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Geohazards Revealed by Myths in the Pacific: a Study of Islands That Have Disappeared in Solomon Islands

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Abstract

Part of the central Solomon Islands island arc is uncommonly vulnerable to a range of geohazards that are related to the southwards convergence of the Pacific Plate along the North Solomons Trench. Among these hazards is likely to be collapses of the flanks of islands resulting from the steep angles, perhaps triggered by earthquakes. A study of oral traditions in the area, principally on the islands Ulawa, Makira and Maramasike (eastern Malaita), targeted those relating to islands alleged to have disappeared. The most widespread tradition refers to Teonimanu that probably slipped down the sides of the wall of the nearby Cape Johnson Trench. Another tradition refers to the Ta'aluapuala group that may have, by analogy with geophysical observations, sunk in the area off northeast Maramasike. Other traditions may refer mostly to low sand islands washed away by large waves. It is clear that the study of myths has much to contribute to an understanding and assessment of geohazards in parts of the Pacific like Solomon Islands.
Key words: geohazards, island flank collapse, myths, plate convergence, Solomon Islands, tsunami

Introduction

The Pacific Ocean is so large that there is not yet a complete understanding of its geological history and current condition, or of the hazards—past and future—that are associated with this (MENARD 1964, NUNN 1999). There are many types of 'geohazard' in the Pacific, from the volcanic eruptions and large-magnitude earthquakes to tsunami that can be generated by mass movements down steep slopes (including island flanks) and sweep across the ocean threatening every coastline in their paths. As the number of people living along Pacific coasts increases, so it is becoming increasingly important to appreciate the nature of potential geohazards, their causes, magnitude, frequency and probable effects.

In the past twenty years it has become clear that many islands in the Pacific (and elsewhere in the world's oceans) have occasionally experienced large-scale collapses

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of their flanks. The phenomenon has been studied at length in the Hawaiian Islands that rise from the Hawaiian Ridge – one of the steepest-sided structures on Earth. In the 1980s, advances in ocean-floor mapping led to the detection and mapping of a 'prodigious' number of giant landslides on the ridge flanks (MOORE *et al*. 1989, 1994).

O'ahu Island in Hawaii is made up from two coalesced volcanoes–the Koolau Volcano in the east and the Waianae Volcano in the west. These volcanoes are incompletely preserved. The eastern side of the Koolau Volcano and the western side of the Waianae Volcano are both missing, removed by giant landslides whose occurrence today is clear from their headwalls–called in Hawaiian '*pali*' –that dominate the island's landscape. The eastern part of the Koolau Volcano slipped away just over two million years ago during the Nuuanu Slide that involved the movement of about 5000 km^3 of material. The movement was so fast– perhaps 80 m/sec at the base of the headwall– that large rocks carried downslope in the slide were then moved about 350 m up the slope on the other side of the undersea moat that surrounds this part of the Hawaiian Ridge. The Nuuanu Slide produced waves 50-60 m high that washed across some of the islands in the area and a long-range tsunami that may have been 20 m high when it ran up on the continental rim of North America, slightly less when it reached Japan (WARD 2001).

For a time it was thought that the Hawaiian Ridge–owing to its steep sides–might be exceptional within the Pacific but this is not the case. The islands of the Marquesas in northern French Polynesia are a group of high volcanic islands whose sides are so steep that coral reefs have never succeeded in growing around them (BROUSSE *et al*. 1978). Most islands in the Marquesas are incomplete: huge arcuate cliffs marking the places where collapses of their flanks have occurred. On the surrounding ocean floor is a massive 'apron' of sediment derived from the islands during repeated collapses. One calculation showed that the volume of material in the apron is 240,000 km^3 while the volume of the volcanoes (from 4 kilometres depth) is just 50,000 km^3. It is clear that, over time, far more of these islands has been removed by flank collapse than exists of them at present (WOLFE *et al*. 1994).

While many of the largest collapses on the flanks of Pacific oceanic islands occurred long before humans had a significant presence in the Pacific, collapses with catastrophic consequences have occurred within historical times. For example, the island volcano named Oshima-Oshima about 50 km southwest of Hokkaido does not erupt often and is generally viewed as a comparatively low risk. Yet during its eruption on 29^{th} August 1791, part of the island (0.2 km^3) collapsed and a 15-metre high tsunami was produced that killed 2000 people on adjacent coasts. Geologists have long doubted that a collapse of this size could have produced such a large tsunami, a view confirmed by recent mapping of the ocean floor surrounding Oshima-Oshima that showed that the 1791 eruption was also accompanied by a collapse of the island's underwater flanks, involving the slip of 2.4 km^3 of material (SATAKE and KATO 2001).

