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DEEPEGS

DEPLOYMENT OF DEEP ENHANCED GEOTHERMAL SYSTEMS FOR SUSTAINABLE ENERGY BUSINESS

Start date of project: 01/12/2015 **Duration: 48 Months**

Deliverable: D1.1
Expert Advisory Panel operational

A Working Document (WD1.2) maintained to update current appointments to the EAP

Project co-funded by European Commission within the H2020 Programme		
Dissemination level of this deliverable		
PU	Public	**X**
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

Document Status Sheet

Due date of deliverable:	Month no. 3
Actual submission date:	Actual month no. 3
Partner in charge of the deliverable and contributing partners	Iceland Geosurvey
Contact person responsible for this deliverable:	Email: ingo@isor.is
Authors:	Ingolfur Thorbjornsson (ISOR) S.G. Bogason, and S.T. Björgvinsson (GEORG, Project Office)
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Change history:

Version	**Date**	**Details** (additions, changes, reviews, performed by whom)
1.0	17.2.2016	First draft (IOT)
2.0	19.2.2016	Second draft (IOT)
2.1	25.2.2016	Final update (HPI)
3.0	29.02.2016	Final draft (SGB)
3.1	01.03.2016	Final, delivered to EC
4.0	31.08.2017	Updated final version, (personal contacts removed, SGB)
5.0	04.10.2019	Updated version, new members added (SGB)
5.1	10.10.2019	Updated CV for P. Pezard (SGB)

CONTENTS

OVERVIEW / EXECUTIVE SUMMARY

GOALS

The objective of the present deliverable is to present the External Advisory Panel (EAP) selected by the DEEPEGS partners. It was decided that a group of four experts would be appropriate and that the nomination of EAP would take into account both gender and ethical issues as well as broad knowledge and experience of the DEEPEGS topics.

This is in accordance with the DOA as stated in several places of the Grant agreement were it is written:

- Four core members are appointed to the EAP, for specific reviewing project results and providing external advice and inputs to the project, its management, and regarding the overall direction of the work and its progress. One of the four core members will be an independent Ethics Advisor to be appointed to advice on use of radioactive tracers, and other ethics related issues arising in the project. If required additional "ad-hoc" members could be temporarily appointed to the EAP
- External Advisors / stakeholder groups: DEEPEGS will establish and form a expert panel (D1.1) this international industry/scientific advisory panel of four high level persons from leading organisations in the field of geothermal energy and EGS. At least one of external experts will be appointed to be the independent Ethics Advisor member of the EAP.
- The External Advisory Panel (EAP) includes from the project proposal stage 2 high-level international experts, and during first implementing quarter we will add 2 more renowned independent external experts to the to further compliment the EAP. An Ethics Advisor will be appointed as one of the four members of the EAP. (D1.1, Mon. 3)"

1. INTRODUCTION

A list of EAP nominees was presented to the DEEPEGS consortium for discussion at the project kick-off meeting in Paris on 10 December 2015. The final list of nominees was then compiled and after further discussions among partners an agreed core list of the four experts and the reserve list established for the *ad hoc* panel members.

The DEEPEGS project may need to call in additional persons not yet listed in the reserve list to present specialised advice and review project outputs at various stages over its four years. Also to supplement its outreach and dissemination impact delivery a internal project working document (WD1.2) will be maintained to supplement the expanded *ad hoc* list as might prove applicable to maximise its communication reach.

During the project operation partner 2-FG objected to one of the original four appointed members, and this resulted in moving Jacques Varet from the main list to the Ad hoc list. A new member P. Pezard from France was added to the list in May 2017. In October 2019 a new member Ó. Sigurdsson was appointed.

2. THE EXTERNAL ADVISORY PANEL (EAP)

The coordinator together with the responsible partner has contacted the nominated EAP members and they have accepted to work with the DEEPEGS consortium as members of the EAP.

2.1 THE CORE GROUP EAP MEMBERS ARE (DETAILED CV IS IN ANNEX I):

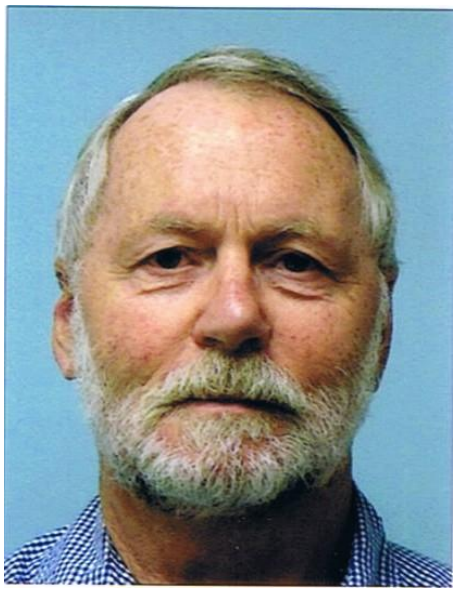
Isabella Nardini, CNR, Italy,

Isabella got her Ph.D. in Geochemistry and Petrology of active volcanoes in 2004 at University of Pisa. She worked on fluid and solid geochemistry applied to geothermal resources at the Centre of Excellence for Geothermal Energy in Larderello and actually working for the National Research Council (CNR-IGG) on HT tracers. Her expertise covers geochemical microanalyses: XRF, ICP-MS; in situ micro-analytical methods: EMPA-WDS, SEM-EDS, LAM-ICP-MS; thermometry, mass spectrometry (H, O, He Pb, Sr, Nd isotopes) and micro-drilling technique applied to natural and synthetic samples, dating.

Grimur Bjornsson, Private Consultant, Iceland,

Grímur holds a BSc in Geophysics from the University of Iceland and a M.Sc. in Reservoir Physics from the University of California, Berkeley, U.S.A.

Current position is owner and founder of Warm Arctic ehf, a limited liability consulting firm registered under Icelandic law that largely comply with EU regulations and standards. Providing consulting services on topics related to geothermal reservoir engineering, green field development, well and field strategies, numerical modeling and consulting to top management layers of geothermal companies worldwide with South America only excluded. Current work is primarily on projects in the Philippines, Indonesia, Nicaragua, the Caribbean, East Africa and the USA with a cumulative pipeline potential of more than 1000 MW and 200 MW in operation.



Kevin Brown, Owner Geokem, New Zealand,

He is also appointed as Ethics advisor

Kevin holds a BSc, MSc and PhD in Chemistry.

He has worked in geothermal since 1980, initially with DSIR at the Wairakei Research Centre, then with GNS and the University of Auckland's Geothermal Institute, and finally as a full time consultant and partner in GEOKEM (est. 1997).

He has undertaken extensive research into geothermal scaling and production problems, and worked as a consultant in New Zealand, Australia, Philippines, Japan, El Salvador, Tibet, China, Indonesia, Papua New Guinea, Nicaragua, Kenya, Iceland and USA. He spent 6 years on the board of IGA, where he held the post of treasurer.

