

Dr Brendan Duffy

Research Interests

My expertise is in tectonics and neotectonics, and in multi-disciplinary aspects of the geological, geotechnical, hydrological and hydrogeological development of tectonic terranes. I have a strong background in structural and fault-rupture field-mapping and interpretation, geotechnical investigations, applied geophysics (surface wave seismic and GPR), geomorphology, mineral exploration and GIS analyses. I am motivated by the application of structural and neotectonics research to sustainable development, particularly in developing countries.

Education

2009–2012 **PhD (Geology) University of Canterbury –**

The Structural and Geomorphic Development of Active Collisional Orogens, from Single Earthquake to Million Year Timescales, Timor-Leste and New Zealand.

- Mapped the structure and sedimentology of synorogenic, turbiditic basins in Timor-Leste using field and remotely sensed data.
- Used petrographic and geochemical provenance analysis to determine unroofing sequence associated with island uplift.
- Analysed fault displacement and other structural data to produce a coherent model for post-orogenic extension in Timor.
- Mapped fault interactions in Quaternary gravels at a releasing fault bend in Canterbury using field, hydrogeological and geomorphic mapping, borehole stratigraphy, cadastral surveying and multi-temporal LiDAR.

2006–2008 **MSc (Geology) University of Canterbury –**

Development of Multi-channel Analysis of Surface Waves (MASW) for Characterizing the Internal Structure of Active Fault-zones as a Predictive Method of Identifying the Distribution of Ground Deformation.

- Used MASW and topographic surveys to locate buried fault zones and study the distribution of concealed deformation.

2003–2005 **BSc (Geology) University of Canterbury**

Awards

2009-2012 Tertiary Education Commission Top Achiever Scholarship, *and* University of Canterbury Roper Scholar in Science, *and* William and Ina Cartwright Teachers Scholarship; **2008** Von Haast Prize in Geology (MSc); **2007-2008** University of Canterbury Masters Scholarship; **2007** Geological Society of New Zealand Hastie Scholarship; **2006** University of Canterbury Senior Scholarship (top ~25 University of Canterbury graduates).

Summary work history

2015 March 2015 to present – structural geologist and modeller – Terra Search Pty Ltd, Townsville

- Pyramid Project: Overall responsibility for \$500k exploration program. Reappraised existing exploration data, revised structural interpretation and drill strategy, and designed/oversaw best performing drill program in 30 years of exploration at the site ([ASX announcement](#)). Results drove share prices up by 11%.
- Co-leader of mine rejuvenation project in Charters Towers Province of Northern Queensland. Responsible for historic drill data validation, structural and grade modelling of depleted and extracted ore, geotechnical advice regarding pit-water drawdown and review of groundwater contamination potential.

January to March 2015 – Independent geologist

- Independent geotechnical assessment and reporting on residential ground failure and foundation damage.
- Consulting for water exploration geology and geophysics in Canterbury, New Zealand.
- Journal services including English language and science editing, and peer reviewing.
- Ad hoc consulting/supervision to >10 University of Canterbury postgraduate students on matters relating to structural and engineering geology, 3-D structural modelling, geophysics and remote sensing. Co-authorship of an earthquake hazards book chapter.

2013–2014 Lecturer – University of Canterbury

18 month fixed term. I taught geology, hazard management and engineering geology courses to postgraduate level, with a focus on structural geology; geomorphological mapping; geophysics; paleoseismology; earthquake hazards; hazard assessment and report writing. I reached the second round of the 2014 Marsden funding round. Details of courses and levels of experience are shown in the following section.

2009–2012 PhD researcher – University of Canterbury

During my PhD, I collaborated on a \$300,000 Royal Society Marsden-funded project in Timor-Leste. As part of this thesis I developed concepts and research directions and led field trips that resulted in successful collaborations with academics from the Universities of Canterbury, Auckland, Queensland, Southern California, Brigham Young (Utah) and Utrecht. I also worked extensively on the Greendale fault with scientists from GNS Science.

