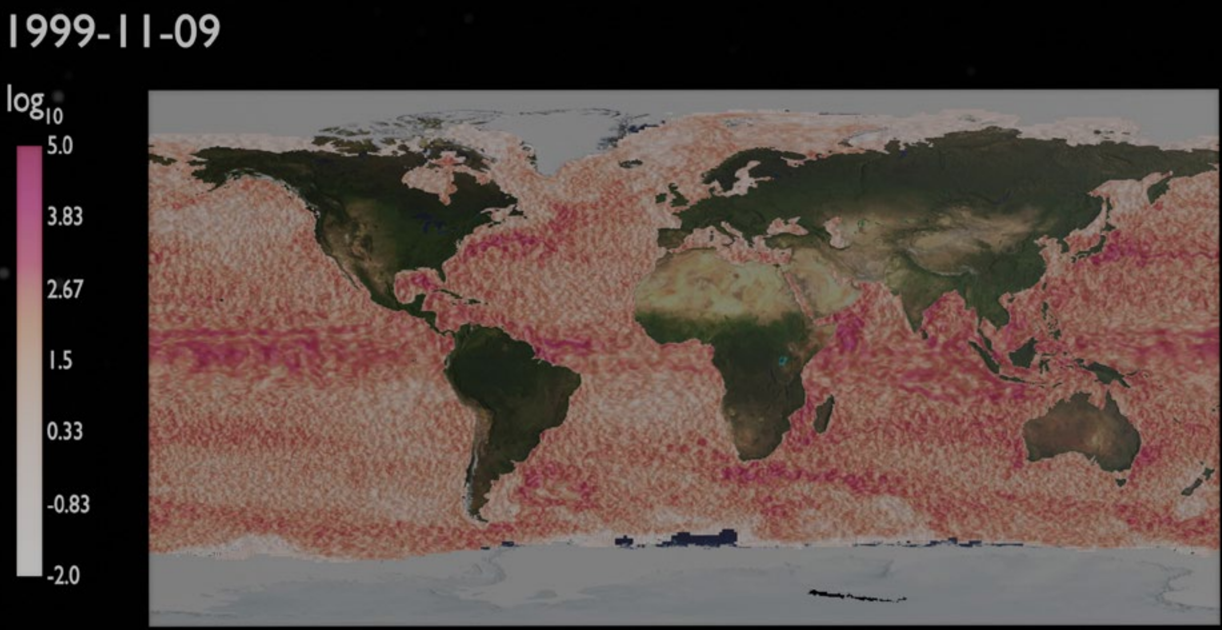


Australian National University

Annual Report 2021

ANU Research School of Earth Sciences

Contents

Cover: Animation "Global changes in oceanic mesoscale currents over the satellite altimetry record" by Josué Martínez-Moreno

From the Director

School Director
Prof. Dorrit Jacob
Research School of Earth
Sciences

Staff lists

ACADEMIC STAFF

Director	D. Jacob, Dr. rer. nat. Georg August University Germany (equivalent PhD) Diplom in Mineralogy, Johannes Gutenberg Univ, Germany (equivalent MSc)
Associate Directors	N.J. Abram, BSC Advanced (Hons) Sydney, PhD ANU
Research	S.J. Fallon, BA MS San Diego, PhD ANU
Higher Degree Research	M.J. Ellwood, BSc (Hons) PhD Otago
Education	C. Shakespeare, BSc (Hons) ANU, PhD Cambridge
Honours Masters	D.C. Heslop, BSc Durham, PhD Liverpool, Dr habil Bremen
Distinguished Professors	H.St.C. O'Neill, BA Oxford, PhD Manchester, FAA, FRS [ARC Laureate Fellow]
Professors	N.J. Abram, BSC Advanced (Hons) Sydney, PhD ANU [ARC Future Fellow]
	L.K. Armand, BSc Flinders, BSc (Hons) PhD ANU
	V.C. Bennett, BSc PhD UCLAV.C. Bennett, BSc PhD UCLA (to 02/10/2021)
	A.J. Berry, BSc (Hons) Sydney, DPhil Oxford
	J.J. Brocks, Dip Freiburg, PhD Sydney
	S.M. Eggins, BAppSci UNSW, PhD Tasmania (to 10/02/2021)
	M.J. Ellwood, BSc (Hons) PhD Otago
	S.J. Fallon, BA MS San Diego, PhD ANU A.McC. Hogg, BSc ANU, PhD UWA
	T.R. Ireland, BSc Otago, PhD ANU (to 18/03/2021)
	P.L. King, BSc (Hons) ANU, PhD Arizona State
	J.A. Mavrogenes, BS Beloit, MS Missouri-Rolla, PhD Virginia Tech
	M.S. Miller, BA Whittier, MSc Columbia, MEng Cornell, PhD ANU
	L.N. Moresi, BA (Hons) Cambridge, DPhil Oxford
	A.P. Roberts, BSc Massey, BSc (Hons) PhD DS Victoria (Wellington)
	E. Rohling, BSc, MSc, PhD Utrecht [ARC Laureate Fellow]
	M.S. Sambridge, BSc Loughborough, PhD ANU, FAA, FRAS

Professors cont.	H. Tkalčić, DipEng in Physics Zagreb, PhD UC Berkley P. Tregoning, BSurv PhD UNSW G.M. Yaxley, BSc PhD Tasmania
Associate Professors	Y. Amelin, MSc PhD Leningrad State D.R. Davies, MSci PhD Cardiff, UK [ARC Future Fellow] D.C. Heslop, BSc (Hons) Durham, PhD Liverpool, Dr habil Bremen J. Yu, BSc MSc Nanjing University, PhD Cambridge [ARC Future Fellow]
Fellows	C. Eakin, MSc Imperial College London, PhD Yale [ARC DECRA Fellow] M.A. Forster, BSc MSc PhD Monash B.N. Opdyke, AB Columbia, MS PhD Michigan (to 06/05/2021) C. Shakespeare, BSc (Hons) ANU, PhD Cambridge [ARC DECRA Fellow to 04/06/2021] A. Valentine, BA MSc Cambridge, DPhil Oxford [ARC DECRA Fellow] (to 31/01/2021)
Research Fellows	S. Allgeyer, PhD Paris Diderot, France A. Burnham, MSci MA Cambridge, PhD Imperial College London N.C. Constantinou, BSc MSc PhD Athens, Greece K. Grant, BSc Southampton, MSc JCU, PhD Southampton D. Guerer, BSc Bonn, MSc Oslo, PhD Utrecht (from 02/08/2021) B. Hejrani, BSc Kurdistan, MSc Tehran, PhD Aarhus, Denmark (to 01/07/2021) M. Hoggard, BA MSc in Natural Sciences PhD Cambridge (from 19/03/2021) C. Jiang, BS and graduate study in geology China Univ of Geosciences, PhD Macquarie A. Kiss, BSc (Hons) PhD ANU S. McKibbin, BSc (Hons) Newcastle, PhD ANU (from 16/08/2021) A. Morrison, BSc (Hons) ANU, GradDipEd Canberra, PhD ANU [ARC DECRA Fellow] J. Nunes Avila, BSc MSc UFRGS, PhD ANU (to 13/02/2021) K. Stewart, BSc (Hons), PhD ANU R. Wood, BSc (Hons) Durham, MSc DPhil Oxford

ACADEMIC STAFF CONT.

