Earth-Science Reviews 107 (2011) 141–146

Contents lists available at ScienceDirect

Earth-Science Reviews

journal homepage: www.elsevier.com/locate/earscirev

Palaeotsunamis in the Pacific Islands

James Goff [a,*], Catherine Chagué-Goff [a,b], Dale Dominey-Howes [a], Brian McAdoo [c], Shane Cronin [d], Michael Bonté-Grapetin [e], Scott Nichol [f], Mark Horrocks [g], Marco Cisternas [h], Geoffroy Lamarche [i], Bernard Pelletier [j], Bruce Jaffe [k], Walter Dudley [l]

[a] Australian Tsunami Research Centre, University of New South Wales, Sydney 2052, NSW, Australia
[b] Australian Nuclear and Science Technology Organisation, Locked Bag 2001, Kirrawee DC NSW 2232, Australia
[c] Department of Earth Science and Geography, Vassar College, Box 735, Poughkeepsie, NY 12604, USA
[d] Volcanic Risk Solutions, Massey University, Private Bag 11222, Palmerston North, New Zealand
[e] SOPAC Pacific Islands Applied Geoscience Commission, Private Mail Bag, GPO, Suva, Fiji
[f] Canberra ACT 2601, Australia
[g] Microfossil Research, 31 Mont Le Grand Rd, Mt Eden, Auckland 1024, New Zealand
[h] Escuela de Ciencias del Mar, Pontificio Universidad Catolica de Valparaiso, Casilla 1020, Valparaiso 1, Chile
[i] National Institute of Water and Atmospheric Research (NIWA), Private Bag 14-901, Wellington 6241, New Zealand
[j] Institut de Recherche pour le Développement (IRD), Port Vila, Vanuatu
[k] US Geological Survey, Pacific Science Center, 400 Natural Bridges Drive, Santa Cruz, CA 95060, USA
[l] Department of Marine Science, University of Hawaii at Hilo, Hilo, HI 96720, USA

ARTICLE INFO

Article history:
Received 2 June 2010
Accepted 21 October 2010
Available online 31 October 2010

Keywords:
Pacific Island Countries
Palaeotsunami
sources
risk

ABSTRACT

The recent 29 September 2009 South Pacific and 27 February 2010 Chilean events are a graphic reminder that the tsunami hazard and risk for the Pacific Ocean region should not be forgotten. Pacific Islands Countries (PICs) generally have short (<150 years) historic records, which means that to understand their tsunami hazard and risk researchers must study evidence for prehistoric events. However, our current state of knowledge of palaeotsunamis in PICs as opposed to their circum-Pacific counterparts is minimal at best. We briefly outline the limited extent of our current knowledge and propose an innovative methodology for future research in the Pacific. Each PIC represents a point source of information in the Pacific Ocean and this would allow their palaeotsunami records to be treated akin to palaeo-DART® (Deep-ocean Assessment and Reporting of Tsunamis) buoys. Contemporaneous palaeotsunamis from local, regional and distant sources could be identified by using the spatial distribution of island records throughout the Pacific Ocean in conjunction with robust event chronologies. This would be highly innovative and, more importantly, would help provide the building blocks necessary to achieve more meaningful disaster risk reduction for PICs.

Contents

1. Introduction

The 29 September 2009 South Pacific tsunami was a truly region-wide disaster, with deaths in Samoa, American Samoa and Tonga (Lamarche et al., 2010). A historical 1917 AD precursor event (National Geophysical Data Center (NGDC), 2010a) from a similar Tonga-Kermadec Trench source suggests that region-wide tsunamis may be rather frequent. Pacific Island Countries (PICs) are not only

* Corresponding author. Tel.: +61 2 9385 831; fax: +61 2 9385 1558.
E-mail addresses: j.goff@unsw.edu.au (J. Goff), c.chague-goff@unsw.edu.au, ccg@ansto.gov.au (C. Chagué-Goff), dale.dh@unsw.edu.au (D. Dominey-Howes), brmcadoo@vassar.edu (B. McAdoo), S.J.Cronin@massey.ac.nz (S. Cronin), michael@sopac.org (M. Bonté-Grapetin), slnichol@tpg.com.au (S. Nichol), info@microfossilresearch.com (M. Horrocks), marco.cisternas@ucv.cl (M. Cisternas), g.lamarche@niwa.co.nz (G. Lamarche), bernard.pelletier@noumea.ird.nc (B. Pelletier), bjaffe@usgs.gov (B. Jaffe), Dudley@hawaii.edu (W. Dudley).

0012-8252/$ – see front matter © 2010 Elsevier B.V. All rights reserved.
doi:10.1016/j.earscirev.2010.10.005

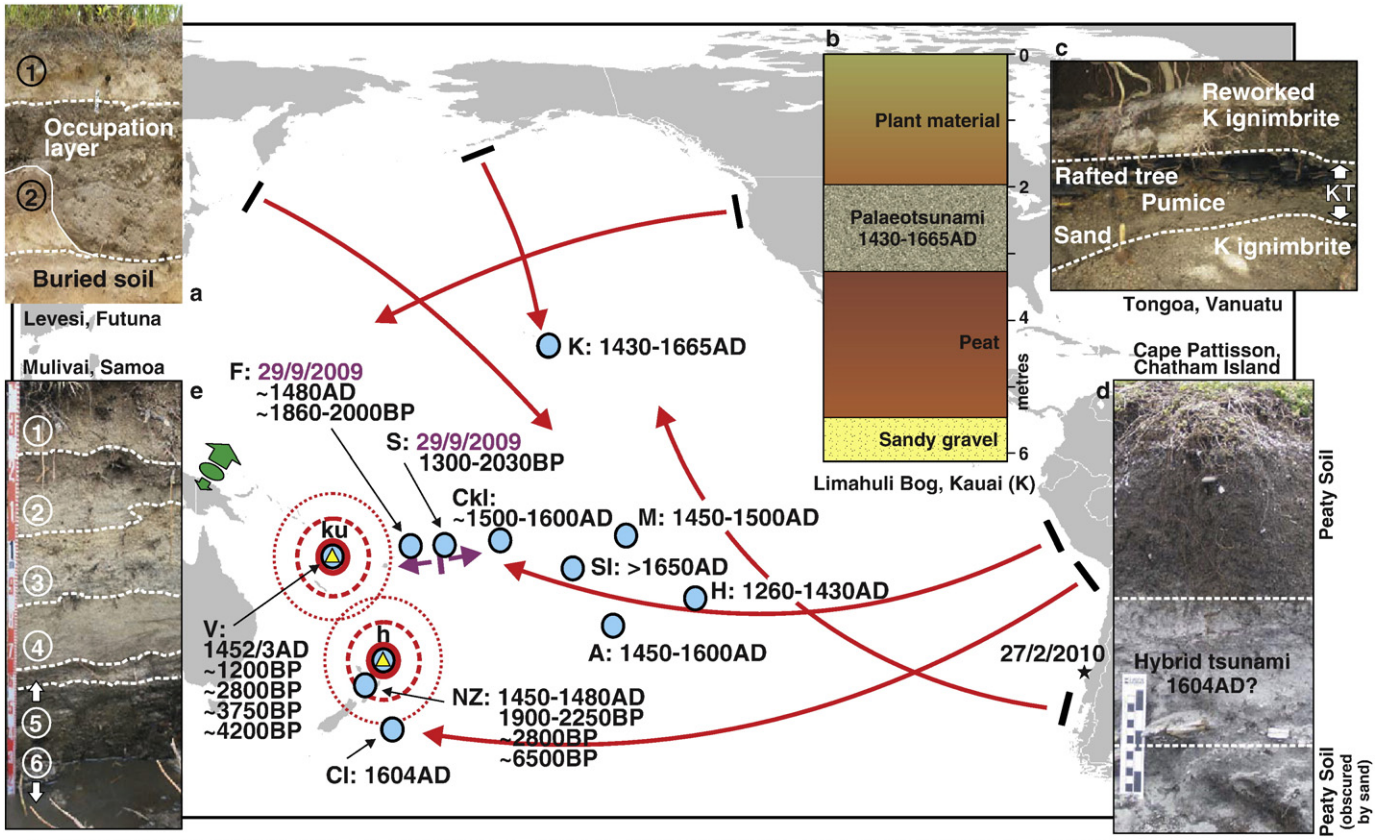

Fig. 1. The Pacific Ocean: Examples of local, regional, and distant tsunami sources: green filled oval = local source (earthquake & submarine landslide — Papua New Guinea 1998 [Davies et al., 2003]); yellow filled triangle = regional source (submarine caldera collapse — Kuwae (ku), 1452/1453AD [Goff et al., 2008b]; Healy (h), c.1280–1350AD [Goff, 2008]); purple line = regional source 29 September 2009 South Pacific earthquakes (Beavan et al., 2010; Lay et al., 2010); black lines = regional/distant sources, representative subduction zone segments from various CPOC source areas. Approximate travel pathways of tsunami away from source: Green filled arrows — local submarine landslide; red solid, dashed and dotted circles — waning radial pattern for a regional submarine volcano; purple arrows — the regional 29 September South Pacific earthquakes (Beavan et al., 2010; Lay et al., 2010); red arrows — CPOC subduction zones (these are indicative of direction of approximate maximum wave energy in deep water only). Black star marks epicentre of 27 February Chilean earthquake and the light blue filled black circles show locations of PICs. Photos: **a**, two palaeotsunami deposits at Levesi, Futuna (F); **b**, core log from Kauai (K) with radiocarbon dated (1430–1665 AD) palaeotsunami deposit; **c**, Kuwae eruption tsunami deposit (KT) in Vanuatu (V); **d**, 1604 AD hybrid tsunami on Chatham Island (CI) matching historical 1604 AD Chilean event; **e**, series of six undated sand units and buried soils in trench from Mulivai, Samoa (S) showing potential for identifying palaeotsunamis in the Pacific (Dominey-Howes and Thaman, 2009). Refer to Table 3 for details about individual events.

exposed to such regional events, but also to locally- (e.g. earthquakes, volcanic eruptions and/or submarine landslides) and distantly-generated (e.g. circum-Pacific subduction zones) sources such as the recent 27 February 2010 Chilean earthquake (Fig. 1). It is a strange situation to be in though, when we appear to know more about the Holocene palaeotsunami record for the Indian Ocean that has fewer events, than we do for PICs located in a region susceptible to tsunamis originating from numerous 'Ring of Fire' sources. To put this in context, there are as many as 22 PICs scattered over one third of the globe, some 30 million sq. km (Pacific Islands Forum, 2010). Here we show that the existing but sparse PIC palaeotsunami data provide us with a tantalising glimpse of what could be achieved through a concerted research effort.

2. Palaeotsunami research

A considerable amount of palaeotsunami research has been carried out in Indian Ocean countries since the 2004 Indian Ocean Tsunami (e.g. Jankaew et al., 2008; Monecke et al., 2008). This has been possible largely because of rapid developments in the field of palaeotsunami research since the late 1980's (Atwater, 1987). This field however, is no longer the sole domain of geology, but benefits from multidisciplinary interactions with archaeology (Bedford, 2006; McFadgen and Goff, 2007), anthropology (King et al., 2007; King and Goff, 2010), palaeoecology (Burney, 2002) and geomorphology (Goff et al., 2008a).

Pacific Island Countries (PICs) may be under-represented within the palaeotsunami literature, but circum-Pacific Ocean Countries (CPOCs) have benefited from extensive geological research on both historical events and their precursors (Pinegina and Bourgeois, 2001; Nanayama et al., 2003; Peters et al., 2003; Goff and Dominey-Howes, 2009). For example, while the 1960 Chilean tsunami was the last major Pacific-wide event, several historical and prehistoric precursors have been identified from deposits along the coastline of South America (Cisternas et al., 2005). Historical Chilean precursors are known to have been Pacific-wide (e.g. 1868, 1877), but little is known about the extent of their prehistoric counterparts (Cisternas et al., 2005) and almost nothing is known about their impacts on PICs.

Most of the CPOC tsunami data are synthesised in the NGDC's Tsunami Deposit Bibliographic Database (NGDC TDBD) (NGDC, 2010b). Many of these countries have moderate to long historical records often spanning several hundreds of years (NGDC, 2010b). PICs on the other hand tend to have rich, but short, historical records, rarely exceeding 150 years (NGDC, 2010b). This means that for tsunamis that occurred