently participated in the 'East Asia and Pacific Summer Institutes for US Graduate Students' (EAPSI) program and spent from June 19th until August 10th working in my laboratory. Her project involved learning a new type of cell-free culture system for the Protozoan parasite Cryptosporidium, which is currently only established in three laboratories worldwide. Dawn proved to be an excellent student. She is very bright and very competent in the laboratory and was quick to master new skills and was also quite independent. Her work was always reliable and she got on well with everyone in the group. I understand that since returning she has successfully established the cell-free technique in her laboratory, which is a great achievement. She was a pleasure to have in the group and I believe it was a rewarding experience for everyone concerned.

Name: Rebecca Frederick

University: University of Utah

Research advisor(s): Dr Michael T Ryan

Host institution(s): La Trobe University

Research subject

A conserved role for Miro proteins in mitochondrial distribution and morphology

Research description

Mitochondria are essential cellular organelles responsible for respiration, viability, and appropriate regulation of cell death. Proper shape and distribution is important for proper mitochondrial function (Okamoto K and Shaw JM. 2005. *Ann Rev Genetics*). Mitochondria usually form tubular networks that are distributed throughout the cell along cytoskeletal tracks. The conserved family of Miro GTPases have previously been shown to be important for this process.

Miro proteins contain two switch-like GTPase domains flanking a pair of calcium binding motifs. Miro is anchored to the outer mitochondrial membrane via a c-terminal transmembrane motif. Absence of Miro in yeast causes collapse of the mitochondrial network into large, globular structures that are inherited less faithfully than tubular mitochondria (Frederick RL, et al. 2004. *JCB*). Although this is a striking phenotype, the primary function of Miro remains unclear.

Identification of protein binding partners often reveals the nature of the process in which they are involved. Fly and human Miro is known to form a complex with Milton, a kinesin motor adapter protein, suggesting that Miro functions in mitochondrial distribution (Glater EE, et al. 2006. *JCB*; Fransson S, et al. 2006. *BBRC*). I have previously attempted identification of yeast Miro binding partners without success. We tried a different tactic in this study by using native protein.

While the yeast and mammalian Miro proteins are very similar at the protein level, differences in cytoskeletal organisation raise the question of whether the functions are truly conserved. We used an RNA interference approach to ask whether the absence of Miro proteins causes similar changes in mitochondrial shape in tissue cultures cells as in yeast (Frederick RL, et al. 2004. *JCB*).

Research activities

We sought to identify whether the yeast Miro homolog, Gem1p, forms a stable complex with effector proteins. Analysis of Gem1p indicated that it ran at a slightly larger molecular weight than predicted on a native gel, suggesting that one or more additional proteins may be present. However, increasing concentrations of detergent failed to alter the size of the Gem1p-containing complex, suggesting that either the complex is extremely stable or Gem1p is monomeric but its globular shape retards mobility in a native gel. I am currently analysing whether mutant Gem1 proteins that I have previously studied are dominant and will pursue native gel analysis with those that may be stabilising intermediate complexes.

In addition, we tested whether depletion of mouse Miro homologs affected mitochondrial movement, distribution, or morphology in cultured fibroblasts. Using an siRNA-mediated approach, mouse Miro-1 protein levels were depleted but no mitochondrial phenotype was observed. Technical difficulties did not allow pilot siRNA for mouse Miro-2 to be completed. Because the mMiro-1 and mMiro-2 orthologs are highly similar, it seems likely that simultaneous knockdown of both will be necessary to reveal essential functions of mouse Miro. I am currently pursuing these experiments in Utah. In any RNAi-mediated depletion experiment, it is essential to confirm specificity by rescue with a construct resistant to RNAi. In this case, we used lentiviral infection to construct a stable cell line that, when induced, expresses human Miro-1 (hMiro-1). hMiro-1 contains nucleotide differences from mouse Miro to confer siRNA resistance. This stable cell line will be used to prove siRNA specificity once mMiro-2 siRNA is accomplished.

Perspective of research after this program

My experience at La Trobe University was very stimulating scientifically. I had the opportunity to think about work only peripherally related to my own and thereby expand my knowledge base. In addition, I was able to ask some scientific questions in my own project that required technology new to me. This was truly invaluable as it would have taken much longer for me to set up the systems on my own. I now feel confident that I have the expertise necessary to continue using those techniques as I finish my PhD. Although the direct results from the projects I initiated in Dr Ryan's laboratory are not particularly promising, the challenge of changing countries, labs, experimental techniques, and focus was refreshing and has renewed my enthusiasm for research.

Advisor's remarks

It was wonderful to have such a bright, competent and enthusiastic person join my lab for a few weeks. Rebecca has the qualities of becoming a prominent scientist in the future and she was an excellent contributor in lab meetings and general discussions. While the research outcomes were not fully realised, a significant amount of data was generated that can be followed up on in the future. Besides the research skills gained, I believe that Rebecca's exposure to an Australian research lab and its operations will also benefit her leadership abilities. I would like to thank the AAS for supporting this program.

Name: Valerie Henderson

University: Georgia Institute of Technology

Research advisor(s): Dr Jennie Carroll

Host institution(s): University of Melbourne and University of Sydney (Dr Carroll was in the process of moving to the University of Sydney during the time I was there.)

Research subject

Understanding ICT trends in the deaf community

Research description

For many people who are born deaf, their native language is American Sign Language (ASL) instead of English. ASL, the dominate sign language of North America, is a gesture based language which uses different hand, face, and body gestures to communicate. ASL's grammar is different from English, and it uses a spatial structure for many linguistic constructs. Additionally, unlike English, ASL does not have a written language form. It is languages' written form which enables electronic communication such as Short Message Service (SMS), Instant Messaging (IM), email, etc. to exist. At first glance, Deaf reliance on a medium which requires the use of a foreign language seems improbable. For six weeks, I worked with Deaf teens in the United States to better understand their use of electronic ICTs and what we could learn about the design of telecommunications devices and assistive technologies. During my time in Australia, I worked to analyse this data.

Research activities

This project involved analysing already collected data using different, qualitative techniques. I wrote case narratives and analysed different forms of qualitative data including social maps, interviews, and daily logs of participant behavior. We found five common themes which emerged from the data. We also analysed preferred modes of communication both in face-to-face communication and non-collocated communication.

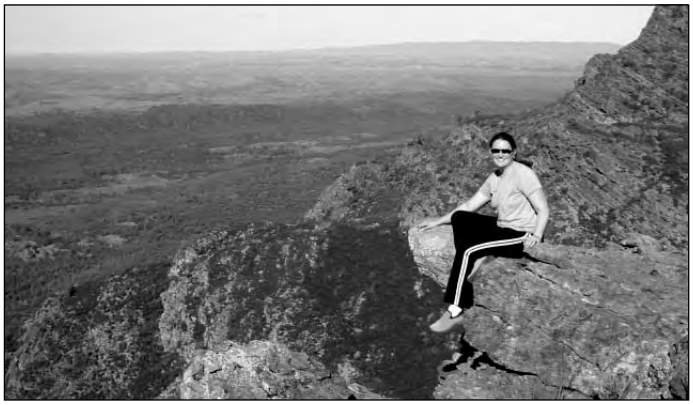
Perspective of research after this program

After this program, I realised that my data and analysis had a very US-centric perspective. I had many conversations with Australian colleagues about differences in telecommunications technologies, infrastructures, pricing, and demographics. These discussions have clarified several directions which should be explored further.

Advisor's remarks

I was extremely impressed with both the management of the program and the outcomes for the participants. The organisation of the visit and the orientation program at the start of Valerie's visit were beneficial in helping her to settle into Australian academic life very quickly and smoothly. By having a significant block of time in Australia, Valerie and I were able to work in depth on her

data analysis and plan some of her likely research activities to complete her PhD. Valerie also met with other researchers, shared ideas with Australian PhD students and gave several presentations on her research. There were also many benefits for those of us undertaking similar research here in Australia – the opportunity to share ideas, compare research approaches and outcomes and to build networks with researchers at Georgia Tech are very valuable. Overall, it is my opinion that the program provided significant benefits to both Valerie and myself.



Taking a break from research and hiking in Wilpena Pound, Flinders Ranges, South Australia.

