APPENDIX: LITHOS III proposal

Background Information

CONTENTS

A: LITHOS Sponsors

We thank and acknowledge our sponsors for their unfailing support and guidance:

Phase I: 1998-2001

Agip (UK) Ltd
Amerada Hess Ltd
BP Amoco Exploration Operating Co Ltd
Conoco (UK) Ltd
ExxonMobil International Ltd
Japan Petroleum Exploration Co
Lasmo Plc
Norsk Hydro ASA
Oil & Natural Gas Corp Ltd, India
Ranger Oil (UK) Ltd
Schlumberger Cambridge Research Ltd
Shell UK Ltd
Texaco Britain Ltd
TotalFinaElf Exploration UK Plc
Veritas DGC Ltd

Phase II: 2002-2006

BP America Production Company
ChevronTexaco
ConocoPhillips (UK) Ltd
ExxonMobil International Ltd
Schlumberger Cambridge Research
Shell UK Exploration and Production
Statoil (UK) Ltd
TOTAL SA

B: LITHOS Group Members

B.1 Research Profiles of Principal Investigators

Professor Satish Singh
Director, Laboratoire de Geosciences Marine

Career Summary:

Ph.D.	Theoretical Seismology	1987	University of Toronto
Post-Doc. Fellow	Inverse Theory	1989	IPG Paris
Post-Doc. Fellow	Inverse Theory	1990	Elf Acquitaine, Pau
Research Associate	Seismic data acquisition, processing, seismic theory	1990-1993	BIRPS Cambridge
Senior Ass. In Res.	Seismic data acquisition, processing, seismic theory	1993-1997	BIRPS Cambridge
Senior Res. Fellow	Seismic data acquisition, processing, seismic theory	1997-present	University of Cambridge
Professor	Marine Geophysics	1999-Present	IPG Paris

Research Interests: Singh's main research interest is the development of seismic modelling and inversion techniques to solve fundamental geological/geophysical problems. He has 25 years of research experience in modelling and inversion of seismic data, and has developed various modelling and inversion techniques to analyse seismic data, some of which have been commercialised by seismic companies. During his time in Cambridge, he created a strong research group in theoretical seismology, which gave the foundation for LITHOS I, and since moving to Paris, he has led to the creation of a new department at IPG Paris, Laboratoire de Geosciences Marines, and the French National Ocean Bottom Seismometer Pool.

Relevant Publications:

Ecoublet, P.O. Singh, S.C., Chapman, C.H. & Jackson, G.M. 2002. Bent-ray traveltime tomography and migration without ray tracing. *Geophys. J Int.*, **149**, 633-645.

Hobro, J., Singh, S.C., & Minshull, T.A. 2003. Three-dimensional tomographic inversion of combined reflection and refraction seismic traveltime data. *Geophys. J. Int*., **152**, 79-93.

McCaughey, M & Singh, S.C., 1997. A simultaneous inversion of both wide-angle and reflection seismic data. *Geophys. J. Int*., **131**, 87-99.

Shipp, R. & Singh, S.C. 2002. Two-dimensional full wavefield inversion of wide-aperture marine seismic streamer data. *Geophy. J. Int*., **151**, 325-344.

Singh, S.C., Hague, P.J. & McCaughey, M. 1998. Study of the crystalline crust from a two-ship normal-incidence and wide-angle experiment. *Tectonophysics*, **286**, 79-91.

Singh, S.C., Kent, G.M., Collier, J.S., Harding, A.J. & Orcutt, J.A. 1998. Melt to mush

variations in crustal magma properties along the ridge crest at the southern East Pacific Rise. *Nature*, **394**, 874-878.
Singh, S.C., Collier, J.S., Harding, A.J., Kent, G.M. & Orcutt, J.A. 1999. Seismic evidence for a hydrothermal layer above the solid roof of the axial magma chamber at the southern East Pacific Rise. *Geology*, **27**, 219-222.
Singh, S.C., Taylor, M.A.J. & Montagner, J.P. 2000. On the presence of liquid in Earth's inner core. *Science*, **287**, 2471-2474.
Singh, S.C., West, G, Bregman, N, & Chapman, C.H., 1989. Full waveform inversion of reflection data, *J.G.R.*, **94**, 1777-1794.
Singh, S.C., & Chapman, C.H., 1988. WKBJ seismogram theory in anisotropic media, *J. Acoust. Soc. Am.*, **84**, 732-741.
Taylor, M. & Singh, S.C. 2002. Composition and microstructure of magma bodies from effective medium theory. *Geophys. J. Int.*, **149**, 15-21.
Trinks, I. Singh, S.C., Chapman, C.H., Barton, P.J., Bosch, M. & Cherrett, A. 2005. Adaptive traveltime tomography of densely sampled seismic data., *Geophys. J. Int.*, **160**, 925-938.
Wang, Y. & Singh, S. 2003. Separation of whole P- and S-wavefields from multicomponent OBC data. *Geophysical Prospecting*, **51**, 233-245.
Ying, J., Singh, S.C. & Hornby, B. 2000. Sensitivity study using genetic algorithm: inversion of amplitude variations with slowness. *Geophysical Prospecting*, **48**, 1053-1073.

Dr Penny Barton
Senior Research Fellow, University of Cambridge

Career Summary:

Ph.D	Wide-angle seismic acquisition and analysis	1983	University of Cambridge
Research Assistant	Wide-angle seismic; deep reflection profiling	1983-1984	University of Cambridge
NERC Res. Fellow	Wide-angle seismics; integrated geophysics	1984-1986	University of Cambridge
Royal Society Research Fellow	Integrated and novel seismic techniques; application to exploration	1986-1997	University of Cambridge
Senior Research Fellow		1997-Present	University of Cambridge

Research Interests: Trained in marine geophysics, Barton has more than 25 years of experience in wide-angle seismics, and has been pioneering in their application to understanding complicated 2- and 3-D structure in the crust of continental margins and basins. This interest has always been centred on problem-solving by novel acquisition and analysis techniques, particularly using OBS, including intruments developed in-house. Since 1991, she has been involved in a close partnership with industry to develop densely-sampled wide-angle profiling as an exploration tool. Key aspects of the success of this work have been the integration of wide-angle data and models with conventional seismic, gravity and well log data, and the use of robust and quantifiable error and uncertainty analyses. During LITHOS phases I & II she has been working on implementing imaging methods for wide aperture and refraction

data.

