A Research Proposal Submitted to a Consortium of Industrial Companies

CURTIN RESERVOIR GEOPHYSICS CONSORTIUM

by

Department of Exploration Geophysics
Curtin University
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Western Australia

DIRECTOR
Boris Gurevich
Professor of Petroleum Geophysics

Contract Period: 1 January 2011 through 31 December 2011

Fee for 2010 $A40,000
(includes 10% for Goods & Services Tax)

Institutional Approval

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Dr. Tony Tate
Director
Office of Research and Development
CURTIN RESERVOIR GEOPHYSICS CONSORTIUM

Research Staff

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Website: www.geophysics.curtin.edu.au
AIMS

To conduct geophysical research and develop new technologies for the benefit of petroleum industry in Australia and worldwide

To train students in geophysical methods and research relevant to the needs of our sponsors

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The CRGC is a partnership between industry and academia undertaking research into seismic acquisition, processing and interpretation with an emphasis on Australian petroleum exploration and production problems.

Details about the Department of Exploration Geophysics can be found at: www.geophysics.curtin.edu.au/

Details about the CRC for Greenhouse Gas Technologies (CO2CRC) can be found at www.co2crc.com.au/
INTRODUCTION

Curtin Reservoir Geophysics Consortium (CRGC) is a partnership between industry and academia. The CRGC is undertaking research into acquisition, processing and quantitative interpretation of geophysical data, with an emphasis on Australian petroleum exploration and production problems.

The CRGC mission is to conduct geophysical research and develop new technologies for the benefit of the petroleum industry, and to train students in geophysical methods and research relevant to the needs of our sponsors.

The proposed research is structured around the concept of improved seismic imaging of reservoirs, methods of signal analysis which will enhance the data processing of existing data, the potential offered using multi-component processing to understand the effects of anisotropy, and obtain a comprehensive knowledge of the effects variations in rock physics have on transmitted and reflected seismic energy.

The CRGC was founded in 1997 with the first funding commencing in 1998. Until 2004 the CRGC operated in close cooperation with the Australian Petroleum Cooperative Research Centre (APCRC), underpinning its Seismic Imaging Program. In that period the CRGC received some $A1.6 million to supplement the funding from the APCRC. From 2004 Curtin has been a participant in the CRC dedicated to Greenhouse Gas Technologies (CO2CRC).

Current CRGC research covers four major project areas:

1. Theoretical and experimental rock physics
2. Seismic processing and imaging
3. Reservoir characterization and monitoring
4. Sea-bed electromagnetics

This document outlines the main research activities of the CRGC. Funding information and intellectual property arrangements are described in Appendix A.
CRGC RESEARCH AREAS
THEORETICAL AND EXPERIMENTAL ROCK PHYSICS

Seismic signatures of patchy saturation

A major effort of the group is focused on the study of the effects of patchy saturation on seismic signatures. This effort is partially funded by the ARC Discovery Project *Seismic response of partially saturated petroleum reservoir zones: towards quantitative recovery monitoring*. The main objective is to quantify the effect of random spatial distribution of fluid patches. The approach is based on the general theory of heterogeneous poroelasticity developed by CRGC in 2003-2005. The aim of the current effort is to build a general model for elastic properties of partially saturated rock with a given statistical distribution of fractures and with arbitrary contrast between the properties of the two fluids (e.g., gas and liquid). Future work will also involve analysis of the effect of self-similar distribution of fluid patches. We are also performing a series of fluid injection experiments with X-ray Computer Tomography and ultrasonic control to validate our theoretical findings.

**Researchers:**
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Modelling of stress dependent attenuation and dispersion due to squirt flow in clastic and carbonate rocks

We are developing and testing a new squirt flow model, in which all (or the majority of) parameters can be independently measured or estimated from measurements. The pore space of the rock is assumed to consist of stiff porosity and compliant (or soft) pores present at grain contacts. The effect of isotropically distributed soft pores is modelled by considering pressure relaxation in a disk-shaped gap between adjacent grains. This derivation gives the complex and frequency-dependent effective bulk and shear moduli of a rock, in which the soft pores are liquid-saturated and stiff pores are dry. The resulting squirt model is consistent with Gassmann’s and Mavko-Jizba equations at low and high frequencies, respectively. As expected, the dispersion and attenuation are the strongest at low effective stress, and much smaller at higher effective stress. We will be testing and refining this model using ultrasonic and low-frequency measurements on clastic and carbonate rocks saturated with different fluids. The model can also be extended to partial saturation, anisotropy and viscoelastic fluids.