Name: Jays Janney

University: Indiana University, Bloomington

Research advisor(s): Dr Michael Hurley

Host institution(s): La Trobe University: Australian Research Centre in Sex, Health and Society

Research subject

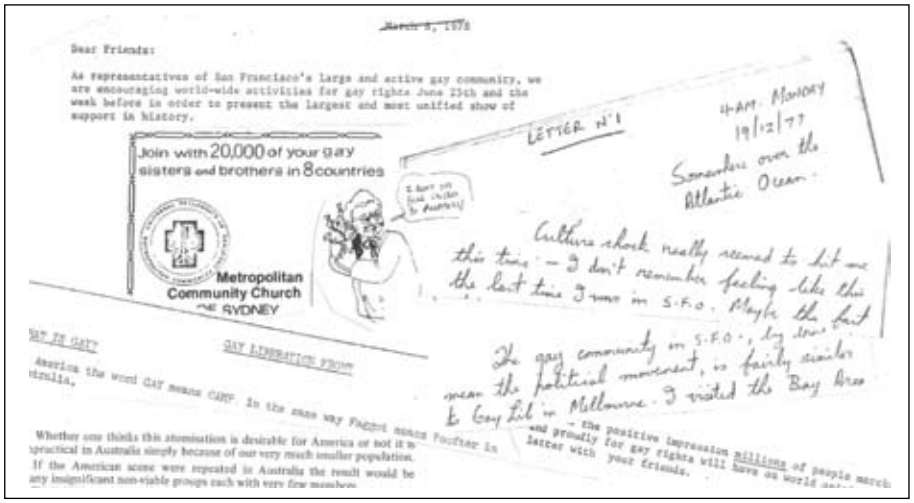
Political sociology, the movement and globalisation of social movements

Research description

The purpose of my study is to investigate how and why origin stories, cultural practices, and political symbols come to be resisted or shared by social movements in different countries. At a broader level, I am interested in understanding both cultural change and persistence within the context of globalisation.

Research activities

My two primary research activities were to visit and access a number of Australian archives and to interview people who were active in gay, lesbian and/or homophile organising in Australia in the 1970's regardless of their sexual orientation. I interviewed twenty-three individuals over a period of six weeks. During my fellowship period I also collected copies of primary documents in my visits to four different archives. These were: the Mitchell Library collections (Sydney); The Women's Library collections (Newtown, Sydney); the Australian Lesbian and Gay Archives (Melbourne); and the Victorian Women's Liberation and Lesbian Feminist Archive at the University of Melbourne Archives. As well, I organised to visit a 5th archives in Wellington, New Zealand (Lesbian and Gay Archives of New Zealand) on my way back to the States.



Collage of Australian documents from the 1970's with references to the United States

Perspective of research after this program

My participation in this fellowship opportunity has lead me to rethink my research agenda in ways I think will strengthen my research. I had originally hoped to begin collecting documentation within two separate social movements. This did occur, but the social movement of comparison was not the one I had originally planned—and my research expanded to include two other movements instead of one. My line of questioning required that I begin research in Australia's Women's Liberation and also in New Left political parties. And while I am a little disappointed that I was not able to gain access during the time I was here to some individuals, I am pleased with the progress I have made. I am now confident that there is enough difference between the Australian and American social structures used by gay and lesbian activists in the 1970's that I can make an interesting comparison between the U.S. and Australia. I am confident that my experiences during the Summer Fellowship will help strengthen my dissertation proposal. I am also optimistic that this research will be of interest to and publishable in both Australia and the United States.

Advisor's remarks

Ms Janney impressed me on several fronts. She had a strong sense of what her research questions were and how these affected data collection. Her project management skills were excellent. She is a very capable logistical organiser, focussed, self motivated and self activating. Visting four archives, and conducting twenty-three interviews in two cities is impressive in a six week period and together with presenting her project to an ARCSHS audience indicates a highly competent graduate student.

Her sense of ethical responsibility in relation to both the archives and the research participants was a pleasure. Ms Janney behaved professionally in all her research activities. She brought a fresh eye to the period and the activities being investigated in her research and I am confident she will present high quality research in her dissertation.

Name: Alissa Johnson

University: University of California, Berkeley

Research advisor(s): Dr Armin Aberle

Host institution(s): ARC Centre of Excellence for Advanced Si Photovoltaics and Photonics at the University of New South Wales

Research subject

Characterisation of polycrystalline thin-film solar cells

Research description

My research focus is defect engineering of polycrystalline silicon for solar cell applications. The main objective is to manipulate the manner in which defects form and behave through a variety of processing techniques. It is essential to first understand the defect structures in the cell in order to work on ways to manipulate their behaviour. It is the goal of my research collaboration with the centre to help them understand the defect structure in their thin-film cells and to identify ways to mitigate their effects.

Research activities

My activities at the Centre focused on learning the techniques currently used to characterise the thin-film solar cells. I was able to learn and perform a variety of electrical characterisation techniques that will be a nice compliment to the physical and chemical characterisation techniques that I use in my research in the US. While the short time frame was not sufficient to undertake new avenues of experimentation with the thin-film cells of the Centre, I was able to gain an in-depth understanding of the novel cells and the goals that the Centre is trying to achieve. This knowledge will be imperative as I return to Berkeley to characterise the physical and chemical attributes of the defects in the thin-film solar cells.

Perspective of research after this program

This program enabled me to gain a new perspective on my research. At Berkeley, the focus is solely on silicon defect characterisation and processing. At the centre I was able to gain insight on the challenges faced with bringing a whole silicon solar cell together, and the silicon material issues are only a small part. Additionally, I was able to gain experience with electrical characterisation techniques. These techniques are widely used and cited in studies throughout the solar science community. Further, it was fascinating to see research conducted in a setting like the Centre of Excellence. Here they bridge the gap between industry and academia and span all three generations of solar cell technology. This was quite a different experience than the five person group working at Berkeley! It is my hope and expectation that the Centre and Berkeley continue to collaborate after the completion of this program. In all, I believe that my experience in Australia will prove to be invaluable to my career in the solar community.

Advisor's remarks

It was a pleasure to have Alissa Johnson as a visiting researcher in my thin-film solar cell group at UNSW in Sydney, Australia. She familiarised herself quickly with several important solar cell device characterisation methods (including quantum efficiency, capacitance-voltage and light intensity vs. open-circuit voltage measurements) and made a series of very useful measurements. Having been trained as a materials scientist, the insight into semiconductor device work and characterisation gained by Alissa during her stay will be very useful for a planned future collaboration between the two groups involved (the Photovoltaics School at UNSW and the Materials Science Department at U California-Berkeley).

Name: Adam LaPrad

University: Boston University

Research advisor(s): Dr Howard Mitchell and Dr Peter Noble

Host institution(s): University of Western Australia

Research subject

The airway's response to a deep inspiration in-vitro: the effects of amplitude and duration

Research description

Recent *in-vivo* animal studies have shown that the ability of a deep inspiration (DI) to reverse constriction depends on the amplitude and duration of the DI, and some DIs can actually cause further bronchoconstriction. A large amplitude and long duration DI causes bronchodilation of the airway that remains for at least 5 minutes after the DI. However, a small amplitude and short duration DI causes initial bronchodilation of the airway and subsequent bronchoconstriction. In this case, the airway actually constricts to a smaller diameter than its pre-DI diameter. The mechanisms underlying these phenomena are not yet understood, but could be due to the response of contracted airway smooth muscle (ASM) in the airway wall to mild stretch. If this were the case, these observations could be attributed solely to the airway, independent of airway-parenchyma interactions. By studying isolated airways, we can determine if these phenomena are present at the airway level. Thus, the objective of this project was to determine the effects of deep inspiration amplitude and duration on the airway's response to a DI *in-vitro*. Ultimately, experiments on DIs in isolated airways can help enhance our understanding of asthma, where it has been shown that deep inspirations do not help to dilate the airways in asthmatics, and may even cause further constriction.

Research activities

The effects of DI amplitude and duration were tested on 9 airways. Lungs were excised from ~25 kg pigs and the main stem bronchus of the right lobe was dissected free of parenchyma. Side branches were ligated and the segment was cannulated. The inner diameter of the airway segments were ~5.0 mm on the proximal ends and ~2.5 mm on the distal ends, with lengths of ~50 mm.

The airways were tested in a pressure-controlled system that was custom-built to mimic an airway's *in-vivo* environment. The airway was mounted horizontally in a tissue bath filled with Krebs solution, a physiologically-balanced saline solution. The Krebs solution was heated to 37°C. The tissue bath was open, exposing the outside of the airway to atmospheric pressure. The lumen of the airway was fluid-filled and was connected via tubing to a pressure column. The height of fluid in the pressure column determined the pressures that were delivered to the airway segment in the

tissue bath. A computer-controlled syringe pump was used to oscillate the height of the fluid in the pressure column. Thus, depending on how the fluid was oscillated, different breathing patterns could be delivered to the airway. For normal, tidal breathing, the syringe would oscillate the pressure column height sinusoidally between 5-10 cmH_2O at 0.2 Hz (12 breaths/minute). Four different DIs were chosen to test the effects of both DI amplitude and duration. They are as follows:

5-20 cmH_2O, 6 seconds

5-30 cmH_2O, 6 seconds

5-40 cmH_2O, 6 seconds

5-30 cmH_2O, 30 seconds

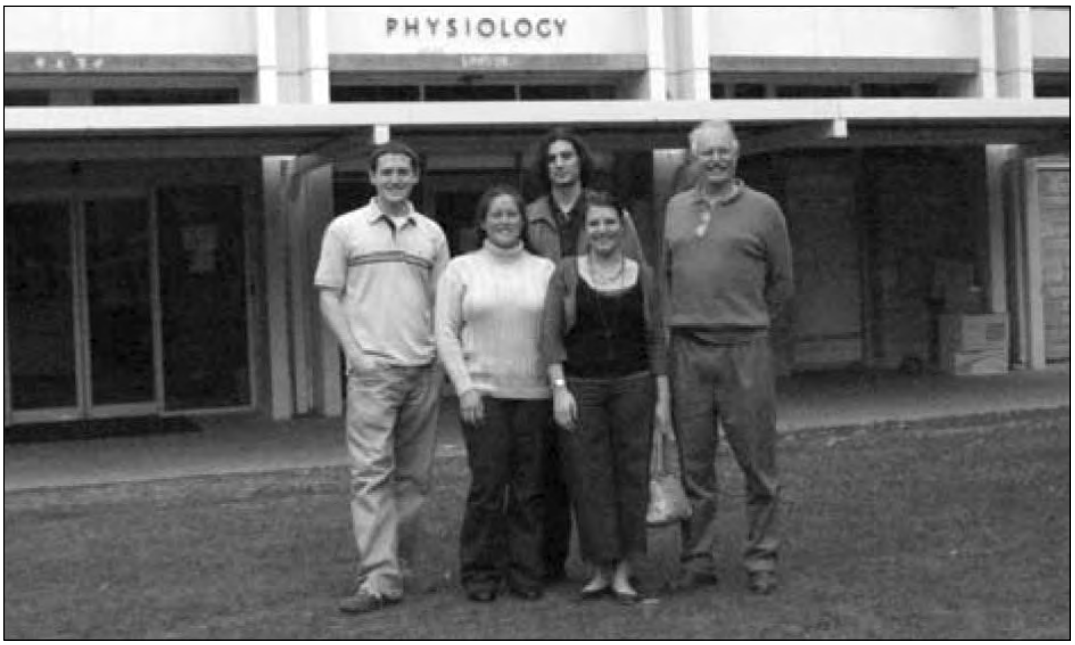
During these breathing patterns, the diameter of the airway lumen was continually imaged using an endoscope that was inserted into the airway. The endoscope was attached to a CCD camera and images were recorded on a desktop computer.

Each airway was subjected to 2 of the 4 above DIs, which were randomly chosen. The 2 DIs were delivered to the airway in two different states: 1) when the airway smooth muscle (ASM) was relaxed, and 2) when the ASM was constricted with a bronchoconstrictor chemical. In the relaxed protocol, the airway was subjected to tidal breathing for 20 minutes. Then, the first DI was given and tidal breathing was continued for 30 minutes after the DI. The second DI was delivered the same manner. In the constricted protocol, the airway was again subjected to tidal breathing for 20 minutes. Then, the bronchoconstrictor was added to the Krebs solution in the tissue bath. Tidal breathing was continued for 20 minutes, followed by a DI, and tidal breathing after the DI. The bronchoconstrictor was then washed out of the tissue bath and the ASM was allowed to relax for 60 minutes. Then, the same protocol was repeated for the second DI. A control was also performed on each airway, where the airway was constricted and tidal breathing was delivered for 60 minutes. This was done to determine if there were any variations in the level of airway constriction over the length of the experiment.

Video of the airway lumen was recorded throughout the whole experiment. Snapshots were taken from the videos at important time points to determine how the DIs affected the airway. These time points corresponded to: immediately before each DI, at the peak of each DI, immediately after the DI, and incrementally for up to 30 minutes after the DI. Image analysis software will be used to determine the diameter of the airway at each time point. From this data, we hope to see if the amplitude and duration of a DI affects the airway's response. Also, we hope to determine if a relaxed airway responds to DIs differently than a constricted airway.

Perspective of research after this program

From this program, I hope to continue to work with my hosts to publish the results we obtained. I also plan to use the skills I learned at University of Western Australia to continue very similar research at Boston University. I am excited to use all the knowledge I obtained from my hosts to continue to study airway physiology. Also, I look forward to continuing this collaboration to collectively enhance our understanding of airway physiology and its implications in asthma.



Name: Rhesa Ledbetter

University: Idaho State University

Research advisor(s): Dr Peter Janssen

Host institution(s): University of Melbourne

Research subject

Growth conditions affecting the culturability of soil microorganisms

Research description

It has been estimated that only about 1% of the bacterial population from 1 gram of soil can form visible colonies on laboratory prepared media. Because of this only a small proportion of the microorganisms present in a sample can be studied due to the lack of representatives isolated. Thus, studying the growth conditions affecting the cultivation of microbes can provide useful tools in developing methods to increase the yield of bacterial colonies in the laboratory setting. To address the issue of understanding factors that may affect culturability, a series of experiments was designed to look at the effects of various growth conditions on colony formation from soil bacteria. The results obtained from this research will greatly aid scientists interested in cultivation studies by offering methods to isolate microorganisms that were previously thought to be unculturable or that have yet to be discovered.

Research activities

The following experiments were designed to examine the effects on bacterial colony formation:

1) Effect of substrate concentration – high and low concentrations
2) Effect of substrate shock – going from an environment of high substrate concentration to low substrate concentration and vice versa
3) Effect of oxygen radicals – using oxygen scavengers to remove oxygen radicals that may be toxic or inhibit bacterial growth

For each experiment, 1 g of soil was diluted and plated onto the appropriate medium. Following the initial inoculation, colony counts were conducted once a week for the first four weeks and will continue to be done monthly for an additional three months. Upon completion of the colony counts, statistical analysis will compare and consider significant differences in the data, and conclusions will be drawn as to whether colony formation was promoted or inhibited under various conditions. These results will allow us to better understand what conditions are important to consider when attempting to culture microorganisms from the environment, specifically from soil.

Perspective of research after this program

Through participation in the 2006 EAPSI program I have not only learned and experienced the benefits of international collaboration, but have also observed and shared in some of the first-rate science that is being performed outside of the US. This experience has enhanced my current research program by granting me the opportunity to work with knowledgeable individuals in a foreign country and also work on an interesting project that complements my research at my home institution. It was a pleasure working with Dr. Janssen and his laboratory group, and I look forward to continuing our collaboration in the future. I am grateful to have had the opportunity to be a part of the EAPSI program.

Advisor's remarks

It has been a great pleasure to have hosted Rhesa for this visit, and to have had her working in my laboratory and interacting with the staff and students in my research group. Rhesa displays a level of diligence and dedication to her research, both that carried out here and also the work she is doing as part of her Masters program, that is instructive for others who work around her. This can only have been of benefit to my research group. The opportunity to meet with scientists from other counties is always valuable, regardless of the level of experience of both parties. I feel that this visit has been instructive for Rhesa, for me, and for the people in the Department of Microbiology and Immunology at the University of Melbourne.

The research carried out by Rhesa has produced some extremely interesting and valuable results, and we both feel that an important underlying principle will be discovered when the leads she has uncovered are thoroughly investigated. It is my sincere hope that a significant publication will result when this work is completed. It is a pity that Rhesa could not have had more time to complete this project, which could easily develop into a PhD research program. Her input to the research and her enthusiasm for it will not be forgotten, and her role will be recognised by due authorship on any publication(s) arising from follow-up research programs.

Rhesa has been most courteous and friendly, and has displayed a willingness to be involved in all aspects of laboratory life while she has been here. She has been an excellent ambassador for her University and country, and she is a credit to her educational system and her advisor in Idaho. I plan to keep in contact with Rhesa, and hope that I may in some way collaborate with her again in a scientific endeavour in the future. I hope too that the links she has forged with members of my department will remain and be built upon.

I sincerely thank the Australian Academy of Sciences for their support of the EAPSI Program 2006, and the benefits it has brought me, my research group, and, I am sure, for the positive experience it has been for Rhesa.

Name: Liliana Lettieri

University: Georgia Institute of Technology

Research advisor(s): Dr Justin Marshall

Host institution(s): University of Queensland

Research subject

Colours, conspicuousness and visual perception in some coral reef fishes- measuring colours and predicting ecological interactions

Research description

The focus of my research is to discover the role that specific colour patterns play in the speciation and evolution of some ecologically important coral reef fishes and the genetic control of those colours. These 'cleaner fish' decrease parasite loads in visiting fishes of many species by eating attached parasites. Visitors queue at 'cleaning stations' to receive the cleaning services. The two places in the world where these interactions are most studied and best understood are in the Caribbean, where the cleaners are several species of gobies, and the Great Barrier Reef, where the cleaners are a species of wrasse. Similar behaviour and colour stripes, but not phylogenetic history, link the fishes. It is not known if the colour plays an important role in driving the behaviour, evolution and distribution of these fishes.

Colour patterns can function as a signal and can play a role in conspicuousness to other organisms including predators, potential mates or rivals. I am trying to uncover the driving evolutionary forces in colour changes within the evolution of a whole clade of gobies, of which many are obligate cleaners. The more derived colour pattern, which occurs only in species which are obligate cleaners, is similar, at least to human observers, to the wrasse cleaner of the Indo-Pacific, including the Great Barrier Reef. The goals of my research were to learn state-of-the-art techniques in the objective measurement and interpretation of colour patterns in reef fishes, all in a system that is analogous to the Caribbean in many respects.