2008–2015 Geophysicist – Southern Geophysical Limited (Full-time Nov 2012 to July 2013)

Gained experience in designing, implementing and processing ground penetrating radar, multi-channel shear wave, reflection seismic and electromagnetic surveys throughout New Zealand. My capabilities cover a wide range of geological and geotechnical applications of near-surface geophysics.

Teaching experience

Level	Years	Description
Supervision	2013-2015	<p>supervised >14 geology and engineering geology student projects, at undergraduate to PhD level. Projects included:</p> <ul style="list-style-type: none"> • Geological, geophysical and paleoseismological investigation of active faults in the Quaternary gravels of Canterbury, New Zealand. • Geological, GIS, mechanical and geophysical investigations of liquefaction and paleo-liquefaction in Christchurch and Greymouth, South Island, New Zealand. • Geophysical and geotechnical investigation of karst terrain. • Using ground penetrating radar, field mapping and topographic analysis to document gravel stopbank damage due to local subsidence. • Morphostructure, mechanics and stability of a large landslide at Lake Coleridge, New Zealand (ongoing PhD - Canterbury) • Geological and geophysical investigations of an active fault at Ross, Westland (ongoing MSc - Canterbury) • Structural context of gold mineralization at the Piccadilly prospect, North Queensland (ongoing BSc Hons – James Cook University)
	2013-2014	<p>Earthquake hazards – Six 2hr seminars on earthquake hazards. Assessment: one field excursion and hazard report based around geomorphic mapping</p>
4th year	2014	<p>Structural geology – Six 2 hour seminars on the role of fluids in the structural evolution of accretionary prisms and their transition to arc-continent collision. Assessment: one case study of collisional processes and geometry, with emphasis on fluid roles. One field excursion to Kaikoura and report on relative timing and structural development of cross-folding on the peninsula.</p>
	2013-2014	<p>Engineering geology and geomorphology – Co-led 2 week field exercise, including elements of engineering geomorphology, geohazards, geophysics and geomechanics (tunnel and pit wall stability)</p>
3rd year	2013-2014	<p>New Zealand Geodynamics and Geohazards – 12 lectures on the tectonics of the New Zealand continent, and relationships to other events around the Pacific. Relationship between tectonic environments and geohazards. Paleoseismic archives. Assessment: 1 day paleoseismic workshop, final exam</p>
	2008-2014	<p>Advanced field mapping. Assessment: 1 map, 1 cross section and stratigraphic column. Oral defence.</p>
2nd year	2014	<p>Structural geology and global geophysics – 24 lectures and 8 laboratory sessions on fundamentals of structural geology. Assessment: 5 assessed laboratory worksheets, final exam.</p>
	2007-2013	<p>Structural geology and global geophysics – develop and present 8 session laboratory course to accompany structural geology course. Assessment: lab exam</p>
	2012	<p>Introductory field mapping Assessment: 1 map, 1 cross section and stratigraphic column, report, notebook.</p>
1st year	2007-2011	<p>Teach introductory laboratory sessions and structural elements of field trips for first year geology.</p>

Publications (Google scholar h-index = 10)

Book chapter (accepted 2015)

Quigley, M. C. and **Duffy**, B. 2015, 'Earthquakes', in Goff, J. and de Freitas, C. 2015 (eds) Australasian Geohazards. Cambridge University Press.