Relevant Publications:

Barton, P.J. & Barker, N., 2003. Velocity imaging by tau-p transformation of refracted seismic traveltimes. *Geophysical Prospecting*, **51**, 195-203.

Barton, P.J., & Wood, R.J., 1984. Tectonic evolution of the North Sea basin: crustal stretching and subsidence. *Geophys. J. R. astr. Soc*., **79**, 987-1022.

Bosch, M., Barton, P.J. & Singh, S.C. 2005. Inversion of short and long offset travel time data from the north-east Atlantic margin. *Geophysics* (in press).

Hughes, S., Barton, P.J., & Harrison, D.J., 1997. Characterising the Mid-Faeroe Ridge using physical property measurements. *J. Geophys. Res*., **102**, 7837-7847.

Hughes, S., Barton, P.J., & Harrison, D.J., 1998. Exploration in the Shetland-Faeroe Basin using densely spaced arrays of OBS. *Geophysics*, **63**, 490-501.

Jones, G.D., Barton, P.J. & Singh, S.C. 2003. Combined structure and velocity stacks via the tau-p transform. *Geophysical Prospecting*, **51**, 205-213.

McCaughey, M., Barton, P. J. & Singh, S. C. 2000. Joint traveltime inversion of wide-angle seismic data and a deep reflection profile from the central North Sea. *Geophys. J. Int*., **141**, 100-114.

Samson, C., Barton, P.J., & Karwatowski, J., 1995. Imaging beneath an opaque basaltic layer using densely sampled wide-angle OBS data. *Geophysical Prospecting*, **43**, 509-527.

Tong, C. H., Barton, P. J., White, R. S., Sinha, M. C., Singh, S. C., Pye, J. W., Hobbs, R. W., Bazin, S., Harding, A. J., Kent, G. M., & Orcutt, J. A. 2003**.** The influence of enhanced melt supply on upper crustal structure at a mid-ocean ridge discontinuity: A three-dimensional seismic tomographic study of 9N East Pacific Rise. *J. Geophys. Res.,* **108**, B10, 2464, doi: 10.1029/2002JB002163.

Zelt, C.A. & Barton, P.J. 1998. Three-dimensional seismic refraction tomography: a comparison of two methods applied to data from the Faeroe Basin. *J. Geophys. Res*., **103**, 7187-7210.

B.2 Present LITHOS Group Members

Principal Investigators

Satish Singh	BSc, Physics (*Varanasi*); MSc Tech, Geophysics (*Varanasi*); PhD, Theoretical Seismology (*Toronto*)
Penny Barton	BA, Geology (*Cambridge*); PhD, Marine Geophysics (*Cambridge*)

Administrator

Paula Aarons

Research Associate

Adam Gosselet	MSc., Physics (*Paris*); DESS, Applied Physics (*Paris*); PhD Geophysics (*Ecole des Mines de Paris*)

Computer Officer

Clare Enright	BSc, Physics with Earth Sciences (*Liverpool*); MSc, Natural Environments and Plant Growth (*London*); PhD, Physics (*Sheffield*)

PhD Students

Hélène Carton	Diplôme d'Ingénieur, Geophysics (*Ecole de Physique du Globe, Strasbourg*); DEA, Geophysics (*Strasbourg*)
Violaine Combier	Diplôme d'Ingénieur, Geology (*Ecole Nationale Supérieure de Géologie, Nancy*)
Pascal Edme	BSc, Physics (*Strasbourg*); MSc, Geophysics (*Strasbourg*)
Benoît Gotab	BSc, Physics (*Rennes*); MSc, Physics (*Institut de Physique du Globe, Paris*)
Hassan Masoomzadeh	BSc, Applied Physics (*Amir Kabir University, Tehran*); MSc, Geophysics (*Geophysics Institute Tehran*)
Mark Roberts	MPhys, Physics (*Oxford*); MSc, Geophysics (*Durham*)
Gillian Royle	BSc, Applied Geophysics (*Memorial University, Newfoundland*); BSc, Physics & Earth Sciences (*Memorial University, Newfoundland*); MSc, Geophysics (*Simon Fraser University*)
Tim Sears	BSc, Exploration Geophysics (*University College, London*); MSc, Geophysics (*Durham*)
Anusha Surendra	BA, Natural Sciences (*Cambridge*); MSci, Geology (*Cambridge*)

B.3 Previous LITHOS Group Members

Principal Investigators

Martin Sinha	University of Southampton

Post-docs

Sara Bazin	University of Martinique
Ron Ben-Hador	IT company, Tel Aviv
Miguel Bosch	University of Caracus
Wayne Crawford	IPG Paris
Philippe Ecoublet	CGG
Rose Edwards	National Oceanography Centre, Southampton
Tom Hulme	Barclays Capital
Ying Ji	Cambridge Science Park
John Maclennan	University of Cambridge
Manuela Mendes	University of Lisbon
Edgardo Di Nicola-Carena	Net Planet, Milan
Patrick Oates	Astrophysics in Perth
Mark Taylor	Morgan-Stanley Dean Witter
Yanbin Wang	Beijing University

Students

Suleiman Al-Kindi	PDO, Oman
Neville Barker	OHM Surveys
Mike Carpenter	CGG
Adam Cherrett	TOTAL
Yann Freudenreich	CGG
Anthony Greer	OHM Surveys
James Hobro	WesternGeco
Geraint Jones	OHM Surveys
Elena Klien	Dept Earth Sciences, Cambridge
Lucy MacGregor	OHM Surveys
Thomas Mensch	WesternGeco
Dhananjai Pandey	NCAOR, Goa
Jonathan Pye	Totalise
Tomas Reed	Teaching physics
Angele Ricolleau	IPG Paris
Richard Shipp	Shell
Chi Hang Tong	Imperial College
Simon Topping	Southampton University
Immo Trinks	National Heritage Board, Sweden