We collected light irradiance data from cleaning stations in the Great Barrier Reef spanning a range of cleaner wrasse ontogenetic stages. Coupled with colorimetric readings we took from live fishes, we used visual perception models to evaluate the conspicuousness of various colour patterns to potential visitors.

Research activities

I received training and gained experience using objective colorimetric techniques and was given the tools to evaluate this data in a broader ecological context. I was able to collect data in an ecosystem that is tremendously valuable for comparison to my own system of study. We used an underwater spectrophotometer to collect irradiance on the reef. We also made behavioural observations on visiting 'clients' to the cleaning stations. This shaped the application

of the visual perception models used to interpret the data. I measured live fish colours using a spectrophotometer and used this data in the models. Modelling results supported existing data by Dr Marshall and colleagues that some colours may serve both as signals at close range and camouflage at further distances underwater. The models also suggest that different ecological guilds of fishes may perceive certain colours differently across a range of environments.

Perspective of research after this program

I learned an enormous amount as a result of my stay at the University of Queensland. As a result of the training, exposure and perspective I gained, I will be a much more knowledgeable and skilled scientist in my field. Training in new equipment and new models, coupled with invaluable discussions will inform and enhance my research in future.

Advisor's remarks

Liliana came here with the advantage of an already well thought out question for a cleaner fish colour communication system in the Caribbean. She was keen to learn techniques and methods, pick up ideas and equipment design details as well as experiencing Pacific fish. She was an excellent sponge and a pleasure to have around and I look forward to interacting with her in the future.

Name: Bethany Lyles

University: University of California, Berkeley

Research advisor(s): Dr David J Hinde and Dr Mahananda Dasgupta

Host institution(s): Australian National University

Research subject

The effect of the angular momentum and parity mismatch on the Surrogate Ratio Method: Fission fragment angular distributions and quantifying the onset of the Weisskopf-Ewing limit

Research description

Many neutron-induced nuclear reaction cross sections cannot be easily determined in the laboratory. This is due to the low intensity of neutron beams, as well as background and fabrication issues on account of the radioactive decay of the target. Surrogate reaction methods obviate these issues by measuring the relevant decay probability of the same compound nucleus produced by an alternative reaction using a stable target and beam. One of these techniques, the Surrogate Ratio Method (SRM), removes the need to measure the total number of reaction events, thus eliminating what was formerly the largest source of systematic uncertainty in the measurement. To determine the limits of validity of the SRM, an experiment was recently performed at the 88" Cyclotron at Lawrence Berkeley National Laboratory: ^{235}U(3He,αx) and ^{238}U(3He,αx) for x=f, γ, n, 2n, etc. The goal is to ascertain the extent to which differences in angular momentum of the compound nuclei affect the extracted cross section values.

Spin-parity differences between the two compound nuclei formed by the (^{3}He,α) reaction on ^{238}U ($J^\pi=0^+$) and ^{235}U ($J^\pi=7/2^-$) targets will be used to explore the effect of J^π-distribution on the SRM. The relative probability of the fission and gamma-decay exit channels will be quantified and the spin populations will be determined through observation of discrete gamma-ray transitions in the residual uranium nuclei. The results of this work will benefit the nuclear science community by refining a method which provides a novel means for generating neutron-induced fission cross sections on radioactive targets.

In order to fully characterise the angular momentum and parity effects on the SRM, the assumptions employed in this method must be rigorously explored. One such assumption is that the reactions on both targets are 'sufficiently similar', such that if any fission fragment anisotropies exist in the data, they are similar for both targets. Another assumption in this method is that the Weisskopf-Ewing limit is applicable, which states that the branching ratios are independent of spin and parity. Fission fragment angular distribution data is useful not only for determining the 'similarity' of the two targets, but also for quantifying the onset of the Weisskopf-Ewing limit.

Research activities

As stated above, outside of the Weisskopf-Ewing limit of Hauser-Feshbach theory, branching ratios for different exit channels are spin and parity dependent. Thus, it is necessary to quantify the energy regime in which the angular momentum and parity of discrete states are expected to significantly influence nuclear reaction cross sections. To this end, the microscopic structure of the ^{237}U and ^{234}U transition nuclei was explored by extracting both in-plane and out-of-plane fission fragment angular distributions from the data.

The fission fragment angular distributions cast in the center-of-mass coordinate system were converted into angular correlation plots from which the pairing gap on top of the fission barrier can be extracted. Above the pairing gap, the level density becomes a quasi-continuum and the microscopic structure of the discrete states is no longer significant in the determination of nuclear reaction cross sections. Given that the SRM assumes that the Weisskopf-Ewing approximation is valid, an accurate determination of the energy at which this assumption becomes applicable is crucial. The collaborative work done through the EAPSI program makes this analysis possible.

Perspective of research after this program

The Australian collaboration has helped to focus my investigations in the study of angular momentum and parity effects on the SRM. Together we have developed a robust approach to investigating the onset of the Weisskopf-Ewing statistical regime, an integral component of my thesis research. Though the program has ended, we plan to continue correspondence in order to sustain a fruitful research effort and publish our findings in a scholarly journal.

Advisor's remarks

Bethany's delightful personality, enthusiasm and perseverance impressed everyone at the lab. She worked hard to achieve the goals she had set for this project, and was able to involve many members of my group in this effort, a key aspect of developing effective collaboration. I would say that her visit was a success in every respect, and if Bethany were to choose to return to Australia to continue her research career, we would be delighted.

Name: Christine Metzger

University: University of Oregon

Research advisor(s): Dr Erick Bestland

Host institution(s): Flinders University

Research subject

Paleosol maps of global climate change in the middle Miocene of Australia: Maps and dataset

Research description

My main project focuses on the expression of the middle Miocene thermal maximum in the paleosol (ancient soil) record. 16 million years ago, during the middle Miocene, temperatures were globally elevated, and this period of warmth was followed by a marked cooling. The period of warmth expanded tropical regions and the soils express this climatic and vegetative change. I hope to combine my field work from Australia with field work I have completed in North America and Argentina and with previously published studies into a soil map of the world for the middle Miocene, modelled after the FAO Soil Map of the World. This map will be accompanied by an interactive dataset which can be input into climate models to refine predictions of paleoclimate.

Research activities

I planned and completed two fieldwork trips while in Australia. I travelled from Adelaide to New South Wales, where I hoped to describe and sample the Home Rule kaolin deposit near Gulgong. Unfortunately, the only deep enough outcrop is now the town dump, but I was able to examine some samples of the kaolin when I visited the Londonderry Core Library outside of Sydney. I also examined the Sydney laterites cropping out on the beach at Maroubra and the extensive Miocene brown coal fields in Gippsland, Victoria. With my advisor from the US, I completed fieldwork at Lake Palankarinna in the Tirari Desert in northern South Australia.

In addition to my field work in New South Wales and South Australia, I visited several museums and worked in the paleobotanical collections at the Australian Museum in Sydney. I examined and photographed Permian leaves from NSW in the collection for comparison with fossils I collected in Antarctica in 2003. (Antarctica and Australia were part of the supercontinent Gondwana during the Permian around 250 million years ago.) I developed a new digital *camera obscura* method for calculating the percent vein density in a fossil leaf (a paleoclimatic proxy), which I hope to publish in a paleobotanical journal. I visited several paleontologists at Flinders University and Adelaide University familiar with my field areas in Australia, and I also visited the Urrbrae campus of CSIRO.

I also worked with my host advisor on a small project relating to a larger watershed characterisation project at Scott Creek in South Australia. After having several soil trenches dug,

I described and sampled the soils and underlying saprolite, and I also collected dust specimens from nearby gutters. In the lab, I measured the bulk density of the soil horizons. We sent the samples off for geochemical analysis shortly before my departure, and when we get the results back, I will continue working on the project, calculating pedogenic strain and doing a mass balance to investigate parent material source, and we hope to publish the results of the study in a geomorphology journal.

Collecting dust (mushy black leaves and millipedes) from a gutter for a geochem analysis

In the field area at Lake Palankarinna in the Tirari Desert

Perspective of research after this program

While my field work did not go as smoothly as I had hoped, I was very successful in other ways. The work I did at the Australian Museum not only will help me complete my secondary dissertation project but also helped me see a new way to solve an old problem. I also enjoyed having the opportunity to explore a new project with my host in an area not related to my dissertation research.

Being able to conduct my research with a great host, in a new place, and in the company of interesting, interested people was a great opportunity.

Advisor's remarks

It is my pleasure to write a few comments about the visit of Christine Metzger from the University of Oregon during July and August of this year. Christine was able to work on two separate projects during her stay here. One was closely allied to her PhD work and involved the examination of Miocene age fossil soils in the Lake Eyre Basin and elsewhere in Australia. The second project occupied Christine while she was in Adelaide waiting for research permits and the like. This second project is linked to a catchment-scale soil hydrology program that the Flinders University hydrology group is conducting in the Adelaide Hills.