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Osni de Paula (o.depaula@postgrad.curtin.edu.au)
Simulation of rock properties from microstructure

A large effort of our group is directed towards modelling elastic properties of rocks from their microstructure. This approach has been made possible by recent advances in high-resolution X-ray imaging of rocks (down to 1 µm) and by advances in computer technology which allow simulations on large 3D microtomographic images. This approach has potential for a multitude of applications. Our current effort is mainly directed towards validation of existing theoretical effective-medium models, both for static and dynamic elastic properties. For static properties, our current approach utilises Finite-Element simulations, and is focused on the validation of mixture models for fractured and porous rocks, velocity-porosity models, models of the effect of clay on the properties of sandstones. For dynamic properties, the effort is aimed at the validation of the models of local (squirt) and mesoscopic flow models. The methodology here is based on the use of advanced Finite-Difference algorithms. The CRGC itself does not aim to develop any new numerical algorithms but cooperates with leading groups in 3D numerical simulations. However significant effort is applied to testing and validation of these algorithms using a variety of exact solutions, as well as adaptation of these algorithms to rock physics problems. Results of numerical modelling are compared with experimental observations.

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Simulation and analysis of borehole waves for production monitoring

Wave propagation in fluid filled boreholes is widely used for investigating the properties of hydrocarbon reservoirs. For a better understanding and investigation of these waves it is important to analyse their dispersion; i.e. their frequency dependent velocity. Conventional techniques like F-K analyses of finite-difference models or classical root-finding techniques are, for these purposes, too time consuming and difficult to implement.

In this work a new technique, the spectral method, is used to model the dispersion of borehole modes. The method will be especially extended for permeable, attenuating and anisotropic layers. Being able to provide a forward modelling tool will be useful in order to understand and interpret wave propagation in hydrocarbon reservoirs. The spectral method can supplement, or even replace, conventional techniques, as the computation time is much shorter and more complicated scenarios are easier to compute. Additionally this tool could be used in the future to invert frequency dependent velocities from experiments where the data could either be acquired in the laboratory or in real boreholes.

Researchers:
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Modelling of properties of rocks saturated with heavy oil

Rock physics for heavy oil is different from rock physics for conventional fluids because its viscoelastic rheology makes Gassmann theory and all its extensions inapplicable in principle. We developed an approximate methodology for fluid substitution in heavy-oil reservoirs. The methodology is based on one particular equivalent-medium approach known as coherent potential approximation (CPA). The methodology has been successfully tested on low frequency laboratory measurements.

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Low frequency acoustic measurements

Attenuation of seismic waves is emerging as an important indicator of oil and gas presence in the subsurface. This is mostly used empirically as existing theories of seismic attenuation/dispersion in fluid-saturated rocks are largely untested. We are performing comprehensive experimental testing of these theories using broadband measurements of dynamic elastic properties of rock samples. Experiments are conducted using a combination of forced-oscillation ultra sensitive strain gauge measurements (10 Hz – 2KHz), laser interferometry (100 Hz – 200 kHz) and ultrasonic testing (100-1000 kHz). The results will be compared with theoretical predictions computed using numerical simulations.

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Modelling elastic properties of fractured reservoirs

Estimation of reservoir fluid properties from seismic data is one of the central issues in petroleum exploration. For isotropic porous reservoirs this is accomplished through the use of Gassmann equations. However, such explicit yet general expressions have not been developed for porous reservoirs with aligned fractures. On the other hand, traditional models of fractured media ignore the background porosity of the rock, and thus do not account for the wave induced fluid flow between pores and fractures.

A major effort of the rock physics group is directed towards modelling attenuation, dispersion and frequency dependent anisotropy of porous reservoirs permeated by aligned fractures. In 2001-2003 we have developed a methodology of fluid substitution in fractured reservoirs, which is based on the combination of anisotropic Gassmann equations and Schoenberg's linear slip parameterisation of the effect of fractures on rock properties. In 2003-2006 we
developed a model for attenuation and dispersion of P-waves propagating perpendicular to a periodic system of parallel planar fractures, and validated this model with numerical simulations using a poroelastic extension of reflectivity method. These simulations helped to extend the attenuation/dispersion model to randomly spaced fractures and to oblique incidence.