Postdoctoral Fellows

M. Anenburg, BSc MSc Ben-Gurion University of the Negev Israel, PhD ANU

R. Beucher, MSc PhD Universite Grenoble Alpes, France

C. Frigo, BSc Padova, MSc Bayerisches, PhD Innsbruck (to 20/03/2021)

S. Ghelichkhan, BSc Tehran, MSc PhD Ludwig-Maximillans-Universitat Munchen

W. Huneke, BSc MSc Kiel, PhD Tasmania

M. Kloecking, MSci (Hons) PhD Cambridge (to 01/04/2021)

V.H. Lai, BA UC Berkeley, MSc PhD California Inst of Technology

X. Ma, BSc Zhejiang University, PhD Chinese Academy of Sciences

P. Martin, A.B. with cum laude honours Harvard, PhD Michigan (from 08/02/2021)

L. Otter, BSc JGU, MSc joint JGU and MPIC, PhD Macquarie

T.S. Pham, BEng Hanoi, Postgrad Dip Intl Center for Theoretical Physics, PhD ANU

R. Pickle, BS UC at Davis, MSc Brown, PhD Auckland

S.M. Razeghi, MSc Tehran, PhD Newcastle

L. Van Maldegem, BSc Avans, MSc Leeds, PhD Bremen (to 09/11/2021)

N. Wright, BSc PhD Sydney (to 05/05/2021)

H. Yang, Bachelor Jilin Univ, Master Copenhagan, PhD Melb (from 09/12/2020)

X. Zhao, BSc Jilin University, PhD Southampton

Emeritus Academics

R.J. Arculus, BSc PhD Durham, FAIMM

V. Bennett, BSc PhD UCLA (from 02/10/2021)

I. Campbell, BSc UWA, PhD DIC London

K.S.W. Campbell, MSc PhD Qld, FAA

W. Compston, BSc PhD DSc (Hon) UWA, FAA, FRS

S.F. Cox, BSc UTas, PhD Monash

P. DeDeckker, BA MSc (Hons) Macquarie, PhD DSc Adelaide

S. Eggins, BAppSci UNSW, PhD Tasmania (from 08/02/2021)

R.A. Eggleton, BSc (Hons) Adelaide, PhD Wisconsin, DSc Adelaide

D.J. Ellis, MSc Melbourne, PhD Tasmania

Emeritus Academics cont.	N.F. Exon, BSc (Hons) UNSW, PhD Kiel
	J.D. Fitzgerald, BSc James Cook, PhD Monash
	D.H. Green, BSc MSc DSc DLitt (Hon) UTas, PhD Cambridge, FAA, FRS
	R.W. Griffiths, BSc PhD ANU, FAIP, FAA
	R. Grun, Diplo Geol, Dr.rer.nat.habil Köln, DSc ANU, FAAH
	I.N.S. Jackson, BSc Qld, PhD ANU, FAA
	B.L.N. Kennett, MA PhD ScD Cambridge, FAA, FRS
	K. Lambeck, BSurv NSW, DPhil DSc Oxford, FAA, FRS
	M.D. Norman, MSc Tennessee, PhD Rice
	H. O'Neill, BA Oxford, PhD Manchester, FAA, FRS (from 09/07/2021)
	B.J. Pillans, BSc PhD ANU, HonFRSNZ
	M. Roderick, BAppSc QUT, PGDipGIS Qld, PhD Curtin
	S.R. Taylor, BSc (Hons) MSc New Zealand, PhD Indiana, MA DSc Oxford, HonAC
	J.S. Turner, MSc Sydney, PhD Cambridge, FIP, FAIP, FAA, FRS
	I.S. Williams, BSc PhD ANU
Honorary Academics	Y. Amelin, MSc PhD Leningrad State (from 01/04/2021)
	R.A. Armstrong, BSc MSc Natal, PhD Witwatersrand
	L. Bean, BSc Sydney, DipEd, Syd Teachers College, Grad Dip PhD, ANU
	R.V. Burne, BSc Wales, DPhil Oxford
	I.H. Campbell, BSc UWA, PhD DIC London
	P.R. Cummins, BA Physics, PhD UC Berkeley
	H. Davies, BSc MSc UWA, PhD Stanford
	T. Esat, BSc Univ College London, MSc Queens Univ Canada, PhD ANU
	C.M. Fanning, BSc Adelaide
	S. Foley, BSc (Hons) Southampton, MSc Memorial Univ Newfoundland, PhD Tasmania
	M.W. Forster, Diplom Geologist (MSc equiv) PhD Macquarie
	C.B. Foster, BSc (Hons) Adelaide, PhD Qld

ACADEMIC STAFF cont.

Honorary Academics cont.	A. Gerson, PhD Strathclyde Scotland
	G.M. Gibson, BSc Edinburgh, PhD Otago
	M. Honda, MSc PhD Tokyo
	T. Ireland, BSc Otago, PhD ANU (19/03/2021)
	A. Jaques, BSc (Hons) WA, PhD Tasmania
	R.C. Kerr, BSc Qld, PhD Cambridge, FAIP
	F. Lilley, BSc (Hons) Sydney, MSc PhD Western Ontario
	W. Maher, BAppSci (Hons) MAppSci Melbourne, PhD Southampton
	G. Marino, MSc (cum laude) 'Federico II' of Naples; PhD Utrecht
	S. McClusky, BSurv PhD UNSW
	T. Mernagh, BSc (Hons) PhD Newcastle
	J. Nunes Avila, BSc MSc UFRGS, PhD ANU (from 15/02/2021)
	B. Opdyke, AB Columbia, MS PhD Michigan (from 07/05/2021)
	R.P. Rapp, BA State University of New York, PhD Rensselaer Polytechnic Institute
	A. Rosenthal, MSc Tech Univ Bergakademie Freiberg, PhD ANU
	R. Skirrow, BSc WA, Postgrad Dip Sci (Hons) Newcastle, MSc Carleton Univ, PhD ANU
	A. Valentine, BA MSc Cambridge, DPhil Oxford (from 01/02/2021)
	N. Williams, BSc (Hons) ANU, MPhil PhD Yale
	L. Wyborn, BSc (Hons) Sydney, Dip Ed UC, PhD ANU
	Y. Yang, BS Univ SciTech China, PhD Brown
Visiting Fellows	G.F. Davies, MSc Monash, PhD CalTech
	P. De Caritat De Peruzzis, PhD ANU
	L. Frankcombe, BSc (Hons) ANU, PhD Utrecht
	D. Hutchinson, PhB (Hons) ANU, PhD UNSW
	K. Jones, BSc (Hons) ANU, PhD Bristol
	A. Kimbrough, BSc Arizona, PhD ANU
	C. Klootwijk, BSc MSc PhD Utrecht
	G.J. Stanley, BS Maths Univ Waterloo, MSc Univ Victoria, PhD Oxford

PROFESSIONAL STAFF

School Manager	G.F.M. Pearson, BA, BTh, MBA, FAIM
Executive Assistant to the Director and the School Manager	S. Devi
Administration Manager	V. Riddle, Dip Leadership & Management AIM
Building and Facilities Officer	E. Ward, Cert V Frontline Management, Quest/ANU
WHS Officer	R. Edwards, Cert IV WHS TAFE NSW, BAppSci Southern Cross University, AdvDip in Aquatic Resource Management Central Qld University (to 29/09/2021)
Education Project Coordinator	A. Duncan, BResEnvSci Univ Canberra, CertBus Quest Solutions
Communications Officer	L.Medenis Grad. Certificate
Education Officer	B. Harrold, BSc ANU (to 06/05/2021)
Education Support Officer	T. Penny , BSc (Hons) Qld
Receptionist	Miriam Sadler (to 09/01/2021) Devoni Neale (from 06/04/2021)
Research Group Administrators	J. Magro A. Daley
ANZIC -IODP Manager	S. Kachovich (from 15/10/2021)
ANZIC -IODP Administrator	K. Kenney
Centre Administrator for Centre of Excellence Climate Extremes	A. Bryleva, BPublicAdmin Lomonosov Moscow State, Cert III Bus Adm CIT

PROFESSIONAL STAFF cont.

Laboratory Operations Manager	A. Latimore, BEng University of Canberra
Technical Support	C. Bryant, BSc (Hons) New England, PhD ANU (from 02/11/2021)
	B. Butler, Cert III Mechanical Engineering Sydney Institute, Cert III Engineering-Mechanical Trade (Toolmaking) (to 08/02/2021)
	D. Clark, Cert III Metal Fabrication AdvDipEng CIT
	R. Esmay, BSc (Sr Thesis) SUNY Purchase
	P. Hu, PhD ANU & Chinese Academy of Sciences
	P. Lanc, AssocDip Bus (Applied Computing) CIT
	H. Miller, AdDipMechEng CIT
	T. Redman, AssocDip(Elect Eng) CIT
	A. Rummery, Cert III CIT (x3)
	H. Sasaki, AssocDip CIT
	H. Williams, BA MAESc ANU, MForSc Western Sydney (from 11/10/2021)

Geochemical Analysis Manager	B. Knowles, BSc Wollongong
Technical Support	T. Cheng, BEng Hefei College, China, PhD USTC China
	B. Fu, BSc Chungchun, MSc Nanjing, PhD Vrije
	J. Hope, BSc James Cook
	M. Misztela, BA MA AGH Univ of Science & Technology, Poland (from 26/07/21)
	L. Rodriguez Sanz, BSc Venezuela, MEnvStudies, PhD Autonomous (Barcelona)
	U. Troitzsch, Diplom Technische Universität Darmstadt, PhD ANU
	D. Vasegh, AssocDeg Khajeh Nasireddin Toosi University of Technology (Iran)
	S. Zink, BSc Hanover, Diploma (MSc) Hanover

PROFESSIONAL STAFF cont.

Geophysical Data & Computation Manager	H.W.S. McQueen, BSc Qld, MSc York, PhD ANU
Technical Support	A. Arcidiaco, BAppSc GradDip SAInst (to 19/06/2021)
	J. Byrne, BSc (Hons) ANU, PhD Monash
	R. Erigela, BTech Jawaharlal Nehru Technological University, PGDip NIELIT-India, MScEng Swinburne
	A. Gibson, BCompSci (Hons) PhD ANU
	A. Heerdegen, BSc (Hons) Massey, PhD ANU
	P. Kaduru, (from 14/12/2021)
	G. Luton, BSurv UNSW
	S. Mousavi, BSc MSc, Tehran University, PhD Leipzig
	M. Salmon, BSc (Hons) PhD Victoria (Wellington)
	J. Tatapudi, BEng Jawaharlal Nehru Technological University, GradDip in Business Information Systems Federation University Melbourne, AdvDip Leadership & Management Mercury Institute of Victoria
Scientific Programmers	J. He, Bachelor of IT (Hons) ANU (from 20/09/2021)
	H. Hollmann, MSc Kiel, PhD Tasmania (from 01/12/2021)