C: LITHOS Publications

C.1 LITHOS Annual Science Reports

Copies of Reports are available on request, or individual papers may be downloaded from http://lithos.esc.cam.ac.uk)

LITHOS Science Report 1999

Satish Singh: *Introduction*

Seismic Inversion and Theory
James Hobro & Satish Singh: *Joint interface and velocity estimation in three dimensions (JIVE3D)*
Thomas Mensch & Veronique Farra: *Seismic travel-time tomography in orthorhombic media*
Adam Cherrett & Satish Singh: *3D anisotropic models from multi-component data*
Y.P. Freudenreich, S.C. Singh, P.J. Barton & M.S. Sinha: *Full waveform inversion for viscoelastic media*
Ying Ji & Satish Singh: *Anisotropy from waveform inversion of multi-component seismic data using a hybrid optimization method*
Ron Ben-Hador & Satish Singh: *Genetic algorithm for 3D velocity analysis*
Mark Taylor, Satish Singh & John Hudson*: Material properties and microstructure from effective medium theory*

Seismic Data Analysis
Edgardo Di Nicola-Carena: *Analysis of real long offset data using a semi-automated traveltimes picking procedure*
Penny Barton & Rose Edwards: *Velocity imaging by tau-p transformation*
Richard Shipp, Edgardo Di Nicola-Carena, & Satish Singh: *2D full wavefield inversion of wide angle marine seismic data*
Rose Edwards, Penny Barton & Satish Singh: *A brief introduction to wide-angle migration*
Jonathan Pye: *3D seismic imaging of the East Pacific Rise and melt lens*
Chi Hang Tong: *3-D crustal study of the East Pacific Rise using densely sampled wide-angle seismic data*

Electromagnetic Methods
Martin Sinha: *Controlled source EM sounding: Survey design considerations for hydrocarbon applications*
Lucy MacGregor: *Marine controlled source electromagnetic sounding: Development of a regularized inversion for 2-dimensional resistivity structures*
Anthony Greer: *Use of effective medium techniques to integrate seismic and controlled source electromagnetic data*

Computing
Clare Enright: *The design of an integrated user interface for the LITHOS modelling software*

LITHOS Science Report 2000

Satish Singh: *Introduction*

Seismic Inversion and Theory
James Hobro*: Seismic travel-time tomography in three dimensions: synthetic experiments*

and results obtained using Jive3D

Adam Cherrett: *Anisotropic tomography of a synthetic multi-offset VSP dataset*

Yann Freudenreich and Richard Shipp: *Full waveform inversion of seismic data: frequency* versus *time domain*

Elena Klein: *Full waveform inversion of mutli-component near offset and wide-aperture seismic data*

Ying Ji, Satish Singh and Brian Hornby: *Sensitivity study using genetic algorithm: inversion of amplitude variations with slowness*

Philippe Ecoublet, Satish Singh & Chris Chapman*: A new approach for traveltime tomography and migration without ray tracing*

Seismic Data Analysis

Edgardo Di Nicola-Carena: *Imaging from PickEd reflection and refraction events*

Richard Shipp: Wide-aperture real seismic data: Applications of traveltime analysis and full wavefield inversion

Neville Barker, Penny Barton and Edgardo Di Nicola-Carena: *Rapid automatic velocity images in depth and time from long-offset two-ship datasets*

Jonathan Pye: *Structure of the melt body beneath the East Pacific Rise at 9 03 N from waveform inversion*

Suleiman Al-Kindi: *A study into underplating as a cause of Tertiary epeirogenic uplift and denudation in the East Irish sea*

Chi Hang Tong: *Model parameterisation and assessment in travel time seismic tomography: a users perspective*

Geraint Jones: *1-D velocity estimation from tau-p data*

Immo Trinks: *Removing multiples from the wide-angle wavefield*

Michael Carpenter: *Seismic imaging using densely sampled long-offset data*

Electromagnetic Methods

Anthony Greer: *A joint effective medium method for geophysical properties of two-phase materials*

Dhananjai Pandey: *Joint inversion of seismic and EM data for subbasalt imaging from central western part of India*

Computing

Clare Enright: *Development of the User Interface for the LITHOS modelling software*

Exchange of ideas

Mark Taylor and Satish Singh: *Is the inner core of Earth partially molten?*

Wayne Crawford: *Seafloor compliance measurements: applications for hydrocarbon exploration*

LITHOS Science Report 2001

Satish Singh*: Introduction*

Seismic Inversion & Theory

Richard Shipp*: Two-dimensional full wavefield inversion of wide-aperture marine seismic streamer data*

Yann Freudenreich: *Estimation of P- and S-wave velocities from full wavefield inversion of wide-angle marine seismic data*

Elena Klien: *Spectral element method*

Immo Trinks: *Traveltime tomography using irregular parameterised grids*

Geraint Jones: *Downward continuation of reflection and refraction wavefields: a combined approach*

Data Analysis

Adam Cherrett: *Results of 3-D anisotropic traveltime and polarisation tomography*

Miguel Bosch: *Imaging the Rockall basin with large aperture reflection seismics*

Dhananjai Pandey: *Towards simultaneous analysis of seismic and electromagnetic data*

Miguel Bosch, Maria Zamora & Widya Utama: *Physical properties of rocks as multiple parameters for lithology discrimination*

Suleiman Al-Kindi: *Crustal velocity structure underneath mid-North Sea High, northern England, East Irish Sea and Ireland*

Sara Bazin: *3-D Magma chamber structure beneath the 9º 03'N overlapping spreading centre*

Jonathan Pye: *Crustal structure beneath the East Pacific Rise at the 9º 03'N overlapping spreading centre*

