

BOARD OF MANAGEMENT (as at 31 December 1999)

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Mr R Penney	Santos Ltd

Director's Report

1999 was a very busy and exciting year for the NCPGG. As those who have visited recently know, the Centre has a new look. In August we moved into bright new offices across the road from our old cosy, but worn, premises on the University of Adelaide's Thebarton Campus¹. The NCPGG has recently been joined on the Thebarton site by Schlumberger/Geoquest's Adelaide offices, and collaborative projects are planned (watch this space).

More significant even than the new physical environment, are the major changes in personnel that have recently taken place. The most recent arrival is Richard Hillis. Richard joined the Centre in September from Adelaide University's Department of Geology and Geophysics to take up the State of South Australia Chair in Petroleum Reservoir Properties/Petrophysics, becoming the University of Adelaide's youngest professor. Richard is well known for his work on in situ stresses and their application to hydrocarbon exploration and development. In July, Simon Lang, from Queensland University of Technology came aboard as Associate Professor in Clastic Sedimentology. Simon has worked extensively on reservoir characterisation and sequence stratigraphy in modern and ancient petroleum systems. Peter Tingate commenced as a lecturer at the Centre in April, specialising in Basin Modelling/Diagenesis. Richard, Simon and Peter join Centre stalwarts Andy Mitchell (Petroleum Geophysics) and Nick Lemon (Petroleum Geology).

Several research fellows have also joined the NCPGG team this year. Richard Jones (Fault Seal Analysis/Evaluation) joined from Leeds University's Rock Deformation Research Group and Ghazi Kraishan (Sedimentology and Reservoir Characterisation) from ACS Laboratories in Brisbane. Thomas Flottmann (Structural Geology) and Scott Mildren (Petroleum Geomechanics) moved to the NCPGG from Adelaide University's Department of Geology and Geophysics. Richard, Ghazi, Thomas and Scott join existing research fellows Abbas Khaksar (Petrophysics) and Chris Dyt (Numerical Modelling). Often unheralded, the admin staff (Maureen Sutton, Barbara Wallis, Nick Mann) were indispensable for keeping the day to day activities of the Centre going throughout 1999.

The appointments of Hillis, Lang, Tingate and the rest of the new members of staff are part of the overall commitment by the NCPGG to continue as one of the top providers of petroleum geoscience technology to industry, government and academia. As you will read in the following pages, the NCPGG is involved in a number of leading-edge research programs. These include our Australian Petroleum Cooperative Research Centre (APCRC) projects on seal evaluation, reservoir characterisation, formation damage, hydrocarbon migration, pore pressure prediction and the geological disposal of CO₂. In addition, non-APCRC research on behalf of industry also flourished. As successful as we were in our research and contract research efforts, preparation of students for careers in the oil industry remains, arguably, the most important role of the Centre. In this light, it was a special pleasure this year to graduate 14 Honours students (the largest class in the history of the Centre). In addition to the Honours group, we had 8 MSc and 20 PhD students on the books. Innovations in Education and Training figure in the recent development of a new cross-disciplinary MSc degree in Reservoir Geoscience which has been inaugurated in conjunction with the School of Petroleum Engineering at the University of New South Wales.

As with most other organisations in the petroleum business, the environment at the NCPGG is continually changing. In this regard, Cedric Griffiths, former Professor of Petroleum Geology, departed the Centre to pursue new challenges. Several Post-Docs have moved on and several postgraduate students have finished up and left to begin their careers. Sadly, Ted Moorcroft, well-beloved Business Manager of the Centre since 1991, passed away suddenly in September. A very uplifting (and very much “Ted”) memorial service was held. Similarly, David Gravestock, long-time friend of the NCPGG, Research and Education Committee member, and Visiting Research Fellow, succumbed to cancer in December. Ever the pragmatists, Ted and David would have said that life goes on – think of the future: one of the most exciting developments with regard to future directions was the announcement of a new \$25M Santos School of Petroleum Engineering at the University of Adelaide. The NCPGG expects to have very strong synergies with this new School.

In its new building, and with its dynamic new staff, the NCPGG is already looking forward to the years ahead. We will continue our core function of training students for careers in the petroleum industry and will further develop the already extensive range of projects with industry and government. I am truly proud to be a part of this exciting group, pleased at its achievements for the year, and expect even greater accomplishments for the years to come.

¹ The new address is 1st Floor, 30-32 Stirling Street, Thebarton Campus, University of Adelaide, SA 5005. Other contact details (phones, faxes and e-mails) are unchanged.

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About the NCPGG

The National Centre for Petroleum Geology and Geophysics (NCPGG) was established in 1985 by the Commonwealth Government as one of a number of Key Centres to promote teaching and research. It is a cooperative venture between the University of Adelaide and the University of South Australia and is a partner in an unincorporated joint venture with CSIRO Division of Petroleum Resources (DPR), the School of Petroleum Engineering at the University of New South Wales and with Curtin University. This venture, the Australian Petroleum Cooperative Research Centre (APCRC) is funded by Federal and State Governments and the petroleum industry.

The NCPGG prides itself in providing leading-edge technology in Petroleum Geoscience to Industry, Government and Academia. This technology is focused through education, research, training and technical services.

Preparation of students for rewarding careers in the oil and gas industry remains the most important role for the NCPGG. However, with the volatility of the industry, placement of students in meaningful positions is a continuous concern. This means that while job opportunities are limited, they are there, but only for those perceived to be adequately trained to perform. There is a "productivity gap" of somewhere between 8 to 10 years from the time a student decides to take up studies leading to a degree in geoscience until he or she accumulates enough experience/knowledge to be a productive petroleum geoscientist. Through the Honours, MSc and PhD program, NCPGG aims to provide well-trained and highly motivated individuals who can not only join the work force, but also "hit the ground running" thus lessening that productivity gap.

Research at NCPGG is designed to be practical and applied to the both the shorter and long-term needs of industry. Research projects thus focus on relevant issues in petroleum geoscience. These include exciting work on reservoir characterization and modeling, petrophysics, sequence stratigraphy, pore geometry, seal evaluation, etc. The research staff are dynamic, enthusiastic scientists dedicated to adding value through their experience and commitment to teaching and research.

Professional continuation training is another important role of the NCPGG. This is significant because technology in the field of petroleum geoscience is evolving so rapidly that most of us working in the field are rarely able to keep abreast of the majority of new advances. NCPGG offers a number of professional short courses that introduce or upgrade the understanding of many of these new technologies. Several of these short courses are provided as "road shows" able to be delivered in-house to companies or to technical associations. In addition, the course work provided to Honours and MSc students is presented in modular format, allowing interested individuals from industry or government the opportunity to audit parts of the curriculum.

Staff and/or students provide contract research, in the form of technical service projects, to industry and government clients. These projects are administered on a case by case basis, and optimally, many have the breadth to become Honours or MSc projects. Technical service projects are generally short turnaround, with specific deliverables and timetables, and mainly augment existing activities within the sponsoring organisation's portfolio. Because of the technical calibre of the Centre's staff and resources, high quality results are integral to the product.

NCPGG Staff - brief resumé

John G Kaldi, Director - PhD Cambridge. Senior Research Geologist for Shell, Senior Reservoir Geologist for ARCO Oil & Gas, Geological Specialist for ARCO Indonesia, Chief Geologist for VICO Indonesia. Research interests in reservoir geology, seal evaluation, formation evaluation, multidisciplinary studies and carbonate sedimentology and diagenesis.

Richard Hillis, State of South Australia Chair in Petroleum Reservoir Properties/Petrophysics - BSc (Hons) Imperial College, University of London (1985), PhD University of Edinburgh (1989). Postdoctoral Fellow at Flinders University and Senior Lecturer at the University of Adelaide (Department of Geology and Geophysics). Research interests in petroleum reservoir properties, contemporary stresses in petroleum exploration and development, and sedimentary basin tectonics.

Simon Lang, Associate Professor in sedimentology and sequence stratigraphy - PhD University of Queensland. Technician and Geologist, Geological Survey of Queensland (13 years), Lecturer in sedimentology and stratigraphy QUT (7 years). Research interest in reservoir- and exploration-oriented sedimentology and sequence stratigraphy, including both modern and ancient analogue studies.

Dr Nicholas Lemon, Senior Lecturer in petroleum geology - PhD Adelaide. Geologist with BHP Minerals (10 yrs). Research interests in structural controls on sedimentation, diagenesis, new methods of analysis of microscope images, reservoir characterisation at a pore level, formation damage at pore level, Flinders Ranges geology.

Mr Andrew B Mitchell, Senior Lecturer in petroleum geophysics - BSc(Hons) Adelaide. Eight years with Esso Australia. Research interests in seismic interpretation, processing, modelling and velocities.

Dr Peter Tingate, Lecturer - BSc (Hons) & PhD from the University of Melbourne. Main research interests include diagenetic controls on reservoir quality, basin thermal history, petroleum generation, apatite fission track dating and stable isotopes. Other interests include regional tectonics, geochronology and meteorite impacts. Peter is familiar with optical microscopy, cathodoluminescence microscopy, XRD, SEM, mercury injection, stable isotopes, thermal maturity data and basin modelling.

Dr Ghazi Kraishan, Research Fellow - PhD NCPGG, The University of Adelaide. Geological Services Supervisor with ACS Laboratories Pty. Ltd. (2 yrs) working on the integration of petrophysical properties and petrology. Project leader of pore-level reservoir characterisation and pore-level formation damage projects. Research interests include integration petrophysical properties and petrology, geochemical modelling, tight gas reservoirs, reservoir quality prediction.

Dr Chris Dyt, Postdoctoral Fellow - PhD Monash. Applied mathematician with a special interest in mathematical techniques for various aspects of geological modelling.

Dr Richard Jones, Postdoctoral Fellow - PhD Keele University, UK - Geologist for Geochem Group UK, Fault Seal Specialist at Rock Deformation Research Group, Leeds University. Research interests in fault and cap seal evaluation, petrophysics and reservoir characterisation.

Abbas Khaksar, Postdoctoral fellow-petrophysics - BSc-Mining Eng., Tehran, (1990), MSc Petrol. Geolog. & Geophys. NCPGG (1994), PhD-petrophysics NCPGG (1999). Research interests include rock physics and well log analysis, relation of seismic response with petrophysical and mechanical properties of rocks.

Scott Mildren, Postdoctoral Fellow - PhD Adelaide (1997). Structural geologist with Z&S (Asia) Ltd. (now Baker Atlas Geoscience). Currently researching the in situ stress field and neotectonics of Brunei and tight gas reservoirs in the Nappamerri Trough, Cooper Basin. Other interests include various petroleum applications of in situ stress studies, rock strength determination using neural networks and interpretation of stress induced features from image logs.

Mr Anthony J Hayball, Information Systems Officer - BSc(Hons) Flinders. Geologist with PIRSA. Specialising in UNIX system administration and Internet based information technologies.

Mr Nick Mann, Technical Officer

Ms Maureen Sutton, Administration Manager

Mrs Barbara Wallis, Administrative Assistant

Committee Participation

John Kaldi was elected secretary for AAPG Asia Pacific Region and as a Member of SPE Development Geology and Geophysics Committee.

Nick Lemon and Chris Dyt are members of the PESA Committee. Andy Mitchell and Richard Hillis are members of the ASEG Committee, with PhD student Mark Tingay as the student representative.

Conferences

During 1999 NCPGG staff and students were involved in many conferences both within Australia and overseas.

In March **Chris Dyt** attended the 5th SIAM Conference on Mathematical and Computational Issues in the Geosciences- San Antonio - and presented *Clastic Depositional Modelling with Sedsim*.

Nick Lemon and **Ian Dyson** attended the AAPG Conference in San Antonio in April. **Nick Lemon** gave the paper *Sea level influence on diapir movement: Enorama Diapir, Flinders Ranges, South Australia*. **Ian Dyson** presented the paper *The Pinda Diapir in the Adelaide Geosyncline of South Australia: and outcrop analog for subsalt* and posters *Salt tectonics and sequence analysis of Neoproterozoic successions in the Adelaide Geosyncline, South Australia*. And (with Bob Dalgarno) *Early Cambrian diapirism in the Adelaide Geosyncline, South Australia*.

The 1999 APPEA conference was in Perth and was attended by a total of ten staff and students. At the conference John Kaldi was Chair for the Borehole Technology Session.

Papers presented:

John Kaldi, Geoff O'Brien (AGSO) and **Tom Kivior** *Seal capacity and hydrocarbon accumulation history in dynamic petroleum systems: the East Java Basin, Indonesia and the Timor Sea Region, Australia*.

Stuart Smith, **Peter Tingate**, **Cedric Griffiths** and **Johnny Hull** *The structural development and petroleum potential of the Roebuck Basin*. This paper was given by Johnny Hull who received a commendation for his presentation.

Posters presented:

Chris Dyt, **Cedric Griffiths**, and **Evelina Paraschivoiu**: *Clastic depositional modelling with Sedsim: recent innovations and sensitivity tests*.

PK Das and **Nick Lemon**: *Transfer zones in extensional basins and their control on structural style and stratigraphy – implications for hydrocarbon exploration*.

Xiaowen Sun and David Gravestock (PIRSA): *Hydrocarbon reservoir potential of the Cambro-Ordovician Warburton Basin, South Australia*.

Cedric Griffiths, **Chris Dyt** and **Evelina Paraschivoiu**: *Three-dimensional forward stratigraphic modelling on the North West Shelf – status and future plans*.

Cedric Griffiths attended the Geological Society of London Conference – Geological Applications of Wireline Logs (GAWL III), London, in January, and presented the paper *Use of core and log in investigating the feasibility of time lapse seismic* which was written with **Abbas Khaksar** and **Andy Mitchell**.

The 61st EAGE Conference & Technical Exhibition, Helsinki, Finland, 7-11 June was attended by **Abbas Khaksar** where he gave a paper co-written with **Cedric Griffiths** – *Acoustic velocities in partially saturated sandstones versus effective stress*.

Cedric Griffiths was co-convenor of The Fifth Annual Conference of the International Association for Mathematical Geology in Trondheim, Norway in August.

Xiaowen Sun was invited to attend the 1999 International Symposium on Carbonates and Petroleum Exploration held in Hangzhou, China in September as part of a trip that was funded by The China National Petroleum Corporation. Xiaowen presented a paper *Carbonate sedimentation and sequence stratigraphy in a Palaeozoic frontier basin (Eastern Warburton), South Australia*. The conference was also attended by Honours student **Ben McLean**. As part of the trip Xiaowen also gave a talk *Fracture Study of the Warburton Basin* at China National Petroleum Corporation in Beijing following field trips held in conjunction with the conference.

Abbas Khaksar presented *Effective stress coefficient for P- and S-wave velocity and quality factor in sandstone, Example from Cooper Basin, Australia* at the 69th SEG Annual Meeting in Houston, a paper co-authored by **Cedric Griffiths** and Clive McCann (Reading University).

Short Course Presentations

John Kaldi gave a course *Compartmentalised Reservoirs* for SPE in Jakarta in March and then he and Andy Mitchell co-presented a three day course *Reservoir Geology and Geophysics for Engineers* to SPE Indonesia.

John Kaldi gave a short course *Evaluating Reservoirs and Seals* to CSIRO and UNSW in Sydney in May, to Santos Queensland in Brisbane in October and to the Japanese National Oil Corporation in Tokyo in December.

Andy Mitchell presented *Petroleum Geology and Exploration for Non-Geologists* for the Australian Mineral Foundation in Darwin in June and in Perth during July.