This emphasises the point that not all island collapses involve the emergent parts of an island; some may be confined to its underwater parts but these can still produce large tsunami. Likewise it is possible that the flank collapse of an island could remove its entire emergent part, resulting in the 'island' completely disappearing. The 1888 eruption of Ritter Island in Papua New Guinea involved a flank collapse of the island that removed about 98% of it, almost causing it to disappear (JOHNSON 1987). In the same area, myths suggest that Yomba Island disappeared for a similar reason about AD 750-850 (MENNIS 1981).

Like much of the lead author's recent work with Pacific Island myths (NUNN 2001, 2003, 2004, NUNN and PASTORIZO 2006), this paper presents some myths concerning islands in the central part of Solomon Islands that are alleged to have disappeared within the past few hundred years. The stories are critically analysed from a geohazard viewpoint, and it is concluded that islands in this area have indeed disappeared - and are liable to do so again. As such, they pose significant threats to the area's inhabitants and those farther afield who may be affected by associated tsunami.

The study area

Most of the islands in Solomon Islands are geologically part of the Solomons Arc and are elongated in a WNW-ESE direction parallel to ocean trenches to both the north and the south. The Solomons Arc developed as part of the Vitiaz Arc, produced by southwards subduction[1] of the Pacific Plate beneath the Indo-Australian Plate several tens of millions of years ago. This process came to an end about 15 million years ago when the Ontong Java Plateau (OJP), an uncommonly thick piece of ocean floor, reached the trench but proved impossible to subduct. The OJP blocked the trench, causing plate convergence to slow considerably, and eventually leading to the development of a new trench along the southern side of the Arc. It is along this trench that most of the convergence in this area is being accommodated at present (MANN and TAIRA 2004).

The area with which this paper is concerned adjoins the eastern part of the North Solomons Trench north of the island of Malaita. Convergence between the Pacific Plate (to the north) and the northern part of the Solomons Arc (in the south) has been occurring throughout the area for the past 15 million years. As efforts have been made to subduct the OJP, much of its surface has been scraped off to form the Malaita Accre-

[1]Subduction involves one plate being thrust downwards into the Earth beneath another plate. The downthrust plate is eventually melted and thereby destroyed.

tionary Prism (MAP), of which the islands Malaita and Ulawa in the study area are formed. Yet the most widespread manifestation of plate convergence along the North Solomons Trench is the uplift of the land. In the north of Choiseul Island, for example, there are staircases of emerged coral reefs extending to 800 m above sea level, evidence for a long history of uplift here.

Most of the islands within the study area (Fig. 1) are part of the MAP and are intensely folded and faulted. The southern end of the MAP lies north of Makira Island (formerly San Cristobal), which is a volcanic island more typical of those found along island arcs in the western Pacific. While the dominant tectonic process in the area seems to be uplift of the land, the system of faults, particularly the normal faults that run parallel to the axis of the North Solomons Trench, also produces steep slopes. The amount of detritus accumulated on, but especially around the bottoms of these slopes, shows that they are indeed steep enough for mass movements to have occurred. Several geophysical surveys in the area have shown submerged islands and large-magnitude landslides (PHINNEY *et al*. 2004).

The southeastern part of the MAP, where the study area is located, is known as the Ulawa structural domain and it was selected for study because there were a number of stories about islands that had disappeared known from the oral traditions of their inhabitants.

Oral traditions and the field surveys in 2002-2005

People throughout the study area (and beyond it) know the story of an island named Teonimanu (or Teo) that disappeared a long time ago. Numerous tribal groups claim descent from the survivors of the disappearance of Teonimanu. The earliest-known written account of this story was made in 1925 and reported that the survivors of the island's 'sinking' had 'escaped' to Makira, Ulawa, and the southern part of Maramasike (the name for the smaller, eastern part of Malaita Island). The island, it was said, sank because of 'sorcery' (FOX 1925). Before the present study began, the only other written report found about Teonimanu was part of a collection of oral traditions from Santa Ana Island, off the eastern end of Makira, where the Pagewa clan claimed descent from the sunken island's inhabitants. These traditions, it was reported, claimed that Teonimanu had sunk because of a 'natural disaster' and had been located at Lark Shoal, a shallow-water reef knoll between Ulawa and Olu Malau (MEAD 1973).