Journal articles

Accepted

Nobes, D., H. Jol, B. **Duffy**, B. Charlton, N. Jaeger, and N. Topper (accepted 9/8/15), Geophysical imaging of disrupted near-shore dune stratigraphy and possible mechanisms, Haast, South Westland, New Zealand, New Zealand Journal of Geology & Geophysics

2014

Duffy, B, Campbell, J & Finnemore, M 2014, 'Defining fault avoidance zones and associated geotechnical properties using MASW: a case study on the Springfield Fault, New Zealand', Engineering Geology. DOI:10.1016/j.enggeo.2014.10.017

Aben, FM, Dekkers, MJ, Bakker, RR, Hinsbergen, DJJv, Zachariasse, WJ, Tate, G, McQuarrie, N, Harris, R & **Duffy**, B 2014, 'Unraveling complex magnetic polarity records carried by greigite through an integrated rock magnetic analysis: A case study on Neogene sections in East Timor ', Geochemistry, Geophysics, Geosystems, vol. 15, no. 6, pp. 2531–54. DOI:10.1002/2014GC005294

2013

Duffy, B, Quigley, MC, Harris, R & Ring, U 2013, 'Arc-parallel extrusion of the Timor sector of the Banda arc-continent collision', Tectonics, vol. 32, no. 3, pp. 641-60. DOI:10.1002/tect.20048 (article, pdf)

Duffy, B, Quigley, MC, Barrell, D, Van Dissen, R, Stahl, T, Leprince, S, McInnes, C & Bilderback, E 2013, 'Fault kinematics and surface deformation across a releasing bend during the 2010 MW 7.1 Darfield, New Zealand, earthquake revealed by differential LiDAR and cadastral surveying', Geological Society of America Bulletin, vol. 125, no. 3-4, pp. 420-31. DOI:10.1130/B30753.1

Nguyen, N, **Duffy**, B, Shulmeister, J & Quigley, MC 2013, 'Rapid Pliocene uplift of Timor', Geology, vol. 41, no. 2, pp. 179-82. DOI:10.1130/G33420.1 (article, pdf)

Stahl, T, Winkler, S, Bebbington, MS, Quigley, MC, **Duffy**, B & Duke, D 2013, 'Schmidt hammer dating of late Quaternary fluvial terraces in New Zealand', Earth Surface Processes and Landforms. DOI:10.1002/esp.3427

2012

Quigley, MC, **Duffy**, B, Woodhead, J, Hellstrom, J, Moody, L, Horton, T, Soares, J & Fernandes, L 2012, 'U/Pb dating of a terminal Pliocene coral from the Indonesian Seaway', Marine Geology, vol. 311-314, pp. 57-62.

Quigley, MC, Van Dissen, R, Litchfield, N, Villamor, P, **Duffy**, B, Barrell, D, Furlong, K, Stahl, T, Bilderback, E & Noble, D 2012, 'Surface rupture during the 2010 MW 7.1 Darfield (Canterbury) earthquake: implications for fault rupture dynamics and seismic-hazard analysis', Geology, vol. 40, no. 1, pp. 55-8. DOI:10.1130/G32528.1

Villamor, P, Litchfield, N, Barrell, D, Van Dissen, R, Hornblow, S, Quigley, MC, Levick, S, Ries, W, **Duffy**, B, Begg, J, Townsend, D, Stahl, T, Bilderback, E, Noble, D, Furlong, K & Grant, H 2012, 'Map of the 2010 Greendale Fault surface rupture, Canterbury, New Zealand: Application to

land use planning ', *New Zealand Journal of Geology and Geophysics* (Special issue: Canterbury, New Zealand, 2010-2011 earthquake sequence), vol. 55, no. 3, pp. 223-330.

2011

Barrell, DJA, Litchfield, NJ, Townsend, DB, Quigley, MC, Van Dissen, RJ, Cox, SC, Cosgrove, R, Furlong, K, Villamor, P, Begg, JG, Hemmings-Sykes, S, Jongens, R, Mackenzie, H, Stahl, T, Bilderback, E, **Duffy**, B, Lang, EMW, Nicol, R, Noble, D & Pedley, K 2011, 'Strike-slip ground-surface rupture (Greendale Fault) associated with the 4 September 2010 Darfield earthquake, Canterbury, New Zealand', *Quarterly Journal of Engineering Geology and Hydrogeology*, vol. 44, pp. 283-91. DOI:10.1144/1470-9236/11-034