Simon Lang held a core sedimentology workshop for Santos Queensland and joint venture partners reporting on the results of Tartulla and Maxwell Field studies in November.

Presentations

Staff and students of the Centre are involved in the teaching programs at the University of Adelaide and the University of South Australia. This year, with the appointment of Associate Professor Simon Lang, this collaboration was extended to the Department of Earth Sciences at the Queensland University of Technology. In July Simon Lang was invited to participate in a 3rd yr BSc QUT and Uni of Qld field trip at Mt Isa with a focus on sedimentology and stratigraphy as well as field mapping skills. Nick Lemon, Cedric Griffiths, Richard Hillis, Simon Lang and Andy Mitchell have lectured to undergraduate and Honours students for the Department of Geology and Geophysics, complemented by demonstrating by PhD student Louise Christian. Hamish Young has demonstrated to undergraduate students at Applied Geology, the University of South Australia.

Whilst visiting the University of Texas at Austin as part of his AAPG conference trip, Nick Lemon presented two lectures to Level III students in *Hydrocarbon habitat of the Barrow Sub-basin and the Cooper Sub-basin*. Nick also gave presentations to the Department of Geological Sciences on *Sea level controls on diapir movement* and to the Bureau of Economic Geology; *Diapirs of the Flinders Ranges*.

Simon Lang gave a seminar, *Applications of sequence stratigraphy in Australian Basins*, as part of the Geological Society of Australia, SA Branch's public seminar series in August.

John Kaldi was the speaker at the August PESA lunch that was sponsored by PIRSA. His topic was *Seal capacity and hydrocarbon accumulation history in dynamic petroleum systems: the East Java Basin and Timor Sea region*.

Victoria Mackie and Jaime Livesey were the NCPGG representatives at the Geological Society of Australia Student Night in December giving presentations on their Honours projects.

Jaime Livesey, Ben McLean, and Lisa Ryan made presentations at the Australian Society of Exploration Geophysicists' Student Night. Ben received the award for the best presentation, and Lisa for best technical content.

Presentations were also given to companies including:

Abbas Khaksar - *Acoustic velocities in partially saturated sandstones versus effective stress*, to Boral Energy Resources (now Origin Energy), and *A petrophysical study on the influence of effective stress and fluid saturation on acoustic properties of sandstones*, for Santos in June and PIRSA in July.

Simon Lang - *Practical applications of sequence stratigraphy and reservoir analogues*, to Santos Ltd

In July the NCPGG was involved in co-hosting a booth at the CONASTA Conference designed for people involved in teaching science in schools. As part of the booth, also involving PESA, ASEG, SPE, PIRSA and SA Chamber of Mines, PhD student Hamish Young demonstrated a flume tank, which simulates the effect of changes in sea level and sediment supply on stratal architecture.

Awards

Students Jon Blank and Victoria Mackie were awarded HECS scholarships to support their Honours year. The scholarships were funded by PESA Federal Branch and BHP respectively.

David Quinn was awarded the Tony Williams Memorial Scholarship to assist with his relocation costs to travel from New Zealand to undertake his Honours degree.

Honours students Jon Blank, Nubia Bon and Nathan Ceglar were awarded Petroleum Geoscience scholarships for 1999, supported by Esso Australia, Strike Oil, and Woodside Energy respectively. These scholarships are a combination of vacation work and industry internship during the Honours degree.

Abbas Khaksar, whilst still a PhD student, received both a Travel Abroad Scholarship from the University of Adelaide, and a EAGE Student Travel Grant to fund his trip to the 1999 EAGE conference in Helsinki.

Honours students Victoria Mackie and Susannah Smart were both awarded PESA Scholarships worth \$1,000.

PhD student Rosalie Pollock was selected by the APCRC for support to attend the Leadership and Career Development Course held at James Cook University in late November. The CRC also successfully nominated Rosalie for a Business and Higher Education Round Table Scholarship which fully funded her attendance.

PhD students Peter van Ruth and Mark Tingay were awarded D R Stranks Travel Scholarships to travel to England and study at Durham University. They spent three months studying with the Geosciences Project into Overpressures (GeoPOP) research group headed by Dr Richard Swarbrick.

Rosalie Pollock received \$1500 from the Adelaide University D R Stranks Travelling Fellowship to travel interstate to conduct field work for her PhD project. She visited sites near Mount Gambier, South Australia and Princetown, Johanna Beach and Port Campbell along the Great Ocean Road on the southern Victorian coast. Many samples were taken for palaeontological analysis and results and photos have been included in a field report.

Visitors

Ulf Nordlund from Uppsala University, Sweden, visited the NCPGG in February to discuss the use of fuzzy logic in forward stratigraphic modelling with Cedric Griffiths. Ulf presented “3D Stratigraphic Modelling using Approximative Reasoning” as part of the NCPGG lunchtime seminar series.

Head of Petroleum Geology and Engineering at Colorado School of Mines, Roger Slatt visited the NCPGG and presented “Petroleum Geology of Turbidite Depositional Systems” on 30 March. This was a full day course forming part of NCPGG coursework program. The course was attended by NCPGG staff and students, and industry personnel. Dr Slatt also gave a seminar at a PESA lunch “Why Outcrop Characterization for Reservoir Studies?” On a return visit in December he presented “Compartmentalized Reservoirs: The Exception or the Rule?”. This was co-hosted by the NCPGG, Department of Geology and Geophysics and PESA.

Dr Bob Park, Principal Development Geologist for Maxus/YPF in Indonesia, visited the NCPGG in March and co-taught Carbonated Depositional Environments-Carbonate Reservoirs with John Kaldi. This course formed part of the NCPGG Coursework Program.

David Smith, StrataData Ltd, UK, visited Cedric Griffiths and gave the seminar “Cyclostratigraphy (or Have Your Rocks got Rhythm?) as part of the NCPGG lunchtime seminar program.

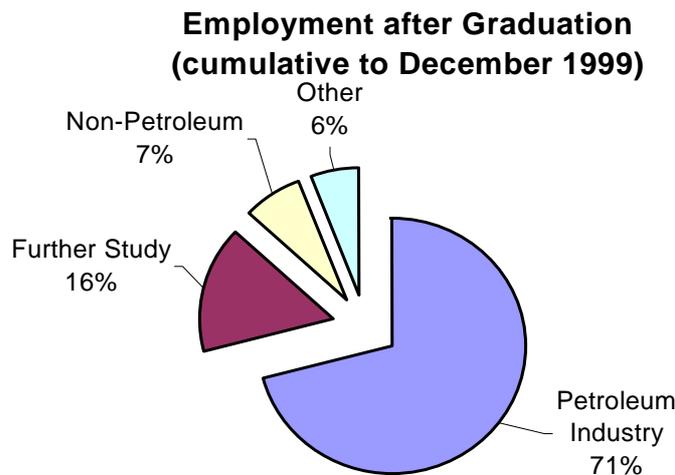
Several members of the Jordanian National Oil Company and Mines Department visited Australia in July and their trip was hosted by Amity Oil NL. As part of their trip to South Australia, PIRSA representatives brought the visitors to the NCPGG for a presentation and discussions on relevant research interests.

Ken McClay was the AAPG Distinguished Lecturer for 1999. The NCPGG, Department of Geology and Geophysics and PESA jointly hosted his lecture “Tectonic and Fault Models”, on the afternoon and evening of 12 July in the Mawson Lecture Theatre.

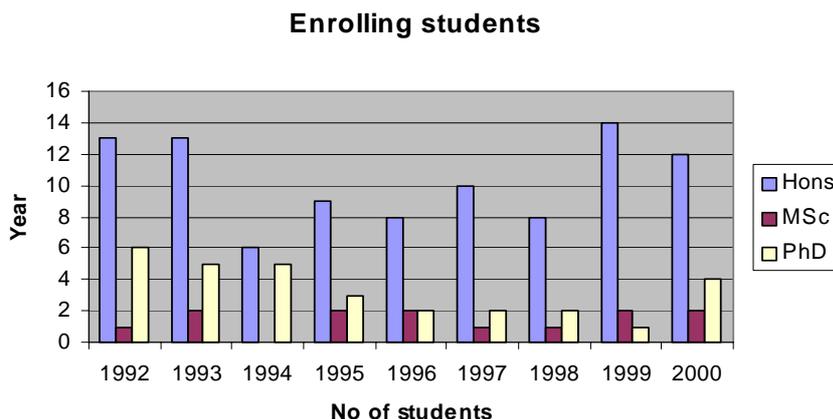
Dr Michel Rocheleau, Chair, Department of Geology and Engineering Geology, Laval University, Quebec visited the NCPGG from September to December. His visit was hosted by Assoc Prof Simon Lang. Michel was in Australia to make some new contacts in the sedimentology and stratigraphy research field, as well as taking some time to complete several papers he was writing. Whilst in Adelaide he gave seminars to the NCPGG and the Department of Geology and Geophysics, and visited the Flinders Ranges on a field trip with other staff members and families.

NCPGG Students

The NCPGG offers BSc(Honours), MSc and PhD degrees and a Graduate Certificate in petroleum geology and geophysics. Students can enrol through The University of Adelaide or The University of South Australia for any of the degree courses. The Graduate Certificate is available only through the University of Adelaide. Research projects for all Honours and most higher degrees are undertaken in cooperation with an industry sponsor. A paid six week industry internship with the sponsoring company at the start of the project is a compulsory element of the Honours programme. The excellent employment record of NCPGG graduates, as shown in the chart below, demonstrates the relevance to, and acceptance by, the petroleum exploration and development industry of NCPGG training.



In 1999 there were 14 Honours students, 2 student enrolled for the MSc and 1 for the PhD. There were no Graduate Certificate students this year. Enrolment trends for the past nine years are shown in the histogram below



The Centre attracts students from throughout Australia into its Honours and higher degree programs, and a typical Honours class comprises roughly equal numbers of local and interstate/international students. It has also gained an international reputation for excellence in teaching and research in its areas of expertise. Students from Canada, China, Germany, India, Indonesia, Iran, Jordan, Malaysia, Malta, New Zealand, Nigeria, Norway, Pakistan, the United Kingdom, the USA, Venezuela and Vietnam have graduated from, or are currently studying at, the NCPGG.

NCPGG Teaching Program

Coursework

The NCPGG coursework program is a compulsory part of the Honours, Graduate Certificate and MSc degrees, and appropriate units are also attended by PhD students as required. The courses are presented by Centre staff, academics from other institutions, and industry experts.

The program runs for 5 months, starting in early February and finishing at the end of June each year. In 1999, 36 topics were presented in modular format, ie as a series of consecutive short courses, varying between one and nine days in length, depending on the topic. This format is different from the "interleaved" presentation of units common in most undergraduate courses, and allows external lecturers to teach and industry personnel to attend the courses.

The NCPGG's multidisciplinary philosophy is reflected in the course curriculum. Approximately 20% of the course time is devoted to either specialised geological or geophysical topics. These are alternatives which allow the student some degree of specialisation. The remaining 80% of the course time comprises a core set of geotechnical topics which are taken by all students. These cover the basic concepts and techniques which need to be understood by any professional geoscientist in the petroleum industry. Such topics include structural geology, clastic sedimentology, reservoir description, sequence stratigraphy, petrophysics, development geology and seismic interpretation. The operational, commercial, managerial and legal aspects of petroleum exploration and development are also covered. There are several field trips, including an 8 day excursion to the Flinders Ranges. Most courses involve considerable practical work, and where appropriate, students obtain hands-on experience with industry-standard computer software.

The topics shown below were presented in the 1999 coursework program

1999 Coursework Units

Advanced Seismic Interpretation	Reserve Estimation
Australian Basins	Reservoir Game
Carbonate Depositional Systems	Reservoirs & Seals
Carbonate Diagenesis and Stable Isotopes	Sandstone Petrology and Diagenesis
Concepts in Sequence Stratigraphy	Seismic Acquisition
Core Analysis	Seismic Acquisition and Processing
CV Preparation and Interview Skills	Seismic Interpretation
Development Geology	Seismic Processing
Drilling Operations	Seismic Sequence Stratigraphy
Exploration Management	Seq Strat Models & Depositional Systems
Flinders Field Trip	Sequence Stratigraphy Field Trip
Flinders Post Mortem	Sequence Stratigraphy from Logs
Geolog Training	Signal Analysis
Micropalaeontology	Statistical Analysis of Log Data

Mudlogging	Structure
Organic Geochemistry	Thermal Maturation
Palynology	Turbidites
Regional Geophysics and Image Processing	Wireline Logging

Honours Program

After undertaking the coursework program, Honours students devote the period from July to early December to researching and writing up a thesis project. All projects have direct relevance to petroleum exploration, and are sponsored by oil and gas companies or Government bodies such as AGSO and State Mines Departments. Students will normally have both an academic supervisor from the NCPGG, and an industry supervisor from their sponsor company, for their thesis.

The first six weeks are spent with the sponsoring company, to gain exposure to the industry environment while commencing work on the research topic. Students are paid a scholarship by the sponsor during this period of industry internship.

Upon returning from their sponsor companies, students continue their research work, leading to the writing up and submission of their results in a thesis.

Fourteen students enrolled in the Honours degree in 1999. This included one interstate student, and two from overseas: one each from New Zealand and Norway. Two of these students were enrolled in the BAppSc(Hons) degree at the University of South Australia, and the remaining 12 in the BSc(Hons) degree at the University of Adelaide.

The following companies provided projects and generously provided industry internships for the 1999 Honours class. Their support is greatly appreciated.

- AGSO (2 students)
- Beach Petroleum
- Boral Energy (now Origin Energy)
- Esso Australia Ltd
- Mobil E&P
- Santos Ltd (SA) (2 students)
- Santos Ltd (Qld) (2 students)
- Shell Australia
- Strike Oil
- Wiltshire Geological Services
- Woodside Energy

Coursework assessments for the Honours and Masters degrees are based on oral and written examinations and the marking of practical exercises. Theses are assessed in accordance with university standards and procedures. Oral examinations and research seminars help to prepare students for future presentations to management and audiences in both industry and academia. Seven Honours students delivered brief presentations of their research work to industry after the Advisory Committee meeting held on 8 December. Selected students also made

presentations to local meetings of the Australian Society of Exploration Geophysicists and the Geological Society of Australia.

The following list of thesis titles shows the wide geographic and disciplinary range of Honours project topics in 1999:

Heidi Best (Santos Qld)	Sedimentology, sequence stratigraphy and reservoir potential of the Warrinilla Field, Bowen Basin.
Jon Blank (Esso)	Late Eocene – Early Oligocene sequence stratigraphy of the nearshore – transition zone, Latrobe Group, Ninety Mile Beach, Gippsland Basin.
Nubia Bon (Strike Oil)	Reservoir and production properties of the Toolachee and Patchawarra Formations, Cooper Basin, South Australia.
Nathan Ceglar (Woodside)	Late Jurassic to Early Cretaceous sequence stratigraphy, Northern Bonaparte Basin, Timor Sea.
Matt Dubsy (Santos SA)	Reservoir quality and distribution of the Late Jurassic sands, Dampier Sub-Basin, Western Australia.
Susann Joraandstad (Santos Qld)	Use of stacking velocity for depth prediction and lithological indication in the Challum Field of the Cooper/Eromanga Basin, Queensland.
Jaime Livesey (Wiltshire Geological Services)	Evaluation of a new method for predicting P-wave sonic data, Timor Sea.
Victoria Mackie (Shell/Woodside)	Seismic sequence stratigraphy of the Early Carboniferous, Petrel Sub-basin, northwestern Australia.
Ben McLean (Beach Petroleum)	Geophysical investigations in the Moorowie Syncline, Arrowie Basin, South Australia.
Tanita Prater (Santos SA)	Comparison of rock-type-derived reservoir properties with estimates from standard petrography.
David Quinn (AGSO)	An evaluation of seals, reservoirs and fault sealing potential in the Eyre Sub-basin, Great Australian Bight.
Ben Royal (Mobil)	Biostratigraphic and sequence stratigraphic correlation of the last Barrow Group foreset, Barrow Sub-basin.
Lisa Ryan (Boral Energy)	Fault seal potential of the Sherbrook Group: Port Campbell Area, Otway Basin, Victoria.
Susannah Smart (AGSO)	Asphaltites from the Southern Australian Margin: submarine oil seeps or maritime artefacts?

