TSUNAMI BOOK GIVES A BETTER UNDERSTANDING OF ANCIENT FLOODS ON MARS

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ABSTRACT

During 2001 Dr Edward Bryant from the University of Wollongong published a book "Tsunami: The Underrated Hazard". He proposes that the best explanation for a range of odd geological features along the south east coast of Australia is that at least one large tsunami struck the coastline around 1500 AD. The book describes these geological features and the mechanisms by which they can be produced by tsunami. The book also covers historical accounts around the world, the physics of tsunami, causes of tsunami and a review of the risk to coastal populations.

After reading the book I was keen to visit Wollongong (just two hours drive south of Sydney) and see the evidence myself. By a fortunate coincidence Dr Vic Baker from the University of Arizona was visiting Wolongong at the time. Dr Baker studies evidence of mega-floods on Mars and related features on Earth, such as the Washington Scablands. Early in 2002 I joined Dr Bryant and Dr Baker on a tour of the coast. This informal report describes that fascinating experience.

INTRODUCTION

This article was originally planned as a review of the book "Tsunami: The Underrated Hazard" by Edward Bryant (Cambridge University Press, 2001) [1]. However, a review by Japanese tsunami expert Kenji Satake appeared in the journal Nature [2] so I decided, instead, to describe my own investigations to verify some of the phenomena that are described in the book.

Ted Bryant is an Associate Professor at the University of Wollongong, on the south east Australian coast. He is a geoscientist with an interest in geomorphology. Bryant had studied the coastal features of the area since the late 1960s. Some things did not add up. He remembers the day in 1989 when he was examining fresh boulders jammed into a crevice in a cliff well above the height of any possible storm waves. After eliminating all other explanations he and his colleague, Bob Young, "were left with the preposterous hypothesis that one or two tsunami waves had impinged upon the coast". Bryant began to gather other evidence of these mega-tsunami, including the overwashing of a headland 130m high.

Many researchers were (and some remain) sceptical about Bryant's claims. They picked on isolated items of evidence and provided alternative explanations for the unusual features. It seems, however, that none of the critics have actually visited the dozens of interesting sites and considered the convergence of evidence which leads to the conclusion that mega-tsunami have struck the south east Australian coast in recent times.

Eventually Bryant decided to set out his research in a book. As well as describing the mechanisms of alteration of coastal landforms he comprehensively covers a wide range of topics concerning tsunami: historical accounts around the world, the physics of tsunami, causes of tsunami and a review of the risk to coastal populations.

Sakate's review in Nature is mostly complimentary but cautions that "the quality and depth varies greatly from chapter to chapter" and that "parts of the book lack vigour and consistency". I do not have the knowledge to make such judgements but I found the book fascinating and it certainly triggered my curiosity. The description of bedrock scouring, in which large chunks of rocky headland are torn away in a matter of minutes was amazing. Sakate commented that "a modern example of bedrock scouring would also have made Bryant's arguments more convincing". I had the same thoughts, and set out to investigate this phenomenon.

SOURCES OF INFORMATION

An internet search led me to an unlikely source - the Creation Research Society. It seems that members of this Society are keen to demonstrate that modern eroded landscapes, such as the Grand Canyon, could have been formed in a few thousand years. Fortuitously they have gathered together recent examples of bedrock scouring by catastrophic floods. A paper by Dr Glen Wolfrom [3] describes sudden erosional effects at three locations. Wolfrom reports that water from a spillway "acted like a chisel, a drill, a grinder and a thousand bulldozers all in one". Pictures illustrate where huge chunks of bedrock are missing from the streambed below dam spillways.

Another potential source that arose from an internet search was research on Martian geology. I have a long-standing amateur interest in Mars so this source caught my attention. The Viking spacecraft that orbited Mars in the early 1970s took pictures of Martian channels that had signs of catastrophic flooding. Dr Mary Bourke from Oxford University in the UK has studied the geomorphology of ancient floods in Central Australia as an analogue for those features on Mars. In one paper she

describes erosion of bedrock including "scour holes generated by macroturbulent vortices" - evidently a similar process to that which generated the whirlpool features at Bass Point [4].

Dr Vic Baker from the University of Arizona also studies the Martian features and has compared them with the strange landforms of the Washington Scablands in the USA [5]. I contacted Dr Baker by email and, to my surprise, he told me he would be visiting Ted Bryant in Wollongong the following week.

A quick call to Dr Bryant confirmed that I could tag along while Dr Baker was shown the tsunami signatures of the area. Fierce rainstorms and dense fog on the two hour drive from Sydney to Wollongong could not deter me from joining the tour.

Now if you intend to visit Wollongong yourself and want to experience that moment of realisation that a mega-tsunami is the only logical explanation for the coastal landforms then I suggest you read no further because I am about to reveal some of Ted Bryant's tantalising evidence.