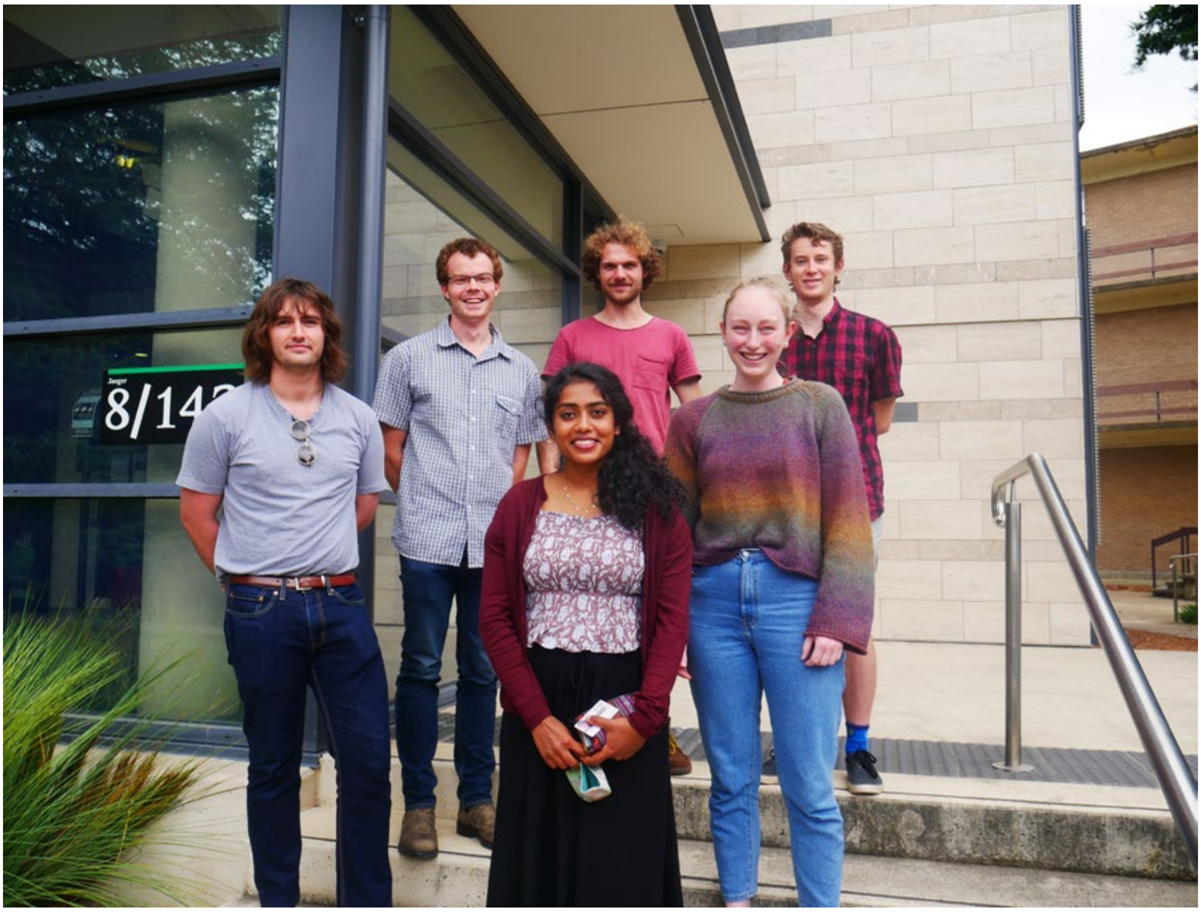
POST-GRADUATE STUDENTS

PhD Condidates

Agrawal, Shubham
Amarathunga, Udara
Baeza, Leonardo
Baile, Riley
Barnes, Ashley
Bhagtani, Dhruv
Bilton, Leon
Bishop, Caleb
Bonning, Geoffrey
Cajal Contreras, Yamila
Carrasco Godoy, Carlos
Chandler, Ross
Chen, Bei
Chen, Fangqin
Chen, Mimi
Chopping, Richard
Connolly, Clare
Costa de Lima, Thuany
Devi, Riteshma
Di, Yankun
Du, Haoran
Durgalakshmi
Duvernay, Thomas
Eggins, Sam
Fang, Bowen
Fouladi Moghaddam, Negin
Gao, Yajie
Gluchowska, Jessica (formerly Lowczak)
Goodarzi, Patrick
Gray, Sharon
Grun, Robin
Harazin, Katie
Hargreaves, Jessica
Hu, Jinyin
Huang, Zhijie
Ingles, Christopher
Jackson, Sarah
Ji, Xuan
Jiang, Shihao
Jones, Alysha
Kinsley, Jordan
Kirby, Rachel
Kou, Yingxin
Krestianinov, Evgenii
Lawler, Kelly-Anne
Liyanage, Tharika
Loidolt, Christina
Lu, Neng
Maharaj, Prayna
Makushkina, Anna
Manceau, Rose
Martin, Stacey
McConachie, Shannon
McGirr, Rebecca
Misztela, Monika
Naina
Nakrong, Nipaporn
Nash, Graeme
Nugroho, Hendro
Owens, Ryan
Pandey, Abhay
Pasic, Bozana
Patkar, Aditya
Piedrahita Velez, Victor
Qu, Tongzhang
Rama, Jemima
Ray, Srijita
Roosmawati, Nova
Ry, Rexha
Sakti, Artadi
Scheiter, Matthias
Sebastian, Nita
Sommer, Johanna
Sudholz, Zachary
Sun, Yaojia
Sweetman, James
Turunctur, Buse
Velzeboer, Nick
Wang, Sheng
Weber, Rikki
Wenham, Lana
Wilsbacher, Catherine
Wu, Jaide
Yeung, HoSonia
Zhang, Ping
Zhao, Siyuan
Zhao, Song
Zheng, Siru
Zhu, Ziyi

MPHIL & HONOURS STUDENTS

MPhil Candidates	Alvarez Rodriguez, Guadalupe
	Hsu, Shao-Chen
	Moller, Bruno



Thesis and awards

PhD theses completed (Supervisor in parentheses)

- **Bean, Lynne** "The morphological revisions of freshwater fish from Late Jurassic - Early Cretaceous sites in Australia and other Gondwanan continents leads to new phylogenetic hypotheses of relationships among stem teleosts" (Leanne Armand)
- **Crisp, Laura** "An experimental study of the trace element geochemistry of zircon, and its use as a proxy for the oxidation state and crystallisation temperature of crustal magmas" (Andrew Berry)
- **D'Andres, Joelle** "Halogens and noble gases in modern and ancient oceanic lithosphere: implications for subduction budgets and evolution of Earth's surface reservoirs" (Mark Kendrick/Victoria Bennett)
- **Ellis, Bethany** "Holocene climate and ocean variability in the Sunda Strait region of the eastern Indian Ocean" (Nerilie Abram)
- **Farmer, Nicholas** "Archives of experimental conditions in solid media apparatus: a new method of determining pressure and temperature applied to a re-evaluation of piston-cylinder techniques and the spinel to garnet phase transition" (Hugh O'Neill)
- **Gai, Congcong** "Paleomagnetic and rock magnetic study of North Pacific Ocean and South China Sea sediments" (Andrew Roberts)

- **Haynes, Marcus** “A Bayesian reappraisal of Australian crustal heat flow and temperature” (Malcolm Sambridge)
- **Hayward, Kathryn** “Evolution of asperity contacts during shear failure on frictional interfaces: implications for the initiation of crustal earthquakes” (Stephen Cox)
- **James, Hannah** “Adventures in archaeological science: an exploration of oxygen and strontium isotopic variability on a micro-to macro-scale” (Ian Williams)
- **Li, Yuwei** “Imaging the D’’ structure using waveform modelling” (Meghan Miller)
- **Loiselle, Liane** “Stable isotope systematics of the Martian regolith” (Trevor Ireland)
- **Martinez Moreno**, Josue “Global changes in mesoscale currents and coherent eddies from satellite altimetry” (Andy Hogg)
- **Matthews, Christopher** “Methods for tracking material properties within an unstructured, adaptive mesh computational modelling framework, with application to simulating the development of seismic anisotropy at spreading centres and transform faults (Rhodri Davies)
- **Ogunsami, Abdulwaheed** “Fluid-mediated seismic properties of some reservoir rocks and analogues” (Caroline Eakin)
- **O’Neill, Cameron** “Determining the causes of atmospheric CO2 changes during the last glacial-interglacial cycle: a model-data study” (Steve Eggins)
- **Qian, Yao** “Environmental magnetism of eastern Mediterranean sediments and aeolian dust flux changes over orbital timescales” (Andrew Roberts)
- **Stephenson, Joanne** “Cylindrical anisotropy of Earth’s inner core re-examined through robust parameter search” (Hrvoje Tkalcic)
- **Vinnichenko, Galina** (A biomarker and isotope study of Paleoproterozoic ecosystems in the northern Australian McArthur Basin” (Jochen Brocks)
- **Ward, Josephine** “Redox controlled trace element attenuation in pyrite: observations from natural and experimental studies” (John Mavrogenes)
- **Wu, Yang** “Geochemical records from porites corals: ocean circulation, pollution, and climate” (Stewart Fallon)

Honours Awards

DA Brown Travel Fellowship	Not awarded due to COVID-19 travel restrictions
Mervyn & Katalin Paterson Fellowship	Not awarded due to COVID-19 travel restrictions
Robert Hill Memorial Prize	TBA
Sue Kesson Experimental Petrology Student Travel Grant	Not awarded due to COVID-19 travel restrictions

Undergraduate and postgraduate courses

Earth & Marine Science Programme

Semester 1	Course description	Convenor, Teaching staff	No. of Students
EMSC1006/6107	Blue Planet	J. Mavrogenes, S. Eggins, M. Ellwood	191
EMSC2022	Introduction to Global Geophysics	M. Miller, D. Heslop, L. Moresi	20
EMSC2023	Fundamentals of Geology	G. Yaxley, A. Roberts	30
EMSC3020/6019	Geobiology & Evolution of Life on Earth	J. Brocks, L. van Maldegem	44
EMSC3023/6023	Marine Biogeochemistry	M. Ellwood, S. Fallon	24
EMSC3024/6024	Magmatism & Metamorphism	A. Berry, A. Bernham, G.Yaxley	16
EMSC3032/6032	Melting Polar Ice Sheets	P. Tregoning	11
EMSC3033	Applied Geophysics	D. Heslop, S. Allgeyer, M. Miller	9
EMSC4017/8017	Research Methods and Proposal	A. Roberts, P. Tregoning	11
EMSC4122	Analytical Techniques	G. Yaxley, S. Fallon	7
EMSC4033/8033	Computational Geosciences: Problem-solving, Logical Thinking and Programming.	L. Moresi, N. Constantinou	9
EMSC4706/8706	Natural Hazards	P. Cummins	9
EMSC8032	Research Proposal & Presentation	D. Heslop	5
EMSC2024/6124	Natural Hazards	P. Cummins	18
EMSC8032	Research Proposal & Presentation	D. Heslop	5

Semester 2			
EMSC1008/6008	Earth	A. Berry, C. Eakin	71
EMSC2024/6124	Geochemistry	J. Brocks, P. King, D. Jacob	30
EMSC2021/6021	Climate System Science	C. Shakespeare, A. Hogg, A. Morrison	53
EMSC3002/6030	Structural Geology & Tectonics	L. Moresi, Chengxin Jiang	8
EMSC3007/6007	Economic Geology	J. Mavrogenes	7
EMSC3022/6022	Planetary Science	P. King	40
EMSC3025/6025	Groundwater	P. Tregoning	19
EMSC3027/6027	Palaeoclimatology & Climate Change	E. Rohling, K. Grant, J. Yu,	10
EMSC4017/8017	Research Methods and Proposal	H. Tkalcic, W. Huneke	11
EMSC4123/8023	Data Analysis	M. Sambridge	12
EMSC8032	Research Proposal & Presentation	D. Heslop	5
Summer			
SCNC2022	Field Geology	J. Mavrogenes, B. Opdyke, G. Yaxley	12
SCNC3022	Field Geology	J. Mavrogenes, B. Opdyke,	8
EMSC3019/6119	Coral Reef Field Studies	S. Fallon,	22
New Columbo Plan			
EMSC3050	NCP Field trip (Japan)	D. Heslop	10
Special topic			
EMSC3050	Research project (6 units)	R. Dey, C. Shakespeare, A. Roberts, P. King, B. Opdyke, M. Miller, D. Hutchinson, M. Ellwood, R. Wood, M. Foster, J. Mavrogenes, H. Tkalcic, S. Fallon	18