Kevin will take lead within the EAP on the ethics issues reviews, and follow up with the DEEPEGS coordination team that the concerns of the EC ethics report are appropriately and timely addressed. In cases where needed additional advice may be called for from the ad hoc (reserve EAP group members or from highly respected ethics experts.

2.2 MEMBERS OF THE "*AD HOC*" EAP RESERVE LIST

The persons listed on the reserve EAP list as *ad hoc* members are all well know experts in their fields, and have been in past collaborations with researchers in the DEEPEGS project.

They have not been formally contacted to invite them to be on the reserve list, but through personal channels of communications have been made aware of the situation, and that future requests might be directed to them from the DEEPEGS project.

In case of invitations being sent out these will be managed independently by ISOR (Iceland GEOSURVEY) that manages the EAP activities, to avoid any risk of conflict of interest regarding the subject being reviewed through an extended DEEPEGS EAP action.

During project operation the Ad Hoc members needed to be called on to facilitate advise and reviews regarding the French demonstration site of partner 2-Fonroche Geothermie. In particular P. Pezard as a native French speaker and expert in the French geological and geothermal environment and O. Sigurdusson for the geothermal reservoir in Vendenheim.

Philippe Pezard (France) 	CNRS, Montpellier, France Philippe holds a Ph.D. in Borehole Geophysics from Columbia University (NY) at Lamont-Doherty Earth Observatory in 1990. He worked initially on downhole measurements from the Ocean Drilling Program (ODP) to found the French borehole geophysics group in Marseille then Montpellier (1992-), participated to 5 ODP expeditions, then became the president of ODP France (2001-2003). • Independent consultant on geosciences for DEEPEGS project • Appointed to the EAP in May 2017
Omar Sigurdsson (IS) 	Geothermal Reservoir Engineer / Forðafræðingur Ómar Sigurdsson is Reservoir Engineer. He holds BSc. in Geophysics and MSc. in Petroleum Engineering. With over 25 years of experience in borehole logging, well testing, stimulation and reservoir modeling at ÍSOR and its predecessor he joined HS Orka in 2008. At HS Orka he was involved with QC of researches and projects in the fields that HS Orka operates and is exploring. Furthermore, he was involved in site locating, targeting and planning for well drilling operations, reservoir engineering and reservoir management for the HS Orka fields. Retired from HS Orka in late 2019 and since been independent consultant. • Appointed to the DEEPEGS EAP in October 2019
Joseph J. Beall (USA) 	**Consulting Geologist** PROJECT AREAS: Use of injection to develop sustainable production from the Geysers reservoir. Use of large and small scale tracer tests and well field steam chemistry to map the movement of injection-derived steam in the reservoir and calculate its contribution to total steam flow. Identifying and mapping potentially corrosive steam. Use and interpretation of induced seismicity to understand injection processes. Evaluation of geothermal prospects and developments. CV: https://www.dropbox.com/s/xhexyxxuo9s0olu/CV_JJ_Beall.pdf?dl=0

Wolfgang Schoebel (DE) 	Technical Sales Manager at Baker Huges, Hannover Are, Germany https://de.linkedin.com/in/wolfgang-schoebel-67a70015
Haukur Ingi Jónasson (IS) 	Assistant Professor, Reykjavik University Project management and ethics https://is.linkedin.com/in/haukur-ingi-jonasson-6bb8847 http://www.ru.is/starfsfolk/haukuringi
Sverrir Þórhallsson (IS), 	Lecturer Reykjavik University CV: http://www.ru.is/starfsfolk/sverrirthor

Peter Rose (USA), 	Research Professor, University of Utah, EGI – Energy & Geoscience Institute CV: https://egi.utah.edu/about/staff/peter-rose/
Jacques Varet (FR) 	Private Consultant, France, Jacques earned his PhD form South Paris University in 1969 and has over 45 years' experience in France, Italy, Ethiopia, Djibouti, Eritrea, China, Indonesia, West Indies, Azores, Reunion, Thailand, Central America, USA, Iceland, Mid Oceanic Ridges. He received the first L.R.Wager Prize award for volcanological research from IAVCEI & Royal Society (with Franco Barberi), 1971 His field of expertise is: Volcanology, Petrology, Mineralogy, Tectonics, Geodynamics, magma geochemistry, especially rift systems. He also has extensive experience on engineering for geothermal energy; management of R&D and engineering team

ANNEX I: CV FOR EAP MEMBERS

CV FOR KEVIN BROWN

GEOKEM
P.O. Box 30-125, Barrington, Christchurch, NZ
ph: +64 3 347 3458
email: kevin@geokem.co.nz

CURRICULUM VITAE

NAME: BROWN	Kevin Laurie
DATE AND	24 July 1946
PLACE OF BIRTH:	Auckland, New Zealand
NATIONALITY:	New Zealand
ACADEMIC RECORD:	1968 B.Sc. Chemistry (University of Auckland) 1969 M.Sc. Chemistry (University of Auckland) 1972 Ph.D. Chemistry (University of Auckland)
CURRENT POSITION:	Partner, GEOKEM Environmental and Geothermal Consulting P.O. Box 30-125, Barrington, Christchurch Email: kevin@geokem.co.nz Website: www.geokem.co.nz Phone + 64 3 347-3458 Adjunct Professor, University of Canterbury, Dept of Geological Sciences
ASSOCIATIONS:	The Geochemical Society Geosciences Society of NZ NZ Geothermal Association International Geothermal Association

RESEARCH EXPERIENCE

1969-1980 At Chemistry Division, DSIR, Gracefield, New Zealand.
During most of this time, research was conducted in the broad area of x-ray crystallography. Numerous crystal structures were solved in two main areas - organic reaction intermediates and new minerals. An 18 month post-doctoral sabbatical awarded by Schweizerische Nationalfond was spent at the ETH in Zurich, Switzerland. Towards the end of this period at Gracefield, some studies were directed towards the hydrogenation of coal to produce synthetic crude oil.

1981-1991 At Geothermal Research Centre, Wairakei, New Zealand.
Leader of Groups for geothermal chemistry, geochemistry and environmental chemistry (~ 60 scientists). Head of geothermal chemical analysis laboratory. Responsible for Government

sponsored research and commercial consulting for Geothermal Group. Specialist in mineral scaling in geothermal development.

1991-1992 At NECAL Laboratory, DSIR, Auckland, and US Geological Survey, Denver, USA. The emphasis of research in this period shifted towards environmental chemistry - particularly environmental chemistry of geothermal development and mineral deposition in geothermal systems.

1992-1997 Assoc Professor at Geology Dept and Geothermal Institute, University of Auckland and Institute of Geological and Nuclear Sciences (Now GNS Science).
Mainly commercial consulting work in the general field of geothermal geochemistry. Research principally towards the mechanism of silica scaling in geothermal development and production geochemistry. Teaching and student supervision at Geothermal Institute.

1997 - 2003 At Geology Dept and Geothermal Institute, University of Auckland, and GEOKEM - environmental and geothermal geochemistry.
Organisation and presentation of Geothermal Environmental Short Course. Research based around geothermal production and exploration geochemistry, mineral deposition and environmental problems. Teaching geothermal geochemistry, mineral deposit geochemistry. Consulting in area of geothermal power station geochemistry.

