AGILE LIBRE

52 THINGS YOU SHOULD KNOW ABOUT GEOPHYSICS

EDITED BY MATT HALL & EVAN BIANCO

"A marvellous little book, full of nuggets of wisdom from the 'who's who?' of our industry. I highly recommend this book to all young and aspiring geoscientists."

Dan Hampson
co-founder of Hampson–Russell

"This is a great book… The contributing authors are among the best known names in our profession. The subject each author selects is an essential 'thing' that we all need to know about geophysics. I predict that when you get a copy of this book in your hand, you will look at every page."

Bob A Hardage
President of SEG

"I was grinning to myself as I read some of the comments. I liked the informal tone and the down-to-earth advice. The bite-sized pieces of advice will be most useful to students starting out in the field. It's a fundamental truth that it is way more efficient to progress in your discipline if you gaze at the horizon standing on the shoulders of those who came before… This book should make a useful addition to any new geophysicist's library!"

Henry Posamentier
Seismic geomorphologist

"Fascinating. In the current world of instant gratification this provides rapid 'bites' of insight into many aspects of geophysics, seen through the eyes of some of the science's best practitioners."

David Monk
President-Elect of SEG

52 THINGS YOU SHOULD KNOW ABOUT GEOPHYSICS

EDITED BY MATT HALL & EVAN BIANCO

AgileLibre

First published in 2012 by Agile Libre
Nova Scotia, Canada. *www.agilelibre.com*

Technical editors Matt Hall & Evan Bianco • *Managing editor* Kara Turner
Designer Neil Meister, MeisterWorks • *Indexer* Linda Lefler
Cover design electr0nika • *Printing* Amazon CreateSpace

We have done our best to ensure that the non-subjective parts of this book are factually accurate. If you find a typo or a factual inaccuracy please let us know at *hello@agilelibre.com*. While every precaution has been taken in the preparation in this book, the publisher, editors, and contributors assume no responsibility for damages resulting from the use of the information contained herein.

Library and Archives Canada Cataloguing in Publication

52 things you should know about geophysics / edited by Matt Hall and Evan Bianco
Includes bibliographical references and index.

ISBN 978-0-9879594-0-9

1. Geophysics. I. Hall, Matt, 1971- II. Bianco, Evan, 1982-
III. Title: Fifty-two things you should know about geophysics.

QC806.F54 2012 550 C2012-902408-2

Who we are

Agile Libre is a new, independent publisher of technical books about the subsurface. The book you are holding is its first book, but there will be more. We have a passion for sharing, so our books are openly licensed and inexpensive to buy.

Our aim is to be useful, relevant, and interesting. How can we make your life better? Send your ideas to *hello@agilelibre.com*.

Where to get this book

You will find this book for sale at *agilelibre.com*, and also at Amazon's various stores worldwide. Professors, chief geoscientists, managers, gift-givers: if you would like to buy more than ten copies, please contact us for a discount at *hello@agilelibre.com*.

About open licenses

Colophon

This book was compiled in Google Docs and Microsoft Word, and laid out on a Mac using Adobe InDesign with the MathMagic plug-in. The cover typeface is Avant Garde Gothic and the text typefaces are Minion and Myriad. The figures were prepared in Inkscape. It was published through Amazon's CreateSpace.

Contents

Alphabetical

Contents

By theme

INTERPRETATION

POWERTOOLS

ATTRIBUTES • NINJA SKILLS

PRE-STACK

ROCK PHYSICS • PRE-STACK • PROCESSING

QUANTITATIVE

MATHEMATICS • ANALYSIS

INTEGRATION

TEAMWORK • WORKFLOW

INNOVATION

HISTORY • INNOVATION • TECHNOLOGY

SKILLS

LEARNING • CAREER • MANAGING

Introduction

This book is an experiment. From the minute we first talked about the idea in May 2011, we have only been sure about one thing: we aren't sure about anything. Well, okay, maybe a few things… We knew we wanted to bring together a group of personal heroes, mentors, friends, colleagues, and well-known interpretation visionaries. We knew we wanted short, highly relevant, fun-to-read, easy-to-share, and above all useful, essays. We knew we wanted to make a book that cost under $20, with an ebook version. We knew we wanted to make it easy to share. And we knew we wanted to do it ourselves.

Lots of people asked us, 'Why not ask the SEG to publish it?' A fair question, since they obviously know what they're doing and we, well, don't. But we're curious people, and maybe we have grand ideas about doing a series, and straying away from geophysics, and doing who-knows-what. We knew enough to know that we didn't know enough to give the project away. We wanted to own it, experiment with it, and see where it ended up.