GEOLOGICAL SIGNATURES OF TSUNAMI NEAR WOLLONGONG

The northern side of Bass Point is covered by a thick, jumbled layer of sand, crushed shells, pebbles and boulders - clearly subjected to severe mechanical action. Bryant's explanation is that they have been dumped there when a mega-tsunami swept over the opposite side of the headland, from the south east. We then crossed to the rugged, exposed south east face of the headland. Here, carved into the rock, are two giant donut-shaped whirlpool features some 50 metres across. One is complete and has a central plug (Figure 1). The other is about three-quarters complete and looks as if it was being quarried when work suddenly ceased (Figure 2). Bryant's explanation is that when the tsunami overwashed the headland giant whirlpools were formed. The outer edges of the whirlpool started to form secondary vortices ("kolks") that were highly erosional and tore out chunks of bedrock in a circular path. For the second whirlpool feature the tsunami finished before the full circle could be completed.

This mechanism is still regarded as speculative by Sakate. I was unable to find a modern example of such an action (that is, where before and after pictures of the changes to bedrock are available). There are however, several other examples of these erosional whirlpools in the Wollongong area. They do not appear to be associated with any localised weakness in the rock. They are similar in topography and aspect - suggesting they were conducive to the formation of vortices during overwashing by a mega-tsunami.

I tend to think of the whirlpool mechanism as being similar to a rock-face tunnelling machine that has a large rotating head with smaller rotating bits on the circumference. However, the hydraulic forces generated by water flowing in excess of 20m/s at depths of, perhaps, tens of metres are much more efficient at excavating rock than these machines.

Bryant then showed us the clinching evidence. We clambered over the rock formations to a valley that had a group of boulders at one end. The boulders were imbricated (stacked like a pile of fallen dominoes). He explained that the boulders had been carried from the seaward side of a ridge that was more than six metres above sea level. He pointed out that one of the boulders had oyster shells attached - it had been scooped up from the shoreline by a tsunami, carried over the top of the ridge and dumped against the other boulders (Figures 3 and 4). The shells had been dated to 1500AD, just 270 years before Captain Cook sailed up the east coast of Australia!

After Bass Point we travelled to several spots along the south coast to see other examples of strange erosion, imbricated boulders and huge sand deposits in odd places. Mega-tsunami are the simplest, most logical explanation for this wide range of features.

POSSIBLE CAUSES OF THE MEGA-TSUNAMI

What could have caused the mega-tsunami that struck the south east coast of Australia five hundred years ago?

Bryant's book describes the four causes of tsunami: earthquakes, undersea landslides, volcanic eruptions/explosions and cosmic (asteroid or comet) impacts with the ocean. Of these cosmic impacts and giant landslides are the most likely causes of mega-tsunami.

Landslides are a possible cause of the Australian mega-tsunami. The shallow continental shelf extends tens of kilometres from the coast then drops off steeply to depths of 4 kilometres in some places. Major rivers such as the Shoalhaven and Hawkesbury deliver sediment to the edge of the shelf and this might periodically tumble down the continental slope. Apparently a thorough survey of the continental slope that might pick up signs of past landslides only recently got underway.

Bryant refers to the work of Ward and Asphaug [6] when considering the possibility that cosmic impacts might have caused mega-tsunami. Their work suggest that for Sydney the average interval between 10m+ tsunami caused by cosmic impacts is about 80,000 years (based on Bryant Figure 9.10). My own investigations of tsunami from cosmic impacts led to a paper in the Science of Tsunami Hazards [7]. In that paper I pointed out major differences between researchers in the estimates of long range wave heights from impact-generated tsunami. Using the more conservative estimates of Crawford and Mader [8] I estimate that, for Sydney, the average interval between 10m+ tsunami from cosmic impacts is about 1 million years.

Even the most pessimistic frequency derived from the work of Ward and Asphaug would not account for frequency of large tsunami established by Bryant - perhaps every 500 years. There remains, however, the possibility of an unusual series of impacts such as a barrage from the breakup of a comet. There are signs of such an event occurring several thousand years ago [9] but it does seem unlikely that "frequent" ocean impacts large enough to devastate the coast of Australia were not accompanied by similar large impacts in the northern hemisphere, including some that would have left impact craters on land.

On the other hand the last major Australian tsunami event, that evidently occurred around 1500AD, has some historical coincidences. The largest recorded death toll from a meteorite fall occurred in China in 1490AD - more than ten thousand died in the city of Ch'ing-yang Shansi [10]. There is also evidence of impact generated fires and tsunami in New Zealand at this time (Bryant's book).

Finally there is speculation about the enigmatic Balls Pyramid rock outcrop near Lord Howe Island, between Australia and New Zealand. It is a stunning sight in the middle of the ocean and looks to me like a giant stone tool that has had shards flaked off to give a ragged edge (Figure 5). The odd thing is that the vane-like island is aligned in the same direction as the mega-tsunami that hit Bass Point and possibly the South Island of New Zealand. In discussions during our tour, Bryant pointed out that a tsunami tens of metres high could cause the strange features observed on Balls Pyramid.

