The Indian Ocean Dipole and great earthquake cycle: Long-term perspectives for improved prediction

M.K. GAGAN[1], N.J. ABRAM[1,2], W.S. HANTORO[3], D.H. NATAWIDJAJA[3] AND K. SIEH[4]

[1]Research School of Earth Sciences, Australian National Univ, Canberra, ACT 0200 (Michael.Gagan@anu.edu.au)
[2]British Antarctic Survey, National Environment Research Council, Cambridge CB3 OET, UK (NABR@bas.ac.uk)
[3]Indonesian Institute of Sciences, Bandung 40135, Indonesia
[4]California Inst. of Technology, Pasadena, CA 91125, USA

Climatic extremes in the densely populated tropical Indian Ocean region are controlled by the interplay between the El Niño-Southern Oscillation (ENSO), Asian monsoon and Indian Ocean Dipole (IOD). Reliable instrumental records of the IOD only cover the last 50 years. To better understand IOD variability, we use a suite of *Porites* coral $^{18}O/^{16}O$ records to extend the basin-wide index of IOD behaviour back to 1846 AD. Our analysis reveals a 3-fold increase in the frequency of IOD events since 1960, accompanied by the development of feedbacks between the IOD and Asian monsoon. We also use coupled Sr/Ca and $^{18}O/^{16}O$ analysis of fossil corals to examine the character of prehistoric eastern IOD upwelling events. During the mid-Holocene, when the Asian monsoon was relatively strong and ENSO was weak, IOD events were characterised by more protracted cooling and droughts in the eastern Indian Ocean [1]. Together, the results suggest that any strengthening of the Asian monsoon in the future will lead to opposing east-west trends in rainfall across the Indian Ocean, with more severe IOD droughts in western Indonesia.

An unanticipated "spin-off" of this work is the finding that skeletal $^{13}C/^{12}C$ in *Porites* corals records vertical crustal deformation during earthquakes, such as the 2004 and 2005 events in Sumatra. Water column light intensity and skeletal $^{13}C/^{12}C$ in symbiotic corals are inextricably linked. Our records show that $^{13}C/^{12}C$ is sensitive to the increase in ambient light intensity when corals rise to shallower water during co-seismic uplift. We now have coral $^{13}C/^{12}C$ time-series showing crustal deformation before, during, and after the 1797, 1907 and 1935 AD earthquakes in Sumatra. With further refinement, the coral "chemo-geodesy" technique could shed light on the recurrence intervals of great submarine earthquakes and tsunamis in island arc subduction zone settings throughout Australasia and the tropical western Pacific region.

[1] Abram *et al.* (2007) *Nature* **445**, 299-302.

Zircon as proxy of magma differentiation and mixing in the Tuscan Magmatic Province (Italy)

D. GAGNEVIN[1]*, J.S. DALY[1], M.J. WHITEHOUSE[2], M. HORSTWOOD[3] AND A. KRONZ[4]

[1]UCD School of Geological Sciences, Dublin, Ireland (*correspondence: damien.gagnevin@ucd.ie)
[2]Swedish Museum of Natural History, Stockholm, Sweden
[3]NERC Isotope Geosciences Laboratory, Keyworth, Nottingham, UK
[4]Georg-August-Universität Göttingen, Germany

The 15-0.2 Ma-old Tuscan Magmatic Province comprises both plutonic and volcanic rocks that were emplaced/erupted in Tuscany and the Northern Tyrrhenian domain during regional extension following the subduction of the Adriatic plate below the Italian Peninsula. This work focuses on the Monte Capanne (MC) pluton (Elba) and the Capraia Volcano (the only volcanic edifice in the Tuscan Archipelago) using U-Pb geochronology, as well as detailed imaging, chemistry and isotopic (Hf) compositions of zircon. The Porto Azzurro (Eastern Elba) and Giglio island (South of Elba) intrusions were also investigated.

Ion microprobe U-Pb zircon ages indicate 3 Ma of magmatic activity, i.e., from c. 8 Ma (MC pluton) to c. 5 Ma (Giglio). Eruption of Capraia Volcano (7.10-7.80 Ma) was essentially coeval with that of the MC pluton (7.04-8.08 Ma). Detailed BSE imaging and quantitative electron microprobe analyses have revealed a variety of textures associated with an extremely large range of trace to minor elements compositions in zircons from the MC pluton, which constrasts with relatively simple textures and zoning patterns from Capraia. Based on both inter- and intra-elemental data, it is suggested that both crystal fractionation and mixing between crustal and mantle-derived melts occurred, and was further complicated by reactions between other accessory phases. Magmatic grains in the MC pluton display a wide range of $\varepsilon Hf(t)$ (-14.95 to -4.25) and two populations are found in almost every component of the pluton, which concurs with the magma mixing model. Other intrusions have a similar, albeit more restricted, range in $\varepsilon Hf(t)$, suggesting a large extent of crust-mantle interaction in the province, with a mantle component (represented by Capraia; $\varepsilon Hf(t)$ = -4 to –7.5) largely modified by subduction-related metasomatic processes.

[1] Dini *et al.* (2004) *Lithos* **78,** 101-118.