It has not ended up anywhere yet, far from it, but this book is the end of the beginning. Now we know how to invite people, how to collate, read, edit, re-read, re-edit, and proof 52 pieces of writing by 39 authors. We know how to design cover art, build page layouts, and typeset equations. And we know how to make a manuscript into an actual book that you can sell to actual people. We are not astute businessmen — we have no idea how many we will sell (100? 1000? 10 000?), or if the project will come close to breaking even. We hope it does, not because we want to make lots of money, but because we want to do it again.

It all started at the annual convention of the Canadian Society of Exploration Geophysicists in May 2011. We'd already decided that for the book to be remarkable, we'd need to somehow convince one or two of a handful of highly accomplished people to contribute something. We weren't at all sure how this bit would work, if anyone would even listen. Evan mentioned the project to Brian Russell at the convention, and he seemed genuinely interested, enthused even. Encouraged enough to put some invites out, we emailed a few potential authors a couple of weeks later.

Brian — Brian Russell, über-geophysicist, ex-president of SEG and CSEG, award-winning entrepreneur — emailed his first contribution, *Don't neglect your math*, 23 hours later. It was perfect, exactly the sort of thing we wanted. We

were ecstatic. And we knew the book was going to work. When Matt expressed his surprise at getting such a fast response from such an awesome geoscientist, his wife Kara (and the book's managing editor) was incredulous: 'It's not surprising at all: that's precisely why he's awesome,' she said.

Well, we had many more moments like this as contributions came in from the amazing, and incredibly busy, geoscientists we'd written to. We don't want to make it sound like this project is all about celebrities, far from it. Admittedly, getting chapters early on from well-known veterans was highly motivating, but ultimately no more so than the insightful chapters from the many energetic young professionals who also contributed.

One of our core principles at Agile is that expertise is distributed — we all have specializations and experience that others can enjoy hearing about and learning from. We are committed to this idea. Insight and creativity come from everyone in this industry, not just from veterans, chiefs, and superstars. If we can cultivate a culture of more open and accessible writing and knowledge, we believe we can spark more ideas, connect more people, and have more fun than ever.

Welcome to the first of these short collections of *Things You Should Know*. If you like it, please share it — give this book to someone you respect.

Matt Hall & Evan Bianco
Nova Scotia, May 2012

Geophysics is all around

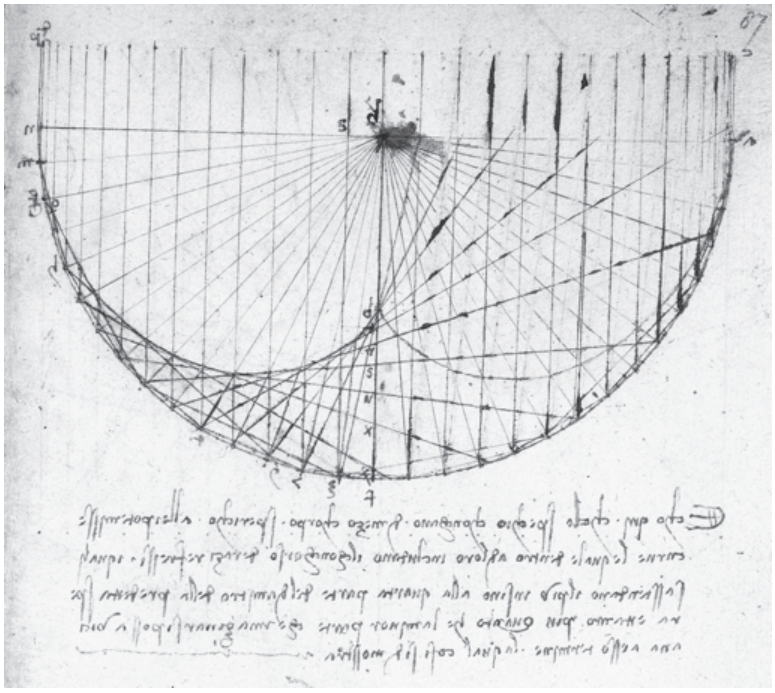
José M Carcione

Hold a well-filled cup of milky coffee on a sunny day and on the liquid's surface you will see a *catacaustic*. This word has a Greek root and means 'burning curve'. The sun is a point source at infinity whose parallel rays hit the cup according to the laws of geometrical optics. The rays are reflected from the reflective inner wall of the cup generating the bright curve, the caustic, formed by the envelope of the rays. The cusp at the centre of the caustic is called the *paraxial focus* and the liquid surface is brighter below the caustic curve. This particular shape of caustic is called *nephroid*, meaning kidney-shaped.