More recently we developed a model for seismic attenuation and dispersion caused by the presence of sparsely distributed finite fractures in the porous reservoirs. The model is based on the combination of Biot’s theory of poroelasticity with the ideas of a multiple scattering theory. The current effort in this area is focused on the deeper understanding of the implications of this theory, and its extensions to:

- Oblique incidence
- Shear waves
- Higher fracture densities
- Arbitrary aspect ratios.

While all of the above models are designed for a single set of aligned fractures, real reservoirs often contain multiple fracture sets. Moreover similar phenomena (fluid flow between pores and fractures) lead to frequency dependent attenuation and dispersion in isotropic rocks with microcracks, compliant grain contacts, etc. These effects will be examined by extending the aligned fracture models to arbitrary angular distributions of fractures.

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SEISMIC PROCESSING AND IMAGING

Use of the Virtual Source technique

Physical modelling of the Virtual Source technique has been conducted in cross well topographic geometry to establish the data processing and technical requirements of this method. This work which will be completed soon should provide a more accurate and reliable method of cross well tomography in which the surface conditions will not influence the result. It is expected that the removal of the influence of overburden will be useful in the monitoring of the disposal of Carbon Dioxide in underground reservoirs but would also be useful for monitoring the reservoir characteristics in production of oil and gas. The data handling requirements can be difficult to manage as the original data can expend greatly in the processing before reducing back to manageable dimensions. Methods are also being studied to for optimising the result and improving the precision which might be achieved with this technique.

Researchers:

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Using higher-order derivatives of traveltime with respect to offset for better imaging

We use higher order derivatives of the traveltime with respect to the receiver location in a shot gather to perform velocity-less migration. For flat reflectors, we need to find only the second derivative of the traveltime. For reflectors with nonzero curvature, we need to compute higher order derivatives. The higher order derivatives can be used to find also the velocity variations within each layer. This project also includes adapting Dix's formula for the discussed methodology.

Researchers:

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3D / 3C VSP

Vertical seismic profiling enable one to analyse and understand geological origin of the wave field generated. The biggest advantage over surface seismic methods is that we have both transmitted and reflected fields available for an analysis; hence we can say that by recording VSP data we are conducting in situ rock-sample measurements. The two fields can then be used to infer rock properties. VSP data also helps us process and/or understand the problems we encounter when processing surface seismic data. We thus use VSP data for most of surface seismic related investigations to utilise the benefits of having full wave field available for the analysis. Frequently we encounter much higher resolution of VSP data in comparison to surface seismic data. Hence 2D and 3D images obtained with VSP data can be important for reservoir development, particularly for deep hydrocarbon accumulations.
Therefore it is of great importance to pursue continuing development of VSP data processing and analysis algorithms for the benefit of oil and gas exploration. The main areas of interest are 2D/3D imaging using monotypic and converted waves, anisotropic imaging, estimation of Q factor from VSP data and developing alternative approaches to Q-compensation and polarisation analysis for investigation of seismic anisotropy.

**Researchers:**

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**Physical Modelling**

The Physical Modelling laboratory is developing a range of measuring capabilities for basic acoustic measurements as well as simulating seismic acquisition. The capabilities in the laboratory now include 3 and 4D seismic acquisition with a variety of geometries and types of signals. A high pressure chamber can imitate thermodynamic conditions of condensable gasses at close to reservoir conditions. Apparatus is being developed to perform acoustic tomographic experiments on simulated reservoirs to image the movement of fluids through porous rocks.

In the last two years physical modelling has been used to study the methodology and promise of the ‘Virtual Source Method’. In this technique strongly heterogeneous and scattering layer in the near surface can be nullified by using subsurface receivers to record seismic signals generated at the surface. By correlation of these recorded signals, the receivers can be simulated to be virtual source as signals received by the receivers continue to lower layers and, when back reflected, act as virtual sources. The cross correlation of the signals can simulate virtual shot records where each sub-surface receiver acts as both a virtual source and an actual receiver. The technique has been verified and brut stack record generated with suitable fold and after processing show the expected reflectors in the subsurface. The technique is now being investigated in cross-well geometry with the expectation of being able to detect small differences in travel times which may result from injection of Carbon Dioxide or depleting of reservoirs by extraction of oil or gas.