Field surveys in 2002-2005 were undertaken to obtain more information about Teonimanu and any other islands that might have 'disappeared' in this area. The surveys were overseen by Nunn and Geraghty, with Heorake targeting Ulawa Island, Tegu, Oloni and Usuramo targeting Maramasike, and Simeon and Wini targeting Makira and the smaller islands off its eastern end. Using appropriate cultural proto-

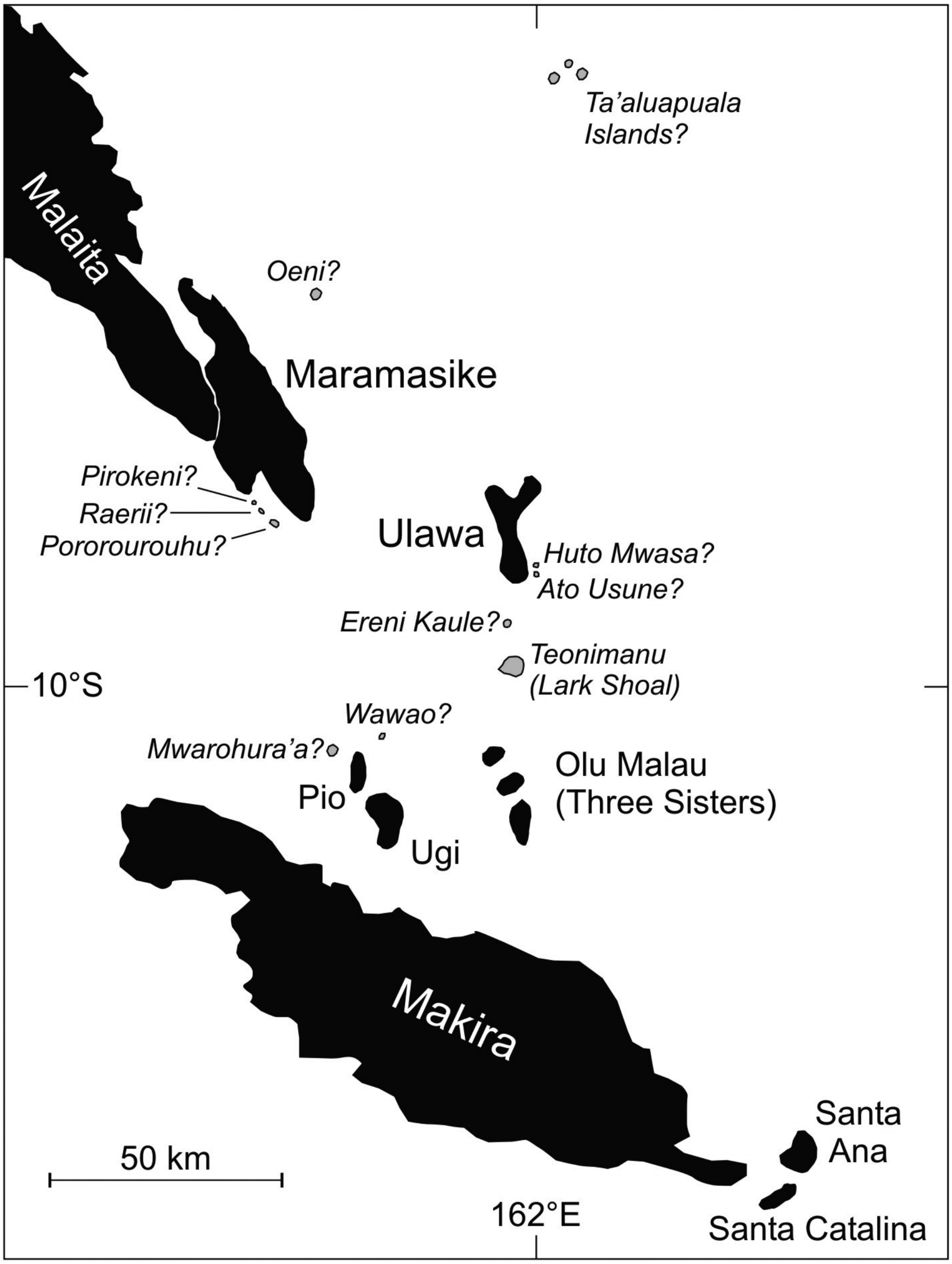

Fig. 1. Part of the central Solomon Islands showing the locations of islands (shaded black) where oral traditions were collected about islands alleged to have disappeared (island names in italics) and the likeliest locations of these (shaded light grey).

cols and vernacular languages, these surveys targeted the older people in a particular community who were known to be familiar with its oral traditions. The informants all gave the information voluntarily on the understanding that it might one day be published. The names of informants are listed in the acknowledgements below.