MSc Program

MSc students undertake the NCPGG coursework program, and then commence work on their thesis project. The degree typically takes about 2 years of full time work to complete.

There were three new enrolments in the MSc program in 1999, one in the University of South Australia (Mr Tim Casey) and two in the University of Adelaide (John Nejedlik and Rodica Dragomirescu). John enrolled in the recently established MSc in Reservoir Geoscience being offered jointly by the NCPGG and the Centre for Petroleum Engineering (CPE) at the University of New South Wales. There were no MSc graduates from the NCPGG in 1999. At year end, nine students, five of whom were part-time, were working on MSc thesis projects. Details of these projects are given in Appendix B, p50.

PhD Program

Students enrolled at the University of Adelaide and the University of South Australia can pursue PhD studies at the NCPGG. Since these are both research degrees, there are no specific coursework or industrial experience components. However, in practice, most PhD students are required to attend selected units in the NCPGG coursework program to augment their knowledge in areas relevant to their project. This coursework requirement is made more formal for the University of Adelaide degree through the "structured" PhD program.

PhD projects take between three and five years to complete. Like the Honours and MSc projects, they must be relevant to the petroleum industry, and, in most cases, are formulated with support, either in terms of data, access to facilities, or direct funding, by industry. PhD theses are assessed by external examiners according to normal university standards and procedures.

There was one new enrolment in the PhD program in 1999, Rosalie Pollock, who was awarded a scholarship by Boral Energy. In addition, five PhD students, Trevor Dhu, Jerry Meyer, Scott Reynolds, Mark Tingay and Peter van Ruth, transferred to the NCPGG from the Department of Geology & Geophysics at the University of Adelaide, following the appointment of their supervisor, Dr Richard Hillis, to the State Chair of Petrophysics at the NCPGG. These students are at varying stages in their projects, ranging from newly started to close to completion.

Four PhD students graduated from the NCPGG program in 1999. Congratulations are due to Drs Johnny Hull, Alex Kaiko, Abbas Khaksar and Stuart Smith. At year end, there were 20 PhD students enrolled in the NCPGG. Of these, ten were working full time on their projects and the other ten were at various stages of writing up or submission. A list of current and completed PhD students is provided in Appendix B, p 50.

Details of NCPGG Graduates

Year Began	Name	Degree	Previous Institution	Graduated	Initial Employment or Study Location after Graduation
1999	Best, Heidi	Hons	Adelaide	1999, Adelaide	Veritas
	Blank, Jon	Hons	RMIT	1999, Adelaide	Schlumberger Geoquest
	Bon, Nubia	Hons	Adelaide	1999, Adelaide	PetroLab
	Ceglar, Nathan	Hons	Adelaide	1999, Adelaide	MSc student, NCPGG
	Dubsky, Matt	Hons	Adelaide	1999, Adelaide	Working overseas
	Joraandstad, Susann	Hons	Norwegian Uni of Sc/ Technology	1999, Adelaide	Norwegian Uni of Sc/Technology
	Livesey, Jaime	Hons	U of SA	1999, U of SA	Casual work overseas
	Mackie, Victoria,	Hons	Adelaide	1999, Adelaide	AGSO
	McLean, Ben	Hons	U of SA	1999, U of SA	PhD student, China
	Prater, Tanita	Hons	RMIT	1999, Adelaide	
	Quinn, David	Hons	Uni of Wellington	1999, Adelaide	Schlumberger Geoquest
	Royal, Ben	Hons	Adelaide	1999, Adelaide	
	Ryan, Lisa	Hons	U of SA	1999, Adelaide	Origin Energy Resources Ltd
	Smart, Susannah	Hons	Adelaide	1999, Adelaide	DPR, CSIRO Perth
1998	Brown, Robert	Hons	Adelaide	1999, Adelaide	
	Chapman, Tim	Hons	Adelaide	1998, Adelaide	Petrosys Pty Ltd
	Forbes, Angus	Hons	U of SA	1998, U of SA	Kangarilla Drilling
	Murphy, Ian	Hons	Armidale	1998, Adelaide	Northline
	Nejedlik, John	Hons	Adelaide	1998, Adelaide	MSc student, NCPGG
	Pollock, Rosalie	Hons	Adelaide	1998, Adelaide	PhD student, NCPGG
	Salter, Darren	Hons	U of SA/Santos	1998, U of SA	Santos Ltd
	Sundsby, Ole	Hons	Norwegian Uni of Sc/ Technology	1998, Adelaide	Norwegian Uni of Sc/Technology
1997	Baines, Carey	Hons	U of SA	1997, U of SA	Santos Ltd
	Baker, Darren	Hons	U of SA	1997, U of SA	Boral Energy Resources
	Hirning, Colin	Hons	QUT	1997, Adelaide	BP Developments Australia
	Kivior, Tomasz	Hons	Adelaide	1997, Adelaide	PhD student, NCPGG
	Purdy, Adrian	Hons	Uni of Melbourne	1997, Adelaide	Esso Australia Ltd
	Quinn, Matt	Hons	Flinders	1997, Adelaide	Santos Ltd
	Robertson, Stephen	Hons	QUT	1997, Adelaide	Santos Ltd
	Rodeghiero, Allen	Hons	Uni of Sydney	1997, Adelaide	Schlumberger, WA

Year Began	Name	Degree	Previous Institution	Graduated	Initial Employment or Study Location after Graduation
1997	Vekas, Frank	Hons	U of SA	1997, Adelaide	Boral Energy Resources
1996	Ahsan, Abul	Hons	Russian People's Friendship University	1996, Adelaide	Santos Queensland
	Bekkers, Pete	Hons	Flinders	1996, Adelaide	Santos Ltd
	Dight, Michelle	Hons	QUT	1996, Adelaide	Santos Ltd
	Dolensky, Ingrid	Hons	Flinders	1996, Adelaide	Western Geophysical
	Enman, Travis	Hons	Flinders	1996, Adelaide	Woodside Offshore Australia
	Hull, Johnny	PhD	Uni of Aberdeen	1999, Adelaide	Woodside Energy Ltd
	Kloss, Olaf	Hons	Flinders	1996, Adelaide	Santos Queensland
	Rowe, David	Hons	Flinders	1996, Adelaide	MESA
	Seweryn, Witold	Hons	Academy of Mining & Metallurgy, Poland	1996, Adelaide	MESA
1995	Brigg, Sandy	Hons	Uni Central Qld	1995, Adelaide	Esso Australia Ltd
	Crimes, Angela	Hons	Flinders	1995, Adelaide	GradDip, Uni of Adelaide, EnvSt.
	Marlow, Alison	Hons	Adelaide	1995, Adelaide	Oil Company of Aust.
	McQueen, Penny	Hons	Flinders	1995, Adelaide	Geoservices
	Mennie, James	Hons	Adelaide	1995, Adelaide	Santos, Queensland
	Novosell, Naomi	Hons	Uni New England	1995, Adelaide	BP Developments Australia
	Rudd, Damion	Hons	Qld Uni Tech	1995, Adelaide	Santos Queensland
	Young, Hamish	Hons	Adelaide	1995, Adelaide	PhD student, NCPGG
1994	Auld, Kerri	Hons	Adelaide	1994, Adelaide	Santos Ltd
	Barnes, Craig	Hons	Adelaide	1994, Adelaide	Santos Ltd
	Beaumont-Smith, Nick	Hons	Adelaide	1994, Adelaide	Santos Queensland
	Christian, Louise	Hons	Adelaide	1994, Adelaide	PhD student, NCPGG
	Draper, Paul	Hons	Adelaide	1995, Adelaide	BPB Wireline Services
	Khaksar, Abbas	PhD	Tehran Uni/NCPGG	1999, Adelaide	Postdoc, NCPGG
	Smith, Stuart	PhD	Uni of Southampton	1999, Adelaide	Shell Development Aust. Pty Ltd
	Wozga, Lizz	Hons	Adelaide	1994, Adelaide	Plutonic Gold Mine, WA
1993	Khaled Al-Arouri	PhD	Adelaide	1996, Adelaide	Postdoctoral Fellow, Macquarie University
	Baldasso, Fortunato	Hons	RMIT	1993, Adelaide	WA Dept of Minerals & Energy
	Burgess, Jamie	Hons	Adelaide	1993, Adelaide	PhD student, Geology Dept University of Adelaide
	Carbone, Michael	Hons	U of SA	1993, U of SA	
	Donley, James	Hons	U of SA	1993, U of SA	SAGASCO Resources

Year Began	Name	Degree	Previous Institution	Graduated	Initial Employment or Study Location after Graduation
1993	Little, Bridget	MSc	U of SA	1996, U of SA	
	Goodall, Anthony	Hons	Adelaide	1993, Adelaide	Western Geophysical
	Harris, Jeremy	Hons	U of SA	1993, U of SA	Santos, Brisbane
	Kaiko, Alex	PhD	Uni of Newcastle /NCPGG	1999, U of SA	Curtin University
	Khaksar, Abbas	MSc	Tehran Uni	1994, Adelaide	PhD student, NCPGG
	Kraishan, Ghazi	PhD	Uni of Jordan	1997, Adelaide	ACS Queensland
	Lanzilli, Elio	Hons	Adelaide	1993, Adelaide	PhD student, U of SA
	Masters, Steven	Hons	RMIT	1993, Adelaide	
	McFadzean, Glen	Hons	Adelaide	1993, Adelaide	Santos Ltd
	Newlands, Ian	Hons	Uni of Sth Qld	1993, Adelaide	Phillips Australian Oil Co
	Rezaee, Mohammed	PhD	Bu-Alis Sina Uni, Iran	1997, Adelaide	Tehran University
	Ryan-Grigor, Sarah	PhD	Uni of Melbourne & NCPGG	1996, Adelaide	Schlumberger Research Institute, UK
	Schellaars, Samantha	Hons	RMIT	1993, Adelaide	Geo & Hydro Pty Ltd
	Spry, Trent	Hons	Adelaide	1993, Adelaide	BHP Petroleum Pty Ltd
Tiainen, Sharon	Hons	Adelaide	1994, Adelaide	Santos Ltd	
1992	Austin, Rod	Hons	Adelaide	1992, Adelaide	Unley High School
	Bracic, Alia	Hons	RMIT	1992, Adelaide	Western Geophysical
	Brincat, Mark	Hons	Adelaide	1992, Adelaide	Geoservices
	Chatfield, Kim	Hons	Qld Uni of Tech.	1992, Adelaide	Santos Ltd
	Christiansen, David	Hons	RMIT	1992, Adelaide	Mobil Exploration & Producing
	Corrie, Glenn	Hons	Qld Uni of Tech	1992, Adelaide	Woodside Offshore
	Cubitt, Christopher	Hons	RMIT	1992, Adelaide	PhD student, NCPGG
	Eldridge, Martin	Hons	Adelaide	1992, Adelaide	Geoservices
	Jong, John	MSc	Adelaide & NCPGG	1997, Adelaide	Shell, Malaysia
	Kaiko, Alex	Hons	Uni of Newcastle	1992, Adelaide	PhD student, NCPGG
	Kamali, Mohammad	PhD	Mysore University, India	1996, Adelaide	National Iranian Oil Company
	Little, Bridget	Hons	Adelaide	1992, Adelaide	PhD student, U of SA
	Mahmood, Tariq	PhD	Punjab Uni, Pakistan	1997, Adelaide	Z & S Asia
	Riordan, Sarah	Hons	RMIT	1992, Adelaide	Santos Ltd
	Sebek, Robert	Hons	RMIT	1992, Adelaide	Perseverance Exploration Pty Ltd
	Spicer, Raymond	Hons	Adelaide	1992, Adelaide	MESA

Year Began	Name	Degree	Previous Institution	Graduated	Initial Employment or Study Location after Graduation
1992	Theologou, Paul	PhD	Uni of SA & NCPGG	1996, U of SA	ACS, Queensland
1991	Boucher, Rodney	Hons	Bendigo CAE	1991, Adelaide	PhD student, Uni of SA
	Carter, Stephen	Hons	Melbourne	1991, Adelaide	Shell Co of Australia Ltd
	Cooper, Andrew	Hons	Adelaide	1991, Adelaide	Homestake Australia Ltd
	Crutchfield, Stuart	Hons	Vic Uni of Tech	1991, Adelaide	Ampolex
	Gardner, Justin	Hons	Sydney	1991, Adelaide	Digital Exploration, Qld
	Jong, John	Hons	Adelaide	1991, Adelaide	PhD student, NCPGG
	Lemar, Robert	MSc	U of SA	1992, U of SA	
	Mack Daniel	MSc	Adelaide	1994, Adelaide	Geophysical Research Institute, Uni of New England
	Mossa, Adel	Hons	Egypt	1991, Adelaide	
	Sun, Xiaowen	PhD	Nanjing University	1996, Adelaide	Research Associate, NCPGG
	Tarabbia, Paul	Hons	Uni of Sth Qld	1991, Adelaide	PhD student, Curtin University
	Theologou, Paul	Hons	U of SA	1991, U of SA	PhD student, U of SA
	Walshe, Paul	MSc	Trinity College, Ireland	1996, Adelaide	Boral Energy Resources Ltd
	Wilson, Richard	Hons	Melbourne	1991, Adelaide	Protocol Solutions
	Zampatti, David	Hons	Curtin Uni	1991, Adelaide	
1990	Chapri, Aslam	MSc	India	1994, Adelaide	Burmine Operations
	Clark, Victoria	Hons	Melbourne	1990, Adelaide	Woodside Offshore
	Enzmann, Frank	Hons	Adelaide	1990, Adelaide	Loxton Research Centre
	Hayball, Tony	Hons	Flinders Uni	1990, Flinders	PhD student, NCPGG
	McManus, Andrew	MSc	Sydney	1992, Adelaide	BP Developments Australia
	Miller, Lyndon	PhD	Canada	1995, Adelaide	Contract position in Calgary
	Nicolaides, Stelios	MSc	Greece	1992, Adelaide	PhD student, University of Melbourne
	Polomka, Simon	GradDip (Hons)	SAIT	1990, U of SA	Halliburton Geodata, now a PhD student, NCPGG
	Singh, Rajendra	Hons	Flinders Uni	1990, Adelaide	Santos Ltd
1989	Anderson, Bruce	Hons	Macquarie University	1989, Adelaide	BHP Coal
	Apak, Sukru	PhD	USA	1994, Adelaide	WA Dept of Minerals & Energy
	Belford, Alexander	Hons	Adelaide	1989, Adelaide	Western Mining Corporation
	Boult, Peter	PhD	U of SA	1997, U of SA	Boral Energy Resources
	Cathro, Donna	Hons	Adelaide	1989, Adelaide	Australian Geological Survey Organisation
	Cox, Andrew	Hons	RMIT	1989, Adelaide	Schlumberger