Recent acquisition of a laser based motion sensor greatly expands the capabilities of the rock physics measurement. This device can remotely and continuously measure displacements down to fractions of a micron at frequencies up to the mega Hertz range and will be used to measure strains and rock movements under various mechanical excitations.

The program will also develop experimental tests of the theoretical rock physics and acoustic behaviour of fluid filled reservoirs.

An experimental study on the effect of the adsorption of different gas species on the velocity-effective stress response of coal is being carried out. This study is largely funded by the CO2CRC.
Velocity-less imaging in curvelet domain

It is possible to find the velocity of a homogeneous layer together with the reflector using the traveltimes and horizontal slownesses from 2D surveys. We use these slownesses (local slopes) to perform velocity-less migration. Since this procedure results also in effective velocities for each reflector, we use this information for suppression of multiples.

If we use also higher than the first derivatives of the traveltimes, we can obtain. To improve the efficiency of the algorithms, they can be formulated in the context of curvelets. This research is a collaboration with Dr. Dennis Cooke (Santos).
RESERVOIR CHARACTERISATION AND MONITORING

Generalised AVO modelling and analysis in isotropic and anisotropic media

All of the present knowledge used for prediction of elastic parameters of a poroelastic media is summarised in a Matlab GUI fluid-replacement application. Algorithms developed for a fractured solid medium will be extended to incorporate fractured porous media and the anisotropic Gassmann substitution of Gurevich (2003). This will provide a highly accurate generalised method for AVO modelling of fractured porous rocks.

Researchers:
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Fracture characterisation from seismic measurements

The current approach is to use the model of vertical or inclined fractures embedded in an isotropic, solid medium. The linear slip theory of Schoenberg and the Hudson’s penny-shape crack model are used to derive effective anisotropic properties of various fracture models, while modelling is conducted via exact anisotropic Zoeppritz equations. The polar representation of the AVO gradient, at constant incidence angles is one of the ways to assess the potential of azimuthal AVO analysis. Otway basin field data are currently being analysed since azimuthal anisotropy was confirmed from VSP measurements.

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Stress and fracture characterisation from multiscale measurements of seismic anisotropy

Knowledge of stress and fracture distribution is vital for hydrocarbon and geothermal reservoir characterization and management, assessment of stability of mines, tunnels and boreholes, CO2 sequestration, and geo-hazard mitigation. Currently, subsurface stress and fracture distributions are estimated from borehole measurements, which provide localised information. We aim to develop and test an integrated remote sensing methodology for characterisation of stress and fractures using elastic anisotropy inferred from seismic data. We will model the effects of fractures and stress on seismic anisotropy, measure these effects in a lab, and invert anisotropy estimates from seismic data to characterise stress and fracture distributions.

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Land and downhole time-lapse seismic monitoring

In the framework of CRC for greenhouse gas technologies, CRGC researchers are involved in the first integrated land time-lapse seismic project in Australia. The project involves monitoring of CO₂ sequestration using 4D seismic data and time-lapse 3D VSP over Naylor field, Otway Basin, Victoria. The first round of TL analysis has been completed. It is shown that the predicted impedance change of 5-6% can be monitored at Otway site with high resolution surface 3D seismic data. This exciting analysis will be expanded to 3D VSP data soon. Post injection monitor 3D surface and borehole sets will be recorded in January 2010.

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SEA-BED ELECTROMAGNETICS

CSEM Modelling, Advanced 3D visualisation and survey design

Sea Bed Electromagnetic methods are a relatively new and valuable technology for hydrocarbon exploration in deep water settings. Modern surveying equipment provides the possibility of multi-offset, multi-frequency and more recently multi-azimuth data sets. The arrangement and orientation of EM sources and receivers relative to the geo-electrical nature of the target and host, is a key part in determining the success of a Sea Bed Electromagnetic survey. Further analysis of complex Sea Bed EM data sets, which typically include MT data, requires the assistance of inversion. The CRGC research in Sea Bed EM is focused on, (a) integrated visualization and survey planning, (b) interactive 2D/3D inversion of Sea Bed Electromagnetic data (c) design of novel instrumentation and (d) understanding the impacts of electrical anisotropy on the Sea Bed EM response.