Chi Hang Tong, Jonathan Pye, Satish Singh & Richard Hobbs: *Depth conversion of reflection data from the East Pacific Rise*

Neville Barker: *Investigation of crustal fluids at the Lucky Strike hydrothermal site using controlled source electromagnetic sounding*

Computing

Clare Enright: *A status report for the LITHOS software*

LITHOS Science Report 2002

Satish Singh*: Introduction*

Seismic Inversion & Theory

Yann Freudenreich: *Elastic wavefield inversion of wide-angle seismic data: application to sub-sill imaging*

Elena Klien & Jean-Pierre Vilotte: *Perfectly matched layers in the spectral element method*

Yanbin Wang & Satish Singh: *Separation of P- and SV-wavefields from multi-component OBC data in tau-p domain*

Geraint Jones: *Combined structure and velocity stacks via the tau-p domain*

Immo Trinks: *Traveltime tomography using irregular parameterized grids: Solving the inverse problem*

Data Analysis

Miguel Bosch: *Travel-time tomography combining short and long offset arrivals*

Suleiman Al-Kindi: *Jive3D as a 'pure' tomographic tool: application to real data from the CSSP line*

Dhananjai Pandey: *Analysis of seismic and magnetotelluric data from Kutch, India*

Jonathan Pye: *Quantitative structure beneath the East Pacific Rise*

John Maclennan: *The magmatic structure of mid-ocean ridges: Integrating geophysical and petrological observations*

Electromagnetic Methods

Lucy MacGregor, Steve Constable & Martin Sinha: *Application of regularized 2.5-dimensional inversion to controlled source electromagnetic sounding data from the Valu Fa Ridge, Lau Basin*

Anthony Greer, Martin Sinha & Lucy MacGregor: *Joint effective medium modeling for co-incident seismic and electromagnetic data and its application to studies of porosity structure at mid-ocean ridge crests*

Lucy MacGregor, Anthony Greer, Martin Sinha & Christine Peirce: *Properties of crustal fluids at the Valu Fa Ridge, Lau Basin, and their relationship to active hydrothermal circulation, from joint analysis of electromagnetic and seismic data*

Neville Barker, Martin Sinha, Lucy MacGregor & the ISO-3D group: *Hydrothermal fluids at Lucky Strike: preliminary results from sub-sea-floor electromagnetic sounding*

Compliance
Wayne Crawford: *The sensitivity of seafloor compliance measurements to sub-basalt reservoirs*
Tom Hulme: *Elastic compliance in an anisotropic half-space*
Angèle Ricolleau, Sara Bazin, Wayne Crawford & Satish Singh: *Joint analysis of seismic and seafloor compliance data: example from the East Pacific Rise*

Computing
Clare Enright: *Input of velocity models through the LITHOS User Interface*
Paddy Oates: *Some preliminary results from PickEd Version 2*

LITHOS Science Report 2003

Penny Barton*: Introduction*

Seismic Inversion and Theory
Immo Trinks: *Traveltime tomography in triangulated grids*
Yanbin Wang & Satish Singh: *Extracting upgoing incident P- and S-wavefields from side-angle multi-component OBC data for a basalt model*
Tomos Reed: *Seismic anisotropy in the tau-p domain*
Pascal Edme: *Receiver functions in seismic exploration*

Data Analysis
Geraint Jones: *Sub-basalt imaging using long offset data in the tau-p domain*
Hassan Masoomzadeh: *Long-offset data processing strategies: non-stretch moveout correction*
Hélène Carton: *Structure of the Çınarcık Basin (eastern Marmara Sea) from densely-spaced multi-channel reflection profiles*

Compliance
Tom Hulme: *The sensitivity of compliance to two-dimensional velocity structure*
Tom Hulme: *Shear wave and attenuation structure from joint analysis of seismic and seafloor compliance data*

Computing
Clare Enright: *Delivery of software in the LITHOS project*

LITHOS Science Report 2004

Satish Singh & Penny Barton*: Introduction*
Pascal Edme: *Multi-component analysis: receiver function approach*
Timothy Sears: *Towards full waveform inversion of multi-component OBC seismic data*
Mark Roberts: *Joint inversion of seismic and compliance data*
Tom Hulme, Wayne Crawford & Satish Singh: *Calculation and inversion of two-dimensional compliance data*
Hassan Masoomzadeh: *Non-stretch imaging in the tau-p domain: exploiting long-offset arrivals for sub-basalt imaging*
Geraint Jones: *Velocity images by downward continuation: synthetic tests*
Immo Trinks: *Adaptive travel-time tomography*
Immo Trinks: *Joint travel-time and ray-parameter inversion*
Hélène Carton: *Testing different seismic sources for academic marine investigation of the subsurface*
Anusha Surendra: *3D tomographic imaging of the Chicxulub impact crater*
Clare Enright: *Integration of Segy_ftaup and Down code into the LITHOS User Interface*

LITHOS Science Report 2005

Satish Singh & Penny Barton*: Introduction*
Pascal Edme: *Wavefield decomposition: application to real OBC data*
Tim Sears: *Full waveform inversion of multi-component OBC seismic data*
Benoît Gotab: *Estimation of transversely isotropic parameters in the tau-p domain*
Mark Roberts: *A review of the seafloor compliance method*
Mark Roberts: *A line source to point source transform for seismograms*
Hassan Masoomzadeh: *Sub-basalt imaging in the Faeroe-Shetland Basin utilizing non-stretching processing*
Hélène Carton: *Three-dimensional seismic images of an active pull-apart basin: the Çınarcık Basin along the North Anatolian Fault*
Violaine Combier: *Upper crustal dynamics of the 9°03´N OSC at the East Pacific Rise: linking surfacial and melt sill structures*
Anusha Surendra: *3D tomographic imaging of the Chicxulub impact crater: Preliminary results from EW0501*
Clare Enright: *Running segy_ftaup and Down under the LITHOS User Interface; a practical example*

C.2 LITHOS core student theses

Completed projects

Carpenter, M.E. 2000. Seismic imaging using densely sampled long-offset data. M. Phil. dissertation University of Cambridge, 65pp.