The phenomenon was known to Huygens in about 1679, and Bernoulli described it mathematically as an *epicycloid*. But almost two centuries earlier, Leonardo da Vinci observed the caustic when he was experimenting with using concave mirrors to generate heat — he called them fire mirrors. He argued that given equal diameters, the one with a shallower curve concentrates the most reflected rays, and 'as a consequence, it will kindle a fire with greater rapidity and force'.

Syncline-shaped reflectors generate seismic reflections resembling these types of caustics.

The shallower curve…
will kindle a fire with greater
rapidity and force.



Leonardo da Vinci's early 16th-century sketch of a caustic, including his famous mirror writing.

Acknowledgments

This chapter is adapted from Carcione, J M (2007). *Wave fields in Real Media*, Elsevier. The cup image is original. The drawing is © The British Library Board, from *Codex Arundel*, MS 263, ff. 86v–87, ca. 1503–05, and used here with permission.

Leonardo was a geophysicist

José M Carcione

The science of geophysics studies the physics of our planet, considering the atmosphere, the hydrosphere, and the core, mantle, and crust of the earth. It is highly interdisciplinary since it involves geology, astronomy, meteorology, physics, engineering, and scientific computing. Today, it is impossible for a single researcher to deal with all these fields.

Before the scientific method was introduced, Leonardo da Vinci (1452–1519), one of the brightest minds of all time, excelled in every aspect of art, humanity, and science. Leonardo foresaw a number of geophysical phenomena. The list below is incomplete but illustrative of his discoveries.

Wave propagation, interference, and Huygens' principle (1678):

> *Everything in the cosmos is propagated by means of waves…*
>
> Manuscript H, 67r, Institut de France, Paris.

> *I say: if you throw two small stones at the same time on a sheet of motionless water at some distance from each other, you will observe that around the two percussions numerous separate circles are formed; these will meet as they increase in size and then penetrate and intersect one another, all the while maintaining as their respective centres the spots struck by the stones.*
>
> Manuscript A, 61r, Institut de France, Paris.

The Doppler effect (1842):

> *If a stone is flung into motionless water, its circles will be equidistant from their centre. But if the stream is moving, these circles will be elongated, egg-shaped, and will travel with their centre away from the spot where they were created.*
>
> Manuscript I, 87, Institut de France, Paris.

Newton's prism experiment (1666):

> *If you place a glass full of water on the windowsill so that the sun's rays will strike it from the other side, you will see the aforesaid colours formed in the impression made by the sun's rays…*
>
> Codex Leicester, 19149r, Royal Library, Windsor.

Explanation of the blue sky, before Tyndall's 1869 experiments and Rayleigh's theory of 1871:

> *I say that the blue which is seen in the atmosphere is not given its own colour, but is caused by the heated moisture having evaporated into the most minute and imperceptible particles*
>
> Codex Leicester, 4r Royal Library, Windsor.

The principle of the telescope, first constructed in the Netherlands in the early 17th century:

> *It is possible to find means by which the eye shall not see remote objects as much diminished as in natural perspective…*
>
> Manuscript E, 15v, Institut de France, Paris.
>
> *The further you place the eyeglass from the eye, the larger the objects appear in them*
>
> Manuscript A, 12v, Institut de France, Paris.
>
> *Construct glasses to see the Moon magnified.*
>
> Codex Atlanticus, 190r, a, Ambrosiana Library, Milan.

A statement anticipating Newton's third law of motion (1666):

> *As much pressure is exerted by the object against the air as by the air against the body.*
>
> Codex Atlanticus, 381, Ambrosiana Library, Milan.

The principle of least action, before Fermat in 1657 and Hamilton in 1834:

> *Every action in nature takes place in the shortest possible way.*
>
> Quaderni, IV, 16r.

The evolution of the earth and living creatures, preceding George Cuvier (1804) and Charles Lyell (1863), and plate tectonics, anticipating Wegener (1915):

> *That in the drifts, among one and another, there are still to be found the traces of the worms which crawled upon them when they were not yet dry. And all marine clays still contain shells, and the shells are petrified together with the clay.*
>
> *…Strata were covered over again from time to time, with mud of various thickness, or carried down to the sea by the rivers and floods of more or less extent; and thus these layers of mud became raised to such a height, that they came up from the bottom to the air. At the present time these bottoms are so high that they form hills or high mountains, and the rivers, which wear away the sides of these mountains, uncover the strata of these shells,…*
>
> Codex Leicester, Royal Library, Windsor.

List of contributors

Eric Andersen is a senior geophysicist with Talisman Malaysia where he has a technical advisory role for Talisman's Southeast Asia Region (Malaysia, Indonesia, and Vietnam). He specializes in quantitative interpretation, seismic processing QC, and reservoir characterization, and has an interest in estimating geomechanical properties from seismic data. Eric received his BSc in mathematics in 1983 and a degree in geophysics in 1989 from the University of Alberta, Canada.