Results

Information was obtained about three groups of islands alleged to have disappeared in this part of Solomon Islands−Teonimanu and nearby islands, the Pororourouhu group, and Oeni and the Ta'aluapuala group (see Fig. 1). A description of each is given separately below.

Teonimanu and nearby islands

Most of the communities in this part of Solomon Islands are familiar with the story of Teonimanu (also known as Teo, or Maro'rouhu in southern Maramasike, or Hanua Asi [*homeland in the sea*] on Ulawa), said to have been destroyed often with five other islands during a series of eight tsunami. We can be specific about this cause as the word for 'tsunami' in Ulawan is *luelue* and is not applied to any other type of large wave. The people who inhabited Teonimanu were known as industrious, they were renowned sailors.

After the tsunami hit the island, the people left alive paddled their canoes or clung to anything that floated to try and reach nearby islands. Some reached the north coast of Makira where, expecting conflict, they fled to the mountains but were later looked after by local people, then moving southeast and eventually settling on the smaller offshore islands of Santa Catalina and Santa Ana. Other survivors reached the south coast of Maramasike, establishing the village named Oroha (that means *swimming across*).

The story of why and how Teonimanu disappeared is preserved in a myth that is known in a similar form throughout the study area. It begins with a man named Rapuanate, living on Ali'ite Island (the northernmost in the Olu Malau group) who took a woman from Teonimanu to be one of his wives. Later, when Rapuanate was elsewhere, the woman's brother took her back to Teonimanu. After having tried many ways of getting her back, Rapuanate resorted to witchcraft, paying 'an old custom lady' from Dai Island, off the north coast of Malaita, to call the sea to sink Teonimanu. She gave Rapuanate three taro plants. He was to plant two on Teonimanu and was to keep one; when it began to sprout new leaves, that was the sign that Teonimanu was about to sink.

Rapuanate did what he was told, and when new leaves appeared on the taro plant he had kept, Teonimanu became 'salty' as seawater rose up slowly around it. As the sea rose further, some people left the island which was finally destroyed as waves crashed into it. Anticipating disaster, some people had already made rafts on which to flee the island but others clung to coconut or banana trees that were washed off the island by the waves.

A number of other islands have disappeared in this area. Some may have done when during the events that saw the end of Teonimanu—oral traditions do not agree. These other islands are Ereni Kaule, Ato Usune and Huto Mwasa off the coasts of Ulawa, and Mwarohura'a and Wawao slightly farther west (see Fig.1). Some accounts we collected mention that Teonimanu was actually two islands, Teonimanu itself and smaller Teoniramarama. Only a few informants gave the time when Teonimanu disappeared. The consensus seems to be that the island existed when Mendana was in Solomon Islands in 1568 but had disappeared about 200 years later when James Cook was in neighbouring Vanuatu.

The Pororourouhu group

Off the south coast of Maramasike between Cape Hartig and Cape Zele'e, a group of three low islands—Pororourouhu, Raerii and Pirokeni—is once said to have existed. The myth that is common among the communities on Maramasike is that the largest island, Pororourouhu, was settled by a man named Roraimanu Paina and his family after he had fought with his two brothers on the Olu Malau islands. Although Roraimanu Paina was a peaceful person, he continued to anger his brothers who one day summoned sharks to drive 'tidal waves' across the islands of the Pororourouhu group, which were destroyed.

Today the reef platforms on which these islands once existed is visible, as was a 'forest' of coconut tree trunks until it was washed away during Cyclone Namu in 1986. Probably these islands disappeared in the last 50 years, one account stating that survivors also joined the Oroha community in southern Maramasike.

Oeni and the Ta'aluapuala group

These islands existed off the northeast coast of Maramasike in the direction of the North Solomons Trench. One of the most remote island groups in Solomon Islands—Sikaiana—lies 212 km off this coast but it is not thought that it has been confused with either Oeni or the Ta'aluapuala group.

Oeni was located within a 'few' kilometres of the coast of northeast Maramasike and was reportedly a low island. When it sank, and there are no available details about why or how this happened, the survivors swam to Manieli Village on the adjacent mainland where they were given land on which to settle.

The Ta'aluapuala group was located much farther offshore, probably 20-40 km, and the people who surviving the islands' sinking were able to swim to the coast of

Maramasike only with the aid of their shark god. There had been as many as 400 people living on the three islands in the Ta'aluapuala group, the location of which is today marked by a submerged reef some 10 m below the ocean surface.