Year Began	Name	Degree	Previous Institution	Graduated	Initial Employment or Study Location after Graduation	
1989	Eletheriou, John	MSc	SAIT	1990, Adelaide	Santos Ltd	
	Eyre, Bradley	Hons	QUT	1989, Adelaide	PhD student, QUT	
	Gaughan, Chris	Hons	Darling Downs	1989, Adelaide	Amdel Core Services	
	Miller, Lyndon	Hons	Canada	1989, Adelaide	Geo-Ex Systems, now a PhD student, NCPGG	
	Montague, Eamonn	Hons	RMIT	1989, Adelaide	Santos Ltd	
	Pickavance, David	Hons	Adelaide	1989, Adelaide	BHP Petroleum Pty Ltd	
	Ryan, Sarah	Hons	Melbourne	1989, Adelaide	Schlumberger, now a PhD student, NCPGG	
	Serafini, Kym	Hons	Adelaide	1989, Adelaide	Santos Ltd	
	Smith, Brenton	Hons	Flinders Uni	1989, Flinders	Pacific Power Services	
	Thomas, Allan	MSc	Adelaide	1991, Adelaide	ACS	
	Thornton, David	MSc	Canberra CAE	1990, Adelaide	WAPET	
	Wythe, Scott	Hons	Adelaide	1989, Adelaide	AMDEL	
1988	Alsop, David	MSc	NSW	1990, Adelaide	Oil Company of Australia	
	Chedid, Rachid	Hons	USA	1988, Adelaide	Corpoven, Venezuela	
	Duckett, Ashley	Hons	WA	1988, Adelaide	Ampolex, Perth	
	Giuliano, Michael	Hons	RMIT	1988, Adelaide	Santos Ltd	
	Hillock, Peter	Hons	Adelaide	1988, Adelaide	Western Mining Corporation	
	Jones, Paul	Hons	Macquarie Uni	1988, Adelaide	Australian Mineral Sands	
	Loeliger, Marius	Hons	Adelaide	1988, Adelaide	NT Geological Survey	
	Menpes, Sandra	Hons	Adelaide	1988, Adelaide	Pacific Oil & Gas Pty Ltd	
	Miller, Lisa	MSc	NSW	1994, Adelaide	BHP Petroleum	
	Ryan, Peter	Hons	Adelaide	1988, Adelaide	ESSO Australia Ltd	
	Sansome, Alan	Hons	Adelaide	1988, Adelaide	MESA	
	Trupp, Mark	Hons	RMIT	1988, Adelaide	Shell Company of Australia	
	Yong, Lee	Hons	USA	1988, Adelaide	Australian Gas & Light	
	Zaubrecher, Michelle	Hons	Darling Downs	1988, Adelaide	BHP Petroleum Pty Ltd	
	1987	Browne, Mark	Hons	Adelaide	1987, Adelaide	Santos Ltd
		Carroll, Paul	MSc	Adelaide	1990, Adelaide	BHP Petroleum Pty Ltd
Lucas, Eric		MSc	Flinders Uni	1990, Flinders	Santos Ltd	
Schulz-Rojahn, Jorg		PhD	Aberdeen	1992, Adelaide	Postdoctoral Fellow, NCPGG	
Siffleet, Paul		MSc	Wales	1994, Adelaide	Santos Ltd	

Year Began	Name	Degree	Previous Institution	Graduated	Initial Employment or Study Location after Graduation
1986	Smith, Mike	Hons	Adelaide	1987, Adelaide	Santos Ltd
	Solomon, Cate	MSc	Adelaide	1992, Adelaide	Santos Ltd
	Stockmann, Janet	Hons	Adelaide	1987, Adelaide	SAGASCO Resources Ltd
	Arndt, Lewis	Hons	Adelaide	1986, Adelaide	Geophysical Services
	Chamberlain, Warren	MSc	Adelaide	1988, Adelaide	
	Conor, Colin*	MSc (ext)	UK		Consultant
	Dalgarno, Bob*	MSc	Adelaide		Geological Survey of Victoria
	Grasso, Carmine	Hons	Adelaide	1986, Adelaide	Santos Ltd
	Hudson, Geoff*	MSc	Canada		Australian Mineral Foundation
	Kennedy, Sean	MSc	Tasmania	1988, Adelaide	Wiltshire Geological Services
	Lanigan, Kevin*		Adelaide		Transferred to Louisiana State University
	O'Cleary, Mark	Hons	Adelaide	1986, Adelaide	Western Mining Corporation
	Oldham, Andrew*	MSc	Wales		Consultant
	Thomas, Andrew*	MSc	Adelaide		Santos Ltd

* Completed course program but did not submit a thesis to obtain a degree.

Computing Facilities

There were a number of improvements in the Centre's computing capabilities in 1999. Our reliance on our web site and high quality graphics and drafting tools for communication have increased dramatically in recent time, and it was clear that the Centre needed to boost its IT manpower in response. Tony Hayball was hired to assist with the upgraded capabilities. Tony brings expertise in UNIX and NT systems, networking, web page design and maintenance, and graphics packages to the NCPGG. The Centre's computing facilities have increased over several years from four UNIX machines and a small PC network to around 13 UNIX boxes and well over 30 networked PCs.

1999 saw the continued expansion of the Centre's PC network, running under Window NT 4.0. This involved the purchase of new Pentium machines, most of which went into offices for personal use by staff or postgraduate students.

Esso Australia Ltd donated 12 Sun Sparc 10 workstations to the Centre in 1999. Although these machines are old, we were able to build six dual processor machines, each with 256 Mb RAM, from them. These have considerably better performance than any of our existing Sun machines. The Solaris 7 operating system was installed on these new machines, allowing us to upgrade a number of our software packages to the newest available versions.

In addition, three other Sun Sparc machines of various vintages were transferred to the NCPGG as a result of Richard Hillis' appointment to the State Chair in Petrophysics. At year end, work was in progress to integrate all these "new" machines into the Centre's UNIX network. This is a major undertaking, and will continue on into 2000.

On the software side, apart from the upgrades to some of our existing code as mentioned above, several new packages were donated to the Centre. Badley Earth Sciences Ltd donated a copy of its FAPS program for analysing fault displacements. Scott Pickford Group Ltd donated licences for its IC2 (seismic attribute analysis), Velit (velocity modelling) and Cubit (earth model building) packages. Roxar (formerly Smedvig Technologies) donated its IRAP RMS and STORM programs (reservoir model building), and Geovisual Systems Ltd provided NT and UNIX licences for its GeoCARD product (also for geological modelling). It will take some time for us to build up expertise in the use of these new packages.

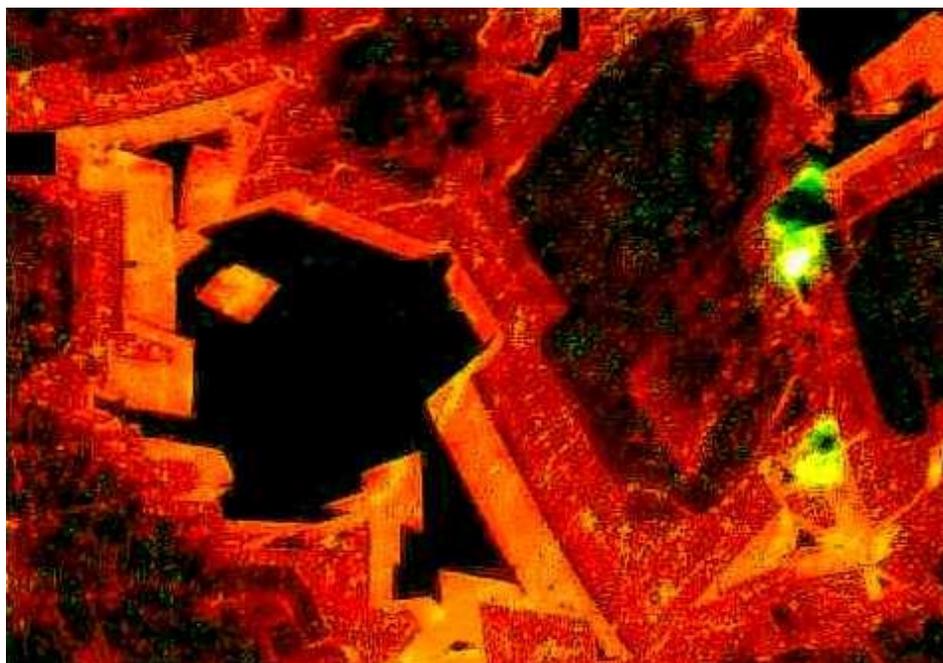
Looking to the future, a most significant development was close to fruition at year end. This is the establishment of the NCPGG/Schlumberger Training and Research Centre. The University of Adelaide will provide space for the suite at the Thebarton Campus, whilst Schlumberger will donate six licences for their entire Geoquest product range. The software will run on new dual-head Sun Ultra 60 machines. NCPGG staff and students will have access to these machines and software for research projects, while Schlumberger will use the suite for client training, the fees for which will pay for the running costs. Once set up, this suite will, at a stroke, provide the NCPGG with access to a state-of-the-art integrated software suite, running on modern hardware. The announcement that this proposal was to proceed was made at the NCPGG Advisory Committee Meeting on 8 December.

Petrographic Facilities

The NCPGG has put together a high quality light-microscope lab for teaching and research purposes. The teaching suite includes four well-configured binocular light microscopes. We now have the capability to use cathode luminescence (CL), UV fluorescence (UVF) and petrographic image analysis (PIA) in addition to standard petrography. These capabilities have made a significant contribution to our research capability and we have completed a number of large (>50 sample) consulting contracts. Both CL and UVF results are recorded on photographic film because the emitted light energy is very low. CL is useful for detecting and quantifying generations of carbonate cements, quartz overgrowths and cements, and the relationships between authigenic and detrital feldspars. UVF is an important technique for studying opaque minerals and detecting residual hydrocarbons. An area of new interest is the UV fluorescence of some authigenic clays in sandstones. Reflected light microscopy associated with UVF has the ability to record delicate intergrowths of cement phases.

High resolution scanning of 35mm negatives has allowed standard petrographic images to be processed with better colour resolution than normal prints. This technique is particularly useful for CL images.

Petrographic image analysis (PIA) is being used to improve the quantification of phase identification in thin section. Ultimately, it is planned to develop the technique to characterise pore types and relate pore information to petrophysical properties of reservoirs. PIA facilities consist of a computer, software, a video camera and a microscope allowing real-time screen display of video images of thin sections. The image analysis software, Video Pro 32, was written in South Australia by Leading Edge, and is adaptable to a number of types of investigations.



Zoned dolomite under CL.

The APCRC

The **Australian Petroleum Cooperative Research Centre (APCRC)** is an unincorporated joint venture between the Australian Geological Survey Organisation (AGSO), the Australian Petroleum Production and Exploration Association (APPEA), CSIRO Petroleum, the Department of Exploration Geophysics and the Petroleum and Environmental Organic Geochemistry Centre of the Curtin University of Technology, the National Centre for Petroleum Geology and Geophysics (NCPGG), and the School of Petroleum Engineering of the University of NSW (PEUNSW), Cooperative Research Centres Program.

The APCRC was established through the Federal Government's Cooperative Research Centres (CRC) program, which aims to 'add value' to our national research effort through:

- supporting long-term, high-quality scientific and technological research
- capturing the benefits of research for Australian industry
- encouraging institutions to cooperate and coordinate their efforts
- stimulating education and training, particularly to graduate programs, through the active involvement of researchers in education and graduate students in research.

The APCRC is a world leader in collaborative petroleum research, development, education and training. Through these activities it provides economic and environmental benefits to the upstream petroleum industry in Australia and to the Australian community at large. "The APCRC, through collaboration between industry, government and universities provides access to the world class research and technology development in petroleum exploration and production, together with the education and training that is needed to underpin a globally competitive Australian petroleum industry."

The APCRC Research programs

The overall science and technology priorities of the APCRC are established through eight focussed programs. The NCPGG is involved in several of these programs, with John Kaldi as Program Manager for Seals, and Nick Lemon Program Manager for Formation Damage. Detail of NCPGG staff and student involvement shown in the following pages with the relevant project reports.

Program

Education and Training
Formation damage
Hydrocarbon sealing potential of faults and cap rocks
Abnormal geopressure prediction
Improved seismic imaging
Australian hydrocarbons: from source to trap
Reservoir characterisation and improved oil recovery
Geological Disposal of CO²

Program Manager

Val Pinczewski
Nick Lemon & Sheik Rahman
John Kaldi
Kevin Dodds
John McDonald
Clinton Foster
Lincoln Paterson
Andy Rigg

The 1999 APCRC Workshop was held in Erskine House at Lorne and attended by over 70 staff and students from the participating institutions. A field trip in the Pt Campbell area was held the day before the workshop and was led by Peter Arditto of BHP Petroleum. Students from each institution were asked to prepare posters detailing their research projects and PhD student, Rosalie Pollock, received the award for the best poster.

APCRC Research Programs/Projects

PROGRAM: Abnormal geopressure prediction

Program Manager: Kevin Dodds (CSIRO)

NCPGG Coordinator: Dr Peter Tingate

Industry issue(s) addressed by the program:

Drilling in areas prone to abnormal pressure profiles has led to high incremental drilling costs associated with contingency planning to reduce risk in meeting objectives. These costs are due to increased safety margins in the well planning, delays and actions required to overcome unexpected hazards, costs associated with changed well construction plans and potential failure to meet target objectives. In some areas this has led to reduced exploration, as the well economics outweigh potential success of increased reserves. These costs are substantially leveraged by the increased engineering requirements associated with exploration in deep waters. The extra costs are necessary to compensate for the current qualitative and non-integrated nature of pressure prediction in the pre-drill phase, and then in accessing and using appropriate information during drilling.

This program aims to establish a reliable predictive and planning technology that will significantly impact these extra costs in an Australian exploration context. It is planned to achieve improved predictability by concentrating on four areas;

- Understanding of specific basin dynamics and overpressure generation mechanisms
- Establishing the seismic signatures of these conditions through improved theory and laboratory testing
- Identifying specific data and calibration strategies to refine the prediction while drilling
- Incorporating this into a data management platform with risk assessment and planning capability, both prior to and while drilling

PROJECTS:

Project: Geological Context of Overpressure.

Project leader: Dr Peter Tingate

Research personnel: Dr Abbas Khaksar, Professor Richard Hillis, Peter van Ruth (PhD student)

Commencement of the compilation of a data base of petrophysical and pressure data centered on the northern Carnarvon Basin in 1999. Pressure-depth profiles have been constructed for all overpressured wells dividing them up into stratigraphic-lithology-structural groupings. Representative wells from each stratigraphic/lithology/structural occurrence are being examined for their porosity/sonic/resistivity/density signature and provide the basis of defining the overpressure mechanism. This work is integrated with the effective stress acoustic studies conducted by Dr Abbas Khaksar. The goals of the geological study are: work out the empirical associations of each category of overpressure and quantify where possible. From this work synthetic seismograms for each overpressure group will be built to see if the overpressure can be imaged with normal seismic or if special processing is needed/possible. Emphasis is to be placed on reducing the uncertainty of pressure prediction. Industry sponsors have been kept informed of progress via a report and presentations.