2003 – Present Partner in GEOKEM – Geothermal and Environmental Consulting
Main areas of interest since 1981:

- Geochemical Thermodynamics,
- Exploration and Production Geothermal Geochemistry
- Geothermal Scaling, and geothermal geochemistry
- Geothermal Power Station geochemistry
- Gold, Silver and Sulfide Deposition in Epithermal Mineral Deposits.
- Environmental Geochemistry

2010 – **Present** Adjunct Professor at University of Canterbury, Dept of Geological Sciences, Christchurch

CONSULTING EXPERIENCE

Consulting within NZ for SOE's, Govt Depts, private consultants, geothermal companies. Overseas consulting work in China, Tibet, Philippines, Indonesia, Iceland, Japan, El Salvador, Mexico, Nicaragua, Australia, USA, Papua New Guinea, Kenya for private companies, government organisations, World Bank, UNDP.

Significant Commercial Projects:

- Experimental and Theoretical Investigation of Silica Scaling at the Ohaaki Geothermal field. Pilot plant verification of effect of aeration, acid and alkali dosing, fluid dynamics.
- Interpret 25 years of chemical data for the Wairakei geothermal field and calculate response of the field to exploitation

- Review reinjection strategy and consequences - Ohaaki geothermal field.
- Investigate the use of calcite antiscalant chemicals in Japan, and introduce technology to New Zealand - now used extensively at geothermal fields in NZ.

- Total chemical modelling and interpretation of the Kakkonda geothermal field including acid wells in Hatchimantai National Park, Honshu, Japan.
- New Zealand Department of External Relations and Trade consultant on mission to Philippine geothermal fields.

- Visited Tibetan geothermal fields as NZ Government foreign aid consultant on calcite scaling.
- Investigate pilot plant extraction of gold and silver from geothermal fluids.
- Investigate reinjection versus treatment strategy for Wairakei geothermal field waste water. Project management for arsenic extraction pilot plant study.
- Field evaluation of silica antiscaling compounds in cooperation with US chemical company.

- Investigation of silica extraction technology for Wairakei geothermal field.
- Silica scaling investigation, World Bank Consultancy at the Berlin geothermal field, El Salvador
- Consultant on geothermal silica scaling to Philippine Geothermal Inc, Philippines.
- Prepare and deliver training course in silica geochemistry and investigate silica scaling problems for PNOC, Philippines. World Bank Consultancy.
- Co-leader of Technical Mission to Tibet Geothermal Fields, sponsored by NZ Government and Chinese Government and UNDP.
- Consultant to CFE (Mexican Govt Power Generation Authority) on scaling and production geochemistry of geothermal sytems.
- Deliver course on "Environmental Aspects of Geothermal Development" to Mexican Geothermal Association.
- Silica scaling consultancy at Wayang Windu geothermal field, Indonesia.
- Theoretical calculations and field measurements of silica scaling at Mokai Geothermal field
- Organise and deliver Geothermal Environmental Short Course at Geothermal Institute, funded by NZ MFAT
- Investigate and suggest controls for steamline deposits at Wairakei Geothermal Field
- Build titanium downhole geothermal sampler for downhole trace metal analysis
- Chairman Peer Review committee for Mokai Geothermal Field environmental consenting
- Trace metal downhole sampling and interpretation at Salak and Wayang Windu, Indonesia
- Heat exchanger scaling and reservoir implications of stibnite deposits at Ngawha Binary Plant, New Zealand
- Short course on Geochemistry and geothermal development, CFE Los Azufres, Mexico.
- Sample and analyse downhole trace metal samples from Rotokawa, Wairakei, Ohaaki, Kawerau and Mokai geothermal fields in New Zealand, Palinpanon geothermal field in the Philippines, and Lihir geothermal field in PNG.
- Interpretation of geothermal chemistry and scaling problems at Lihir Gold Mine and Geothermal Field, Papua New Guinea
- Identification and chemical removal of sulfide scaling deposits, Mokai and Rotokawa geothermal binary power projects
- Reservoir and Scaling Geochemistry for Geodynamics “Hot Fractured Rock” project in Cooper Basin, Australia
- Manage and interpret results from silica scaling test rig for Mighty River Power Ltd, NZ, and contribute to design parameters for new 90MW and 130 MW power stations at Kawerau and Rotokawa.
- Calcite scaling consultancy at Lihir Gold mine/geothermal system, PNG

- Overview of geochemical data interpretation, Chevron Geothermal, Philippines
- Trace metal sampling downhole, Reykjanes, Iceland
- Silica scaling pilot plant, San Jacinto, Nicaragua
- Injectivity decline in a geothermal field – experimental investigation of causes
- Invited Keynote Speaker – International Workshop on Mineral Scaling in Geothermal Development. Makati, Philippines, 2011
- Scientific advisory panel member for GDC, Geothermal Development Company, Kenya – including review of laboratory setup and facilities.
- Pilot plant experiment for binary bottoming plant, Lihir Island, PNG
- Pilot plant design and supervision to investigate silica and stibnite scaling for Ngatamaraki 80MW Binary Power station.

RESEARCH EXPERIENCE:

Significant Research Projects:
- Effect of aeration on silica scaling,
- pH adjustment of brines (acid and alkaline) to control silica scaling,
- Polymerisation rates of colloidal silica,
- Effect of polymerisation time on silica scaling,
- Inhibition of calcite scaling by injection of antiscalant into well,
- Calculation of calcite scaling likelihood in Ohaaki geothermal field,
- Computer program to calculate downhole chemistry and flash chemistry,
- Analysis and thermodynamic interpretation of deposited gold and silver rich sulphide scales at Ohaaki and Kawerau,
- Pilot plant to extract gold and silver from geothermal brines,
- Laboratory kinetic studies of gold and silver solubilities,
- Interpret 25 years of geochemistry from Wairakei geothermal field and propose hydrological model,
- Interpret geochemistry of Kawerau geothermal field,
- Total chemical modelling and interpretation of the Kakkonda geothermal field, Honshu, Japan.
- Antarctic gas chemistry in Dry Valley Lakes,
- Oxidation of H2S in aerosols.
- Pilot plant extraction of silica from geothermal brines
- Pilot plant extraction of arsenic from geothermal brines
- Pilot plant investigation of hydrodynamic factors in silica scaling
- Investigation of thermophilic bacteria and silica deposition in geothermal systems
- Chemistry of mineral deposition in Antarctic ponds, summer 2004/5
- Geochemical thermodynamic calculations of stibnite solubility in geothermal systems
- Construction and operation of pilot plant to investigate silica scaling and pH modification
- Geochemistry of acid dosing at Kawerau Power Plant
- Geochemistry of acid dosing at Rotokawa Power Plant
- Pilot plant and acid dosing for Ngatamariki binary power plant
- Trace metal concentrations in seawater fed geothermal systems – application to "black smokers".
- Run "Scaling and corrosion in geothermal development" short course at WGC2015