Per Avseth is a geophysical adviser at Odin Petroleum in Bergen, Norway, and a consultant to oil companies within the field of quantitative seismic interpretation and rock physics analysis. He is also an adjunct professor in applied geophysics at the Norwegian University of Science and Technology (NTNU) in Trondheim, Norway. Per received his MSc in applied petroleum geosciences from NTNU in 1993, and his PhD in geophysics from Stanford University, California, in 2000. He was the SEG Honorary Lecturer for Europe in 2009. Per is a co-author of the book *Quantitative Seismic Interpretation* (Cambridge University Press, 2005).

Art Barnes received a BS (1974) in physics from Denison University, an MS (1980) in geophysics from the University of Arizona, and a PhD (1990) in geophysics from Cornell University. His work experience includes seismic data acquisition, data processing, software development, and research. He is currently a geophysical researcher with Petronas in Malaysia. His research interests include seismic attributes, seismic processing, and pattern recognition applied to problems of seismic interpretation. He is a member of SEG, EAGE, and AAPG.

Evan Bianco is the Chief Scientific Officer at Agile Geoscience. He is a blogger, freelance geophysicist, entrepreneur, and knowledge-sharing aficionado. He has an MSc in geophysics from the University of Alberta and four years' experience as an industry consultant in Halifax, Nova Scotia. Evan's interests span a range of disciplines from time-lapse seismic in oil sands to geomodelling, seismic rock physics, and geothermal reservoir characterization. Evan tries to teach himself something new every day, and every so often, it proves useful. He can be reached at *evan@agilegeoscience.com*, or you can follow him on Twitter *@EvanBianco*.

Clare Bond is a structural geologist at the University of Aberdeen. She graduated from the University of Leeds and completed a PhD at Edinburgh University. Clare worked in geological conservation and policy roles in a range of fields before taking a research position co-hosted by the University of Glasgow and Midland Valley Exploration. She worked full-time for Midland Valley, working on consulting projects worldwide and leading their knowledge centre and R&D initiatives. Clare's research interests include uncertainty in seismic interpretation, and fault and fracture influence on sub-surface reservoirs. Having worked in both academia and industry she enjoys interdisciplinary research and has collaborated with social scientists, psychologists, and modellers.

Bert Bril is a co-founder and head of R&D at dGB Earth Sciences, *dgbes.com*. Bert holds an MSc in geophysics from Utrecht University. He began his career in 1988 as an acquisition geophysicist with Delft Geophysical, switched to software development in 1991, and worked for Jason Geosystems until 1992. He then worked at the TNO Institute of Applied Geoscience before co-founding dGB in 1995. He currently focuses on special projects and supporting his software team as an internal consultant.

José M Carcione was born in Buenos Aires, Argentina in 1953. He received the degree Licenciado in Ciencias Físicas from Buenos Aires University in 1978, the degree Dottore in Fisica from Milan University in 1984, and a PhD in geophysics from Tel-Aviv University in 1987. He has worked at the Comisión Nacional de Energía Atómica at Buenos Aires, and at Yacimientos Petrolíferos Fiscales, the national oil company of Argentina. Presently, he is a senior geophysicist at the Istituto Nazionale di Oceanografia e di Geofisica Sperimentale (OGS) in Trieste, Italy. In 2007, he received the Anstey award at the EAGE in London. José has published more than 200 journal articles on acoustic and electromagnetic numerical modelling, with applications to oil exploration and environmental geophysics. He is the author of the book *Wave fields in Real Media* (Elsevier Science, 2007) and co-author of *Arqueogeofísica* (Fundación de Historia Natural, 2006). He has been an editor of *Geophysics* since 1999.

Pavlo Cholach is a geophysicist with Abu Dhabi National Energy Company (TAQA) working on conventional oil assets in Alberta and Saskatchewan. Pavlo's previous seven-year experience with BP included geophysical support of a variety of conventional (structured carbonated and clastic gas reservoirs) and unconventional (tight gas, coal-bed methane, and oil sands) Canadian assets. Pavlo holds a PhD in geophysics from the University of Alberta, Canada, and a diploma with distinction in geophysics from Taras Shevchenko National University of Kyiv, Ukraine.

Alan J Cohen is Chief Geophysicist and Manager of Processing and Interpretation at RSI in Houston. He has over 30 years of experience in global oil and gas exploration. He has worked in operating units, in technical service organizations, and in research and development. He is regarded as an industry expert in rock physics of clastic and carbonate reservoirs, and in quantitative seismic interpretation. He was formerly Chief Geophysicist for Royal Dutch Shell in the western hemisphere. He can be reached at *alan.cohen@rocksolidimages.com*.