Cherrett, A.J. 2000. Traveltime and polarisation tomography in 3-D anisotropic media. Ph.D. thesis University of Cambridge, 191pp.

Freudenreich, Y.P. 2002. P- and S-wave velocity estimation from full wavefield inversion of wide-aperture seismic data, Ph.D. thesis University of Cambridge, 196pp.

Hobro, J.W.D. 1999. Three-dimensional tomographic inversion of combined reflection and refraction seismic travel-time data, Ph.D. thesis University of Cambridge, 211pp.

Jones, G.D. 2003. Velocity images by stacking slowness-depth seismic wavefields, Ph.D. thesis University of Cambridge, 187pp.

Pandey, D.K 2003. Analysis of seismic and magnetotelluric data from Kutch, India, Ph.D. thesis University of Cambridge, 220pp.

Shipp, R.M. 2000. Two-dimensional full wavefield inversion of wide-aperture marine seismic streamer data, Ph.D. thesis University of Cambridge, 238pp.

Trinks I. 2003. Traveltime tomography of densely sampled seismic data, Ph.D. thesis University of Cambridge, 254pp.

In preparation

Edme, P., Receiver function method adapted to OBC data. IPG Paris.

Gotab, B., Extraction of anisotropic parameters in the tau-p domain. IPG Paris.

Masoomzadeh, H., Non-stretch processing of long-offset data in the t-x and tau-p domains. University of Cambridge.

Roberts, M., 2D elastic waveform inversion of walkaway VSP data in the time-domain. IPG Paris.

Royle, G., 2D waveform inversion of visco-elastic data. IPG Paris.

Sears, T., Full waveform inversion of multi-component OBC seismic data. University of Cambridge

C.3 LITHOS external publications and published abstracts, 1998-present

Barton, P. J. 2000. Velocity imaging by tau-p transformation. In: Jacob, A.W.B., Bean, C.J. & Jacob S.T.F. (eds.), Communications of the Dublin Institute for Advanced Studies Series D, Geophysical Bulletin,Active and passive seismic techniques reviewed. Dublin Institute of Advanced Studies, 49, 46-48.

Barton, P.J., 2001. Rooted ophiolites on the east Oman margin. International conference on the geology of Oman, Muscat, Oman. (Abstract)

Barton, P.J., 2003. Imaging the North Atlantic margin. 6th Petroleum Geology Conference, London. (Abstract)

Barton, P.J., & Barker, N., 2002. Rapid automatic velocity images from long-offset seismic data. Journal of Conference Abstracts, 7(2), 130. (Abstract)

Barton, P.J. & Barker, N., 2003. Velocity imaging by tau-p transformation of refracted seismic traveltimes. Geophysical Prospecting, 51, 195-203.

Barton, P., Barker, N., & Di Nicola-Carena, E., 2000. Rapid automatic 2D velocity images in depth and time from refracted arrivals. Deep seismic profiling of the continents and their margins, Ulvik, Norway. (Abstract)

Barton, P.J., & Edwards, R.A., 1998. A new method for analysing densely-sampled wide-angle seismic data. 8th International Symposium on deep seismic profiling of the continents and their margins, Barcelona: Abstracts, 60. (Abstract)

Barton, P.J., & Edwards, R.A., 1999. Velocity images of complex structures. Extended abstracts volume, AAPG International Conference and Exhibition, Birmingham, UK. (Abstract)

Barton, P.J., & Jones, L.E.A., 2003. Tau-p velocity imaging of regolith structure. Extended abstract, ASEG 16th Geophysical conference and exhibition, Adelaide. (Abstract)

Barton, P., Owen, T., Gulick, S., Urrutia, J., Morgan, J., Warner, M., Christeson, G., & Rebolledo, M., 2005. Seismics in the environmental spotlight: counting the cost. 75th SEG meeting, Houston (Abstract)

Barton, P.J., Singh, S., & Sinha, M., 1998. LITHOS: the Cambridge advanced lithological imaging project. New trends in crustal seismology. Workshop, EAGE, Leipzig 1998. Abstract 9. (Abstract)

Bazin, S., Harding, A .J., Kent, G. M., Orcutt, J. A., Tong, C. H., Pye, J. W., Singh, S. C, Barton, P. J., Sinha, M. C., White, R. S., Hobbs, R. W. & van Avendonk, H. J. A. 2001. Three-dimensional shallow crustal emplacement at the 9° 03' N overlapping spreading center on the East Pacific Rise: Correlations between magnetization and tomographic imaging. J. Geophys. Res., 106, 16101-16118.

Bazin, S., Harding, A.J., Kent, G.M., Orcutt, J.A., Singh, S.C., Tong, C.H., Pye, J.W., Barton, P.J., Sinha, M.C., White, R.S., Hobbs, R.W. & van Avendonk, H.J.A. 2003. A three-dimensional study of a crustal low velocity region beneath 9° 03' N overlapping spreading center. Geophysical Research Letters, 30, 2, 1039, doi:10.1029/2002GL015137, 2003.

Bosch, M., Barton, P., & Singh, S., 2002. Inversion of short and long offset travel time data from the north east Atlantic margin. Journal of Conference Abstracts, 7(2), 132. (Abstract)

Bosch, M.R., Barton, P. and Singh, S., 2002, Geostatistical Tomography of Short and Long Offset Seismic Data from the NE Atlantic Margin, 64th Mtg.: Eur. Assn. Geosci. Eng., P174. (Abstract)

Bosch, M., Barton, P. and Singh, S., 2003, Traveltime inversion under geostatistical constraints, 73rd Ann. Internat. Mtg.: Soc. of Expl. Geophys., 718-721. (Abstract)

Bosch, M., & McCaughey, J. 2001. Joint inversion of gravity and magnetic data under lithologic constraints. The Leading Edge, 20, 877-881.