Other:
- Guest lecturer, Auckland University Geothermal Institute teaching

Environmental Geochemistry, *Geothermal Scaling*, *Geochemical Thermodynamics* and *Production Geochemistry*

- Seconded to NZ Foreign Affairs in geothermal advisory role in Philippines 1984 and 1985,
- Guest scientist at US Geological Survey, Branch of Geochemistry,

Denver, USA, 12 months 1986/87,

- Visited geothermal fields of Central Mexican Volcanic Belt, 1987,
- Visited geothermal fields in Honshu and Kyushu, Japan, 1988.
- Environmental Geochemistry in Dry Valleys, Antarctica 1989/90.
- Visited geothermal fields of Tibet as invited guest of People's

Republic of China , September 1991

- Invited short course convenor, International Geological Congress, Kyoto Aug.1992
- Gas chemistry of Dry Valley lakes, Antarctica, 1991/92
- Visiting Scientist, US Geological Survey, Denver, Colorado 1992.
- Conduct course in "Geothermal Scaling". People's Republic of China, May 1992.
- Member, Scientific Advisory Board, Simbol Mining, USA.
- Reviewer at various stages for *Economic Geology*, *Geothermics*, *Applied Geochemistry*, American NSF proposals, and NZ FRST proposals.
- Invited lecturer, Geochemistry short course, GRC meeting, Reno, 1999
- Invited Convenor, World Geothermal Congress Short Course on "Environmental Aspects of Geothermal Development". June 2000
- Member, Board of Directors, International Geothermal Association (2001 –2007 Treasurer 2004 - 2007)
- Editorial Board *Geothermics* (2002 - 2011)
- Antarctic meltwater geochemistry; summer seasons of 2003/04, 2004/05
- Short Course organiser and presenter. World Geothermal Congress 2015. ‘Scaling and corrosion in Geothermal Development.

Selected Refereed Papers in Scientific Journals:

"Gold Deposition from Geothermal Discharges in New Zealand" , by K.L.Brown. Economic Geology, 81, (1986), 979-983.

"Kinetics of Gold Precipitation from Experimental Hydrothermal Sulfide Solutions", by K.L.Brown. Economic Geology Monograph 6, (1989), pp.320-327.

"Comparison of Early Exploration at Platanares (Honduras) and Wairakei (New Zealand)". A.H. Truesdell, F. Goff, K.L.Brown, R.B. Glover and C.J. Janik. GRC Transactions (1989), p.207-212.

"A note on Gases Dissolved in the Deep Waters of Lake Vanda" K.L. Brown, J.G. Webster, W.F. Giggenbach and G.L. Lyon. Antarctic Record, 11, (1991), pp 14-18

"Geochemical Processes affecting meltwater chemistry and the formation of saline ponds in the Victoria Valley and Bull Pass region, Antarctica". J.G. Webster, K.L. Brown and W.F. Vincent. Hydrobiologia, 281, (1994),171-186

"Modelling Chloride and CO2 Chemistry in the Wairakei Geothermal Reservoir" W.M. Kissling, K.L. Brown, M.J. O'Sullivan, S.P. White, D.P. Bullivant. Geothermics, 25, (1996) 285-305

"Chemical characteristics of the deep geothermal fluid in the Kakkonda geothermal system, Iwate prefecture" S.Yanagiya, K. Kasai, K.L. Brown and W.F. Giggenbach. Chinetsu , 33(1), (1996) 1-18

Source and transport of trace metals in the Hatea River catchment and estuary, Whangarei, New Zealand. J.G. Webster, K.L. Brown & K.S. Webster. NZ Journal of Marine and Freshwater Research, 34, (2000) 187 - 201.

Trace metal chemistry and silicification of microorganisms in geothermal sinter, TVZ, New Zealand. E.J. McKenzie, K.L. Brown, S.L. Cady and K.A Campbell. Geothermics, 30, (2001), 483-502

IC-ICP-MS and IC-ICP-HEX-MS determination of arsenic speciation in surface and groundwaters: preservation and analytical issues. D.A. Polya, P.R, Lythgoe, F.Abou-Shakra, A.G. Gault, J.R. Brydie, J.G. Webster, K.L. Brown, M.K. Nimfopoulos and K.M. Michailidis. Mineralogical Magazine, 67, (2003), 247-261

K.L. Brown and S.F. Simmons (2003) Precious metals in high temperature geothermal systems in New Zealand. *Geothermics*, **32**, 619-625

Pope, J.G., McConchie, D., Clark, M.D. and Brown, K.L.. (2004). Diurnal variations in the chemistry of geothermal fluids after discharge, Champagne Pool, Waiotapu, New Zealand. *Chemical Geology* .**203**, 253-272

Pope, J.G., Brown, K.L., McConchie, D. (2005). Gold Concentrations in Springs at Waiotapu, New Zealand: Implications for Precious Metal Deposition in Geothermal Systems. *Econ Geol*, **100**, 677-687

40. Healy, M., Brown K.L., Webster-Brown, J.G. & Lane, V. (2006). Chemistry and stratification of Antarctic meltwater ponds II: Inland ponds in the McMurdo Dry Valleys (Lat 77°S), Victoria Land. *Antarctic Science*, **18**, 525–533

Wait, B.R., Webster-Brown, J.G., Brown, K.L., Healy, M. & Hawes, I. (2006). Chemistry and stratification of Antarctic meltwater ponds I: Coastal ponds near Bratina Island (Lat 78°S), Ross Sea. *Antarctic Science*, **18**, 515–524.

S.F.Simmons and K.L. Brown (2006). Gold in Magmatic Hydrothermal Solutions and the Rapid Formation of a Giant Ore Deposit., *Science*, **314**, 288 – 291

Nathaniel Wilson, Jenny Webster-Brown and Kevin Brown(2007). Controls on stibnite precipitation at two New Zealand geothermal power stations., *Geothermics*, **36**, , 330-347

S.F.Simmons and K.L. Brown (2007). The flux of gold and related metals through a volcanic arc,Taupo Volcanic Zone, New Zealand. *Geology*, **35**, 1099 – 1102

V. Hardardóttir, K.L. Brown, Th. Fridriksson, J.W. Hedenquist, M.D. Hannington and S. Thorhallsson (2009). Metals in deep liquid of the Reykjanes geothermal system, southwest Iceland: Implications for the composition of seafloor black smoker fluids. *Geology*, **37**, 1103-1106

A.J. Rae, D.R. Cook, K.L. Brown (2011). The trace metal chemistry of deep geothermal water, Palinpinon Geothermal field, Negros Island, Philippines: Implications for Precious Metal Deposition in Epithermal Gold deposits. *Economic Geology*, **106**, 1425 – 1446

N. Wilson, J. Webster-Brown and K. Brown (2012), The behavior of antimony released from surface geothermal features in New Zealand. *Journal of Volcanology and Geothermal Research*, **247 – 248**, 158 – 167