Alex Cullum has a BSc in geology and a PhD in palynology from the University of Aberystwyth, Wales. In 1996 he started work at IKU SINTEF in Trondheim, Norway, and since 1997 has worked in exploration for Statoil in Stavanger, Norway.

Paul de Groot is president of dGB Earth Sciences, *dgbes.com*. He worked 10 years for Shell where he served in various technical and management positions. Paul subsequently worked four years as a research geophysicist for TNO Institute of Applied Geosciences before co-founding dGB in 1995. He has authored many papers covering a wide range of geophysical topics and co-authored a patent on seismic object detection. Together with Fred Aminzadeh, Paul wrote a book on soft computing techniques in the oil industry. He holds MSc and PhD degrees in geophysics from Delft University of Technology in the Netherlands. Find him on LinkedIn at *ageo.co/IhwEUg*.

Duncan Emsley graduated with a BSc from the University of Durham in 1984. He worked for processing contractors for several years before joining Phillips Petroleum in 1992. Continuing in the seismic processing vein, he worked with data from all sectors of the North Sea and northeast Atlantic. The merger of ConocoPhillips brought about moves to Scotland, Alaska, and Calgary, Canada, and a progression into rock physics and seismic attributes and their uses in the interpretation process.

Maitri Erwin is a geophysicist at an independent oil and gas company, where she currently specializes in the inversion and interpretation of deepwater data. She has previously worked as a 3D geospatial technology executive as well as a geoscientist and subsurface information technologist at an oil major. Maitri is an advisor to Project Gutenberg, the oldest producer of free electronic books. She is *@Maitri* on Twitter.

Tooney Fink has been involved in the Canadian energy industry as a geophysicist for over 37 years, working for Gulf Canada Resources and successive companies which have since joined together to become ConocoPhillips Canada where he is now Supervisor of Geophysical Services. After graduating from the University of British Columbia in 1974, Tooney's career in the Canadian energy industry involved seismic field acquisition in the Mackenzie Delta and Parsons Lake, seismic processing, exploration in many of Canada's frontier basins, several international projects, and an endless number of projects in the Western Canada Sedimentary Basin. Tooney has been an active member of the CSEG Chief Geophysicists Forum since 2001, and helped compile *Practice Standard For Use Of Geophysical Data*. In 2008, Tooney was the CSEG General Chairman at the CSEG/CSPG/CWLS joint convention. Tooney also holds membership in AAPG, APEGA, NAPEGG, and SEG.

Remember the bootstrap 68

Victoria French is interested in all aspects of geosciences and even delves into the dark side of engineering when the opportunity presents itself. She holds BSc and MSc degrees from Baylor University and a PhD from the University of Oklahoma. Her favorite projects are integrated ones that incorporate geological, geophysical, and engineering inputs into models for reservoir characterization. Having held a number of technical and management roles in the last 17 years, she is currently Technical Director, Subsurface for TAQA NORTH. In this role, Victoria acts as technical advisor to TAQA NORTH's management team. She gives credit for her success to the incredible mentors that have inspired her and shaped her future: Emily Stoudt, Susan Longacre, Greg Hinterlong, and Kim Moore.

What I learned as a geophysicist wannabe 108

Taras Gerya is a professor at the Swiss Federal Institute of Technology (ETH-Zurich) working in the field of numerical modelling of geodynamic and planetary processes. He earned a PhD in petrology from Moscow State University in 1990 and a habilitation in geodynamics from ETH-Zurich in 2008. His recent research interests include modelling of subduction and collision processes, ridge-transform oceanic spreading patterns, intrusion emplacement into the crust, and core formation of terrestrial planets. He is the author of *Introduction to Numerical Geodynamic Modelling* (Cambridge University Press, 2009).

Calibrate your intuition 18

Bill Goodway obtained a BSc in geology from the University of London and an MSc in geophysics from the University of Calgary. Prior to 1985 Bill worked for various seismic contractors in the UK and Canada. Since 1985 Bill has been employed at PanCanadian and then EnCana in various capacities from geophysicist to Team Lead of the Seismic Analysis Group, to Advisor for Seismic Analysis within the Frontier and New Ventures Group, and subsequently in the Canadian Ventures and Gas Shales business unit. In 2010 he ended his career with EnCana to join Apache as Manager of Geophysics and Advisor Senior Staff in the Exploration and Production Technology group. Bill has received numerous CSEG Best Paper awards as well as the CSEG

Medal in 2008. He is a member of the CSEG, SEG, EAGE, and APEGA as well as the SEG Research Committee. In addition, Bill was elected Vice President and President of the CSEG for the 2002–04 term and in 2009 he was selected as the SEG's Honorary Lecturer for North America.