Bosch, M., Barnes, Ch. & Mosegaard, K. 2000. Multi-step samplers for improving efficiency in probabilistic geophysical inference. In: Hansen, P.C. Jacobsen, B.H. & Mosegaard, K. (eds.), Methods and applications of inversion. Springer Verlag, 50-67.

Bosch, M., Guillen, A. & Ledru, P. 2001. Lithologic tomography: an application to geophysical data from the French Brittany region. Tectonophysics, 331, 197-227.

Bosch, M., Zamora, M.& Utama, W. 2002. Lithology discrimination from physical rock properties. Geophysics, 67, 573-581.

Bosch, M., Barton, P., Singh, S., and Trinks, I., 2005. Inversion of travel-time data under a statistical model for seismic velocities and layer interfaces, Geophysics (in press).

Bry, M., White, N.J., Singh, S.C., England, R. & Trowell, C. 2004. Anatomy and formation of oblique continental collision: South Falkland basin. Tectonics, 23, doi:10.1029/2002TC001482.

Carpenter, M.E., Singh, S.C., Barton, P., & Jakubowicz, H., 2000. Imaging basement blocks with wide-angle multi-channel data. Deep seismic profiling of the continents and their margins, Ulvik, Norway. (Abstract)

Cherrett, A & Singh S. 1998. Traveltime and polarisation tomography in 3-D anisotropic media. 68th Ann.Internat. Mtg. Soc. Expl. Geophys., Extended Abstracts, 1859-1862.

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D: Draft letter of intent

Companies intending to participate in the LITHOS III Project should send a letter of intent as soon as possible. You will then be invited to attend the First Steering Committee meeting in December 2005. The letter of intent should be of the following form, or equivalent:

To:
Dr Penny Barton
Bullard Laboratories
University of Cambridge
Madingley Road
Cambridge CB3 0EZ

This letter is to confirm that .....(company)... intends to join the LITHOS III Project at the University of Cambridge and will be willing to contribute £30,000 (~45,000 EUR) (+ VAT where applicable) p.a. for an initial duration of four years.

The person dealing with commercial and contractual matters is: .....

Our technical/steering committee representative will be:.....

The invoice should be sent to: .....

E: Draft contract

The contract below is of the standard form signed by all members of LITHOS II, with updated figures and dates to be indicative of LITHOS III. It is expected that the LITHOS III contract will be of the same form, but small changes may be necessary after negotiations with members.

LITHOS Membership Agreement

This Agreement is dated ……..….and made between:

1. (Company name)…….. having its registered office at …
…… ("Member");

and

2. The CHANCELLOR, MASTERS AND SCHOLARS OF THE UNIVERSITY OF CAMBRIDGE of the Old Schools, Trinity Lane, Cambridge, CB2 1TN, England

3. THE INSTITUT DE PHYSIQUE DU GLOBE DE PARIS, whose registered address is 4 Place Jussieu, 75252 Paris Cedex 05, France

parties 2 and 3 hereinafter referred to as "the Organisers".

WHEREAS:

(A) The Organisers run the LITHOS III Consortium ("the Consortium") as more fully described in the proposal 'LITHOS III Phase 3: 2006-2010 (″the Project″)' set out in Appendix I; and

(B) The Member wishes to join the Consortium.

The conditions relating to the Consortium are as set out below.

1. Interpretation

"Intellectual Property" means patents, registered and unregistered designs, registered and unregistered trade marks, design rights, topography and mask rights, copyrights (including the copyright on software in any code), know-how and trade secrets, rights in inventions, discoveries, improvements as well as applications for any such rights and any rights of a similar or equivalent nature which arise in any jurisdiction;

"Background Intellectual Property" means any Intellectual Property owned by or at the free disposal of the Members or the Organisers and not generated in the performance of the Project;

"Results" means all results, Intellectual Property and information generated in the performance of the Project;

"Affiliate" means any corporation or other business entity controlling, controlled by or under common control with the Member, and for such purpose "control" shall mean direct or indirect ownership of more than fifty (50) % of the voting interest in such corporation or other entity

2. Payment:

2.1 In consideration of the Organisers entering into this Agreement the Member agrees to pay £30,000 (plus VAT where applicable) per annum for four years (1 July 2006 to 30 June 2010) to the Organisers unless terminated sooner as provided elsewhere herein. Payment shall be made annually in advance on or before 30th July and the Organisers shall provide a valid tax invoice for each payment due. The first payment is due before 1 August 2006. The Member agrees to pay VAT invoices (where applicable) within 30 days of receipt to the University of Cambridge.

2.2 Following execution of this Agreement, the Organisers will submit an invoice to the Member for the first £30,000 payment to the details specified below:

(Company contact and address for invoice)

2.3 The Member agrees to pay the invoice within thirty (30) days following receipt.

2.4 The Organisers will keep all records necessary to support any charges made under this Agreement in accordance with generally accepted accounting principles and practices. At all times during the term of this Agreement, and for three years thereafter, the Member will have the right during normal business hours and with reasonable notice, to audit the Organisers accounting records related to the performance of this Agreement.

3. Term:

3.1 Subject to the provisions hereof membership of the Consortium will be for a period of four years commencing on 1 July 2006. This period may be extended by mutual agreement in writing between the Member and the Organisers with agreement of the Steering Committee.

3.2 It is not the intention of the parties to create, nor shall this agreement be deemed or construed as creating a partnership. The parties are independent of one another.

4. Directors/Principal Investigators: The Principal Investigators of LITHOS III are Professor S.C. Singh and Dr P.J. Barton. The Principal Investigators will be responsible for managing the Project, selecting and supervising other personnel.