Project: Sandstone Petro-Acoustic Study

Project Leader: Dr Abbas Khaksar

Staff: Dr Abbas Khaksar and Dr Peter Tingate

A program to develop a data base of acoustic response for the permeable sandstones in the study area has been developed started during the fourth quarter of 1999. This study parallels the work being done on the elastic response of the shales, and is based on the work Dr Abbas Khaksar has carried out in the past few years in the Cooper Basin. The goal of this study is to systematically measure the relationship of effective stress as a function of the degree of pore fluid saturation, porosity and mineralogy with the acoustic velocities in sandstone cores from the Lower Cretaceous Barrow Group within the study area. These acoustic measurements will be related to prediction of pore pressure from sonic log and surface seismic in general.

PROGRAM: Australian hydrocarbons: from source to trap

Program Manager: Dr Clinton Foster (AGSO)

NCPGG Coordinator: Dr Peter Tingate

Ranking likelihood of finding oil in a trap by predictive mapping of oil migration pathways from source to trap, through time and space.

Aims and Benefits of Program:

- Mapping oil migration in time and space
- Regional assessment - seismic, structural framework
- Recognition of oil migration pathways - fluid inclusions, geochemistry
- Source characterisation, maturity
- Prediction of oil migration pathways using heuristic modelling

PROJECTS:**Project: Application of Illite K-Ar Ages to constrain thermal histories and oil migration**

Project Leader: Horst Zwingmann (CSIRO)

Staff: Dr Horst Zwingmann, Dr Peter Tingate, Dr Nick Lemon, Chris Cubitt (PhD student)

The team have expertise in geo-and thermochronology, inorganic geochemistry, petrology, diagenesis, thermal modelling and their application to basin analysis. They are currently working on directly dating diagenetic phases such as illite so that the evolution of reservoir quality and timing of hydrocarbon charge can be constrained. Samples from the Cooper Basin have been analysed and are currently being interpreted.

PROGRAM: Formation Damage

Program Manager: Dr Nick Lemon

Reservoir rocks in the immediate vicinity of an oil/gas well can be subjected to damage during the process of drilling the well. Such damage may restrict or prevent the flow of hydrocarbons from the reservoir when the well is brought into production. Damage occurs at the level of individual pores and must be studied at that level. Clay distribution and mineralogy is the fundamental control on formation damage, thereby providing a link between these studies and those of reservoir characterisation and seals.

Aims and Benefits of Program:

- Identification of the clay types and distribution patterns which influence formation damage
- Remote detection of likely trouble spots using downhole logging tools (Nuclear Magnetic Resonance imaging)
- Prediction of areas of damage
- Provide choices for remedial action to clean up wellbores
- Production of an atlas of formations subject to damage

PROJECTS:

Project: Swelling behaviour in greensands

Project leader: Dr Nick Lemon

Research personnel: Dr Ghazi Kraishan, Dr Nick Lemon

Funding: APCRC

The range of glauconitic clays in greensands display a range of swelling characteristics. The change from a smectite structure to an illitic structure is the main reason for the observed differences in swelling but not all the controls on this mechanism are known. The availability of potassium can determine the rate of change but it appears that oxidation of glaucony to a goethitic clay can also alter the swelling behaviour. Influx of meteoric water and proximity to exposure surfaces are therefore controlling factors. Prediction of likely zones of formation damage may then follow from detailed sequence stratigraphic studies.

MSc Project: Inter relationship between reservoir properties and nuclear magnetic resonance (NMR) measurements in the Cooper Basin

MSc student: Nita Musu (commenced 1998)

Supervisors: Dr Nick Lemon, Dr John Kaldi

Funding support: Santos Ltd and APCRC

Scholarship support: AusAid

The project uses NMR imaging to determine pore size and distribution in a series of low permeability lithic sandstones. The samples selected for analysis all show the same low ambient permeability but show a range of permeability in reservoir conditions. The project aims to assess the applicability of NMR logging in the discrimination of variable reservoir quality.

Traditional petrography, including thin section, XRD and SEM analysis, has identified a continuum of reservoir types largely discriminated by the amount, type and distribution of clays. While it is suspected that clays control permeability, further testing is in progress to prove this point.

The results from this traditional methodology will then be compared with NMR measurements, in particular the relaxation time, which depends on pore size and its distribution.

PROGRAM: Geodisc

Program Manager: Mr Andy Rigg (APCRC)

NCPGG Coordinators: Prof Richard Hillis, Assoc Prof Simon Lang, Dr Nick Lemon

Liquefied natural gas projects with a total value of around \$20 billion are planned for Australia over the next decade. Together, they will generate an increase of approximately 3% in Australia's GDP and in excess of 50, 000 jobs. One of the major risks to this vast investment is the lack of an agreed strategy to deal with the major increase in CO₂ emissions that will result from these developments. The recent Kyoto Protocol has served to focus even more attention on this issue. This proposal addresses the issue through leading edge cooperative research.

The answer to sustaining Australia's economic development whilst at the same time meeting emission targets lies in developing suitable methodologies for CO₂ sequestration. One of the key sequestration options is geological disposal. The method, which involves injection of supercritical CO₂ into the deep subsurface is being tested on a commercial scale in only one place in the world, although several other countries are now developing research programs into the technique. This proposal for research into the Geological Disposal of CO₂ (GEODISC) will for the first time investigate the applicability of the method to Australia to enable it to dispose of large volumes of CO₂.

PROJECTS:

Title: Site specific studies for geological disposal of CO₂

Project leader: Assoc Prof Simon Lang

The NCPGG is involved in three project areas for GEODISC. Project 2 (Site specific studies) of the GEODISC program scheduled to start in late 1999 began, but only for the initial planning stages, with the bulk of the work awaiting the results of Project 1 (Regional Studies) being undertaken by AGSO. It is expected that several sites (at least four) will be selected around Australia to study CO₂ sequestration potential. The main outcomes included targeting at least three potential PhD candidates that would undertake the studies starting in the year 2000. Projects 4a, 4b (Petrophysics and Geomechanics) and Project 10 (Geological Analogues) were confined only to initial planning stages.

PROGRAM: Hydrocarbon Sealing Potential of Faults and Cap Rocks

Program Manager: Dr John Kaldi

The accurate evaluation of seals is a major part of the estimation of the efficiency of any petroleum system. In the past the general method of estimating the efficiency of the seal has been qualitative in nature and often arbitrary judgements have resulted in the wrongful estimate of risk associated with this part of the system. Recent developments in integrating geological, geochemical, geomechanical and petrophysical data has resulted in the ability to provide better risk evaluation. This program will build upon the multidisciplinary capabilities of the Centre and its APCRC partners to provide criteria to identify and quantify risks in top seals and faults.

AIMS AND BENEFITS OF PROGRAM

- Quantitative prediction of top and fault seal potential to improve estimation of prospect and play risk
- Improved understanding of geological components contributing to seal potential of cap rocks
- Improved understanding of criteria necessary to determine whether faults are seals or conduits in specific basins/petroleum systems
- Improved understanding of the mechanics of fault reactivation, leading to improved estimation of seal vs. conduit behaviour
- Improved prediction of fault breach risk from the relationship between fault and regional stress orientations

PROJECTS:

Calibrating core to cuttings for Mercury Injection Capillary Pressure (MICP) analysis of seal rocks

Project leaders: Dr Richard Jones, Dr John Kaldi

Research personnel: Tom Kivior (PhD student), Rodica Dragomirescu (MSc student)

Funding support: APCRC

This study compares MICP results obtained from vertical and horizontal core plugs and synthetic chip samples generated from the same core. In addition, MICP results of actual cuttings from the same interval are also compared. The aims of this study are to determine if MICP tests run on mud chips give an accurate seal capacity result and to quantify any local correctional factors. Preliminary results helped derive a more accurate technique for determining the conformance of mercury around a sample.

Development of F.A.S.T (Fault Analysis Seal Technology) software to evaluate relative risk of fault failure with respect to regional stress tensors.

Project leader: Dr Richard Jones

Research personnel: Dr Scott Mildren, Professor Richard Hillis

Funding support: APCRC

One of the major risks factors for fault sealed prospects is the possibility of reactivation and the development of effective structural permeability. Shear and tensile fractures can form

inter-linked networks of structural permeability that provide pathways for hydrocarbon migration across fault seals. The permeability of such networks is best developed (i.e. the networks best provide effective structural permeability) when they are at or close to failure. Ideally, knowledge of the failure envelope for sealing units would be required for this kind of study. However, information on the seal failure envelope of the sealing units is not commonly available or too simplistic. A program of structural and geomechanical research has been undertaken to develop a tool (F.A.S.T) that allows risking and mapping of seismic scale structures with respect to likelihood of structural permeability failure. F.A.S.T. provides a relative approach to assessing the risk of structural permeability given in situ stress data only, and consequently enables easy integration with other seal failure mechanism risk estimates. A major advantage of F.A.S.T. seal evaluation is the mapping of the relative probability of structural permeability along the fault trace. This technique captures the change in risk of fault failure associated with subtle changes in fault geometry (orientation and dip).

Development of fractal fault modelling software

Project Leader: Dr Richard Jones

Research Personnel: Dr Chris Dyt

Funding support: APCRC

Faults are not simply single dislocation planes, their architecture is the result of cumulative strain accommodation imparted by the regional geohistory. Enveloping most major faults there exists a zone of high deformation intensity (known as the Damage Zone). Due to the scale and invariant nature of fault growth, damage zone architecture tends to follow a fractal relationship ie between fault length and the cumulative population. The aim of this project is to investigate the influence these faults have on fluid flows around the major fault. To this end, a computer modelling package has been built to simulate the positioning of the smaller faults, and estimate the fluid flow properties through the fault network. The backbone of the model is a random number generator coupled with probability distributions. A great deal of ongoing work is required to determine the correct distribution functions, and accurate representation of the fluid flows.

PhD Project: Characterising faults and sealing units in the Southern Vulcan and Northern Browse Basin, NW Shelf, Australia

PhD Student: Tom Kivior (commenced 1998)

Supervisor: Dr John Kaldi

Funding support: AGSO, APCRC

Scholarship support: APCRC - Bill Stuart Memorial Scholarship

Regional Seal Study of the Vulcan / Browse Sub-basins is continuing. Interpretation of biostratigraphic data from two strike and one dip oriented wireline log sections was completed. The aim of constructing these regional wireline log sections was to determine the age and continuity of sealing lithologies over different parts of the Vulcan Sub-Basin. As a follow up to this work chronostratigraphic sections were also constructed with an overlay of known sealing units. The chronostratigraphic sections highlight three unconformities in the Vulcan Sub-Basin. These unconformities are co-incident over structural highs and separated by depositional packages within troughs. Based on the regional wireline log correlation, as well as hydrocarbon accumulation data, representative seal samples have been selected for

mercury injection capillary (MICP) analysis for seal capacity determination. Preliminary results suggest capillary threshold pressures are over 1000 psi. These values will be converted to hydrocarbon column heights once reservoir fluid properties are incorporated. Ten wells within the bounds of the Skua 3D seismic survey have been correlated using a chronostratigraphic interval model, which is being developed as part of this study. The Tithonian unconformity is the most consistent seismic marker in this area.

MSc Project: Intraformational seals in the Triassic Nappamerri Group, Cooper Basin

MSc Student: Rodica Dragomirescu (commenced 1999)

Supervisors: Dr Nick Lemon, Dr John Kaldi

Funding: Primary Industries and Resources, South Australia (PIRSA)

Specific attributes for the different seal and reservoir lithologies of Triassic rocks of the Cooper Basin have been characterised. Four major seal lithologies are identified in the Nappamerri Group: lacustrine, palaeosol, floodplain, and diagenetically cemented sands. Petrographic attributes (grain size, composition, cement relationships and diagenesis) of rocks from these depositional settings are integrated with petrophysical attributes (porosities, permeabilities, pore geometry and capillary pressure analyses). These data are being used to quantify seal capacity, seal geometry and seal integrity for the various seal lithologies in the study area.

PROGRAM: Reservoir characterisation and improved oil recovery

Program Manager: Dr Lincoln Paterson (CSIRO)

NCPGG Coordinator: Dr Nick Lemon

Defining the properties and heterogeneity of petroleum reservoirs is an industry-wide problem that is highly significant for investment, development and reservoir management decisions. Data are limited, measured on different scales, and key components may be sparse or omitted.

The problem ranges from spatial distributions of porosity and permeability through to multiphase dynamic relative permeability and capillary pressure. Measurements are made at scales that range from the core and the well log to the seismic scale, or measurements are not made and have to be estimated. The problem is to combine these measurements and implement them at the scale of the reservoir simulation gridblock.

This research program aims at an integrated approach to reservoir characterisation and improved oil recovery. A range of overlapping specific activities that include such things as laboratory measurements of core-scale heterogeneity and network modelling through to developing the necessary scale-up rules for two and three-phase displacements in addition to integrating data from various sources. Each of these activities have stand-alone deliverables which will be transferred into practice in their own right. However, the strength of the program is contained in the multidisciplinary approach that the APCRC can deliver.

PROJECTS:

Pore Level Reservoir Characterisation

Project Leader: Dr Nick Lemon

Research personnel: Dr Nick Lemon, Dr Ghazi Kraishan

Funding: APCRC

Several projects are underway to improve the understanding of diagenesis on reservoir quality. One line of study follows from the discontinued project on chlorite occurrences. That project concentrated on greensand reservoirs, known to have highly variable characteristics over short distances, from reservoir to seal. The controls on the reservoir potential are the amount and compactability of the glaucony grains and the amount and distribution of siderite cements. A breakthrough has been made in the understanding of siderite cements, linking them to the availability of oxidised iron on the sea floor. Goethitic iron is available when glaucony is oxidised and a class of bacteria use iron reduction as an energy source, precipitating siderite in the process. As there are obvious links between siderite cement and exposure surfaces, hardgrounds can confidently be used in sequence analysis.

MSc project: Porosity heterogeneity in the Hutton sandstone, Eromanga Basin, South Australia

MSc student: John Nejedlik

Supervisors: Dr John Kaldi, Dr Nick Lemon, Prof Val Pinczewski (Uni of NSW)

The Hutton Sandstone was chosen as the unit to be analysed by micro-CT scanning in a joint APCRC project because of its supposed homogeneity. Detailed thin section petrography has shown the sandstone to be far from homogenous, especially in view of the sample size used for micro scanning (0.5 cm³). Petrographic image analysis is being used to quantify that heterogeneity in order to upscale the data collected to date. Complete coverage of porosity readings across several adjoining thin sections has allowed a thorough statistical analysis to be done. This has given parameters from which a set of rules for measuring porosity by image analysis have been drawn up. It should also be possible to now recreate porosity distribution using a predictive tool such as kriging analysis. A side benefit of the study is an appreciation of the way in which authigenic quartz is distributed in a "clean" sandstone.

Non-APCRC Research Programs/Projects

PROGRAM: Petrophysics/Petroleum Reservoir Properties

Program Manager: Professor Richard Hillis

The petrophysics/petroleum reservoir properties program is a broad one encompassing the outputs of a research group of eleven. Most of the group moved to the NCPGG in September 1999 with the arrival of Richard Hillis

AIMS AND BENEFITS OF PROGRAM

The aim of the group is to undertake both fundamental and applied research pertaining to petrophysics/petroleum reservoir properties. There is a particular focus on in situ stress-related issues (petroleum geomechanics) and on tectonic/structural issues and their influence on reservoir properties, including, for example, fractured reservoirs and broader field- and basin-scale tectonic processes.