J Pope and K.L. Brown (2014). Geochemistry of discharge at Waiotapu geothermal area, New Zealand – Trace elements and temporal changes. *Geothermics*, **51**, 253 – 269

Kokhanenko P., Jermy M., Brown K., Silica aquasols of incipient instability: synthesis, growth and stability, Journal of Colloid and Interface Science, 2016 (in review)

Kokhanenko P., Jermy M., Brown K., Experimental study of colloidal silica aggregation and deposition in a turbulent flow, Journal of Fluid Mechanics, 2016 (in review)

Simmons, S.F., Brown, K.L., Browne, P.R.L., Rowland, J.V. (2016) Gold and silver resources in Taupo Volcanic Zone geothermal systems. *Geothermics*, 59, 205 – 214

Simmons S.F., Brown, K.L., Tutolo, B.M., (2016). Hydrothermal transport of Ag, Au, Cu, Pb, Te, Zn, and other metals and metalloids in New Zealand geothermal systems: Spatial Patterns, Fluid-mineral Equilibria, and Implications for Epithermal Mineralization. *Economic Geology* –accepted for publication

Hannington, M., Hardardottir, V., Garbe-Schoenberg, D., and Brown, K.L. (2016). Gold enrichment in active geothermal systems by accumulating colloidal suspensions. *Nature Geoscience* accepted for publication

Book Chapters:

1. "A Practical Guide to Thermodynamics of Geothermal Fluids and Hydrothermal Ore Deposits" (1986), R.W. Henley and K.L. Brown. Reviews in Economic Geology. Volume 2 - Editor J.M. Robertson.
2. "Applications of Geochemistry in Geothermal Reservoir Development (1992)". K.L. Brown and R.B. Glover. Technical Guide No.5, UNITAR/UNDP Centre on Small Energy Resources.
3. "Environmental Aspects of Geothermal Development", (2000). K.L. Brown, Convenor, 145pp. International School of Geothermics, Pisa, Italy. Published for International Geothermal Association.
4. "Environmental Aspects of Geothermal Development" (2004) K.L. Brown and J.G. Webster-Brown. in "Geothermal Energy" Edited by M.H. Dickson and M. Fanelli. UNESCO Energy series – Wiley and Son

CV FOR ISABELLA NARDINI

Isabella Nardini got her Ph.D. in Geochemistry and Petrology of active volcanoes in 2004 at University of Pisa. She worked on fluid and solid geochemistry applied to geothermal resources at the Centre of Excellence for Geothermal Energy in Larderello and actually working for the National Research Council (CNR-IGG) on HT tracers. Her expertise covers geochemical microanalyses: XRF, ICP-MS; in situ micro-analytical methods: EMPA-WDS, SEM-EDS, LAM-ICP-MS; thermometry, mass spectrometry (H, O, He Pb, Sr, Nd isotopes) and micro-drilling technique applied to natural and synthetic samples, dating. She is part of the management team for the EERA-Joint Programme on Geothermal Energy since 2010 and participated to the European Commission of the WG 'Geothermal Energy' - Energy Education and Training for the Strategic Energy Technology Plan (SET-Plan) in 2012. Author and co-author of publications on national and international scientific journals and proceedings of conferences/workshop, convenor at national and international conferences, lecturer and lab teacher for the courses at the Dept. of Earth Sciences and of Environmental Sciences at the University of Pisa.

CV FOR GRIMUR BJORNSSON

Name: Mr Grímur Björnsson

Date of birth: June 7, 1960 Nationality: Icelandic

Education: 1966-1975	Primary education, Iceland
1975-1980	Secondary/Senior secondary education, Iceland
1980-1984	University of Iceland, B.Sc. in Geophysics
1985-1987	University of California, Berkeley, U.S.A., M.Sc. in Reservoir Physics
1999	6 months Sabbatical leave at Lawrence Berkeley Laboratory, California
2004	2 months Sabbatical leave at United States Geological Survey, Seismic Hazard team, Menlo Park, California

Languages:
Native Icelandic Second English Other Danish, German (read, speak a bit)

PRESENT POSITION AND PROFESSIONAL EXPERIENCE 1987-2014:

Current position is owner and founder of Warm Arctic ehf, a limited liability consulting firm registered under Icelandic law that largely comply with EU regulations and standars. Providing consulting services on topics related to geothermal reservoir engineering, green field development, well and field strategies, numerical modeling and consulting to top management layers of geothermal companies worldwide with South America only excluded. Current work is primarily on projects in the Philippines, Indonesia, Nicaragua, the Caribbean, East Africa and the USA with a cumulative pipeline potential of more than 1000 MW and 200 MW in operation.
Senior reservoir engineer, manager and head of geosciences at Reykjavik Geothermal between 2008 and 2014. Work included review of field data, site visits, and reservoir models, how to realize them and couple into financial models. Due diligence work on large geothermal projects for investors. Intense travel to SE-Asia geothermal locations, in particular Papua New Guinea, to meet with governments, regulatory authorities, landowners and financial institutes. Resource and generating capacity assessment for RG own licensed areas in Ethiopia, currently aiming for developing and commissioning of 500-1000 MW of power in the next 10 years. Study emerging production technologies, including geothermal sustained district cooling system and desalination facilities for a green city project in Abu Dhabi and for Aramco in Saudi Arabia. Part of Orka Energy resource team for the current 50-100 MW geothermal power development project in Biliran, Philippines. Appointed by President of Iceland and major of Reykjavik to brief their guests on geothermal energy and power plants. Reservoir Engineer at Orkuveita Reykjavikur (Reykjavik Energy) and Reykjavik Energy Invest 2006-2008. Work includes well siting, design and drilling decisions, geothermal resource assessment and characterization. In particular on the Hengill system where two large geothermal power stations are already in operation (420 MWe). Member of an Iceland government appointed expert group defining sustainability and renewability of geothermal energy projects, through field work, numerical modelling, reporting and meetings. Member of an international expert group studying mineral CO2 sequestration into Icelandic basalts. Member of an expert group studying impact of deep water injection to geothermal wells, where aim is to better understand coupling of stress and permeability field in the subsurface, optimally thereby increasing mean output of geothermal wells.

Senior reservoir physicist at the Geothermal Logging and Reservoir Physics Division at Orkustofnun (1987-2003) and at ISOR, the Icelandic GeoSurvey (2003-2006). Work includes numerical modelling of single- and two-phase flow in geothermal reservoirs and boreholes, well logging (~3000 km cumulative in 300 wells on 650 days), well testing, hydrological interpretation of well tests and software development. Monitoring internal changes in high-temperature reservoirs due to production. Supervising geothermal research and production monitoring for a few district heating systems in Iceland. Analyze tracer return curves to estimate thermal efficiency of long term injection. Storing and retrieving the collected data in an Oracle relational database. Summarize and draw geographical and potential field data by using various mapping tools and geographical information systems (ArcView and GMT). Develop various Unix shell scripts and Fortran programs for the data processing.

