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MICROPALAEONTOLOGY NOTEBOOK

The Hawaiian megatsunami of 110 ± 10 ka: the use of microfossils in detection

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INTRODUCTION

McMurtry *et al.* (2004) described a thin (*c.* 20–50 cm) bioclastic, carbonate gravel from the NW coast of Hawaii, on the flanks of the extinct Kohala volcano (Fig. 1). This unit is found between modern altitudes of *c.* 1.5–61 m above sea-level. The deposit is sandwiched between a fossil soil below and a modern soil above in Keawe'ula Bay (Fig. 2). Dating of coral fragments from within the deposit indicate an age of 110 ± 10 ka (McMurtry *et al.*, 2004). Given rates of subsidence on Hawaii, this would place the deposit at an original palaeo-altitude up to 491 m. The deposit contains a range of bioclasts including bivalves, gastropods, corals, bryozoans and foraminifera, largely representing assemblages from a reef flat. The geological setting of the unit, coupled with the evidence from the contained marine fossils, indicate a megatsunami genesis, probably linked to the collapse of the submarine Alika Slide at about 120 ka and with a run-up in excess of 400 m and at least 6 km inland (McMurtry *et al.*, 2004).

FOSSILS PRESERVED IN THE TSUNAMI DEPOSIT

Fossils of the tsunami, and adjacent deposits, have been collected at 14 sites (material is deposited in the collections of the British Geological Survey, registered as MPA51883–51891, 51893–51897). Further information is available in BGS archives (see report IR/02/197R, available through the BGS library at: *http://www.bgs.ac.uk* and *http://geolib.bgs.ac.uk*).

The tsunami deposit on the flank of Kohala volcano contains a range of macrofossil debris and prolific microfauna (Fig. 3). The macrofauna is pummelled to sub-centimetre fragments, indicating a high-energy milieu depositional setting. Microfauna comprise predominantly the benthic foraminifer *Amphistegina lessoni* d'Orbigny, though several other *Amphistegina* morphotypes occur less commonly (Figs 3, 4a). Live *A. lessoni* has a modern coral reef, coral flat and lagoonal distribution around Hawaii (Coulbourn & Resig, 1975) but, because of its robust test, dead specimens are preserved abundantly in Hawaiian beach sands (Fig. 4b). Specimens of *A. lessoni* in the tsunami deposit are coated by carbonate cement (Fig. 4a).

Modern beach sands of Keawe'ula Bay to the west of Kohala volcano, assessed by McMurtry *et al.* (2004), contain large numbers of dead *A. lessoni*, but also a range of smaller foraminifer tests not found in the tsunami deposit (see Fig. 3; Coulbourn & Resig, 1975). The modern beach deposits also contain ostracods (Wilkinson & Williams, 2004), particularly the interstitial-dwelling *Semicytherura challengeri* Wilkinson & Williams, 2004, which are also absent in the tsunami deposit. This suggests that the lighter, less robust elements of Hawaiian shallow-marine fauna (and beach sands) were selectively removed during genesis of the tsunami deposit.

As part of a multidisciplinary study, microfossils and the geological setting have provided critical evidence for the identification of this Hawaiian deposit as the product of a

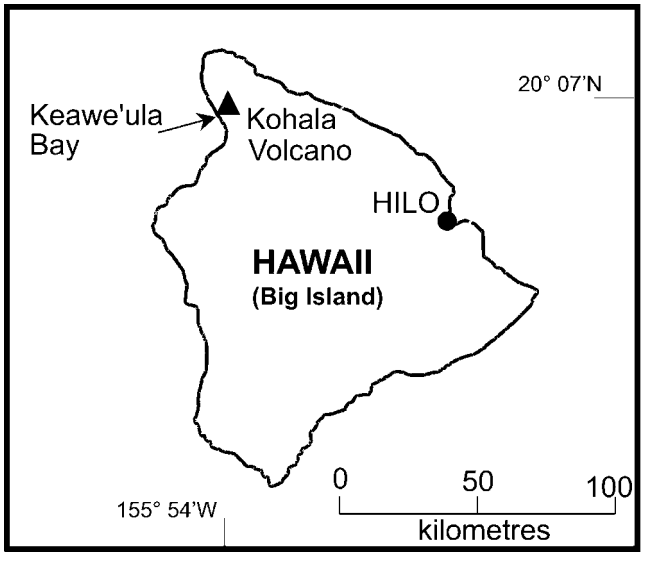

Fig. 1. Outline map of Hawaii showing the position of Keawe'ula Bay.