The group works on projects in South Australia, Australia and wider Australasia/SE Asia. There is a strong link with the South Australian Department of Primary Industries and Resources through their funding of the Chair in Petrophysics/Petroleum Reservoir Properties. In addition, fundamental research within the group is supported by the Australian Research Council and applied research by a large variety of company sponsors and supporters.

PROJECTS:

Exploration for Tight Gas Reservoirs Enhanced by Natural Fracturing, Cooper Basin, South Australia

Project leader: Professor Richard Hillis

Research personnel: Dr Scott Mildren, Dr Thomas Flottmann and Peter van Ruth (PhD student)

Funding support: ARC (SPIRT Scheme) and Santos Ltd: 1999-2001, \$321K

This is the key project in the basin-centre gas and fractured reservoir area. The gas reservoir rocks in the Nappamerri Trough (Cooper Basin, SA) have low permeability (ie. fluids cannot easily flow through them). The low permeability of these 'tight' gas reservoirs precludes commercial gas production. This project aims to identify where natural fractures enhance reservoir permeability. This will be achieved by detailed analysis of the structural history and contemporary, in situ stress field of the Cooper Basin. The Nappamerri Trough tight gas resource is estimated to be 30 trillion cubic feet. If this project unlocks one trillion cubic feet of tight gas, its economic value would be \$1.7 billion.

In Situ Stress and Natural Fracturing in the Mereenie Field: Implications for Field Development

Project leader: Professor Richard Hillis

Research personnel: Dr Scott Mildren, Dr Thomas Flottmann, Jeremy Meyer (PhD student)

Funding support: Santos Ltd: 1999, \$35K

This was a contract research project, details of which are confidential.

MSc Project: Overpressure in New Zealand Basins

MSc Student: Angus Oraekwuotu (commenced 1999)

Supervisor: Prof Richard Hillis

Project Support: Student-funded

This project involves analysing the distribution and origin of overpressure in the East Coast and Taranaki Basins of New Zealand. Direct pressure measurements (mud weights, RFTs, DSTs etc.) will be compared with the log signature of overpressure to investigate whether disequilibrium compaction or fluid expansion mechanisms represent the most likely origin of overpressure. The former is associated with undercompaction on log data the latter may not be witnessed by undercompaction on log (especially density and neutron porosity) data. Understanding the distribution and origin of overpressure will help mitigate associated drilling risk and provide a valuable input to basin modelling of hydrocarbon migration.

PhD Project: Overpressure in Australian Basins (North West Shelf and Cooper Basin)

PhD Student: Peter van Ruth (commenced 1999)

Supervisor: Prof. Richard Hillis

Project Support: ASEG Research Foundation

Scholarship Support: ARC Large Grant

The project will focus on two main study areas, the Cooper Basin and the North West Shelf. Research is currently being conducted on the distribution of overpressure in the North West Shelf and the wireline log response to overpressured strata in the Cooper Basin.

To date the study has identified overpressure in the Nappamerri Trough region of the Cooper Basin, and extensive overpressured strata along the entire length of the North West Shelf. Sonic log analysis of the Cooper Basin indicates there is a complex acoustic velocity-depth relationship that cannot be simply explained by variations in pore pressure and compaction. A more detailed analysis of the wireline log data incorporating uplift and other logs is needed to gain accurate pore pressure estimates.

This project will focus on the occurrence and nature of overpressure in the study regions. Wells will be selected for detailed wireline log analysis to try to establish transforms between sonic/density/resistivity and overpressure. Provided a reasonable velocity-pore pressure transform can be established a sonic velocity model will be created using available seismic surveys in the study areas from which overpressure will be estimated.

This project is scheduled for completion in March 2002.

In Situ Stress and Neotectonics of Brunei

Project leader: Professor Richard Hillis

Research personnel: Dr Scott Mildren and Mark Tingay (PhD student)

Funding support: ARC (Large Grant Scheme): 1999-2001 inclusive, \$190K

Brunei's Baram Delta affords a unique opportunity to analyse a structurally complex deltaic sequence using data from offshore oil exploration and onshore outcrops. This project will determine the contemporary stress regime associated with deltaic extensional tectonics, and that associated with the transition from extensional to compressional and wrench tectonics exhibited within the deltaic sequence. The distribution and origin of elevated pore pressures, and coupling between pore pressure and stress will also be determined, as will the influence of contemporary stress on fluid flow. These issues have major implications for deltaic tectonics and for oil exploration. This project is being undertaken in collaboration with Dr Chris Morley (University of Brunei) and Dr Dick Swarbrick (University of Durham, UK). The PhD project of Mark Tingay falls within this project, and its description below, provides further information on the project.

PhD Project: In Situ Stress and Neotectonics of Brunei Darussalam

PhD Student: Mark Tingay (commenced 1999)

Supervisor: Prof Richard Hillis

Project Support: ARC Large Grant

Scholarship Support: Australian Postgraduate Award

Research is currently being conducted on the in situ stress field and neotectonics of Brunei Darussalam. Brunei Darussalam is located on the Northwest coast of Borneo in the South China Sea. The Baram Basin that covers most of the onshore and offshore areas of Brunei is a Tertiary delta deposited adjacent to an active margin and contains several large oil and gas fields. The in situ stress field is of primary importance to the petroleum industry for improving petroleum production and decreasing exploration risk. Neotectonics within the Baram Basin is complex. However, understanding the nature of neotectonics has important influences on maturity, migration and trap development. Pore fluid pressures also play an important role in understanding both the neotectonics and in situ stresses of Brunei. Overpressures are commonly encountered throughout the Baram Basin and can sometimes reach the lithostatic gradient.

The in situ stress field and pore fluid pressures within the Baram Basin will be examined by means of downhole data (petrophysical logs, leak-off tests, repeat formation tests). The neotectonics will be investigated by means of petrophysical logs, field observations and seismic data.

To date the in situ stress field has been examined in detail within the Champion oil and gas Field. The results suggest a normal faulting stress state in the shallow deltaic foreset units, trending into a normal/strike-slip stress environment in the highly overpressured deltaic bottomset unit. Horizontal stresses within the Champion Field have a low anisotropy with a poorly defined maximum horizontal stress direction trending approximately northwest-southeast. The origin of overpressures within Brunei has been examined over much of the Baram Basin. The origin of overpressure is most likely due to disequilibrium compaction based on the geological history of the region and from analysis of petrophysical logs and

direct pressure tests. However, overpressures have also migrated to shallower depths by means of conduits such as faults.

The project is scheduled for completion in February 2002.

PhD Project: Lithospheric Modelling: Viscoelastic/Flexural Modelling of the Late Cretaceous to Recent Barrow and Dampier Sub-Basins

PhD student: Ainslie Baxter (commenced 1997)

Supervisor: Professor Richard Hillis

Funding support: Mobil Exploration & Producing Australia Pty Ltd

Scholarship support: Mobil Exploration & Producing Australia Pty Ltd

A high resolution Tertiary sequence stratigraphic data set for the Barrow and Dampier sub-Basins is being used as part of a study to numerically model the Tertiary subsidence history of the sub-basins. The study entails forward modelling of the thick plate viscoelastic response of the basement to sedimentary load. The flexural modelling will help to constrain the mechanisms of Tertiary basement movement in the Barrow and Dampier Sub-Basins. In particular, objectives of the study are: to determine whether flexure can account, wholly or in part, for the observed pattern of basin development (especially the shifting centres of deposition in the Barrow-Dampier sub-Basins); to determine to what extent flexure contributes to the late Miocene to Recent aggradational pattern of sequence deposition in the sub-basins; and to investigate whether a viscoelastic model is applicable to the development of other Australian basins.

Work in the past year has focused on sensitivity testing of a thick plate viscoelastic algorithm on data from the Cooper-Eromanga Basin, and on writing literature review chapters (on geological setting, rheology and model formulation).

Australian Stress Map

Project leader: Professor R Hillis

Research personnel: Dr Scott Mildren, Jeremy Meyer(PhD student), and Scott Reynolds (PhD student)

Funding support: Contract research projects and Australian Postgraduate Awards

The Australian Stress Map project commenced in 1996 with funding from the Australian Research Council. Inspired by the World Stress Map project (Zoback, 1992), there were three key drivers for the project.

- (1) The in situ stress field of the Australian Continent was poorly constrained at the time of compilation of the World Stress Map.
- (2) The limited data that did exist indicated complex and scattered stress orientations in the Australian Continent.
- (3) Increasing recognition of the importance of in situ stress data to problems related to hydrocarbon exploration and development in Australia.

The Australian Stress Map project has had a major impact in all three of the above areas and the project is ongoing. New data are continually being added to the database as result of projects undertaken at the NCPGG. The project involves Prof. Richard Hillis, Dr. Scott

Mildren and PhD students Jeremy Meyer and Scott Reynolds. For further information see the Australian Stress Map website: www.ncpgg.adelaide.edu.au/asm/

The PhD projects of Scott Reynolds and Jeremy Meyer fall within this project, and descriptions of their PhD projects below, provide further information on the project.

PhD Project: The Regional In Situ Stress Field of Australia

PhD student: Scott Reynolds (commenced 1998)

Supervisor: Prof Richard Hillis

Project support: Contract Research Projects

Scholarship support: University of Adelaide Faculty of Science Scholarship

This project is concerned with the analysis and modelling of the regional in situ stress field of continental Australia. Previous work has shown that within many continents a uniform orientation of maximum horizontal stress (SHmax) exists, and parallels the direction of absolute plate velocity. Contrastingly the stress orientations throughout Australia do not parallel the direction of absolute plate velocity. Thus Australia is an important place to study the relationship between plate boundary forces and the intraplate stress field.

The first stage of the work has focused on better defining the regional stress field throughout Australia. The Bowen and Perth Basins have been analysed and show a consistent regional SHmax trend while the Sydney Basin shows no significant regional trend. Two techniques have been used to highlight the regional in situ stress trends throughout Australia: the definition of stress provinces and stress trajectory mapping. These two different statistical approaches have produced consistent results, which emphasize the regional trends throughout Australia. The second stage of the work has been to undertake plate boundary force modelling on the Indo-Australian plate using a new statistical approach on the updated regional trends. This has resulted in an improved fit to the observed stress field and has further confirmed that the regional stress pattern is consistent with control by plate boundary forces.

PhD Project: The Stress Field of the South Australian Region

PhD student: Jeremy Meyer (commenced 1997)

Supervisor: Prof Richard Hillis

Project support: Contract Research Projects

Scholarship support: Australian Postgraduate Award

Knowledge of stresses within the earth's crust has become increasingly important to a wide range of fields, including understanding plate driving forces, earthquake hazard assessment, petroleum exploration and production, mine design, civil engineering and geothermal energy exploitation. This has resulted in an increased effort to determine those stresses.

The stress field of the South Australian region is poorly constrained and existing information suggests a complex stress field. This lack of knowledge of the stress field of the South Australian region and the necessary application of such data provided the key motivation for this project. The primary aim of this project is to better constrain our knowledge of the stress field of the South Australian region. (Most of the data upon which stress determination can be based results from petroleum exploration and production activities.) The secondary aims of this project are, to better understand the plate boundary forces acting on the Indo-

Australian plate and to investigate application of the stress field to petroleum exploration and production.

The project is scheduled for completion in 2001.

PhD Project: Magnetic Petrophysics: The Use of Fractal Dimension for Textural Based Enhancement of Aeromagnetic Data

PhD student: Trevor Dhu (commenced 1997)

Supervisors: Prof Richard Hillis, Dr Mike Dentith (University of Western Australia)

Project support: ASEG Research Foundation

Scholarship support: Australian Postgraduate Award

Airborne magnetic data are one of the most commonly used geophysical tools for mineral exploration, and are beginning to have an increased role within the field of petroleum exploration. Once these data are acquired, it is standard procedure to produce a series of enhanced images, such as horizontal or vertical derivatives, to aid in the interpretation of the data. These enhancements are based on tone or amplitude features, with the textural component of the data tending to only be used in a subjective manner by the interpreter.

This research is investigating the use of fractal dimension as a measure of texture that can be used to enhance aeromagnetic data. Research is being carried out into which of the numerous techniques for estimating fractal dimension is most suited to aeromagnetic data. As well as this, work is being done to determine what styles of magnetic data are most responsive to this style of textural enhancement.

The project is scheduled for completion in 2001

PROGRAM: Sedimentology and Sequence Stratigraphy

Program Manager: Assoc Prof Simon Lang

Integration of high-resolution sequence stratigraphic studies and sedimentological analysis can substantially reduce risks for petroleum exploration and reservoir development. This research program encompasses projects that have as their central theme the application of sedimentology and sequence analysis to reservoir characterisation at the basin or field scale. Typically projects are industry-funded, and use real datasets from petroleum fields in Australia or overseas. Whilst most projects use cores, cuttings, wireline logs and seismic as their basic data sources, outcrops, mine exposures and modern depositional environments are also used as valuable reservoir analogue tools.

AIMS AND BENEFITS OF PROGRAM

- Improved understanding of depositional settings of clastic reservoir facies
- Improved understanding of geological controls on reservoir, seal or baffle distribution in time and space within a basin, with particular emphasis on stratigraphic traps

- Quantitative estimates of reservoir scale, geometry, orientation and interconnectivity to improve estimation of reservoir volumes and compartmentalisation, and to assess prospect and play risk, and also drilling strategies
- Improved application of sequence stratigraphic principles to a variety of basin styles, in particular coal-bearing non-marine intracratonic basins, where complex interactions occur between tectonics, eustasy, sediment supply and climate

PROJECTS:

PhD Project: Sequence stratigraphy, and foraminiferal biostratigraphy of the mid-Miocene of South Australia. *

**In collaboration with the Department of Geology and Geophysics, The University of Adelaide.*

PhD student: Louise Christian (commenced 1995).

Supervisors: Assoc Prof Simon Lang, Dr Brian McGowran, Dr Q Li

Funding support: Primary Industries and Resources South Australia

Scholarship support: The University of Adelaide

This project forms part of a larger initiative by the University of Adelaide and the NCPGG to examine high resolution Tertiary sea level variations around the Australian continent.

Foraminiferal analyses, including biozonation from planktonic species, and determination of palaeoenvironments largely from benthic faunas, have been carried out on core, side-wall core and cuttings samples from approximately twenty wells. Samples have been selected from the offshore sectors of the Gippsland, Bass, and Duntroon Basins. Significant changes have been made in many instances from the original biozonations, delineated in the 1970's and 80's.

Seismic and wireline log data from the three basins form the basis of sequence stratigraphic interpretations. This interpretation is well under way, with significant surfaces showing excellent correlation with proposed foraminiferal events. The mid-Miocene has been selected as the focus of this study, as it is considered to be the climatic optimum for the Neogene - thus, sediments from this period are widespread, displaying a variety of facies.

PhD Project: The use of forward stratigraphic modelling for reservoir characterisation

PhD Student: Evelina Paraschivoiu (commenced 1998)

Supervisors: Assoc Prof Simon Lang, Prof Cedric Griffiths (CSIRO)

Project support: NCPGG

Scholarship support: The University of Adelaide

The project aims to investigate the possibility of using forward stratigraphic modelling (specifically SedSim) to build a reservoir flow model for an oil field which exhibits stratigraphically controlled lateral and vertical facies variations. The SedSim model will form the base for a reservoir simulation model, which in turn will be history matched with production data.