Special, onsite training in Berkeley, California, in the use and application of the TOUGH2 and iTOUGH2 geothermal reservoir simulators. Beta tester for that same software. Parallel computing using the iTOUGH2 code on a 50 CPU unit cluster. Lead developer of a large 3-D reservoir model for the Hengill volcanic center in SW-Iceland. Member of two consultancy boards which dealt with present and possible leakages into Icelandic road tunnels during construction. Reservoir engineering consultant for Ormat Industries Ltd. in Nevada, Kenya and Nicaragua. Reservoir engineering consultant for Shell International, CEL, GESAL and LAGEO in El Salvador. Group leader on the monitoring of hydrological changes associated with large earthquakes in S-Iceland in the summer 2000. Participate in the development, instalment and operation of remote data logging stations, which monitor principal parameters of high and low-temperature geothermal wells. Develop software to automatically retrieve the collected data, analyze it and present on frequently updated web pages. Lead purchase of an acoustic televiewer for determining strike and dip of permeable zones in geothermal wells and correlate with regional stress fields. Member of EU supported projects Foresight and Hiti.

Tens of consultancy missions to El Salvador, Djibouti, Greece, Israel, Kenya, Nicaragua, Guatemala and the US regarding geophysical surveys, geothermal reservoir engineering studies, drilling strategy and reservoir management.

Instructor at the United Nations Geothermal Training Program, Iceland 1988 to present. Part time lecturer in geothermal reservoir physics and engineering. Supervising approximately 25 students on analyzing field data, modeling and writing their final reports. Thereof are two master students who graduated from University of Iceland and two from the Renewable Energy School in Iceland. On the study board of one PhD student at University of Iceland. Student supervision involves the following countries: Costa Rica, Guatemala, El Salvador and Nicaragua in Central America; Nevis in the Caribbean; Ethiopia, Djibouti, Kenya and Rwanda in Africa; Poland, Ukraine and Kamchatka in Central and Eastern Europe; China, the Philippines and Indonesia in Asia.

Instructor on training courses on geothermal reservoir engineering and reservoir management, held for CEL in El Salvador in 1992, for IGME in Athens, Greece in the year 2000, for GESAL in El Salvador in 2002, and for the African Development Bank in Iceland in 2011.

Research assistant at Lawrence Berkeley National Laboratory during MSc studies in 1985 to 1987. Summer jobs at the Icelandic National Energy Authority in 1982 to 1985 on surface exploration work, primarily resistivity surveying.

LIST OF MOST PUBLIC DOMAIN ENGLISH PUBLICATIONS

Björnsson, Grímur, 1987: A Multi-Feedzone, Geothermal Wellbore Simulator. MS thesis at University of California, Berkeley. Lawrence Berkeley Laboratory Report no. LBL-23546, 102 p.

Björnsson, Grímur and Gudmundur S. Bodvarsson, 1990: A Survey of Geothermal Reservoir

properties. Geothermics, Vol 19, N0. 1, pp 17-27.
Björnsson, Grímur and Benedikt Steingrímsson, 1992: Fifteen Years of Temperature and Pressure Monitoring in the Svartsengi High-Temperature Geothermal Field in SW-Iceland. Geothermal Resources Council Transactions, vol 16, October 1992, pp. 627-633.
Björnsson, Grímur and Gudni Axelsson, 1994: Feasibility Study for the Thelamörk Low-Temperature System in N-Iceland. Nineteenth Workshop on Geothermal Reservoir Engineering, Stanford, California, 9 p.
Arason, Þordur and Grímur Björnsson, 1994: Icebox. A collection of useful PC programs in the field of geothermal work. United Nations University, Geothermal Training Programme, Reykjavik, Iceland.
Axelsson, Guðni, Grímur Björnsson, Ólafur G. Flóvenz, Hrefna Kristmannsdóttir and Guðrún Sverrisdóttir, 1995: Injection Experiments in low-temperature geothermal areas in Iceland. Proceedings of the World Geothermal Congress, 1995, Florence, Italy, Vol 3, pp. 1991-1996.
Björnsson, Grímur, 1997: Reservoir Modeling Integrating Isotope and Chemical data. Report on a expert mission to El Salvador, Jan. 30th to February 8th, 1997. International Atomic Energy Agency, Project ELS/8/005-03, Wienna, Austria.
Björnsson, Grímur, Guðmundur S. Bodvarsson and Ómar Sigurðsson, 1998: Status of the Development of the Numerical Model of the Krafla Geothermal System - May 1998. Orkustofnun report GrB/GSB/ÓS-98/02.
Björnsson, Grímur, 1999: Predicting Future Performance of a Shallow Steam-Zone in the Svartsengi Geothermal Field, Iceland. Proc., 24th Geothermal Workshop on Geothermal Reservoir Engineering, Stanford, California.
Finsterle, S., K. Pruess, G. Björnsson, and A. Battistelli,1999: Evaluation of geothermal well behavior using inverse modeling. Proceedings, Dynamics of Fluids in Fractured Rocks, Report LBNL-42718, Lawrence Berkeley National Laboratory, Berkeley, Calif., 152-154, February 10-12, 1999.
Björnsson G., Sigvaldi Thordarson and Benedikt Steingrímsson, 2000: Temperature Distribution and Conceptual Reservoir Model for Geothermal Fields in and around the city of Reykjavik, Iceland. Proc., 25th Geothermal Workshop on Geothermal Reservoir Engineering, Stanford, California
Olafur G. Flovenz, Ragna Karlsdottir, Kritstjan Saemundsson, Omar B. Smarason, Hjalmar Eysteinsson, Grimur Bjornsson, Magnus Olafsson and Thorsteinn Bjornsson, 2000: Geothermal Exploration in Arskogsstrond, N-Iceland. Proceedings of the World Geothermal Congress 2000.
Yiheyis Amdeberhan and Grimur Bjornsson, 2000: Well Testing and Reservoir Engineering Studies at the Tendaho Geothermal Field, Ethiopia. Proceeding of the World Geothermal Congress 2000.
Björnsson, Grímur, Ólafur G. Flóvenz, Kristjan Saemundsson and Einar M. Einarsson, 2000: Pre- and post- hydrological pressure signals associated with two large earthquakes in S-Iceland in June 2000. Poster S11B-04, presented at the year 2000 fall meeting of AGU in San Fransisco, California.
Björnsson, Grímur, Ólafur G. Flóvenz, Kristjan Saemundsson and Einar M. Einarsson, 2001: Pressure changes in Icelandic Geothermal Reservoirs Associated with Two Large Earthquakes in June 2000. Proc., 26th Geothermal Workshop on Geothermal Reservoir Engineering, Stanford, California.
Björnsson, Grímur, Olafur G. Flovenz and Kristjan Saemundsson 2001: Long and Short-term Hydro-Tectonic Events in the South-Iceland Seismic Zone, Associated with Two Large Earthquakes in June 2000. AGU 2001 Fall Meeting, San Fransisco.
Franzson Hjalti, Sigvaldi Thordarson, Grimur Bjornsson, Steinar Th. Gudlaugsson, Bjarni Richter, Gudmundur O. Fridleifsson and Sverrir Thorhallsson, 2002: Reykjanes High-

Temperature Field, SW-Iceland. Geology and Hydrothermal Alteration of Well RN-10. Proc., 27th Geothermal Workshop on Geothermal Reservoir Engineering, Stanford, California.