Van Dissen, R, Barrell, D, Litchfield, N, King, A, Quigley, MC, Villamor, P, Furlong, K, Mackenzie, H, Klahn, A, Begg, J, Townsend, D, Stahl, T, Noble, D, **Duffy**, B, Bilderback, E, Jongens, R, Cox, S, Langridge, R, Ries, W, Dhakal, R, Smith, A, Nicol, R, Pedley, K, Henham, H & Hunter, R 2011, 'Surface rupture displacement on the Greendale Fault during the Mw 7.1 Darfield (Canterbury) Earthquake, New Zealand, and its impact on man-made structures', Ninth Pacific Conference on Earthquake Engineering, Building an Earthquake-Resilient Society, Paper 186, 8 p., New Zealand Society for Earthquake Engineering, Auckland, New Zealand.

2010

Quigley, MC, Van Dissen, R, Villamor, P, Litchfield, N, Barrell, D, Furlong, K, Stahl, T, **Duffy**, B, Bilderback, E, Noble, D, Townsend, D, Begg, J, Jongens, R, Ries, W, Claridge, J, Klahn, A, Mackenzie, H, Smith, A, Hornblow, S, Nicol, R, Cox, S, Langridge, R & Pedley, K 2010, 'Surface rupture of the Greendale Fault during the Darfield (Canterbury) earthquake, New Zealand: Initial findings', *Bulletin of the New Zealand Society for Earthquake Engineering*, vol. 43, no. 4, pp. 236-42.

Quigley, MC, Villamor, P, Furlong, K, Beavan, J, Van Dissen, R, Litchfield, N, Stahl, T, **Duffy**, B, Bilderback, E, Noble, D, Barrell, D, Jongens, R & Cox, S 2010, 'Previously unknown fault shakes New Zealand's South Island', *EOS*, vol. 91, no. 49, pp. 469-70.

Conference contributions

2015

Duffy, B, Beams, SD and Beams, T 2015 'Far Fanning – innovative rejuvenation, rehabilitation and reconciliation of an existing mine site', *The Exploration round-up: Metallogeny and exploration potential in the Charters Towers Province*. Charters Towers, Queensland, Australia.

Duffy, B, Beams, SD and Beams, T 2015 'Pyramid Project: Geology, geochemistry and gold prospectivity along the northernmost Anakie Inlier', *The Exploration round-up: Metallogeny and exploration potential in the Charters Towers Province*. Charters Towers, Queensland, Australia.

2014

Duffy, BG 2014, 'Tilting of marine terraces above a listric thrust fault', 2014 GSA Annual Meeting in Vancouver, British Columbia.

2013

Aben, FM, Bakker, RR, Dekkers, MJ, Hinsbergen, DJJv, Tate, G, McQuarrie, N, Harris, R, Zachariasse, JW & **Duffy**, B 2013, 'Greigite-related complex magnetic polarity records unraveled through an integrated rock magnetic analysis: A case study on Neogene sections in East Timor (Paper GP42A-06)', in AGU Fall Meeting 2013, San Francisco, California

Duffy, B, Pettinga, JR & Campbell, J 2013, 'Geomorphology, structure and interactions of the Canterbury active fault network', in CM Reid & SJ Hampton (eds), Field Trip Guides, Geosciences 2013 Conference, Geoscience Society of New Zealand Miscellaneous Publication 136B, Christchurch, New Zealand.

Duffy, B, Quigley, MC, Bassett, K & Strachan, LJ 2013, 'Timing and provenance of synorogenic sedimentation during arc-continent collision and extrusion in the Timor sector of the Banda Arc', in Geosciences 2013, eds. CM Reid & AM Wandres. Geoscience Society of New Zealand Miscellaneous Publication 136A, Christchurch, New Zealand

Duffy, B & Quigley, M 2013, 'Subduction and extrusion of Australian continental crust at the Banda Arc', Programme, Abstracts & Fieldtrip Guide, Bradshaw & Weaver Symposium, eds. AM Wandres, B Storey & M Bradshaw, Geosciences Society of New Zealand Misc. Publ. 135, Christchurch, New Zealand.

2012

Duffy, B 2012, 'Tectonics, earthquakes, geomorphology and surveyors', Annual conference of the Institute of Cadastral Surveyors of New Zealand. NZICS, Christchurch, New Zealand

Duffy, B 2011, 'The Canterbury Earthquake Sequence: Implications for surveyors', Annual conference of the Institute of Cadastral Surveyors of New Zealand. NZICS, Christchurch, New Zealand

Duffy, B, McInnes, C, Van Dissen, R, Litchfield, N, Barrell, D, Quigley, MC, Bilderback, E & Stahl, T 2011, 'Kinematics of the Greendale Fault releasing bend: Insights from cadastral and multi-temporal LiDAR surveys', in IUGG General Assembly - Earth on the Edge: Science for a Sustainable Planet, Melbourne, Australia

Duffy, B, Quigley, MC, Nguyen, N & Shulmeister, J 2011, 'The rise and fall of an arc-continent collisional orogen: insights from synorogenic sediments in Timor Leste', AGU Fall Meeting.

Duffy, B, McInnes, C, Van Dissen, R, Litchfield, N, Barrell, D, Quigley, MC, Bilderback, E, Stahl, T & Carson, N 2011, 'Tectonic geomorphology, river avulsion and fault kinematics at the releasing termination of the strike slip Greendale Fault, Canterbury, New Zealand', Australia New Zealand Geomorphology Group, Oamaru, New Zealand.

Duffy, B, Van Dissen, R, Quigley, MC, Litchfield, N, McInnes, C, Leprince, S, Barrell, D, Stahl, T & Bilderback, E 2011, 'Co-seismic displacements from differencing and sub-pixel correlation of multi-temporal LiDAR and cadastral surveys: application to the Greendale Fault, Canterbury, New Zealand (Invited paper EP51E-04)', 2011 Fall Meeting, AGU, San Francisco, California.

2010

Duffy, B & Quigley, MC 2010, 'Extension at a collision-subduction transition: New insights from Timor', Geoscience Society of New Zealand Miscellaneous Publication 129A, eds. JD Eccles, MR Grigor, PWO Hoskin & DCH Hikuroa, Auckland, New Zealand, p. 89.

2009

Duffy, B, Quigley, MC, Haig, DW & Bassett, K 2009, 'Indonesian Geodynamics and Paleooceanography revealed in an exhumed Pliocene Forearc Basin, Timor Leste', Geosciences 09, eds. DJA Barrell & AJ Tulloch, Geological Society of New Zealand Miscellaneous Publication 128A, Oamaru, New Zealand, p. 62.

2008

Duffy, B, Kilner, J, Campbell, J & Finnemore, M 2008, 'Multi-Channel Analysis Of Surface Waves (MASW) To Image The Taieri Ridge Fault, Macraes Flat, Central Otago', in University of Otago

and University of Canterbury Geology Postgraduate student conference, Dunedin, New Zealand

2007

Duffy, B, Campbell, J & Finnemore, M 2007, 'Multi-channel analysis of surface waves for characterizing the internal structure of active fault zones.', Geological Society of New Zealand Conference, Tauranga.

Theses

Duffy, BG 2013, The Structural and Geomorphic Development of Active Collisional Orogens, from Single Earthquake to Million Year Timescales, Timor Leste and New Zealand, PhD Thesis, University of Canterbury.

Duffy, BG 2008, Development of Multi-Channel Analysis of Surface Waves (MASW) for characterising the internal structure of active fault zones as a predictive method of identifying the distribution of ground deformation, MSc Thesis, University of Canterbury.