The Stag Field in the Dampier Sub-basin (North West Shelf) has been chosen as a case study for simulating a shallow marine siliciclastic reservoir, after consultation with Apache Energy and Santos. The SedSim computer package can simulate 3D distribution of uncompacted sediments of four different grain sizes on a bathymetric surface, by modelling forward in time

sediment transport, deposition and erosion. The first stage of this modelling study consists of running a depositional simulation over an 80x50 km area on the Enderby Terrace, surrounding the Stag field, for a time interval of 10 million years in the Early Cretaceous. The palaeoreconstruction is based on 2D and 3D seismic and well data from around 20 exploration wells. Once the overall grain size distribution in this regional model is achieved -and thus the main depositional controls identified- a more detailed model will be built for the Stag field (approx. 10x15km), simulating the deposition of the sands included in the *M. australis* palynozone. The reservoir scale model will predict and quantify facies variations and stratal architecture for the inter-well space, beyond the seismic resolution.

As part of the project, sensitivity studies and variable-resolution simulations have been run for different data sets, and have shown that SedSim can be used to identify an optimum lateral and vertical scale of the reservoir model, as well as capturing the salient lateral and vertical variations and facies continuity.

Subsequent compaction and diagenesis will be estimated for the computer-generated sediment bodies. Synthetic lithologies will be then translated into distributions of rock/flow unit properties, thus generating a reservoir model in a format suitable for a multi-phase flow reservoir simulator.

PhD project: The effect of Tertiary tectonic movements on stratal architecture, hydrocarbon maturation and migration in the Gambier Sub-basin, Otway Basin, Southern Australia*

**In collaboration with the Department of Geology and Geophysics, The University of Adelaide.*

PhD student: Rosalie Pollock (commenced 1999)

Supervisor: Assoc Prof Simon Lang, Assoc Prof Brian McGowran

Funding support: Boral Energy Resources (now Origin Energy Resources)

Scholarship support: Boral Energy Resources (now Origin Energy Resources)

Sequence stratigraphy is an important technique that predicts the location of facies, allowing the position of potential sources of oil and gas to be identified. The Gambier Sub-basin is an example of a frontier basin in southern Australia with only a few small developing gas fields. There is good seismic coverage and limited well coverage. A regional sequence stratigraphic study is needed to investigate the tectonic movements in the Tertiary that have affected basin architecture and altered maturation and migration pathways.

The purpose of this study is to develop a sequence stratigraphic framework for the Gambier Sub-basin which will enable prediction of reservoir and seal facies. This study will analyse the timing and degree of faulting within a sequence stratigraphic and chronostratigraphic framework, integrating seismic, well logs, biostratigraphy, outcrops, and core and cuttings descriptions, to determine the localities of kitchens which may be linked to migration pathways and potential stratigraphic and structural traps.

The sequence stratigraphic evolution of Tertiary passive margins: An example from the Barrow - Exmouth Sub-basin, W.A.

PhD student: Hamish Young (commenced 1996)

Supervisors: Dr Nick Lemon, Assoc Prof Jim Jago (Uni of SA)

Project support: Mobil Exploration & Producing Australia Pty Ltd

Scholarship support: The University of South Australia & NCPGG

A high resolution, regional sequence stratigraphic interpretation is being conducted in the Albian - Recent section of the Barrow - Exmouth Sub-basin, on the North West Shelf where a typical passive margin shows hinged subsidence. The shelf profile evolved from a ramped siliciclastic platform in the Late Cretaceous - Late Eocene, into a rimmed carbonate platform in the Early Oligocene to Recent.

The study has identified thirty-five chronostratigraphic events using biostratigraphic, wireline and seismic data. A new sequence stratigraphic model was developed to interpret within a mixed siliciclastic-carbonate system. Several key sequence boundaries recognised in the Barrow - Exmouth Sub-basin were identified in passive margins globally. Australasia Atlantic and Indian Ocean continental shelf examples were correlated for changes in lithofacies, sedimentation rates and shelf geometries. The study demonstrated that passive margins evolve as dynamic systems, reflecting similar characteristics, irrespective of their rift-drift histories.

The estimated completion date is June 2000.

PROGRAM: Structural Controls on Sedimentation

Program Manager: Dr Nick Lemon

The response of sedimentation to tectonic movement has been a topic of study at the NCPGG since its inception. The Flinders Ranges in South Australia provide an area of excellent outcrop where detailed mapping can be done to build and test models of the interaction between sedimentation and tectonics. In particular, synsedimentary diapirs in the Flinders Ranges display many features only suspected in oilfield examples.

The lessons learnt from outcrop studies and from literature have been applied to studies of several Australian basins with known hydrocarbon potential. Structural analysis of the Bass Basin will allow prediction of the position of viable source rocks. Understanding of the tectonics of the Bowen-Surat Basin has allowed a better model of the sequence architecture in a continental succession to be established.

PROJECTS:

PhD Project: Rift geometry and its influence on the sedimentation history of the Bass Basin of Australia with particular reference to the Boobyalla Sub-basin.

PhD student: PK Das (commenced 1997)

Supervisor: Dr Nick Lemon

Funding support: Mineral Resources, Tasmania & AGSO

Scholarship support: OPRS and The University of Adelaide.

A detailed study of the evolution of the rift geometry of the Mesozoic-Cenozoic interior rift Bass Basin through geological time maps the sequential development of the structural style and sedimentation patterns in response to tectonic episodes. A large seismic data base, gravity-magnetic data, wireline and biostratigraphic information from 32 wells drilled so far in the basin allow determination of a detailed tectono-stratigraphic evolutionary model for the whole basin.

The integrated interpretation of the wireline, seismic and biostratigraphic data of the southeastern part of the basin has revealed good insights into the tectonic evolution of this area. The predominant influence of the Tasman Sea rifting episode over the earlier Otway rifting phase has shaped the structural style of the Durroon Basin separate from the rest of the Bass Basin. A poster paper on these topics will be prepared for the APPEA'2000 Conference. An interesting prospect in the northwestern part of the basin has been identified at the *M.diversus* level and mapping of this is being documented for publication. Difficulties in loading of the AGSO-40 Survey data have been overcome allowing the contrast in the structural and stratigraphic history of the two basins to be better documented.

PhD Project: Regional Analysis of the Rewan Group (Bowen Basin)

PhD student: Paul Grech (commenced 1994)

Supervisor: Dr Nick Lemon, Dr Neville Alley (PIRSA)

Project support: Industry

Scholarship support: The University of Adelaide

Outcrop, wireline log, biostratigraphy, core and seismic data were integrated in this study of the Rewan Group in the Bowen Basin to achieve an understanding of the depositional systems involved. The major objective is to clarify the sedimentology and stratigraphy of the Early Triassic sand bodies and identify potential reservoirs.

Detailed outcrop stratigraphic work and core logging was carried out in Queensland. Facies analysis of the data has been completed and at the moment the results of the whole study are being written-up. Seismic data had been interpreted and at an earlier stage of the project, in an effort to use seismic sequence stratigraphy to interpret depositional facies. This direction was abandoned because quality of the data did not allow such an approach. However, some aspects from this earlier work will be integrated into the overall sequence stratigraphic interpretation, resulting in an improved depositional model for the Rewan Group.

A major aspect from this study has been the understanding of continental sequence stratigraphy. A new model has been proposed and will be presented in June 2000 at the

Sprigg Symposium in Adelaide, and in July 2000 at the AAPG Regional Conference in Istanbul.

PROGRAM: Thermal Modelling and Basin Analysis

Program Manager: Dr Peter Tingate

This program examines regional aspects of hydrocarbon generation and migration in sedimentary basins. Thermal history modelling is the basis for predicting the timing and extent of petroleum generation and is the main technique used. Regional hydrological studies are also underway since they give important information on formation water resistivity, fluid flow and hydrocarbon migration.

Recent research areas include: NW Shelf - Barrow and Dampier Sub-basins & Roebuck Basin, Centralian Basins - Amadeus and Officer Basins, Cooper-Eromanga, Pedirka and Stansbury Basins

PROJECTS:

Thermal History Modelling of the Officer Basin

The Officer Basin contains Neoproterozoic-Palaeozoic shallow marine to terrestrial sediments separated by unconformities that represent regional deformational and erosional events. These events range in age from the latest Neoproterozoic to mid-Palaeozoic. It is difficult to assess the thermal effects of these events as these sediments are not suitable for vitrinite reflectance determinations.

Due to large gaps in the stratigraphy apatite fission track dating was carried out to constrain the thermal history of the region and see what implications it had for the geological and hydrocarbon generation history. The study, initially funded by PIRSA Petroleum Group demonstrates the usefulness of apatite fission track dating to regional geology and frontier hydrocarbon exploration. A paper will be presented and a manuscript submitted in 2000.

Formation water resistivities in the Carnarvon Basin

MSc student: Srdjan Jovanovic (Commenced 1995, part time)

Supervisor: Dr Peter Tingate

Scholarship support: Self funded

This project is studying the lateral variation in salinity of the formation fluids for each Stage on the NW Shelf. The results will be presented as an Rwa atlas of the Carnarvon Basin. This will be of practical use to all companies operating on the NW Shelf. Regional trends have been mapped and predictive patterns can be seen. The thesis is more than half complete.

Completed PhD Projects

Sequence stratigraphic evolution of the Albian to Recent section of the Dampier Sub-basin, North West Shelf, Australia

PhD student: Johnny Hull (commenced 1996, completed 1999)

Supervisors: Prof Cedric Griffiths (CSIRO), Dr Nick Lemon

Project support: Mobil Exploration & Producing Australia Pty Ltd

Scholarship support: Northcote Scholarship (UK)

This project is complete with the thesis handed in, marked and passed. A quantitative understanding of the spatial and temporal evolution of the Mid Cretaceous to Recent section of the Dampier Sub-Basin was determined from seismic interpretation and log analysis.

The Albian to Recent section of the Dampier Sub-basin was initially subdivided into a series of genetically-related units using a sequence stratigraphic approach that combined biostratigraphic and wireline log data. A new model for the sequence stratigraphic interpretation of carbonate wireline log motifs was developed and published. The events defined in the early phase of the project were then identified on seismic data and their spatial distribution was mapped throughout the study area. The internal architecture of each sequence was then analysed using 3D-Chronostrat software to yield important information on the three-dimensional evolution of the basin.

The study has defined 30 major regional sequence stratigraphic events in the Dampier Sub-basin. A series of depth and isochron maps have been created for each sequence and combined with the results from the 3D Chronostrat analysis to develop a model for the three-dimensional evolution of the basin. The study has also revealed important insights on the nature and rates of sedimentation in carbonate progradational systems.

Thermal history analysis of the Barrow and Dampier Sub-basins, North West Shelf, Western Australia

PhD student: Alex Kaiko (commenced 1993, completed 1999)

Supervisors: Dr Nick Lemon, Dr Peter Tingate, Assoc Prof Jim Jago (UofSA)

Project support: Industry & APCRC

Scholarship support: The University of South Australia

This project is completed with the thesis submitted, marked and passed by examiners.

The project showed that estimation of thermal maturity of a sedimentary succession through the use of vitrinite reflectance alone can be flawed. Vitrinite measurements in the northern Carnarvon Basin were compared with other estimates of thermal maturation such as heat flow modelling, spore colour index and organic geochemical markers. Several of the ancilliary techniques were in agreement with each other but the vitrinite reported lower values, strongly suggesting suppression. A new technique using facilities in Christchurch (NZ) which measures combined vitrinite fluorescence and reflectance (VRF) was trialled to overcome the suppression. VRF results agreed with the ancilliary techniques. As VRF response varies with the hydrogen content of coals, it was supposed that vitrinite suppression may be related to the occurrence of perhydrous macerals in the dispersed organic matter.

The identification of regional suppression problems and the understanding of the thermal regime that exists through much of the Barrow and Dampier Sub-basin (maximum temperature today) has allowed initial corrections to maturity estimates to be made based on corrected BHT. These corrections significantly reduce (by up to 1600m) the estimated depth to the onset of maturity (~0.7%Ro) throughout much of the region. This also significantly alters the timing of the onset of maturity for hydrocarbon generation for many of the identified source rocks throughout the region.

A petrophysical study on the influence of effective stress and fluid saturation on acoustic velocities in sandstones

PhD student: Abbas Khaksar (commenced 1995, completed 1999)

Supervisor: Professor Cedric Griffiths

Project support: Industry, ASEG & APCRC

Scholarship support: Iranian Government

The study integrated wireline log data and petrography with laboratory measurements of compressional and shear wave velocities of 22 representative samples to investigate factors affecting the seismic properties of Cooper Basin sandstone reservoirs. The velocity-effective stress relationship obtained from laboratory data is consistent with the sonic log anomaly observed in partially pressure-depleted reservoirs in the region. Neglecting the pressure effect on velocity results in the overestimation of rock porosity by the sonic log in overpressured formations, and underestimation of porosity in pressure depleted zones. The potential exists to use the velocity ratio (V_p/V_s) to detect fluid type and saturation status under in situ reservoir effective stress. The possibility of predicting of V_s from V_p , was demonstrated for both air- and water-saturated conditions over a range of effective stresses for the sandstone reservoirs of the study area. Time lapse seismic for the monitoring of depletion may be possible in the Cooper Basin. Although these results refer specifically to Cooper Basin reservoir rocks, the methods used and results of this study have direct implications elsewhere.

The Phanerozoic basin-fill history of the Roebuck Basin

PhD student: Stuart Smith (commenced 1994)

Supervisots: Professor Cedric Griffiths, Mr Howard Stagg (AGSO)

Project support: AGSO & APCRC

Scholarship support: AGSO

The Roebuck Basin occupies a strategic position on the North West Shelf but is also one of the lease explored basins in Australia. A complete review of the structural and stratigraphic framework was conducted to improve our knowledge of this area. Palaeogeographic reconstruction, 3D chronosome mapping, and 2D forward stratigraphic modelling using SEDPAK and 1D thermal modelling were completed in 1999. The thesis was submitted in September 1999.

Completed Research Projects

True Grain Sizes from Thin Section Data

Research Staff: Dr Chris Dyt, Dr Nick Lemon

Funding Support: APCRC

When a thin section is made, the grain can be cut anywhere along its axis. As a result the grain-size seen in thin section is normally smaller than the true grain-size. The grain-size distribution calculated from a thin section is therefore skewed towards the smaller size ranges. The program 'grsort' created by this project uses simple geometric relationships and statistics to correct this skewed distribution back to the true distribution.

Early Cretaceous Greensands of the North West Shelf

Research Staff: Dr Ian Dyson

Funding support: Mobil Exploration and Producing Australia Pty Ltd

This project interpreted the sequence stratigraphy and sedimentology of Early Cretaceous greensands in the Carnarvon Basin. These greensands of Valanginian to Aptian age are important hydrocarbon reservoirs on the North West Shelf and are commonly below seismic resolution. The greensands were deposited in estuarine and shoreface environments, and commonly overlie ravinement surfaces. A number of other greensands from the St Vincent, Otway and Bass basins were studied for comparison. In particular, the Maslin Sands of Eocene age are interpreted as analogues for the M. australis greensands on the Pedamullah Shelf and in the Barrow and Dampier sub-basins. Several field trips for both sponsor and University staff were organised to detail the sedimentology and sequence stratigraphy of the Maslin outcrops. This approach, together with the integration of palynology, core and wireline logs was used to identify potential reservoirs across the onshore and offshore Carnarvon Basin. Dr Dyson left the Centre in June.