Interpretation

Most of the disappeared islands referred to in oral accounts from this area of Solomon Islands are said to have been low islands. They were probably sand cays or *motu*[2], comparatively easily washed off their underlying reef surfaces by large waves. This is something that could happen with any large wave, either a tsunami or a storm surge created during a typhoon (tropical cyclone). While wave erosion may have been responsible for causing some of these islands to disappear, there are three reasons for doubting that this is the only explanation for the disappearance of all the islands named.

First, the reef platforms that mark the places where islands disappeared are today all quite deep—typically around 10 m below the ocean surface. This implies that sinking (subsidence) may have played a role in island disappearance.

Second, it is unlikely that the islands were sand cays: basically piles of unconsolidated sand and gravel thrown up on a reef platform by a large wave. It is unlikely because, throughout the history of the Pacific Islands, people have recognised the innate vulnerability of such islands and would not have settled them in large numbers or on a permanent basis, as would appear to be the case with most of the islands described above. It is more likely that the islands, if low, were *motu* but possibly many of the islands were higher bedrock islands. In particular, Teonimanu and the three islands to the north—Ereni Kaule, Ato Usune and Huto Mwasa—are all likely to have been bedrock islands because of their proximity to mountainous Ulawa. As bedrock islands, they could not have disappeared simply by wave impact; a component of subsidence (including flank collapse) would also be needed.

Third, the alternate building and removal (through erosion) of low sand islands occurs regularly in the Pacific as a result of both storm surges and tsunami impacts. It seems unlikely that the story of Teonimanu, because it is so well-known and because so many tribes claim descent from the people who lived there, refers to such a common event. Yet the disappearances of islands like Oeni and those in the Pororourouhu group, because they appear less widely known and because the details (such as the settlement of Oroha) may have become confused with older traditions, may in fact refer to such a more common event.

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[2] Motu are sand cays that have developed armouring, perhaps of beachrock or phosphate rock, that protect their shorelines from wave erosion (Nunn 1994). Most inhabited atoll islands in the Pacific are motu.

It is considered likely that subsidence associated with the collapse of island flanks may have been a factor in the disappearance of Teonimanu (and nearby islands) and the Ta'aluapuala group. Both islands were home to large numbers of people suggesting that they had existed for a comparatively long time and had successfully withstood the effects of tsunami and storm surges.

Geohazard implications

The people of this part of Solomon Islands—like those inhabiting most islands close to convergent plate boundaries throughout the western Pacific—have considerable experience of a range of geohazards, including earthquakes that can produce localised uplift or subsidence, or can generate tsunami. The Ulawa structural domain (Fig. 2A) that covers most of the study area is that part of the MAP under which the OJP dips most steeply (as much as 7°) and where the associated ocean trench is deepest (as much as 5700 m). These two factors make the area uncommonly unstable, something exemplified in recent historical times by the rapid uplift of 1 m during an earthquake in 1930 at Rohinari in southwest Malaita (GROVER 1960).

The area off northeast Maramasike, where Oeni and the Ta'aluapuala group are located, is the underwater section of the MAP. In seismic sections across it, a number of submerged islands are visible, most with their surfaces hundreds of metres below the ocean surface (seismic line 9 in Fig. 2B). The presence of these submerged islands suggests that the process of island sinking has probably been going on for several million years. In the same section, steep fault scarps were mapped, many with large debris aprons that also testify to a long history of flank collapse (PHINNEY *et al*. 1999, 2004).

Teonimanu, marked today by Lark Shoal, is part of a ridge stretching through Ulawa Island and the islands of the Olu Malau group. The eastern flank of this ridge dips steeply to depths of more than 5000 m where the Cape Johnson Trench lies. While there is no information about any islands that may have slipped downslope in pre-human times here, it is certainly likely—on account of the steepness of these slopes and the presence of an active convergent plate boundary (marked by the Cape Johnson Trench)—that they have done so (seismic line 3b in Fig. 2B). In this case, the subsidence of Teonimanu that led to the disappearance of the island can be seen as one incident in a series that occur along the eastern margin of this ridge. Another such incident may have led to the development of the arcuate scarp (landslide headwall?) that dominates the eastern side of Ulawa Island, and may have been associated with the disappearance of Huto Mwasa and Ato Usune islands (see Fig.1).

While the flank collapse (perhaps involving the disappearance) of islands in this area is itself a notable hazard, the waves that would be generated by such collapses are

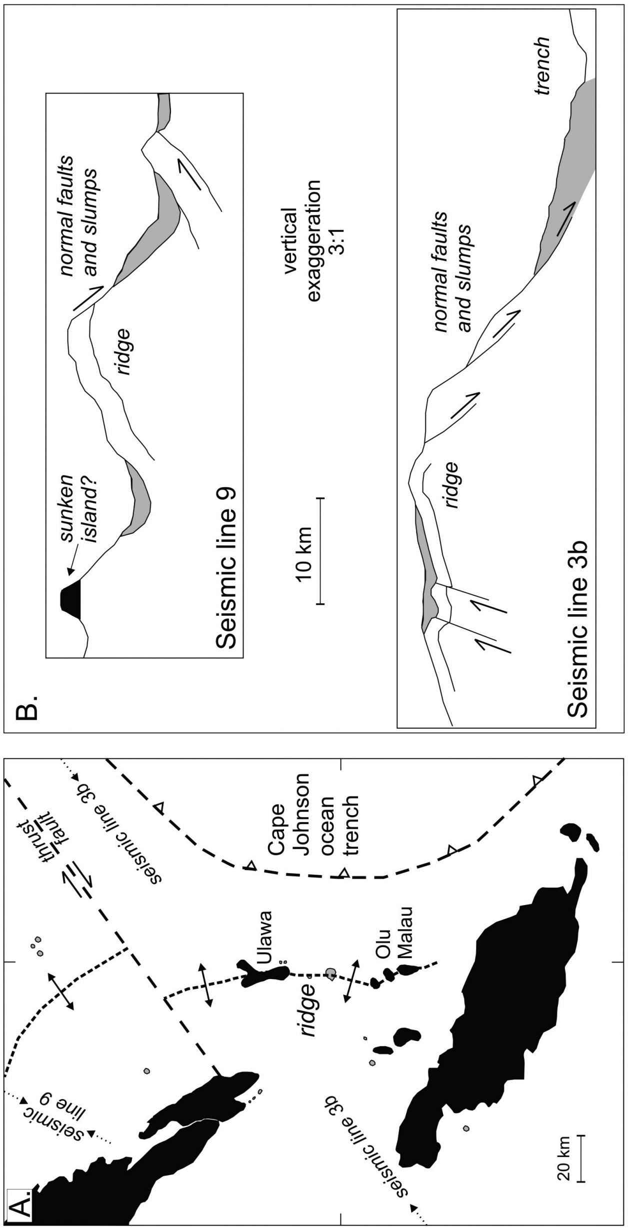

Fig. 2. (A) Outline of the geology of the area in Fig.1 (after PHINNEY *et al*. 2004, TAIRA *et al*. 2004). Note the presence of the Ulawa-Teonimanu-Olu Malau ridge, the eastern flank of which dips steeply down to the Cape Johnson ocean trench.

(B) Simplified interpretations of part of the two seismic lines (locations shown in A) run during the 1995 cruise of RV *Maurice Ewing*, after PHINNEY *et al*. (2004). Note in seismic line 9, the presence of a sunken island (?) within 10 kilometres of the northeast coast of Malaita, and also the evidence of a long history of slumping along the northeast side of the ridge farther north. Seismic line 3b crosses the ridge north from Ulawa; note the evidence for slumping along its eastern flanks.

hazardous across much wider areas. Modelling of past collapses would give a better idea of which areas might be affected by waves from some future collapse. This area would also benefit from more detailed work on geohazards, particularly to identify areas liable to collapse in the future.

Conclusions

This paper has taken a novel approach to determining and understanding a particular group of geohazards. Using oral tales about islands that disappeared, it has been possible to identify the likely causes of such incidents, the influence of which could be felt across the Pacific. Of course not all island flank collapses cause islands to completely disappear, but partial disappearances–especially at times when there were few people living on these islands–may not have given rise to such enduring myths.

The use of myths to aid the understanding of both the nature and the geography of geohazards is not new, but should become more common. Recently the lead author and his co-workers have undertaken studies of such 'vanished islands' in Vanuatu and Fiji (NUNN *et al*. 2006, 2007) that show many similarities to the examples discussed here; a forthcoming review paper, to be published in a Special Volume of the Geological Society of London on 'Myth and Geology', targets the 'vanished island myth' motif in Pacific Island oral traditions (NUNN and PASTORIZO 2007). This seems to be a fruitful area of future co-operative research for anthropologists, geohazard planners, and geophysicists.

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