The magic of Lamé 90

David Gray received a BSc in geophysics from the University of Western Ontario (1984) and a MMath in statistics from the University of Waterloo (1989). He worked in processing for Gulf, Seismic Data Processors, and Geo-X Systems and in reservoir and research for Veritas and CGGVeritas. He now works for Nexen, where he is a Senior Technical Advisor responsible for geophysical reservoir characterization in the Oil Sands group. David is a member of SEG, CSEG, EAGE, SPE, and APEGA. He has published and presented more than 100 papers, holds two patents, and is a registered Professional Geophysicist in Alberta.

Explore the azimuths 28

Vladimir Grechka received his MSc degree (1984) in geophysical exploration from Novosibirsk State University, Russia and a PhD (1990) in geophysics from the Institute of Geophysics, Novosibirsk where he worked from 1984 to 1994 as a research scientist. He was a graduate student at the University of Texas at Dallas from 1994 to 1995, then joined the Colorado School of Mines where he was Associate Research Professor and co-leader of the Center for Wave Phenomena. From 2001 to 2012, Vladimir worked at Shell as a Senior Staff Geophysicist. Currently he is a Geoscience Consultant with Marathon Oil. Vladimir is the author of three books and more than 300 research papers devoted to various aspects of elastic wave propagation and seismic exploration. He is a member of SEG and EAGE. In 2009–2011, he served as the Editor-in-Chief of *Geophysics*. He received the East European Award from the European Geophysical Society in 1992 and the J Clarence Karcher Award from the SEG in 1997.

Anisotropy is not going away 14

Matt Hall is the founder of Agile Geoscience. A sedimentologist who found geophysics later in his career, Matt has worked at Statoil in Stavanger, Norway, Landmark and ConocoPhillips in Calgary, Alberta, and is now running Agile from its world headquarters: an office conveniently located in his garden. He is passionate about communicating science and technology, and especially about putting specialist knowledge into the hands of anyone who needs it. Find Matt on Twitter as *@kwinkunks* or by email at *matt@agilegeoscience.com*.

Five things I wish I'd known 30
Learn to program 40
Prove it 62

Marian Hanna is President and Director of ION/GX Technology Canada. She has 23 years of diverse experience in the oil and gas industry. Marian started out as a seismic processing geophysicist with Amoco, moving into interpretation with an emphasis on reservoir characterization. Marian's experience includes many collaborative technical and business contributions to discoveries in international and domestic North American basins from onshore to deep water settings in all aspects of exploration, development and production, including business development/new ventures. Marian is a native of New Orleans, Louisiana.

One cannot live on geophysics alone 52

Don Herron received a ScB in geological sciences from Brown University and an MS in geological sciences from the California Institute of Technology in 1973. He enjoyed a career as a seismic interpreter at Texaco from 1973–77, Gulf from 1977–1984, and Sohio/BP from 1984–2008. Since retirement in 2008 he has worked as an independent geophysical consultant for PGS and with several oil companies as a seismic interpretation instructor. He was co-instructor for the SEG course *Seismic Interpretation in the Exploration Domain* from 1995–2007. He was a member of the editorial board of *The Leading Edge* from 2002–07, its chairman from 2006–07, and is author of the bi-monthly *Interpreter Sam* column in *The Leading Edge*. He is also author of SEG Geophysical Monograph Series #15, *The Misadventures of Interpreter Sam*, and Geophysical Monograph Series #16, *First Steps in Seismic Interpretation*. He is an active member of SEG, AAPG, and Sigma Xi.

Practise smart autotracking 58
Use names to manage data 98

Chris Jackson completed his BSc (1998) and PhD (2002) at the University of Manchester, UK before working as a seismic interpreter for Norsk Hydro in Bergen, Norway. He left Norsk Hydro in 2004 to take an academic position at Imperial College, London, where he is now Reader in Basin Analysis.

Geology comes first 32

Linn Margareth Johansen graduated from the University of Bergen with an MSc in marine geology and micropaleontology. She has worked at Statoil since then and is currently a team leader in biostratigraphy in Stavanger, Norway.

Seek out the biostrat 74

Chris Kent is from the UK and graduated from Camborne School of Mines. He has 17 years experience working in various places in Asia, West Africa, Saudi Arabia, North America, and Europe. He currently works as a geophysicist at Talisman Energy in Stavanger, Norway.