Warburton Basin, South Australia

Research staff: Dr Xiaowen Sun

Funding support: Primary and Industries and Resources South Australia (PIRSA)

Dr Sun completed a fracture study of the Warburton Basin, and provided a report for PIRSA. This study details the fracture systems in the Warburton Basin and is the first such systematic compilation. Another study focusing on reservoir facies mapping of the Warburton Basin was also concluded. This work concentrated on matrix porosity and permeability as contributing factors to reservoir quality. The final report is in press. Dr Sun left the Centre in August.

Discontinued Projects

SEDSIM Development and Testing

Research Staff: Professor C Griffiths, Dr C Dyt

Funding support: APCRC

The SEDSIM three-dimensional stratigraphic forward modelling program was originally developed by Professor John Harbaugh's graduate students at Stanford University. SEDSIM is a useful tool for investigating fluvial and marine siliciclastic deposition on a pre-existing surface at many scales, from tens of metres to hundreds of kilometres. The program will continue to be used as part of a PhD project, however, development at the National Centre has been discontinued.

Upper Jurassic Sedimentation in the Echo-Yodel, Keast, and Goodwyn Area of the Rankin Trend (a continuation of 1997 Honours project by Mr Colin Hirning)

Research Staff: Professor C Griffiths, Ms E Paraschivoiu

Funding support: APCRC

A high resolution SEDSIM model (with a duration of 12 Ma) was initiated in 1998. The plan was to examine the distribution of sediments eroded from the Echo-Yodel and Goodwyn blocks on the Rankin Trend, NW Shelf. Since the principal investigator left NCPGG, the project was discontinued. Results up to project cessation include sensitivity studies of the effects of grid-size and time-step variation on the aliasing of the sediment distribution patterns. The study results will enable more rigorous selection of grid size for a given tectonic environment. The model has led to a revised interpretation of the tectonic history of the eastern margin of the Rankin Trend. Professor Griffiths left the Centre in November.

Investigation of the enigmatic occurrence of early or low temperature chlorite

Research staff: Dr N Lemon

Funding support: APCRC

The project on chlorite has been closed although some of the work has continued under the APCRC programs of Formation Damage and Reservoir Characterisation. Much of the initial work on chlorite was found to be duplicating the research effort by IFP in France. There was some exchange of data and a realisation that glaucony forms a continuum with some chlorite types, especially the very early formed varieties. The APCRC project evolved to concentrate on the glauconitic end-members.

Finance

1. The following statement of income and expenditure in the year 1999 is provisional. The University of Adelaide is introducing a new finance system and at the time of preparing this report final confirmed figures for 1999 were not available.
2. On the basis of the figures that are available, total funds to be carried forward to the year 2000 are \$579,000 compared to \$973,000 carried forward from the previous year.
3. In part this reflects the use in 1999 of funds carried forward from previous years that were “tied” to particular projects. However the major causes of the operating deficit were the decline in funding from the APCRC and the absence of substantial funds from industry sources.

**NCPGG Income & Expenditure Statement
for the period ended 31 December, 1999***

INCOME	\$K
University of Adelaide	
Teaching Program	180,000
Contrib to APCRC	100,000
Other	134,000
 University of SA	
Contribution to APCRC	30,000
 SA Government	 196,000
 Industry	 168,000
 Commonwealth	
APCRC	467,000
ARC	134,000
Other	8,000
 Interest (1999 interest will be credited in 2000)	 0
 TOTAL INCOME	 <u>1,417,000</u>
 EXPENDITURE	
 General Operating	 <u>1,811,000</u>
 SURPLUS/(DEFICIT)	 -394,000
 FUNDS CARRIED FORWARD FROM 1998	 973,000
 NETT POSITION - END 1999	 <u>\$579,000</u>

* Provisional - final figures not yet available from University Finance system

Appendix A - Publications in 1999

Note: a full list of NCPGG publications is available at the web site www.ncpgg.adelaide.edu.au

Books

SUN, X. 1999 – Fracture analysis of the eastern Warburton Basin (Early Palaeozoic, south Australia). Report Book 99/14. Primary Industries and Resources South Australia. 52 p.

Journals

DUAN, T., GRIFFITHS, C.M. and JOHNSEN, S.O. 1999 – A new approach to reservoir heterogeneity modelling: conditional simulation of 2-D parasequences in shallow marine depositional systems using an attributed controlled grammar. *Computers & Geosciences*, 25(6), p. 667-681.

KALDI, J.G., O'BRIEN, G.W. and KIVIOR, T. 1999 – Seal capacity and hydrocarbon accumulation history in dynamic petroleum systems: the East Java Basin, Indonesia and the Timor Sea Region, Australia. *APPEA Journal*, 39(1), p. 73-86.

KHAKSAR, A. and GRIFFITHS, C.M. 1999 - Influence of effective stress on the acoustic velocity and log derived porosity. *SPE Reservoir Evaluation and Engineering*, 2(1), p. 69-74.

KHAKSAR, A., GRIFFITHS, C.M. and McCANN, C. 1999 – Compressional- and shear-wave velocities as a function of confining stress in dry sandstones. *Geophysical Prospecting*, 47, p. 487-508.

SMITH, S.A., TINGATE, P.R., GRIFFITHS, C.M. and HULL, J.N.F. 1999 – The structural development and petroleum potential of the Roebuck Basin. *APPEA Journal*, 39(1), p.364-385.

Conferences

DAS, P.K. and LEMON, N.M. 1999 – Transfer zones in extensional basins and their control on structural style and stratigraphy – implications for hydrocarbon exploration. *APPEA Journal*, 39(1), p. 727-728.

DYT, C.P., GRIFFITHS, C.M. and PARASCHIVOIU, E. 1999 – Clastic depositional modelling with SedSim. 5th SIAM Conference on Mathematical and Computational Issues in the Geosciences, Abstracts, San Antonio, Texas, 24-27 March.

DYT, C.P., GRIFFITHS, C.M. and PARASCHIVOIU, E. 1999 – Clastic depositional modelling with SedSim: recent innovations and sensitivity tests. *APPEA Journal*, 39(1), p. 728-729.

GRIFFITHS, C.M., DYT, C.P. and PARASCHIVOIU, E. 1999 – Three-dimensional forward stratigraphic modelling on the North West Shelf – status and future plans. *APPEA Journal*, 39(1), p. 729.

KHAKSAR, A. and GRIFFITHS, C.M. 1999 – Acoustic velocities in partially saturated sandstones versus effective stress. 61st EAGE Conference & Technical Exhibition, Helsinki, Finland, 7-11 June, Extended Abstracts volume 1, paper 2-04.

KHAKSAR, A., GRIFFITHS, C.M. and McCAN, C. 1999 – Effective stress coefficient for P- and S-wave velocity and quality factor in sandstone, Example from Cooper Basin, Australia. 69th SEG Annual Meeting, Houston, USA.

KHAKSAR, A., MITCHELL, A. and GRIFFITHS, C. 1999 – Use of core and log in investigating the feasibility of time lapse seismic. Geological Society of London Conference – Geological Applications of Wireline Logs (GAWL III) Abstracts, London, 20-21 January.

SUN, X. and GRAVESTOCK, D.I. 1999 – Hydrocarbon reservoir potential of the Cambro-Ordovician Warburton Basin, South Australia. *APPEA Journal*, 39(1), p. 730-731.

TUTTLE, K.J., DYT, C.P., GRIFFITHS, C.M. and AAGAARD, P. 1999 – Sedimentary process simulation of spatial heterogeneity and clastic lithofacies architecture in nested models. In: Lippard, S.J., Nass, A. & Sinding-Larsen, R. (Eds), *Proceedings of the IAMG'99 The Fifth Annual Conference of the International Association for Mathematical Geology*, 6-11 August, Trondheim, Norway.

Appendix B - Theses, continuing or completed in 1999

Note: a full list of NCPGG theses is available at the web site www.ncpgg.adelaide.edu.au

IN PROGRESS – MASTERS

DRAGOMIRESCU, R. (1999) – Intraformational seals in the Triassic Nappamerri Group, Cooper Basin. (UA)

JOVANOVIC, S. (1995) - Formation water resistivities in the Carnarvon Basin. (UA)

MUSU, J. (1998) – Inter-relationship between reservoir properties and nuclear magnetic resonance (NMR) in the Cooper Basin. (UA/UNSW)

NEJEDLIK, J. (1999) – Porosity heterogeneity in the Hutton sandstone, Eromanga Basin, South Australia (UA/UNSW)

ORAEKWUOTU, A. (1996) – Overpressure in New Zealand Basins. (UA)

WEISS, R. (1993) - An analysis of velocities within the Lake Hope 3-D Seismic Survey Area, Cooper Basin. (UA)

IN PROGRESS - Ph.D.

BAXTER, A. (1997) – Lithospheric modelling: Viscoelastic/flexural modelling of the Late Cretaceous to Recent Barrow and Dampier Sub-basins. (UA)

BOUCHER, R.K. (1992) - The influence of deep-seated structure on hydrocarbon accumulations in the Cooper and Eromanga Basins. (USA)

CHRISTIAN, L.R. (1995) - Sequence stratigraphy, and foraminiferal biostratigraphy of the mid-Miocene of South Australia. (UA)

CUBITT, C.J. (1994) - Provenance and diagenesis studies: Merrimelia Formation, Cooper Basin, South Australia. (UA)

DAS, P.K. (1997) – Rift geometry and its influence on the sedimentation history of the Bass Basin of Australia with particular reference to the Boobyalla Sub-basin. (UA)

DHU, T. (1997) – Magnetic petrophysics: The use of fractal dimensions for textural based enhancement of aeromagnetic data. (UA)

GRECH, P.V. (1994) - Regional analysis of the Rewan Group (Bowen Basin). (UA)

KIVIOR, T. (1998) – Characterising faults and sealing units in the southern Vulcan and northern Browse Basin, North West Shelf, Australia. (UA)

- LANZILLI, E. (1994) – Reservoir characterisation of the Gidgealpa South Dome with extension to the general Eromanga Basin. (USA)
- MEYER, J. (1997) – The stress field of the South Australian region. (UA)
- PARASCHIVOIU, E. (1998) - The use of stratigraphic forward modelling for reservoir characterisation. (UA)
- POLLOCK, R.M. (1999) – The influence of Tertiary tectonic movements on stratal architecture, hydrocarbon maturation and migration history in the Gambier Basin. (UA)
- POLOMKA, S.M. (1992) – Development from rift to passive margin: structure and sedimentology. A case history from the Barrow Sub-basin. (USA)
- REYNOLDS, S. (1998) – The regional in situ stress field of Australia. (UA)
- TINGAY, M. (1999) – In situ stress and neotectonics of Brunei. (UA)
- VAN RUTH, P. (1999) - Overpressure in Australian Basins. (UA)
- YOUNG, H.C. (1996) – The sequence stratigraphic evolution of Tertiary passive margins: An example from the Barrow – Exmouth Sub-basin, WA. (USA)

COMPLETED in 1999

Honours

- BEST, H. 1999 - Sedimentology, sequence stratigraphy and reservoir potential of the Warrinilla Field, Bowen Basin. (BSc(Hons), UA)
- BLANK, J. 1999 - Late Oecene – Early Oligocene sequence stratigraphy of the nearshore – transition zone Latrobe Group, Ninety Mile Beach, Gippsland Basin. (BAppSc(Hons), UA)
- BON, N. 1999 - Reservoir and production properties of the Toolachee and Patchawarra Formations, Cooper Basin, South Australia. (BSc(Hons), UA)
- CEGLAR, N. 1999 - Late Jurassic to Early Cretaceous sequence stratigraphy, Northern Bonaparte Basin, Timor Sea. (BSc(Hons), UA)
- DUBSKY, M. 1999 - Reservoir quality and distribution of the Late Jurassic sands, Dampier Sub-Basin, Western Australia. (BSc(Hons), UA)
- JORAANDSTAD, S. 1999 - Use of stacking velocity for depth prediction and lithological indication in the Challum Field of the Cooper/Eromanga Basin, Queensland. (BSc(Hons), UA)

- LIVESEY, J. 1999 – Evaluation of a new method for predicting P-wave sonic data, Timor Sea. (BAppSc(Hons), USA)
- MACKIE, V. 1999 - Seismic sequence stratigraphy of the Early Carboniferous, Petrel Sub-basin, northwestern Australia. (BSc(Hons), UA)
- MCLEAN, B. 1999 - Geophysical investigations in the Moorowie Syncline, Arrowie Basin, South Australia. (BAppSc(Hons), USA)
- PRATER, T. 1999 - Comparison of rock-type-derived reservoir properties with estimates from standard petrography. (BAppSc(Hons), UA)
- QUINN, D. 1999 - An evaluation of seals, reservoirs and fault sealing potential in the Eyre Sub-basin, Great Australian Bight. (BSc(Hons), UA)
- ROYAL, B. 1999 - Biostratigraphic and sequence stratigraphic correlation of the Last Barrow Group Foreset, Barrow Sub-basin. (BSc(Hons), UA)
- RYAN, L. 1999 - Fault seal potential of the Sherbrook Group: Port Campbell Area, Otway Basin, Victoria. (BSc(Hons), UA)
- SMART, S. 1999 - Asphaltites from the Southern Australian Margin: submarine oil seeps or maritime artefacts? (BSc(Hons), UA)

PhD

- HULL, J.N.F. 1999 – Sequence stratigraphic evolution of the Albian to Recent section of the Dampier Sub-basin, North West Shelf, Australia. (UA)
- KAIKO, A.R. 1999 –Thermal history analysis of the Barrow and Dampier Sub-basins, North West Shelf, Western Australia. (USA)
- KHAKSAR, A. 1999 - A petrophysical study on the influence of effective stress and fluid saturation on acoustic velocities in sandstones. (UA)
- SMITH, S.A. 1999 – The Phanerozoic Basin-fill history of the Roebuck Basin. (UA)

NCPGG 1999 SUPPORT FRAMEWORK

ADMINISTRATION SUPPORT

THE UNIVERSITY OF ADELAIDE

FINANCIAL SUPPORT

Government:

AUSTRALIAN PETROLEUM COOPERATIVE
RESEARCH CENTRE
PRIMARY INDUSTRY & RESOURCES, SOUTH AUSTRALIA

Industry:

BHP PETROLEUM PTY LTD
MOBIL EXPLORATION & PRODUCING AUST. PTY LTD
SHELL DEVELOPMENT (AUSTRALIA) PTY LTD

Institutions:

THE UNIVERSITY OF ADELAIDE
THE UNIVERSITY OF SOUTH AUSTRALIA

FUNDING SUPPORT - TEACHING PROGRAM

Government:

AUSTRALIAN GEOLOGICAL SURVEY ORGANISATION (2)

Industry:

BEACH PETROLEUM
ORIGIN ENERGY RESOURCES LTD (formerly Boral)
ESSO AUSTRALIA LTD
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Institutions: THE UNIVERSITY OF ADELAIDE
THE UNIVERSITY OF SOUTH AUST.

FUNDING SUPPORT - RESEARCH

Government:

PRIMARY INDUSTRY & RESOURCES, SOUTH AUSTRALIA

Industry:

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CSIRO DIV OF PETROLEUM RESOURCES, SYDNEY
DEPT OF EXPLORATION GEOPHYSICS, CURTIN UNI
DEPT OF GEOCHEMISTRY, CURTIN UNI
SCHOOL OF PETROLEUM ENGINEERING, UNI OF NSW
THE UNIVERSITY OF ADELAIDE
THE UNIVERSITY OF SOUTH AUSTRALIA
VICTORIA UNIVERSITY OF WELLINGTON