5. **Steering Committee**: Each Member shall be entitled to appoint one representative to the Steering Committee, which shall also comprise the two Principal Investigators. One of the Principal Investigators shall be a voting member and one will chair the Committee. Each Member is entitled to one vote, which may be by written proxy if a representative is unable to attend a meeting of the Committee. The role of the Steering Committee shall be to review progress, and to approve the Project research programme and budget. The date of a meeting will normally be agreed at the preceding meeting and circulated with the minutes of that meeting, but in the event of an emergency meeting being necessary, at least two weeks notice in writing will be given. Except where stated otherwise in this Agreement, voting shall be by simple majority. In the event of a tie the Chair may exercise a casting vote.

6. Deliverables:

6.1 Subject to timely receipt of financial support from the Member in accordance with this Agreement, the Organisers will use all reasonable endeavours to carry out the Project in accordance with the terms of this Agreement.

6.2 The Member will receive from the Organisers:

6.2.1 A royalty-free, world-wide non-exclusive multi-user licence for the Member's internal use to Intellectual Property in the field of geophysics of the data processing software (hereinafter referred to as the "Licence") (and related documentation) generated from the research described in the Project ("the Software"). The Member shall not have the right to exploit its Licence commercially, to sub-license or to use its Licence in projects in collaboration with non-Members, other than as specified in clause 12. The Member may distribute the Software to its Affiliates and may use the Software for projects in collaboration with other Members. The Member may disclose data generated from its use of the Software to non-Members.

6.2.2 Free and direct access to all research carried out under the Project.

6.2.3 An annual report on the state of the Project operated by the Consortium.

6.2.4 An annual presentation on the Results of the Project.

6.2.5 A bi-monthly bulletin by e-mail.

6.2.6 Copies of PhD dissertations and published papers.

6.2.7 Such other deliverables agreed from time to time by the Steering Committee.

6.2.8 Provide Members with Results in a timely manner

7. Confidentiality:

7.1 The Member may wish from time to time to contribute a specific proprietary dataset to the Project for the purpose of evaluating or testing new software or techniques. Any such dataset will be the subject of a separate confidentiality agreement, which should include a warranty from the Member supplying the data set that it has the right to use such information and such use does not breach any third party intellectual property rights, between the Member and the Organisers.

7.2 The Member and the Organisers recognise that from time to time they may be in receipt of confidential information from each other and from other members of the Consortium. The Member and the Organisers undertake to treat as confidential all information designated as confidential with the same degree of care as they treat their own confidential information and in any event shall not disclose confidential information except for use by the Consortium pursuant to this Agreement without the written consent of the provider of such information. The provision of this section 7.2 shall survive termination of this Agreement for a period of five years only from the date of termination.

7.3 The Member shall treat the Results of the Project undertaken by the Consortium as confidential and shall not pass on those Results to a third party without prior approval by the Steering Committee. Each Member may disclose all information, Results and reports arising hereunder to its Affiliates subject to them being bound by a confidentiality agreement no less onerous than that provided under this clause 7 and that the Member

shall remain personally liable for any breach of this Agreement and Confidentiality for and on behalf of its Affiliates.

7.4 The obligation of confidentiality shall not apply to information which

7.4.1 is at the date of this Agreement or at any time after the date of this Agreement comes into the public domain other than through breach of this Agreement by the receiving party;

7.4.2 can be shown by the receiving party to have been already known by the receiving party at the date of disclosure by the disclosing party;

7.4.3 subsequently comes lawfully into the possession of the receiving party from a third party in good faith without a confidentiality obligation;

7.4.4 is independently acquired by the receiving party as a result of work carried out by an employee of the receiving party to whom no disclosure of Confidential Information has been made; or

7.4.5 is required by law to be disclosed.

8. Publication:

8.1 It is intended that the Results of the Project should be published (whether in writing or orally) in accordance with normal academic practice. In order to safeguard proprietary information and patent rights no party shall publish or publicly disclose the Results of the research without prior written consent of the Steering Committee.

8.2 The Party which wishes to publish (' the Publishing Party') shall submit to the Steering Committee for its review a copy of the proposed publication at least thirty (30) days in advance of the submission of the publication to a third party. If the Steering Committee determines that the proposed publication discloses confidential information then the Steering Committee shall request that the Publishing Party removes such Confidential Information from the proposed publication, such request not to be unreasonably denied.

8.3 If the Steering Committee fails to reply to the Publishing Party within thirty (30) days of receipt of a proposed publication the Publishing Party is free to submit the publication to a third party.

8.4 Notwithstanding the above under no circumstances will any registered student of either of the Organisers be delayed or prevented from submitting, for examination as part of the requirements for a degree, a thesis or dissertation arising from this Agreement. The student and the supervisor may include some or all of the Results acquired during the Project in a thesis submitted for a degree of their University. The thesis shall be examined by examiners appointed by their University and a successful thesis deposited in their University Library in accordance with their University's Regulations. The student will provide the Steering Committee with a copy of the publication 30 days prior to submission for publication and the student shall, on request of the Steering Committee, request that access to the thesis be restricted intially for two (2) years and then up to five (5) years, one year at a time. This request shall not be unreasonably denied.

9. Collaboration with other academic institutions: The Principal Investigators may collaborate with other academic institutions with agreement of the Steering Committee and subject to clause 7.

10. Intellectual Property Rights: The Intellectual Property rights in the Results, including all rights in patents, patent applications, copyright and designs whether registered or unregistered, shall be owned by the Organisers who shall make them available to the Members under licence as described in sections 6 and 12.

11. Licensing of non-Members: Licensing of non-Members shall be the responsibility of the Organisers. For the period of Membership specified in section 3 above and one full year thereafter the Organisers shall not license the Results of the Project in the form of software or documentation to a third party without the consent of the Steering Committee, such decision to be made by a two-thirds majority.

12. Commercialisation

12.1 Commercialisation of the Software: Commercialisation of the Results of the Project in the form of software, know-how or algorithms shall take place only with the agreement of the Organisers. The Organisers may grant a licence to exploit the Results of the Project to either a Member or a non-Member on commercial terms to be negotiated between the Organisers and the proposed licensee. The provisions in section 6 are not affected by this commercialisation. For the period of Membership specified in section 3 above and one full year thereafter the Organiser shall not license the Results of the Project for the purposes of commercialisation in the field of geophysics either to a Member or to a non-Member without the consent of the Steering Committee, such decision to be made by a two-thirds majority.