The fine art of Mother Nature 82

Derik Kleibacker is currently the Chief Geologist for ConocoPhillips Indonesia. He graduated with an MSc degree in geology from Oregon State University and has worked for ConocoPhillips in various exploration and development roles since 2002. Derik hates to admit it, but he loves geophysical interpretation as much as geological field mapping.

You are a geologist 116

John Logel is lead geophysicist for Talisman Energy in Stavanger, Norway, leading them in the application of value-adding geoscience technology to improve prospect quality and reduce risk. Prior to Talisman, John held several technical management and advisory positions with Anadarko Canada and Petro-Canada in Calgary, Alberta, and before that worked 19 years for Mobil on numerous assignments in Europe and North America. John teaches professional development courses for PetroSkills in basic geophysics, AVO, inversion, and attributes. John is a professional geophysicist and holds a BS and MS from the University of Iowa. He is a member of SEG, CSEG, APEGA, and AAPG.

Simplify everything 76

Dave Mackidd started his career at Esso in Calgary, Alberta, and enjoyed exploring the Canadian Arctic before moving to Canadian Hunter and, later, PanCanadian and EnCana. Throughout his career, he has been a prolific creator of geophysical tools and workflows, devising such marvels as the grid balance algorithm for 2D seismic lines. He is now a Geophysical Advisor at EnCana, pushing the boundaries of geophysics every day.

My geophysical toolbox, circa 1973 46
The evolution of workstation interpretation 80
The last fifteen years 86

Mostafa Naghizadeh received a BSc in mining engineering from the University of Kerman, Iran, and an MSc in geophysics from the University of Tehran in 2003. He received his PhD in geophysics from the University of Alberta in 2009. He worked as a postdoctoral researcher with CREWES at the University of Calgary from 2010–11. His interests are in seismic data reconstruction methods, sampling theory, and seismic imaging. He currently holds a postdoctoral fellow position with Signal Analysis and Imaging Group (SAIG) at the University of Alberta. In 2011, Mostafa received the J Clarence Karcher Award from SEG.

The magic of Fourier 88

Rachel Newrick obtained her BSc (geology; 1992) and BSc Honours (applied geophysics; 1993) at Victoria University of Wellington, New Zealand and her PhD (exploration seismology; 2004) at the University of Calgary. Since 1992 she has worked for BHP Petroleum in Melbourne, Warburg Dillon Read in London, Telecom NZ and Bank of NZ in Wellington, Occidental Petroleum in Houston, Exxon Mobil in Houston, Veritas DGC in Calgary, Nexen Inc in Calgary, and Nexen Petroleum UK in London. She is currently a senior geophysicist for Cairn Energy in Edinburgh

working in frontier exploration. Rachel is the co-author of SEG Geophysical Monograph Series #13, *Fundamentals of Geophysical Interpretation* with Laurence Lines, has presented at a variety of conferences, and is presently the chairperson of the SEG Special Projects Committee.

Well tie basics 104
Well tie perfection 106
Where did the data come from? 110

Matteo Niccoli graduated from the University of Rome, Italy, with an honors degree in geology, and holds an MSc in geophysics from the University of Calgary. He worked for Canadian Natural Resources in Calgary, Alberta, and moved to Norway in the summer of 2012 where he is a senior geophysicist for DONG Energy. In his free time he does research and occasional consulting in geoscience visualization with his company MyCarta. On his blog he writes about exploration data enhancement and visualization, as well as image processing and its applications in geoscience, medical imaging, and forensics. He is a professional geophysicist of Alberta, and a member of AAPG, CSEG, and SEG. He can be contacted at *matteo@mycarta.ca* and is *@My_Carta* on Twitter.

How to assess a colourmap 36

Carl Reine graduated from the University of Alberta in 2000 with a BSc in geophysics. He worked a variety of conventional and heavy oil fields with Nexen Inc until 2006, when he attended the University of Leeds to complete a PhD. His research involved developing an algorithm for robustly measuring seismic attenuation from surface seismic data. Since 2010, Carl has worked for Nexen in the shale gas group, where he works on projects defining fracture/fault behaviour and reservoir characterization. He is an active member of CSEG, SEG, and EAGE, and is a professional member of APEGA.

Don't ignore seismic attenuation 20

Brian Romans is a sedimentary geologist and assistant professor in the Department of Geosciences at Virginia Tech. He graduated from SUNY Buffalo with a geology degree in 1997 and then worked as a geotech for small oil and gas companies in Buffalo, New York and Denver, Colorado for a few years. Brian received an MS in geology from Colorado School of Mines in 2003 and then headed to California where he earned a PhD in geological and environmental sciences from Stanford University in 2008. He worked as a research geologist for Chevron Energy Technology from 2008 to 2011 before joining the faculty at Virginia Tech. Brian's research on the patterns and controls of clastic sedimentation during and since graduate school have resulted in numerous papers, which you can access at *www.geos.vt.edu/people/romans*. Brian is *@clasticdetritus* on Twitter and writes the blog *Clastic Detritus* where he shares thoughts and photos about earth science.