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**UNIQUE FACILITIES AVAILABLE TO CRGC**

**Western Australian Interactive Virtual Environments Centre (IVEC)**

IVEC is a research centre supported by federal and state funds and contributions from the four partner institutions, namely CSIRO, Curtin University (CU), Edith Cowan University, and The University of Western Australia (UWA). IVEC is also part of The National Computational Infrastructure (NCI) project which is funded through the National Collaborative Research Infrastructure Strategy (NCRIS) Platforms for Collaboration (www.pfc.org.au) capability. IVEC’s central role is to carry out R&D for visualisation and high-performance computing in geosciences. IVEC’s central node has been established in the Australian Resources Research Centre to serve the CSIRO Division of Exploration and Mining and Curtin’s Exploration Geophysics, Petroleum Geology and Petroleum Engineering departments. The ARRC node is equipped with a high-performance parallel computer, a state-of-the art immersive visualisation system (the "Wedge", a cut down version of a CAVE system), and various graphics workstations. R&D at the ARRC node is focused on (semi-)automatic seismic interpretation techniques, visualisation of seismic and mining data, parallelisation of seismic processing algorithms, and applications of immersive visualisation environments in data visualisation and training.

For more information see [www.ivec.org](http://www.ivec.org).

**Pressure/Temperature Chamber**

A large pressure chamber with a 1m internal diameter and maximum hydrostatic pressure capacity of 8.5MPa has been built to enable physical modelling experiments to be carried out in which fluid behaviour approximates that found under shallow reservoir or aquifer conditions. This chamber is fitted out with an automated 48 channel ultrasonic signal generation and data acquisition system capable of performing in a variety of configurations to perform physical modelling of seismic response or close to real time tomographic imaging of fluid behaviour.

**Laser-Doppler Vibrometer (Interferometer)**

A unique Laser-Doppler interferometer has been available for rock physics experiments. Combined with existing equipment the interferometer provides unique opportunity to perform accurate acoustic measurements of rocks properties at wide range from seismic to ultrasonics frequencies.
CRGC COMPUTER RESOURCES AND FIELD & LABORATORY EQUIPMENT

The Department of Exploration Geophysics runs a UNIX and PC computer network and all resources are available for CRGC research.

1. Hardware

UNIX

• 2 x Redhat Linux High Performance Dual Screen workstations
• 4 x Dual processor rack mounted servers (Linux Cluster AS2.1 and 3U5)
• 2 Node ROCKS 16 CPU Cluster with 4TB Disk Array
  • 1.2TB RAID Array
  • 2.4TB RAID Array

PC

• IBM Eserver X series 235 running Windows 2003 Server
• 600 Gb of Local RAID Storage and 1.5TB NAS
• PC network running Windows XP Professional
• 32 Pentium 4 PCs (Various specs)

2. Software

From Landmark Graphics Corporation

• Promax 2D/3D/4D/VSP
• Sierra Modelling
• SeisWorks 2D & 3D
• ZAP
• Geoprobe
• Depth Charge

From Petrosys

• Petrosys interpretation Software

From Paradigm (Epos3 SE)

• GeoDepth
• Probe
• Reservoir navigator
• Vanguard
• Solid Geo
• Explorer
• Geo Sec
• Voxel Geo
• Geolog
• Stratamagic

From Hampson-Russell

• Geoview complete
Other Software

- Matlab
- Solid
- Maple
- Seismic UNIX
- Kingdom Software

3. Field Equipment

The research program has access to full field land seismic recording equipment including:

- 4-station 3-component downhole geophone recording string, remotely controlled for azimuthal changes
- a 12-channel GEOMETRICS enhancement seismograph
- a 444-channel distributed Seistronix seismic acquisition system that can operate in 2D or 3D mode (as a replacement for the old 96 channel OYO seismograph)
- two new geophone sets: (500) 28 Hz natural frequency and (500) 14 Hz natural frequency
- a downhole hydrophone string (24 elements to 20MP)
- access to GPS surveying equipment.