Physics Programme (Research School of Physics & Engineering)

PHYS2201	Classical Mechanics	A. Hogg	74
PHYS3070	Physics of the Earth	H.Tkalčić, L. Moresi	6
PHYS3202	Fluids & Plasma	A. Hogg, K. Stewart	6

Environmental Science Programme (Fenner School of Environment & Society)

ENVS3013	Climate Change: past, present and future	N. Abram, A. Morrison	45

Mt Isa field trip

Blue Planet, Snowy Mountains

Lord Howe Island field trip

Eden, NSW mapping field trip

Field Geology field trip

Climate Oceans and Geoscience

Group leader Prof. Andy hogg

Academic members

Prof. Nerilie Abram	Dr David Heslop	Dr. Mahdiyeh Razeghi
Dr Sebastien Allgeyer	Dr Wilma Huneke	Prof. Andrew P Roberts
Prof. Leanne Armand	Dr Andrew Kiss	Prof. Eelco Rohling
Dr Pamela Barrett	Dr Jia Liu	Dr Callum Shakespeare
Dr Navid Constantinou	Dr Simon McClusky	Dr Kial Stewart
Prof. Stephen Eggins	Dr Herb McQueen	Prof. Paul Tregoning
Prof. Michael Ellwood	Dr Adele Morrison	Dr Rachel Wood
Prof. Stewart Fallon	Dr Bradley Opdyke	Dr Nicky Wright
Dr Katharine Grant	Emeritus Prof. Brad Pillans	Prof. Jimin Yu
Emeritus Prof. Ross Griffiths	Dr Anthony Purcell	Dr Xiang Zhao

Paleoenvironments

In research led by Prof. Nerilie Abram, a team of climate and fire experts investigated the multiple ways in which human-caused climate change contributed to Australia's Black Summer disaster. They found that Black Summer fires were unprecedented in their scale and power, as well as the number of fires that transitioned into extreme pyrocumulonimbus events -- extremely dangerous fires that generate their own thunderstorms. Long-term climate warming and declines in cool season rainfall, as well as climate change-driven changes in the behaviour of natural variability, all played a role in the exceptionally hot and dry conditions that led to the fire disaster. Changes in other important contributors to fire risk, such as the passage of strong cold fronts, are less certain both in observations and future climate change projects. These combined climate change impacts on fire risk mean that bushfires are expected to rapidly become even more severe in southeast Australia. The study concluded that improving the methods used to adapt to the now inevitable increase in fire risk here in Australia, while also pursuing urgent global climate change mitigation efforts, was the best strategy for limiting further increases in fire risk. The review article was published in Communications Earth and Environment (https://www.nature.com/articles/s43247-020-00065-8).

Research led by Katharine Grant presented the first continuous, astronomically dated records of 'Green Sahara Periods' and Mediterranean sapropel deposition back to 5.2 million years ago. Previously, detailed records typically only extended over a few glacial cycles at most (back to ~300,000 years ago). We generated multiple palaeoclimate proxy records (e.g. Saharan dust, riverine inputs) from Eastern Mediterranean sediments, and these revealed a dramatic shift in terrigenous inputs and sapropel development 3.2 Myr ago, when large ice sheets expanded over the Northern Hemisphere. Our records 1) imply that there was a major change in North African arid:humid variability then, and 2) provide much-needed longterm climatic context for understanding hominin evolution and migrations out of Africa (The article was published in Communications Earth and Environment https://www.nature.com/articles/s43247-021-00339-9).

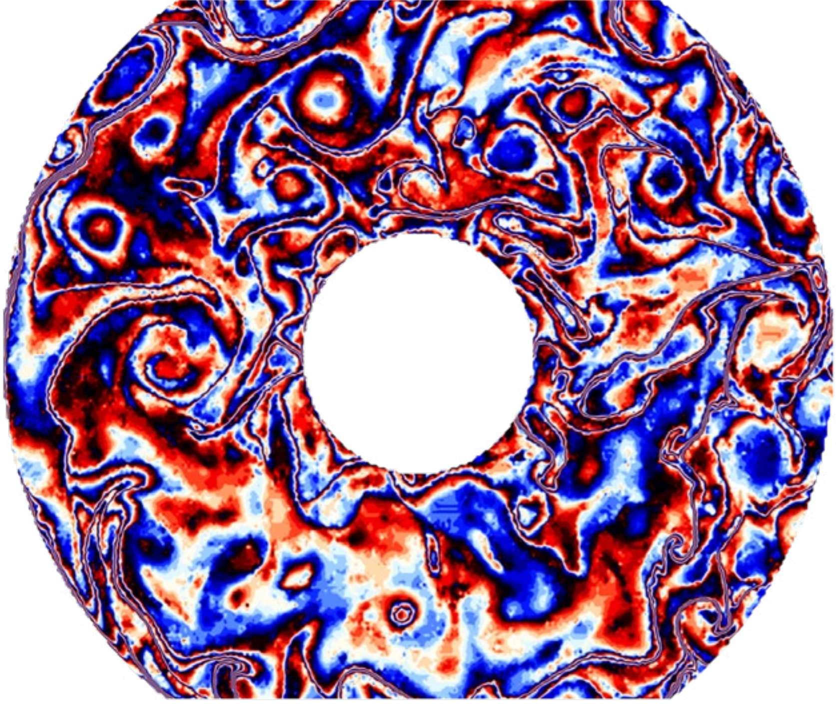


Figure 1: The surface temperature gradient of the complex eddying flow generated by thermal and tidal forcing in the Large Rotating Annulus Facility in the GFD Laboratory.

Climate and Fluid Physics

2021 was a big year in the Geophysical Fluid Dynamics (GFD) Laboratory with new and continuing experiments spanning diverse topics including melting polar glaciers, sea ice formation, internal wave-eddy interactions, and changes to evaporation with climate change. Students Jim Sweetman (PhD) and Will Palm (Hons.) commenced projects: Jim is investigating how ocean stratification and ice slope affect the ablation rate of marine-terminating Antarctic glaciers, while Will is examining how the salinity and temperature of seawater affects the composition of sea ice. Research Fellow Kial Stewart began new experiments on our Large Rotating Annulus (pictured), exploring the role of internal waves generated by tides in enhancing the ocean's eddy field. We also completed construction of a novel temperature and humidity-controlled wind tunnel. Emeritus Prof. Mike Roderick led experiments using this apparatus to investigate changes to water surface temperatures under increasing longwave (climate) radiative forcing. One surprising result is that under certain conditions, increasing longwave can lead to a cooling of the ocean surface!

2021 also saw the establishment of new funding for the Consortium of Ocean Sea Ice Modelling in Australia (COSIMA) which is hosted by RSES. This program is responsible for the development of Australia's high-resolution ocean model, ACCESS-OM2 (see Figure 2). This model is a key research tool for the group, and also feeds into the development of national ocean forecasting tools.

The role played by ocean circulation in the low frequency (e.g. decadal) variability of climate is a key unresolved question. Research led by Navid Constantinou set out to ask whether the ocean's intrinsic dynamics alone lead to large-scale patterns of upper-ocean heat flux that vary at decadal time scales? Output from ACCESS-OM2 at several different resolutions was used to answer this question. It was found that higher resolution models produce more variance of upper-ocean heat content at decadal time scales, with very different spatial patterns that vary at longer timescales. Through this process,small-scale processes create upper-ocean heat content patterns that vary at time scales that seem to match those of the various climate modes of variability (El Nino, Interdecadal Pacific Oscillation, North Atlantic Oscillation, etc). This raises the follow-up question: could ocean eddies somehow be responsible for triggering these climate modes of variability? (Constantinou & Hogg, 2021).

Marine Biogeochemistry

The marine biogeochemistry group at RSES had a dynamic year under challenging times with Covid19. The group continues to focus on its research strengths to answer key research problems in marine science, e.g. What is the role of the oceans in regulating global climate? How do changes in the bioavailability of trace metals shape the microbial community in the ocean? Specific projects being undertaken include:

• Culturing Southern Ocean phytoplankton species under multiple stressors to understand future responses to a changing climate

• Determining pH and alkalinity variations with the aim of constraining net photosynthesis, respiration, calcification and dissolution rates on the algal ridge at One Tree Island

• Understanding iron cycling in Southern Ocean waters.

In early 2020, 3 group members were involved in a 40-day Southern Ocean voyage aimed at understanding carbon export to the twilight zone. The group continued to publish high impacting papers with notable additions in Earth Planetary Science Letters, Limnology and Oceanography Letters and Global Biogeochemical Cycles. The group was also successful in gaining ARC Discovery funding to support their ongoing work.

The radiocarbon group published papers on a diverse group of projects. These ranged from collaborative projects on the archaeology and palaeontology of Cloggs Cave on Gunaikurnai Country to Scottish medical practices, and from the development of methods to radiocarbon date tooth enamel to an assessment of methods to establish sea-surface temperature. Stewart Fallon participated in a major review of the radiocarbon dating method in Nature Reviews Methods Primers.