The scale of a wavelet 92

Brian Russell started his career as an exploration geophysicist with Chevron in 1976, and worked for Chevron affiliates in both Calgary and Houston. He then worked for Teknica and Veritas in Calgary before co-founding Hampson-Russell in 1987 with Dan Hampson. Hampson-Russell develops and markets seismic inversion software which is used by oil and gas companies throughout the world. Since 2002, Hampson-Russell has been a fully owned subsidiary of Veritas and Brian is currently Vice President of Veritas Hampson-Russell. He is also an Adjunct Professor in the Department of Geology and Geophysics at the University of Calgary. Brian was President of the CSEG in 1991, received the CSEG Meritorious Service Award in 1995, the CSEG medal in 1999, and CSEG Honorary Membership in 2001. He served as chair of *The Leading Edge* editorial board in 1995, technical co-chair of the 1996 SEG annual meeting in Denver, and as President of SEG in 1998. In 1996, Brian and Dan Hampson were jointly awarded the SEG Enterprise Award, and in 2005 Brian received Life Membership from SEG. Brian holds a BSc in geophysics from the University of Saskatchewan, an MSc in geophysics from Durham University, UK, and a PhD in geophysics from the University of Calgary. He is a registered Professional Geophysicist in Alberta.

Mihaela Ryer has more than 17 years of experience in the oil and gas industry. She has worked for Marathon Oil, the ARIES Group, Prospectiuni (in Romania), and ConocoPhillips. Mihaela's research interests have been in the fields of seismic, sequence stratigraphy, depositional systems analysis and prediction. Most recently, she has employed a process-based approach to the prediction of lithofacies distribution and three-dimensional architecture of clastic systems through time and space, by using data-constrained stratigraphic forward-modelling technologies and tools. She is *@mihaela4021* on Twitter.

Marc Sbar got his PhD in earthquake seismology from Columbia University in 1972, and enjoyed a research and teaching career at Lamont-Doherty Earth Observatory and the University of Arizona until 1983. He then changed gears and spent 18 years as a geophysical specialist at BP, before moving to Phillips Petroleum in 2000, staying on at ConocoPhillips until 2009. Returning to academia, Marc recently moved to Tuscon, Arizona, impressing the next generation of University of Arizona geoscientists with the wonders of geophysics.

Rob Simm is a seismic interpreter with a special interest in rock physics, AVO, and seismic inversion technologies. Rob's early career (1985–1999) was spent with British independent oil and gas exploration companies Britoil, Tricentrol, and Enterprise Oil, working in both exploration and production. An interest in applying rock physics in prospect generation and field development led him to set up his own consultancy, Rock Physics Associates. His training course *The Essentials of Rock Physics for Seismic*

Amplitude Interpretation is recognized worldwide. Rob is the author of numerous papers as well as co-author of *3-D Seismic Interpretation* (Cambridge University Press, 2007). Since May 2010, Rob has had a staff position as Senior Geophysical Advisor at Agora Oil and Gas, a North Sea exploration company.

Resolution on maps and sections 70
The unified AVO equation 96

Sven Treitel grew up in Argentina and was educated at MIT where he graduated with a PhD in geophysics in 1958, before enjoying a long career at Amoco. Sven has published over 40 papers and is the recipient of numerous learned society awards, including the 1969 SEG Reginald Fessenden award, and in 1983 was awarded Honorary Membership of SEG. While his interests have been broad and varied, his main contribution to the field of geophysics has been to bridge the gap between signal processing theory and its application in exploration geophysics. He is the co-author of the definitive volumes *Geophysical Signal Analysis* (Prentice-Hall, 1980 & SEG, 2000) and *Digital Imaging and Deconvolution* (SEG, 2008). Although officially retired, Sven still lectures and consults widely.

Publish or perish, industrial style 64

Fereidoon Vasheghani received his PhD in geophysics in 2011, and MEng in petroleum engineering in 2006, both from the University of Calgary, Alberta. He is currently working as a geophysicist at ConocoPhillips. He is a member of SEG and SPE.

The subtle effect of attenuation 94

Index

Available from ***ageo.co/52geology*** and
online bookstores worldwide.

ISBN 978-0-9879594-2-3

Discounts for orders of 10 copies or more.
Email ***hello@agilelibre.com*** for more information.