4. Laboratories

Laboratories available to Curtin Geophysics researchers include:

- a physical properties laboratory,
- an elastic wave Physical Modelling Laboratory,
- Triaxial Cell for core sample ultrasonic measurement at confining and axial pressures up to 60 MPa and
- the Pressure/Temperature Chamber described earlier
- Interactive Virtual Environment Centre’s high performance computer and a 'Wedge' visualisation environment described earlier.
CALENDAR OF EVENTS

CRGC Annual Meeting
9-10 December 2010
Rottnest Lodge
Rottnest Island
APPENDIX A

ADMINISTRATIVE, LEGAL AND FINANCIAL ARRANGEMENTS

1. Personnel

**Director**
Boris Gurevich, PhD, Professor

**Researchers**
Aleksandar Dzunic, BSc, Research Fellow
Andrej Bona, PhD, Senior Lecturer
Anton Kepic, PhD, Head of Department
Brett Harris, PhD, Senior Research Fellow
Bruce Hartley, PhD, Associate Professor
Boris Gurevich, PhD, Professor
Christian Dupuis, PhD, Research Fellow
Maxim Lebedev, PhD, Senior Research Fellow
Milovan Urosevic, PhD, Associate Professor
Roman Pevzner, PhD, Associate Professor

**Adjunct Researchers**
John A. McDonald, Adjunct Professor, PhD
Tobias M. Müller, Adjunct Associate Professor, PhD
Norm F. Uren, Adjunct Professor, PhD
Chris Juhlin, Adjunct Associate Professor, PhD
Peter Hatherly, Adjunct Professor, PhD

**Computer Systems Manager**
Robert Verstandig

**Financial Officer**
Melanie Troebinger

**Research Secretary**
Elizabeth Morrah

**PA/Administrative Assistant – Academic**
Deirdre Hollingsworth
2. Industrial Steering Committee

The Consortium will have an Industrial Steering Committee consisting of representatives of members of the CRGC. The Committee will be known as the Curtin Industrial Steering Committee (CISC). Meetings will be scheduled as required throughout the contract period.

3. Contract Period

The contract period for the CRGC is 1 January 2010 to 31 December 2010, which is renewable annually.

4. Fees and Taxes

The annual CRGC sponsor membership fee is $A 40,000 (inclusive of 10% Goods and Services Tax or GST).

If any law is introduced, is amended or takes affect during the term of this agreement that results in an increase in the rate of any taxes (including Goods and Services Tax), charges, fees and other imposts levied or assessed in connection with goods and services, or research services, Curtin will increase the fees chargeable to take into account the net effect of the tax increases.

Consortium fees are to be used to support students’ research, the CRGC’s professional personnel, and to maintain computers and other research equipment. Also supported are publications, media preparation, attendance at national and international scientific meetings and the CRGC Resource Room.

5. Publication

Research and development carried out during the project shall be subject to review by the CISC. Unless included in a previously written report, all materials must be made available to all consortium members at the same time. The submitted material may be held in review before publication for up to six months.

6. Intellectual Property

IP is assigned to Curtin and it has the first right of refusal for commercial development. CRGC sponsors can use the IP for their own purposes, including commercial use, but are prohibited from on-selling the IP to others.

7. Deliverables

In return for membership of the consortium the following items will also be delivered:

(a) An Annual General Meeting late in the year with one other meeting mid year.

(b) The CRGC Progress Reports which are re-packaged student theses, pertinent to CRGC research.
(c) Sponsor-only web access to preprints of all papers submitted to scientific conferences and journals.

(d) Newsletters published four times a year, which will be widely distributed.

(e) Copies of computer algorithms developed during the year by CRGC personnel

(f) Tape copies (at members' expense) of all data recorded under funding by the CRGC.

(g) Early access to any non-proprietary information developed with non-CRGC funding.

8. Disclaimer of Liability and Indemnity

Sponsors of the CRGC acknowledge that a) that they use the results of the research, and any advice, opinions or information supplied by Curtin, at their own risk; and b) it is the responsibility of each CRGC sponsor to makes its own assessment of the suitability of CRGC research, results and any advice, opinions or information supplied by Curtin.

The sponsors of the CRGC indemnifies Curtin, its officers, employees and agents against any claim or action arising out of the use of the application of the results of the CRGC research work, including, but not limited to the commercialisation of the research results by any sponsor.

9. Limitations of Liability

Sponsors of the CRGC acknowledge and agree that the maximum liability of Curtin under this agreement, whether in contract, tort, negligence or other cause of action is limited to the amount the sponsor pays to Curtin for undertaking research under this agreement. Curtin is not liable for, and specifically excludes liability for, consequential damages or any other form of indirect damages.