Fig. 2. Photograph of the fossiliferous marine gravel in Keawe'ula Bay identified in Stearns & Macdonald (1946) (they located it on the north side of Keawanui Bay) and lost to science for over 56 years.

CALCAREOUS MICROFAUNA	Beach Sand	Tsunami deposit
Foraminifera		
Amphistegina lessoni	■	■
Amphistegina lobifera	●	-
Quinqueloculina cf. *curta* (fragment)	+	-
Siphonina sp (fragment)	+	-
Hauerinoides pacifica	○	-
Spirillina inaequalis	○	-
Fissurina sp	+	-
Bolivina limbata	+	-
Peneroplis pertusa	○	-
Rosalina vilardeboana	○	-
Cassidulina sp	+	-
Buliminella sp	○	-
Amphistegina cf. *bicirculata*	-	○
Amphistegina cf. *lobifera*	-	○
?Saccammina sp	-	○
Spirillina sp	-	+
Ostracoda		
Semicytherura sp nov.	■	-
Xestoleberis hawaiiensis	+	-
?Bairdia sp	-	+

Key:

■ Abundant: >20 specimens/sample
● Frequent: 10–19 specimens/sample
○ Rare: 1–9 specimens in some samples
\+ Very rare: few specimens in few samples
\- Absent

Fig. 3. Calcareous microfauna recorded from the tsunami deposit (Unit 2) and those present in recent beach sand (after McMurtry *et al*., 2004).

megatsunami (McMurtry *et al*., 2004). They provide unequivocal evidence of a marine source for the sediments and they also suggest possible taphonomic differences between microfossils preserved in tsunami deposits and those typical of beach sands around Hawaii. In the evaluation of known or putative products of tsunamis, microfossils provide vital evidence elucidating the passage of such events. They should be studied actively in any sedimentological or genetic evaluation of ancient or more recent tsunami deposits.

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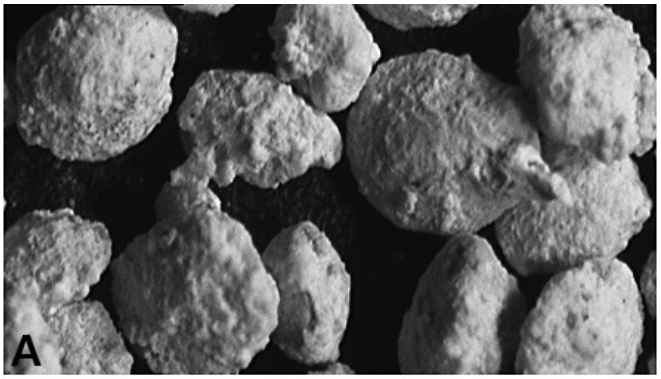

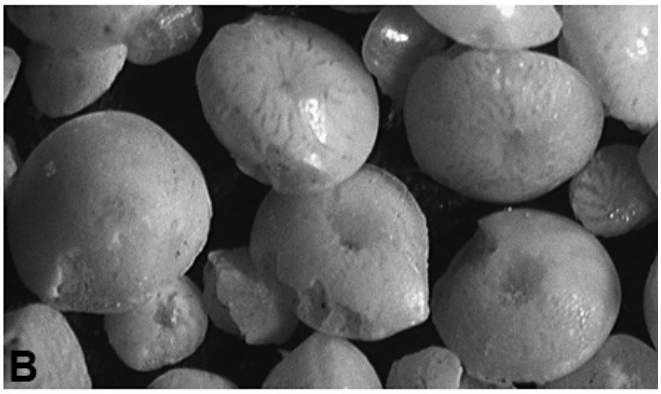

Fig. 4. (**a**) *Amphistegina lessoni* isolated from the tsunami deposit (Unit 2 of McMurtry *et al*., 2004). Most specimens are coated in carbonate cement. Contrast preservation with those specimens from the beach. Scale bar is 1 millimetre; (**b**) *A. lessoni* from a modern Hawaiian beach sand in Keawe'ula Bay.

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