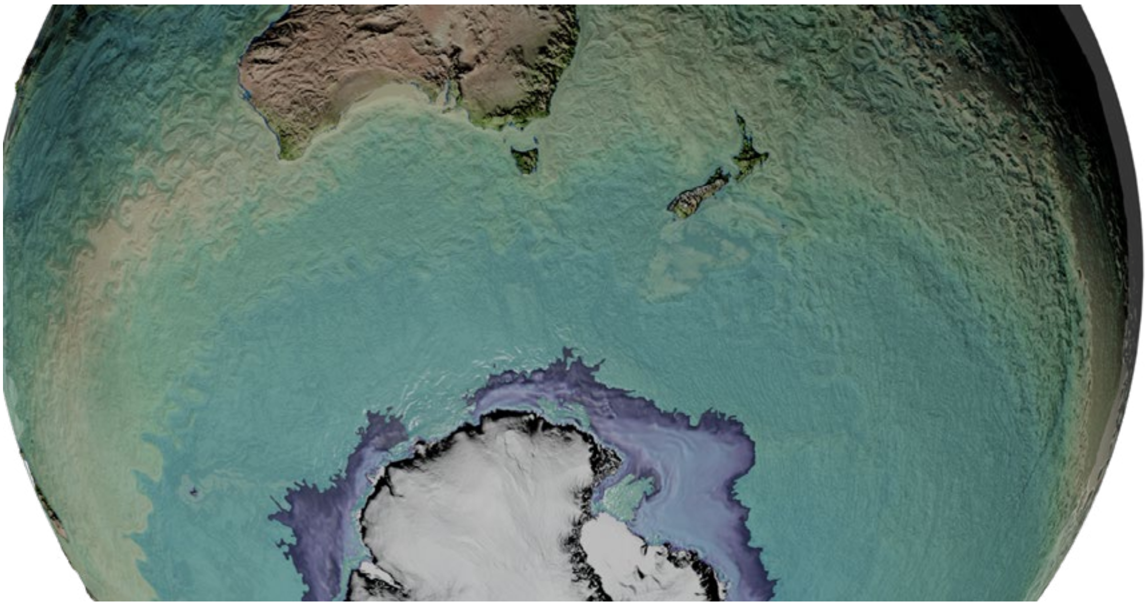


Figure 2: Sea ice and salinity variation in the ACCESS-OM2-01 global ocean-sea ice model.

Environmental Geodesy

TBC

CLEX Annual group dinner

Staff news

Georgy Falster started as a postdoc in the Paleoenvironments group in December 2021.

Nicky Wright finished her postdoctoral research position in 2021 and has moved to a postdoc position with the University of Sydney.

Paige Martin joined the Climate & Fluid Physics group on a short-term contract.

Student news

Josué Martinéz Moreno graduated from his PhD.

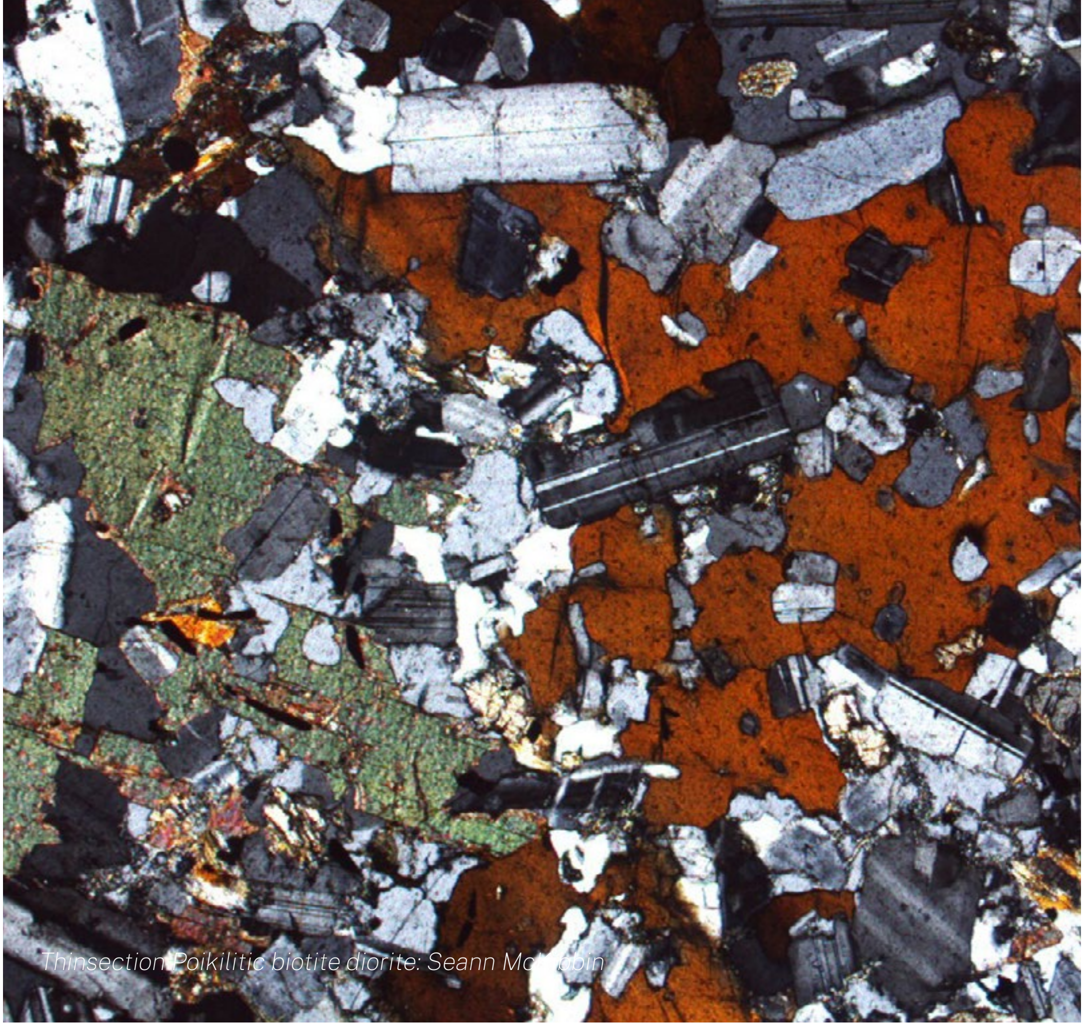
Yang Wu graduated from his PhD.

Anton Steketee, Chenhui Wang and Hana Camellia completed their masters research projects (Masters of Environment (Advanced))

Emeritus, Honorary staff and visitors

Prof Ross Griffiths, Prof Michael Roderick and Dr Ross Kerr remain as active Emeritus members of the Climate & Fluid Physics group.

Dr Claire Carouge remains as a long-term visitor from UNSW, heading the Computational Modelling Support team for the ARC Centre of Excellence for Climate Extremes. Dr Leela Frankcombe, Dr Geoff Stanley and Dr David Hutchinson also contributed as long-term visitors.



Thinsection Poikilitic biotite diorite: Seann McKibbin

Geochemistry

Group leader Prof. Greg Yaxley

Academic members

Assoc. Prof. Yuri Amelin

Dr Michael Anenburg

Emieritus Prof. Richard Arculus

Prof. Vickie C. Bennett

Prof. Andrew Berry

Prof. Jochen J. Brocks

Dr Antony Burnham

Emieritus Prof. Ian Campbell

Dr Marnie Forster

Prof. David Green

Dr Masahiko Honda

Prof. Trevor Ireland

Prof. Dorrit Jacob

Prof. Penelope King

Prof. John Mavrogenes

Dr Seann McKibbin

Dr Laura M. Otter

Dr Zachary Sudholz

Dr Lennart van Maldegem

Emeritus Prof. Ian Williams

Emeritus Prof. Lesley Wyborn

The Geochemistry Research Area at RSES undertakes diverse, fundamental research to understand the evolution of Earth, its resources, and its life. It comprises several research groups encompassing Experimental Petrology, High Temperature Geochemistry, Geobiology, Argon Geochronology, Structure and Tectonics and Biomineralization. Current academic staff are Prof.s Greg Yaxley (Head of Geochemistry Research Area, Experimental Petrology), Andrew Berry (Group Leader of Experimental Petrology), John Mavrogenes (Experimental Petrology), Penny King (Earth Systems Geochemistry), Vickie Bennett (Earth Systems Geochemistry), Jochen Brocks (Geobiology), Associate Prof. Marnie Forster (Argon, Structure and Tectonics) and Prof. Dorrit Jacob (Biomineralization). This year we sadly farewelled Prof.s Hugh O'Neill, Trevor Ireland and Associate Prof. Yuri Amelin from our staff, as a result of the ANU change plan implemented during 2020. Despite these setbacks, there were many highlights and achievements during 2021.

Experimental Petrology

We continued to develop a strategic research program in critical metals, the ore deposits that host them and the development of novel technologies for the metallurgical extraction of the rare earth elements from ore. We are collaborating with industry, state geological surveys, Geoscience Australia and other Universities, as well as colleagues in other research groups and areas at RSES, in this broad research program. We hold several ARC Discovery and Linkage grants to fund the research.

In the laboratory, we maintained and operated five 1 atm gas-mixing furnaces, 11 piston cylinders (4 of which are fully automated for both pressure and temperature), and a multi-anvil. We also have access to a LA-ICPMS at RSES and to a JEOL JXA-8530F Field Emission Gun Probe in the ANU Centre for Advanced Microscopy. We are regular awardees of synchrotron beamtime at the Australian Synchrotron (AS) and Advanced Photon Source (USA).

Greg Yaxley and Michael Anenburg, along with former RSES PhD student Suzette Timmerman coordinated and authored a series of papers in a thematic issue of Elements Magazine on Carbonatites which was published in October.

The group benefited from the contributions of Richard Arculus (Emeritus), Lynton Jaques and Terry Mernagh (Honorary staff members) and Andrea Gerson (Adjunct Prof.).

Shadow Resources Minister, Madeline King and MP Alicia Payne visit RSES

Geobiology Group

Clinton Foster published a paper in Science about the discovery of the oldest traces of land plants, and wrote an accompanying article for the Conversation.

The biomarker group had two back to back papers in Nature Ecology and Evolution about so called 'sponge biomarkers' - showing that these molecules are not the oldest evidence for animals in the geological record but formed in bottom sediments through abiogenic alteration of sterol from green algae. The results have massive impact on the timeline of animal evolution and our understanding of the ecology of Ediacaran and early Palaezoic oceans.

PhD student Tharika won the ANU Three-minute Thesis and went on to become runner up at the Asia Pacific finals ANSWERING THE QUESTION: who made cheilanthanes?

We sadly farewelled Lennart van Maldegem, who concluded his postdoc and Galina Vinnichenko, who completed her PhD.

Tharika Liyanage

Earth Systems Chemistry

Em. Prof. Ian Williams took over the day-to-day running of the SHRIMP lab; Penny King and Sonja Zink were seconded to help with its management for 2021; and Ulrike Troitzsch helped with the Scanning Electron Microscope in 2021. Seventeen different researchers from RSES, other universities and several companies accessed the laboratory and new projects were encouraged via "SHRIMP on Us Awards" sponsored by the School. The labs ran successfully for ~200+ days, which is impressive given lockdowns and maintenance. Expert trouble-shooting was carried out by Ian Williams, Sonja Zink and Peter Lanc to fix inevitable equipment failures typical of all ion probe laboratories (pumps, chiller, plus electrical and mechanical maintenance). The web site and booking systems were given an overhaul.

Photo left: Ian Williams ran a hands-on 4-day training course for students and staff interested in running the SHRIMP.

The SHRIMP lab became involved in the AuScope Geochemical Network through an AuScope Opportunity Grant (King and Williams) that includes data delivery and upgrades to the SHRIMP-II multi-collector. This will enable light isotope detection (e.g., B-, Be-, Li-, C-, S-, Ca , Mg-, and Si-isotopes) which comprises an important tool for research in critical minerals, archaeology, volcanology, climate science, biogeoscience/ medicine, and deep Earth geochemistry.

We celebrated Sonja Zink's promotion to ANU07 level.

We sadly farewelled a long time postdoctoral fellow and past PhD student, Dr. Janaina Avila, who started a new job in Queensland.

SPEC-E

The SPEC-E (Spectroscopy, Experiments and Characterisation of Earth Materials) Laboratory group continued work relevant to space science (exploring the asteroid belt, planets, exoplanets and meteorites; Riley Baile, Rachel Kirby and Sarah McIntyre – HDR students), climate science (carbon sequestration: Emily Robson – Special Topics student), and natural hazards/volcanology (volatiles in volcanoes: Mady Hall – Summer Scholar). A highlight of 2021 was field work collecting infrared spectra on the Sydney Harbour Bridge granite pylons. The data is being used for conservation efforts of the 90 year old bridge as part of a Linkage Grant in the Research School of Physics with University of Canberra and Transport NSW.

We received ARC funding for a new ultra-fast mapping infrared microscope and SHRIMP upgrades (King, Jacob, Mavrogenes, Williams, Wood, Macquarie University, Griffith University, CSIRO and Geoscience Australia). The new equipment and funds for staff should reinvigorate the lab in 2022. The infrared and X-ray diffraction laboratories are moving to a new location with Dorrit Jacob's photo-induced force microscopy (PIFM).

Penny King ran a 1-day training course on infrared spectroscopy that was attended by people from across ANU. She served on awards committees for the Mineralogical Society of America, American Geophysical Union and was a member of the Planetary Science Working Group for the Australian Academy of Sciences, Space Sciences Review.

Prof Vickie Bennett served as President of the Geochemical Society (first Australian scientist elected to this international leadership position). She presented the presidential plenary "Deep Time, Deep Earth: Revealing Earth's early history" at the 2021 Goldschmidt Conference.

Prof. Bennett was also was also co-organiser of the Geochemical Society-European Association of Geochemistry Town Hall: Covid-19 Impacts on Geochemistry: What's next? (Sept. 15, 2021) which explored the diverse impacts the pandemic has had on the geochemistry community and possible ways of mitigation, particularly for early career researchers. She was also invited to join the advisory Board of the Journal of Petrology.

Dr. Bin Fu worked on both U-Pb geochronology, trace element and isotope geochemistry of igneous and metamorphic rocks and ore deposits from China and India using ion microprobe (SHRIMP) and LA-(MC)-ICPMS. We are pleased that Bin was promoted to ANU07.

Dr. George Gibson, Honorary Associate Prof. continued collaborations with group members on mineralization processes in northern Australia.

Dr. Marc Norman, ANU Emeritus Fellow, continued independent research activities and collaborations with group members on ore deposit geochronology, granite genesis, and planetary science.

Dr. Lesley Wyborn, Honorary Associate Prof., continued her leadership of F.A.I.R data principles in application to geoscience data.

Argon, Structure and Tectonics

Marnie Forster lead the National Argon Map (NAM), project, which is successfully collaborating with 9 Australian universities, all the State Geological Surveys (6), Geoscience Australia, AngloGold Ashanti and Mt Isa Mines Glencore. NAM has a spatial representation of 40Ar/39Ar geochronology data from diverse areas across Australian, highlighting the capability of this geochronometer across different geological settings. NAM is an AuScope project. http://argon.anu.edu.au/NAM.php.

The group was also heavily involved in MinEx CRC Phase One, which was completed Dec 2021 with Ar/Ar research on the National Drilling Initiative (NDI) program in the Mt Isa and East Tennant region. Research was also undertaken on large-scale crustal movement zones in WA, mineralisation zones in NSW e.g. Cobar Basin, alteration zones in the Olympic Dam region and Gawler regions in SA. Weekly Ar/Ar tutorials are given to participants involved in the MinEx CRC. Associate Prof. Forster has been accepted into MinEx Phase 2 for the next three years.

AuScope

Australian National University

RSES School Director and Geochemist Professor Dorrit Jacob and based biologist Professor Barry Pogson have been elected fellows of the Australian Academy of Science. Picture: Dion

Awards

A number of Geochemistry staff, post-doctoral fellows and students won awards and fellowships during 2021. Prof. Dorrit Jacob was awarded a fellow of the Australian Academy of Science, Dr Antony Burnham received the Minerals Young Investigator Award, Dr Michael Anenburg received the Lindgren Award of the Society of Economic Geologists and Prof Greg Yaxley was made a Fellow of the Geological Society of Australia. Liam Johnston won a Geoscience Australia MSc scholarships to undertake a joint GA/RSES biomarker project. Dr Lesley Wyborn (Honorary Prof.) was the recipient of the prestigious Grahame Sands Memorial Award from the Australian Society of Exploration Geophysicists. She was a panellist on an AGU Town Hall on the topic of “Reciprocity in AGU: The Beginnings of an Indigenous Action Committee”.

Ross Taylor Memorial

The memorial celebrating Ross Taylor’s life and science was held on Friday 2nd of July. afternoon. It was well attended with over 130 guests. The memorial was live streamed and included a series of tribute videos from Brian Schmidt, Christian Koeberl, Horton Newsom, David Whitford and most of his PHD students: Scott McLennan, Roberta Rudnick, Jeff Taylor and Marc Norman (Live).

Geophysics

Group leader Prof. Hrvoje Tkalčić

Academic members

Prof. Steve Cox
Prof. Phil Cummins
Ass. Prof. Rhodri Davies
Dr Caroline M. Eakin
Dr Sia Ghelichkhan
Dr Babak Hejrani
Dr Mark Hoggard
Prof. Ian Jackson
Dr Chengxin Jiang
Dr Voon Hui Lai
Dr Xiaolong Ma
Prof. Meghan S. Miller
Prof., ARC Future Fellow
Prof. Louis Moresi
Dr Thanh-Son Pham
Dr Robert Pickle
Prof. Malcolm Sambridge

Geophysics area researchers were highly productive, publishing more than 40 papers in leading peer-reviewed international journals during 2021. The research spanned everything from Earth's crust to the innermost inner core, earthquake sources, hazards, heterogeneity and anisotropy, observational and theoretical seismology, arrays, ocean-bottom seismometers and distributed acoustic sensing, geophysical inference, geodynamical modelling across multiple scales, from regional scale analyses of groundwater in artesian basis, through intermediate-scale simulations of subduction, to global simulations of mantle dynamics. The research touched on the anelasticity and attenuation, anisotropy, cryosphere, volcanoes, oceans, and Mars. To offer a flavour of these studies, here are several highlights.

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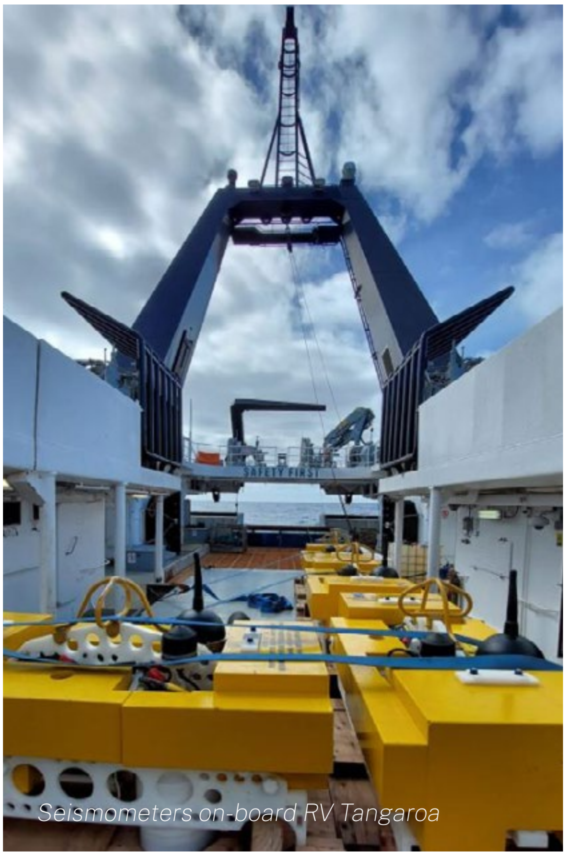
A new study demonstrated that Australia's rich geological history is expressed as variations in lithospheric seismic anisotropy generated by past tectonic deformation and preserved over billions of years (Commun. Earth Environ., Eakin). Integration of new seismic images beneath the Banda arc with river terrace inferred uplift, geochemical analyses of volcanic rocks suggested that the tectonic evolution of this region is defined by the inherited structure of the Gondwana rifted continental margin of the incoming plate (Geology, Miller). Editor-highlighted in EOS, a new RSES-pioneered correlation wavefield study revealed shear-wave anisotropy in the inner core (J. Geophys. Res., Wang & Tkalčić). Bayesian inference methods developed at RSES in the last decade revealed, for the first time, an internal structure of ultra-low velocity zones in the lowermost mantle (Nature. Geosc., Pachhai et al.). Further to that, the application of Sparsity promoting solutions to Earth imaging, and the application to Generative models and Optimal Transport to inverse problems, were advanced and submitted for multiple publications.

Geodynamics studies spanned subduction dynamics, the mechanisms underpinning intra-plate volcanism, dynamic topography, regional and global sea-level controls, deep mantle structure and composition, glacial isostatic adjustment, and links between lithospheric structure and lithospheric structure sediment-hosted metal deposits. Numerical modelling of basins considered the basin structure surfaces and lithology and created a mesh and material field that described the distribution of permeability and thermal properties everywhere in the basin. These geodynamical applications were underpinned by substantial theoretical and algorithmic advances.

The onset of high-temperature anelasticity in polycrystalline olivine, responsible for seismic wave attenuation in the Earth's upper mantle, was better constrained through a laboratory study employing stainless-steel rather than the usual mild-steel jacket material. For this purpose, stainless-steel rather than the usual mild-steel jacket material. For this purpose, stainless steel itself was first carefully characterised (Mat. Today Commun., Qu and Jackson).

Emeritus Prof. Brian Kennett published a new book co-authored with Andreas Fichtner, a former RSES geophysics affiliate, in January 2021. A memoir concerning the life and work of the late Prof. Mervyn Paterson, prepared by Emeritus Prof. Ian Jackson, was accepted for publication in Historical Records of Australian Science.



Seismometers on-board RV Tangaroa

This year's notable achievements of the Geophysics area members include fieldwork and proliferation of seismic receivers of different kinds, including land, ocean-bottom seismometers, and distributed acoustic sensing. We accomplished the second stage of the Macquarie Ridge Complex (MRC) project in the Southern Ocean, supported by ARC, CSIRO and NERC, exceeding 10M $AU in value. Tkalčić and Eakin led the RV Tangaroa voyage in October/November from on-shore, with the technical support of Pickle and Latimore. 15 ocean-bottom seismometers were recovered, and a significant portion of the MRC mapping was completed. The project aims to investigate the subsurface of the MRC, large earthquakes and underwater landslides occurring in that region; it is led by RSES/ANU and joined by UTAS, Caltech and Cambridge. The recovery of the missing 10 OBS instruments is being planned.

Led by Miller, the ANU very first Distributed Acoustic Sensing (DAS) experiment for dedicated passive seismic imaging was conducted at NASA's Deep Space Network in mid-2021, which recorded the Jindabyne earthquake and about a month worth of data. This was followed by the second DAS experiment in mid-December that is ongoing in Melbourne using dark fibre between RMIT and Monash. Also led by Miller, twenty-five broadband seismometers continue to operate in south-western WA as part of the ARC Linkage Project with GSWA and GA, which have recorded a series of earthquake swarms across the wheatbelt region of WA.


Meghan Miller and Voon Hui Lai, installing nodes and testing the DAS deployment.

Led by Eakin, the Lake Eyre Basin Seismic Array continued operating for another year, with a service run completed in October by our collaborators at the Geological Survey of South Australia in light of state border restrictions. Led by Tkalčić and Waszek, now at JCU, the 16-element spiral array is still operating in Warramunga, NT. Geophysics continues to operate Warramunga on behalf of the United Nations and the Australian Government. The year 2021 passed without major fire-or flood-related incidents, and we welcomed a new technical officer, Paul-Hyde Kaduru. He replaced Rajesh Erigela, who joined our team in Canberra.

In Mathematical geophysics, this year saw the continued development of InLab, the Inference Lab, established with the assistance of the CSIRO Future Science Platform for Deep Earth Imaging. Led by Sambridge, a major project of InLab that got underway was the Common Framework for Inversion (CoFI). This software platform aims to seamlessly connect data, forward models, inversion tools, hardware and software, servers for research and education.

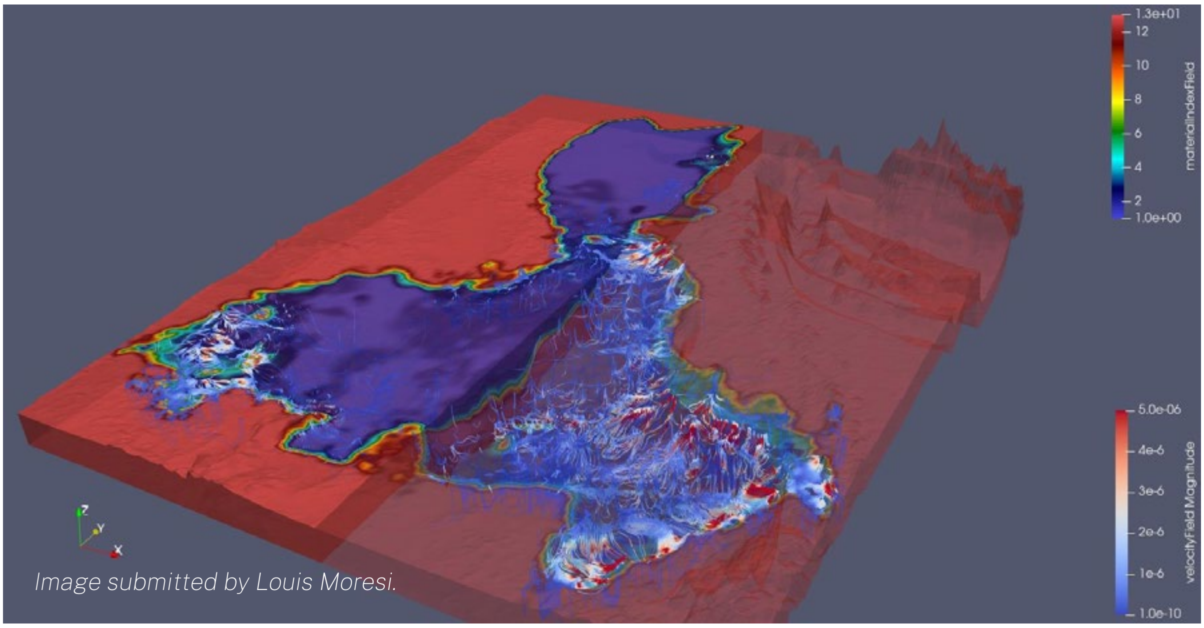


Image submitted by Louis Moresi.

Among the most productive projects led by Moresi last year was the Geoscience Australia sponsored groundwater forward and inverse modelling project on applications of the software package Underworld to groundwater flow in the Great Artesian Basin (GAB). Australian Research Data Commons grant G-Adopt (Geodynamic Adjoint Optimization PlaTform) led by Davies will develop and support a computational platform for inverse geodynamics, which will enable robust reconstruction of the history of mantle convection.

Geophysics area researchers went to the field, kept the instruments running, opened new research frontiers, and provided educational and countless other services at many levels. Apart from research excellence, we increased our teaching loads, with many ECRs engaging in lectures and tutorials. Sambridge delivered the European Geosciences Union's Beno Gutenberg Medal online lecture, and Tkalčić delivered a keynote online lecture in the Solid Earth Sciences Section of the Japan Geoscience Union. In summary, Geophysics truly embodies the ANU's "research-driven education" vision. This is reflected in the received recognition and awards for excellence in both research and education.

Research Awards

Davies & Sambridge: ARC Discovery Project – Earth's dynamic topography through space and time.

Davies: Harold Jeffreys Lecture – The Royal Astronomical Society.

Eakin: Outstanding Early Career Scientist Award – European Geosciences Union.

Hoggard: ARC DECRA – Sedimentary basins: windows into the dynamics of Australian lithosphere.

Jiang: ARC DECRA – Tracking groundwater variations via 4-dimensional seismic imaging.

Miller: ARC Future Fellowship ¬– Lighting up dark fibre for seismic imaging.

Sambridge: 2021 Beno Gutenberg Medal – European Geosciences Union.

Tkalčić: 2022 Price Medal – The Royal Astronomical Society

Tkalčić: ARC Discovery Project – A new journey to the Earth's inner core: a planet within the planet.

Education Awards

Davies: Dean's Commendation for Excellence in Education for Excellence in Teaching.

Davies: Bear McPhail Excellence in Teaching Award (Semester 1, 2021).

Miller: Dean's Commendation for Excellence in Education for Excellence in Supervision.

Miller: Bear McPhail Excellence in Teaching Award (Semester 2, 2021).

Tkalčić: Dean's Commendation for Excellence in Education for Excellence in Supervision.

Arrivals

Leon Bilton – started his PhD; jointly supervised between Eakin & Davies.

Haoran Du – started his PhD; supervised by Eakin.

Rajesh Erigela – started technical officer position.

Jiawen He – started as scientific programmer.

Mark Hoggard – started as a research fellow.

Hannes Hollmann – started research support position.

Shihao Jiang – started his PhD, supervised by Davies & Campbell (geochemistry).

Paul-Hyde Kaduru – started technical officer position in Warramunga.

Departures

Armando Arcidiaco – retired.

Marcus Haynes – graduated from PhD; now working at Geoscience Australia.

Marthe Klocking – moved on to a position in Gottingen.

Chris Matthews – graduated from PhD; now working at BoM.

Jo Stephenson ¬– graduated from PhD; now working at Department of Defense.

Andrew Valentine – moved to a continuing position at the University of Durham, UK.

Group photo post lock-down

Figure 1: Rotation Table Internal Wave system

Laboratory Operations Group

Electronics Group Engineers/Technical Officers

Andrew Latimore - Head of Lab Operations

Hideo Sasaki

Tristan Redman

Petr Lanc

Mechanical Facility Technical Officers

Hayden Miller

Angus Rummery

Laboratory Research Assistants

Climate and Fluid Physics - Angus Rummery

Experimental Petrology - David Clark

Paleomagnetism - Pengxiang Hu

Carbon14 Accelerator Mass Spectrometer - Rebecca Esmay

Rock Physics – Hayden Miller

SHRIMP - Petr Lanc

RSES Collections Officers

- Coleen Bryant
- Holly Williams

In 2021 the Laboratory Operations Group welcomed Holly Williams to the RSES Collections team. Tristan Redman departs from the RSES Electronics Group after 16 years of service to the University.

Overview

The Research School of Earth Sciences' Laboratory Operations Group began in 2021 as a unit of Professional staff members who design, maintain, and operate, scientific instrumentation, analytical systems, and materials for the Australian National University. The Group underpins the Research School of Earth Sciences' academic endeavours with professional, highly trained, and motivated staff employing their expertise and knowledge to push for the best outcomes in their areas. Collections and Laboratory staff. 2021 was the inaugural year for the Group who successfully achieved strategic goals to improve communications and deliver timely service to the Research School of Earth Sciences, overcoming challenges of COVID-19 campus lockdowns. flow gases through an environmental chamber for in situ reaction monitoring. Amongst other projects, the handheld spectrometer is being used to assess the best approaches to clean the Sydney Harbour Bridge.

Electronics Group

The RSES Electronics Group supports the Research School of Earth Sciences' and Australian National University's academic research activities providing Electronic Engineering design, technical expertise, fabrication, and maintenance service. The Group holds the responsibility for maintaining and servicing electronic systems within RSES and offers a development facility able to engineer innovative electronic solutions. The Group is equipped with a circuit production facility utilising an automated component placement machine and reflow oven. The Electronics Group endeavours to ensure the Research School of Earth Sciences remains a state-of-the-art institution and achieves the strategic goals of the University.

The Electronics Group has continued to support the Sensitive High Resolution Ion MicroProbe (SHRIMP) Laboratory with regular maintenance to electronic instrumentation throughout 2021. This year, the SHRIMP Group planned to undertake only essential developments to sustain operations, Petr Lanc was employed 0.2FTE to help achieve a successful year of analysis while the SHRIMP Laboratory staffing is under re-structuring.

Notable essential work includes the development of an In-house designed new Windows 10 compatible communication interface for SHRIMPs (and other) instruments. This device is now installed on local and overseas laboratories including, Stanford, Ottawa, Korea, Spain, RSES SHRIMP RG, SHRIMP II, SHRIMP SI and Geosciences Australia.

Australian Scientific Instruments Pty Ltd (ASI), an ANU company, was the commercial fabricator and distributor of SHRIMP instruments to the world until 2020. The RSES Electronics Group has collaborated with ASI for years and made our SHRIMP developments available to other Laboratories and new SHRIMP installations. The ANU recently sold the fabrication and development rights to Dunyi (Beijing) Technology Development Co. Ltd and agreed to supply RSES designed technology for future SHRIMP sales and upgrades. During 2021 the RSES Electronics Group , were steadily involved with fabricating RSES designed technology for this new collaboration and assumed the responsibility of supporting world-wide SHRIMP Laboratories, this includes the construction and testing of;

• 3 units of FC4 Digital Magnetic Field Controllers Version 4.

• 4 units of Magnetic Field probes TT4.

• 16 units of Iflex Electrometers.

•Supporting SHRIMP Labs with technical expert advice.

Figure 2: Picomu

The Distributed Energy Resource laboratory (DERlab)

Figure 3: DERlab

The Der Lab is located at the ANU and has an array of DER devices such as residential batteries, solar PV systems, inverters, and real and simulated controllable electrical loads. The facility provides test and troubleshooting the interconnectivity and communications of technologies that monitor, control and coordinate distributed electrical generation, storage and demand response assets. This facility was made possible by the RSES Electronics development of the Picomu, a 28-channel high resolution, voltage and current acquisition system with faster sampling speed (64Ksps @24bit resolution) than any product available on the market. Andrew Latimore and Tristan Redman of the RSES Electronics Group completed construction and implemented 9 Picomu units into the DERlab during 2021.

The DERlab user interface and data handling software was developed by Peter Lanc from RSES Electronics Group. This LabVIEW analysis software is a sophisticated program that can handle the high data rates from the acquisition system and display real-time, Voltage, Current Root-Mean-Square values, Active Power, Reactive Power and frequency in three phases. The RSES Electronics Group has been working in collaboration with the Battery Storage and Grid Integration Program, an Australian National University initiative.

With expertise in LabVIEW programming and specialist knowledge in scientific acquisition systems, the Laboratory Operations Group has developed control software for RSES and ANU Research Groups, projects highlights include;

• Ion Back Scatter Acquisition system for RSPhysics, diagnose and fix existing issues in LabVIEW control software for dual beam line.• Design of Optical Gas Sensing control software for ANU Engineering.

• Design of mixing valve strata control software for RSES Climate and Fluid Physics laboratory. This LabVIEW program utilises optical character recognition to read and control water density

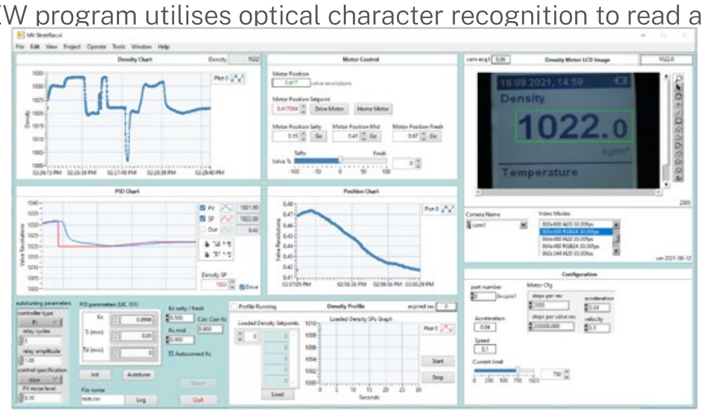


Figure 4: Stratification controller

Mechanical Facility

The Mechanical Facility was formed after the RSES restructure beginning 2021. Hayden Miller was given guardianship of the facility and has developed, with RSES management, a plan for future of Facility that enables RSES to continue mechanical engineering projects and utilises expertise from within RSES. The Facility will downsize equipment and staff numbers to coincide with current levels of demand from the 2019 model, however, still retain CNC milling, EDM wire-cutting, grinding, manual mills and lathes.

The Facility will be available to qualified staff and will provide mechanical engineering service for RSES within limitations. Large projects will be outsourced across campus to the RSPhysics Workshop. The surplus machinery will be donated to RSPhysics and will strengthen our collaboration with the RSPhysics Mechanical Workshop.

During 2021 the RSES Mechanical Facility was utilised and maintained by Hayden Miller and Angus Rummery. Research activities requiring mechanical design and fabrication were possible due to the ongoing support of these technical officers, highlights include;

- Design and construction of Laser rotating slit modifications for ICPMS laser ablation apparatus.
- Design and construction of Laser system for C14 AMS Laboratory.
- New AMS Sample Graphitization line construction.
- Refurbish J3 laboratories.

Collections

The Research School of Earth Sciences houses an important array of collected specimens and samples used for teaching and research. The Collection team undertake the management, cataloguing and databasing, investigation and researching provenance and scientific significance of RSES' Collections. During 2021 Holly Williams joined Colleen Bryant to establish the Collections Team, together they have built on Colleen's previous work cataloguing the Collection with plans to deliver an accessible system for future academic researchers. During 2021 the Collections Team established a Collections committee to devise the best strategy for RSES' Collections and have worked in collaboration with the ANU Collections Advisory Group to establish a common digital storage database system suited to all ANU Collections.

Lynne Bean, RSES Collections

Climate and Fluid Physics Laboratory

Improvements to the Climate and Fluid Physics, Rotating table apparatus were implemented during 2021. A new method to generate internal waves enclosed by the rotating tank was designed, fabricated and tested by Angus Rummery with control software designed by Petr Lanc. The modifications include an additional servo motor controlling a 3D printed wave generating structure. This allows Researchers the ability to generate internal wave perpendicular to the tank rotation movement. The system improvements also include the addition of thermal camera technology to capture eddy currents movements.

Other highlights for the Lab include design, construction and implementation of a novel electronic controlled, water stratification system, utilising in-house designed and manufactured mixing valve. Parts for this device were 3D printed in the Laboratory Operations, Electronics Group.

Paleomagnetism Lab

A new automatic long-core track system has been designed and built by Dr. Xiang Zhao and staff members in ANU paleomagnetism lab to provide a convenient means to convey geological core sections through the Bartington susceptibility core logging sensor.

This core track can accommodate core sections up to 14 cm in diameter and 1.5 meters in length. The core logging sensor can be installed on the sensor mount. The core is put onto a solid Arcylic track and will stay still during the whole scanning. The logging sensor can be controlled with assorted app installed in any windows laptop and moved automatically and smoothly along the track to perform scanning.

Outreach

During 2021 due to COVID RSES and the ANU had to cancel most outreach events. Many were moved on-line including ANU Open day. RSES did manage to participate in WINGS: Women in STEM day May 2021, showcasing Earth Sciences to secondary students at Hawker College. Inspiring women in STEM Tharika Liyanage, Sima Mousavi , Michelle Salmon and and Yamila Cajal Contreras represented RSES.

Throughout the year we held many on-line engagement sessions including, Did you feel it? all about the Victorian Earthquake in October and MinCup, mineral competition and a Flashback reunion morning tea. .

Student News

Due to COVID related restrictions the student activities planned for 2021 did not proceed. These included the annual GeoBall, AUSIM meets industry evening, the 2021 Student Conference STUCON, and other student led events and initiatives. We did manage to have two Staff vs Student events, both won by the Staff teams, Ultimate Frisbee and a Pool competition before the ACT lock-downs. During parts of 2021 classes were back on campus, we held some morning teas, Friday drinks, student poster sessions and an End of Year Party.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