My recommendation is that people living near the coast read Bryant's book and go out looking for some of the tsunami signatures that he describes. You may discover unsettling evidence that our populated coastlines are surprisingly vulnerable to these giant waves.

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An interactive map of the New South Wales tsunami features, with many new photographs, is now available at: http://www.uow.edu.au/science/geosciences/research/tsunami/tsunami_nsw.htm

Picture credits: All pictures by Michael Paine. Email for copies: mpaine@tpgi.com.au

Figure 1. Complete Whirlpool Formation at Bass Point

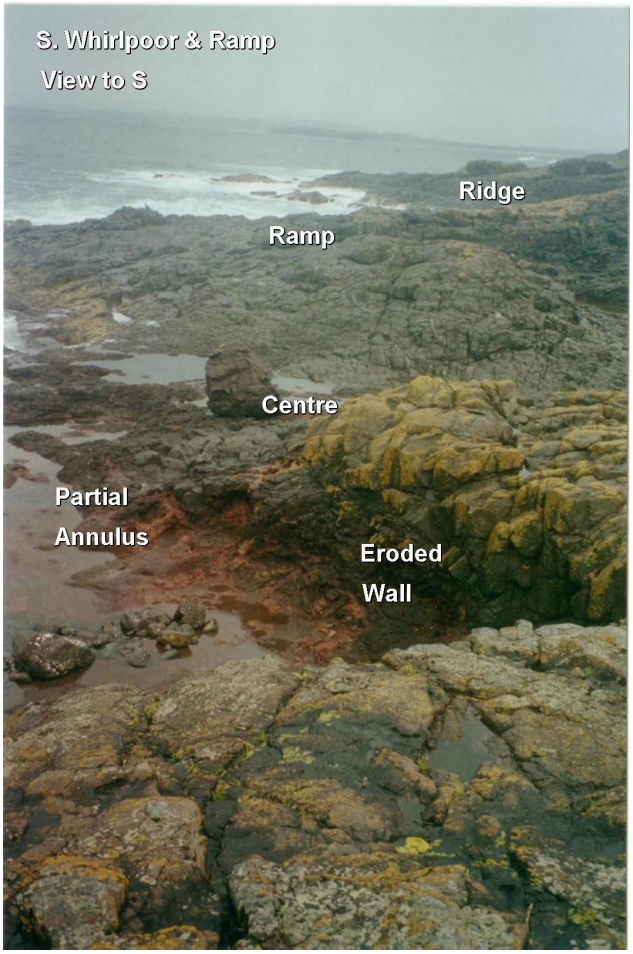

Figure 2. Incomplete whirlpool and the ramp that faces the direction of approach of the tsunami.

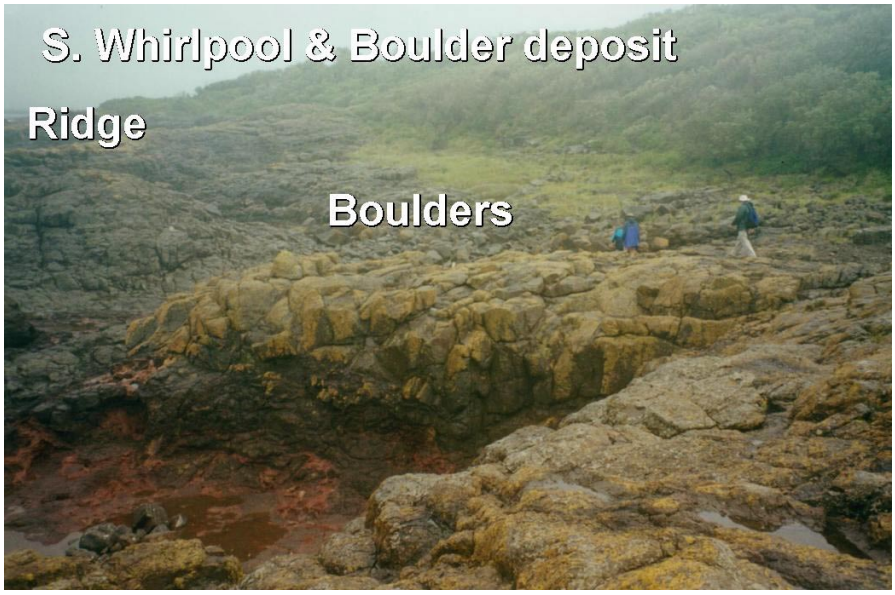

Figure 3. View of valley behind ridge (a wall of the incomplete whirlpool is in the foreground)

Figure 4. Vic Baker, Ted Bryant and Gerald Nanson (left to right) examine the boulder with oyster shells. The boulder has been carried over the ridge by a tsunami.

Figure 5. Balls Pyramid near Lord Howe Island in the Tasman Sea. The ragged ridgeline and scalloped surfaces are difficult to explain by conventional geological processes. It is speculated that a mega-tsunami could tear away pieces of rock to produce this type of formation. Interestingly the vane-shaped island is aligned towards the south east - the same direction as the mega-tsunami that apparently struck Bass Point in 1500AD.