12.2. Commercialisation of Data: The Members have the right to sell data generated from the use of the Software applied to their own data to Members and non-Members, with the consent of the Steering Committee, such decisions to be made by a two-thirds majority. The Members shall receive a 10% discount up to a maximum of £35000 on the purchase of such data. This discount shall only apply to the price of additional data products derived using the Software, not to any licence fees associated with the original data acquisition and processing.

12.3 Such data shall be subject to the Data Protection Act 1998 and the EU Data Protection Directive 1995.

13. Liabilities:

13.1 Whilst both parties will use all reasonable endeavours to ensure the accuracy of the work performed and any information given in performance of this Agreement, the parties make no warranty, express or implied, as to the accuracy of their work, LITHOS III, the Results or any other advice or information furnished by it or by any of its employees, students, agents or appointees who work on LITHOS III.

13.2 The Organisers accept no responsibility whatsoever for any use which may be made of any work carried out under or pursuant to this Agreement, or of their Background Intellectual Property or the Results, and no liability whatsoever either direct or indirect shall rest upon the Organisers or their employees, students, agents or appointees for the effects of any product or process that may be developed, manufactured, used, sold, imported or distributed, notwithstanding that such product or process may be based upon the findings of LITHOS III, the Results or upon any other advice or information furnished by the Organisers or their employees, students, agents or appointees under this Agreement.

13.3 The liability of any party for any breach of this Agreement, or arising in any other way out of the subject matter of this Agreement, will not extend to any incidental or consequential damages or losses including (without limitation) loss of contracts or profit.

13.4 Under no circumstances whatsoever shall any party's liability to the others under or otherwise in connection with this Agreement exceed sums paid by the Member to the Organisers in accordance with article 2.

13.5 So far as the Organisers are aware, the use by the Member of the Organisers' Background Intellectual Property or the Results generated by this Agreement will not infringe the valid intellectual property rights of any third party. However, the Organisers will not perform any searches or other investigations into the existence of such rights and it is the Member's responsibility to perform any investigations in this respect.

14. Termination:

14.1 This Agreement shall terminate four years from 1 July 2006 unless terminated by the Member pursuant to article 14 or extended by mutual agreement pursuant to the terms of this Agreement, except the obligation referred to in section 6.

14.2 In the event that the Organisers are unable to maintain the Consortium as a consequence of events outside the reasonable control of the Organisers then this Agreement shall be deemed to be terminated at the end of the contract year in which such event occurs.

14.3 At any time after twelve (12) months from the date that this Agreement takes effect, either party may in writing to the other request a joint review of the Project, such review to be held no later than three (3) months following such a request. At the end of such review, or at the end of such three (3) month period if no review is held, either party shall have the option to terminate this Agreement by giving three (3) months' written notice to the other.

14.4 In the event of termination under clauses 14.2 or 14.3, notwithstanding the above, the proportion of the payment described in article 2 of this Agreement which has been allocated by the Steering Committee to the support of PhD students for a full course of study shall be treated as an obligation that will survive premature termination of the Agreement for any reason. A full course of study shall normally comprise three years.

14.5 In the event of termination under clauses 14.2 or 14.3, the Organisers will be entitled to retain funds to cover all demonstrable costs and expenses incurred by the Organisers up to the date of termination, including costs and expenses which arise from commitments reasonably and necessarily entered into by the Organisers before the date of termination but which fall due for payment after the date of termination. Any unspent funds then remaining will be returned to the Member.

14.6 Either party ("the Initiating Party") may terminate this Agreement with immediate effect by notice in writing to the other party ("the Breaching Party") on the occurrence of any of the following events in relation to the Breaching Party:

14.6.1 a material breach by the Breaching Party of any of its obligations under this Agreement which (if the breach is capable of remedy) the Breaching Party has failed to remedy within thirty (30) days after receipt of notice in writing from the Initiating Party identifying the breach and requiring it to be remedied;

14.6.2 the passing by the Breaching Party of a resolution for its winding-up or the making by a court of competent jurisdiction of an order for the winding-up or the dissolution of the Breaching Party.

14.7 For the avoidance of doubt, should one of the Organisers be unable or unwilling to continue with the Project the remaining Organiser may continue the co-ordination of the Project on their own if they so wish subject to the agreement of the Steering Committee.

15. Governing Law:

This Agreement and all questions of construction, validity and performance under this Agreement shall be governed by English law and subject to the exclusive jurisdiction of the English courts.

16. Miscellaneous

16.1 Except as otherwise provided herein, no party will use the name of another party in any publicity, advertising or other publication intended for use in the public media in connection with the work performed under this Agreement without the prior written approval of the other party.

16.2 This agreement sets forth the entire understanding between the parties with respect to the LITHOS III project, and this Agreement supercedes, cancels and merges all prior to contemporaneous communications, negotiations, understandings, representations and agreements, whether oral or written, with respect to the subject matter of this Agreement. To the extent there is a variation between the foregoing provisions and attached exhibits, the foregoing provisions will prevail. No changes, alterations or modifications to this Agreement will be effective unless in writing and signed by the parties hereto.

16.3 Each party shall exercise reasonable care and diligence to prevent their employees and agents from making, receiving, providing or offering substantial gifts, entertainment, payments, loans or other considerations for the purpose of improperly influencing the relationship between the parties. This obligation shall apply to the activities of each party in relations with the other party's employees, representatives, vendors, contractors and or consultants.

16.4The parties shall comply with all applicable UK laws.

Signed for and on behalf of
the Organisers

Name:
For: the Chancellor Masters and Scholars of the University of Cambridge
Date:

Name:
For: l'Institut de Physique du Globe de Paris
Date:

Signed for and on behalf of
the Member

Name
For ……
……
Date: