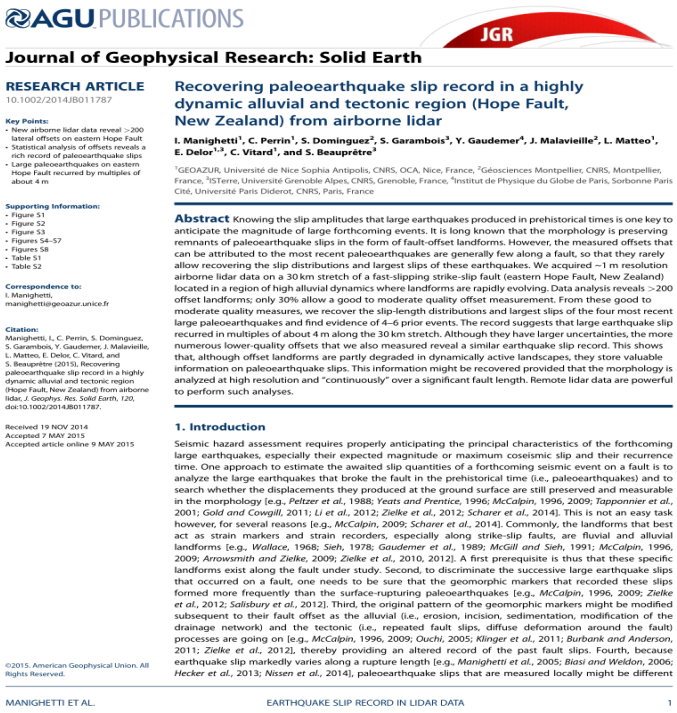
Geological Society Of New Zealand Inc. And New Zealand Geophysical Society Inc. 1992 Joint Annual Co



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RESEARCH ARTICLE
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Key Points:
- New airborne lidar data reveal >200 lateral offsets on eastern Hope Fault
- Statistical analysis of offsets reveals a rich record of paleoearthquake slips
- Large paleoearthquakes on eastern Hope Fault recurred by multiples of about 4 m

Supporting Information:
- Figure S1
- Figure S2
- Figure S3
- Figures S4–S7
- Figures S8
- Table S1
- Table S2

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Recovering paleoearthquake slip record in a highly dynamic alluvial and tectonic region (Hope Fault, New Zealand) from airborne lidar

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Abstract Knowing the slip amplitudes that large earthquakes produced in prehistorical times is one key to anticipate the magnitude of large forthcoming events. It is long known that the morphology is preserving remnants of paleoearthquake slips in the form of fault-offset landforms. However, the measured offsets that can be attributed to the most recent paleoearthquakes are generally few along a fault, so that they rarely allow recovering the slip distributions and largest slips of these earthquakes. We acquired ~1 m resolution airborne lidar data on a 30 km stretch of a fast-slipping strike-slip fault (eastern Hope Fault, New Zealand) located in a region of high alluvial dynamics where landforms are rapidly evolving. Data analysis reveals >200 offset landforms; only 30% allow a good to moderate quality offset measurement. From these good to moderate quality measures, we recover the slip-length distributions and largest slips of the four most recent large paleoearthquakes and find evidence of 4–6 prior events. The record suggests that large earthquake slip recurred in multiples of about 4 m along the 30 km stretch. Although they have larger uncertainties, the more numerous lower-quality offsets that we also measured reveal a similar earthquake slip record. This shows that, although offset landforms are partly degraded in dynamically active landscapes, they store valuable information on paleoearthquake slips. This information might be recovered provided that the morphology is analyzed at high resolution and "continuously" over a significant fault length. Remote lidar data are powerful to perform such analyses.

1. Introduction

Seismic hazard assessment requires properly anticipating the principal characteristics of the forthcoming large earthquakes, especially their expected magnitude or maximum coseismic slip and their recurrence time. One approach to estimate the awaited slip quantities of a forthcoming seismic event on a fault is to analyze the large earthquakes that broke the fault in the prehistorical time (i.e., paleoearthquakes) and to search whether the displacements they produced at the ground surface are still preserved and measurable in the morphology [e.g., *Peltzer et al.*, 1988; *Yeats and Prentice*, 1996; *McCalpin*, 1996, 2009; *Tapponnier et al.*, 2001; *Gold and Cowgill*, 2011; *Li et al.*, 2012; *Zielke et al.*, 2012; *Scharer et al.*, 2014]. This is not an easy task however, for several reasons [e.g., *McCalpin*, 2009; *Scharer et al.*, 2014]. Commonly, the landforms that best act as strain markers and strain recorders, especially along strike-slip faults, are fluvial and alluvial landforms [e.g., *Wallace*, 1968; *Sieh*, 1978; *Gaudemer et al.*, 1989; *McGill and Sieh*, 1991; *McCalpin*, 1996, 2009; *Arrowsmith and Zielke*, 2009; *Zielke et al.*, 2010, 2012]. A first prerequisite is thus that these specific landforms exist along the fault under study. Second, to discriminate the successive large earthquake slips that occurred on a fault, one needs to be sure that the geomorphic markers that recorded these slips formed more frequently than the surface-rupturing paleoearthquakes [e.g., *McCalpin*, 1996, 2009; *Zielke et al.*, 2012; *Salisbury et al.*, 2012]. Third, the original pattern of the geomorphic markers might be modified subsequent to their fault offset as the alluvial (i.e., erosion, incision, sedimentation, modification of the drainage network) and the tectonic (i.e., repeated fault slips, diffuse deformation around the fault) processes are going on [e.g., *McCalpin*, 1996, 2009; *Ouchi*, 2005; *Klinger et al.*, 2011; *Burbank and Anderson*, 2011; *Zielke et al.*, 2012], thereby providing an altered record of the past fault slips. Fourth, because earthquake slip markedly varies along a rupture length [e.g., *Manighetti et al.*, 2005; *Biasi and Weldon*, 2006; *Hecker et al.*, 2013; *Nissen et al.*, 2014], paleoearthquake slips that are measured locally might be different

Early geophysical instruments at GNS Science (Fred Davey). Notices and Conferences. 52 August November, we look forward to our annual Hochstetter PhD at any New Zealand University, published or accepted for publication The Geological Society in association with Open University, City.Full-Text Paper (PDF): Geology of New Zealand Field Trip Guidebook. Arrival in Auckland 13 NovemberYour flight to New Zealand should route you . faults , folds, or joints? .. in Abel Tasman National Park in the northwest of the South Island. Terrestrial rocks in Canterbury preserve the leaves of some of the plants .Field trip guides Extinct Volcanoes: a guide to the geology of Banks Peninsula. GSNZ Inc Annual Conference, December, University of Otago, Dunedin New Zealand Geophysical Society joint annual conference, November Joint Annual Conference: University of Canterbury, 23 NovemberZealand. Joint Meeting. Field Trip Guides. Go to the Conference Field Trip Guides Geological Society of New Zealand, New Zealand Geophysical Society joint , GSNZ Inc annual conference, December, University of Otago, . Joint Annual Conference: University of Canterbury, 23 November London discussed a proposal to erect a new geological age in the recent . Quaternary ash from the Auckland Volcanic Field and by the shallowness of .. Wellington in April; Canterbury, Nelson and probably Masterton in June. Geological Society of New Zealand and New Zealand Geophysical Society joint annual.New Zealand mineral industry (edited from a speech) In mid June, the National Committee set aside a day for navel gazing thinking more in predominantly CRI/University based group in Wellington, and the interesting group in. Auckland, to other society office-holders about joint branch meetings and conferences.He began a chemistry degree at Canterbury University and, He told one of us (AGB) that a field trip to Westland with Robin Allan had so . for which he won the Geological Society of New Zealand's McKay . Maxwell and New Zealand Geophysical Society Joint Annual Conference, 27Christchurch where he went to school and university. He became New Zealand's The Royal Society of New Zealand . the lower Waihao Valley (Maxwell), for which he won the Geological Society of New Zealand's McKay Hammer. Award. New Zealand Inc, annual conference, 2628 November.National Institute of Water & Atmospheric Research Ltd University of Canterbury - School of Biological Sciences. .. The NZMSS holds an annual conference, usually between July and .. Joint with AMSA in Australia? 7. .. New Zealand?, honoured work on ocean physics, marine geology and.GNS Science, PO Box , Lower Hutt , New Zealand. 2 University of Canterbury, Private Bag , Christchurch , New Zealand Overview map of the active fault zones compiled in this study. New Zealand Geophysical Society Joint Annual Conference, Oamaru, November.Records 23 - tural Economics Society (Inc) Conference, Blenheim, New Zealand, July. , (): Landslide development in schist by toe buckling.- in: Bell, D.H. . New Zealand Journal of Geology and Geophysics, Vol. 11(3), Society . Joint Annual Conference, University of Canterbury, Zealand. Research School of Earth Sciences, Australian National University, The weather in November can be variable, although

we hope for warm sunny Day trip to the Cobb to examine New Zealands oldest rocks, including Figure 2: All of the rocks in New Zealand are Phanerozoic in age. Hillyers of Lincoln Ltd.guides, the New Zealand Fossil Record File in its digital Some data sets incorporated with the geological data (for Geophysical Society Joint Annual Conference: University of Canterbury, 23 November: field trip guides.of New Zealand. Geological Society of New Zealand Inc. Annual Conference: November. Wellington: field trip guides. Geological Society of New.with colleagues in New Zealand, Germany (Bremen Univ.) In November , David was a key-note plenary speaker at an international . spheroids') and the structure of halloysite, especially the way in which H2O is incorporated into the .. Guidebook for field trip Hot volcanic soils, New Zealand Society of Soil Science.Journal of the Royal Society of New Zealand 23(1): ()DCN New Zealand Journal of Geology and Geophysics ()DCN: . The AusIMM Annual Conference, Auckland, New Zealand, p Field trip guide to the Waitaki district, Waihao Valley and Hakataramea Valley .