Christine sampled several backhoe trenches of soil profiles as well as windblown material from a farm house gutter. In the lab Christine measured the density of the soil samples and prepared the samples for ICP analysis. With major and trace elemental data from soils and dust samples as well as density measurements, gains and losses to the soil profile will be calculated and the component of the soil derived from underlying rock and from dust addition can be calculated. This work will add to our basic knowledge of soil genesis and aid in our understanding of the soil geochemisty of this Adelaide Hills catchment.

Name: Vanessa Michelou

University: University of Delaware – Graduate College of Marine Studies

Research advisor(s): Dr Peter Pollard

Host institution(s): Griffith University

Research subject

Viral ecology and control of toxic cyanobacteria

Research description

Little is known of the role of viruses in aquatic ecosystem processes. Blooms of toxic cyanobacteria ('blue-green algae') are a major concern in water storages used for drinking. Increased nutrients from the watershed contribute to these blooms but nutrients alone do not always account for them. Viruses (obligate parasites) may play a key role in naturally controlling cyanobacterial growth. This project was carried out to help determine the ecological role of viruses in the control of blooms of toxic cyanobacteria (blue-green algae) in drinking water supplies. The project was based in Brisbane and it helped develop and apply methods that will ultimately be applied to Lake Baroon, on the Sunshine Coast, to quantify and qualify viruses and cyanobacteria. The research outcomes will contribute significantly to a sound scientific basis for the management of toxic cyanobacterial blooms in these aquatic environments.

Research activities

The very short time frame of the EAPSI program was not suited to undertaking any significant new experimentation due to the difficulty in working with cultured organisms. Instead I focused on learning the experimental techniques and methodologies used in Dr Pollard's lab. I also undertook the project of getting the Pulse Field Gel Electrophoresis method up and running in the lab. This method will be a vital component for the research taking place in the lab dealing with Microcystis and its cyanophages. I was able to get a significant result in that I was able to extract and isolate the DNA of the cyanophage of a toxic cyanobacteria using pulse field gel electrophoresis. This is only the first step but know that everything is set up to get very good data which will be helpful in solving one of the many questions dealing with this research into how viruses control plumes of toxic cyanobacteria.

Perspective of research after this program

The EAPSI program allowed me to work with new laboratory equipment and interact with premier researchers in the field of freshwater viral ecology. I was able to develop and learn a new molecular method (PFGE) which I will be able to apply to my own research once I return home. In addition, conversations with my host and other scientists at Griffith University, have provided important

motivation to pursue avenues of research that, until now, I had not yet thought of. Indeed, I am anxious to continue my research back in the US, with fresh motivation and novel perspectives. I am planning on applying the new PFGE method I learned to my work with marine cyanobacteria.

Advisor's remarks

Vanessa was a great addition to our laboratory. She worked closely with one of my postgraduate students and interacted well with the other members. Her research topic was difficult because it relied on growing host bacteria and its associated virus. The project was also removed from her area in marine studies, freshwater was a new experience. She rose to the challenge and was able to ultimately isolate the DNA of a cyanophage using pulse field gel electrophoresis. Vanessa contributed significantly to the lab. Her determination, work ethic and enthusiasm were admirable and very much appreciated by everyone in the lab. I hope she will work with us again some time in the future. Vanessa's visit has encouraged the postgraduate she worked with. The EAPSI program was very beneficial and we appreciated the funding from NSF and the Australian Academy of Science. On a personal note, Vanessa was always bright and cheery and keen to be apart of the Australian culture. We enjoyed having her around. She also seemed to enjoy the friendly environment of my lab. Generally this was a very rewarding experience for my research group and Vanessa. I think Vanessa took away some worthwhile experiences in how to study viral ecology as well as an appreciation of the enjoyable Australian research environment. We look forward to any opportunity to continue this type of interaction with visitors from the USA.

Name: Jessica Robinson

University: North Carolina State University

Research advisor(s): Dr Yu-Fai Leung

Host institution(s): The International Centre for Ecotourism Research at Griffith University (Gold Coast Campus)

Research subject

Recreation ecology: current state of monitoring programs in New South Wales National Parks

Research description

This study examines the extent and nature of visitor use and impact monitoring (VUIM) in Australian protected areas with different cultural and ecological contexts and what influence VUIM has on protected area management practices. The project outcomes will better inform protected area VUIM and aid in developing consistent recommendations for protected area practices worldwide. This study's objectives are: 1. Develop a conceptual model of VUIM explaining the threats to monitoring programs 2. Identify best practice criteria for VUIM programs 3. Use best practice criteria to evaluate the role of VUIM in a protected area system. The initial study is designed to collect data on VUIM approaches and practice in Australian protected areas. Our guiding hypothesis is that the variation of VUIM in protected areas is related to the environmental, social and cultural attributes of these areas. An understanding of the commonalities and challenges of VUIM programs can benefit a variety of protected area systems. The research questions for this project are:

1. What are the levels and types of VUIM programs in protected areas of Australia, and to what extent are visitor-related impacts emphasised in overall natural resource monitoring programs in Australian protected areas?
2. What characteristics of protected areas and protected area monitoring practices foster flexibility and adaptability of VUIM programs?
3. To what extent are protected area practices are influenced by protected area monitoring for different protected area types and locations?
4. Are Australian VUIM programs consistent with with monitoring and indicator recommendations for practice?
5. Can the VUIM of these protected areas be considered an adaptive approach?

Answering these questions will be done in a three-part study. First, an existing national survey of Australian park monitoring programs dataset will be analysed in conjunction with Griffith University to determine the extent parks are participating in impact monitoring programs as part of their management strategies and the variety of indicators used in these programs. The dataset covers a large set of protected areas and consistencies between monitoring plans and practice

were tracked. This part will be initiated in the EAPSI Summer 2006 trip to Australia and help to answer research question one.

Second, a sample of parks from the dataset will be evaluated to gather evidence of monitoring and related practices. These parks will be selected from the initial set of parks that will be identified by region and viability of existing park monitoring program. Follow-up questions will be directed to managers to understand observations and their potential connections between monitoring and management practices. This phase of the research project will require development expected observations that indicate VUIM, management, and connection of monitoring and park practice. This part of the research will answer research question two and three.

Finally, analysis of findings and a comparison between Australian protected area-monitoring programs will be conducted to evaluate system wide commonalities and challenges. Recommendations for practice will be developed and compared to the protected area programs to identify the most adaptive VUIM programs. This part of the research will answer research questions four and five.

Research activities

First, the state of stage one was aimed to examine the existing dataset about national park monitoring. It is a rich dataset that was limited to New South Wales National Parks because at the time of the original data collection NSW had the most information available. Many of the States did not have or publish information relating to management plans and monitoring. The NSW parks are also of interest because unlike most AU States the NSW management system is decentralised and focuses efforts by ecoregion. I contributed to this project by working with the centre to update from 2002 and produce a manuscript about the state of monitoring in NSW based on this dataset.

Second, Enhancing the national parks monitoring data with Queensland and Victoria Park plans. Starting enhancement of the existing dataset of NSW with information from Queensland and Victoria National Parks. I had hoped to make this into a full dataset for a full National Parks survey, but it was unwise to try to do a comprehensive national survey in my limited time in Australia without a full existing dataset. I have learned a great deal about park monitoring priorities, but I did not see this as an efficient use of my time here. I have left this task for the time being, but intend to work on it incrementally to develop a dataset that can be revisited in the future.

Third, Identifying a sampling structure for future research including a large-scale comparison study starting with my dissertation work. World Heritage Areas (WHAs) across the globe have vast differences in available support and sophistication in management. Looking at the level of monitoring and reporting of the believably advanced systems of US and AU can inform developing systems. WHAs are a natural choice for a root state of comparison, because in the US and AU there is a similar expectation of reporting internationally. The management of WHAs in AU is generally left to the national parks controlled by the states. The Commonwealth is responsible for international reporting, but the States are carrying out the park functions including monitoring with the exception of Commonwealth areas (i.e. Kakadu, Uluru, and Great Barrier Reef).

Additionally, I was able to interact with several researchers working in similar areas. As well as participate in a few days of fieldwork and several discussions about the direction of research in this field in Australia and other countries.

Perspective of research after this program

The research topic has been opened to me in a larger context. Additionally, I have been able to experience the climate and organisation of the Centre which lended a great deal of perspective as to how this work is done abroad.

Advisor's remarks

As Jessica mentions in her report, we are writing a joint research article on impact monitoring in national parks, combining our previous data and her work during her visit.

We also expect to host a visit by her and her US PhD supervisor next year to expand the scope of cross-continental comparative work. Our plan is to compare the use of impact monitoring in the management of tropical, warm and cool temperate World Heritage areas, in each continent. It appears that Jessica's PhD thesis will make extensive use of this cross-continental comparison.

I think Jessica was surprised – as many US visitors are – to find how much we have already done in Australia. The Recreation Ecology Research Network, which we started under another of the Academy's programs, has been well received internationally, and Australian research showed up very well at a recent international conference in Switzerland (MMV3). Jessica's supervisor is one of the founding members of RERN and we shall look forward to their visit next year.

So it would seem to have been a very successful visit. Our thanks to the Academy for supporting Jessica's project.

Name: Alyson Sagle

University: University of Texas at Austin

Research advisor(s): Dr Vicki Chen

Host institution(s): University of New South Wales

Research subject

Surface characterisation of polymer-coated reverse osmosis membranes

Research description

Membranes are materials used in water purification applications. Reverse osmosis (RO) membranes remove monovalent salt ions from water. The majority of commercial reverse osmosis membranes are crosslinked polyamide thin film composites which can achieve at least 99% rejection of NaCl from solution.

Effective use of RO and other membranes in water treatment is limited by membrane fouling. Fouling occurs when particles, called foulants, are deposited on or inside the membrane, drastically reducing water flux and limiting the membrane lifetime. Fouling prevention is a key focus area to enhance membrane lifetime and performance.

Membrane surface charge plays a significant role in membrane fouling. For example, charged particles would be attracted to an oppositely-charged surface, promoting membrane fouling. Zeta potential, ζ, is a measure of surface charge and is calculated using streaming potential measurements. Commercial RO membranes are known to have a negative surface charge, a remnant of its material chemistry and manufacturing process. Measuring this charge would lend insight into observed fouling behaviour in the presence of charged particles.

A proposed means for preventing membrane fouling is applying a dense hydrophilic polymer coating over the membrane surface. A hydrophilic coating would allow for water to continue permeating through the membrane, and a solid film would prevent particles from entering membrane pores. Poly (ethylene glycol) (PEG) based materials are being investigated as possible coating materials due to their hydrophilic nature and favourable water transport properties. Determining the PEG material surface charge will be instrumental in predicting the fouling behaviour of coated membranes.

Proteins and other biomaterials are key culprits in membrane fouling. Two methods are investigated for measuring the amount of protein on the membrane surface: the Lowry method and MALDI-MS. Each method is widely used in the biochemistry sector, but both are experimental in their application to membranes. The Lowry method involves protein extraction from the membrane surface and then a series of reactions to produce a product absorbing UV light. UV absorbance is measured and correlated to a protein concentration. The method can detect microgram quantities of proteins. MALDI-MS or matrix-assisted laser desorption ionization mass

spectrometry was also used to measure adsorbed proteins. MALDI can distinguish both the amount of protein absorption and the identity of the absorbed species, and it can detect femtomole quantities of proteins. MALDI measurements use a laser to cause the analyte to desorb directly to an ionized gaseous state. The gaseous analytes are then analysed using time-of-flight mass spectroscopy.

Research activities

Zeta potential measurements

Zeta potential measurements were performed using an Anton Parr Electrokinetic Analyzer. Preliminary tests examining the effects of solution pH, electrolyte, and electrolyte concentration on ζ of a commercial reverse osmosis membrane were performed. GE AG brackish water reverse osmosis membranes were used. In concordance with literature values of similar polyamide RO membranes, the GE AG membrane isoelectric point, the pH where ζ is zero, was between pH 3 and 4, and the magnitude of ζ increased as the electrolyte concentration decreased.

Next, the GE membrane was compared to another commercial RO membrane, the Dow Filmtec XLE RO membrane. Both membranes are crosslinked polyamides with their main differences stemming from their respective manufacturing processes. 2000 mg/L NaCl was the electrolyte solution used because it is the typical feed solution for these membranes. Figure 1 shows that both membranes have similar isoelectric points, but the GE membrane appears to carry a slightly larger negative charge at higher pH values. The relative similarity between the two membranes was expected due to their essentially identical chemistries.

Finally, zeta potential measurements were performed on a series of PEG hydrogel films being considered for membrane coating. The measurements were taken under the same conditions as the RO membranes. As Figure 2 demonstrates, the 100% PEGDA crosslinked film and the copolymers all showed similar behaviour. None of the films exhibited an isoelectric point, and ζ appeared to remain relatively constant over the entire pH range. Most importantly, all the films carry significantly less negative charge than the two RO membranes shown in Figure 1, indicating that a PEG-coated membrane would be less likely to foul when subjected to oppositely charged particles than an uncoated RO membrane.

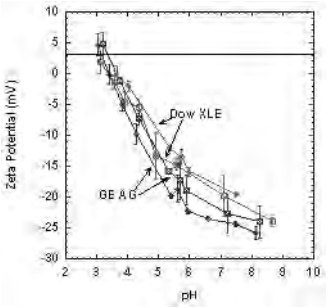


Figure 1: ζ for two commercial RO membranes

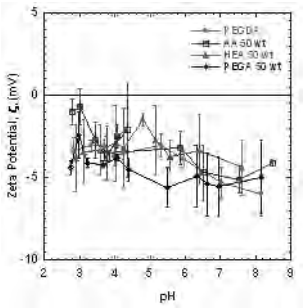


Figure 2: ζ for PEG-based films

Evaluation of protein adsorption: Lowry method and MALDI-MS

Static protein adsorption tests were carried out on GE AG membranes using bovine serum albumin (BSA) as a model protein. Solutions were made of 0.1, 1, and 5 wt% BSA, and the pH was adjusted to

7 using 0.1 M NaOH. Samples were exposed to 20 mL of BSA solution for a given length of time, rinsed three times in deionized water, and dried before Lowry or MALDI analysis.

The Lowry method was used to construct a calibration curve, but it was not linear as expected, and therefore was not used to convert absorbance values into protein amounts. Water soaked AG membranes and BSA exposed membranes were both tested using the Lowry method. No significant difference was seen between membranes soaked in water and those soaked in 0.1 wt% and 1 wt% BSA for 2 hours. Membranes soaked in 0.1 wt% BSA solution for 68 hrs did show a higher absorbance than the control membrane, suggesting that absorption increases as a function of time. In general, Lowry measurements were not highly reproducible and showed a large amount of error, most likely due to sample contamination.

Membrane samples soaked in BSA solutions were also analysed using MALDI-MS. Even though MALDI is more sensitive than the Lowry method, BSA was not detected for most samples tested. One sample soaked in a 5 wt% BSA solution for 2 hours did show a small amount of BSA on the surface. However this peak was not seen in spectra taken of different sections of the same membrane, demonstrating the variability of the technique. Even though the MALDI results were not conclusive or reproducible, the technique is still experimental in its application to membrane characterization and with time and practice could become a very powerful tool in analysing protein fouling of RO membranes.

Perspective of research after this program

This research experience served as a reminder of exactly how unpredictable and frustrating research can be. Despite my best efforts, I was not able to collect all the data that I had projected. Through various combinations of instrument malfunctions, difficulties with sample preparation, and general unfamiliarity with the laboratory surroundings, my progress was much slower than expected. However, even without producing world-changing results, I was exposed to new techniques, methods, and expertise.

Advisor's remarks

Ms Sagle was able to conduct some preliminary experiments on surface charge on her RO membranes and be exposed to a number of novel surface characterisation techniques developed in our Centre. While a good range of streaming potential experiments were accomplished, further work in extending our MALDI-MS techniques to RO membranes needs to be undertaken. We plan to continue the collaboration with future characterisation work on Ms Sagle's samples.

Name: Kathleen Staffier

University: University of Wisconsin at Madison

Research advisor(s): Dr Tom Blenkinsop

Host institution(s): James Cook University – Townsville, Qld

Research subject

Understanding the effects of Proterozoic deformation in the Kalkadoon-Leichardt belt, Mt Isa, Australia

Research description

The aim of this study is to investigate a Precambrian mountain building episode in Queensland, Australia, known as the Isan orogeny (Blake et al., 1990). The Precambrian rocks affected by the Isan orogeny are exposed in a region of northwest Queensland called the Mount Isa inlier. The purpose of studying this area is three-fold: 1) To understand mountain building in the mid-Proterozoic (1.5 Ga or billion years ago) and to compare the tectonic style to ongoing orogenic belts (particularly the North American Cordillera); 2) To understand the nature of supercontinent assembly as it occurred 1.5 billion years ago; and 3) To provide a tectonic context for the development of the massive economic mineral deposits of the Mt Isa inlier.

Research activities

The main research activity associated with this project was reconnaissance mapping of rock types and structures present in the Kalkadoon-Leichardt Belt, a region of igneous and metamorphic rocks in the central part of the Mount Isa inlier. This was conducted over an 8 week period from July 10 to August 29. Mapping included identification of rock composition and measurement of structural elements such as foliation, folds, veins, faults and shear zones. Samples were also collected at all sites for geochemical and structural analyses to be performed at the University of Wisconsin-Madison Department of Geology & Geophysics. These analyses will provide information necessary for determining the origin and tectonic path of the rocks exposed in the Kalkadoon-Leichardt Belt. However, much more work, including more detailed mapping and structural analyses, are necessary before any conclusions can be made as to the geologic history of the field area.

Perspective of research after this program

This program afforded me an opportunity to design and begin a research project which will be the basis for my future PhD studies. As such, it gave me a more realistic perspective to research in general, allowing me to understand the difficulties and complications that can arise.

Advisor's remarks

Ms Staffier participated in geological field work and teaching in North Queensland in conjunction with James Cook University School of Earth and Environmental Science field program in the Mount Isa inlier from June to August. She also helped with supervision of two visiting students and partly designed their field program.

Her fieldwork concentrated on two areas on the inlier. In the first area, she constructed a very detailed map of an outcrop and collected approximately 30 orientated cores of deformed rocks for microscopic analysis. She also collected suites of core for paleomagnetic work from a wider area around this outcrop. The second area comprised a significant part of the inlier, in which she conducted regional scale structural analysis as well as sampling.

Both of these programs were highly successful in terms of acquiring field data. Moreover, they have initiated research on new hypotheses for the geological evolution of the areas. Assessing the full significance of the results awaits further laboratory analysis, but I have every confidence that at least two papers may be the outcome of this research, publishable in top quality international journals. This is an impressive achievement for a single field season.

Name: Jan Weiss

University: University of Colorado, Boulder

Research advisor(s): Professor Chris Rizos and Professor Andrew Dempster

Host institution(s): Satellite Navigation and Positioning (SNAP) Lab, University of New South Wales

Research subject

Validation of a GPS multipath model in an urban environment using 3D LiDAR-derived structural models

Research description

Several error sources affect GNSS measurements including orbit and clock errors, ionospheric and tropospheric delays, and multipath. Often multipath is the dominant GPS error source, especially in high accuracy applications such as aircraft precision approach and geodetic measurements. Multipath errors occur when the GPS receiver tracks not only a satellite's direct signal but also signals which have interacted with the local environment. Since multipath is specific to a given environment it is not easily predicted or removed. In many applications one would of course like to mitigate multipath errors as much as possible, so it is important to understand how and where it occurs and how it affects the GNSS receiver system.

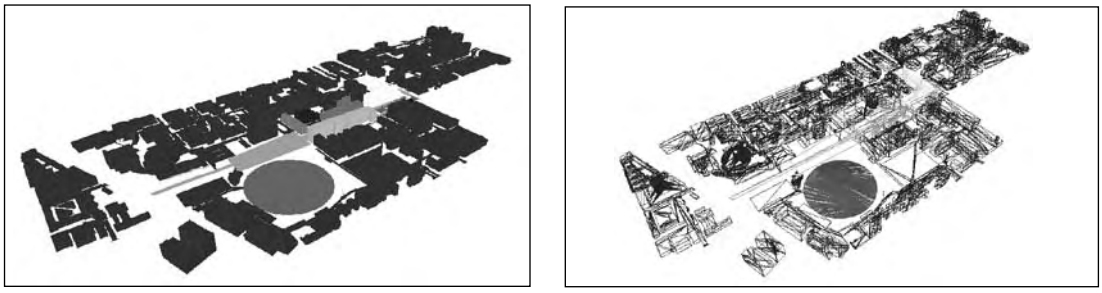
An advanced GNSS multipath model has been developed at the University of Colorado [1,3] and is extended in this research. This model simulates GNSS signal propagation in complex 3D geometries and encompasses detailed antenna and receiver tracking loop simulations. The model is capable of simulating any number of ranging signals and receiver tracking loop configurations in addition to fixed and controlled radiation pattern antennas.

This research extends the multipath model in two ways. First, a large environment model of the UNSW campus derived from light detection and ranging (LiDAR) measurements is integrated into the overall model. The environment model is accurate to ~25 cm and covers an area of about 1 km x 0.5 km. This is our first implementation of a complex urban environment model of this size an accuracy. Experimental data are also collected in several locations on the UNSW campus for the purpose of model validation. This is accomplished via comparisons of code multipath time histories and overall error statistics. In addition to validation, the experimental and simulated data are used to evaluate a new algorithm for estimating electrical properties. This is a least-squares algorithm which minimises the difference between the experimental and simulated multipath time histories by adjusting the reflection coefficient and phase offset of each material type.

Research activities

The research project encompasses several tasks. The first is environment modeling. This work begins with an existing georeferenced structure model of rooftops and ground/lawn areas of the UNSW campus. The data were collected in a previous UNSW Satellite Navigation and Positioning

(SNAP) lab study and were made available for this project. The data are stored in an ArcGIS shapefile and are initially extruded so that all structures are defined in 3D. A digital elevation model (DEM) of the terrain around the UNSW campus is used as well, such that the extrusion correctly captures both building base height and roof height above the ground. The shapefile model is then exported to AutoCAD Drawing Exchange Format (DXF). This is imported into the WinProp ray-tracing software from AWE Communications which performs the electromagnetic ray-tracing computations. WinProp allows for basic geometry editing functions and it is here that several missing surfaces (smaller sidewalks) are added. Material properties are also defined at this stage, separately specifying various buildings near the test sites. Initial reflection and diffraction coefficients are defined based on previous work [3]. The resulting model includes ~27600 surfaces and is shown in Figure 1. Note that different colors denote separate material properties. The test sites are located near the non-blue buildings.



Solid view **Mesh view**

Figure 1: UNSW campus model

The second task consists of experimental data collection. Here, a Novatel OEM4 GPS receiver with a GPS-702 antenna recorded measurements for 6-8 hours at three locations on the UNSW 'Mall'. To ensure reliable tracking and more limited susceptibility to long delay multipath, the receiver was set to code track with a fixed 0.1 chip (i.e., narrow) correlator spacing. The recorded data types include L1 and L2 pseudorange and carrier phase, signal-to-noise ratio, satellite visibility, and associated measurement quality and validity flags. The test sites were chosen because they provide good satellite visibility and have limited exposure to vehicle traffic. This ensures that the majority of multipath will be due to buildings and terrain rather than dynamic objects that are not modeled. The experimental setup at these locations was in fact challenging because power for the GPS and computer equipment had to be provided via batteries and because protection of the equipment from weather and any passers by had to be ensured. These challenges imposed unexpected delays but were eventually overcome, and the collected data include approximately 150 satellite hours across three test sites. The experimental setup for Location 1 is shown in Figure 2.

Figure 2: Equipment at location 1

The next task is the running of simulations that are setup to mimic the experiment as closely as possible. For example, simulated receiver tracking parameter such as correlator spacing and front-end bandwidth are matched to the real equipment, and the receiving antenna gain and phase pattern model is based on anechoic chamber measurements provided by the manufacturer. The satellite tracks for each of the data sets are simulated with consideration of up to 2 reflections and/or 1 diffraction in the ray-tracing computations. To limit the computational time, only surfaces within 400 m of the antenna are considered. Even with a limited area, there are still on the order of 7000 surfaces for the ray-tracing to consider so computations take 2-3 days per satellite at a 1/10 Hz simulation rate using a standard pc.

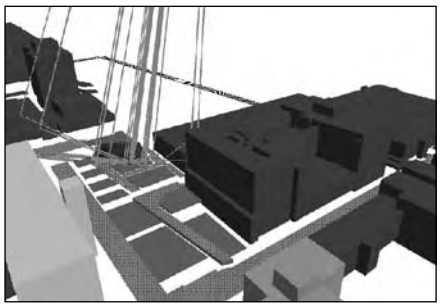


Figure 3: Sample signal path snapshot showing reflection/diffraction interactions

Due to the long computational times required by ray-tracing , only preliminary results are available at this time. These represent location 1 and include 45.5 satellite hours. Figure 4 shows a sample code multipath time history for Location 1. This represents the ranging error to a particular satellite over time due to the presence of multipath. One can see that the simulation correctly predicts when large multipath errors occur although the magnitudes are sometimes off. Figure 5 shows the overall error statistics according to satellite elevation bins. It is expected that the errors will be larger at low elevations and smaller at high elevations due to more limited multipath when satellites are high in the sky. The simulation mimics this trend but again the magnitudes are sometimes off, especially in the 5 10 deg and 80 90 deg bins. The low elevation difference is mostly due to low signal level tracking problems in the experimental data (i.e., cycle slips) which are not modeled. The high elevation bin discrepancy indicates that the modeled ground reflection coefficients are set too high as multipath for high elevation satellite geometries is typically caused by the ground. Previous experience indicates that the consideration of second order interactions in the simulations will improve these results. These simulation are expected to be complete by early November, 2006.