Björnsson, Grímur, Arnar Hjartarson, Gudmundur S. Bodvarsson and Benedikt Steingrimsson, 2003: Development of a 3-D reservoir model for the greater Hengill area in SW-Iceland. Proceedings, TOUGH symposium 2003, Lawrence Berkeley National Laboratory, Berkeley, California.

Jonsson, Sigurjon, Paul Segall, Rikke Pedersen and Grimur Bjornsson, 2003: Post-Earthquake Ground Movements Correlate to Pore-Pressure Transients. Nature, vol. 224, 179-183.

Arason Thordur, Grímur Björnsson, Guðni Axelsson, Jón Örn Bjarnason and Páll Helgason 2004: ICEBOX-Geothermal reservoir engineering software for Windows: A user's manual. Íslenskar orkurannsóknir ÍSOR-2004/014 80 s.

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Axelsson Gudni, Grímur Björnsson and Julio E. Quijano, 2005: Reliability of Lumped Parameter Modelling of Pressure Changes in Geothermal Reservoirs. Proc. Word Geothermal Congress, Antalya, Turkey.

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Franzson Hjalti, Bjarni Reyr Kristjánsson, Gunnar Gunnarsson, Grímur Björnsson, Arnar Hjartarson, Benedikt Steingrímsson, Einar Gunnlaugsson and Gestur Gíslason, 2005: The Hengill-Hellisheiði Geothermal Field. Development of a Conceptual Geothermal Model. Proc. Word Geothermal Congress, Antalya, Turkey.

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Bjornsson G., Einar Gunnlaugsson and Arnar Hjartarson, 2006: Applying The Hengill Geothermal Reservoir Model In Power Plant Decision Making And Environmental Impact Studies. Proc, Tough Symposium 2006. Lawrence Berkeley National Laboratory, Berkeley, California, May 15–17, 2006

Sarmiento Z.F., and G. Bjornsson, 2007: Reliability of Early Modeling Studies for High-Temperature Reservoirs in Iceland and the Philippines. Stanford Geothermal Workshop.

Sarmiento Z.F. and G. Bjornsson, 2007: Geothermal Resource Assessment – Volumetric Reserves Estimation and Numerical Modelling. Presented at Short Course on Geothermal Development in Central America – Resource Assessment and Environmental Management, organized by UNU-GTP and LaGeo, in San Salvador, El Salvador, 25 Nov. – 1 Dec., 2007.

Bjornsson G., 2008: Review of Generating Capacity Estimates for the Momotombo Geothermal Reservoir in Nicaragua. Geothermal Resources Council Transactions.

Gislason S.R., W. Broecker, E.H. Oelkers, E. Gunnlaugsson, A. Stefánsson, J. Matter and Grimur Björnsson, 2008: Mineral CO2 sequestration into basalt: the Hellisheidi,

Iceland project. Proceedings International Geological Congress, Oslo, 2008.
Aradottir E., E. Sonnenthal, G. Bjornsson, E. Gunnlaugsson and H. Jónsson, 2009: Development of a coupled reactive fluid flow model for mineral CO2 capture in Hellisheiði, Iceland. In: Proceedings of the 2009 TOUGH Symposium, Lawrence Berkeley Laboratory, Sept 14-16, 2009, Berkeley, USA
Porras E.A. and G. Bjornsson, 2010: The Momotombo Reservoir Performance upon 27 Years of Exploitation. World Geothermal Congress 2010.
Ketilsson J., G. Axelsson, A. Bjornsson, G. Bjornsson, B. Palsson, A.E. Sveinbjornsdottir and K. Saemundsson, 2010: Introducing the Concept of Sustainable Geothermal Utilization into Icelandic Legislation. World Geothermal Congress, 2010.
Porras E., E. Mabwa, P. Spielman, G. Bjornsson, P. Hirtz and M. Broaddus, 2010: Analysis and Interpretation of Nds Tracer Test Results at the Olkaria West Geothermal Field, Kenya. Geothermal Resources Council Annual Meeting, 2010. Warm Arctic ehf February 2015
Aradottir E., E. Sonnenthal, G. Bjornsson and H. Jonsson, 2010: Reactive transport models for mineral CO2 storage in basaltic rocks. In: Proceedings of the 2010 AGU Fall Meeting, Moscone Convention Center, Dec 13-17, San Francisco, USA
Aradottir E., E. Sonnenthal, G. Bjornsson and H. Jonsson, 2011: Reactive transport modeling of CO2 mineral sequestration in basaltic rocks. In: Proceedings of the 2011 AGU Fall Meeting, Moscone Convention Center, Dec 5-9, San Francisco, USA.
Bjornsson G. and N. Mosusu, 2011: Potential of Geothermal Energy in PNG. Proceedings Papua New Guinea Chamber of Mines and Petroleum - Seminar, Gateway Hotel, December 2nd, 2011
Drakos, P., P. Spielman and G. Björnsson, 2011: Jersey Valley Exploration and Development, GRC Transactions, Vol. 35
Björnsson G. and S. Hickman, 2011: Conceptualizing stress and permeability fields in deep roots of geothermal systems. In Deep Roots of Geothermal Systems. Workshop at Hotel Hengill, Nesjavellir, August 27th 2011 (http://georg.hi.is/node/136).
Aradóttir E., E.L. Sonnenthal, G. Björnsson and H. Jónsson, 2012: Multidimensional reactive transport modeling of CO2 mineral sequestration in basalts at the Hellisheidi geothermal field, Iceland. International Journal of Greenhouse Gas Control. Volume 9, July 2012, pp. 24–40
Aradóttir E., B. Sigfússon, E.L. Sonnenthal, G. Björnsson and H. Jónsson, 2013: Dynamics of basaltic glass dissolution – Capturing microscopic effects in continuum scale models. Geochimica et Cosmochimica Acta. Volume 121, 15 November 2013, pp. 311–327
Bjornsson G., A. Arnaldsson, and J. Akerley, 2014: A 3D Numerical Reservoir Model for Steamboat, Nevada. Geothermal Resources Council Transactions. Vol. 38.

ICELANDIC PUBLICATIONS

Author and coauthor of > 500 reports, on the various aspects regarding research, modeling and management of many Icelandic and a few overseas geothermal systems.

PROPRIETARY AND CONFIDENTIAL PUBLICATIONS

Many 3-D well-by-well numerical geothermal reservoir models for various developers and investors worldwide, mostly under the iTOUGH2 inverse platform and on large scale Linux parallel computing environment. Various documents regarding field development strategies, and how the geothermal reservoir parameters couple into business models.

CV FOR JACQUES L. VARET

Jacques L. VARET (PhD)

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Born in Lyon, France; PhD thesis, 1967, State thesis 1973, Paris-South University; First L.R.Wager Prize award for Volcanological Research from IAVCEI & Royal Society (with Franco Barberi), 1971

1966-1976: Assistant professor at Paris South University (Orsay, France) and Addis-Ababa (Ethiopia); CNRS Research Team Leader (Afar & Eastern Africa Rift); NERC project partner.

1976-1986: Head of Geothermal Dept, Director for Energy, French geological Survey (BRGM). Founding President - *Compagnie Française de Géothermie* (CFG, BRGM group).

1986-1996: Counselor for Science and Technology, French Embassy – Beijing, China; Director for Energy, Ministry of Research and Technology; Director, *Institut Français de l'Environnement*; Director for Research and Economic Affairs, Ministry of Environment Paris.

1996-2011: Director of the French Geological Survey; twice President of Eurogeosurveys; Foresight & Strategy Director BRGM; Advisor to the CEO.

2011-Present: Consultant, Geothermal Energy and Sustainable Geosciences Applications (SARL Géo2D); Advisor to the Minister of Energy, Water and Natural Resources, Djibouti; consulting and research for GEOTHERM (BGR), USAID (GeoPower Africa), AFD, EU in France, Overseas Islands, Ethiopia, Kenya, Rwanda, Tanzania, Djibouti…

Past or Present Member of the Board/President/Scientific Advisor of various entities: CTGA Italy, ALCEN, Electerre de France, CFG, ENAG, CESMAT, PNC, CPP, FFEM, asso.4D…).

Languages: French, English, Italian, German.

A list of 300 scientific references can be made available upon request

CV FOR PHILIPPE PEZARD

Philippe Pezard, CNRS, Montpellier, France

Philippe holds a Ph.D. in Borehole Geophysics from Columbia University (NY) at Lamont-Doherty Earth Observatory in 1990. He worked initially on downhole measurements from the Ocean Drilling Program (ODP) to found the French borehole geophysics group in Marseille then Montpellier (1992-), participated to 5 ODP expeditions, then became the president of ODP France (2001-2003). His expertise covers petrophysics, geophysics, both downhole and from surface (particularly electrical methods), and downhole geophysical monitoring. He has applied these methods to the study of a variety of topics including the structure of the oceanic crust and ophiolites, hydrothermal circulation and geothermal fields, seismogenic faults and landslides, geological storage of gases (such as CO2) and nuclear wastes in crystaline rocks, salt water intrusion in coastal reservoirs (both clastics and carbonates) and submarine groundwater discharge at sea. He founded in 2009 imaGeau, a start-up now owned by SAUR (France) and dedicated to the on-line and downhole monitoring of subsurface resources. He was the advisor of 18 Ph.D. and 21 Master theses and is the author of 210 scientific papers.

CV FOR OMAR SIGURDSSON

Omar Sigurdsson

Name:	Omar Sigurdsson
Profession:	Geothermal Reservoir Engineer
Date of Birth:	April 10, 1953
Name of Firm:	Independent Consultant
Years with Firm/Entity:	From 2019
Nationality:	Icelandic
Membership in Professional Associations:	○ Society of Petroleum Engineers of AIME, USA. ○ Pi Epsilon Tau, Alpha Chapter, USA ○ The Physical Society of Iceland

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Key Qualifications: Geothermal consultant, broad experience in geothermal geophysical well logging and well testing. Geothermal reservoir engineering and numerical simulations of high and low enthalpy fields. Knowledge of technical aspects of drilling.

Main projects:

Orkustofnun (NEA-ROS) and Iceland GeoSurvey (ISOR):

- Working as a geothermal consultant, supervisor, well logger and reservoir engineer in all high temperature geothermal areas in Iceland (Krafla, Nesjavellir, Hellisheiði, Svartsengi and Reykjanes).
- Working on geothermal consulting abroad for several different Icelandic and foreign firms (Djibouti, Greece, Guadeloupe (France), Hungary, USA etc.).
- Project managing of local and foreign geothermal projects, as well as tendering.
- Design, execution and interpretation of well tests in low and high enthalpy fields.
- Reservoir engineering studies and numerical simulation of low and high enthalpy geothermal fields (TOUGH2).

HS Orka former Hitaveita Sudurnesja (HS):

- Consulting, reviewing, quality controlling researches and projects in the geothermal areas that HS operates and is exploring. Site locating, targeting and planning for well drilling operations. Reservoir engineering and well testing.

Independent Consultant

Education:

1973-1977 B.Sc. in Geophysics, University of Iceland

1979-1982 M.Sc. in Petroleum Engineering, University of Oklahoma, USA.

Languages:
English excellent

Norwegian and Danish reading knowledge

Icelandic mother tongue.

Employment record:

2019- Independent consultant on reservoir engineering, stimulation, well siting, testing and more.

2008-2019 Geothermal reservoir engineer with HS Orka hf. former Hitaveita Sudurnesja, Ltd.

2003-2008 Geothermal reservoir engineer, well test engineer, geophysical well logger and project manager with Iceland GeoSurvey (ISOR).

1982-2003 Geothermal reservoir engineer, well test engineer, geophysical well logger and project manager at Orkustofnun (National Energy Authority, Iceland), GeoScience Div.

1983-2000 Lecturer in geothermal well testing and supervisor at the United Nations University Training Program in Reykjavik Iceland

1981-1982 Graduate Teaching Assistant at University of Oklahoma School of Geological and Petroleum Engineering, Norman Oklahoma, USA, in well testing and oil reservoir mechanic laboratory.

1981 Part-time assistant engineer at Lawrence Berkeley Laboratory, Berkeley, California, USA, in data preparation for the simulation of the Krafla high enthalpy field, Iceland.

1977-1978 Assistant geophysicists in the Geothermal Division at Orkustofnun, Iceland. Planning and execution of magnetic and resistivity field surveys, interpretation of hydro geological data, and participation in volcanic activity alert watch.

Publications/presentations:

Over 25 international publications as author or co-author.

Most recent:

Fridleifsson, G. O, W. Elders, R. A. Zierenberg, A. P. G. Fowler, T. B. Weisenberger, K. G. Mesfin, O. Sigurdsson, S. Nielsson, G. Einarsson, F. Oskarsson, E. A. Gudnason, H. Tulinius, K. Hokstad, G. Benoit, F. Nono, D. Loggia, F. Parat. S. B. Cichy, D. Escobedo, D. Mainprice, 2018: The Iceland Deep Drilling Project at Reykjanes: Drilling into the root zone of a black smoker analog. Journal of Volcanology and Geothermal Research, August 2018.

Parks, M., F. Sigmundsson, O. Sigurdsson, A. Hooper, S. Hreinsdottir, B. G. Ofeigsson, K. Michalczewska, 2018: Deformation due to geothermal exploitation at Reykjanes, Iceland. Journal of Volcanology and Geothermal Research, September 2018.

Sigurdsson, O., 2015: Experimenting with Deflagration for Stimulating Geothermal Wells. Proceedings World Geothermal Congress 2015, Melbourne, Australia, April 2015.

Large number of reports and short reports (Icelandic and English).