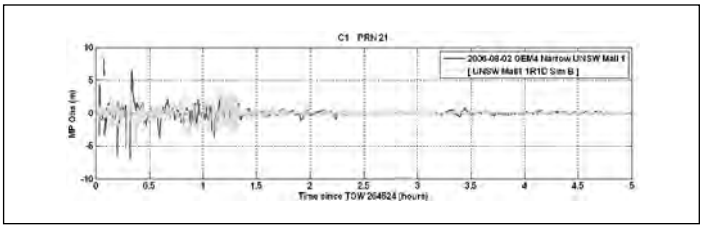


Figure 4: Sample multipath time history comparison for UNSW Location 1

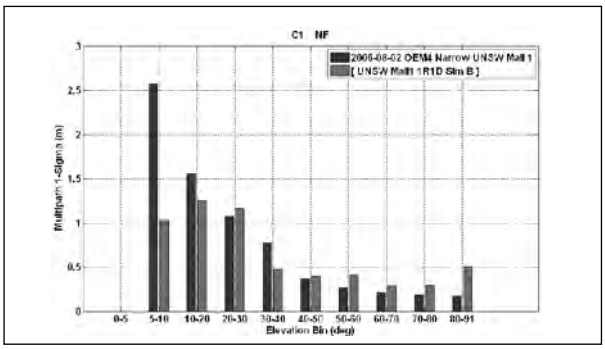


Figure 5: Error statistics comparison for location 1

Finally, a least-squares algorithm for material property is developed and evaluated. The premise of the algorithm is that geometric delays are accurately modeled while material properties may not be specified correctly. Instead of manually adjusting material properties, this algorithm estimates how initial values should be changed in order to achieve the best match between the experimental and simulated multipath data. A sample result for a test simulation is shown in Figure 6. Up to two interactions are considered and up to two reflectors are active at any one time. The blue line represents the experimental data (including tracking noise) and the red line shows simulated multipath resulting from incorrect reflection coefficients and phase offsets. The green line is the simulated multipath error after applying the estimation algorithm to the data. One can see that the improved result matches the real data quite well. Further testing of the algorithm against experimental data will be performed once simulated second order interaction data are available. Details on the algorithm, including equations, are provided in [2].

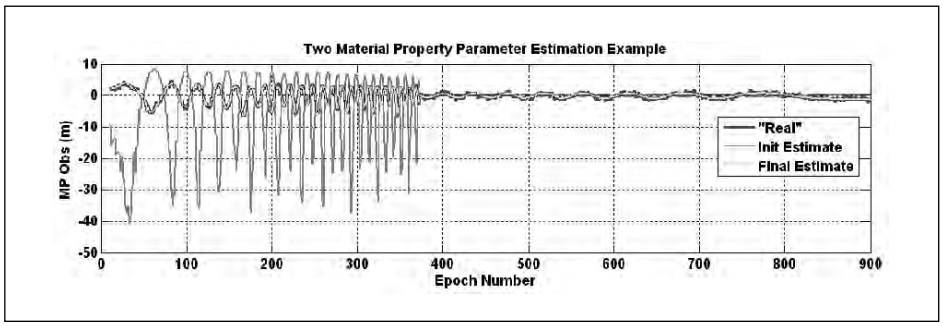


Figure 6: Sample material property estimation results

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2. Weiss, Jan P. *Extension and Testing of the CU Multipath Model for an Urban and Rural Environment*. Staff / Student Development Seminar presented at the University of New South Wales, Sydney, Australia, August 22, 2006.

3. Weiss, Jan P., S. Anderson, P. Axelrad. *Improved Multipath Model Validation in Semi-Urban, Aircraft, and Shipboard Environments*. Proceedings of the International Global Navigation Satellite Systems Society Symposium 2006.

Perspective of research after this program

The EAPSI research experience has been beneficial in a number of ways. The program offered me a focused opportunity to pursue new research and expand existing work with help and expertise provided by the UNSW SNAP group. Overall my research perspective has been broadened by the program because I feel more knowledgeable about work done at various international institutions and am interested in further collaboration in the future. While US university education and research are excellent and highly regarded around the world, similar excellence exists elsewhere and it is important to be aware of and connected with it. The goal of such connections should be both in a spirit of friendly competition and combined efforts for more effective progress.

Advisor's remarks

Andrew Dempster: We appreciate having international visitors to our group because we are geographically distant from the world's main research centres and understand that travel to Australia can be long and time differences can cause problems. Jan's visit was a good one - relatively short for doing a defined research project but this did not prevent him from accumulating several good data sets in a new, large, model derived from our laser scan of the UNSW campus. As is often the case, most of his time was actually spent solving problems with the equipment and data formats that he had to work with. He overcame these obstacles well, demonstrating good engineering skills. He presented twice at our research seminars, on his earlier work then on what he did here. Both these presentations were clear and engaging. In that respect, he disseminated his ideas well and the group here benefited from his visit. We look forward to a growth in the relationship with Jan and his institution.

Chris Rizos: Andrew has provided the input from our side. I echo his sentiments that we got a lot out of your visit and are eager to participate in this scheme in the future.

Name: Meredith Wright

University: University of Georgia

Research advisor(s): Professor Harold W Stokes

Host institution(s): Macquarie University

Research subject

The structure and function of the class I integron-associated gene cassette pool in environmental bacteria under varying degrees of selective pressure (microbial ecology/evolution)

Research description

An objective of my dissertation research is to conduct an in depth characterisation of genetic determinants that may be involved in the co-selection of metal and antibiotic resistance in environmental bacteria. As such, integrons are of particular interest because they are genetic elements through which bacteria can rapidly evolve through the acquisition of new genetic material (i.e., gene cassettes). My previous research indicates that class 1 integrons are significantly more abundant in metal-exposed bacterial communities in comparison to bacteria from reference sites, yet this does not reveal what aspect of the integron is being selected. The potential genes that are contained within integrons are therefore in need of examination for both structural aspects (e.g., gene diversity) and functional aspects (gene function). To assess the hypothesis that selective pressure constrains the diversity of the cassette gene pool, I compared the number and the relative abundance of different gene cassettes between metal-contaminated and reference sites. This approach takes advantage of the fact that gene cassettes vary in size due to differences in their coding sequences. Diversity metrics can then be used to quantitatively assess differences between sites, and similarity scores can be calculated to assess whether a selective pressure shapes gene cassette structure at different sites. Additionally, to assess gene cassette function, gene cassette PCR products from environmental samples were sequenced using primers shown to effectively recover gene cassettes from diverse habitats. Though previous sequencing attempts using this approach have identified gene cassettes with little to no similarity to annotated genes in database searches, this aspect of the study will yield information regarding potential qualitative differences between integron-associated genes in contaminated and reference locations. Results from this study will be used in conjunction with the quantitative assessment of integrase abundance from ongoing work for a fuller understanding of the role integrons play in gene acquisition in sites where bacteria are exposed to a selective pressure.

Research activities

To assess gene cassette structure and function, I modified a method previously developed in my host laboratory to assess the diversity of gene cassettes in environmental samples so as to target

gene cassettes associated with just class 1 integrons. I analysed a variety of environmental samples including freshwater and estuarine sediment samples that varied in extent of metal contamination and analysed experimental microcosms in which bacterial exposure to metals was directly manipulated. As a side project, I worked with a graduate student at University of New South Wales to assess the structure of class I gene cassettes in bacteria from Antarctica. Gene cassettes were obtained from DNA extracted from environmental samples though PCR amplification using fluorescently labelled primers that target conserved regions of the gene cassette. Gene cassette PCR products were then analysed on a capillary sequencer that separates DNA fragments based on size differences. I then sequenced numerous gene cassette PCR products to assess potential function of these genes and to validate the method. Sequencing efforts revealed that many of the gene cassettes generated during PCR amplification were actually false positives due to non-specific PCR amplification thereby invalidating my gene cassette data.

Perspective of research after this program

Though the data I collected turned out in large part not to be valid, I still learned new techniques that I can modify to apply back in my home laboratory. Additionally, I was exposed to new information and ideas, and was able to interact with researchers whose expertise varied from mine.

Advisor's remarks

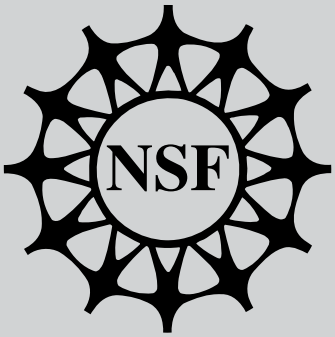
Meredith was an asset in the lab and a pleasure to host. She accomplished a lot in her short time in my lab despite the fact that some of the avenues of work tried were unsuccessful. Nonetheless, the skills she learned and ideas she exchanged have helped initiate joint work with Macquarie but also with workers at La Trobe and UNSW as noted.

Australian Government

Department of Education, Science and Training

If you are interested in hosting a US graduate student, or would like more information about the program, please contact the International Programs section at the Australian Academy of Science, email is@science.org.au, phone (02) 6201 9411 or visit: **www.science.org.au/internat/eapsi.htm**.

More information on the EAPSI Summer Program, including application forms and deadlines, is at the NSF Website: **www.nsf.gov/funding/pgm_summ.jsp?pims_id=5284**.



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